



Service Manual

Spicer® Convertible Tandem Axles

AXSM0510

October 2011

| | |
|----------|----------|
| Forward | Rear |
| S21-170 | S21-060B |
| S23-190 | S23-070B |
| S23-170D | S23-090B |
| S23-190D | |

General Information

The description and specifications contained in this service publication are current at the time of printing.

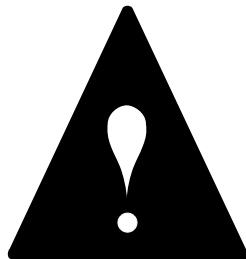
Dana reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents, if available, may be used.

Important Notice

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.

Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.



WARNING: Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.

CAUTION: Failure to follow indicated procedures may cause component damage or malfunction.

IMPORTANT: Highly recommended procedures for proper service of this unit.

Note: Additional service information not covered in the service procedures.

Tip: Helpful removal and installation procedures to aid in the service of this unit.

Always use genuine Spicer replacement parts.

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Introduction

Dana Commercial Vehicle Systems Division, presents this publication to aid in maintenance and overhaul of Spicer tandem drive axles.

Instructions contained cover the models listed. Their design is common, with differences in load capacity. Capacity variations are achieved by combining basic differential carrier assemblies with different axle housings, axle shafts and wheel equipment.

Model Information

The following models are included in this publication:

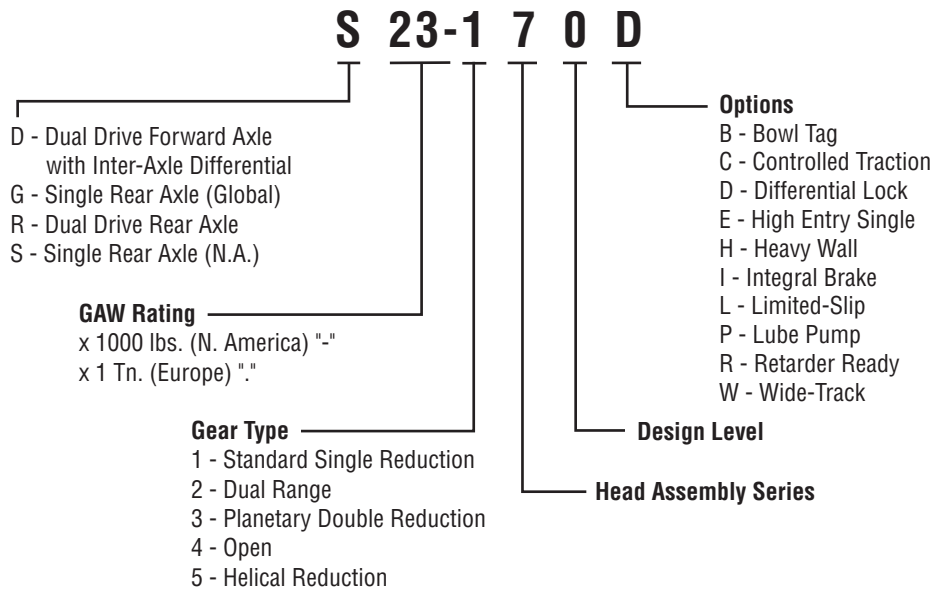
Heavy Singles

| | |
|----------|----------|
| S21-170 | S26-190 |
| S21-170D | S26-190D |
| S23-170 | S30-590 |
| S23-170D | S30-190 |
| S23-190 | S30-190D |
| S23-190D | S35-590 |
| S25-170 | |
| S26-170 | |

Bowl Tag Axles

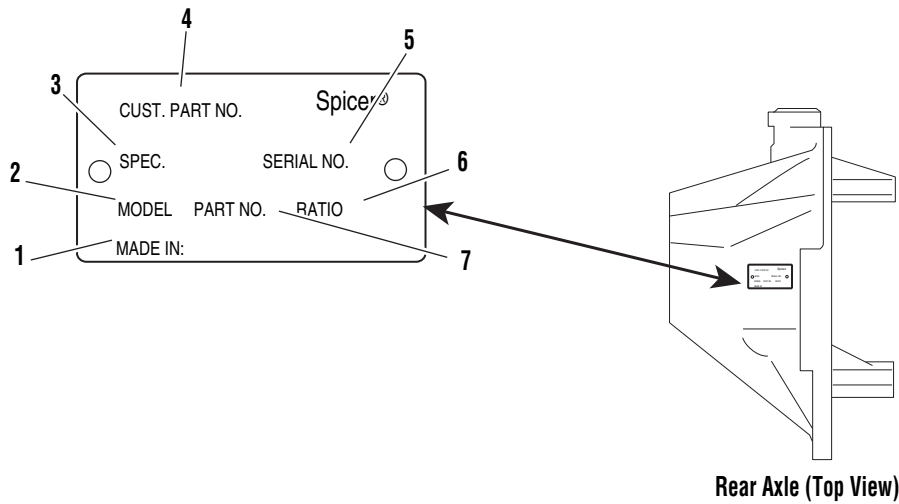
| Forward | Rear |
|----------|----------|
| S21-170 | S21-160B |
| S23-170 | S23-070B |
| S23-170D | S23-070B |
| S23-190D | S23-090B |

Model Listing



Model Identification

Drive Axle

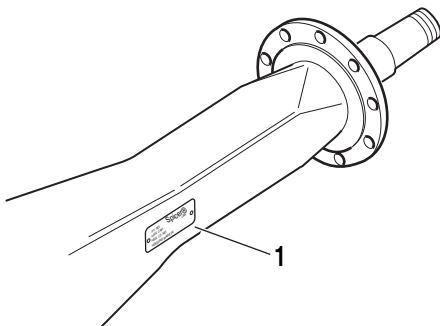


- 1 - Country or origin
- 2 - Axle model identification
- 3 - Specification number assigned to the axle built by Spicer. Identifies all component parts of the axle including special OEM requirements such as yokes or flanges.

- 4 - OEM part number assigned to the axle build
- 5 - Carrier assembly serial number assigned by the manufacturing plant
- 6 - Axle gear ratio
- 7 - Carrier assembly production or service part number

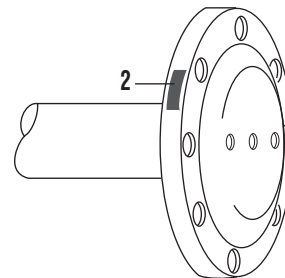
Parts Identification

Axle Housing



1 - ID Tag

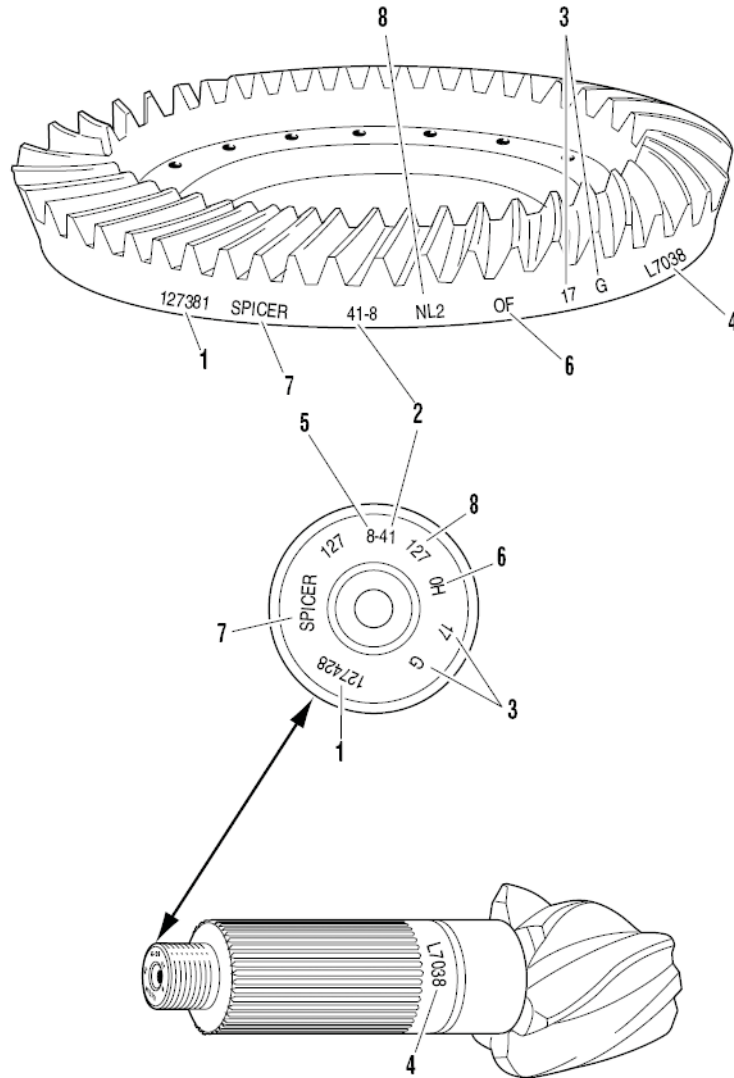
Axle Shaft



2 - Axle shaft part number

Ring Gear and Pinion

Note: Ring gear and drive pinion are matched parts and must be replaced in sets.



- 1 - Part number
- 2 - Number of ring gear teeth
- 3 - Manufacturing numbers
- 4 - Matching gear set number
- 5 - Number of pinion teeth
- 6 - Date code
- 7 - Indicates genuine Spicer parts
- 8 - Heat code

Inspection

Failure Analysis

Failure analysis is the process of determining the original cause of a component failure in order to keep it from Inspection

happening again. Too often, when a failed component is replaced without determining its cause, there will be a recurring failure. If a carrier housing is opened, revealing a ring gear with a broken tooth, it is not enough to settle on the broken tooth as the cause of the carrier failure. Other parts of the carrier must be examined. For a thorough understanding of the failure and possible insight into related problems, the technician needs to observe the overall condition of the vehicle.

No one benefits when a failed component goes on the junk pile with the cause unknown. Nothing is more disturbing to a customer than a repeat failure. Systematically analyzing a failure to prevent a repeat occurrence assures quality service by avoiding unnecessary downtime and further expense to the customer.

The true cause of a failure can be better determined by knowing what to look for, determining how a piece of the equipment was running, and learning about previous problems. In the case of a rebuilt rear axle, mismatched gears may have been installed.

The more successful shops prevent repeat equipment failures by developing good failure analysis practices. Knowing how to diagnose the cause of a premature failure is one of the prerequisites of a good heavy-equipment technician.

How to Diagnose a Failure

The following five steps are an effective approach to good failure diagnostics.

1. Document the problem.
2. Make a preliminary investigation.
3. Prepare the parts for inspection.
4. Find the cause of the failure.
5. Correct the cause of the problem.

Document the Problem

Here are some guidelines for starting to learn about a failure.

- Talk to the operator of the truck.
- Look at the service records.
- Find out when the truck was last serviced.

Ask the following questions:

- In what type of service is the truck being used?
- Has this particular failure occurred before?
- How was the truck working prior to the failure?

You need to be a good listener. Sometimes insignificant or unrelated symptoms can point to the cause of the failure.

Ask the following questions:

- Was the vehicle operating at normal temperatures?
- Were the gauges showing normal ranges of operation?
- Was there any unusual noise or vibration?

After listening, review the previous repair and maintenance records. If there is more than one driver, talk to all of them and compare their observations for consistency with the service and maintenance records. Verify the chassis Vehicle Identification Number (VIN) number from the vehicle identification plate, as well as the mileage and hours on the vehicle.

Make a Preliminary Investigation

These steps consist of external inspections and observations that will be valuable when combined with the results of the parts examination.

- Look for leaks, cracks or other damage that can point to the cause of the failure.
- Make note of obvious leaks around plugs and seals. A missing fill or drain plug would be an obvious cause for concern.
- Look for cracks in the carrier housing (harder to see, but sometimes visible).
- Does the general mechanical condition of the vehicle indicate proper maintenance or are there signs of neglect?
- Are the tires in good condition and do the sizes match?
- If equipped with a torque-limiting device, is it working properly?

During the preliminary investigation, write down anything out of the ordinary for later reference. Items that appear insignificant now may take on more importance when the subassemblies are torn down.

Prepare the Parts for Inspection

After the preliminary investigation, locate the failure and prepare the part for examination. In carrier failure analysis, it may be necessary to disassemble the unit.

- When disassembling subassemblies and parts, do not clean the parts immediately since cleaning may destroy some of the evidence.
- When tearing down the drive axle, do it in the recommended manner. Minimize any further damage to the unit.
- Ask more questions when examining the interior of the carrier. Does the lubricant meet the manufacturer specifications regarding quality, quantity and viscosity? As soon as you have located the failed part, take time to analyze the data.

Find the Cause of the Failure

Here begins the real challenge to determine the exact cause of the failure. Keep in mind that there is no benefit to replacing a failed part without determining the cause of the failure. For example, after examining a failed part and finding that the failure is caused by a lack of lubrication, you must determine if there was an external leak. Obviously, if there is an external leak, just replacing the failed gear is not going to correct the situation.

Another important consideration is to determine the specific type of failure which can be a valuable indicator for the cause of failure. The following pages show different types of failures and possible causes. Use this as a guide in determining types of failures and to correct problems.

Correct the Cause of the Problem

Once the cause of the problem has been determined, refer to the appropriate service manual to perform the repairs.

Inspection

Clean

1. Wash steel parts with ground or polished surfaces in solvent. There are many suitable commercial solvents available. Kerosene and diesel fuel are acceptable.

⚠ WARNING

Gasoline is not an acceptable solvent because of its extreme combustibility. It is unsafe in the workshop environment.

2. Wash castings or other rough parts in solvent or clean in hot solution tanks using mild alkali solutions.

Note: If a hot solution tank is used, make sure parts are heated thoroughly before rinsing.

3. Rinse thoroughly to remove all traces of the cleaning solution.
4. Dry parts immediately with clean rags.
5. Oil parts.
 - If parts are to be reused immediately: Lightly oil.
 - If parts are to be stored: Coat with oil, wrap in corrosion resistant paper and store in a clean, dry place.

Inspect Axle Housing

Axle housing inspection and repairs are limited to the following checks or repairs.

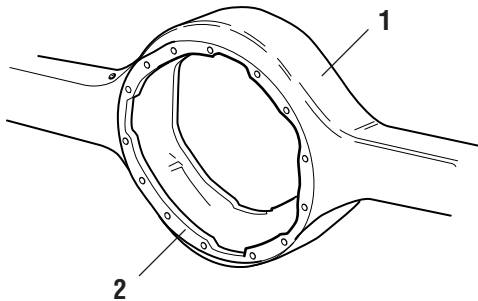
- Visually inspect axle housing for cracks, nicks, and burrs on machined surfaces.
- Check carrier bolt holes and studs for foreign material.
- Replace damaged fasteners. Look for loose studs or cross threaded holes.

CAUTION

Any damage which affects the alignment or structural integrity of the housing requires housing replacement. Do not repair by bending or straightening. This process can affect the material's properties and cause it to fail completely under load.

- Check all seals and gaskets.

Note: Replace conventional gaskets with silicone rubber gasket compound (included in many repair kits). The compound provides a more effective seal against lube seepage and is easier to remove from mating surfaces when replacing parts.



1 - Axle housing
2 - Machined surface

Inspect Components

Inspect all steel parts for:

- Notches, visible steps or grooves created by wear
- Pitting or cracking along gear contact lines
- Scuffing, deformation, or discolorations. These are signs of excessive heat in the axle and are usually related to low lubrication levels or improper lubrication practices.

In addition, inspect the following for damage:

- Differential gearing.

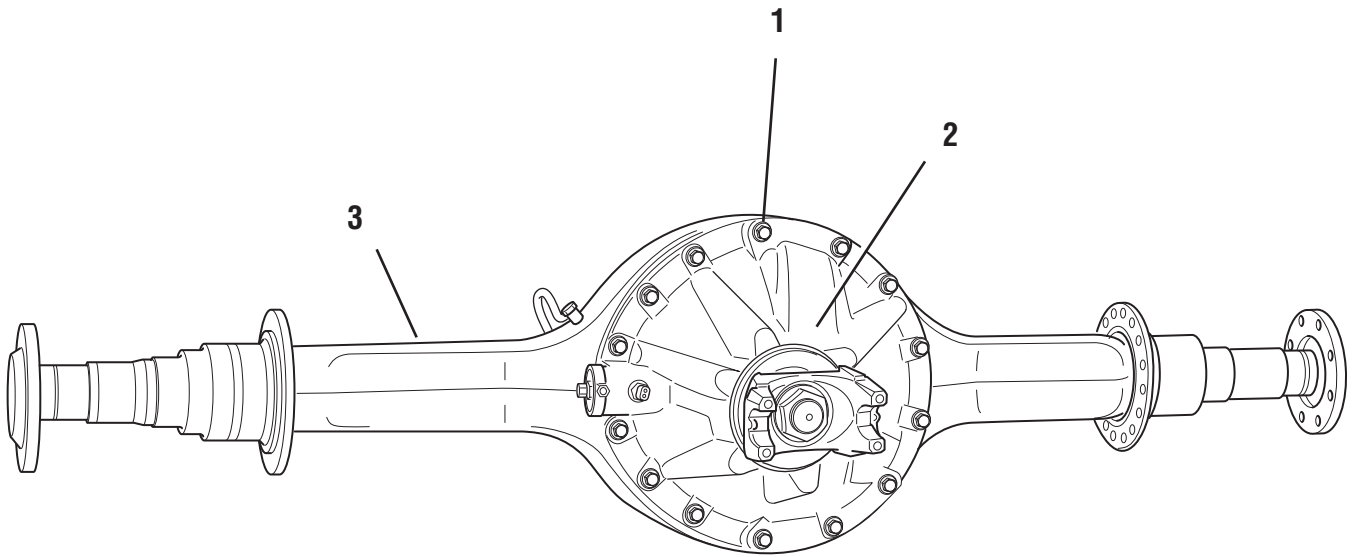
- Bearings for loose fit on drive pinion, pilot bearing, and differential bearings.
- All fasteners for rounded heads, bends, cracks, or damaged threads.
- Inspect machined surfaces of cast or malleable parts. They must be free of nicks, burrs, cracks, scoring, and wear.
- Look for elongation of drilled holes, wear on surfaces machined for bearing fits and nicks or burrs in mating surfaces.

Inspect Primary Gearing

Before reusing a primary gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment.

Differential Carrier Assembly

Exploded Parts View



- 1 - Carrier fasteners
- 2 - Carrier assembly
- 3 - Single axle assembly

Remove Differential Carrier

Note: The removal of the forward carrier does not require disconnecting of the inter-axle driveline and removal of the output shaft yoke assembly as most other Spicer tandems require.

Standard Differentials

1. Block the vehicle.
2. Drain axle lubricant.
3. Disconnect driveline.
4. Disconnect lead wires to the selector switch and air line at shift cylinder.
5. Remove axle shafts.

WARNING:

WARNING

Do not lie under carrier after fasteners are removed. Use transmission jack to support differential carrier assembly prior to loosening fasteners.

6. To remove axle shaft, remove axle stud nuts. (If used, remove lock washers and taper dowels.)
7. Remove axle shafts.

Note: All models in this publication use axle shafts with unequal lengths. Axle shafts may also be location specific with various wheel equipment. Do not misplace axle shafts from their intended location. Identify left and right shafts for reference during reassembly.

TIP: If necessary, loosen dowels by holding a brass drift in the center of the shaft head and striking drift with a sharp blow with a hammer.

CAUTION:

CAUTION

Do not strike the shaft head with a steel hammer. Do not use chisels or wedges to loosen shaft or dowels.

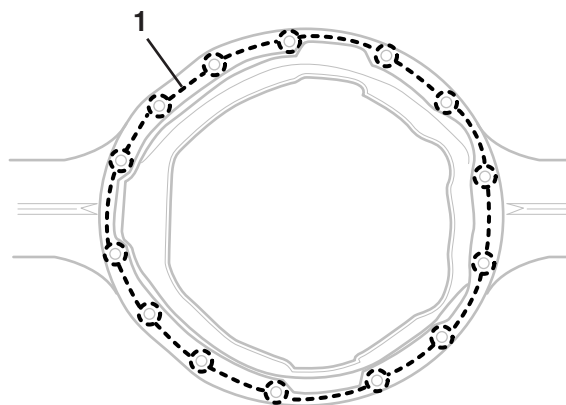
8. Remove carrier cap screws, nuts, and lock washers.
9. Remove differential carrier assembly.

Install Differential Carrier

IMPORTANT

Before installing carrier assembly, inspect and thoroughly clean interior of axle housing using an appropriate solvent and clean rag.

1. Apply Spicer approved RTV compound on axle housing mating surface as shown in the illustration. Completely remove all old gasket material prior to applying new material. Compound will set in 5 minutes. Install carrier before compound sets or reapply.



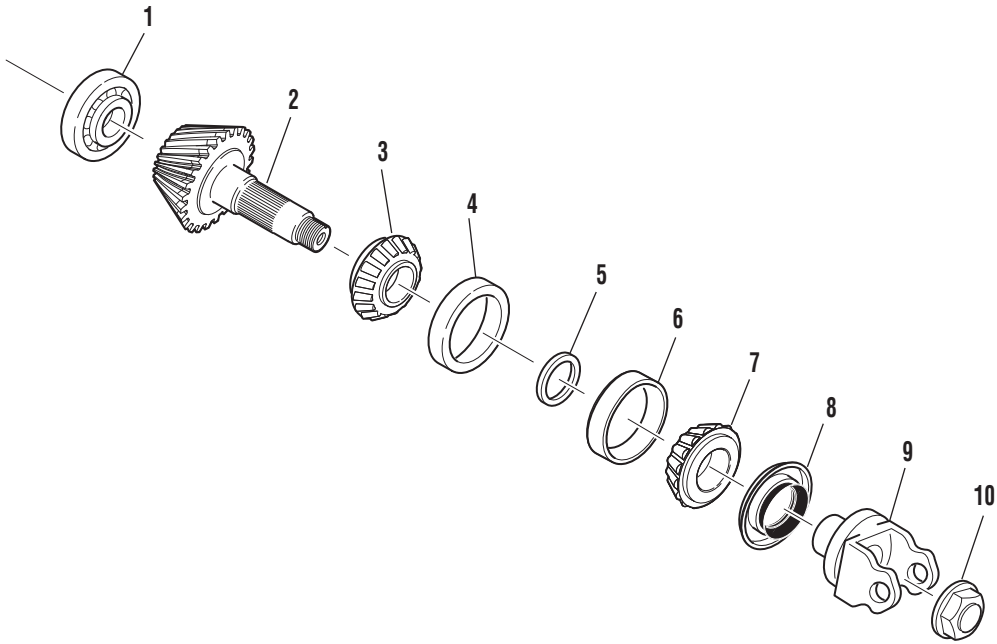
1 - Apply silicone gasket in this pattern

TIP: To assist in installing complete differential carrier use two pieces of threaded rod (M16 X 1.5) threaded into carrier cap screw holes. Rod should be approximately 6" long. Use these to pilot the carrier into the housing.

2. Install carrier to housing, lock washers, cap screws and nuts. Torque to proper specification. Torque to 250–290 lb-ft. (339–393 N•m).
3. Install axle shafts and axle stud nuts. (If used, also install lock washers and tapered dowels.)
4. Add axle lubricant. Fill to bottom of filler hole.
5. Connect driveline, making sure all yokes are in phase. Lubricate u-joints.

Drive Pinion Assembly

Parts Exploded View



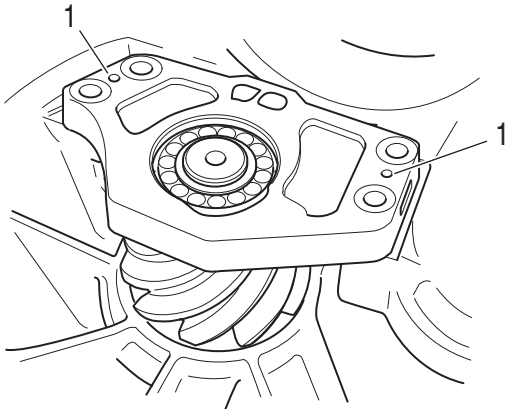
- 1 - Pinion pilot bearing
- 2 - Pinion
- 3 - Pinion bearing cone - inner
- 4 - Pinion bearing cup - inner

- 5 - Pinion bearing spacer
- 6 - Pinion bearing cup - outer
- 7 - Pinion bearing cone - outer
- 8 - Oil seal

- 9 - Yoke
- 10 - Pinion nut

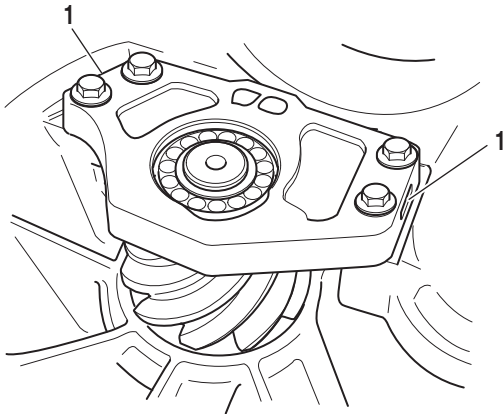
Pinion Removal

1. If a pilot web is used, remove the web cap screws.
 - a. For S190 disassembly, install a M10 x 1.50 bolt in the threaded jack holes found in-between the pilot web cap screws.



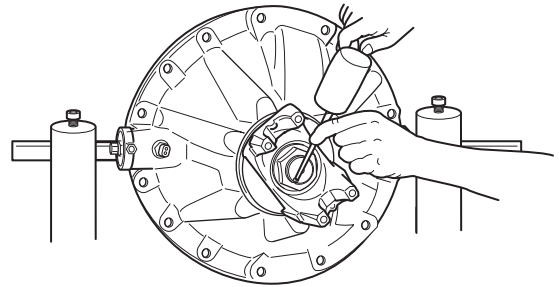
1 - Threaded Jack Holes

- b. For S190 disassembly, use the pry slots provided at each end of the pilot web.



1 - Slots

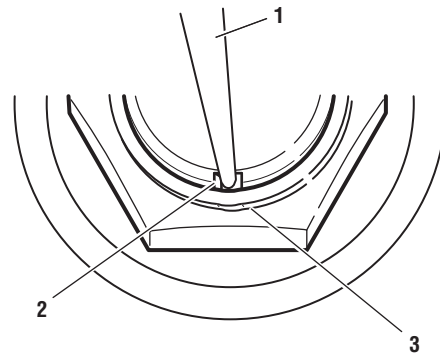
2. Before the pinion nut can be loosened, you must de-stake the nut from the slot of the pinion.



3. To de-stake the nut, use a chisel or drift with a round tip. The flange of the nut must be pushed far enough outward so that the staked area will not interfere with the pinion threads when the nut is removed. See diagram below.

CAUTION

Failure to de-stake the pinion nut will result in damage to the drive pinion threads when removed. The pinion nut should never be reused, always replace with new.



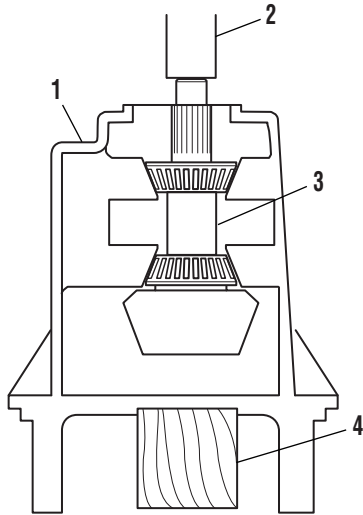
1 - Round Tipped Chisel
2 - Machined Slot In Pinion
3 - Nuts Staking Flange

4. Remove the pinion nut.

5. Place carrier assembly into a press, place a 2" x 6" x 6" wood block under the pinion. This will ensure that when the pinion is pressed free from the bearings the pinion will not be damaged.

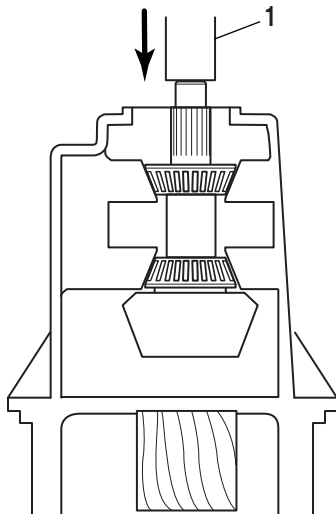
▲ IMPORTANT

The bearing spacer will be reused or used as a starting point when resetting the pinion bearing preload. Do not discard this part.



- 1 - Carrier Assembly
- 2 - Press
- 3 - Pinion
- 4 - Wood Block

6. Use the proper pressing tool to press the end of the pinion until free from the pinion bearings.



- 1 - Press

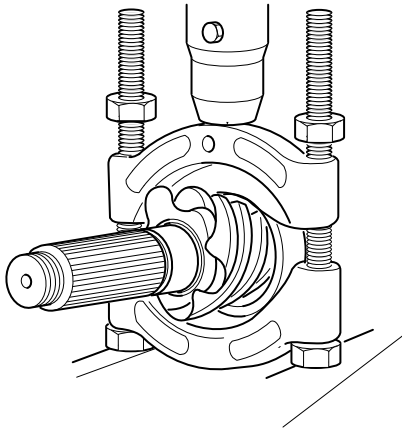
Drive Pinion Overhaul and Assembly

The preload of the bearings on the drive pinion is adjusted by a spacer between the inner and outer bearing cones and the helical gear. The preload is adjusted by changing the thickness of the spacer. A thicker spacer will decrease the preload, a thinner spacer will increase the bearing preload.

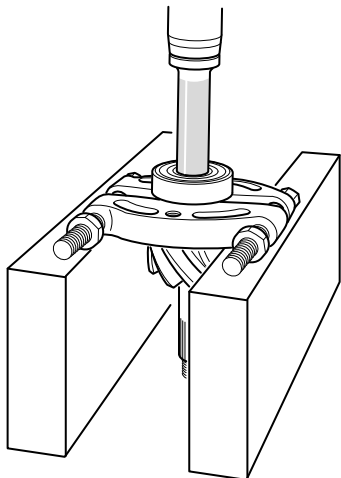
The following procedure covers both the forward and rear axle carrier overhaul and assembly.

Note: See carrier disassembly for instructions on pinion and yoke removal.

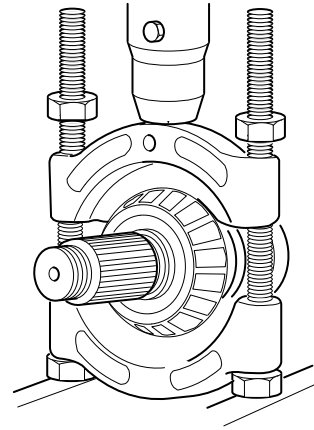
1. If the model of axle uses a pilot bearing, remove the bearing using a split-type puller. Use two procedure steps to remove each bearing.
 - a. Mount the puller vertically to separate the bearing from the pinion. This action will force the puller halves behind the bearing race and start moving the bearing from the pinion.



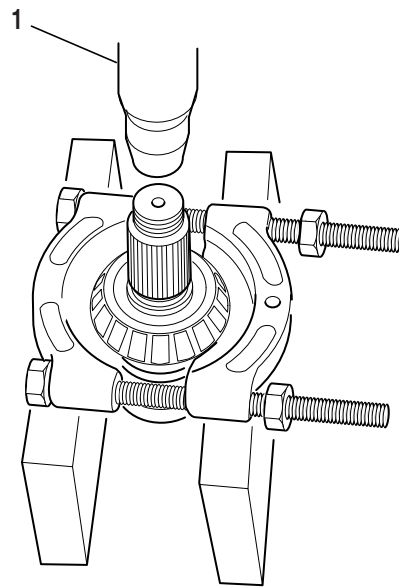
- b. Mount the puller horizontally to press the bearing from the pinion.



2. Remove the inner pinion bearing cone from the pinion using a split-type puller. Use two procedure steps to remove each bearing.
 - a. Mount the puller vertically to separate the bearing from the pinion. This action will force the puller halves behind the bearing race and start moving the bearing from the pinion.



- b. Mount the puller horizontally to press the bearing from the pinion.



1 - Press

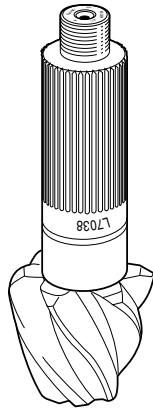
▲ IMPORTANT

Use the correctly sized spacer. Do not use shim stock or

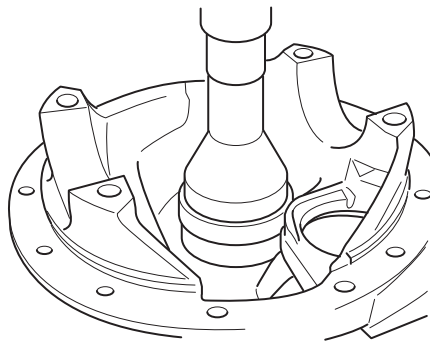
grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

To prevent bearing damage, use suitable sleeve that only contacts the inner race of bearing cone.

3. Use a press sleeve to install the inner bearing cone and pilot bearing, if used, onto the pinion. Apply pressure until the bottom of the cone touches the shoulder of the pinion. Apply lubricant to the cone of the bearing.



4. If removed, install the inner and outer bearing cups into the carrier.
 - a. To install the inner bearing cup, place the carrier in a press with the bottom of the carrier facing up.
 - b. Place the cup in the bore, use a sleeve or bearing driver tool to press the cup until it is fully seated. Use a feeler gage to make sure the cup is fully seated.

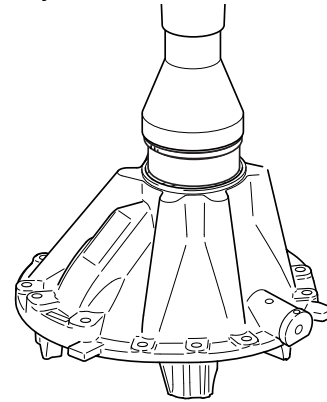


- c. If replacement of the output shaft side gear bearing cup is necessary, use either of the following methods:

Weld: Place a weld bead around the inside of the cup, when the weld cools the cup will fall out.

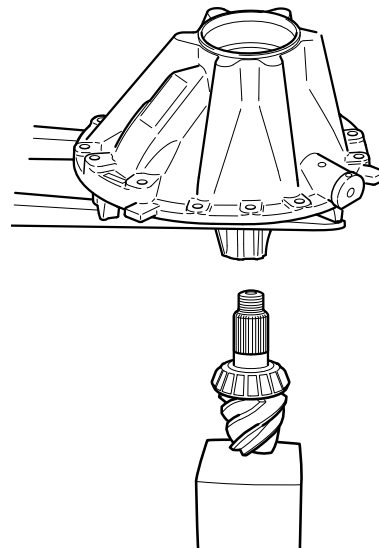
Hammer: Use a rolling head prybar to get under the cup and then, with a hammer and drift from the back side of carrier, tap out bearing cup.

- d. To install the outer bearing cup, place the carrier in a press with the top of the carrier facing up.
- e. Place the cup in the bore, use a sleeve or bearing driver tool to press the cup until it is fully seated. Use a feeler gage to make sure the cup is fully seated.



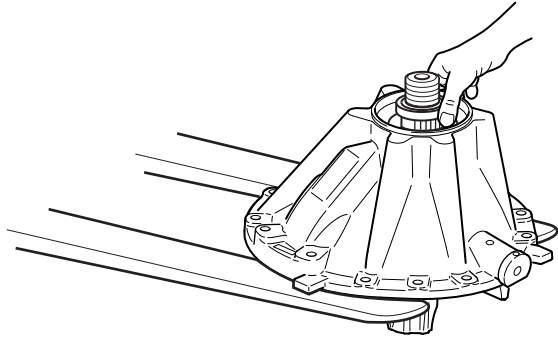
Note: If a press is not available, use a sleeve or bearing driver and a hammer to install the cups.

5. Place the pinion on a 6" x 6" x 6" block of wood and lower the carrier over the pinion.

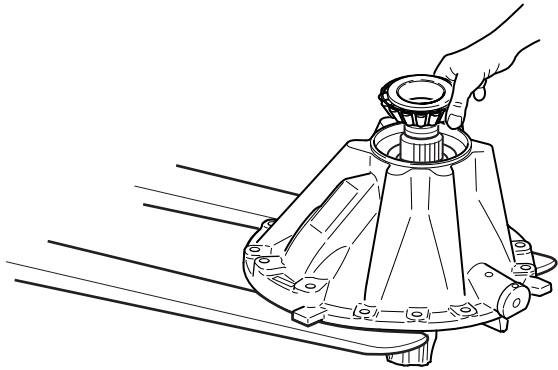


6. Install the pinion spacer.

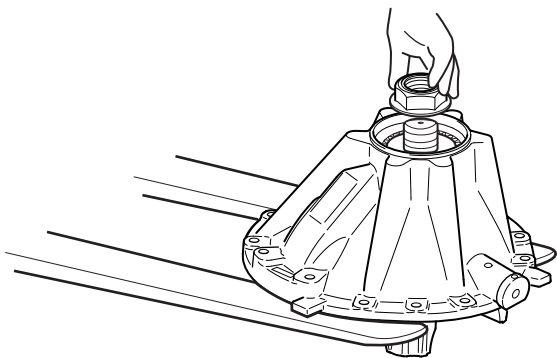
Note: If you are using the same drive pinion, use the same spacer that was originally installed in the assembly. If the drive pinion is to be replaced, the original spacer will be used as the starting point of adjustment.



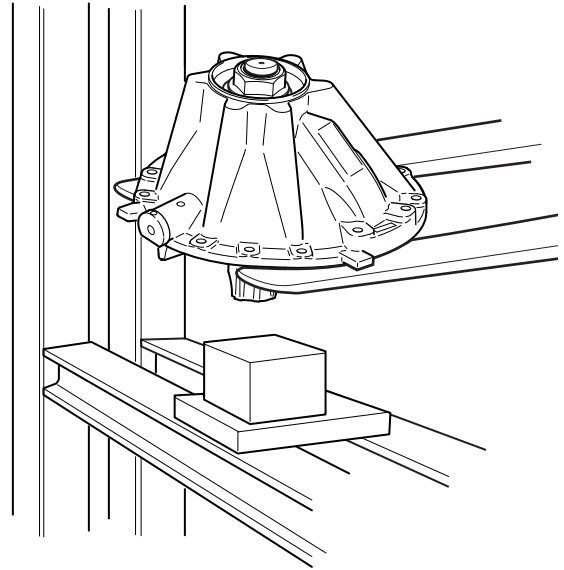
7. Install the outer bearing cone.



8. Install a pinion nut finger tight. This will hold the pinion in place while it is positioned into the press.

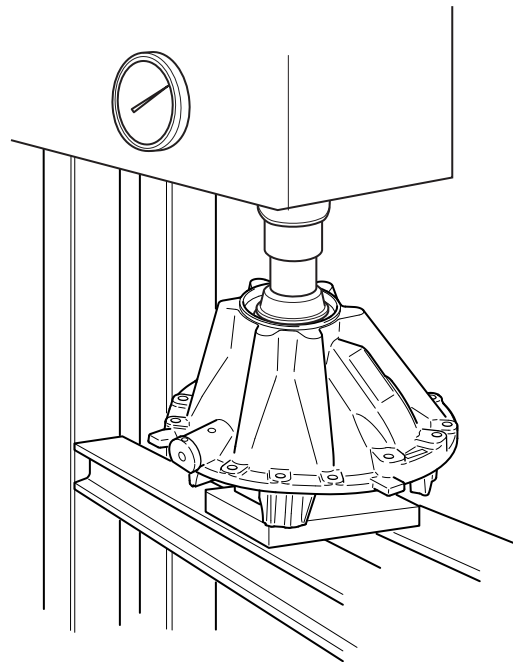


9. Align a 6" x 6" x 6" wood block under the drive pinion, then lower the carrier and pinion assembly into a press so that it is supported by the block.

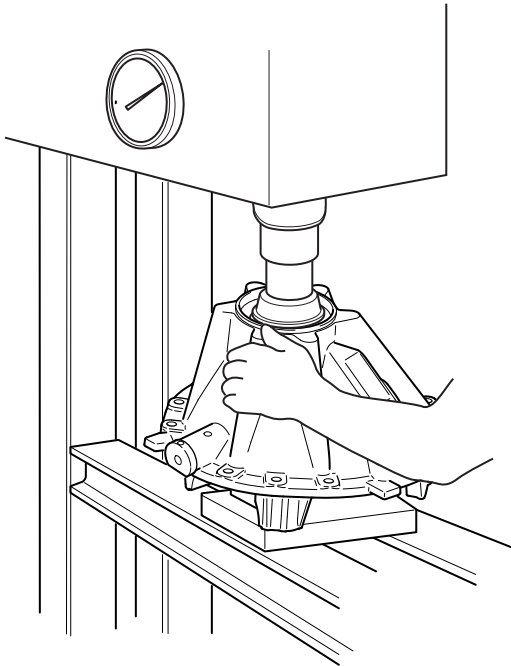


10. Remove the pinion nut.

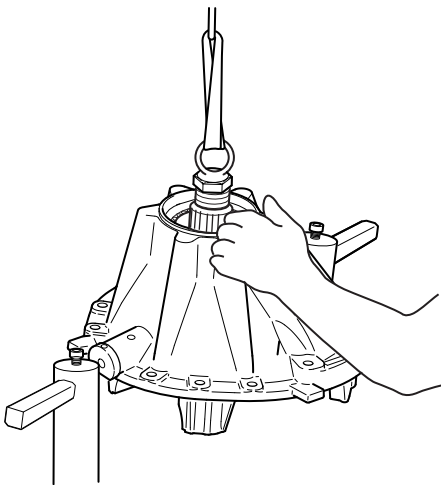
11. Place a press sleeve over the top of the outer bearing cone. Use the press to apply 5 tons of force. It is important to rotate the carrier slightly to make sure that the rollers of the bearing are properly seated.



- With 15 tons of force on the press, you should be able to feel a small amount of drag from the bearing as you rotate the carrier. If the carrier turns with no drag at all, the pinion spacer thickness should be decreased by using a thinner spacer. If the carrier is hard to turn, the spacer thickness must be increased.

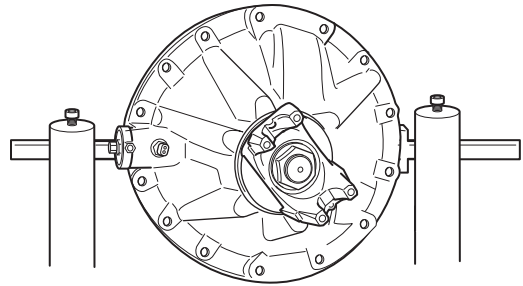


- Remove the carrier from the press. Secure the carrier in a head stand.

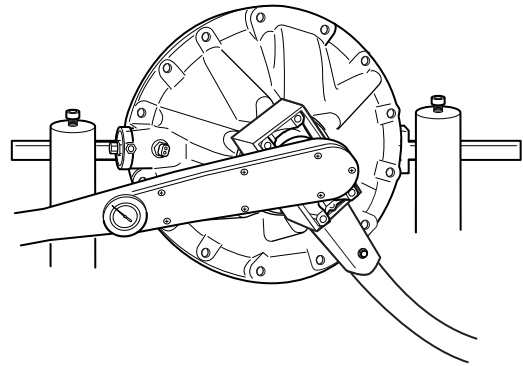


Note: Do Not Install the Pinion Seal at this time.

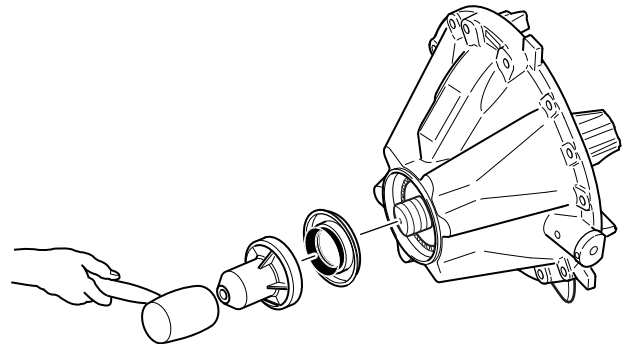
- Install the drive yoke and pinion nut.



- Torque the nut to 800-1000 lb-ft. (1084-1355 N•m).

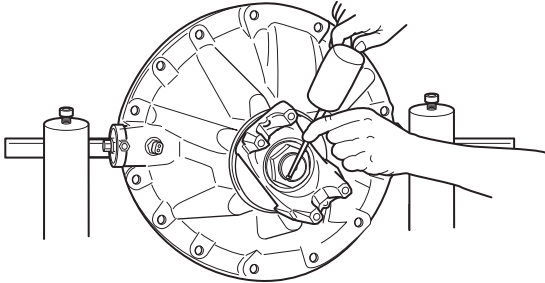


- Use an lb-in torque wrench and correct socket to check the rolling torque of the pinion. Read torque while rotating the assembly. Record the rotating torque, not the breakaway torque. Torque must be between 20 to 50 lb-in. If the torque recorded is not within the specified torque, the pinion spacer must be changed. Repeat Steps 6-17.
- Now remove the pinion nut and yoke and install the pinion seal. Use Spicer's seal drive (part number 210749) and drive adapter (part number 131472).



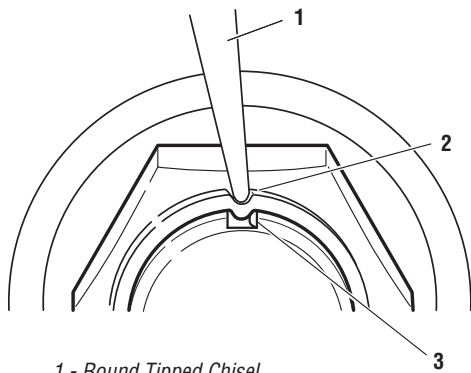
- Reinstall the yoke and pinion nut. Torque to 800-1000 lb-ft.

19. Once the proper rolling torque is achieved, use a punch with a round tip to stake the pinion nuts flange into the machined slot in the pinion shaft. See diagram below.



CAUTION

The stake must be deep enough to enter the machined slot of the pinion. See diagram below.

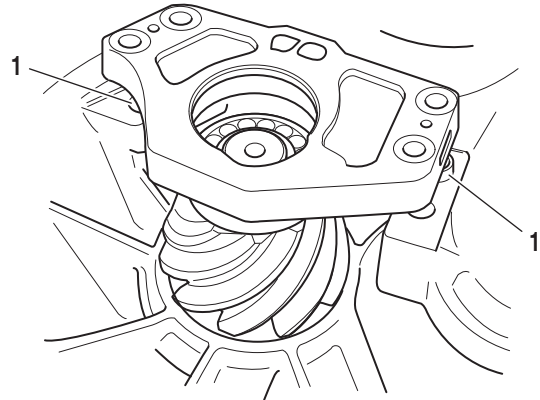


- 1 - Round Tipped Chisel
2 - Nuts Staking Flange
3 - Machined Slot In Pinion

WARNING

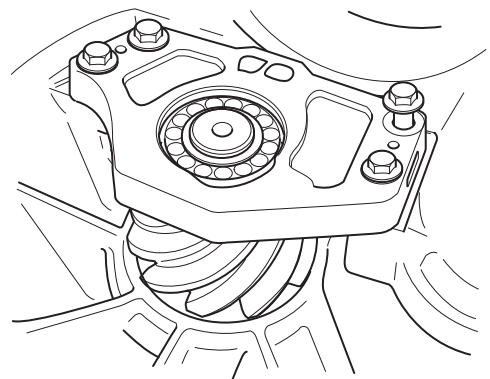
Failure to stake the pinion nut properly may result in the nut coming loose during service. The pinion nut should never be reused, always replace with new.

20. If a pilot bearing web is used, lineup the web to the locating sleeves and tap in place with a rubber mallet.



1 - Locating Sleeves

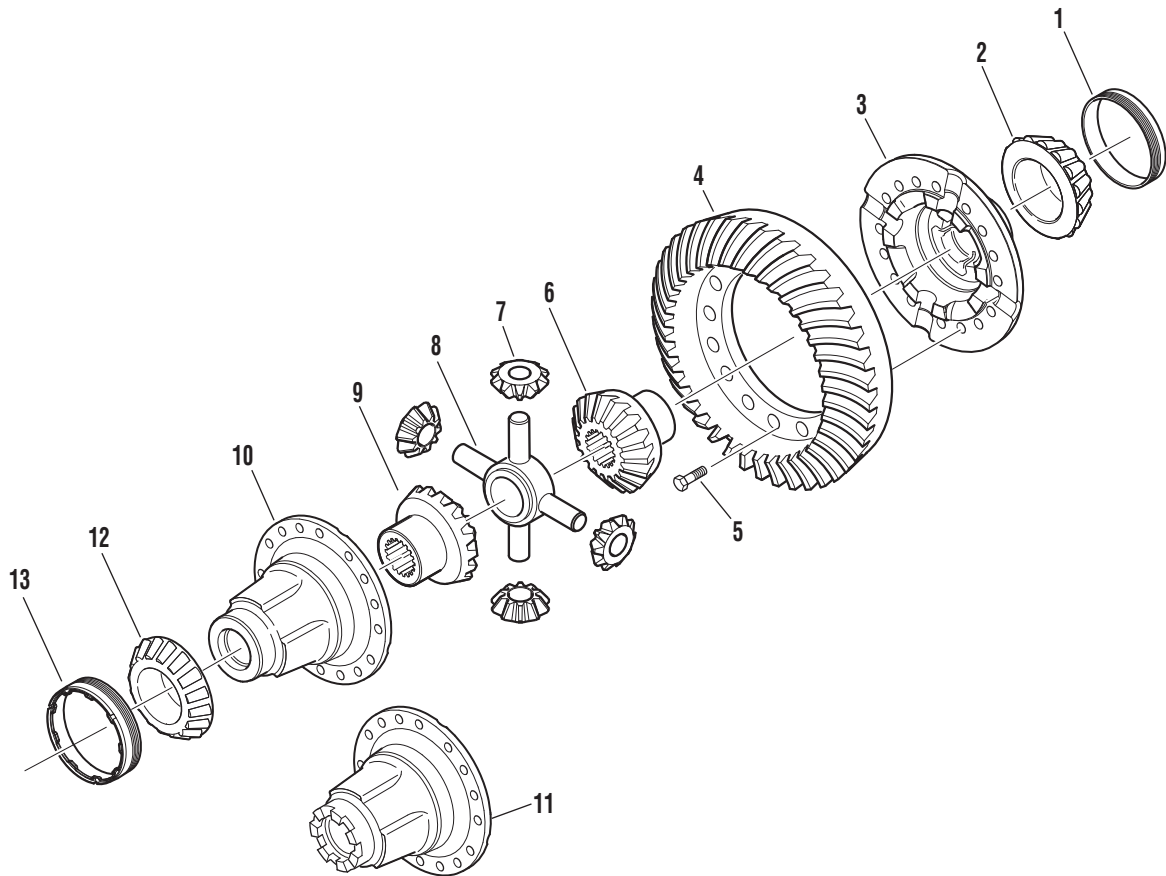
21. Install cap screws and torque to the proper specifications. See the Torque Chart.



TIP: If you are unable to torque the yoke nut correctly, try torquing the nut with the truck wheels on the ground and with the axle shafts installed.

Wheel Differential Assembly

Exploded Parts View



1 - Threaded bearing adj - flange half
2 - Bearing cone - flange half
3 - Bearing cup - flange half
4 - Ring gear and pinion set
5 - Bolt

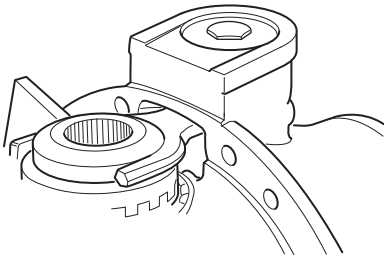
6 - Output side gear
7 - Side pinion thrust washer
8 - Differential spider
9 - Side gear
10 - Differential case - RH (plain half)

11 - Differential case - RH (plain half)
wheel diff lock
12 - Bearing cone - plain half
13 - Threaded bearing adj - plain half

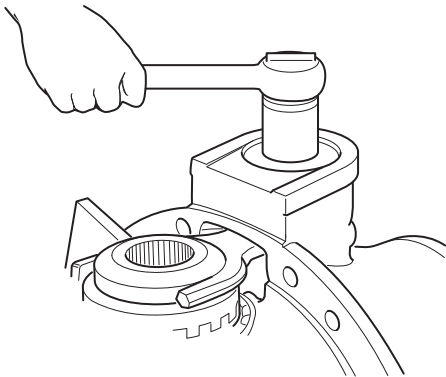
Remove Wheel Differential Carrier Disassembly (All Standard Models)

For models having the wheel differential lock option or a carrier thrust bolt, refer to the following procedure. These parts must be removed first before further disassembly of the wheel differential can take place.

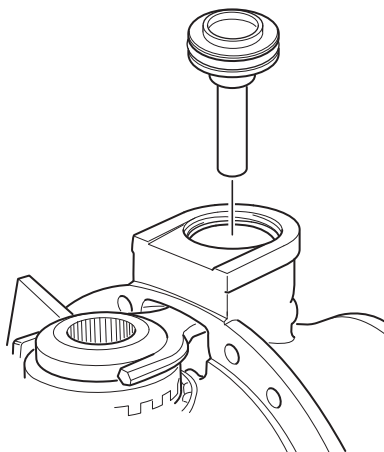
1. For ease of service, mount differential carrier in head stand with differential locked with the differential lock facing up.



2. Remove the threaded cylinder cap.

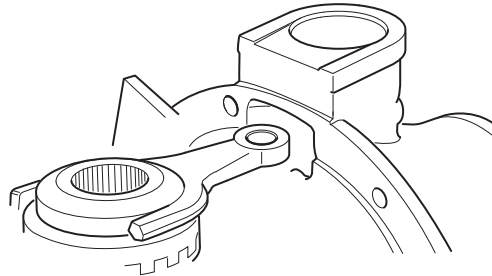


3. Remove the piston push rod from the shift fork.

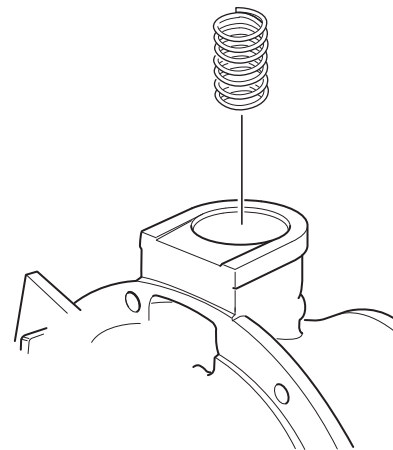


4. Remove the shift fork and sliding clutch assembly.

Note: Do not disassemble the shift fork from the sliding clutch unless parts are to be replaced. To disassemble, use a pin punch to remove spring pin from the fork leg. The sliding clutch can now be removed from the fork.

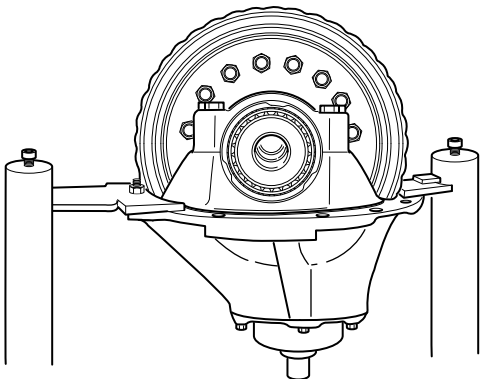


5. Remove the shift fork spring.



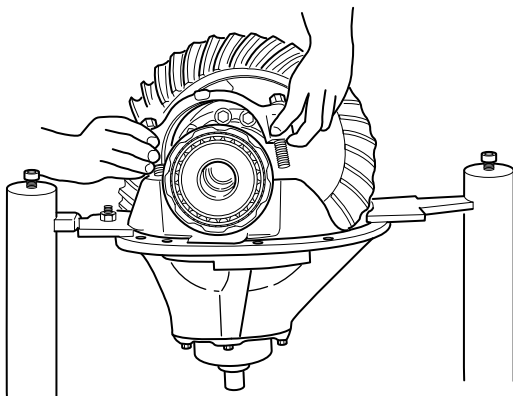
Note: Omit this step if the ring gear is to be replaced. If the ring gear is to be reused, check the tooth contact pattern and ring gear backlash before disassembling the carrier assembly. When checking the backlash, a yoke or helical gear must be installed and torqued to the proper specification to get an accurate reading. Best results are obtained when tooth contact patterns are maintained in used gearing.

6. Mount the differential carrier in a head stand with the wheel differential facing upward.

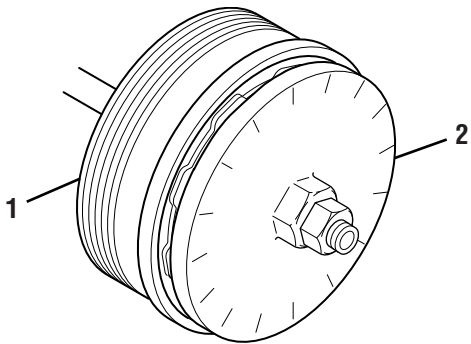


Note: For easier disassembly, loosen but do not remove the pinion nut.

7. Remove the carrier differential bearing cap screws, flat washers and bearing caps.

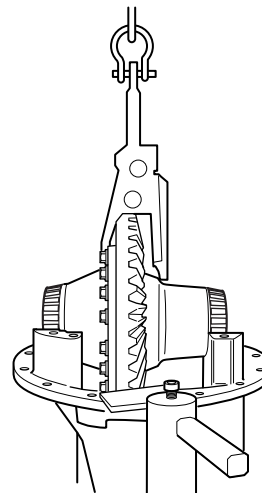


8. Use Spicer's wheel diff. bearing adjustment tool (part number 513061) to back off the threaded cups and remove.



1 - Threaded bearing cup
2 - Adjustment plate

9. Using a chain hoist and the proper strap, lift the ring gear and wheel differential assembly from the carrier.

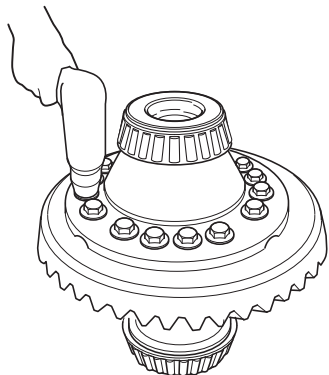


Forward Carrier Disassembly

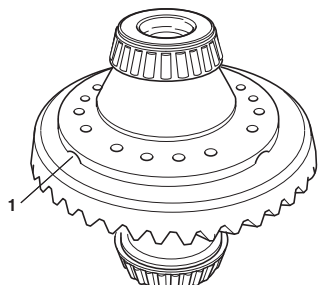
▲ IMPORTANT

During the following procedures, place the differential assembly on a malleable surface to prevent damage when removing components.

1. Remove the differential case cap screws.

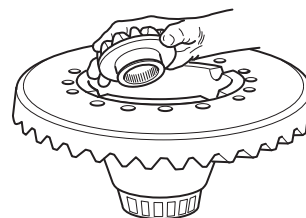
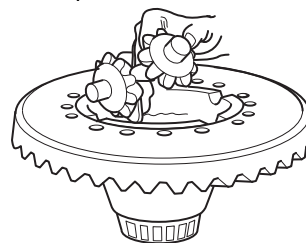


2. Remove the flange half differential case and bearing assembly. Use a screwdriver at the spider arm machined slots of the case to loosen the flange from the ring gear.

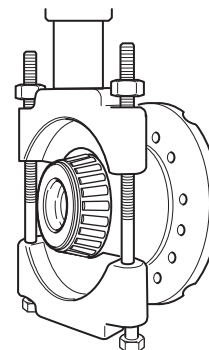


1 - Spider Arm Slots

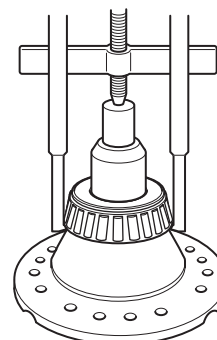
3. Remove the side gears, side pinions and differential spider from the plain half case.



4. Place a block under the plain half, use a rubber mallet to remove the ring gear.
5. Remove the bearing cones from the case halves using suitable pullers.
6. Remove the bearing cones from the plain and flange halves in two steps:
 - a. Mount the puller vertically to split the bearing. This action will start the bearing moving off the differential case.



- b. Mount the puller horizontally to remove the cone.



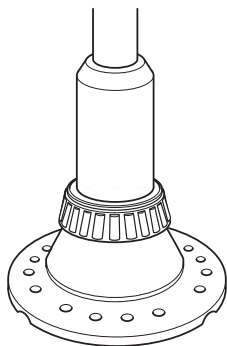
Forward Carrier Assembly

IMPORTANT:

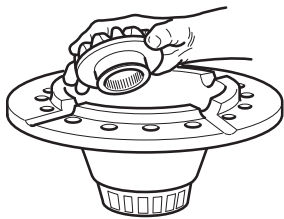


To prevent bearing damage, use suitable sleeve that only contacts the inner race of the cone. A used bearing race would be a suitable tool. This tool should have a slit cut if the ID is the same as the flange OD.

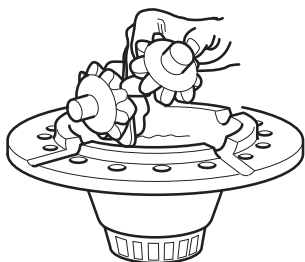
1. Press the new bearing cone on the plain half and flange half bearing boss using the proper press sleeve or bearing installation tool.



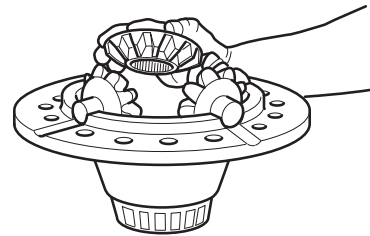
2. Place the plain half side of the differential case on a malleable surface.
3. Install the side gear. Apply a thin coat of oil to the mating surfaces of the side gear and plain half.



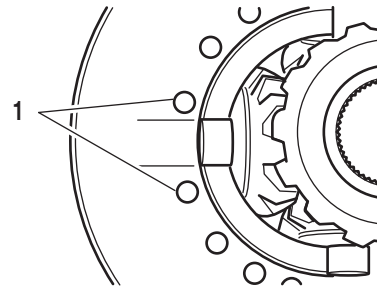
4. Assemble the side pinions onto the wheel differential spider. Apply a thin coat of oil to the mating surfaces of the side pinion and differential spider. Install the wheel differential nest on top of the side gear.



5. Install the flange half side gear. Apply a thin coat of oil to the mating surfaces.

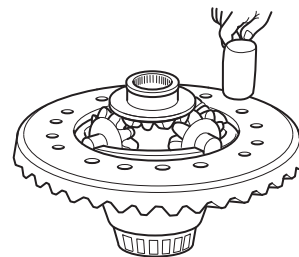


6. Install the ring gear. Align the cap screw holes.

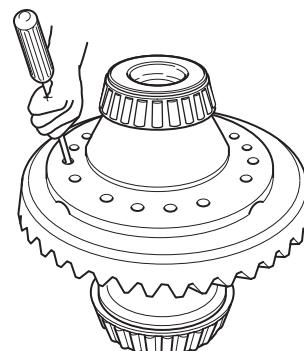


1 - Match spacing of holes on each side of spider slots

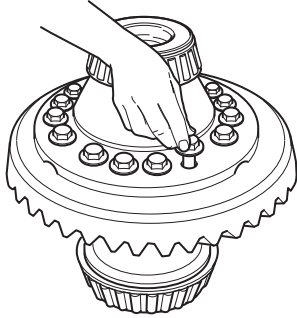
7. Use a rubber mallet to seat the ring gear to the plain half.



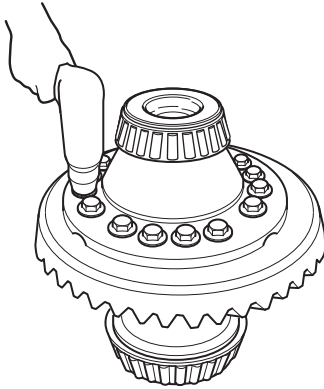
8. Install the flange half of the case. Align the cap screw holes.



9. Install the ring gear cap screws.



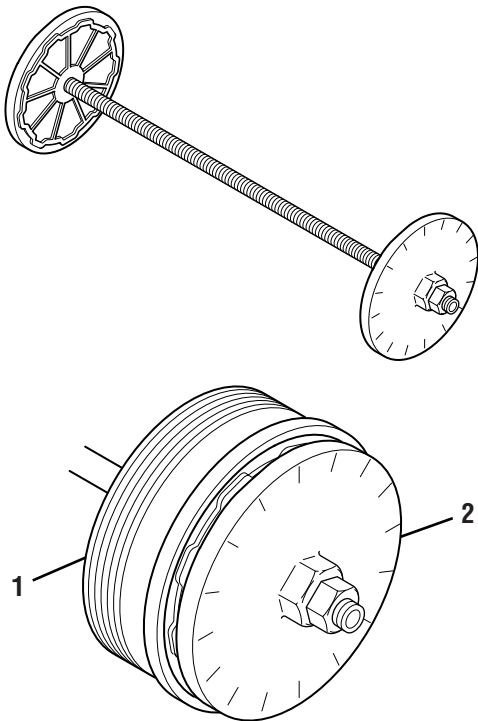
10. Tighten the ring gear cap screws with an impact gun and then use a torque wrench to torque to the proper specifications. See the Torque Chart.



Set Backlash and Bearing Preload

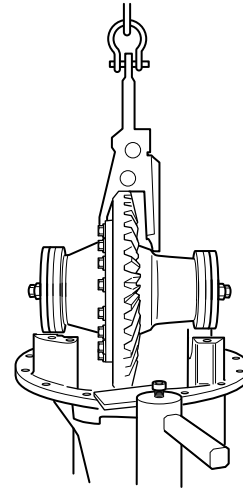
Note: To install the wheel differential assembly, properly setup the gear pattern and set the differential bearing preload. This will require the use of the following Spicer tools or equivalent. These tools will allow you to align the bearing adjuster assembly to the carrier. This tool (part number 513061) will also gage the adjustment for the differential bearing preload and assist in setting the backlash. Below you will find detailed instructions explaining each procedure.

- The bearing adjustment tool is made up of a threaded rod, two nuts, two washers and two adjustment plates. Fit one adjustment plate to the plain half threaded cup. Fit the other adjustment plate to the flange half cup. The adjustment rings will fit into slots of the threaded bearing cups stamped adjustment ring.



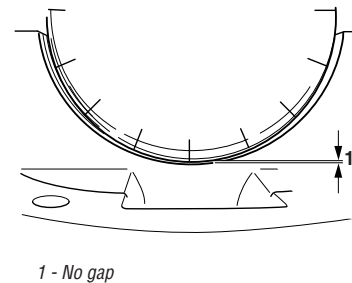
1 - Threaded bearing cup
2 - Adjustment plate

- Connect the adjuster plates using the threaded rod, washers and nuts. Tighten the nuts on the rod to hold the threaded cups in place. Carefully lower the wheel differential and ring gear assembly into the carrier.

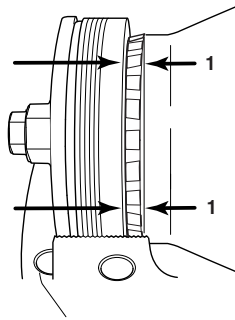


Note: There are two ways to make sure that the threaded cups are seated properly. If there is a misalignment, reinstall the differential assembly at a slightly different angle.

- Make sure there is no gap between the carrier threads and the cup threads.

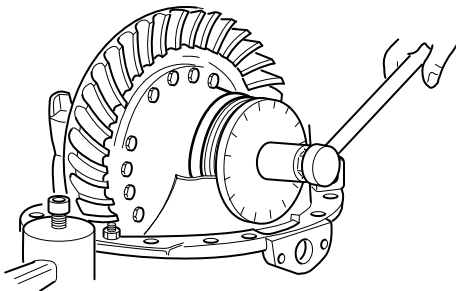


14. Make sure that the bearings cage is parallel to the edge of the threaded cup.

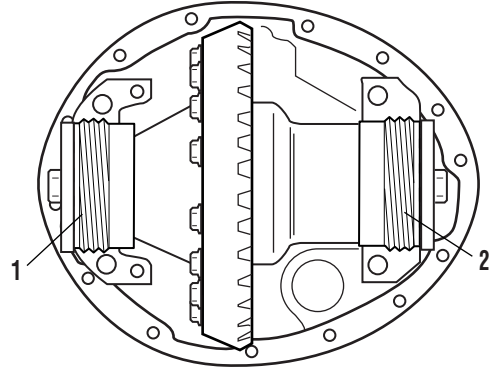


1 - Parallel

15. Use a ratchet or breaker bar and a 1 1/4" deep wall socket to turn the flange half threaded bearing cup in until the ring gear contacts the pinion (zero backlash). Back the cup out two notches of the adjustment plate.

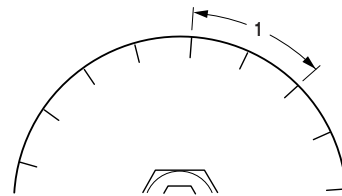


16. Turn the plain half adjuster ring until there is zero preload on the bearings. This is done by turning the adjuster plate clockwise until you feel the threaded cup gain resistance. The threaded bearing cup should only be slightly snugged to achieve a zero preload condition.



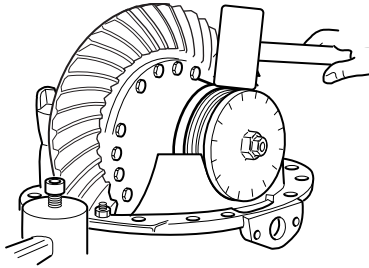
1 - Flange Half
2 - Plain Half

17. Obtain two notches of preload by tightening the plain half adjustment ring two notches. Start with the notch at the top, count two notches counter-clockwise on the adjuster ring, turn the adjuster ring so that the notch is facing straight up.

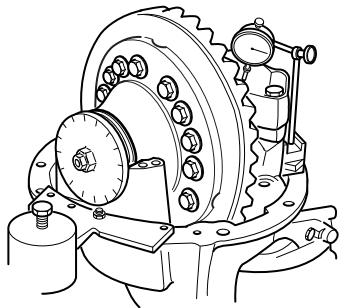


1 - Two Notches

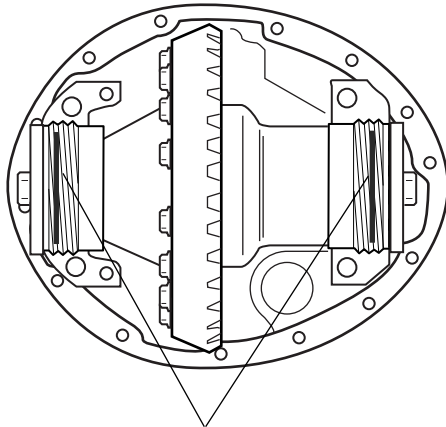
18. Use a rubber mallet to fully seat the threaded bearing cups.



19. With a dial indicator, check the ring and pinion backlash. Set the backlash from 0.010" to 0.012". This will give you room to adjust the contact pattern, if necessary.

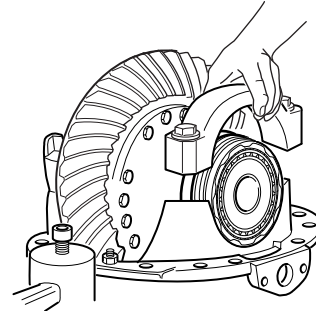


20. Remove the adjuster plates and threaded rod assembly.
 21. Apply a 1/8" bead of Loctite 540 to the exposed threads of the bearing adjuster.

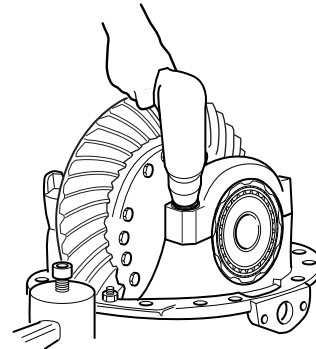


Apply Loctite 5

22. Install the carrier differential bearing caps and caps crews. Make certain there is no gap between the carrier cap and the carrier surface.



23. Use an impact gun to snug all carrier cap fasteners.



24. Recheck the backlash. For new gearing, the backlash should be between 0.008" and 0.018" (0.20 and 0.46 mm).

Note: For used gearing, the backlash should be reset to what it was at the time of disassembly.

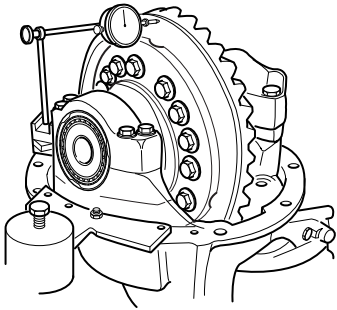
Note: If you have too much backlash, move the ring gear closer to the pinion. Count the number of notches you back off the plain half threaded cup. Each notch equals about 0.003" (0.08 mm) of backlash.

IMPORTANT:

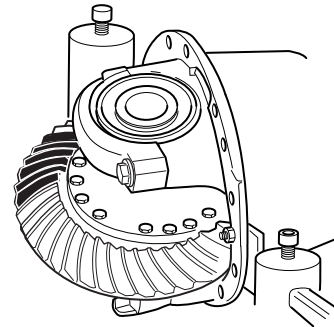
WARNING

In order to maintain the differential bearing preload, you will need to turn the flange half threaded cup the same amount in the same direction. If you need more backlash, reverse the procedure.

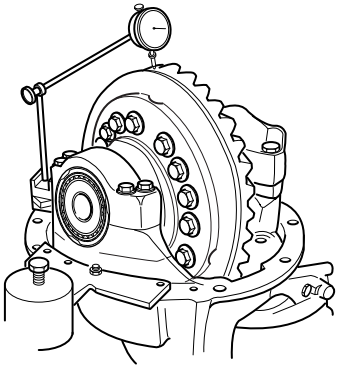
25. Measure the ring gear total radial runout. Indicator reading should not exceed 0.010" (0.25 mm).



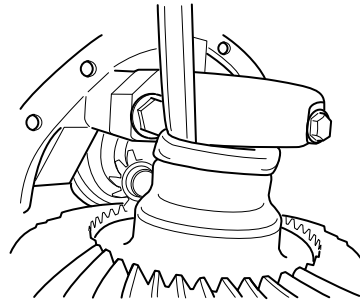
28. With the carrier mounted in a head stand, roll the carrier on its side.



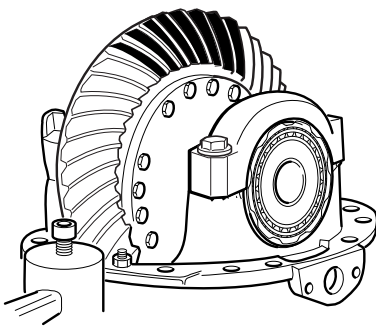
26. Measure the ring gear total backface runout. Indicator reading should not exceed 0.010" (0.25 mm).



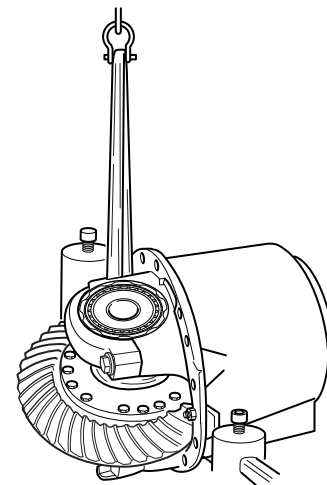
29. Make a sling out of a strap and position around the plain half of the wheel differential.



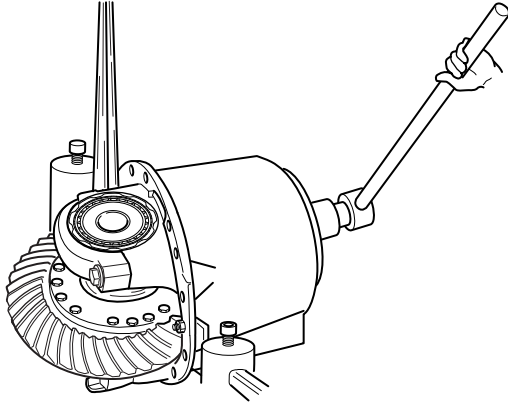
27. Check the ring gear tooth pattern. Paint 5 or 6 ring gear teeth 180 degrees apart on the ring gear.



30. Connect the end of the strap to a hoist and apply pressure to the sling.



31. Use the correct socket and a breaker bar to rotate the differential. The differential should be hard to turn. Rotate the pinion until the ring gear rotates 3 or 4 times in both directions. See page 31, "Adjust Tooth Contact Position" for descriptions of correct pattern position for new and used gearing.

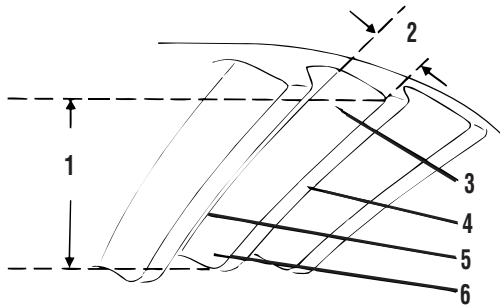


32. When contact pattern is correct, use a punch with a round head to stake the threaded bearing cups in place. Stake the outer edge of the bearing adjustment ring into the machined slots in the carrier bearing bore on both sides. Must be staked at two locations. Rotate cup if necessary to provide surfaces for staking.

Adjust Tooth Contact Position

Adjust Ring and Pinion Tooth Contact Pattern

Note: Rear axle gearing is shown in the following instructions. Correct tooth contact patterns and adjustments are the same for forward and rear axles.



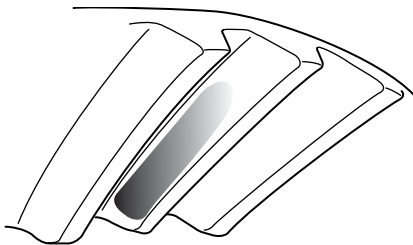
- 1 - Face width
- 2 - Tooth depth
- 3 - Heel
- 4 - Top land
- 5 - Root
- 6 - Toe

1. Identify if new or used gearing.
2. Check tooth contact pattern (new or used gearing).

New Gearing - Correct Pattern

Paint six ring gear teeth 180° apart with marking compound and roll the gear to obtain a contact pattern. The correct pattern is slightly below center on the ring gear tooth with lengthwise contact up off the toe. The length of the pattern in an unloaded condition is approximately one-half to two-thirds of the ring gear tooth in most models and ratios.

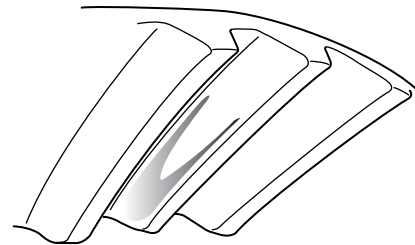
The pattern could vary in length and should cover 1/2 tooth or more (face width). The pattern should be evenly centered between tooth top land and root and should be up off the tooth toe.



Used Gearing - Correct Pattern

Used gearing will not usually display the square, even contact pattern found in new gear sets. The gear will normally have a "pocket" at the heel end of the gear tooth. The more use a gear has had, the more the line becomes the dominant characteristic of the pattern.

Adjust used gear sets to display the same contact pattern observed before disassembly. A correct pattern is up off the toe and centers evenly along the face width between the top land and root. Otherwise, the length and shape of the pattern are highly variable and is considered acceptable as long as it does not run off the tooth at any point.



1 - Pattern along the face width could be longer

Adjust Contact Pattern

If necessary, adjust the contact pattern by moving the ring gear and drive pinion.

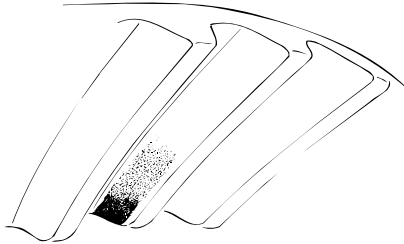
- Ring gear position controls the backlash. This adjustment moves the contact pattern along the face width of the gear tooth.
- Pinion position is determined by the size of the pinion bearing cage shim pack. It controls contact on the tooth depth of the gear tooth.

These adjustments are interrelated. As a result, they must be considered together even though the pattern is altered by two distinct operations. When making adjustments, first adjust the pinion, then the backlash. Continue this sequence until the pattern is satisfactory.

Adjust Ring Gear Position (Backlash)

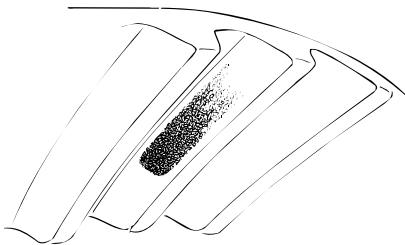
If the gear pattern shows incorrect face width contact, change backlash by adjusting the ring gear.

If the pattern is too close to the edge of the tooth toe, move the ring gear away from the pinion to increase backlash.



1. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
2. Loosen the opposite adjuster one notch.
3. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster 2 or 3 notches and recheck backlash.

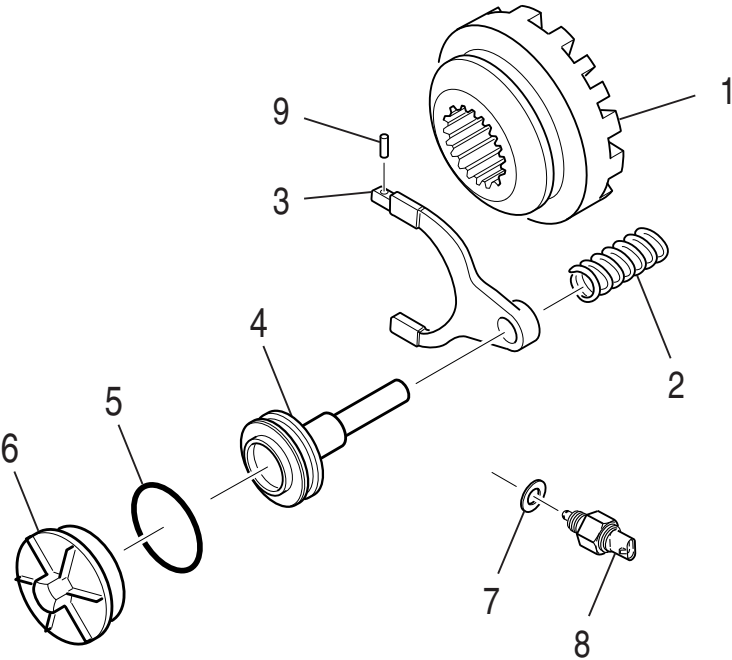
If the pattern is concentrated at the heel (too far up the tooth), move the ring gear toward the pinion to decrease backlash.



1. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
2. Tighten the opposite adjuster one notch.
3. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster 2 or 3 notches and recheck backlash.

Wheel Differential Lock

Parts Exploded View



- 1 - Sliding clutch
- 2 - Spring
- 3 - Clutch fork
- 4 - Push rod

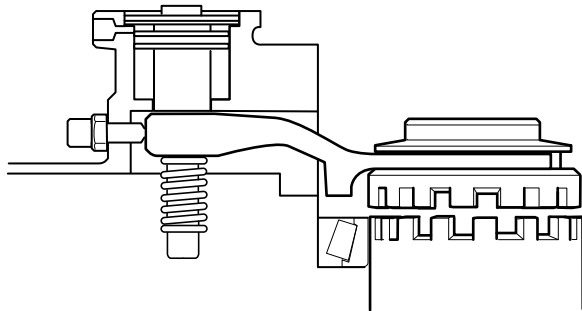
- 5 - Piston
- 6 - O-ring
- 7 - Piston cover
- 8 - Washer

- 9 - Switch
- 10 - Pin

Install and Adjust Wheel Differential Lock

Note: With differential carrier completely assembled and adjusted, install differential lock as follows:

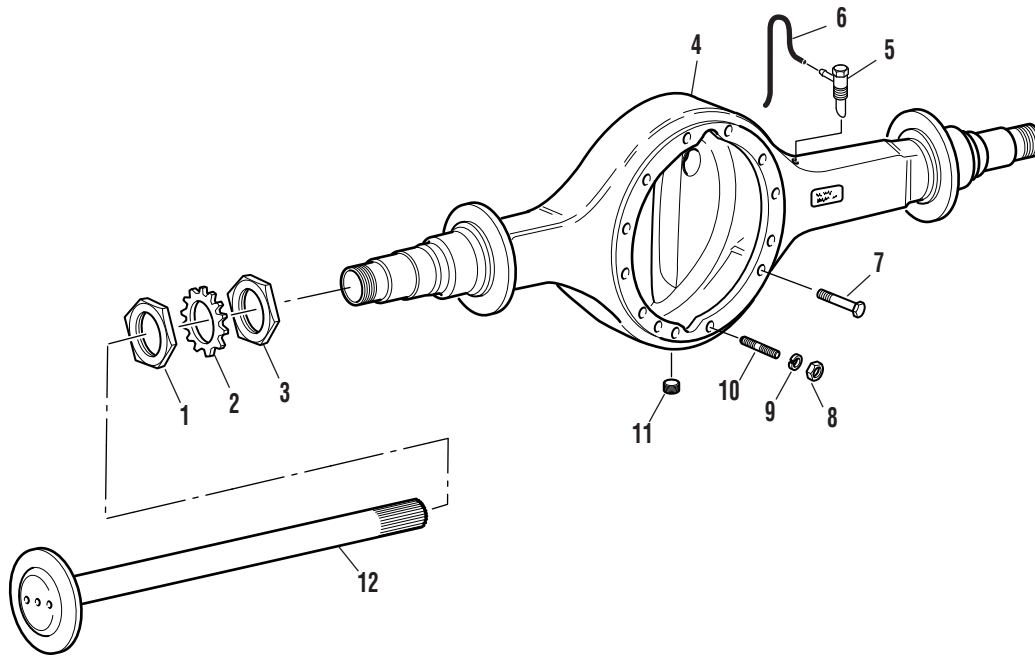
1. If shift fork and sliding clutch are disassembled, engage fork with the clutch hub and install spring pin in the fork leg. See illustration below for fork mounting position on clutch.
2. Position compression spring, shift fork and clutch in shift opening of the carrier. Align pilot hole of shift fork with the pilot hole of carrier.
3. Install pushrod through shift fork, compression spring and carrier pilot hole.



4. Lubricate piston and o-ring with silicone grease. Install shift piston assembly into cylinder. Position piston with small diameter hub toward closed end of cylinder.
5. Install piston cover o-ring.
6. Install piston cover and torque to 50–75 lb-ft. (68–102 N•m).
7. Install selector switch and torque to 10–12 lb-ft. (14–16 N•m).
8. Check selector switch operation. Check switch electrically with an ohmmeter. Switch should be closed when clutches are engaged and open when disengaged.

Housing Assembly Forward

Parts Exploded View



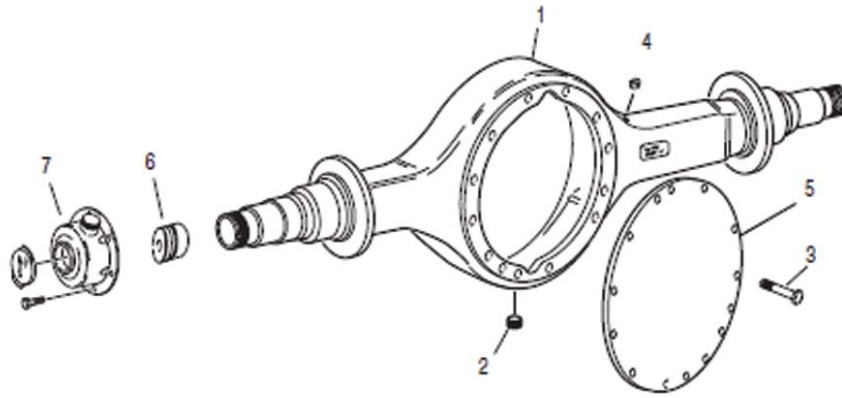
- 1 - Jam nut
- 2 - Locking ring
- 3 - Spindle nut
- 4 - Axle housing
- 5 - Breather

- 6 - Breather hose
- 7 - Carriage caps screw
- 8 - Nut
- 9 - Lock washer

- 10 - Stud
- 11 - Drain plug
- 12 - Axle shaft

Bowl Tag Housing Assembly

Parts Exploded View

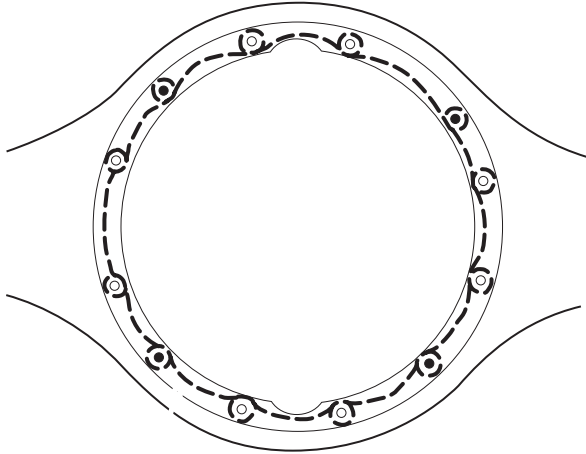


- 1 - Housing Assembly
- 2 - Drain plug
- 3 - Cover cap screw
- 4 - Plug - Breather
- 5 - Cover
- 6 - Spindle Plug
- 7 - Hub Cap

Install Bowl Tag Housing Cover

Axle Assembly Procedure

1. Apply a 1/8" bead of Ultra gray sealant to the drive axle housing to carrier interface. Make sure to apply sealant around each bolt hole as shown.



2. Install the housing cover plate using cap screw part number 132820 and washer part number 130877.
3. Torque cap screws in a criss-cross pattern to 250 +/- 10 lb-ft.

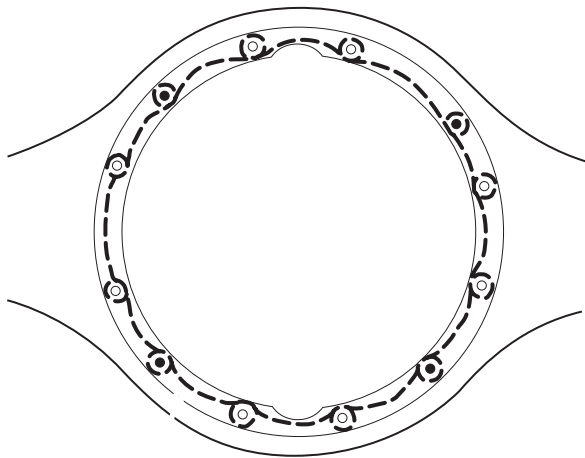
Bowl Tag Axle Conversion Process

Axle Disassembly Procedure

1. Block the front and rear of at least one of the steer axle wheels so the vehicle can not move during this procedure. Always wear safety glasses.
2. Drain the lube from the rear drive axle by removing the drain plug at the bottom of the housing.
3. Remove inter axle driveline.
4. Remove the axle shaft nuts and washers. Remove rear axle shafts.
5. Remove rear axles U-tube breather assembly.
6. Now, remove the rear axle carrier assembly. Start by removing the carrier to housing caps screws, nuts and washers.
7. Remove carrier assembly.
8. With a rag, wipe out the inside of the drive axle housing to remove the majority of any remaining lube. There is no need to use a solvent to remove residual oil. The residual lube will help keep the inside of the housing from rusting due to condensation in the future.
9. Reinstall the housing drain plug and torque to 60 +/- 10 lb-ft.

Axle Assembly Procedure

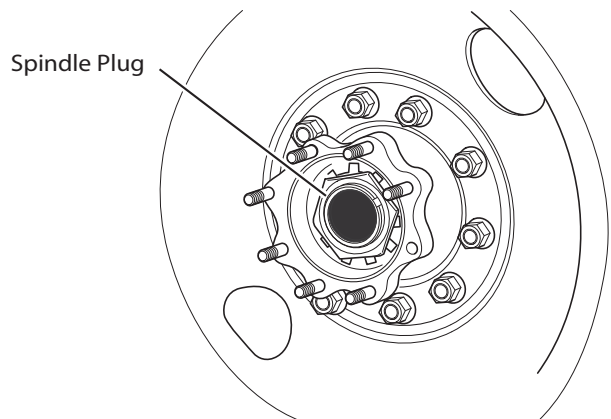
1. Apply a 1/8" bead of Ultra Gray sealant to the drive axle housing to carrier interface. Make sure to apply sealant around each bolt hole as shown.



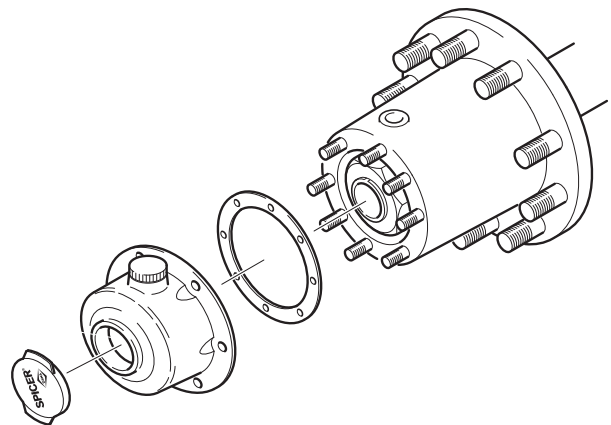
2. Install the housing cover plate using caps screw part number 130836 and washer part number 130877.
3. Torque caps screw in a criss-cross pattern to 250 +/- 10 lb-ft.

4. Now install the housing breather plug, part number 673360 and torque to 25 lb-ft.
5. At the wheel end of the rear-rear axle, install the spindle end plugs part number 302835 to both sides of the housing.

Note: Apply a thin coat of oil to the plug O-rings before installing. Only use a rubber dead blow hammer to install if the plug will not go in by hand.



6. Install the hub cap gasket, hub cap assembly, washers and nuts.



7. Torque to 25 +/- 5 lb-ft in a criss-cross pattern.
8. The wheel ends can now be refilled with lube through the end of the hub cap or the fill hole in the hub if available.
9. Proper fill level is marked on the window of the hub cap.

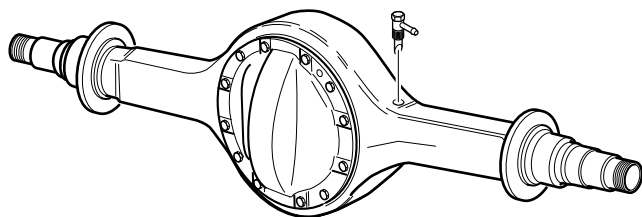
IMPORTANT

Note: The vehicle must be driven, then recheck the lube level before the vehicle is returned to service.

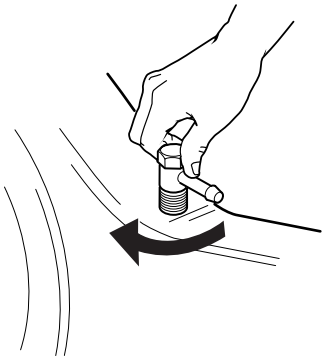
Housing Breather

Spicer has an axle breather that consists of a fitting, hose and clamp assembly. This breather design has improved resistance to water ingestion, clogging caused by dirt, ice or snow buildup around the base of the breather. See installation instructions below (all views from rear).

1. Install fitting in breather hole.

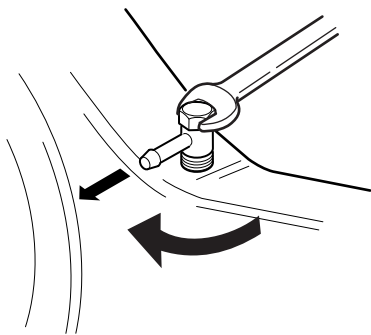


2. Tighten fitting finger tight.

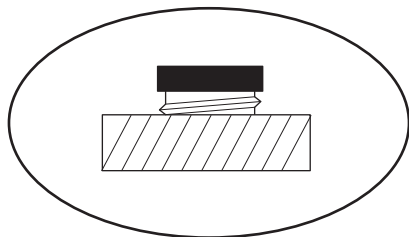


3. Using a 3/4" wrench:

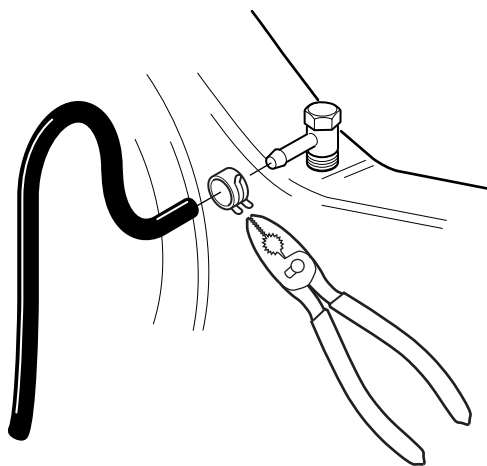
- **Metal only:** Rotate the fitting at least 1/2 turn until nipple points to rear.



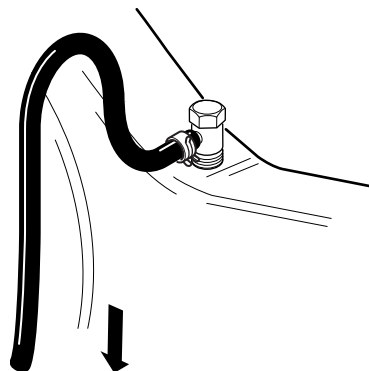
- **Plastic only:** Tighten until one thread is showing.



4. Insert hose onto fitting, long end down.

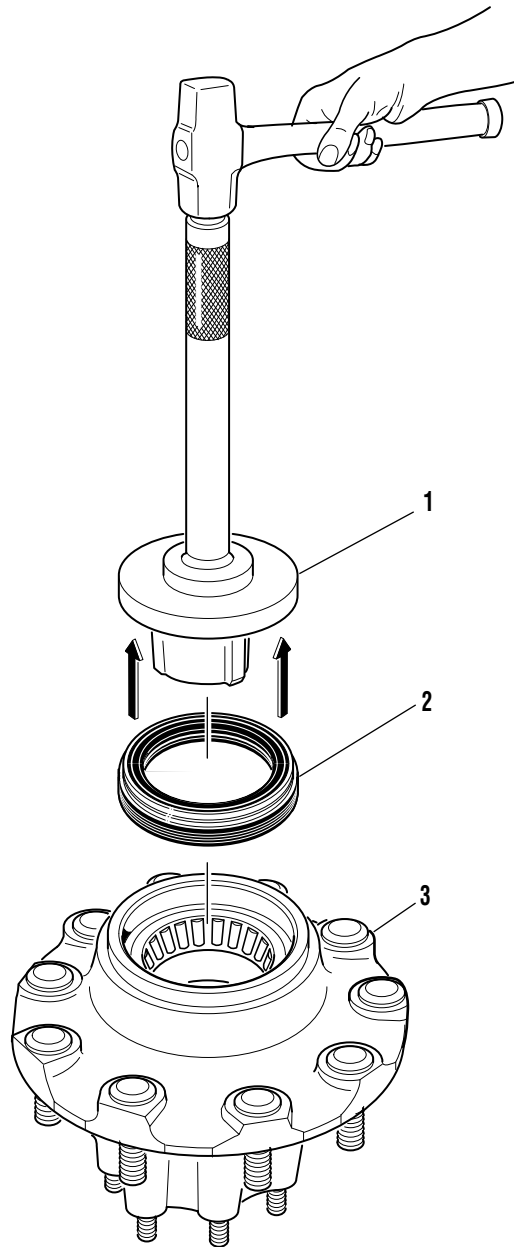


5. Push hose firmly against fitting. Rotate hose to point down.



Wheel End Seal

Parts Exploded View



- 1 - Installation tool
- 2 - Seal
- 3 - Rear hub

Remove and Overhaul Wheel End Seal

WARNING:

 WARNING

Never work under a vehicle supported by only a jack. Always support vehicle with stands. Block the wheels and make sure the vehicle will not roll before releasing the brakes.

IMPORTANT:

 IMPORTANT

Wheel end seals can be easily damaged during handling. Leave the seal in its package until installation to prevent damage or contamination.

1. Remove outer bearing and wheel.
2. Remove oil seal.
3. Remove inner bearing.
4. Remove old wear sleeve (2-piece design only) with a ball peen hammer and discard.

CAUTION:

 CAUTION

Do not cut through the old wear sleeve. Damage to the housing may result.

5. Inspect spindle journal and hub bore for scratches or burrs. Recondition with an emery cloth as required.

Note: Deep gouges can be repaired by filling gouge with hardening gasket cement and smoothing with emery cloth.

6. Clean hub cavity and bearing bores before reassembly. Be sure to remove contaminants from all recesses and corners.
7. Clean bearings thoroughly with solvent and examine for damage. Replace damaged or worn bearings.

IMPORTANT:

 IMPORTANT

Always use the seal installation tool specified by the seal manufacturer. Using an improper tool can distort or damage the seal and cause premature seal failure.

Install Wheel End Seal

1. Before installation, lubricate the following with the same lubricant used in the axle sump.
 - Inner bearing
 - Wheel seal (follow the directions provided by the seal supplier)
2. Place seal on installation tool.
3. Drive seal with installation tool onto hub.

Adjust Wheel Bearing

WARNING:

 WARNING

Do not mix spindle nuts and lock washers from different systems. Mixing spindle nuts and lock washers can cause wheel separation.

Note: The lock washer for a four-piece tang/dowel-type wheel nut system is thinner than the lock washer for a three-piece tang-type wheel nut system and is not designed to bear against the inner nut.

4. Inspect the spindle and nut threads for corrosion and clean thoroughly or replace as required.

Note: Proper assembly and adjustment is not possible if the spindle or nut threads are corroded.

5. Inspect the tang-type washer (if used). Replace the washer if the tangs are broken, cracked, or damaged.
6. Install the hub and drum on the spindle with care to prevent damage or distortion to the wheel seal.

CAUTION:

 CAUTION

A wheel dolly is recommended during installation to make sure that the wheel seal is not damaged by the weight of the hub and drum. Never support the hub on the spindle with just the inner bearing and seal. This can damage the seal and cause premature failure.

7. Completely fill the hub cavity between the inner and outer bearing races with the same lubricant used in the axle sump.
8. Before installation, lubricate the outer bearing with the same lubricant used in the axle sump.

Note: Lubricate only with clean axle lubricant of the same type used in the axle sump. Do not pack the bearings with grease before installation. Grease will prevent the proper circulation of axle lubricant and may cause wheel seal failure.

9. Install the outer bearing on the spindle.
10. Install the inner nut on the spindle. Tighten the inner nut to 200 lb-ft. (271 N•m) while rotating the wheel hub.

CAUTION:



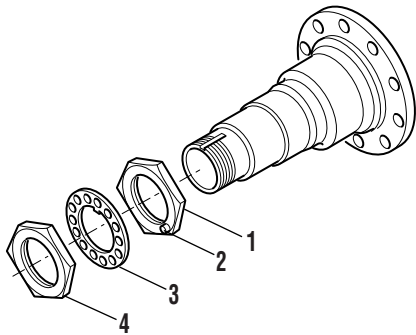
Never use an impact wrench to adjust wheel bearings. A torque wrench is required to assure that the nuts are properly tightened.

11. Back off the inner nut one full turn. Rotate the wheel hub.
12. Retighten the inner nut to 50 lb-ft. (68 N•m) while rotating the wheel hub.
13. Back off the inner nut exactly 1/4 turn.

Note: This adjustment procedure allows the wheel to rotate freely with 0.001"–0.005" (0.025 mm–0.127 mm) endplay.

14. Install the correct lock washer for the wheel nut system being used.

Three-piece Dowel-type Lock Washer System



- 1 - Inner Nut
- 2 - Dowel Pin
- 3 - Dowel-type Lock Washer
- 4 - Outer Nut

- a. Install the Dowel-type lock washer on the spindle.

Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

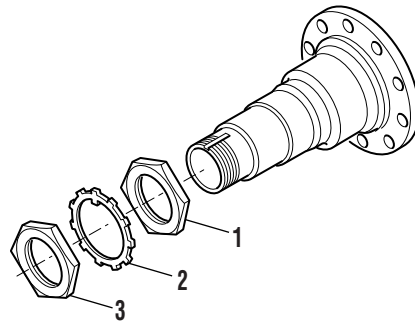
CAUTION:



Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- b. Install the outer nut on the spindle and tighten to 350 lb-ft. (475 N•m).
- c. Verify endplay.

Three-piece Tang-type Lock Washer System



- 1 - Inner Nut
- 2 - Tang-type Lock Washer
0.123" (3.124 mm) thick
- 3 - Outer Nut

- a. Install the Tang-type lock washer on the spindle.

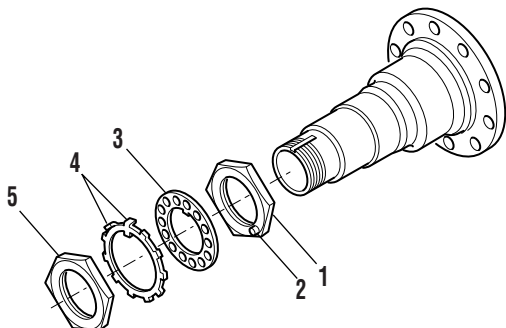
CAUTION:



Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- b. Install the outer nut on the spindle and tighten to 250 lb-ft. (339 N•m).
- c. Verify endplay.
- d. After verifying endplay, secure wheel nuts by bending one of the locking washer tangs over the outer wheel nut and another tang over the inner wheel nut.
- e. Go to step 12.

Four-piece Tang/Dowel-type Lock Washer System



- 1 - Inner Nut
- 2 - Dowel Pin
- 3 - Dowel-type Lock Washer
- 4 - Tang-type Lock Washer
0.0478" (1.2065 mm) thick
- 5 - Outer Nut

a. Install the Dowel-type lock washer on the spindle.

Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

CAUTION:

▲ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- b. Install the Tang-type lock washer on the spindle.
 - c. Install the outer nut on the spindle and tighten to 250 lb-ft. (339 N•m).
 - d. Verify endplay.
 - e. After verifying endplay, secure the outer nut by bending (180° apart) two opposing tangs of the locking washer over the outer nut.
15. Install the following:
- New gasket at axle shaft flange
 - Axle shaft
 - Axle flange nuts and tighten to specified torque
16. Lubricate axle wheel ends.

Replace Seal

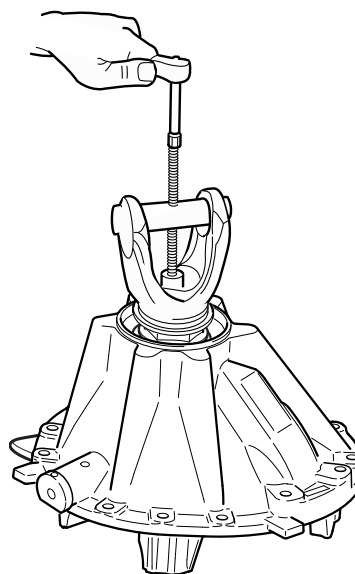
Spicer strongly recommends using seal drivers when installing new seals. Use the proper driver to make sure that the seal is square and installed to the proper depth.

CAUTION:

▲ CAUTION

Oil seals can be easily damaged prior to installation. Use care when handling the new seal to prevent damage or contamination. Leave the seal in its package until installation. On new yokes, leave the protector on the yoke until it is installed on the shaft to prevent damage or contamination.

17. Remove the old yoke using appropriate tool. A yoke puller tool may be made from the center section of most gear puller tools, or may be purchased from your local tool distributor.



18. Remove seal. Use care when removing the old seal to prevent damage to the housing seal bore.
19. Inspect the seal bore area for any damage (nicks, gouges, corrosion). Carefully remove any slight damage with a crocus cloth. Clean the bore area to remove any loose debris.

CAUTION:

▲ CAUTION

Do not use any silicone or permatex-type bore sealant with this seal.

20. Remove the new seal from its package and install with the proper driver:

R - Pinion Driver - 210749

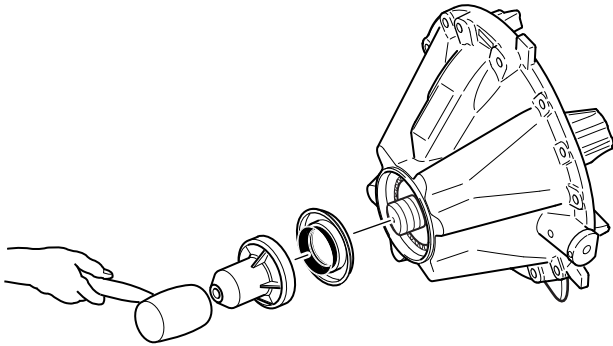
R - Pinion Insert - 131472

WARNING:

WARNING

Due to the resiliency of the plastic driver, hammer rebound may occur when the seal is seated. Keep clear of the hammer rebound path!

21. Handle the seal by its outside diameter avoiding any contact with the seal lips. During installation, use the proper driver to make sure that the seal is mounted properly.
22. Use a rubber mallet to drive the seal tool in until the flange bottoms on the housing cover bore face. The flange will locate the seal at the proper depth.



Guidelines for Reusing Yoke

CAUTION:

CAUTION

Do not use the yoke if it has any damage on the seal surface (nicks or scratches).

The surface of the yoke and the lips of the seal form a critical interface which retains the axle's lubricant while sealing the axle from outside contaminants. The condition of the yoke hub's surface is a very important factor in determining seal life.

Carefully inspect the seal surface area of the yoke hub for signs of wear and damage. Do not reuse the yoke if there is noticeable wear, such as heavy grooving, beyond normal polishing from the seal lips.

Note: Do not rework the yoke with abrasives such as emery paper or crocus cloth. Clean the surface of the yoke as necessary using chemical cleaners. Remove all trace of the chemicals from the yoke after cleaning.

CAUTION:

CAUTION

Do not use wear sleeves. Wear sleeves increase the yoke hub surface diameter and cause premature seal wear and repeat seal failure.

Verify Wheel Endplay Procedure

Verify that endplay meets specification using a dial indicator. An indicator with 0.001" (0.03 mm) resolution is required. Wheel endplay is the free movement of the tire and wheel assembly along the spindle axis.

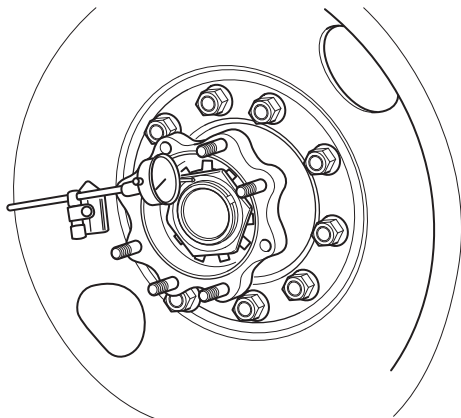
Correct endplay is 0.001"–0.005" (0.025–0.125 mm).

1. Attach a dial indicator with its magnetic base to the hub or brake drum as shown below.
2. Adjust the dial indicator so that its plunger or pointer is against the end of the spindle with its line of action approximately parallel to the axis of the spindle.
3. Grasp the wheel assembly at the 3 o'clock and 9 o'clock positions. Push the wheel assembly in and out while oscillating it to seat the bearings. Read bearing endplay as the total indicator movement.

CAUTION:



If endplay is not within specification, readjustment is required.



Readjust Wheel Endplay Procedure

Excessive Endplay—If end-play is greater than 0.005" (.127 mm), remove the outer nut and pull the lock washer away from the inner nut, but not off the spindle. Tighten the inner nut to the next alignment hole of the dowel-type washer (if used). Reassemble the washer and re-torque the outer nut. Verify endplay with a dial indicator.

Insufficient Endplay—If endplay is not present, remove the outer nut and pull the lock washer away from the inner nut, but not off the spindle. Loosen the inner nut to the next adjustment hole of the dowel-type washer (if used). Reassemble the washer and re-torque the outer nut. Verify endplay with a dial indicator.

Fine Tuning the Endplay—If, after performing the readjustment procedures, endplay is still not within the 0.001"–0.005" (0.025–0.127 mm) range, disassemble and inspect the components. If parts are found to be defective, replace the defective parts, reassemble and repeat wheel bearing adjustment procedure. Verify endplay with a dial indicator.

Lubricate Wheel End

CAUTION:



Before operating the axle, the wheel hub cavities and bearings must be lubricated to prevent failure.

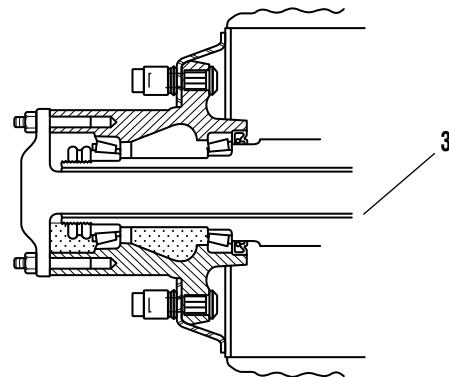
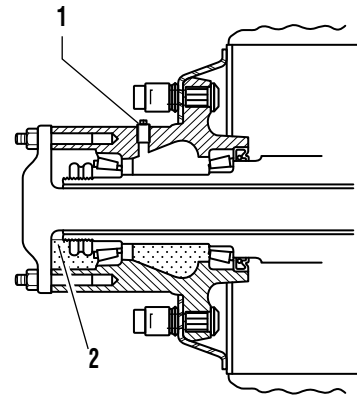
When wheel ends are serviced, follow Spicer's wheel end lubrication procedure before operating the axle.

Spicer axles may be equipped with either of two wheel end designs:

- Wheel ends **with** an oil fill hole.
- Wheel ends **without** an oil fill hole.

Wheel Ends with an Oil Fill Hole

4. Rotate the wheel end hub until the oil fill hole is up.
5. Remove the oil fill plug.
6. Pour 1/2 pint of axle sump lubricant into each hub through the wheel end fill hole.
7. Install oil fill plug and tighten to specified torque.



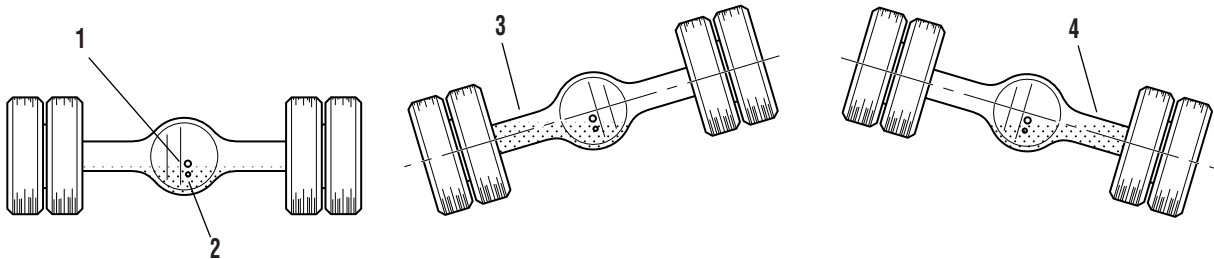
1 - Wheel End Oil Fill Hole
2 - Proper Lubricant Level
3 - Lubricant Flow from Sump

Wheel Ends Without Oil Fill Hole

1. With axle level and wheel ends assembled, add lubricant through filler hole in axle housing cover until fluid is level with the bottom of filler hole.
2. Raise the right side of the axle 6" or more. Hold axle in this position for one minute.
3. Lower the right side.

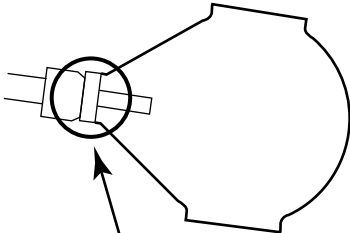
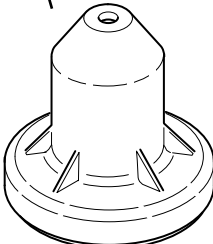
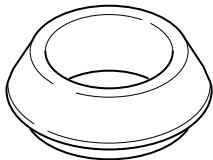
4. Raise the left side of the axle 6" or more. Hold axle in this position for one minute.
5. Lower the left side.
6. With axle on a level surface, add lubricant through housing cover oil filler hole until fluid is level with the bottom of the hole.

Note: Axles without wheel end fill holes will require approximately 2.5 additional pints of lubricant to bring the lube level even with the bottom of fill hole.



- 1 - With axle on level surface, fill housing with oil to bottom of plug
- 2 - Temperature sensor mounting hole
- 3 - Oil will run into wheel end
- 4 - Oil will run into wheel end
- 5 - Tilt housing side to side (1 minute per side)
- 6 - Recheck oil level in axle

Service Kit

| | R-Pinion |
|----------|---|
| Location |  |
| Tool |  210749  131472 |

General Lubrication Information

The ability of a drive axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubrication in the correct quantity. The most satisfactory results can be obtained by following the directions contained in this manual.

The following lubrication instructions represent the most current recommendations from Dana.

Approved Lubricants

General—Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105D (Lubricating Oils, Gear, Multipurpose) are approved for use in Spicer Drive Axles. The MIL-L-2105D specification defines performance and viscosity requirements for multigrade oils. It supersedes both MIL-L-2105B, MIL-L-2105C and cold weather specification MIL-L-10324A. This specification applies to both petroleum-based and synthetic based gear lubricants if they appear on the most current “Qualified Products List” (QPL-2105) for MIL-L-2105D.

Note: The use of separate oil additives and/or friction modifiers are not approved in Spicer Drive Axles.

Synthetic based—Synthetic-based gear lubricants exhibit superior thermal and oxidation stability, and generally degrade at a lower rate when compared to petroleum-based lubricants. The performance characteristics of these lubricants include extended change intervals, improved fuel economy, better extreme temperature operation, reduced wear and cleaner component appearance. The family of Spicer gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105D. These products, available in both 75W-90 and 80W-140, have demonstrated superior performance in comparison to others qualified under the MILSPEC, as demonstrated by extensive laboratory and field testing. For a complete list of Dana Spicer approved synthetic lubricants contact your local Dana representative. See back cover of this manual for appropriate phone number.

Makeup Lube—Maximum amount of non-synthetic makeup lube is 10%. For additional lubrication information, see TCMT-0021.

Recommendations for Viscosity/Ambient Temperature

The following chart lists the various SAE Grades covered by MIL-L-2105D and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (*) are available in the Spicer family of synthetic gear lubricants.

The lowest ambient temperatures covered by this chart are -40°F and -40°C. Lubrication recommendations for those applications which consistently operate below this temperature range, must be obtained through Dana by contacting your local Dana representative.

| Grade | Ambient Temperature Range |
|--|-----------------------------------|
| 75W | -40°F to -15°F (-40°C to -26°C) |
| 75W-90* | -40°F to 100°F (-40°C to 38°C) |
| 75W-80 | -40°F to 80°F (-40°C to 21°C) |
| 75W-140 | -40°F and above (-40°C and above) |
| 80W-90 | -15°F to 100°F (-26°C to 38°C) |
| 80W-140* | -15°F and above (-26°C and above) |
| 85W-140 | 10°F and above (-12°C and above) |
| * Available in the Spicer family of synthetic gear lubricants. | |

Lube Change Intervals

This product combines the latest manufacturing and part washing technology. **When filled with a Spicer approved synthetic lubricant at the factory, the initial drain is not required.**

Change the lubricant within the first 5,000 miles of operation when not using a Spicer approved synthetic lubricant in either a new axle or after a carrier head replacement.

Base subsequent lubricant changes on a combination of the following chart and user assessment of the application and operating environment.

Severe Service Lubrication Change Intervals—Severe service applications are those where the vehicle consistently operates at or near its maximum GCW or GVW ratings, dusty or wet environments, or consistent operation on grades greater than 8%. For these applications, the ON/OFF HIGH-WAY portion of the chart should be used. Typical applications are construction, logging, mining and refuse removal.

Note: Clean metallic particles from the magnetic filler plug and drain plugs. Clean or replace the breather yearly to avoid lube contamination due to water ingestion.

Lubricant Chart

| Synthetic or Mineral | Lubricant | SAE | Change Interval for Line Haul | Change Interval for Vocational |
|----------------------|--|---------------------------------------|---------------------------------------|--------------------------------------|
| Synthetic * | SHAES-256 | SAE 75W-90 | 500,000 miles [800,000 Km] or 5 years | 120,000 miles [193,000 Km] or 1 year |
| Synthetic ** | SHAES-256 | SAE 75W-90, 75W-140 | 250,000 miles [400,000 Km] or 3 years | 60,000 miles [96,500 Km] or 1 year |
| Mineral Base | MIL-L-2105E/J02360, API GL-5 Gear Oil, MIL-PRF-2105E | 75W, 75W-90, 75W-140, 80W-90, 85W-140 | 120,000 miles [193,000 Km] or 1 year | 60,000 miles [96,500 Km] or 1 year |

* Axles using LMS wheel end system

** Axles using adjustable wheel bearing system

For additional lubrication information, see TCMT-0021.

Change Lube

Drain

Drain when the lube is at normal operating temperature (150°–200°F). It will run freely and minimize the time necessary to fully drain the axle, this insures the axle is flushed.

Unscrew the magnetic drain plug on the underside of the axle housing and allow the lube to drain into a suitable container.

Note: Dispose of all used lubricants properly by following disposal methods approved for mineral or synthetic based oils.

After initial oil change, inspect drain plug for large quantities of metal particles. These are signs of damage or extreme wear in the axle. Clean the drain plug and replace it after the lube has drained completely. Inspect breather for clogging or corrosion. Clean or replace as necessary.

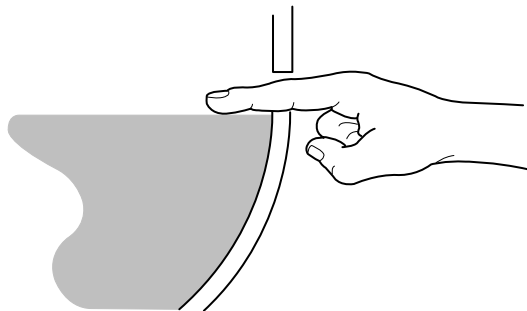
Fill

Front Axle

- a. With vehicle on level ground, remove the filler hole plug from the axle housing cover and fill the axle with approved lubricant until level with the bottom of the hole.

Rear Axle

- a. Remove the filler hole plug from the axle housing cover and fill the axle with the approved lubricant until level with the bottom of the hole.
- b. If wheel ends were removed, follow instructions in wheel end servicing page 40.

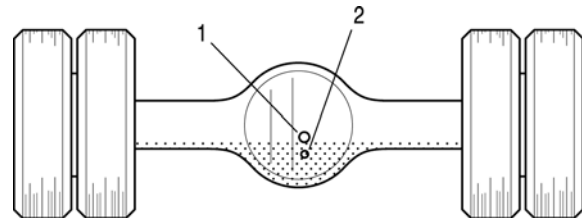


Correct lube level at bottom of filler hole.

Always use the filler hole as the final reference. If lube is level with the bottom of the hole, the axle is properly filled.

Note: Lube fill capacities (see chart) are basic guidelines and will vary based on the angle the axle is installed in a particular chassis. Torque fill plug to 40–60 lb-ft. (54–82 N•m).

TIP: The axle can be filled through the axle housing breather hole. Fill until lube level is even with the bottom of filler hole in axle housing rear cover.



- 1 - With axle on level surface, fill housing with oil to bottom of plug
- 2 - Temperature sensor mounting hole

Standpipes

Drive axles are lubricated with oil drawn from a large sump integral to the assembly. Most axle designs attempt to position vital components such as pinion bearings in close proximity to this sump, keeping them bathed in a generous supply of oil at all times.

When drive axles are installed at severe angles in vehicle chassis, the position of these components is changed relative to the oil sump. The same effect is present when the vehicle travels up a steep grade. Oil in the sump remains level while the axle itself tilts up or down. This makes it possible for bearings and gears located well forward in the assembly to “starve” for lubrication even though the axle is filled to the base of the fill plug hole as recommended by the manufacturer.

Axles should be modified with standpipes to raise lube levels whenever chassis installation angles exceed 10° and when the vehicle must negotiate continuous or lengthy grades on a routine basis.

The chart gives standpipe recommendations for vehicles operating in consistently mountainous areas.

| S170 | | |
|-------------------------|-----------------|------------------|
| Axle Installation Angle | Axle Location | Quantity (pints) |
| 12° | Rear | 29* |
| 10° | Rear | 30* |
| 8° | Rear | 31 |
| 6° | Forward Rear | 39 32 |
| 4° | Forward Rear | 41 33.5 |
| 2° | Forward Rear | 43 35 |
| 0° | Forward Rear | 45 36 |

*Does not allow for standpipe.

Capacities do not include wheel equipment requirements. An additional 1-2 pints is required in each wheel hub.

| S190 | | |
|-------------------------|-----------------|------------------|
| Axle Installation Angle | Axle Location | Quantity (pints) |
| 12° | Rear | 29* |
| 10° | Rear | 30* |
| 8° | Rear | 31 |
| 6° | Forward Rear | 42.5 32 |
| 4° | Forward Rear | 44.5 33.5 |
| 2° | Forward Rear | 47 35 |
| 0° | Forward Rear | 50 36 |

*Does not allow for standpipe.

Capacities do not include wheel equipment requirements. An additional 1-2 pints is required in each wheel hub.

| Tandem Forward Axles | | | |
|----------------------|-------------|--------------|--------------|
| Installation Angle* | 5-10% Grade | 10-15% Grade | 15-20% Grade |
| 0° | – | – | – |
| 3° | – | – | 2.00" |
| 5° | – | 1.00" | 2.25" |
| 7° | – | 1.25" | 2.50" |
| 10° | 1.50" | 1.75" | 2.75" |
| 13° | 1.75" | 2.00" | 3.00" |
| 15° | 2.50" | 2.50" | 3.25" |

*Pinion pointing upward

Theory of Operation

Power Divider Operation (Power Flow and Torque Distribution)

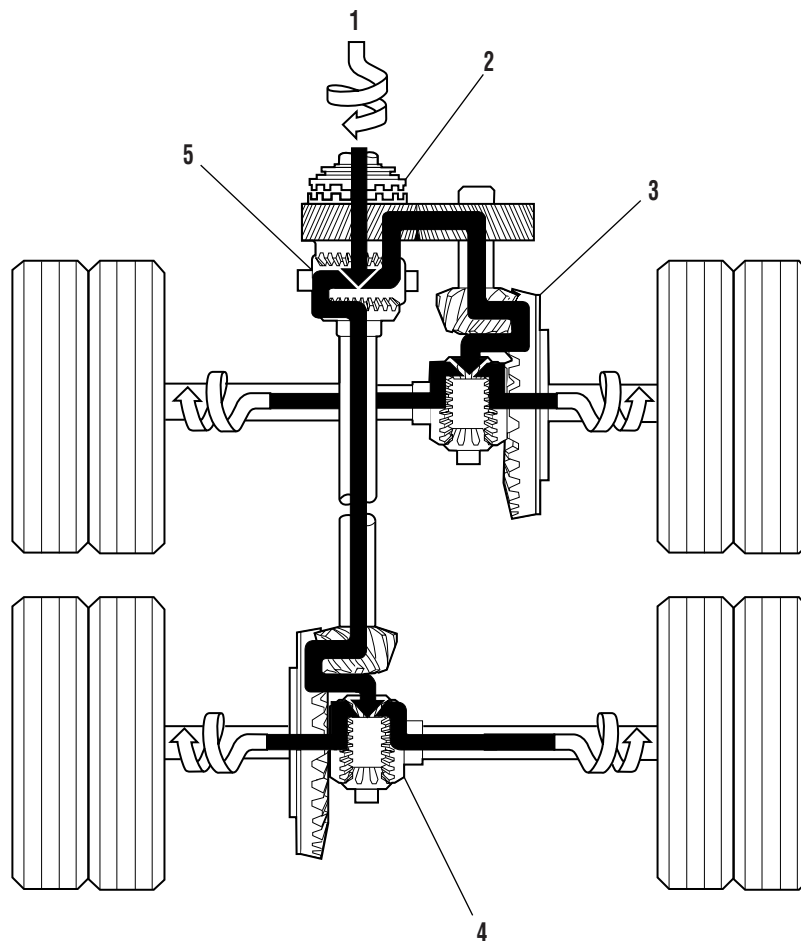
In operation, the power divider accepts torque from the vehicle driveline and distributes it equally to the two axles.

This assembly is of the two-gear design consisting of an input shaft, inter-axle differential, output shaft and two constant-mesh helical gears.

With Lockout Engaged (Inter-Axle Differential is Operating)

The inter-axle differential compensates for minor variations in speed between the two axles, the same way the wheel differential works between the two wheels of a single drive axle. This unit also acts as a central point in distribution of torque to the two axles.

The power divider also includes a driver-controlled, air-operated lockout. When lockout is engaged, it mechanically prevents inter-axle differentiation for better performance under poor traction conditions.



- 1 - Input torque
- 2 - Lockout disengaged
- 3 - Forward axle torque is transmitted from the helical side gear through the pinion helical gear, drive pinion, ring gear, wheel differential and axle shafts.

- 4 - Rear axle torque is transmitted from the output shaft side gear through the output shaft, inter-axle driveline, drive pinion, ring gear, wheel differential and axle shafts.
- 5 - Input torque (power flow) from the vehicle driveline is transmitted to the input shaft and the inter-axle differential spider. The differential distributes torque equally to both axles.

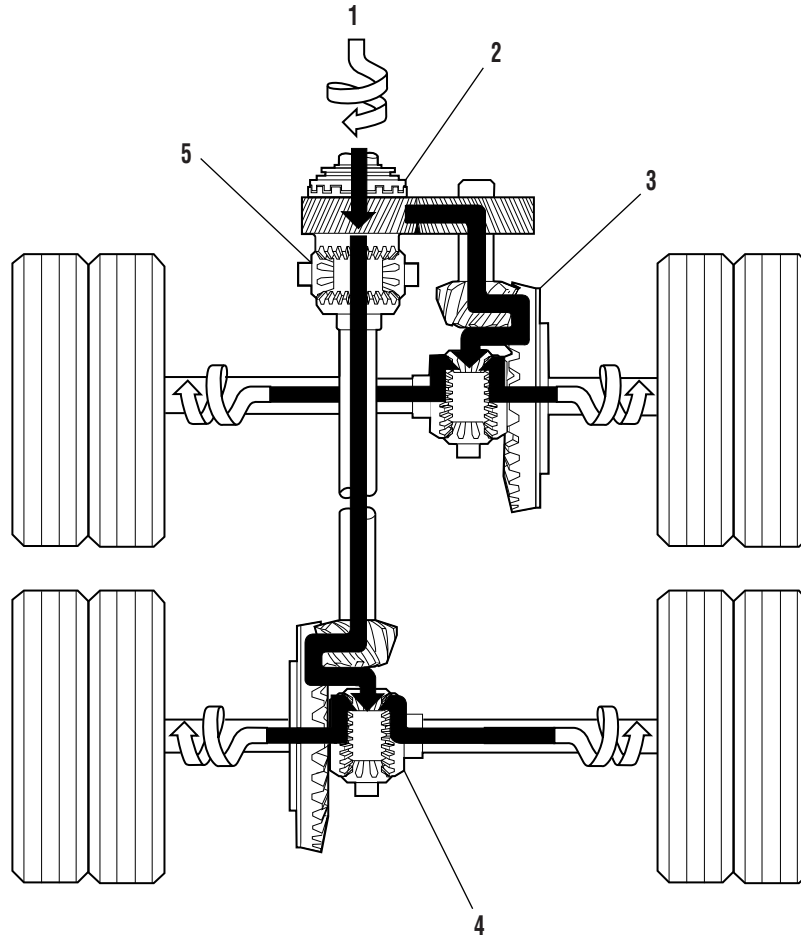
With Lockout Engaged (Inter-Axle Differential is Not Operating)

Lockout should only be engaged when both axles are rotating at the same speed. Operation should be limited to low-traction situations and should be disengaged when normal traction returns. Failure to do so will result in poor handling and damage to the axle components.

Note: Varied road surface conditions can result in unequal torque distribution between the two axle assemblies.

CAUTION

Prolonged operation with the lockout engaged can damage axle and driveline components.



1 - Input torque

2 - Lockout engaged

3 - Forward axle torque is transmitted from the helical side gear through the pinion helical gear, drive pinion, ring gear, wheel differential and axle shafts.

4 - Rear axle torque is transmitted from the output shaft side gear through the output shaft, inter-axle driveline, drive pinion, ring gear, wheel differential and axle shafts.

5 - Input torque (power flow) from the vehicle driveline is transmitted directly to the helical side gear and the output shaft. A positive drive is provided to both axles for maximum traction under adverse road conditions.

Operate Wheel Differential Assembly

The Spicer wheel differential lock is driver-controlled and operated by a carrier mounted air-actuated shift unit. In operation, it positively locks the wheel differential to provide improved traction under adverse road conditions.

Control Systems for Differential Lock

Two systems may be used to control the differential lock operation.

Transmission Low Range Interlock Control System

The wheel differential is locked manually with the transmission in Low Range. It is unlocked by the driver or unlocked when the transmission is shifted out of Low Range.

Note: The interlock system is preferred for vehicles equipped with an air-shifted, Low Range transmission. It is designed to ensure the differential lock is not left engaged (and to prevent accidental engagement) when transmission is in high range.

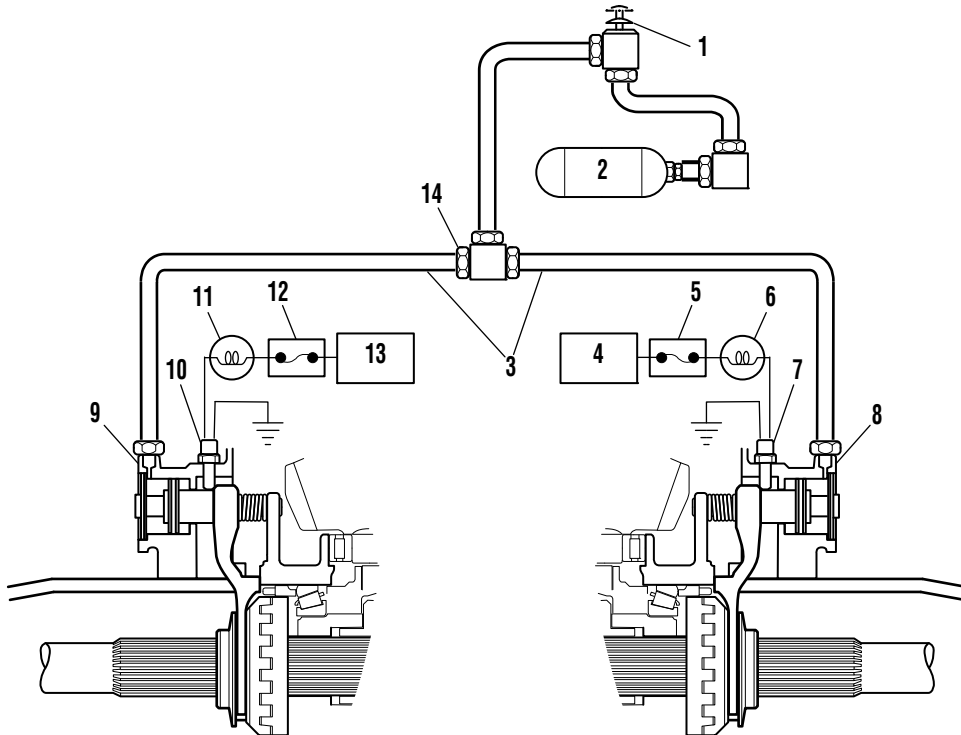
Direct Driver-controlled System

The driver manually locks and unlocks the wheel differential, using a cab-mounted electric switch (or air valve). The following description assumes the system includes a cab-mounted electric switch and a solenoid valve as shown in the illustration. An air valve may be substituted for these components.

Operation is as follows:

1. With control switch in the “unlock” position, the wheel differential functions normally.
2. When the control switch is placed in the “lock” position, the air supply solenoid valve opens and air pressure activates the shift cylinder. The shift fork is moved to engage the curvic clutches, which, in turn, lock the wheel differential.
3. When the control switch is placed in the “unlock” position, air pressure supply to the shift cylinder is shut off and air pressure is released from the cylinder. A compression spring moves the shift fork to disengage the curvic clutch and unlock the wheel differential.

Wheel Differential Lock System



- 1 - Cab-mounted control valve (plunger in—valve open)
- 2 - Dry air supply tank 80–120 PSI
- 3 - Preferably equal in length
- 4 - Power supply
- 5 - Fuse or circuit breaker
- 6 - Indicator light or audible signal
- 7 - Wheel differential lock indicator switch
(part of axle assembly)
- 8 - Rear axle wheel differential lock air shift cylinder
(part of axle assembly)

- 9 - Forward rear axle wheel differential lock air shift cylinder
(part of axle assembly)
- 10 - Wheel differential lock indicator switch
(part of axle assembly)
- 11 - Indicator light of audible signal
- 12 - Fuse or circuit breaker
- 13 - Power supply
- 14 - 66468 Quick release valve (optional) located on frame rail
and within 10 feet of tubing from control valve

Wheel Differential Lock

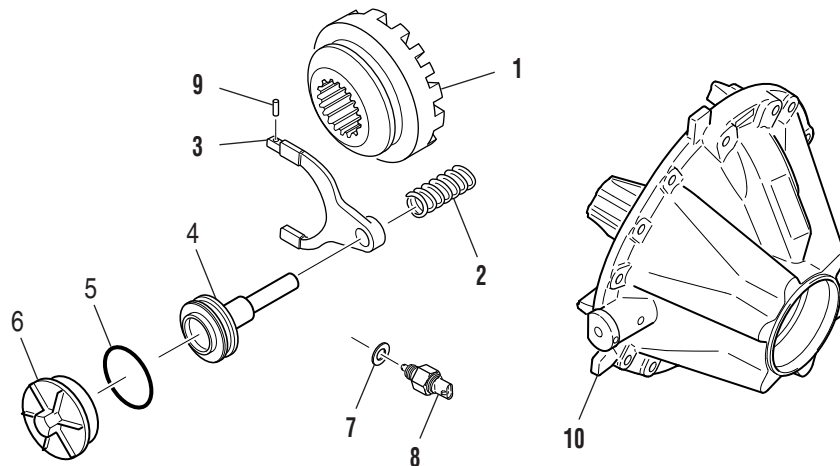
The Spicer Wheel Differential Lock is an optional feature for Spicer Axles. In operation, it positively locks the wheel differential, to provide improved traction under adverse road conditions.

The differential lock is driver-controlled through an electric switch or air valve mounted in the cab. The locking mechanism is air-operated to engage a mechanical clutch and lock the wheel differential. It is spring-operated to disengage the lock and permit the wheel differential to function normally.

The wheel differential lock consists of three major assemblies.

- **Shift Cylinder Assembly:** Operates a shift fork and push rod assembly.
- **Shift Fork and Push Rod Assembly:** Engages and disengages the differential lock curvic clutch assembly.
- **Curvic Clutch Assembly:** Consists of a sliding clutch splined to an axle shaft and a fixed clutch which is splined to the differential case hub.

The differential lock also includes a selector switch (electric) which senses clutch engagement and sends an electrical signal to a cab mounted indicator light (or an audible signal device).



- 1 - Sliding clutch
- 2 - Spring
- 3 - Clutch fork
- 4 - Piston and rod

- 5 - O-ring
- 6 - Piston cover
- 7 - Washer
- 8 - Switch

- 9 - Pin
- 10 - Carrier

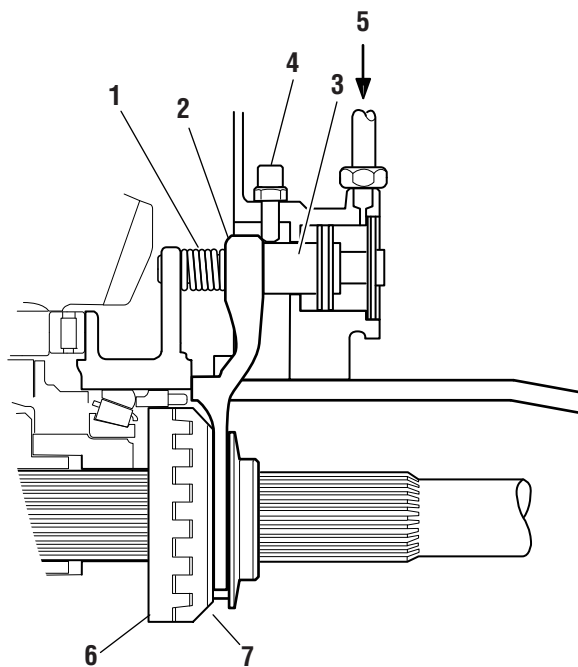
Differential Lock Engaged

Air pressure applied to the shift cylinder moves the piston, push rod, shift fork and the sliding curvic clutch engages the fixed curvic clutch.

The sliding clutch is splined to the axle shaft. The fixed clutch is splined to the differential case hub. Engaging the two clutches locks the wheel differential thus preventing wheel differential action.

Differential Lock Disengaged

When air pressure at the shift cylinder is released, a compression spring (mounted on the push rod) moves the push rod, shift fork and sliding clutch as an assembly. The sliding clutch moves out of engagement with the fixed clutch. The wheel differential is unlocked and operates normally.



Differential Lock Engaged

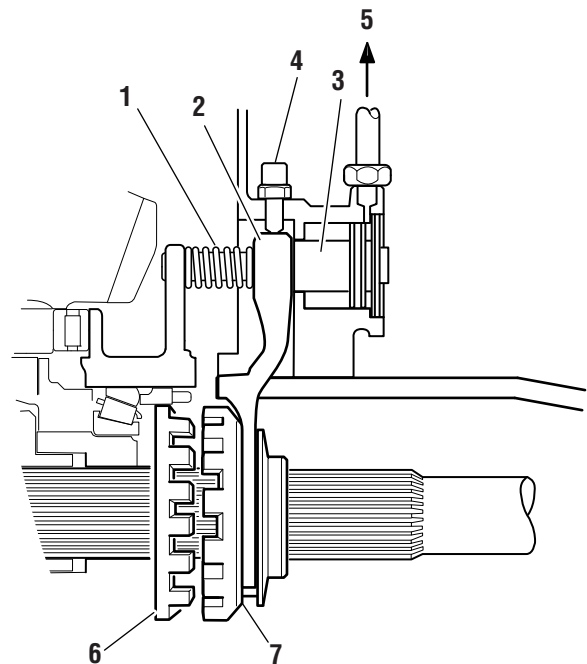
- 1 - Spring is compressed
- 2 - Shift fork
- 3 - Piston and rod
- 4 - Selector switch
- 5 - Air pressure applied engages clutches
- 6 - Fixed clutch splined to differential case
- 7 - Sliding clutch splined to axle shaft and engaged with fixed clutch

Differential Lock Engagement Indicator

Differential lock engagement is detected by a switch (electric) mounted on the differential carrier. An actuator, mounted in the piston cover, operates the switch.

When the shift fork moves to engage the differential lock, the push rod actuator moves away from the switch, allows the switch to close and send an electrical signal to turn on a cab-mounted indicator light (or an audible signal).

When the shift fork moves to disengage the differential lock, the compression spring also moves the push rod actuator to contact the switch. The switch is opened and turns off the cab-mounted indicator light (or the audible signal).



Differential Lock Disengaged

- 1 - Spring is decompressed
- 2 - Shift fork
- 3 - Piston and rod
- 4 - Selector switch
- 5 - Air pressure applied disengages clutches
- 6 - Fixed clutch splined to differential case
- 7 - Sliding clutch splined to axle shaft

Proper Vehicle Towing

Without Wheel Differential Lock

Lift the drive wheels completely off of the ground or damage will occur.

⚠ WARNING

Do not lift the front wheels (non-drive wheels). This alters the oil's position in the drive axle, draining it away from the drive pinion and its bearings. If the pinion is rotated under these conditions for any period of time, bearings will over-heat resulting in axle damage or failure.

If it is impossible to lift the drive wheels, remove all axle shafts to prevent gear rotation and cap the wheel hubs to prevent loss of lubricant and a possible road hazard. See the following section Proper Vehicle Towing with Wheel Differential Lock for removal procedure.

With Wheel Differential Lock

Follow this procedure to remove all axle shafts preventing gear rotation with the drive wheels and possible lubrication damage:

1. Engage the wheel differential lock, indicator light is on (move vehicle to verify engagement).
2. Shift transmission into neutral.
3. With vehicle stationary, release the air pressure on the wheel differential lock shift system and apply the parking brake.
4. Disconnect the air supply and fitting at the shift cylinder.
5. Install the shipping caps screw 128642 (0.250 X 18 X 1.5") NPSM screw. GM models require part number 128274 (M12 X 1.5 X 38mm) screw. Tighten caps screw to manually engage the wheel differential lock until the indicator light is on and the differential lock is completely engaged.
6. Remove the axle shafts.
7. Install temporary cover on hub to prevent contamination entering and also to prevent the loss of lubricant.

Fastener Torque Specifications

| Location | Size | Lb-Ft. | N•m |
|---------------------------------------|------------------|-----------|------------|
| WHEEL DIFFERENTIAL AND GEARING | | | |
| Front Pinion Helical Nut | M48 x 1.5 | 900 ± 100 | 1220 ± 135 |
| Output Shaft Nut | M42 x 1.5 | 900 ± 100 | 1220 ± 135 |
| Rear Pinion Nut | M48 x 1.5 | 900 ± 100 | 1220 ± 135 |
| Ring Gear, Diff. Case Bolts | M20 x 1.5 x 55 | 500 ± 25 | 675 ± 30 |
| CARRIER | | | |
| Carrier Diff. Bearing Cap | M18 x 1.5 x 85 | 265 ± 15 | 360 ± 20 |
| Carrier to Housing Cap Screws | M16 x 1.5 x 85 | 250 ± 15 | 335 ± 20 |
| | M16 x 1.5 x 55 | 250 ± 15 | 335 ± 20 |
| Carrier to Housing Nuts | M16 x 1.5 | 250 ± 15 | 335 ± 20 |
| Pilot Bearing Web | M16 x 1.5 x 70 | 210 ± 10 | 285 ± 15 |
| Differential Lock Switch | M14 x 1.5 | 10 ± 1 | 15 ± 3 |
| Differential Lock End Cap | 2.375 - 16 UN-2A | 65 ± 10 | 85 ± 15 |
| HOUSING | | | |
| Rear Cover Caps Screws | M16 x 1.5 x 70 | 250 ± 15 | 335 ± 20 |
| | M16 x 1.5 x 55 | 250 ± 15 | 335 ± 20 |
| Rear Cover Nuts | M16 x 1.5 | 250 ± 15 | 335 ± 20 |
| Magnetic Plug (Fill) | 1 x 11.5 NPTF | 50 ± 5 | 72 ± 5 |
| Drain Plug | 0.750 - 14 NPTF | 50 ± 5 | 72 ± 5 |
| Housing Breather | 0.375 - 18 NPTF | 20 - 26 | 27 - 35 |
| Temperature Sending Plug | 0.500 - 20 NPTF | 50 ± 5 | 72 ± 5 |
| Axle Shaft to Wheel Hub Nut | 0.625 - 18 | 180 ± 10 | 245 ± 15 |
| | 0.750 - 16 | 315 ± 30 | 425 ± 40 |
| Wheel Diff. Lock Caps | 2.37 - 16UN-2A | 65 ± 10 | 85 ± 15 |

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Dana Commercial Vehicle Products Group

3939 Technology Drive
Maumee, Ohio, USA 43537

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