

Section 2

Steering

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Power Steering System

Specifications

Fastener Tightening Specifications

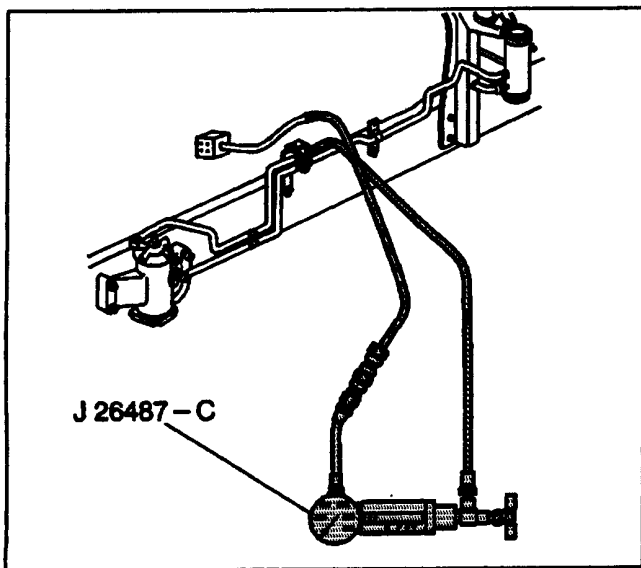
Application	Specification	
	Metric	English
Cardan Nut	55 N.m	41 lb ft
Power Steering Gear Mounting Nut	450 N.m	330 lb ft
Power Steering Pipe Adapter Nut at Bulk Head	52 N.m	38 lb ft
Power Steering Pipe Mounting Nut	22 N.m	16 lb ft
Reservoir Mounting Bolt	40 N.m	30 lb ft
Power Steering Pump Hose Adapter Mounting Bolt	52 N.m	38 lb ft
Pressure Plate Screw	8 N.m	71 lb in
Pump Body Bolt	54 N.m	40 lb ft
Valve Plug	54 N.m	40 lb ft

Diagnostic Information and Procedures

Power Steering System Test Procedure

Tools Required

J 26487-C Power Steering Analyzer



The J 26487-C tool set includes the following components:

- The 0–3000 psi pressure gage
- The 0–10 gpm (gallons per minute) flow meter
- The Gate Valve
- Hoses
- Hose Adapters

Important: The steering gear has end limiter valves (end limiters) which provide an increase in steering effort at a point within 1/3 turn of the axle stop contact. This is normal operation.

1. Place a container under the power steering hoses at the power steering hose bulk head in order to catch the fluid when disconnecting or connecting the hoses.

Clean the surface of the hoses before disconnecting the hoses.

2. Use the J-42971 (Hydraulic Line Separator) to disconnect the pressure hose snap-to-connect fittings at the power steering hose bulk head.

Important: Lubricate the tool end in power steering fluid to ensure smooth engagement with the quick disconnectors.

3. Connect the analyzer hoses to the adapters.
4. Bleed the power steering system if the analyzer has never been used. Refer to *Bleeding Power Steering System*.

Ensure that the analyzer gate valve remains open during the bleeding procedure.

Important: Throughout the following testing procedure, the letters in parentheses indicate specific pressures and flows.

Document the values of the pressures and the flows. Use the letters in parentheses as references for comparing the values.

5. Run the engine at idle speed with the gate valve open. Record the flow (A) and the pressure (B).
 - 5.1. If the flow is below 2 gpm, then the pump may need repair. Continue the test.
 - 5.2. If the pressure is above 200 psi, inspect the hoses for restrictions.

6. Partially close the gate valve in order to build up to 700 psi. Record the flow (C).
7. Compare the values of flow (A) and flow (C). If flow (C) drops more than 1 gpm under flow (A) then:
 8. Replace or rebuild the pump.
 9. Refer to the appropriate procedure:
 - *Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes)* or
 - *Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)*.
10. Replace the following components:
 - The ring
 - The rotor
 - The vanes
 - The O-ring seals
11. Complete the following steps in order to obtain the pressure value (D):
 - 11.1. Close the gate valve for not more than five seconds. partially open the gate valve.
 - 11.2. Close and partially open the valve two more times. Observe and record the pressure (D) each time that the gate is closed.
12. Compare the pressures (D) to the specified pressures.
 - If the recorded pressures are 100 psi lower than specifications, than replace the pump flow control valve.
 - If the pressures (D) are greater than the low specifications and vary from each other by more than 100 psi (1,450 BAR) than remove and clean the pump flow control valve.
 - Inspect the pump flow control valve bore for dirt or foreign materials. clean the pump flow control valve bore.
 - Inspect the system fluid for contamination. If the fluid is contaminated, disassemble and clean the steering gear and the pump before assembly.
13. Increase the engine speed from idle to approximately 1500 RPM. Record the flow (E).
14. Compare the values of flow (A) and flow (E). Complete the following steps if flow (E) varies by more than 1 gpm from flow (A).
 - 14.1. Remove and clean the pump flow control valve.
 - 14.2. Inspect the pump flow control valve bore for dirt or foreign materials. Clean the pump flow control bore.
 - 14.3. Inspect the fluid for contamination. If the fluid is contaminated, disassemble and clean the steering gear and the pump before assembly.
15. Have an assistant lightly turn the steering wheel into the left steering stop and then the right steering stop.

Caution: *This test can be dangerous if not performed correctly. Keep your fingers clear of steering stops and spacer block during this test. Make sure that the spacer block contacts the steering stop squarely. Contact that is not square could break the steering stop or dangerously throw or eject the spacer block.*

Notice: Do not hold the steering wheel in the full turn position longer than five seconds. To do so may damage the power steering pump.

Important: Use a non-hardened 1.3 cm (0.5 in) steel spacer on the steering gear.
16. Use a long handle to hold the spacer in place in front of the steering stops. this action will prevent pressure relief poppets from tripping.
17. Record the pressure and the flow (F). Verify that the following conditions exist:
 - The pressures measured at the steering stops are close in value to the maximum pump output (D).
 - The flow drops below 1 gpm.

If the above conditions do not exist, the steering gear is leaking internally. Repair the steering gear.
18. Perform the following actions simultaneously.
 - Have an assistant turn the steering wheel slightly in both directions and then quickly release the wheel.
 - Observe the pressure gage.

Under normal conditions, the needle will move from the normal back pressure reading and snap back when the wheel is released. A slow or sticking needle indicates a sticking rotary valve in the steering gear.
19. Complete the following steps if the pressure gage needle moves slowly or sticks:
 - 19.1. Remove the rotary valve.
 - 19.2. Disassemble and clean the rotary valve
20. If contamination exists in the system oil, disassemble and clean or replace the pump.
21. Refer to the appropriate procedure:
 - 21.1. *Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes)* or
 - 21.2. *Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)*.

Objectionable Hiss

Problem	Action
There is a noisy relief valve in the hydraulic pump.	- Noise is evident in all power steering systems. - Hissing is a common noise. The hissing noise is most evident at standstill parking. A hiss is a high frequency noise. - The noise is present in every valve and results from a high velocity fluid passing over the valve orifice edges. - There is not a relationship between the hissing noise and the performance of the steering. A hiss may be expected when the steering wheel is at the end of travel or when it is slowly turning at a standstill. - Do not replace the valve unless the hiss is extremely objectionable. A replacement valve will also exhibit some slight noise and is not always a cure for the objection.

Rattle or Chuckle Noise in Steering Gear

Problem	Action
The steering gear mounting is loose.	- Inspect the mounting hardware on the steering gear. - Torque the hardware to specifications.
The steering linkage is loose.	- Inspect the linkage pivot points for wear. - Replace any worn component.
The pressure hose is touching other parts of the vehicle.	Adjust the hose position. Do not bend the tubing by hand.
The Pitman arm is loose.	Torque the pitman arm nut.
The over-center adjustment is improper. A slight rattle may occur on turns because of an increased clearance off the High Point. This is a normal condition. Do not reduce the clearance below the specified limit in an attempt to eliminate this slight rattle.	Adjust to specifications.

Excessive Wheel Kickback or Loose Steering

Problem	Action
Air is present in the system.	- Add power steering fluid to the power steering reservoir. - Bleed the system. - Inspect the hose connectors for proper torque and leakage.
The steering gear mounting is loose.	Tighten the attaching bolts to the specified torque. Refer to <i>Fastener Tightening Specifications</i> .
The steering linkage joints are worn.	Replace any loose parts.
The steering gear mounting is improper.	Tighten the steering gear mounting bolt nuts to specifications. Refer to <i>Fastener Tightening Specifications</i> .
Worn or maladjusted front wheel bearings	Adjust or replace the bearings
Worn or damaged steering gear	Replace the steering gear.

Increase in Effort While Turning Steering Wheel

Problem	Action
The power steering fluid is low.	Add an adequate amount of power steering fluid.
There is a high degree of internal leakage (power steering pump or power steering gear).	Refer to <i>Power Steering System Test Procedure</i> .

Poor Return of Steering Wheel

Problem	Action
Under-inflated tires	Inflate the tires to the specified pressure.
The steering wheel is rubbing against the steering column cover.	Adjust the steering column cover.
The steering shaft bearings are tight or frozen.	Replace the bearings.
There is a binding in the steering linkage.	Replace any of the affected parts.
Misalignment of the steering gear to the column.	Align the steering column.
The suspension joints and the steering linkage are not adequately lubricated.	Lubricate the suspension joints and the steering linkage. Refer to <i>Fluid and Lubricant Recommendations</i> in Maintenance and Lubrication.
Sticking or plugging in the steering gear valve spool.	Replace the steering gear. Refer to <i>Power Steering Gear Replacement</i> .
Improper front wheel alignment.	1. Inspect the front wheel alignment. 2. Adjust the front wheel alignment to specifications.
A kink in the supply hose.	Replace the hose.

Steering Wheel Surges/Jerks While Turning

Problem	Action
The power steering fluid is low.	Add an adequate amount of power steering fluid.
The pump pressure is insufficient.	Refer to <i>Power Steering System Test Procedure</i> .
The gear pressure relief valve is faulty.	Replace the faulty gear pressure relief valve.
The steering linkage is binding.	1. Inspect the steering linkage for any worn components. 2. Replace the worn components.

Steering Effort Hard in Both Directions

Problem	Action
The tire pressure is low.	Inflate the tires to the specified pressure. Refer to <i>Tire Inflation Description</i> in Tires and Wheels.
A lack of lubrication in the suspension or ball joint (worn/contaminated joints).	Lubricate and relubricate at the proper intervals or replace the joints. Refer to <i>Fluid and Lubricant Recommendations</i> in Maintenance and Lubrication.
There is a binding in the steering linkage.	Replace any affected parts.
There is a misalignment of the steering gear to the column.	Align the steering column.
The power steering fluid is low.	1. Add an adequate amount of power steering fluid. 2. Inspect the lines and the joints for any external leakage.

Steering Effort Hard in Both Directions (cont'd)

Problem	Action
High internal leakage exists in the steering gear or in the pump.	Refer to <i>Power Steering System Test Procedure</i> .
Misalignment of the front wheels.	Check and adjust the front wheel alignment to specifications.

Vehicle Leads to One Side or the Other

Problem	Action
The road or wind conditions are poor.	1. Test drive the vehicle on a flat road. 2. Turn the vehicle in both directions.
The front wheels are misaligned.	Adjust the front wheels to specifications.
An unbalanced steering gear valve. If the steering gear valve is unbalanced, the steering effort will be very light in the direction of the lead and heavy in the opposite direction.	Replace the steering gear. Refer to <i>Power Steering Gear Replacement</i> .
The steering shaft is rubbing the I.D. of the shaft tube.	Align or replace the steering column.

Foaming, Milky-Appearing PS Fluid, Low in Level

Problem	Action
Air in the fluid and a loss of fluid due to internal pump leakage causing overflow.	1. Locate and repair the leak. 2. Bleed the power steering system. Refer to <i>Bleeding Power Steering System</i> . Extremely cold temperatures will cause system aeration if the power steering fluid is low.
Hose or air leakage in the reservoir line.	1. Locate and repair the leak 2. Bleed the power steering system. Refer to <i>Bleeding Power Steering System</i> . Extremely cold temperatures will cause system aeration if the power steering fluid is low.

Low Oil Pressure Due to Restriction in the Hose

Problem	Action
The hoses are kinked.	1. Remove the kinks. 2. Replace the hoses as necessary.
A foreign object is stuck in the hoses.	1. Remove the foreign object. 2. Replace the hoses as necessary.

Low Oil Pressure Due to Steering Gear

Problem	Action
There is a loss of pressure due to a worn piston ring or a scored housing bore.	Replace the steering gear. Refer to <i>Power Steering Gear Replacement</i> .
There is leakage in the steering gear.	Replace the steering gear. Refer to <i>Power Steering Gear Replacement</i> .
A damaged end limiter	Replace the end limiters. Refer to <i>End Limiters Replacement</i> .

Low Oil Pressure Due to Steering Pump

Problem	Action
The flow control valve is stuck or inoperative.	1. Replace or clean the vanes. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
The pressure plate is not flat against the cam ring.	1. Replace the pressure plate. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
An excessively worn cam ring.	1. Replace the cam ring. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
A scored pressure plate, thrust plate, or rotor.	1. Replace the components. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
The vanes are sticking in the rotor slots.	1. Clean the vanes. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
Improperly installed vanes	1. Inspect the pump for internal damage. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
There is air in the fluid.	Locate and repair the leak.
There is damage on the hoses or the steering gear.	Replace any damaged components.
The power steering fluid is low.	Add an adequate amount of power steering fluid.

Groan Noise in Steering Pump

Problem	Action
The power steering fluid is low.	Add an adequate amount of power steering fluid.
Air is present in the power steering system.	Locate and repair the leak.

Growl Noise in Steering Pump

Problem	Action
Excessive back pressure in the hoses or the steering gear caused by restriction	Locate and repair the restriction.

Growl Noise in Steering Pump

Problem	Action
Scoring on the pressure plates, thrust plates, or rotor	1. Replace the components. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
An excessively worn cam ring	1. Replace the components. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)

Rattle or Knock Noise in Steering Pump

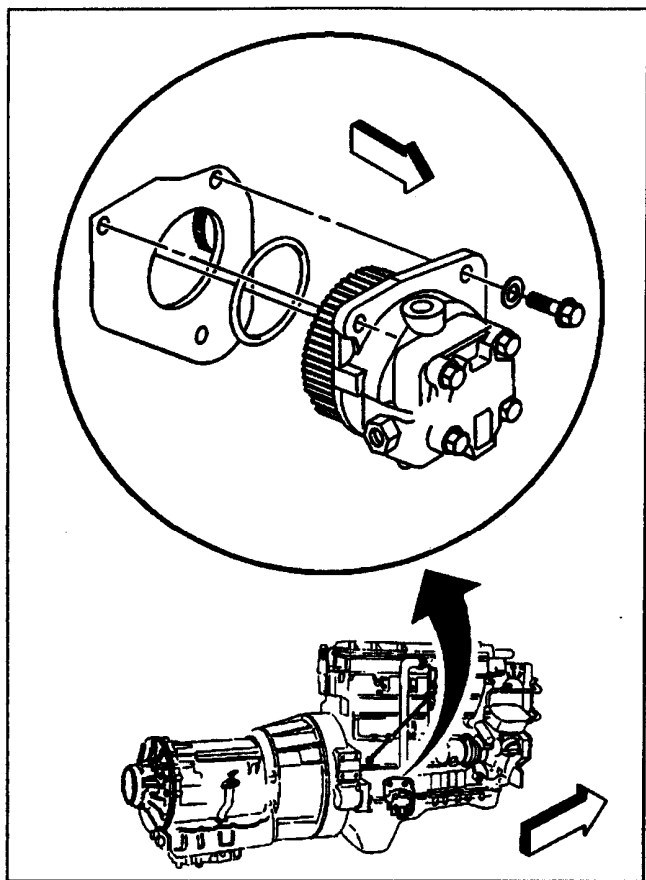
Problem	Action
Loose power steering pump gear nut	Tighten the gear nut to specifications.
The pump vanes are sticking in the rotor slots.	1. Free the pump vanes by removing any burrs, varnish, or dirt. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)
The pressure hose is touching other parts of the vehicle.	Adjust the hose position.

Swish Noise in Steering Pump

Problem	Action
A faulty control valve	1. Replace the components. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)

Whine Noise in Steering Pump

Problem	Action
A scored pump shaft bearing	1. Replace the components. 2. Refer to the appropriate procedure: • Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes) • Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)



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Repair Instructions

Power Steering Pump Replacement

Removal Procedure

1. Tilt the cab. Refer to *Cab Tilting* in General Information.

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

2. Place a container under the power steering hoses at the power steering pump in order to catch the fluid when disconnecting or connecting the hoses.

Clean the hose surfaces before disconnecting the hoses.

3. Remove the power steering hoses at the power steering pump.
4. Cap the hoses to prevent any dirt from entering the system.
5. Tag the hose locations.
6. Remove the power steering pump mounting bolts and the washers.

Notice: Do not Hammer the pump off the engine. Damage to the pump housing may result.

7. Gently pry the power steering pump and the O-ring from the engine.
8. Remove the power steering pump hose adapters mounting bolts and the power steering pump hose adapter, if necessary.

Installation Procedure

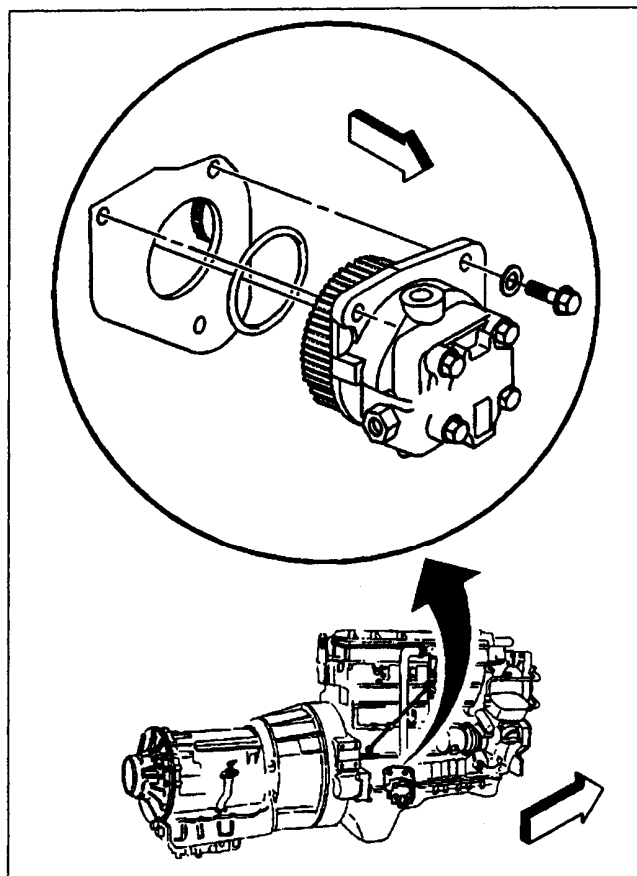
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the power steering pump hose adapter to the power steering pump hose, if necessary. Secure the adapter with the adapter mounting bolts.

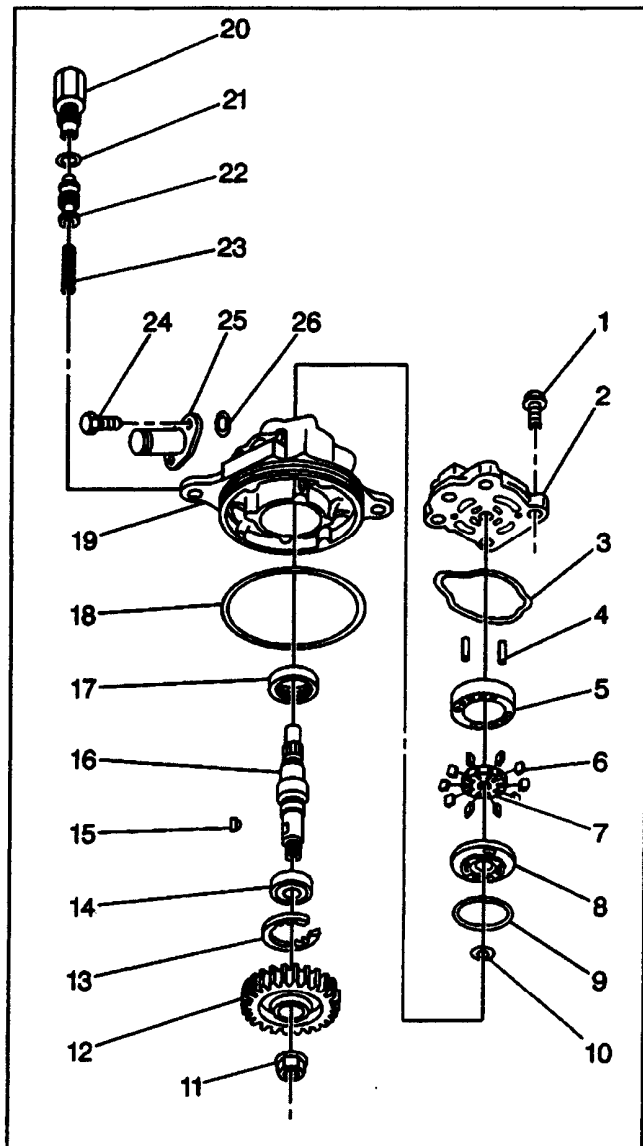
Tighten

Tighten the power steering pump hose adapter mounting bolts to 52 N·m (38 lb ft).

2. Position the O-ring and the power steering pump to the engine.
3. Install the power steering pump mounting washers and bolt.
4. Install the power steering pump hoses to the power steering pump.
5. Fill and bleed the power steering system. Refer to *Bleeding Power Steering System*.
6. Lower the cab.



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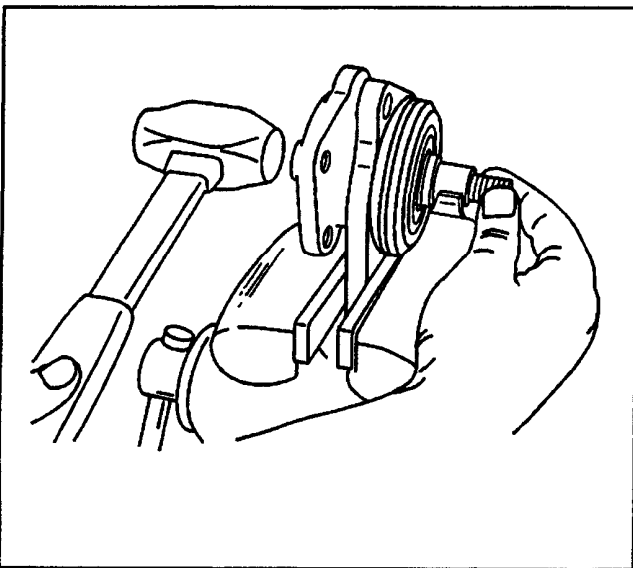
Power Steering Pump Assemble (P/S Pump Repair W/ Air Brakes)

Disassemble Procedure

1. Clean the exterior of the power steering pump with a suitable cleaning solvent that will not damage the rubber components.
2. Remove the following components from the shaft:
 - The nut (11).
 - The gear (2). (the gear is a slip fit)
 - The key (5).
3. Remove the pump body bolts (1).
4. Remove the rear cover (2) and gasket (3) from the pump body (19).
5. Remove the side plate (12) and ring (5) assembly.
6. Disassemble the following components:
 - The side plate (8)
 - The pins (4)
 - The rotor (7)
 - The vanes (6)
7. Remove the snap ring (13) from the pump body.

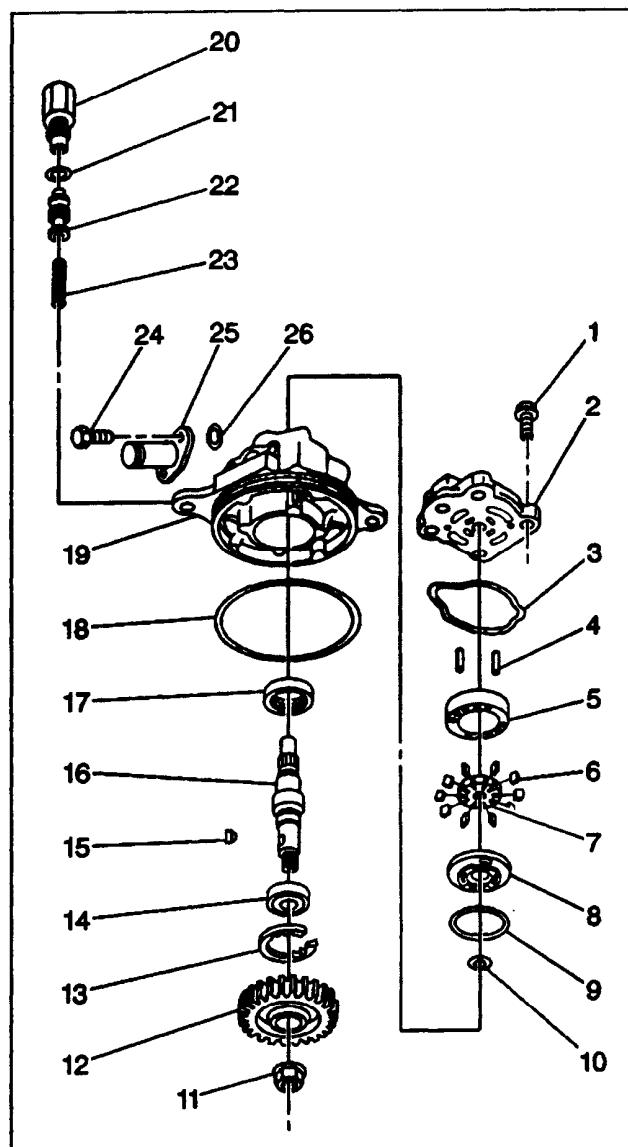
Important: Gently tap with a plastic mallet on the end opposite the drive end to remove the shaft from the pump body.

8. Remove the shaft from the pump body.

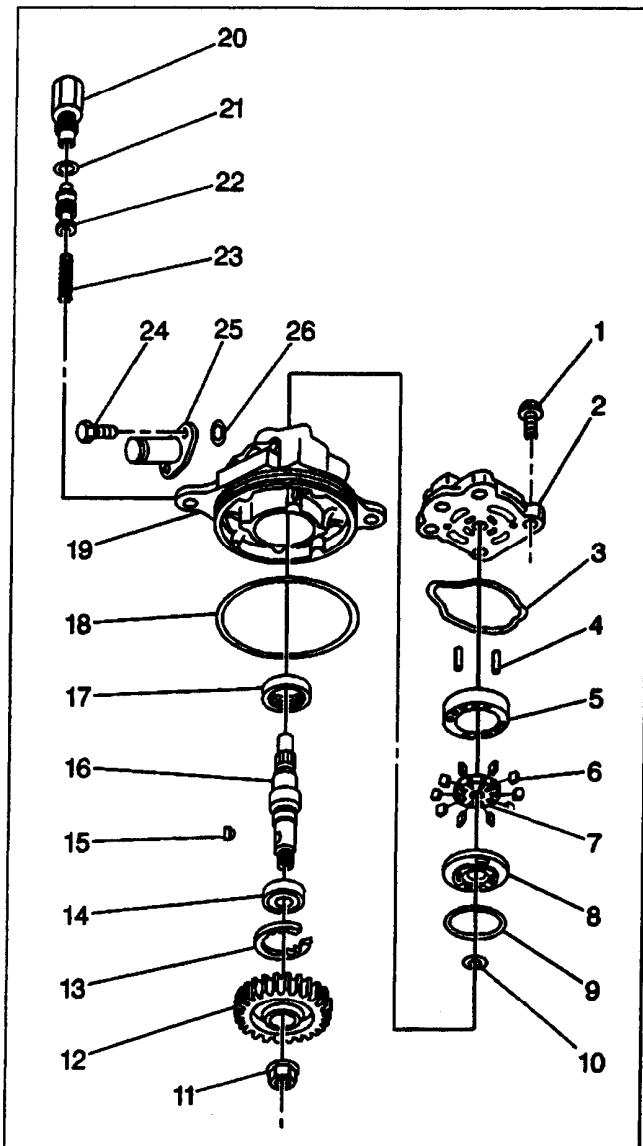


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9. Remove the shaft seal from the pump body.
10. Remove the O-ring from the pump body.



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Inspection Procedure

1. Inspect the bushing for the following conditions:
 - Scores
 - Wear

Important: The bushing is not serviced.

If the bushing shows abnormal conditions, the rear cover must be replaced (2).

2. Use a suitable solvent in order to clean all of the parts.

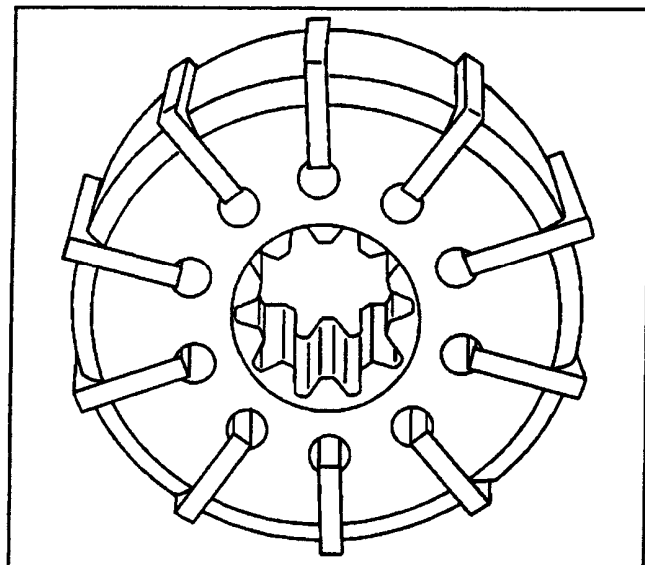
Dry all of the parts.

3. Inspect the vane tips (6) for the following conditions:

- Wear
- Damage

4. Inspect the inner surface of the ring (5) for the following conditions:

- Scoring
- Wear
- Damage

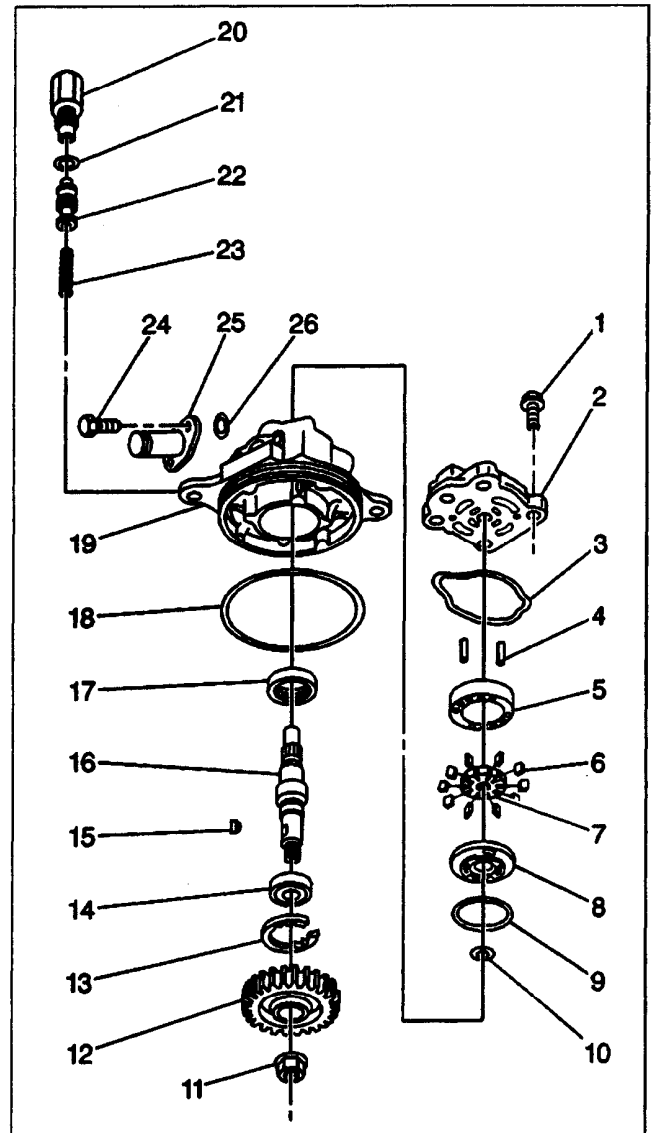


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Important: The vanes must fit properly in the rotor slots, without sticking or excessive play.

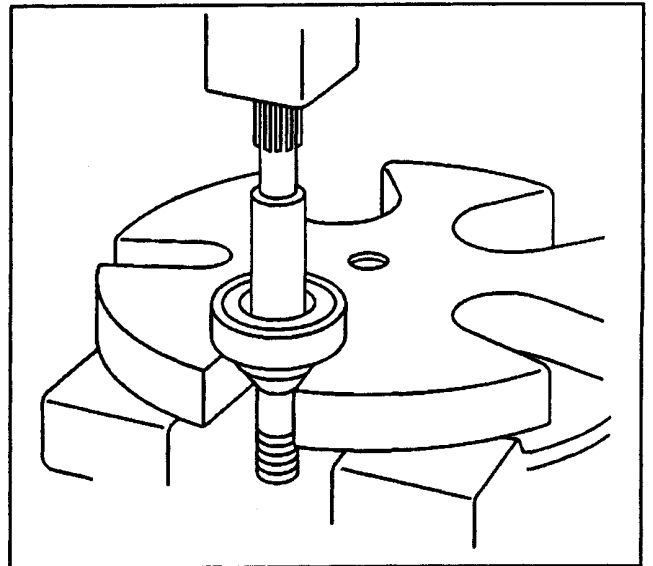
5. Inspect the fit of the vanes in the rotor
6. Inspect for the following conditions:
 - Burrs in the rotor slots
 - Excessive wear at the thrust faces
7. Replace the rotor, the ring, and all the vanes if any of the following conditions are present:
 - Heavy wear
 - Damage

8. Inspect the side plate (8) and rear cover for wear at the thrust faces.
 9. Replace the side plate (8) and the rear cover (2) if wear is excessive.
 10. Inspect the shaft (16) for the following conditions:
 - Scoring
 - Damage
- Important:** Replace the rear cover (2) whenever a shaft replacement is necessary.
11. Secure the pump body (19).
 12. Remove the connector (20) and the O-ring (21).
 13. Remove the valve body (22) and spring (23).

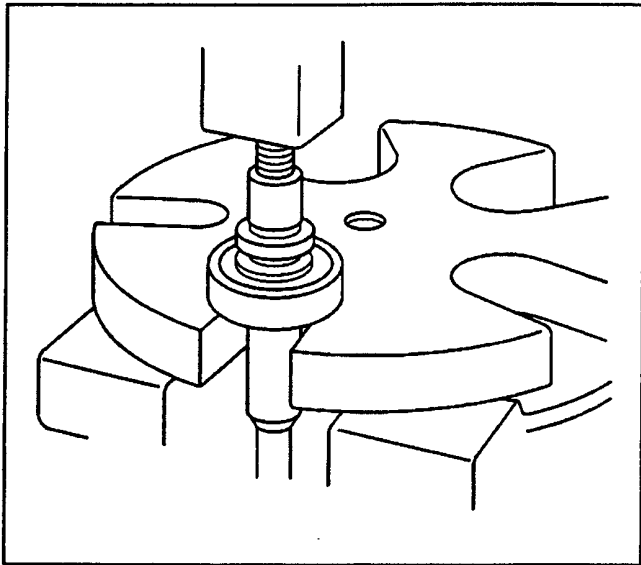


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14. Inspect the shaft bearing. Refer to *Wheel Bearings Diagnosis*.
15. If the shaft or bearing needs to be replaced, perform the following steps:
 - Press the shaft bearing off of the shaft using an arbor press.
 - Discard the shaft bearing.



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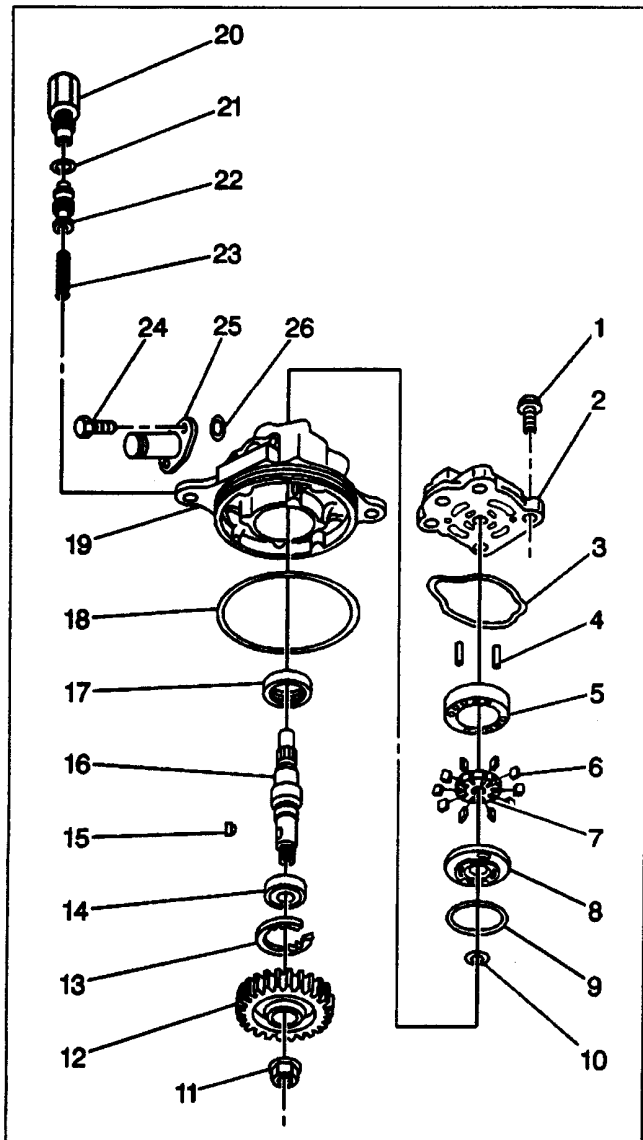


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Assembly procedure

1. Press the new bearing on to the shaft using an arbor press.

Important: Lubricate the new bearing with power steering fluid prior to pressing.



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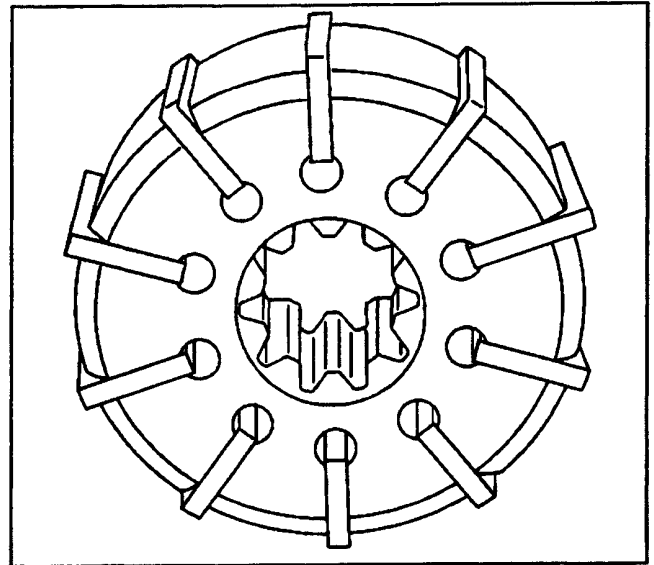
2. Install the O-ring (18) into the pump body (19).

Important: Lubricate the lips of the new seal (17) with petroleum jelly.

3. Install a new shaft seal (17) into the pump housing (19) using an arbor press and a suitable spacer.
4. Install the shaft bearing assembly (14, 16) into the pump housing (19).
5. Install the retainer ring (13) into the pump housing (19).
- Important:** Lubricate the rotor (7), ring (5) and the vanes (6) with power steering fluid prior to assembly.
6. Install the rotor (7) into the ring (5).

Important: Ensure that the rounded edges of the vanes contact the rotor.

7. Install the vanes into the rotor.



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8. Install the O-rings into the pump body.
9. Install the following components into the pump housing (19):
 - 9.1. The side plate (8)
 - 9.2. The rotor (7)
 - 9.3. The pins (4)
10. Install the rear cover (2) and gasket (3) to the pump housing (19) with the rear cover bolts (1).

Tighten

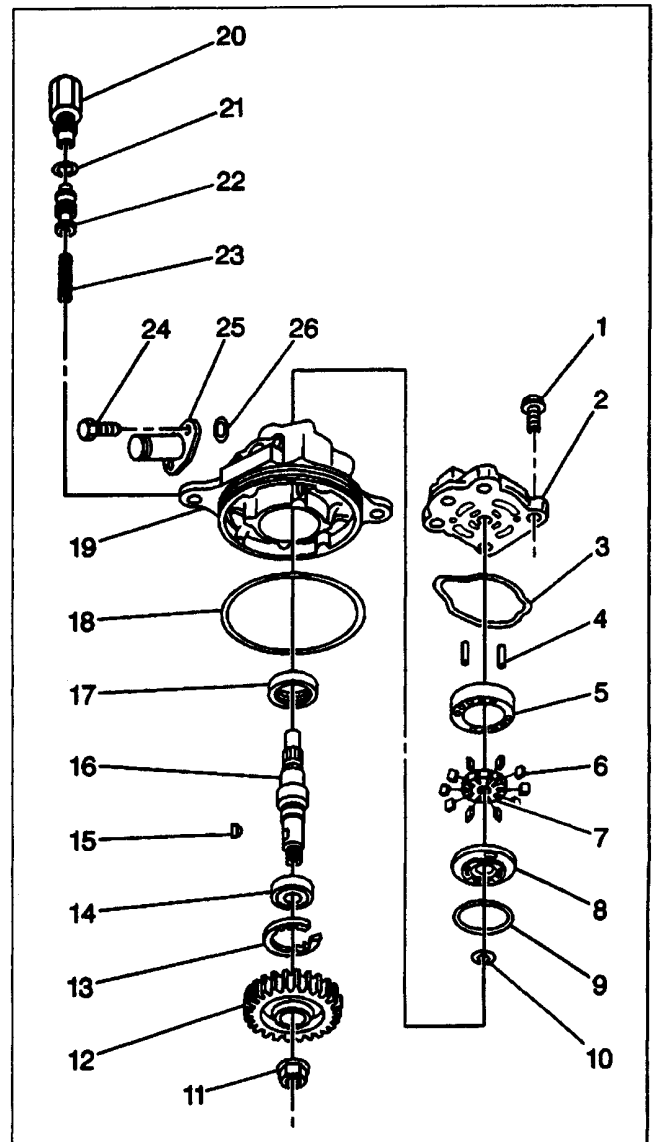
Tighten the rear cover bolts to 21 N.m (15 lb ft).

11. Install the valve spring (23) and valve body (22) into the pump housing (19).
12. Install the O-ring (21) and connector (20) into the pump housing (19).

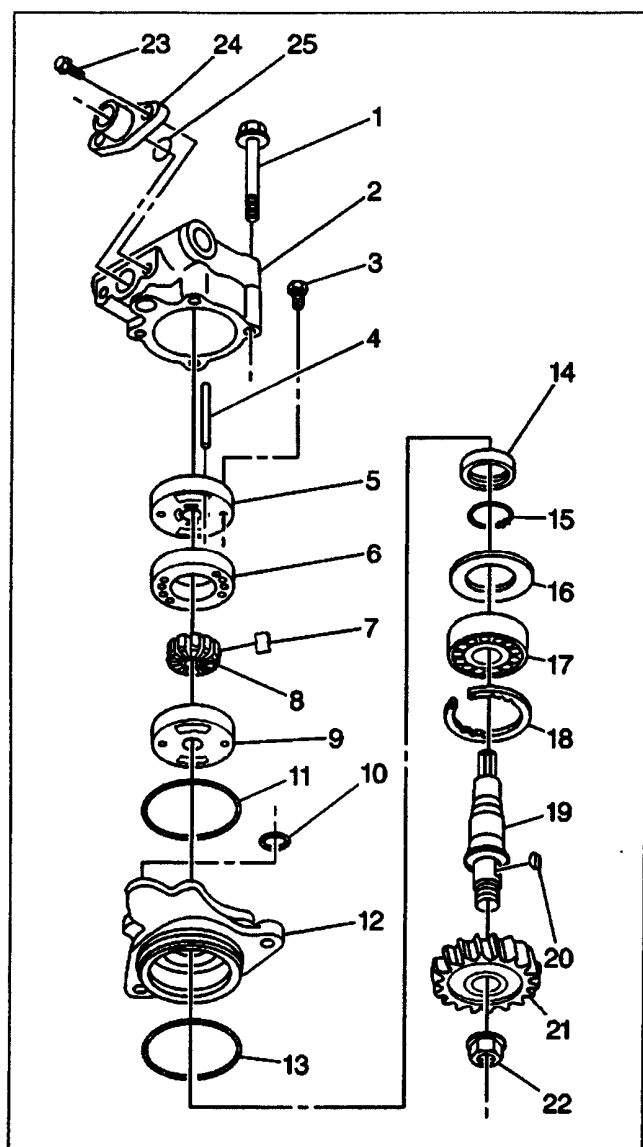
Tighten

Tighten the connector to 49 N.m (36 lb ft).

13. Install the following components:
 - 13.1. The key (15)
 - 13.2. The gear (12)
 - 13.3. The washered nut (11)



361660

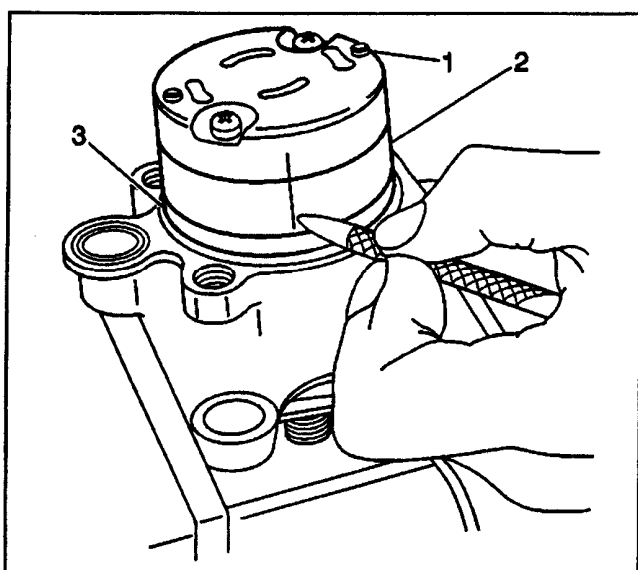


361652

Power Steering Pump Assemble (P/S Pump Repair W/ Hyd Brakes)

Disassemble Procedure

1. Clean the exterior of the power steering pump with a suitable cleaning solvent that will not damage the rubber components.
2. Remove the following components from the shaft (18):
 - The nut (22).
 - The gear (21) (the gear is a slip fit)
 - The key (19)
3. Remove the pump body bolts (1).
4. Remove the following components from the front cover (12):
 - The pump body (2)
 - The O-rings (10, 11)

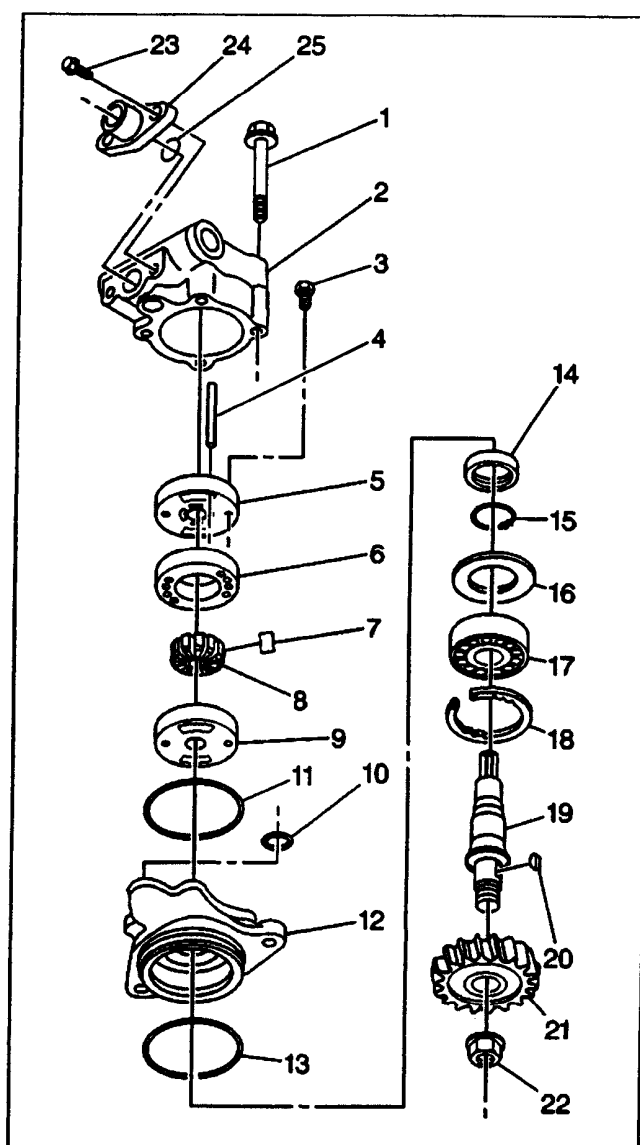


228844

Important: The side plate, the ring, and the pressure plate must be assembled in the exact position that they were removed.

5. Mark the following components:
 - The side plate (3)
 - The ring (2)
 - The pressure plate (1)

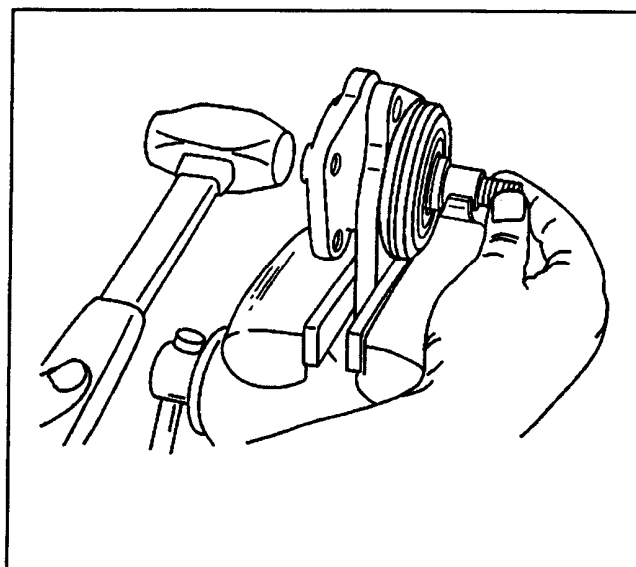
6. Remove the following components from the ring (6):
 - The pressure plate screws (3)
 - The pressure plate (5)
7. Remove the following components from the ring (6)
 - The side plate (9)
 - The pin (4)
 - The rotor (8)
 - The vanes (7)
8. Remove the snap ring (20) from the front cover (12)



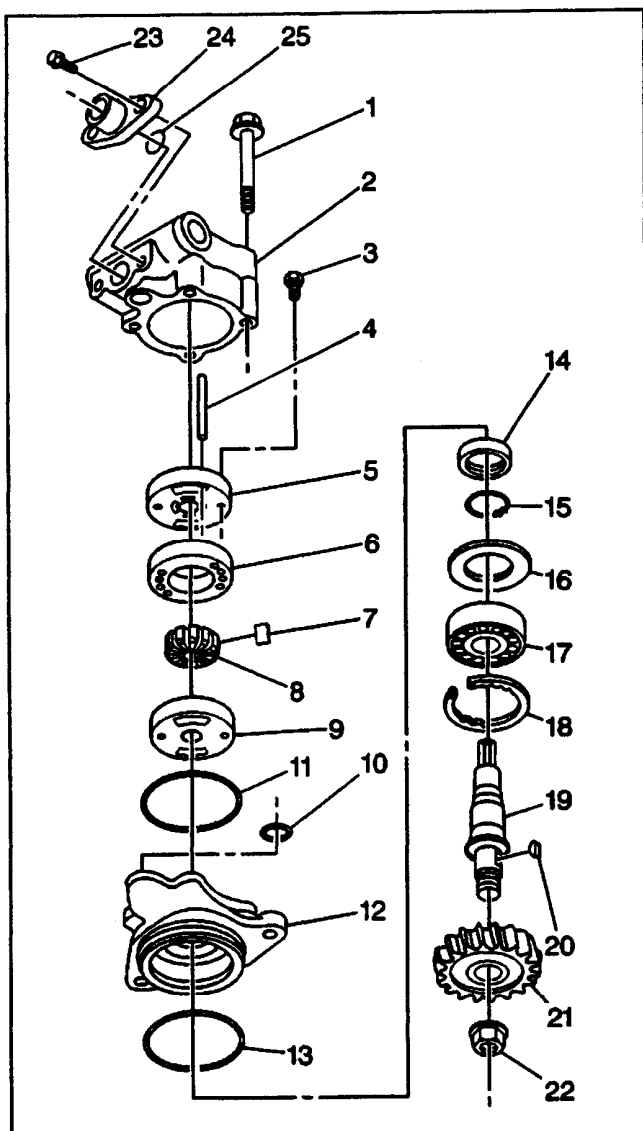
361652

Important: Gently tap with a plastic mallet on the end opposite the drive end in order to remove the shaft from the front cover.

9. Remove the shaft from the front cover.

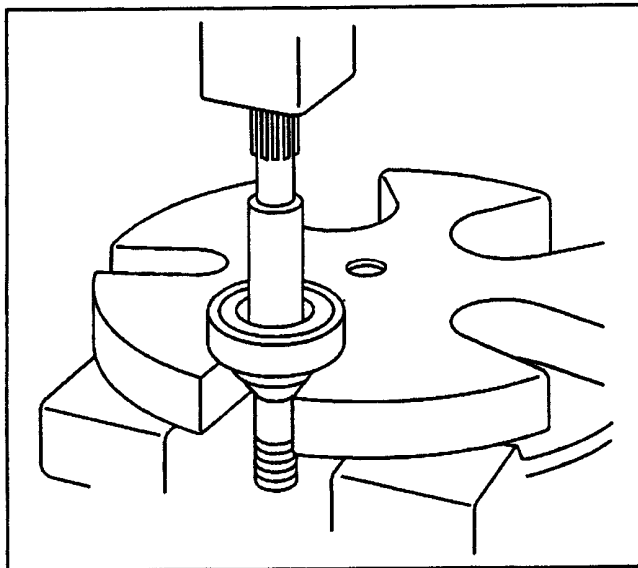


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361652

10. Remove the retainer ring (16) from the shaft (18)
11. Remove the shaft seal (14) from the front cover (12)
12. Remove the O-ring (13) from the front cover (12)

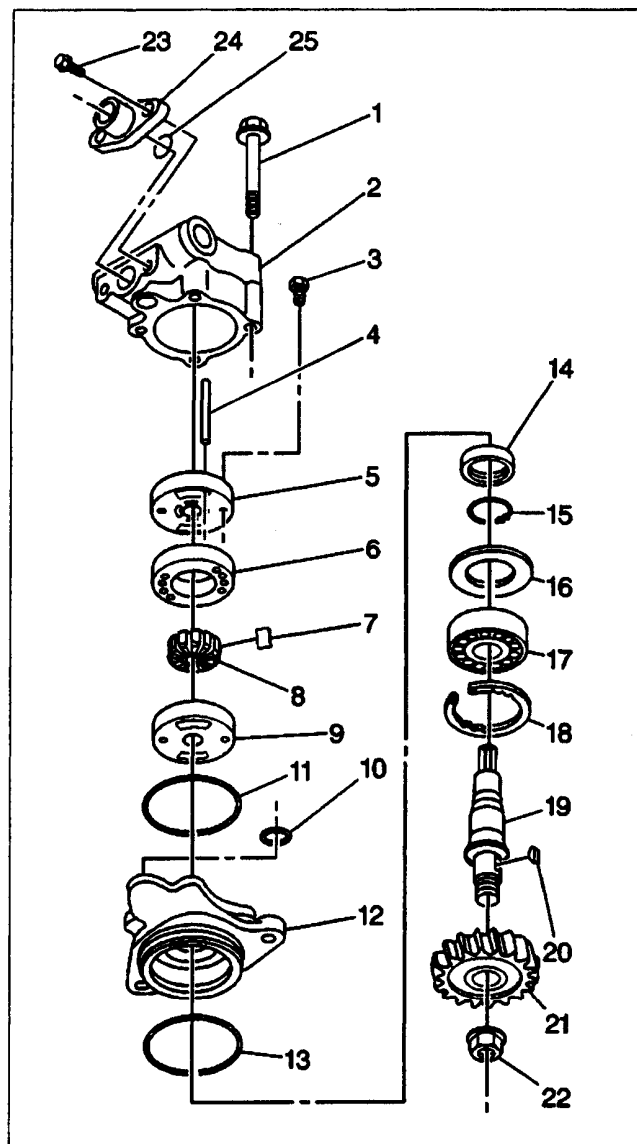


228883

13. Inspect the shaft bearing Refer to *Wheel Bearings Diagnosis* in Suspension General Diagnosis.
14. If the shaft bearing needs to be replaced, perform the following steps:
 - Remove the snap ring from the shaft
 - Press the shaft bearing off of the shaft
 - Discard the shaft bearing

Inspection Procedure

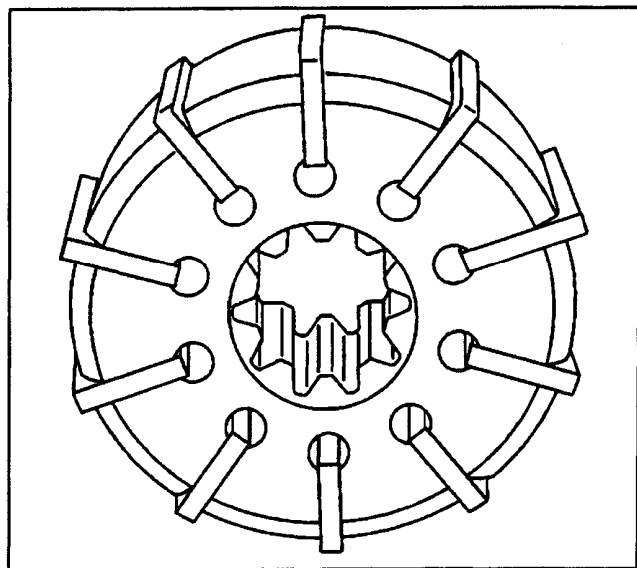
1. Inspect the bushing for the following conditions:
 - Scores
 - Wear
2. If the bushing shows any of these conditions, the pump body (2) must be replaced.
3. Use a suitable solvent in order to clean all of the parts.
Dry all of the parts.
4. Inspect the vane tips (7) for the following conditions:
 - Wear
 - Damage
5. Inspect the inner surface of the ring (6) for the following conditions:
 - Scoring
 - Wear
 - Damage



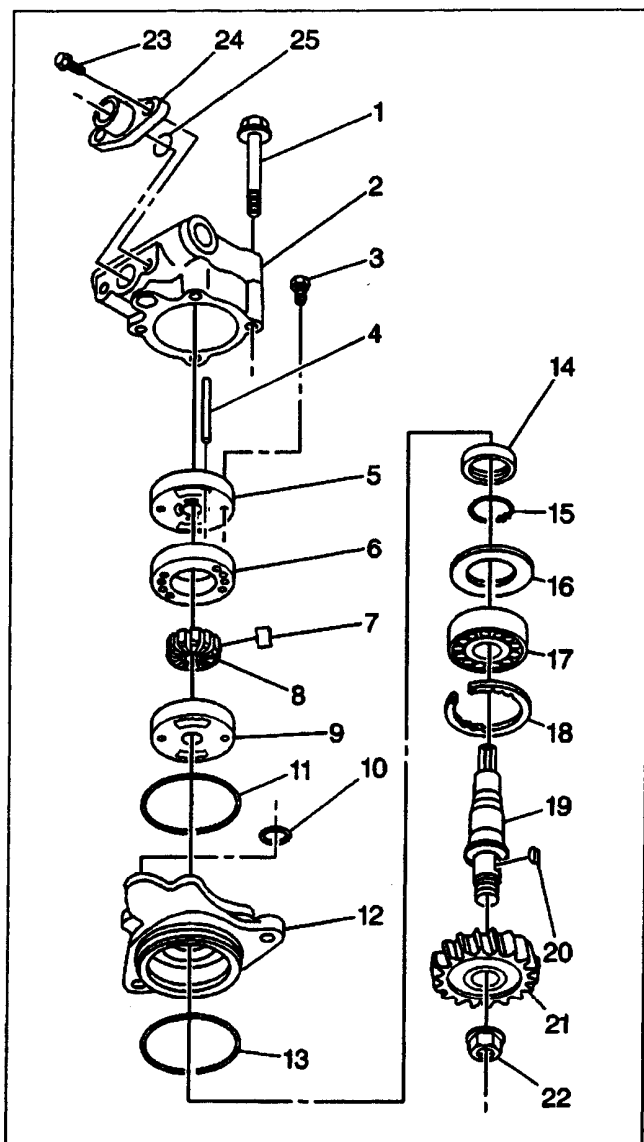
361652

Important: The vanes must fit properly in the rotor slots, without sticking or excessive play.

6. Inspect the fit of the vanes in the rotor.
7. Inspect for the following conditions:
 - Burrs in the rotor slots
 - Excessive wear at the thrust faces
8. Replace the rotor, the ring, and all the vanes if any of the following conditions are present:
 - Heavy wear
 - Damage



228886



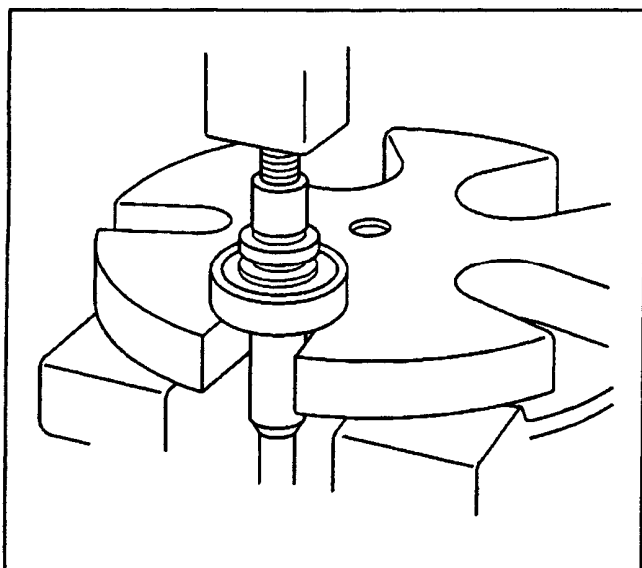
361652

9. Inspect the side plate (9) for wear at the thrust faces.
 10. Replace the side plate (9) if wear is excessive.
 11. Inspect the pressure plate (5) for wear at the thrust faces.
 12. Replace the pressure plate (5) if wear is excessive.
 13. Inspect the shaft bearing (17). Refer to *Wheel Bearings Diagnosis* in Suspension General Diagnosis.
 14. Inspect the shaft (18) for the following conditions:
 - Scoring
 - Damage
- Important:** Replace the pump body (2) whenever a shaft replacement or bushing replacement is necessary.
15. Replace the shaft (18) if it is necessary.

Assemble Procedure

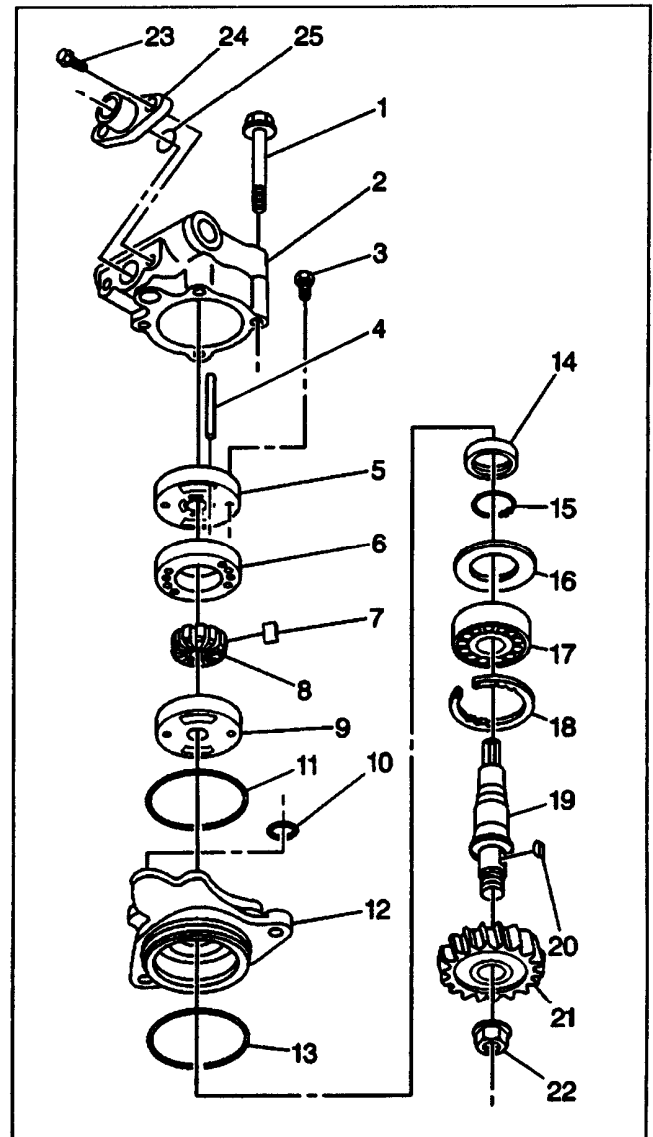
Important: Lubricate the new shaft bearing with power steering fluid prior to pressing the new shaft bearing onto the shaft.

1. Use an arbor press and a suitable spacer in order to press the new shaft bearing onto the shaft.



228865

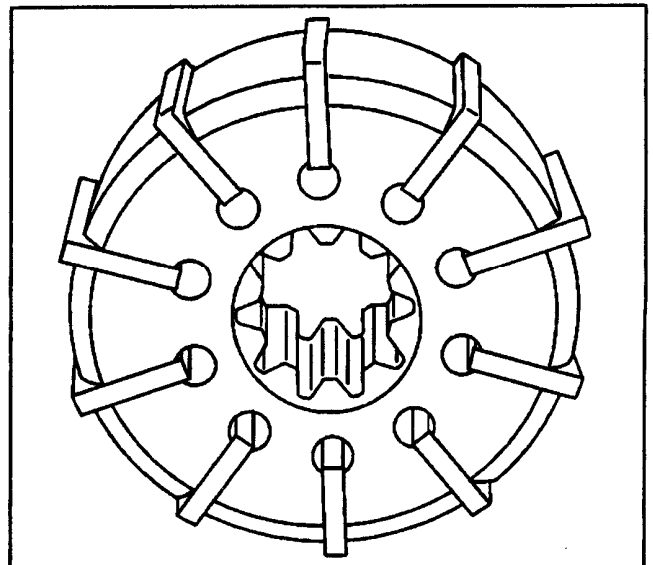
2. If the shaft bearing (17) was removed, install the snap ring (15) on the shaft (18).
3. Install the O-ring (13) into the front cover (12).
Important: Lubricate the lips of the new seal (14) with petroleum jelly.
4. Install a new shaft seal (14) into the pump housing (2) using an arbor press and a suitable spacer.
5. Install the retainer ring (16) on the shaft (18).
6. Install the following components into the front cover (12):
 - A new O-ring (13)
 - The bearing shaft assembly
7. Install the snap ring (20) into the front cover (12)
- Important:** Lubricate the rotor (8), ring (6), and the vanes (7) with power steering fluid prior to assembly.
8. Install the rotor (8) into the ring (6).



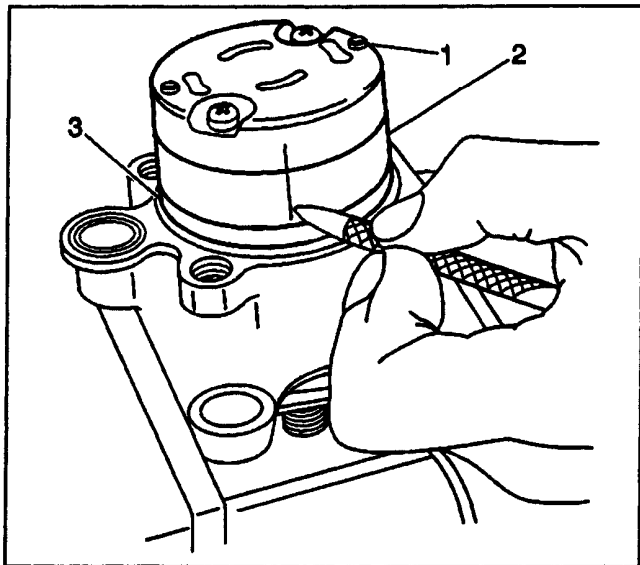
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Important: Ensure that the rounded edges of the vanes contact the rotor.

9. Install the vanes into the rotor.



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10. Align the marks on the following components:

- The side plate (3)
- The pins
- The ring (2)

11. Install the following components on the ring (2):

- The side plate (3)
- The pins

Notice: Refer to *Fastener Notice* in Cautions and Notices.

12. Install the pressure plate (1) on the ring (2) with screws.

Tighten

Tighten the pressure plate screws to 8 N.m (71 lb in).

13. Install the following components into the pump housing (2):

- The pressure plate (5)
- The ring (6)
- The rotor assembly (7, 8)

14. Install both O-rings (10, 11) into the front cover (12)

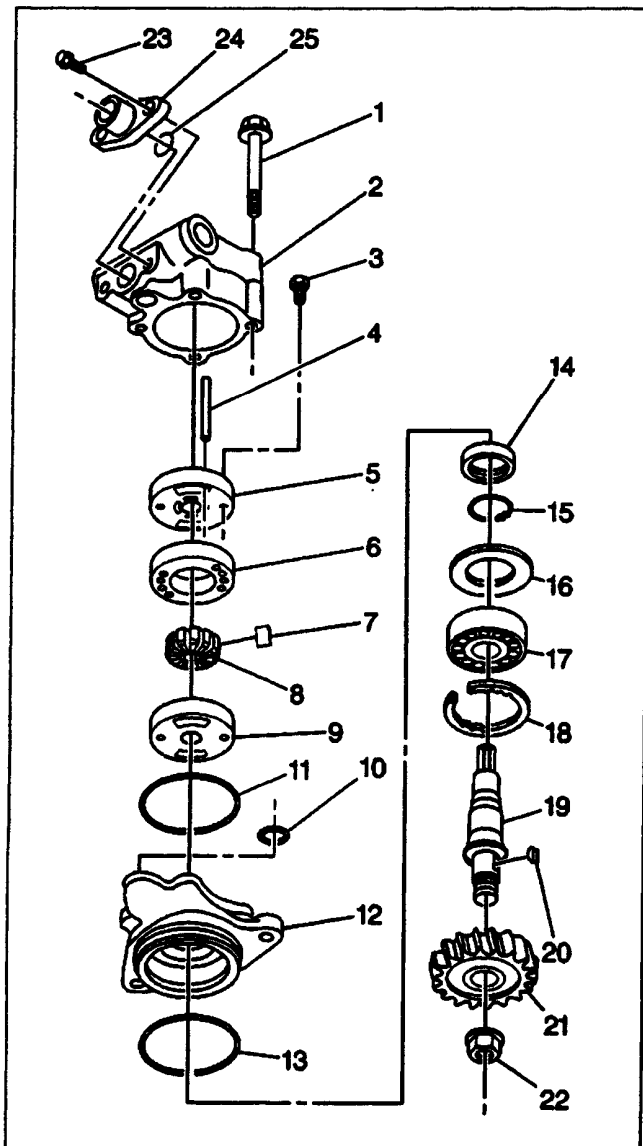
15. Install the front cover (12) on the pump housing (2)

Secure the front cover with the pump body bolts (1)

Tighten

Tighten the pump body bolts to 54 N.m (40 lb ft).

16. Install the gear (21) on the shaft (18) using the washer nut (22).



361652

**Disassemble Procedure
(Pressure Relief Valve)**

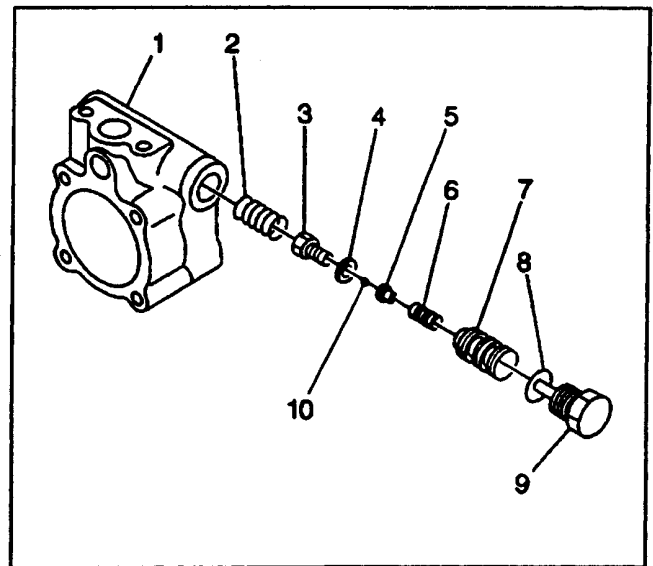
Important: Do not disassemble the pressure relief valve unless the system pressure is incorrect. Refer to *Power Steering System Test Procedure*.

Important: Do not disassemble the pressure relief valve unless it is absolutely necessary. It is difficult to hold the valve body while removing the valve plug. This increases the possibility of damaging the valve body.

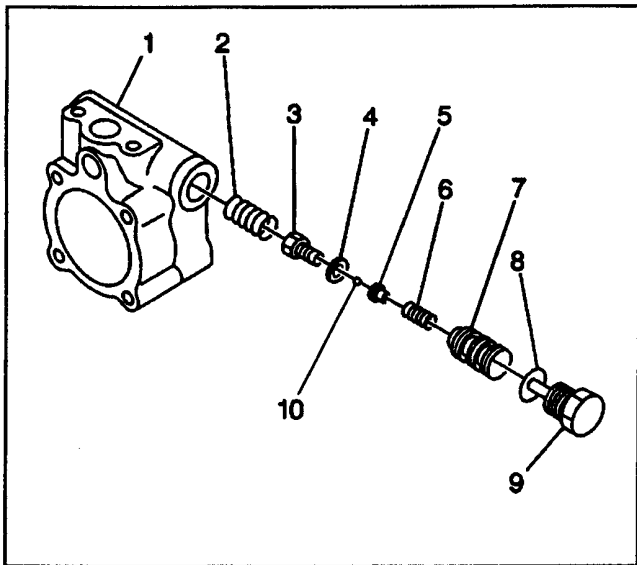
1. Secure the pump.
2. Remove the following components from the pump:
 - The plug (9)
 - The O-ring (8)

Notice: Always protect the pressure relief valve body when securing the valve body. Following this instruction can help you avoid damage to the valve body.

3. Remove the following components from the pump housing (1):
 - The valve body (7)
 - The valve spring (2)
 4. Secure the valve body (7).
- Important:** Note the number of shims (4) that are removed from the pressure relief valve.
5. Remove the following components from the valve body (7):
 - The valve retainer (3)
 - The shim(s) (4)
 6. Remove the ball (10) from the valve body (7).
 7. Remove the following components from the valve body (7):
 - The retainer (5)
 - The spring (6)



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361648

Assemble Procedure

1. Install the following components into the valve body (7):

- 1.1. The retainer spring (6)
- 1.2. The retainer (5)

Important: Be certain to install all of the shims which were removed.

2. Install the shims (4) into the valve body (7).

Notice: Always protect the pressure relief valve body when securing the valve body. Following this instruction can help you avoid damage to the valve body.

3. Secure the valve body (7).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the valve plug (3)

Tighten

Tighten the valve body plug to 54 N.m (40 lb ft).

5. Install the following components into the pump housing (1):

- 5.1. The valve spring (2)
- 5.2. The valve body (7)
- 5.3. The O-ring (8)
- 5.4. The plug (9)

Bleeding Power Steering System

Bleed the air from the system before operating the vehicle whenever the following components are installed:

- The power steering pump
- The power steering hose

Air in the power steering fluid system may cause the following conditions:

- Noise
- Unsatisfactory operation

Use only the specified power steering fluid whenever fluid is added to the power steering system. Do not use automatic transmission fluid or any other unapproved fluids. Refer to *Fluid and Lubricant Recommendations* in Maintenance and Lubrication.

Before bleeding the system, ensure that the following components are closed tightly enough to prevent air or fluid leaks:

- The hose clamps
- The hose connectors
- The fittings

Have enough power steering fluid to maintain the fluid in the reservoir at all times during the bleeding procedure. Refer to *Fluid and Lubricant Recommendations* in Maintenance and Lubrication.

This procedure is designed to minimize the chance of fluid aeration or overflow during the bleeding process.

Important: Do not install the reservoir cap during the bleeding procedure. Air may be trapped in the system. When the engine stops, power steering fluid will be forced out through the breather hole in the cap.

1. Raise the front end of the vehicle until the wheels can turn freely. Support the vehicle with suitable safety stands. Refer to *Lifting and Jacking the Vehicle* in General Information.

Important: Removing the drag link at the pitman arm and turning the steering wheel stop to stop may cause the following conditions:

- Increased steering gear travel
- End limiter valve misadjustment
- End limiter valve damage

2. Replace the end limiters if any of the above conditions exist. Refer to *End Limiters Replacement*.

Notice: When adding fluid to the reservoir, do not overfill. The fluid expands when hot and overfilling could result in the spillage of fluid from the reservoir.

3. Fill the reservoir.

Ensure that the following conditions are met:

- The glass sight is covered.
- The fluid level is within 50 mm (2 in) of the top of the reservoir.

4. Leave the cap off.

Important: Do not turn the steering wheel before completing operational steps thru 10.

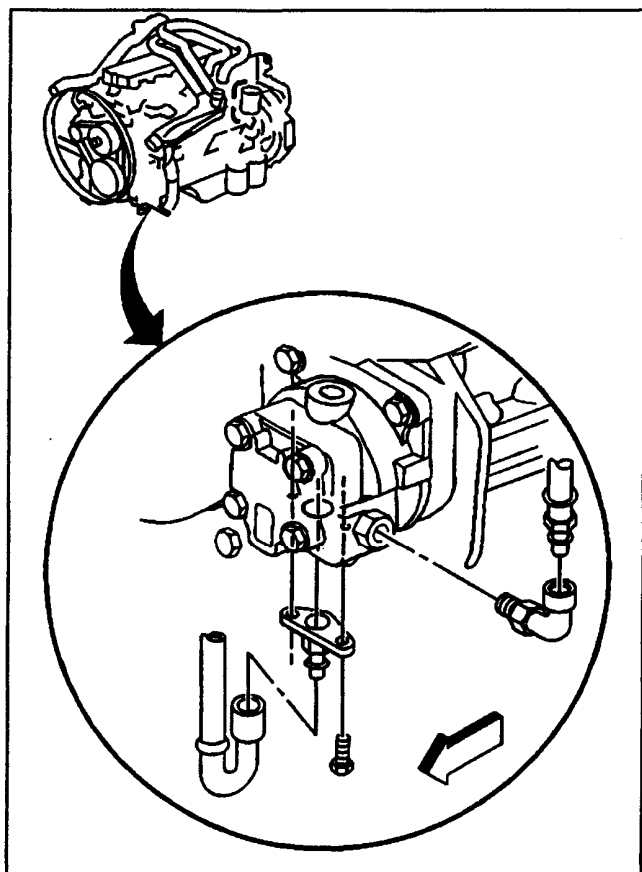
5. Start the engine.
 6. Operate the vehicle for 10 seconds.
 7. Turn the ignition switch to the OFF position.
 8. Continuously fill the reservoir.
- Ensure that the following conditions are met at all times:

- The glass sight is covered.
- The fluid level is within 50 mm (2 in) of the top of the reservoir.

9. Repeat the procedure until no more bubbles appear in the reservoir.
 10. Fill the reservoir in order to cover sight glass within 50 mm (2 in) of the top of the reservoir.
 11. Start the engine.
 12. Operate the vehicle for 10 seconds while turning the steering wheel completely to the right and to the left.
 13. Turn the ignition switch to the OFF position.
 14. Continuously fill the reservoir.
- Ensure that the following conditions are met at all times:

- The glass sight is covered.
- The fluid level is within 50 mm (2 in) of the top of the reservoir.

15. Repeat the procedure until no more bubbles appear in the reservoir.



228859

Flushing the Power Steering System

1. Raise the front of the vehicle until the wheels can turn freely. Support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

Important: Plug the connector port on the pump in order to prevent dirt from entering the system.

2. Remove the fluid return hose at the pump inlet connector.
3. Position the hose towards a large container to catch the draining fluid.
4. Start the engine
5. Run the engine at idle.

Notice: Do not contact wheel stops or hold wheel in a corner. Fluid flow will stop and pump will be in relief pressure mode. A sudden overflow from the reservoir may also develop if wheel is held at a corner.

6. While an assistant is filling the reservoir with new power steering fluid, turn the steering wheel from right to left.

Repeat this step until all of the foreign material is cleared from the draining fluid.

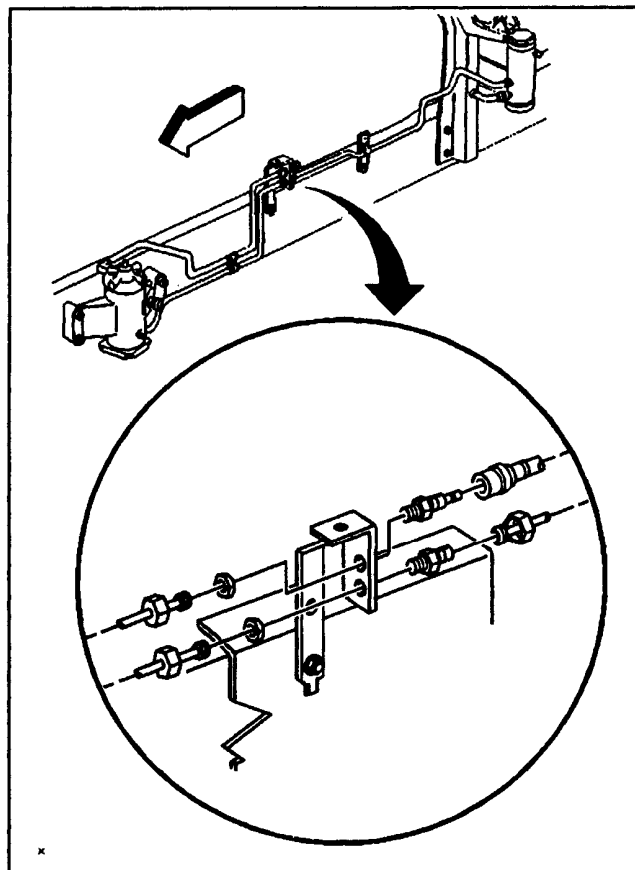
7. Flush the individual components if foreign material is still evident. Refer to *Power Steering Hose Flushing*.
8. Install the fluid return hose at the pump inlet connector.
9. Fill the system with new power steering fluid.
10. Bleed the power steering system. Refer to *Bleeding Power Steering System*.
11. Operate the engine for approximately 15 minutes.
12. Remove the pump return hose at the pump inlet.
13. Plug the connection on the pump.
14. Inspect the draining fluid for foreign material while replenishing the fluid in the reservoir.
15. Repeat the procedure if foreign material is present in the draining fluid.

Important: Do not reuse any drained power steering fluid.

16. Replace the hoses and repair or replace all of the power steering components if foreign material is still present. Refer to *Power Steering Hoses Replacement* and *Bleeding Power Steering System*.

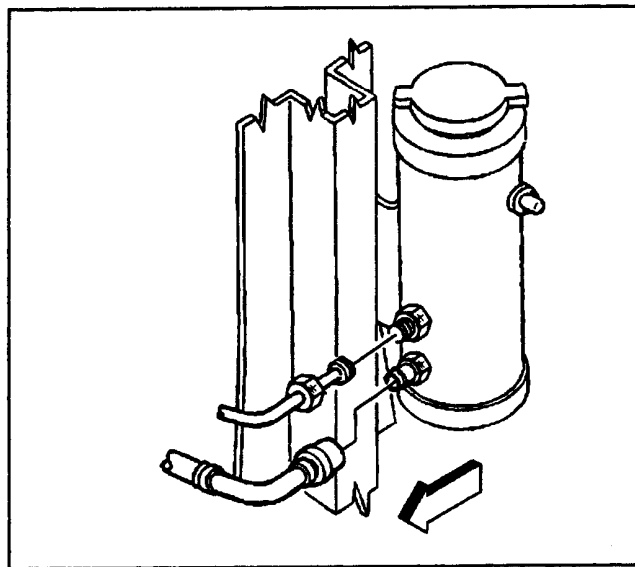
Power Steering Hose Flushing

1. Position a drainage container under the connectors at the bulkhead bracket.
2. Disconnect the fluid hoses at the bulkhead bracket.
3. Drain the hoses into the container.

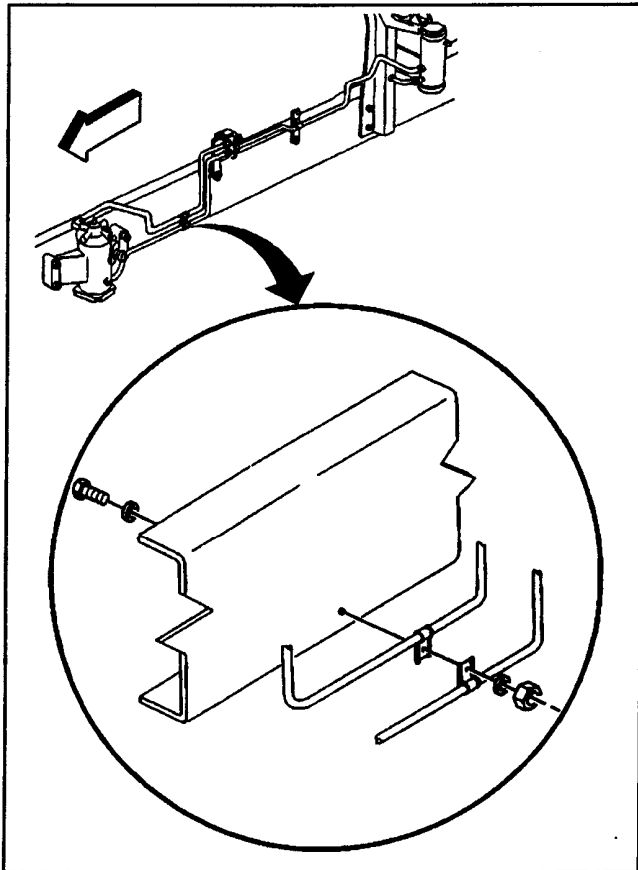


227963

4. Remove the power steering hoses at the reservoir.
5. Drain the hoses and the reservoir into the container.

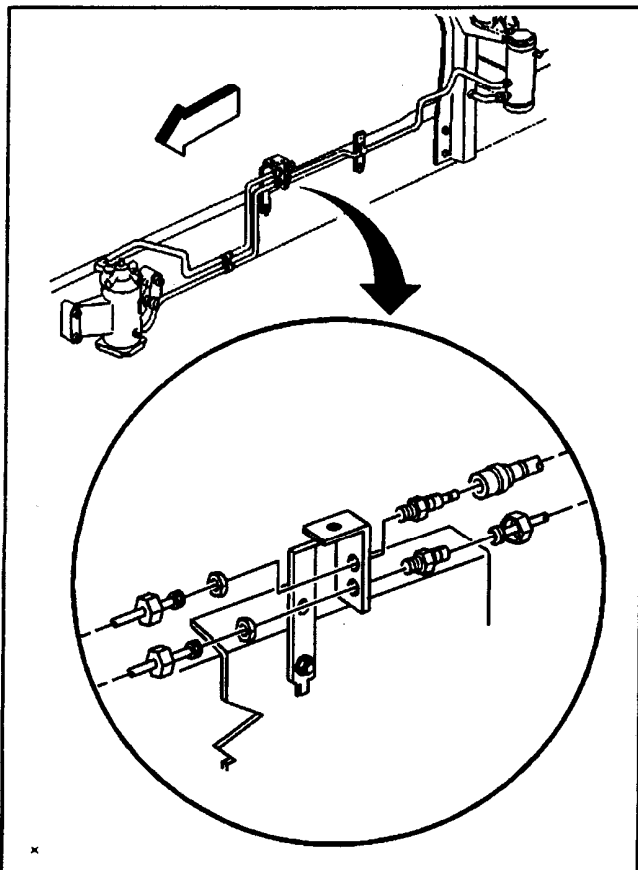


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227964

6. Remove the hose mounting brackets.
7. Drain the power steering system.
8. Raise the front of the vehicle until the wheels can turn freely. Support the vehicle. Refer to *Lifting and Jacking the Vehicle*
9. Ensure that the ignition switch is in the OFF position.
10. Turn the steering wheel from wheel stop to wheel stop.



227963

11. Remove all of the power steering hoses.
12. Drain all of the hoses.
13. Use compressed air in order to blow out the fluid.
14. Flush the hoses with new power steering fluid.
15. Drain and reinstall the hoses.
16. Fill the power steering system. Refer to *Bleeding Power Steering System*
17. Perform the following procedure:
 - 17.1. Set the parking brake.
 - 17.2. Place the gear selector in the N (Neutral) position.
 - 17.3. Start the engine.
 - 17.4. Operate the vehicle at idle.

Caution: Do not touch the inner edges of the steering wheel spokes when testing. If the power steering lines have been crossed by mistake, the steering wheel may spin violently when it is turned, causing injury to the hands. In order to stop the steering wheel from spinning, turn off the engine and make the necessary corrections.

18. Turn the steering wheel.

Be sure to make hand contact only with the outer edge of the wheel.

Power Steering Hoses Replacement

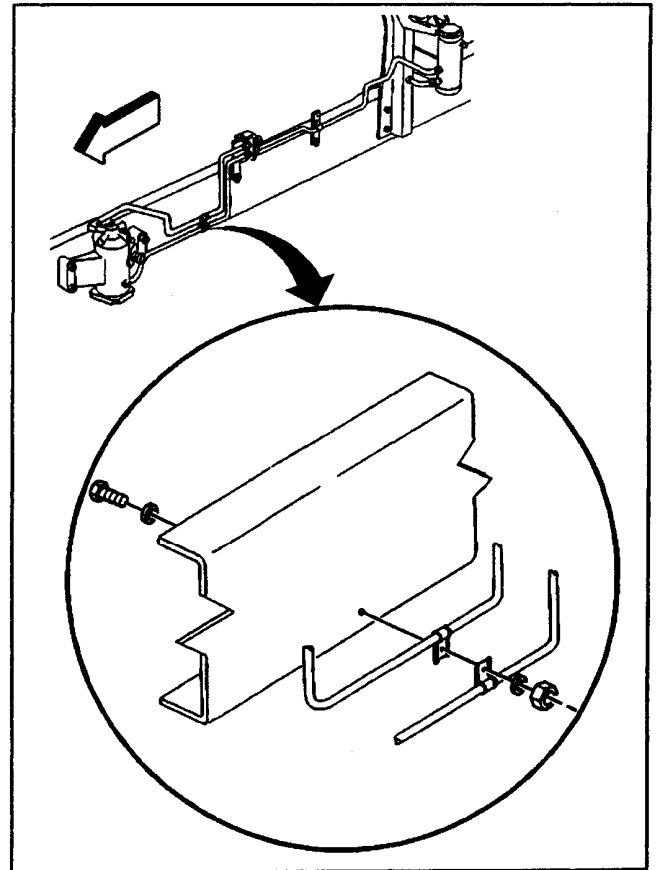
Removal Procedure

Tools required

- J 42971 Hydraulic Line separator
- The J 42971 is used to separate quick connects on hydraulic lines.

Important: Always clean the connectors and lubricate the tool end in power steering fluid when inserting into the coupling.

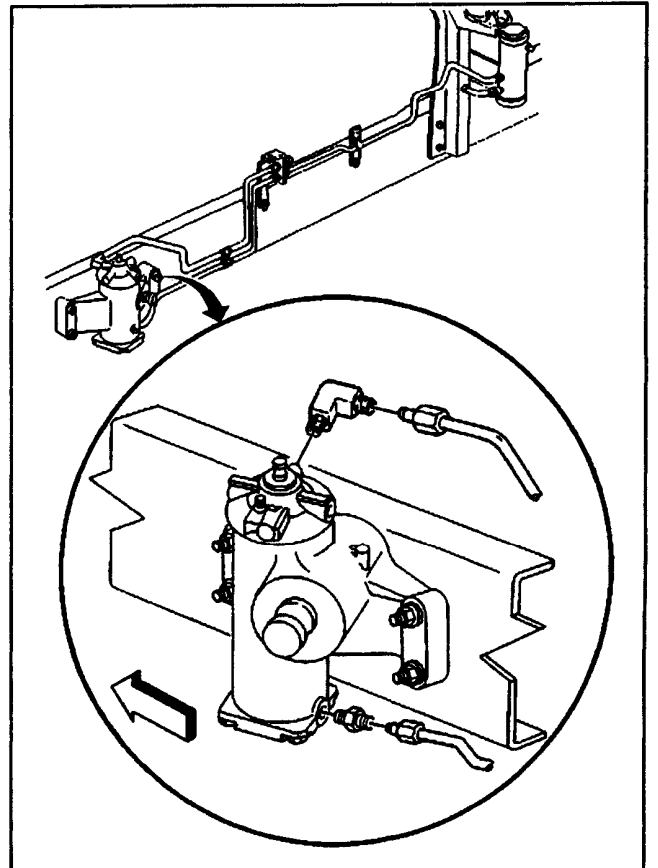
1. Tilt the cab. Refer to *Cab Tilting*
2. Remove the power steering hose clamp nuts, bolts and washers as needed.



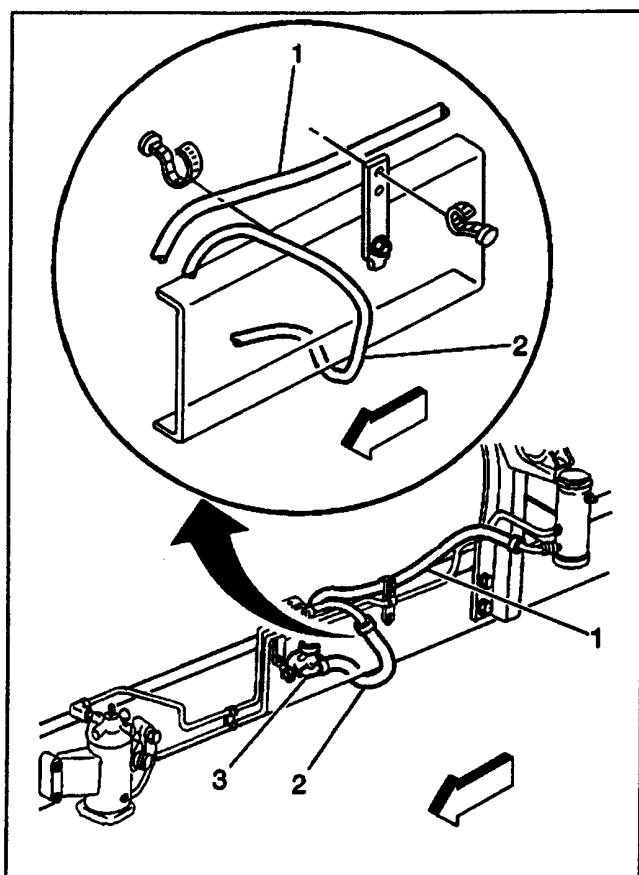
227964

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

3. Place a container under the power steering hose at the place of disconnection in order to catch the fluid when disconnecting or connecting hoses.
4. Clean the surface of the hoses prior to disconnection.

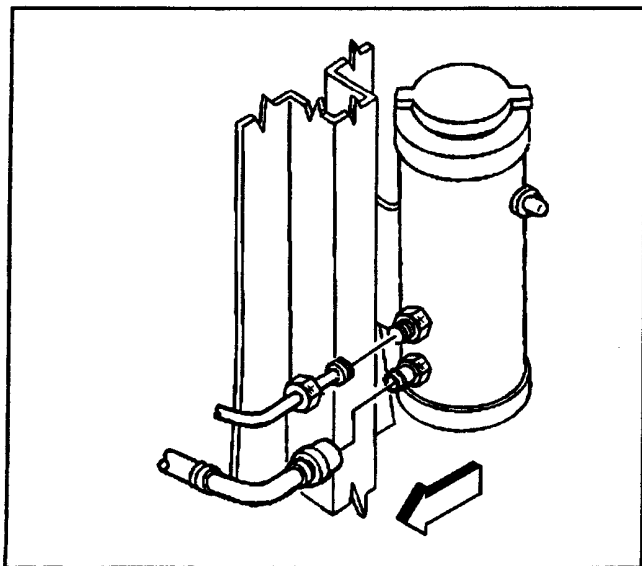


227949



227965

5. Disconnect the power steering pump hose (2) from the component (3) or the hose (1).

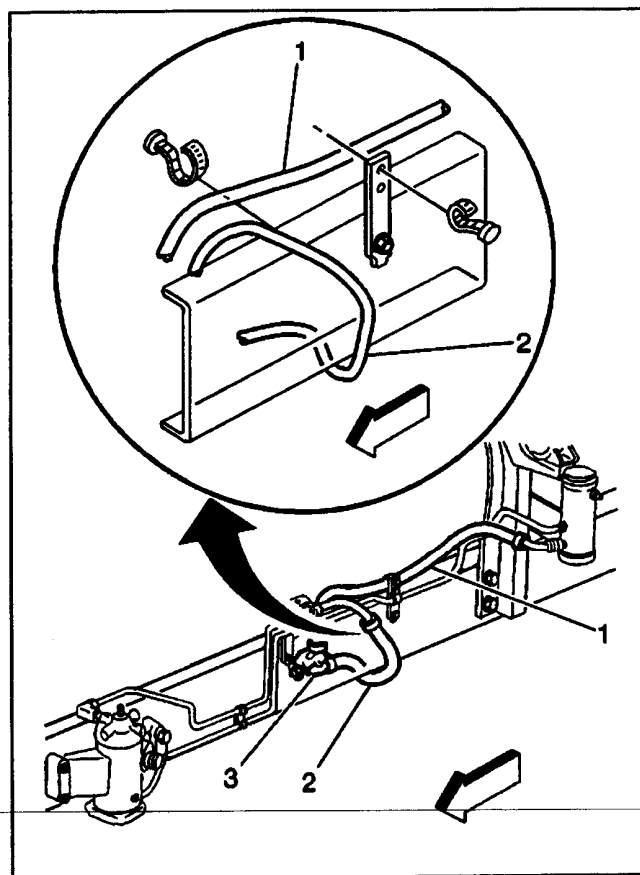


227966

6. Cap the hose and the component the at the hose was connected to in order to prevent dirt from entering the system.

Installation Procedure

1. Connect the power steering pump hose (2) to the component (3) or the hose (1).



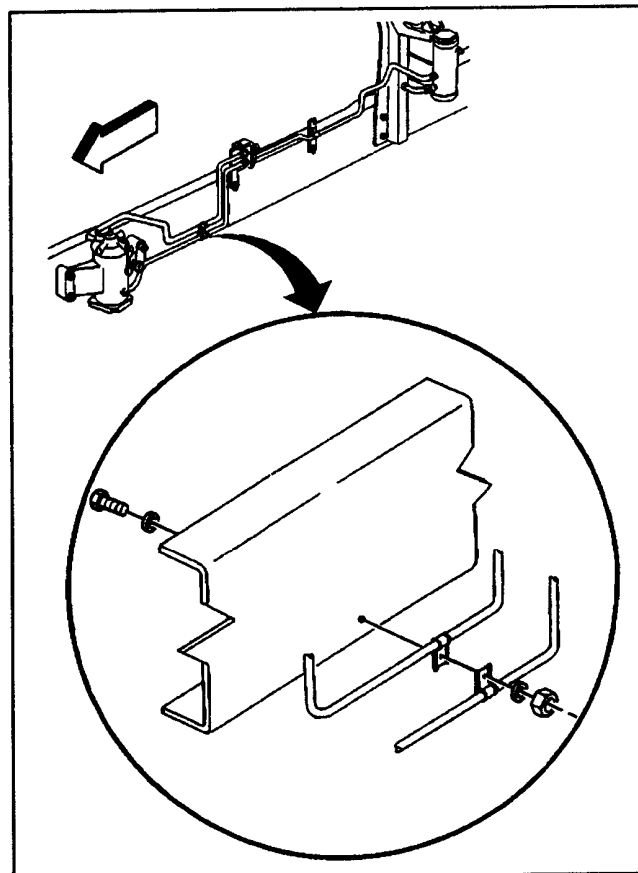
227965

Notice: Refer to *Fastener Notice*

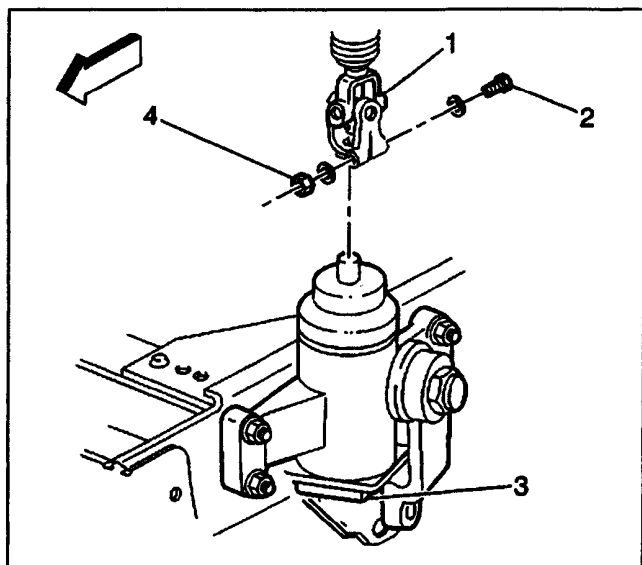
2. Install the power steering hose clamp nuts, bolts and washers as needed.

Tighten

- Tighten the power steering pipe mounting to 22 N·m (16 lb ft).
 - Tighten the power steering pipe adapter nuts at bulk head to 52 N·m (38 lb ft).
3. Fill and bleed the power steering system. Refer to *Bleeding Power Steering System*
 4. Lower the cab.



227964



227947

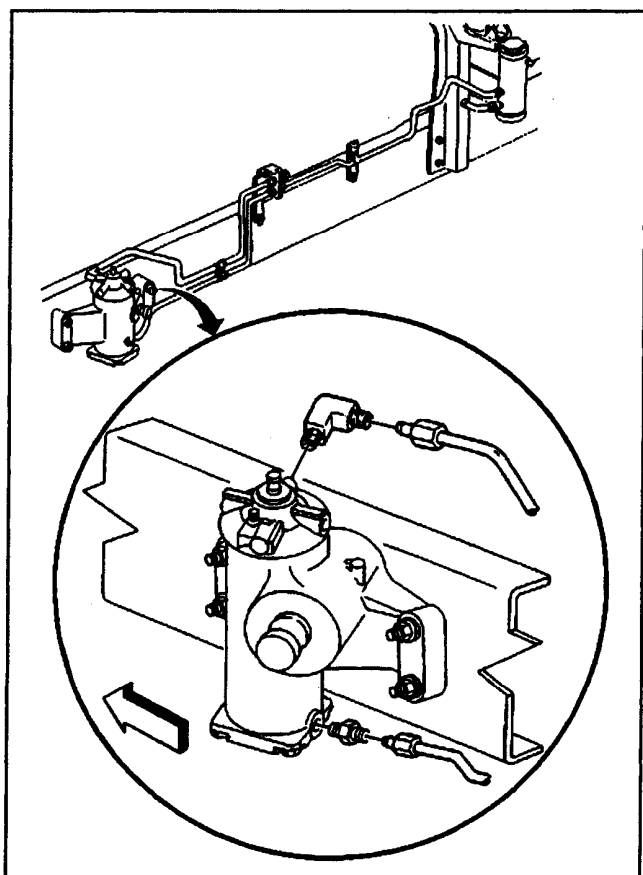
Power Steering Gear Replacement

Removal Procedure

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting*
3. Mark the position of the steering gear input shaft and the cardan joint (1) of the lower steering shaft.
4. Remove the cardan joint nut (4) and the washer.
5. Remove the cardan joint bolt (2) and the washer.
6. Gently pry the cardan joint off from the steering gear input shaft.
7. Remove the Pitman Arm. Refer to *Pitman Arm Replacement*

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

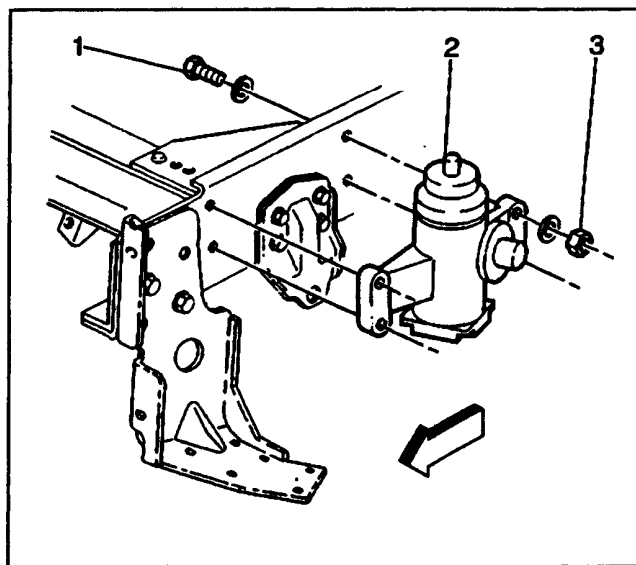
8. Place a container under the power steering gear in order to catch the fluid.
9. Remove the power steering hoses from the steering gear.



227949

10. Remove the following components from the vehicle:

- 10.1. The mounting nuts (3)
- 10.2. The washers
- 10.3. The mounting bolts (1)
- 10.4. The steering gear (2)



227951

Installation Procedure

1. Install the steering gear (2) onto the vehicle.

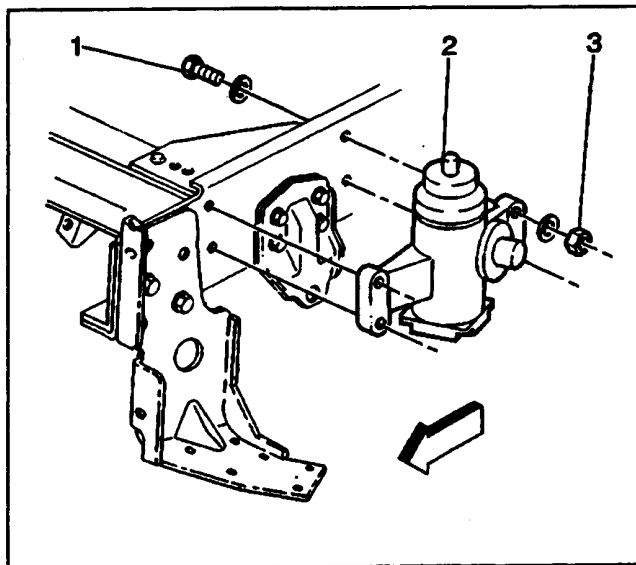
Tighten

Tighten the power steering gear mounting nuts to 450 N.m (330 lb ft).

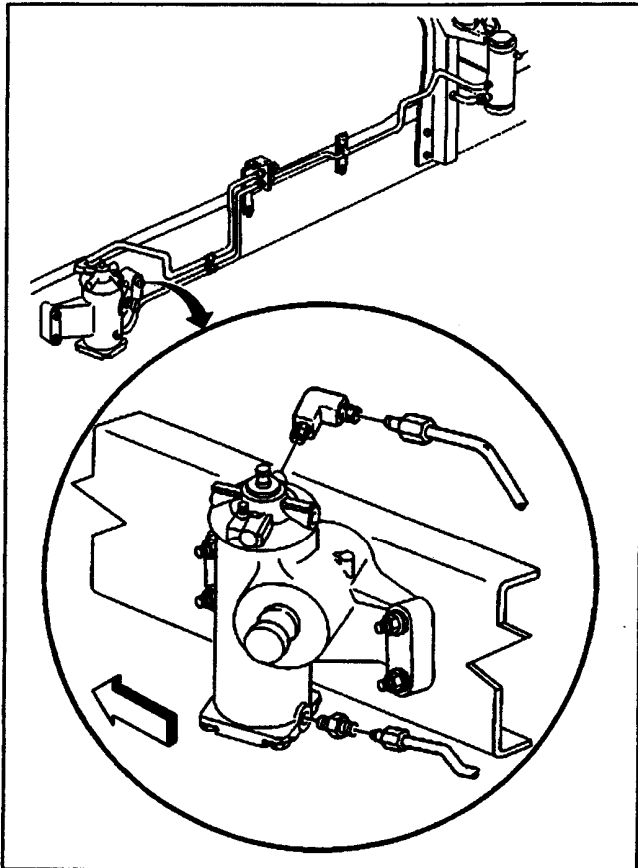
Notice: Refer to *Fastener Notice*

2. Secure the steering gear (2) with the following components:

- The mounting nuts (3)
- The washers
- The mounting bolts (1)

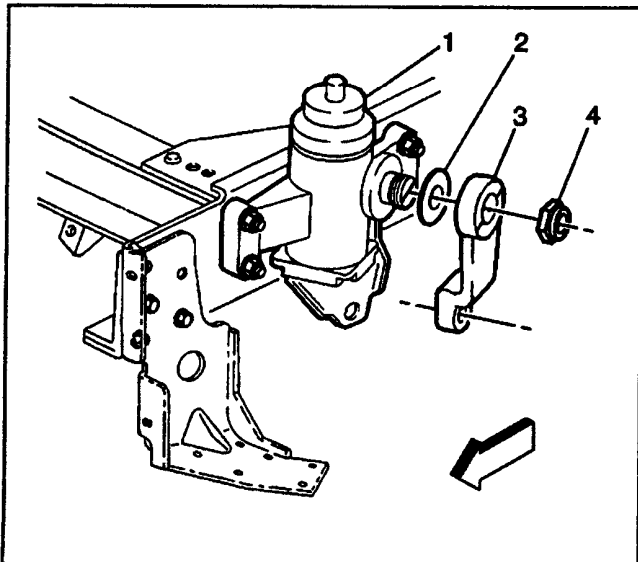


227951



227949

3. Install the power steering hoses onto the steering gear.



294139

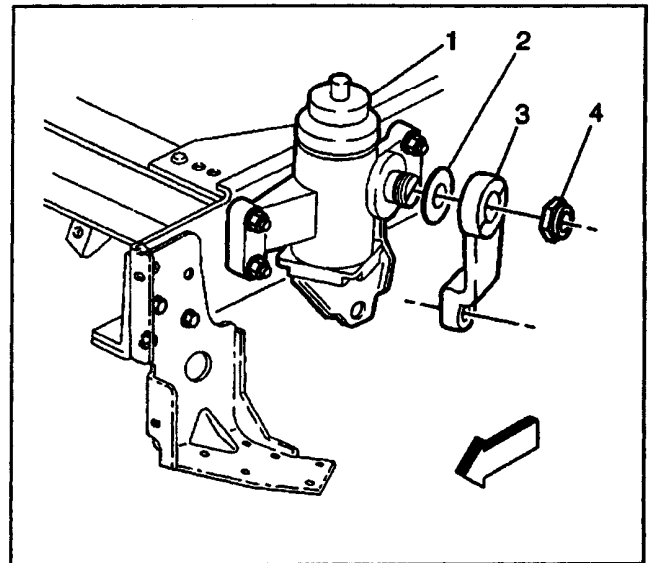
Sector Shaft Dust Cap Replacement

Removal Procedure

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cap. Refer to *Cab Tilting* in General Information.
3. Remove the Pitman arm (3). Refer to *Pitman Arm Replacement* in Steering Linkage (Non-Rack and Pinion).
4. Gently pry the steering gear sector shaft dust cap (2) away from the sector shaft.
5. Remove the steering gear sector shaft dust cap.

Installation Procedure

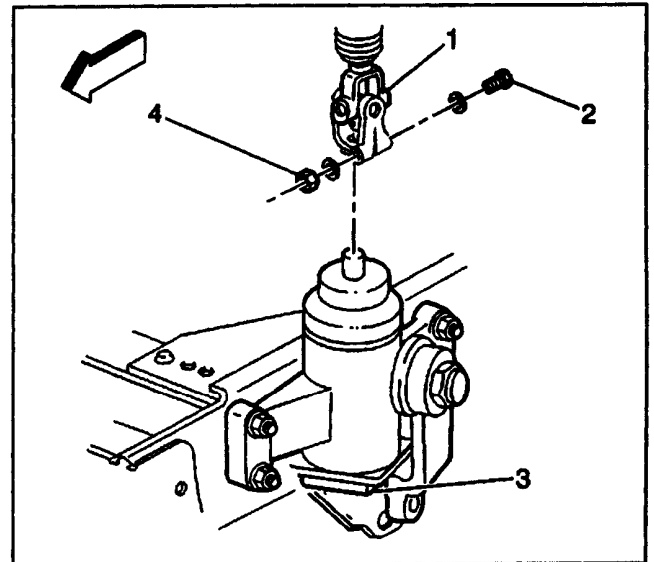
1. Install the steering gear sector shaft dust cap (2) onto the sector shaft.
2. Install the Pitman arm (3). Refer to *Pitman Arm Replacement in Steering Linkage (Non-Rack and Pinion)*.
3. Lower the cab.



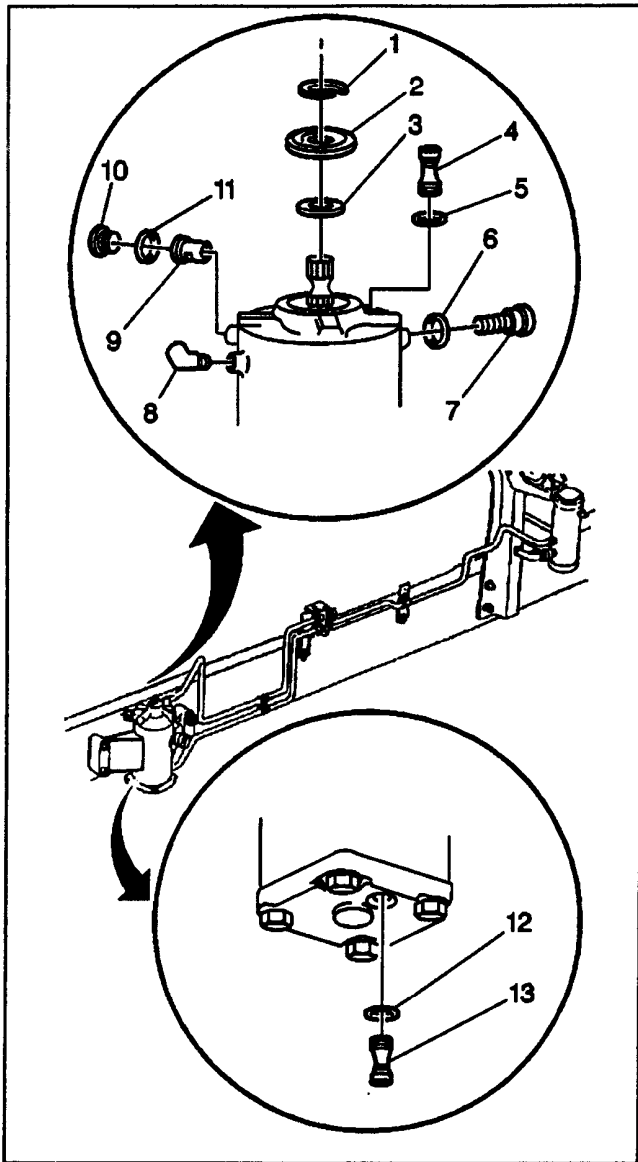
294139

Input Shaft Dust Cap Replacement**Removal Procedure**

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting in General Information*.
3. Mark the position of the following components.
 - The steering gear input shaft.
 - the cardan joint of the lower steering shaft.
4. Remove the following components from the cardan joint:
 - 4.1. The cardan joint nut (4)
 - 4.2. The washer
 - 4.3. The cardan joint bolt (2)
5. Gently pry the cardan joint (1) off the steering gear input shaft.



227947

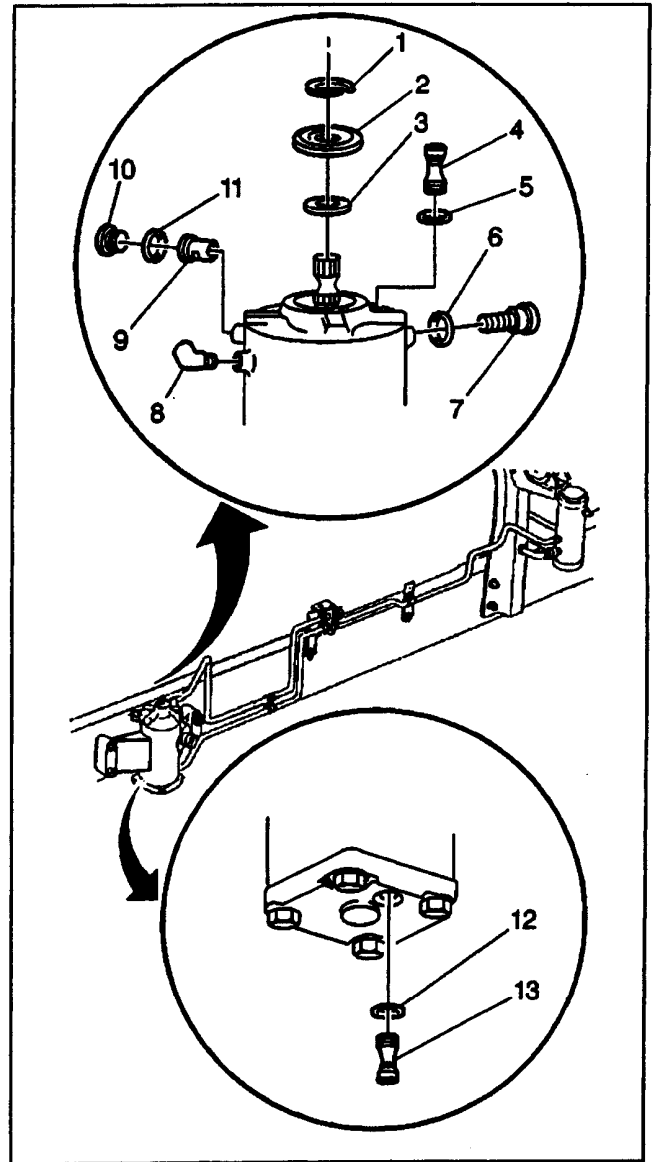


227948

6. Remove the snap ring (1) from the steering gear input shaft.
7. Remove the steering gear input shaft dust cap (2) from the steering gear input shaft.

Installation Procedure

1. Install the input shaft dust cap (2).
2. Install the snap ring (1) onto the input shaft.
3. Align the marks on the cardan joint and the steering gear input shaft.
4. Position the cardan joint on the steering gear input shaft.



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5. Install the following components:

- 5.1. The cardan joint washer

- 5.2. The bolt (2)

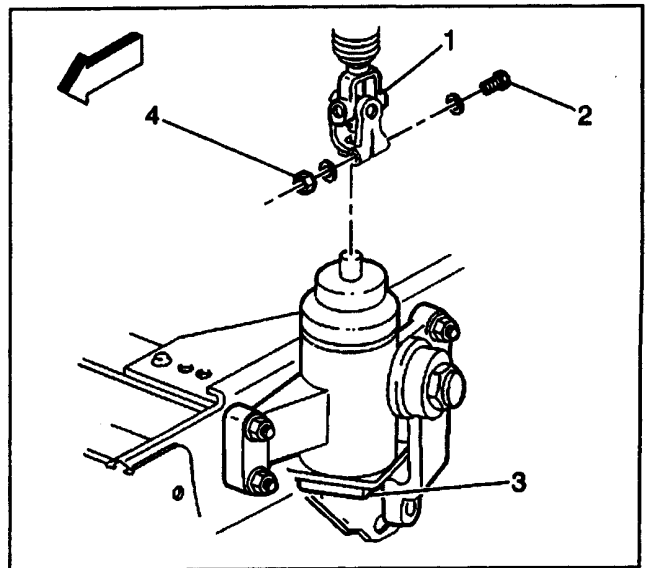
Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the cardan joint washer and the nut (4).

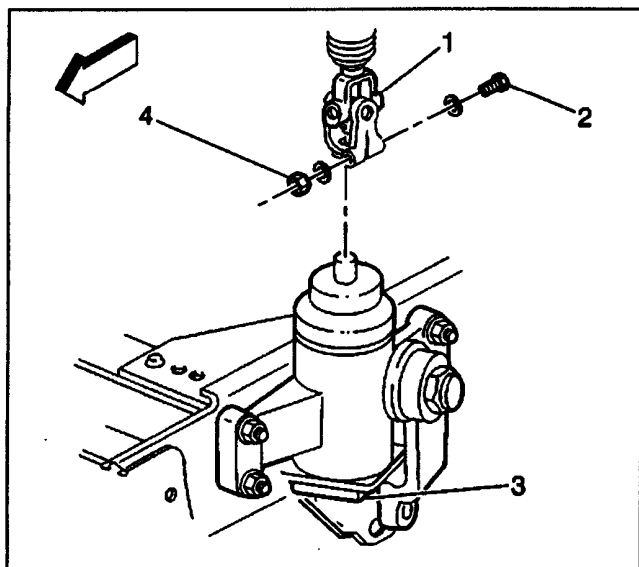
Tighten

Tighten the cardan joint nut to 55 N·m (41 lb ft).

7. Lower the cab.



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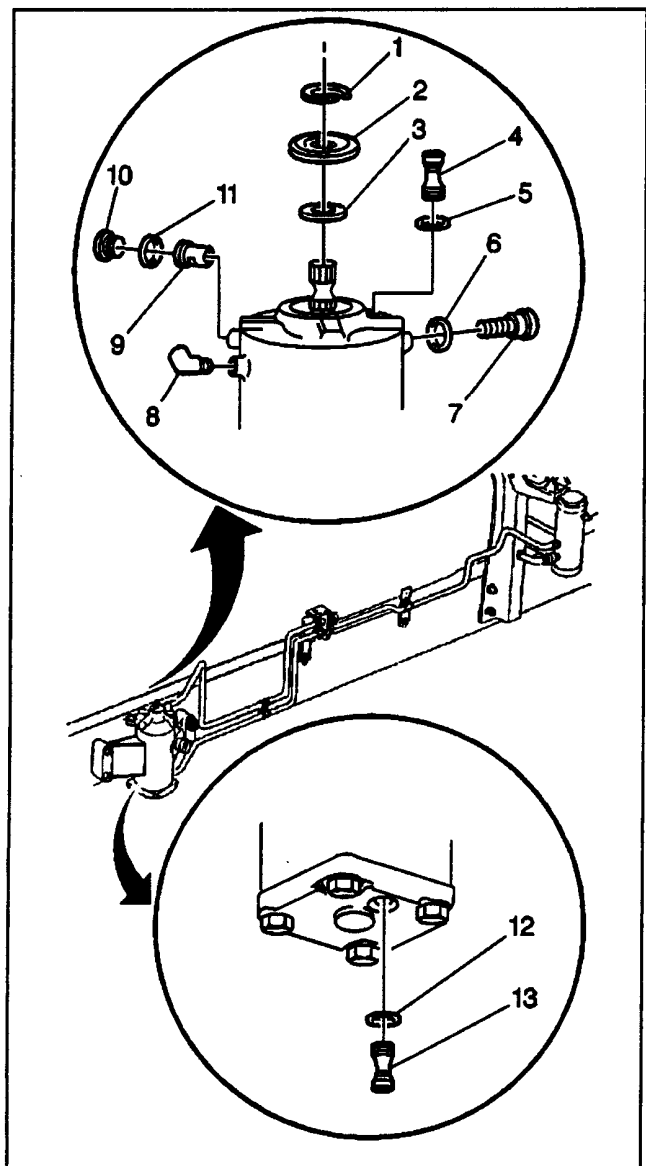


227947

Input Shaft Bearing Protector Cap Replacement

Removal Procedure

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.
3. Mark the position of the steering gear input shaft and the cardan joint of the lower steering shaft.
4. Remove the following components:
 - 4.1. The cardan joint nut (4)
 - 4.2. The washer
 - 4.3. The cardan joint bolt (2)
5. Gently pry the cardan joint off the steering gear input shaft.
6. Remove the snap ring (1) from the steering gear input shaft.
7. Remove the steering gear input shaft dust cap (2) from the steering gear input shaft.
8. Remove the steering gear input shaft bearing protecting cap (3) from the steering gear input shaft.

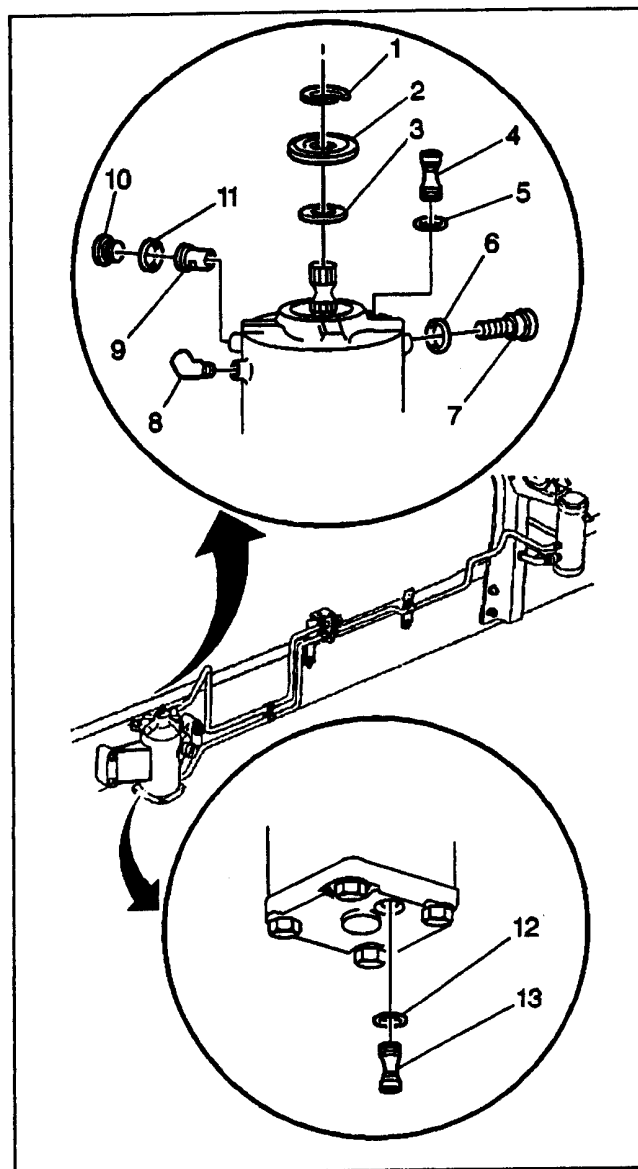


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Installation Procedure

Remove the following components.

1. Install the input shaft bearing protecting cap (3).
2. Install the input shaft dust cap (2).
3. Align the marks on the cardan joint and the steering gear input shaft.
4. Position the cardan joint on the steering gear input shaft.



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5. Install the following components:

- 5.1. The cardan joint washer
- 5.2. The bolt (2)

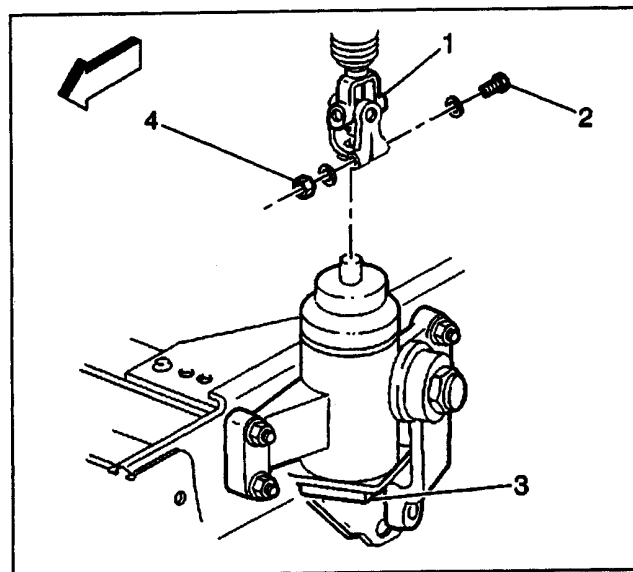
Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the cardan joint washer and the nut (4).

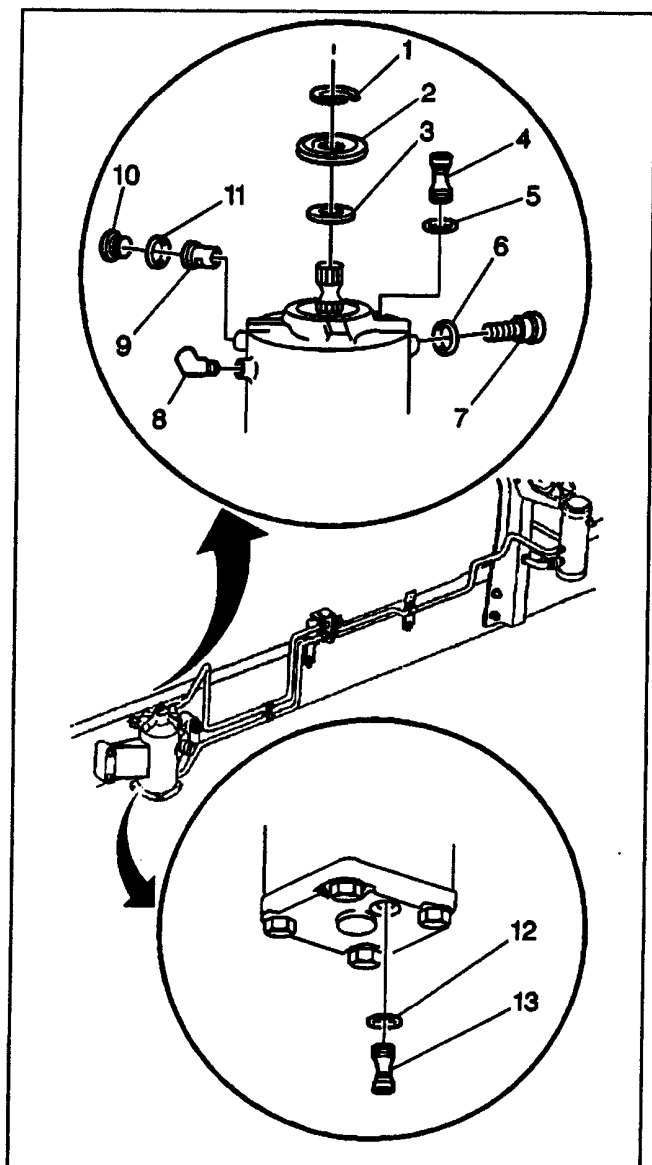
Tighten

Tighten the cardan nut to 55 N.m (41 lb ft).

7. Lower the cab.



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End Limiters Replacement

Removal Procedure

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

3. Place a container under the power steering gear in order to catch the fluid.
4. Remove the following components from the steering gear:
 - 4.1. The top end limiter (4)
 - 4.2. The O-ring (5)
5. Remove the following components from the steering gear:
 - 5.1. The bottom end limiter (13)
 - 5.2. The O-ring (12)

Installation Procedure

1. Install the following components into the steering gear.
 - 1.1. The O-ring (12)
 - 1.2. The bottom end limiter (13)
2. Install the following components into the steering gear.
 - 2.1. the O-ring (5).
 - 2.2. the top end limiter (4)
3. Fill and bleed the power steering system. Refer to *Bleeding Power Steering System*.

Adjustment Procedure

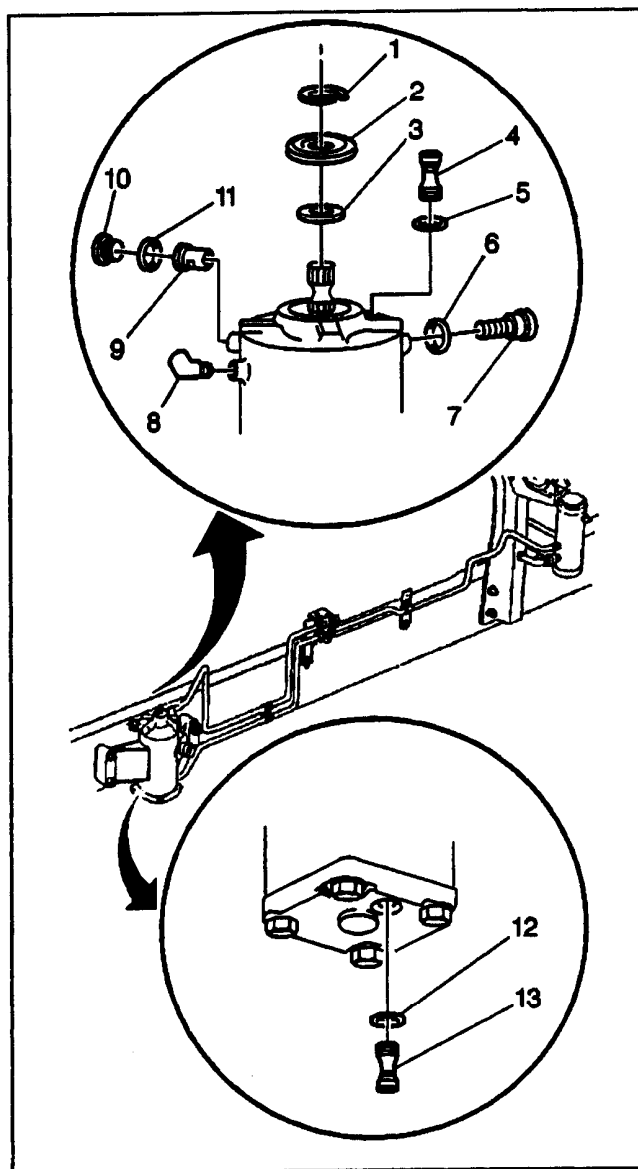
Important: Check the end limiter valves whenever different sized tires are installed on a vehicle.

1. Ensure that the steering stop screws are properly adjusted. Refer to *Wheel Alignment in Suspension*.
2. Start the engine.

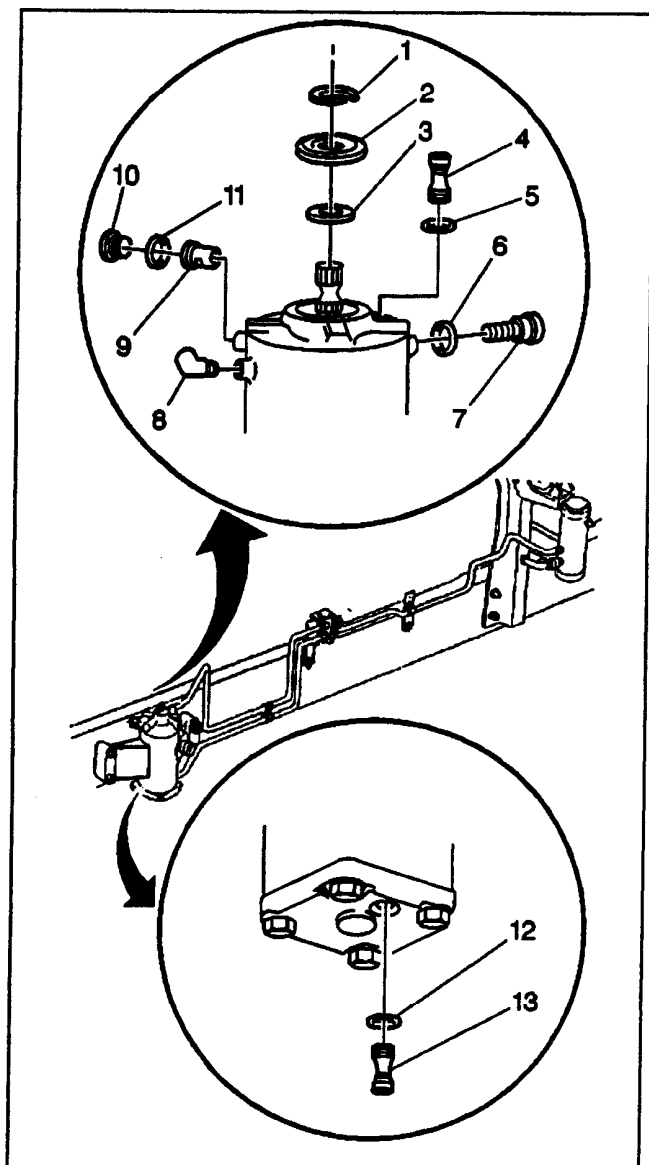
Operate the vehicle at idle.

Notice: Do not hold the steering wheel in the full turn position longer than 5 seconds, as damage to the steering pump may result.

3. Perform the following procedures:
 - 3.1. Turn the steering wheel counter-clockwise until the steering effort increases
Turn the steering wheel to a full lock
Do not use force on the steering wheel.
 - 3.2. Observe the steering pump in order to determine if the steering pump goes into pressure relief. The following actions occur when the steering pump goes into pressure relief:
 - Engine loading begins
 - The chassis rises or lowers
 The movement of the chassis depends on the turn direction.
 - 3.3. If the steering pump goes into pressure relief, replace the end limiter valves.
 - 3.4. Proceed to step 4 if the power steering pump does not go into pressure relief.
4. Measure the clearance between the steering stop bolt and the axle center.
The correct clearance value is 3–5 mm (0.1250-0.1875 in) with the steering at full lock.
5. Replace the end limiter valves if the clearance is incorrect.
6. Lower the cab.



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Pressure Relief Valve Replacement

Removal Procedure

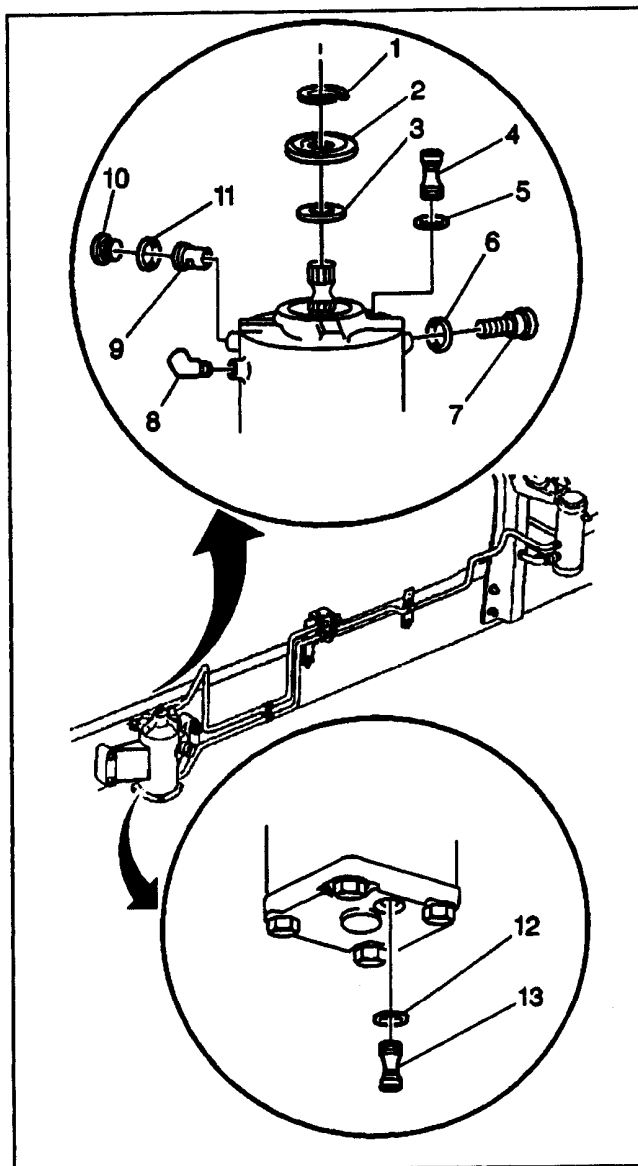
1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

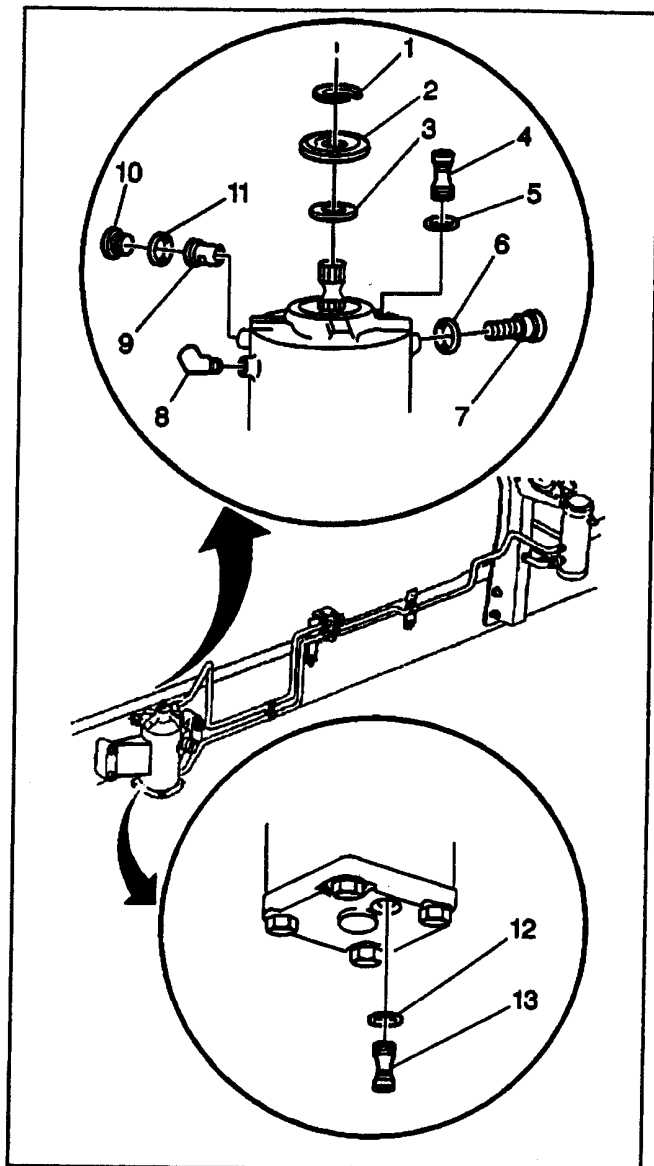
3. Place a container under the power steering gear in order to catch the fluid.
4. Remove the following components from the steering gear:
 - 4.1. The pressure relief valve (7)
 - 4.2. The O-ring (6)

Installation Procedure

1. Install the following components into the steering gear:
 - 1.1. The O-ring (6)
 - 1.2. The pressure relief valve (7)
2. Fill and bleed the power steering system. Refer to *Bleeding Power Steering System*.
3. Lower the cab.



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Resuction Valve Replacement

Removal Procedure

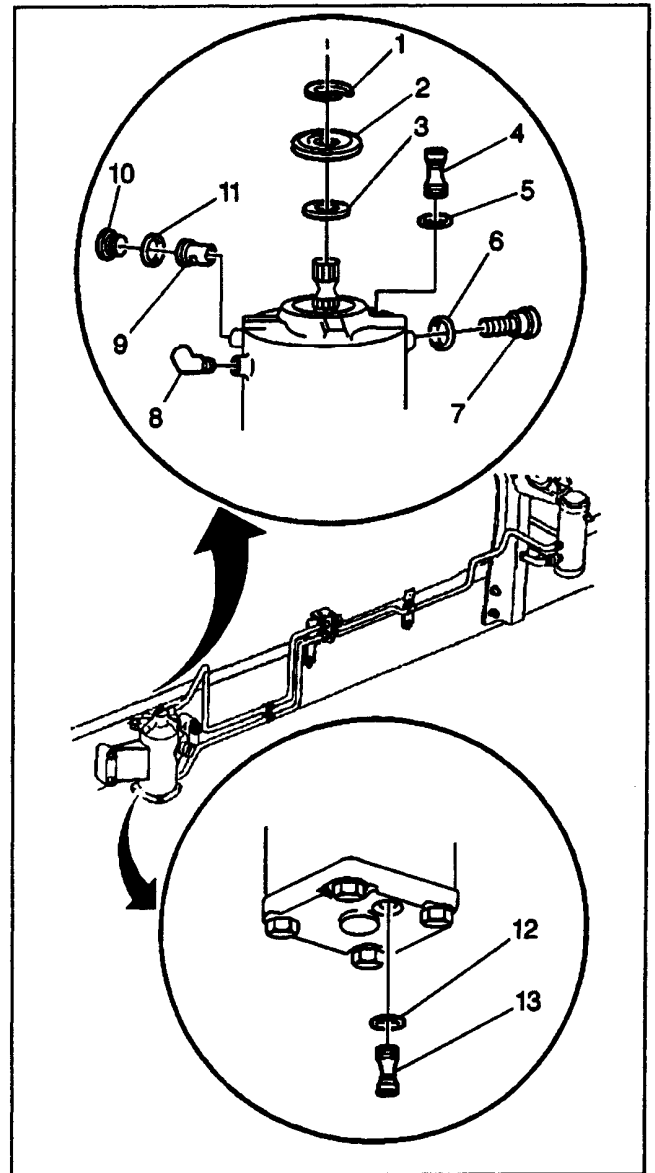
1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.

Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

3. Place a container under the power steering gear in order to catch the fluid.
4. Remove the following components from the steering gear:
 - 4.1. The resuction valve plug (10)
 - 4.2. The O-ring (12)
 - 4.3. The resuction valve (9)

Installation Procedure

1. Install the following components into the steering gear:
 - 1.1. The resuction valve (9)
 - 1.2. The O-ring (12),
 - 1.3. The resuction valve plug (10)
2. Fill and bleed the power steering system. Refer to *Bleeding Power Steering System*.
3. Lower the cab.



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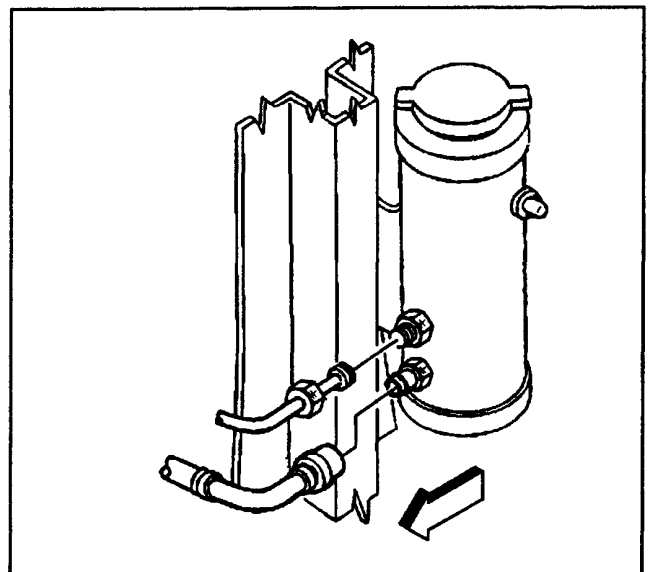
Power Steering Reservoir Replacement**Removal Procedure**

1. Tilt the cab. Refer to *Cab Tilting* in General Information.
2. Place a container under the power steering reservoir hoses.
3. Clean the surfaces of the power steering reservoir hoses.
4. Disconnect the power steering reservoir hoses.
5. Remove the hoses from the reservoir.

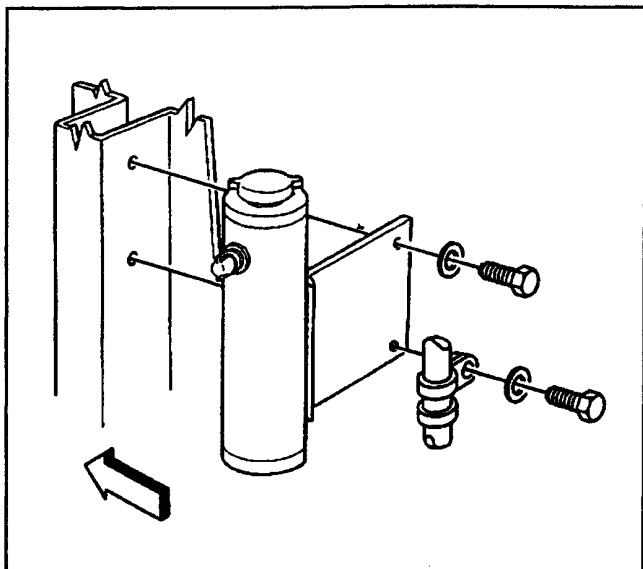
Notice: Avoid contaminating the power steering system. Cap open hoses and ports to prevent dirt and debris from entering system. Contaminated power steering fluid and dirt can cause early parts failure.

Important: Cap the hoses to prevent dirt from entering the system.

6. Allow the reservoir to drain.



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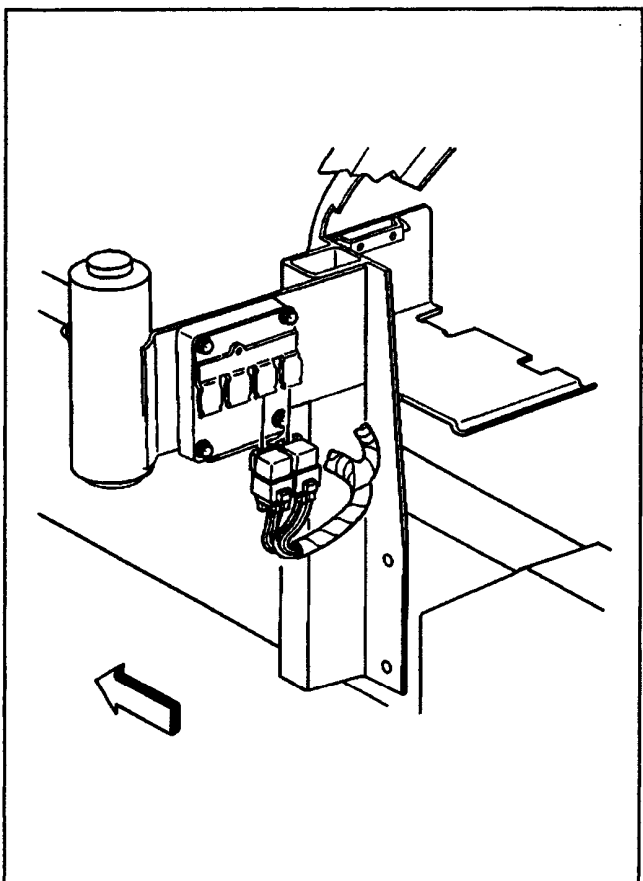
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7. Remove the following components:

- The bracket bolts.
- The washers

8. Remove the following components:

- The reservoir
- The overflow hose clamp
- The relay bracket



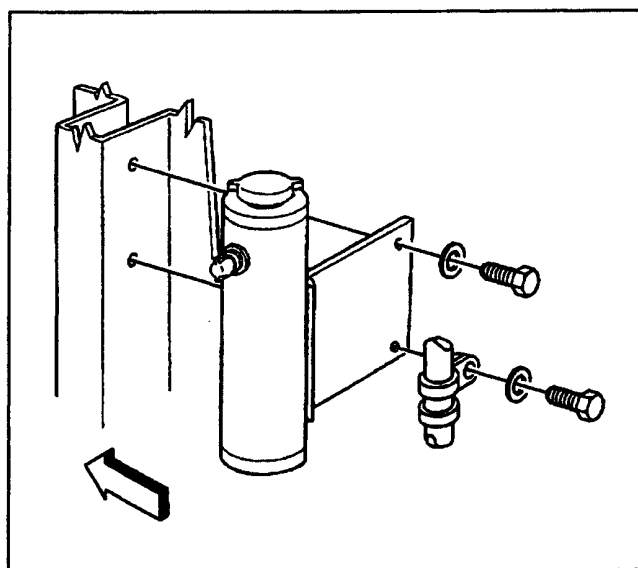
227969

Important: The ABS control module is only on the vehicles equipped with ABS.

9. Remove the ABS control module from the vehicle (if the vehicle is equipped).

Installation Procedure

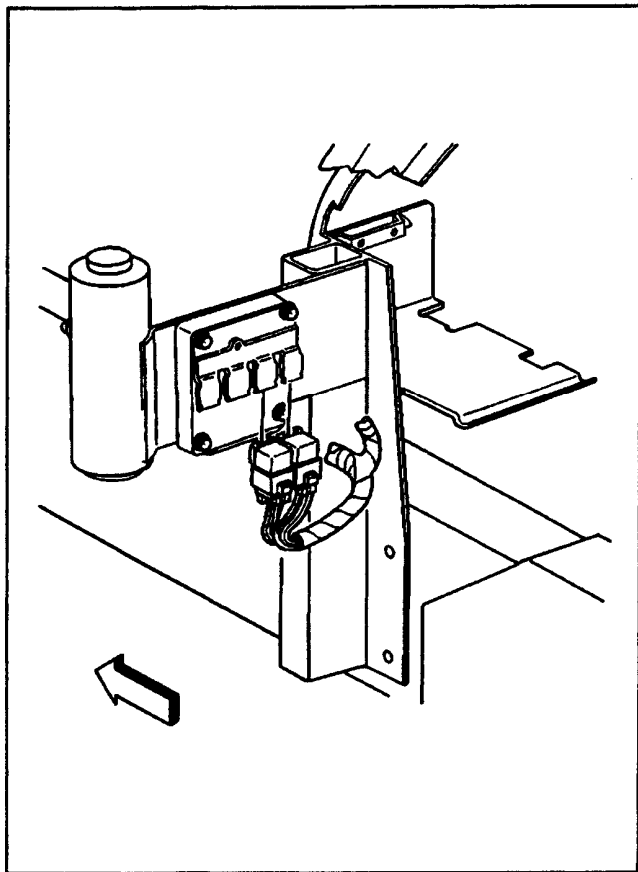
1. Position the following components on the vehicle:
 - The reservoir.
 - The overflow hose clamp.
 - The relay bracket.



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Important: The ABS control module is only on the vehicles equipped with ABS.

2. Position the ABS control module on the vehicle (if the vehicle is equipped).



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2-50 Power Steering System

Steering

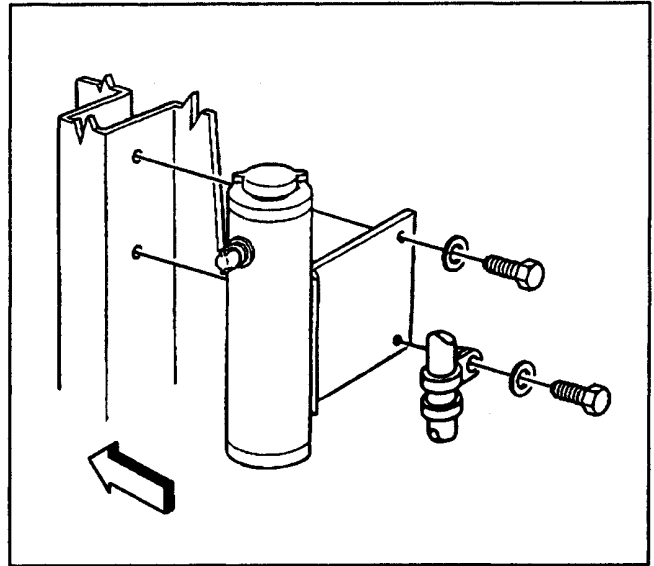
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the following components:

- The bracket bolts.
- The washers.

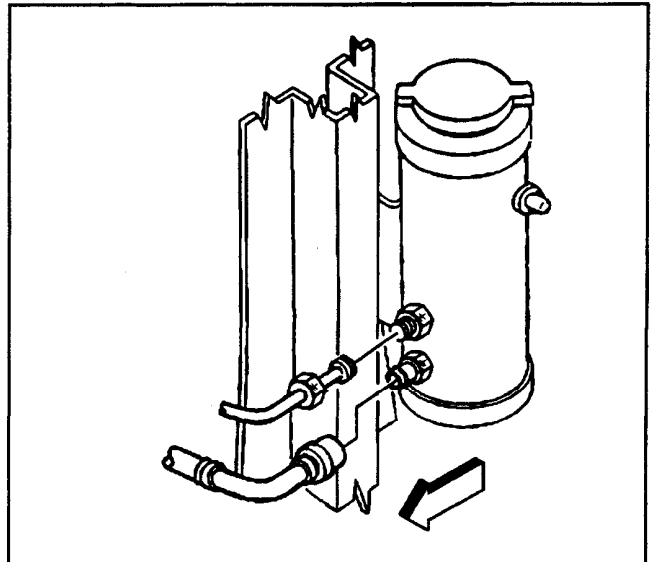
Tighten

Tighten the reservoir mounting bolts to 40 N.m (30 lb ft).



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4. Install the hoses to the reservoir.
5. Fill the system with new power steering fluid.
6. Bleed the system. Refer to *Bleeding Power Steering System*.
7. Lower the cab.



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Description and Operation

Power Steering System Description

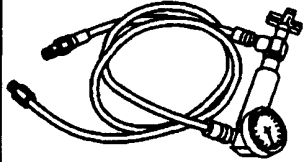
This vehicle uses an integral power steering system. The integral power steering system integrates the power steering cylinder and the control valves into the steering gear unit. The integral power steering system does not require a separate power steering cylinder. The integral power steering system consists of the following components:

- The power steering gear
- The power steering pump
- The hydraulic reservoir

The power steering pump components are a combination of many machined and polished surfaces with very fine tolerances.

Care and cleanliness are very important when servicing the power steering pump components. The entry of even small amounts of dirt may cause an unsatisfactory repair and possible damage. Clean the power steering components in a solvent that will not damage any of the rubber parts.

Special Tools and Equipment

Illustration	Tool Number/Description
 219426	J 26487-C Power Steering Analyzer

BLANK

Steering Linkage (Non-Rack & Pinion)

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Ball Joint Nut		
Axle Assemblies with a 3675 kg (8100 lb) Rating	130 N.m	95 lb ft
All other Axle Assemblies	160 N.m	120 lb ft
Pitman Arm Nut	370 N.m	275 lb ft
Relay Rod Nut	160 N.m	120 lb ft
Steering Arm Bolt	620–700 N.m	457–516 lb ft
Tie Rod Arm Bolt	620–700 N.m	457–516 lb ft
Tie Rod Tube Clamp Bolt Nut	75 N.m	55 lb ft

Repair Instructions

Steering Linkage Inspection

Important: Replace any parts that exhibit damage or wear. Do not attempt to repair the parts by welding.

The steering linkage rod ends are adjustable for toe adjustment and require periodic lubrication. Refer to *Fluid and Lubricant Recommendations*.

Replace the steering linkage rod ends when any of the following conditions exist:

- Excessive up-and-down motion
- Excessive end play
- Loss of motion at the ball stud

Note the following items before beginning any repairs:

- The position of the tie rod adjuster tube
- The direction from which the bolts are installed

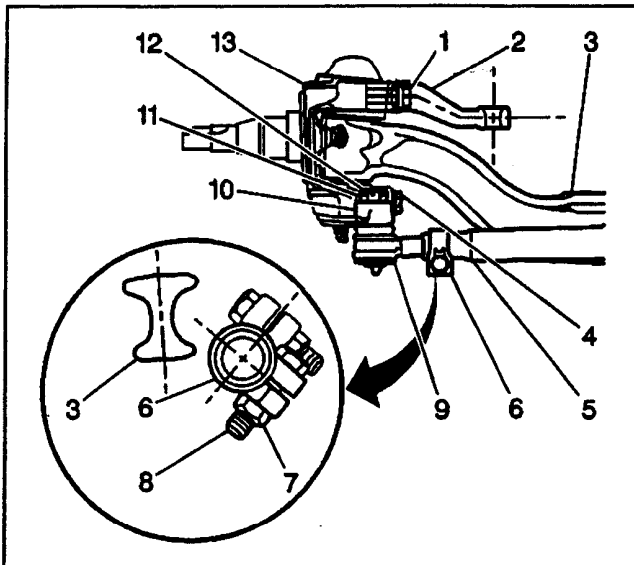
Inspect the tie rod adjuster tube components for rust. If rust is found, apply penetrating oil between the clamp and the tube. Rotate the clamps until they move freely.

Install all of the components in the proper positions. Ensure that each of the components has the correct part number.

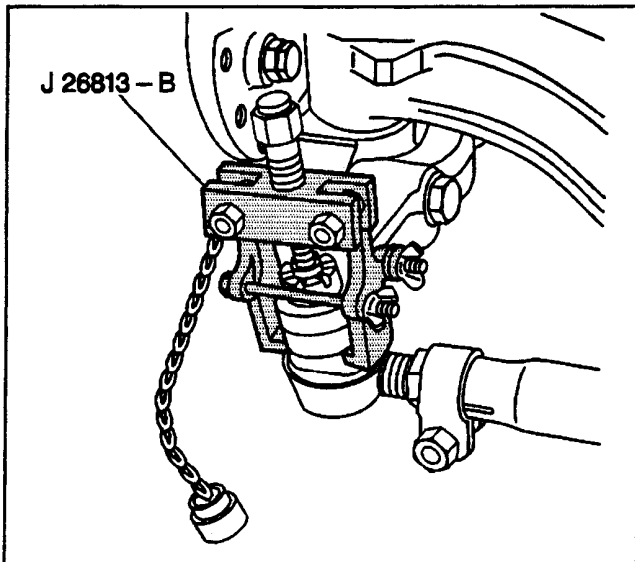
The following conditions may cause a "shimmy":

- Suspension system defects
- Steering system defects
- Dynamic imbalance in the wheel and tire assembly
- Runout
- Force variations
- Road surface irregularities

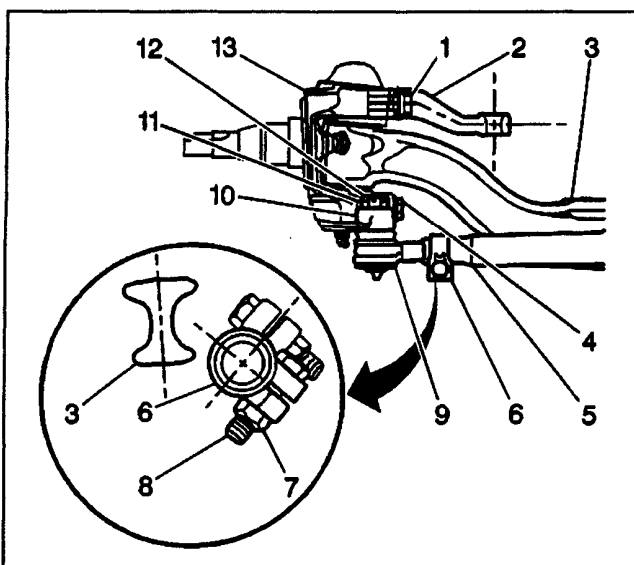
Refer to *Tire and Wheel Vibration* in *Tires and Wheels*.



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Tie Rod Replacement

Removal Procedure

Tools Required

J 26813-B Steering Linkage Puller.

1. Remove the cotter pin (12) from the tie rod end ball joint (9).
2. Discard the cotter pin (12).
3. Remove the nut (11) from the tie rod ball joint (9).

4. Use the *J 26813-B* to remove the relay rod from the steering arm.

5. Loosen the tie rod tube clamp (6).
6. Remove the tie rod ball joint (9) from the tie rod tube (5).
7. Inspect the tie rod end threads for the following conditions:
 - Damage
 - Corrosion
8. Inspect the rod stud threads for the following conditions:
 - Damage
 - Corrosion
9. Inspect the rod stud nut threads for the following conditions:
 - Damage
 - Corrosion

10. Inspect the rod stud taper for the following conditions:

- Nicks
- Dirt

Important:

- If the tube is bent less than 5 degrees, cold straighten the tube.
- If the tube is bent more than 5 degrees, replace the tube.

11. Inspect the tie rod tube (5) for straightness.
12. Clean any dirt or rust from all of the threads.
13. Clean any dirt or rust from the tapers.

Installation Procedure

Important: Thread in the tie rod ball joints an equal distance.

1. Install the tie rod ball joint (9) into the tie rod tube (5).
2. Install the tie rod ball joint (9) into the tie rod arm (10).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important:

- Advance the ball joint nut (11) to the nearest cotter pin slot.
- Do not back off a ball joint nut in order to insert a cotter pin.

3. Install the ball joint nut (11).

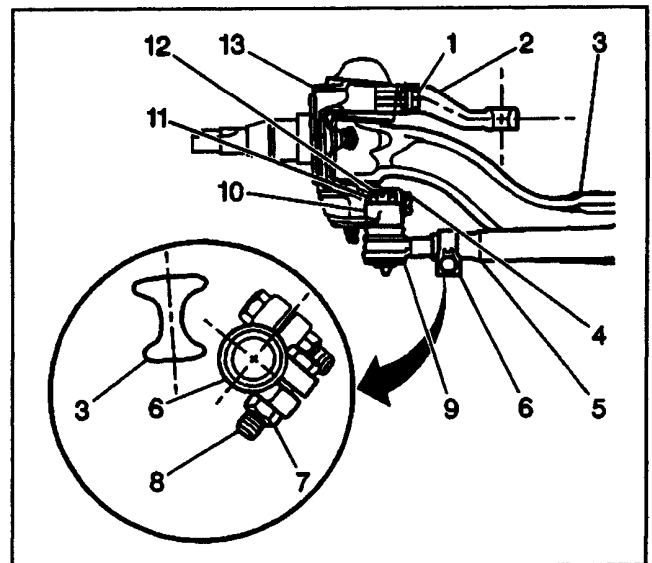
Tighten

- Tighten the ball joint nuts in the axle assemblies with a 3675 kg (8100 lb) rating to 130 N.m (95 lb ft).
- Tighten the ball joint nuts in all other axle assemblies to 160 N.m (120 lb ft).

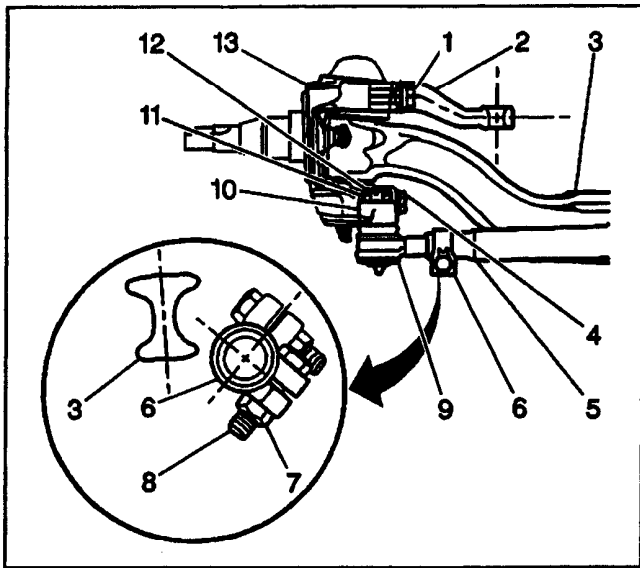
4. Install the new cotter pin (12).
5. Lubricate the tie rod ball with the chassis lubricant. Refer to *Fluid and Lubricant Recommendations*.
6. Adjust the toe-in. Refer to *Front Toe Adjustment*.
7. Install the tie rod tube clamp bolt nuts.

Tighten

Tighten the tie rod tube clamp bolt nuts to 75 N.m (55 lb ft).



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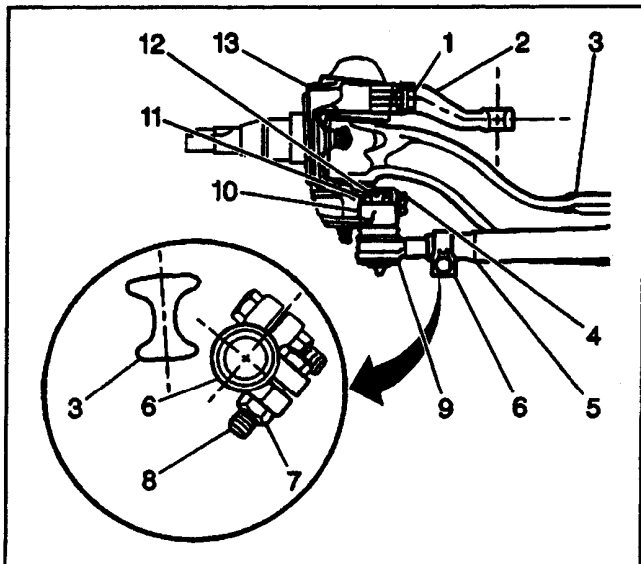
Steering Arm Replacement

Removal Procedure

1. Remove the relay rod. Refer to *Relay Rod Replacement*.
2. Remove the steering arm bolts (1) and the flat washers from the steering knuckle (13).
3. Remove the steering arm (2).

Important: The steering arm is non-repairable. Replace the steering arm if it is damaged or worn.

4. Inspect the steering arm for the following conditions:
 - Damage
 - Wear



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Installation Procedure

1. Install the steering arm (2) to the knuckle (13).
2. Install the flat washers.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the steering arm bolts (1).

Tighten

Tighten the steering arm bolts to 620–700 N.m (457–516 lb ft).

4. Install the relay rod to the steering arm. Refer to *Relay Rod Replacement*

5. Install the relay rod nut.

Tighten

Tighten the relay rod nut to 160 N.m (120 lb ft).

6. Advance the pins to the nearest cotter pin slot.
7. Install the new cotter pins.
8. Lower the cab.
9. Adjust the toe-in. Refer to *Front Toe Adjustment*.

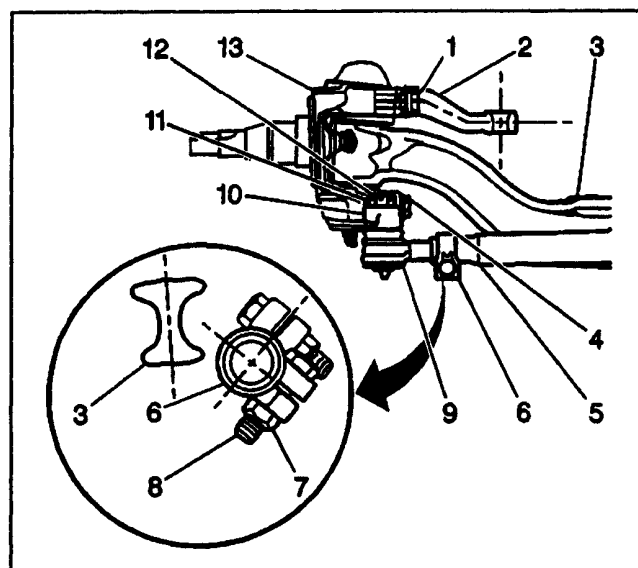
Tie Rod Arm Replacement

Removal Procedure

1. Remove the tie rod ball joint from the tie rod arm. Refer to *Tie Rod Replacement*.
2. Remove the following components from the steering knuckle:
 - The tie rod arm bolts (4)
 - The flat washers
 - The tie rod arm (10).

Important: The tie rod arm is not serviceable. Replace the rod arm if it is worn or damaged.

3. Inspect the tie rod arm for the following conditions:
 - Damage
 - Wear



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Installation Procedure

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the tie rod arm to the steering knuckle.
2. Secure the tie rod arm (10) with the following components:

- The flat washers
- The tie rod arm bolts (4)

Tighten

Tighten the tie rod arm bolts to 620–700 N·m (457–516 lb ft).

3. Install the tie rod ball joint (9) to the tie rod arm (10).

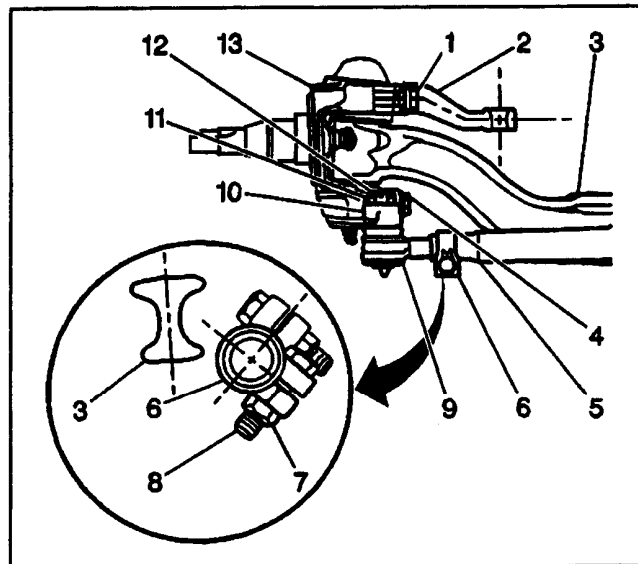
Important: Do not back off a tie rod ball joint nut in order to insert a cotter pin.

4. Install the tie rod ball joint nut (12).

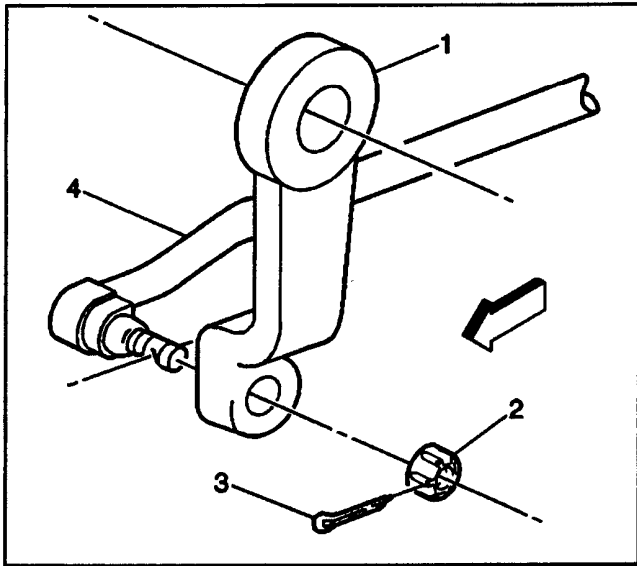
Tighten

- Tighten the ball joint nuts on axle (2) assemblies with a 3675 kg (8100 lb) rating to 130 N·m (95 lb ft).
- Tighten the ball joint nuts on all other axle assemblies to 160 N·m (120 lb ft).

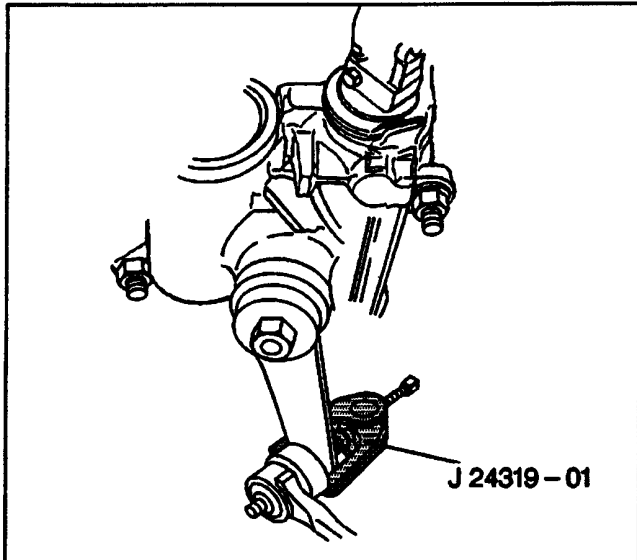
5. Advance the tie rod ball joint nut to the nearest cotter pin slot.
6. Install the new cotter pin (12).
7. Adjust the toe-in. Refer to *Front Toe Adjustment*.



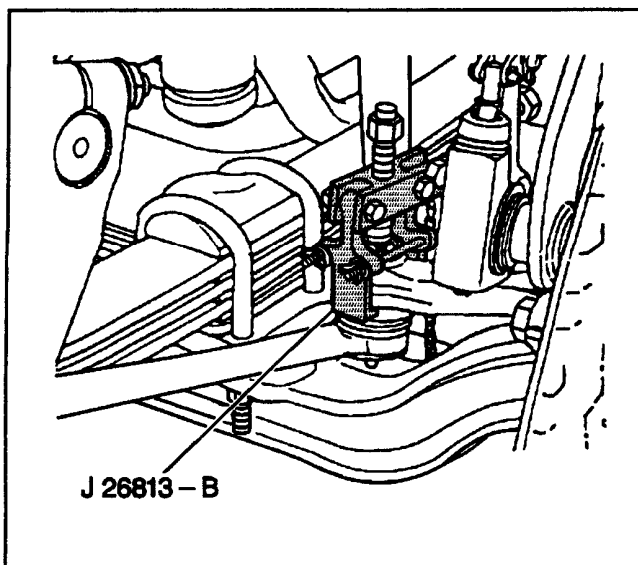
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Relay Rod Replacement

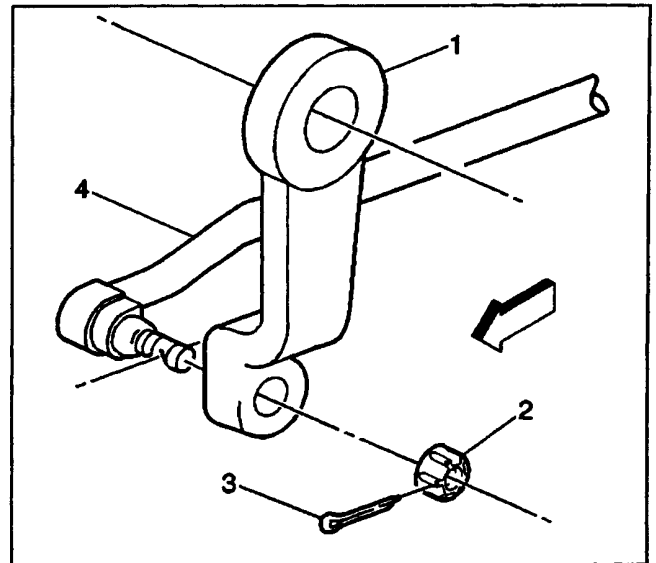
Removal Procedure

Tools Required

- J 24319-01 Steering Linkage Puller
 - J 26813-B Steering Linkage Puller
1. Position the front wheels and the steering wheel straight ahead.
 2. Tilt the cab. Refer to *Cab Tilting* in General Information.
 3. Remove the cotter pins (3) at each end of the relay rod (4).
 4. Discard the cotter pins.
 5. Remove the relay rod nuts (2).
 6. Use the J 24319-01 in order to remove the relay rod from the pitman arm.
 7. Use the J 26813-B in order to remove the relay rod from the steering arm.
 8. Inspect the relay rod for damage.
 9. Inspect the end assembly stud threads for damage.
 10. Inspect the end assembly rubber seals for the following conditions:
 - Damage
 - Deterioration
 11. Install the relay rod nut (2).
 12. Install the cotter pin (3).
 13. Measure the torque required to turn the ball stud.
 14. Replace the relay rod if the turning torque is less than 0.5 N·m (5 lb in).
 15. Repeat steps 11 through 14 for the other ball stud.

Installation Procedure

1. Install the relay rod (4) assembly to the pitman arm (1).
2. Install the relay rod nut (2).



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3. Install the relay rod end assembly (2) to the steering arm (1).

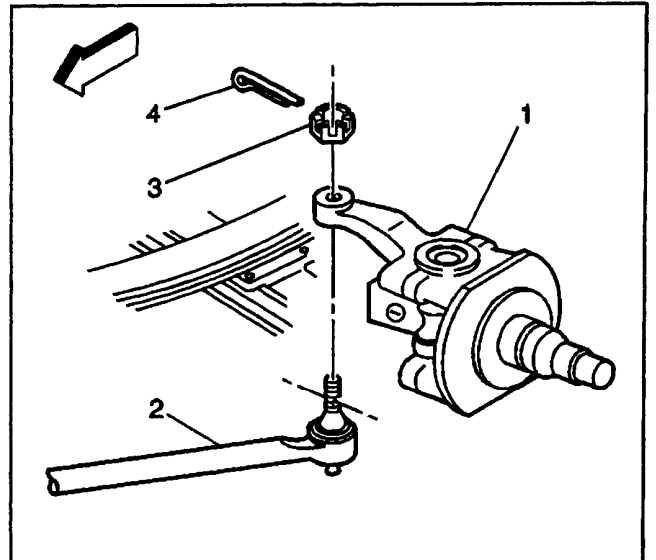
Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the relay rod nut (3).

Tighten

Tighten the relay rod nut to 160 N.m (120 lb ft).

5. Advance the nuts (3) to the nearest cotter pin slot.
6. Install the new cotter pins (4)..
7. Lower the cab.
8. Lubricate the relay rod with the chassis lubricant. Refer to *Fluid and Lubricant Recommendations* in Maintenance and Lubrication.



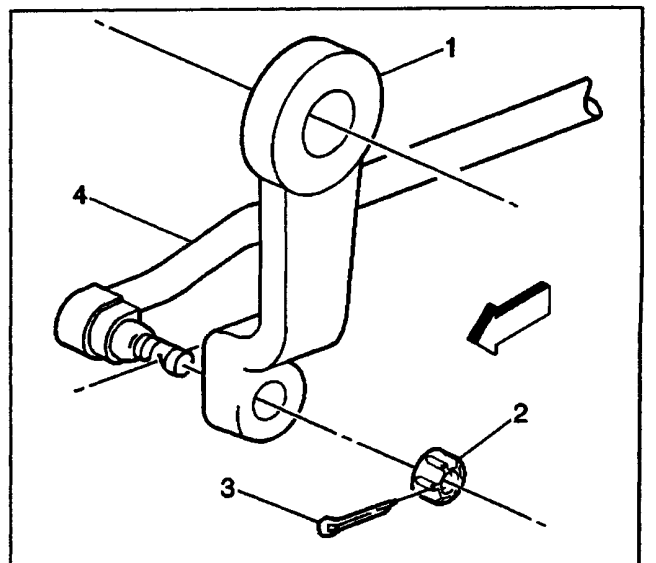
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Pitman Arm Replacement**Removal Procedure****Tools Required**

- J 39256 Pitman Arm Puller
- J 24319-01 Steering Linkage Puller

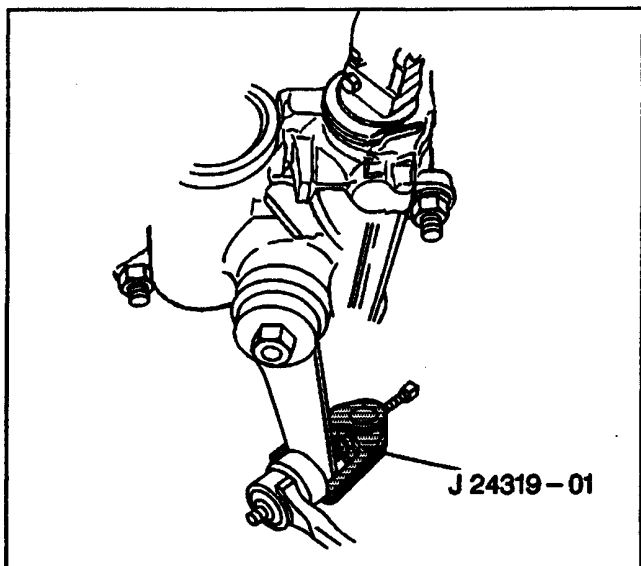
Notice: Do not hammer on the pitman arm, pitman arm shaft, or puller. Damage to the pitman or steering gear may result. Pitman arms are non-repairable and must be replaced when damaged or worn.

1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.



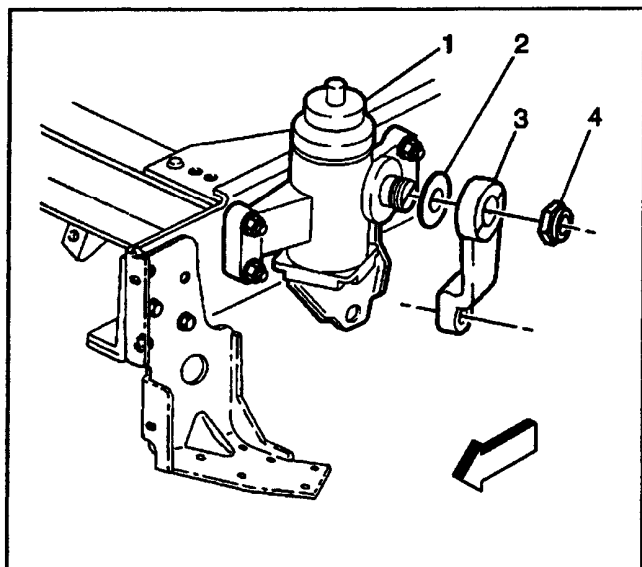
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3. Remove the cotter pin (3).
4. Discard the cotter pin.
5. Remove the relay rod nut (2)
6. Mark the position of the pitman arm (1) on the pitman shaft.
7. Use the *J 24319-01* in order to remove the relay rod end from the pitman arm end.



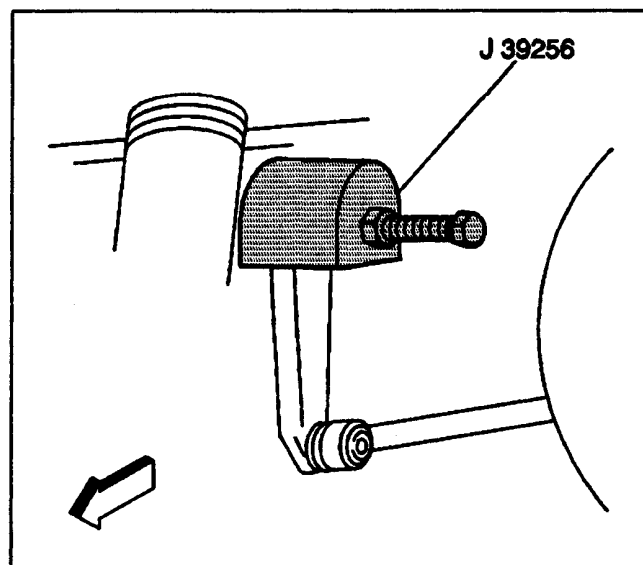
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8. Remove the pitman arm nut (4).



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9. Use the J 39256 in order to remove the pitman arm (3) from the pitman shaft.



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Installation Procedure

Important: Align the position marks made during removal on the pitman arm and the pitman shaft.

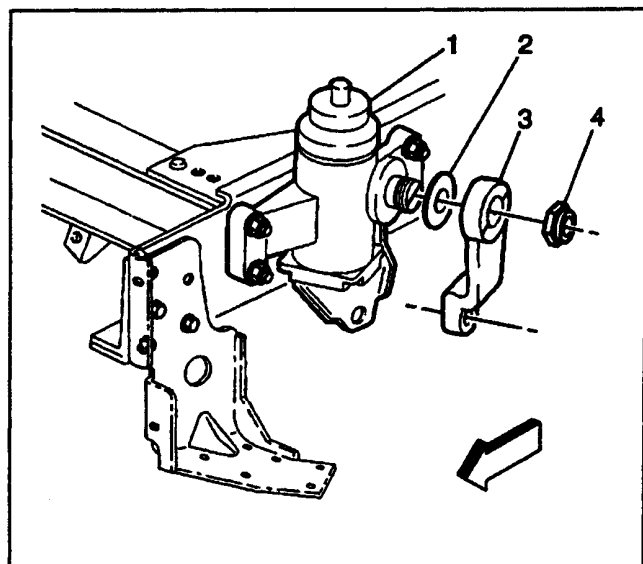
1. Install the pitman arm (3) on the pitman shaft.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the pitman arm nut (4).

Tighten

Tighten the pitman arm nut to 370 N.m (275 lb ft).



294139

3. Install the relay rod (4).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the relay rod nut (2).

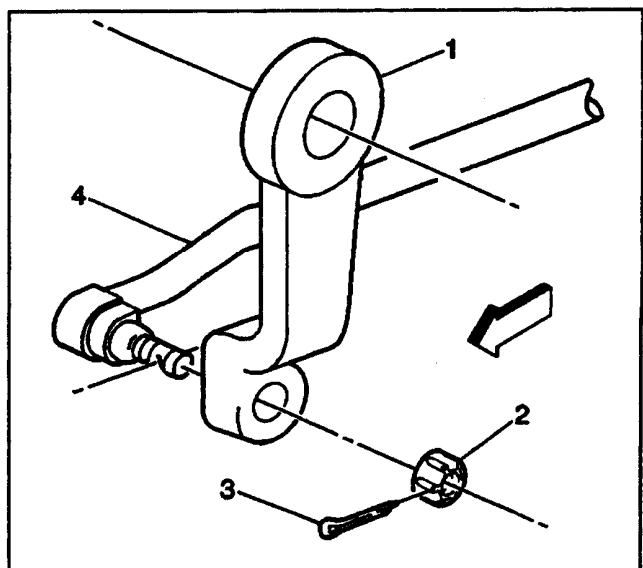
Tighten

Tighten the relay rod nut to 160 N.m (120 lb ft).

5. Advance the relay rod nuts to the nearest cotter pin slot.

6. Install the new cotter pin (3).

7. Lower the cab.



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Description and Operation

Steering Linkage Description

The steering linkage consists of the following components:

- The pitman arm
- The relay rod
- The steering arms
- The tie rod

The turning motion of the steering wheel is transmitted through the steering gear and the pitman arm to the relay rod.

Inspect the following conditions whenever any steering linkage components are repaired or replaced:

- The steering geometry
- The front end alignment

Refer to *Front Caster Adjustment*, *Front Camber Adjustment* and *Front Toe Adjustment* in Wheel Alignment.

Relay Rod

The relay rod has a ball joint at each end. The relay rod connects to the forward steering arm on the left side.

The tie rod extends the length of the axle. The tie rod connects the left and the right steering arms. This arrangement provides control of the right wheel.

The overall condition of the steering linkage affects the steering performance. The following conditions may cause poor steering performance:

- Bent parts
- Damaged parts
- Worn parts
- Poorly lubricated parts

Tie Rod

The tie rod assembly consists the following components:

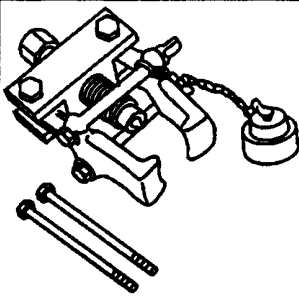
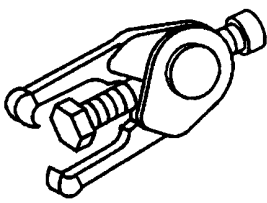
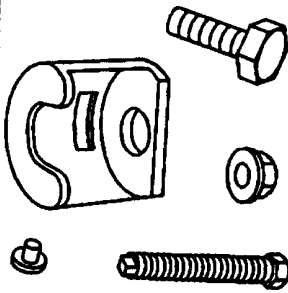
- The tie rod tube
- The two tie rod ends

The tie rod ends thread into the tube. Clamps secure the tied rod end to the tube. The right and left hand threads provide a convenient method of adjusting the toe-in. Replace the tie rod ends when an any of the following conditions are noted:

- An excessive up and down motion is present
- Excessive end play at the ball end of the stud is present
- Loss of motion at the ball end of the stud is present

Before any repair is undertaken, note the position of the tie rod end clamps and the direction from which the bolts are installed. Reinstall the parts in the proper position in order to avoid interference with the adjacent parts of the vehicle.

Special Tools and Equipment

Illustration	Tool Number Description
 216198	J 26813-B Steering Linkage Puller
 82244	J 24319-01 Steering Linkage Puller
 216175	J 39256 Pitman Arm Puller

Steering Wheel and Column - Tilt

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Cardan Joint Nut	55 N.m	41 lb ft
Steering Wheel Nut	55 N.m	41 lb ft

Diagnostic Information and Procedures

Lock System Sticks In Start

Problem	Action
The ignition switch is worn.	Replace the ignition switch.
A high effort condition exists.	Refer to <i>High Steering Shaft Effort</i> .

Key Cannot Be Removed in the Off Lock Position

Problem	Action
The ignition switch faulty or loose.	Tighten the mounting bolts or replace the ignition switch

Noise in Steering Column

Problem	Action
The upper steering shaft bearings are worn, tight or frozen.	Replace the upper steering shaft.
The column mounting is loose.	Tighten the attaching bolts.
One click in the OFF-LOCK position is heard during movement of the steering wheel.	Seat the lock bolt normally.
The horn contact ring is not lubricated.	Lubricate as necessary.
The column is improperly mounted.	Tighten the attaching bolts.
The tilt shoe or the attaching hardware is loose.	1. Tighten the tilt shoe or the attaching hardware. 2. Replace the tilt shoe, if necessary.

High Steering Shaft Effort

Problem	Action
The upper steering shaft bearings are worn, tight or frozen.	Replace the upper steering shaft.
The lower shaft universal joints are binding.	Replace the lower steering shaft universal joints.

Loose Steering Wheel (Every Other Tilt Position)

Problem	Action
A loose fit exists between the tilt shoe and the pivot pin.	Replace the tilt shoe.

Steering Wheel Does Not Lock in Any Tilt Position

Problem	Action
The tilt shoe grooves have burrs or dirt.	Replace the tilt shoe. Clean the grooves.
The tilt spring is weak or broken.	Replace the spring.
The tilt shoe is seized on the pivot pin.	Replace the tilt shoe.

Steering Wheel Not Returning to Top Tilt Position

Problem	Action
The pivot bolts are bound.	Replace the pivot bolts.
The tilt springs are broken or missing.	Replace the tilt springs.
Column binding exists in the following components: • The ignition switch • The combination switch wiring harness	Reroute the harness.

Noise When Tilting Steering Column

Problem	Action
The tilt springs are rubbing in the housing.	1. Reposition the tilt springs. 2. Lubricate the tilt springs.
The tilt shoe grooves have burrs or dirt.	1. Replace the tilt shoe. 2. Clean the grooves.

Turn Signal Does Not Cancel

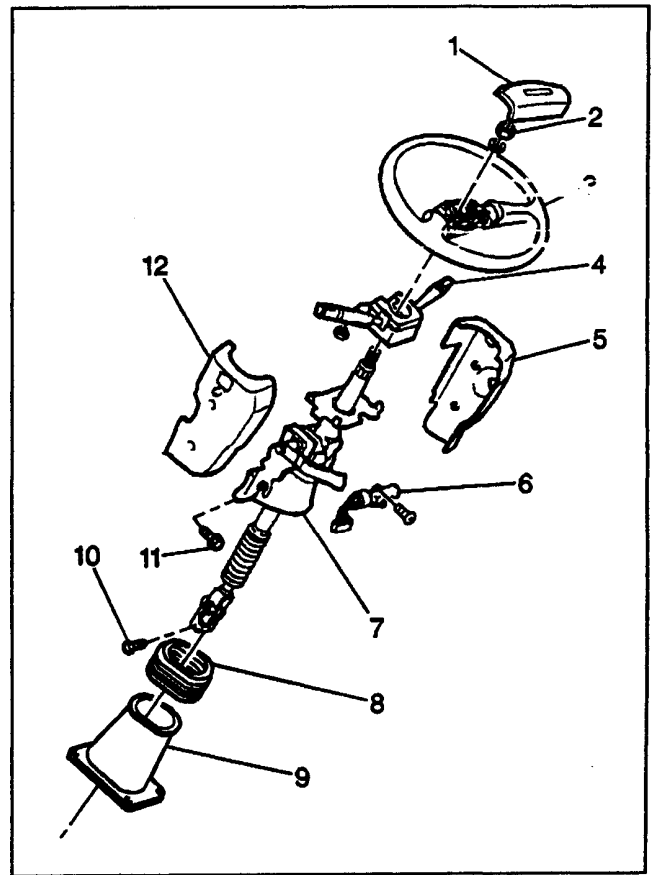
Problem	Action
The combination switch mounting is loose.	Tighten the combination switch mounting screws.
The detent is broken or missing.	Replace the combination switch.
The combination switch is faulty.	Replace the combination switch.

Repair Instructions

Ignition Switch Replacement

Removal Procedure

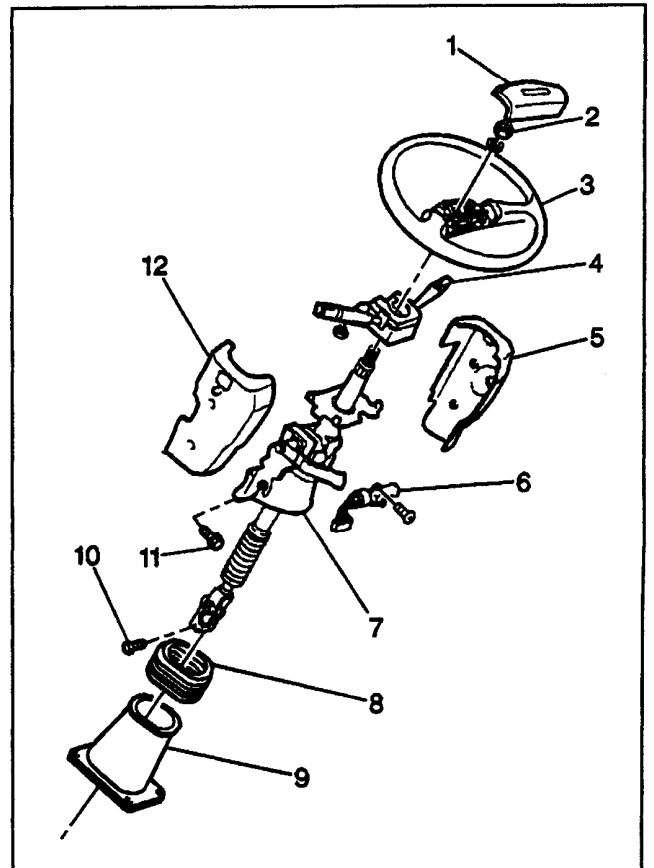
1. Remove the steering wheel (3). Refer to *Steering Wheel Replacement*.
2. Push the boot (8) off of the cowl halves (5, 12) onto the lower steering shaft cover (9).
3. Remove the left and right side cowl half screws.
4. Remove the left (12) and right (5) side cowl halves from the upper steering shaft assembly (7).
5. Disconnect the electrical connector from the ignition switch (6).
6. Remove the following components from the upper steering shaft assembly (7):
 - 6.1. The ignition switch screws
 - 6.2. The wiring harness clamp
 - 6.3. The ignition switch (6)



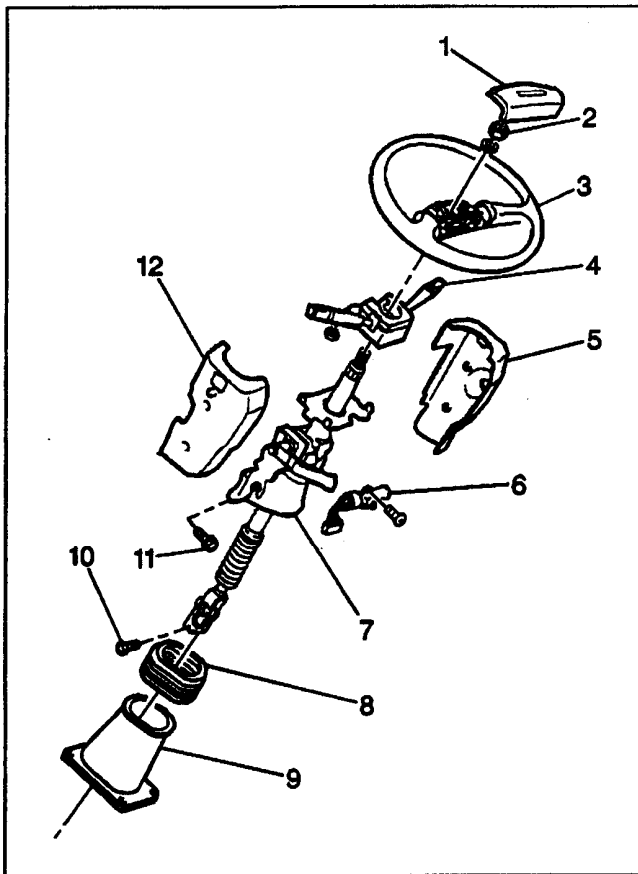
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Installation Procedure

1. Install the ignition switch (6) to the upper steering shaft assembly (7), with the wiring harness clamp and screws.
2. Connect the electrical connector to the ignition switch (6).
3. Install the left (12) and the right (5) side cowl halves to the upper steering shaft assembly (7) with screws.
4. Position the boot (8) over the lower steering shaft cover (9).
5. Install the steering wheel (3).



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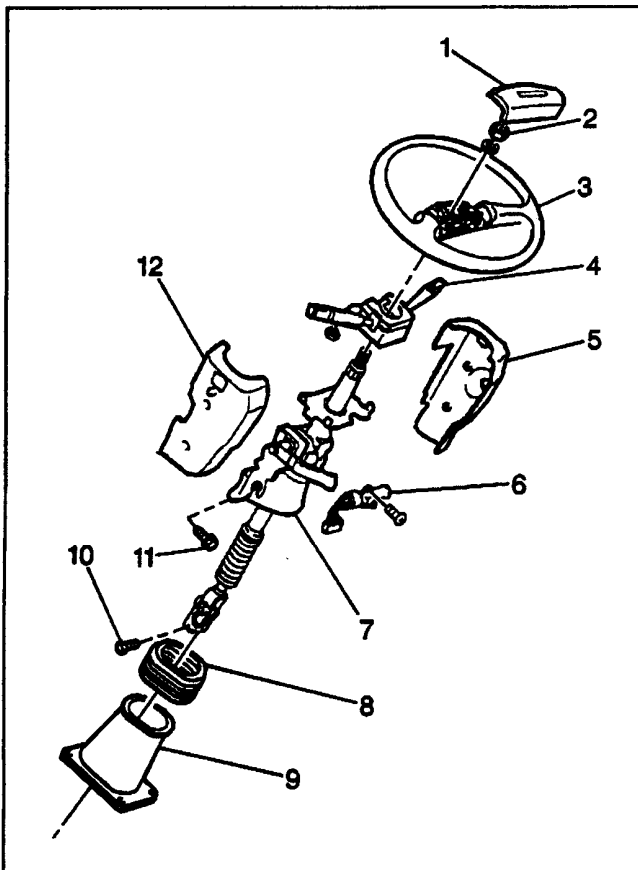
Multifunction Turn Signal Lever Replacement

Removal Procedure

1. Remove the steering wheel (3). Refer to *Steering Wheel Replacement*.
2. Push the boot (8) off of the cowl halves (5, 12) onto the lower steering shaft cover (9).
3. Remove the left and right side cowl half screws.
4. Remove the left (12) and right (5) side cowl halves from the upper steering shaft assembly (7).
5. Disconnect the electrical connector from the combination switch (4).
6. Remove the combination switch screws and the combination switch (4) from the upper steering shaft assembly (7).

Installation Procedure

1. Install the combination switch (4) to the upper steering shaft assembly (7).
2. Connect the electrical connector to the combination switch (4).
3. Install the left (12) and the right (5) side cowl halves to the upper steering shaft assembly (7) with screws.
4. Position the boot (8) over the lower steering shaft cover (9).
5. Install the steering wheel (3).

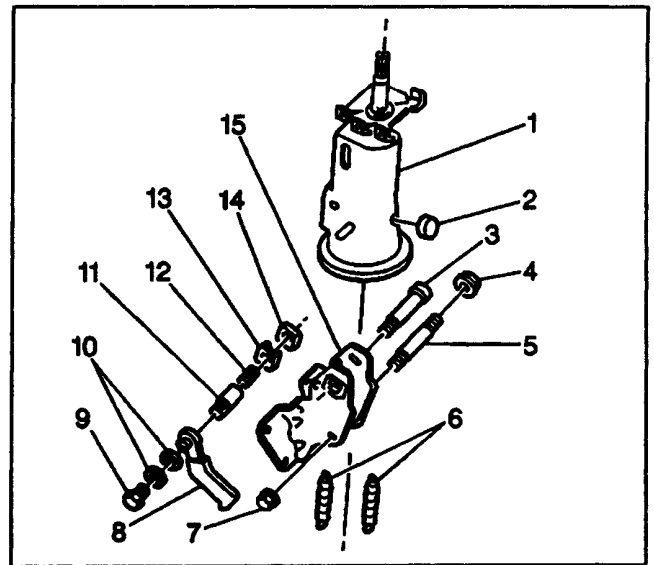


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Tilt Lever Replacement

Removal Procedure

1. Remove the upper steering shaft assembly. Refer to *Upper Steering Shaft Assembly Replacement*.
2. Remove the following components:
 - 2.1. The bolt (9)
 - 2.2. The washer (10)
 - 2.3. The tilt lever (8)
3. Remove the following components:
 - 3.1. The tilt lever bolt (3)
 - 3.2. The spacer (11)
 - 3.3. The spring (12)
 - 3.4. The tilt shoe holder (13)
 - 3.5. The tilt shoe (14)

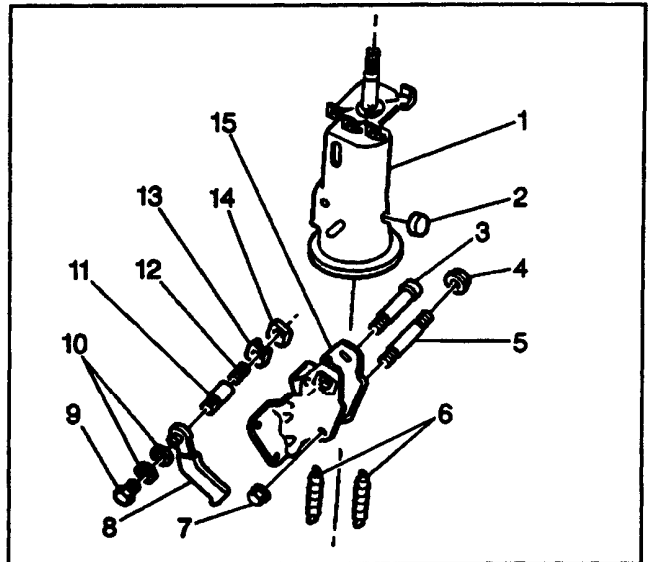


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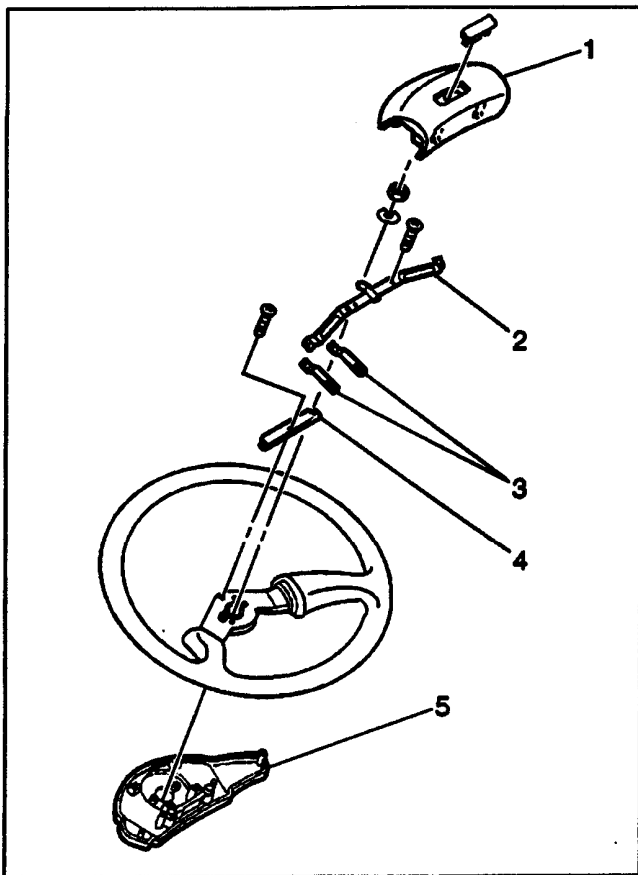
Installation Procedure

1. Position the tilt shoe in the tilt shoe holder in order for the teeth of the shoe to align with the teeth of the steering column mounting bracket.
2. Install the following components:
 - 2.1. The tilt lever bolt (3).
 - 2.2. The tilt shoe holder (13).
 - 2.3. The tilt shoe (14).
 - 2.4. The spacer (11).
 - 2.5. The spring (12).

Important: To ensure that the tilt lever will be in a locked position, it may be necessary to reposition or turn the tilt lever bolt 90 degrees.
- 2.6. Install the following components:
 - 2.7. The tilt lever (8).
 - 2.8. The washer (10).
 - 2.9. The bolt (9).
- 2.10. Install the upper steering shaft assembly.



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Steering Wheel Replacement

Removal Procedure

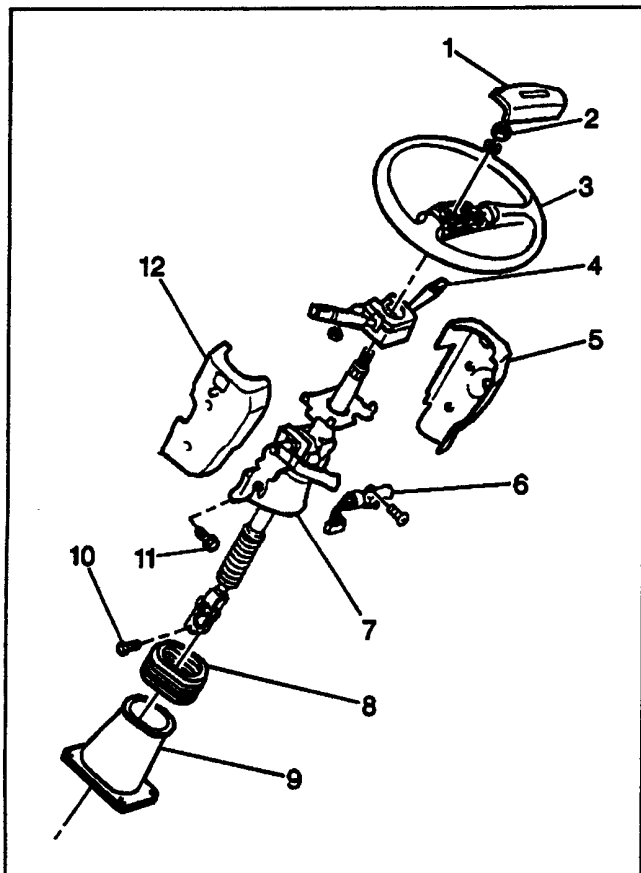
Tools Required

J 1859-A Universal Steering Wheel Puller

Caution: Refer to *Battery Disconnect Caution* in *Cautions and Notices*.

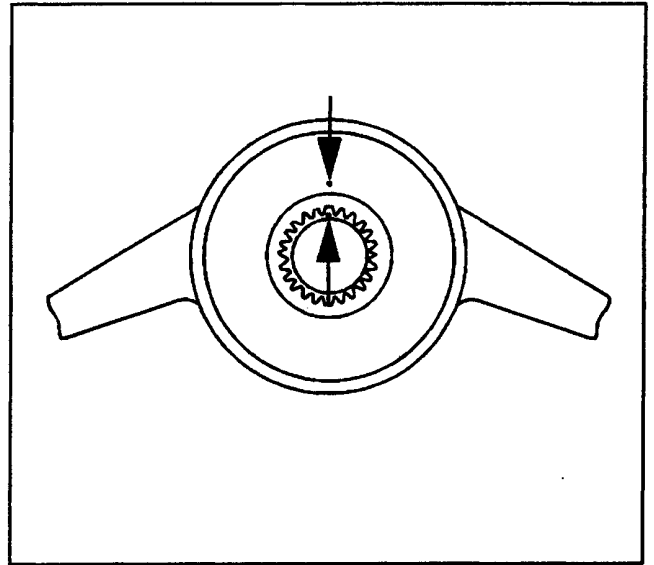
1. Disconnect the negative battery cable. Refer to *Battery Replacement* in *Engine Electrical*.
2. Remove the horn pad (1).

3. Remove the steering wheel nut (2) and the washer.
4. Disconnect the horn electrical connector.



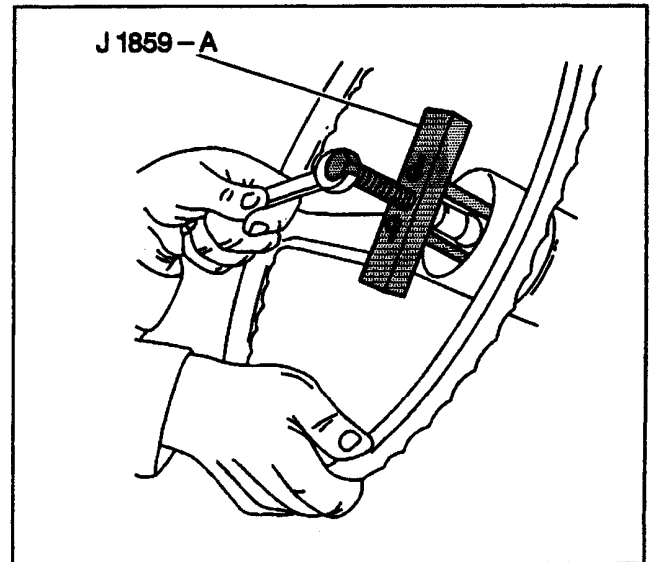
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5. Mark the position of the steering wheel in relation to the steering column shaft for installation.



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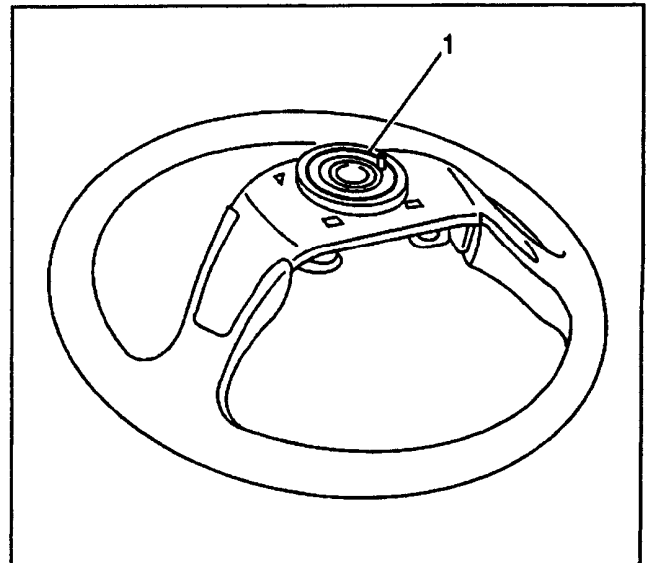
6. Use the J 1859-A in order to remove the steering wheel from the steering column shaft.



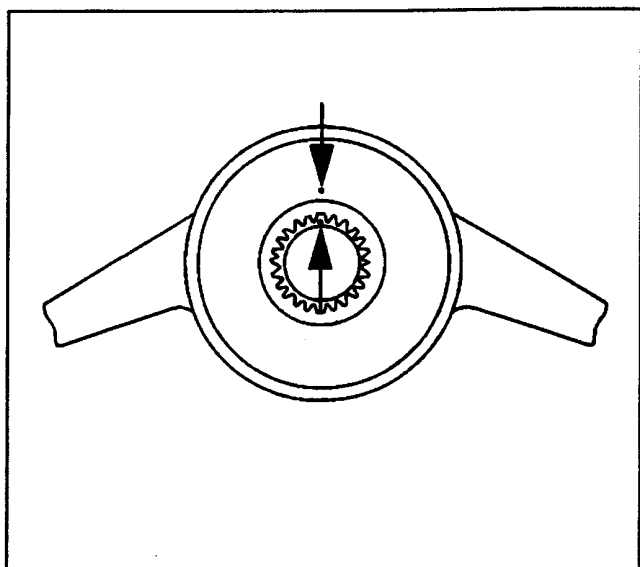
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Installation Procedure

1. Apply a thin coat of lithium grease to the bottom of the horn contact ring (1).



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228500

2. Install the steering wheel on the steering shaft. Be sure to align the marks.

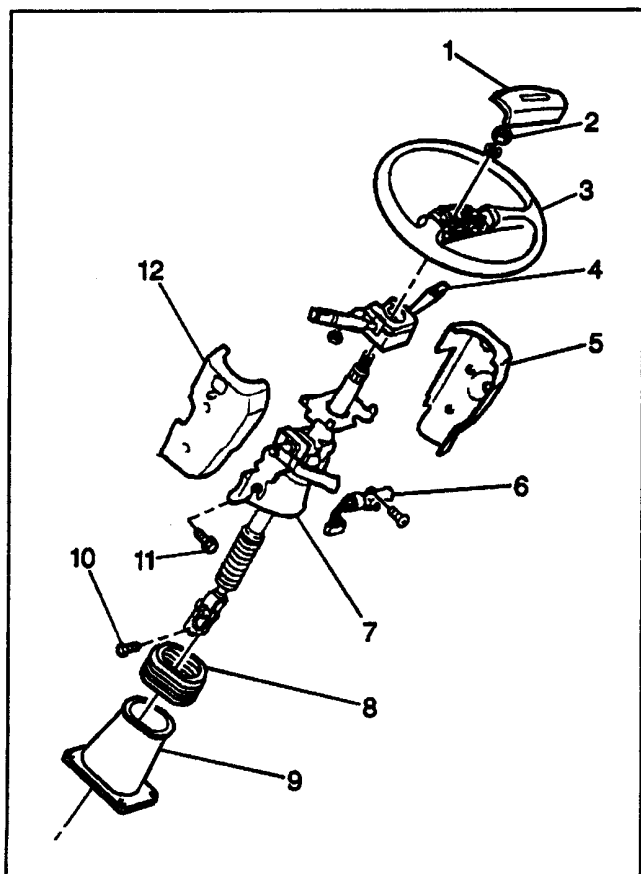
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the washer and the steering wheel nut (2).

Tighten

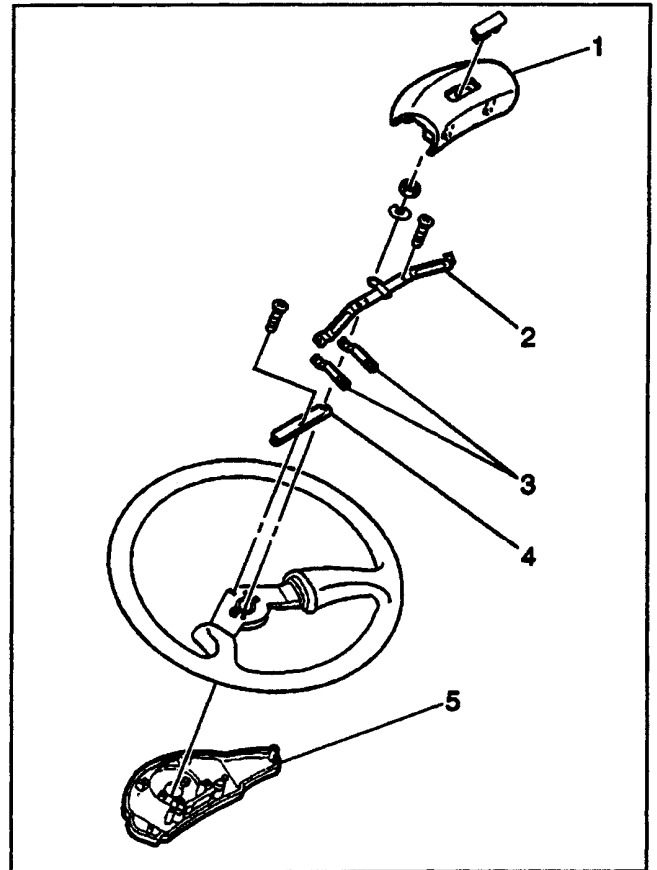
Tighten the steering wheel nut to 55 N.m (41 lb ft).

4. Connect the horn electrical connector.



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5. Install the horn pad (1).
6. Connect the negative battery cable.

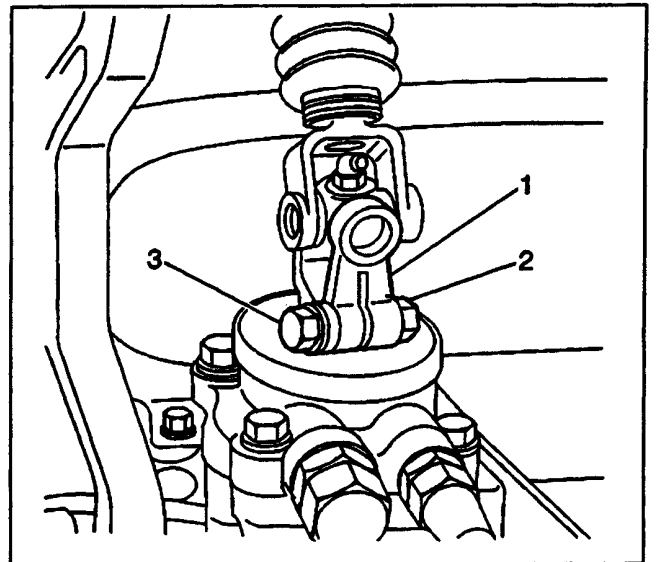


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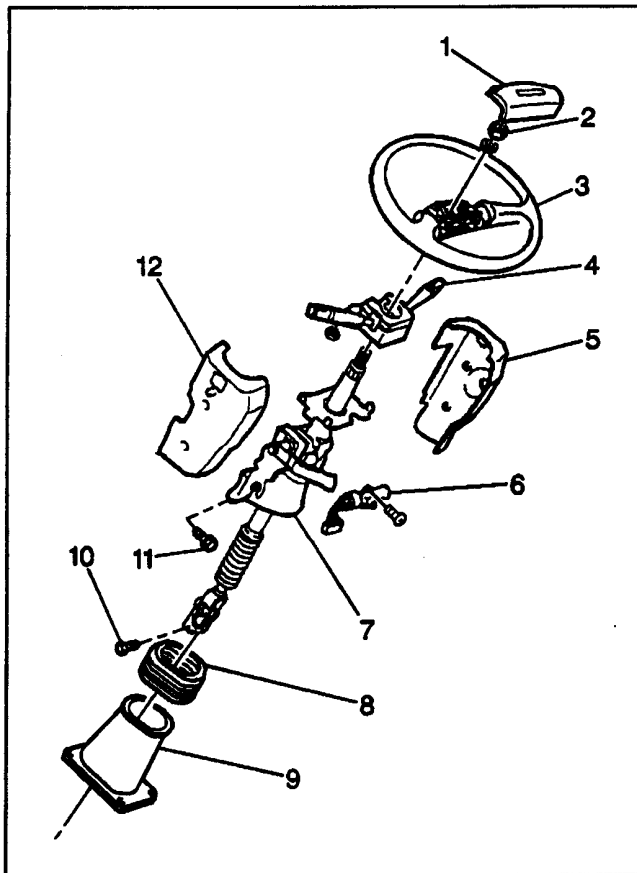
Upper Steering Shaft Assembly Replacement

Removal Procedure

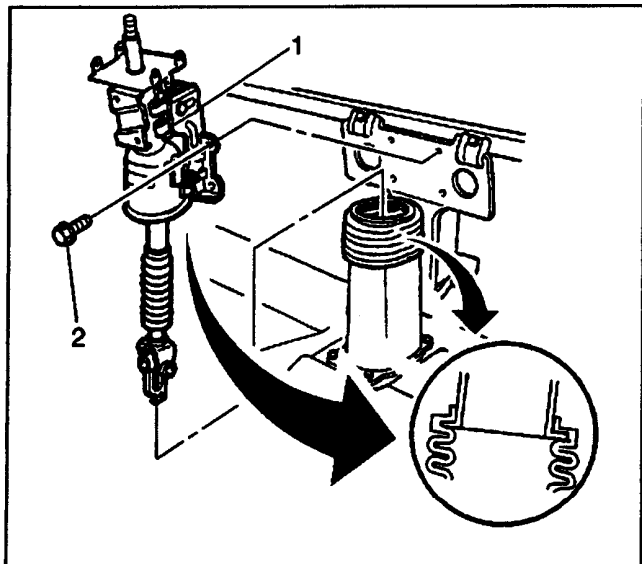
1. Position the front wheels and the steering wheel straight ahead.
2. Tilt the cab. Refer to *Cab Tilting* in General Information.
3. Mark the position of the steering gear input shaft and the lower cardan joint (1) of the lower steering shaft.
4. Remove the following components from the lower cardan joint (1):
 - The nut (2)
 - The washer
 - The cardan bolt (3)
5. Gently pry the lower cardan joint (1) off of the steering gear input shaft.
6. Retract the lower steering shaft toward the cab.
7. Close the cab slowly, in order to ensure the lower steering shaft does not come in contact with the cab.



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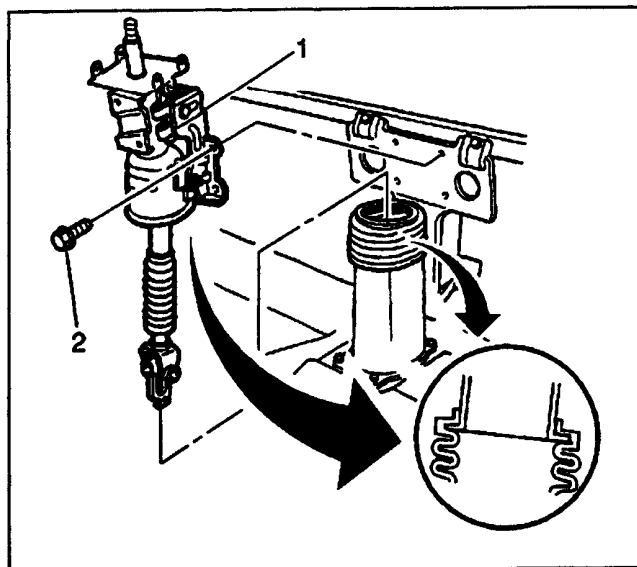


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8. Remove the steering wheel (3). Refer to *Steering Wheel Replacement*.
9. Push the boot (8) off of the cowl halves (5, 12) and onto the lower steering shaft cover (9).
10. Remove the following components from the upper steering shaft assembly (7):
 - The left side cowl half screws
 - The right side cowl half screws
 - The left side cowl half (12)
 - The right side cowl half (5)
11. Remove the electrical connector from the combination switch (6).
12. Remove the following components from the upper steering shaft assembly (7):
 - The combination switch screws
 - The combination switch (4)
13. Remove the electrical connector from the ignition switch (6).
14. Remove the following components from the upper steering shaft assembly (7):
 - The ignition switch screws
 - The ignition switch (6)
15. Remove the following components from the wire harness:
 - The wiring harness screw
 - The clamp
16. Remove the tie wraps from the wiring harness, as necessary.
17. Remove the following components from the vehicle:
 - The upper steering shaft assembly mounting bolt (2)
 - The upper steering shaft assembly (1)

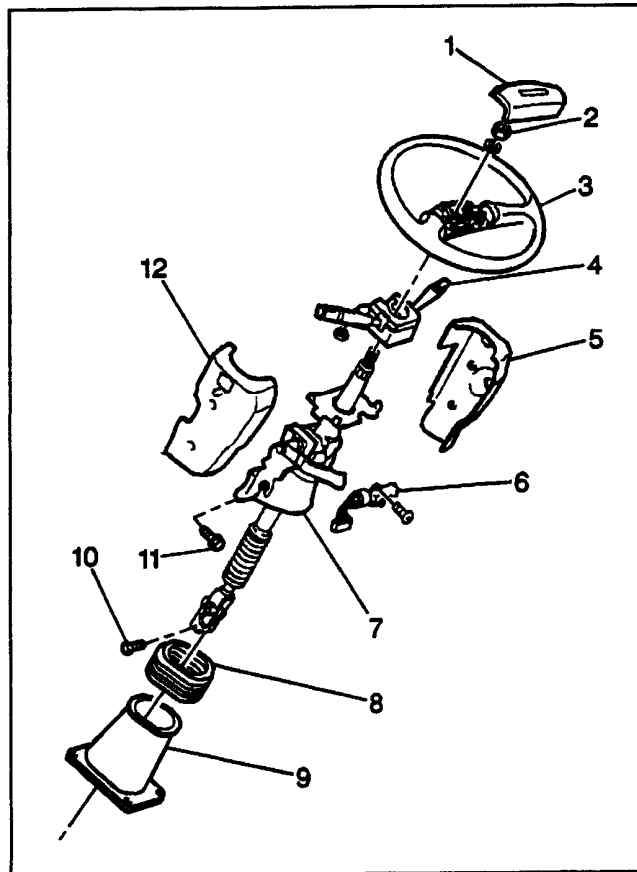
Installation Procedure

1. Install the following components to the vehicle:
 - The upper steering shaft assembly (1)
 - The upper steering shaft assembly mounting bolts (2)



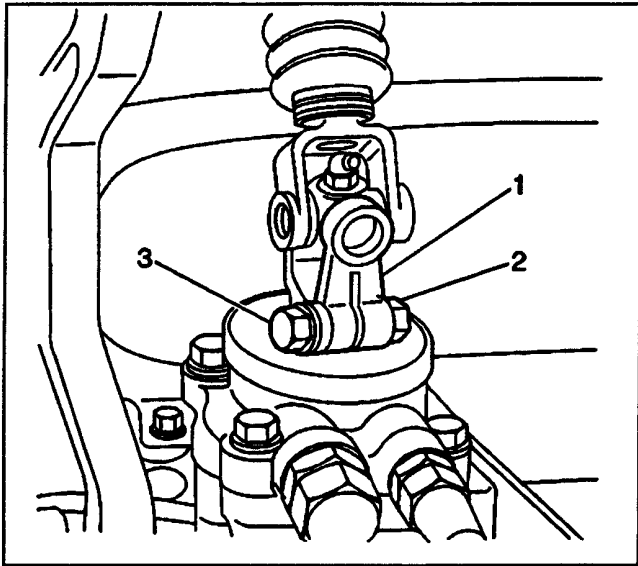
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2. Install the ignition switch (6) to the upper steering shaft assembly (7).
Secure the ignition switch with the following components:
 - The wiring harness clamp
 - The screws
3. Install the electrical connector to the ignition switch (6).
4. Install the combination switch (4) to the upper steering shaft assembly (7).
Secure the combination switch with screws.
5. Install the electrical connector to the combination switch (4).
6. Install the wiring harness clamp to the upper steering shaft assembly (7).
Secure the wiring harness clamp with a screw.
7. Install the tie wraps to the wiring harness, as necessary.



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8. Install the following components to the upper steering shaft assembly:
 - The left side cowl half (12)
 - The right side cowl half (5)
9. Secure the cowl halves with screws.
10. Position the boot (8) over the lower steering shaft cover (9).
11. Install the steering wheel (3).
12. Slowly lower the cab. Ensure that the lower steering shaft does not come in contact with the cab.
13. Align the marks on the steering gear input shaft and the lower cardan joint (1) of the lower steering shaft.
14. Position the lower steering shaft lower cardan joint (1) on the steering gear input shaft.



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15. Install the following components:

- The lower cardan joint (1).
- The lower cardan joint bolt (3)
- The lower cardan joint nut (2)

Tighten

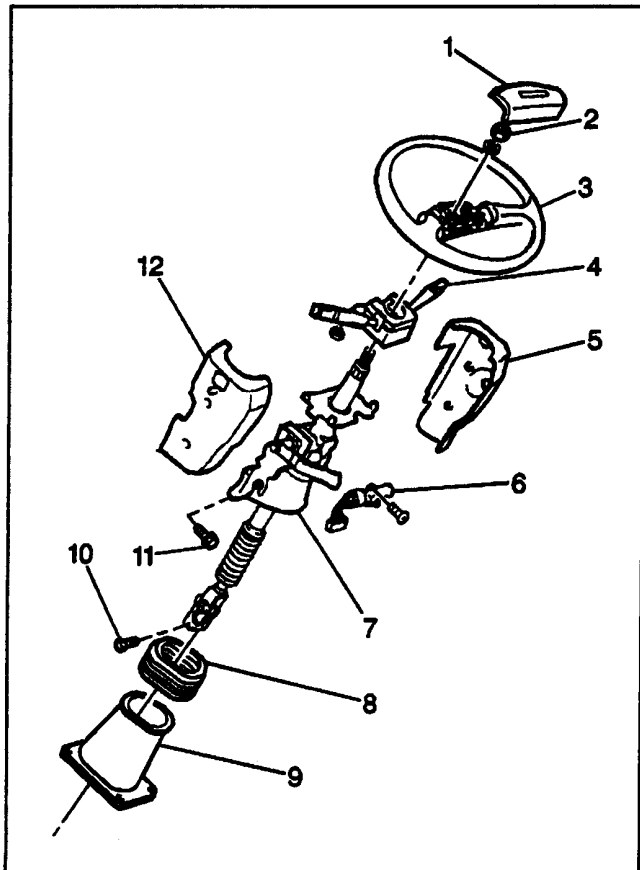
Tighten to 55 N.m (41 lb ft).

16. Lower the cab.

Lower Steering Shaft Assembly Replacement

Removal Procedure

1. Remove the upper steering shaft assembly. Refer to *Upper Steering Shaft Assembly Replacement*.
2. Mark the position of the upper steering shaft (7) and the upper cardan joint of the lower steering shaft.



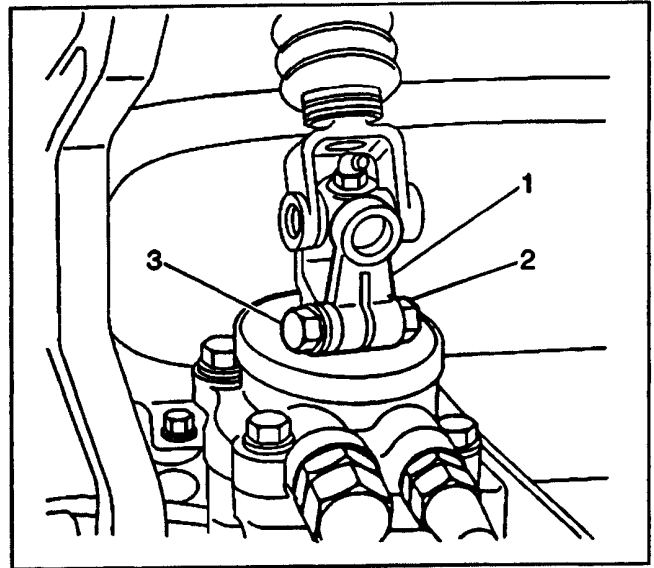
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Steering

Steering Wheel and Column - Tilt 2-75

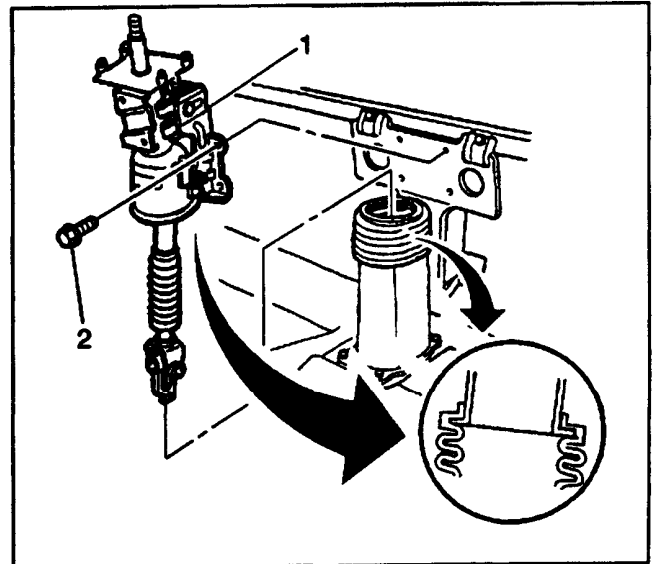
3. Remove the following components from the upper cardan joint:

- The nut (2)
- The washer
- The cardan bolt (3)
- The washer



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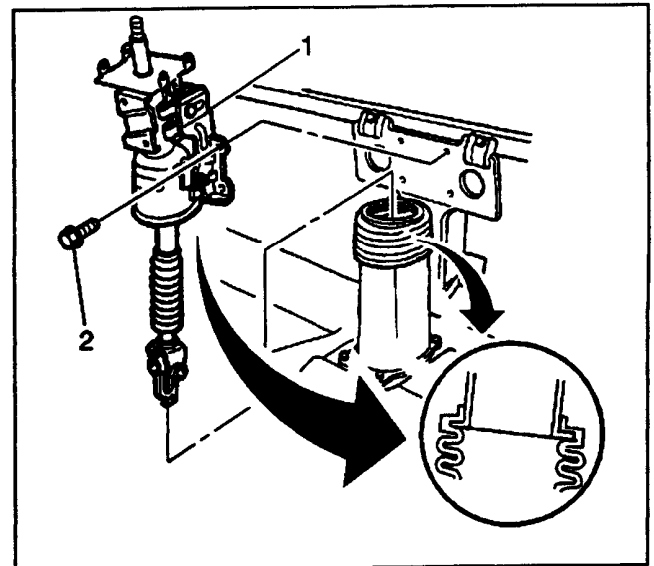
4. Gently pry the upper cardan joint off of the upper steering shaft (1).



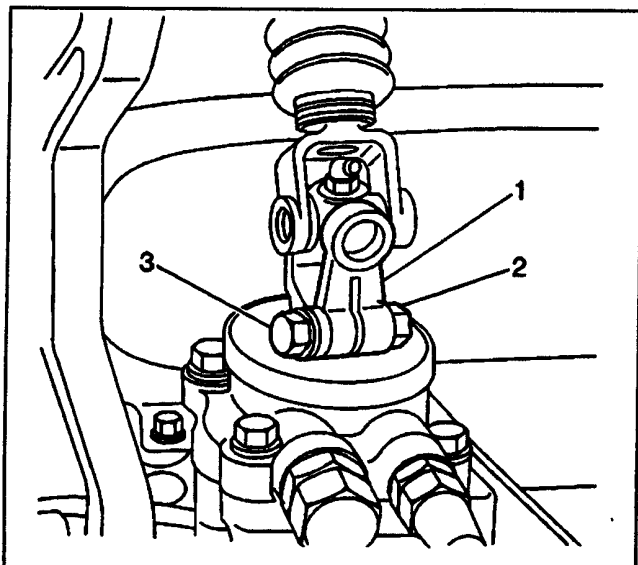
228520

Installation Procedure

1. Align the marks on the lower steering shaft upper cardan joint and the upper steering shaft (1).
2. Position the lower steering shaft upper cardan joint on to the upper steering shaft (1).



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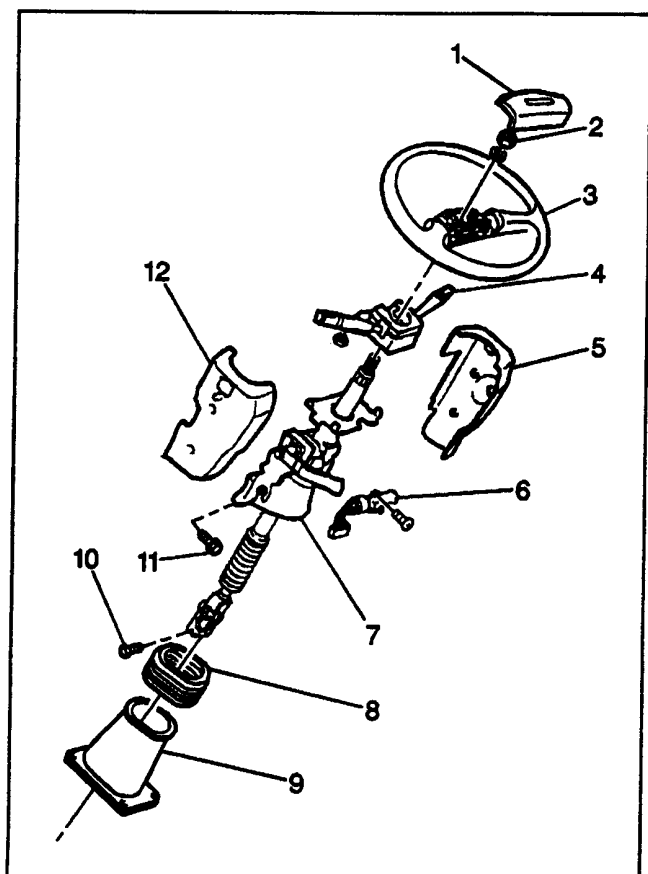
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the following components:

- The cardan joint washer
- The bolt (3)
- The washer
- The nut (2)

Tighten

Tighten the cardan nut to 55 N·m (41 lb ft).



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4. Install the upper shaft assembly (7).

Description and Operation

Steering Wheel and Column Description

The steering column is a tilt column. The left hand lock lever releases the column for tilt adjustment.

A combination switch is present on the steering column. The combination switch, on the steering column, controls the following components:

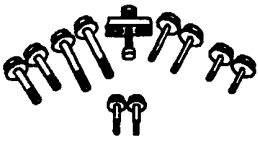
- The headlamps
- The turn signals
- The windshield washers
- The windshield wipers

The engine control switch is mounted on the column.

Sealed bearings support the upper steering shaft at both ends.

The steering column is connected to the steering gear by a slip-type shaft with cardan universal joints. Fittings for the slip-type shaft with the cardan universal joints provide lubrication.

Special Tools and Equipment

Illustration	Tool Number Description
 802	J 1859-A Steering Wheel Puller