



**Spicer® Tandem Drive Axles**

**Roadranger®** More time on the road™

# Service Manual

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**AXSM0057**

**January 2009**

D170 Series

D190 Series

D590 Series

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## General Inspection

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

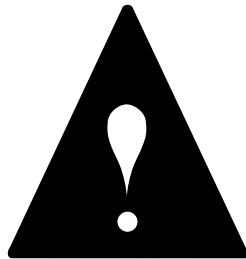
Dana Corporation reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

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.

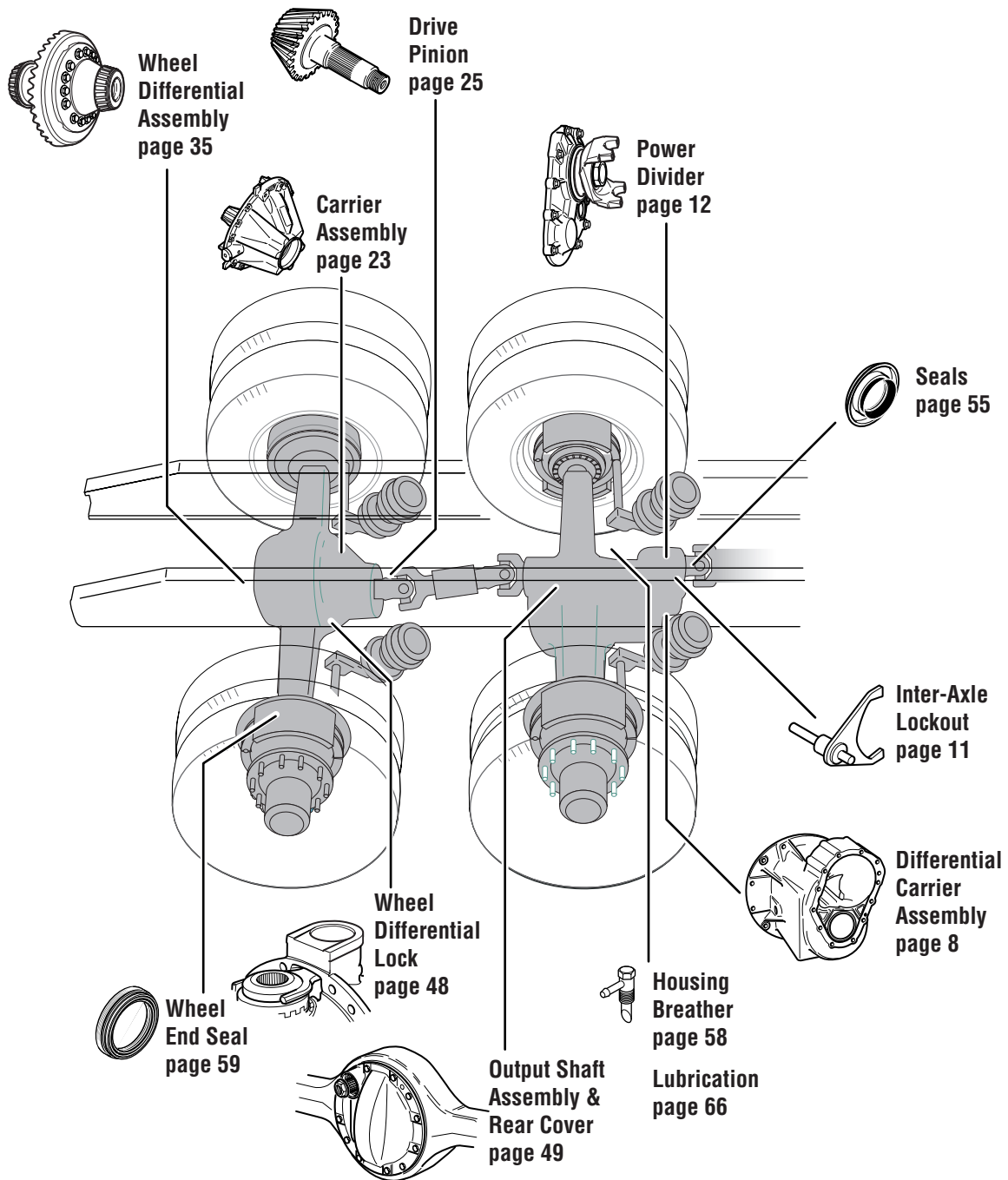
**IMPORTANT:** Highly recommended procedures for proper service of this unit.

**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 Dana replacement parts.***

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## Introduction

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

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

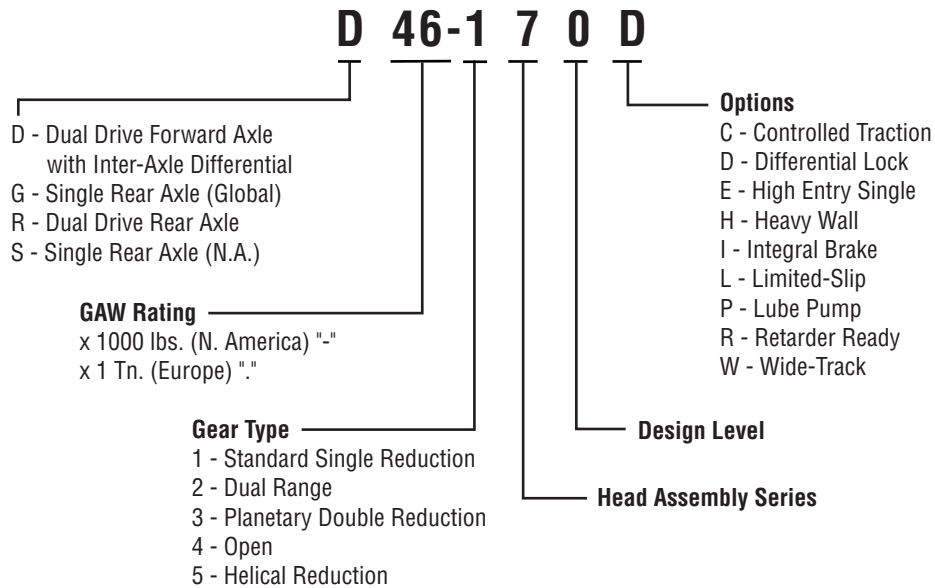
The suffix letter "P" in the model number indicates optional lube pump. The pump is designed to provide additional lubrication to the inter-axle differential and related parts.

## Model Information

The following models are included in this publication:  
Heavy Tandems

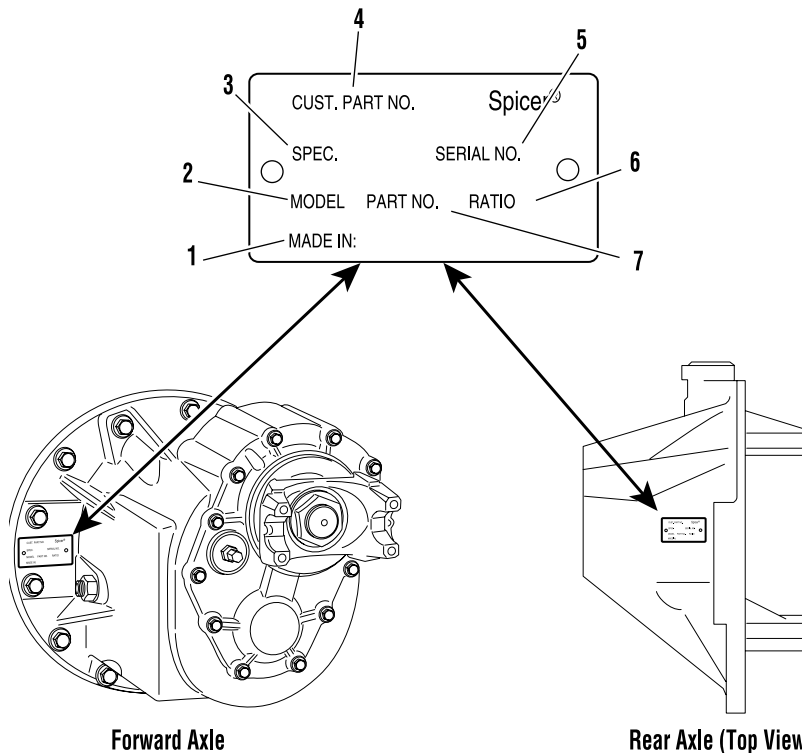
|              |           |
|--------------|-----------|
| D40-170      | D46-590HP |
| D40-170(P)   | D50-170   |
| D40-170D(P)  | D52-190P  |
| D46-170      | D52-190DP |
| D46-170(P)   | D52-590P  |
| D46-170D(P)  | D60-190P  |
| D46-170H     | D60-590P  |
| D46-170H(P)  | D70-190P  |
| D46-170DH(P) |           |

## Model Listing



## Model Identification

### Drive Axle

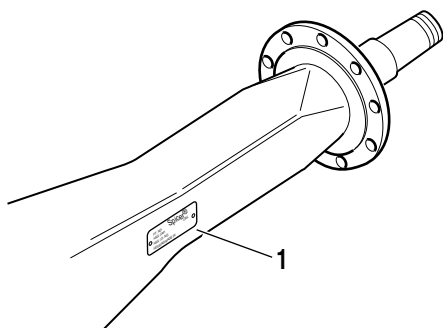


- 1 - Country or origin
- 2 - Axle model identification
- 3 - Specification number assigned to the axle built by Dana.  
Identifies all component parts of the axle including special OEM requirements such as yokes or flanges.

- 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

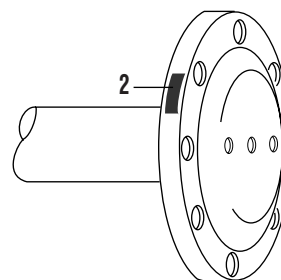
## Parts Identification

### Axle Housing



1 - ID Tag

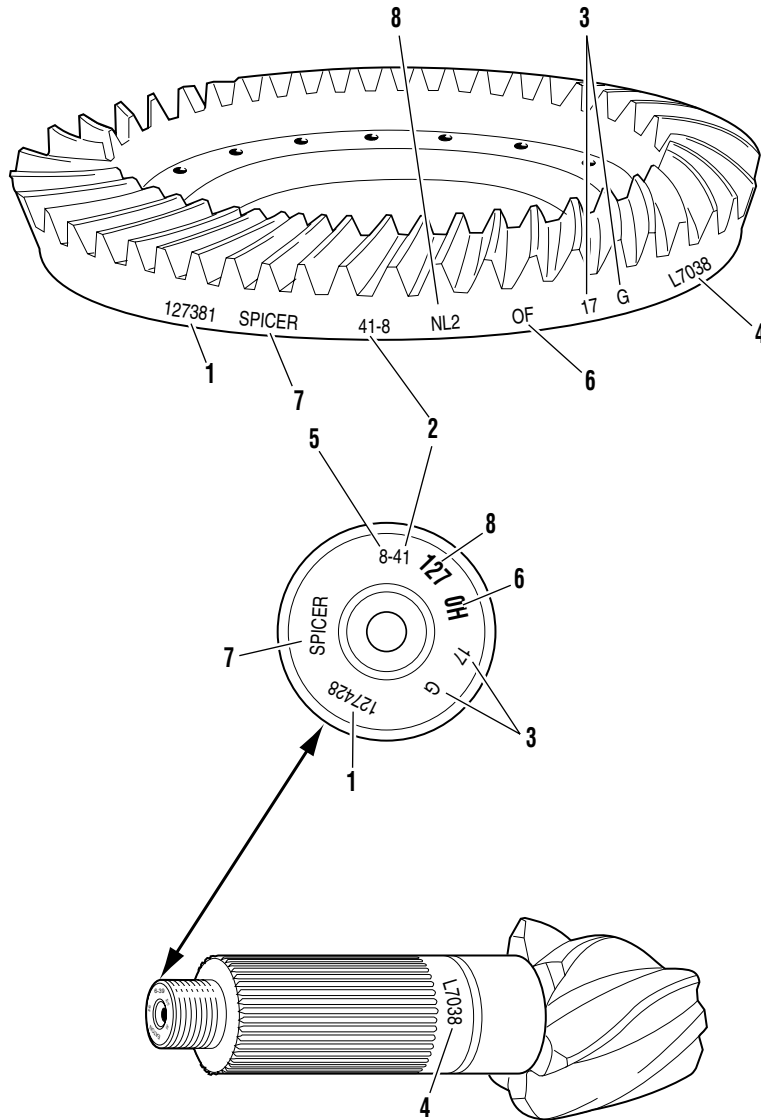
### Axle Shaft



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



## Failure Analysis

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

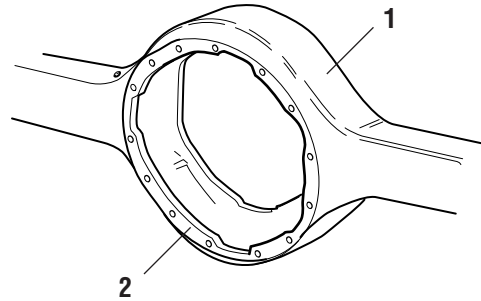
- Visually inspect axle housing for cracks, nicks, and burrs on machined surfaces.
- Check carrier bolt holes and studs for foreign material.
- Replace damaged fasteners. Look for loose studs or cross threaded holes.

**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

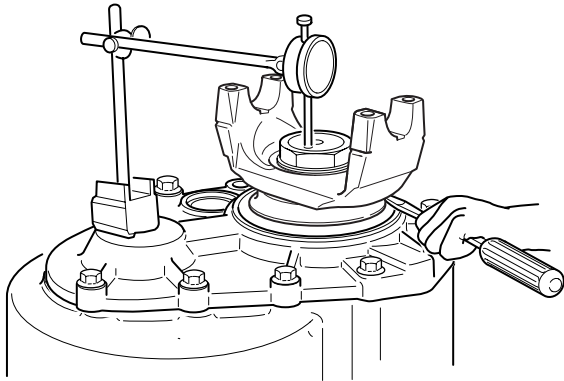
Before reusing a primary gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment.

## Endplay Procedure

### Check Input Shaft Endplay (Forward Axle)

**Note:** Before disassembling the power divider, measure and record input shaft endplay.

1. Position dial indicator at yoke end of input shaft.
2. Push in on input shaft and zero the dial indicator.
3. Using a pry bar, move input shaft axially and measure/record endplay.

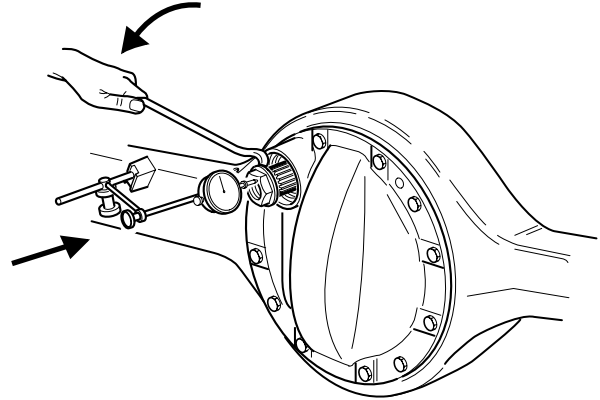


#### Adjustment

Correct endplay for a new assembly is 0.001" to 0.005". See the "Input Shaft Endplay" procedure in the "Power Divider Assembly" section for proper endplay adjustment procedure.

### Check Output Shaft Endplay (Forward Axle)

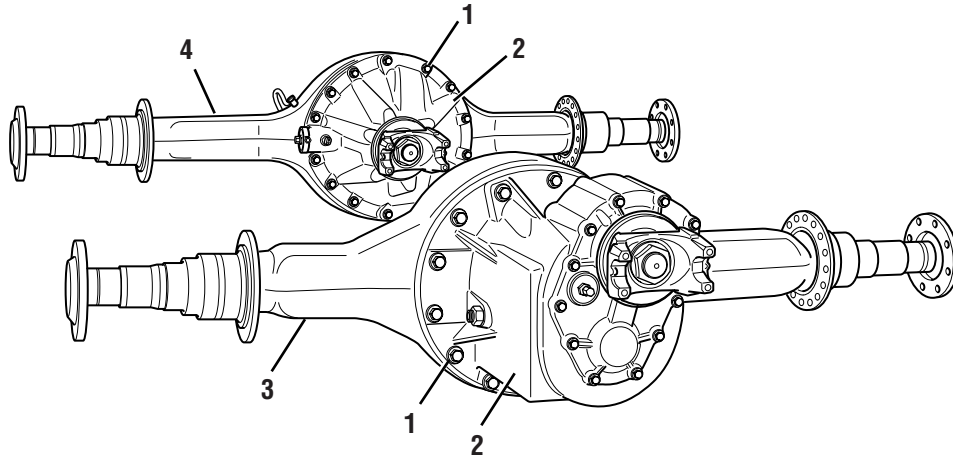
1. Position dial indicator at yoke end of output shaft.
2. Push in on output shaft and zero the dial indicator.
3. Using a pry bar, move output shaft axially and measure/record endplay.



#### Adjustment

Correct endplay for a new assembly is 0.001" to 0.045". The maximum endplay for a used assembly is no more than 0.045". If endplay is incorrect, contact Dana.

## Differential Carrier Assembly - Parts



- 1 - Carrier fasteners
- 2 - Carrier assembly
- 3 - Forward axle assembly
- 4 - Rear axle assembly

## Remove Differential Carrier - (Forward and Rear)

**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 Dana tandems require.

### Standard Differentials

1. Block the vehicle.
2. Drain axle lubricant.
3. **Rear Only:** Disconnect inter-axle driveline.
4. **Front Only:** Disconnect main driveline.
5. **Front Only:** Disconnect differential lockout air line.
6. Disconnect lead wires to the selector switch and air line at shift cylinder.
7. Remove axle shafts.

 WARNING

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

8. To remove axle shaft, remove axle stud nuts. (If used, remove lock washers and taper dowels.)
9. 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

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

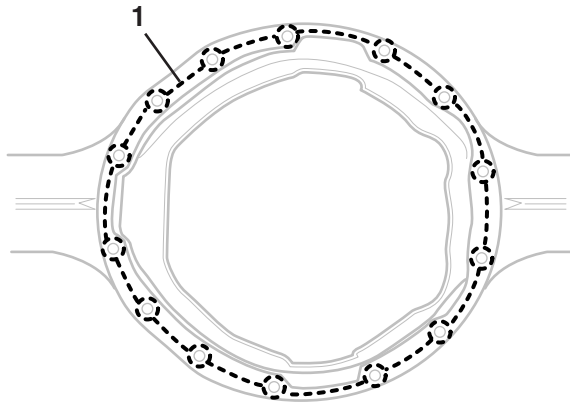
10. Remove carrier capscrews, nuts, and lock washers.
11. Remove differential carrier assembly.

## Install Differential Carrier (Forward and Rear)

**▲ IMPORTANT**

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

1. Apply Dana 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

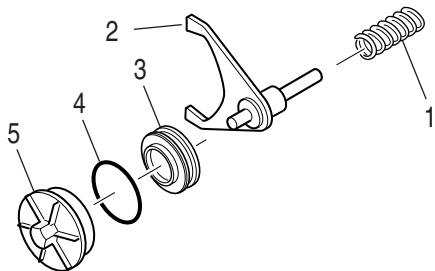
**Tip:** To assist in installing complete differential carrier use two pieces of threaded rod (M16 X 1.5) threaded into carrier capscrew holes. Rod should be approximately 6" long. Use these to pilot the carrier into the housing.

2. Install carrier to housing, lock washers, capscrews and nuts. Torque to proper specification. Torque to 250–290 lbs. 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. **Rear Only:** Connect inter-axle driveline, making sure all yokes are in phase. Lubricate u-joints.
6. **Front Only:** Connect main driveline, making sure all yokes are in phase. Lubricate u-joints.
7. **Front Only:** Connect differential lockout air line.

## IAD Differential Lock Disassembly

### Inter-Axle Lockout

#### Integral Shift Cylinder with Welded Push Rod Assembly



- 1 - Compression spring
- 2 - Shift fork assembly
- 3 - Piston
- 4 - O-ring
- 5 - Piston cover

#### Disassembly

1. With the axle installed in vehicle, place differential lock selector valve in the disengaged or unlocked position.
2. Disconnect the differential lockout air line.
3. Remove the piston cover.
4. Remove the piston and o-ring assembly with pliers.

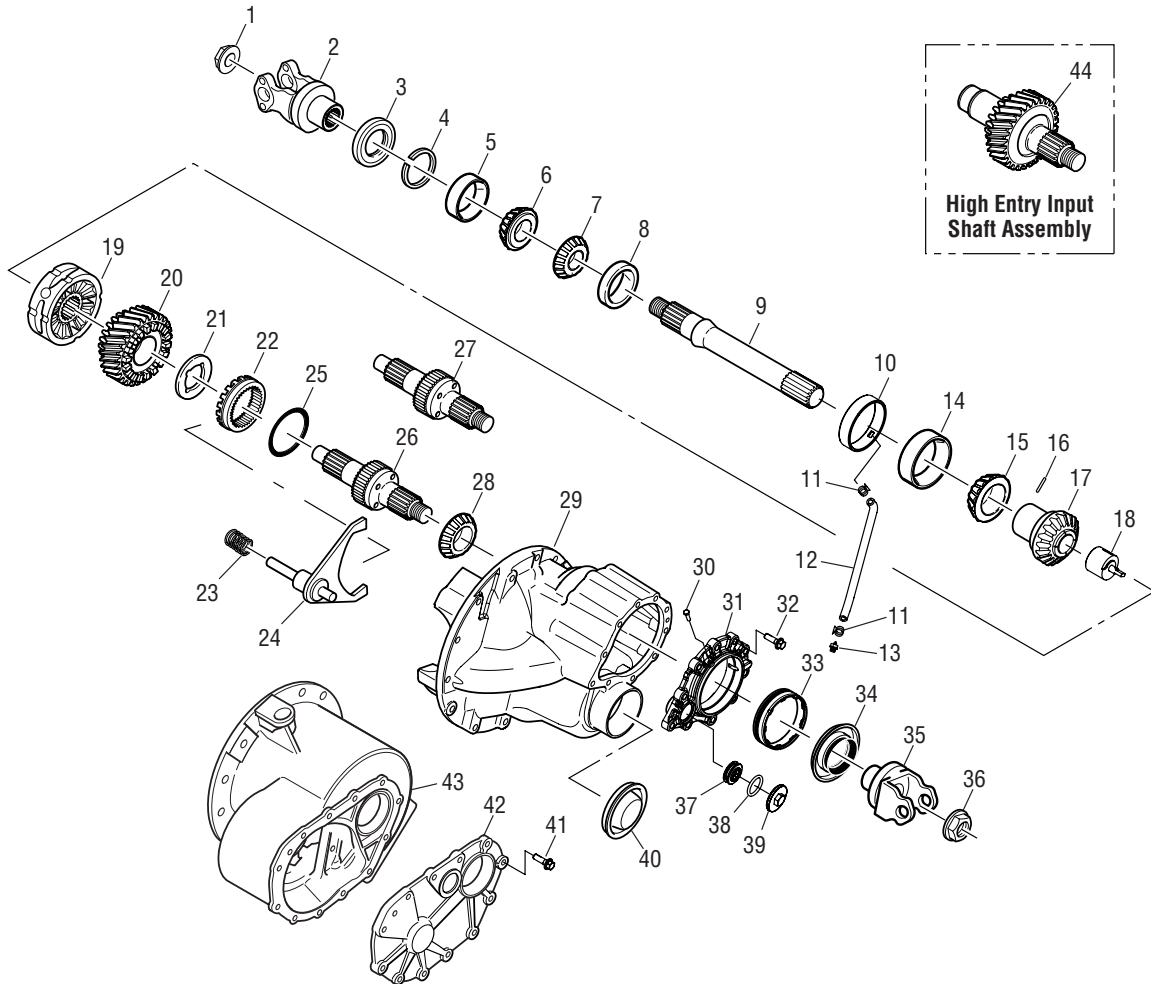
**Note:** In order to remove the shift fork and push rod parts, first remove the power divider cover. See the Power Divider section.

#### Assembly

1. Assemble the o-ring onto the piston. Apply silicone grease to the o-ring.
2. Gently push the piston o-ring assembly into the lockout cylinder bore. Make sure the piston assembly is pushed in all the way.
3. Install the piston cover. Tighten by hand and then torque from 50-75 lbs. ft. (68-102 N•m).
4. Connect the differential lock air line.
5. Cycle the lockout to make sure there are no leaks and the system is operating properly.



## Power Divider - Parts Exploded View



- |                                    |                               |                           |
|------------------------------------|-------------------------------|---------------------------|
| 1 - Output shaft nut               | 16 - Pin                      | 31 - Input cover          |
| 2 - Output yoke                    | 17 - Output side gear         | 32 - Input cover capscrew |
| 3 - Output seal                    | 18 - Pump                     | 33 - Bearing cup and cage |
| 4 - Output shaft bearing snap ring | 19 - Inter-axle differential  | 34 - Input seal           |
| 5 - Outer bearing cup              | 20 - Helical side gear        | 35 - Input yoke           |
| 6 - Outer bearing cone             | 21 - Thrust washer            | 36 - Input nut            |
| 7 - Inner bearing cone             | 22 - Lockout sliding clutch   | 37 - Piston               |
| 8 - Inner bearing cup              | 23 - Shift fork spring        | 38 - O-ring               |
| 9 - Output shaft                   | 24 - Shift fork assembly      | 39 - Piston cover         |
| 10 - Seal manifold                 | 25 - V-ring                   | 40 - Pinion cover         |
| 11 - Clamp                         | 26 - Input shaft              | 41 - Input cover capscrew |
| 12 - Seal manifold feed tube       | 27 - Input shaft              | 42 - Input cover          |
| 13 - Sump screen                   | 28 - Input shaft bearing cone | 43 - Carrier housing      |
| 14 - Output side gear bearing cup  | 29 - Carrier housing          |                           |
| 15 - Output side gear bearing cone | 30 - Locking capscrew         |                           |

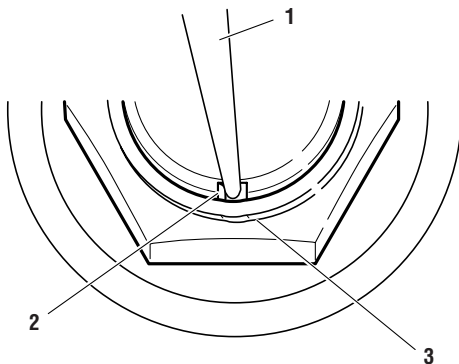
## Power Divider Disassembly - Forward Carrier Assembly

Use these instructions with the carrier assembly in or out of the vehicle.

1. Disconnect the main driveline.
2. Disconnect the lockout airline.
3. Drain the axle lubricant into a clean oil pan.
4. Remove the input yoke nut and yoke.
5. 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 input shaft threads when the nut is removed. See diagrams 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

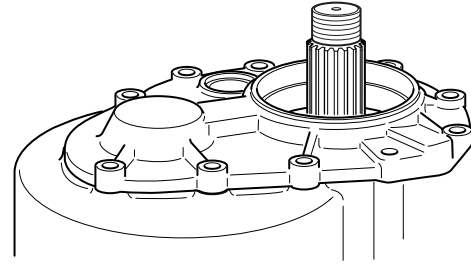
6. Remove the input seal.

**Note:** Do not reuse the seals after disassembly.

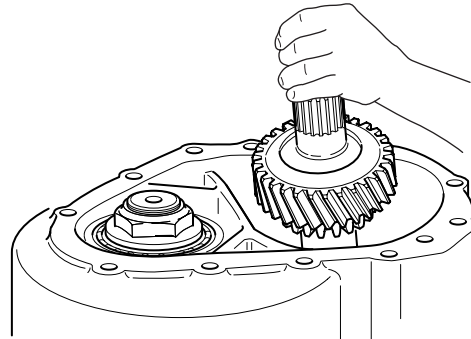
7. Remove the power divider cover assembly. Use the tabs provided to free the cover from the carrier assembly.

**CAUTION**

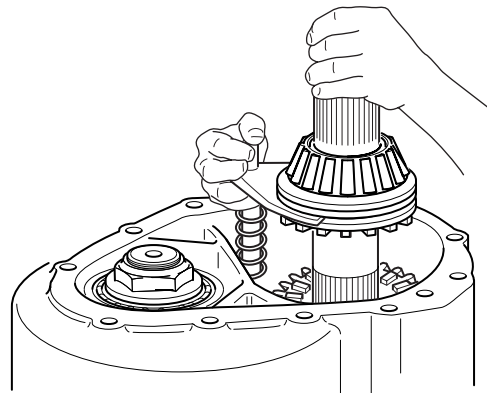
**During removal of the power divider cover, the inter-axle differential (IAD), input shaft assembly or IAD shift system may fall from the carrier if not careful. Use caution to prevent injury or damage.**



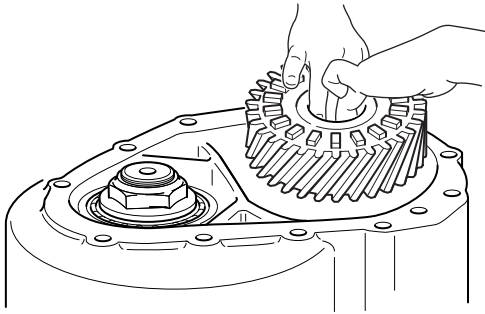
8. **For High Entry Applications Only:** Remove the input shaft and gear assembly. Proceed to step 13.



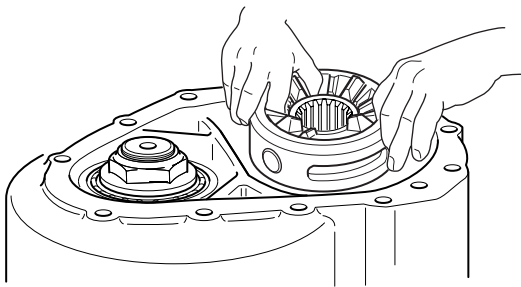
9. Remove the input shaft, sliding clutch, shift fork and spring as an assembly.



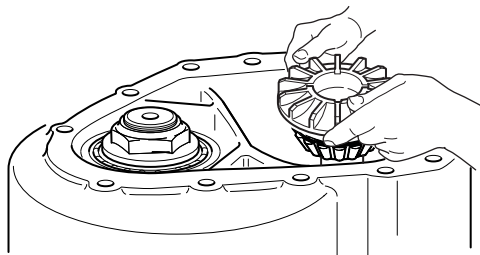
10. Remove the thrust washer and helical side gear.



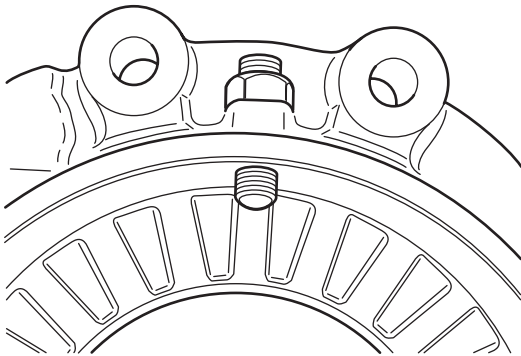
11. Remove the inter-axle differential assembly.



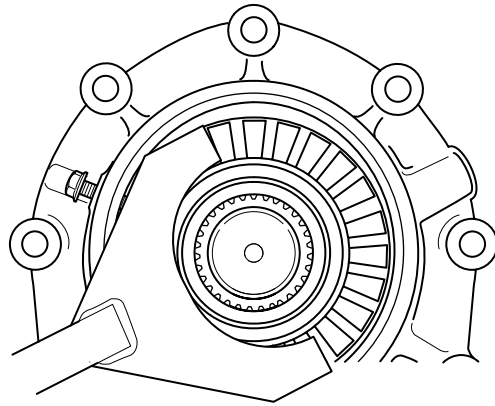
12. Remove the output side gear and pump assembly.



13. To replace the input bearing cup, back off the bearing cage locking fastener or jam nut and stud.



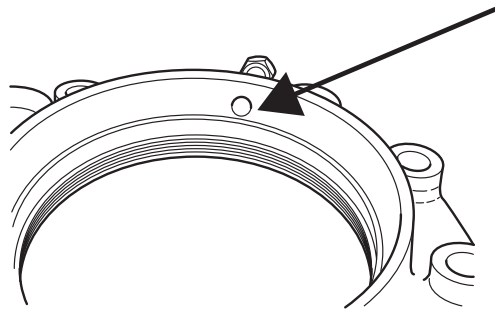
14. Input cage is threaded into the PDU cover, use the proper tool to remove the cage from the cover.



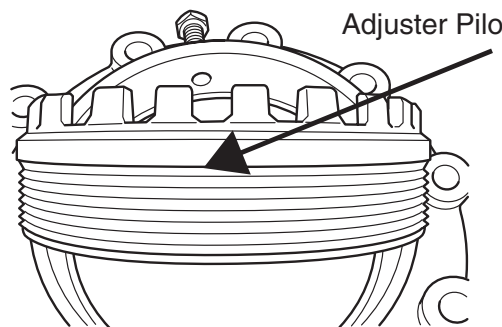
15. Use a suitable bearing puller to replace the input bearing cup.

**Note:** In August of 2006 the piloted input adjuster design was implemented. The lockin and fastener was replaced with a 12mm stud and jam nut. It is not recommended that the piloted designed adjuster and cover be mixed with the non-piloted design.

Cover Pilot



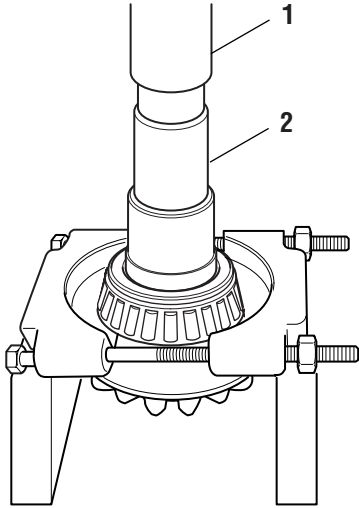
Adjuster Pilot



## Pump Disassembly

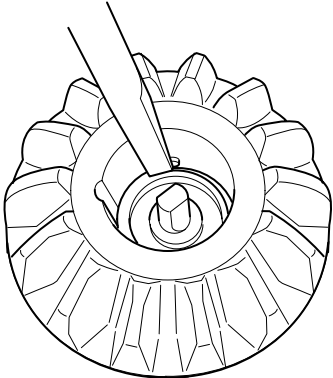
For output side gear and/or pump replacement, follow the procedure below.

1. Remove the output side gear bearing cone, if required.

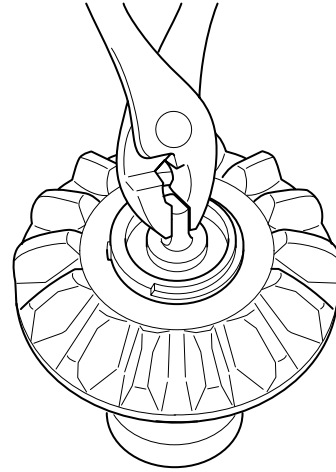


1 - Press  
2 - Press Tool

2. Remove pump locking dowel pin from the hole in the output side gear hub.



3. Remove pump from the output side gear.



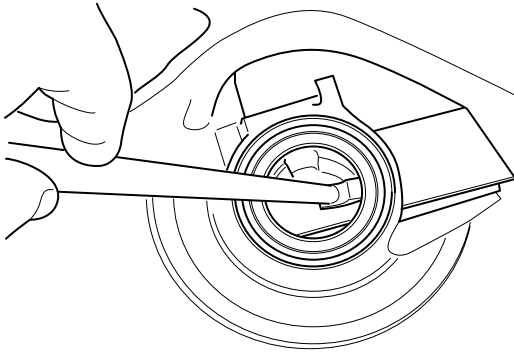
4. Remove the output side gear bearing cup from the carrier with the proper bearing puller tool.

## Lube Manifold Disassembly

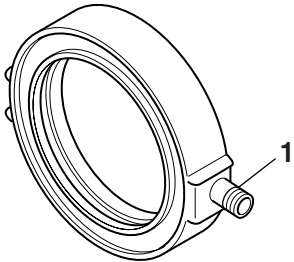
1. Disconnect the hose from the lube manifold.
2. Remove the manifold assembly by prying it out around the inner diameter.

 IMPORTANT

Once removed, the seal manifold assembly cannot be reused. This component should always be replaced with new. Use the same removal procedure for the output side gear seal removal on the non-pump models.



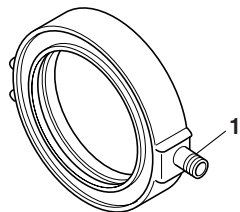
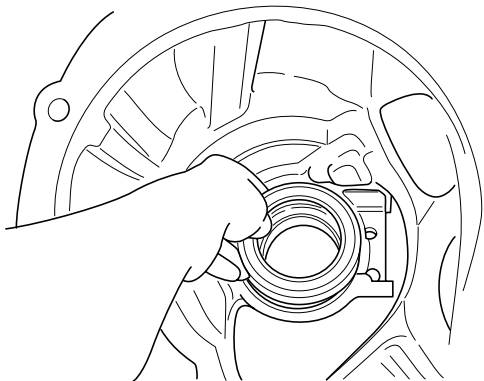
**Note:** Seals are not sold separately from the manifold.



1 - Barbed Nipple

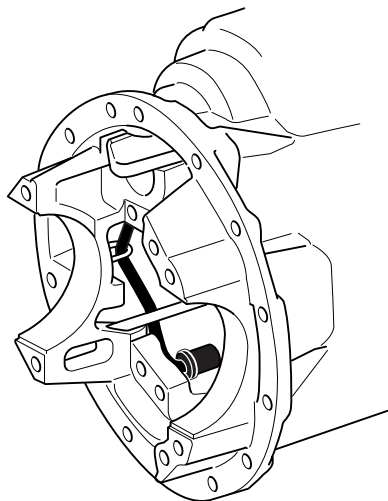
## Manifold Assembly

1. Install the manifold assembly into the output side gear bore in the carrier. Make sure the barbed nipple is lined up with the opening in the carrier casting.



1 - Barbed Nipple

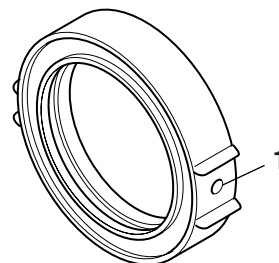
2. Install the hose clamp on the hose, push the hose onto the barbed fitting and slide the clamp over the barbed nipple.
3. Route the suction end of the hose through the holes in the carrier casting to the bottom of the carrier.



4. Fully press the manifold assembly into position.

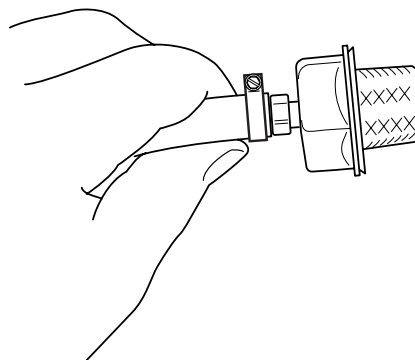
**Note:** Use care when pressing the manifold assembly to avoid damaging the seals and barbed nipple. Do not over-press plastic.

**Note:** For non-pump manifold installation, it is important to line up the oil inlet path hole in the manifold with the oil path opening in the carrier manifold casting.



1 - Manifold Oil Inlet Hole

5. Attach the suction screen to the end of the hose.



If the unit does not have a pump, go to the Power Divider Assembly section.

If the unit contains a pump, go to the Pump Assembly section.

## Pump Assembly

Use these instructions with the carrier assembly in or out of the vehicle.

If the unit does not have a pump, go to the Power Divider Assembly section.

**Note:** Keep work area clean. Dirt is an abrasive and will cause premature wear of the otherwise serviceable parts.

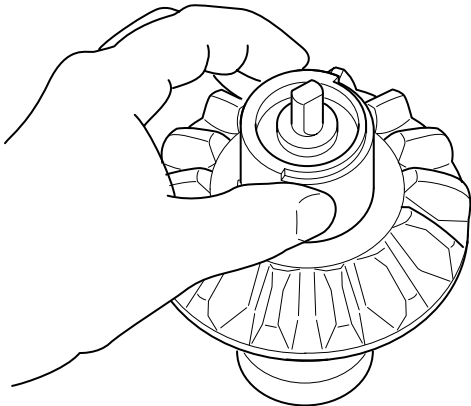
**Note:** For non-pump models, see page 17 for output side gear seal manifold installation.

**Note:** Only service the power divider if the differential carrier is secured in a stand or while the axle is still attached to the housing.

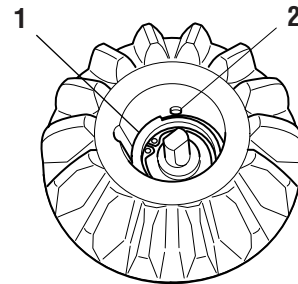
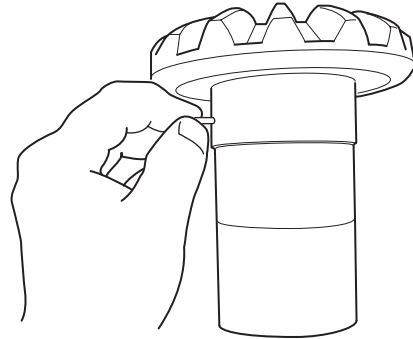
**CAUTION**

**During installation of power divider cover, the inter-axle differential (IAD), input shaft assembly or IAD shift system parts may fall from the carrier if not careful. Use caution to prevent injury or damage.**

1. Install the pump into the output side gear so that the pump shaft is facing toward the teeth end of the side gear.



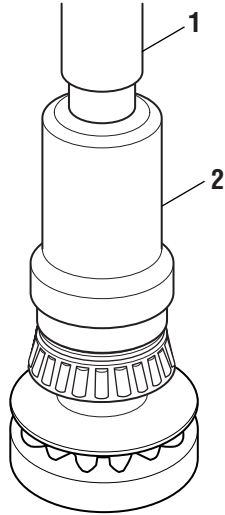
2. Install the pump locking dowel pin into the hole in the output side gear hub. Make sure the pin is lined up with the machined slot in the pump body.



1 - Machined Slot  
2 - Pin

## Power Divider Assembly

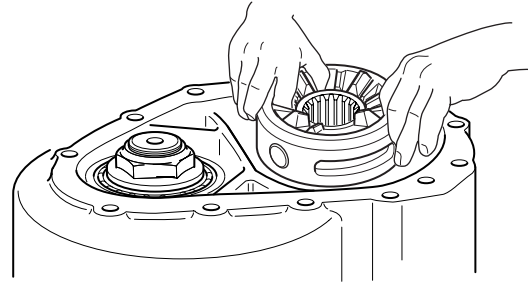
1. Install output side gear bearing cone and press until fully seated. Use proper press tools.



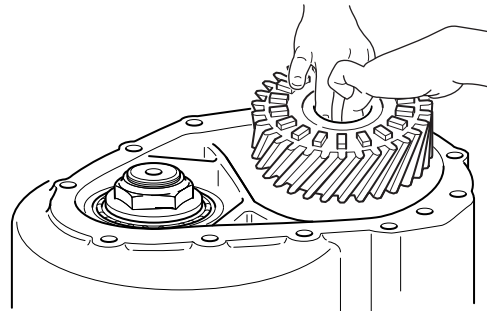
1 - Press  
2 - Press Tool

2. Fully press the output side gear bearing cup into the carrier seat.

**Note:** Install in the same direction as removed.



5. Install the helical side gear so that the clutch teeth are facing upward in the carrier.



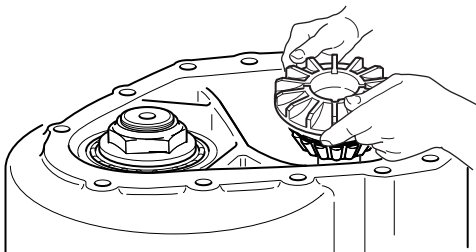
6. Install helical side gear thrust washer.

### ▲ IMPORTANT

When inserting the input shaft assembly through the IAD components, turn the shaft as necessary to align the slot of the input shaft with the pump drive shaft. The keyway on the threaded end of the input shaft is aligned with the pump driver slot. This can be used as a visual aid during assembly.

3. Install the output side gear. Apply a thin layer of oil to the output side gear boss before installing into the seal.

**Note:** For non-pump models, fill bore of output side gear models with synthetic grease.

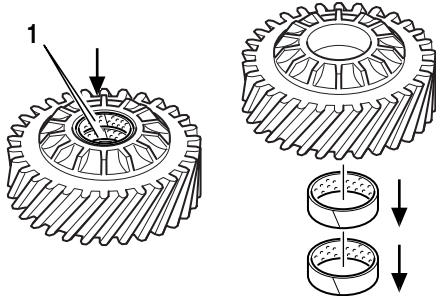


4. Install the inter-axle differential.



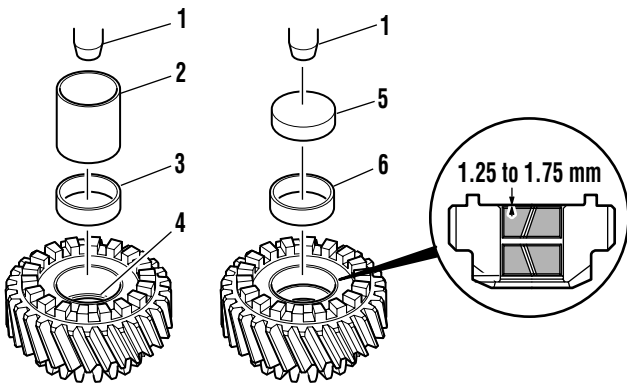
## Helical Gear Bushing Replacement:

- a. If bushing removal is needed, the bushings must exit from the thrust side of the helical side gear.



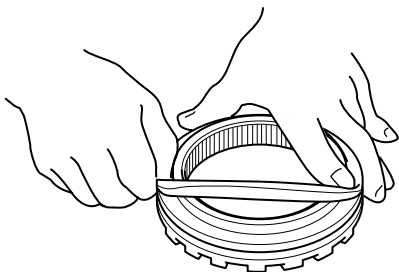
1 - Tap out bushings

- b. Install bushings in helical side gear. Bushing must be installed from the thrust side of the helical side gear. See illustration for installation depth.

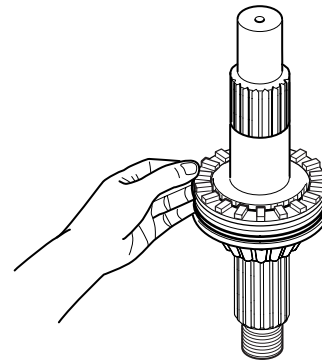


- 1 - Press
- 2 - Sleeve
- 3 - 1st bushing (press to shoulder)
- 4 - Shoulder
- 5 - Sleeve
- 6 - 2nd bushing (recess 1.25 to 1.75 mm)

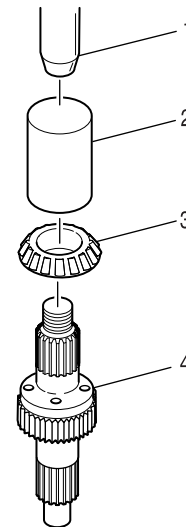
7. Install the helical side gear thrust washer.
8. Install the v-ring seal to the sliding clutch.



9. Install the sliding clutch so that the teeth are facing up.

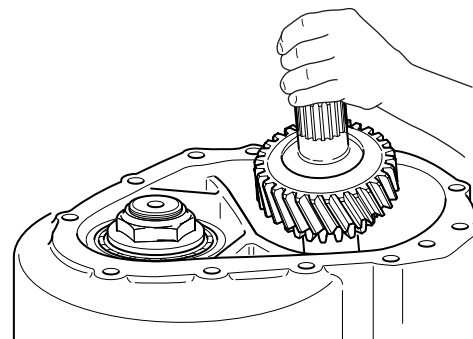


10. If removed, press the new input bearing cone in place until seated using the proper press sleeve or bearing installer.

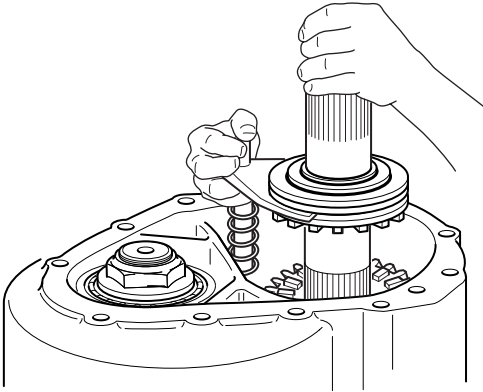


- 1 - Press
- 2 - Press Tool
- 3 - Bearing
- 4 - Input shaft

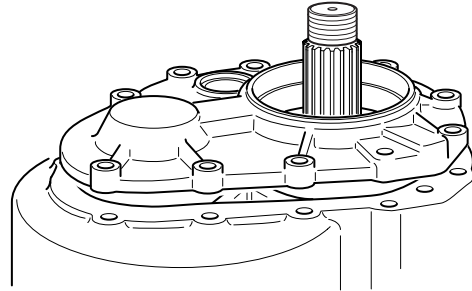
11. **For High Entry Applications Only:** Install shaft/gear assembly. Proceed to step 13.



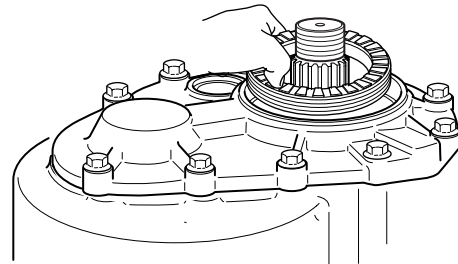
- Assemble the sliding clutch, shift fork and fork spring to the input shaft and install assembly into carrier. Make sure that the shift fork rod is piloted in the carrier bore.



- Install input cover and capscrews. Torque to the proper specifications. See the Torque Chart on page D-1. Tighten fasteners in a criss cross pattern.



- Install input shaft bearing adjuster, adjust inward until snug against the bearing cone.

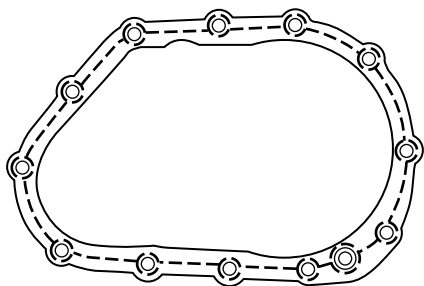


**▲ IMPORTANT**

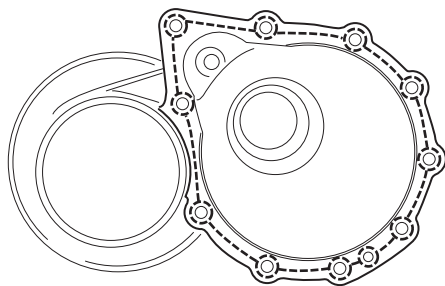
**Before installing input cover, inspect and thoroughly clean mating surfaces using an appropriate solvent and clean rag.**

**Note:** Completely remove all old gasket material prior to applying new Loctite.

- Apply a bead of Loctite 518 to the carrier surface as shown in the illustration.



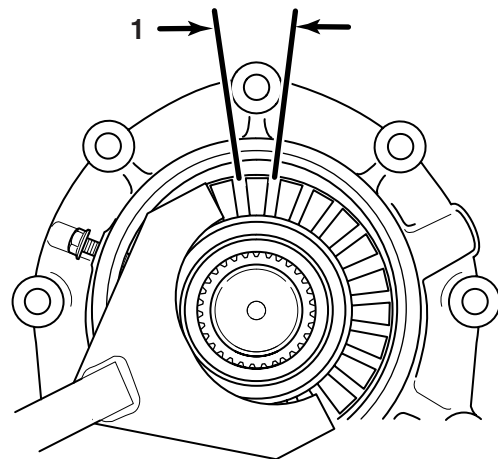
190 Cover



170 Cover

### Input Shaft Endplay

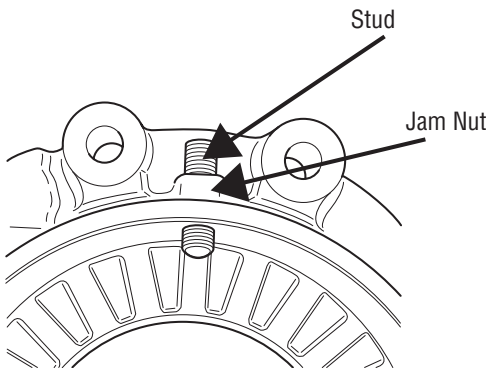
- Back off input bearing cage one notch and check endplay. Endplay should be between 0.001" to 0.005" (0.03 to 0.13 mm). Rotate cage in or out to get proper setting.



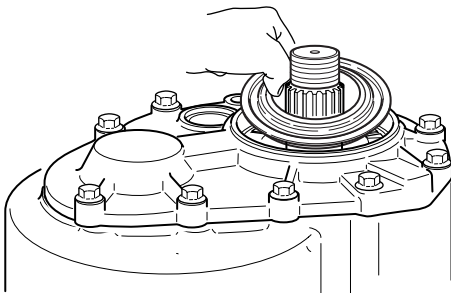
1 - One Notch

17. **A. For axles built before August 2006.** Line up cage slot with locking fastener. Turn in input cage locking fastener and torque to the proper specifications. See Torque Chart.

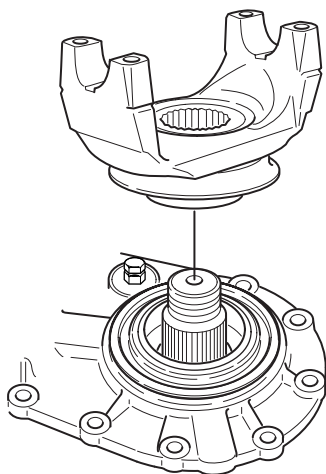
**B. For axles built after August 2006 using the piloted adjuster and cover.** Torque locking stud to 20 ft. lbs. then torque jam nut to 65 ft. lbs.



18. Install input seal using proper installation tool.



19. Install yoke and slinger assembly.

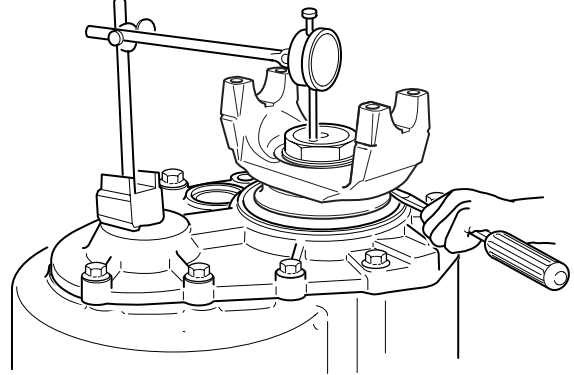


20. Install input shaft flanged nut and torque to the proper specifications. See Torque Chart.

**Note:** A torque multiplier is recommended. If difficulty achieving correct torque, torque the nut with the truck wheels on the ground and with the axle shaft installed.

21. Verify that the endplay is between 0.001" to 0.005" (0.03 to 0.13 mm). If not, readjust until the proper specification is achieved.

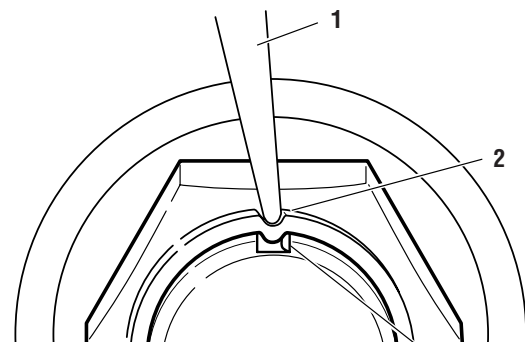
**Note:** High entry models should be set to an endplay of 0.001" to 0.005".



22. 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 input shaft. See diagram below.



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

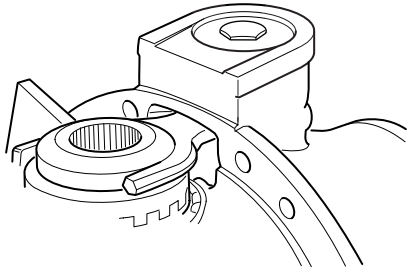
**WARNING**

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.

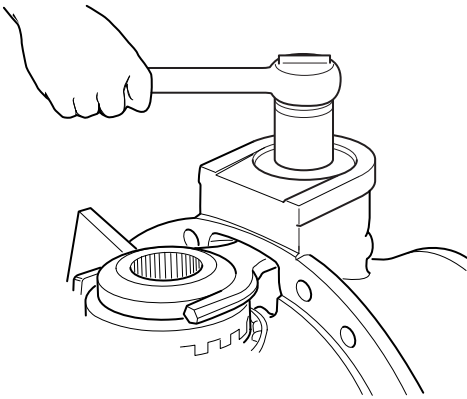
## Carrier Disassembly - Forward Carrier Assembly

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

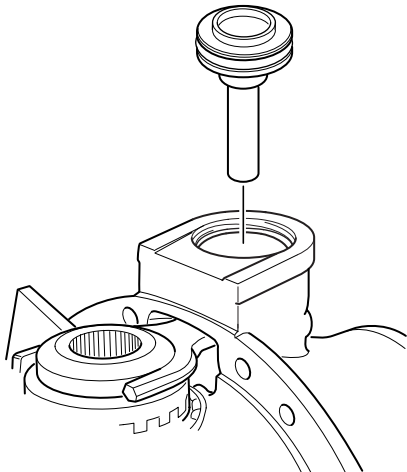
1. For ease of service, mount differential carrier in head stand with the differential lock facing up.



2. Remove the threaded cylinder cap.

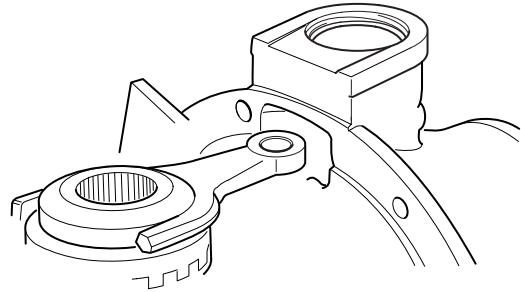


3. Remove the piston push rod from the shift fork.

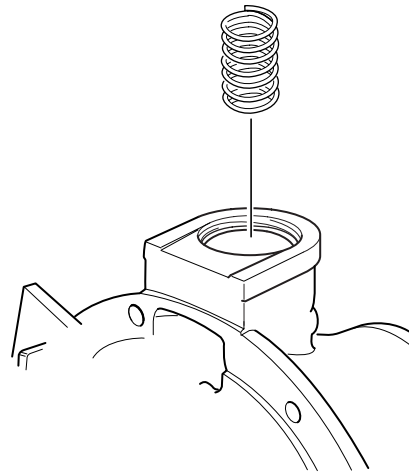


4. Remove the shift fork and sliding clutch assembly.

**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.

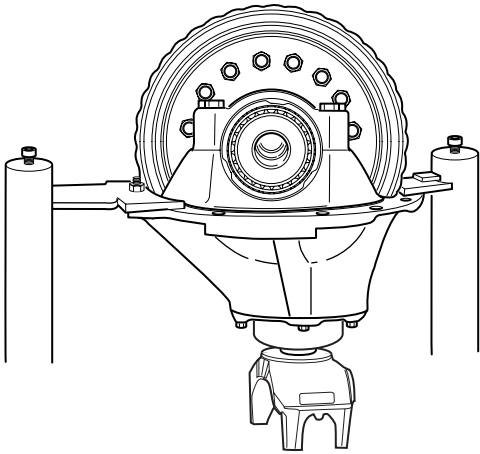


5. Remove the shift fork spring.

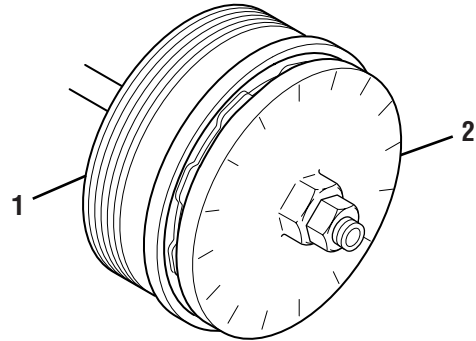


**Note:** Omit this step if the ring gear is to be replaced. If the ring gear is to be reused, check the tooth contact pattern and ring gear backlash before disassembling the carrier assembly. When checking the backlash, a yoke or helical gear must be installed and torqued to the proper specification 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.



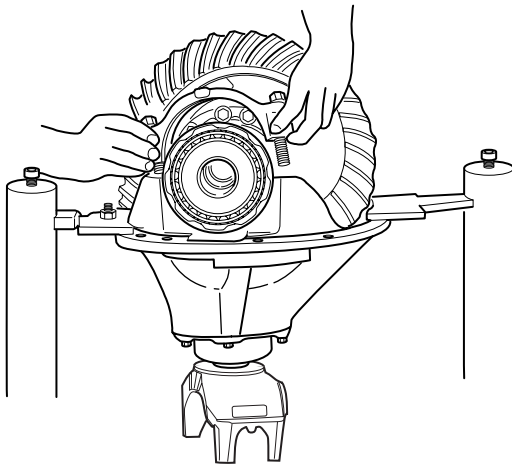
8. Use Dana's wheel diff. bearing adjustment tool (part number 513061) to back off the threaded cups and remove.



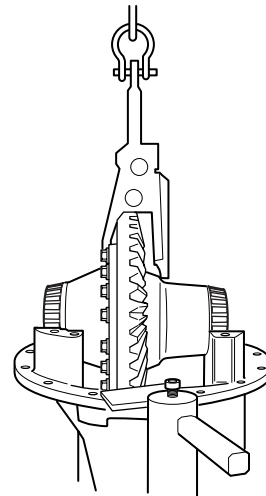
1 - Threaded bearing cup  
2 - Adjustment plate

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

7. Remove the carrier differential bearing cap capscrews and bearing caps.

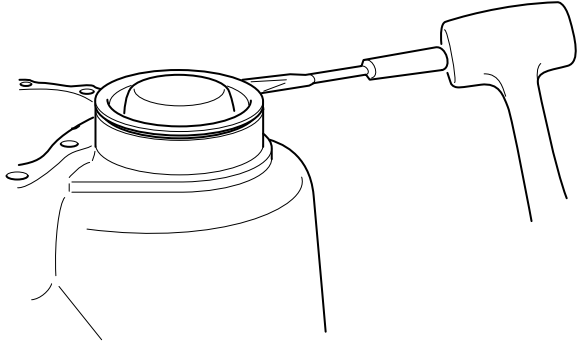


9. Use a chain hoist and the proper strap, lift the ring gear and wheel differential assembly from the carrier.

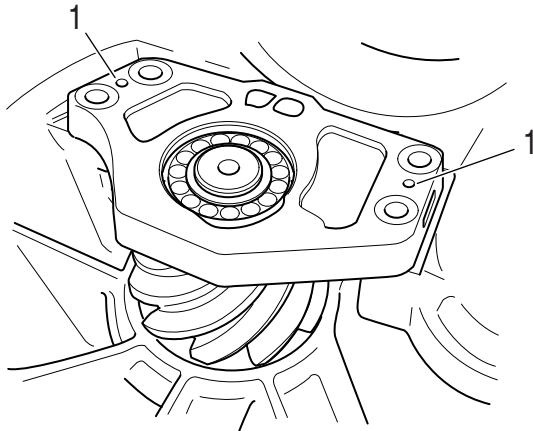


## Pinion Removal

1. For D170 assembly, remove the pinion cover. Use a flat chisel to remove the cover from the carrier.

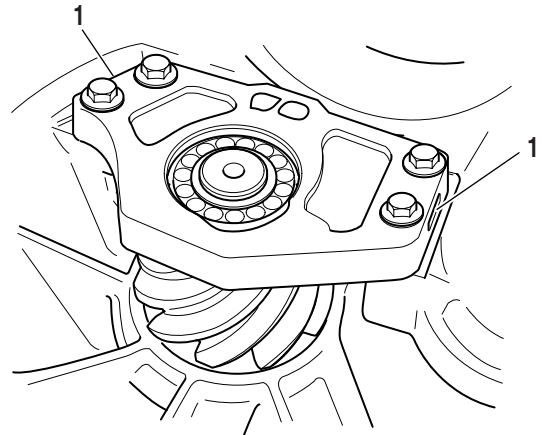


2. If a pilot web is used, remove the web capscrews.
  - a. For D190 disassembly, install a M10 x 1.5 bolt in the threaded jack holes found in-between the pilot web capscrews.



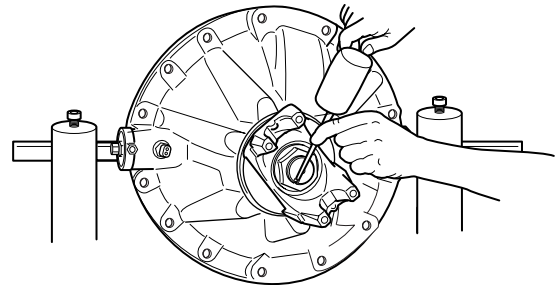
1 - Threaded Jack Holes

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



1 - Slots

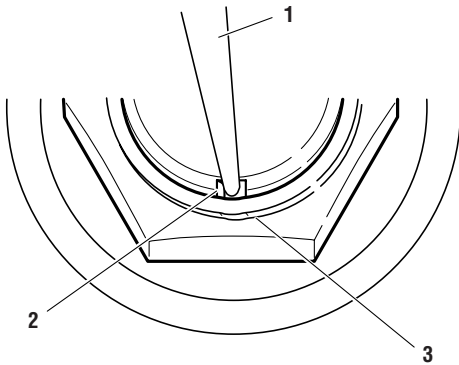
3. Before the pinion nut can be loosened, you must de-stake the nut from the slot of the pinion.



4. 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 on next page.

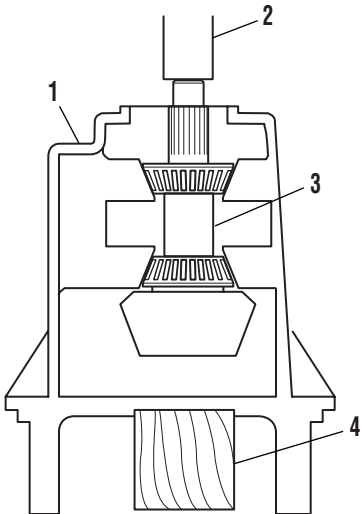
**CAUTION**

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.



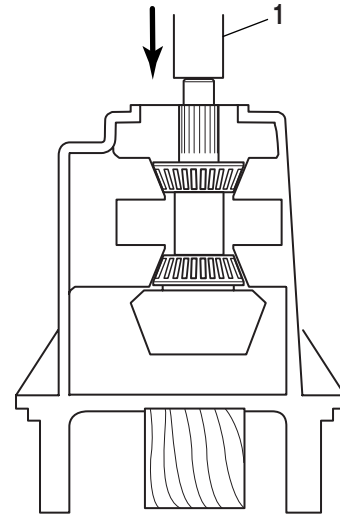
1 - Round Tipped Chisel  
2 - Machined Slot In Pinion  
3 - Nuts Staking Flange

- Remove the pinion nut.
- 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.



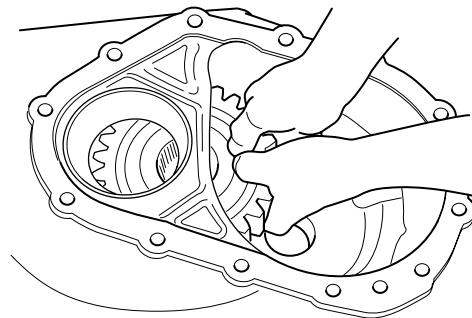
1 - Carrier Assembly  
2 - Press  
3 - Pinion  
4 - Wood Block

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



1 - Press

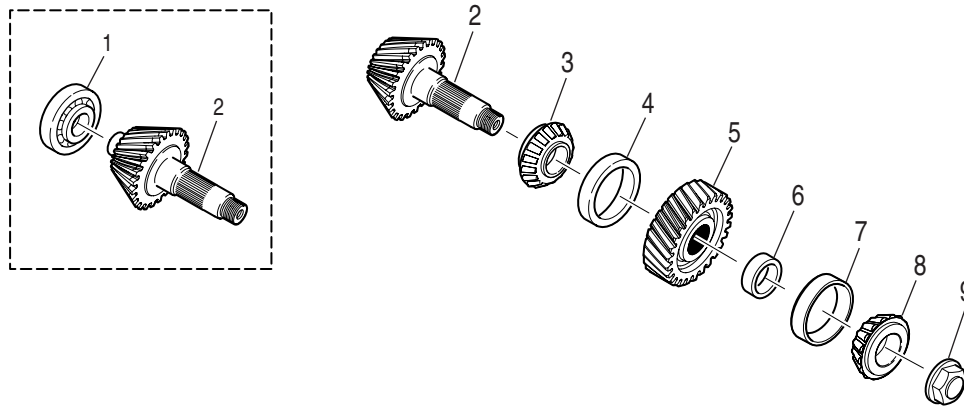
- Forward Axles Only:** Remove the pinion spacer and the helical gear.



**IMPORTANT**

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

**Forward Axle Pinion Assembly - Parts Exploded View**

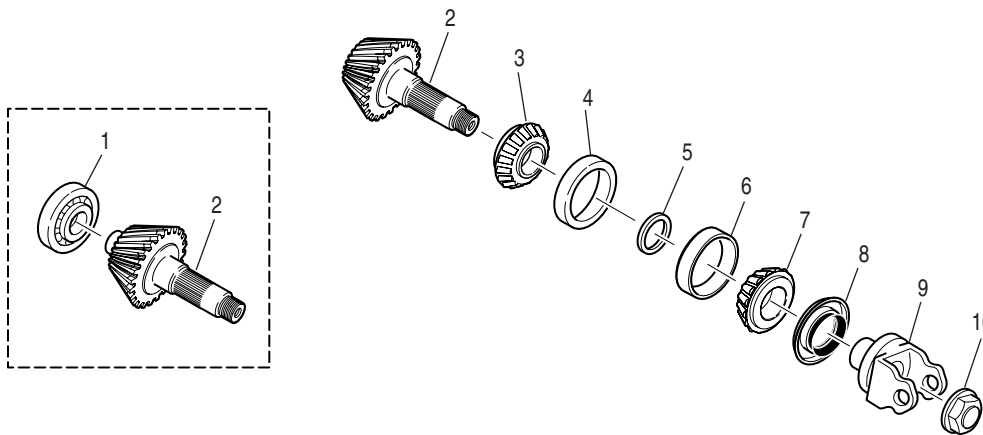


- 1 - Pinion pilot bearing
- 2 - Pinion
- 3 - Pinion bearing cone - inner

- 4 - Pinion bearing cup - inner
- 5 - Pinion helical gear
- 6 - Pinion bearing spacer

- 7 - Pinion bearing cup - outer
- 8 - Pinion bearing cone - outer
- 9 - Pinion nut

**Rear Axle 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



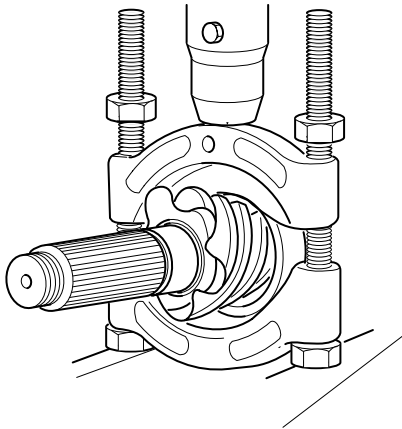
## Drive Pinion Overhaul and Assembly - Forward and Rear Carrier Assembly

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.

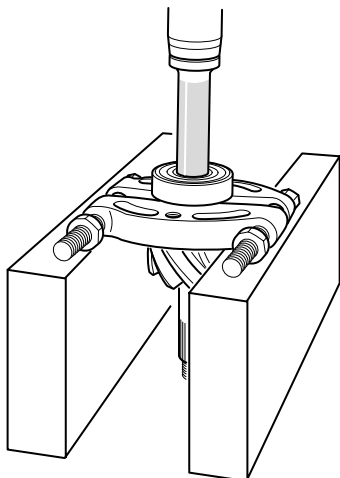
The following procedure covers both the forward and rear axle carrier overhaul and assembly.

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

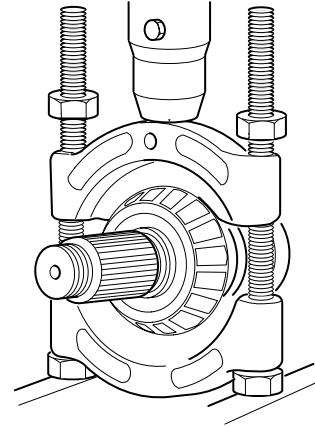
1. If the model of axle uses a pilot bearing, remove the bearing using a split-type puller. Use two procedure steps to remove each bearing.
  - a. Mount the puller vertically to separate the bearing from the pinion. This action will force the puller halves behind the bearing race and start moving the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



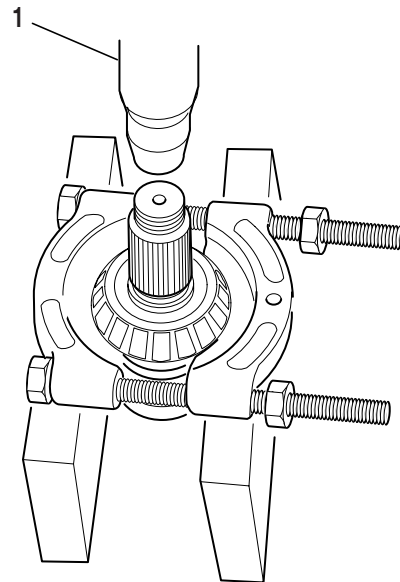
- b. Mount the puller horizontally to press the bearing from the pinion.



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.



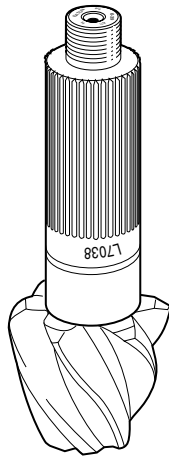
1 - Press

**▲ IMPORTANT**

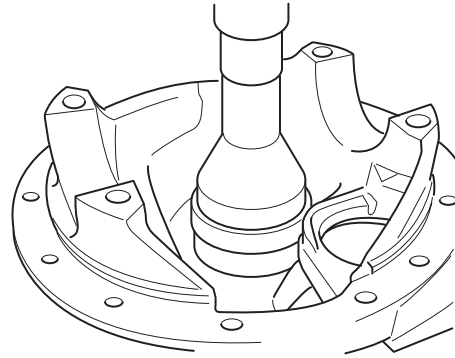
Use the correctly sized spacer. Do not use shim stock or grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

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.



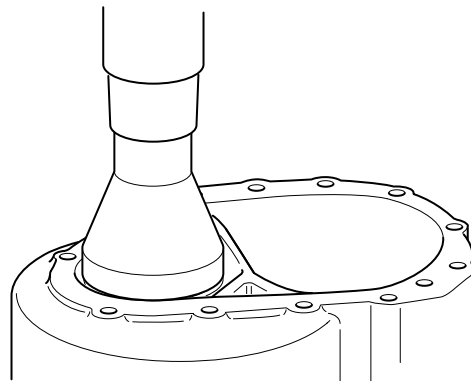
- c. If replacement of the output shaft side gear bearing cup is necessary, use either of the following methods:

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

**Hammer:** Use slipper to get under the cup and with a hammer and drift from the back side of carrier tap out bearing cup.

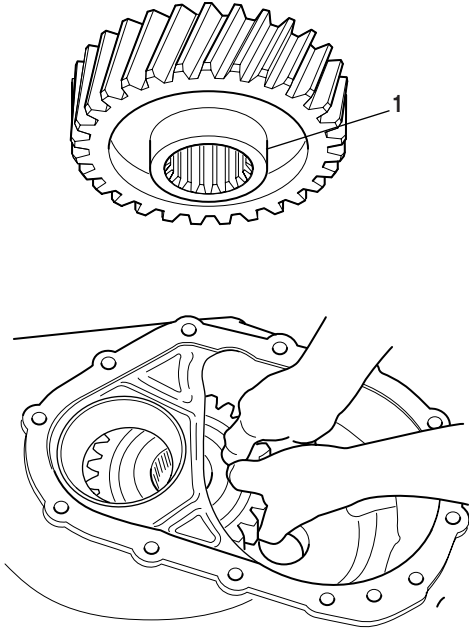
- d. To install the outer bearing cup, place the carrier in a press with the top of the carrier facing up.

- 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.



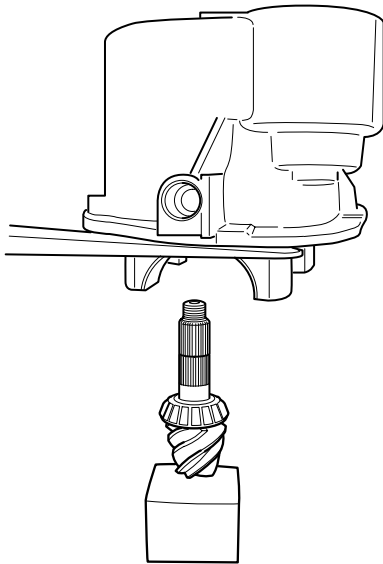
**Note:** If a press is not available, use a sleeve or bearing driver and a hammer to install the cups.

5. **For Forward Carriers Only:** Install the helical with the larger boss side facing down in the carrier. Align the helical gear between the inner and outer bearing cups.

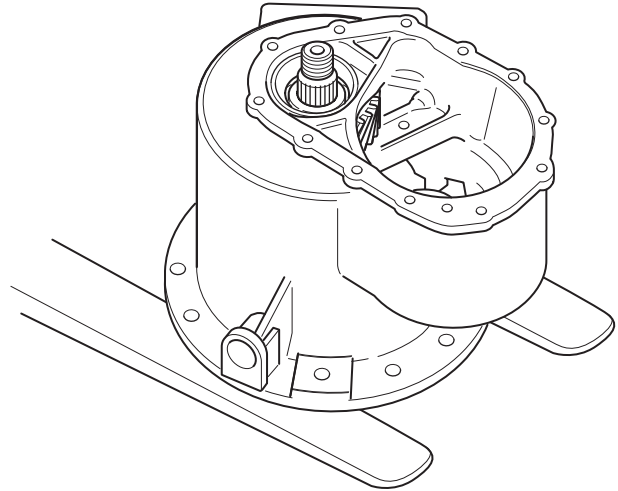


1 - Large - Long Boss

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

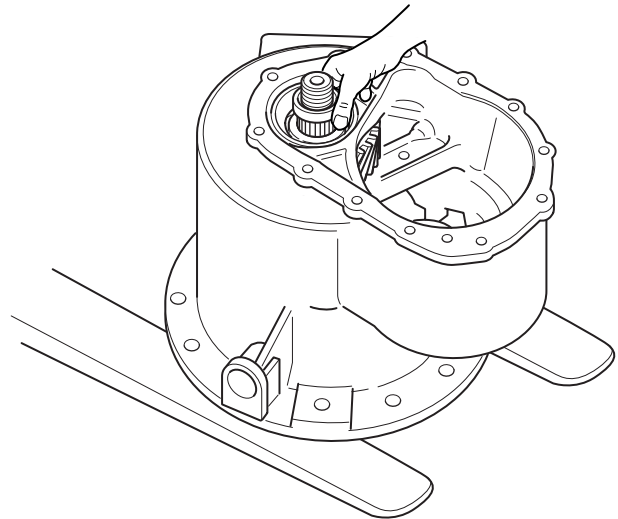


7. To align the splines of the helical gear to the pinion, use a old pinion nut with a metal ring welded to the top, thread onto the pinion. Then lift the pinion while aligning the two splined surfaces.

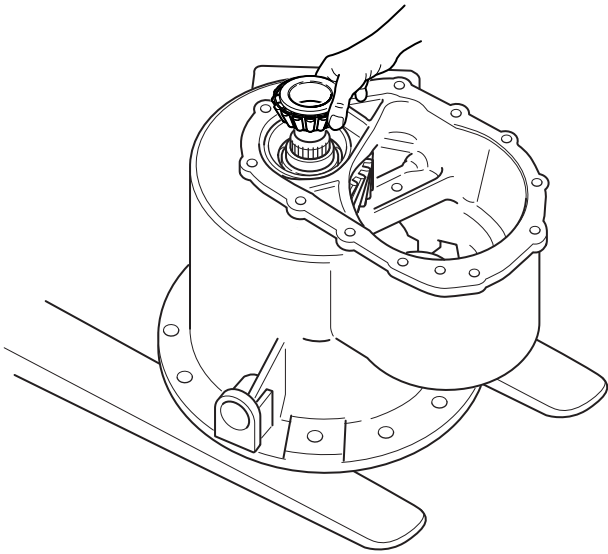


8. Install the pinion spacer.

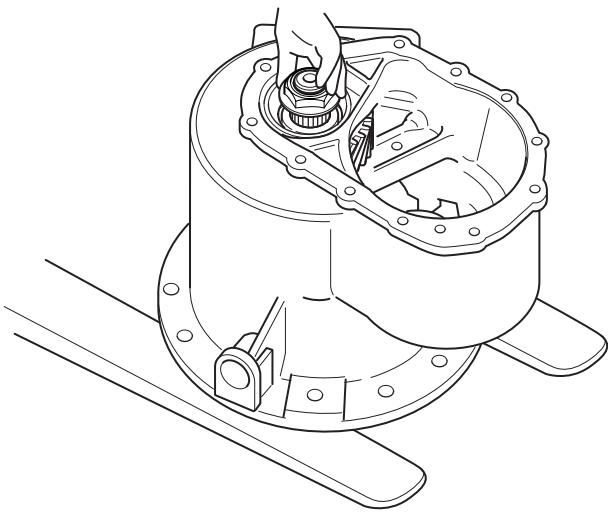
**Note:** If you are using the same drive pinion, use the same spacer that was originally installed in the assembly. If the drive pinion is to be replaced, the original spacer will be used as the starting point of adjustment.



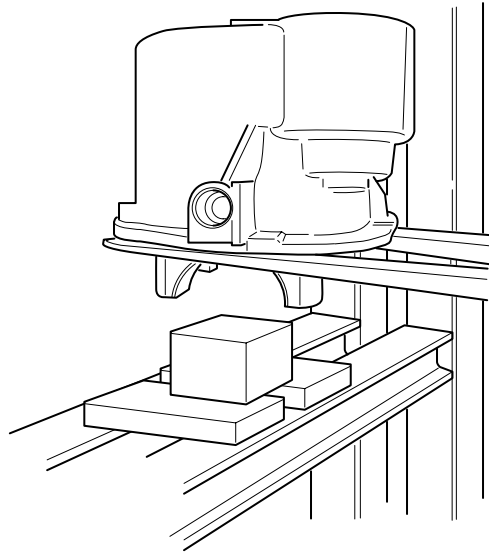
9. Install the outer bearing cone.



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

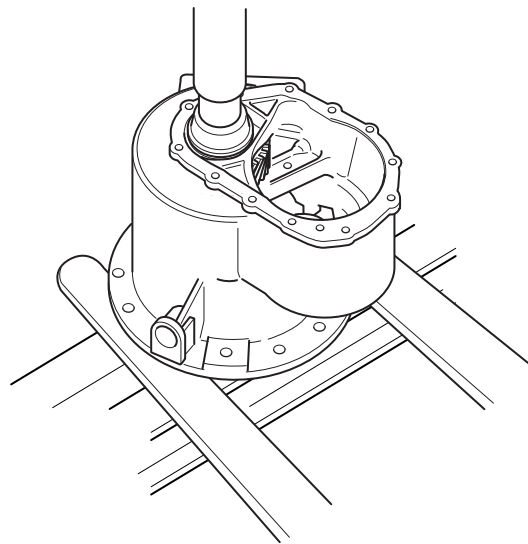


11. Align a 6" x 6" x 6" wood block under the drive pinion, then lower the carrier and pinion assembly into a press so that it is supported by the block.

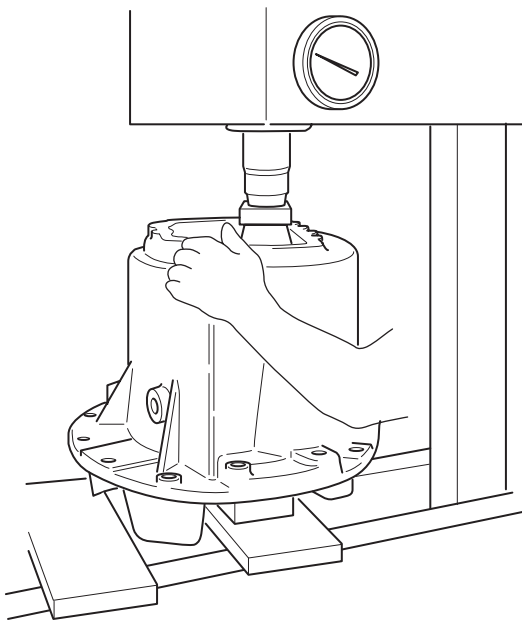


12. Remove the pinion nut.

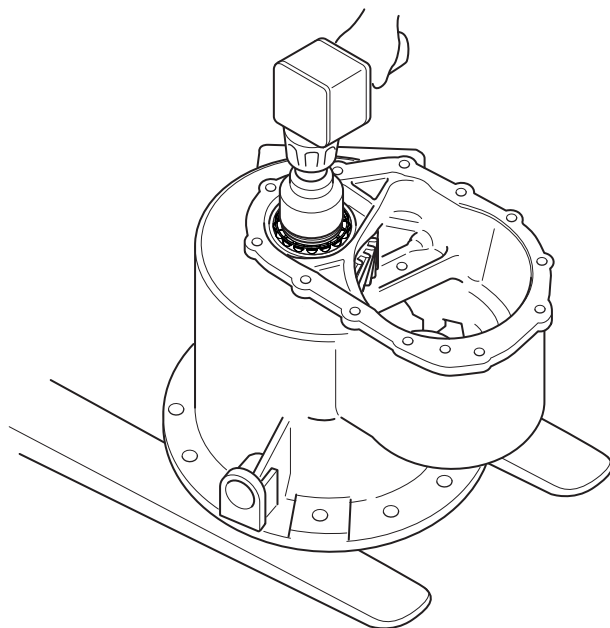
13. Place a press sleeve over the top of the outer bearing cone. Use the press to apply 5 tons of force. It is important to rotate the carrier slightly to make sure that the rollers of the bearing are properly seated.



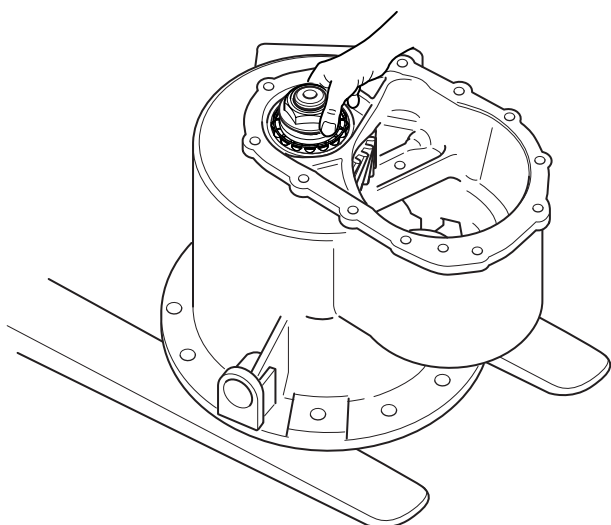
14. With 5 tons of force on the press, you should be able to feel a small amount of drag from the bearing as you rotate the carrier. If the carrier turns with no drag at all, the pinion spacer thickness should be decreased by using a thinner spacer. If the carrier is hard to turn, the spacer thickness must be increased.



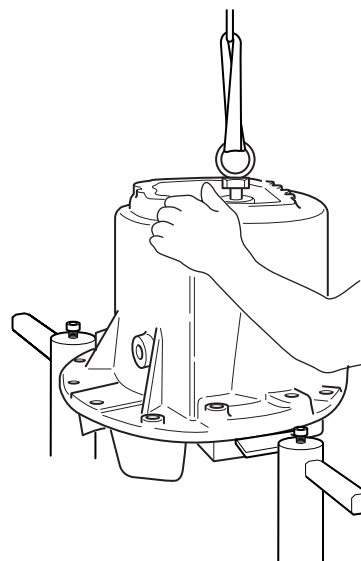
16. Run the nut down with an impact gun. The pinion should still have the same slight drag that was obtained in the press.



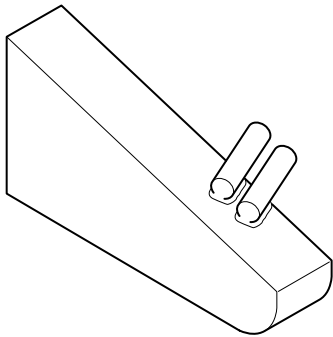
15. Remove the carrier from the press and reinstall the pinion nut.



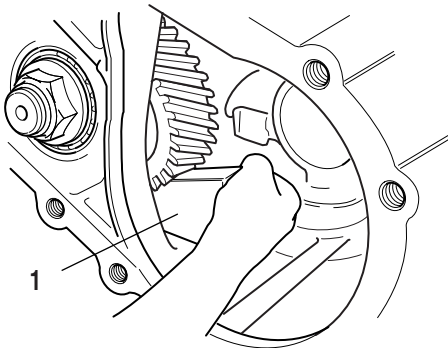
17. Secure the carrier in a head stand, rotate carrier so the pinion nut can be torqued.



**TIP:** A torquing wedge can be made to hold the helical gear from turning while the nut is torqued.

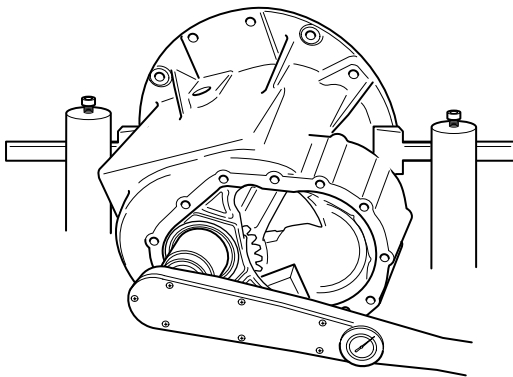


18. Install the wedge between the carrier wall and the teeth of the helical gear.



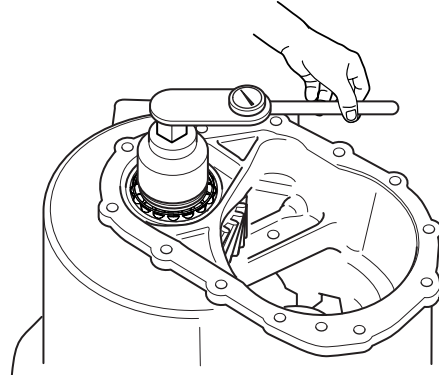
1 - Wedge

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

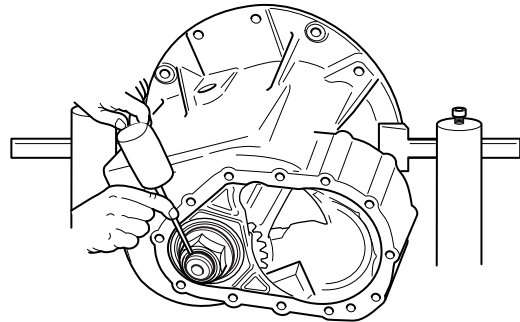


**TIP:** If you are unable to torque the yoke nut correctly, try torquing the nut with the truck wheels on the ground and with the axle shafts installed.

20. Use an lbs. 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 lbs. in. If the torque recorded is not within the specified torque, the pinion spacer must be changed. Repeat Steps 6-17.



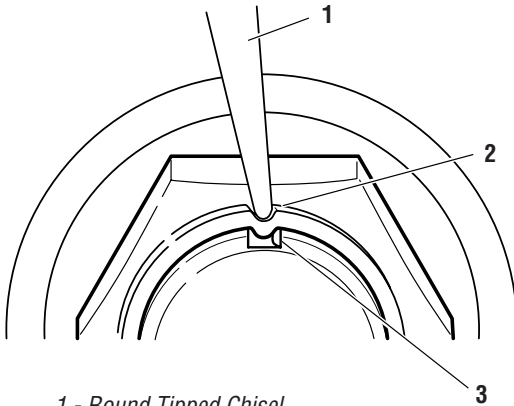
21. Once the proper rolling torque is achieved, use a punch with a round head to stake the nut collar into the slot in the pinion.



**Note:** Always use a new nut and coat threads with Loctite 277 if not pre-coated.

**CAUTION**

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

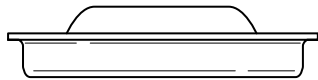


1 - Round Tipped Chisel  
2 - Nuts Staking Flange  
3 - Machined Slot In Pinion

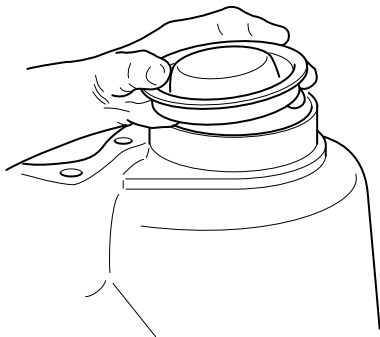
**WARNING**

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.

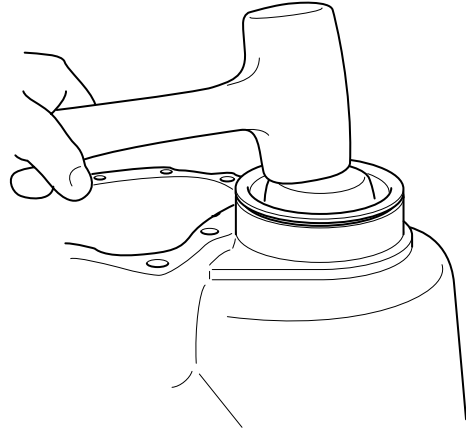
22. For D170 assembly, install the pinion cover. Apply a bead of Loctite 518 sealant to the outer flange of the cover.



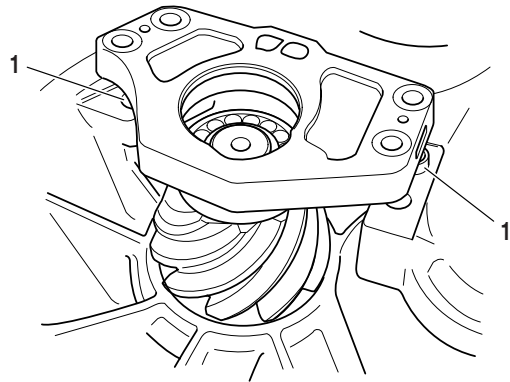
23. Install the cover, making sure that the cover is parallel to the carrier opening.



24. Use a dead blow mallet to seat the cover.

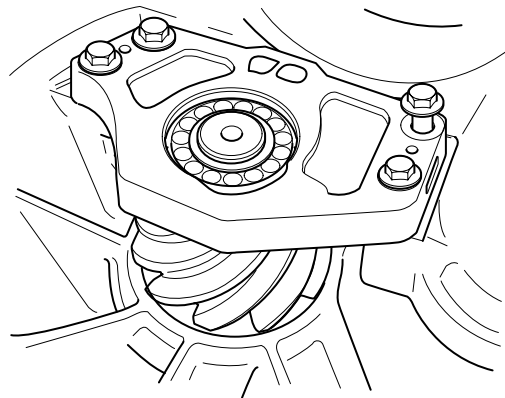


25. If a pilot bearing web is used, lineup the web to the locating sleeves and tap in place with a rubber mallet.

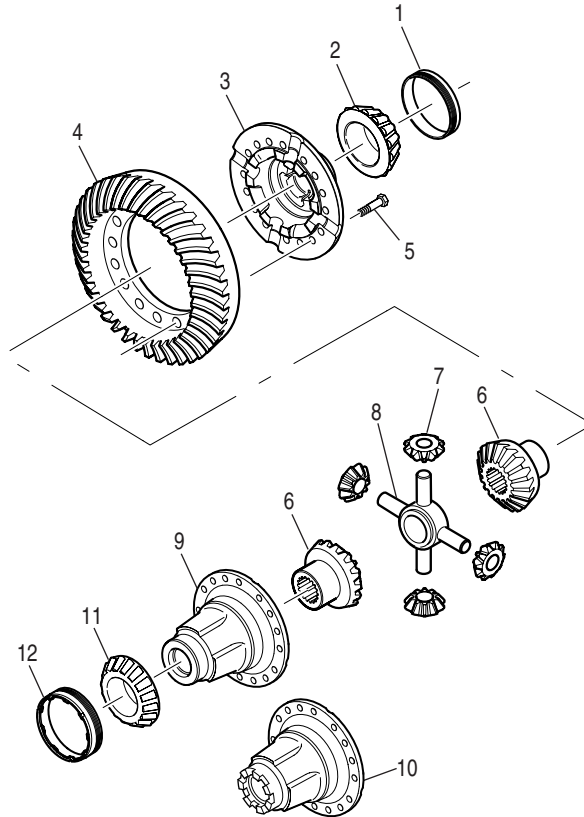


1 - Locating Sleeves

26. Install capscrews and torque to the proper specifications. See the Torque Chart.



## Wheel Differential - Parts Exploded View



1 - Threaded bearing adj. - flange half  
2 - Bearing cone - flange half  
3 - Differential case - flange half  
4 - Ring gear  
5 - Ring gear bolt

6 - Side gear  
7 - Side pinion  
8 - Differential spider  
9 - Differential case - plain half

10 - Differential case - plain half  
wheel diff. lock  
11 - Bearing cone - plain half  
12 - Threaded bearing adj. - plain half

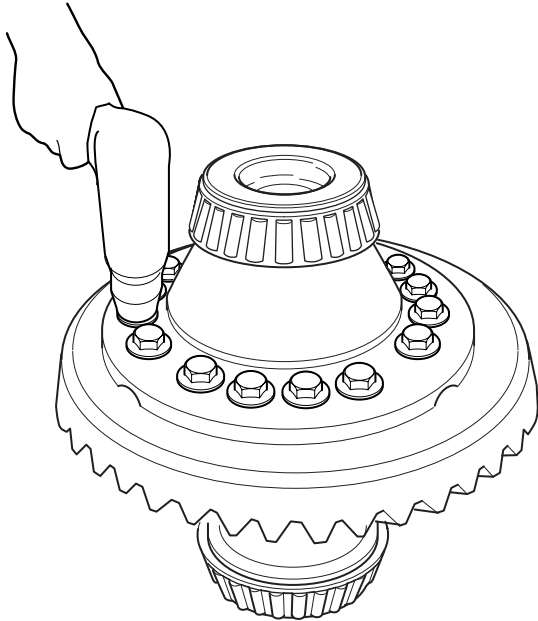


## Wheel Differential Disassembly

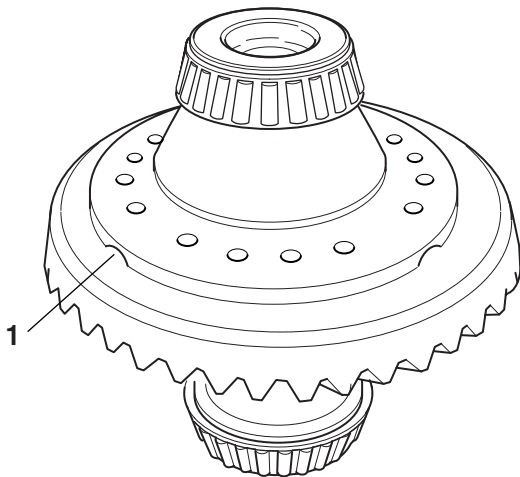
**▲ IMPORTANT**

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

1. Remove the differential case capscrews.

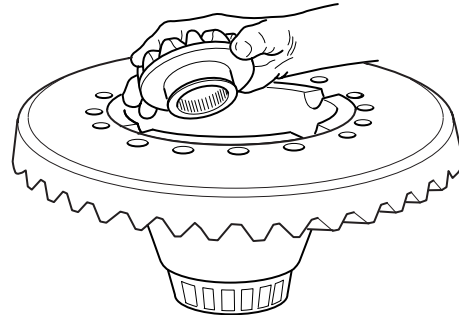
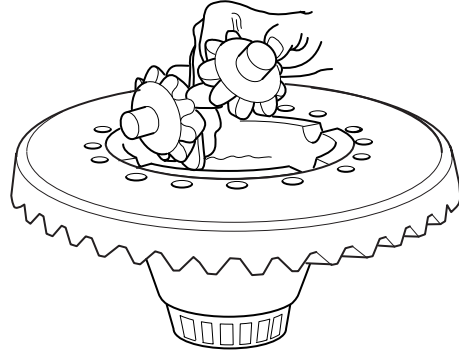


2. Remove the flange half differential case and bearing assembly. Use a screwdriver at the spider arm machined slots of the case to loosen the flange from the ring gear.



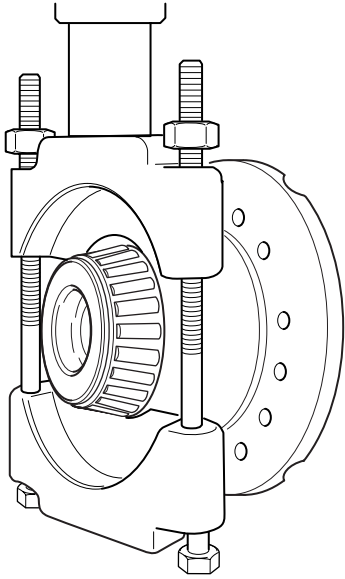
1 - Spider Arm Slots

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

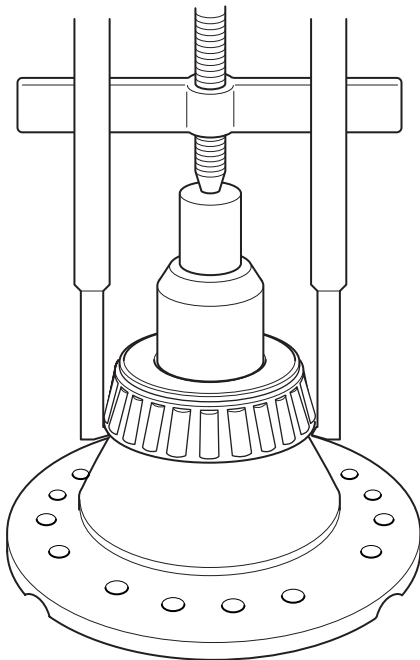


4. Place a block under the plain half, use a rubber mallet to remove the ring gear.
5. Remove the bearing cones from the case halves using suitable pullers.

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.

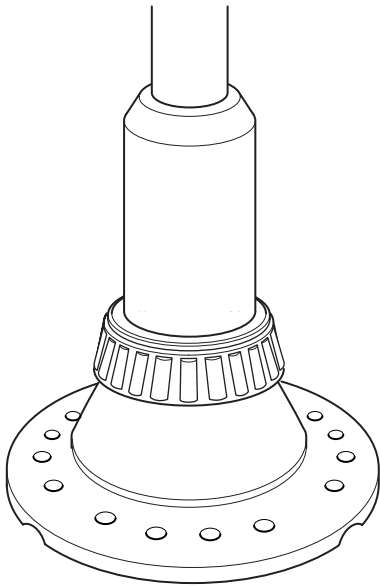


## Wheel Differential Assembly

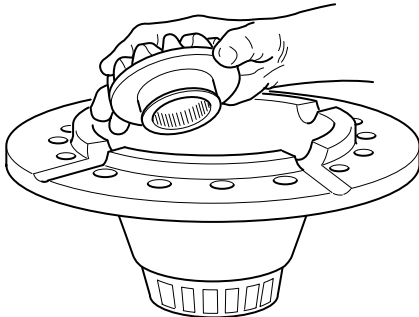
**▲ IMPORTANT**

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.

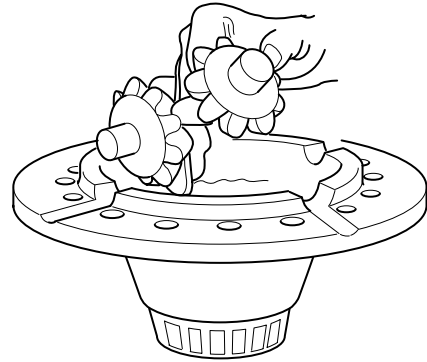
1. Press the new bearing cone on the plain half and flange half bearing boss using the proper press sleeve or bearing installation tool.



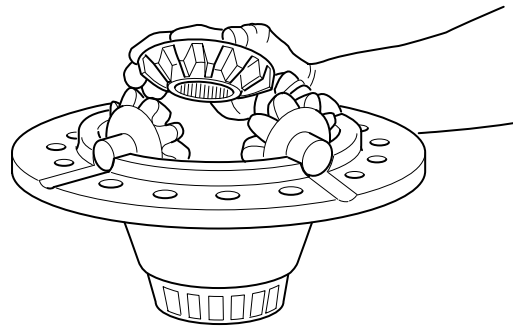
2. Place the plain half side of the differential case on a malleable surface.
3. Install the side gear. Apply a thin coat of oil to the mating surfaces of the side gear and plain half.



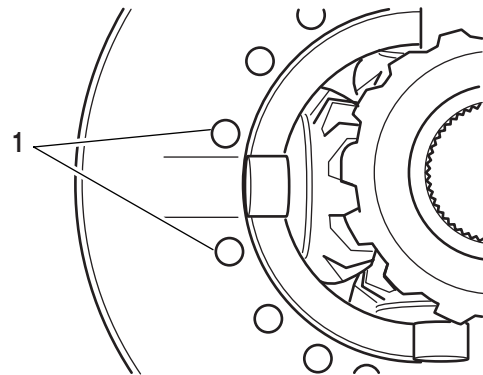
4. Assemble the side pinions onto the wheel differential spider. Apply a thin coat of oil to the mating surfaces of the side pinion and differential spider. Install the wheel differential nest on top of the side gear.



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

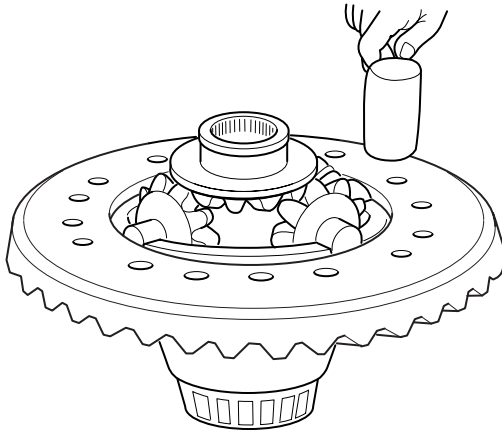


6. Install the ring gear. Align the capscrew holes.

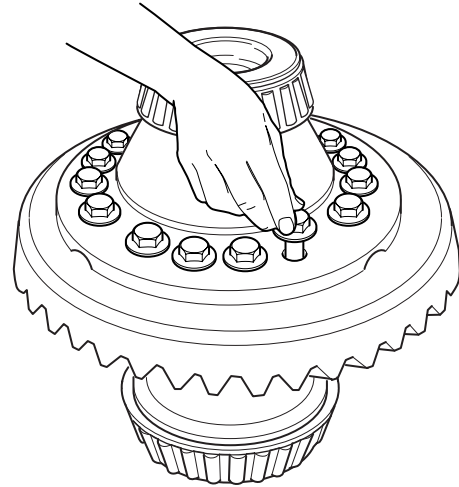


1 - Match spacing of holes on each side of spider slots

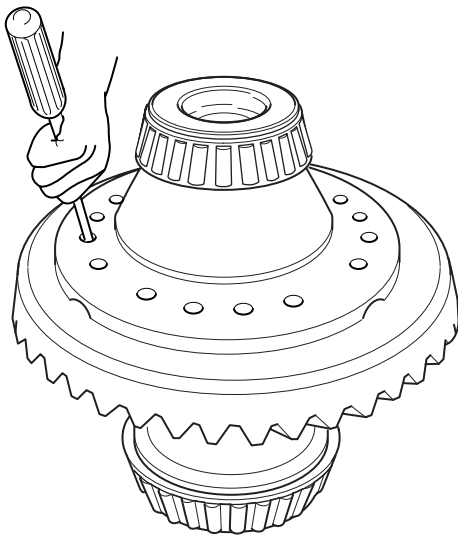
7. Use a rubber mallet to seat the ring gear to the plain half.



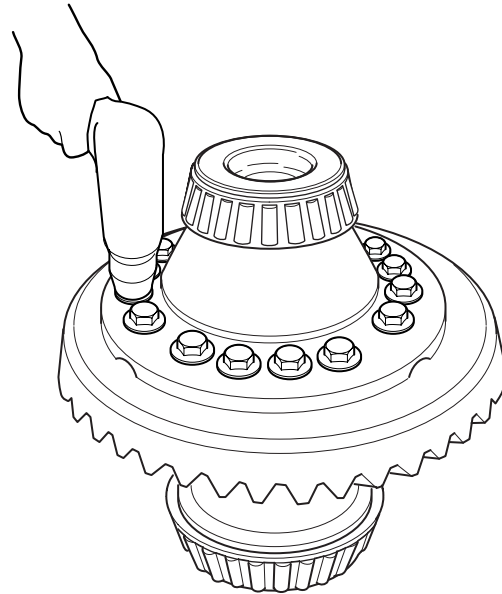
9. Install the ring gear capscrews.



8. Install the flange half of the case. Align the capscrew holes.



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

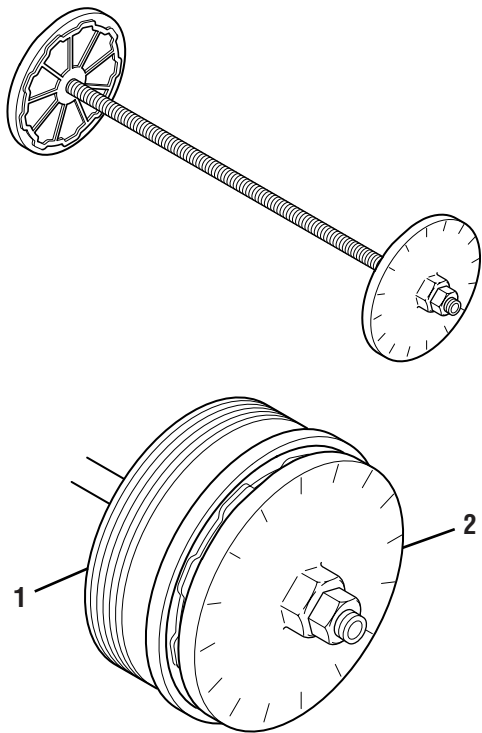


## Wheel Differential Assembly

### Set Backlash and Bearing Preload

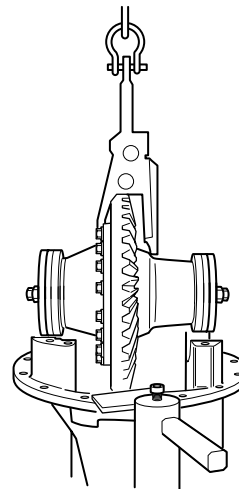
**Note:** To install the wheel differential assembly, properly setup the gear pattern and set the differential bearing preload. This will require the use of the following Dana tools or equivalent. These tools will allow you to align the bearing adjuster assembly to the carrier. This tool (part number 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.

1. 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.



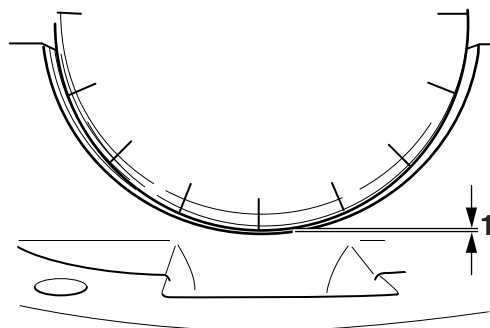
1 - Threaded bearing cup  
2 - Adjustment plate

2. 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.



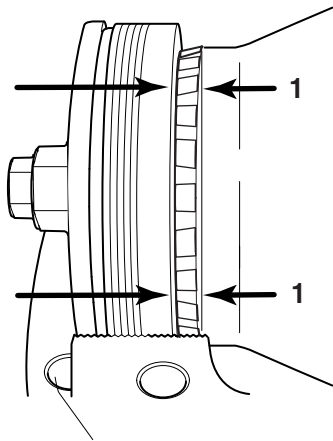
**Note:** There are two ways to make sure that the threaded cups are seated properly. If there is a misalignment, reinstall the differential assembly at a slightly different angle.

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



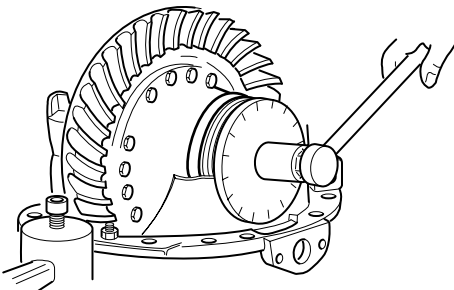
1 - No gap

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

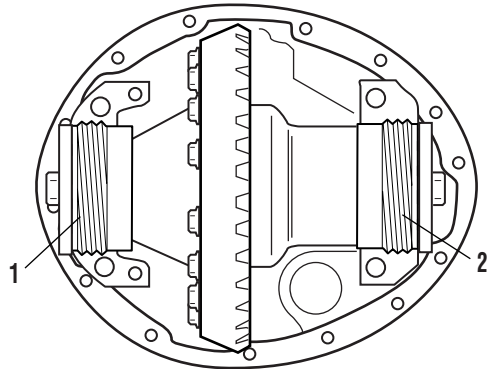


1 - Parallel

5. 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.

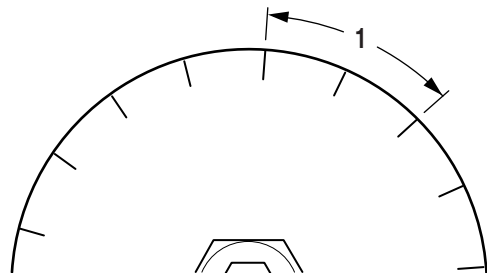


6. Turn the plain half adjuster ring until there is zero preload on the bearings. This is done by turning the adjuster plate clockwise until you feel the threaded cup gain resistance. The threaded bearing cup should only be slightly snugged to achieve a zero preload condition.



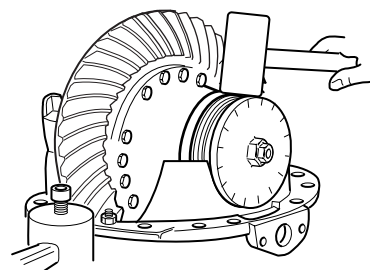
1 - Flange Half  
2 - Plain Half

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

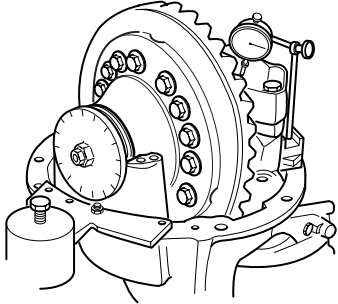


1 - Two Notches

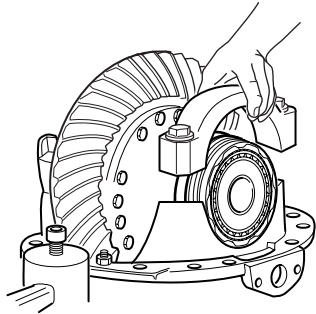
8. Use a rubber mallet to fully seat the threaded bearing cups.



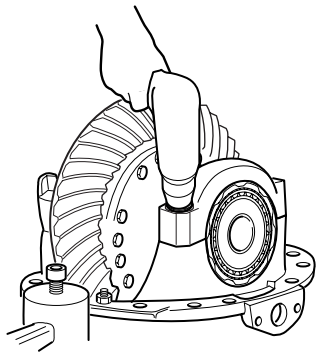
- With a dial indicator, check the ring and pinion backlash. Set the backlash from 0.010" to 0.012". This will give you room to adjust the contact pattern, if necessary.



- Remove the adjuster plates and threaded rod assembly.
- Install the carrier differential bearing caps and cap-screws. Make certain there is no gap between the carrier cap and the carrier surface.



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



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

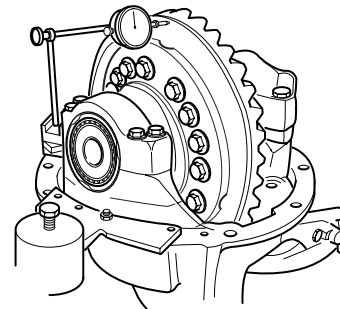
**Note:** For used gearing, the backlash should be reset to what it was at the time of disassembly.

**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.

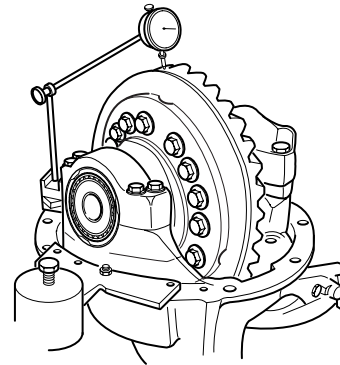
### ▲ IMPORTANT

**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.**

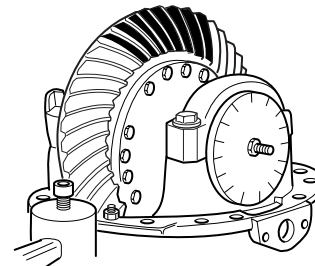
- Measure the ring gear total radial runout. Indicator reading should not exceed 0.010" (0.25 mm).



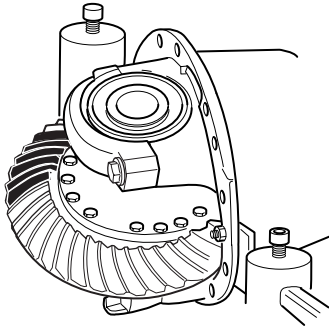
- Measure the ring gear total backface runout. Indicator reading should not exceed 0.010" (0.25 mm).



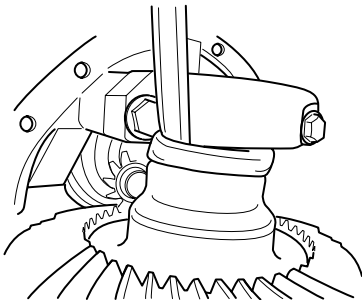
- Check the ring gear tooth pattern. Paint 5 or 6 ring gear teeth 180 degrees apart on the ring gear.



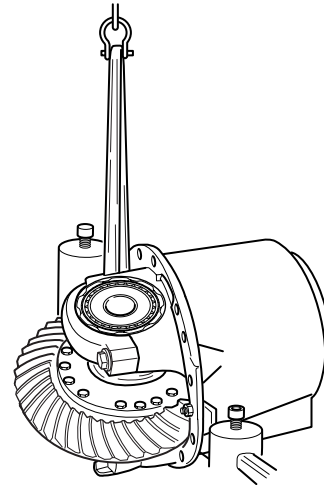
17. With the carrier mounted in a head stand, roll the carrier on its side.



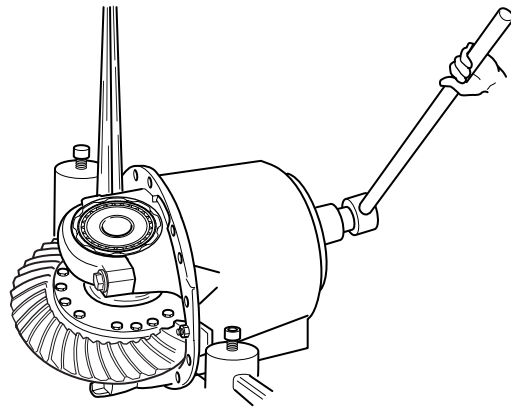
18. Make a sling out of a strap and position around the plain half of the wheel differential.



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

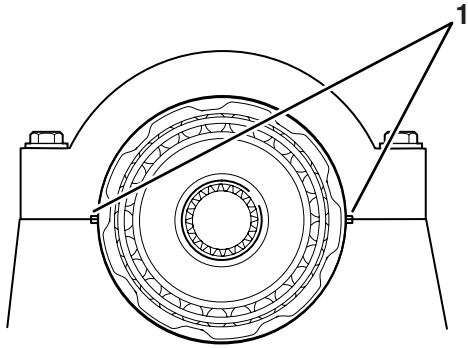


20. Use the correct socket and a breaker bar to rotate the differential. The differential should be hard to turn. Rotate the pinion until the ring gear rotates 3 or 4 times in both directions. See page 45 for descriptions of correct pattern position for new and used gearing.

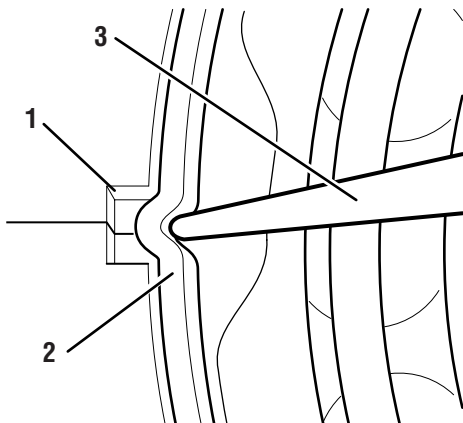




21. When contact pattern is correct. Use a punch with a round head to stake the threaded bearing cups in place. Stake the outer edge of the bearing adjustment ring into the machined slots in the carrier bearing bore on both sides. Must be staked at two locations. Rotate cup if necessary to provide surfaces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



1 - Two Stake Locations

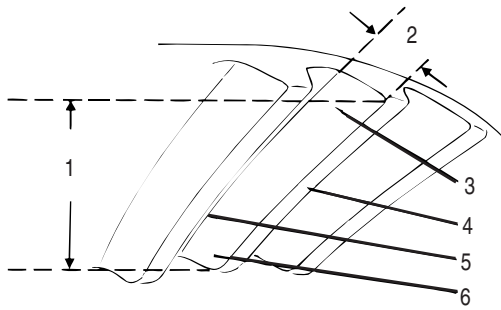


1 - Machined slot  
2 - Bearing Adjustment Ring  
3 - Round Head Punch

## 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.



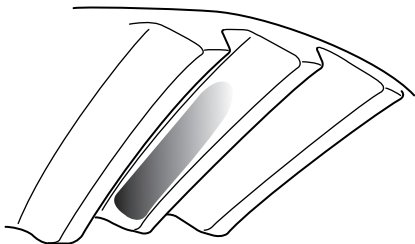
- 1 - Face width
- 2 - Tooth depth
- 3 - Heel
- 4 - Top land
- 5 - Root
- 6 - Toe

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.

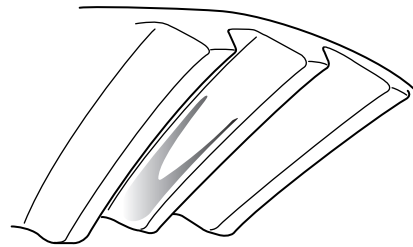
The pattern could vary in length and should cover 1/2 tooth or more (face width). The pattern should be evenly centered between tooth top land and root and should be up off the tooth toe.



### 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.

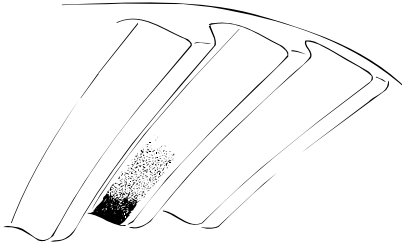
- Ring gear position controls the backlash. This adjustment moves the contact pattern along the face width of the gear tooth.
- Pinion position is determined by the size of the pinion bearing cage shim pack. It controls contact on the tooth depth of the gear tooth.

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)

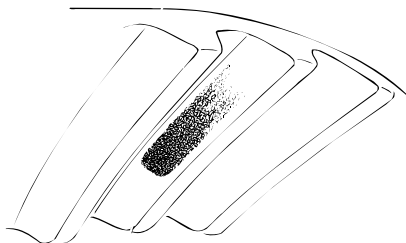
If the gear pattern shows incorrect face width contact, change backlash by adjusting the ring gear.

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.

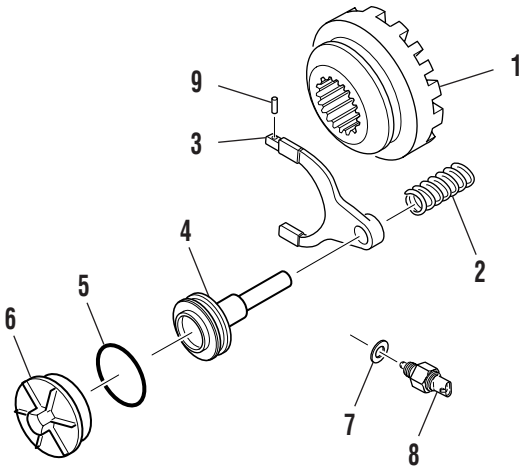
If the pattern is concentrated at the heel (too far up the tooth), move the ring gear toward the pinion to decrease backlash.



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

## Wheel Differential Lock - Parts Exploded View



1 - Sliding clutch  
2 - Spring  
3 - Clutch fork

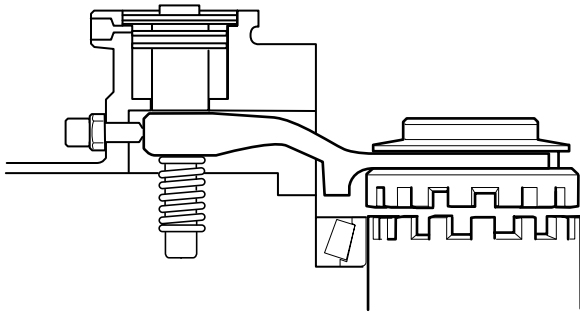
4 - Piston and rod  
5 - O-ring  
6 - Piston cover

7 - Washer  
8 - Switch  
9 - Pin

## Install and Adjust Wheel Differential Lock

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

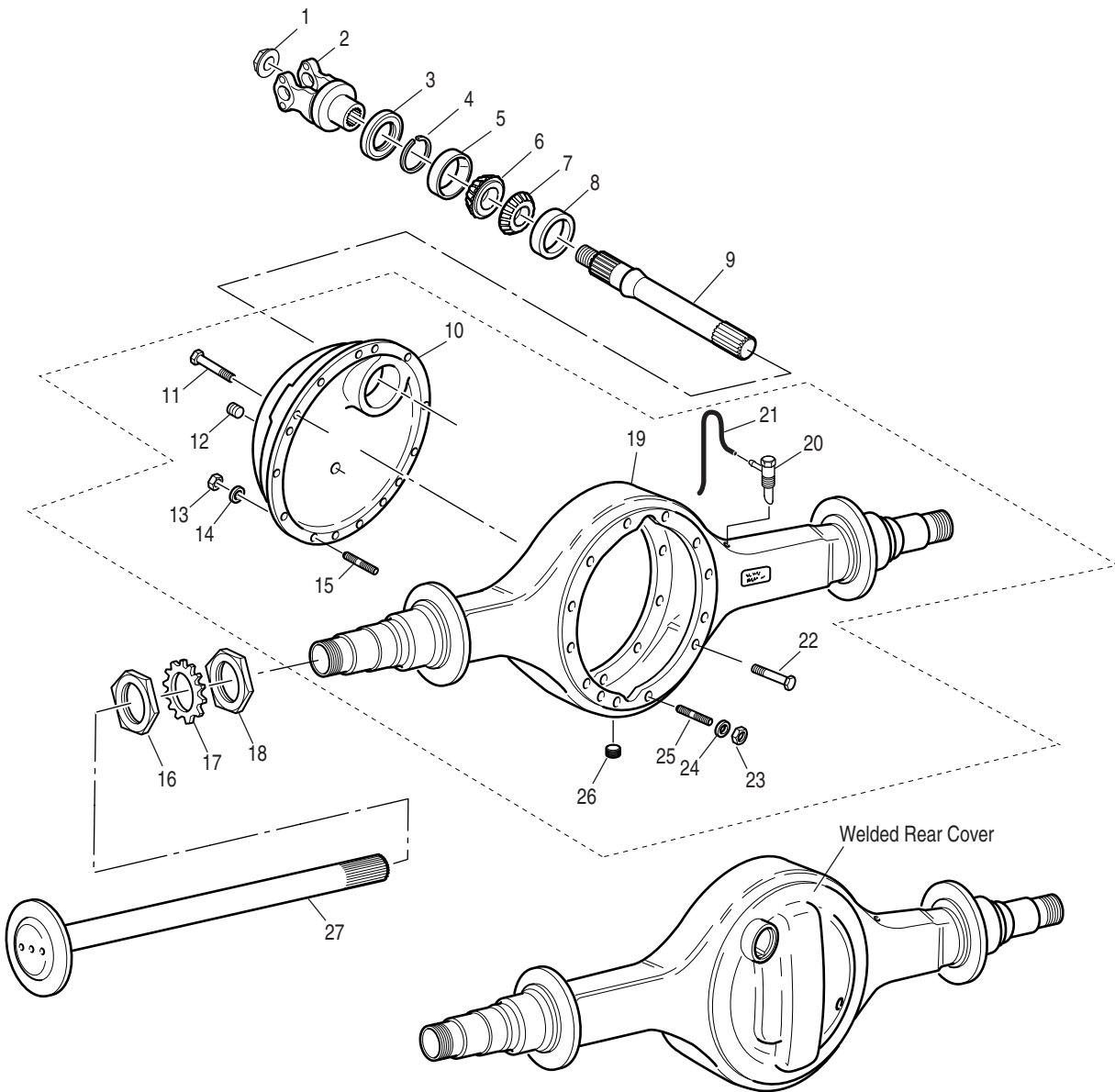
1. If shift fork and sliding clutch are disassembled, engage fork with the clutch hub and install spring pin in the fork leg.
2. Position spring, shift fork and clutch in shift opening of the carrier. Align pilot hole of shift fork with the pilot hole of carrier.
3. Install pushrod through shift fork, 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 lbs. ft. (68–102 N•m).
7. Install selector switch and torque to 10–12 lbs. 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.

# Output Shaft Assembly & Rear Cover

## Housing and Output Shaft Assembly - Parts Exploded View



- 1 - Output shaft nut
- 2 - Output yoke
- 3 - Output seal
- 4 - Snap ring
- 5 - Outer bearing cup
- 6 - Outer bearing cone
- 7 - Inner bearing cone
- 8 - Inner bearing cup
- 9 - Output shaft

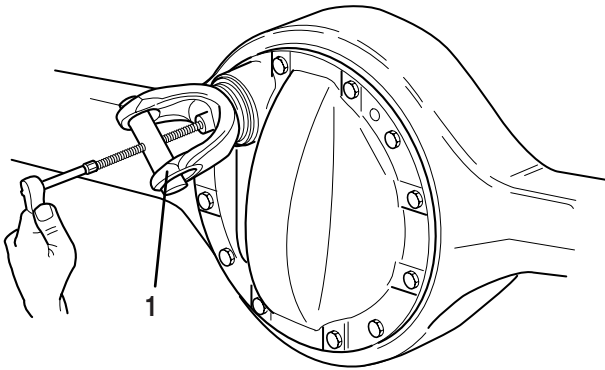
- 10 - Rear cover
- 11 - Rear cover capscrew
- 12 - Fill plug
- 13 - Rear cover nut
- 14 - Washer
- 15 - Stud
- 16 - Spindle nut - Outer
- 17 - Locking ring
- 18 - Spindle nut - Inner

- 19 - Axle housing
- 20 - Breather
- 21 - Breather hose
- 22 - Carrier capscrew
- 23 - Nut
- 24 - Washer
- 25 - Stud
- 26 - Drain plug
- 27 - Axle shaft

## Remove Output Shaft Assembly

**Note:** For forward axle rear covers that are removable the output shaft may be removed when the cover is in or out of the axle assembly.

1. Disconnect the inter-axle driveline at the forward axle rear cover position.
2. Remove yoke nut (shoulder nut).
3. Remove yoke from output shaft using appropriate tool.

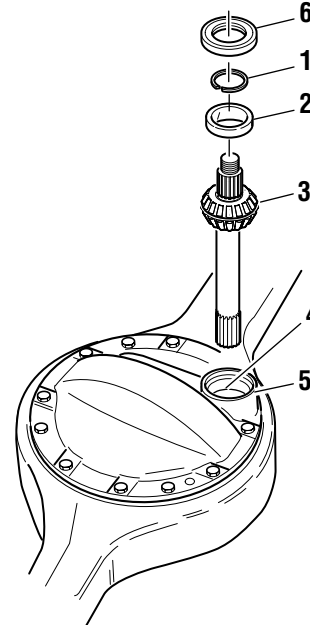


1 - Yoke Puller Tool

**TIP:** A yoke puller tool may be made from the center section of most gear puller tools, or may be purchased from your tool distributor.

4. Remove oil seal.
5. Remove snap ring.

6. Remove output shaft and outer bearing cup as an assembly.



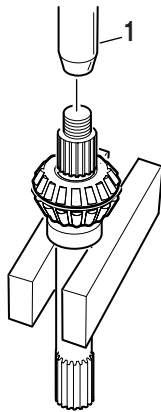
1 - Snap Ring  
 2 - Outer Bearing Cup  
 3 - Output Shaft Assembly  
 4 - Inner Bearing Cup  
 5 - Rear Cover Assembly  
 6 - Output Seal

**TIP:** It may be helpful to loosely reinstall the yoke and shoulder nut giving the technician more of an area to grip when removing the output shaft.

7. Remove the inner bearing cup from rear cover assembly. This may be removed from inside the axle housing when the carrier is removed, or by removal of the forward axle rear cover.

## Output Shaft Assembly & Rear Cover

8. Remove both inner and outer bearing from output shaft.



1 - Press

9. Remove output shaft inner bearing cup.

**Note:** Components such as the inter-axle driveline, yoke, oil seal and output shaft assembly should have been removed according to normal service procedures. Removing the differential assembly from the axle housing is not necessary, but would ease the removal process of the inner bearing cup from the cover bore.

- a. Using a bearing puller tool, remove the inner bearing cup.
- b. Visually inspect the inner-machined bore surface of the welded-on cover for nicks and burrs. Repair if necessary.



## Overhaul and Assemble Output Shaft Assembly

**Note:** Lubricate the parts with gear lube during assembly.

1. The output shaft bearings are assembled with both bearing cones back to back. Use a press and a sleeve to install one bearing at a time.



**To prevent bearing damage, use a suitable sleeve that only contacts the bearing race.**

2. Apply pressure until the inner bearing cone touches the shoulder of the output shaft.
3. Apply pressure until the back of the outer bearing cone touches the back of the inner bearing.

**Note:** Axle housings with welded-on covers procured through service will include the inner bearing cup as part of the "service" axle housing assembly. Go to Step 6 if the inner cup has already been installed.

4. Lightly coat the output bore of the axle housing cover with a 9.5 mm (.38") wide application of Loctite 680 where the bore contacts the inner bearing cup. Do not apply Loctite outside of this area—to the bearing rollers or outboard of the inner cup bore. Improper application of the Loctite could lock the rollers or cause excessive pre-load.

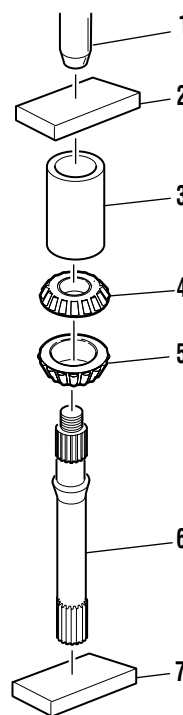


**Add Loctite adhesive to the inner bearing surface of the housing and NOT to the bearing race itself. If added to the race, excessive adhesive could get on the surface of the outer bearing race journal during installation and cure the outer cap in place with excessive pre-load.**

5. Using a sleeve and driver (hammer), install the inner bearing cup.
6. Put the output shaft and bearing assembly into the axle housing assembly.

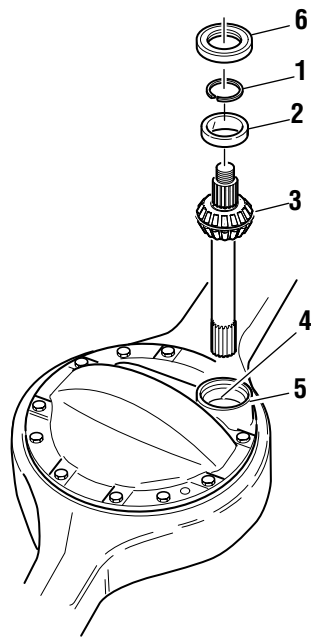
7. Using a sleeve and driver (hammer), install the outer bearing cup into the housing assembly over the output shaft bearing cone.
8. Using snap ring pliers, install the snap ring that fastens the outer bearing cup into the welded-on cover assembly.
9. Check the endplay of the output shaft. New assemblies should measure 0.001" to 0.045" (0.03 to 1.143 mm)

**Note:** Use the bearing cup driver to insure seating of snap ring after installation with snap ring pliers.



- 1 - Press
- 2 - Plate
- 3 - Sleeve
- 4 - Press Bearing on Second
- 5 - Press Bearing on First
- 6 - Output Shaft
- 7 - Plate

## Output Shaft Assembly & Rear Cover



- 1 - Snap Ring
- 2 - Bearing Cup
- 3 - Output Shaft Assembly
- 4 - Inner Bearing Cup
- 5 - Rear Cover Assembly
- 6 - Output Seal

10. **Bolted rear cover only:** If removed, install cover and fasten with nuts, capscrews and lock washers. Tighten to proper torque specifications. See the Torque Chart.

**Note:** Use Dana approved RTV compound on axle housing mating surface. Completely remove all old gasket material prior to applying new material. Compound will set in 20 minutes. Install axle housing cover and output shaft assembly before compound sets or reapply.

11. Install the output seal.

12. Install output yoke.

**Note:** Use of a torque multiplier is recommended.

**TIP:** If you can't get the correct torque on yoke nut, try torquing the nut with the truck wheels on the ground and with the axle shafts installed.

13. Install axle shafts and axle stud nuts (If used, also install lock washers and taper dowels).
14. Connect inter-axle driveline. Make sure driveline is properly phased. Lubricate u-joints.
15. Add axle lubricant. Fill to bottom of filler hole.

### ▲ IMPORTANT

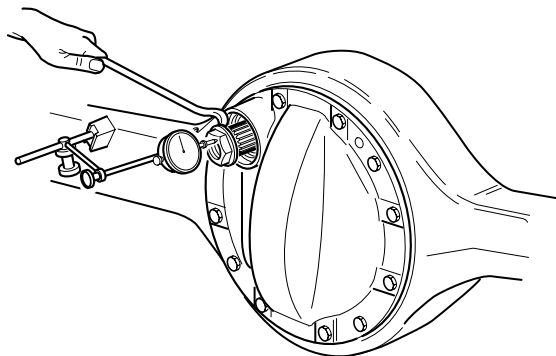
**When axle has been disassembled or housing, axle shafts or wheel equipment replaced, check axle assembly for proper differential actions before operating vehicle. Wheels must rotate freely and independently.**

Road test vehicle to bring axle lubricant up to temperature. Recheck joints, drain and fill plugs for leakage. Retighten as necessary.

## Measure

Correct endplay for a new assembly is 0.001" to 0.045" [0.03 to 1.143 mm]. The maximum endplay for a used assembly is no more than 0.045" (1.143 mm). If endplay is incorrect, contact Dana.

1. Install oil seal.
2. Install yoke.
3. Install yoke nut. One of the following options may be utilized:
  - a. Install a new nut with the pre-applied thread adhesive compound. Tighten the nut to the specified torque. See the Torque Chart.
  - b. If a new nut with pre-applied thread adhesive compound is unavailable, apply Loctite 277 or 271 (available in 0.5 ml tube—Dana P/N 129293) to the nut along two threads, for at least two flats (120°) of the nut midway through the thickness (see illustration). Tighten the nut to the specified torque. See the Torque Chart.



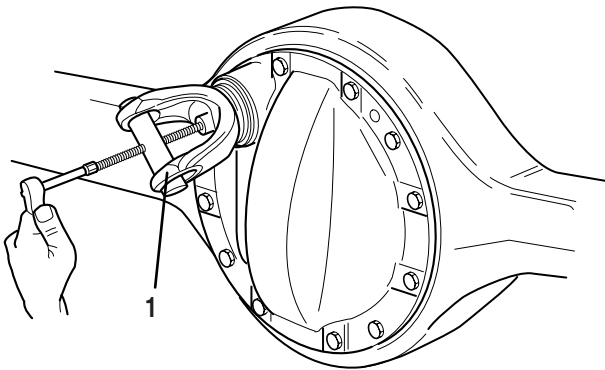
## Replace Seal

Dana 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**

**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.**

1. Inspect axle endplay at the yoke (see page 10). Service if beyond specified limit.
2. 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.



1 - Yoke Puller Tool

3. Remove seal. Use care when removing the old seal to prevent damage to the housing seal bore.
4. 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**

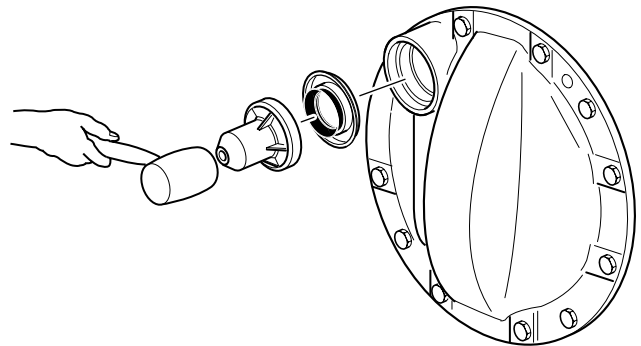
**Do not use any silicone or permatex-type bore sealant with this seal.**

5. Remove the new seal from its package and install with the proper driver:
  - D - Input Driver - 210749
  - D - Input Insert - 131472
  - D - Output Driver - 131471
  - R - Pinion Driver - 210749
  - R - Pinion Insert - 131472

**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!**

6. 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.
7. 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.



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## Guidelines for Reusing Yoke

 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.

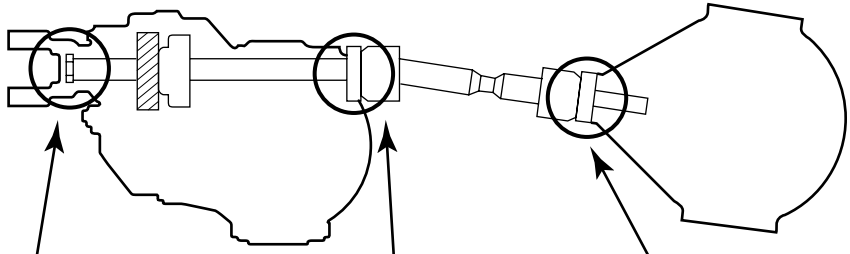
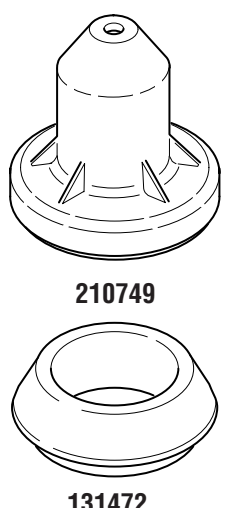
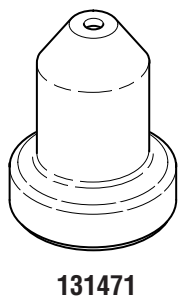
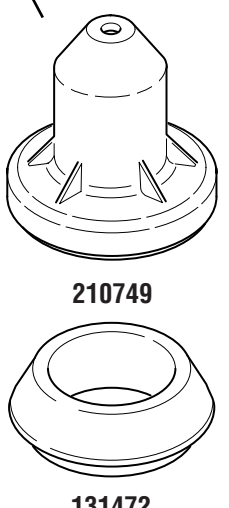
**Note:** Do not rework the yoke with abrasives such as emery paper or crocus cloth. Clean the surface of the yoke as necessary using chemical cleaners. Remove all trace of the chemicals from the yoke after cleaning.

 CAUTION

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

# Seal - Replace

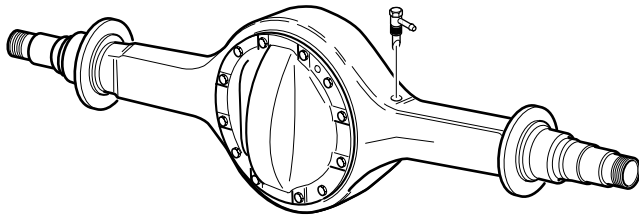
## Service Kit

|          | D-Input   | D-Output   | R-Pinion  |
|----------|---|--|---|
| Location |                           |  |   |
| Tool     |  <p>210749<br/>131472</p> |  <p>131471</p> |  <p>210749<br/>131472</p> |

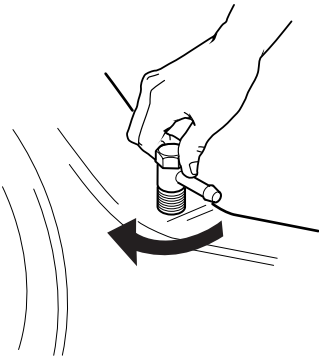
## Housing Breather

Dana 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.

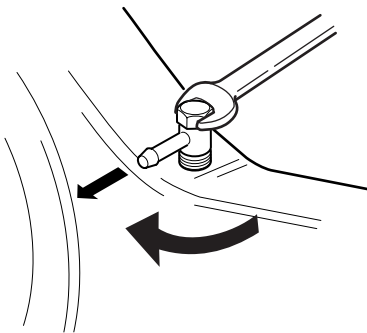


2. Tighten fitting finger tight.

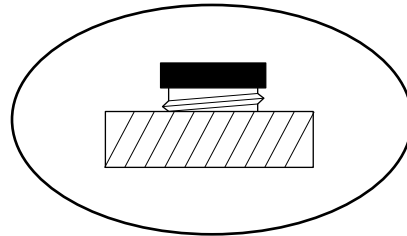


3. Using a 3/4" wrench:

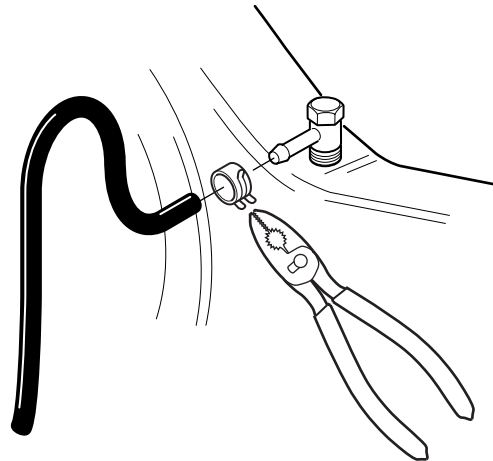
- **Metal only:** Rotate the fitting at least 1/2 turn until nipple points to rear.



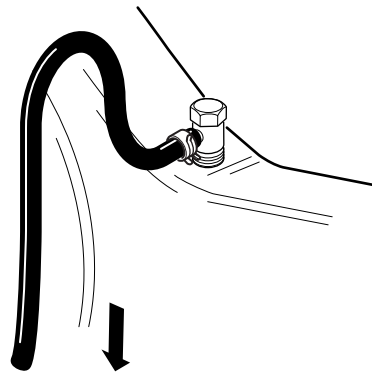
- **Plastic only:** Tighten until one thread is showing.



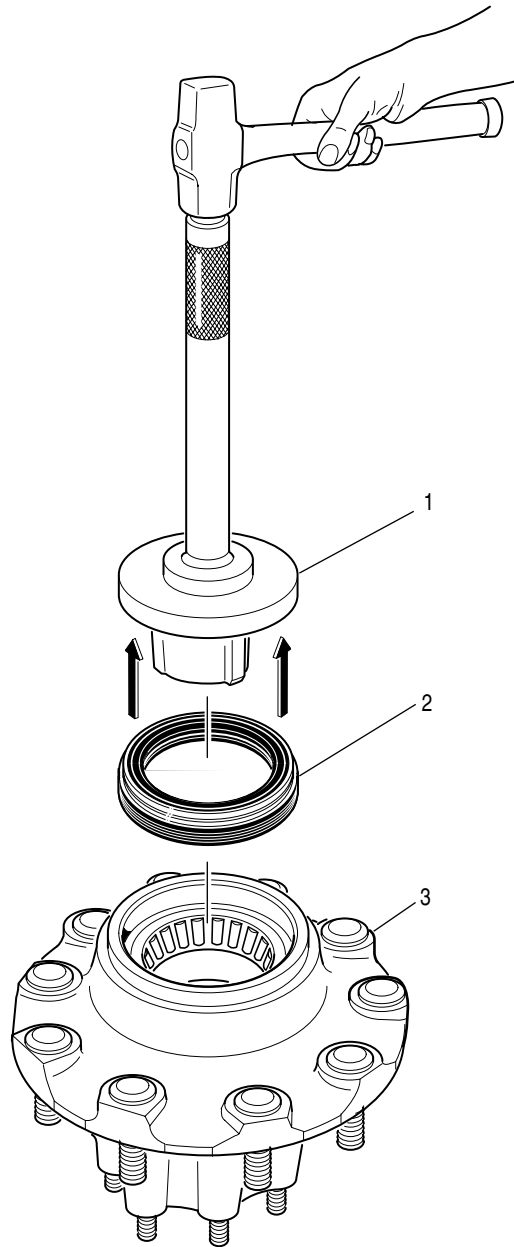
4. Insert hose onto fitting, long end down.



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

**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

**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

**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

**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

**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.

1. 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.

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

### ⚠ 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.**

4. Completely fill the hub cavity between the inner and outer bearing races with the same lubricant used in the axle sump.
5. 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.

6. Install the outer bearing on the spindle.
7. Install the inner nut on the spindle. Tighten the inner nut to 200 ft. lbs. (271 N•m) while rotating the wheel hub.

### ⚠ CAUTION

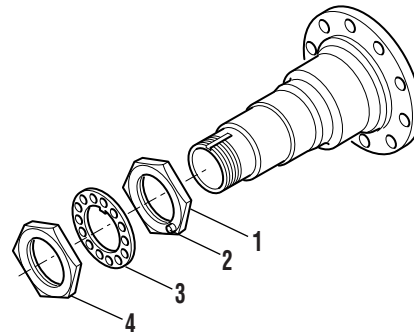
**Never use an impact wrench to adjust wheel bearings. A torque wrench is required to assure that the nuts are properly tightened.**

8. Back off the inner nut one full turn. Rotate the wheel hub.
9. Retighten the inner nut to 50 lbs. ft. (68 N•m) while rotating the wheel hub.
10. 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.

11. 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.

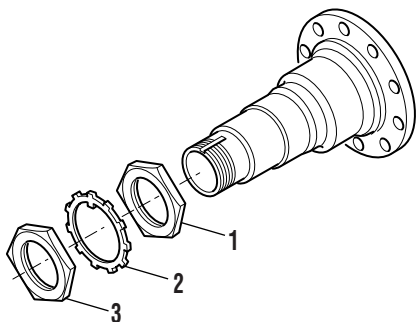
**Note:** If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

**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 lbs. ft. (475 N•m).
- c. Verify endplay, see “Verify Wheel Endplay Procedure.”

### Three-piece Tang-type Lock Washer System



- 1 - Inner Nut
- 2 - Tang-type Lock Washer
- 3 - Outer Nut

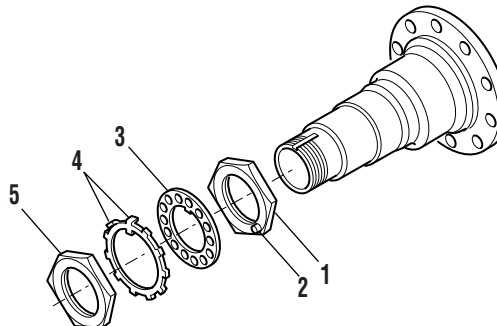
- a. Install the Tang-type lock washer on the spindle.

**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 lbs. ft. (339 N•m).
- c. Verify endplay, see “Verify Wheel Endplay Procedure.”
- 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
- 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**

**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 lbs. ft. (339 N•m).
  - d. Verify endplay, see “Verify Wheel Endplay Procedure.”
  - e. After verifying endplay, secure the outer nut by bending (180° apart) two opposing tangs of the locking washer over the outer nut.
12. Install the following:
- New gasket at axle shaft flange
  - Axle shaft
  - Axle flange nuts and tighten to specified torque
13. Lubricate axle wheel ends.

## Verify Wheel Endplay Procedure

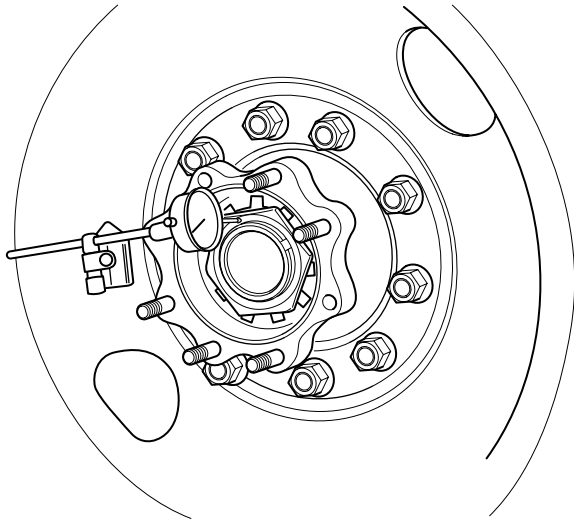
Verify that endplay meets specification using a dial indicator. An indicator with 0.001" (0.03 mm) resolution is required. Wheel endplay is the free movement of the tire and wheel assembly along the spindle axis.

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.**

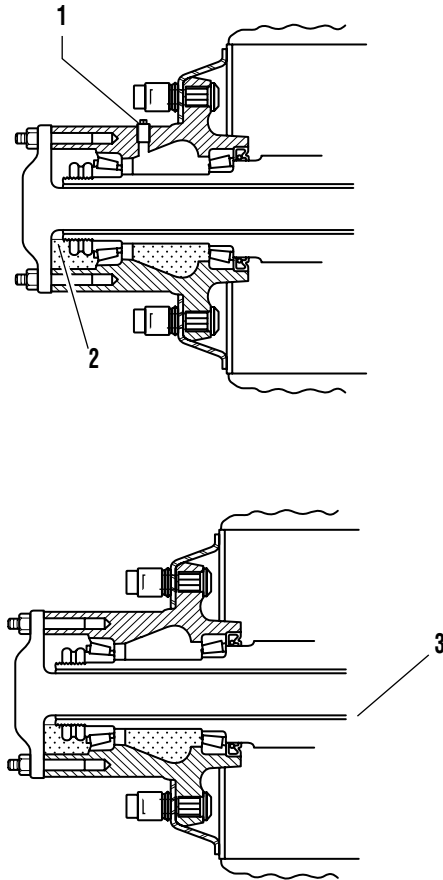
When wheel ends are serviced, follow Dana's wheel end lubrication procedure before operating the axle.

Dana 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

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



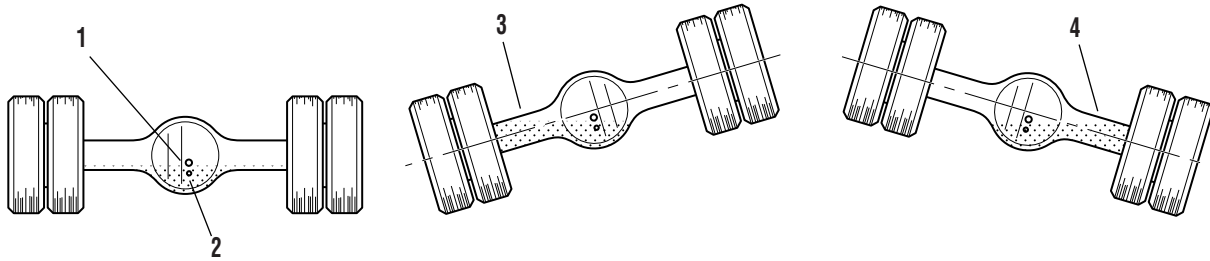
1 - Wheel End Oil Fill Hole  
2 - Proper Lubricant Level  
3 - Lubricant Flow from Sump

## 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

## 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 the Axle & Brake Division of Dana Corporation.

## Approved Lubricants

**General**—Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105E (Lubricating Oils, Gear, Multipurpose) are approved for use in Dana Drive Axles. The MIL-L-2105E 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-2105E.

**Note:** The use of separate oil additives and/or friction modifiers are not approved in Dana 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 Dana Roadranger™ gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105E. 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 Roadranger® 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-2105E and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (\*) are available in the Roadranger 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 Corporation 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 Roadranger family of synthetic gear lubricants. |                                   |

## Lube Change Intervals

This product combines the latest manufacturing and part washing technology. **When filled with an Dana 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 Roadranger 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 HIGHWAY 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.

| 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

For additional lubrication information, see TCMT0021.

\*\* Axles using adjustable wheel bearing system



## 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.

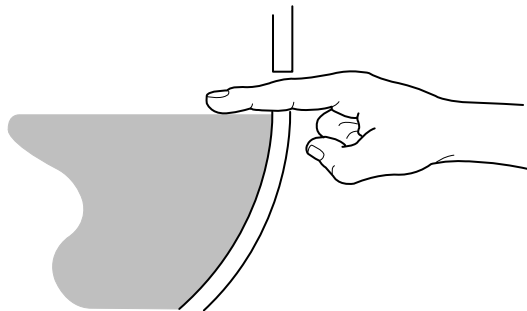
### Fill

#### 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 section.

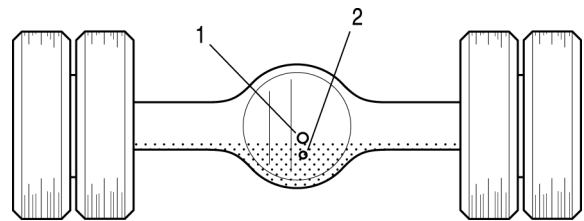


Correct lube level at bottom of filler hole.

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 lbs. 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.

| <b>D170</b>                    |                      |                         |
|--------------------------------|----------------------|-------------------------|
| <b>Axle Installation Angle</b> | <b>Axle Location</b> | <b>Quantity (pints)</b> |
| 12°                            | Rear                 | 29*                     |
| 10°                            | Rear                 | 30*                     |
| 8°                             | Rear                 | 31                      |
| 6°                             | Forward<br>Rear      | 39<br>32                |
| 4°                             | Forward<br>Rear      | 41<br>33.5              |
| 2°                             | Forward<br>Rear      | 43<br>35                |
| 0°                             | Forward<br>Rear      | 45<br>36                |

\*Does not allow for standpipe.

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

| <b>D190</b>                    |                      |                         |
|--------------------------------|----------------------|-------------------------|
| <b>Axle Installation Angle</b> | <b>Axle Location</b> | <b>Quantity (pints)</b> |
| 12°                            | Rear                 | 29*                     |
| 10°                            | Rear                 | 30*                     |
| 8°                             | Rear                 | 31                      |
| 6°                             | Forward<br>Rear      | 42.5<br>32              |
| 4°                             | Forward<br>Rear      | 44.5<br>33.5            |
| 2°                             | Forward<br>Rear      | 47<br>35                |
| 0°                             | Forward<br>Rear      | 50<br>36                |

\*Does not allow for standpipe.

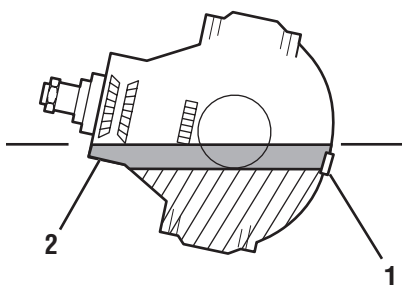
Capacities do not include wheel equipment requirements. An additional 1-2 pints is required in each wheel hub.

| <b>Tandem Forward Axles</b> |                    |                     |                     |
|-----------------------------|--------------------|---------------------|---------------------|
| <b>Installation Angle*</b>  | <b>5-10% Grade</b> | <b>10-15% Grade</b> | <b>15-20% Grade</b> |
| 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"               |

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

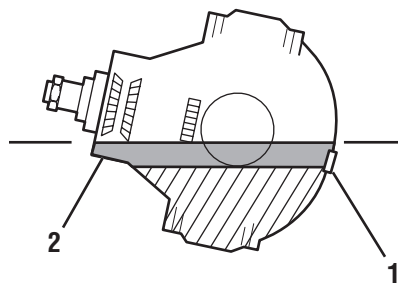
\*Pinion pointing upward

### Horizontal Mounting



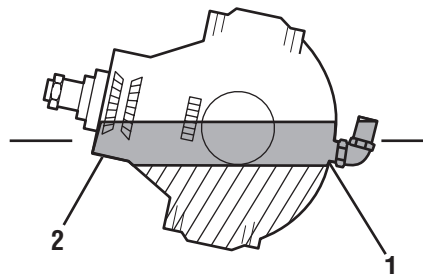
1 - Oil Filler Hole  
2 - Lost Oil Capacity

### 12° Installation



1 - Oil Filler Hole  
2 - Lost Oil Capacity

### 12° Installation with Standpipe



1 - Oil Filler Hole  
2 - Additional Oil Capacity

**Note:** Grades must be continuous or lengthy in nature. Monitor oil temperatures before installing standpipes. Axles should operate at approximately 100°F (38°C) over ambient temperature and not exceed 240°F (116°C).

### Final Check

Prior to putting vehicle back into service, run the vehicle to bring axle lube up to temperature. Check filler and drain plugs and axle joint for leakage. Re-tighten to specifications as necessary.

## 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. Remove the axle shafts.
6. Install temporary cover on hub to prevent contamination entering and also to prevent the loss of lubricant.

## Power Divider Operation (Power Flow and Torque Distribution)

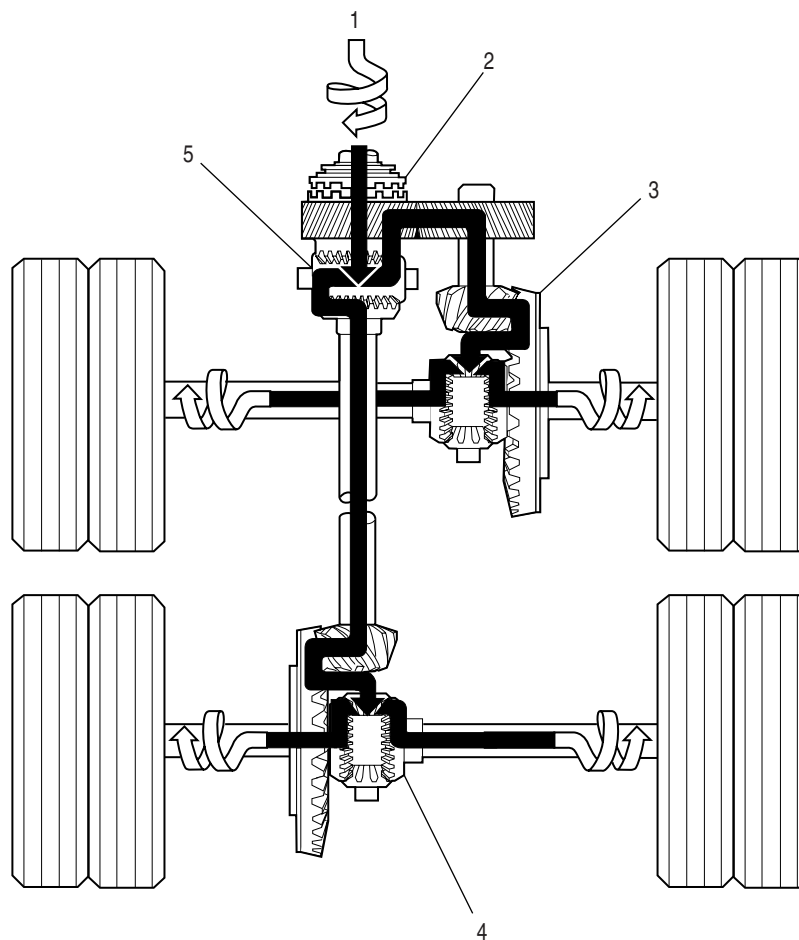
In operation, the power divider accepts torque from the vehicle driveline and distributes it equally to the two axles.

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.

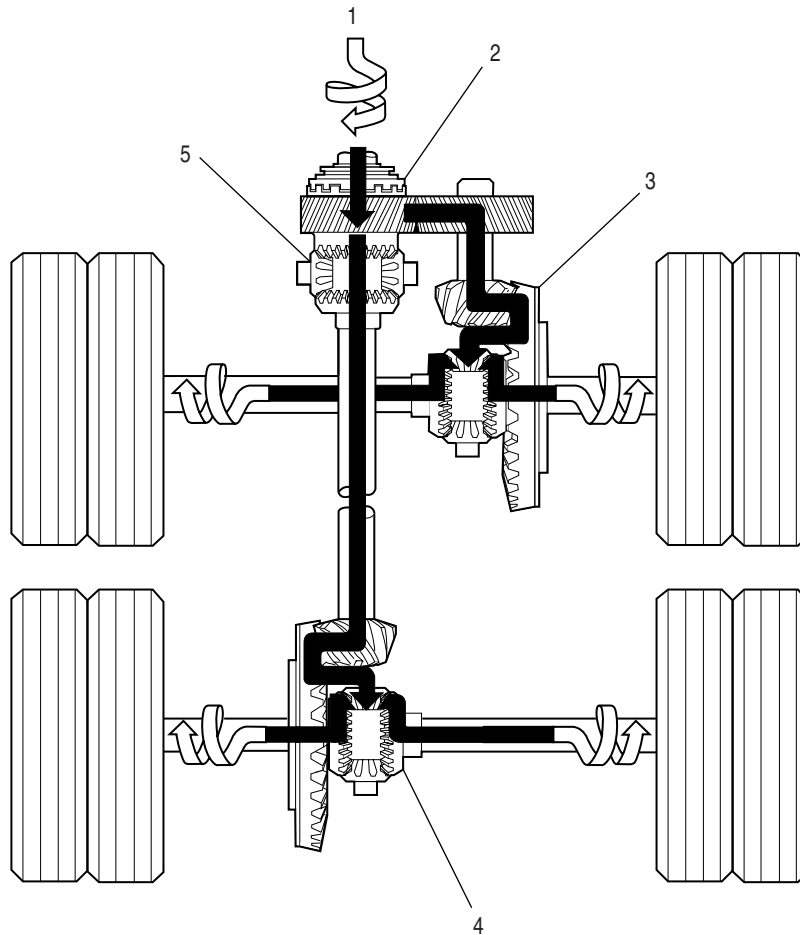
## With Lockout Engaged (Inter-Axle Differential is Not Operating)

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 Dana 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.

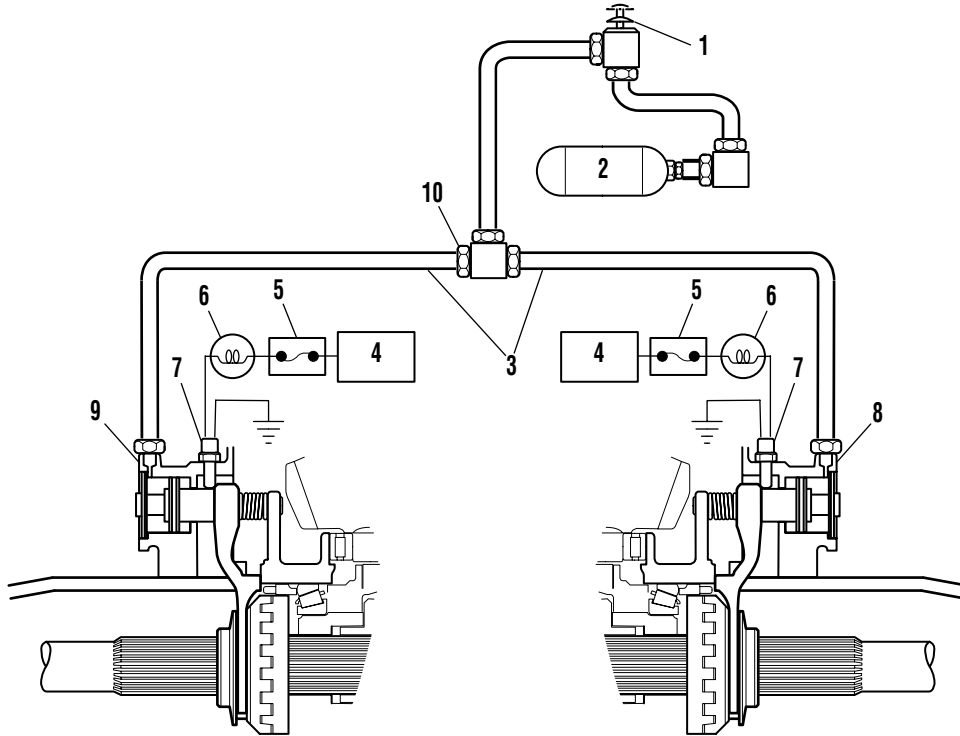
### Direct Driver-controlled System

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.

## Direct Driver-controlled System



- 1 - Cab-mounted control valve (plunger in—valve open)
- 2 - Dry air supply tank 80–120 PSI
- 3 - Preferably equal in length - Airline
- 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
- 9 - Forward rear axle wheel differential lock air shift cylinder
- 10 - 66468 Quick release valve (optional) located on frame rail and within 10 feet of tubing from control valve



## Wheel Differential Lock

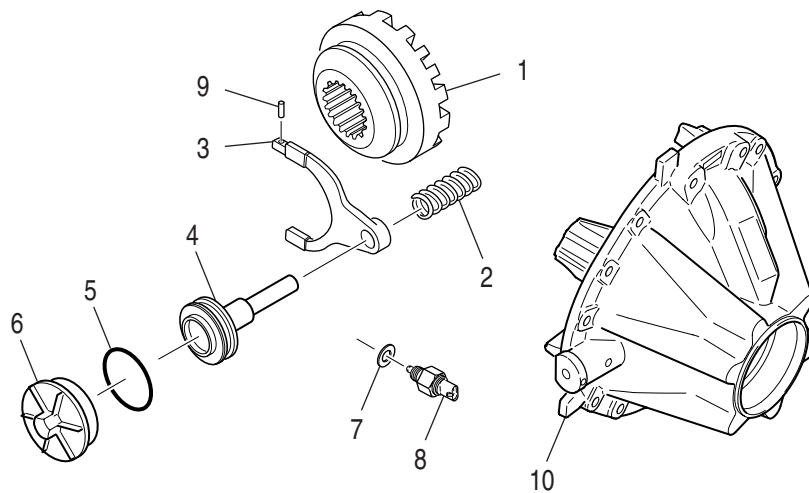
The Dana Wheel Differential Lock is an optional feature for Dana Axles. In operation, it positively locks the wheel differential, to provide improved traction under adverse road conditions.

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 a 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

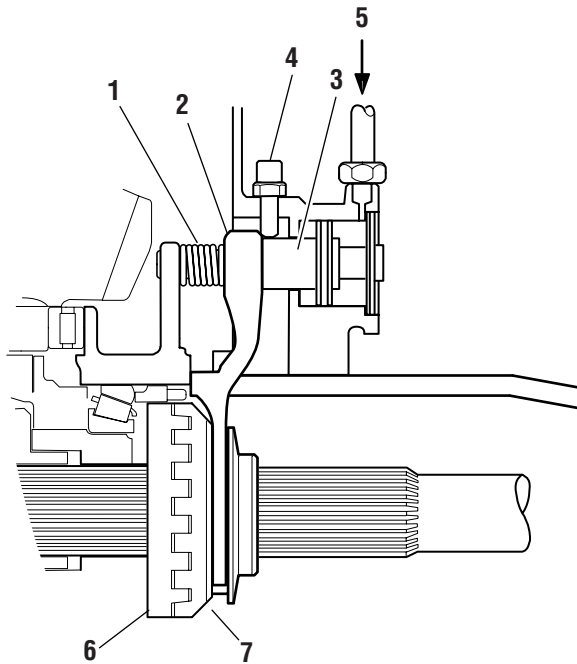
5 - O-ring  
6 - Piston cover  
7 - Washer  
8 - Switch

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.

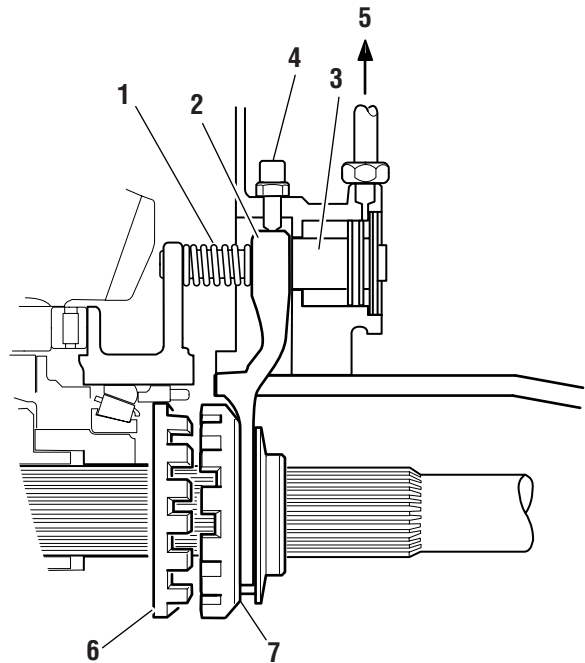


### **Differential Lock Engaged**

- 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 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 Disengaged**

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

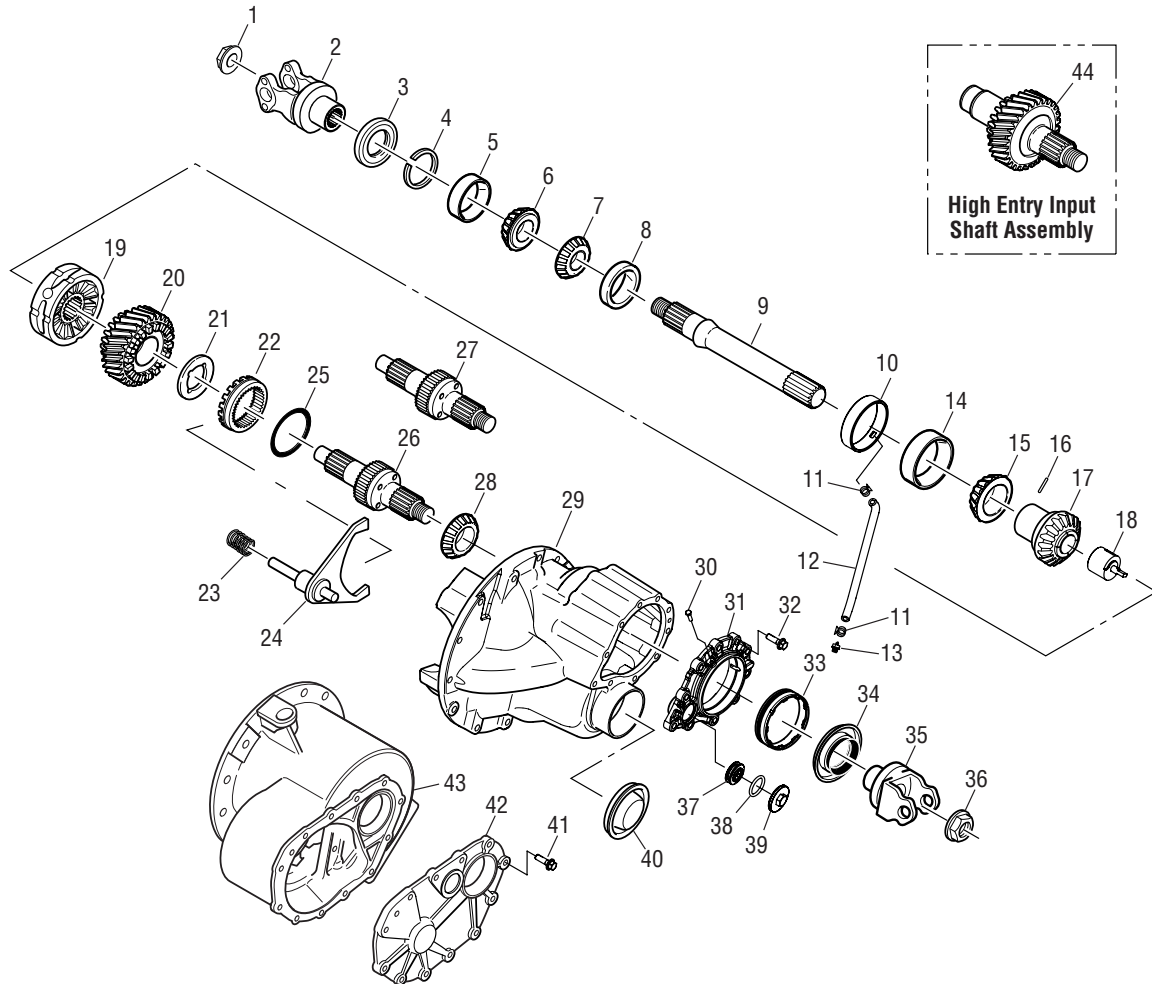
## Differential Lock Engagement Indicator

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).

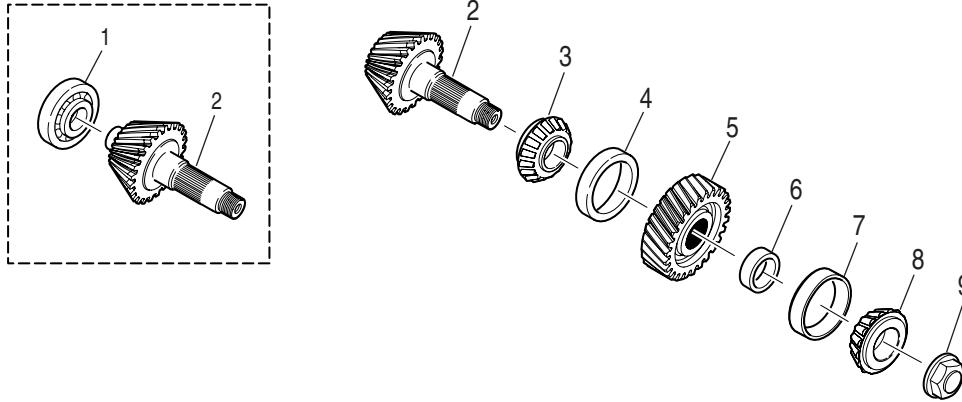
When the shift fork moves to disengage the differential lock, the compression spring also moves the push rod actuator to contact the switch. The switch is opened and turns off the cab-mounted indicator light (or the audible signal).

Power Divider - Parts Exploded View



- |                                    |                                    |                           |
|------------------------------------|------------------------------------|---------------------------|
| 1 - Output shaft nut               | 15 - Output side gear bearing cone | 29 - Carrier housing      |
| 2 - Output yoke                    | 16 - Pin                           | 30 - Locking capscrew     |
| 3 - Output seal                    | 17 - Output side gear              | 31 - Input cover          |
| 4 - Output shaft bearing snap ring | 18 - Pump                          | 32 - Input cover capscrew |
| 5 - Outer bearing cup              | 19 - Inter-axle differential       | 33 - Bearing cup and cage |
| 6 - Outer bearing cone             | 20 - Helical side gear             | 34 - Input seal           |
| 7 - Inner bearing cone             | 21 - Thrust washer                 | 35 - Input yoke           |
| 8 - Inner bearing cup              | 22 - Lockout sliding clutch        | 36 - Input nut            |
| 9 - Output shaft                   | 23 - Shift fork spring             | 37 - Piston               |
| 10 - Seal manifold                 | 24 - Shift fork assembly           | 38 - O-ring               |
| 11 - Clamp                         | 25 - V-ring                        | 39 - Piston cover         |
| 12 - Seal manifold feed tube       | 26 - Input shaft                   | 40 - Pinion cover         |
| 13 - Sump screen                   | 27 - Input shaft                   | 41 - Input cover capscrew |
| 14 - Output side gear bearing cup  | 28 - Input shaft bearing cone      | 42 - Input cover          |
|                                    |                                    | 43 - Carrier housing      |

**Forward Axle Pinion Assembly - Parts Exploded View**

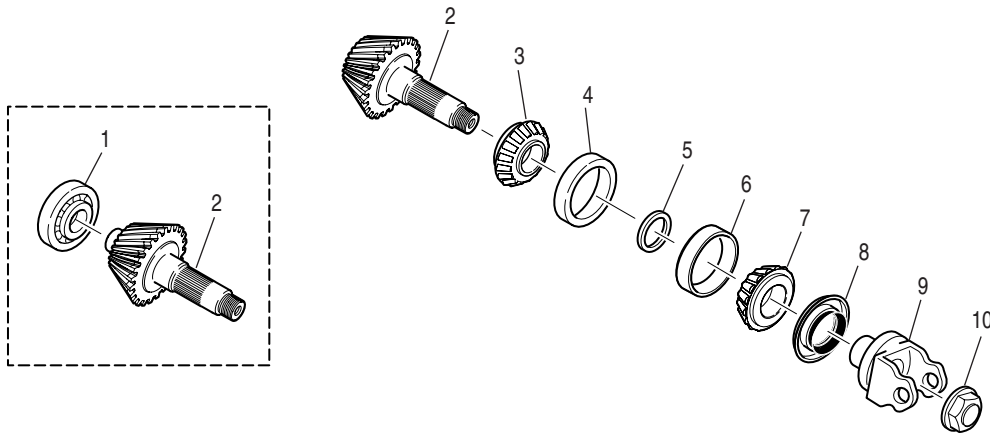


- 1 - Pinion pilot bearing
- 2 - Pinion
- 3 - Pinion bearing cone - inner

- 4 - Pinion bearing cup - inner
- 5 - Pinion helical gear
- 6 - Pinion bearing spacer

- 7 - Pinion bearing cup - outer
- 8 - Pinion bearing cone - outer
- 9 - Pinion nut

## Rear Axle 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

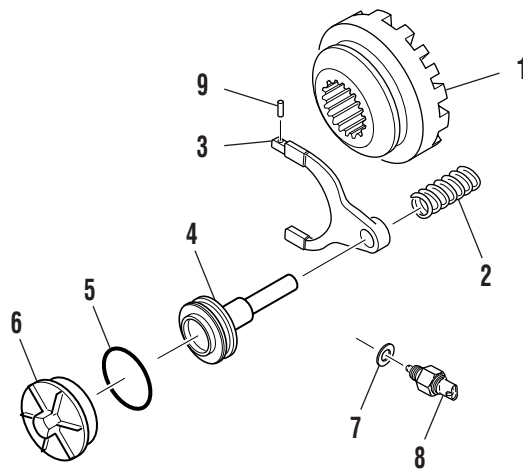
7 - Pinion bearing cone - outer

8 - Oil seal

9 - Yoke

10 - Pinion nut

## Wheel Differential Lock - Parts Exploded View

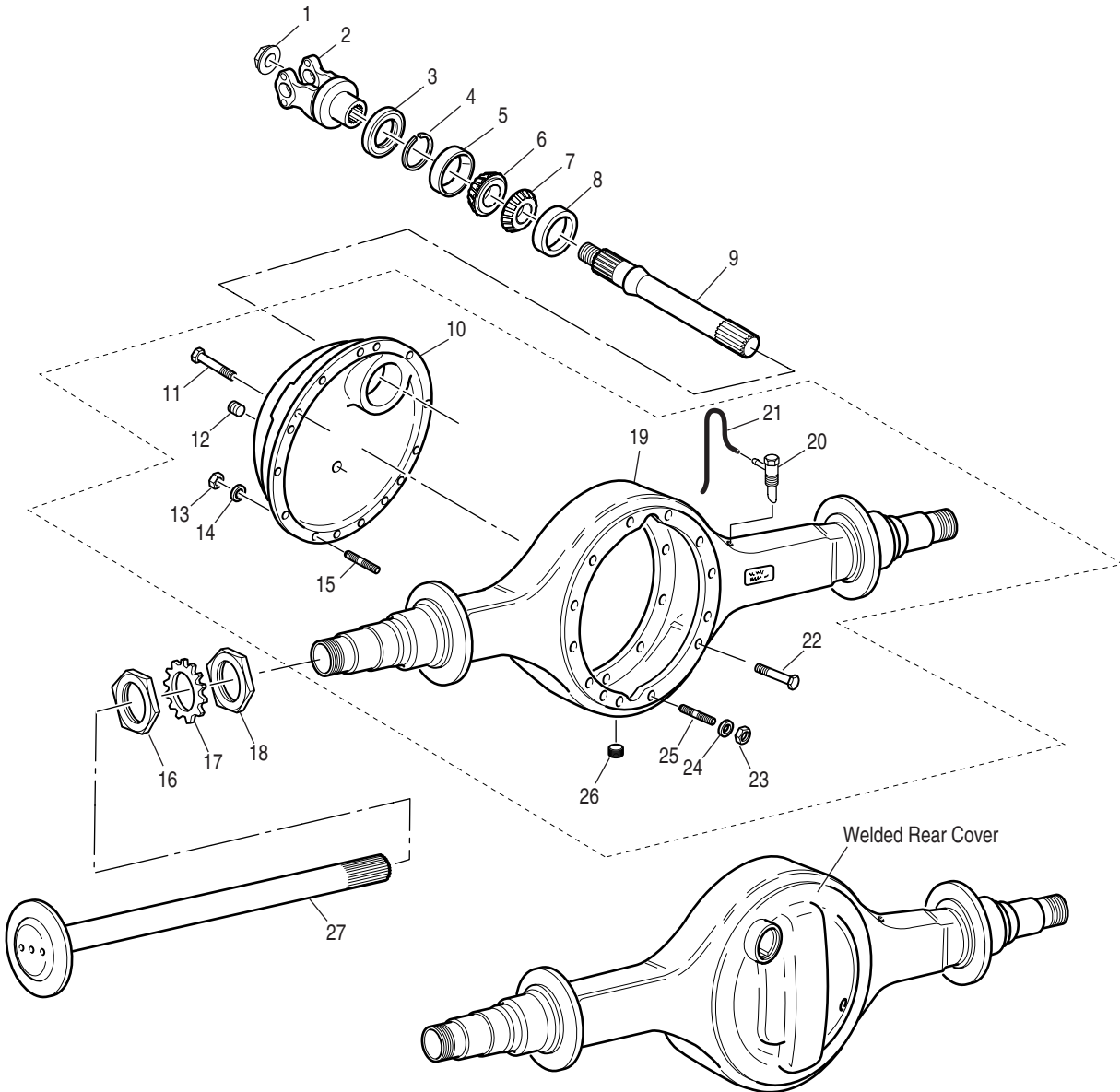


1 - Sliding clutch  
2 - Spring  
3 - Clutch fork

4 - Piston and rod  
5 - O-ring  
6 - Piston cover

7 - Washer  
8 - Switch  
9 - Pin

Housing and Output Shaft Assembly - Parts Exploded View



- 1 - Output shaft nut
- 2 - Output yoke
- 3 - Output seal
- 4 - Snap ring
- 5 - Outer bearing cup
- 6 - Outer bearing cone
- 7 - Inner bearing cone
- 8 - Inner bearing cup
- 9 - Output shaft

- 10 - Rear cover
- 11 - Rear cover capscrew
- 12 - Fill plug
- 13 - Rear cover nut
- 14 - Washer
- 15 - Stud
- 16 - Spindle nut - Outer
- 17 - Locking ring
- 18 - Spindle nut - Inner

- 19 - Axle housing
- 20 - Breather
- 21 - Breather hose
- 22 - Carrier capscrew
- 23 - Nut
- 24 - Washer
- 25 - Stud
- 26 - Drain plug
- 27 - Axle shaft

## Fastener Torque Specifications

| Location                              | Size             | Lbs. Ft.  | N•m        |
|---------------------------------------|------------------|-----------|------------|
| <b>POWER DIVIDER</b>                  |                  |           |            |
| Input Cage Locking Bolt               | M8 x 1.0 x 30    | 13 ± 17   | 17 ± 23    |
| Input Cage Locking Stud               | M12 x 1.75       | 15 ± 20   | 20 ± 27    |
| Locking Stud Jam Nut                  | M12 x 1.75       | 60 ± 65   | 81 ± 88    |
| IAD Shift End Cap                     | 2.375 - 16 UN-2A | 65 ± 10   | 85 ± 15    |
| Power Divider Cover Capscrews         | M14 x 1.5 x 45   | 175 ± 10  | 235 ± 10   |
| Input Shaft Nut                       | M48 x 1.5        | 900 ± 100 | 1220 ± 135 |
| <b>WHEEL DIFFERENTIAL AND GEARING</b> |                  |           |            |
| 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   |
| <b>CARRIER</b>                        |                  |           |            |
| Carrier Diff. Bearing Cap             | M18 x 1.5 x 85   | 265 ± 15  | 360 ± 20   |
| Carrier to Housing Capscrews          | 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    |
| <b>HOUSING</b>                        |                  |           |            |
| Rear Cover Capscrews                  | 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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