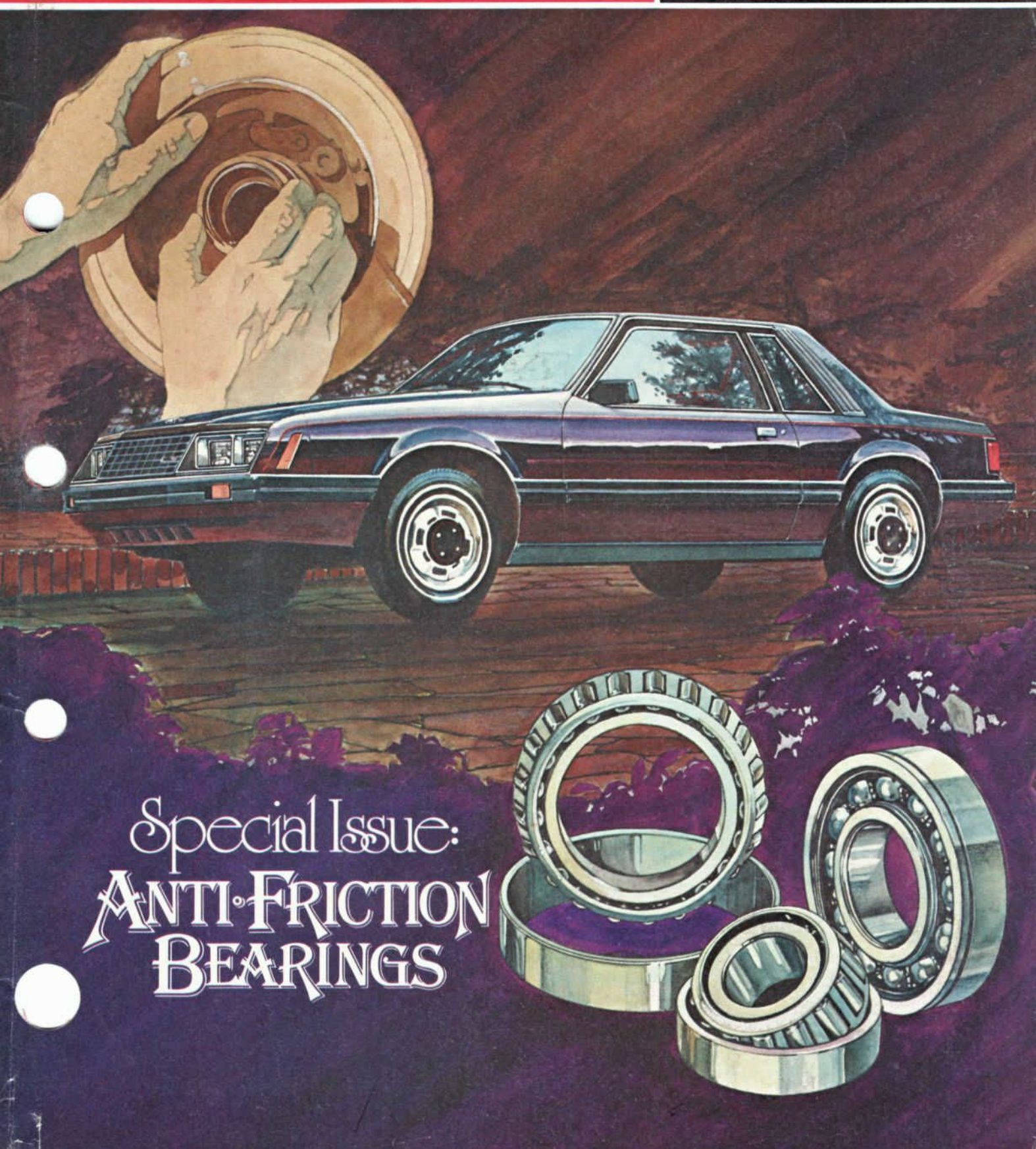
SHOP TIPS

VOL. 17, NO. 6 JULY 1979

Motorcraft Ford



Special Issue: ANTI-FRICTION BEARINGS

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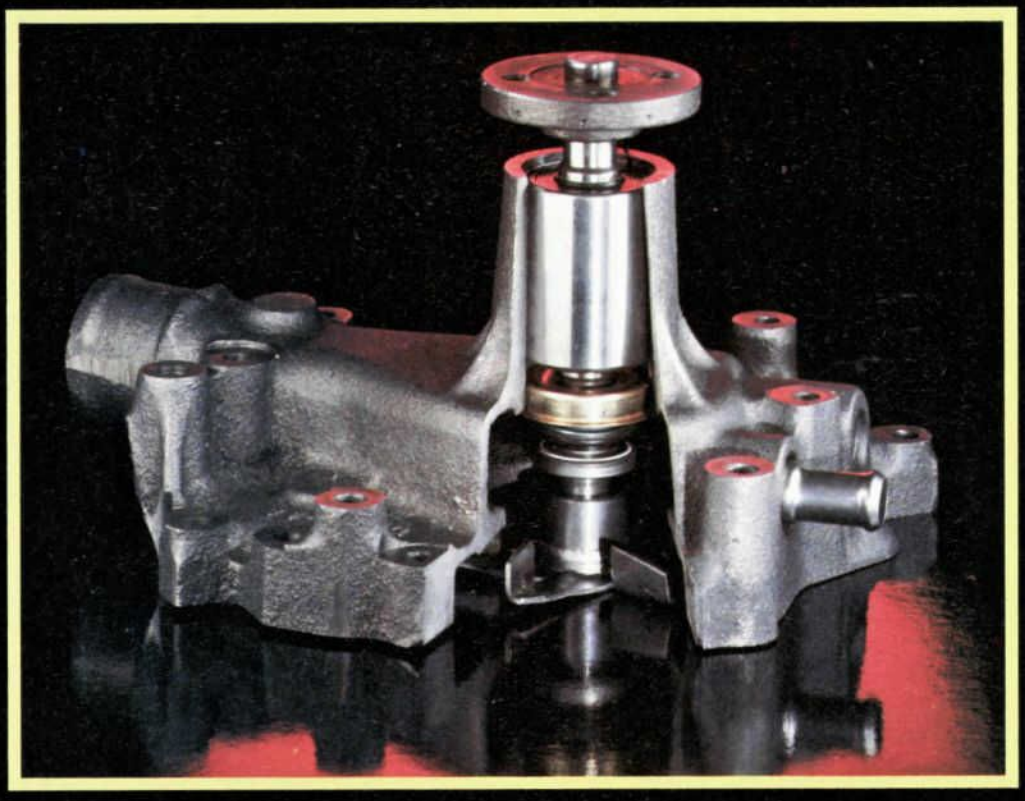

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BEARINGS HELP THE WHEELS GO 'ROUND!

The topic of this month's "Shop Tips" may seem a little strange at first, but there's good reason to cover the basics of a very basic topic: Bearings.

Car and light truck registrations show that the length of ownership is growing. It used to be five years, on the average. Now, it's seven. What this indicates is that with people owning their vehicles longer, they will be going back to having some repairs done that would have been cause for trading the car or truck in just a few years back.

For "Shop Tips" readers who maintain full-service facilities, we are offering this basic course in anti-friction bearings for two reasons: One, as a refresher for seasoned technicians, and second, as reference for the newcomer to the trade – something which can be used to help instruct talented, mechanically inclined young people and help them become productive technicians.

IMPORTANT NOTE FOR APPLICATION OF CORROSION COMPOUND FOR ALL FORD AND LINCOLN-MERCURY VEHICLES:

It is requested that when applying a Corrosion Protection Compound to the inner door panels and the tailgate inner panels on a station wagon, caution should be taken not to allow any compound to get into the glass flocked run material and on the glass guide tube.

This material, when inadvertently applied to these glass operating components, will make the glass operation difficult.

Therefore, it is recommended that these components be protected prior to compound application and that the windows and/or tailgate be functioned two or three times after corrosion compound material operation is completed to insure the mechanism is operating properly.

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Be sure to file this and future issues for ready reference. If you have any suggestions for articles that you would like to see included in this publication, please write to: Ford Parts and Service Division, Shop Tips, P.O. Box 1804, Dearborn, Michigan 48121.

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Ford Parts and Service Division
Dearborn, Michigan

BEARINGS KEEP THE WHEELS

WHY WE NEED BEARINGS

Very simply, bearings are needed to reduce friction between two parts. Usually, one part may be fixed, while the other rotates about it (such as a wheel bearing). Whatever the application or type of bearing used, overcoming friction is the reason it is there. So let's talk about the nature of friction.

THE NATURE OF FRICTION

Friction is simply RESISTANCE TO MOTION between two surfaces that are touching each other. Friction can be both a benefit or it can cause problems.

For a car being driven on dry pavement, friction keeps the tires firmly gripped to the pavement. (Fig. 1). There is no slippage. Assuming normal highway driving conditions, this helps provide good fuel economy for the speed and minimizes tire wear.

However, where you have two moving parts rubbing against each other, heat is generated. Recall how early indians rubbed sticks together to start fires.

The same kind of friction in machining can be totally damaging. Therefore, today's cars and other products would not be possible if man hadn't learned to overcome friction.

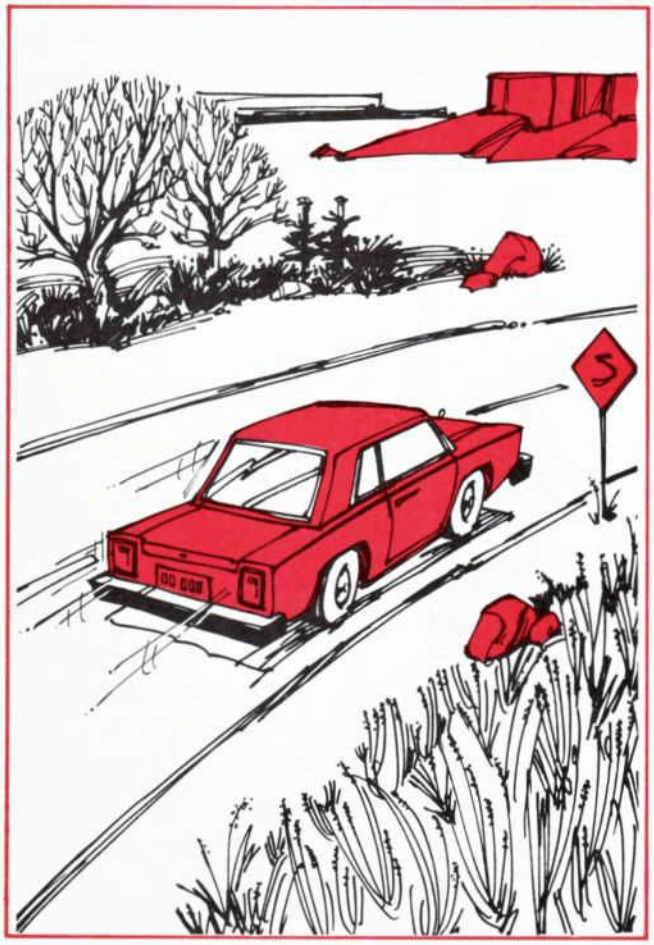

Figure 1 – On dry pavement, friction between the wheels and the road is a benefit.

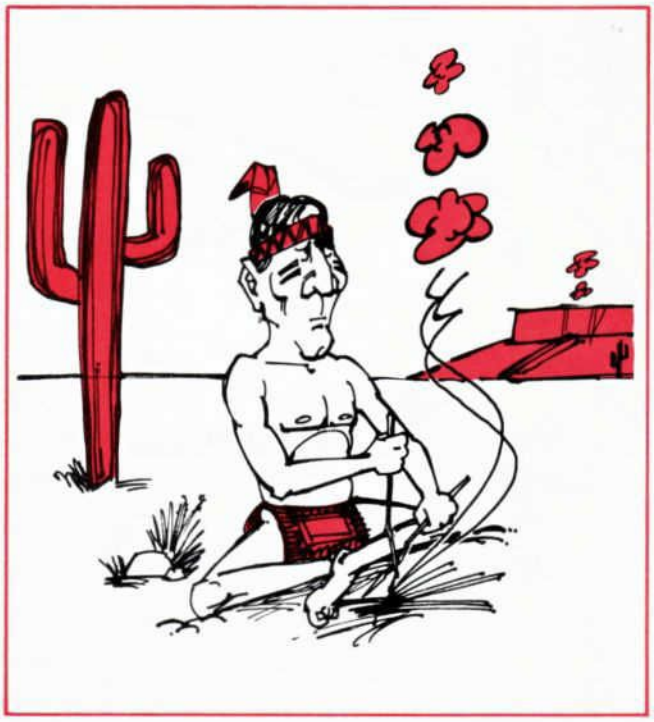

Figure 2 – Friction causes heat.

OVERCOMING FRICTION

It makes sense to control friction. Trying to control it has been a battle as old as man himself. Think of the cave-man trying to pull or push a large chunk of stone. (Fig. 3) MAXIMUM friction made the job very difficult.

Figure 3 – Pushing a load across the raw ground makes the job extra hard.

GOING 'ROUND!

It didn't take early man long to realize that if he pushed the same kind of load over logs, he could ROLL it along much easier. You probably have done this a dozen times yourself in a mini-fashion . . . using round pipe or other round objects under a heavy load. (Fig. 4)

Figure 4 — Placing a roller under the load makes the job easier.

But there is still an easier way of getting the job done. Try this little three-step demonstration for yourself. First, place a large book such as a thick repair manual on a desk and try to push it across the desk with the tip of a flexible ruler as shown in Figure 5.

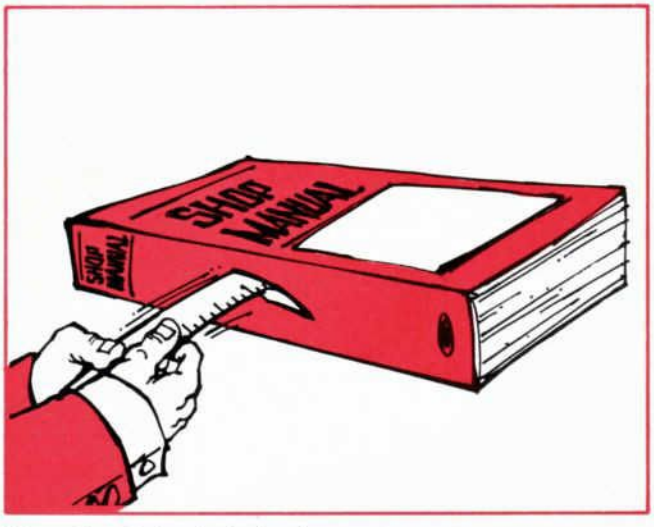

Figure 5 — Doing it the hard way.

This is doing it the cave man's way. The friction between the book and the table makes it real work to move the book, as evidenced by the bend in the ruler.

Next, place two or three pencils under the book as shown in Figure 6 and try the experiment again. The job becomes easier because of *rolling motion.*

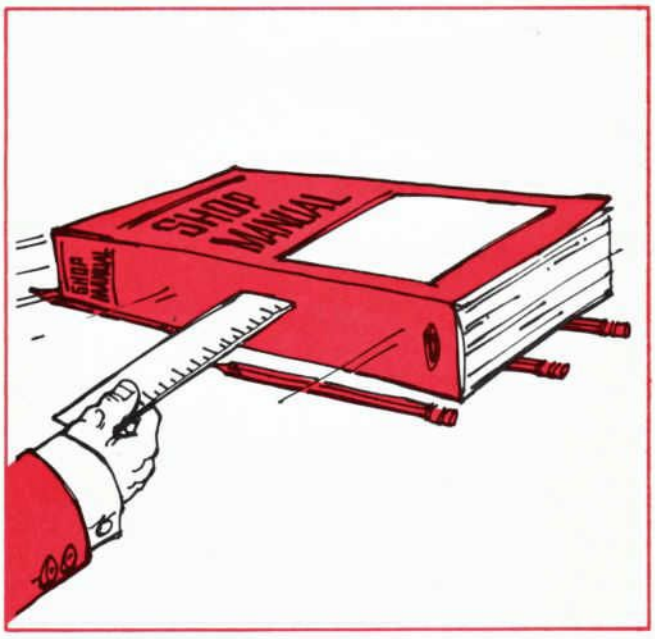

Figure 6 — Rolling motion takes less effort.

Now, if you substitute a few marbles for the pencils, the book will virtually fly across the table with practically no effort at all! Only a touch with the ruler will set the book in motion which is due, in part, to no distortion of the marbles. This is called *point contact* rolling motion. See Figure 7.

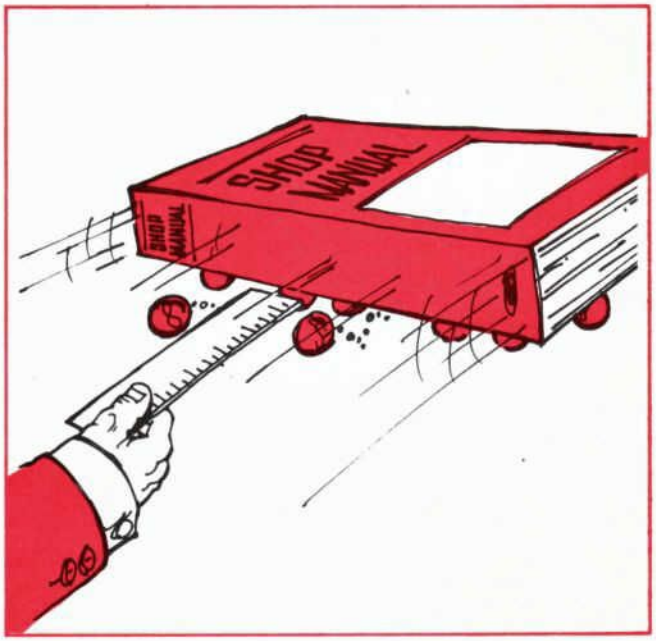

Figure 7 — Theoretically, point contact rolling motion reduces friction almost entirely.

What you have experienced are the principles of friction and anti-friction bearings . . . the subject of this issue of "Shop Tips". Now, we're ready to take a look at the various types of bearings that you come in contact with, based on the principles just demonstrated.

BASIC BEARING TYPES

Bearings fall basically into two types: FRICTION OR ANTIFRICTION.

Friction (or sleeve) bearings slide against a bearing surface with a coat of lubrication between the bearing and the contact surface. In automotive applications, major uses of the friction bearings are crankshaft main bearings, connecting rod bearings and camshaft bearings. (Fig. 8).

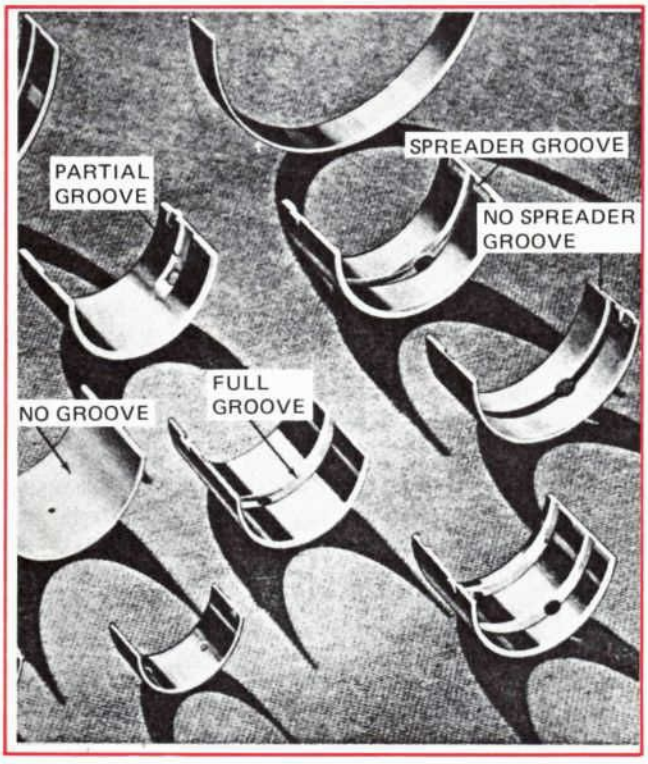

Figure 8 — Typical automotive friction bearings.

The bearing surface uses a steel backing upon which one or more layers of other materials such as lead-tin babbitt, copper alloy and aluminum alloy are bonded. These bearings are light, strong and have excellent bearing characteristics.

We are not going to discuss this type of bearing in this issue. Instead, the balance of our basic course will cover ANTIFRICTION BEARINGS.

ANTIFRICTION BEARINGS

Antifriction bearings use rolling elements to reduce friction. They are commonly divided into three types: BALL, ROLLER and NEEDLE.

Needle bearings are commonly used as thrust bearings in transmissions. They are merely a type of roller bearing. So we will concentrate on the ball and roller types you're more likely to be servicing.

In all cases, the rollers or balls are placed between inner and outer rings. The rolling elements are separated by a cage to keep them from bunching up as the bearing turns. (See Fig. 9).

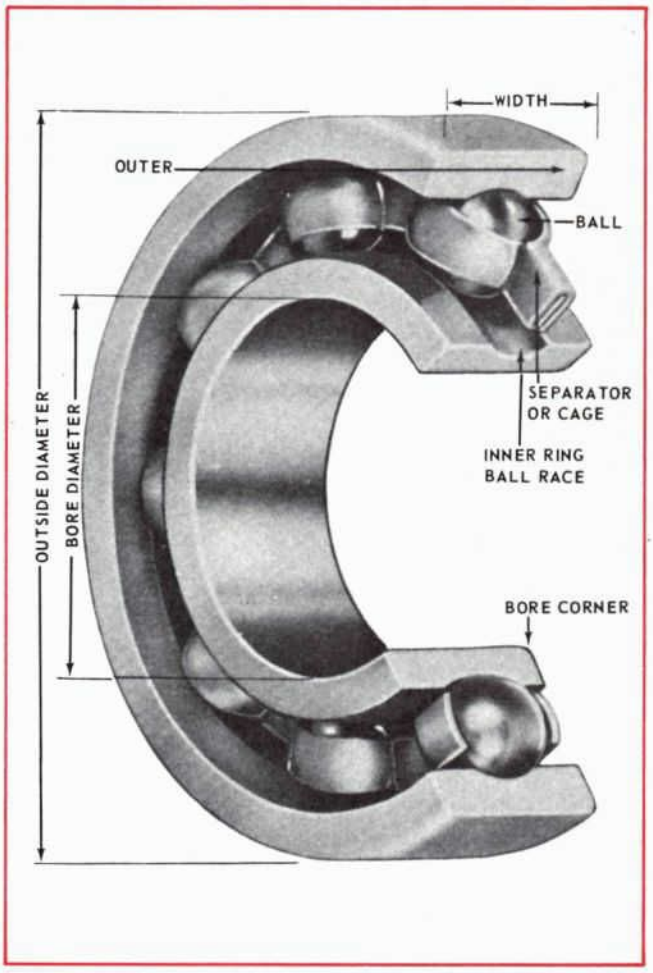

Figure 9 — Typical antifriction bearing construction.

In both roller and ball bearings, the rolling elements, as well as the inner and outer rings or races, are hardened and ground to assure proper contact, clearance and reduce friction.

BEARING LOADS

Antifriction bearings are designed to handle specific RADIAL loads, THRUST loads, or a combination. Radial designs handle loads at right angles to the axis of the bearing. Thrust designs handle loads parallel to the axis such as rear axle bearings. Combination designs handle loads from any direction such as front wheel bearings.

HOW ANTIFRICTION BEARINGS WORK

Recalling your demonstration with the book, you can relate the results to the two basic types of antifriction bearings we're discussing.

Roller bearings use a variety of roller shapes, but all convert sliding friction into CONTACT ROLLING MOTION. Generally, roller bearings provide greater contact area than ball bearings. They therefore can support heavier loads than the same size ball bearings. (See Fig. 10)

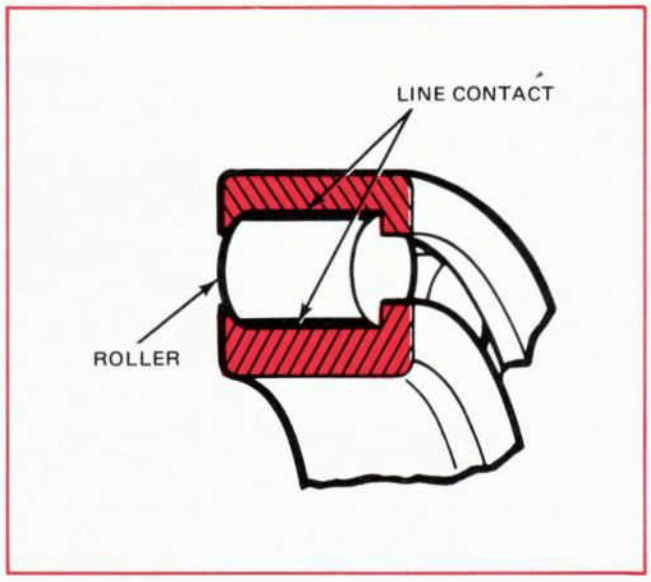

Figure 10 – Typical roller bearing. Note extra contact area.

Ball bearings convert sliding friction into point contact rolling motion just as the marbles did under the shop manual. While ball bearings can't support the same weight as a similar size roller bearing, they have an advantage all their own. The smaller contact area between the balls and the cone and race creates less rolling friction as long as the balls do not deform and are properly installed and lubricated. Therefore, ball bearings generally operate at higher speeds than roller bearings. (See Fig. 11)

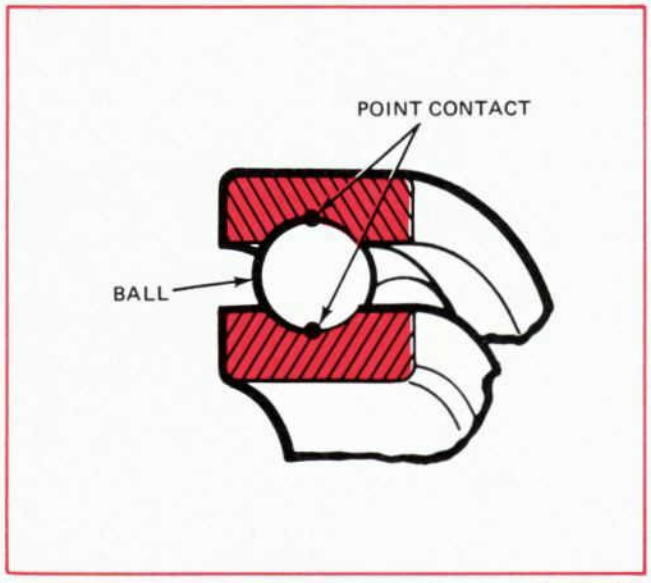

Figure 11 – Non-limited point contact area in typical ball bearing.

For both ball and straight cylindrical (not tapered) roller bearings, the clearance between the diameter of the ball or roller and the inner and outer ring is called the radial clearance . . . and *IS NOT* adjustable!

TAPERED ROLLER BEARINGS

Tapered roller bearings are widely used for front wheel bearings on cars and trucks and in rear axle assemblies including the rear axle shaft.

These bearings get their name because of the tapered shape of the rollers. By their design, they can withstand heavy radial and thrust loads, when compared to same-size ball bearings (See Fig. 12).

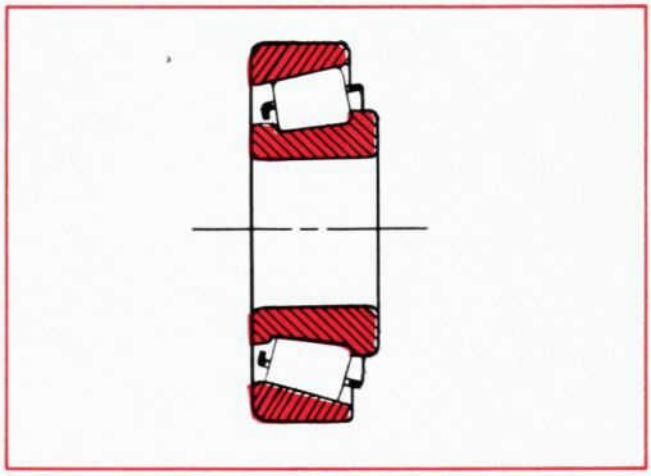

Figure 12 – Cutaway of typical single row roller bearing.

The standard tapered roller bearing you'll most likely see is the single row design as shown in Figure 12. For other applications, there are many variations of the tapered roller bearing that we will not get into because they are mostly non-automotive.

Although tapered rollers and raceways are made of hardened steel, they "give" under load. Therefore, when tapered roller bearings are installed the bearing must be properly set for increased life and rigidity (Fig. 13). These procedures will be covered in the last portion of this issue.

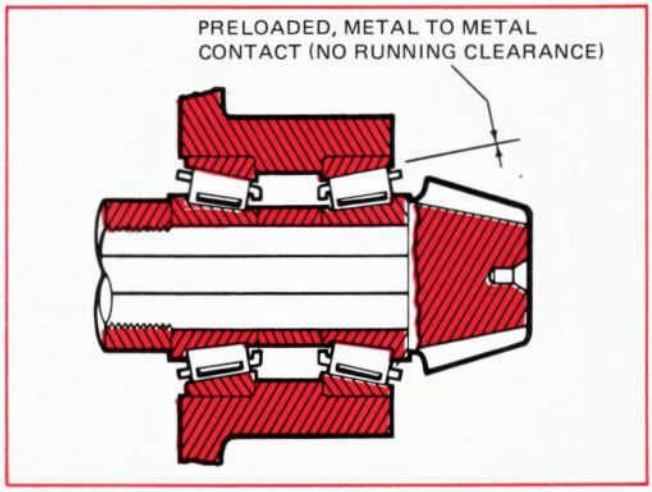

Figure 13 – Typical pre-loaded taper roller bearing installation. Note both an inner and outer bearing to resist thrust in both directions.

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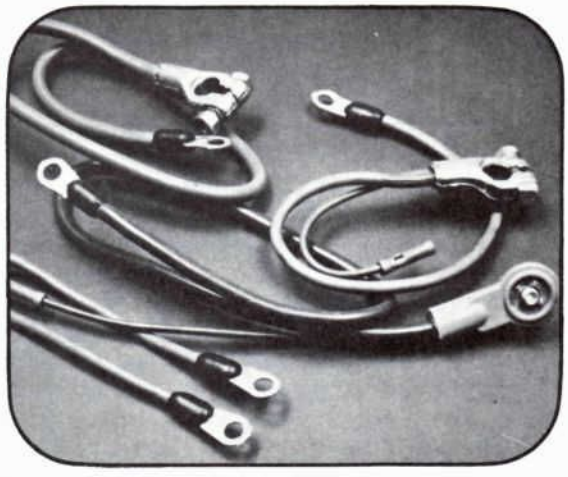

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HANDLING BEARINGS

HANDLING BEARINGS

To look at a new bearing, you would think that it is indestructible. However, such is far from the case. The surfaces are so highly polished that any abrasive dirt or corrosion can damage it.

Therefore, learn proper bearing handling procedures to avoid premature failure. Bearings will wear out eventually but this chapter will deal with those causes of failure "before their time", due to improper storage or handling, improper disassembly and reassembly, cleaning, packing or installation.

CLEANLINESS IS A MUST

When the bearings are removed, cleanliness and care must be maintained. Keep the work area and tools clean and dry. After used bearings are cleaned, ready for inspection, keep them lightly oiled or greased and covered up until ready for final packing and installation.

If you plan to install new bearings, keep them wrapped in their protective wax paper and in the box until you are ready to install them.

BEARING IDENTIFICATION

Most bearings are marked with a part number, usually on the face of the rings. This is your double check that you have the right replacement bearing should new bearings be indicated.

KEEP BEARING PARTS TOGETHER

When you have bearings that come apart such as front wheel bearings, keep the parts of each bearing set together! Under no circumstances should various bearing elements be mixed.

BEARING REMOVAL

IMPORTANT SAFETY NOTE: BEFORE YOU SERVICE A BEARING YOU MUST REMOVE IT! CERTAIN INSTALLATIONS SUCH AS REAR AXLE SHAFTS, PINION SHAFTS, ETC., REQUIRE THE USE OF SPECIAL TOOLS SUCH AS AN ARBOR PRESS. UNDER SUCH PRESSURE, BEARINGS COULD DISINTEGRATE SENDING FRAGMENTS IN ALL DIRECTIONS. THEREFORE, WHEN USING SUCH EQUIPMENT, COVER THE BEARING WITH A CLOTH AND BE SURE TO WEAR SAFETY GOGGLES.

ALSO, USE OF PROPER TOOLS AND PROCEDURES IN BEARING REMOVAL ARE EXTREMELY IMPORTANT TO AVOID PREMATURE FAILURE. TOO MUCH PRESSURE AT THE WRONG PLACE CAN RUIN A BEARING. (See Fig. 14).

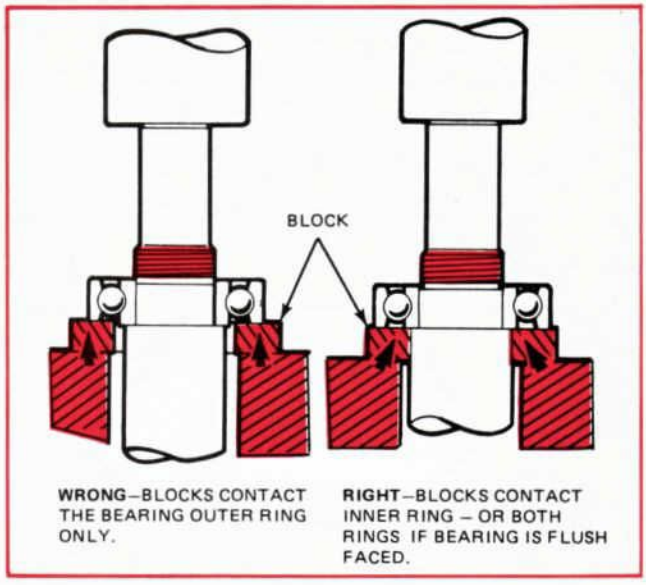

Figure 14 – Right and wrong places to exert pressure to press bearing off of shaft.

To avoid damaging the bearing, press on the bearing ring that is *tightly* fitted (as shown in Fig. 14). Since the *inner* ring is generally pressed on the shaft, note that in the "RIGHT" method shown, pressure is being exerted on the inner ring. If you press on the outer ring, it is possible to damage the rolling elements, retainer, or raceways by over-stressing them.

If a press isn't available, bearings can also be removed with a variety of special pullers. (See Fig. 15). Before selecting a puller, study the assembly a moment to determine the best tool to use for the bearing you're trying to remove.

Figure 15 – Typical bearing pullers.

When using any of the special pullers, observe the same precaution as when using a press. Make sure the fingers or collars of the puller pull only against the bearing ring that is tightly fitted. When pulling, make sure to pull straight and square to the centerline of the shaft. (See Fig. 16).

Figure 16 – Using a bearing puller. Be sure and pull in a straight line.

AS A LAST RESORT

If an arbor press or special puller isn't available, it's possible – but not recommended – to remove bearings using a vice, hammer and soft brass drift. If you have to use this method, observe these precautions.

1. Set bearing and shaft in position on vice jaws as shown in Fig. 17.
2. Never pound directly on the bearing ring! You'll probably ruin both the bearing and the shaft. (Fig. 18).

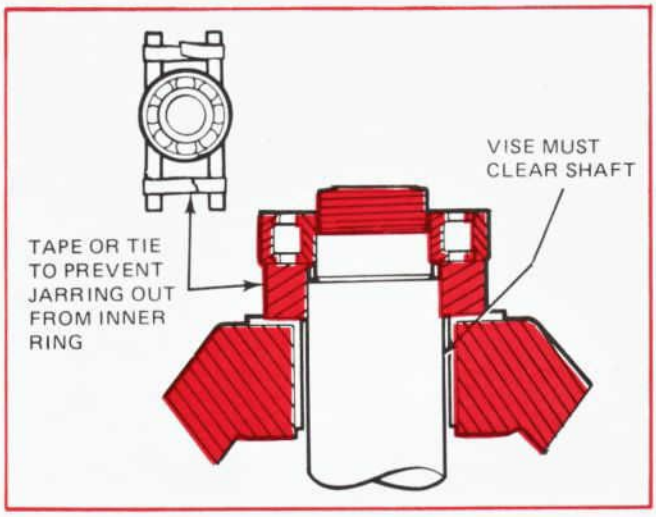

Figure 17 – Set shaft and bearing in vice as shown:

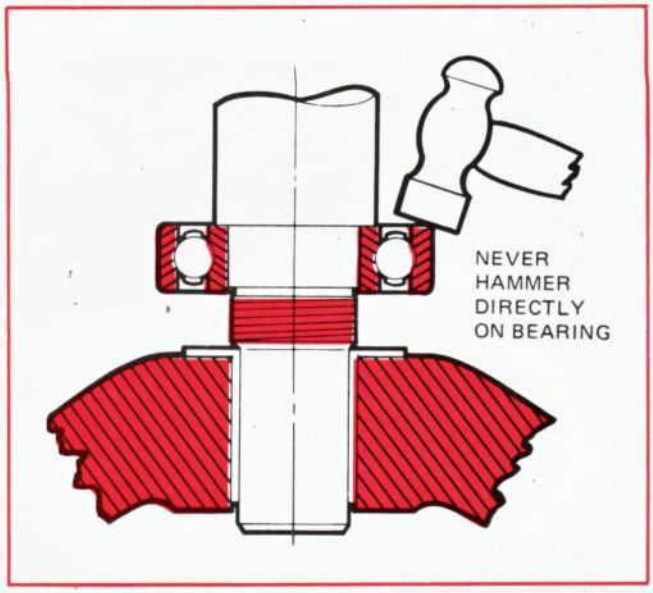

Figure 18 – NEVER pound on the bearing ring.

3. Shaft should be removed from the bearing with a SOFT metal slug to avoid damaging the bearing and shaft. (Fig. 19)

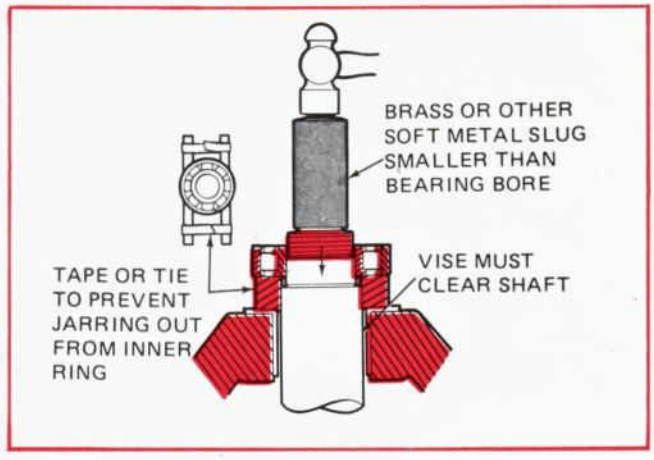

Figure 19 – Use a soft metal slug to protect the bearing.

CLEANING

You cannot expect a greasy or oily bearing to tell what condition it's in. When a bearing is removed, first wipe off most of the grease or oil. Then, soak in kerosene or a cleaning solvent. A regular cleaning tank with tray and solvent hose is ideal.

IMPORTANT SAFETY NOTE: NEVER USE GASOLINE AS A CLEANER BECAUSE OF THE FIRE HAZARD. ALSO NEVER USE CARBON TETRACHLORIDE BECAUSE IT PRODUCES POISONOUS FUMES.

HANDLING BEARINGS

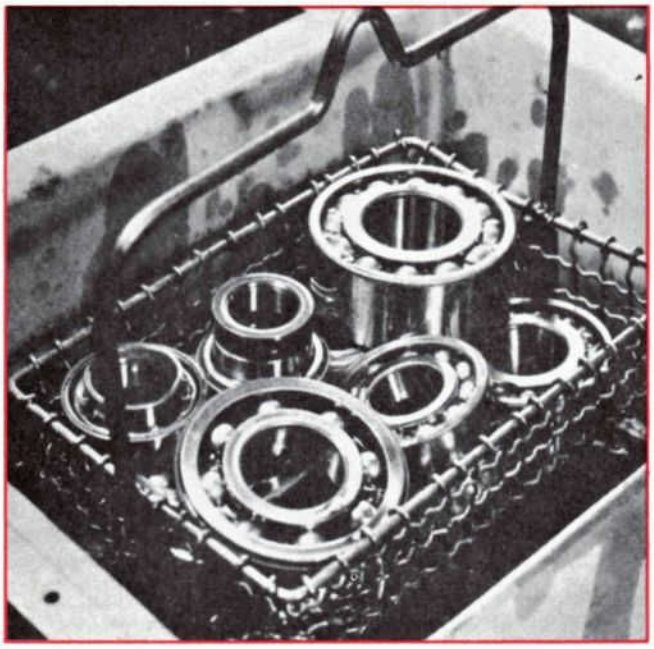

Figure 20 – Clean bearings in a regular solvent tank.

These recommended cleaning procedures apply to "open" bearings and bearings with only one seal or shield. BEARINGS WITH SEALS OR SHIELDS ON BOTH SIDES SHOULD NOT BE WASHED BECAUSE THEY ARE PERMANENTLY LUBRICATED DURING MANUFACTURE.

For sealed bearings, simply wipe them off with a clean cloth and keep them covered to keep dirt from working inside.

IMPORTANT NOTE!

Once you have washed the bearing, you can speed up the inspection process by air-drying them with compressed air as shown in Fig. 21. Note that the fingers through the bearing have it tightly gripped against the thumb. HOWEVER, NEVER SPIN A BEARING WITH AIR PRESSURE!

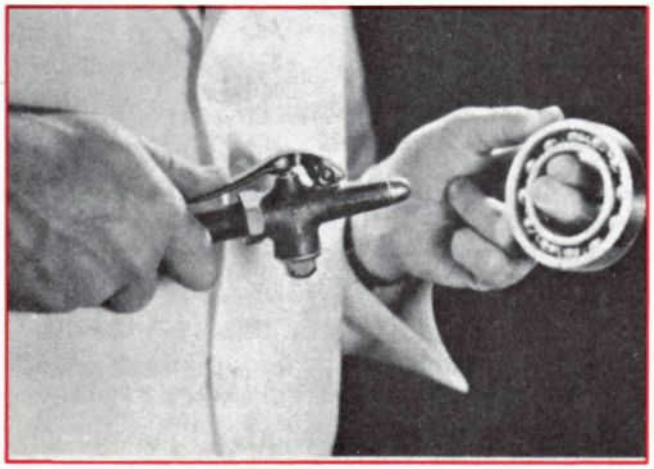

Figure 21 – The right way to hold a bearing while drying with air.

Not only will it likely damage the bearing, it can also be dangerous. Remember that the rolling elements are held together with the cage. If the cage and rollers are spun, the tremendous centrifugal force generated can cause one or more elements to fly out with violent force.

Always handle cleaned bearings with a fresh, lint-free shop cloth or towel. The perspiration from your hands can start early corrosion!

BEARING INSPECTION

After the bearings are cleaned, your next step is to inspect them to determine if they can be re-used or should be replaced. Keep in mind this thought: Bearings that pass inspection, but that can't be installed the same day should be dipped in a rust-preventive and stored in an air-tight container. For longer storage, coat bearings with light grease and wrap in grease-proof paper. (Fig. 22).

Figure 22 – Bearing wrapped for storage.

Bearings can show a wide variety of conditions that tell you they are due for failure soon. In the trade, these damage signs are grouped into 7 categories:

1. Cracks or Dents
2. Spalling and Indenting
3. Pitting and Scoring
4. Brinelling
5. Discoloration
6. Excessive Wear
7. Noise

Any of the above symptoms are cause to inspect the bearings and are usually the result of one or more of the following: Dirt and grit in the bearing, corrosion from some source, mechanical damage which includes improper installation adjustment, and removal or infrequent lubrication. When you find a bearing that has failed, you should look for the cause before installing a new bearing. Otherwise, the failure may be repeated.

Here are some samples of typical bearing damage you're likely to see.

EXAMPLES OF BEARING FAILURES

ABRASIVE WEAR

Dirt and grit cause abrasive wear . . . usually the result of poor sealing, improper maintenance, contaminated lubricants or improper handling. In severe cases, the bearing is noisy, and if you turn it by hand, you will detect roughness and looseness due to excessive clearances. Fig. 23 shows typical abrasive-type wear.

Figure 23 – Typical abrasive wear.

Fig. 24 and 25 show the damage to the raceways caused by the rolling elements rolling over hard metal particles. The raceway is scarred, resulting in a rough contact surface. This is called indenting.

Figure 24 and 25 – Indented and scarred raceways from metal particles.

CORROSIVE DAMAGE

Corrosive damage is usually caused by either water or acid. Reasons for corrosive damage taking place include inadequate sealing against moisture, acid fumes, contaminated lubricant, improper storage or even perspiration from a technician's hands. Corrosive failure can be identified by staining, very small etch marks, pitting or evidence of common rust. Study Fig. 26 which shows typical etching by acid, and Fig. 27 shows damages caused by moisture in the bearing.

Acid etched bearing cone

Figure 26

Moisture damage

Figure 27

MECHANICAL DAMAGE

A wide range of bearing failures is caused by some form of mechanical damage. The causes may be one or more of the following:

- Inner ring too loose on the shaft, assuring a tight fit is required.
- Outer ring too loose in housing
- Improper adjustment (too loose or too tight)
- Use of improper tools for removal or replacement
- Bearings installed backwards
- Improper lubrication

Study the following pictures (Figs. 28-36) that illustrate typical bearing failures due to mechanical damage.

Figure 28 – Improper Clearance

Improper Adjustment

Figure 29

Loss of Adjustment

Figure 30

Too Tight Adjustment

Figure 31

Improper Installation

Figure 32

Brinelling from Shock Loads

Figure 33

Spalling from Overloading

Figure 34

HANDLING BEARINGS

Bearing Installed Backwards

Figure 35

Improper Lubrication

Figure 36

COLOR	AMT. OVERHEATING
Beige	Low
Blue to Purple	Medium
Black	High

Another helpful hint is detailed above. This chart shows the amount of overheating that has taken place with an improperly lubricated bearing. Any bearing that shows evidence of medium to high overheat ranges should be replaced.

BEARING REPLACEMENT TIPS

1. Before installing bearings, make sure the shafts, housings, keyways, splines, etc. are clean and free from burrs, slivers of metal or solvents that could damage the bearing.

2. Unless pre-lubricated, all other bearings must be "packed" before installation. If a bearing packer is not available, place a "gob" of grease on one palm. With the other, press bearing edge into grease until it comes out the other side. Repeat until entire bearing is treated. (Fig. 37).

3. Follow procedures outlined by the automotive shop manual for the particular vehicle and application.

4. A small amount of oil applied to the seat area helps mounting of pressed-on bearings. (Fig. 38).

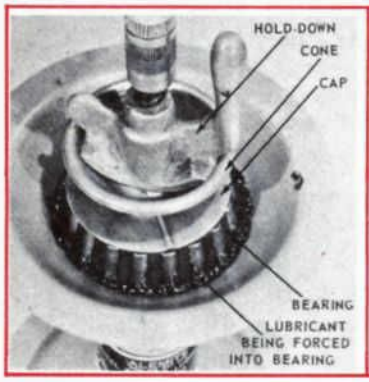

Figure 37 – Typical bearing packer.

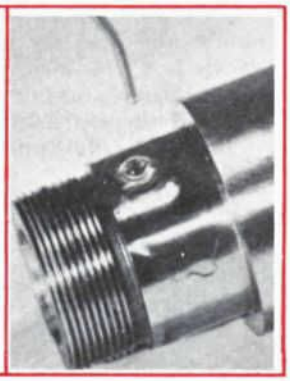

Figure 38 – Oil seat area.

5. For press-on bearings, use an arbor press and reverse the removal procedures. If necessary to use hand tools, never hammer directly on bearing. Use a soft hollow tube and a block of wood as shown in Fig. 39.

6. Apply force squarely to avoid cocking the bearing. Check to make sure that it is securely seated in its proper mounting position.

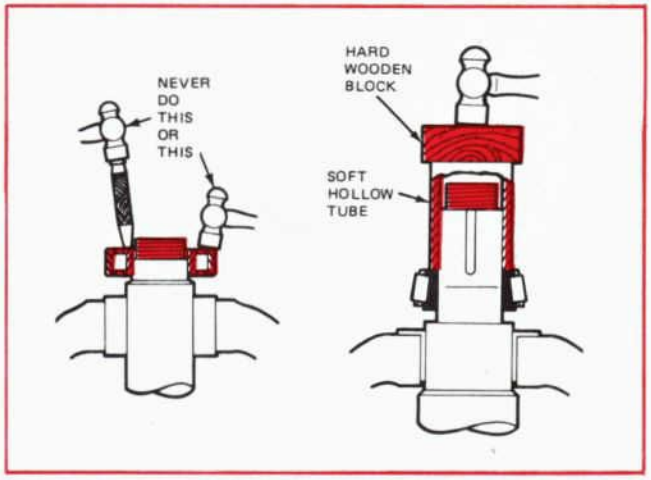

Figure 39 – Never strike bearing directly.

SETTING FRONT WHEEL BEARINGS

Specifications for tightening front wheel bearings to the proper setting will vary from one car make to another. The following procedures covering Ford-built passenger cars are typical:

- Rotate the wheel, hub and rotor assembly by hand and torque adjusting nut to 17-25 ft-lb to seat the bearing.
- Loosen adjusting nut ONE-HALF TURN.
- Retighten to 10-15 in-lb using a torque wrench.
- Place the lock nut on the adjusting nut so the castellations on the lock are in line with the cotter pin hole in the spindle.
- Install a new cotter pin and bend the ends around the castellated flange of the lock nut.
- Check front wheel rotation. If the wheel rotates properly, reinstall the grease cap. If rotation is rough or noisy, disassemble and inspect.

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