
KINGSBURY

THRUST BEARINGS

A B O A R D S H I P



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TO THE READER

Most of you who read this booklet will be in training as marine engineers. You will be under the necessity of absorbing rapidly a mass of information about the propulsion, lighting, and fire fighting equipment aboard ship. Whatever helps to make easier your task of learning will increase your competence and your confidence for the tasks that lie ahead.

It is in that spirit that this booklet has been written. It explains the basic principle of the wedge-shaped oil film around which all Kingsbury Thrust Bearings are built. It describes the commoner types of bearings and their applications, and goes briefly into installation, operation, care and maintenance. We have tried to give you something of the "feel" of the thrust bearings that will one day be in your charge.

With the material in this booklet familiar to you, you should find it easy to follow the specific data which are given in the Instruction Book furnished to every Chief Engineer for the Kingsbury Bearings in his charge. Read your Instruction Book carefully. Kingsbury Bearings ask for very little: given that little, they will do their part to earn the pride which you as engineer will feel in your ship.

KINGSBURY * * * * *

THRUST BEARINGS

* * * * * ABOARD SHIP

BASIC PRINCIPLE THE WEDGE-SHAPED OIL FILM

The principle of Kingsbury Thrust Bearings is that of the wedge-shaped film. An oil film between any two sliding surfaces (for example, a journal and its bearing) tends to assume a tapering form, with the thick end at the entering side. The rotating journal shifts to a slightly eccentric

maximum near the center of the loaded area; and the sum of the hydrostatic pressures equals the load. Depending on load, speed and viscosity, the excess of film thickness on the entering side over the trailing side may be no more than one or two thousandths of an inch; yet that tiny

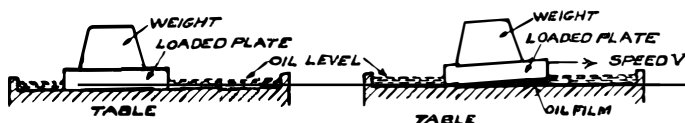


Figure 1: The wedge film between flat surfaces. When motion begins, the wedge is formed.

position. Part of the oil entering the loaded area follows the journal's rotation to the trailing side; the rest fans out and escapes at the edges. Thus the film is thicker on the entering side and thinner on the trailing side; and continual entry of fresh oil is needed on the entering side to maintain the film. The film pressure is

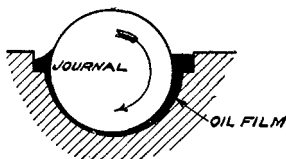


Figure 2: The wedge film between a journal and its bearing. When motion begins, the journal shifts to a laterally eccentric position.

displacement of the journal is essential for proper functioning of the bearing.

The Kingsbury Bearing makes possible the automatic formation of wedge-shaped oil films under a thrust load, thus accomplishing in thrust bearings what a properly designed journal bearing does in the case of radial loads. This result is secured by dividing the stationary bearing element into segments, two, three, six or eight in number. These segments or "shoes" are so supported and pivoted that they are free to tilt slightly, and oil is drawn between the working surfaces by adhesion to the thrust collar. Since the bearing is

flooded with oil, the films assume automatically whatever taper is required by the speed, load and oil viscosity.

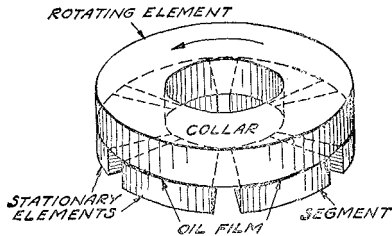


Figure 3: Basic elements of Kingsbury Thrust Bearing, showing wedge-shaped oil films.

This continual drawing-in of oil, replacing that heated and squeezed out, enables a Kingsbury Bearing to carry loads far beyond those possible with parallel-surface bearings like the horseshoe type. Since horseshoe bearings tend continually to squeeze the oil out, they can bear only about one-tenth as much load as Kingsburys per square inch of working area; and their friction and tendency to heat and wear are much greater.

An Air-Lubricated Model Bearing

The complete separation of surfaces in the Kingsbury Bearing is strikingly illustrated in the small model bearing here illustrated. It runs with *air* as the only lubricant. The bearing has three

shoes, and the collar ("runner") is spun by hand. The shaft is insulated from the shoes; and, when the runner spins, films of air are drawn between runner and shoes, and there is no metallic contact. An electric battery and miniature bulb are wired so that, when the runner touches the shoes, the bulb glows. When the runner is twirled rapidly, the light goes out; and the runner spins a considerable time on the air films.

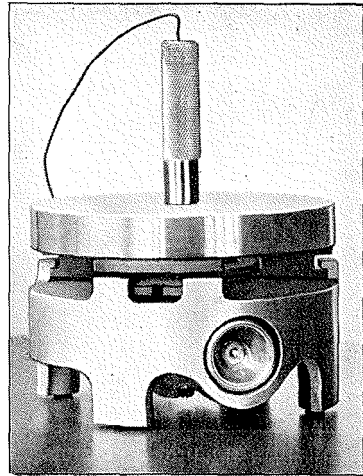


Figure 4: A model Kingsbury Bearing lubricated by air. The electric lamp is extinguished as long as the working surfaces are separated by air films.

As it slows down, flashes of the bulb show momentary contacts, which are followed by a steady glow as the runner stops and the bearing surfaces come into contact.

KINGSBURY APPLICATIONS

One of the important uses of Kingsbury Thrust Bearings aboard ship is for the propeller thrust. In this service they have been found to have approximately one-tenth as much friction as the old horseshoe collar thrusts; and they sustain, roughly, ten times as much load per square inch of effective bearing area. Unlike the horseshoe type, a single thrust collar is sufficient.

Another important application is to steam turbines, in which freedom from wear even at high speeds is of great value in keeping the power plant operating. Kingsbury Thrusts are found not only in the main propulsion turbines but in the turbines driving the boiler feed pumps and condenser circulating pumps; also in the small turbines of lighting generator sets and certain blowers.

KINGSBURY PROPELLER THRUSTS

Kingsbury Propeller Shaft Thrust Bearings are of two principal types. The first and simplest type is the two-shoe adjustable self-oiling design, which is mounted on a section of the shaft aft of the engine or main drive. The thrust collar is forged integral with a short section of shaft, and the bearing is mounted in an independent housing, bolted either to the engine foundation or to an extension of the engine base. Since the shaft at this point is large, two shoes of normal proportions, arranged as shown in Figure 5-A, usually have sufficient area to carry the ahead

thrust. On the after side of the collar are two similar shoes to carry the astern thrust.

A similar bearing is built with three shoes, instead of two, in the lower housing, to carry somewhat heavier thrusts. See Figure 5-B. Special means are used, resembling those in the six-shoe bearings described later, to equalize the load between the shoes. The method of lubrication is the same as in the two-shoe design. Both two and three-shoe bearings of this general type usually, but not always, include a journal bearing.

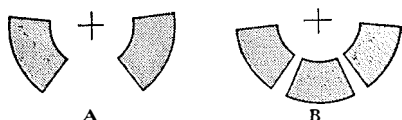


Figure 5: A, two-shoe arrangement for propeller thrust. B, three-shoe arrangement sometimes used.

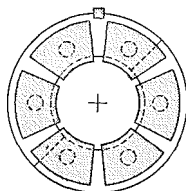


Figure 6: Six-shoe arrangement used in many built-in thrusts.

On ships having reduction gear drives or direct-connected electric motors a much more compact form of thrust bearing can be used. It is installed at the forward end of the shaft, in an extension of the gear housing or motor pedestal. At this point the shaft diameter can be considerably reduced, and the needed

bearing area divided between six smaller shoes, instead of two large ones. These shoes are arranged as shown in Figure 6.

Since the self-contained two-shoe thrust bearing and the built-in six-shoe type are so different in design and application, they will be considered separately.

TWO-SHOE PROPELLER THRUSTS

The most-used types of two-shoe propeller thrust bearings are illustrated in Figures 8 to 13, inclusive. There are minor differences in detail: some types have replaceable half or full journal bearing shells instead of babbitt cast in the housing; and a few (not illustrated) have no journal bearing.

The thrust shoes are usually cast steel, faced with babbitt. Their back faces have steel inserts with hardened, rounded surface, bearing against hardened thrust pins which are backed by heavy adjustable jack screws. The shoes and jack screws are mounted in the lower half of the housing, just below the center plane of the shaft. This makes it unnecessary to disturb them when the housing cover is lifted. The jack screws are separately adjusted when the bearing is installed, and require care to ensure that the shoes bear equally against the collar.

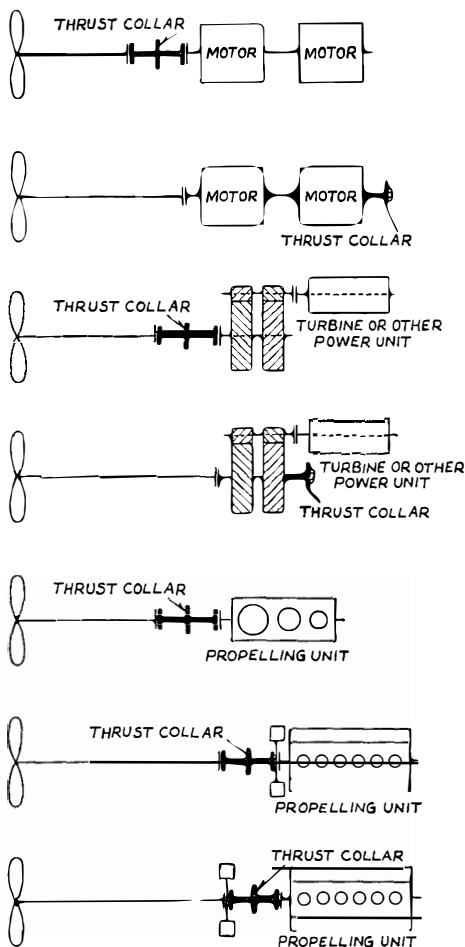


Figure 7: Various locations of Kingsbury Thrust Bearings in marine propulsion.

Lubrication is similar in all types. The standard arrangement is a self-contained oil bath. The thrust collar dips into the bath and carries oil to the top, where the oil is taken off by a bronze scraper riding on the collar, and is delivered partly to both faces of the collar and partly to the journal bearing. This not only floods

However, the heat generated in the oil films depends largely on the speed; and, for the higher speeds, provision must be made to take care of heat beyond that which the housing can radiate. For that purpose a small supplementary cooling coil is used. It is commonly of the form shown in Figure 8.

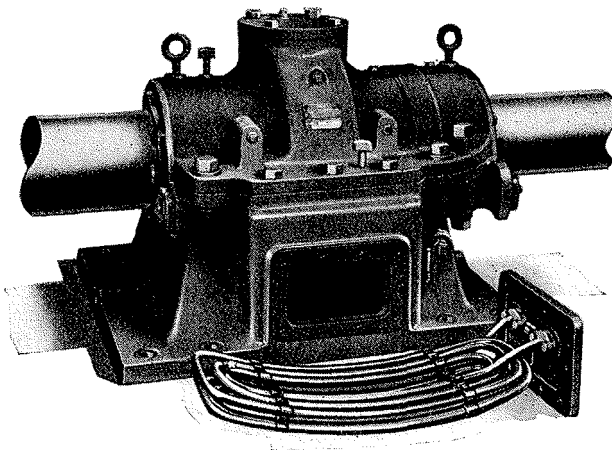


Figure 8: Small two-shoe bearing, showing water cooling coil sometimes used.

the working surface with oil, but serves to circulate the oil in the bath. The arrangement is illustrated in Figure 10, which shows a bearing with babbitt journal bearing cast in both upper and lower housing.

Rather heavy oil, usually 400 SUV (Saybolt Universal Viscosity) at 100° F., is used in these two-shoe bearings. At moderate speeds, air radiation is sufficient to take care of the heat generated by oil friction; and the oil is selected to bear a running temperature of as much as 130° to 150° F. without becoming too thin to carry the thrust load.

Sometimes, when the speed is high enough to require cooling, the oil in these two-shoe bearings is cooled by connecting the bearing to the main oil circulating system. The inlet is so placed as to deliver the oil stream to the top of the collar. The outlet is at the customary oil level, a little below the shaft, and is large enough to allow the overflow to escape by gravity.

Figure 11 shows a large two-shoe bearing with the housing cover raised, revealing the shoes in position, but without the shaft and thrust collar.

The most frequent end closures are stuffing boxes, as shown. Since there is no appreciable radial wear in normal service and no internal pressure to force oil outward, the stuffing boxes are set up very lightly. However, severe conditions of oil, water, dirt and high speed are met by the

all-metal Crown Ring Closure shown on page 20.

Figures 12 and 13 show one type of this bearing in vertical lengthwise and crosswise sections. As above noted, the upper half of the journal bearing is sometimes made removable like the lower half.

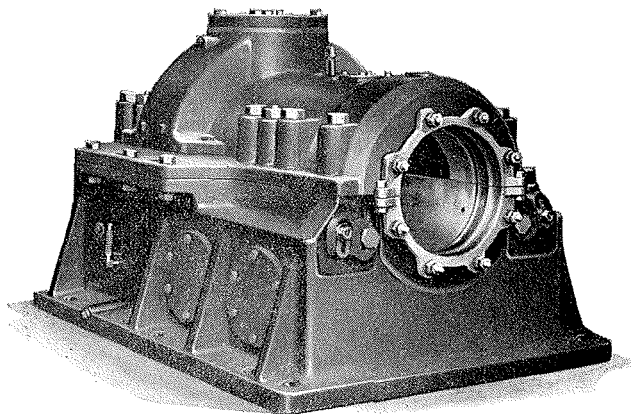


Figure 9: Large two-shoe thrust bearing in self-contained mounting.

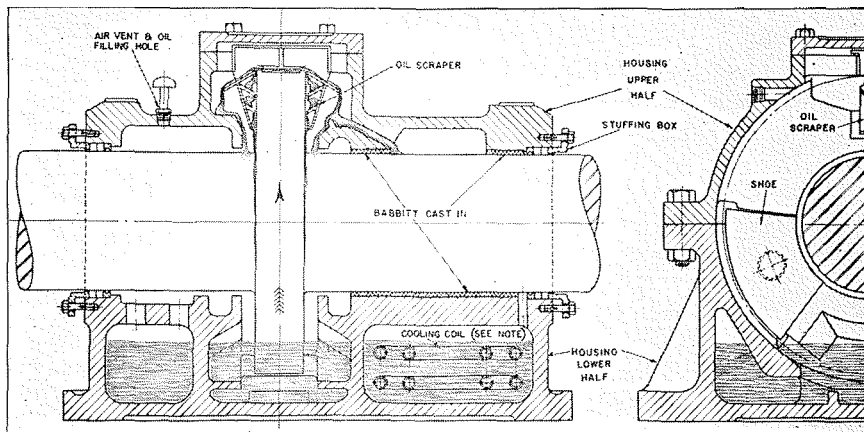


Figure 10: Two-shoe bearing, showing oil picked up by thrust collar and distributed to collar faces and journal bearing. The coil is not always used.

Installation of Two-Shoe Thrusts

Although installation is a matter for the shipyard or the engine builder, a few notes are given here.

The bottom of the housing is machined flat, and is intended to be

for it when the shaft couplings have been made up. The end closures must not bind.

The thrust forces are usually transmitted to the foundation by steel

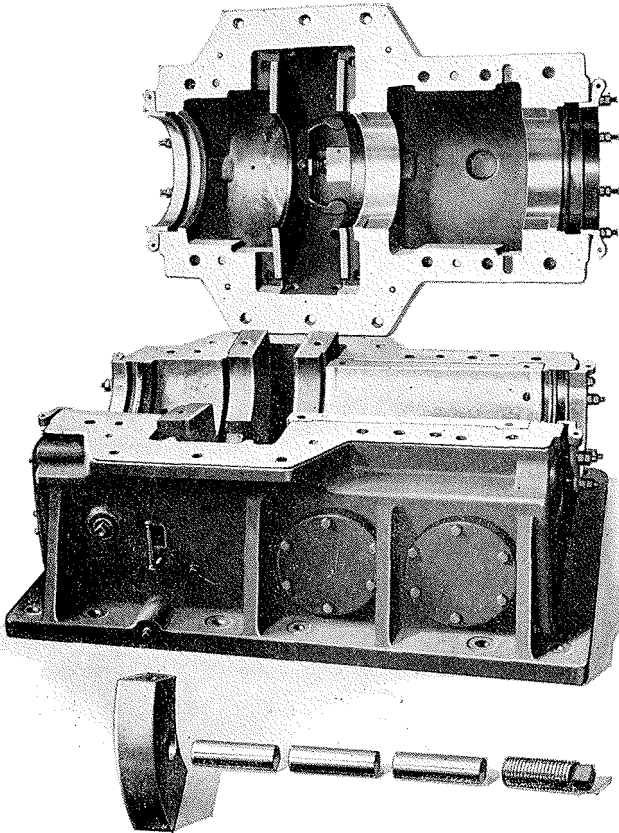


Figure 11: Two-shoe bearing with cover raised. One thrust shoe and its spacing pins and adjusting screw are shown separately. Shaft and collar not shown.

supported on the foundation by blocks of carefully selected thickness to bring the thrust shaft into line with the tailshaft. The housing should be so placed fore and aft as to center the thrust collar in the space provided

angles and blocking keys or wedges, so that the thrust does not impose a shearing force on the holding-down bolts. However, it is desirable that at least two bolts on each side be fitted by reaming, in order to determine the

exact location of the housing before the blocking keys or wedges are driven home. If keys or wedges cannot be used, all the holding-down bolts should be fitted.

Before assembling, make sure that all bearing parts, as well as the interior of the housing and oil piping, are clean. The slushing compound should be washed off, preferably with

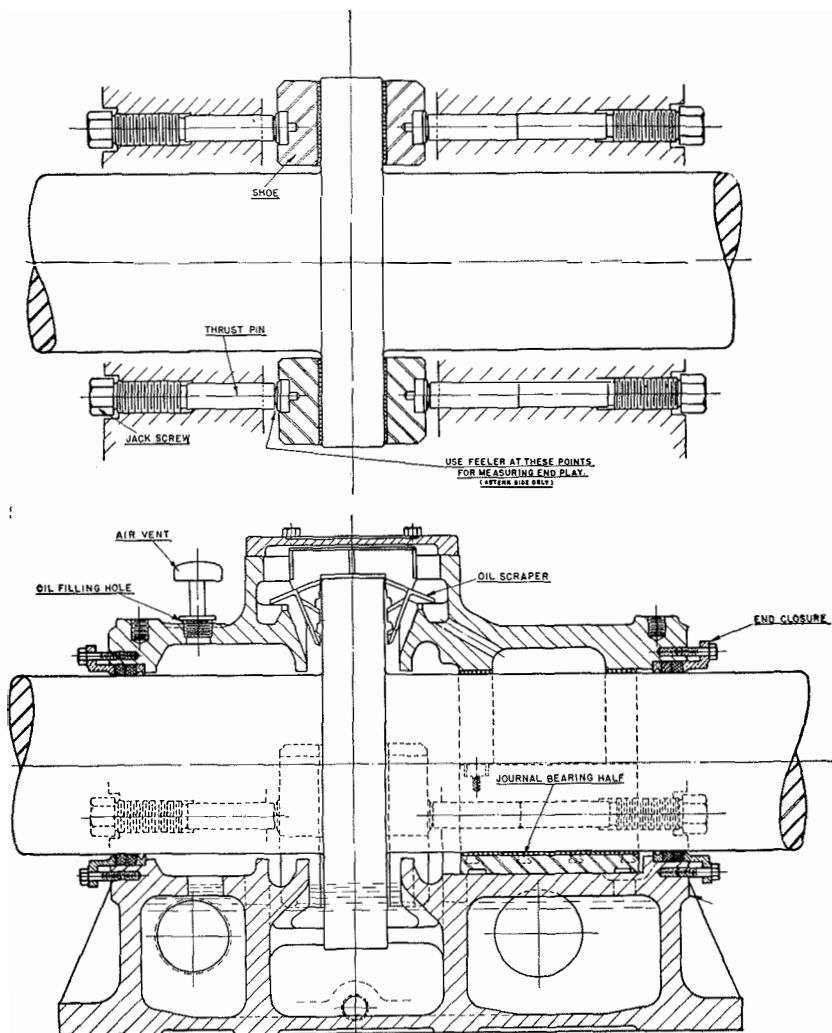


Figure 12: Two-shoe bearing, showing where feeler is inserted to measure end play. Removable journal bearing half shell is shown.

kerosene, and all traces of dirt removed. This is particularly necessary for the bearing surfaces of shoes and collar. *A bearing surface is not clean until a white cloth wiped over it shows no soil.*

To adjust the jack screws which support the thrust shoes, the following procedure should be followed:

A total end play of about .001" per inch of collar diameter is satisfactory. After the housing has been bolted down, run all the jack screws in until the shoes bear evenly on the collar. Use a hand wrench, and take light fractional turns on alternate screws till the oil films stop yielding. Lock the jack screws on the ahead

(loaded) side. Then back the jack screws on the unloaded side by exactly equal amounts, using a "feeler" with thickness equal to end play, back of the supporting pivot of each shoe on the unloaded side. See Figure 12. Lock the jack screws and remove the "feelers." Now re-oil the collar.

Before placing the housing upper half, remove the top cover plate and the bronze oil scraper. Replace these after the upper housing is bolted down.

After assembling, pour oil into the housing up to the "HIGH" mark on the oil level gauge before starting to run.

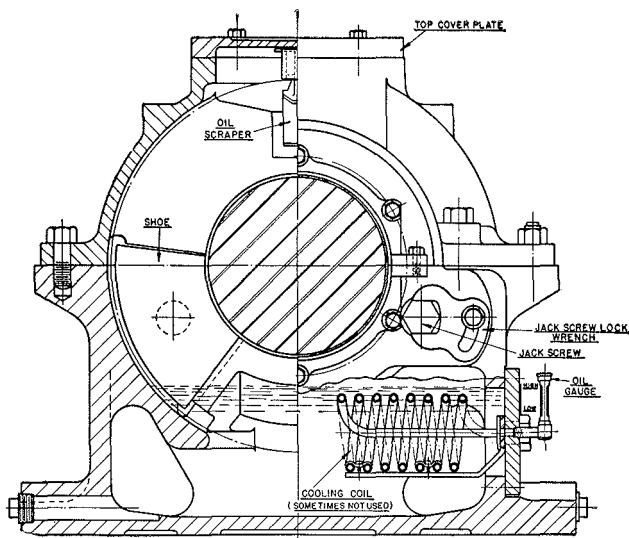


Figure 13: Same bearing in cross-section, showing another form of cooling coil.

SIX-SHOE PROPELLER THRUSTS

Figure 14 illustrates a typical six-shoe main thrust bearing as it appears installed in the forward end of a reduction gear housing. Such housings usually have a separate cover over

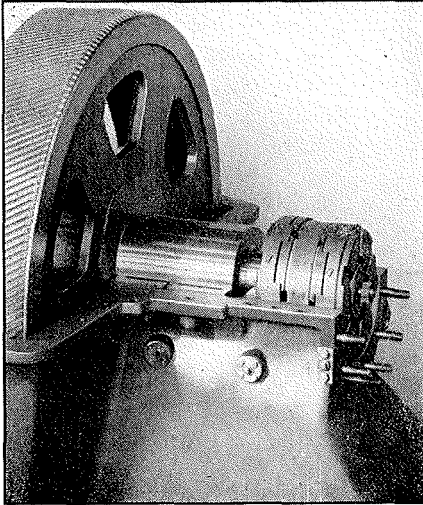


Figure 14: Double six-shoe thrust bearing in typical reduction gear housing.

the thrust bearing, and always a separate end cover plate (or equivalent), which may be removed in order to assemble or withdraw the collar over the end of the shaft without raising the shaft.

A small one-way six-shoe thrust (or half of a two-way thrust) is shown in Figure 15.

In order to equalize the load be-

tween the six shoes, they are backed by a series of rocking levers called *leveling plates*, arranged as is shown diagrammatically in Figure 16, and in the photograph, Figure 17. The shoes have hardened inserts in their backs, as above described; and in large bearings, the leveling plates also have hardened inserts to minimize wear. Because of this arrangement, it is unnecessary (for example, when refitting a bearing) that all the shoes should have exactly the same thickness. Since slight variations in shoe thickness are accommodated by the leveling plates,

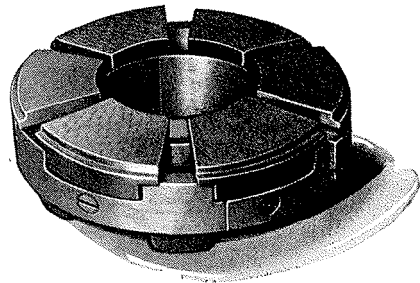


Figure 15: Small single six-shoe bearing removed from housing.

the shoes in a given bearing are interchangeable.

The shoes and leveling plates are held loosely in position by cast or forged steel *base rings*, which are held against rotation by keys in the housing. The exact form of these base rings varies, and they may be made as solid rings or in halves.

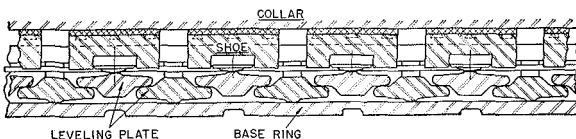


Figure 16: Developed section, showing how the leveling plates of six-shoe bearings equalize the load between the shoes.

Typical forms of split base rings for small and large bearings are shown in Figures 17 and 18.

The leveling plates are always loosely retained in the base rings, either by set screws allowing limited freedom (Figure 19), or by spring wire retaining rings or half rings.

For bearings at the forward end of the shaft, the base rings are usually made each in one piece. Sometimes, however, the base ring aft of the thrust collar is split, so that it can be removed or assembled without disturbing the collar. Occasionally both forward and aft base rings are split, and therefore can be assembled and removed simply by lifting the housing cover.

inward toward the shaft through channels in the backs of the base rings, as shown by the arrows in Figures 19 and 21. At the shaft the flow turns toward the two faces of the thrust collar. At the thrust collar the flow turns outward through the spaces between the thrust shoes. Thus a continuous supply of cooled oil is

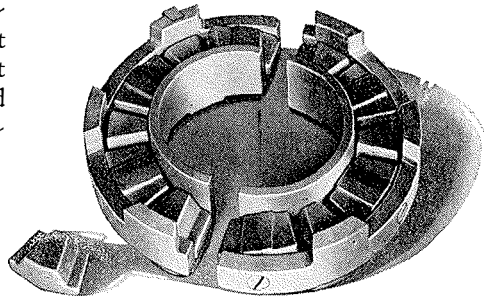


Figure 17: Split base ring and leveling plates of small six-shoe bearing.

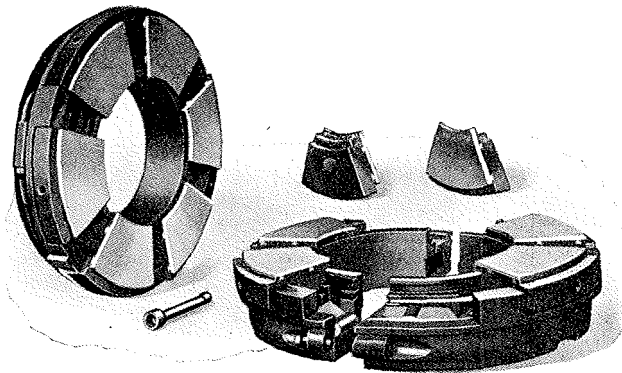


Figure 18: Large double six-shoe bearing with split base rings.

The shoes are inserted and removed by rotating the base rings while the housing cap is lifted.

In all six-shoe propeller thrust bearings the bearing cavity is filled with oil. The oil enters at both ends of the bearing cavity and flows radially

provided for the oil films between the thrust collar and shoes. The oil finally leaves the thrust housing through an outlet at or near the top directly over the collar. In propeller shaft bearings, oil flow is usually controlled by restricting the outlet.

Although the leveling plates afford considerable movement, they are intended only to compensate for such errors as careful shop work cannot avoid. Under no circumstances are they expected to compensate for a collar out of square on its shaft, be-

misalignment of the shaft or springing of the housing and foundation.

An essential requirement in Kingsbury Bearings is sufficient end play or oil clearance to permit the wedge-shaped oil films to form. The allowable limits of end play are always

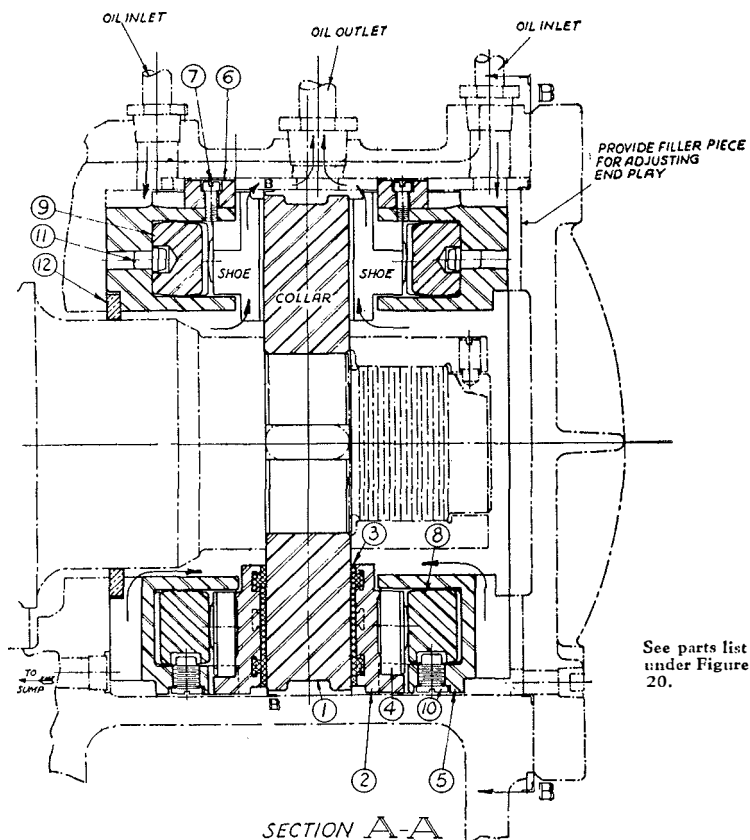


Figure 19: Typical installation of medium-size double six-shoe main thrust bearing in gear housing. Arrows show oil flow. Compare Figure 21.

cause the continual movement which that condition would impose on the leveling plates would rapidly wear them. However, the leveling plates can safely compensate for a few thousandths of an inch variation in thickness of the shoes, and for slight

stated in the instruction books which accompany the bearing.

The end play is usually adjusted by grinding a filler piece such as shown in Figure 19. This is the final step when first assembling.

Installation of Six-Shoe Propeller Thrust Bearings

The procedure for installing these bearings will depend on whether the base rings are split or in one piece.

One-piece or "solid" base rings must be assembled in sequence with the thrust collar over the end of the

covers of the thrust bearing housing removed.

All parts must have been carefully cleaned as described on page 10.

The leveling plates are first assembled in the base rings and loosely

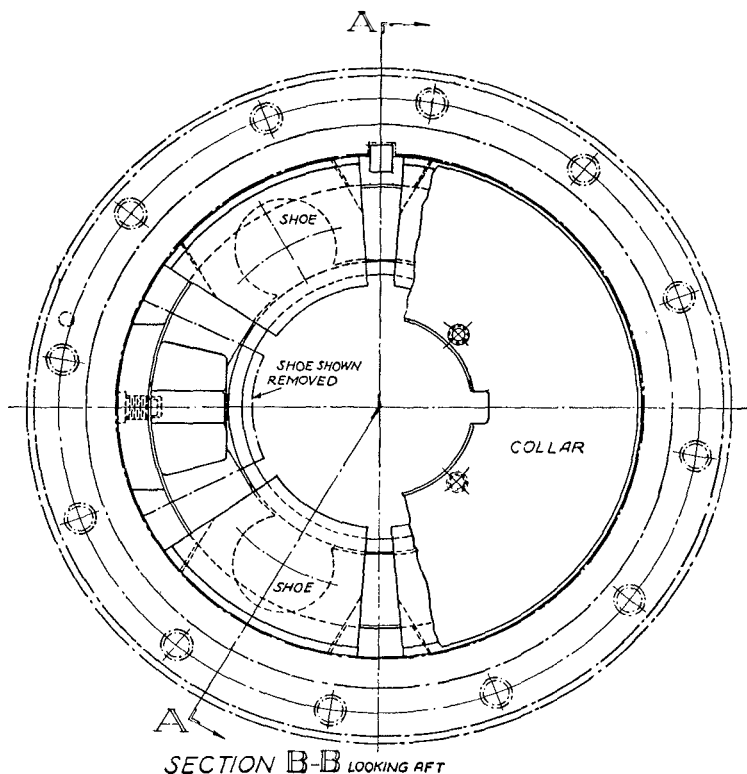


Figure 20: Cross-section of thrust bearing, Figure 19.
 (1) Collar; (2) Shoe; (3) Shoe Babbitt; (4) Shoe Support; (5) Base Ring (solid);
 (6) Base Ring Key; (7) Key Screw; (8) Upper Leveling Plate; (9) Lower Level-
 ing Plate; (10) Leveling Plate Set Screw; (11) Leveling Plate Dowel; (12) Oil
 Seal Ring.

shaft. Such items as seal rings and filler pieces, if solid, must be assembled likewise in their proper order.

The usual procedure is to start with the main gear shaft on its journal bearings, and with the end and top

held, either by set screws in the "upper" leveling plates (i.e., those in contact with the shoes) as in Figure 19, or by wire retaining rings.

Before assembling the outer base ring in place, the shaft nut should be

driven very tight on the collar, using a heavy face spanner if possible, and then locked. Remove any chips carefully, and oil the thrust collar faces.

The shoes are not inserted until the base rings and thrust collar are in place. They are then inserted one at a time by rotating the base rings. After the shoes are inserted, turn the base rings to bring the keys to top center.

Such checking must always be done with the housing cap bolted down. The exact procedure will be governed by the housing construction and by the feasibility of jacking the main shaft fore and aft.

When the general arrangement of housing end cover and filler plate are as shown in Figure 19 (which is a very common arrangement), the following simple procedure can be used:

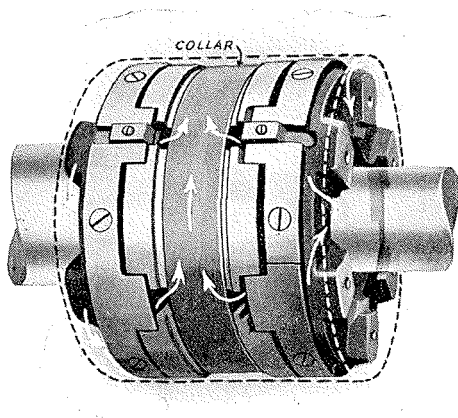


Figure 21: Small double six-shoe thrust bearing removed from housing. When installed, the end walls and bore of the housing constrain the oil to follow the paths shown by the arrows. See text description, page 13.

A filler piece is used to establish the proper play; and sometimes two are used in order to fix the fore-and-aft position of the thrust collar, and hence the position of the main gear. Usually the filler piece, or pieces, will have been ground to the proper thickness by the gear manufacturer, and should require no attention from the ship's engineer. However, the procedure for checking the end play and for correcting it, if that is made necessary by abnormal wear, should be understood by the Chief Engineer.

With the bearing assembled and the housing cap bolted down, insert, *in addition to the regular filler plate*, a dummy filler plate of accurately measured uniform thickness. Replace the end cover, and tighten the bolts with a light hand wrench. Measure the gap between the end cover flange and the housing, and subtract this gap from the thickness of the dummy. The amount by which the thickness of the dummy exceeds the gap is the end play under the load imposed by the bolts. Compare this difference

with the designed end play, which is specified in the assembly drawing and instructions for the bearing. If it is less than the designed end play, grind the filler plate to suit; if greater than the designed end play, a thicker filler plate may be needed. (End play

tolerances are given with the end play in the instruction booklet.)

After the end filler piece and end cover are in place, the top cover should be lifted if necessary in order to pour oil into the thrust cavity for starting lubrication.

STEAM TURBINE THRUSTS

According to the load to be carried, turbine thrust bearings may be of three-shoe or six-shoe type. In special

However, more commonly, the thrust bearing of a steam turbine takes one or the other of two special forms

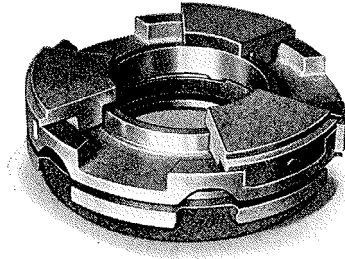


Figure 22: Small single three-shoe bearing, frequently used in steam turbines.

cases, a small two-shoe or four-shoe bearing may be used.

In the three-shoe bearing, the load is equalized between the shoes by spherical-seated leveling washers. A small bearing of this type is illustrated in Figure 22. The shoes are held in a "shoe cage," which, like the spherical-seated members, is never split.

Bearings of this type must be assembled and dismantled over the end of the shaft.

The simplest thrust bearing application to steam turbines consists of a six-shoe or three-shoe bearing in a housing with no special features.

Cage Type:

One form is the "Cage Type." The entire bearing is enclosed in a steel cage, so that it may be handled as a unit with the turbine shaft. The cage has a flange at its one end, which is secured to the open end of the housing. By means of liners between the cage flange and the housing end cover, or otherwise, the fore-and-aft location of the cage can be adjusted to give the proper clearances to the turbine rotor blades.

Certain cages embody features which are equivalent to the Oil Control Rings described in the following paragraphs.

Oil Control Ring Type:

Another design of Kingsbury Thrust Bearing for steam turbines is called the Oil Control Ring Type. A common form is illustrated in Figures 23 and 24. According to the load, it may

speeds may be the principal cause of loss of power. This is accomplished by treating the thrust collar like the runner of a centrifugal pump, and providing an outlet or outlets near the top of the thrust cavity, by which

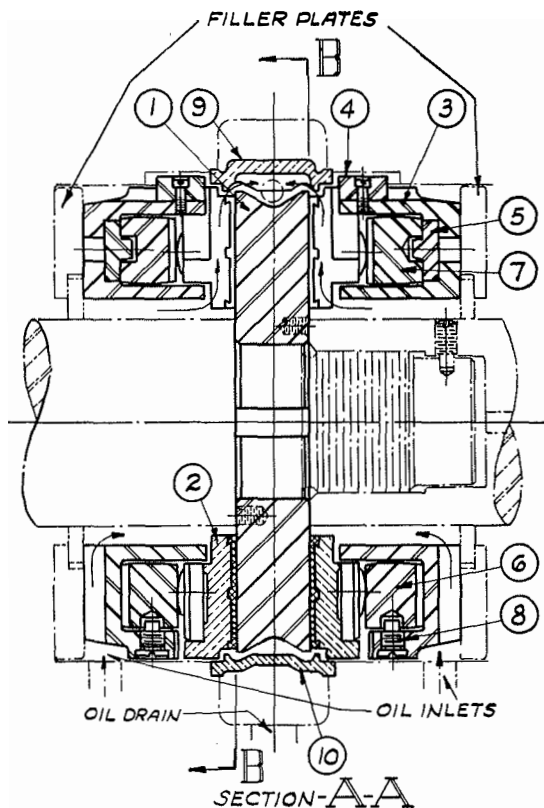


Figure 23: Small double six-shoe bearing with oil control ring for high-speed turbines. (Three-shoe bearings may be used instead of six-shoe.)

- (1) Collar; (2) Shoe Assembly; (3) Base Ring (split); (4) Base Ring Key; (5) Leveling Plate Support; (6) Upper Leveling Plate; (7) Lower Leveling Plate; (8) Leveling Plate Set Screw; (9) (10) Oil Control Ring (in halves).

have three or six shoes, or six on the side carrying the principal load and three on the other.

The Oil Control Ring Type is designed to minimize churning and heating of the oil, which at high

the oil may be expelled as soon as it reaches the periphery of the collar.

In the standard types of this bearing, the thrust collar is surrounded by a bronze ring called the *oil control ring*. The rim of the thrust collar

nas a wide shallow groove, forming in effect two flanges. Hence, oil reaching these flanges from the working faces is at once thrown off.

Surrounding each flange is an internal groove in the bronze ring. In

In the other form of control ring, there are two narrow semi-circular slots in the top half of the ring, by which oil may escape anywhere above the center plane into a similar drain passage in the housing.

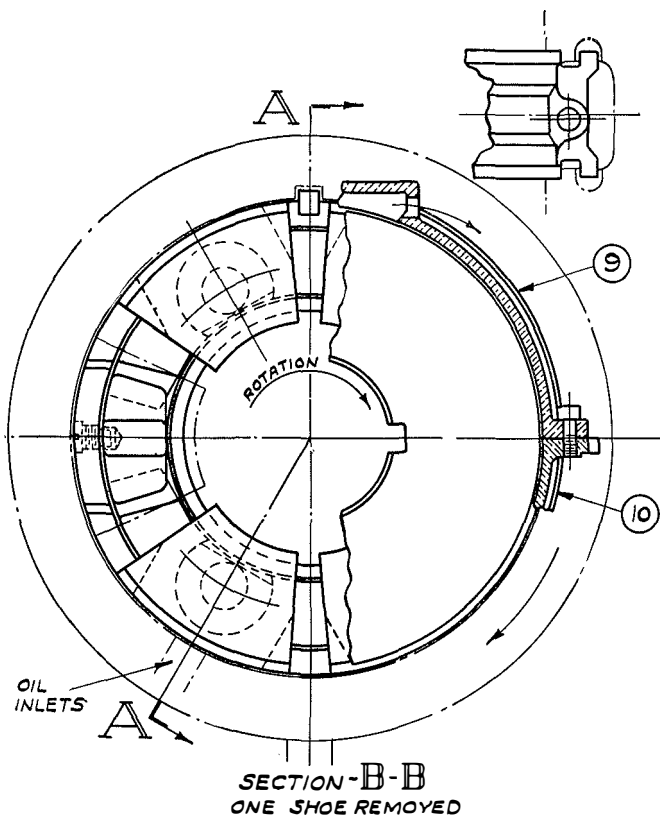


Figure 24: Cross-section of oil control ring bearing shown in Figure 23.

one form of ring, Figures 23 and 24, there are two tangential discharge holes at the top, which may converge into one outlet, like the discharge from a pump. Sometimes these converging streams of oil impinge on a thermometer. In any case, they run down, by a channel in the housing surrounding the oil control ring, to a drain at the bottom.

Tests show that both forms are equally effective.

The oil is delivered as usual to both sides of the bearing cavity (fore and aft), and the desired flow is obtained by a restriction on the inlet side, rather than (as in most other Kingsbury Bearings) on the outlet.

In addition to the two forms of oil control ring bearings just described, there are several other forms, differing mainly in the arrangements for permitting centrifugal discharge of the heated oil. These arrangements are fully covered in the instruction books furnished with the bearings. They are used mainly with turbines driving boiler feed pumps.

A simple form of three-shoe or six-shoe thrust bearing is used at the top of the shaft of turbines driving vertical circulating pumps for condensers. Other small Kingsbury Thrusts are used in the turbines of lighting generator sets. All these bearings are so simple that they will readily be understood from the foregoing description. Directions for their care will be found in instruction books.

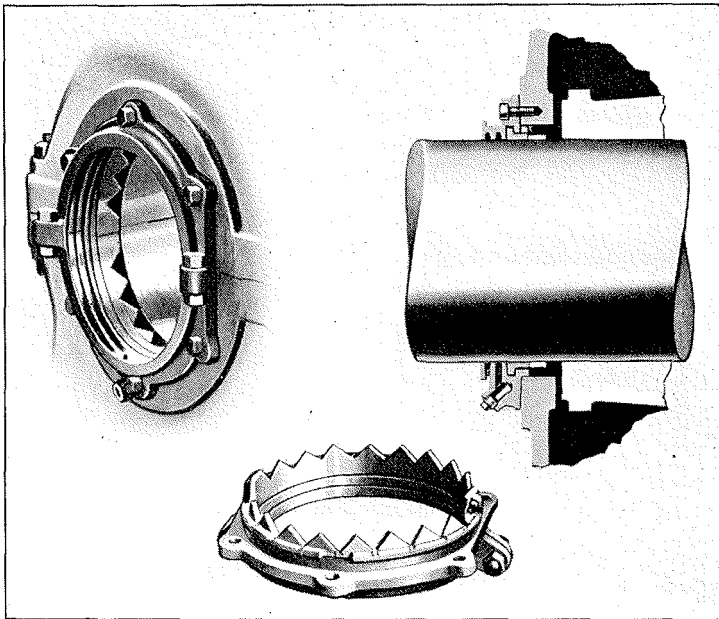


Figure 25: "Crown Ring" all-metal end closure, used in two-shoe thrust housings to prevent passage of oil and water. It is wearless and needs no adjustment.

OPERATION AND CARE

The essential requirements in Kingsbury Bearing lubrication may be summed up as (1) an adequate supply of clean oil, and (2) adequate cooling.

Clean oil lasts indefinitely in a Kingsbury Bearing. However, occasionally oil must be added to make up for evaporation and leakage.

Since there is no absolute guarantee against contamination, samples of oil should be taken occasionally (as from the drain plug at the bottom of the housing) to see whether sediment is accumulating. For this purpose, it is convenient to insert a small valve (or small test plug) in the main drain plug. If a valve is used, it should be well guarded against accidental damage.

Two-shoe bearings, Figures 10 and 12, commonly run air-cooled, unless the speed is high, since the housings are large enough to radiate the heat generated by oil friction at moderate speeds. They run somewhat warmer than bearings that are fully cooled by water or by oil circulation. Accordingly, heavier oil is used in them, i.e., usually 400 to 500 SUV at 100° F. and sometimes heavier.

With proper lubrication and when suitably loaded and correctly aligned,

a Kingsbury Bearing should run indefinitely without appreciable wear.

Bearings in highly responsible service, such as main thrust bearings, turbine thrust bearings, and the thrust bearings of boiler feed pumps and circulating pumps, are frequently equipped with thermometers to show at once any abnormal rise in temperature. Any such rise should be a signal for shutting down, if possible, and investigating the cause. Most likely, the cause is stoppage of the oil circulation.

In case any irregularities in oil supply, or impurities in the oil, give ground for suspicion, the end play should be checked, and the shoe faces inspected, at the first opportunity.

Specific instructions for checking end play are always given in the instruction books accompanying the bearings or incorporated in the instructions for the engine or the reduction gears. The reader will find general notes on checking the end play of two-shoe main thrust bearings in the text on installing those bearings, page 11. For checking the end play of six-shoe main thrust bearings, and of turbine and pump thrusts, see the chapter on Installation, pages 16-17.

CARE OF TWO-SHOE BEARINGS

As the stuffing boxes at the ends of the bearing are not under pressure, they need to be only lightly tightened to prevent undue leakage. For the all-metal Crown Ring type of closure, see page 20.

If there is a water cooling coil, check occasionally for leaks. If the coil is needed only occasionally (as in tropical waters), it is well to be able to shut off the water flow on the inlet side to minimize corrosion.

CARE OF SIX-SHOE MAIN THRUST BEARINGS

Ordinarily these thrust bearings, built into the gear housings, use the same oil as the reduction gears themselves. The oil is cooled and filtered, and is delivered in two streams, one forward and one aft of the thrust collar, to the lower half of the thrust housing. The housing is constantly full, and oil issues centrally at or near the top.

If a thermometer is used, it is commonly placed in the outgoing stream. In addition, an oil flow indi-

cator may be located close to the thermometer.

In these main thrust bearings the flow of oil is regulated mainly at the outlet, the purpose being to ensure that the oil in the thrust cavity is always under some pressure, though not enough to make undue leakage at the oil seals. If necessary, further restriction may be applied at the inlets.

CARE OF TURBINE BEARINGS

Because of the high speed at which these bearings run, it is especially necessary to maintain the oil supply. A thermometer or oil flow indicator, or both, are usually installed in the outgoing stream.

For plain or cage-type thrusts, the oil restriction is applied to the outlet, as for six-shoe main thrusts. If that makes for too much leakage at the oil seals, a supplementary restriction

is applied on the inlet side. For oil control ring bearings, the inlet only is restricted.

The best form of restriction is one which cannot be shut off by accident. For instance, a drilled plug, with hole of size to suit the flow desired, can be inserted in the piping connection. The location of this or any similar concealed device should be indicated in the oil piping plan.

EMERGENCY REPAIRS

Spare shoes, and sometimes spare collars for six-shoe bearings, are usually available aboard ship. In case of damage, the spares can usually be put in service, and the damaged parts repaired or replaced at convenience.

Slight damage to the shoe faces may be removed by careful scraping to a surface plate. Such damage may or may not be sufficient to require readjustment of end play.

For repairing shoes aboard ship, the following notes will be useful:

1—Face with high-tin babbitt, if available; if not, use nearest substitute.

2—Machine the surfaces to make the shoes of equal thickness from face to back of pivot.

3—Scrape to a surface plate. Round the radial edges slightly.

4—In emergencies, the forward and aft shoes may be transposed. (The collar also, if removable, may be reversed, after stoning, to bring the undamaged face to the loaded side. See next paragraph.)

Damage to the collar, if slight, may be temporarily repaired by stoning down the ridges to a straightedge, and reversing if that can be done. If machine facilities are available, re-grind the faces square with bore, parallel and true to a surface plate. Finish by fine grinding and polishing, or by lapping.

Recheck the end play. For six-shoe bearings, correct it by grinding the filler piece(s) or replacing with thicker ones, as needed. If shims are used, they should usually be thick enough to hold rivets, securing them to the filler pieces. Split shims must always be riveted to keep them from overlapping.

Thin one-piece shims can sometimes be inserted by slotting one side, warping sideways, and rotating around the shaft. Space for this maneuver can be gained by removing the nearest shoes and shifting the base ring, and by lifting the top half of the base ring if that is split.

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