## 5.7 Mounting and dismounting of rolling bearing

The quality of rolling bearing mounting and dismounting will directly impact bearing precision, life and capability, so, bearing mounting and dismounting will strictly accord to rule, and take right means and tools.

### 5.7.1 The preparation for bearing mounting.

1) Be familiar with mounting drawing and technical file, and sure mounting technical and tools. By analysis of drawing and technical file , to determine bearing characteristic and requirement ,draw out mounting scheme 、plan、program and tools. When there is special request of bearing mounting, choose the best mounting technique to guarantee mounting quality.

2) Checking bearing type. Check bearing casing type if the same with mounting drawing before mounting.

For special require bearing, example: high temperature bearing, no basic clearance bearing and no basic class bearing, but it is the same with general bearing of package, so that need to seriously check or to separate storage.

3) Cleaning bearing. Bearing should be installed in a dry, clear environment. Mounting should be away from machining metalworking or other machines producing forge and dust.

The bearings need to be left in their original packages until immediately before mounting so that they will not be exposed to any contaminants, especially dirt.

Using gasoline or kerosene to clean anti-rust's bearings, but to anti-rust bearing with anti-rust grease or thick oil, first hot dissolve clean with 950C-1000C light mineral oil. After anti-rust grease melted, then use gasoline or kerosene to clean.

When cleaning a few bearings, it is immediate put into oil sink. When cleaning lots of small and medium bearings, it is put into wire netting and by sway immerge oil sink. When cleaning lots of large size bearing, the best method using cleaning machine.

4) Expect cleaning the bearings, careful check coordinate with face if have burr, pocking and sundries of shaft radial, lining, end closure and separate ring, and must be clean with gasoline or kerosene, to prevent sundries to enter the bearings.

5) Measuring and matching bearings and its parts. The match precision must be kept strictly between the bearing and shaft ring & interrelated parts. When mass produced, the match precision is guarantee by the parts process precision.

In the important occasion, such as the bearings of steel rolling machine, railway locomotive, high speed diesel engine, accuracy numerical control machine and so on, it must overall check strictly with the kinds of parts technical requirement of drawing before mounting.

For whirl accuracy requirement high shaft , example accuracy machine tool principal axis, so as to increase whirl accuracy of principal axis parts, except choose high accuracy bearing , increase principal axis and prop up hole accuracy, reasonable choose bearing, may matching bearing.

Measuring roll bearing inner ring and shaft radial before mounting, and make sign at the most highest, then grouping with practical pulse, to take the similar pulse mounting , they are contrary with the high point ,and increase whirl accuracy.

### 5.7.2 Roll bearing mounting method

Roll bearing mounting method is very more, there is several methods for general use,①using hand hammer and sleeve ②using pressure③using temperature difference④the oil injection method

#### 5.7.2.1 Mounting bearing with a cylindrical bore

**1) Using pressure**

The method is simply in using tools and operating, basis bearing measure 、fit quality and mounting's place, It can take bearing mounted in shaft and shell with using hand hammer and sleeve or pressure fitting.



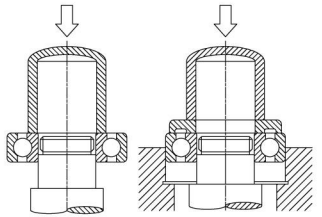


**2) Mounting bearing using pressure method and notation proceeding:**

1、To ensure mounting pressure and bearing fit piece, Figure 6-14 .It is not allowed to be harmful to the bearing's other part of mounting and dismounting force caused damage and deformation.

2、Axial pressure can not be imposed on the bearing rings，But through the soft metal sleeve or pad to impose average on the lap, Preventing ring unilateral force to tilt, mounting process cause damage and clip death.

3、Must be based bearing's structure、size、accuracy, character and location of the installation of an integrated to consider bearing mounting methods and used tools.



(a) Mounting with inner ring pressed

(b) Mounting with both inner ring and outer ring pressed

4、Bearing pre-installed should be carefully cleaned ,after using bearing some times and with some lubricant between the trickle-down to reduce the pressure of dismounting.

5、with separable cylindrical roller bearing、taper roller bearing、thrust ball bearing ,the outer ring and inner ring can installing the shaft, make sure misalignment.

#### 5.7.2.2 Mounting and adjustment bearing with a tapered bore

For bearing having a tapered bore, the degree of interference is not determined by the chosen shaft tolerance, as with bearing having a cylindrical bore, but by how far the bearing is driven up onto the tapered shaft seating, or onto the adapter or withdrawal sleeve. General there is three methods of this bearing fit.

**1、Mounting taper bore bearing measure fit method**

1) Controlling the reduction in radial internal clearance .The bearing internal clearance because the process due to the expansion of the inner ring.

2) Directly control the axial movement. Figure 5-10, the bearing was pushed into the cone shaft .Measuring inner ring side and axial drive-up A. According to the request to push the bearing with appropriate location .

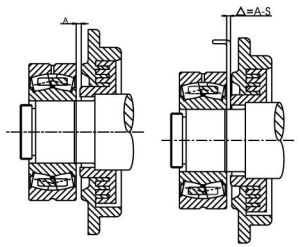



Figure 5-10 control axial trip

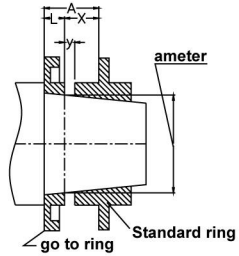



Figure 5-11 control orientation ring long

3) Control orientation ring long figure 5-11, orientation of the bearing be seal ring. Check measure, choose and control orientation ring long before mounting. Keep orientation ring A-A face shaft tolerance .To ensure the same as interference of the bearing.

L-orientation ring long

A-form standard ring measure face to shaft distance

x-form measure face to orientation ring face distance

y-measure clearance ,ensure positive tolerance of tapered

**2、Notes for mounting tapered bore bearing**

1)The fitting quality of tapered bore bearing and shaft diameter depends on the bearing movement up to shaft , as a result of produce difference, measure and account difference , it's very difficult to meet the best fitting quality and high precise requirement only using the three method above.

2) Tunable of mounting place is very ideal method for, figure 5-12, Mounting and adjustment clearance use lock nut. Generally this method is used for the bearing of machine tool.

3) To count course of mounting. Relation formula of Interference and course

$s = \frac{\delta}{c} \times 10^{-3}$

s- mounting course

δ- fitting interference

c –taper angle of inner bore c=1:12

Relation formula of course and the bearing diameter interference clearance .

$\Delta u = \frac{d}{d_E} \times 10^{3}$

Δu- bearing diameter interference clearance

d- bearing inner diameter

dE- Bearing inner diameter of the equivalent table 5-22 method

Self –aligning bearing ： $\Delta u = \frac{s}{15} \times 10^{3}$

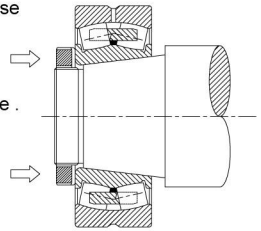


Figure 5-12 Mounting and adjustment clearance use lock nut

table 5-22 dE and DE formula

| Bearing type | $d_E$ | $D_E$ |
|---|---|---|
| Deep groove ball bearing, angular contact ball bearing, cylindrical roller thrust bearing(unrib) | $0.25D+0.75d$ | $0.75D+0.25d$ |
| Self-aligning ball bearing | $0.25D+0.75d$ | $0.73D+0.27d$ |
| Cylindrical roller bearing(rib), taper roller bearing | $0.30D+0.70d$ | $0.70D+0.30d$ |
| Cylindrical roller bearing(rib), taper roller bearing | $0.30D+0.70d$ | $0.70D+0.30d$ |
| Self-aligning roll bearing | $0.30D+0.70d$ | $0.73D+0.27d$ |

When consider uses of adaptive sleeve or withdrawal sleeve, that have clearance of coat and shaft and bearing in between, and need preload ,so in the same interference ,and need increase 0.1~0.2mm for step S. In the calculation of the radial clearance reduced to Δu , still take practical and effective step s .

To control radial clearance decrement and step, that be to ensure the quality of the important methods with taper face, so that give us in the drawing in the technical conditions. Table 5-23 and 5-24,Two kinds of bearing radial internal clearance and axial movement relationship.

table 5-23 taper bore cylindrical (1:12) roll bearing Δu and s relationship

| Bore radial /mm | Radial internal clearance △u/μm | axial movement s/mm | |
|---|---|---|---|
| | | no taper sleeve | taper sleeve |
| 45-50 | 25-30 | 0.40-0.50 | 0.55-0.60 |
| 50-65 | 30-35 | 0.50-0.55 | 0.60-0.70 |
| 65-80 | 30-40 | 0.50-0.65 | 0.60-0.75 |
| 80-100 | 35-45 | 0.55-0.70 | 0.70-0.85 |
| 100-120 | 40-50 | 0.65-0.80 | 0.75-0.90 |
| 120-140 | 45-55 | 0.70-0.85 | 0.85-1.00 |
| 140-160 | 45-60 | 0.70-0.95 | 0.85-1.05 |
| 160-180 | 50-65 | 0.80-1.00 | 0.90-1.15 |
| 180-200 | 55-70 | 0.85-1.10 | 1.00-0.20 |
| 200-225 | 65-80 | 1.00-1.25 | 1.15-1.35 |





| Bore radial /mm | Radial internal clearance △u/μm | axial movement s/mm | |
|---|---|---|---|
| | | no taper sleeve | taper sleeve |
| 225-250 | 70-85 | 1.10-1.30 | 1.20-1.45 |
| 250-280 | 75-95 | 1.15-1.45 | 1.30-1.60 |
| 280-315 | 80-100 | 1.25-1.55 | 1.35-1.65 |
| 315-355 | 95-115 | 1.45-1.75 | 1.60-1.90 |
| 355-400 | 100-125 | 1.55-1.90 | 1.65-2.05 |
| 400-450 | 115-140 | 1.80-2.20 | 1.90-2.30 |
| 450-500 | 130-160 | 2.00-2.50 | 2.10-2.60 |
| 500-560 | 140-180 | 2.20-2.80 | 2.30-2.90 |
| 560-630 | 150-200 | 2.40-3.10 | 2.50-3.20 |
| 630-710 | 180-230 | 2.80-3.50 | 2.90-3.60 |
| 710-800 | 210-270 | 3.20-4.10 | 3.30-4.20 |
| 800-900 | 230-300 | 3.60-4.60 | 3.70-4.70 |
| 900-1000 | 260-340 | 4.00-5.20 | 4.10-5.20 |
| 1000-1120 | 280-370 | 4.30-5.60 | 4.40-6.70 |
| 1120-1250 | 300-400 | 4.60-6.10 | 4.70-6.20 |

table 5-24 taper bore self-aligning (1:12) roll bearing Δu and s relationship

| Bore radial /mm | Radial internal clearance △u/μm | axial movement s/mm | |
|---|---|---|---|
| | | no taper sleeve | taper sleeve |
| 45-50 | 30-35 | 0.50-0.55 | 0.60-0.70 |
| 50-65 | 35-40 | 0.55-0.65 | 0.70-0.75 |
| 65-80 | 40-50 | 0.65-0.80 | 0.75-0.90 |
| 80-100 | 50-60 | 0.80-0.95 | 0.90-1.05 |
| 100-120 | 55-65 | 0.85-1.00 | 1.00-1.15 |
| 120-140 | 60-70 | 0.95-1.10 | 1.05-1.20 |
| 140-160 | 70-85 | 1.10-1.30 | 1.20-1.45 |
| 160-180 | 75-90 | 1.15-1.40 | 1.30-1.50 |
| 180-200 | 85-100 | 1.30-1.55 | 1.45-1.65 |
| 200-225 | 100-115 | 1.55-1.75 | 1.65-1.90 |
| 225-250 | 105-25 | 1.60-1.90 | 1.75-2.05 |
| 250-280 | 120-140 | 1.80-2.15 | 1.95-2.25 |
| 280-315 | 130-150 | 2.00-2.30 | 2.10-2.50 |
| 315-355 | 150-170 | 2.20-2.60 | 2.50-2.70 |
| 355-400 | 160-190 | 2.40-2.90 | 2.55-3.00 |
| 400-450 | 180-210 | 2.60-3.20 | 2.85-3.30 |
| 450-500 | 200-240 | 3.05-3.65 | 3.15-3.75 |
| 500-560 | 220-270 | 3.30-4.10 | 3.50-4.20 |
| 560-630 | 250-300 | 3.80-4.50 | 3.90-4.70 |
| 630-710 | 290-350 | 4.40-5.30 | 4.50-5.40 |
| 710-800 | 330-400 | 5.00-6.00 | 5.10-6.20 |
| 800-900 | 360-450 | 5.40-6.80 | 5.60-6.90 |
| 900-1000 | 400-500 | 6.00-7.50 | 6.20-7.70 |
| 1000-1120 | 440-550 | 6.60-8.30 | 6.80-8.40 |
| 1120-1250 | 480-600 | 7.20-9.00 | 7.40-9.2 |

### 5.7.2.3 Mounting and Dismounting force calculation

The bearing mounting and dismounting force is important according to choose sure method and tools. According interference to the calculated of important bearing with mounting and dismounting force.

Mounting and dismounting force of solid shaft and thick shell:

$$F=f_k f_f \delta_E B,\ N$$

$f_k$- resistance coefficient of mounting and dismounting

$f_f$- geometry size coefficient of the bearing: $f_f=1-\frac{d^2}{d_E^2}$, when mounting and dismounting inner ring, $d_E$ calculated see table 6-50 , $f_f=1-\frac{D^2}{D_E^2}$ , when mounting and dismounting outer ring, $D_E$ calculated to meet table 5-25

$\delta_E$ -effective interference of finish the bearing mounting ,μm.

B -the bearing width

Mounting and dismounting force of hollow shaft and thin-wall shell:

$$F=f_k f_f f' \delta_E B$$

the meaning of $f_k$, $f_f$, $\delta_E$, B before

f- hollow coefficient f1 of hollow shaft, determined $\frac{d_0}{d}$ and $\frac{D}{d}$ by figure 5-13; thin-walled coefficient FEG of thin-walled steel shell , determined $\frac{D_0}{d}$ and $\frac{D}{d}$ by figure 5-14; thin-walled coefficient FEG of thin-walled cast iron shell , determined $\frac{D}{d}$ and by figure 5-15;

when $d_0/d<0.5$, hollow shaft and solid shaft approximate as same ,$f_1=1$; when $D_0/D>2$, steel of shell is greater than the bearing outer ring , $f_{EG}=f_{ET}=1$。

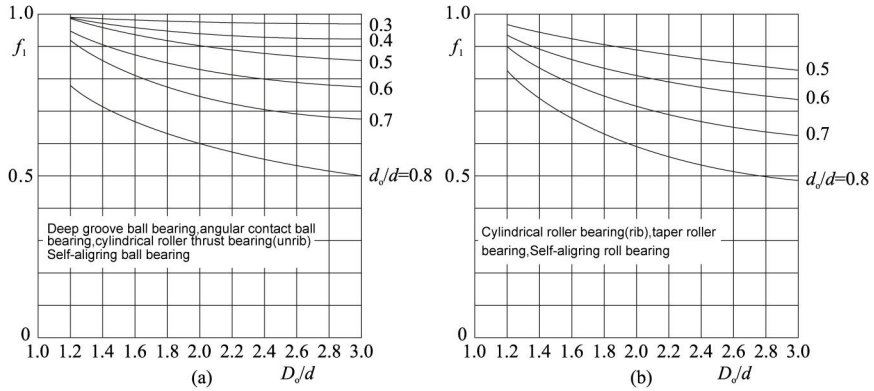



**Figure 5-13 coefficient $f_1$**





table 5-25 taper bore self-aligning (1:12) roll bearing $\Delta_\mu$ and s relationship

| structural style of mating surface | process | $f_k$ |
|---|---|---|
| Cylindrical bore bearing | mounting | 40-50 |
| | dismounting | 60-80 |
| Taper bore bearing(taper shaft radial and adapter sleeve) | mounting | 55-65 |
| | dismounting | 45-70 |
| withdrawal sleeve of taper bore bearing | mounting | 100-120 |
| | dismounting | 110-150 |

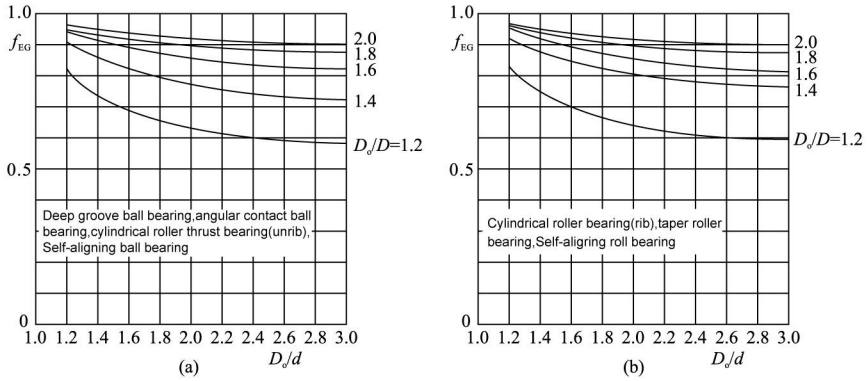



Figure 5-14 coefficient $f_{EG}$

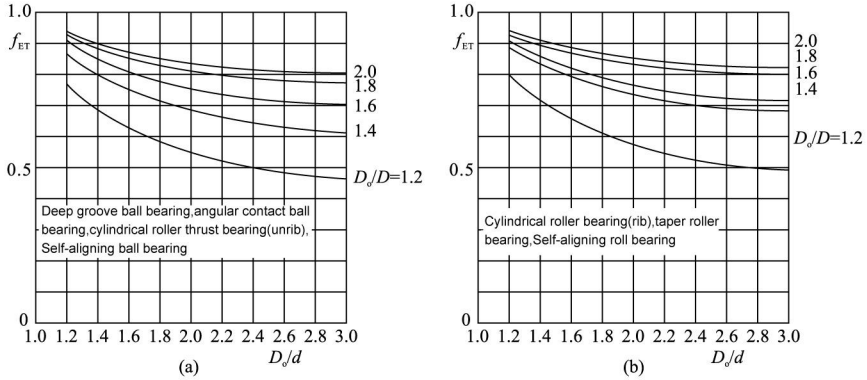



Figure 5-15 coefficient $f_{ET}$

#### 5.7.2.4 Hot mounting

When the bearing is larger or the interference is large, the mounting will increase the pressure, so many times in the mounting and removal or replacement of bearings, particularly bearing and metal seat empty flat, interference fit, easy to lead with the pressure method Surface damage. Therefore requires the use of temperature difference method.

Temperature difference method is to use the principle of expansion and contraction so that bearing ring and shaft or hole temperature difference between the production installation. When the bearings are mounted to the shaft, the bearing heating, diameter swell, set in the journal, the other bearing cooling, the diameter reduced the amount of interference resume, work closely with the shaft bearings.

When the bearing mount of bearing home, heated bearing, if the body such as seat hole is large, bearing cooling can also be installed, when bearings recovery room, they get the interference fit.

The requisite difference in temperature between the bearing ring and shaft or housing depends on the degree of interference and the diameter of the bearing seating.

When heated bearings are generally lower than the tempering temperature is about 60-70℃, or bearing deformation and reduce the hardness, heat at 80-100℃ for ordinary bearings, not more than 120℃

Bearing cooling, in order to prevent the bearings cold brittle behavior, the temperature is not lower than -50℃, sometimes can also be used -80℃. Heat and cool method see table 5-26

Table 5-26 Heat and cool method see table

| Heat and cool method | feature and applicable |
|---|---|
| Oven and hothouse heating | The bearing can be heated by oven and hothouse with temperature adjustment and strict control. The feature is safe, cleaning and temperature strict control; it is use other occasion of general equipment. That fault is long times of heat, space limitation, no method lot heating and large bearing heating |
| heater plate heating | The bearing can be heated by heater plate with temperature accurate adjustment and control, and even-heating ,handiness, safe , signs of overheating if no person to look after, be applicable to small bearings. |
| oil bath heating | the oil is transformer oil with better ,to control 80~1000C of oil temperature, even-heating ,flash heat, heat large bearing. But it isn't heat bearing of seal ring and dust cap with grease lubricant. |
| Induction heating | A fast and very efficient way to heat a bearing for mounting is to use an induction heater. At the end of each heating cycle, the bearings are automatically demagnetized. |
| Cold method | The bearings can be cooled by kinds of cryogenic box with refrigeration, and put in intermixture of dry ice and alcohol. |

#### 5.7.2.5 The oil injection method

Interference with the shaft and bearings, the friction with the surface large. When the interference is large, and may damage mating surfaces, as reduce friction between mating surfaces, the protection with the surface, can be used in injection pressure between the surface of the oil with the method, Figure 5-16 is a hole in this way mounting cone bearing Example.

mounting bearings, the first bearing into the cone surface, with surface Press closer, tightening the nut, with a manual pump or oiling to meet the injection pressure between the surface of the oil, while moving with the nut wrench nut, push forward bearing until appropriate location.

This method is typically used when mounting bearing directly on tapered journals. but is also used to mount bearings on adapter and withdrawal sleeves that have been prepared for the oil injection method .a pump or oil injector produces the requisite pressure the oil is injected between the mating surfaces via ducts and distributor grooves in the shaft or sleeve.





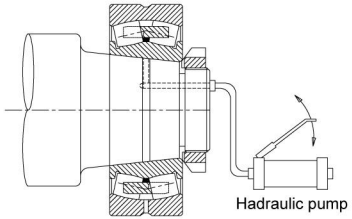


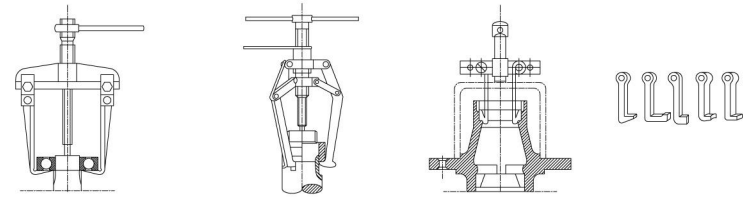

Figure 5-16 mounting bearing of the oil injection method

### 5.7.3 Dismounting of rolling bearing

To choose fitting method and tools of dismounting bearing , and according to type, precision, mounting structure, position, size and if use to future.

It is more difficult dismounting than mounting, because the part rust and deform. if the bearing again be use, That not must be allow to transitive dismounting force with rolling element, if not it isn't used for rollaway nest and rolling element damage.

The puller is used of center bearing with pressure method. See figure 5-17



(a) duplex pull rod (b) three pull rod (c) inner bore pull rod (d)kinds of pull rod

Figure 5-17 kinds of pull rod tools

Larger bearing dismounted with an interference fit generally require greater force to remove them, See figure 5-18 dismounting cushion block. It makes up of two semicircle cushion block and outer ring. The method is evenness distributing press of bearing ferrule head face.

The ferrule must be lock dismounting bearings with pull rod, that is require have enough space for physical design. See figure 5-19, processing groove of shaft and seat bore beforehand.

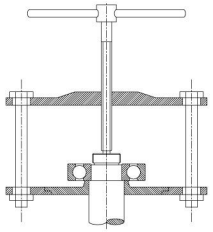
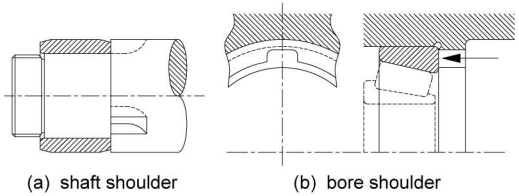


Figure 5-18 used bisection cushion block dismounting bearing



(a) shaft shoulder (b) bore shoulder

Figure 5-19 groove of shaft shoulder and bore shoulder

When dismounting bearings outer ring if no enough bore shoulder high , that screw hole and unthreaded hole be process in the circumference of bore shoulder, and the outer ring is push-out convenient with crew hole and unthreaded hole , see figure 5-19(b) and 5-20

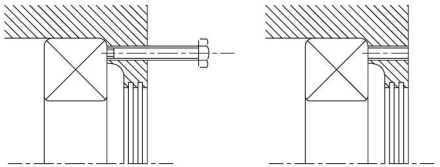


Figure 5-20 push-out outer ring with crew hole and unthreaded hole

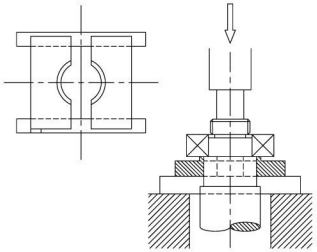


Figure 5-21 forcing press inner ring

When dismounting inner ring of separable bearings or with interference fit between inner ring and shaft, shaft and bearing inner bore is easily damaged due to high dismounting force. It's recommended to heat the bearings inner ring with Induction heater as figure 5-21.

For large bearings to hydraulic demolition methods, figure 5-22,First, loosen the nut, then use the manual high-pressure pump to the cone axis of the hole to send oil to make bearing removal bearing inner ring expansion.

For small and medium with tight sleeves and withdrawal sleeves bearing removal in Figure 5-23, 5-23(a)the nuts loose after a few laps, using a hammer tap the demolition.5-23(b) Use tighten the nut pulled back sleeves.

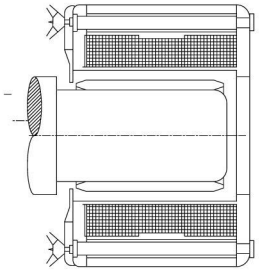
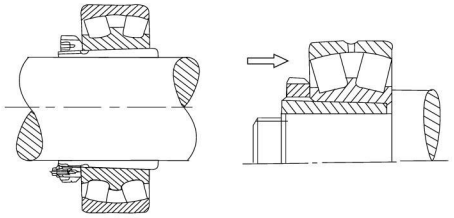


Figure 5-22 Induction heater



(a)dismounting of cone bearing (b)use tight sleeves to dismounting

Figure 5-23 adaptive sleeve or withdrawal sleeve bearing