

## 2008 STEERING

## Power Steering - LaCrosse

## SPECIFICATIONS

## FASTENER TIGHTENING SPECIFICATIONS

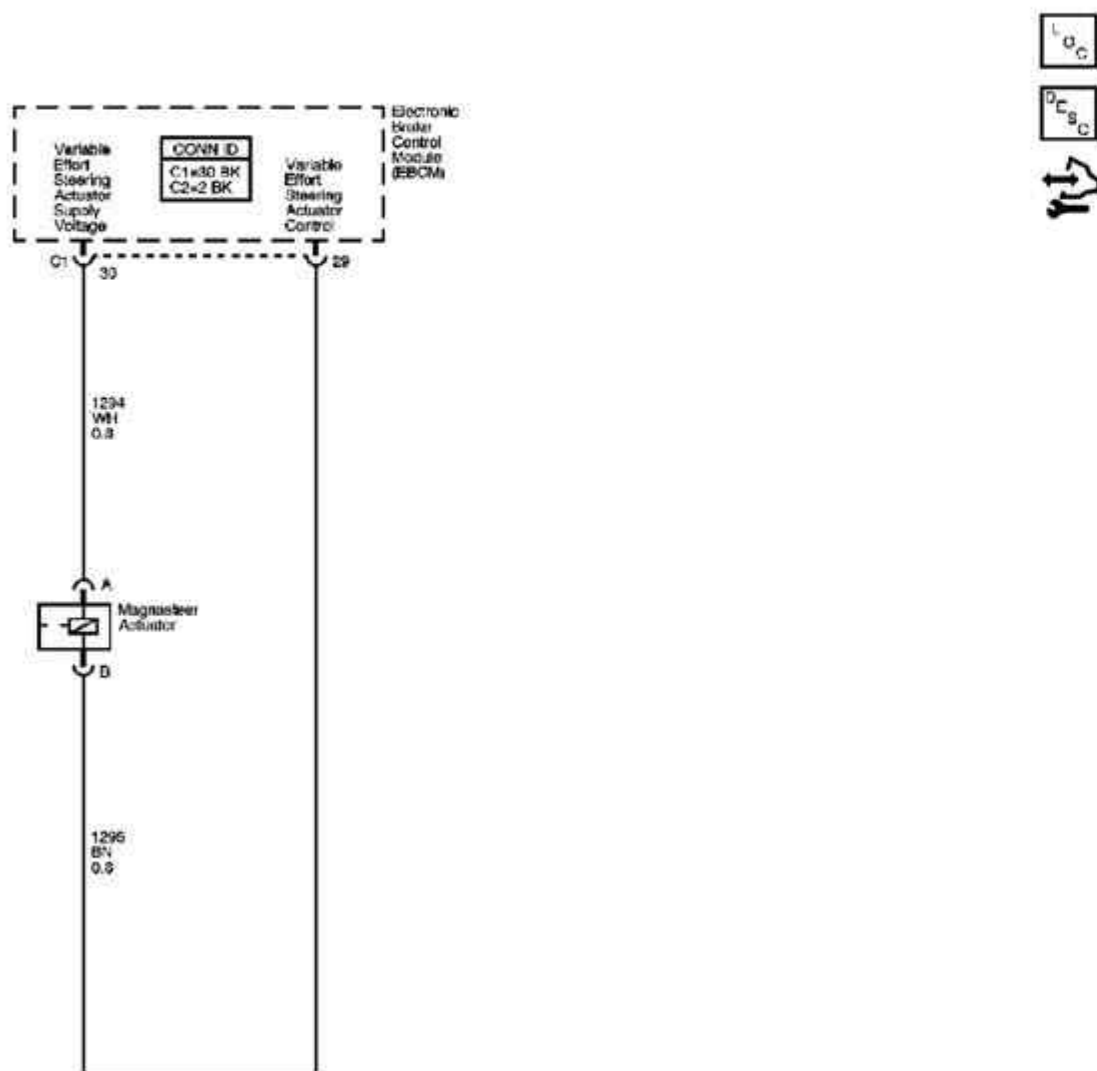
| Application                                                              | Specification           |                           |
|--------------------------------------------------------------------------|-------------------------|---------------------------|
|                                                                          | Metric                  | English                   |
| Drive Belt Tensioner Bolt                                                | 50 N.m                  | 37 lb ft                  |
| Power Steering Cooler Hose Fitting                                       | 27 N.m                  | 20 lb ft                  |
| Power Steering Cooler Hose Retaining Bolt                                | 10 N.m                  | 89 lb in                  |
| Power Steering Pressure Hose Fitting                                     | 27 N.m                  | 20 lb ft                  |
| Power Steering Pump Bracket Bolt (LY7)                                   | 9 N.m                   | 80 lb in                  |
| Power Steering Pump Bracket Bolt (LY7)                                   | 25 N.m                  | 18 lb ft                  |
| Power Steering Pump Bolt (L26,LS4)                                       | 25 N.m                  | 18 lb ft                  |
| Power Steering Pump Bolt (LY7)                                           | 50 N.m                  | 37 lb ft                  |
| Power Steering Pump O-ring Union Fitting                                 | 75 N.m                  | 55 lb ft                  |
| Power Steering Pump Quick Connect Fitting (LY7)                          | 40 N.m                  | 30 lb ft                  |
| Power Steering Return Hose Fitting (L26)                                 | 27 N.m                  | 20 lb ft                  |
| Power Steering Return Hose Bolt (LS4)                                    | 55 N.m                  | 41 lb ft                  |
| Rack and Pinion Inner Tie Rod                                            | 100 N.m                 | 74 lb ft                  |
| Rack and Pinion Outer Tie Rod End Nut                                    | 30 N.m plus 120 degrees | 22 lb ft plus 120 degrees |
| Remote Power Steering Reservoir Bolt (LS4)                               | 18 N.m                  | 13 lb ft                  |
| Steering Gear Adjuster Plug Nut                                          | 68 N.m                  | 50 lb ft                  |
| Steering Gear Bolt                                                       | 60 N.m plus 180 degrees | 42 N.m plus 180 degrees   |
| Steering Gear Cylinder Pipe Fitting (at the steering gear valve end)     | 17 N.m                  | 13 lb in                  |
| Steering Gear Cylinder Pipe Fitting (not at the steering gear valve end) | 27 N.m                  | 20 lb in                  |

## POWER STEERING PUMP SPECIFICATIONS

| Vehicle         | Engine Code | Engine Size | High Flow |         | Pressure Relief |           |
|-----------------|-------------|-------------|-----------|---------|-----------------|-----------|
|                 |             |             | LPM       | GPM     | kPa             | psi       |
| Allure/Lacrosse | L26         | 3.8L        | 9.1/10.6  | 2.4/2.8 | 9650            | 1400      |
|                 | LY7         | 3.6L        | 15.8      | 4.2     | 9650            | 1400      |
|                 | LS4         | 5.3L        | 9.1/10.6  | 2.4/2.8 | 9846/10342      | 1400/1500 |

## SCHEMATIC AND ROUTING DIAGRAMS

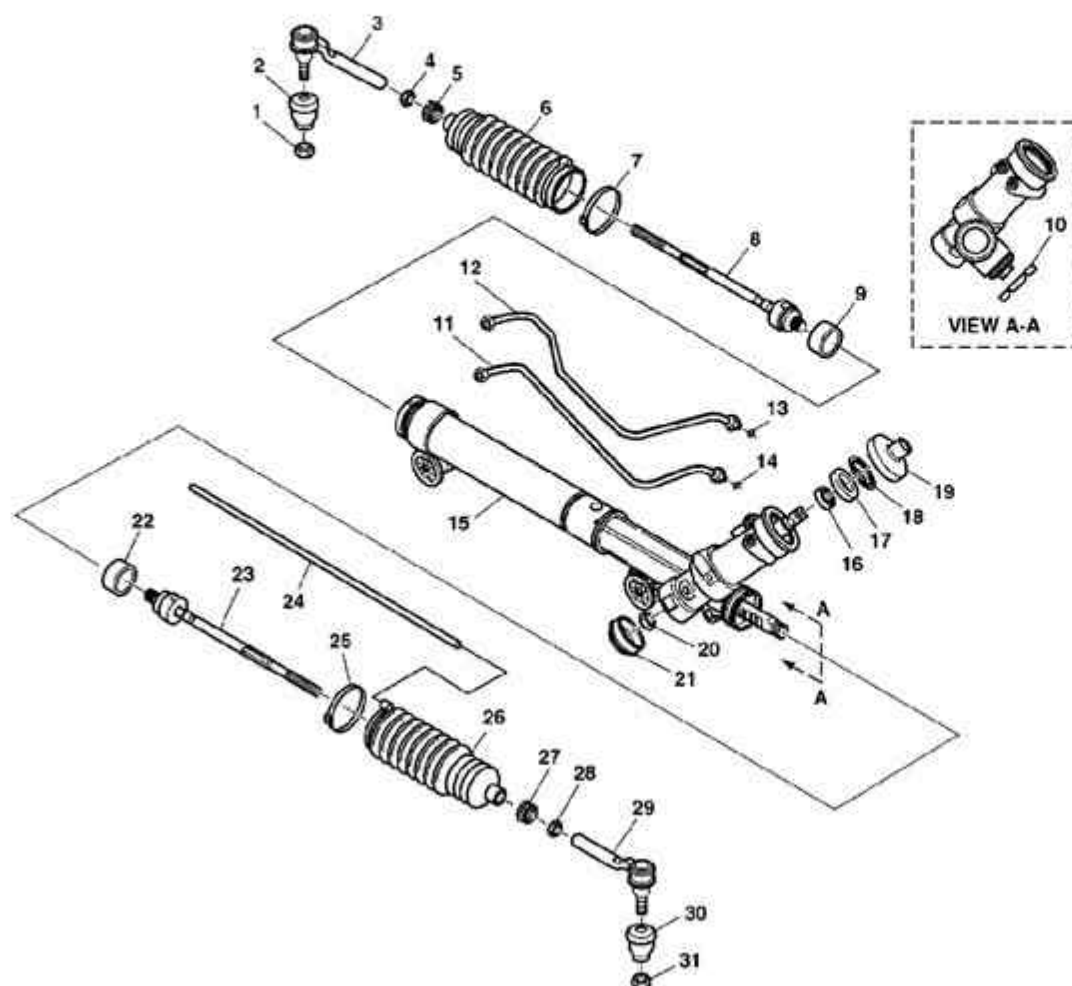
## POWER STEERING SCHEMATICS



**Fig. 1: Power Steering Schematic**  
 Courtesy of GENERAL MOTORS CORP.

## COMPONENT LOCATOR

POWER STEERING GEAR DISASSEMBLED VIEW

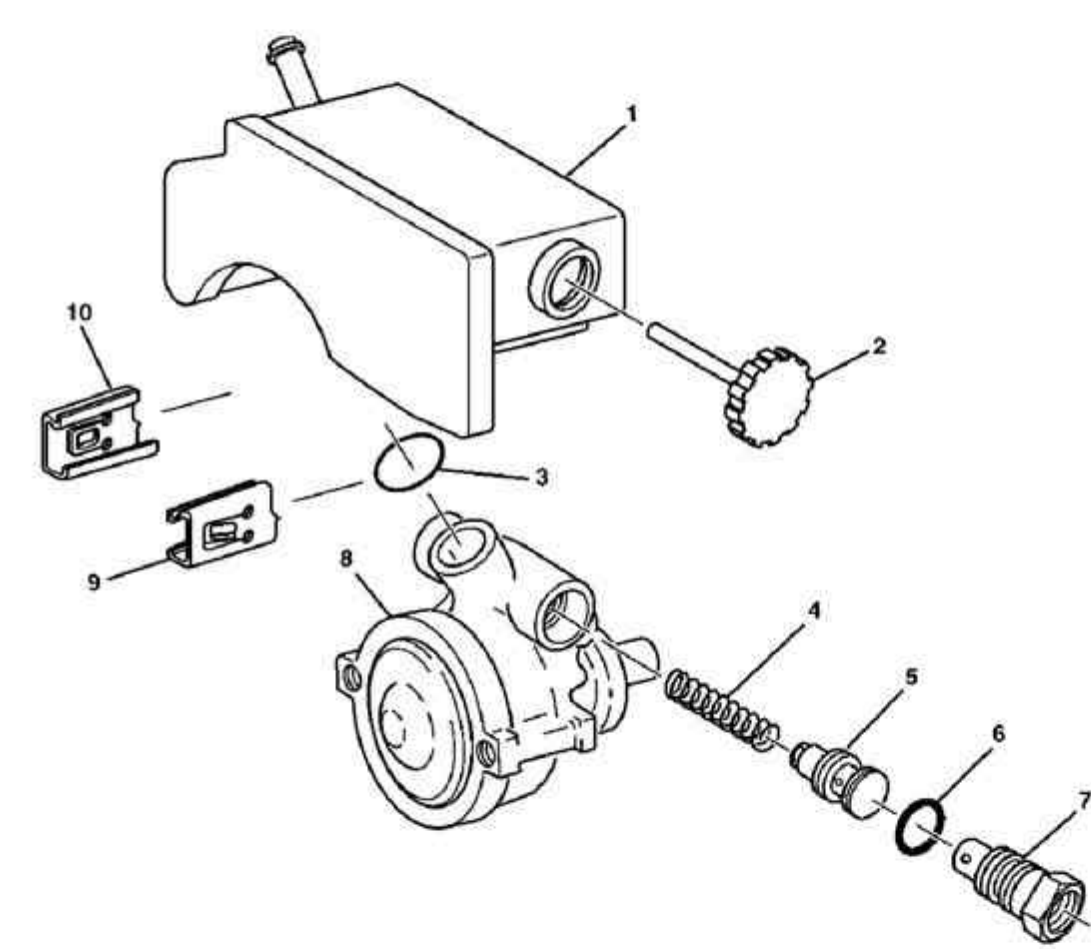


**Fig. 2: View Of Rack & Pinion Power Steering Gear**  
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name                          |
|---------|-----------------------------------------|
| 1       | Hexagon Torque Prevailing Nut           |
| 2       | Tie Rod Seal                            |
| 3       | Outer Tie Road Assembly                 |
| 4       | Hexagon Jam Nut                         |
| 5       | Tie Rod End Clamp                       |
| 6       | Rack and Pinion Boot                    |
| 7       | Boot Clamp                              |
| 8       | Inner Tie Rod Assembly                  |
| 9       | Shock Dampener Ring                     |
| 10      | Adjuster Plug Lock Nut                  |
| 11      | Cylinder Line Assembly (RH)             |
| 12      | Cylinder Line Assembly (LH)             |
| 13      | O-Ring Seal                             |
| 14      | O-Ring Seal                             |
| 15      | Rack and Pinion Gear Assembly (Partial) |
| 16      | Needle Bearing Annulus Assembly         |
| 17      | Seal Adapter                            |
| 18      | Retaining Ring                          |
| 19      | Spool Shaft Seal                        |
| 20      | Hexagon Lock Nut                        |

|      |                                           |  |
|------|-------------------------------------------|--|
| 621  | Rack and Pinion Boot                      |  |
| 722  | Shock Absorber Ring                       |  |
| 823  | Inner Tie Rod Assembly                    |  |
| 924  | Shock Absorber Ring                       |  |
| 1025 | Adjuster Clamp Lock Nut                   |  |
| 1126 | Cylinder and Piston Assembly (RH)         |  |
| 1127 | Cylinder and Piston Assembly (LH)         |  |
| 1128 | O-Ring Seal Jam Nut                       |  |
| 1129 | O-Ring Seal Rod Assembly                  |  |
| 1130 | Rack and Pinion Gear Assembly (Partial)   |  |
| 1161 | Needle Bearing and Thrust Washer Assembly |  |

POWER STEERING PUMP DISASSEMBLED VIEW



**Fig. 3: Exploded View Of Power Steering Pump Components (CB Series)**  
 Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name                              |
|---------|---------------------------------------------|
| 1       | Hydraulic Pump Reservoir Assembly (Typical) |
| 2       | Reservoir Capstick Assembly                 |
| 3       | O-Ring Seal                                 |
| 4       | Flow Control Spring                         |
| 5       | Control Valve Assembly                      |
| 6       | O-Ring Seal                                 |
| 7       | O-Ring Union Fitting                        |

| Callout | Component Name                            |  |
|---------|-------------------------------------------|--|
| 1 9     | Hydraulic Pump Housing Assembly (Typical) |  |
| 210     | Reservoir Clamping Assembly (LH)          |  |

## DIAGNOSTIC INFORMATION AND PROCEDURES

### DIAGNOSTIC CODE INDEX

#### DIAGNOSTIC CODE INDEX

| DTC              | Description                                                 |
|------------------|-------------------------------------------------------------|
| <b>DTC C0450</b> | C0450 00: Steering Assist Control Solenoid Actuator Circuit |

#### DIAGNOSTIC STARTING POINT - POWER STEERING SYSTEM (W/O ELECTRO-HYDRAULIC STEERING)

Begin the system diagnosis by reviewing the system Description and Operation. Refer to **Power Steering System Description and Operation (w/o Electro-Hydraulic Steering)**. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Power Steering System** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

#### DIAGNOSTIC STARTING POINT - VARIABLE EFFORT STEERING

Begin the system diagnosis with the **Diagnostic System Check - Vehicle** . The Diagnostic System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored DTCs and their status

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

#### DTC C0450

##### Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

##### DTC Descriptors

#### DTC C0450 00

Steering Assist Control Solenoid Actuator Circuit

##### Circuit/System Description

The electronic brake control module (EBCM) commands current from negative 2-amps positive 3-amps to the variable effort steering (VES) actuator, depending on vehicle speed. At low speeds, 0-amps of current is commanded to the actuator and the steering gear receives full flow of power steering fluid causing less effort to steer vehicle. As vehicle speed increases, the amount of amps increases to the actuator causing fluid to bypass steering gear. This limits hydraulic assist to steering gear causing firm steering. The EBCM monitors and compares

the VES Commanded Current and VES Feedback Current parameters to detect malfunctions in the VES System.

**Conditions for Running the DTC**

- The ignition is ON and engine ON.
- Ignition voltage is between 10.5-17 volts.

**Conditions for Setting the DTC**

An open, short to ground, or short to voltage in the VES actuator or the circuits to the actuator.

**Action Taken When the DTC Sets**

- DTC C0450 is stored in memory.
- VES output is disabled for the remainder of the ignition cycle.

**Conditions for Clearing the DTC**

- The condition for setting the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

**Reference Information****Schematic Reference****Power Steering Schematics****Connector End View Reference****Component Connector End Views****Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

**Scan Tool Reference****Control Module References** for scan tool information**Circuit/System Testing**

1. Ignition OFF, disconnect the harness connector at the VES actuator.
2. Measure for 0 volts between the actuator control circuit terminal B and ground.
  - If over the specified range, test the actuator control circuit terminal B for short to voltage. If the circuit tests normal, replace the EBCM.
3. Ignition ON, measure for 12 volts between the actuator control circuit and ground.
  - If under the specified range, test the actuator control circuit for short to ground or open/high resistance. If the circuit tests normal, replace the VES actuator.

**Component Testing**

1. Ignition OFF, disconnect the VES actuator harness connector.
2. Measure for 1.6-3.1 ohms between the VES actuator terminals A and B.
  - If not within the specified range, replace the VES actuator.
3. Measure for infinite ohms of resistance between each VES actuator terminal and the VES actuator housing.
  - If less than the specified range, replace the VES actuator.

#### Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Gear Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

#### SYMPTOMS - POWER STEERING SYSTEM

Begin the system diagnosis by reviewing the system Description and Operation. Refer to **Power Steering System Description and Operation (w/o Electro-Hydraulic Steering)**. Reviewing the Description and Operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the Description and Operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Power Steering System** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

**IMPORTANT: Review the system description and operation in order to familiarize yourself with the system functions. Refer to Power Steering System Description and Operation (w/o Electro-Hydraulic Steering).**

#### Visual/Physical Inspection

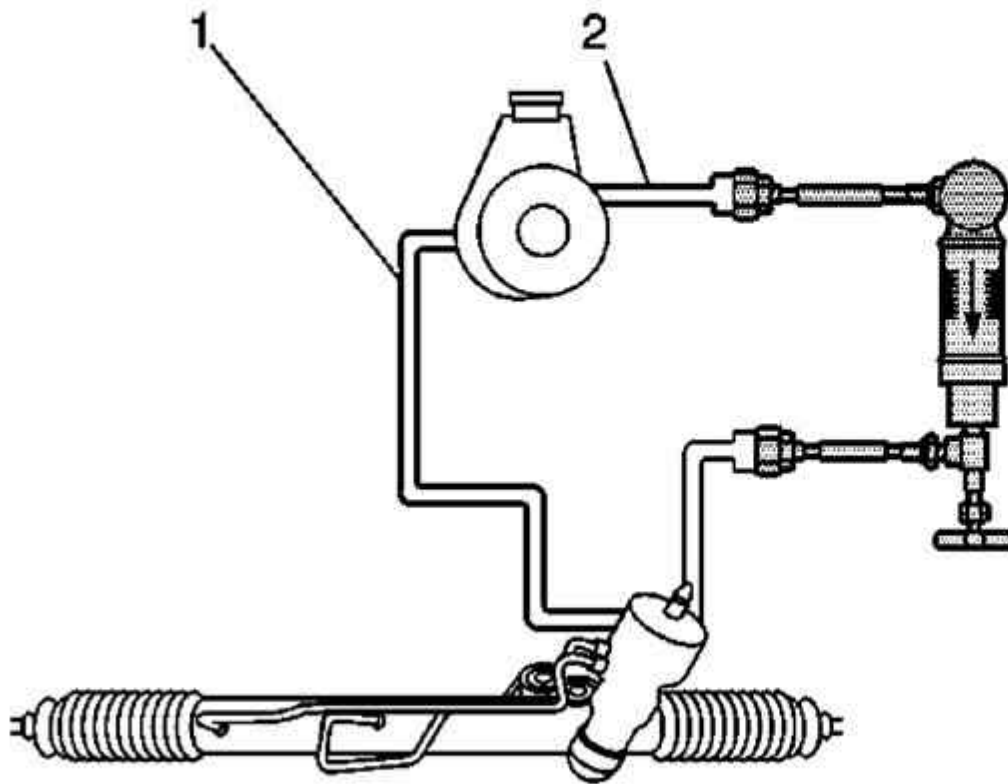
- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for leaking power steering components. If necessary, refer to **Power Steering Fluid Leaks**.
- Verify the power steering fluid level per operating specification. Refer to **Checking and Adding Power Steering Fluid**.
- Inspect the power steering fluid for the following indications of contamination:
  - Milky fluid - water
  - Brown fluid - burnt
  - Debris in fluid - plastic or dirt
- If necessary, flush the power steering system. Refer to **Power Steering System Flushing**.

#### Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Steering Fluid Leaks**
- **Rattle, Clunk, or Shudder Noise from the Power Steering System**
- **Whine or Growl Noise from the Power Steering System**
- **Steering Effort Hard in One or Both Directions**
- **Steering Effort Too Easy in One or Both Directions**

#### POWER STEERING SYSTEM TEST



**Fig. 4: Testing Rack and Pinion System Pressures**  
 Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name               |
|---------|------------------------------|
| 1       | Power Steering Return Hose   |
| 2       | Power Steering Pressure Hose |

#### Test Description

The numbers below refer to the step numbers on the diagnostic table.

- 5: This step tests the system for restrictions.
- 7: This step tests the following components for the following conditions:
  - The pump for internal leaks
  - The power steering pipes for kinks
- 8: This step tests the ability of the pump to regulate flow at maximum pressure.
- 10: This step tests the ability of the pump to regulate flow under normal operating conditions.
- 12: This step tests the internal components of the pump and the gear.

| Step                                                                                                                                                                                                                                             | Action                                                                           | Value(s) | Yes | No |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|----------|-----|----|
| DEFINITION: The Power Steering System Test Procedure will perform the following functions:                                                                                                                                                       |                                                                                  |          |     |    |
| <ul style="list-style-type: none"> <li>• Test the operation of the hydraulic power steering system.</li> <li>• Test the operation of the power steering pump and power steering gear.</li> <li>• Identify restrictions in the system.</li> </ul> |                                                                                  |          |     |    |
|                                                                                                                                                                                                                                                  | Inspect the power steering fluid for the following indications of contamination: |          |     |    |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                     |                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------|---------------------|
| 1 | <ul style="list-style-type: none"> <li>• Milky fluid - water</li> <li>• Brown fluid - burnt</li> <li>• Debris in fluid - plastic or dirt</li> </ul> <p>Is the fluid free of contamination?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                     | Go to <b>Step 3</b> | Go to <b>Step 2</b> |
| 2 | <p>Flush the power steering system. Refer to <b>Power Steering System Flushing</b>.</p> <p>Did you complete the procedure?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -                     | Go to <b>Step 3</b> | -                   |
| 3 | <p><b>IMPORTANT:</b><br/>In order to accurately diagnose the system, the malfunction must be present during the test procedure.</p> <p>Attempt to duplicate the condition. Is the condition present?</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -                     | Go to <b>Step 4</b> | System OK           |
| 4 | <ol style="list-style-type: none"> <li>1. Turn the ignition switch to the OFF position.</li> <li>2. Place a drain pan under the vehicle in order to catch any power steering fluid.</li> <li>3. Disconnect the power steering pressure pipe/hose from the power steering pump or the power steering gear as necessary.</li> <li>4. Install the <b>J 44721</b> Power Steering System Analyzer. See <b>Special Tools</b>.</li> <li>5. Fill the power steering system. Refer to <b>Checking and Adding Power Steering Fluid</b>.</li> </ol> <p>Did you complete the installation?</p>                                                                                                                                  | -                     | Go to <b>Step 5</b> | -                   |
| 5 | <ol style="list-style-type: none"> <li>1. Fully open the <b>J 44721</b> valve. See <b>Special Tools</b>.</li> <li>2. Start the engine.</li> </ol> <p><b>NOTE:</b><br/>Refer to <b>STEERING WHEEL IN THE FULL TURN POSITION NOTICE</b>.</p> <ol style="list-style-type: none"> <li>3. Turn the steering wheel and BRIEFLY hold the steering wheel against the steering stop in order to release any trapped air from the system.</li> <li>4. Inspect and ensure that all of the power steering pipe/hose connections are not leaking.</li> <li>5. Making sure the steering wheel is OFF the steering stop, observe the pressure reading.</li> </ol> <p>Is the pressure reading greater than the specified value?</p> | 1379 kPa<br>(200 psi) | Go to <b>Step 6</b> | Go to <b>Step 7</b> |
|   | <p><b>IMPORTANT:</b><br/>A restriction may be present in the power steering</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |                     |                     |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |                      |                      |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------|----------------------|
| 6  | <p>system. Turn off the engine <b>IMMEDIATELY</b>.</p> <p>Locate and repair the restriction. Did you complete the repair?</p>                                                                                                                                                                                                                                                                                                                                                                                   | -                     | Go to <b>Step 18</b> | -                    |
| 7  | <ol style="list-style-type: none"> <li>1. Allow the engine to run until the engine reaches full operating temperature.</li> <li>2. Record the pressure reading and flow reading.</li> <li>3. Partially close the <b>J 44721</b> valve until the system pressure reaches the specified value, then record the FLOW reading. See <b>Special Tools</b>.</li> <li>4. Subtract second flow reading from the first flow reading.</li> </ol> <p>Is the flow <b>DECREASE</b> greater than 3.8 L (1 gal) per minute?</p> | 4827 kPa<br>(700 psi) | Go to <b>Step 13</b> | Go to <b>Step 8</b>  |
| 8  | <p><b>NOTE:</b><br/>Do not leave the valve fully closed for more than 5 seconds, or the pump could be damaged internally.</p> <p>Fully close then open the <b>J 44721</b> valve 3 times. See <b>Special Tools</b>. Record all of the high pressure readings. Refer to <b>Power Steering Pump Specifications</b> for power steering system pressure relief specifications. Are the three high pressure readings within specifications?</p>                                                                       | -                     | Go to <b>Step 9</b>  | Go to <b>Step 15</b> |
| 9  | Are the three high pressure readings within 245 kPa (50 psi) of each other?                                                                                                                                                                                                                                                                                                                                                                                                                                     | -                     | Go to <b>Step 10</b> | Go to <b>Step 14</b> |
| 10 | <ol style="list-style-type: none"> <li>1. Increase the engine speed to approximately 1500 RPM.</li> <li>2. Record the flow reading. Refer to <b>Power Steering Pump Specifications</b> for power steering system pressure specifications.</li> </ol> <p>Is the actual flow reading within specifications?</p>                                                                                                                                                                                                   | -                     | Go to <b>Step 11</b> | Go to <b>Step 13</b> |
| 11 | Is the difference between the actual flow reading and the maximum flow specification more than 3.8 L (1 gal) per minute?                                                                                                                                                                                                                                                                                                                                                                                        | -                     | Go to <b>Step 16</b> | Go to <b>Step 12</b> |
| 12 | <p><b>NOTE:</b><br/>Refer to <b>STEERING WHEEL IN THE FULL TURN POSITION NOTICE</b> Steering Wheel in the Full Turn Position Notice.</p> <p>Turn the steering wheel from steering stop to steering stop and record the FLOW readings at each stop. Is the flow <b>LOWER</b> than 3.8 L (1 gal) per minute?</p>                                                                                                                                                                                                  | -                     | Go to <b>Step 18</b> | Go to <b>Step 17</b> |
| 13 | Replace the power steering pump. Refer to <b>Power Steering Pump Replacement (L26)</b> or <b>Power Steering Pump Replacement (LY7)</b> or <b>Power Steering Pump Replacement (LS4)</b> .                                                                                                                                                                                                                                                                                                                        | -                     |                      | -                    |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

| Step                                                                                              | Did you complete the action?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Value(s) | Yes          | Go to Step    |
|---------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|---------------|
| <b>DEFINITION:</b> The Power Steering System Test Procedure will perform the following functions: |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |              |               |
| 1                                                                                                 | Remove the power steering pump flow control valve. Refer to <b>Power Steering Pump Flow Control Valve Replacement - Off Vehicle</b> . <ul style="list-style-type: none"> <li>• Test the operation of the hydraulic power steering system.</li> <li>• Test the operation of the power steering pump and power steering gear.</li> </ul>                                                                                                                                                                                                                                                            |          |              | Go to Step 18 |
| 14                                                                                                | Inspect the power steering fluid for the following conditions: <ul style="list-style-type: none"> <li>• Milky fluid - Refer to <b>Power Steering Pump Flow Control Valve Replacement - Off Vehicle</b>.</li> <li>• Debris in fluid - plastic or dirt</li> </ul> 3. Inspect the flow control valve bore. <p>Is the fluid free of contamination?<br/>If any burrs or scratches are present in the control valve bore, replace the power steering pump. Refer to <b>Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4)</b>.</p> |          | -            | Go to Step 3  |
| 2                                                                                                 | Flush the power steering system. Refer to <b>Power Steering System Flushing</b> .<br>Did you complete the procedure?                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          | Go to Step 3 | -             |
| 3                                                                                                 | Did you complete the repair?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | -        |              | Go to Step 18 |
| 15                                                                                                | Replace the power steering pump flow control valve. Refer to <b>Power Steering Pump Flow Control Valve Replacement - Off Vehicle</b> .<br>Did you complete the replacement?                                                                                                                                                                                                                                                                                                                                                                                                                       |          | Go to Step 4 | System OK     |
| 16                                                                                                | 1. Remove the power steering pump flow control valve and inspect for any wear or damage. Do NOT disassemble the flow control valve.<br>2. If the flow control valve is worn/damaged, replace the flow control valve. Refer to <b>Power Steering Pump Flow Control Valve Replacement - Off Vehicle</b> .<br>Did you complete the repair?                                                                                                                                                                                                                                                           |          | -            | Go to Step 18 |
| 17                                                                                                | The power steering gear is leaking across the piston or bypassing the valve circuit. Replace the power steering gear. Refer to <b>Steering Gear Replacement</b> .<br>Did you complete the replacement?                                                                                                                                                                                                                                                                                                                                                                                            | -        |              | Go to Step 18 |
| 18                                                                                                | Test the power steering system for the original condition.<br>Does the original condition still exist?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | -        |              | Go to Step 5  |
| 19                                                                                                | 1. Disconnect and remove the <b>J 44721</b> from the vehicle. See <b>Special Tools</b> .<br>2. Connect the vehicle power steering pipes/hoses.<br>3. Bleed the power steering system and add fluid                                                                                                                                                                                                                                                                                                                                                                                                | -        |              | Go to Step 19 |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|                              |                                                                                                                |  |  |  |           |  |
|------------------------------|----------------------------------------------------------------------------------------------------------------|--|--|--|-----------|--|
| 1.                           | as necessary, Refer to <b>Power Steering System Bleeding</b> .<br>Turn the ignition switch to the ON position. |  |  |  |           |  |
| 2.                           | Place a drain pan under the vehicle in order to catch any power steering fluid.                                |  |  |  |           |  |
| Did you complete the repair? |                                                                                                                |  |  |  | System OK |  |

## POWER STEERING FLUID LEAKS

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Yes                  | No                                            |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-----------------------------------------------|
| 1    | Did you review the Power Steering System General Description and perform the necessary inspections?                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 2</b>  | Go to <b>Symptoms - Power Steering System</b> |
| 2    | Verify that power steering fluid leaks are present.<br>Is the power steering system leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Go to <b>Step 3</b>  | System OK                                     |
| 3    | Inspect the power steering system fittings.<br>Are the fittings leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Go to <b>Step 8</b>  | Go to <b>Step 4</b>                           |
| 4    | Inspect the power steering hoses.<br>Are the hoses leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Go to <b>Step 9</b>  | Go to <b>Step 5</b>                           |
| 5    | Inspect the power steering sensors.<br>Are the sensors leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Go to <b>Step 10</b> | Go to <b>Step 6</b>                           |
| 6    | Inspect the power steering pump and the reservoir for leaks.<br>Is the power steering pump or reservoir leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                       | Go to <b>Step 11</b> | Go to <b>Step 7</b>                           |
| 7    | Inspect the power steering gear for leaks.<br>Is the power steering gear leaking?                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Go to <b>Step 12</b> | Go to <b>Step 8</b>                           |
| 8    | <b>NOTE:</b><br>Refer to <b>FASTENER NOTICE</b> .<br><br>Tighten the fittings. Refer to <b>Fastener Tightening Specifications</b> . Did you complete the repair?                                                                                                                                                                                                                                                                                                                                                                                       | Go to <b>Step 13</b> | -                                             |
| 9    | Replace the power steering hoses. Refer to the appropriate procedure(s):<br><br><ul style="list-style-type: none"> <li>• <b>Power Steering Pressure Pipe/Hose Replacement (L26)</b> or <b>Power Steering Pressure Pipe/Hose Replacement (LY7)</b> or <b>Power Steering Pressure Pipe/Hose Replacement (LS4)</b></li> <li>• <b>Power Steering Cooler Pipe/Hose Replacement (LY7)</b> or <b>Power Steering Cooler Pipe/Hose Replacement (LS4)</b> or <b>Power Steering Cooler Pipe/Hose Replacement (L26)</b></li> </ul><br>Did you complete the repair? | Go to <b>Step 13</b> | -                                             |
| 10   | Replace the power steering sensors.<br>Did you complete the repair?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Go to <b>Step 13</b> | -                                             |
| 11   | Replace the power steering pump or reservoir. Refer to <b>Power Steering Pump Replacement (L26)</b> or <b>Power Steering Pump Replacement (LY7)</b> or <b>Power Steering Pump Replacement (LS4)</b> or <b>Power Steering Fluid Reservoir Replacement - Off Vehicle</b> .<br>Did you complete the repair?                                                                                                                                                                                                                                               | Go to <b>Step 13</b> | -                                             |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|    |                                                                                                                     |                      |                     |
|----|---------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|
| 12 | Replace the power steering gear. Refer to <b><u>Steering Gear Replacement</u></b> .<br>Did you complete the repair? | Go to <b>Step 13</b> | -                   |
| 13 | Operate the system in order to verify the repair.<br>Did you correct the condition?                                 | System OK            | Go to <b>Step 3</b> |

## RATTLE, CLUNK, OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                          | Yes                  | No                                                   |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|------------------------------------------------------|
| 1    | Did you review the Power Steering System General Description and perform the necessary inspections?                                                                                                                                                                                                                                                                                             | Go to <b>Step 2</b>  | Go to <b><u>Symptoms - Power Steering System</u></b> |
| 2    | Verify that a rattle, clunk or shudder noise is present.<br>Is a rattle, clunk or shudder noise present?                                                                                                                                                                                                                                                                                        | Go to <b>Step 3</b>  | System OK                                            |
| 3    | Inspect the power steering hoses for proper routing and clearance.<br>Is the routing or clearance of the power steering hoses incorrect?                                                                                                                                                                                                                                                        | Go to <b>Step 12</b> | Go to <b>Step 4</b>                                  |
| 4    | Inspect the engine drive belt for cracking or excessive wear. Refer to <b><u>Drive Belt Falls Off and Excessive Wear Diagnosis</u></b> .<br>Is the drive belt cracked or excessively worn?                                                                                                                                                                                                      | Go to <b>Step 13</b> | Go to <b>Step 5</b>                                  |
| 5    | Inspect the power steering pump pulley for damage.<br>Is the power steering pump pulley damaged?                                                                                                                                                                                                                                                                                                | Go to <b>Step 14</b> | Go to <b>Step 6</b>                                  |
| 6    | Inspect the power steering pump and the power steering mounting bracket/brace for the proper installation. Refer to <b><u>Power Steering Pump Replacement (L26)</u></b> or <b><u>Power Steering Pump Replacement (LY7)</u></b> or <b><u>Power Steering Pump Replacement (LS4)</u></b> .<br>Is the power steering pump installation incorrect?                                                   | Go to <b>Step 15</b> | Go to <b>Step 7</b>                                  |
| 7    | Inspect the power steering gear for the proper installation. Refer to <b><u>Steering Gear Replacement</u></b> .<br>Is the power steering gear installation incorrect?                                                                                                                                                                                                                           | Go to <b>Step 16</b> | Go to <b>Step 8</b>                                  |
| 8    | Inspect the steering gear bearing preload for the proper adjustment. Refer to <b><u>Steering Gear Rack Bearing Preload Adjustment - Off Vehicle (Magnasteer)</u></b> .<br>Did you find and correct the condition?                                                                                                                                                                               | Go to <b>Step 20</b> | Go to <b>Step 9</b>                                  |
| 9    | Inspect for looseness in the inner and outer tie rod ends.<br>Did you find looseness in the tie rod ends?                                                                                                                                                                                                                                                                                       | Go to <b>Step 17</b> | Go to <b>Step 10</b>                                 |
| 10   | Inspect the suspension.<br>Is the suspension worn?                                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 18</b> | Go to <b>Step 11</b>                                 |
| 11   | Inspect the intermediate shaft.<br>Is the intermediate shaft worn?                                                                                                                                                                                                                                                                                                                              | Go to <b>Step 19</b> | Go to <b>Step 3</b>                                  |
| 12   | Adjust or replace the hoses. Refer to the appropriate procedure(s):<br><br><ul style="list-style-type: none"> <li>• <b><u>Power Steering Cooler Pipe/Hose Replacement (LY7)</u></b> or <b><u>Power Steering Cooler Pipe/Hose Replacement (LS4)</u></b> or <b><u>Power Steering Cooler Pipe/Hose Replacement (L26)</u></b></li> <li>• <b><u>Power Steering Pressure Pipe/Hose</u></b></li> </ul> |                      |                                                      |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|    |                                                                                                                                                                                                                                               |                      |                     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|
|    | <b><u>Replacement (L26) or Power Steering Pressure Pipe/Hose Replacement (LY7) or Power Steering Pressure Pipe/Hose Replacement (LS4)</u></b>                                                                                                 |                      |                     |
|    | Did you complete the repair?                                                                                                                                                                                                                  | Go to <b>Step 20</b> | -                   |
| 13 | Replace the engine drive belt. Refer to <b><u>Drive Belt Replacement (L26)</u></b> .<br>Did you complete the repair?                                                                                                                          | Go to <b>Step 20</b> | -                   |
| 14 | Replace the power steering pump pulley. Refer to <b><u>Power Steering Pump Pulley Replacement (L26) or Power Steering Pump Pulley Replacement (LS4) or Power Steering Pump Pulley Replacement (LY7)</u></b> .<br>Did you complete the repair? | Go to <b>Step 20</b> | -                   |
| 15 | Install the power steering pump correctly. Refer to <b><u>Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4)</u></b> .<br>Did you complete the repair?                   | Go to <b>Step 20</b> | -                   |
| 16 | Install the power steering gear correctly. Refer to <b><u>Steering Gear Replacement</u></b> .<br>Did you complete the repair?                                                                                                                 | Go to <b>Step 20</b> | -                   |
| 17 | Replace the tie rod end.<br>Refer to <b><u>Rack and Pinion Inner Tie Rod Replacement</u></b> .<br>Did you complete the repair?                                                                                                                | Go to <b>Step 20</b> | -                   |
| 18 | Replace the worn suspension components. Refer to <b><u>Diagnostic Starting Point - Suspension General Diagnosis</u></b> .<br>Did you complete the repair?                                                                                     | Go to <b>Step 20</b> | -                   |
| 19 | Replace the intermediate shaft. Refer to <b><u>Intermediate Steering Shaft Replacement</u></b> .<br>Did you complete the repair?                                                                                                              | Go to <b>Step 20</b> | -                   |
| 20 | Operate the system in order to verify the repair.<br>Did you correct the condition?                                                                                                                                                           | System OK            | Go to <b>Step 3</b> |

## WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM

| Step | Action                                                                                                                                                                                                                               | Yes                 | No                                                   |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------------------|
| 1    | Did you review the Power Steering System General Description and perform the necessary inspections?                                                                                                                                  | Go to <b>Step 2</b> | Go to <b><u>Symptoms - Power Steering System</u></b> |
| 2    | Verify that a whine or growl noise is present.<br>Is a whine or growl noise present?                                                                                                                                                 | Go to <b>Step 3</b> | System OK                                            |
| 3    | Inspect the power steering fluid for the following indications of contamination: <ul style="list-style-type: none"> <li>• Milky fluid - water</li> <li>• Brown fluid - burnt</li> <li>• Debris in fluid - plastic or dirt</li> </ul> |                     |                                                      |

## 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|    |                                                                                                                                                                                                                                               |                      |                     |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------|
|    | Is the fluid free of contamination?                                                                                                                                                                                                           | Go to <b>Step 5</b>  | Go to <b>Step 4</b> |
| 4  | Flush the power steering system. Refer to <b><u>Power Steering System Bleeding</u></b> .<br>Did you complete the procedure?                                                                                                                   | Go to <b>Step 11</b> | Go to <b>Step 5</b> |
| 5  | Inspect the power steering gear for a whine or growl noise.<br>Is the noise present at the power steering gear?                                                                                                                               | Go to <b>Step 8</b>  | Go to <b>Step 6</b> |
| 6  | Inspect the power steering pump for a whine or growl noise.<br>Is the noise present at the power steering pump?                                                                                                                               | Go to <b>Step 9</b>  | Go to <b>Step 7</b> |
| 7  | Inspect the power steering hoses for a whine or growl noise.<br>Is the noise present at the power steering hoses?                                                                                                                             | Go to <b>Step 10</b> | Go to <b>Step 2</b> |
| 8  | Replace the power steering gear. Refer to <b><u>Steering Gear Replacement</u></b> .<br>Did you complete the repair?                                                                                                                           | Go to <b>Step 11</b> | -                   |
| 9  | Replace the power steering pump. Refer to <b><u>Power Steering Pump Replacement (L26)</u></b> or <b><u>Power Steering Pump Replacement (LY7)</u></b> or <b><u>Power Steering Pump Replacement (LS4)</u></b> .<br>Did you complete the repair? | Go to <b>Step 11</b> | -                   |
| 10 | Adjust the routing of the power steering hoses.<br>Did you complete the repair?                                                                                                                                                               | Go to <b>Step 11</b> | -                   |
| 11 | Operate the system in order to verify the repair.<br>Did you correct the condition?                                                                                                                                                           | System OK            | Go to <b>Step 3</b> |

### POOR RETURN OF STEERING WHEEL

#### Poor Return of Steering Wheel

| Step                                                                                                              | Action                                                                                                                                                                                                                                                                                                                        | Yes                 | No                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------------------------------------------------------------------|
| DEFINITION: After completing a turn, extra steering input is required for the steering wheel to return to center. |                                                                                                                                                                                                                                                                                                                               |                     |                                                                                                      |
| 1                                                                                                                 | Did you review the General Description and perform the necessary inspections?                                                                                                                                                                                                                                                 | Go to <b>Step 2</b> | Go to <b><u>Power Steering System Description and Operation (w/o Electro-Hydraulic Steering)</u></b> |
| 2                                                                                                                 | Verify that poor return of the steering wheel is present.<br>Does the system operate normally?                                                                                                                                                                                                                                | System OK           | Go to <b>Step 3</b>                                                                                  |
| 3                                                                                                                 | <ol style="list-style-type: none"> <li>1. Raise and support the vehicle. Refer to <b><u>Lifting and Jacking the Vehicle</u></b>.</li> <li>2. Lubricate the tie rod ends and ball joints, if applicable.</li> <li>3. Inspect the suspension system for worn or damaged components.</li> <li>4. Repair as necessary.</li> </ol> |                     |                                                                                                      |

# 2008 Buick LaCrosse CXL

2008 STEERING Power Steering - LaCrosse

|   | Did you find and correct the condition?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Go to <b>Step 12</b> | Go to <b>Step 4</b>  |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|----------------------|
| 4 | <ol style="list-style-type: none"> <li>1. Rotate the steering wheel ONE revolution in both directions.</li> <li>2. Rotate the steering wheel back to the original position.</li> </ol> <p>Was the steering wheel abnormally difficult to rotate in either direction?</p>                                                                                                                                                                                                                                                                                        | Go to <b>Step 5</b>  | Go to <b>Step 10</b> |
| 5 | <p><b>IMPORTANT:</b><br/>Position the wheels straight ahead. Do NOT rotate the steering wheel more than one complete revolution from center.</p> <ol style="list-style-type: none"> <li>1. Disconnect the intermediate shaft from the steering column.</li> <li>2. Note the position of the steering wheel and rotate the steering wheel ONE revolution in both directions.</li> <li>3. Rotate the steering wheel back to the original position.</li> </ol> <p>Was the steering wheel abnormally difficult to rotate in either direction?</p>                   | Go to <b>Step 11</b> | Go to <b>Step 6</b>  |
| 6 | <p>Inspect the intermediate shaft for stiff or loose joints. Repair or replace as necessary.</p> <p>Did you find and complete the repair?</p>                                                                                                                                                                                                                                                                                                                                                                                                                   | Go to <b>Step 12</b> | Go to <b>Step 7</b>  |
| 7 | <ol style="list-style-type: none"> <li>1. Remove the front tire and wheel assemblies. Refer to <b><u>Tire and Wheel Removal and Installation</u></b>.</li> <li>2. Disconnect both outer tie rod ends from the steering knuckles.</li> <li>3. Use your hands in order to move the tie rod end studs.</li> <li>4. If abnormally difficult to move, replace the tie rod end. If equipped with recirculating ball steering, ensure that idler and pitman arm joints are not too stiff. Repair as necessary.</li> </ol> <p>Did you find and complete the repair?</p> | Go to <b>Step 12</b> | Go to <b>Step 8</b>  |
| 8 | <ol style="list-style-type: none"> <li>1. Use your hands to rotate the steering knuckle inboard and outboard in order to inspect for a binding strut bearings, ball joints, or axle.</li> <li>2. Repair or replace any abnormally stiff or loose components.</li> </ol> <p>Did you find and complete the repair?</p>                                                                                                                                                                                                                                            | Go to <b>Step 12</b> | Go to <b>Step 9</b>  |
| 9 | <p>Inspect for binding in the steering gear. If a binding is present repair or replace the steering gear.</p> <p>Did you find and complete the repair?</p>                                                                                                                                                                                                                                                                                                                                                                                                      | Go to <b>Step 12</b> | Go to <b>Step 10</b> |

## 2008 Buick LaCrosse CXL

### 2008 STEERING Power Steering - LaCrosse

|    |                                                                                                                                                                  |                      |   |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|---|
| 10 | Inspect the wheel alignment and adjust as necessary. Refer to <b>Wheel Alignment Measurement</b> .<br>Did you find and complete the repair?                      | Go to <b>Step 12</b> | - |
| 11 | Inspect the steering column for a binding. If a binding is present, repair or replace the steering column as necessary.<br>Did you find and complete the repair? | Go to <b>Step 12</b> | - |
| 12 | Operate the system in order to verify the repair.<br>Did you correct the condition?                                                                              | System OK            | - |

#### STEERING EFFORT TOO EASY IN ONE OR BOTH DIRECTIONS

| Step | Action                                                                                                                     | Yes                 | No                                            |
|------|----------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------|
| 1    | Did you review the Power Steering System Description and perform the necessary inspections?                                | Go to <b>Step 2</b> | Go to <b>Symptoms - Power Steering System</b> |
| 2    | Verify that the steering effort is too easy in one or both directions.<br>Does the system operate normally?                | System OK           | Go to <b>Step 3</b>                           |
| 3    | Perform the power steering test procedure. Refer to <b>Power Steering System Test</b> .<br>Did you complete the procedure? | Go to <b>Step 4</b> | -                                             |
| 4    | Operate the system in order to verify the repair.<br>Did you correct the condition?                                        | System OK           | Go to <b>Step 3</b>                           |

#### STEERING EFFORT HARD OR TOO EASY IN ONE OR BOTH DIRECTIONS

| Step | Action                                                                                                                     | Yes                 | No                                            |
|------|----------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------|
| 1    | Did you review the Power Steering System Description and perform the necessary inspections?                                | Go to <b>Step 2</b> | Go to <b>Symptoms - Power Steering System</b> |
| 2    | Verify that the steering effort is hard or too easy in one or both directions.<br>Does the system operate normally?        | System OK           | Go to <b>Step 3</b>                           |
| 3    | Perform the power steering test procedure. Refer to <b>Power Steering System Test</b> .<br>Did you complete the procedure? | Go to <b>Step 4</b> | -                                             |
| 4    | Operate the system in order to verify the repair.<br>Did you correct the condition?                                        | System OK           | Go to <b>Step 3</b>                           |

#### STEERING EFFORT HARD IN ONE OR BOTH DIRECTIONS

| Step | Action                                                                                                  | Yes                 | No                                            |
|------|---------------------------------------------------------------------------------------------------------|---------------------|-----------------------------------------------|
| 1    | Did you review the Power Steering System General Description and perform the necessary inspections?     | Go to <b>Step 2</b> | Go to <b>Symptoms - Power Steering System</b> |
| 2    | Verify that the steering effort is hard in one or both directions.<br>Does the system operate normally? | System OK           | Go to <b>Step 3</b>                           |
|      | Perform the power steering test procedure. Refer to                                                     |                     |                                               |

|   |                                                                                     |                     |                     |
|---|-------------------------------------------------------------------------------------|---------------------|---------------------|
| 3 | <b>Power Steering System Test.</b><br>Did you complete the procedure?               | Go to <b>Step 4</b> | -                   |
| 4 | Operate the system in order to verify the repair.<br>Did you correct the condition? | System OK           | Go to <b>Step 3</b> |

## REPAIR INSTRUCTIONS

### POWER STEERING SYSTEM BLEEDING

#### IMPORTANT:

- Use clean, new power steering fluid type only. See the Maintenance and Lubrication subsection for fluid specifications. Refer to Fluid and Lubricant Recommendations .
- Hoses touching the frame, body or engine may cause system noise. Verify that the hoses do not touch any other part of the vehicle.
- Loose connections may not leak, but could allow air into the steering system. Verify that all hose connections are tight.

**IMPORTANT:** Power steering fluid level must be maintained throughout bleed procedure.

1. Fill pump reservoir with fluid to minimum system level, FULL COLD level, or middle of hash mark on cap stick fluid level indicator.

**IMPORTANT:** With hydro-boost only, the oil level will appear falsely high if the hydro-boost accumulator is not fully charged. Do not apply the brake pedal with the engine OFF. This will discharge the hydro-boost accumulator.

2. If equipped with hydro-boost, fully charge the hydro-boost accumulator using the following procedure:
  1. Start the engine.
  2. Firmly apply the brake pedal 10-15 times.
  3. Turn the engine OFF.
3. Raise the vehicle until the front wheels are off the ground. Refer to Lifting and Jacking the Vehicle .
4. Key on engine OFF, turn the steering wheel from stop to stop 12 times.

Vehicles equipped with hydro-boost systems or longer length power steering hoses may require turns up to 15 to 20 stop to stops.

5. Verify power steering fluid level per operating specification. Refer to Checking and Adding Power Steering Fluid.
6. Start the engine. Rotate steering wheel from left to right. Check for sign of cavitation or fluid aeration (pump noise/whining).
7. Verify the fluid level. Repeat the bleed procedure, if necessary.

### CHECKING AND ADDING POWER STEERING FLUID

**NOTE:** When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

1. Clean the area surrounding the reservoir cap.
2. Remove the reservoir cap.

3. Inspect the power steering pump fluid level at regular intervals. Add fluid when required. Refer to **Fluid and Lubricant Recommendations**.
  - If the fluid level is being checked cold, perform the following steps:
    - Remove the reservoir cap.
    - Inspect the fluid level on the dipstick.
    - The fluid level should be between the bottom of the COLD/FULL mark and the end of the dipstick.
  - If the fluid level is being checked hot, perform the following steps:
    - Run the engine until the fluid reaches about 80°C (170°F).
    - Turn OFF the engine.
    - Remove the reservoir cap.
    - Inspect the fluid level on the dipstick.
    - The fluid level should be between the HOT/FULL and the COLD/FULL marks on the dipstick.
4. If the fluid level is low, add the power steering fluid to the proper level.
5. Install the reservoir cap.
6. When you inspect the fluid level after servicing the steering system, bleed the air from the system. Refer to **Power Steering System Bleeding**.

#### POWER STEERING SYSTEM FLUSHING

**IMPORTANT: Do not reuse any drained power steering fluid regardless of appearance or condition.**

1. Turn OFF the engine.
2. Raise the front end of the vehicle off the ground until the tires and wheels turn freely. Refer to **Lifting and Jacking the Vehicle**.
3. Place a large container under the fluid return hose in order to collect the draining fluid.
4. Remove the fluid return hose at the power steering pump reservoir inlet connection.
5. Plug the reservoir return hose inlet connection on the power steering pump.

**IMPORTANT: This step may require 4 L (4 qt) of power steering fluid until the draining fluid appears clear.**

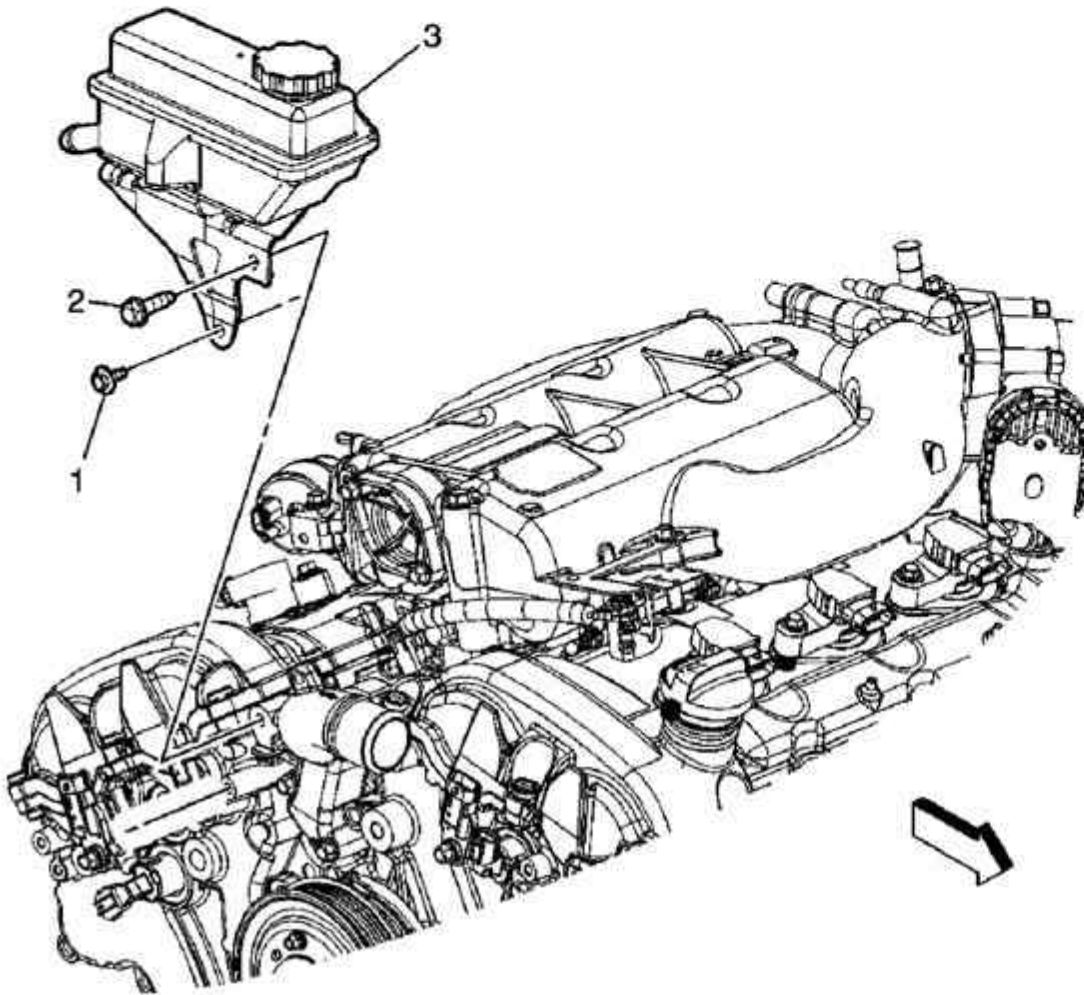
6. With the key on engine off, turn the steering wheel fully to the left and to the right while an assistant maintains the minimum fluid level in the reservoir using new approved power steering fluid. Continue until the fluid from the return hose runs clear.
7. Remove the plug from the pump reservoir inlet connection and install the fluid return hose to the pump reservoir.

**IMPORTANT: Do NOT run the engine without the power steering fluid at a minimum system level.**

8. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Inspect the power steering fluid for the following indications of contamination:
  - Milky fluid - water
  - Brown fluid - burnt
  - Plastic debris or dirt chunks

10. If the fluid is contaminated, repeat steps 2-9.
11. Lower the vehicle and check the Power Steering system for leaks.

#### REMOTE POWER STEERING FLUID RESERVOIR REPLACEMENT (LY7)

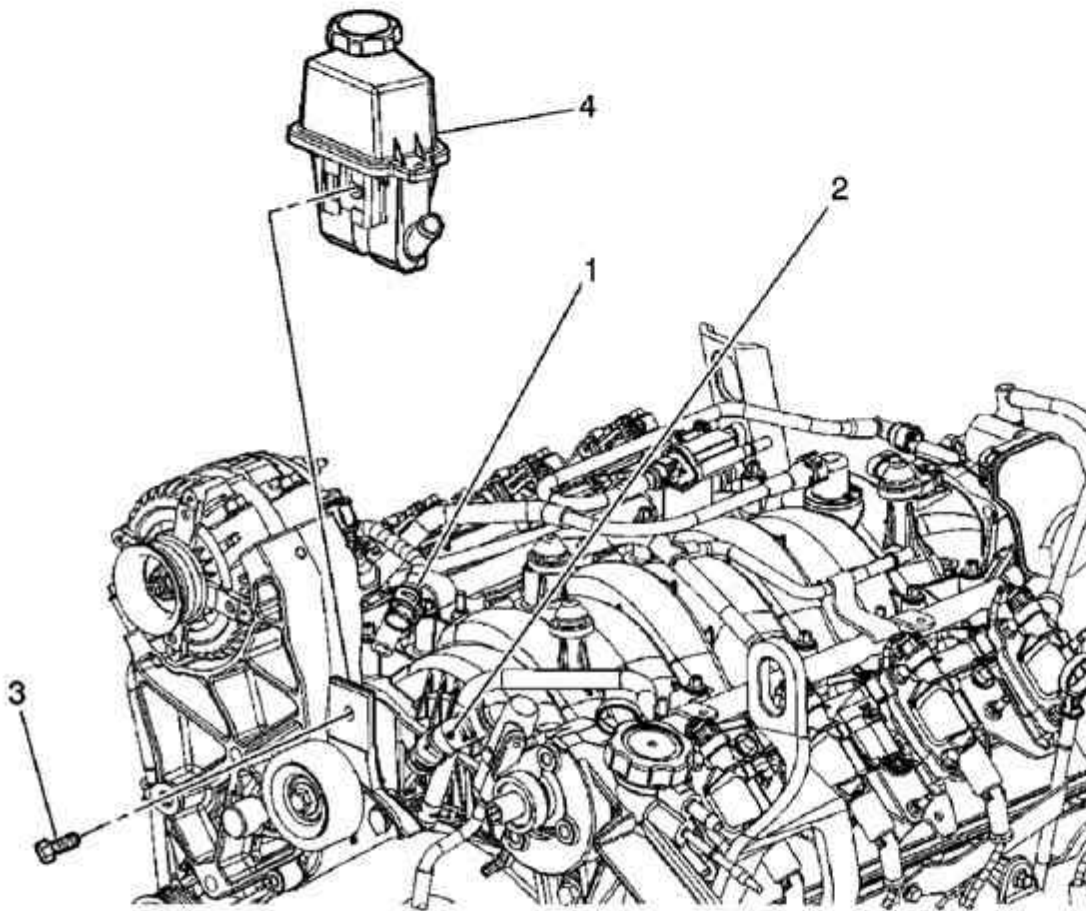


**Fig. 5: View Of Remote Power Steering Fluid Reservoir**  
 Courtesy of GENERAL MOTORS CORP.

| Callout                                                                                                                                   | Component Name                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure:</b><br>Remove the fuel injector sight shield. Refer to <a href="#">Fuel Injector Sight Shield Replacement</a> . |                                                                                                                                                                                                                             |
| 1                                                                                                                                         | Power Steering Pump Bracket Bolt<br><br><b>NOTE:</b><br>Refer to <a href="#">Fastener Notice</a> .<br><br><b>Tighten:</b> 9 N.m (80 lb in)                                                                                  |
| 2                                                                                                                                         | Power Steering Pump Bracket Bolt<br><br><b>Tighten:</b> 25 N.m (18 lb ft)                                                                                                                                                   |
| 3                                                                                                                                         | Remote Power Steering Fluid Reservoir<br><br><b>Procedure</b><br><br>1. Remove as much power steering fluid from the remote power steering fluid reservoir as possible.<br>2. Place drain pans under the vehicle as needed. |

3. Disconnect the power steering reservoir inlet hose and the power steering fluid reservoir outlet hose.
4. Transfer any parts as needed.
5. After repairs, fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.

#### REMOTE POWER STEERING FLUID RESERVOIR REPLACEMENT (LS4)



**Fig. 6: Identifying Remote Power Steering Fluid Reservoir**  
 Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name                                                                                                                                                                                            |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Power Steering Return Hose Clamp<br><b>Tip:</b> Using the appropriate tool, remove the power steering fluid from the reservoir. Also, plug the open end of the hose to limit the amount of fluid leakage. |
| 2       | Power Steering Pump Feed Hose Clamp<br><b>Tip:</b> Plug or cap the hose between the power steering pump and the reservoir so as to limit the amount of fluid loss.                                        |
| 3       | Remote Power Steering Reservoir Bolt<br><b>NOTE:</b><br>Refer to <b><u>Fastener Notice</u></b> .<br><b>Tighten:</b> 18 N.m (13 lb ft)                                                                     |
| 4       | Power Steering Remote Reservoir                                                                                                                                                                           |

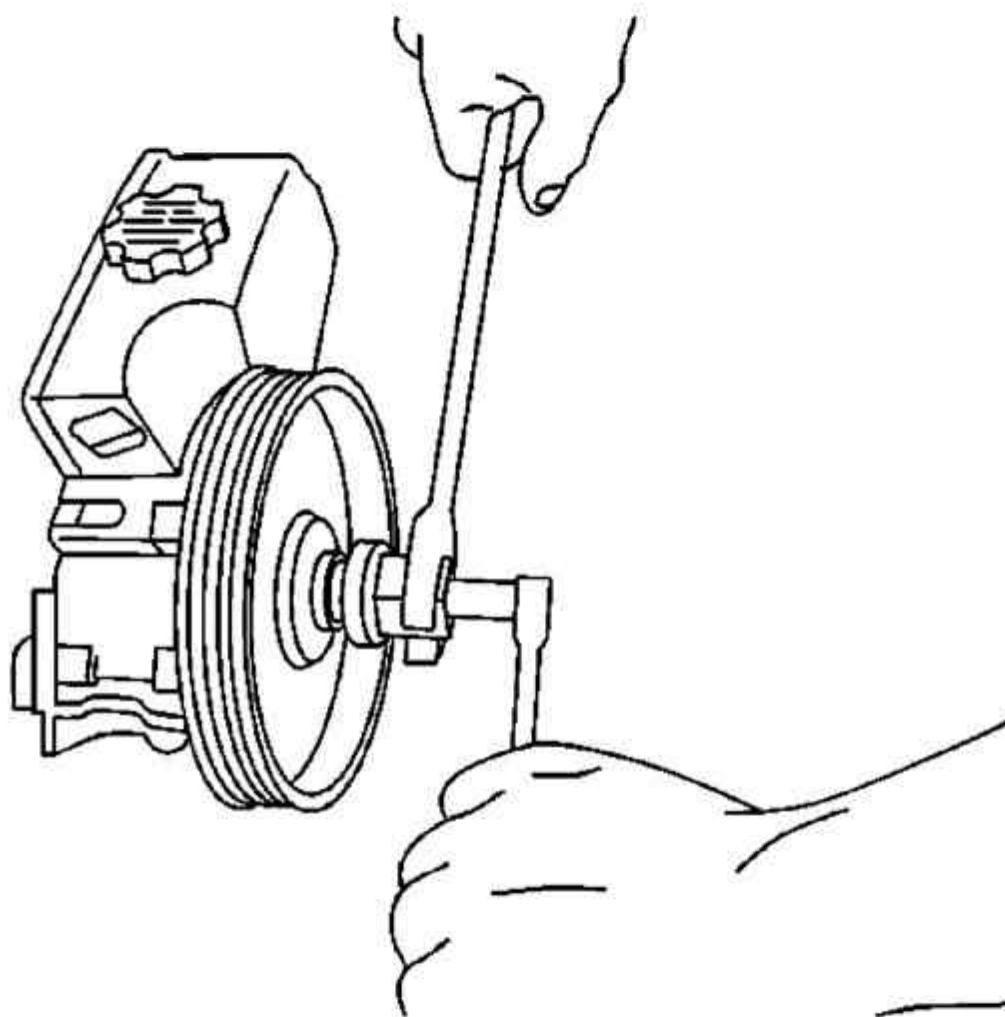
#### POWER STEERING PUMP PULLEY REPLACEMENT (L26)

Tools Required

- J 25033-C Pulley Installer
- J 25034-C Pulley Remover

**Removal Procedure**

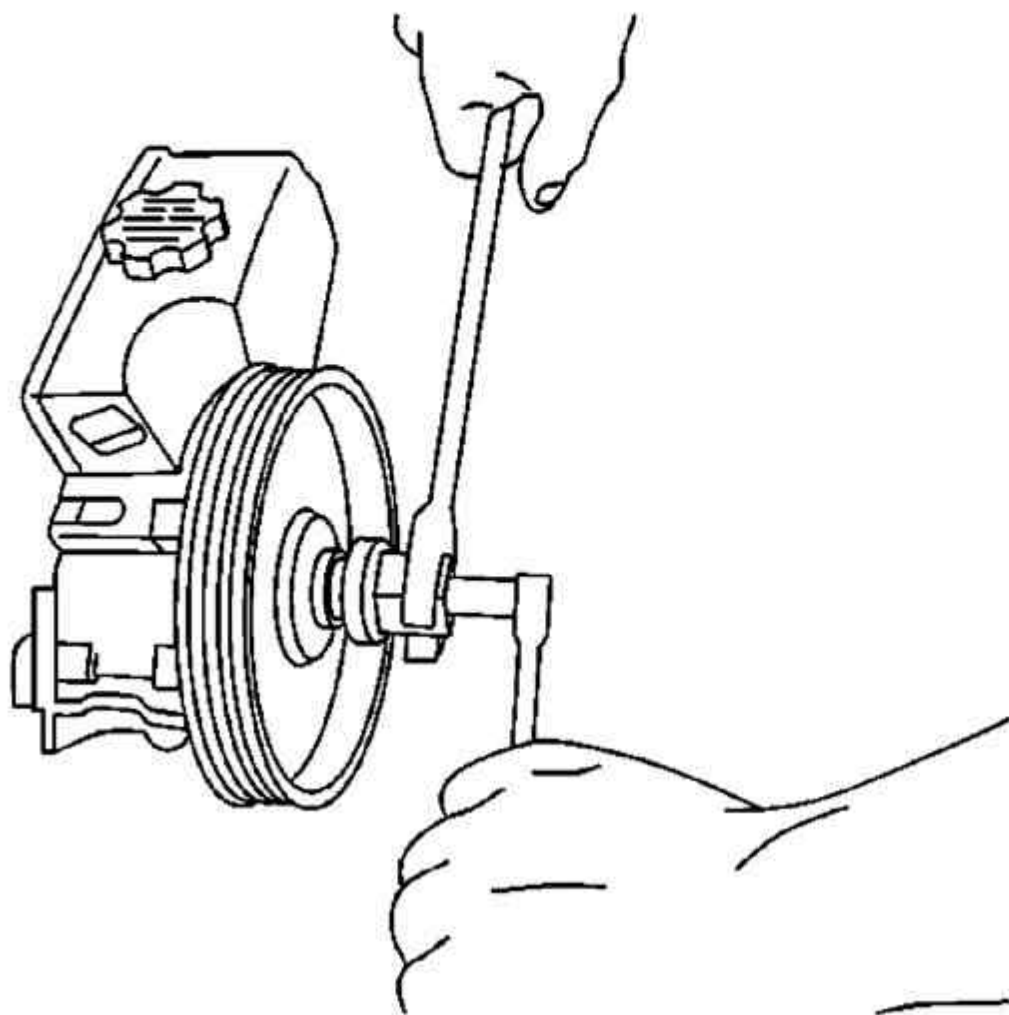
1. Remove the power steering pump from the engine for clearance. Refer to **Power Steering Pump Replacement (L26)** or **Power Steering Pump Replacement (LY7)** or **Power Steering Pump Replacement (LS4)**.



**Fig. 7: Identifying Power Steering Pump Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

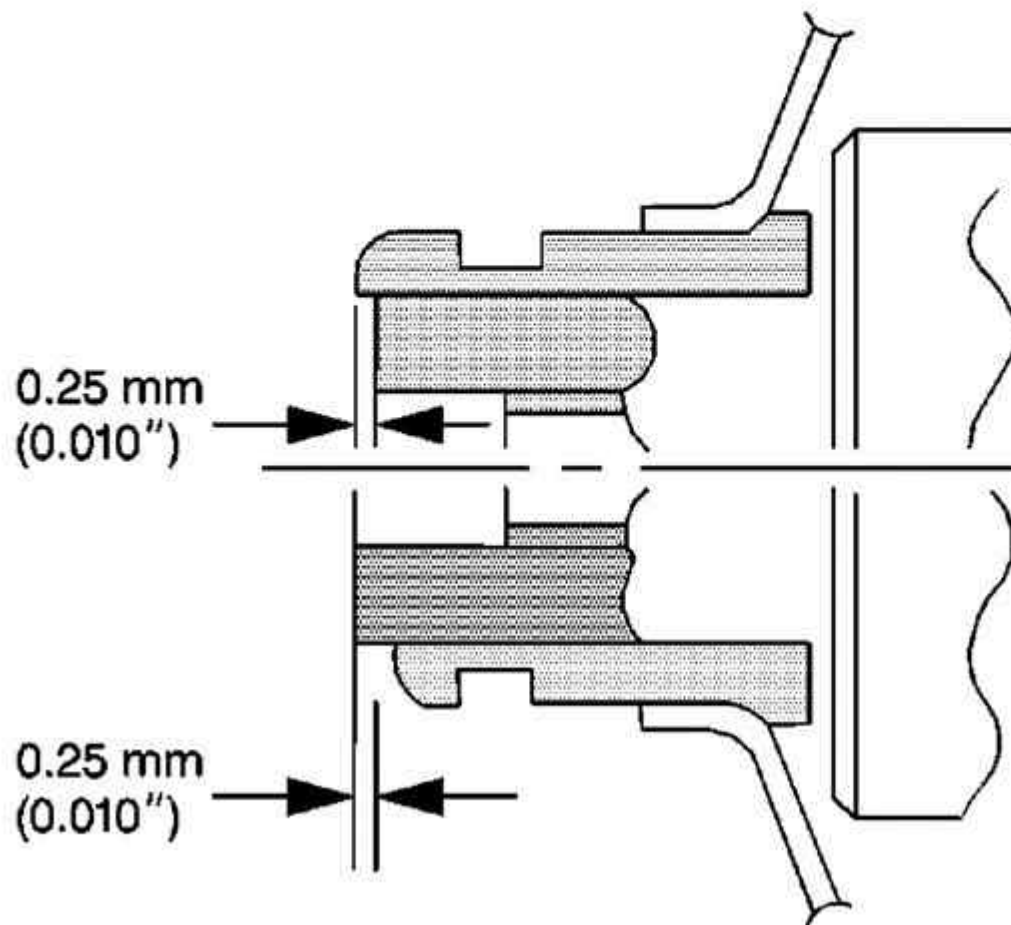
2. Using J 25034-C remove the power steering pump pulley from the power steering pump.

**Installation Procedure**



**Fig. 8: Identifying Power Steering Pump Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

1. Using **J 25033-C** install the power steering pump pulley to the power steering pump.



**Fig. 9: Measuring Axial Tolerance Of Power Steering Pulley On Pump**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- Never use a hammer to install the power steering pulley.
- The face of the power steering pulley hub must be flush to within 0.25 mm (0.010 in) with the end of the power steering pump driveshaft.

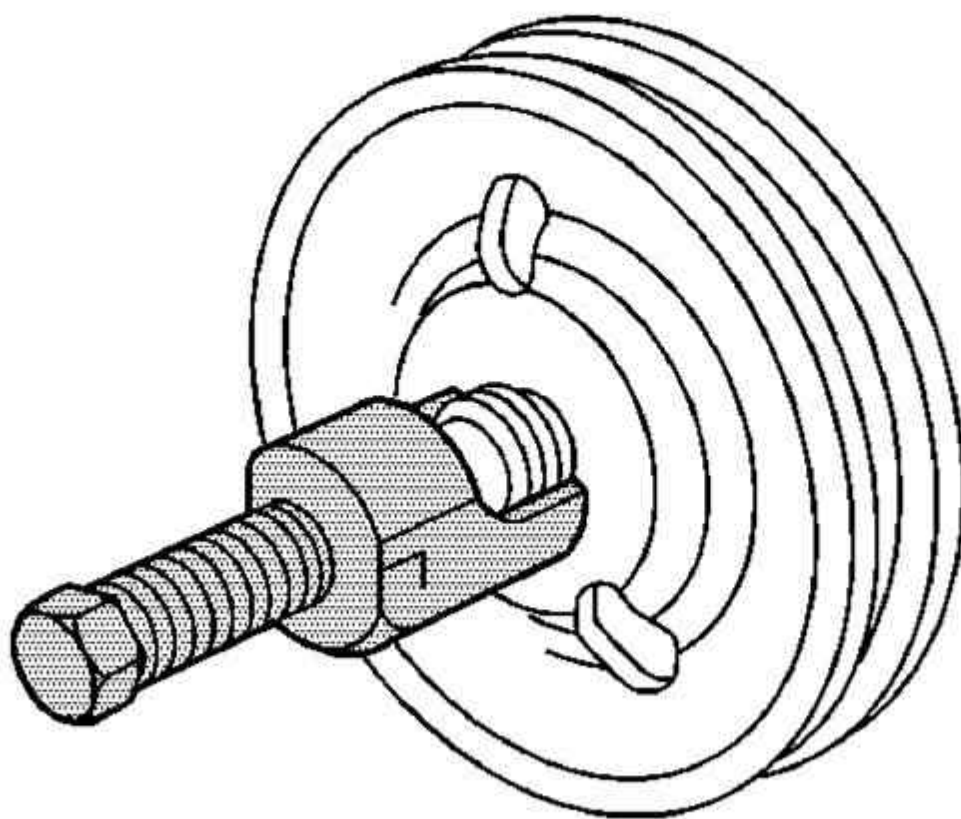
2. Install the power steering pump to the engine. Refer to Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4).
3. Fill the power steering system. Refer to Checking and Adding Power Steering Fluid.
4. Bleed the power steering system. Refer to Power Steering System Bleeding.
5. Inspect the power steering system for leaks. Refer to Power Steering Fluid Leaks.

**POWER STEERING PUMP PULLEY REPLACEMENT (LS4)**

**Tools Required**

- J 25033-C Pulley Installer
- J 25034-C Pulley Remover

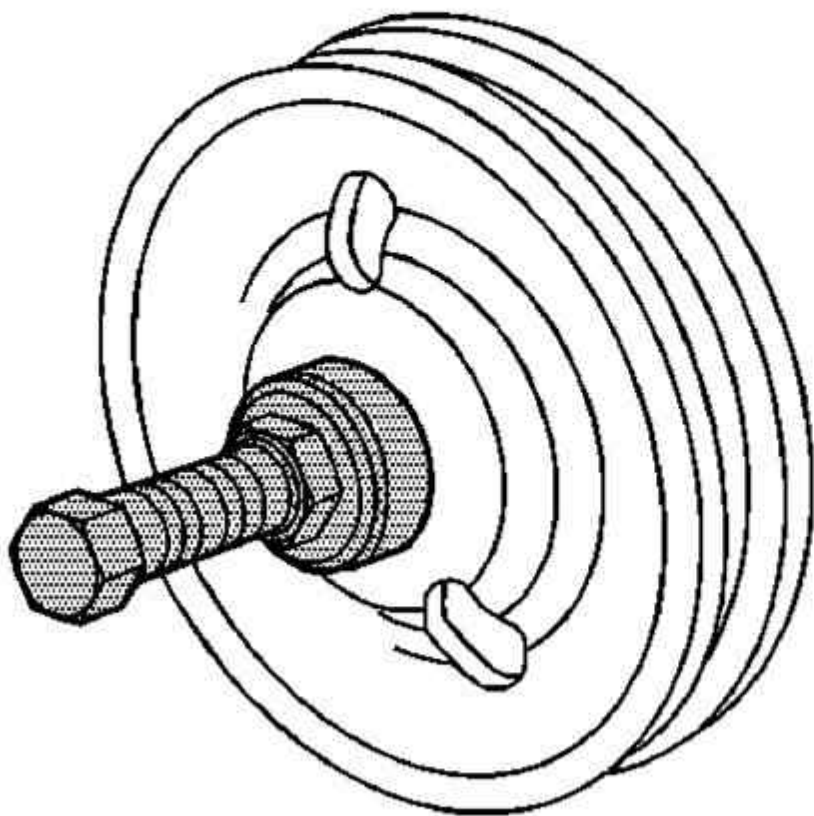
**Removal Procedure**



**Fig. 10: View Of Power Steering Pump Pulley Remover**  
Courtesy of GENERAL MOTORS CORP.

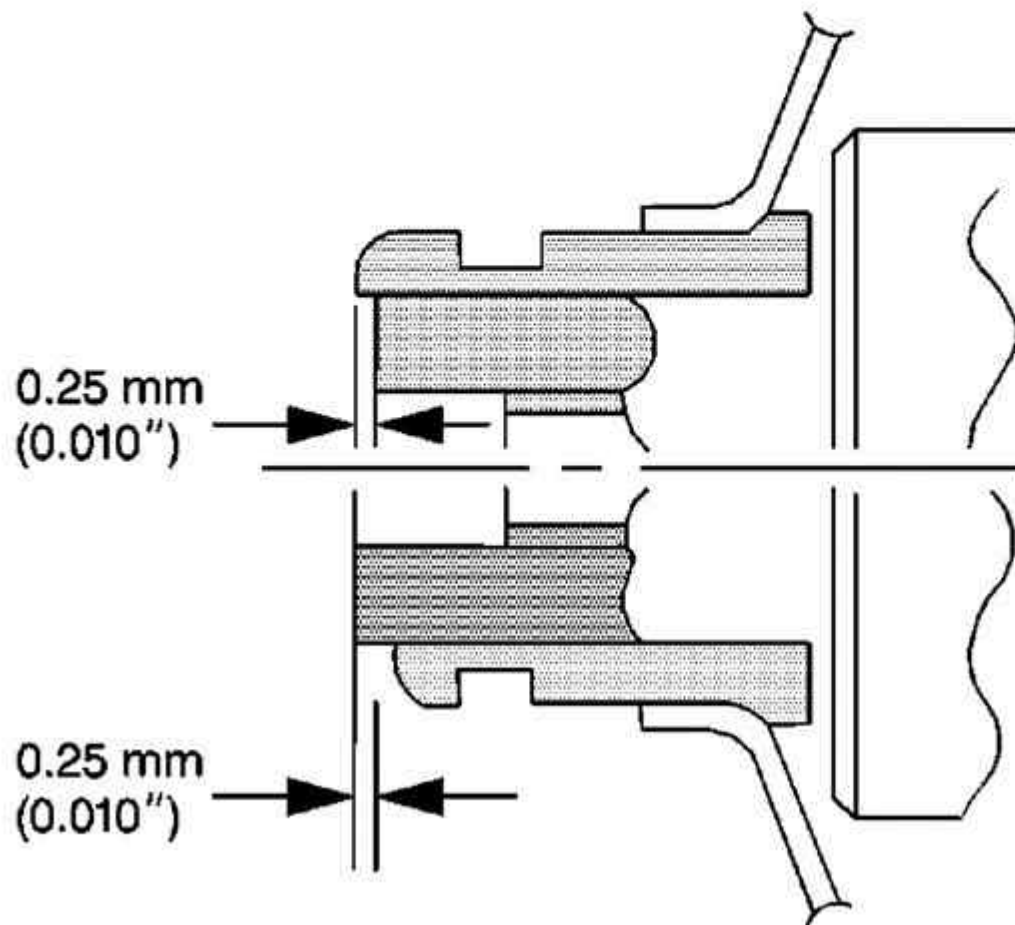
1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory.
2. Using the **J 25034-C**, remove the pulley from the pump.

**Installation Procedure**



**Fig. 11: View Of Power Steering Pump Pulley Installer**  
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 25033-C** , install the pulley to the pump.



**Fig. 12: Measuring Axial Tolerance Of Power Steering Pulley On Pump**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- Never use a hammer to install the power steering pulley.
- The face of the power steering pulley hub must be flush to within 0.25 mm (0.010 in) with the end of the power steering pump driveshaft.

2. Install the drive belt. Refer to Drive Belt Replacement - Accessory.

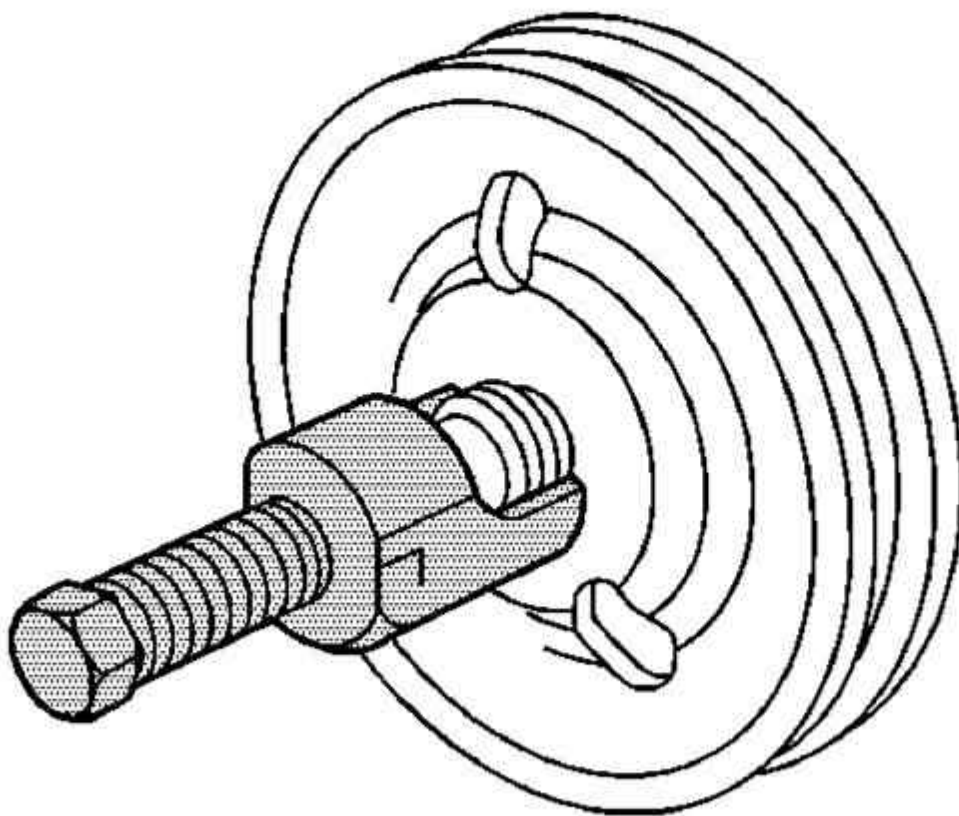
**POWER STEERING PUMP PULLEY REPLACEMENT (LY7)**

**Tools Required**

- **J 25034-C** Power Steering Pump Pulley Remover
- **J 25034-257** Power Steering Pump Pulley Remover Adapter. See Special Tools.

**Removal Procedure**

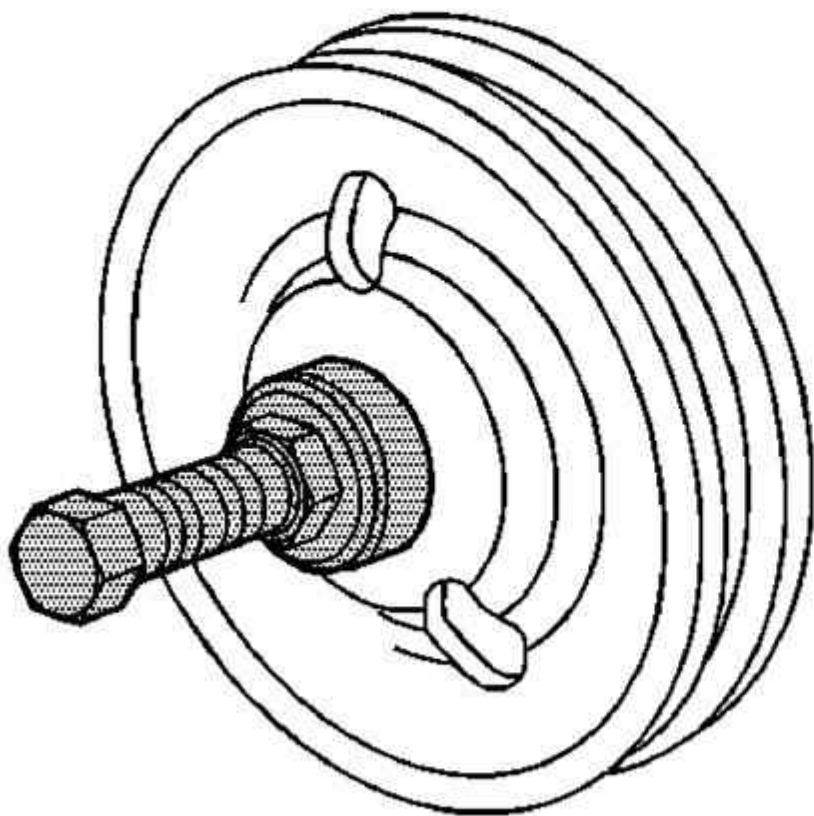
1. Remove the power steering pump from the engine for clearance. Refer to Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4).



**Fig. 13: View Of Power Steering Pump Pulley Remover**  
Courtesy of GENERAL MOTORS CORP.

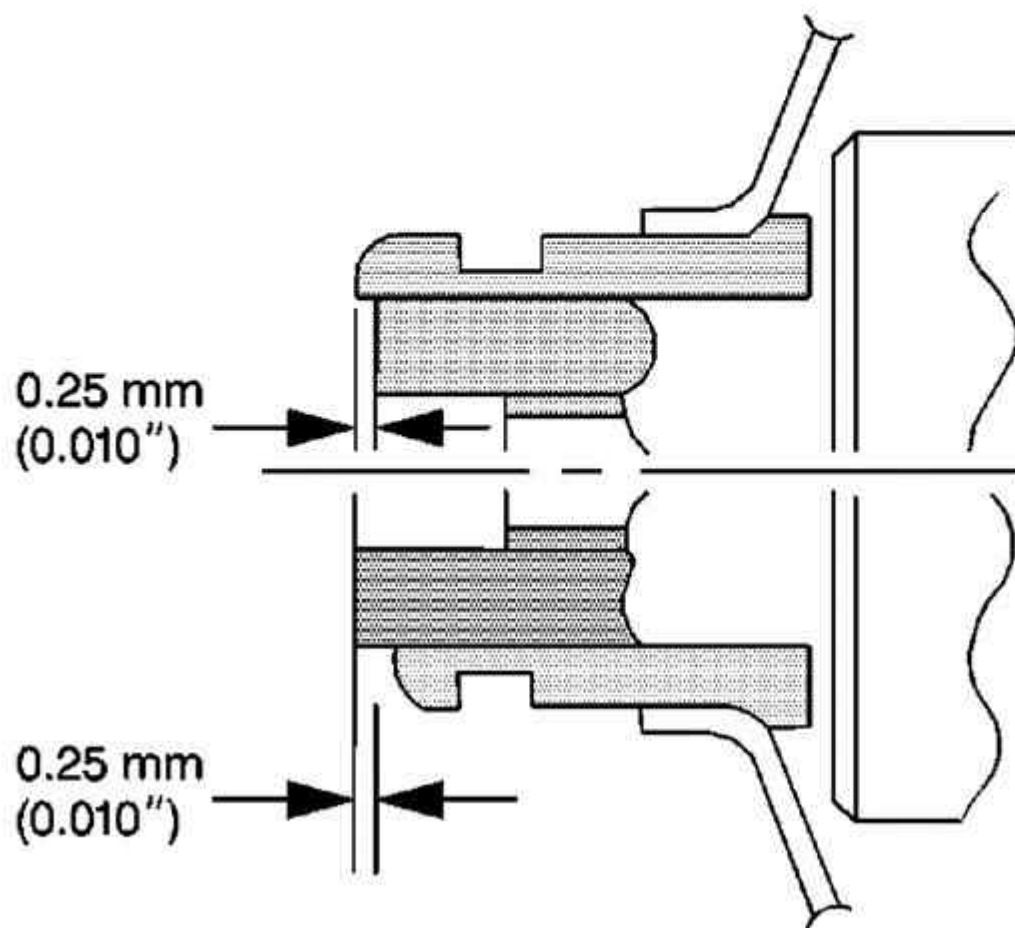
2. Use the **J 25034-C** and **J 25034-257** in order to remove the pump pulley. See **Special Tools**.

**Installation Procedure**



**Fig. 14: View Of Power Steering Pump Pulley Installer**  
**Courtesy of GENERAL MOTORS CORP.**

1. Use an appropriate Power Steering Pump Pulley Service Kit to install the power steering pump pulley.



**Fig. 15: Measuring Axial Tolerance Of Power Steering Pulley On Pump**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

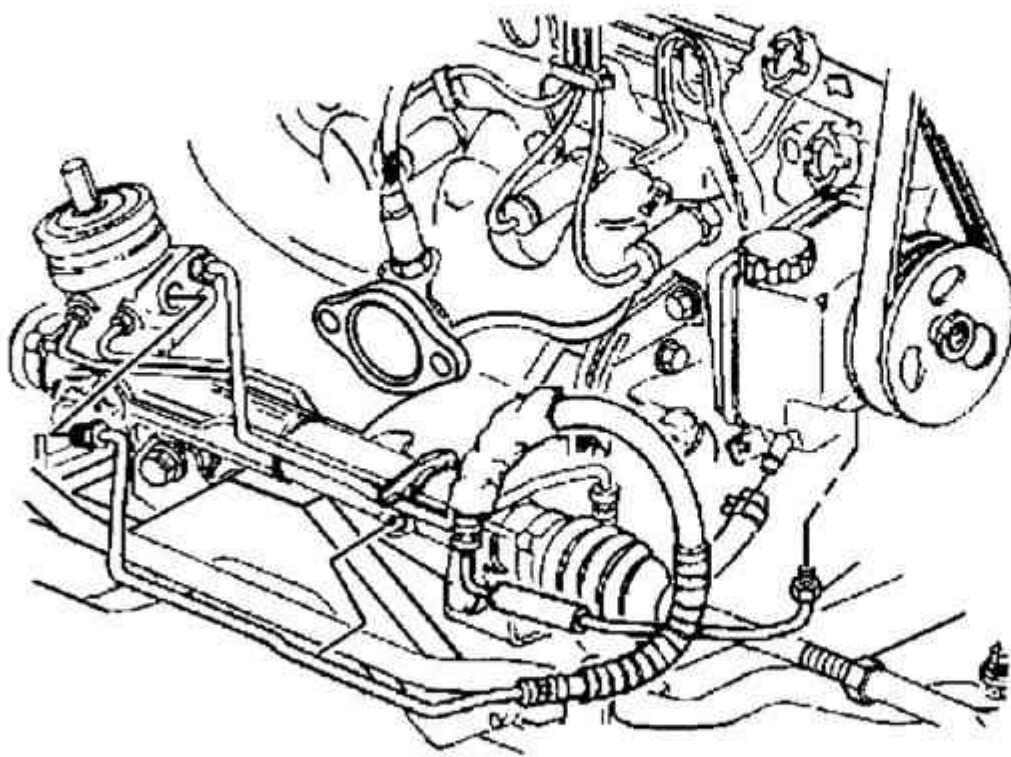
- Ensure that the face of the pulley hub is flush to within 0.25 mm (0.010 in) with the end of the pump shaft.
- Do not use the arbor press to install the pulley.

2. Install the power steering pump to the engine. Refer to Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4).

**POWER STEERING PUMP REPLACEMENT (L26)**

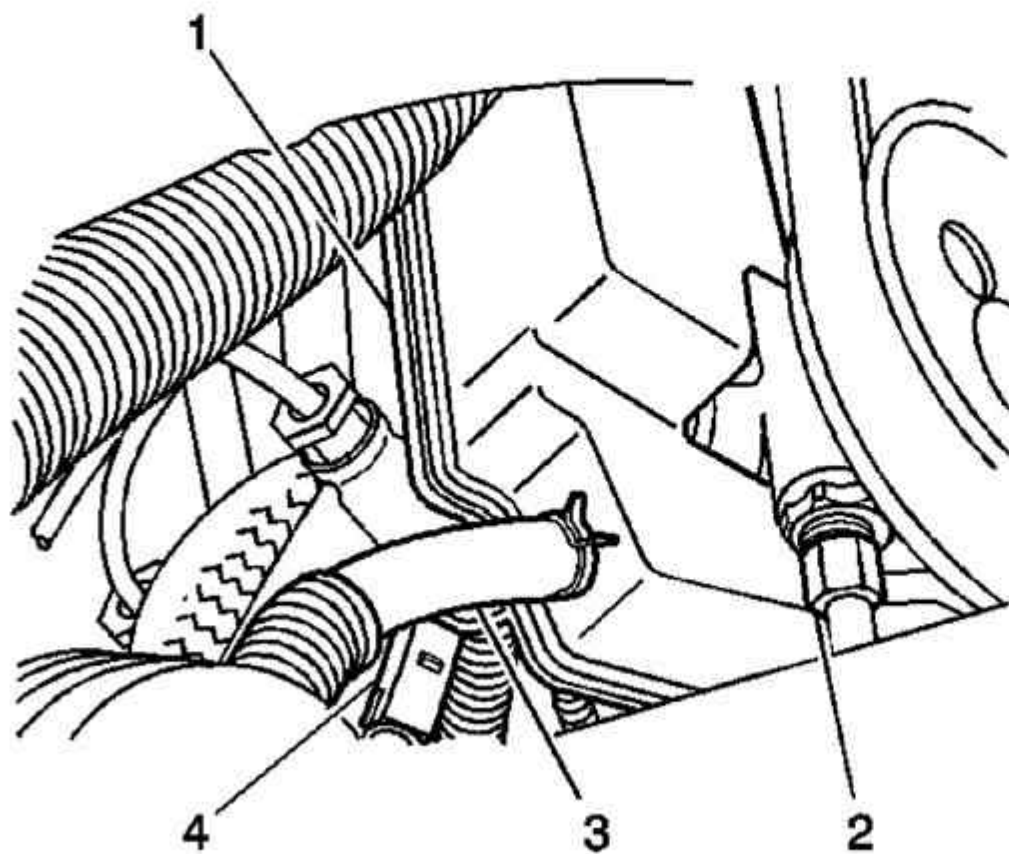
**Removal Procedure**

1. Remove the accessory drive belt. Refer to Drive Belt Replacement (L26).
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
3. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation.



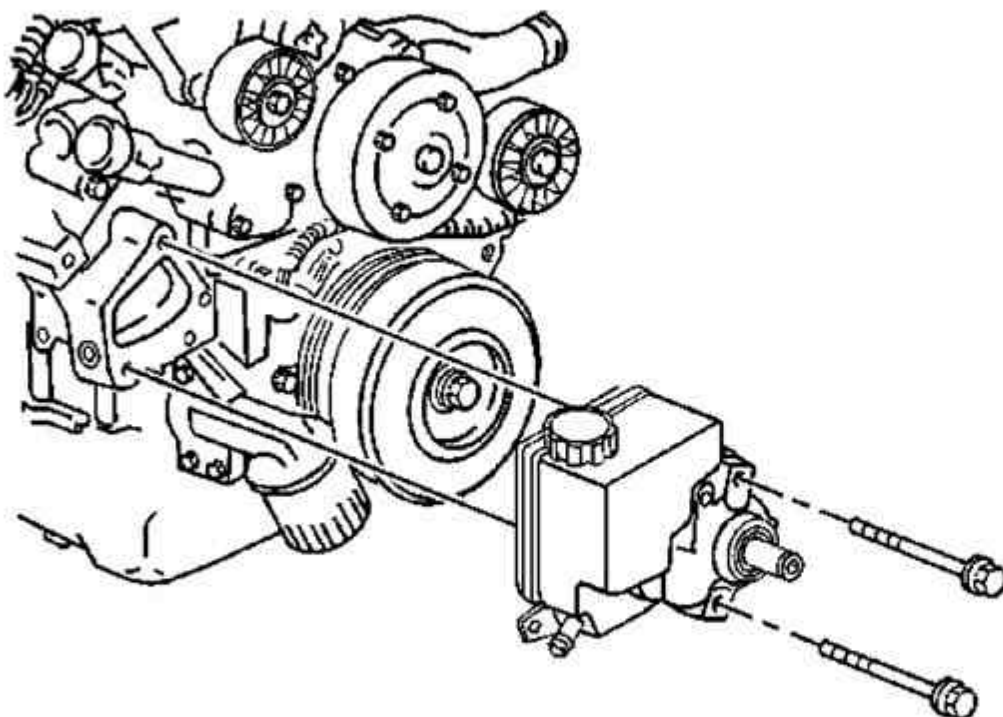
**Fig. 16: View Of Power Steering Hoses**  
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the power steering pressure hose from the power steering pump. Refer to **Power Steering Pressure Pipe/Hose Replacement (L26)** or **Power Steering Pressure Pipe/Hose Replacement (LY7)** or **Power Steering Pressure Pipe/Hose Replacement (LS4)**.
5. Disconnect the power steering return hose from the power steering pump. Refer to **Power Steering Cooler Pipe/Hose Replacement (LY7)** or **Power Steering Cooler Pipe/Hose Replacement (LS4)** or **Power Steering Cooler Pipe/Hose Replacement (L26)**.



**Fig. 17: Locating Electrical Connector For Power Steering Pump**  
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the harness connector (4) from the power steering pump (1).

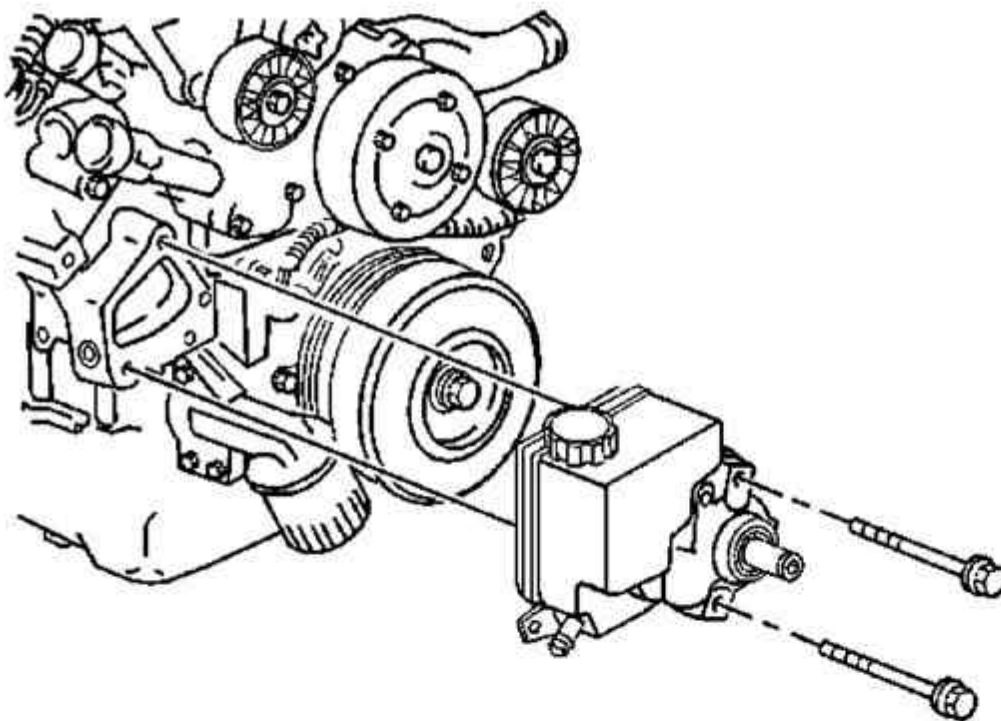


**Fig. 18: View Of Power Steering Pump & Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the power steering mounting bolts from the power steering pump.
8. Remove the power steering pump from the engine.
9. Remove the power steering pump pulley from the power steering pump. Refer to Power Steering Pump Pulley Replacement (L26) or Power Steering Pump Pulley Replacement (LS4) or Power Steering Pump Pulley Replacement (LY7).
10. Remove the power steering pump reservoir from the power steering pump. Refer to Power Steering Fluid Reservoir Replacement - Off Vehicle.

**Installation Procedure**

1. Install the power steering pump reservoir to the power steering pump. Refer to Power Steering Fluid Reservoir Replacement - Off Vehicle.
2. Install the power steering pump pulley to the power steering pump. Refer to Power Steering Pump Pulley Replacement (L26) or Power Steering Pump Pulley Replacement (LS4) or Power Steering Pump Pulley Replacement (LY7).
3. Position the power steering pump to the engine.

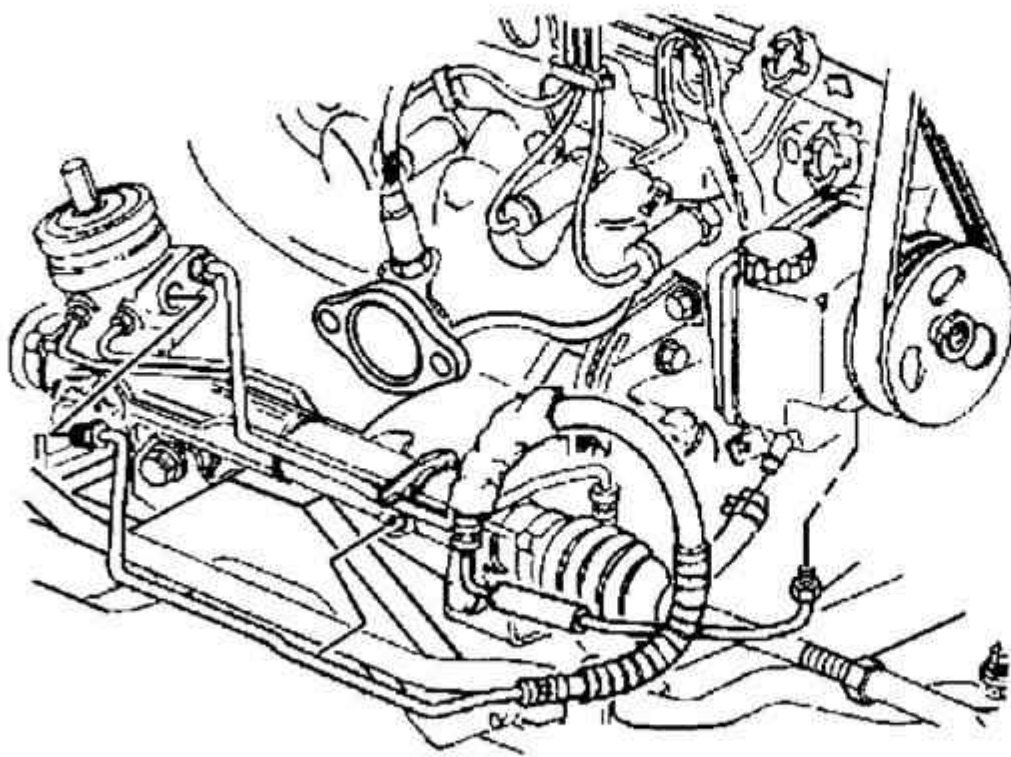


**Fig. 19: View Of Power Steering Pump & Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

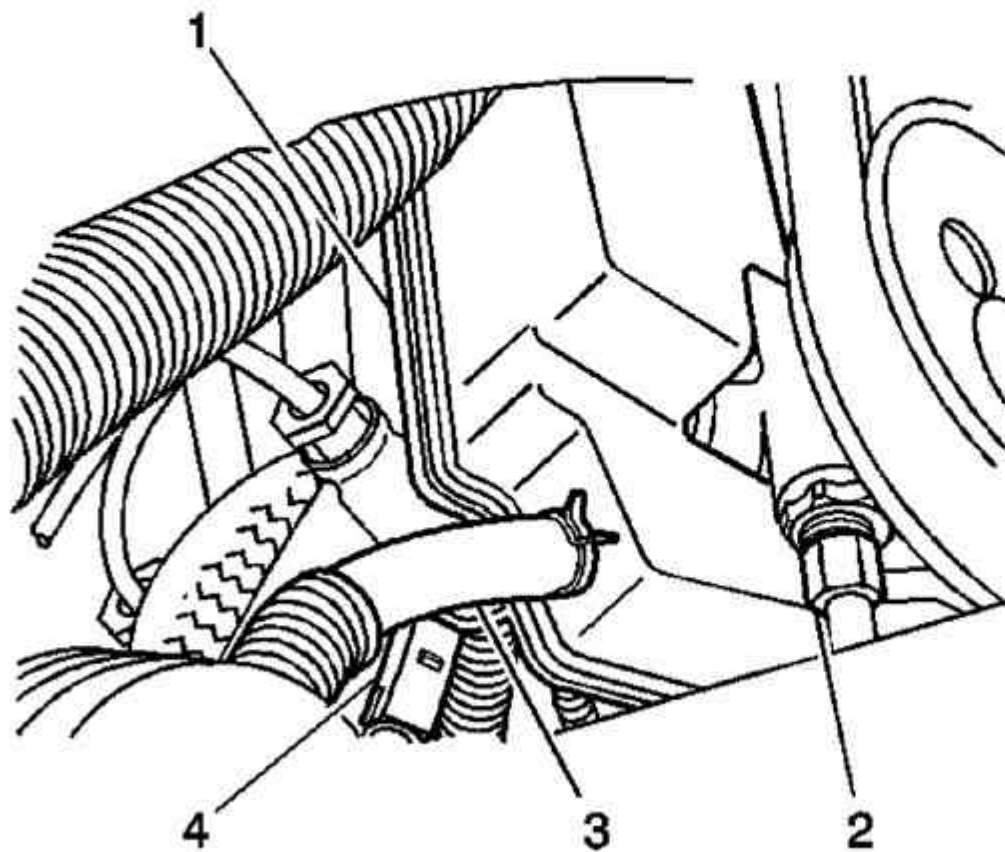
4. Install the power steering pump mounting bolts.

**Tighten:** Tighten the bolts to 25 N.m (18 lb ft).



**Fig. 20: View Of Power Steering Hoses**  
Courtesy of GENERAL MOTORS CORP.

5. Connect the power steering pressure hose to the power steering pump. Refer to **Power Steering Pressure Pipe/Hose Replacement (L26)** or **Power Steering Pressure Pipe/Hose Replacement (LY7)** or **Power Steering Pressure Pipe/Hose Replacement (LS4)**.
6. Connect the power steering return hose to the power steering pump. Refer to **Power Steering Cooler Pipe/Hose Replacement (LY7)** or **Power Steering Cooler Pipe/Hose Replacement (LS4)** or **Power Steering Cooler Pipe/Hose Replacement (L26)**.



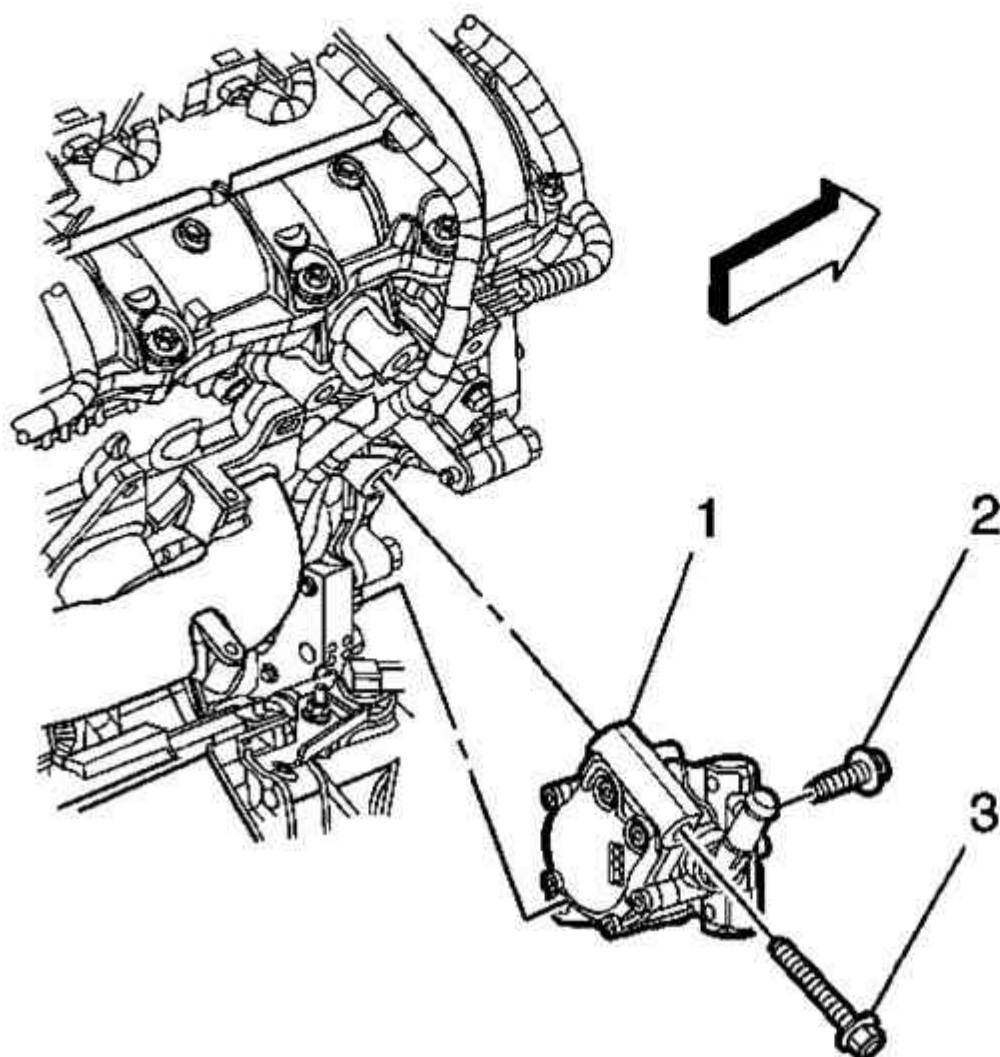
**Fig. 21: Locating Electrical Connector For Power Steering Pump**  
Courtesy of GENERAL MOTORS CORP.

7. Install the harness connector (1) to the power steering pump (4).
8. Install the accessory drive belt. Refer to **Drive Belt Replacement (L26)**.
9. Fill the power steering system with fluid. Refer to **Checking and Adding Power Steering Fluid**.
10. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
11. Operate the power steering system and inspect for power steering system leaks. Refer to **Power Steering Fluid Leaks**.

#### POWER STEERING PUMP REPLACEMENT (LY7)

##### Removal Procedure

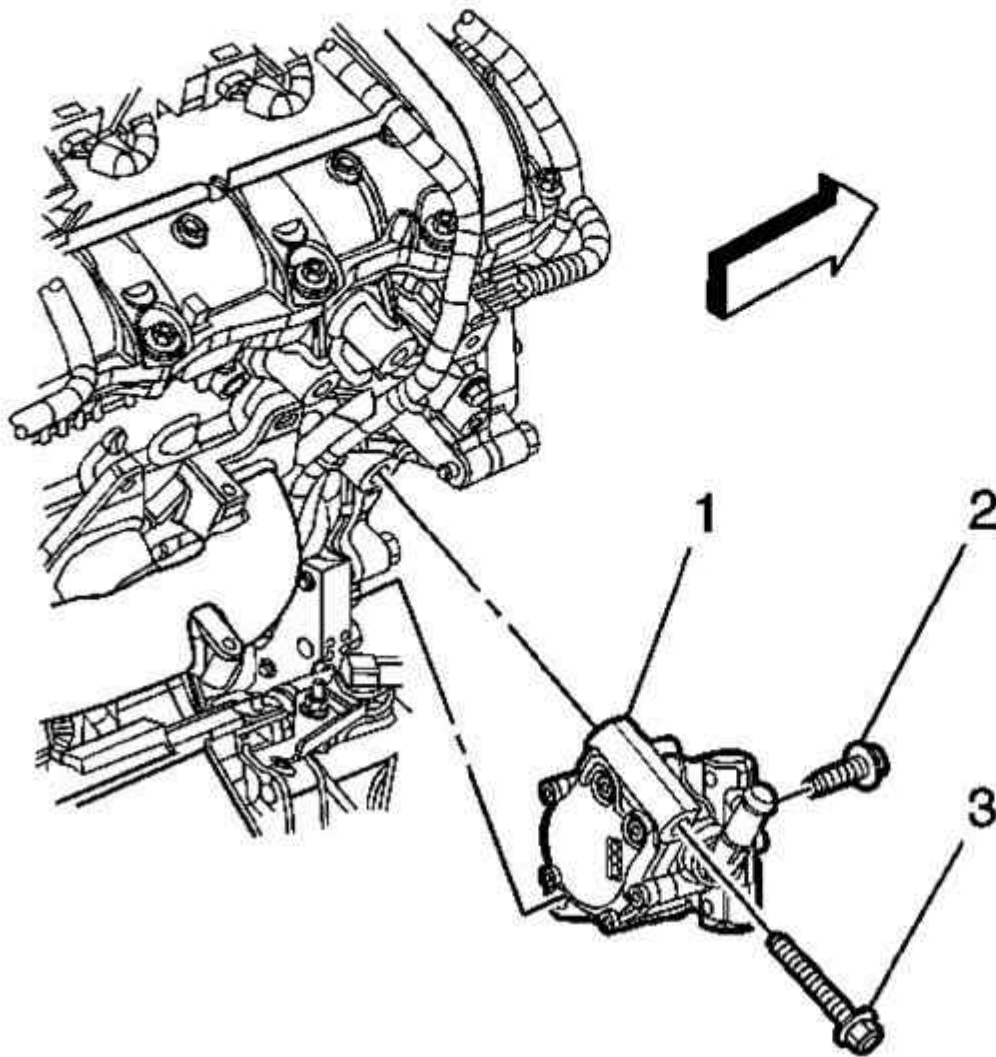
1. Place a drain pan under the vehicle.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Turn the steering wheel to the right in order to allow clearance to remove the pump.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation**.
6. Disconnect the power steering pump inlet hose from the power steering pump.
7. Disconnect the power steering pressure hose from the power steering pump.



**Fig. 22: View Of Power Steering Pump Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the power steering pump mounting bolts.
9. Remove the power steering pump from the engine.
10. Cap the power steering pump fittings and hoses to prevent contamination.
11. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (L26)** or **Power Steering Pump Pulley Replacement (LS4)** or **Power Steering Pump Pulley Replacement (LY7)**.

#### Installation Procedure



**Fig. 23: View Of Power Steering Pump Mounting Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (L26)** or **Power Steering Pump Pulley Replacement (LS4)** or **Power Steering Pump Pulley Replacement (LY7)**.
2. Remove the caps from the power steering pump fittings and hoses.
3. Position the power steering pump (1) on the engine.
4. Install the power steering pump mounting bolts. HAND TIGHTEN ONLY.

**NOTE:** Refer to **Fastener Notice** .

5. Tighten the mounting bolt (3).

**Tighten:** Tighten the mounting bolt (3) to 50 N.m (37 lb ft).

6. Tighten the rear power steering pump mounting bolt (2).

**Tighten:** Tighten the rear power steering pump mounting bolt (2) to 50 N.m (37 lb ft).

**IMPORTANT:** Clean the material from the power steering pressure hose and install a new

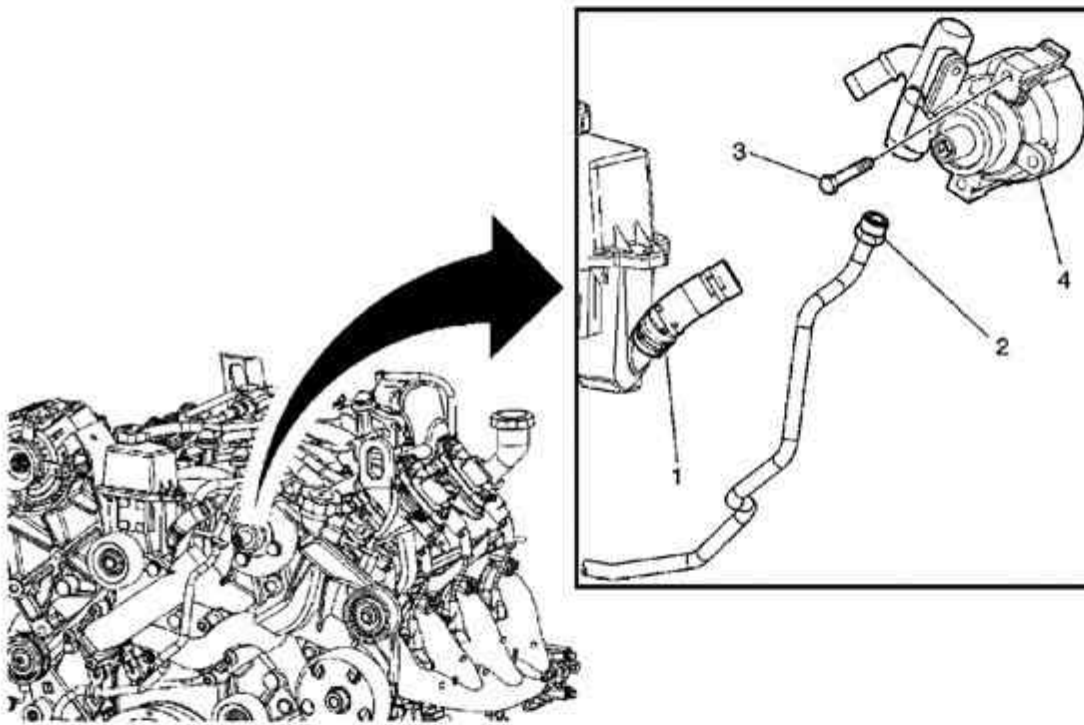
seal.

7. Connect the power steering pressure hose to the power steering pump.

**Tighten:** Tighten the hose to 40 N.m (30 lb ft).

8. Connect the power steering reservoir outlet hose to the power steering pump.
9. Install the right front tire and wheel. Refer to Tire and Wheel Removal and Installation.
10. Lower the vehicle.
11. Install the drive belt. Refer to Drive Belt Replacement.
12. Remove the drain pan from under the vehicle.
13. Bleed the power steering system. Refer to Power Steering System Bleeding.
14. Inspect the system for leaks. Refer to Power Steering Fluid Leaks.

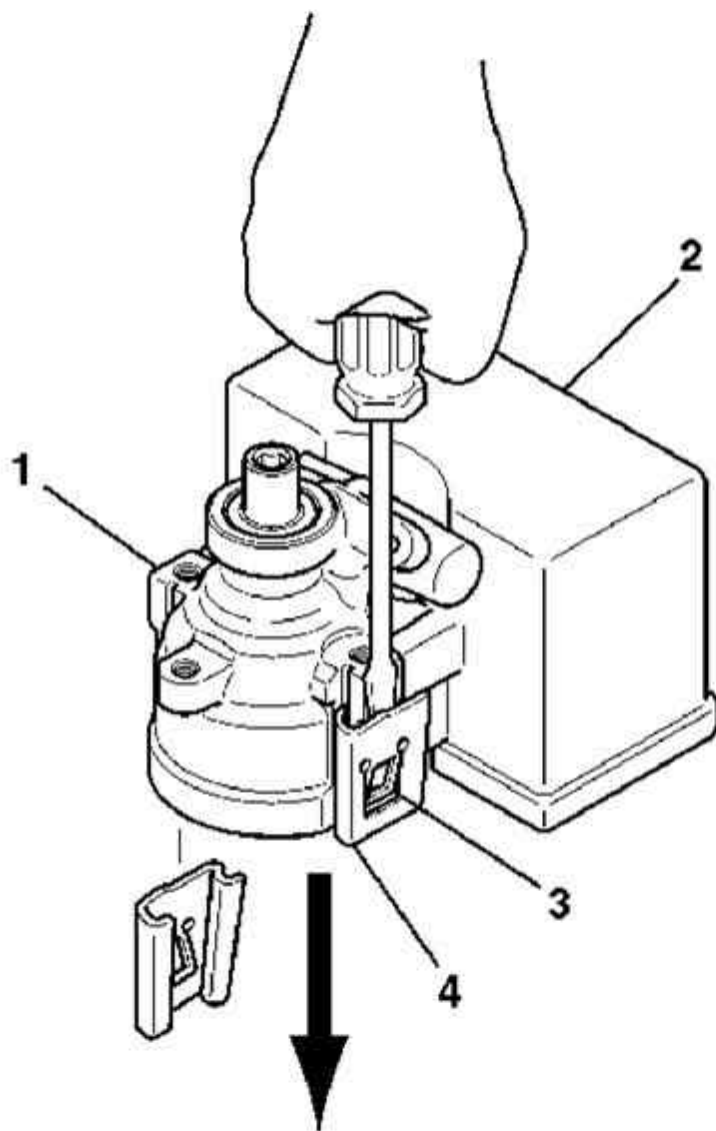
#### POWER STEERING PUMP REPLACEMENT (LS4)



**Fig. 24: Replacing Power Steering Pump**  
Courtesy of GENERAL MOTORS CORP.

| Callout                                                                                                                                                                                                                                              | Component Name                                                                                                                                                                                                                                                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure:</b><br>Remove the power steering pump pulley. Refer to <u>Power Steering Pump Pulley Replacement (L26)</u> or <u>Power Steering Pump Pulley Replacement (LS4)</u> or <u>Power Steering Pump Pulley Replacement (LY7)</u> . |                                                                                                                                                                                                                                                                                            |
| 1                                                                                                                                                                                                                                                    | Power Steering Pump Hose Clamp<br><b>Tip:</b> Use an appropriate tool to remove the power steering fluid from the reservoir before relocating the clamp. Also plug the end of the hose between the reservoir and the power steering pump to limit the leakage of the power steering fluid. |
| 2                                                                                                                                                                                                                                                    | Power Steering High Pressure Hose Fitting<br><br><b>NOTE:</b><br>Refer to <u>Fastener Notice</u> .                                                                                                                                                                                         |

|   |                                   |
|---|-----------------------------------|
|   | <b>Tighten:</b> 27 N.m (20 lb ft) |
| 3 | Power Steering Pump Bolt (Qty: 3) |
|   | <b>Tighten:</b> 25 N.m (18 lb ft) |
| 4 | Power Steering Pump               |

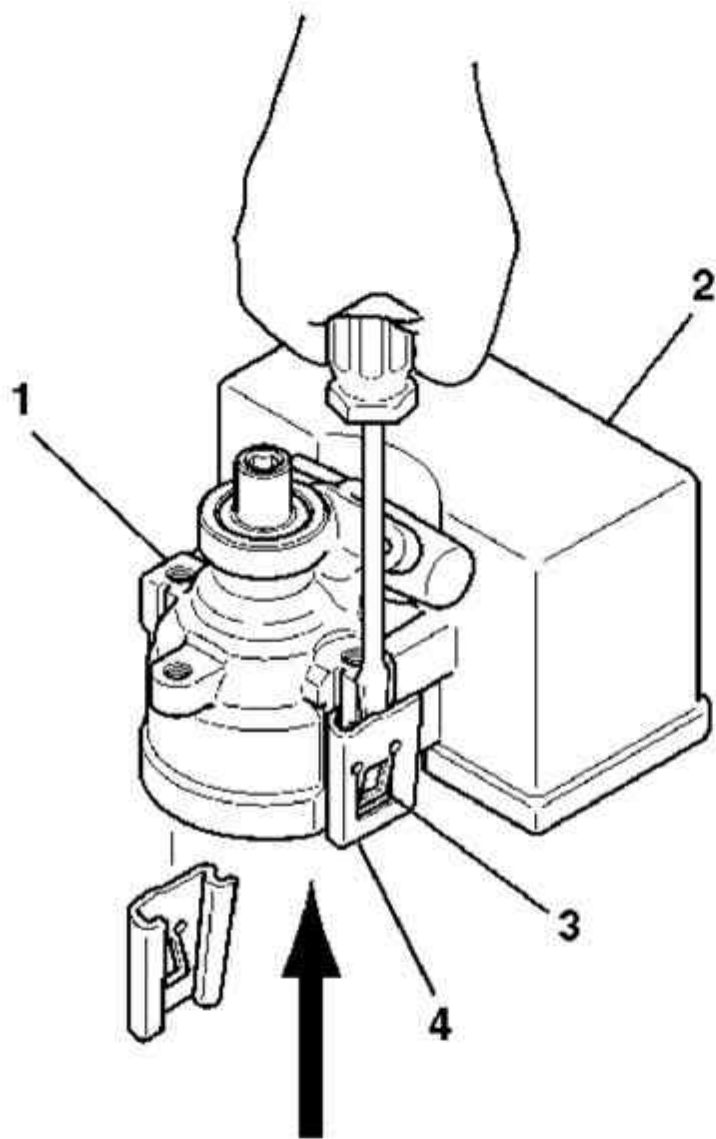
**POWER STEERING FLUID RESERVOIR REPLACEMENT - OFF VEHICLE****Disassembly Procedure**

**Fig. 25: View Of Power Steering Pump & Reservoir (CB Series)**  
**Courtesy of GENERAL MOTORS CORP.**

1. Place the hydraulic pump (1) on a fixed, flat surface, with the shaft facing upward.
2. Insert a screwdriver into the retaining clip tab (3).
3. Using the screwdriver, force the retaining clip tab (3) outward.
4. Slide the reservoir clip (4) away from the hydraulic pump assembly (1).
5. Repeat the above steps to remove the second reservoir clip (4).
6. Remove the reservoir (2) from the hydraulic pump housing (1).

7. Remove the O-ring seal from the neck of the reservoir (2) or inside the hydraulic pump housing (1). Discard the O-ring seal.

#### Assembly Procedure

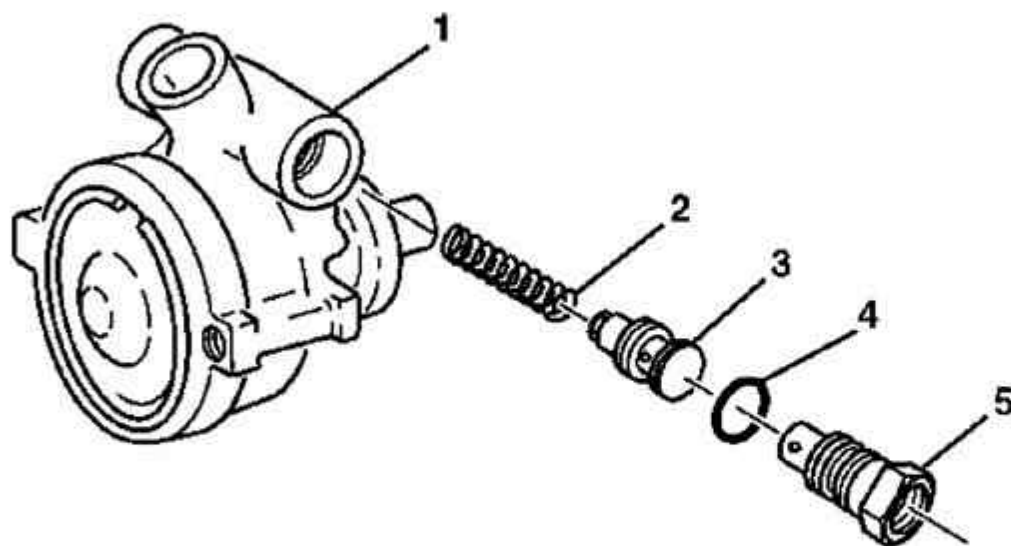


**Fig. 26: View Of Power Steering Pump And Reservoir (CB Series)**  
**Courtesy of GENERAL MOTORS CORP.**

1. Lubricate the new O-ring seal with power steering fluid.
2. Install the new O-ring seal onto the neck of the reservoir (2).
3. Install the reservoir (2) onto the hydraulic pump assembly (1). Ensure the reservoir neck is completely engaged onto the hydraulic pump assembly (1).
4. Align the feet of the reservoir with the sides of the hydraulic pump housing.
5. Install the new reservoir retaining clips (4) (supplied with the pump). Ensure the retaining clip tabs (3) fully engage with the hydraulic pump housing (1).

#### POWER STEERING PUMP FLOW CONTROL VALVE REPLACEMENT - OFF VEHICLE

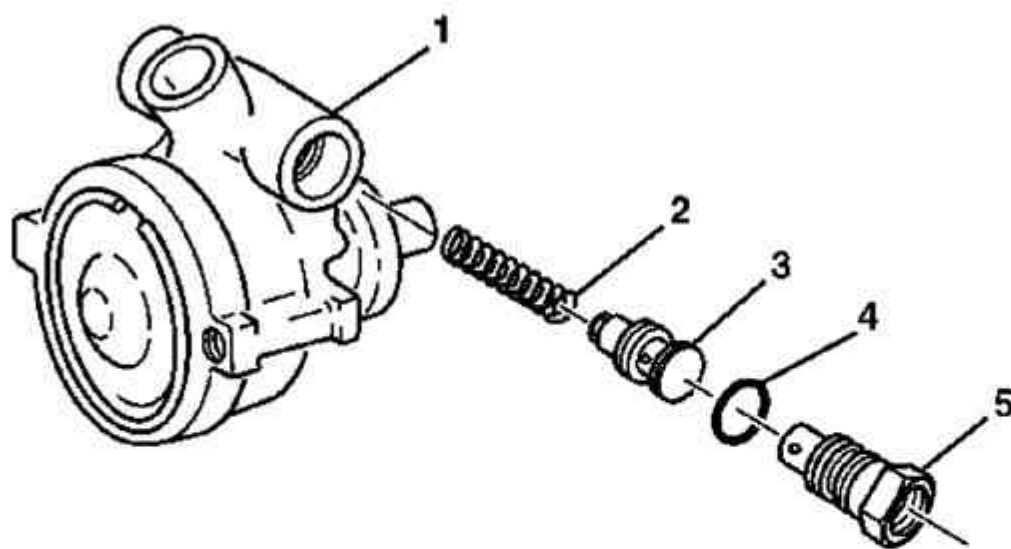
##### Disassembly Procedure



**Fig. 27: Exploded View Of Power Steering Pump Flow Control Valve (CB Series)**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the O-ring union fitting (5) from the hydraulic pump housing assembly (1).
2. Remove the O-ring seal (4) from the O-ring union fitting (5).
3. Remove the control valve assembly (3).
4. Remove the flow control spring (2).

#### Assembly Procedure



**Fig. 28: Exploded View Of Power Steering Pump Flow Control Valve (CB Series)**  
Courtesy of GENERAL MOTORS CORP.

1. Install the flow control spring (2) to the hydraulic pump housing assembly (1).
2. Install the control valve assembly (3).

3. Lubricate the O-ring seal (4) with power steering fluid.
4. Install the O-ring seal (4) onto the O-ring union fitting (5).

**NOTE:** Refer to Fastener Notice .

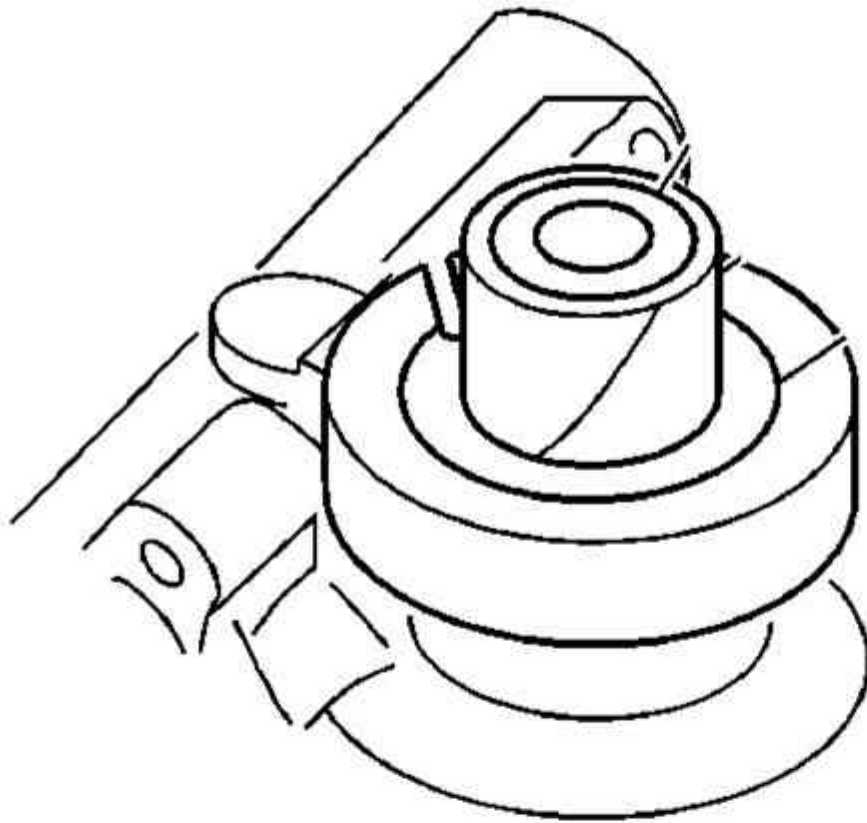
5. Install the O-ring union fitting (5) into the hydraulic pump housing assembly (1).

**Tighten:** Tighten the fitting (5) to 75 N.m (55 lb ft).

#### POWER STEERING PUMP SHAFT SEAL REPLACEMENT

##### Removal Procedure

1. Remove the power steering pump from the vehicle, if necessary. Refer to Power Steering Pump Replacement (L26) or Power Steering Pump Replacement (LY7) or Power Steering Pump Replacement (LS4).



**Fig. 29: View Of Power Steering Pump Drive Shaft Seal**  
Courtesy of GENERAL MOTORS CORP.

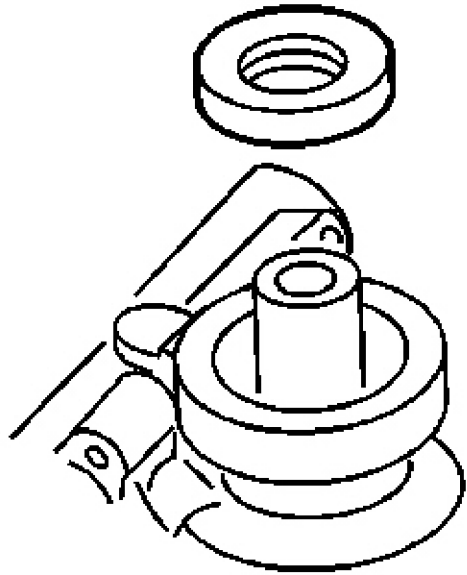
**IMPORTANT:** Protect the drive shaft with the shim stock.

2. Use a small chisel in order to remove the seal.

Discard the seal.

##### Installation Procedure

1. Lubricate the new drive shaft seal using power steering fluid.



**Fig. 30: Identifying Power Steering Pump Drive Shaft Seal**  
Courtesy of GENERAL MOTORS CORP.

2. Use a deep socket in order to install the new drive shaft seal.
3. Install the power steering pump, if removed. Refer to **Power Steering Pump Replacement (L26)** or **Power Steering Pump Replacement (LY7)** or **Power Steering Pump Replacement (LS4)**.

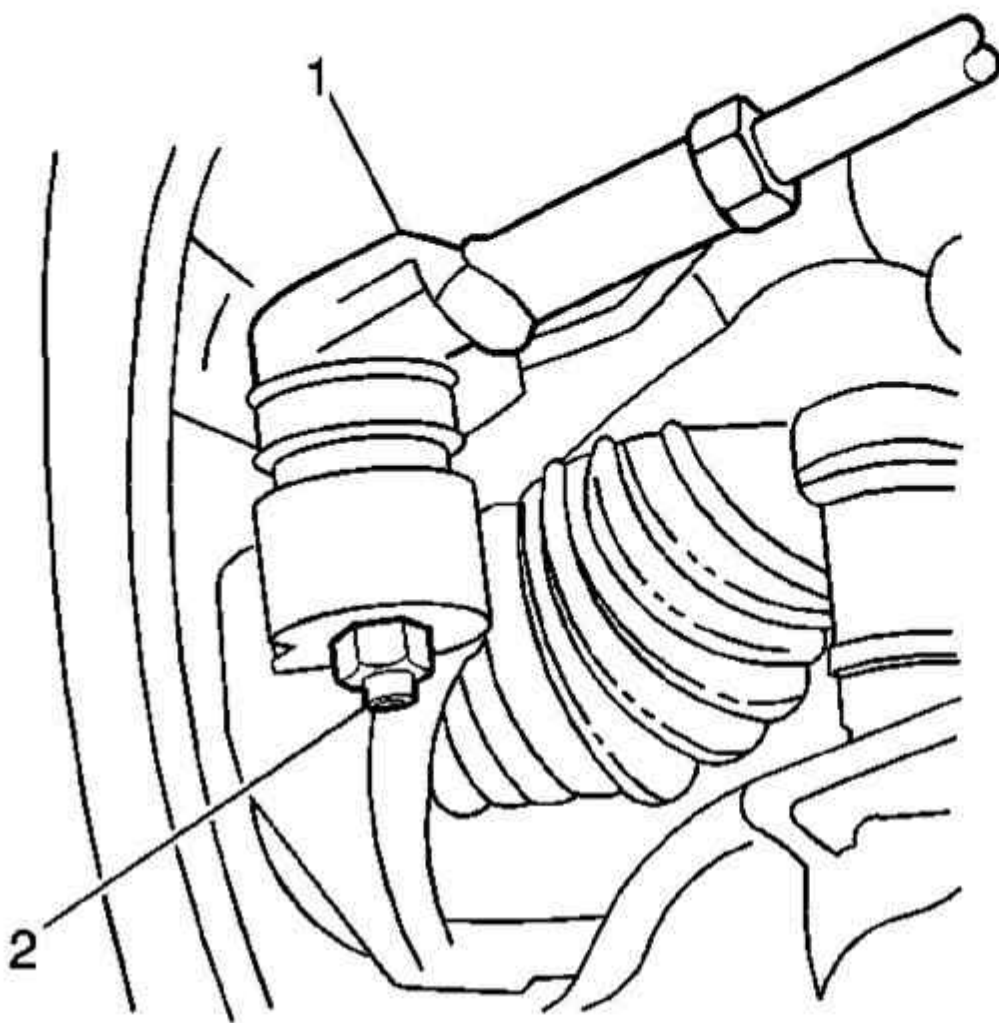
#### **RACK AND PINION OUTER TIE ROD END REPLACEMENT**

##### **Tools Required**

**J 24319-B** Universal Steering Linkage Puller. See **Special Tools**.

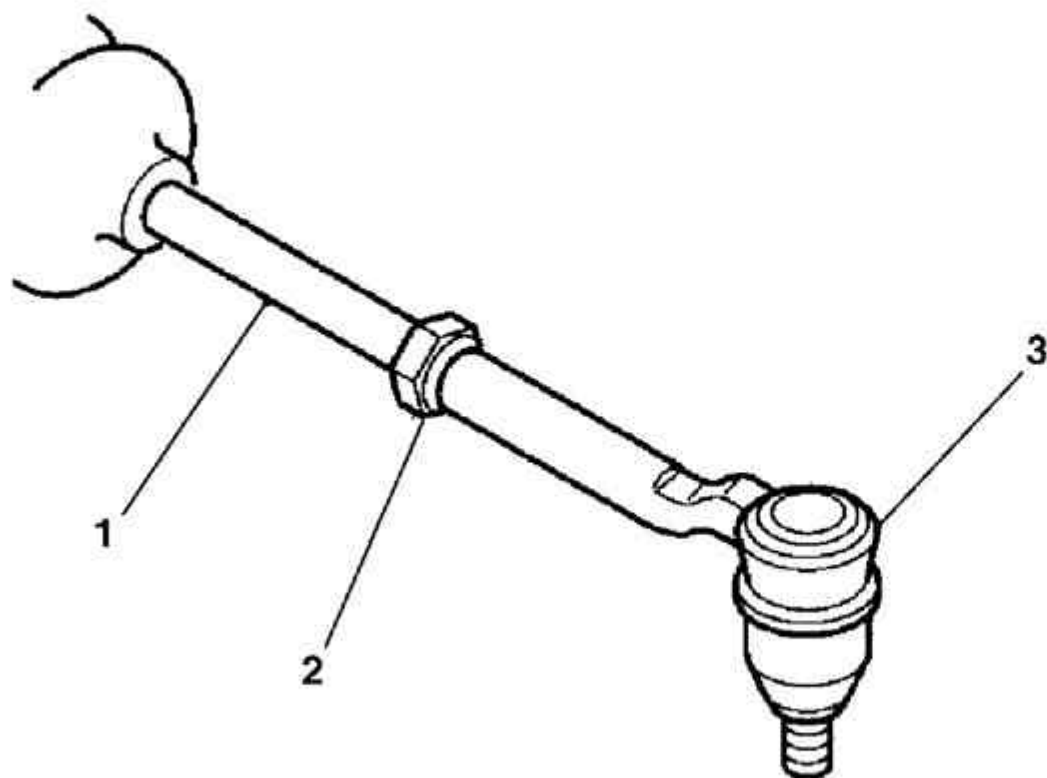
##### **Removal Procedure**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .



**Fig. 31: Identifying Outer Tie Rod & Retaining Nut**  
Courtesy of GENERAL MOTORS CORP.

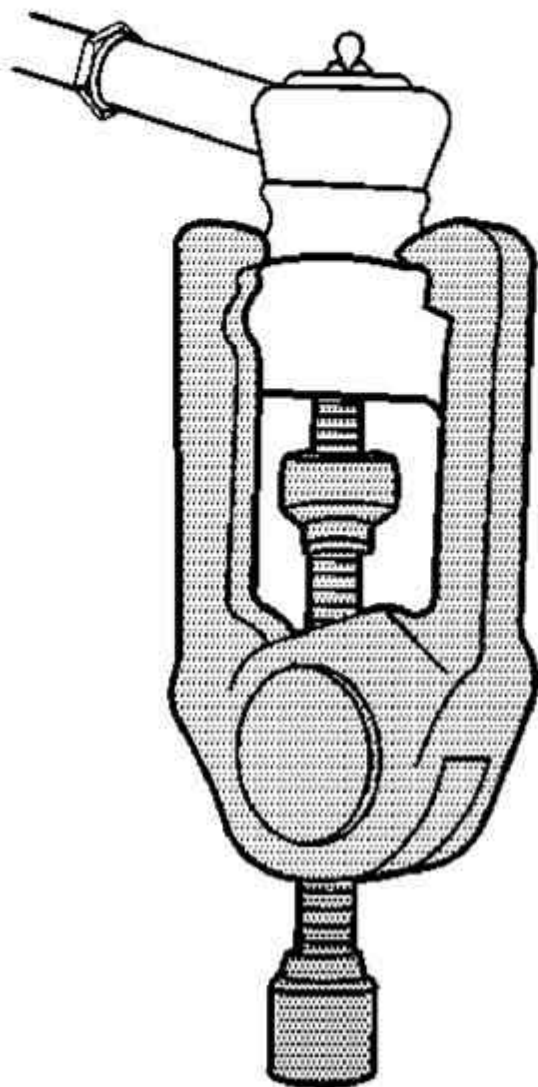
3. Remove the prevailing torque nut (2) from the outer tie rod assembly (1).



**Fig. 32: Identifying Tie Rod & Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

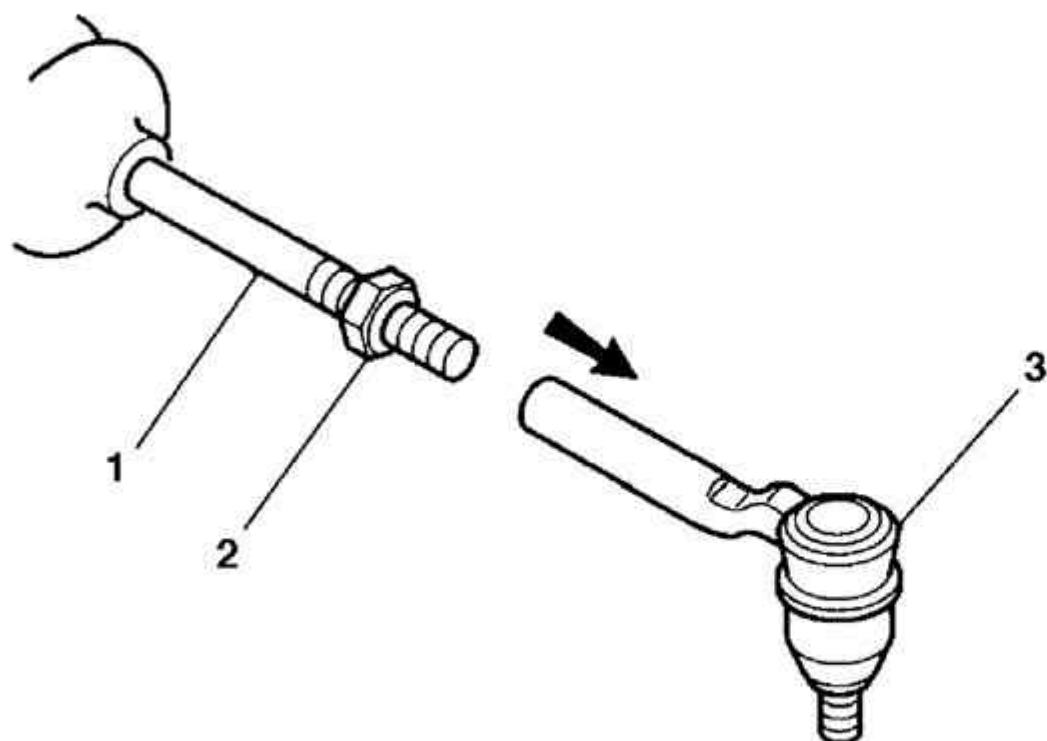
4. Loosen the jam nut (2) on the inner tie rod assembly (1).

**NOTE:** Do not attempt to disconnect a steering linkage joint by driving a wedge between the joint and the attached part. Seal damage may result which will cause premature failure of the joint.



**Fig. 33: View of Outer Tie Rod Assembly From Steering Knuckle**  
**Courtesy of GENERAL MOTORS CORP.**

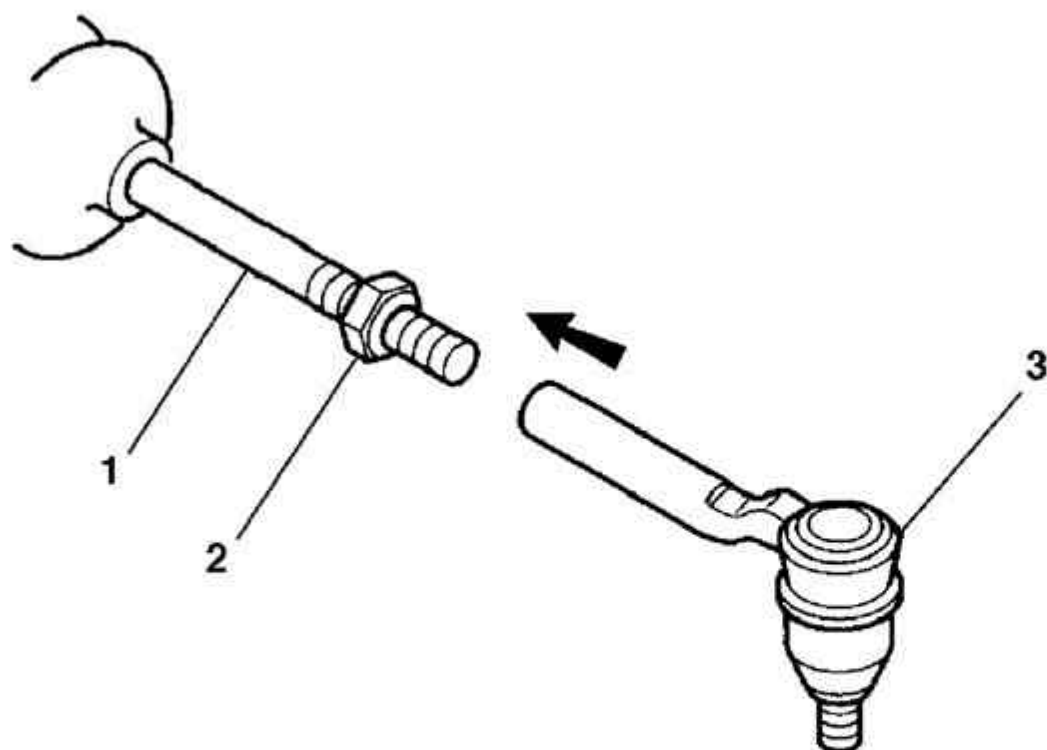
5. Remove the outer tie rod assembly from the steering knuckle using **J 24319-B** . See **Special Tools**.



**Fig. 34: View Of Outer Tie Rod & Inner Tie Rod**  
Courtesy of GENERAL MOTORS CORP.

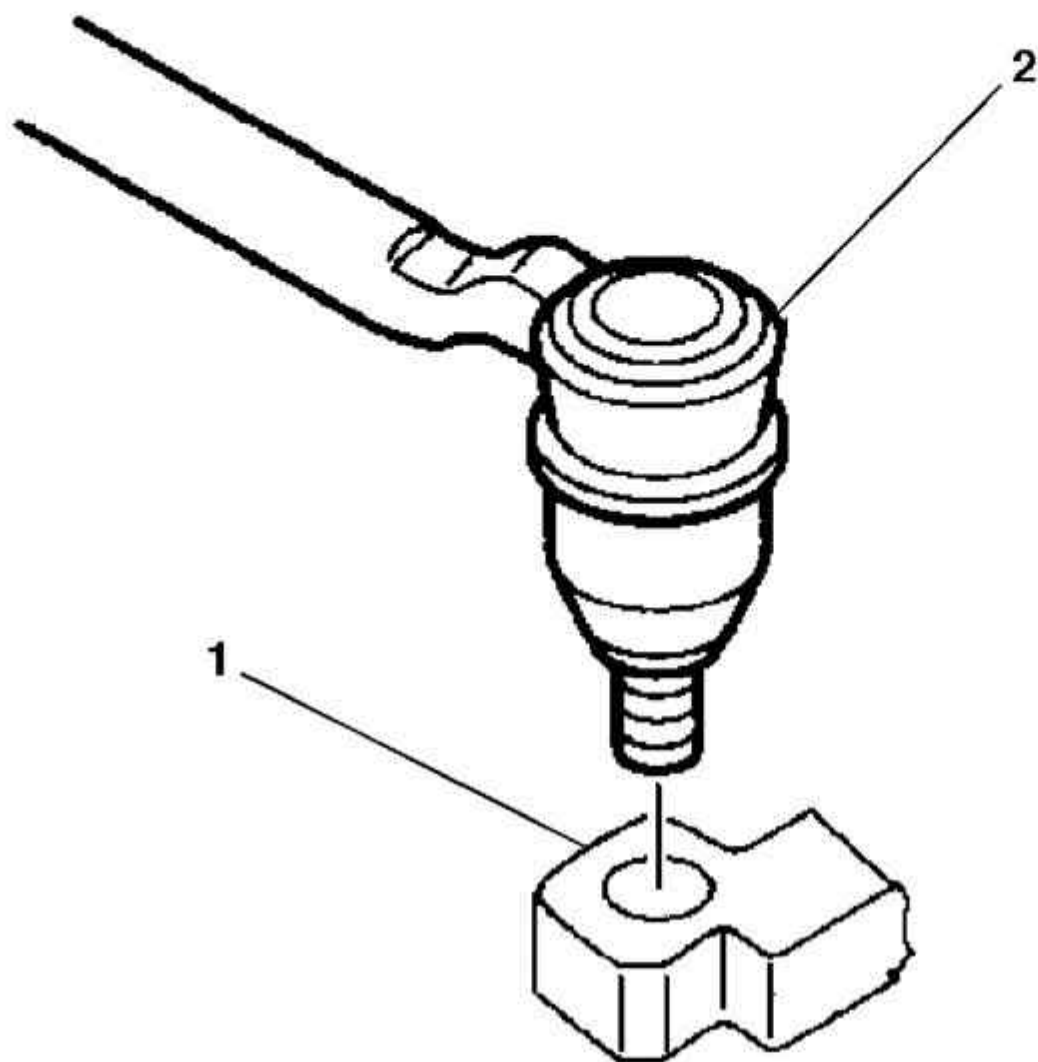
6. Remove the outer tie rod assembly (3) from the inner tie rod assembly (1).

#### Installation Procedure



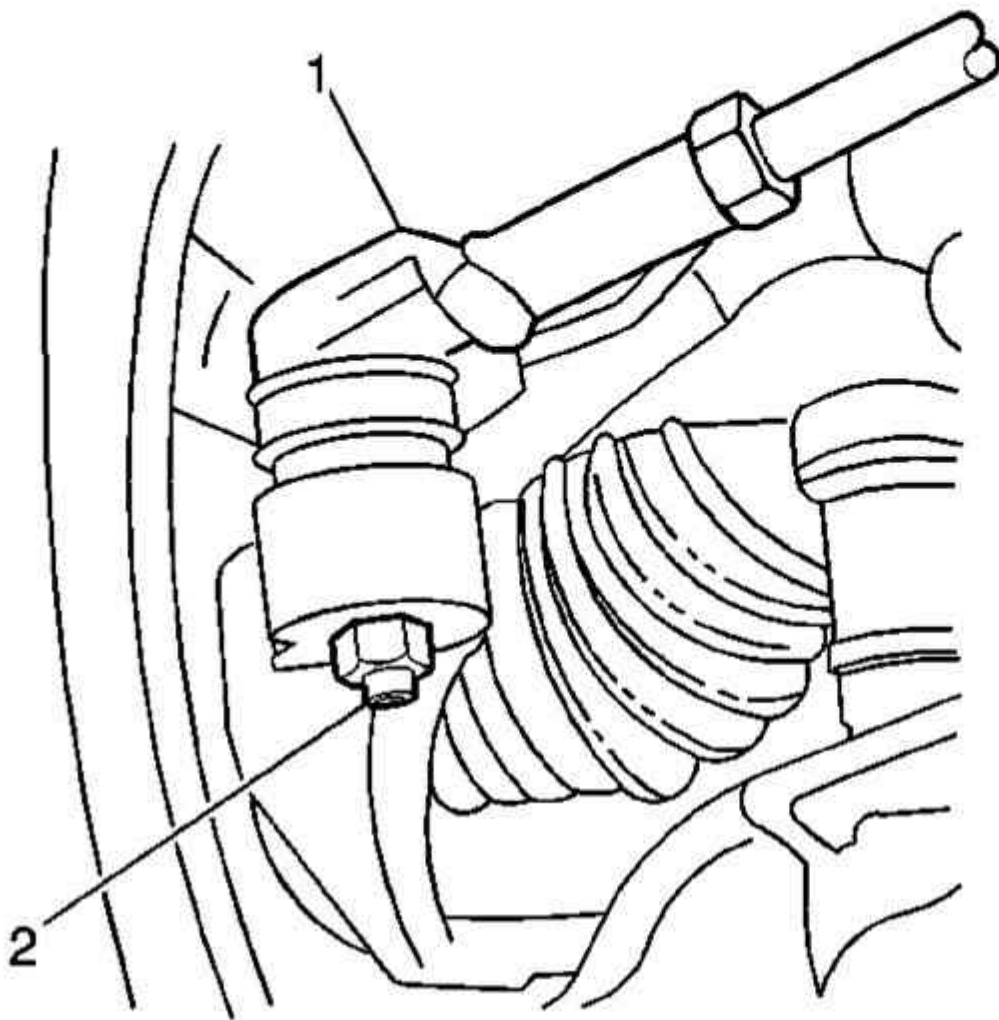
**Fig. 35: Identifying Outer Tie Rod Assembly & Inner Tie Rod Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Install the outer tie rod assembly (3) to the inner tie rod assembly (1). Do NOT tighten the jam nut (2).



**Fig. 36: View Of Outer Tie Rod & Steering Knuckle**  
**Courtesy of GENERAL MOTORS CORP.**

2. Install the outer tie rod assembly (2) to the steering knuckle (1).



**Fig. 37: Identifying Outer Tie Rod & Retaining Nut**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

3. Install the prevailing torque nut (2) to the outer tie rod assembly (1).

**Tighten:** Tighten the nut to 30 N.m plus 120 degrees (22 lb ft plus 120 degrees). Inspect to ensure that 21/2-41/2 threads are visible above the nylon washer.

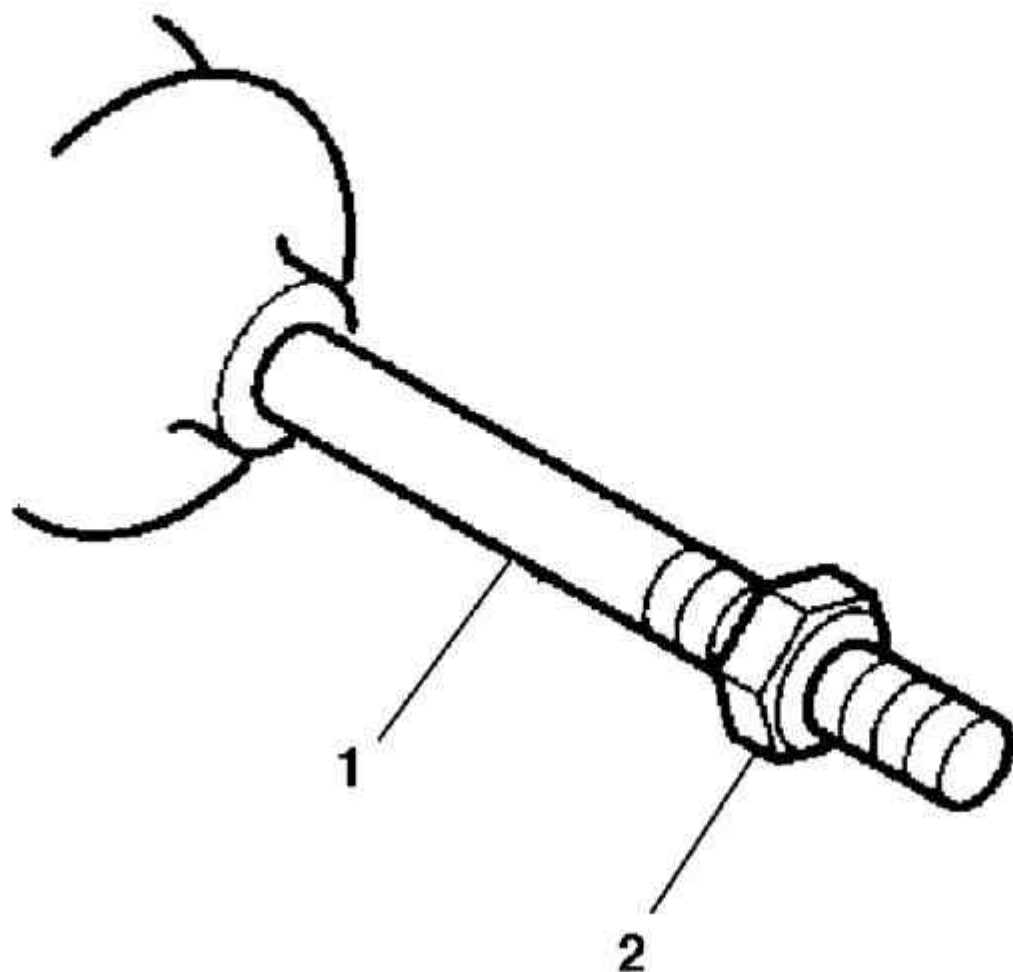
4. Install tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
5. Lower the vehicle.
6. Perform a front end alignment. Refer to Wheel Alignment Measurement .

## RACK AND PINION BOOT REPLACEMENT

### Tools Required

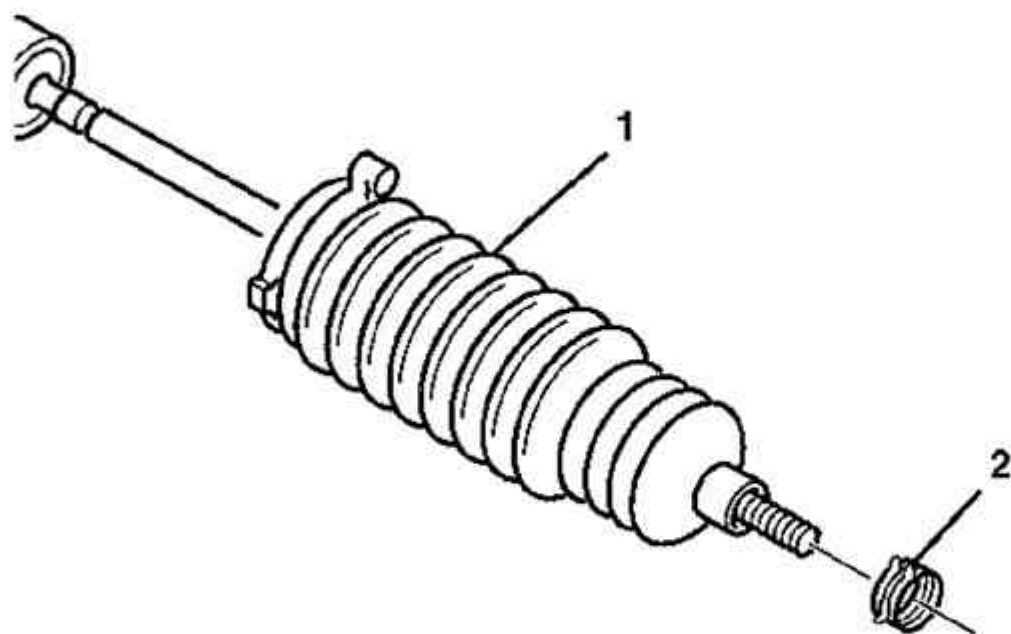
**J 22610** Keystone Clamp Pliers

### Disassembly Procedure



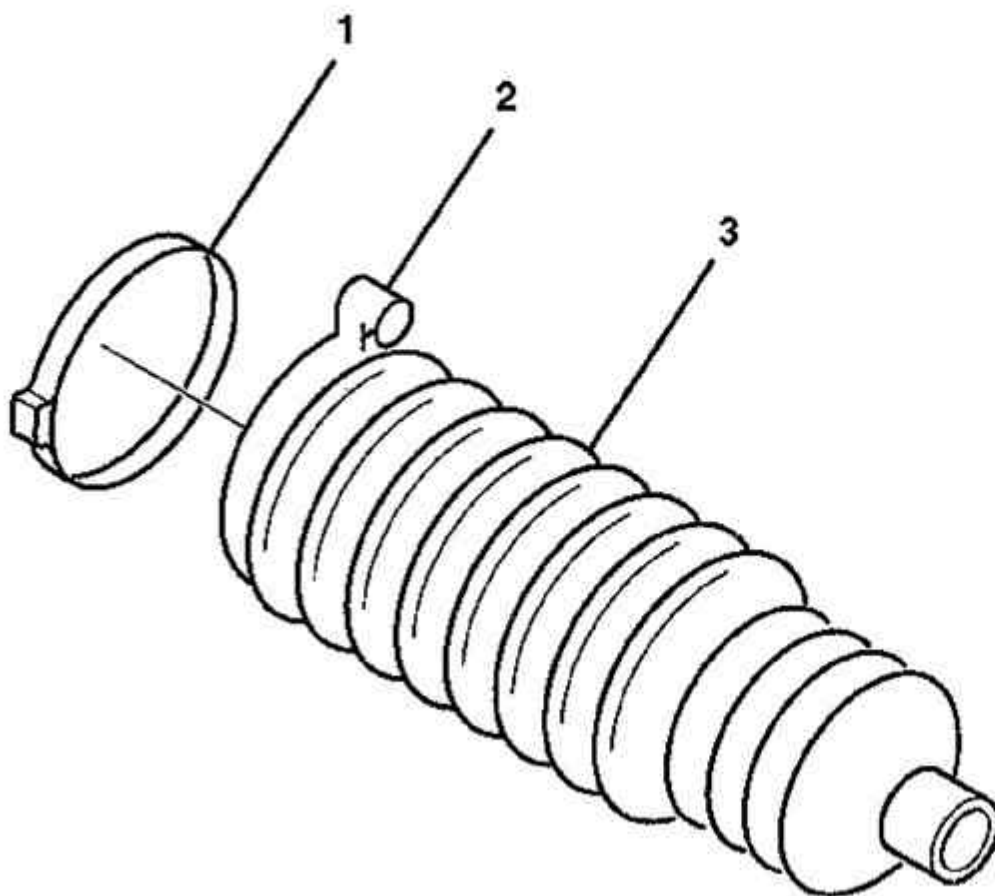
**Fig. 38: Identifying Inner Tie Rod Assembly Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

1. To remove the outer tie rod, Refer to **Rack and Pinion Outer Tie Rod End Replacement**.
2. Remove the hexagon jam nut (2) from the inner tie rod assembly (1).



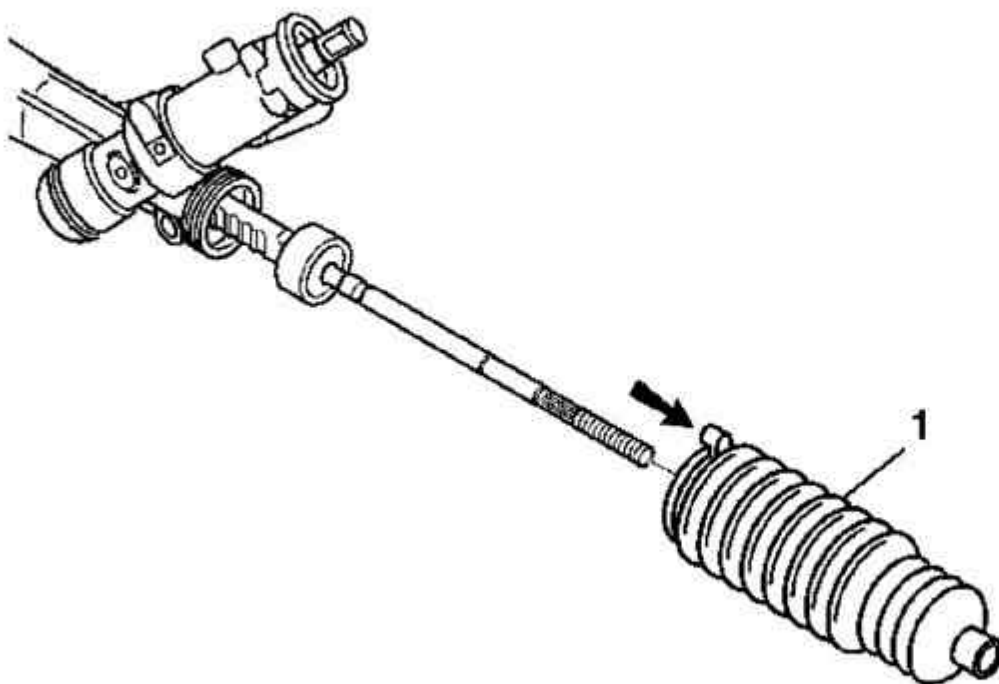
**Fig. 39: View Of Tie Rod End Clamp At Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the tie rod end clamp (2) from the rack and pinion boot (1).



**Fig. 40: View Of Boot Clamp & Rack & Pinion Boot**  
**Courtesy of GENERAL MOTORS CORP.**

4. Remove the boot clamp (1) from the rack and pinion boot with side cutters.
5. Discard the boot clamp (1).

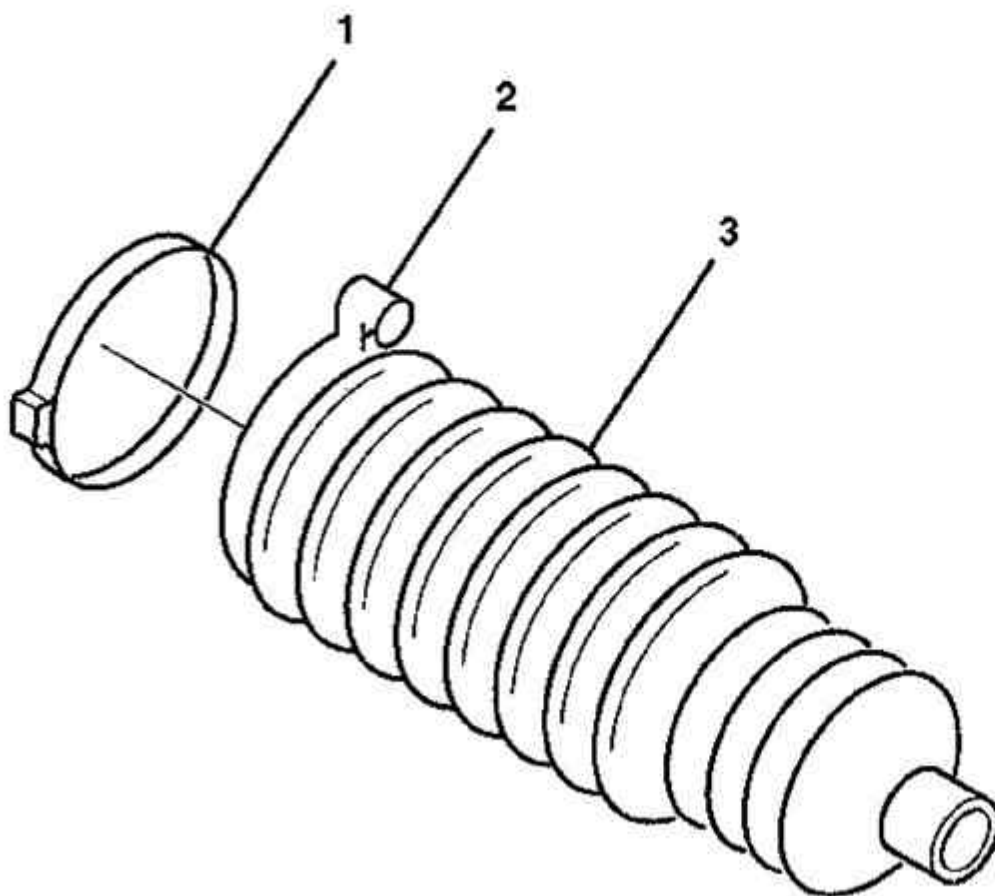


**Fig. 41: Identifying Rack & Pinion Boot & Breather Tube**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** If a breather tube is present, mark the location of the breather tube on the gear assembly before removal of the rack and pinion boot.

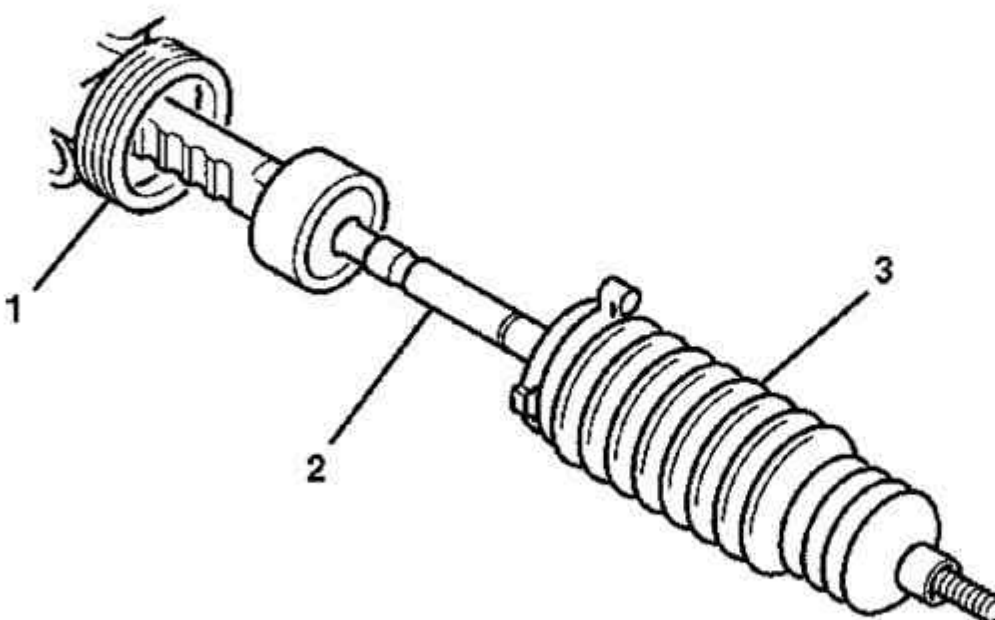
6. Remove the rack and pinion boot (1) and the breather tube, if present, from the rack and pinion gear assembly.

#### Assembly Procedure



**Fig. 42: View Of Boot Clamp & Rack & Pinion Boot**  
**Courtesy of GENERAL MOTORS CORP.**

1. Install the new boot clamp (1) onto the rack and pinion boot (3).

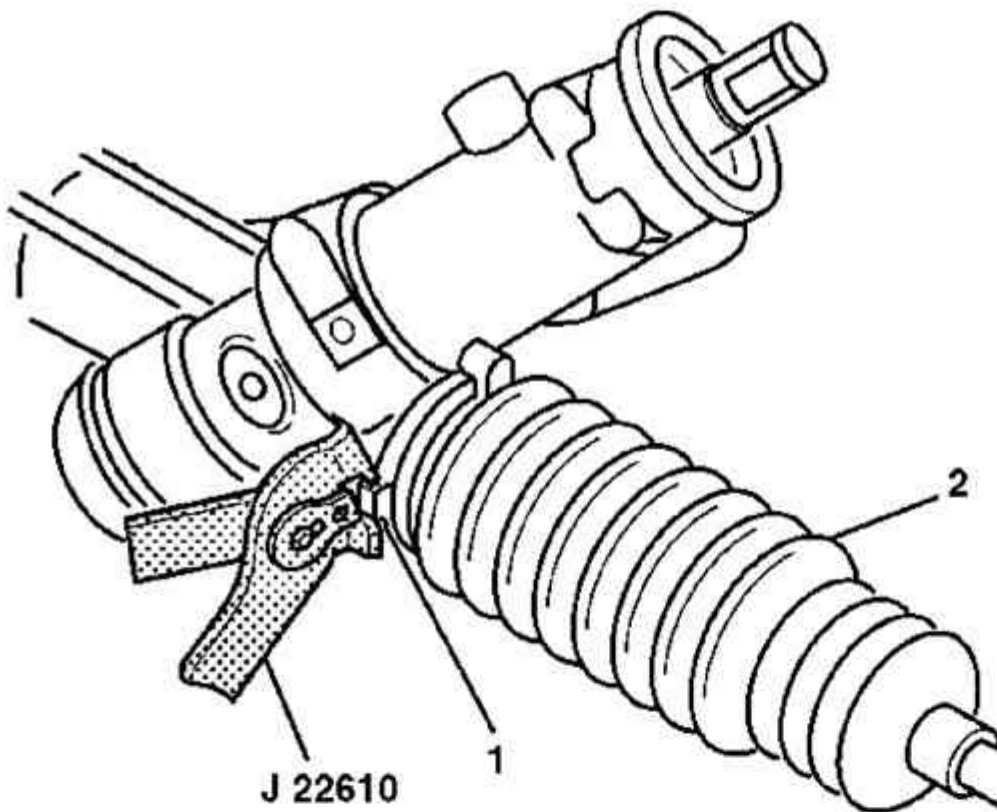


**Fig. 43: View Of Rack & Pinion Gear Assembly, Boot & Inner Tie Rod Assembly**  
Courtesy of GENERAL MOTORS CORP.

2. Prior to rack and pinion boot installation, apply grease to the inner tie rod assembly (2) and the rack and pinion gear assembly (1).
3. Install the rack and pinion boot (3) onto the inner tie rod assembly (2).
4. If present, install the breather tube while aligning the breather tube with the mark made during removal and the molded nipple of the rack and pinion boot.

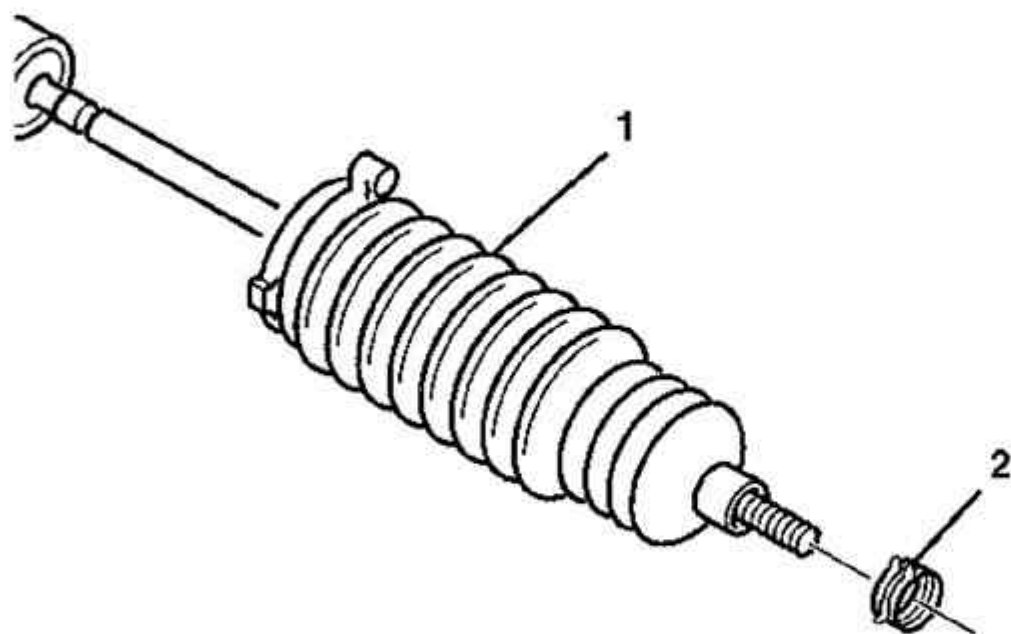
**IMPORTANT:** The rack and pinion boot (3) must not be twisted, puckered or out of shape in any way. If the rack and pinion boot (3) is not shaped properly, adjust the rack and pinion boot (3) by hand before installing the boot clamp.

5. Install the rack and pinion boot onto the gear assembly (1) until the rack and pinion boot (3) is seated in the gear assembly groove.



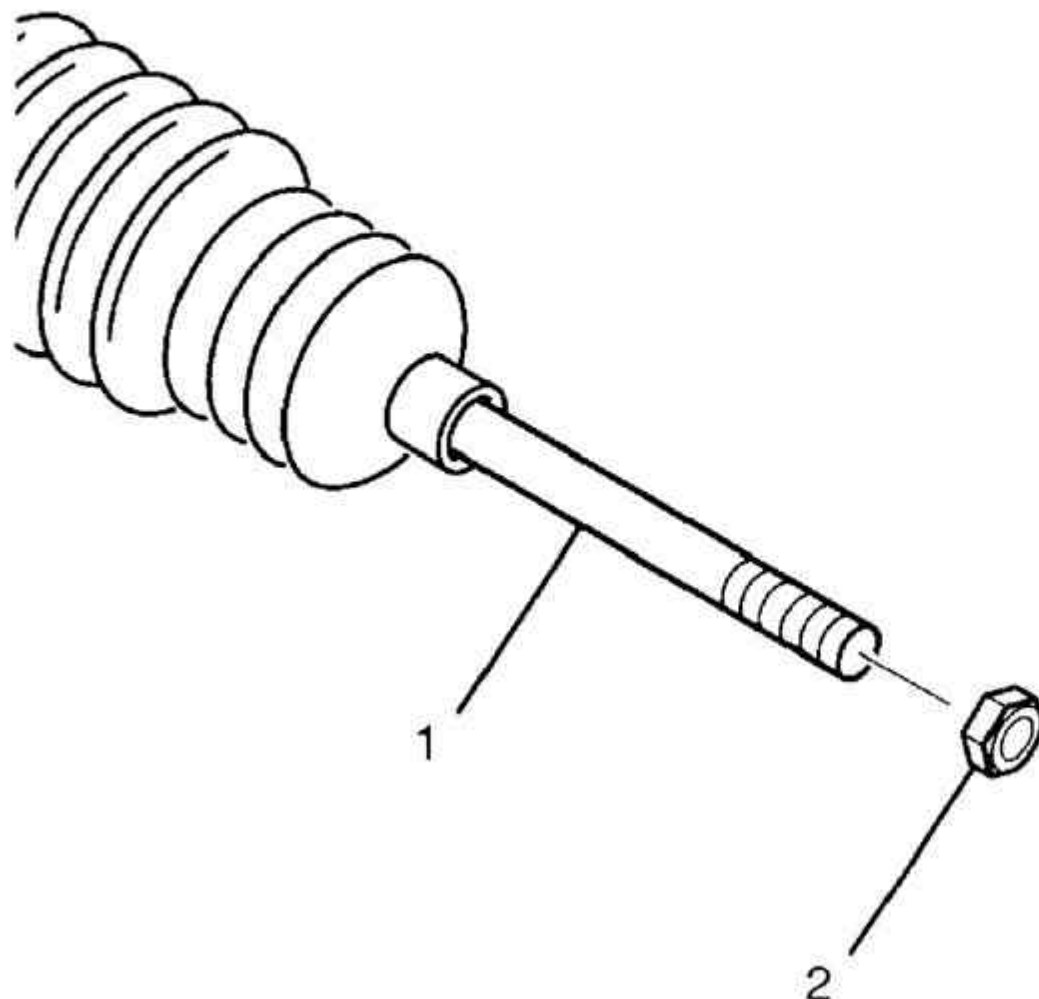
**Fig. 44: Using J 22610 To Install Boot Clamp**  
Courtesy of GENERAL MOTORS CORP.

6. Install the boot clamp (1) on the rack and pinion boot (2) with J 22610 .
7. Crimp the boot clamp (1).
8. Pinch the pliers together on the rack and pinion boot (2) in order to install the tie rod end clamp.



**Fig. 45: View Of Tie Rod End Clamp At Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

9. Install the tie rod end clamp (2) onto the rack and pinion boot (1).



**Fig. 46: View Of Inner Tie Rod & Hex Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

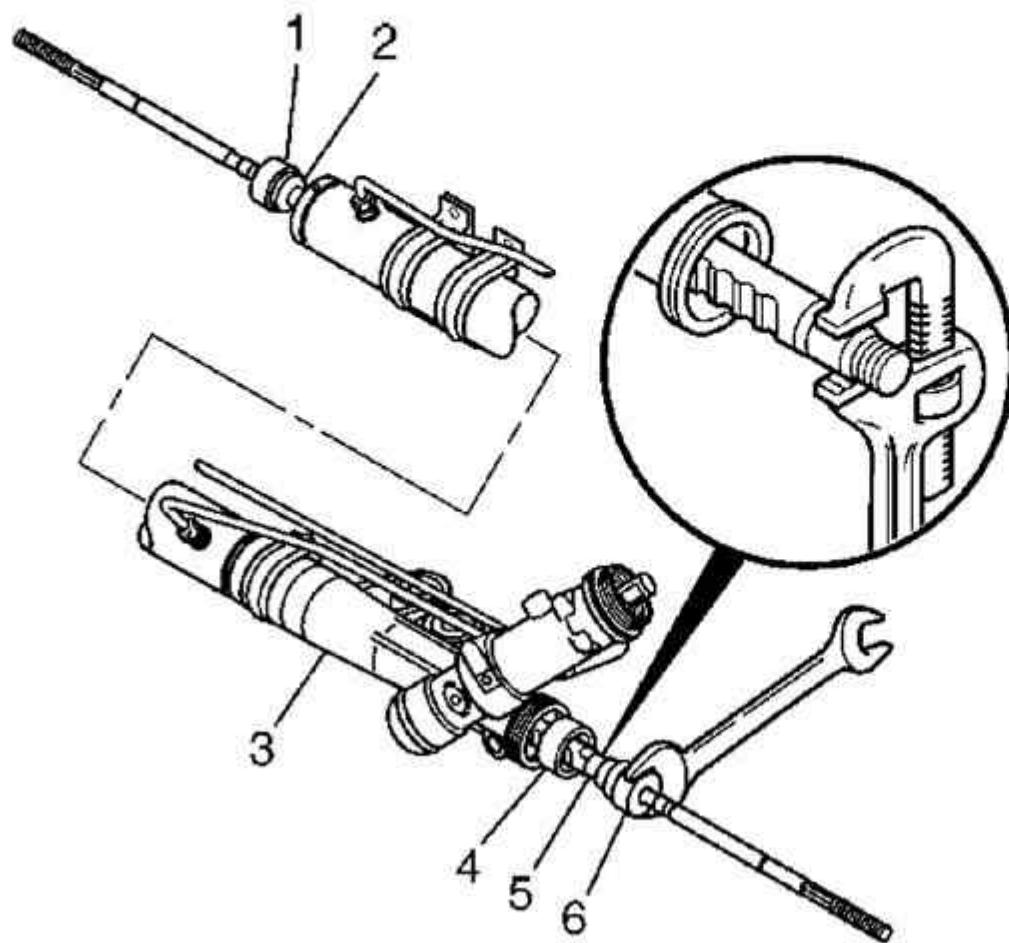
10. Install the hexagon jam nut (2) to the inner tie rod assembly (1).
11. To assemble the outer tie rod assembly. Refer to **Rack and Pinion Outer Tie Rod End Replacement**.

#### **RACK AND PINION INNER TIE ROD REPLACEMENT**

##### **Tools Required**

**J 34028** Inner Tie Rod Wrench. See **Special Tools**.

##### **Disassembly Procedure**



**Fig. 47: Identifying Inner Tie Rod Components**  
Courtesy of GENERAL MOTORS CORP.

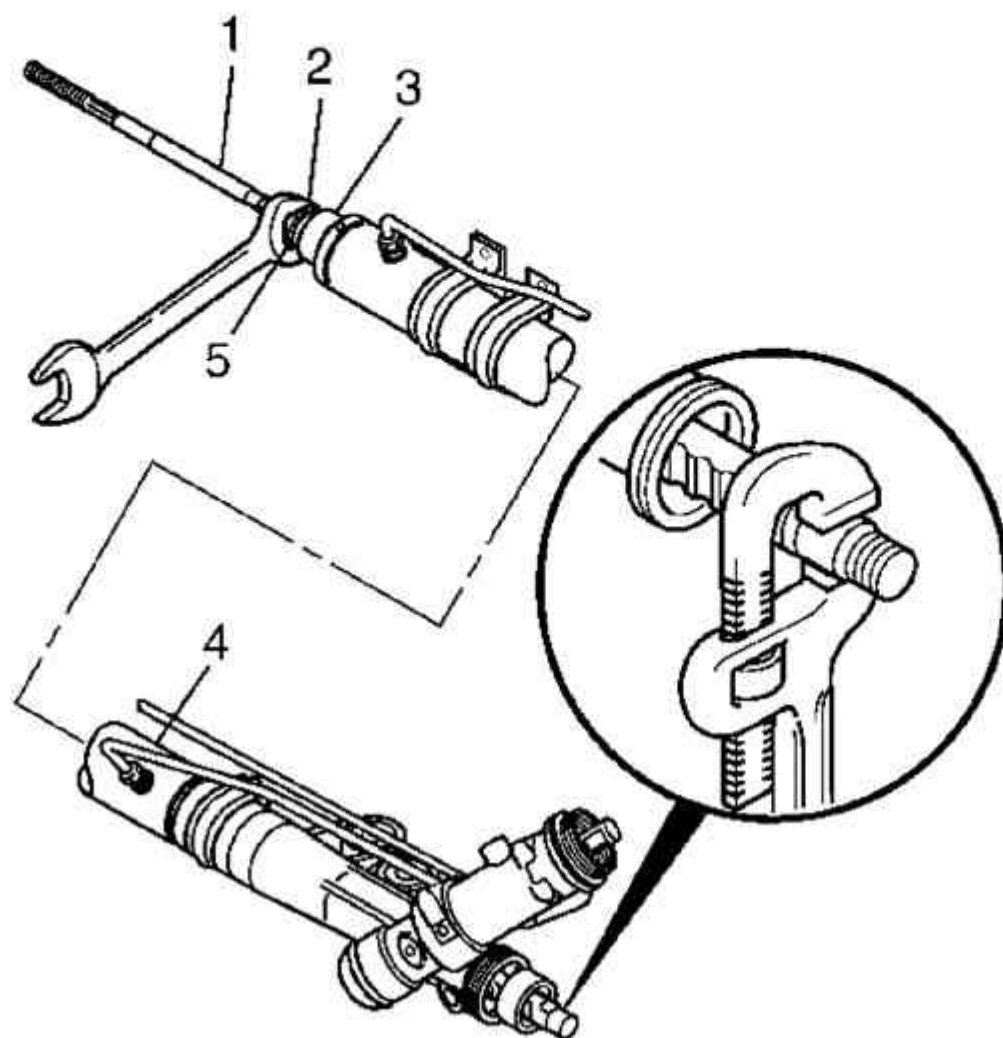
1. To remove the rack and pinion boot and the breather tube. Refer to **Rack and Pinion Boot Replacement**.
2. Place the gear in a vise.

**NOTE:** Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

3. Remove the shock dampener (4) from the inner tie rod housing (6).
4. Slide the shock dampener (4) back on the rack (5).

**NOTE:** Refer to **Pipe Wrench Positioning Notice**.

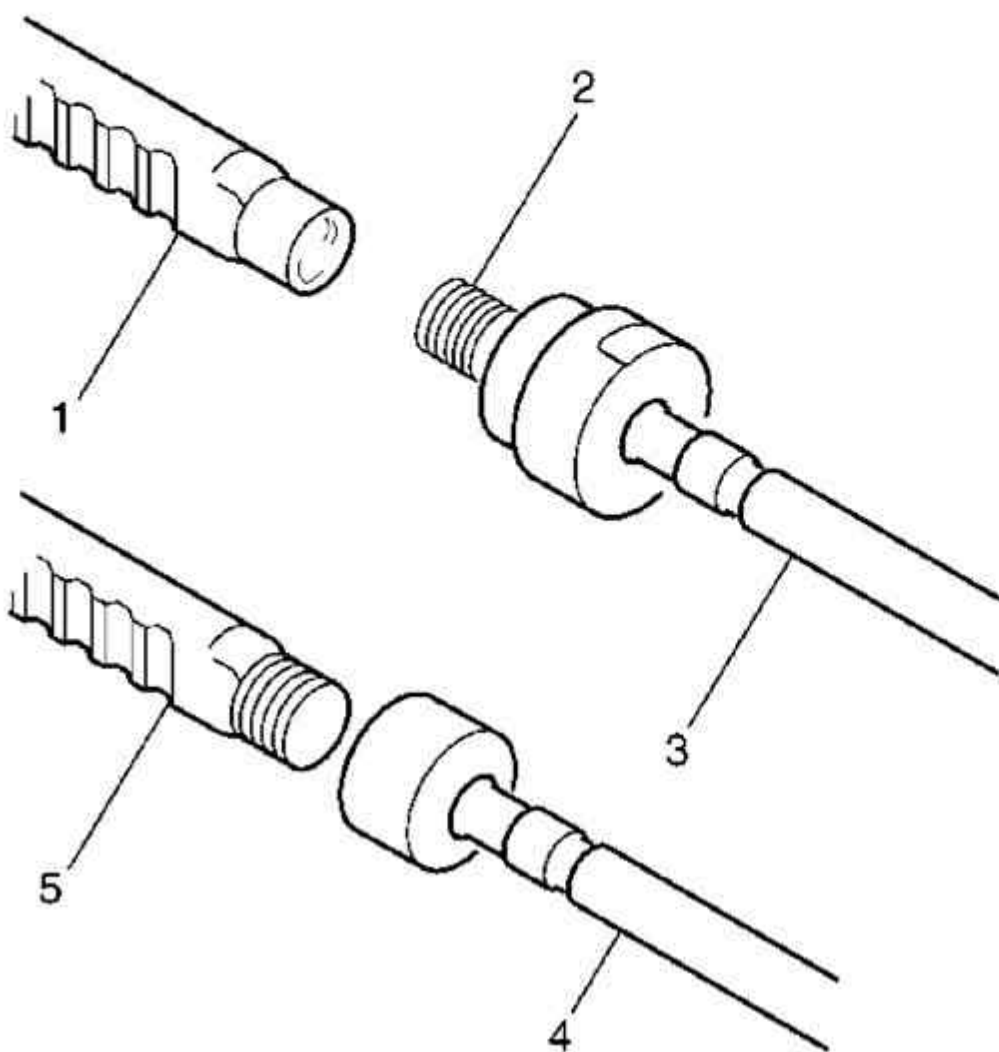
5. Place a pipe wrench on the rack (5) next to the inner tie rod housing (6).
6. Place a wrench on the flats of the inner tie rod housing (6).
7. Rotate the inner tie rod housing (6) counterclockwise, while holding the rack stationary, until the inner tie rod separates from the rack (5).



**Fig. 48: Illustrating Separating Inner Tie Rod From Rack**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Pipe Wrench Positioning Notice .

8. Remove the shock dampener (3) from the inner tie rod housing (2).
9. Slide the shock dampener (3) back on the rack (5).
10. Place a pipe wrench on the rack.
11. Place a wrench on the flats of the inner tie rod housing (2).
12. Rotate the inner tie rod housing (2) counterclockwise, while holding the rack stationary, until the inner tie rod (1) separates from the rack (5).

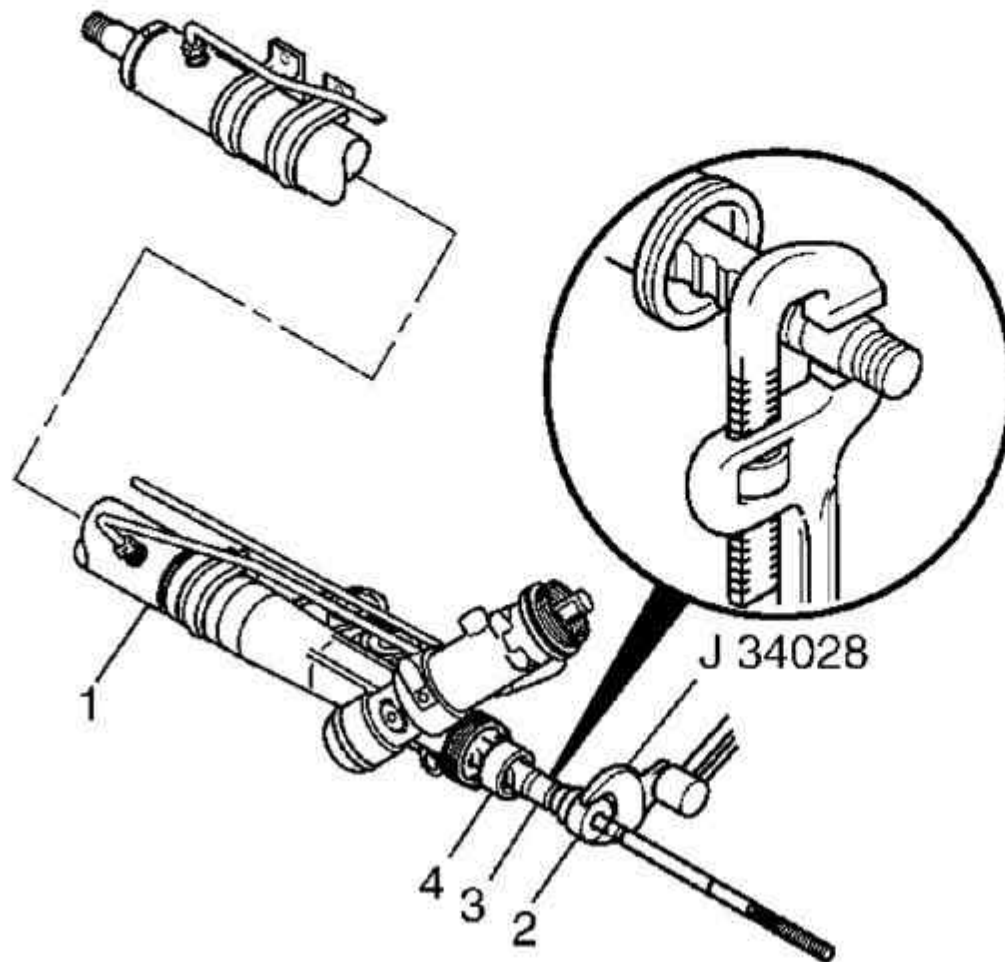


**Fig. 49: Identifying Tie Rod Male & Female Ends**  
Courtesy of GENERAL MOTORS CORP.

13. If female rack (1) and male inner tie rod (3), remove the old LOCTITE® from the threads (2) of the inner tie rod and the rack.

If male rack (5) and female inner tie rod (4) LOCTITE® will not be present.

#### Assembly Procedure



**Fig. 50: Illustrating Connecting Inner Tie Rod To Rack**  
Courtesy of GENERAL MOTORS CORP.

1. Slide the shock dampener (4) forward onto the rack (3).

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE®, or equivalent, container for expiration date. Use only enough LOCTITE® to evenly coat threads.

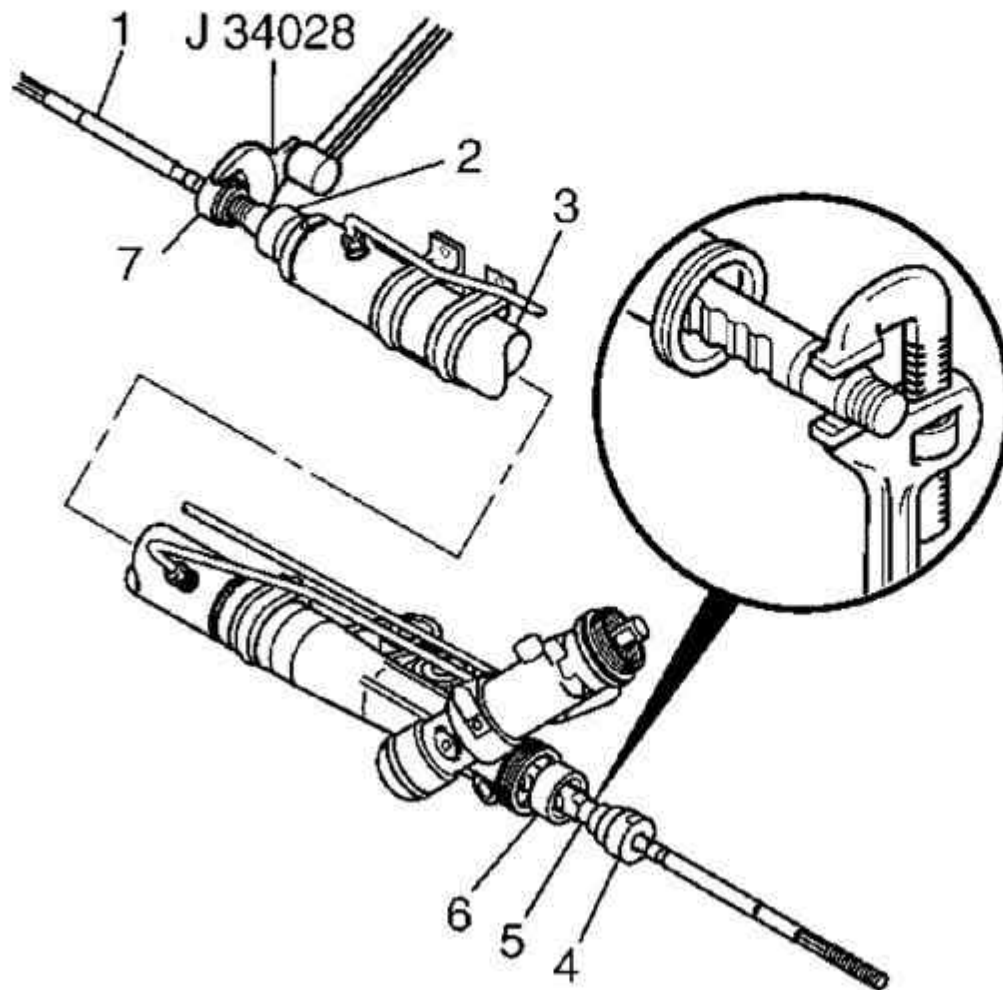
If male rack (3) and female inner tie rod (2) do not apply LOCTITE®.

2. If female rack (3) and male inner tie rod (2), apply LOCTITE® 262, or equivalent, to the inner tie rod threads.
3. Attach the inner tie rod onto the rack (3).
4. Place a pipe wrench on the rack (3) next to the inner tie rod housing (2).

**NOTE:** Refer to Fastener Notice .

5. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (2). See Special Tools.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).



**Fig. 51: Illustrating Tightening Of Inner Tie Rod To Rack**  
 Courtesy of GENERAL MOTORS CORP.

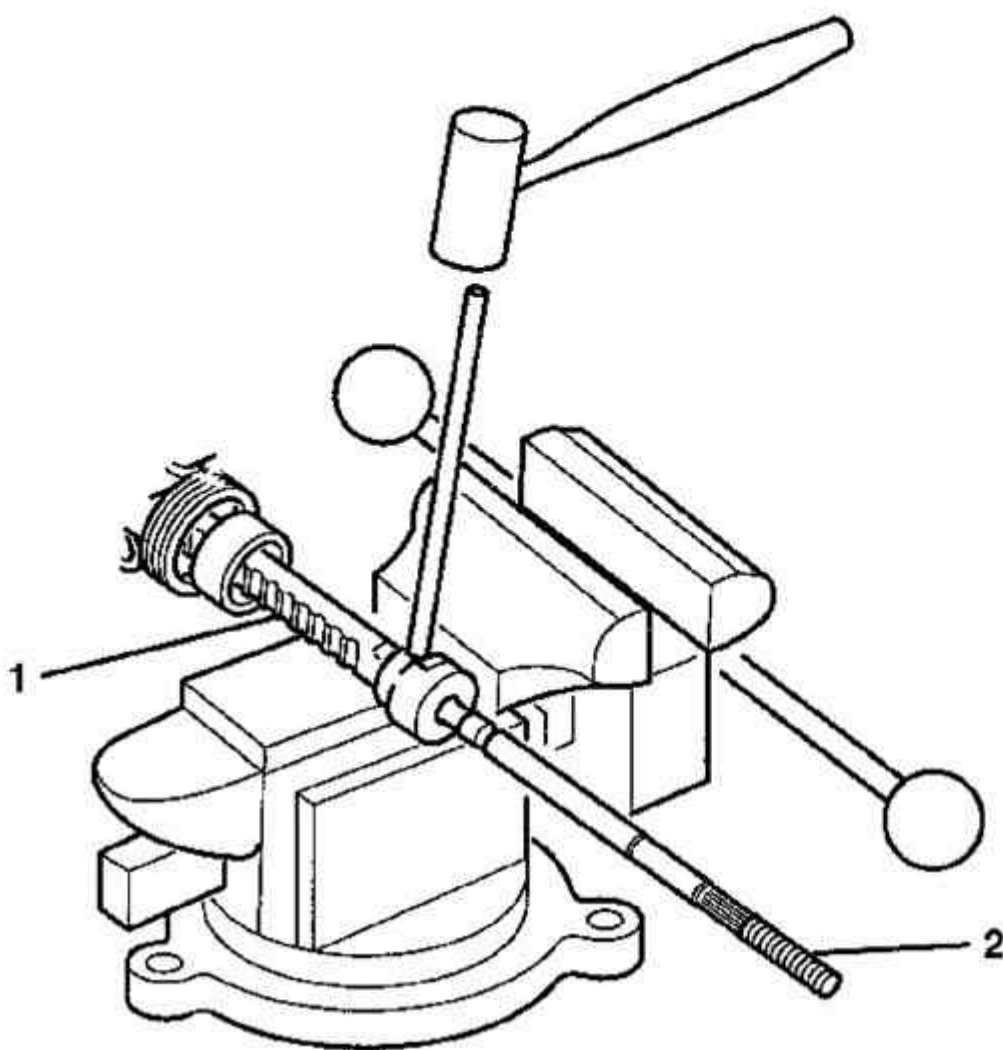
6. Slide the shock dampener (2) forward onto the rack.

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE®, or equivalent, container for expiration date. Use only enough LOCTITE® to evenly coat threads.

If male rack and female inner tie rod (1) do not apply LOCTITE®.

7. If female rack and male inner tie rod (1), apply LOCTITE® 262, or equivalent, to the inner tie rod threads.
8. Attach the inner tie rod (1) onto the rack.
9. Place a pipe wrench on the rack next to the inner tie rod housing (4).
10. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (7). See **Special Tools**.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).

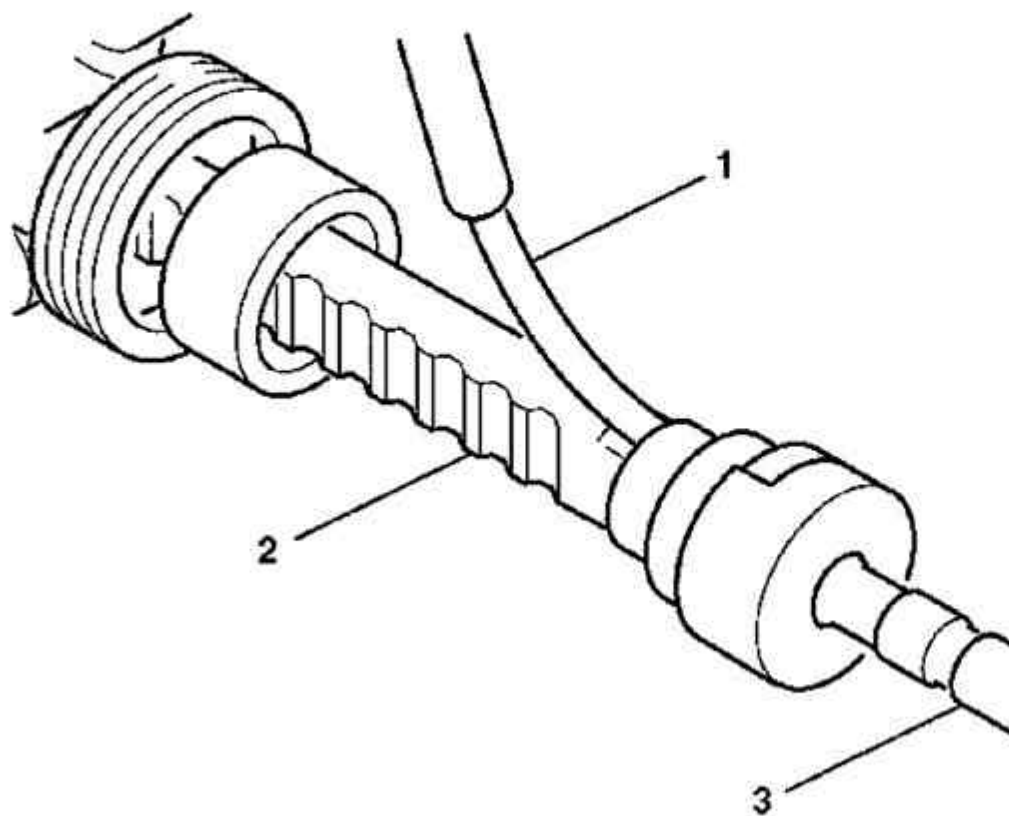


**Fig. 52: Staking Both Sides Of Female Inner Tie Rod Assembly Housing To Male Rack**  
Courtesy of GENERAL MOTORS CORP.

11. Place the inner tie rod assembly (2) in a vise.

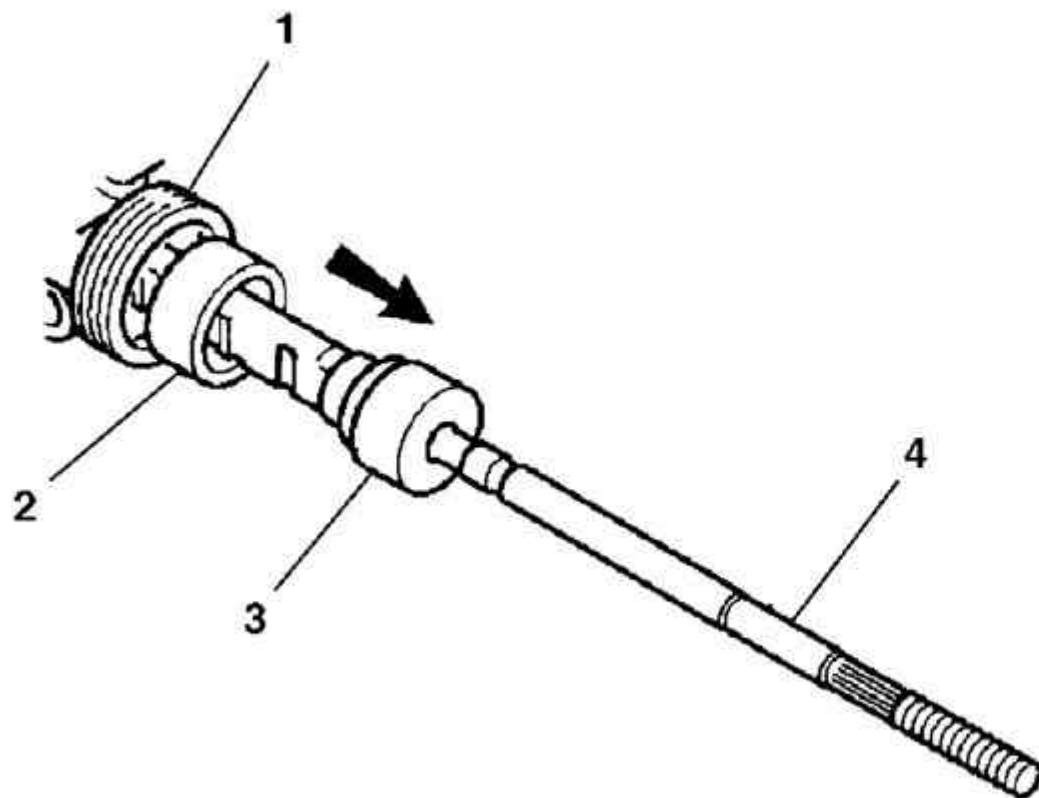
**IMPORTANT:** If female rack (1) and male inner tie rod (2) do not stake. If male rack (1) and female inner tie rod (2) you must stake.

12. Stake both sides of the female inner tie rod assembly housing to the male rack.



**Fig. 53: Inserting Gage Between Rack & Inner Tie Rod Housing**  
**Courtesy of GENERAL MOTORS CORP.**

13. Insert a 0.25 mm gage (1) between the rack (2) and the inner tie rod housing in order to check both stakes. The feeler gage (1) must not pass between the rack and the housing stake.



**Fig. 54: Identifying Shock Dampener & Inner Tie Rod Housing**  
Courtesy of GENERAL MOTORS CORP.

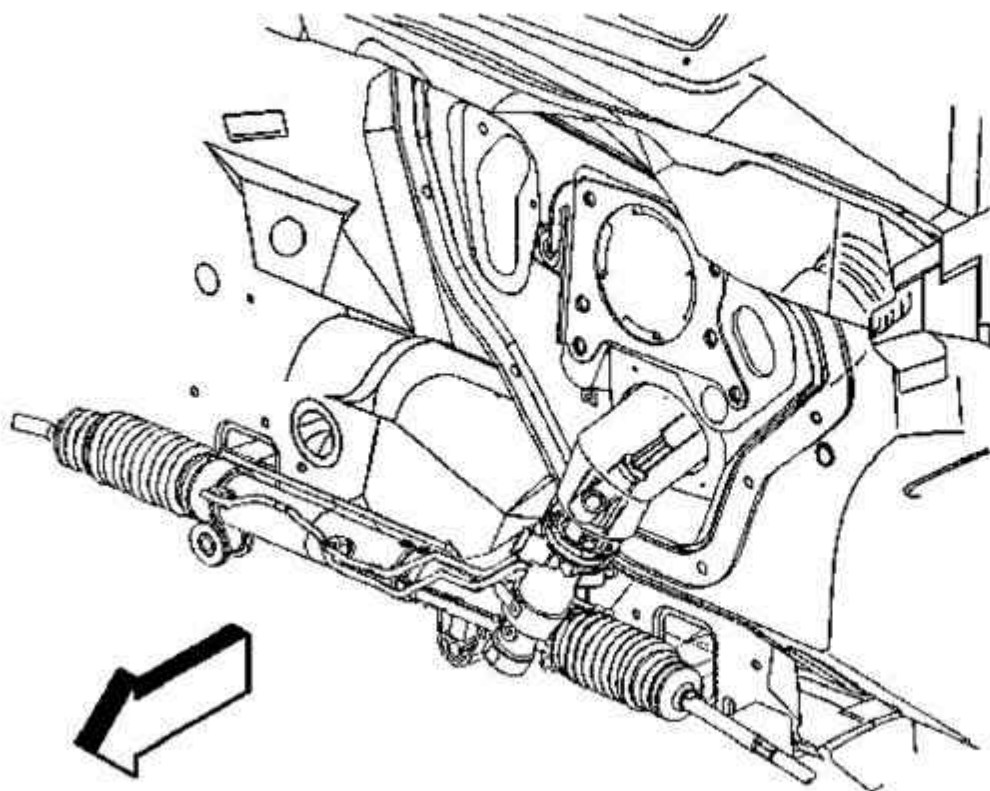
14. Slide the shock dampener (2) over the inner tie rod housing (3) until the front lip of the shock dampener (2) bottoms against the inner tie rod housing (3).
15. To assemble the rack and pinion boot and the breather tube. Refer to **Rack and Pinion Boot Replacement**.

#### **STEERING GEAR BOOT REPLACEMENT - ON VEHICLE**

##### **Tools Required**

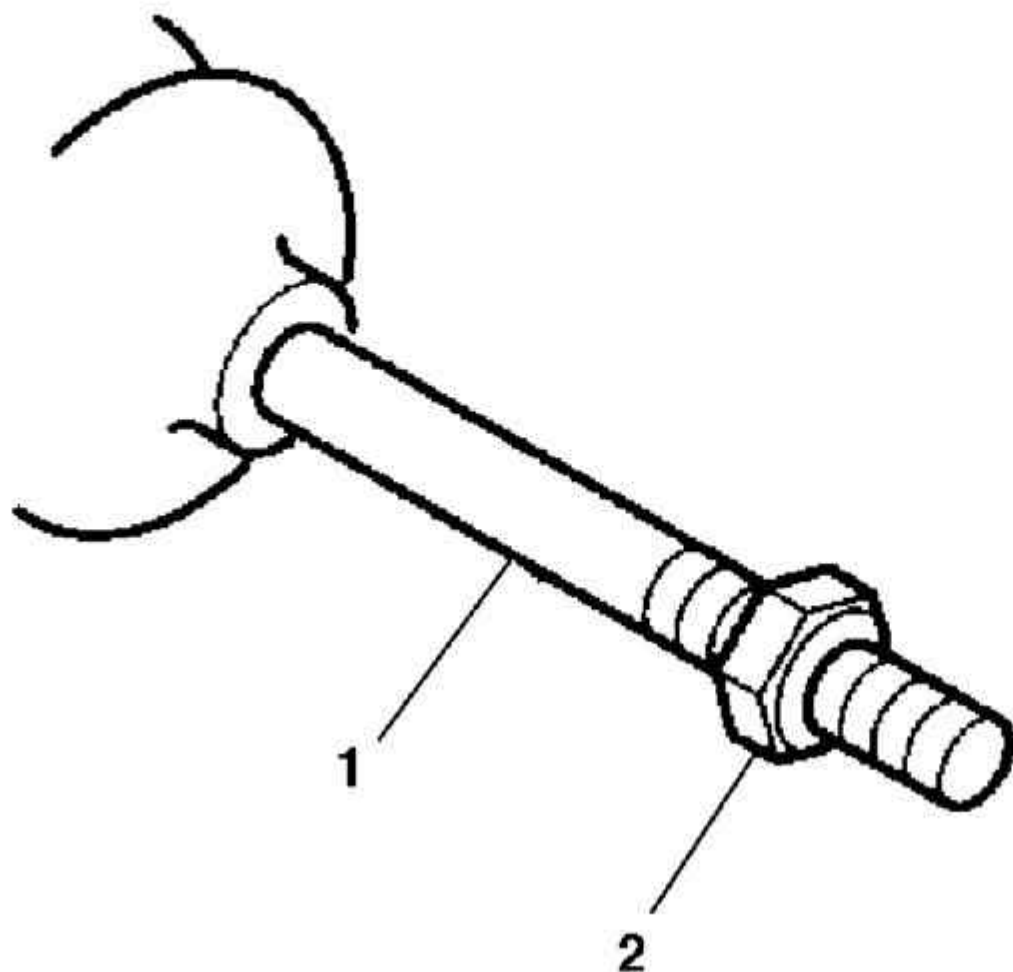
**J 22610** Keystone Clamp Pliers

##### **Removal Procedure**



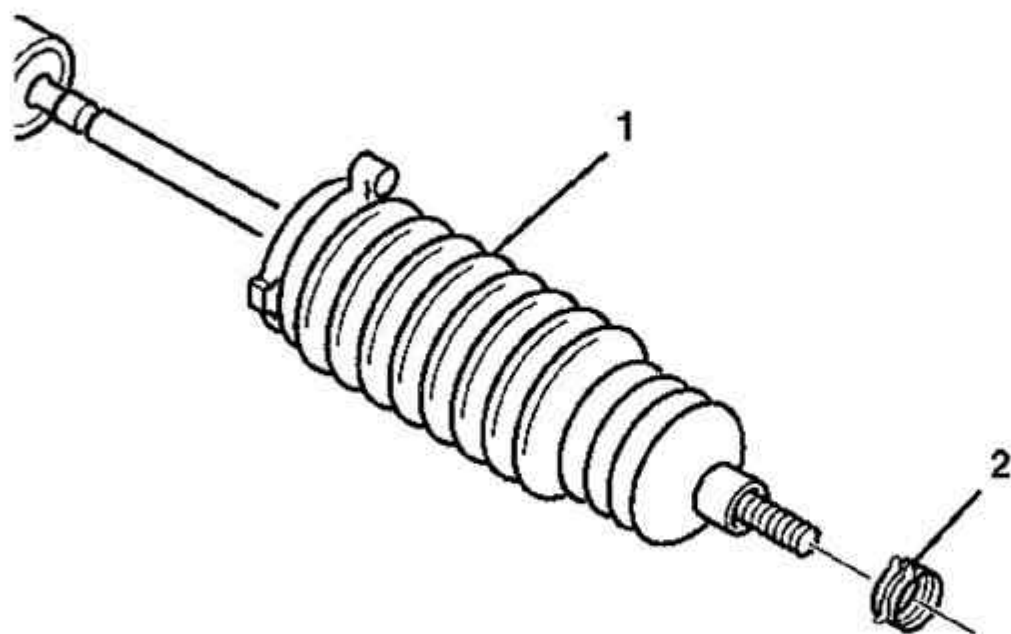
**Fig. 55: View Of Steering Rack Assembly**  
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
3. Remove the outer tie rod from the inner tie rod assembly. Refer to Rack and Pinion Outer Tie Rod End Replacement .
4. Remove the intermediate steering shaft lower pinch bolt. Refer to Intermediate Steering Shaft Replacement .
5. Remove the rear frame mounting bolts to allow for tool access. Refer to Frame Replacement .



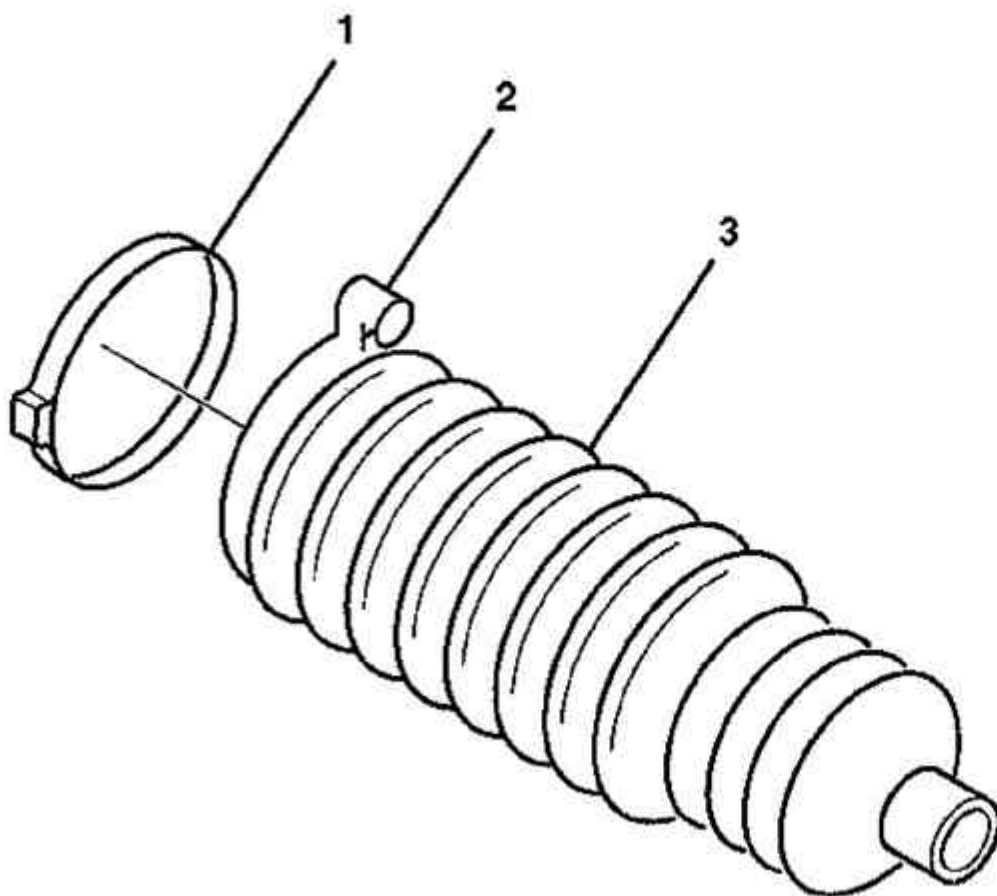
**Fig. 56: Identifying Inner Tie Rod Assembly Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the inner tie rod jam nut (2) from the inner tie rod assembly (1).



**Fig. 57: View Of Tie Rod End Clamp, Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the clamp (2) from the end of the inner tie rod boot (1).



**Fig. 58: View Of Inner Tie Rod Boot Clamp**  
Courtesy of GENERAL MOTORS CORP.

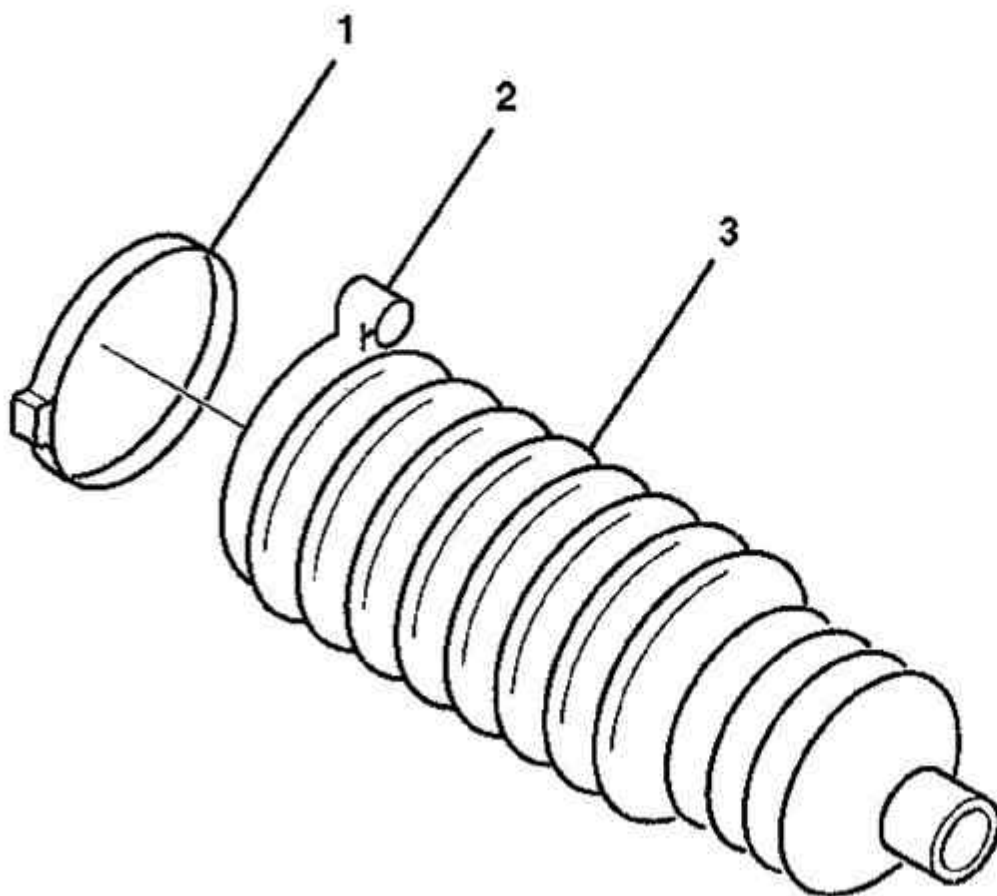
8. Remove the inner tie rod boot clamp (1) from the inner tie rod boot (3) with side cutters.
9. Discard the inner tie rod boot clamp (1).

**IMPORTANT:**

- Prior to removing breather tube (2) or the inner tie rod boot (3), mark the location of the breather tube (2) on the power steering gear assembly.
- After removing the boot, inspect the inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear.

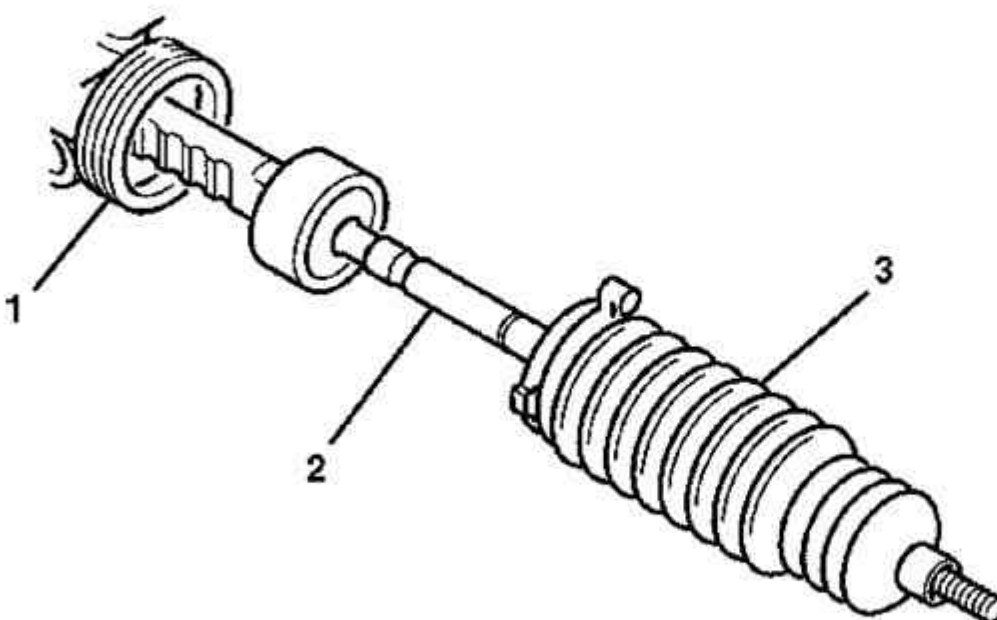
10. Remove the inner tie rod boot (3) and the breather tube (2).

**Installation Procedure**



**Fig. 59: View Of Inner Tie Rod Boot Clamp**  
Courtesy of GENERAL MOTORS CORP.

1. Install the new inner tie rod boot clamp (1) onto the inner tie rod boot (3).

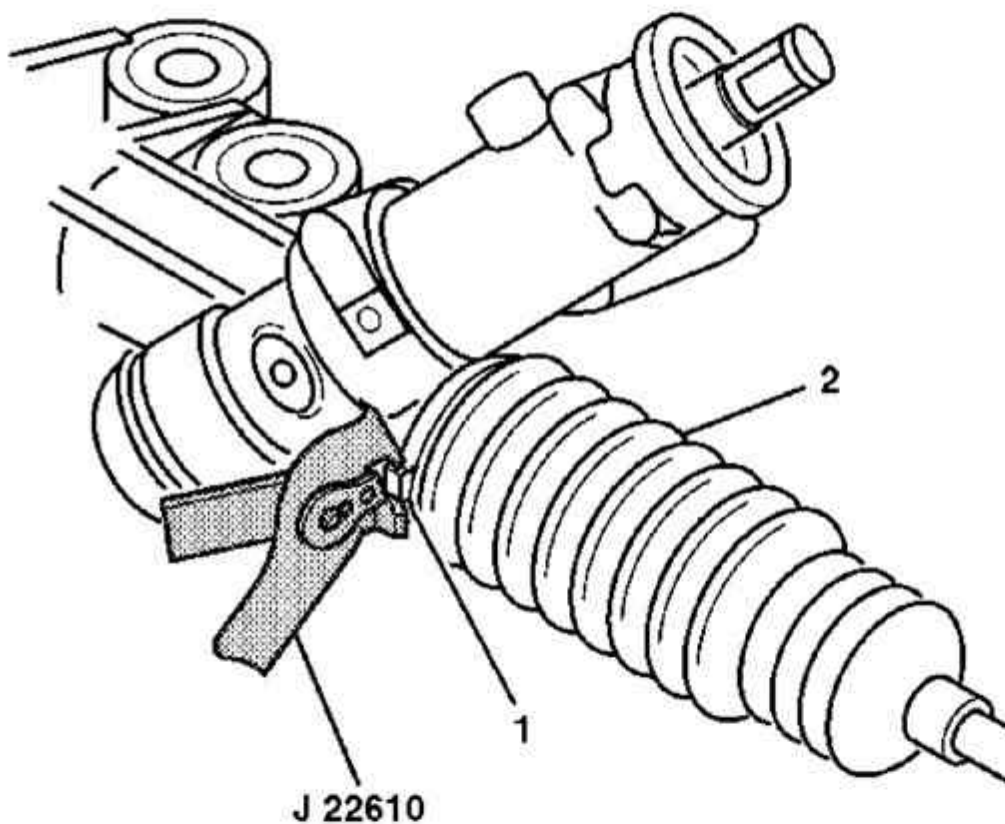


**Fig. 60: Identifying Inner Tie Rod, Rack & Pinion Gear & Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

2. Prior to the inner tie rod boot (3) installation, apply grease to the inner tie rod assembly (2) and the power steering gear assembly (1).

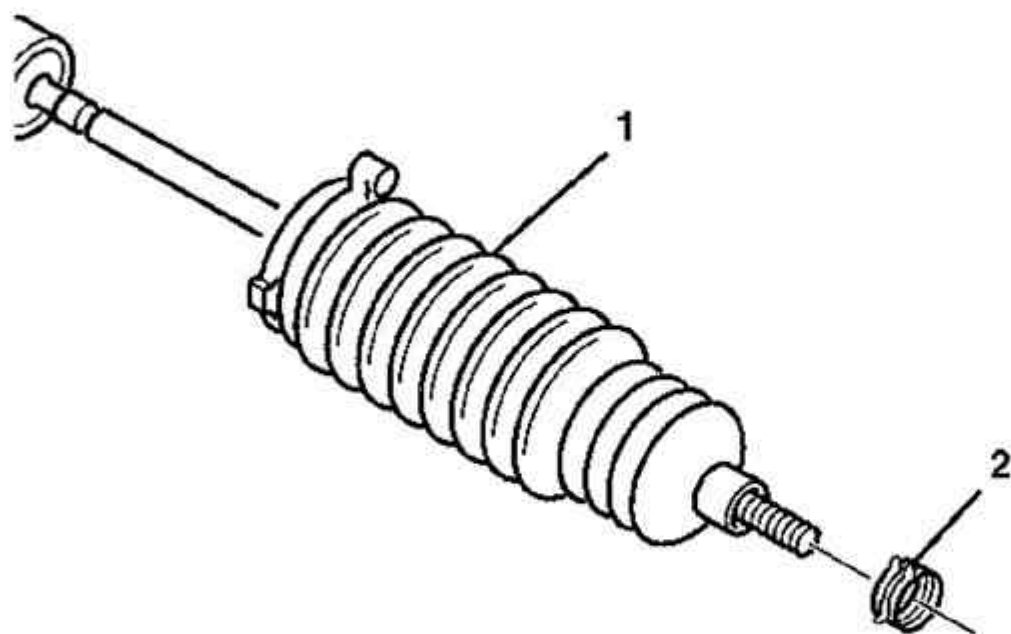
**IMPORTANT:** The inner tie rod boot (3) must not be twisted, puckered or out of shape in any way. If the inner tie rod boot (3) is not shaped properly, adjust the inner tie rod boot (3) by hand before installing the boot clamp.

3. Install the inner tie rod boot (3) onto the inner tie rod assembly (2).
4. Align the breather tube with the mark made during removal and the molded nipple of the inner tie rod boot.
5. Install the inner tie rod boot (3) onto the power steering gear assembly until the inner tie rod boot (3) is seated in the power steering gear assembly groove.

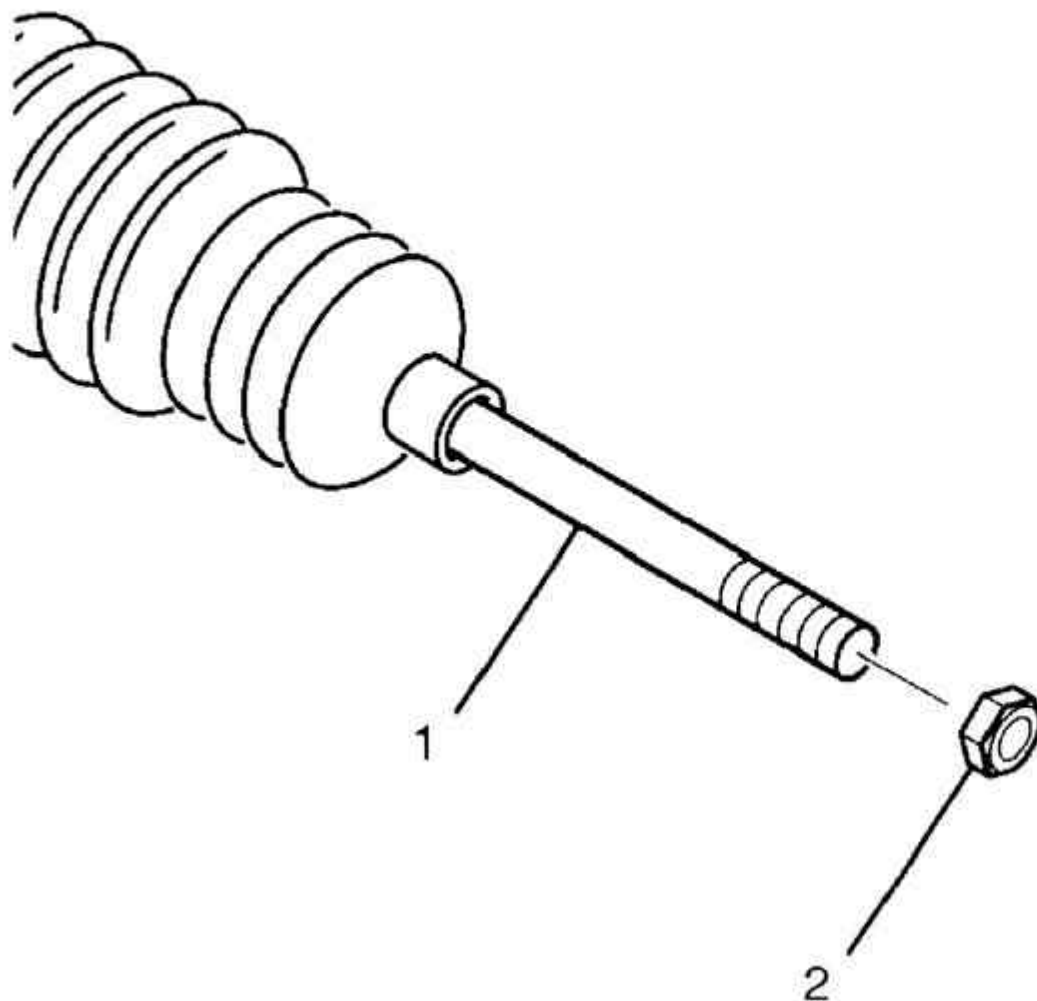


**Fig. 61: Installing Inner Tie Rod Boot Clamp**  
Courtesy of GENERAL MOTORS CORP.

6. Using the J 22610 install the inner tie rod boot clamp (1) on the inner tie rod boot (2) by firmly crimping the inner tie rod boot clamp (1).
7. Install the inner tie rod small boot clamp (2).

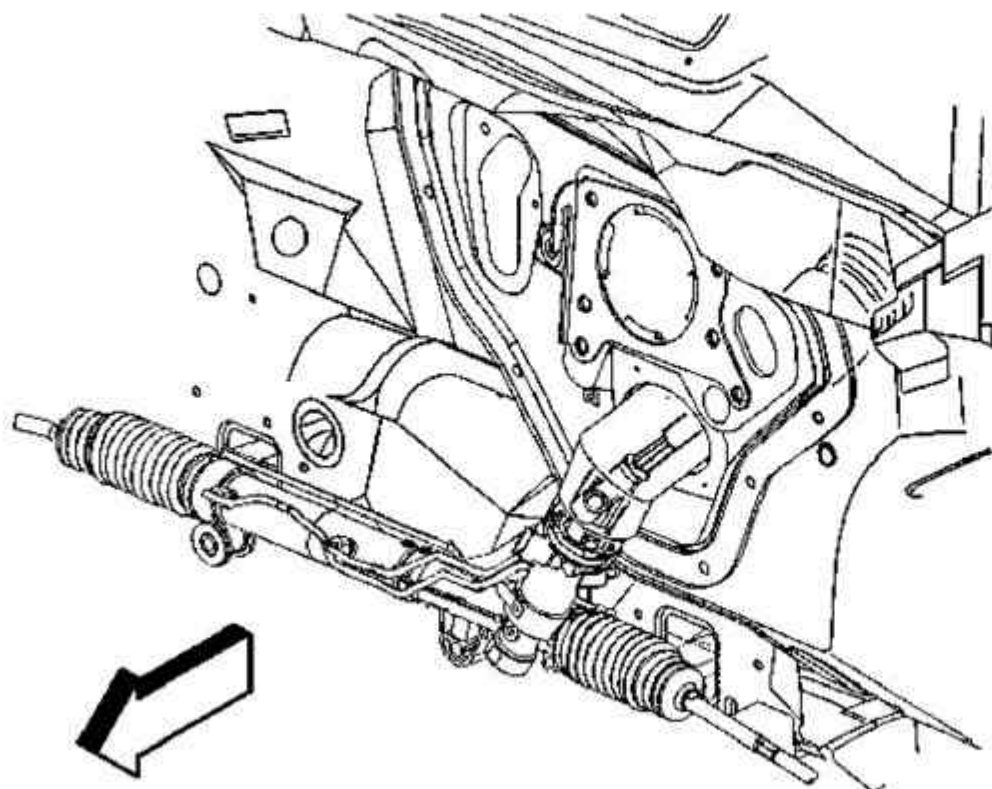


**Fig. 62: View Of Tie Rod End Clamp, Rack & Pinion Boot**  
**Courtesy of GENERAL MOTORS CORP.**



**Fig. 63: View Of Inner Tie Rod & Hex Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

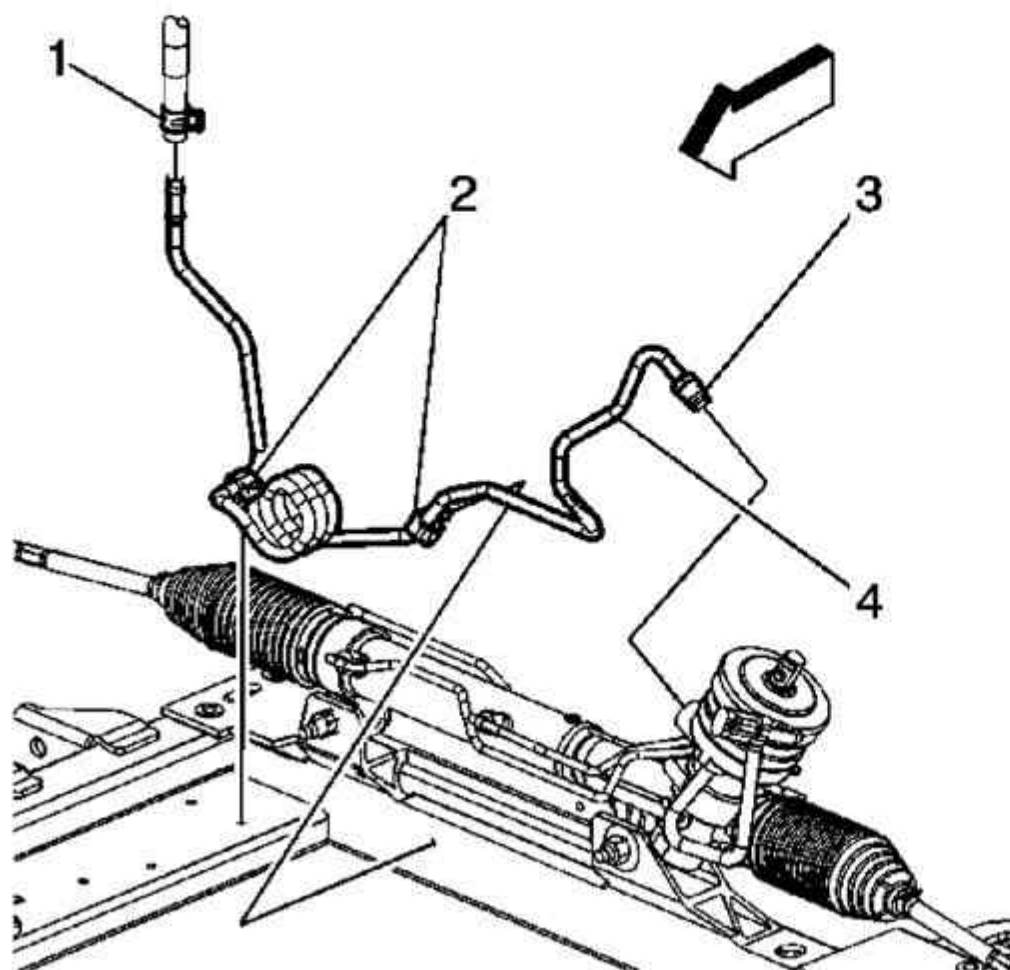
8. Install the inner tie rod jam nut (2) to the inner tie rod assembly (1).
9. Install the rear frame mounting bolts. Refer to **Frame Replacement**.
10. Install the intermediate steering shaft lower pinch bolt. Refer to **Intermediate Steering Shaft Replacement**.
11. Install the outer tie rod to the inner tie rod assembly. Refer to **Rack and Pinion Outer Tie Rod End Replacement**.



**Fig. 64: View Of Steering Rack Assembly**  
Courtesy of GENERAL MOTORS CORP.

12. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
13. Lower the vehicle.
14. Perform a front end alignment. Refer to **Wheel Alignment Measurement** .

**POWER STEERING COOLER PIPE/HOSE REPLACEMENT (LY7)**

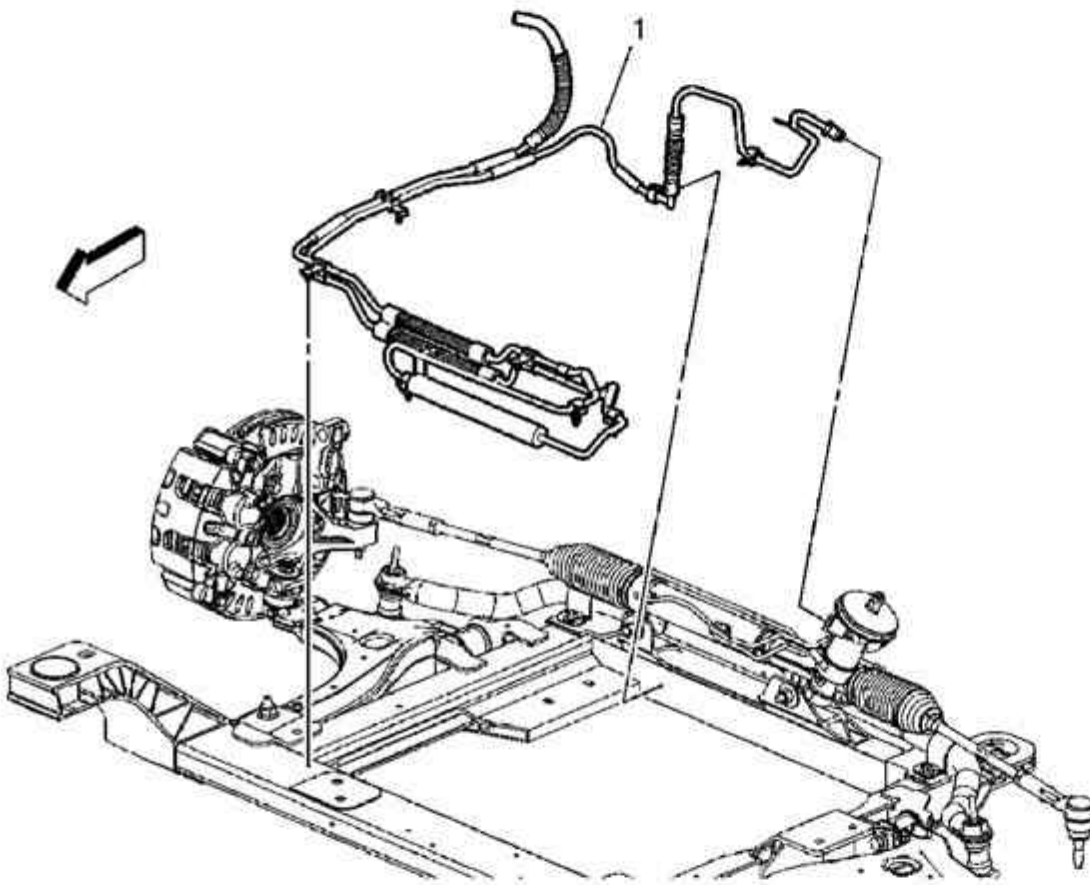


**Fig. 65: View Of Power Steering Hoses (3.6L)**  
 Courtesy of GENERAL MOTORS CORP.

| Callout                                                                                                                                                                                                                                                                                                                                                            | Component Name                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b>                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                               |
| <ol style="list-style-type: none"> <li>1. Remove the right front tire/wheel assembly. Refer to <u><b>Power Steering Cooler Pipe/Hose Replacement (LY7)</b></u> or <u><b>Power Steering Cooler Pipe/Hose Replacement (LS4)</b></u> or <u><b>Power Steering Cooler Pipe/Hose Replacement (L26)</b></u>.</li> <li>2. Remove the steering gear heat shield.</li> </ol> |                                                                                                                                                                                                                                                                                                                                                                                                               |
| 1                                                                                                                                                                                                                                                                                                                                                                  | Power Steering Reservoir Inlet Hose<br><br><b>Procedure</b> <ol style="list-style-type: none"> <li>1. Remove as much power steering fluid from the remote power steering fluid reservoir as possible.</li> <li>2. Place drain pans under the vehicle as needed.</li> <li>3. Release the power steering reservoir inlet hose clamp.</li> <li>4. Disconnect the power steering reservoir inlet hose.</li> </ol> |
| 2                                                                                                                                                                                                                                                                                                                                                                  | Power Steering Cooler Hose Retaining Clip (Qty: 2)<br><b>Tip:</b> Use a trim panel removal tool to disengage the clips and replace them if needed.                                                                                                                                                                                                                                                            |
|                                                                                                                                                                                                                                                                                                                                                                    | Power Steering Cooler Hose Fitting                                                                                                                                                                                                                                                                                                                                                                            |

|   |                                                                                                                                                                                                                                                                                  |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | <p><b>NOTE:</b><br/>Refer to <u>Fastener Notice</u> .</p> <p><b>Tighten:</b> 27 N.m (20 lb ft)</p>                                                                                                                                                                               |
| 4 | <p>Power Steering Cooler Hose</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Replace the power steering cooler hose seal.</li> <li>2. After repairs, fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>.</li> </ol> |

#### POWER STEERING COOLER PIPE/HOSE REPLACEMENT (LS4)



**Fig. 66: Identifying Power Steering Cooler Pipe/Hose**  
Courtesy of GENERAL MOTORS CORP.

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Component Name                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| <b>Preliminary Procedure</b> <ol style="list-style-type: none"> <li>1. Remove the front tire/wheel assemblies. Refer to <u>Tire and Wheel Removal and Installation</u> .</li> <li>2. Remove the right fender liner. Refer to <u>Front Fender Liner Replacement</u> .</li> <li>3. Lower the rear of the frame approximately 51 mm (2 in). Refer to <u>Frame Replacement</u> .</li> <li>4. Loosen the power steering gear bolts. Refer to <u>Steering Gear Replacement</u>.</li> <li>5. Fill and bleed the power steering system after the repair has been completed. Refer to <u>Power Steering System Bleeding</u>.</li> </ol> |                                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>Power Steering Cooler Pipe</p> <p><b>NOTE:</b></p> |

Refer to Fastener Notice .

### Procedure

1

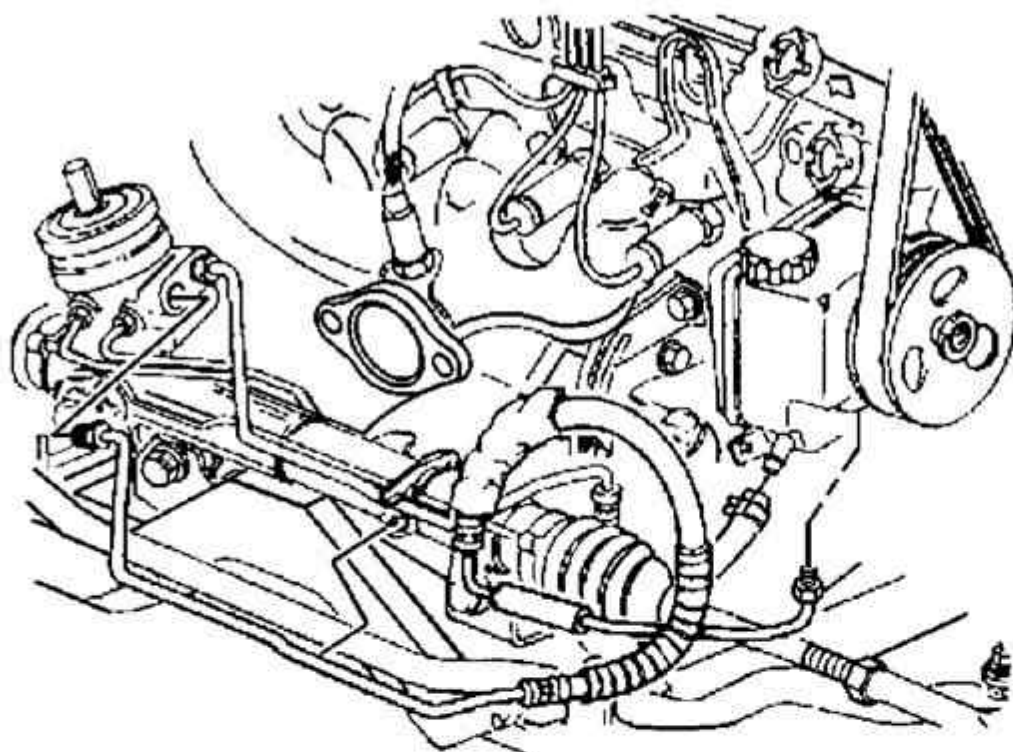
1. Remove as much power steering fluid from the power steering fluid reservoir as possible.
2. Place drain pans under the vehicle as needed.
3. Disconnect the power steering cooler pipe from the power steering fluid reservoir.
4. Disconnect all power steering cooler pipe retaining clips as needed with an appropriate tool. Replace any as needed.
5. Disconnect the power steering cooler pipe fitting.
6. After repairs, fill and bleed the power steering system. Refer to Power Steering System Bleeding.

**Tighten:** 27 N.m (20 lb ft)

## POWER STEERING COOLER PIPE/HOSE REPLACEMENT (L26)

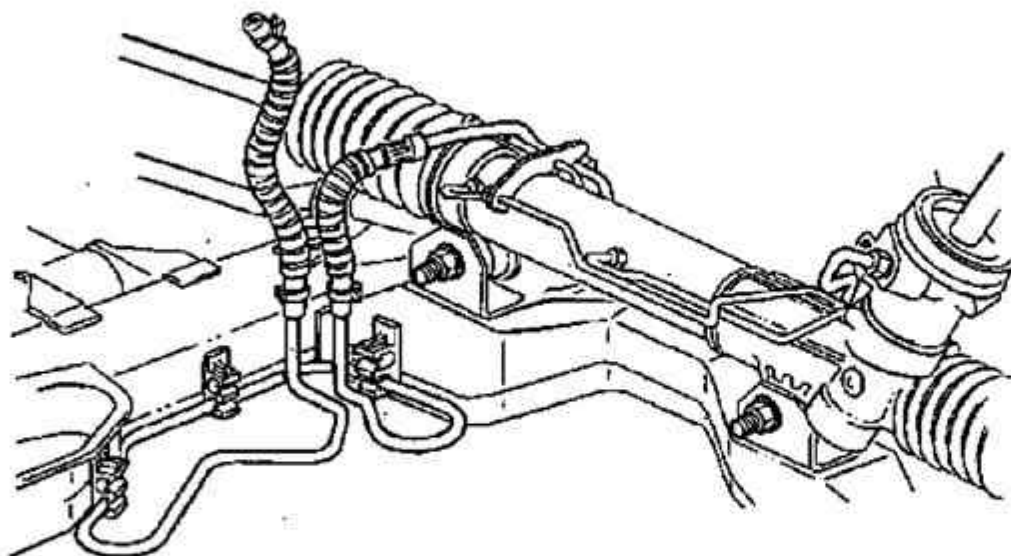
### Removal Procedure

1. Remove the drive belt. Refer to Drive Belt Replacement (L26) .
2. Place a drain pans under the vehicle as needed.
3. Remove the right front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .



**Fig. 67: View Of Power Steering Hoses**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the power steering cooler hose from the steering gear.

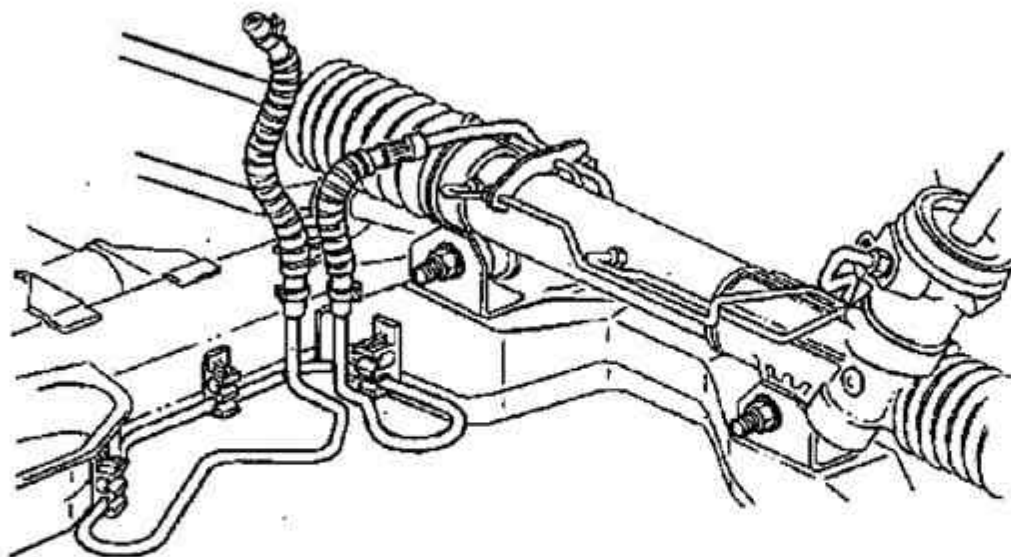


**Fig. 68: View Of Cooler Pipe/Hose**  
Courtesy of GENERAL MOTORS CORP.

5. Remove the power steering cooler hose from the power steering pump.
6. Unclip the power steering cooler hose from any front frame retainers as needed.
7. Remove the power steering cooler hose from the vehicle.

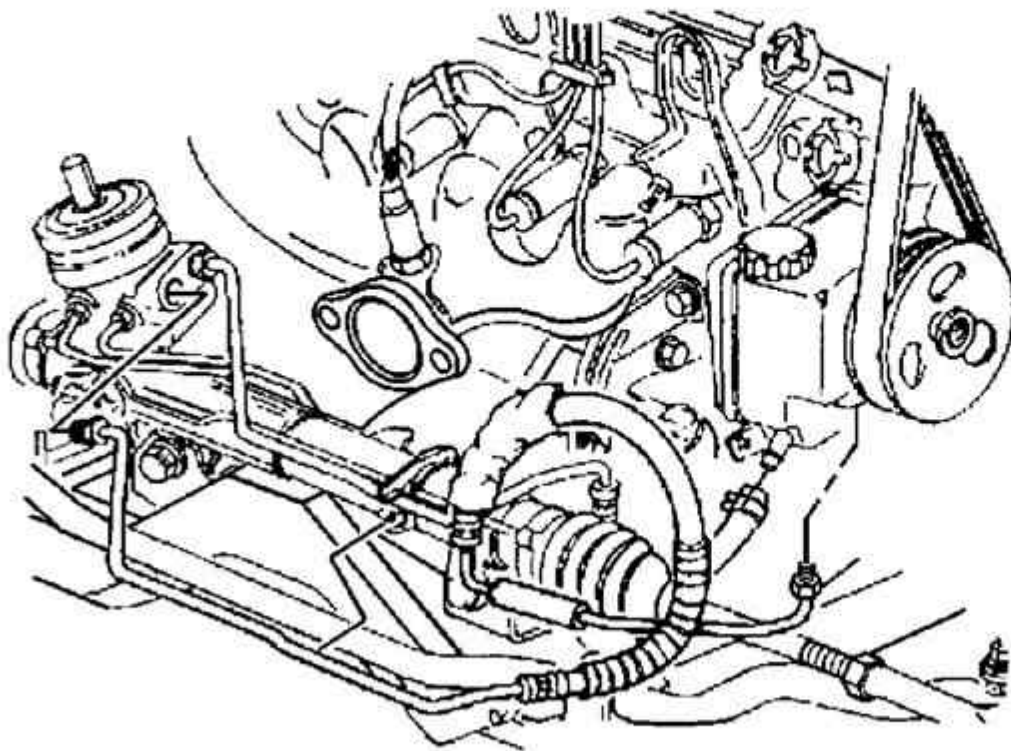
**Installation Procedure**

1. Position the power steering cooler hose to the vehicle.
2. Clip the power steering cooler hose to any front frame retainers as needed.



**Fig. 69: View Of Cooler Pipe/Hose**  
Courtesy of GENERAL MOTORS CORP.

3. Install the power steering cooler hose to the power steering pump.



**Fig. 70: View Of Power Steering Hoses**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

4. Install the power steering cooler hose to the steering gear.

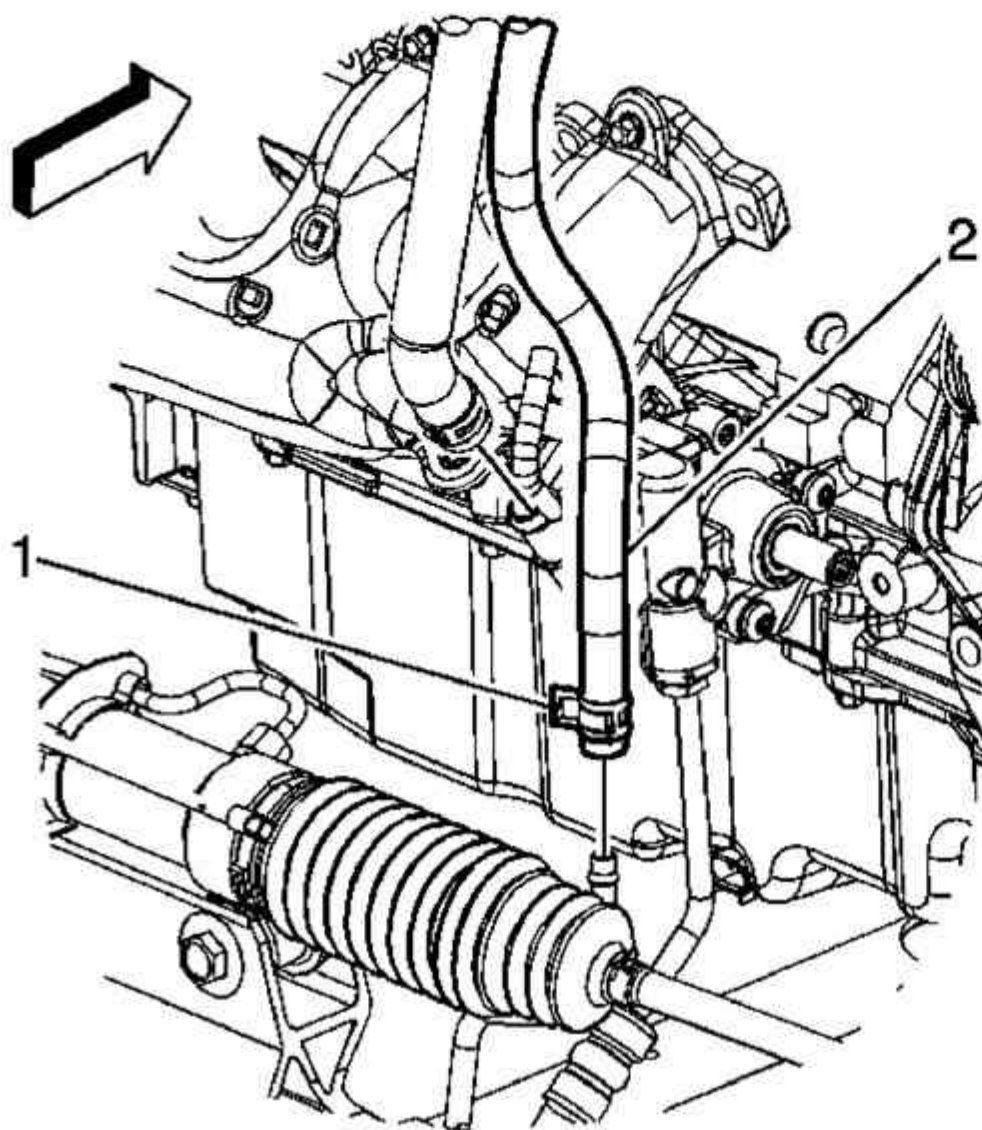
**Tighten:** Tighten the fitting to 27 N.m (20 lb ft).

5. Clean any excess fluid from the vehicle and remove the drain pans.
6. Install the right front tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
7. Install the drive belt. Refer to Drive Belt Replacement (L26) .
8. Fill and bleed the power steering system. Refer to Power Steering System Bleeding.

#### POWER STEERING FLUID RESERVOIR INLET HOSE REPLACEMENT (LY7)

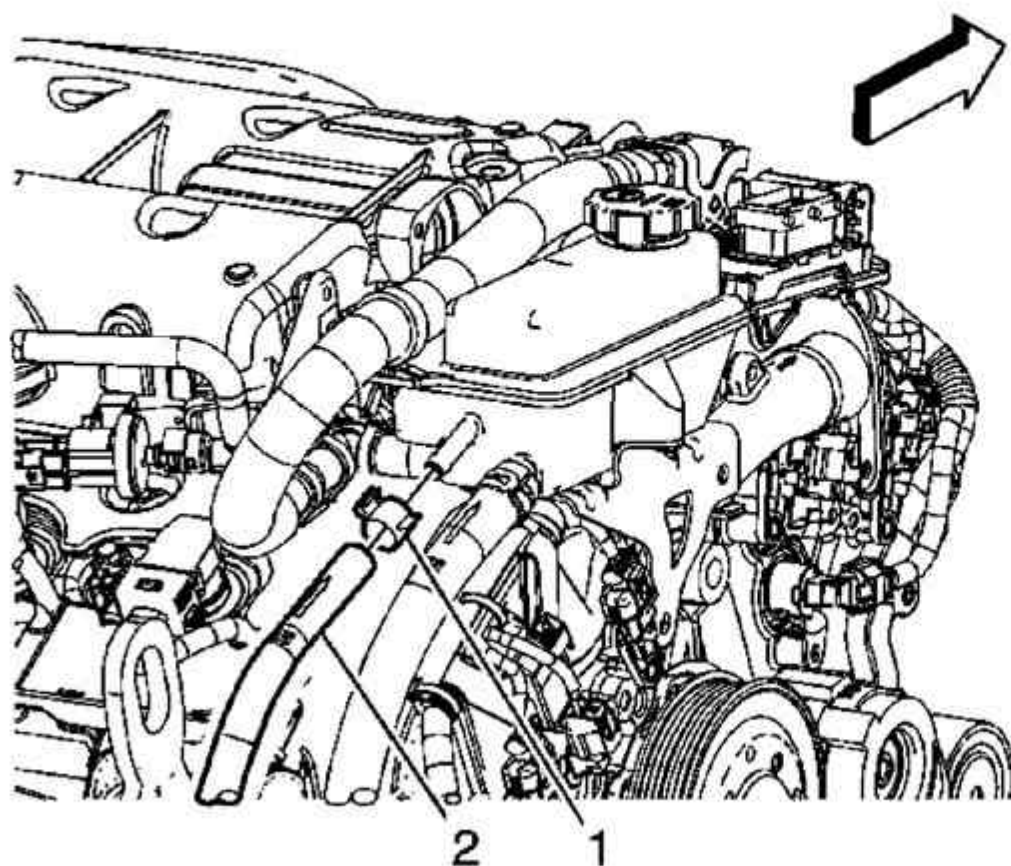
##### Removal Procedure

1. Remove the fuel injection sight shield. Refer to Fuel Injector Sight Shield Replacement .
2. Remove as much power steering fluid from the remote power steering fluid reservoir as possible.
3. Place drain pans under the vehicle as needed.



**Fig. 71: View Of Power Steering Reservoir Inlet Hose & Clamp**  
**Courtesy of GENERAL MOTORS CORP.**

4. Loosen the power steering reservoir inlet hose clamp (1) and disconnect the power steering reservoir inlet hose (2) at the power steering cooler hose.

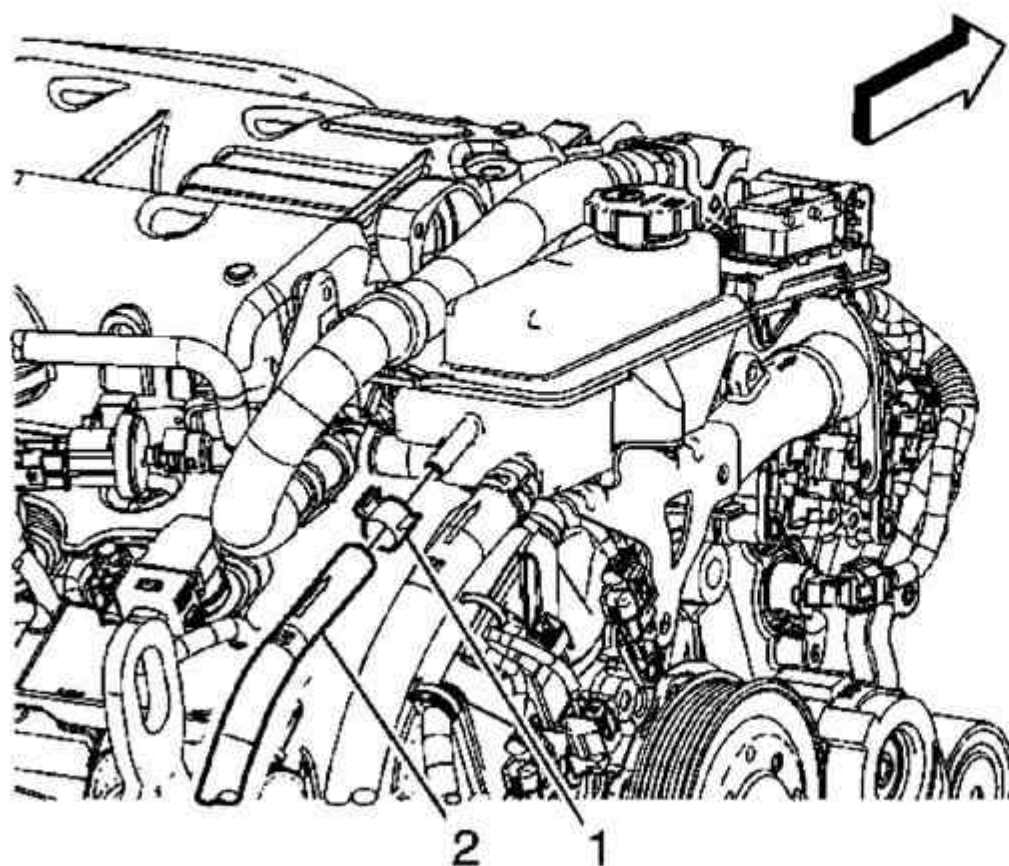


**Fig. 72: Identifying Power Steering Reservoir Inlet Hose**  
**Courtesy of GENERAL MOTORS CORP.**

5. Loosen the power steering reservoir inlet hose clamp (1) and disconnect the power steering reservoir inlet hose (2) at the remote power steering fluid reservoir.
6. Remove the power steering reservoir inlet hose from the vehicle.

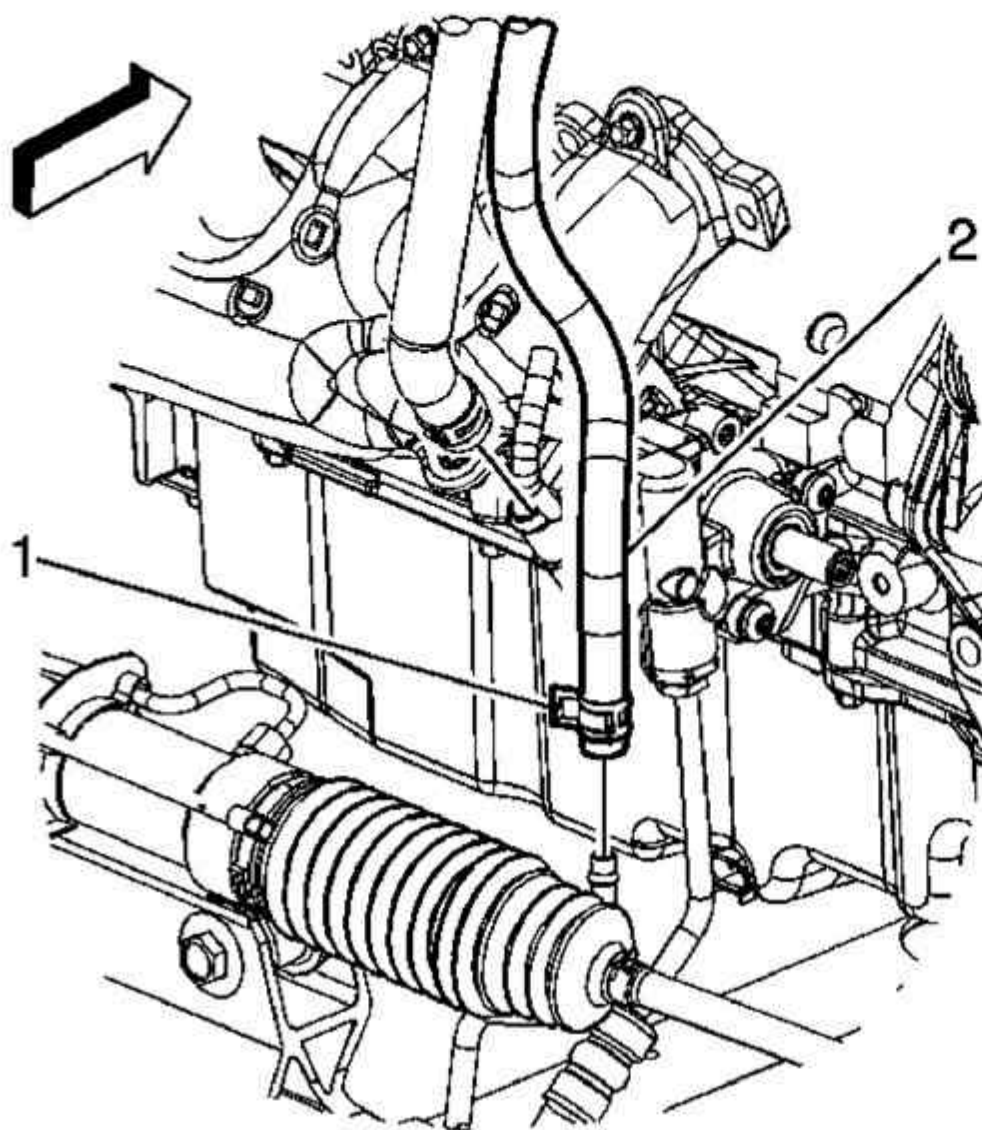
**Installation Procedure**

1. Install the power steering reservoir inlet hose to the vehicle.



**Fig. 73: Identifying Power Steering Reservoir Inlet Hose**  
**Courtesy of GENERAL MOTORS CORP.**

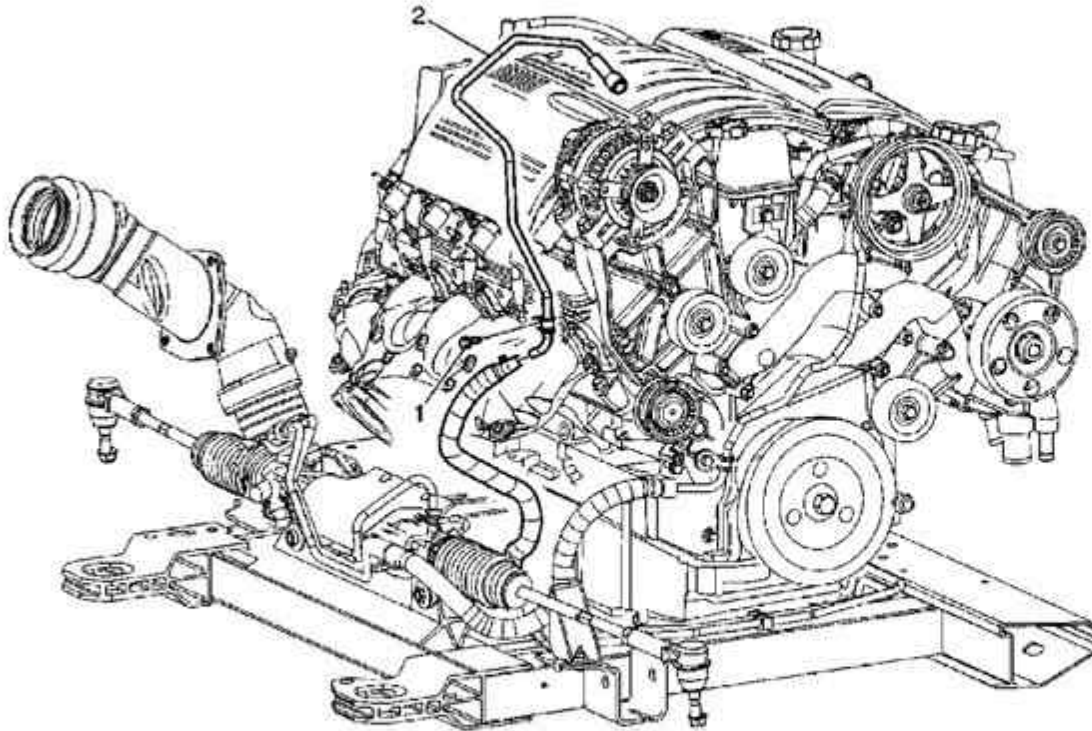
2. Connect the power steering reservoir inlet hose (2) and release the power steering reservoir inlet hose clamp (1) in place at the remote power steering fluid reservoir.



**Fig. 74: View Of Power Steering Reservoir Inlet Hose & Clamp**  
Courtesy of GENERAL MOTORS CORP.

3. Connect the power steering reservoir inlet hose (2) and release the power steering reservoir inlet hose clamp (1) in place at the power steering cooler hose.
4. Clean any excess fluid from the vehicle and remove any drain pans.
5. Fill and bleed the power steering fluid system. Refer to **Power Steering System Bleeding**.
6. Install the fuel injection sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

#### POWER STEERING FLUID RESERVOIR INLET HOSE REPLACEMENT (LS4)



**Fig. 75: Replacing Power Steering Return Hose**  
 Courtesy of GENERAL MOTORS CORP.

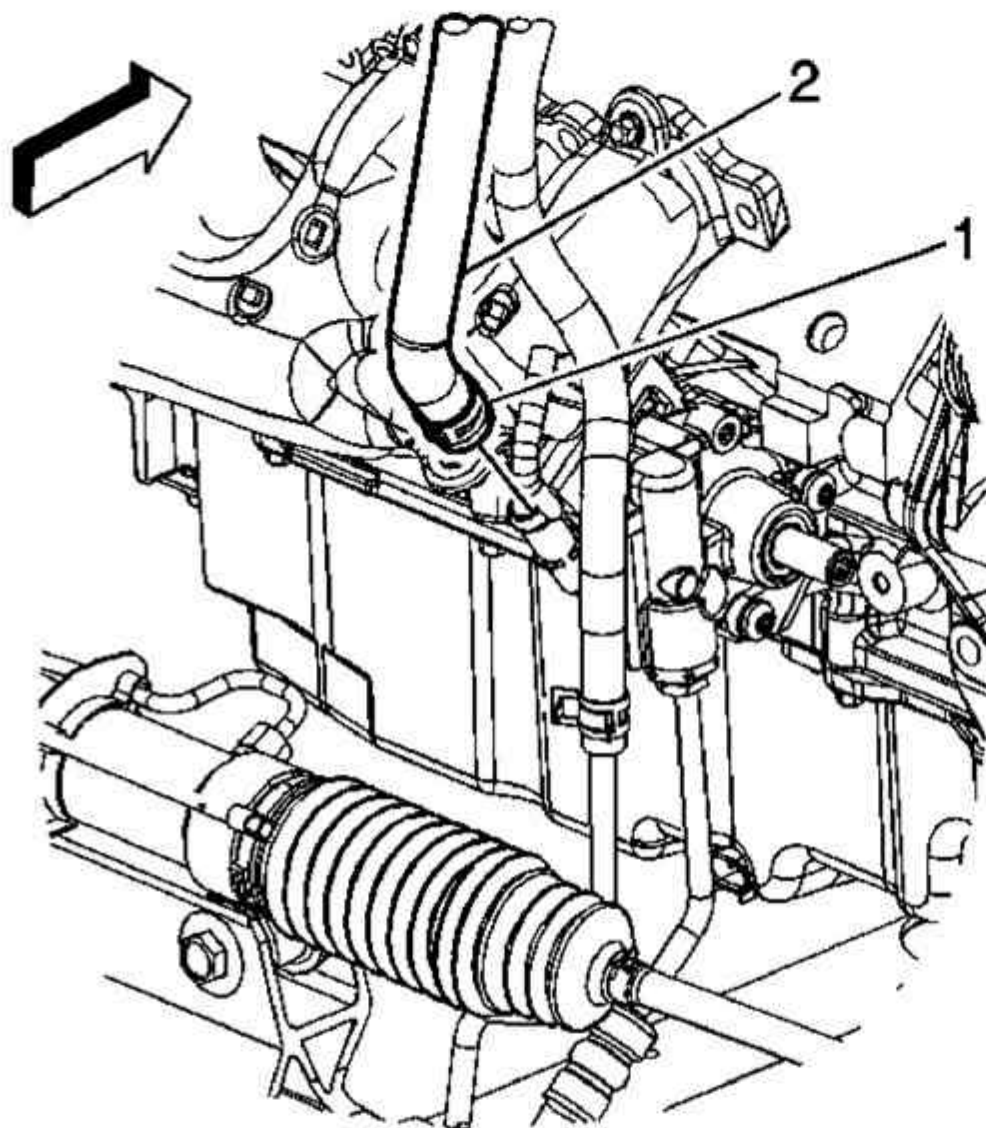
| Callout                                                                                                                                          | Component Name                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure:</b><br>Remove the upper intake manifold sight shield. Refer to <u>Upper Intake Manifold Sight Shield Replacement</u> . |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1                                                                                                                                                | Power Steering Reservoir Inlet Hose Bolt<br><br><b>NOTE:</b><br>Refer to <u>Fastener Notice</u> .<br><br><b>Tighten:</b> 55 N.m (41 lb ft)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2                                                                                                                                                | Power Steering Reservoir Inlet Hose<br><br><b>Procedure</b> <ol style="list-style-type: none"> <li>1. Disconnect the power steering reservoir inlet hose from the power steering cooler hose.</li> <li>2. Disconnect the power steering reservoir inlet hose from the power steering pump.</li> <li>3. Fill and bleed the power steering system. Refer to <u>Power Steering System Bleeding</u>.</li> </ol> <b>Tip:</b> <ul style="list-style-type: none"> <li>• Before repairs, remove as much power steering fluid from the power steering fluid reservoir as possible.</li> <li>• Before repairs, place drain pans under the vehicle as needed.</li> <li>• After repairs, clean any excess fluid from the vehicle and remove the drain pans.</li> </ul> |

#### POWER STEERING FLUID RESERVOIR OUTLET HOSE REPLACEMENT (LY7)

##### Removal Procedure

1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .

2. Remove as much power steering fluid from the remote power steering fluid reservoir as possible.
3. Place drain pans under the vehicle as needed.

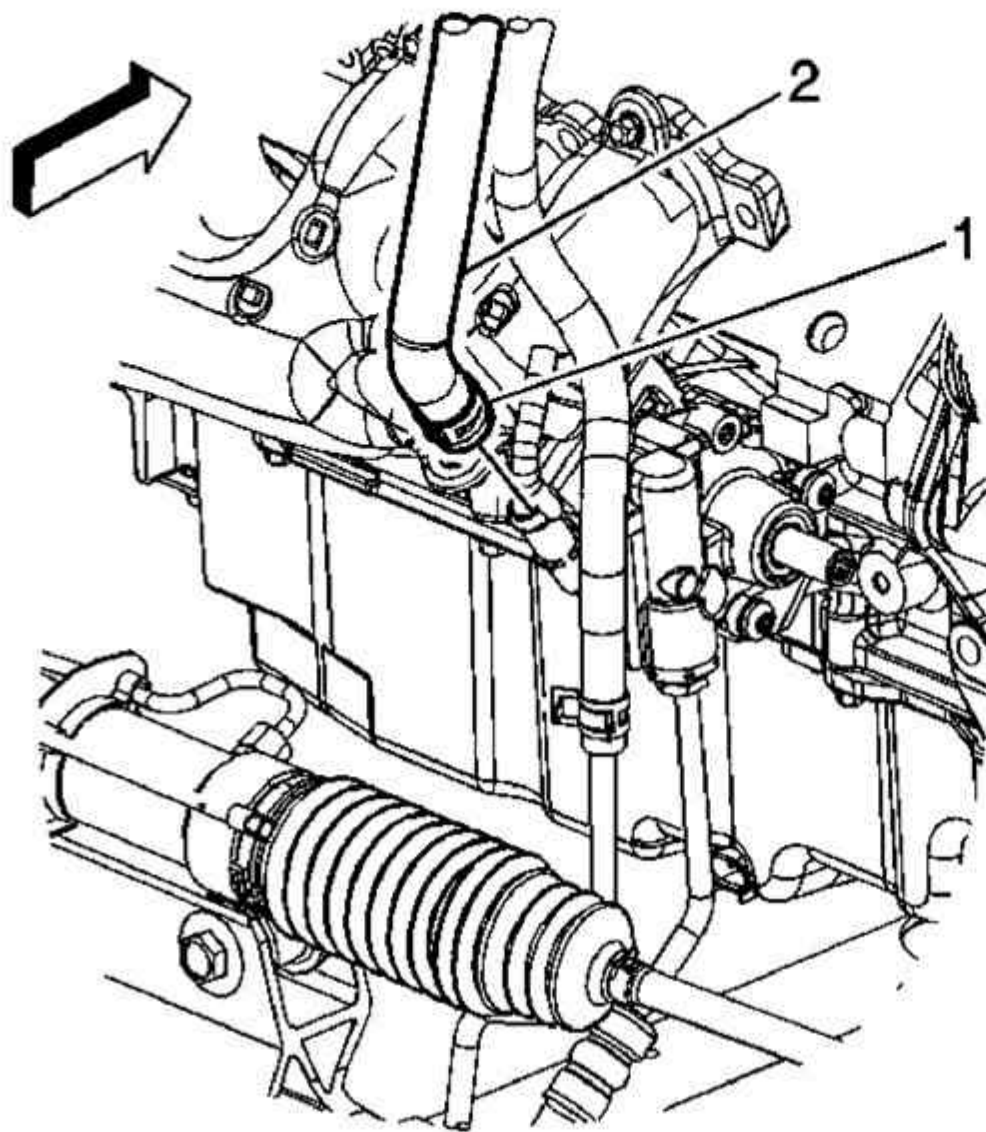


**Fig. 76: Identifying Power Steering Reservoir Outlet Hose**  
Courtesy of GENERAL MOTORS CORP.

4. Loosen the power steering fluid reservoir outlet hose clamp (1) and disconnect the power steering fluid reservoir outlet hose (2) from the power steering pump.
5. Loosen the power steering fluid reservoir outlet hose clamp and disconnect the power steering fluid reservoir outlet hose from the remote power steering fluid reservoir.
6. Remove the power steering fluid reservoir outlet hose from the vehicle.

#### Installation Procedure

1. Install the power steering fluid reservoir outlet hose to the vehicle.



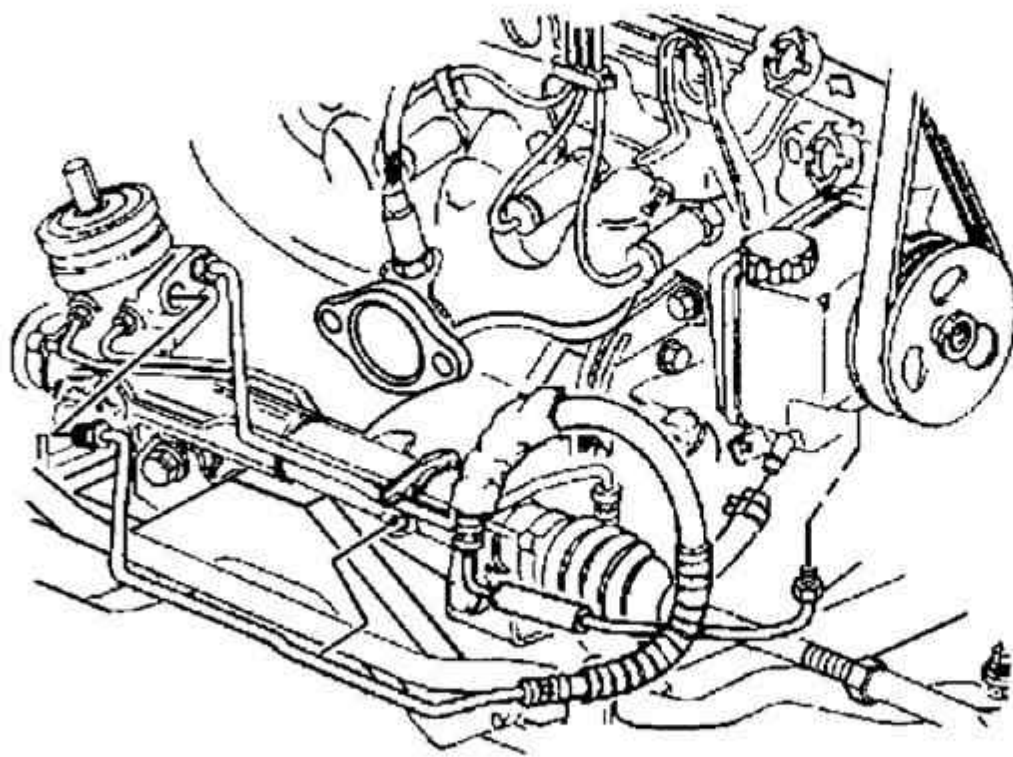
**Fig. 77: Identifying Power Steering Reservoir Outlet Hose**  
Courtesy of GENERAL MOTORS CORP.

1. Connect the power steering fluid reservoir outlet hose (2) to the power steering pump and release the power steering fluid reservoir outlet hose clamp (1).
2. Connect the power steering fluid reservoir outlet hose to the remote power steering fluid reservoir and release the power steering fluid reservoir outlet hose clamp.
3. Clean any excess fluid from the vehicle and remove any drain pans.
4. Fill and bleed the power steering fluid system. Refer to **Power Steering System Bleeding**.
5. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

#### POWER STEERING PRESSURE PIPE/HOSE REPLACEMENT (L26)

##### Removal Procedure

1. Place a drain pan under the vehicle.
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement (L26)**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
4. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation**.



**Fig. 78: View Of Power Steering Hoses**  
Courtesy of GENERAL MOTORS CORP.

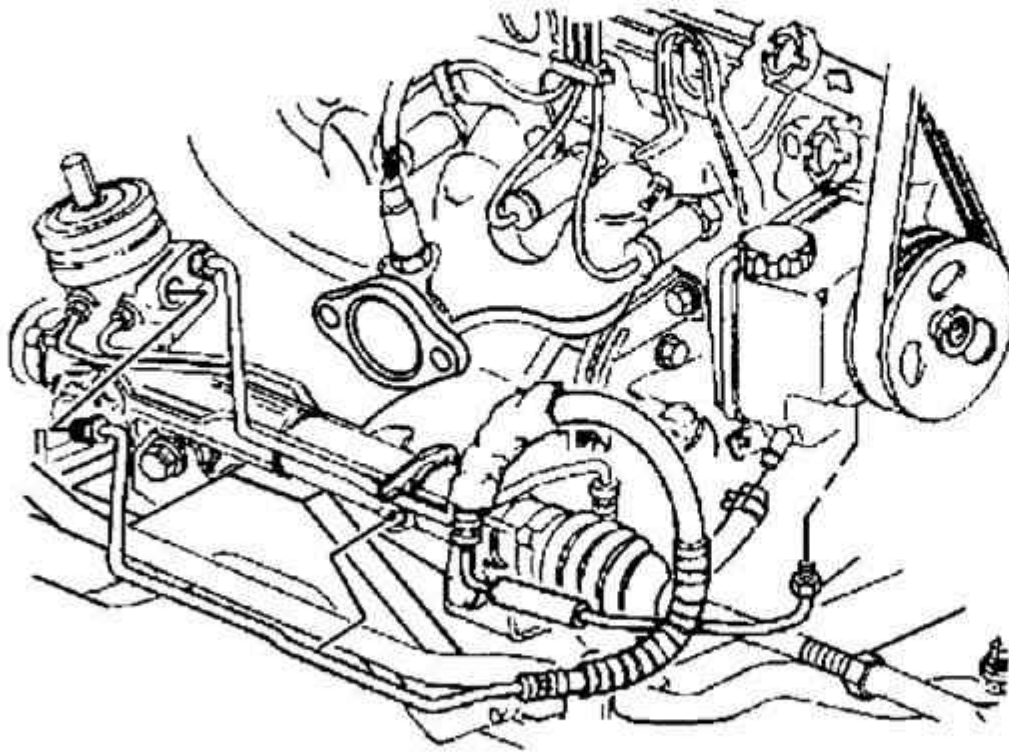
5. The power steering pressure hose is the lower hose at the power steering gear.

Remove the power steering pressure hose from the power steering gear.

6. Remove the power steering pressure hose from the power steering pump.
7. Remove the power steering pressure hose from the clamps on the power steering gear.
8. Remove the power steering pressure hose from the vehicle.

#### Installation Procedure

1. Install the power steering pressure hose to the vehicle.



**Fig. 79: View Of Power Steering Hoses**  
**Courtesy of GENERAL MOTORS CORP.**

2. Install the power steering pressure hose to the clamps on the power steering gear.

**NOTE:** Refer to FASTENER NOTICE .

3. Install the power steering pressure hose to the power steering pump.

**Tighten:** Tighten the fitting to 27 N.m (20 lb ft).

4. Install the power steering pressure hose to the power steering gear.

**Tighten:** Tighten the pressure hose fitting to 27 N.m (20 lb ft).

5. Install the tire and wheel assembly. Refer to Tire and Wheel Removal and Installation .
6. Remove the drain pan from under the vehicle.
7. Lower the vehicle.
8. Install the accessory drive belt. Refer to Drive Belt Replacement (L26) .
9. Fill the power steering system with power steering fluid. Refer to Checking and Adding Power Steering Fluid .
10. Bleed the power steering system. Refer to Power Steering System Bleeding .
11. Inspect the power steering system for leaks. Refer to Power Steering Fluid Leaks .

#### POWER STEERING PRESSURE PIPE/HOSE REPLACEMENT (LY7)

##### Removal Procedure

1. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .

2. Remove the engine mount struts. Refer to **Engine Mount Strut Replacement - Left Side** and **Engine Mount Strut Replacement - Right Side**.

One engine mount strut bolt and nut can be reinstalled to the engine mount strut bracket on the engine to be used as an attachment point for the front engine attachment.

3. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement (L27, LY7)** or **Coolant Recovery Reservoir Replacement (LS4)**.
4. Disconnect the electrical harness clip at the underhood junction block (UHJB) and the coolant housing.
5. Disconnect the electrical connector at the engine control module (ECM).
6. Remove as much power steering fluid from the remote power steering fluid reservoir as possible.
7. Place drain pans under the vehicle as needed.
8. Remove the remote power steering fluid reservoir and separate it from the bracket. Refer to **Remote Power Steering Fluid Reservoir Replacement (LY7)** or **Remote Power Steering Fluid Reservoir Replacement (LS4)**.

**NOTE:** Refer to **Fastener Notice**.

9. Install the engine support fixture hook to the remote power steering fluid reservoir bracket and reinstall it to the cylinder head. Tighten the remote power steering fluid reservoir bracket bolts.

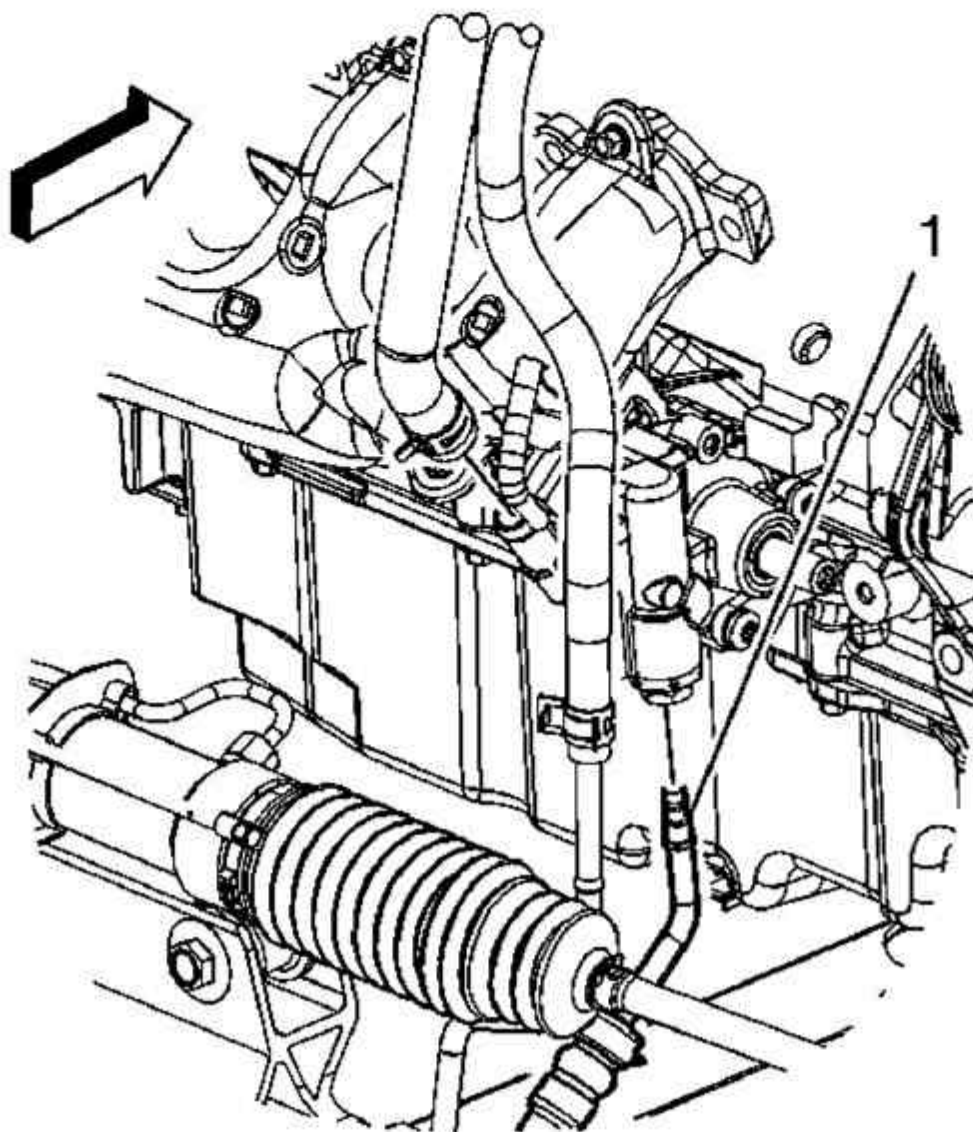
**Tighten:**

- Tighten the M6 bolt to 9 N.m (80 lb in).
- Tighten the M8 bolt to 25 N.m (18 lb ft).

10. Install the engine support fixture. Refer to **Engine Support Fixture**.
11. Remove the right front tire/wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
12. Remove the right front engine splash shield. Refer to **Engine Splash Shield Replacement**.
13. Remove the steering gear heat shield.
14. Remove the right side engine mount lower nuts. Refer to **Engine Mount Replacement - Right Side**.
15. Remove the left side transmission mount lower nuts. Refer to **Transmission Mount Replacement - Left Side**.

**NOTE:** Do NOT allow the wheel drive shaft constant velocity joint to contact the inner wheel structure. Use care when raising the engine in order to prevent wheel drive shaft constant velocity joint damage.

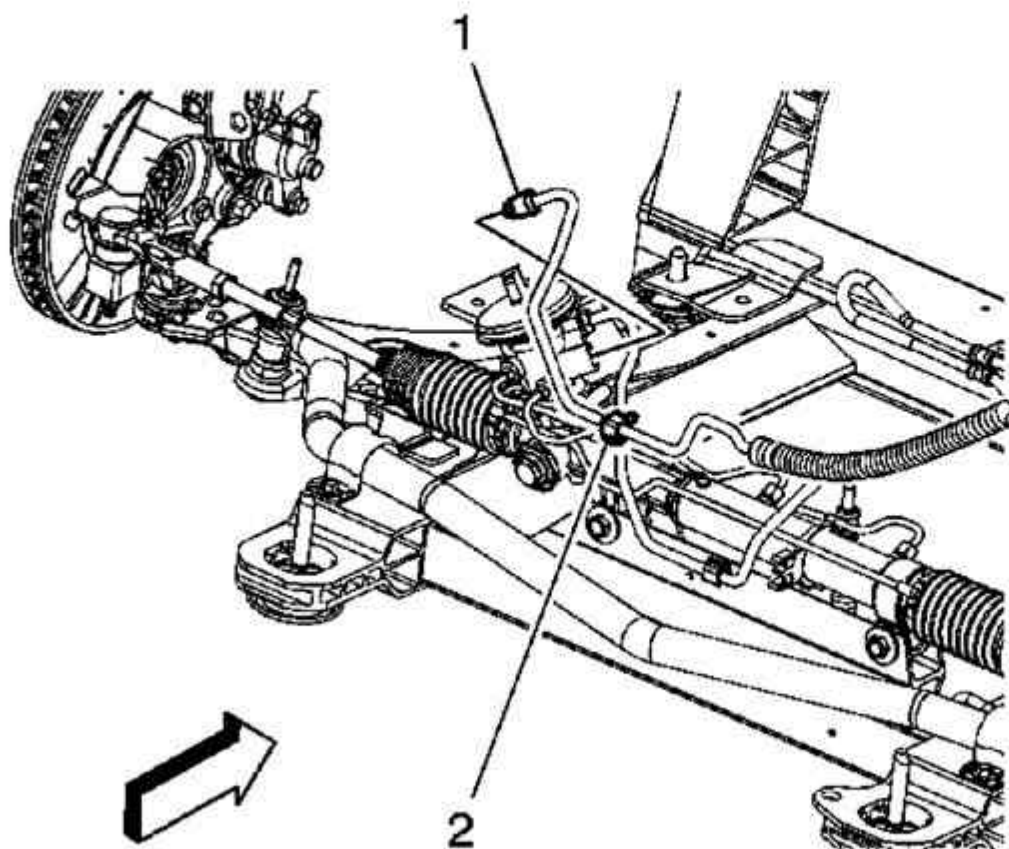
16. Lift the engine upward using the engine support fixture to allow the right side engine mount studs to separate from the cradle. This will allow the power steering pressure hose to pass under the left side engine mount location during removal and installation.
17. Remove the right side engine mount/bracket assembly. Refer to **Engine Mount Replacement - Right Side**.



**Fig. 80: Identifying Power Steering Pressure Hose**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** DO NOT try to remove the power steering pump nut from the power steering pressure hose. The power steering pump nut is a quick-connect fitting and once the power steering pressure hose is installed, the quick-connect fitting cannot be removed. If a new power steering pressure hose is required for further repairs, then a new power steering pump nut will be required.

18. Disconnect the power steering pressure hose (1) from the power steering pump.



**Fig. 81: Identifying Power Steering Pressure Hose Fitting**  
**Courtesy of GENERAL MOTORS CORP.**

19. Remove the power steering pressure hose fitting (1) from the steering gear.
20. Unclip the power steering pressure hose retaining clips (2).

Replace any retaining clips as needed.

21. Remove the power steering pressure hose from the vehicle.

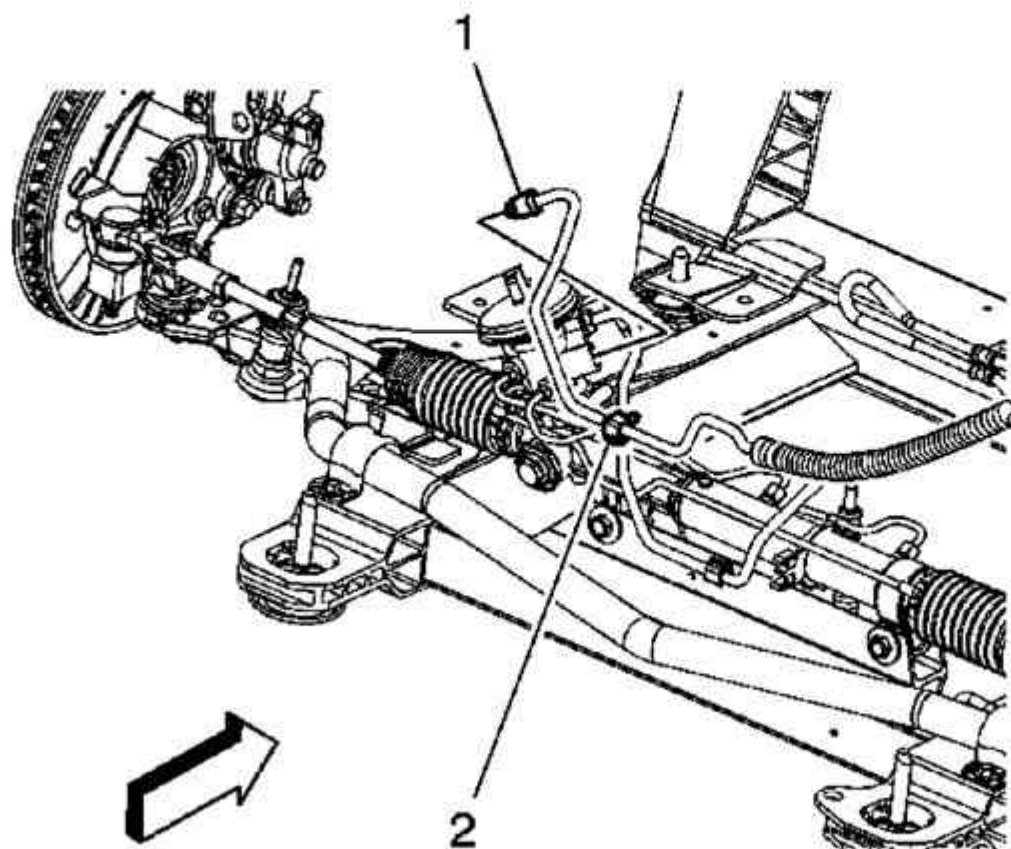
#### Installation Procedure

**IMPORTANT: Replace the O-ring seal.**

1. Install a NEW quick connect fitting at the power steering pump.

**Tighten:** Tighten the fitting to 40 N.m (30 lb ft).

2. Install the power steering pressure hose to the vehicle.

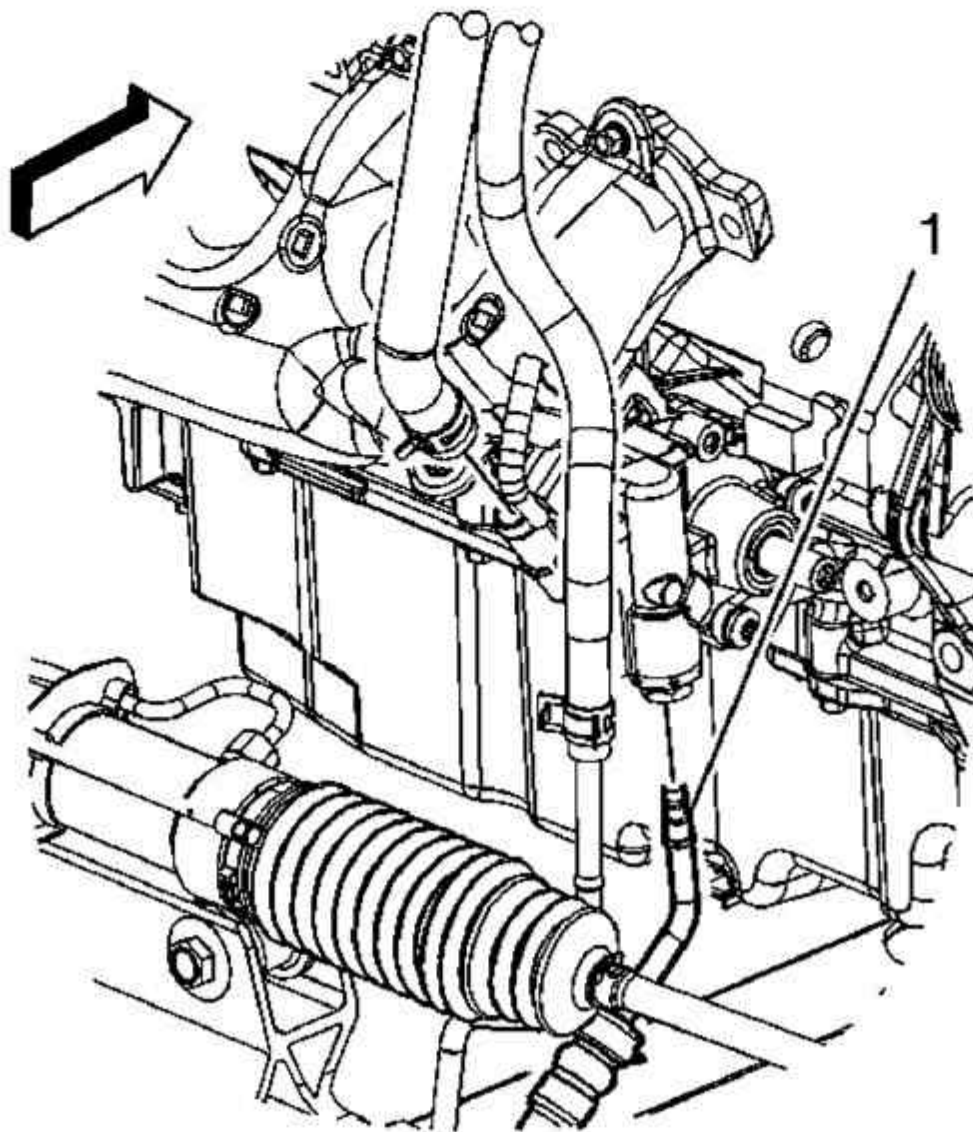


**Fig. 82: Identifying Power Steering Pressure Hose Fitting**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Hand tighten all fittings and retaining clips before finalizing any torques.

3. Install the power steering pressure hose fitting (1) to the steering gear.

**Tighten:** Tighten the fitting to 27 N.m (20 lb ft).



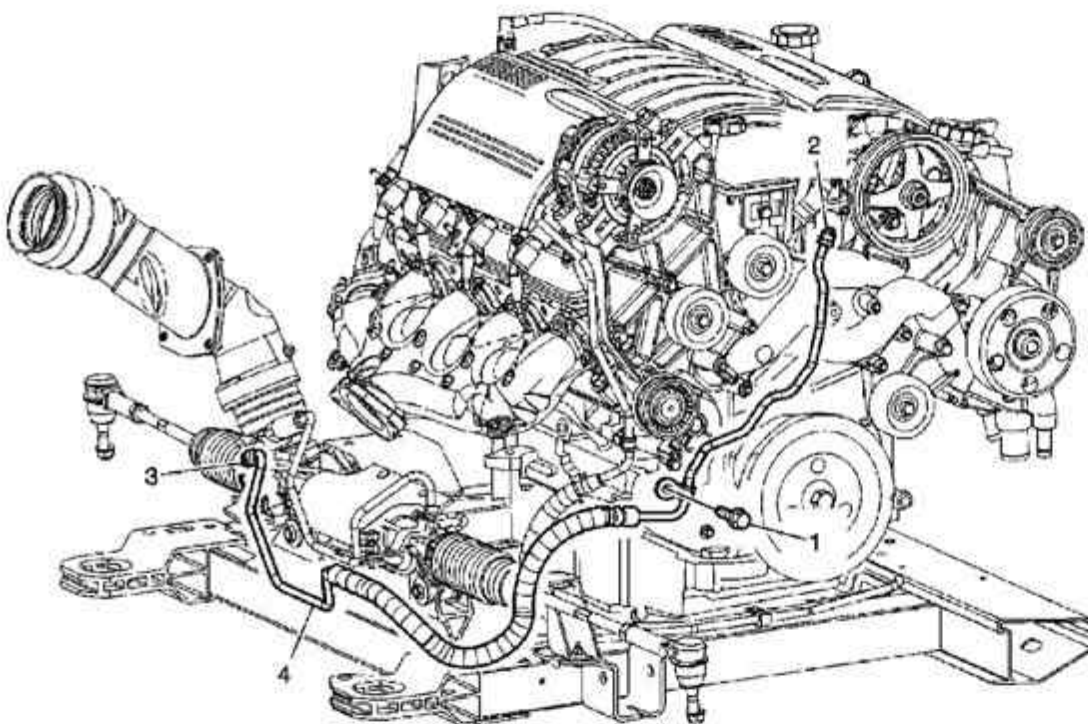
**Fig. 83: Identifying Power Steering Pressure Hose**  
Courtesy of GENERAL MOTORS CORP.

4. Connect the power steering pressure hose (1) to the power steering pump.
5. Install the right side engine mount/bracket assembly. Refer to **Engine Mount Replacement - Right Side**.
6. Lower the powertrain into position while aligning the right side engine mount and left side transmission mount into position.
7. Clip the power steering pressure hose retaining clips (2) into place.
8. Install the right side engine mount lower nuts. Refer to **Engine Mount Replacement - Right Side**.
9. Install the left side transmission mount lower nuts. Refer to **Transmission Mount Replacement - Left Side**.
10. Install the steering gear heat shield.
11. Install the right front engine splash shield. Refer to **Engine Splash Shield Replacement**.
12. Install the right front tire/wheel assembly. Refer to **Tire and Wheel Removal and Installation**.
13. Remove the engine support fixture. Refer to **Engine Support Fixture**.
14. Remove the remote power steering fluid reservoir bracket and engine support fixture hook.
15. Connect the remote power steering fluid reservoir and bracket.

**Tighten:** Tighten the screws to 6 N.m (53 lb in).

16. Install the remote power steering fluid reservoir. Refer to Remote Power Steering Fluid Reservoir Replacement (LY7) or Remote Power Steering Fluid Reservoir Replacement (LS4).
17. Clean any excess fluid from the vehicle and remove any drain pans.
18. Connect the electrical connector at the engine control module ECM.
19. Connect the electrical harness clip at the UHJB and the coolant housing.
20. Install the coolant recovery reservoir. Refer to Coolant Recovery Reservoir Replacement (L27, LY7) or Coolant Recovery Reservoir Replacement (LS4).
21. Install the engine mount struts. Refer to Engine Mount Strut Replacement - Left Side and Engine Mount Strut Replacement - Right Side.
22. Fill and bleed the power steering system. Refer to Power Steering System Bleeding.
23. Install the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement.

#### POWER STEERING PRESSURE PIPE/HOSE REPLACEMENT (LS4)



**Fig. 84: Replacing Power Steering Pressure Pipe/Hose**  
Courtesy of GENERAL MOTORS CORP.

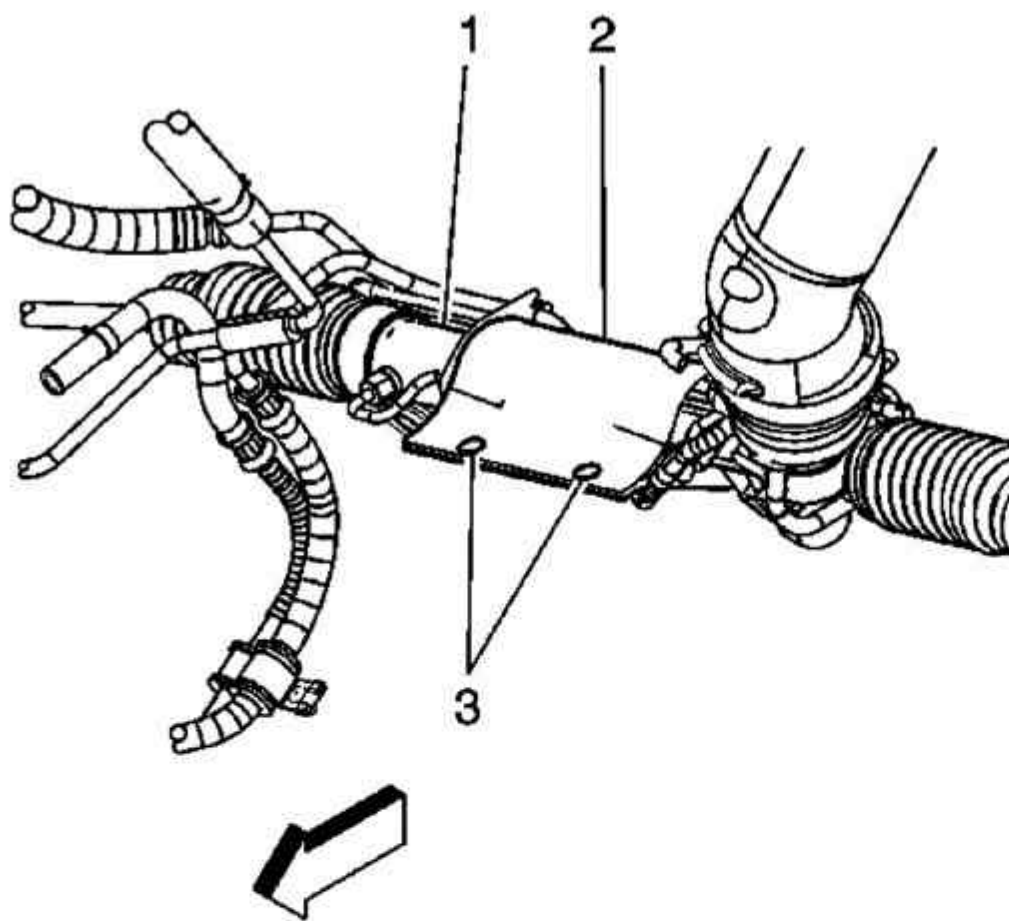
| Callout                       | Component Name                                                                                                                                               |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b> |                                                                                                                                                              |
| 1.                            | Remove the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> .                                                                                  |
| 2.                            | Place a drain pan under the vehicle.                                                                                                                         |
| 3.                            | Raise and lower the vehicle as necessary to access the power steering hose fitting at the rack and pinion. Refer to <u>Lifting and Jacking the Vehicle</u> . |
| 4.                            | Fill and bleed the power steering system after the repair has been completed. Refer to <u>Power Steering System Bleeding</u> .                               |
|                               | Drive Belt Tensioner Bolt                                                                                                                                    |
|                               | <b>NOTE:</b><br>Refer to <u>Fastener Notice</u> .                                                                                                            |

|   |                                                                                                                                    |
|---|------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>Tip:</b> Only remove the one tensioner bolt that retains the power steering pressure hose.<br><b>Tighten:</b> 50 N.m (37 lb ft) |
| 2 | Power Steering Pressure Hose Fitting Nut (at pump)<br><b>Tighten:</b> 27 N.m (20 lb ft)                                            |
| 3 | Power Steering Pressure Hose Fitting Nut (at rack and pinion)<br><b>Tighten:</b> 27 N.m (20 lb ft)                                 |
| 4 | Power Steering Pressure Hose<br><b>Tip:</b> Release the hose from the retainers to remove it from the vehicle.                     |

## STEERING GEAR REPLACEMENT

### Removal Procedure

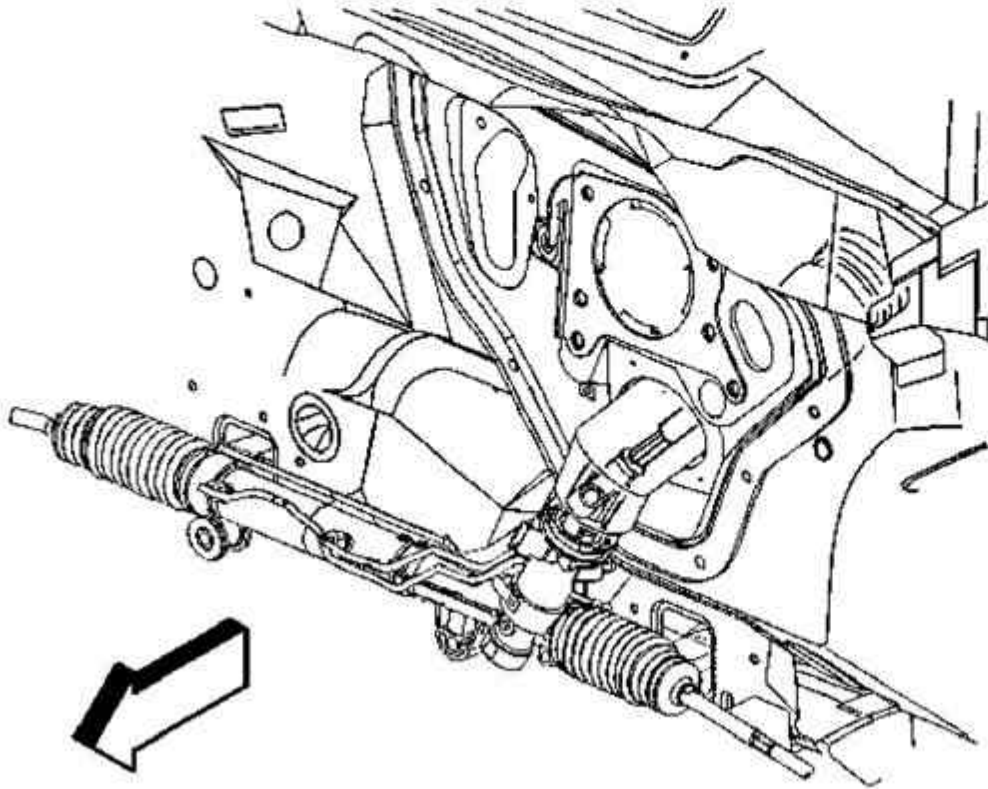
1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Place a drain pan under the vehicle.
3. Remove the tire and wheel assemblies. Refer to Tire and Wheel Removal and Installation.



**Fig. 85: Identifying Power Steering Heat Shield & Power Steering Gear**  
 Courtesy of GENERAL MOTORS CORP.

4. Disconnect the snaps (3) from the power steering heat shield (2).

5. Remove the power steering heat shield (2) from the power steering gear (1).

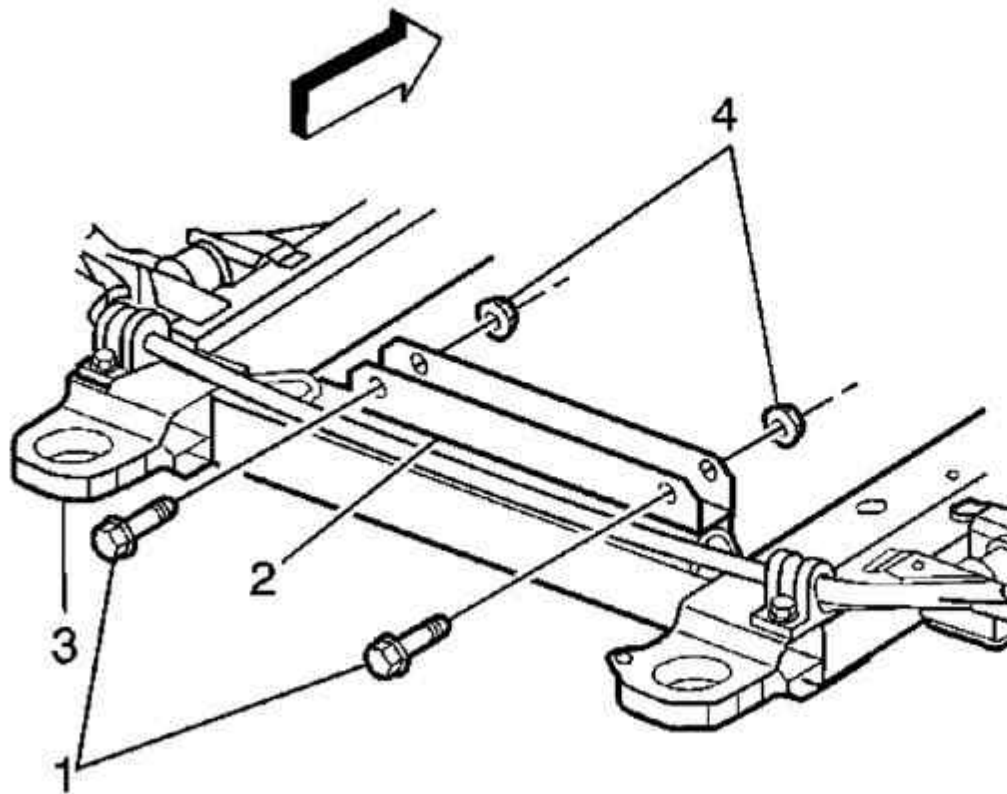


**Fig. 86: View Of Steering Rack Assembly**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Failure to disconnect the intermediate shaft from the rack and pinion stub shaft can result in damage to the steering gear and/or intermediate shaft. This damage can cause loss of steering control which could result in personal injury.

**NOTE:** Set steering shaft so the block tooth on the upper steering shaft is at the 12 o'clock position, the wheels on the vehicle are straight ahead and set the ignition switch to the LOCK position. Failure to follow these procedures could result in damage to the coil.

6. Disconnect the intermediate steering shaft from the steering gear. Refer to Intermediate Steering Shaft Replacement.
7. Disconnect both outer tie rod ends from the steering knuckles. Refer to Rack and Pinion Outer Tie Rod End Replacement.
8. Disconnect the stabilizer shaft from the frame to allow bolt access. Refer to Stabilizer Shaft Insulator Replacement.



**Fig. 87: Identifying Power Steering Gear Mounting Bolts & Nuts**  
 Courtesy of GENERAL MOTORS CORP.

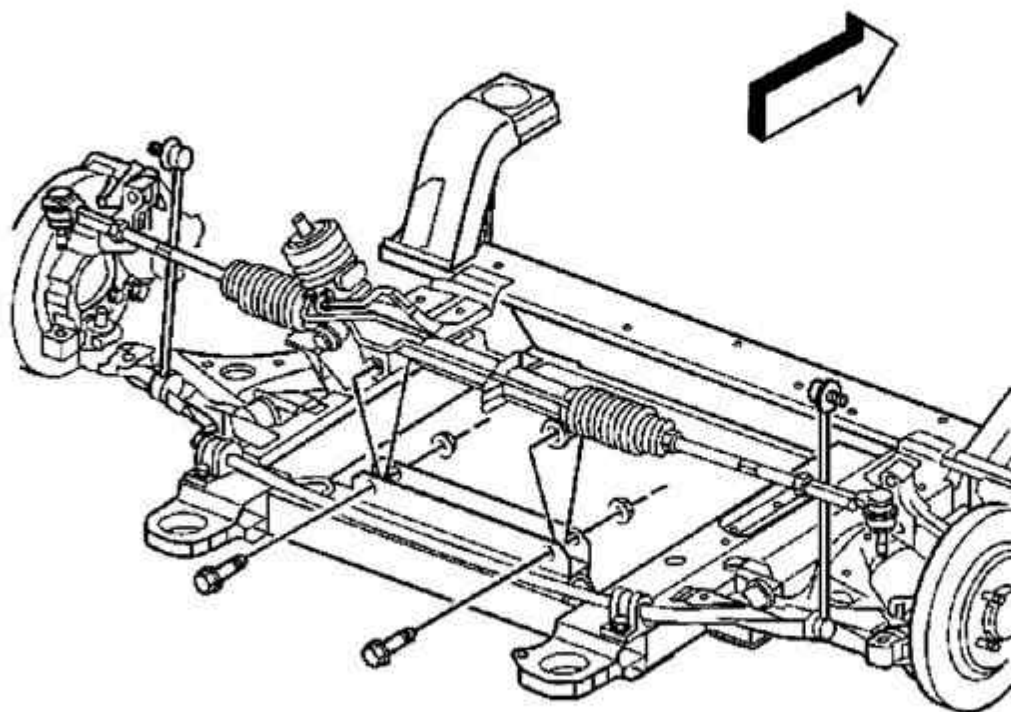
9. Support the rear of the frame (3) using jackstands.

**IMPORTANT:** The power steering gear mounting bolts are different sizes. Note each bolt location for assembly.

10. Remove the frame bolts from the rear of the frame. Refer to Frame Replacement.

**NOTE:** Do not lower the rear of the frame too far as damage to the engine components nearest to the cowl may result.

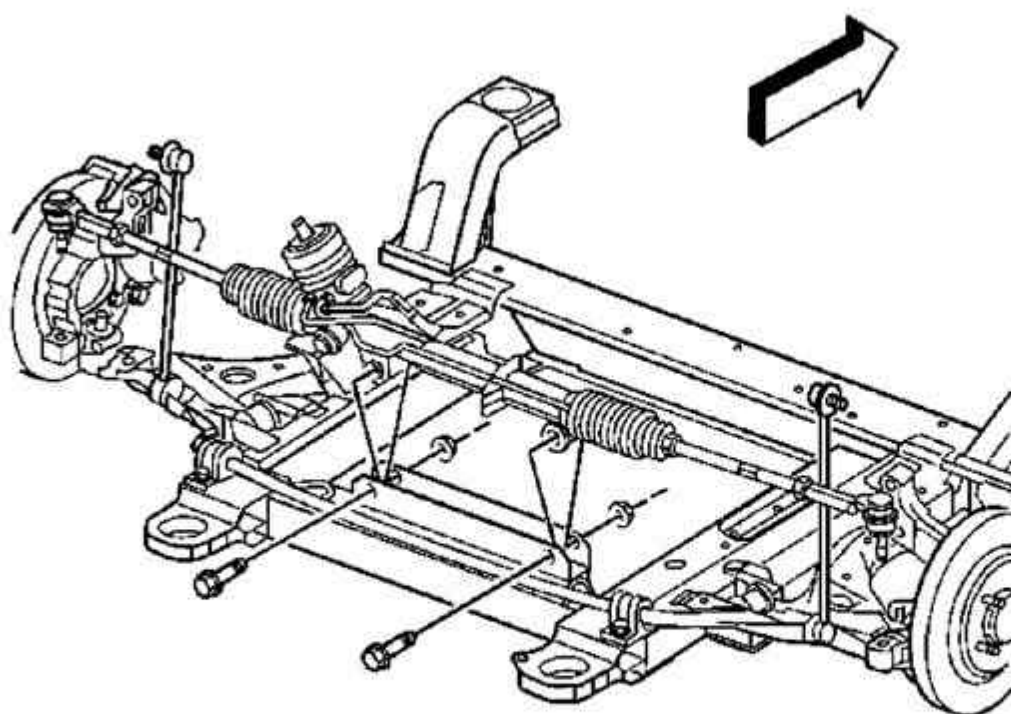
11. Lower the rear of the frame (3).
12. Disconnect the power steering pressure hose from the power steering gear. Refer to Power Steering Pressure Pipe/Hose Replacement (L26) or Power Steering Pressure Pipe/Hose Replacement (LY7) or Power Steering Pressure Pipe/Hose Replacement (LS4).
13. Disconnect the power steering return hose from the power steering gear. Refer to Power Steering Cooler Pipe/Hose Replacement (LY7) or Power Steering Cooler Pipe/Hose Replacement (LS4) or Power Steering Cooler Pipe/Hose Replacement (L26).
14. If applicable, disconnect the Magnasteer Variable Assist harness connector from the power steering gear assembly.
15. Remove the power steering gear mounting bolts and nuts (1, 4).



**Fig. 88: Identifying Power Steering Gear**  
Courtesy of GENERAL MOTORS CORP.

16. Remove the power steering gear through the left wheel opening.

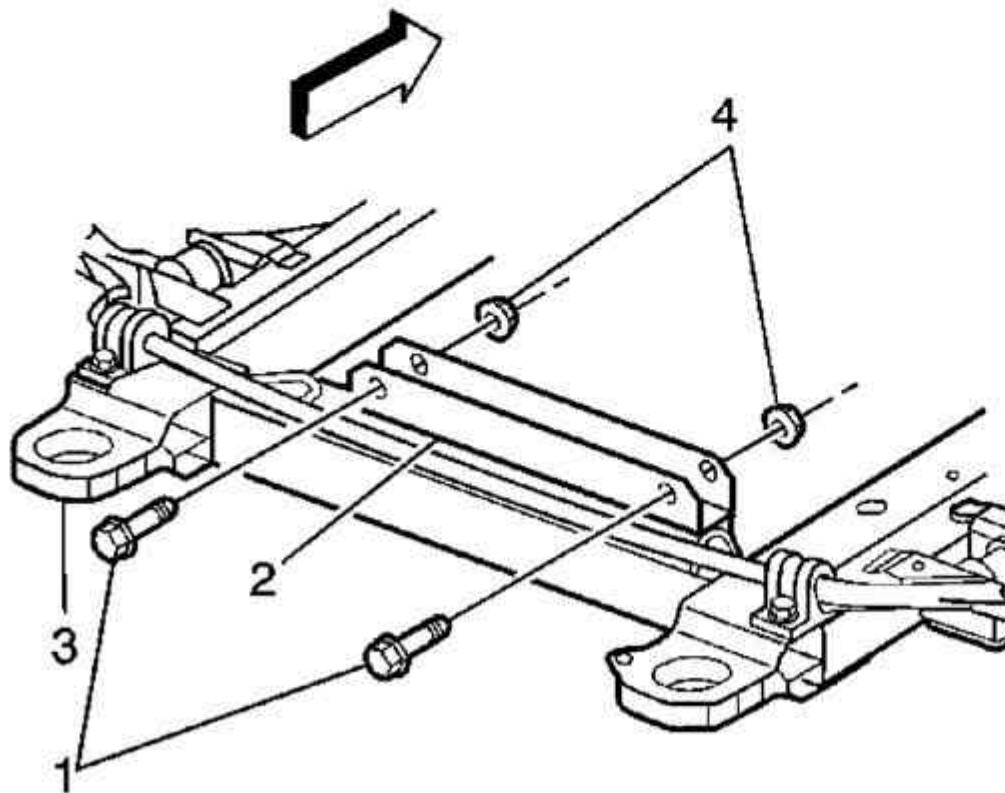
**Installation Procedure**



**Fig. 89: Identifying Power Steering Gear**

Courtesy of GENERAL MOTORS CORP.

1. Install the power steering gear through the left wheel opening.



**Fig. 90: Identifying Power Steering Gear Mounting Bolts & Nuts**  
Courtesy of GENERAL MOTORS CORP.

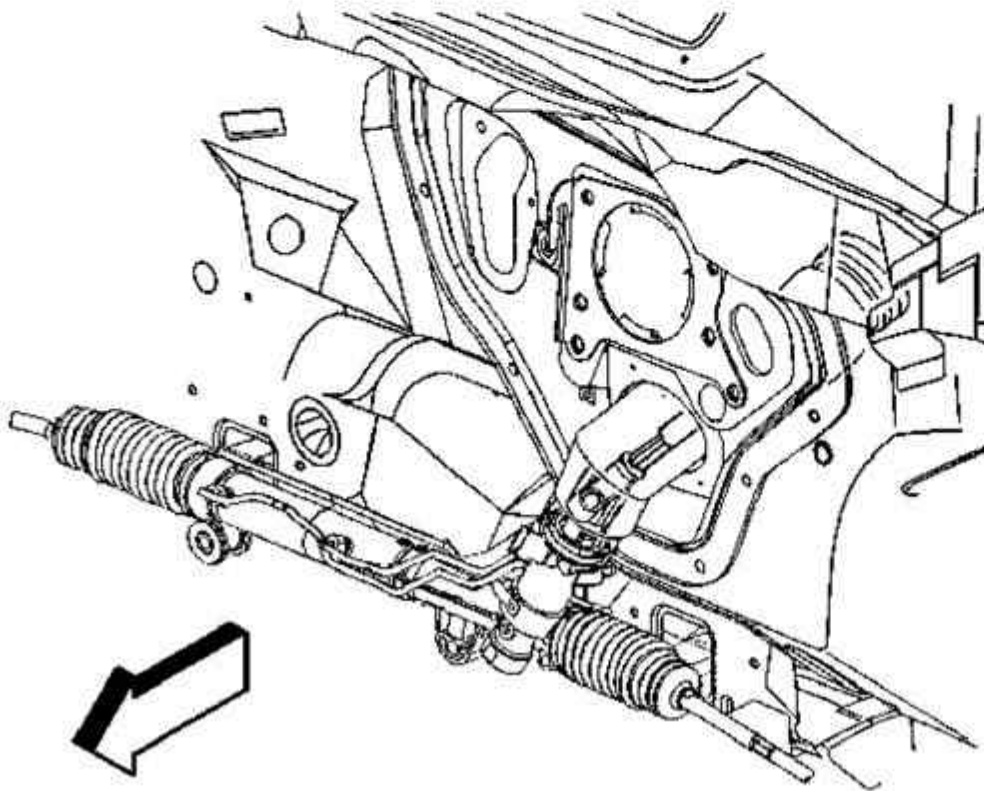
**NOTE:** Refer to Fastener Notice .

2. Install the power steering gear mounting bolts and nuts as previously noted.

**Tighten:** Tighten both (M12) bolts to 60 N.m (42 lb ft) plus 180 degrees.

3. Inspect the threads on the power steering pressure hose and the power steering return hose.
4. Inspect the O-ring seals on the power steering hoses.
5. Replace the seals if damaged, lubricate the seals before installation.
6. Install the clamp that holds the power steering hoses to the power steering gear.
7. If applicable, connect the Magnasteer Variable Assist harness connector to the power steering gear assembly.
8. Connect the power steering pressure hose to the power steering gear. Refer to Power Steering Pressure Pipe/Hose Replacement (L26) or Power Steering Pressure Pipe/Hose Replacement (LY7) or Power Steering Pressure Pipe/Hose Replacement (LS4).
9. Connect the power steering return hose to the power steering gear. Refer to Power Steering Cooler Pipe/Hose Replacement (LY7) or Power Steering Cooler Pipe/Hose Replacement (LS4) or Power Steering Cooler Pipe/Hose Replacement (L26).
10. Raise the frame into position (3).
11. Install the rear frame bolts. Refer to Frame Replacement .
12. Remove the jackstands.

13. Connect the tie rod ends to the steering knuckles. Refer to Rack and Pinion Outer Tie Rod End Replacement.
14. Connect the stabilizer shaft to the frame. Refer to Stabilizer Shaft Insulator Replacement.

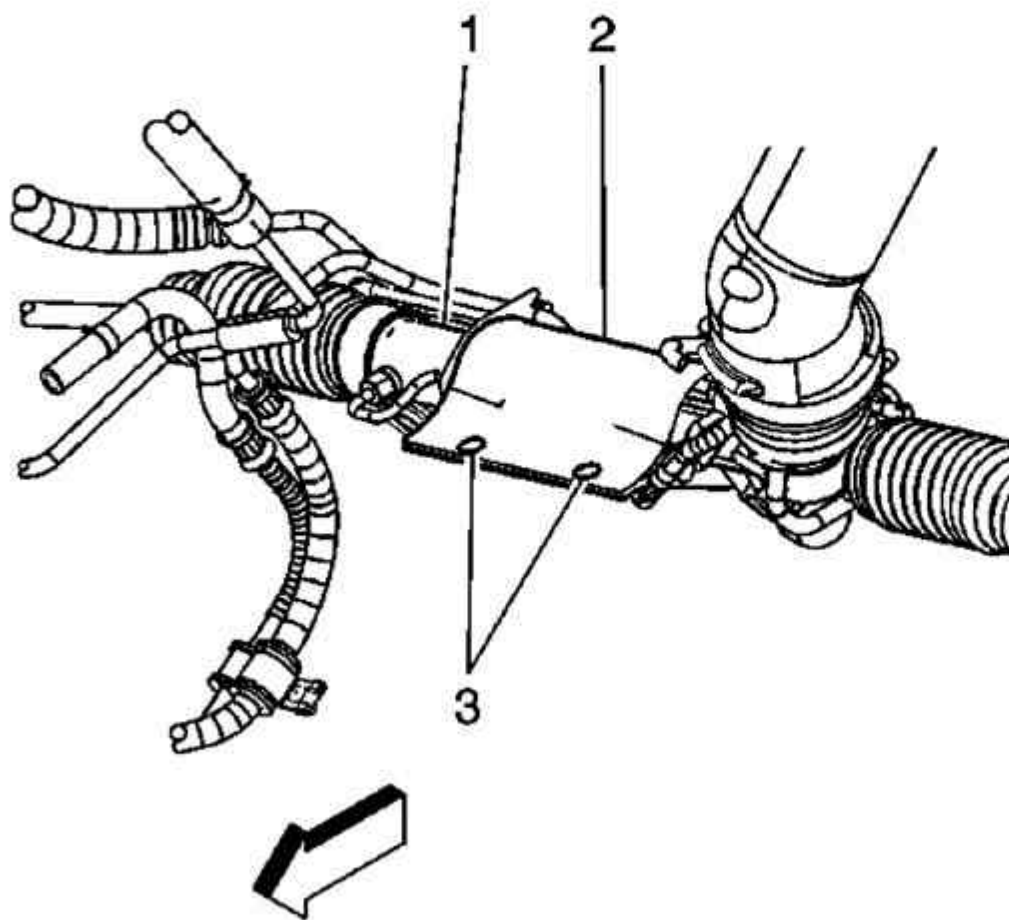


**Fig. 91: View Of Steering Rack Assembly**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Set steering shaft so the block tooth on the upper steering shaft is at the 12 o'clock position, the wheels on the vehicle are straight ahead and set the ignition switch to the LOCK position. Failure to follow these procedures could result in damage to the coil.

**IMPORTANT:** During the installation of the intermediate steering shaft, ensure the steering shaft is seated before you install the pinch bolt. The two mating shafts may disengage if the pinch bolt is inserted into the coupling before the steering shaft installation.

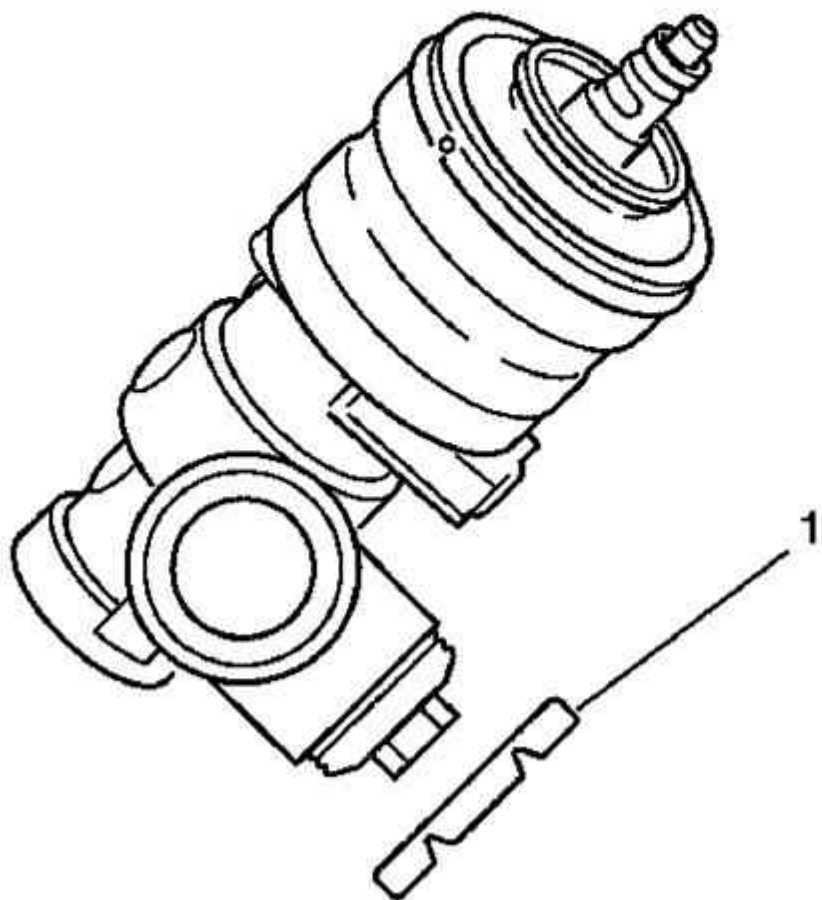
15. Connect the intermediate steering shaft to the steering gear. Refer to Intermediate Steering Shaft Replacement.



**Fig. 92: Identifying Power Steering Heat Shield & Power Steering Gear**  
Courtesy of GENERAL MOTORS CORP.

16. Install the power steering heat shield (2) to the steering gear (1).
17. Connect the snaps (3) on the power steering heat shield (2).
18. Install the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation**.
19. Remove the drain pan from under the vehicle.
20. Lower the vehicle.
21. Fill the power steering system with power steering fluid. Refer to **Checking and Adding Power Steering Fluid**.
22. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
23. Inspect the power steering system for leaks. Refer to **Power Steering Fluid Leaks**.
24. Perform a front end alignment. Refer to **Wheel Alignment Measurement**.

**STEERING GEAR RACK BEARING PRELOAD ADJUSTMENT - OFF VEHICLE (MAGNASTEER)**



**Fig. 93: Adjusting Rack & Pinion Gear Rack Bearing Preload**  
Courtesy of GENERAL MOTORS CORP.

1. Loosen the adjuster plug lock nut (1).
2. Turn the adjuster plug clockwise until the adjuster plug bottoms in the gear assembly.
3. Turn the adjuster plug back 50 degrees to 70 degrees (approximately one flat).

**NOTE:** Refer to Fastener Notice .

4. Install the adjuster plug lock nut (1) to the adjuster plug.

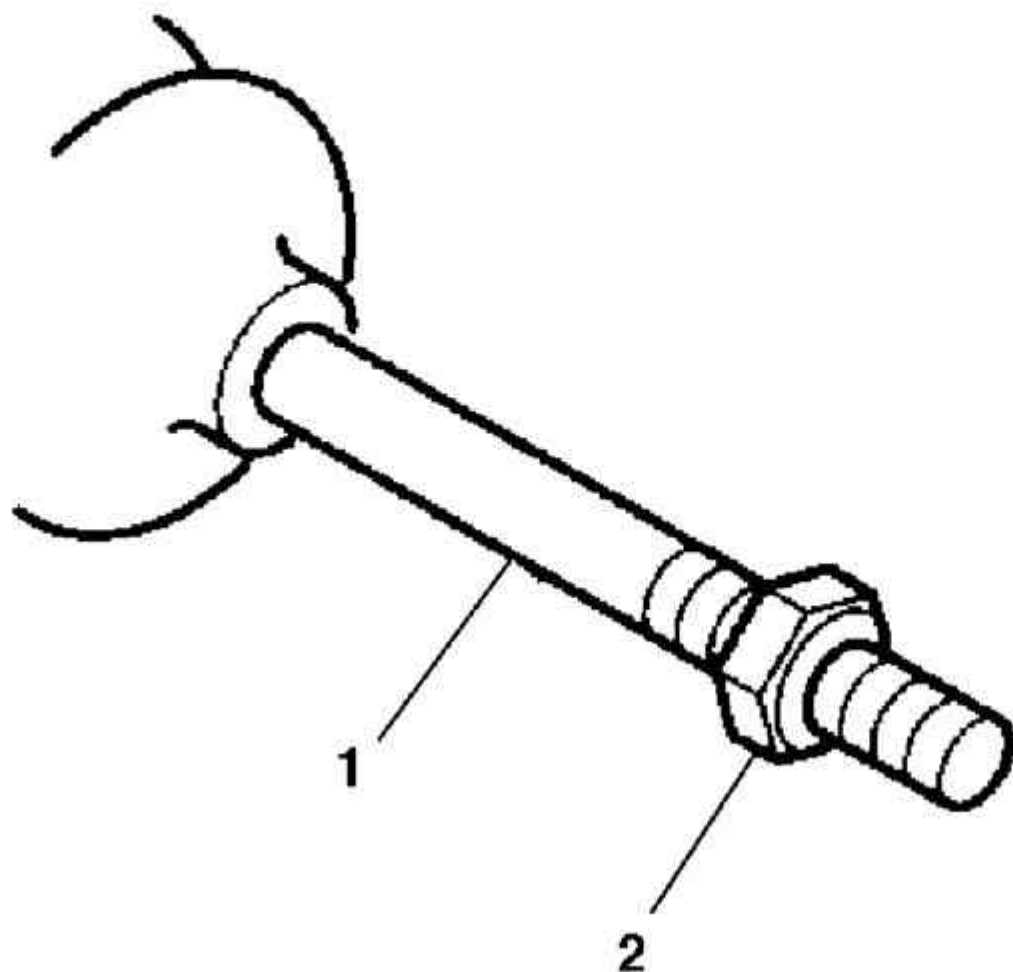
**Tighten:** Hold the adjuster plug stationary while tightening the adjuster plug lock nut (1) to 68 N.m (50 lb ft).

#### STEERING GEAR BOOT AND BREATHER TUBE REPLACEMENT - OFF VEHICLE

##### Tools Required

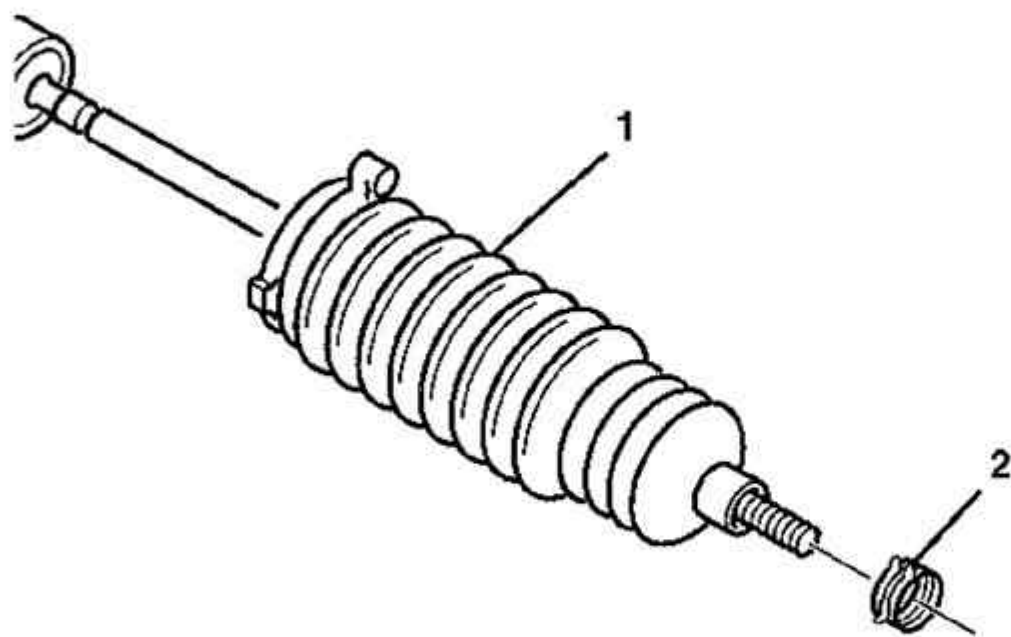
**J 22610** Keystone Clamp Pliers.

##### Disassembly Procedure



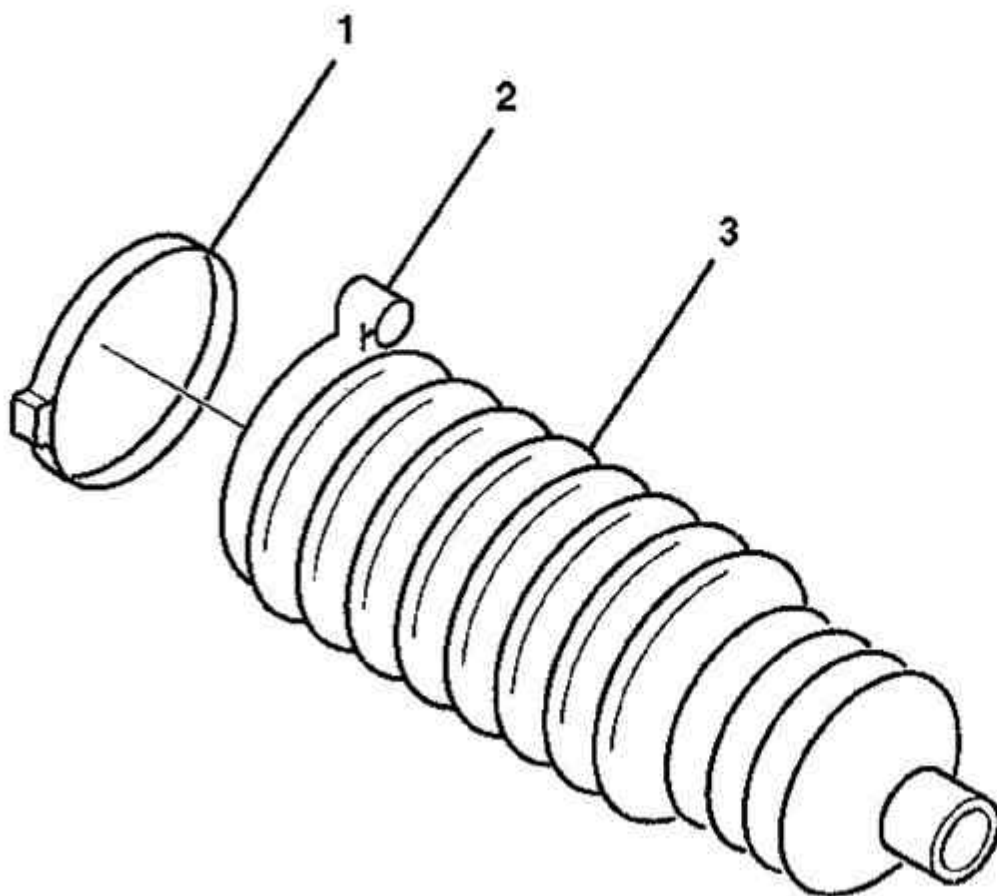
**Fig. 94: Identifying Inner Tie Rod Assembly Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

1. To remove the outer tie rod, Refer to **Rack and Pinion Outer Tie Rod End Replacement**.
2. Remove the hexagon jam nut (2) from the inner tie rod assembly (1).



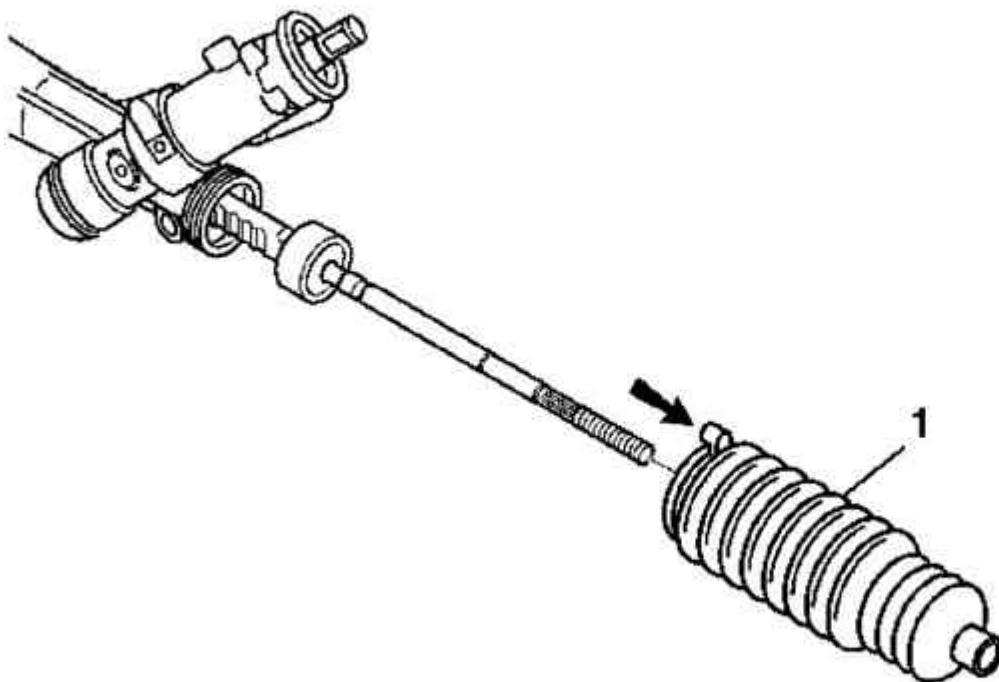
**Fig. 95: View Of Tie Rod End Clamp At Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

3. Remove the tie rod end clamp (2) from the rack and pinion boot (1).



**Fig. 96: View Of Boot Clamp & Rack & Pinion Boot**  
**Courtesy of GENERAL MOTORS CORP.**

4. Remove the boot clamp (1) from the rack and pinion boot with side cutters.
5. Discard the boot clamp (1).



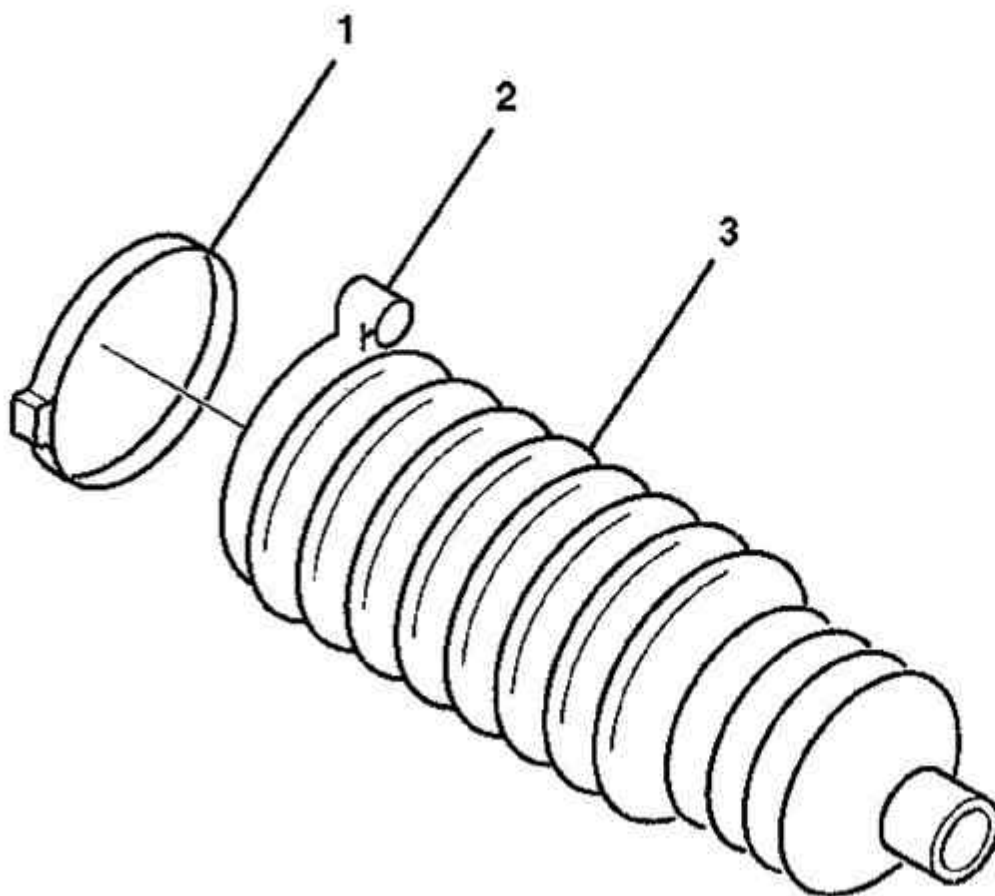
**Fig. 97: Identifying Rack & Pinion Boot & Breather Tube**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:**

- If a breather tube is present, mark the location of the breather tube on the gear assembly before removal of the rack and pinion boot.
- After removing the boot, inspect the inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear.

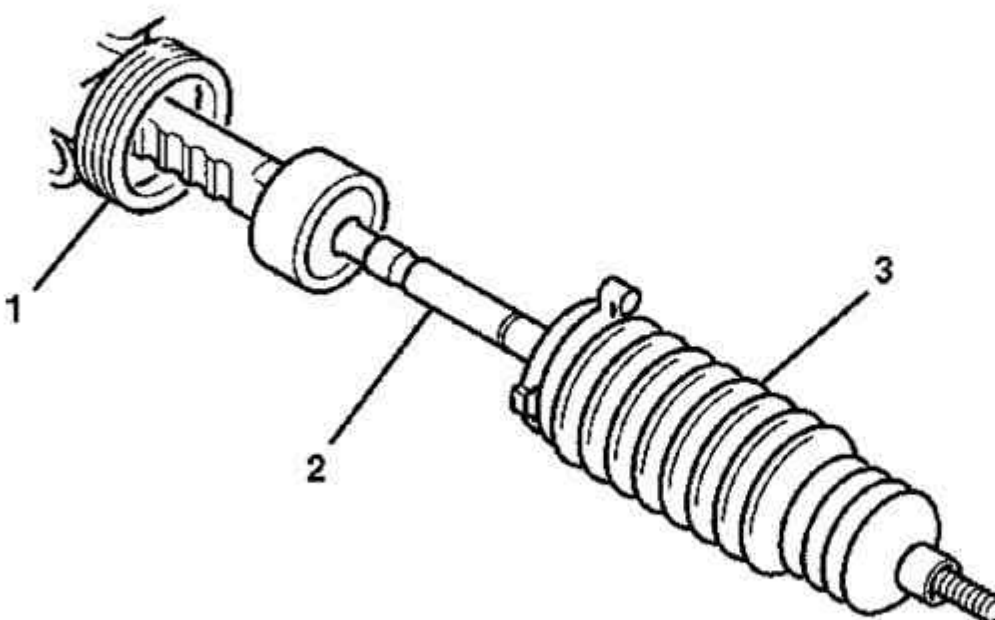
6. Remove the rack and pinion boot (1) and the breather tube, if present, from the rack and pinion gear assembly.

**Assembly Procedure**



**Fig. 98: View Of Boot Clamp & Rack & Pinion Boot**  
**Courtesy of GENERAL MOTORS CORP.**

1. Install the new boot clamp (1) onto the rack and pinion boot (3).

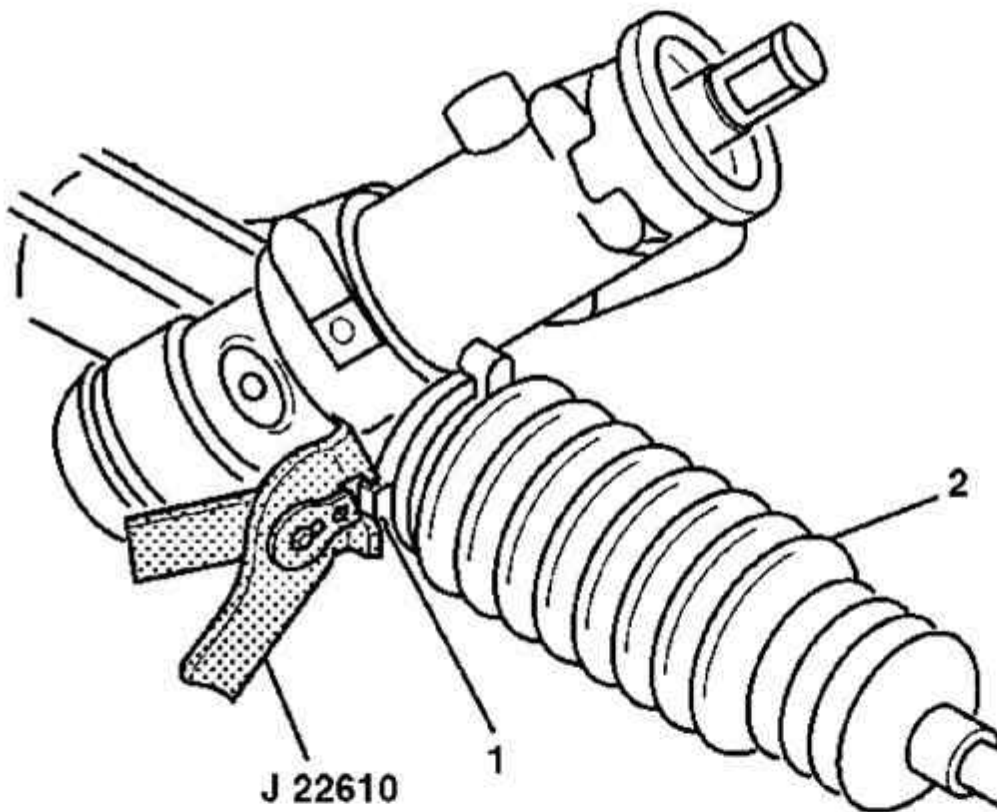


**Fig. 99: View Of Rack & Pinion Gear Assembly, Boot & Inner Tie Rod Assembly**  
Courtesy of GENERAL MOTORS CORP.

2. Prior to rack and pinion boot installation, apply grease to the inner tie rod assembly (2) and the rack and pinion gear assembly (1).
3. Install the rack and pinion boot (3) onto the inner tie rod assembly (2).
4. If present, install the breather tube while aligning the breather tube with the mark made during removal and the molded nipple of the rack and pinion boot.

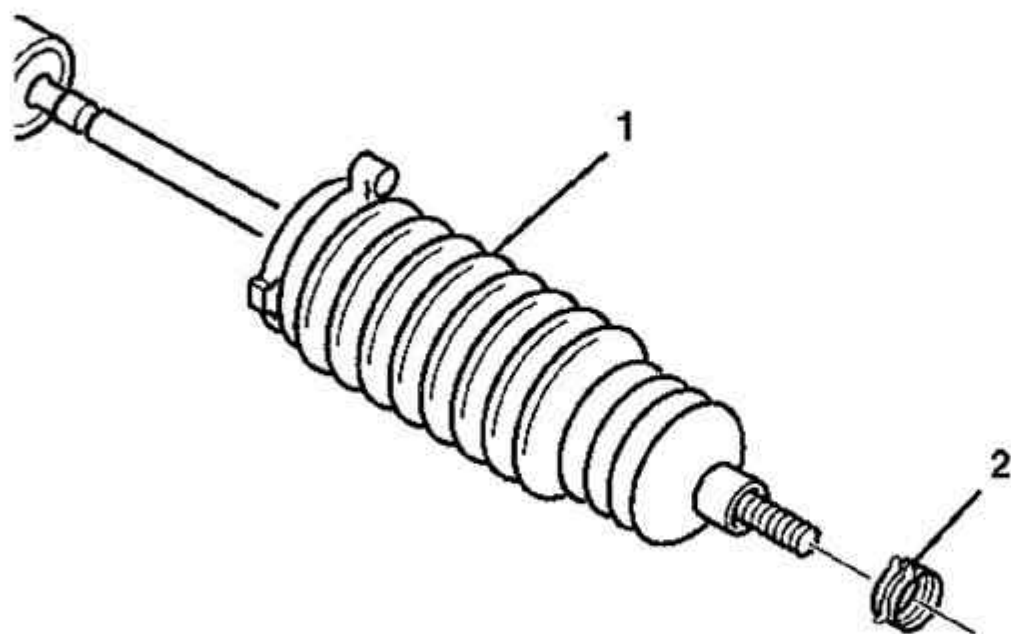
**IMPORTANT:** The rack and pinion boot (3) must not be twisted, puckered or out of shape in any way. If the rack and pinion boot (3) is not shaped properly, adjust the rack and pinion boot (3) by hand before installing the boot clamp.

5. Install the rack and pinion boot onto the gear assembly (1) until the rack and pinion boot (3) is seated in the gear assembly groove.



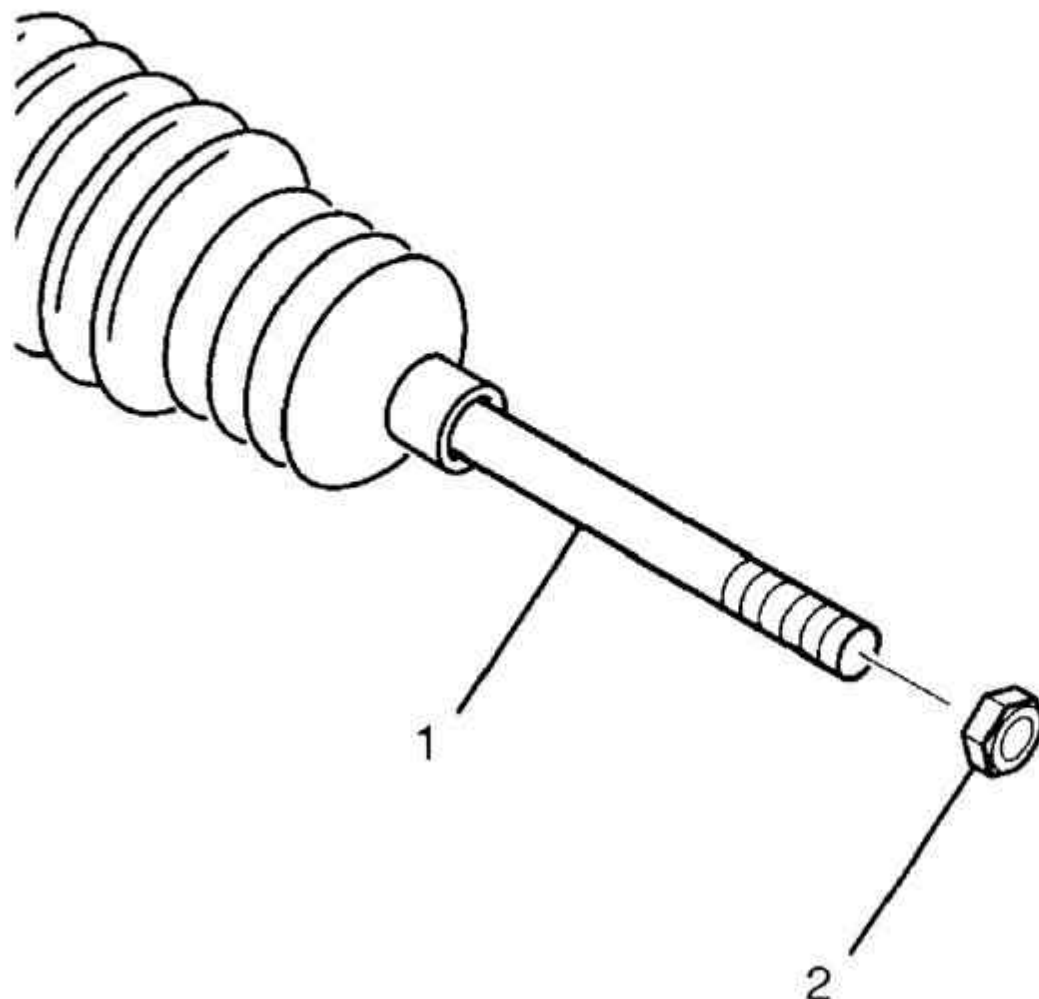
**Fig. 100: Using J 22610 To Install Boot Clamp**  
Courtesy of GENERAL MOTORS CORP.

6. Install the boot clamp (1) on the rack and pinion boot (2) with J 22610 .
7. Crimp the boot clamp (1).
8. Pinch the pliers together on the rack and pinion boot (2) in order to install the tie rod end clamp.



**Fig. 101: View Of Tie Rod End Clamp At Rack & Pinion Boot**  
Courtesy of GENERAL MOTORS CORP.

9. Install the tie rod end clamp (2) onto the rack and pinion boot (1).



**Fig. 102: View Of Inner Tie Rod & Hex Jam Nut**  
Courtesy of GENERAL MOTORS CORP.

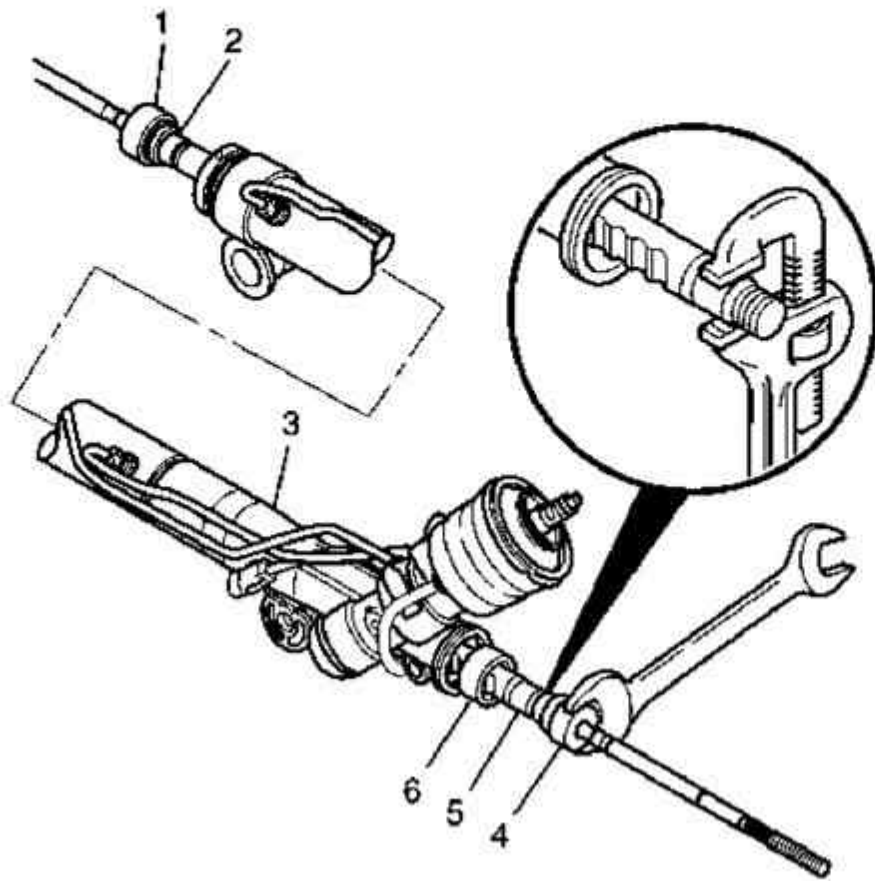
10. Install the hexagon jam nut (2) to the inner tie rod assembly (1).
11. To assemble the outer tie rod assembly. Refer to **Rack and Pinion Outer Tie Rod End Replacement**.

#### **STEERING GEAR INNER TIE ROD REPLACEMENT - OFF VEHICLE (MAGNASTEER)**

##### **Tools Required**

**J 34028** Inner Tie Rod Wrench. See **Special Tools**.

##### **Disassembly Procedure**



**Fig. 103: View of Shock Dampener, Inner Tie Rod Housing, and Rack**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** After removing the boot, inspect the inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear.

1. To remove the rack and pinion boot, refer to Steering Gear Boot and Breather Tube Replacement - Off Vehicle.
2. Place the gear in a vise.

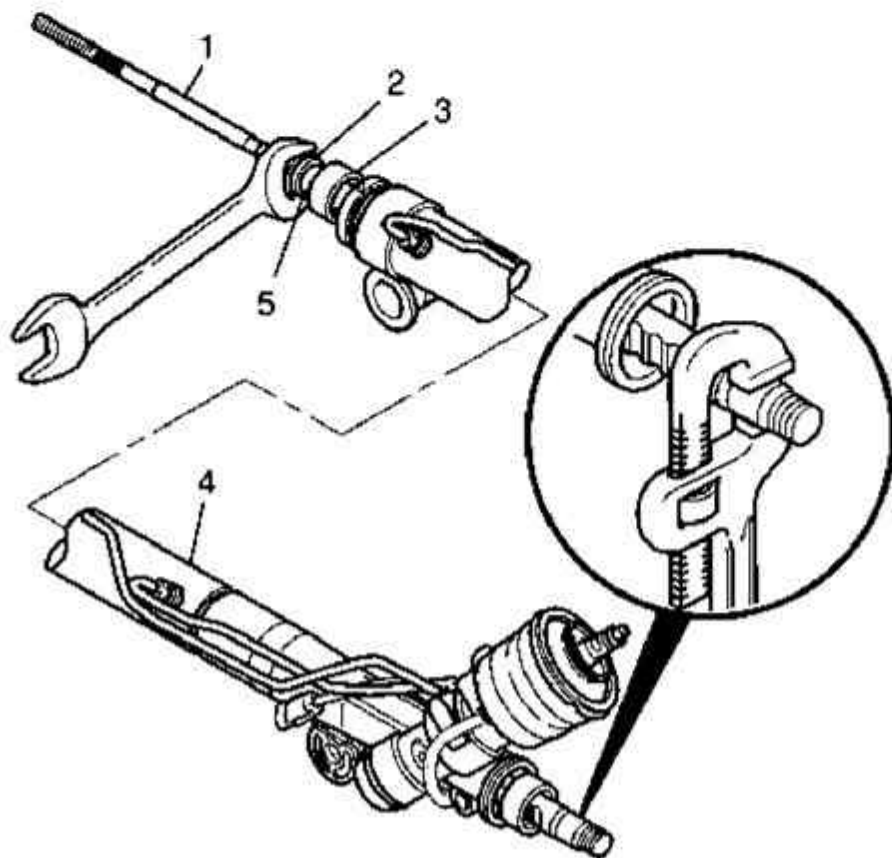
**NOTE:** Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

3. Remove the shock dampener (6) from the inner tie rod housing (4).
4. Slide the shock dampener (6) back on the rack (5).

**NOTE:** The pipe wrench must be placed at the valve end of the steering gear and positioned up against the inner tie rod housing. Placing the pipe wrench in any other location will cause damage to the steering gear.

5. Place a pipe wrench on the rack (5) next to the inner tie rod housing (4).

6. Place a wrench on the flats of the inner tie rod housing (4).
7. Rotate the inner tie rod housing (4) counterclockwise, while holding the rack stationary, until the inner tie rod separates from the rack (5).

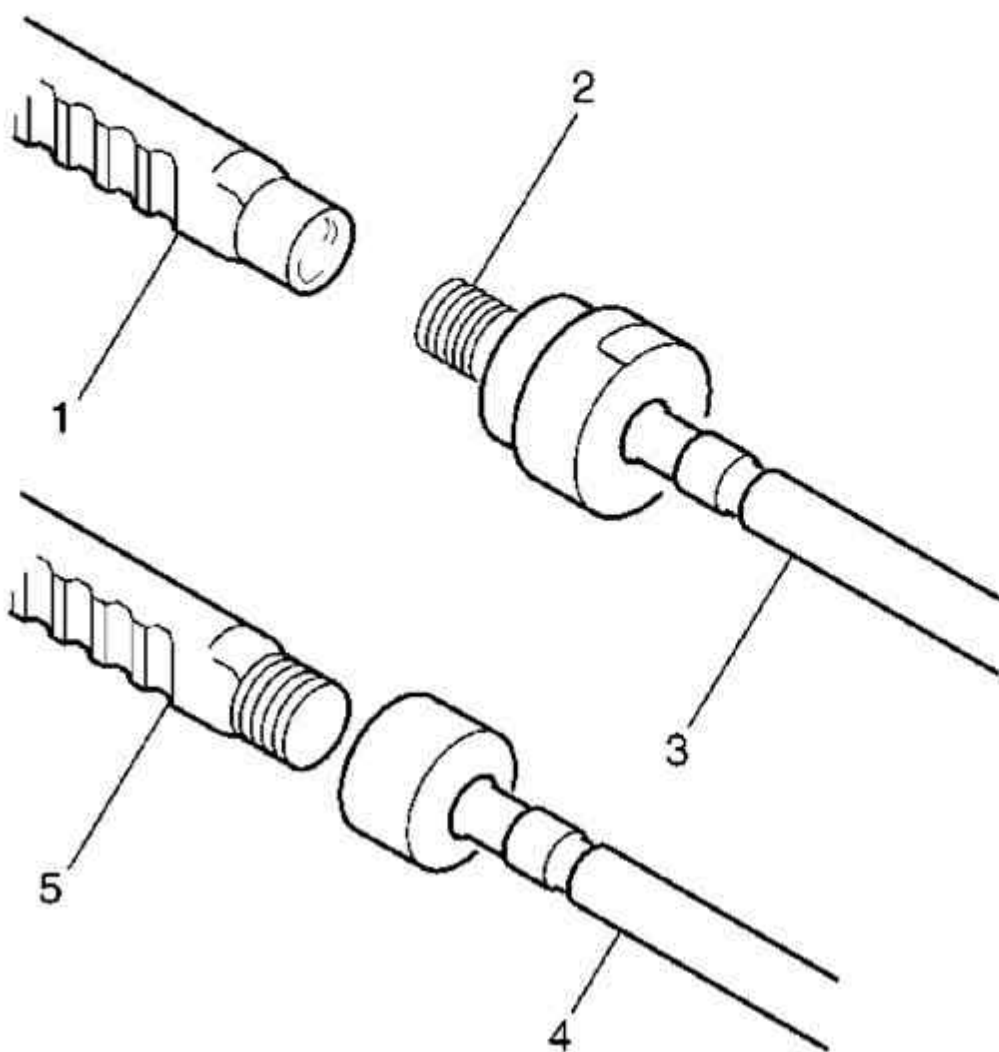


**Fig. 104: View of Shock Dampener, Inner Tie Rod Housing, Rack and Inner Tie Rod**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the shock dampener (3) from the inner tie rod housing (2).
9. Slide the shock dampener (3) back on the rack (5).

**NOTE:** Refer to Pipe Wrench Positioning Notice .

10. Place a pipe wrench on the rack.
11. Place a wrench on the flats of the inner tie rod housing (2).
12. Rotate the inner tie rod housing (2) counterclockwise, while holding the rack stationary, until the inner tie rod (1) separates from the rack (5).

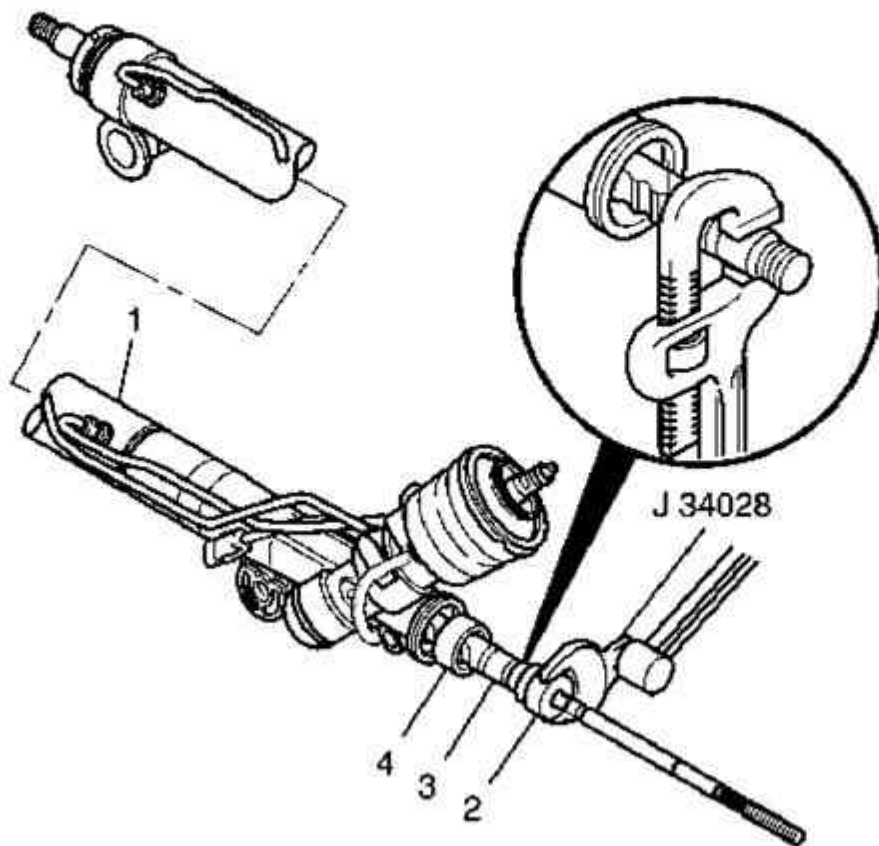


**Fig. 105: Identifying Tie Rod Male & Female Ends**  
Courtesy of GENERAL MOTORS CORP.

13. If female rack (1) and male inner tie rod (3), remove the old LOCTITE® from the threads (2) of the inner tie rod (3) and the rack (1).

If male rack (5) and female inner tie rod (4) LOCTITE® will not be present.

#### Assembly Procedure



**Fig. 106: View of Shock Dampener, Rack, Female/Male Inner Tie Rod with J 34028**  
 Courtesy of GENERAL MOTORS CORP.

1. Slide the shock dampener (4) forward onto the rack (3).

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE®, or equivalent, container for expiration date. Use only enough LOCTITE® to evenly coat threads.

If male rack (3) and female inner tie rod (2) do not apply LOCTITE®.

2. If female rack (3) and male inner tie rod (2), apply LOCTITE® 262, or equivalent, to the inner tie rod threads.
3. Attach the inner tie rod onto the rack (3).

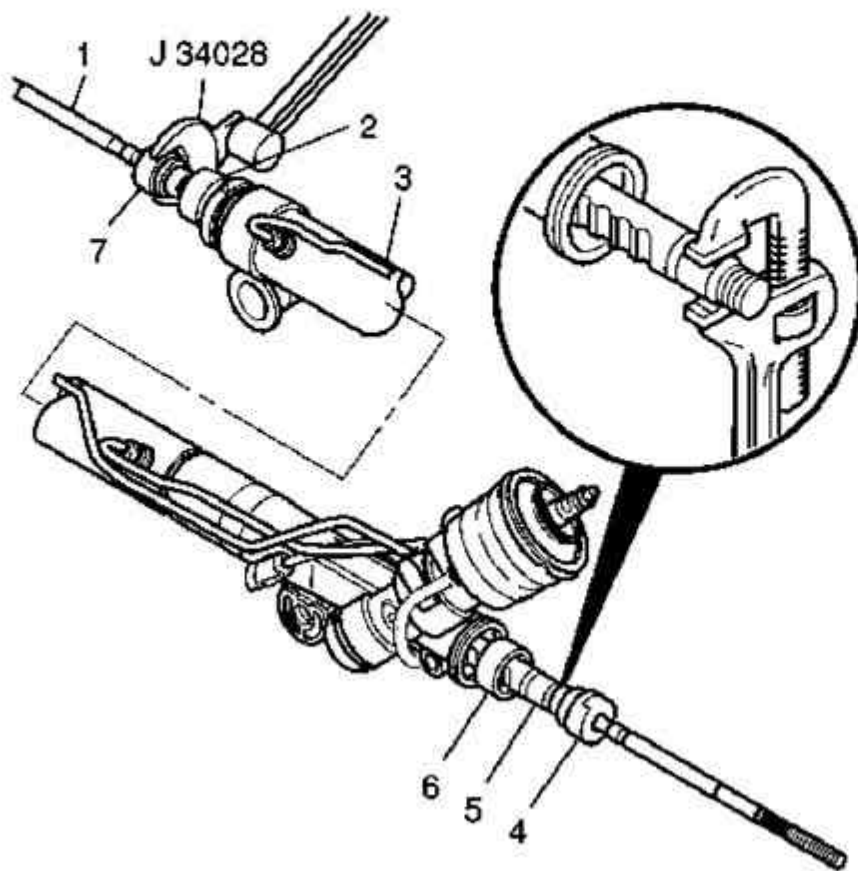
**NOTE:** Refer to Pipe Wrench Positioning Notice .

4. Place a pipe wrench on the rack (3) next to the inner tie rod housing (2).

**NOTE:** Refer to Fastener Notice .

5. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (2). See Special Tools.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).



**Fig. 107: View of Shock Dampener, Female/Male Inner Tie Rod and Inner Tie Rod Housing with J 34028**

Courtesy of GENERAL MOTORS CORP.

6. Slide the shock dampener (2) forward onto the rack.

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE®, or equivalent, container for expiration date. Use only enough LOCTITE® to evenly coat threads.

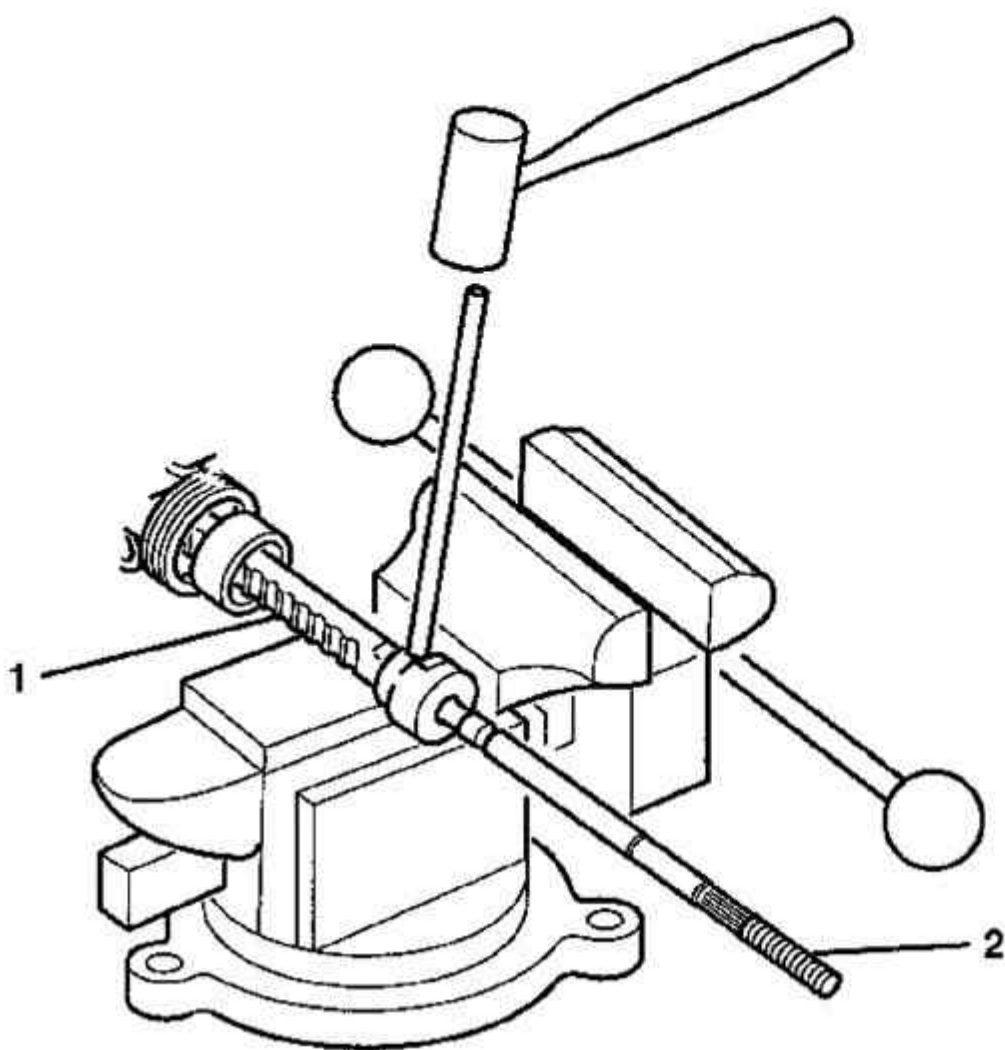
If male rack and female inner tie rod (1) do not apply LOCTITE®.

7. If female rack and male inner tie rod (1), apply LOCTITE® 262, or equivalent, to the inner tie rod threads.
8. Attach the inner tie rod (1) onto the rack.

**NOTE:** Refer to Pipe Wrench Positioning Notice .

9. Place a pipe wrench on the rack next to the inner tie rod housing (4).
10. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (7). See Special Tools.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).

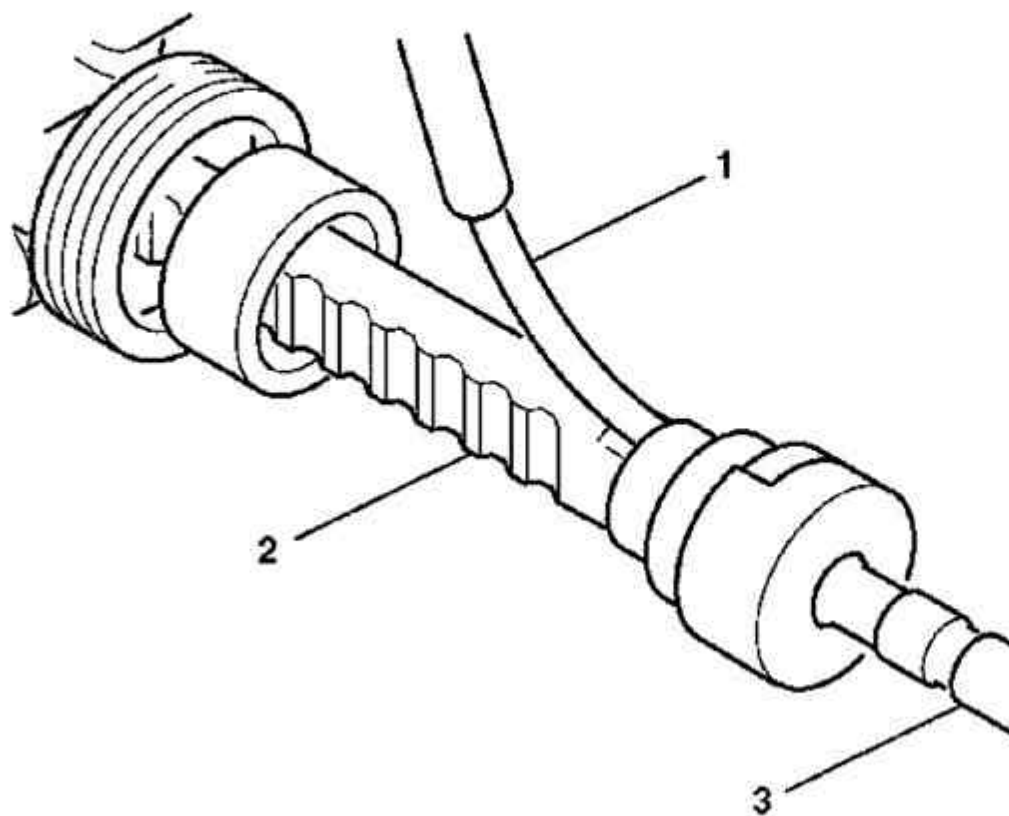


**Fig. 108: Staking Both Sides Of Female Inner Tie Rod Assembly Housing To Male Rack**  
Courtesy of GENERAL MOTORS CORP.

11. Place the inner tie rod assembly (2) in a vise.

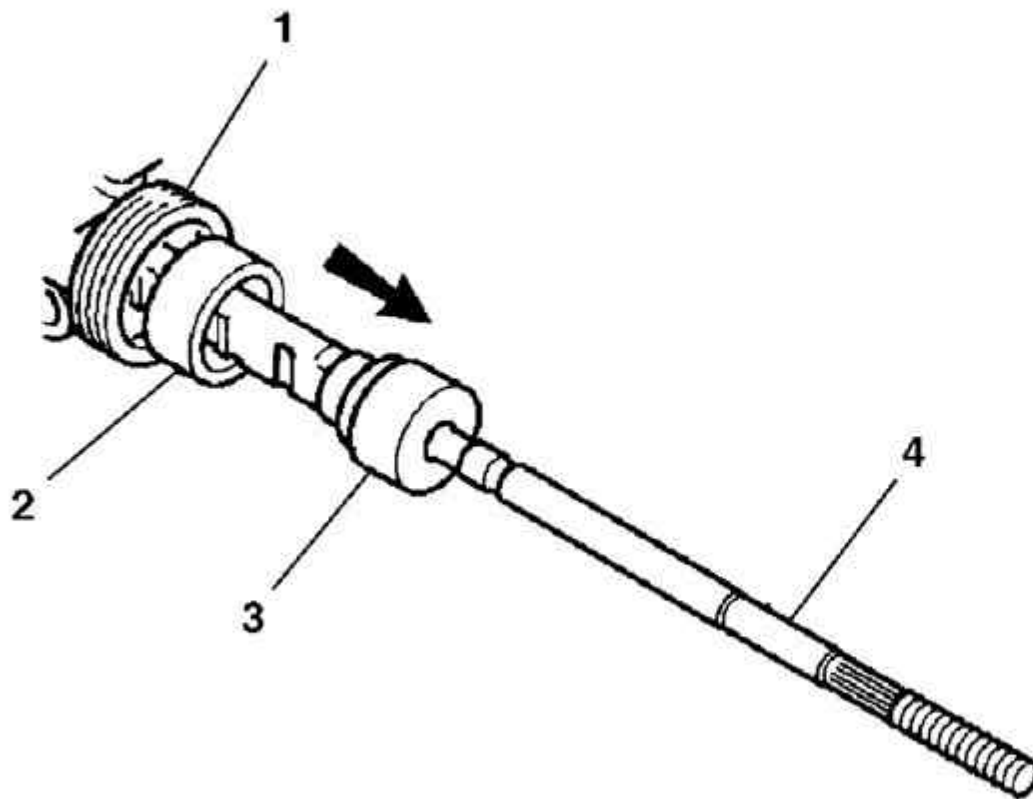
**IMPORTANT:** If female rack (1) and male inner tie rod (2) do not stake. If male rack (1) and female inner tie rod (2) you must stake.

12. Stake both sides of the female inner tie rod assembly housing to the male rack (1).



**Fig. 109: Inserting Gage Between Rack & Inner Tie Rod Housing**  
Courtesy of GENERAL MOTORS CORP.

13. Insert a 0.25 mm gage (1) between the rack (2) and the inner tie rod housing in order to check both stakes. The feeler gage (1) must not pass between the rack and the housing stake.

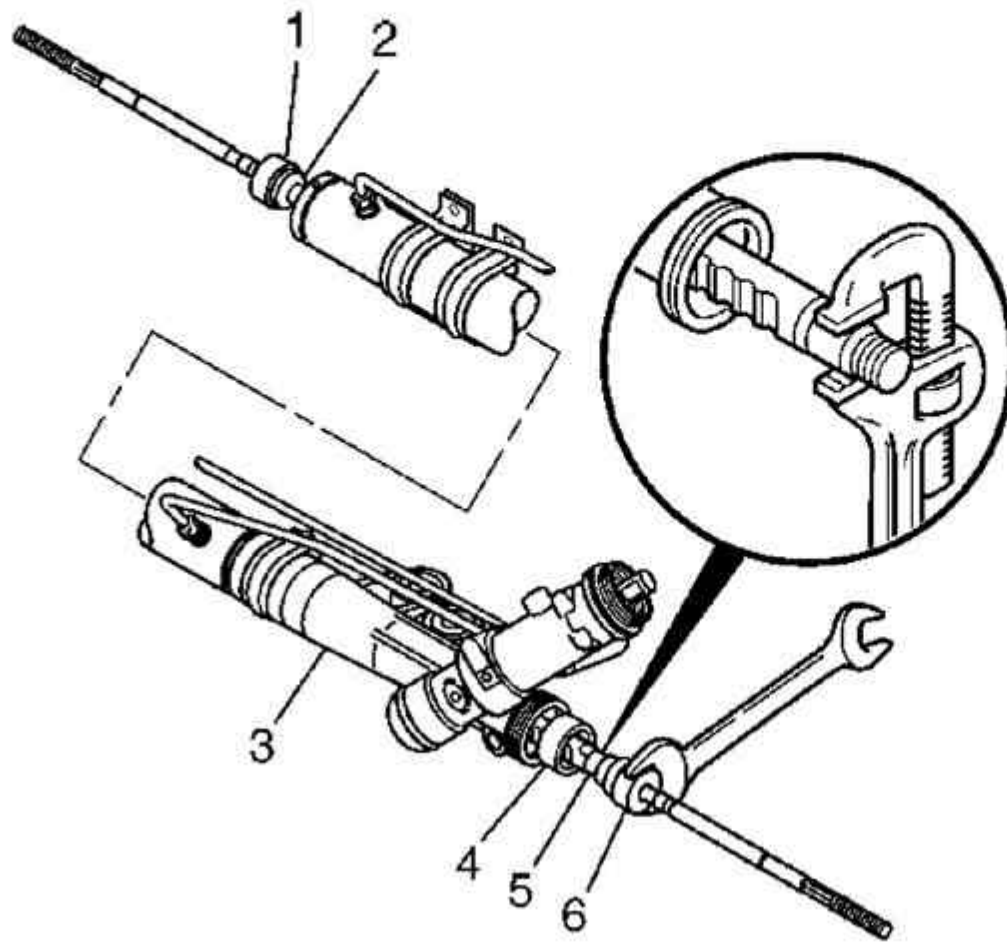


**Fig. 110: Identifying Shock Dampener & Inner Tie Rod Housing**  
Courtesy of GENERAL MOTORS CORP.

14. Slide the shock dampener (2) over the inner tie rod housing (3) until the front lip of the shock dampener (2) bottoms against the inner tie rod housing (3).
15. To assemble the rack and pinion boot. Refer to Steering Gear Boot and Breather Tube Replacement - Off Vehicle.

#### STEERING GEAR INNER TIE ROD REPLACEMENT - OFF VEHICLE (QUIET VALVE)

##### Disassembly Procedure



**Fig. 111: Identifying Inner Tie Rod Components**  
 Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** After removing the boot, inspect the inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear.

1. Remove the rack and pinion boot. Refer to Steering Gear Boot and Breather Tube Replacement - Off Vehicle.
2. Place the gear in a vise.

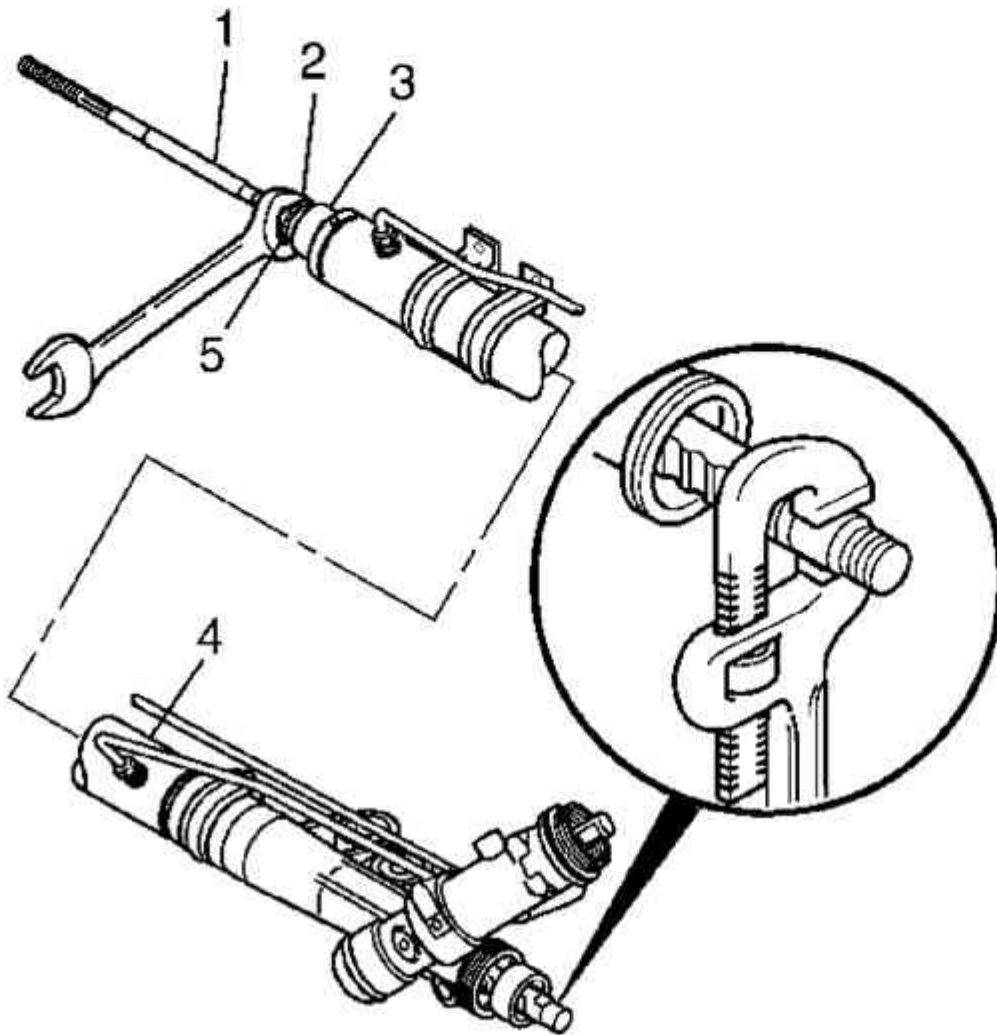
**NOTE:** Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

3. Remove the shock dampener (4) from the inner tie rod assembly (6).
4. Slide the shock dampener (4) back on the rack (5).

**NOTE:** Refer to Pipe Wrench Positioning Notice.

5. Place a pipe wrench on the rack (5) next to the inner tie rod housing (6).
6. Place a wrench on the flats of the inner tie rod housing (6).
7. Rotate the inner tie rod housing (6) counterclockwise, while holding the rack stationary, until the inner tie

rod separates from the rack (5).



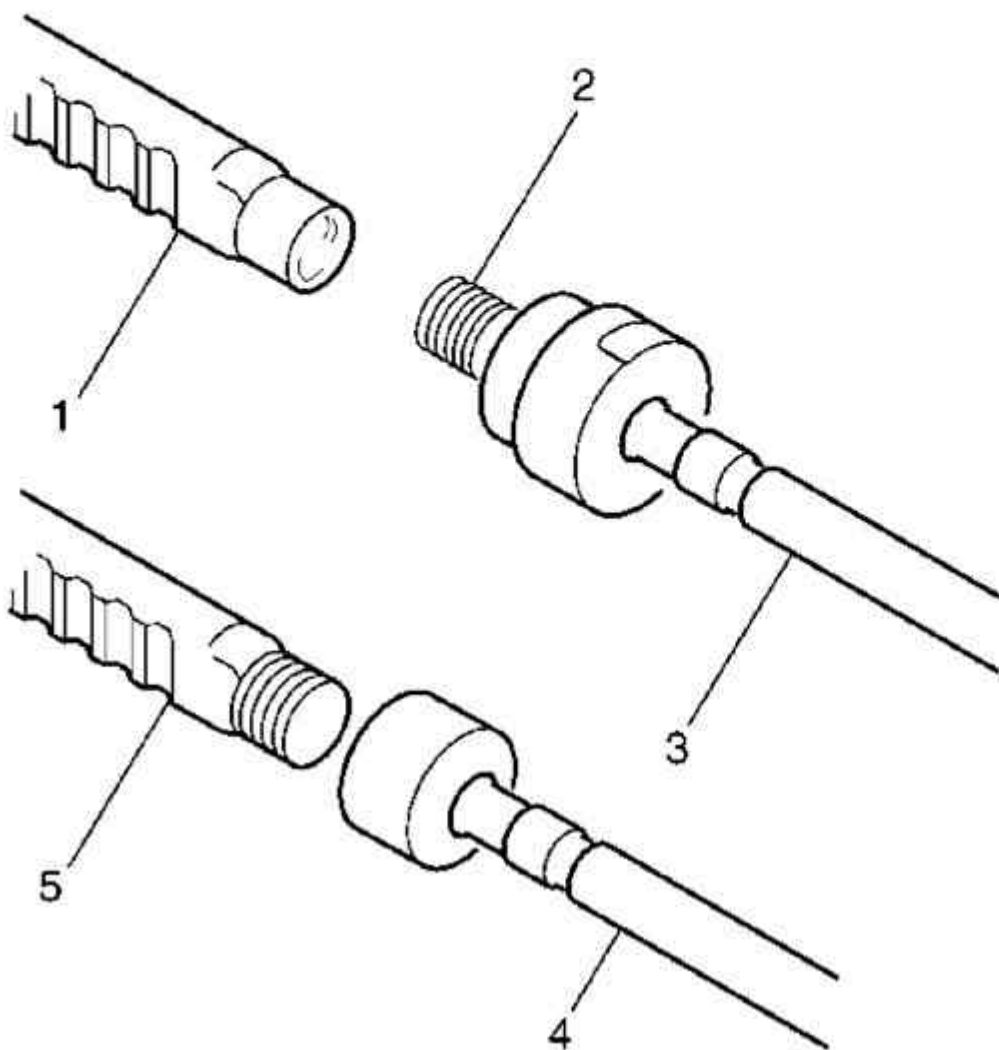
**Fig. 112: Illustrating Separating Inner Tie Rod From Rack**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear.

8. Remove the shock dampener (3) from the inner tie rod housing (2).
9. Slide the shock dampener (3) back on the rack (5).

**NOTE:** Refer to Pipe Wrench Positioning Notice .

10. Place a pipe wrench on the rack.
11. Place a wrench on the flats of the inner tie rod housing (2).
12. Rotate the inner tie rod housing (2) counterclockwise, while holding the rack stationary, until the inner tie rod (1) separates from the rack (5).

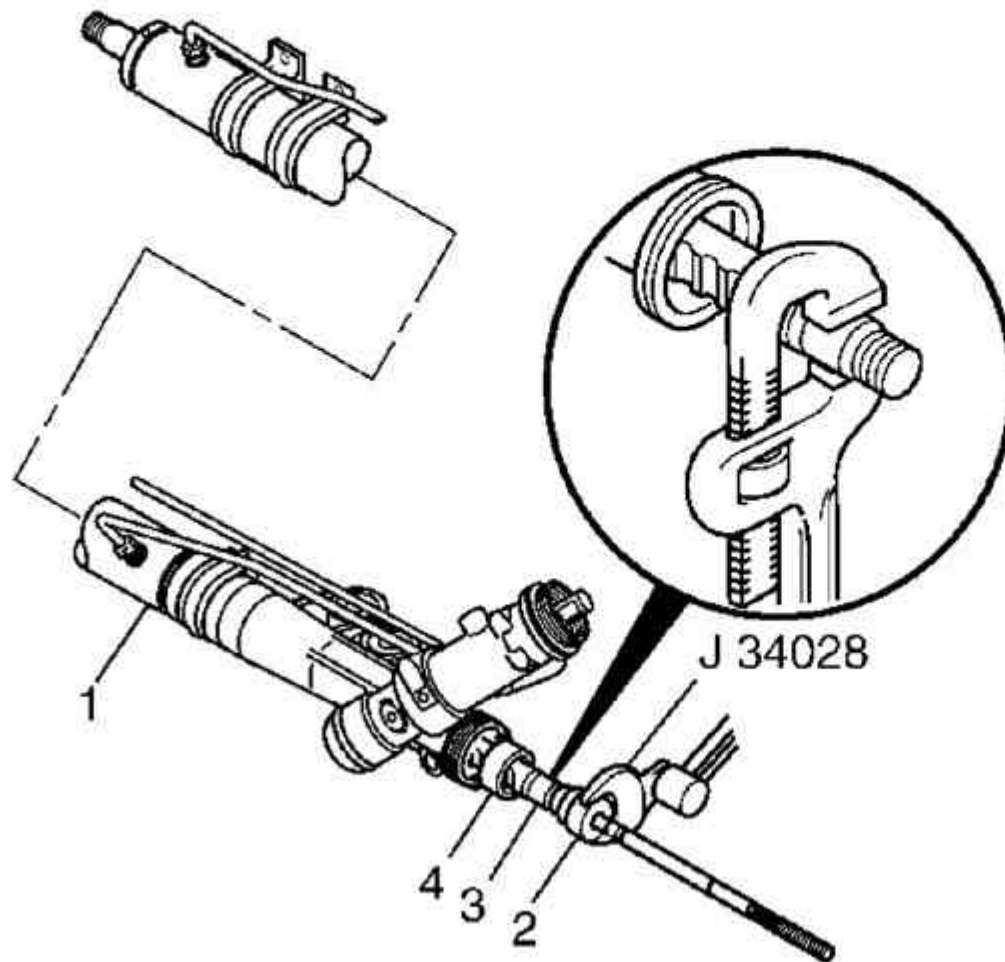


**Fig. 113: Identifying Tie Rod Male & Female Ends**  
Courtesy of GENERAL MOTORS CORP.

13. If female rack (1) and male inner tie rod (3), remove the old LOCTITE® from the threads (2) of the inner tie rod and the rack.

If male rack (5) and female inner tie rod (4) LOCTITE® will not be present.

#### Assembly Procedure



**Fig. 114: Illustrating Connecting Inner Tie Rod To Rack**  
Courtesy of GENERAL MOTORS CORP.

1. Slide the shock dampener (4) forward onto the rack (3).

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE® or equivalent container for expiration date. Use only enough LOCTITE® to evenly coat threads.

If male rack (3) and female inner tie rod (2) do not apply LOCTITE®.

2. If female rack (3) and male inner tie rod (2), apply LOCTITE® 262 or equivalent to the inner tie rod threads.
3. Attach the inner tie rod onto the rack (3).

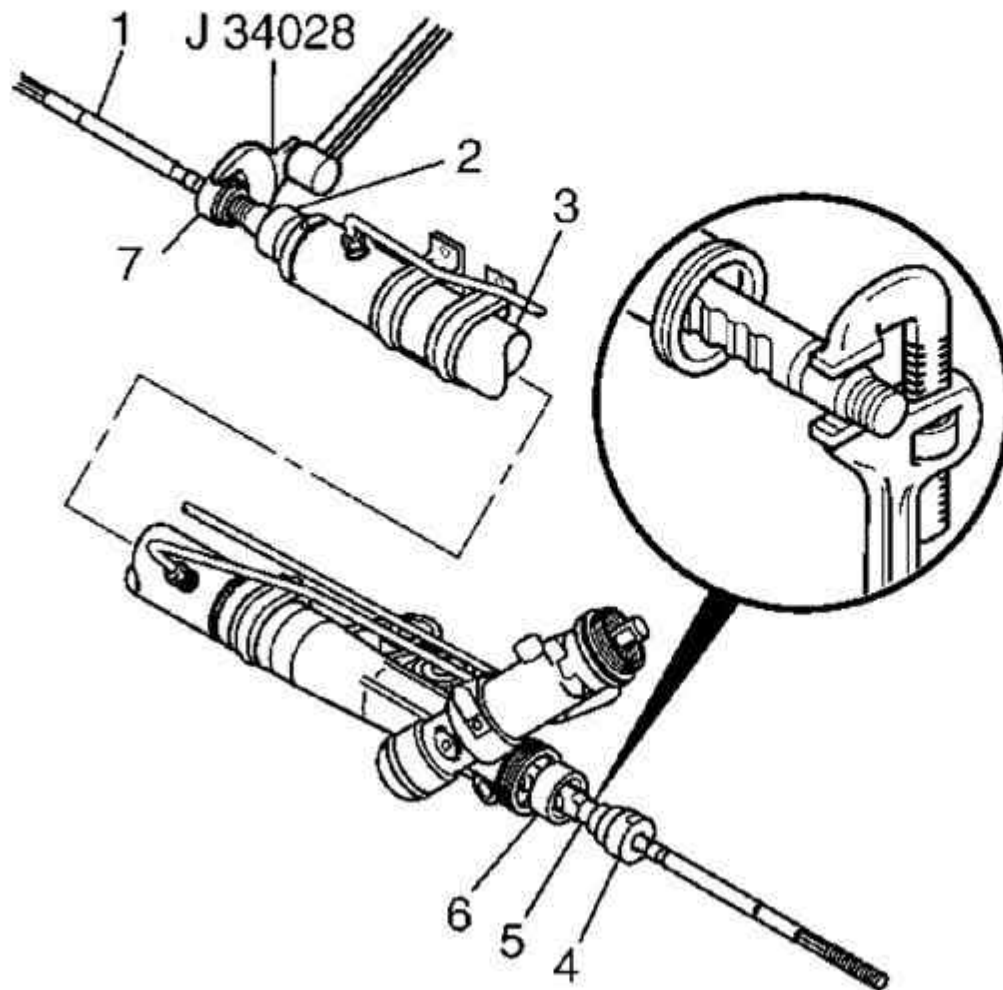
**NOTE:** Refer to Pipe Wrench Positioning Notice.

4. Place a pipe wrench on the rack (3) next to the inner tie rod housing (2).

**NOTE:** Refer to Fastener Notice.

5. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (2). See Special Tools.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).



**Fig. 115: Illustrating Tightening Of Inner Tie Rod To Rack**  
 Courtesy of GENERAL MOTORS CORP.

6. Slide the shock dampener (2) forward onto the rack.

**IMPORTANT:** Threads must be clean prior to LOCTITE® application. Check LOCTITE® or equivalent container for expiration date. Use only enough LOCTITE® to evenly coat threads.

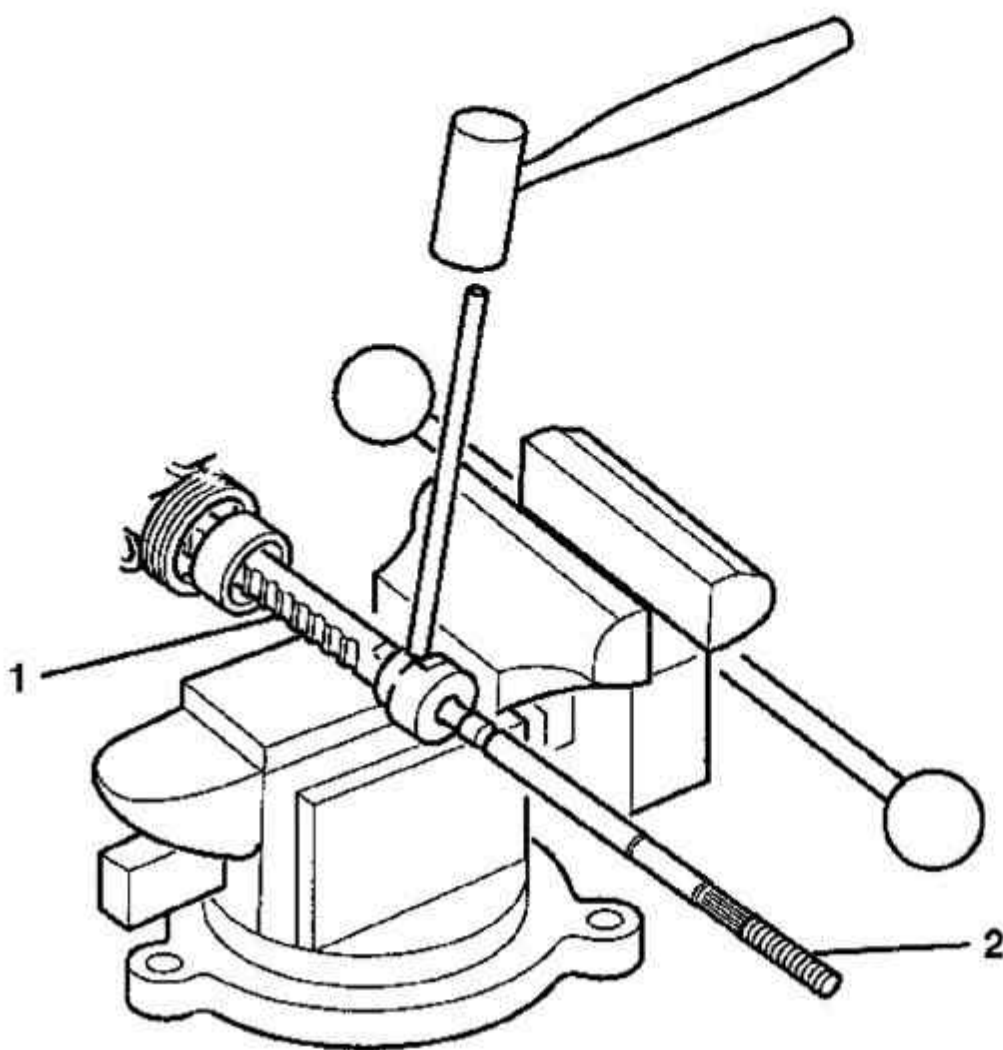
If male rack and female inner tie rod (1) do not apply LOCTITE®.

7. If female rack and male inner tie rod (1), apply LOCTITE® 262 or equivalent to the inner tie rod threads.
8. Attach the inner tie rod (1) onto the rack.

**NOTE:** Refer to Pipe Wrench Positioning Notice .

9. Place a pipe wrench on the rack next to the inner tie rod housing (4).
10. Place a torque wrench and J 34028 on the flats of the inner tie rod housing (7). See Special Tools.

**Tighten:** Tighten the inner tie rod to 100 N.m (74 lb ft).

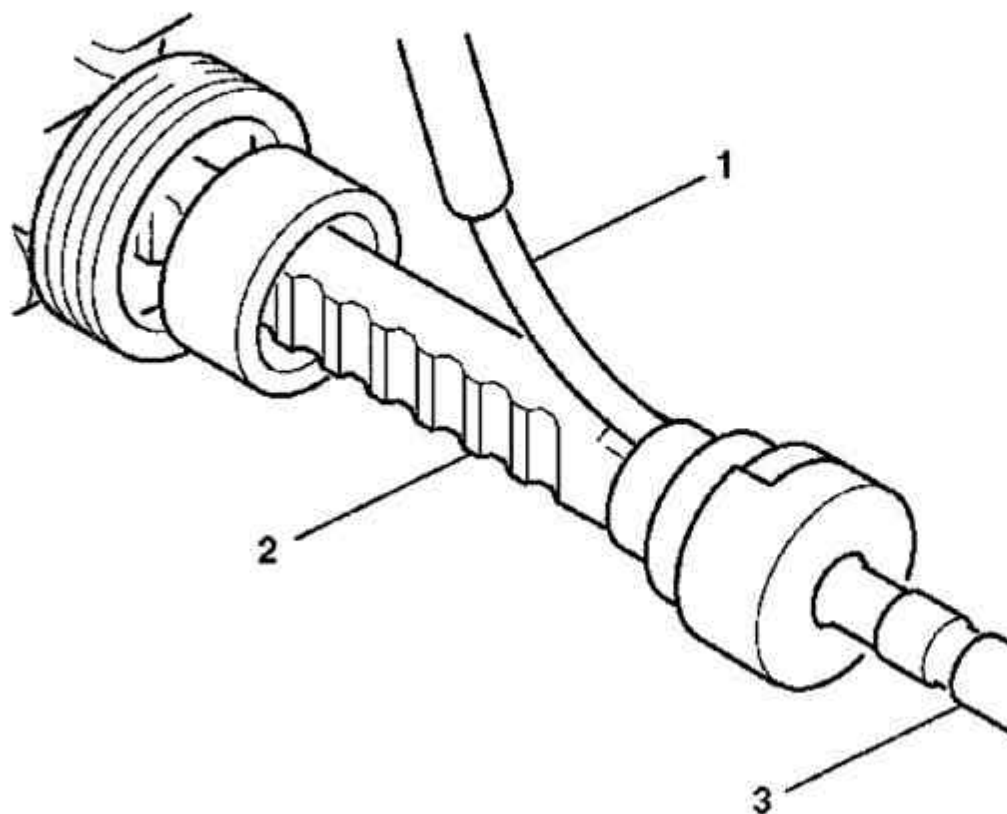


**Fig. 116: Staking Both Sides Of Female Inner Tie Rod Assembly Housing To Male Rack**  
Courtesy of GENERAL MOTORS CORP.

11. Place the inner tie rod assembly (2) in a vise.

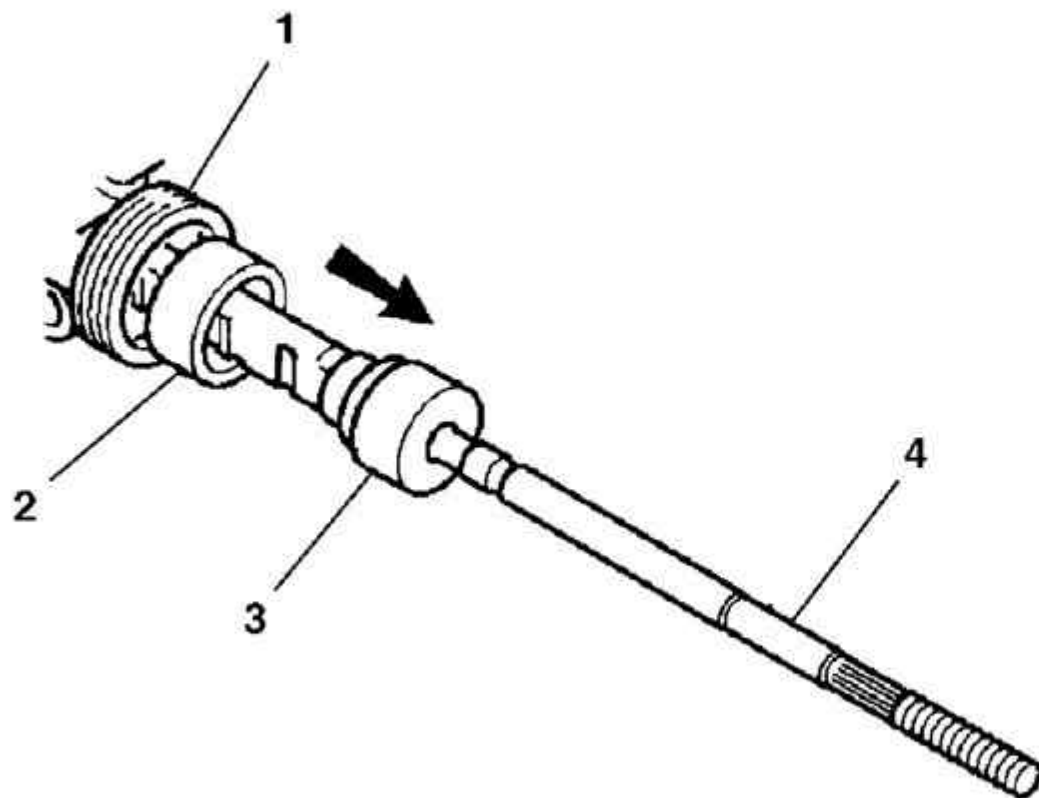
**IMPORTANT:** If female rack (1) and male inner tie rod (2) do not stake. If male rack (1) and female inner tie rod (2) you must stake.

12. Stake both sides of the female inner tie rod assembly housing to the male rack.



**Fig. 117: Inserting Gage Between Rack & Inner Tie Rod Housing**  
**Courtesy of GENERAL MOTORS CORP.**

13. Insert a 0.25 mm gage (1) between the rack (2) and the inner tie rod housing in order to check both stakes. The feeler gage (1) must not pass between the rack and the housing stake.

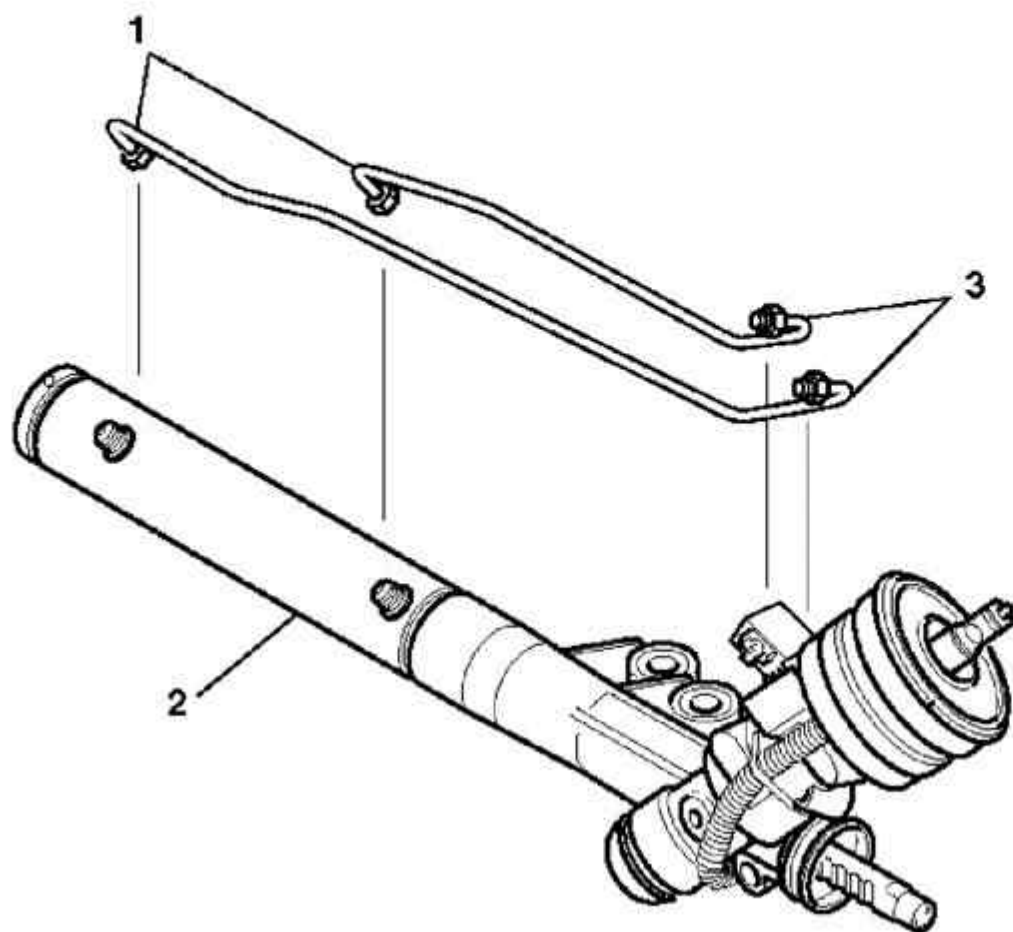


**Fig. 118: Identifying Shock Dampener & Inner Tie Rod Housing**  
Courtesy of GENERAL MOTORS CORP.

14. Slide the shock dampener (2) over the inner tie rod housing (3) until the front lip of the shock dampener (2) bottoms against the inner tie rod housing (3).
15. To assemble the rack and pinion boot. Refer to Steering Gear Boot and Breather Tube Replacement - Off Vehicle.

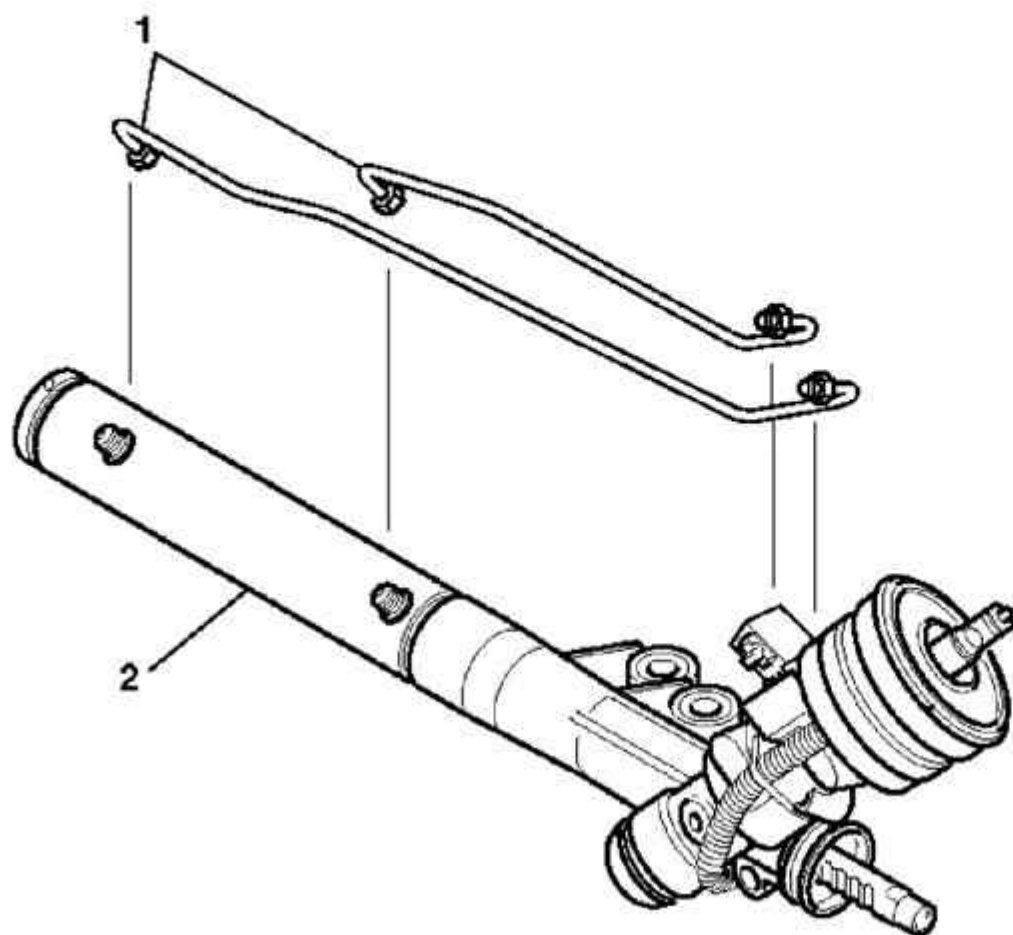
#### STEERING GEAR CYLINDER PIPE ASSEMBLY AND SEALS REPLACEMENT - OFF VEHICLE (MAGNASTEER)

##### Disassembly Procedure



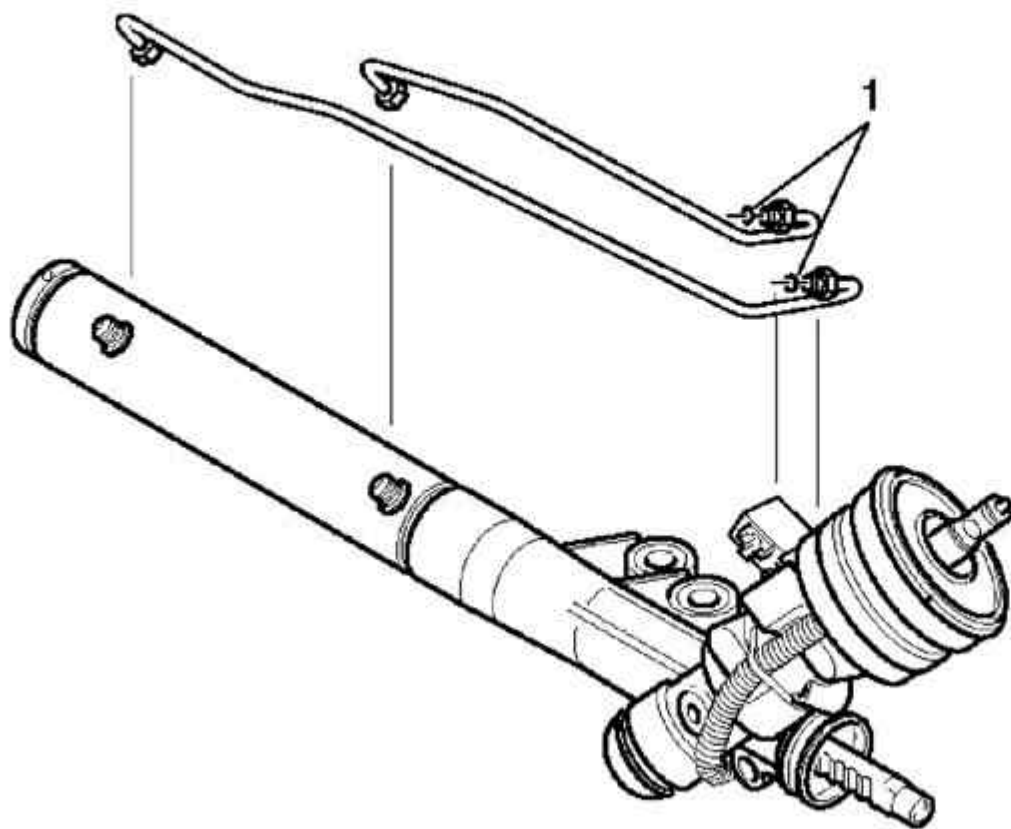
**Fig. 119: View of Cylinder Line Fittings & Cylinder Line Assemblies**  
**Courtesy of GENERAL MOTORS CORP.**

1. Loosen both cylinder line fittings (1) on the cylinder end of the gear assembly.
2. Loosen both fittings on the cylinder line assemblies (3) at the valve end of the gear assembly.



**Fig. 120: View Of Cylinder Line Assemblies & Rack & Pinion Gear Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

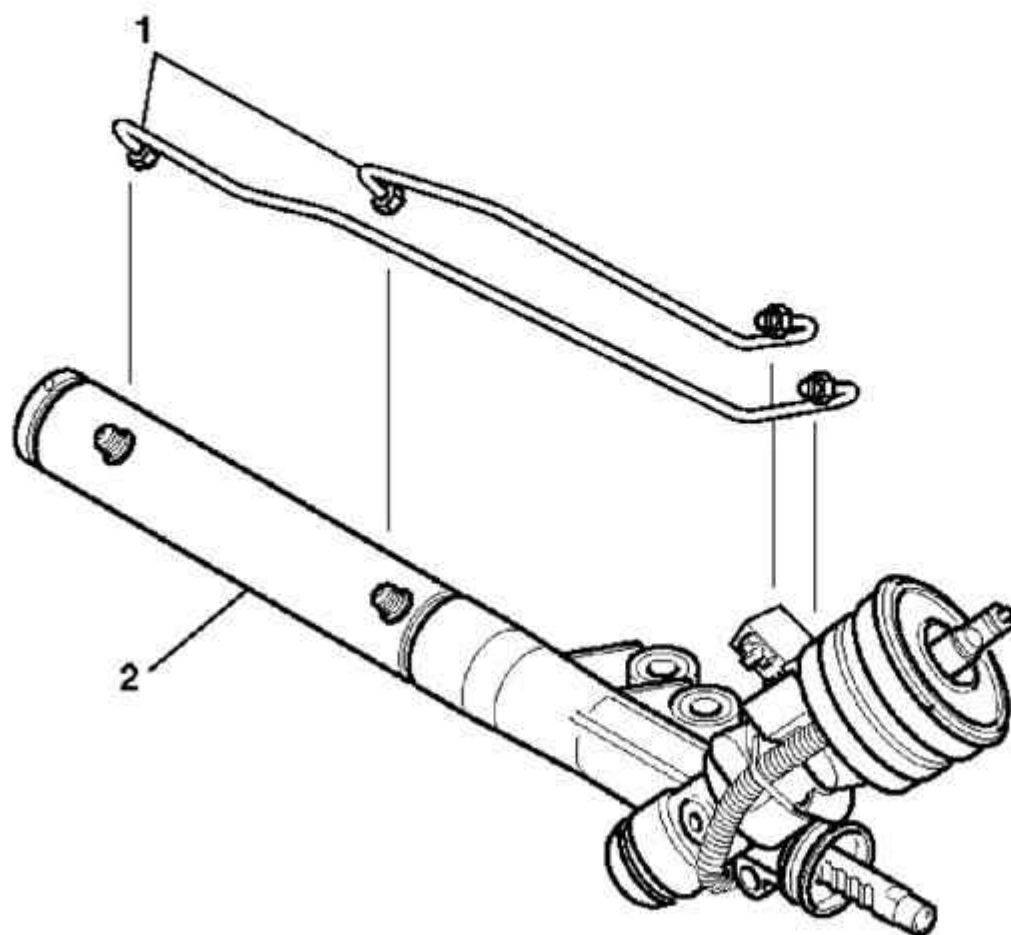
3. Remove both cylinder line assemblies (1) from the rack and pinion gear assembly (2).



**Fig. 121: View Of Steering Fittings At Rack**  
**Courtesy of GENERAL MOTORS CORP.**

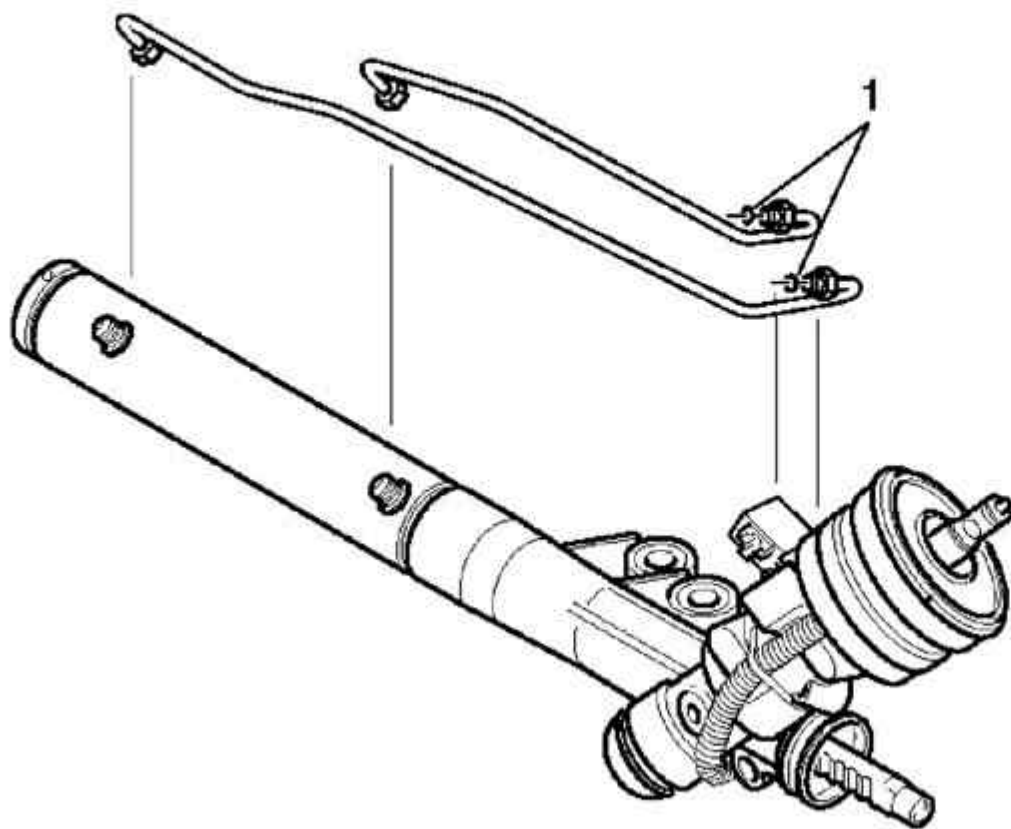
4. Remove the O-ring seals (1) from the valve end of line.
5. Discard the O-ring seals (1).

**Assembly Procedure**



**Fig. 122: View Of Cylinder Line Assemblies & Rack & Pinion Gear Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

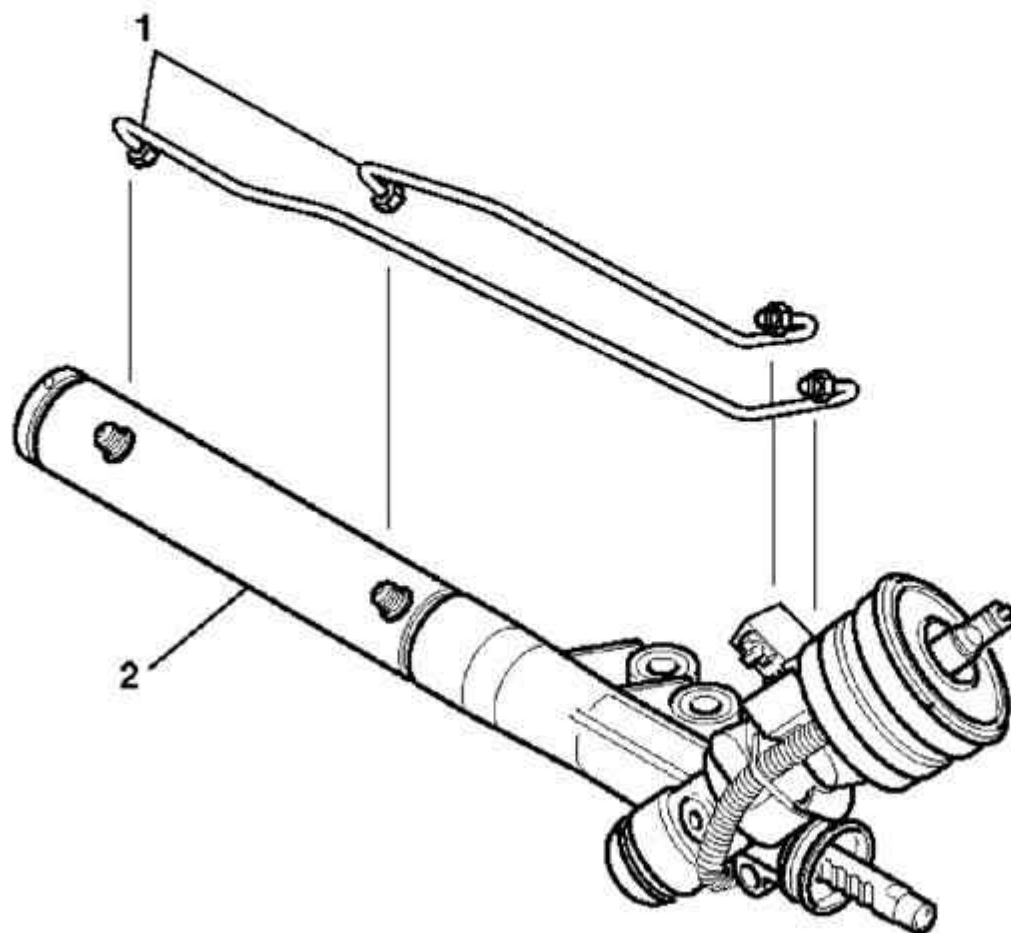
1. Inspect the cylinder lines (1) for the following items:
  - Cracks
  - Dents
  - Damage to the threads
2. Replace the parts as needed.



**Fig. 123: View Of Steering Fittings At Rack**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** Carefully align the threads on all of the fittings. Finger tighten the fittings in order to avoid stripping and cross-threading the fittings.

3. Install the new O-ring seals (1) to the valve end of the cylinder lines.



**Fig. 124: View Of Cylinder Line Assemblies & Rack & Pinion Gear Assembly**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

**IMPORTANT:** Flush and bleed power steering system hoses, reservoir and cooler lines with power steering fluid GM P/N 1050017, Canadian P/N 992646 (or equivalent meeting GM Specification number 9985010). Refer to Power Steering System Bleeding.

4. Install the cylinder line assemblies (1) to the gear assembly (2).

**Tighten**

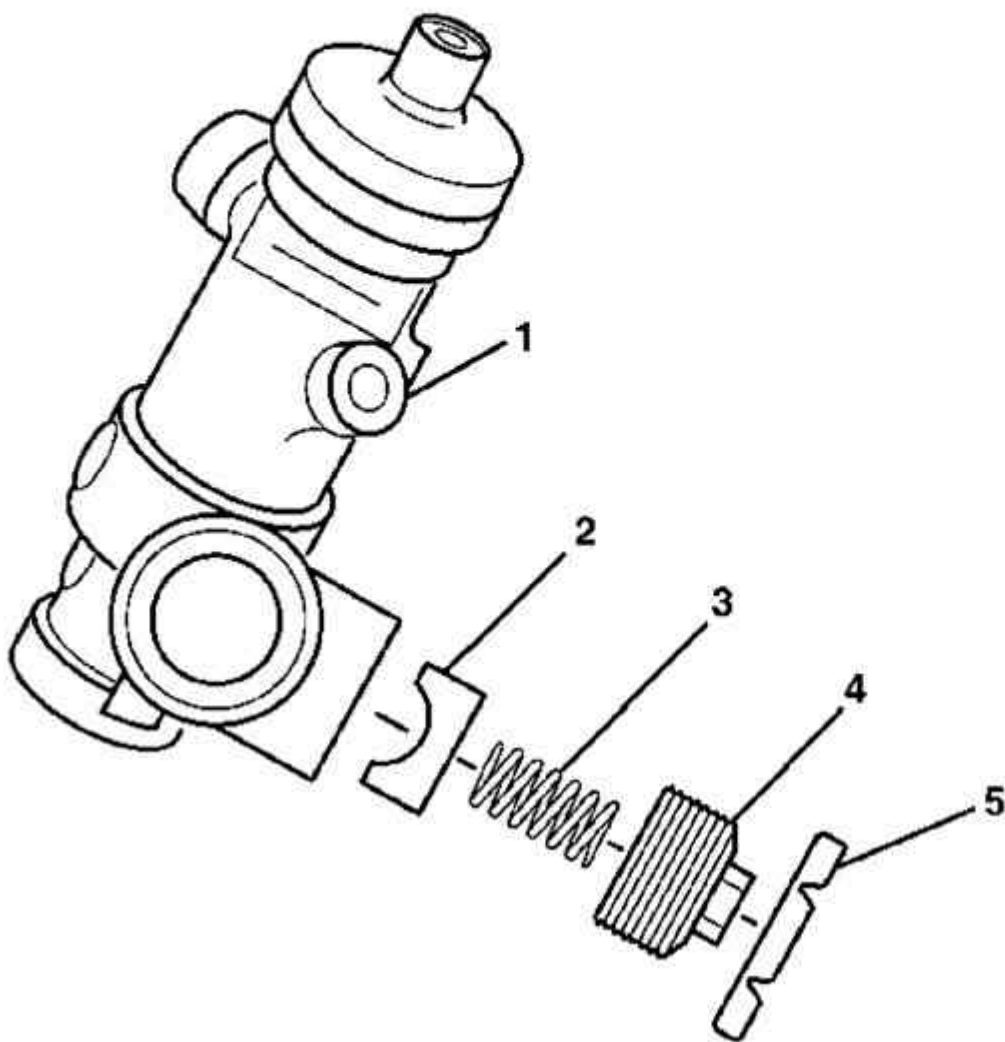
- Tighten the valve end fittings to 17 N.m (13 lb ft).
- Tighten the cylinder end fittings to 27 N.m (20 lb ft).

**STEERING GEAR STUB SHAFT SEAL AND BEARING REPLACEMENT - OFF VEHICLE**

**Special Tools**

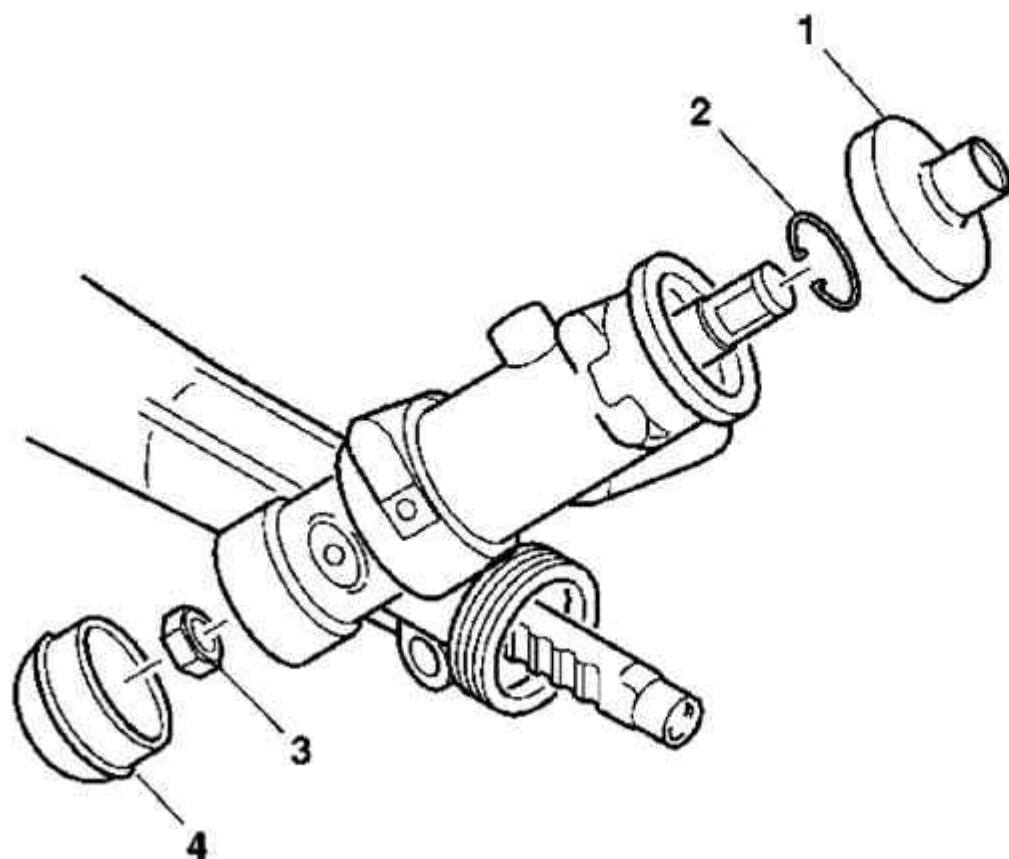
**J 29810** Stub Shaft Seal Protector

**Disassembly Procedure**



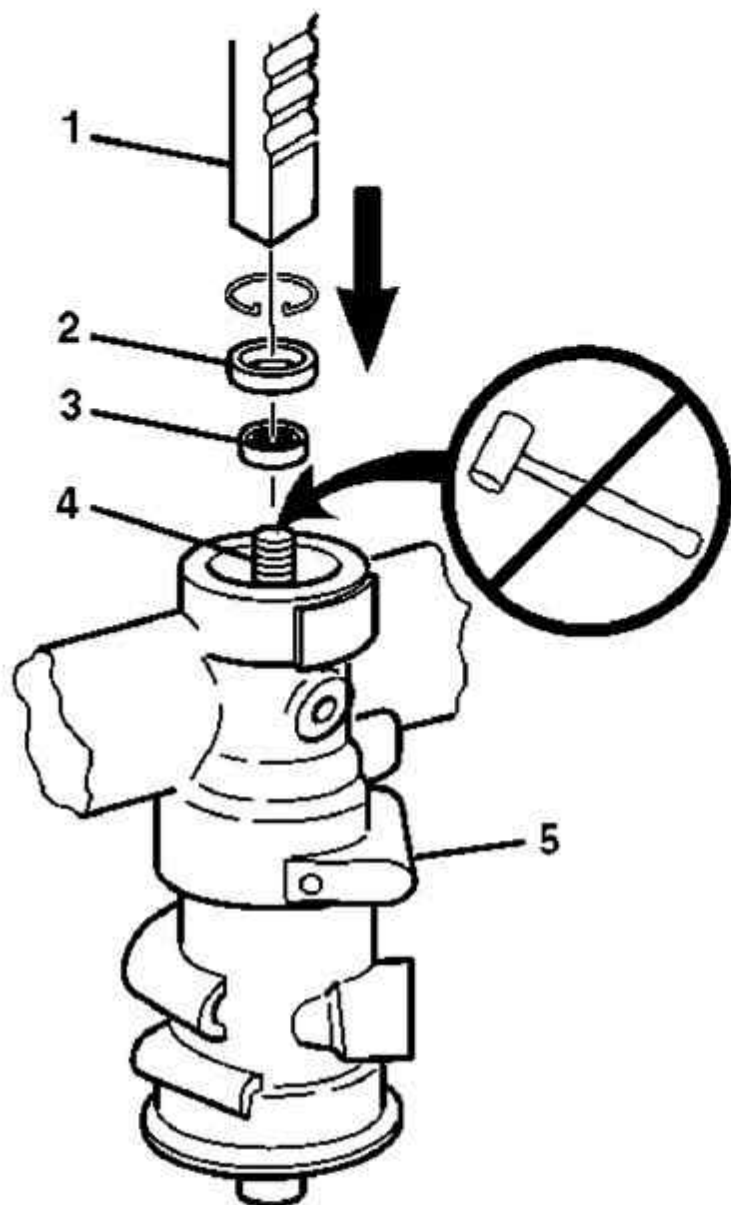
**Fig. 125: View Of Adjuster Plug Lock Nut & Adjuster Plug**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the steering gear from the vehicle, refer to **Steering Gear Replacement**.
2. Remove the adjuster plug lock nut (5) from the adjuster plug (4).
3. Remove the adjuster plug (4) from the gear assembly (1).
4. Remove the adjuster spring (3) and the rack bearing (2).



**Fig. 126: View Of Rack And Pinion Gear Assembly Components**  
Courtesy of GENERAL MOTORS CORP.

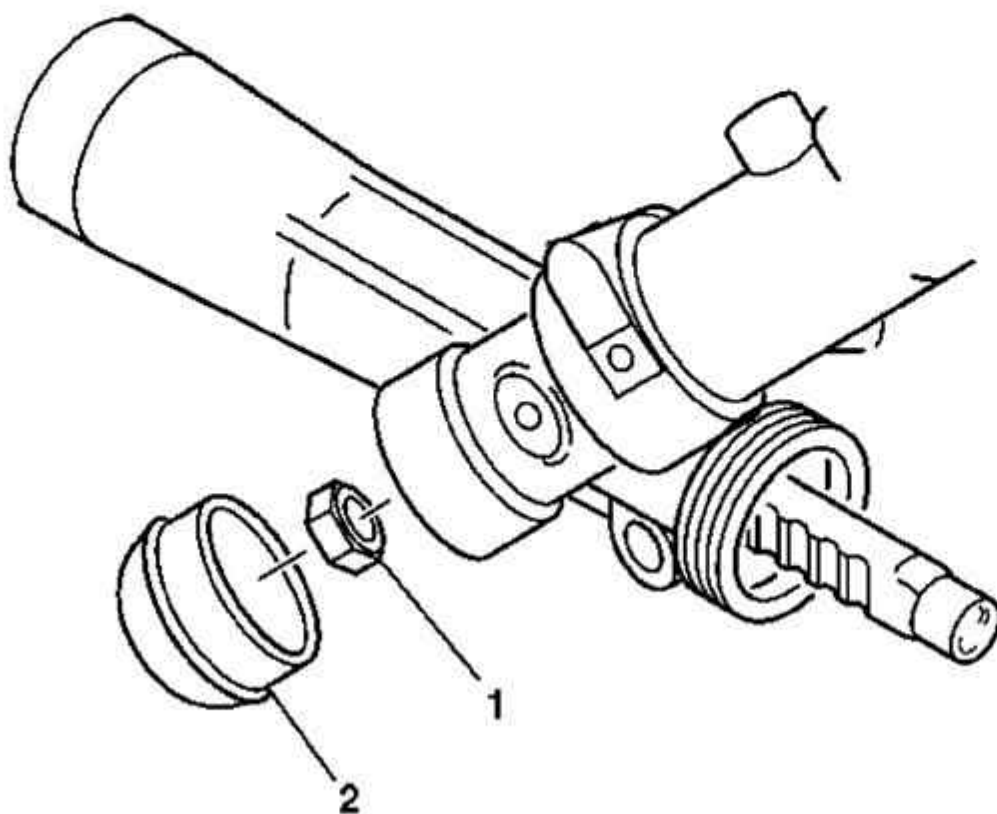
5. Remove the spool shaft boot (1) from the rack and pinion gear assembly.
6. Remove the retaining ring (2) from the valve bore of the rack and pinion gear assembly.
7. Remove the dust cover (4) from the bottom of the rack and pinion gear assembly.
8. Remove the hex lock nut (3) from the lower end of the pinion and valve assembly while holding the stub shaft with a 14 mm crowfoot wrench.



**Fig. 127: View Of Stub Shaft Assembly**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** When performing the following procedure, do not remove pinion and valve assembly from the rack and pinion gear assembly (5). Press the pinion and valve assembly only far enough to allow removal of the stub shaft bearing annulus (3) and the stub shaft seal (2).

9. Using an arbor press (1), press on the threaded end of the pinion until removal of the following items is possible:
  1. The stub shaft (4)
  2. The stub shaft seal (2)
  3. The stub shaft bearing annulus assembly (3)



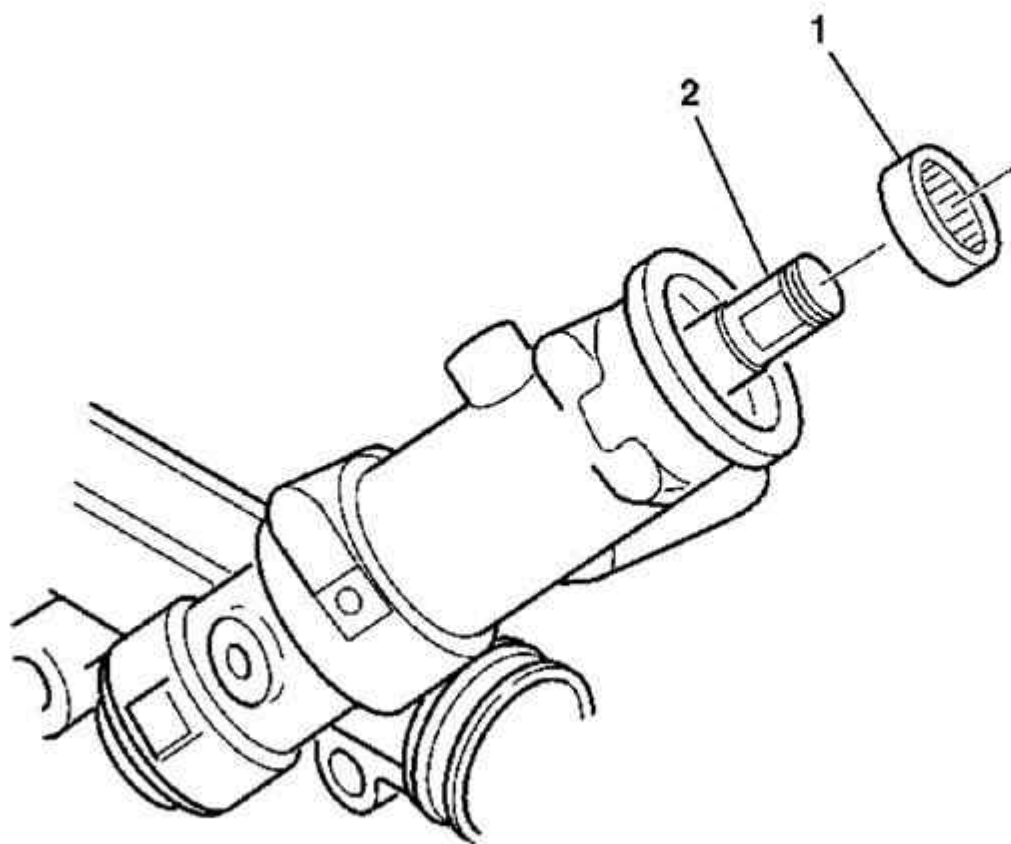
**Fig. 128: Identifying Hexagon Lock Nut**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

1. Install the hex lock nut (1) onto the pinion while holding the valve stub shaft.

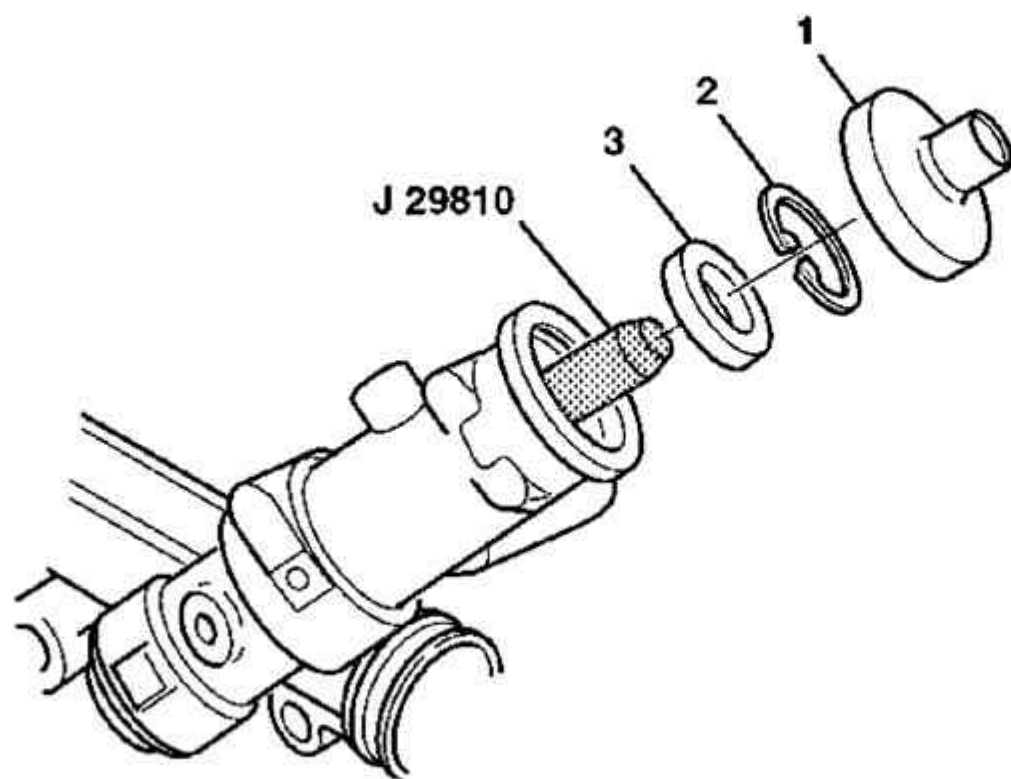
**Tighten:** Tighten the nut to 30 N.m (22 lb ft).

2. Install the dust cover (2) to the rack and pinion gear assembly.



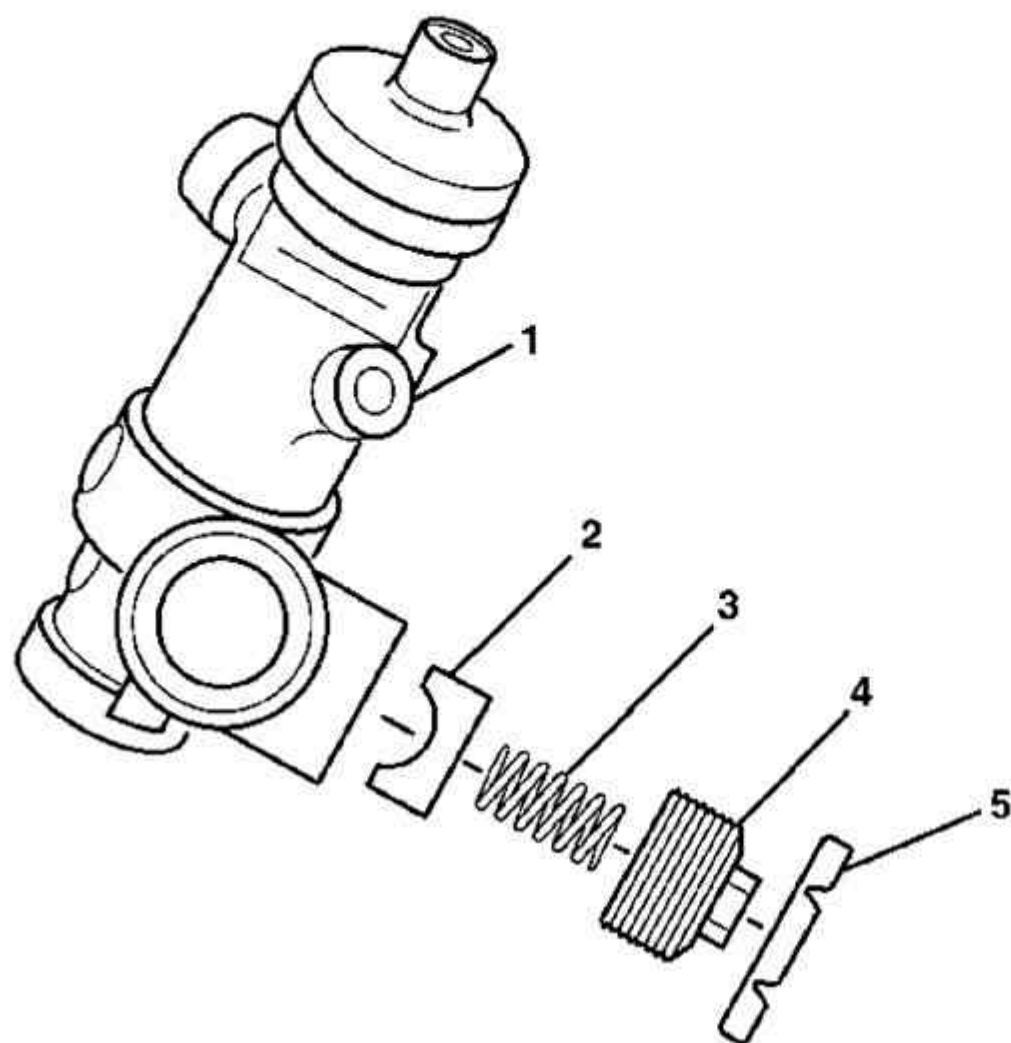
**Fig. 129: View Of Stub Shaft Bearing Annulus Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

3. Install the stub shaft bearing annulus assembly (1) onto the valve stub shaft (2).



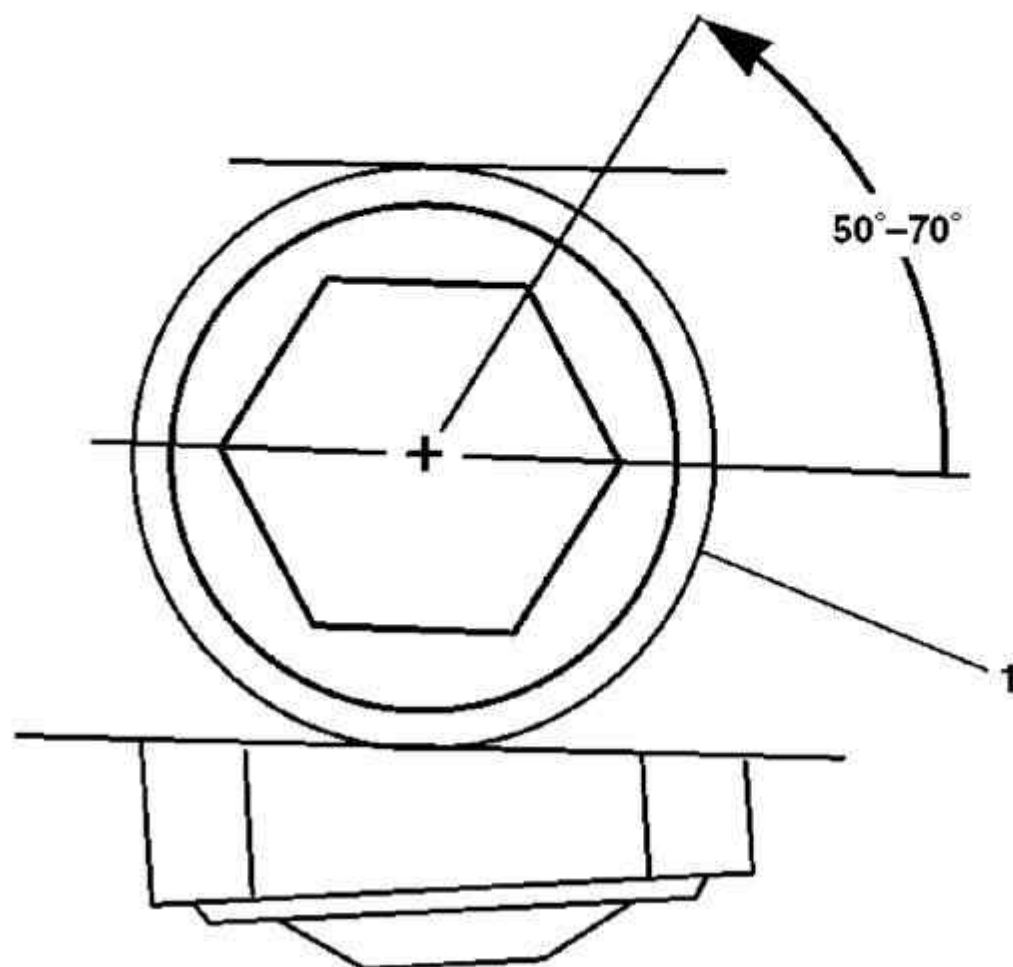
**Fig. 130: View Of Stub Shaft Assembly Components**  
Courtesy of GENERAL MOTORS CORP.

4. Install **J 29810** onto the valve stub shaft.
5. Lubricate the stub shaft seal (3) with grease.
6. Install the stub shaft seal (3) into the rack and pinion gear assembly.
7. Install the retaining ring (2) into the groove in the rack and pinion gear assembly.
8. Install the spool shaft boot (1) onto the rack and pinion gear assembly.



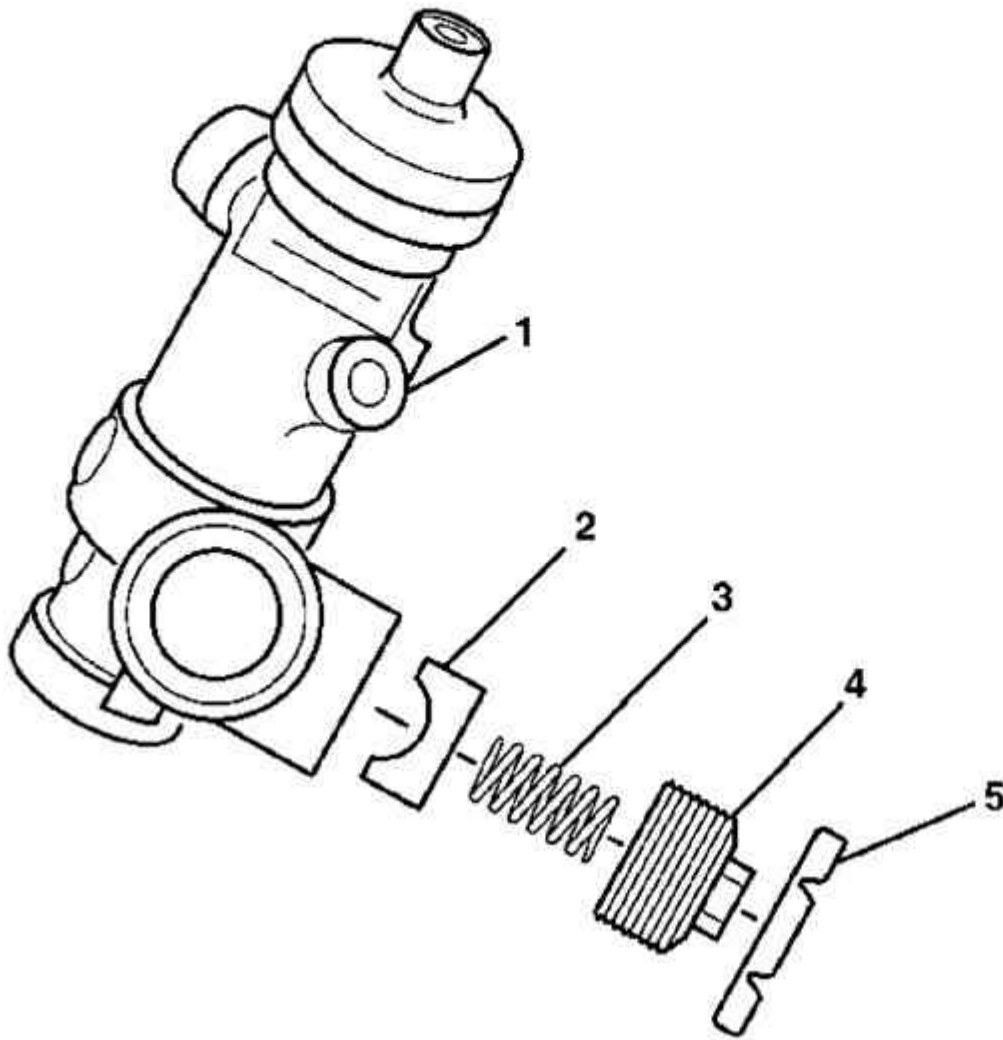
**Fig. 131: View Of Adjuster Plug Lock Nut & Adjuster Plug**  
Courtesy of GENERAL MOTORS CORP.

9. Lubricate the following items with lithium base grease:
  1. The rack bearing (2)
  2. The adjuster spring (3)
  3. The adjuster plug (4)
10. Install the following items into the gear assembly:
  1. The rack bearing (2)
  2. The adjuster spring (3)
  3. The adjuster plug (4)



**Fig. 132: Adjusting Pinion Rotational Torque**  
Courtesy of GENERAL MOTORS CORP.

11. Turn the adjuster plug (1) clockwise onto the rack and pinion gear assembly until the adjuster plug (1) bottoms in the rack and pinion gear assembly, then turn the adjuster plug (1) back 50 degrees to 70 degrees.
12. Check the rotational torque on the pinion. The maximum pinion preload torque is 1.8 N.m (16 lb in).



**Fig. 133: View Of Adjuster Plug Lock Nut & Adjuster Plug**  
Courtesy of GENERAL MOTORS CORP.

13. Install the adjuster plug lock nut (5) to the adjuster plug (4).

Finger tighten the adjuster plug lock nut (5) while holding the adjuster plug (4) stationary.

**Tighten:** Tighten the nut to 68 N.m (50 lb ft).

14. Install the steering gear into the vehicle. Refer to Steering Gear Replacement.

**IMPORTANT:** Flush and bleed power the steering system (hoses, reservoir and cooler lines) with power steering fluid GM P/N 89020661 (Canadian P/N 89021184) (or equivalent meeting GM Specification number 9985010).

15. Flush and bleed power the steering system. Refer to Power Steering System Bleeding.

## DESCRIPTION AND OPERATION

### POWER STEERING SYSTEM DESCRIPTION AND OPERATION (W/O ELECTRO-HYDRAULIC STEERING)

The hydraulic power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The hydraulic power steering pumps are either belt-driven or direct-drive, cam-

driven.

The power steering fluid reservoir holds the power steering fluid and may be integral with the power steering pump or remotely located. The following locations are typical locations for the remote reservoir:

- Mounted to the front of the dash panel
- Mounted to the inner fender
- Mounted to a bracket on the engine

The 2 basic types of power steering gears are listed below:

- A recirculating ball system
- A rack and pinion system

In the recirculating ball system, a worm gear converts steering wheel movement to movement of a sector shaft. A pitman arm attached to the bottom of the sector shaft actually moves one tie rod and an intermediate rod move the other tie rod.

In the rack and pinion system, the rack and the pinion are the 2 components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with the gear teeth on the rack. The rotating pinion moves the rack from side to side. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

The power steering pressure hose connects the power steering pump union fitting to the power steering gear and allows pressurized power steering fluid to flow from the pump to the gear.

The power steering return hose returns fluid from the power steering gear back to the power steering fluid reservoir. The power steering return line may contain an integral fin-type or line-type power steering fluid cooler.

In a typical power steering system, a pump generates hydraulic pressure, causing fluid to flow, via the pressure hose, to the steering gear valve assembly. The steering gear valve assembly regulates the incoming fluid to the right and left chambers in order to assist in right and left turns.

Turning the steering wheel activates the valve assembly, which applies greater fluid pressure and flow to 1 side of the steering gear piston, and lower pressure and flow to the other side of the piston. The pressure assists the movement of the gear piston. Tie rods transfer this force to the front wheels, which turn the vehicle right or left.

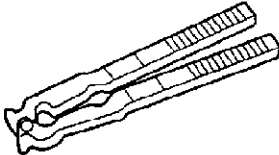
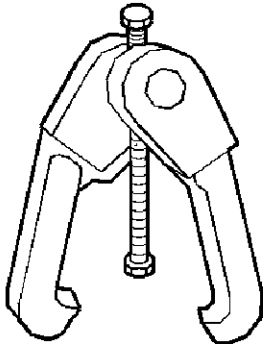
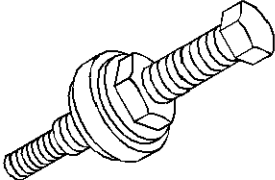
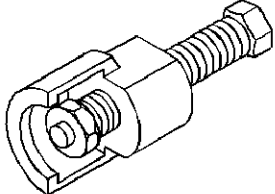
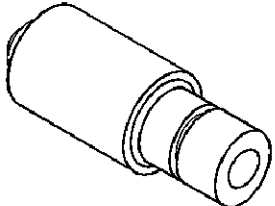
#### **VARIABLE EFFORT STEERING SYSTEM DESCRIPTION AND OPERATION**

The Variable Effort Steering (VES) system or MAGNASTEER® Varies the amount of effort required to steer the vehicle as vehicle speed changes. At low speeds, the system provides minimal steering effort for easy turning and parking Maneuvers. Steering effort is increased at higher speeds to provide firmer steering (road feel) and directional stability. The Electronic Brake Control Module (EBCM) controls a bi-directional magnetic rotary actuator located in the steering rack and pinion. The EBCM varies the steering assist by adjusting the current flow through the actuator to achieve a given level of effort to steer the vehicle. The VES system accomplishes this by adding or subtracting torque on the input shaft to the rack and pinion. The main component of the system is an electromagnetic actuator, which consists of a multiple-pole ring-style permanent magnet, a pole piece, and an electromagnetic coil assembly. The VES system uses the ABS wheel speed sensor inputs to determine vehicle speed. When the EBCM senses wheel speed, it commands a current to the VES actuator that is most appropriate for each speed. The EBCM commands current from negative two amps to positive three amps to the actuator, which is polarized. At low speeds, a negative current is commanded, which assists steering. At medium speeds no current is commanded and steering is assisted by hydraulics only. At high speeds, a positive current is commanded, which creates steering resistance. Ignition voltage and ground are provided through the EBCM. The EBCM has the

ability to detect malfunctions in the actuator or the circuits to the actuator. Any malfunctions detected will cause the system to ramp to zero amps and steering will be assisted by hydraulics only and setting a DTC.

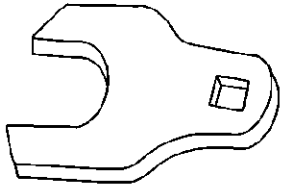
## SPECIAL TOOLS AND EQUIPMENT

### SPECIAL TOOLS

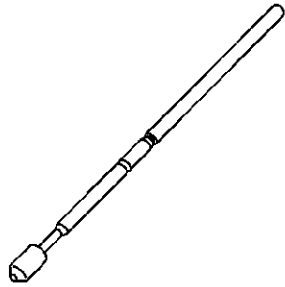
| Illustration                                                                        | Tool Number/Description                                  |
|-------------------------------------------------------------------------------------|----------------------------------------------------------|
|    | J 22610<br>Keystone Clamp Pliers                         |
|   | J 24319-B<br>Steering Linkage and Tie Rod Puller         |
|  | J 25033-C<br>Pulley Installer                            |
|  | J 25034-C<br>Pulley Remover                              |
|  | J25034-257<br>Power Steering Pump Pulley Remover Adapter |
|                                                                                     |                                                          |

**2008 Buick LaCrosse CXL**

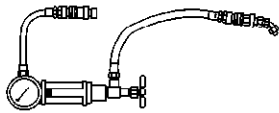
2008 STEERING Power Steering - LaCrosse



J 34028  
Inner Tie Rod Wrench



J 42640  
Steering Column Anti-rotation Pin



J 44721  
Power Steering Analyzer

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