READING MATERIAL

ON

"BEARING-FITTING"

& LUBRICATION

ROURKELA STEEL PLANT
STEEL AUTHORITY OF INDIA LIMITED

ENGG. MAINT. GROUP, R.S.P

THE FITTING OF BEARINGS

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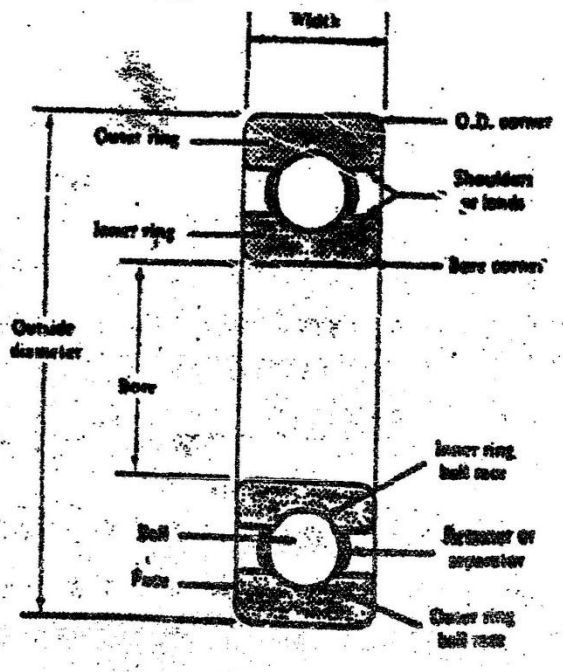
PART 1 - TYPES OF BEARING

(A) Ball and roller bearings (antifriction)

This type of bearing (as the name suggests) consists of :

- rolling elements that are either balls (ball bearings) or rollers (roller bearings). The rollers may be either cylindrical or tapered.
- inner and outer rings (casings). For ball bearings these have specially shaped recesses (ball races) to contain and enclose the balls within the casing.
- a retainer or separator which spaces the balls or rollers evenly within the casing.

The section across a typical ball bearing is as follows:



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The balls, rollers and casings are usually made from carbon or special alloy steels and are then hardened and ground to a fine surface finish. The retainer or seperator is usually made out of gun metal.

Ball and roller bearings come in various designs to cater for radial, thrust and combined radial/thrust loads. They are used in preference to other types of bearing for the following main reasons:

- the co-efficient of friction is lower, that is, there is less resistance offered by the surfaces in contact due to the rolling action over the casing surface.
- the starting resistance is low. This is again due to the rolling action.
- the bearings are shorter and generally more compact.
- wear is very small if the bearings are properly lubricated.
- they do not need any adjustment such as scraping to fit them to the shaft or housing.

The main types of ball bearing and roller bearings are as follows :

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TYPES OF BALL AND ROLLER BEARINGS

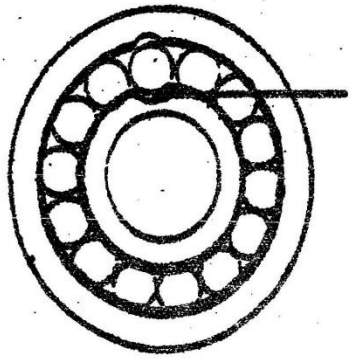
Illustrated below are some of the many types of ball and roller bearings in common use.

1. Single Row Deep Groove Bearing

A most widely used bearing which will take both Journal and Thrust loads.

2. Single Row Deep Groove Bearing with Filling Slot

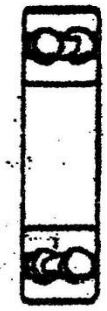
The filling slot allows the manufacturer to put in more ball elements than normal, this enables it to take greater journal loads.



Filling Slot

3. Double Row Rigid Ball Bearings

For heavy journal loads and to provide greater rigidity.

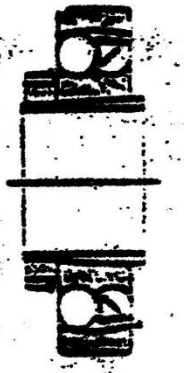


4. Double Row Self Aligning Ball Bearing

The spherical track of the outer ring allows this bearing to accept mis-alignment between shafts.

5. Double Row Self Aligning Ball Bearing with Adaptor Sleeve

This bearing is produced with a tapered bore to match the tapered adaptor sleeve. The adaptor sleeve permits easy assembly of the bearing to a shaft.



6. Single Row Angular Contact Bearing

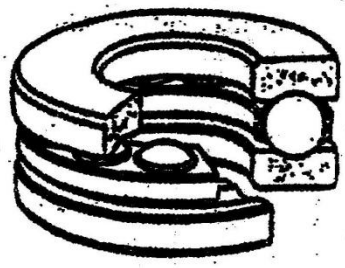
Takes journal loads and also gives precise location under one 'directional' thrust loads.

7. Duplex Bearing

This bearing is designed to take thrust loads in both directions.

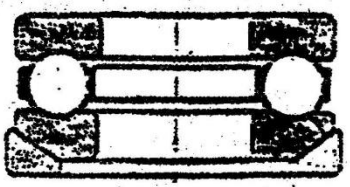
8. Single Row Thrust Bearing

Takes heavy thrust loads in one direction only. Will not accept any journal loads.



9. Aligning Thrust Bearing

A single row thrust bearing with spherical housing and seating ring to correct initial mis-alignment.



10. Single Row Cylindrical Roller Bearing

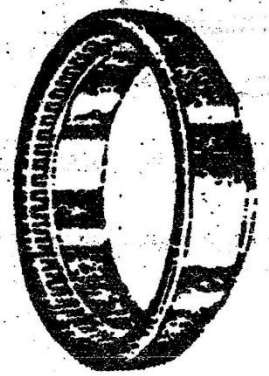
The basic type, used for heavy journal loads will not take any thrust loads.

11. Lipped Roller Bearings

Single and double lipped to locate assemblies in one or both directions. They will take some 2" thrust loading against the lip.

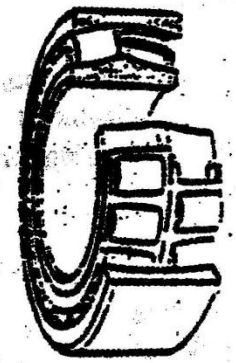
12. Needle Roller Bearing

Light bearings for use where space and weight are restricted.



13. Barrell Roller Bearings

Spherical roller bearings - single or double track have the advantage of being self-aligning.



14. Taper Roller Bearings

Have a high weight carrying capacity radially and also take high thrust loads in one direction.

Taper Roller Bearings Are -

- Normally mounted in pairs on the shaft to oppose each other's thrust. Can carry high radial and thrust loads but are not used for high speed applications.

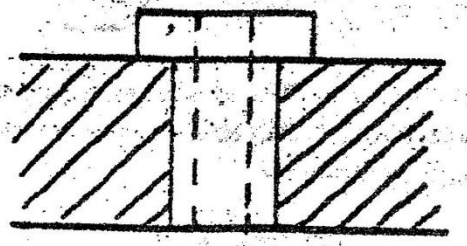
(B) Plain and Sleeve Bearings

Plain and sleeve bearings come in various designs to cater for radial, thrust and combined radial/thrust loads. They are used in preference to other types of bearing for the following main reasons:

- where the bearing must have the smallest possible diameter
- where noise must be reduced
- for high speed applications
- for high radial loadings
- for long life
- where adjustment for wear is desirable

There are three main types of plain bearings. They are:

Solid - The simplest type of bearing. Normally consists of a machined bush (generally made of brass) fitted into the bore of the bearing housing to cater for radial loads. The bush may have a collar to cater for thrust loading.



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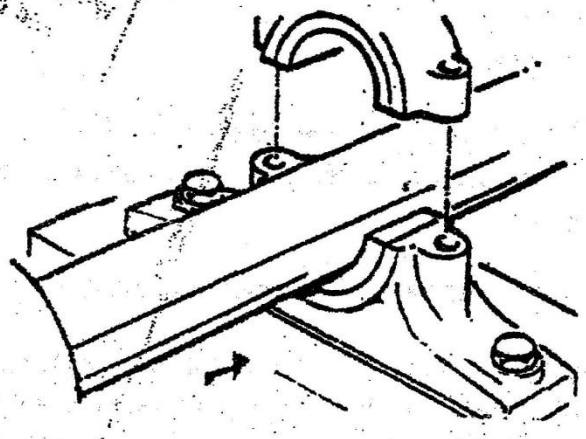
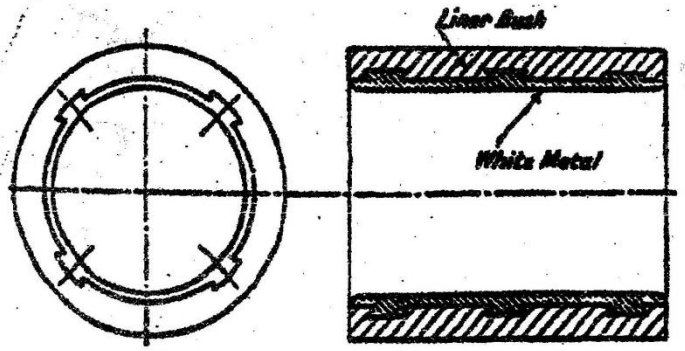
Divided - Pre machined bearings normally divided into two halves at a 90 degree angle to the load pressure. The half bearing (Called Shells) fit into the half housing (called pedestal

or plummer blocks) which are then bolted together to form the complete bearing. The bearing material can be brass, phospher bronze, gunmetal, nylon or other synthetic materials. Normally used for low speed applications and high radial loads.



Metalled - It nearly all cases white metal is poured in a molten state into the joined bearing housings. After cooling the housing bore is then machined to the approximate shaft size. Final fitting is carried out by scraping the bearing. Suitable for large bearings and high speed applications.



PART 2 - IDENTIFYING BALL AND ROLLER BEARINGS

When renewing a ball or roller bearing the replacement must be absolutely identical to the one removed.

Bearings often look identical but may differ in dimensional limits, material specification or in the type of heat treatment given to the component parts.

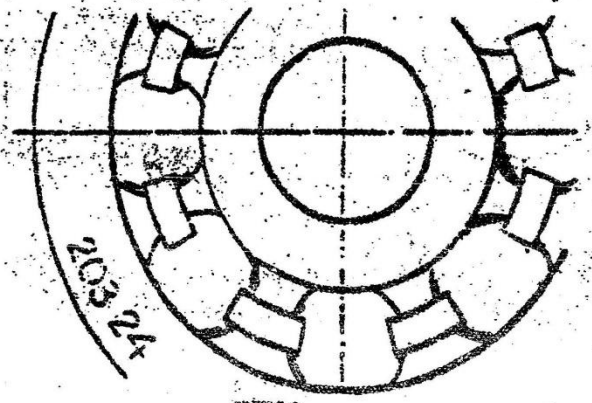
If an identical bearing is not available, a satisfactory equivalent can be identified by consulting the manufacturer's equivalent bearing list.

Each bearing manufacturer has a system of numbering bearings.

The number is used to identify a particular bearing but also gives information on dimensions, type and the maximum working temperature. The manufacturer's catalogue will contain this information and explain what each digit or combination of digits means.

The number is usually stamped on the edge of the outer case.

Always note the number of a bearing which is to be renewed to ensure that it is replaced with the identical or correct equivalent bearing.



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DESIGNATION OF ANTIFRICTION BEARINGS

Every bearing of standard dimentions is designated by unequivocal symbols. This denotes the bearing type, dimention series, and bore diameter. By multiplying the last two digits by five the bearing bore is obtained. For example:

Bearing no 6208, will have bore daimeter of 08 X 5 =40 mm. This rule is valid only for bearings with a diameter larger than 20mm. For diameter upto 20 mm the size of the bore is denoted as follows :

00 SAY (6200) DENOTES A BORE DIA. OF 10 MM
01 SAY (6201) DENOTES ----------12 MM
02 SAY (6202) DENOTES ----------15 MM
03 SAY (6203) DENOTES ---------- 17 MM

A bearing with a bore upto 10mm is designated by attaching the bore diameter dimention in millimetres to the bearing symble i.e. bearing no EL5 indicates a single row ball bearing with 5 mm bore.

BEARING TABLES

1- SINGLE ROW DEEP GROOVE BALL BEARINGS:
SERIES : EL, R, 60, 62, 63, 64.

2- SINGLE ROW ANGULAR CONTACT BALL BEARINGS:
SERIES: - 72, 73.

3 - DOUBLE ROW SELF ALIGNING BALL BEARINGS:
SERIES:- 133, 12, 22, 13, 23, 115.

4-DOUBLE ROW ANGULAR CONTACT BALL BEARINGS:
SERIES : 32, 33

5 - SINGLE AND DOUBLE ROW CYLINDRICAL ROLLER

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BEARINGS:

SERIES: NU10, NU2, NJ2. N2, NU22, NJ22, NU3, NJ3, N3, NU23, NJ23, NU4, NJ4, N4.

6- NEEDLE ROLLER BEARINGS:
SERIES: - 49, 40.

7. DOUBLE ROW SELF ALIGNING ROLLER BEARINGS:
SERIES:- 230, 231, 222, 232 223.

8 - TAPER ROLLER BEARINGS
SERIES: 302, 322, 303, 313 323.

9 - SINGLE THRUST BALL BEARINGS:
SERIES: 511, 512, 513, 514.

10- DOUBLE THRUST BALL BEARINGS:
SERIES: 522, 523, 524.

11. SELF ALIGNING THRUST ROLLER BEARINGS:
SERIES: 292, 293, 294.

ADAPTER SLEEVE THICKNESS FOR TAPER BORE BEARINGS

FOR BEARING NO 12K, 22K, 13K, 23K.

BRG. NO.	SLEEVE THICKNESS (TOTAL)
1204K	3MM
1205K TO 1213K	5MM
1215K TO 1222K	10MM
23024K	10MM
23026K TO 23030K	15MM
23032K TO 23064K	20MM

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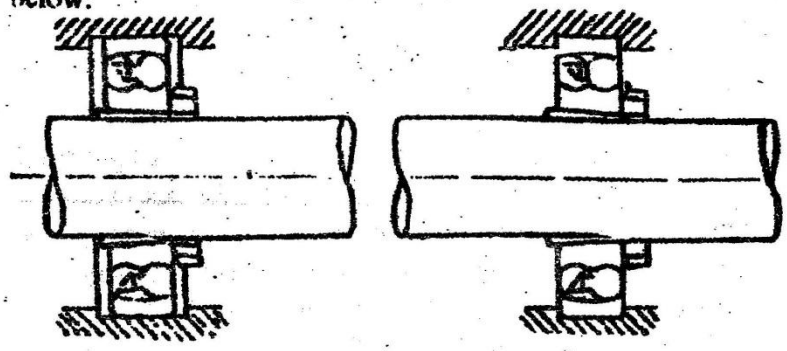
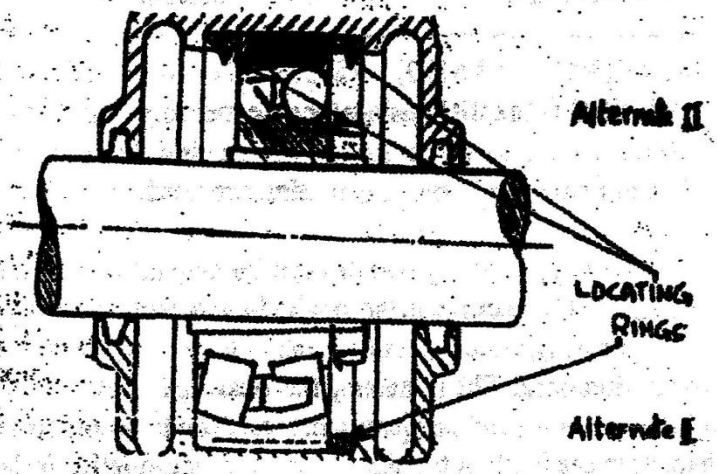
22206K TO 22213K	5MM
22215K TO 22224K	10MM
22226K TO 22230K	15MM
22232K TO 22264K	20MM

LOCATING. (FIXED) BEARINGS & FLOATING BEARINGS :- In split housings the outer bearing ring has always a slide fit to prevent oval compression of the ring. To ensure a tight fit of outer rings solid bearing housing are used.

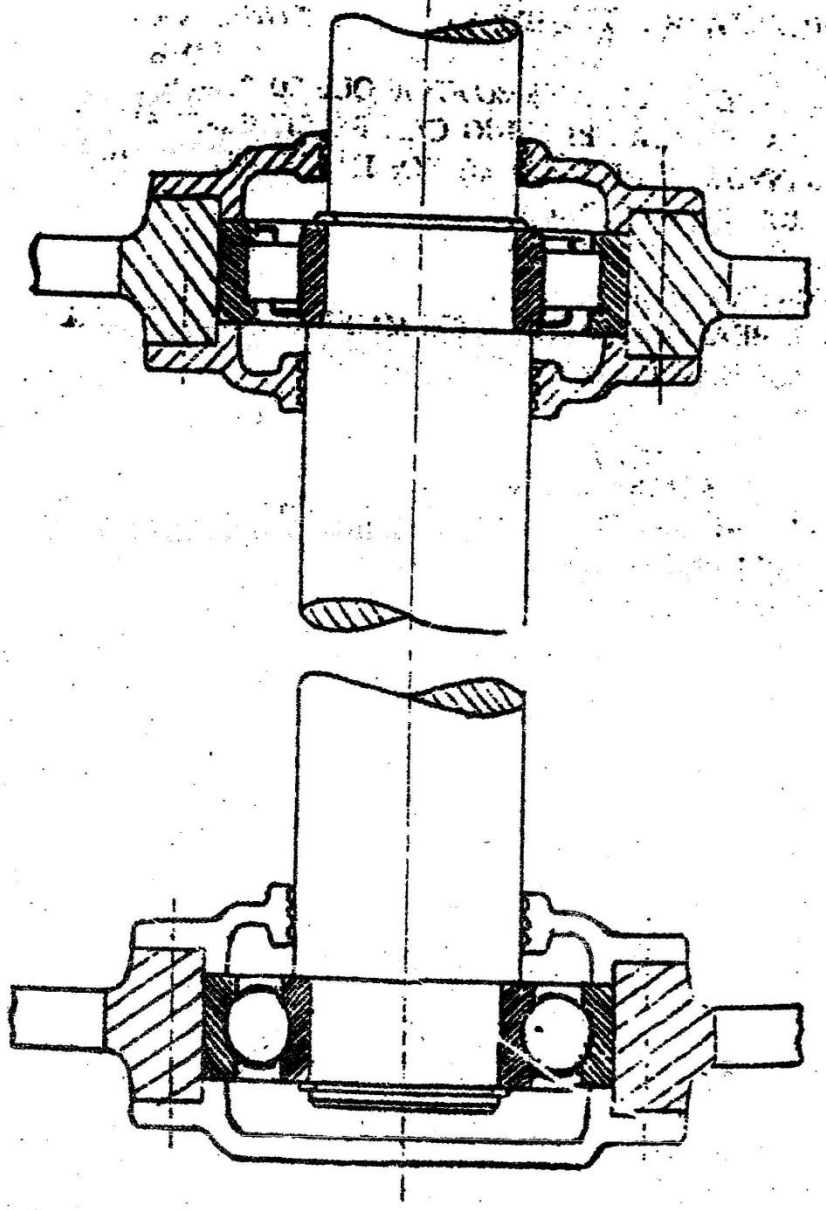
A shaft supported by two or even by several non separable bearingsmust be secured in the longitudinal direction by only one locating bearing which sustains the axial load components acting in both directions. The remaining free bearings must have a slide fit in the housing and adequate axial freedom to accomodate the changes in the lenth of the shaft. This bearing mounting is shown below:



A locating bearing is positioned by the insertion of one locating ring on the same side of the bearing as the adapter sleeve nut or by means of two rings placed on each side of the bearing as shown below.



Sometimes the given operating conditions require a tight fit of both the inner and the outer bearing rings as in the case of electric motors, dynamometers, etc. In such cases a bearing arrangement with one single row deep groove ball bearing and one single row cylindrical roller bearing with flanges on one of the rings only is useful and appropriate assembly. The outer rings of the bearings are always axially located because the possibility of mutual displacement of both rings of the single row cylindrical roller bearing permits thermal expansion of the shaft. This type of mounting is shown below.



Mounting of Electric Motor Shaft

SPLIT BEARING HOUSINGS

THE SIZE OF PLUMMER BLOCK REQUIRED TO ASSEMBLE A TAPER BORE BEARING CAN BE DETERMINED BY ADDING 3 IN THE THIRD DIGIT OF THE BEARING NUMBER (FROM RIGHT SIDE).

FOR EXAMPLE:
FOR BEARING NO 22318K, PLUMMER BLOCK SIZE WILL BE ----- 318
+3

S - 618

SIMILARILY FOR BEARING NO.1213K, PLUMMER BLOCK SIZE WILL BE

213
+3

S-513

PART 3 - HANDLING AND STORING BEARINGS

A bearing is a precision made item and as such can be damaged if it is badly handled or stored. Even improper handling during replacement may damage.

By following the guidelines listed below, damage will be prevented from occuring.

(a) Bearings are usually protected by a film of light oil or grease and wrapped in greaseproof paper before they leave the manufacturer's premises. Keep all bearings in the manufacturer's wrappings until required for use.

(b) Store bearings in a place where they cannot be damaged. Damage can be caused by heat, water, dirt, corrosive substances or when other stored equipment is moved.

(c) Store bearing shells in rows or on end. NEVER stack them one on top of another.

(d) Handle bearings carefully after removing the manufacturer's wrapping. Ensure that any surface on which a bearing is placed is clean.

(e) Take care not to scratch or mark the bearing surfaces of metalled or shell bearings.

(f) If a bearing is too heavy to be lifted manually, make sure that the lifting gear does not damage or distort the bearing.

(g) If a bearing is to be returned unused, make sure it is oiled and re-wrapped properly.

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PART 4 - LUBRICATION OF BEARINGS

When a metallic surface moves over another metallic surface the motion is opposed by a resistance along the surface in contact. This resistance is known as friction. Friction causes wear and generates heat. The heat generated can be sufficient to weld similar materials together. To reduce the chances of this occuring, bearings are made of different materials to the surface with which they will be in contact.

Substances which reduce friction are called lubricants. Lubricants can be solid, liquid or gas. The most common lubricants in everyday use are oils and greases.

In bearings. friction may be either sliding or rolling friction. Sliding friction is highest when movement begins but lessens as the speed increases. Rolling friction is much lower then sliding friction and can be as little as one tenth of that caused by sliding friction. Friction is reduced significantly by proper Lubrication.

Proper lubrication is essential to maintain the efficiency and to prolong the life of all types of bearing.

The lubrication of a bearing serves four main purposes.
These are:

- to reduce friction
- to reduce wear
- to remove the heat from the bearing by the flow of the lubricant
- to protect the bearing from contaminants

Plain and sleeve bearings are usually lubricated with oil. Ball and roller bearings are usually lubricated with grease although those used for high speed applications may need The following guidelines if followed will reduce the possibility of lubrication failure.

(a) Establish the type and grade of lubricant recommended by the bearing or machine manufacturer.

(b) If the recommended lubricant is not available, consult the lubrication chart to identify a suitable alternative.

(c) NEVER mix different types or grades of lubricant.

(d) Make sure that the oilcan, grease gun or applicator are clean and free of contaminants.

(e) Take care when removing oil or grease caps that dirt does not enter the bearing.

(f) Look out for signs of contamination. A milky appearance suggests that water has contaminated the oil or grease. Hard grease suggests that the bearing is running hot. Other indicators are given on the lubrication chart.

(g) Check the level or quantity of lubricant and top-up as necessary.

(h) DO NOT overfill the bearing with lubricant.

(j) ALWAYS replace the oil or grease cap.

REMEMBER - LUBRICATION TO BEARINGS IS LIKE BLOOD TO A HUMAN BEING. THEY CANNOT SURVIVE WITHOUT IT.

PART 5 - METHODS OF REMOVING BEARINGS

SAFETY NOTE

Before carrying out work on any bearing, the drive must be isolated and locked off electrically and mechanically and a Permit to Work must be obtained from a responsible person.

GENERAL

There are a number of methods which may be used to remove a bearing. The selection of a method will generally depend on:

- **whether the bearing is to be re-used**
- **the tools and equipment available**
- **the accessability of the bearing**
- **the time available.**

Before selecting a method, work through the following checklist to establish :

- **if lifting gear will be required**
- **that a replacement bearing is available**
- **that the tools and equipment are available to dismantle any components prior to withdrawing the bearing**
- **the types of fit (interference) that will have to be overcome**
- **the time available to carry out the work**
- **that the ideal withdrawal method can be used**

REMEMBER THE SHAFT MAY NEED SUPPORTING BY LIFTING GEAR OR BLOCKS AND WEDGES.

The time taken to replace the bearing will be reduced if you have the correct tools and tackle and the correct replacement available before you start.

(A) Methods of removing ball and roller bearings

There are several non destructive methods of removing bearings.

They are:

- by carefull tapping with a soft mallet for bearings which are only push fitted to the shaft or housing
- using a bearing puller (which can be hydraulically or mechanically operated)
- by using a bench press in the workshop. This method is used when the shaft can be easily removed or when the bearing is large and fitted very tightly.

There are also a number of destructive methods of removing bearings. They are:

- Cold cutting by chisel
- Cutting by grinding. This method should only be used by personnel trained in the use of powered hand tools.
- Oxy-acetylene cutting. This method should only be used by personnel trained in burning techniques.

(B) Methods of removing plain or sleeve bearings

Solid bearings have to be extracted or pressed out in much the same way as ball and roller bearings. They can also be removed fairly easily by careful chiseling as the bearings metal is soft in comparison to the shaft and housing.

Divided and metalled bearings are easily removed by simply removing the housing bolts and separating the two halves.

PART 6 INSPECTION OF BEARINGS

SAFETY NOTE

Before carrying out work on any bearing, the drive must be isolated and locked off electrically and mechanically and a Permit to Work must be obtained from a responsible person.

General

Develop the habit of listening to the sounds made by running machinery. Damaged bearings make a noise. Experienced listeners can detect these noises before the bearing becomes too badly damaged to function properly.

If possible, when examining a bearing removed from a machine, compare it with a new identical bearing in order to establish the overall condition and likely degree of wear.

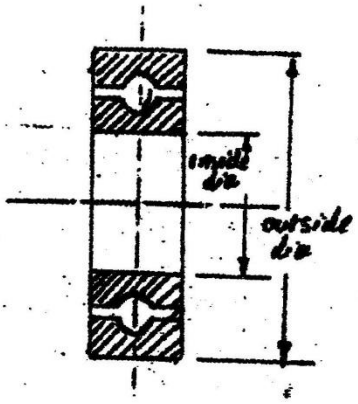
A bearing which is to be returned to the manufacturer for examination should NOT be cleaned. They will want to examine it just as it was removed.

Ball and rollers bearings

Do NOT spin the bearing after its removal from the shaft or housing as dirt or other material may have entered the rolling elements during bearing removal.

Carry out the following inspection routine:

- Visually check the working faces and sides of the bearing for signs of damage
- Check the inside and outside diameter using appropriate micrometers.



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- Check the lubricant for the presence of steel/brass particles or dirt and for lubricant hardness or dryness

- Clean the bearing using the following procedure:

  1. Remove as much of the old lubricant as possible by careful wiping with a soft cloth.

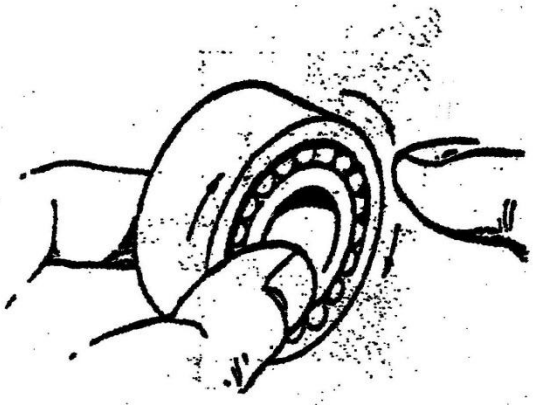
  2. Immerse the bearing in degreasing fluid or solvent held in a suitably sized container.

  3. After soaking, clean the bearing with a soft brush while rotating it slowly.

  4. Change the cleaning fluid as often as is necessary.

  5. Dry off using a soft non fluffy cloth and then lightly oil the bearing.

- Spin the bearing and listen to the noise it makes. If possible, compare it to the noise made by a new bearing. Damage to the rolling surfaces can be heard quite plainly.



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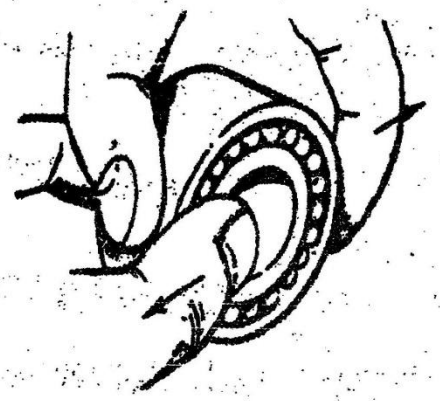
Juggle the bearing in the hands to feel for undue movement in the bearing. If possible compare it with the movement in a new bearing.



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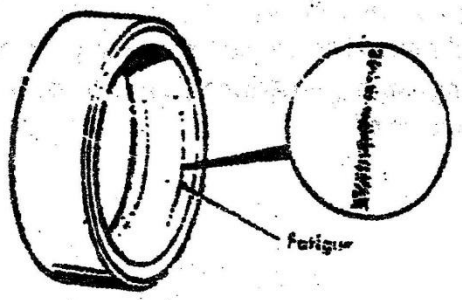
Inspect the bearing visually for signs of:

1. Rust stains
2. Discolouration
3. Cracks
4. Indentations or marks
5. Wear areas or tracks

Common faults found in ball and roller bearings

1. Normal fatigue: The bearing has reached the end of its life and must be replaced. This is characterised by visible and quite deep wear tracks made by the balls or rollers on the inside of the casing.



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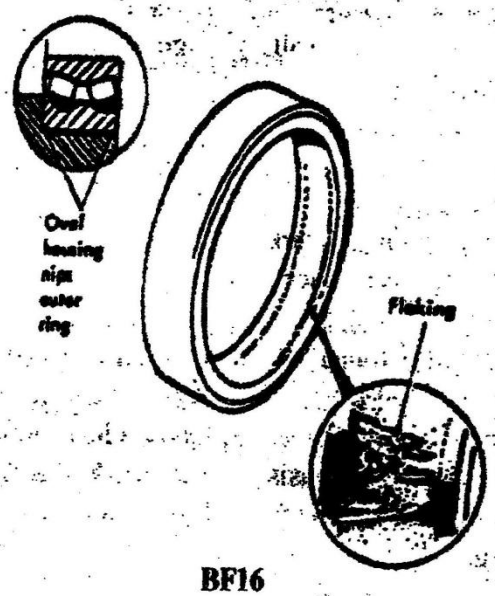
2. Faulty housing Flaking at opposite points on the inside of the casing caused by fitting of the bearing in a housing that is not round but oval. Replace the bearing and check the housing.



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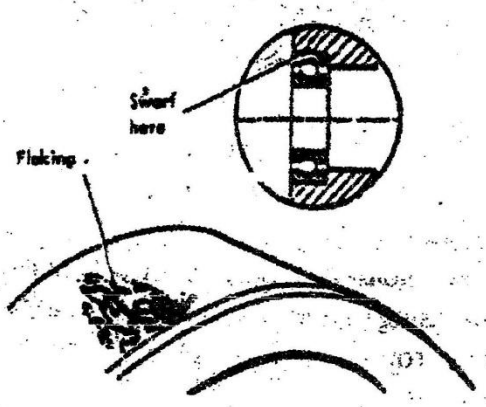
3. Dirt between the housing and the bearing outer case - Caused by swarf or solid material becoming trapped in between the housing and casing resulting in flacking of the outer casing. The bearing must be replaced.



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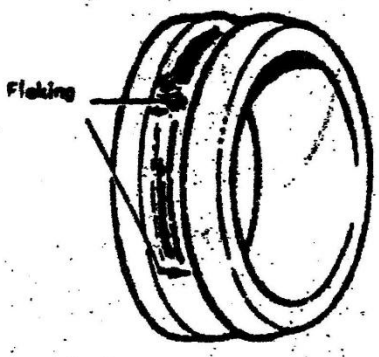
4. Track flaking can be caused by lack of lubrication or by striking the outer ring when fitting the bearing to the shaft. The bearing must be replaced.



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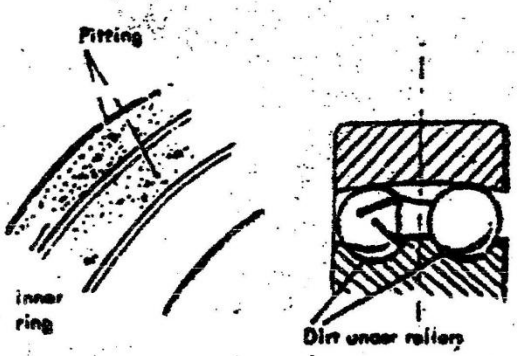
5. Dirt in the bearing - Causing pitting on the tracks balls and rollers. The bearing must be replaced.



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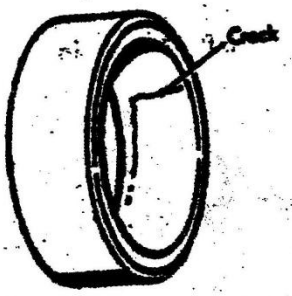
6. Casing crack - Usually caused by the outer case not being fully supported by the housing. The bearing must be replaced. Also examine the housing and repair or renew it.



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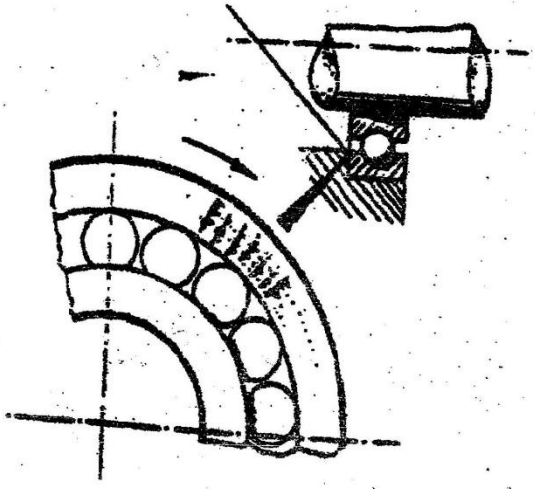
7. C reep - caused byincorrectly fitting either the inner casing to the shaft or the outer casing to the housing resulting in a slight rotary movement of the bearing casing. The bearing must be replaced.



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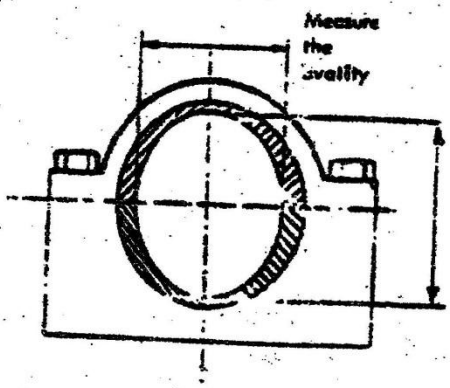
(C) Plain and Sleeve bearings

Carry out the following inspection routine :

- Check the lubricant for the presence of bearing metal or dirt.
- Visually check the working faces and sides of the bearing for signs of scouring or other damage.
- Check that divided bearing halves fit correctly into the housing.
- Check the inside and outside diameter using appropriate micrometers. If the bearing is oval in shape on the inside diameter, it is worn and may need replacing.



BF22

Examine metalled bearings for signs of blueing or melting.

PART 7 - FITTING OF BEARINGS

SAFETY NOTE

Before carrying out work on any bearing the drive must be isolated and locked off electrically and mechanically and a Permit to Work must be obtained from a responsible person.

If the bearing is too heavy to be lifted manually, ensure that a safe system of lifting is adopted.

TECHNIQUES USED TO FIT A BEARING

Four techniques are generally used to position bearings needing an interference fit. They are:

- tapping into position by using a soft mallet. Used for bearings needing only a push or light force fit.
- the use of heat to temporarily expand one of the components.
- the use of power to provide the force required in a controlled manner.
- freezing one of the components to cause it to temporarily contract.

In practice the last technique is rarely used in a steelworks and so can be ignored at this stage of training.
Two basic techniques are used to fit divided or metalled bearings

They are:

- machining the bearing to the required diamensions.
- scraping the bearings to obtain the required running fit.

Fitting Ball and Roller Bearings

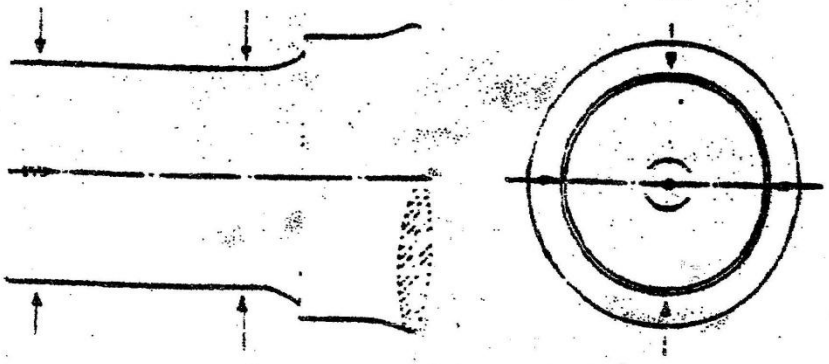
rules the fitter must be aware of class :-

(1) Absolute cleanliness is essential. Any partical of dirt entering the bearing will cause damage to the bearing as soon as it rotates.

(2) Keep the bearing in its original packing until actually required for fitting. This will protect the bearing from contamination from the atmosphere and from accidental damage.

(3) Make sure that the bearing is of the correct type, size and diametrical clearance for the purpose being fitted. The information is always on the outside of the bearing packing.

(4) Check the shaft and housing for size and roundness. The tolerance on size and roundness is extremely critical and should be measured with a micrometer in 4 positions.

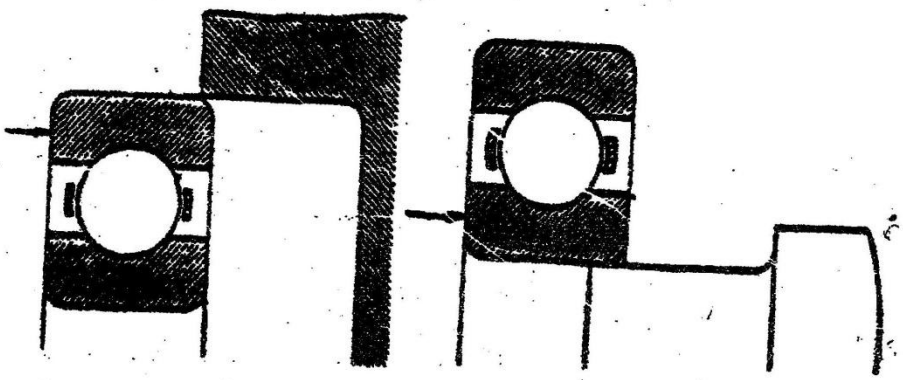


To Check the shape of the bearing seating, two micrometer readings should be taken at right angles at each end of seating.

(5) The shaft and housing must be free from burrs and damage. Burrs would be liable to break off and enter the bearing during use and any damage mark would affect the fit of the bearing.

(6) Mounting pressure must always be applied to the ring which is interference fit. To apply pressure to the wrong ring would cause damage to the bearing.

For a bearing being fitted into a floating wheel or loose pulley, the force to mount the bearing must be applied to the end face of the OUTER race.



For a bearing which is to be fitted on to a rotating shaft the force to mount the bearing must be applied to the end face of the INNER race.

—SAIL HRD

Preparing Split Bearing for Fitting

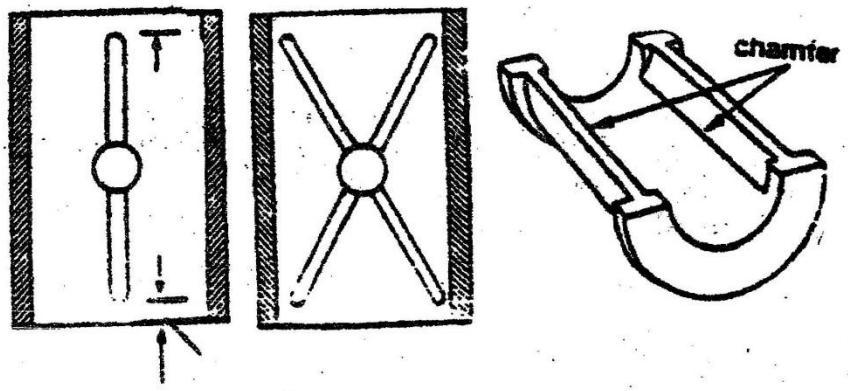
Before going into service some machined split bearings need final preparation by hand. These operations are chamfering, grooving and scraping to fit the shaft.

(1) Chamfering

Chamfers are cut along the split of the two halves of the bearing. They provide a reservoir for lubricating oil or grease.

(2) Grooving.

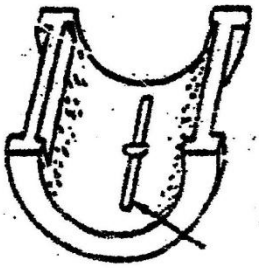
A hole is drilled in the middle of the top half of the bearing. Grooves are then cut from the hole towards the outer edges of the bearing. The grooves distribute the lubricant over a wide area of the bearing surface.



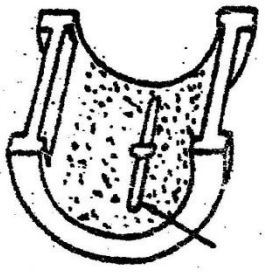
(3) Scraping to fit the Shaft

This process, often called 'bedding in', is carried out to make the bearing fit the shaft better. It reduces the amount of friction during running in.

The shaft is lightly coated with marking blue and rotated in the bearing. The high spots on the bearing are marked by the blue and can be skillfully removed by hand scraping. This process is repeated until the desired contact is obtained.



BAD - CONTACT HIGH UP THE SIDES OF THE BEARING

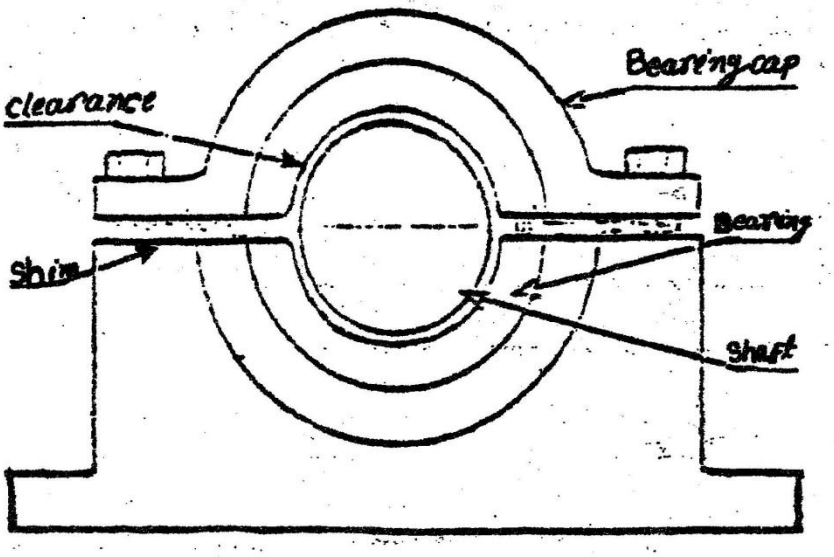


GOOD - CONTACT DOWN IN THE BOTTOM OF THE BEARING

Clearance in a Split Bearing

When a split bearing is assembled there must be a certain amount of clearance between the bearing and the shaft to pmit free movement. The clearance is obtained by placing shims between the two halves of the bearing. As the bearing wears some of the shims are removed to restore the clearance back to the correct amount.

Shims are made in varying thicknesses from sheet steel, brass, plastics or any material which does not compress under working conditions.



To Check the Clearance in a split bearing.

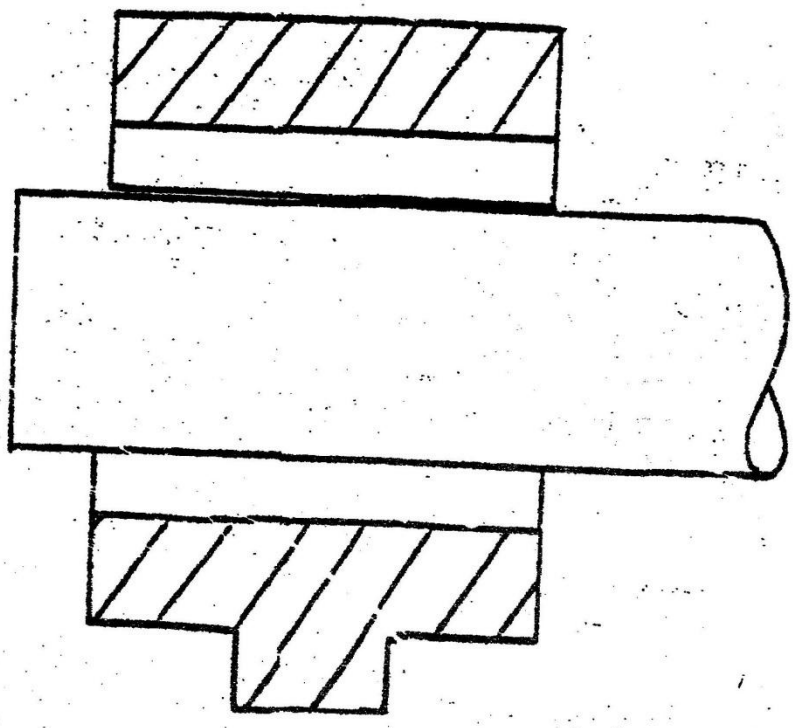
The clearance is always checked when the shaft is stationary. The gap between the top of the shaft and the top bearing is measured. Three common ways of checking the clearance are by using feeler gauges, soft lead wire or a dial test indicator and a

jack.

(1) Feeler Gauges

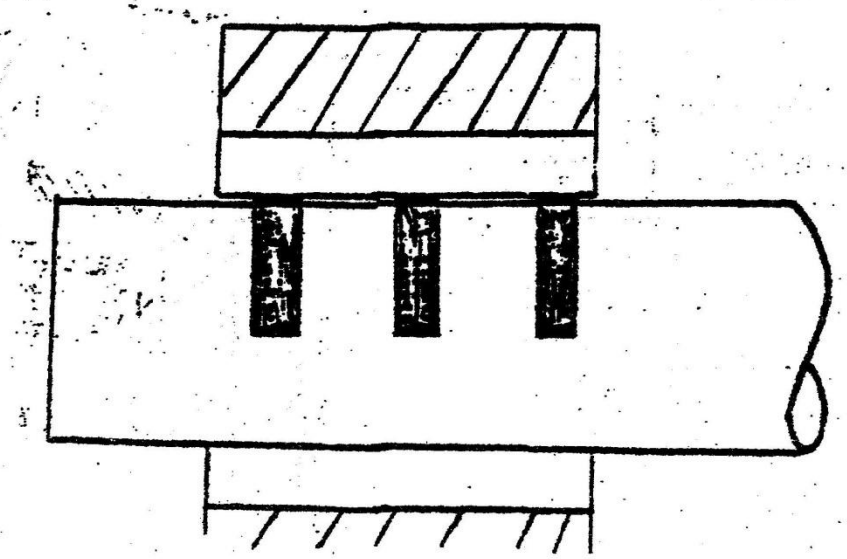
If the bearing is open at either end the clearance can easily be checked by using long feeler gauges.

FEELER GAUGE



(2) Soft Lead Wire

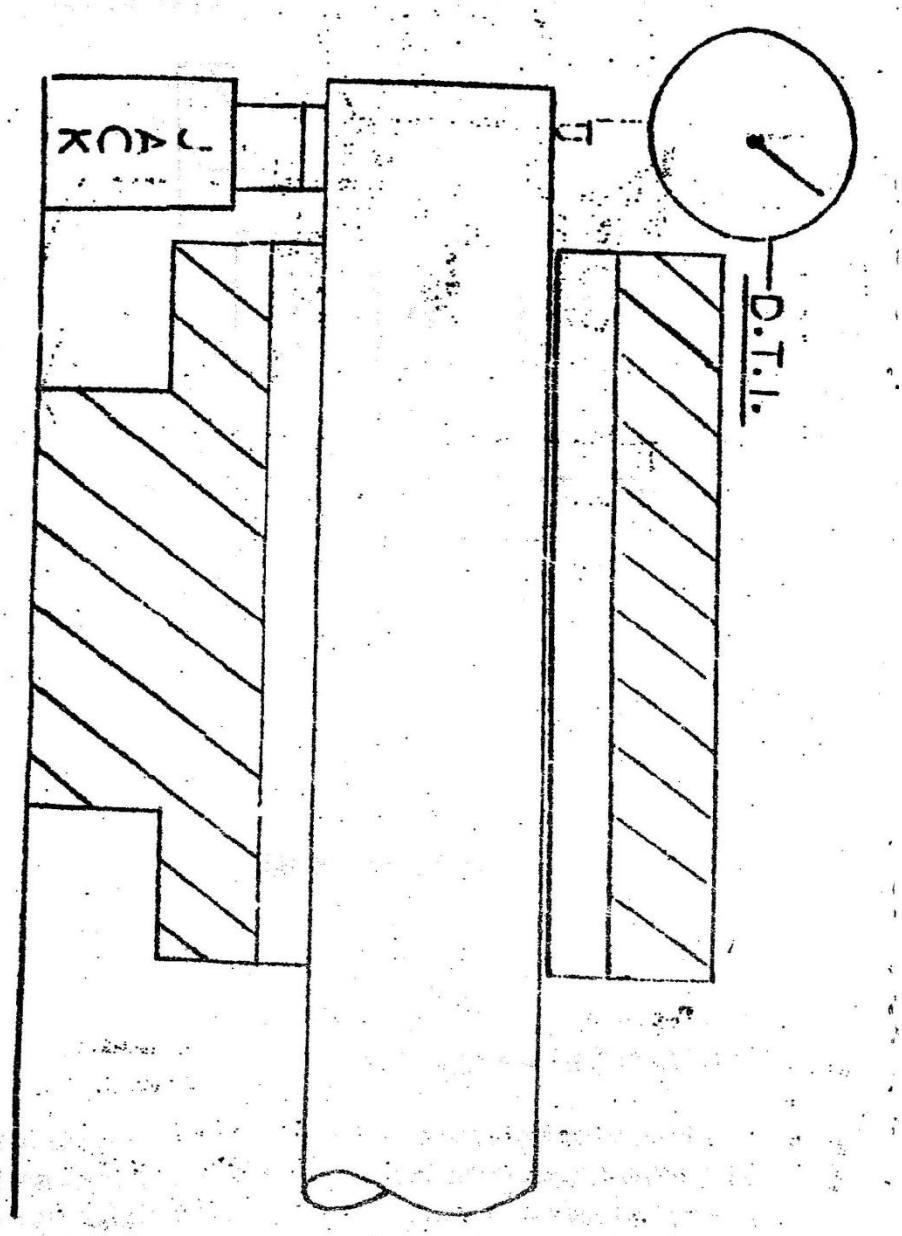
Strips of soft lead wire are placed onto the top of the shaft. The top half of the bearing and the bearing cap are placed back in position and tightened down. When the lead wire is removed, its thickness will be the same as the clearance in the bearing. The thickness of the wire is measured by using a micrometer and shim thickness can be calculated to give the correct clearance.



SOFT LEAD WIRE

(3) Dial Test Indicator and Jack

When the bearing is shielded at both ends and it is impossible to use feeler gauges an alternative method of testing clearance is by using the dial test indicator and jack. The dial test indicator is zeroed on the top of the shaft, the shaft is jacked up and the deflection on the gauge is noted. Adjustments in shimming are made from the information obtained.


D.T.I.

Instructions for Controlling the Clearance of Double-Row Self-Aligning Bearings with Tapered Bore during Mounting

Bearing Bore Diameter d, mm		Normal Operating Conditions for Bearings with Standard Radial Clearance			Very Severe Operating Conditions for Bearings with Radial clearance (C3[1])		
Over	Including	Decrease in Radial Clearance in Thousandth of a Millimetre [R]	Axial Displacement, mm	Minimum Radial Clearance after Mounting [R]	Decrease in Radial Clearance [μ]	Acial Displacement, (mm)	Minimum Radial Clearance after Mounting, [μ]
(30)	40	20 to 25	0.35 to 0.4	15 to 25	25 to 30	0.4 to 0.45	25 to 35
(40)	50	25 to 30	0.4 to 0.45	20 to 30	30 to 40	0.45 to 0.6	30 to 40
(50)	65	30 to 40	0.45 to 0.6	25 to 35	40 to 50	0.6 to 0.75	35 to 45
(65)	80	40 to 50	0.6 to 0.75	25 to 40	50 to 60	0.75 to 0.9	40 to 60
(80)	100	45 to 60	0.7 to 0.9	35 to 50	60 to 70	0.9 to 1.1	50 to 70
(100)	120	50 to 70	0.75 to 1.1	50 to 65	70 to 90	1.1. to 1.4	65 to 80
(120)	140	65 to 90	1.1. to 1.4	55 to 70	80 to 100	1.3 to 1.6	80 to 100
(140)	160	75 to 100	1.2 to 1.6	55 to 80	90 to 120	1.4 to 1.9	90 to 110
(160)	180	80 to 110	1.3 to 1.7	60 to 90	100 to 140	1.6 to 2.2	100 to 120
(180)	200	90 to 120	1.4 to 1.9	70 to 100	120 to 160	1.9 to 2.5	100 to 130
(200)	225	100 to 140	1.6 to 2.2	80 to 110	130 to 180	2 to 2.8	120 to 140
(225)	250	110 to 150	1.7 to 2.4	90 to 120	140 to 200	2.2 to 3.1	130 to 150

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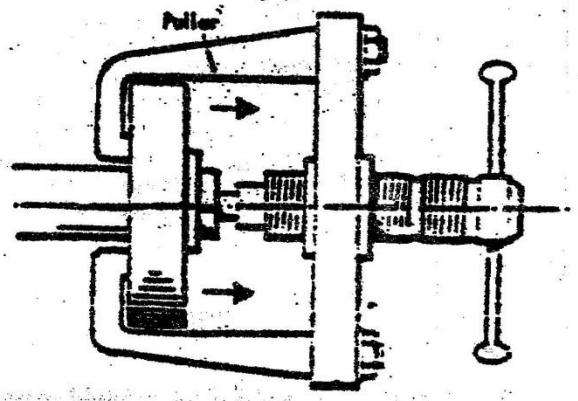
Instructions for Controlling the Clearance of Double-Row Self-Aligning Bearings with Tapered Bore during Mounting

Bearing Bore Diameter d, mm		Normal Operating Conditions for Bearings with Standard Radial Clearance			Very Severe Operating Conditions for Bearings with Radilal clearance (C3[1])		
Over	Including	Decrease in Radial Clearance in Thousandth of a Millimetre [μ]	Axial Displace-ment, mm	Minimum Radial Clearance after Mounting [μ]	Decrease in Radial Clearance, [μ]	Acial Displacement, (mm)	Minimum Radial Clearance after Mounting, [μ]
(250)	280	120 to 170	1.9 to 2.7	100 to 130	160 to 220	2.5 to 3.5	140 to 170
(280)	315	130 to 190	2 to 3	110 to 140	180 to 250	2.8 to 3.9	150 to 180
(315)	355	150 to 210	2.4 to 3.3	120 to 150	190 to 260	3 to 4	170 to 210
(355)	400	170 to 230	2.6 to 3.6	130 to 170	210 to 290	3.3 to 4.5	190 to 230
(400)	450	200 to 260	3.1 to 4	130 to 180	240 to 320	3.7 to 5	200 to 250
(450)	500	210 to 280	3.3 to 4.4	160 to 210	260 to 340	4 to 5.3	230 to 290
(500)	560	240 to 320	3.7 to 5	170 to 220	290 to 360	4.5 to 5.6	250 to 320
(560)	630	260 to 350	4 to 5.4	200 to 250	310 to 400	4.8 to 6.2	290 to 360
(630)	710	300 to 400	4.6 to 6.2	210 to 270	360 to 470	5.6 to 7.3	310 to 380
(710)	800	340 to 450	5.3 to 7	230 to 300	400 to 520	6.2 to 8	350 to 440
(800)	900	370 to 500	5.7 to 7.8	270 to 340	450 to 580	7 to 9	390 to 490
(900)	1000	410 to 550	6.3 to 8.5	300 to 380	600 to 650	7.8 to 10	430 to 540

USING A BEARING PULLER

This method is normally used for removing bearing from shafts

Step 1	- remove any bearing retaining nuts and lockwashers.
Step 2	- remove any burrs or marks from the shaft or housing with a file or emery cloth.
Step 3	- select the appropriate sized bearing puller and split plate ring
Step 4	- lubricate the area of shaft over which the bearing will travel.
Step 5	- lubricate the shaft end where the extractor screw will be tightened.
Step 6	- position the extractor and tighten the screw.



BF24

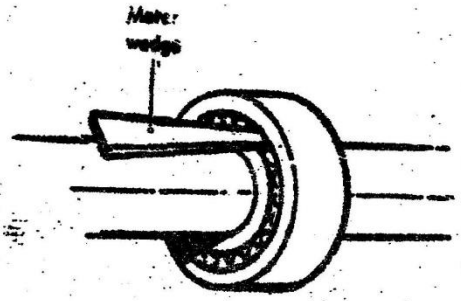
Step 7	- check that the bearing is moving smoothly.

EXERCISE 1 :

COLD CUTTING BY CHISEL

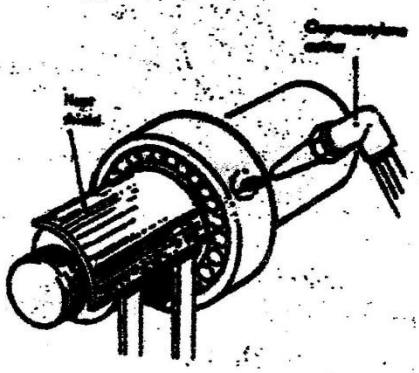
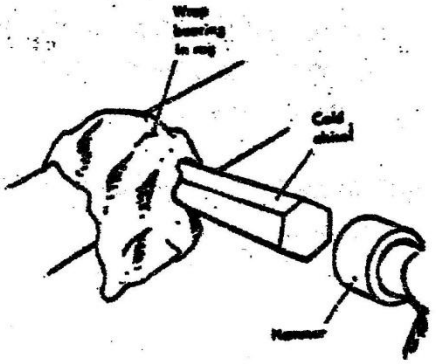
This method is normally used for removing bearings from shafts

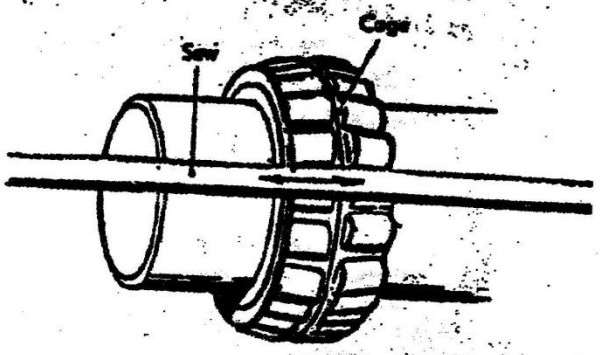
Step 1	- remove any bearing retaining nuts and lockwashers
Step 2	- ensure that the shaft is rigidly supported before applying any hammer blows
Step 3	- prevent the ball or roller bearing from rotating by knocking a wedge into the ball race



(BF26)

Step 4	- place a metal deflector shield in position next to the bearing to prevent any damage to the shaft occuring from misdirected hammer blows
Step 5	- select a suitable chisel and ball-pein hammer

Step 6	- position the chisel and strike the outer casing sharply until the casing cracks. A rag draped over the bearing will reduce the danger of pieces of the casing flying off and creating a hazard
	
	
	BF27
Step 7	- if necessary do this in several positions until the casing can be removed. Place the broken casing pieces in the scrap bin
Step 8	- chisel or hacksaw through the separator cage and remove the balls or rollers. Do not let the balls or rollers fall on the floor where they would create an



underfoot hazard. Put them in the scrap bin.
BF28

Step 9 - position the chisel and strike the inner casing until it cracks taking great care that the chisel does not damage the shaft.

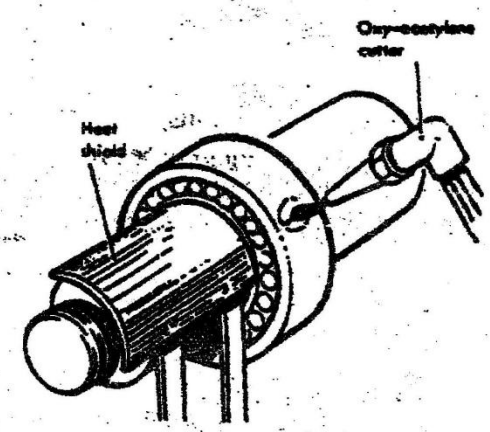
Step 10 - do this in several places until the inner casing can be removed

EXERCISE 2 :

CUTTING WITH A BURNING TORCH

This method of removing bearings from shafts should only be used by personnel trained in the use of burning gear.

Step 1	- remove any retaining nuts or lockwashers
Step 2	- select the correct cutting nozzle for the torch
Step 3	- burn through the outer casing intwo places and remove it



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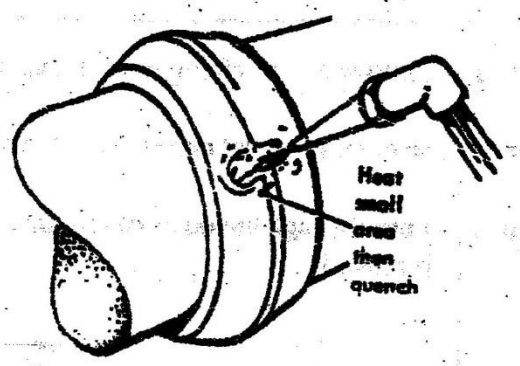
Step 4	- burn through the ball or roller cage in two places and remove it

DO NOT BURN THROUGH THE INNER CASING AS THIS WILL DAMAGE THE SHAFT

Step 5 - rapidly heat a small area of the inner casing and then quench it with water to try and crack the casing



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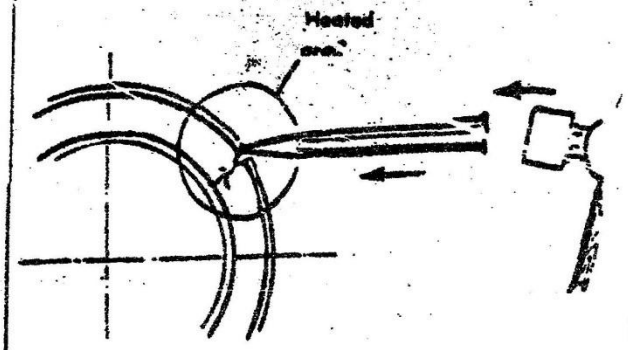
Step 6 - if this fails, use a chisel to crack the inner casing after heating it up with the torch.



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EXERCISE 3 :

INSPECTION OF BEARING

For each of the damaged bearings, the procedure for inspection is:

Step 1	- identify the class of bearing and state the circumstances in which it would be used.
Step 2	- in the case of the ball and roller bearings, note the bearing number and identify its type dimensions, equivalent and lubrication details by consulting the manufacturer's chart
Step 3	- measure the bearing and note the internal and external diameter together with the width. Compare the measurements with those given on the manufacturer's chart or literature noting and establishing the reason for any differences
Step 4	- compare the bearing with a new bearing and note down any differences and the reasons for them
Step 5	- visually examine the bearing and identify any defects by comparison with photographs and examples of bearing defects
Step 6	- decide whether the bearing can be re-used or scrapped giving reasons for the decision. In the case of a plain or sleeve bearing, decide whether the bearing can be shimmed or re-machined
Step 7	- in the case of a thrust bearing identify which way it should be positioned on the shaft or in the housing

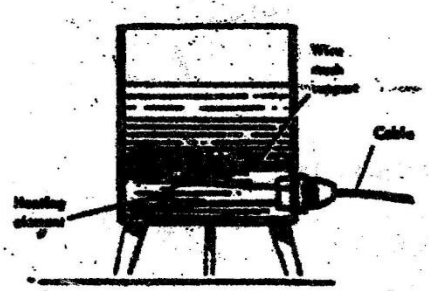
EXERCISE 4 :

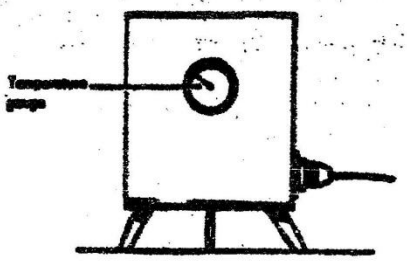
FITTING A BALL OR ROLLER BEARING BY HEATING ONE OF THE COMPONENTS

SAFETY NOTE - Wear suitable protective clothing when handling hot bearings or housings.

Step 1	- If the work is to be carried out on site, ensure that there is sufficient access and that the work area is clean and free from obstructions.
Step 2	- Select and rig up any lifting gear that will be needed.
Step 3	- Assemble the tools and equipment necessary to carry out the work.
Step 4	- Prepare the shaft and bearing housing by: (a) removing any protective grease orpaint (b) cleaning of any light rust using fine emery cloth (c) removing any burrs with a fine file
Step 5	- Prepare the bearing by: (a) removing the protective grease or oil using the appropriate solvent or method (b) checking the free rotation of the bearing
Step 6	- If necessary check : (a) the dimensions and shape of the shaft and housings (b) the shaft concentricity (c) the squareness of any shaft shoulders

Step 7	- Decide whether the bearing or bearing housing is to be heated. Note: (a) The bearing is heated when the inner casing is an interference fit onto the shaft (b) The housing is heated when the outer casing is an interference fit into the housing
Step 8	- If the bearing is to be heated lubricate the area of shaft or housing over which the bearing will travel
Step 9	- Heat the bearing to the correct temperature using an electrically heated oil bath or a suitable temperature controlled oven situated close to where the bearing needs to be fitted





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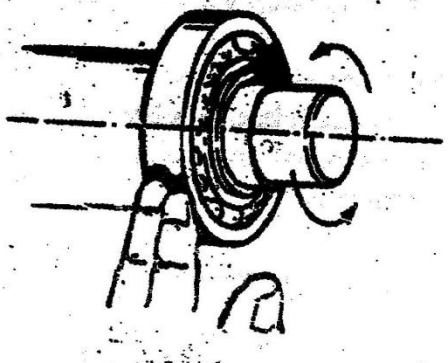
Step 10 - Working quickly, position the bearing correctly using a soft drift if necessary. If the heating operation has been correctly carried out, the bearing should move smoothly into positon. Have a suitable withdrawl tool available to remove it if it jams or does not align squarely.

Step 11 - Check that the bearing is square and rolls correctly



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Step 12 - Lubricate the bearing

Step 13 - Check the free rotation of the shaft

Step 14 - Test run the machine. Investigate any noise, vibration or heat

EXERCISE 5 :

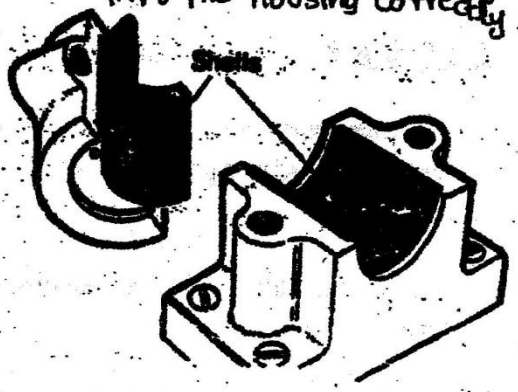
FITTING A PLAIN OR SLEEVE BEARING

Solid bearings can be fitted by heating one of the components or by using a press or portable ram in exactly the same manner as for ball and roller bearings.

The procedure for divided or metalled bearings is as follows :

Step 1	- If the work is to be carried out on site , ensure that there is sufficient access and that the work area is clean.
Step 2	- Select and rig up any lifting gear that will be needed.
Step 3	- Assemble the tools and equipment necessary to carry out the work.
Step 4	- Prepare the shaft and bearing housing by: (a) removing any protective grease or paint (b) cleaning off any light rust using fine emery cloth (c) removing any burrs with a fine file
Step 5	Prepare the bearing by removing the protective grease or oil using the appropriate solvent or method
Step 6	- If necessary check the (a) dimensions and shape of the shaft and housings (b) the shaft concentricity (c) the squareness of any shaft abutment

Step 7 - Ensure that the bearing fits into the housing correctly



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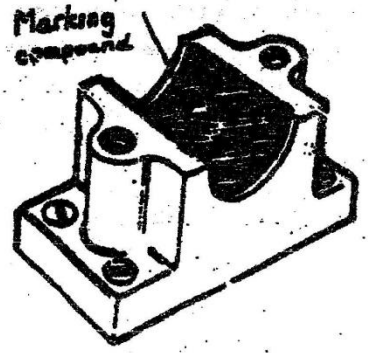
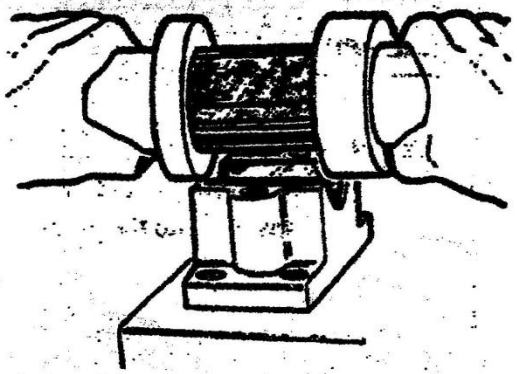
Step 8 - Fit the bearing by :

(a) coating the bearing surface with marking compound



BF42

(b) position the bearing and rotate the shaft by hand



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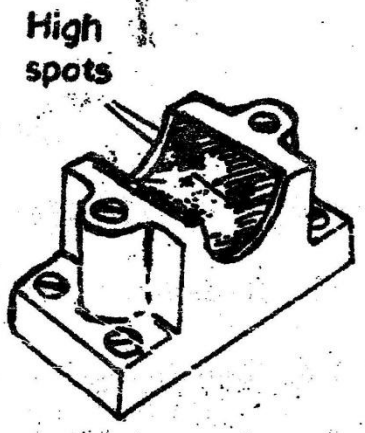
(c) checking the bearing surface for high spots and removing any high spots with a scraper



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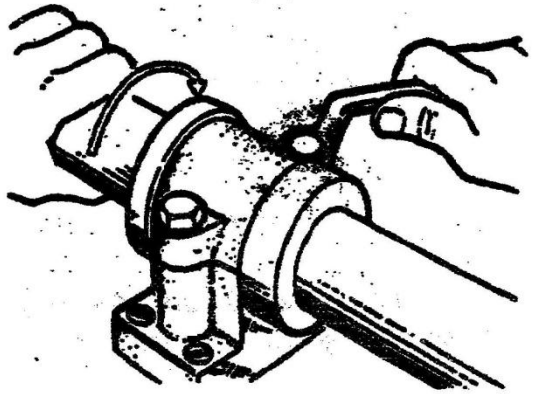
(d) repeating the process until there are no high spots

Step 9 - Assemble the bearing inserting any shims necessary to ensure that the bearing housing sits correctly into the plummer block



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Step 10 - Fill the lubricate system to the required level

Step 11 - check the free rotation of the shaft

Step 12 - Test run the machine . Investigate any noise vibration or heat