

Wheel Bearings

4 CHAPTER

Wheel Bearings

LEARNING OBJECTIVES

After studying this chapter and with the aid of a manufacturer's shop manual, you should be able to:

- Explain the purposes of the front wheel and rear wheel axle bearings,
- Explain how to inspect, diagnose, and service front wheel and rear wheel axle bearings.

INTRODUCTION

Where would humans and transportation be today without the invention of the wheel? Archaeologists suggest that the wheel came into use at least 6000 years ago in Near Eastern countries. The first wheels were made from round wooden logs, with a hole in the center for a wooden axle. The basic design of the wheel remained unchanged for centuries until the period of the Industrial Revolution and the invention of the steam engine. Wooden wheels gave way to wheels made of steel, and transportation began to advance into a new technological era.

Pioneering vehicle manufacturers constructed wheels with wooden spokes, fitted with a band of solid rubber around a steel rim. The rubber band provided the necessary traction. However, it also transmitted road shock because of its inability to flex under the load of the vehicle. The designers

went back to their drawing boards. Two brothers, Edward and André Michelin, developed the first detachable cycle tire in 1891. The tire consisted of a separate tube and an outer cover bolted to a rim. This development led to the first pneumatic automotive tire in 1895 and the first commercial truck tire in 1912. These tires were made from woven canvas fabrics held together by rubber binding.

The effect of friction between the threads of the canvas generated excessive heat and caused the tires to have blowouts. To overcome the problem, tires were inflated to increased air pressure. This solution reduced their ability to flex, however, thereby defeating the prime purpose of the pneumatic tire. For example, an early tire designed to carry 395 kilograms (kg) (900 pounds) of weight required a pressure of 420 kPa (60 psi); a similar modern tire would require an inflation of only 210 kPa (30 psi).

To begin our discussion of the wheel, let's start

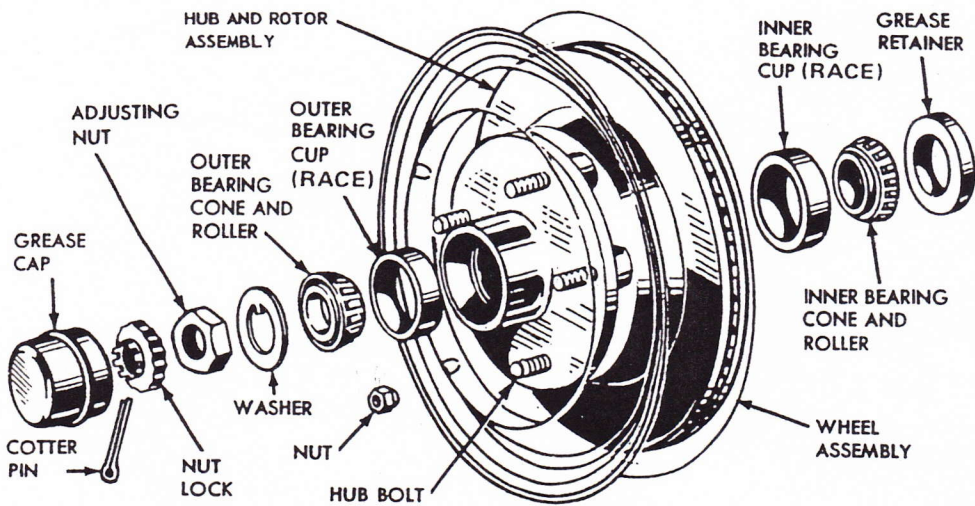


FIGURE 4-1. Assembly of a Wheel. (Courtesy of Ford Motor Company)

at the center of the wheel assembly by first becoming familiar with front wheel bearings on cars with rear differentials. We then discuss wheel hubs and bearings on vehicles with front wheel drive and conclude the chapter with a discussion on rear wheel axle bearings.

FRONT WHEEL BEARINGS

Figure 4-1 shows the assembly of a wheel. The front wheel of a vehicle is bolted to a hub and brake drum or rotor assembly. Two opposed tapered roller bearings and raceways made of case-hardened steel are fitted inside the hub and allow the wheel assembly to revolve with a minimum of friction. The grease retainer, recessed in the hub, prevents contamination of the bearings and keeps the lubricating grease away from the brake mechanism. The outer part of the hub is protected from contamination and loss of lubricant by a grease retainer cap.

Figure 4-2 illustrates an important principle of mechanical design. After you have removed the front wheel hub from a vehicle, you will notice the tapered design of the front spindle axle. The center-load line of the wheel is almost in line with the larger, inside wheel bearing. The tapered roller bearings and axle spindle are required to support the radial load of the vehicle, reducing the shearing of the spindle. As you examine the illustration, you will observe a center-load line through the kingpin or steering knuckle (ball joint suspension). Both center-load lines are designed to intersect near the road surface in order to reduce the effort required to turn the wheel at the road surface.

Wheel bearings are an integral part of the front wheel assembly. Too few vehicle owners realize the importance and purpose of wheel bearings. Figure 4-3 illustrates the four basic parts of a tapered roller

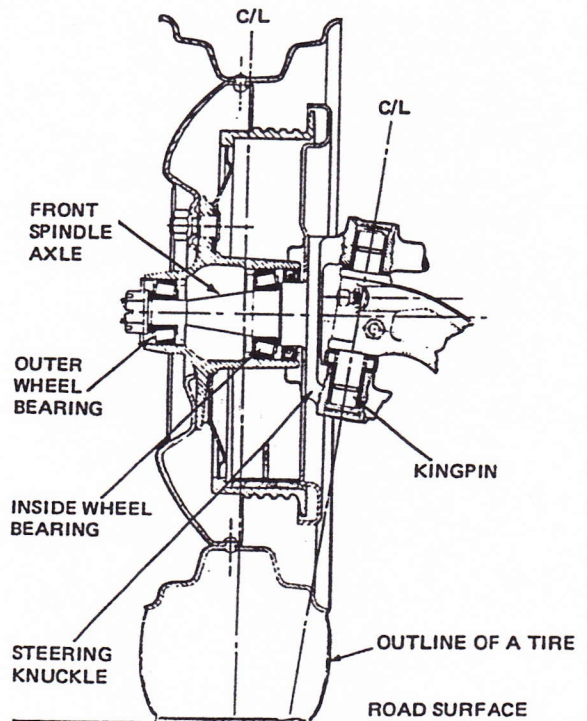


FIGURE 4-2. Loads Directed through Center Lines. The wheel bearings and the kingpin support the vehicle's weight along the center-load lines.

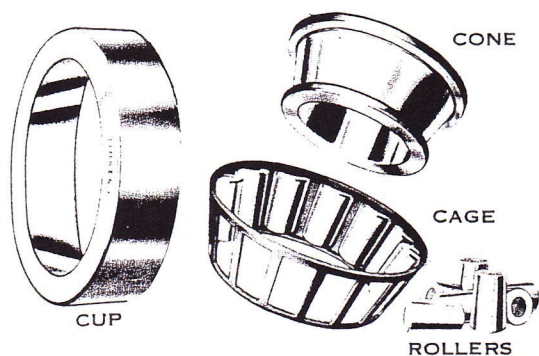


FIGURE 4-3. Major Component Parts of a Wheel Bearing.

bearing: the *cup*, or *outer race*; the *cone*, or *inner race*; the *tapered rollers*, which roll freely between the cup and cone; and the *cage*, which serves as a retainer to maintain the proper spacing between the tapered rollers grouped around the cone. All the parts are assembled into a complete bearing assembly by the manufacturer and are not made to be separated. Bearing part identification numbers are stamped on the cup and cone for reference purposes.

Purposes of Front Wheel Bearings

Front wheel bearings have six purposes:

1. To reduce friction between the revolving wheel hub and spindle,
2. To transmit the radial (vertical support) load and the thrust (lateral, side to side) load of a vehicle when the wheel is revolving,
3. To transfer undesirable road shock from the tire to the axle,
4. To keep the front wheels in correct alignment with the vehicle's suspension system regardless of road surface terrain,
5. To transfer the steering action produced by the driver to the wheels of the vehicle,
6. To allow the driver to sense turning resistance and road feel in order to control the direction of the vehicle.

Loose or rough front wheel bearings will produce a noise that may be confused with rear axle noises. The difference is that front wheel bearing noise does not change when the vehicle is coasting or accelerating. A light application of the brake while holding the vehicle's speed constant will often cause a bearing noise to diminish. This action tends

to reduce some of the weight supported by the bearings. Front wheel bearings may be checked easily for noise by raising the suspected wheel and then spinning it. If the vehicle is equipped with disc brakes, you will need to disengage the brake pads from the rotor. You may also use lateral force to check for excessive looseness.

Front Wheel Bearing Service

Most vehicle manufacturers recommend that front wheel bearings be serviced (lubricated) at intervals of 40,000 to 48,000 kilometers (25,000 to 30,000 miles). If you have been directed by the shop instructor to lubricate the front wheel bearings of a vehicle, it is suggested that you remove the front wheels from the hubs before you remove the brake drum or rotor from the vehicle.

Step-by-Step Procedure

1. Obtain the necessary hand tools, safety stands, vehicle floor jack, and manufacturer's shop manual.

2. Carefully remove the front hubcaps from the wheels. Preloosen the wheel lug bolts or nuts one complete turn. *Note:* Upon removing the hubcaps, you will notice that the front wheels probably have balanced weights attached to the rim. To ensure that you do not disturb the balance of the front wheels, use a piece of crayon or chalk to index each wheel to its hub, as illustrated in Figure 4-4.

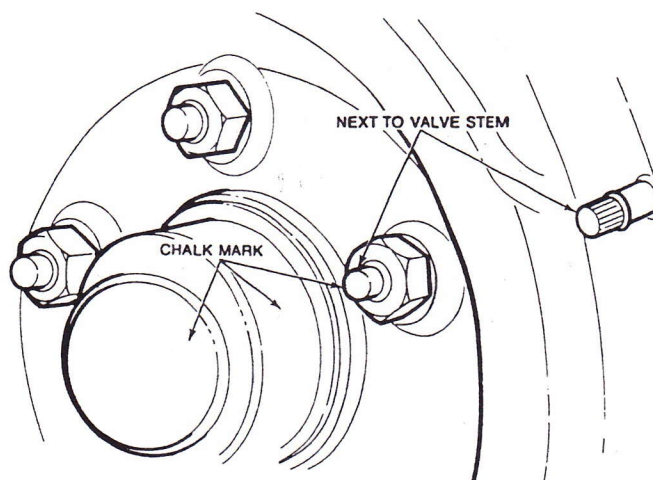


FIGURE 4-4. Indexing the Wheel. Mark each wheel with chalk or crayon to make sure balanced wheels are installed in same position. (Courtesy of Ford Motor Company)

The indexing is done to prevent the wheel from being unbalanced after installation of the wheel, since the wheel assembly may have been balanced on the vehicle. Balancing is discussed in Chapter 7.

3. Place the floor jack under the front cross-member and raise the vehicle. Position the safety stands under the frame of the vehicle (under the front door hinge post). Allow the vehicle to rest on the safety stands. Loosen the wheel lug bolts or nuts, and remove the front wheels. *Note:* If the vehicle is equipped with front disc brakes, the brake calipers will need to be removed from the vehicle before the next step. When the calipers have been detached from the vehicle, wire the assemblies to the frame to prevent damage to the brake flex lines.

4. Remove the grease retainer cap from the hub; use the special pliers if they are available. Remove the cotter pin, nut lock, wheel bearing adjusting nut, and flat washer from the spindle. (See Figure 4-1.) Move the brake drum or rotor toward you approximately 7 millimeters (1/4 inch). Push the brake drum or rotor in toward the steering knuckle to free the outer bearing from the hub. Remove the outer bearing. Place the parts in the hubcap.

Caution: Before you remove a brake drum or rotor, put on a respirator so that you do not inhale harmful asbestos dust.

5. Remove the hub from the spindle. Place the hub on the workbench. To protect yourself, vacuum any loose asbestos dust from the many parts of the brake mechanism and from the brake drum or rotor. You may remove the seal and inside bearing from the hub by using a piece of round wooden dowling, 30 centimeters (12 inches) in length, inserted through the outside bearing cup. Place one end of the dowling against the inner wheel bearing; the dowling will be positioned on a slight angle. Gently tap the opposite end of the dowling. Remove the seal and bearing from its recessed position in the hub. Discard the seal (Figure 4-5).

6. Thoroughly clean the bearings with solvent (*not gasoline*); steam or water are not recommended because of the possibility of rust. Dry the bearings with compressed air.

Caution: Compressed air can be dangerous. Direct the flow of air away from you and, if possible, toward the work floor area. Also, be sure to direct the flow of air down through the bearings. Do not allow the bearings to spin or they may fly apart.

7. Clean the lubricant from the inner and outer bearing cups with a solvent (for example, varsol). Inspect the cups for scratches, pits, excessive wear, and other damages. (See the front wheel bearing illustrations in Figure 4-6.)

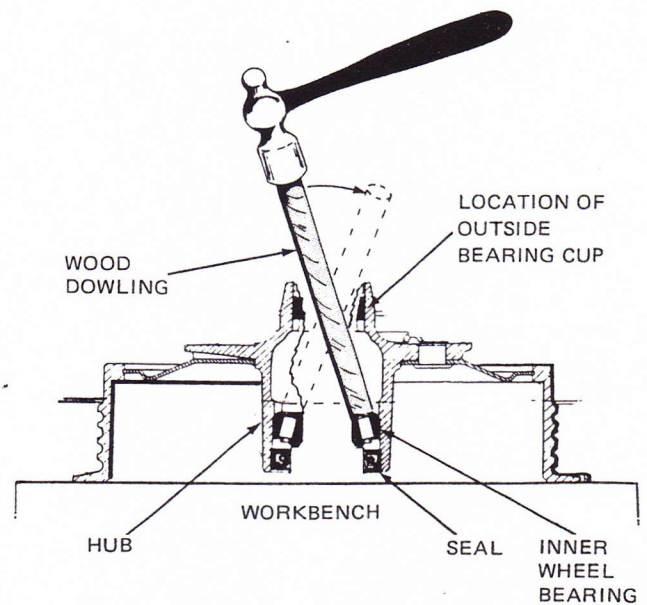


FIGURE 4-5. Removing Wheel Bearing from Hub. As you use a hammer to tap on the end of the wooden dowling, alternate the positions of the dowling to remove the bearing and seal from the hub.

8. If, after close examination, you decide the bearings and cups must be replaced, use the correct tools to remove and install the cups (Figure 4-7). There must be no metal chips under the bearing cups prior to installation.

9. Remove all old grease from the hub and spindle before repacking the bearings. *Note:* Do not immerse the hub, brake drum, or rotor in varsol; immersion will leave a film of oil on the part and will affect the braking of the vehicle. A cloth dampened with varsol will suffice.

10. If a bearing grease packer is not available (Figure 4-8A), the bearing must then be lubricated by hand. Place lubricant in the palm of one hand. Then, holding the bearing in the other hand, scrape the large end of the bearing against your palm, forcing the lubricant completely through the rollers and cage of the bearing (Figure 4-8B). Lubricate the inside cone surfaces with a light film of grease. A 5 millimeter (3/16 inch) layer of grease must also cover the inside of the hub (Figure 4-9).

11. Properly position the inside wheel bearing into the bearing cup. Apply a light film of grease to the lip of the seal and install the new seal.

12. Install the hub, drum, or rotor assembly on the wheel spindle. Keep the hub centered on the spindle to prevent damage to the seal or spindle threads.

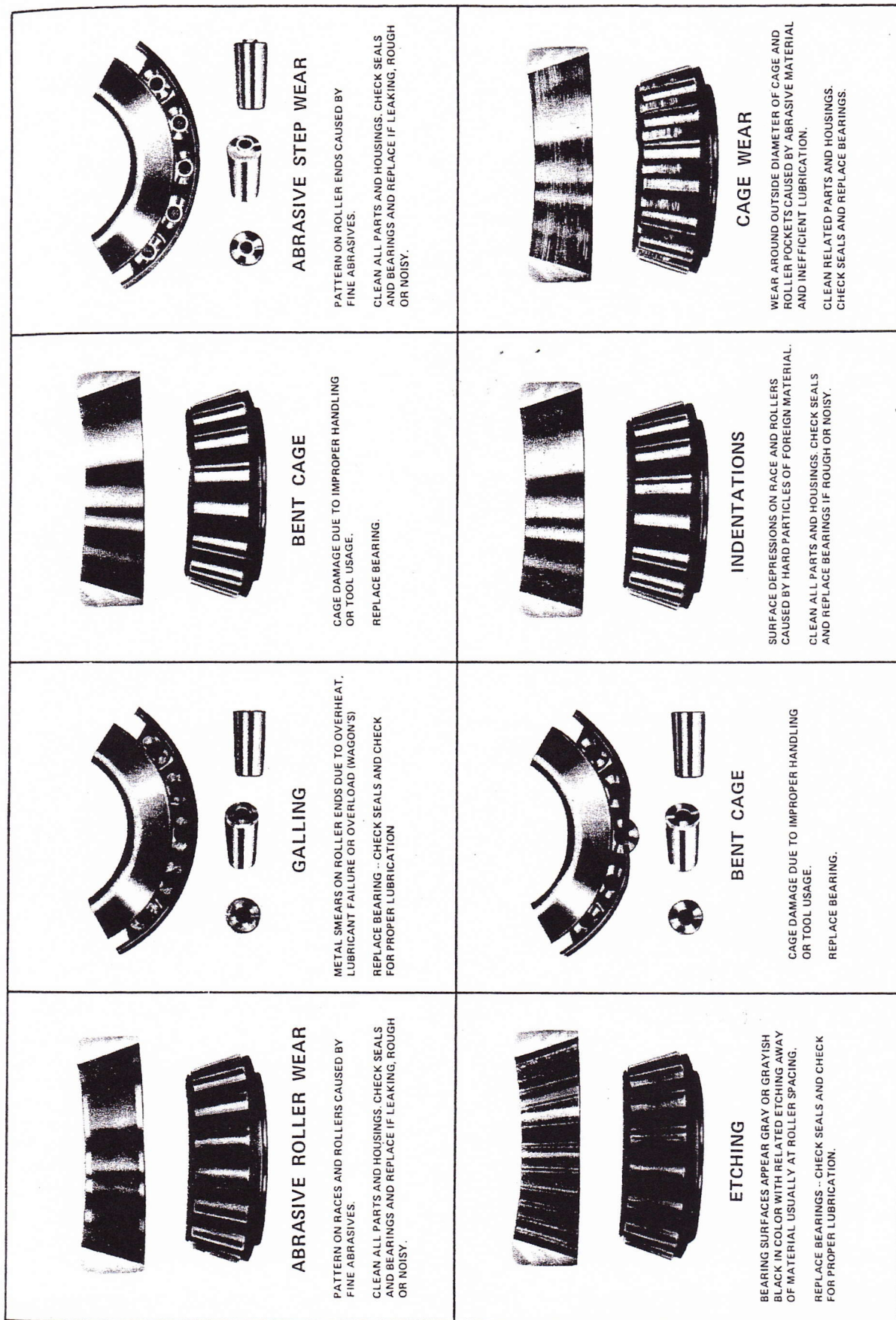


FIGURE 4-6. Types of Wheel Bearing Wear. (Courtesy of General Motors of Canada, Ltd.)

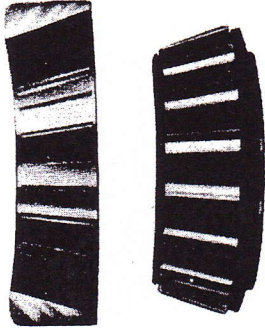
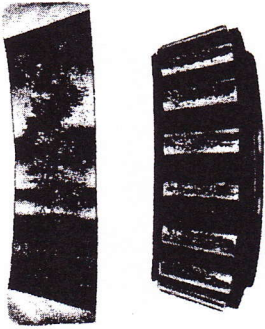

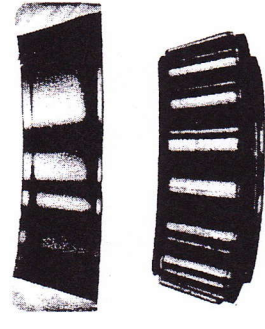
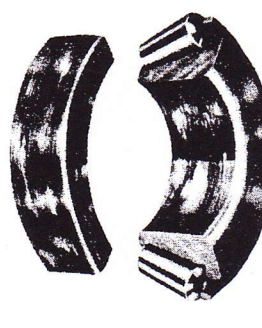

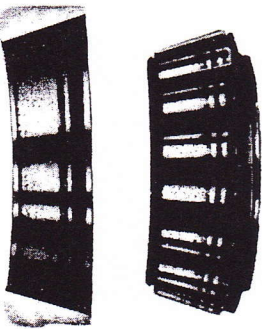
	<p>BRINELLING</p> <p>SURFACE INDENTATIONS IN RACEWAY CAUSED BY ROLLERS EITHER UNDER IMPACT LOADING OR VIBRATION WHILE THE BEARING IS NOT ROTATING.</p> <p>REPLACE BEARING IF ROUGH OR NOISY.</p>
	<p>FATIGUE SPALLING</p> <p>FLAKING OF SURFACE METAL RESULTING FROM FATIGUE.</p> <p>REPLACE BEARING -- CLEAN ALL RELATED PARTS.</p>
	<p>CRACKED INNER RACE</p> <p>RACE CRACKED DUE TO IMPROPER FIT, COCKING, OR POOR BEARING SEATS.</p> <p>REPLACE BEARING AND CORRECT BEARING SEATS.</p>
	<p>STAIN DISCOLORATION</p> <p>DISCOLORATION CAN RANGE FROM LIGHT BROWN TO BLACK CAUSED BY INCORRECT LUBRICANT OR MOISTURE.</p> <p>RE USE BEARINGS IF STAINS CAN BE REMOVED BY LIGHT POLISHING OR IF NO EVIDENCE OF OVERHEATING IS OBSERVED.</p> <p>CHECK SEALS AND RELATED PARTS FOR DAMAGE.</p>
	<p>SMEARS</p> <p>SMEARING OF METAL DUE TO SLIPPAGE. SLIPPAGE CAN BE CAUSED BY POOR FITS, LUBRICATION, OVERHEATING, OVERLOADS OR HANDLING DAMAGE.</p> <p>REPLACE BEARINGS, CLEAN RELATED PARTS AND CHECK FOR PROPER FITS AND LUBRICATION.</p>
	<p>HEAT DISCOLORATION</p> <p>HEAT DISCOLORATION CAN RANGE FROM FAINT YELLOW TO DARK BLUE RESULTING FROM OVERLOAD (WAGON'S) OR INCORRECT LUBRICANT, OR ROLLERS.</p> <p>TO CHECK FOR LOSS OF TEMPER ON RACES OR ROLLERS A SIMPLE FILE TEST MAY BE MADE. A FILE DRAWN OVER A TEMPERED PART WILL GRAB AND CUT METAL, WHEREAS, A FILE DRAWN OVER A HARD PART WILL GLIDE READILY WITH NO METAL CUTTING.</p> <p>REPLACE BEARINGS IF OVER HEATING DAMAGE IS INDICATED. CHECK SEALS AND OTHER PARTS.</p>
	<p>FRETTAGE</p> <p>CORROSION SET UP BY SMALL RELATIVE MOVEMENT OF PARTS WITH NO LUBRICATION.</p> <p>REPLACE BEARING, CLEAN RELATED PARTS, CHECK SEALS AND CHECK FOR PROPER LUBRICATION.</p>

FIGURE 4-6. Continued.

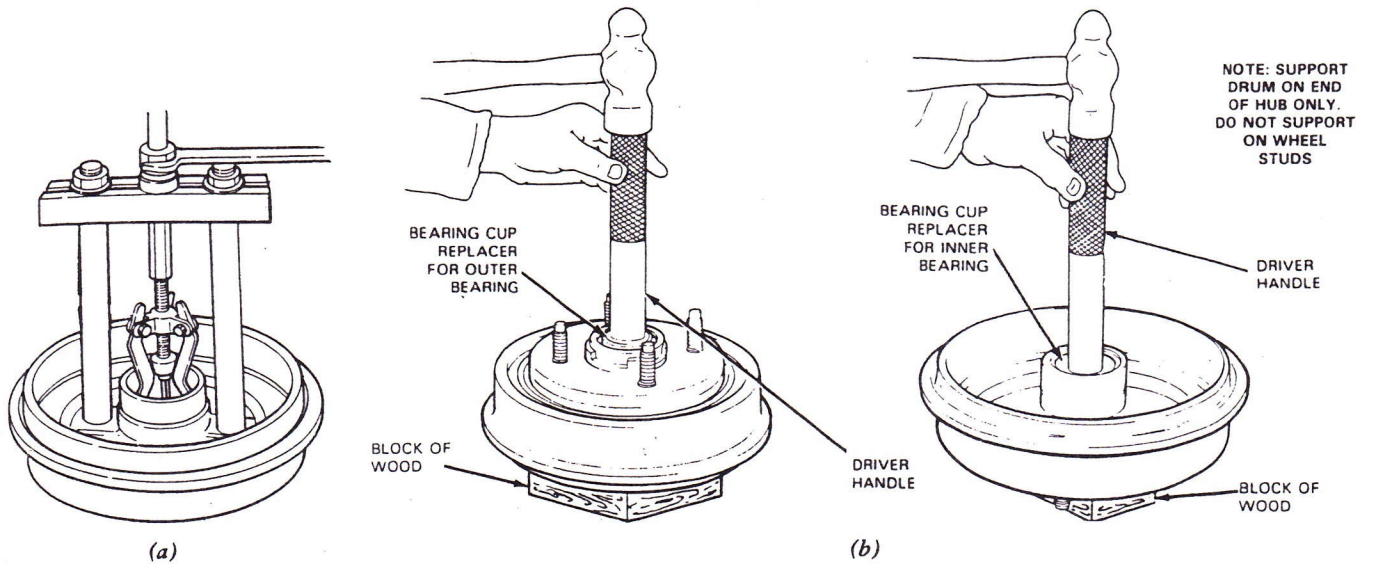


FIGURE 4-7. Replacing Front Wheel Bearing Cups. (a) Removing cups; (b) installing cups. (Courtesy of Ford Motor Company)

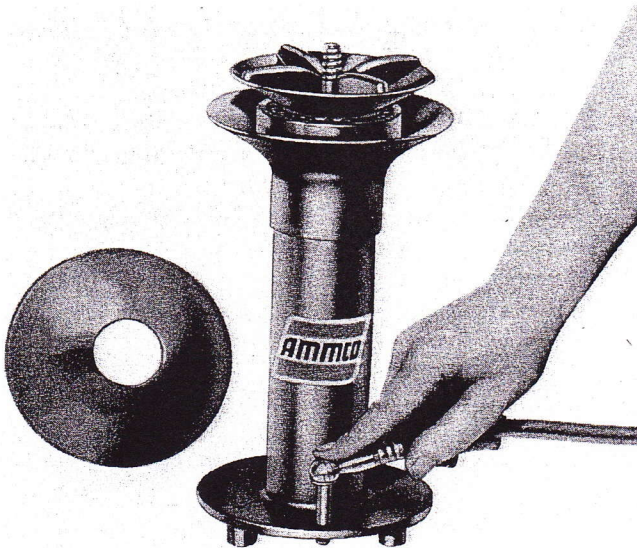


FIGURE 4-8A. Model 7150 Bearing Packer. (Courtesy of Ammco Tools, Inc.)

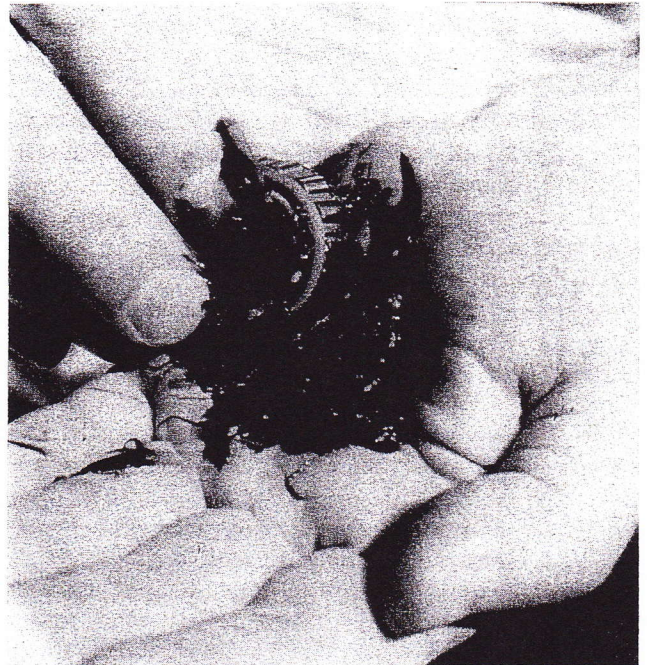


FIGURE 4-8B. Lubricating a Front Wheel Bearing by Hand.

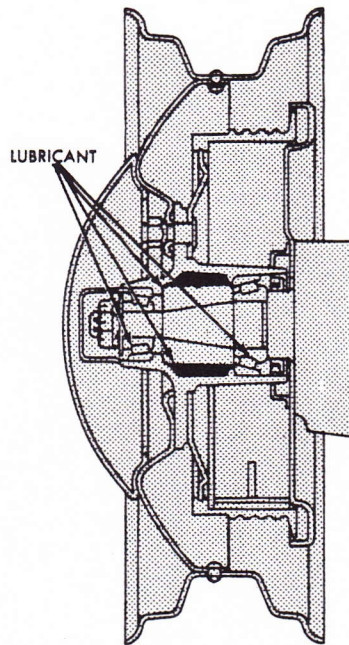


FIGURE 4-9. Lubrication Sites on Front Wheel Hub. (Courtesy of Ford Motor Company)

13. Install the outer bearing cone, flat washer, and bearing, adjusting nut and torque to manufacturer's specifications. *Note:* All manufacturers do not have a common torque specification. Figure 4-10 illustrates the procedure for vehicles manufactured by Ford Motor Company.

14. Cover the inside of the grease retainer cap with a light film of grease and install the cap. Mount the caliper according to the manufacturer's instructions. Install the wheel. Tighten the wheel lug bolts or nuts in correct sequence and torque to specifications (this procedure is covered in Chapter 5).

PRACTICAL SERVICE TIPS

1. When servicing and repacking front wheel bearings, use safe working practices.
2. Cleanliness is essential to wheel bearing service.
3. When inspecting, replacing, or repacking bearings, be certain that the inner cones of the bearings are free to creep (turn) on the spindle. The bearings are designed to creep in order to afford a constantly changing load contact between the

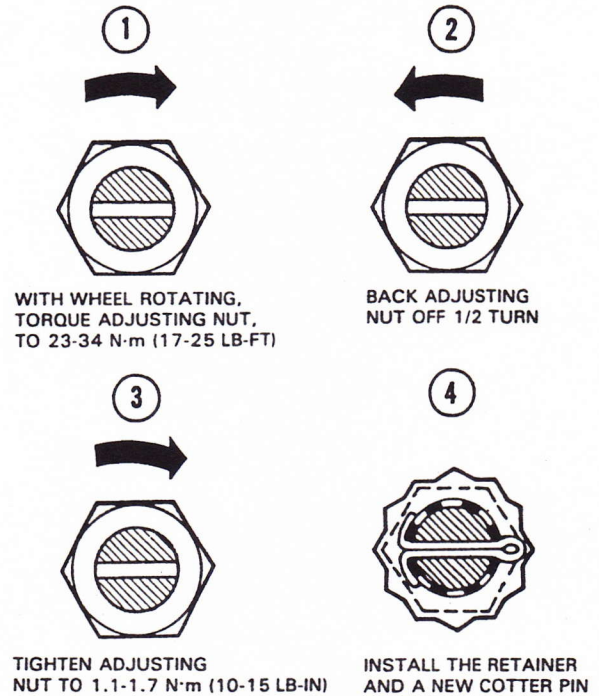


FIGURE 4-10. Front Wheel Bearing Adjustment. (Courtesy of Ford Motor Company)

cones and the rollers. Polishing and applying lubricant to the spindle will permit this movement and prevent rust from forming.

4. Make sure that the wheel bearing cups are secure in the hub. If the cups are not secure, replace the hub.
5. Make all repairs following the manufacturer's recommended procedures.
6. Always tighten wheel lug bolts, nuts, and bearings according to the manufacturer's instructions and torque specifications.

FRONT WHEEL DRIVE HUBS AND BEARINGS

Many front wheel drive cars are designed with permanently sealed front wheel bearings that require no adjustment or lubrication. Each front wheel is bolted to a hub assembly. Inside the steering knuckle's hub are two opposed and tapered roller bearings. Some manufacturers have front wheel

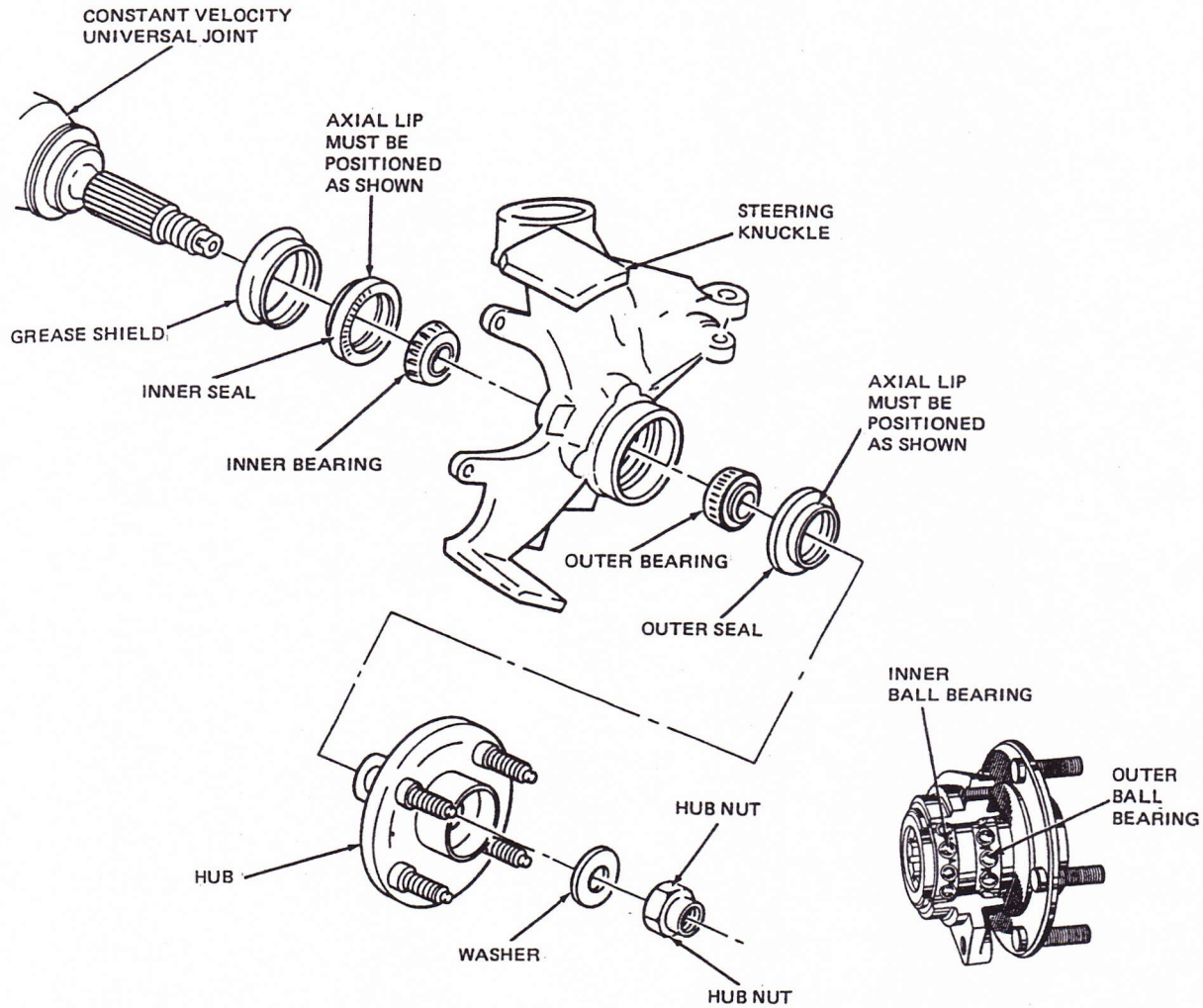


FIGURE 4-11. Front Wheel Drive Wheel Hub and Bearing Assemblies. (a) Wheel hub and bearings. (Courtesy of Ford Motor Company); (b) permanently sealed and lubricated front wheel ball bearings. (Courtesy of General Motors of Canada, Limited)

hubs designed with inner and outer ball bearings (Figure 4-11).

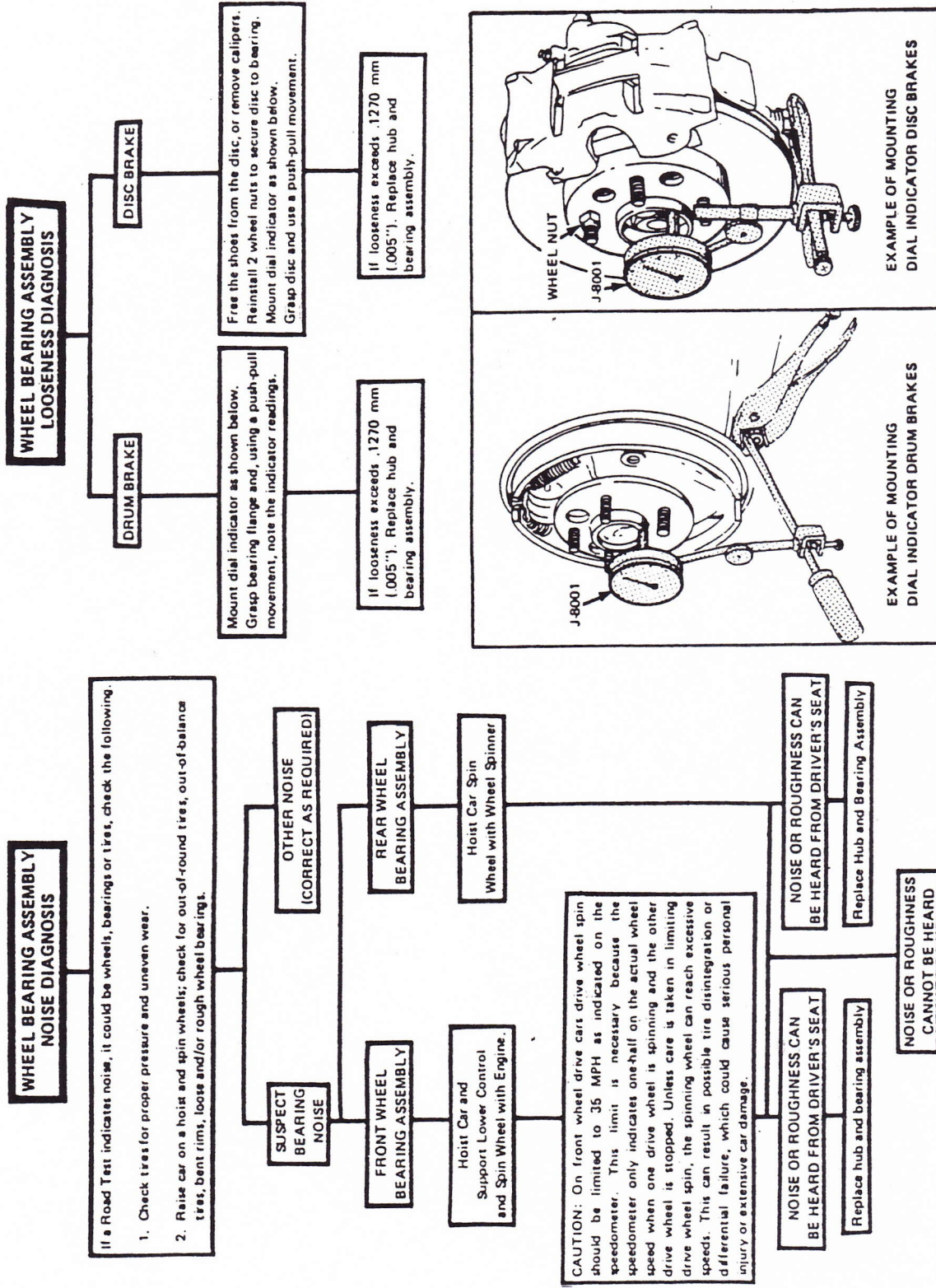
Regardless of the design of the bearings, they have the same purpose as the bearings discussed earlier in this chapter. To enable you to diagnose a suspected defective bearing, study and follow the procedures that are described and shown in the sealed wheel bearing diagnostic check flowchart in Figure 4-12.

If you determine that the wheel bearings need to be replaced, obtain a shop manual for that year and make of car. Follow precisely the removal service

and installation. Special tools are often required to remove the hub from and to install the hub to the constant velocity universal joint splined stub shaft (Figure 4-13).

Rear Wheel Bearings on Front Wheel Drive Cars

The rear wheel bearings on many front wheel drive cars require periodic repacking. Lubrication



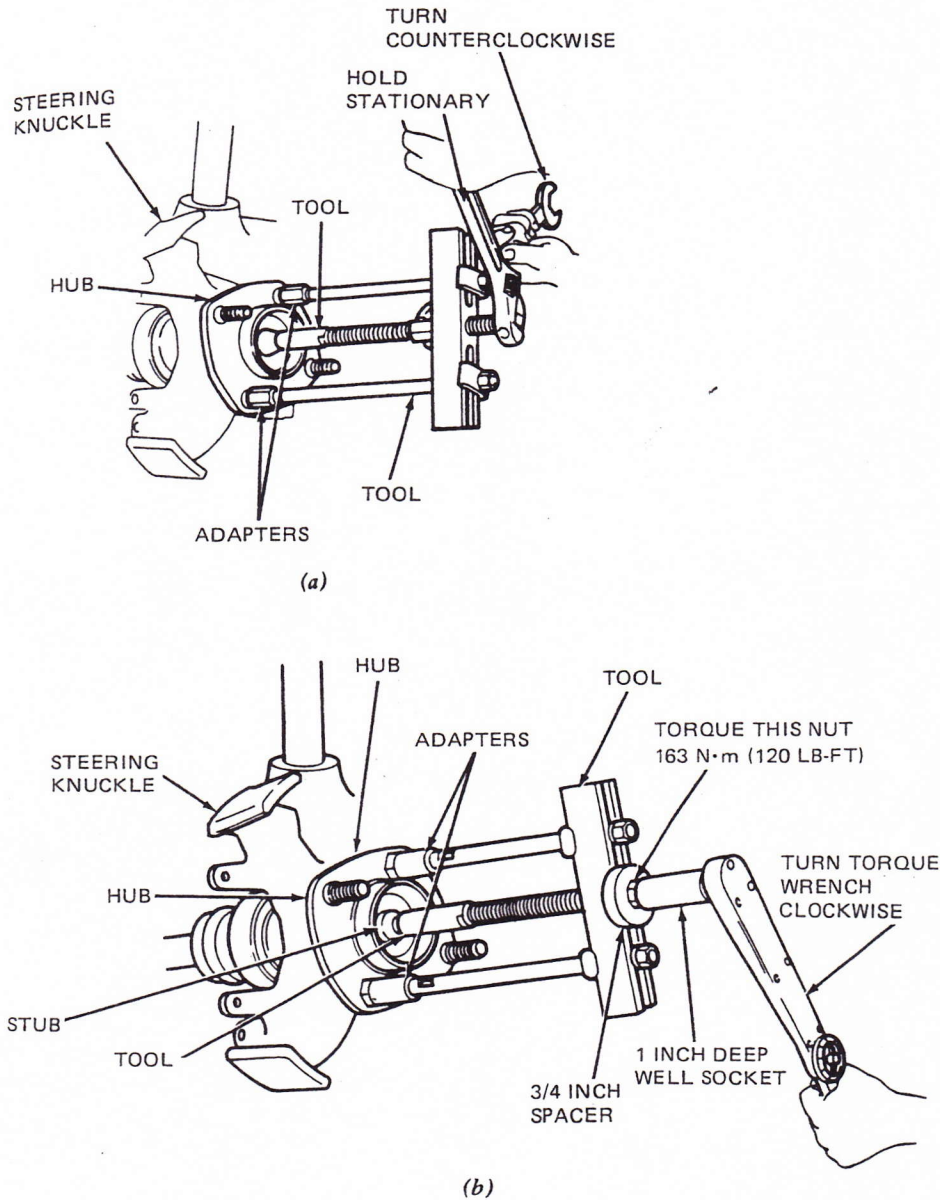


FIGURE 4-13. Replacing Wheel Bearings. (a) Removing hub from constant velocity universal joint stub shaft; (b) installing hub to constant velocity universal joint splined stub shaft. (Courtesy of Ford Motor Company)

and adjustment procedures are similar to those used with front wheel bearings on rear wheel drive cars. Service intervals, lubricants, and adjustment instructions are listed on the service charts.

REAR WHEEL AXLE BEARINGS

Rear wheel axle bearings serve the same purpose as the front wheel bearings. They reduce the revolving

friction of the axle shaft and support the weight of the vehicle. Rear wheel axle bearings are not serviced in the same manner as the front wheel bearings, however. Depending on the type of vehicle, the rear wheel axle bearings may be permanently sealed (lubricated when manufactured) or lubricated by gear lube from within the rear axle housing (Figure 4-14). The rear wheel bearings on some trucks with *full-floating axles* require periodic lubrication. Lubricant may be applied through a fitting or by removing and repacking the bearings, depending on

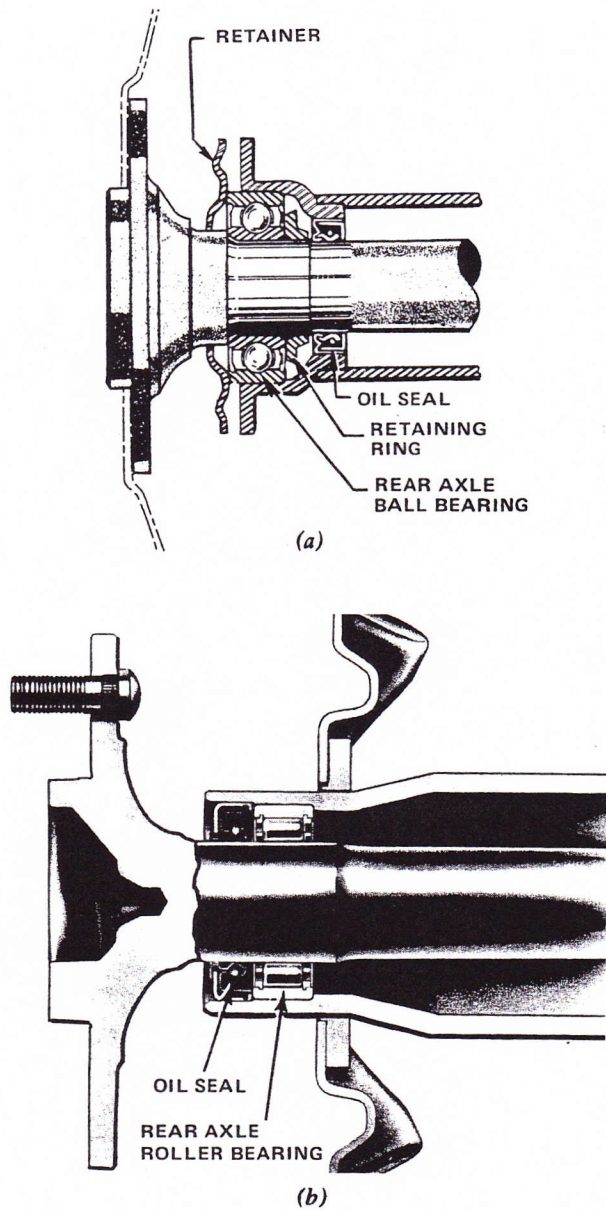


FIGURE 4-14. Two Types of Rear Wheel Axle Bearings.
 (a) Sealed ball bearing design; (b) roller bearing design.
 (Courtesy of General Motors of Canada, Limited)

axle design. Service intervals and lubricants are listed on the service charts.

Replacing Rear Wheel Axle Bearings

Rear wheel axle bearings normally require replacement at high vehicle mileage. Bearing failure at

low mileage is often caused by the following problems:

- Pulling a trailer with a heavy load,
- Carrying excessive weight in the trunk,
- Overloading the permissible payload of the vehicle.

Failure may result in a partly broken weld of the rear axle housing. Unfortunately, few drivers pay any attention to load restrictions of automobiles or light trucks. A rough rear wheel axle bearing produces a vibration or growl that continues when the vehicle is coasting with the transmission in neutral. Rear wheel axle bearing rollers do not rotate or travel at the same speed as the rear axle. A defective rear axle bearing will knock or click approximately every two revolutions of the rear wheel.

If you suspect that a rear wheel drive axle bearing is defective, raise the vehicle wheels and position the rear axle housing on two safety stands. Release the parking brake. Use the engine and driveline to rotate the rear wheels. Place a long screwdriver or a rod against the axle bearing positions and listen, as with a stethoscope, for bearing noise. If you detect a roughness or a clicking sound, the bearing is probably defective and must be replaced. Follow the procedures described in the shop manual for that model and year of vehicle.

Step-by-Step Procedure

1. If a rear wheel axle bearing is in need of replacement, you may have to partially dismantle the gears inside the crown and pinion housing. Always refer to the manufacturer's shop manual for disassembly, service, and assembly procedures.

2. Inspect the gear lube for signs of gear or bearing metal fatigue. If the gear lube is silvery in color, other serious problems may exist within the gear housing.

3. Carefully clean the bearing and seal area in the housing. Remove any metal particles.

4. Do not use an acetylene torch to remove a pressed lock or bearing from the axle. You will remove the temper (strength and hardness) from the shaft. Instead, drill into or notch the retainer ring in several places with a cold chisel to break the press (Figure 4-15). Use an arbor press or puller to remove the bearing from the axle shaft or housing.

Caution: When removing an axle bearing from an axle shaft and you have the bearing positioned in a press, always wrap a heavy cloth around the bearing. If the bearing shatters during removal, the cloth will prevent the broken pieces of metal from

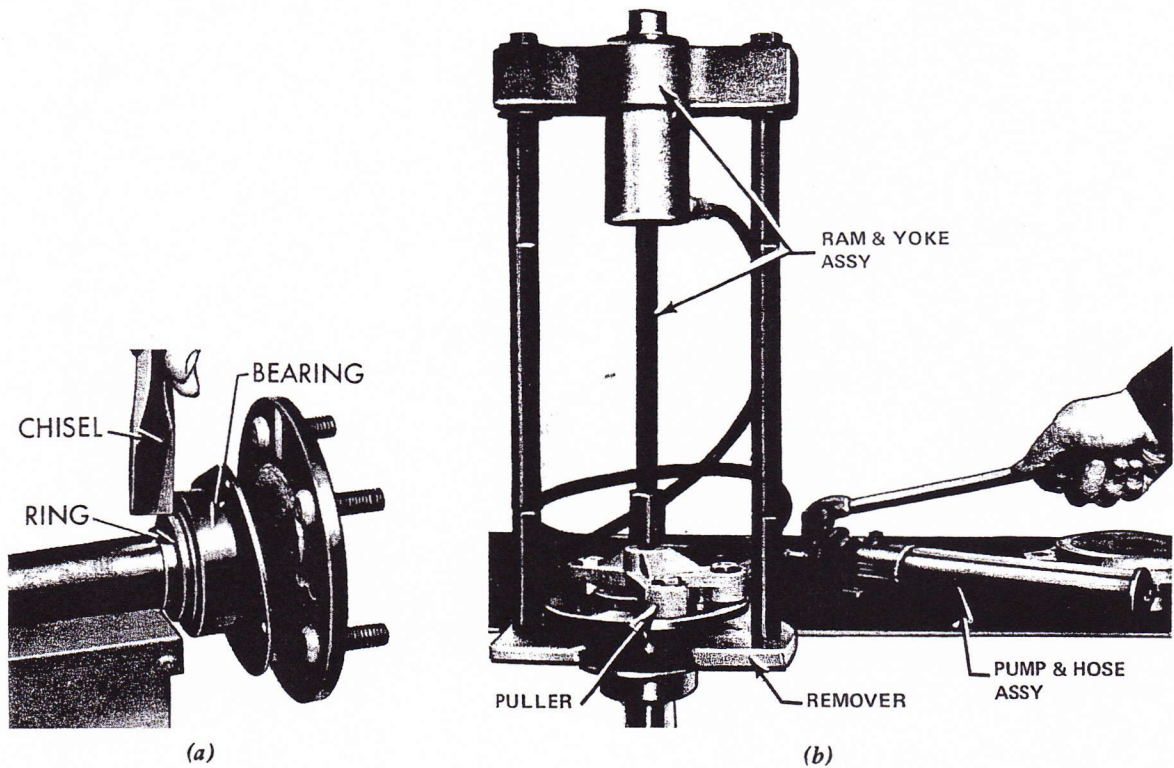


FIGURE 4-15. Removing Lock and Bearing from Axle. (a) Using a cold chisel to notch the retaining ring; (b) removing the rear axle bearing.

scattering and thus prevent injury. Removing a lock ring or bearing from a shaft destroys its press (tightness); neither can be reused.

5. Always install a new seal if it is not part of the new bearing assembly.

6. Care must be taken not to install the seal in a cocked position. Incorrect seal installation will cause loss of gear lubricant and affect the brake mechanism (Figure 4-16).

7. Check the rear axle housing breather vent to ensure that the vent hose or breather is not obstructed. If there is an obstruction, lubricant will be forced past the lip of the seal.

8. When you install the axle, tighten the wheel lug bolts or nuts in the correct sequence and torque to specifications.

REVIEW TEST

1. List six purposes for a wheel bearing.
2. Define the terms *radial load* and *thrust load*.
3. Describe the design of an inside front wheel bearing.
4. Name the major parts of a wheel bearing.

5. Explain how you would diagnose a defective front wheel bearing.

6. Explain why a wheel should be indexed to the hub.

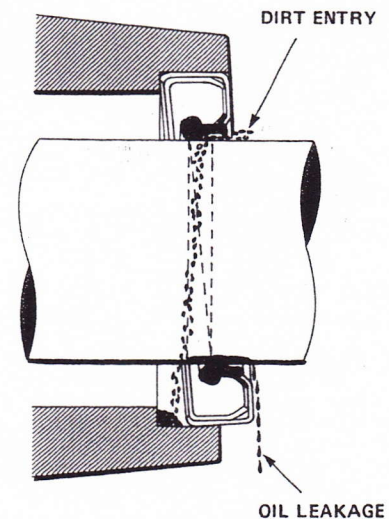


FIGURE 4-16. Results of an Improperly Installed Seal.

