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WAR DEPARTMENT TECHNICAL MANUAL

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INSTRUCTION GUIDE CARE AND MAINTENANCE OF BALL AND ROLLER BEARINGS

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WAR DEPARTMENT
Washington 25, D.C., 31 January 1945

TM 37–265, Instruction Guide, Care and Maintenance of Ball and Roller Bearings, is published for the information and guidance of all concerned.

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SECTION I

GENERAL

1. Purpose

This Technical Manual has been prepared to aid in the conservation of antifriction bearings and is published for the information and guidance of all concerned. A shortage in nearly all types and sizes of ball and roller bearings makes conservation imperative. The shortage has been aggravated by improper handling of bearings and by unnecessary replacement as a result of inspections by nontechnically qualified personnel.

2. Scope

This manual sets forth information on the proper cleaning, lubrication, adjustment, inspection, care, and handling of ball and roller bearings and gives operational instructions of a general nature to aid in the conservation program.

3. Description

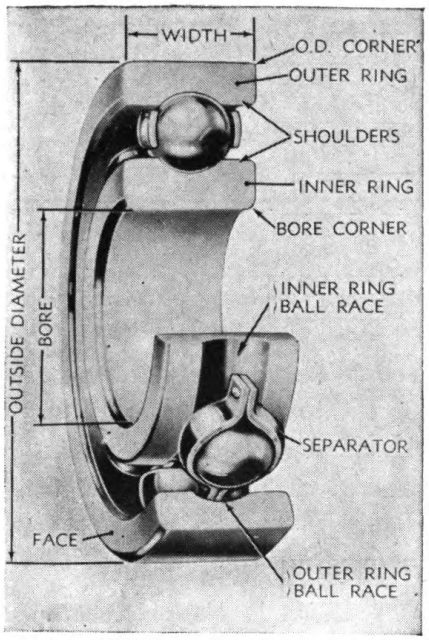
a. Basically all antifriction bearings consist of two hardened steel rings (races), hardened balls or rollers, and a separator. A number of variations of these types are in use. Some types, such as needle roller bearings (fig. 1, ④), may be used without an inner ring (race), the rollers bearing directly upon the hardened shaft. Needle bearings have no separator.

b. The parts common to all standard ball and roller bearings have, for the purpose of this manual, been given names as shown in figure 1.

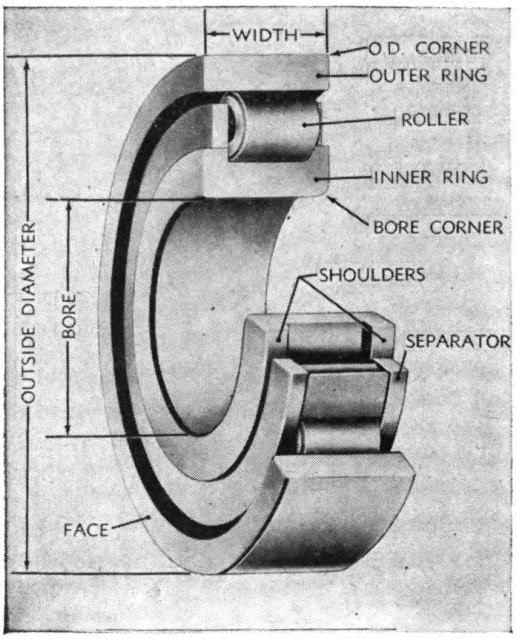
c. The following drawings illustrate the more common types of ball and roller bearings. (See figs. 2 and 3.)

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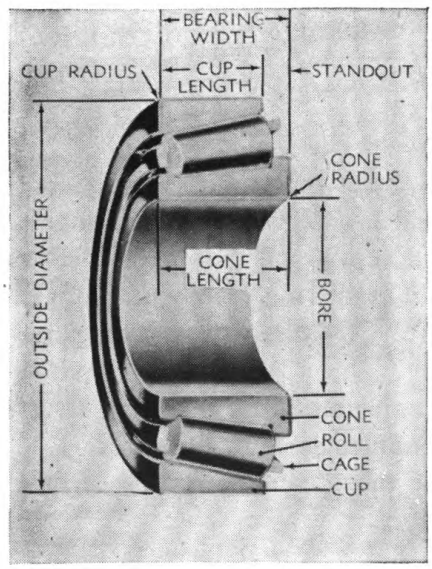
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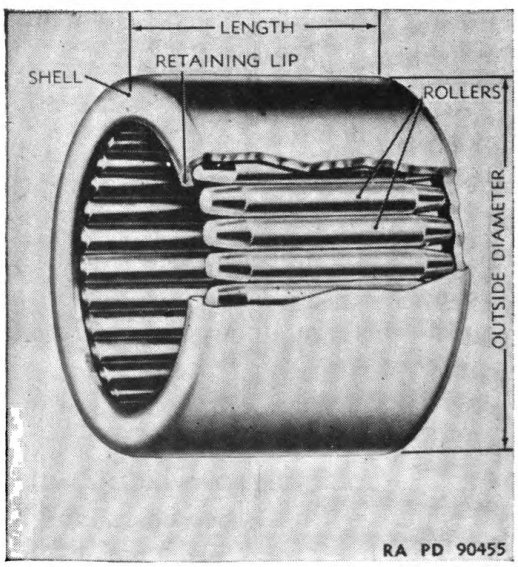
① *Ball bearing.*



② *Straight roller bearing.*



③ *Tapered roller bearing.*



④ *Needle roller bearing.*

Figure 1. Bearing parts and their names.

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NOTE: *4. Duplex bearings are specially face ground for use in pairs.

5. Snap Ring bearings are used both with and without shields.

6. Shields may be on either one or both sides.

7. Sealed bearings may have seals on both sides — are then wider.

9 and 10. Magneto and Front Wheel bearings are separable.

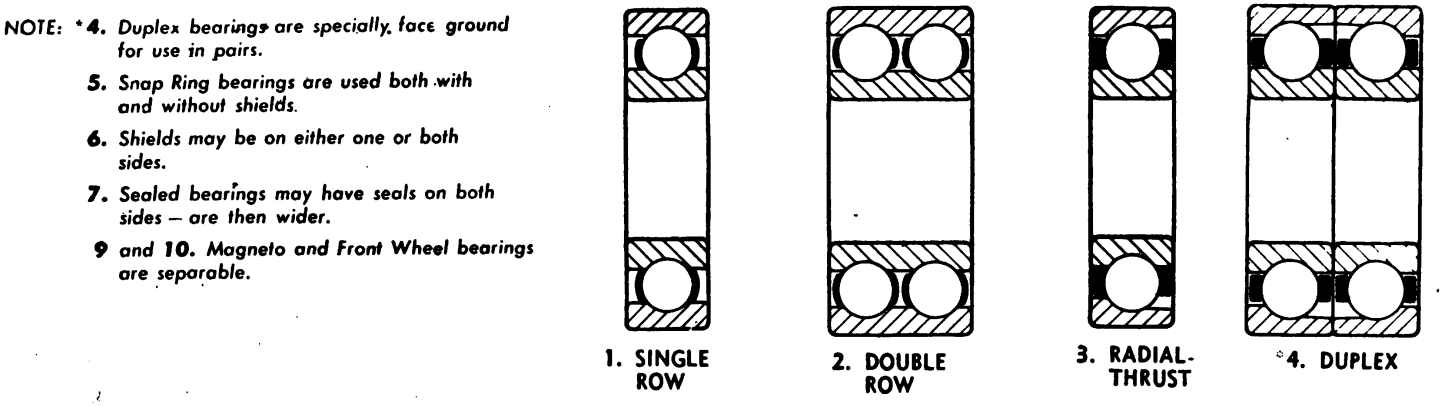


Figure 2. Types of ball bearings.

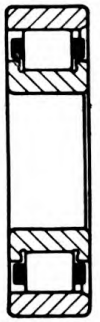
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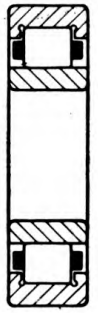
NOTE: *1, 2, 4, 5, 6, and 8. These bearings are all separable either as to inner or outer rings.

5. Double row tapered roller adjustable through cones.

10. In some cases needle bearings may have inner rings which are separable.



*1. STRAIGHT ROLLER. SEPARABLE OUTER RING.



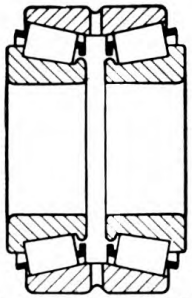
*2. STRAIGHT ROLLER. SEPARABLE INNER RING.



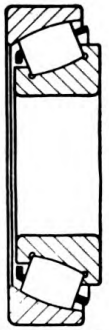
*3. STRAIGHT ROLLER. NON-SEPARABLE.



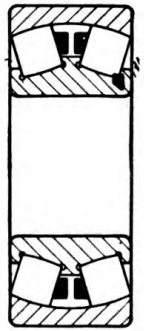
*4. TAPERED ROLLER.



5. TAPERED ROLLER DOUBLE ROW.



*6. BARREL ROLLER.



7. BARREL ROLLER DOUBLE ROW



*8. CONCAVE ROLLER.



9. CONCAVE ROLLER DOUBLE ROW.



10. NEEDLE ROLLER.

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Figure 3. Types of roller bearings.

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4. Precautions

a. Cleanliness is of utmost importance in bearing conservation. (See fig. 4.)

(1) Work with clean tools in clean surroundings. Never use wooden mallets or dirty, brittle, or chipped tools. Do not work on rough or dirty bench tops.

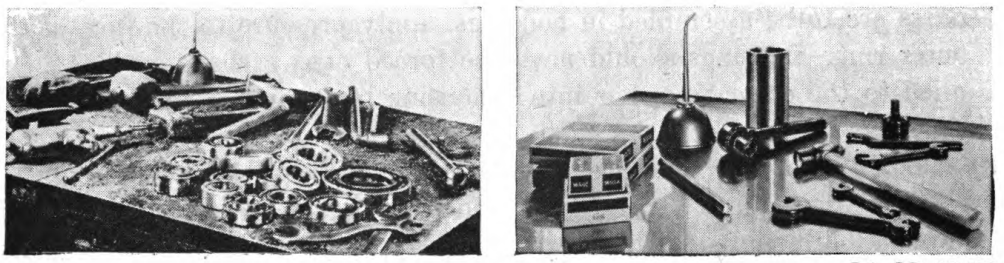
(2) Always keep hands clean and dry when handling bearings, or better, wear clean, cloth gloves.

(3) Lay bearings out on clean paper and protect them from moisture or dirt.

(4) Use clean, lint-free wiping cloths if bearings are wiped.

(5) Use dry-cleaning solvent. Diesel fuel oil is prescribed in the event dry-cleaning solvent is not available.

(6) Allow bearings to dry thoroughly before lubricating.



RA PD 90458

① *Poor tools, rough bench, plenty of dirt—bad.*

② *Ideal, but work as close to it as possible.*

Figure 4. Cleanliness is important.

b. Treat a used bearing as carefully as a new one.

c. Never spin bearings unless they are clean and lubricated. Never dry *any* bearings with compressed air.

d. Remove all outside dirt from housing before exposing bearing and clean inside of housing before replacing bearing.

e. Always clean and lubricate new bearings prior to installation, unless it is definitely established that they have been lubricated at assembly. Sealed bearings require no further lubrication.

f. Do not scratch or nick bearing surfaces.

g. Use separate containers for cleaning and final rinsing of bearings.

h. Be sure to use the correct amount of prescribed lubricant. Keep lubricants clean when applying and cover containers when not in use.

i. Keep unused bearings protected by the prescribed preservative, wrapped in greaseproof wrapping paper, and sealed with nonhygroscopic adhesive tape.

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SECTION II

INSTALLATION

5. General

a. Where bearings or bearing parts are to be assembled on shafts, apply pressure to the face of the inner ring. Where bearings or bearing parts are to be assembled in housings, apply pressure to the face of the outer ring. Bearings should never be forced onto a shaft by blows applied to the outer ring, nor into a housing by pounding upon the inner ring.

b. In applying pressure to race ends, be sure that application is straight and square. (See figs. 5 and 6.) Cocking the ring (race) will damage both shaft and bearing. Never apply pressure to roller bearing cages, ball separators, or seals.

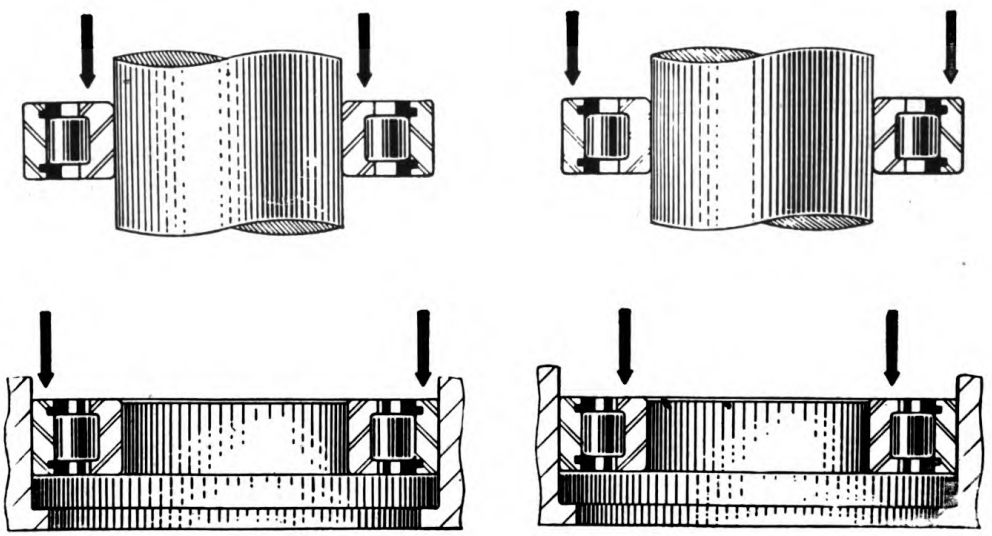


Figure 5. Pressing rings.

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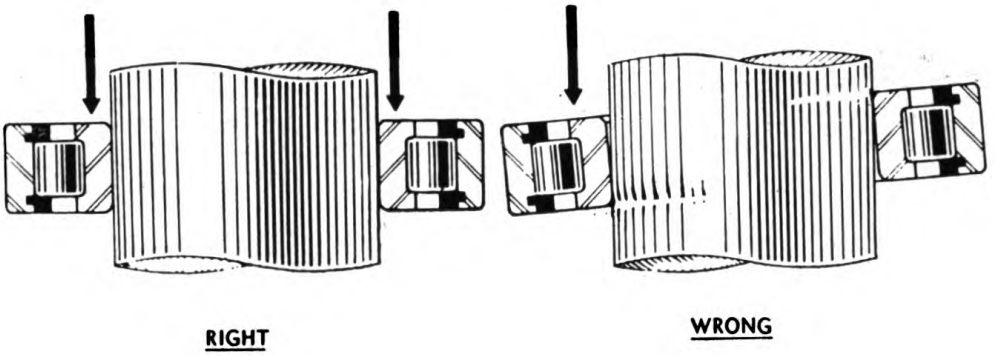


Figure 6. Press straight and square.

c. The following precautions should be taken to avoid damage in assembling:

(1) Be careful that particles of metal from tools do not fall into the bearings during assembly.

(2) Make sure that shaft seat and housing bore are of the correct diameter.

(3) Never use a wooden or soft metal mallet (unless pounding directly on shaft), as chips or splinters may enter the bearing.

(4) Use many smart quick taps rather than a few heavy ones.

(5) Start bearings on shaft with rounded corner radius of ring going first.

(6) Have straight square ends on accessories and fixtures used to drive bearings.

(7) Clean tools, clean hands, and clean surroundings are essential if damage to the bearing is to be avoided.

6. Cleaning

Clean shafts and bearing housings thoroughly. Clean dirt out of keyways, splines and grooves and remove burs and slivers. Apply a film of prescribed lubricant to the surfaces of the bearing and machine part which are to be press fitted to ease mounting and help prevent scoring. (See fig. 7.)

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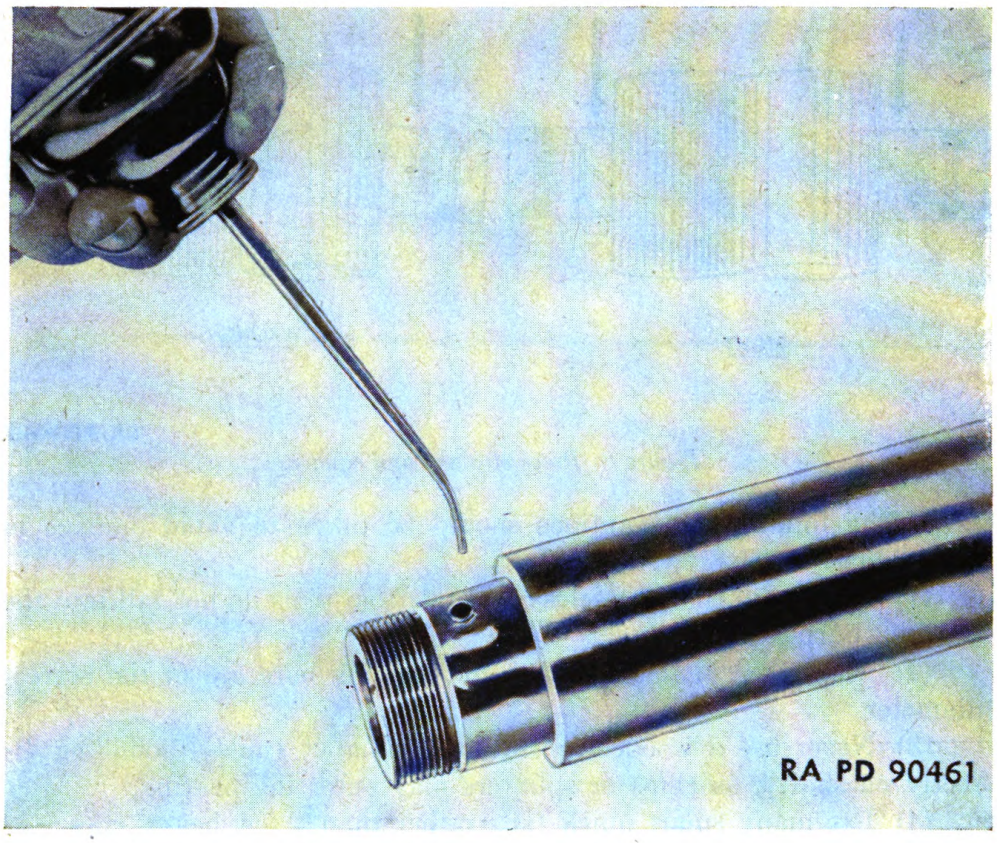


Figure 7. A small amount of oil on bearing seat eases mounting—helps prevent scoring.

7. Tools

a. Arbor press (fig. 8). Use an arbor press to install bearings if it is available. Lay the bearing on a face block having a slot or hole slightly greater than the bearing bore. Press the shaft into the bearing, supporting the inner ring of the bearing on blocks. Press bearing on straight and square, starting it true on the shaft, and not cocked; otherwise the shaft surface may be roughened or burred. Press only on the bearing ring which takes the tight fit. Bearing should be pressed until it is seated against the shaft or housing shoulder. Be sure that the blocks which support the inner ring do not scrape the shaft or threads. (See fig. 9.)

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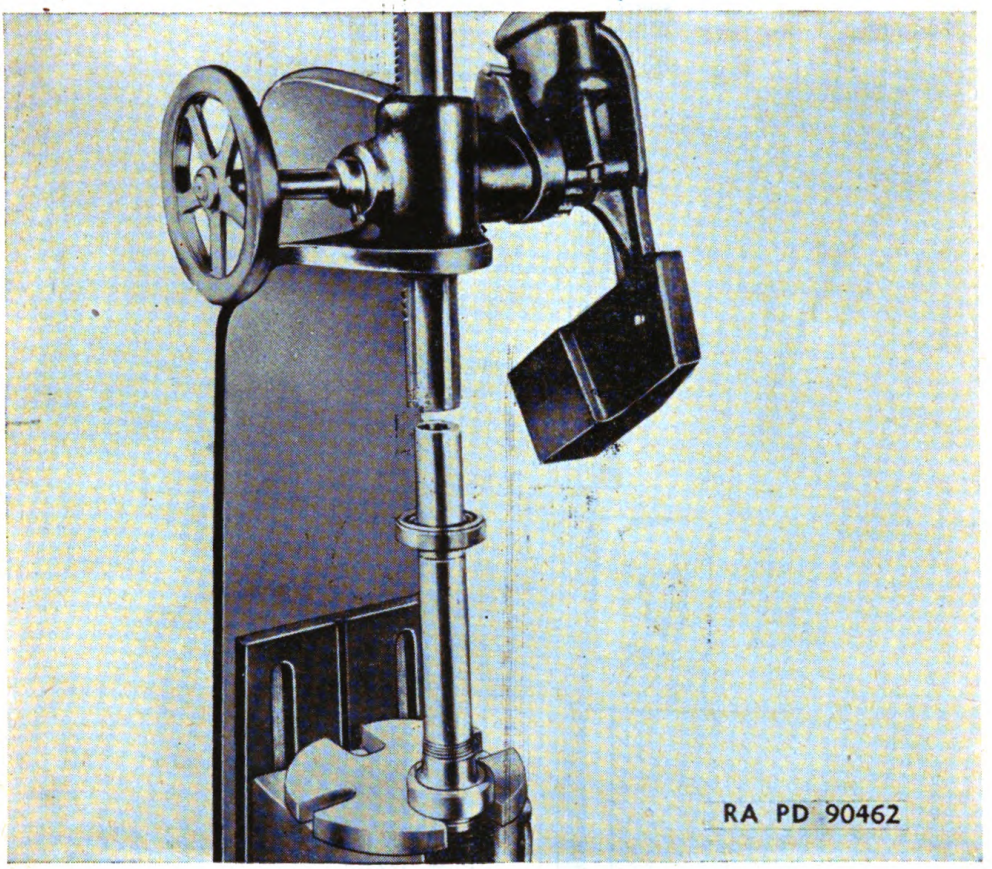


Figure 8. An arbor press is equally good for either mounting or removing bearings.

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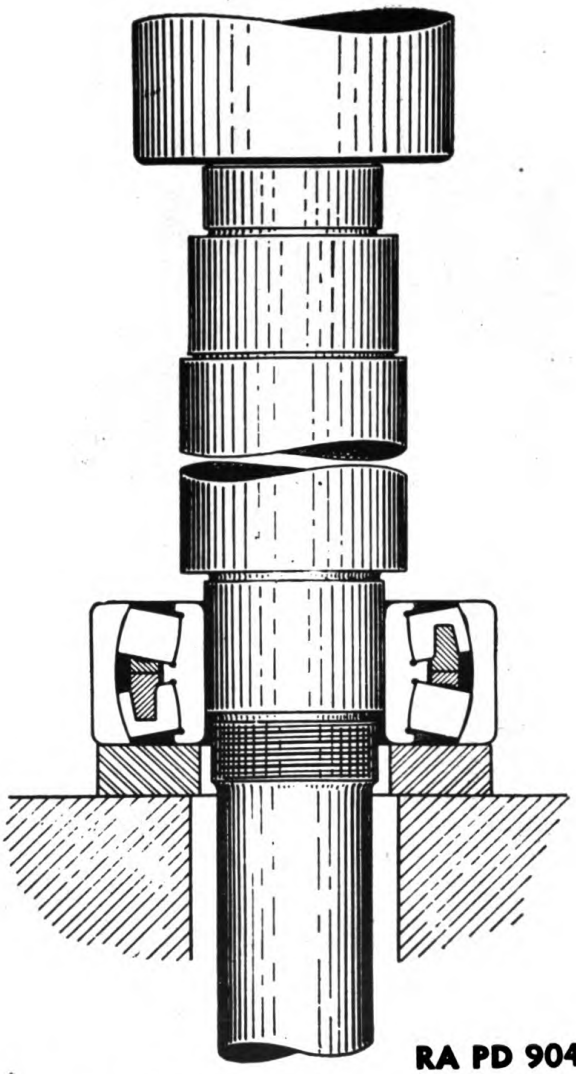


Figure 9. Be sure blocks will clear threads before forcing shaft into bearing.

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b. TUBING OR PIPE (fig. 10). If the distance between the end of the shaft and the bearing seat is fairly short, hold the shaft in a vise and press the bearing onto the shaft with a clean section of soft metal tubing squared on the ends and of such inside diameter as to slip loosely over the shaft. This can be done either in an arbor press or by tapping with a hammer *evenly* around the tube. Never use a hammer direct on any bearing; it will damage the bearing. If the shaft is too long, use a split pipe wired together.

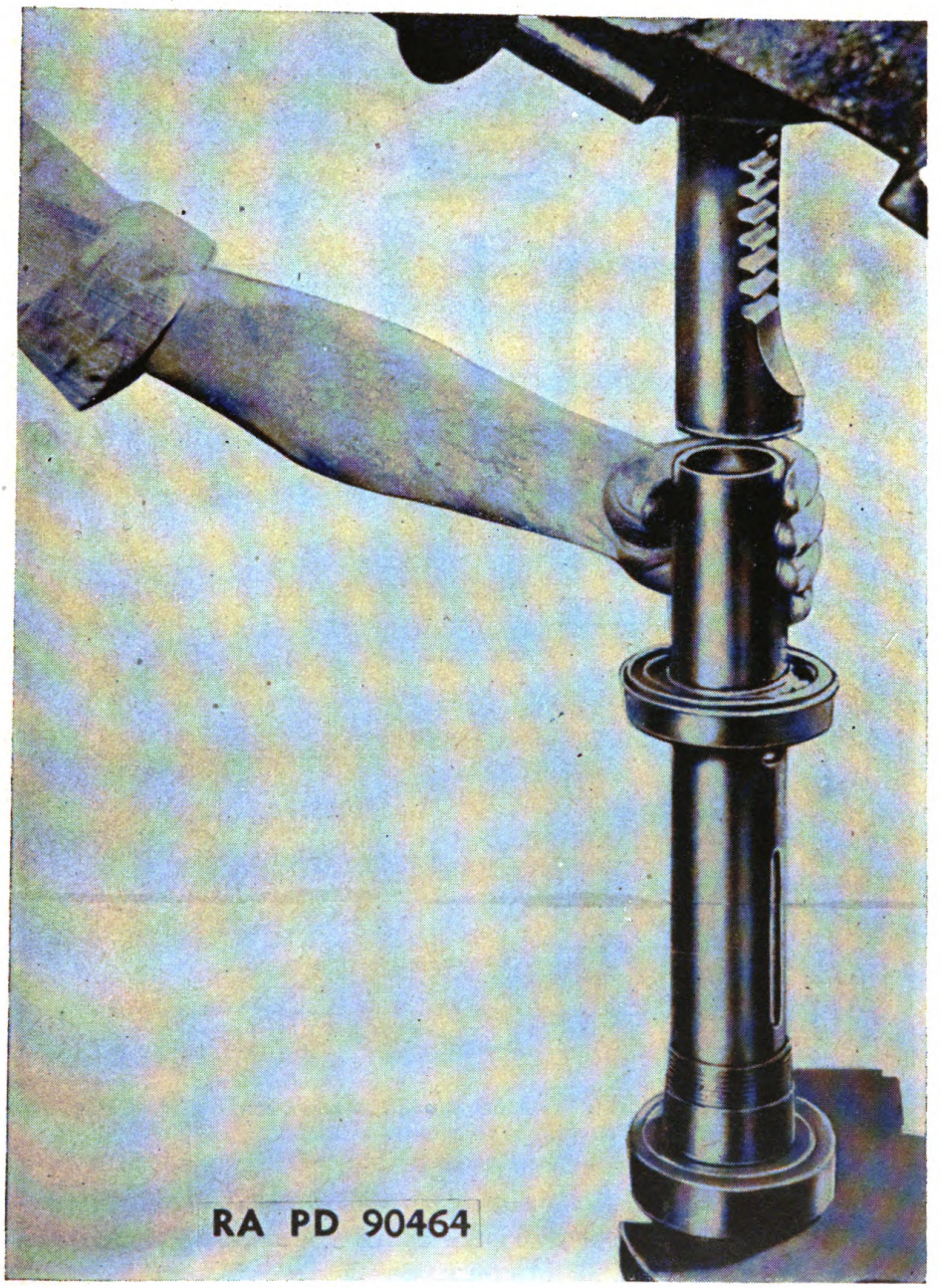


Figure 10. Use tubing with squared ends to avoid cocking bearing. Center it before pressing.

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c. DRIFT OR BEARING INSTALLER (fig. 11). If the end of the shaft is flush with the bearing, use a drift or bearing installer with a flat end. When the shaft projects beyond the end of the bearing for a short distance, use a drift or bearing installer with a counterbore. Tap lightly at first to make sure the bearing or ring goes on square and does not scrape or bur the bearing seat. Be sure bearing is tapped to a firm seat against the shaft shoulder.

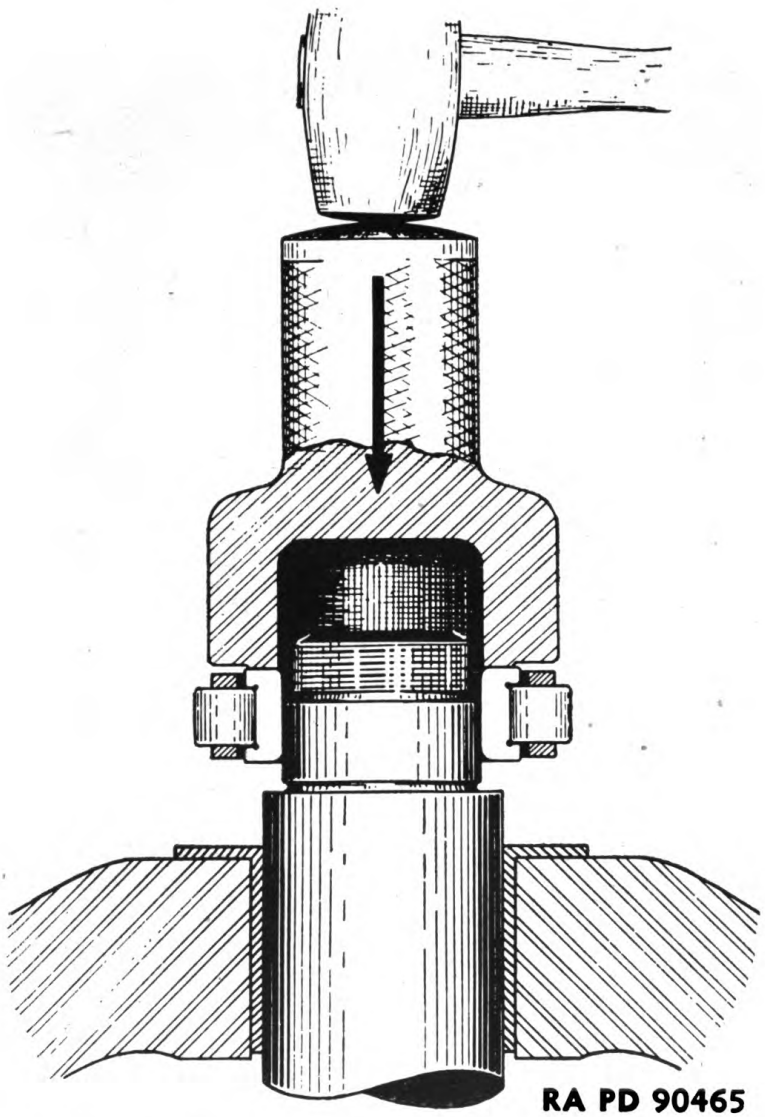


Figure 11. After bearing is on far enough to align itself with shaft, drive to firm seat against shoulder.

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d. Use of hammers (fig. 12). Hammers or mallets must never be used by themselves to drive bearings or bearing parts. Hammering directly against rings injures the bearing, and splinters from the hard bearing ring may injure the eyes and face of the operator.

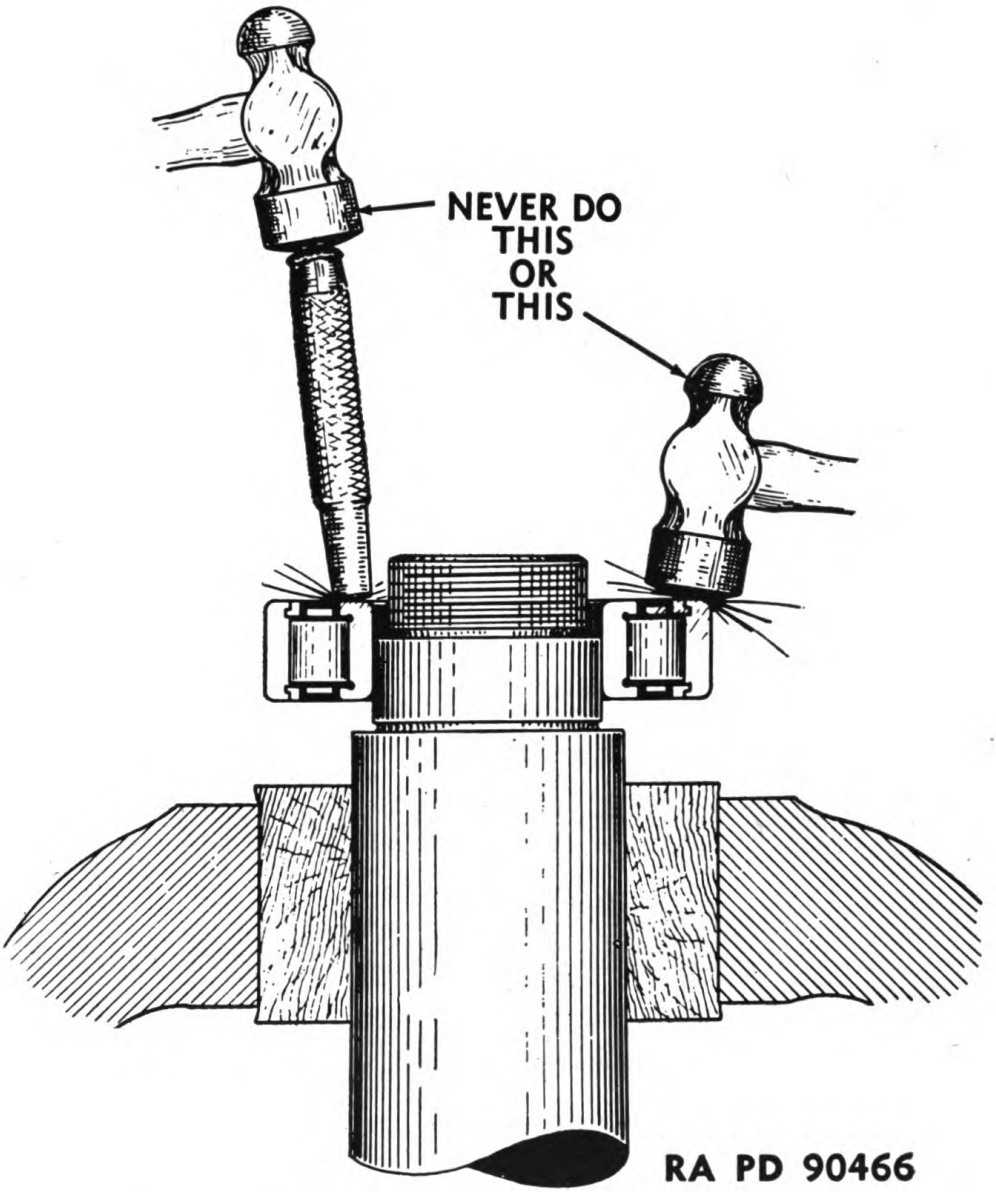


Figure 12. Never use a hammer direct on any bearing; it will result in damage.

e. Drive blocks (fig. 13). Drive blocks are one of the most convenient means of driving a bearing on a shaft or into a housing. They are simple to construct and are especially useful where the operation is repeated time after time. Drive blocks can be used for either outer ring, inner ring, or complete bearing assembly. They must be so con-

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structed, however, that the pressure travels only through the press fitted ring and that the ring is brought up snug against the shoulder or other means of retainment provided for it.

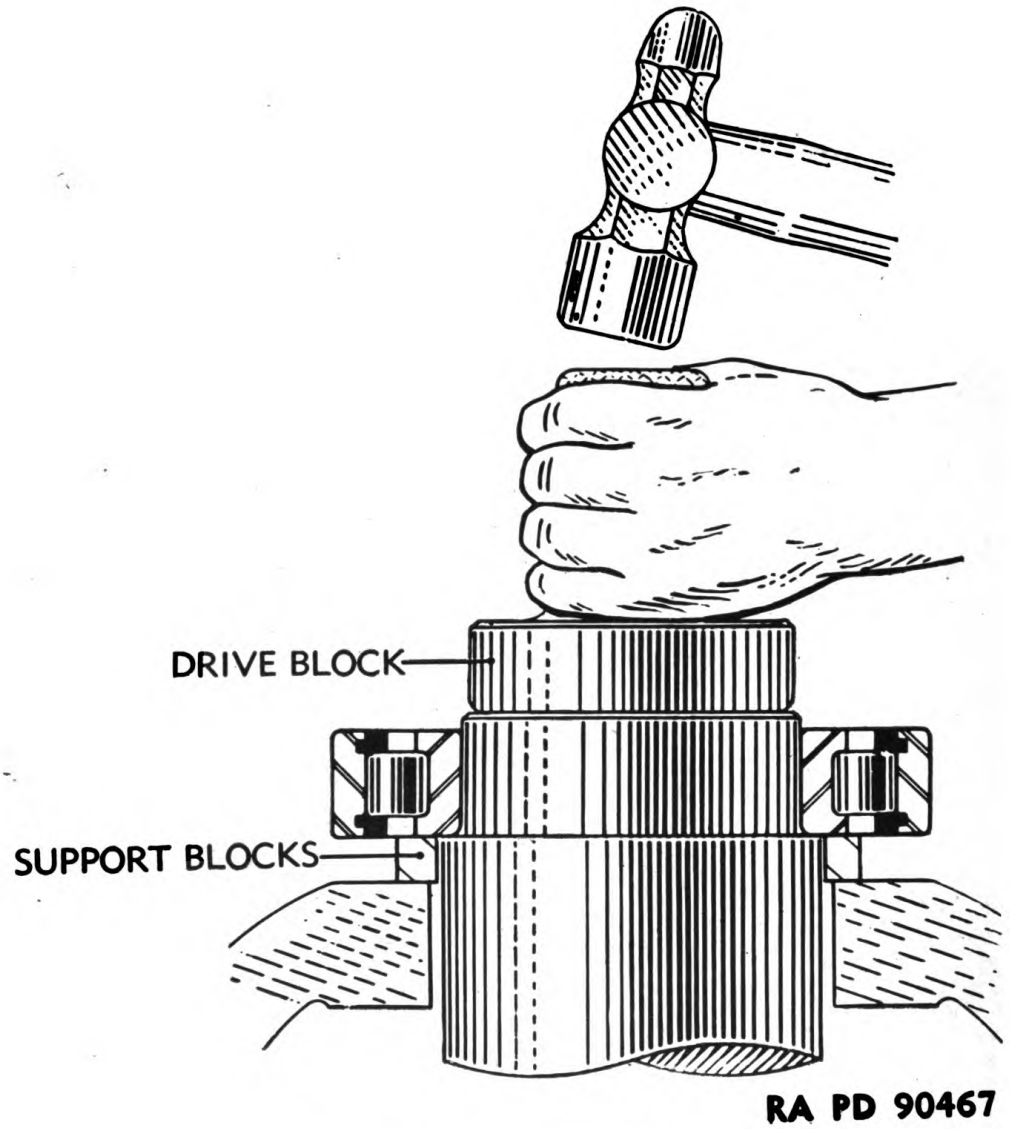


Figure 13. Driving with a drive block.

f. Bearing pullers (fig. 14). Certain types of bearing pullers can be used to drive inner rings on shafts. However, these devices are limited to inner ring mountings.

g. Heating. Large bearings and bearings which must be pressed over a considerable length of shaft or over a tight fitting bearing seat may require heating for assembly on shafts.

(1) This operation consists of heating the bearing or inner ring in clean engine oil (SAE 30) or in a temperature controlled oven to a tem-

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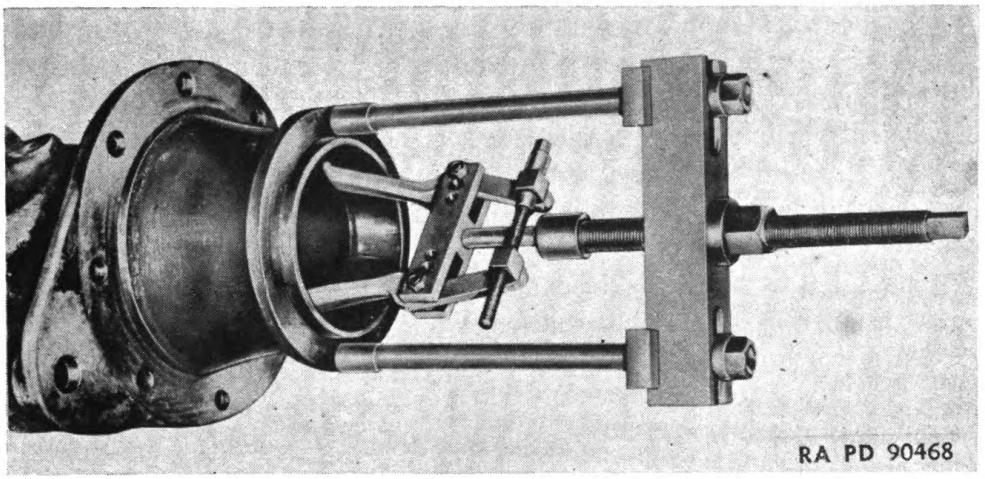


Figure 14. Bearing pullers are essential to most field work. Many are designed to push bearings into place as well as pull them.

perature of between 200° to 250° F. This expands the inner ring sufficiently so it can slip over the shaft to the bearing seat, thus avoiding use of excessive force and damage to the ground surface of the shaft. The bearing should be worked on straight and quickly because if it should become cocked or stuck it may cool in that position and will have to be pulled off and started over. ***Caution:*** Do not exceed a temperature of 250° F., or leave the bearing in the oil or oven longer than necessary to obtain the required temperature. Overheating may cause the bearing to lose its hardness.

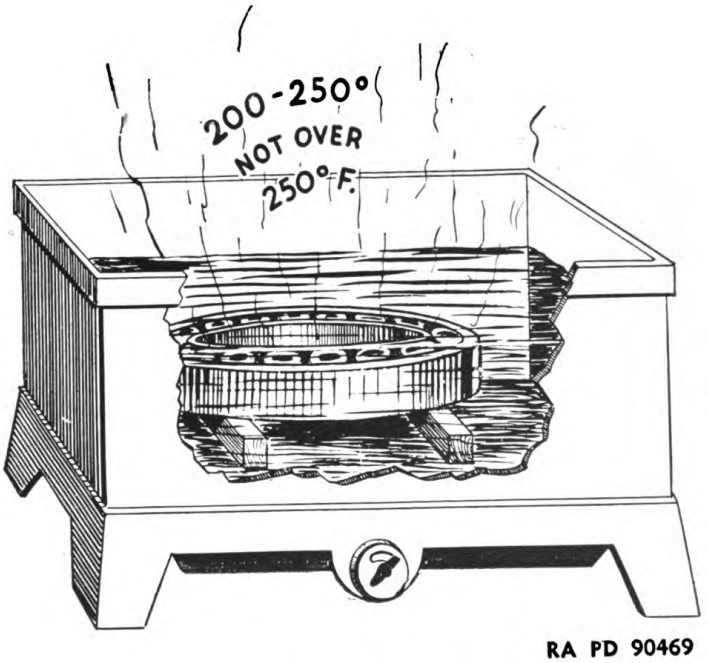


Figure 15. Support bearing on blocks, well away from bottom. Don't keep bearings in hot oil or oven after correct temperature is reached.

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(2) Bearings should never be placed on the bottom of a tank, but should be suspended by hooks or laid on a screen or blocks (fig. 15), so that they may be heated uniformly and be free from sludge or dirt which will accumulate at the bottom of the tank.

(3) When hot air is used instead of oil to expand rings on large bearings, heating may be done in a small electric furnace or in a muffle type gas fired furnace. Service bearings may be retained in their original cartons. In this way, the bearings are kept fully protected from dirt until actually ready for installation.

(4) Electric lamps may also be used for expanding rings. A shelf-like structure is arranged so that when the bearing rests on it the inner ring bore surrounds the large section of the bulb. The burning lamp heats up the ring, expanding it, while permitting the outer ring to remain cool for convenient handling. Where large quantities of bearings are to be heated for assembly purposes, infrared lamps are used. The bearings are placed on a shelf between batteries of infrared lamps and reflectors and are moved along the shelf regularly, or are permitted to remain there until the required temperature is reached.

(5) If ring cannot be expanded sufficiently to install it, the shaft may be shrunk by cooling with dry ice or carbon dioxide snow.

(6) Equipment and methods described previously other than heating are still advisable for best results.

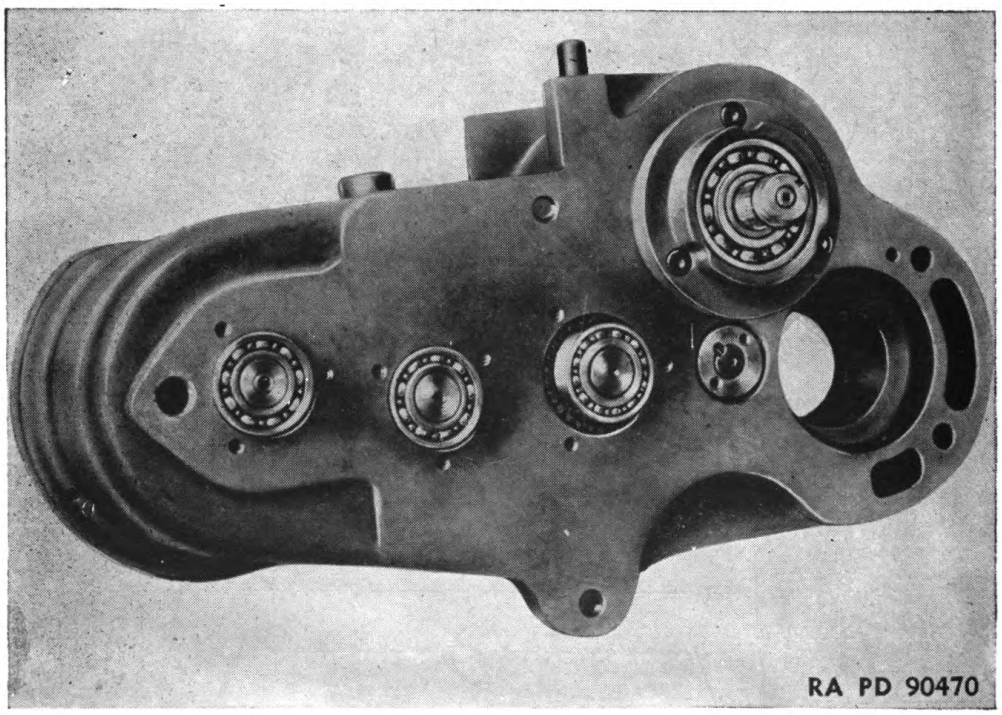


Figure 16. Bearings in partial assemblies like this will collect harmful dust or dirt if left standing too long.

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8. Partial Assemblies

Bearings in partial assemblies should not be exposed. (See fig. 16.) Lubricate and cover them well with clean cloth or paper until ready to complete the assembly, to prevent damage by moisture, dirt or other foreign matter. (See fig. 17.)

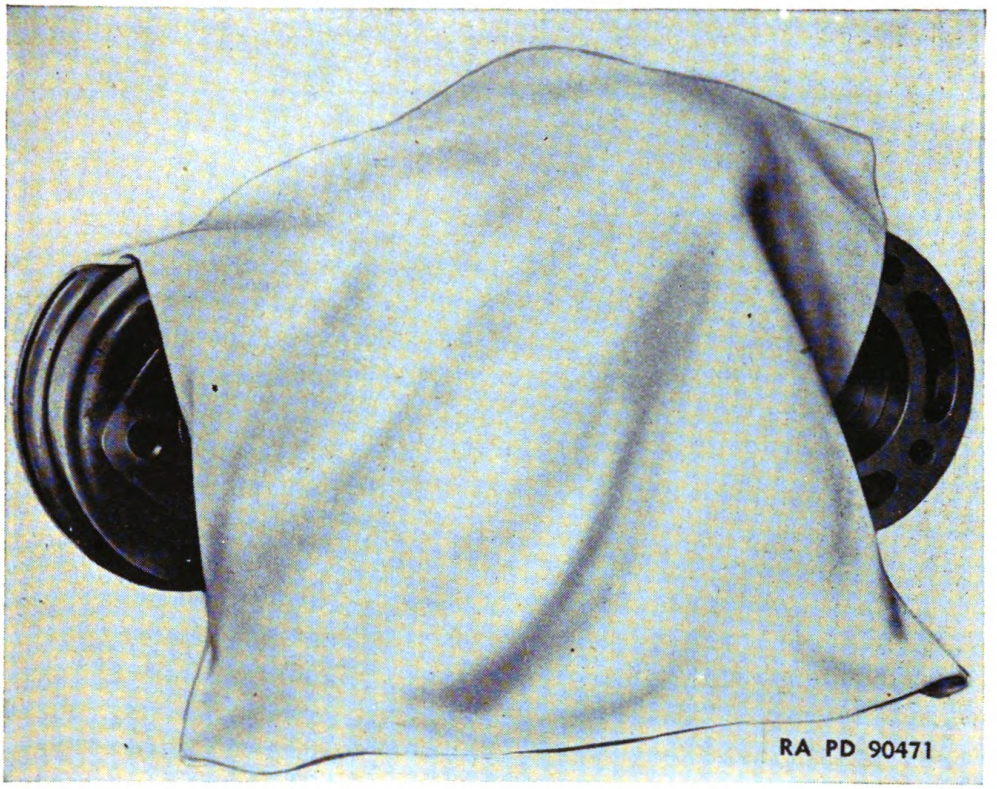


Figure 17. Cover parts with clean cloth or paper, especially if they are to be left several hours or overnight.

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SECTION III

REMOVAL

9. General

Press fitted bearings should not ordinarily be disturbed. When it is necessary to remove bearings, it is done in the reverse order of bearing installation. Study the bearing assembly and determine the best way to undertake bearing removal. Be careful to avoid damage, as the bearings may be good enough to use again. Wash off the bearing housing, taking care to keep loose dirt from getting into the housing. Never apply pressure to a bearing raceway surface, roller, ball, ball separator, or snap ring.

a. When a piece of equipment is taken apart, the bearings stay with the member to which they are tightly fitted. To remove a bearing, press or pull only on the ring which is tight. Bearings are removed from shafts by force applied to the inner ring. They are removed from housings where "tap fits" are used by pressure applied to the outer ring. Press or pull straight and square (figs. 5, 6, and 14) to keep ring from cocking, which might score the shaft or housing and damage the bearing. ***Caution:*** Never press or pull against bearing shield or separator.

b. In cases where you can't get a grip on the correct ring and have to press or pull on the other ring, pull just enough to clear the tight ring so you can grip it.

c. In bearings of separable parts—inner ring, outer ring, and ball or roller assembly—both rings may be a tight fit.

d. When hammers are used, as with a drift or tubing, they should be of steel. Soft hammers are liable to chip, and the chips may fall into the bearing. However, for hammering directly on the shaft or other machine part, a soft hammer, such as brass, should be used to avoid marking the shaft. Never pound directly on a bearing. (See fig. 18.)

10. Tools

The best tool for removing a bearing is usually an arbor press. Most field work, however, is done with some form of bearing puller. Refer to instructions in Technical Manual on the matériel for proper tool to employ. Use it for speed and for safety.

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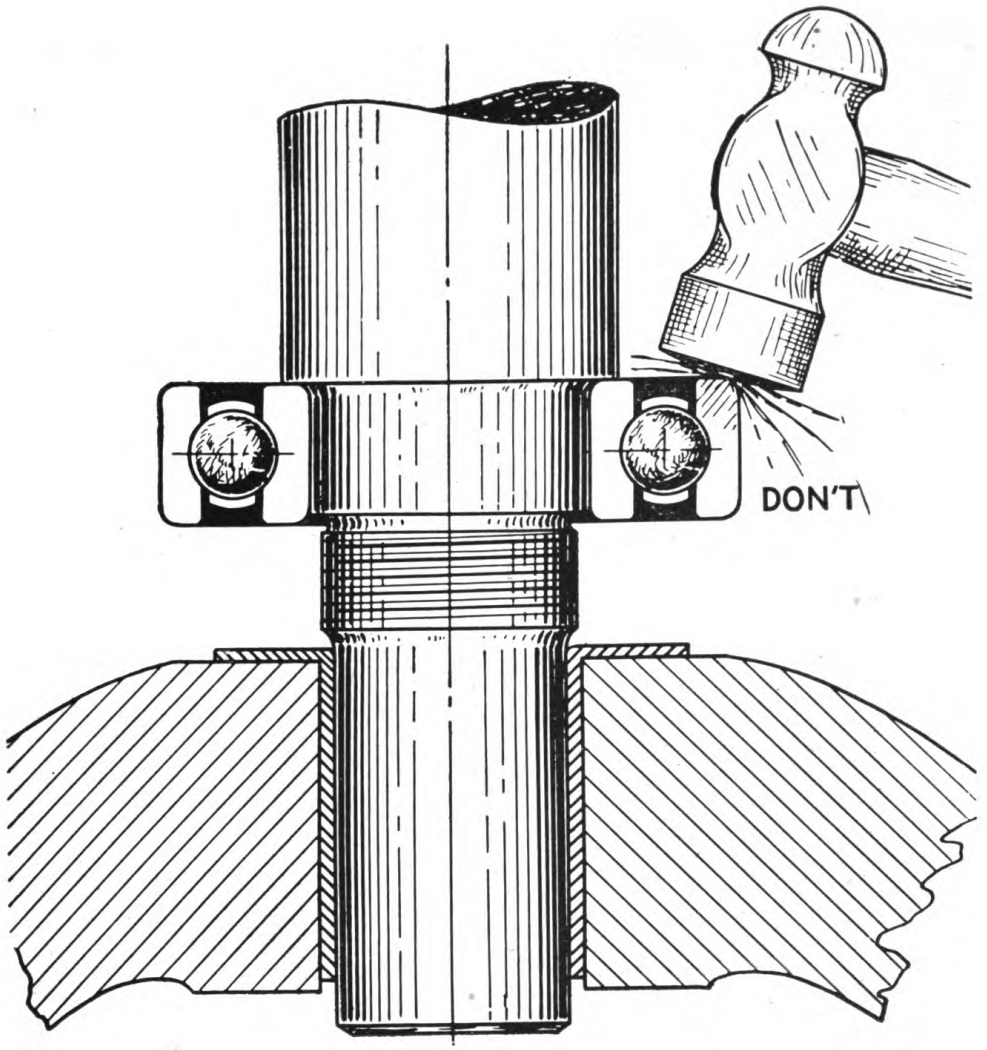
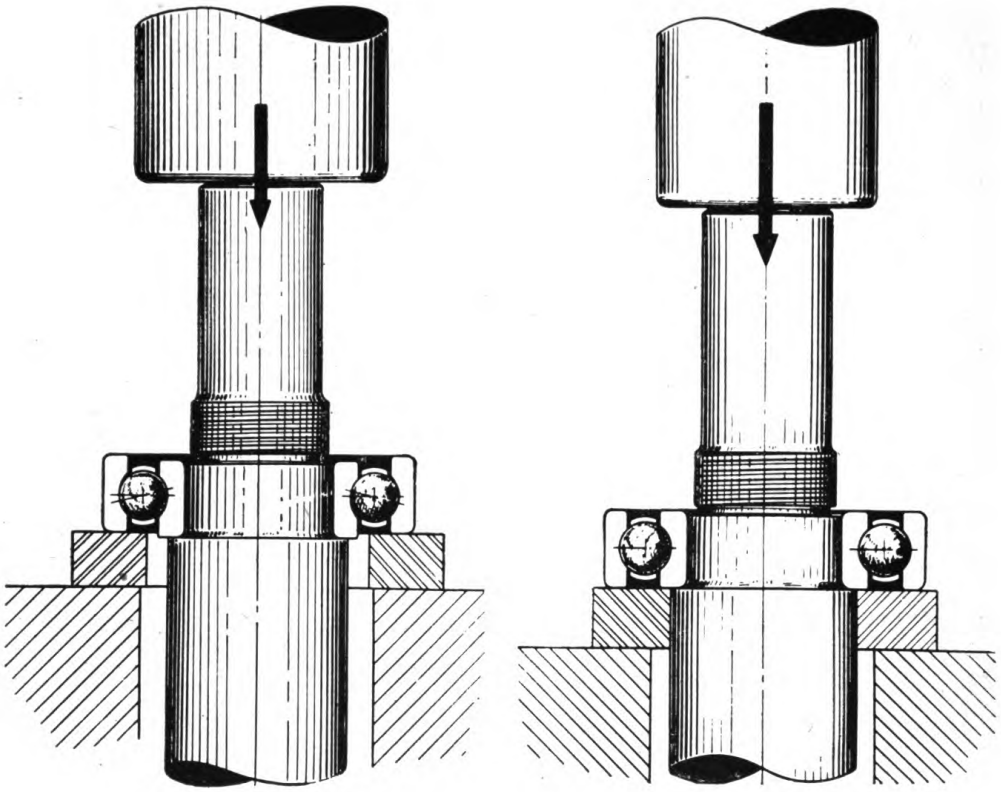


Figure 18. Never pound directly on a bearing or ring. It will likely damage both shaft and bearing.

a. Arbor press (fig. 8). In using the arbor press to remove a bearing, be sure that the anvil and bearing supports are clean and smooth and that the shaft and press ram are lined up vertically. The press ram pushes down against the shaft on which the bearing inner ring is tightly fitted, but the stripping of the bearing is done by the support blocks under the rings. Therefore, the support blocks should contact the inner ring, or both rings if bearing is flush faced (fig. 19), so that the pressure will not be against the outer ring, shield, or separator. If the support blocks are spaced too far out, the pressure on the outer ring causes a heavy stress on balls or rollers which can injure them and cause indentation of both rings.

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① *WRONG—Blocks contact the bearing outer ring only.* ② *RIGHT—Blocks contact inner ring—or both rings if bearing is flush faced.*

Figure 19. Methods of removing a bearing with an arbor press.

(1) Support blocks may consist of flat bars placed beneath the inner ring adjacent to the shaft (fig. 20), a piece of flat stock with a U-shaped cutout for repeated operation, or a circular ring bored slightly larger than the shaft diameter and sawed into two semicircular segments.

(2) The press table and blocks should be clean and square, and some means should be provided to keep the shaft from falling to the floor.

(3) The arbor press can only be used to remove rings or bearings from housings which are so designed that some portion of the outer ring can be exposed. In cases where the entire face of the outer ring is exposed, a section of pipe or tubing, capped by a steel block, can be used.

b. BEARING PULLERS (figs. 21, 22, 23 and 24). Pulling tools are useful where no arbor press is available or where the shaft is too large or obstructed to go into a press. They are recommended when shoulder height permits and when enough of the bearing is exposed. Set pullers up so they will push or pull straight and square. (See fig. 23.) Take care not to damage shaft threads, keyways, or shoulders in the process.

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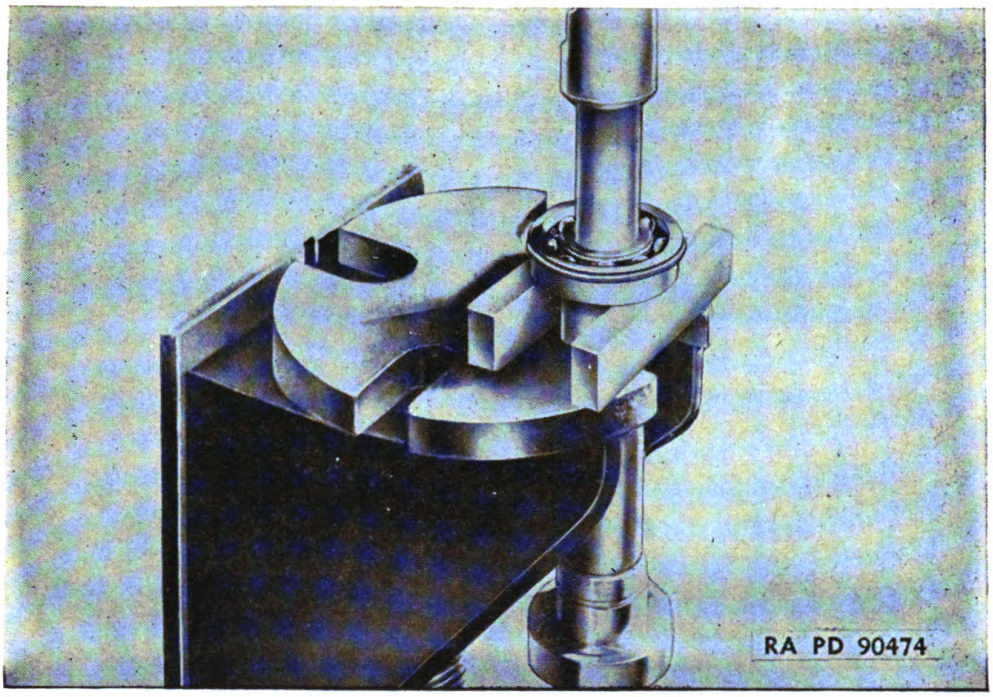


Figure 20. Use steel blocks that are the same size and squared up on all sides to assure even contact by both blocks.

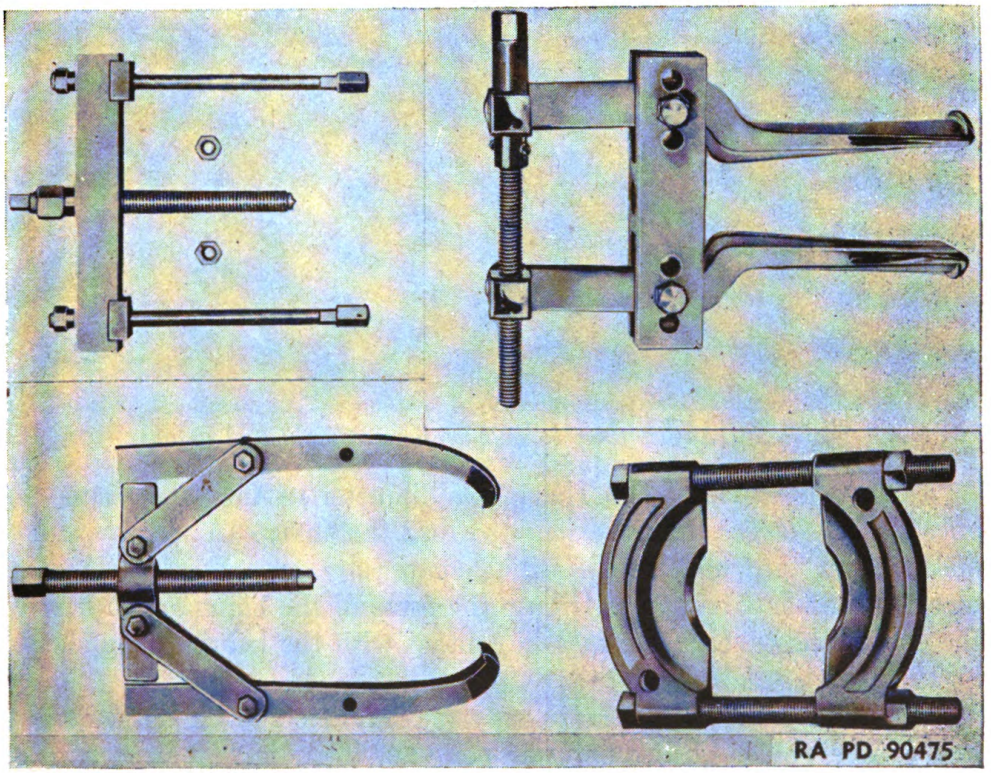


Figure 21. Typical bearing pullers which may be used separately or in various combinations to pull or push complete bearings or individual rings.

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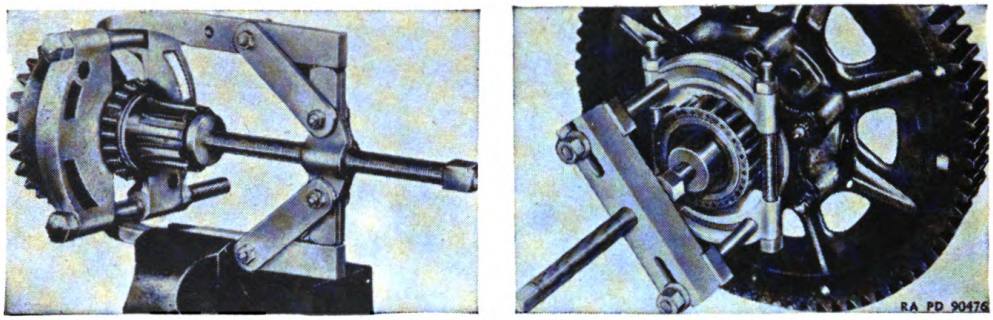


Figure 22. Where there is enough space behind a bearing or bearing ring to admit a puller, always be sure that the puller is adjusted so that it will not slip over the inner ring when pulling pressure is applied. If this happens, bearing parts can be severely damaged.

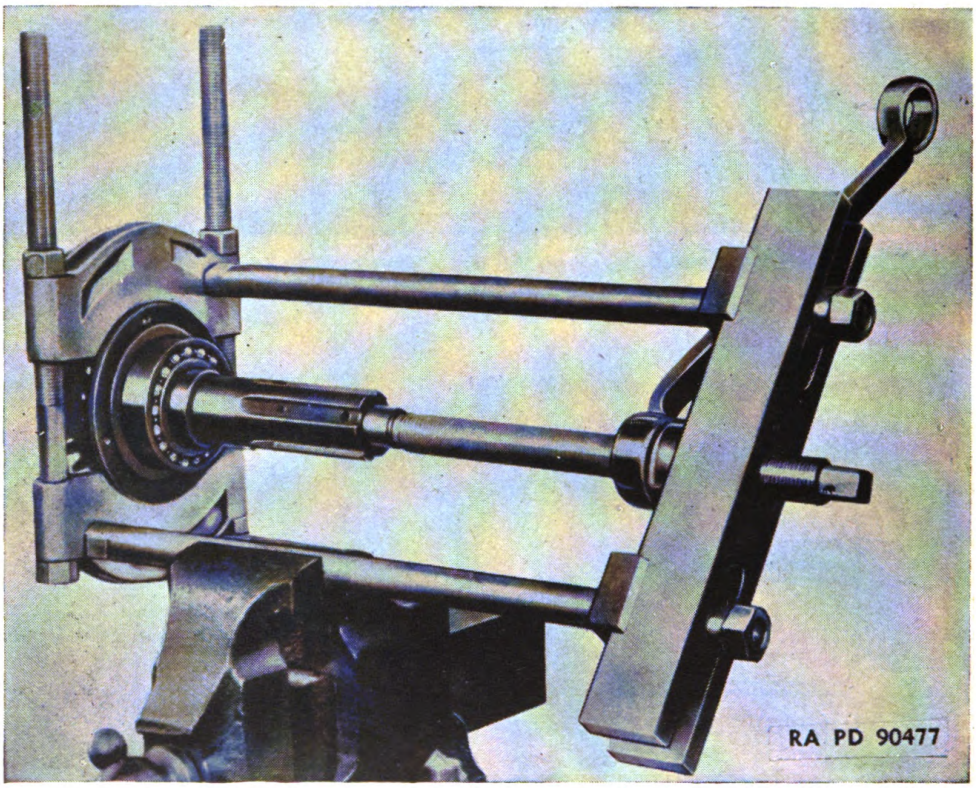
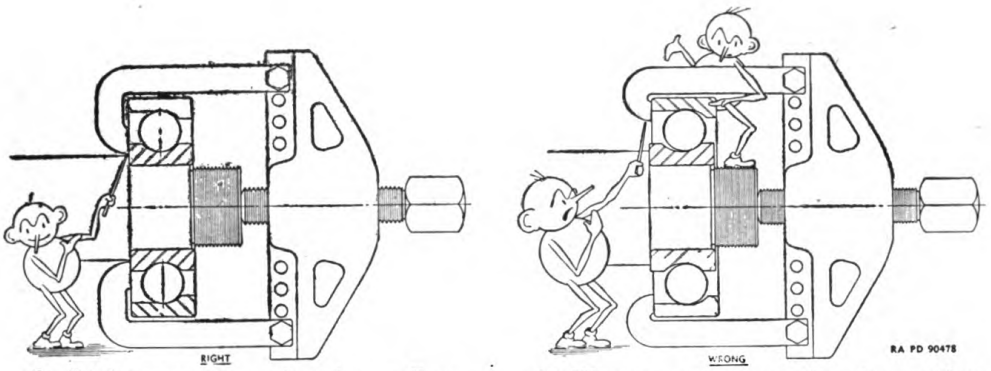


Figure 23. Adjust tools to pull bearings straight and square.

c. TUBING OR PIPE. (1) The inside diameter of the tube should be only slightly larger than the shaft so that the shaft can act as a guide and prevent the tube from injuring snap rings or separator. A steel block is used as a cap to distribute the force of the hammer blows over the end of the tube. Tube face in contact with the bearing ring should be clean and square.

(2) If the shaft is too long to use a pipe and steel block conveniently, lugs can be welded on two opposite points of the outside diameter. (See fig. 25.) The driving is done against these lugs, and should be done on opposite sides alternately in order to move the ring off uniformly. Where obstructions prevent the tube from being slipped over the shaft, this

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① *Right way to use bearing pullers.* ② *Wrong way to use bearing pullers.*

Figure 24. Sectional views of right and wrong way to use bearing pullers.

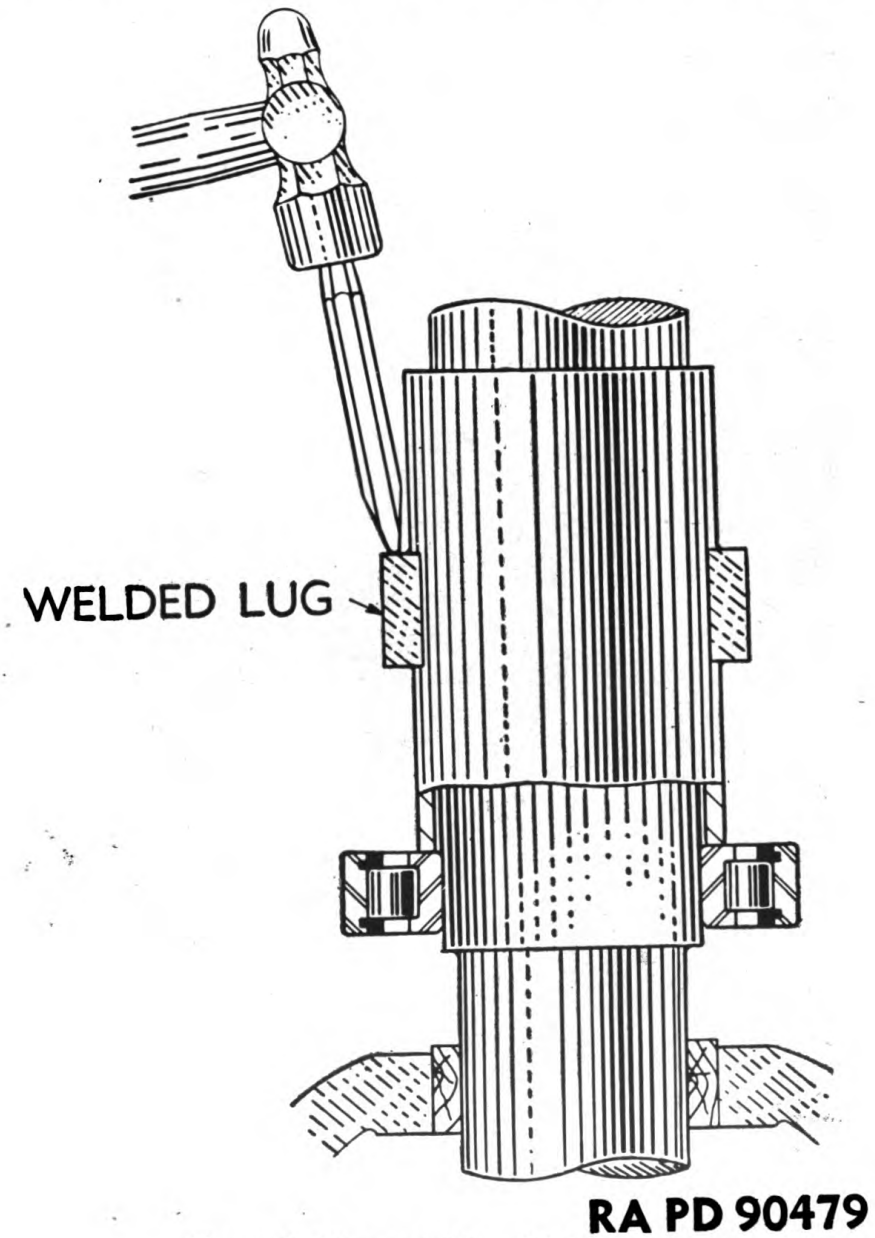


Figure 25. Pipe or tubing with long shafts.

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tube can be split and the two halves assembled around the shaft where they can be held together by means of wire, steel bands or heavy cord.

d. DRIVE BLOCKS (fig. 13). Drive blocks are preferable to pipes or tubing, but they cannot be used with very large bearings or where the back face of the inner ring is obstructed. The block face in contact with the bearing ring should be clean and square.

e. HEATING. When available equipment does not have sufficient force to remove bearings, heat may be used, although it is not recommended because of danger of overheating, temper drawing and the development of soft spots in the bearing, leading to failure when it is later operated. Pouring hot oil over the ring is the best means of applying heat. Sometimes it may be necessary to use a direct flame from a blow torch. Temperature of the bearing should never go beyond 250° F. Wet cloths wrapped around the shaft may help to carry away excessive heat.

f. GRINDING AND SPLITTING. Sometimes a separable inner ring is installed against a shoulder of equal diameter so that there is no way to grip it. Leave the bearing ring on if it is usable. Otherwise, when no other method of ring removal can be used, the ring must be cut off with a torch. Using a grinder or acetylene flame, burn it part way through in order not to harm the shaft. This may loosen the ring enough so that it can be pulled off. If not, crack through the rest of the way with hammer and cold chisel. (See fig. 26.) The chisel should not be directed

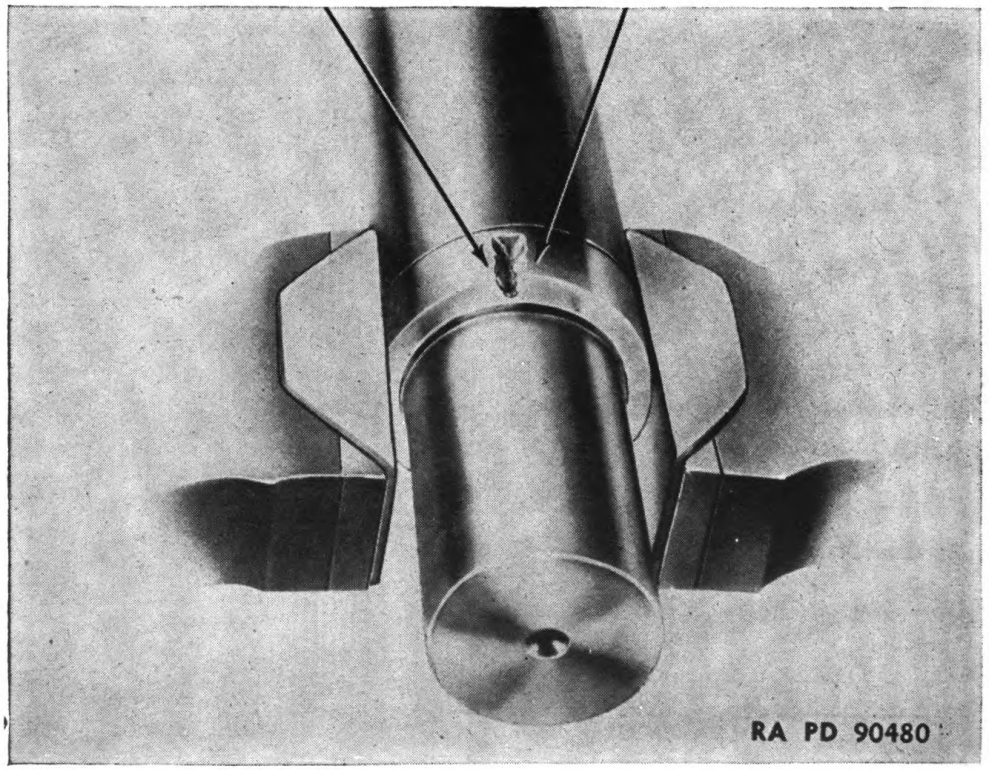


Figure 26. If ring has been cut to remove, squeeze in vise and strike smartly at points indicated to fracture it. Be careful of shaft.

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straight down toward the shaft, but rather at a tangent against the side of the groove which has been cut in the ring. With small rings mounted on such shafts, a sharp blow may be enough to crack the ring. Precautions should be taken to prevent personal injury by flying parts.

11. Improvised Tools

Where the right tools are not available, improvised methods may be used, but care must be taken. A vise can be used instead of an arbor press and a drift will take the place of the press ram. (See fig. 27.) If the shaft is held in the vise, protect its surface with copper or lead sheet or by hardwood blocks. (See fig. 28.)

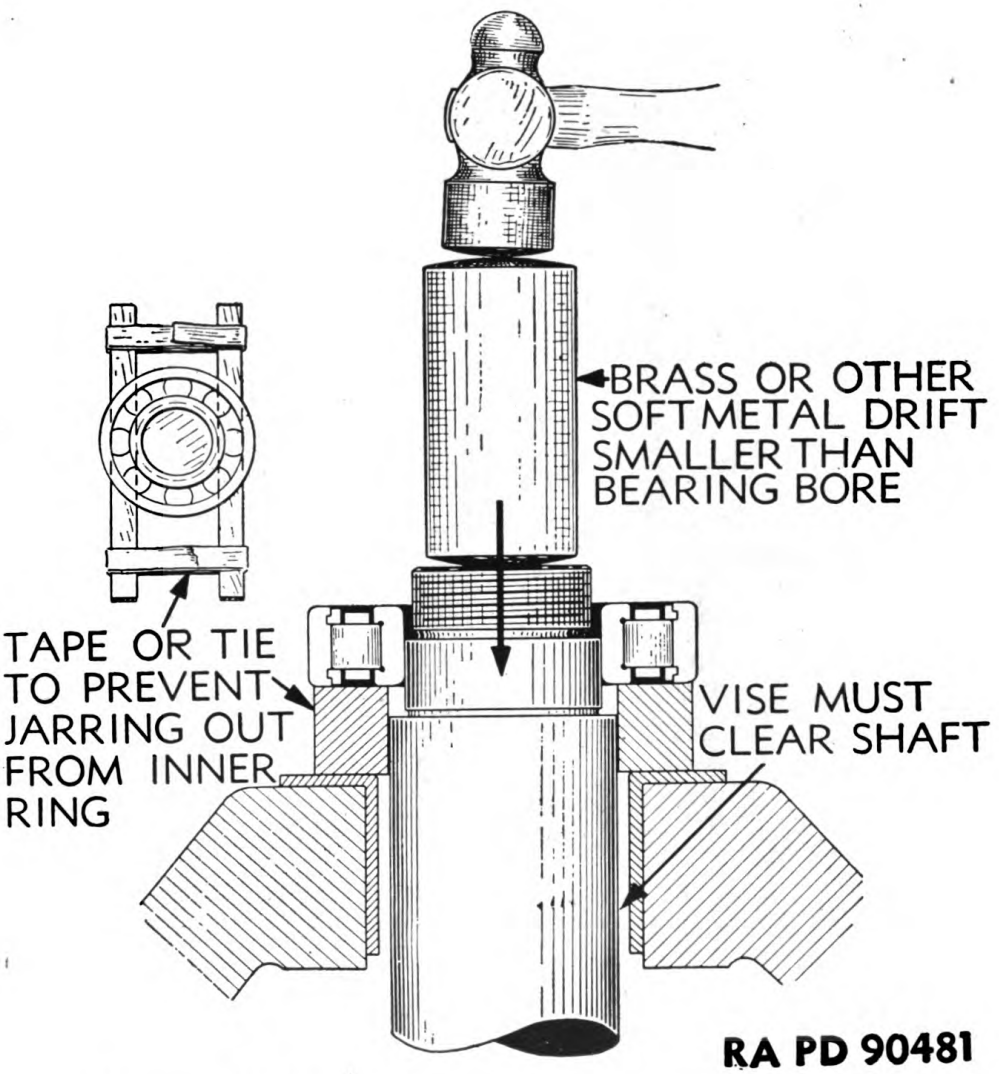


Figure 27. To drive shaft out of bearing, use a soft metal drift which will not mar the shaft.

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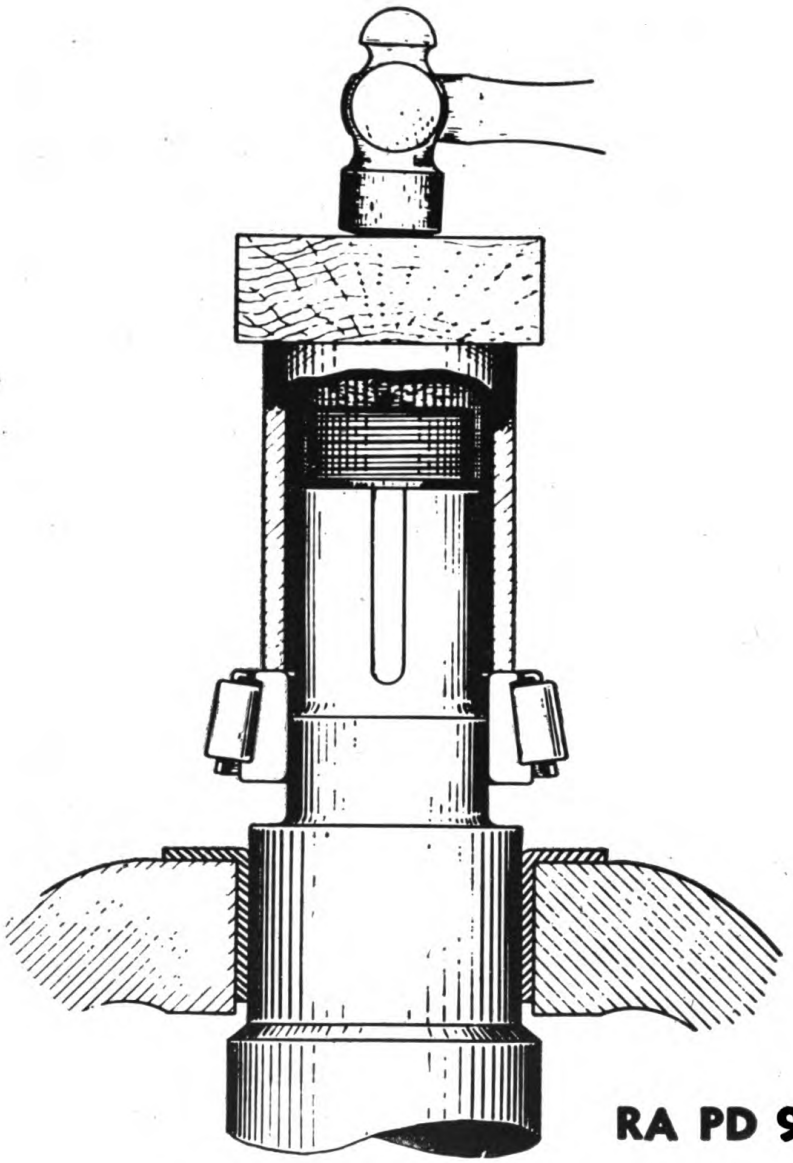


Figure 28. A tough hardwood block used like this protects the end of the tube.

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SECTION IV

CARE AND ADJUSTMENT

12. Cleaning

a. GENERAL. Dirt is the most common cause of bearing failure and the principal cause of wear. When dirt gets into a bearing, it mixes with the grease or oil and forms a "lapping compound" that quickly wears the balls or rollers. The word "dirt" is used in a broad sense and includes all foreign matter which may enter and prove injurious to the bearings. The substances most likely to enter bearings may be divided into three groups:

(1) *Abrasives.* Materials of sufficient hardness to cut or scratch, such as emery dust, particles from grinding wheels, sand and grit contained in contaminated lubricants.

(2) *Obstructives.* Material not hard enough to cut, but of sufficient strength to interfere seriously with the motion of the bearings, such as metal particles, small chips, or improper lubricants.

(3) *Clogging substances.* Materials which may gradually accumulate in the bearing, prevent proper lubrication, reduce the clearance between parts and interfere with smooth operation.

b. METHOD. (1) Small tanks and wire baskets may be used for soaking and washing bearings. If these are not available, a clean lubricant container filled with dry-cleaning solvent (fig. 29) can be used. Do not let bearings rest on the bottom of the container. One way to avoid this is to suspend the bearings in the solvent by a length of wire. The bearings should soak long enough to loosen the lubricant and dirt. This may take several hours or longer. After they have soaked sufficiently, slosh the bearings around near the top of the container, giving them a turn now and then until they are clean. An oil spray cleaner may also be used. (See fig. 30.) Rinse in a *clean* container of *clean* solvent. (See fig. 31.) Use clean lintless wiping cloths for wiping and handling.

(2) If the lubricant is badly gummed or caked, the bearings can be soaked in a light engine oil heated at 180° to 200° F. This can be done

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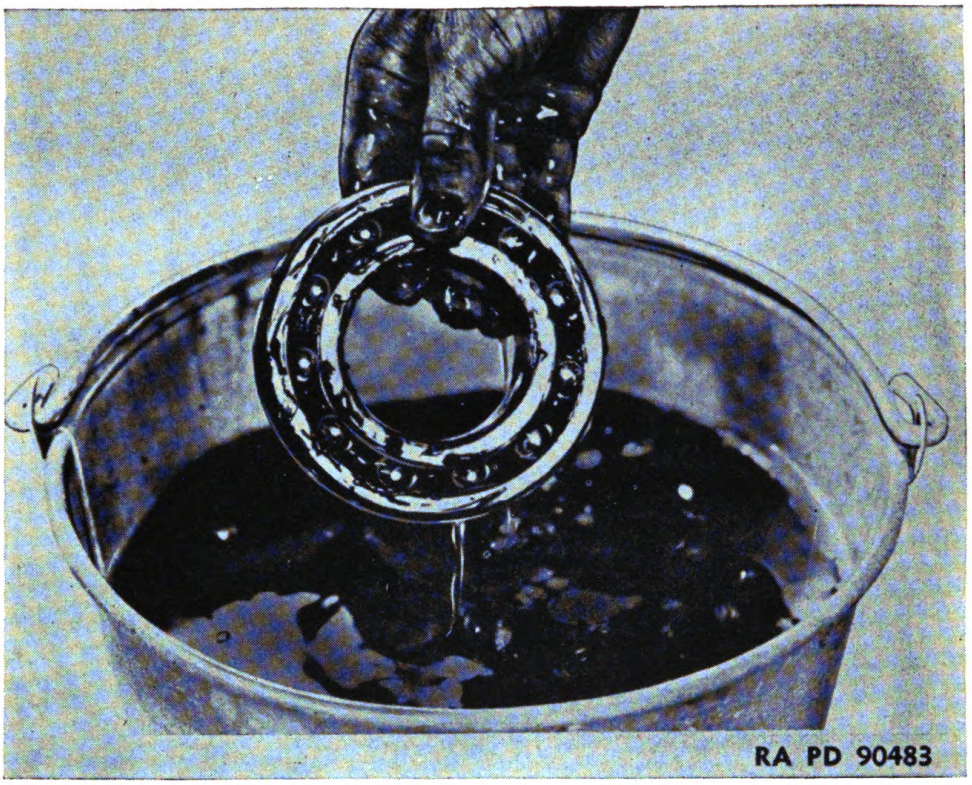


Figure 29. Soak bearings thoroughly in solvent.

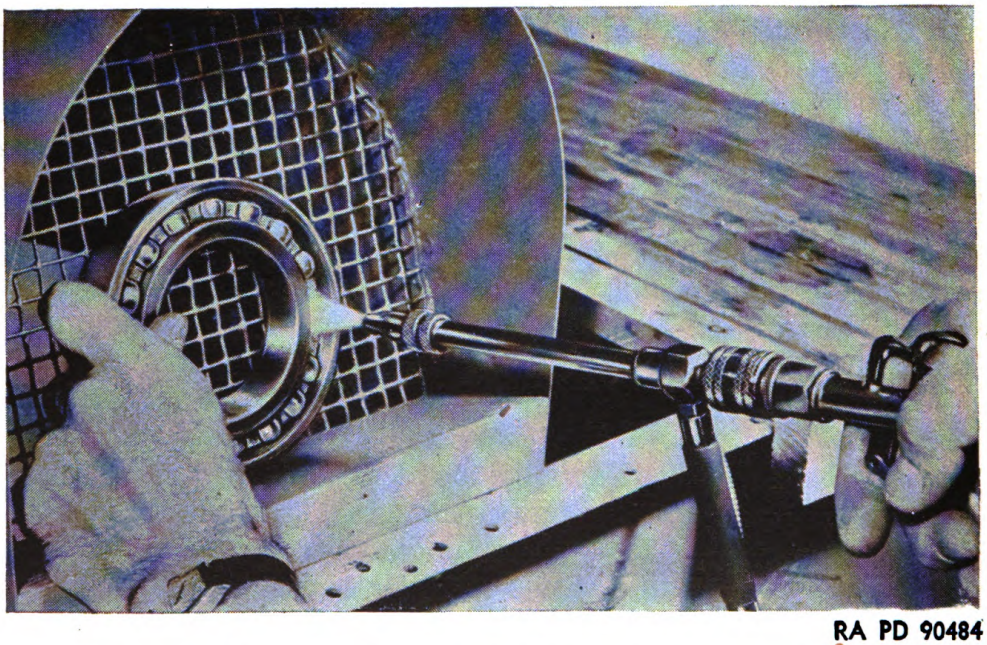


Figure 30. Oil spray cleaner is desirable and efficient equipment. Use it with a filter in the air line.

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Figure 31. Rinse them in clean solvent.

ly sloshing the basket or wire through the oil slowly as often as possible. In cases of extreme sludging, the bearings may be soaked in a mixture of denatured alcohol and dry-cleaning solvent, unless the bearings have shields or seals on both sides. (See par. 12d.)

c. PRECAUTIONS. (1) Do not spin dirty bearings, as dirt can cause serious scratchings. (See fig. 32.) Rotate them slowly while washing.

(2) After bearings have been cleaned and inspected protect them immediately from corrosion and dirt by coating with a film of lubricant prescribed for their lubrication servicing when reassembled. If immediate reassembly is impossible, wrap in greaseproof wrapping paper or other protective materials such as clean wiping cloths and store in covered container.

d. SHIELDS OR SEALS. (1) Bearings with a shield or seal on one side only should be washed, inspected and handled in the same manner as bearings without shields or seals.

(2) Bearings with removable seals should be washed and inspected, after removal of seals, in the same manner as bearings without seals.

(3) Bearings with shields or seals on *both* sides should *not* be washed. Wipe them off to keep dirt from working inside. Smooth turning bearings can be coated with rust-preventive compound (light) or lubricating grease (special), then wrapped and stored or used in their original application.

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Figure 32. Don't spin bearings before cleaning.
Dirt can cause serious scratching.

Note. If bearings with two shields or seals stick or feel too rough for further use, forward them to a higher echelon of maintenance where special shielded bearing cleaning and lubricating equipment is available.

e. CLEANING SOLUTIONS. Use only dry-cleaning solvent or Diesel fuel oil for cleaning.

f. CLEANING INSTALLED BEARINGS. When bearings cannot be removed from their housings and shafts for cleaning, engine oil (SAE 10) heated at 180° to 200° F., should be flushed through the housing while the bearing is slowly rotated. Where the grease or oil is badly gummed or caked and cannot be removed by this method, flushing with dry-cleaning solvent may prove effective. In extreme cases, acetone or a mixture of denatured alcohol and dry-cleaning solvent will remove the greater part of the sludge and gums. This should be followed by a flushing with engine oil (SAE 10) before the lubricant is added to the housing, in order to wash away any of these solvents which would otherwise dilute the lubricant.

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13. Inspection

a. PROCEDURE. After a bearing is washed clean, it must be inspected to determine its serviceability.

(1) Drain off cleaning agent and dry thoroughly by wiping or suspending the bearing until the solvent has entirely evaporated.

(2) Unless better equipment is available, cleaned bearings that are not separable are inspected by holding the inner ring stationary with its axis vertical. (See fig. 33.)



Figure 33. Hold clean bearing like this when rotating outer ring during inspection.

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(3) With the hand, apply force to the outer ring of the bearing and allow it to spin. Listen carefully for any excessive noise while the bearing is revolving. Feel it for excessive roughness. Watch the bearing for signs of grit or roughness while it coasts to a stop. Bearings suitable for re-use will coast smoothly and freely to a stop and will not emit excessive noise. If grit or roughness is noted, reclean the bearing and recheck.

(4) Since the bearing is without lubrication, continued rotation will score and/or burn the rings.

(5) Defective bearings will emit excessive noise while revolving. They will transmit easily felt vibrations to the hand while being held and revolved and will not coast to a stop, but will stop abruptly.

b. CAUSES FOR REJECTION OF BEARINGS. The following types of defects are such as to cause the bearings to be rejected:

(1) Broken, cracked, or split rings. (See fig. 34.) This is often due to wrong fit of bearings on shafts having diameters larger than specified, cocking the ring while installing or removing it, and improper force during removal.

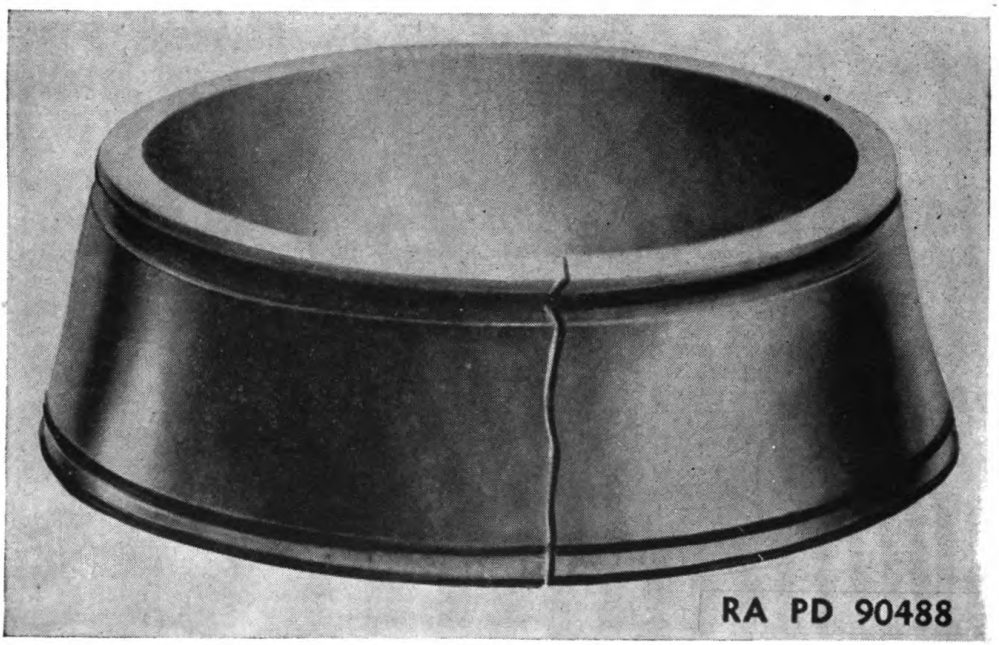


Figure 34. Cracked inner ring. Often due to wrong fit or improper force during removal.

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(2) Dented seals, shields or rings. (See figs. 35 and 36.)

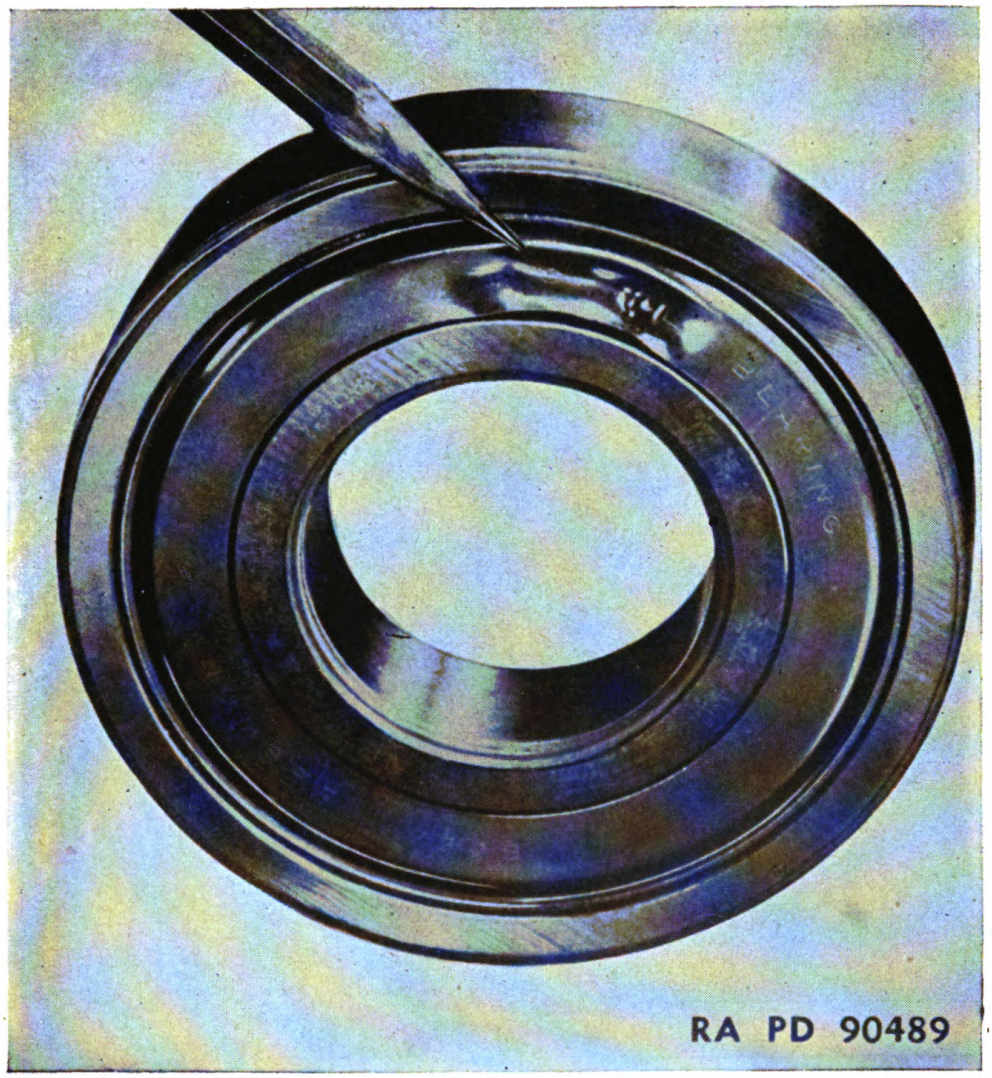


Figure 35. Shield bent by drift that slipped.

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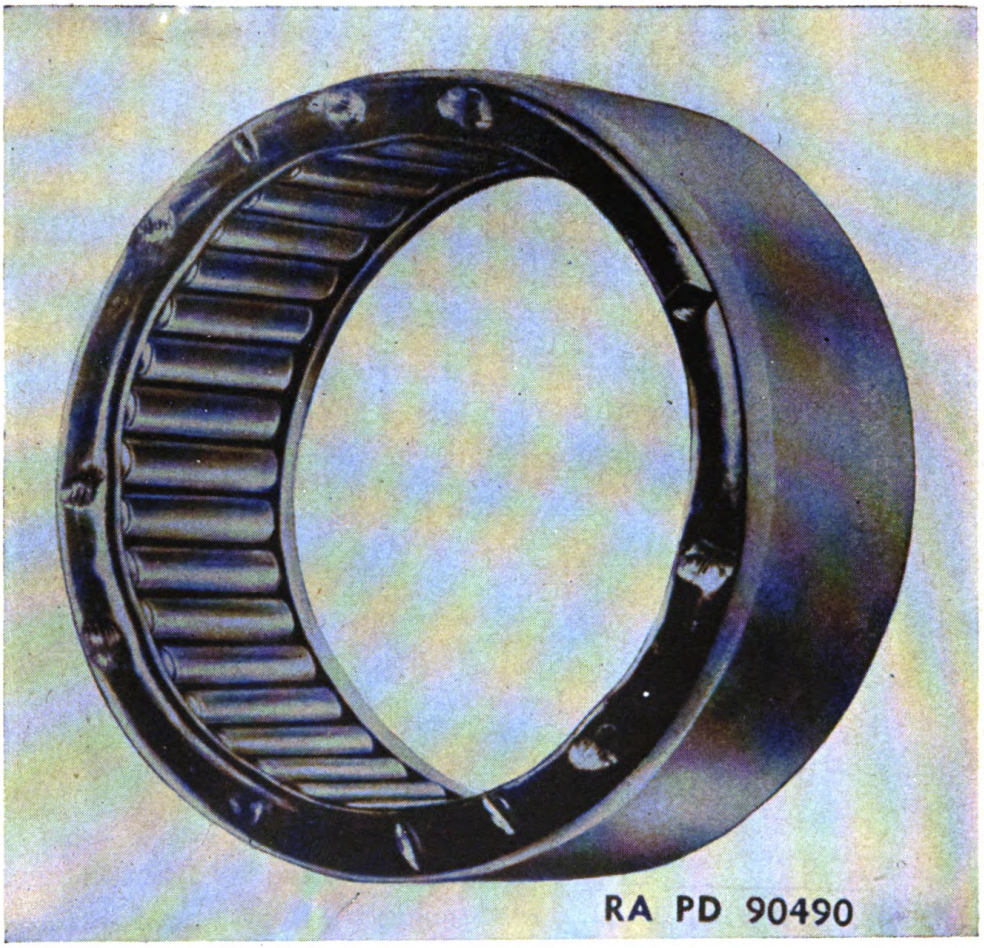


Figure 36. Outer ring or shell dented by wrong use of hammer and chisel.

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(3) Cracked or broken separators, balls, or rollers. (See fig. 37.)

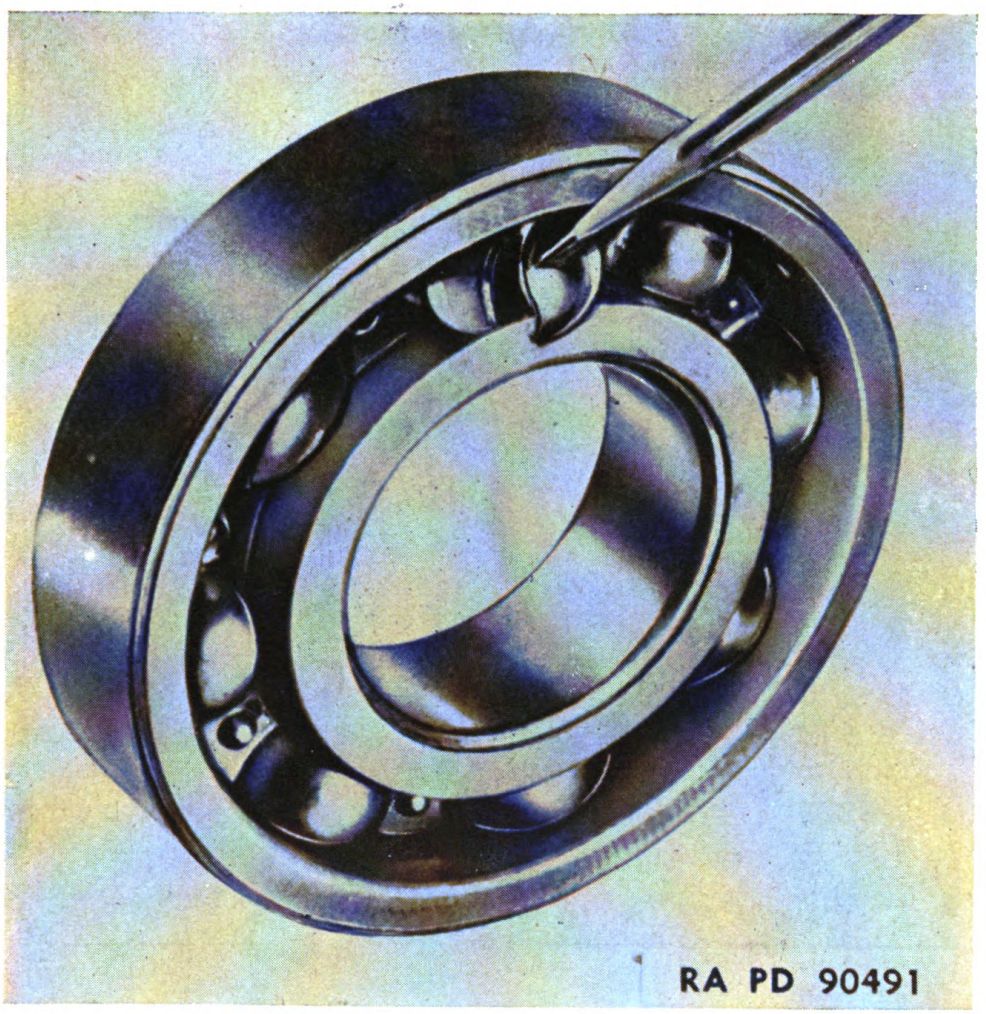


Figure 37. Broken separator often due to presence of dirt or metal chips.

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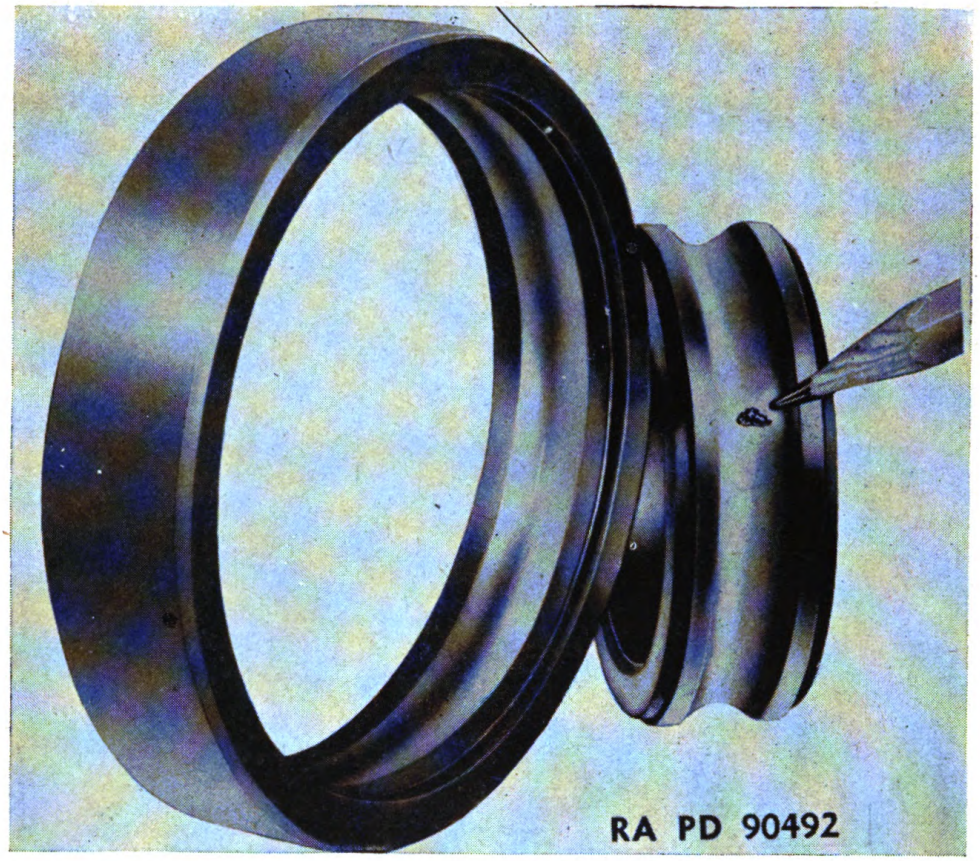


Figure 38. Typical spalling on inner raceway of a ball bearing.

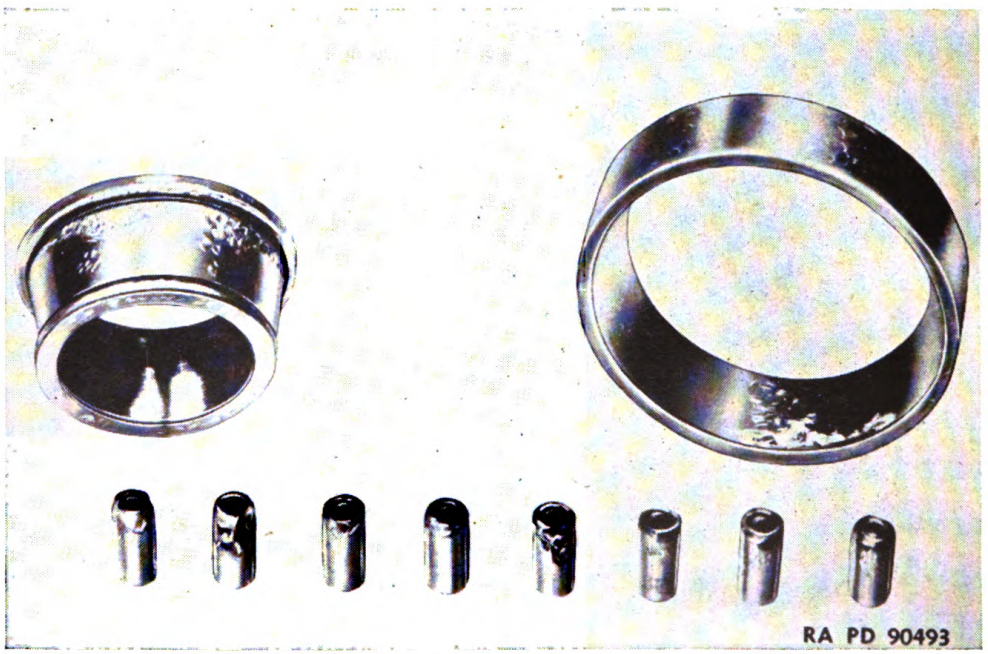


Figure 39. Spalled cone, cup, and rollers of tapered roller bearing. Spalled bearings of any kind should never be returned to service.

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Figure 40. Flaked or spalled area on inner raceway of straight roller bearing.

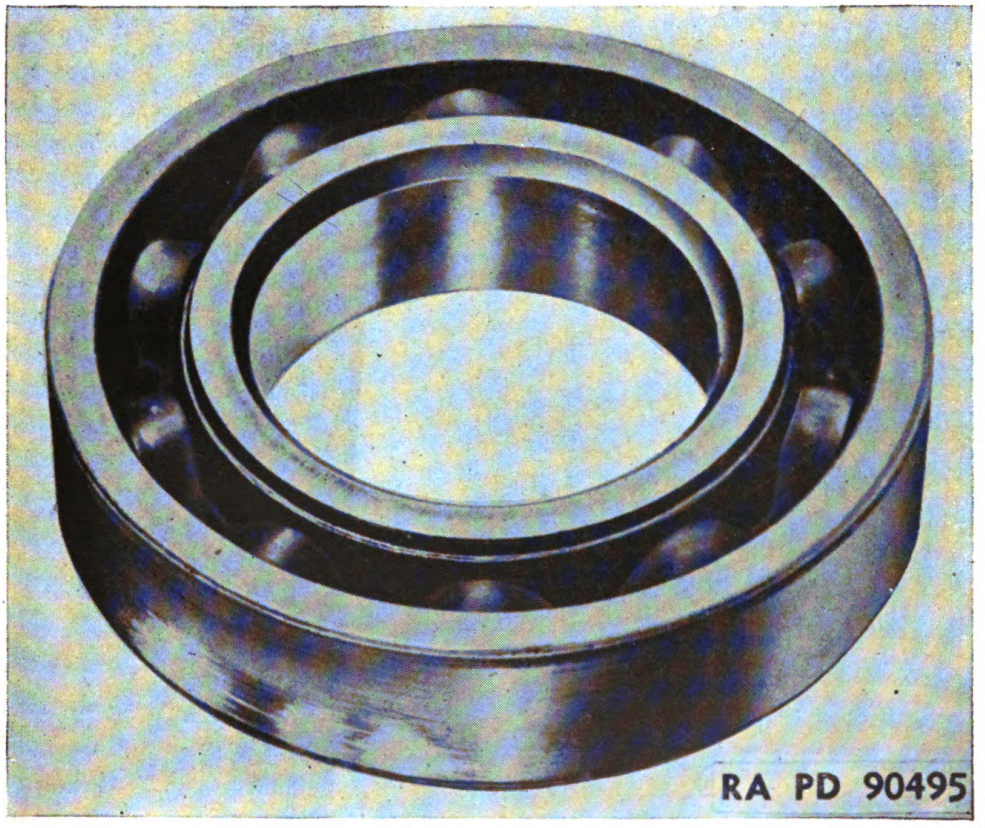


Figure 41. Typical discoloration caused by overheating.

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(4) Flaked or spalled areas on balls, rollers, or raceways. (See figs. 38, 39, and 40.) This is primarily due to excessive overload.

(5) Overheated bearings (fig. 41) are generally darkened to brownish blue or blue-black color.

(6) "Brinelled" raceways. (See figs. 42 and 43.) Brinelling is caused by impressing balls or rollers into the rings (races) and appears as a series of nicks or indentations under each roller. It often results when the driving force travels through the rollers instead of being applied directly to the press-fitted ring. Hammer blows or sudden or excessive loads may also cause brinelling. Roughness due to brinelling may be detected by slowly rotating the bearing when the inner and outer races are tightly gripped with the forefinger and thumb.

(7) False brinelling resembles true brinelling very closely in appearance, but comes from entirely different causes. Bearings which are subject to vibration or which oscillate through a small arc instead of revolving will show false brinelling.

(8) Scoring is produced by dragging the roller assembly across the surface of the rings in a cocked position or with a heavy load on the bearing. It causes noisy bearing operation and eventually leads to pitting.

(9) Etching by moisture or acid formation. (See fig. 44.)

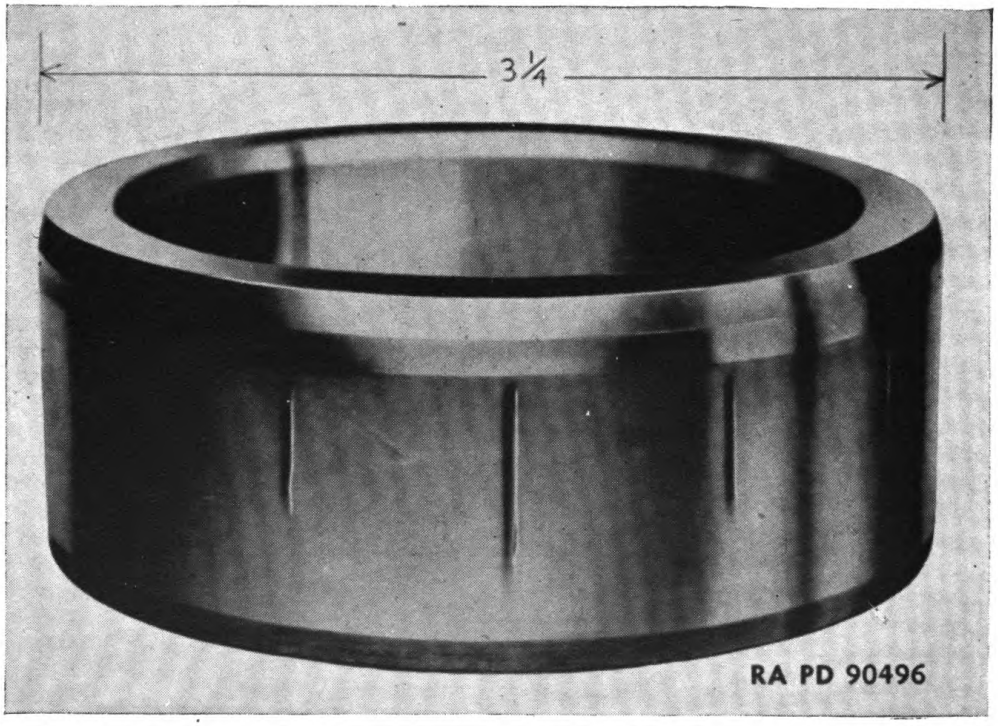


Figure 42. Inner raceway showing indentation or "Brinell" marks of rollers.

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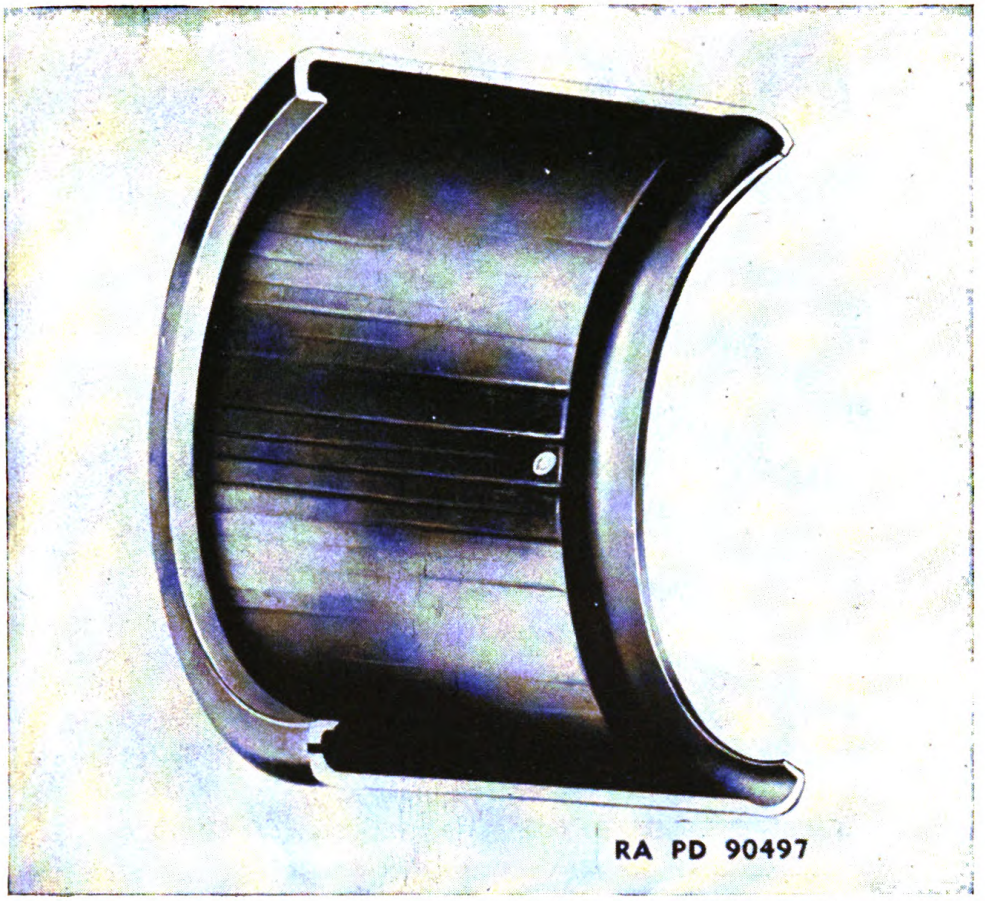


Figure 43. Needle bearing shell indented or "Brinelled."

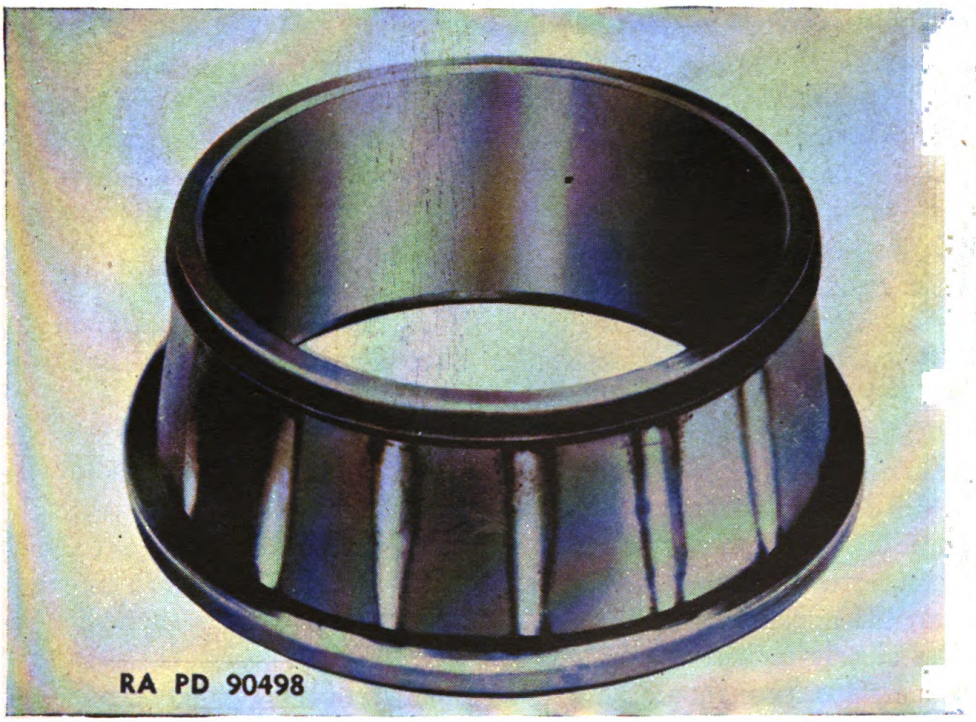


Figure 44. Tapered roller bearing cone etched by moisture or acid formation.

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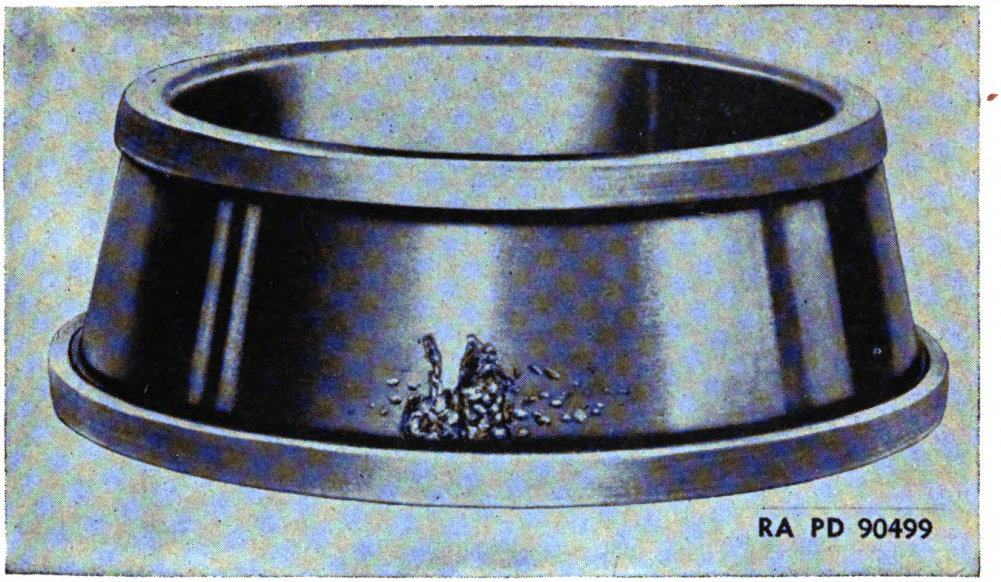


Figure 45. Pitting.

(10) Pitting (fig. 45) eventually occurs in a bearing which has operated beyond its expected life, but it is hastened by nicking, scoring, brinelling, and the operation of bearings with excessive loads and speeds.

(11) Indenting results from the presence of foreign particles such as dirt, chips, or carbonized lubricants. These substances become wedged between rollers and rings and are pressed into the surface. Early pitting usually follows. Indenting of one part of a bearing may indicate pitting on another part. Extreme cleanliness is the best precaution against indenting.

c. Roughness. Bearings should not be rejected because they feel slightly rough or have a tendency to stick at certain points when rotated by hand until the bearings have been recleaned. Then, if the bearings still feel rough and catch, inspect them in greater detail for the cause of the catch or roughness.

d. Tarnish. A little tarnish or stain on the surfaces of the rings or balls is not detrimental to the operation of the bearing. Tarnish or stain need not be removed. Corrosion on outside surface of rings should be removed with crocus cloth prior to cleaning.

e. Looseness. Clean bearings will nearly always be looser when held in the hands than when mounted. This is because they are made with certain limits of internal looseness. When pressed on the shaft with the proper fit, the inner ring is expanded slightly and the looseness is reduced to the correct operating fit. However, where looseness is due to excessive wear, the appearance of the balls or rollers and raceways is nearly always clearly indicative of the condition. Bearings which are suspected of being too loose should be sent to a higher echelon of maintenance to determine their serviceability.

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14. Storage

a. TEMPORARY STORAGE. Inspected bearings which are considered good enough to use again, but which are not immediately reassembled in the equipment from which they were removed should be dipped in heated rust-preventive compound (light), wrapped in greaseproof wrapping paper, sealed with nonhygroscopic adhesive tape and stored. Bearings which are scheduled for shipment to higher echelons for overhaul will be treated in the same manner. If bearings are not removed from shafts or housings they should be freely coated with heated rust-preventive compound (light), and wrapped with greaseproof wrapping paper, held firmly in place with nonhygroscopic adhesive tape.

b. LONG TERM STORAGE. If inspected bearings are to be stored permanently the following steps should be taken:

(1) Dip them in heated rust-preventive compound (light) (fig. 46), rotating them to work the preservative thoroughly around the rolling members and on the raceways.



Figure 46. For longer storage, coat all surfaces of bearings with preservative. Don't handle more than necessary before coating.

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(2) Wrap the bearings in greaseproof wrapping paper to retain the preservative on all surfaces. (See fig. 47.)

(3) Place in a clean box or carton and seal with nonhygroscopic adhesive tape.

(4) Where cartons are not obtainable, overwrap with waterproof barrier wrapping paper, seal with nonhygroscopic adhesive tape and mark the outside of the package to identify the bearing. (See fig. 48.)

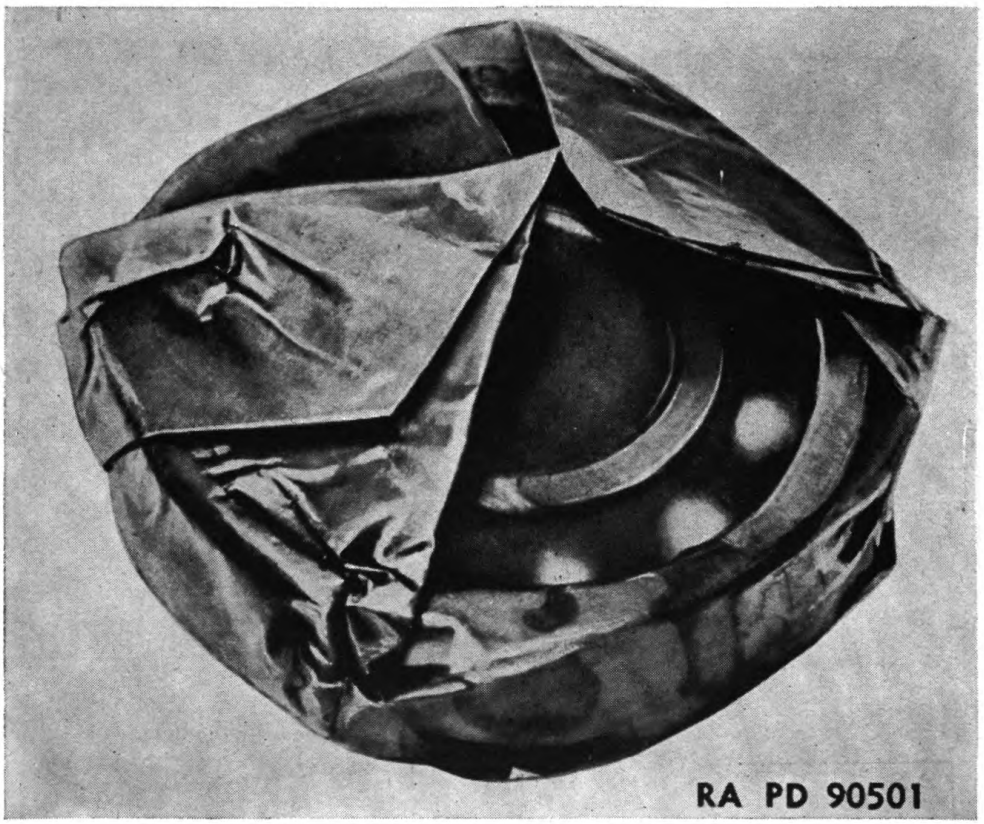


Figure 47. Wrap bearings in greaseproof wrapping paper to keep preservative from escaping before placing bearings in boxes or cartons.

15. Lubrication

a. Bearings should be lubricated in accordance with the detailed instructions in the Technical Manual or Lubrication Order covering the equipment in which the bearing is used. These instructions specify the kind of grease or oil to be used, how often and how much.

b. Follow instructions. Use only the lubricant the instructions call for.

c. Store lubricants in clean containers and keep containers covered. Apply grease with clean paddles or lubricating guns.

d. Don't overfill bearings and bearing housings. Grease or oil will ooze out of overfilled housings past seals and closures, collect dirt, and

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cause trouble. Too much lubricant will also cause overheating. This is particularly true of bearings running at high speeds where the churning of the lubricant will cause the bearings to run excessively hot.

e. Don't let any machine stand around for weeks without turning it over once in awhile so that all surfaces of the bearings will be covered with lubricant. Oil tends to drain down off a standing bearing, and moisture may condense in the housing and cause corrosion.

f. Inspect seals and vents regularly.

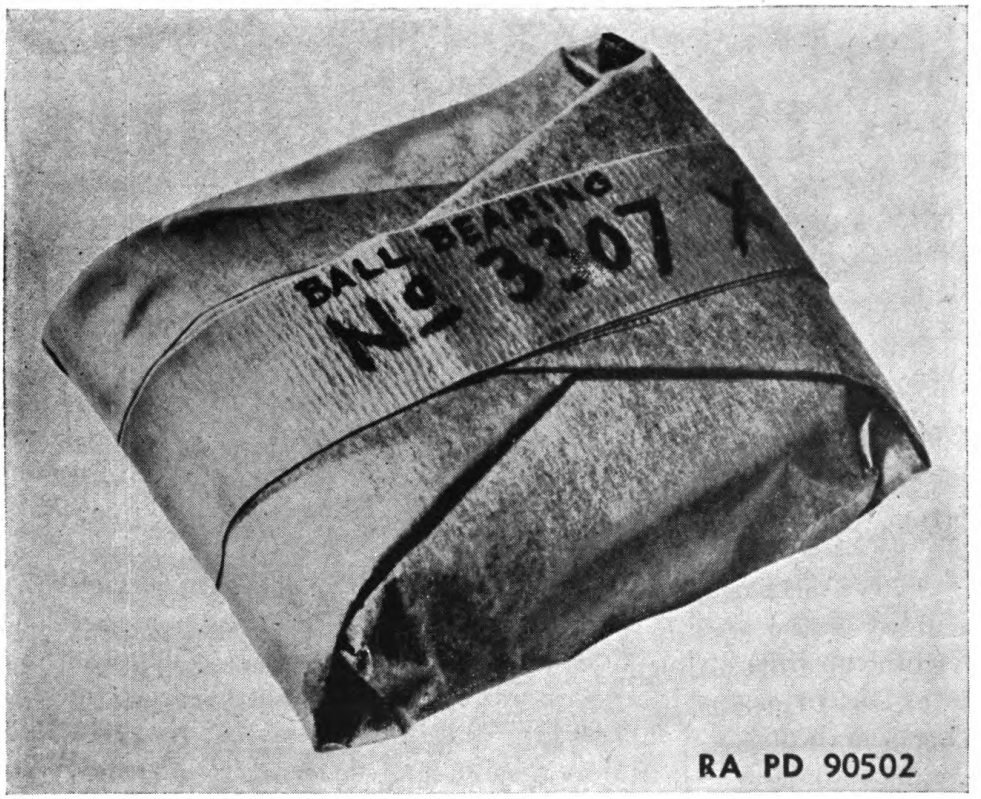


Figure 48. If no cartons are available, wrap the bearings in waterproof barrier wrapping paper, and seal mark outside to identify bearing.

16. New Bearings

a. New bearings, before being wrapped or packed, are carefully cleaned by the manufacturer and are thoroughly coated with a preservative. They are wrapped in greaseproof wrapping paper to keep them clean and have a carton or other covering for further protection. Keep bearings in original cartons or wrappings until ready for use. (See fig. 49.)

b. In storage, the cartons should not be stacked too high in order to prevent damaging the lower packages by crushing. In all cases, the site selected for storage should be free from excessive heat and moisture and away from dusty or corrosive atmospheres.

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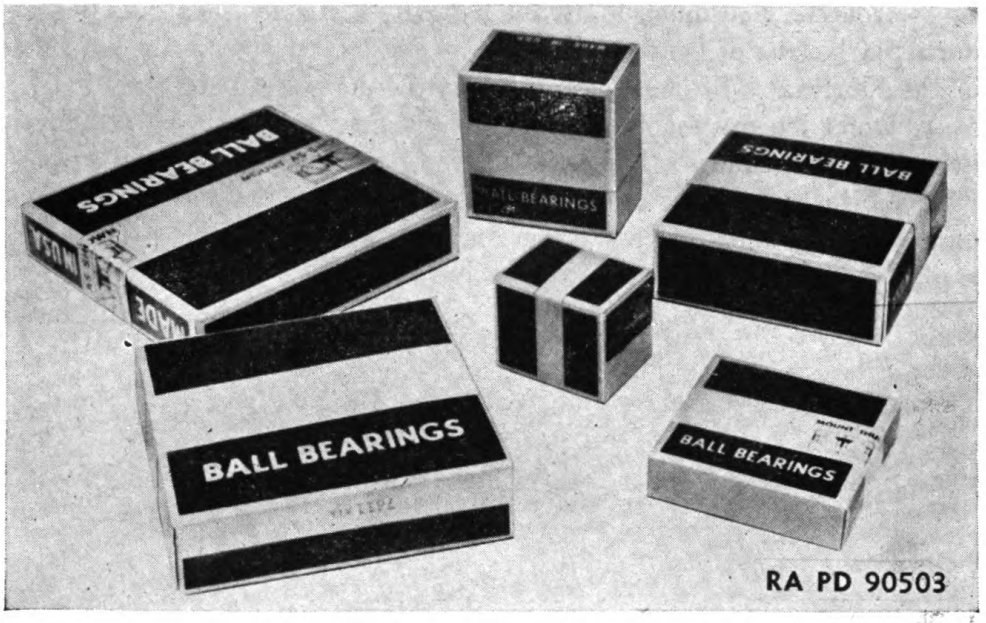


Figure 49. Keep bearings in their original boxes and wrappings until they are to be mounted.

c. If a package is opened and the bearing is not used immediately, protect by rewrapping. The preservative coating of a new bearing should not be removed (fig. 52), unless inspection reveals the presence of rust or dirt, in which case, the bearings should be thoroughly cleaned, inspected, and the preservative then renewed.

d. New bearings should not be taken apart. They are correctly assembled in the first place. Rollers and rings are often matched, and even the position of the slit in some snap ring bearings is important.

e. Dirt or grit in bearings is responsible for many bearing failures. Therefore, bearings should be kept clean, preserved, and packed. They should be handled as little as possible and the ball or roller operating surfaces should not be touched. Finger marks are hard to remove and perspiration starts corrosion. (See fig. 50.) When necessary to handle bearings, be sure that the hands, tools, and wiping cloths are clean. (See fig. 51.)

17. Bearing Seats and Housings

a. Smoothness in bearing seats. Care should be taken that bearing seats on shafts have the same high degree of accuracy and smoothness they had when new. A roughly ground bearing seat will have the tops of the grinding ridge peened down and will cause looseness after the ·aring has been operating a short time. Hand finishing with emery or ·us cloth should be done very carefully to avoid high and low spots, er. In addition, remove all burs and sharp corners from shaft ends ich rings must pass.

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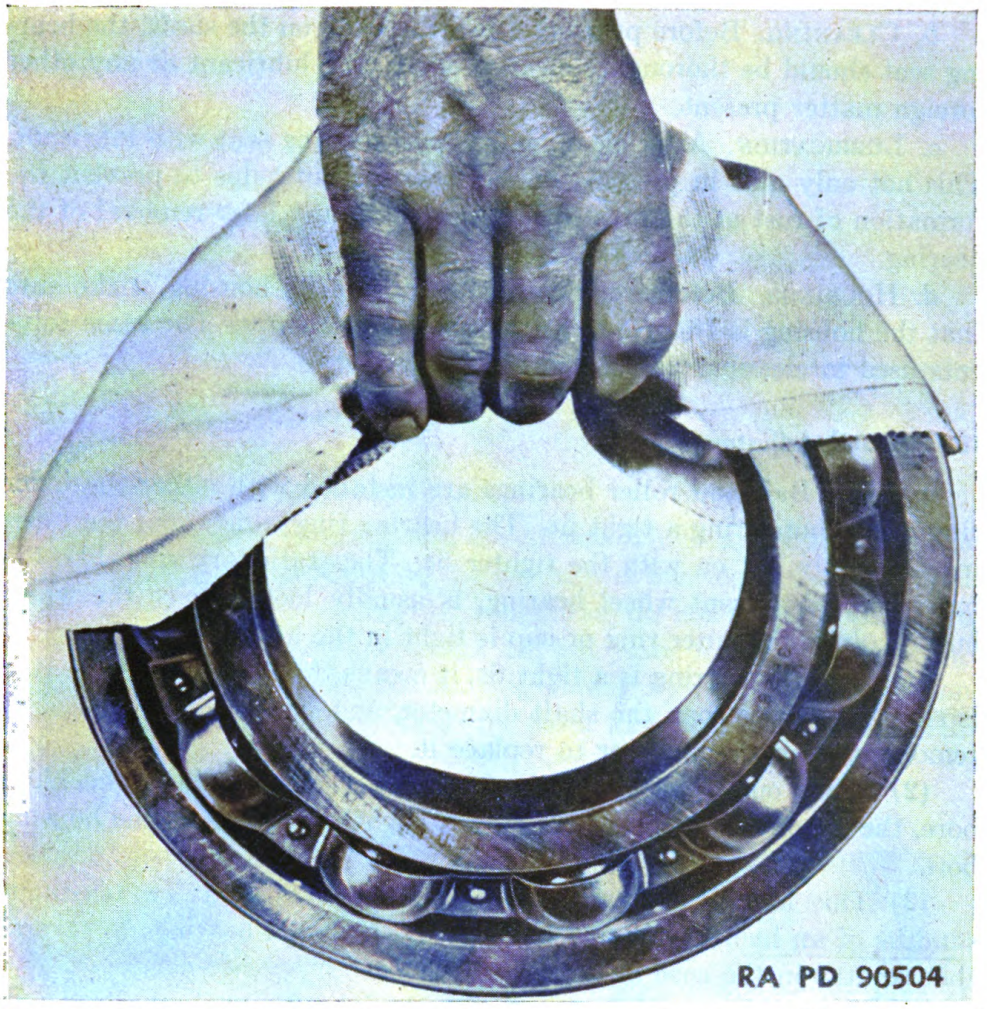


Figure 50. Clean hands plus clean cloths mean cleaner bearings and less chance of corrosion from perspiration.

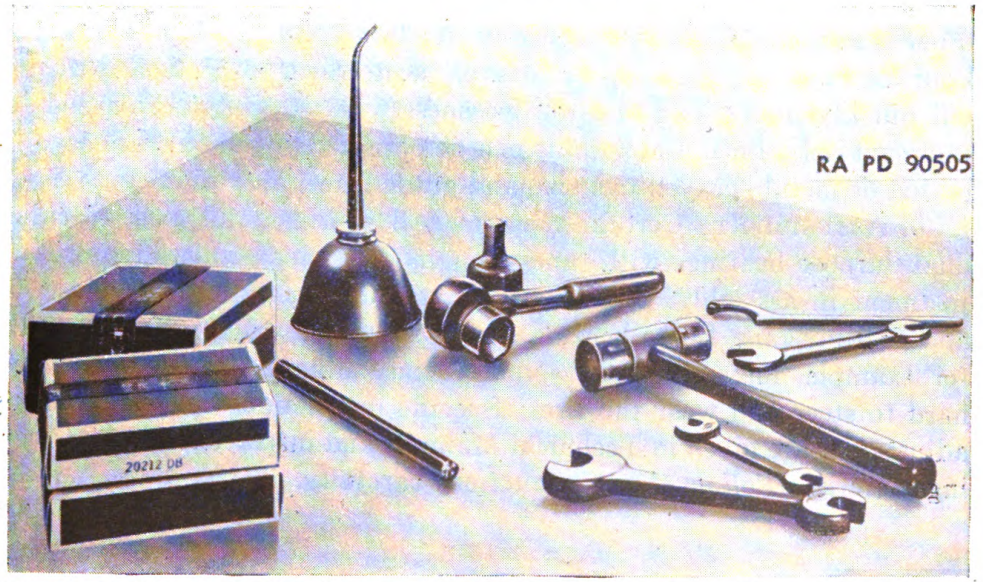


Figure 51. Get the habit of wiping tools and work benches. Clean tools are "half the battle" in keeping bearings clean.

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b. CLEANING. Before pressing a bearing back on the shaft, the bearing seat should be thoroughly cleaned of all dirt, lubricant or any other foreign matter present.

c. LUBRICATION. After cleaning, coat the bearing seat with lubricant. This not only aids in pressing on the bearing, but helps to prevent the formation of rust at the press fit and assists in any later removal of the bearing.

d. HOUSINGS. Before replacing a bearing in its housing, make sure that the housing is free from dirt, dust, or metal chips. The same solvents used in cleaning the bearings may be used.

18. Fits and Adjustment

a. FITS. Ball and roller bearings are installed with either the inner ring or the outer ring a tight fit. The bearing ring which does the turning is usually put on with the tighter fit. The stationary ring, like the inner ring of a front wheel bearing, is usually loose. Since the wheel hub revolves, the outer ring or cup is tight in the hub bore.

(1) If the inner ring is a tight fit, it means that the bore of the ring is slightly smaller than the shaft diameter, and some force is needed to remove it from the shaft or to replace it.

(2) If the outer ring is a tight fit in the housing, as in a wheel hub bore, the outside diameter of the ring is slightly larger than the housing bore.

(3) This fit or "interference" usually amounts to a few ten-thousandths of an inch (.0001 inch) in the case of small bearings to several thousandths in the case of large bearings.

(4) Certain bearings are applied with tight fits on both rings and some with loose fits on both rings.

(5) If a shaft becomes scored and is polished down for that or some other reason and loses the necessary fit, do not try to roughen it up by knurling or prick-punching the bearing seat. Such roughening will iron out quickly under load and the looseness will return. Rely on end retainment only, until a new shaft can be obtained or the old shaft can be plated or metal sprayed oversize and ground to proper diameter.

b. ADJUSTMENT. Certain types of ball bearings and most so-called dual purpose bearings with tapered or barrel-shaped rollers require adjustment in assembly. If a bearing is set up too tight, it will heat up and possibly fail. Loose bearings cause pounding which in front wheels, for example, may crack the spindle, cause shimmy, make the vehicle hard to steer and wear the tires. Specific instructions covering bearing adjustment are given in Technical Manuals and instruction books covering matériel. *Follow these instructions carefully.*

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SECTION V

BALL THRUST BEARINGS

19. General

Precautions on cleaning and cleanliness which apply to other antifriction bearings also apply to the ball thrust bearing. (See figs. 52 and 53.) However, when testing for roughness, do not spin the ball thrust bearing as described in paragraph 13, but place it flat face down on a clean table. Then rotate the bearing slowly by exerting pressure and, at the same time, turning with the palm and heel of the hand. (See fig. 54.)

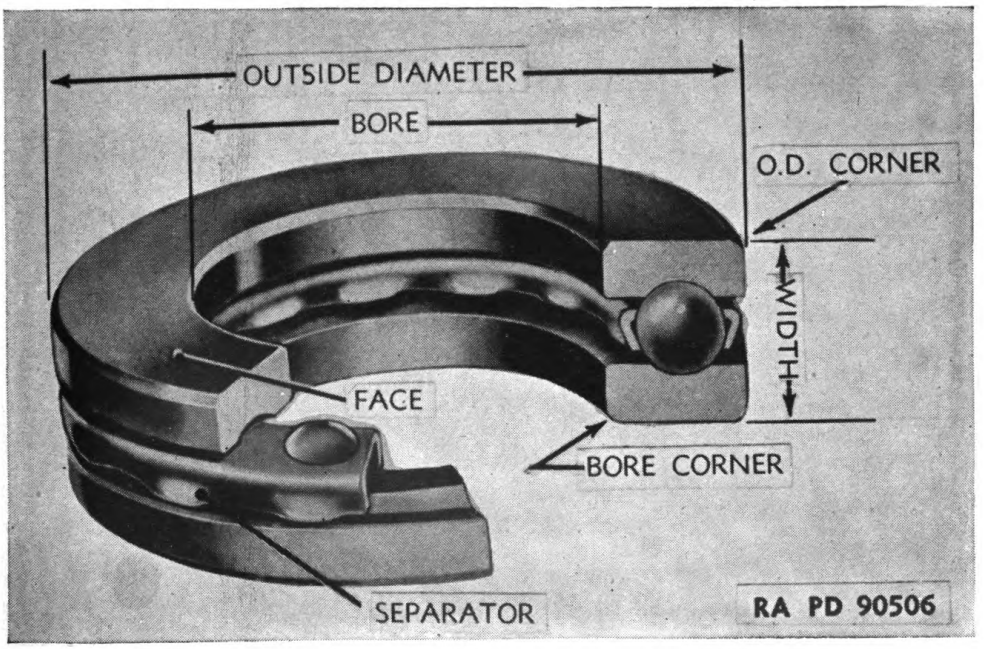
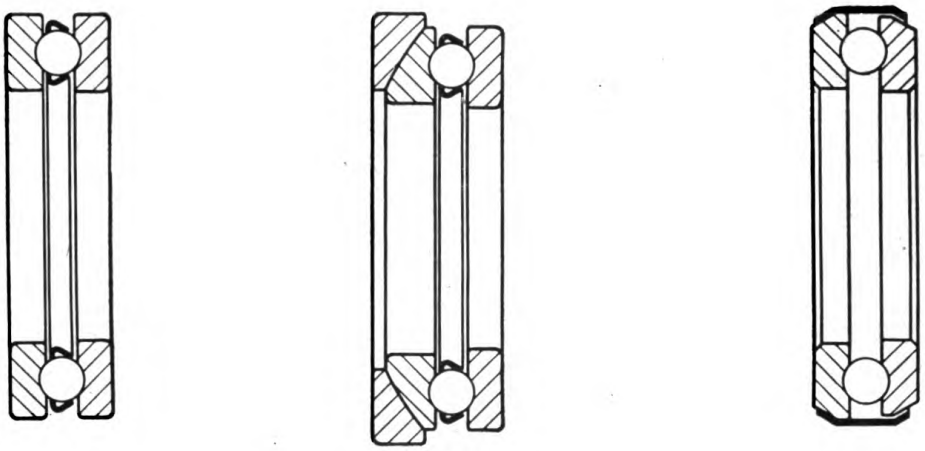


Figure 52. Ball thrust bearing.

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① *Flat seat open grooved ring.*

② *Self-aligning open grooved ring.*

③ *Banded or shielded grooved ring.*

Figure 53. Types of ball thrust bearings.

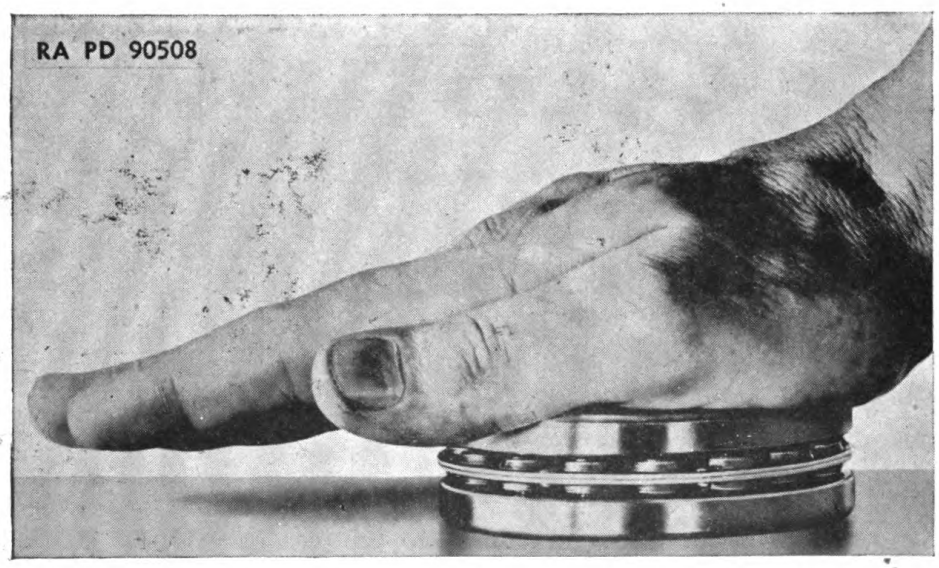


Figure 54. Exert even pressure over bearing and rotate slowly when testing condition of balls and rings by feel.

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20. Installation

a. Ball thrust bearings of the open type may be a slip fit on the shaft or in the housing. Be sure to start the bearing square and straight to avoid jamming the bearing.

b. Ball thrust bearings of the open type may have one ring tight on the shaft, or in the housing, or both. Press the individual rings into place separately (figs. 55 and 56), adding the ball separator as the assembly is completed. *Never apply pressure through the complete bearing to seat a ring, or use a hammer.* (See fig. 57.) Brinelling or nicking of the ball path may result.

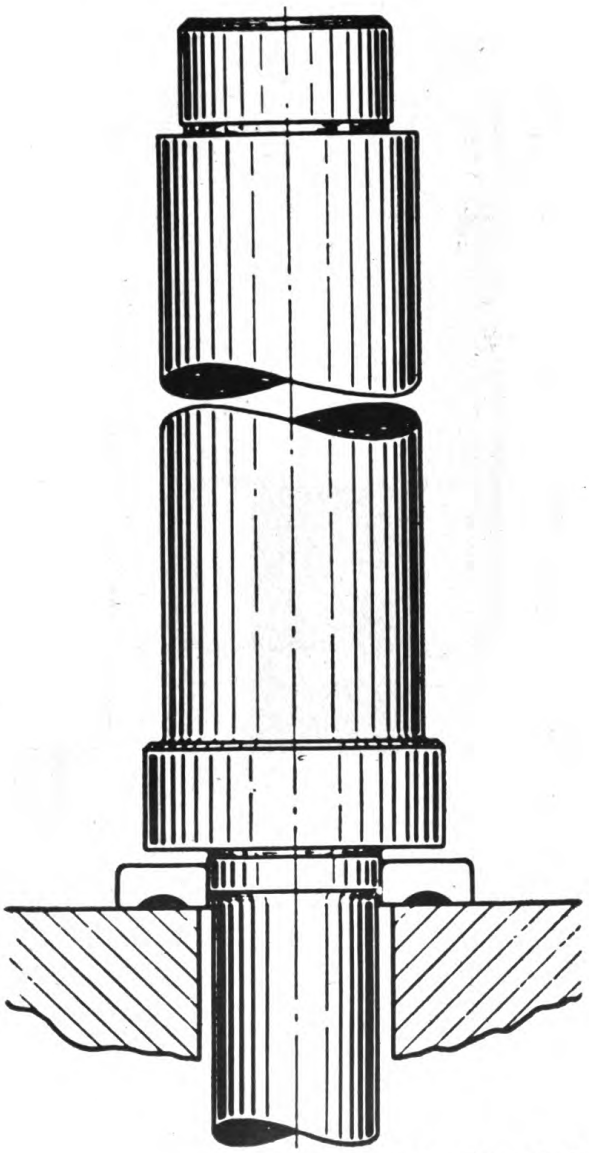


Figure 55. Be sure parts are clean so that ring can be pressed to a firm seat against shaft shoulder.

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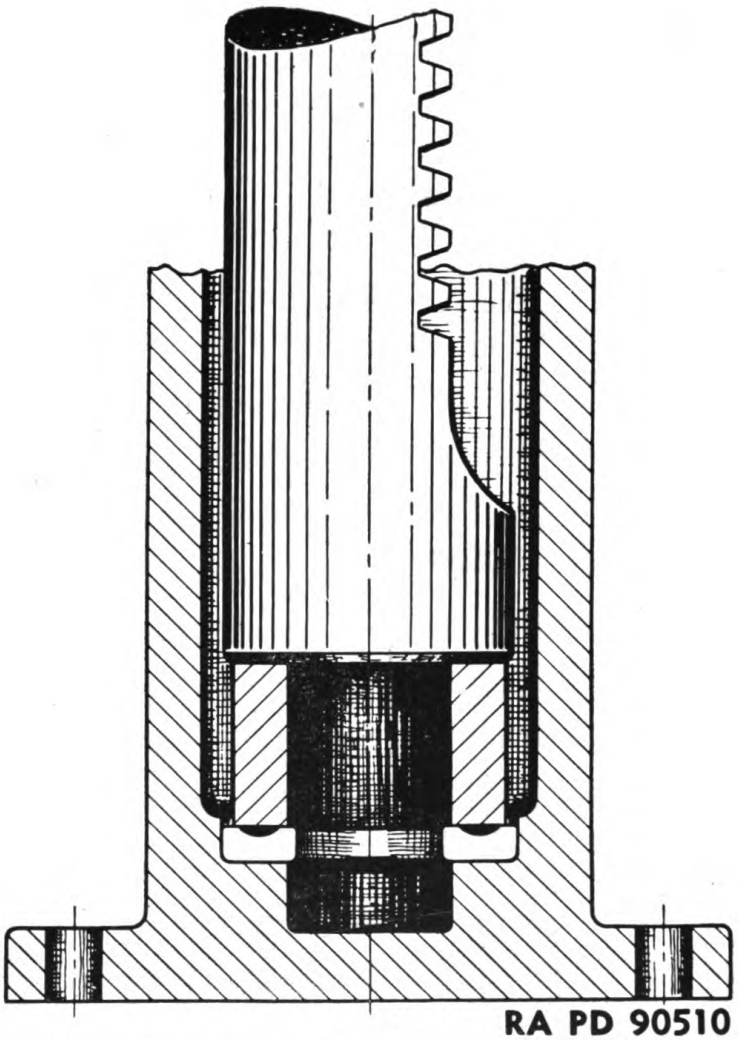


Figure 56. Wipe ends of tubing to be sure a metal chip or dirt isn't forced against the ball ring.

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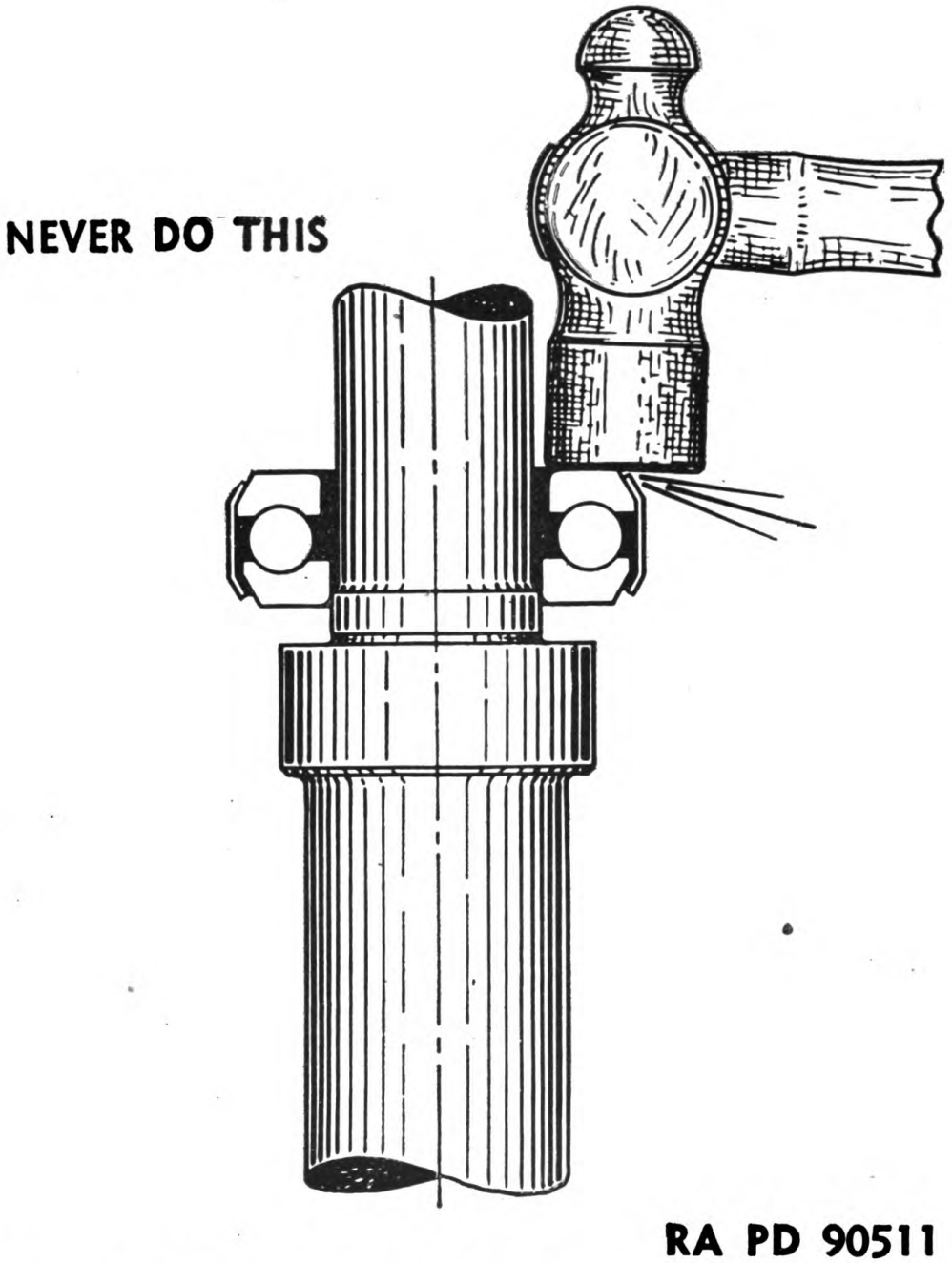


Figure 57. A hammer applied to a ball thrust bearing like this is almost certain to cause serious damage. Don't do it.

c. Banded ball thrust bearings, where the rings are inseparable and are tight either on the shaft or in the housing, should have one ring slowly rotated while being pressed into position. On small assemblies a drill press may be used. (See fig. 58.)

21. Removal

Slip fit ball thrust bearings are removable by hand pressure. To remove individual ball rings present in housing or on shaft, use the various

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tools described, making sure that the jaws of the puller or edge of sleeves do not contact the ball path. Never exert or apply pressure on the band or shield of a bearing.

22. Assembly on Carriers or Sleeves (fig. 58)

In order to assemble ball thrust clutch release bearings on carriers or sleeves without brinelling or nicking the ball rings and causing a noisy bearing, the following mounting practice is recommended:

a. Clean *new* bearings with dry-cleaning solvent to remove the protective coating on the bearing. Bearings, prepacked with lubricant at time of assembly, such as the sealed type, will be wiped clean with a *clean* cloth dampened with dry-cleaning solvent.

b. Place a film of engine oil (SAE 10 or 30) on the bearing shoulder of the carrier or sleeve and pack or lubricate bearing with lubricant as prescribed by the applicable Technical Manual.

c. Place bearing on *clean* drill press table with clutch finger face down.

d. Start bearing carrier or sleeve into bore of bearing by hand, making sure of a square start.

e. Shift the drill press into the lowest spindle speed available. Close chuck tight without drill.

f. With the spindle turning, feed the chuck into bore of bearing carrier or sleeve (view A, fig. 58), until bearing is completely seated, as shown in view B, figure 58. If chuck diameter is too small or too large, use a small shanked pilot clamped in the chuck and piloting the carrier or sleeve similar to one shown in view B.

g. Pack recess of carrier or sleeve with the lubricant prescribed by the applicable Technical Manual or War Department Lubrication Order and then install.

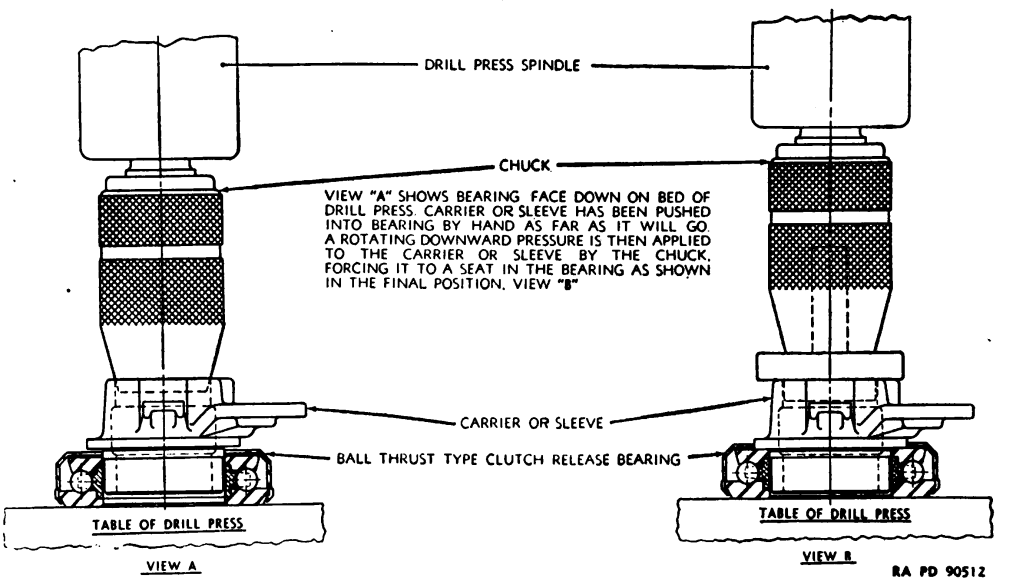


Figure 58. Assembling ball thrust clutch release bearings on carriers or sleeves.

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SECTION VI

REFERENCES

23. Publications Indexes

The following publications indexes should be consulted frequently for latest changes or revisions of references given in this section and for new publications relating to material covered in this manual:

Ordnance Publications for Supply Index (Index to SNL's) ..... ASF Cat. ORD 2 OPSI
List of Publications for Training (listing MR's, MTP's, FM's, TM's, TR's, TB's, SB's, MWO's, and FT's) ..... FM 21–6
List of War Department Films, Film Strips, and Recognition Film Slides ..... FM 21–7
Military Training Aids (listing Graphic Training Aids, Devices, and Displays) ..... FM 21–8

24. Standard Nomenclature Lists

Antifriction bearings and related items ..... SNL H–12
Cleaning, preserving and lubricating materials; recoil fluids, special oils, and miscellaneous related items ..... SNL K–1

25. Explanatory Publications

Cleaning, preserving, sealing, lubricating, and related materials issued for Ordnance matériel ..... TM 9–850
Defense against chemical attack ..... FM 21–40
Decontamination ..... TM 3–220
Dictionary of United States Army Terms ..... TM 20–205
Inspection of Ordnance matériel ..... TM 9–1100
Basic maintenance manual ..... TM 38–250

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