**2010 ENGINE**

**Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - Equinox & Terrain**

# DRIVE BELT REPLACEMENT

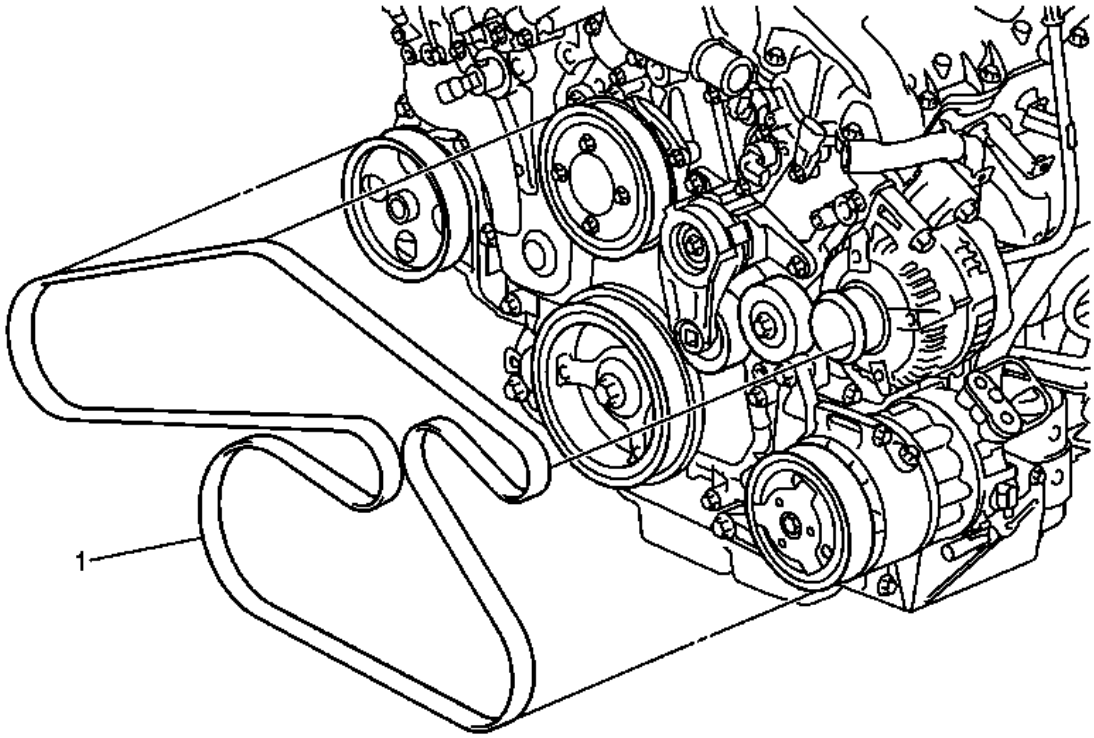


**Fig. 1: Drive Belt Routing**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedures:**<br>Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side** | |
| 1 | Drive Belt<br><br>**Procedure**<br><br>1. Rotate the drive belt tensioner clockwise to release the drive belt tension.<br>2. Slide the drive belt off of the belt idler pulley.<br>3. Slowly release the drive belt tensioner. |

# DRIVE BELT TENSIONER REPLACEMENT

 

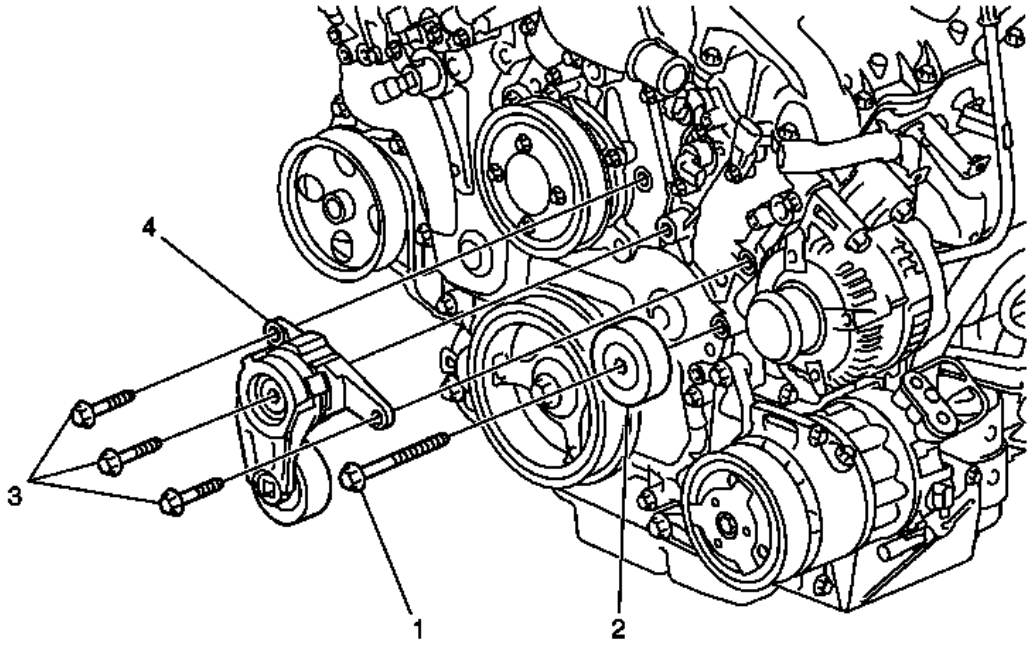


**Fig. 2: Drive Belt Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedure:** Remove the drive belt. Refer to **Drive Belt Replacement**. | |
| 1 | Drive Belt Idler Pulley Fastener<br><br>**CAUTION:**<br>**Refer to Fastener Caution .**<br><br>**Tighten:** 58 N.m (43 lb ft) |
| 2 | Drive Belt Idler Pulley |
| 3 | Drive Belt Tensioner Fastener (Qty: 3)<br><br>**Tighten:** 25 N.m (19 lb ft) |
| 4 | Drive Belt Tensioner |

# DRIVE BELT IDLER PULLEY REPLACEMENT

### REMOVAL PROCEDURE

1. Remove the drive belt. Refer to **Drive Belt Replacement**.

 

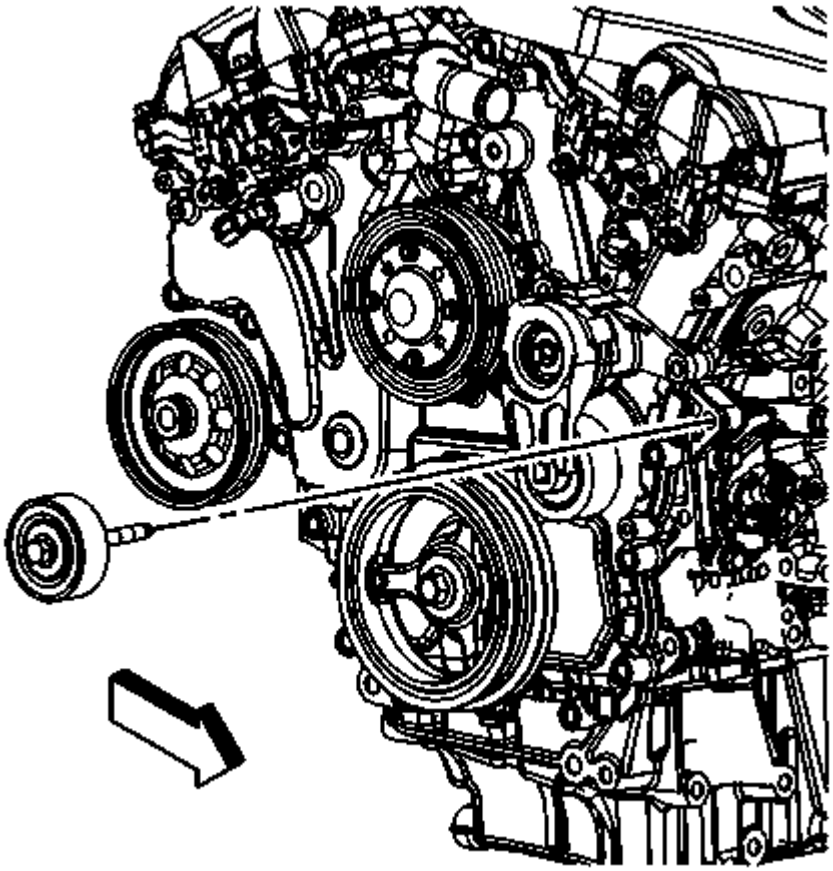

**Fig. 3: Identifying Drive Belt Idler Pulley**
**Courtesy of GENERAL MOTORS CORP.**

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

## INSTALLATION PROCEDURE

 

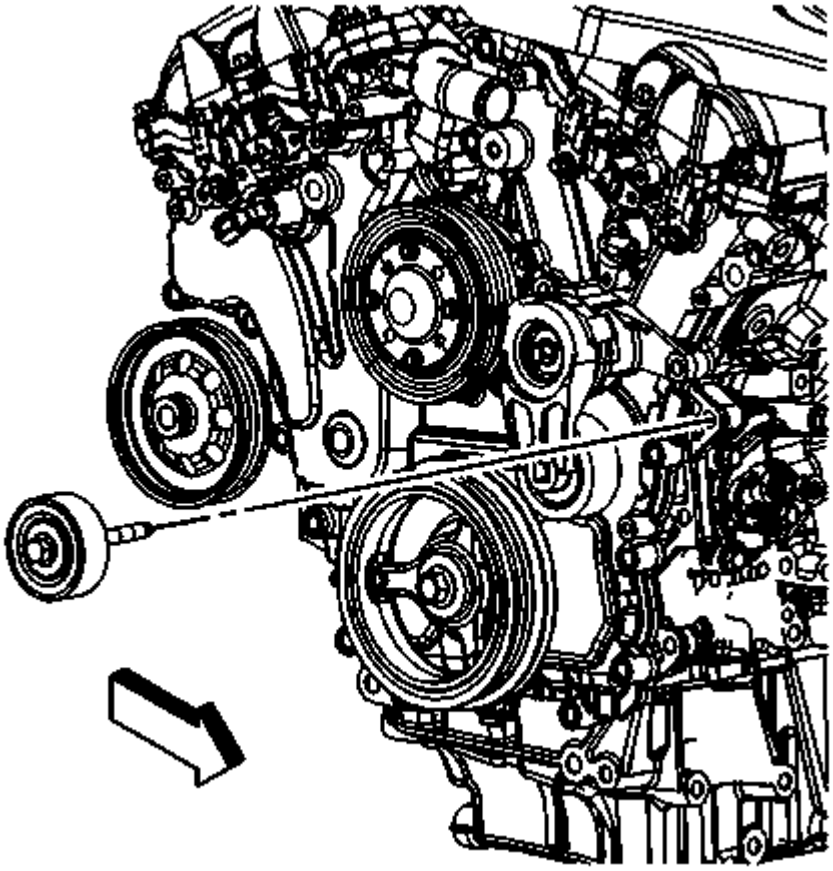

**Fig. 4: Identifying Drive Belt Idler Pulley**
**Courtesy of GENERAL MOTORS CORP.**

1. Install the drive belt idler pulley.

   **CAUTION: Refer to Fastener Caution .**

2. Install the drive belt idler pulley bolt and tighten to

   **Tighten:** 58 N.m (43 lb ft).

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

## ENGINE SUPPORT FIXTURE

**Special Tools**

- **J 28467-B** Universal Engine Support Fixture
- **J 28467-7A** Bolt Hook

 

- **J-28467-13** Engine Support Fixture Adapters
- **J 28467-34** Lift Hook Wing Nut and Washer
- **J 36462-A** Engine Support Adapter Leg Set
- **J 42451-1** Engine Support Adapter
- GM P/N 11519137 4 Studs or equivalent

**INSTALLATION PROCEDURE**

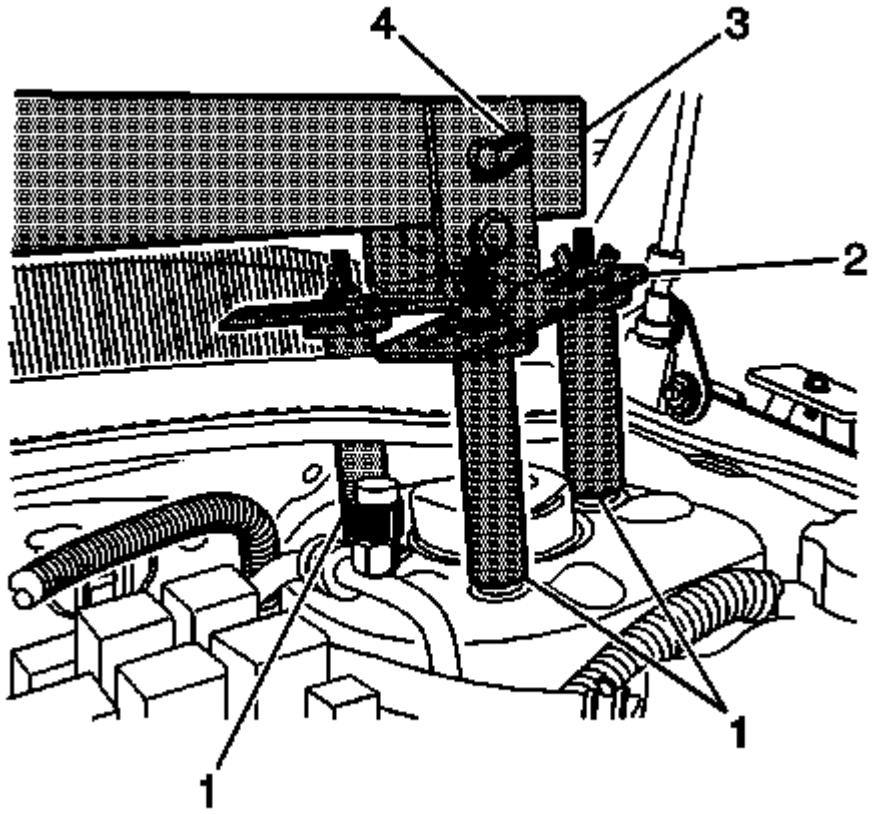


**Fig. 5: View Of Engine Support Fixture Adapter (J-28467-13)**
**Courtesy of GENERAL MOTORS CORP.**

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the Front Bumper Fascia Support. Refer to **Front Bumper Fascia Support Replacement**
3. Remove the air inlet screen. Refer to **Air Inlet Screen Replacement (Equinox)** or **Air Inlet Screen Replacement (Terrain)**
4. Install two M8 x 1.25 double ended studs to each strut tower with 30 mm engagement to the strut tower and 16 mm engagement to the **J-28467-13** adapters.
5. Install three **J-28467-13** (1) and two J 28467-5 strut tower adapters (2) to the top of the left and right strut tower.

 

6. Install a 127 cm (50 in) engine support fixture cross bar **J 28467-B** (3) transversely across the vehicle between both J 28467-5 strut tower adapters (2).
7. Insert safety pins J-28467-10 (4) through the J 28467-5 strut tower adapters (2) and the cross bar (3) to prevent movement.

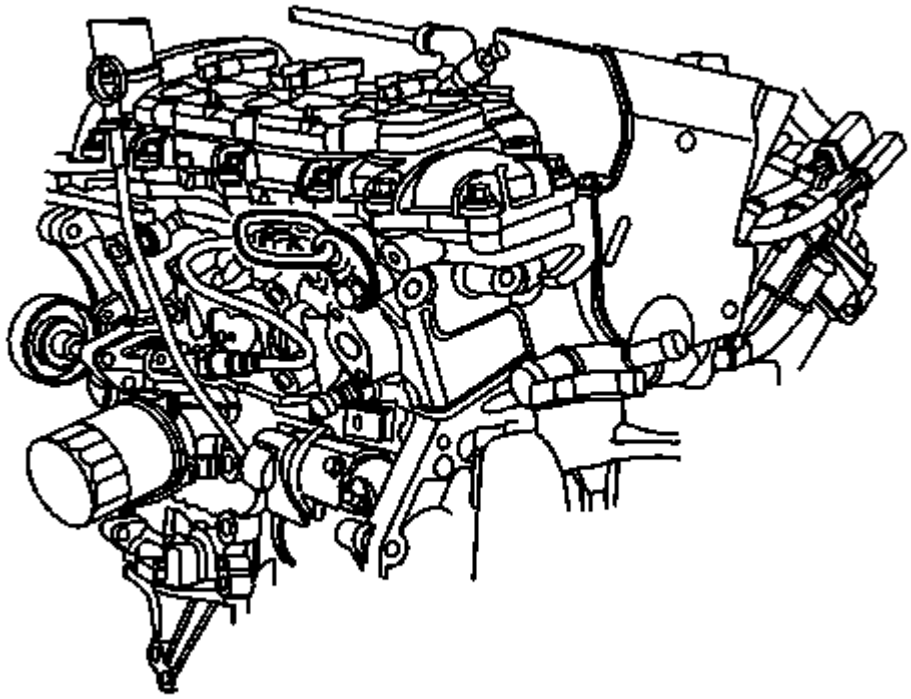

**Fig. 6: Engine Support Bracket**
**Courtesy of GENERAL MOTORS CORP.**

8. Install the engine support bracket **J 42451-1** to the engine.

 

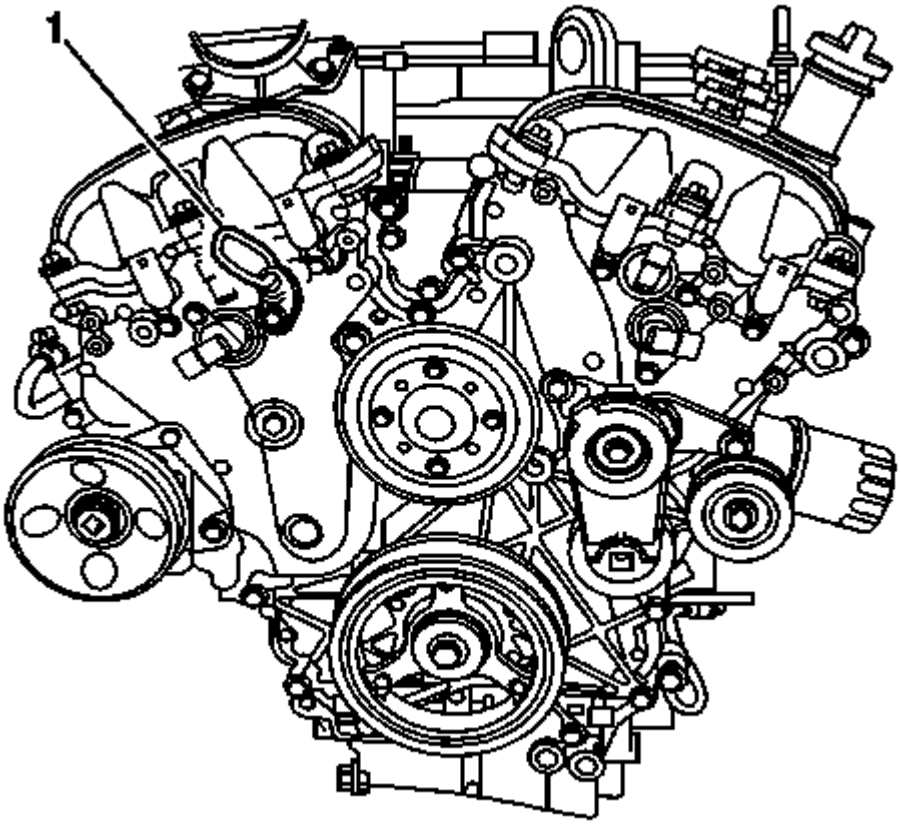


**Fig. 7: Engine Support Bracket**
**Courtesy of GENERAL MOTORS CORP.**

9. Install the engine support bracket **J 42451-1** to the engine.

 

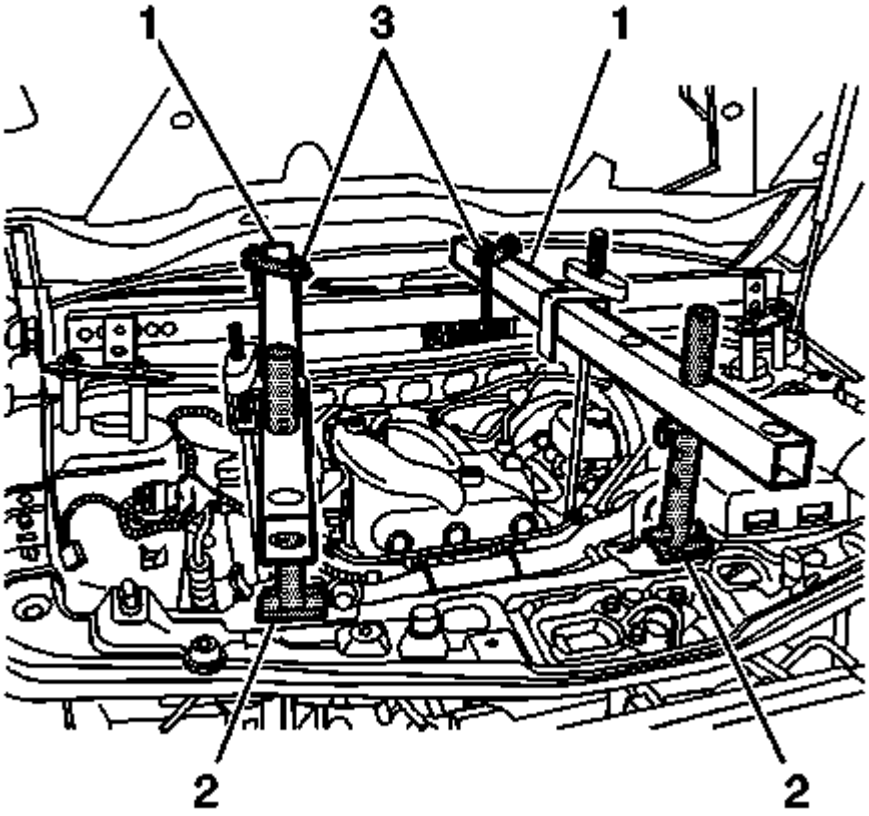


**Fig. 8: View Of Engine Support Fixture**
**Courtesy of GENERAL MOTORS CORP.**

10. Position two 58 cm (23 in) engine support fixture cross bars (1) longitudinally with two **J 36462-A** leg assembly (2).
11. Install two J 28467-1A clamp (3) to secure the longitudinal mounted cross bar to the transverse mounted cross bar.

 

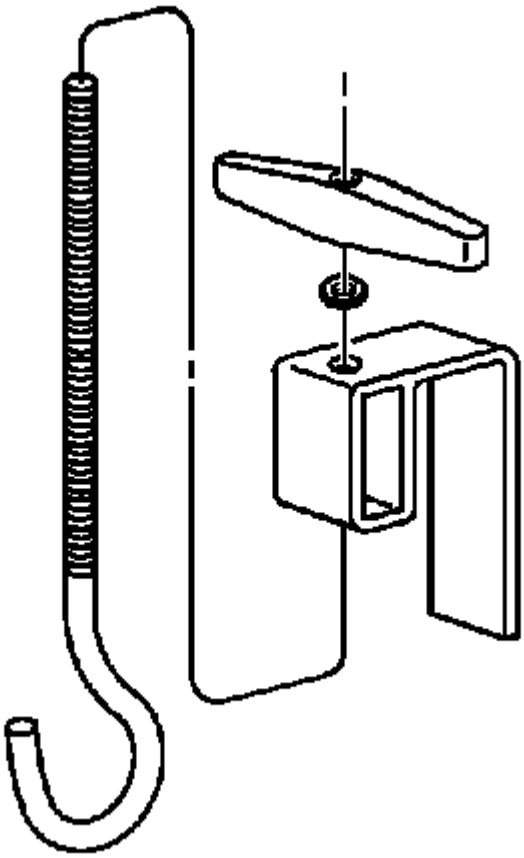

**Fig. 9: View Of Lift Hook Assembly**
**Courtesy of GENERAL MOTORS CORP.**

12. Assemble the lift hook wing nut **J 28467-34** and the lift hook bracket J-28467-6A to the lift hook **J 28467-7A** .

 

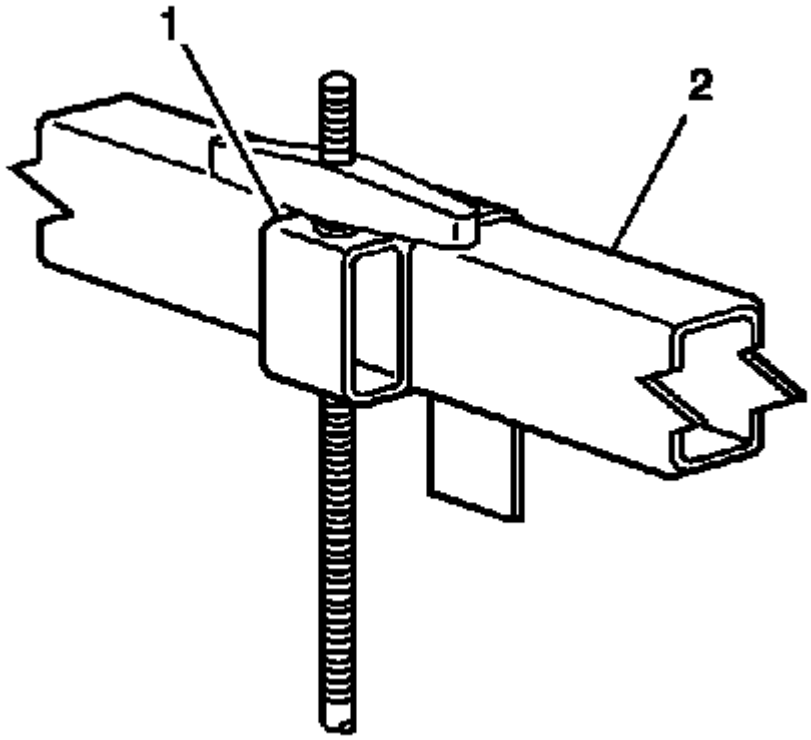


**Fig. 10: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar**
**Courtesy of GENERAL MOTORS CORP.**

13. Install the lift hook and bracket assembly (1) to the longitudinal mounted cross bar (2).

 

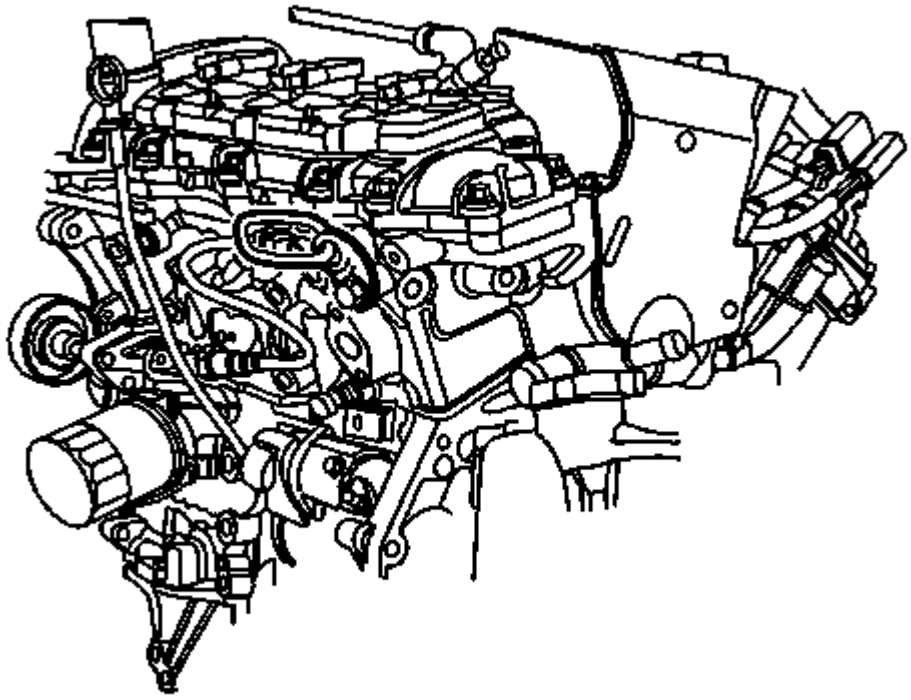

**Fig. 11: Engine Support Bracket**
**Courtesy of GENERAL MOTORS CORP.**

14. Position the **J 28467-7A** lift hook to the rear engine lift bracket **J 42451-1** (2).

 

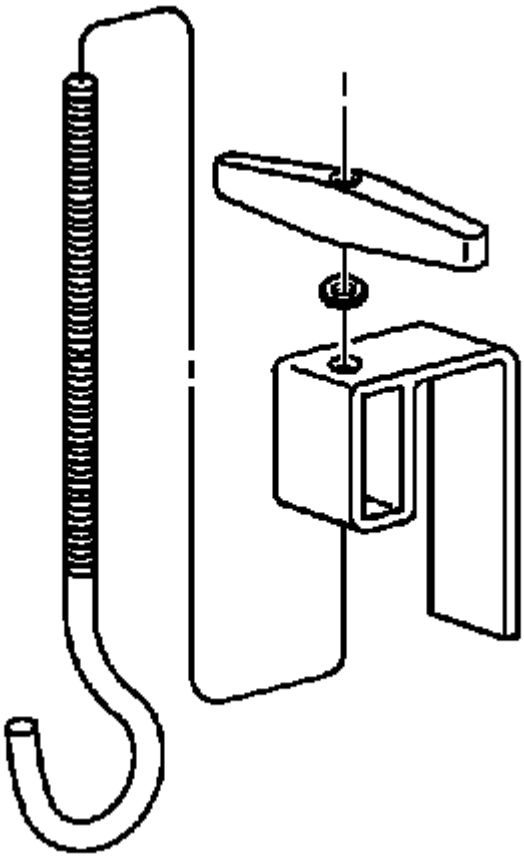

**Fig. 12: View Of Lift Hook Assembly**
**Courtesy of GENERAL MOTORS CORP.**

15. Assemble the lift hook wing nut **J 28467-34** and the lift hook bracket J-28467-6A to the lift hook **J 28467-7A** .

 

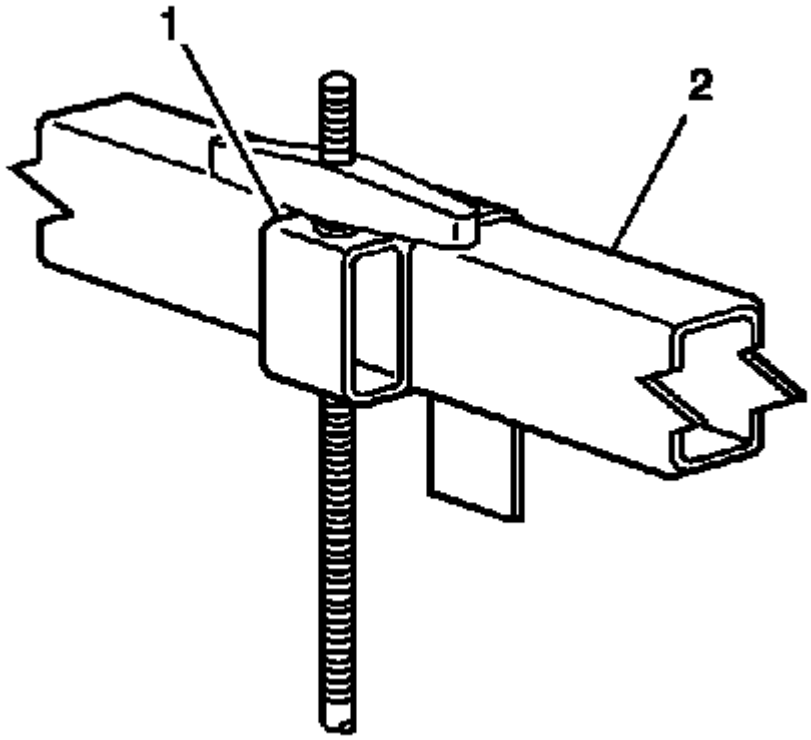


**Fig. 13: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar**
**Courtesy of GENERAL MOTORS CORP.**

16. Install the lift hook and bracket assembly (1) to the longitudinal mounted cross bar (2).

 

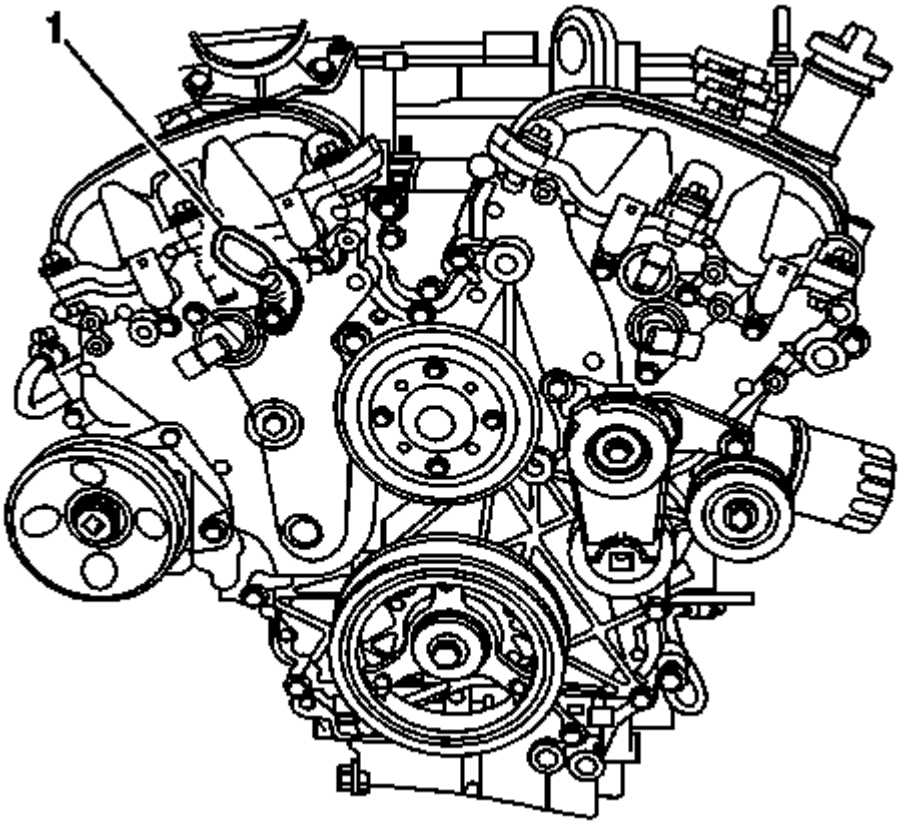


**Fig. 14: Engine Support Bracket**
**Courtesy of GENERAL MOTORS CORP.**

17. Position the **J 28467-7A** bolt hook (1) to the front engine lift bracket **J 42451-1** (2).

 


**Fig. 15: View Of Engine Support Fixture**
**Courtesy of GENERAL MOTORS CORP.**

18. Evenly tighten both wing nuts **J 28467-34** (1) until the engine weight is supported by the engine support fixture and no longer carried by the engine mounts.

## 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

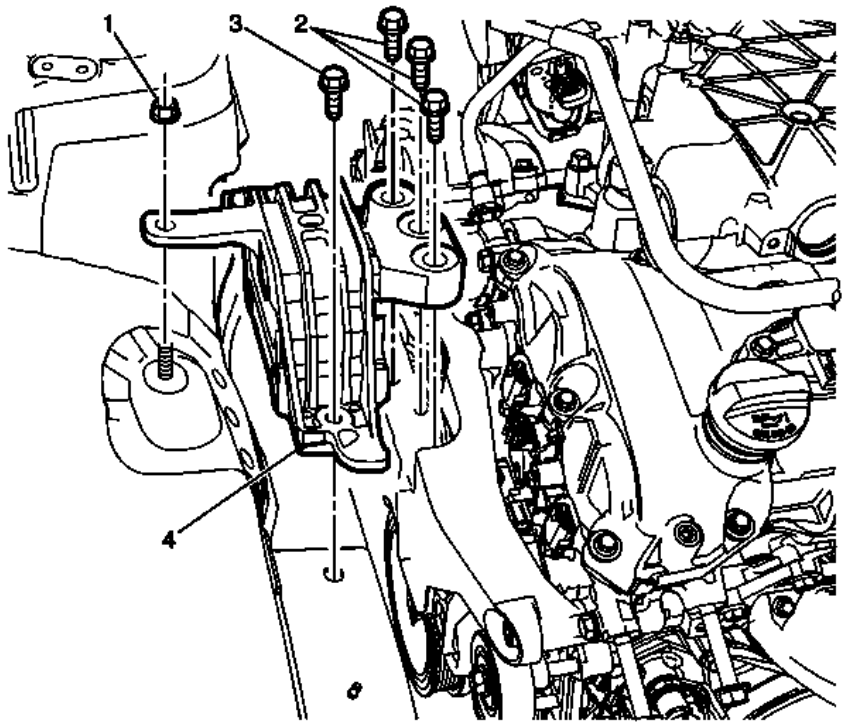


**Fig. 16: Engine Mount - Right Side**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedures**<br><br>1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .<br>2. Install engine support fixture. Refer to **Engine Support Fixture**.<br>3. If equipped with LAU, reposition the power steering reservoir outlet hose. Refer to **Power Steering Fluid Reservoir Outlet Hose Replacement** .<br>4. If equipped with LAU, remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LAF)** or **Radiator Inlet Hose Replacement (LF1)** .<br>5. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.<br><br>If all powertrain mounts are replaced, perform "Powertrain Mount Balancing". Refer to the appropriate engine section. | |
| | Engine Mount Fastener<br><br>**CAUTION:** |

 

| | |
|---|---|
| 1 | **Refer to Fastener Caution .**<br><br>**Tip:** Perform the "Powertrain Mount Balancing-lower". Refer to the appropriate engine section.<br><br>**Tighten:** 62 N.m (46 lb ft) |
| 2 | Engine Mount Fastener (Qty: 3)<br><br>**Tighten:** 62 N.m (46 lb ft) |
| 3 | Engine Mount Fastener (Qty: 2)<br><br>**Tighten:** 100 N.m (73 lb ft) |
| 4 | Engine Mount<br>**Procedure:**<br>Transfer components as necessary. |

## ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

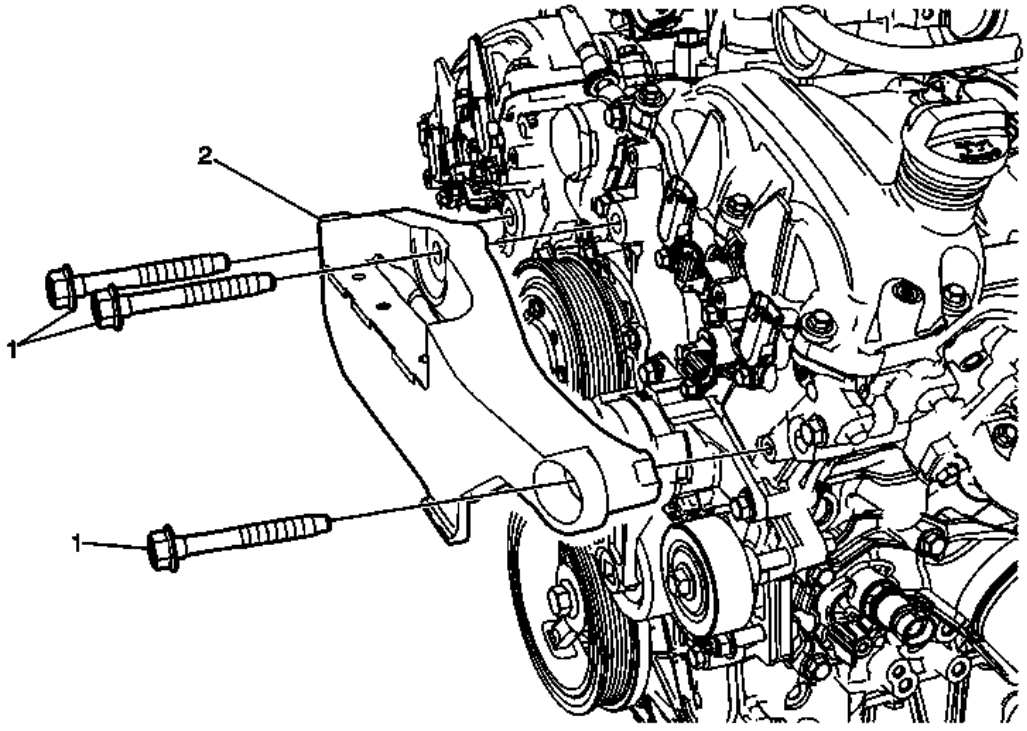


**Fig. 17: Engine Mount Bracket - Right Side**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedures** | |

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

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

## INTAKE MANIFOLD COVER REPLACEMENT

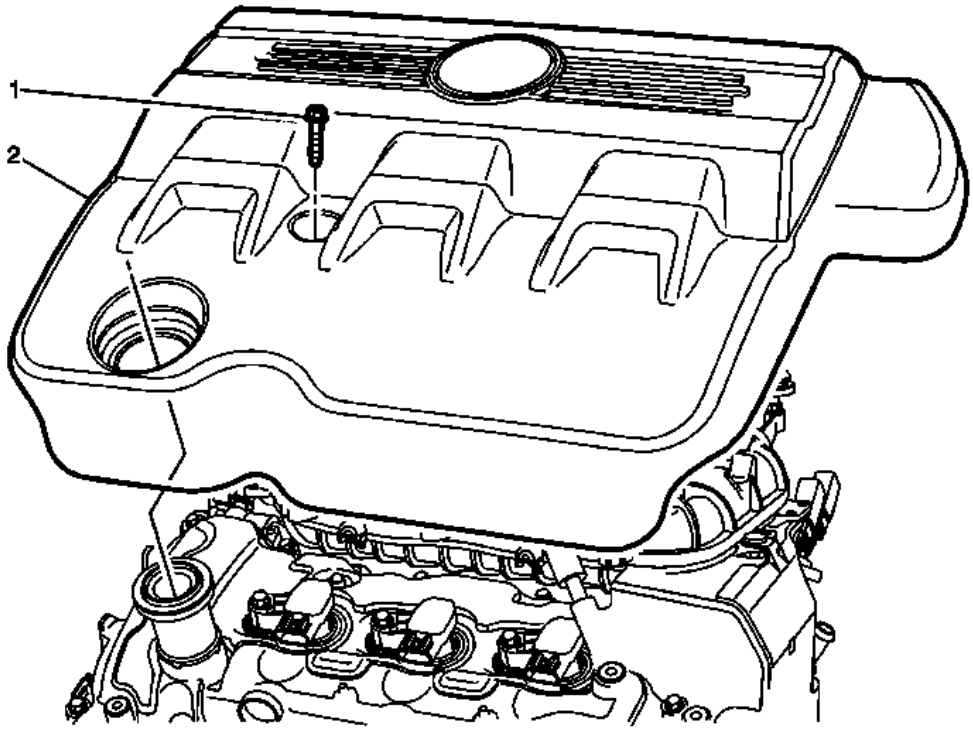


**Fig. 18: Intake Manifold Cover**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| | Intake Manifold Cover |

 

| | |
|---|---|
| 1 | **Procedure**<br>1. Remove the oil cap before removing the intake manifold cover.<br>2. Transfer components as necessary. |

## POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT

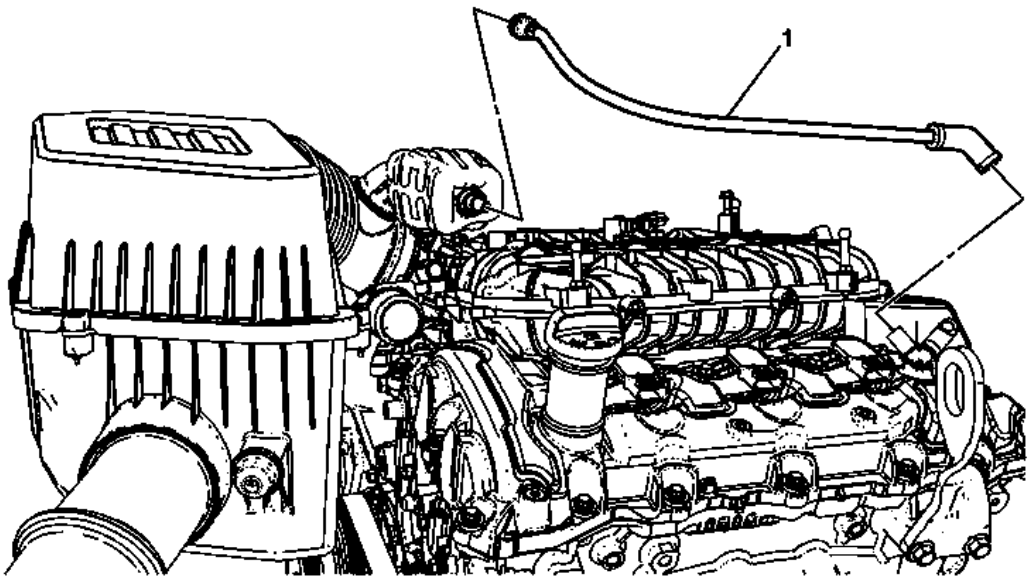


**Fig. 19: Positive Crankcase Ventilation Tube - Front**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedure:**<br>Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**. | |
| 1 | Positive Crankcase Ventilation Tube |

## POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - REAR

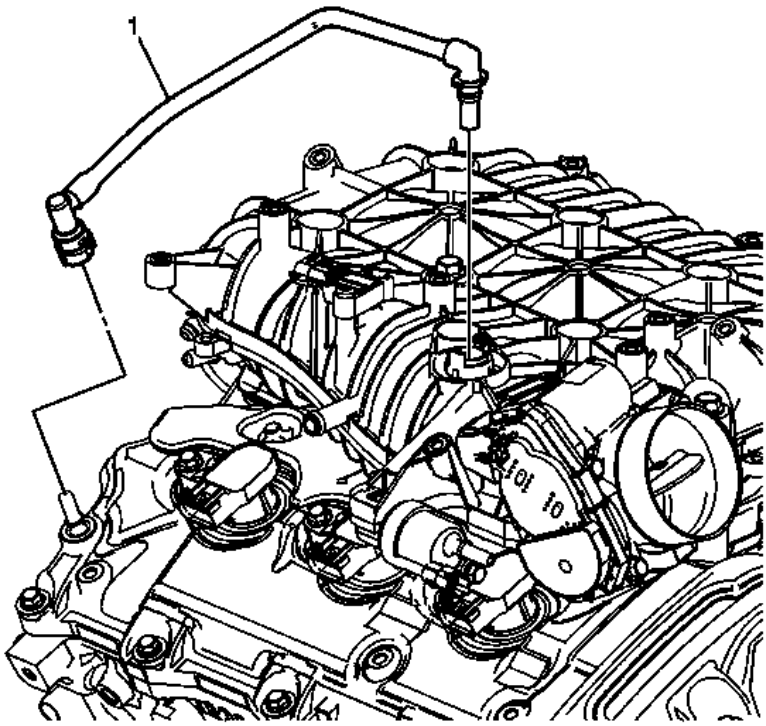


**Fig. 20: Positive Crankcase Ventilation Tube Replacement - Rear**
**Courtesy of GENERAL MOTORS CORP.**

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

# INTAKE MANIFOLD REPLACEMENT

**REMOVAL PROCEDURE**

1. Remove the power steering fluid reservoir upper bracket only.
2. Remove the power brake booster vacuum check valve and hose. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement (2.4L)** or **Power Brake Booster Vacuum Check Valve and Hose Replacement (3.0L)** .
3. Remove the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LF1)** .
4. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

 

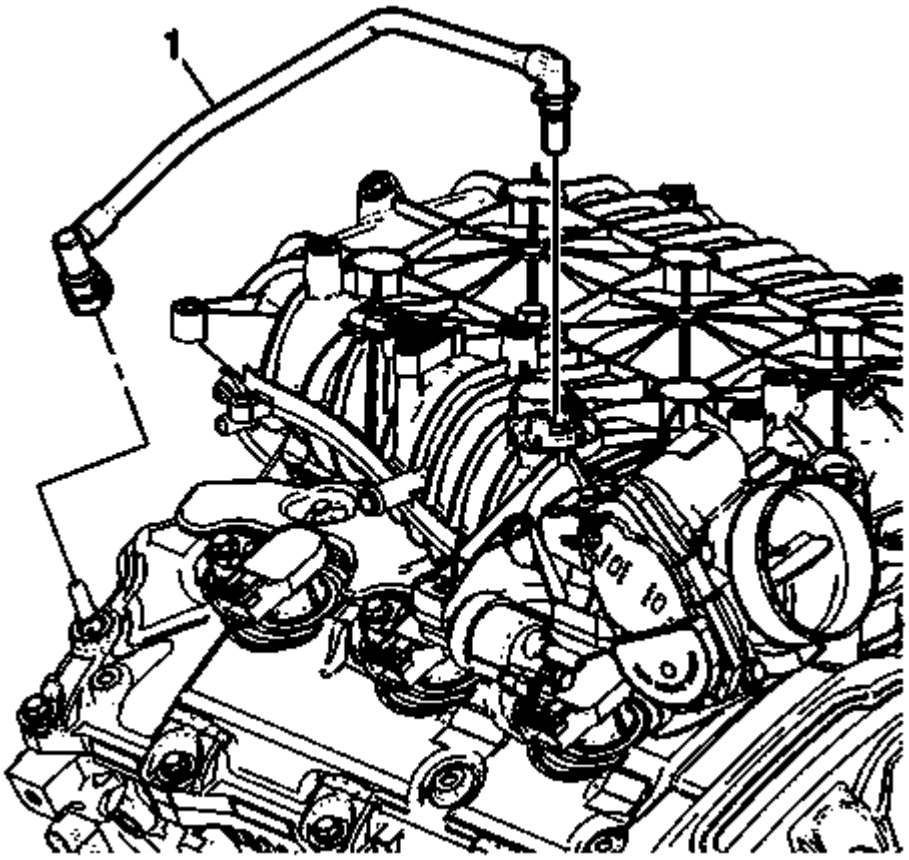


**Fig. 21: Positive Crankcase Ventilation Tube**
**Courtesy of GENERAL MOTORS CORP.**

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

 

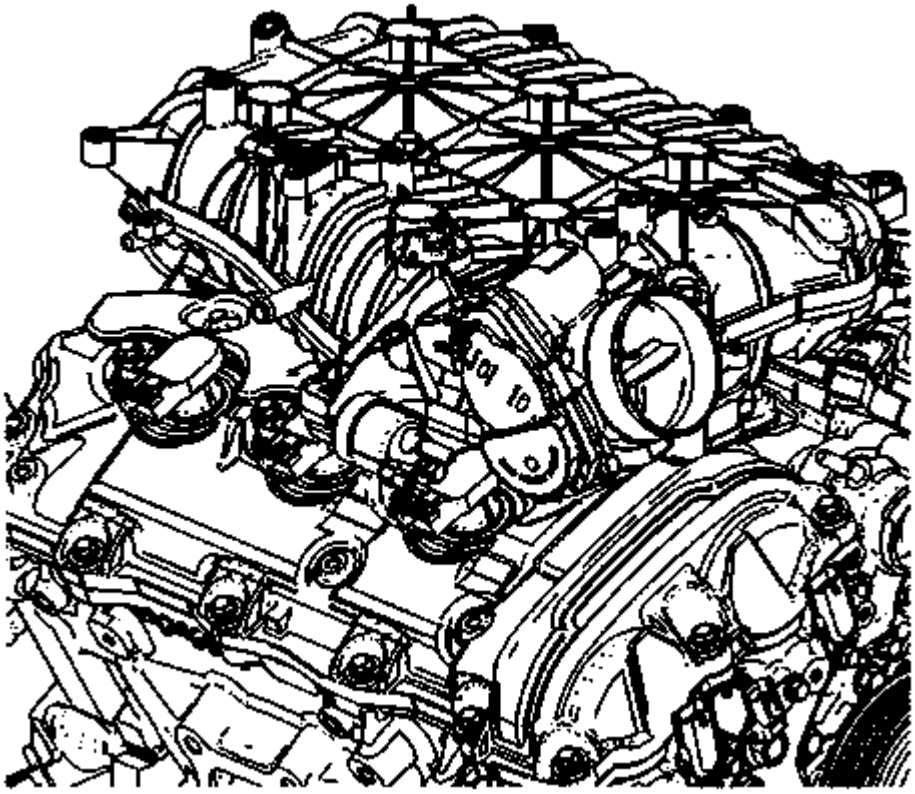

**Fig. 22: Evaporative Emission Hose**
**Courtesy of GENERAL MOTORS CORP.**

6. Remove the evaporative emission (EVAP) hose from the intake manifold and EVAP solenoid.
7. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** .
8. Unclip wire harnesses as necessary.

 

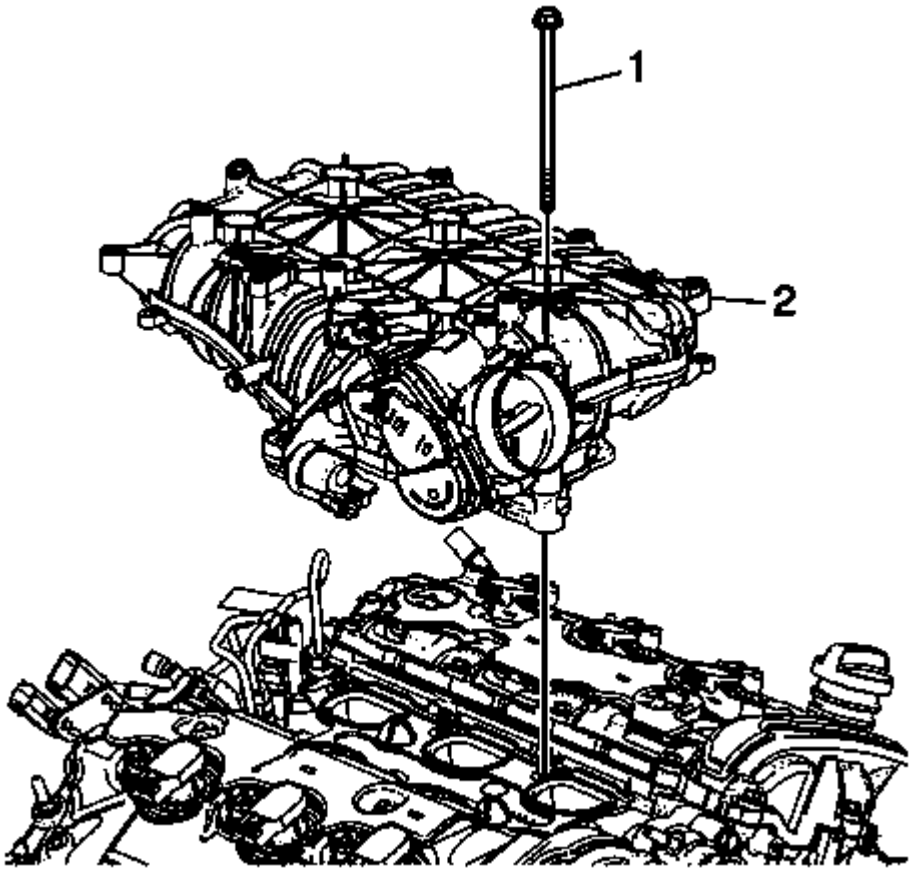


**Fig. 23: Intake Manifold Assembly**
**Courtesy of GENERAL MOTORS CORP.**

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

 

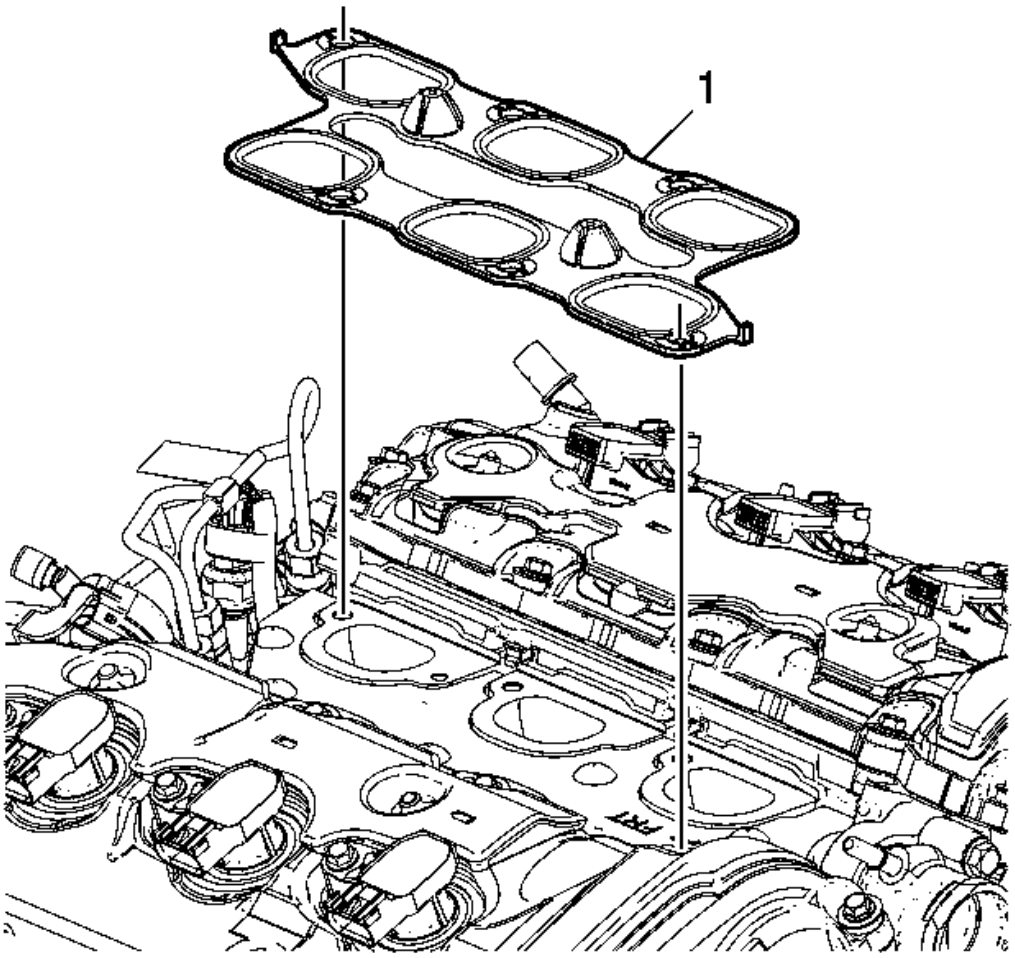


**Fig. 24: Intake Manifold Gasket**
**Courtesy of GENERAL MOTORS CORP.**

11. Remove and discard the intake manifold gasket (1).
12. To clean the intake manifold, refer to **Intake Manifold Cleaning and Inspection (LF1 or LFW)** .
13. To disassemble the intake manifold, refer to **Intake Manifold Disassemble (LF1 or LFW)** .

**INSTALLATION PROCEDURE**

1. Assemble the intake manifold if needed. Refer to **Intake Manifold Assemble (LF1 or LFW)** .

 

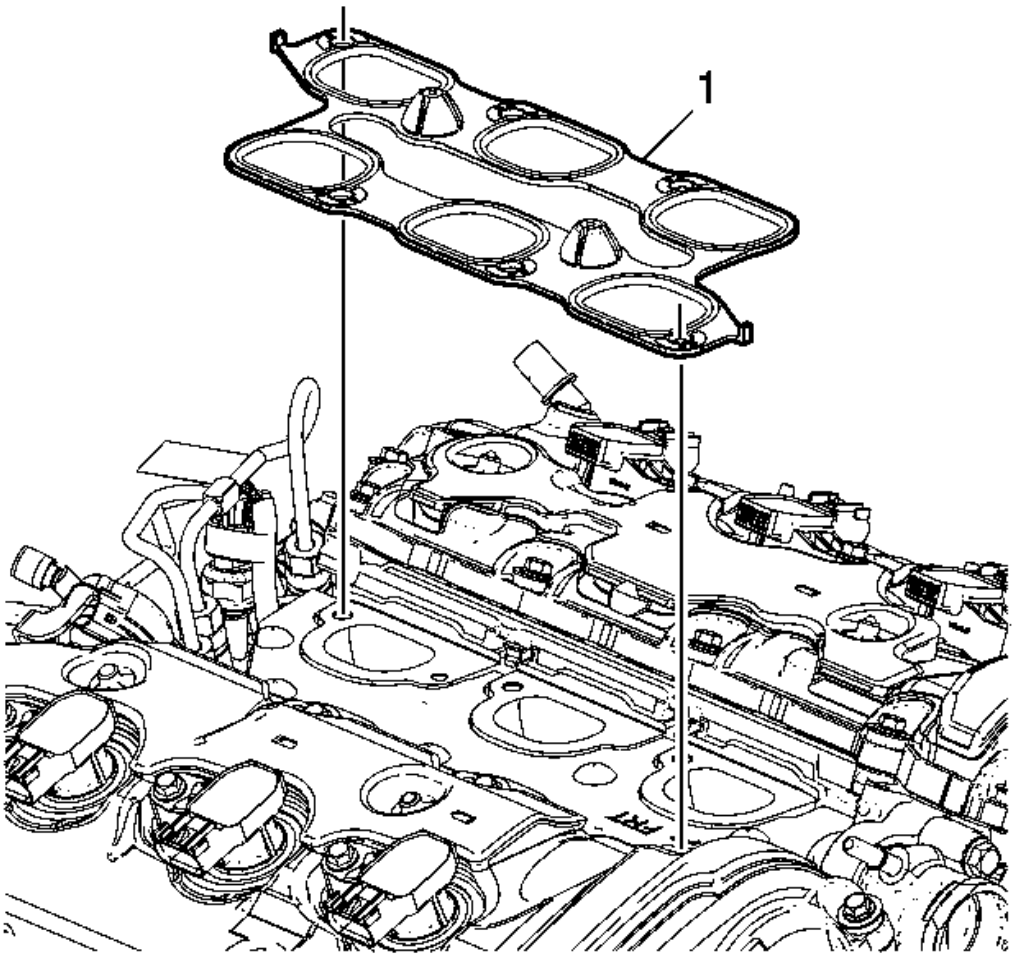


**Fig. 25: Intake Manifold Gasket**
**Courtesy of GENERAL MOTORS CORP.**

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

 

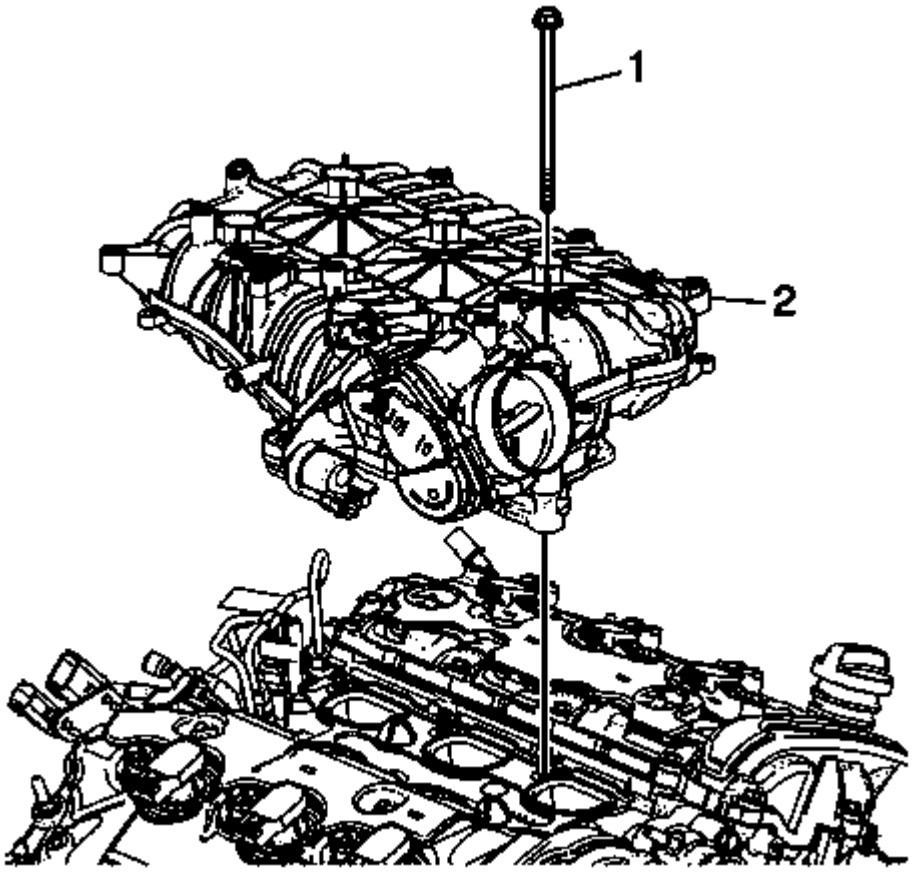


**Fig. 26: Intake Manifold Assembly**
**Courtesy of GENERAL MOTORS CORP.**

3. Install the intake manifold assembly (2).

**CAUTION: Refer to Fastener Caution .**

4. Install the intake manifold bolts (1).

 

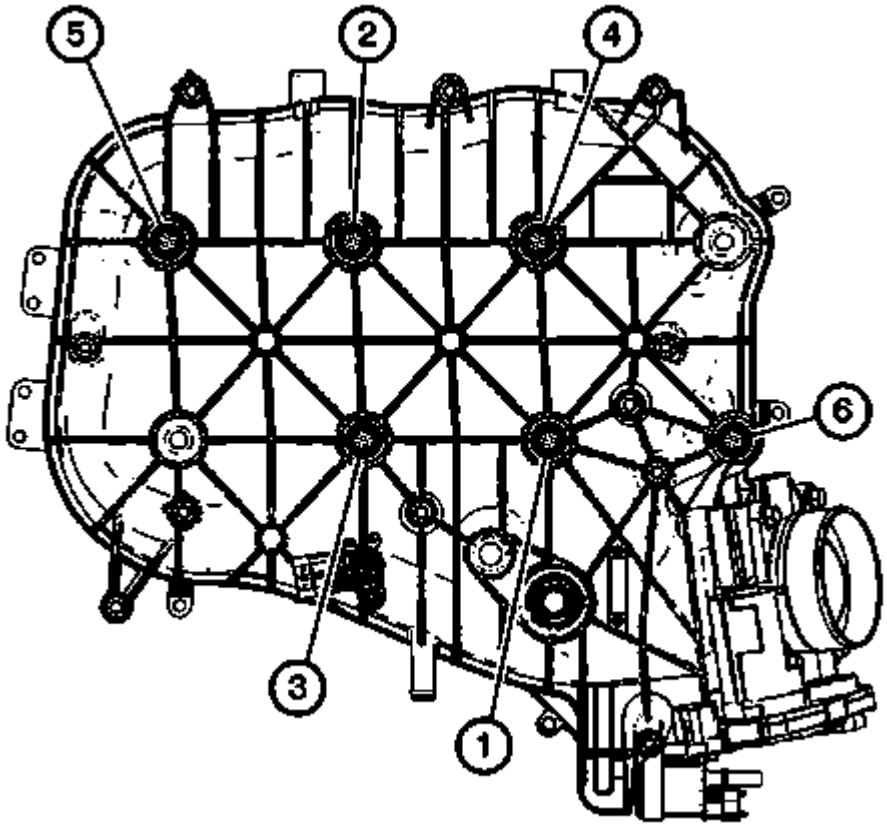


**Fig. 27: Identifying Intake Manifold Bolt Tightening Sequence**
**Courtesy of GENERAL MOTORS CORP.**

5. Tighten the intake manifold bolts in the sequence shown.
6. Tighten the intake manifold bolts in sequence to 23 N.m (17 lb ft).
7. Tighten the intake manifold bolts a second pass in sequence to 23 N.m (17 lb ft).
8. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** .

 

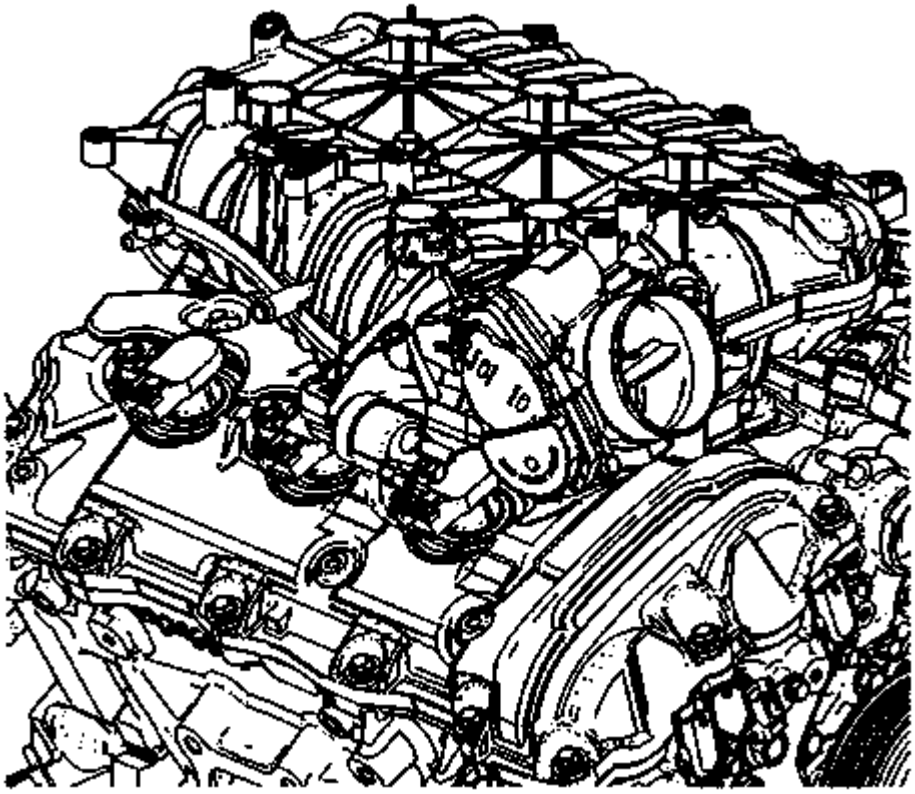

**Fig. 28: Evaporative Emission Hose**
**Courtesy of GENERAL MOTORS CORP.**

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

 

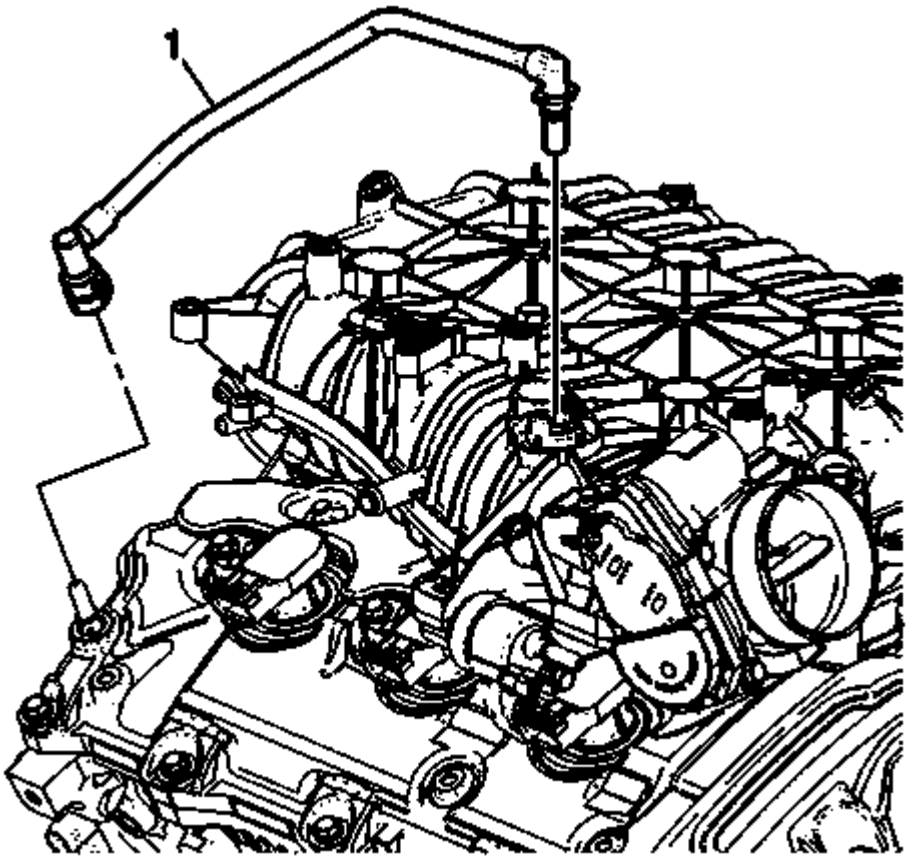


**Fig. 29: Positive Crankcase Ventilation Tube**
**Courtesy of GENERAL MOTORS CORP.**

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**.
13. Install the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LF1)** .
14. Install the power steering fluid reservoir upper bracket.
15. Install the power brake booster vacuum check valve and hose. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement (2.4L)** or **Power Brake Booster Vacuum Check Valve and Hose Replacement (3.0L)** .

# OIL LEVEL INDICATOR TUBE REPLACEMENT (LF1)

**REMOVAL PROCEDURE**

 

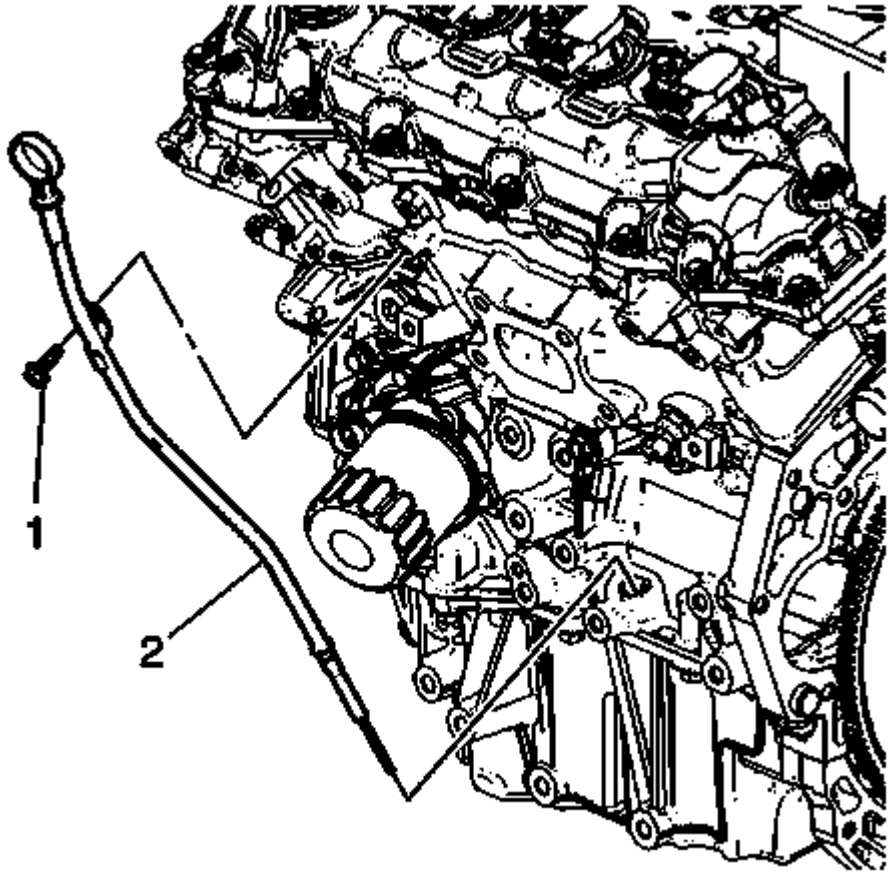


**Fig. 30: Oil Level Indicator Tube**
**Courtesy of GENERAL MOTORS CORP.**

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**
2. Remove the oil level indicator tube bracket bolt (1).
3. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.

 

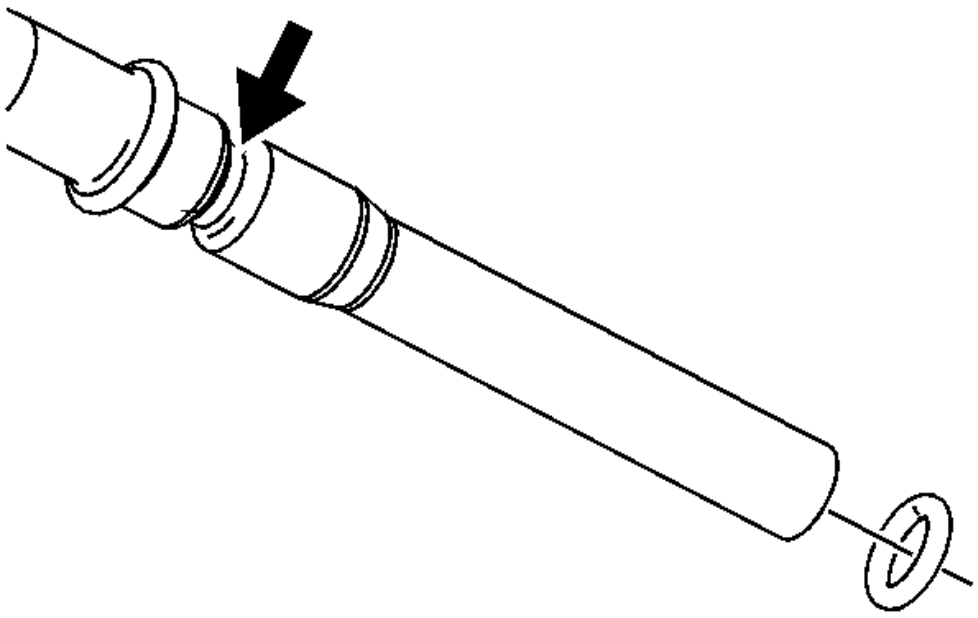

**Fig. 31: View Of Oil Level Indicator Tube O-Ring**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

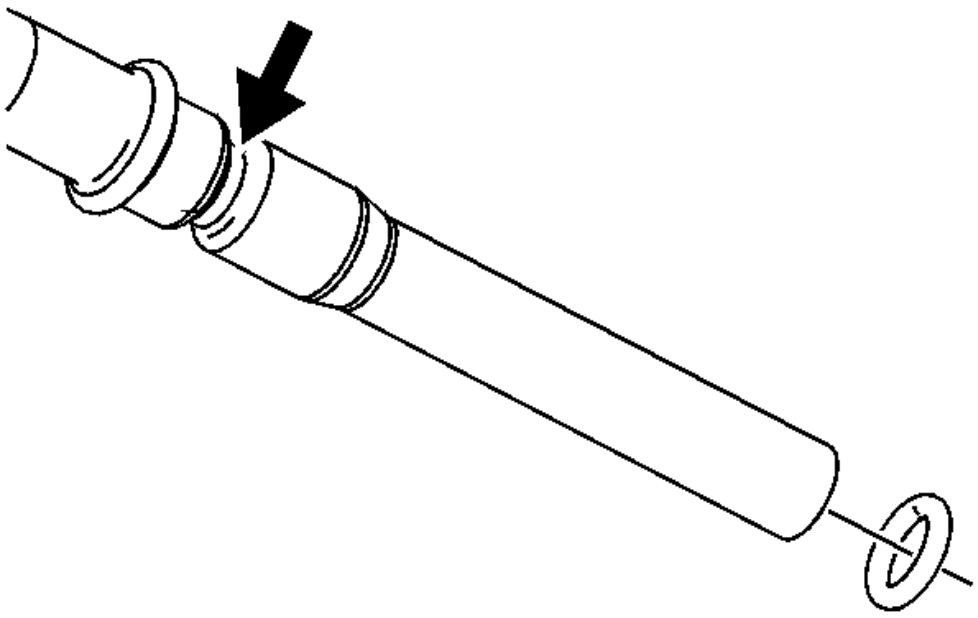

**Fig. 32: View Of Oil Level Indicator Tube O-Ring**
**Courtesy of GENERAL MOTORS CORP.**

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

 

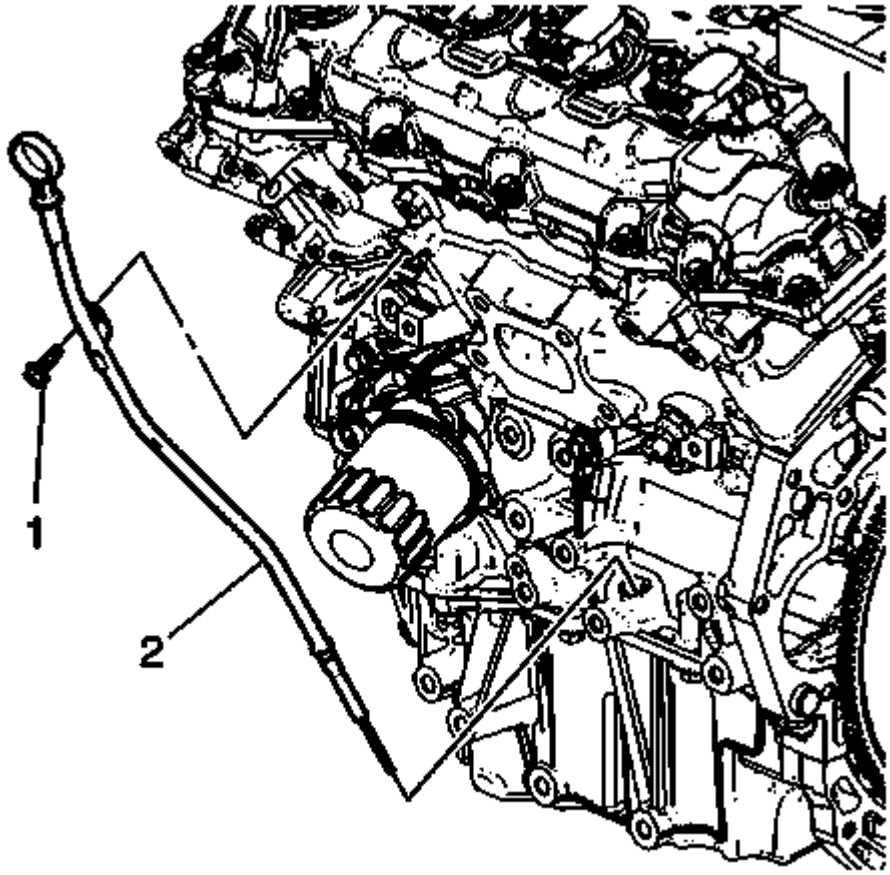


**Fig. 33: Oil Level Indicator Tube**
**Courtesy of GENERAL MOTORS CORP.**

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).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

## OIL FILTER ADAPTER REPLACEMENT

 

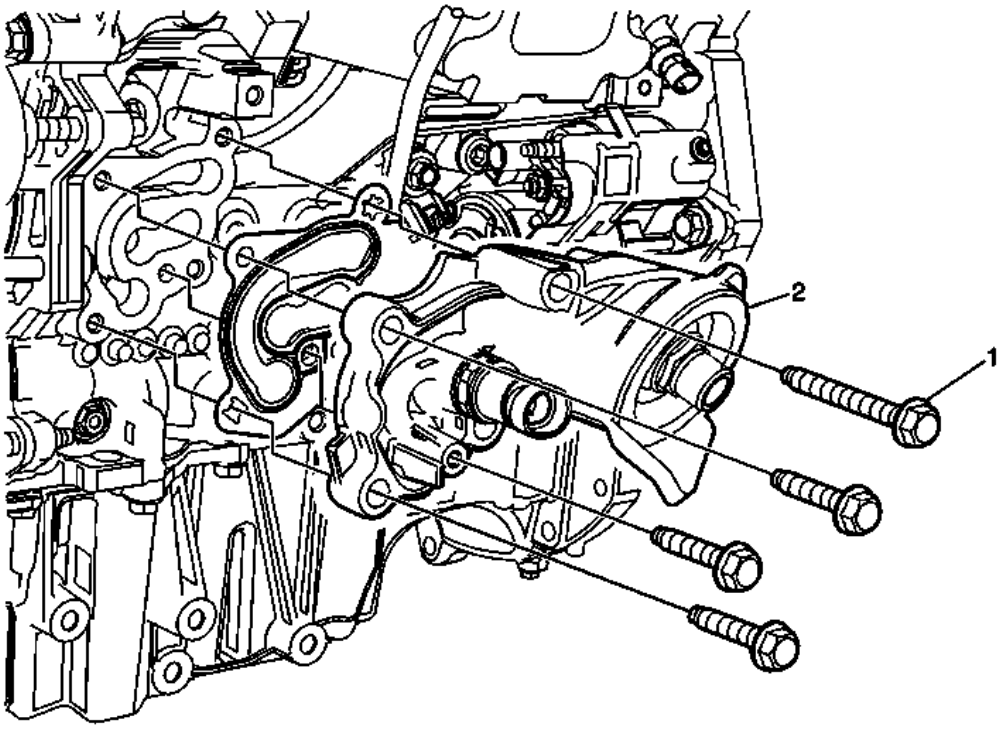


**Fig. 34: Oil Filter Adapter**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedures**<br><br>1. Remove the generator. Refer to **Generator Replacement (LAF)** or **Generator Replacement (LF1)** .<br>2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement (LF1)** . | |
| 1 | Oil Filter Adapter Fastener (Qty: 4)<br><br>**CAUTION:**<br>**Refer to Fastener Caution .**<br><br>**Tighten:** 25 N.m (18 lb ft) |
| 2 | Oil Filter Adapter<br><br>**Procedure**<br><br>1. Replace oil filter adapter gasket.<br>2. Disconnect electrical connector as needed.<br>3. Transfer components as necessary. |

## CRANKSHAFT BALANCER REPLACEMENT

 

**Special Tools**

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

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

**REMOVAL PROCEDURE**

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Install the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the starter. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .

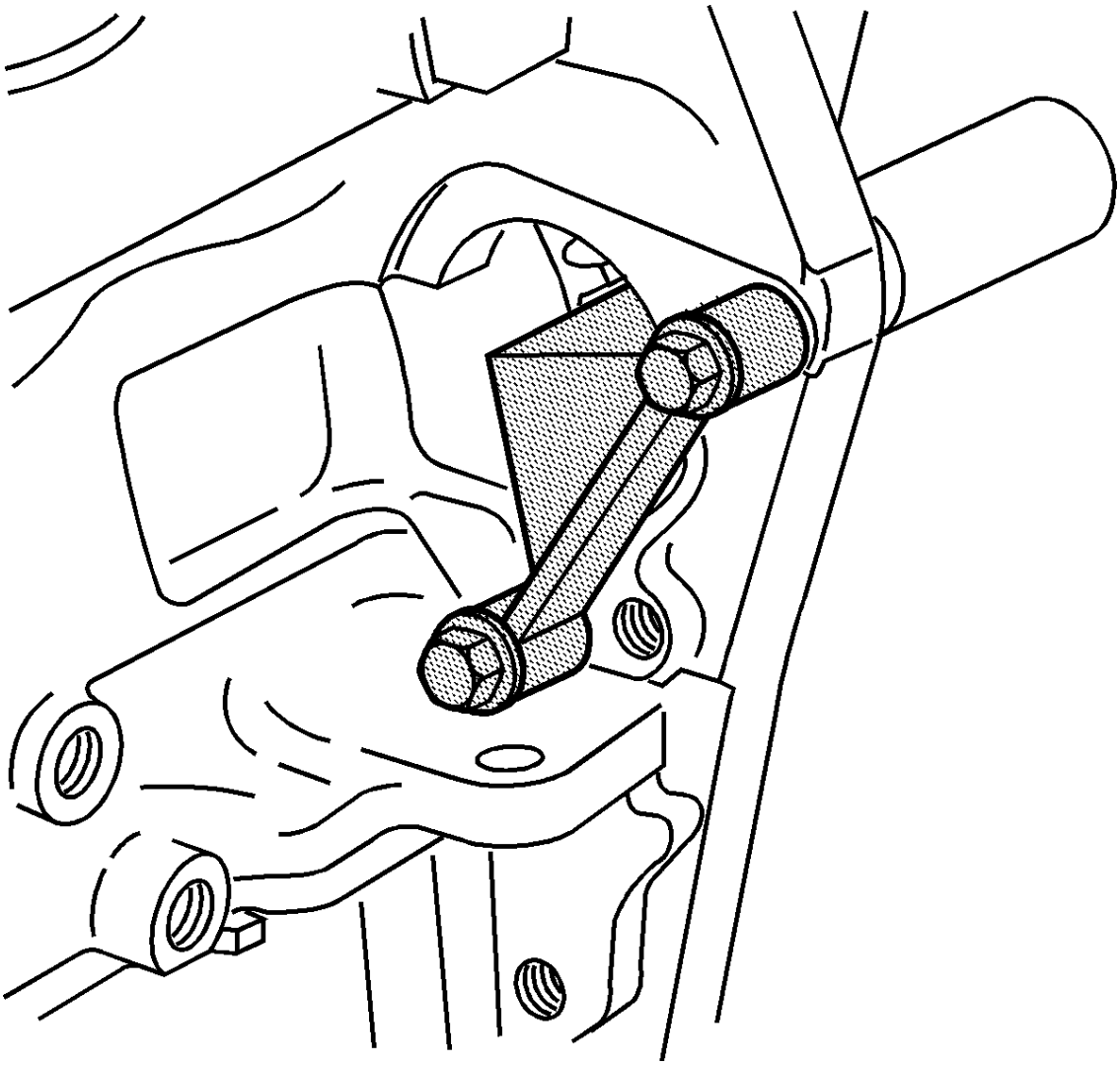

 

**Fig. 35: View Of Tool EN 46106**
**Courtesy of GENERAL MOTORS CORP.**

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

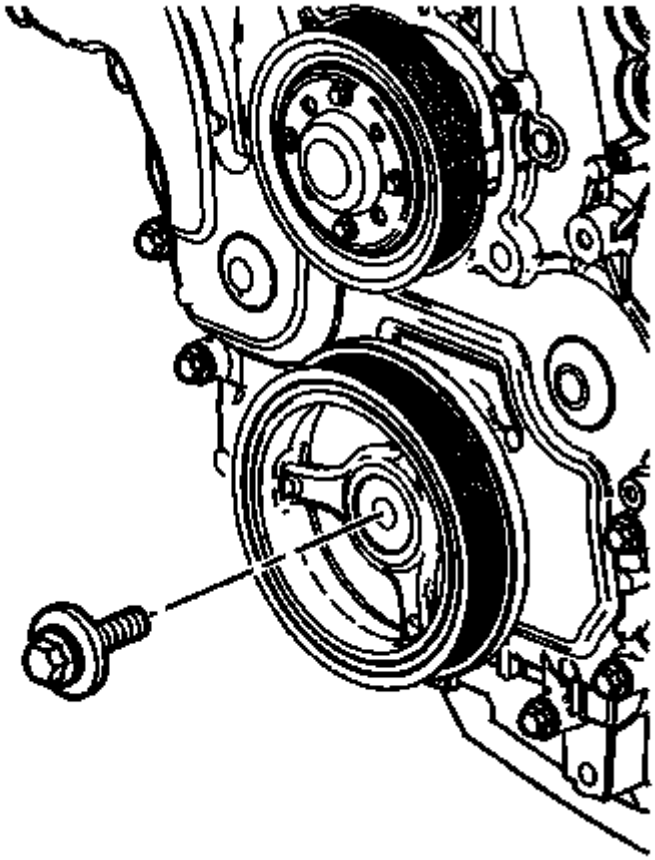

**Fig. 36: View Of Crankshaft Balancer Bolt**
**Courtesy of GENERAL MOTORS CORP.**

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

 

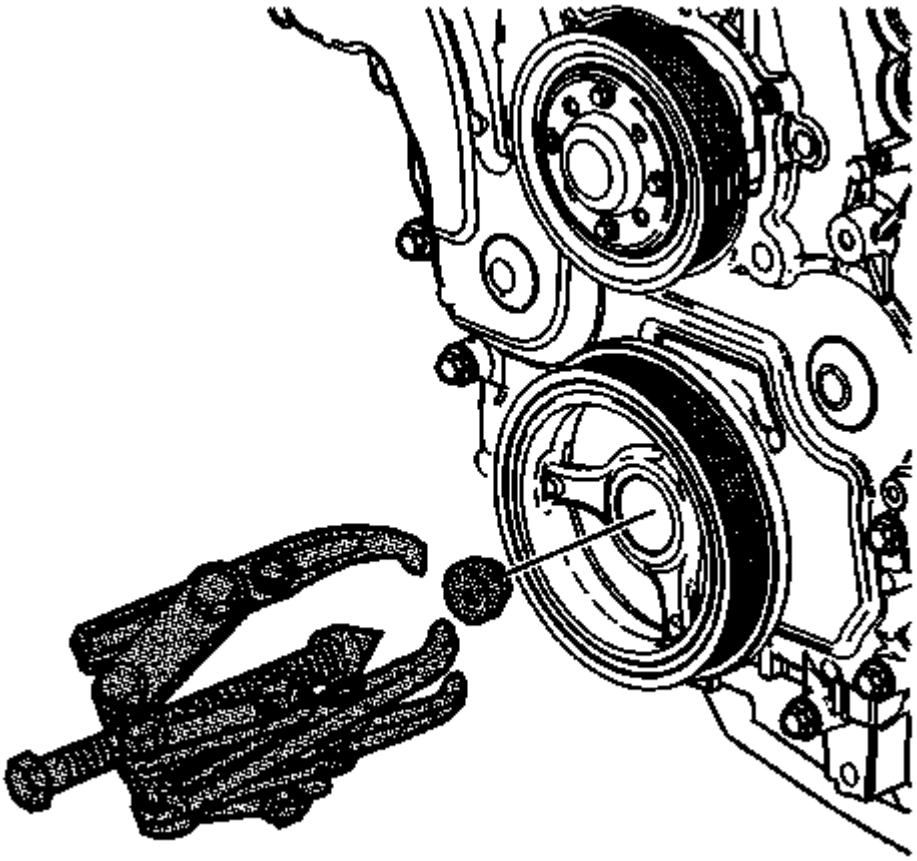

**Fig. 37: Removing Crankshaft Balancer**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

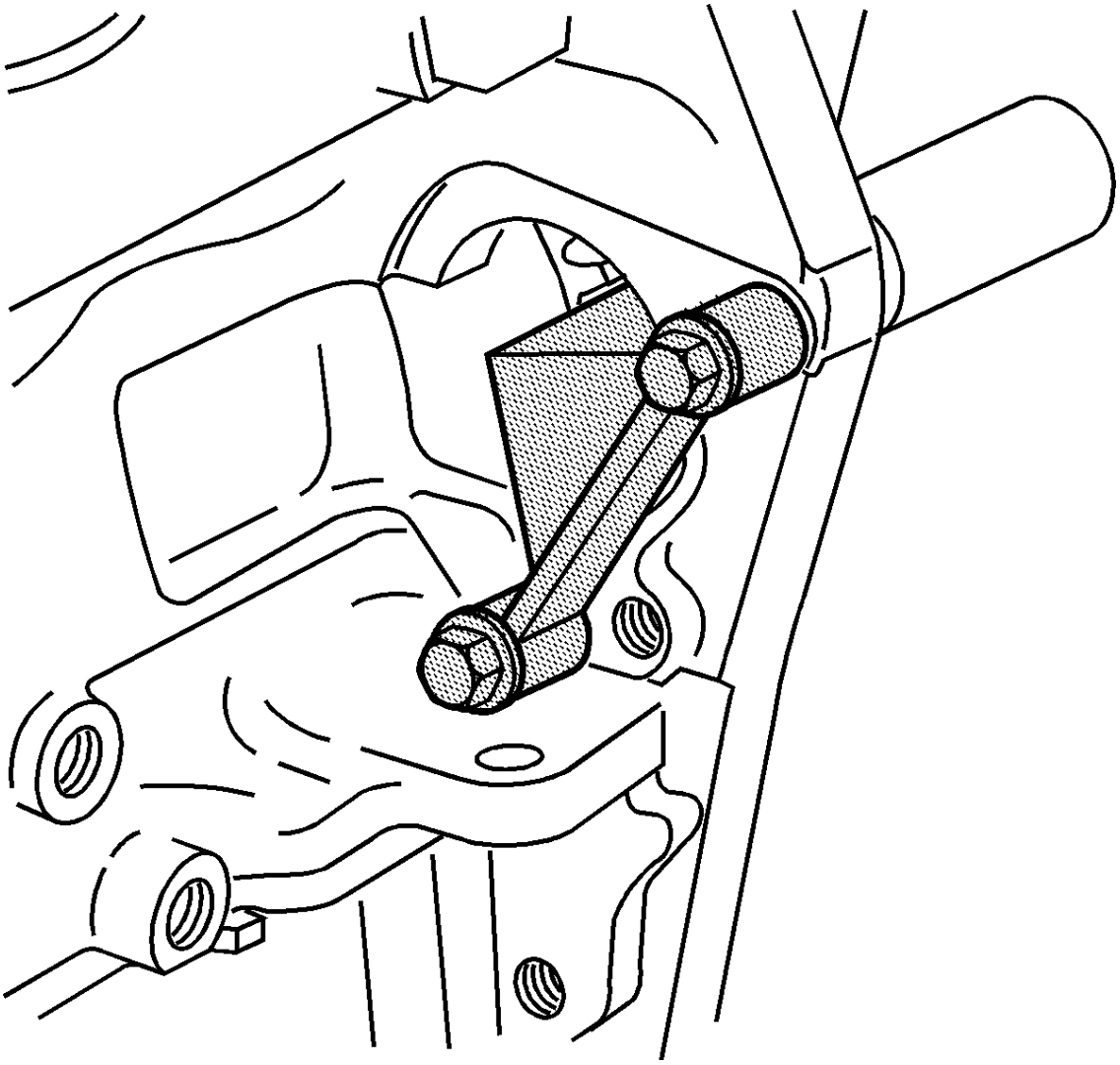

**Fig. 38: View Of Tool EN 46106**
**Courtesy of GENERAL MOTORS CORP.**

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

 

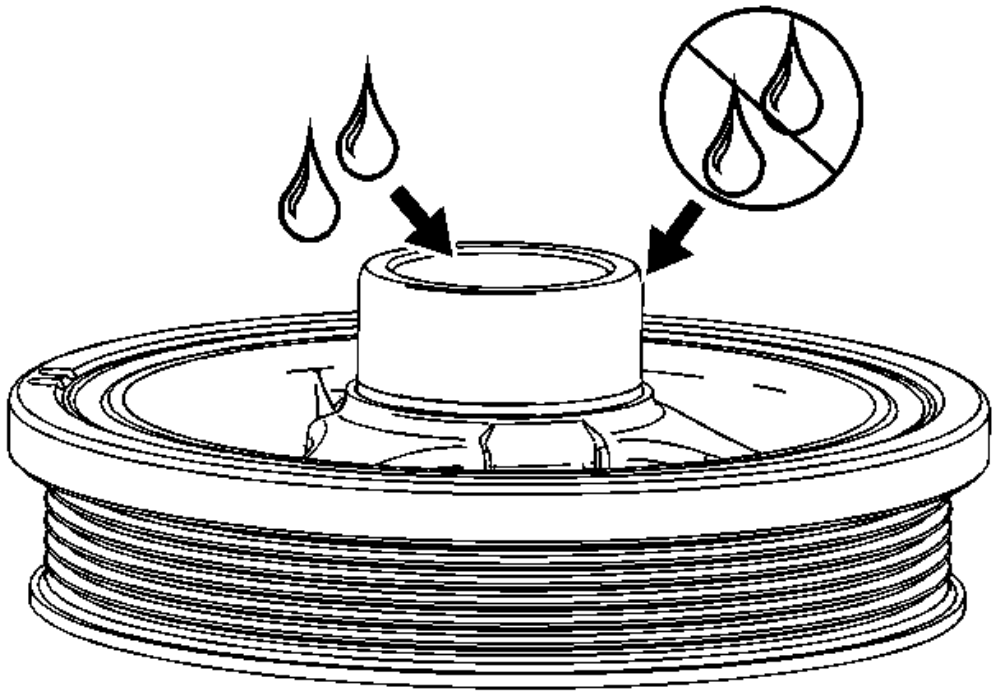

**Fig. 39: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

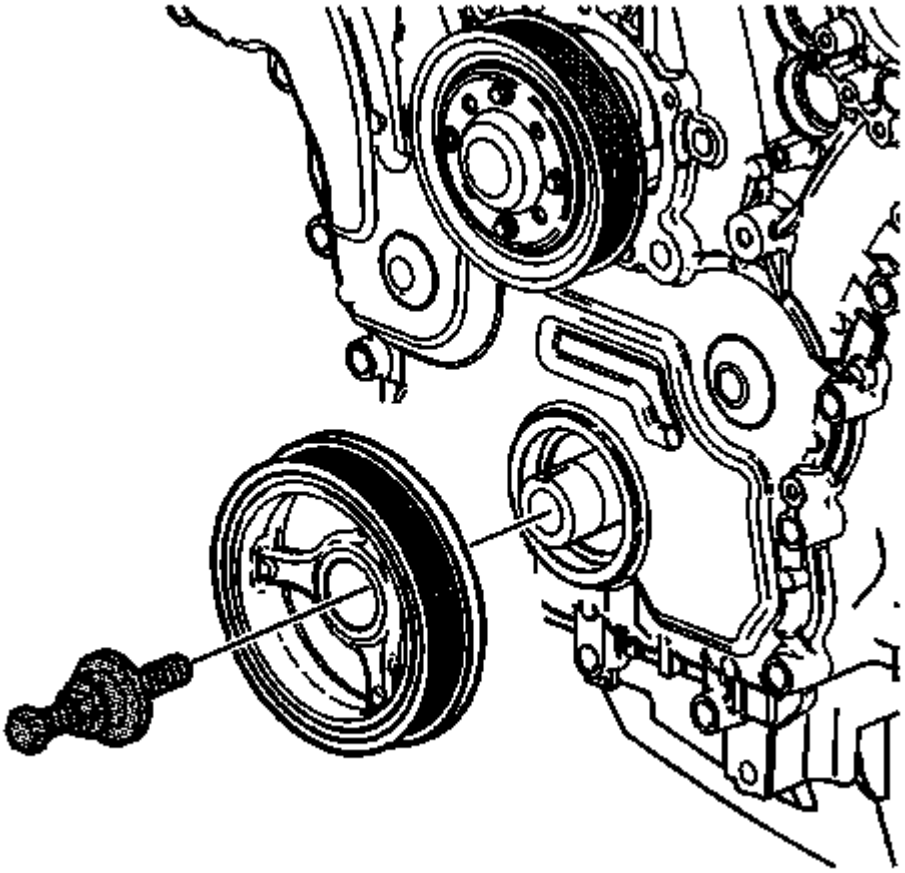

**Fig. 40: Installing Crankshaft Balancer Using J 41998-B**
**Courtesy of GENERAL MOTORS CORP.**

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

 

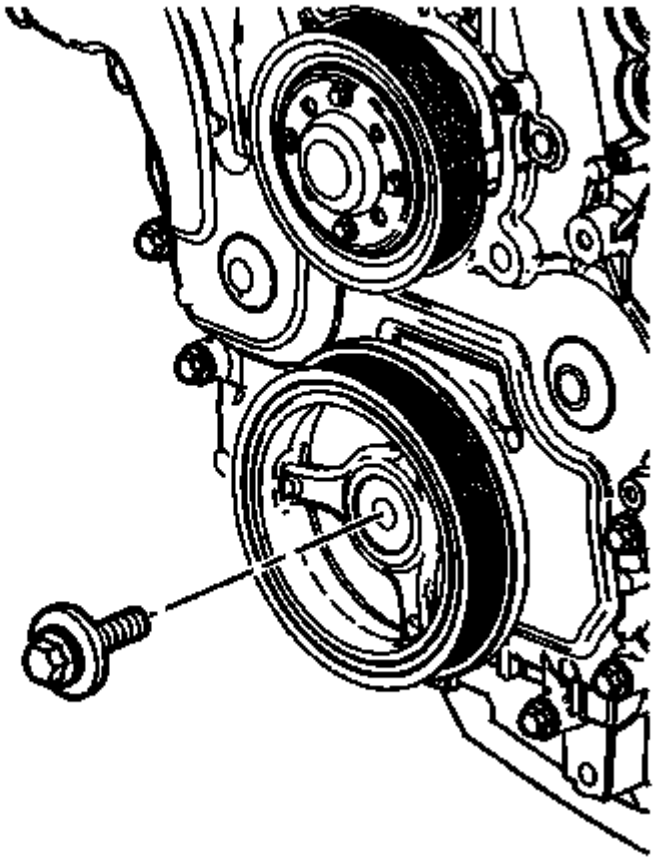

**Fig. 41: View Of Crankshaft Balancer Bolt**
**Courtesy of GENERAL MOTORS CORP.**

**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 **EN-45059:** meter.

 

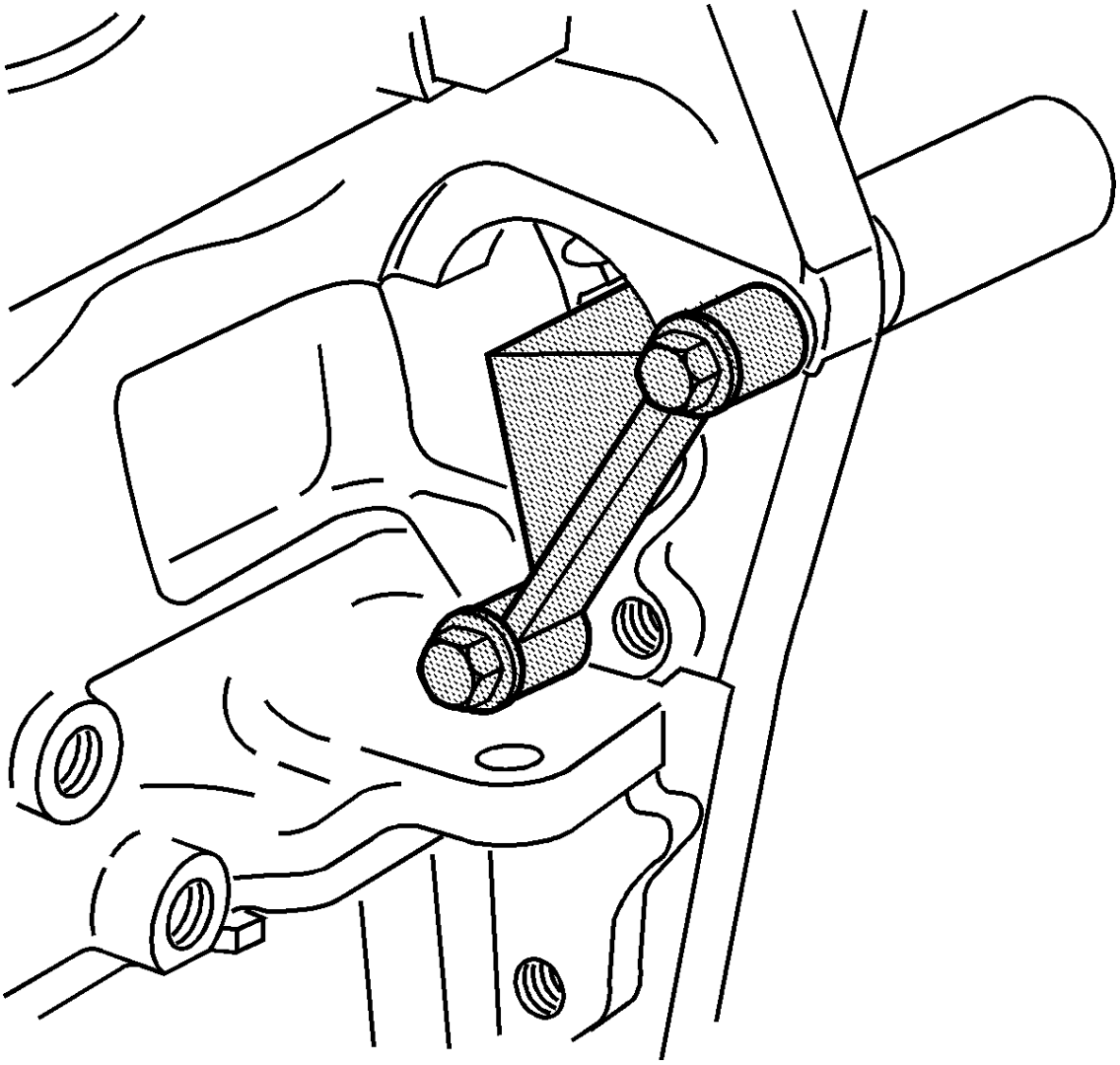

**Fig. 42: View Of Tool EN 46106**
**Courtesy of GENERAL MOTORS CORP.**

10. Remove the **EN-46106:** tool.
11. Install the starter. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .
12. Install the drive belt. Refer to **Drive Belt Replacement**.
13. 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**

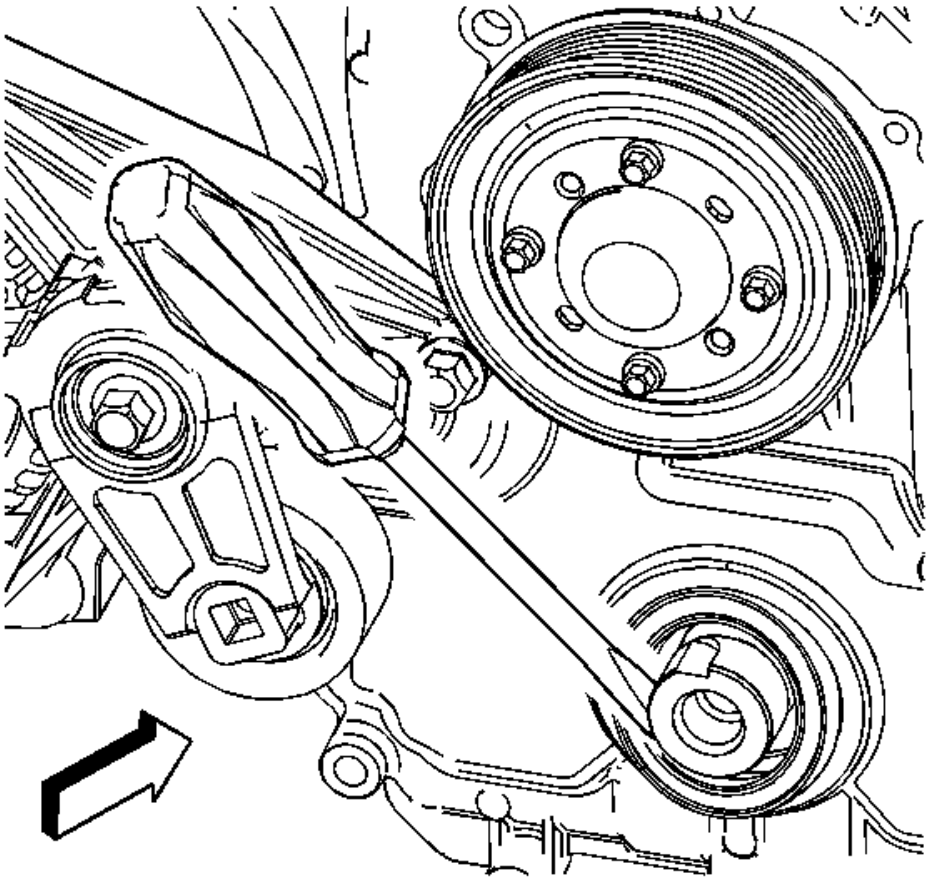

**Fig. 43: Removing Crankshaft Front Oil Seal**
**Courtesy of GENERAL MOTORS CORP.**

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Use a flat-bladed tool in order to remove the crankshaft oil seal.

**INSTALLATION PROCEDURE**

 

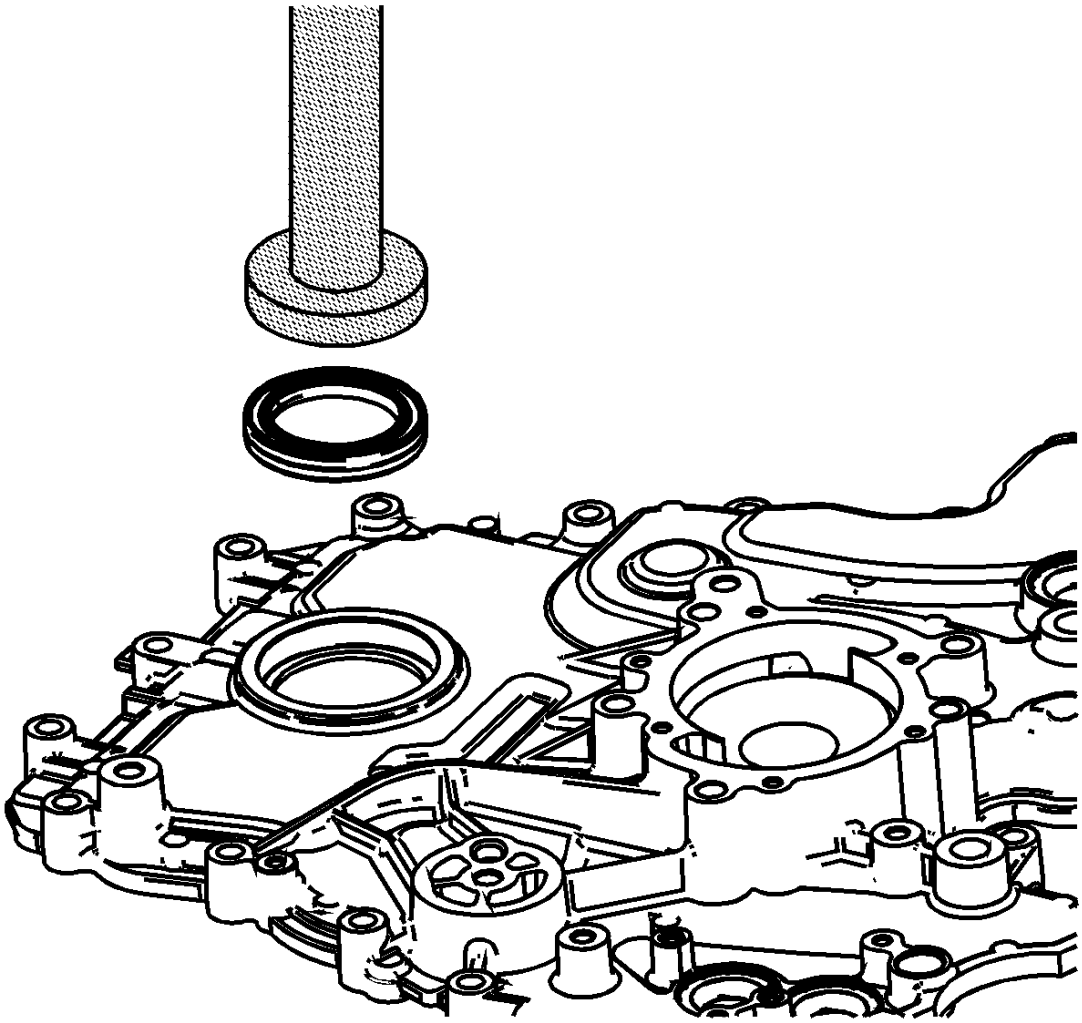

**Fig. 44: Installing Crankshaft Front Oil Seal**
**Courtesy of GENERAL MOTORS CORP.**

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

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

## CAMSHAFT COVER REPLACEMENT - LEFT SIDE (LF1)

**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**.

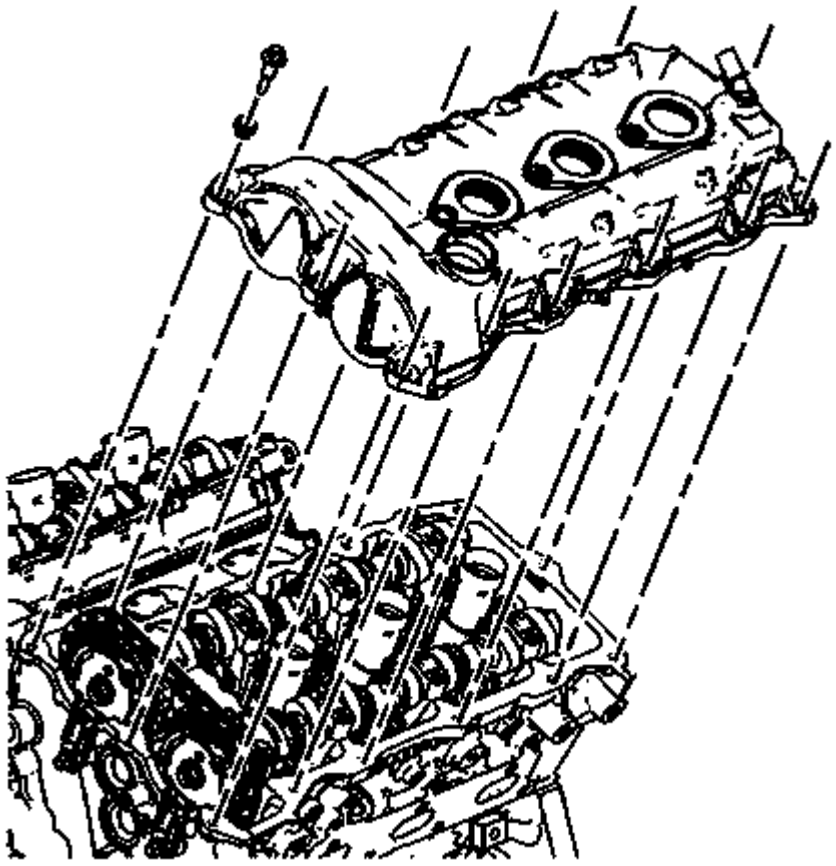

**Fig. 45: Removing & Installing Left Camshaft Cover**
**Courtesy of GENERAL MOTORS CORP.**

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

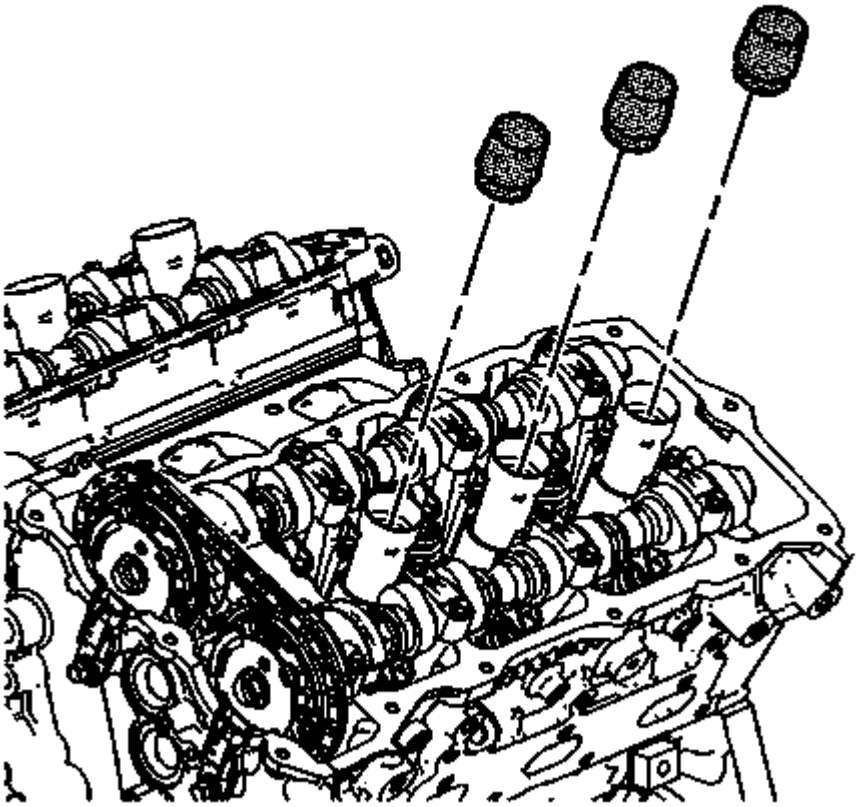

**Fig. 46: Identifying Special Tool - EN 46101**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

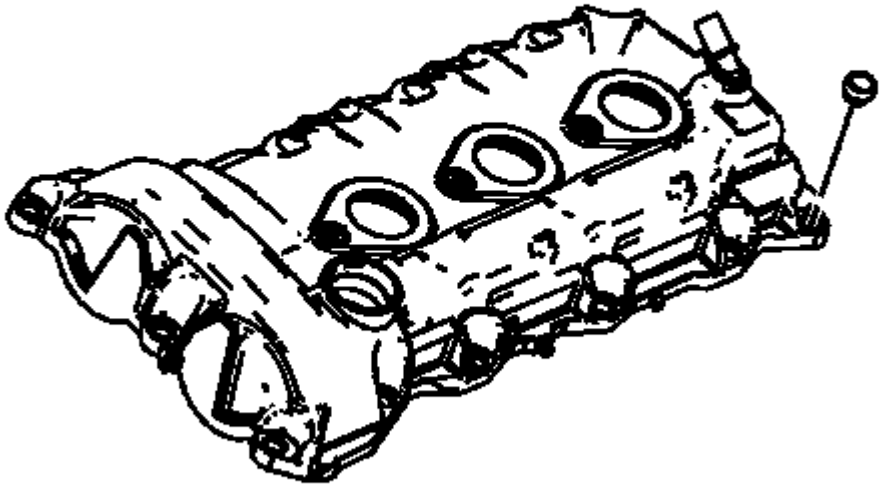

**Fig. 47: Removing & Installing Camshaft Cover Bolt Grommets**
**Courtesy of GENERAL MOTORS CORP.**

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

 

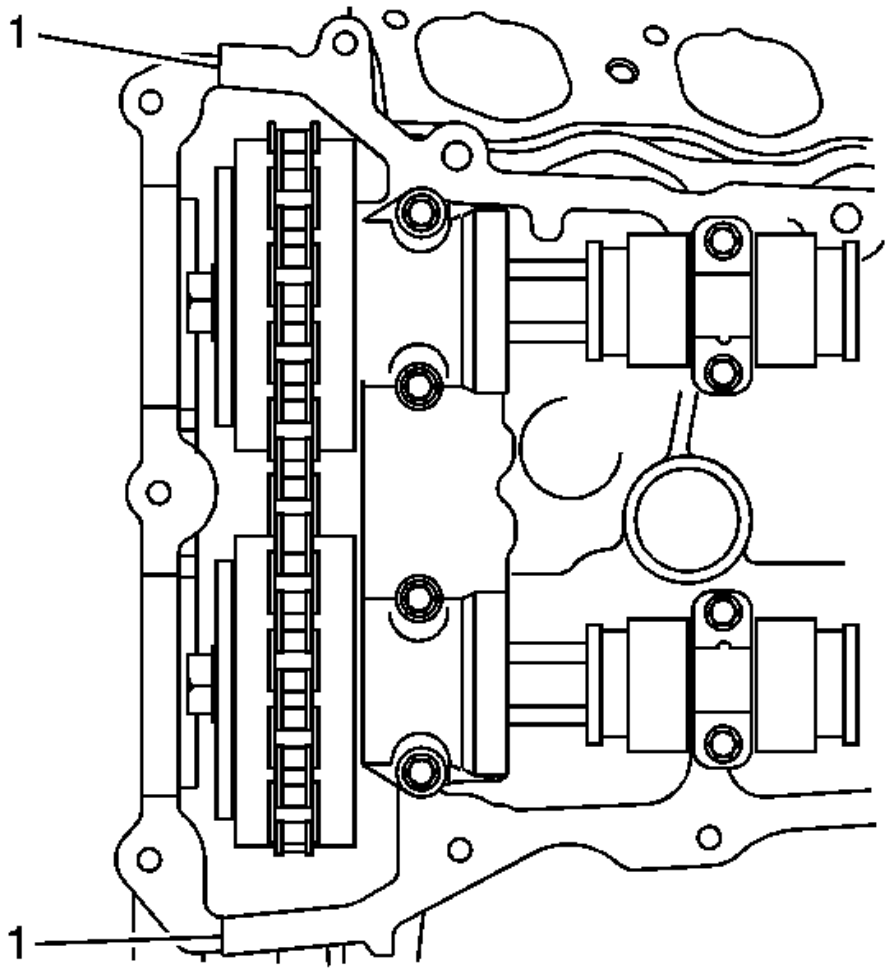


**Fig. 48: Locating Engine Front Cover Split Lines**
**Courtesy of GENERAL MOTORS CORP.**

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).

 

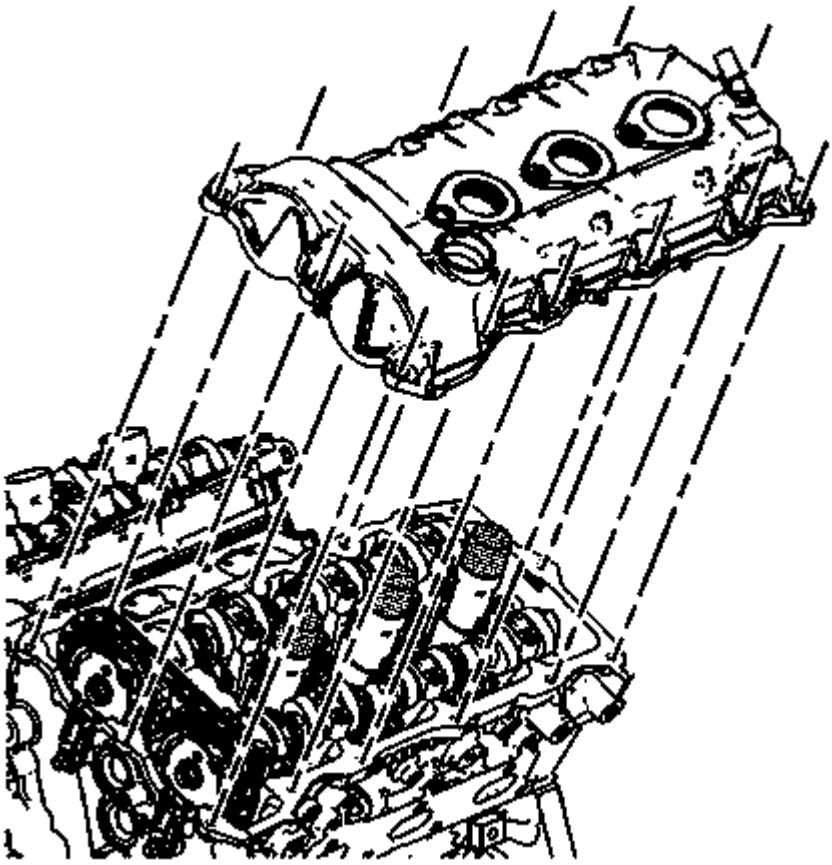

**Fig. 49: Aligning Left Camshaft Cover On Left Cylinder Head**
**Courtesy of GENERAL MOTORS CORP.**

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

 

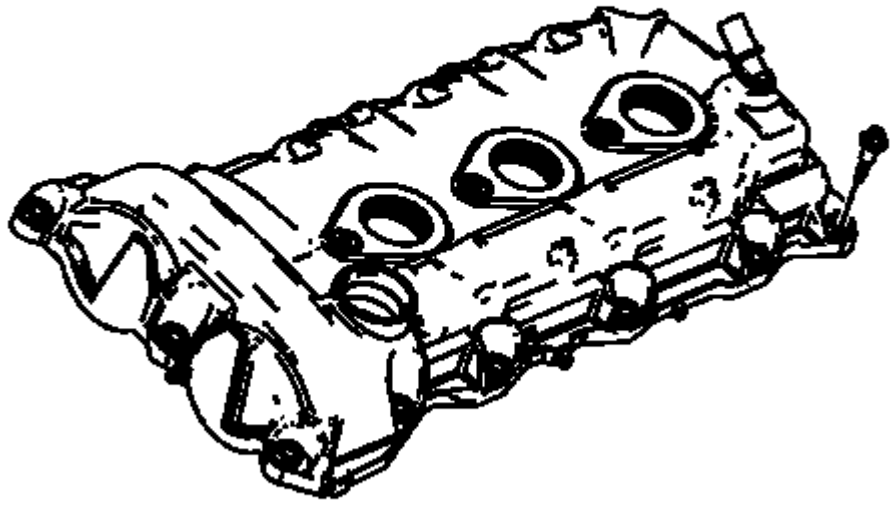

**Fig. 50: Identifying Left Camshaft Cover Bolts**
**Courtesy of GENERAL MOTORS CORP.**

**CAUTION: Refer to Fastener Caution .**

4. Loosely install the left camshaft cover bolts.

 

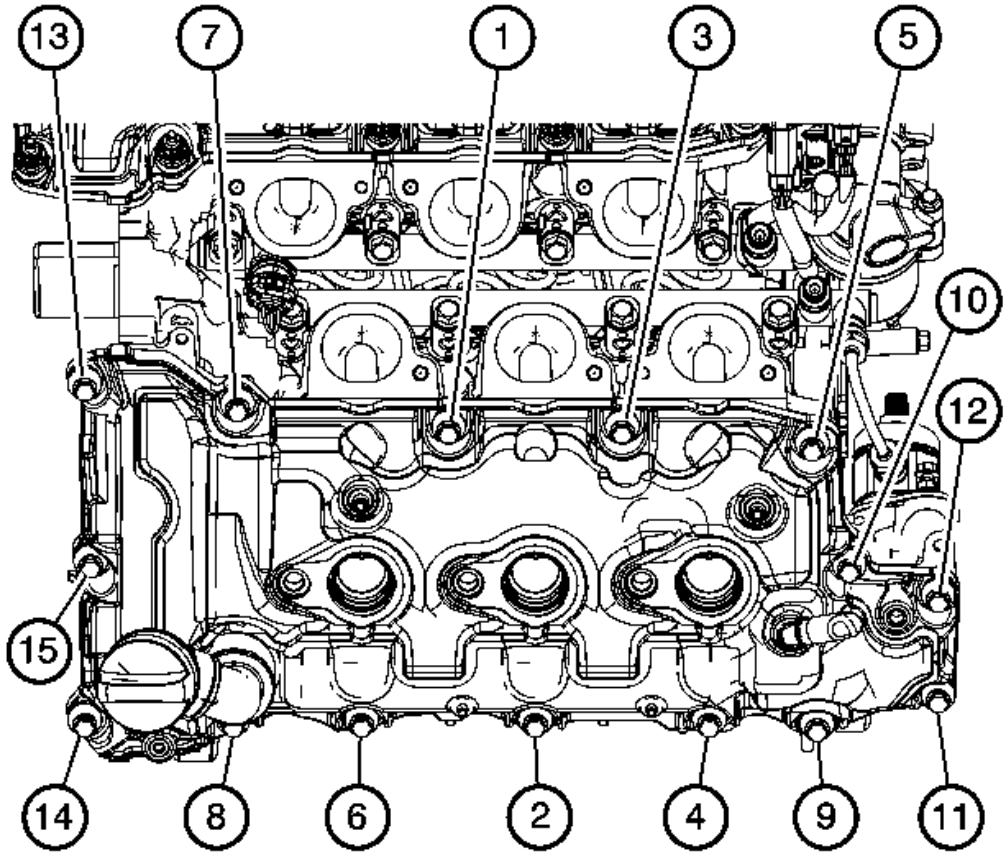


**Fig. 51: Identifying Left Camshaft Cover Bolt Tightening Sequence**
**Courtesy of GENERAL MOTORS CORP.**

5. Tighten the left 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 intake manifold. Refer to **Intake Manifold Replacement**.

 

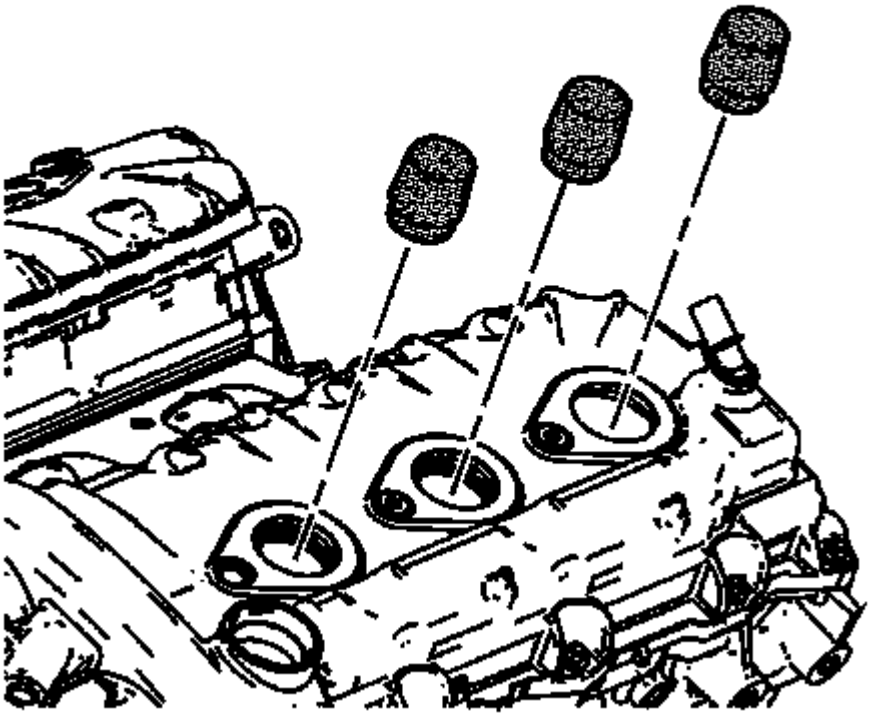

**Fig. 52: Identifying Special Tool - EN 46101**
**Courtesy of GENERAL MOTORS CORP.**

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

## CAMSHAFT COVER REPLACEMENT - RIGHT SIDE (LF1)

### 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. Disconnect and remove the engine harness from the camshaft cover.

 

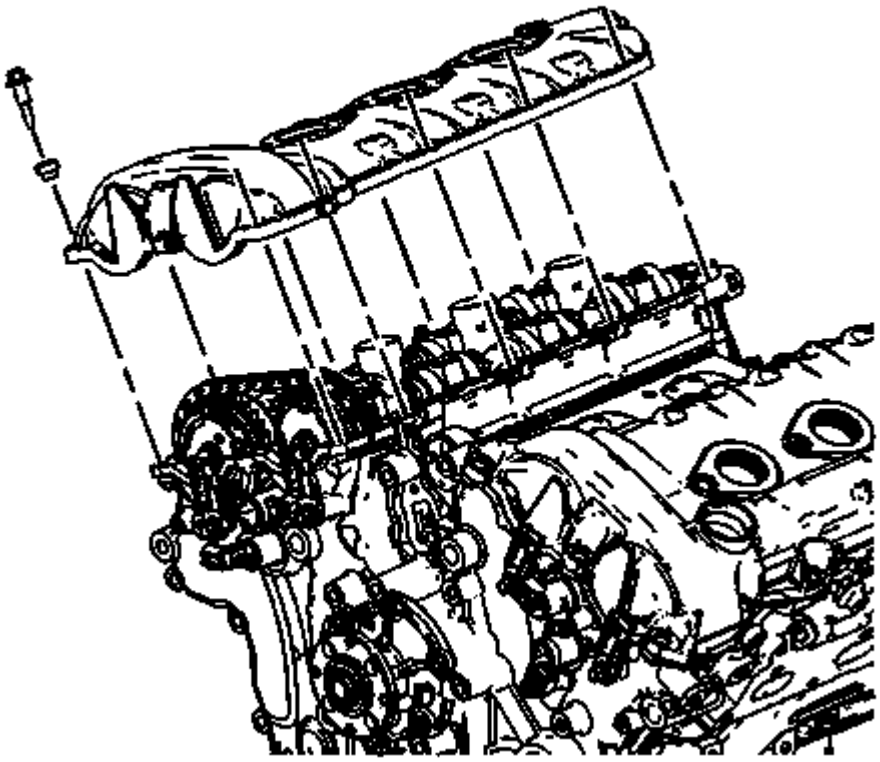

**Fig. 53: Removing & Installing Camshaft Cover**
**Courtesy of GENERAL MOTORS CORP.**

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

 

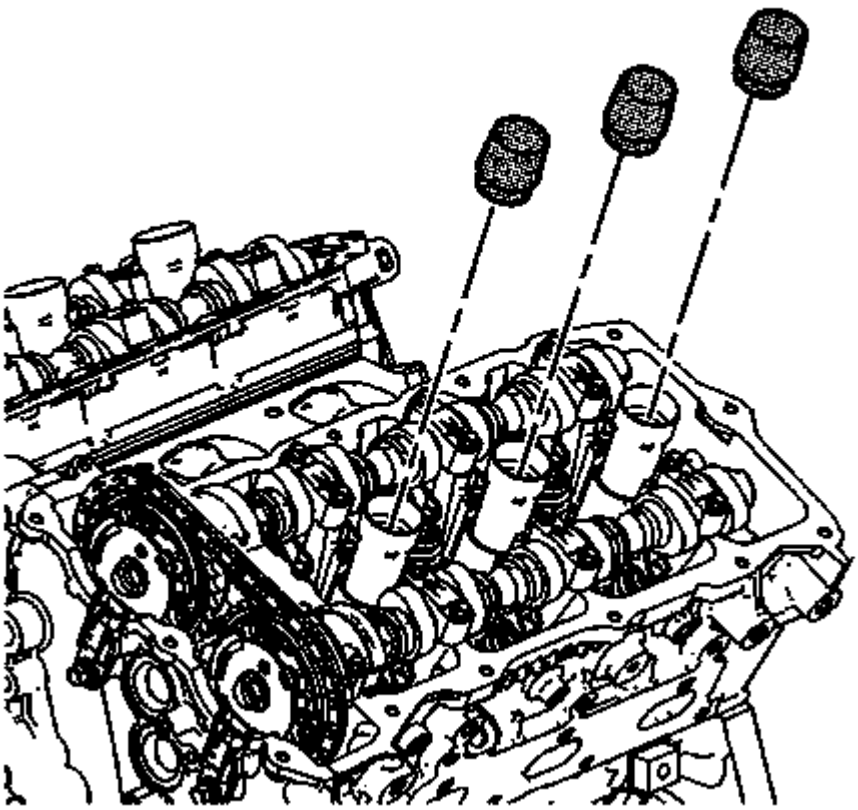

**Fig. 54: Identifying Special Tool - EN 46101**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

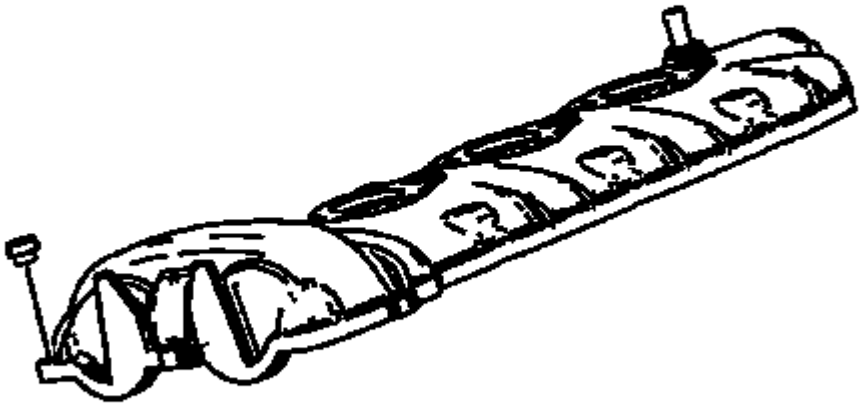

**Fig. 55: Locating Camshaft Cover Bolt Grommets**
**Courtesy of GENERAL MOTORS CORP.**

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

 

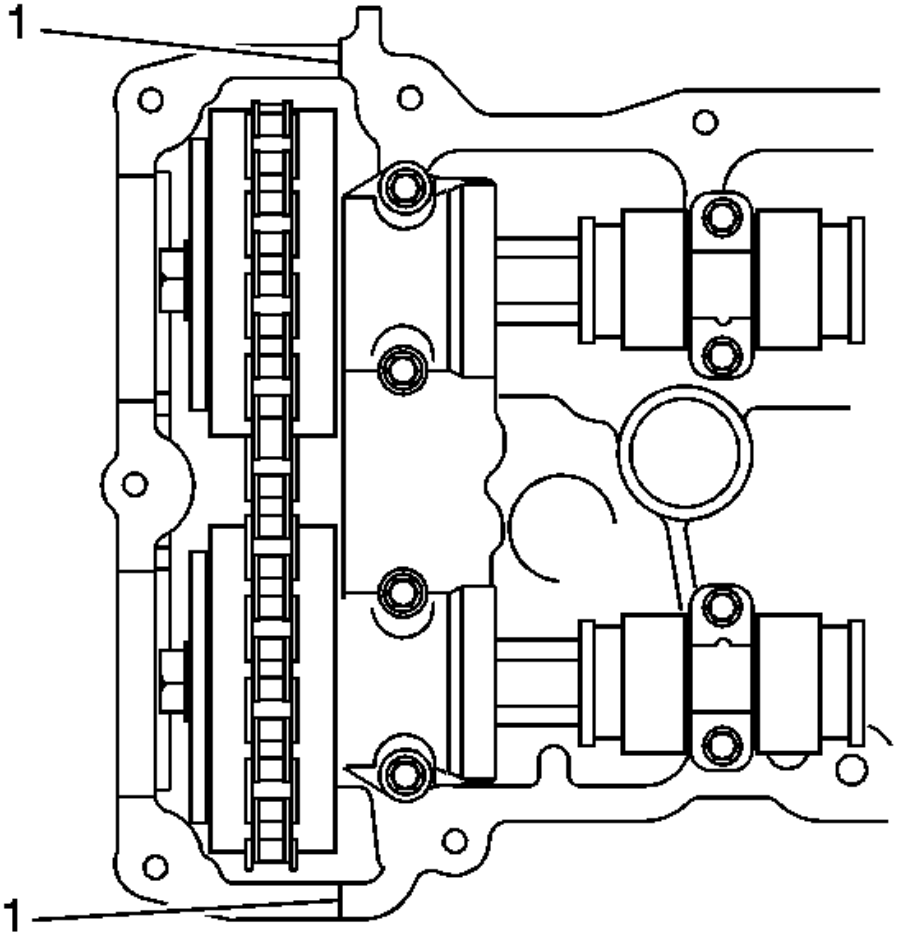


**Fig. 56: Identifying Engine Front Cover Split Lines**
**Courtesy of GENERAL MOTORS CORP.**

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).

 

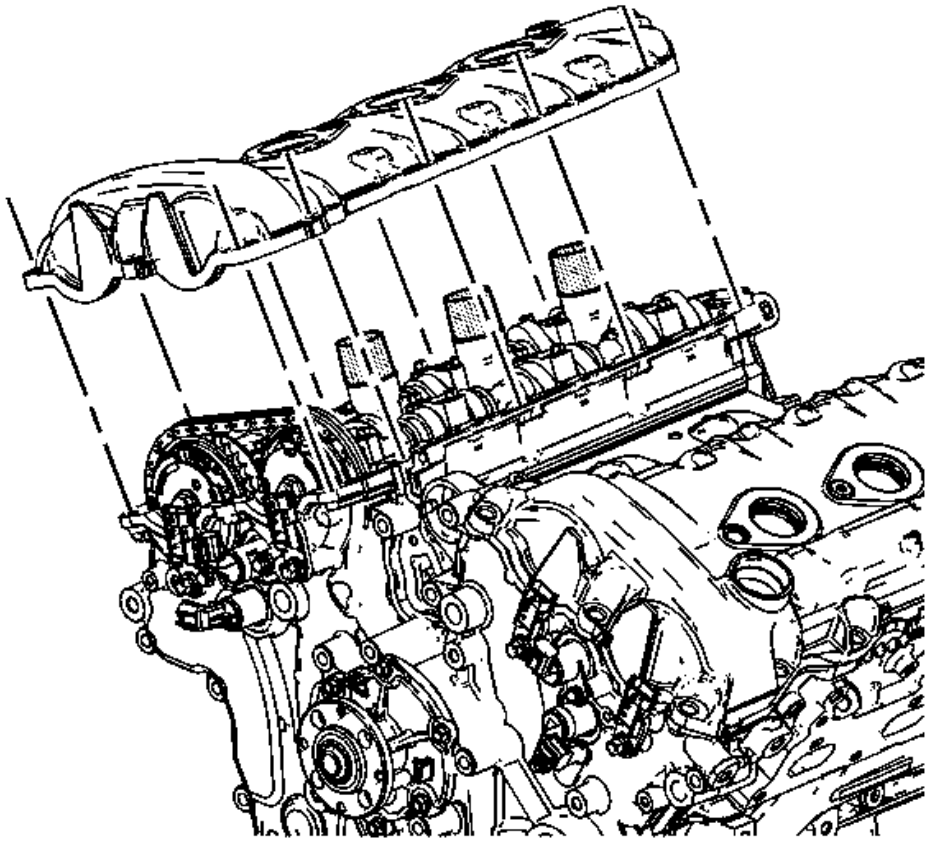

**Fig. 57: View Of Right Camshaft Cover**
**Courtesy of GENERAL MOTORS CORP.**

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

 

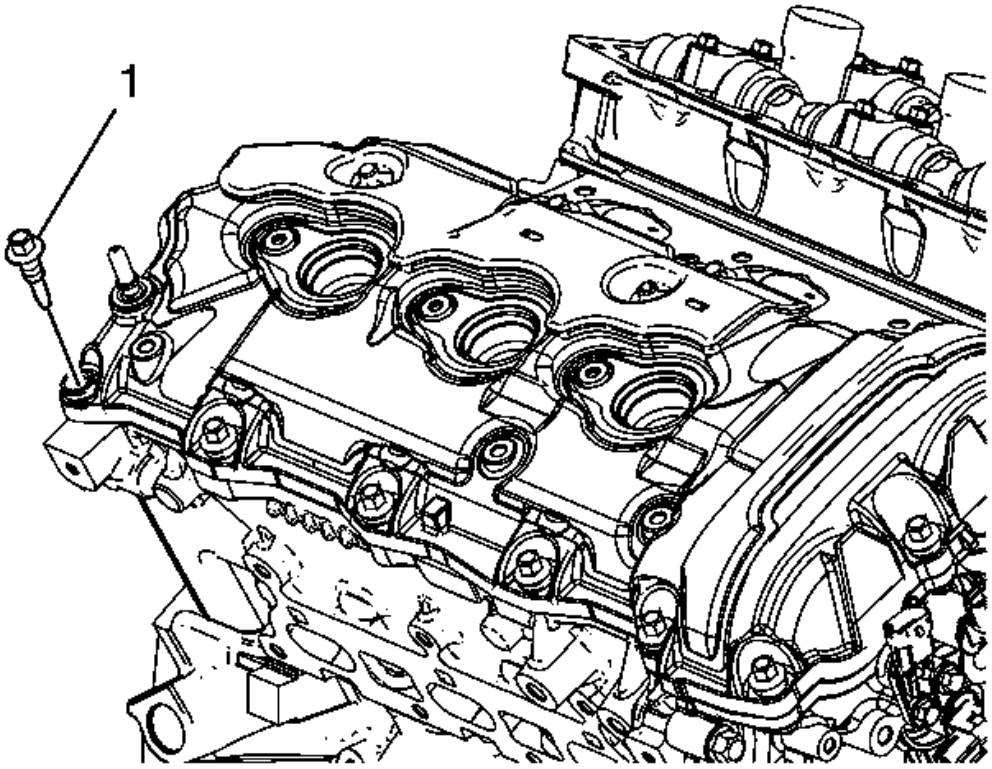


**Fig. 58: View Of Camshaft Cover Bolts**
**Courtesy of GENERAL MOTORS CORP.**

**CAUTION: Refer to Fastener Caution**

4. Loosely install the right camshaft cover bolts.

 

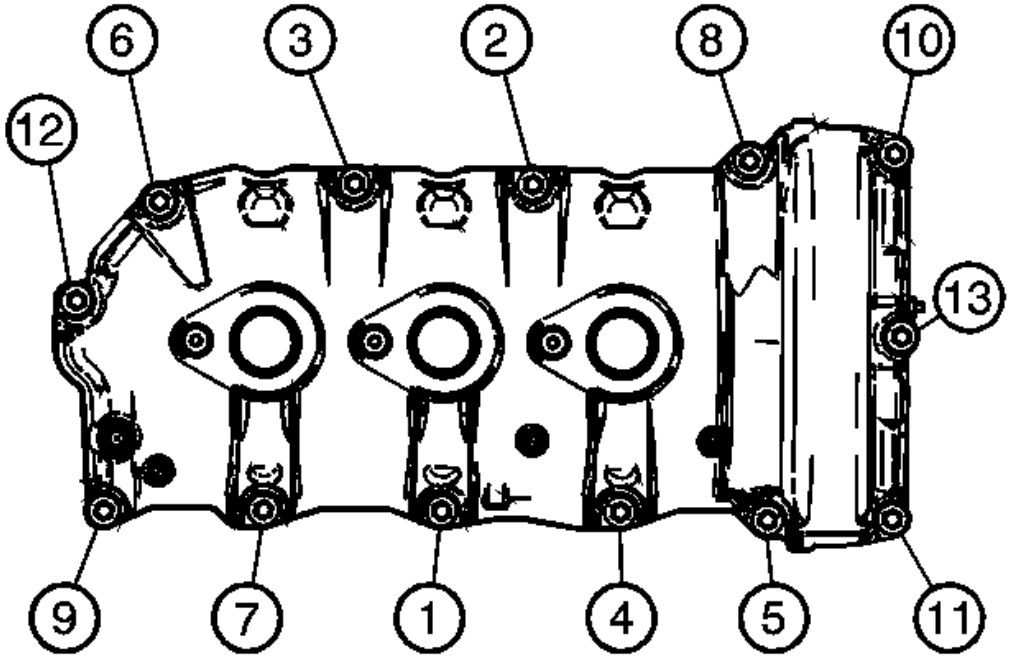


**Fig. 59: Identifying Tightening Sequence For Right Camshaft Cover Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

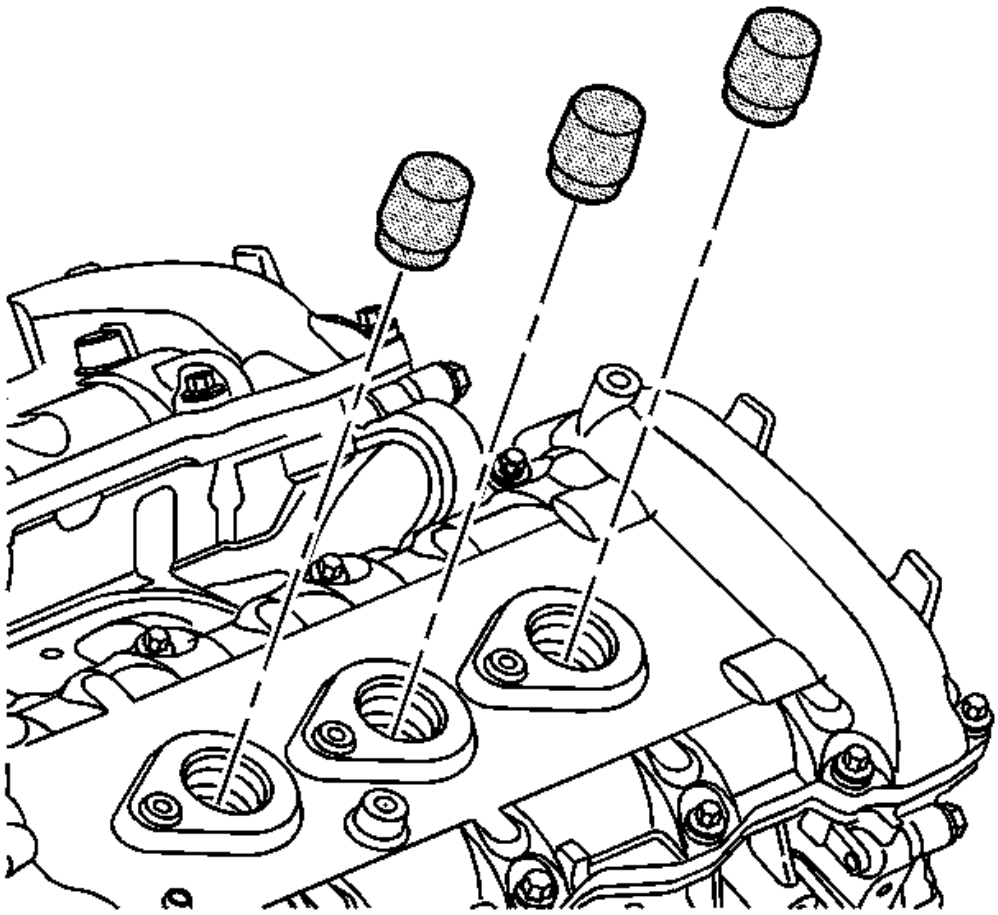

**Fig. 60: View Of EN 46101**
**Courtesy of GENERAL MOTORS CORP.**

7. Remove the **EN-46101:** guide from the spark plug tubes of the right cylinder head.
8. 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**.
2. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side (LF1)** and **Camshaft**

 

**Cover Replacement - Right Side (LF1)**.

3. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)** .
4. Disconnect the purge vent hose from the water outlet.
5. Remove the water outlet with the radiator hose and reposition aside. Refer to **Water Outlet Replacement (LF1)** .
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
7. 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** .
8. Remove the generator. Refer to **Generator Replacement (LAF)** or **Generator Replacement (LF1)** .
9. Remove the water pump pulley only.
10. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
11. 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** .

 

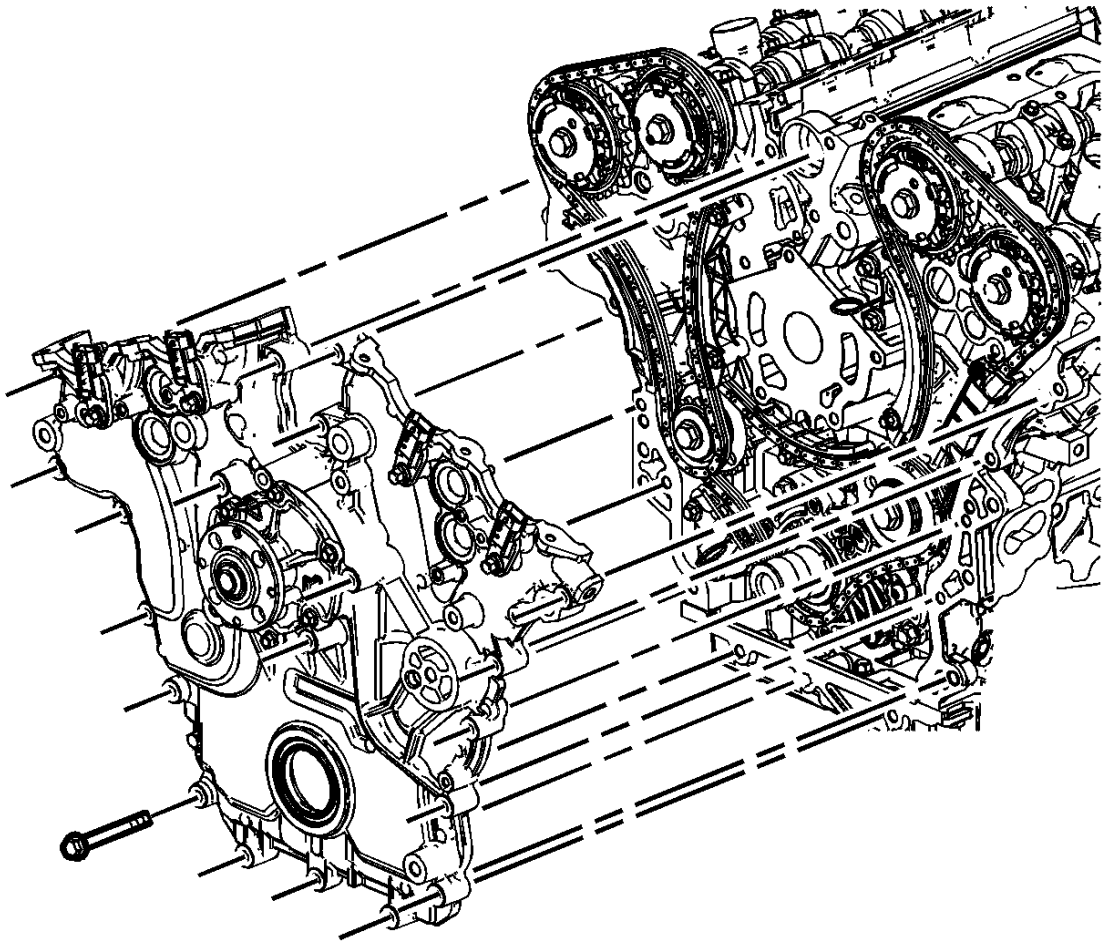

**Fig. 61: Engine Front Cover**
**Courtesy of GENERAL MOTORS CORP.**

**NOTE: There are a total of 22 M8 bolts that must be removed and 3 optional M12 bolts that may need to be removed before the front cover will separate from the engine block.**

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

14. 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.**

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

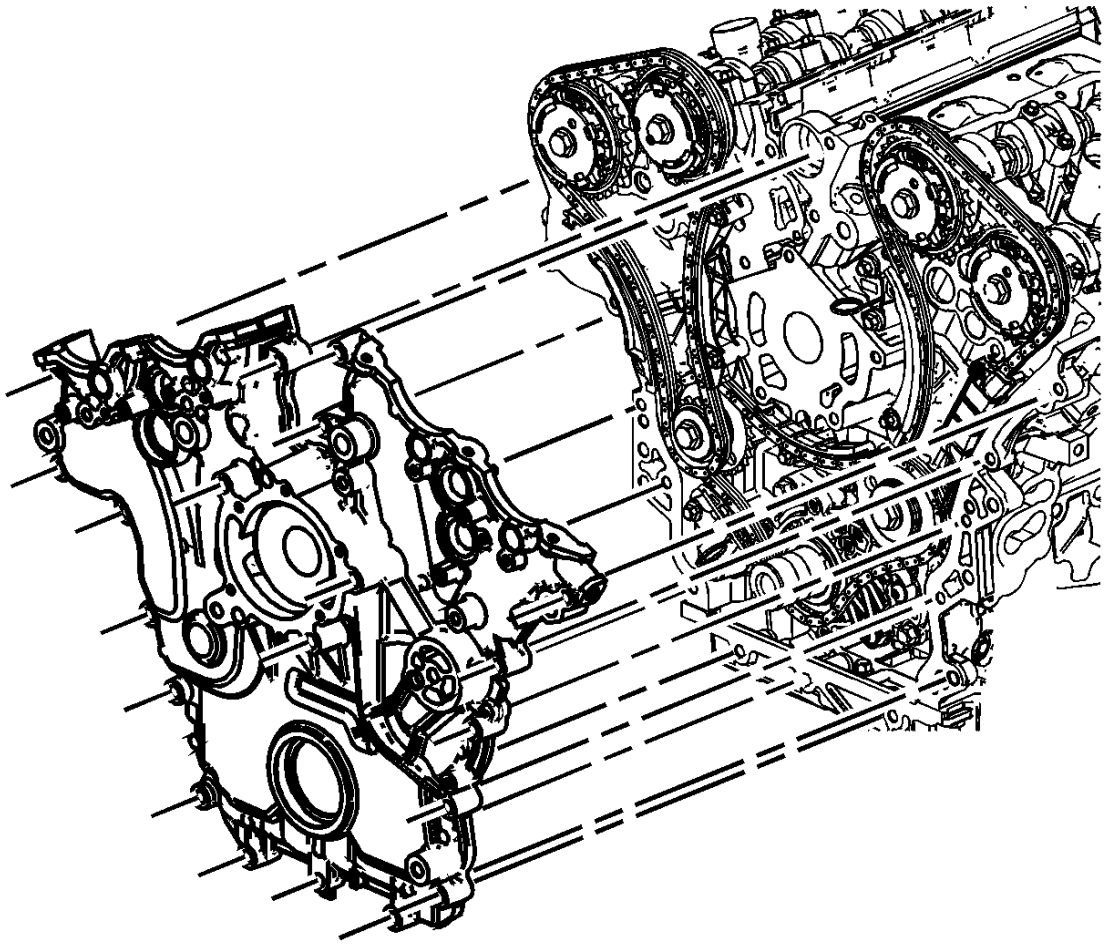

**Fig. 62: Engine Front Cover**
**Courtesy of GENERAL MOTORS CORP.**

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 Installation** .
6. Install the generator bracket with the generator and the belt tensioner. Refer to **Generator Replacement (LAF)** or **Generator Replacement (LF1)** .
7. Install the water outlet. Refer to **Water Outlet Replacement (LF1)** .
8. Install the purge vent hose to the water outlet.
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)** .
10. Install the water pump pulley.
11. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
12. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side (LF1)** and **Camshaft Cover Replacement - Right Side (LF1)**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **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** .

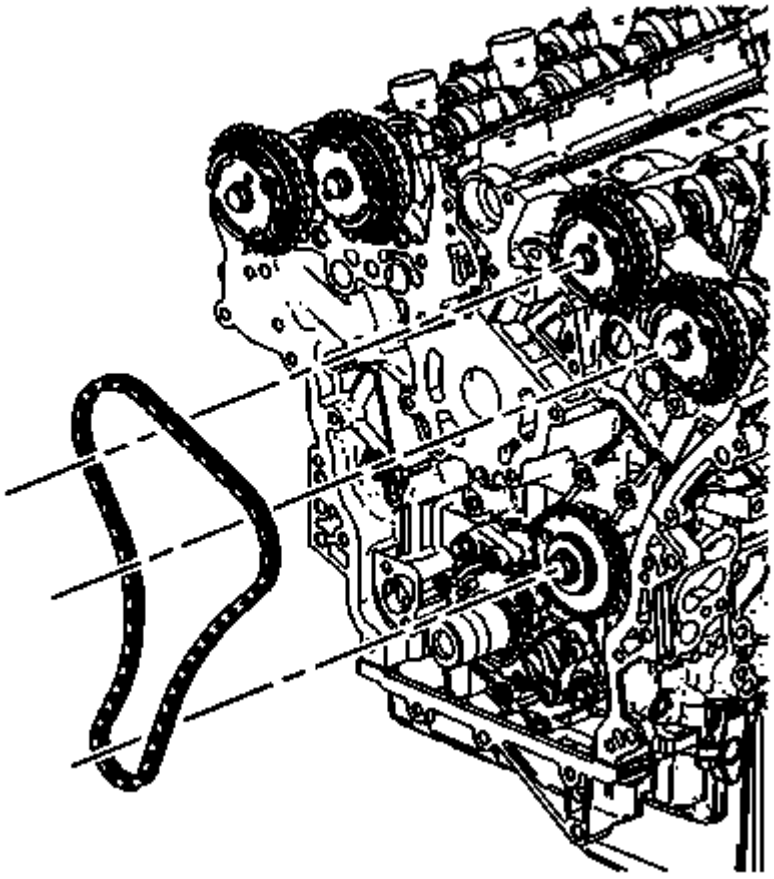

**Fig. 63: View Of Left Bank Secondary Camshaft Drive Chain**
**Courtesy of GENERAL MOTORS CORP.**

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**

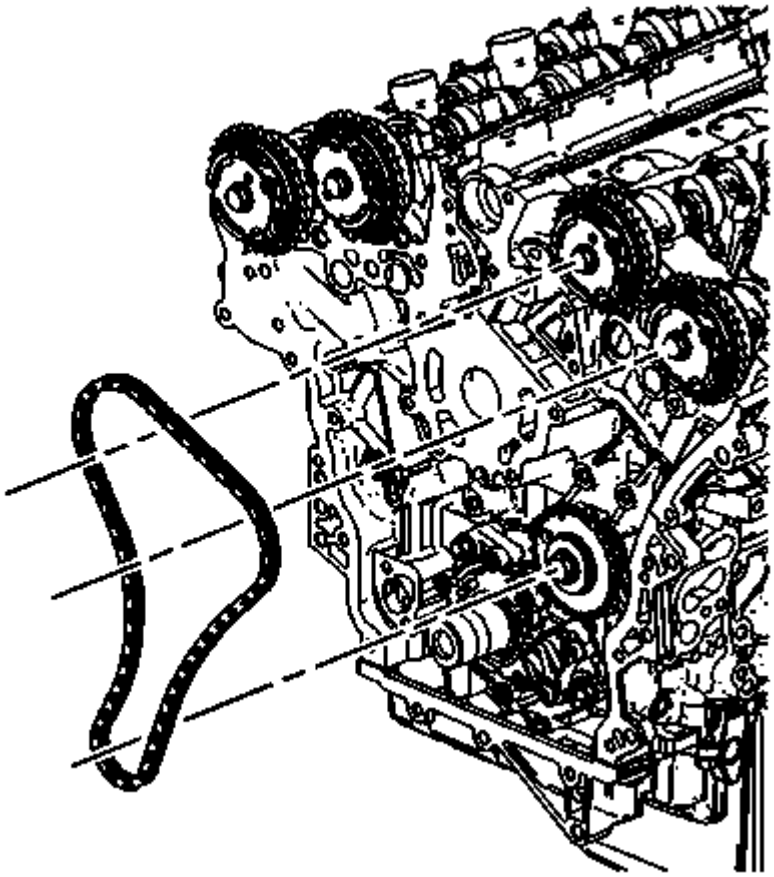

**Fig. 64: View Of Left Bank Secondary Camshaft Drive Chain**
**Courtesy of GENERAL MOTORS CORP.**

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** .

 

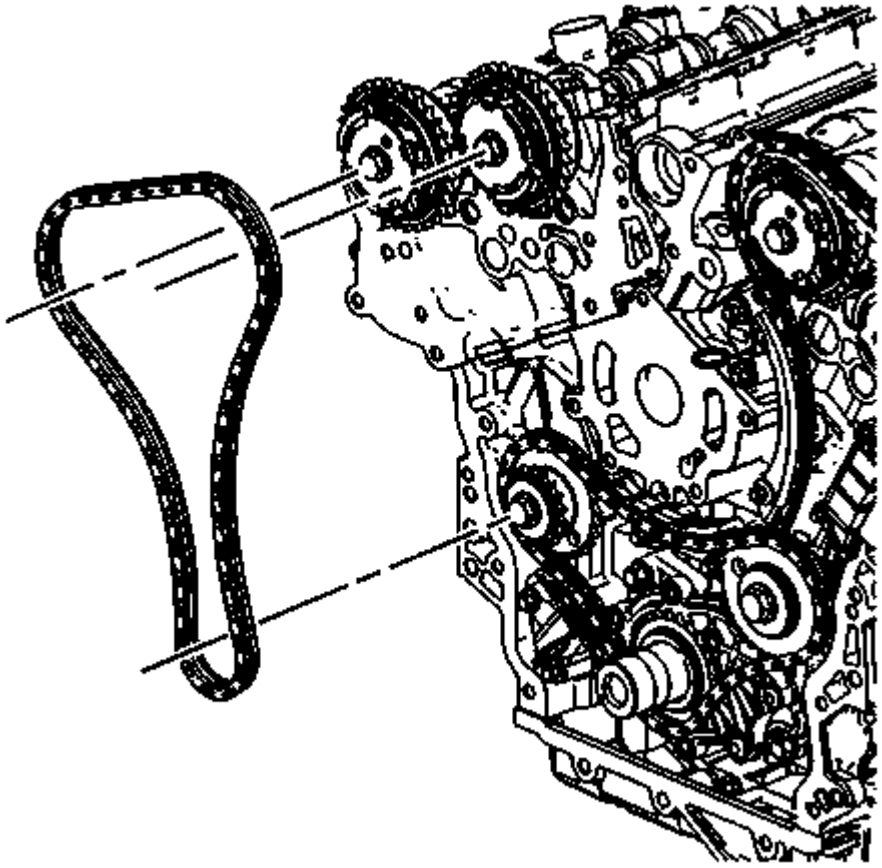

**Fig. 65: View Of Right Bank Secondary Camshaft Drive Chain**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

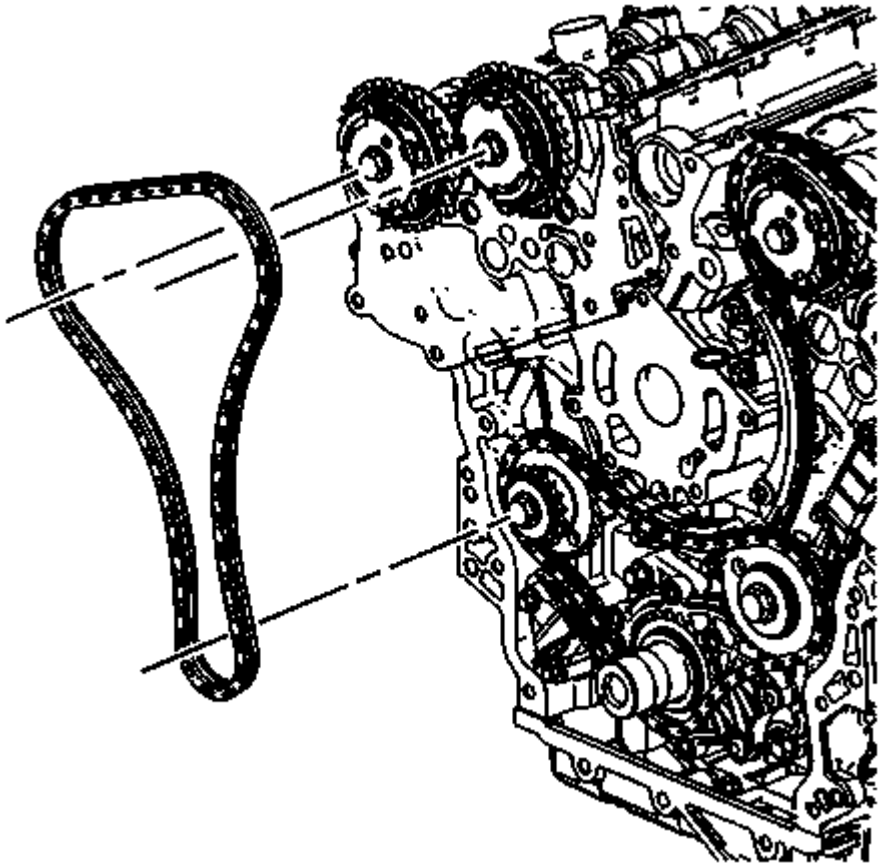

**Fig. 66: View Of Right Bank Secondary Camshaft Drive Chain**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

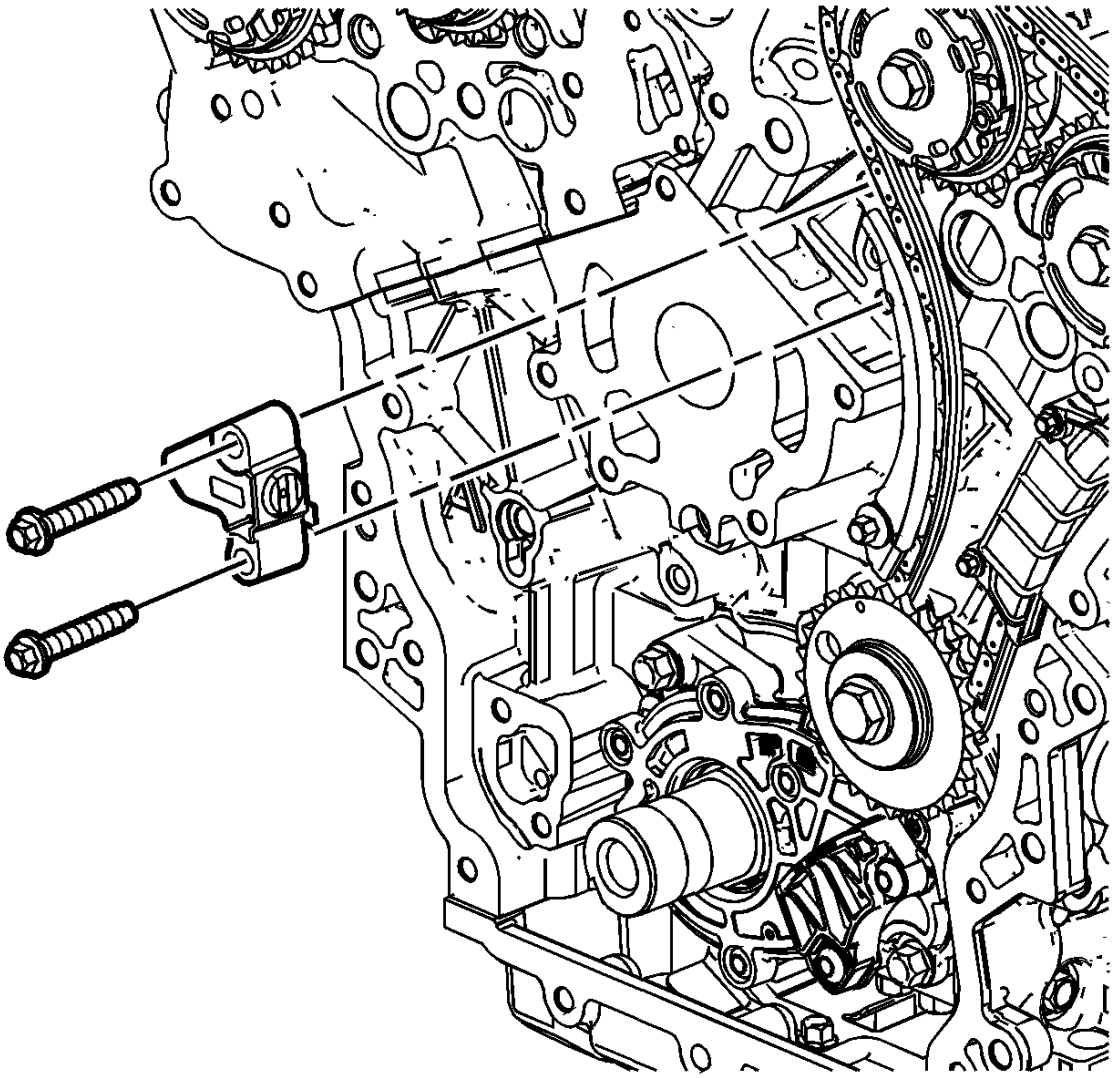

**Fig. 67: Left Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

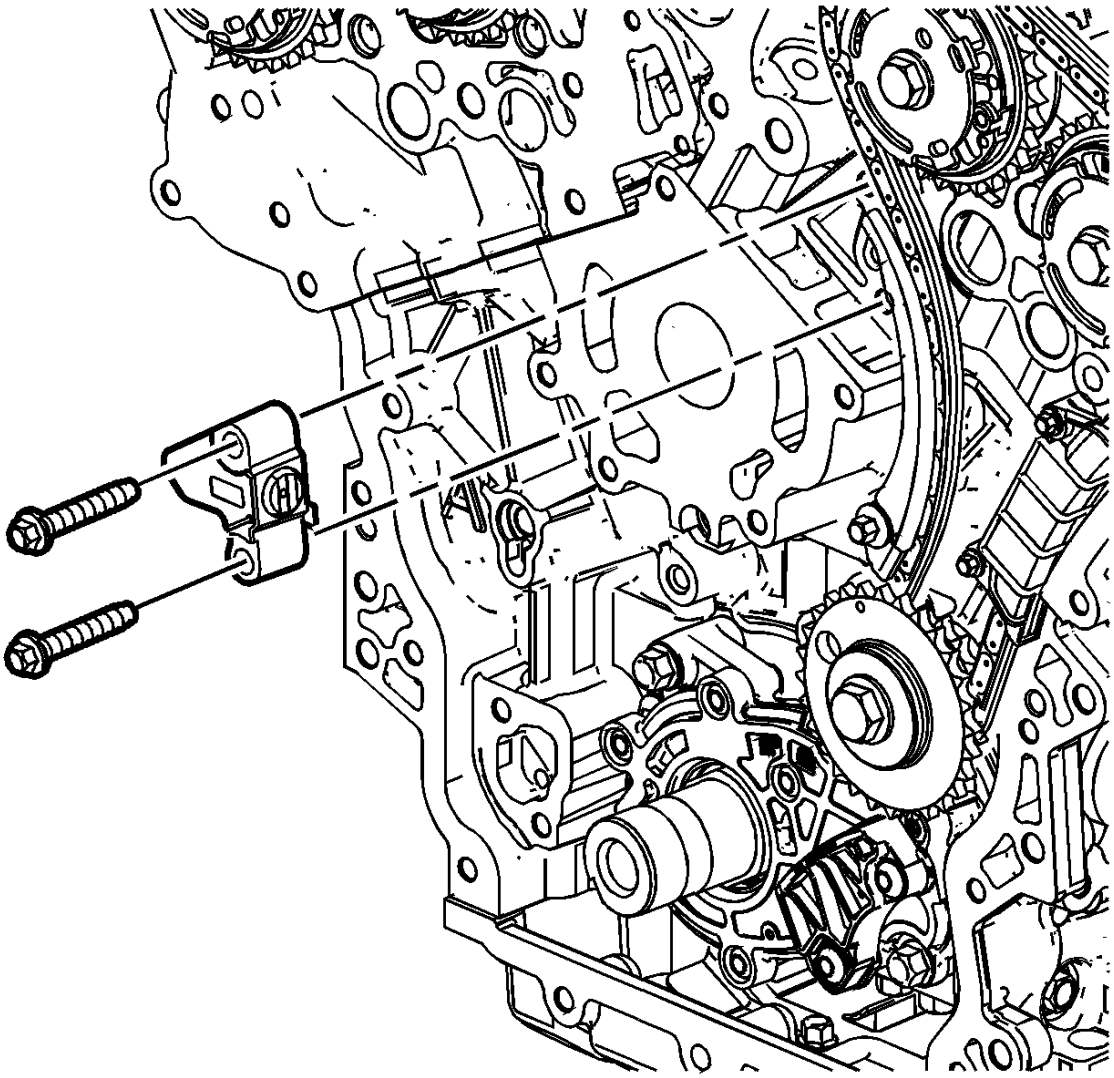

**Fig. 68: Left Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

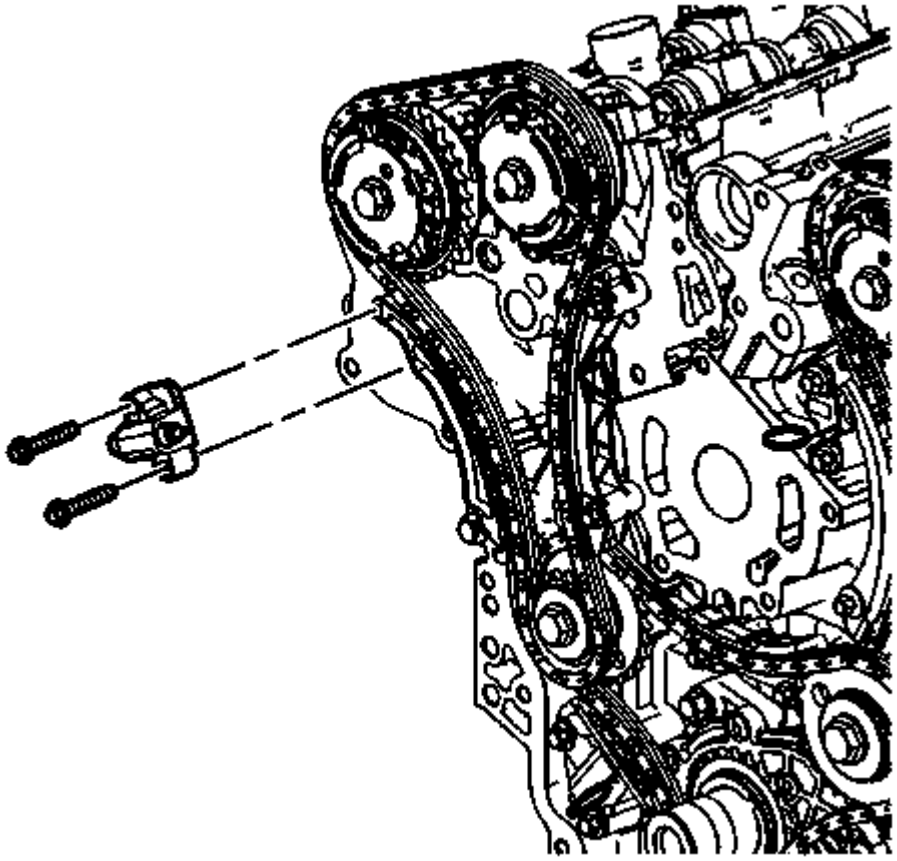

**Fig. 69: Right Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

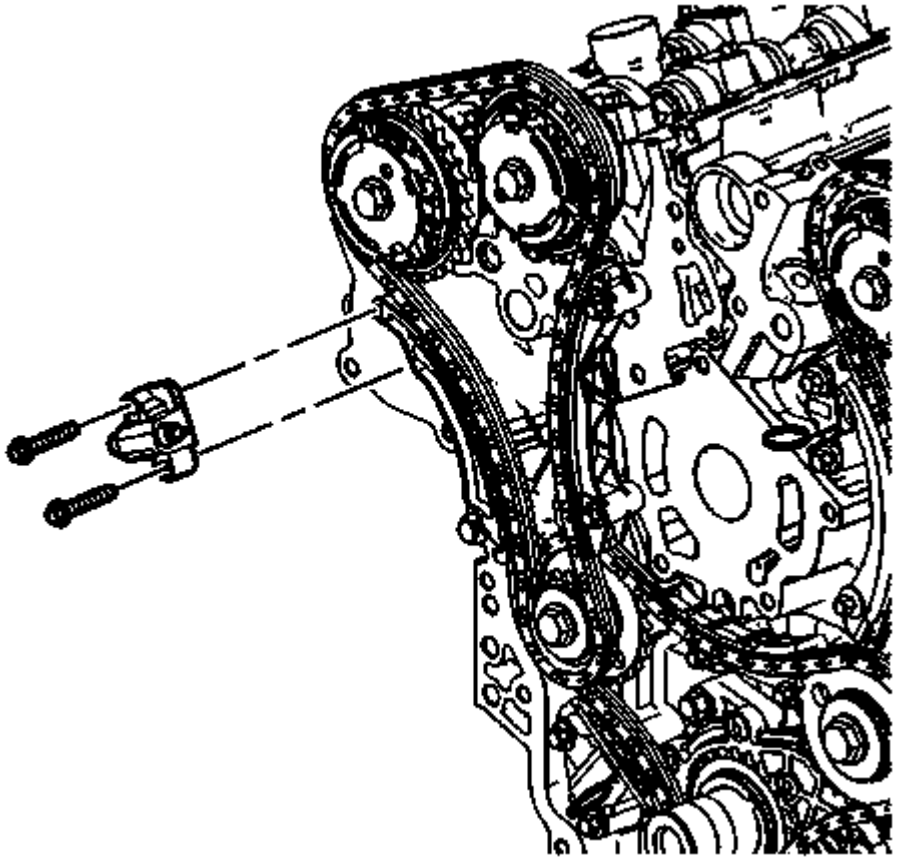

**Fig. 70: Right Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

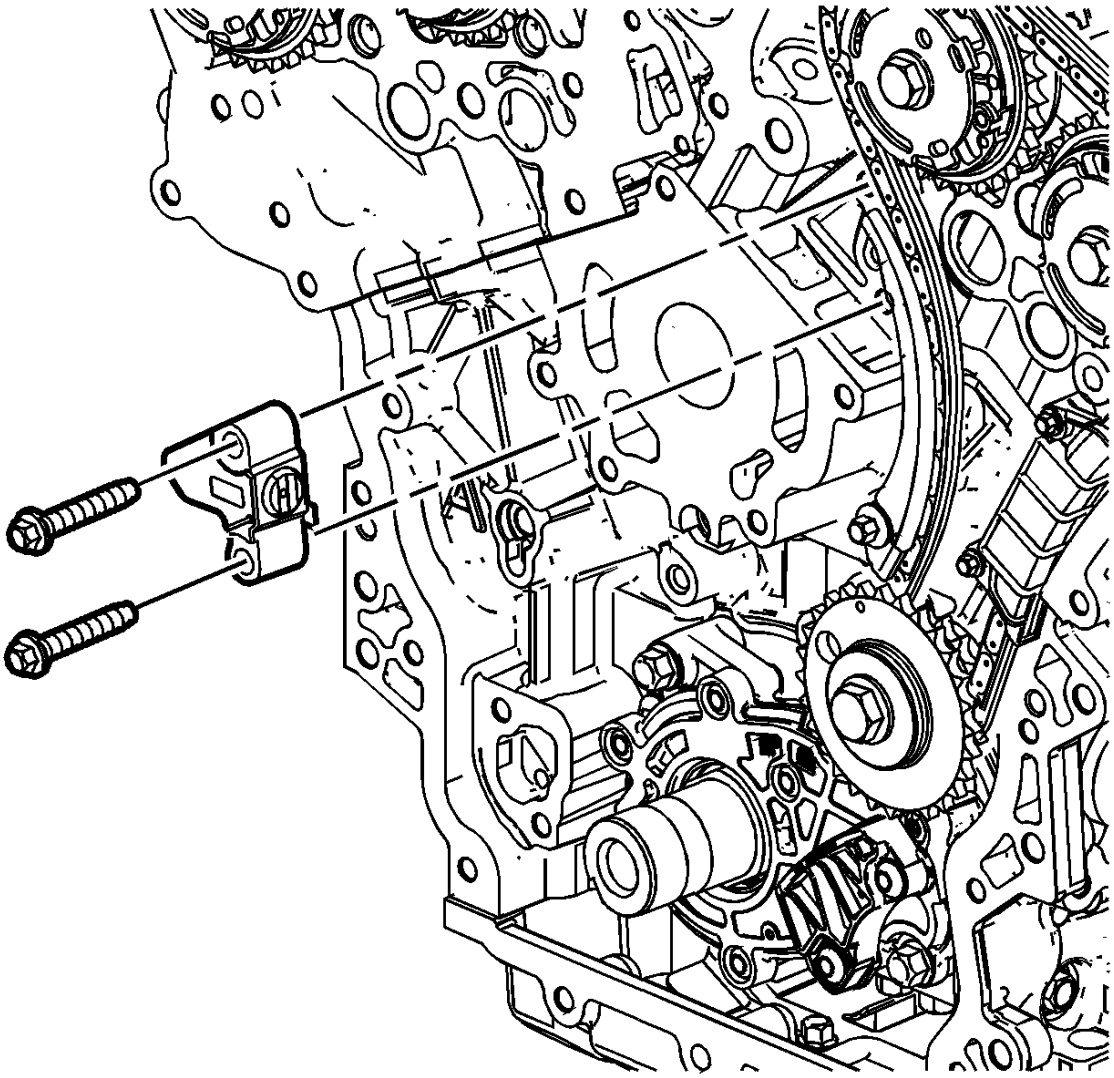

**Fig. 71: Left Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

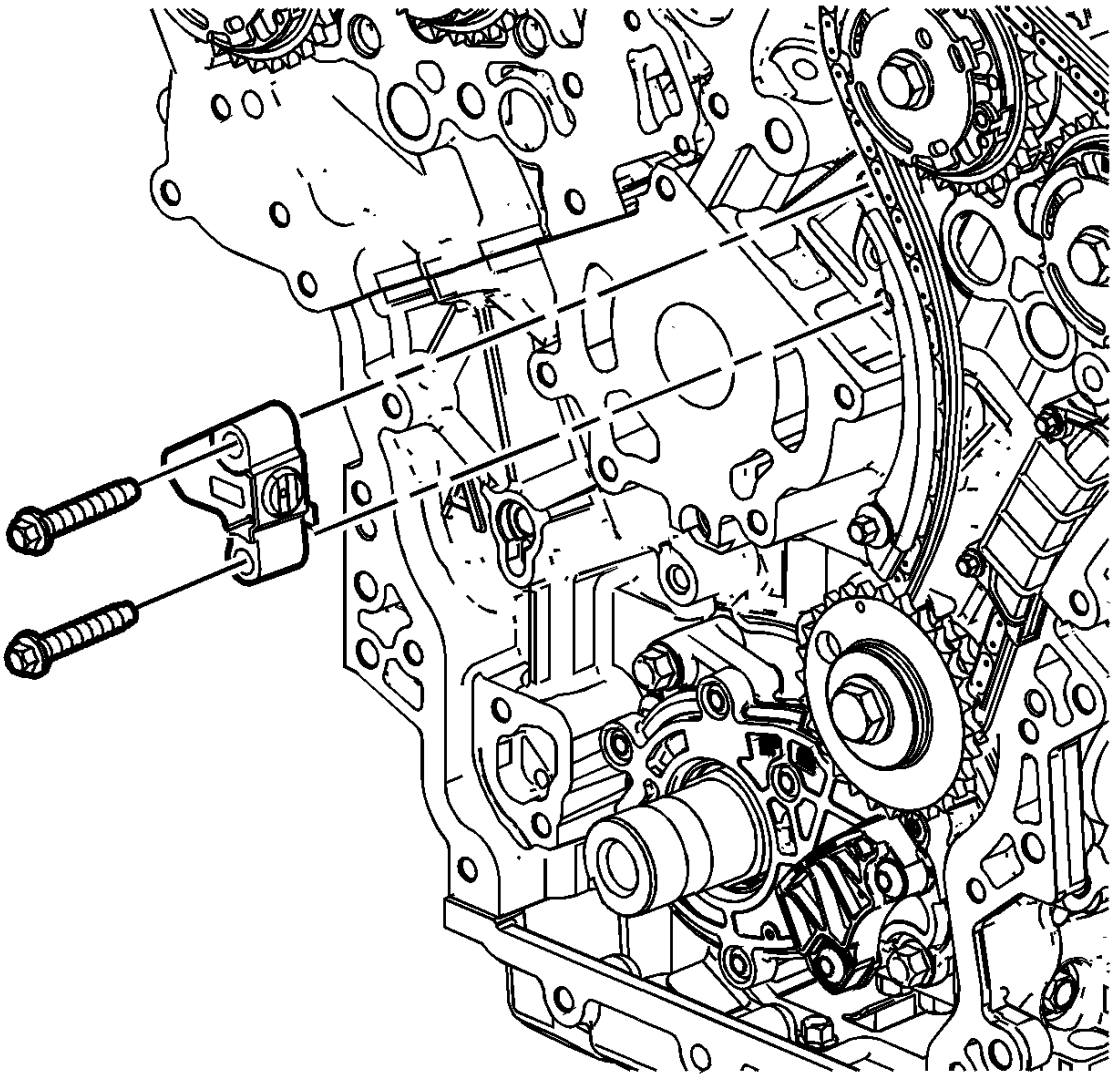

**Fig. 72: Left Bank Secondary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

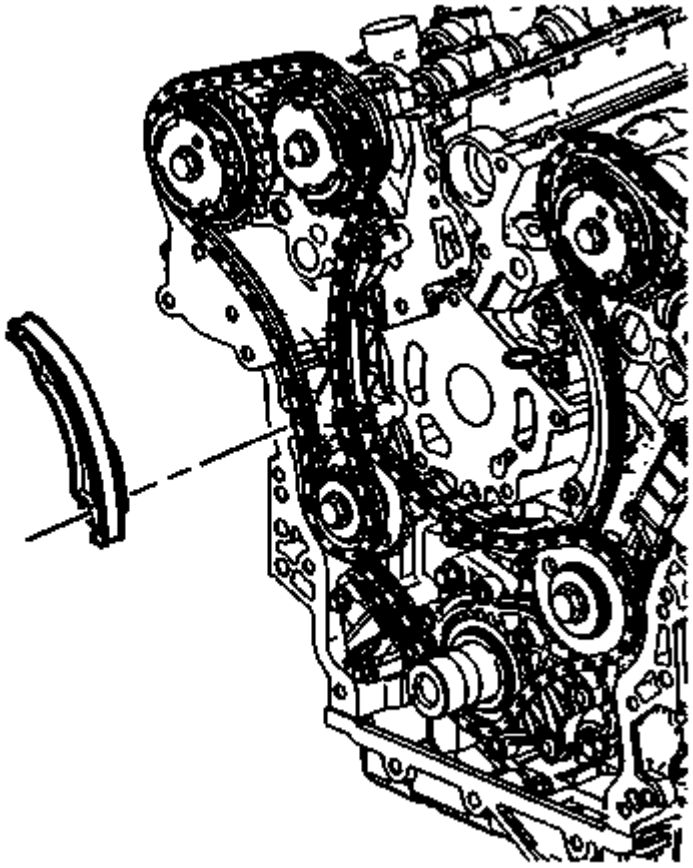

**Fig. 73: View Of Right Secondary Camshaft Drive Chain Shoe**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

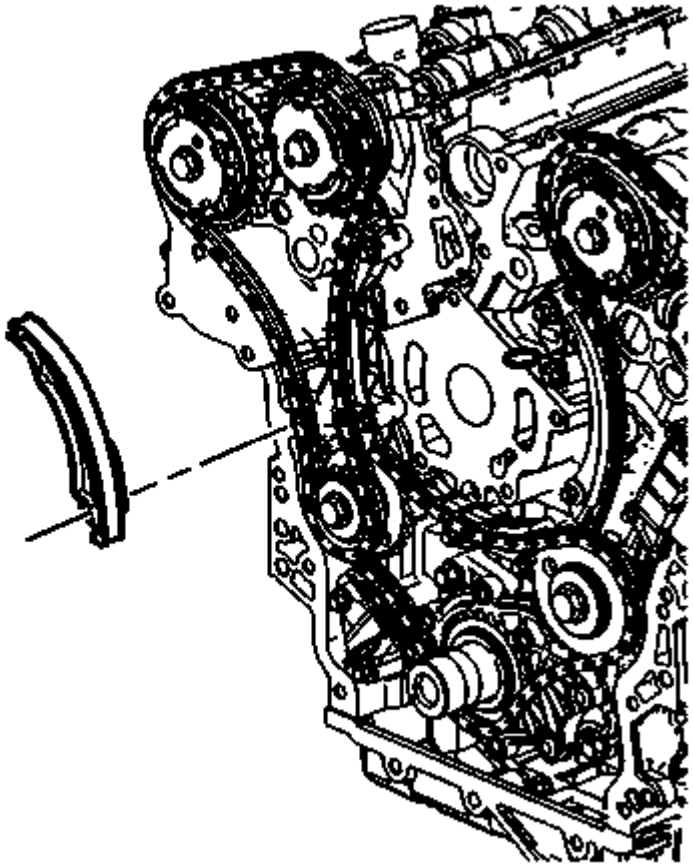

**Fig. 74: View Of Right Secondary Camshaft Drive Chain Shoe**
**Courtesy of GENERAL MOTORS CORP.**

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** .

 

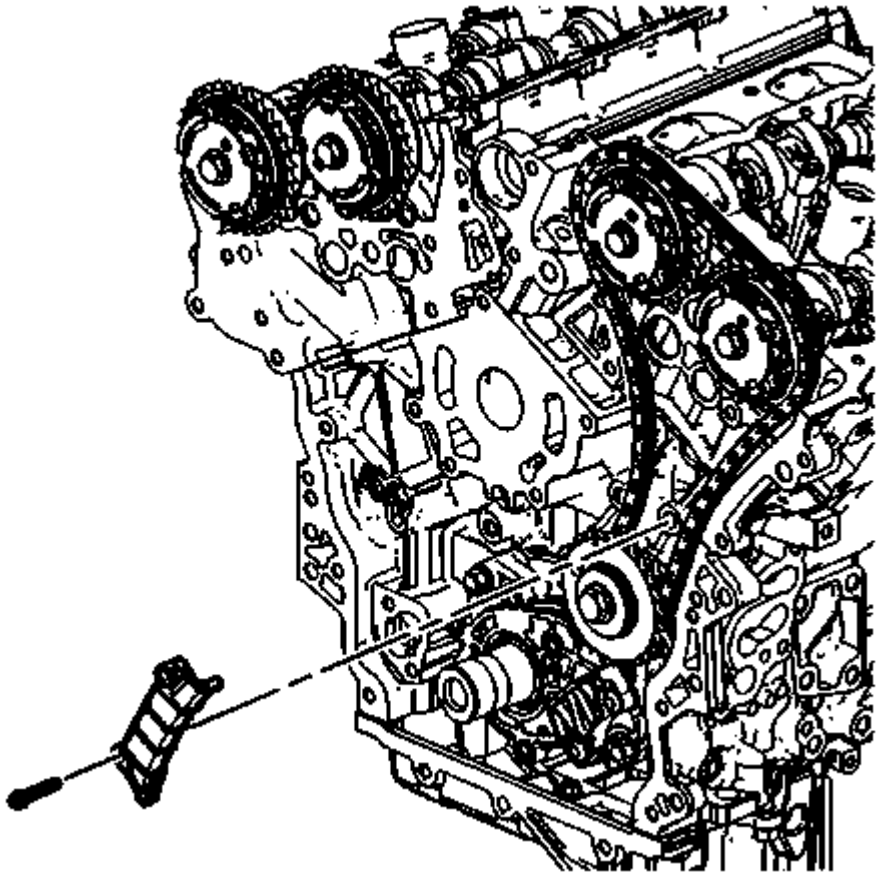

**Fig. 75: View Of Left Bank Secondary Camshaft Drive Chain Guide**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

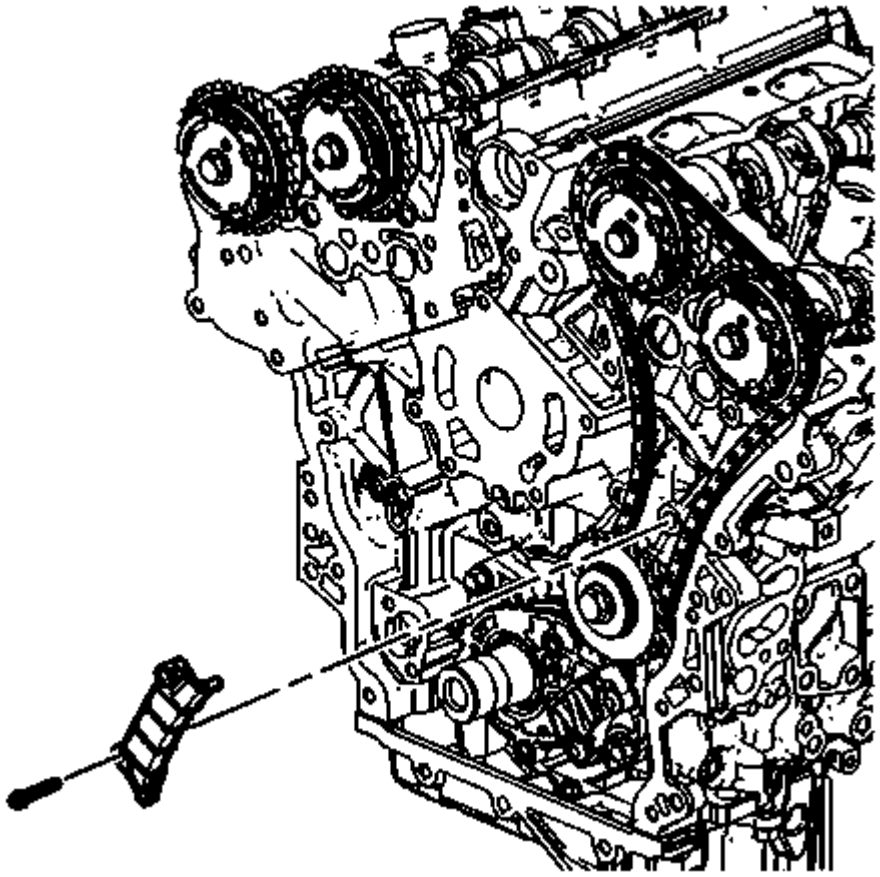

**Fig. 76: View Of Left Bank Secondary Camshaft Drive Chain Guide**
**Courtesy of GENERAL MOTORS CORP.**

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** .

 

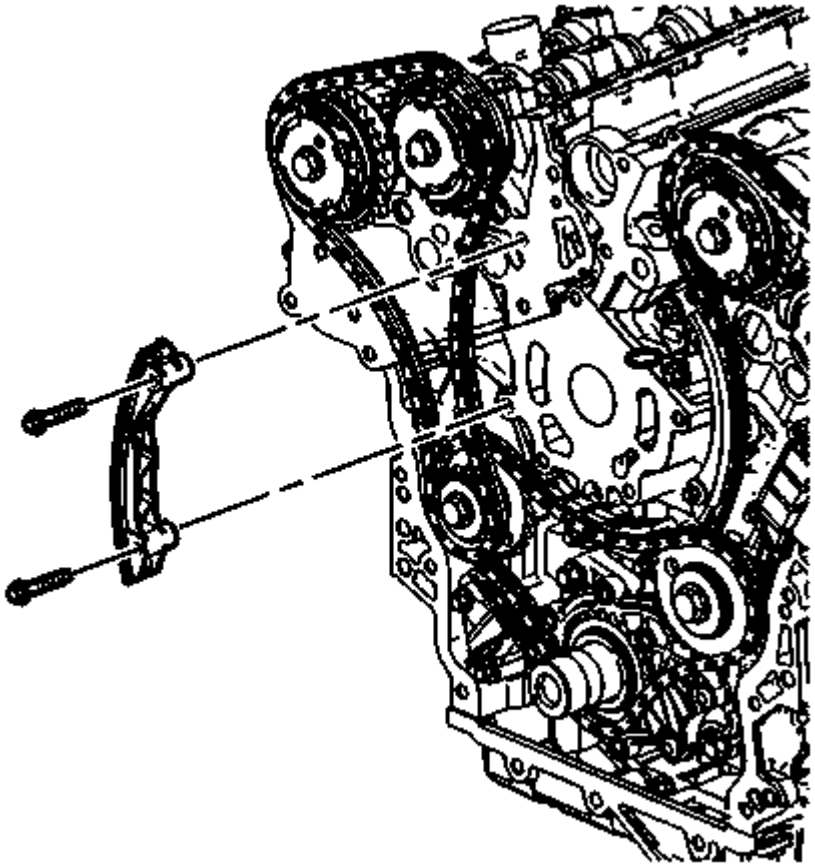

**Fig. 77: View Of Right Secondary Camshaft Drive Chain Guide & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

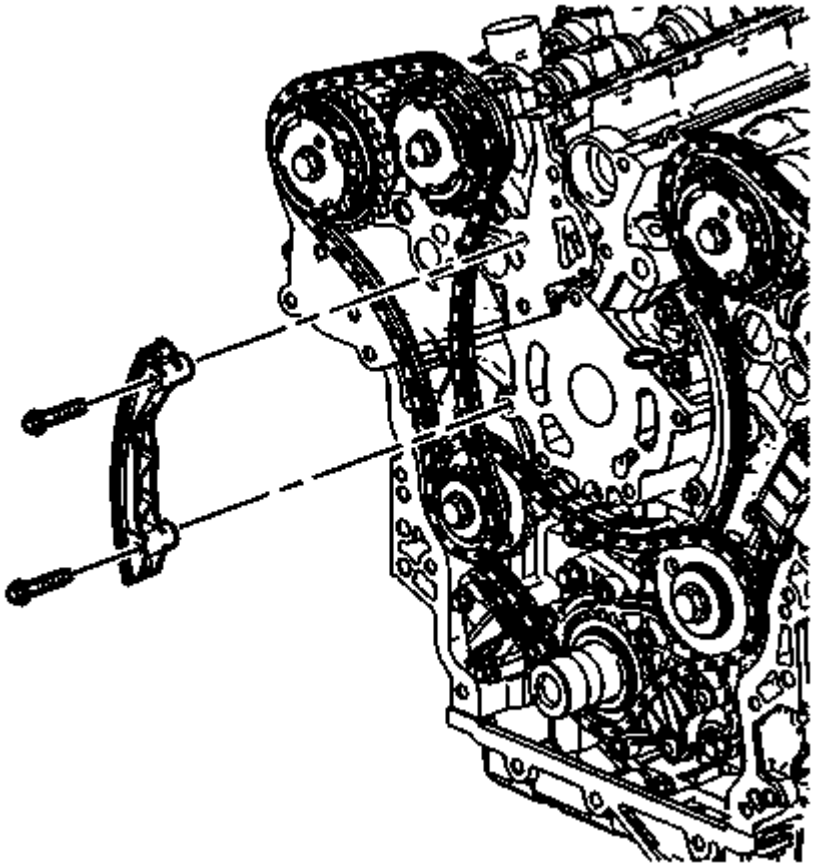

**Fig. 78: View Of Right Secondary Camshaft Drive Chain Guide & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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** .

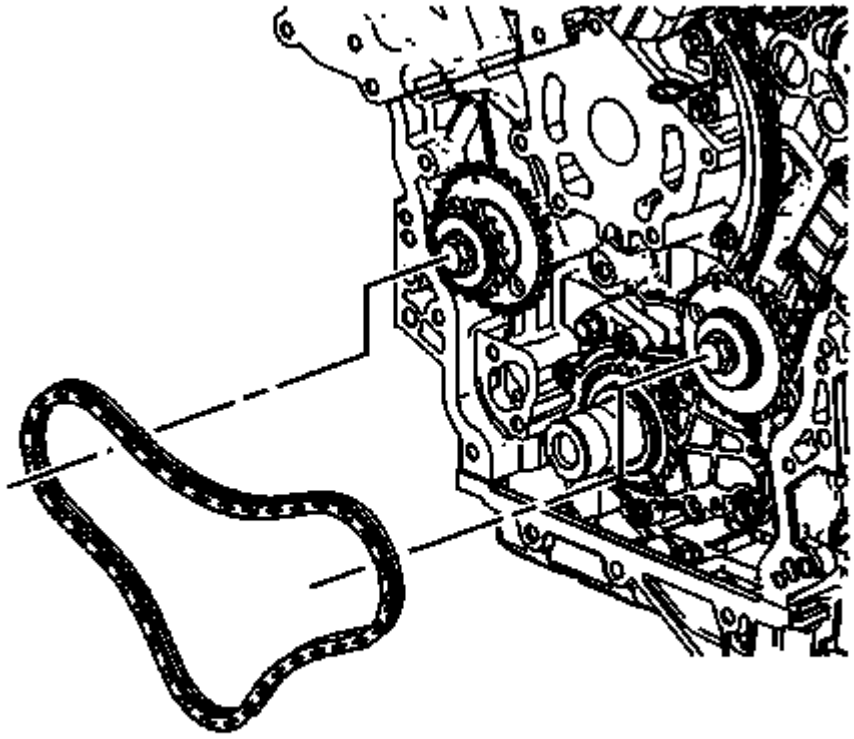

**Fig. 79: View Of Primary Camshaft Timing Chain**
**Courtesy of GENERAL MOTORS CORP.**

8. Remove the primary camshaft timing chain.

**INSTALLATION PROCEDURE**

 

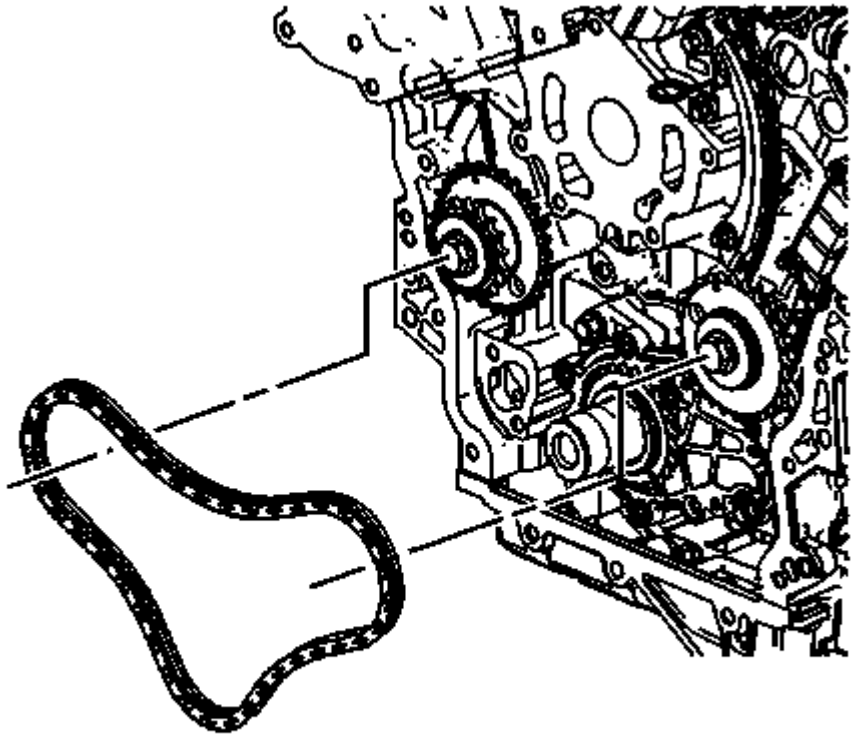

**Fig. 80: View Of Primary Camshaft Timing Chain**
**Courtesy of GENERAL MOTORS CORP.**

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**

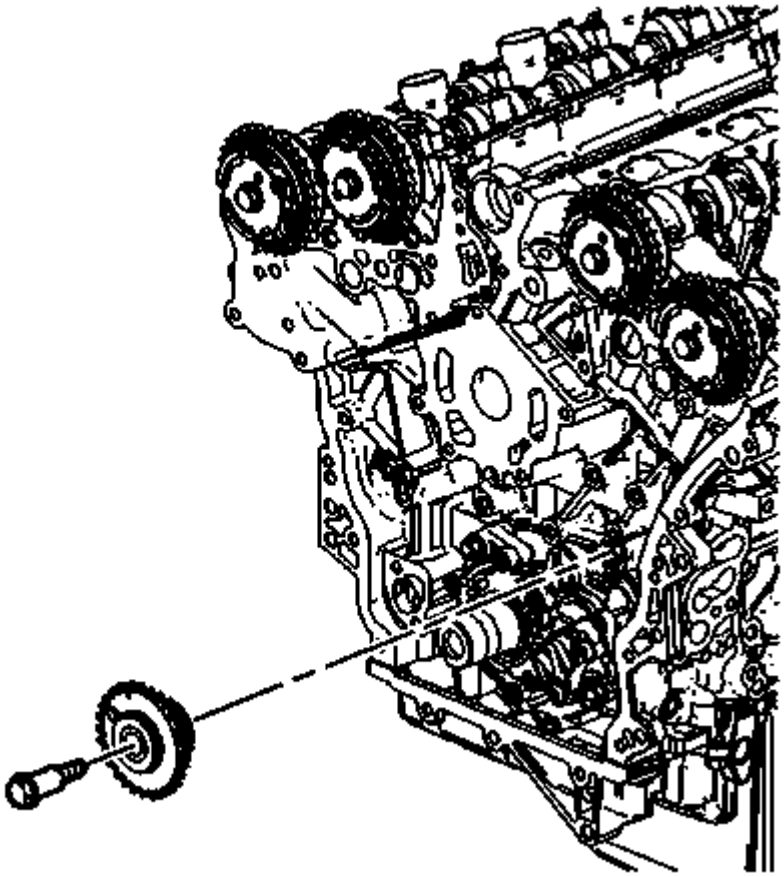

**Fig. 81: View Of Camshaft Intermediate Drive Chain Idler**
**Courtesy of GENERAL MOTORS CORP.**

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** .

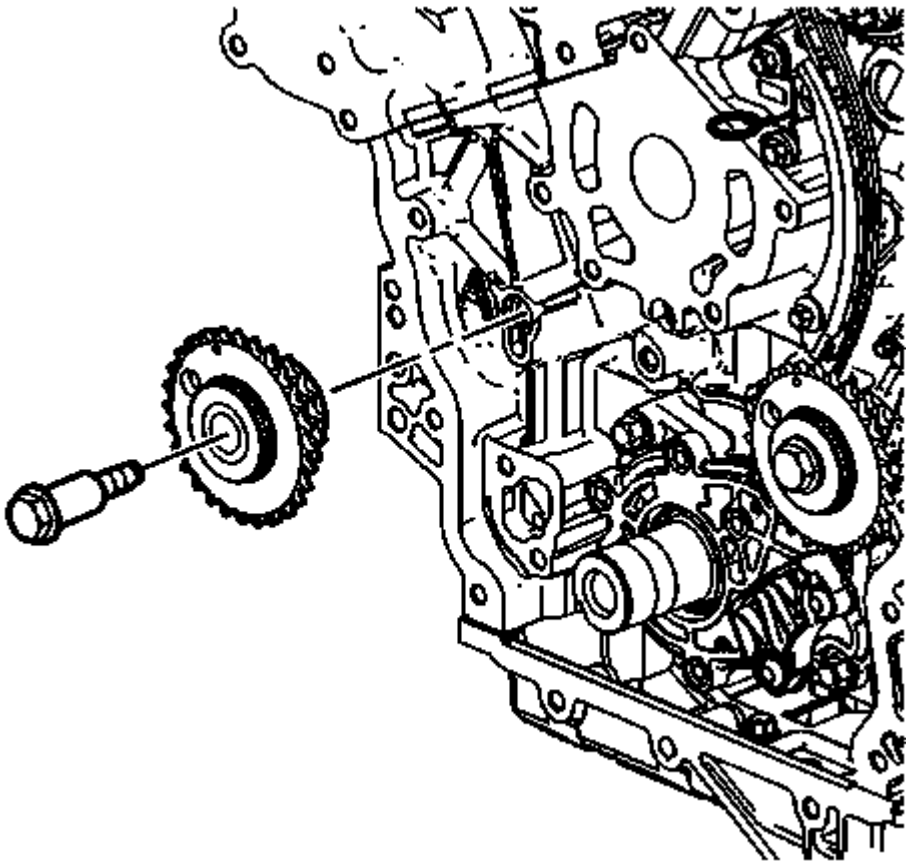

**Fig. 82: View Of Camshaft Intermediate Drive Chain Idler**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

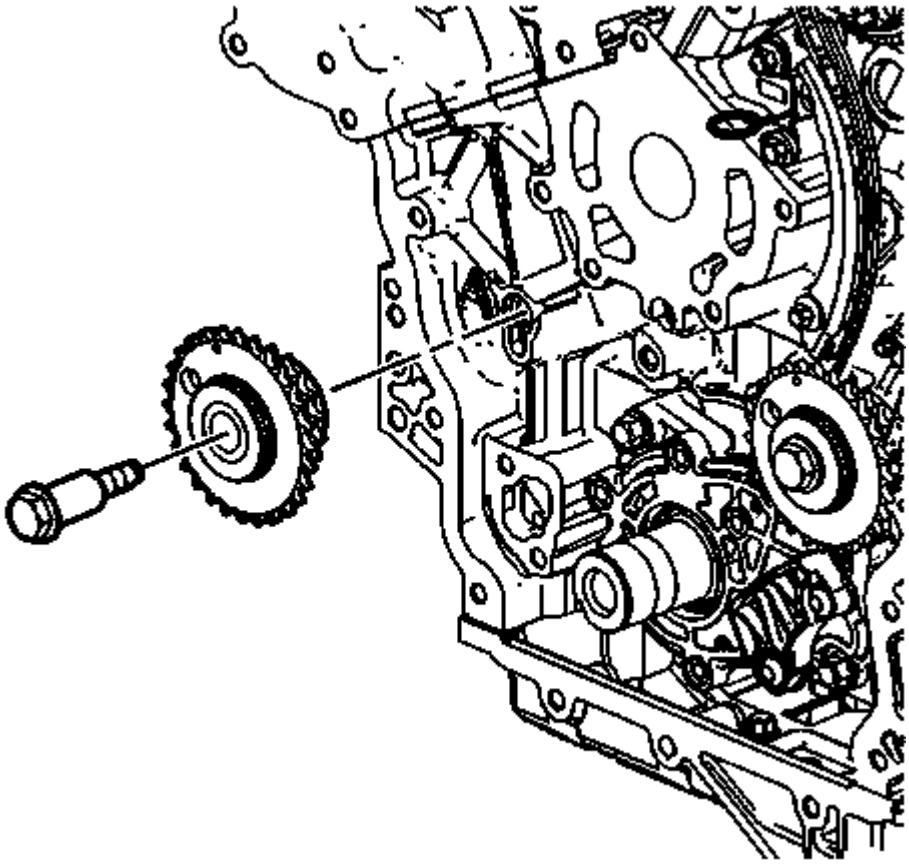

**Fig. 83: View Of Camshaft Intermediate Drive Chain Idler**
**Courtesy of GENERAL MOTORS CORP.**

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** .

 

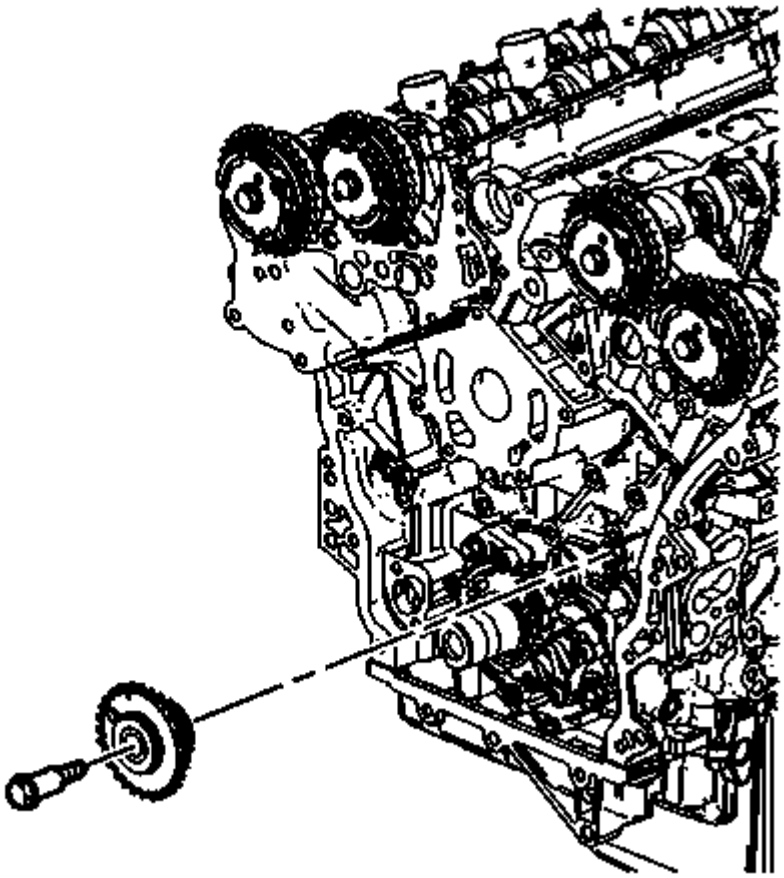

**Fig. 84: View Of Camshaft Intermediate Drive Chain Idler**
**Courtesy of GENERAL MOTORS CORP.**

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**

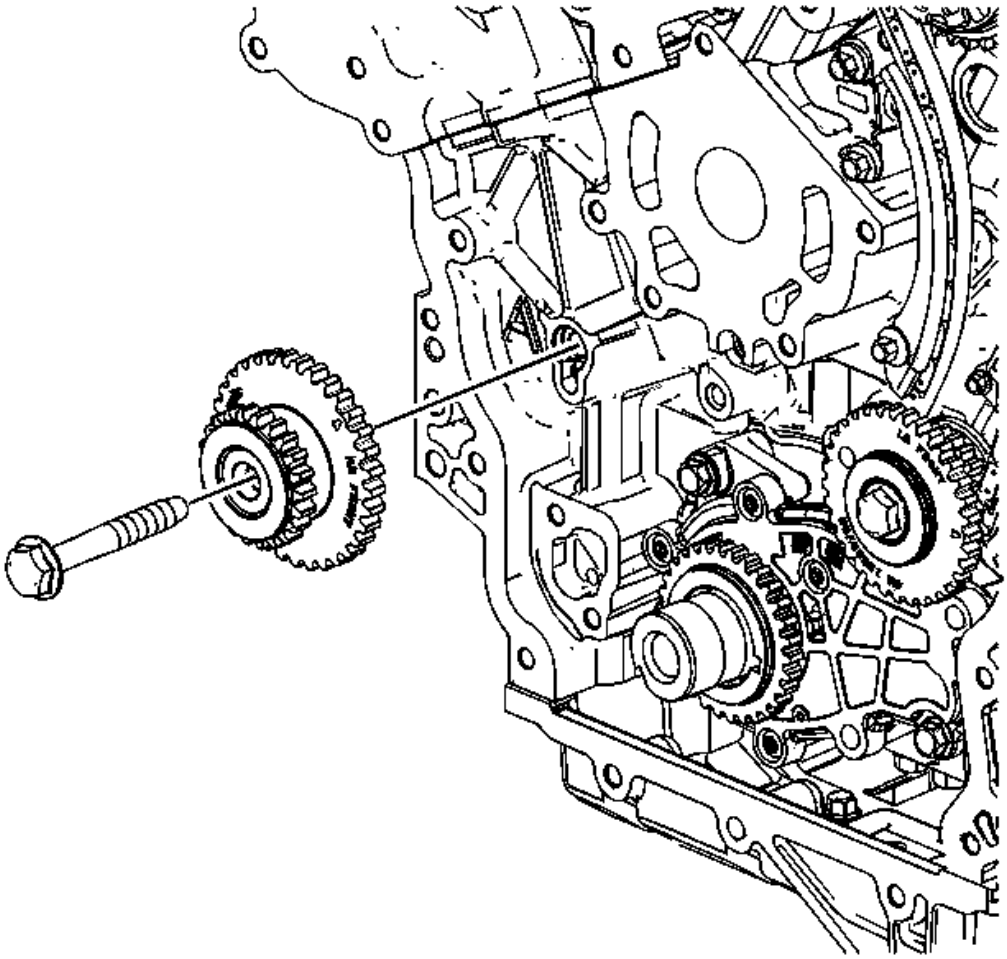

**Fig. 85: View Of Camshaft Intermediate Drive Chain Idler & Bolt**
**Courtesy of GENERAL MOTORS CORP.**

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**.

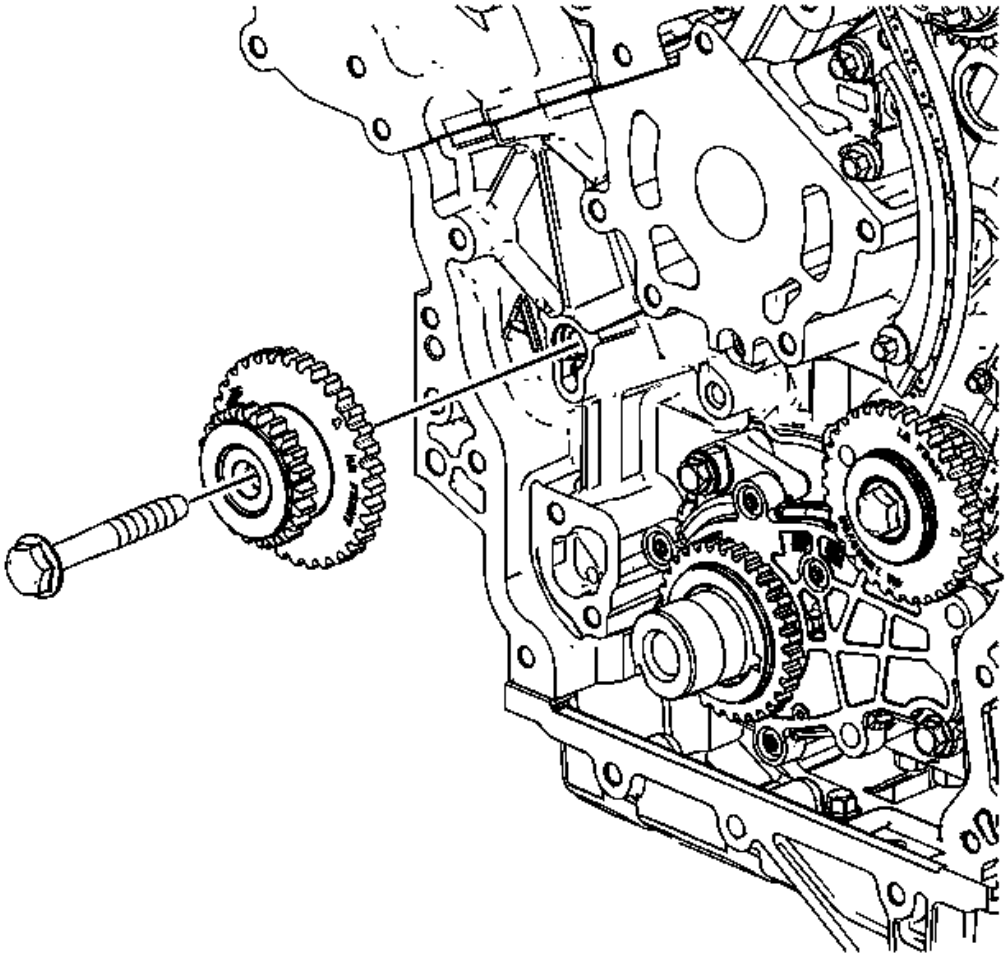

**Fig. 86: View Of Camshaft Intermediate Drive Chain Idler & Bolt**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

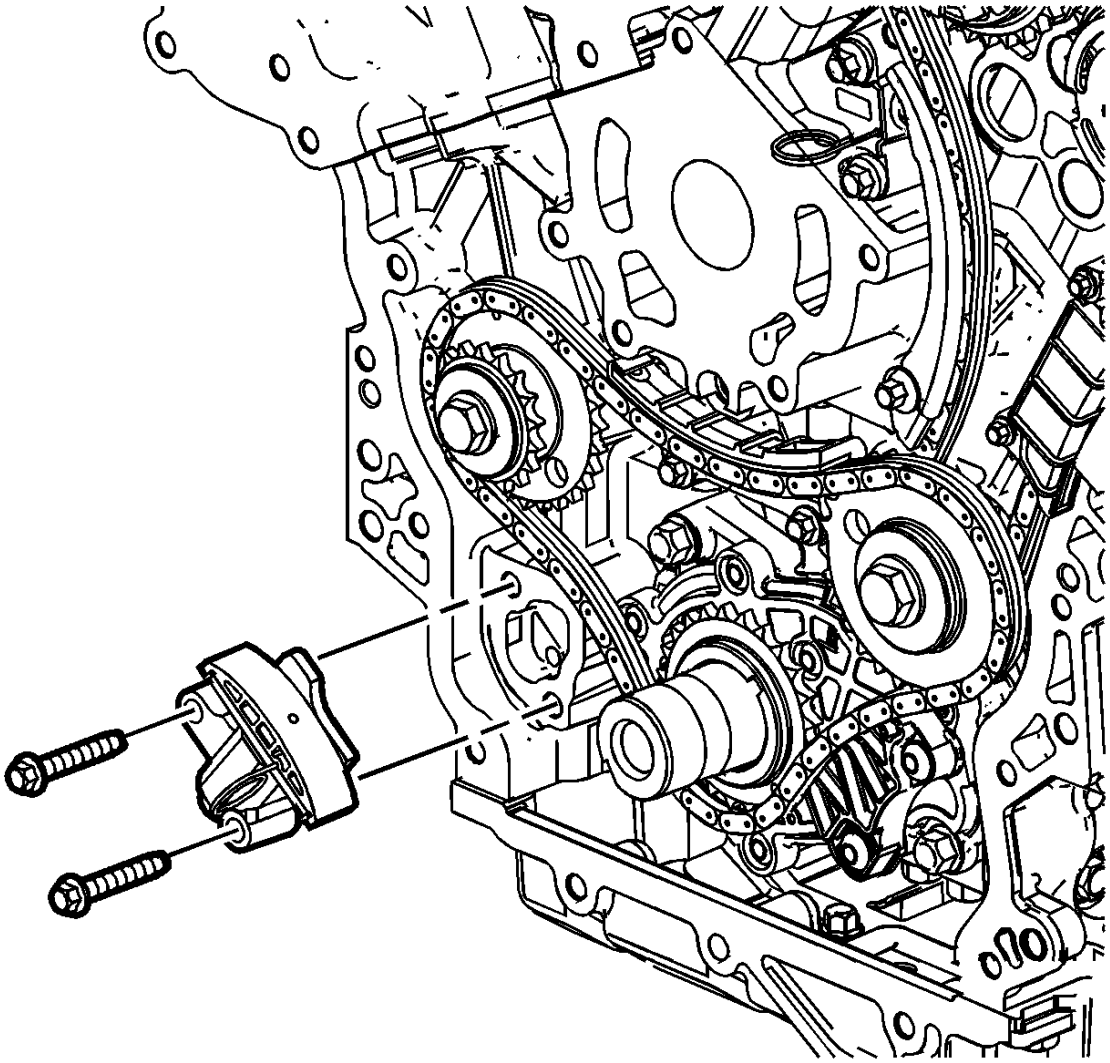

**Fig. 87: View Of Primary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

**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**

 

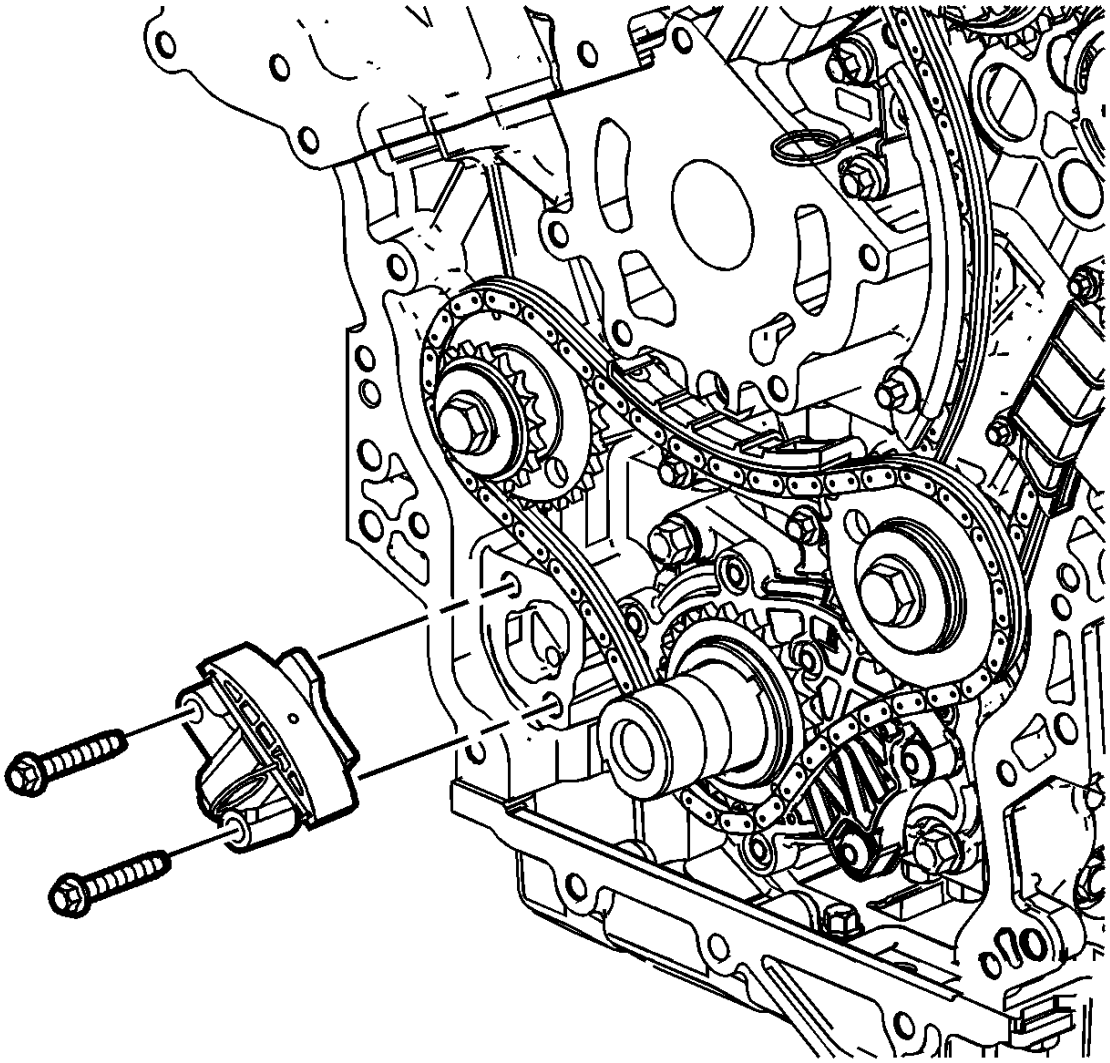

**Fig. 88: View Of Primary Camshaft Drive Chain Tensioner**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

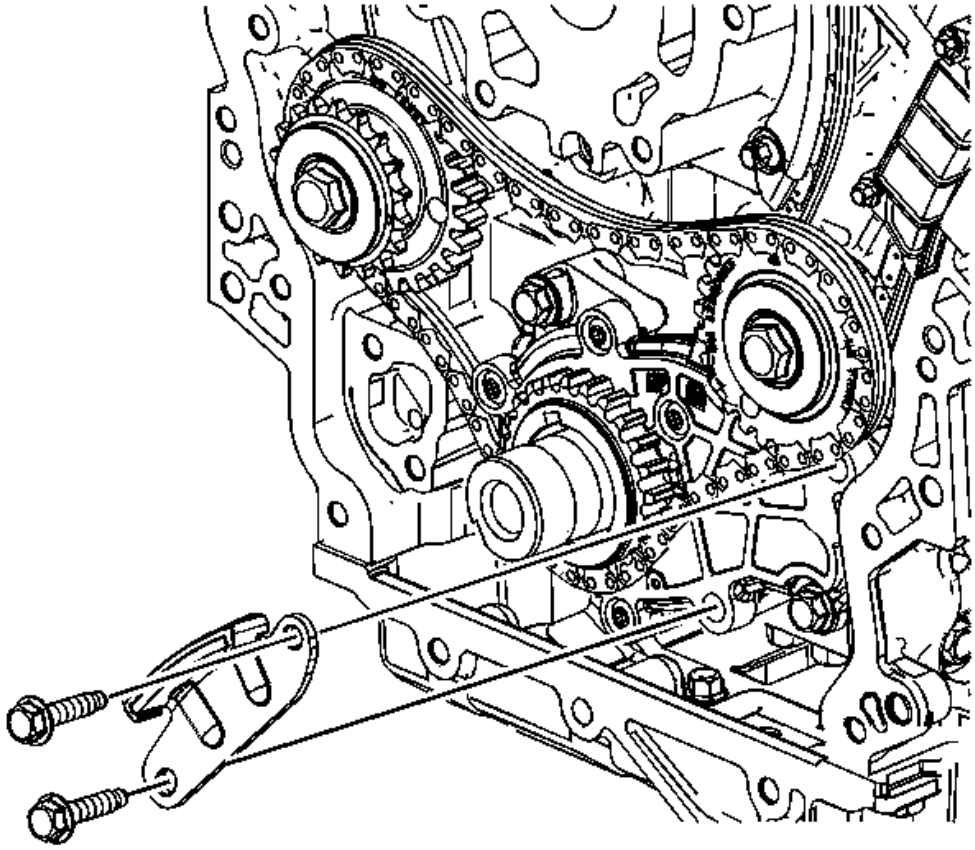

**Fig. 89: Primary Camshaft Drive Chain Lower Guide**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

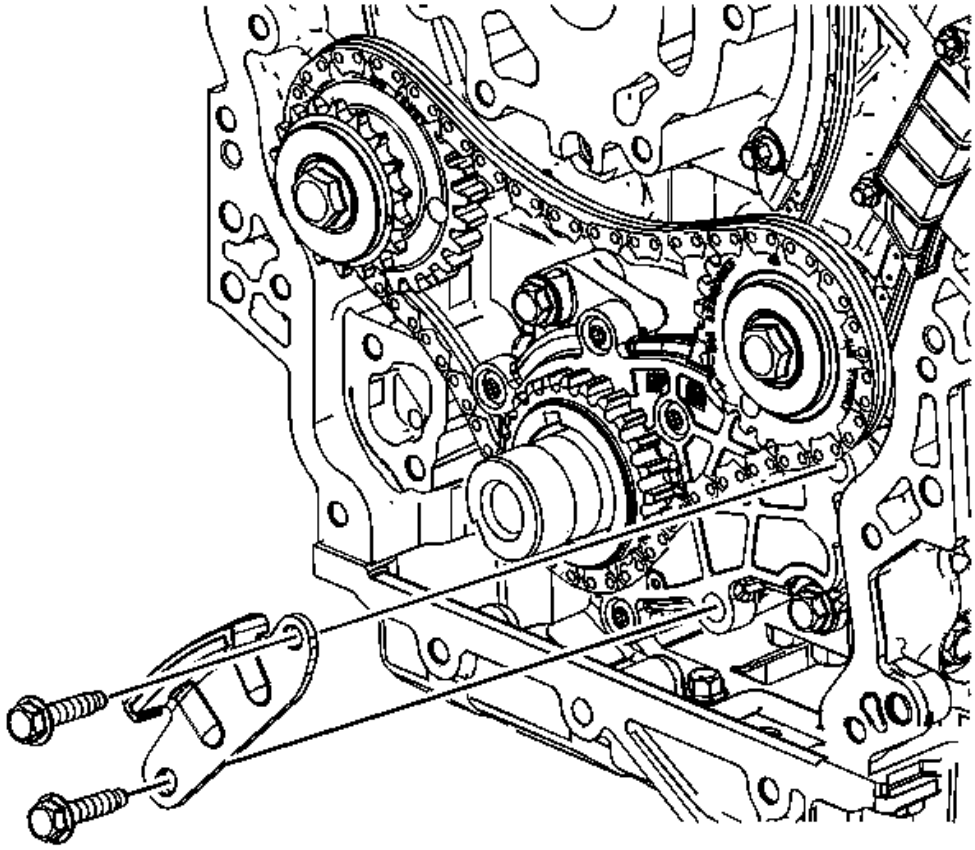

**Fig. 90: Primary Camshaft Drive Chain Lower Guide**
**Courtesy of GENERAL MOTORS CORP.**

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 23 N.m (17 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**.

 

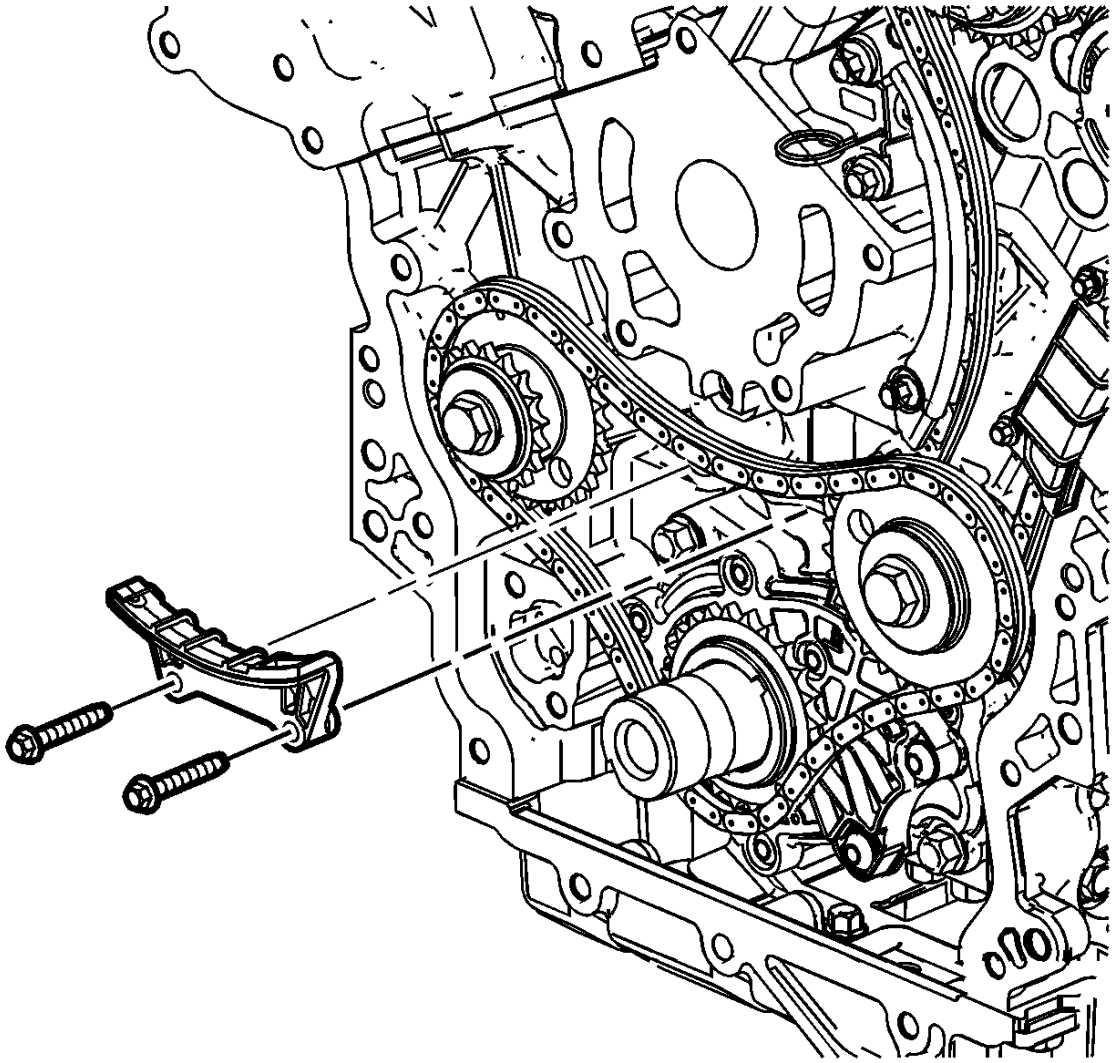

**Fig. 91: View Of Upper Primary Camshaft Drive Chain Guide**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

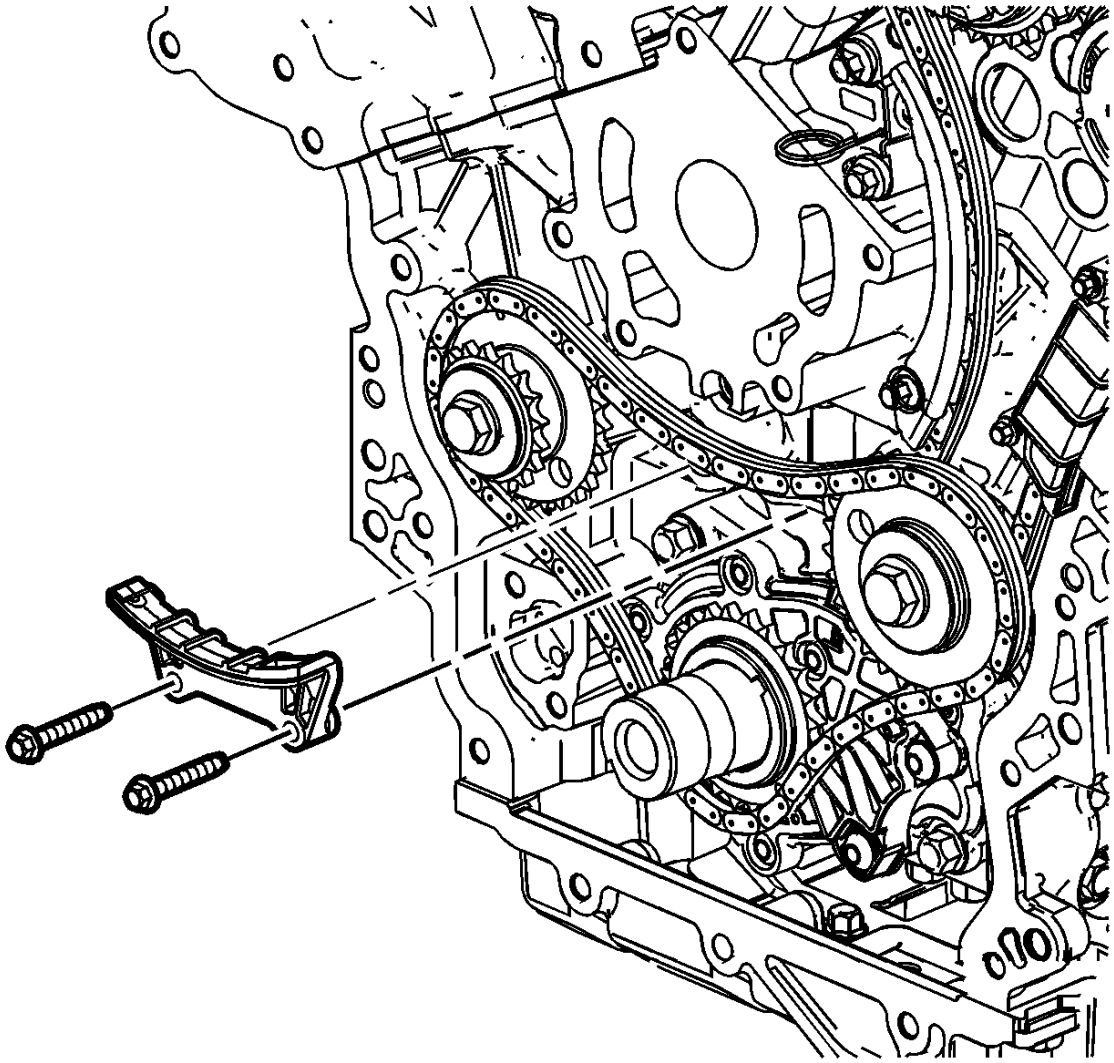

**Fig. 92: View Of Upper Primary Camshaft Drive Chain Guide**
**Courtesy of GENERAL MOTORS CORP.**

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 (LF1)

**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 (LF1)**.
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.

 

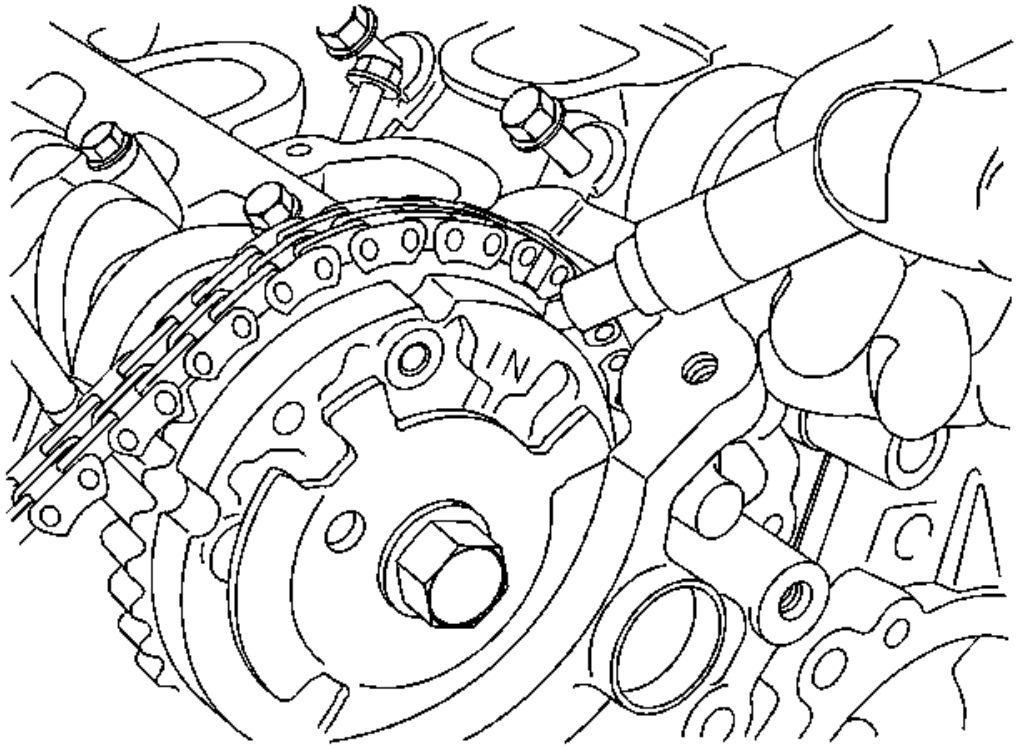


**Fig. 93: Marking Position Of Chain To Camshaft Position Actuator - Intake**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

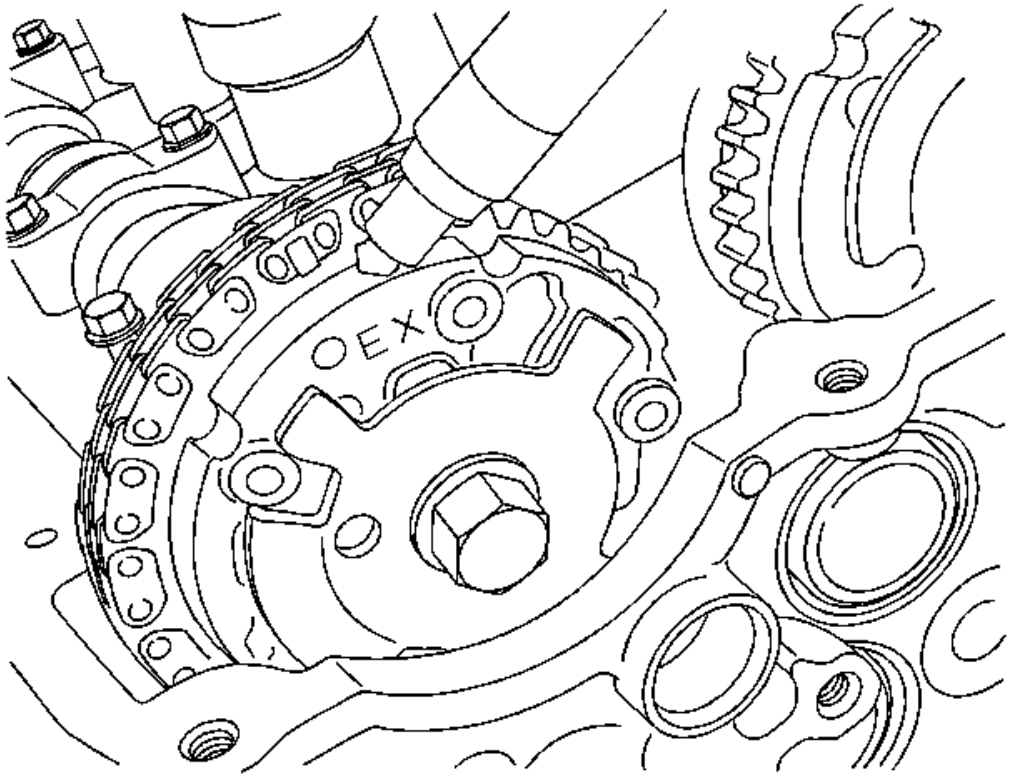


**Fig. 94: Marking Position Of Chain To Camshaft Position Actuator - Exhaust**
**Courtesy of GENERAL MOTORS CORP.**

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

 

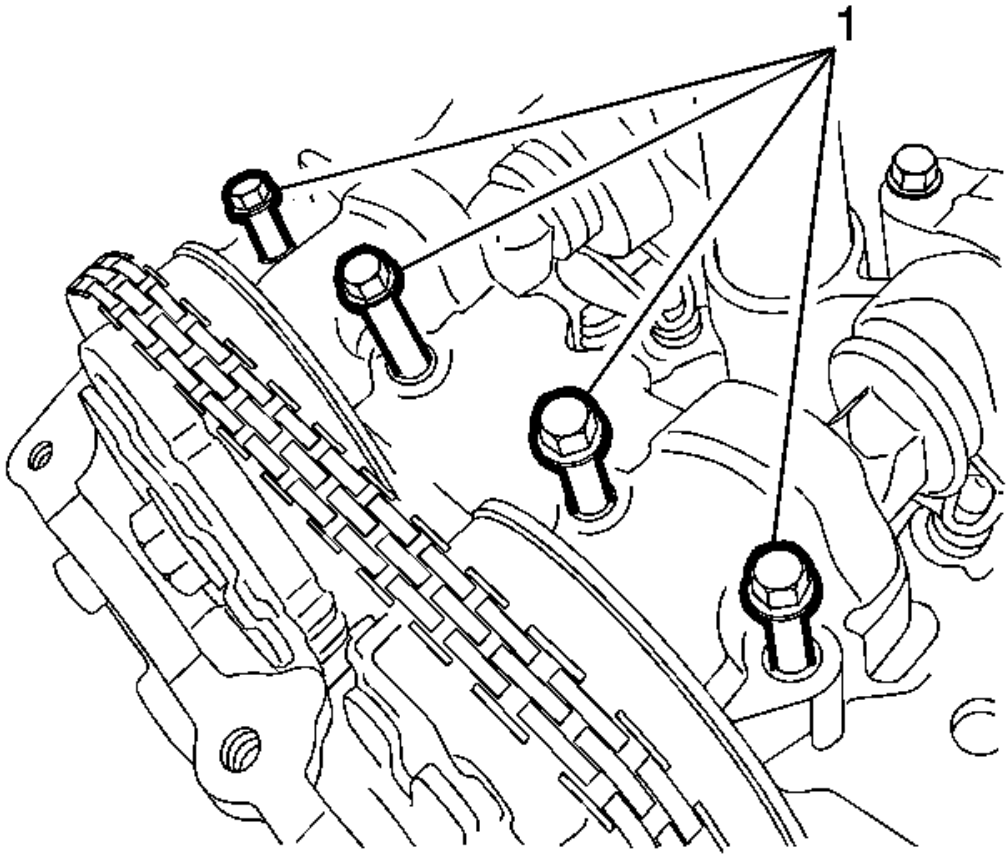


**Fig. 95: Camshaft Front Cap Bolts**
**Courtesy of GENERAL MOTORS CORP.**

10. Remove camshaft front cap bolts (1).

 

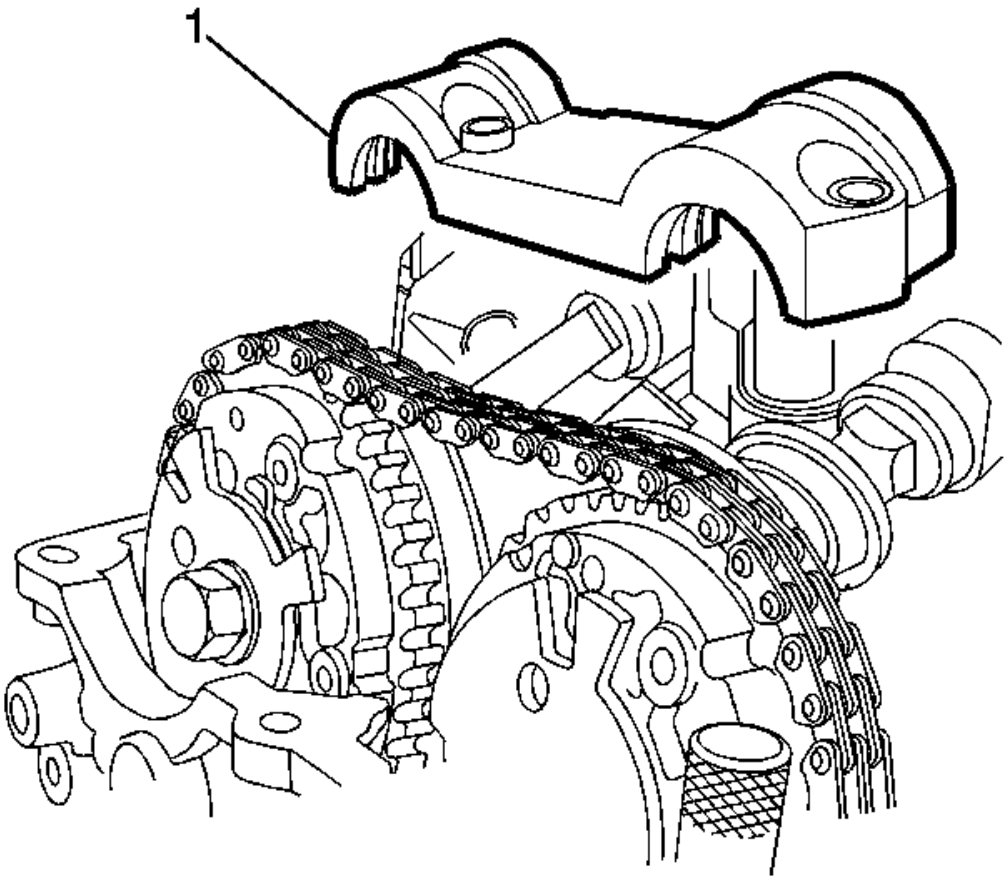


**Fig. 96: Camshaft Front Cap**
**Courtesy of GENERAL MOTORS CORP.**

**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).

 

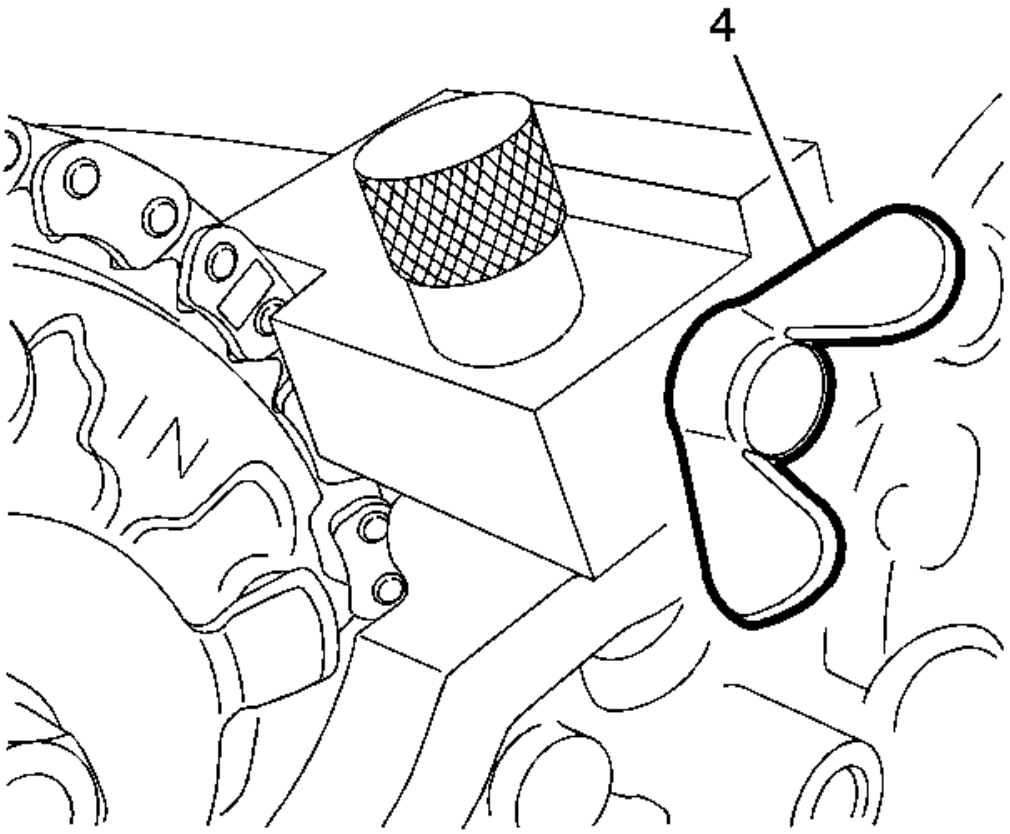


**Fig. 97: Retainer Wingnut**
**Courtesy of GENERAL MOTORS CORP.**

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

 

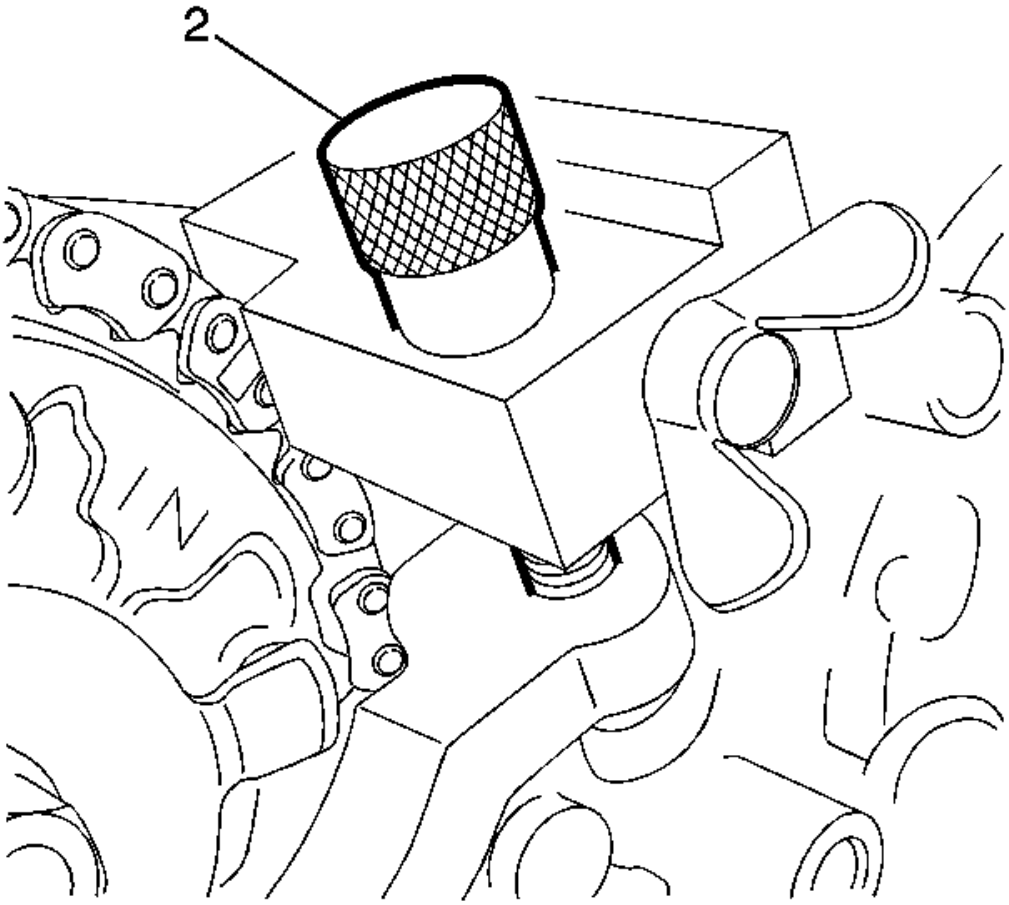


**Fig. 98: Retainer Thumbscrew**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

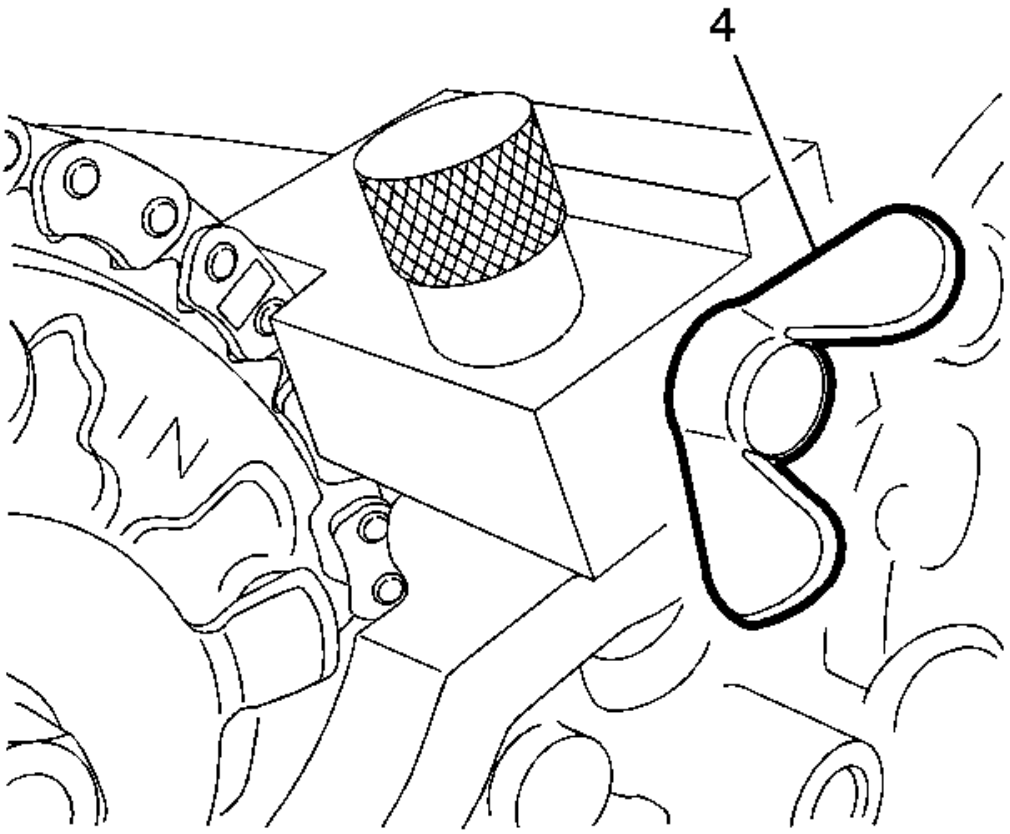


**Fig. 99: Retainer Wingnut**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

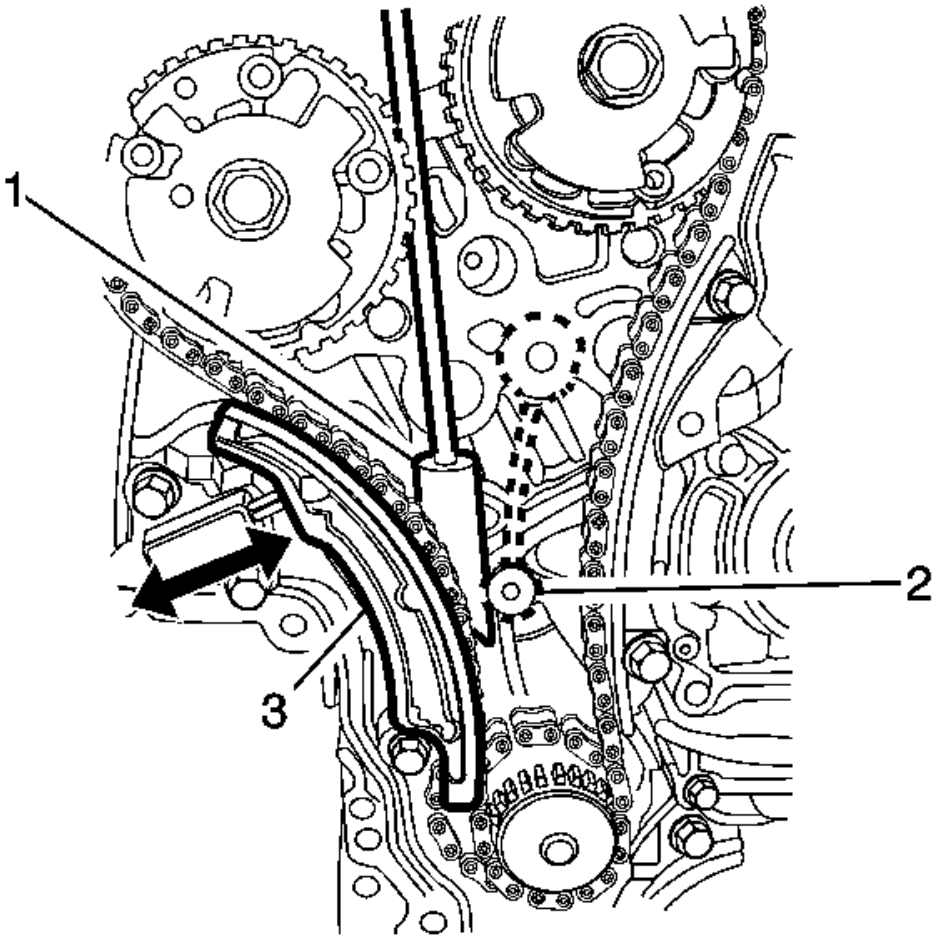


**Fig. 100: Retainer Wedge**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

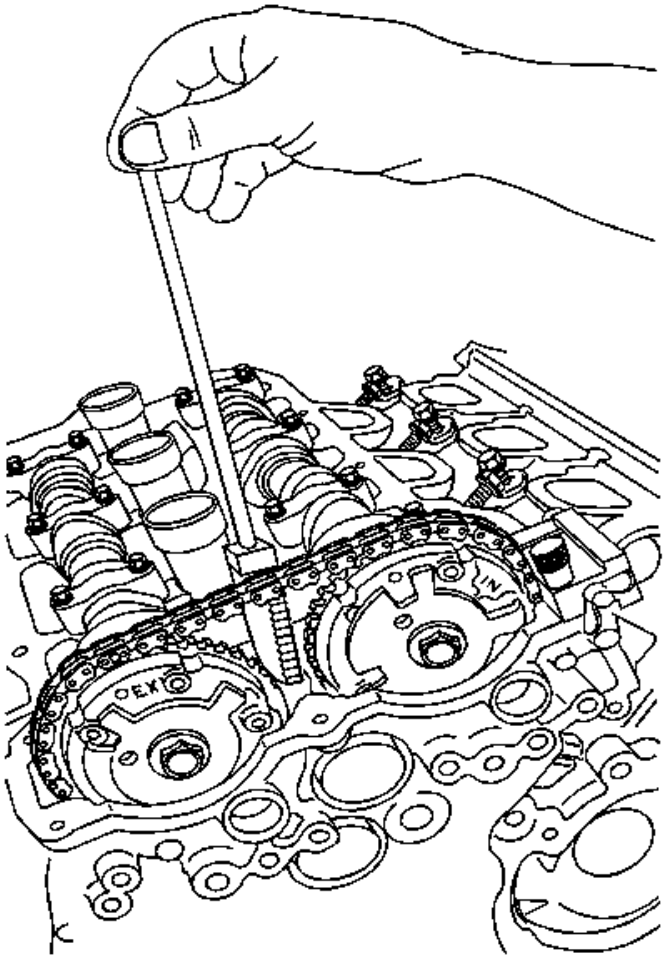


**Fig. 101: Inserting Retainer**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

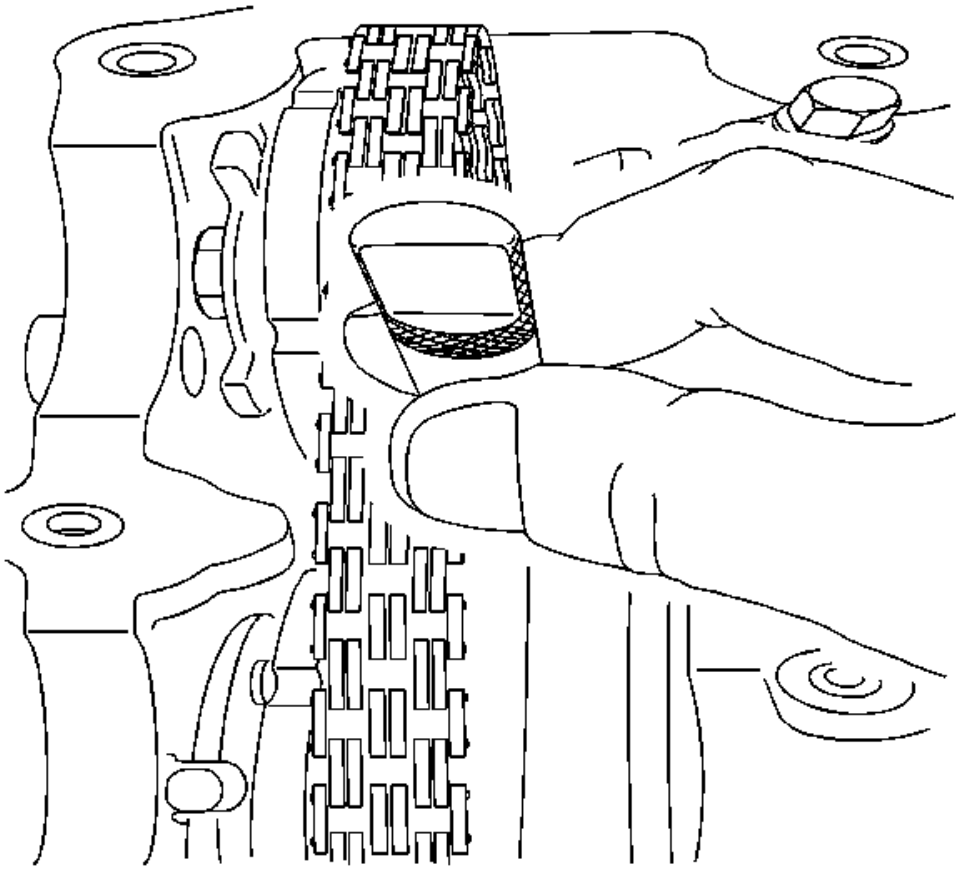

**Fig. 102: Orienting Retainer Teeth**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

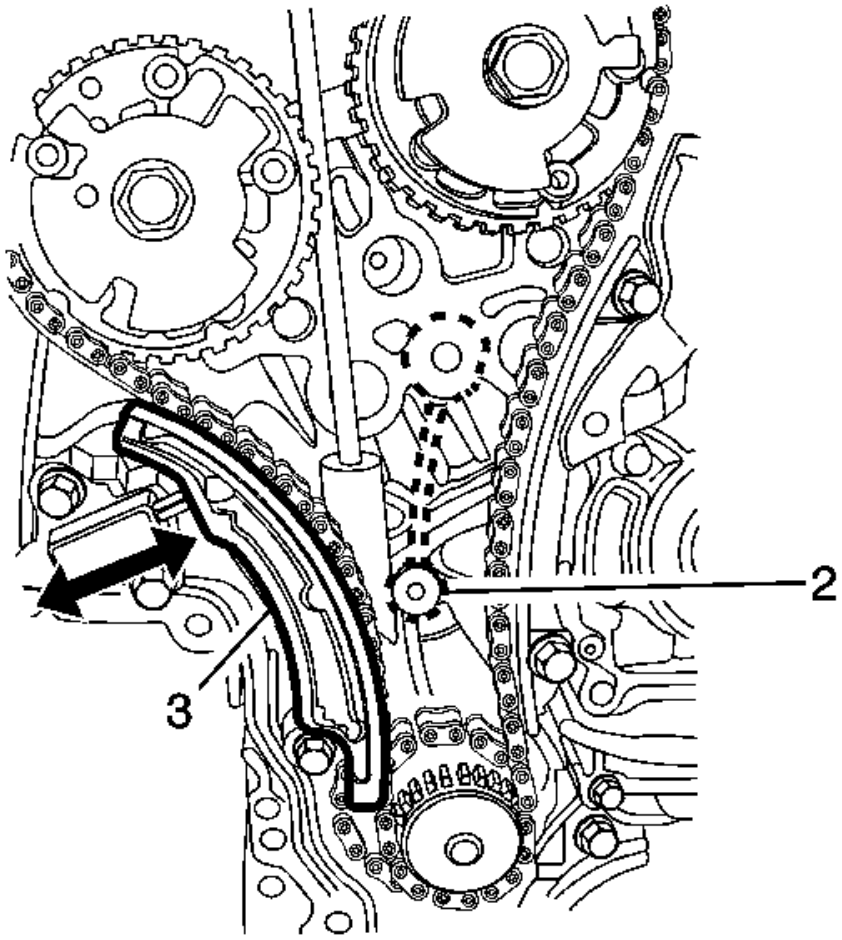


**Fig. 103: Dropping Wedge Down**
**Courtesy of GENERAL MOTORS CORP.**

**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).

 

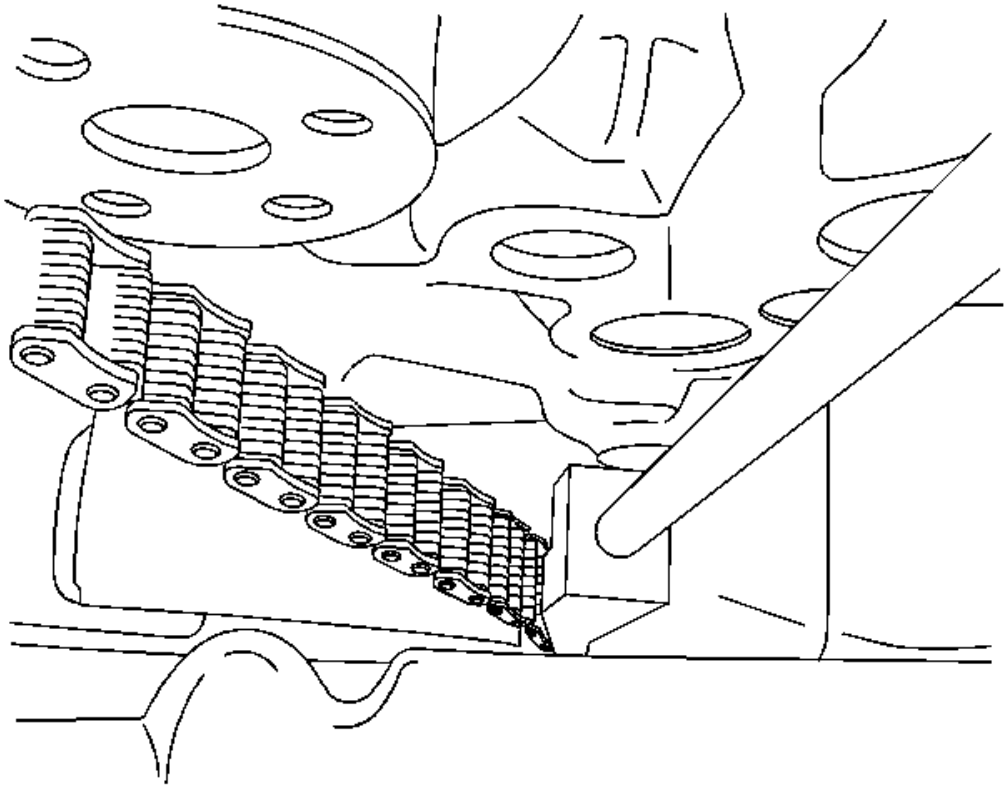

**Fig. 104: Identifying Wedge Position**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

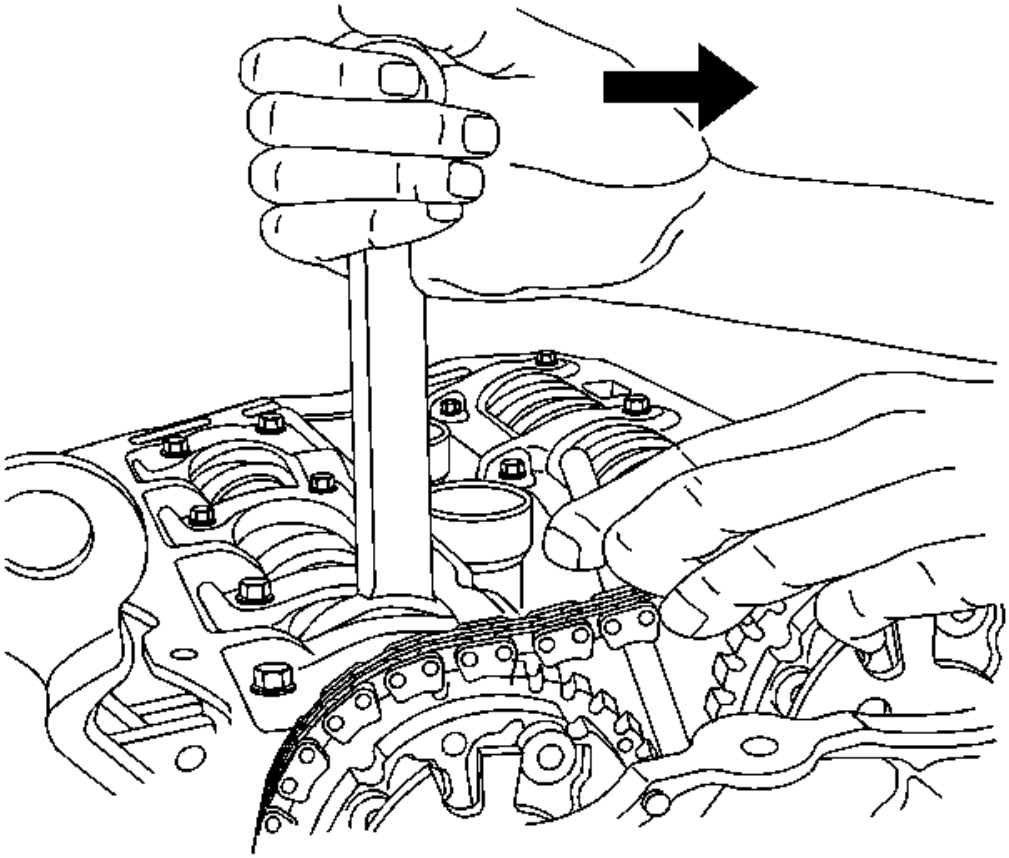

**Fig. 105: Rotating Camshaft**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

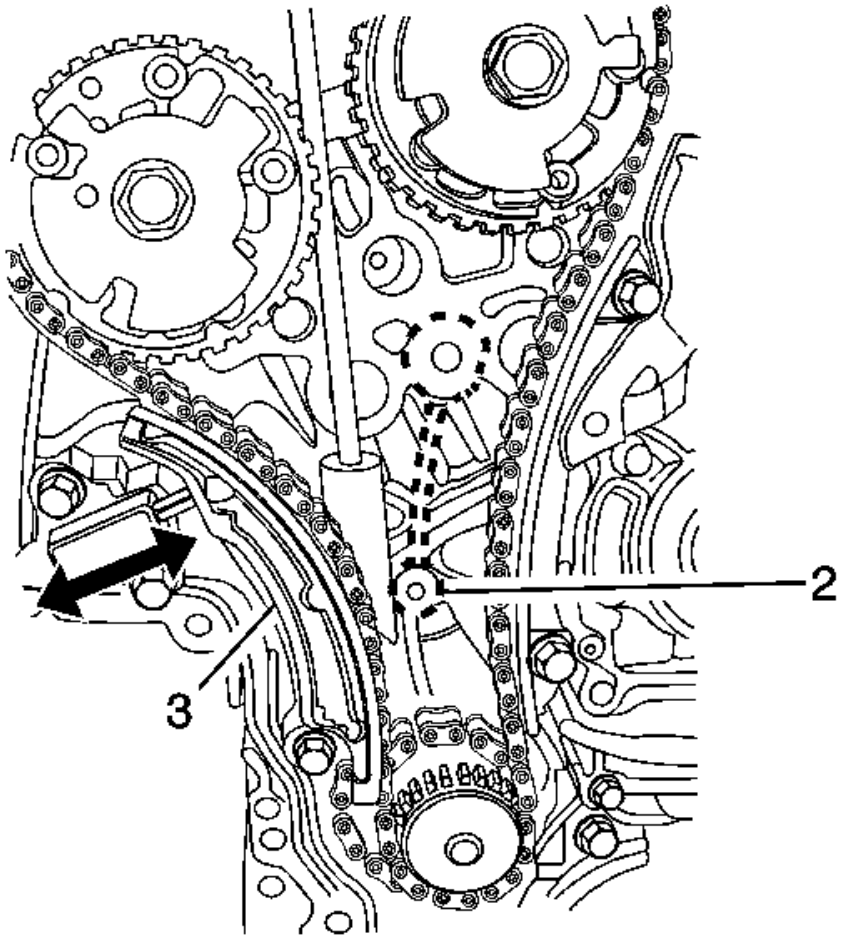


**Fig. 106: Opening Gap Between Chain & Internal Rib In Front Cover**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

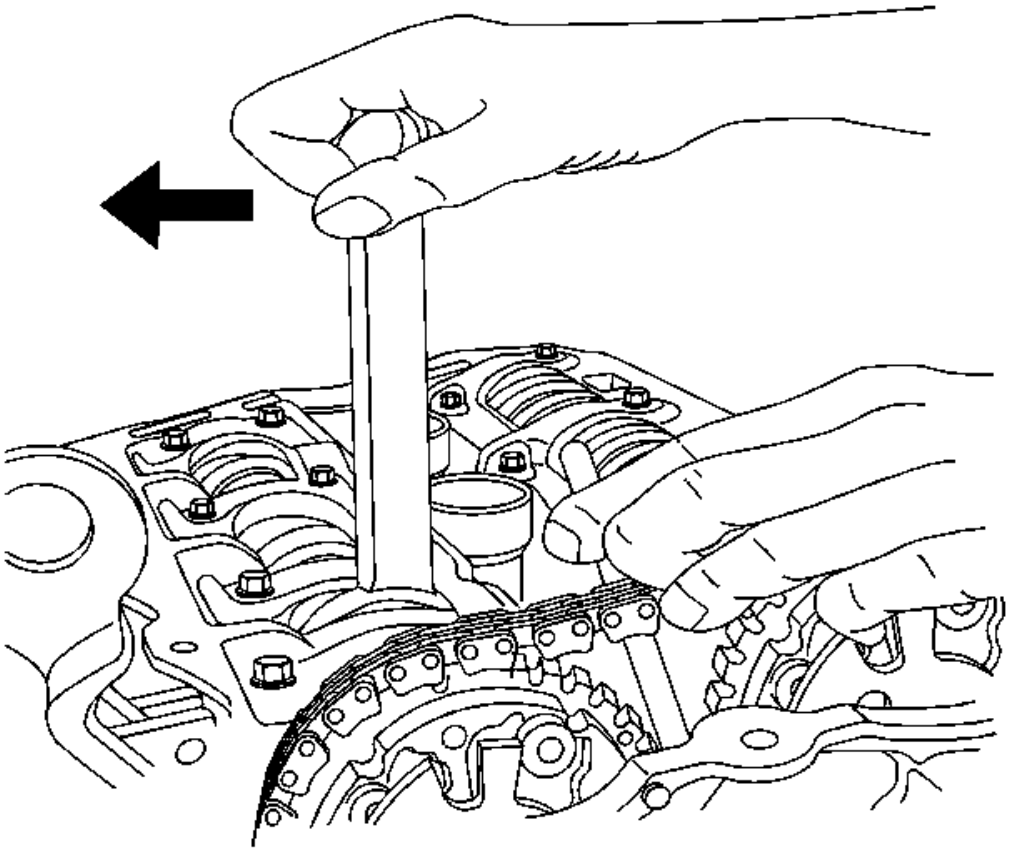

**Fig. 107: Releasing Force On Wrench**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

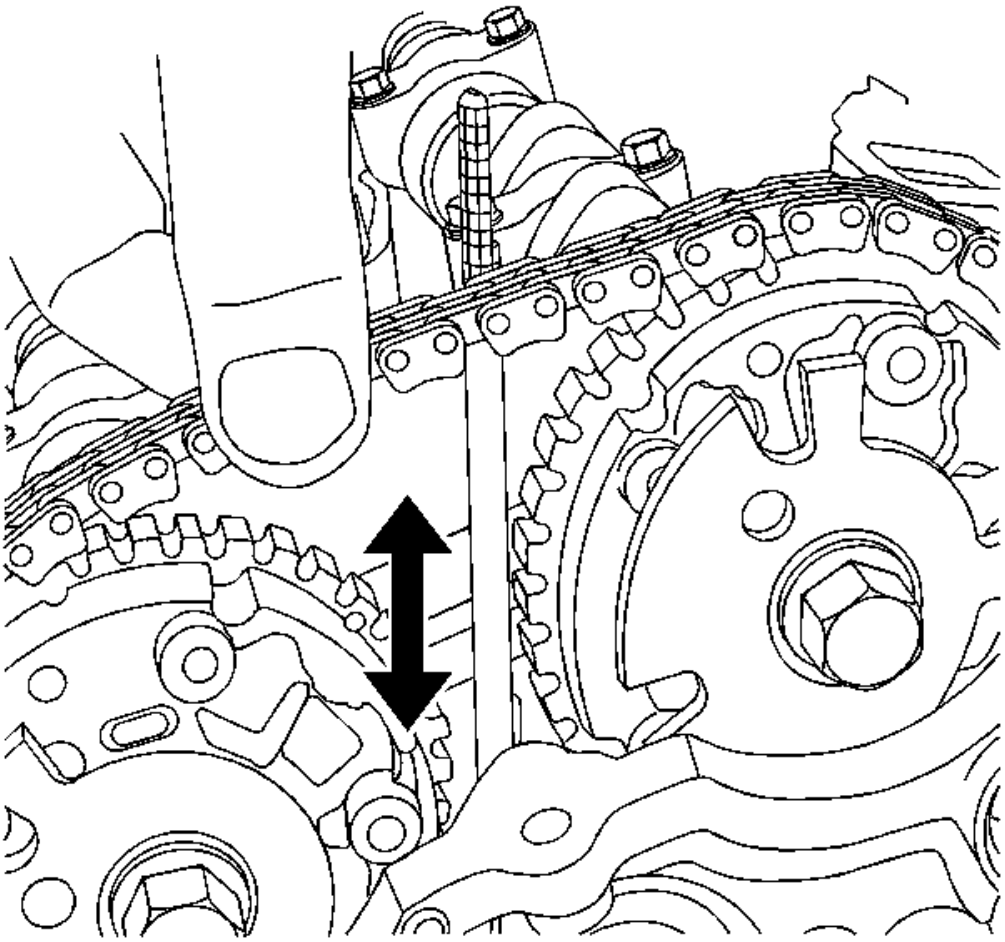

**Fig. 108: Identifying Slack In Timing Drive Chain**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

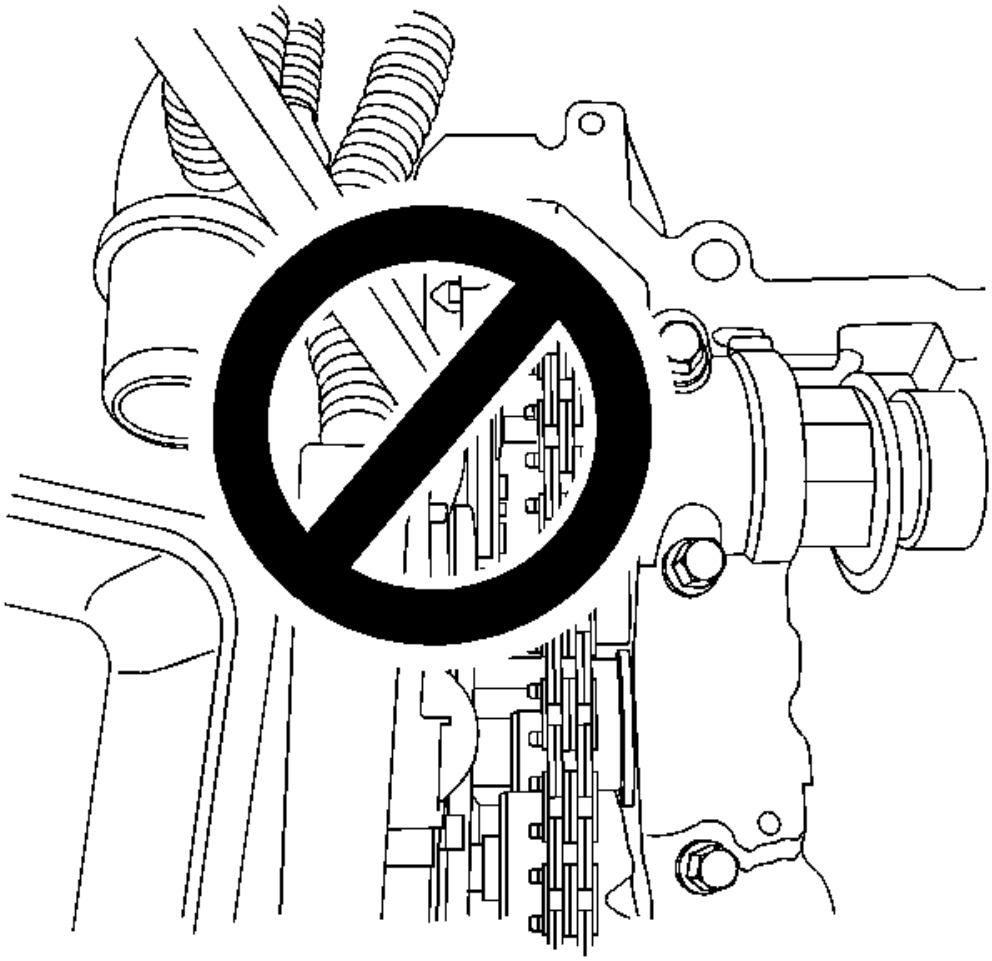

**Fig. 109: Do Not Pry**
**Courtesy of GENERAL MOTORS CORP.**

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

 

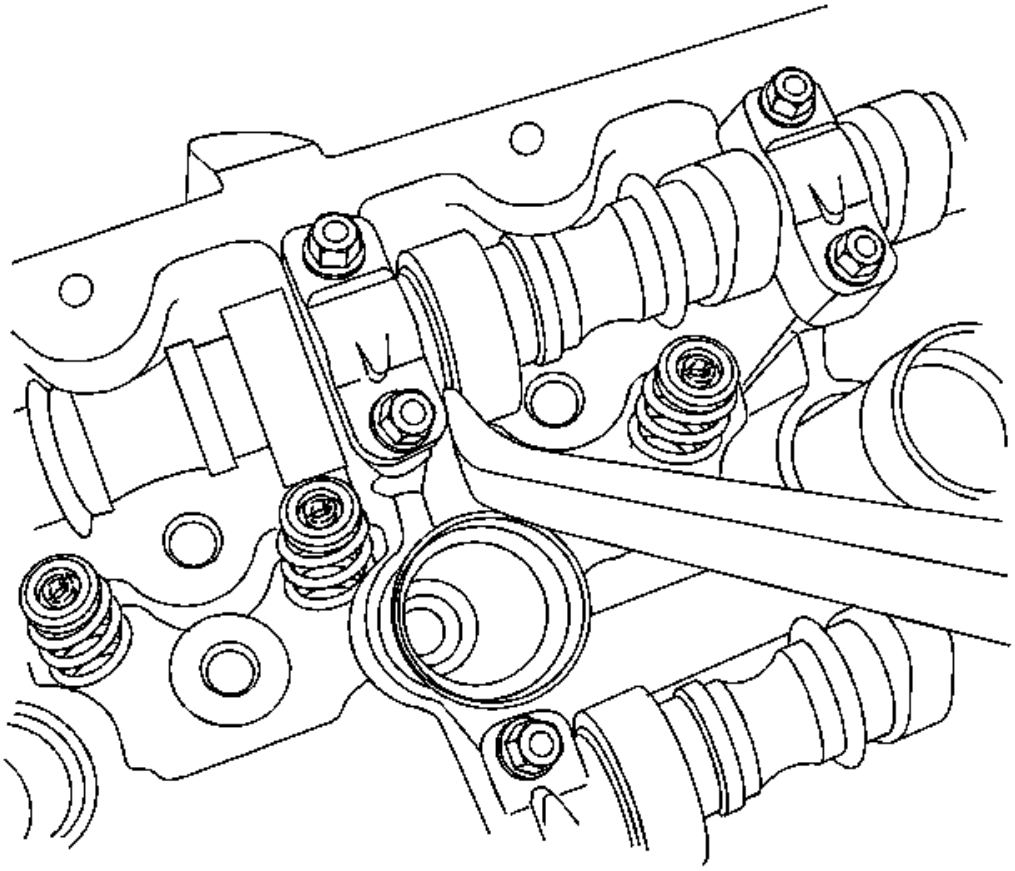

**Fig. 110: Prying Camshaft Forward**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

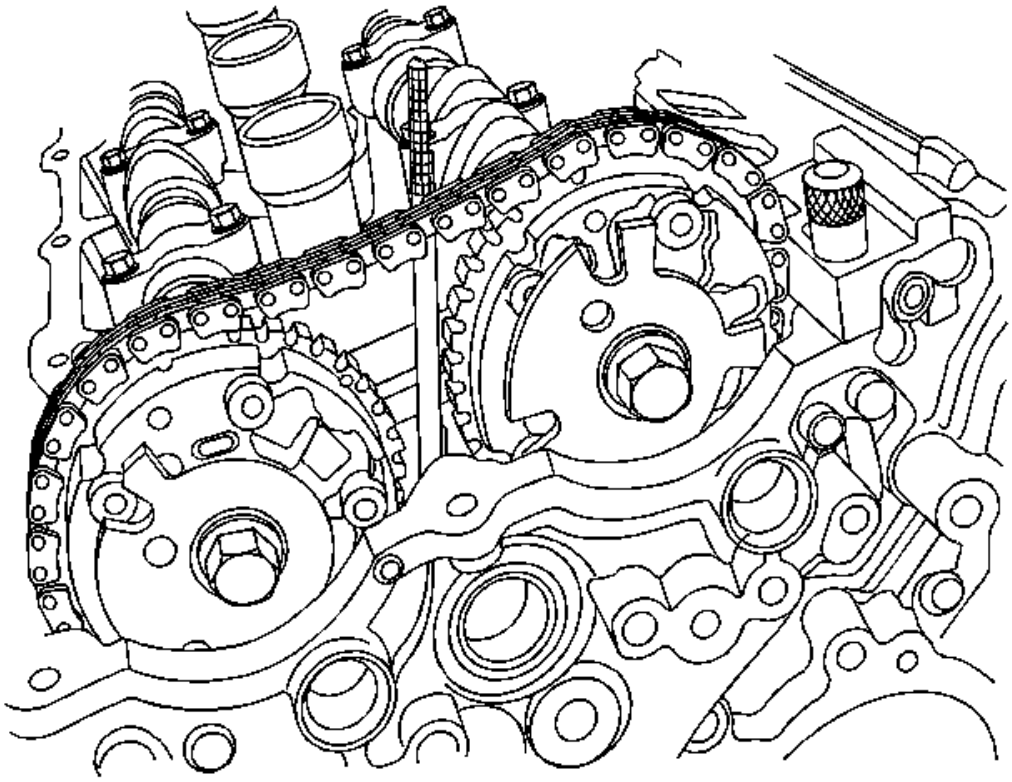

**Fig. 111: Identifying Retainer Position**
**Courtesy of GENERAL MOTORS CORP.**

**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).

 

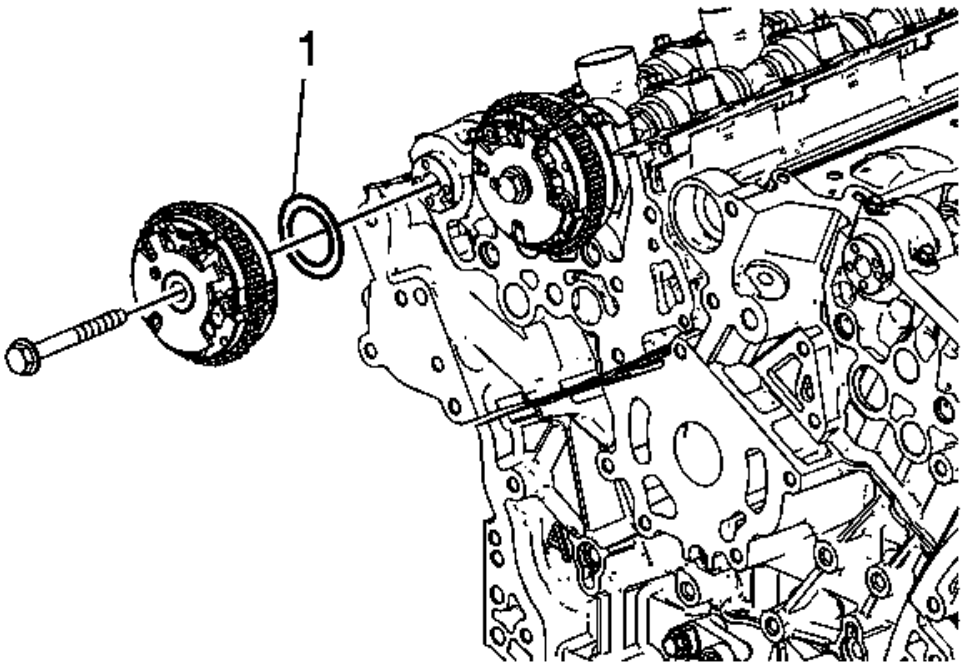


**Fig. 112: Plastic Thrust Washers**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

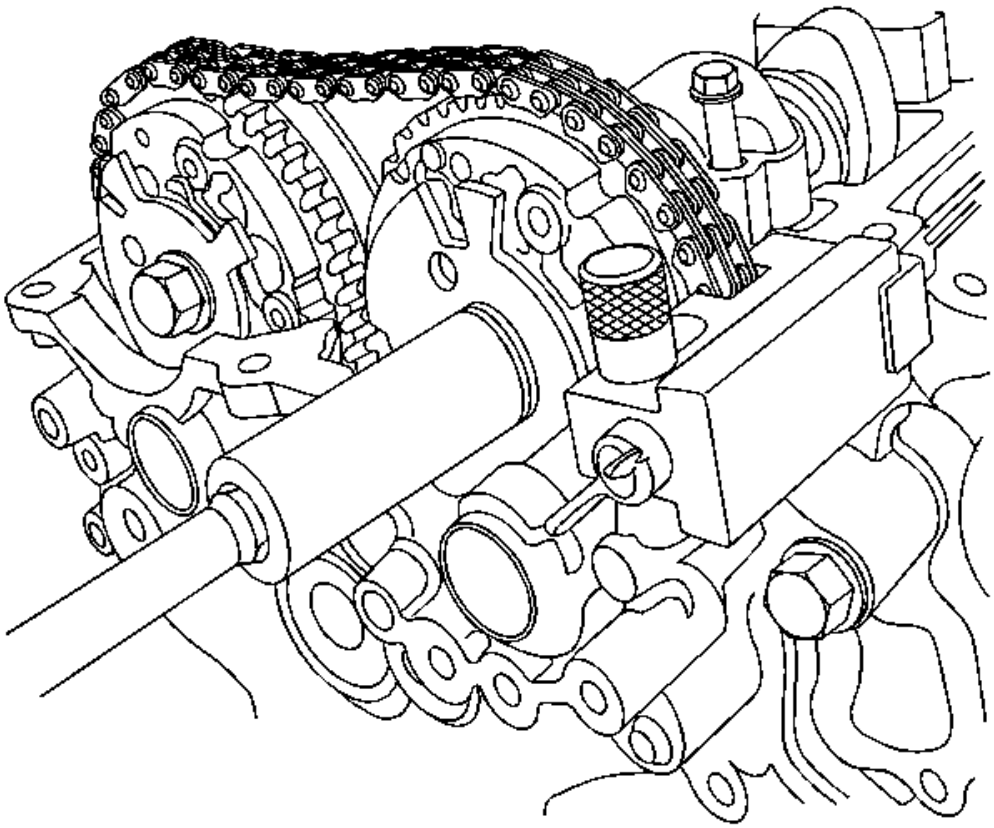

**Fig. 113: Intake Camshaft Position Actuator**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

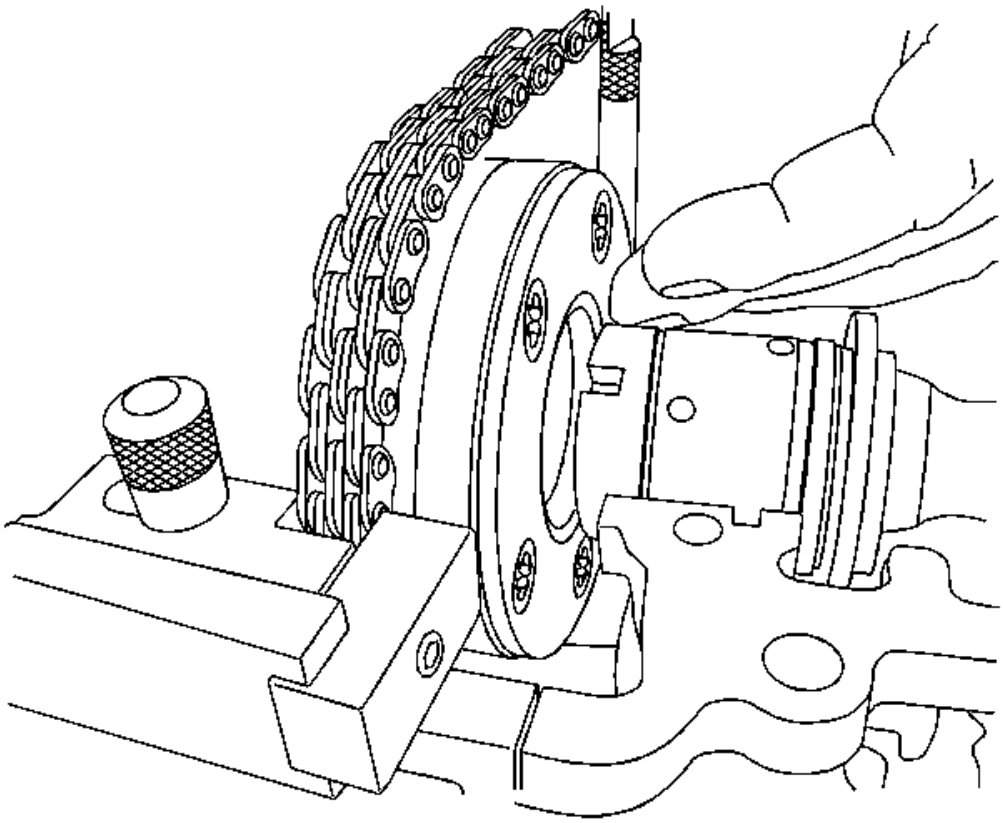

**Fig. 114: Sliding Camshaft Position Actuator Off End Of Intake Camshaft**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

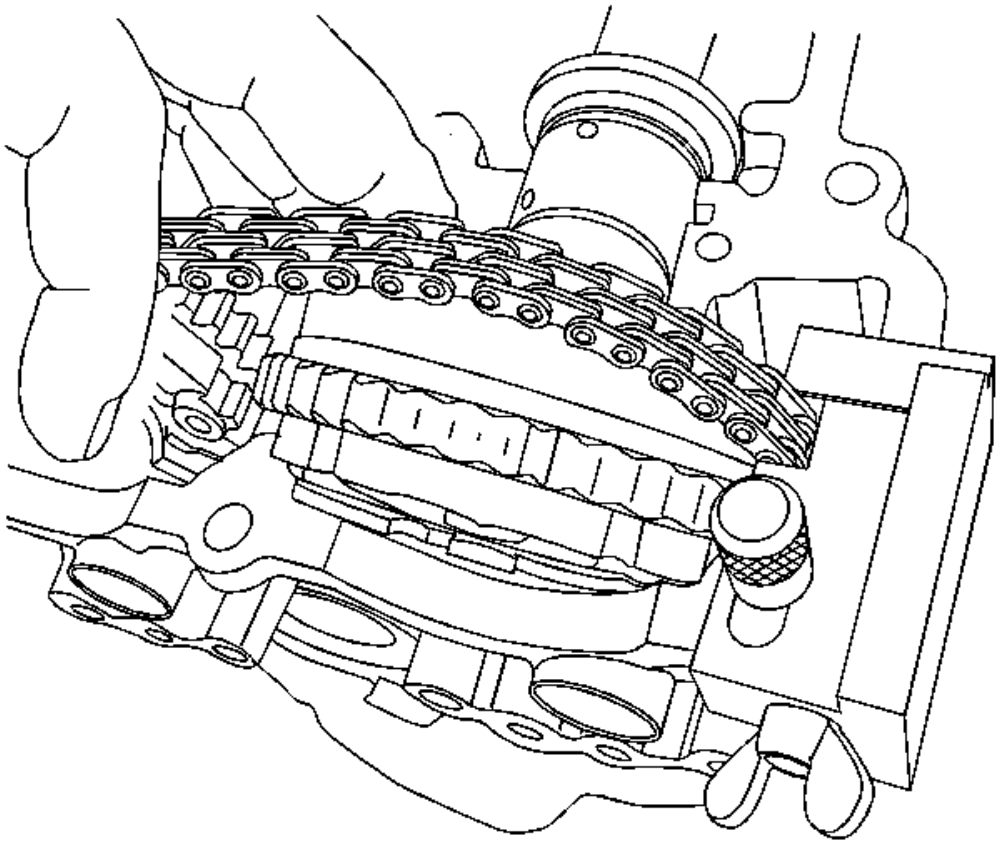

**Fig. 115: Tilting Camshaft Position Actuator Forward**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

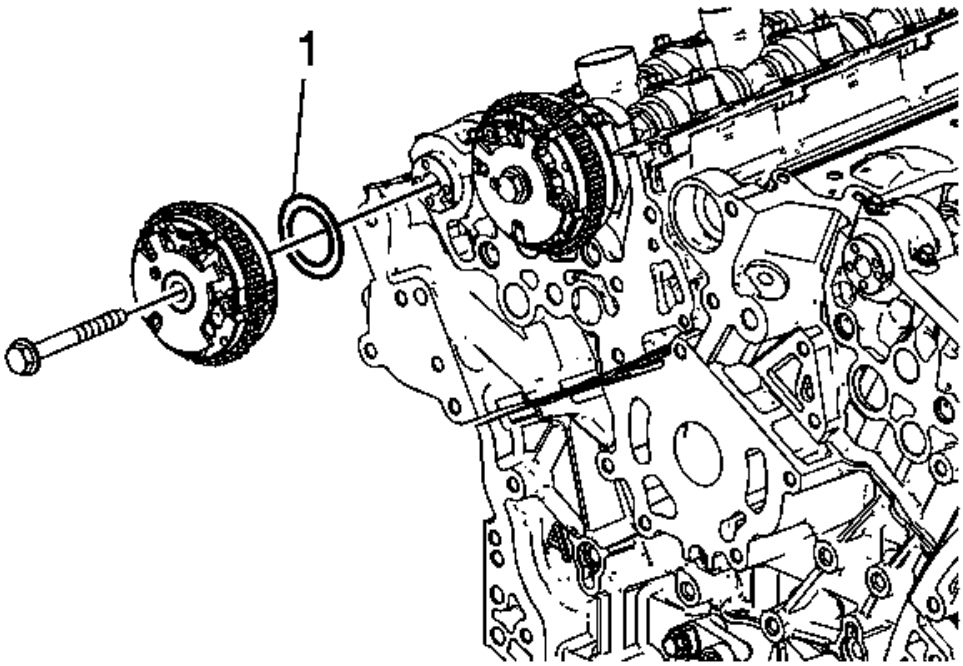


**Fig. 116: Plastic Thrust Washers**
**Courtesy of GENERAL MOTORS CORP.**

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

 

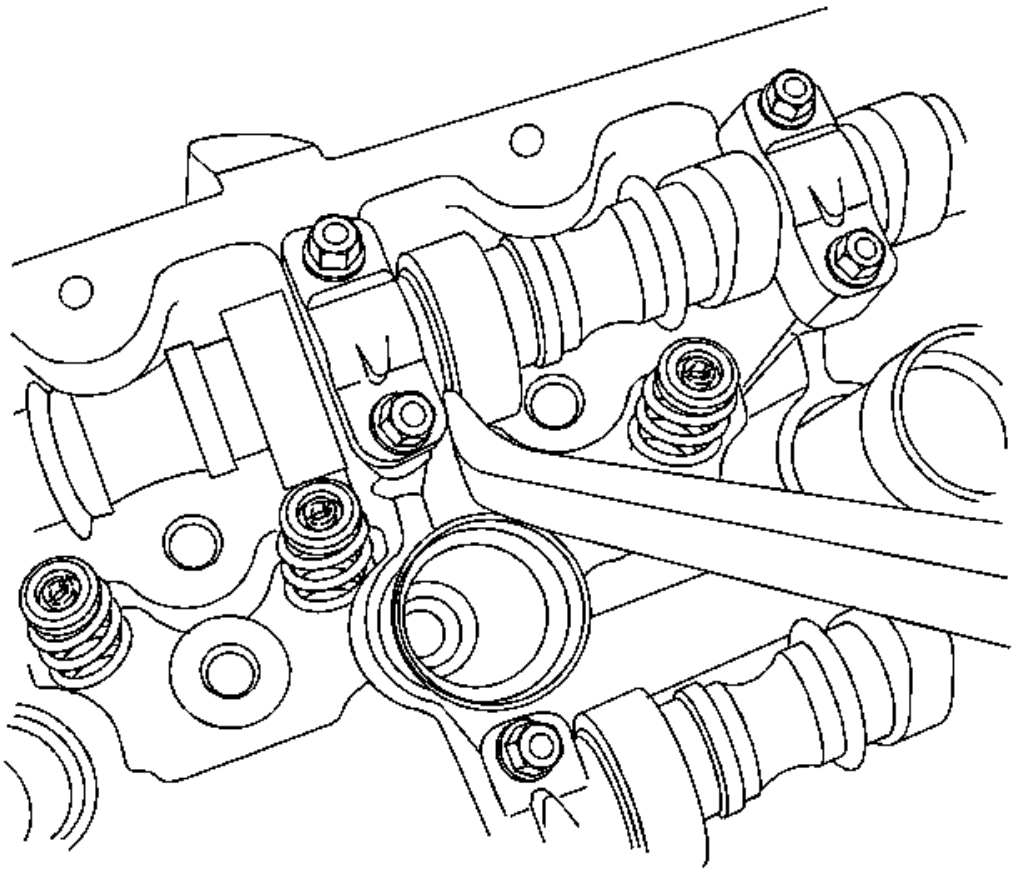

**Fig. 117: Prying Camshaft Forward**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

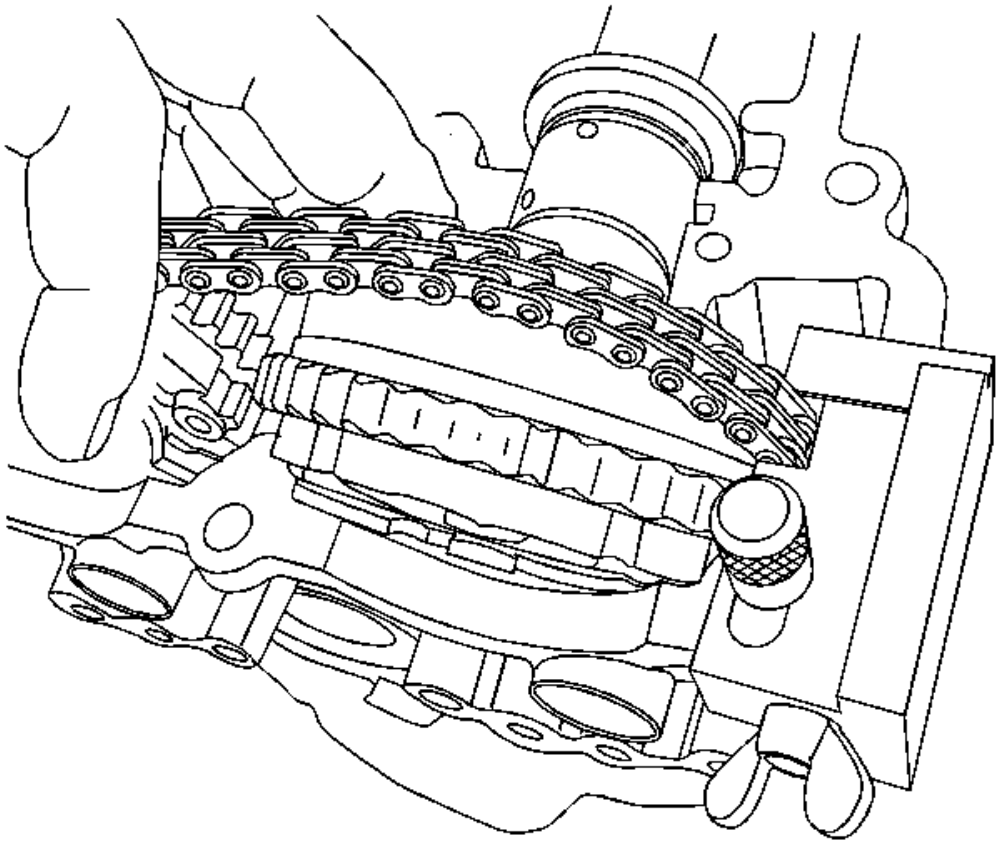

**Fig. 118: Tilting Camshaft Position Actuator Forward**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

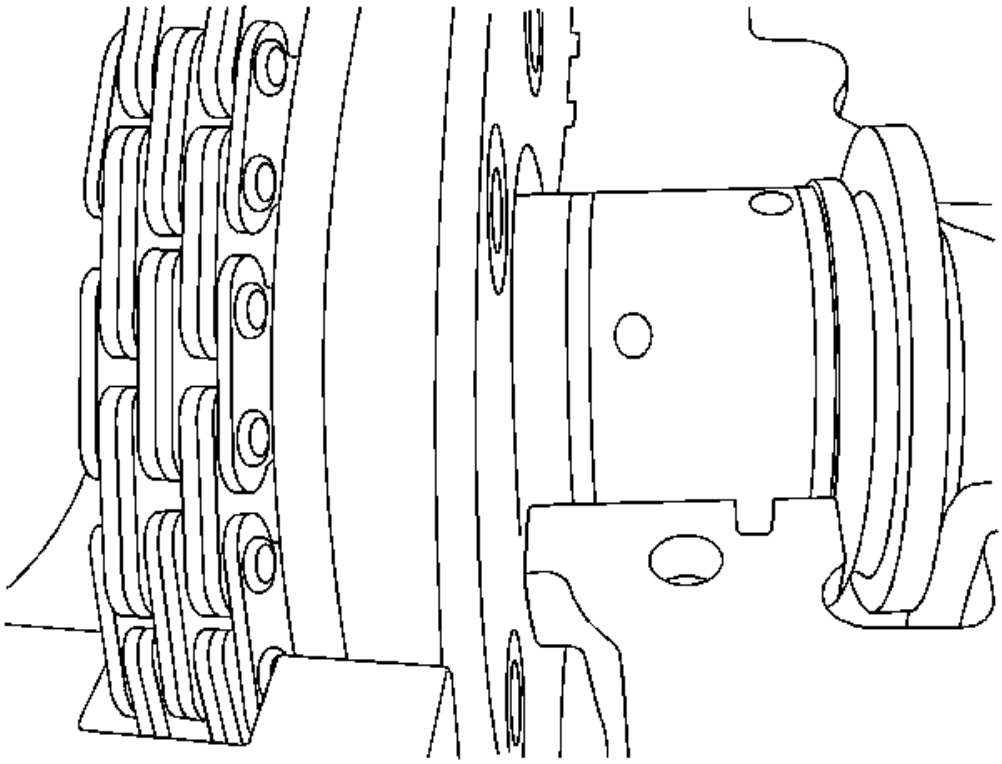

**Fig. 119: Fitting Camshaft Position Actuator**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

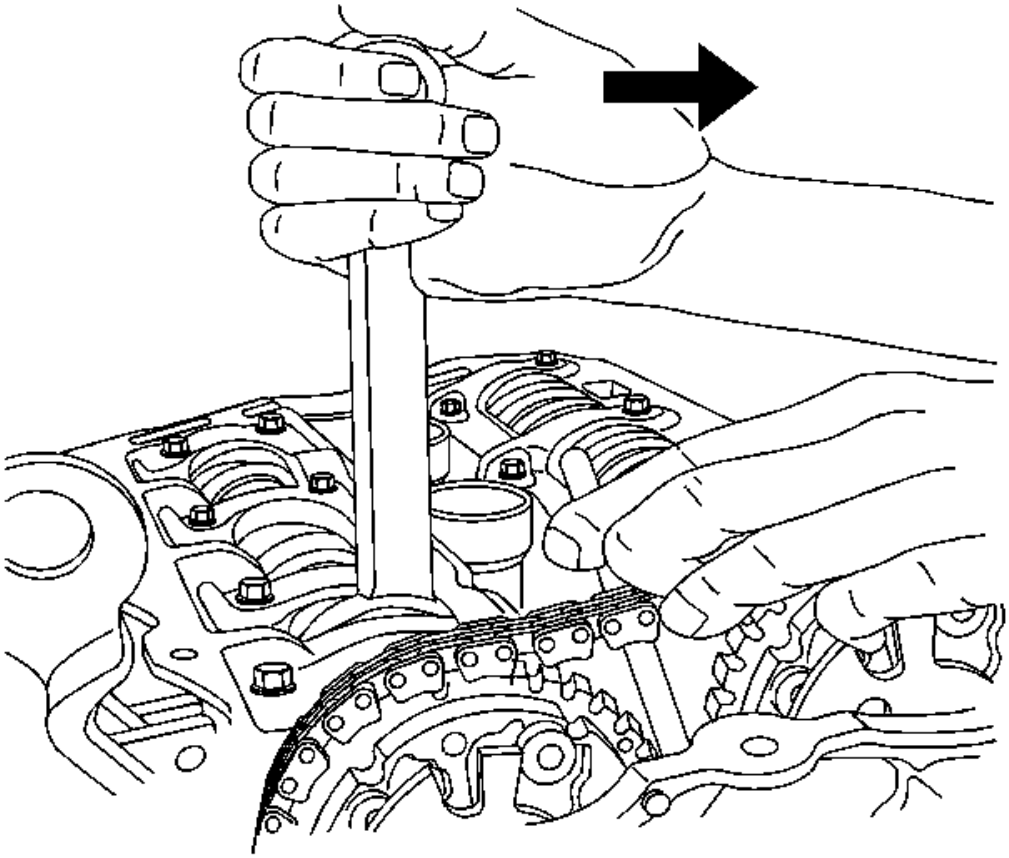

**Fig. 120: Rotating Camshaft**
**Courtesy of GENERAL MOTORS CORP.**

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).

 

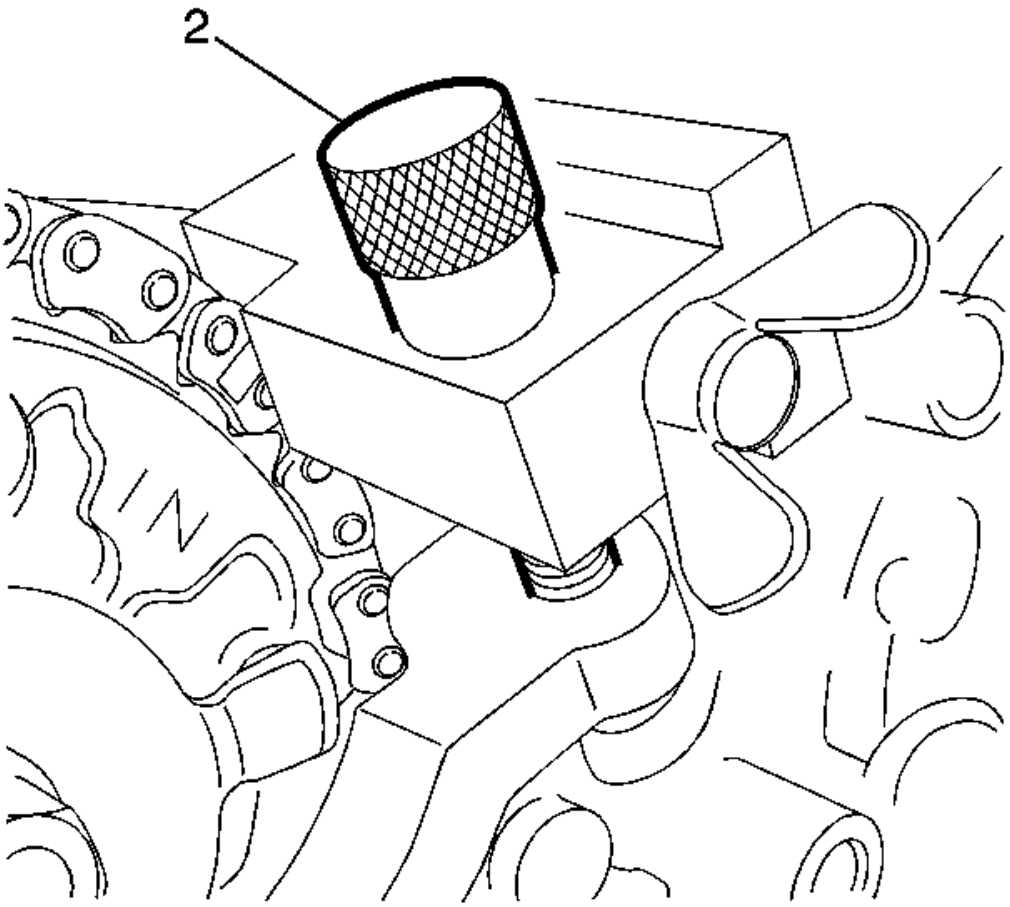


**Fig. 121: Retainer Thumbscrew**
**Courtesy of GENERAL MOTORS CORP.**

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).

 

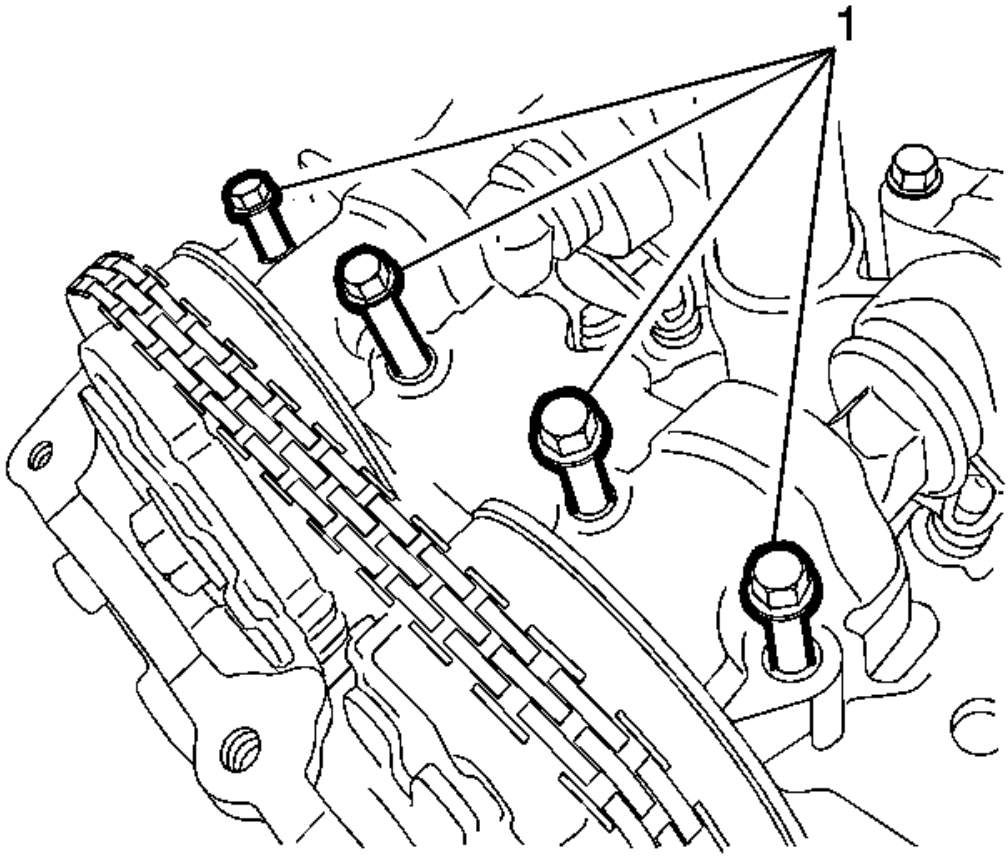


**Fig. 122: Camshaft Front Cap Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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 (LF1)**.

## CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LF1)

 

**SPECIAL TOOLS**

**EN-48313:** Timing Chain Retention Tool

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

**REMOVAL PROCEDURE**

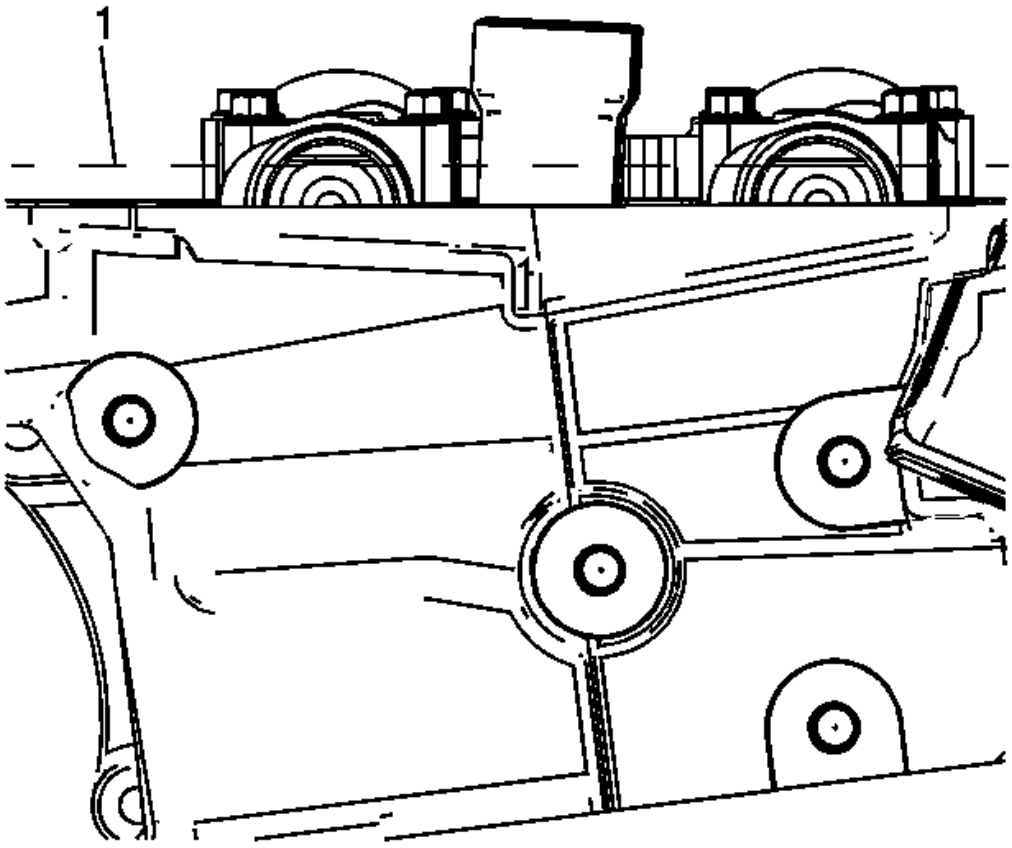


**Fig. 123: Camshaft Flats Parallel With Camshaft Cover Rail**
**Courtesy of GENERAL MOTORS CORP.**

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LF1)**.
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).

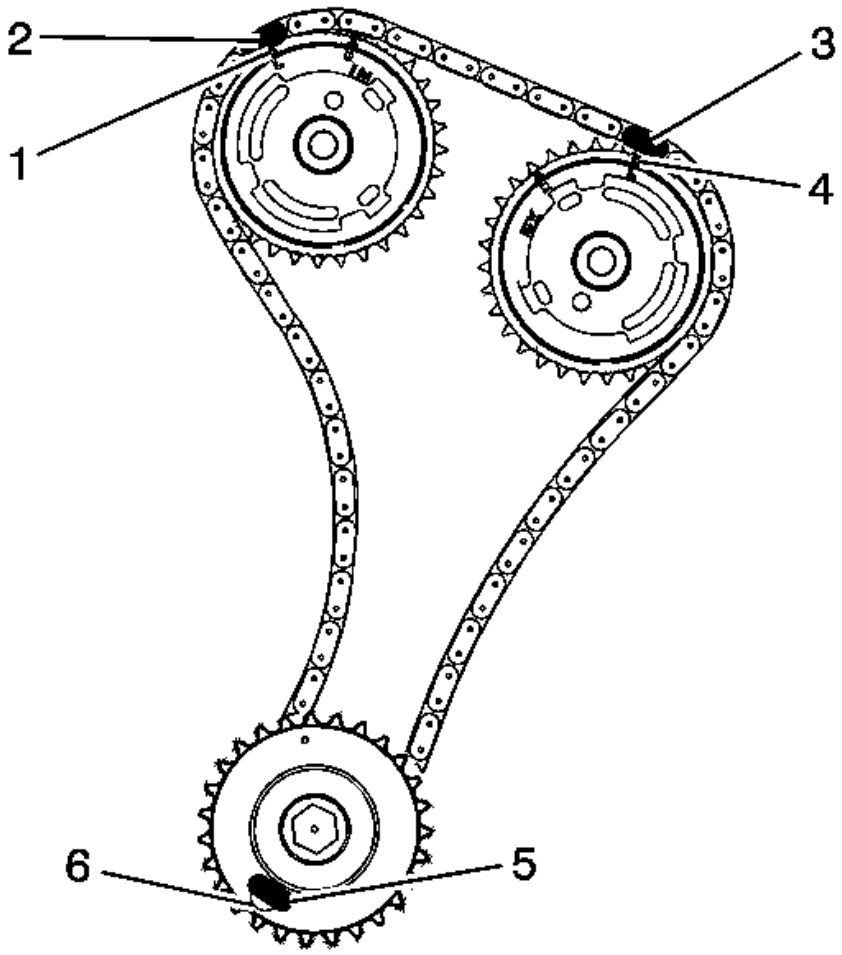


**Fig. 124: Locating Left Secondary Camshaft Drive Chain Timing Marks**
**Courtesy of GENERAL MOTORS CORP.**

**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.

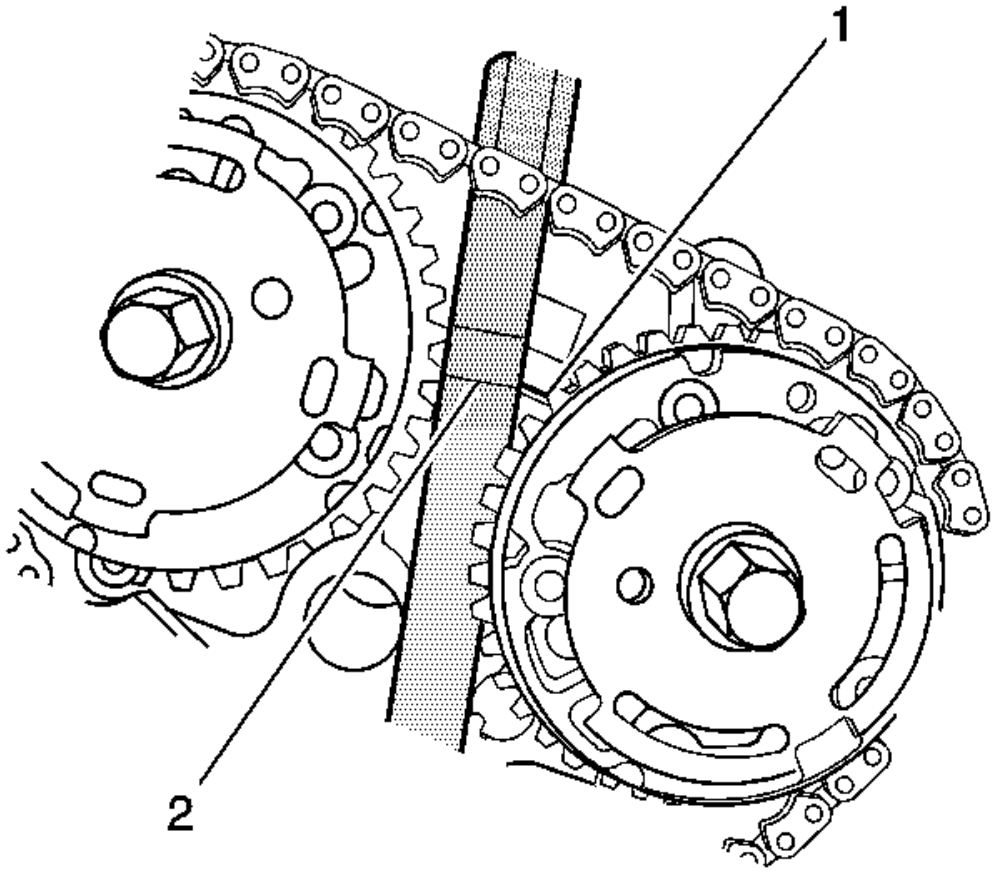


**Fig. 125: Inserting Timing Chain Rentention Tool**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

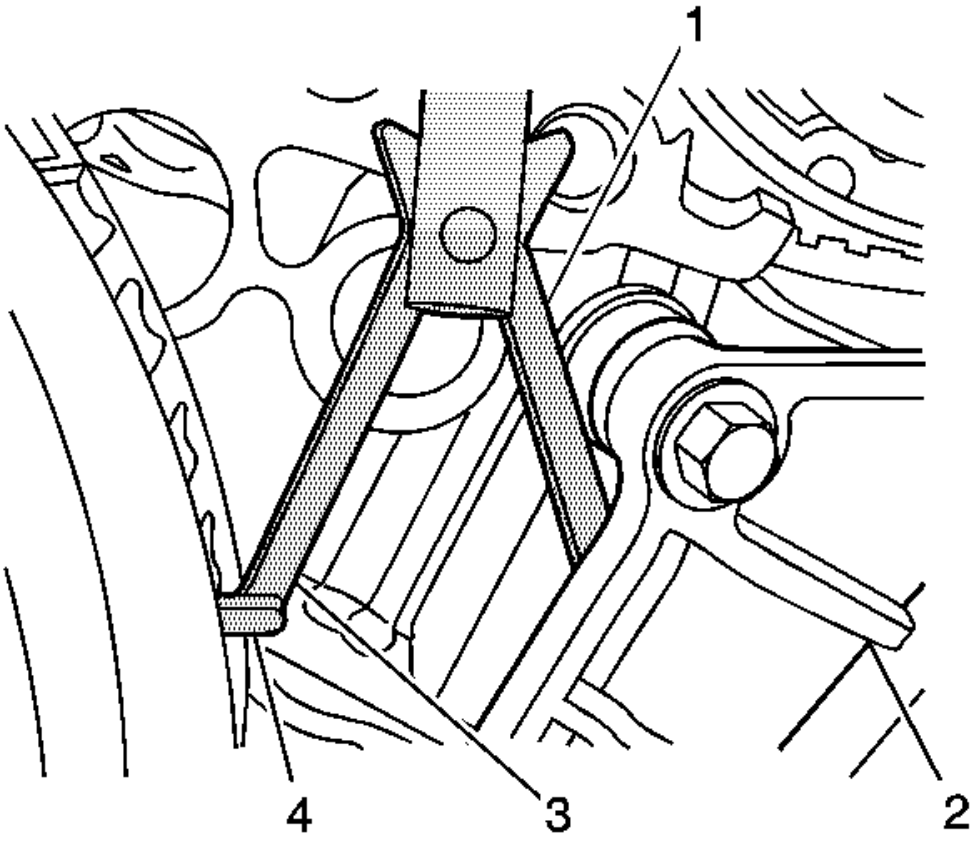


**Fig. 126: View Of Feet, Legs & Timing Chain Guide**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

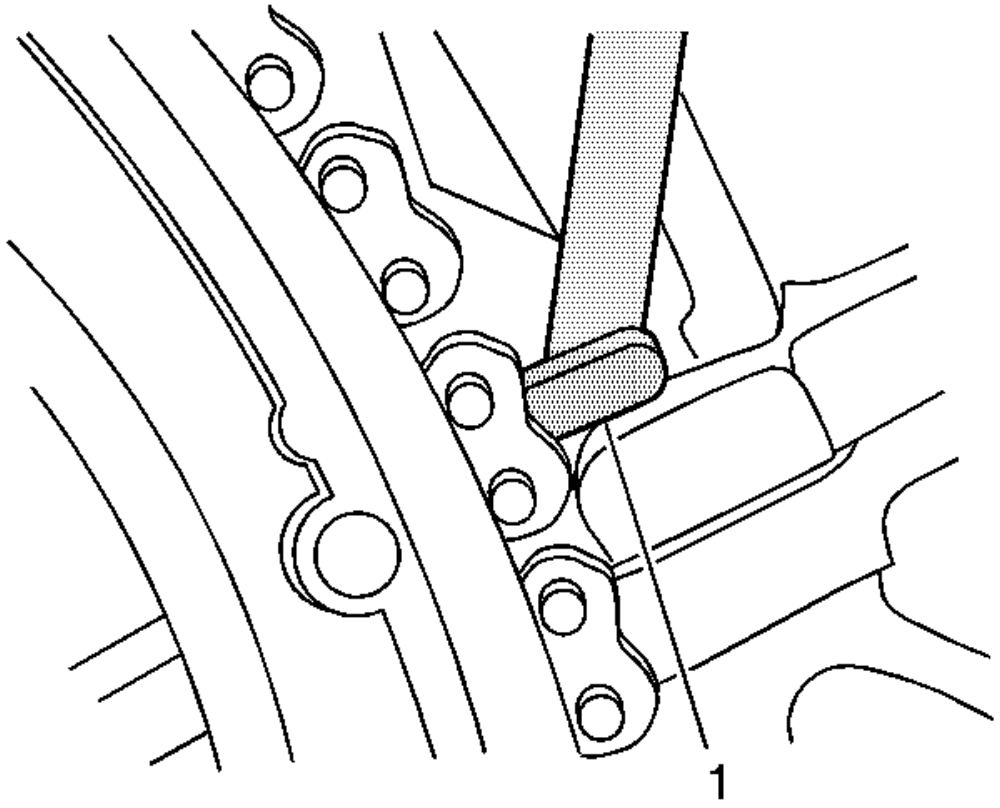


**Fig. 127: Identifying Foot Of EN-48313**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

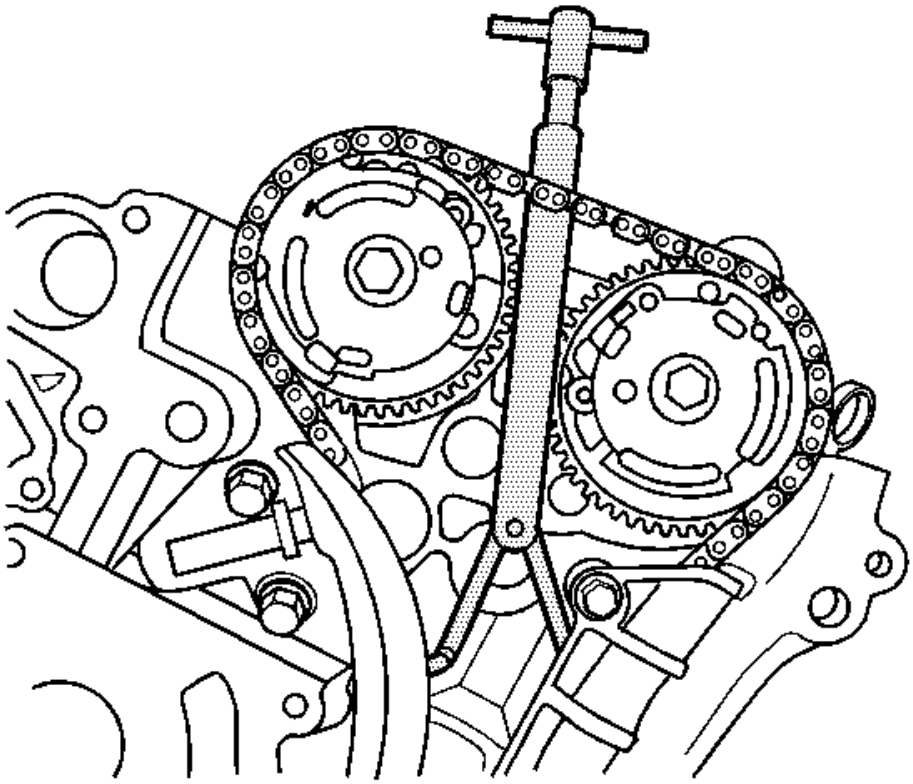

**Fig. 128: View Of EN-48313**
**Courtesy of GENERAL MOTORS CORP.**

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

 

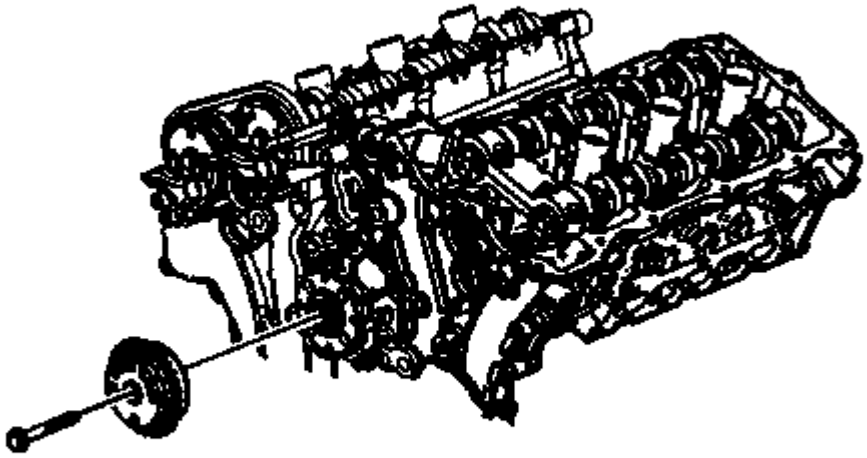

**Fig. 129: Camshaft Position Actuator**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

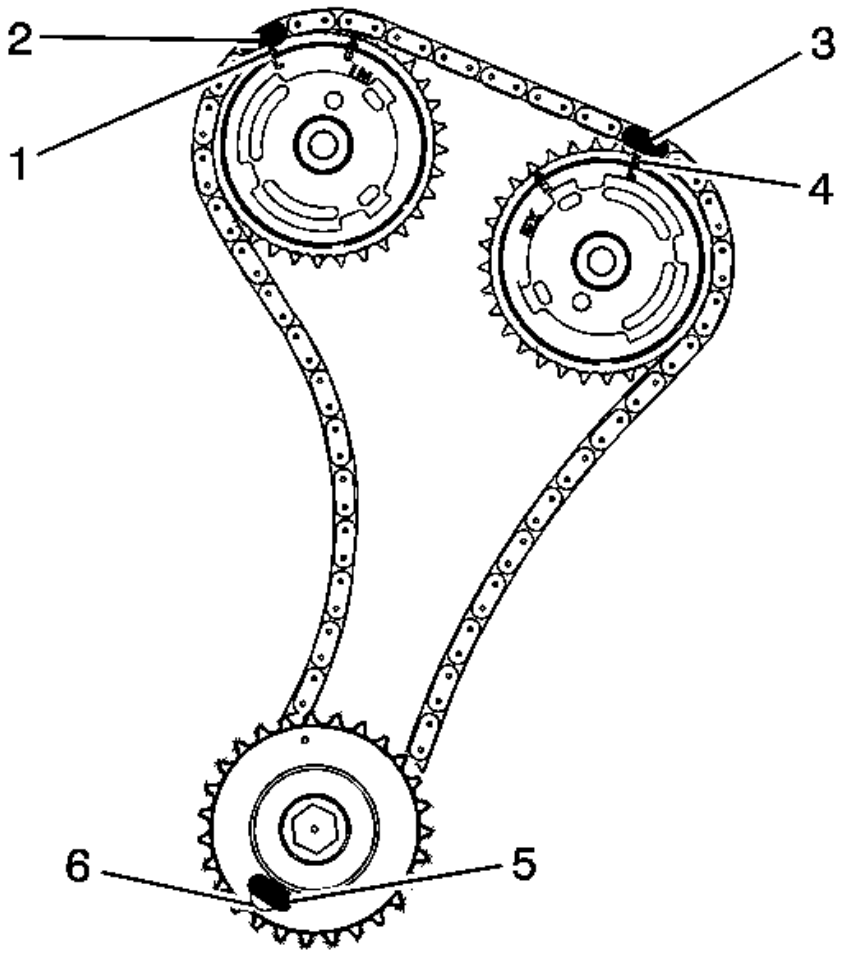


**Fig. 130: Locating Left Secondary Camshaft Drive Chain Timing Marks**
**Courtesy of GENERAL MOTORS CORP.**

**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.

 

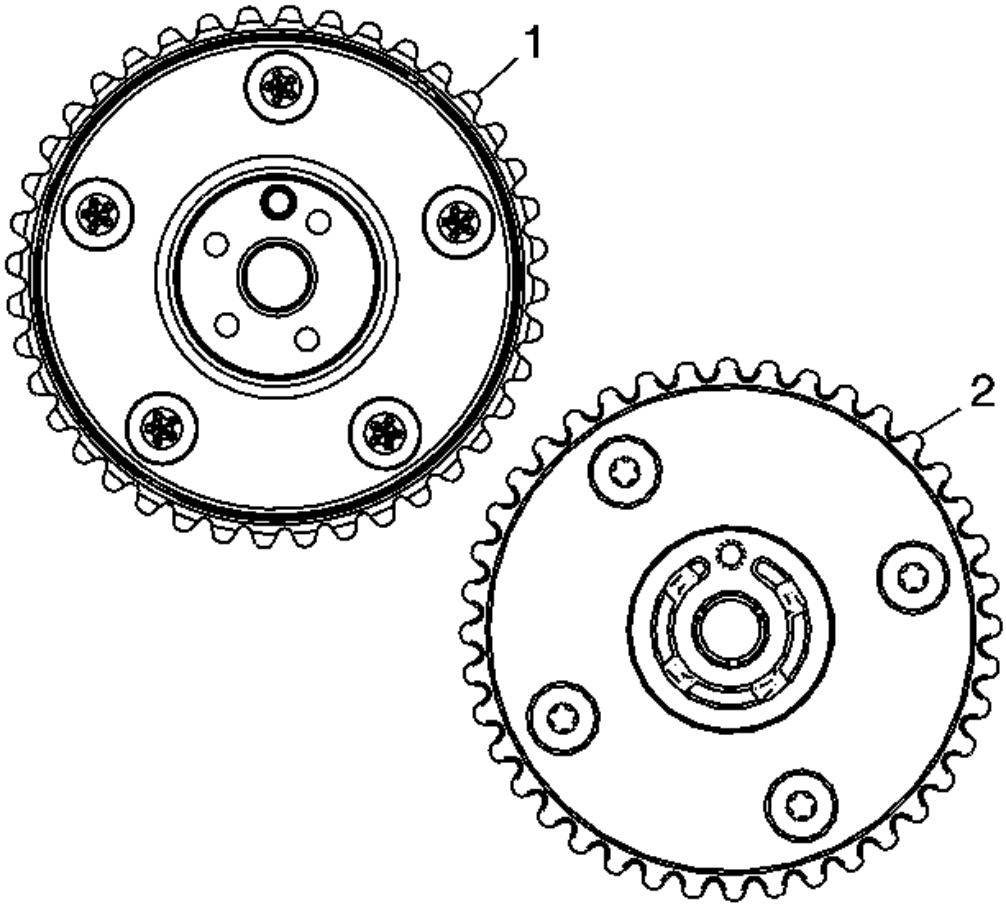


**Fig. 131: Identifying Camshaft Position Actuators**
**Courtesy of GENERAL MOTORS CORP.**

**NOTE:**

- **The camshaft position actuator will vary depending on application.**
- **Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.**

5. 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.

 

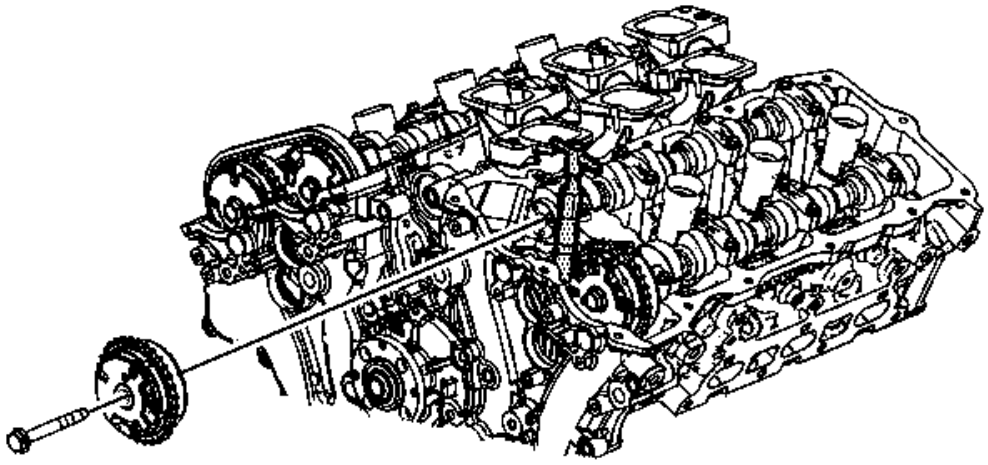

**Fig. 132: Exhaust Camshaft Position Actuator & Bolt**
**Courtesy of GENERAL MOTORS CORP.**

**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 (LF1)**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.

 

# 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-46111:** Crankshaft Rotation Socket
- **EN-46313:** Timing Chain Retention Tool

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

**REMOVAL PROCEDURE**

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left bank camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LF1)**.
3. 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** .
4. Remove the camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** .
5. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2 (LF1)**.
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

 

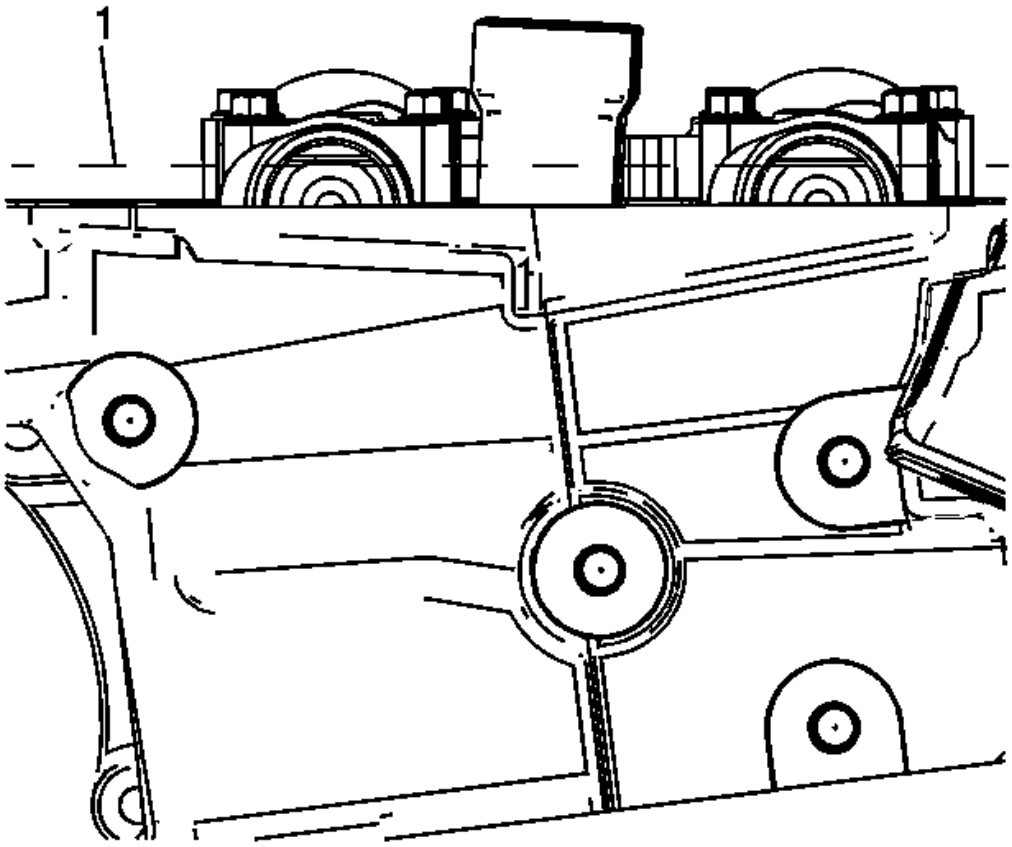


**Fig. 133: Camshaft Flats Parallel With Camshaft Cover Rail**
**Courtesy of GENERAL MOTORS CORP.**

7. Rotate the crankshaft with the **EN-46111:** socket until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).

 

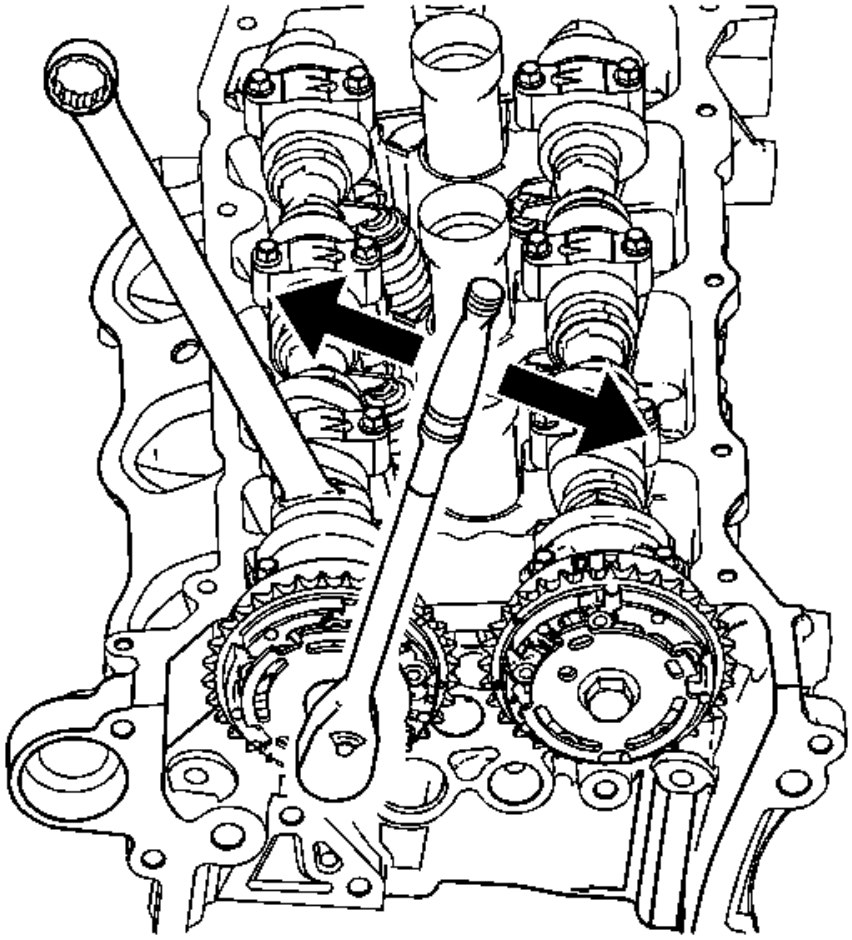

**Fig. 134: Preventing Camshaft/Engine Rotation**
**Courtesy of GENERAL MOTORS CORP.**

**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.**

8. Loosen the camshaft position actuator bolt.

**NOTE: Ensure that the tips of the EN-46313: tool are fully engaged into the timing chain.**

9. Install the **EN-46313:** tool in order to retain the timing chain.

 

Firmly tighten the **EN-46313:** tool nuts.

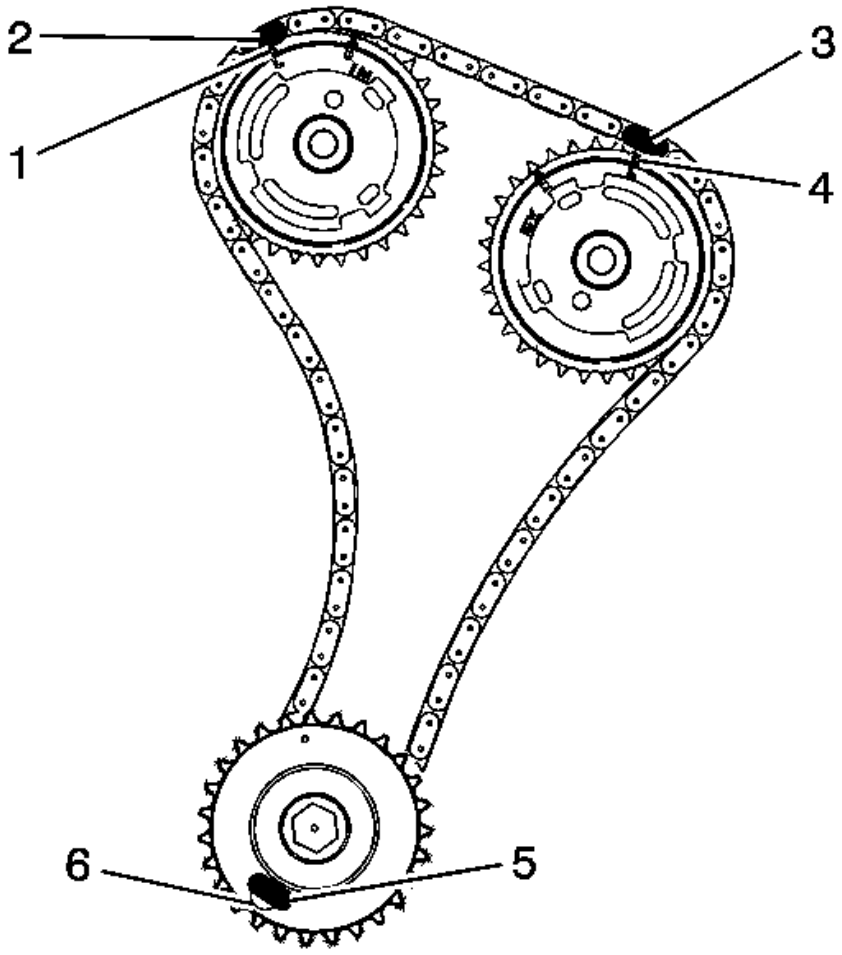


**Fig. 135: Locating Left Secondary Camshaft Drive Chain Timing Marks**
**Courtesy of GENERAL MOTORS CORP.**

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

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

**INSTALLATION PROCEDURE**

 

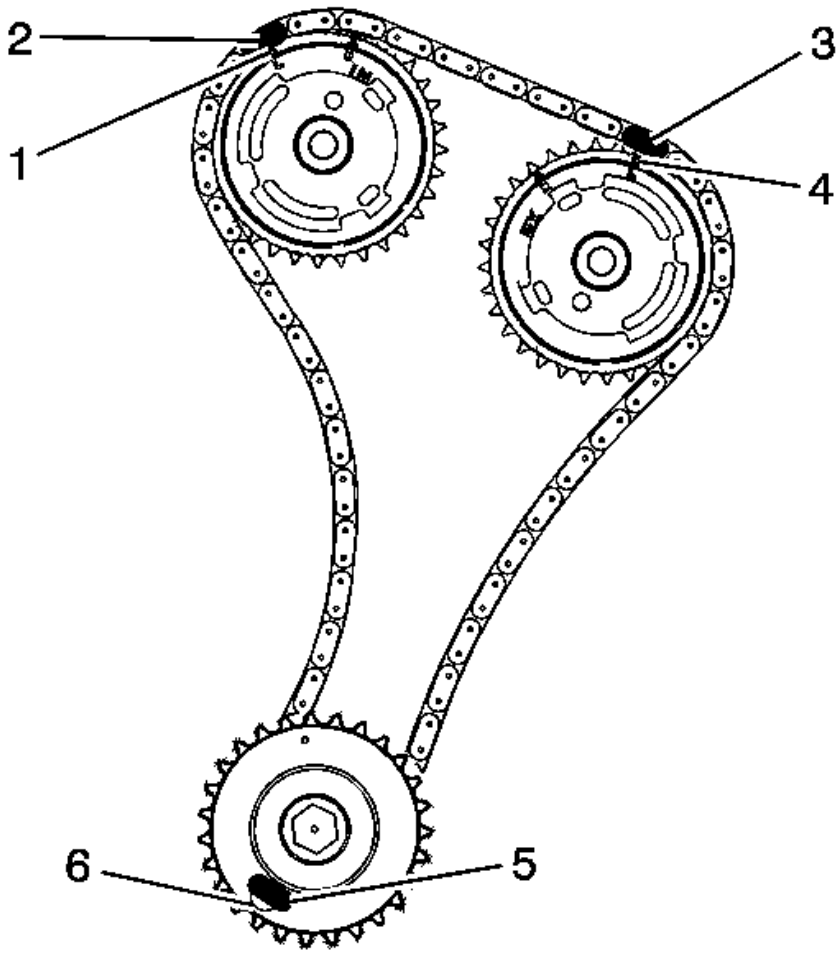


**Fig. 136: Locating Left Secondary Camshaft Drive Chain Timing Marks**
**Courtesy of GENERAL MOTORS CORP.**

**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-46108:** tool.

 

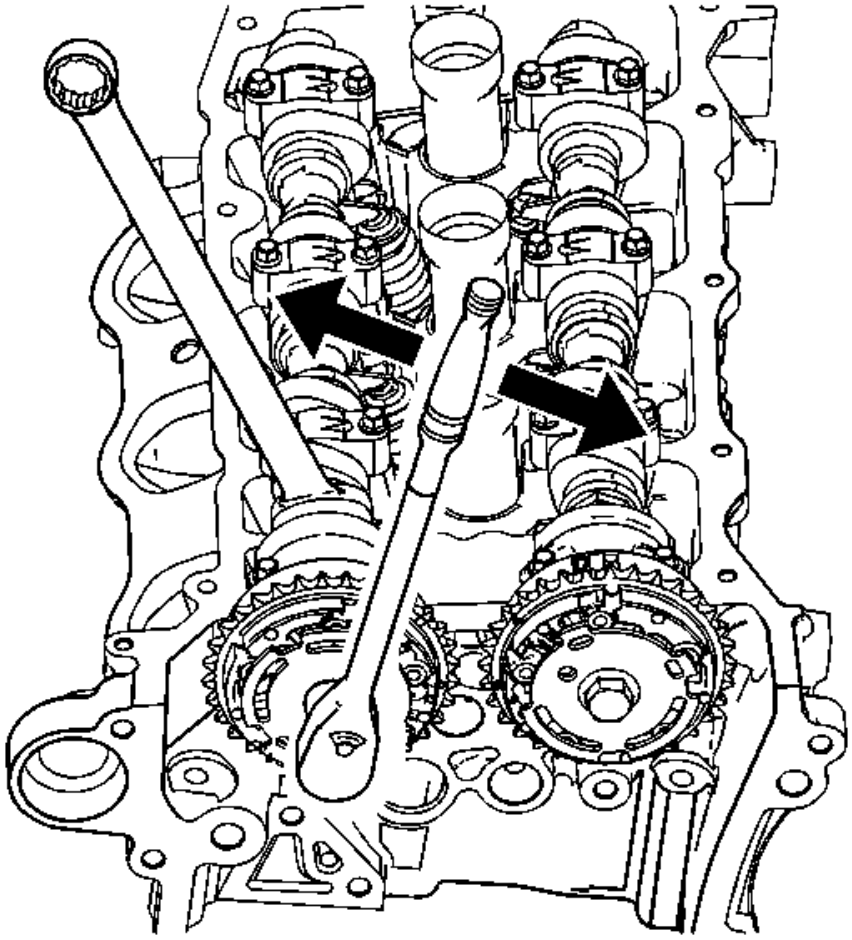

**Fig. 137: Preventing Camshaft/Engine Rotation**
**Courtesy of GENERAL MOTORS CORP.**

**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 (LF1)**.

 

9. Install the intake manifold. Refer to **Intake Manifold Replacement**.

# CAMSHAFT REPLACEMENT - RIGHT SIDE

**Special Tools**

- **EN-46111:** Crankshaft Rotation Socket
- **EN-46313:** Timing Chain Retention Tool

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

**REMOVAL PROCEDURE**

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side (LF1)**.
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 (LF1)**.
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

 

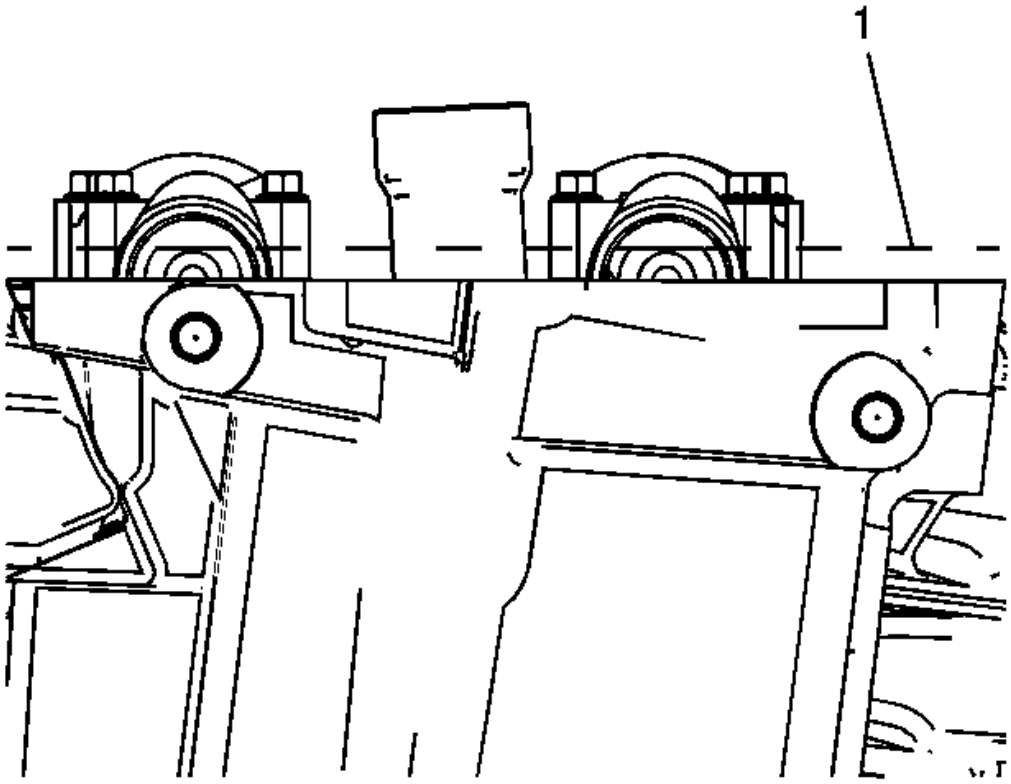


**Fig. 138: Identifying Camshaft Neutral (Low Tension) Position**
**Courtesy of GENERAL MOTORS CORP.**

7. Rotate the crankshaft with the **EN-46111:** socket until the camshafts are in a neutral (low tension) position.

   The camshaft flats will be parallel with the camshaft cover rail (1).

 

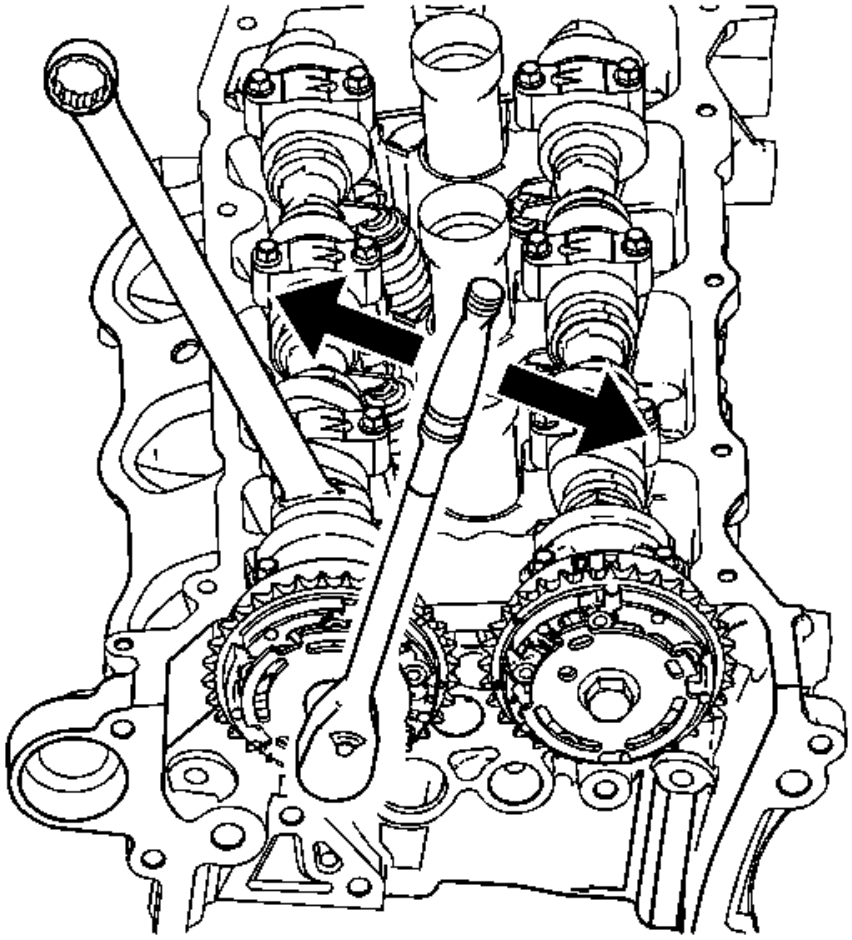

**Fig. 139: Preventing Camshaft/Engine Rotation**
**Courtesy of GENERAL MOTORS CORP.**

**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.**

8. Loosen the camshaft position actuator bolt.

**NOTE: Ensure that the tips of the EN-46313: tool are fully engaged into the timing chain.**

9. Install the **EN-46313:** tool in order to retain the timing chain.

 

Firmly tighten the **EN-46313:** tool nuts.

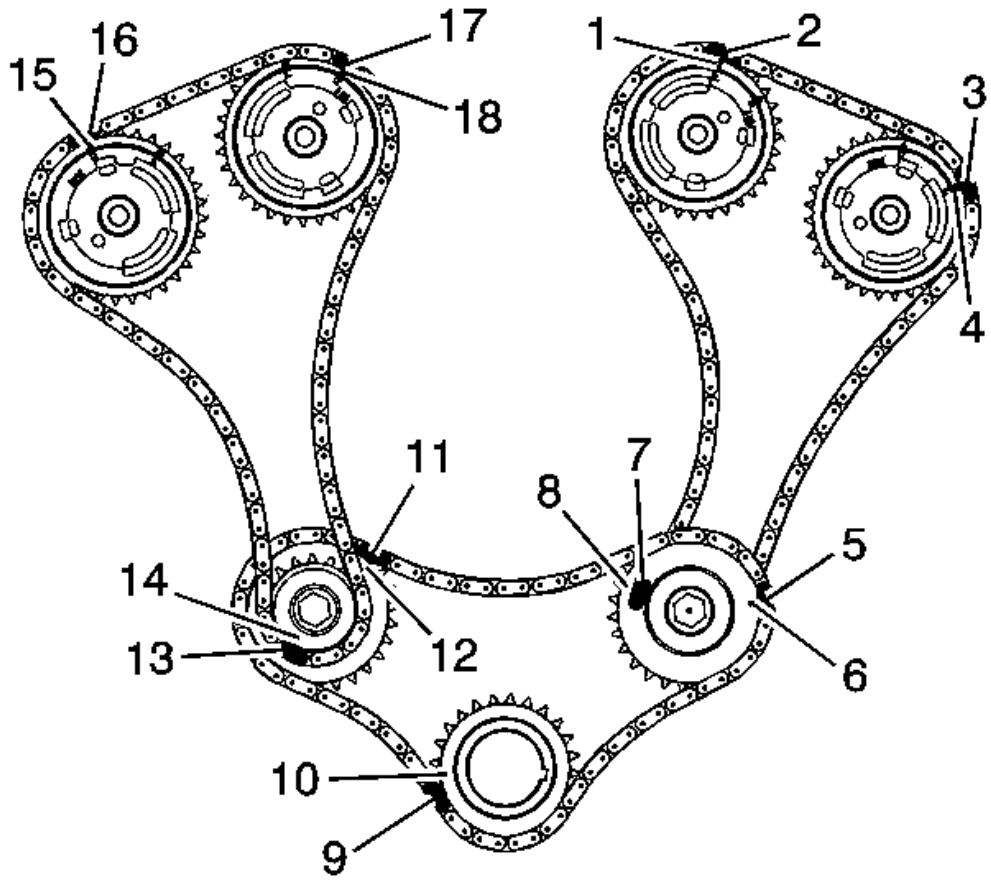


**Fig. 140: Identifying Timing Chain Marks & Locations On Gears, Sprockets & Actuators**
**Courtesy of GENERAL MOTORS CORP.**

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

10. Mark the timing chain and the respective locations on camshaft position actuators (15-18).
11. Remove the camshaft position actuator bolt.
12. Remove the camshaft bearing caps and the camshaft. Refer to **Camshaft Removal - Right Side** .

**INSTALLATION PROCEDURE**

 

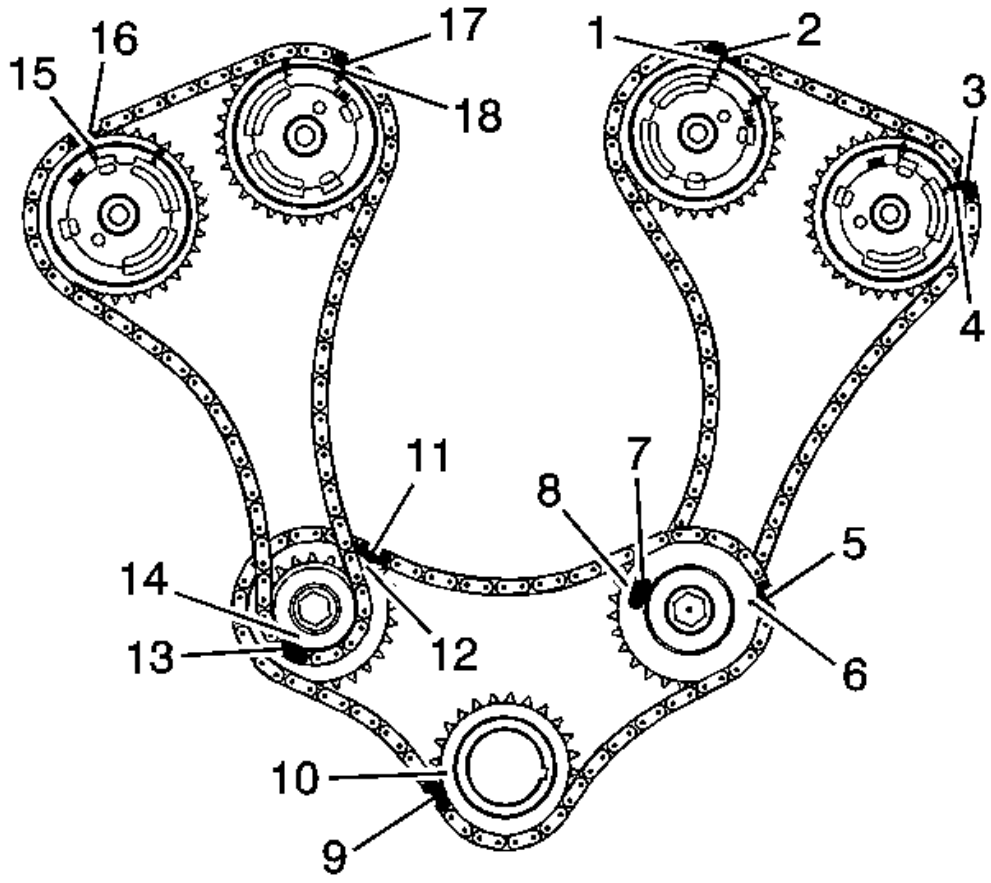


**Fig. 141: Identifying Timing Chain Marks & Locations On Gears, Sprockets & Actuators**
**Courtesy of GENERAL MOTORS CORP.**

**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** .
3. Remove the **EN-46313:** tool.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

 

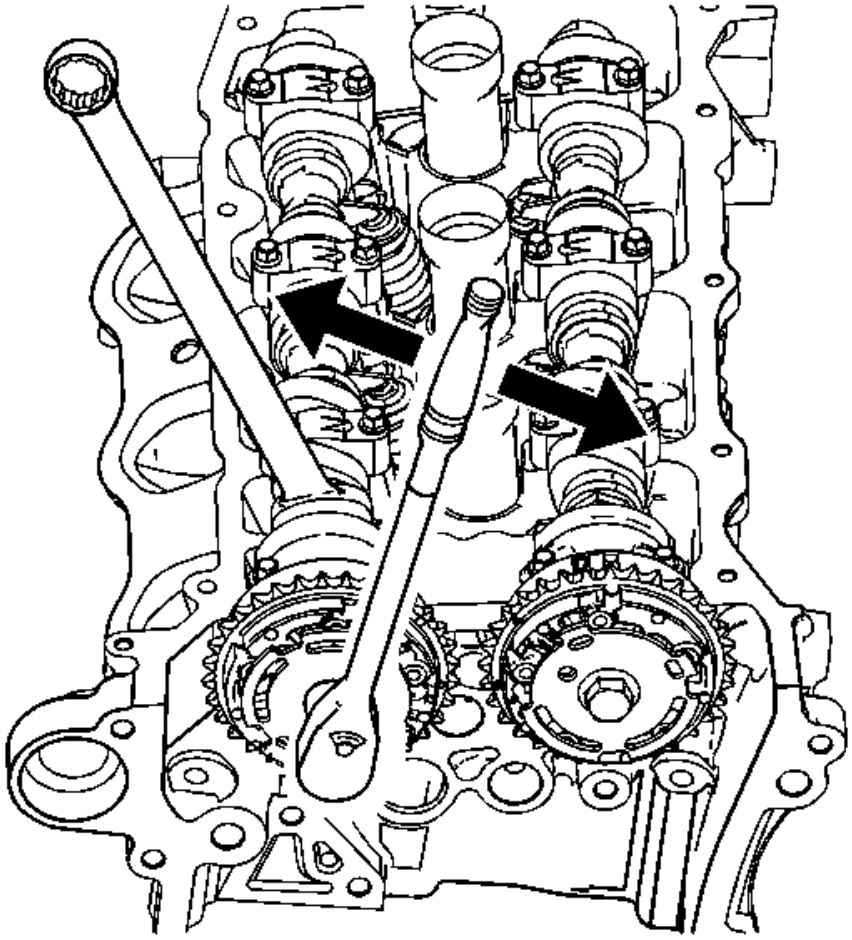

**Fig. 142: Preventing Camshaft/Engine Rotation**
**Courtesy of GENERAL MOTORS CORP.**

**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.**

5. Install and tighten the camshaft position actuators. Refer to **Camshaft Position Actuator Installation - Right Side Intake** and **Camshaft Position Actuator Installation - Right Side Exhaust** .
6. Install the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
7. 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** .
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side (LF1)**.
9. Install the intake manifold. Refer to **Intake Manifold Replacement**.

 

# VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

## REMOVAL PROCEDURE

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

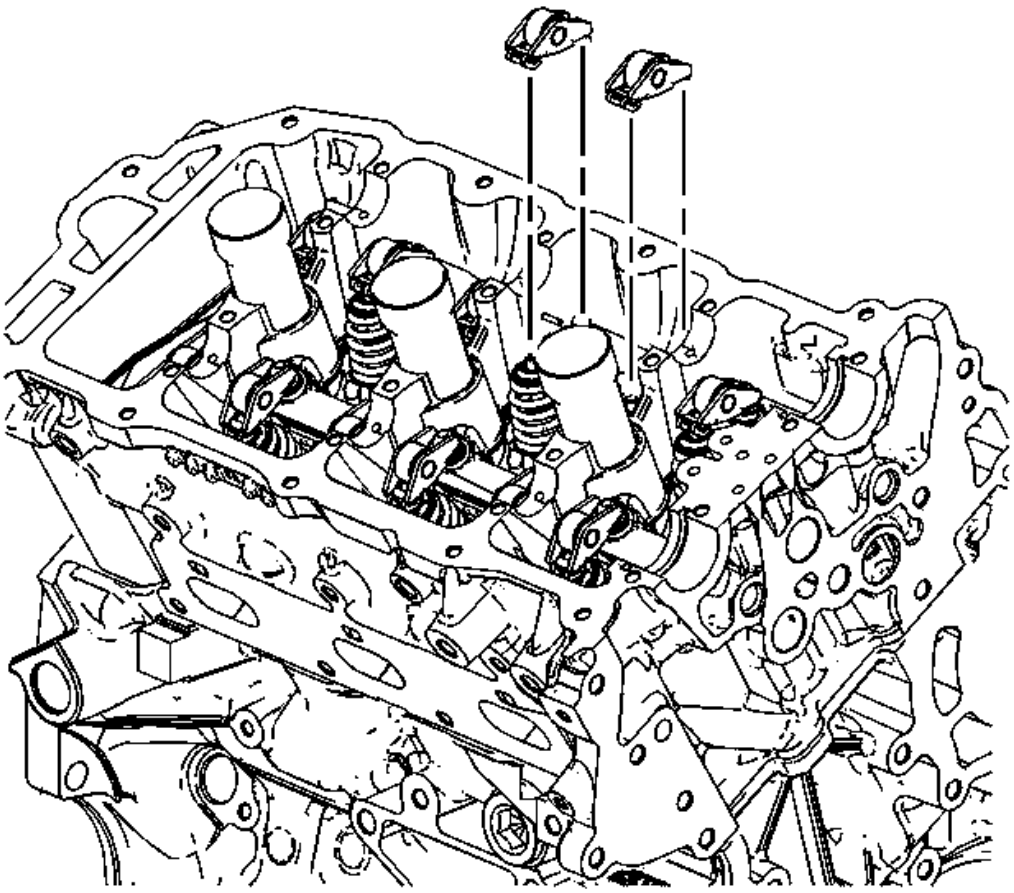

**Fig. 143: Valve Rocker Arms**
**Courtesy of GENERAL MOTORS CORP.**

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

 

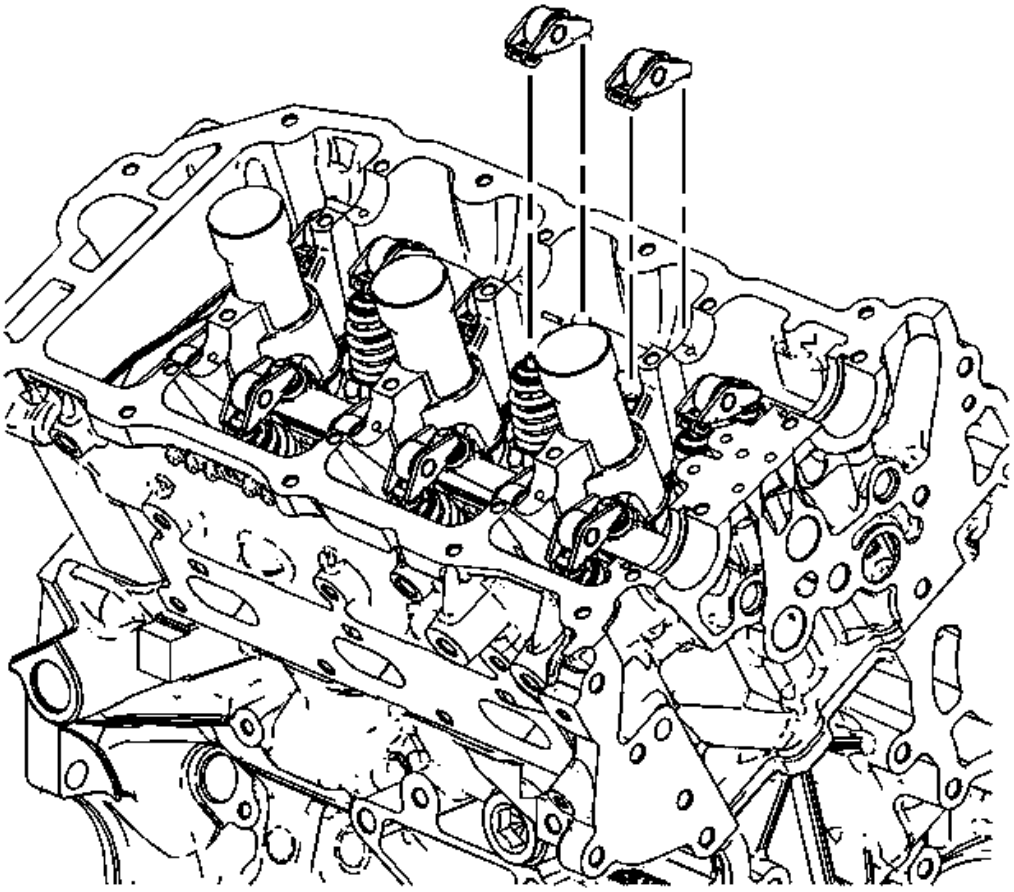

**Fig. 144: Valve Rocker Arms**
**Courtesy of GENERAL MOTORS CORP.**

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**.

 

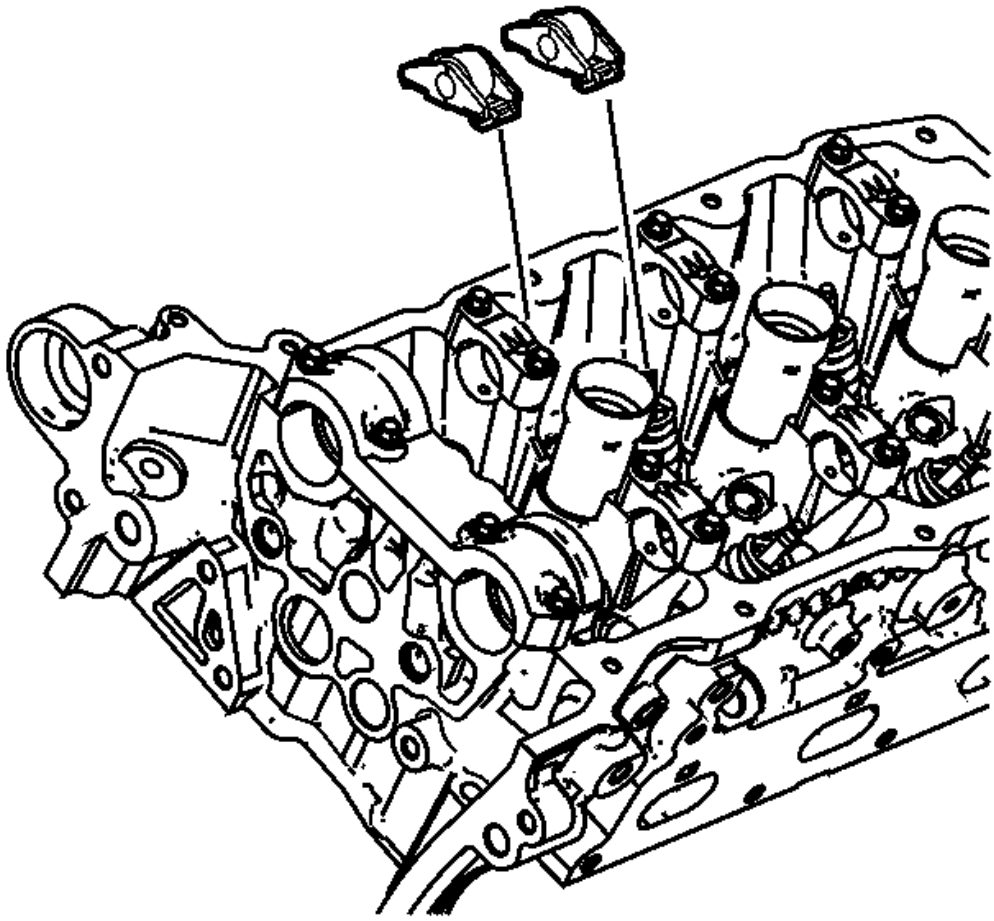

**Fig. 145: Rocker Arms**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

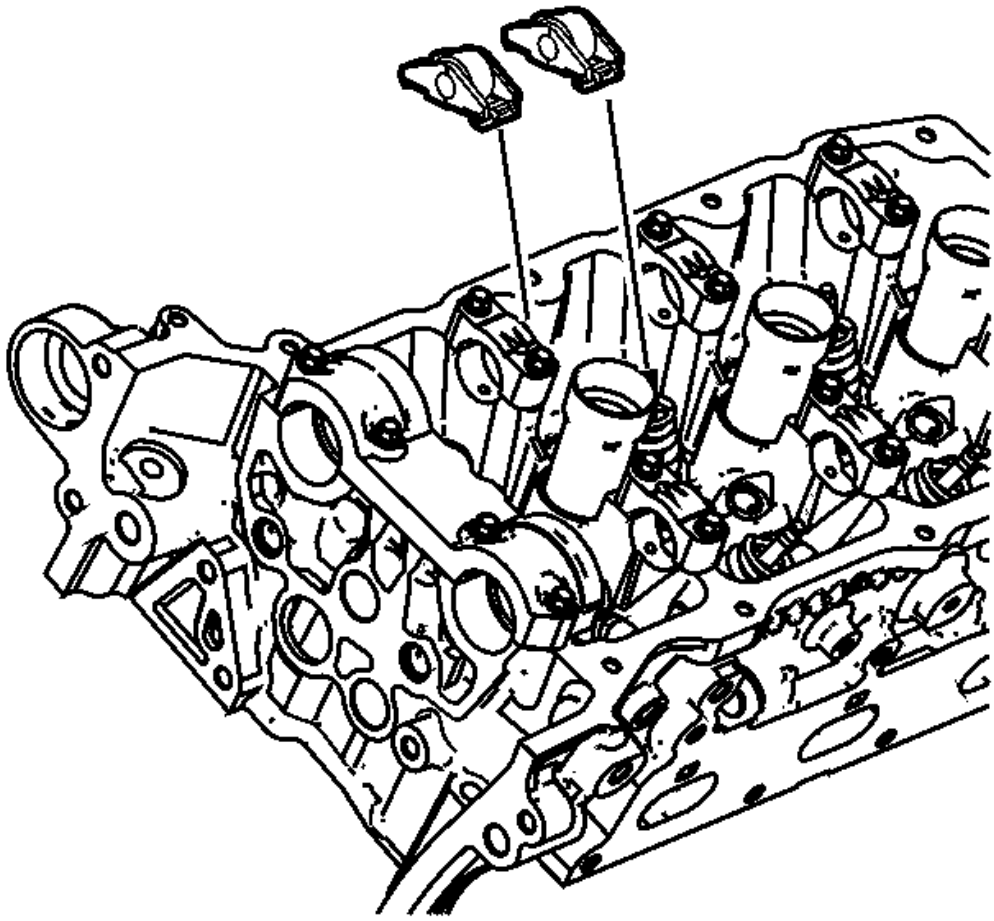

**Fig. 146: Rocker Arms**
**Courtesy of GENERAL MOTORS CORP.**

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

## VALVE LIFTER REPLACEMENT - LEFT SIDE

**REMOVAL PROCEDURE**

 

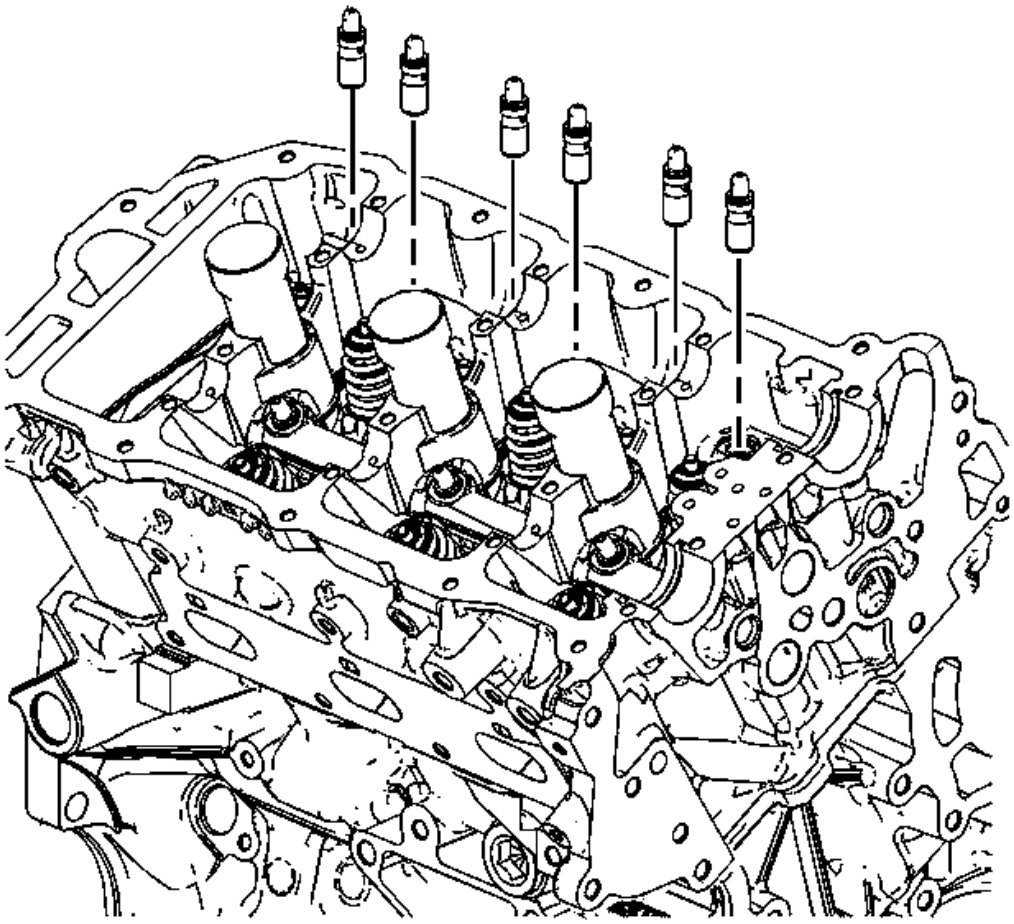

**Fig. 147: View Of Stationary Hydraulic Lash Adjusters**
**Courtesy of GENERAL MOTORS CORP.**

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 ispect the rocker arm. Refer to **Valve Rocker Arm Cleaning and Inspection**

**INSTALLATION PROCEDURE**

 

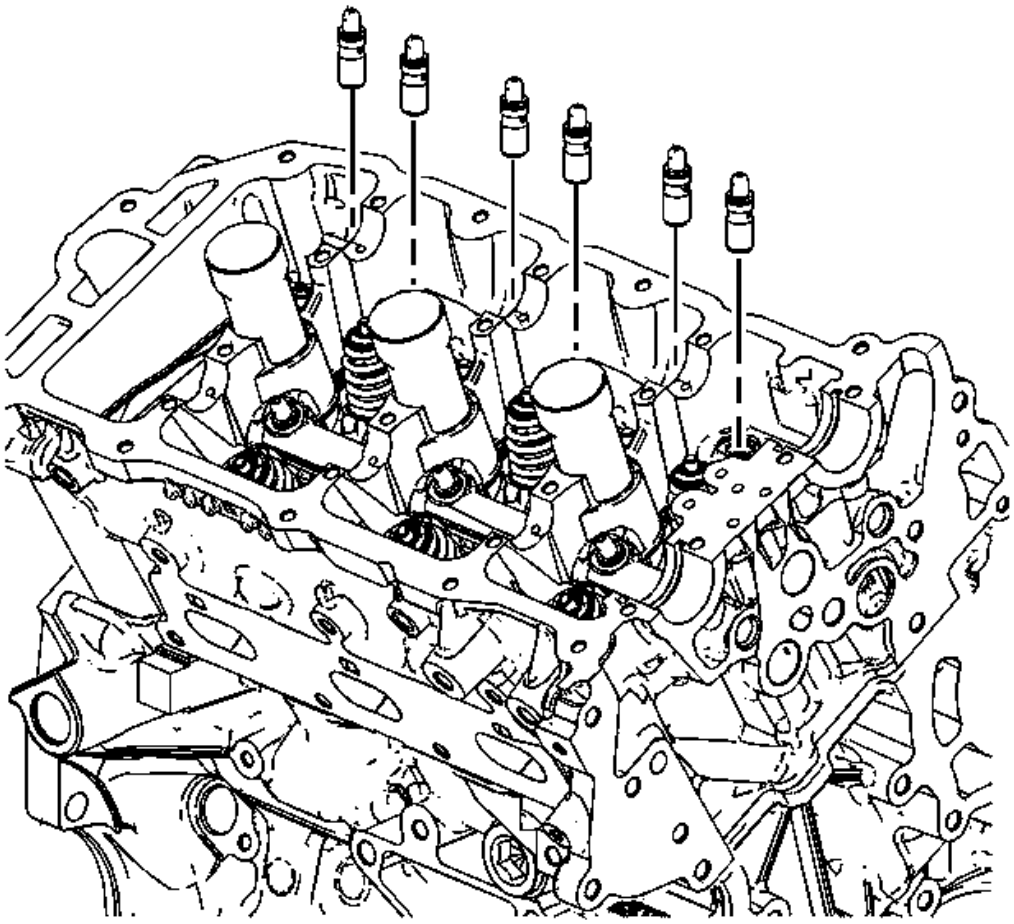

**Fig. 148: View Of Stationary Hydraulic Lash Adjusters**
**Courtesy of GENERAL MOTORS CORP.**

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** .

 

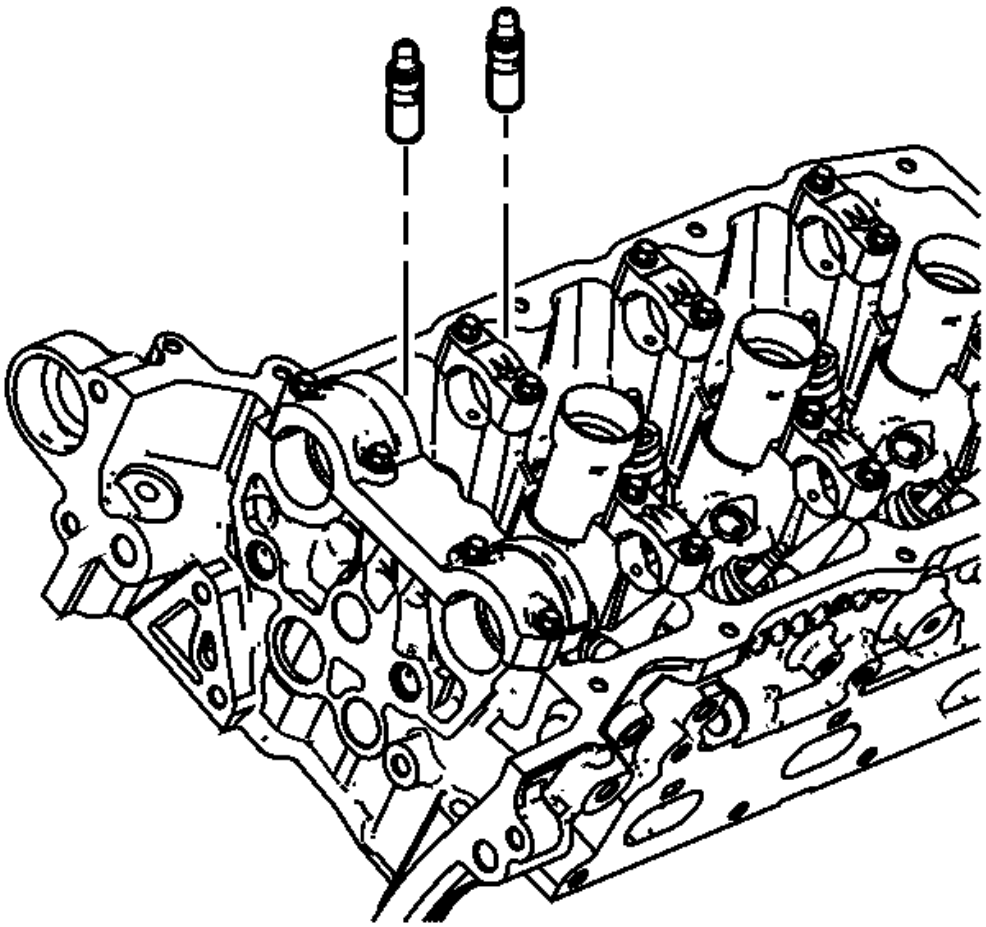

**Fig. 149: View Of Lifters**
**Courtesy of GENERAL MOTORS CORP.**

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**

 

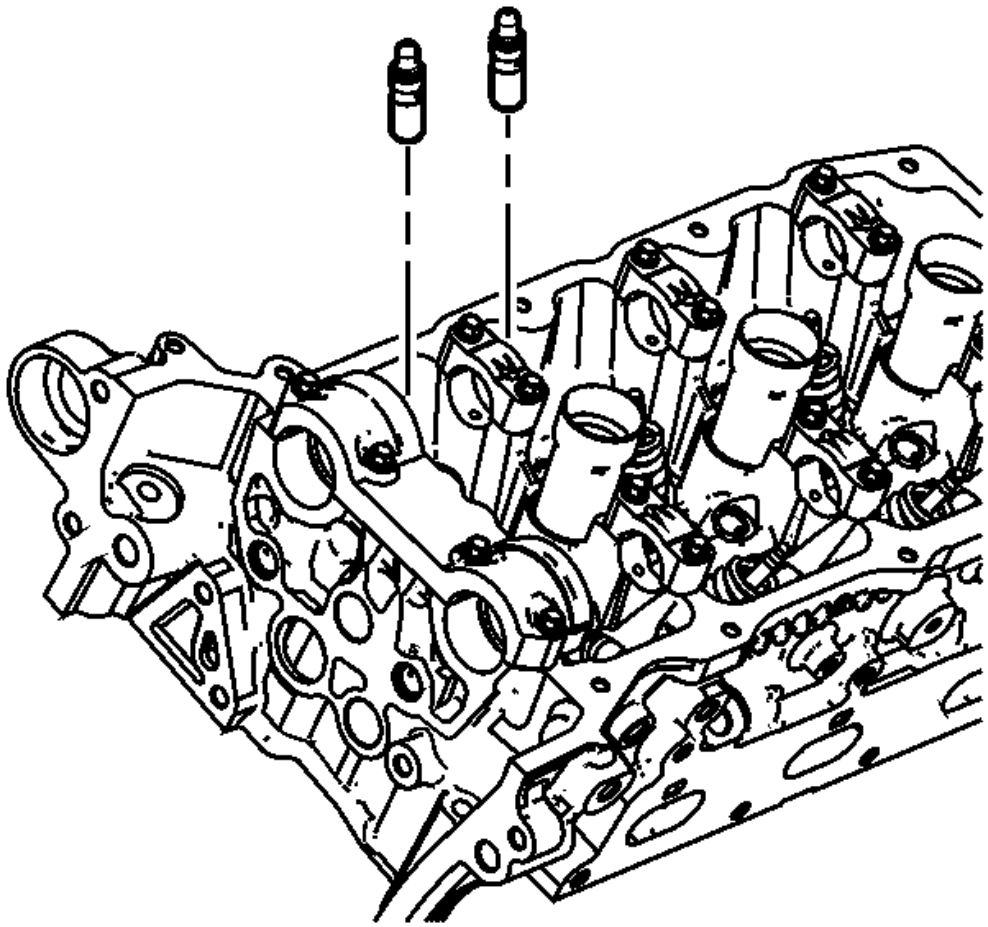

**Fig. 150: View Of Lifters**
**Courtesy of GENERAL MOTORS CORP.**

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**

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
2. Remove the starter motor. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .

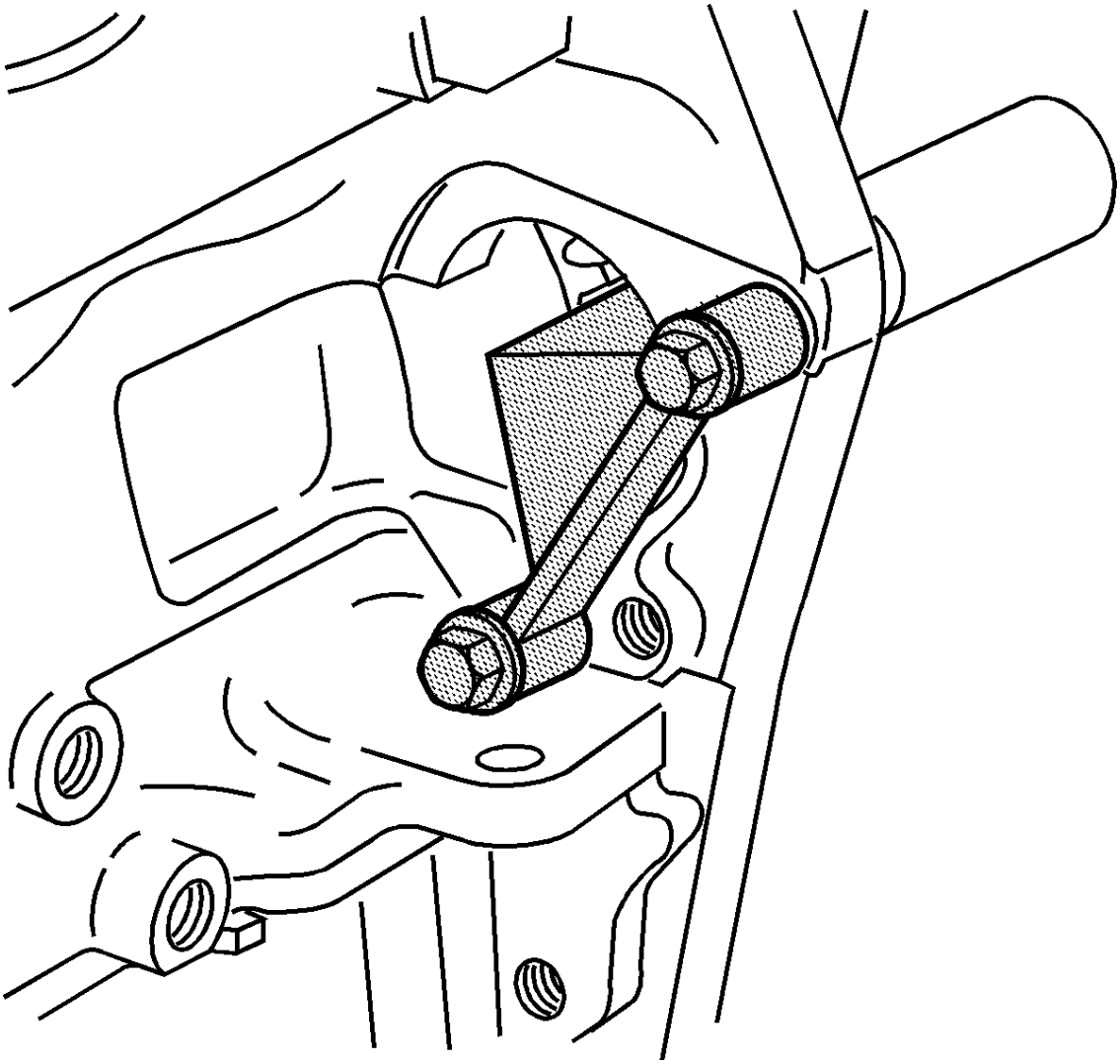

**Fig. 151: View Of Tool EN 46106**
**Courtesy of GENERAL MOTORS CORP.**

**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.

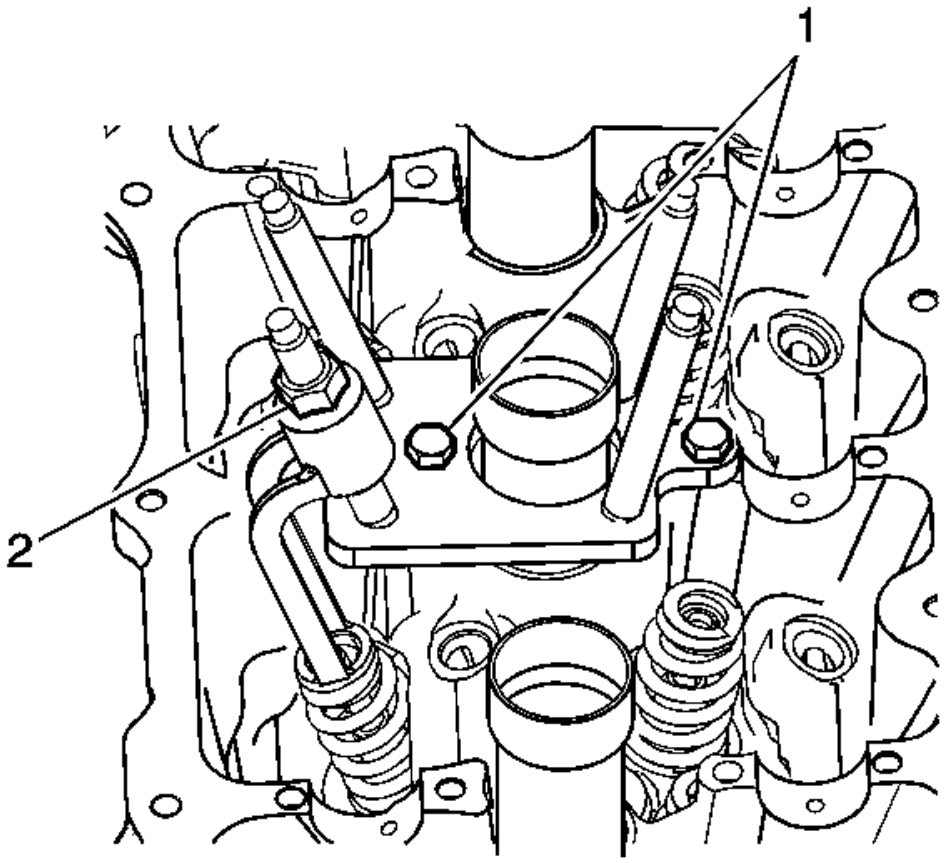


**Fig. 152: View Of Installed Valve Spring Compressor Tool**
**Courtesy of GENERAL MOTORS CORP.**

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

 

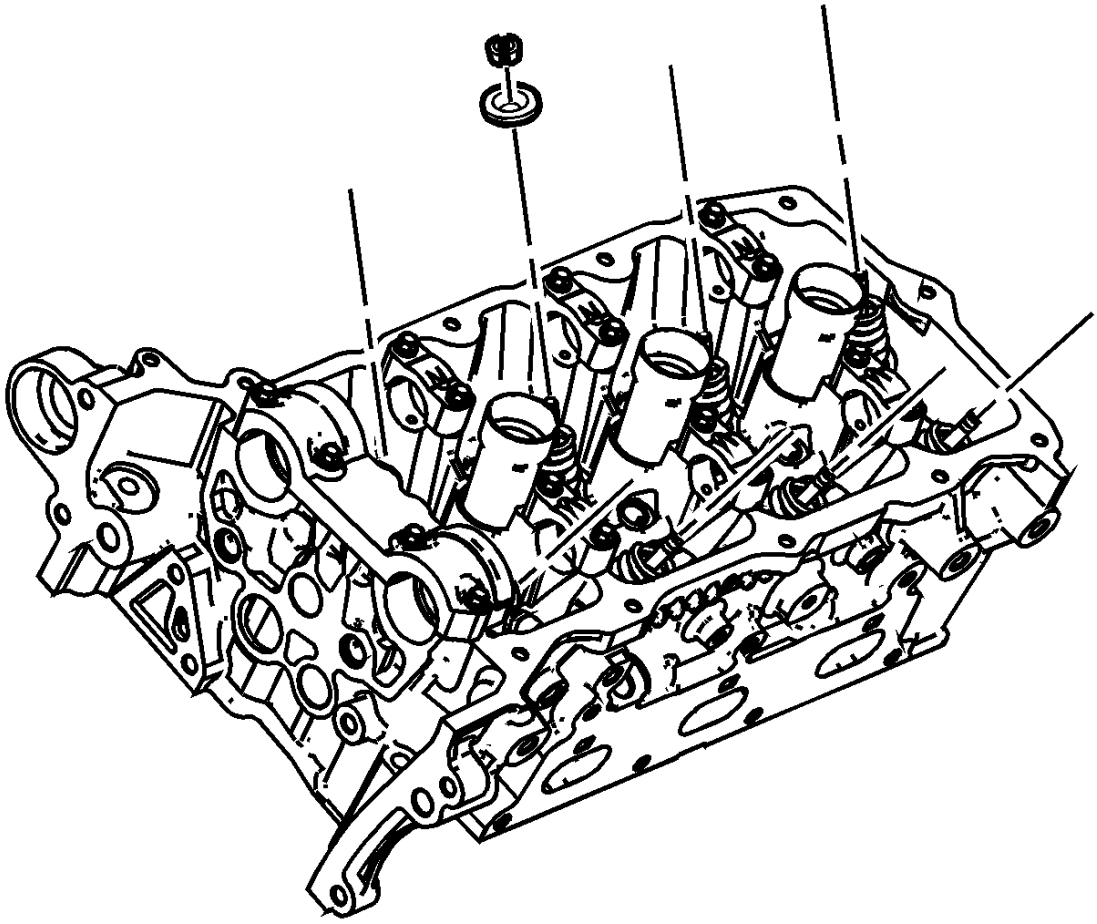

**Fig. 153: View Of Valve Spring Keepers**
**Courtesy of GENERAL MOTORS CORP.**

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

 

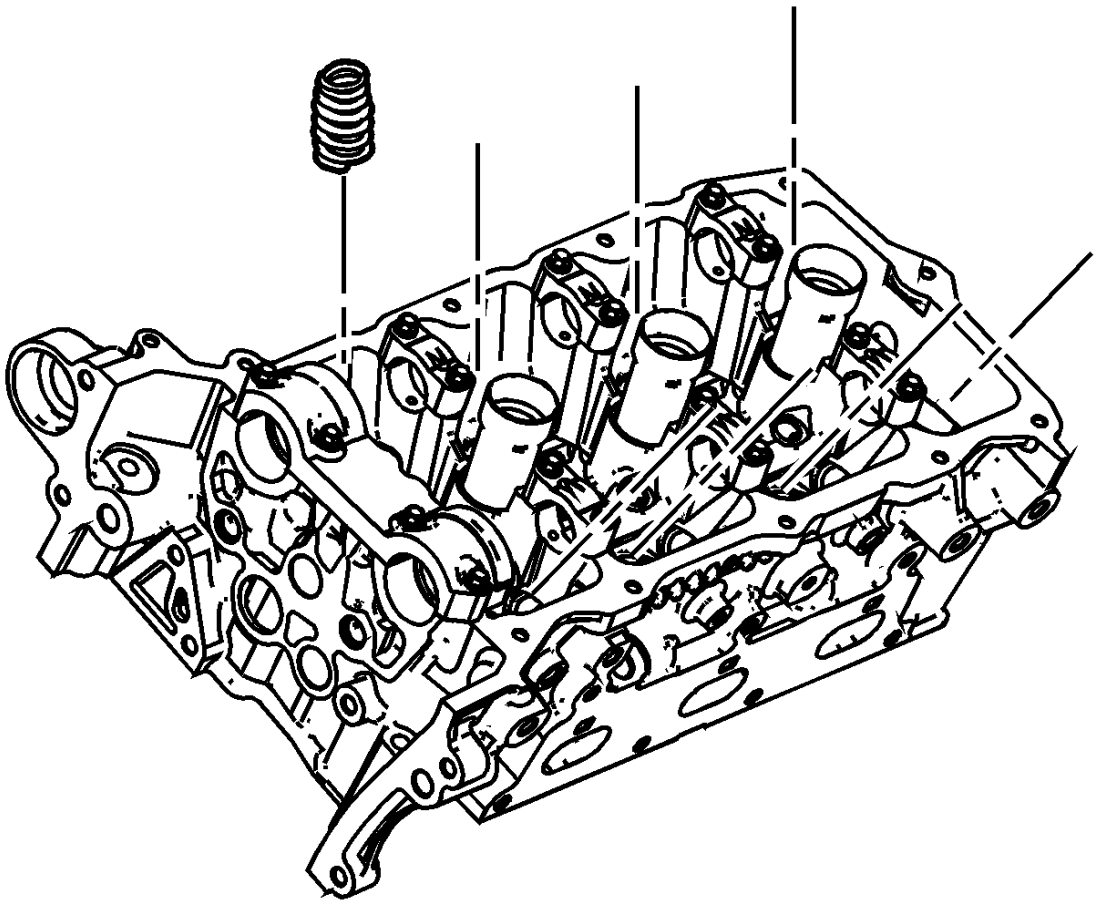

**Fig. 154: View Of Valve Spring**
**Courtesy of GENERAL MOTORS CORP.**

12. Remove the valve spring.

 

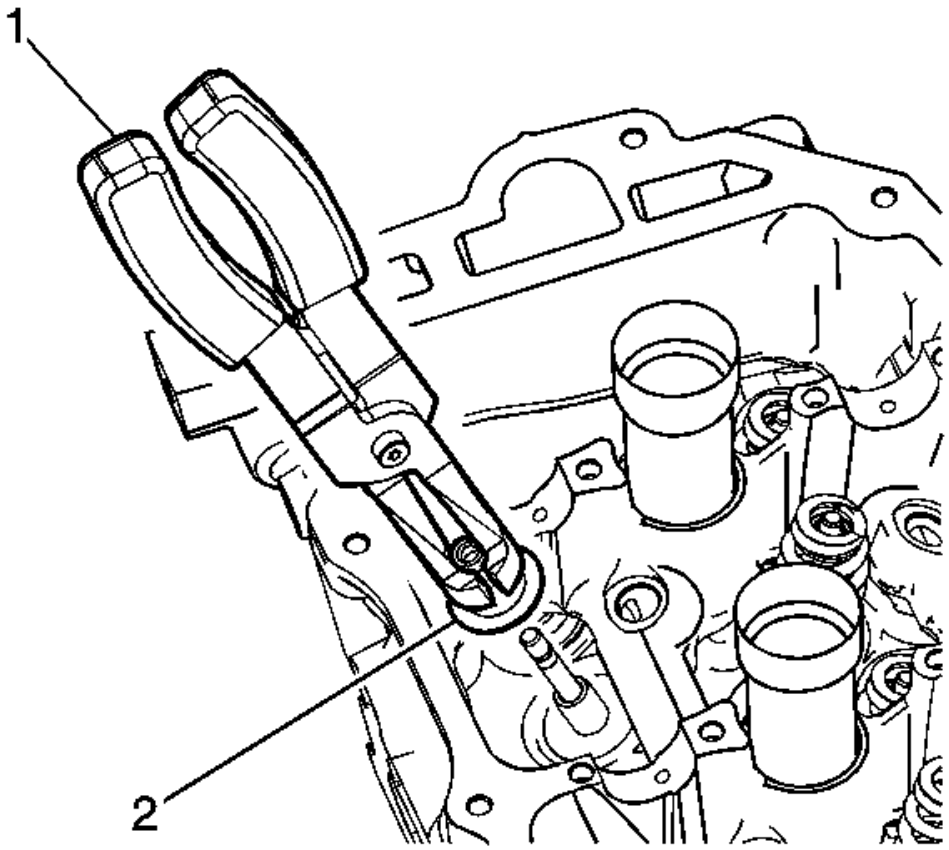


**Fig. 155: Removing/Installing Valve Stem Seal**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

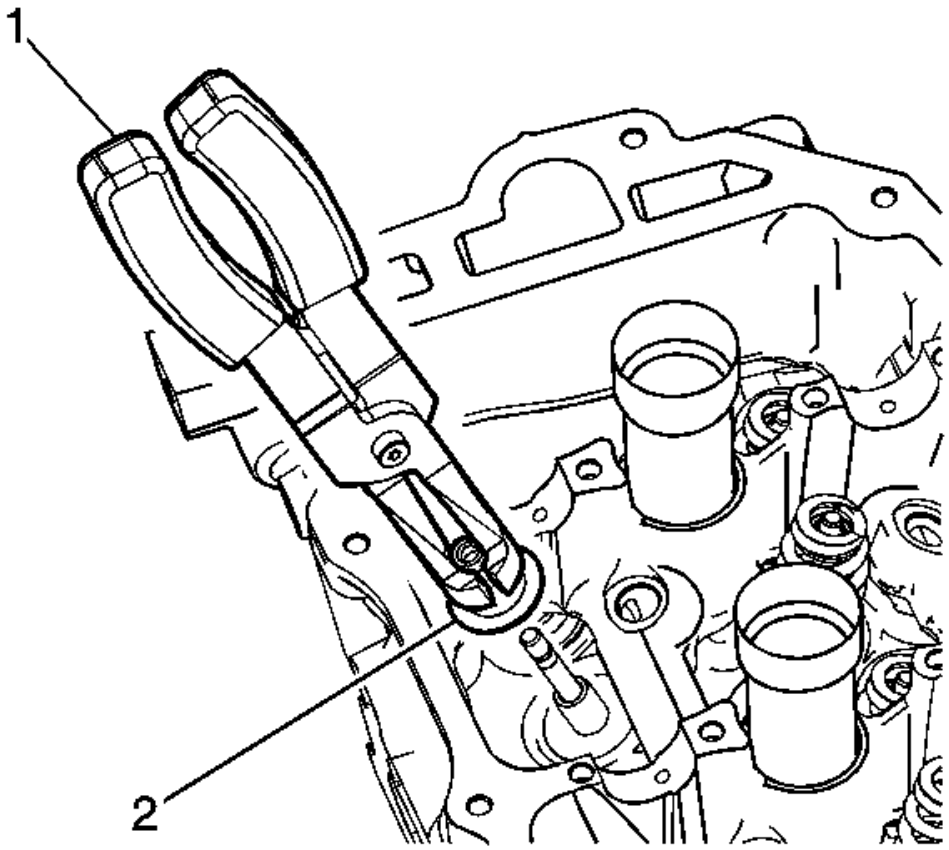


**Fig. 156: Removing/Installing Valve Stem Seal**
**Courtesy of GENERAL MOTORS CORP.**

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

 

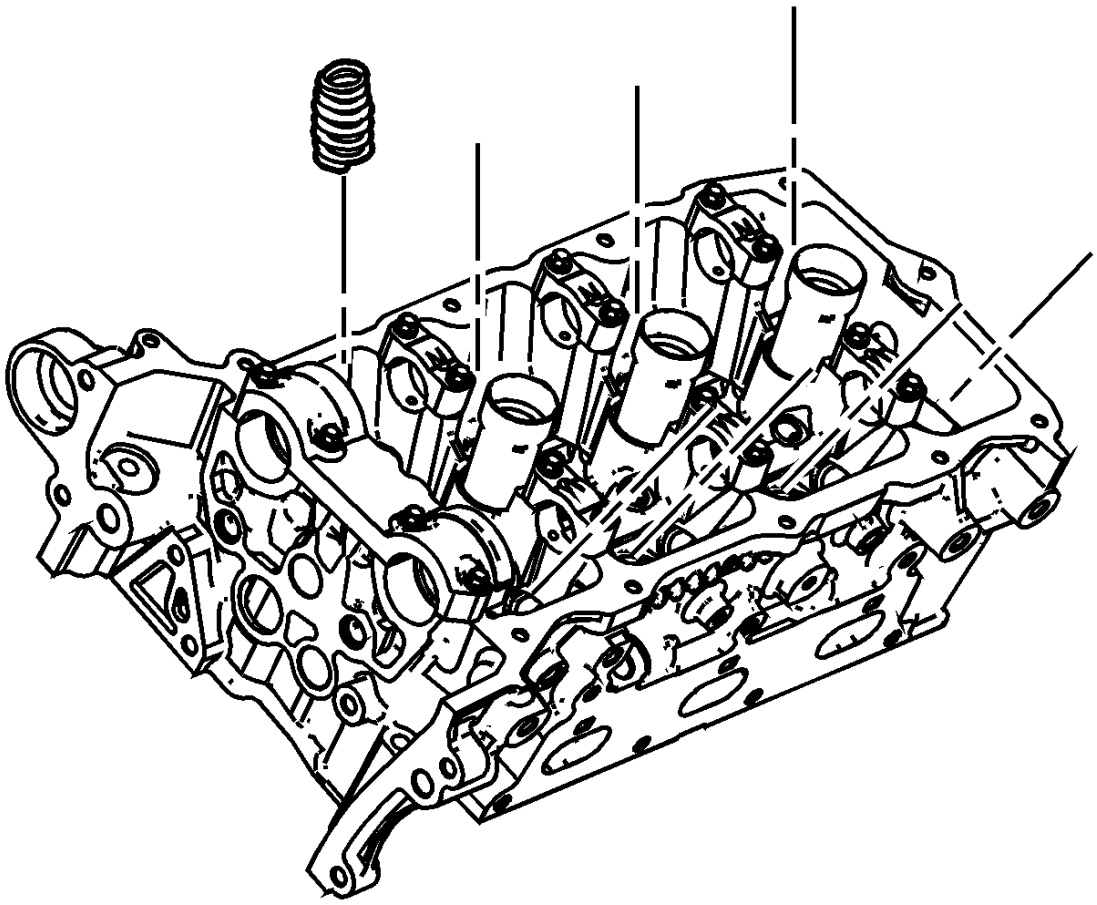

**Fig. 157: View Of Valve Spring**
**Courtesy of GENERAL MOTORS CORP.**

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

 

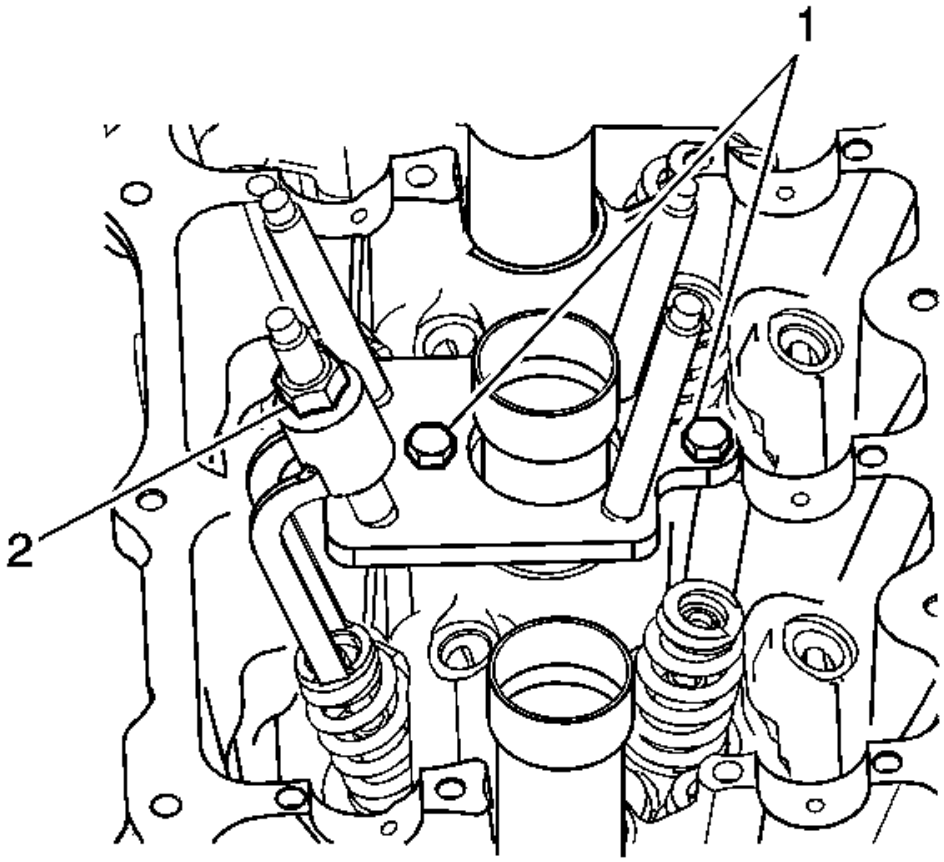


**Fig. 158: View Of Installed Valve Spring Compressor Tool**
**Courtesy of GENERAL MOTORS CORP.**

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

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

 

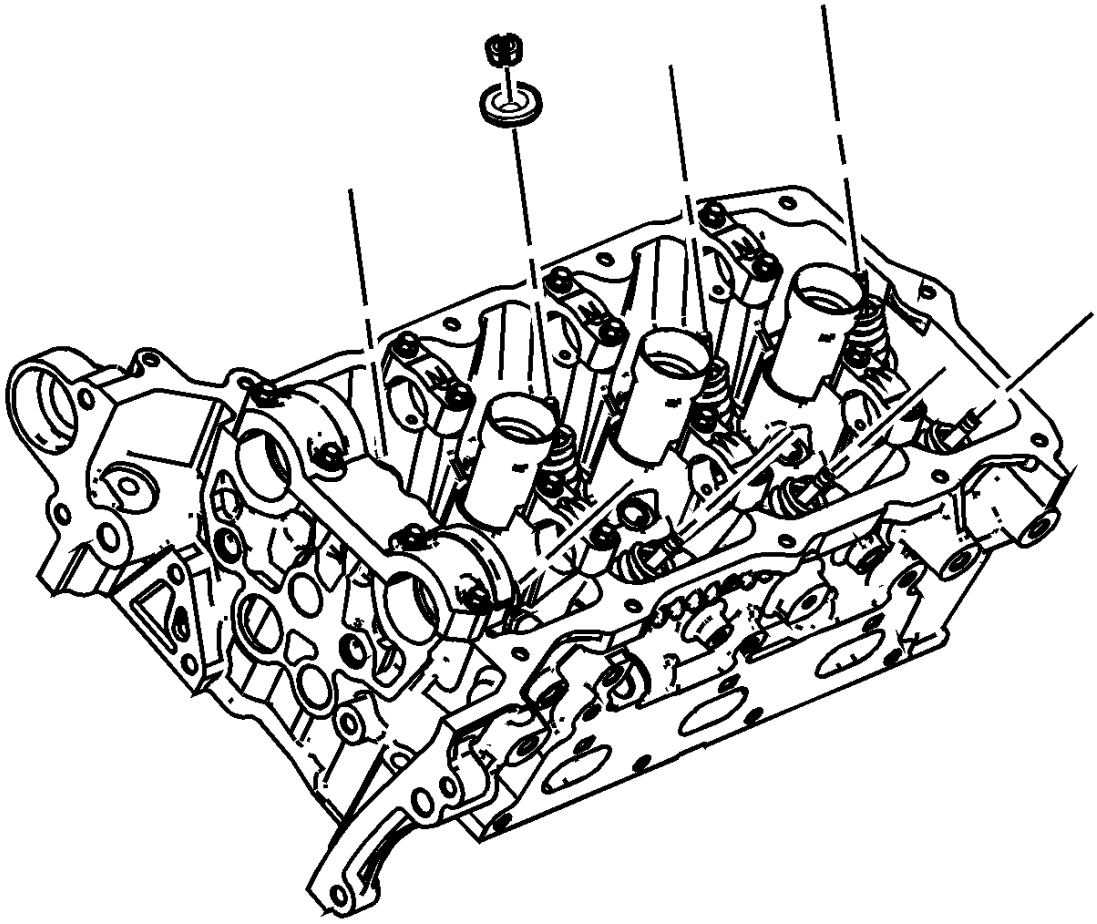

**Fig. 159: View Of Valve Spring Keepers**
**Courtesy of GENERAL MOTORS CORP.**

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 (LAF)** or **Starter Replacement (LF1)** .

## 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**

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.
2. Remove the starter motor. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .

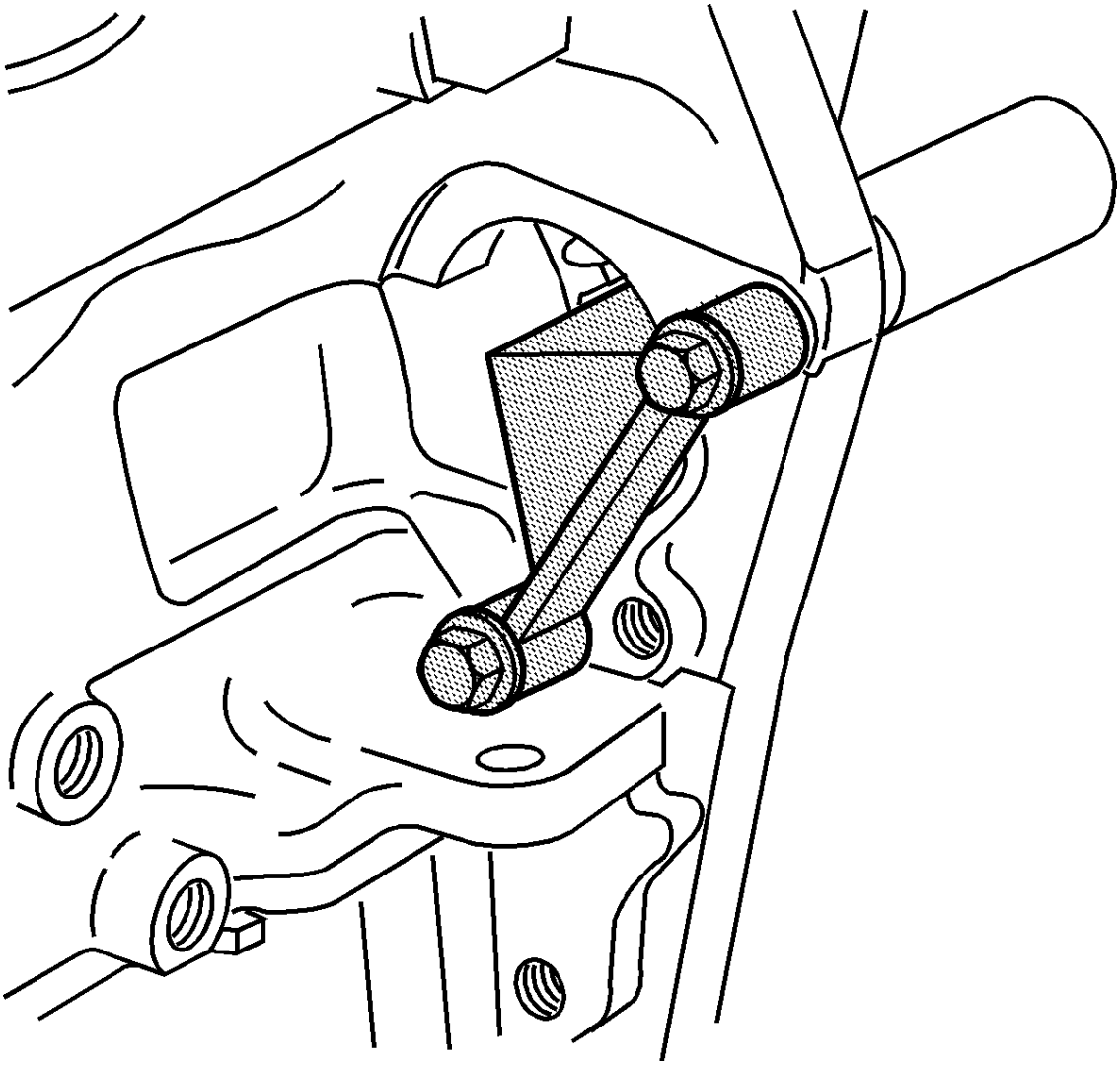

**Fig. 160: View Of Tool EN 46106**
**Courtesy of GENERAL MOTORS CORP.**

**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.

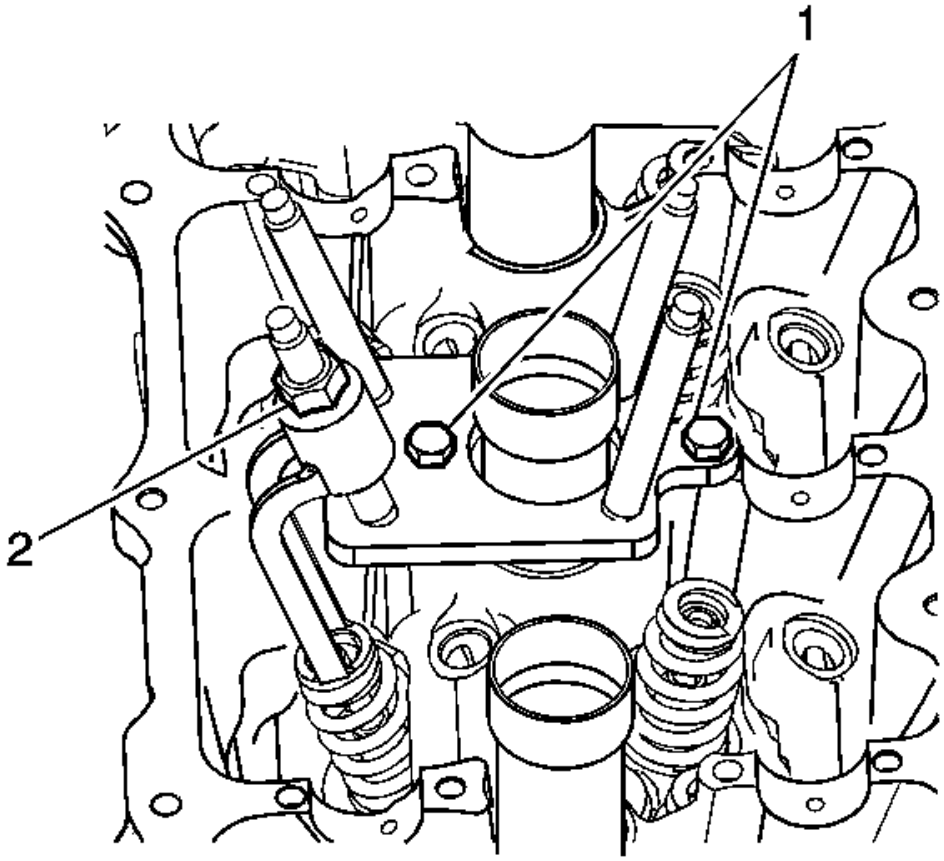


**Fig. 161: View Of Installed Valve Spring Compressor Tool**
**Courtesy of GENERAL MOTORS CORP.**

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

 

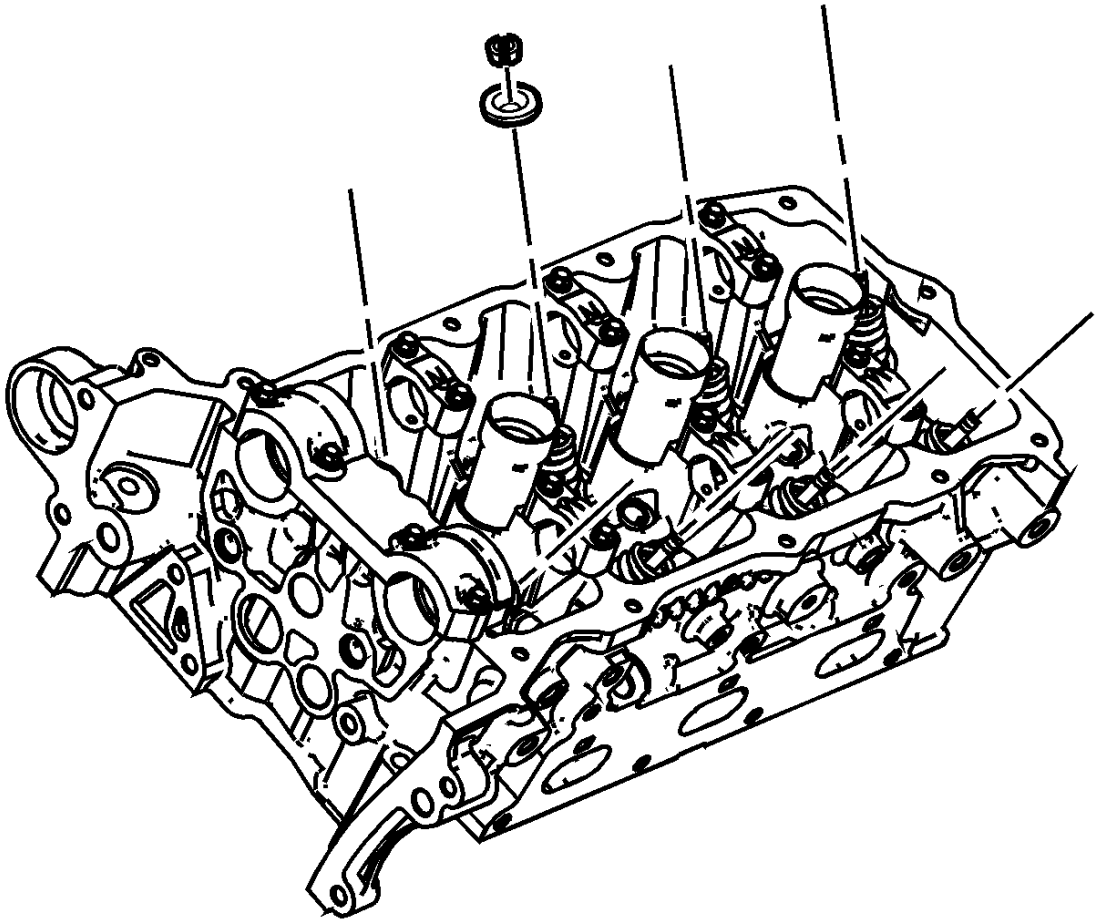

**Fig. 162: View Of Valve Spring Keepers**
**Courtesy of GENERAL MOTORS CORP.**

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

 

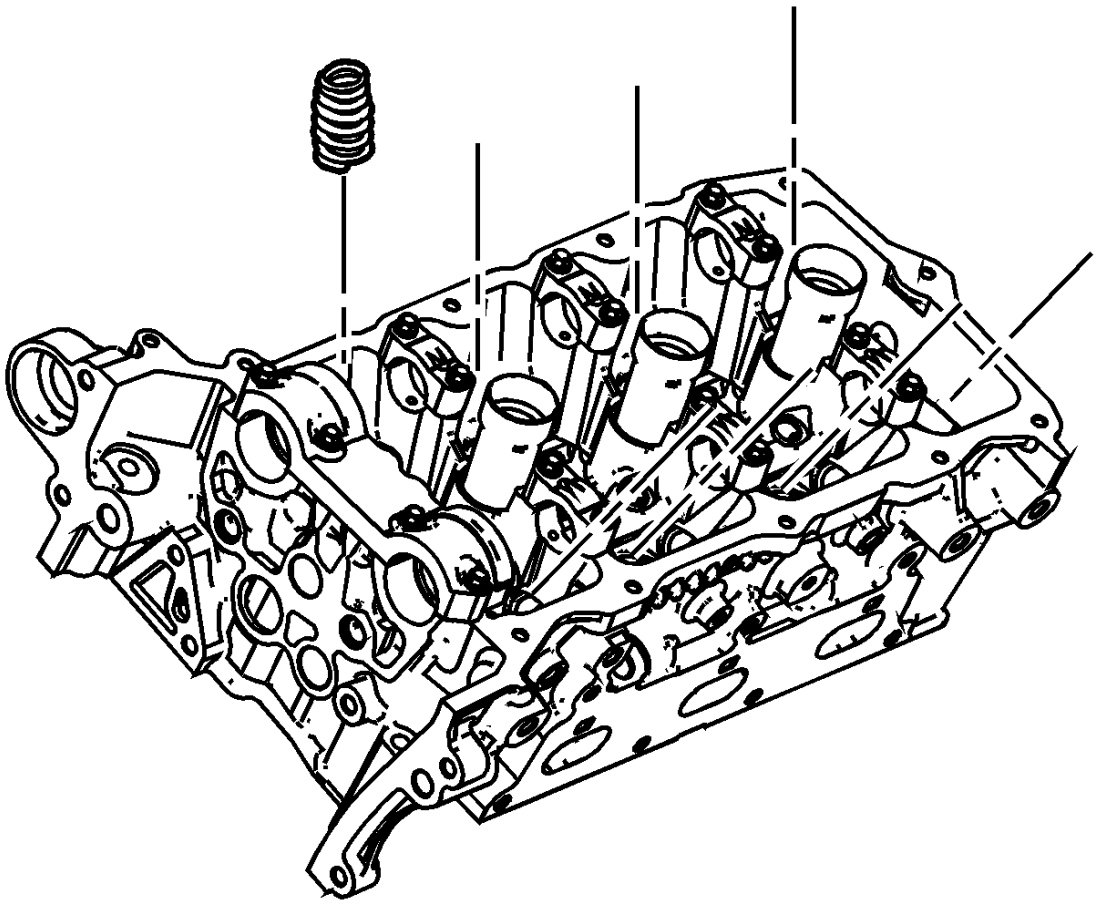

**Fig. 163: View Of Valve Spring**
**Courtesy of GENERAL MOTORS CORP.**

12. Remove the valve spring.

 

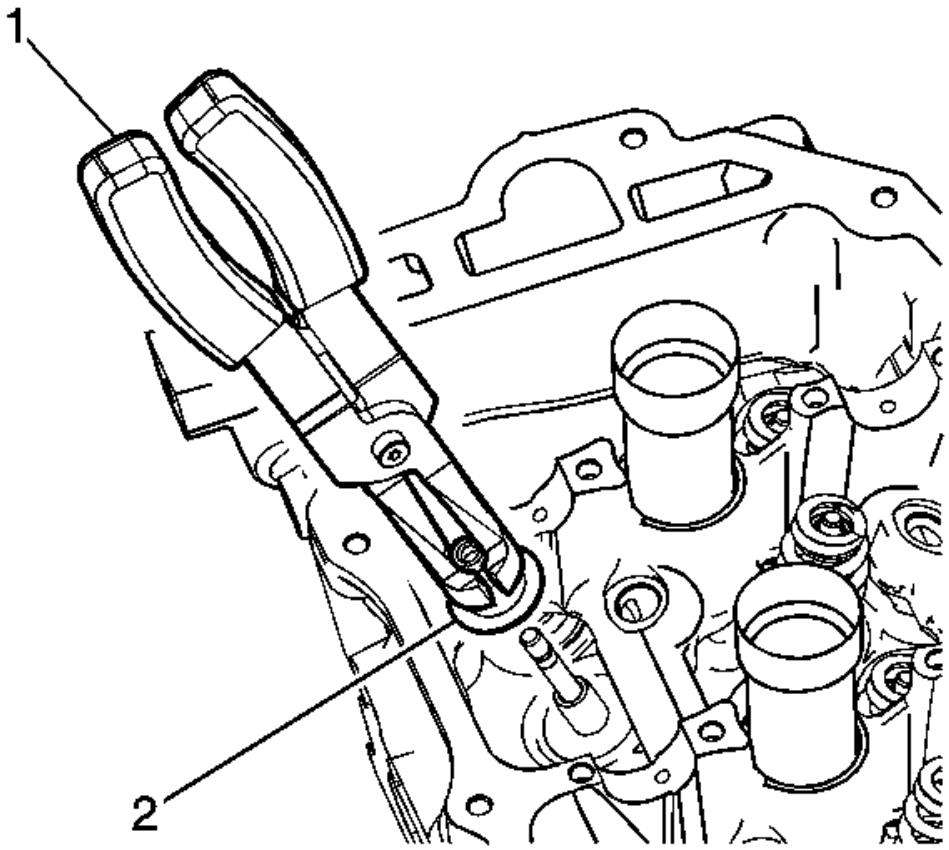


**Fig. 164: Removing/Installing Valve Stem Seal**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

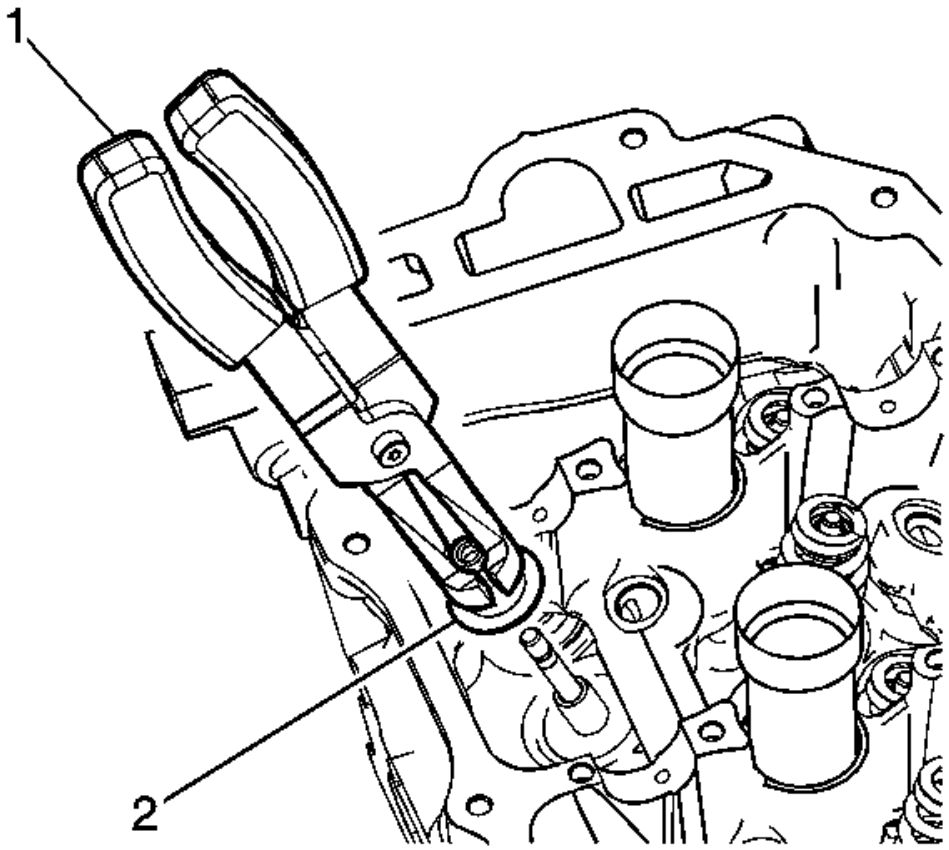


**Fig. 165: Removing/Installing Valve Stem Seal**
**Courtesy of GENERAL MOTORS CORP.**

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

 

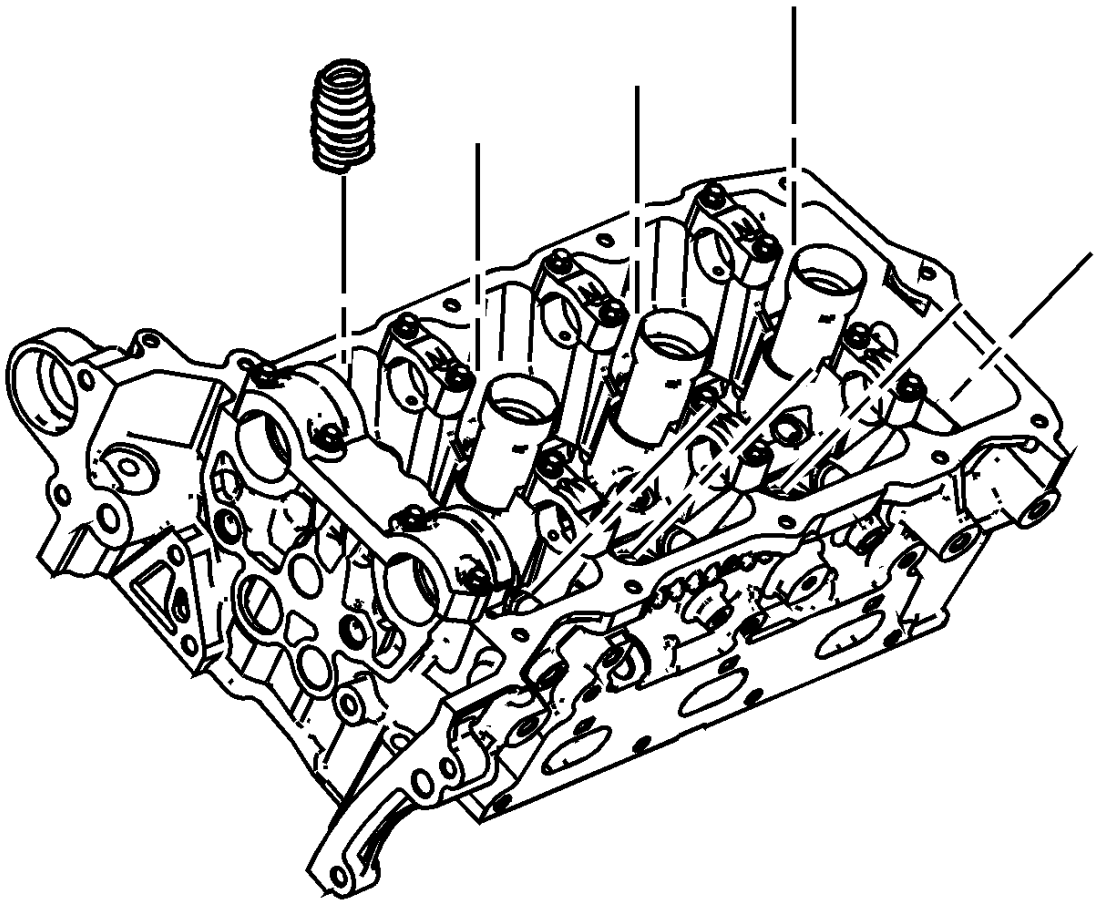

**Fig. 166: View Of Valve Spring**
**Courtesy of GENERAL MOTORS CORP.**

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

 

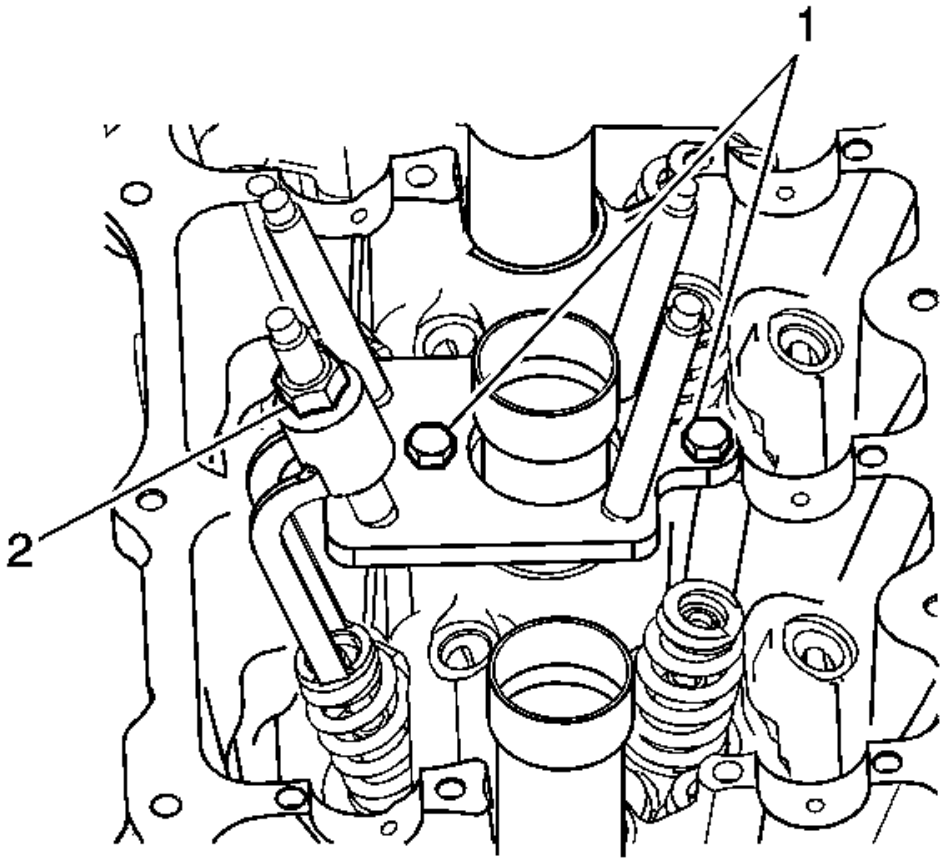


**Fig. 167: View Of Installed Valve Spring Compressor Tool**
**Courtesy of GENERAL MOTORS CORP.**

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

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

 

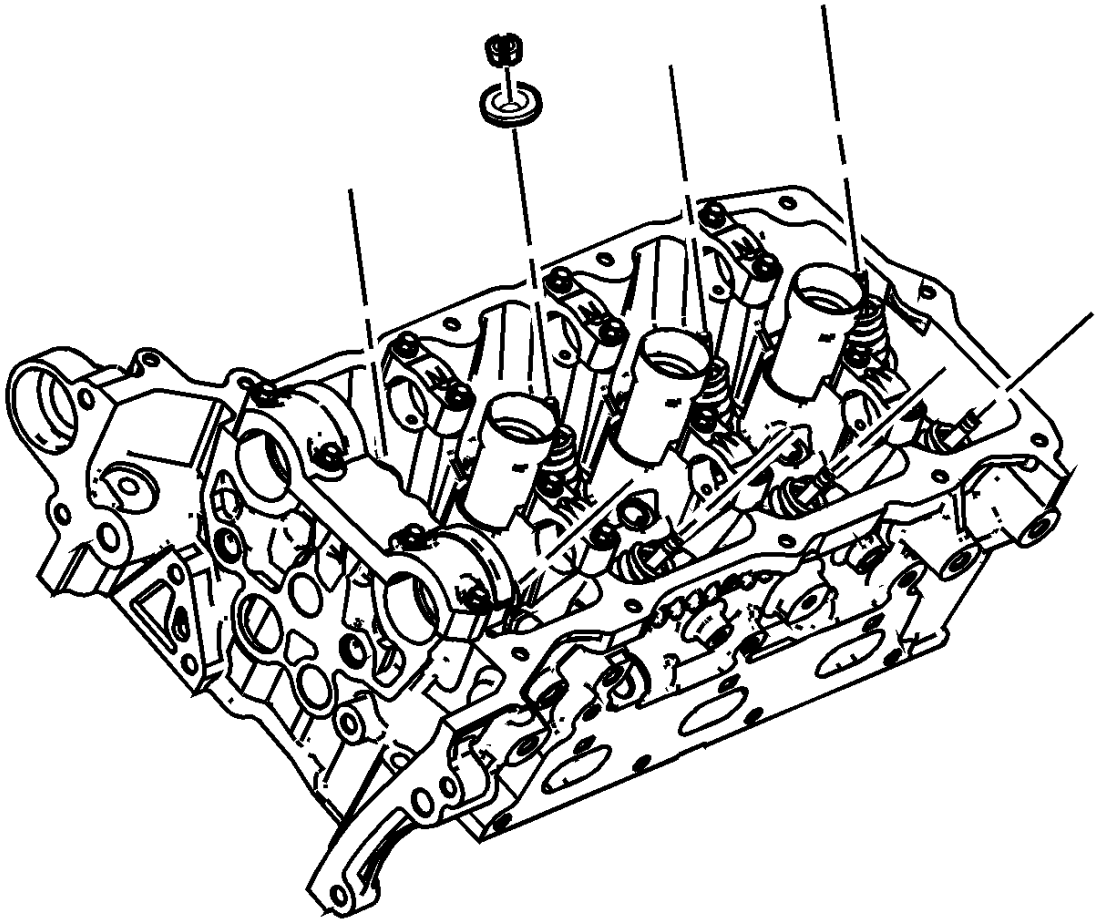

**Fig. 168: View Of Valve Spring Keepers**
**Courtesy of GENERAL MOTORS CORP.**

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 (LAF)** or **Starter Replacement (LF1)** .

## CYLINDER HEAD REPLACEMENT - LEFT SIDE (LF1)

### SPECIAL TOOLS

 

**J-45059:** Angle Meter

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

**REMOVAL PROCEDURE**

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
2. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
3. Remove the Catalytic Converter. Refer to **Catalytic Converter Replacement - Left Side (LF1)** .
4. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LF1)**.

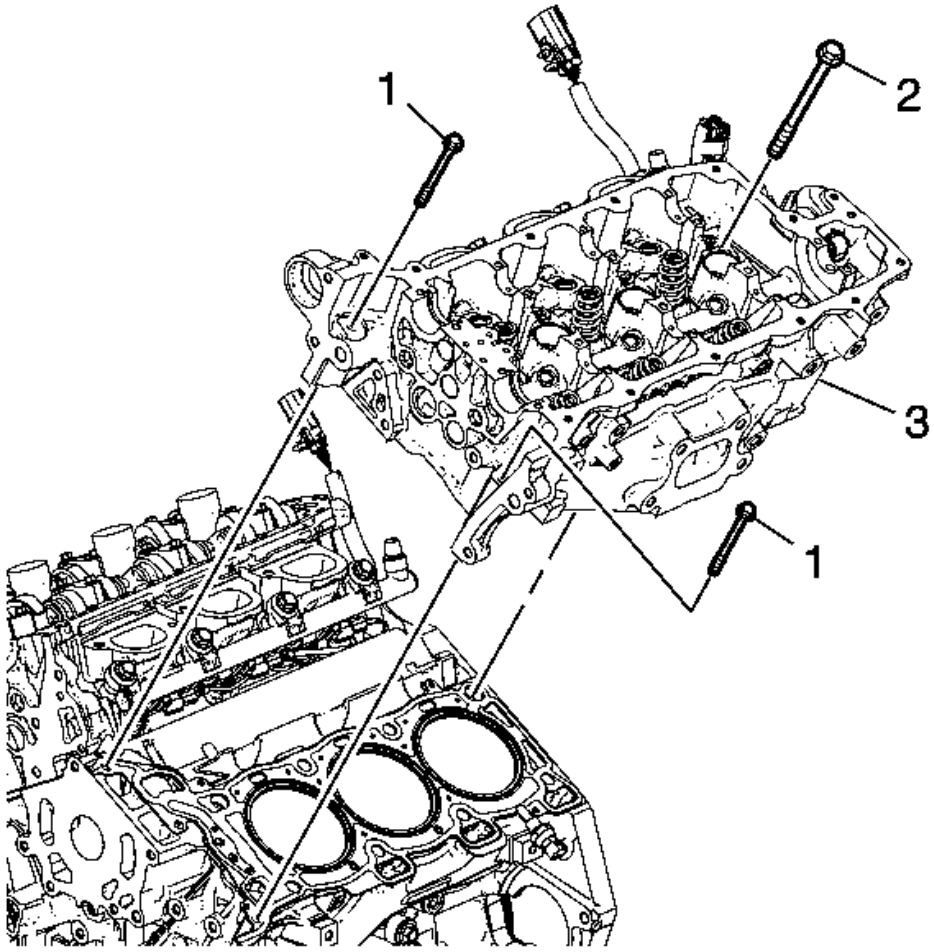


**Fig. 169: Cylinder Head & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

5. Remove the 2 front M8 left cylinder head bolts (1).
6. Remove the left cylinder head bolts (2).
7. Remove the left cylinder head (3).

 

8. Remove the ground wire bolt and ground wire.
9. Disconnect and reposition harness as necessary.

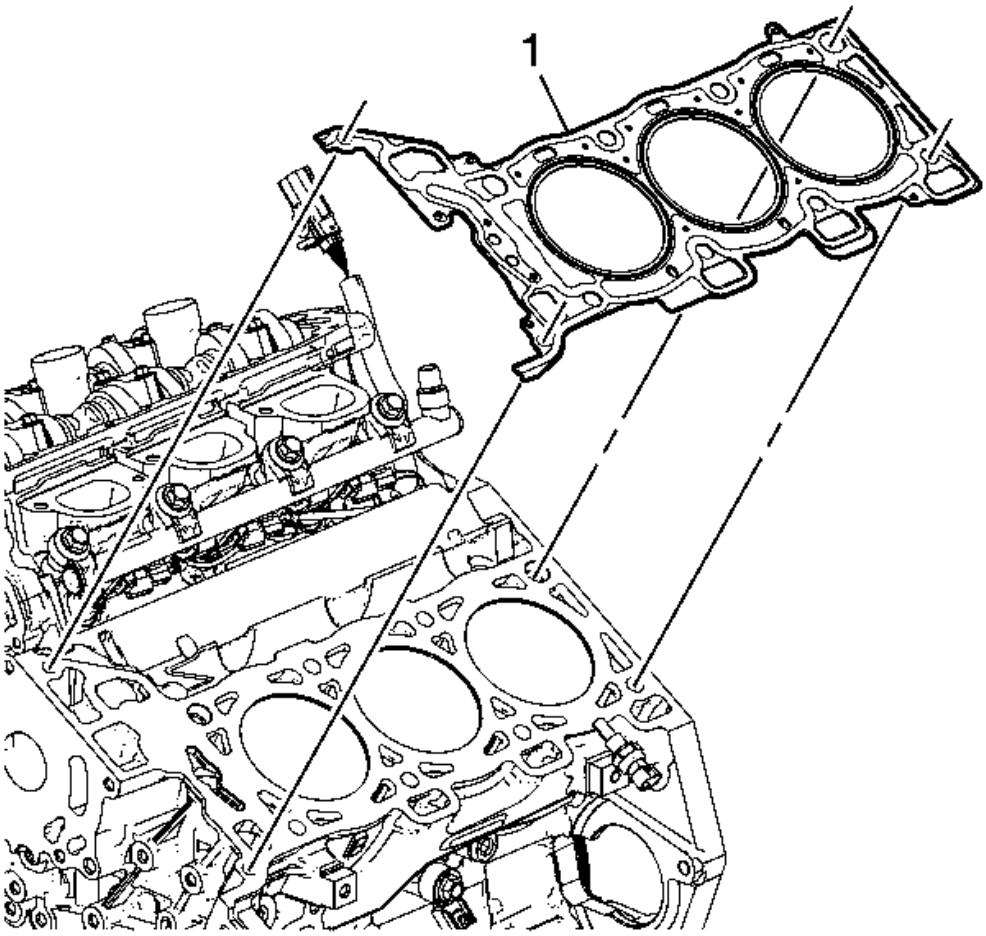


**Fig. 170: Cylinder Head Gasket**
**Courtesy of GENERAL MOTORS CORP.**

10. Remove and discard the left cylinder head gasket (1).
11. 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** .
12. Transfer parts as needed. Refer to **Cylinder Head Disassemble (LF1 or LFW)**

**INSTALLATION PROCEDURE**

 

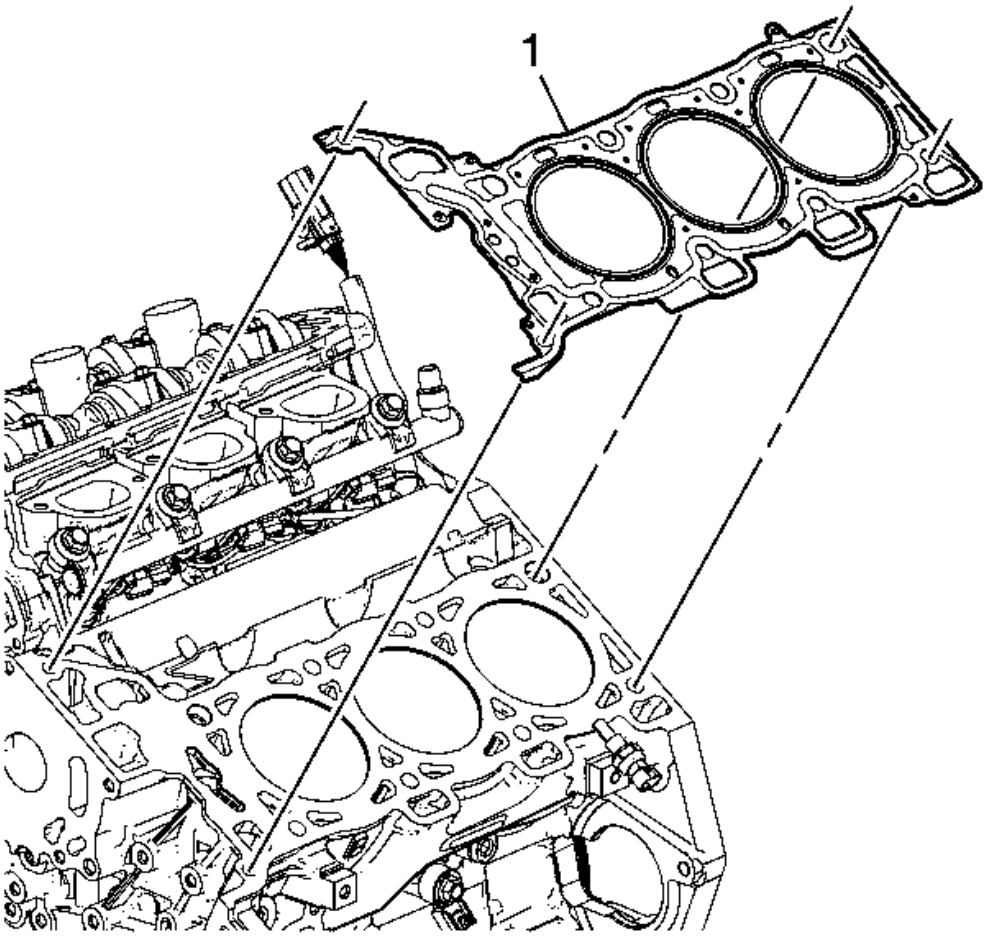


**Fig. 171: Cylinder Head Gasket**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

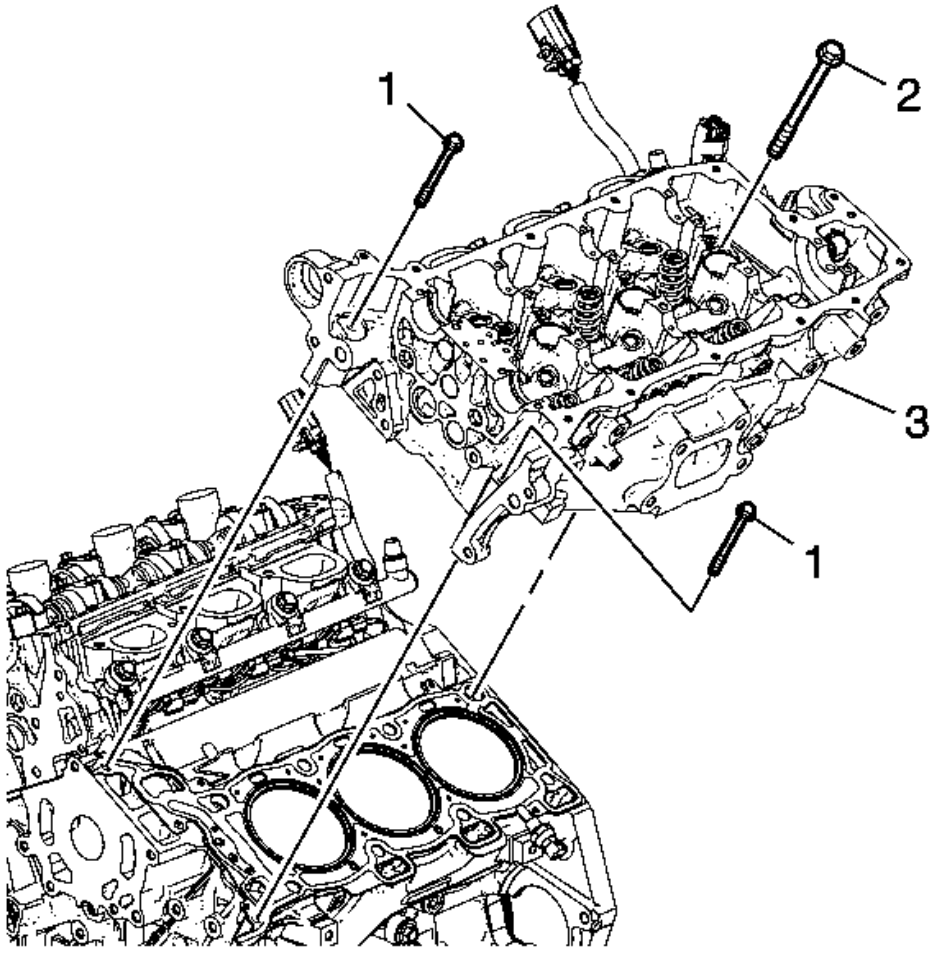


**Fig. 172: Cylinder Head & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

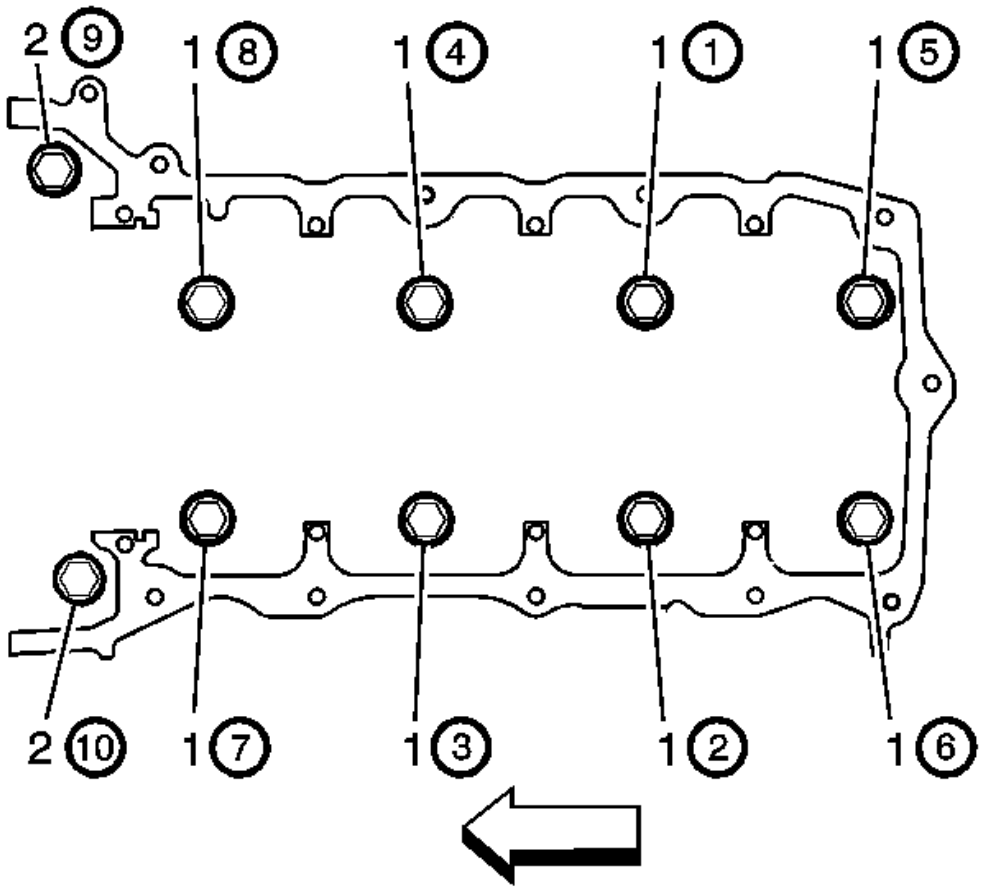


**Fig. 173: Identifying M11 Cylinder Head Bolts & Tightening Sequence**
**Courtesy of GENERAL MOTORS CORP.**

**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 **J-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 **J-**

 

**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 (LF1)**.
9. Install the fuel pump. Refer to **Fuel Pump Replacement** .
10. Install the generator. Refer to **Generator Replacement (LAF)** or **Generator Replacement (LF1)** .
11. Install the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (LF1)** .
12. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LF1)**.

# CYLINDER HEAD REPLACEMENT - RIGHT SIDE (LF1)

### SPECIAL TOOLS

**J-45059:** Angle Meter

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

### REMOVAL PROCEDURE

1. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Remove the Power Brake Booster Pump aside.
3. Remove the Catalytic Converter. Refer to **Catalytic Converter Replacement - Right Side (LF1)** .

 

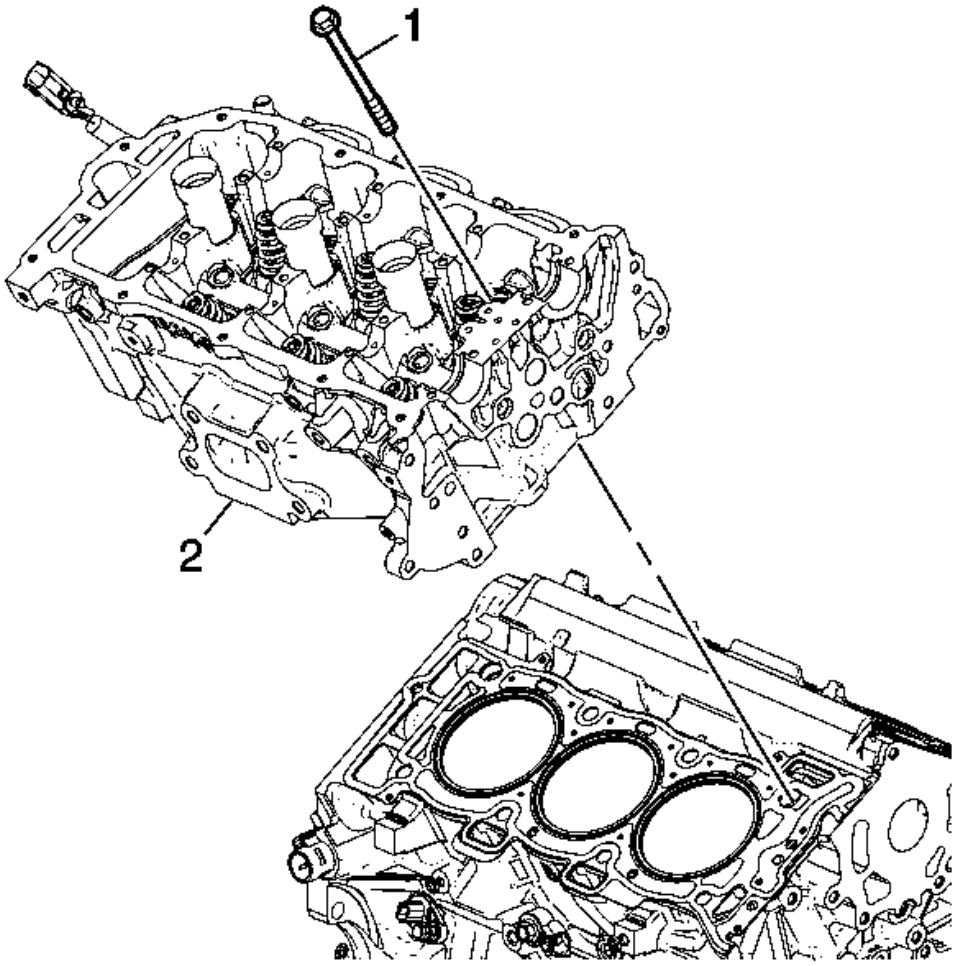


**Fig. 174: Right Cylinder Head & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

4. Remove the right cylinder head bolts (1).
5. Remove the right cylinder head (2).
6. Remove Ground wire and harness and position aside.

 

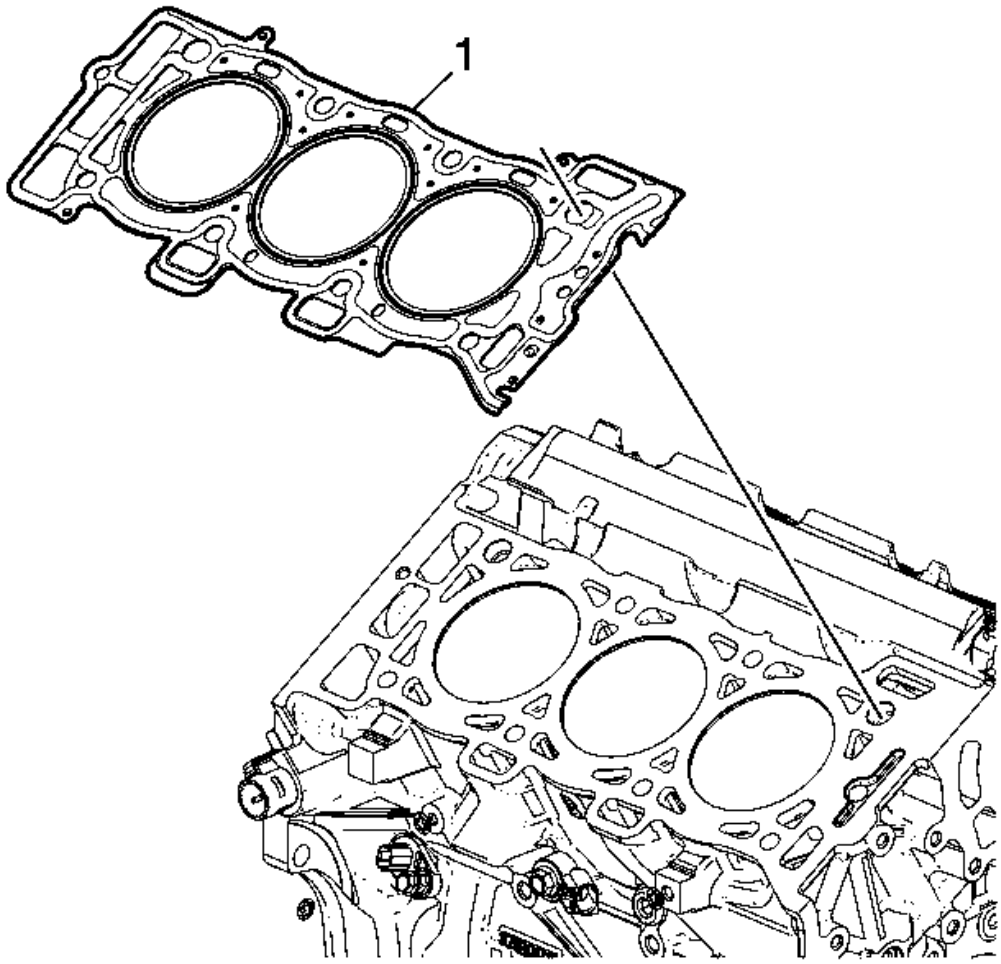


**Fig. 175: Cylinder Head Gasket**
**Courtesy of GENERAL MOTORS CORP.**

7. Remove and discard the cylinder head gasket (1).
8. 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** .
9. Disassemble the cylinder head if needed. Refer to **Cylinder Head Disassemble (LF1 or LFW)** .
10. Transfer parts as needed.

**INSTALLATION PROCEDURE**

 

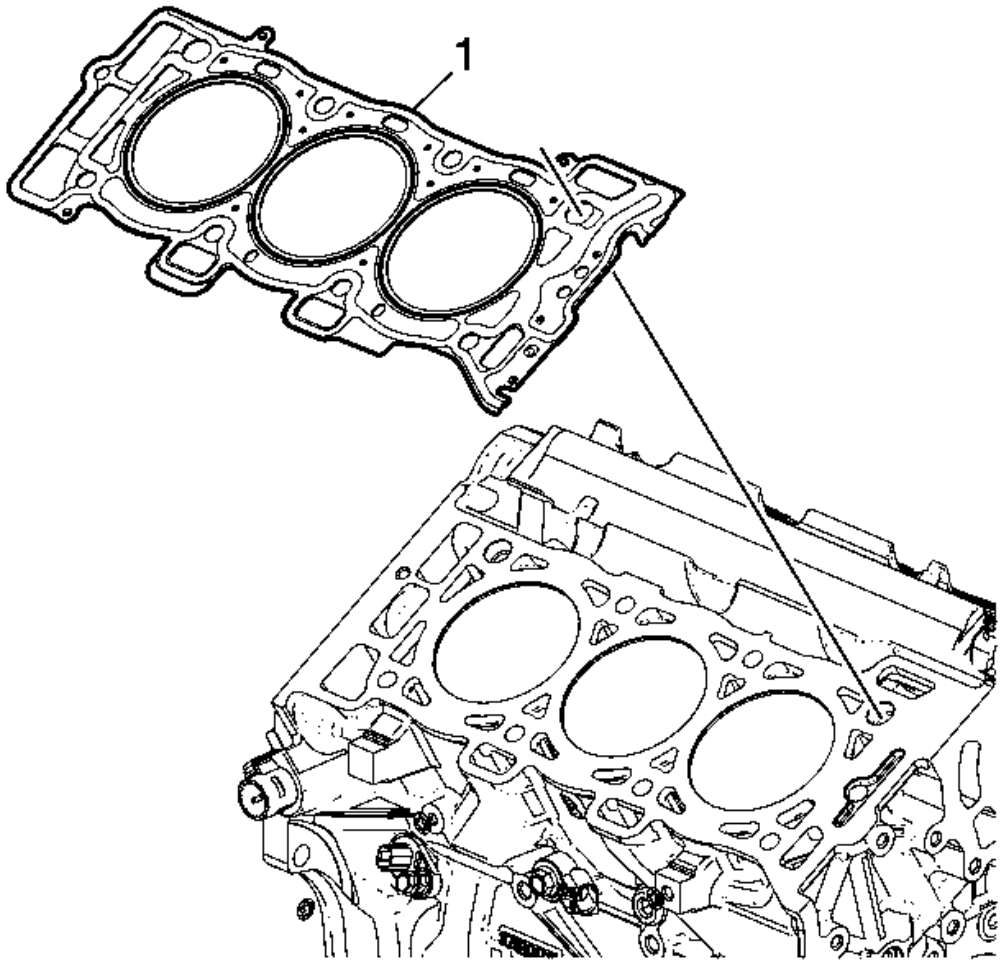


**Fig. 176: Cylinder Head Gasket**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

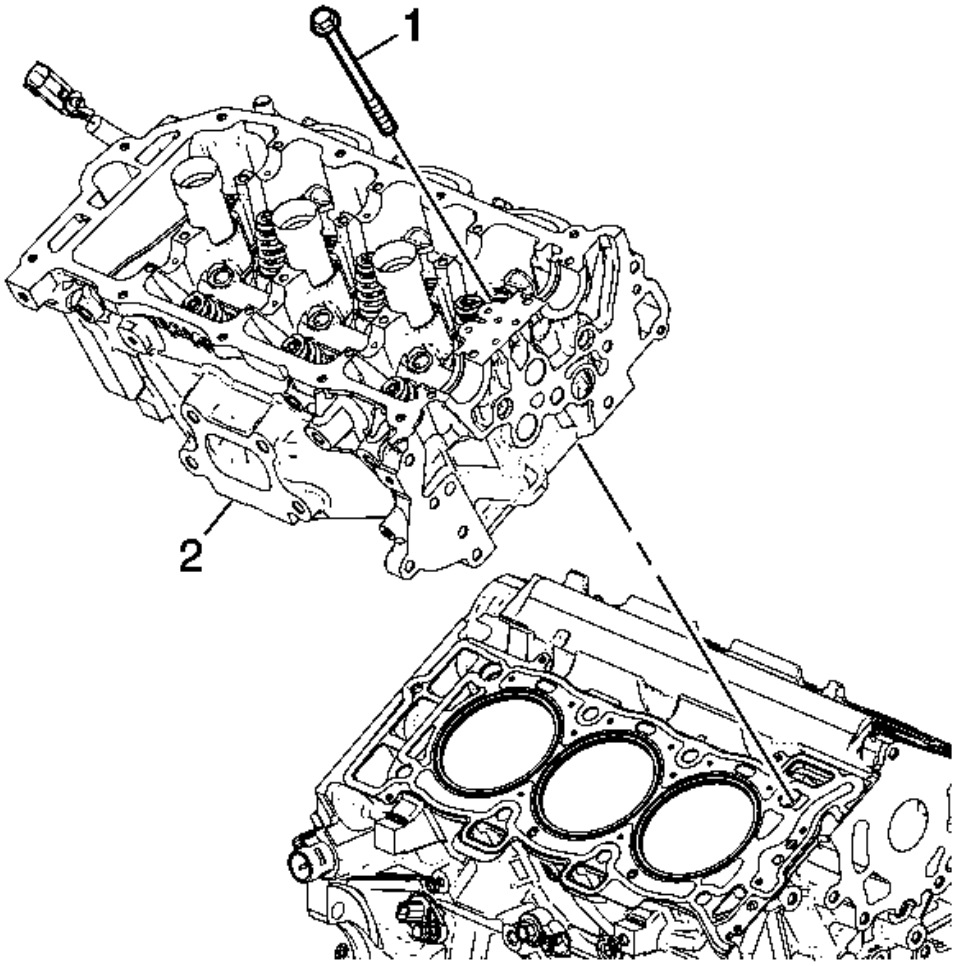


**Fig. 177: Right Cylinder Head & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

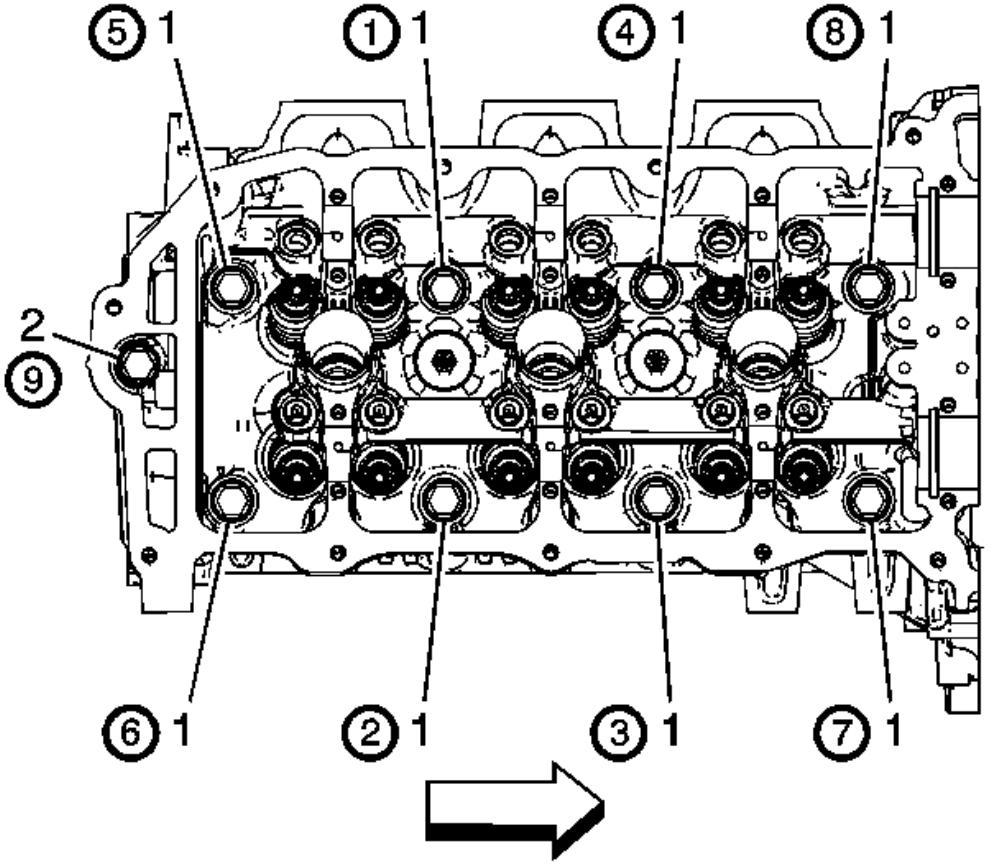


**Fig. 178: Identifying M11 Cylinder Head Bolts & Tightening Sequence**
**Courtesy of GENERAL MOTORS CORP.**

**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 **J-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 **J-45059:** meter.

 

7. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
8. Install the exhaust manifold. Refer to **Catalytic Converter Replacement - Right Side (LF1)**
9. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side (LF1)**.

## ENGINE FLYWHEEL REPLACEMENT

### REMOVAL PROCEDURE

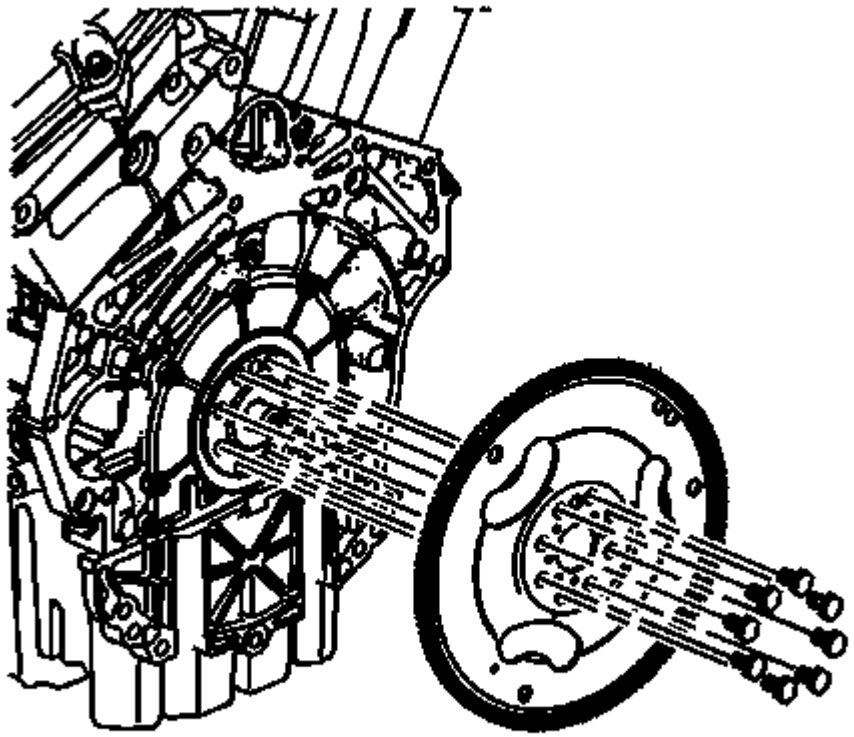

**Fig. 179: View Of Engine Flywheel**
**Courtesy of GENERAL MOTORS CORP.**

1. Remove the transmission. Refer to **Transmission Replacement (FWD)** or **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

 

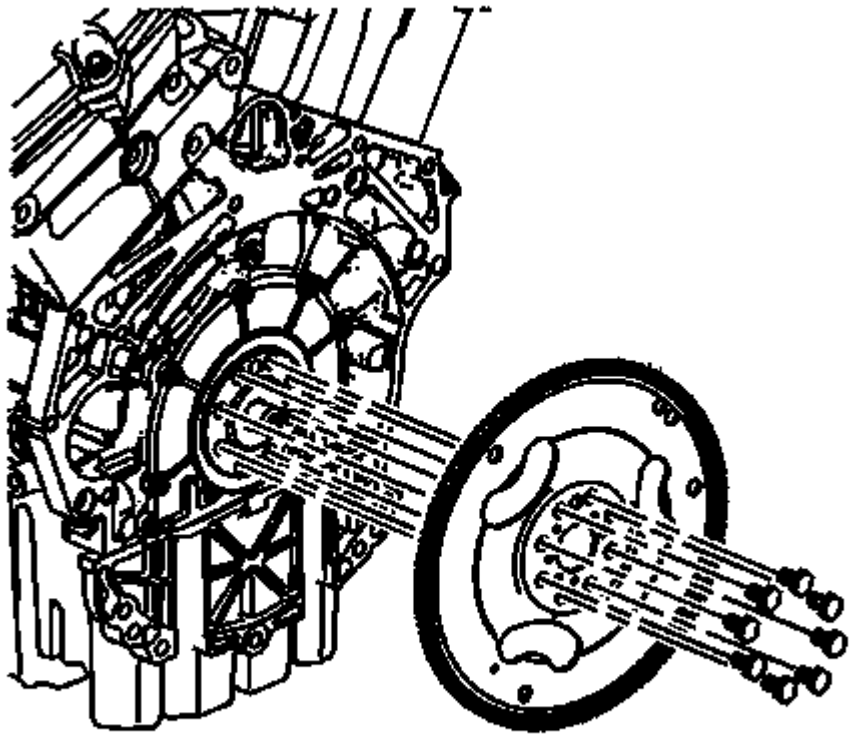

**Fig. 180: View Of Engine Flywheel**
**Courtesy of GENERAL MOTORS CORP.**

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

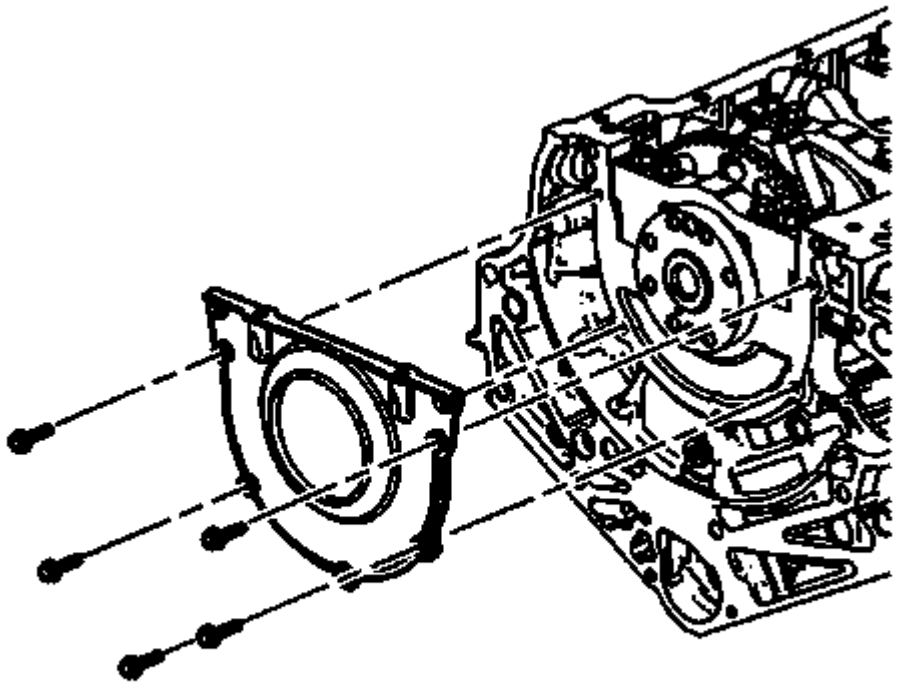

**Fig. 181: View Of Crankshaft Rear Oil Seal & Housing**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

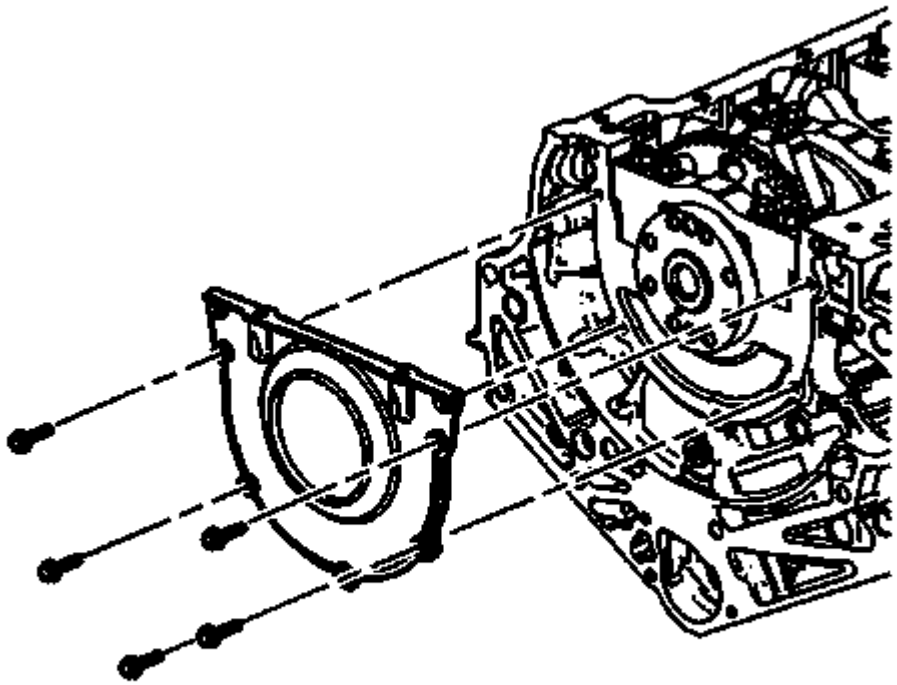

**Fig. 182: View Of Crankshaft Rear Oil Seal & Housing**
**Courtesy of GENERAL MOTORS CORP.**

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

 

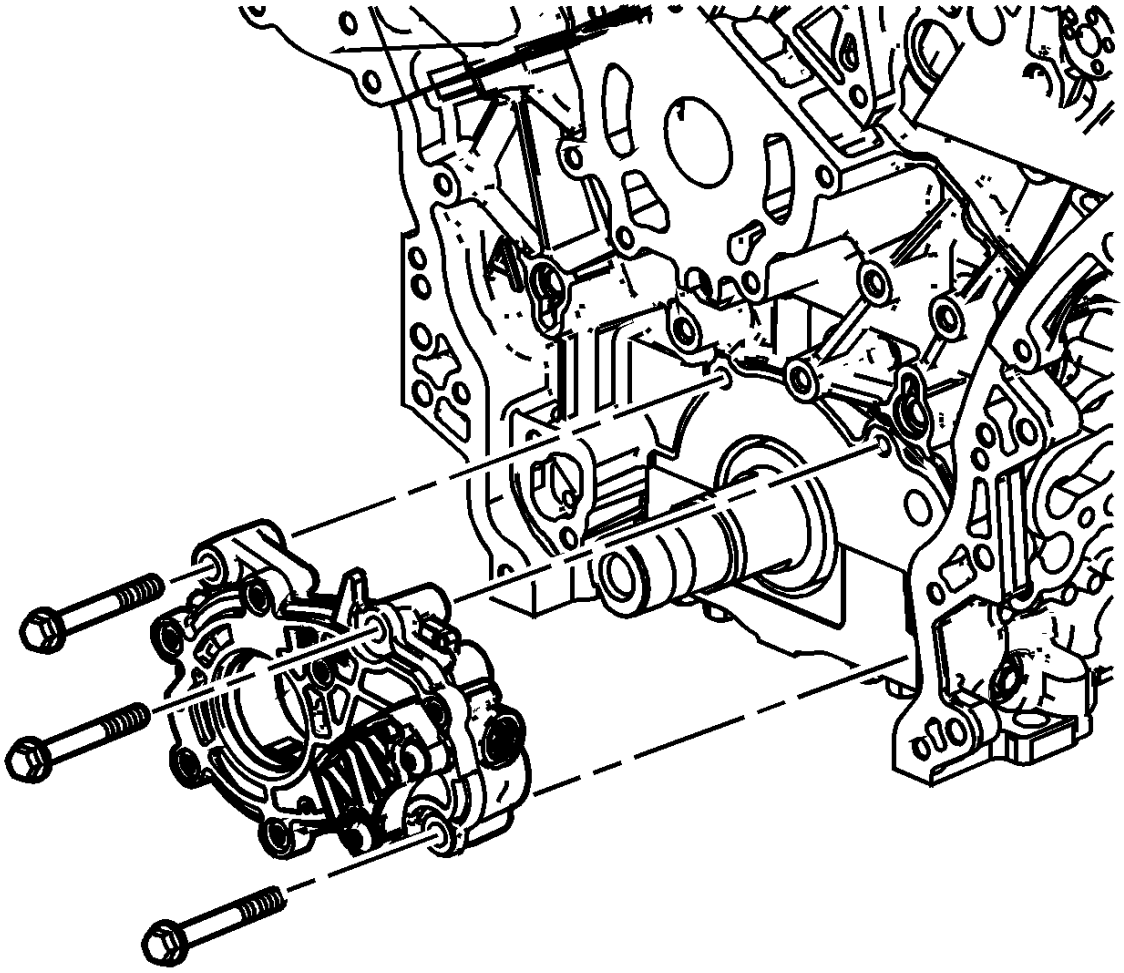

**Fig. 183: View Of Oil Pump & Mounting Bolts**
**Courtesy of GENERAL MOTORS CORP.**

**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**

 

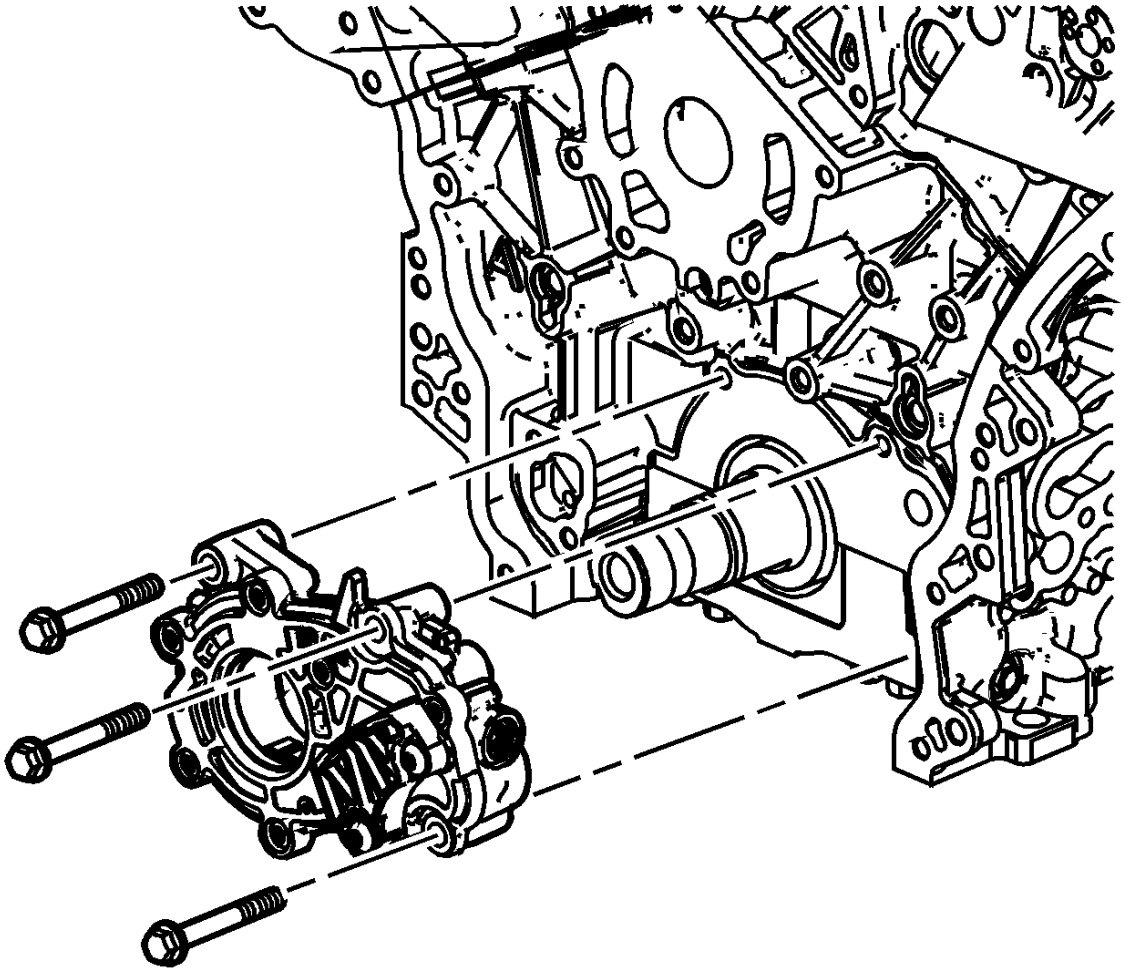

**Fig. 184: View Of Oil Pump & Mounting Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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)** .
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LF1)** .
4. Remove the air conditioning (A/C) compressor bolts and reposition. Refer to **Air Conditioning Compressor Replacement (LAF)** or **Air Conditioning Compressor Replacement (LF1)** .
5. Remove the front cover. Refer to **Engine Front Cover Replacement**.
6. Remove the oil pan to transmission bolts.

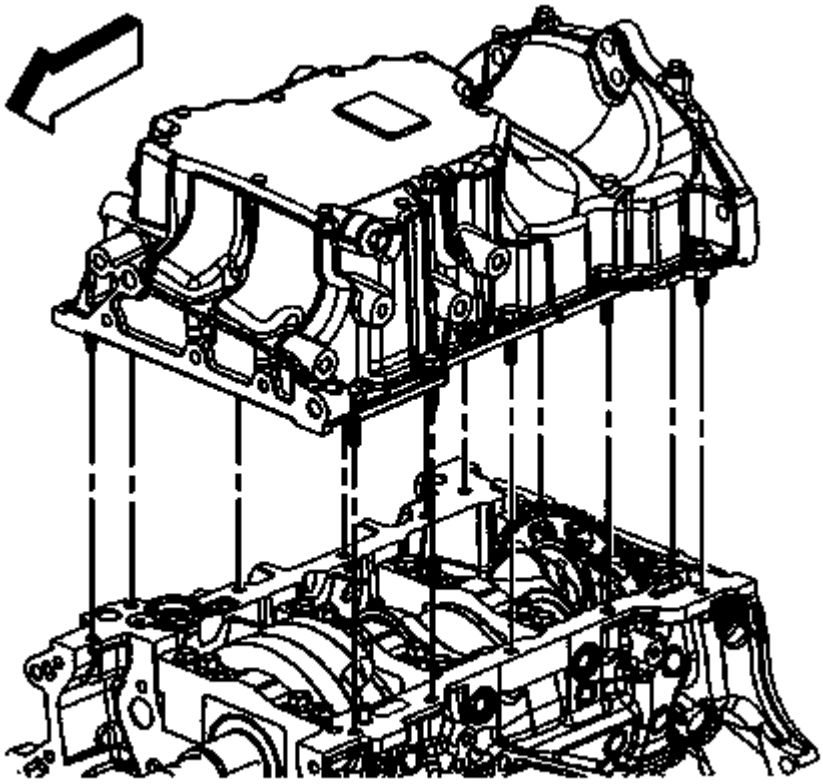

**Fig. 185: Removing/Installing Oil Pan**
**Courtesy of GENERAL MOTORS CORP.**

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**

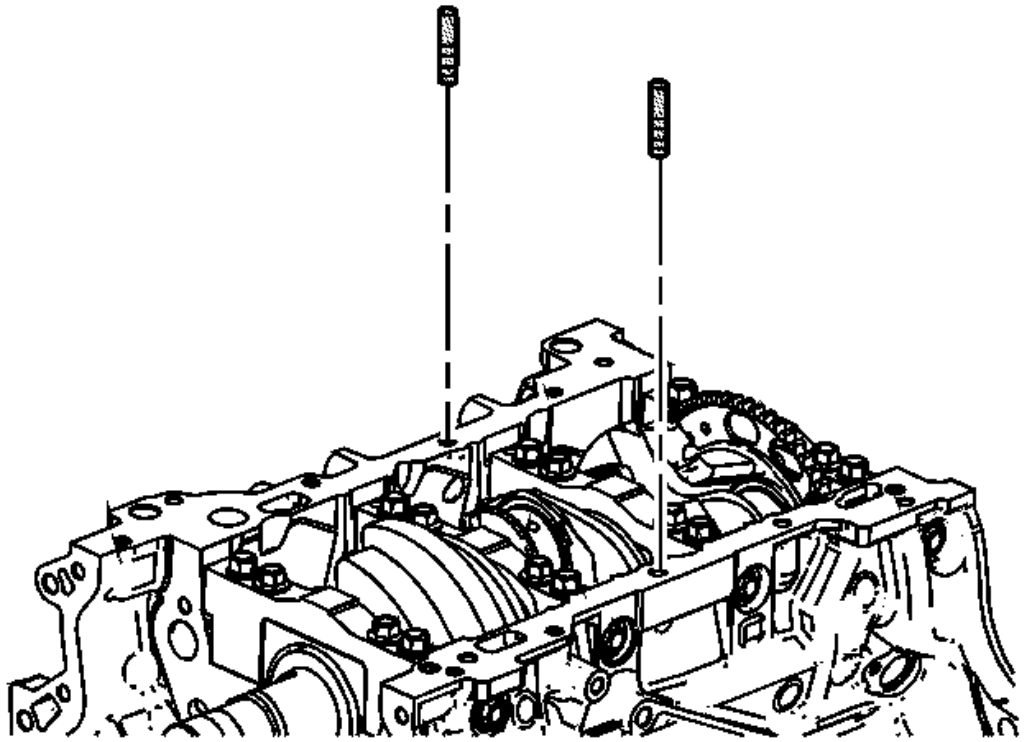

**Fig. 186: View Of Guides**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

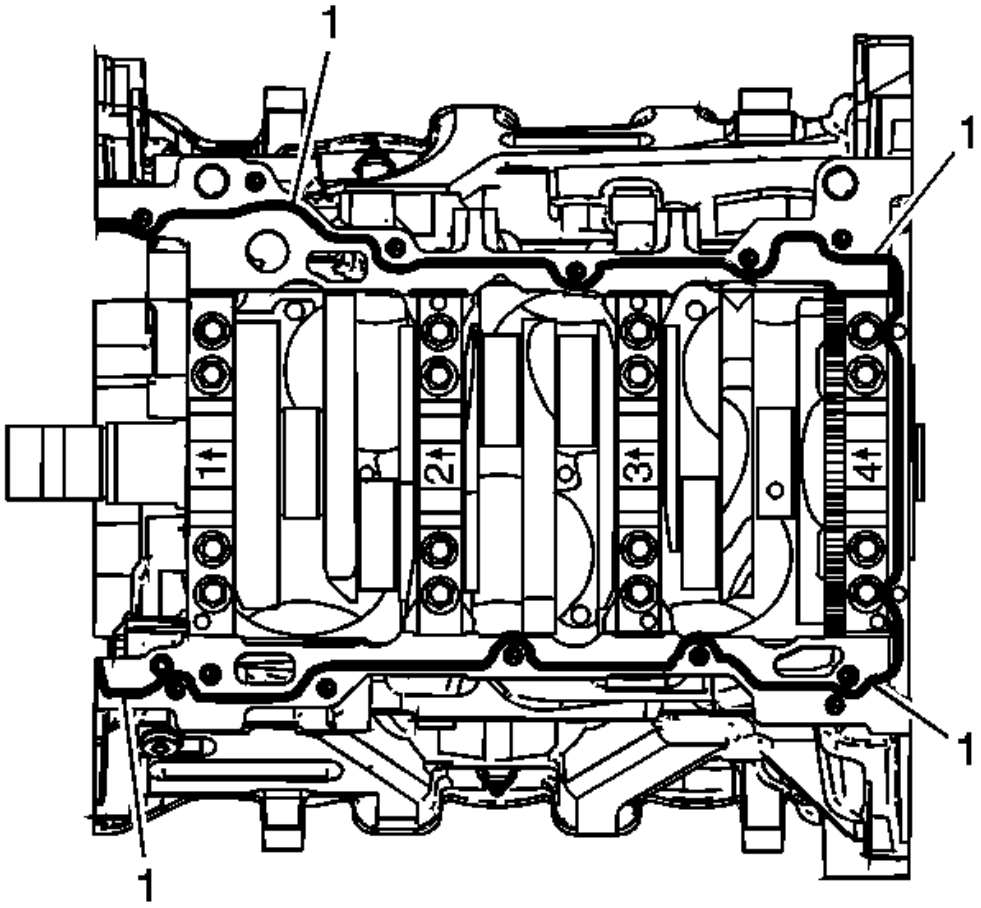


**Fig. 187: Locating Sealant**
**Courtesy of GENERAL MOTORS CORP.**

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.

 

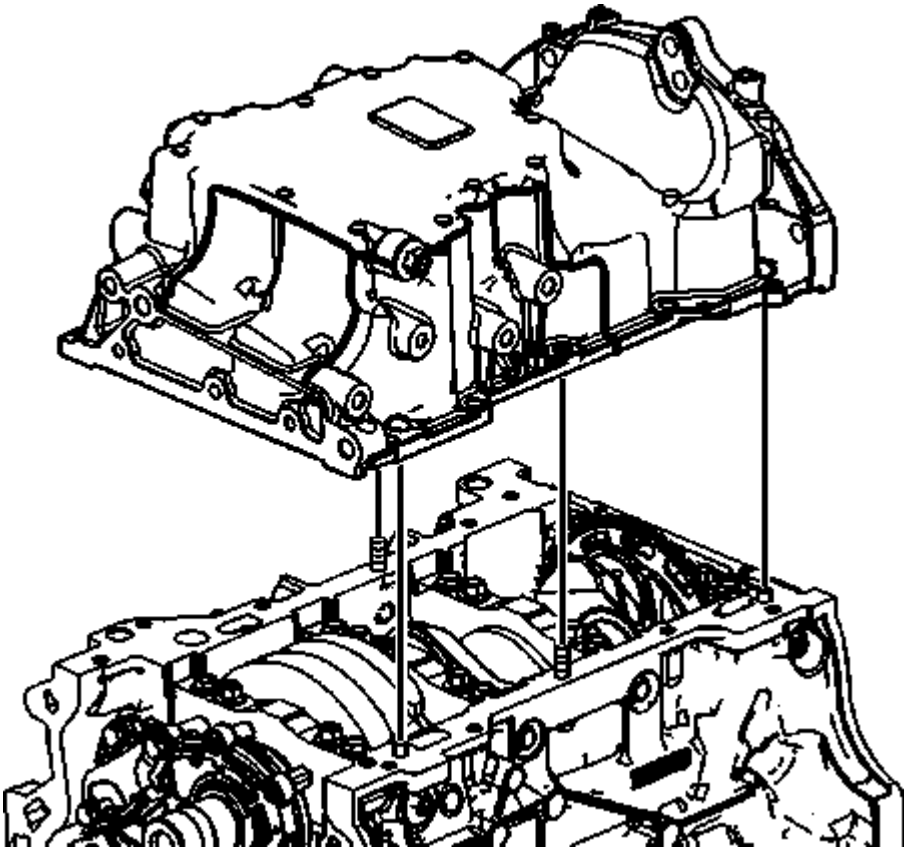

**Fig. 188: Removing/Installing Oil Pan**
**Courtesy of GENERAL MOTORS CORP.**

3. Position the oil pan onto the block.

 

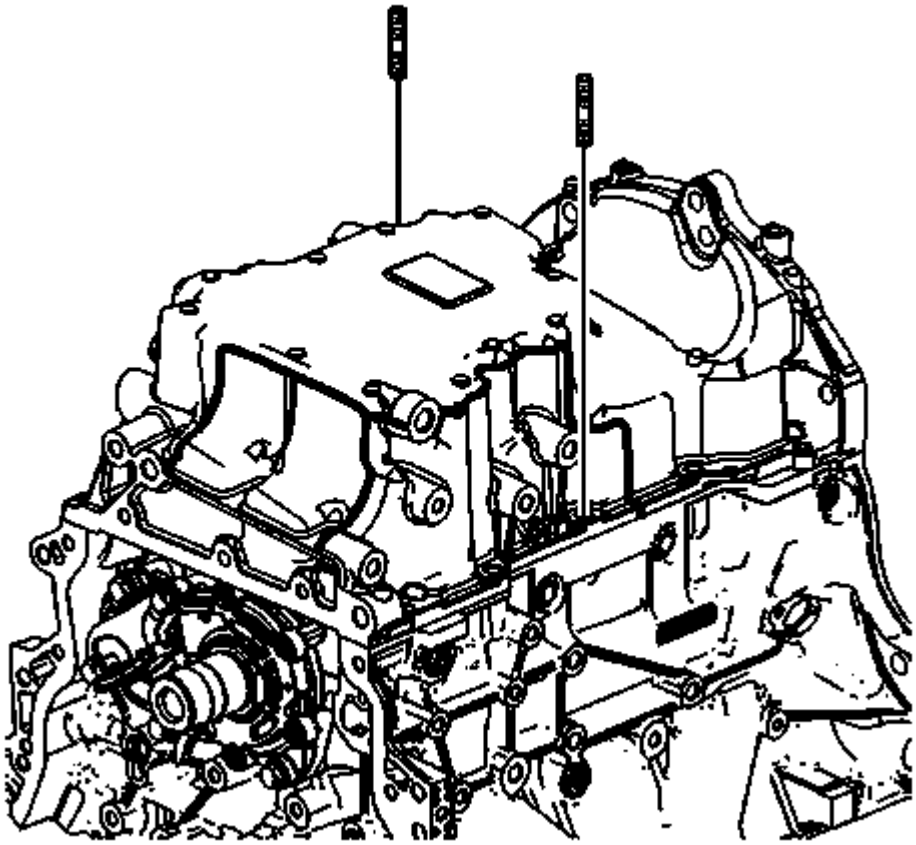

**Fig. 189: View Of Engine Block Guides**
**Courtesy of GENERAL MOTORS CORP.**

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

 

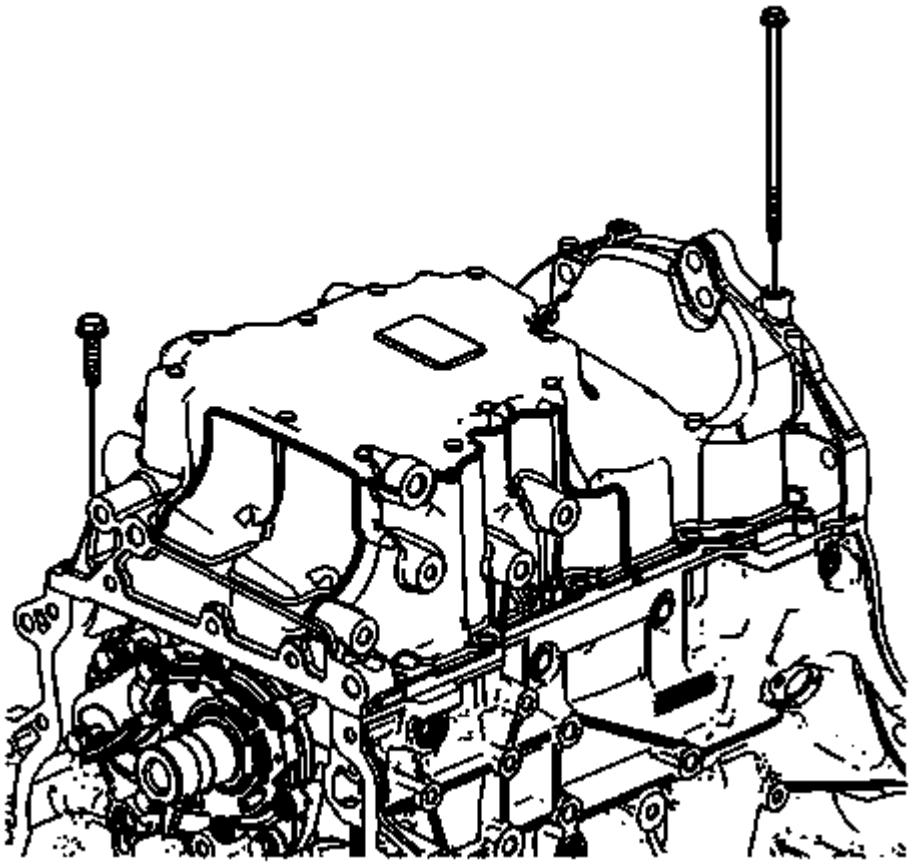

**Fig. 190: Oil Pan Bolts**
**Courtesy of GENERAL MOTORS CORP.**

5. Loosely install the oil pan bolts.

 

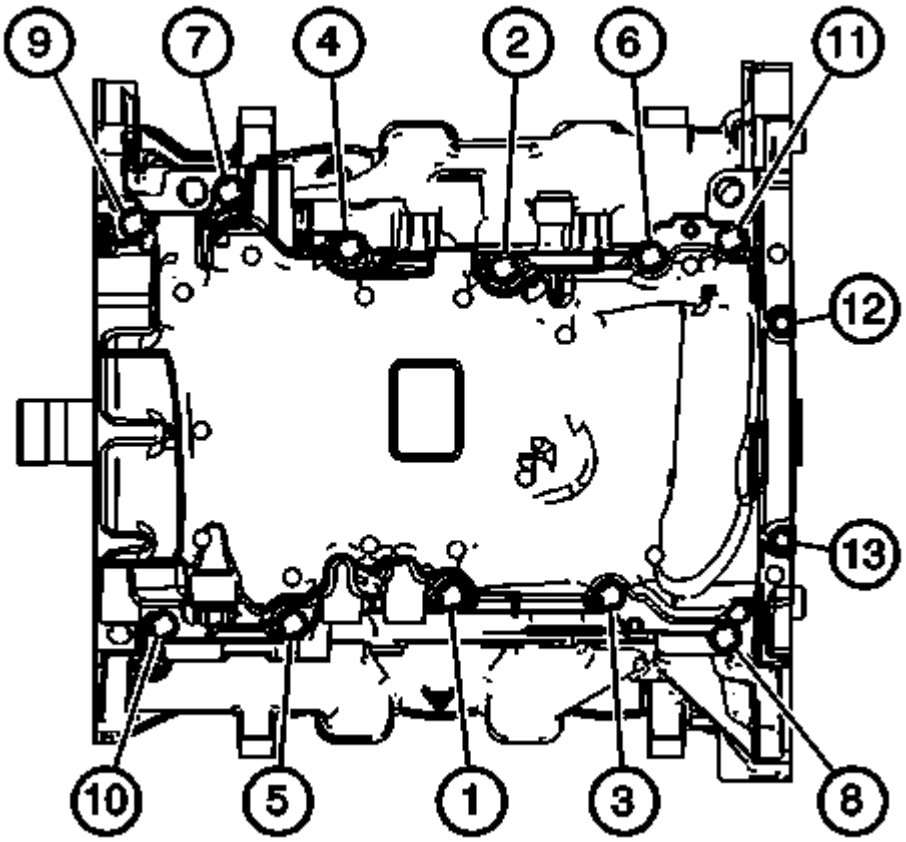


**Fig. 191: Identifying Oil Pan Bolt Tightening Sequence**
**Courtesy of GENERAL MOTORS CORP.**

**CAUTION: Refer to Fastener Caution .**

6. Tighten the oil pan bolts in sequence.
   - The 8 mm bolts (1-11) to 23 N.m (17 lb ft).
   - 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. Install the air conditioning (A/C) compressor. Refer to **Air Conditioning Compressor Replacement (LAF)** or **Air Conditioning Compressor Replacement (LF1)** .
9. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LF1)** .
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)** .

## ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (LF1)

 

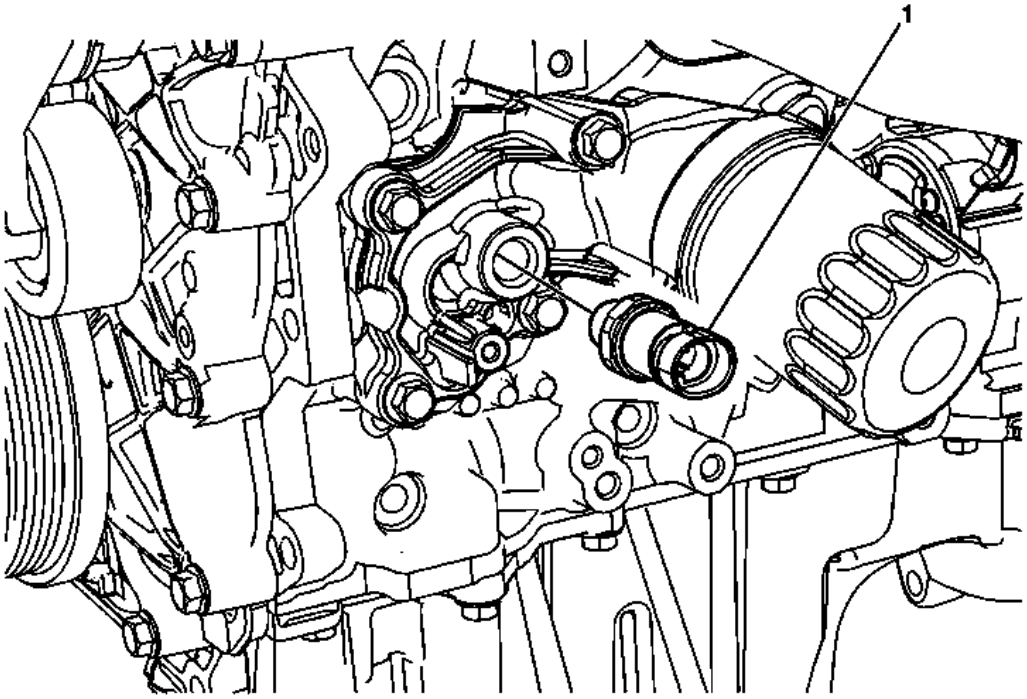


**Fig. 192: Engine Oil Pressure Sensor And/Or Switch (LF1)**
**Courtesy of GENERAL MOTORS CORP.**

| Callout | Component Name |
|---|---|
| **Preliminary Procedure:**<br>**Remove the generator. Refer to Generator Replacement (LAF) or Generator Replacement (LF1) .** | |
| 1 | Engine Oil Pressure Sensor and/or Switch<br><br>**CAUTION:**<br>**Refer to Component Fastener Tightening Caution .**<br><br>**Procedure**<br><br>1. Disconnect the oil pressure sensor electrical connector.<br>2. Transfer components as necessary.<br><br>**Tighten:** 20 N.m (15 lb ft)<br><br>**Special Tools:**<br>**EN-41712:** Oil Pressure Switch Socket<br>For equivalent regional tools, refer to **Special Tools** . |

 

**2010 ENGINE**

**Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - Equinox & Terrain**

# OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

## REMOVAL PROCEDURE

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

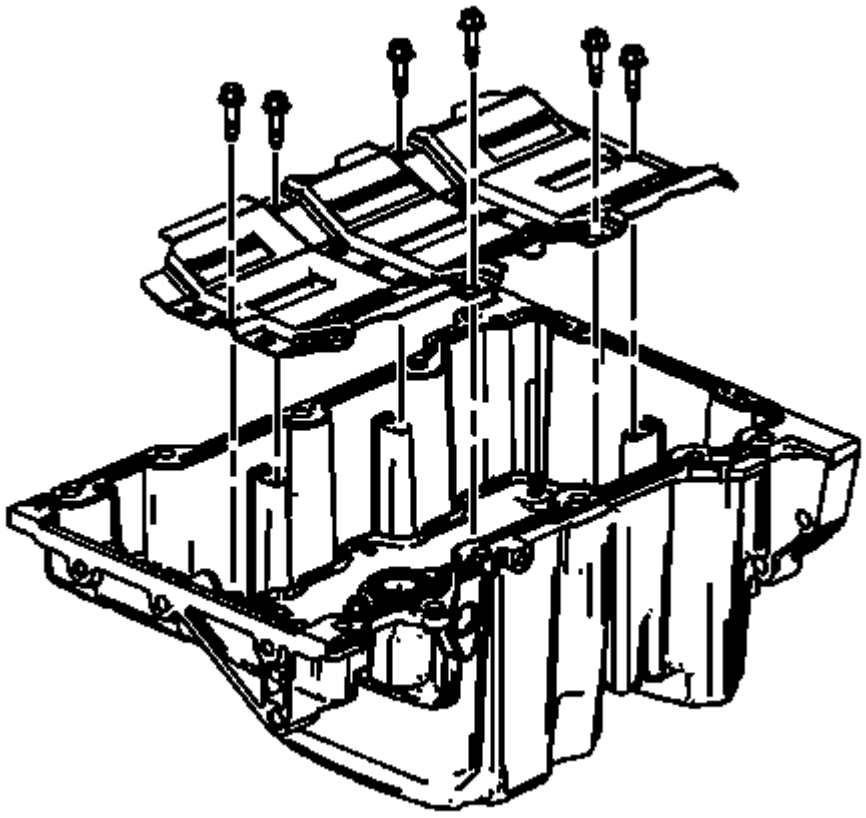

**Fig. 1: View Of Oil Pan Scraper & Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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

 

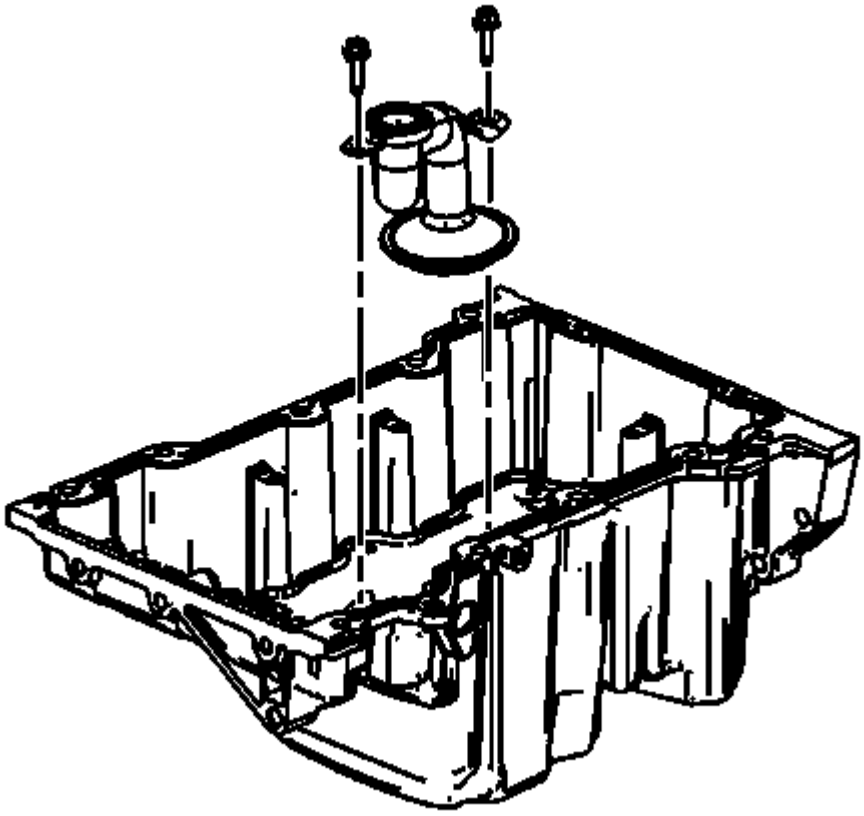

**Fig. 2: View Of Oil Suction Pipe**
**Courtesy of GENERAL MOTORS CORP.**

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

 

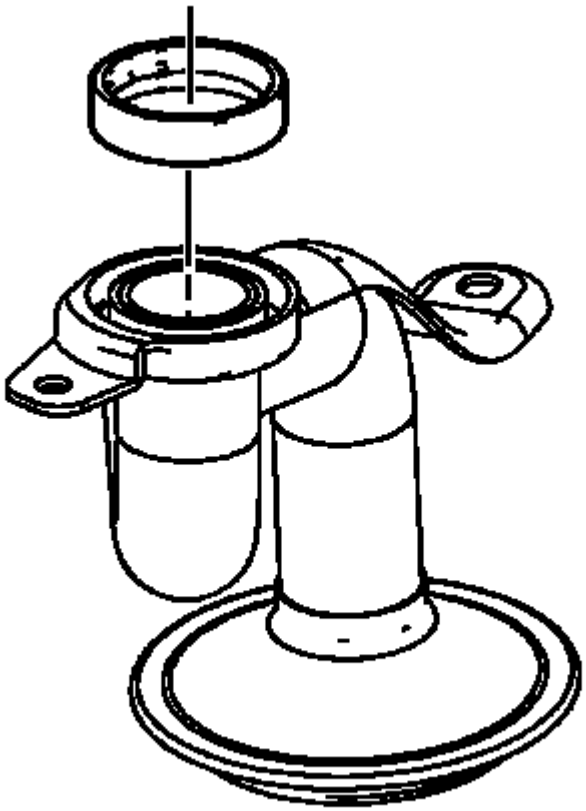

**Fig. 3: View Of Oil Suction Tube Seal & Oil Suction Tube**
**Courtesy of GENERAL MOTORS CORP.**

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

**INSTALLATION PROCEDURE**

 

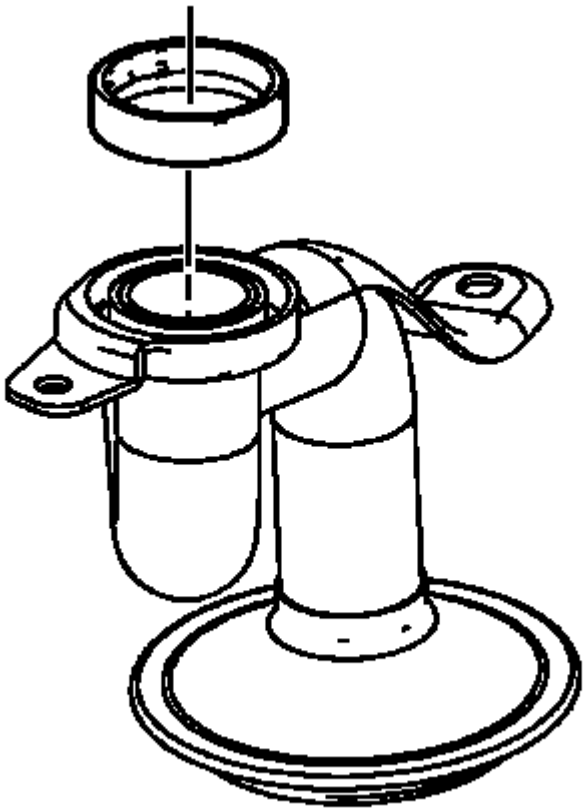

**Fig. 4: View Of Oil Suction Tube Seal & Oil Suction Tube**
**Courtesy of GENERAL MOTORS CORP.**

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

 

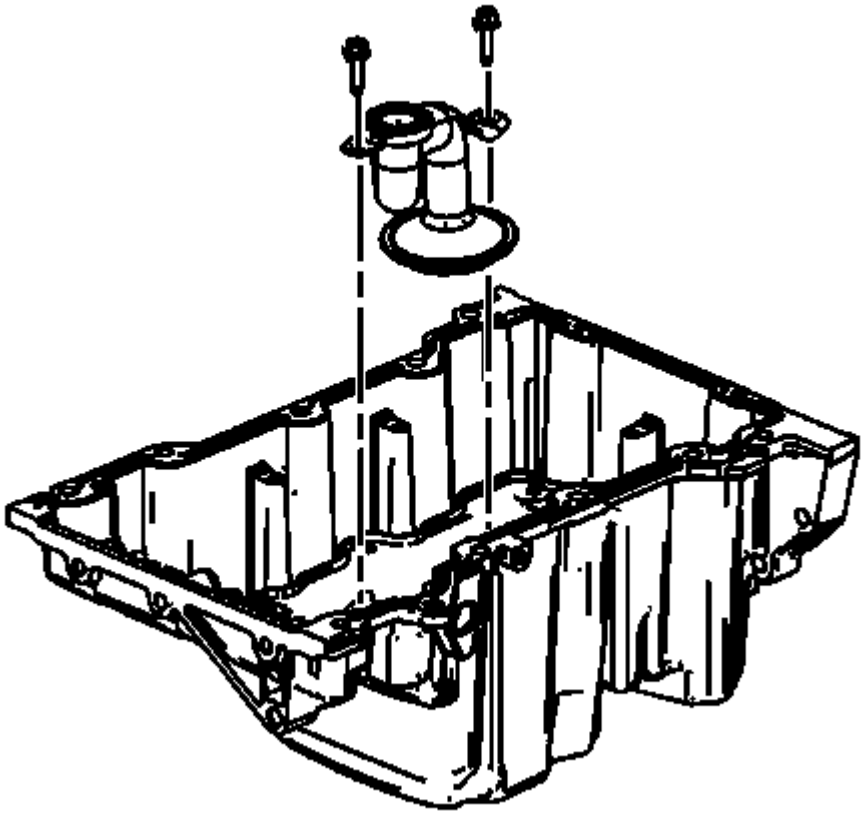

**Fig. 5: View Of Oil Suction Pipe**
**Courtesy of GENERAL MOTORS CORP.**

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).

 

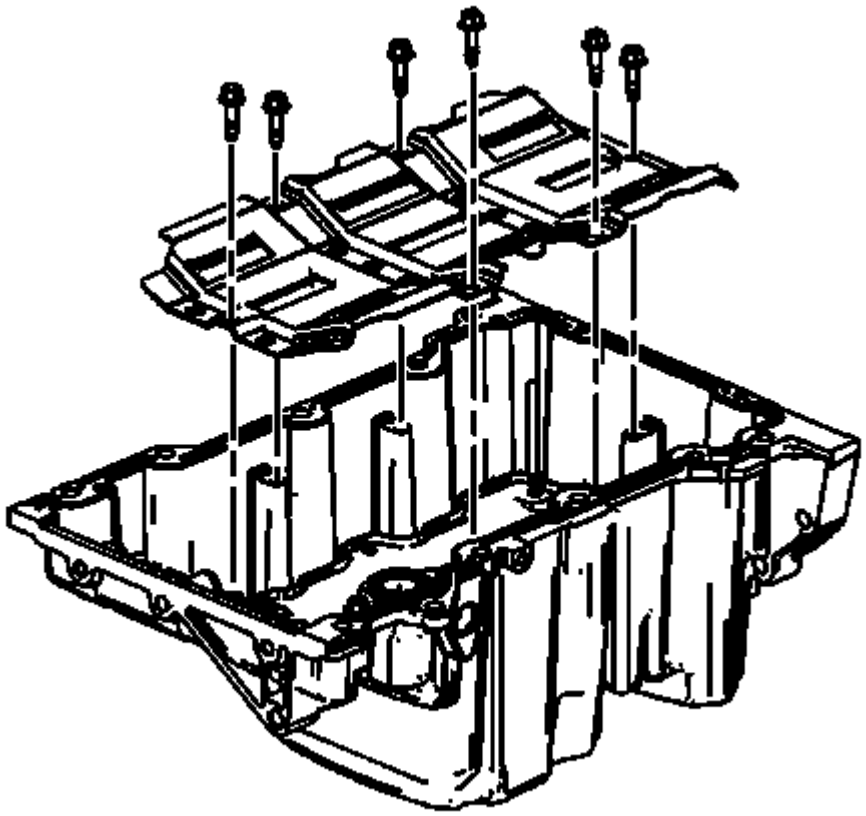

**Fig. 6: View Of Oil Pan Scraper And Bolts**
**Courtesy of GENERAL MOTORS CORP.**

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. Relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
2. Remove negative battery cable from engine block. Refer to **Battery Negative Cable Replacement (LF1)** or **Battery Negative Cable Replacement (LAF)**
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

 

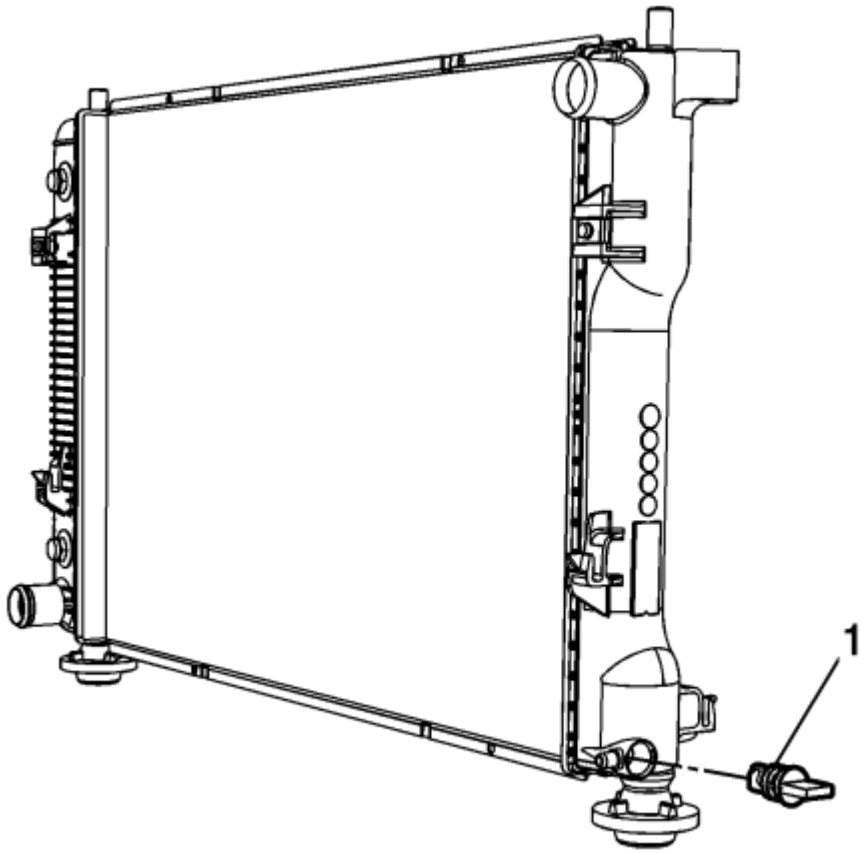


**Fig. 7: Radiator Drain Cock**
**Courtesy of GENERAL MOTORS CORP.**

5. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)** .
6. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement (LF1)**.
7. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
8. Remove the battery tray. Refer to **Battery Tray Replacement** .

 

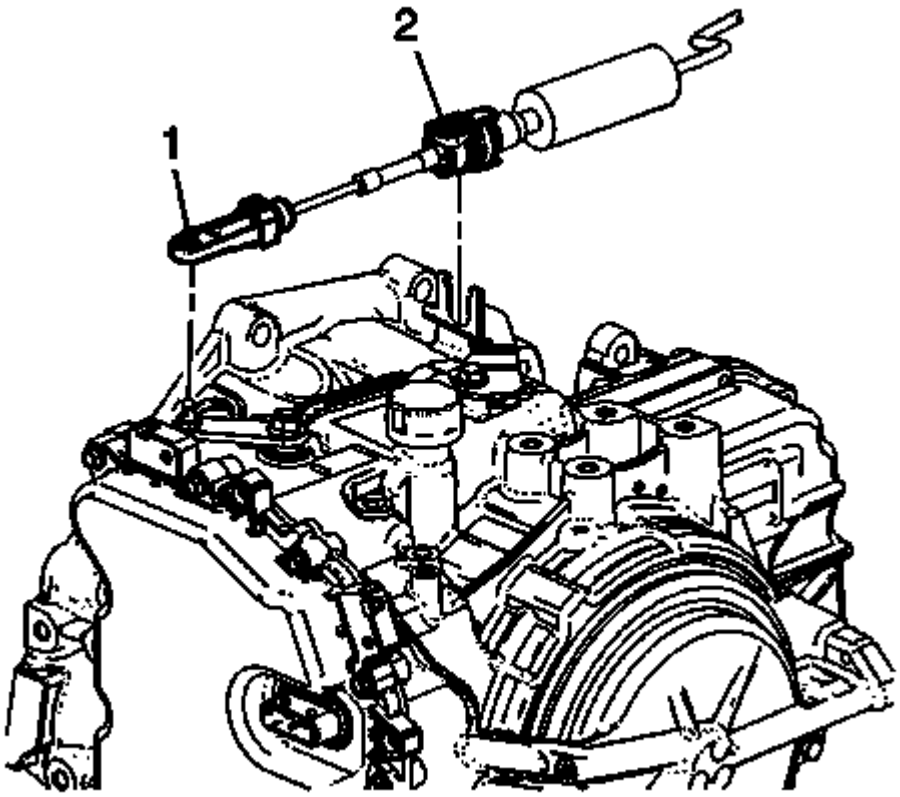


**Fig. 8: View Of Transmission Range Selector Lever & Cable Connection**
**Courtesy of GENERAL MOTORS CORP.**

9. Disconnect the range selector cable end (1) from the range selector lever.
10. Disconnect the range selector cable (2) from the range selector cable bracket.
11. Disconnect the wiring harness from the underhood junction block. refer to **Accessory Wiring Junction Block Replacement** .
12. Remove battery hold down retainer bracket.
13. Disconnect right side inline electrical connector.

 

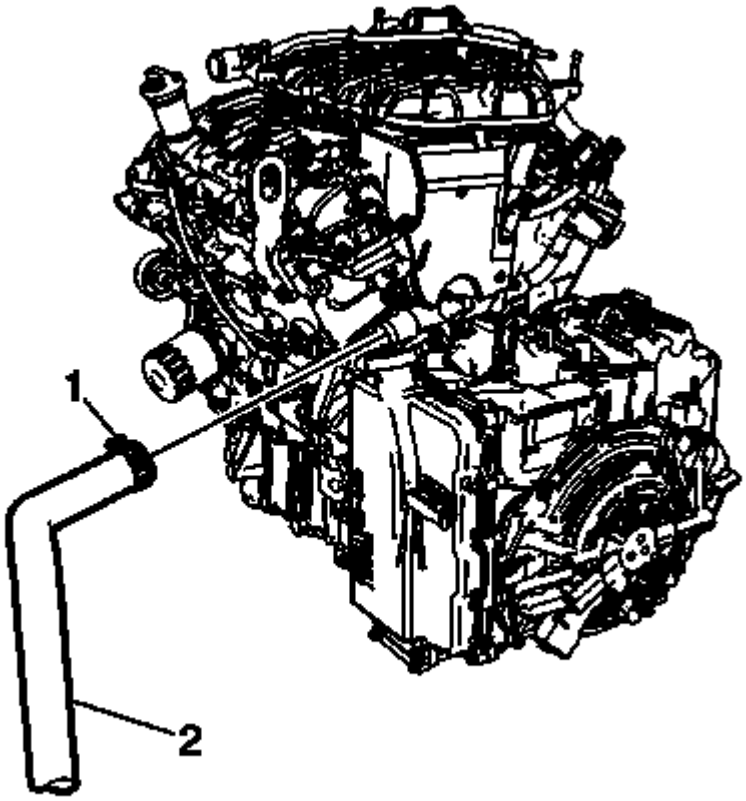


**Fig. 9: Radiator Outlet Hose At Engine**
**Courtesy of GENERAL MOTORS CORP.**

14. Disengage tension on the radiator outlet hose clamp (1) at the engine using **J-38185:** Hose Clamp Pliers.

 

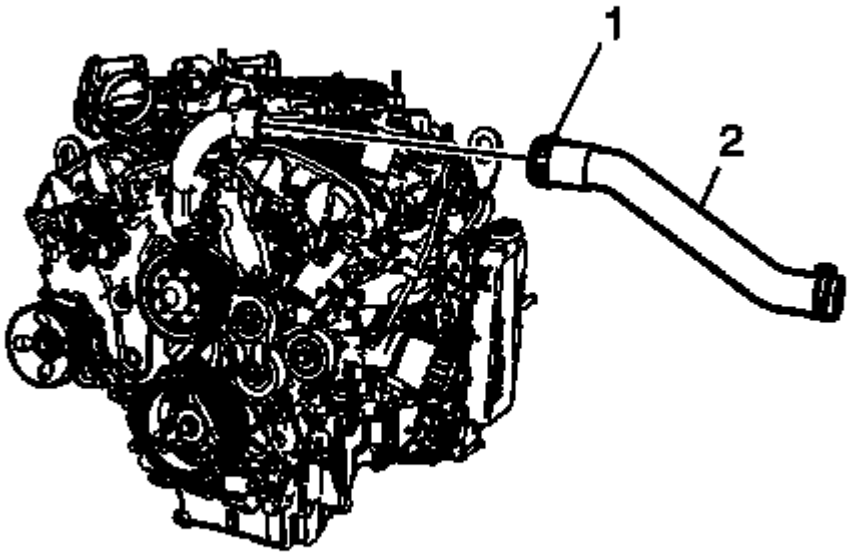


**Fig. 10: Radiator Inlet Hose At Engine**
**Courtesy of GENERAL MOTORS CORP.**

15. Remove the radiator inlet hose (2) from the engine.

 

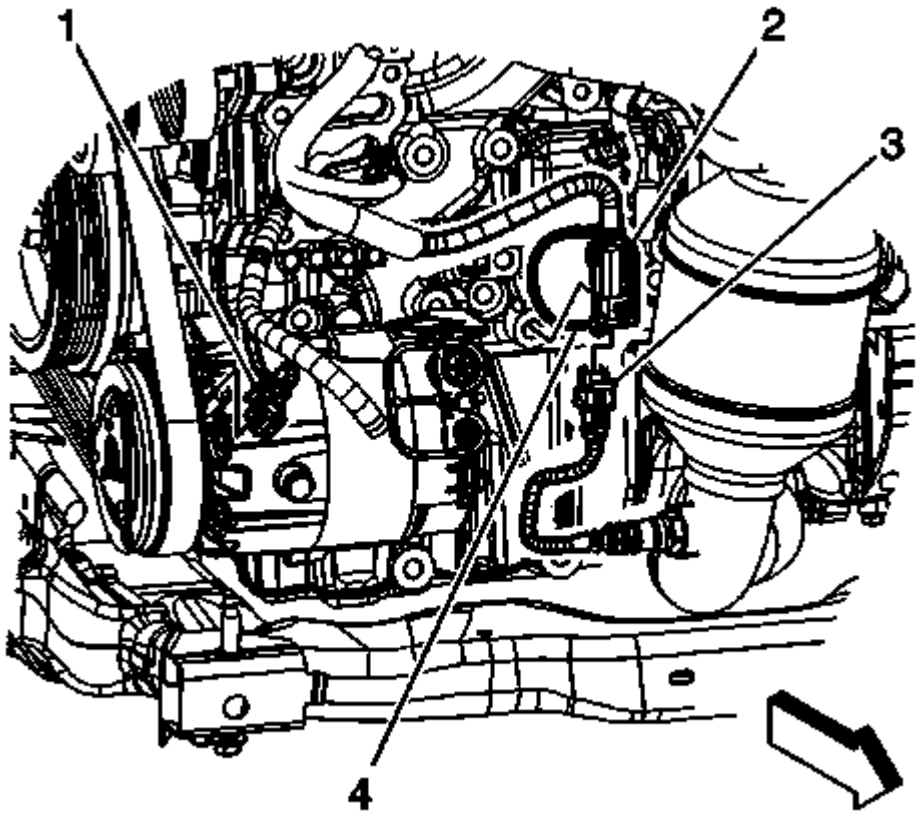


**Fig. 11: Electrical Connectors - Left Side**
**Courtesy of GENERAL MOTORS CORP.**

16. Disconnect the A/C compressor (1).
17. Disconnect the radiator outlet hose from the engine. Refer to **Radiator Outlet Hose Replacement (LAF)** or **Radiator Outlet Hose Replacement (LF1)** .
18. Disconnect the radiator inlet hose from the engine. Refer to **Radiator Inlet Hose Replacement (LAF)** or **Radiator Inlet Hose Replacement (LF1)** .

 

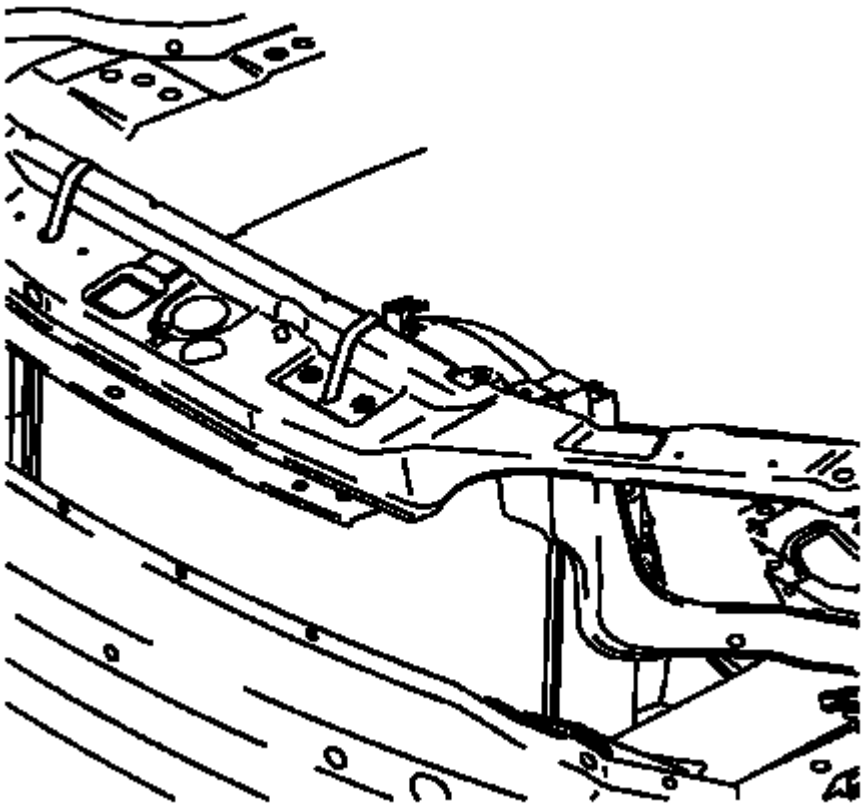

**Fig. 12: View Of Cooling Module Secured To Upper Body Structure**
**Courtesy of GENERAL MOTORS CORP.**

19. Secure the cooling module to the upper body structure
20. Remove the engine control module (ECM). Refer to **Engine Control Module Replacement** .
21. Support the engine in the cradle with wood blocks.
22. Remove right side engine mount. Refer to **Engine Mount Replacement - Right Side** .
23. Disconnect the A/C high pressure switch harness.
24. Discharge A/C system. Refer to **Refrigerant Recovery and Recharging** .
25. Disconnect the electrical connector from the air conditioning refrigerant pressure sensor valve.

 

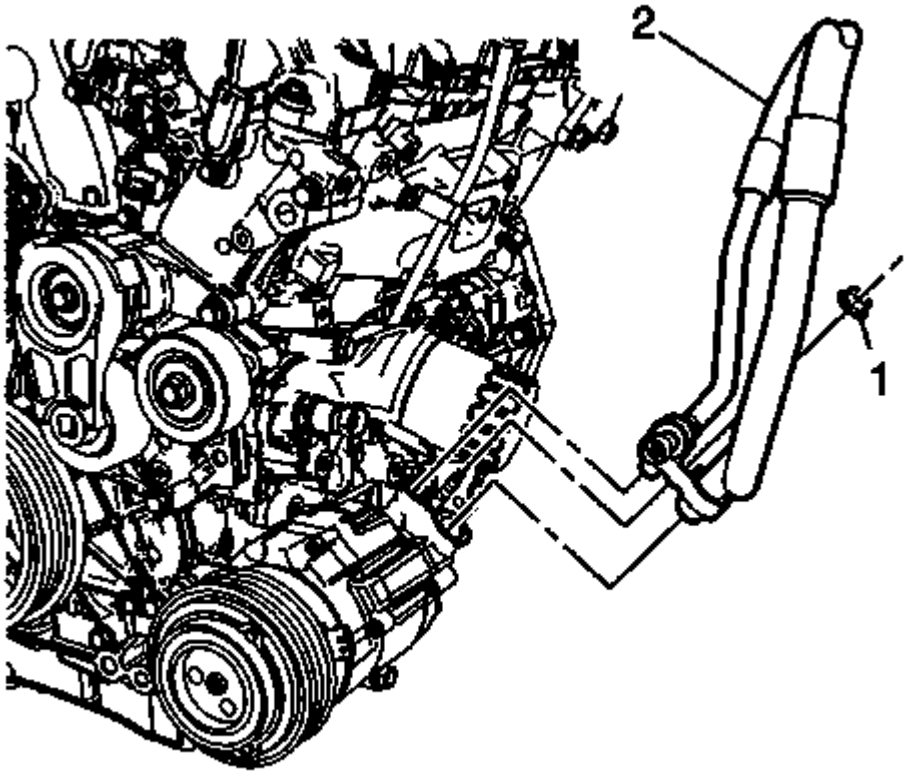


**Fig. 13: Compressor Hose & Nut**
**Courtesy of GENERAL MOTORS CORP.**

26. Remove the compressor hose nut (1) at the compressor
27. Remove the compressor hose (2) from the compressor.
28. Remove the A/C compressor hose from the compressor, then reposition the hose out of the way.
29. Disconnect the Coolant Recovery Reservoir Vent Hose. Refer to **Coolant Recovery Reservoir Vent Hose Replacement (LAF)** or **Coolant Recovery Reservoir Vent Hose Replacement (LF1)** .
30. Disconnect the Coolant Recovery Reservoir Outlet Hose. Refer to **Coolant Recovery Reservoir Outlet Hose Replacement (LAF)** or **Coolant Recovery Reservoir Outlet Hose Replacement (LF1)** .
31. Disconnect the heater inlet hose from the engine.
32. Disconnect the heater outlet hose from the engine.

 

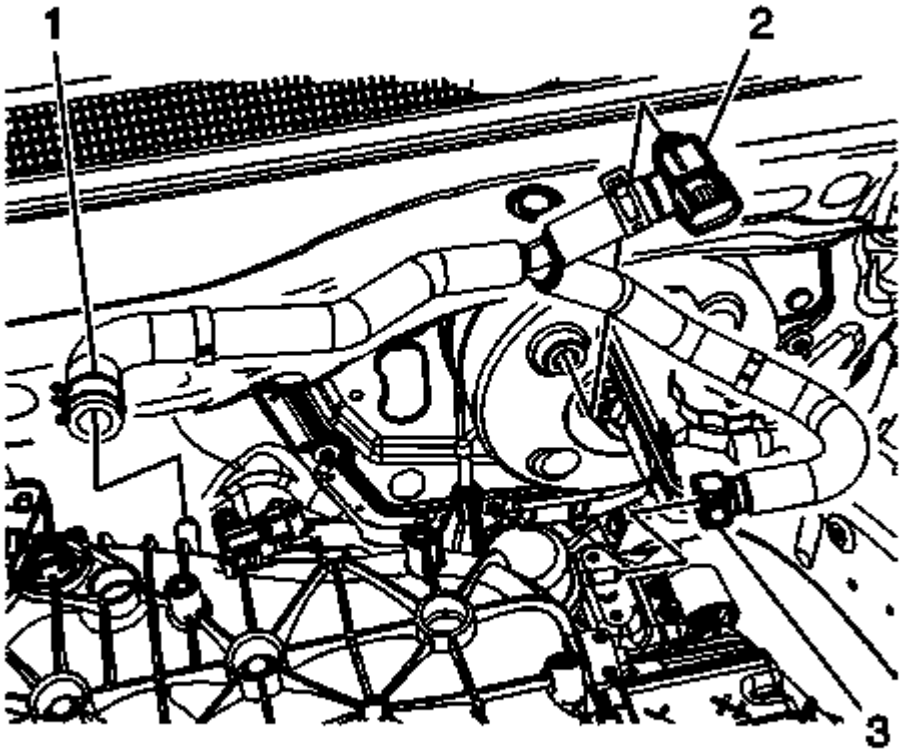


**Fig. 14: Power Brake Booster Vacuum Hose Quick Connect, Spring Clamp & Vacuum Sensor**
**Courtesy of GENERAL MOTORS CORP.**

33. Release the spring clamp (1) and remove the power brake booster vacuum hose from the intake manifold vacuum port.
34. Remove the power brake booster vacuum sensor (2) from the power vacuum brake booster.
35. Disconnect the fuel feed line. Refer to **Fuel Feed Pipe Replacement (LF1)** .
36. Disconnect the fuel EVAP emission line. Refer to **Plastic Collar Quick Connect Fitting Service** .
37. Disconnect the coolant reservoir hose from the engine to reservoir.
38. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
39. Remove the lower transaxle-to-engine bolts.
40. Remove the torque converter inspection cover.
41. Remove the starter. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .
42. Mark the relationship of the flywheel to the torque converter for reassembly.
43. Remove the torque converter to flywheel bolts.

 

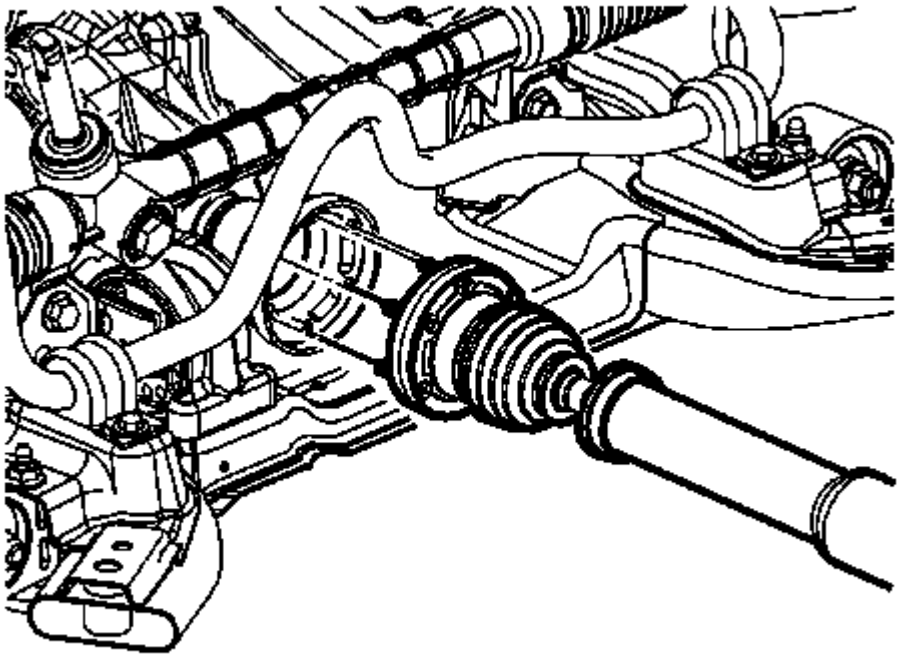

**Fig. 15: View Of Propeller Shaft**
**Courtesy of GENERAL MOTORS CORP.**

44. For AWD, remove the propeller shaft completely from the vehicle. Refer to **Propeller Shaft Replacement** .
45. For AWD, remove the transfer case. Refer to **Transfer Case Assembly Replacement** .
46. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation** .
47. Remove the right and left engine splash shields.
48. Disconnect the transmission cooler lines from the radiator.
49. Disconnect the power steering hoses from the power steering cooler.
50. Remove the left and right tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
51. Remove the left and right stabilizer bar links. Refer to **Stabilizer Shaft Link Replacement** .
52. Disconnect the left and right lower ball joints. Refer to **Lower Control Arm Replacement** .
53. Disconnect the left and right axle shafts from the hubs. Refer to **Front Wheel Drive Shaft Replacement** .

**NOTE: In order to prevent possible SIR system deployment, do not attempt to rotate the steering shaft.**

 

54. Disconnect the steering shaft coupling from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
55. Remove the front exhaust pipe. Refer to **Catalytic Converter Replacement - Left Side (LF1)** and **Catalytic Converter Replacement - Right Side (LF1)** .
56. Support the engine in the cradle with wood blocks.
57. Remove the left engine mount. Refer to **Transmission Mount Replacement - Left Side**

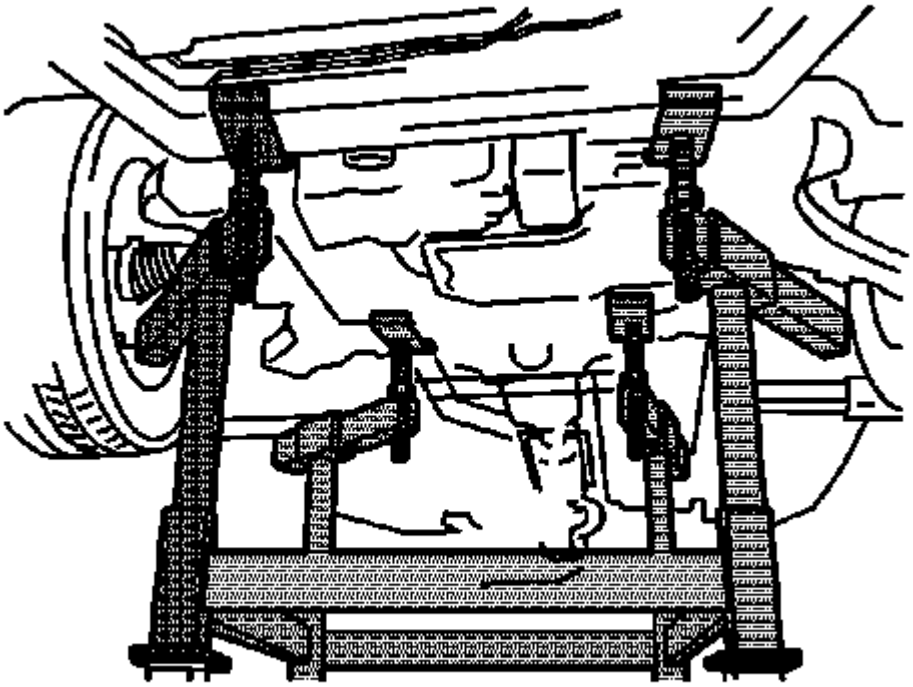

**Fig. 16: Identifying Utility Stand**
**Courtesy of GENERAL MOTORS CORP.**

58. Position the engine support table under the powertrain assembly.
59. With the table positioned, fully raise the table to contact with the powertrain assembly.
60. Remove the front crossmember support bracket to body bolts.
61. Remove the cradle bolts.

**NOTE: During the powertrain removal, support the vehicle body by placing a jack at the rear of the vehicle.**

62. Slowly raise the vehicle until the powertrain assembly is clear of the vehicle.

 

63. Remove the front transmission mount from the frame. Refer to **Transmission Front Mount Replacement** .
64. Separate the engine from the transmission.
65. Transfer parts as needed.

**INSTALLATION PROCEDURE**

1. Align the engine to the transmission.

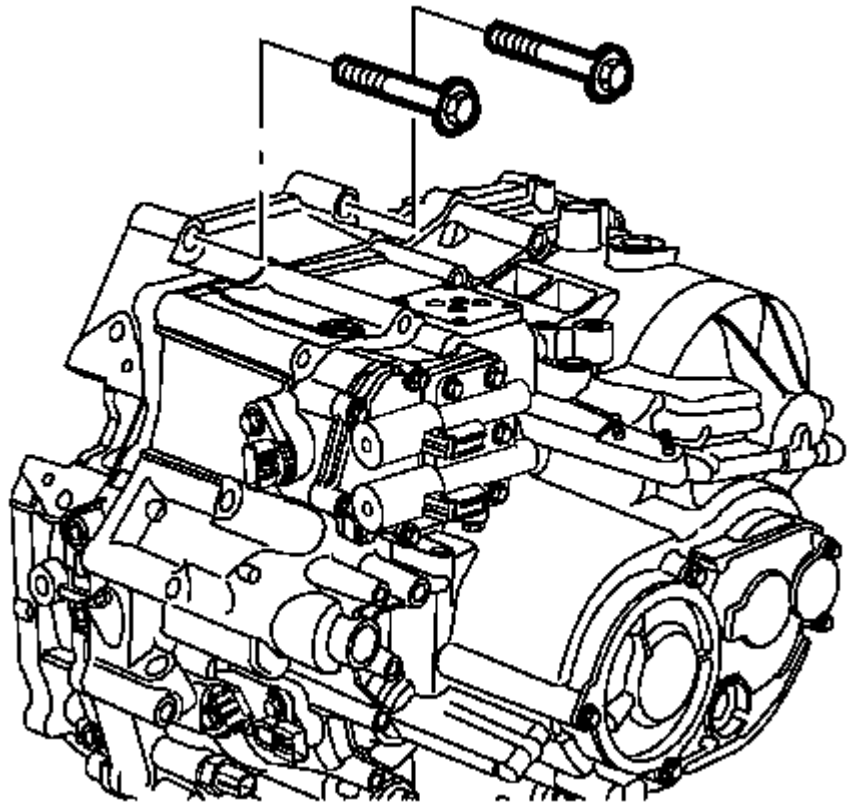

**Fig. 17: View Of Transmission-To-Engine Mounting Bolts**
**Courtesy of GENERAL MOTORS CORP.**

**CAUTION: Refer to Fastener Caution .**

2. Install the transmission-to-engine mounting bolts. Tighten the bolts to 75 N.m (55 lb ft).
3. Install the right engine mount. Refer to **Engine Mount Replacement - Right Side** .
4. Install the front transmission mount to the engine. Refer to **Transmission Front Mount Replacement** .
5. Install the powertrain assembly to the vehicle.
6. Install the cradle bolts. Refer to **Drivetrain and Front Suspension Frame Replacement** .

 

7. Install the front crossmember support bracket to body bolts. Tighten the bolts to 50 N.m (37 lb ft)
8. Remove the engine support table.
9. Install the front transmission mount bolts to the body. Refer to **Transmission Front Mount Replacement** .
10. Remove the wood blocks from the cradle.
11. Install the lower transaxle-to-engine bolts and tighten to 75 N.m (55 lb ft).
12. For AWD, install the transfer case. Refer to **Transfer Case Assembly Replacement** .
13. Install the torque converter-to-flywheel bolts and tighten to 62 N.m (46 lb ft).
14. Install the starter. Refer to **Starter Replacement (LAF)** or **Starter Replacement (LF1)** .
15. Install the torque converter inspection cover.
16. Install the torque converter inspection cover and tighten the bolts to 12 N.m (106 lb in).
17. Install the front exhaust pipe. Refer to **Catalytic Converter Replacement - Left Side (LF1)** and **Catalytic Converter Replacement - Right Side (LF1)** .
18. Connect the steering shaft coupling from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
19. For AWD, install the propeller shaft. Refer to **Propeller Shaft Replacement** .
20. Install the left and right axle shaft nuts. Refer to **Front Wheel Drive Shaft Replacement** .
21. Connect the left and right lower ball joints. Refer to **Lower Control Arm Replacement** .
22. Install the left and right stabilizer bar links. Refer to **Stabilizer Shaft Link Replacement** .
23. Install the left and right tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
24. Connect the transmission cooler lines to the transmission.
25. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LAF)** or **Air Conditioning Compressor Replacement (LF1)** .
26. Install the right and left engine splash shields.
27. Connect the transmission cooler lines to the radiator.
28. Connect the power steering hoses to the power steering cooler.
29. Install the front tires. Refer to **Tire and Wheel Removal and Installation** .
30. Lower the vehicle.
31. Connect the range selector cable (2) to the range selector cable bracket.
32. Connect the wiring harness to the underhood junction block. refer to **Accessory Wiring Junction Block Replacement** .
33. Connect right side inline electrical connector.
34. Install the fuel EVAP line.
35. Connect the fuel feed line. Refer to **Fuel Feed Pipe Replacement (LF1)** .
36. Connect the heater inlet hose to the engine.
37. Connect the heater outlet hose to the engine.
38. Install the A/C compressor hose to the compressor.
39. Connect the transmission cooler lines to the radiator.

 

40. Connect the power steering hoses to the power steering cooler.
41. Connect the Coolant Recovery Reservoir Vent Hose. Refer to **Coolant Recovery Reservoir Vent Hose Replacement (LAF)** or **Coolant Recovery Reservoir Vent Hose Replacement (LF1)** .
42. Connect the Coolant Recovery Reservoir Outlet Hose. Refer to **Coolant Recovery Reservoir Outlet Hose Replacement (LAF)** or **Coolant Recovery Reservoir Outlet Hose Replacement (LF1)** .

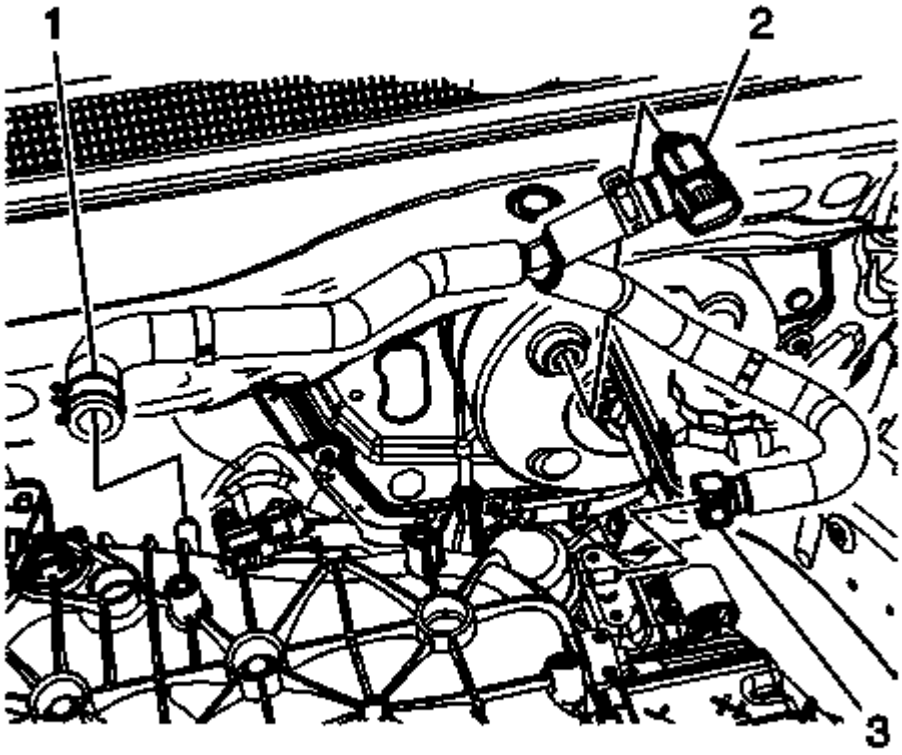


**Fig. 18: Power Brake Booster Vacuum Hose Quick Connect, Spring Clamp & Vacuum Sensor**
**Courtesy of GENERAL MOTORS CORP.**

43. Install the power brake booster vacuum sensor (2) to the power vacuum brake booster.
44. Install the starter positive cable and tighten to 10 N.m (89 lb in).
45. Connect the coolant reservoir hose from the engine to reservoir.
46. Connect the A/C high pressure switch harness.
47. Connect the electrical connector to the air conditioning refrigerant pressure sensor valve.
48. Connect the generator positive cable and nut and tighten to 12 N.m (106 lb in).
49. Install the ECM. Refer to **Engine Control Module Replacement** .
50. Connect the radiator outlet hose to the engine. Refer to **Radiator Outlet Hose Replacement (LAF)** or **Radiator Outlet Hose Replacement (LF1)** .
51. Connect the radiator inlet hose to the engine. Refer to **Radiator Inlet Hose Replacement (LAF)** or

 

**Radiator Inlet Hose Replacement (LF1)** .

52. Fill the vehicle with coolant. Refer to **Cooling System Draining and Filling (Static)** or **Cooling System Draining and Filling (GE 47716)** .
53. Fill the vehicle with engine oil. Refer to **Engine Oil and Oil Filter Replacement (LF1)**.
54. Connect the wiring harness to the underhood junction block.
55. Connect the transmission shifter cable.
56. Remove the cooling module support.
57. Install the battery tray and battery. Refer to **Battery Tray Replacement** .
58. Install battery hold down retainer bracket.
59. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
60. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
61. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
62. Perform the throttle learn procedure. Refer to **Throttle/Idle Learn (LF1, LFW)** .

# ENGINE OIL AND OIL FILTER REPLACEMENT (LF1)

### 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 20 N.m (15 lb ft).

 

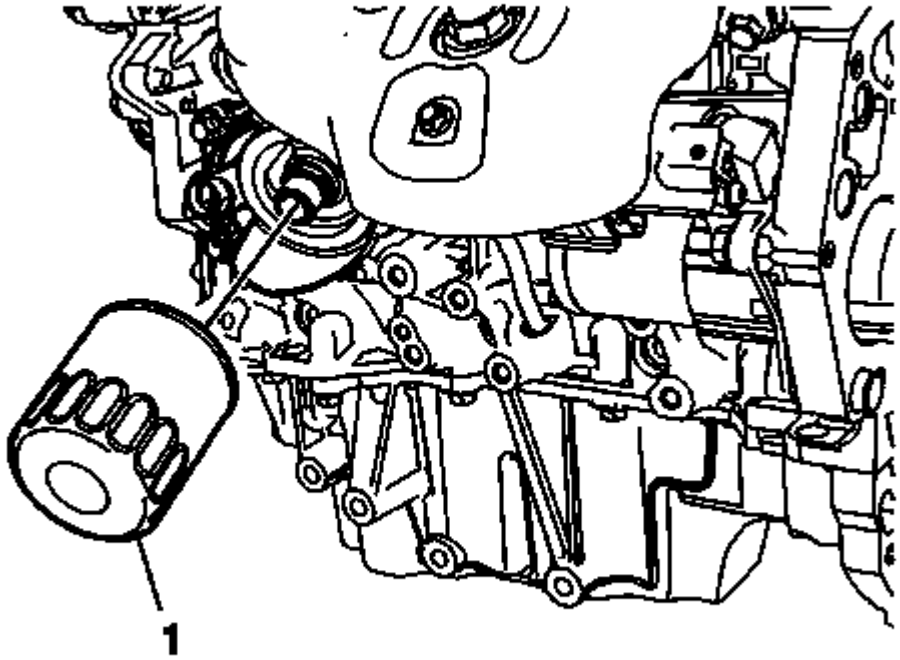


**Fig. 19: Oil Filter**
**Courtesy of GENERAL MOTORS CORP.**

**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**

 

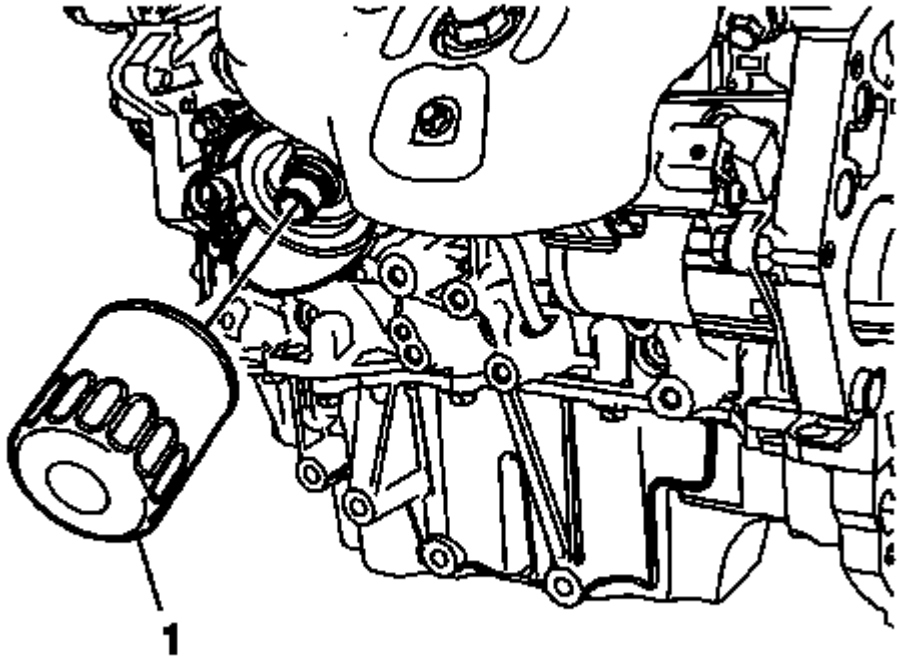


**Fig. 20: Oil Filter**
**Courtesy of GENERAL MOTORS CORP.**

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Tighten the oil filter (1) to 30 N.m (22 lb ft).
3. Lower the vehicle.
4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
5. Start the engine and inspect for leaks.

 