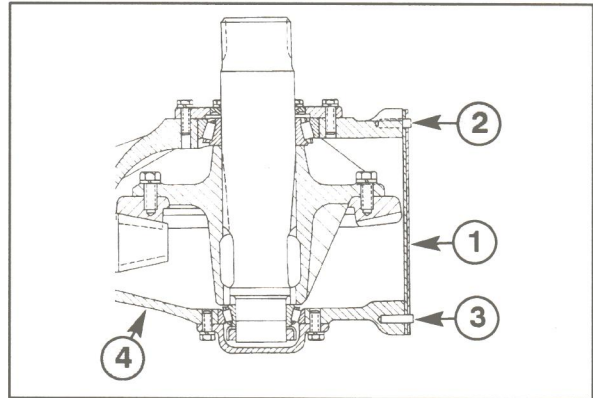
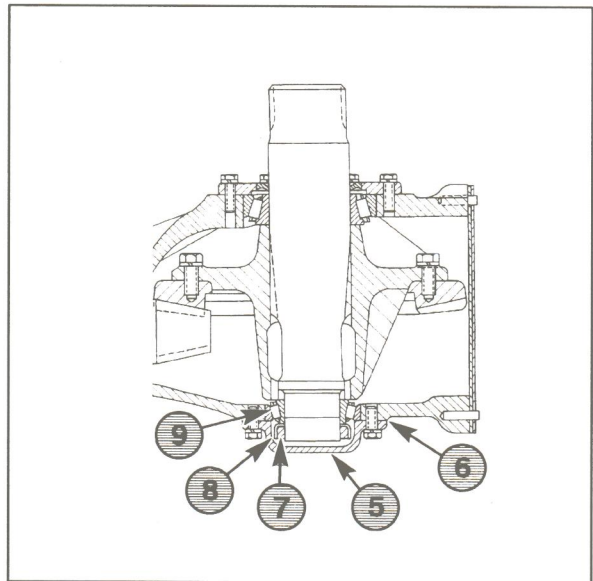


1. Remove the gearbox cover assembly, 1, by removing twelve hex head cap screws. It is not necessary to remove the dowel pins, 2 and 3, from the gearbox housing, 4.



22

2. Remove the bearing cap and retainer, 5, by removing four hex head cap screws and lock washers.
3. Remove the shims, 6, which were between the bearing retainer and the gearbox. Save these shims for use when reassembling the gearbox.
4. Bend the tab of lock washer, 8, away from locknut, 7,
5. Remove the locknut and lock washer. The cup for bearing, 9, can also be removed at this time, if it is free.



23

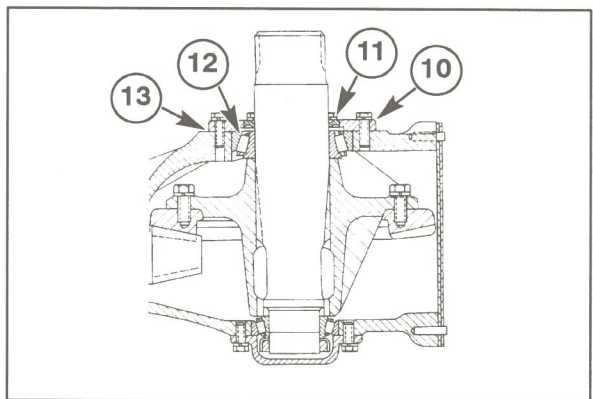
6. Remove the bearing retainer, 10, on the opposite side of the gearbox by removing six hex head cap screws and lock washers.

IMPORTANT: Be careful not to damage the oil seal, 11, when removing this bearing retainer if the seal is to be reused.

Remove the seal from the retainer.

The cup for bearing, 12, can also be removed at this time, if it is free.

7. Remove the shims, 13, and save them for use when reassembling the gearbox.

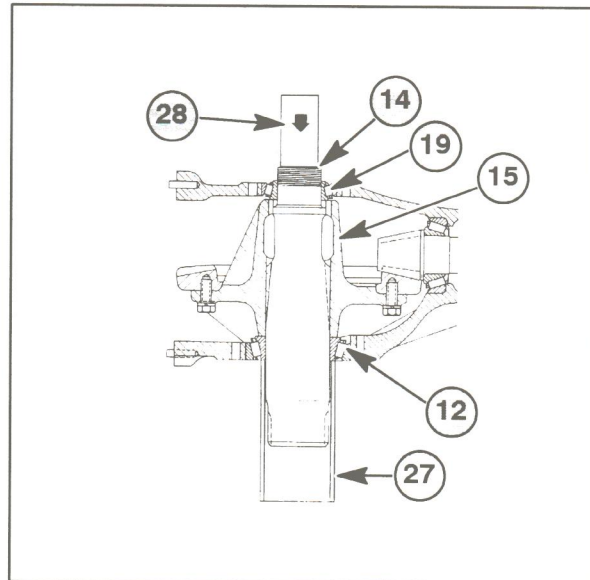


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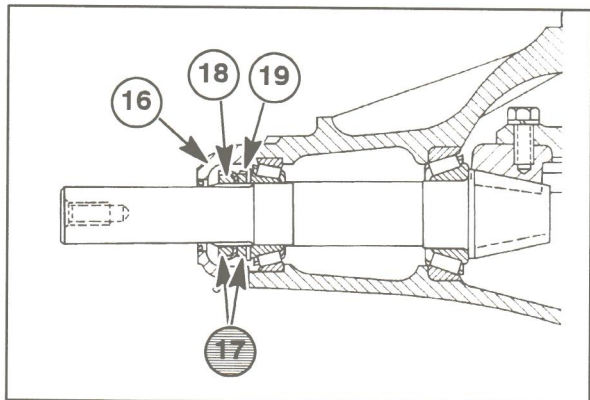
8. Support the inner race of bearing, 12, on a section of 88 mm (3-1/2") pipe, 27, approximately 30 cm (12") long. Place the gearbox assembly in a press with a capacity of at least 30 tons of force.

IMPORTANT: It is important that the OD of this pipe be turned down slightly on the end so the outside diameter does not interfere with the outer race of the bearing and result in damage. A section of pipe, which has been threaded, is correct in size. If a threaded section of pipe is not readily available, the OD of the standard 88 mm (3-1/2") pipe may be turned down 4 mm (5/32").

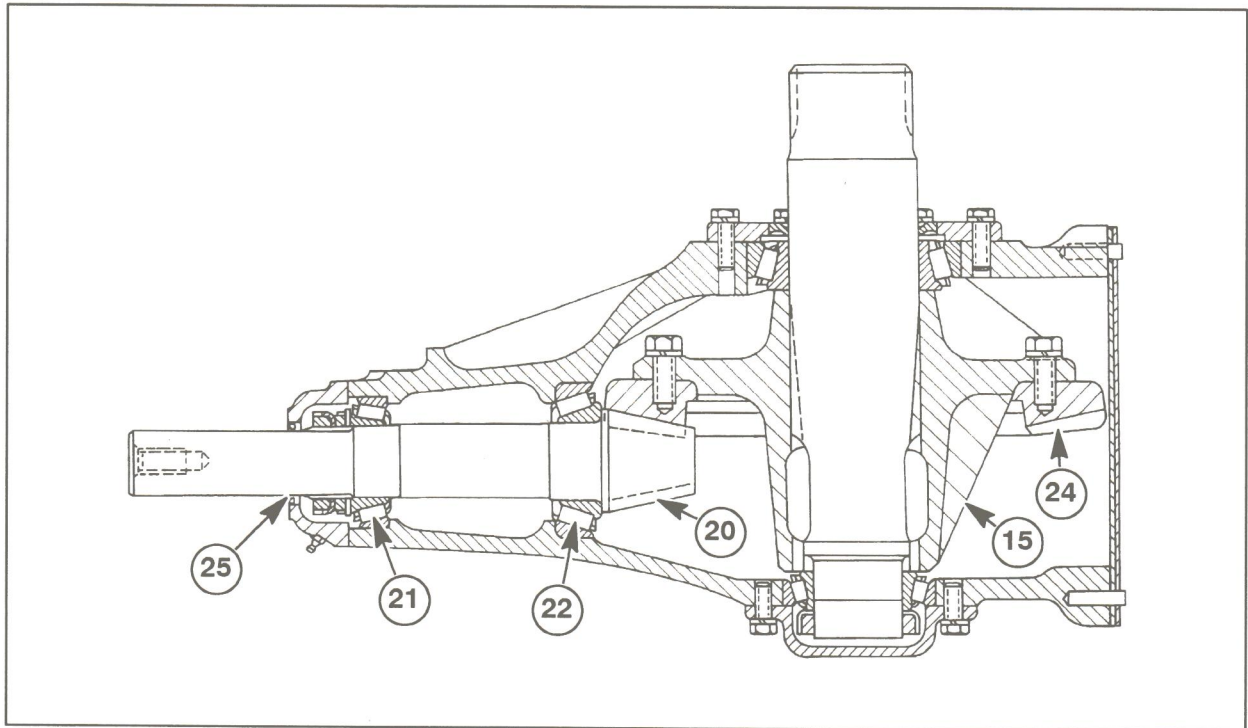
9. Use a 50 mm (2") OD driver, 28, to press the crankshaft, 14, out of the ring gear hub, 15, and bearing cones, 12, and 9, as shown. It will require 25 - 30 tons of force to separate the crankshaft from the ring gear hub.
10. Remove the crankshaft, the ring gear and hub assembly, and the bearings, from the gearbox.
11. Remove the pinion shaft end cap, 16, by removing the four hex head cap screws and lock washers.
12. Unlock the pinion lock nuts, 17, by removing the lugs of lock washer 18, which hold the lock nuts.
13. Remove the lock nuts, lock washer and washer, 19.



25

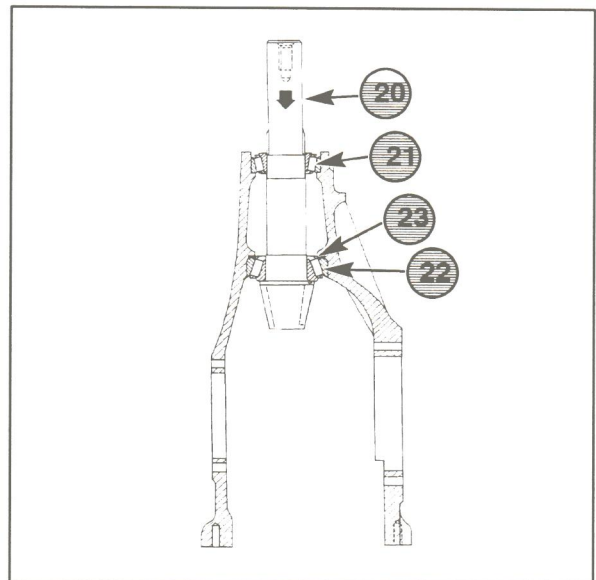


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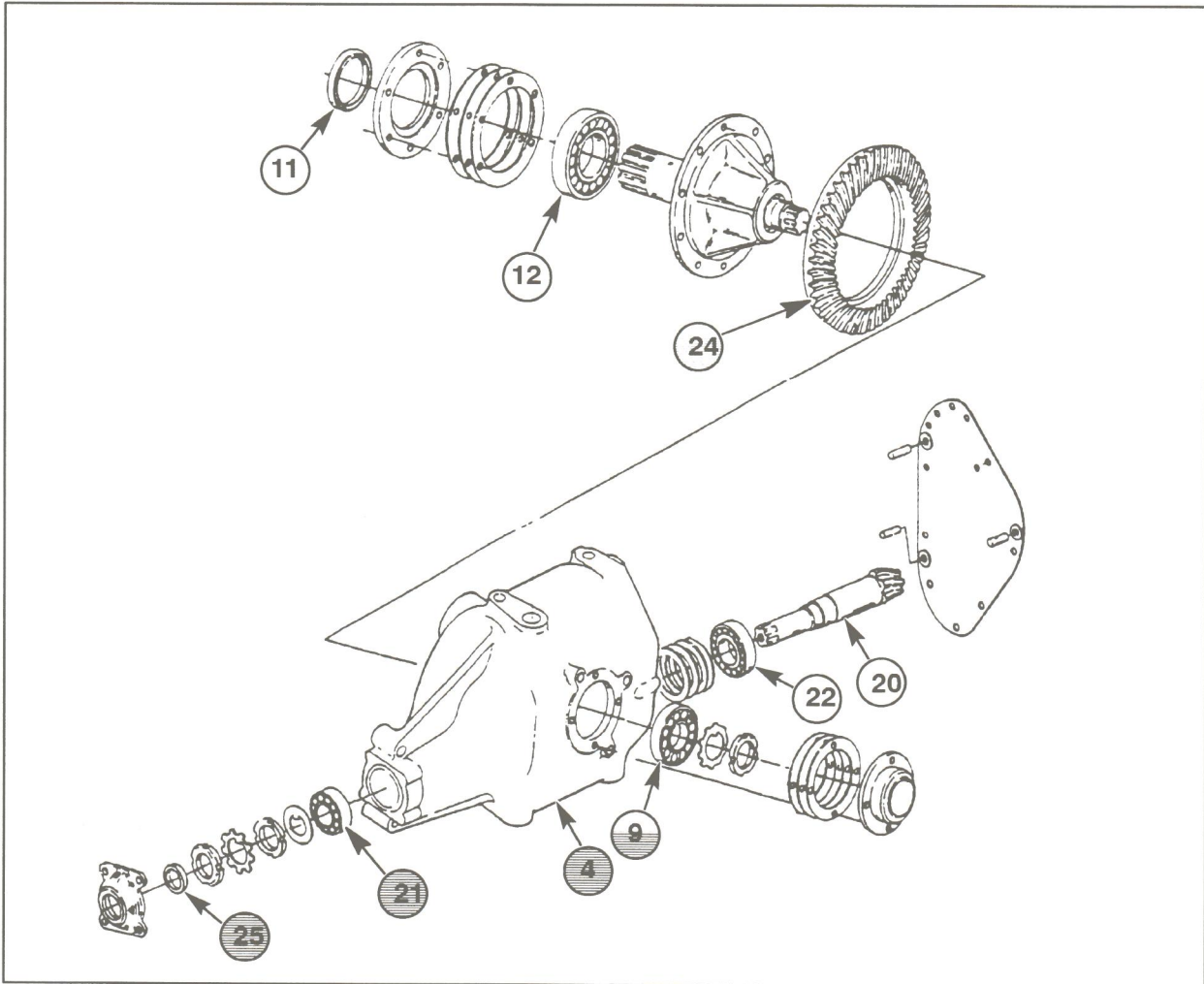


27

14. Install the original cap screw in the end of pinion shaft, 20, and turn medium tight. Firmly support the gearbox on the cover end and remove the pinion shaft by pressing down through the gearbox.
15. Remove the bearings, 21 and 22, from the pinion shaft. If replacing the inner pinion bearing, 22, remove the inner pinion bearing cup and the shims, 23.
16. If replacing the ring gear, 24, Figure 27, and pinion, 20, or the ring gear hub, 15, remove the cap screws and lock washers attaching the ring gear to the ring gear hub. Separate the ring gear from the hub.
17. Remove the seal, 25, from the end cap.
18. Remove the cups for bearings, 21 and 22, from the housing if new bearings are to be installed.



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29

Inspecting the Gearbox

Cleaning

Use a solvent such as diesel fuel or kerosene to clean all parts that may be reused.

After the parts are cleaned, inspect for wear or damage and replace if required.

Dry the parts immediately after they have been cleaned using a clean rag. Parts other than bearings can also be dried by compressed air.

Prevent rust or corrosion of dried parts by coating them with SAE 80W-90 GL5 lubricant.

Gearbox housing

Examine the gearbox housing, 4, closely for cracks or any other damage. If any damage or questionable quality is apparent, use a new gearbox housing.

Ring and pinion

Inspect all other parts for wear or damage, especially the ring gear, 24, and pinion, 20, and bearings, 9, 12, 21 and 22. If any questionable parts are noted, replace them. If the ring gear is starting to show wear from heavy loading at one spot only, this is usually the position where the plunger was nearing the rear of its stroke. The gear can be reused. However, mark the wear position. Mark the position on the crankshaft when the gearbox is reassembled. Install the crankshaft to position the ring gear so the highest load is at 90° or 180° from the worn area.

IMPORTANT: If either the ring gear or the pinion must be replaced, replace both of these parts. They are supplied only in matched sets and must be used as matched sets. Be sure to check the numbers etched on the ring gear and end of the pinion. The numbers must be the same.

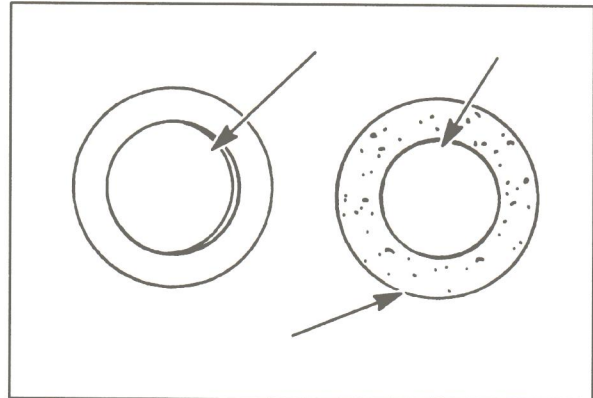
Oil seals

Inspect oil seals, 11 and 25, to be sure they are in good condition and free of nicks or scratches. If they are questionable, use new seals when reassembling the gearbox.

Bearings

Clean the lubricant from the bearings. Inspect the cup, cone, rollers and cage. If any of the following are found, replace the bearing.

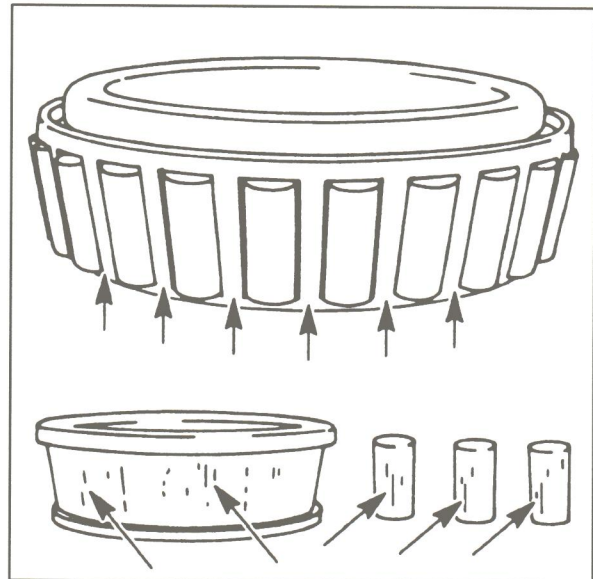
- The center of the large diameter end of the rollers is worn level or below the outer surface.
- The radius of the rollers are worn to a sharp edge.



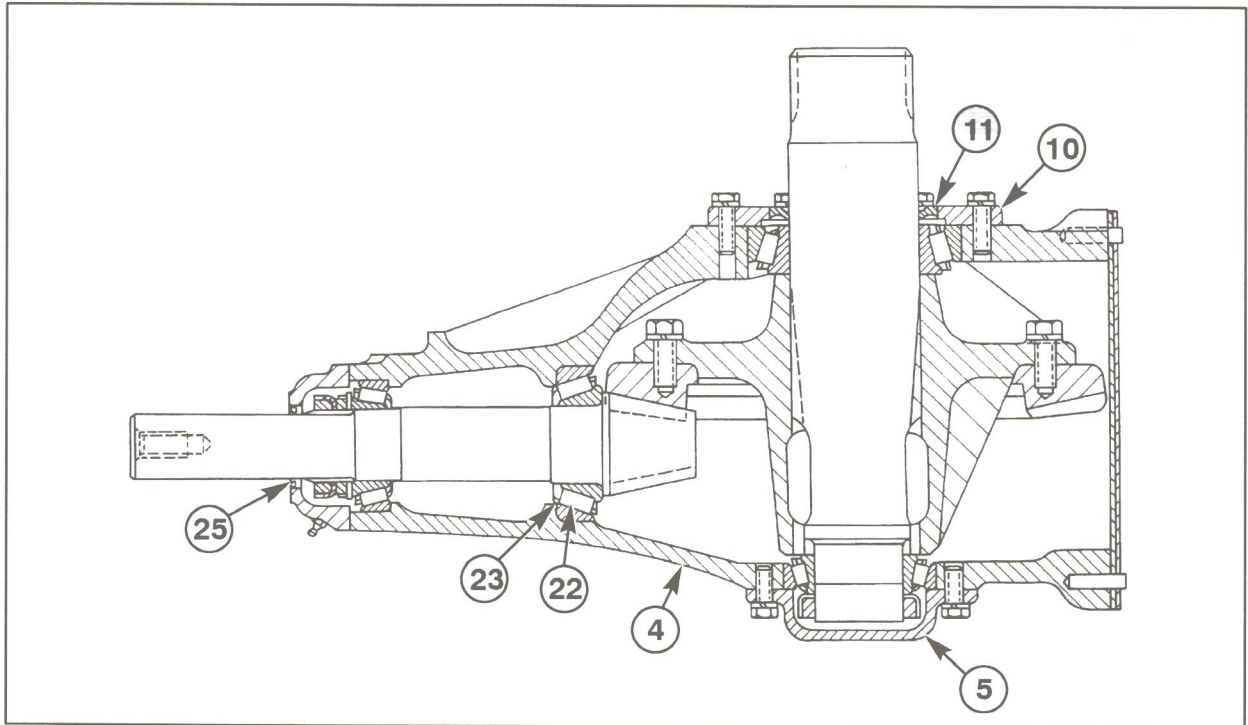
30

- There is a visible roller groove in the cup or cone.
- There are cracks or breaks in the cup, cone, rollers or cage.
- Bright wear marks on the outer surface of the cage.
- Damage to the rollers, cone surface, or cup surface that contacts the rollers.

NOTE: The tapered roller bearing assemblies are made from matched cups and cones and must be replaced as an assembly. DO NOT replace either the cup or cone separately.



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Assembling the Gearbox

Shaft seals

Do not install seals, 25 and 11, until the backlash and bearing preload have been adjusted. Install the seals with the lips facing in, toward the gearbox.

Sealing the gearbox

Apply a light coat of #2 Permatex or equivalent to all retainers and covers attached to the gearbox and to their attaching hardware. Crankshaft bearing retainers, 5 and 10, may have to be removed and reinstalled several times when adjusting the

backlash and bearing preload. It is recommended that the #2 Permatex not be applied to them until after the adjustments are completed. They can then be removed and the Permatex applied at final assembly.

Bearing shim codes

When bearing, 22, or housing, 4, is being replaced, determine the correct number of shims and install them at 23. This is necessary to properly locate the pinion with respect to the center of the ring gear. Proper location insures long life of the ring gear and pinion set.

A number, usually between 5 and 15, is stamped on the machined surface of the top of the gearbox at "X".

The bearing is packed with an important note indicating the shim factor of that particular bearing. This shim factor is indicated by a number written on the enclosed paper slip. This number will usually be within a range of 0 - 8. To determine the correct thickness of shims to be installed at 23, add these two figures - the one on the gearbox, and the one marked on the bearing tag.

For example, if the number or shim factor written on the enclosed slip with the bearing is 5 and the number stamped on the gearbox is 8. Add 5 and 8 for a total is 13. Therefore, install 0.013" thickness of shims at 23, Figure 32, under the inner pinion bearing race.

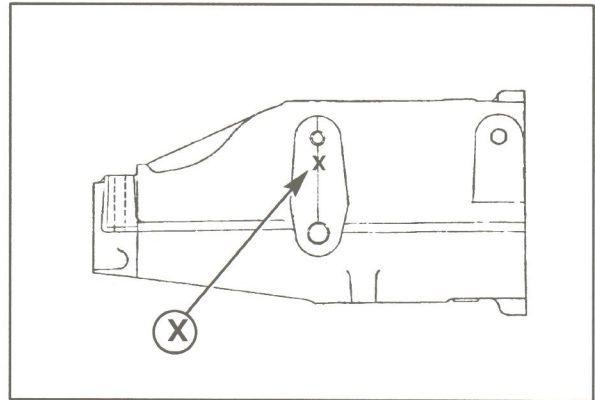
NOTE: If there is no shim factor paper slip in the box with the bearing, assume the shim factor is 4. Some bearings now are supplied as "half tolerance" bearings. The variation in thickness of these bearings is controlled closer than other bearings. They are made to the middle of the tolerance range which would require a shim factor of 4.

Bearing Installation

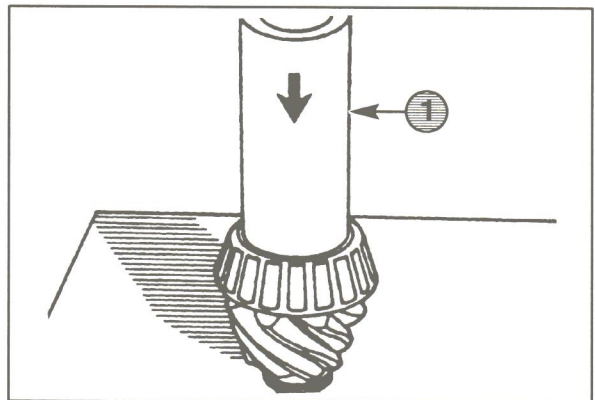
The bearing cups and cones can be installed by either of two methods as follows:

1. Use appropriate sized spacers, 1, and a press or hammer to seat the bearing halves. Spacers used to install the cones should be slightly larger than the shaft diameter and also contact only the inner race of the cone. Spacers used to install the cups should be slightly smaller than the bore in the housing and contact only the edge of the cup.
2. Use a brass punch to drive the cups and cones into position. Be sure to drive against only the edge of the cups or the inner race of the cones.

NOTE: The cups for the crankshaft bearings will be seated when checking the backlash and preload. They do not have to be driven into position.



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Install the Pinion Shaft and Bearings

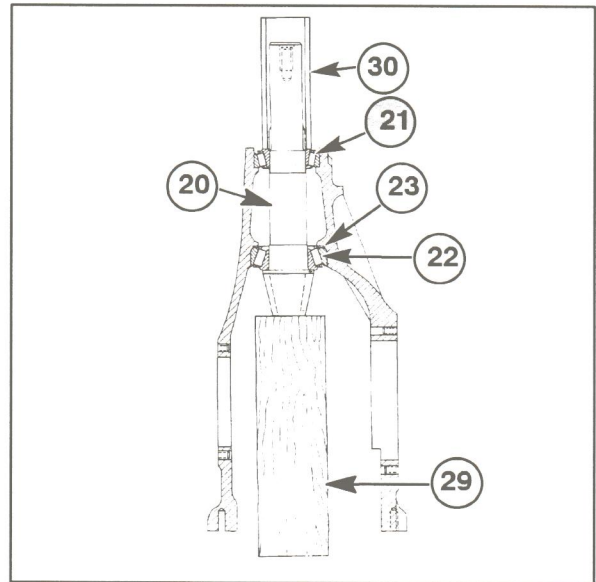
1. Calculate the correct thickness of shims as described in the shim code section and install the shims at 23. Install the cup half of inner pinion bearing, 22, in the housing using a brass punch or spacer. Be sure the bearing cup is properly seated.
2. Install the cone half of inner pinion bearing, 22, on the pinion shaft, 20.

IMPORTANT: Be certain the bearing is seated firmly against the shoulder of the shaft all the way around.

3. Install the cup half of outer pinion bearing, 21, in the housing. Be sure it is properly seated all the way around. Be careful not to damage the race.
4. Position the pinion shaft with the inner pinion bearing cone installed on it in the gearbox.
5. Turn the gearbox on end as shown and support the pinion on a hard wooden block, 29. Be sure the wooden block is tall enough to support the pinion shaft and gearbox so that the bottom of the gearbox housing is not resting against the floor or workbench.

IMPORTANT: If the gearbox housing contacts the floor or workbench, the outer bearing cone cannot be installed correctly.

6. Use a spacer, 30, to install the cone half of the outer pinion bearing, 21, on the pinion shaft.



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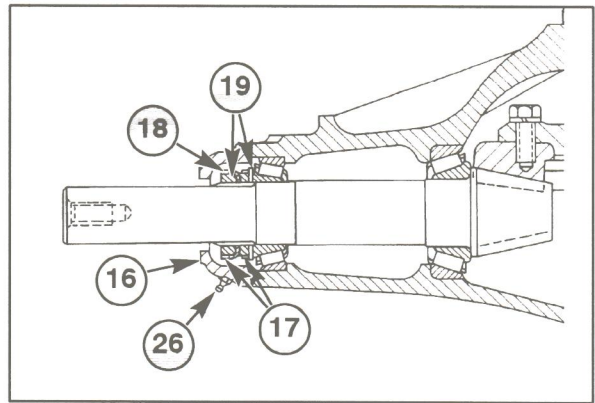
7. Clean the threads on the pinion shaft and lock nuts, 17, with a clean solvent. Apply a few drops of Loctite 277 or equivalent thread sealant to both threads.
8. Install washer, 19 on the pinion shaft.
9. Install inner locknut, 17. Tighten the locknut until the pinion bearings are moderately preloaded and check the bearing preload. If a torque wrench is available, install the original cap screw in the end of the pinion shaft and tighten the locknut until a preload of 1.7 - 2.8 N·m (15 - 25 in. lbs) is obtained. If a torque wrench is not available, measure this preload by suspending a weight of 6.8 - 11.3 kg (15 - 25 lbs) from a string wrapped around the pinion shaft when the gearbox is in a horizontal position. When the preload on the bearings is properly adjusted, this weight will rotate the shaft slowly and steadily.

Record the preload setting for a reference when checking the crankshaft bearing preload.

10. Install lock washer, 18. Bend one segment of the lock washer into the locknut.
11. Install outer locknut, 17. Tighten the locknut to 162 N·m (120 ft lbs). Recheck the pinion bearing preload to be sure it has not changed. Bend one segment of the lock washer into the outer locknut.

NOTE: Bend one tab on the lock washer into each locknut.

12. Apply a thin coat of Permatex to the mating surface of the end cap, 16, and install it on the gearbox. Be sure the lube fitting, 26, is facing toward the left side.



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Install the Ring Gear and Crankshaft

13. Check the ring gear to make certain it is correctly matched with the pinion. The identifying number etched on the outer circumference of the ring gear should correspond with the number etched on the pinion face. If the numbers on the pinion and ring gear are not the same, the gears are not matched and must not be used together.

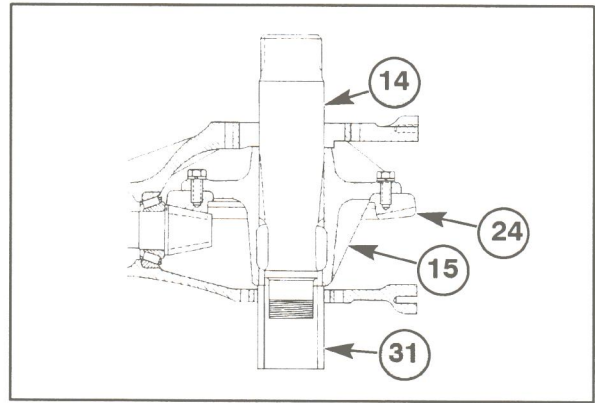
Place the ring gear hub, 15, in a vise and bolt the ring gear, 24, to the ring gear hub with ten cap screws and lock washers. Tighten the cap screws uniformly to 95 - 100 N·m (70 - 74 ft lbs) if they are M12 x 30 or tighten to 115 N·m (85 ft lbs) if they are 1/2" x 1 1/4". The M12, metric, cap screws can be identified by an 8.8 on the head.

14. Place the gearbox in a press. Coat the heavy spline on the ring gear hub and crankshaft, 14, with white lead or an equivalent. Position the ring gear hub in the gearbox and insert the crankshaft into the hub. Use a soft hammer to tap the crankshaft end until the ring gear hub fits tight against the taper of the crankshaft.

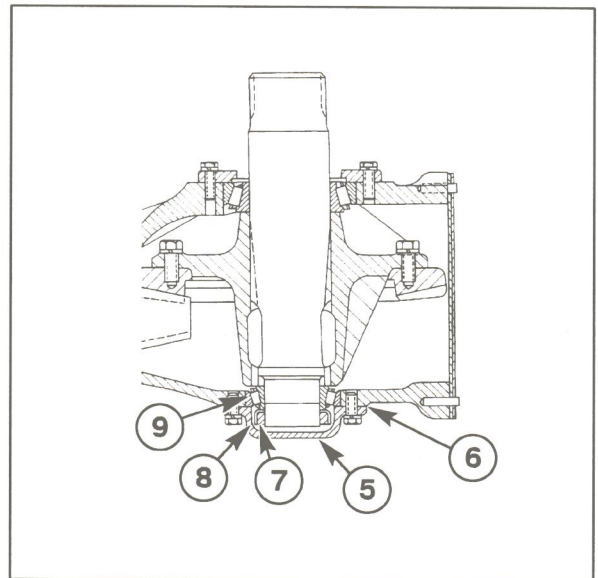
Support the smaller end of the ring gear hub on a 75 mm (2-1/2") pipe, 31, and press the crankshaft into the ring gear hub with approximately 22.6 metric tons (25 tons) of pressure.

NOTE: If the ring gear was showing heavy wear at one position, mark that position on the crankshaft so the crank can be installed 180° from the original position.

15. Install the cone half of bearing, 9, on the crankshaft. Be sure it is seated tight against the ring gear hub all the way around.
16. Place the cup half of bearing, 9, on the crankshaft and install lock washer, 8, and locknut, 7. Tighten the locknut securely and bend one segment of the lock washer into a notch of the locknut to hold it securely in position.
17. Install the same number of shims at 6 as were removed from the gearbox, and install bearing retainer, 5. If a new gearbox or a new ring gear hub is being used, install one 0.003" shim, one 0.005", and one 0.007" shim at this time.

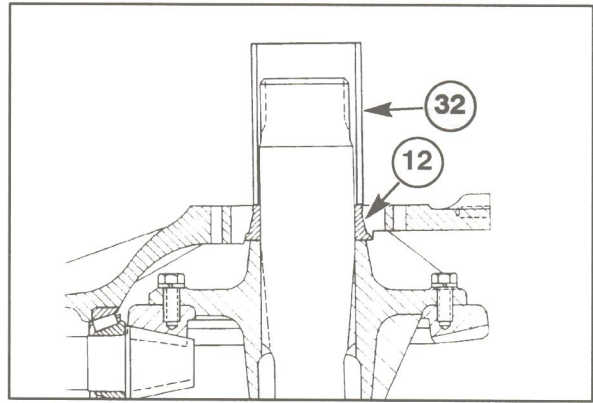


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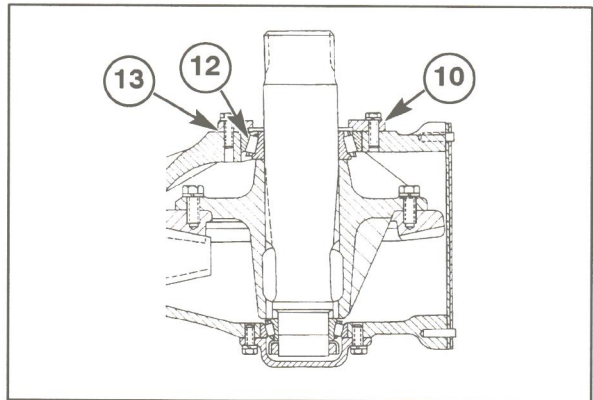
38

18. Turn the gearbox over on the left side. Use a spacer, 32, to install the cone half of bearing, 12. Be sure it is seated tight against the ring gear hub all the way around.



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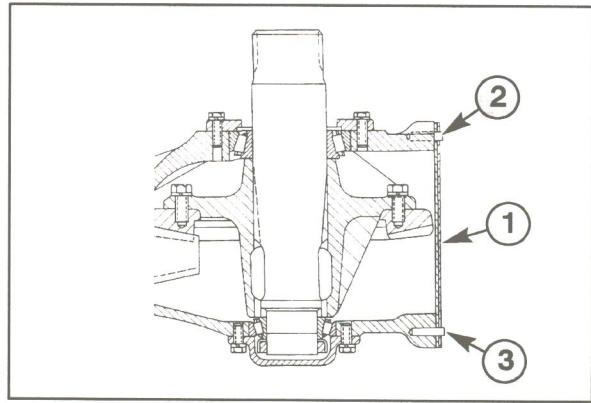
19. Place the cup half of bearing, 12, in position. Install the bearing retainer, 10. If the original bearing is being used, install the same shims at 13 as were originally used. However, if a new bearing or a new gearbox is being used, install one 0.003" shim, one 0.005" shim, and one 0.007" shim at this time.



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Install the End Cover

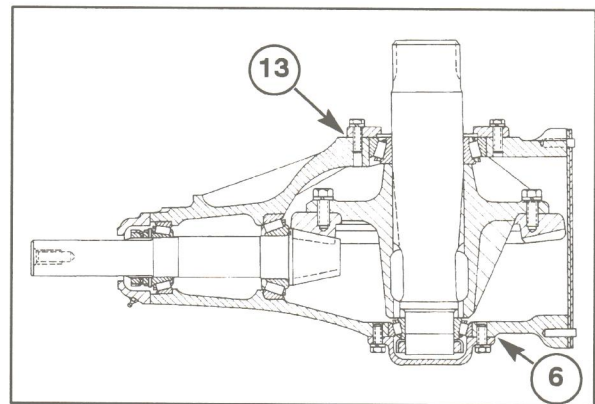
20. Be sure dowel pins, 2 and 3, are installed in the gearbox housing. Apply a light coat of Permatex to cover assembly, 1, and install it on the gearbox.



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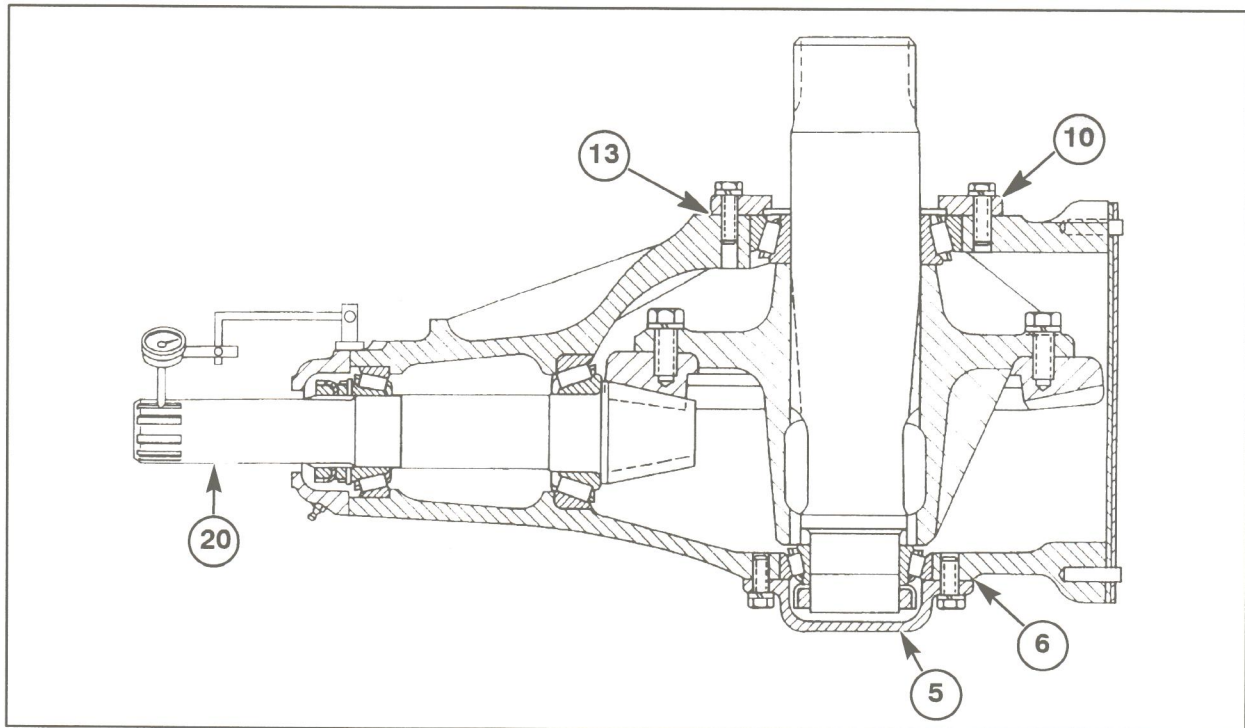
Adjust the Crankshaft Bearing Preload, Initial Adjustment

21. At this stage of assembly, the crankshaft should have no end play, and the crankshaft bearing should be moderately preloaded. If any end play is present, remove an equal thickness of shims, 6 and 13, from under the bearing retainer on each side of the gearbox. Remove shims until all the end play is eliminated from the crankshaft and the crankshaft bearings are moderately preloaded. If the crankshaft bearings bind when the bearing retainers are tightened, add an equal thickness of shims at 6 and 13, until the bearings are moderately preloaded.



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NOTE: This is a preliminary adjustment to allow the backlash to be adjusted. The preload must be rechecked and adjusted if required after the backlash is adjusted.



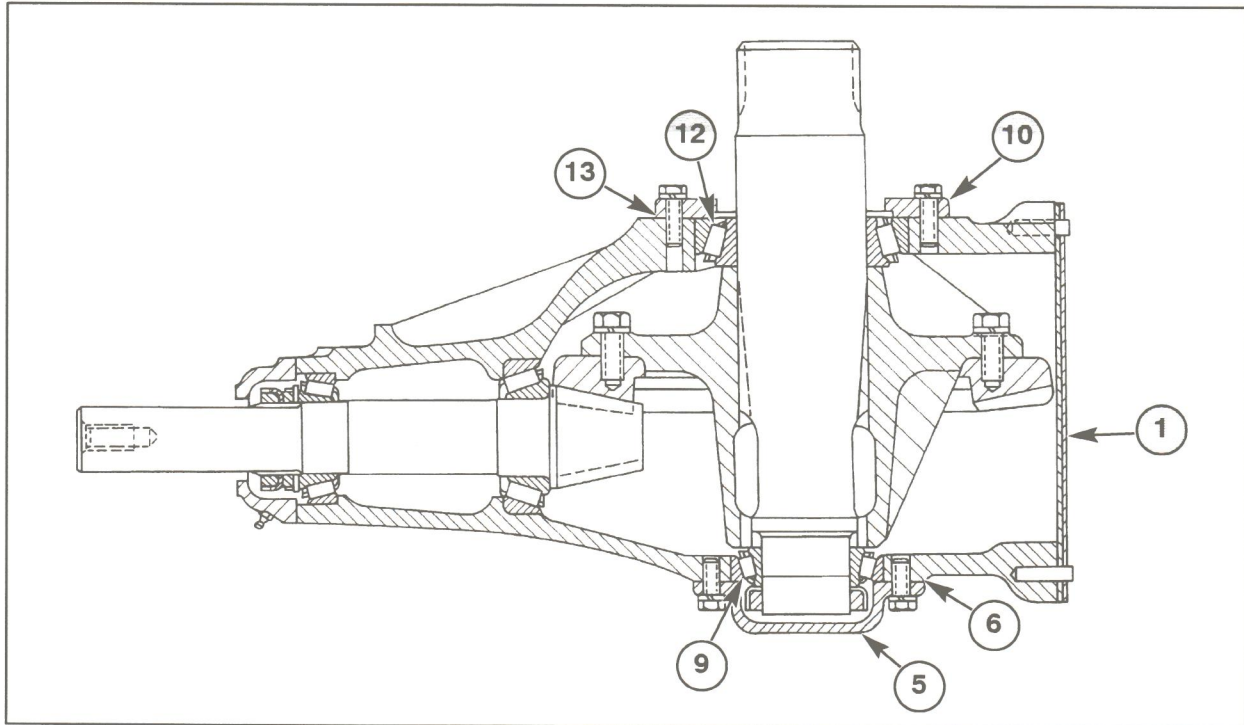
43

Adjust the Backlash

22. With the crankshaft bearings moderately preloaded, check the backlash between the ring gear and pinion in the following manner:
- Mount a dial indicator on the gearbox so the plunger of the indicator contacts the edge of one of the splines on the pinion shaft, 20.
 - Rotate the pinion shaft and check the backlash every third turn to obtain at least eight consecutive backlash readings. The backlash reading in each case should be no more than 0.3 mm (0.012") and no less than 0.1 mm (0.005"). A backlash reading of 0.17 - 0.22 mm (0.007 - 0.009") is considered ideal.

- Adjust to obtain the proper backlash by increasing the thickness of shims, 6 and 13, under one bearing cap and decreasing the thickness of shims under the opposite bearing cap. When making this adjustment, remove shims from one side and add to the other side. The moderate preload already set for the bearings should not change.

Removing the shims at 6 from bearing cap, 5, and adding an equal thickness of shims at 13 under the right bearing cap, 10, increases the backlash between the ring gear and the pinion. Removing the shims from the right side at 13, and adding an equal number of shims on the left side at 6, will decrease the backlash. Manipulate the shims until the proper backlash is obtained.



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Adjust the Crankshaft Bearing Preload, Final adjustment

23. If a torque wrench is available, take a reading from the pinion shaft as was originally done to adjust the pinion bearing preload. However, at this time the reading should be higher to include the preload on both the pinion shaft bearings and the crankshaft bearings. This total bearing preload should be from 3.3 - 3.9 N·m (30 - 35 in. lbs).

If a torque wrench is not available, check the crankshaft bearing preload by suspending a 18 kg (40 lbs) weight by a cord wrapped around the pinion shaft. If the bearings of both the pinion shaft and crankshaft are properly preloaded, this weight will rotate the shaft slowly and uniformly.

IMPORTANT: The rear cover, 1, must always be in place before adjusting the bearing preload.

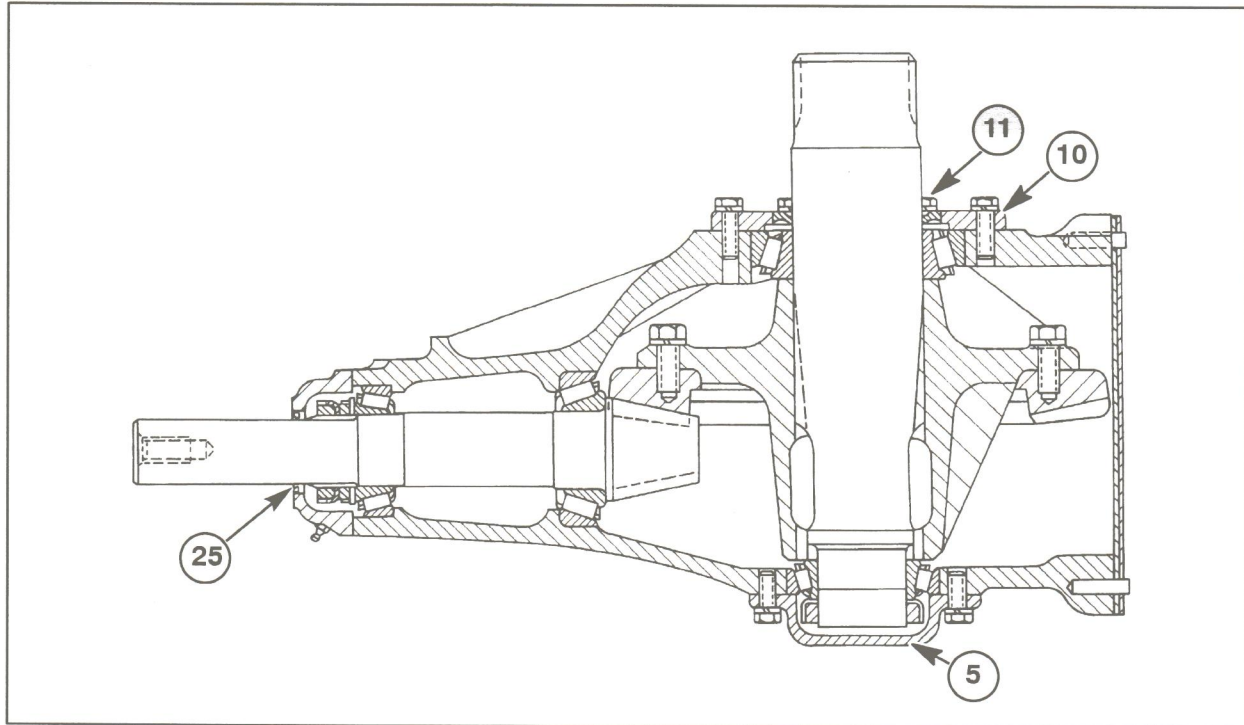
If the crankshaft bearings do not have sufficient preload, remove an equal thickness of shims at

6 and 13 from under both right and left bearing caps, 5 and 10. Remove shims until the correct preload is obtained.

If the bearing preload is too great, add an equal thickness of shims under the bearing caps on each side. This will decrease the preload on the bearings.

24. After the proper preload has been obtained, check the backlash again to be certain it is still correct (occasionally, the backlash may be affected when the bearing preload is being adjusted).

NOTE: If all the shims have been removed from under either bearing cap and the correct backlash or bearing preload cannot be obtained, remove a crankshaft bearing, 9 or 12. Install approximately 0.010" thickness of shim stock between the bearing and the ring gear hub. This will allow additional shims to be placed under the bearing cap and provide a means for further backlash and preload adjustment.



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Seal the Retainers

25. After the backlash and bearing preload are adjusted correctly, the bearing retainers, 5 and 10, should be removed and the mounting surface coated lightly with #2 Permatex. Coat the threads of the retainer cap screws with #2 Permatex when reinstalling the retainers.

Tighten M10 cap screws for the retainers to 55 - 60 N·m (41 - 44 ft lbs).

Tighten 3/8" cap screws for the retainers to 42 - 45 N·m (31 - 33 ft lbs).

Install the Shaft Seals

26. Inspect oil seals, 11 and 25, to be sure they are in good condition. If a seal is questionable, replace it.

Install the seals in the retainers with the lips facing toward the gearbox.