


INTER PLANT STANDARDS IN STEEL INDUSTRY		
 IPSS	CODE OF PRACTICE FOR MOUNTING AND DISMOUNTING OF ANTIFRICTION BEARINGS	IPSS: 3-02-003-18
	Corresponding IS does not exist	Formerly: IPSS: 3-02-003-95

0. FOREWORD

- 0.1 Interplant standardization in steel industry was initiated under the aegis of the Indian Standards Institution (ISI) and the Steel Authority of India Limited (SAIL). This IPSS was prepared by the standard committee on Operation and Maintenance, IPSS 3:2 and firstly published in 1995. Lastly, this has been revised by the standard committee in July 2018 with the active participation of the representatives from major Indian steel plants and leading consultants.
- 0.2 This revision is an updated version to take care of the latest procedural requirements.

1. Scope

- 1.1 This Inter Plant Standard covers the details regarding mounting and dismounting of antifricion bearings.

2. PREPARATION FOR MOUNTING AND DISMOUNTING OF ROLLING BEARINGS

- 2.1 **Work Planning** – Prior to mounting and dismounting of antifricion bearings, following preparatory steps shall be taken:
- a) Study the shop drawing and the details of the application and the assembly sequence.
 - b) Sequence the individual operations and get reliable information on heating temperature, mounting and dismounting forces and the amount and type of grease to be packed into the bearing.
 - c) Whenever mounting and dismounting of antifricion bearings require special measures, the bearing technician should be provided with:
 - i) Comprehensive instructions on mounting details, including means of transport for the bearing,
 - ii) mounting and dismounting equipment,
 - iii) measuring devices,
 - iv) heating facilities and
 - v) type and quality of lubricant.

- 2.2. **The “RIGHT” Bearing** – Prior to mounting, the bearing technician shall make sure that the bearing number stamped on the package agrees with the designation given in the drawing and in the parts list. New bearing should not have surface defect (fitting, scoring, rust mark). The clearance of the bearing should be compared with the manufacturer's catalogue.
- 2.3 **Handling of antifriction Bearings Before Mounting** – Though some of the antifriction bearings are preserved, in their original package, with an anti-corrosive oil, it is preferable to wash all the bearings with kerosene or cold-cleaning agent before mounting. The seats and the mating surfaces shall be wiped clean of anticorrosive oil before mounting. Prior to mounting, used bearings shall be washed carefully with kerosene or cold-cleaning agent and shall be oiled or greased immediately afterwards.
- 2.4 **Cleanliness in Mounting** – Absolute cleanliness shall be ensured. Dirt and humidity are dangerous offenders, since even the smallest particle penetrating into the bearing will damage the rolling surfaces.
- 2.5 **Check Mating Parts** – All mating parts shall be carefully checked for dimensional accuracy prior to assembly.
- 2.6 **Inspection of Bearing Seats**
- 2.6.1 **Cylindrical Seats** – Shafts shall be checked with external micrometers and bores with internal micrometers.
- 2.6.2 **Tapered Seats** – Master taper ring/sine bars shall preferably be used for checking tapered seats.
- Note** : Full inner ring support on the shaft requires exact coincidence of shaft taper and inner ring bore taper. The taper of antifriction bearing rings is standardized. For most bearing series it is 1:12, for some large width series it is 1:30.

3. **MOUNTING OF ANTIFRICTION BEARING**

- 3.1 The various bearing types and sizes require different mounting methods depending on the individual conditions these can be mechanically, hydraulic or thermal. As the hardened bearing rings are sensitive to blows, these shall never be applied directly to the rings. On mounting of non-separable bearings, the mounting forces shall always be applied to the ring which will have the right fit and therefore is the first to be mounted.
- 3.1.1 Mounting of separable bearing is easier, since the two rings can be mounted separately. In order to avoid score marks during assembly, the parts shall be slightly rotated. While mounting the mating surfaces of the bearings should be smeared with oil.
- 3.2 **Mechanical Methods**
- 3.2.1 Mounting of Cylindrical Bore Bearings – Bearings with a maximum bore of approximately 80 mm may be mounted cold. The use of a mechanical or hydraulic press is recommended. If press is not available, the bearing can be driven on the shaft by gentle taps with a hammer or mallet. However, a mounting sleeve of soft steel and with a flat face shall be used in order to

distribute the mounting force evenly over the entire ring circumference and to avoid damage to the bearing, (see Fig. 1). If necessary, small bearings may be driven on the shaft with gentle hammer taps using an appropriate mounting sleeve.

- 3.2.1.1 The inside diameter of the sleeve shall be little larger than the bearing bore and to avoid damage to the cage, its outside diameter shall not exceed the inner ring shoulder height.
- 3.2.1.2 If a self-aligning bearing is pressed on the shaft and pushed into the housing at the same time, a disk shall be used which bears against both the rings, thus avoiding misalignment of the outer ring in the housing (See Fig. 2 & 3).
- 3.2.1.3 If very tight fits are required, even smaller bearings shall be heated for mounting, preferably with induction heater.
- 3.2.2 Mounting of Needle Antifriction Bearings
 - 3.2.2.1 Needle antifriction bearings with machined rings – The same mounting principles shall apply to needle antifriction bearings as to cylindrical antifriction bearings.
 - 3.2.2.2 Drawn cup needle antifriction bearings – Due to their thin outer rings the form accuracy for the drawn cup needle antifriction bearings is achieved by means of tight fit in the housing. For mounting these bearings special mounting mandrels shall be used (see Fig. 4)
- 3.2.3 Mounting of Tapered Bore Bearings
 - 3.2.3.1 Bearing with tapered bore shall be either fitted directly on the tapered shaft journal or, if shaft is cylindrical, on an adapter sleeve or a withdrawal sleeve.
 - 3.2.3.2 Forcing the bearing on to the tapered seat expands the inner ring and reduces radial clearance. Therefore, reduction in radial clearance may be used as a measure of the seating condition of the inner ring. The initial radial clearance shall be determined before mounting and then to check the clearance repeatedly during mounting until the proper amount of reduction and thus the required tight fit are obtained (See Fig. 5, 6, 7 & 8).
 - 3.2.3.3 The radial clearance shall be measured with feeler gauges or alternatively the reduction in radial clearance, the distance the bearing is forced on to the tapered seat may be measured. For the standard inner ring bore taper of 1:12 the ratio of axial drive-up to radial clearance reduction is approximately 15:1. This ratio considers the fact that the expansion of the inner ring is more than 75% to 80 % of the amount of the interference existing between the fitted parts.
 - 3.2.3.4 The adapter sleeve nut and a hook spanner shall be used for driving small bearings on to the tapered seat of the sleeve.
 - 3.2.3.5 Shaft nuts shall also be used to press small withdrawal sleeves into the space between shaft and bearing inner ring.
 - 3.2.3.6 For mounting larger bearings, it is advisable to use a hydraulic press.

- 3.2.3.7 The taperdness of adapter sleeves should be matched with the taperdness of inner & it should be checked before mounting.
- 3.3 **Hydraulic Methods** – With the hydraulic method, oil is injected between the mating surfaces. This may be machine oil, or oil containing rust dissolving additives. The oil film greatly reduces the friction between the mating parts which can then be easily displaced in relation to one another without the risk of surface damage (see Fig. 9).
- 3.3.1 Tapered bore bearings can be mounted on and dismantled from, their tapered counterpart by the hydraulic method. Cylindrical bore bearings or rings are heated for mounting, whilst dismantling is performed hydraulically. For oil injection, oil grooves, feed channels and threaded connections for the pump are machined into the shaft or the sleeve (see Fig. 10 & 11).
- 3.4 **Thermal Methods** – If tight fits are specified for the inner rings on cylindrical shaft seats, the bearings shall be heated for mounting. Sufficient expansion is obtained when heated between **80oC and 100oC**. For bearing with moulded cages of glass fibre reinforced polymide, the same temperature limits are valid as for other antifriction bearings.
- Note** : Bearings with shields and with seats are packed with grease during manufacture. They may be heated up to 80oC maximum, but never in an oil bath.
- 3.4.1 **Heating Plate** – Provisionally, antifriction bearings may be heated on a heating plate which shall be thermostatically controlled. Turn the bearings over several times in order to ensure uniform heating.
- 3.4.2 **Oil Bath** – For uniform heating, antifriction bearings shall be immersed in an oil bath which is thermostatically controlled to a temperature of 80oC to 100oC. The bearing shall not be in direct contact with the heat source as such should be suspended in the oil bath.
- 3.4.3 **Induction Heating Device** – With the induction heating device, antifriction bearings shall be brought up to mounting temperature or a fast secure and clean manner. This device can be used for any antifriction bearing types including greased and sealed bearings.
- 3.5 **Clearance Adjustment on Mounting**
- 3.5.1 **Angular Contact Ball Bearing and Tapered Roller Bearings** – Angular contact ball bearings and tapered roller bearings shall always be mounted in pairs. The axial and radial clearance of two bearings mounted in opposition shall be adjusted on mounting, the clearance or preload depending on the operating conditions.
- 3.5.1.1 **Effect of Temperature** – High loads and high speeds cause a temperature rise at the bearing location. This leads to thermal expansion and clearance variation. If close shaft guidance is required, the clearance shall be adjusted in stages. Each adjustment shall be followed by a trail run and a temperature check, to ensure that the clearance does not become too small resulting in a higher running temperature.

Note : The right temperature for a bearing operating in the medium to high speed range under medium load can indicatively be defined as follows:

After 2 or 3 hours running, this temperature should, however drop especially when in the case of grease lubrication, the churning action diminishes, after the excess grease is expected from the bearing interior.

- 3.5.1.2 **Axial Clearance** – Axial clearance or preload of adjustable bearings is established by loosening or tightening the adjusting nut or by insertion of calibrated shims. From the thread pitch, axial clearance and preload can be converted into turns of adjusting nut. The changeover from clearance to preload during adjustment shall be found by constant manual rotation of the shaft. Simultaneously a dial gauge shall be applied to check the axial freedom of the shaft.

4. **DISMOUNTING OF ANTIFRICTION BEARING**

- 4.1 **General** – If the bearings are intended for reuse, dismounting shall be performed most carefully; with extracting tools applied to the ring to be extracted to prevent the rolling elements from scoring the raceways. Additional care shall be taken for the thin-walled outer rings having the risk of ring fracture (See Fig. 12).

- 4.1.1 With non-separable bearings, first the ring with sliding fit shall be withdrawn from its seat and then the tight-fitted ring shall be dismounted. The force required for dismounting is generally higher than the mounting force, since, as time passes, the ring becomes embedded on its seat. Even with loose-fitted rings, fretting corrosion may make dismounting work difficult.

4.2 **Mechanical Methods**

- 4.2.1 Dismounting of Cylindrical Bore Bearings – Small bearings shall be dismounted with the aid of mechanical extracting devices or hydraulic presses. These shall be applied either directly to the tight fitted ring or to the mating parts, such as the labyrinth ring (See Fig. 13).

- 4.2.1.1 Provisionally, small bearings may be driven off their seat with a hammer and a metal drift. The light hammer blows shall be applied evenly round the whole circumference of the tight fitted ring.

- 4.2.1.2 To facilitate dismounting extracting slots shall be provided so that the extractor can be directly applied to the tight-fitted bearing ring (See Fig. 14 & 15). When the inner ring abuts the shaft shoulder and when no extracting slots are provided, ball bearings, tapered antifriction bearings and cylindrical antifriction bearings may be dismounted with special extractor, the clamping piece inserted in the extractor engages with finger shaped extensions between the balls at the inner ring raceway edge; with extractors for cylindrical and tapered roller bearings the clamping piece engages behind the rollers. The clamping piece forms part of a collect and shall be clamped against the inner ring with a tapered clamping ring. The extraction force shall be generated by a spindle. This extractor enables bearings mounted in housing to be withdrawn from the shaft.

4.2.2 **Dismounting of Tapered Bore Bearings**

4.2.2.1 Dismounting of adapter sleeve mounted bearings – For dismounting bearing directly seated on the tapered shaft or an adapter sleeve, the locking device of the shaft or sleeve nut shall be loosened by an amount corresponding to the drive up distance. The inner ring shall be driven off the adapter sleeve or tapered shaft seat by gentle hammer taps, using a soft metal drift or even better a piece of pipe (See Fig. 16 & 17).

When a press is used, the adapter sleeve or the loosened adapter sleeve nut shall be supported and the bearing from the sleeve shall be withdrawn.

Adapter sleeves may be released with an annular piston press provided the bearing rests against an angular support ring. The press shall take support on a plate or the like (See Fig. 18).

4.2.2.2 Dismounting of withdrawal sleeve mounted bearings - withdrawal sleeves mounted bearings shall be removed by means of the extraction nut. For this purpose, the shaft nut shall be removed. In difficult cases (for large size bearings), extraction nuts with additional thrust bolts may be used. A washer shall be inserted between the inner ring and thrust bolts (See Fig. 19).

Dismounting of withdrawal sleeves is much easier and less costly with annular piston presses. Withdrawal sleeves projecting beyond the shaft end, shall be backed up by a thick walled support ring (See Fig. 20).

4.3 **Hydraulic Methods**

4.3.0 In the hydraulic method, oil is injected between the mating surfaces. The oil film greatly reduces the friction between the mating parts which can then be conveniently displaced in relation to one another without the risk of damaging the mating surfaces.

The hydraulic method is suitable for dismounting bearings with tapered and cylindrical bore. In both cases, oil grooves, ducts and threaded connection for the pump must be provided. Larger adapter and withdrawal sleeves feature the corresponding grooves and holes.

For dismounting tapered bore bearings directly seated on the shaft, injectors will do for pressure generation. Cylindrical bore bearings and adapter and withdrawal sleeve mounted bearings require a pump.

For dismounting, a thicker oil with a viscosity of about 150 mm²/s at 20°C (nominal viscosity 46 mm²/s at 40°C) can be used. If the contact surfaces are damaged, a high-viscosity oil of about 1,150 mm²/s at 20°C (nominal viscosity 320 mm²/s at 40°C) should be used. Fretting corrosion can be dissolved by anti-corrosive additives to the oil.

4.3.1 Dismounting of Tapered Bore Bearing – For hydraulic dismounting of bearings, mounted on a tapered journal, a withdrawal sleeve or an adapter sleeve, oil is pumped between the surfaces in contact. This releases the press fit instantly. The release being rather abrupt, a stop should be provided to control the movement. This may be a shaft or sleeve nut or any other convenient means.

The incidence of fretting corrosion may render dismantling more difficult. In this case, a rust-dissolving hydraulic oil should be used, especially for bearings of long service. For a seized withdrawal sleeve, the extra force required to set it moving can be applied through the withdrawal nut. If the withdrawal nut features thrust bolts, a plate or washer should be inserted between the bolts and the bearings, to avoid damaging the lips of the bearing ring.

- 4.3.2 Dismounting of Cylindrical Bore Bearings – For cylindrical bore bearings, the use of the hydraulic technique is generally limited to dismantling. The first step is to apply a bearing extractor to the bearing ring. The hydraulic oil is pumped into the oil grooves. When the bearing ring moves easily, it should be displaced far enough to expose the rear oil groove; the oil feed to this groove is stopped.

Then the ring is given a further pull, until the ring covers the forward oil groove at either side by an identical length. The oil feed to the forward groove is stopped which means that the ring will freeze again. A spring is inserted into the guide sleeve of the extractor and preloaded. The travel stroke of the extractor spring should be a little greater than the length occupied by the ring on the shaft. Rebuilding the oil film by vigorous pumping enables the extractor to slide the ring off the shaft. It is recommended to catch the ring on its way off. The spring preload should be approximately $F=20xd$ (F in N and d in mm). Whenever several rings are mounted on the shaft side by side, they are dismantled separately.

The displacement of the ring up to the point where the forward oil groove is still covered evenly, can generally be done by hand, since upon injection of the hydraulic oil, the rings are easily displaceable. The better the ring “floats” in the extraction phase, when the spring pressure pulls it from, the shaft, the less the probability of its getting caught at the shaft end.

In the absence of oil grooves and ducts in the shaft, the oil can be injected between the mating surfaces from the inner ring front face. To this effect, a sealed oil injection ring is placed in front of the bearing feeding pressurized oil into the fitting joint. Mounting a sleeve to the shaft end allows oil to be pumped between the mating surfaces all the time the dismantling operation lasts. If the use of such a sleeve is not possible, a high viscosity oil of 320 mm²/s at 40°C must be used. An oil of this viscosity maintains an adequate oil film for approximately 5 minutes which is sufficient for bearing removal.

These special extracting devices are relatively complicated. They are, for example, used for applications where no oil grooves are provided in the shafts or axles for strength reasons, but which required frequent dismantling (e.g. for rail vehicles).

4.4 **Thermal Methods**

- 4.4.1 Heating Rings – Heating rings shall be used for dismantling cylindrical antifriction bearing and needle antifriction bearing inner rings (of light alloy are radically slotted and with insulated handles) without lip or with one lip only (See Fig. 21). With an electric heating plate, the heating rings shall be heated to a temperature of 200°C to 300°C, placed around the inner ring

to be extracted and clamped by means of the handles. The heat is rapidly transferred from the heating ring to the inner ring. When the tight inner ring fit on the shaft is loosened, both the rings shall be withdrawn simultaneously. After extraction, the inner ring shall be removed immediately from the heating ring to avoid overheating.

Note : Heating rings are of great advantage for occasional withdrawal of small or medium size bearing rings each bearing size requiring its own heating ring.

4.4.2 Induction Coil – For extraction, the induction coil shall be pushed over the inner ring and the fingers shall provided on the coil to grip the ring at its back face. The labyrinth ring shall have milled recesses to allow positioning of the fingers. The current shall be switched on and as soon as the ring is heated to 80oC to 100oC, the current shall be switched off and the ring together with the appliance shall be removed from the shaft.

Note : Induction oils are used for withdrawing shrunk on cylindrical antifriction and needle antifriction bearing inner rings of 100 mm bore onward from the shaft. Since the coil heats up at a very fast rate, the amount of heat transferred to the shaft is minimized so that the rings can be easily withdrawn.

4.4.3 Ring Burner – If oil grooves are not provided in the shaft for hydraulic mounting and if electrical devices are not economical, inner rings of larger separable bearings can also be dismantled by heating them with a flame.

4.4.3.1 The surfaces of hardened bearing rings are susceptible to overheating, therefore the burner shall always be held concentric to the bearing ring. The burner shall be moved slowly and evenly across the bearing ring in the axial direction. This will avoid a tempering effect and additional stressing in the ring.

4.4.3.2 A welding torch shall never be used because of the danger of overheating or unequal heating of the ring affecting the hardness and dimensional stability of the ring.

4.4.3.3 Sometimes, heavy fretting corrosion or cold welding can make the regular removal of the bearing rings impossible. In such cases (which, of course, only apply to unserviceable rings) the rings shall be heated by a welding torch to 350oC and hosed with cold water. The heavy internal stresses thus produced in the ring will make it crack. Since the ring is likely to burst, the area of dismantling shall be well screened or covered to avoid accidents (See Fig. 22).

5. USE OF FITS & TOLERANCES

The following Indian Standards shall be referred:

- a) IS 5669:1987/ISO IS:1981, General Plan of boundary dimensions for radial rolling bearings (first revision) (ISO Title: Rolling bearing – Radial bearing – Boundary dimensions – General Plan)
- b) IS 5933:1970 Tolerances for thrust ball bearings with flat seats

- c) IS 5934 : 1987/ISO 582:1979 Chamfer dimensions limits for rolling bearings (First revision)
- d) IS 7460 : 1988 Tolerances for tapered roller bearing (first revision)
- e) IS 7461 General Plan of boundary dimensions for tapered roller bearings
 - i) Part I - 1993 - Part I - Single row bearings
 - ii) Part II - 1992 - Part II - Double row bearings
 - iii) Part III - 1992 - Part III - Flanged cups

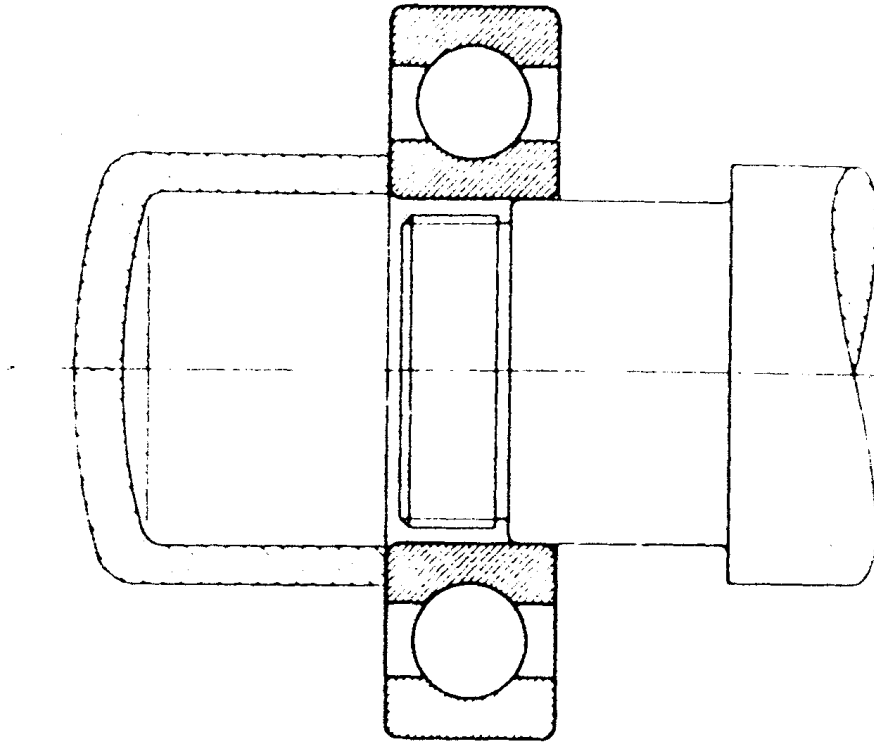


FIG 1 : MOUNTING OF CYLINDRICAL BORE BEARING
(Clause 3.2.1)

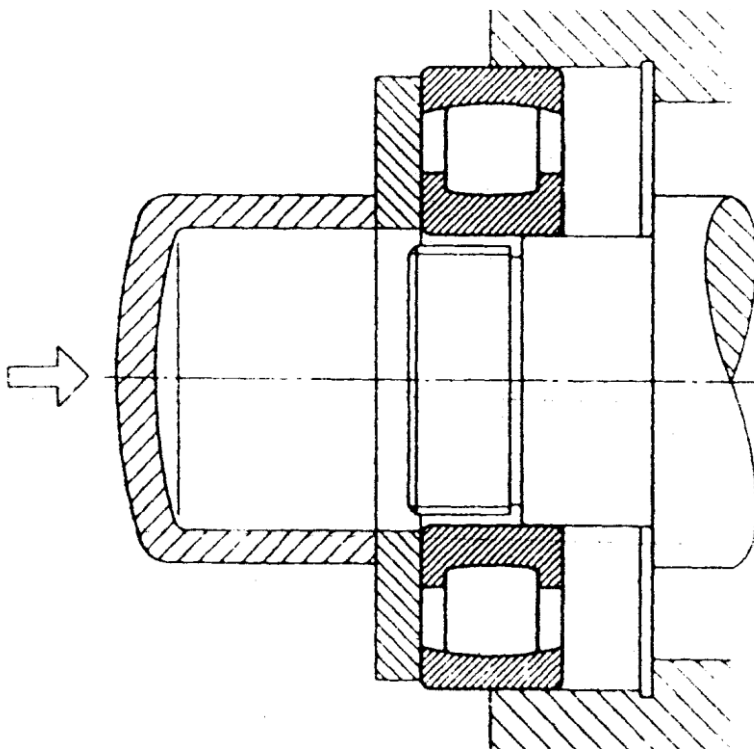


FIG 2 : SELF ALIGNING BEARING – FIXATION OF SHAFT
(Clause 3.2.1.2)

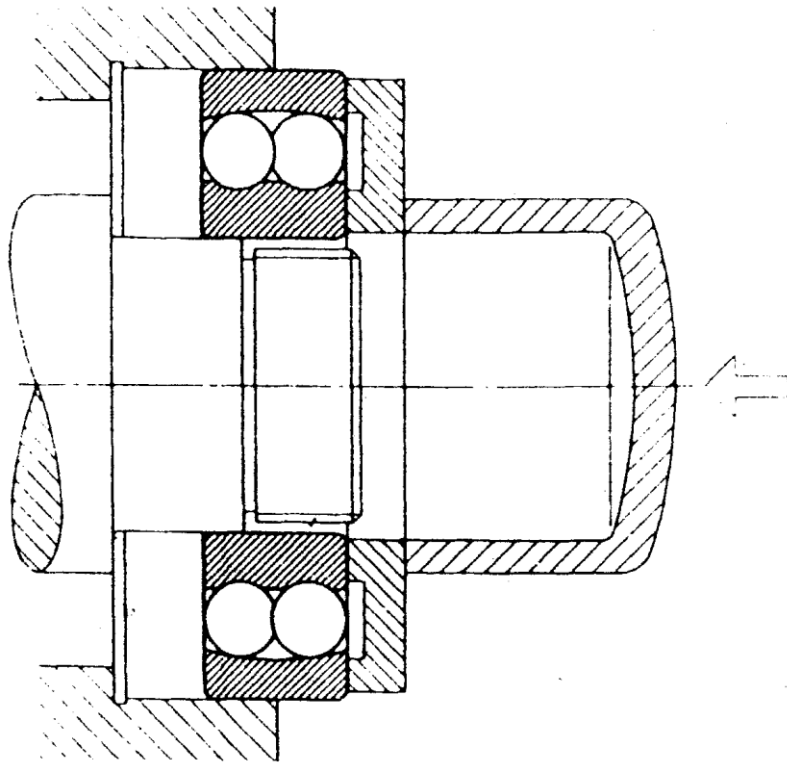


FIG 3 : SELF ALIGNING BEARING – FIXATION OF SHAFT
(Clause 3.2.1.2)

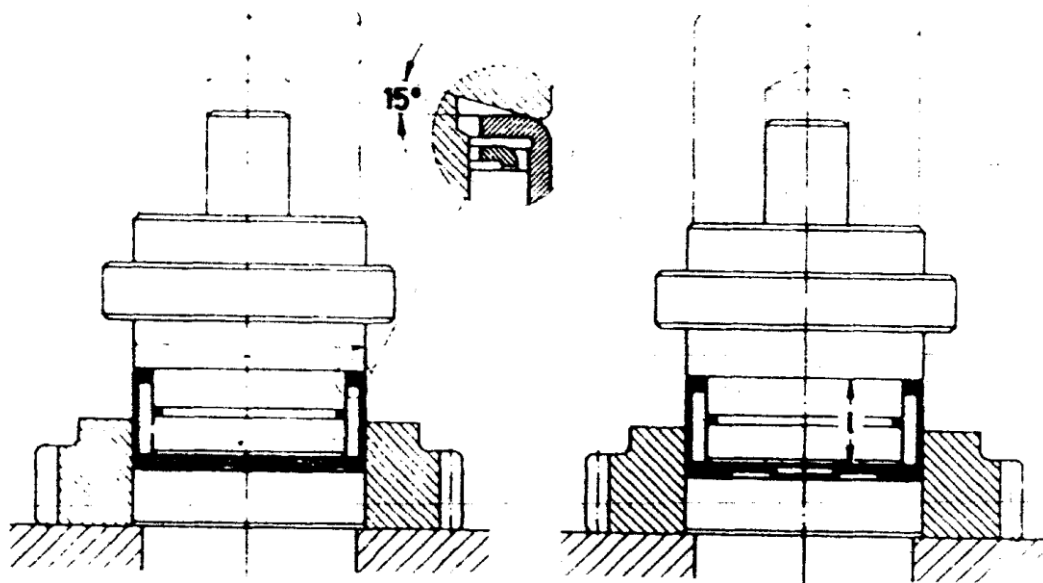


FIG 4 : DRAWN CUP NEEDLE ROLLER BEARING
(Clause 3.2.3.2)

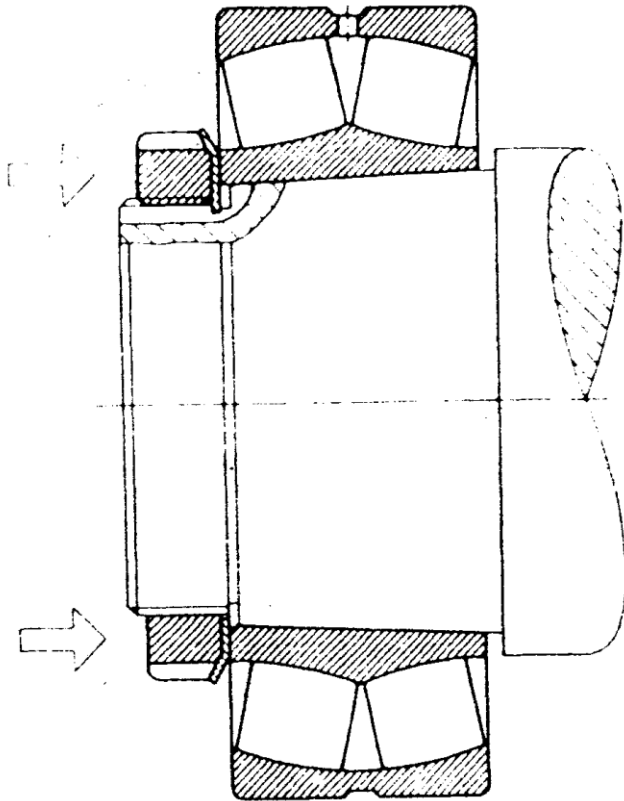
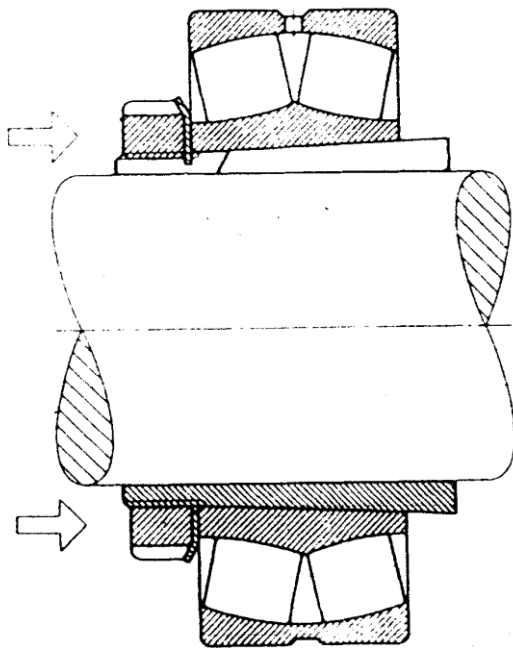
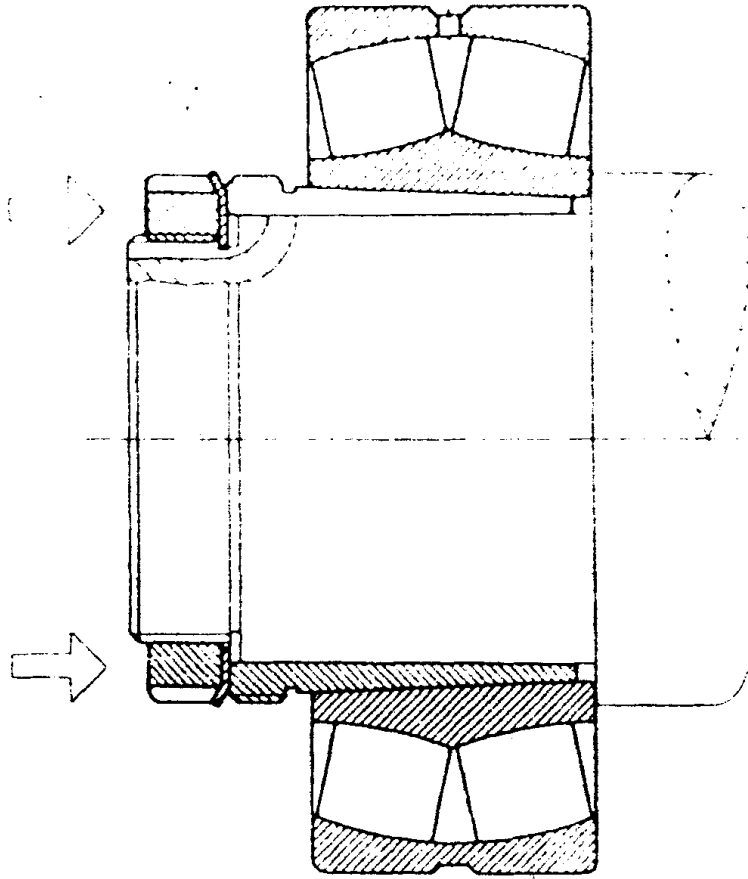


FIG 5 : MOUNTING OF TAPERED BORE BEARING
(Clause 3.2.3.2)



Press fitting an adapter sleeve mounted spherical roller bearing
with the adapter sleeve nut.

FIG 6 : MOUNTING OF TAPERED BORE BEARING (Cont.)
(Clause 3.2.3.2)



Press fitting a withdrawal sleeve with the shaft nut.

FIG 7 : MOUNTING OF TAPERED BORE BEARING (Cont.)
(Clause 3.2.3.2)

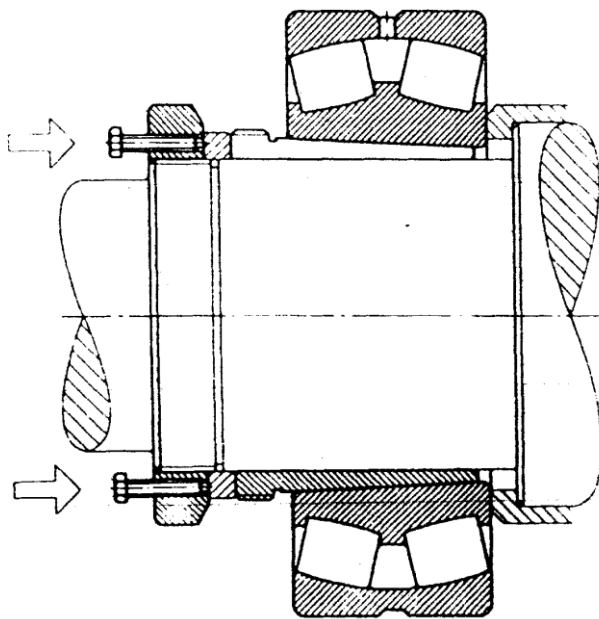


FIG 8 : MOUNTING OF TAPERED BORE BEARING (Cont.)
(Clause 3.2.3.2)

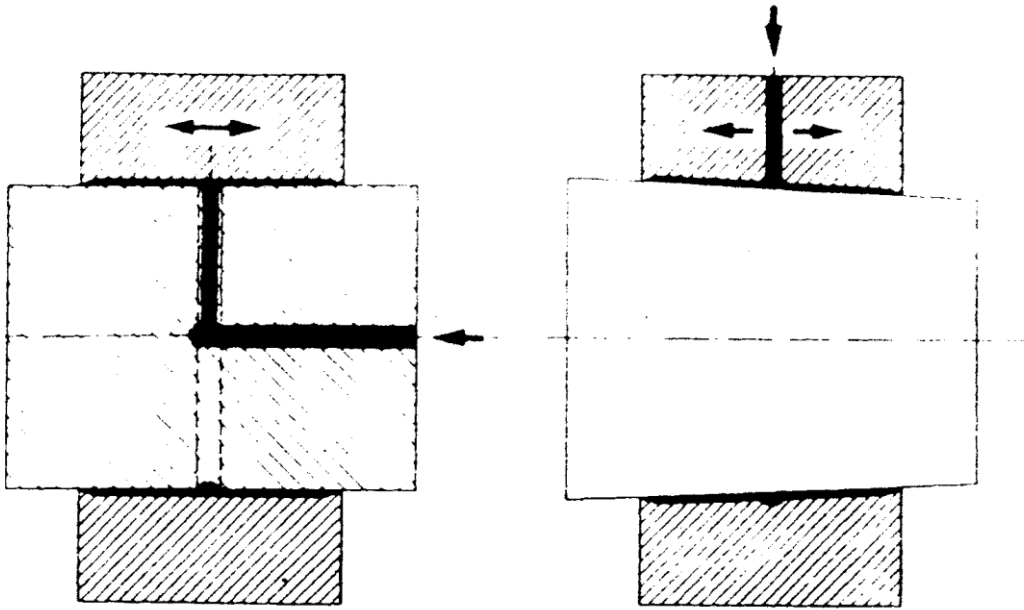


FIG 9 : ROLLING BEARING MOUNTING – HYDRAULIC METHOD
(Clause 3.3)

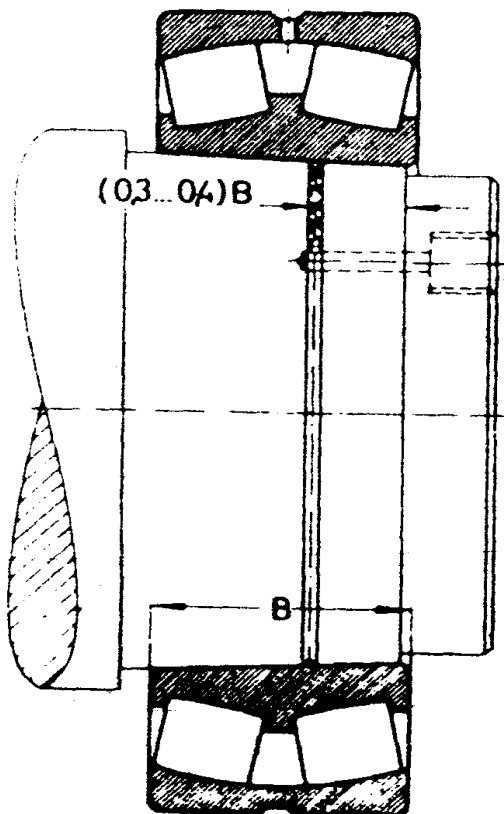


FIG 10 : MOUNTING OF BEARING – HYDRAULIC METHOD
(Claus 3.3.1)

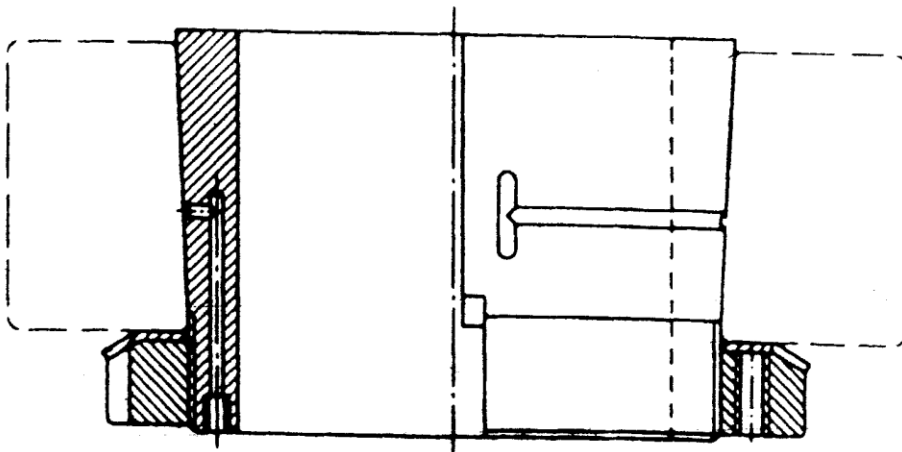
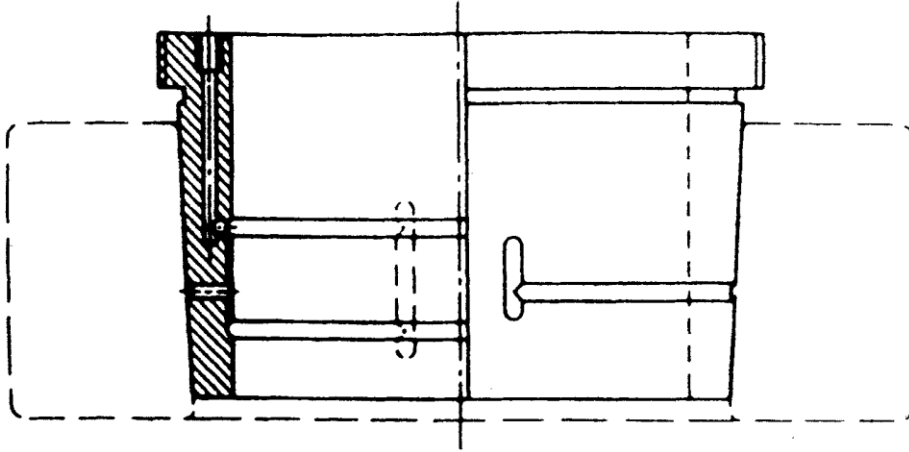


FIG 11 : MOUNTING OF BEARING – HYDRAULIC METHOD (Cont.)
(Clause 3.3.1)

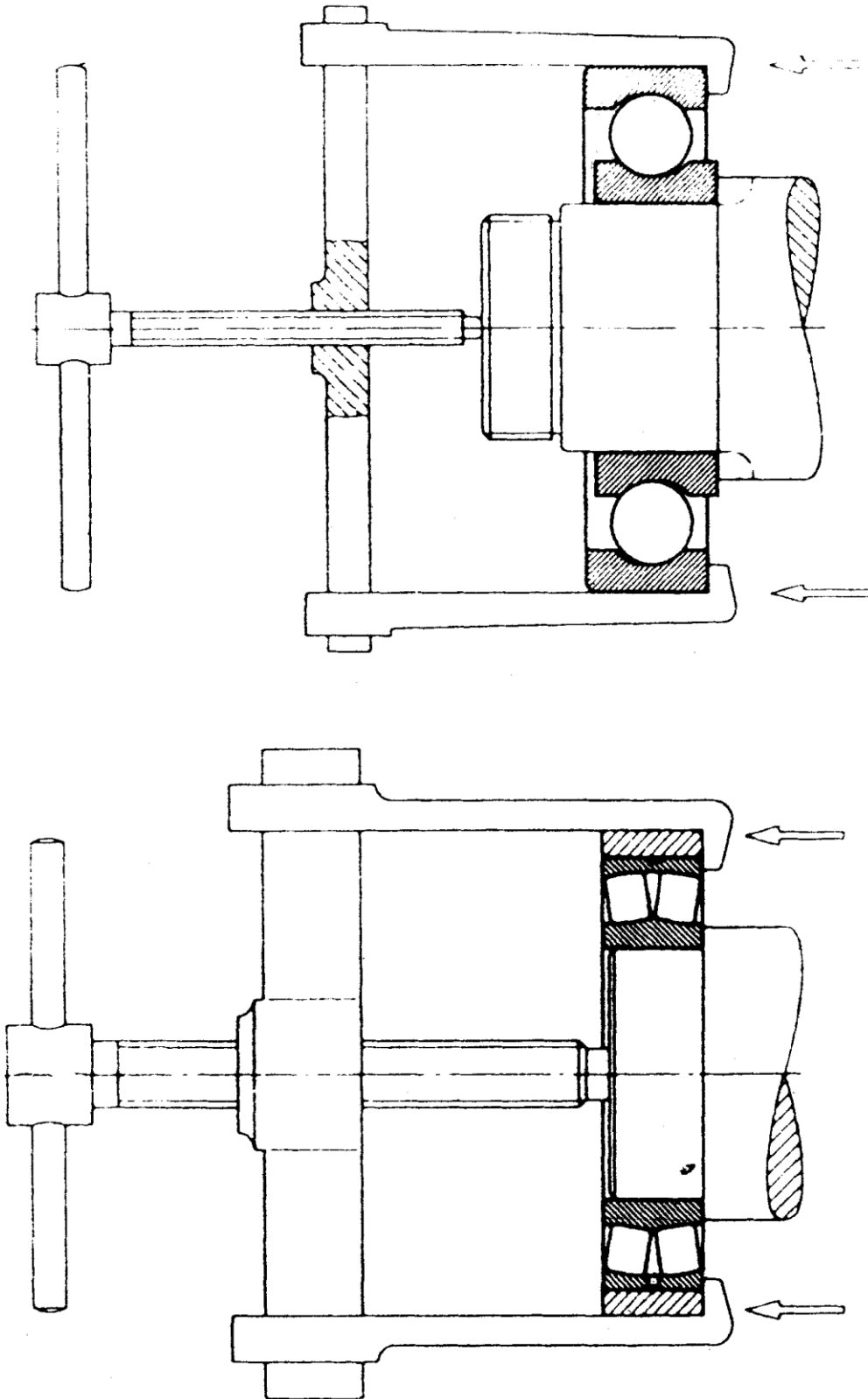


FIG 12 : DISMOUNTING OF ROLLING BEARING (Clause 4.1)

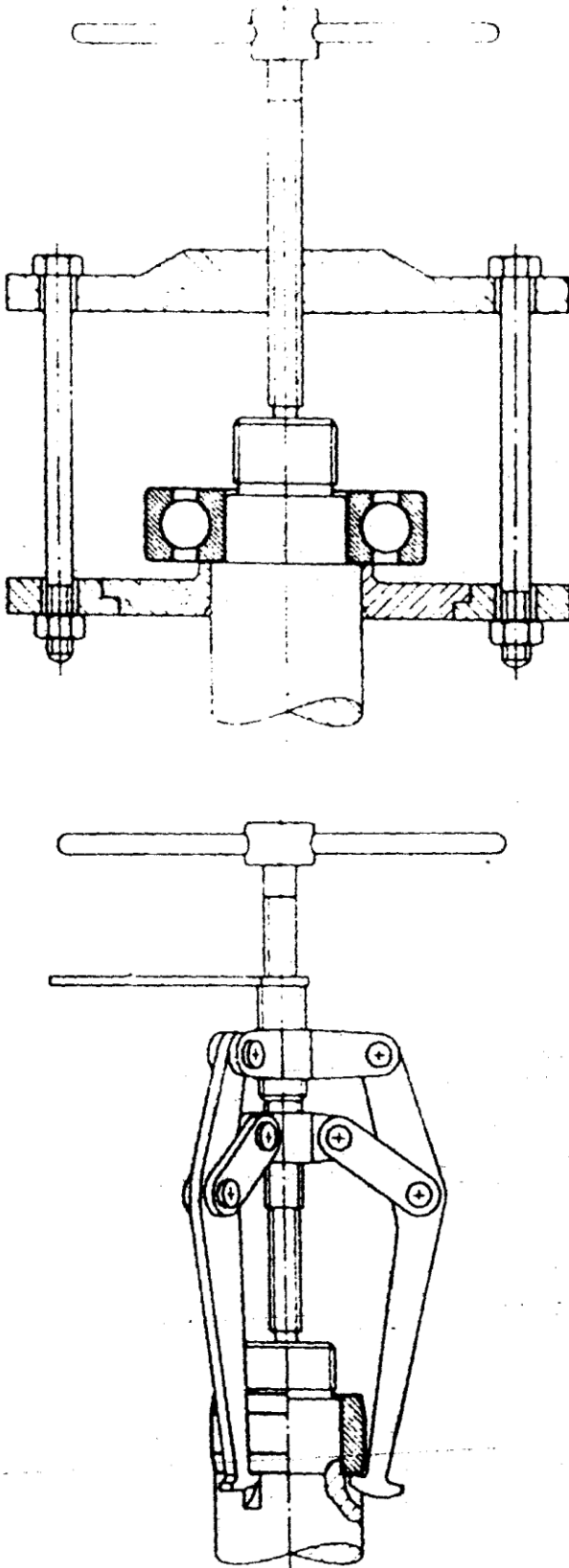


FIG 13 : DISMOUNTING OF CYLINDRICAL BORE BEARING (Clause 4.2.1)

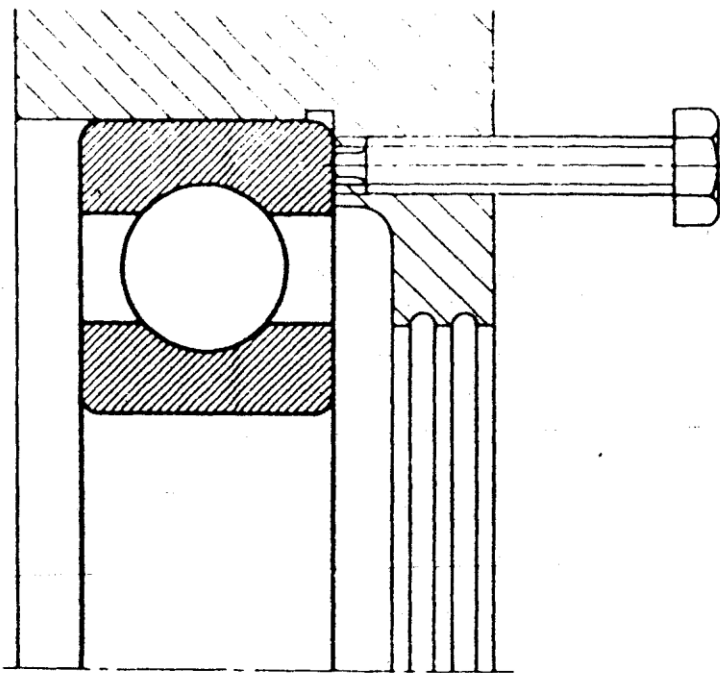
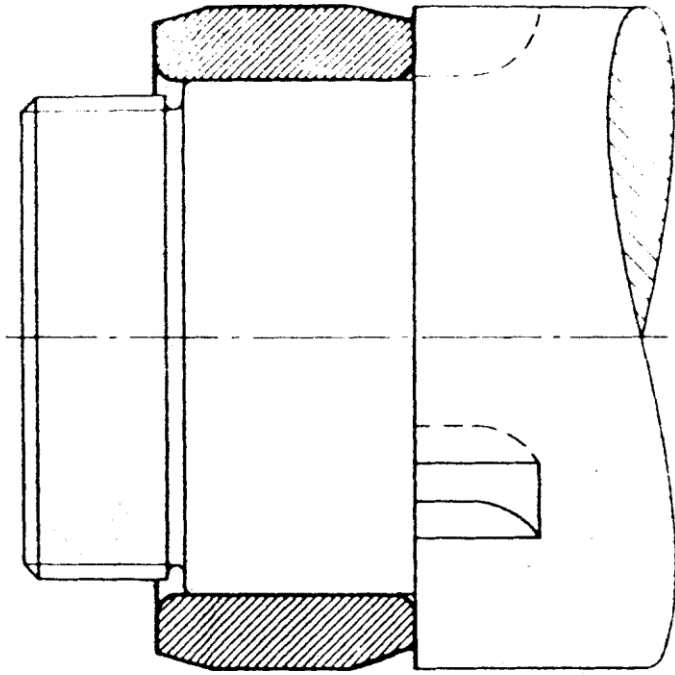


FIG 14 : DISMOUNTING OF BEARING – MECHANICAL METHOD
(Clause 4.2.1.2)

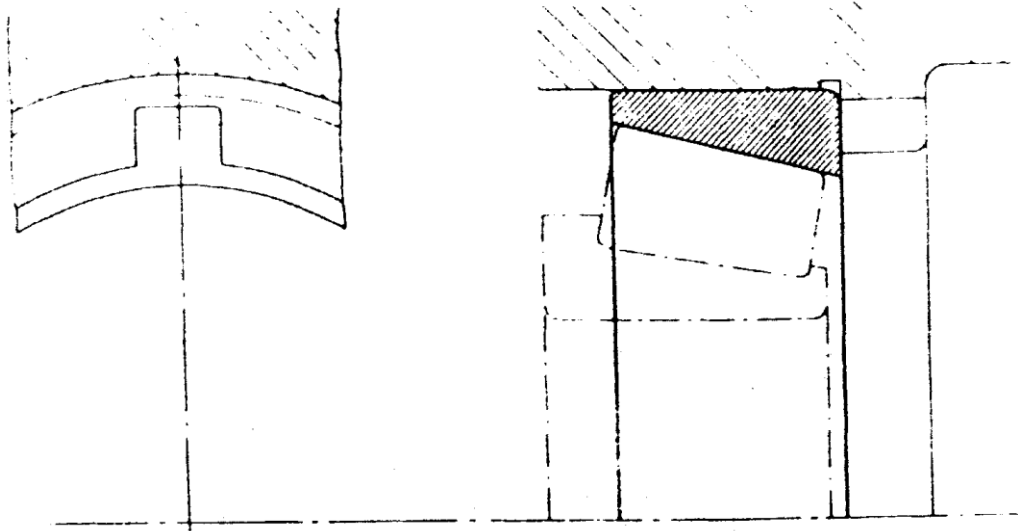


FIG 15 : DISMOUNTING OF BEARING – MECHANICAL METHOD (Cont.)
(Clause 4.2.1.2)

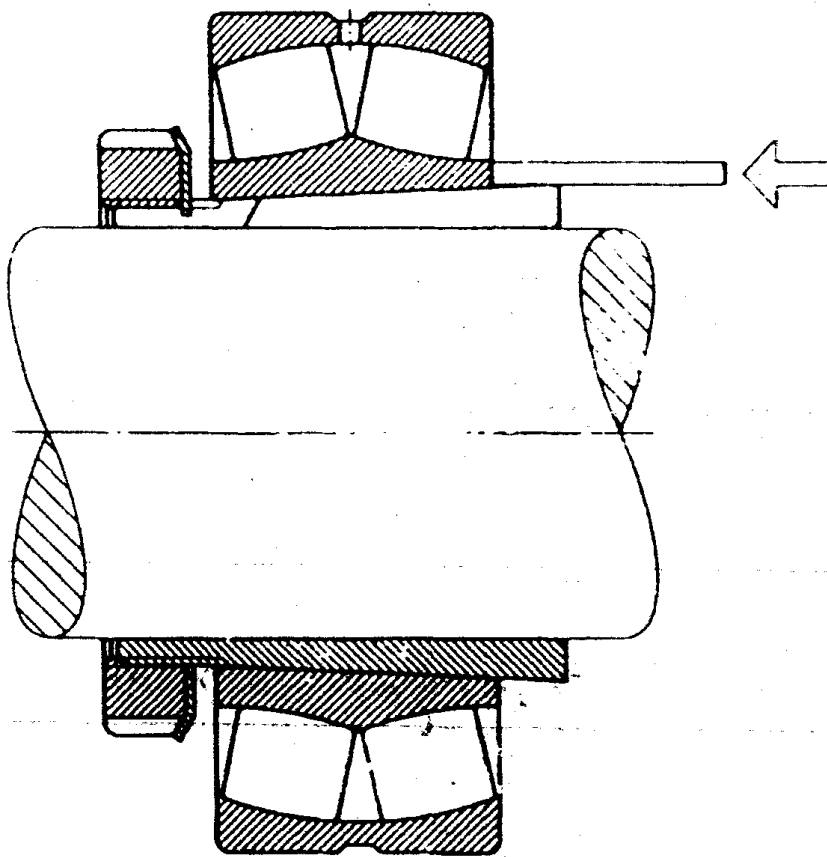
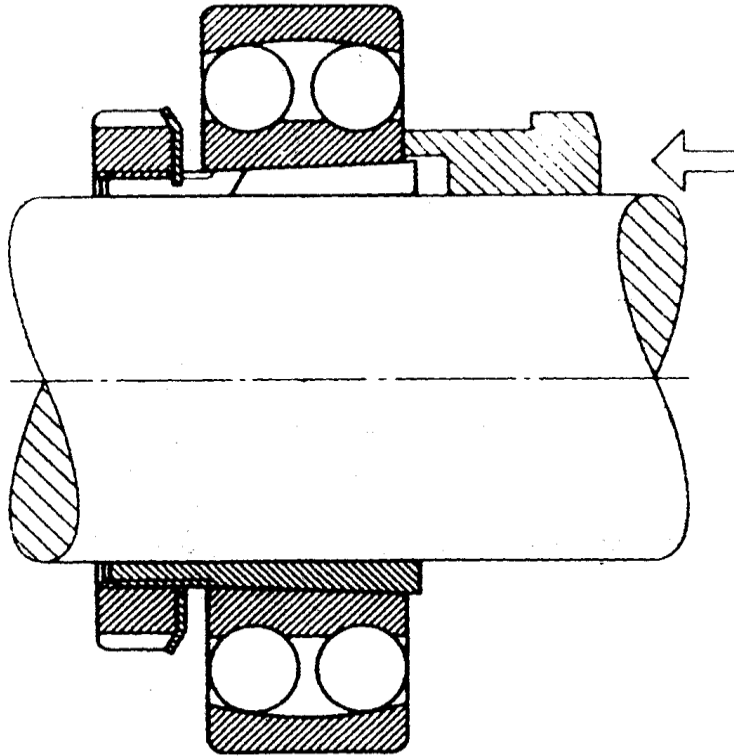


FIG 16 : DISMOUNTING OF ADAPTER SLEEV MOUNTED BEARING
(Clause 4.2.2.1)



**FIG 17 : DISMOUNTING OF ADAPTER SLEEV MOUNTED BEARING (Cont.)
(Clause 4.2.2.1)**

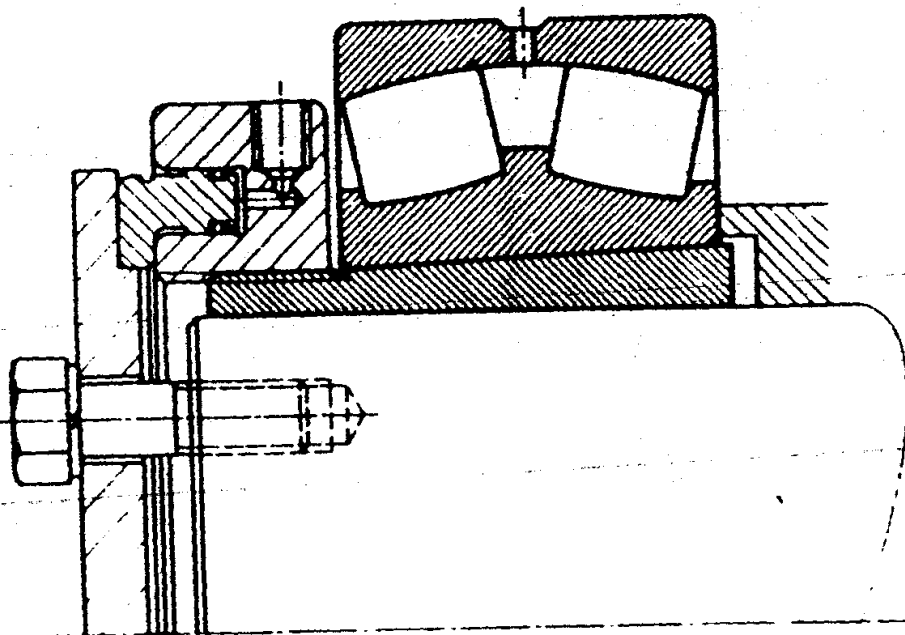


FIG 18 : DISMOUNTING OF ADAPTER SLEEVE MOUNTED BEARING (Cont.)
(Claus 4.2.2.1)

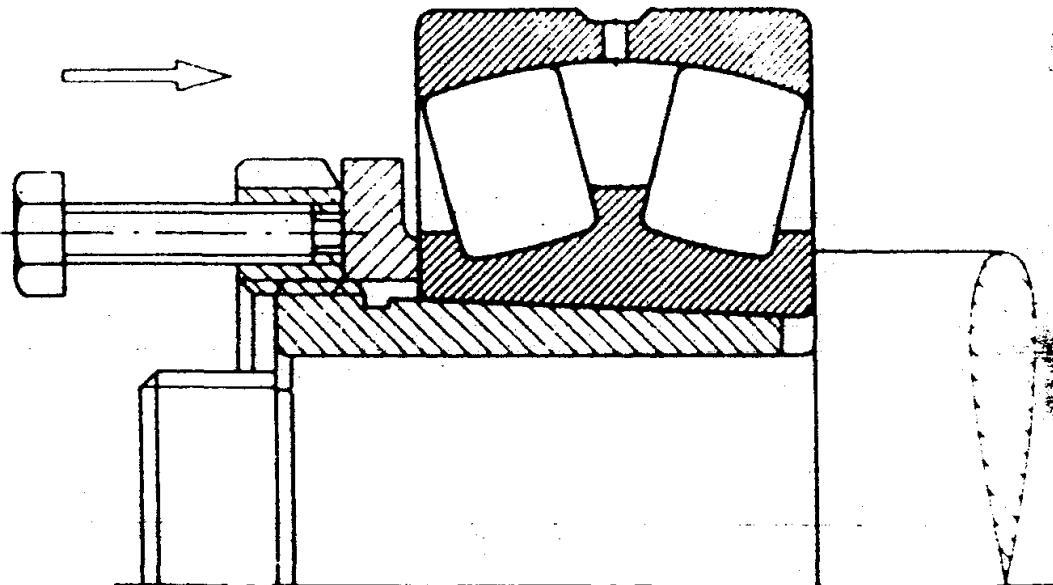
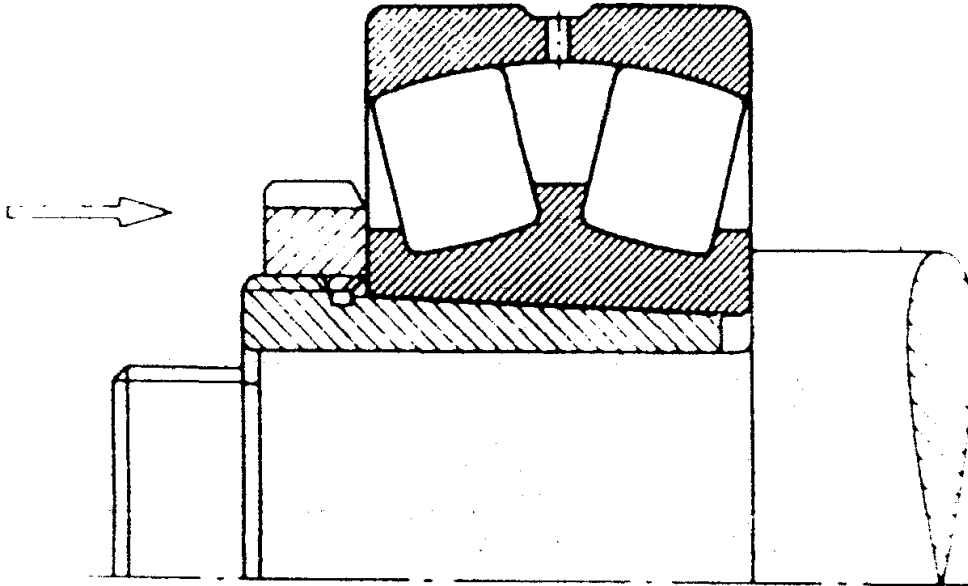
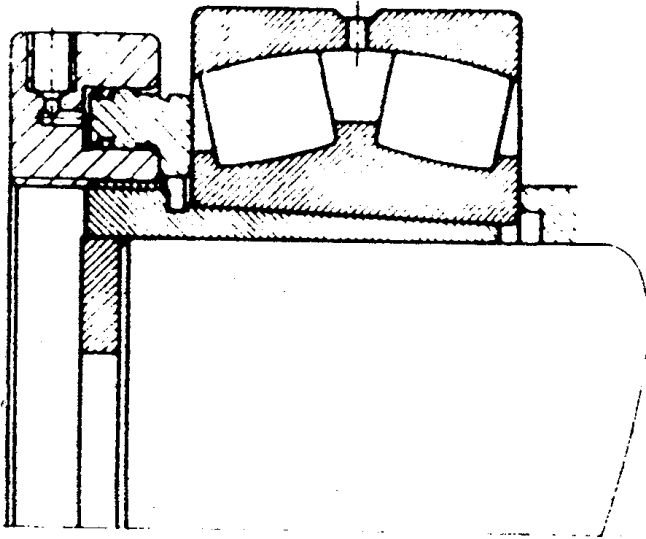


FIG 19 : DISMOUNTING OF WITHDRAWAL SLEEVE MOUNTED BEARING
(Clause 4.2.2.2.)



**FIG 20 : DISMOUNTING OF WITHDRAWAL SLEEVE MOUNTED BEARING
(Cont.) (Clause 4.2.2.2)**

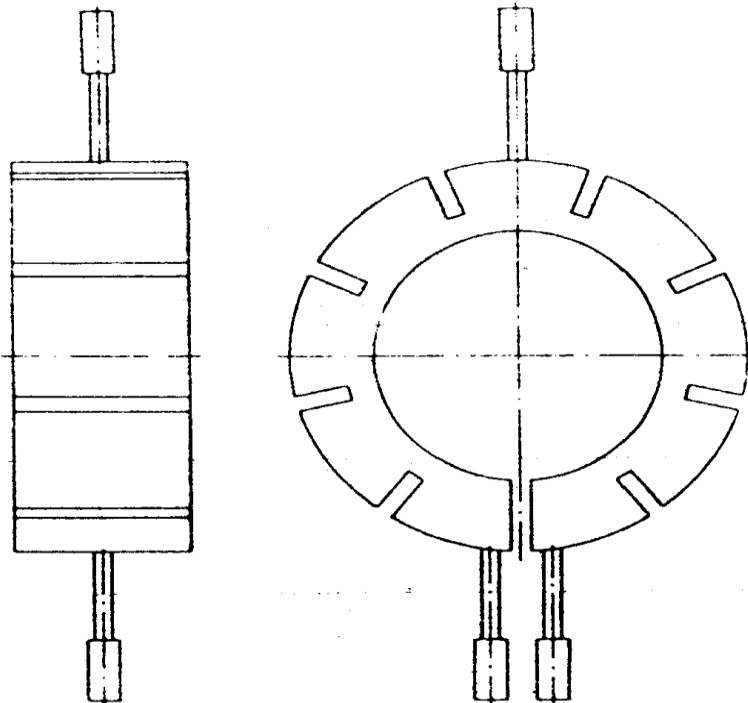


FIG 21 : HEATING RING (Clause 4.4.1)

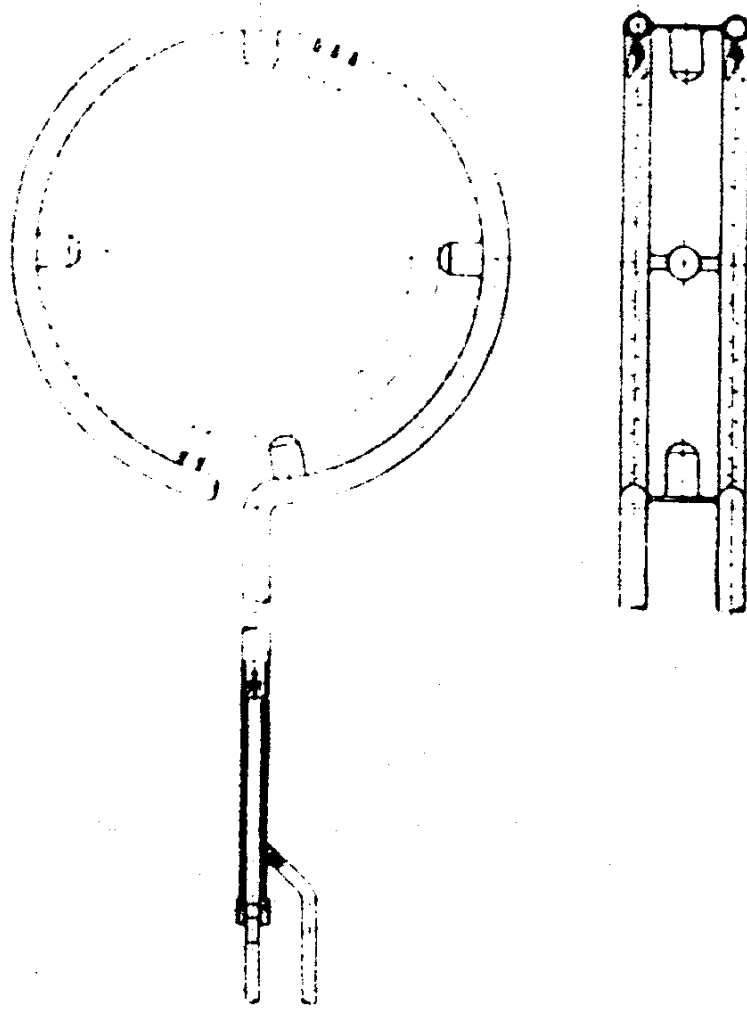


FIG 22 : RING BURNER (Clause 4.4.3.3)