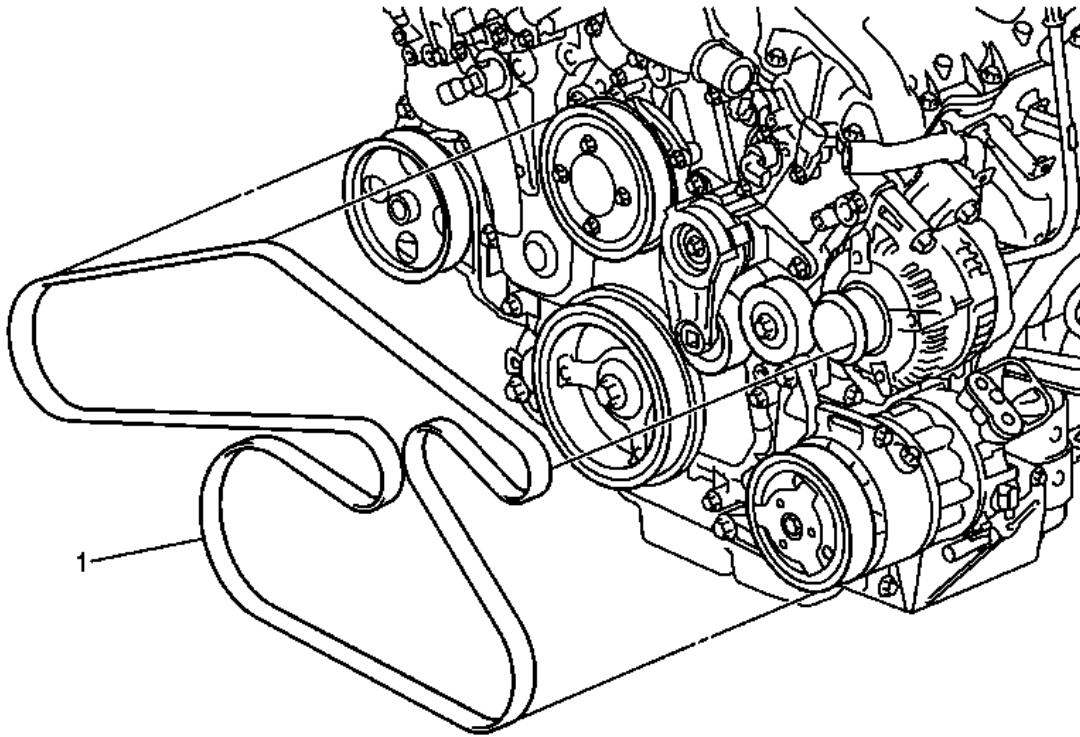


## 2012 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - LaCrosse

## REPAIR INSTRUCTIONS - ON VEHICLE

## DRIVE BELT REPLACEMENT

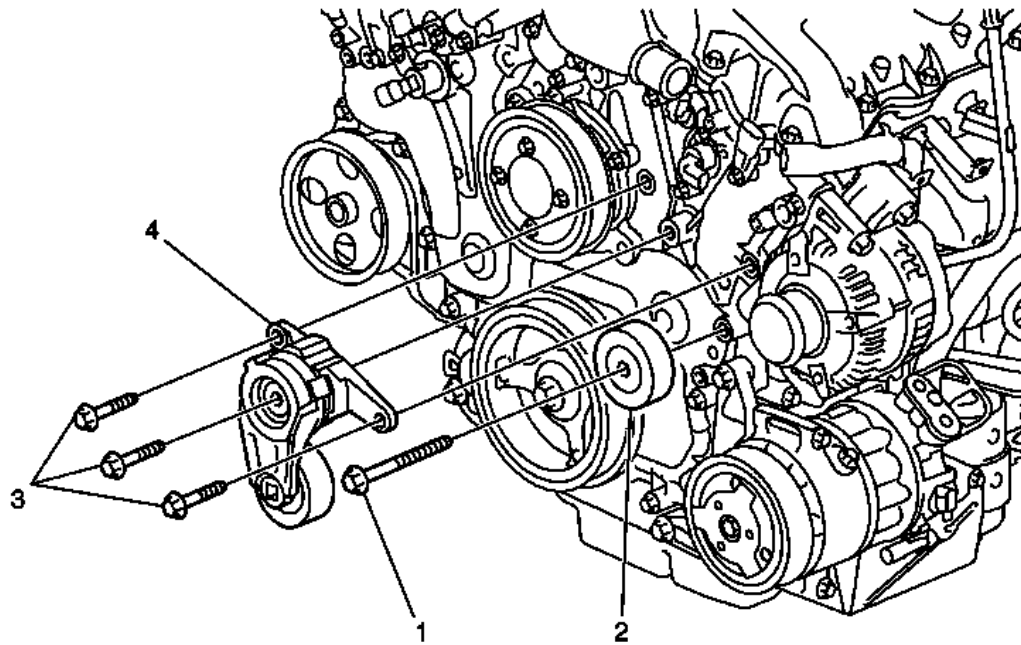
**Fig. 1: Drive Belt Routing**

Courtesy of GENERAL MOTORS COMPANY

## Drive Belt Replacement

| Callout                                                                                        | Component Name                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b>                                                                  |                                                                                                                                                                                                                                                                                             |
| Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> |                                                                                                                                                                                                                                                                                             |
| 1                                                                                              | <b>Drive Belt</b><br><br><b>Procedure</b> <ol style="list-style-type: none"><li>1. Rotate the drive belt tensioner clockwise to release the drive belt tension.</li><li>2. Slide the drive belt off of the belt idler pulley.</li><li>3. Slowly release the drive belt tensioner.</li></ol> |

## DRIVE BELT TENSIONER REPLACEMENT

**Fig. 2: Drive Belt Tensioner**

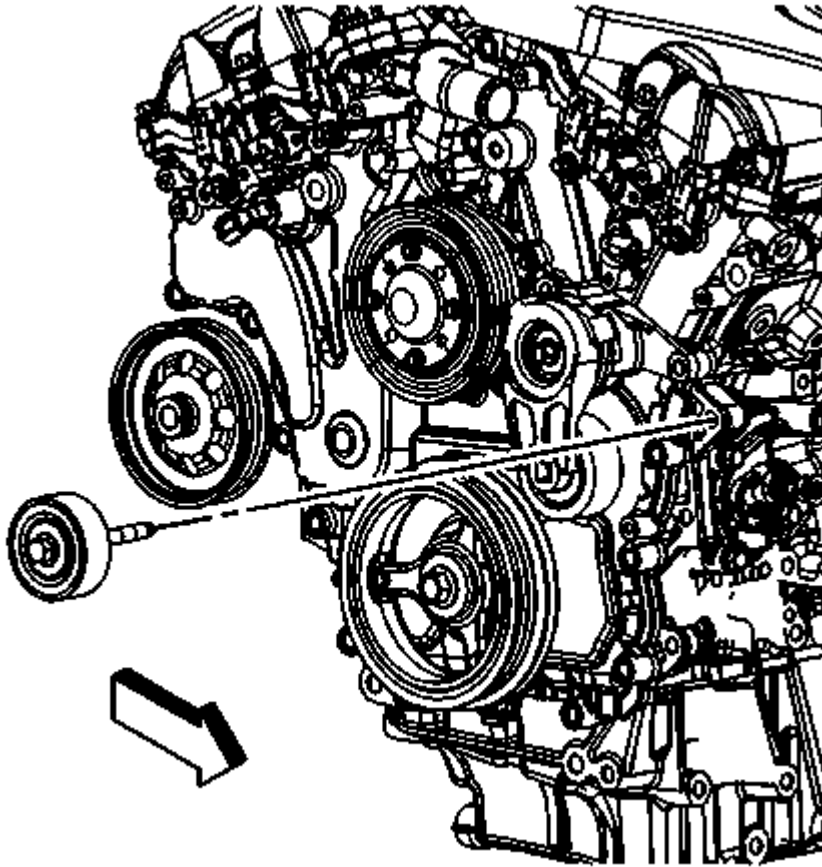
Courtesy of GENERAL MOTORS COMPANY

**Drive Belt Tensioner Replacement**

| Callout                                                                                         | Component Name                                                                                                                                  |
|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the drive belt. Refer to <b>Drive Belt Replacement</b> . |                                                                                                                                                 |
| 1                                                                                               | Drive Belt Idler Pulley Fastener<br><br><b>CAUTION:</b><br><b>Refer to <u>Fastener Caution</u> .</b><br><br><b>Tighten</b><br>58 N.m (43 lb ft) |
| 2                                                                                               | Drive Belt Idler Pulley                                                                                                                         |
| 3                                                                                               | Drive Belt Tensioner Fastener (Qty: 3)<br><b>Tighten</b><br>25 N.m (18 lb ft)                                                                   |
| 4                                                                                               | Drive Belt Tensioner                                                                                                                            |

**DRIVE BELT IDLER PULLEY REPLACEMENT****Removal Procedure**

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Completely loosen the idler pulley bolt.

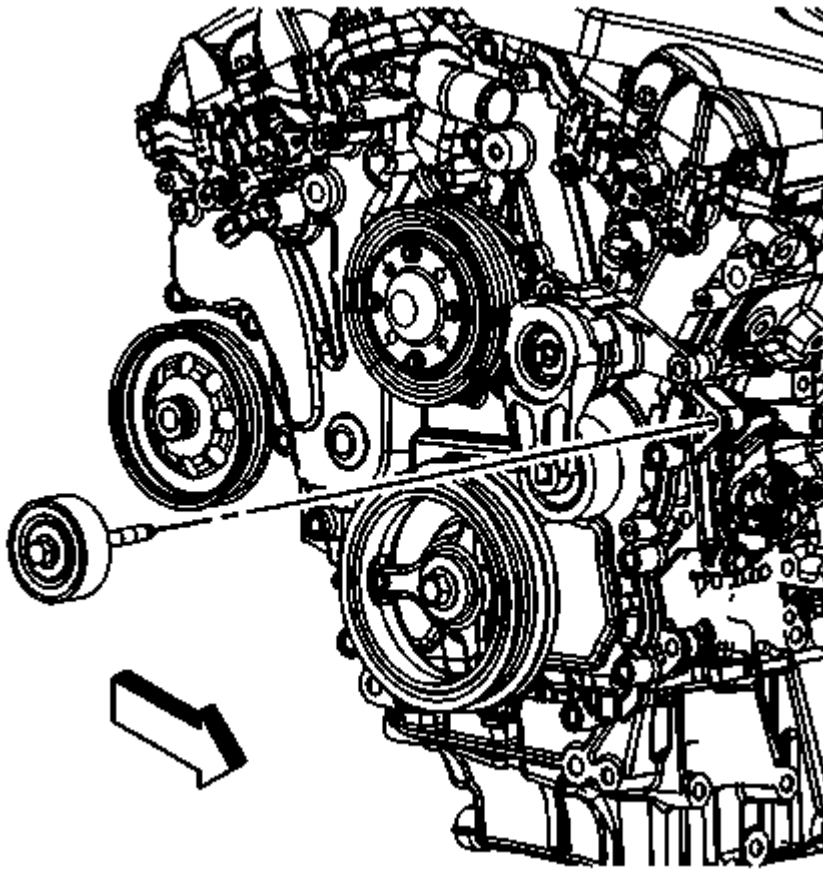


**Fig. 3: Drive Belt Idler Pulley**

Courtesy of GENERAL MOTORS COMPANY

3. Remove the drive belt idler pulley bolt.
4. Remove the drive belt idler pulley.

#### **Installation Procedure**



**Fig. 4: Drive Belt Idler Pulley**

Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt idler pulley.

**CAUTION:** Refer to Fastener Caution .

2. Install the drive belt idler pulley bolt.

### **Tighten**

Tighten the drive belt idler pulley bolt to 58 N.m (43 lb ft).

3. Install the drive belt. Refer to Drive Belt Replacement.

## **ENGINE SUPPORT FIXTURE**

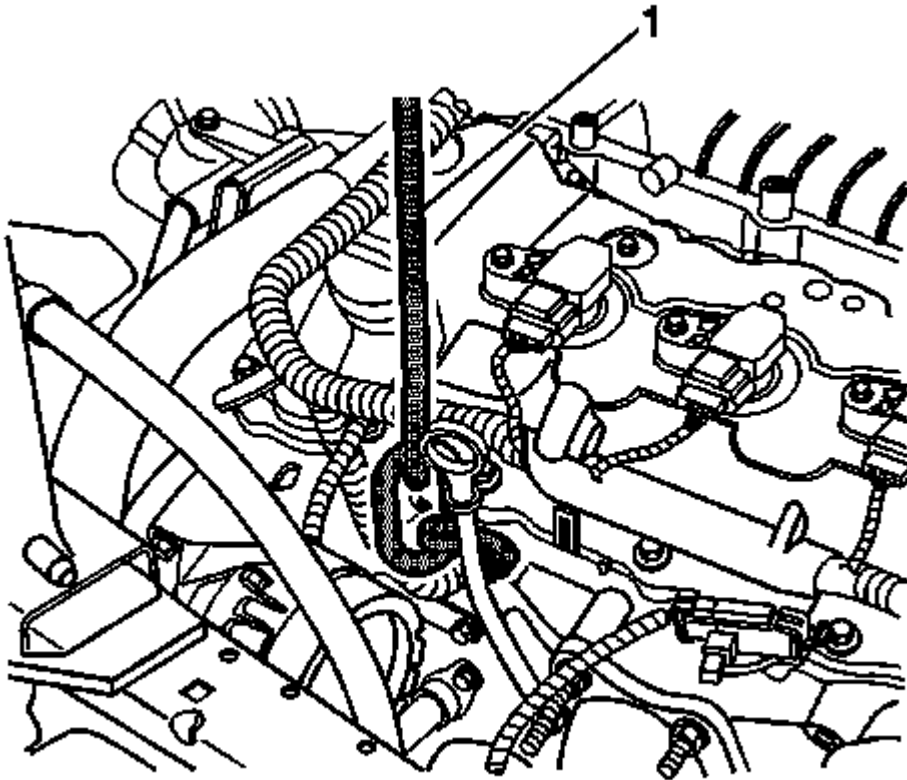
### **Special Tools**

- **EN-28467-B** Universal Engine Support Fixture

- **EN-28467-501B** Engine Support Fixture Adapters
- **EN-36857** Engine Lift Bracket

For equivalent regional tools, refer to **Special Tools** .

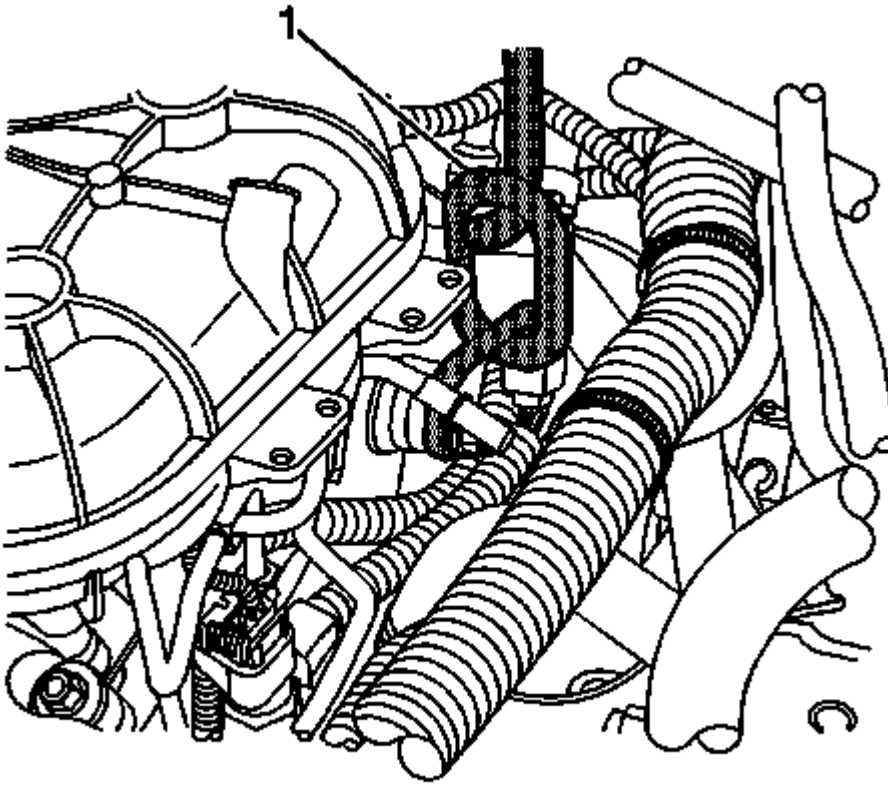
1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement** .



**Fig. 5: Engine Lift Bracket (Right Cylinder Head)**  
Courtesy of GENERAL MOTORS COMPANY

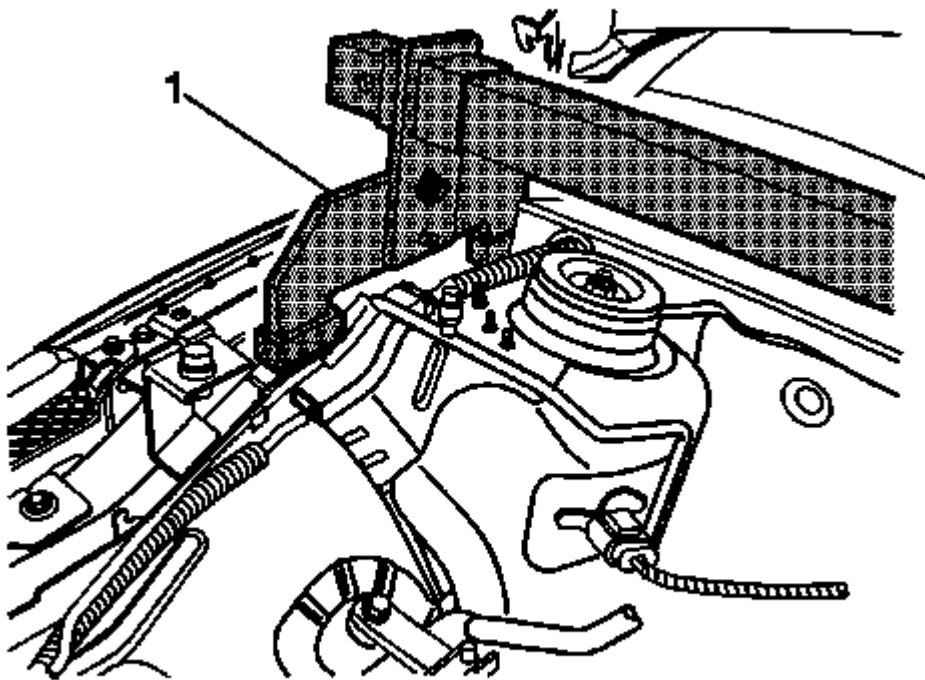
**CAUTION:** Refer to **Fastener Caution**

3. Use a grade 10.9 bolt to install a **EN-36857** bracket (1) to the right cylinder head in the location shown. Tighten the bolt to 65 N.m (48 lb ft).



**Fig. 6: Engine Lift Bracket (Left Cylinder Head)**  
**Courtesy of GENERAL MOTORS COMPANY**

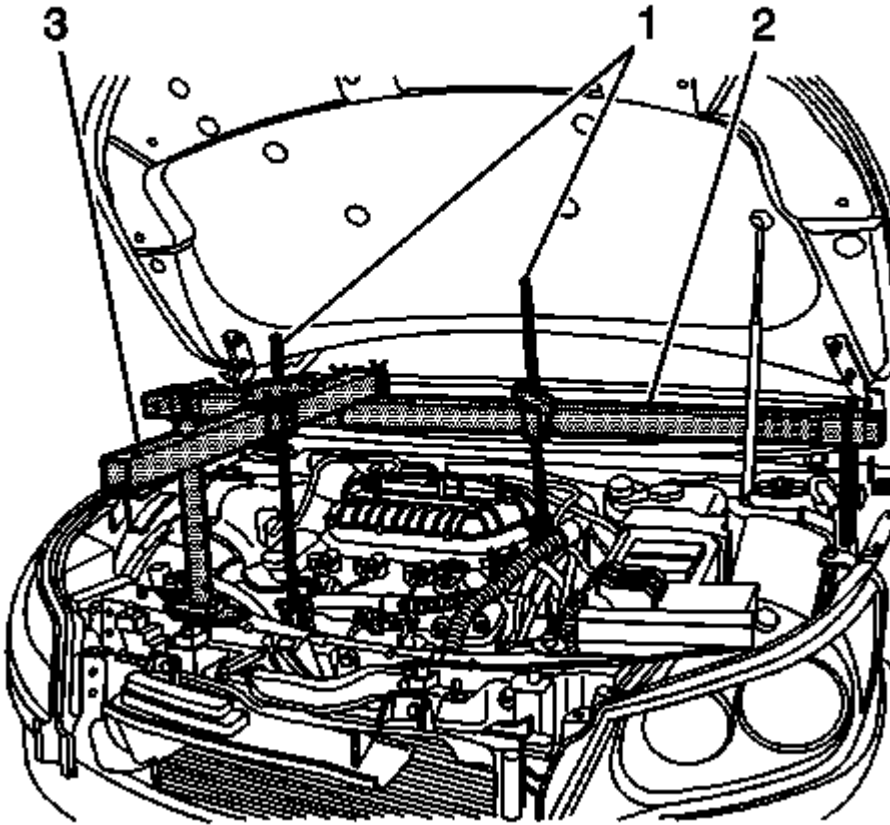
4. Use a grade 10.9 bolt with a 25 mm (1 in) spacer to install the **EN-36857** bracket (1) to the left cylinder head in the location shown. Tighten the bolt to 65 N.m (48 lb ft).



**Fig. 7: Special Tool**

Courtesy of GENERAL MOTORS COMPANY

5. Assemble the **EN-28467-501B** legs (1) to the **EN-28467-B** cross bar.



**Fig. 8: Support Hooks**

Courtesy of GENERAL MOTORS COMPANY

6. Install the support hook (1) to the **EN-28467-B** fixture (2).
7. Install the support hook (1) to the **EN-36857** bracket.
8. Raise the engine to release the pressure off of the engine mounts.
9. Reverse the procedure for removal.

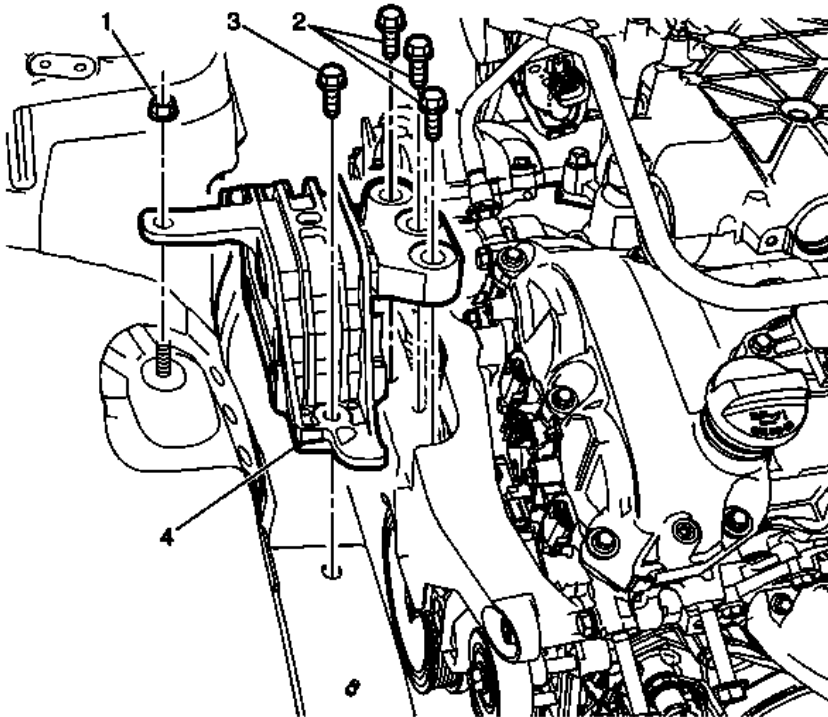
## ENGINE MOUNT INSPECTION

**NOTE:** Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
  - The hard rubber is covered with heat check cracks.
  - The rubber is separated from the metal plate of the engine mount.

- The rubber is split through the center of the engine mount.
  - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Mount Replacement - Right Side**.

### ENGINE MOUNT REPLACEMENT - RIGHT SIDE



**Fig. 9: Engine Mount - Right Side**

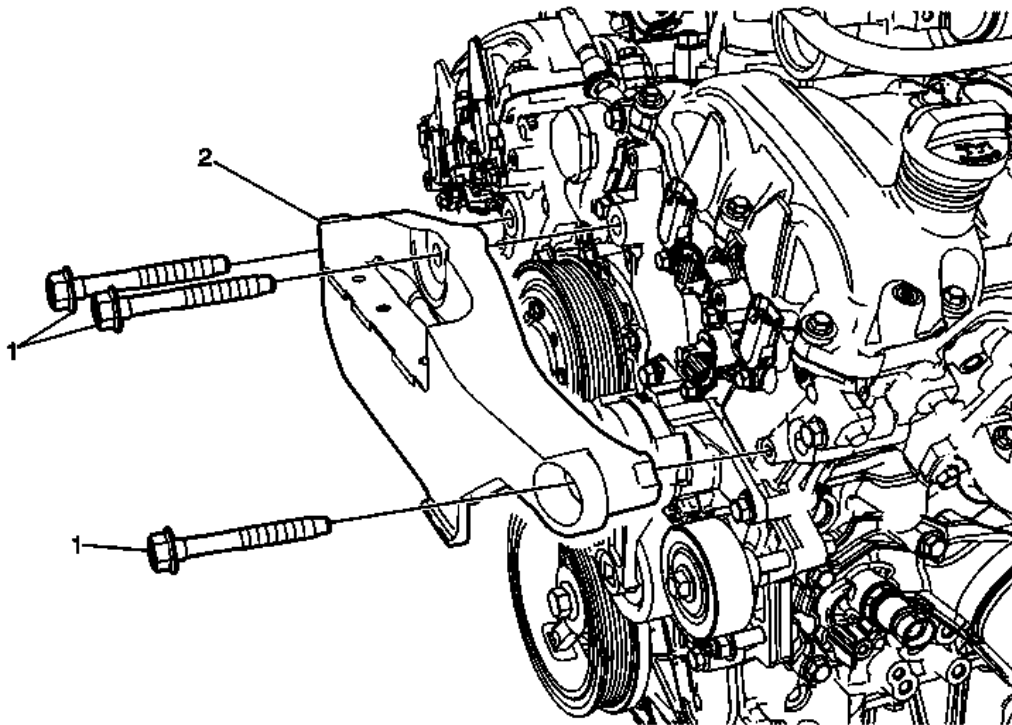
Courtesy of GENERAL MOTORS COMPANY

### Engine Mount Replacement - Right Side

| Callout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Component Name                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                           |
| <ol style="list-style-type: none"> <li>1. Remove the air cleaner assembly. Refer to <b><u>Air Cleaner Assembly Replacement (LFW or LFX)</u></b>.</li> <li>2. Install engine support fixture. Refer to <b><u>Engine Support Fixture</u></b>.</li> <li>3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.</li> </ol> <p>If all powertrain mounts are replaced, perform "Powertrain Mount Balancing". Refer to the appropriate engine section.</p> |                                                                                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Engine Mount Fastener<br><br><b>CAUTION:</b><br><b>Refer to <u>Fastener Caution</u> .</b> |

|   |                                                                                                                                         |
|---|-----------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <b>TIP:</b> Perform the "Powertrain Mount Balancing-lower". Refer to the appropriate engine section.<br><b>Tighten</b><br>62 (46 lb ft) |
| 2 | Engine Mount Fastener (Qty: 3)<br><b>Tighten</b><br>62 (46 lb ft)                                                                       |
| 3 | Engine Mount Fastener (Qty: 2)<br><b>Tighten</b><br>62 (46 lb ft)                                                                       |
| 4 | Engine Mount<br><b>Procedure</b><br>Transfer components as necessary.                                                                   |

## ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE



**Fig. 10: Engine Mount Bracket - Right Side**  
 Courtesy of GENERAL MOTORS COMPANY

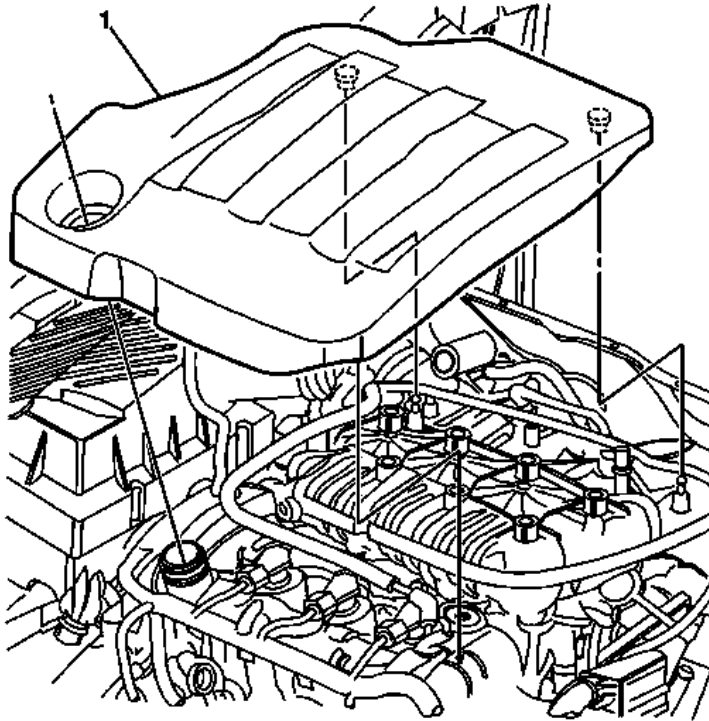
### Engine Mount Bracket Replacement - Right Side

| Callout                       | Component Name |
|-------------------------------|----------------|
| <b>Preliminary Procedures</b> |                |

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFW or LFX)**.
2. Remove engine mount. Refer to **Engine Mount Replacement - Right Side**.

|   |                                                                                                                                                                                                                                                                              |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | <p>Engine Mount Bracket Fastener (Qty: 3)</p> <p><b>CAUTION:</b><br/>Refer to <b>Fastener Caution</b>.</p> <p><b>Procedure</b><br/>Remove the A/C pipe bracket nut and reposition pipe to access front mount bracket fastener.<br/><b>Tighten</b><br/>100 N.m (74 lb ft)</p> |
| 2 | <p>Engine Mount Bracket</p> <p><b>Procedure</b><br/>Transfer components as necessary.</p>                                                                                                                                                                                    |

## INTAKE MANIFOLD COVER REPLACEMENT



**Fig. 11: Intake Manifold Cover**  
Courtesy of GENERAL MOTORS COMPANY

### Intake Manifold Cover Replacement

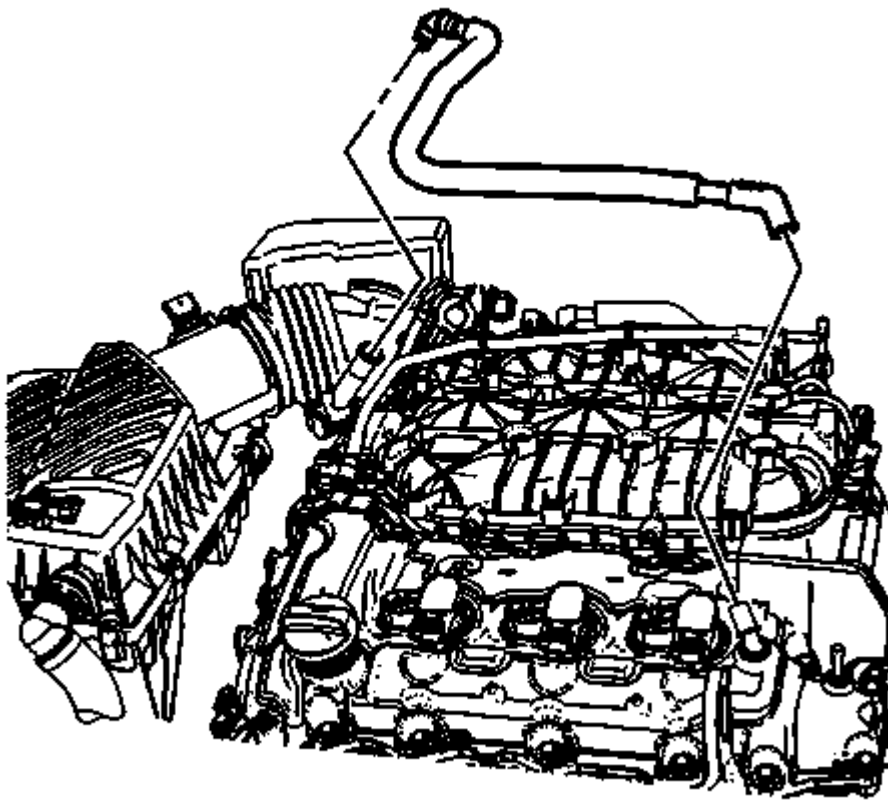
| Callout | Component Name |
|---------|----------------|
|         |                |

## Intake Manifold Cover

**Procedure**

1

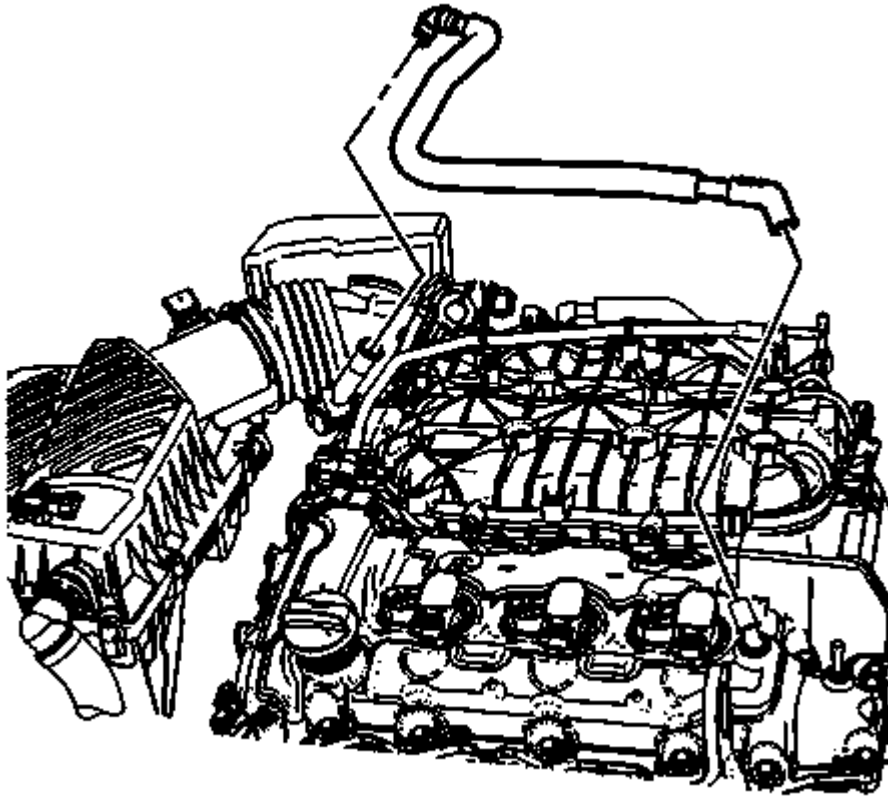
1. Remove the oil cap before removing the intake manifold cover.
2. The intake manifold cover needs to be pulled straight up to disconnect from the ball studs to prevent joysticking of the ball studs.
3. Install the intake manifold cover straight down and ensure the oil fill tube is properly seated.
4. Install the oil cap.

**POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT (LF1, LFW OR LFX)****Removal Procedure**

**Fig. 12: Positive Crankcase Ventilation Tube - Front**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine cover. Refer to **Intake Manifold Cover Replacement**.
2. Disconnect the positive crankcase ventilation (PCV) fresh air pipe from the air cleaner duct.

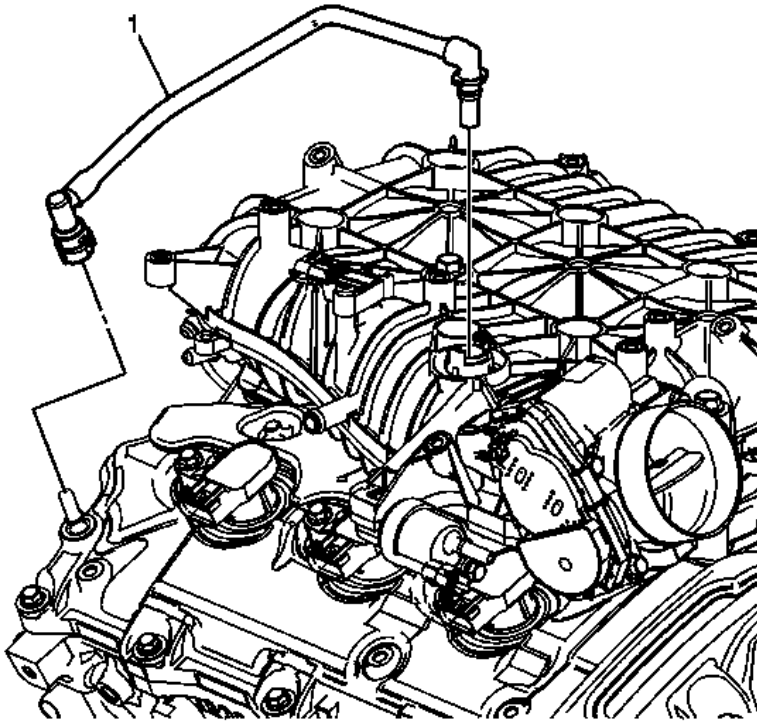
3. Disconnect the PCV air pipe from the valve cover.

**Installation Procedure**

**Fig. 13: Positive Crankcase Ventilation Tube - Front**  
Courtesy of GENERAL MOTORS COMPANY

1. Connect the PCV air pipe to the valve cover valve.
2. Connect the PCV fresh air pipe to the air cleaner duct.
3. Install the engine cover. Refer to **Intake Manifold Cover Replacement**.

**POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - REAR (LF1, LFW OR LFX)**



**Fig. 14: Positive Crankcase Ventilation Tube - Rear**  
Courtesy of GENERAL MOTORS COMPANY

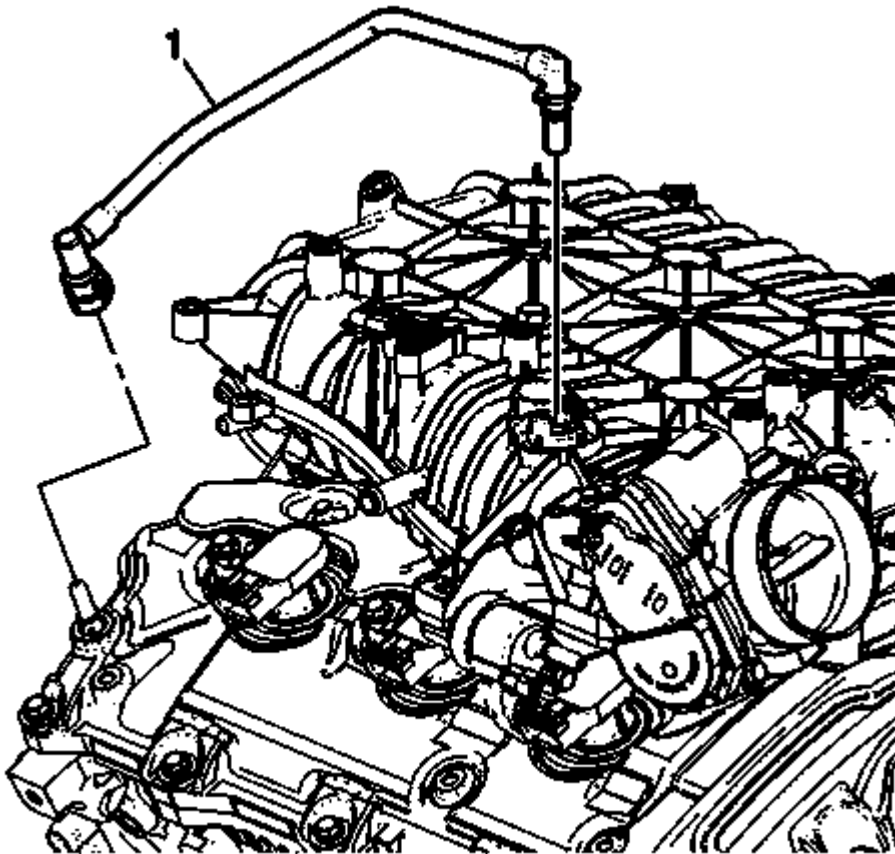
#### Positive Crankcase Ventilation Tube Replacement - Rear (LF1, LFW or LFX)

| Callout                                                                                                                      | Component Name                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b><br>Remove the intake manifold cover. Refer to <u><b>Intake Manifold Cover Replacement</b></u> . |                                                                                                                                                                |
| 1                                                                                                                            | Positive Crankcase Ventilation Tube<br><br><b>Procedure</b><br><br>1. Disconnect the electrical connectors, as needed.<br>2. Transfer components as necessary. |

#### INTAKE MANIFOLD REPLACEMENT (LF1, LFW OR LFX)

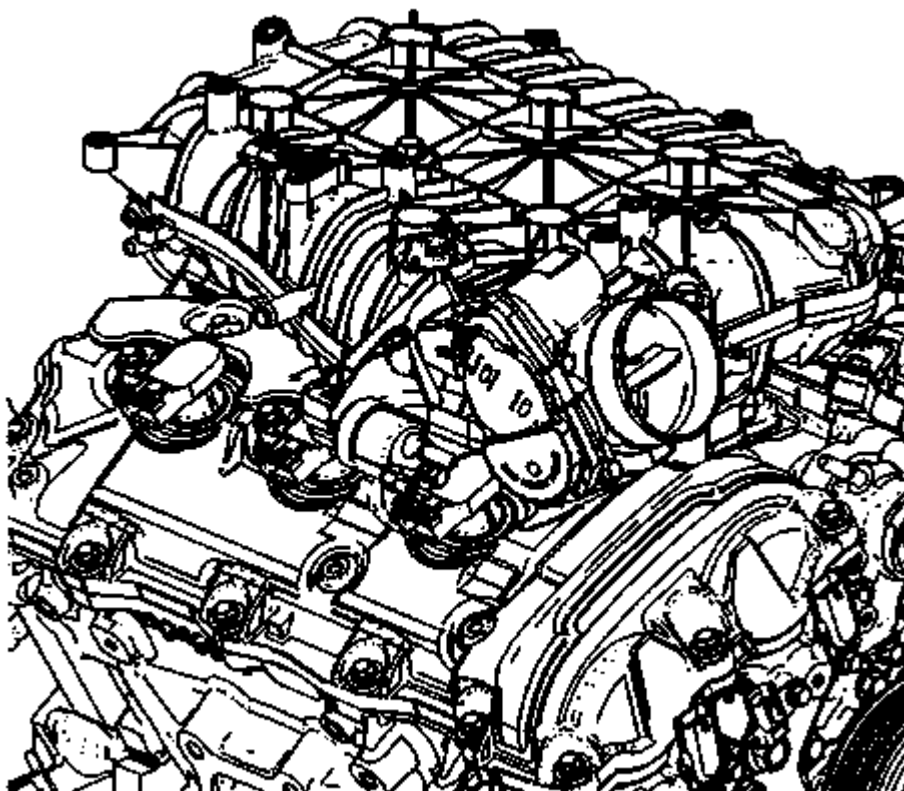
##### Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**



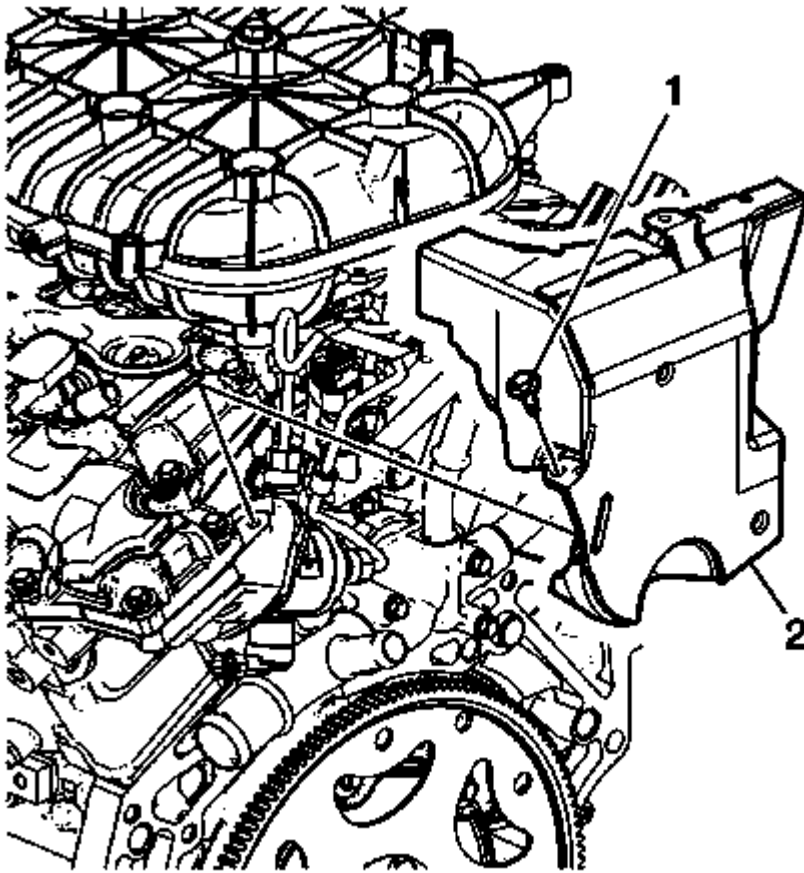
**Fig. 15: Positive Crankcase Ventilation Tube**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Disconnect and remove the positive crankcase ventilation (PCV) tube (1) from the intake manifold and right camshaft cover.



**Fig. 16: Evaporative Emission Hose**  
Courtesy of GENERAL MOTORS COMPANY

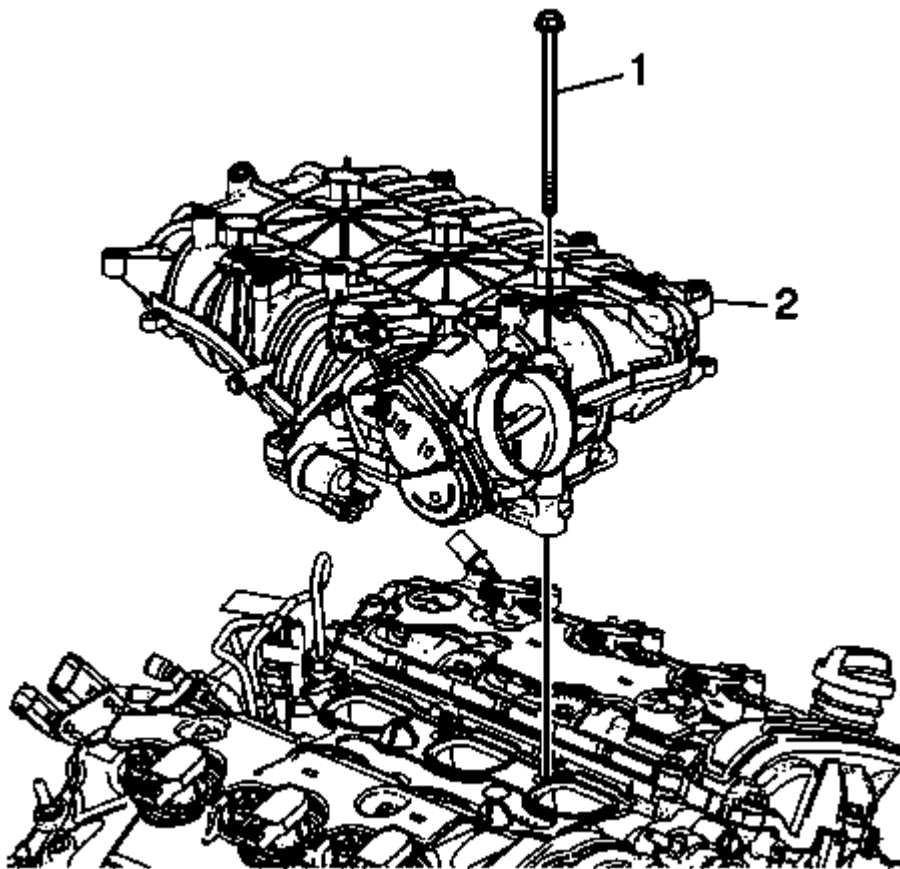
3. Remove the evaporative emission (EVAP) hose from the intake manifold and EVAP solenoid.



**Fig. 17: Fuel Pump Cover**

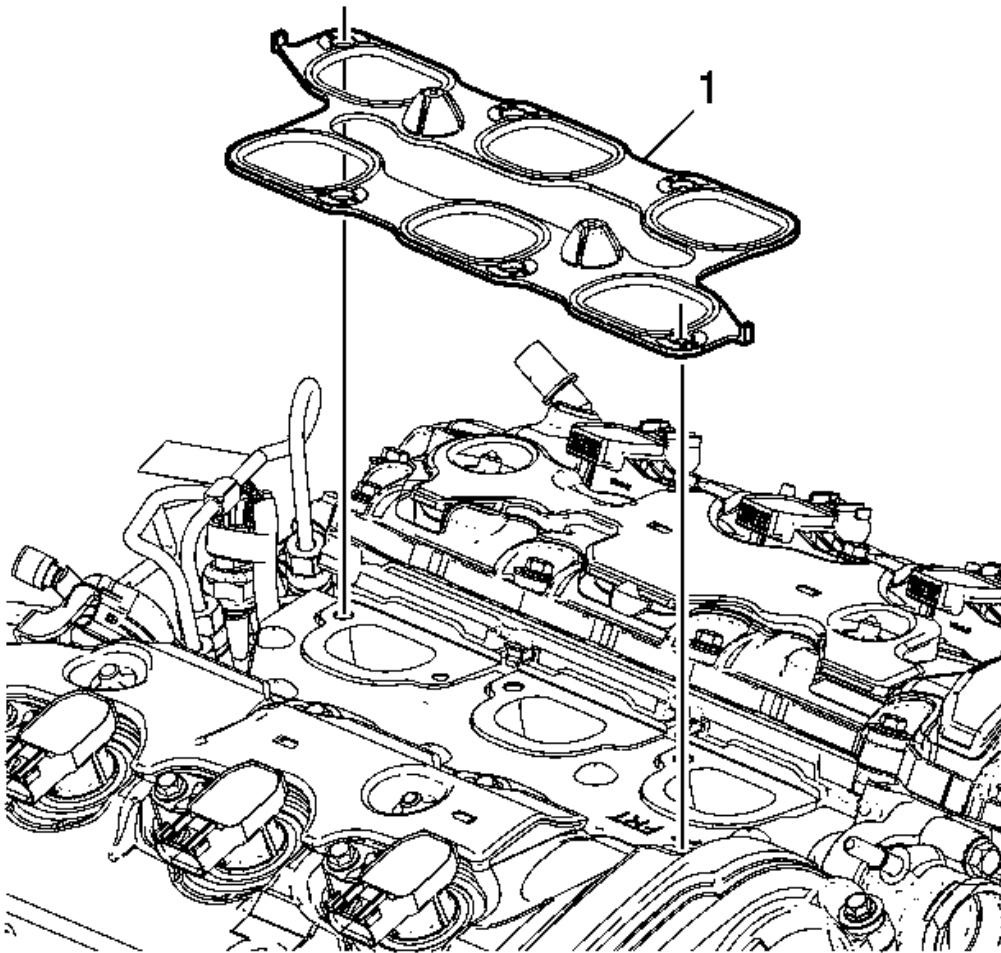
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel pump cover bolt (1).
5. Remove the fuel pump cover (2).
6. Remove the fuel line booster hose bracket.
7. Disconnect the brake booster vacuum hose.
8. Disconnect electrical connectors as needed.
9. Remove engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (V6)** .



**Fig. 18: Intake Manifold Assembly**  
Courtesy of GENERAL MOTORS COMPANY

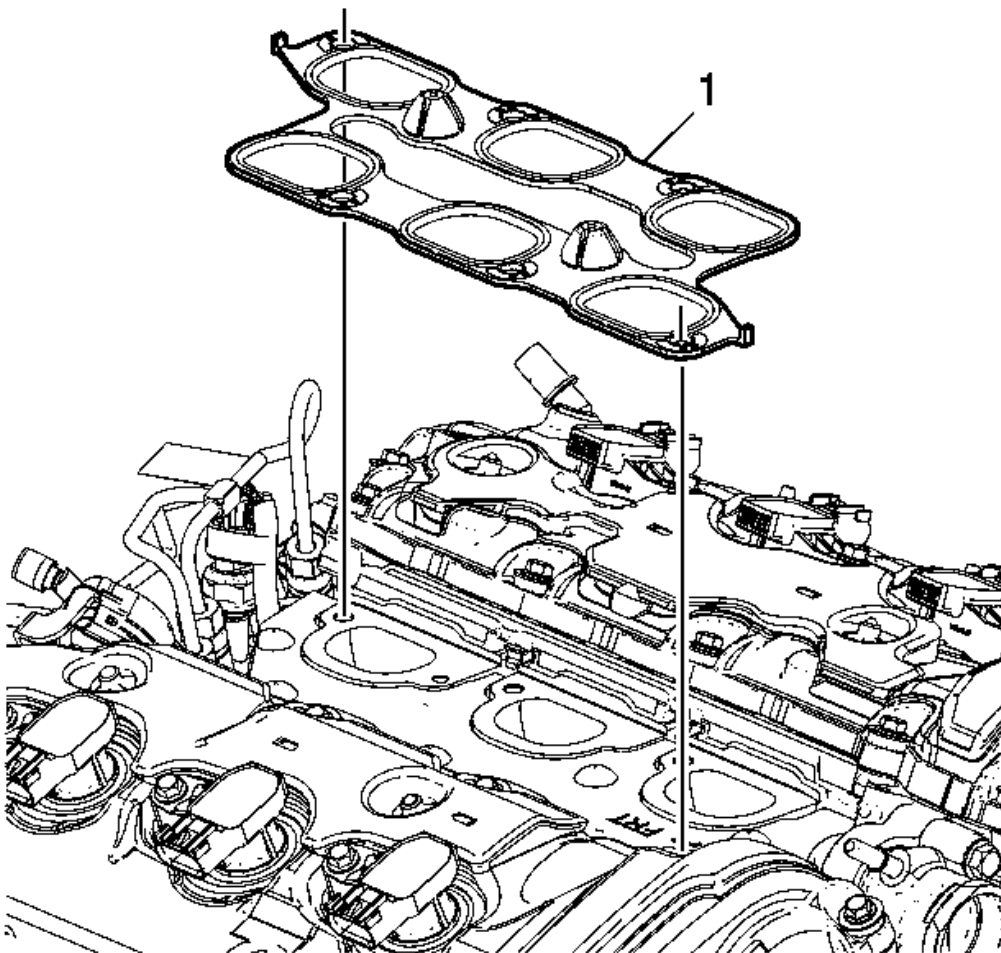
10. Remove the intake manifold bolts (1).
11. Remove the intake manifold assembly (2).



**Fig. 19: Intake Manifold Gasket**  
Courtesy of GENERAL MOTORS COMPANY

12. Remove and discard the intake manifold gasket (1).
13. Transfer parts as needed.

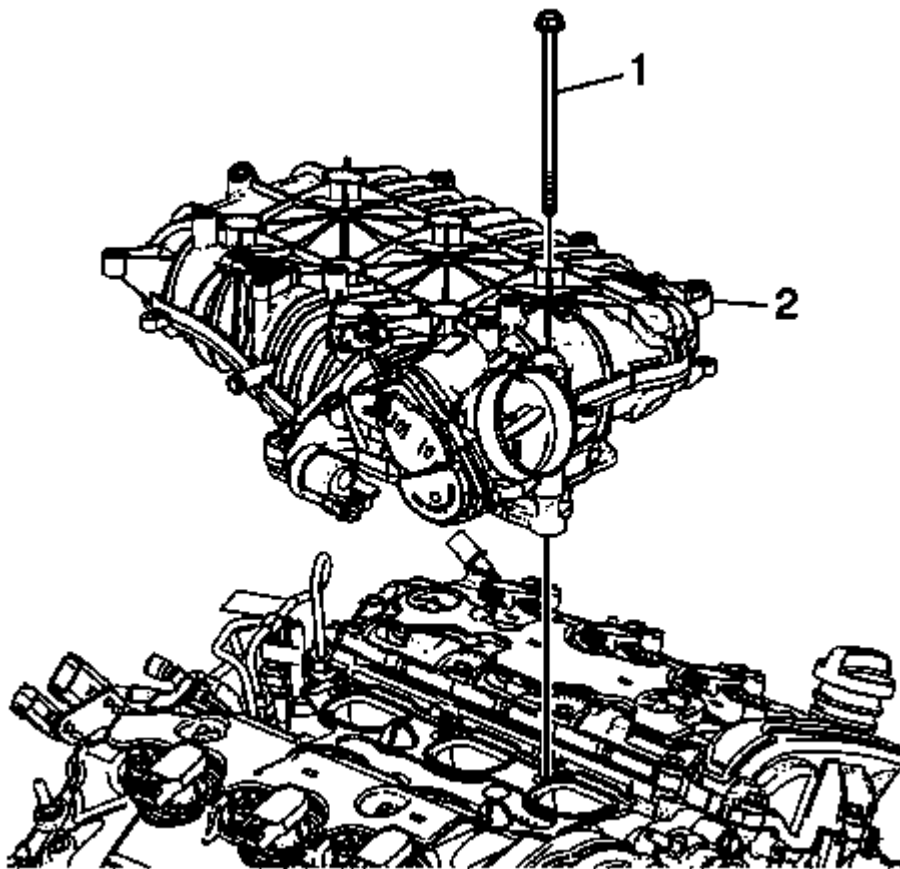
#### **Installation Procedure**



**Fig. 20: Intake Manifold Gasket**

Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW intake manifold gasket (1).

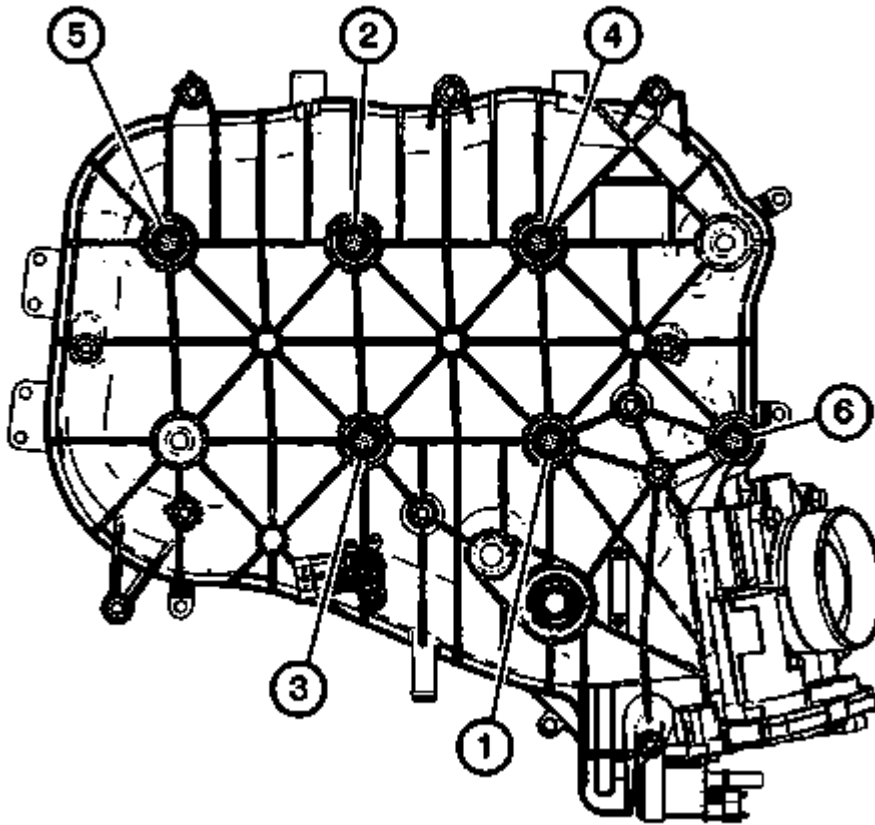


**Fig. 21: Intake Manifold Assembly**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold assembly (2).

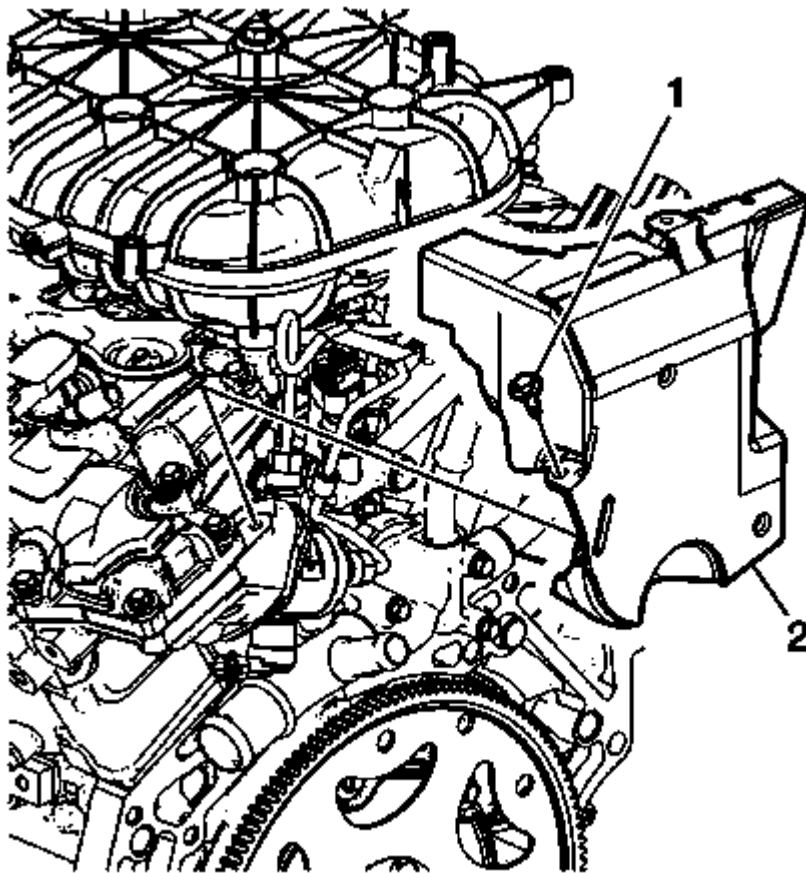
**CAUTION: Refer to Fastener Caution**

3. Install the intake manifold bolts (1).



**Fig. 22: Intake Manifold Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

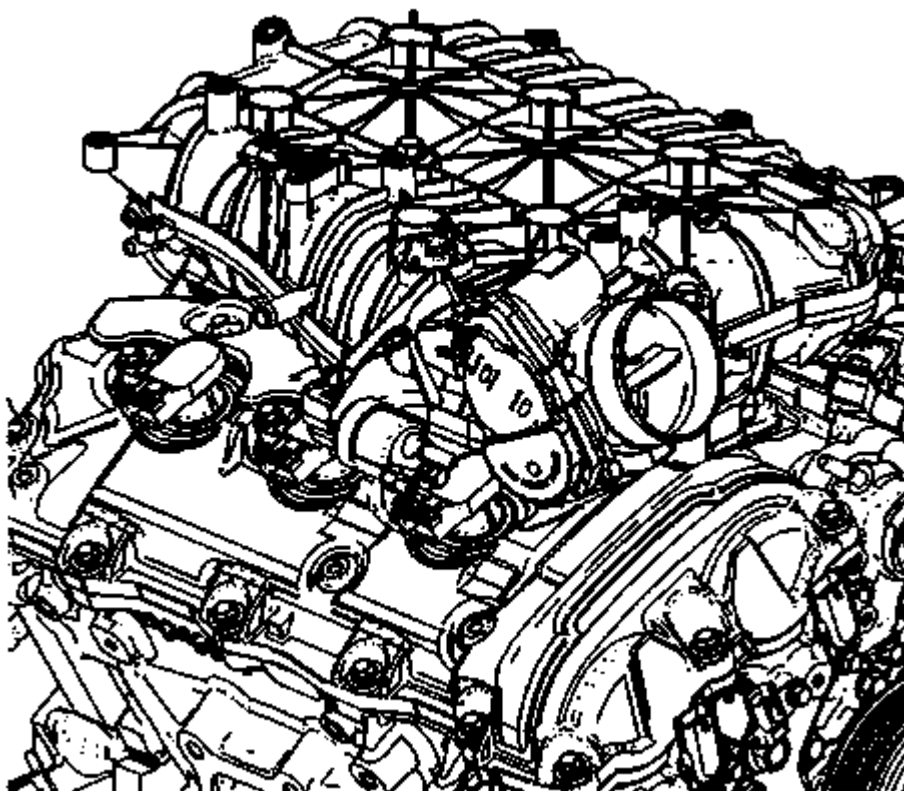
4. Tighten the intake manifold bolts in the sequence shown.
5. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft).
6. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft).



**Fig. 23: Fuel Pump Cover**

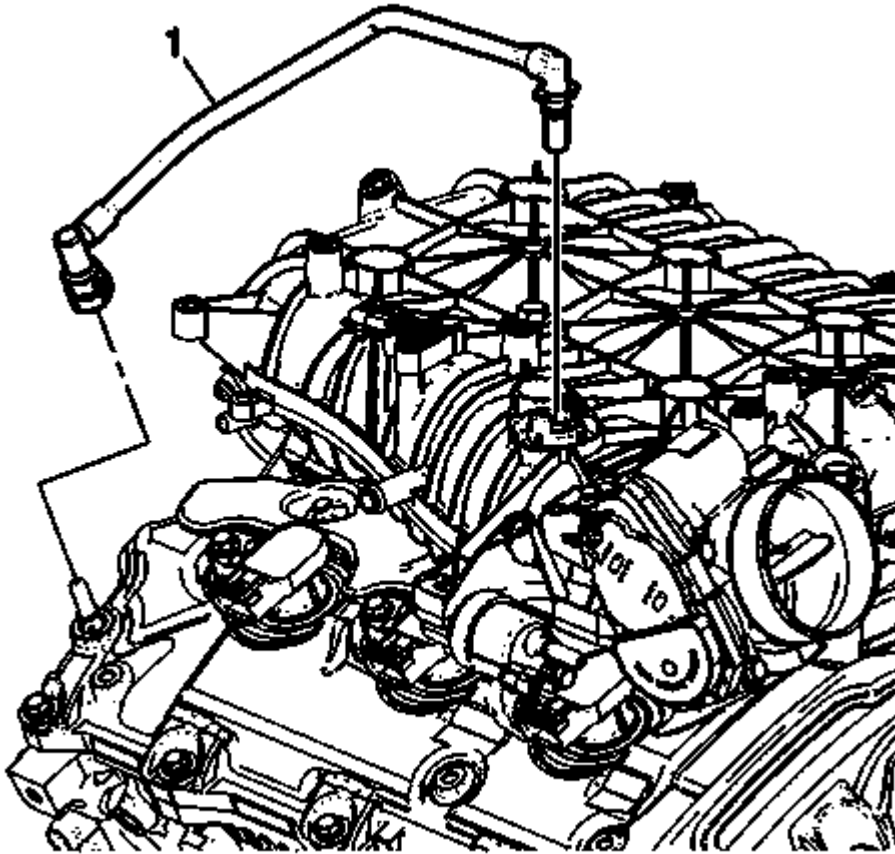
Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel pump cover (2).
8. Install the fuel pump cover bolt (1) and tighten to 10 N.m (89 lb in).



**Fig. 24: Evaporative Emission Hose**  
Courtesy of GENERAL MOTORS COMPANY

9. Connect the EVAP hose to the upper intake manifold and EVAP solenoid.

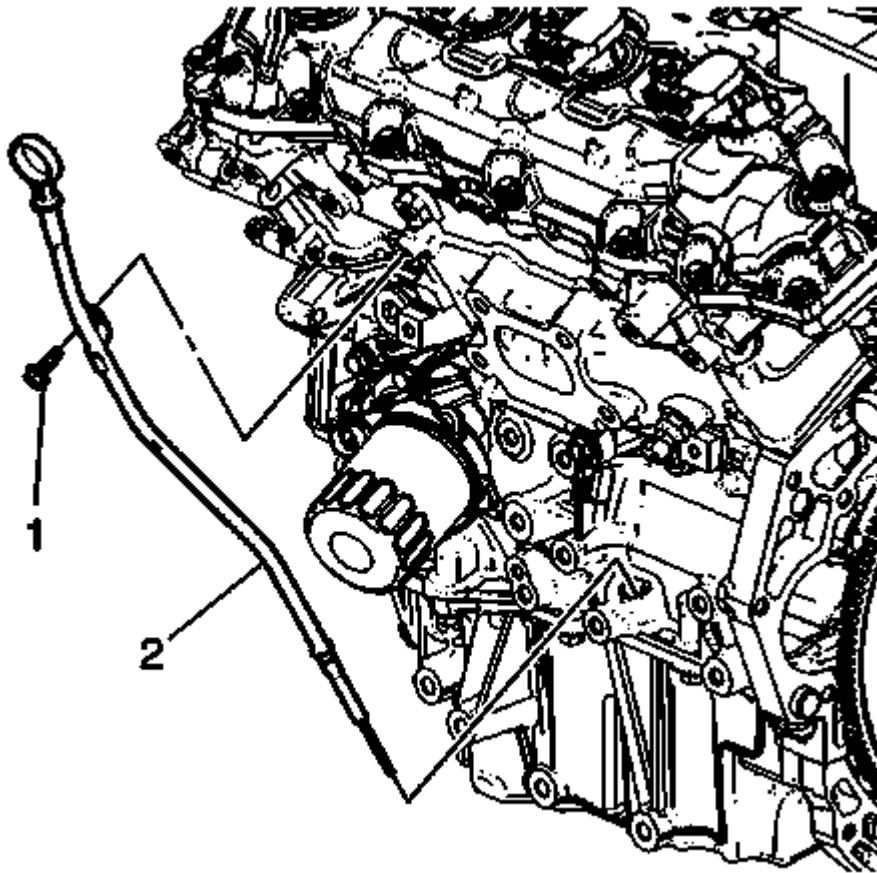


**Fig. 25: Positive Crankcase Ventilation Tube**  
Courtesy of GENERAL MOTORS COMPANY

10. Connect the PCV tube assembly (1) to the upper intake manifold and the right camshaft cover.
11. Install coolant hose.
12. Install intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

## **OIL LEVEL INDICATOR TUBE REPLACEMENT (LF1, LFW OR LFX)**

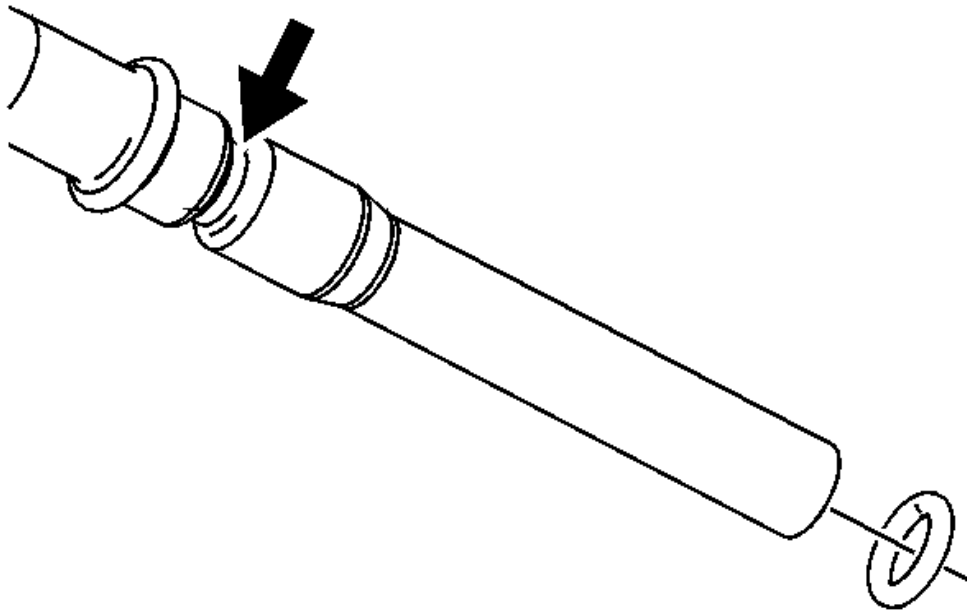
### **Removal Procedure**



**Fig. 26: Oil Level Indicator Tube**

Courtesy of GENERAL MOTORS COMPANY

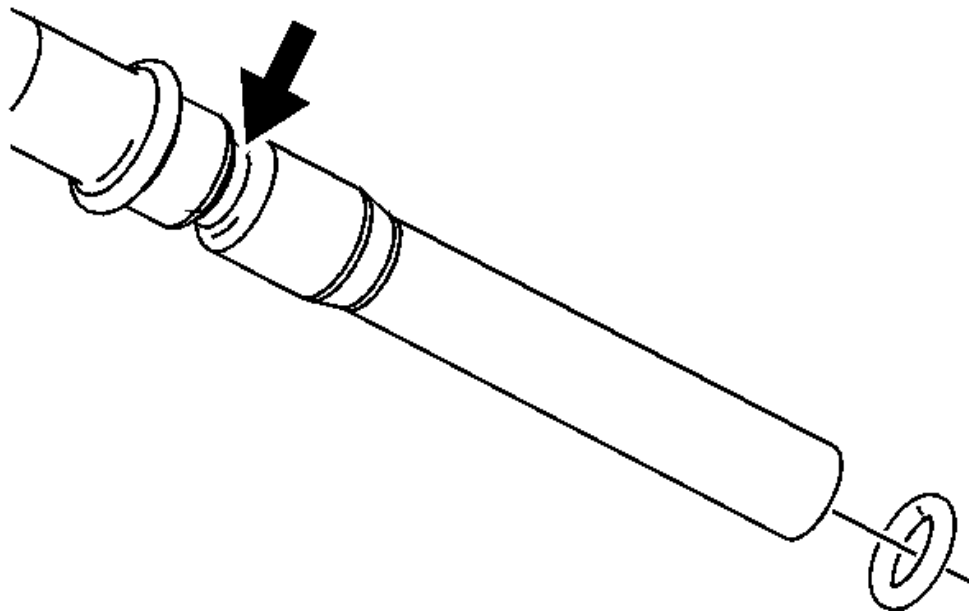
1. Remove the oil level indicator tube bracket bolt (1).
2. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.



**Fig. 27: Oil Level Indicator Tube O-Ring**  
Courtesy of GENERAL MOTORS COMPANY

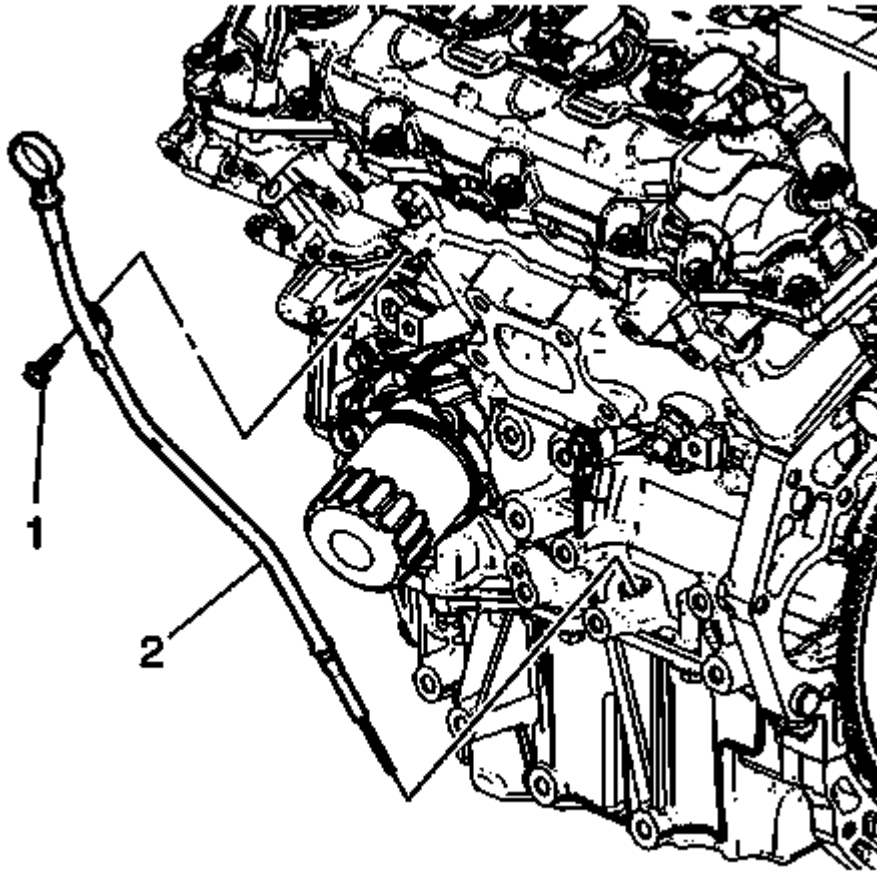
3. Remove and discard the O-ring from the oil level indicator tube if damaged.

#### **Installation Procedure**



**Fig. 28: Oil Level Indicator Tube O-Ring**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Install a NEW O-ring on the oil level indicator tube.



**Fig. 29: Oil Level Indicator Tube**

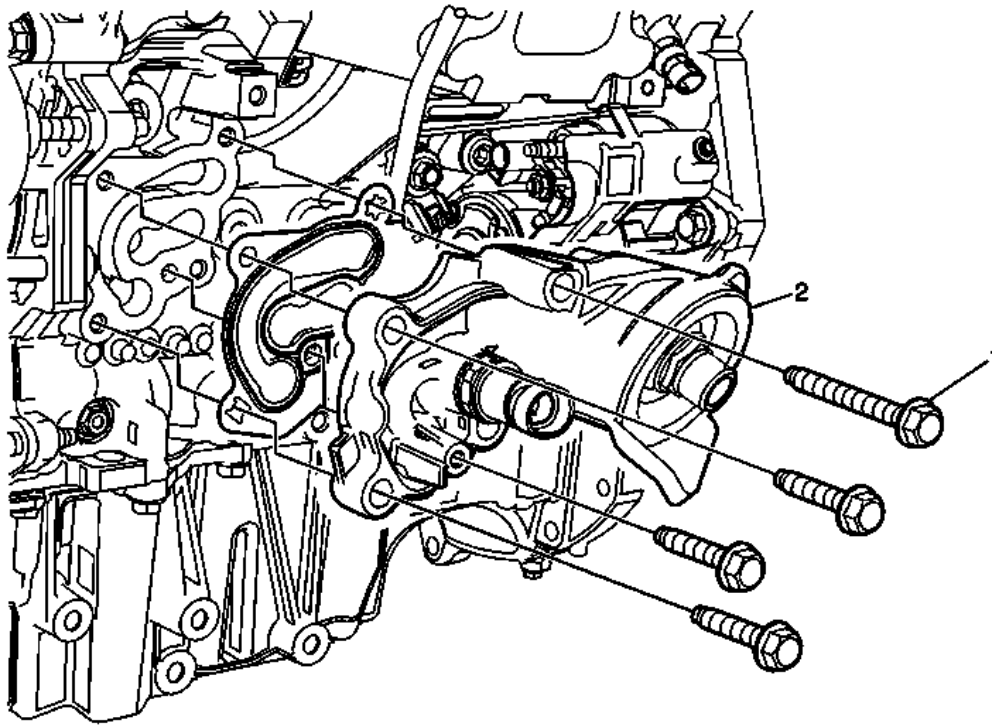
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil level indicator and tube (2) by sliding the tube down through the lower crankcase hole.

**CAUTION: Refer to Fastener Caution .**

3. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).

## OIL FILTER ADAPTER REPLACEMENT

**Fig. 30: Oil Filter Adapter**

Courtesy of GENERAL MOTORS COMPANY

**Oil Filter Adapter Replacement**

| Callout                                                                                                                                                                      | Component Name                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedures</b>                                                                                                                                                |                                                                                                                                                                                                                                         |
| 1. Remove the generator. Refer to <b>Generator Replacement (V6)</b> .<br>2. Remove the oil filter. Refer to <b>Engine Oil and Oil Filter Replacement (LF1, LFW or LFX)</b> . |                                                                                                                                                                                                                                         |
| 1                                                                                                                                                                            | Oil Filter Adapter Fastener (Qty: 4)<br><br><b>CAUTION:</b><br><b>Refer to <u>Fastener Caution</u> .</b><br><br><b>Tighten</b><br>25 N.m (18 lb ft)                                                                                     |
| 2                                                                                                                                                                            | Oil Filter Adapter<br><br><b>Procedure</b> <ol style="list-style-type: none"> <li>1. Replace oil filter adapter gasket.</li> <li>2. Disconnect electrical connector as needed.</li> <li>3. Transfer components as necessary.</li> </ol> |

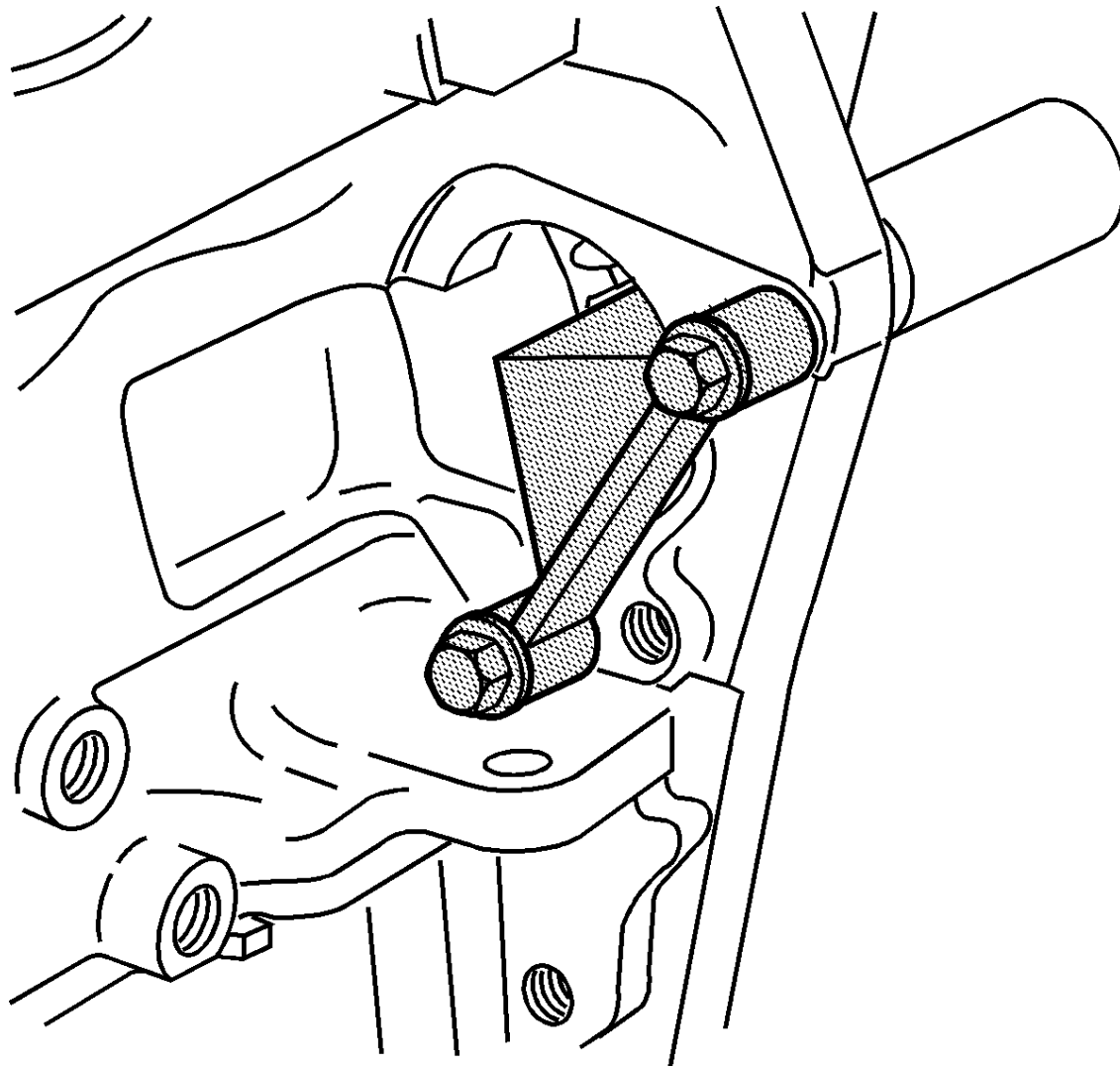
**CRANKSHAFT BALANCER REPLACEMENT****Special Tools**

- **EN-46106** Flywheel Holding Tool
- **J-38416-2** Crankshaft Button
- **J-41816** Crankshaft Balancer Remover
- **J-41998-B** Crankshaft Balancer Installer
- **J-45059** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

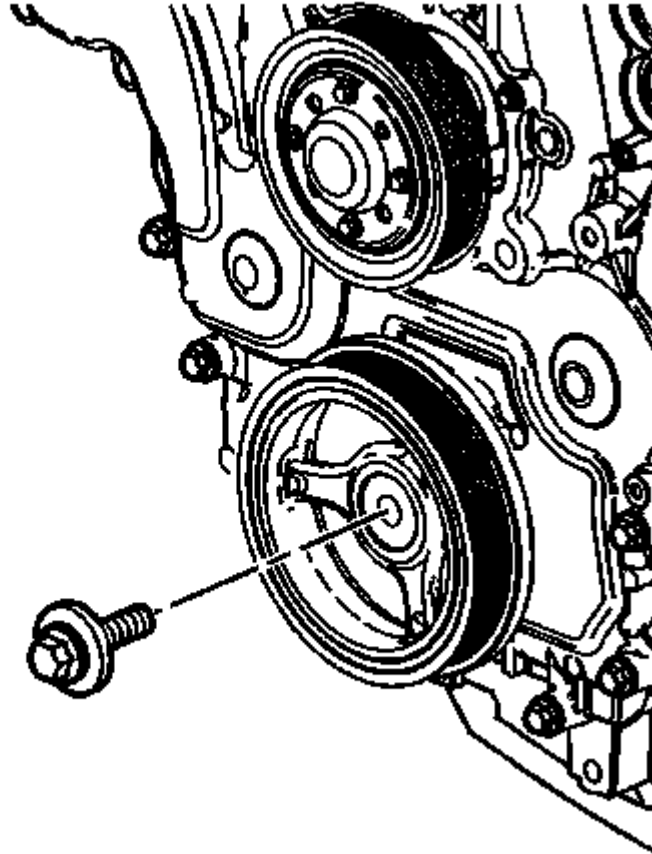
**Removal Procedure**

1. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Front Liner Replacement** .
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Install the engine support fixture. Refer to **Engine Support Fixture**.
4. Remove the starter. Refer to **Starter Replacement (V6)** .



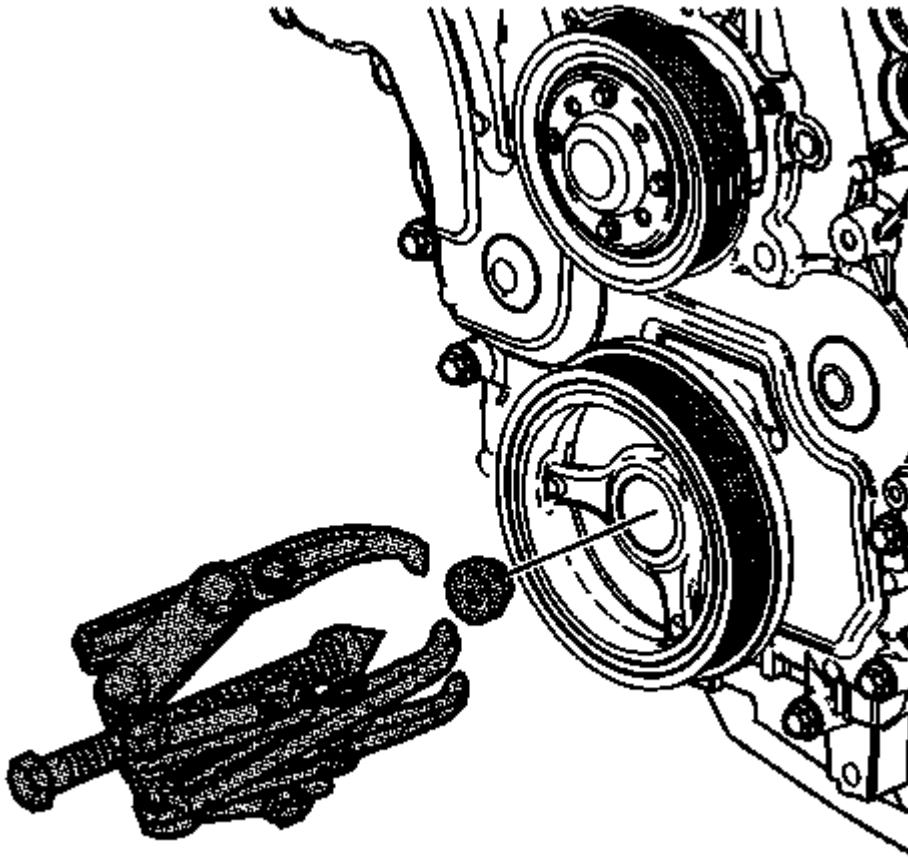
**Fig. 31: Flywheel Holding Tool**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-46106** tool through the starter mounting hole.



**Fig. 32: Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS COMPANY

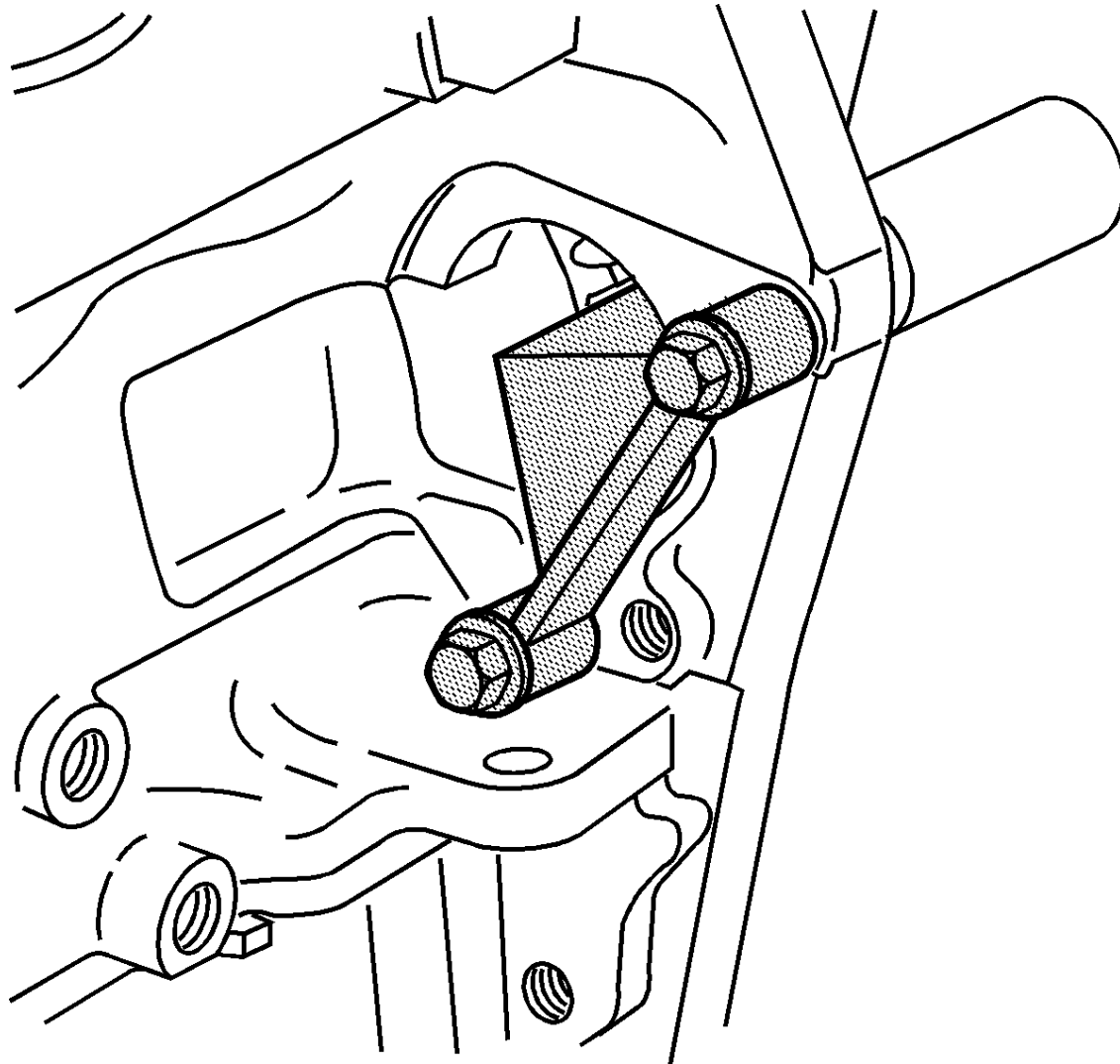
6. Using engine support fixture, lower engine approximately two inches.
7. Remove the crankshaft balancer bolt. Discard the bolt.



**Fig. 33: Crankshaft Balancer Remover And Button**  
Courtesy of GENERAL MOTORS COMPANY

8. Install the **J-38416-2** button in the nose of the crankshaft.
9. Install the **J-41816** remover in order to remove the crankshaft balancer.
10. Tighten the center bolt of the **J-41816** remover in order to pull the crankshaft balancer off of the crankshaft.
11. Remove the **J-41816** remover from the crankshaft balancer.

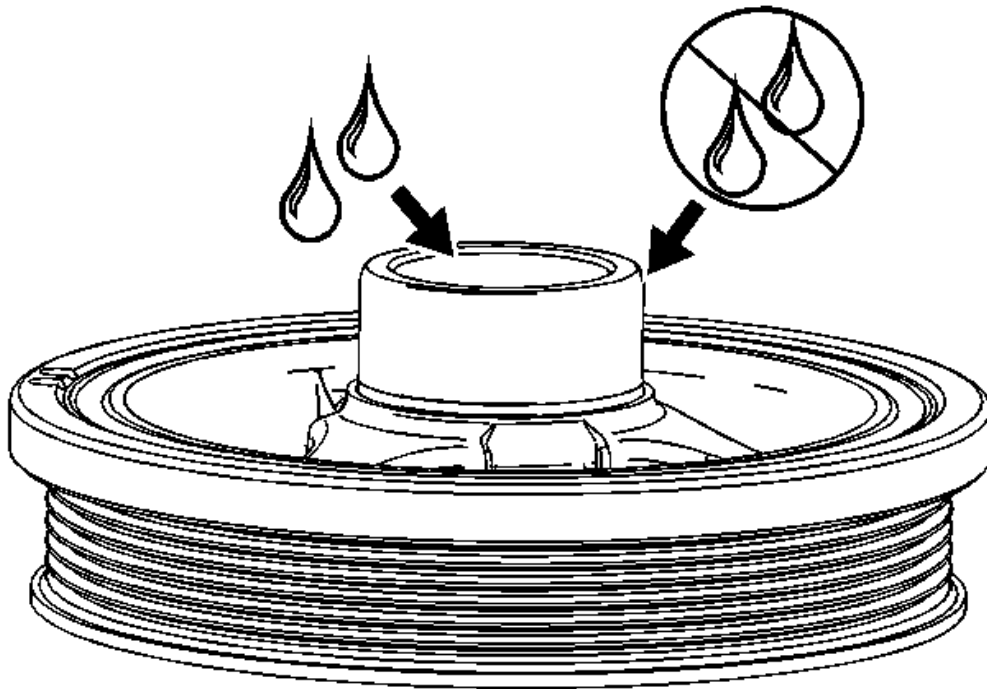
#### Installation Procedure



**Fig. 34: Flywheel Holding Tool**

Courtesy of GENERAL MOTORS COMPANY

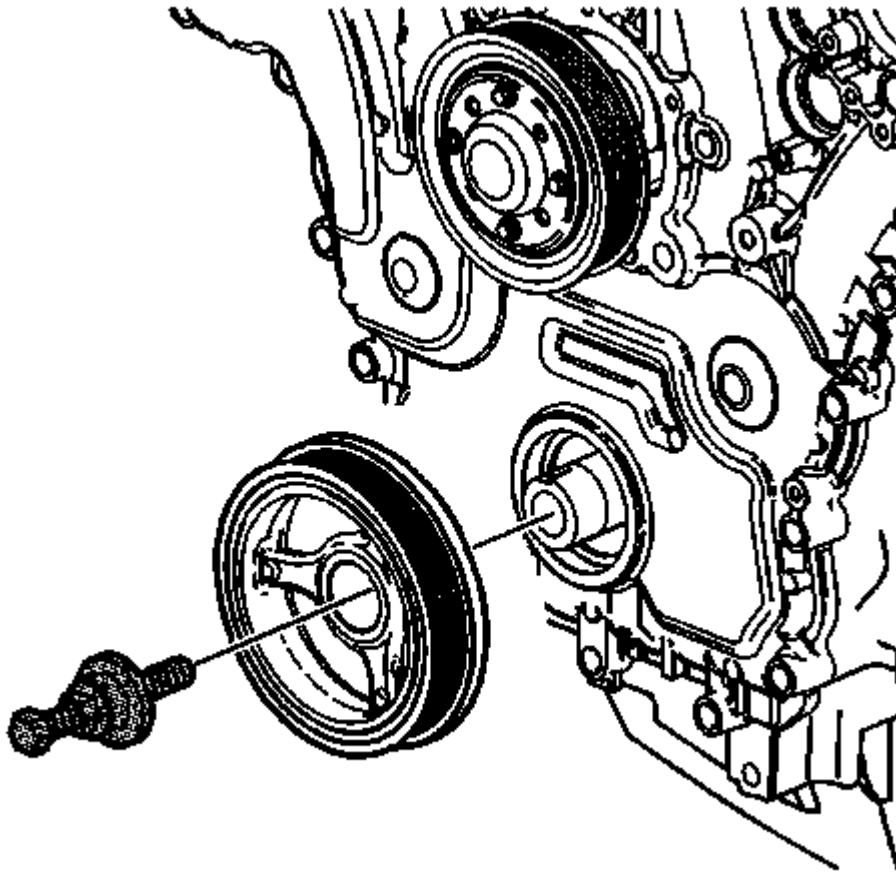
1. The **EN-46106** tool must be installed onto the flywheel.
2. Use the **J-41998-B** installer, nut, bearing and washer to install the crankshaft balancer.



**Fig. 35: Lubrication And Non-Lubrication Areas On Crankshaft Balancer**  
 Courtesy of GENERAL MOTORS COMPANY

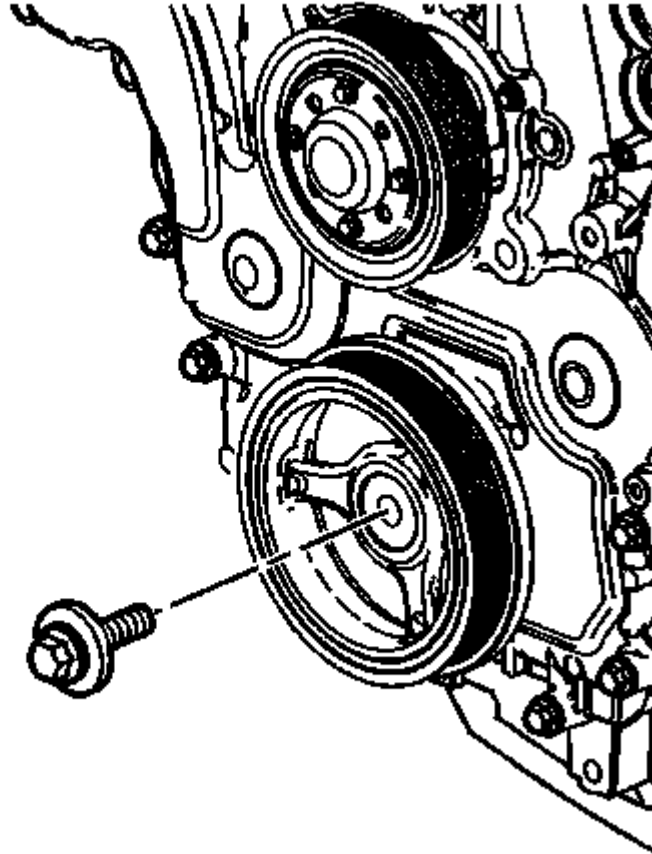
**NOTE:** Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

3. Apply lubricant to the inside of the crankshaft balancer hub bore.



**Fig. 36: Crankshaft Balancer And Installation Tool**  
 Courtesy of GENERAL MOTORS COMPANY

4. Place the crankshaft balancer in position on the crankshaft.
5. Thread the **J-41998-B** installer in the crankshaft. Ensure you engage at least 10 threads of the **J-41998-B** installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **J-41998-B** installer until the large washer bottoms out on the crankshaft end.
7. Remove the **J-41998-B** installer.



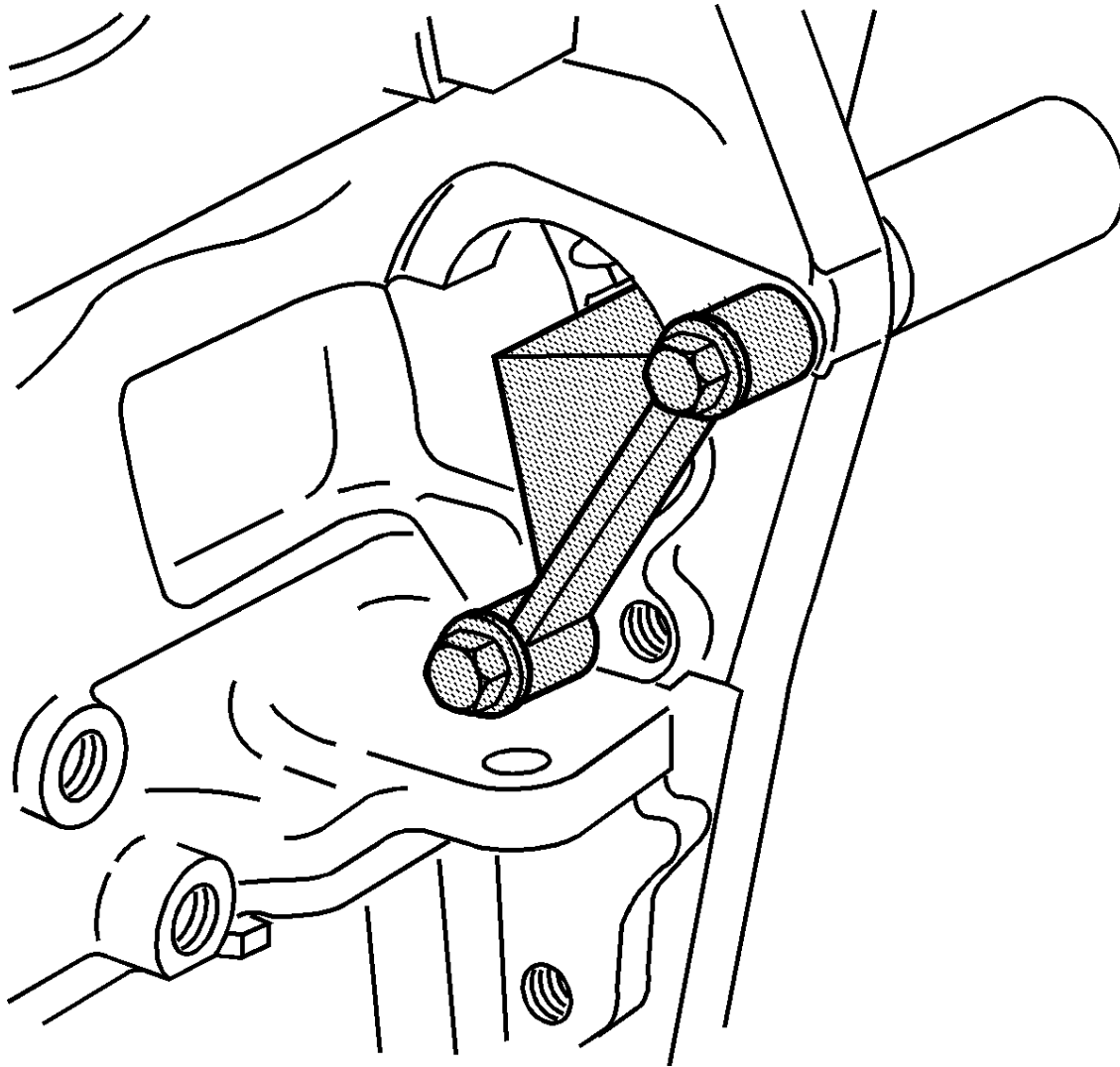
**Fig. 37: Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Always install a new crankshaft balancer retaining bolt and washer.

8. Install the NEW crankshaft balancer bolt.

**CAUTION:** Refer to Fastener Caution .

9. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft) and an additional 150 degrees using the **J-45059** meter.



**Fig. 38: Flywheel Holding Tool**

Courtesy of GENERAL MOTORS COMPANY

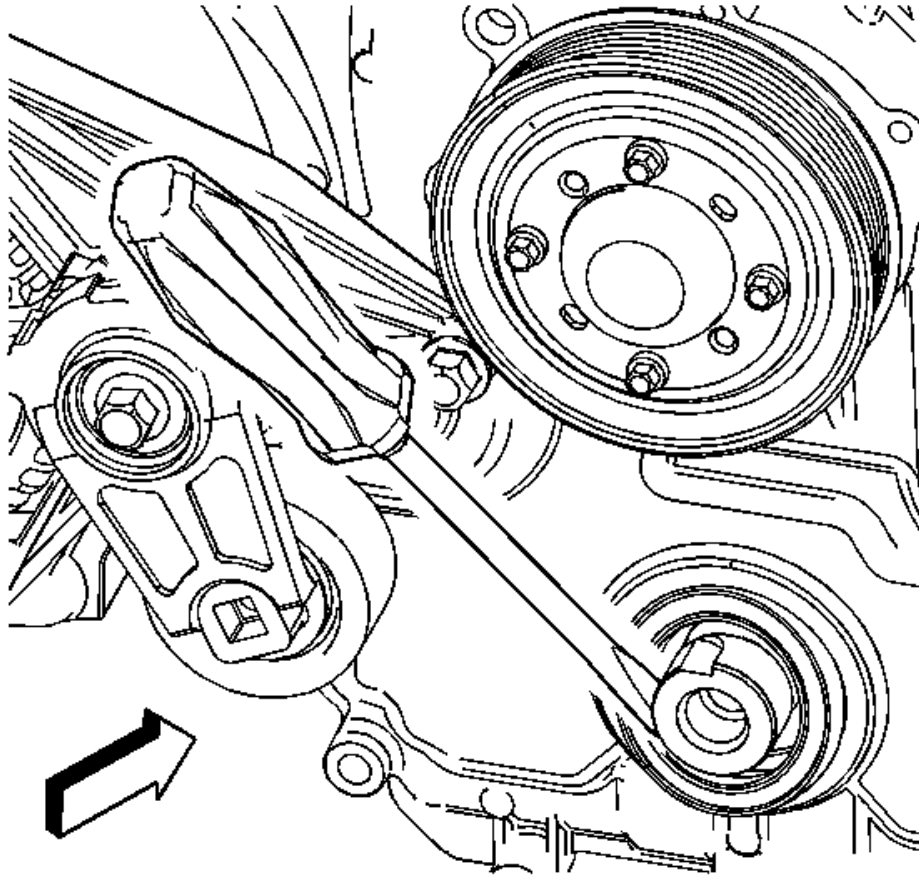
10. Remove the **EN-46106** tool.
11. Install the starter. Refer to **Starter Replacement (V6)**.
12. Install the drive belt. Refer to **Drive Belt Replacement**.
13. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Front Liner Replacement**.
14. Remove the engine support fixture. Refer to **Engine Support Fixture**.

## CRANKSHAFT FRONT OIL SEAL REPLACEMENT

### Special Tools

**EN-29184** Oil Seal Installer

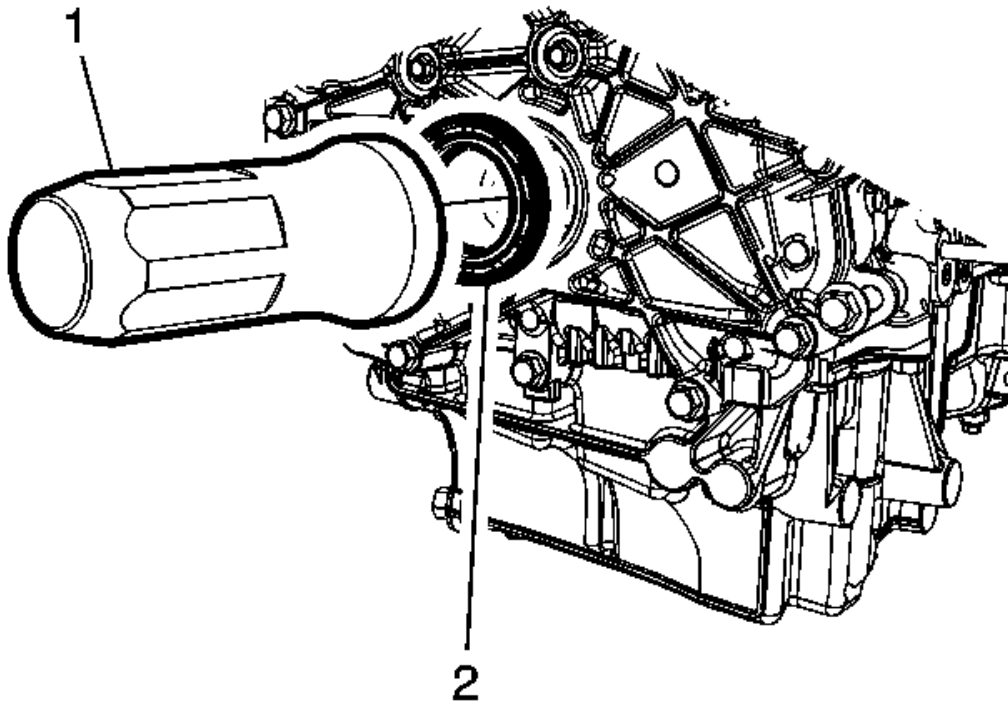
For equivalent regional tools, refer to **Special Tools**.

**Removal Procedure**

**Fig. 39: Crankshaft Front Oil Seal And Flat-Bladed Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the crankshaft front oil seal using a suitable flat blade tool.

**Installation Procedure**



**Fig. 40: Crankshaft Front Oil Seal And Installer**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

1. Use the **EN-29184** installer (1) or equivalent to install the crankshaft front oil seal (2).
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

## **CAMSHAFT COVER REPLACEMENT - LEFT SIDE**

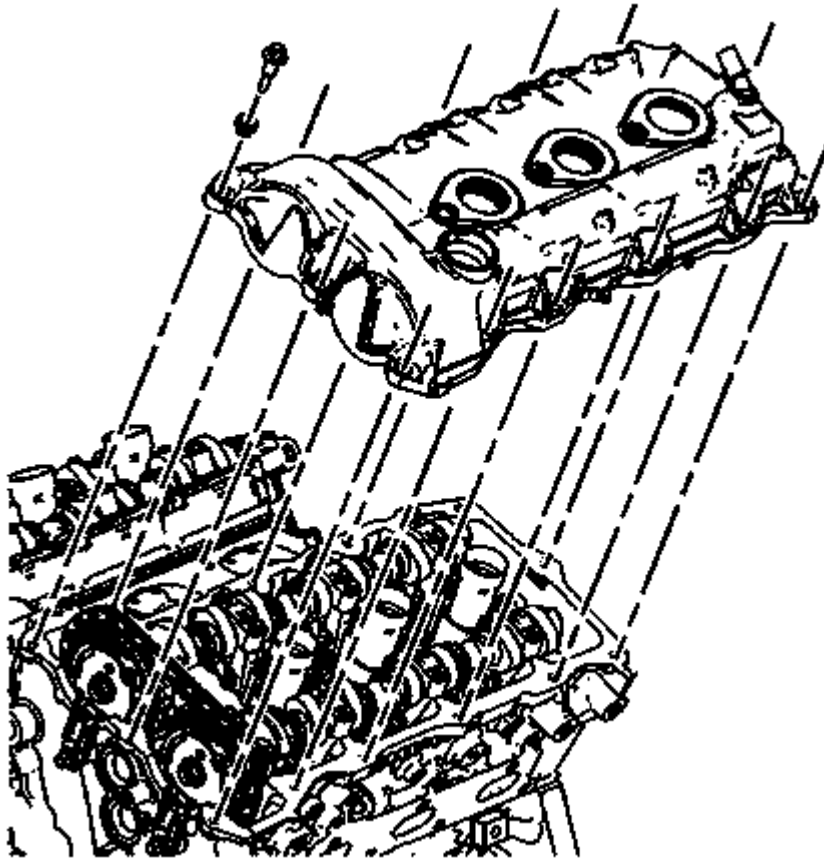
### **Special Tools**

**EN-46101** Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools** .

### **Removal Procedure**

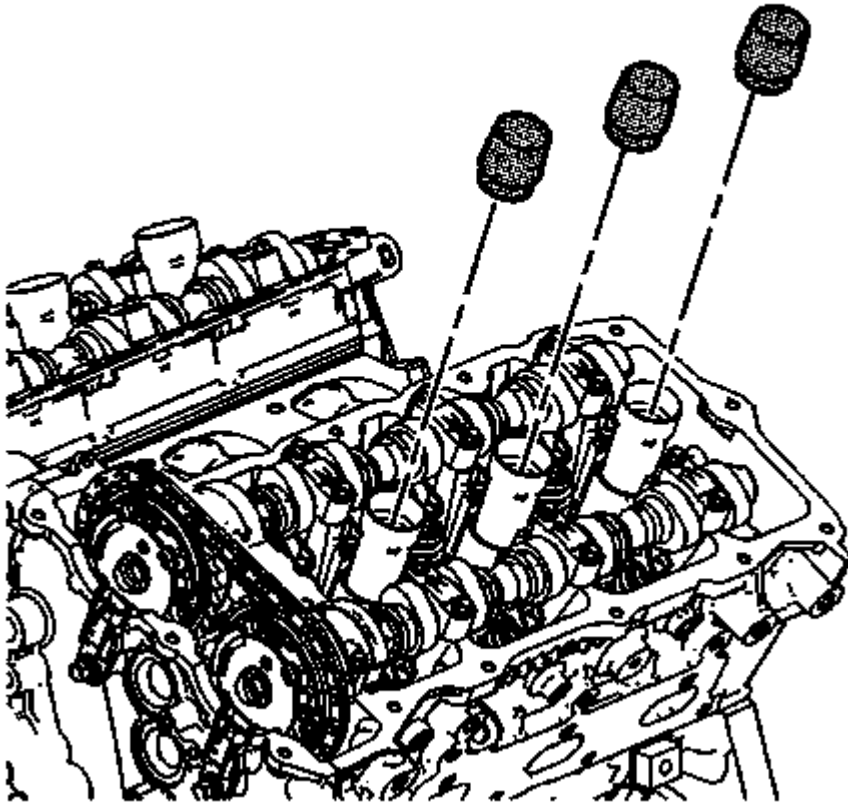
1. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .
2. Disconnect and remove the engine harness from the camshaft cover.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
4. Remove the power steering reservoir bracket and reposition without disconnecting the hoses. Refer to **Power Steering Fluid Reservoir Bracket Replacement (V6)** .



**Fig. 41: Left Camshaft Cover**

Courtesy of GENERAL MOTORS COMPANY

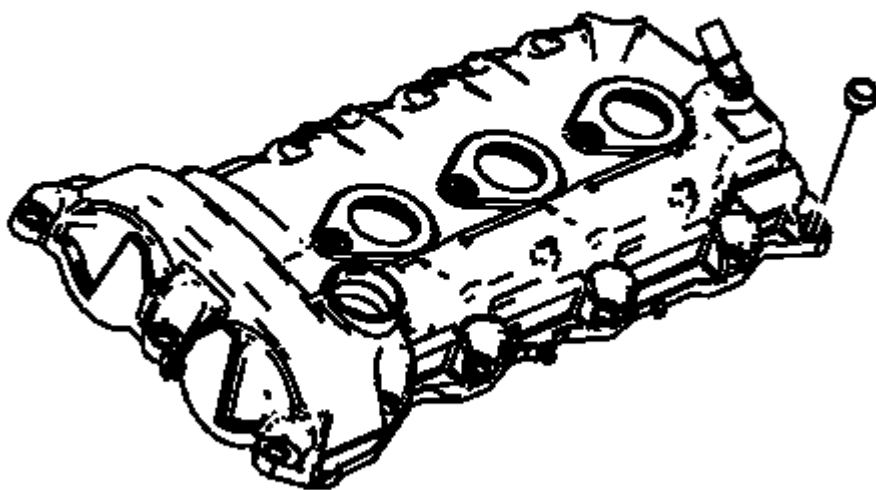
5. Remove the left camshaft cover bolts.
6. Remove the left camshaft cover from the left cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .



**Fig. 42: Spark Plug Tube Seal Guides**  
Courtesy of GENERAL MOTORS COMPANY

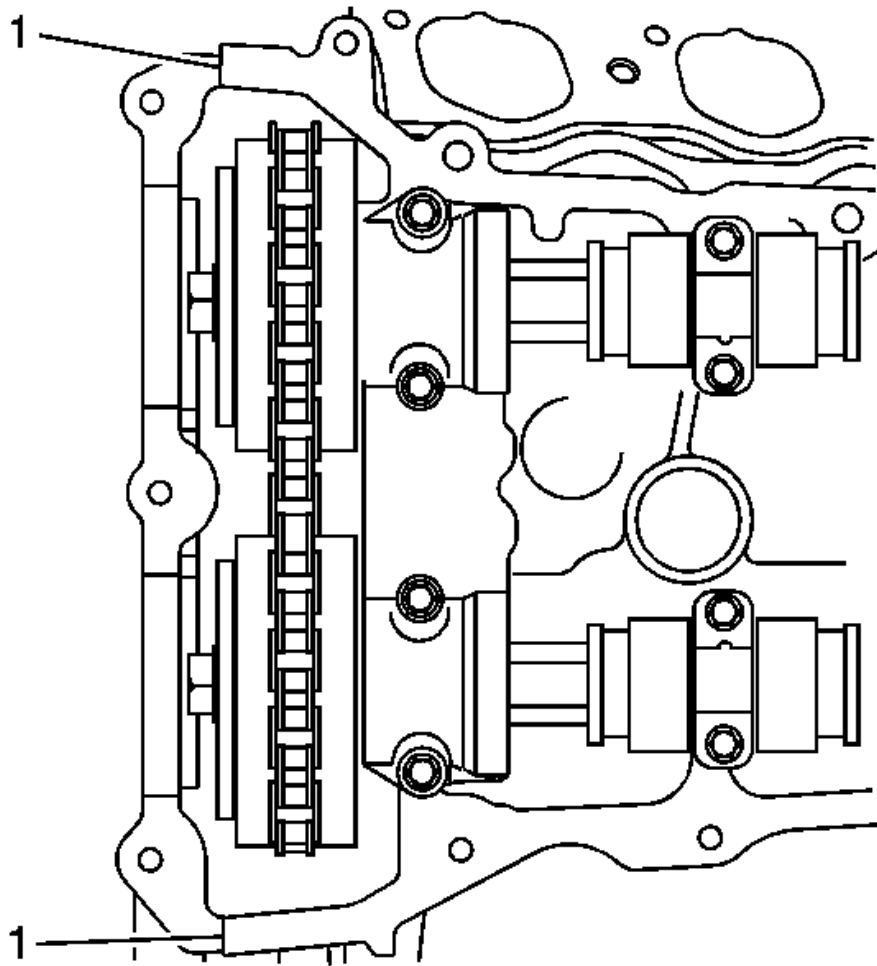
8. Install the **EN-46101** guide onto the spark plug tubes of the left cylinder head.

#### Installation Procedure



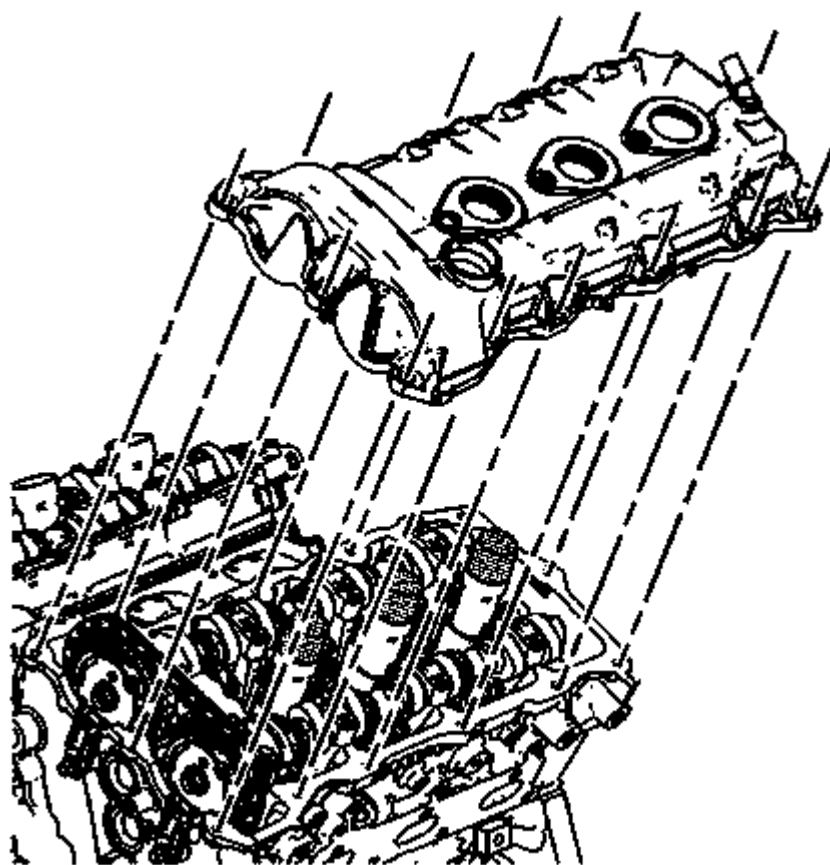
**Fig. 43: Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.



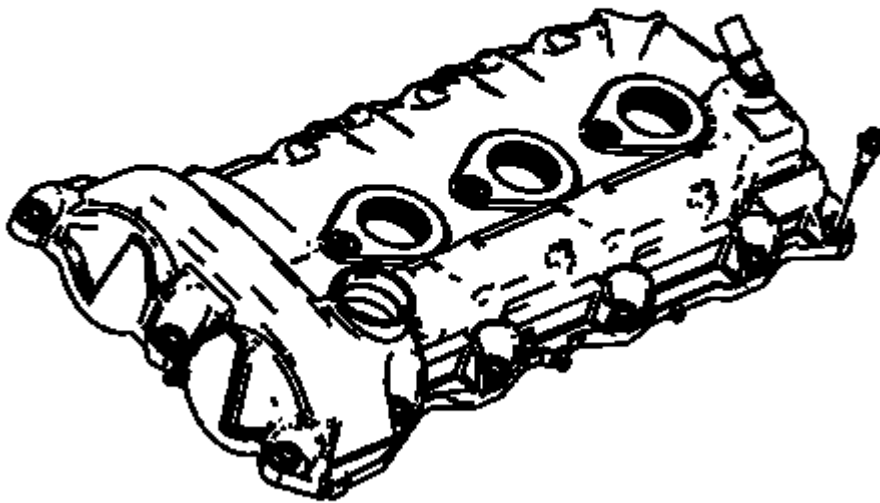
**Fig. 44: Applying Sealant On Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1).



**Fig. 45: Aligning Left Camshaft Cover On Left Cylinder Head**  
Courtesy of GENERAL MOTORS COMPANY

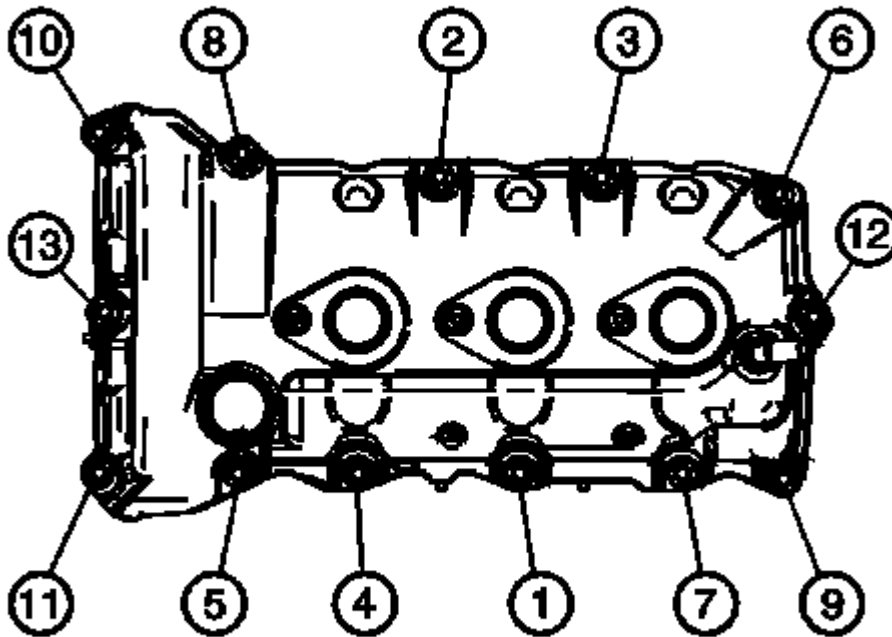
3. Place the left camshaft cover into position onto the left cylinder head.



**Fig. 46: Left Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS COMPANY

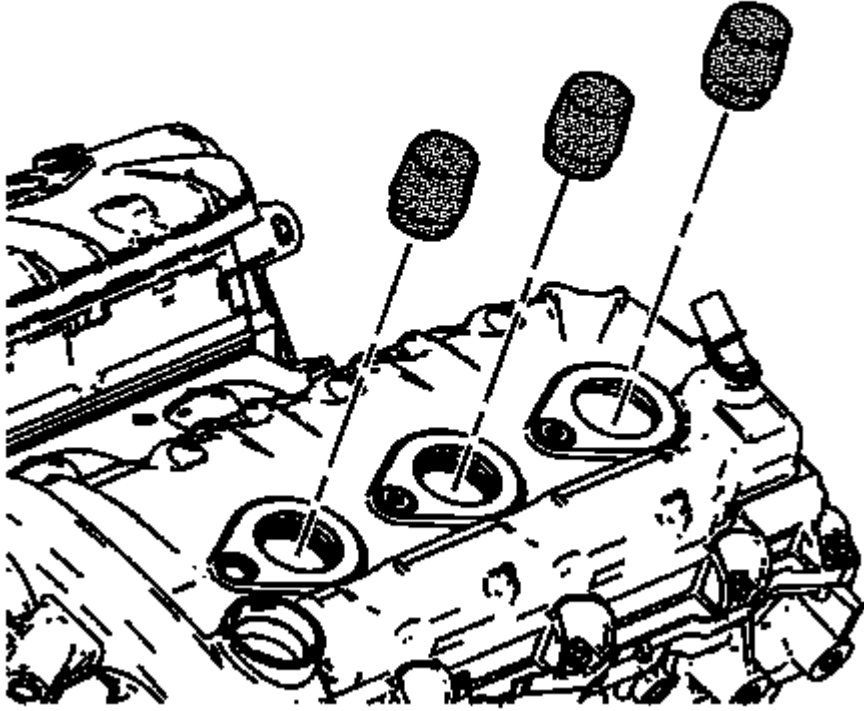
**CAUTION:** Refer to Fastener Caution .

4. Loosely install the left camshaft cover bolts.



**Fig. 47: Left Camshaft Cover Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the left camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
6. Install the power steering reservoir bracket. Refer to **Power Steering Fluid Reservoir Bracket Replacement (V6)** .
7. Connect and install the engine harness to the camshaft cover.
8. Install the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.



**Fig. 48: Spark Plug Tube Plugs**

Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46101** guide from the spark plug tubes of the left cylinder head.
10. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .

## **CAMSHAFT COVER REPLACEMENT - RIGHT SIDE**

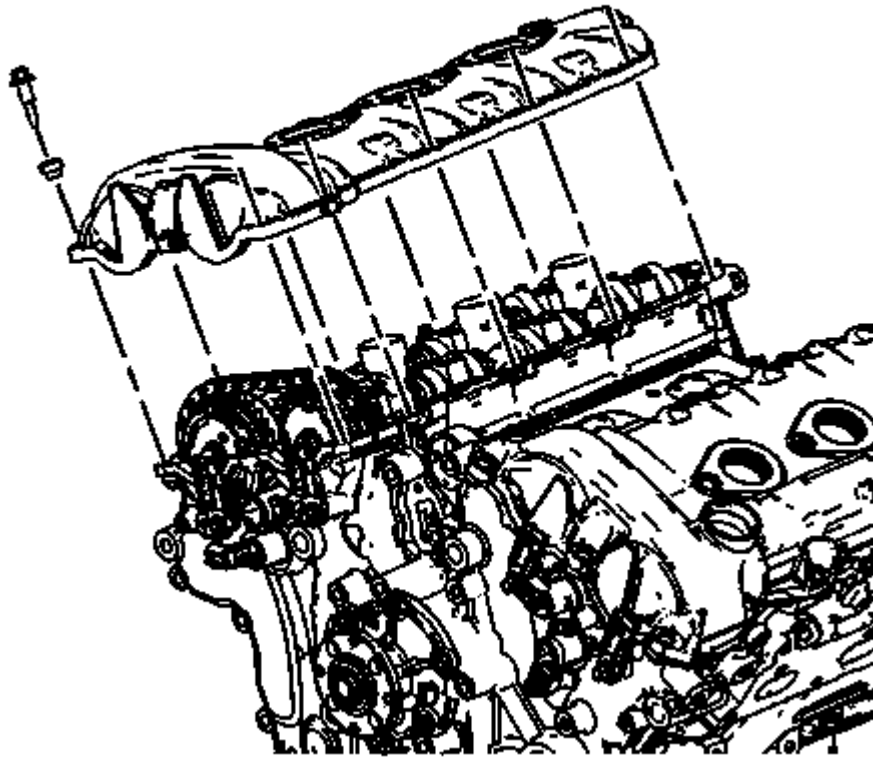
### **Special Tools**

**EN-46101** Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools** .

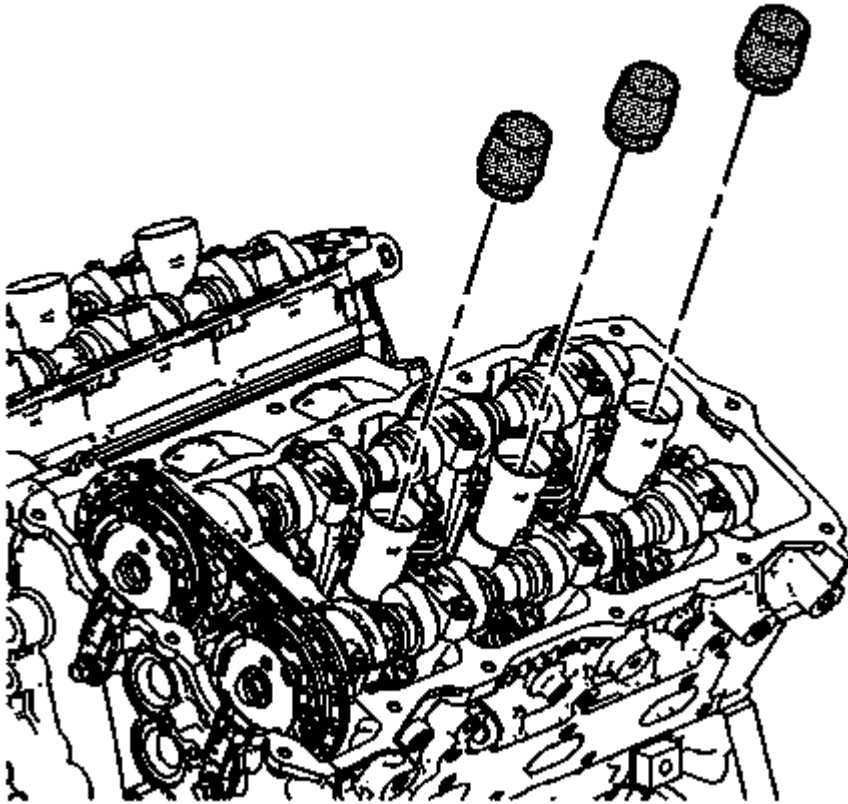
### **Removal Procedure**

1. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 1** .
2. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
3. Remove the power steering reservoir from the bracket and reposition without disconnecting the hoses. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
4. Disconnect and remove the engine harness from the camshaft cover.



**Fig. 49: Camshaft Cover And Seal**  
Courtesy of GENERAL MOTORS COMPANY

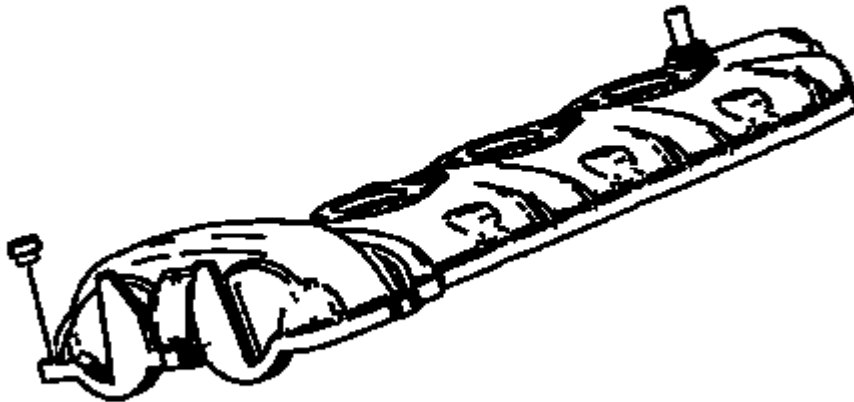
5. Remove the right camshaft cover bolts.
6. Remove the right camshaft cover from the right cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection**



**Fig. 50: Spark Plug Tube Seal Guides**  
Courtesy of GENERAL MOTORS COMPANY

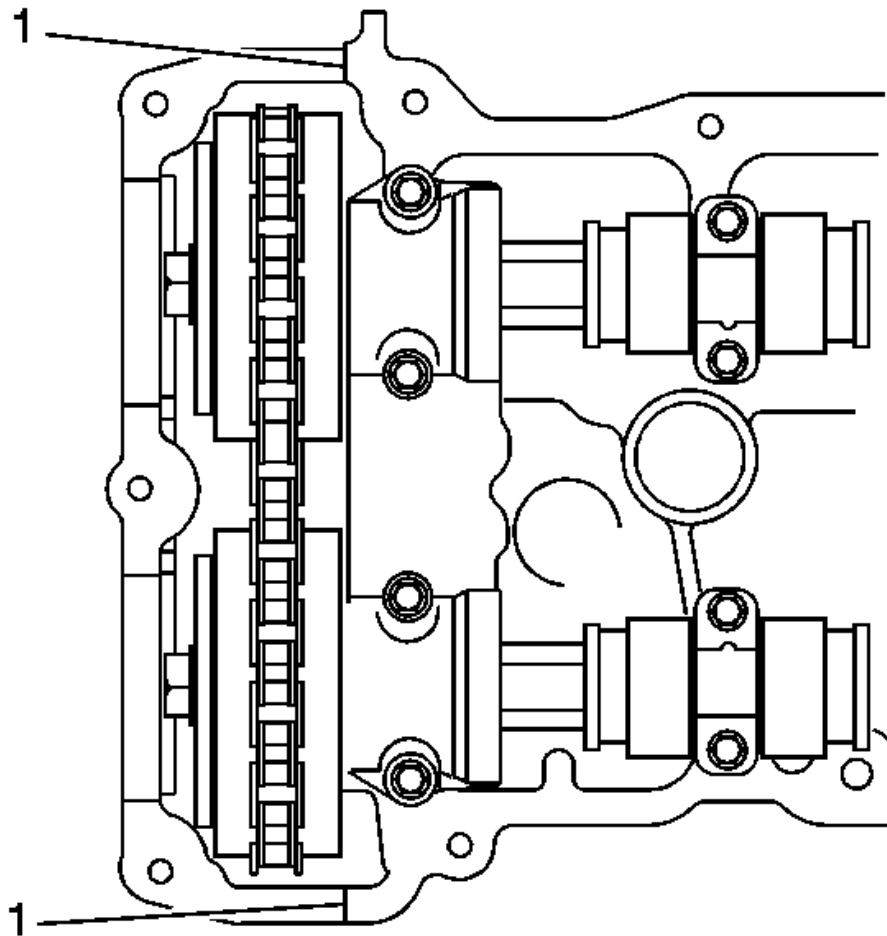
8. Install the **EN-46101** guide onto the spark plug tubes of the right cylinder head.

#### Installation Procedure



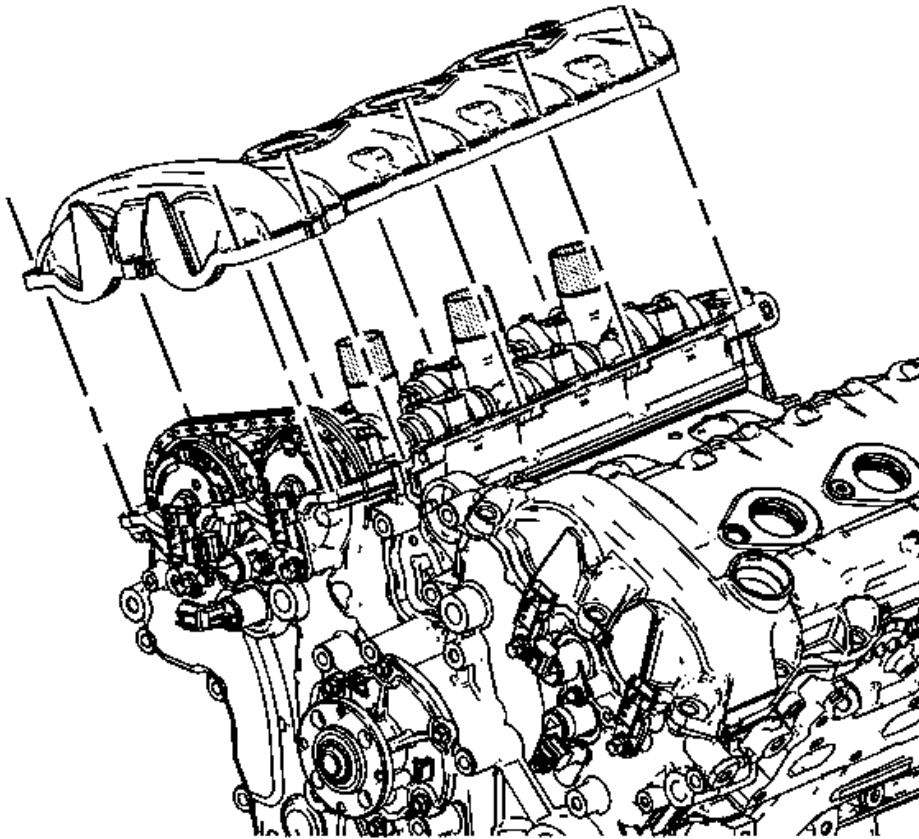
**Fig. 51: Camshaft Cover Bolt Grommets**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.



**Fig. 52: Applying Sealant On Engine Front Cover Split Lines**  
 Courtesy of GENERAL MOTORS COMPANY

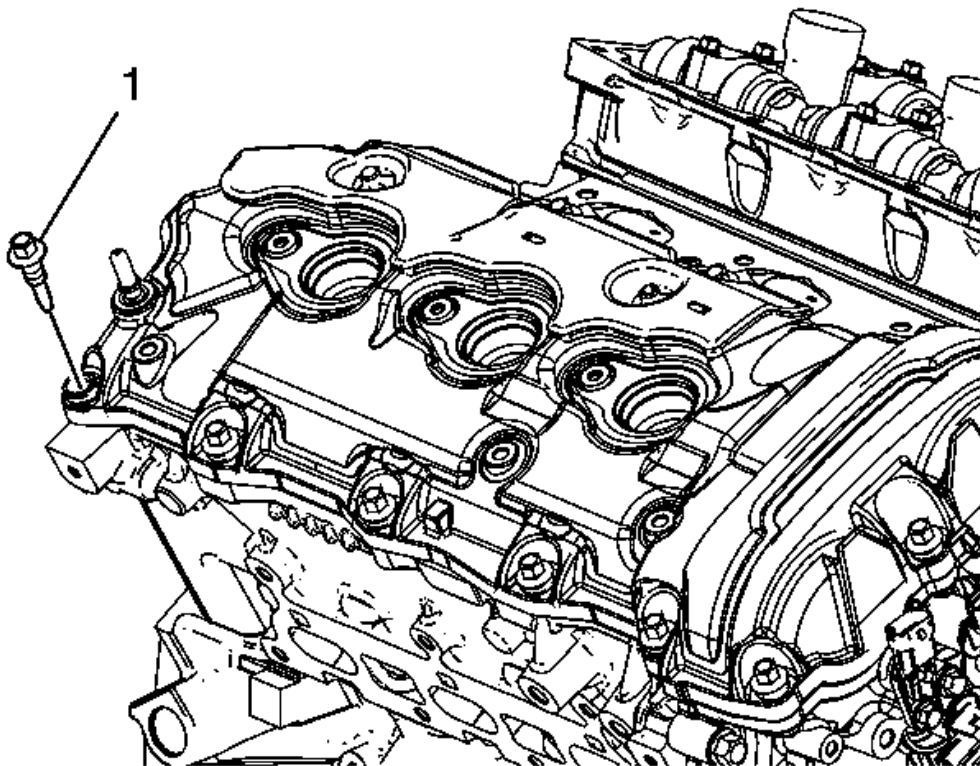
2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1).



**Fig. 53: Right Camshaft Cover**

Courtesy of GENERAL MOTORS COMPANY

3. Place the right camshaft cover into position onto the right cylinder head.

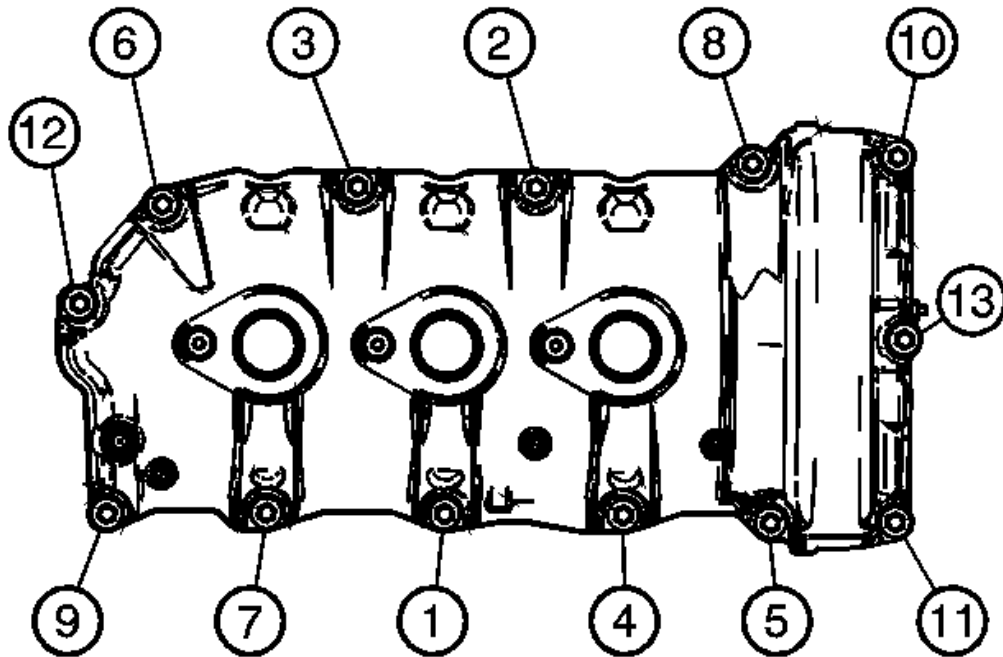


**Fig. 54: Camshaft Cover Bolts**

Courtesy of GENERAL MOTORS COMPANY

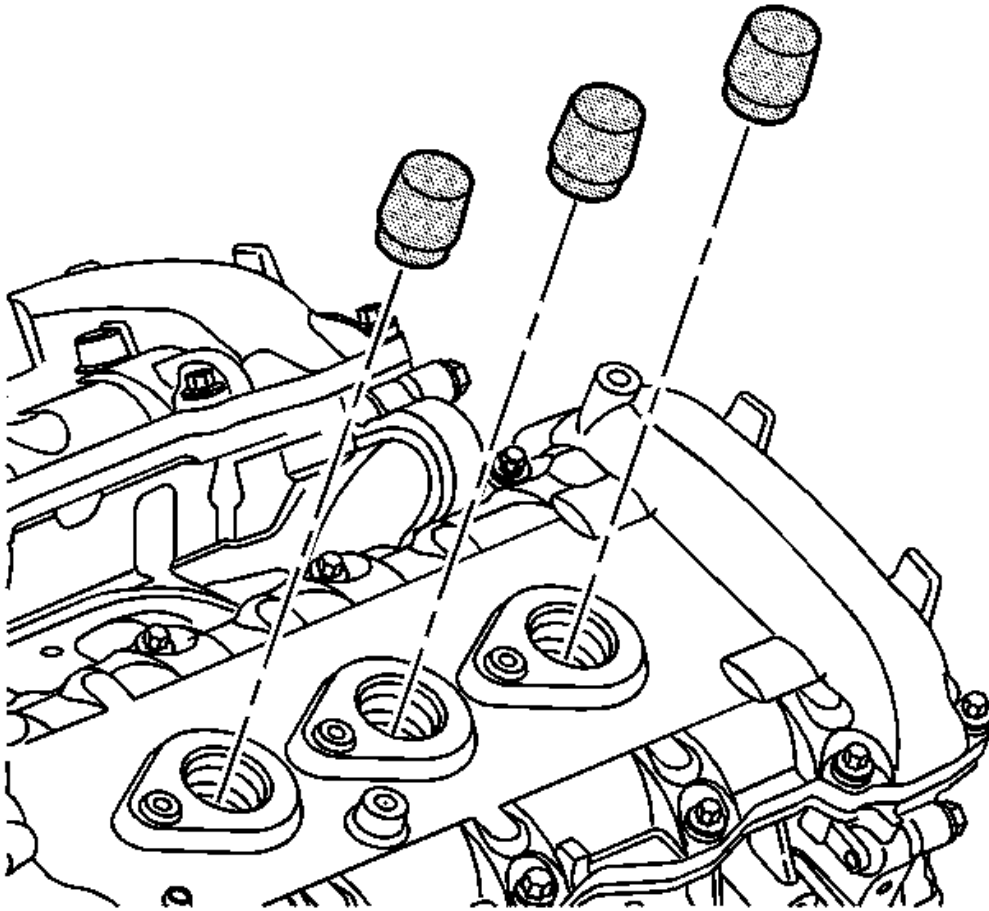
**CAUTION: Refer to Fastener Caution .**

4. Loosely install the right camshaft cover bolts.



**Fig. 55: Right Camshaft Cover Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the right camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
6. Connect and install the engine harness to the camshaft cover.
7. Install the power steering reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
8. Install the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.



**Fig. 56: Spark Plug Tube Guides**

Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46101** guide from the spark plug tubes of the right cylinder head.
10. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 1**.

## ENGINE FRONT COVER REPLACEMENT

### Special Tools

**EN-46109** Engine Front Cover Installation Guide Pins

For equivalent regional tools, refer to **Special Tools**.

### Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
2. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.

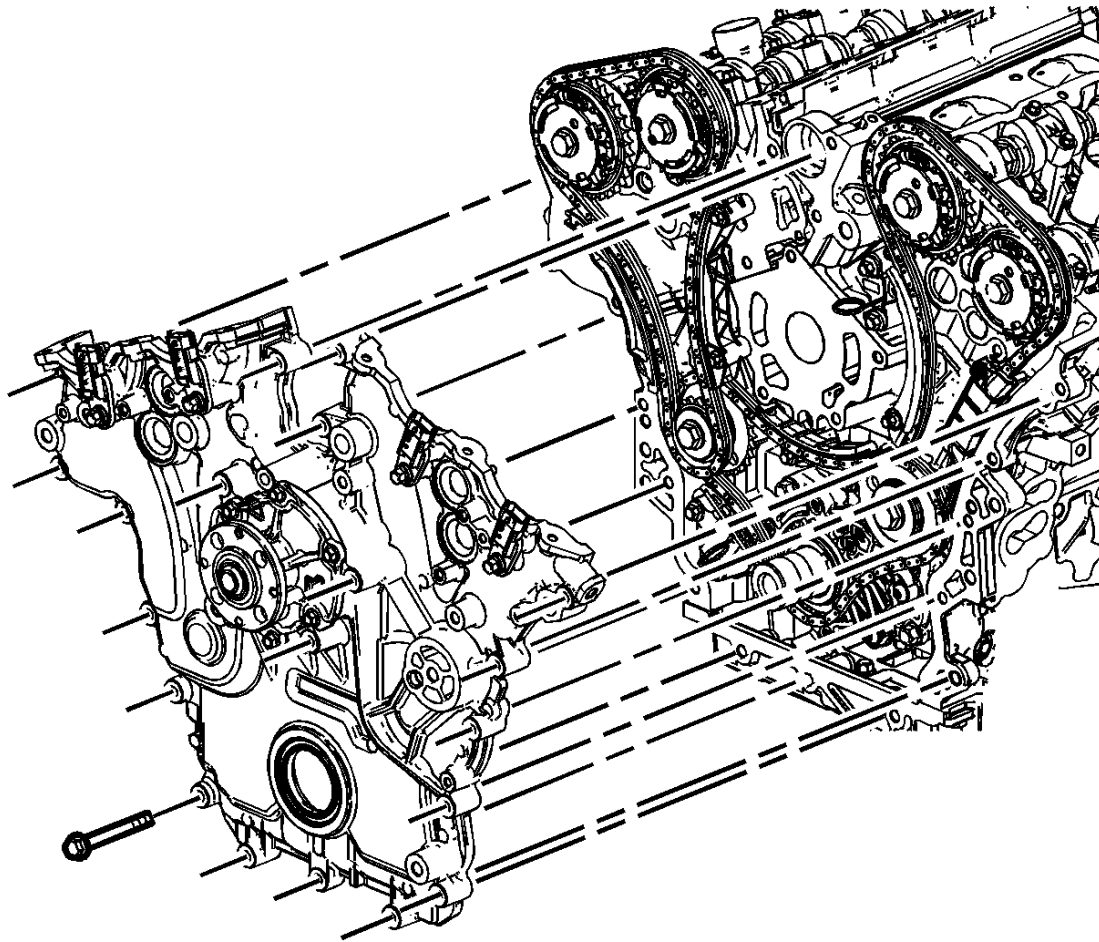
3. Drain the engine coolant. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .
4. Remove the water outlet with the radiator hose and reposition aside. Refer to Water Outlet Replacement (V6) .
5. Remove the generator. Refer to Generator Replacement (V6) .

**NOTE:**        **Do not disconnect the power steering pipes or drain the power steering fluid.**

6. Remove the power steering fluid reservoir and reposition the power steering fluid reservoir in order to provide access. Refer to Power Steering Fluid Reservoir Replacement (V6) .
7. Remove the power steering pump pulley. Refer to Power Steering Pump Pulley Replacement .

**NOTE:**        **Do not disconnect the power steering pipes/hoses.**

8. Remove the power steering pump upper front bolt and loosen the remaining two bolts. Refer to Power Steering Pump Replacement (V6) .
9. Remove the crankshaft balancer. Refer to Crankshaft Balancer Replacement.
10. Remove the camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust , Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake , Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust , and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
11. Remove the belt tensioner. Refer to Drive Belt Tensioner Replacement
12. Remove the camshaft position actuator solenoid valves from the front cover. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake , Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust , Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake , and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .



**Fig. 57: Engine Front Cover**

Courtesy of GENERAL MOTORS COMPANY

13. Remove the engine front cover with the water pump. Refer to **Engine Front Cover Removal** .
14. Disassemble the engine front cover. Refer to **Engine Front Cover Disassemble** .

**NOTE:** Do NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.

15. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection** .

**NOTE:** Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

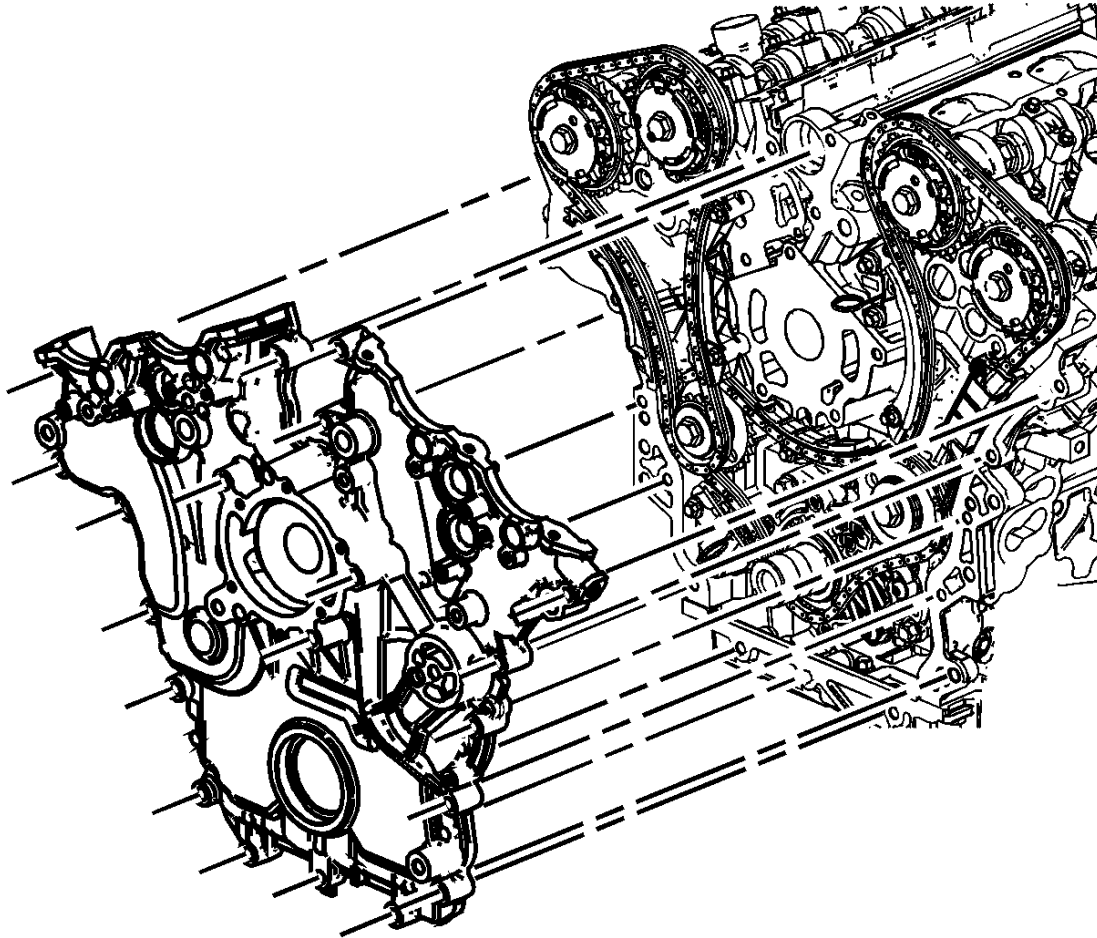
16. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and**

**Inspection .**

17. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

**Installation Procedure**

1. Assemble the engine front cover. Refer to **Engine Front Cover Assemble .**

**Fig. 58: Engine Front Cover****Courtesy of GENERAL MOTORS COMPANY**

2. Use the EN-46109 pins in order to install the engine front cover. Refer to **Engine Front Cover Installation .**
3. Install the camshaft position actuator solenoid valves to the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position**

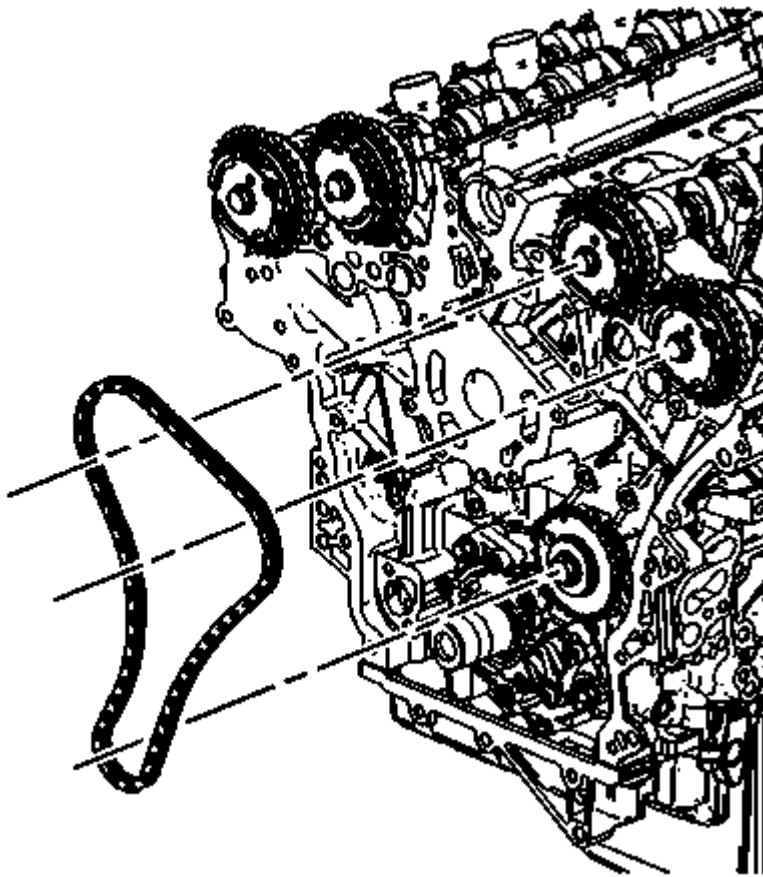
**Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .**

4. Install the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
5. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement** .
6. Install the power steering pump upper front bolt and tighten the remaining two bolts. Refer to **Power Steering Pump Replacement (V6)** .
7. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement** .
8. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
9. Install the generator bracket with the generator and the belt tensioner. Refer to **Generator Replacement (V6)** .
10. Install the water outlet. Refer to **Water Outlet Replacement (V6)** .
11. Install the purge vent hose to the water outlet. Refer to **Engine Coolant Air Bleed Pipe Replacement (V6)** .
12. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
13. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.
14. Install the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
15. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

**SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE****Removal Procedure**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .

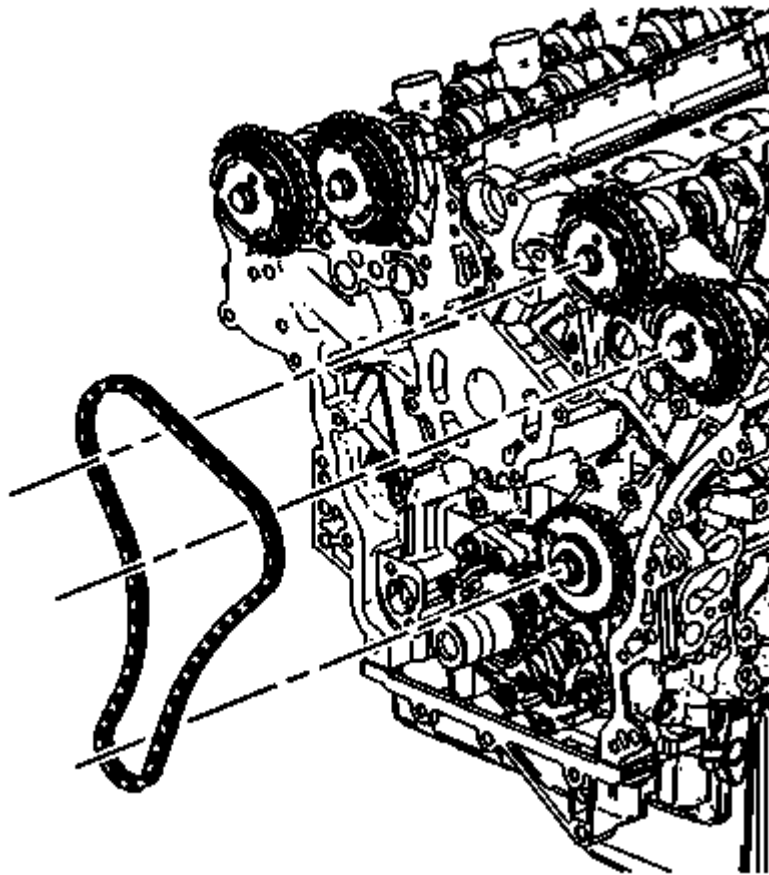
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side**.
10. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side**.
11. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side**.
12. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side**.
13. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side**.



**Fig. 59: Left Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS COMPANY

14. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side**
15. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection**. Replace components as necessary.

#### Installation Procedure



**Fig. 60: Left Bank Secondary Camshaft Drive Chain**  
 Courtesy of GENERAL MOTORS COMPANY

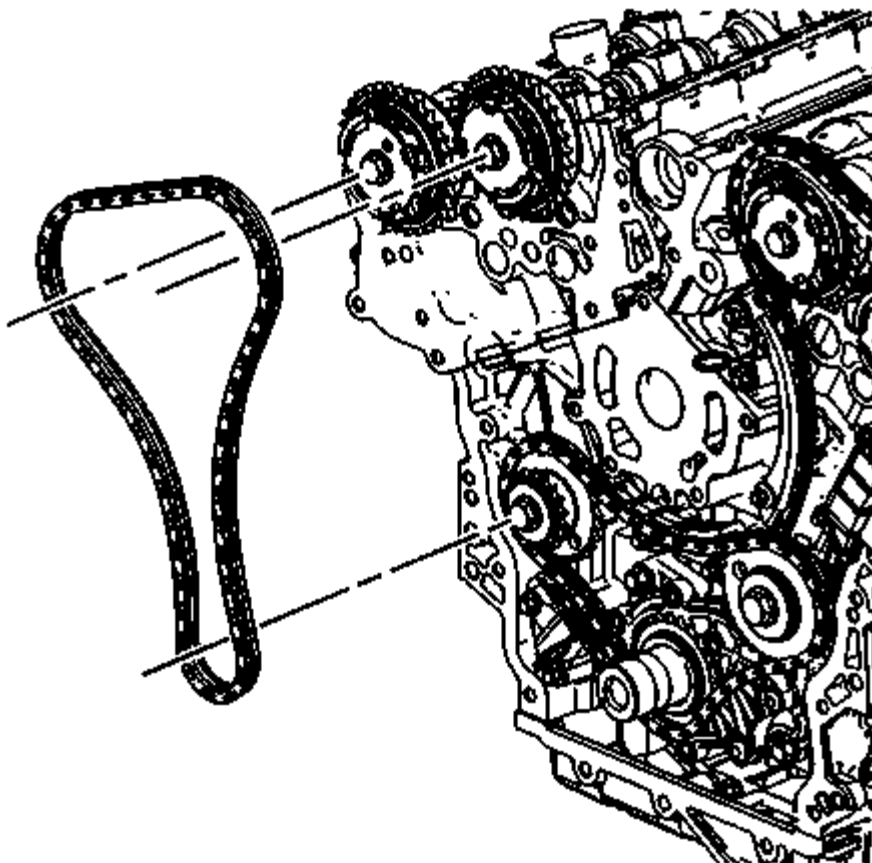
1. Install the left bank secondary camshaft drive chain.
2. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .
4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side** .
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
6. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
7. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
8. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
9. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
10. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate**

**Drive Chain Installation - Right Side .**

11. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side .**
12. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side .**
13. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side .**
14. Install the engine front cover. Refer to **Engine Front Cover Replacement.**

**SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE****Removal Procedure**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement.**
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side .**
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side .**
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side .**

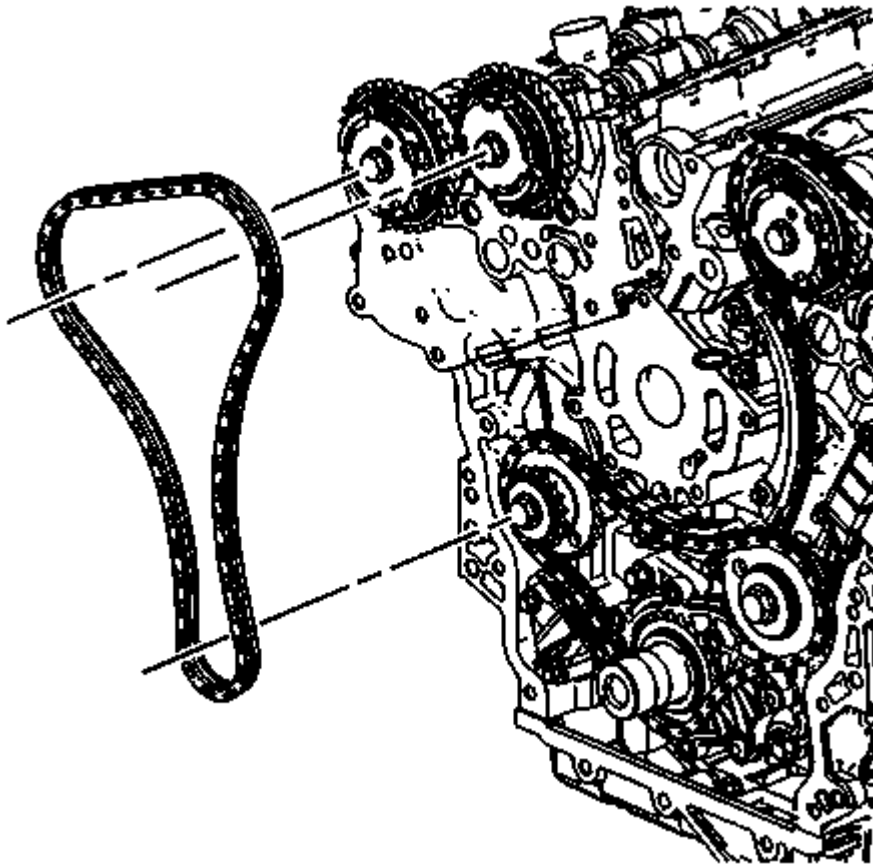


**Fig. 61: Right Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right bank secondary camshaft drive chain.

#### Installation Procedure

1. Ensure the stage 1 camshaft timing is correct. Refer to **Setting Camshaft Timing**.

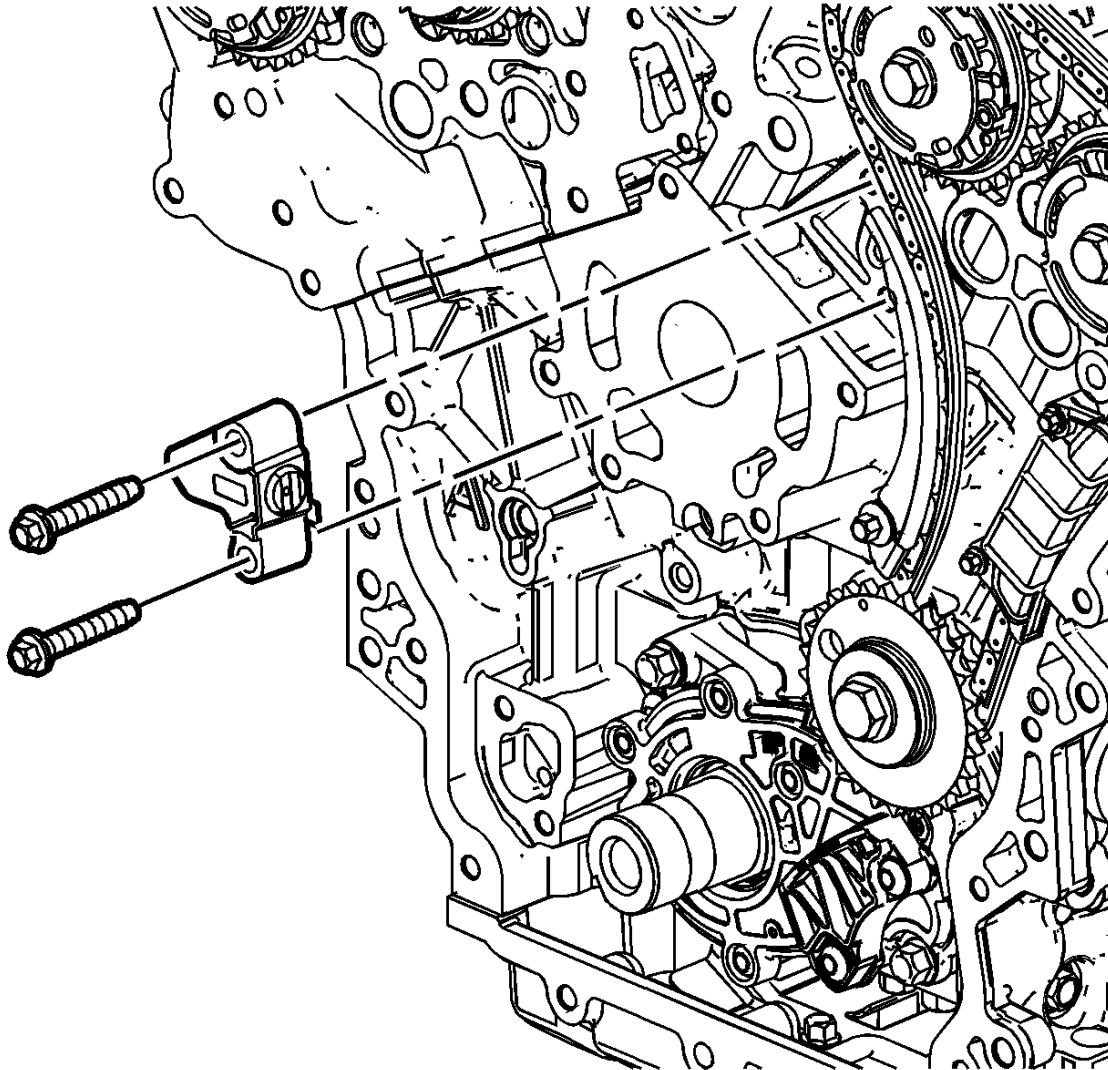


**Fig. 62: Right Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side**
3. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side**.
4. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side**.
5. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
6. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

**SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE****Removal Procedure**

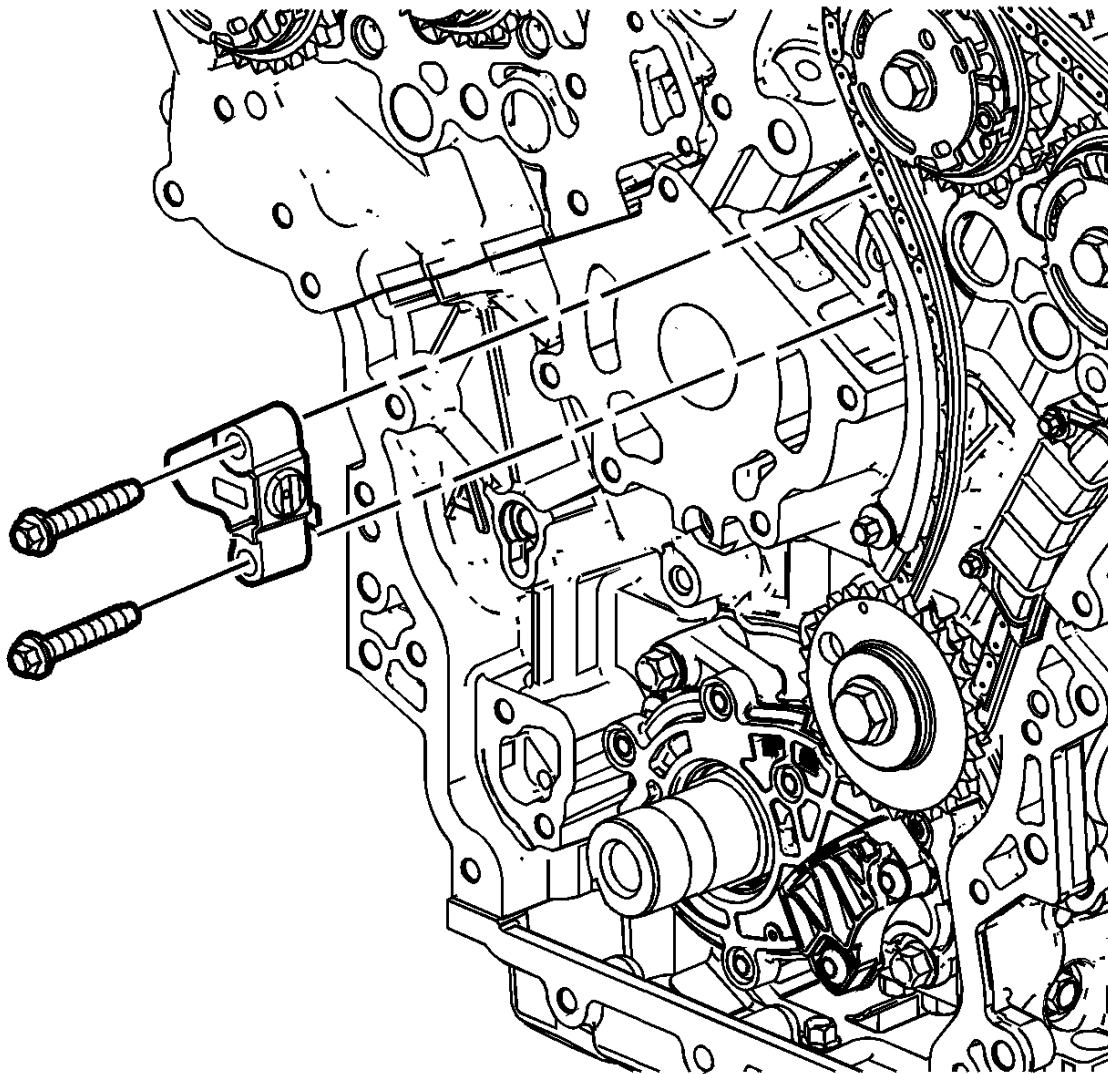
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.



**Fig. 63: Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side**.

**Installation Procedure**



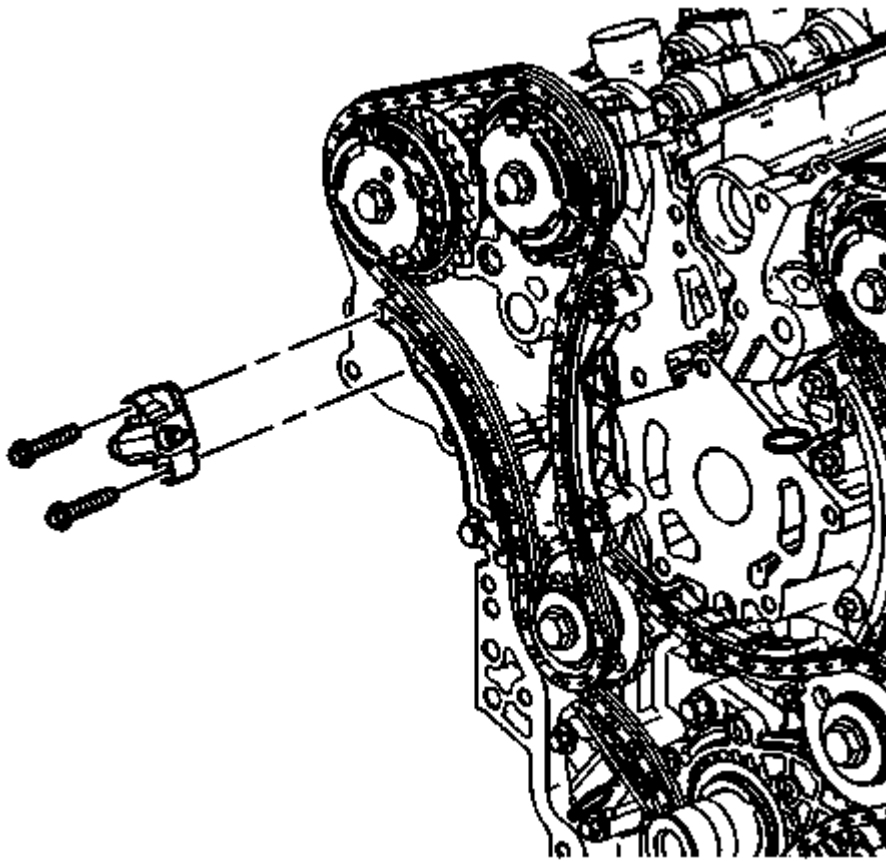
**Fig. 64: Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Left Side.
2. Install the engine front cover. Refer to Engine Front Cover Replacement.

## **SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE**

### **Removal Procedure**

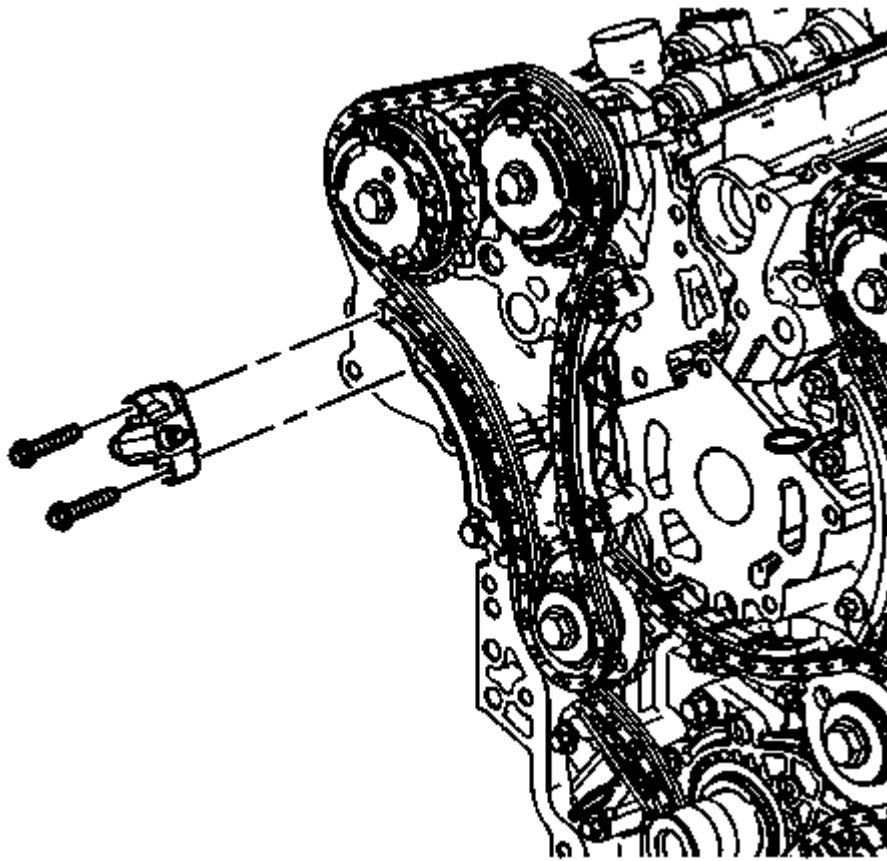
1. Remove the engine front cover. Refer to Engine Front Cover Replacement.



**Fig. 65: Right Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

#### Installation Procedure



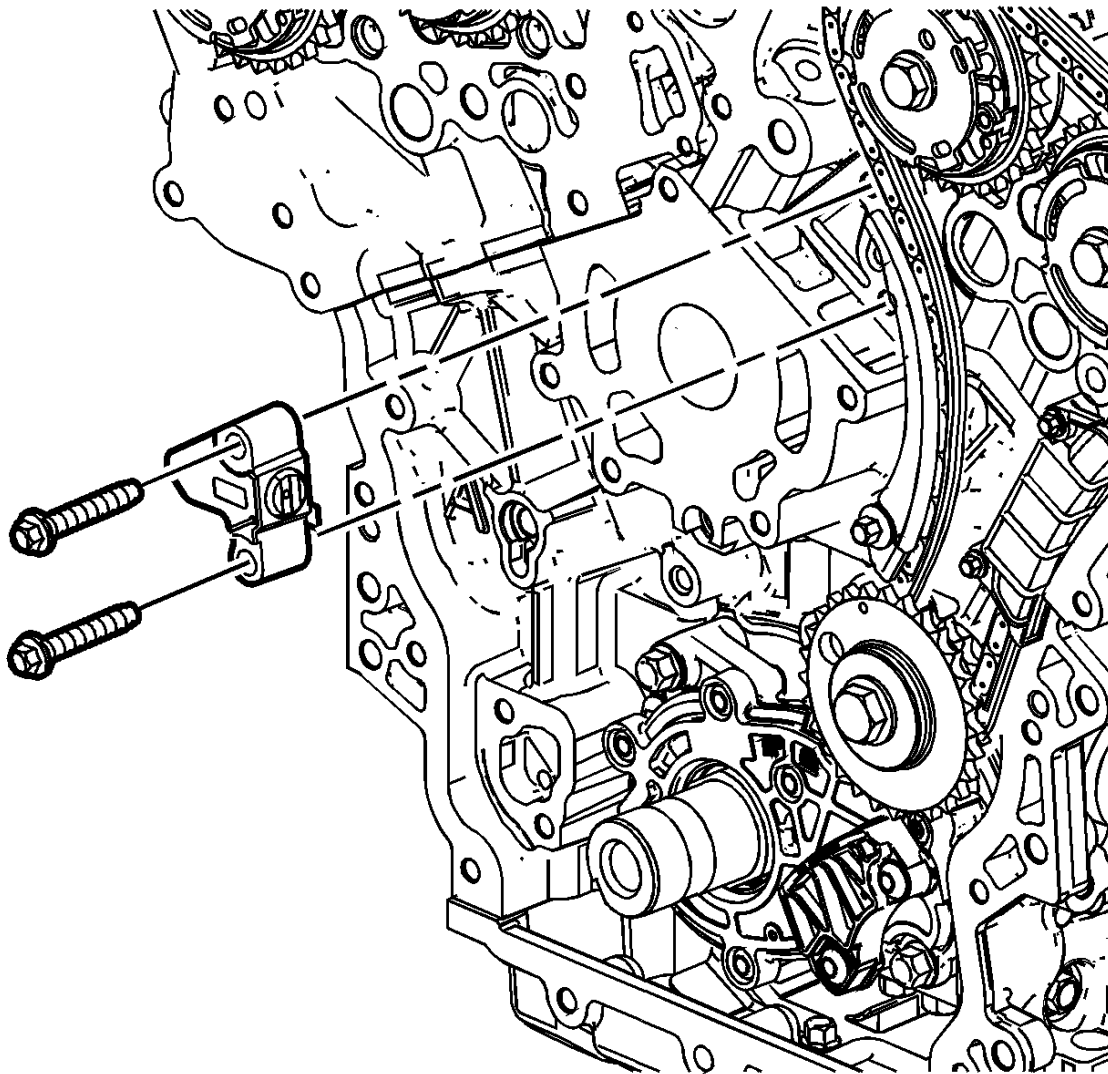
**Fig. 66: Right Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## **SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE**

### **Removal Procedure**

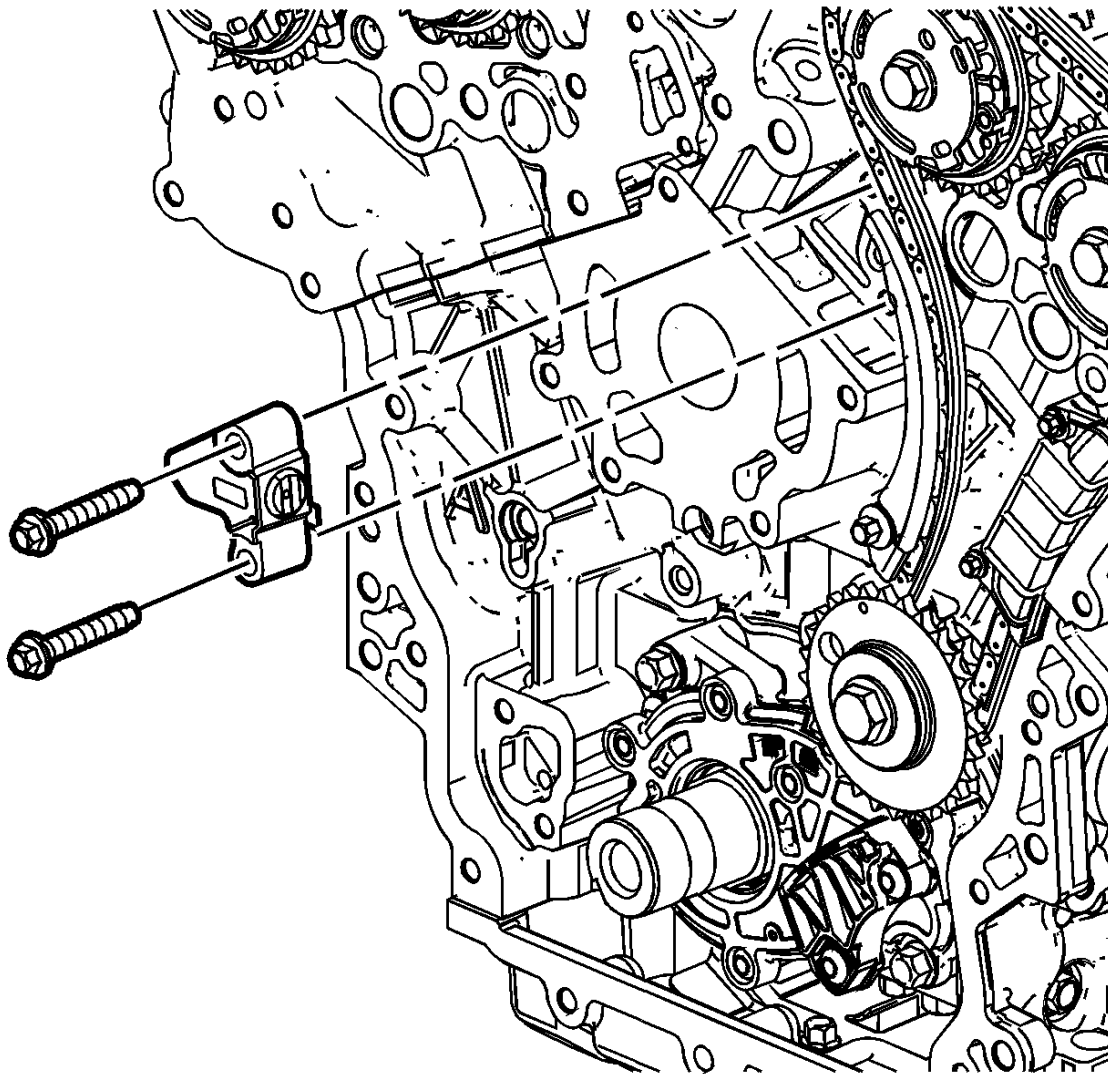
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.



**Fig. 67: Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side**.
3. Remove the secondary shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side**.

#### **Installation Procedure**

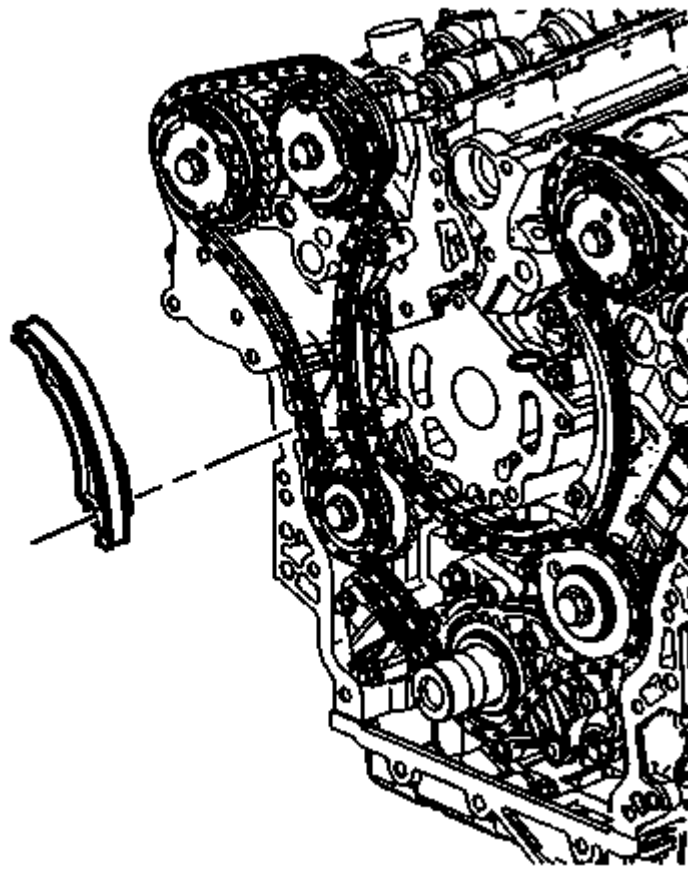


**Fig. 68: Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the secondary shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Left Side .
2. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Left Side .
3. Install the engine front cover. Refer to Engine Front Cover Replacement.

## SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

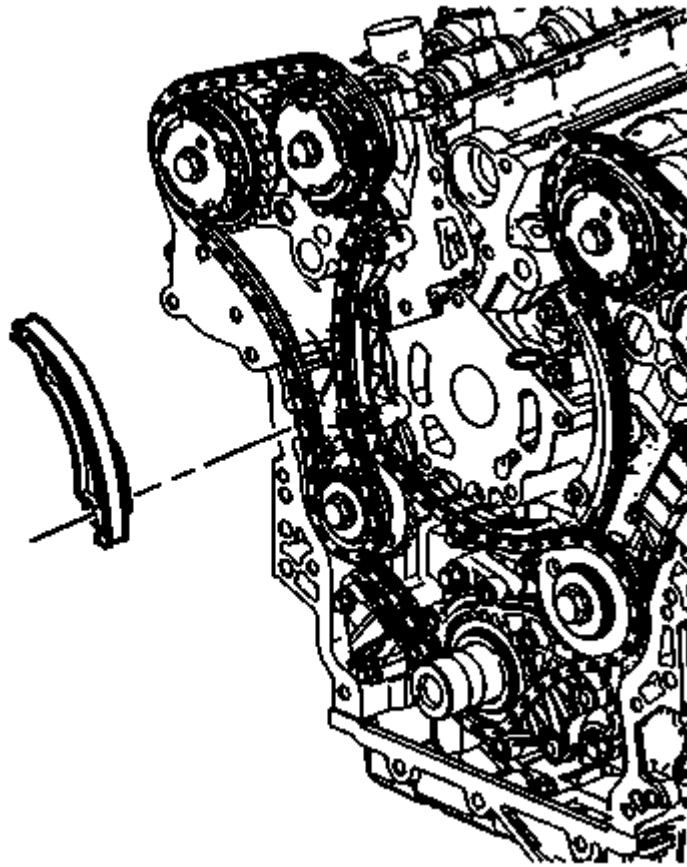
### Removal Procedure



**Fig. 69: Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.

#### Installation Procedure



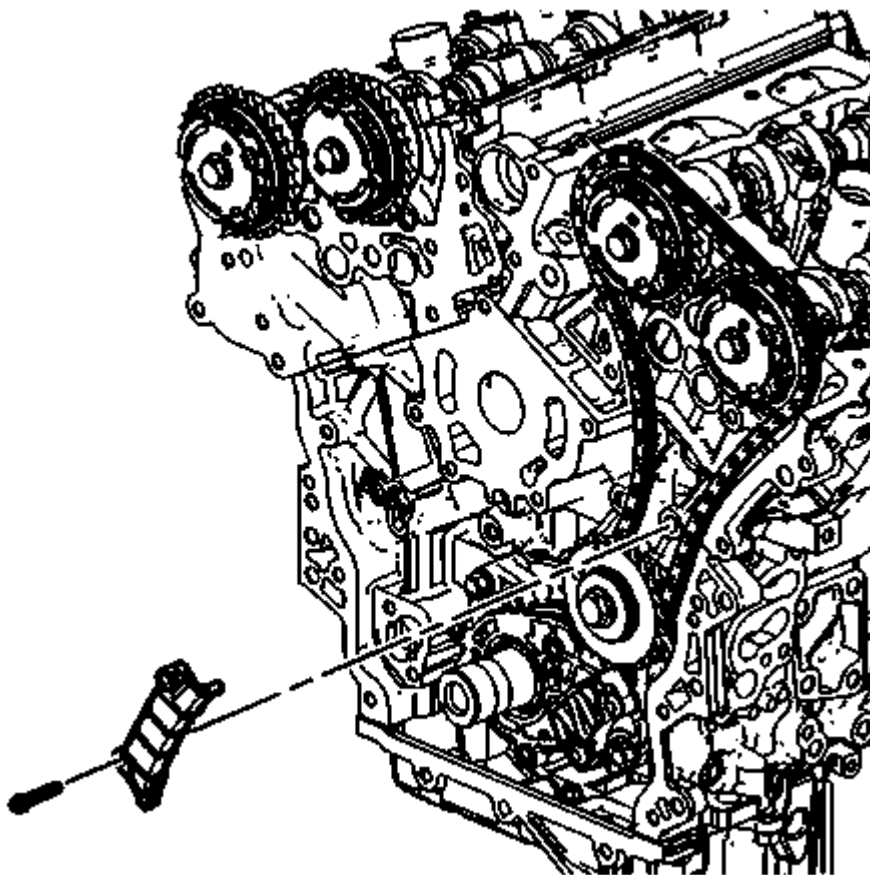
**Fig. 70: Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side**.
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

### Removal Procedure

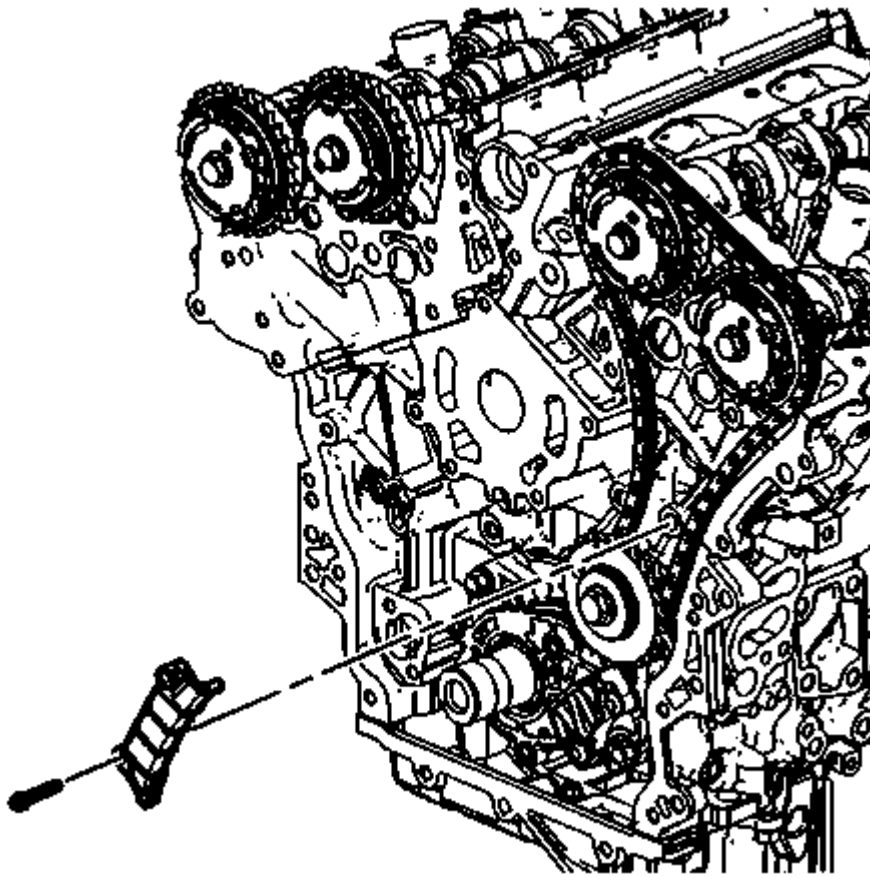
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side**.



**Fig. 71: Left Bank Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left bank secondary camshaft drive chain guide.

#### Installation Procedure



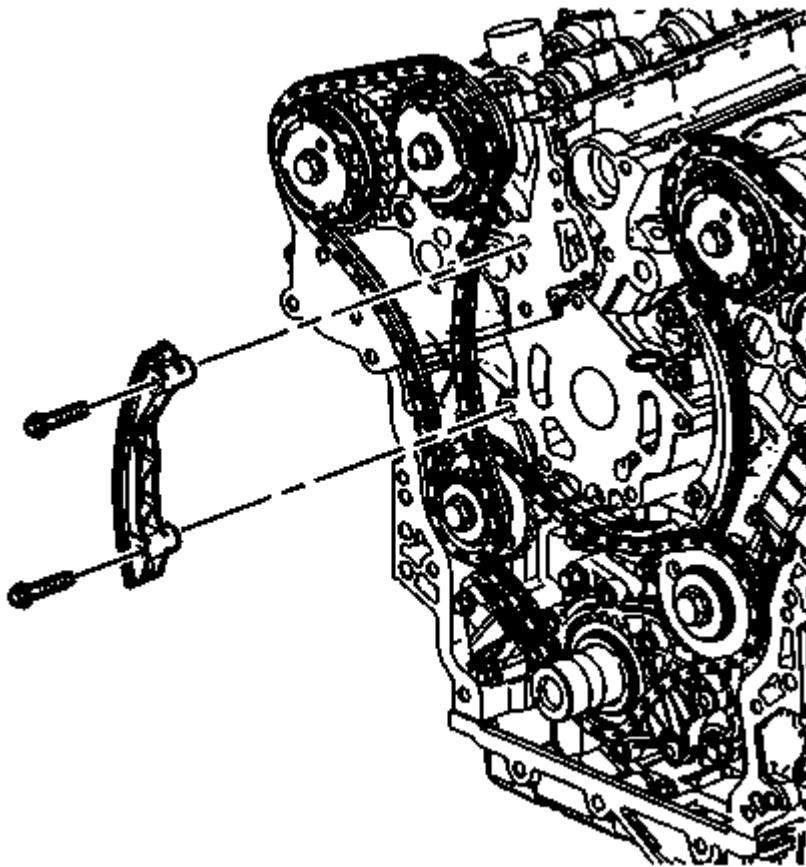
**Fig. 72: Left Bank Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the left bank secondary camshaft drive chain guide. Refer to [Secondary Timing Chain Guide Installation - Left Side](#)
2. Install the left bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Installation - Left Side](#) .
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

## SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

### Removal Procedure

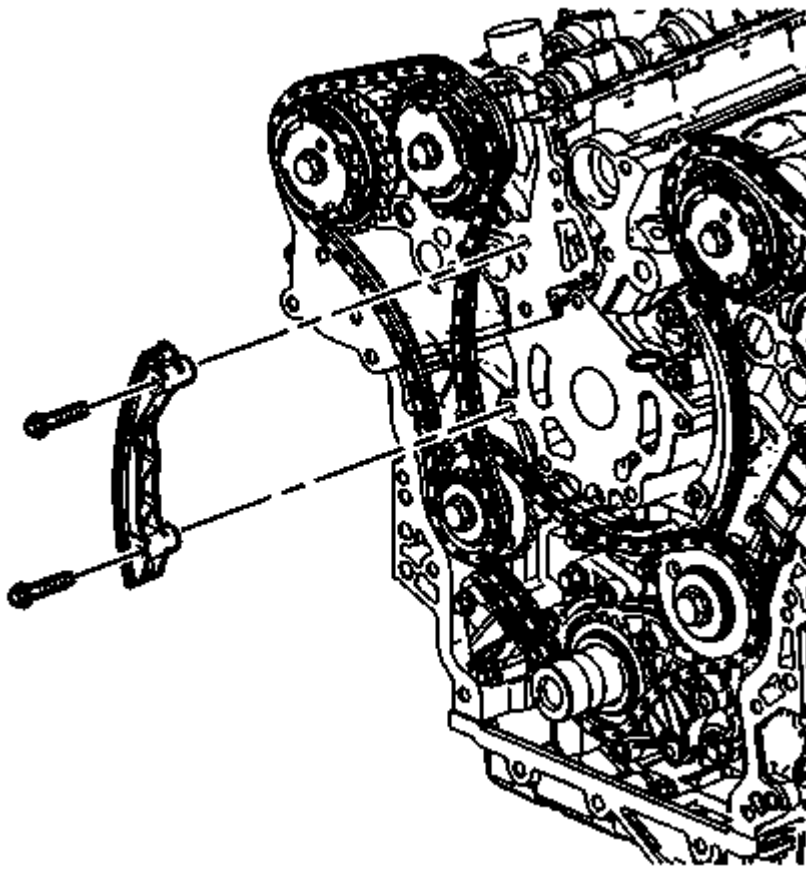
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to [Spark Plug Replacement](#) .
2. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Removal - Right Side](#) .



**Fig. 73: Right Secondary Camshaft Drive Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .

#### Installation Procedure



**Fig. 74: Right Secondary Camshaft Drive Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

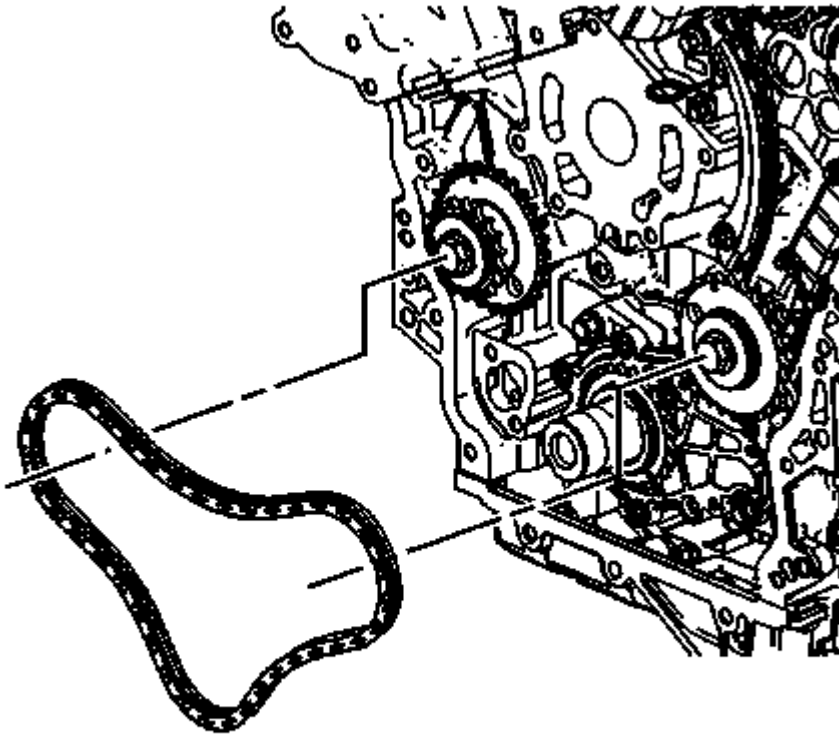
1. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Timing Chain Guide Installation - Right Side .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Right Side .
3. Install the engine front cover. Refer to Engine Front Cover Replacement.
4. Install the spark plugs. Refer to Spark Plug Replacement .

## PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

### Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Removal - Right Side .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Right Side .
4. Remove the right bank secondary camshaft drive chain guide. Refer to Secondary Timing Chain Guide Removal - Right Side .

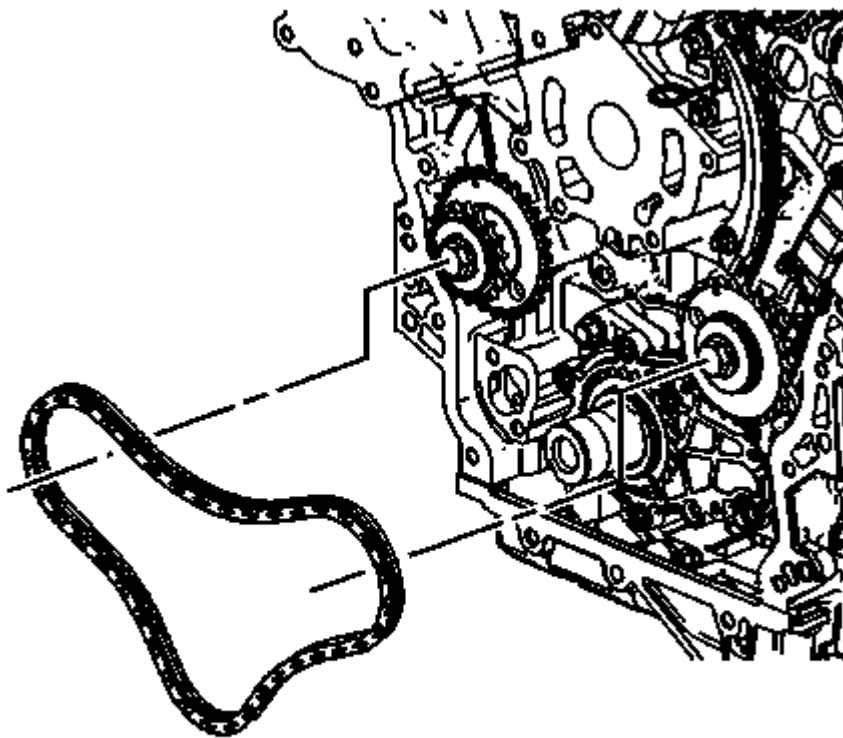
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side**.
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal**.
7. Remove the primary camshaft drive chain upper guide. Refer to **Primary Timing Chain Guide Removal - Upper**.



**Fig. 75: Primary Camshaft Timing Chain**  
Courtesy of GENERAL MOTORS COMPANY

8. Remove the primary camshaft timing chain.

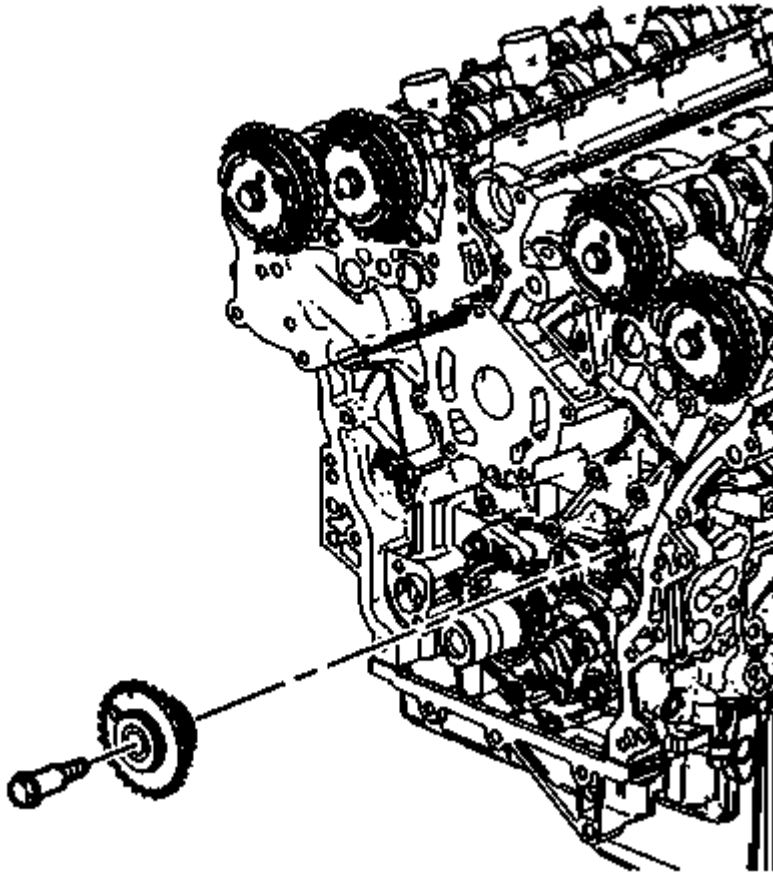
#### **Installation Procedure**



**Fig. 76: Primary Camshaft Timing Chain**  
Courtesy of GENERAL MOTORS COMPANY

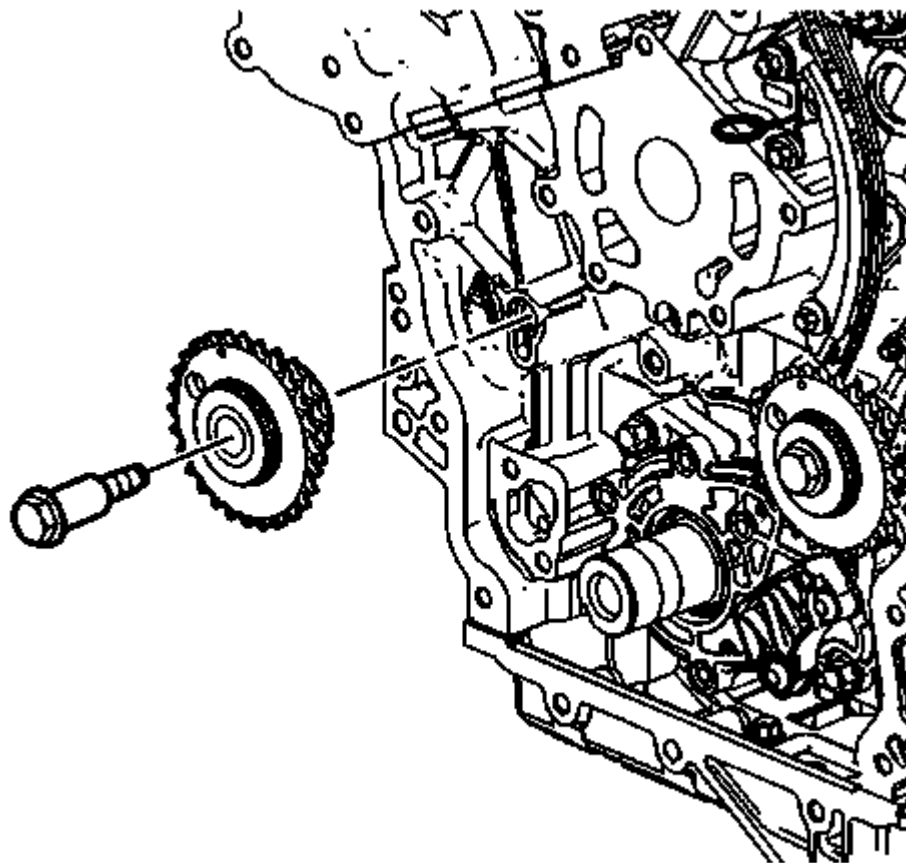
1. Install the primary camshaft timing chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
2. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
4. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
5. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
6. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
7. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

#### **TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE**

**Removal Procedure**

**Fig. 77: Left Camshaft Intermediate Drive Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

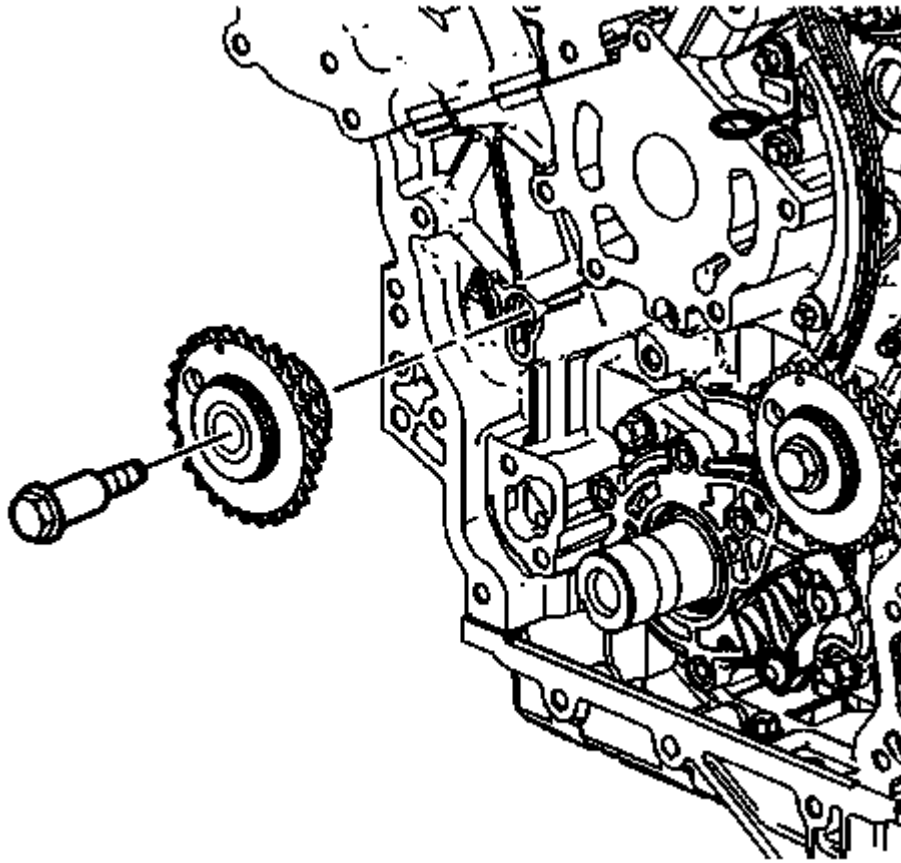
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side**.
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side**.
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal**.
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper**.
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal**.
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket**

**Removal - Right Side .**

**Fig. 78: Left Bank Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS COMPANY

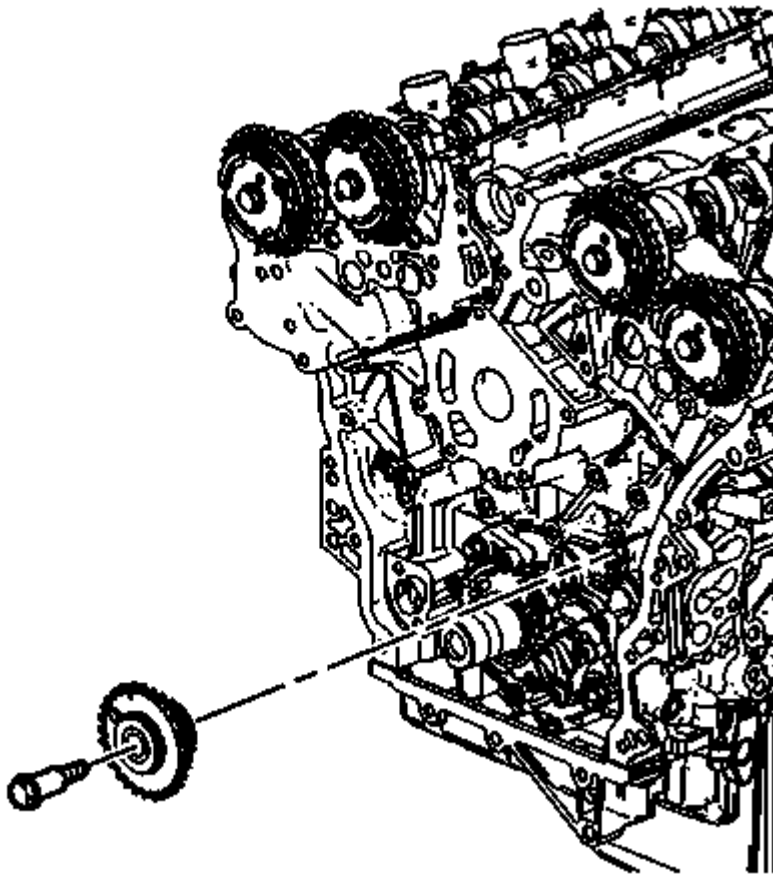
10. If you are servicing the left bank camshaft intermediate drive chain idler, perform the following steps:
  1. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .
  2. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side** .
  3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .
  4. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Left Side** .
  5. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

**Installation Procedure**



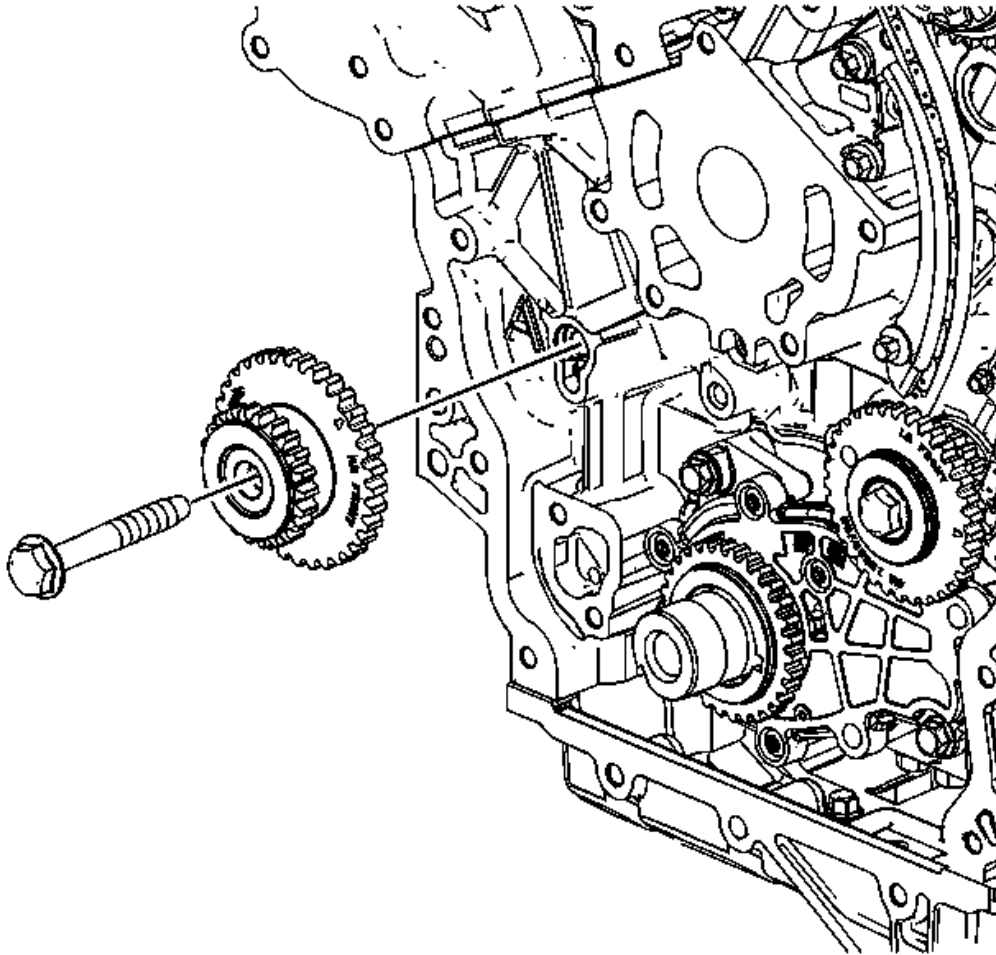
**Fig. 79: Left Bank Camshaft Intermediate Drive Chain Idler**  
Courtesy of GENERAL MOTORS COMPANY

1. If you are servicing the left bank idler sprocket, perform the following steps:
  1. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
  2. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side** .
  3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .
  4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side** .
  5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .



**Fig. 80: Left Camshaft Intermediate Drive Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side**.
3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation**.
4. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper**.
5. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation**.
6. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side**.
7. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side**.
8. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side**.
9. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

**TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE****Removal Procedure**

**Fig. 81: Right Timing Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

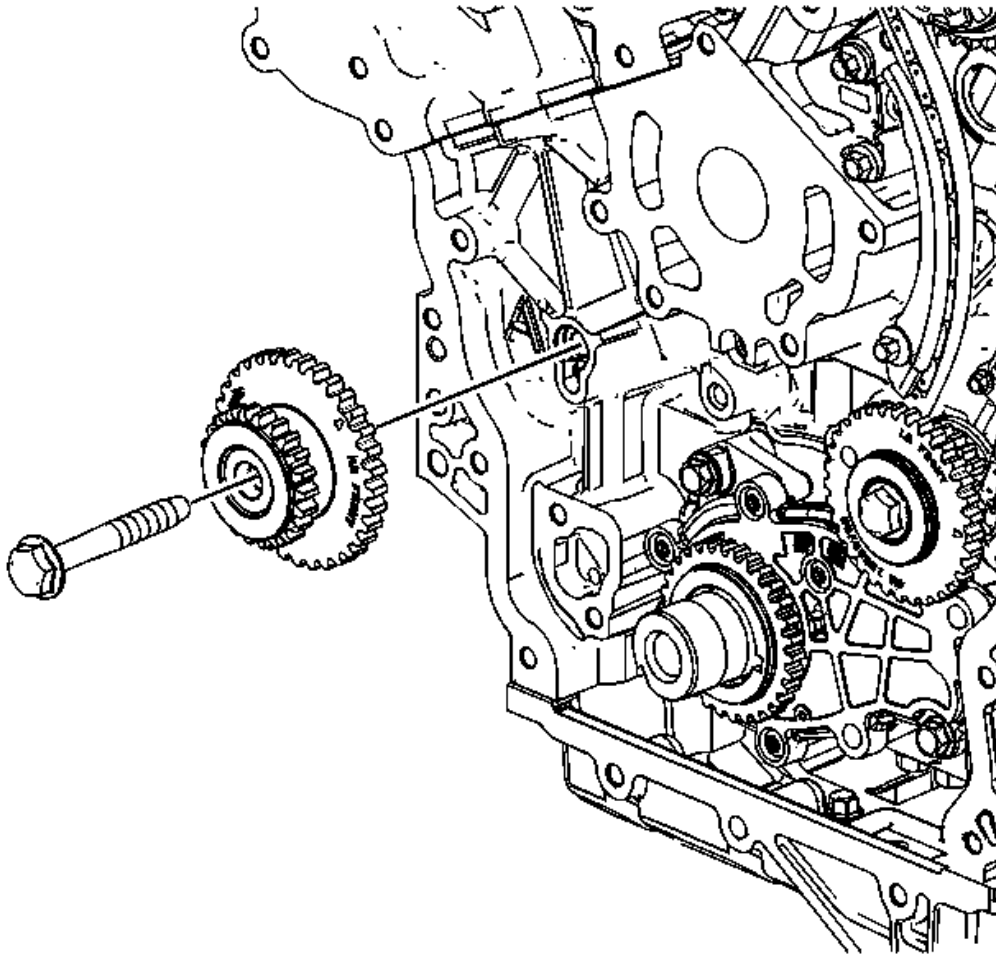
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement**.
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
4. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.
5. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side**.
6. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side**.
7. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive**

**Chain Tensioner Removal .**

8. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
9. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
10. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

**Installation Procedure**

1. Ensure stage 1 camshaft timing is correct. Refer to **Setting Camshaft Timing**.



**Fig. 82: Right Timing Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

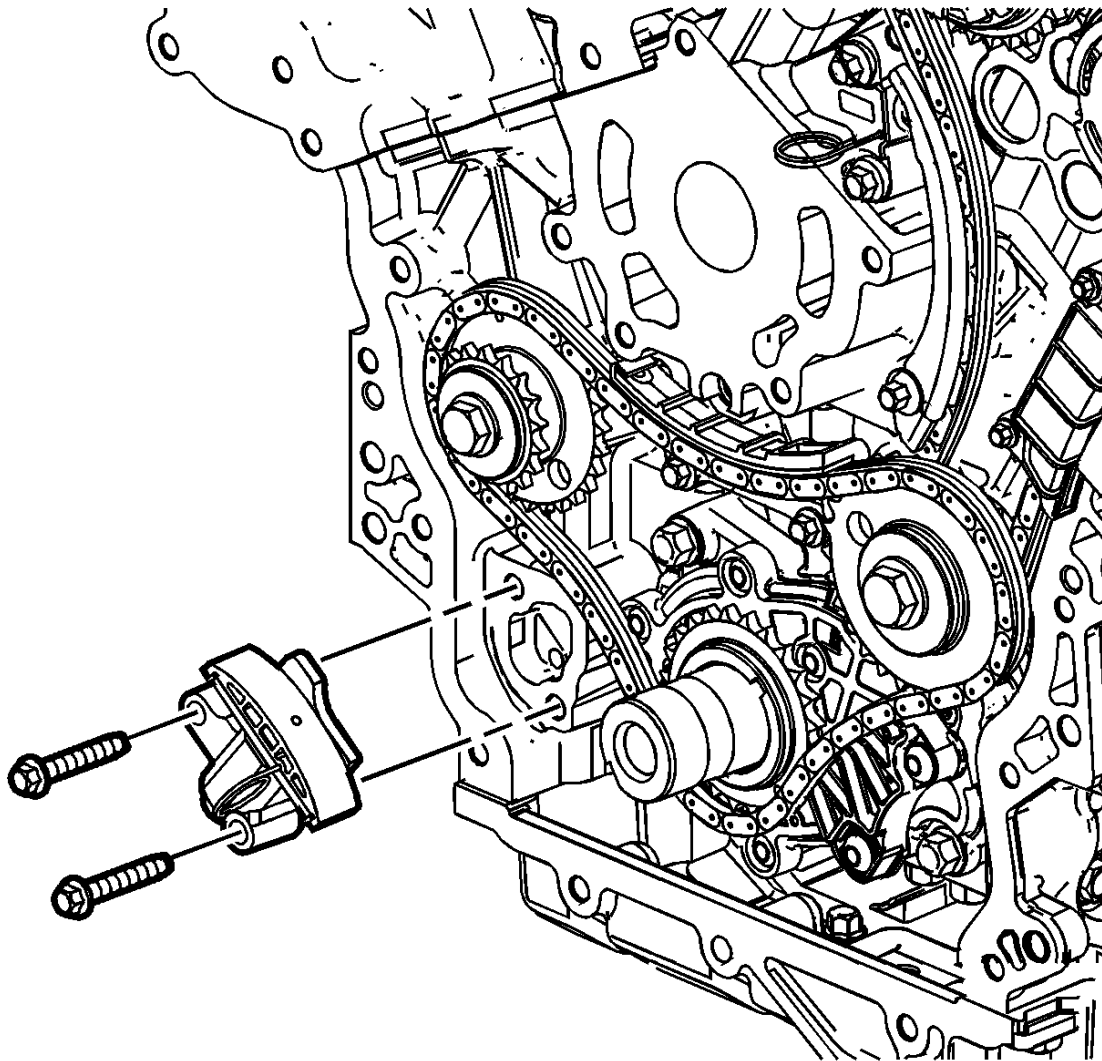
2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain**

**Installation .**

4. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper .**
5. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation .**
6. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side .**
7. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side .**
8. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side .**
9. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side .**
10. Install the spark plugs. Refer to **Spark Plug Replacement .**
11. Install the engine front cover. Refer to **Engine Front Cover Replacement.**

**PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT****Removal Procedure**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement.**

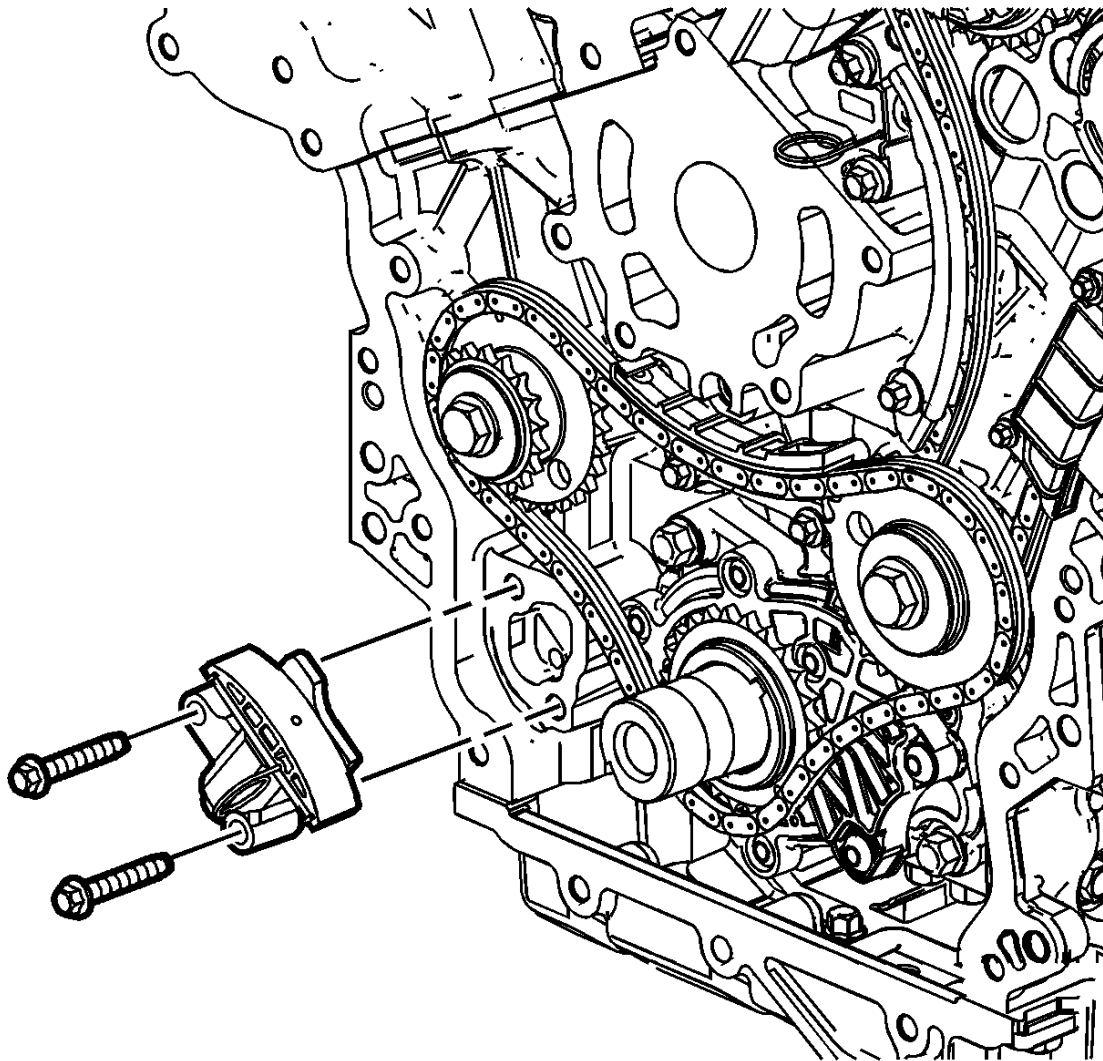


**Fig. 83: Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the entire camshaft timing system is not in Stage 2, Timing Chain Alignment Diagram, mark the timing chain and sprockets in order to ensure proper reassembly.

2. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal.

#### Installation Procedure



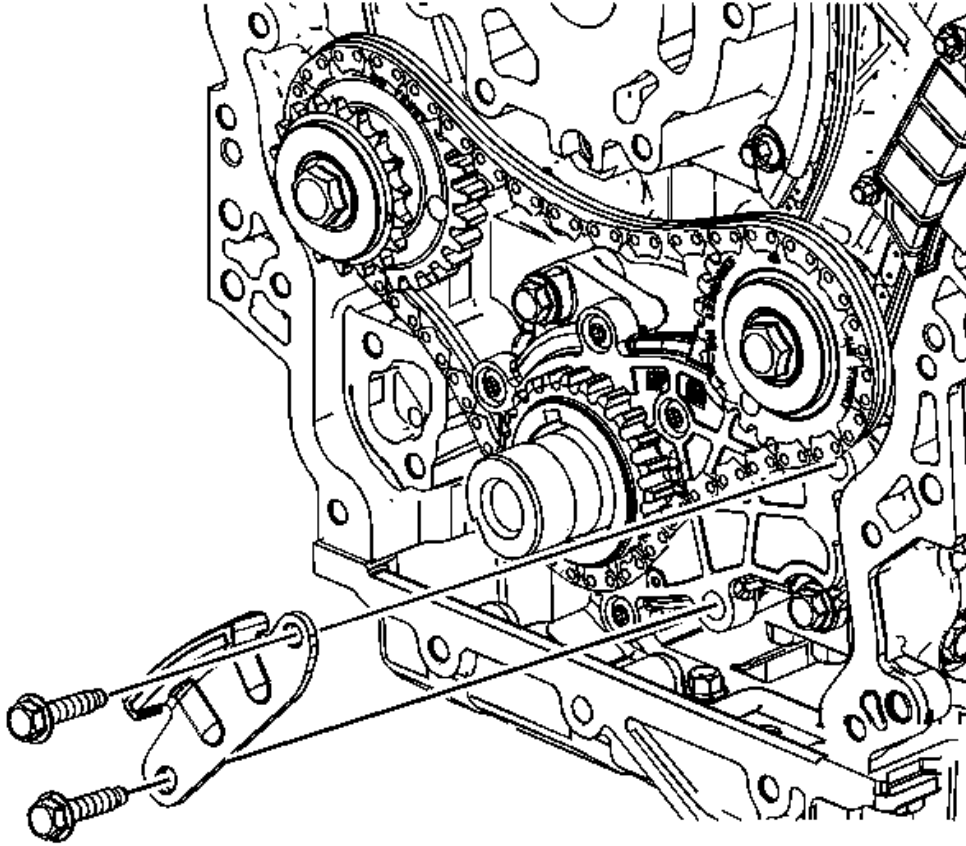
**Fig. 84: Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

### Removal Procedure

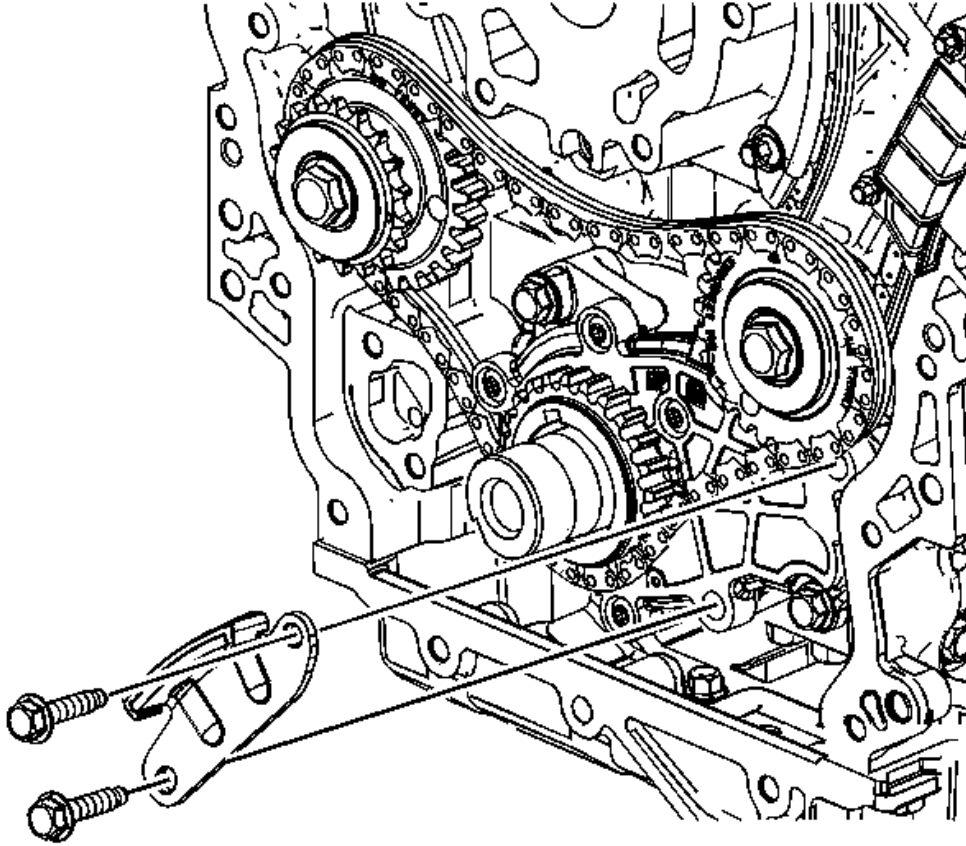
1. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.



**Fig. 85: Primary Camshaft Drive Chain Guide**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

**Installation Procedure**



**Fig. 86: Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

1. Position the primary camshaft drive chain lower guide to the oil pump.

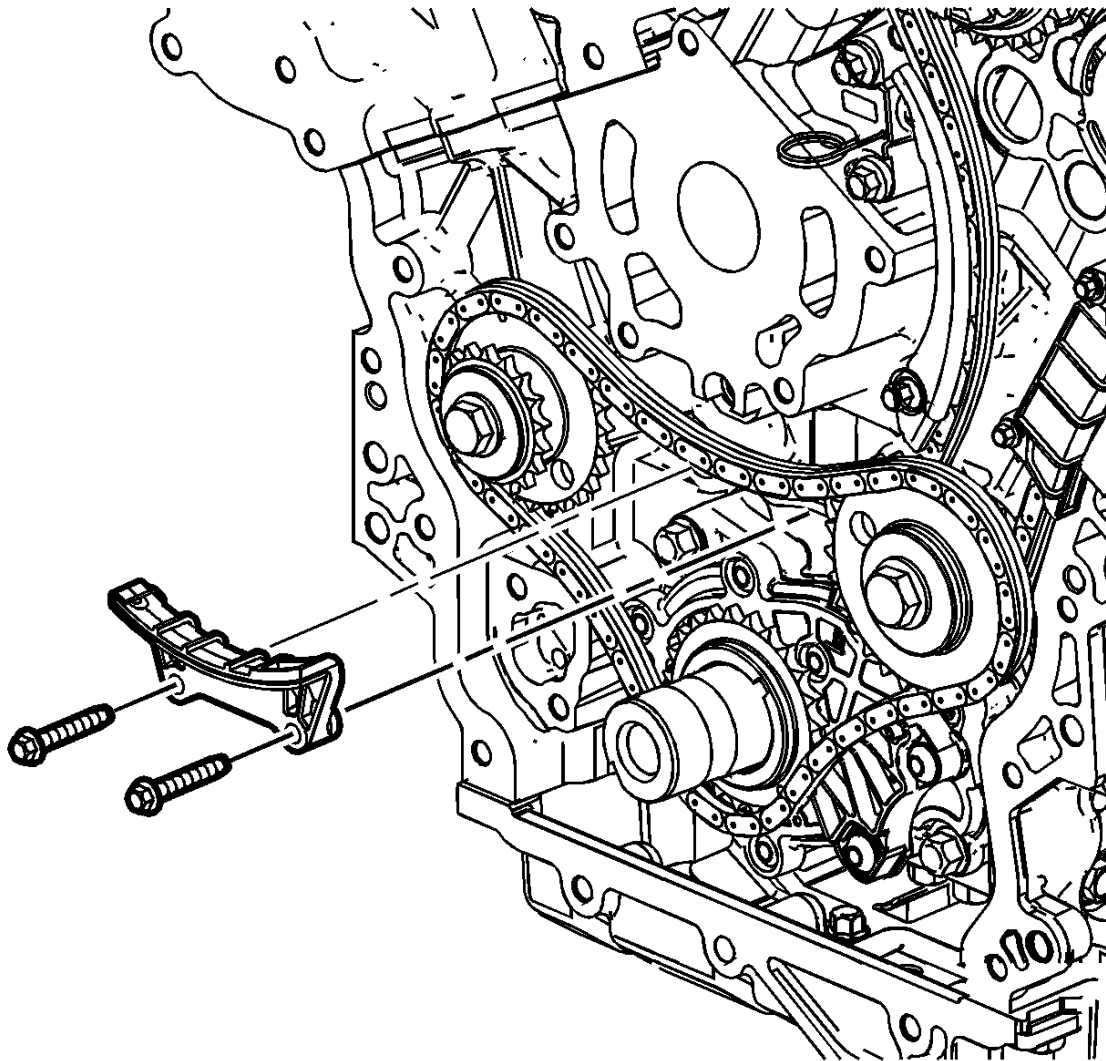
**CAUTION:** Refer to **Fastener Caution** .

2. Install the primary camshaft drive chain lower guide bolts and tighten to 25 N.m (18 lb ft).
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

## PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

### Removal Procedure

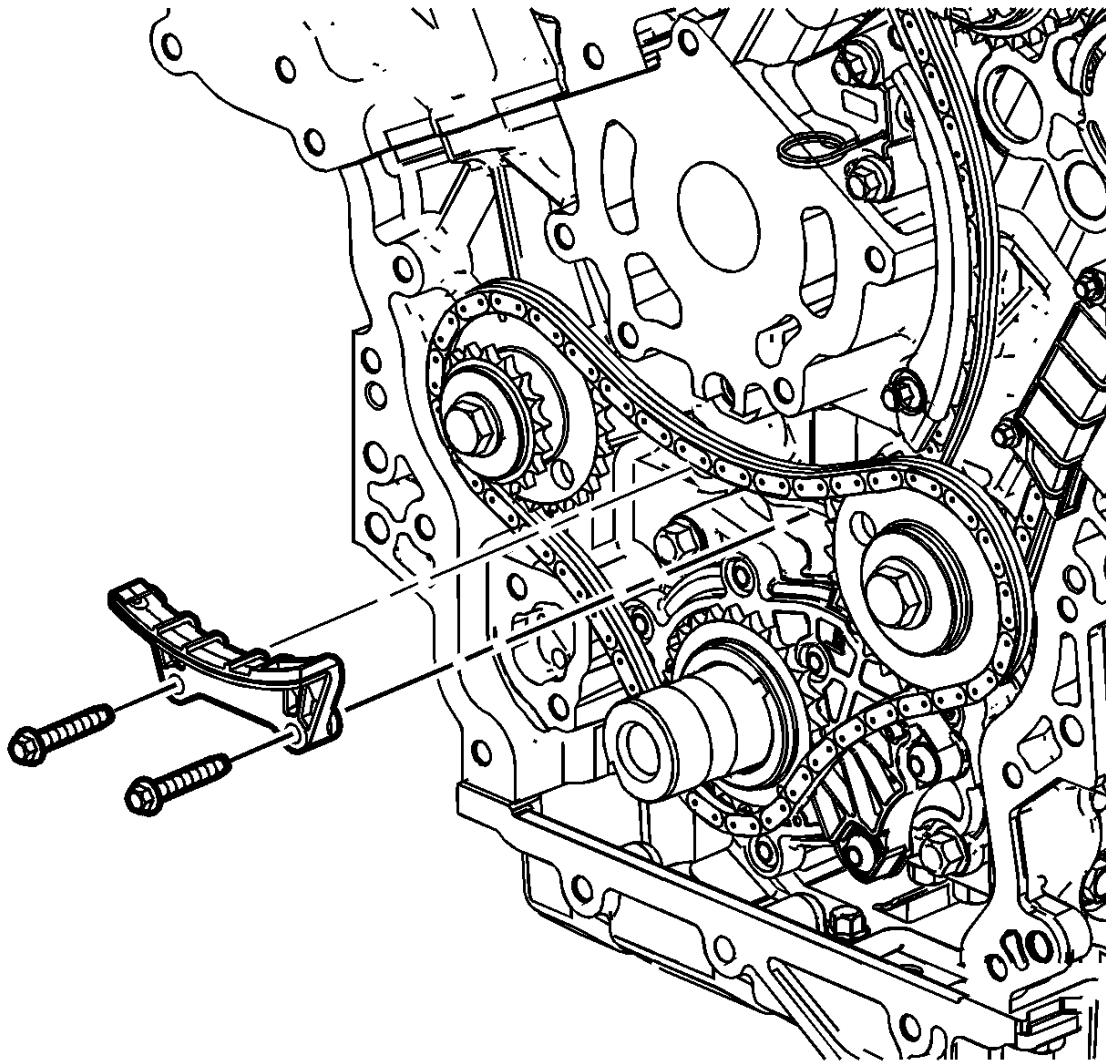
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.



**Fig. 87: Upper Primary Camshaft Drive Chain Guide**  
 Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.
3. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper**.

**Installation Procedure**



**Fig. 88: Upper Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Lower**.
2. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation**.
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

### Special Tools

- EN49982-1 Timing Chain Retainer
- EN49982-2 Timing Chain Retainer

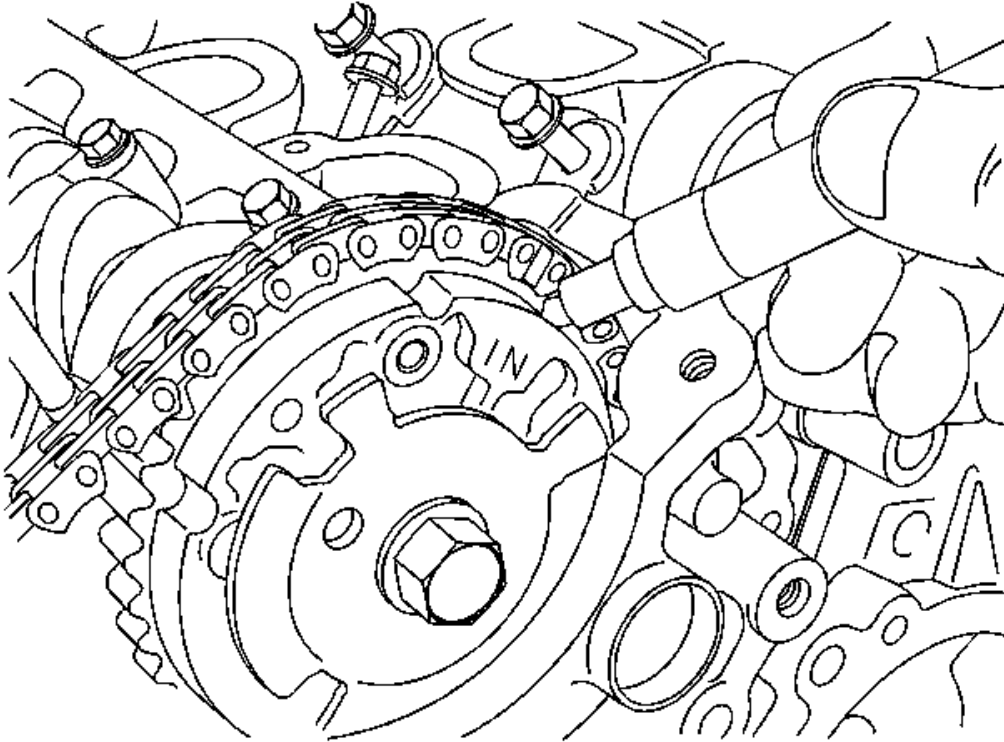
For equivalent regional tools, refer to **Special Tools**.

**Removal Procedure**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the camshaft position actuator solenoid valve solenoid - intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**.
3. Remove the intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**.
4. Remove the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**.
5. Remove the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**.
6. Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on "base circle" and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.

**NOTE:**        **Do NOT remove or back out the camshaft position actuator bolt(s) significantly, simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.**

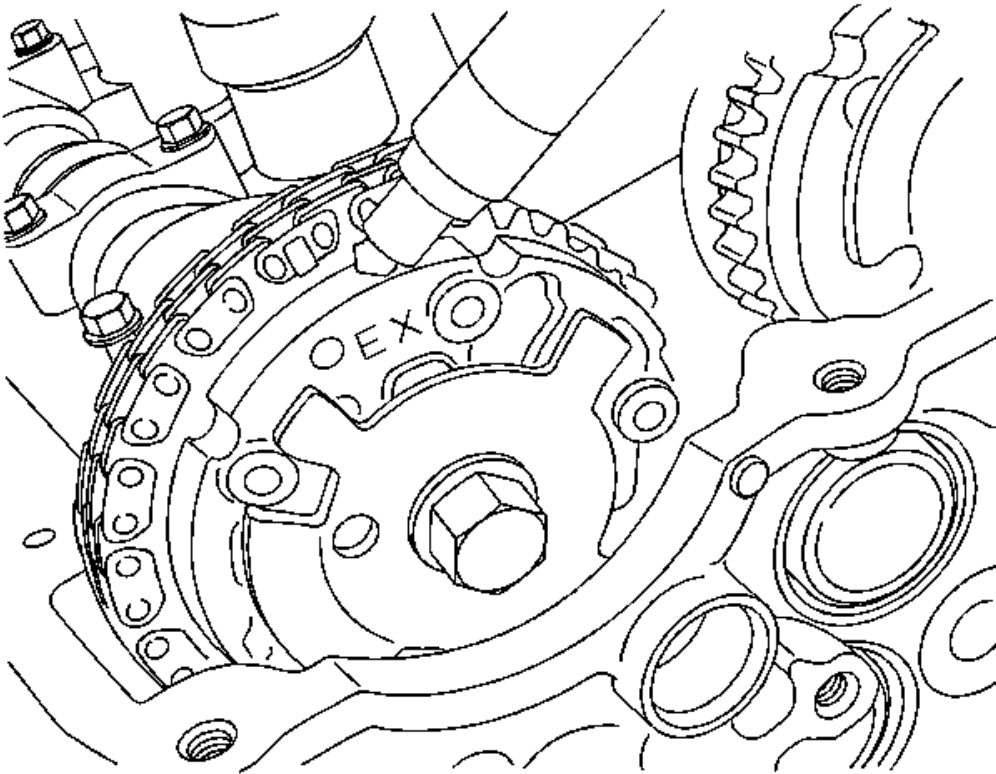
7. Loosen intake and/or exhaust camshaft position actuator retaining bolts, depending on which camshaft position actuator and/or camshaft you will be servicing. If servicing both camshaft position actuators and/or camshafts, loosen both bolts.



**Fig. 89: Marking Position Of Chain To Camshaft Position Actuator - Intake**  
Courtesy of GENERAL MOTORS COMPANY

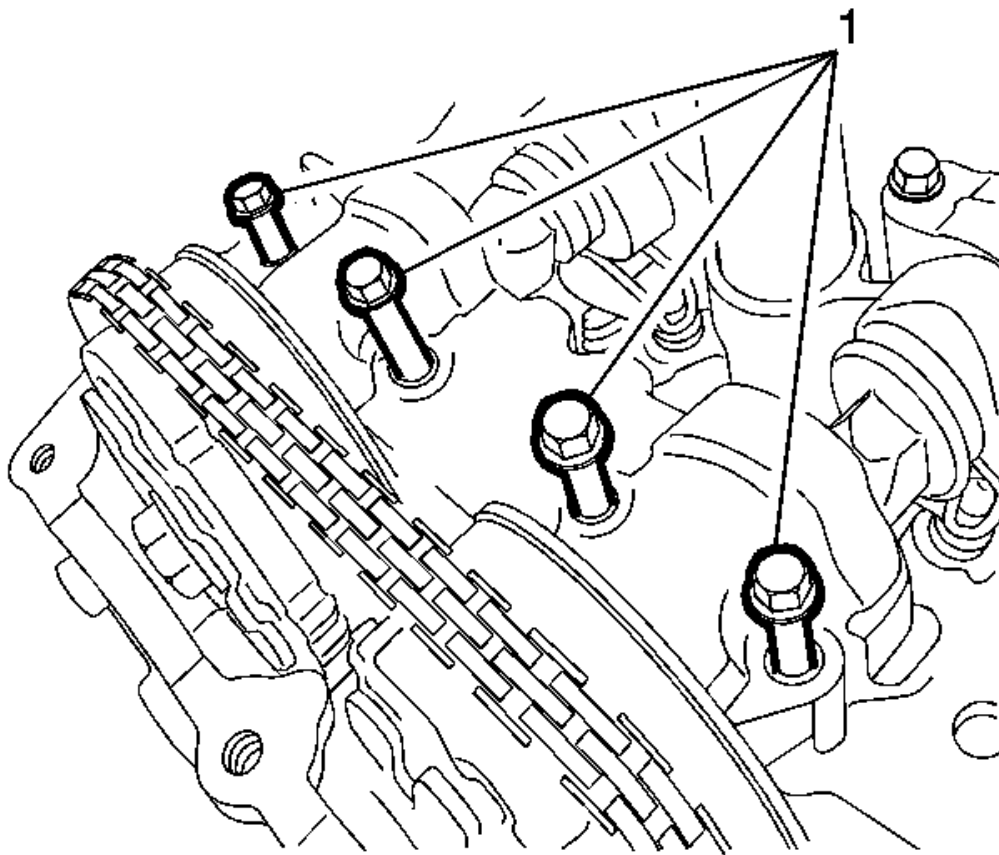
**NOTE:** Be certain to clearly mark the position of the chain to the camshaft position actuator(s). Though the engine does not need to be set to a specific timing mark before starting the procedure, the relationship of the chain to the actuator(s) is critical and must be reestablished on assembly.

8. Mark the position of the chain to the camshaft position actuator - intake.



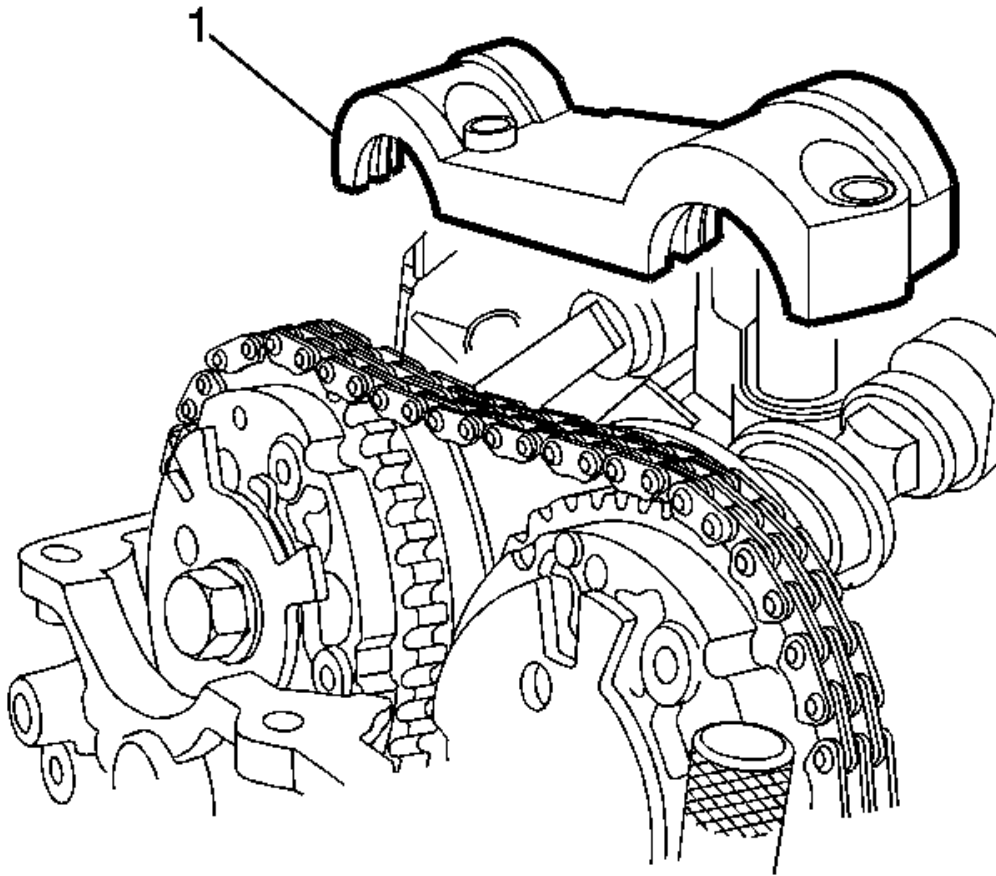
**Fig. 90: Marking Position Of Chain To Camshaft Position Actuator - Exhaust**  
Courtesy of GENERAL MOTORS COMPANY

9. Mark the position of the chain to the camshaft position actuator - exhaust.



**Fig. 91: Camshaft Front Cap And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

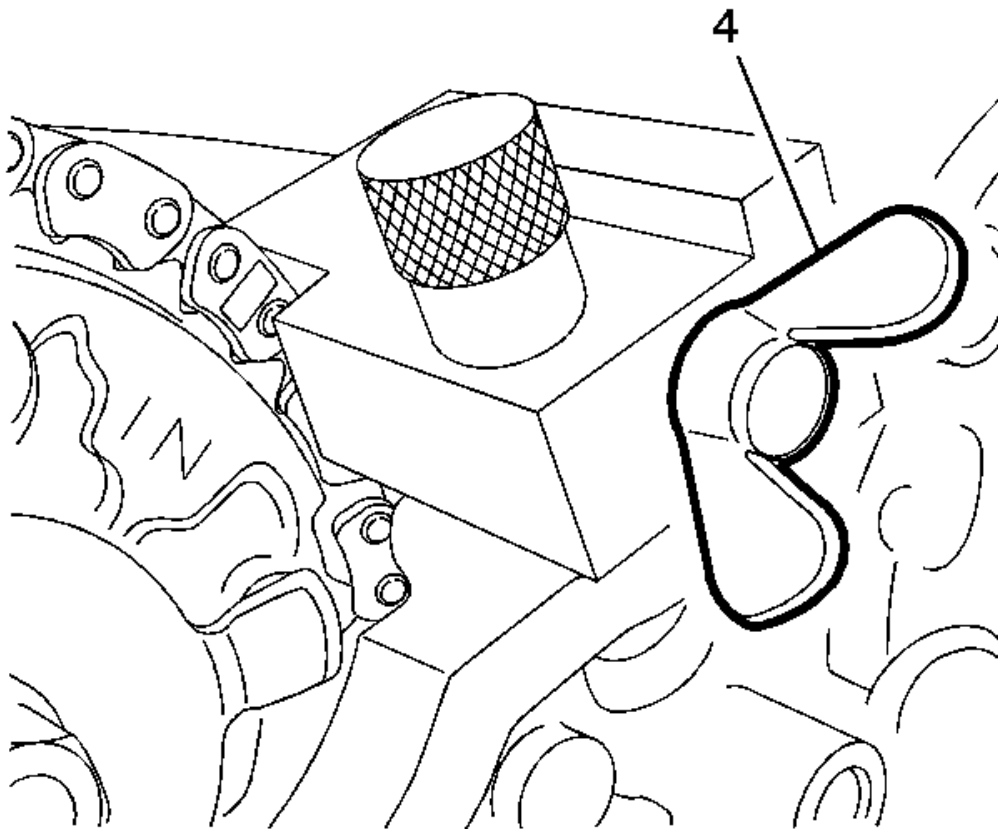


**Fig. 92: Camshaft Front Cap**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to eventually remove the camshaft.

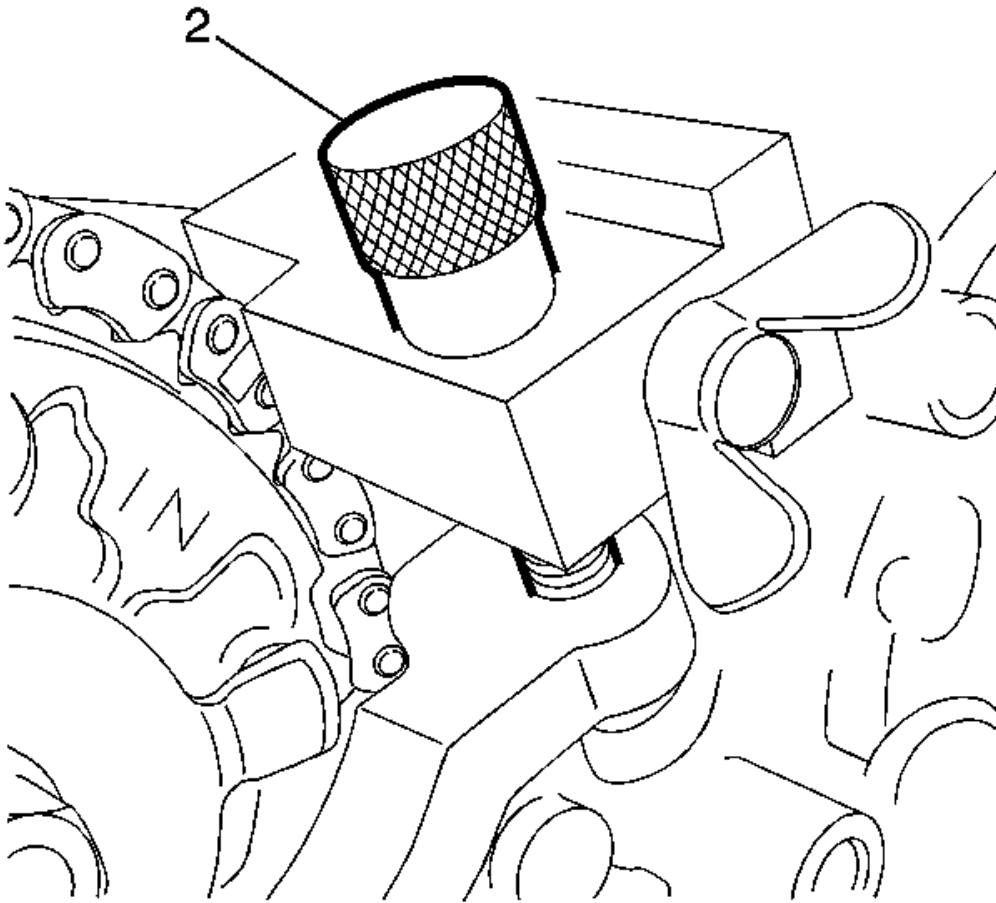
11. Remove the camshaft front cap (1).



**Fig. 93: Retainer Wingnut**

Courtesy of GENERAL MOTORS COMPANY

12. Loosen wingnut (4) to open the clamping area of EN49982-1 retainer.

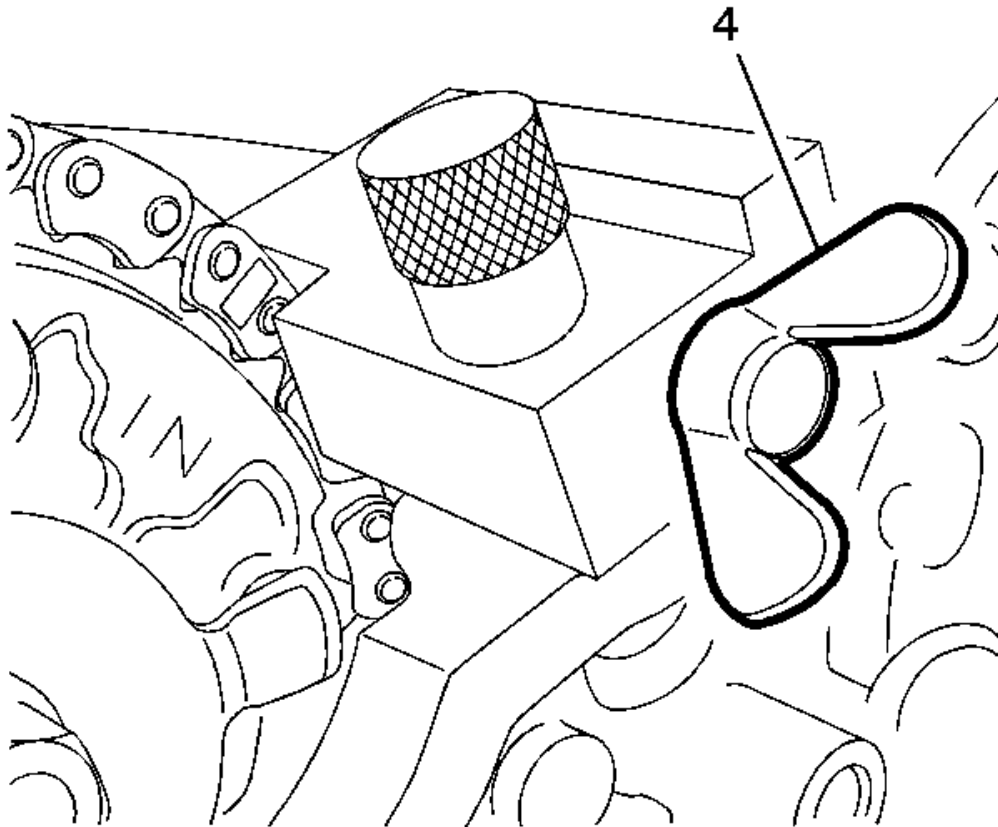


**Fig. 94: Retainer Thumbscrew**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do NOT overtighten the thumbscrew. The EN49982-1 retainer should be able to slide slightly via the slot the screw goes through. This fore/aft movement will allow easier removal and installation of the chain later.

13. Install EN49982-1 retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the EN49982-1 retainer finger-tight.

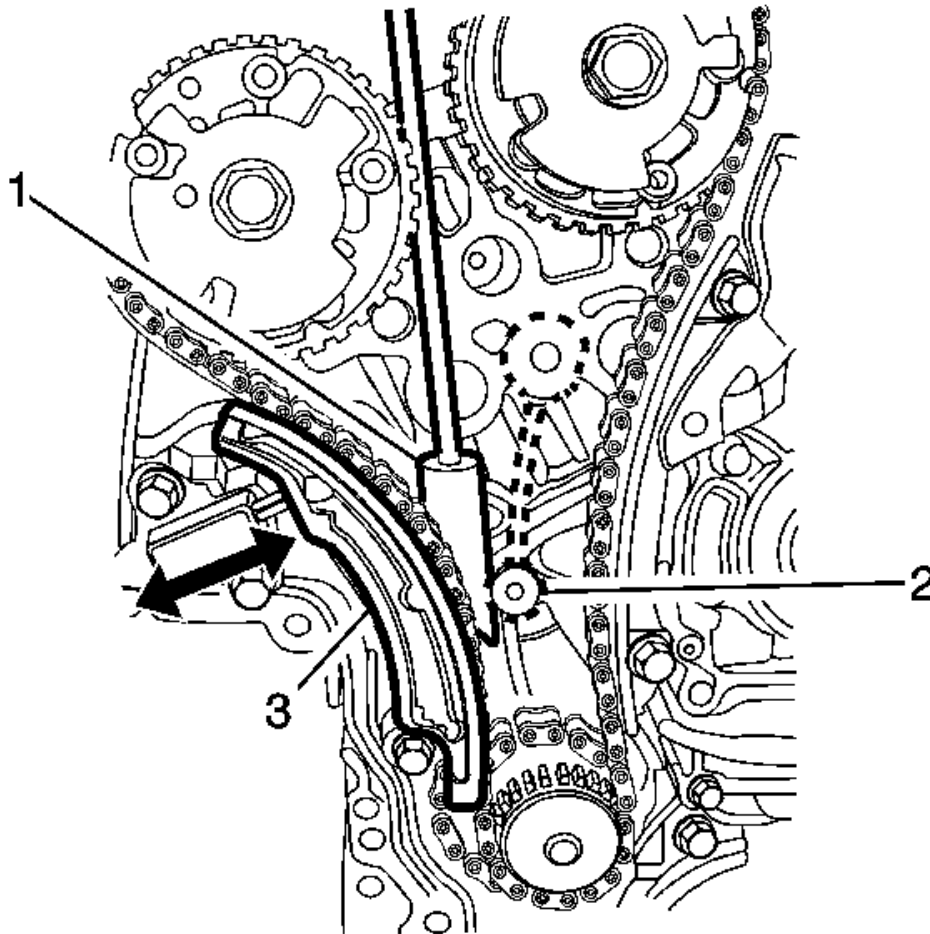


**Fig. 95: Retainer Wingnut**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

14. Tighten wingnut (4) so EN49982-1 retainer closes over and firmly grasps timing chain.

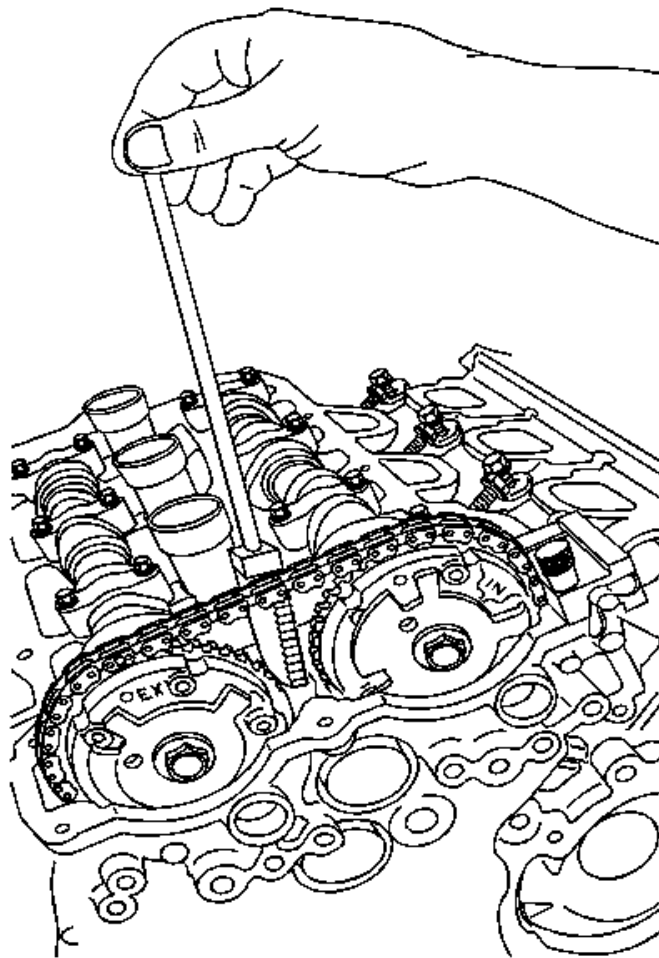


**Fig. 96: Retainer Wedge**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The engine front cover is removed for clarity in the following graphics, but is **NOT** required to be removed to perform the procedure.

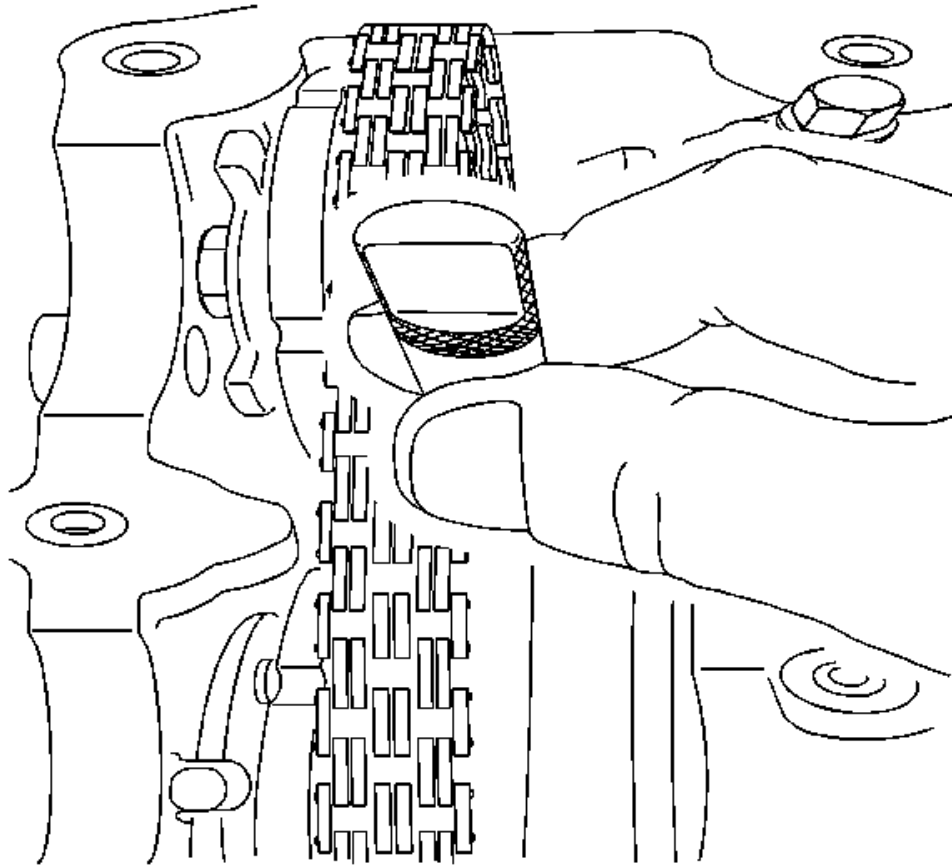
15. **EN49982-2** retainer (1) will be installed in the following steps such that it wedges between an internal rib (2) that is cast into the inside of the front cover (shown in dotted line above) and the timing chain and spring-loaded tensioner shoe (3), holding the chain in position. The wedge will be left in place during the cam position actuator and/or camshaft service.



**Fig. 97: Inserting Retainer**

Courtesy of GENERAL MOTORS COMPANY

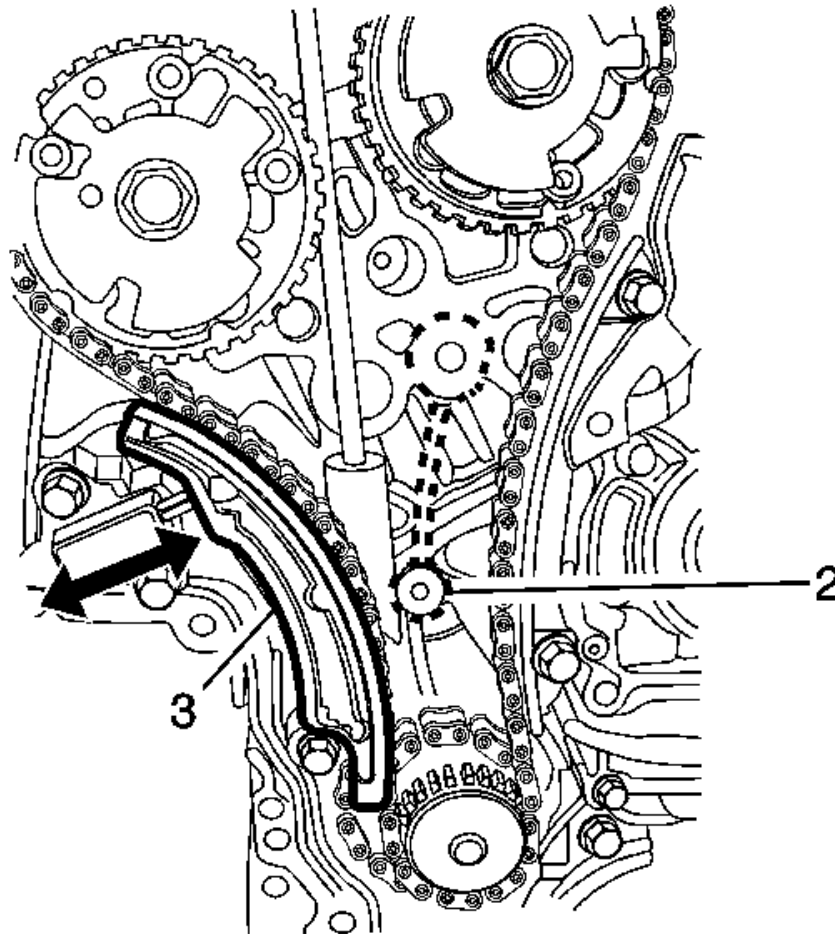
16. Insert the **EN49982-2** retainer between the two camshaft position actuators with the "teeth" on the **EN49982-2** retainer facing toward the front cover.



**Fig. 98: Orienting Retainer Teeth**

Courtesy of GENERAL MOTORS COMPANY

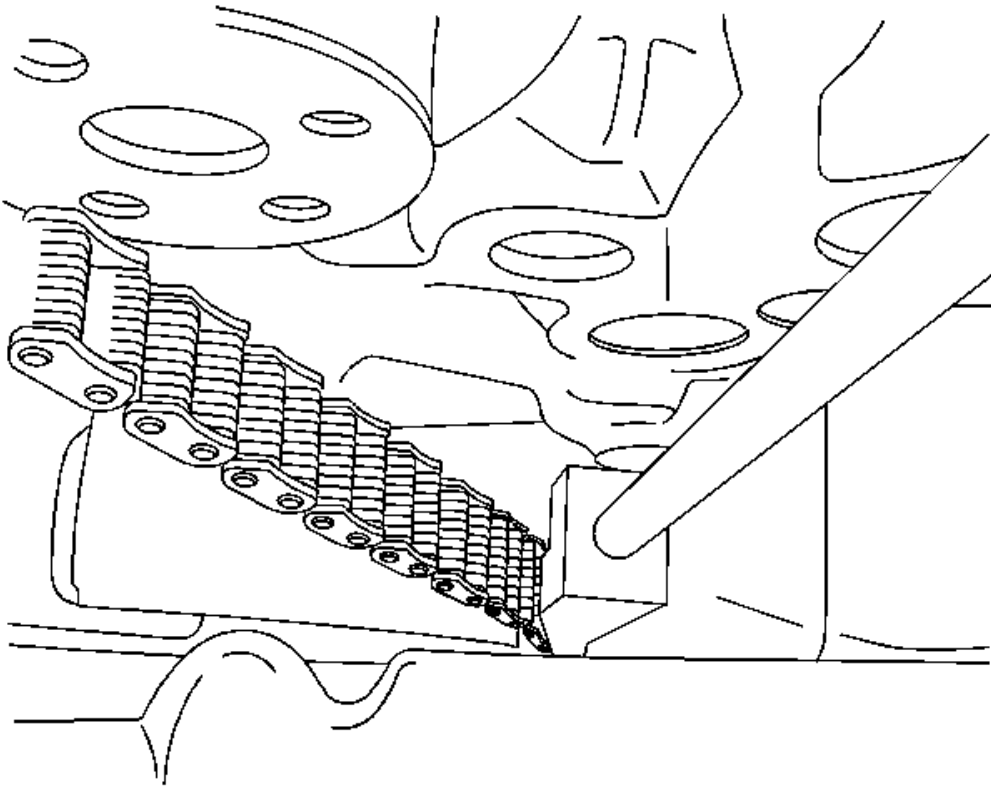
17. Once the wedge portion of **EN49982-2** retainer is below the camshaft position actuators, rotate the **EN49982-2** retainer until the flat in the handle faces toward the intake camshaft position actuator. This orients the "teeth" toward the chain.



**Fig. 99: Wedge, Timing Chain And Belt Casting**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not try to force the wedge into position, simply ensure it is loosely engaged in the timing chain and in the correct overall position.

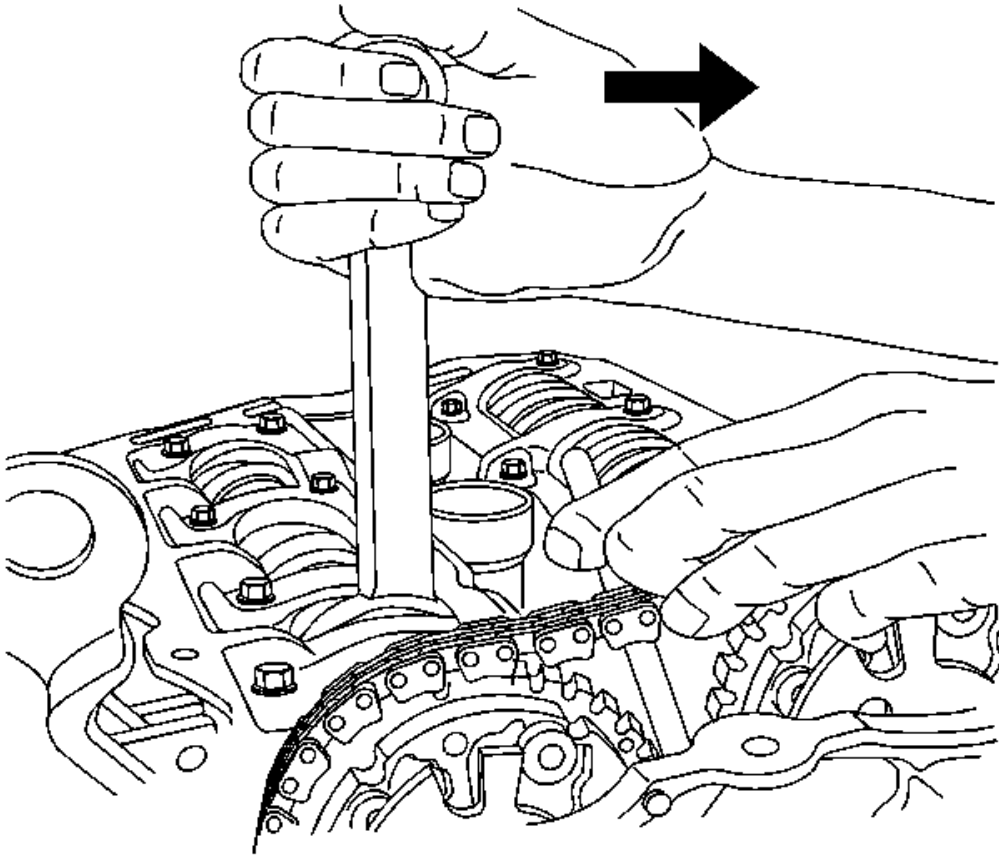
18. Drop the wedge down until it begins to engage the timing chain and the belt casting (2).



**Fig. 100: Positioning Wedge**

Courtesy of GENERAL MOTORS COMPANY

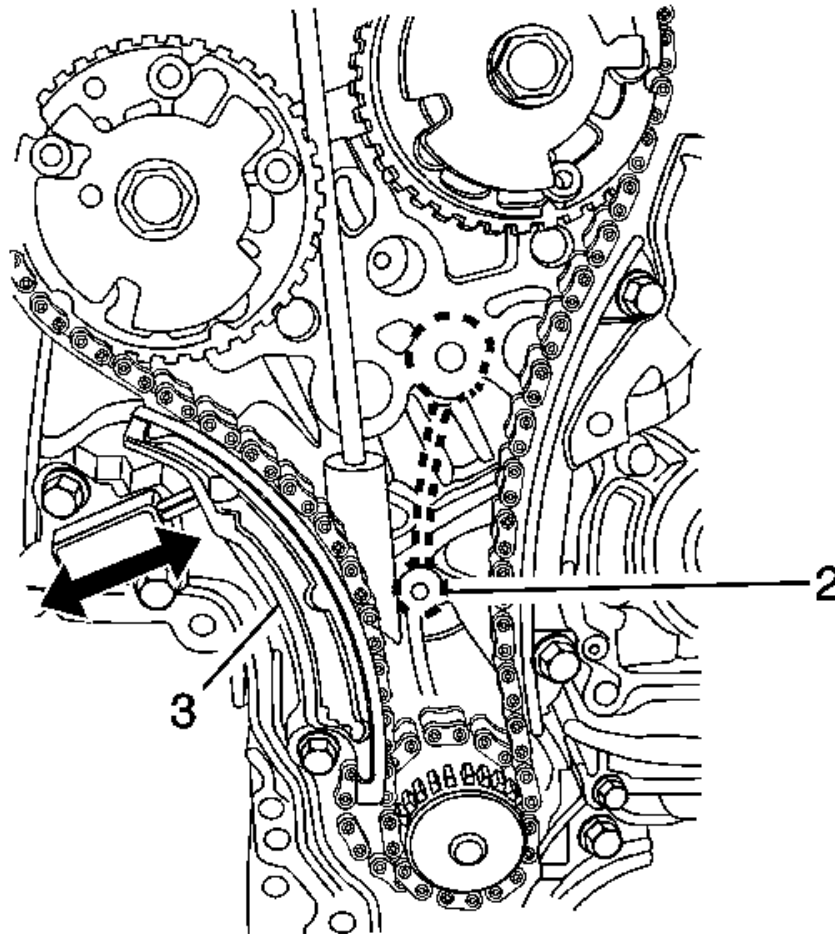
19. If possible shine a strong light down from above, between the camshaft position actuators, and see the wedge in overall position as shown in the above graphic.



**Fig. 101: Rotating Camshaft**

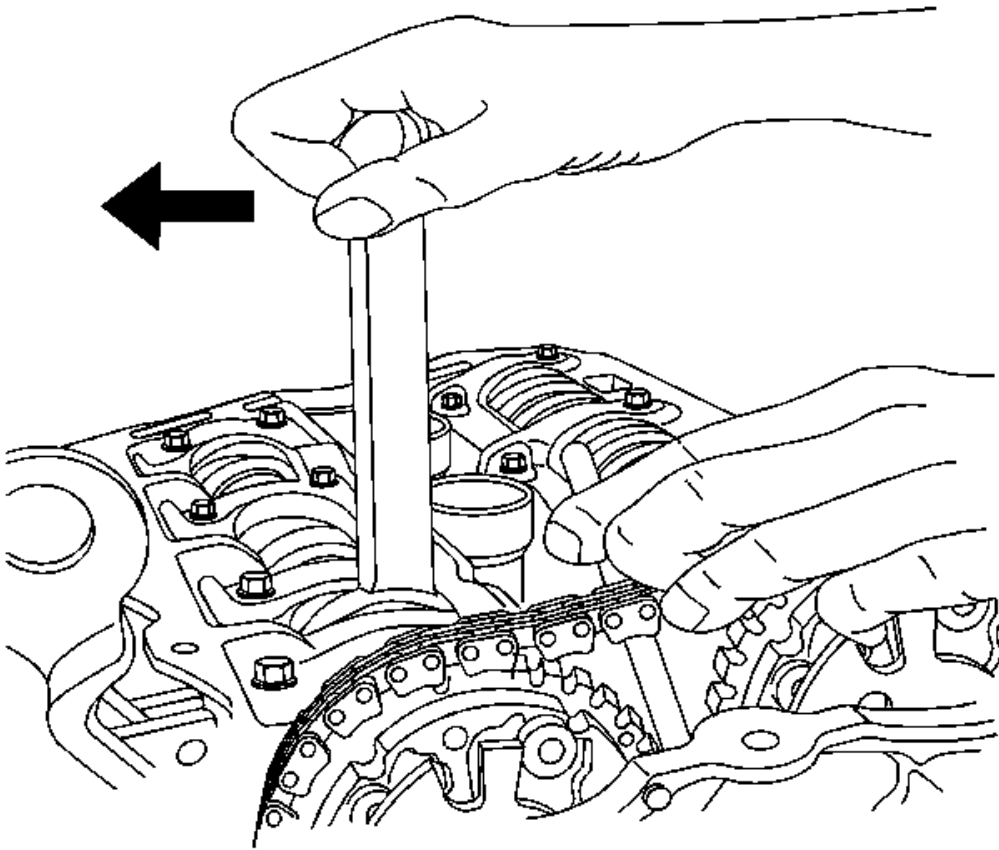
Courtesy of GENERAL MOTORS COMPANY

20. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the **EN49982-2** retainer.



**Fig. 102: Gap Between Chain And Internal Rib In Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

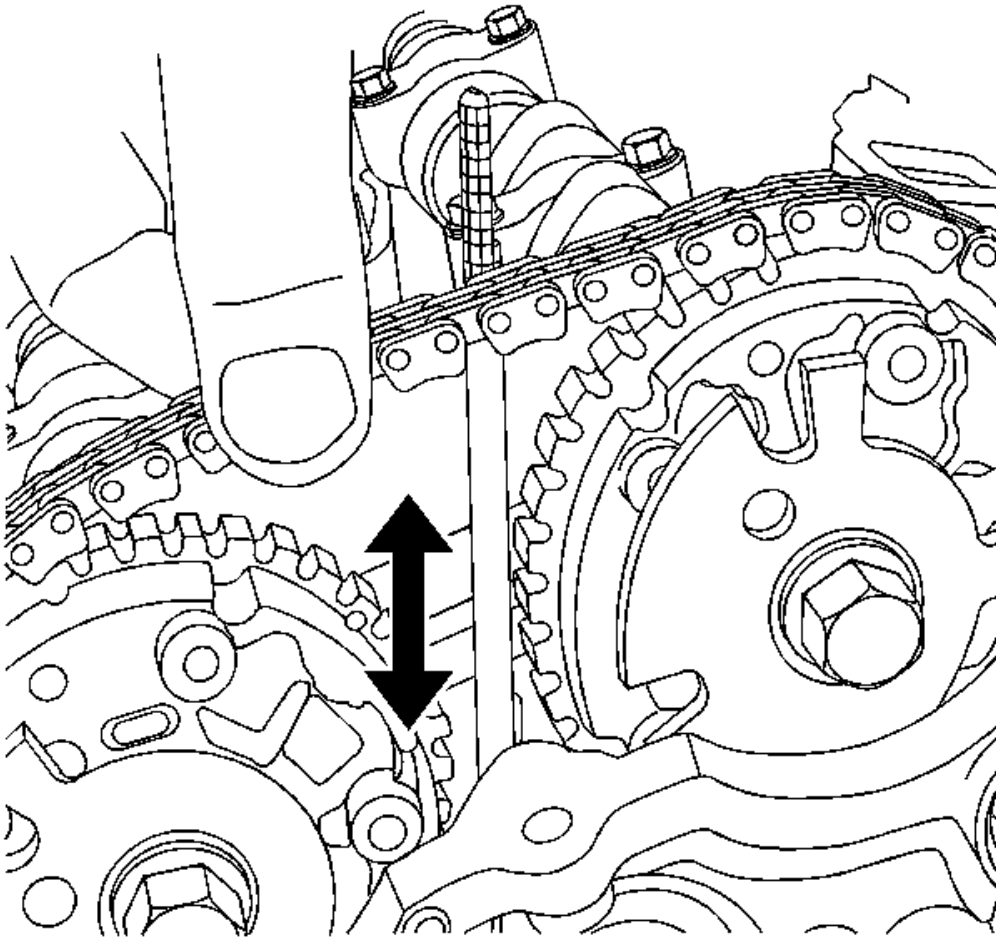
21. This rotation of the camshaft will compress the tensioner shoe (3) against the spring force of the tensioner, opening up a gap between the chain and the internal rib in the front cover. The wedge will then drop into this gap. You will feel a distinct click as the teeth engage the chain.



**Fig. 103: Releasing Force On Wrench**  
Courtesy of GENERAL MOTORS COMPANY

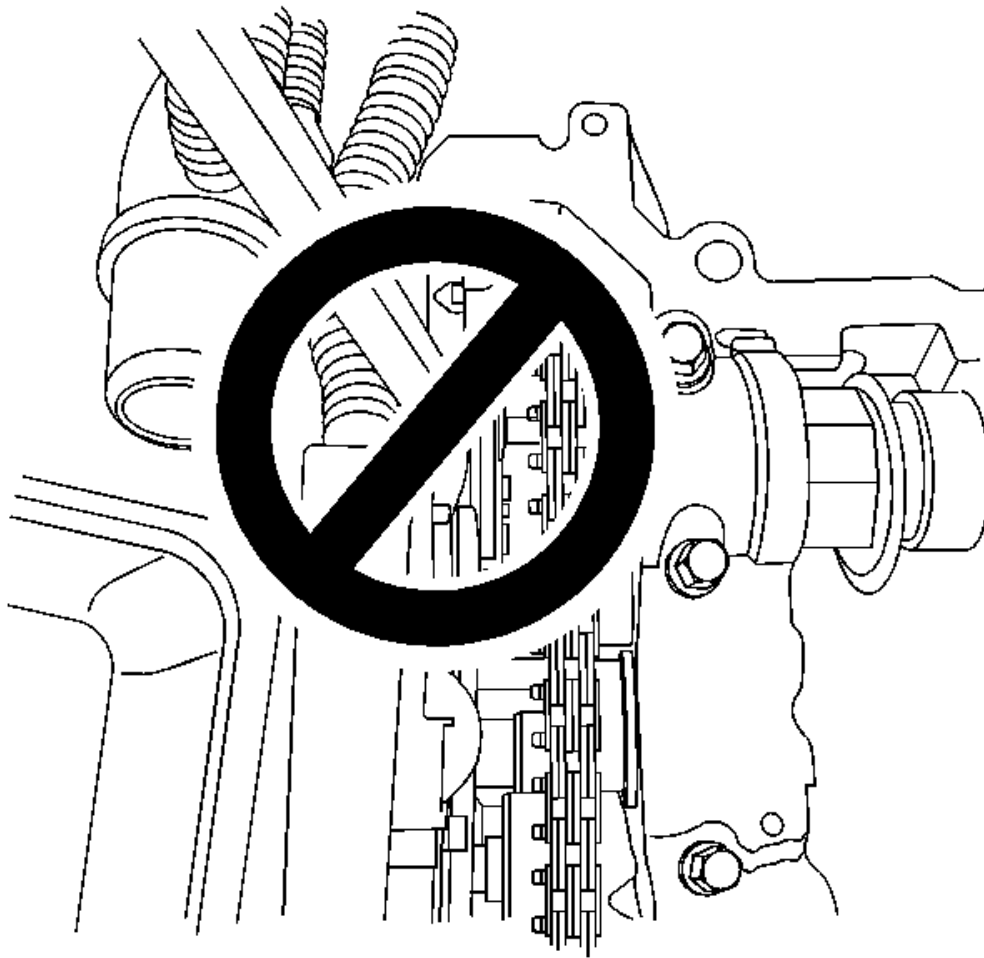
**CAUTION:** Be sure the EN49982-2 is captured firmly as described before continuing. This is critical to ensuring the camshaft drive chains stay properly timed.

22. Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of EN49982-2 retainer. You should be able to lightly tug on the EN49982-2 retainer and it should stay in position. Repeat Steps 20 and 21 if necessary to re-insert the EN49982-2 retainer until you are certain it is in position and will stay in position.



**Fig. 104: Slack In Timing Drive Chain**  
Courtesy of GENERAL MOTORS COMPANY

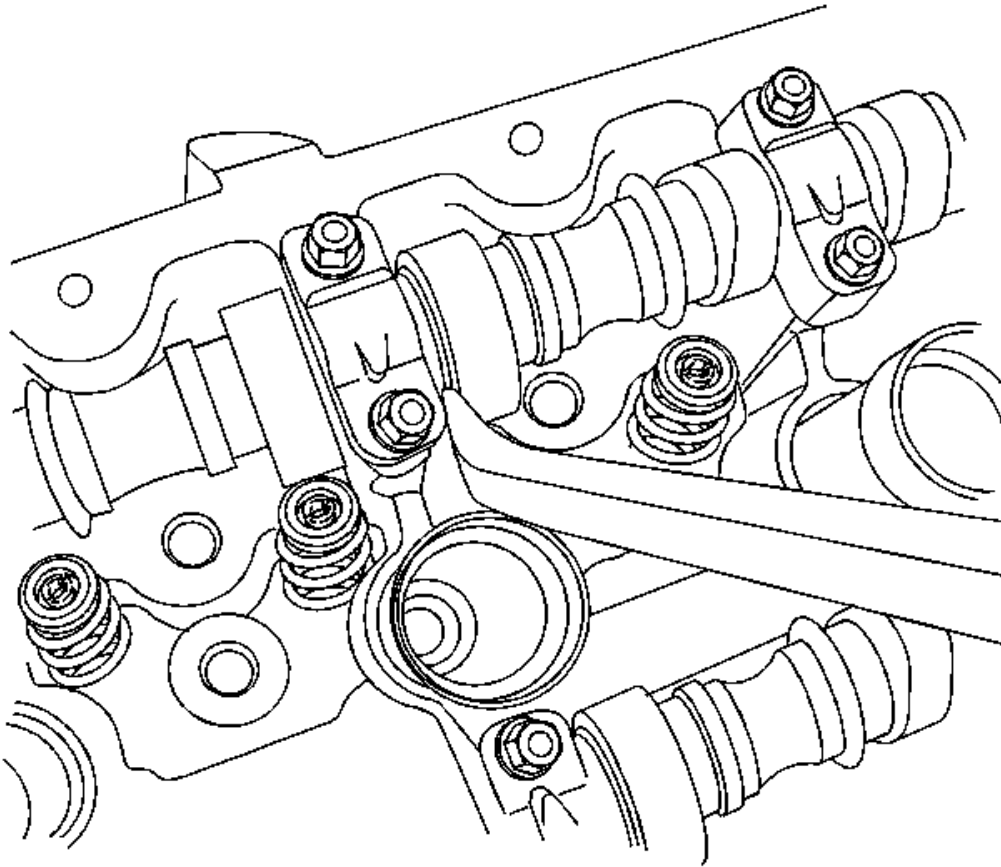
23. With EN49982-2 retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown.



**Fig. 105: Do Not Pry Warning**

Courtesy of GENERAL MOTORS COMPANY

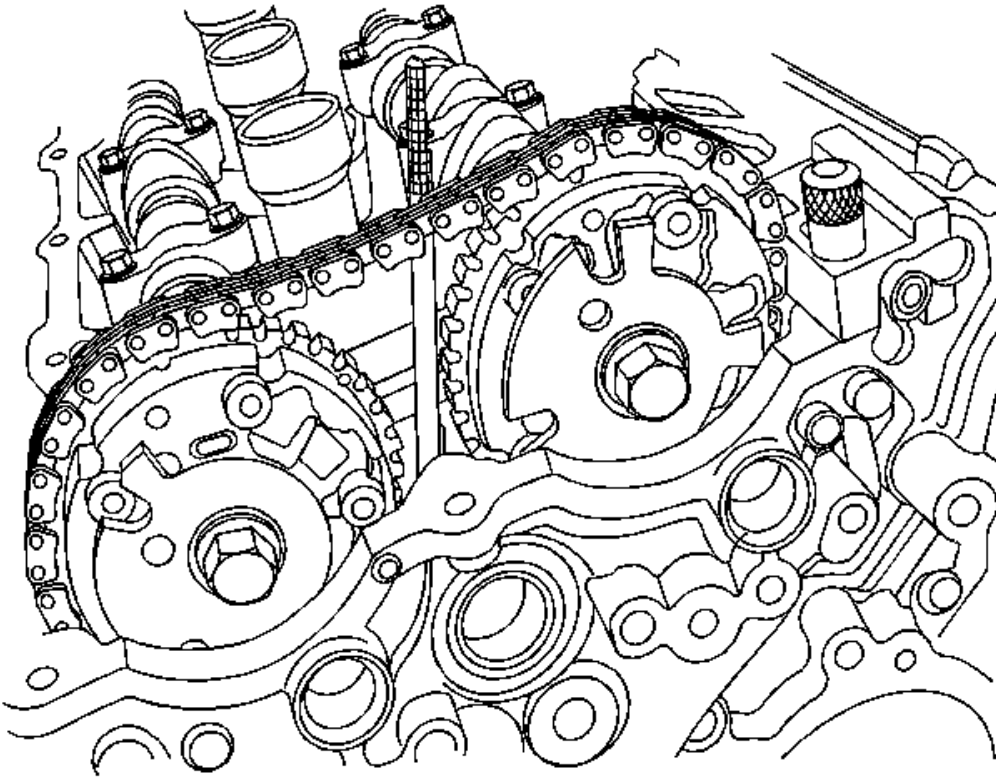
24. Do not pry against the face of the camshaft position actuators or the position actuator retaining bolt.



**Fig. 106: Prying Camshaft Forward**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine.

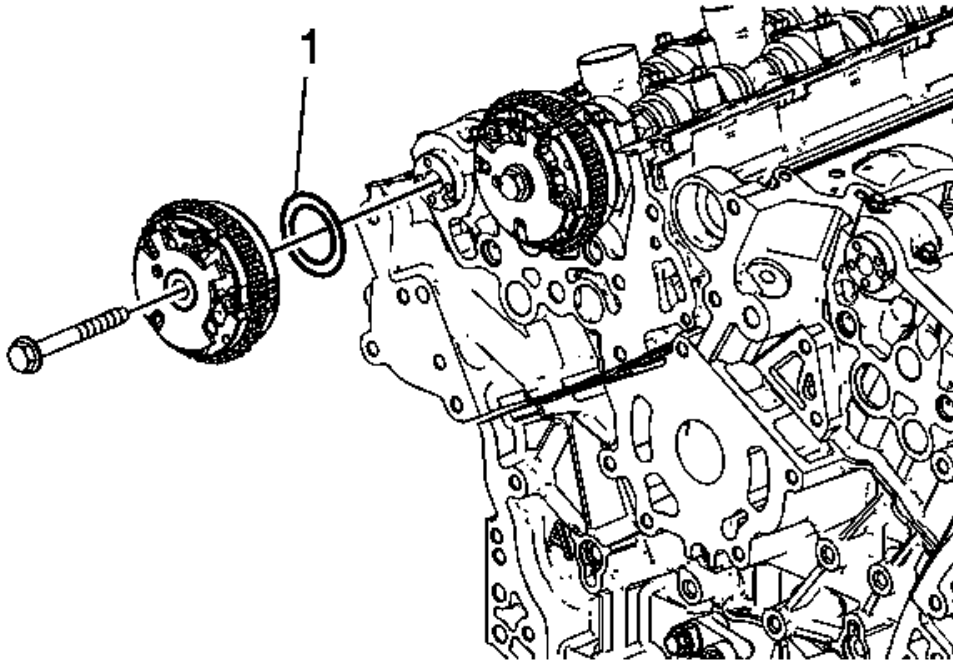


**Fig. 107: Retainer Position**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not move or disturb the EN49982 retainer components after their installation or the timing chains may be lost inside the front cover.

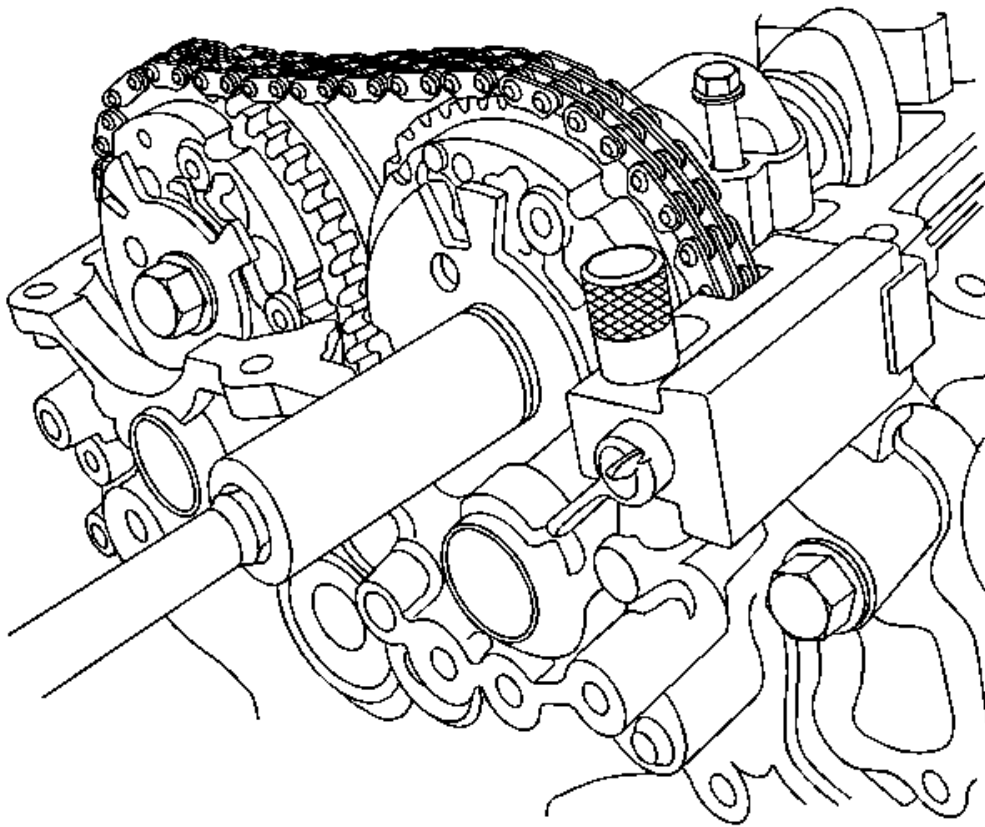
26. The EN49982-1 retainer and EN49982-2 retainer should be in position as shown, they must be left in position during the servicing of the camshaft position actuator(s) and/or camshaft(s).



**Fig. 108: Plastic Thrust Washers**

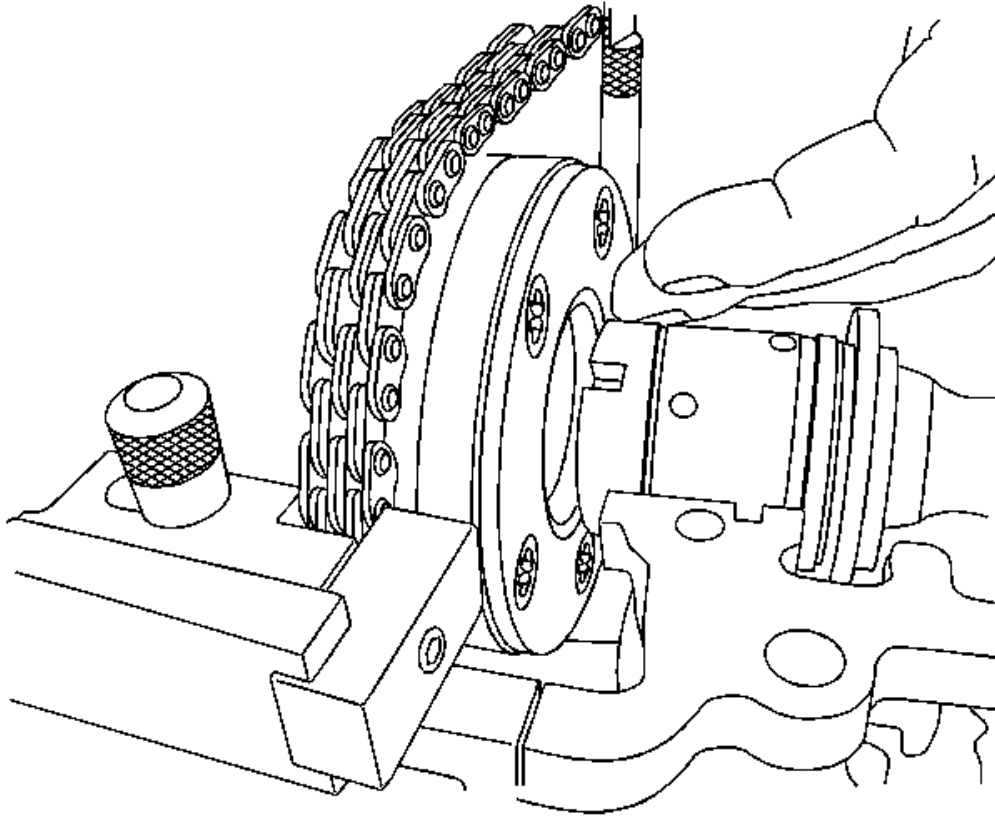
**Courtesy of GENERAL MOTORS COMPANY**

27. Remove and capture the plastic thrust washers (1) in the following steps. Ensure the plastic thrust washer does not fall into the front cover area.



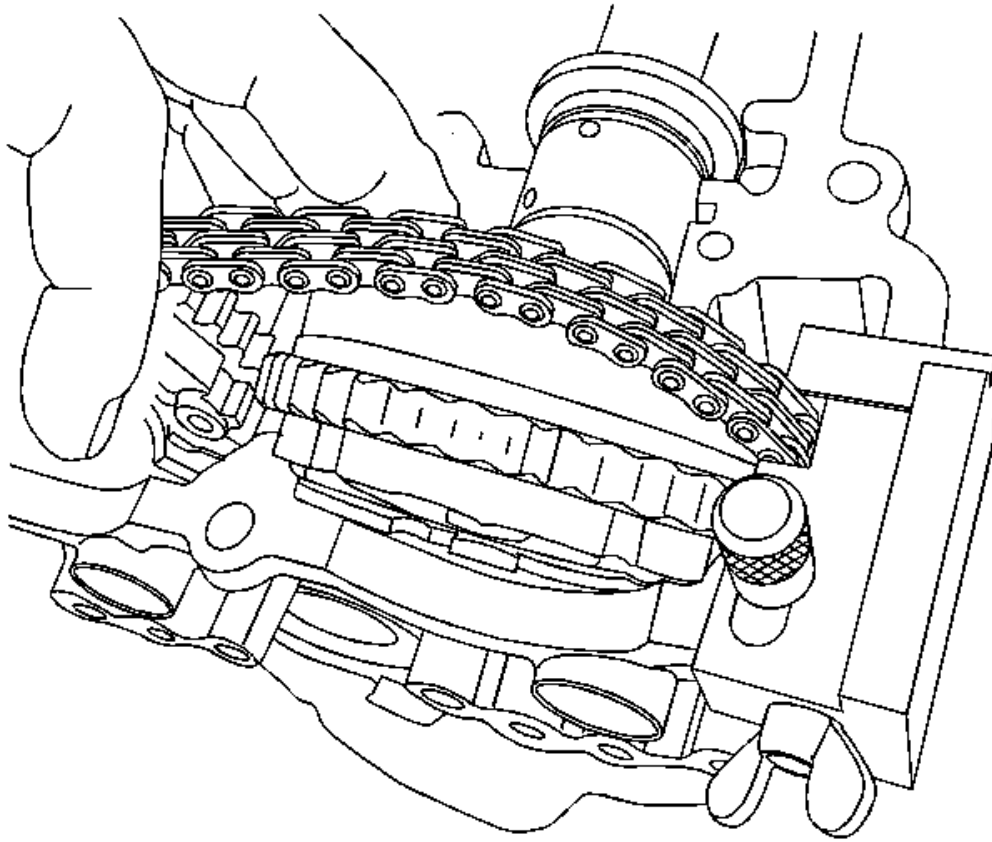
**Fig. 109: Intake Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS COMPANY

28. To remove the intake camshaft position actuator, remove the loosened retaining bolt. To remove only the exhaust camshaft position actuator, skip the steps for removing the intake camshaft position actuator. However, the **EN49982-1** retainer **MUST** be installed as discussed even if the intake side will not be serviced or the timing of the camshaft chains will be lost.



**Fig. 110: Sliding Camshaft Position Actuator Off End Of Intake Camshaft**  
Courtesy of GENERAL MOTORS COMPANY

29. Slide the camshaft position actuator forward and off the end of the intake camshaft. The slot in the **EN49982-1** retainer will allow the tool to move forward enough to disengage the camshaft position actuator from the front of the camshaft. Remove the plastic thrust washer when removing the camshaft position actuator from the end of the camshaft.



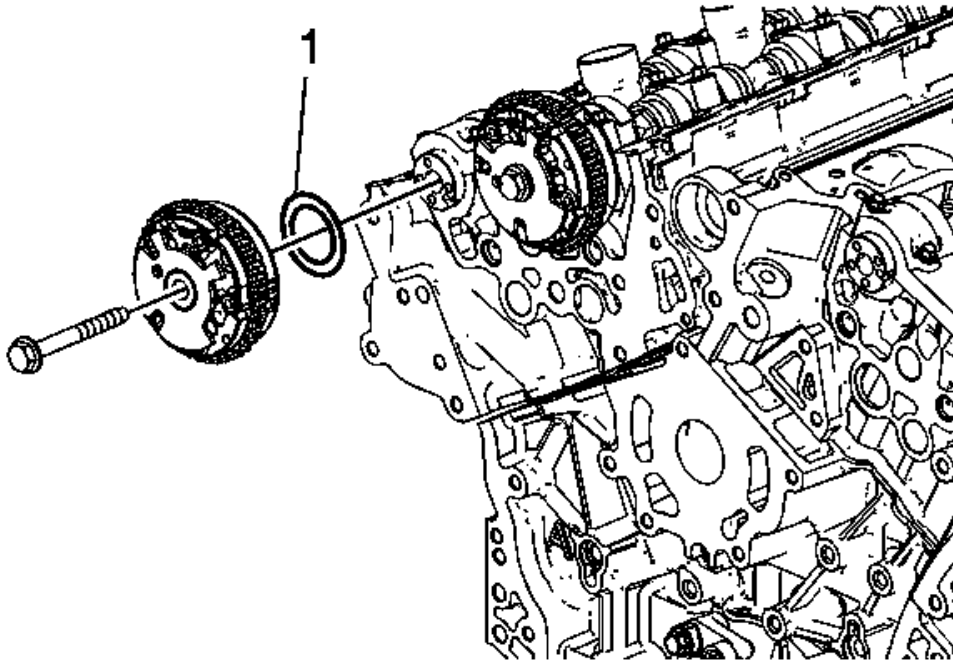
**Fig. 111: Tilting Camshaft Position Actuator Forward**  
Courtesy of GENERAL MOTORS COMPANY

30. Tilt the camshaft position actuator forward and out/away from the engine.

**NOTE:**        **DO NOT** remove the EN49982 retainers. They are holding the cam chains to maintain their properly-timed positions.

31. Allow the chain to rest on the EN49982-1 retainer and EN49982-2 retainer in position during service.

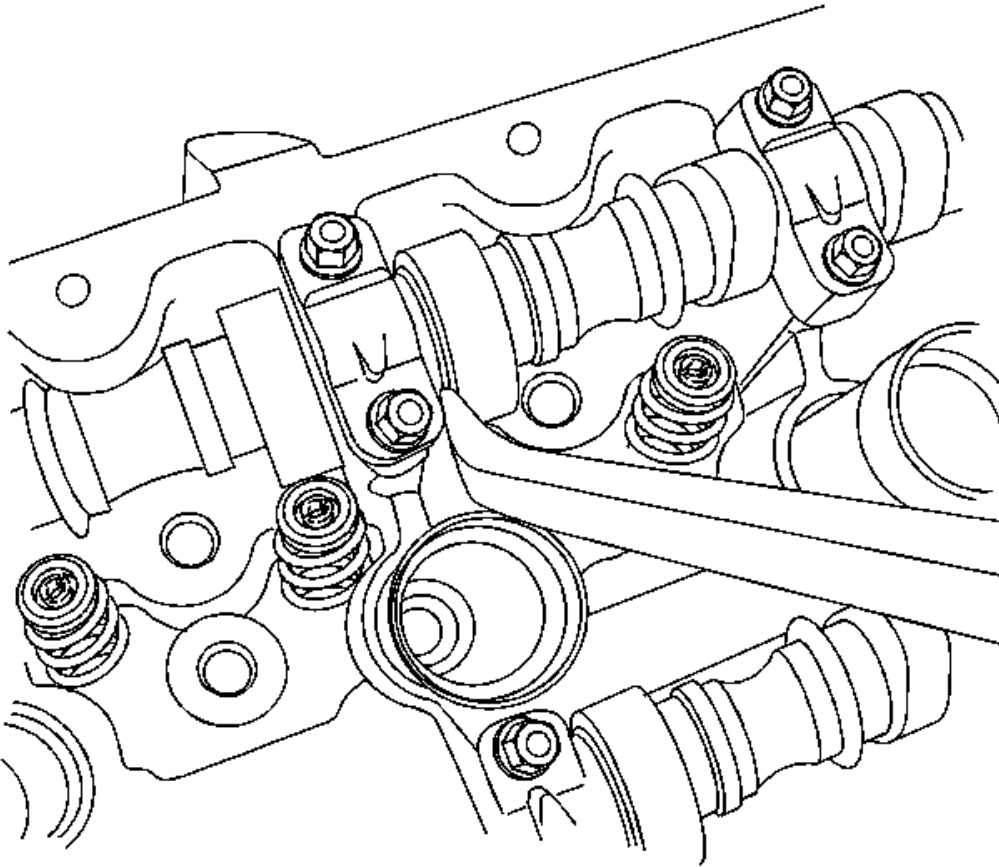
#### Installation Procedure



**Fig. 112: Plastic Thrust Washers**

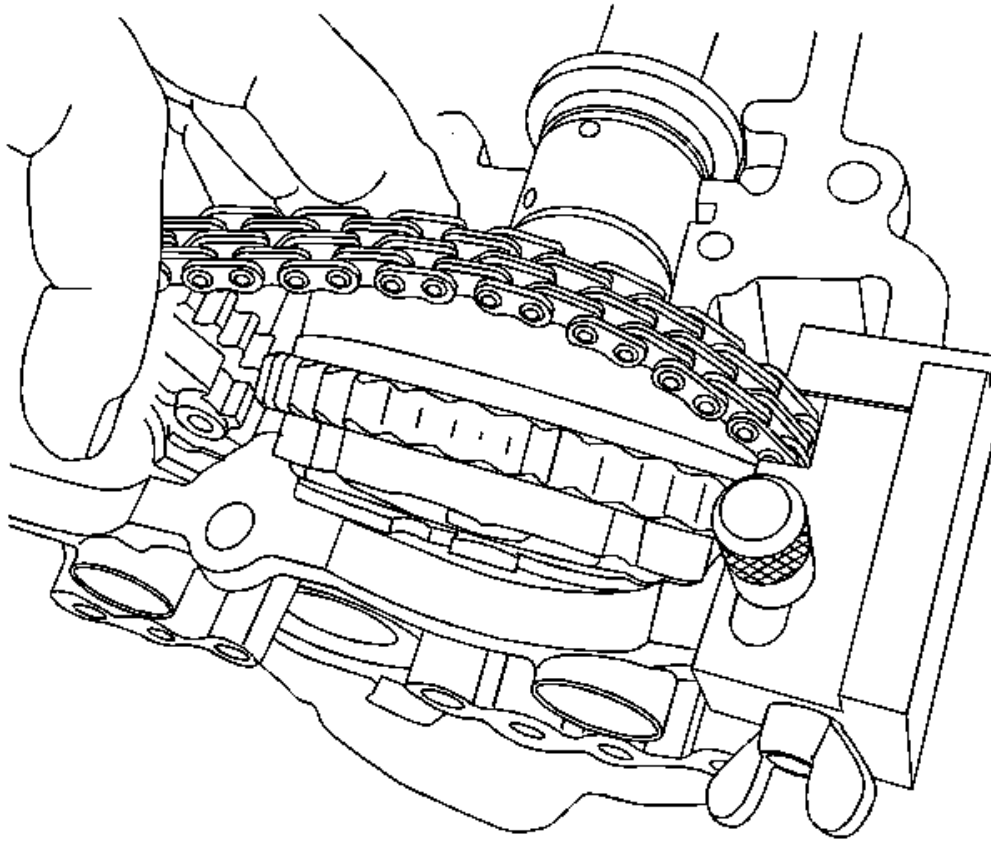
**Courtesy of GENERAL MOTORS COMPANY**

1. Install plastic camshaft position actuator thrust washer (1) between cylinder head face and camshaft position actuator on assembly.



**Fig. 113: Prying Camshaft Forward**  
**Courtesy of GENERAL MOTORS COMPANY**

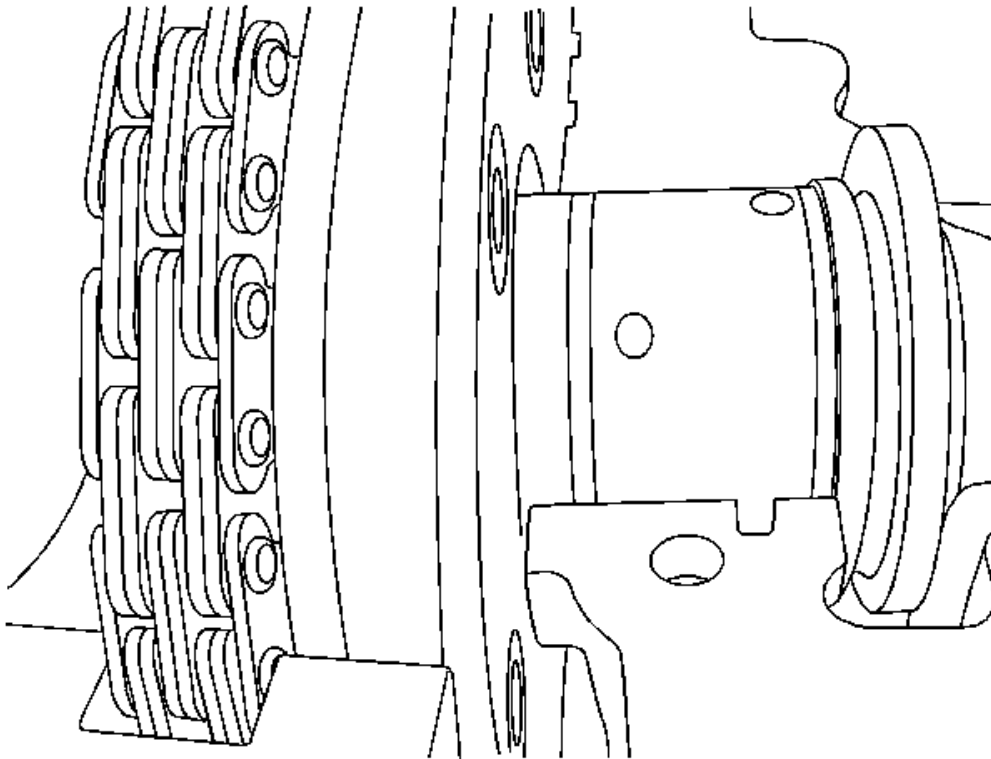
2. It may help to carefully pry the camshaft forward and to move the **EN49982-1** retainer backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.



**Fig. 114: Tilting Camshaft Position Actuator Forward**  
 Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Ensure plastic thrust washer is in place before installing the actuator.

3. Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator.

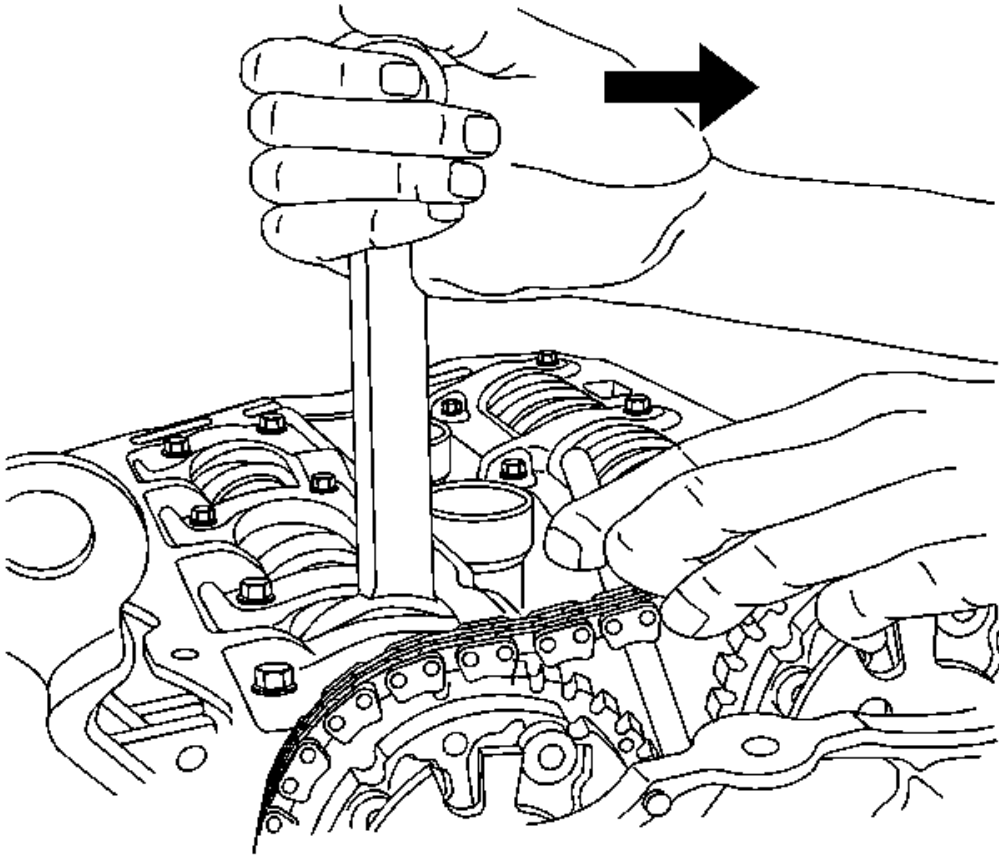


**Fig. 115: Fitting Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the camshaft position actuator fits snugly to the end of the camshaft.

**CAUTION: Refer to Fastener Caution .**

5. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
6. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
7. Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.



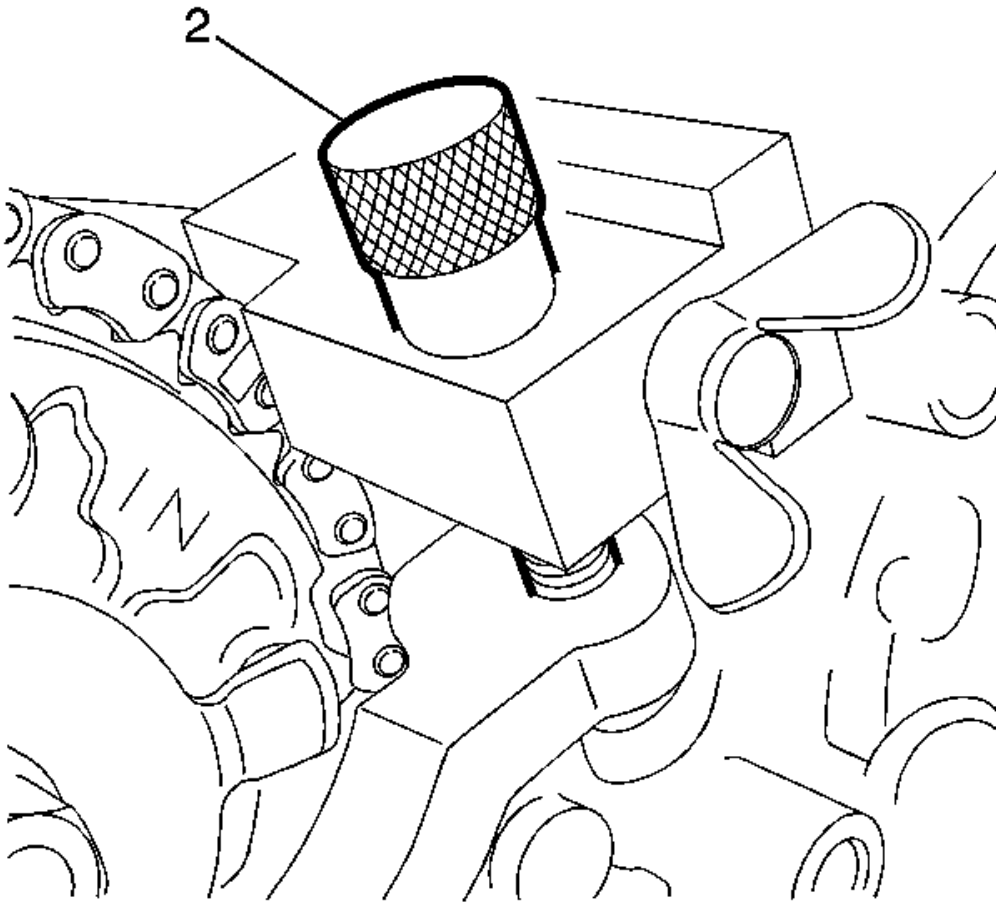
**Fig. 116: Rotating Camshaft**

Courtesy of GENERAL MOTORS COMPANY

8. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the **EN49982-2** retainer.
9. Remove EN49982-2 retainer.
10. Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.

**NOTE:**      **Double-check the marks on the camshaft position actuators and chains to ensure they are correct.**

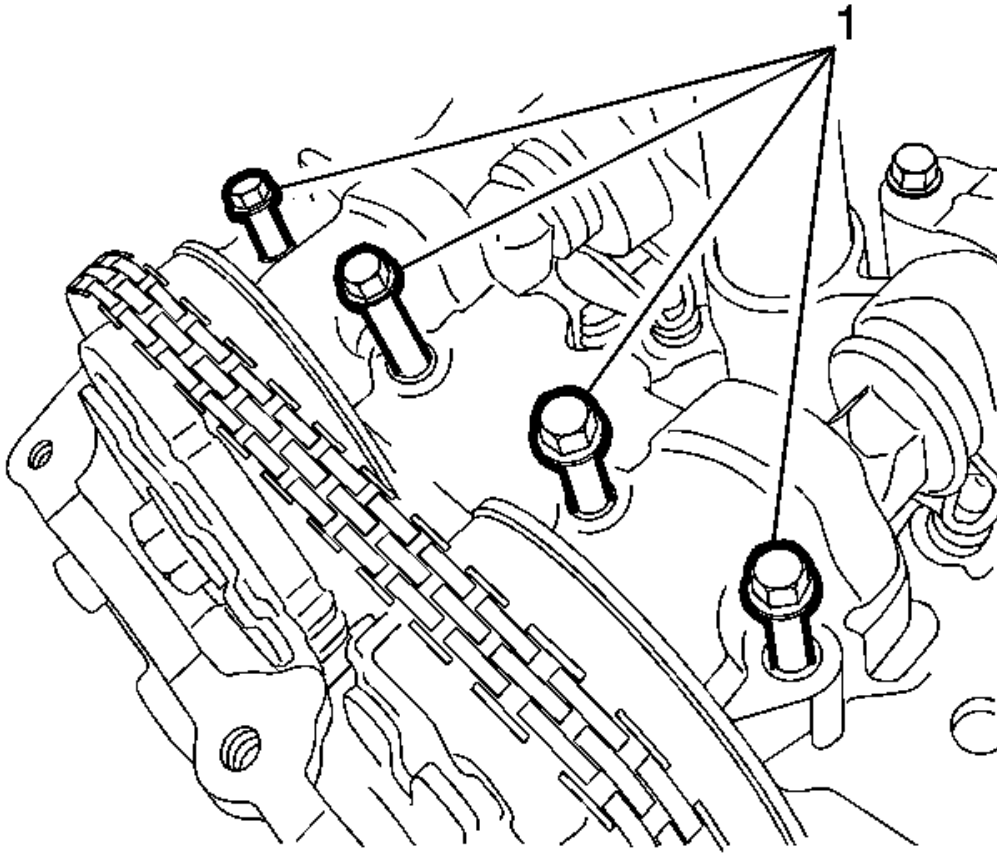
11. Torque one or both camshaft position actuator retaining bolts to 58 N.m (43 lb ft).



**Fig. 117: Retainer Thumbscrew**

Courtesy of GENERAL MOTORS COMPANY

12. Unscrew the wingnut on **EN49982-1** retainer to release timing chain, and then remove **EN49982-1** retainer from the front cover by unscrewing the thumbscrew (2).



**Fig. 118: Camshaft Front Cap And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

13. Install camshaft front cap and bolts (1).
14. Tighten the camshaft front cap outer bolts to 10 N.m (89 lb in).
15. Tighten the camshaft front cap inner bolts to 10 N.m (89 lb in).
16. Install the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
17. Install the camshaft position actuator solenoid valve solenoid-intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
18. Install the intake camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
19. Install the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** .
20. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

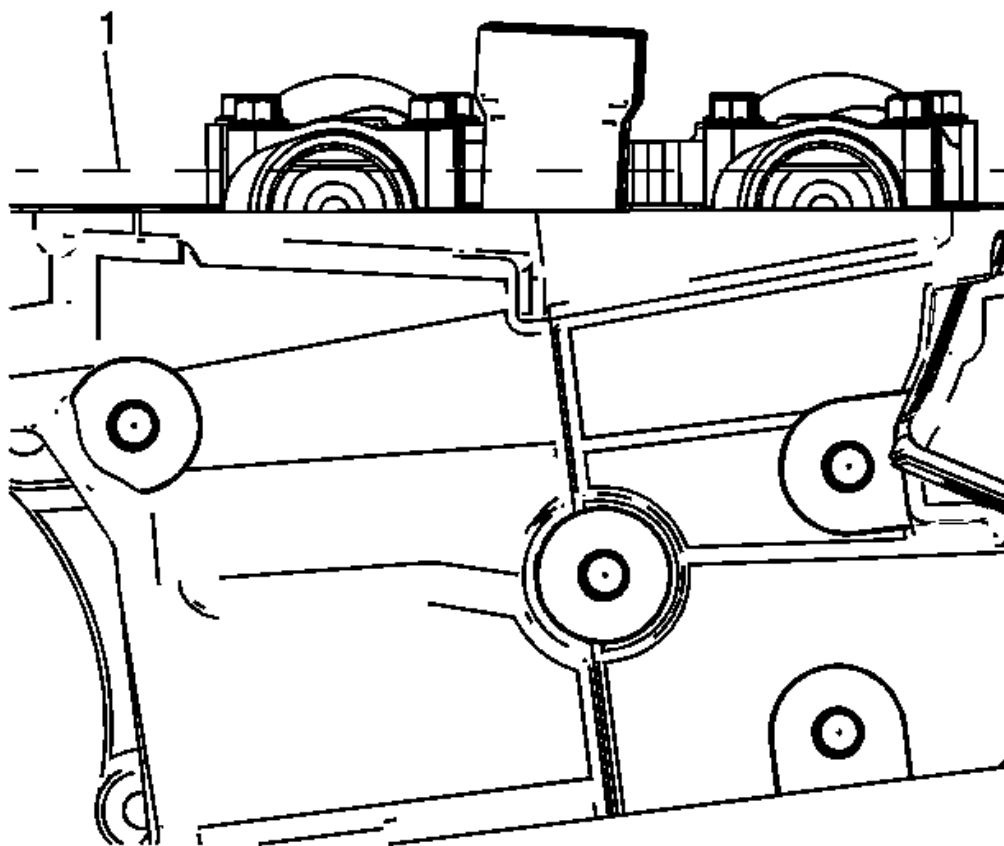
#### **CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2**

## Special Tools

### EN-48313 Timing Chain Retention Tool

For equivalent regional tools, refer to Special Tools .

## Removal Procedure



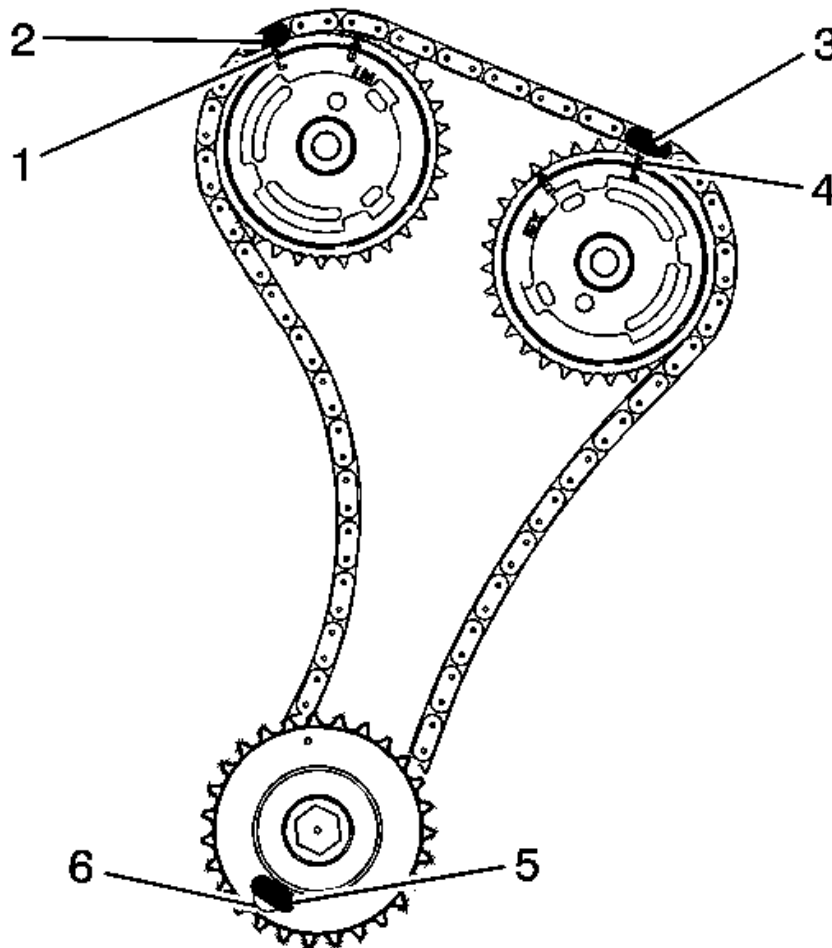
**Fig. 119: Camshaft Flats Parallel With Camshaft Cover Rail -- Left**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold. Refer to Intake Manifold Replacement (LF1, LFW or LFX).
2. Remove the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
3. Remove the left intake and exhaust camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake , and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust .
4. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake , and Camshaft Position

**Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .**

**NOTE:** Rotate the crankshaft balancer bolt in a clockwise direction **ONLY**.

5. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).



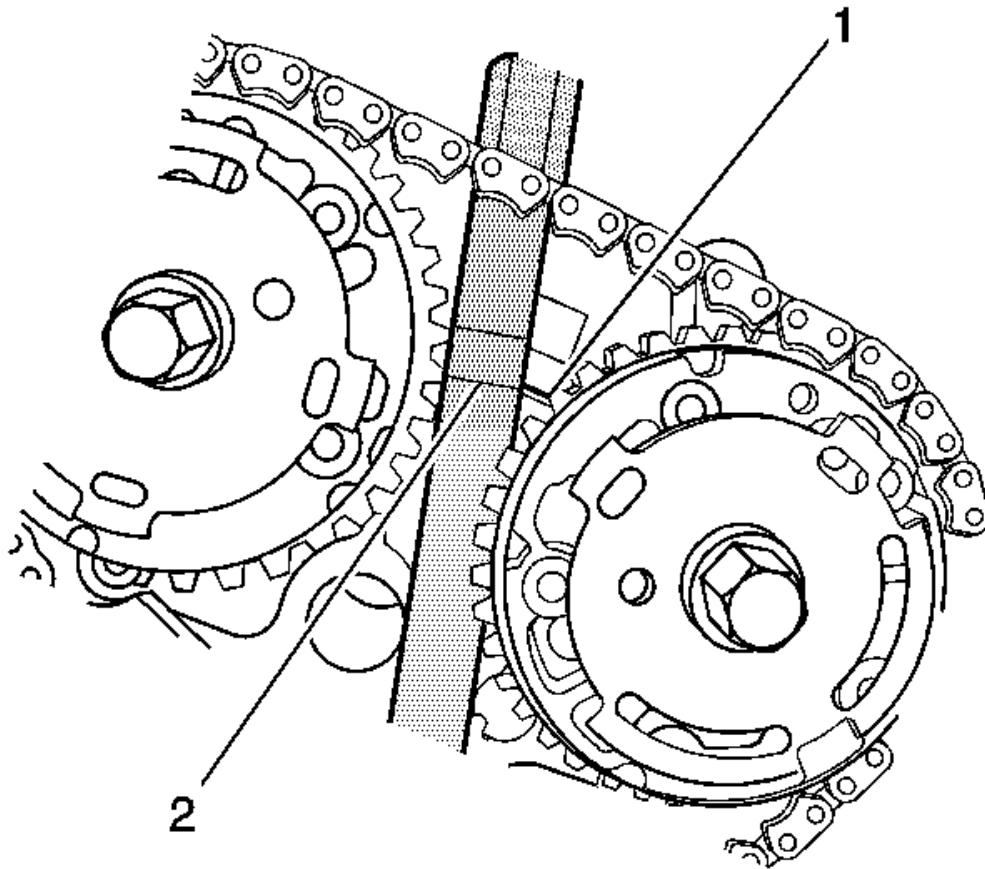
**Fig. 120: Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

6. Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1).
7. Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).

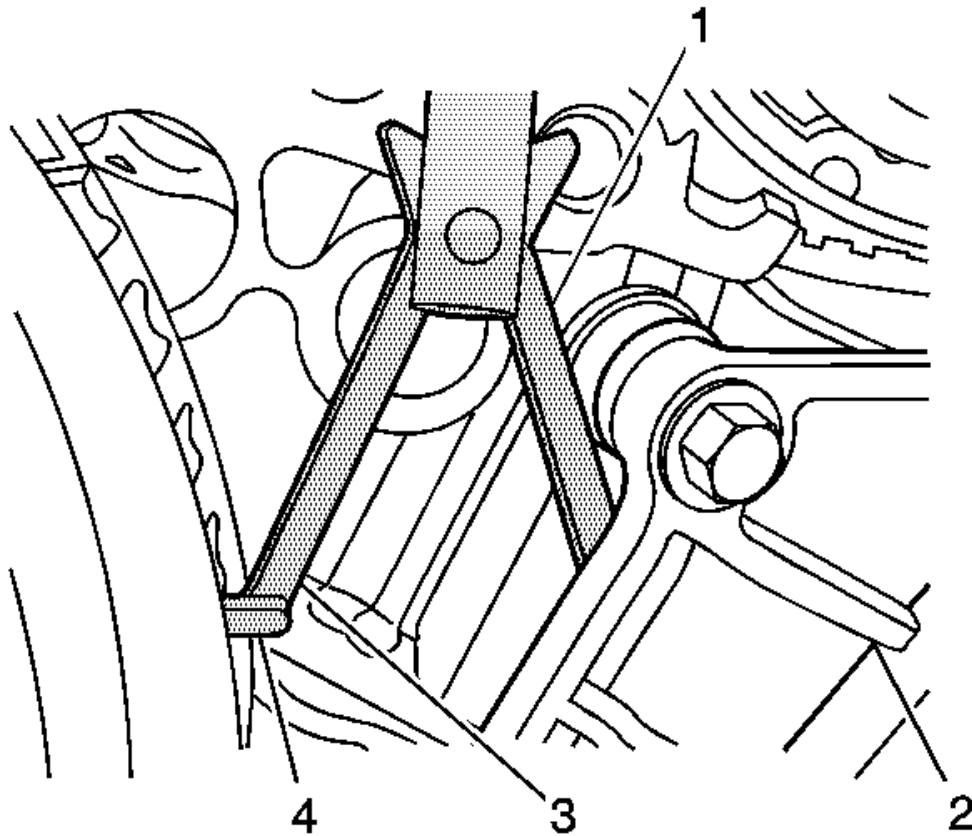
**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

8. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.



**Fig. 121: Inserting Timing Chain Retention Tool**  
Courtesy of GENERAL MOTORS COMPANY

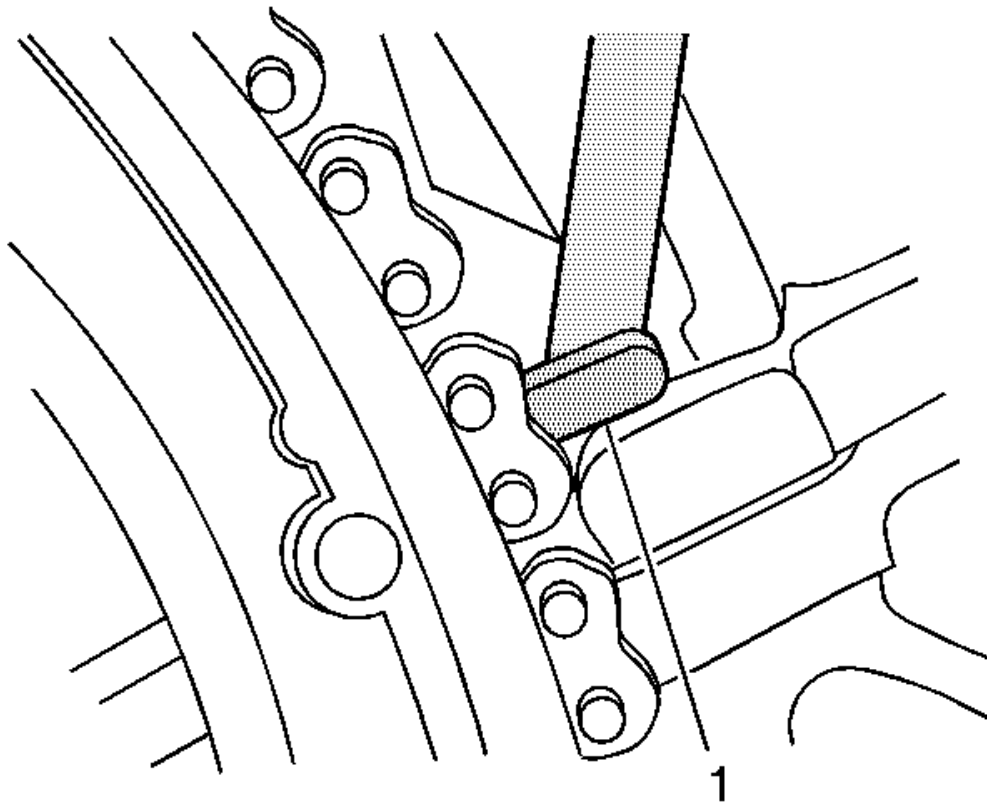
9. Unscrew the **EN-48313** tool so that the legs of the tool are retracted.
10. Insert the **EN-48313** tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.



**Fig. 122: Chain Guide And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The engine front cover is removed for clarity in the following graphics, but NOT required to perform the procedure.

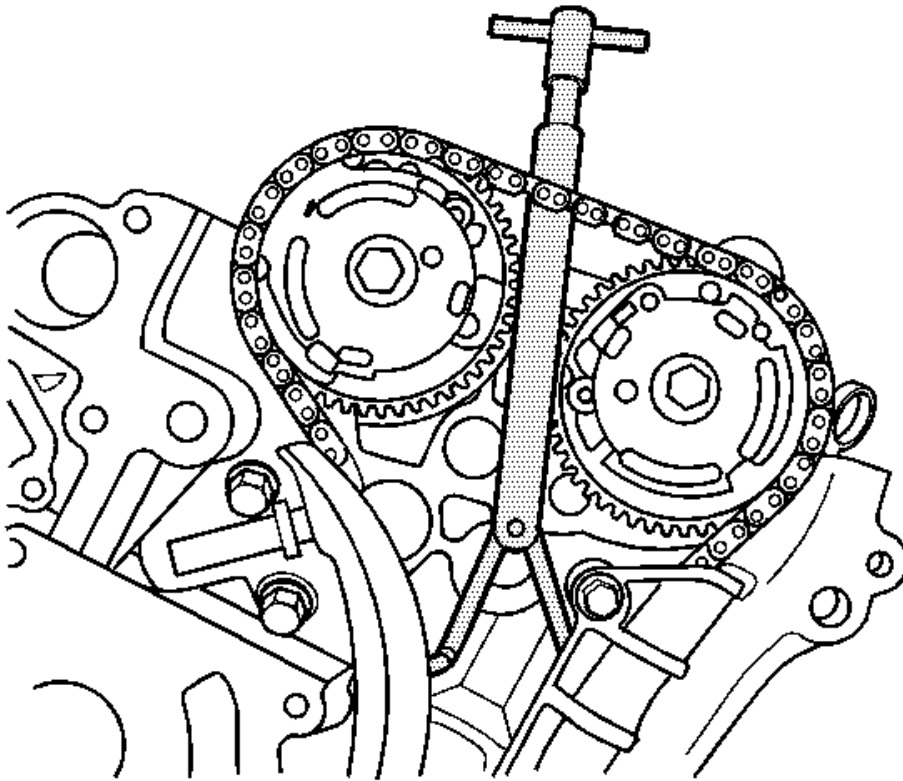
11. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
12. Partially expand the legs (1, 3) of the **EN-48313** tool by turning the T-shaped handle clockwise.
13. Insert the leg of the tool (1) behind the timing chain guide (2).
14. Continue expanding the **EN-48313** tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.



**Fig. 123: Foot of Timing Chain Retention Tool**  
Courtesy of GENERAL MOTORS COMPANY

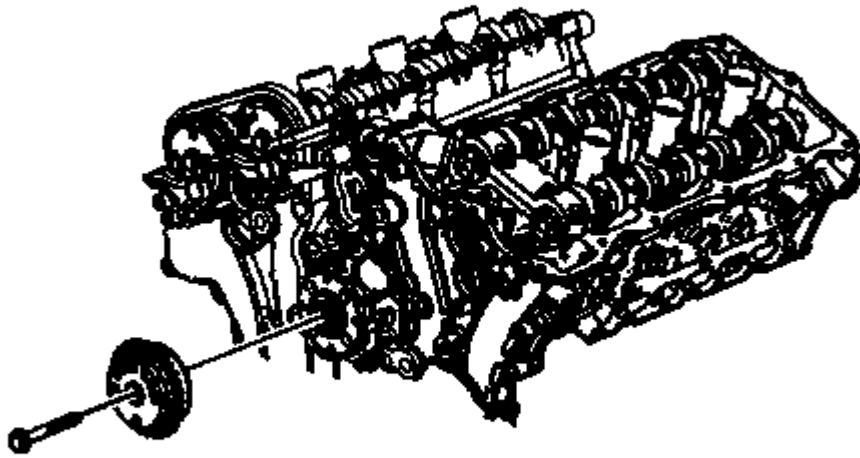
**NOTE:** Ensure that the foot (1) of the EN-48313 tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313 tool.

15. Hand tighten the **EN-48313** tool.
16. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.



**Fig. 124: Timing Chain Retention Tool**  
Courtesy of GENERAL MOTORS COMPANY

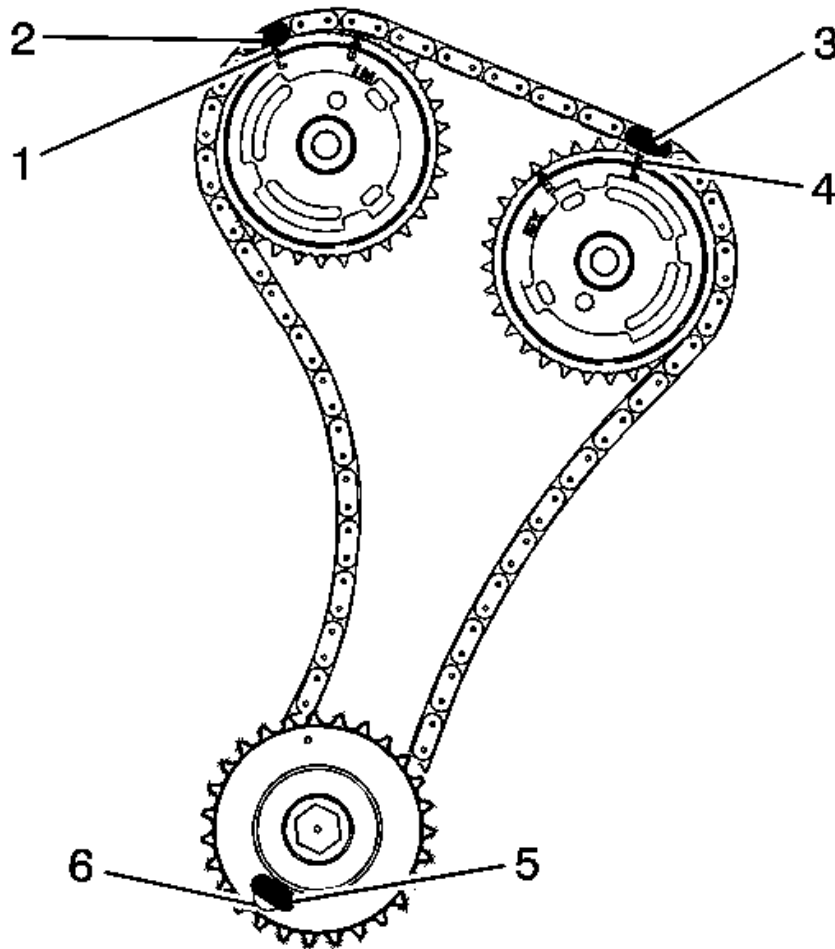
17. The **EN-48313** tool is now properly installed to hold the timing chain in position.



**Fig. 125: Camshaft Position Actuator**  
**Courtesy of GENERAL MOTORS COMPANY**

18. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
19. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
20. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
21. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313** tool once the actuators have been removed.
22. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
23. Remove the camshaft thrust washer.

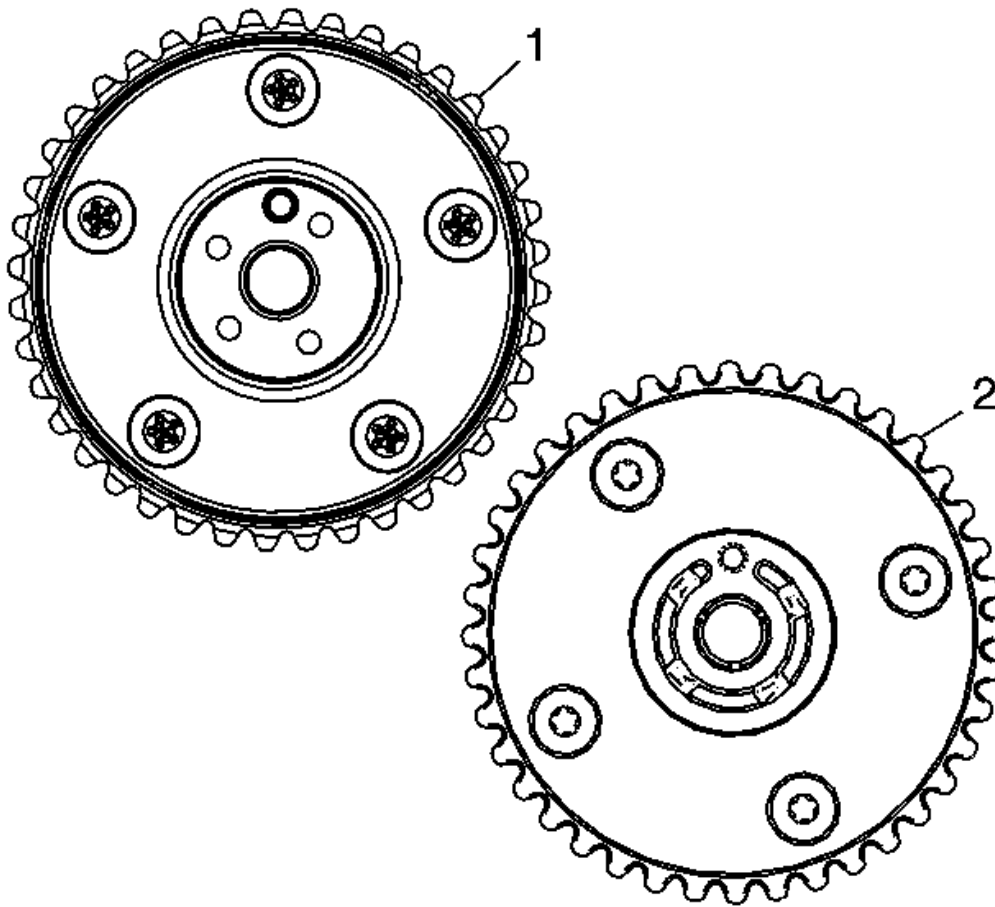
#### **Installation Procedure**



**Fig. 126: Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.
2. Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
3. Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
4. Remove the **EN-48313** tool.

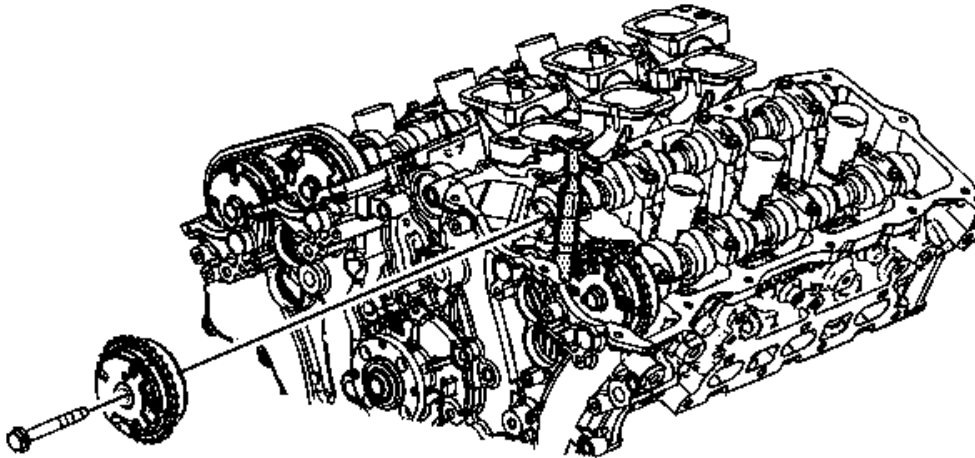


**Fig. 127: 4 And 5 Screw Camshaft Position Actuators**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- The camshaft position actuator will vary depending on application.
- Camshaft thrust washers must only be installed on applications that had thrust washers present during removal of the camshaft position actuators. Do not install washers on applications if they are not already present.

5. If equipped, ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).
6. Install the thrust washer, if applicable.



**Fig. 128: Camshaft Position Actuator And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
8. If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
9. If both the exhaust and intake has been replaced, then tighten bolt to 58 N.m (43 lb ft).
10. Install the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
11. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
12. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.

**SETTING CAMSHAFT TIMING**

**NOTE:**        **Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.**

Follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

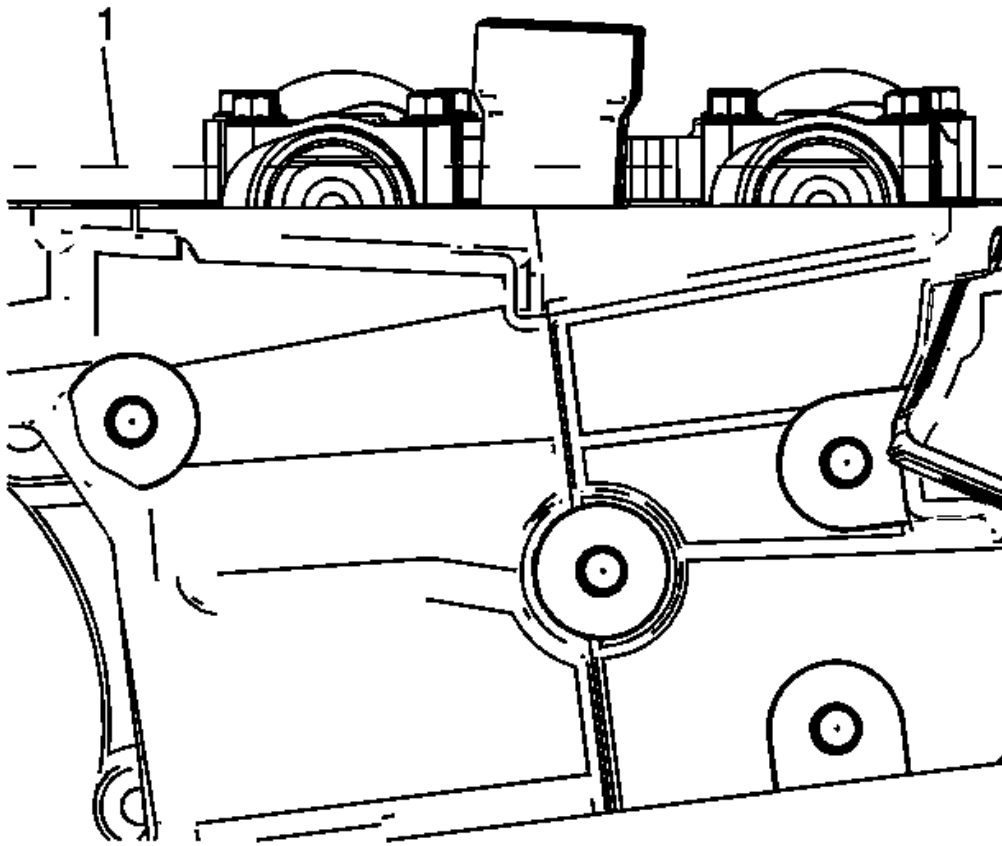
**CAMSHAFT REPLACEMENT - LEFT SIDE****Special Tools**

- **EN-48589** Crankshaft Rotation Socket
- **EN-48383** Timing Chain Retention Tool

For equivalent regional tools, refer to **Special Tools** .

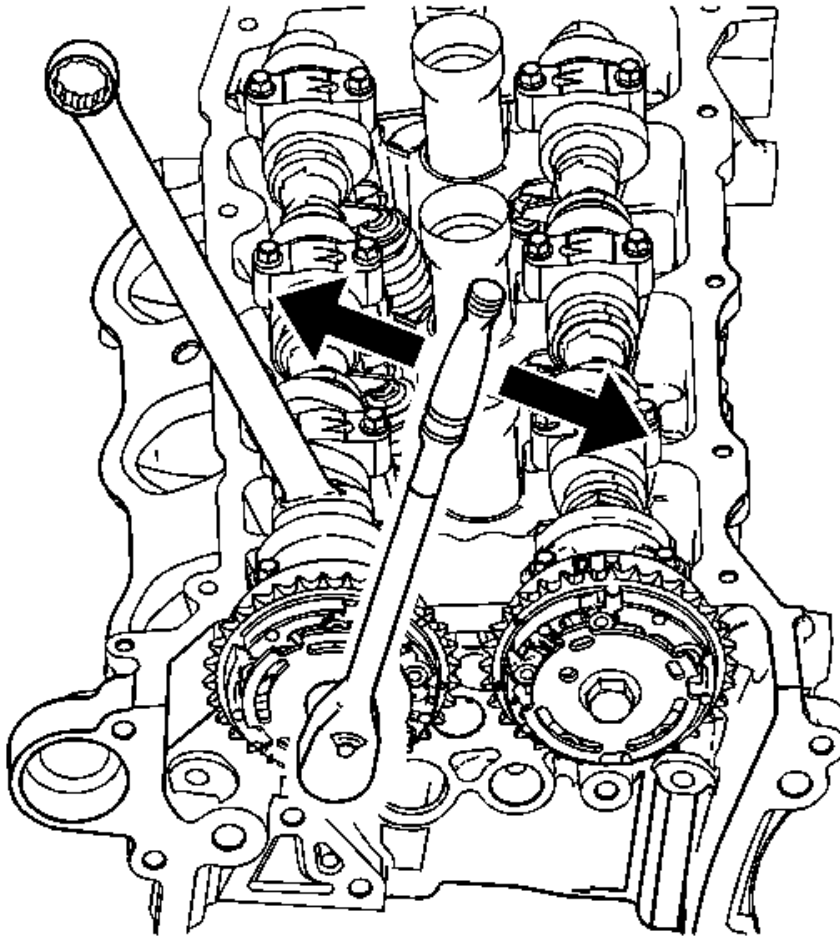
**Removal Procedure**

1. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
2. Remove the fuel pump from the cylinder head. Refer to **Fuel Pump Replacement** .
3. Remove the left bank camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
4. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
5. Remove the camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** .
6. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2**.
7. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.



**Fig. 129: Camshaft Flats Parallel With Camshaft Cover Rail -- Left**  
 Courtesy of GENERAL MOTORS COMPANY

8. Rotate the crankshaft with the **EN-48589** socket until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).



**Fig. 130: Preventing Camshaft/Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

**NOTE:**

- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator bolt at this time.

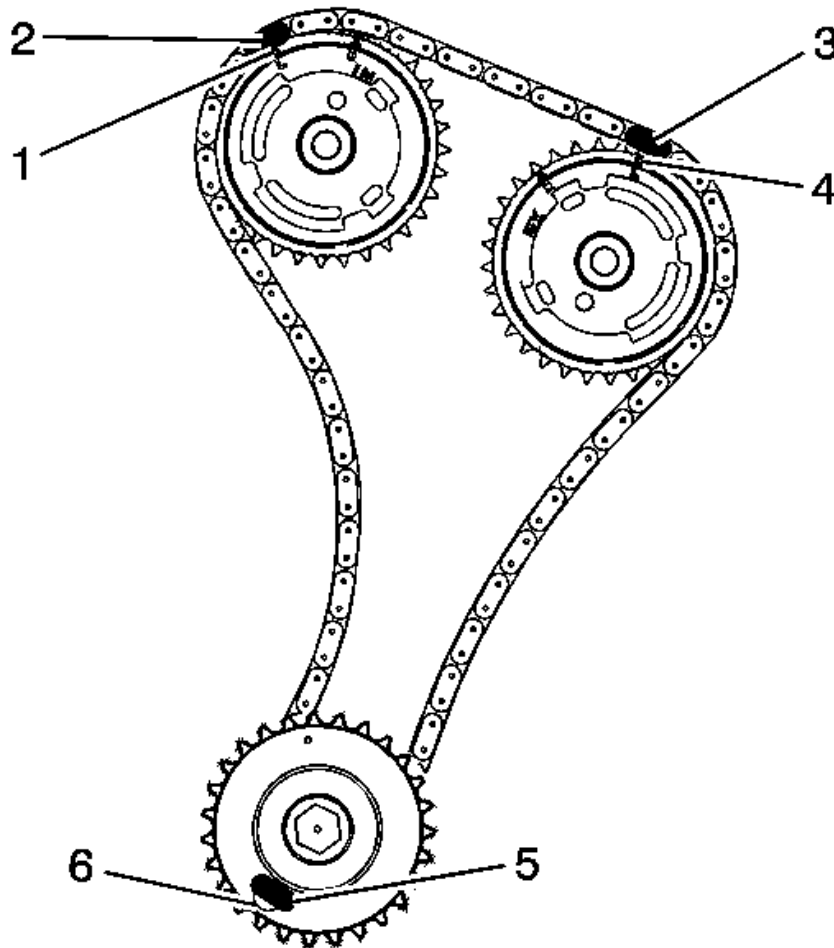
9. Loosen the camshaft position actuator bolt.

**NOTE:**

**Ensure that the tips of the EN-48383 tool are fully engaged into the timing chain.**

10. Install the **EN-48383** tool in order to retain the timing chain.

Firmly tighten the **EN-48383** tool nuts.

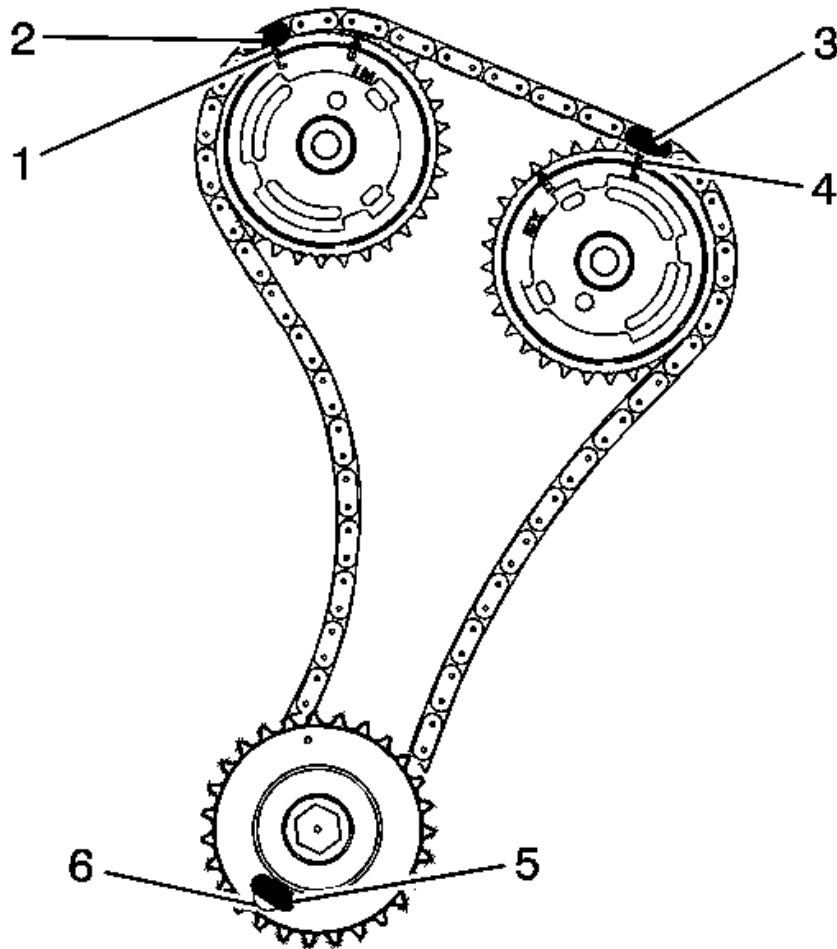


**Fig. 131: Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

11. Mark the timing chain and the respective locations on the camshaft position actuators (1-4).
12. Remove the camshaft position actuator bolt.
13. Remove the camshafts. Refer to **Camshaft Removal - Left Side** .

#### Installation Procedure

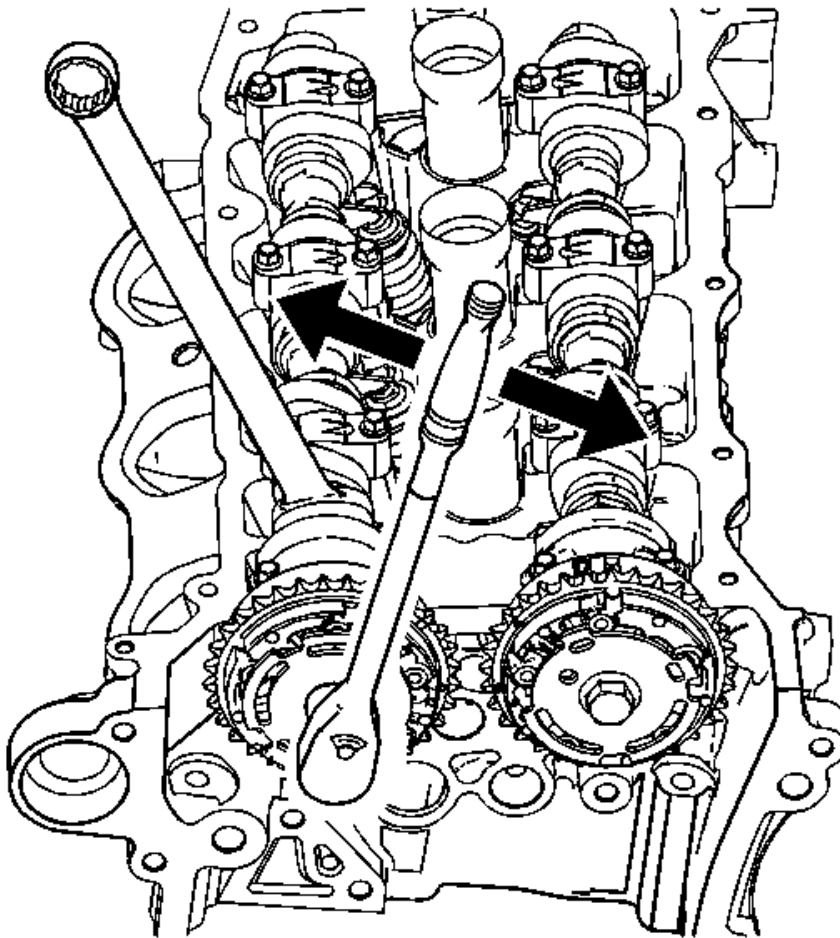


**Fig. 132: Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- Ensure that the marks on the camshaft position actuator and the timing chain (1-4) are aligned.
- **DO NOT** tighten the camshaft position actuator bolt at this time.

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Left Side**.
3. Remove the **EN-48383** tool.



**Fig. 133: Preventing Camshaft/Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

**NOTE:** Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

4. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Left Side Intake , and Camshaft Position Actuator Installation - Left Side Exhaust .
5. Install the intake camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake .
6. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust , and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake .
7. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement.
8. Install the camshaft cover. Refer to Camshaft Cover Replacement - Left Side.

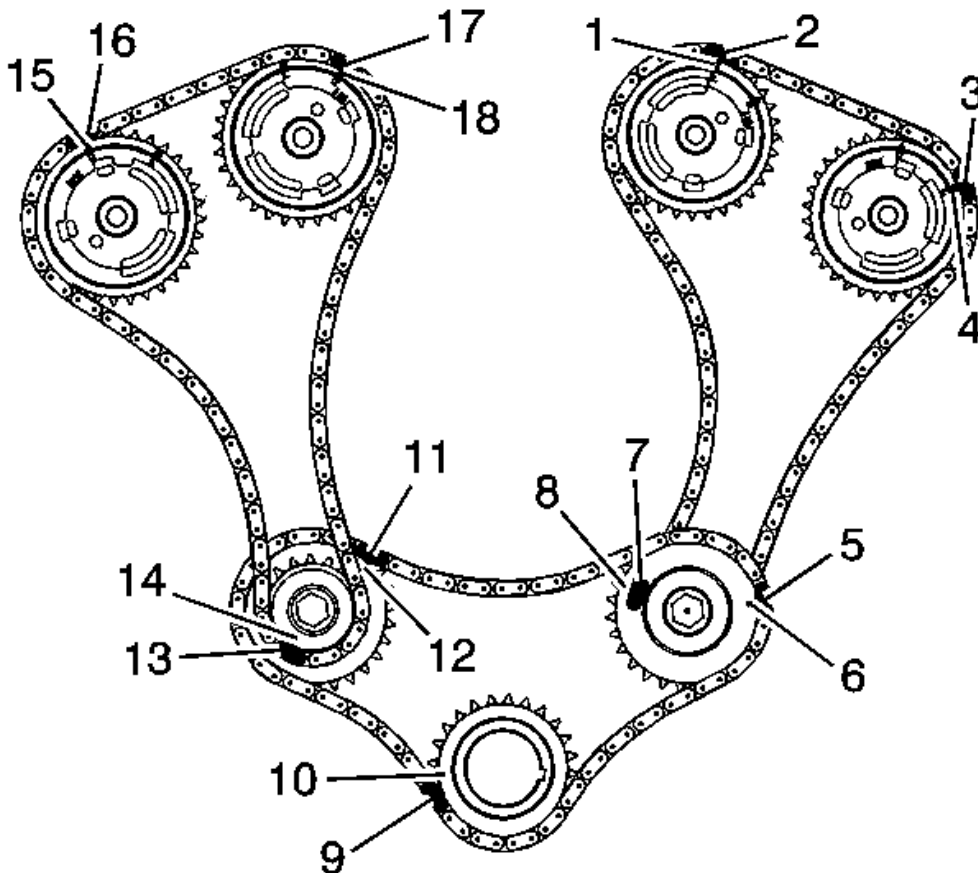
9. Install the fuel pump to the cylinder head. Refer to **Fuel Pump Replacement**.
10. Install the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.

## CAMSHAFT REPLACEMENT - RIGHT SIDE

### Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement (LF1, LFW or LFX)**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**, and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**.
4. Remove the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**.
5. Remove the Camshaft Position Actuator. Refer to **Camshaft Position Actuator Replacement - Bank 1**.
6. Remove the camshaft bearing caps and the camshaft. Refer to **Camshaft Removal - Right Side**.

### Installation Procedure

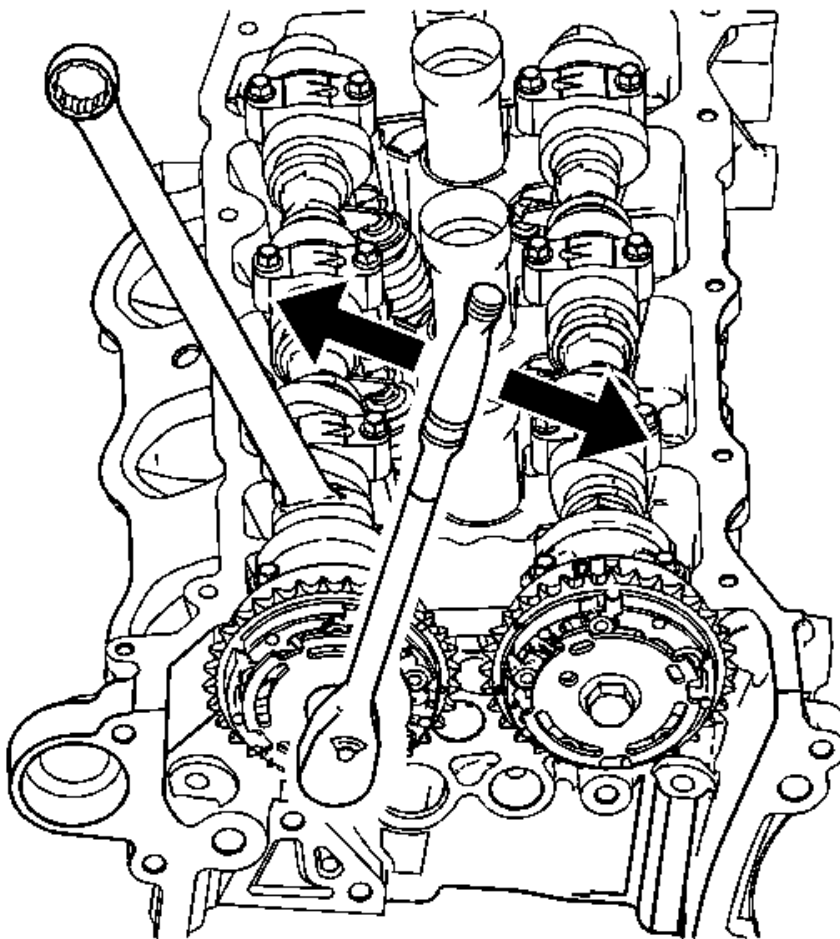


**Fig. 134: Timing Chain Marks & Locations On Gears, Sprockets And Actuators**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- Ensure that the marks on the camshaft position actuators and the timing chain (15-18) are aligned.
- DO NOT tighten the camshaft position actuator bolt at this time.

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to Camshaft Installation - Right Side .



**Fig. 135: Preventing Camshaft/Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

**NOTE:** Use an open-end wrench at the camshaft hex to prevent camshaft/engine

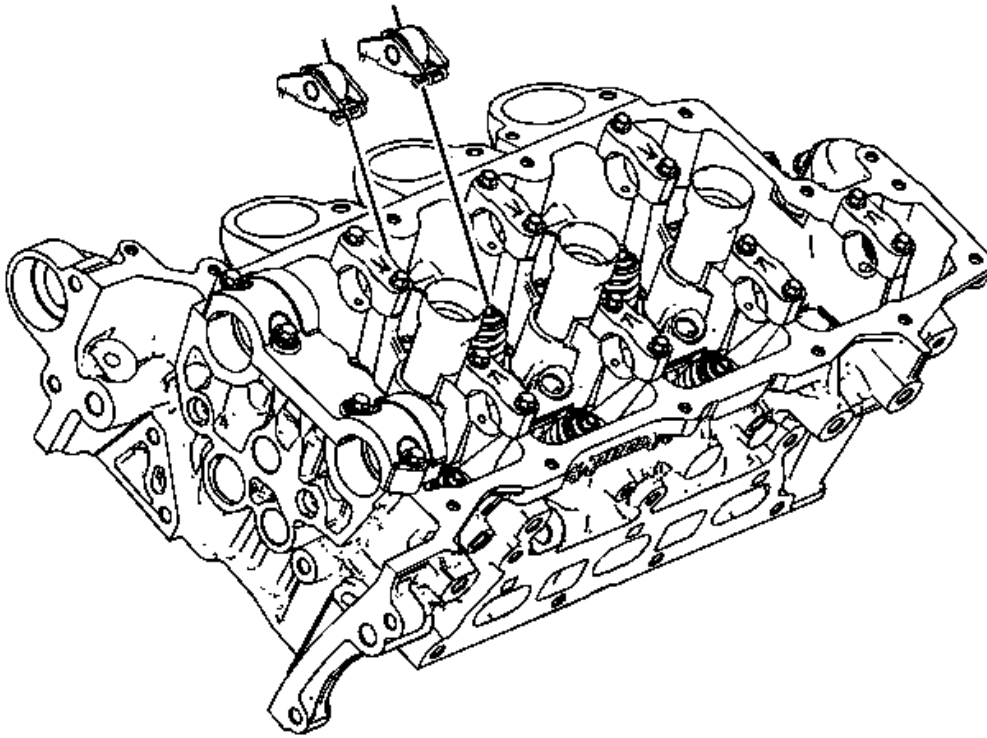
rotation.

3. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Right Side Intake , and Camshaft Position Actuator Installation - Right Side Exhaust .
4. Install the intake camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
5. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust , and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
6. Install the camshaft cover. Refer to Camshaft Cover Replacement - Right Side.
7. Install the intake manifold. Refer to Intake Manifold Replacement (LF1, LFW or LFX).

## VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

### Removal Procedure

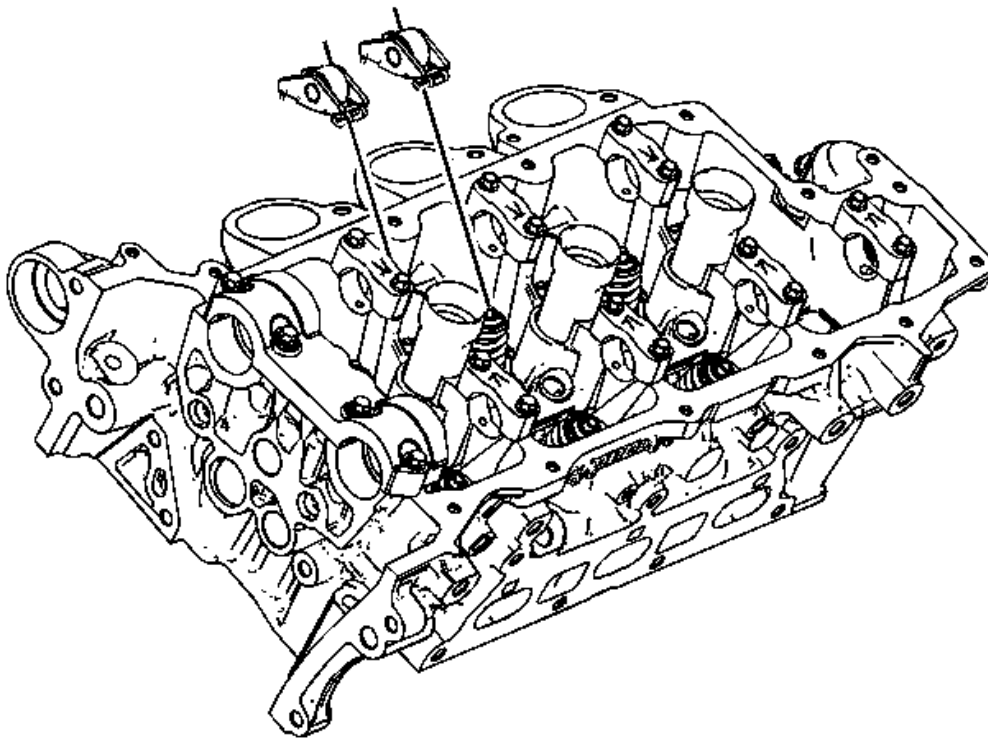
1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.



**Fig. 136: Valve Rocker Arm - Left Side**

**Courtesy of GENERAL MOTORS COMPANY**

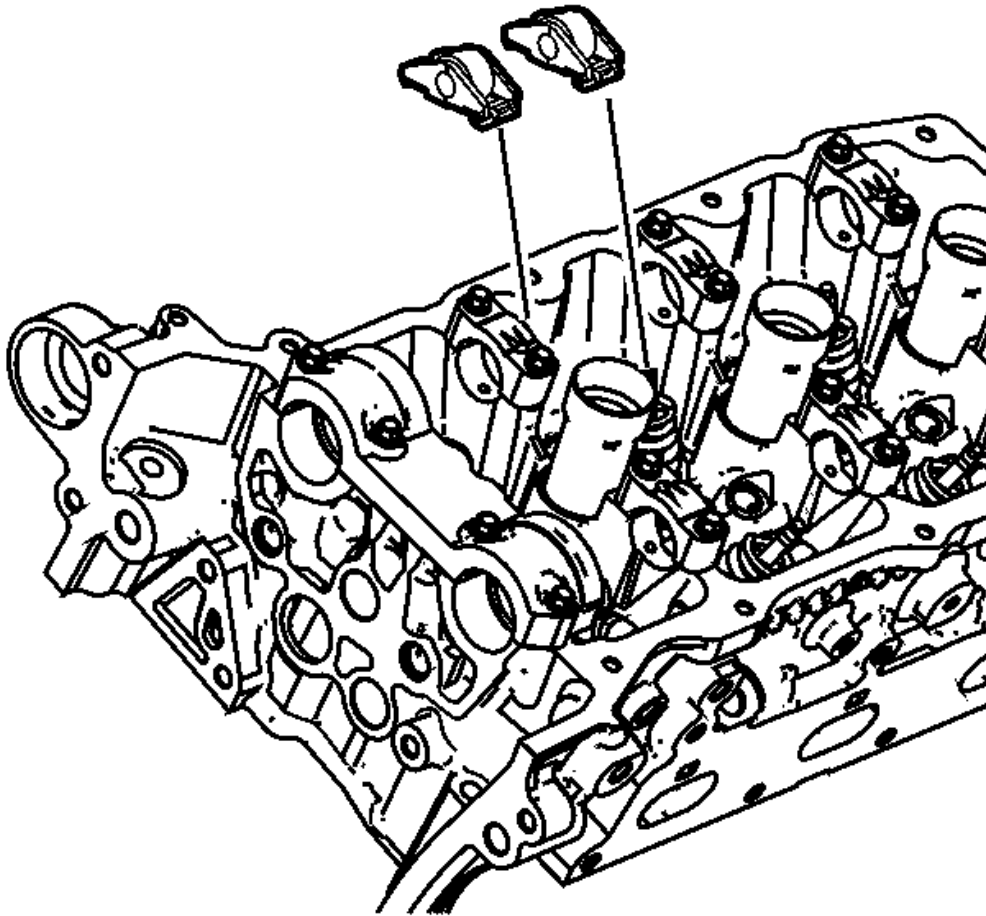
2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Lifter Cleaning and Inspection** .

**Installation Procedure****Fig. 137: Valve Rocker Arm - Left Side****Courtesy of GENERAL MOTORS COMPANY**

1. Install the rocker arms.
2. Install the camshaft(s). Refer to **Camshaft Replacement - Left Side**.

**VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE****Removal Procedure**

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

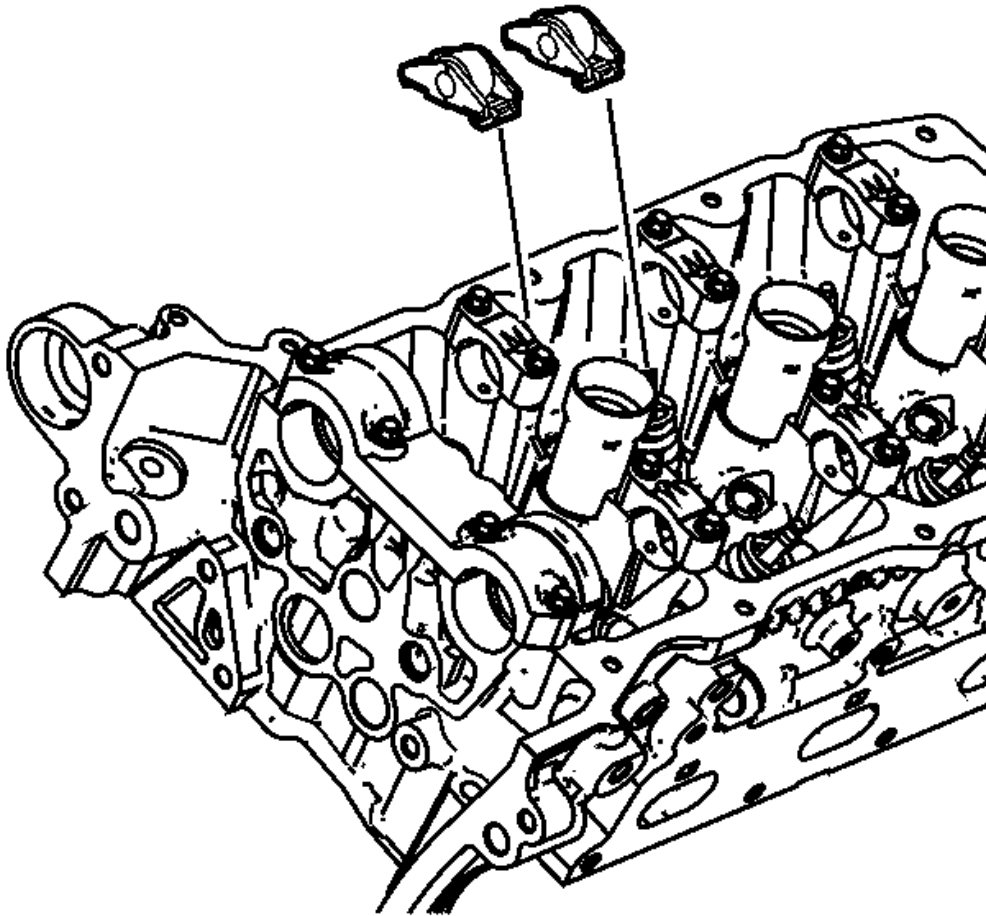


**Fig. 138: Valve Rocker Arms**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Lifter Cleaning and Inspection** .
4. Clean and inspect the valve rocker arm. Refer to **Valve Rocker Arm Cleaning and Inspection**

#### Installation Procedure



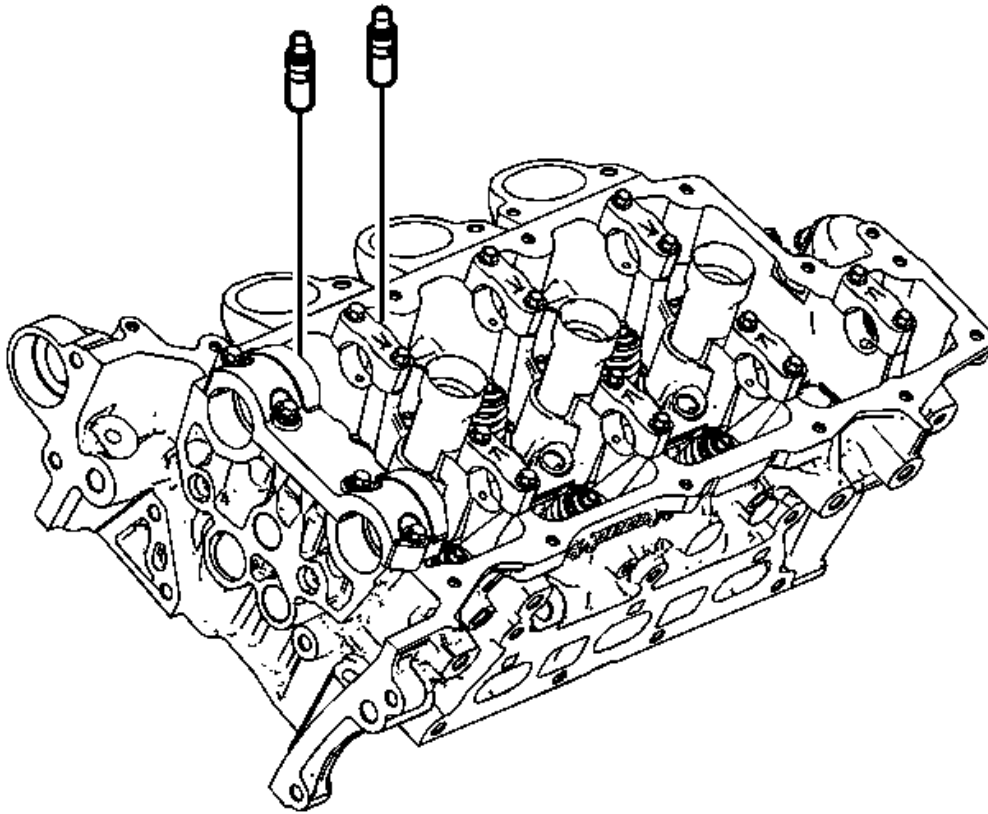
**Fig. 139: Valve Rocker Arms**

Courtesy of GENERAL MOTORS COMPANY

1. Install the rocker arms.
2. Install the camshaft(s). Refer to Camshaft Replacement - Right Side.

## **VALVE LIFTER REPLACEMENT - LEFT SIDE**

### **Removal Procedure**

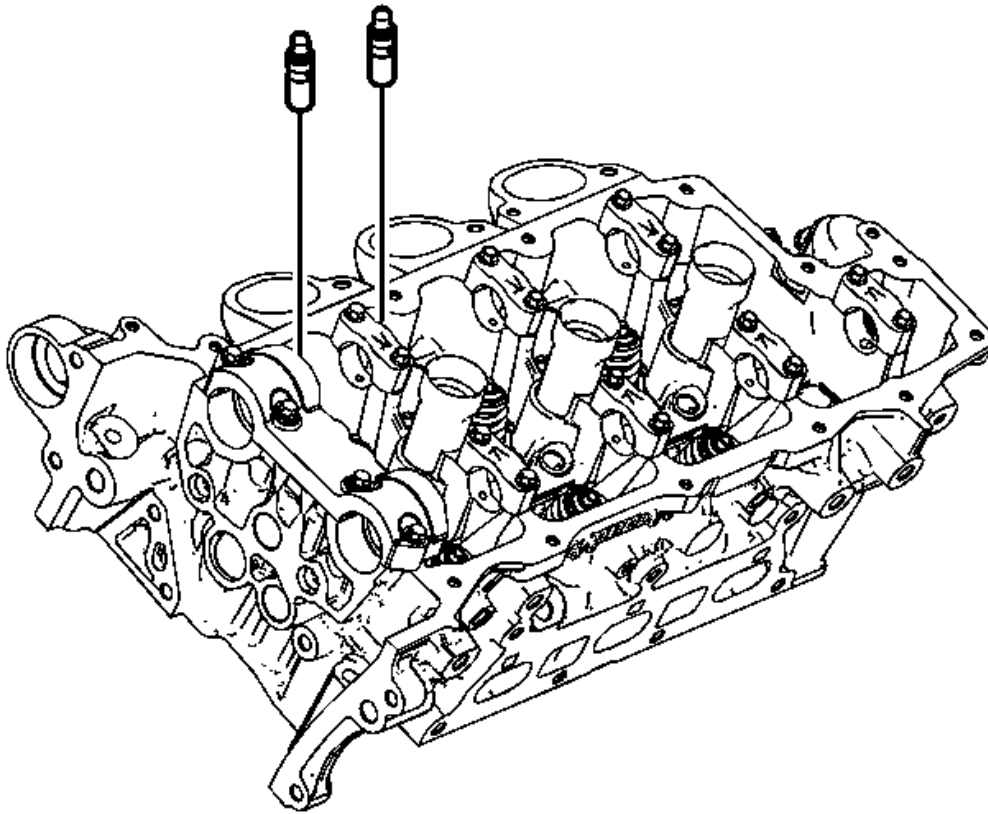


**Fig. 140: Valve Lifter - Left Side**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the applicable camshafts. Refer to **Camshaft Replacement - Left Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side**
4. Clean and inspect the camshafts, rocker arms and lifters. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Lifter Cleaning and Inspection** .
5. Clean and inspect the rocker arm. Refer to **Valve Rocker Arm Cleaning and Inspection**

#### **Installation Procedure**



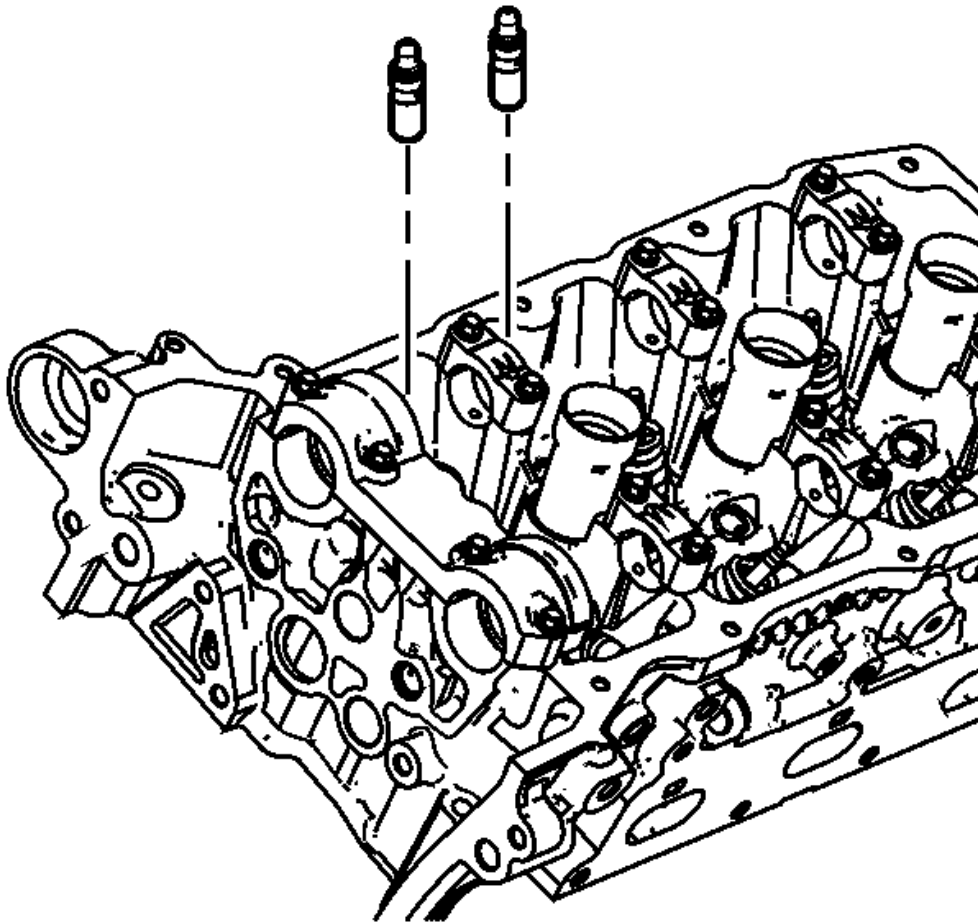
**Fig. 141: Valve Lifter - Left Side**  
 Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters.
2. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Install the camshafts. Refer to **Camshaft Replacement - Left Side**.

## **VALVE LIFTER REPLACEMENT - RIGHT SIDE**

### **Removal Procedure**

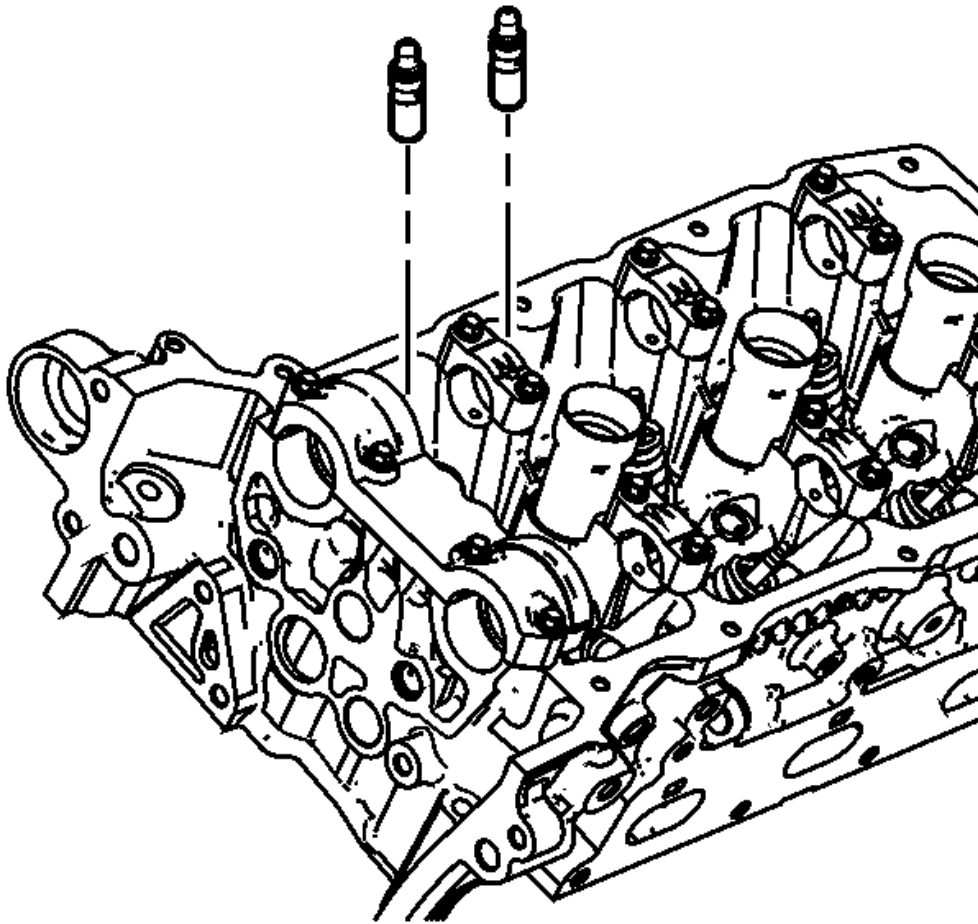
1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side**.



**Fig. 142: Stationary Hydraulic Lash Adjuster (SHLAs)**  
 Courtesy of GENERAL MOTORS COMPANY

3. Remove the lifters. Refer to **Valve Lifter Removal - Right Side** .
4. Clean and inspect the camshaft(s) and the rocker arm(s) and lifter. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , **Valve Lifter Cleaning and Inspection** , and **Valve Rocker Arm Cleaning and Inspection** .

#### Installation Procedure



**Fig. 143: Stationary Hydraulic Lash Adjuster (SHLAs)**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters. Refer to **Valve Lifter Installation - Right Side** .
2. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Right Side** .
3. Install the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

## **VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE**

### **Special Tools**

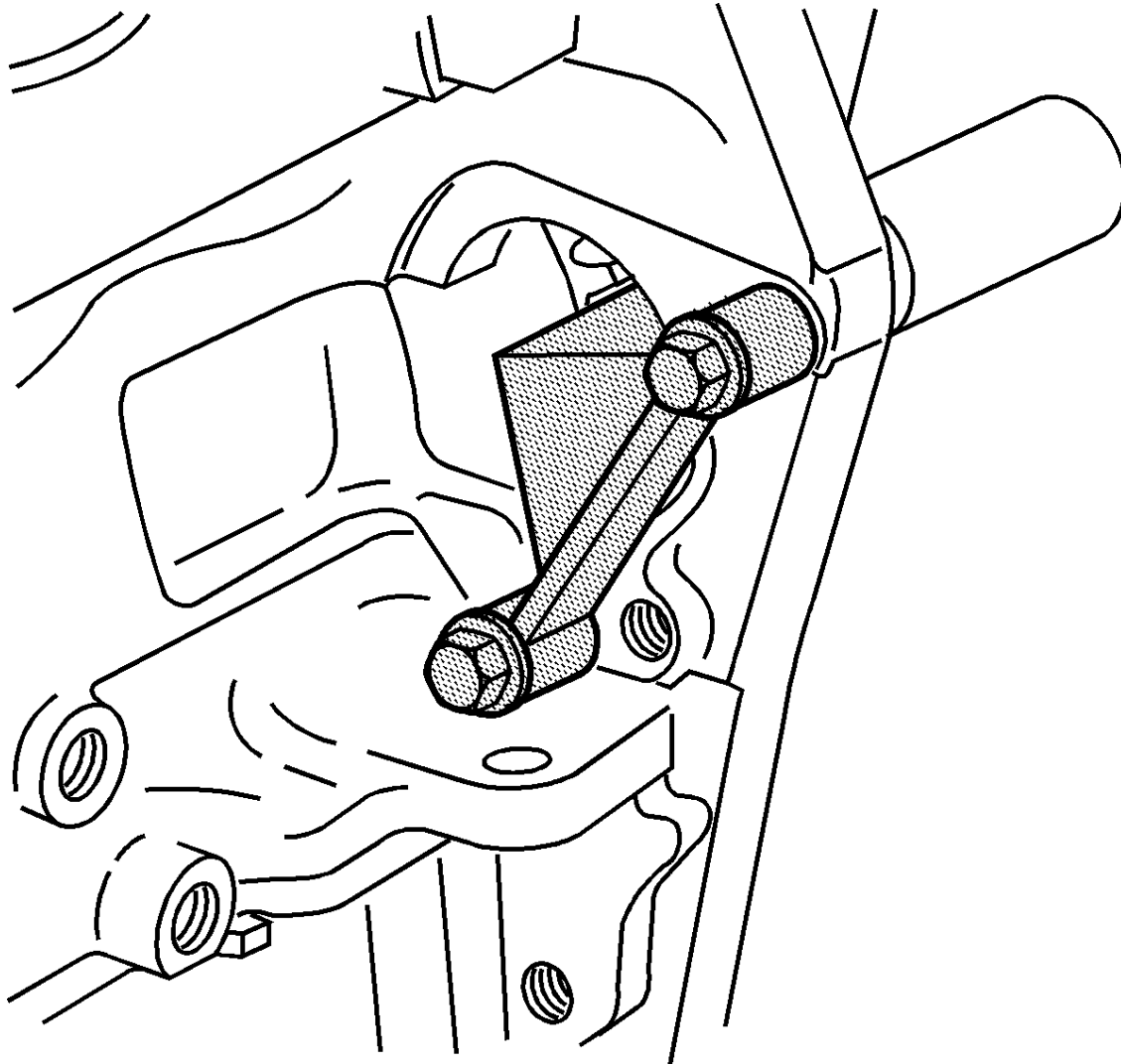
- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to Special Tools .

#### Removal Procedure

**NOTE:** This procedure is not used in Brazil.

1. Remove the rocker arms. Refer to Valve Rocker Arm Replacement - Left Side.
2. Remove the starter motor. Refer to Starter Replacement (V6) .



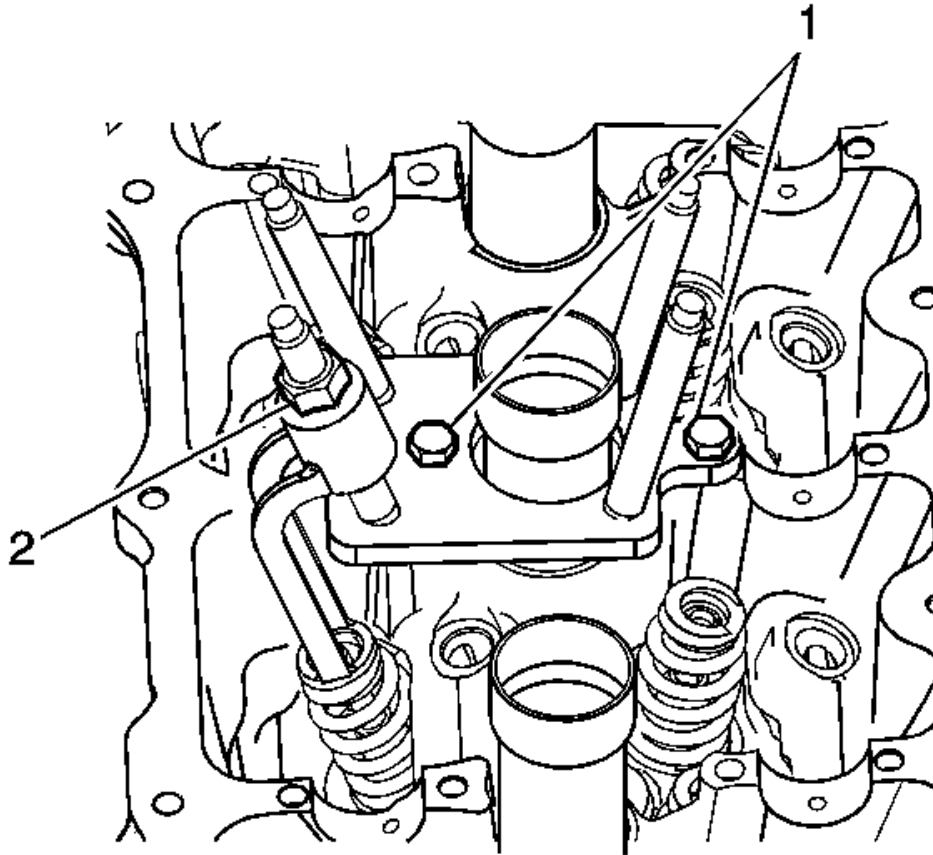
**Fig. 144: Flywheel Holding Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

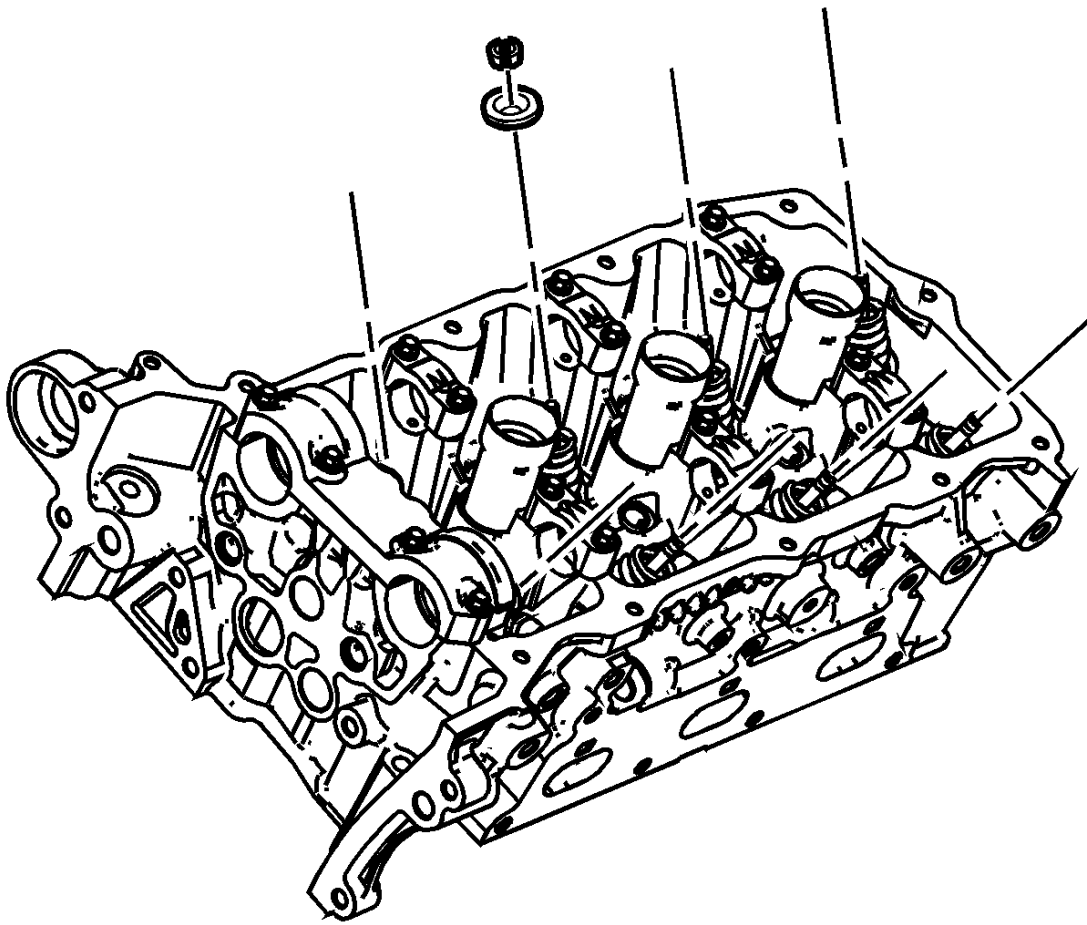
3. Install the **EN-46106** tool in order to prevent crankshaft rotation.

4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.



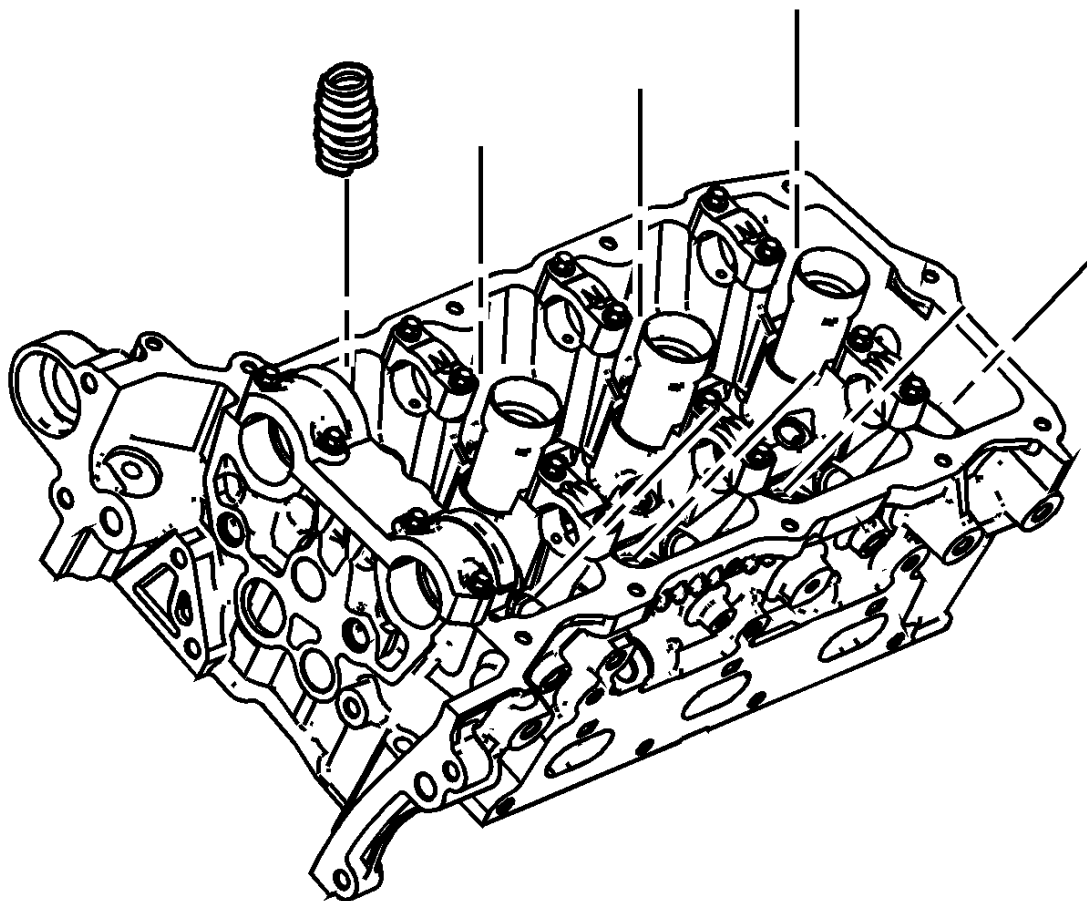
**Fig. 145: Valve Spring Compressor**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).



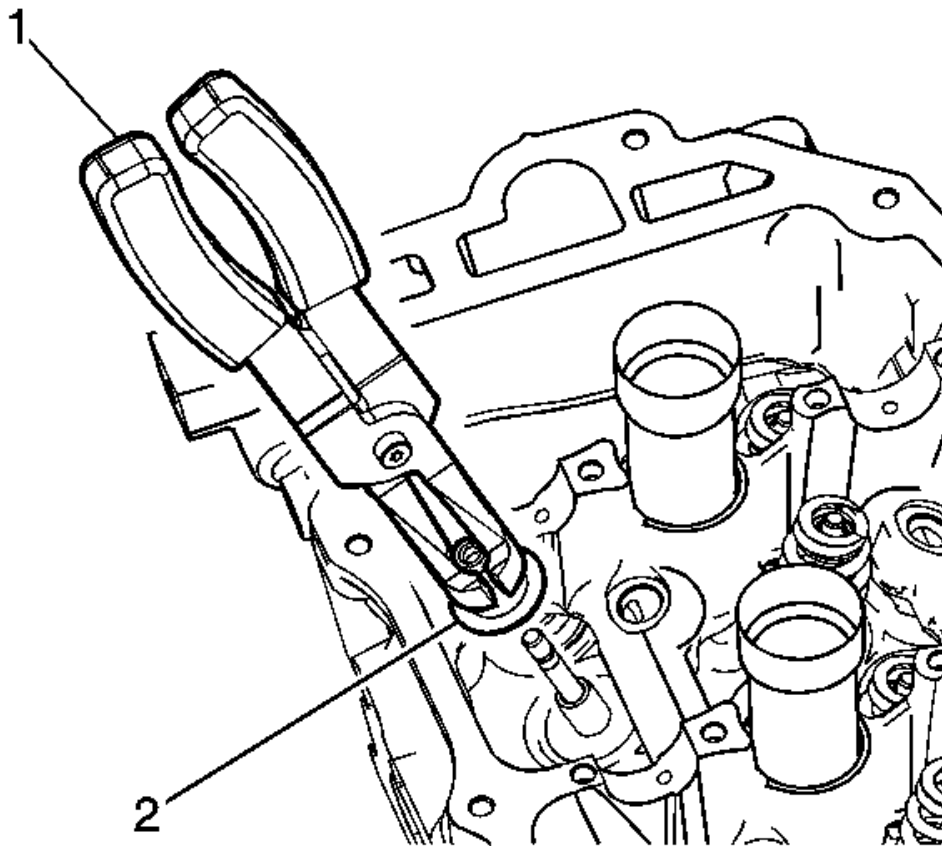
**Fig. 146: Valve Spring Keepers And Valve Spring Retainers**  
Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.



**Fig. 147: Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

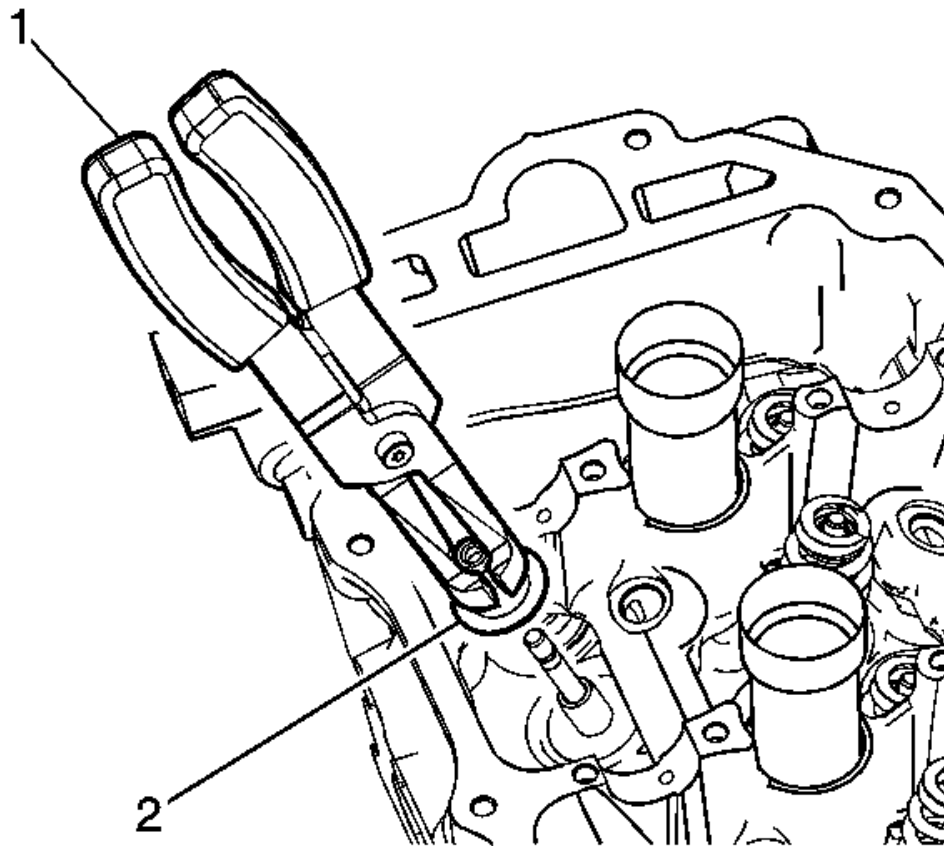
12. Remove the valve spring.



**Fig. 148: Special Tool And Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

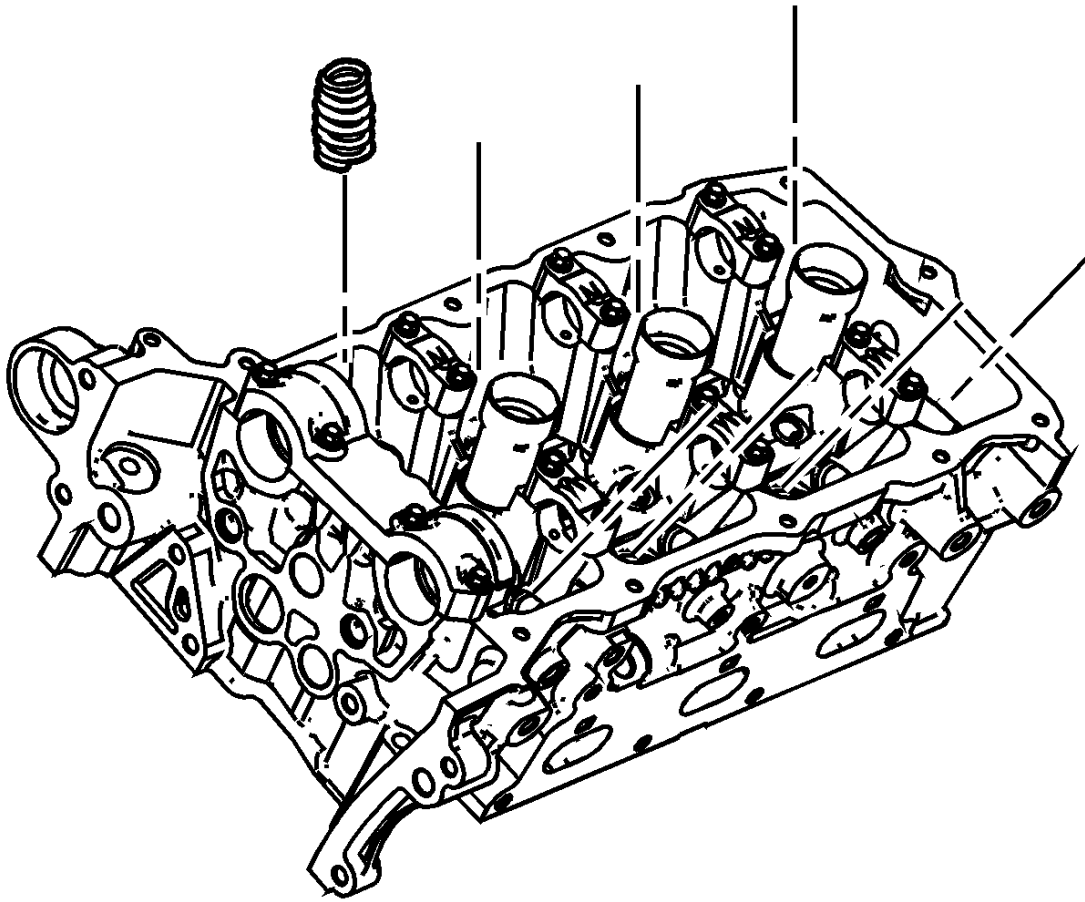
13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

#### Installation Procedure



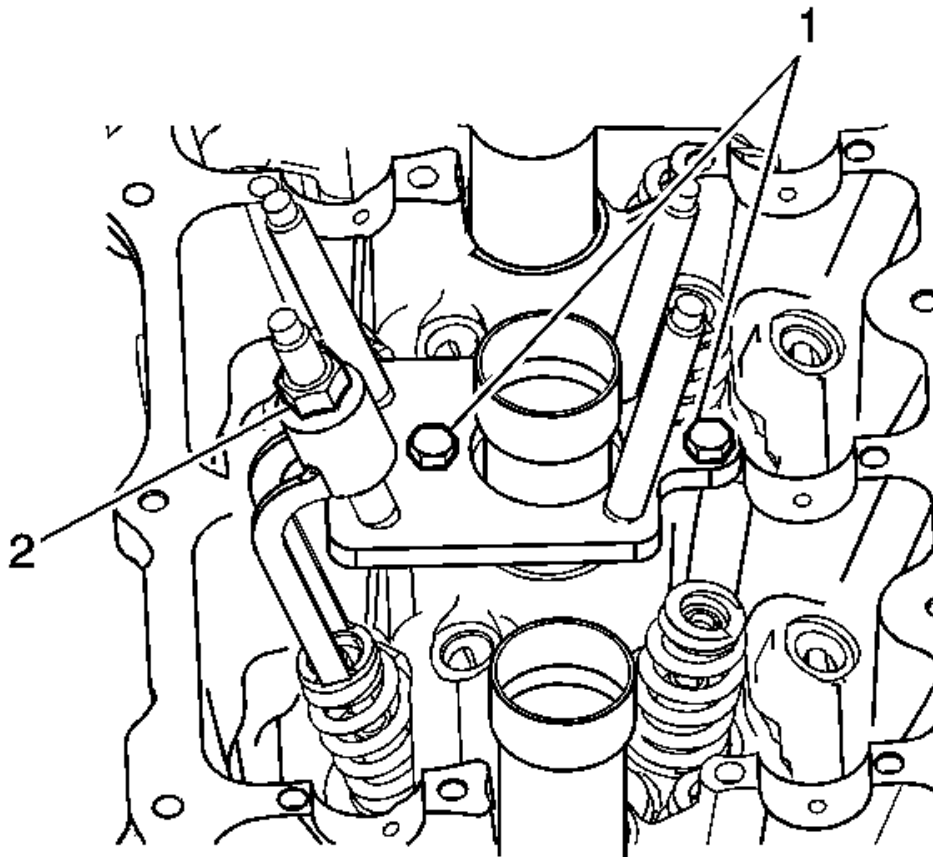
**Fig. 149: Special Tool And Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seal (2).



**Fig. 150: Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

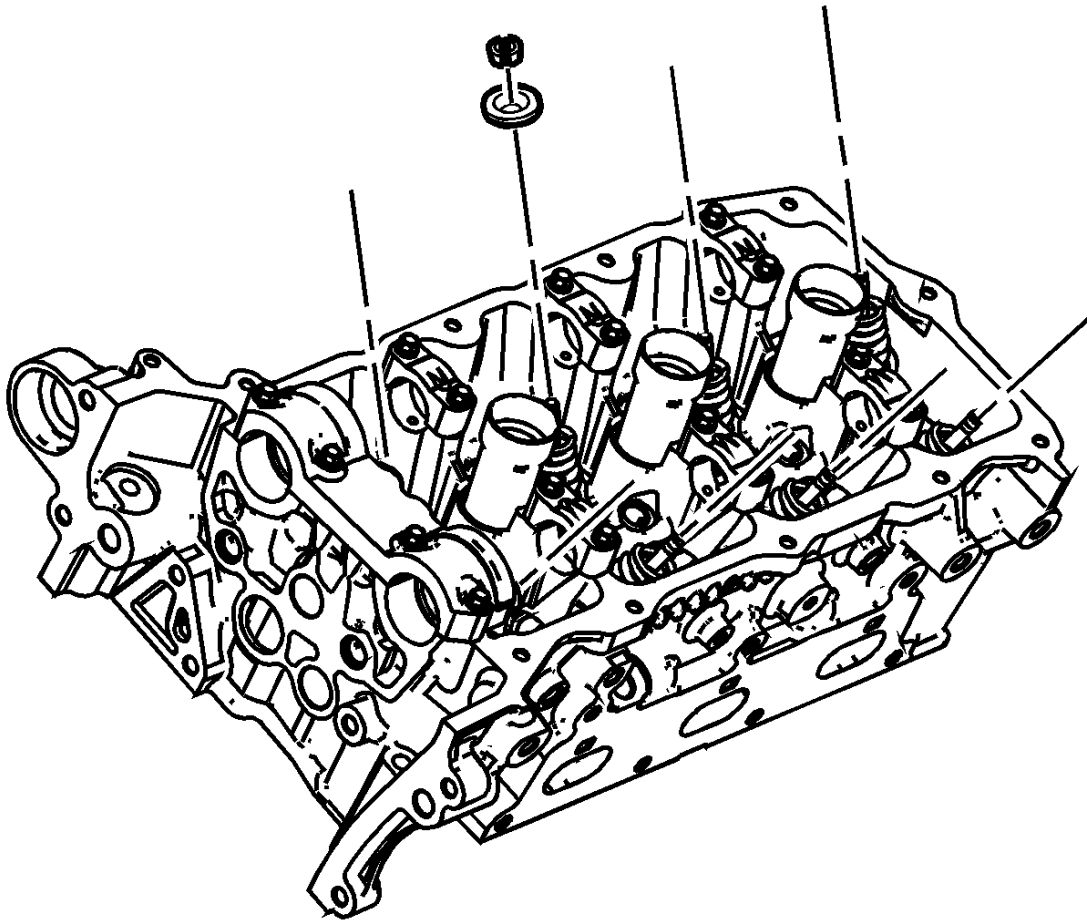
2. Install the valve spring.
3. Install the valve spring retainer.



**Fig. 151: Valve Spring Compressor**  
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

Tighten the **EN-46110** compressor nut (2).



**Fig. 152: Valve Spring Keepers And Valve Spring Retainers**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
11. Remove the **EN-46106** tool in order to prevent crankshaft rotation.
12. Install the starter motor. Refer to **Starter Replacement (V6)** .

## VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

### Special Tools

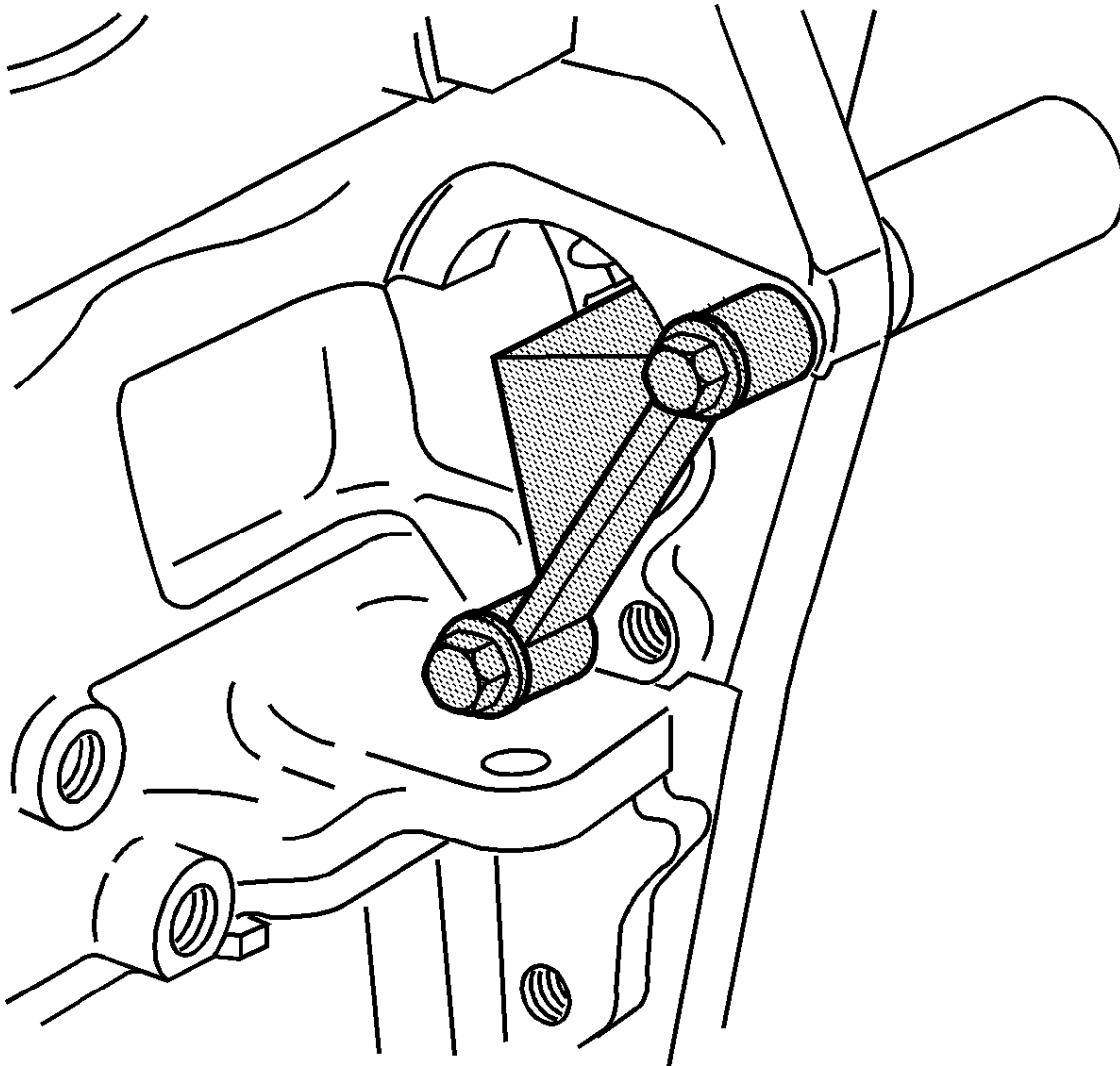
- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

#### Removal Procedure

**NOTE:** This procedure is not used in Brazil.

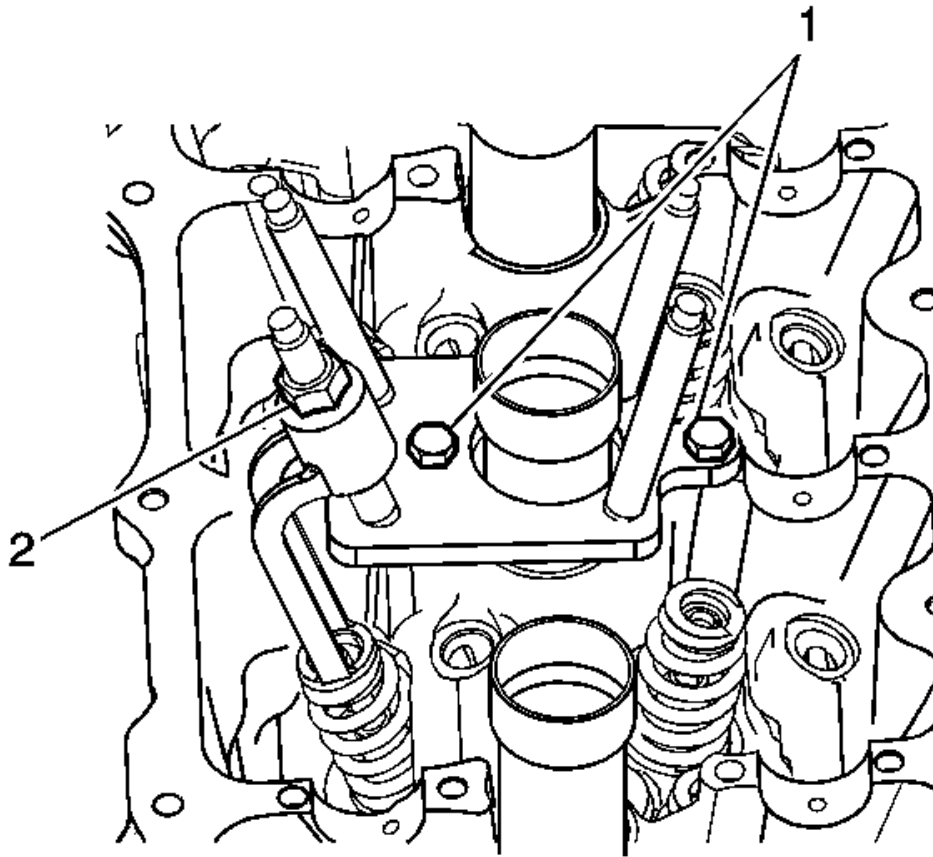
1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.
2. Remove the starter motor. Refer to **Starter Replacement (V6)** .



**Fig. 153: Flywheel Holding Tool**  
Courtesy of GENERAL MOTORS COMPANY

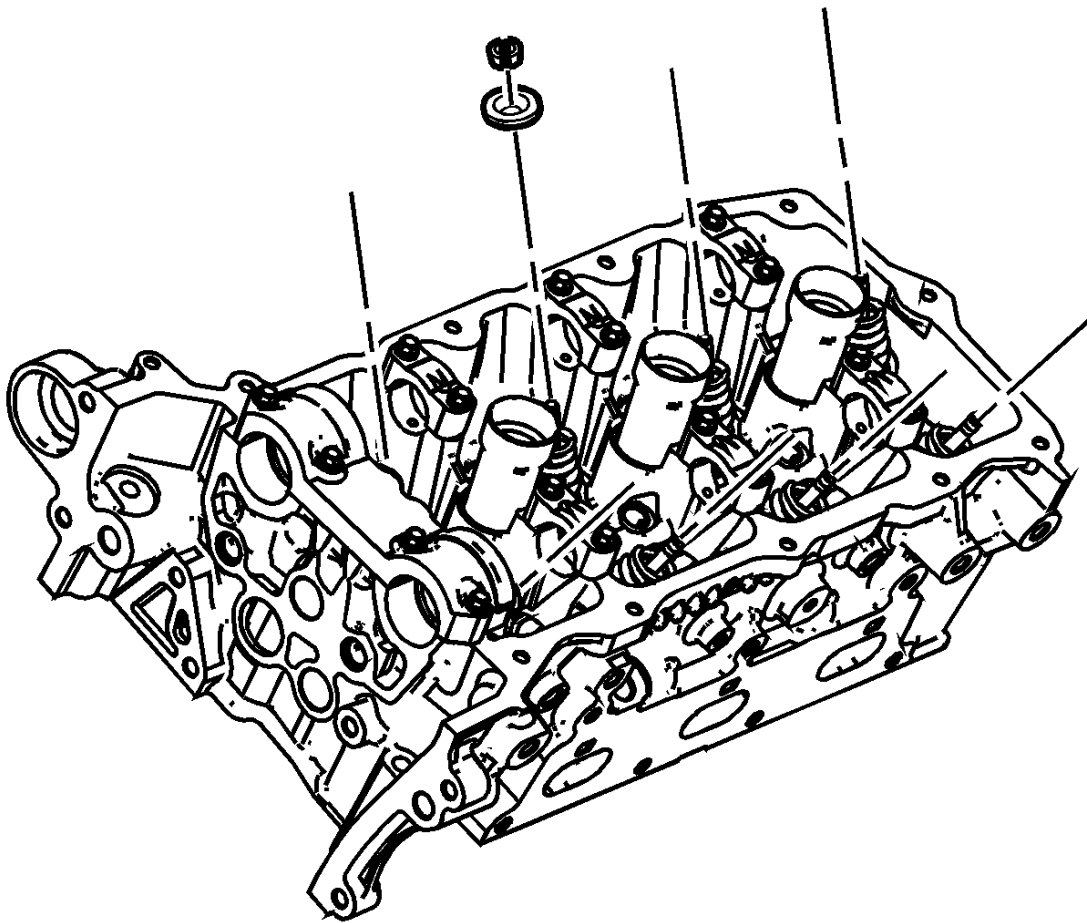
**NOTE:** If the **EN-46106** tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement**.
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.



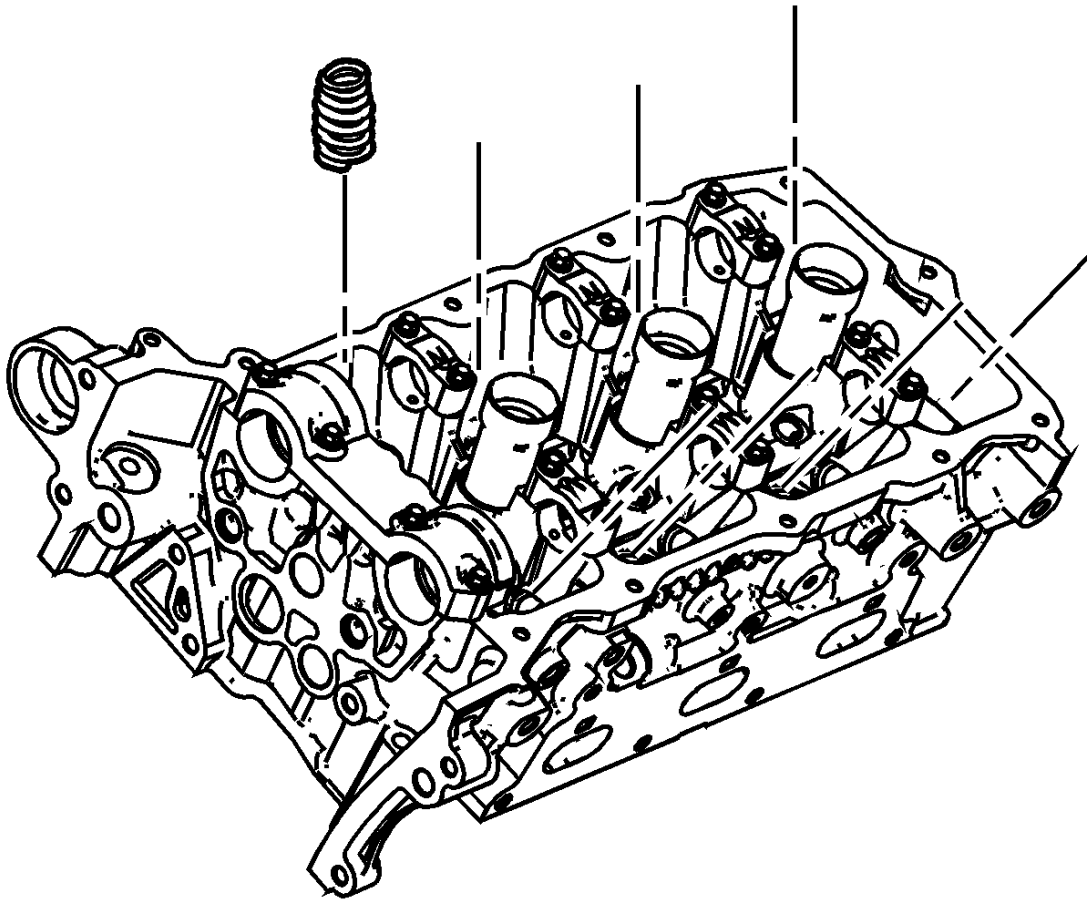
**Fig. 154: Valve Spring Compressor**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).



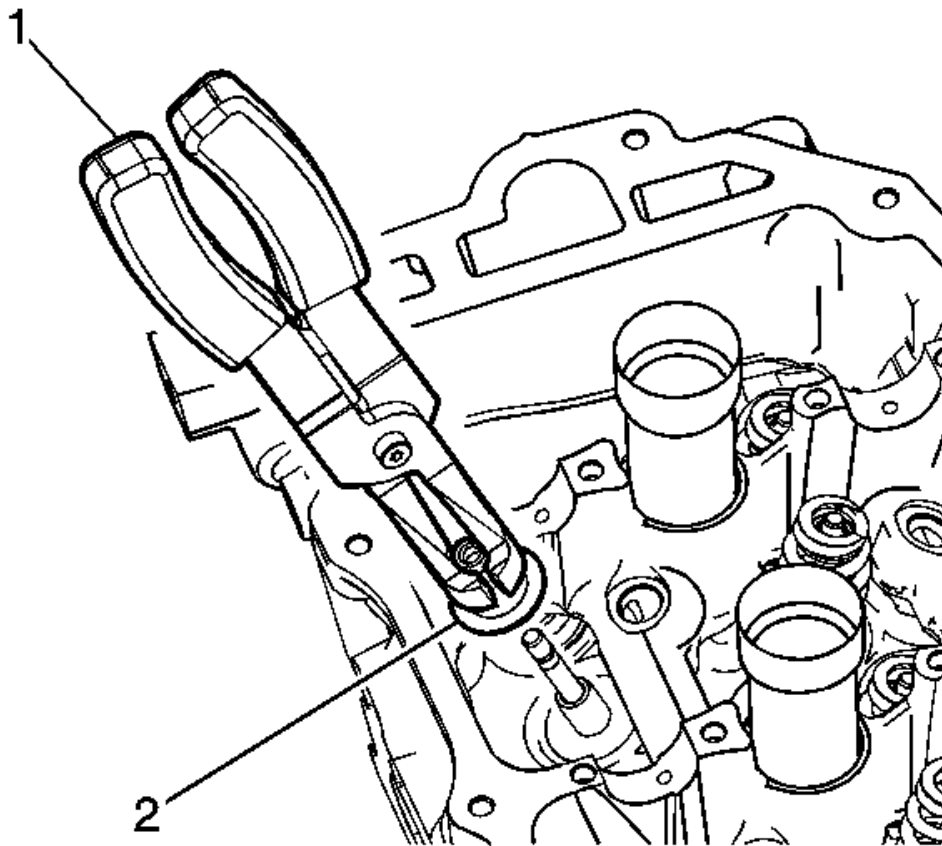
**Fig. 155: Valve Spring Keepers And Valve Spring Retainers**  
Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.



**Fig. 156: Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

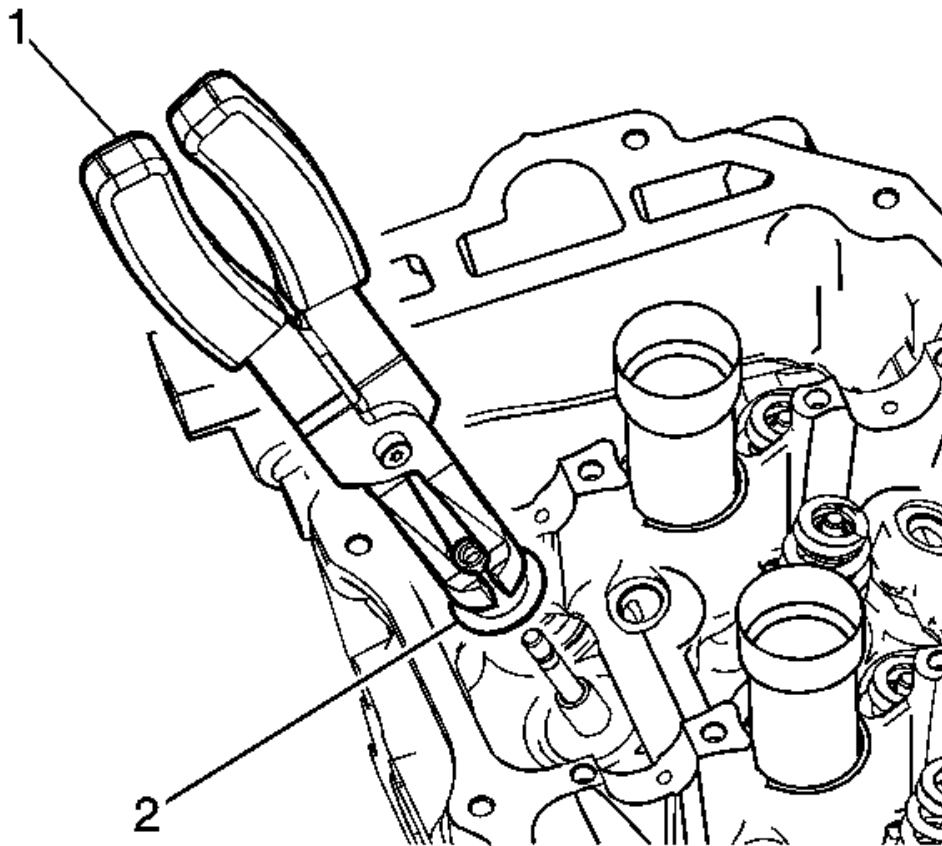
12. Remove the valve spring.



**Fig. 157: Special Tool And Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

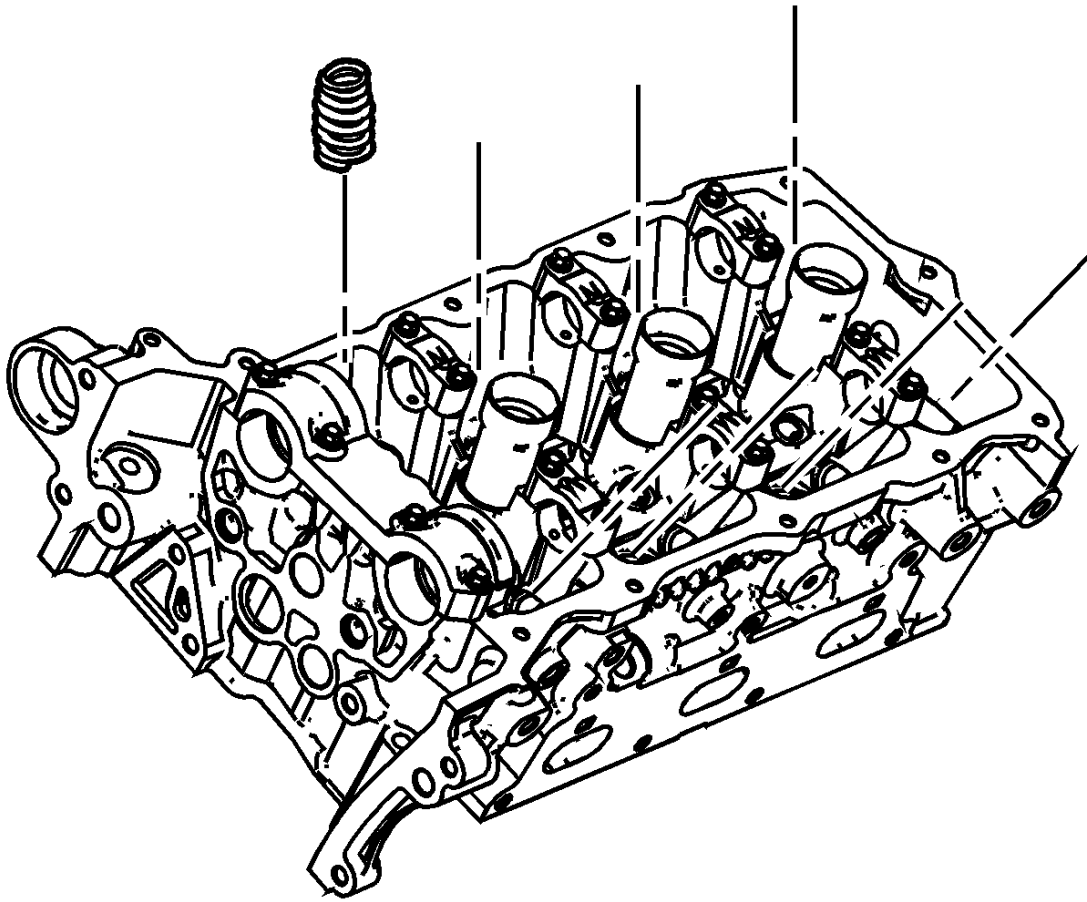
13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

#### Installation Procedure



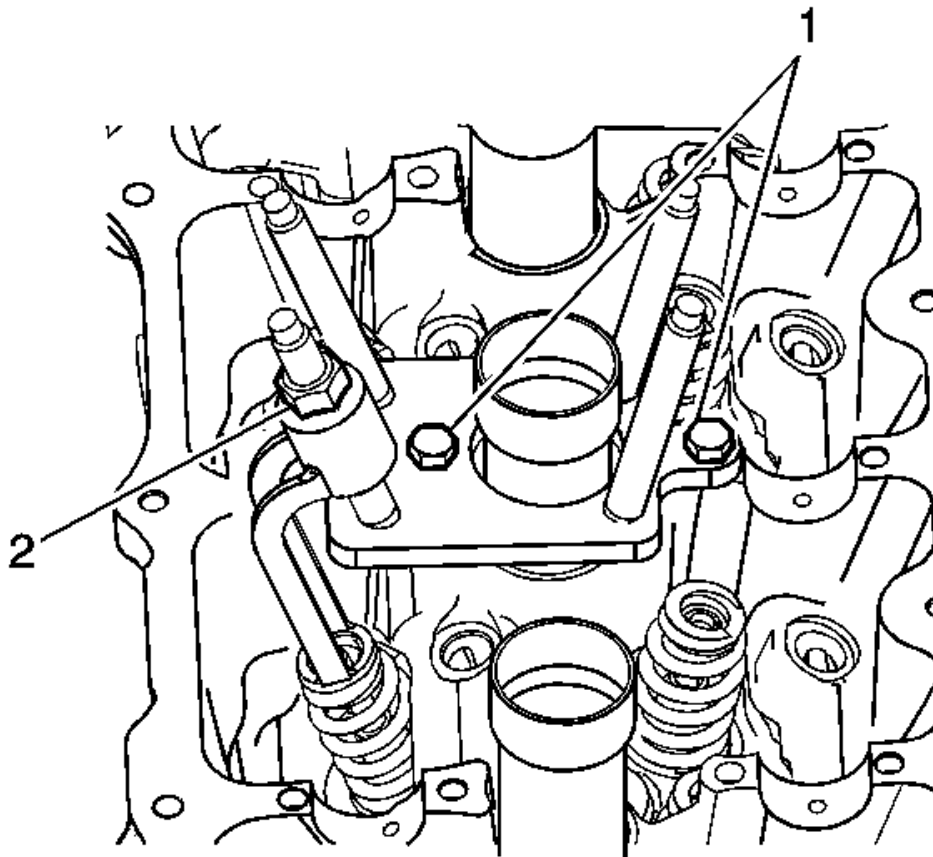
**Fig. 158: Special Tool And Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seals (2).



**Fig. 159: Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

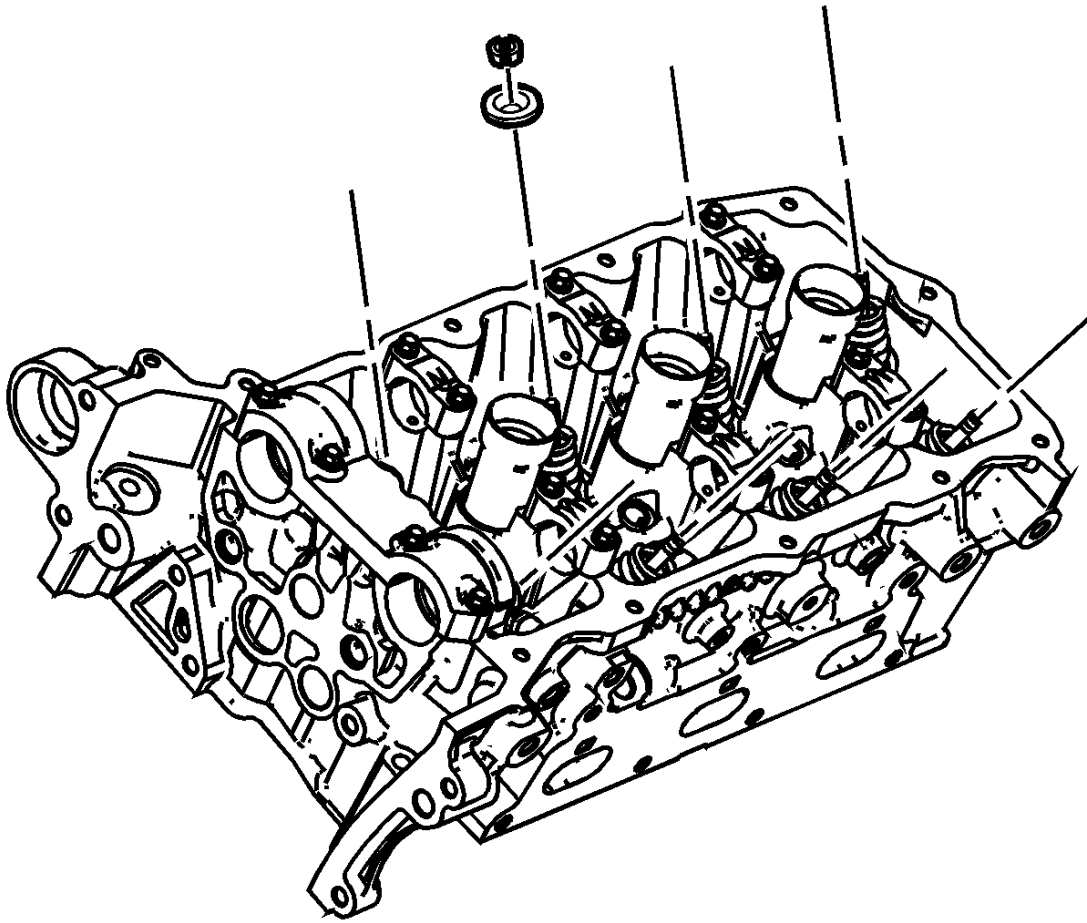
2. Install the valve spring.
3. Install the valve spring retainer.



**Fig. 160: Valve Spring Compressor**  
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

Tighten the **EN-46110** compressor nut (2).



**Fig. 161: Valve Spring Keepers And Valve Spring Retainers**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.
11. Remove the **EN-46106** tool.
12. Install the starter motor. Refer to **Starter Replacement (V6)** .

## CYLINDER HEAD REPLACEMENT - LEFT SIDE (LF1, LFW OR LFX)

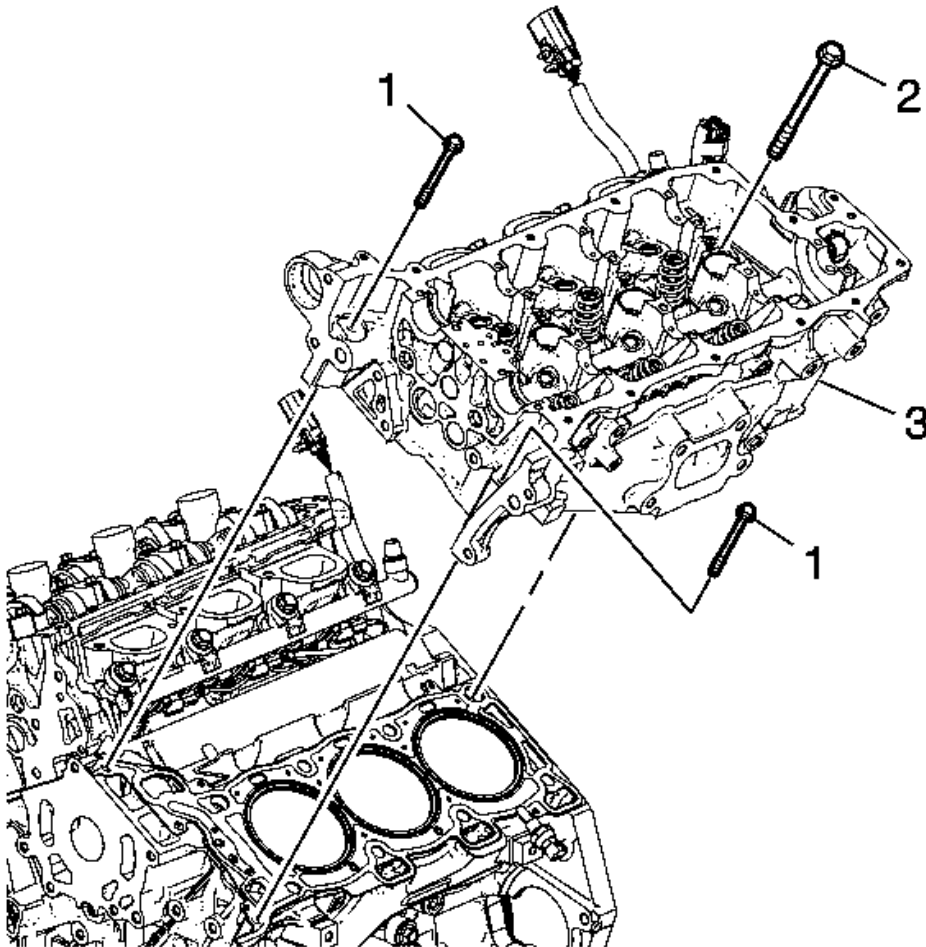
### Special Tools

**EN-45059 Angle Meter**

For equivalent regional tools, refer to **Special Tools** .

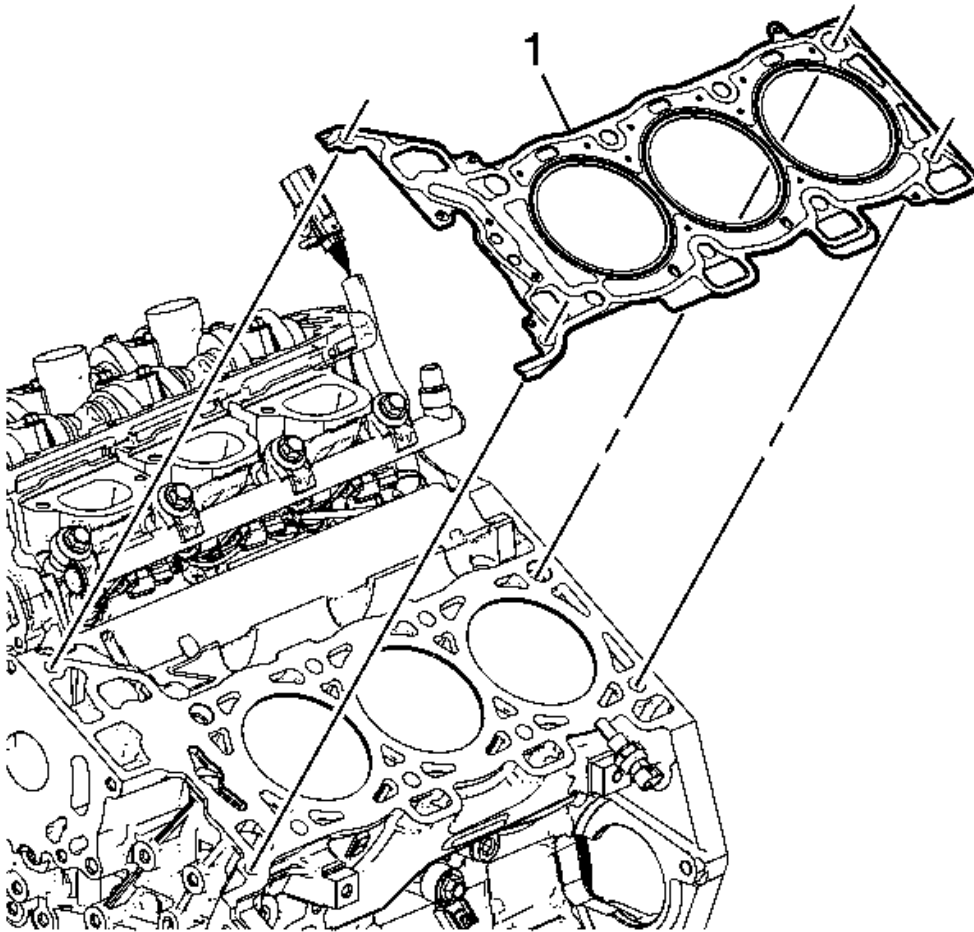
**Removal Procedure**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
2. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
3. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
4. Remove the generator. Refer to **Generator Replacement (V6)** .
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LFX-Front)** .
6. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LF1, LFW or LFX)**.
7. Remove the ground wire bolt and wire from the cylinder head.



**Fig. 162: Left Cylinder Head And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

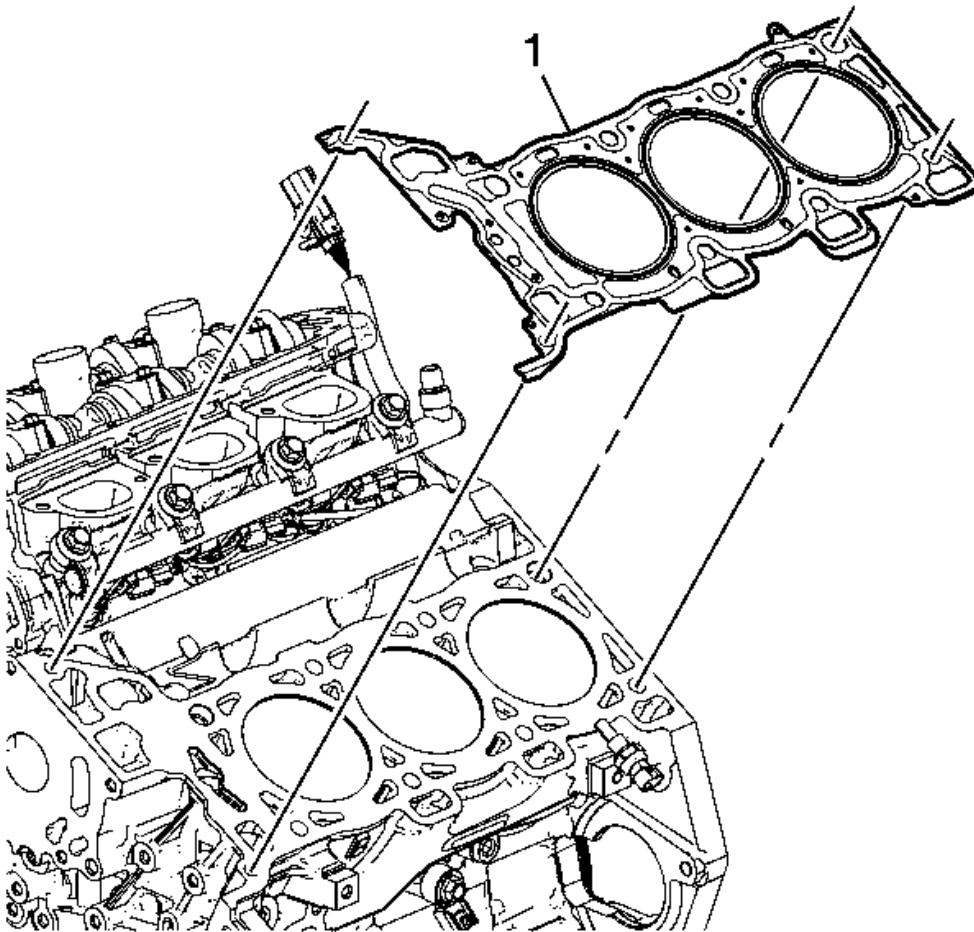
8. Remove the 2 front M8 left cylinder head bolts (1).
9. Remove the left cylinder head bolts (2).
10. Remove the left cylinder head (3).



**Fig. 163: Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS COMPANY

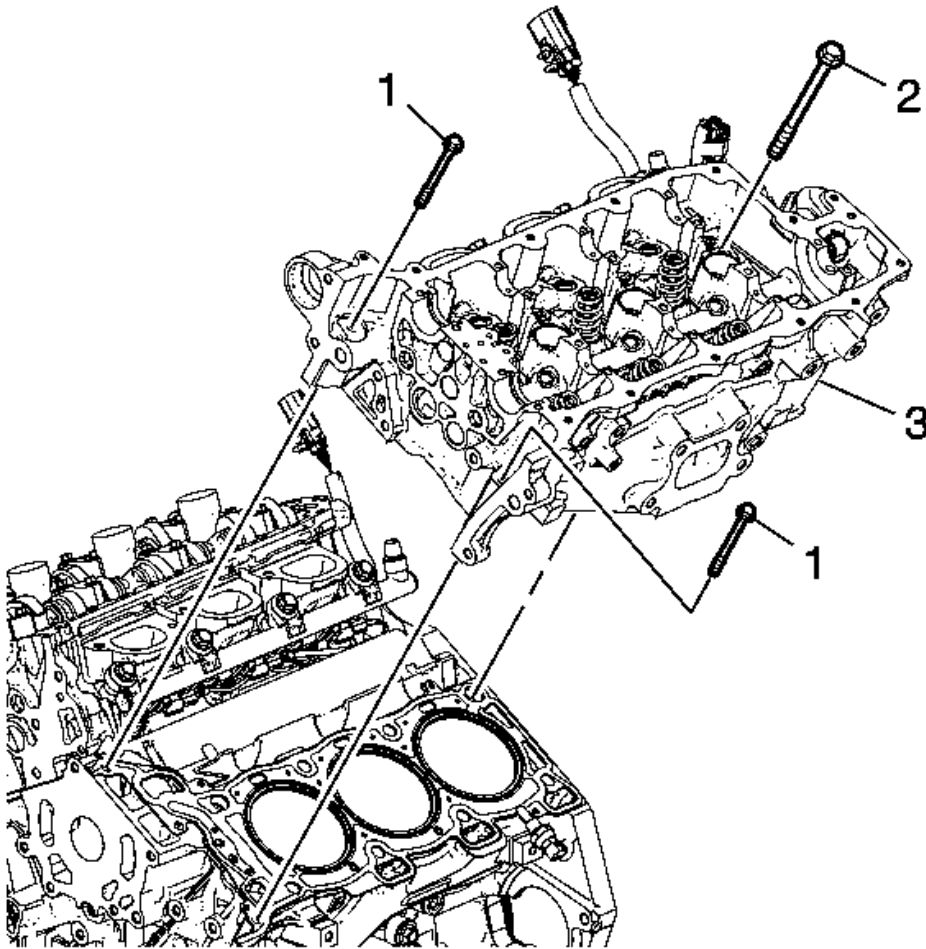
11. Remove and discard the left cylinder head gasket (1).
12. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection , and Engine Block Cleaning and Inspection .
13. Disassemble the cylinder head if needed. Refer to Cylinder Head Disassemble (LF1, LFW or LFX) .

#### Installation Procedure



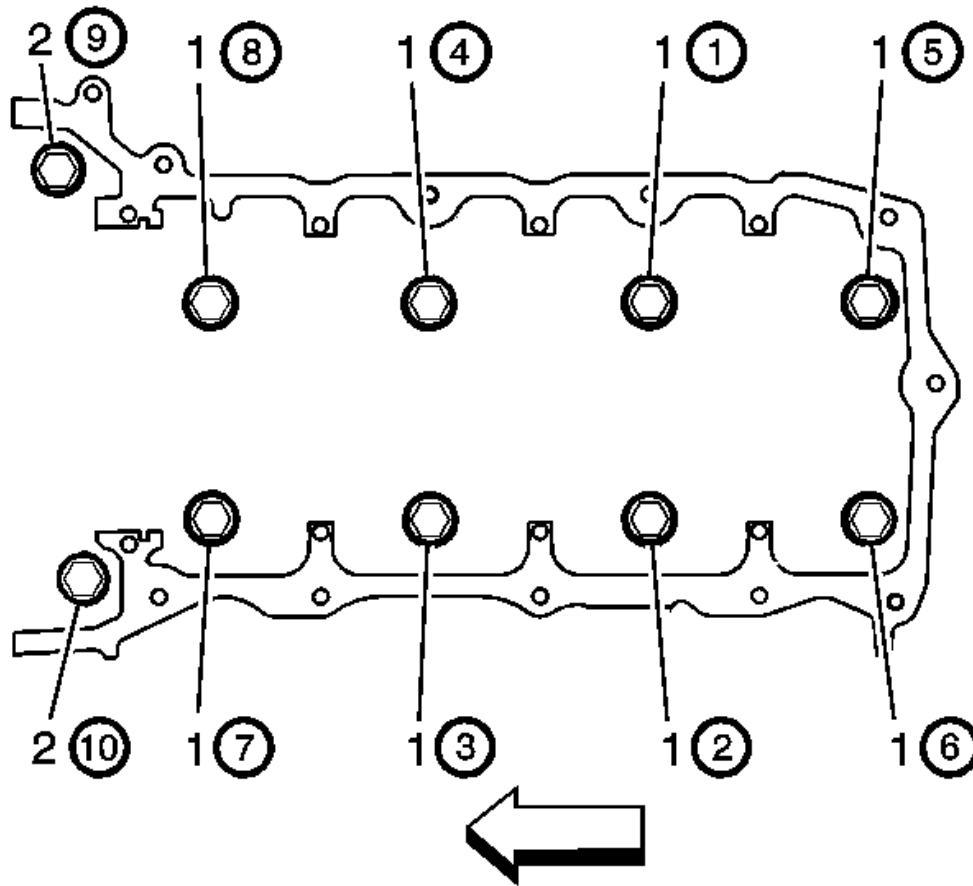
**Fig. 164: Left Cylinder Head Gasket**  
 Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.



**Fig. 165: Left Cylinder Head And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

3. Align the left cylinder head (3) with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.



**Fig. 166: M11 Cylinder Head Bolt Tightening Sequence**  
 Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

**NOTE:**

- **DO NOT** allow oil on the cylinder head bolt bosses.
- **DO NOT** reuse the old cylinder head bolts.

5. Install the NEW M11 cylinder head bolts (1).
  1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
  2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.
6. Install the 2 NEW front M8 left cylinder head bolts (2).
  1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft).
  2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the

**EN-45059** meter.

7. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
9. Install the fuel pump. Refer to **Fuel Pump Replacement**.
10. Install the generator. Refer to **Generator Replacement (V6)**.
11. Install the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (LFX-Front)**.
12. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LF1, LFW or LFX)**.

## **CYLINDER HEAD REPLACEMENT - RIGHT SIDE (LF1, LFW OR LFX)**

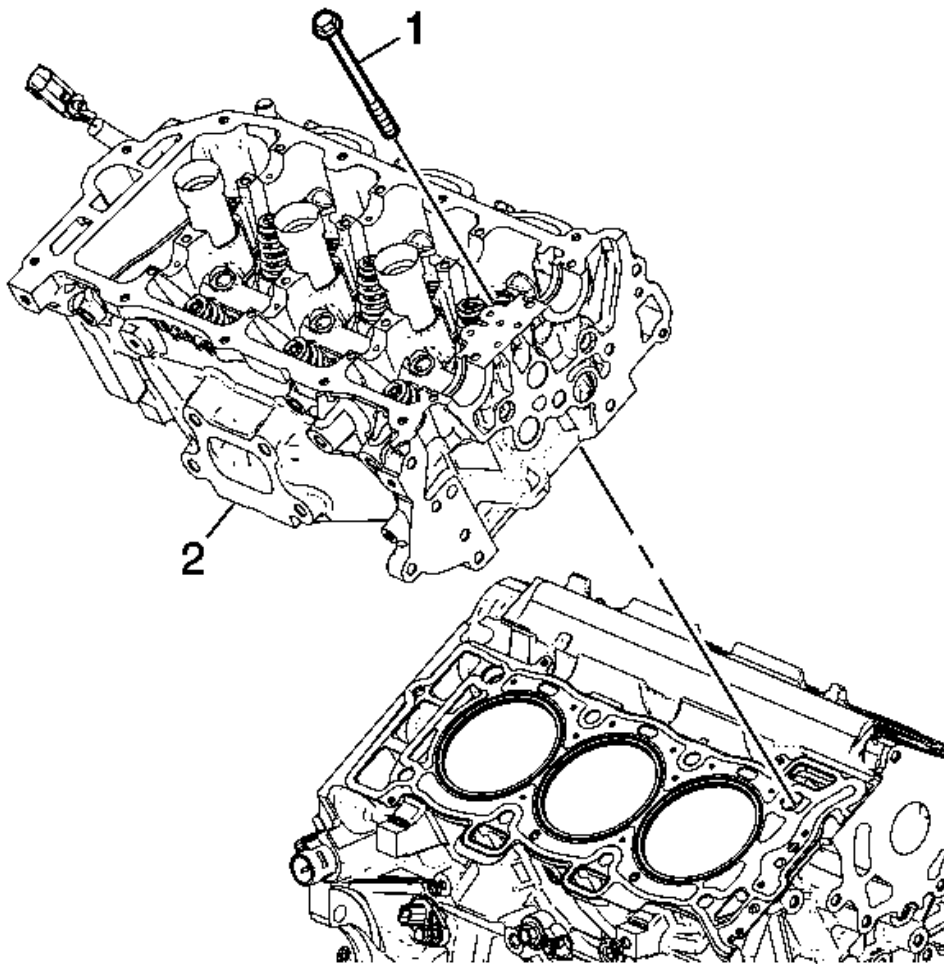
### **Special Tools**

**EN-45059** Angle Meter

For equivalent regional tools, refer to **Special Tools**.

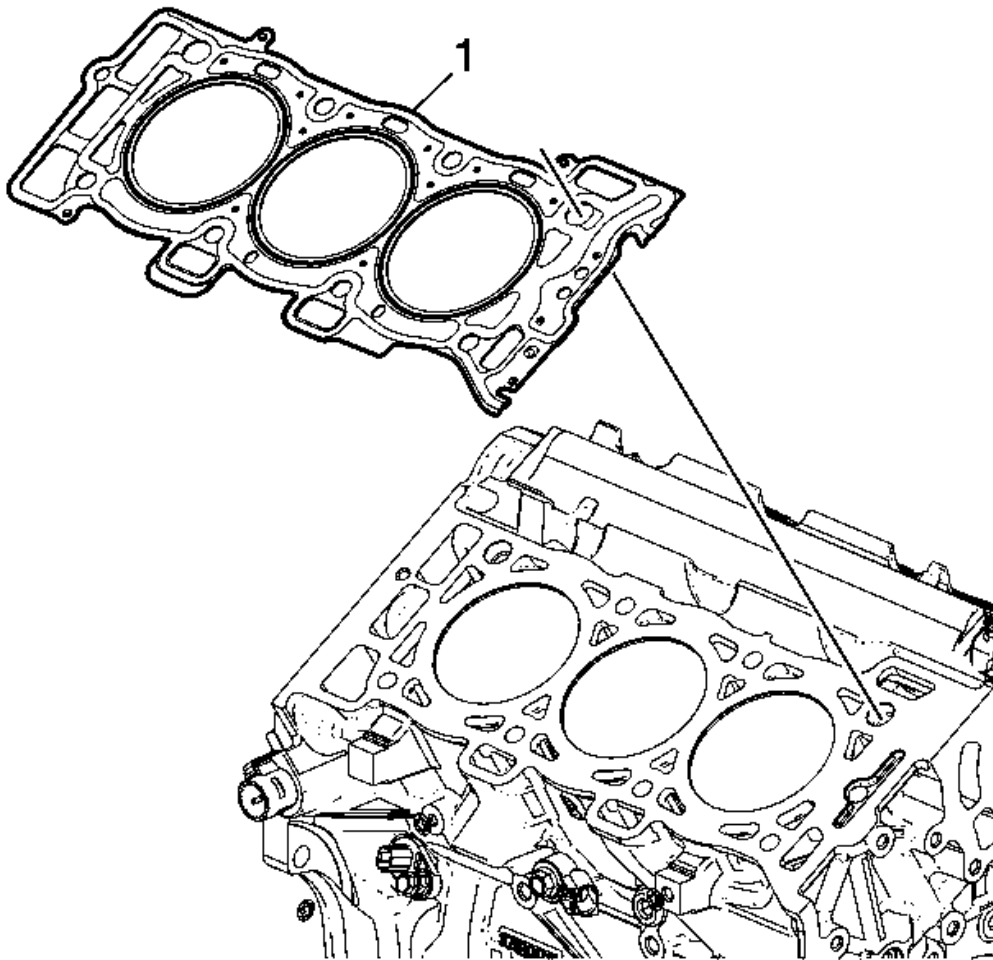
### **Removal Procedure**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement (With AWD at Tank)**, **Fuel Feed Pipe Replacement (LFW or LFX)**.
3. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFW or LFX)**.
4. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LFX-Rear)**.



**Fig. 167: Right Cylinder Head And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

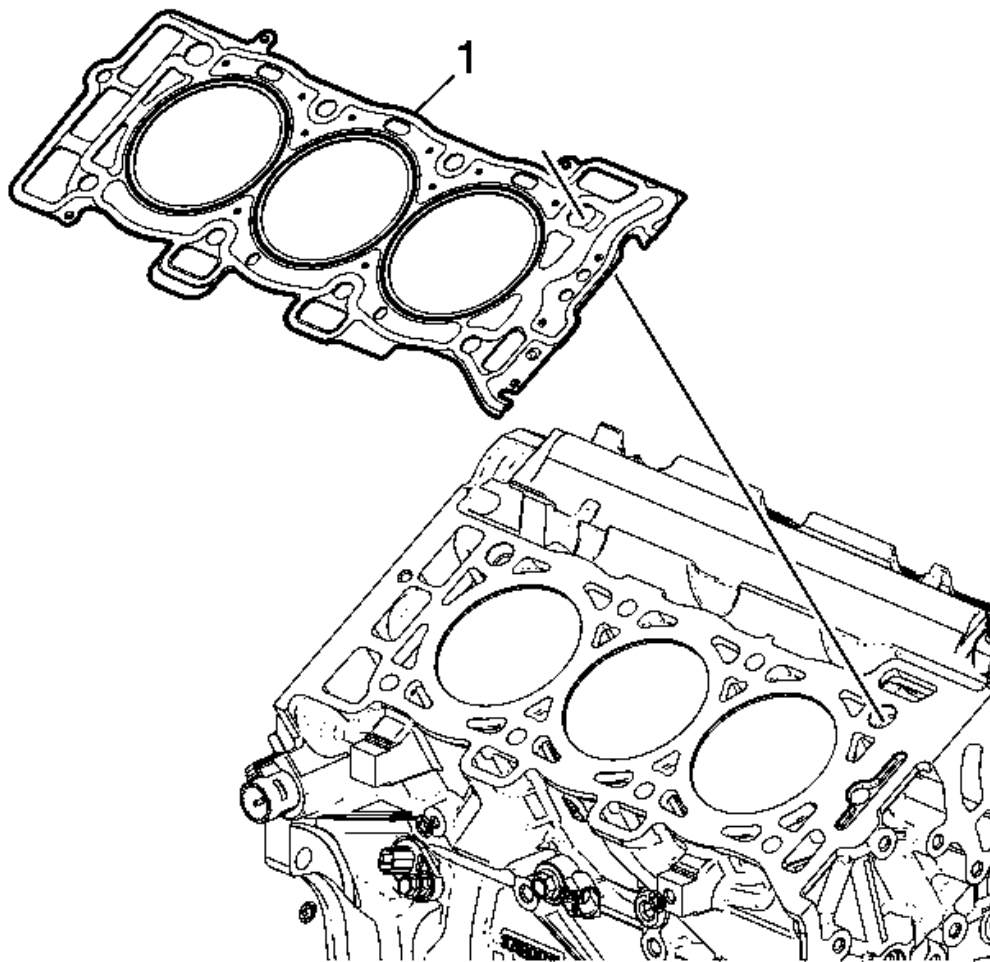
6. Remove the right cylinder head bolts (1).
7. Remove the right cylinder head (2).



**Fig. 168: Right Cylinder Head Gasket**  
 Courtesy of GENERAL MOTORS COMPANY

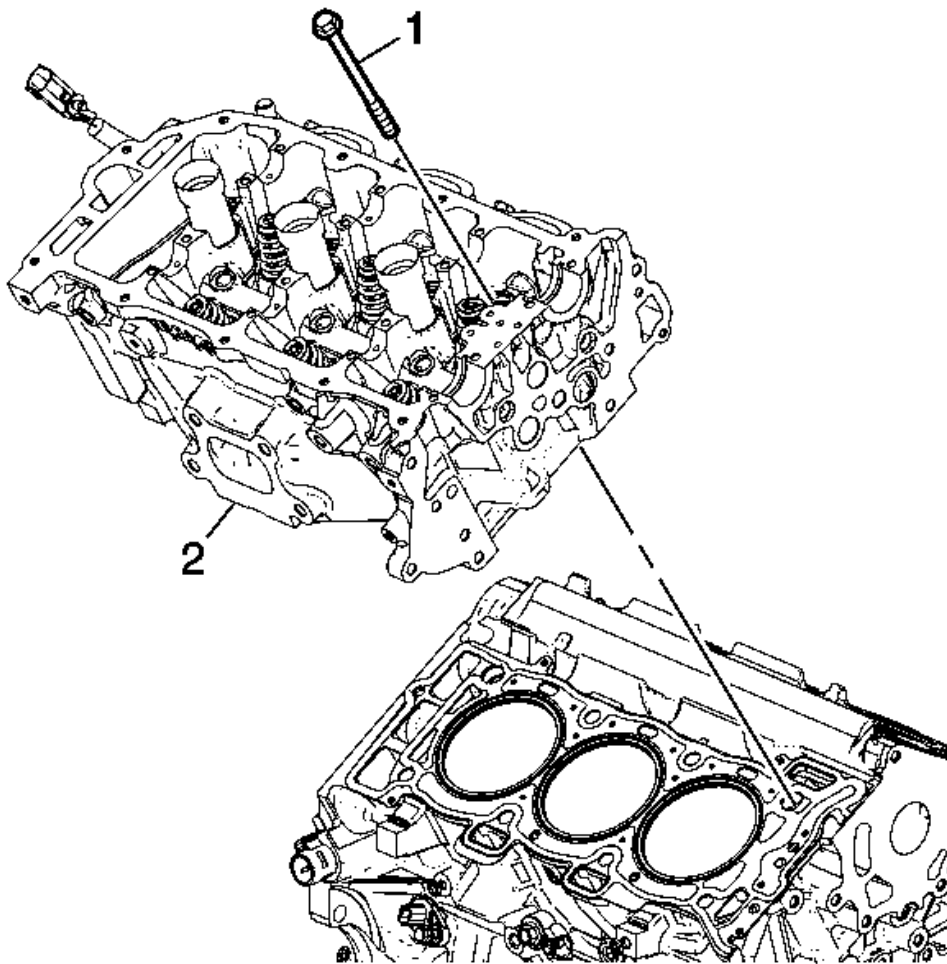
8. Remove and discard the cylinder head gasket (1).
9. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection , and Engine Block Cleaning and Inspection .
10. Disassemble the cylinder head if needed. Refer to Cylinder Head Disassemble (LF1, LFW or LFX) .

#### Installation Procedure



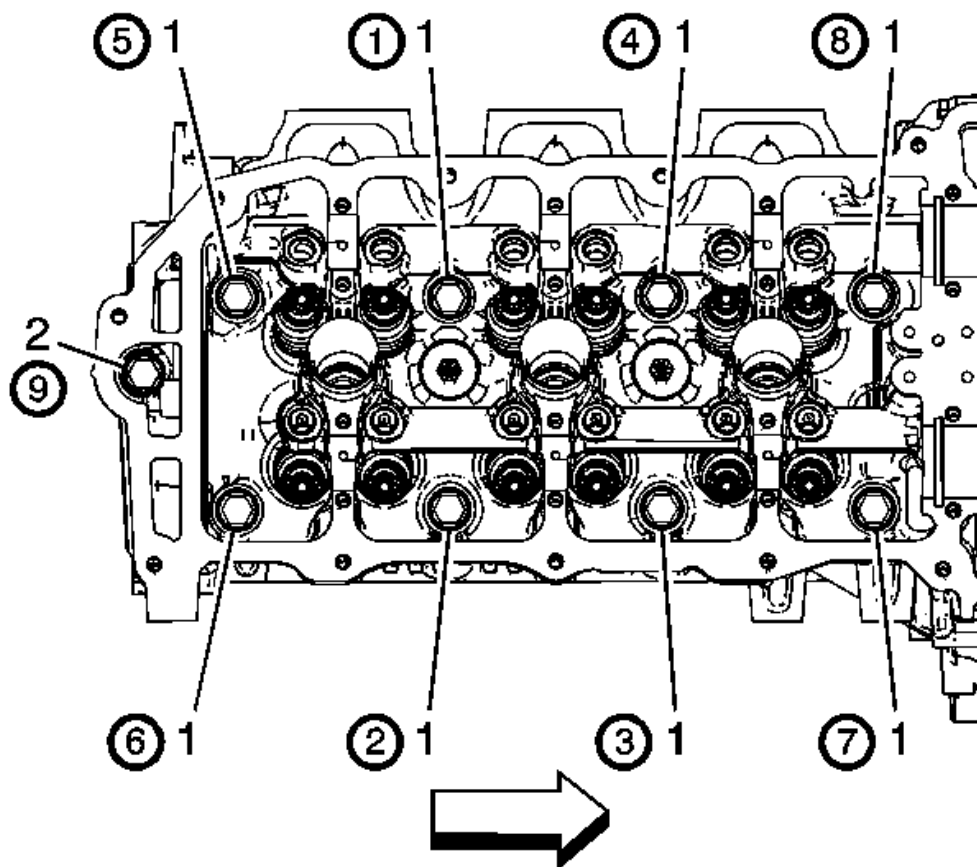
**Fig. 169: Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.



**Fig. 170: Right Cylinder Head And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

3. Align the right cylinder head (2) with the deck face locating pins.
4. Place the right cylinder head in position on the deck face.



**Fig. 171: Cylinder Head Bolt Tightening Sequence**  
 Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

**NOTE:**

- **DO NOT** allow oil on the cylinder head bolt bosses.
- **DO NOT** reuse the old cylinder head bolts.

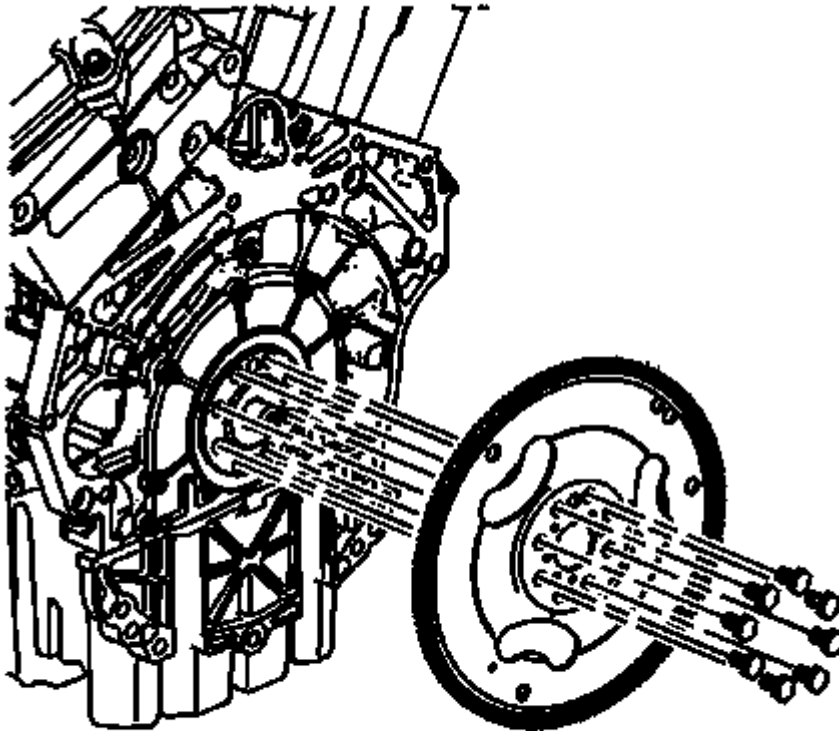
5. Install the NEW M11 cylinder head bolts (1).
  1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
  2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.
6. Install the NEW M8 cylinder head bolt (2).
  1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
  2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **EN-45059**

meter.

7. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
8. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LFX-Rear)**.
9. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFW or LFX)**.
10. Install the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement (With AWD at Tank)**, **Fuel Feed Pipe Replacement (LFW or LFX)**.
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

## ENGINE FLYWHEEL REPLACEMENT

### Removal Procedure



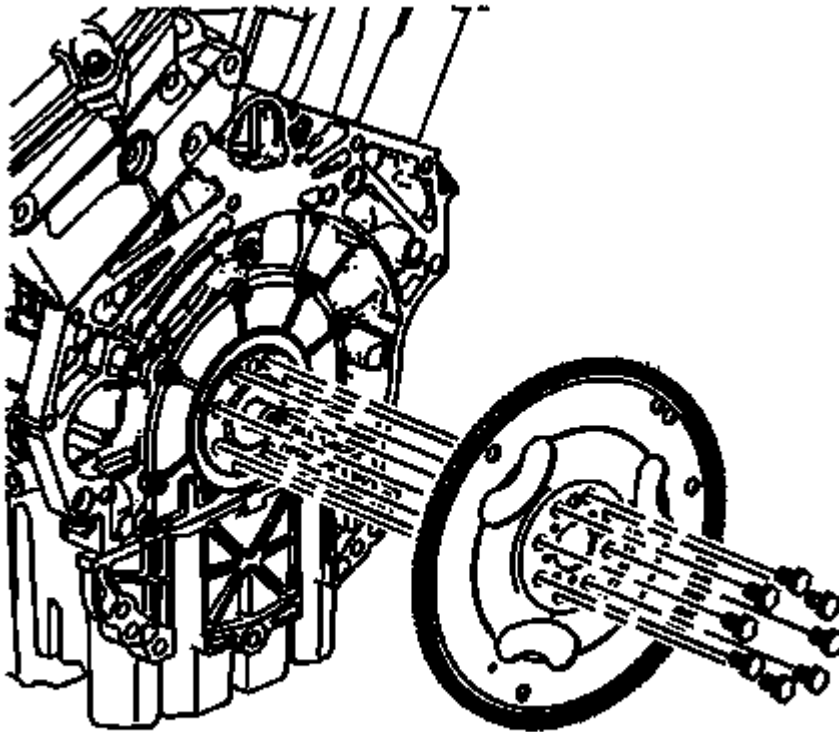
**Fig. 172: Engine Flywheel**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the transmission. Refer to **Transmission Replacement (FWD)**, **Transmission Replacement (AWD)**.
2. Remove the flywheel. Refer to **Engine Flywheel Removal**

3. Clean and inspect the flywheel. Refer to Engine Flywheel Cleaning and Inspection . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive.

#### Installation Procedure



**Fig. 173: Engine Flywheel**

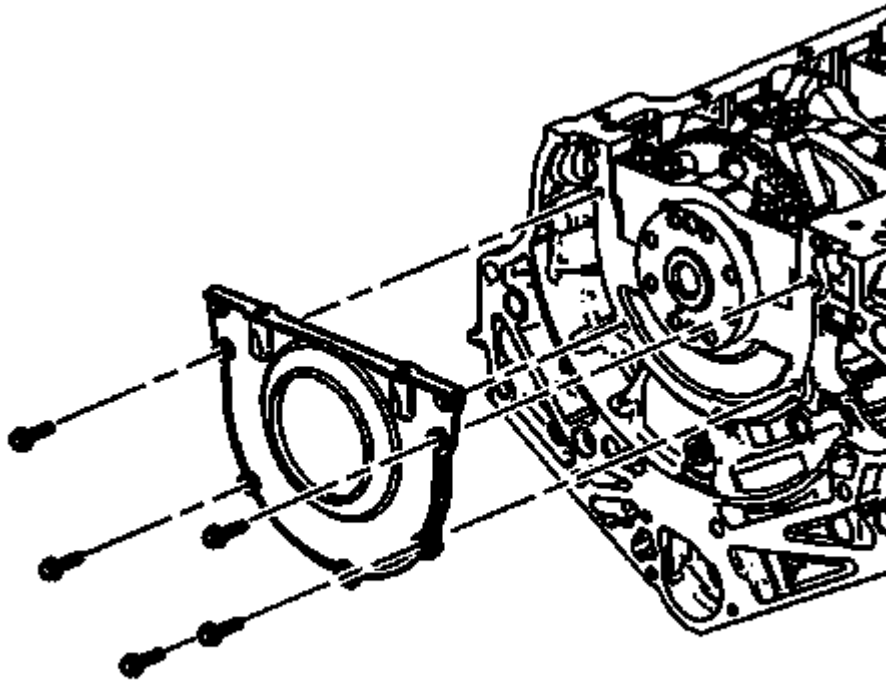
Courtesy of GENERAL MOTORS COMPANY

1. Install the flywheel. Refer to Engine Flywheel Installation
2. Install the transmission. Refer to Transmission Replacement (FWD) , Transmission Replacement (AWD) .

#### CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

##### Removal Procedure

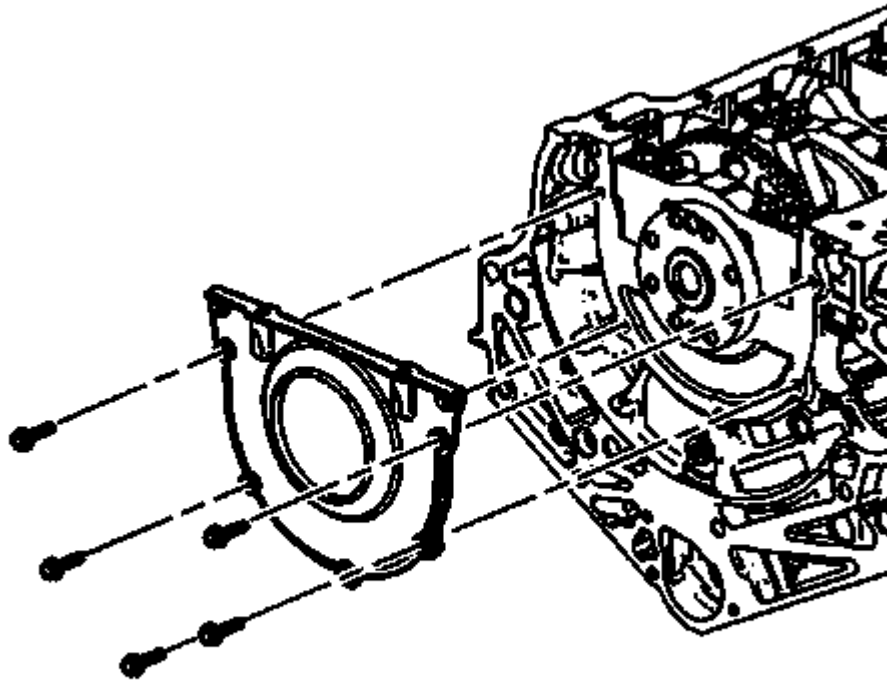
1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.
2. Remove the oil pan. Refer to Oil Pan Replacement.



**Fig. 174: Crankshaft Rear Oil Seal And Housing**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Removal**.

#### Installation Procedure

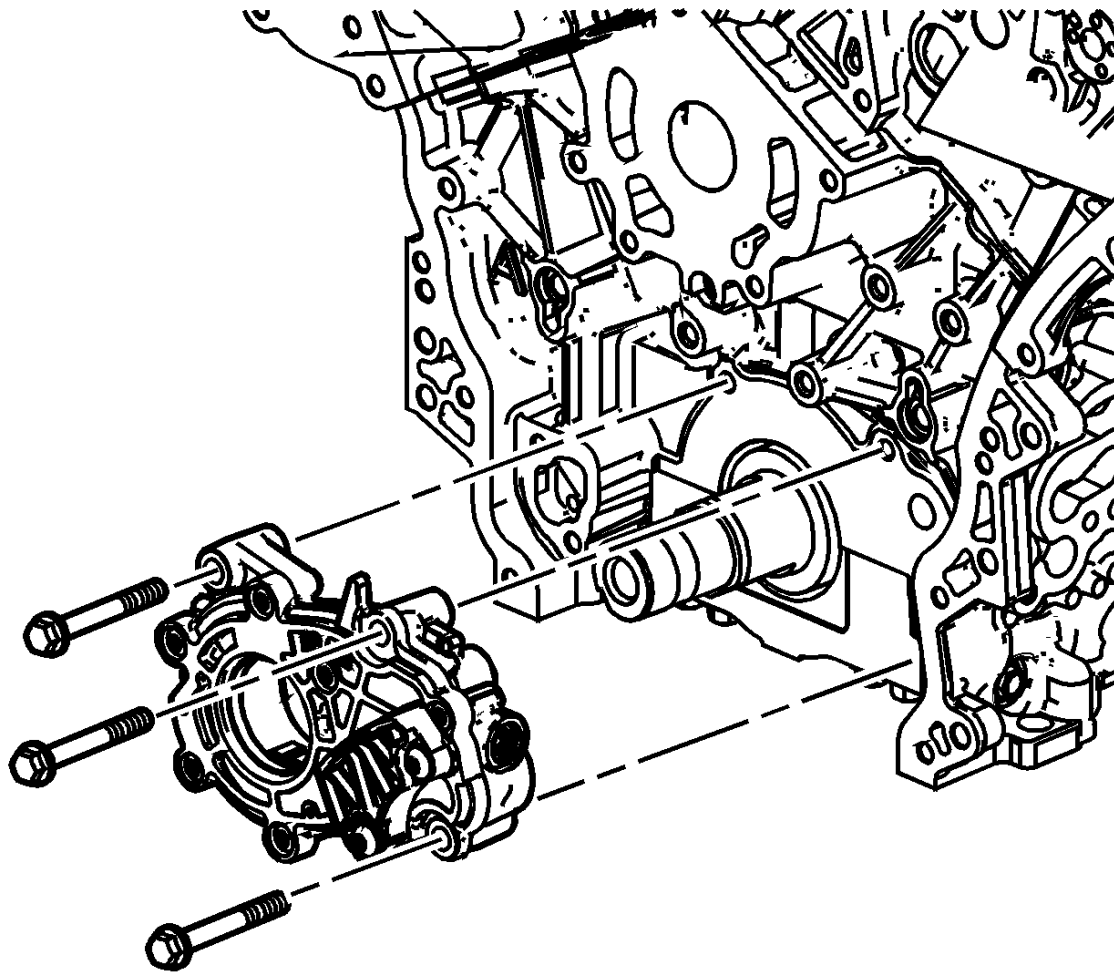


**Fig. 175: Crankshaft Rear Oil Seal And Housing**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Installation** .
2. Install the oil pan. Refer to **Oil Pan Replacement**.
3. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

## OIL PUMP REPLACEMENT

### Removal Procedure

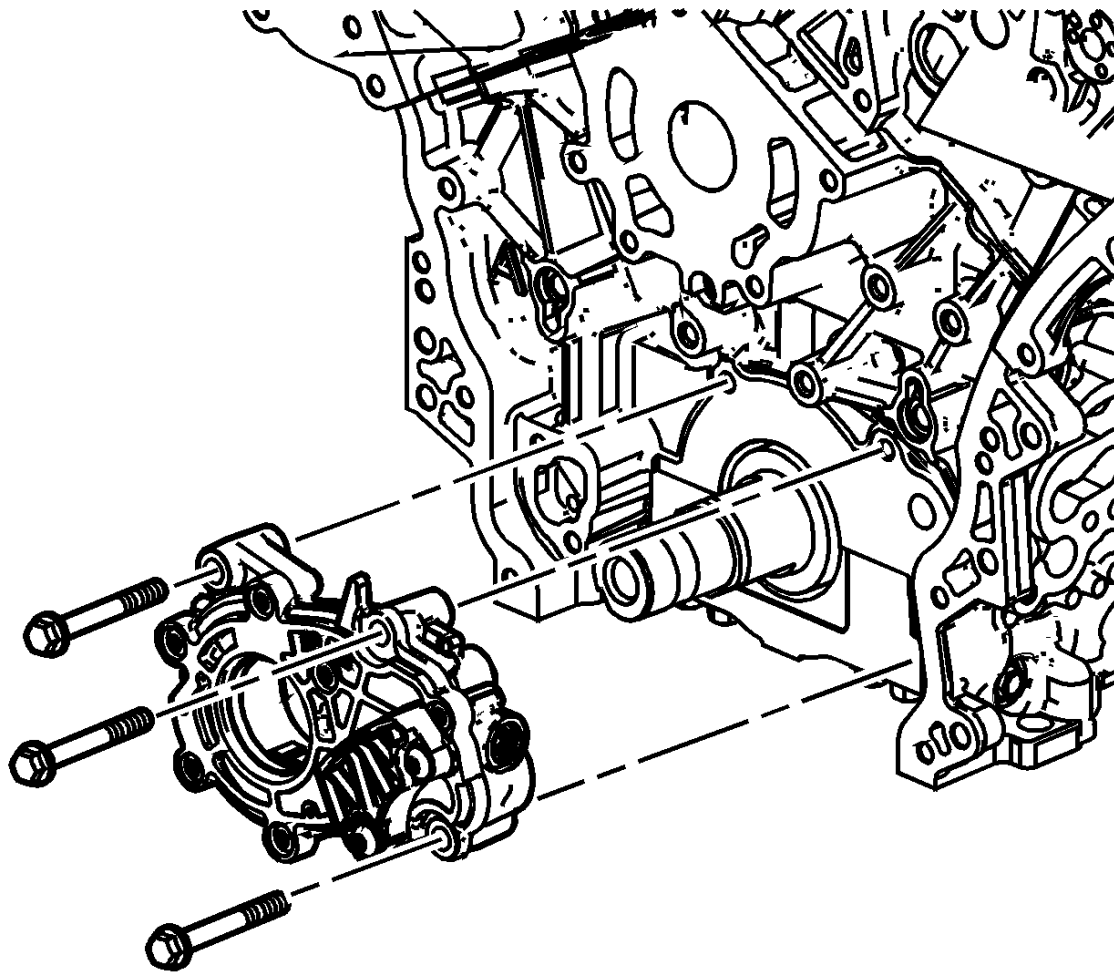


**Fig. 176: Oil Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not remove the left bank idler sprocket.

1. Remove the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.
2. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal**.
3. Remove the oil pump bolts and the oil pump.

#### Installation Procedure



**Fig. 177: Oil Pump And Mounting Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pump and bolts. Refer to **Oil Pump Installation**
2. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation** .
3. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

## OIL PAN REPLACEMENT

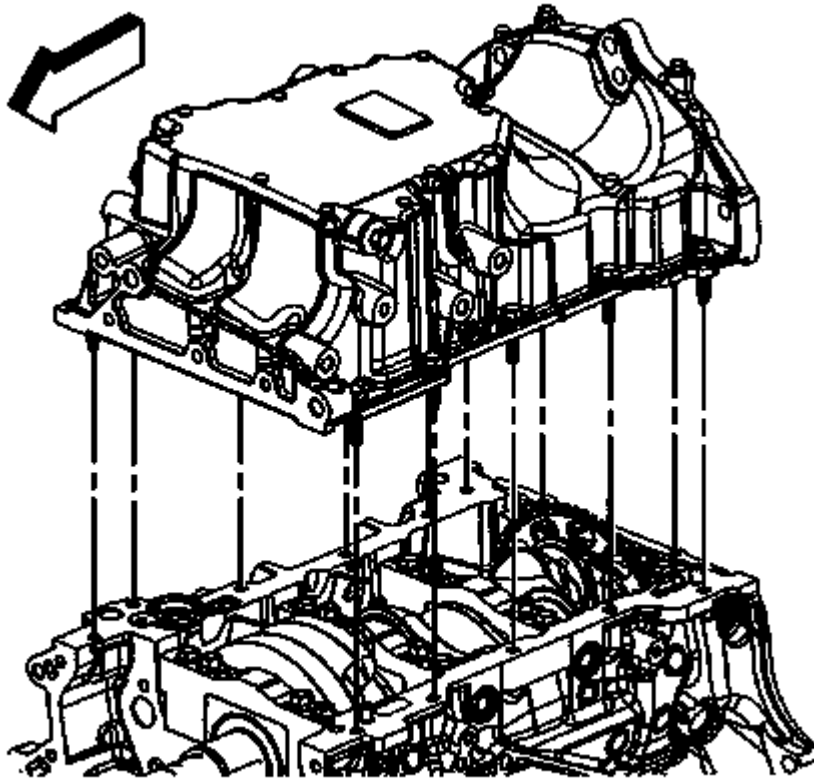
### Special Tools

EN-46109 Guide Pin Set

For equivalent regional tools, refer to **Special Tools** .

### Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement (LF1, LFW or LFX)**.
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LFX-Front)** .
4. Remove the air conditioning (A/C) compressor bolts and reposition. DO NOT discharge the A/C system. Support the A/C compressor. Refer to **Air Conditioning Compressor Replacement (V6)** .
5. Remove the front cover. Refer to **Engine Front Cover Replacement**.
6. Remove the oil pan to transmission bolts.

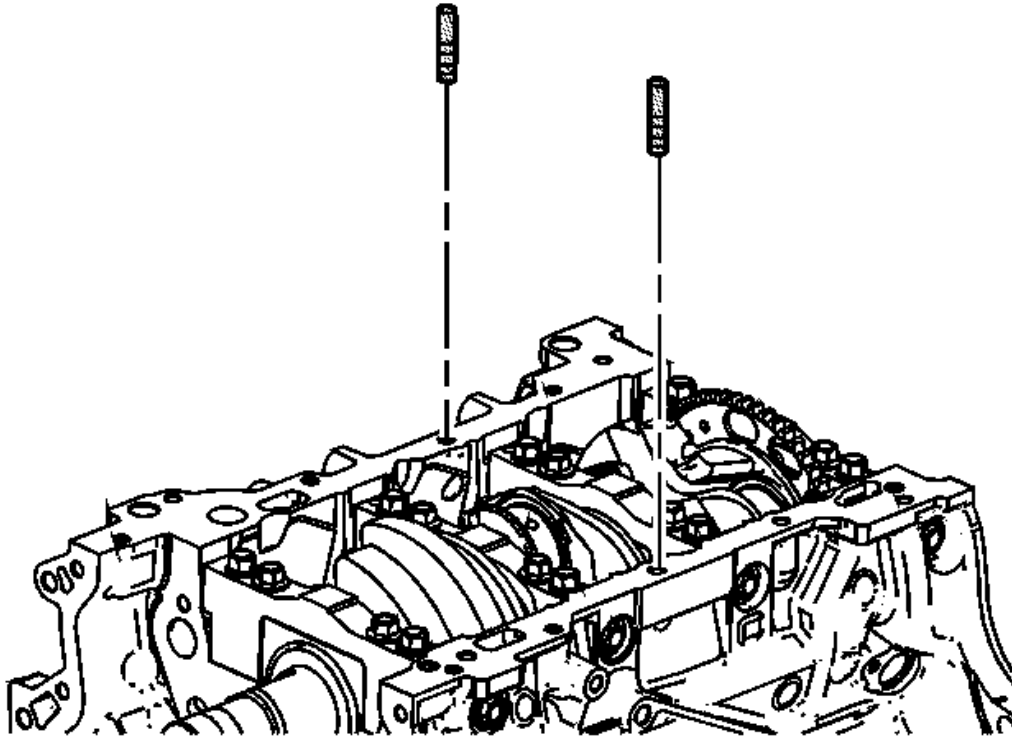


**Fig. 178: Engine Oil Pan**

Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil pan bolts.
8. Remove the oil pan.
9. Clean the oil pan and the engine block gasket surface. Refer to **Oil Pan Cleaning and Inspection** .

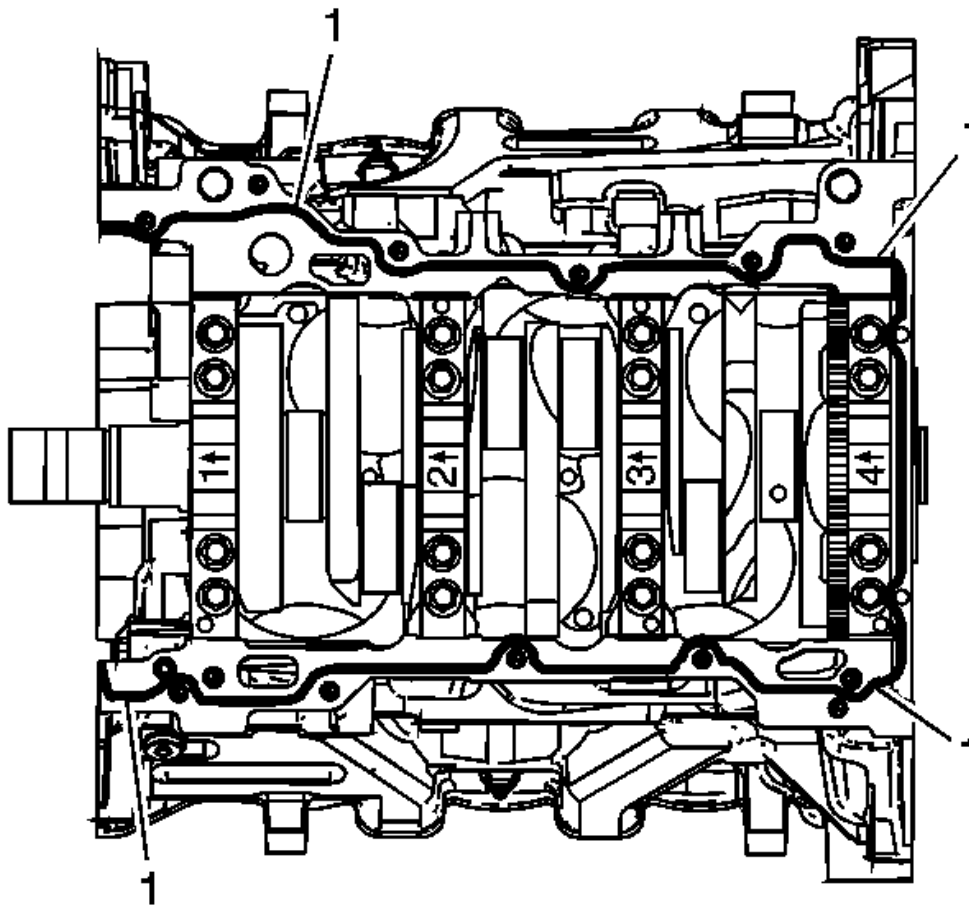
#### Installation Procedure



**Fig. 179: Guide Pin Set Guides**

Courtesy of GENERAL MOTORS COMPANY

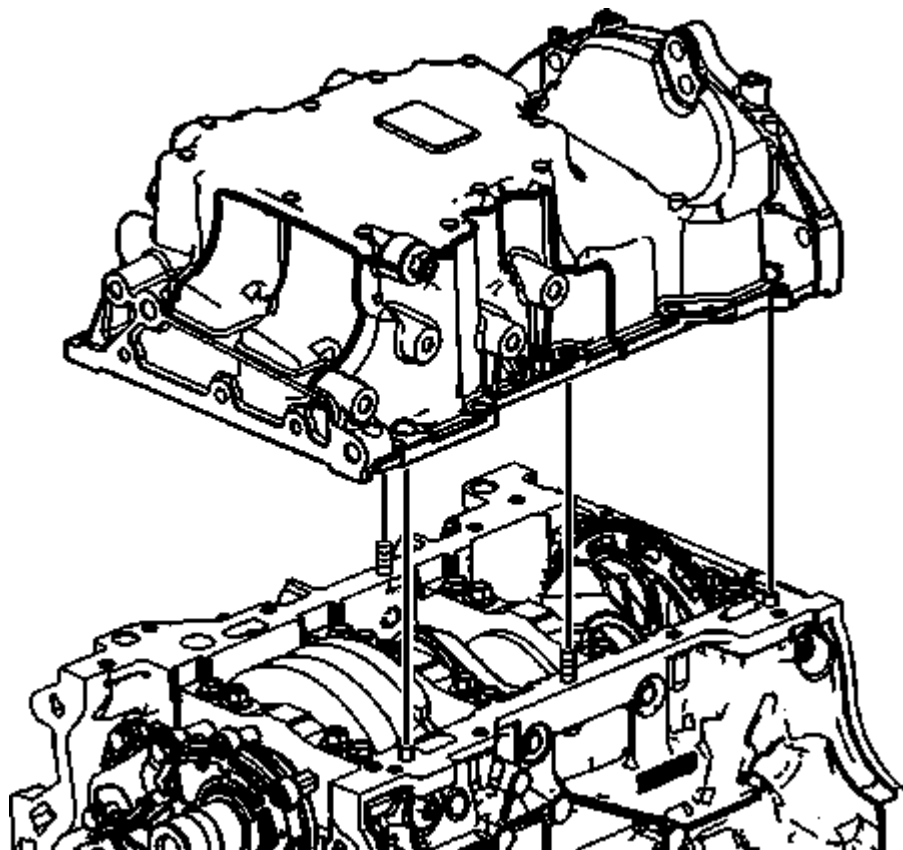
1. Install the 8 mm (0.315 in) guides from the **EN-46109** set into the center oil pan rail bolt hole on each side of the engine block.



**Fig. 180: Sealant Application Locations On Block Pan Rail And The Crankshaft Rear Oil Seal Housing**

Courtesy of GENERAL MOTORS COMPANY

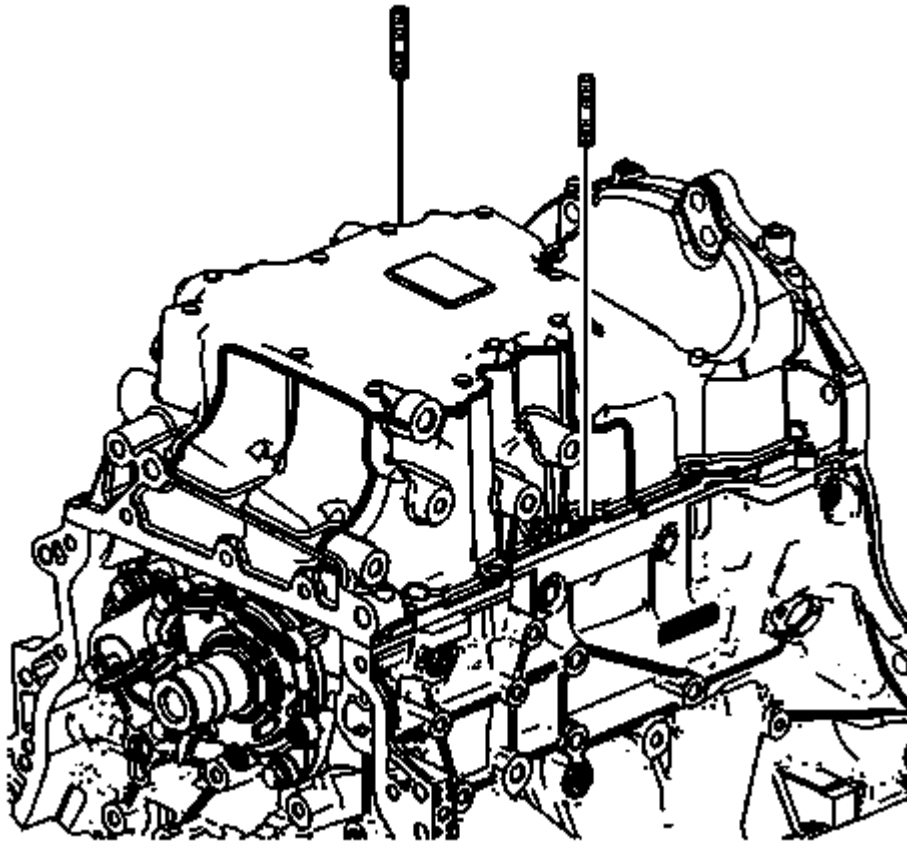
2. Place a 3 mm (0.118 in) bead (1) of RTV sealant, on the block pan rail and the crankshaft rear oil seal housing.



**Fig. 181: Engine Oil Pan**

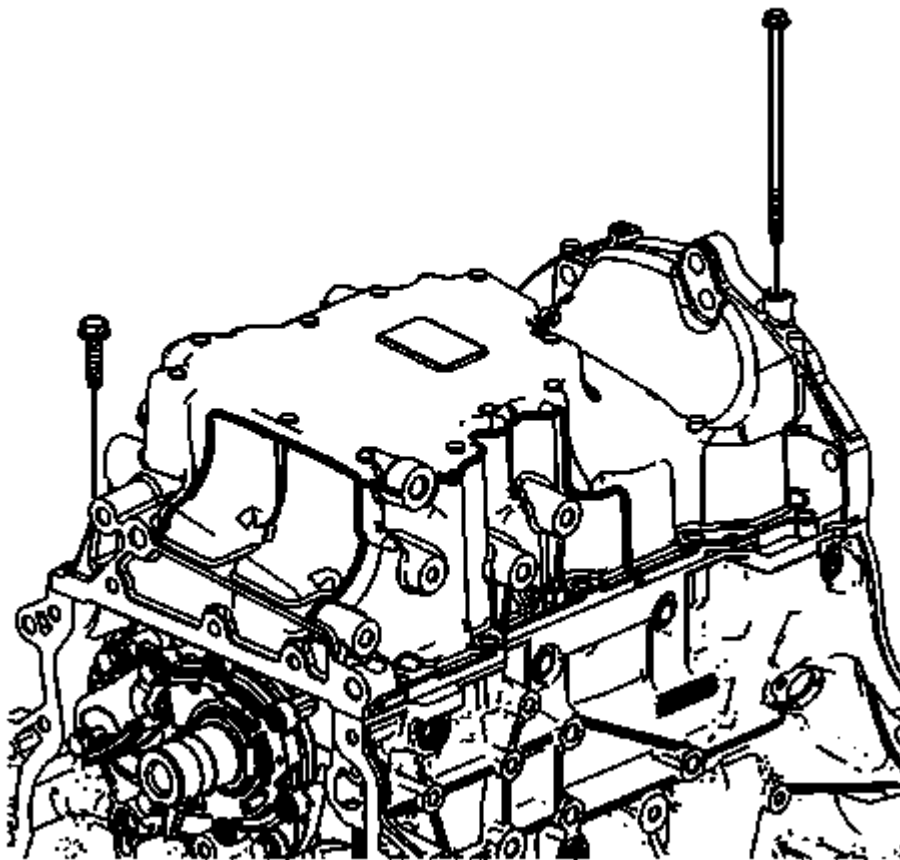
Courtesy of GENERAL MOTORS COMPANY

3. Position the oil pan onto the block.



**Fig. 182: Engine Block Guide Pins**  
Courtesy of GENERAL MOTORS COMPANY

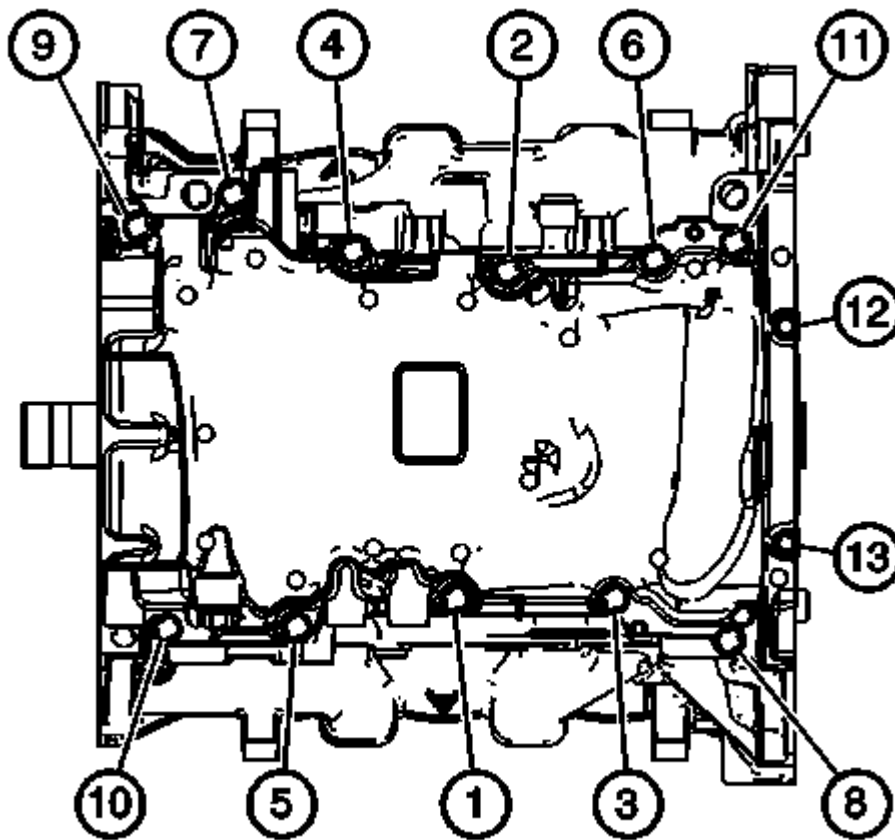
4. Remove the **EN-46109** set 8 mm (0.315 in) guides from the engine block.



**Fig. 183: Oil Pan Bolts**

Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the oil pan bolts.

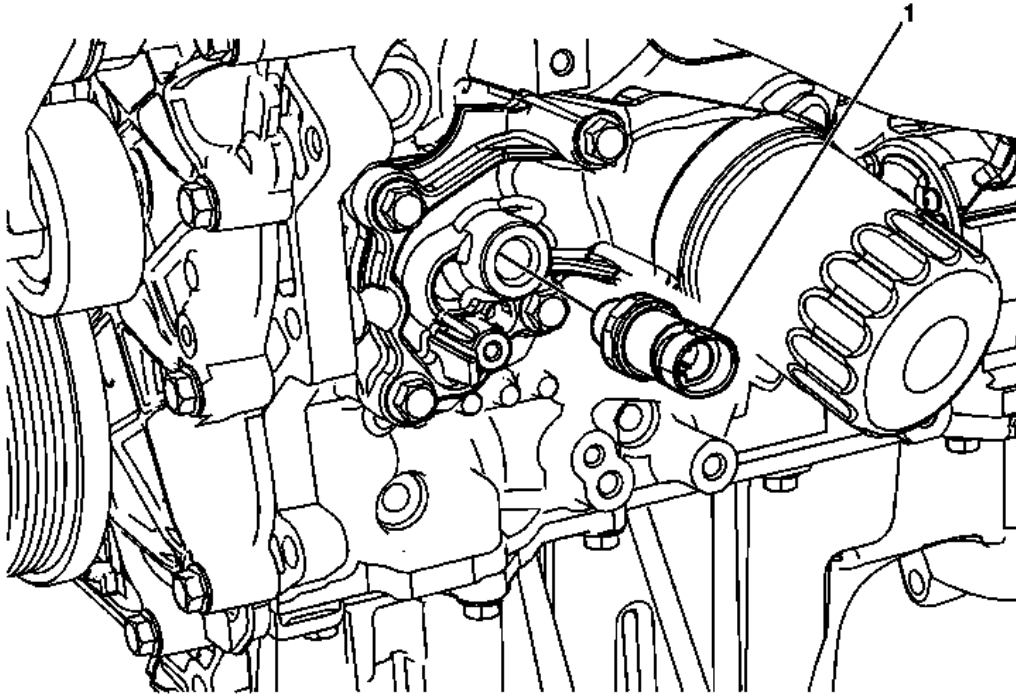


**Fig. 184: Oil Pan Bolts Tightening Sequence**  
 Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

6. Tighten the oil pan bolts in sequence.
  1. The 8 mm bolts (1-11) to 25 N.m (18 lb ft).
  2. The 6 mm bolts (12, 13) to 10 N.m (89 lb in).
7. Install engine front cover. Refer to Engine Front Cover Replacement.
8. Reposition the air conditioning (A/C) compressor and install the bolts. Refer to Air Conditioning Compressor Replacement (V6) .
9. Install the catalytic converter. Refer to Catalytic Converter Replacement - Left Side (LFX-Front) .
10. Lower the vehicle. Refer to Lifting and Jacking the Vehicle .
11. Refill the engine oil. Refer to Engine Oil and Oil Filter Replacement (LF1, LFW or LFX).

## ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

**Fig. 185: Engine Oil Pressure Sensor And/Or Switch**

Courtesy of GENERAL MOTORS COMPANY

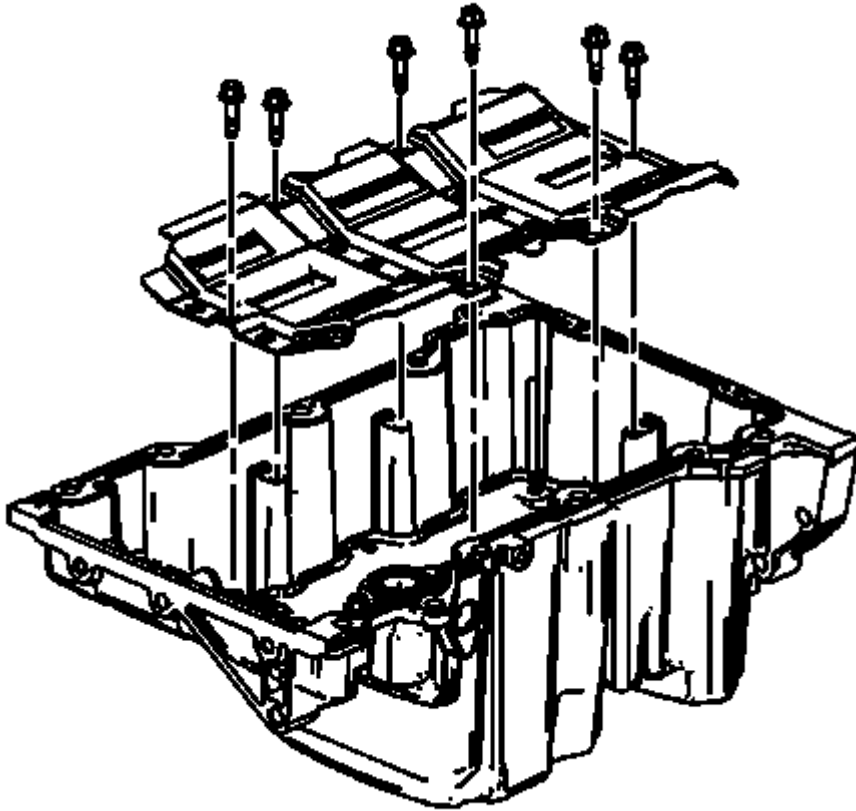
**Engine Oil Pressure Sensor and/or Switch Replacement**

| Callout                                                                   | Component Name                                                                                                                                                                     |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Preliminary Procedure</b>                                              |                                                                                                                                                                                    |
| <b>Remove the generator. Refer to <u>Generator Replacement (V6)</u> .</b> |                                                                                                                                                                                    |
| 1                                                                         | Engine Oil Pressure Sensor and/or Switch                                                                                                                                           |
|                                                                           | <b>CAUTION:</b><br><b>Refer to <u>Component Fastener Tightening Caution</u> .</b>                                                                                                  |
|                                                                           | <b>Procedure</b>                                                                                                                                                                   |
|                                                                           | <ol style="list-style-type: none"> <li>1. Disconnect the oil pressure sensor electrical connector.</li> <li>2. Transfer components as necessary.</li> </ol>                        |
|                                                                           | <b>Tighten</b><br>20 N.m (15 lb ft)<br><b>Special Tools</b><br><b>EN-41712</b> Oil Pressure Switch Socket<br>For equivalent regional tools, refer to <b><u>Special Tools</u></b> . |

**OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT**

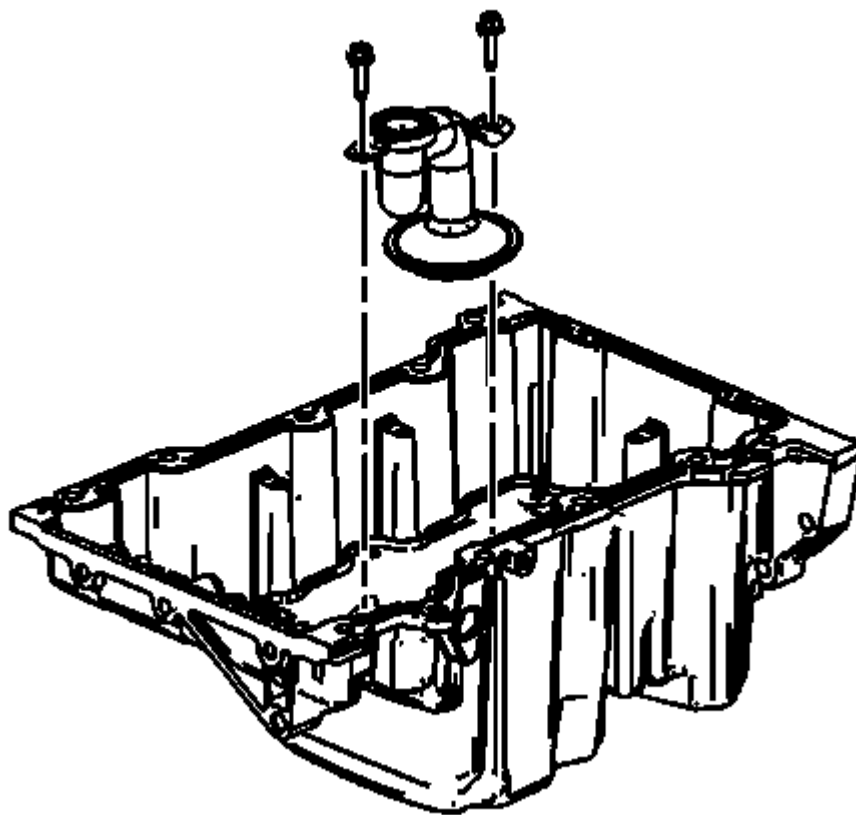
**Removal Procedure**

1. Remove the oil pan. Refer to **Oil Pan Replacement**.



**Fig. 186: Oil Pan Scraper And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

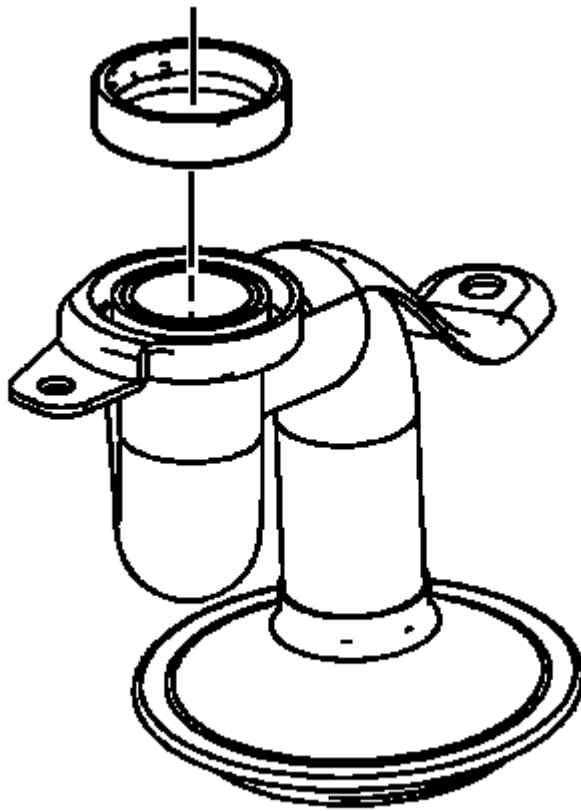
2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.



**Fig. 187: Oil Suction Pipe**

Courtesy of GENERAL MOTORS COMPANY

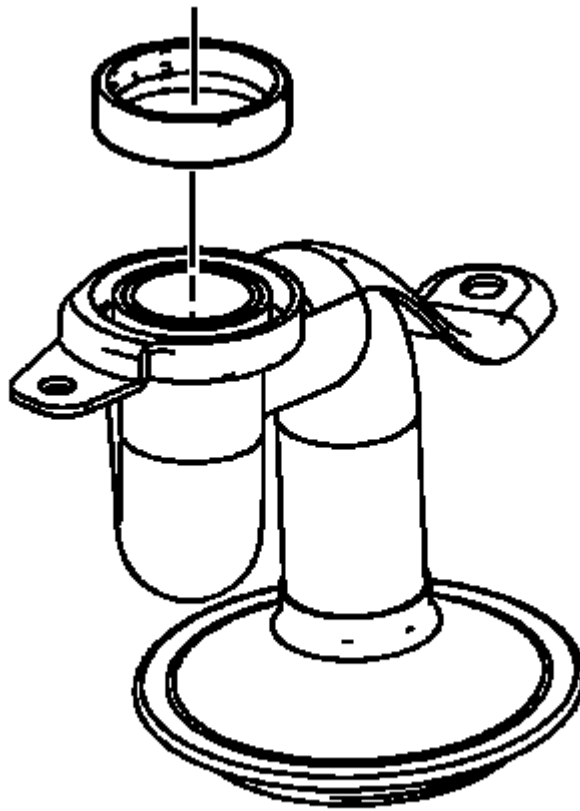
4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.



**Fig. 188: Oil Suction Tube And Seal**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

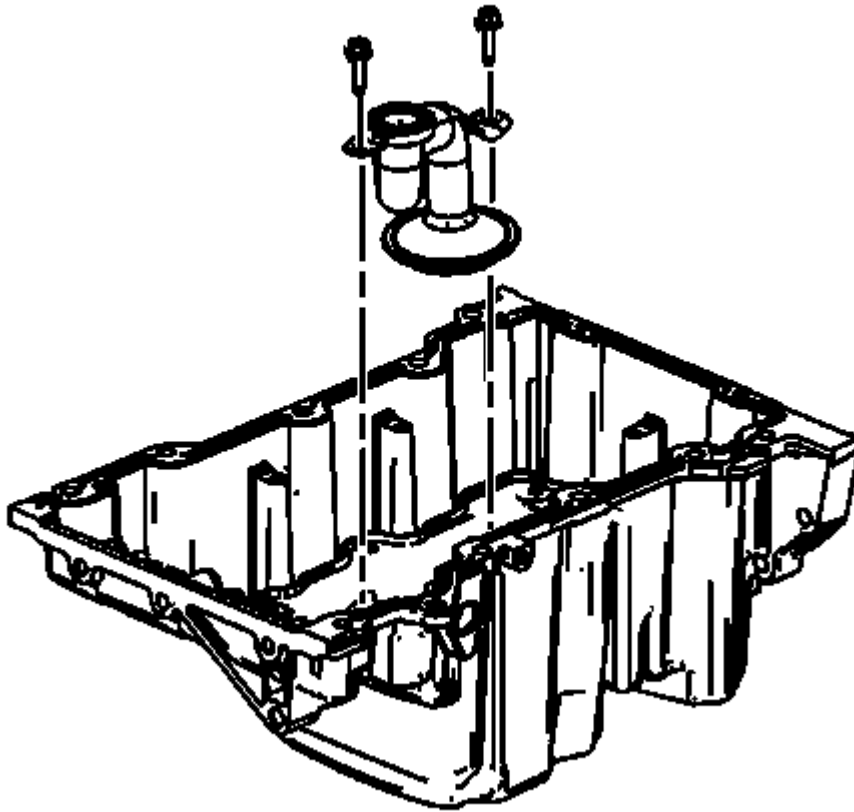
#### Installation Procedure



**Fig. 189: Oil Suction Tube And Seal**

**Courtesy of GENERAL MOTORS COMPANY**

1. Install a NEW oil suction tube seal onto the oil suction tube. DO NOT reuse the old oil suction tube seal.



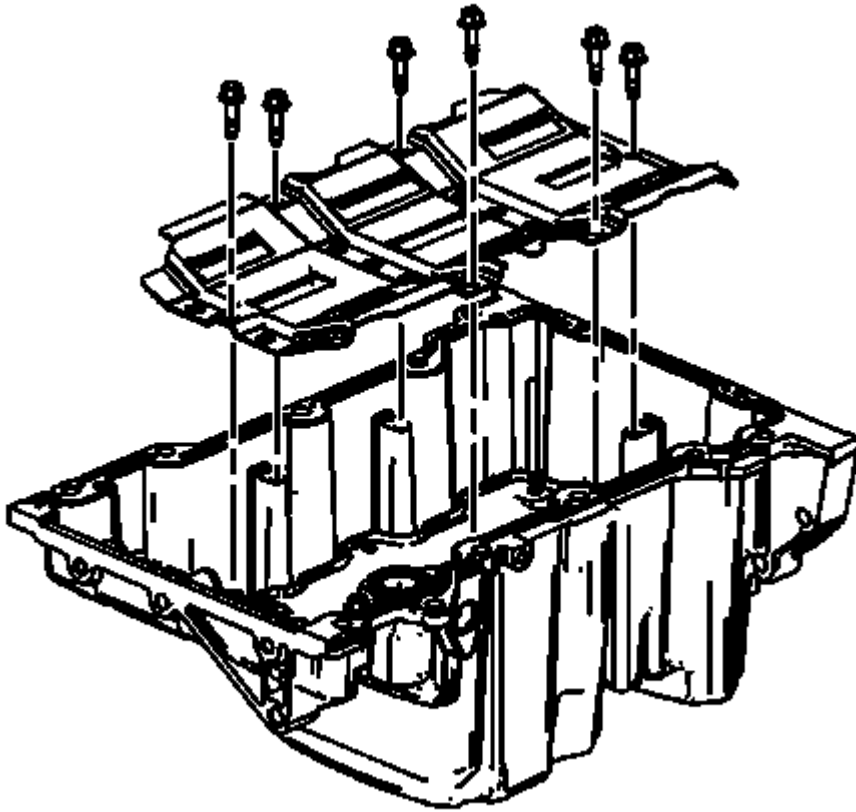
**Fig. 190: Oil Suction Pipe**

Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe.

**CAUTION:** Refer to Fastener Caution .

3. Install the oil suction pipe bolts and tighten to 10 N.m (89 lb in).



**Fig. 191: Oil Pan Scraper And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

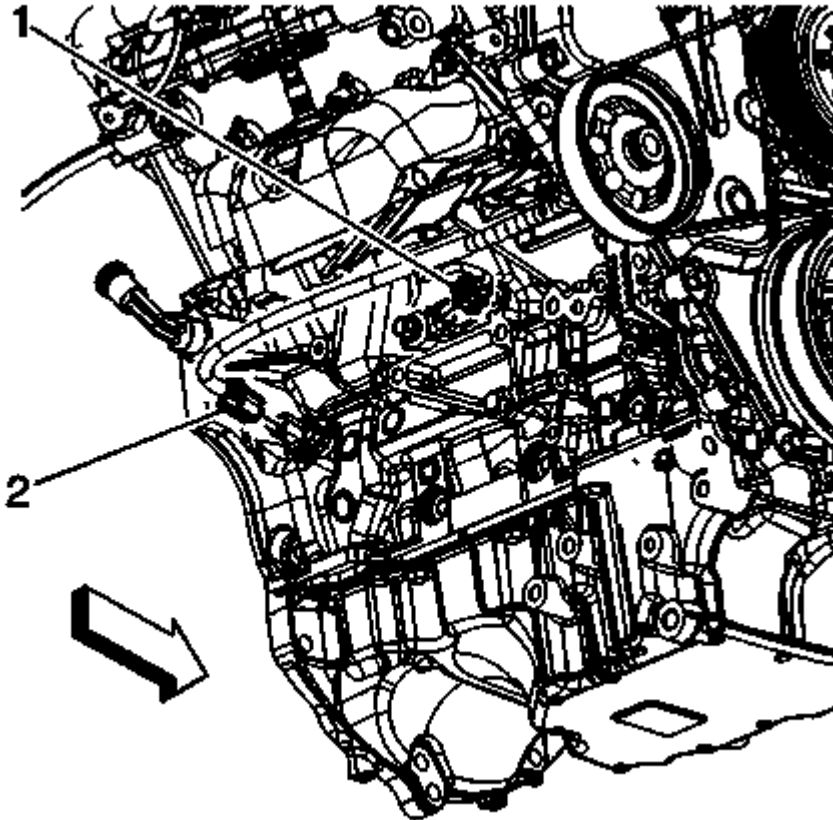
4. Install the oil pan scraper.
5. Install the oil pan scraper bolts and tighten to 10 N.m (89 lb in).
6. Install the oil pan. Refer to **Oil Pan Replacement**.

## ENGINE REPLACEMENT

### Removal Procedure

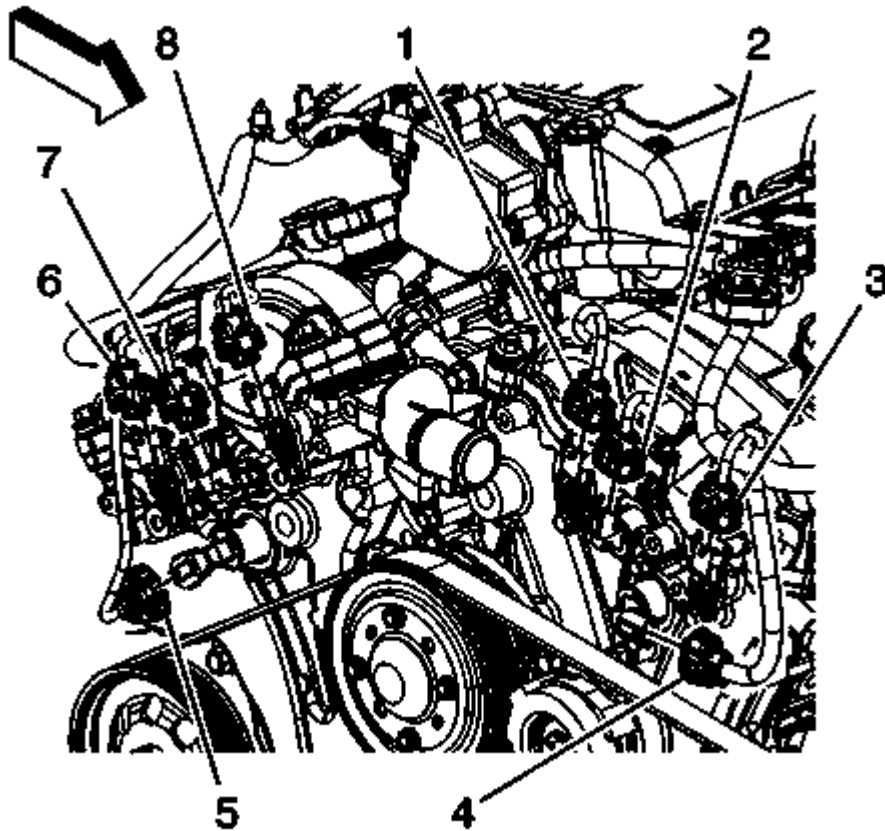
1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (GE 47716)**.
4. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement (LF1, LFW or LFX)**.
5. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFW or LFX)**.
6. Remove the hood. Refer to **Hood Replacement**.
7. Remove the drive belt. Refer to **Drive Belt Replacement**.

8. Disconnect the front knock sensor (KS).



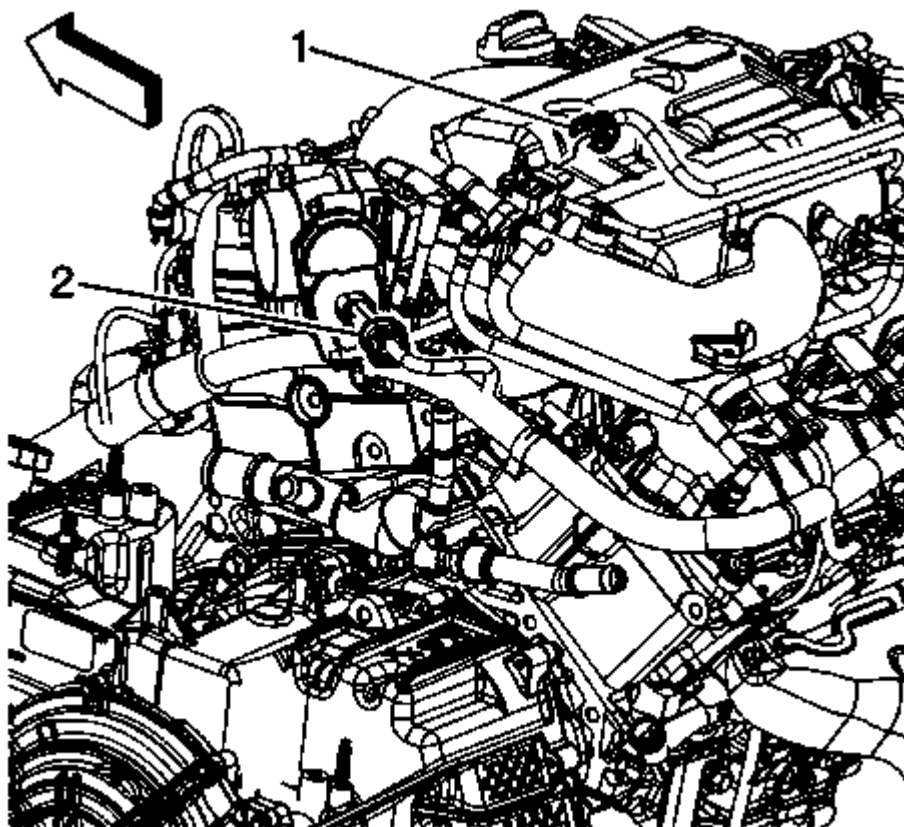
**Fig. 192: CKP Sensor And Knock Sensor**  
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the rear KS (1) and the crank sensor. Refer to **Crankshaft Position Sensor Replacement** .



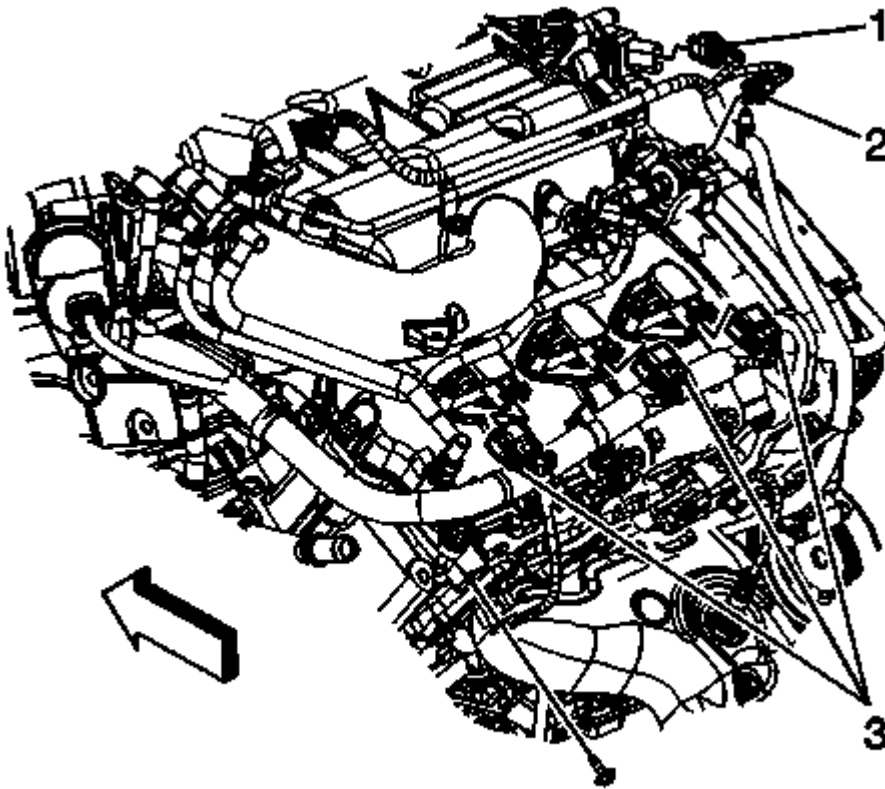
**Fig. 193: Camshaft Position Sensor Electrical Connectors**  
 Courtesy of GENERAL MOTORS COMPANY

10. Re-position the plastic wire loom/shield on each valve cover, then disconnect the camshaft position (CMP) sensor (1-8).



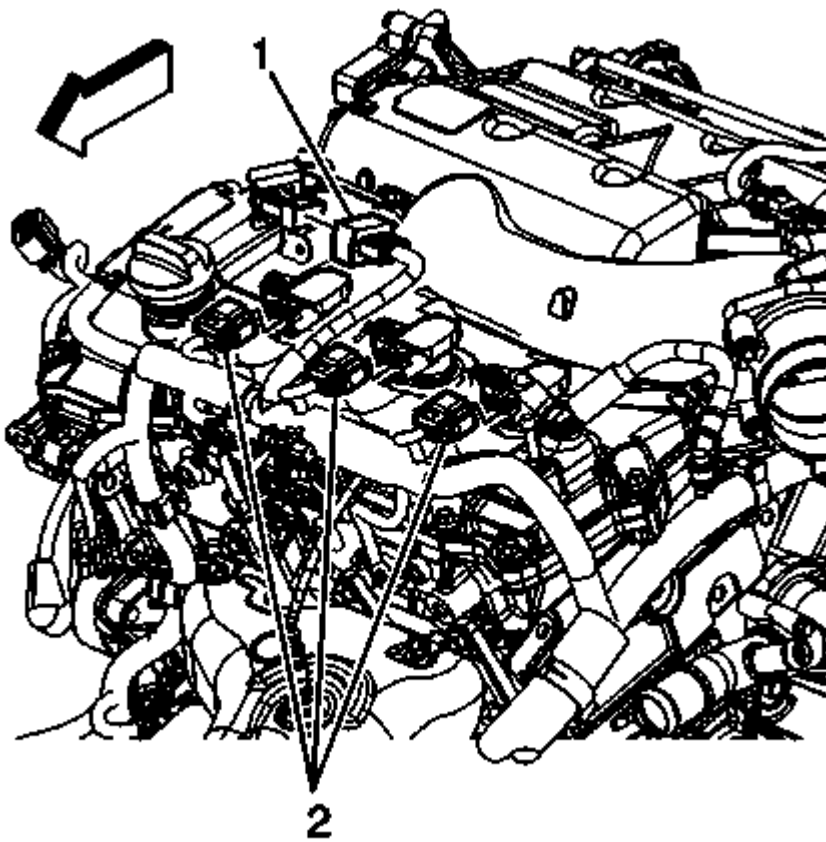
**Fig. 194: MAP Sensor And ETC Electrical Connectors**  
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the manifold absolute pressure (MAP) sensor (1).



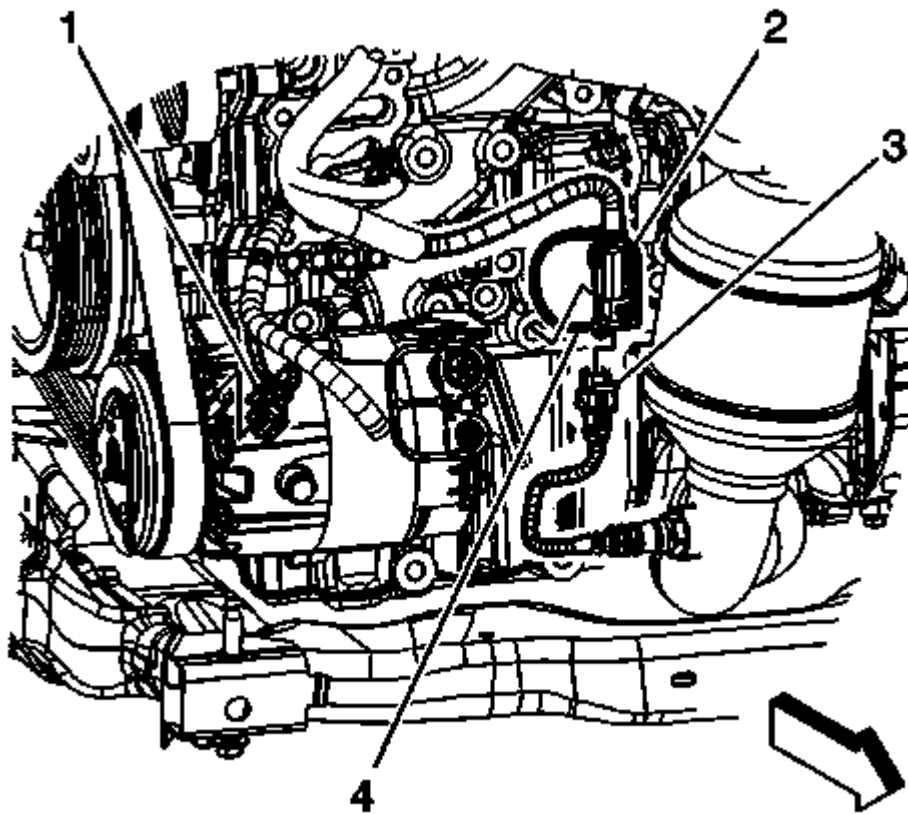
**Fig. 195: EVAP Canister Purge Solenoid, Ignition Coils And Intake Manifold Tuning Valve**  
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the evaporative emission (EVAP) canister purge solenoid (2).



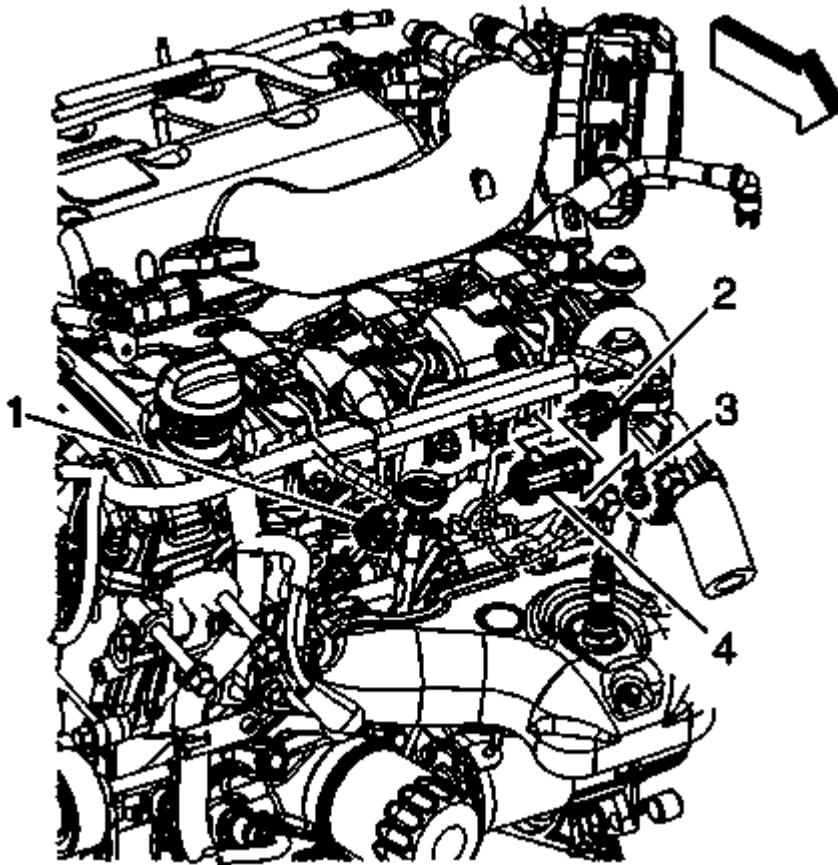
**Fig. 196: Ignition Coil And Fuel Injector Wiring Harness Connectors**  
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the front and rear ignition coils (2).



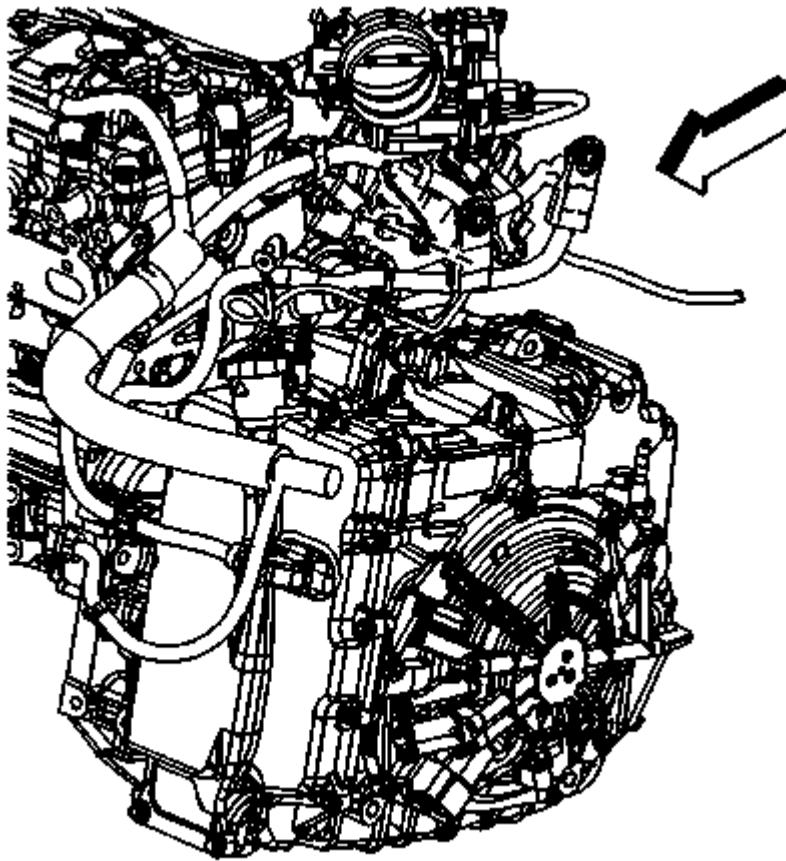
**Fig. 197: Electrical Connectors - Left Side**  
**Courtesy of GENERAL MOTORS COMPANY**

14. Disconnect the A/C compressor (1).



**Fig. 198: ECT And HO2S Wiring Harness Connectors**  
Courtesy of GENERAL MOTORS COMPANY

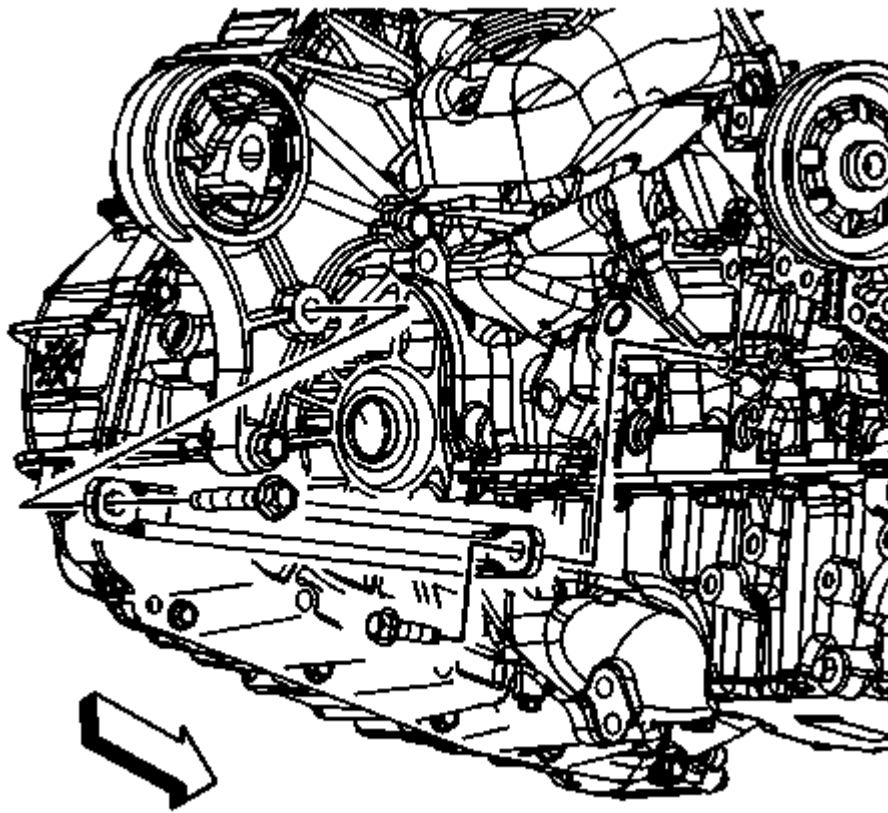
15. Disconnect the coolant temperature sensor (1).
16. Disconnect the following electrical connectors:
  - The heated oxygen sensor HO2S
  - The electronic throttle control
  - Unclip harness as necessary and lay harnesses off to the side.
17. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
18. Remove the catalytic converters. Refer to **Catalytic Converter Replacement - Left Side (LFX-Front)** , and **Catalytic Converter Replacement - Right Side (LFX-Rear)** .



**Fig. 199: Engine Wiring Harness**

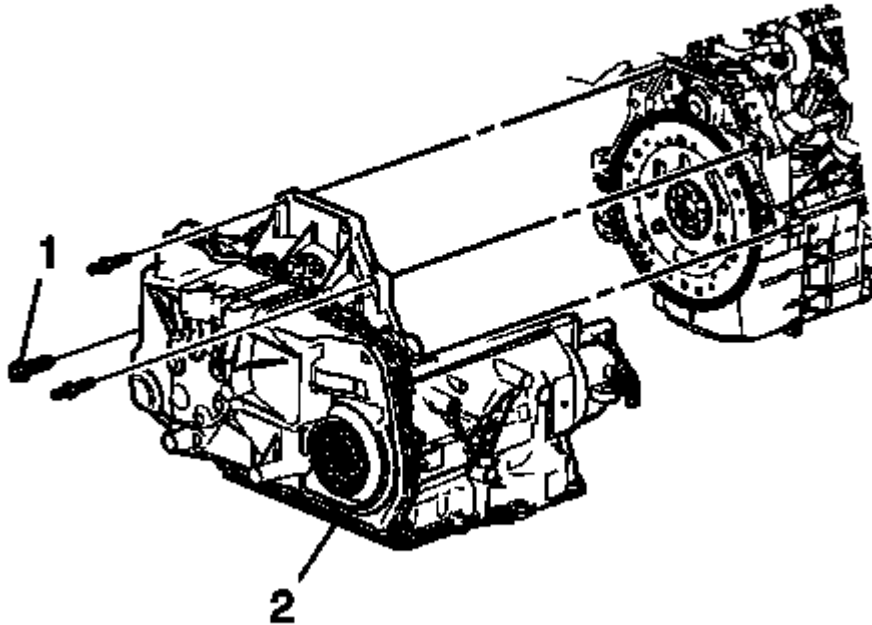
Courtesy of GENERAL MOTORS COMPANY

19. Remove the engine wiring harness grounds and negative cable from the cylinder head.
20. Remove the starter motor. Refer to **Starter Replacement (V6)** .
21. Remove the torque converter bolts.
22. Remove the air conditioning (A/C) compressor. DO NOT discharge the A/C system. Support the compressor. Refer to **Air Conditioning Compressor Replacement (V6)** .
23. Remove the power steering pump and position aside. Refer to **Power Steering Pump Replacement (V6)** .



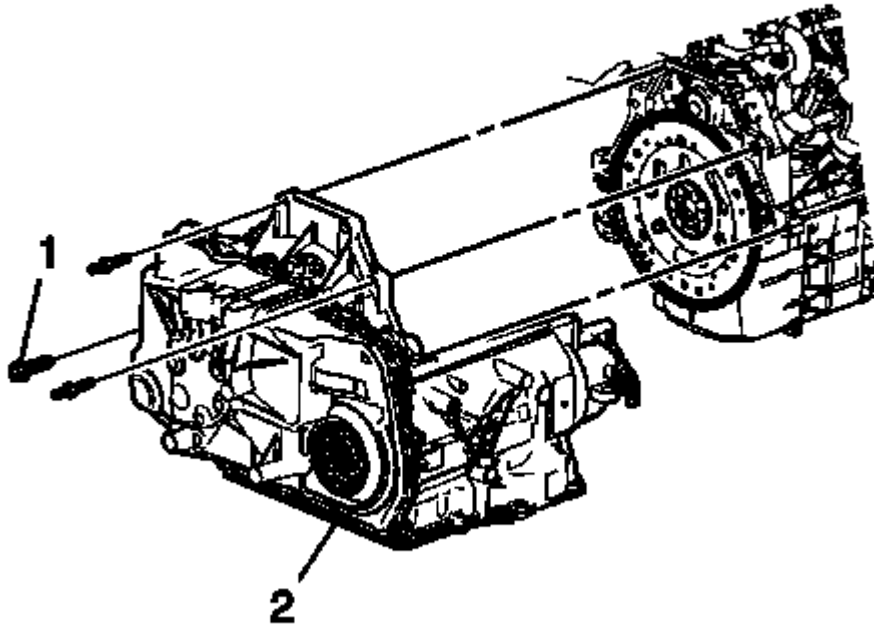
**Fig. 200: Oil Pan Brace Bolt And Brace**  
**Courtesy of GENERAL MOTORS COMPANY**

24. Remove the transaxle to oil pan brace bolts and brace (FWD). If equipped with (AWD), remove the transfer case bracket and unbolt transfer case from the engine and set aside.



**Fig. 201: Transaxle-To-Engine Bolts**  
Courtesy of GENERAL MOTORS COMPANY

25. Remove the lower transaxle-to-engine bolts (1).
26. Unbolt intermediate shaft support frame engine block rotate support away from block leaving intermediate shaft and axle in place (FWD) only.
27. Remove the radiator outlet hose from the engine. Refer to **Radiator Outlet Hose Replacement (V6)** .
28. Remove the engine coolant thermostat housing from the engine. Refer to **Engine Coolant Thermostat Housing Replacement (LFX)** .
29. Remove the vacuum hoses from the upper intake manifold.
30. Remove the radiator inlet hose from the engine. Refer to **Radiator Inlet Hose Replacement (V6)** .
31. Install the engine lifting device to the engine.
32. Remove the upper transaxle-to-engine bolts.
33. Remove the engine from the vehicle.
34. Remove the flywheel. Refer to **Engine Flywheel Replacement**.
35. Install the engine to the engine stand.
36. Disconnect electrical connectors as needed.
37. Transfer parts as needed.

**Installation Procedure**

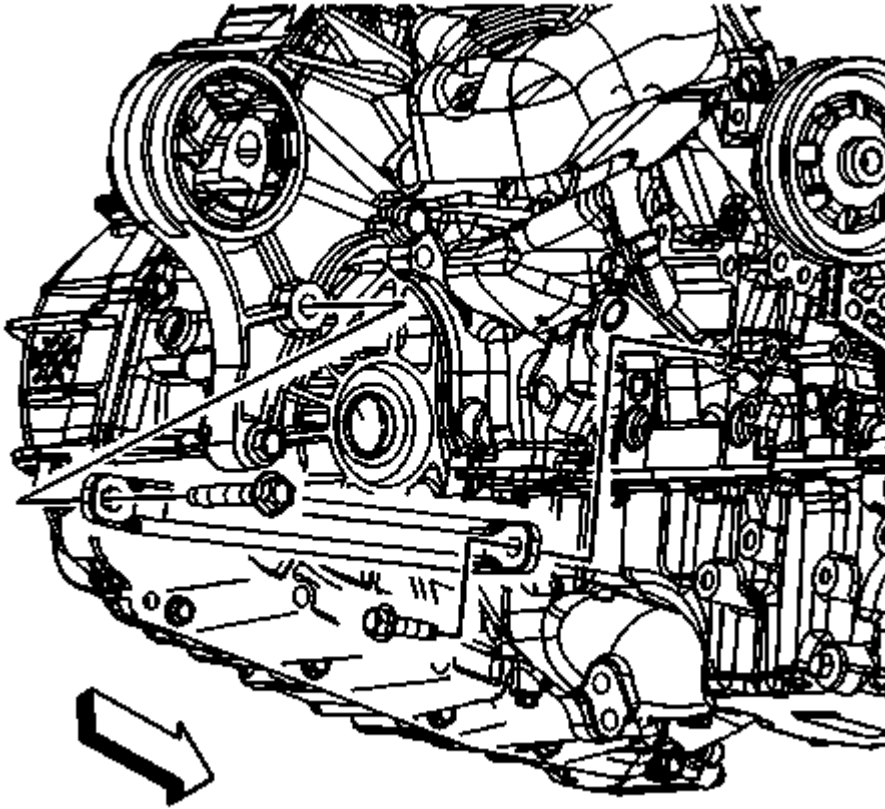
**Fig. 202: Transaxle-To-Engine Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine from the engine stand.
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.
3. Install the engine to the vehicle.

**CAUTION: Refer to Fastener Caution .**

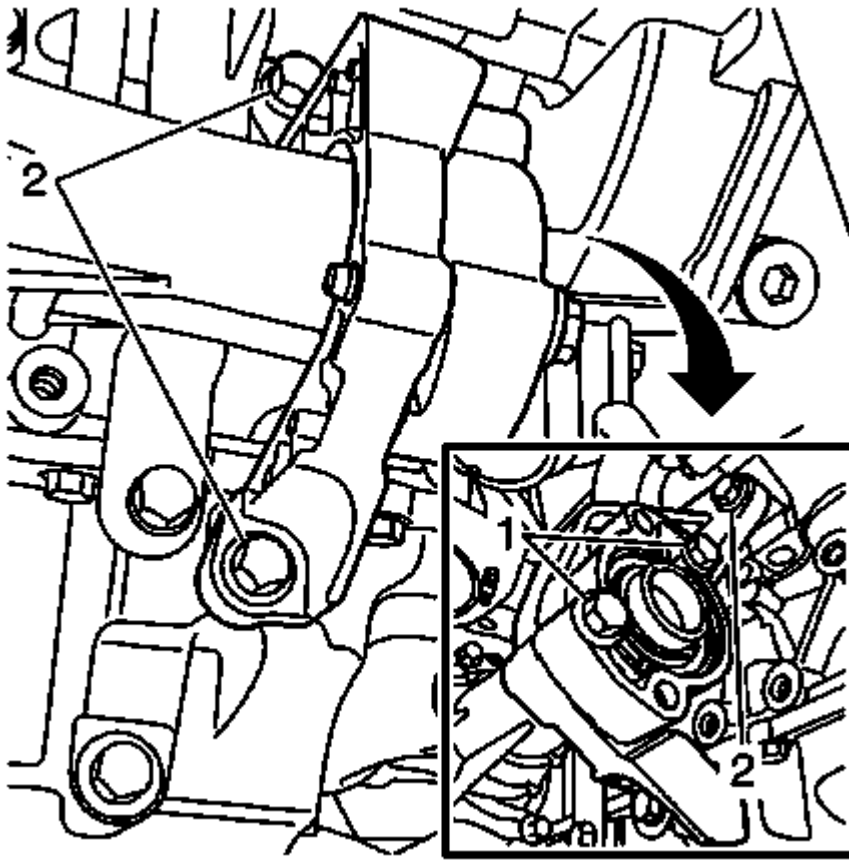
4. Install the upper transaxle-to-engine bolts (1) and tighten to 75 N.m (55 lb ft).
5. Remove the engine lifting device.
6. Install the radiator inlet hose to the engine. Refer to **Radiator Inlet Hose Replacement (V6)** .
7. Install the battery ground to the rear of engine.
8. Install the fuel lines to the fuel rail.
9. Install the brake booster vacuum hose to the upper intake manifold.
10. Install the vacuum hoses to the upper intake manifold.

11. Install the engine coolant thermostat housing to the engine. Refer to **Engine Coolant Thermostat Housing Replacement (LFX)**.
12. Raise the vehicle and remove the transaxle support.
13. Install the radiator outlet hose to the engine. Refer to **Radiator Outlet Hose Replacement (V6)**.
14. Install the lower transaxle-to-engine bolt (6) and the stud (1) and tighten to 75 N.m (55 lb ft).



**Fig. 203: Oil Pan Brace Bolt And Brace**  
Courtesy of GENERAL MOTORS COMPANY

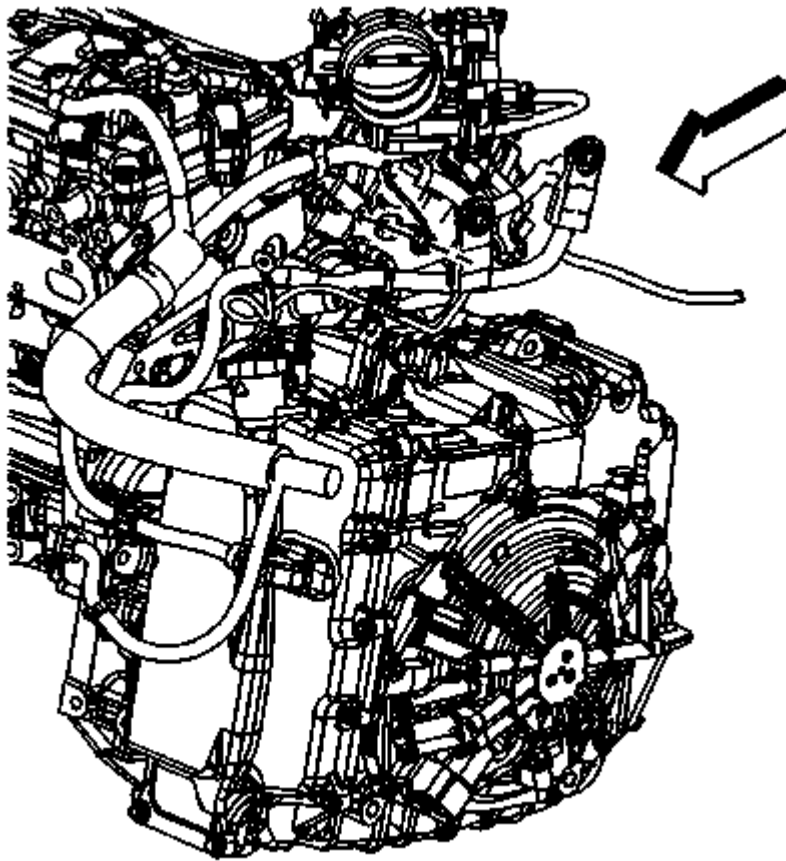
15. Position the transaxle to oil pan brace and install the bolts. Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 204: Transfer Case Bracket And Bolts**

Courtesy of GENERAL MOTORS COMPANY

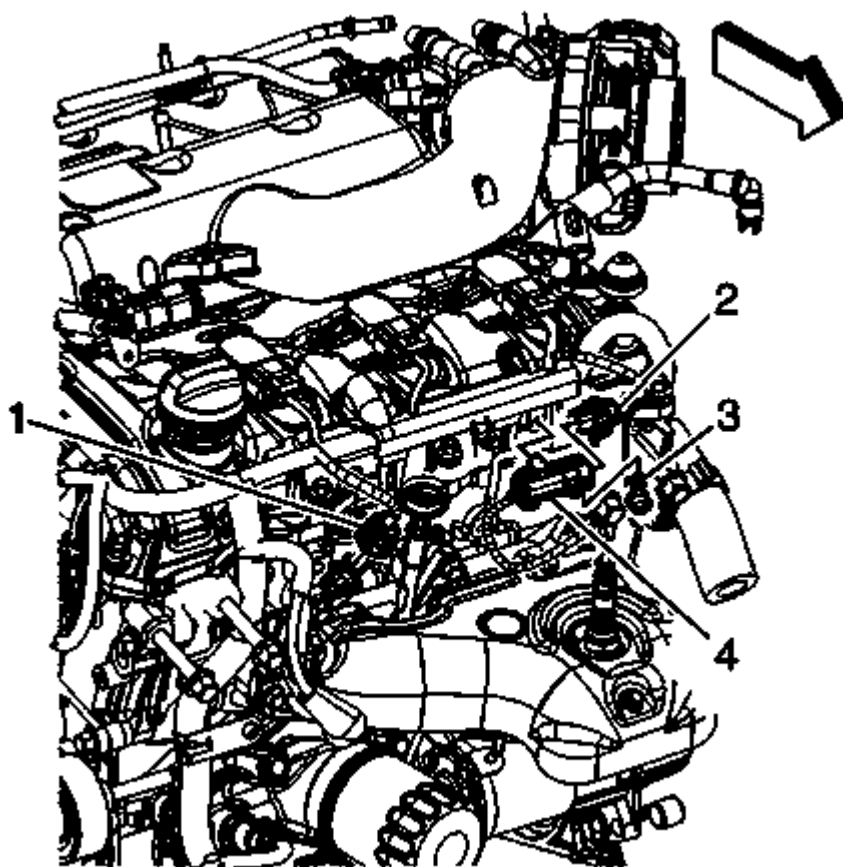
16. If equipped with AWD, install the transfer case bracket and bolt (1, 2)
17. Tighten the support bracket fasteners (1) to 5 N.m (44 lb in). Tighten the support bracket to engine fasteners (2) to 60 N.m (44 lb ft). Tighten the support bracket fasteners (1) to 60 N.m (44 lb ft).
18. Install the engine mount. Refer to **Engine Mount Replacement - Right Side**.
19. Install the torque converter bolts.
20. Install the power steering pump. Refer to **Power Steering Pump Replacement (V6)** .
21. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (V6)** .
22. Install the starter motor. Refer to **Starter Replacement (V6)** .
23. Install the torque converter covers.



**Fig. 205: Engine Wiring Harness**

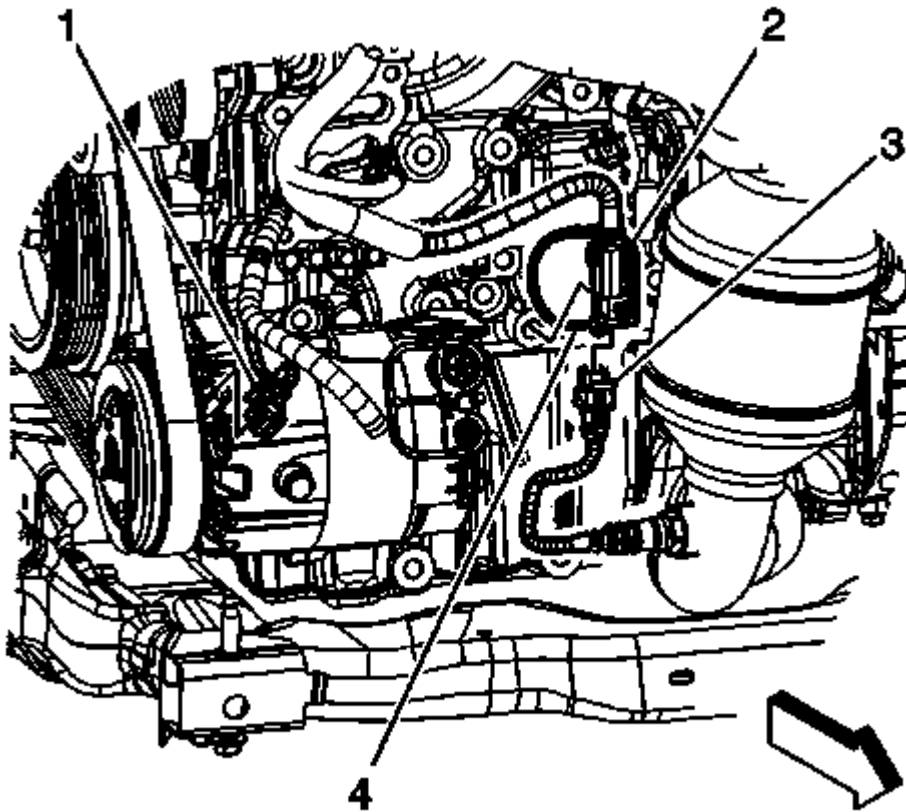
Courtesy of GENERAL MOTORS COMPANY

24. Install the engine wiring harness grounds to the transaxle.
25. Install the engine wiring harness ground nut to the transaxle stud. Tighten the nut to 35 N.m (26 lb ft).
26. Install the catalytic converters. Refer to **Catalytic Converter Replacement - Left Side (LFX-Front)** , and **Catalytic Converter Replacement - Right Side (LFX-Rear)** .
27. Lower the vehicle.
28. Connect the following electrical connectors:
  - The body wiring harness-to-engine harness
  - The electronic throttle control
  - The EGR valve
  - The HO2S



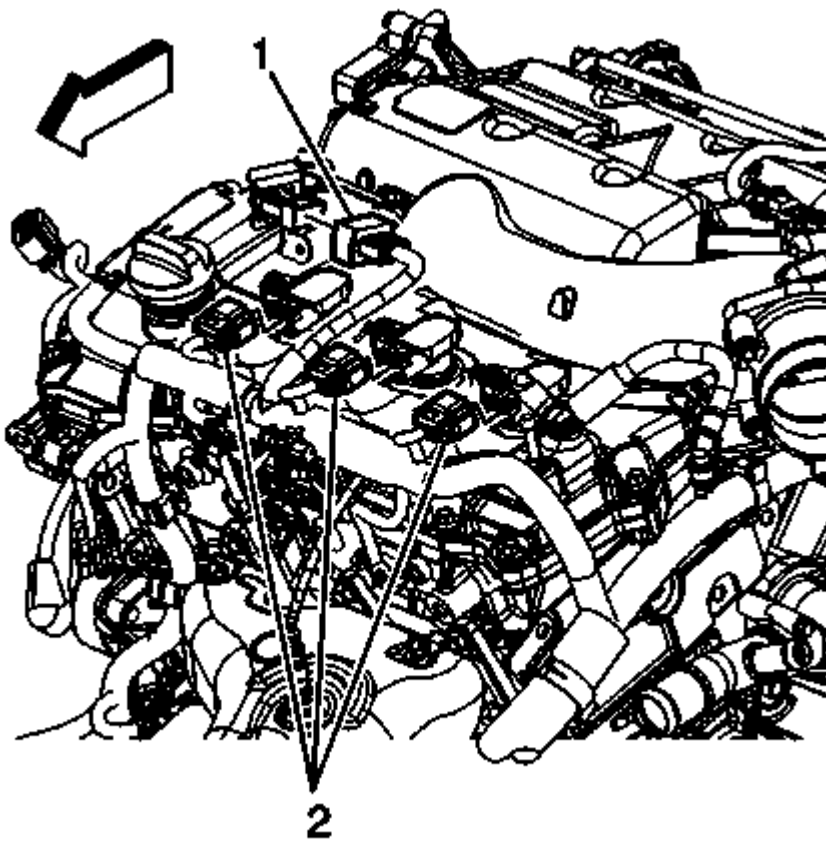
**Fig. 206: ECT And HO2S Wiring Harness Connectors**  
Courtesy of GENERAL MOTORS COMPANY

29. Connect the coolant temperature sensor (1).



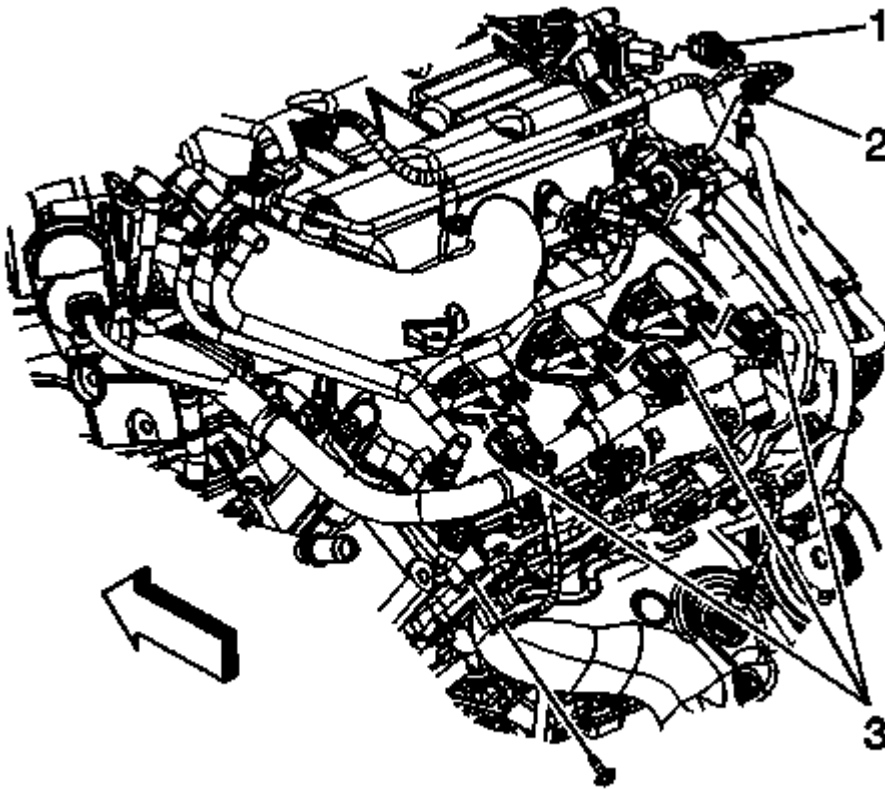
**Fig. 207: Electrical Connectors - Left Side**  
**Courtesy of GENERAL MOTORS COMPANY**

30. Connect the A/C compressor (1).



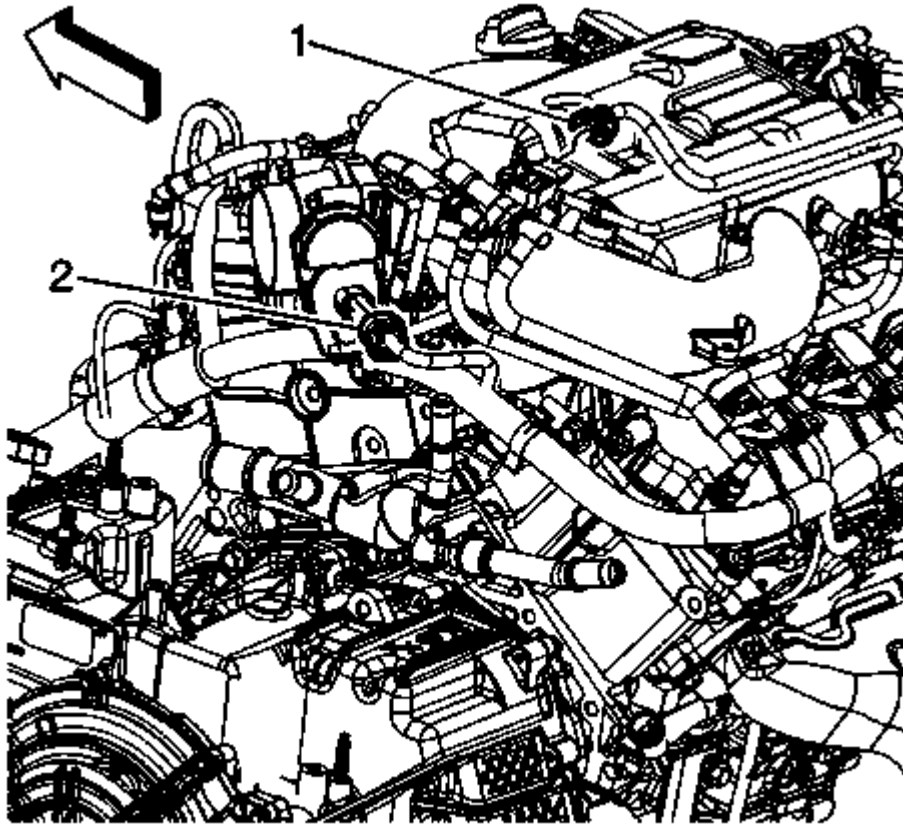
**Fig. 208: Ignition Coil And Fuel Injector Wiring Harness Connectors**  
Courtesy of GENERAL MOTORS COMPANY

31. Connect the front and rear ignition coils (2).



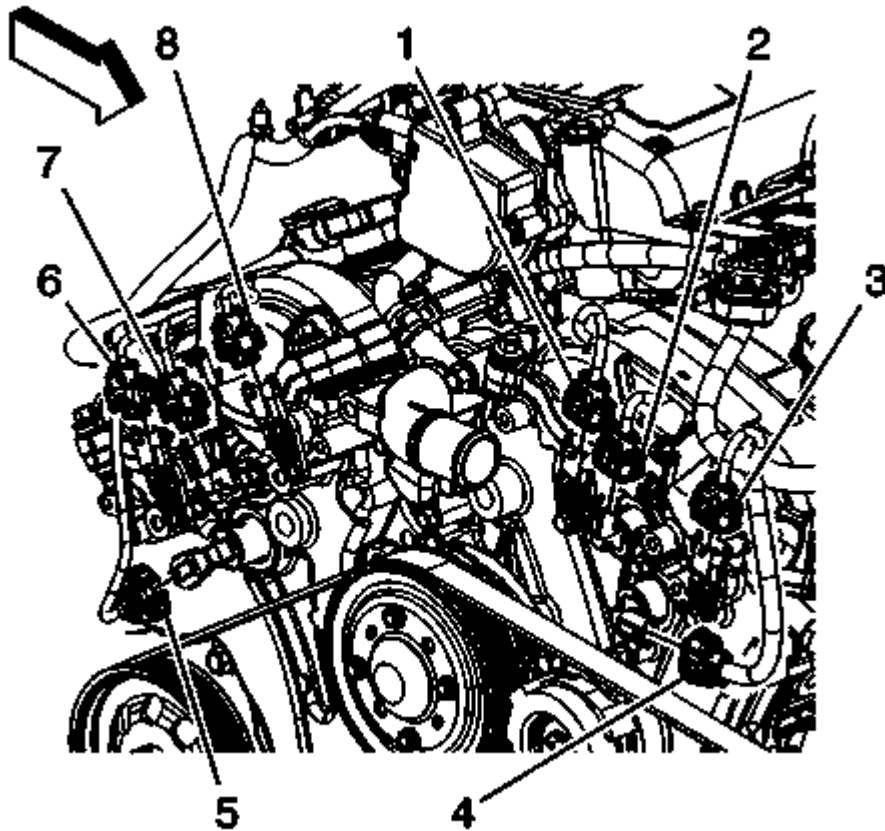
**Fig. 209: EVAP Canister Purge Solenoid, Ignition Coils And Intake Manifold Tuning Valve**  
Courtesy of GENERAL MOTORS COMPANY

32. Connect the EVAP canister purge solenoid (2).



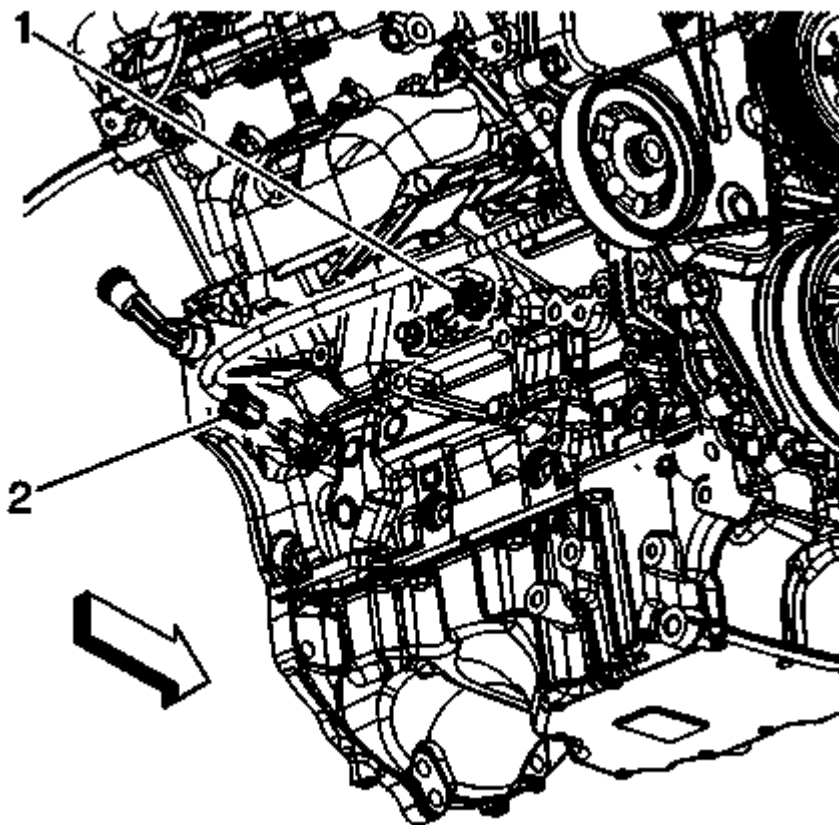
**Fig. 210: MAP Sensor And ETC Electrical Connectors**  
**Courtesy of GENERAL MOTORS COMPANY**

33. Connect the MAP sensor (1).



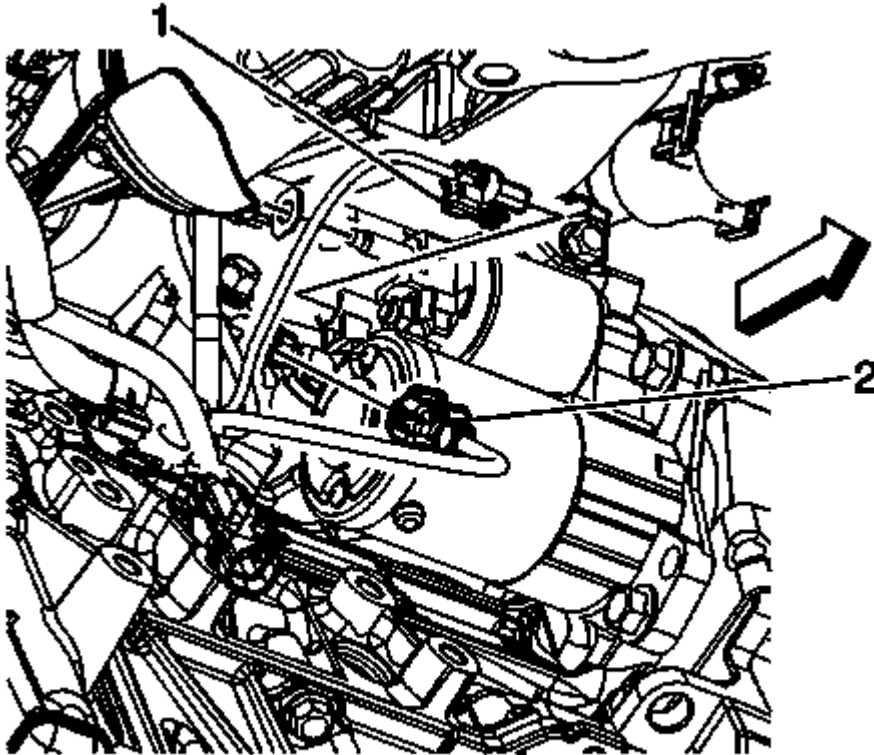
**Fig. 211: Camshaft Position Sensor Electrical Connectors**  
 Courtesy of GENERAL MOTORS COMPANY

34. Connect the CMP sensor (1-8), then re-position the plastic wire loom/shield on each valve cover.



**Fig. 212: CKP Sensor And Knock Sensor**  
**Courtesy of GENERAL MOTORS COMPANY**

35. Connect the rear KS (1).

**Fig. 213: Front Knock Sensor**

Courtesy of GENERAL MOTORS COMPANY

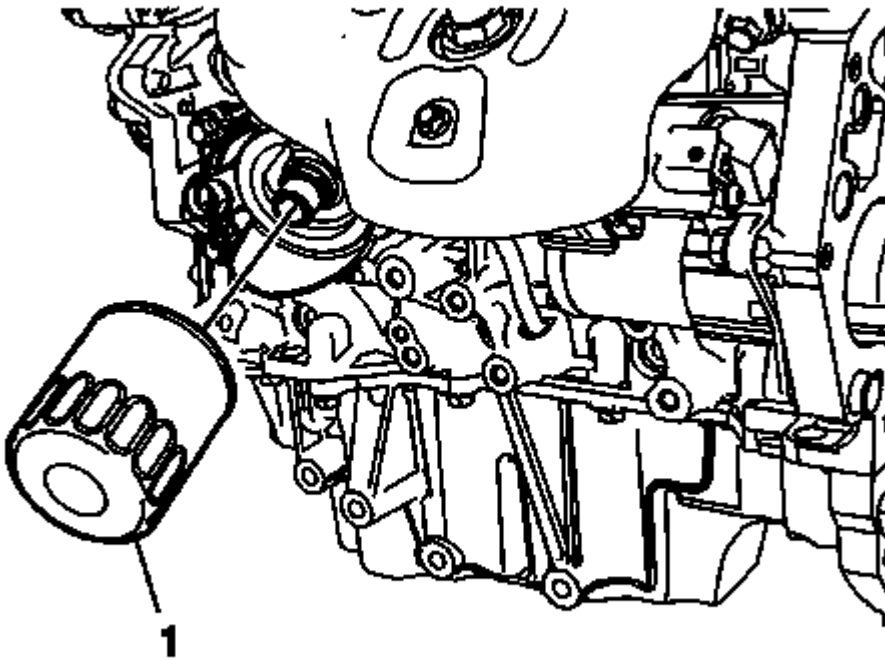
36. Connect the front KS (2) and the crank sensor. Refer to **Crankshaft Position Sensor Replacement** .
37. Install the drive belt. Refer to **Drive Belt Replacement**.
38. Install the hood. Refer to **Hood Replacement** .
39. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFW or LFX)** .
40. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
41. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement (LF1, LFW or LFX)**.
42. Fill cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
43. Perform a crankshaft position system variation learn procedure.
44. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
45. Inspect for leaks.

**ENGINE OIL AND OIL FILTER REPLACEMENT (LF1, LFW OR LFX)****Removal Procedure**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a drain pan under the oil pan drain plug.
3. Remove the oil pan drain plug. Allow the oil to drain completely.

**CAUTION:** Refer to **Fastener Caution** .

4. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).



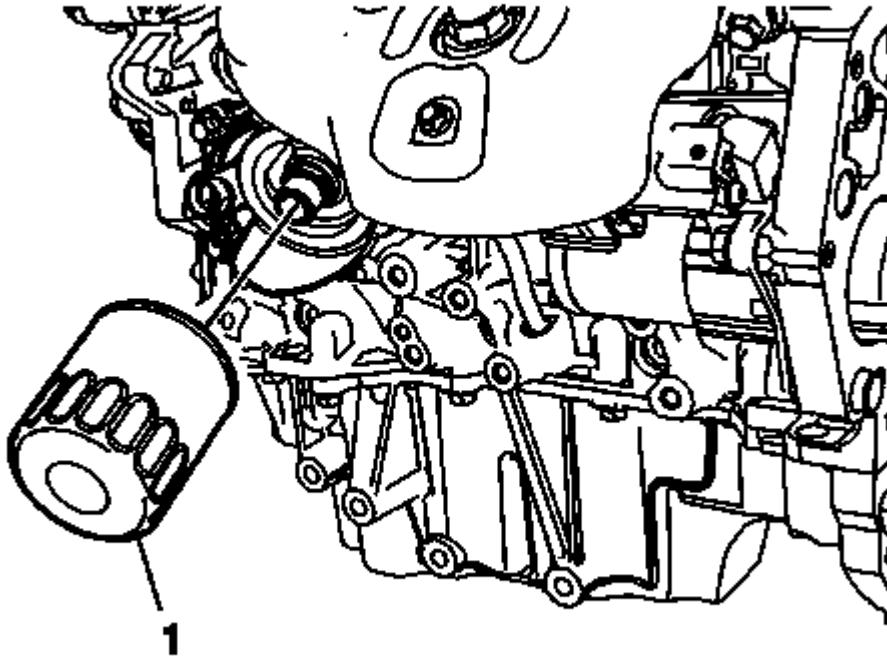
**Fig. 214: Oil Filter**

Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Refer to **Hot Exhaust System Warning** .

5. Place the drain pan under the oil filter (1).
6. Remove the oil filter. Allow the oil to drain completely.

#### **Installation Procedure**



**Fig. 215: Oil Filter**

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Tighten the oil filter (1) to 25 N.m (18 lb ft).
3. Lower the vehicle.
4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
5. Start the engine and inspect for leaks.