

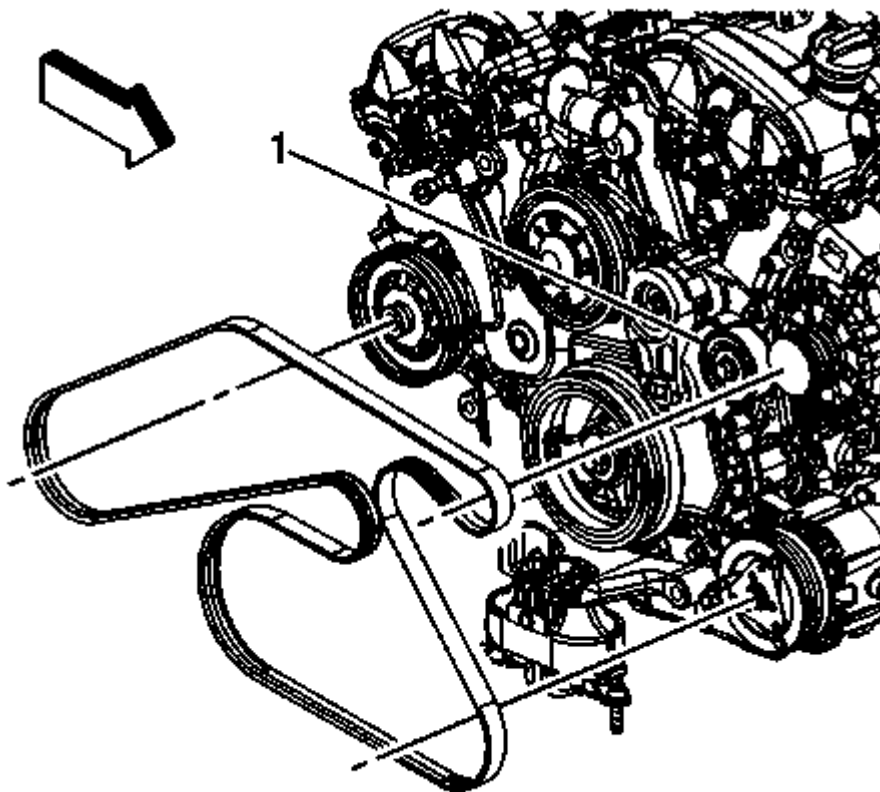
## 2010 ENGINE

### Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - G6

## DRIVE BELT REPLACEMENT

### REMOVAL PROCEDURE

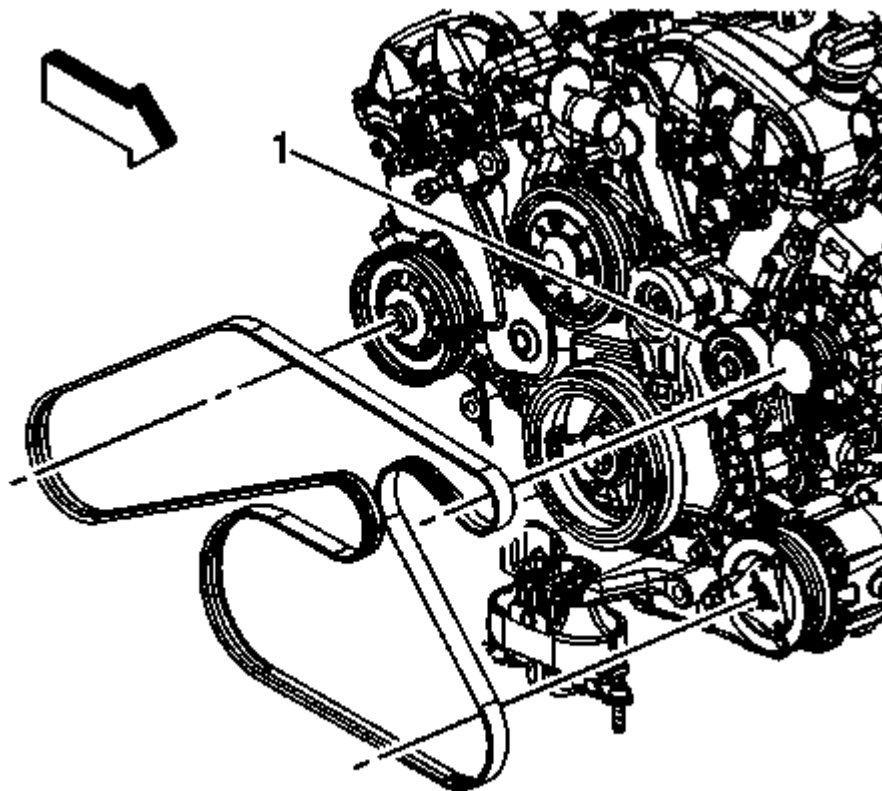
1. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
2. Remove the engine mount snubber bracket. Refer to [Engine Mount Snubber Bracket Replacement](#).



**Fig. 1: Identifying Drive Belt Routing & Idler Pulley**  
Courtesy of GENERAL MOTORS CORP.

3. Rotate the drive belt tensioner clockwise to release the drive belt tension.
4. Slide the drive belt off of the belt idler pulley (1).
5. Slowly release the drive belt tensioner.
6. Remove the drive belt from the accessory drive pulleys.

### INSTALLATION PROCEDURE



**Fig. 2: Identifying Drive Belt Routing & Idler Pulley**  
Courtesy of GENERAL MOTORS CORP.

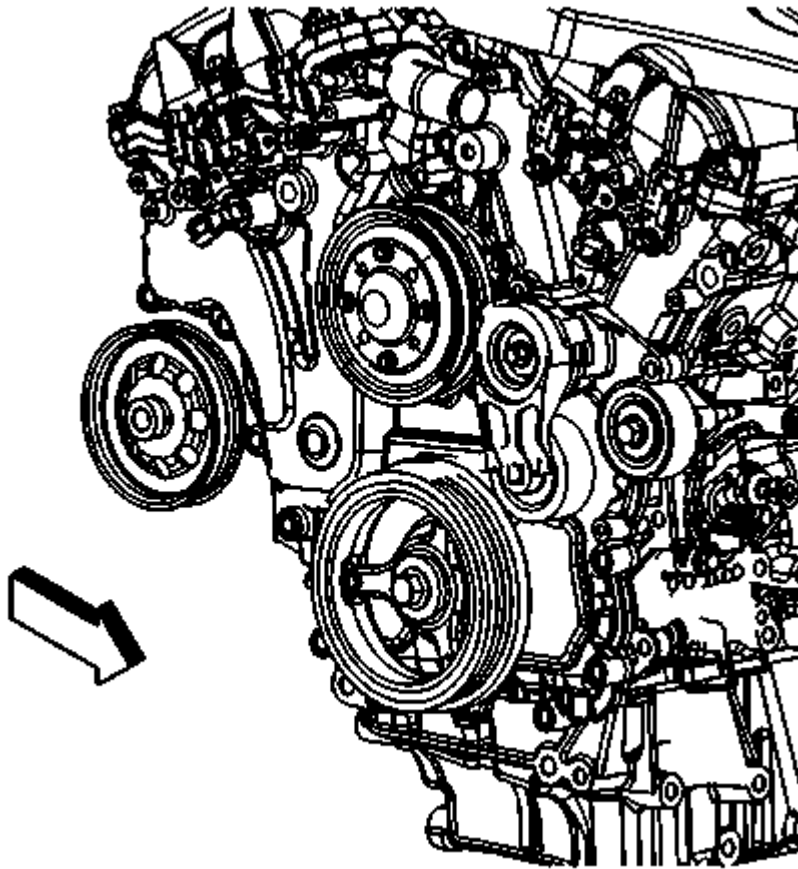
1. Install the drive belt to the crankshaft pulley, the tensioner and the generator.
2. Rotate the drive belt tensioner clockwise.
3. Install the drive belt to the idler pulley (1).

**NOTE:** Ensure the drive belt is properly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner.
5. Install the engine mount snubber. Refer to [Engine Mount Snubber Bracket Replacement](#).
6. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

## **DRIVE BELT TENSIONER REPLACEMENT**

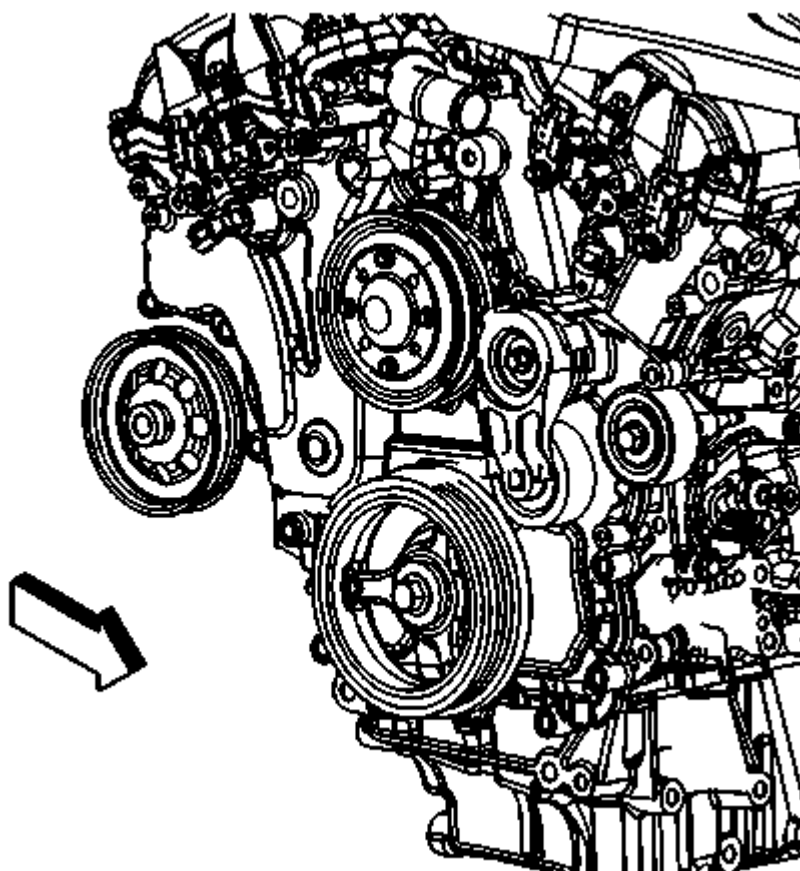
### **REMOVAL PROCEDURE**



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

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Loosen the idler pulley.
3. Remove the tensioner bolts.
4. Remove the tensioner.

## INSTALLATION PROCEDURE



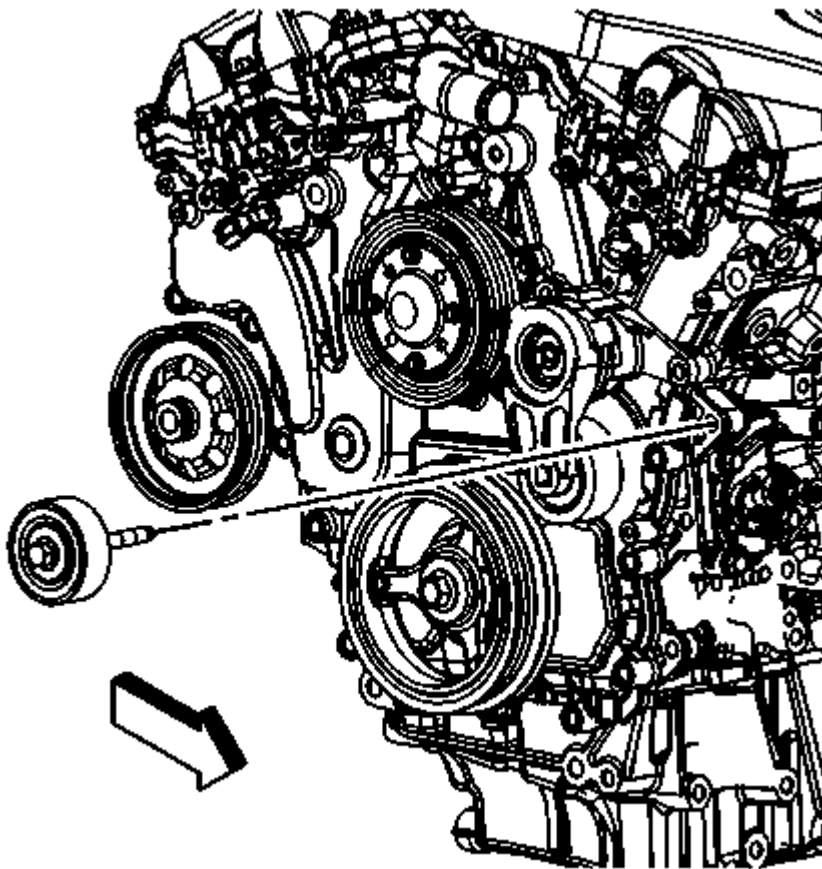
**Fig. 4: Identifying Drive Belt Tensioner**  
Courtesy of GENERAL MOTORS CORP.

1. Position the tensioner and install the tensioner bolts.
2. Tighten the idler pulley.
3. Install the drive belt. Refer to **Drive Belt Replacement**.

## **DRIVE BELT IDLER PULLEY REPLACEMENT**

### **REMOVAL PROCEDURE**

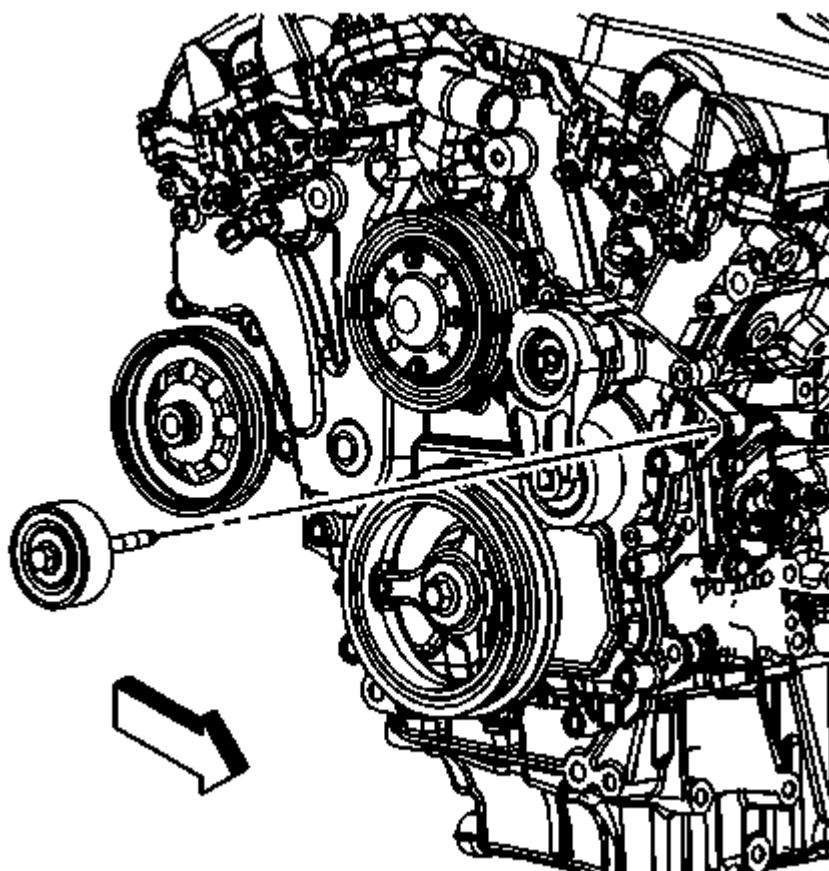
1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Completely loosen the idler pulley bolt.



**Fig. 5: View Of Drive Belt Idler Pulley**  
**Courtesy of GENERAL MOTORS CORP.**

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

## **INSTALLATION PROCEDURE**



**Fig. 6: View Of 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.

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

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

## ENGINE SUPPORT FIXTURE

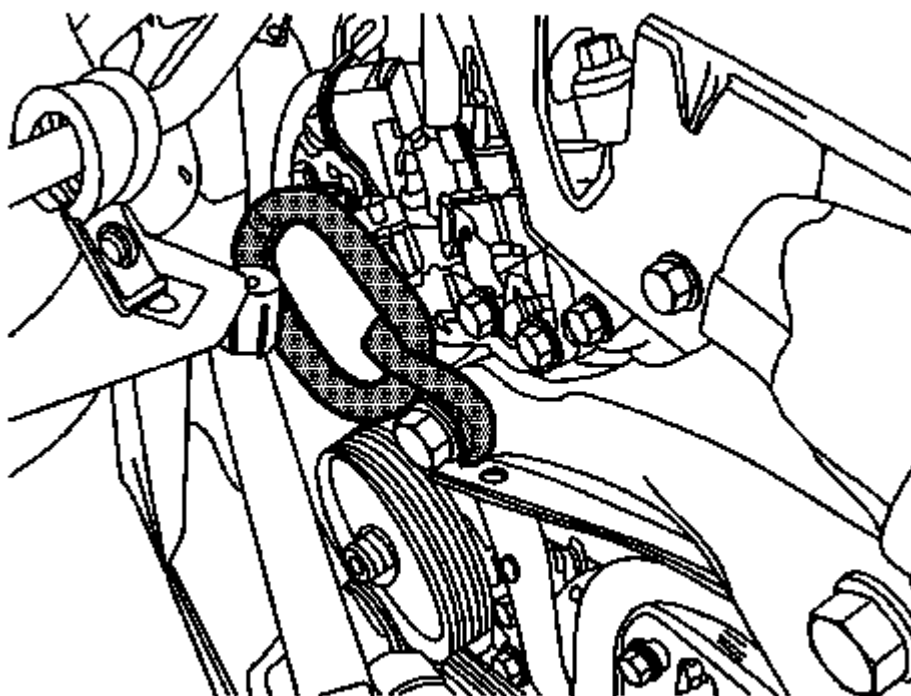
### SPECIAL TOOLS

- **J 28467-B** Universal Engine Support Fixture
- **J 42451-1** Engine Support Adapter

- **J 28467-500** Engine Support Fixture. See **Special Tools** .

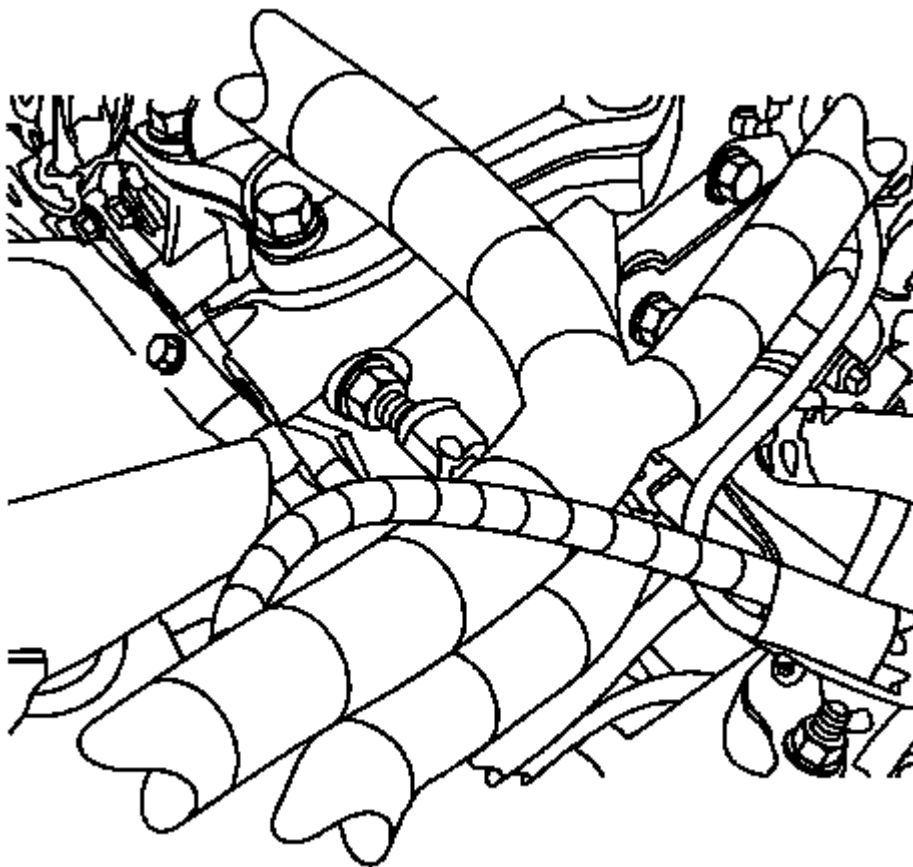
## INSTALLATION PROCEDURE

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.



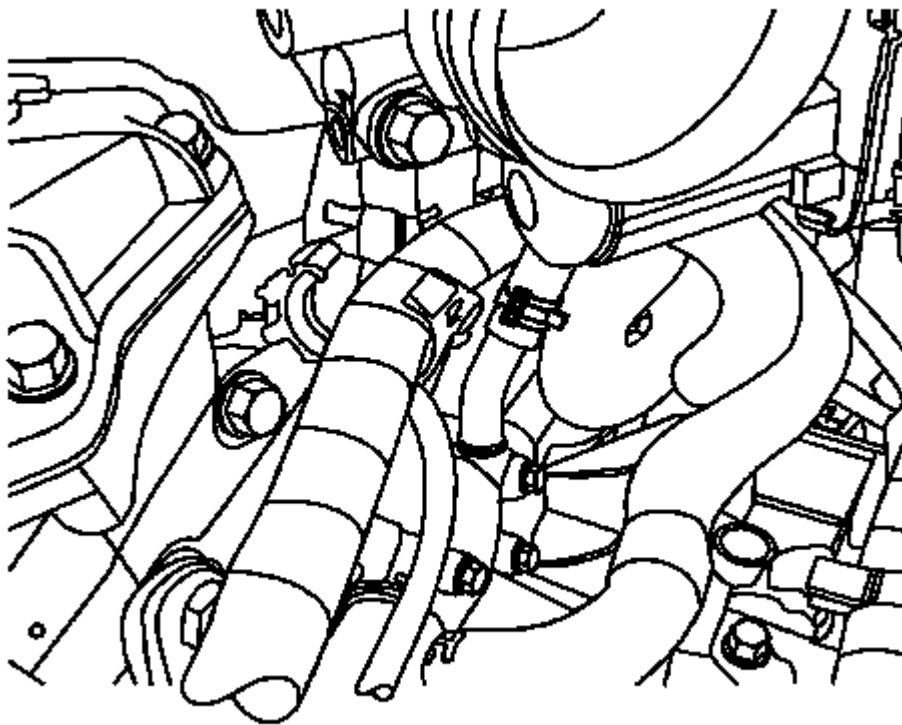
**Fig. 7: Identifying Engine Mount Bracket & Engine Support Bracket**  
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount bracket with the engine support bracket **J 42451-1** to the engine.



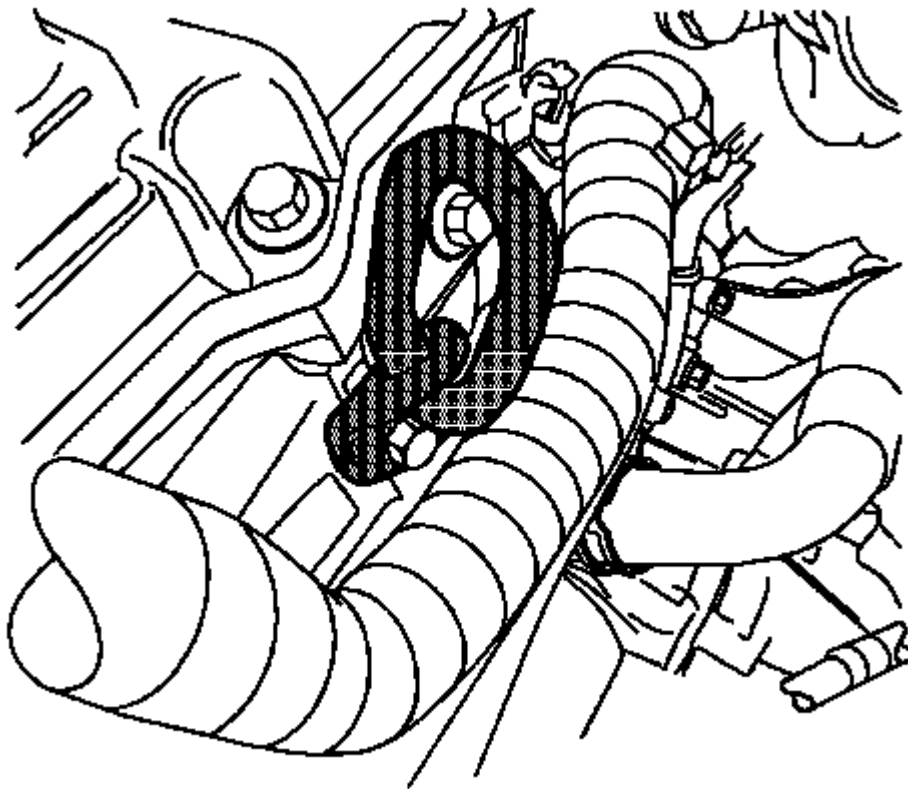
**Fig. 8: Identifying Engine Harness Clip & Holding Stud**  
Courtesy of GENERAL MOTORS CORP.

6. Remove engine harness clip from the holding stud.



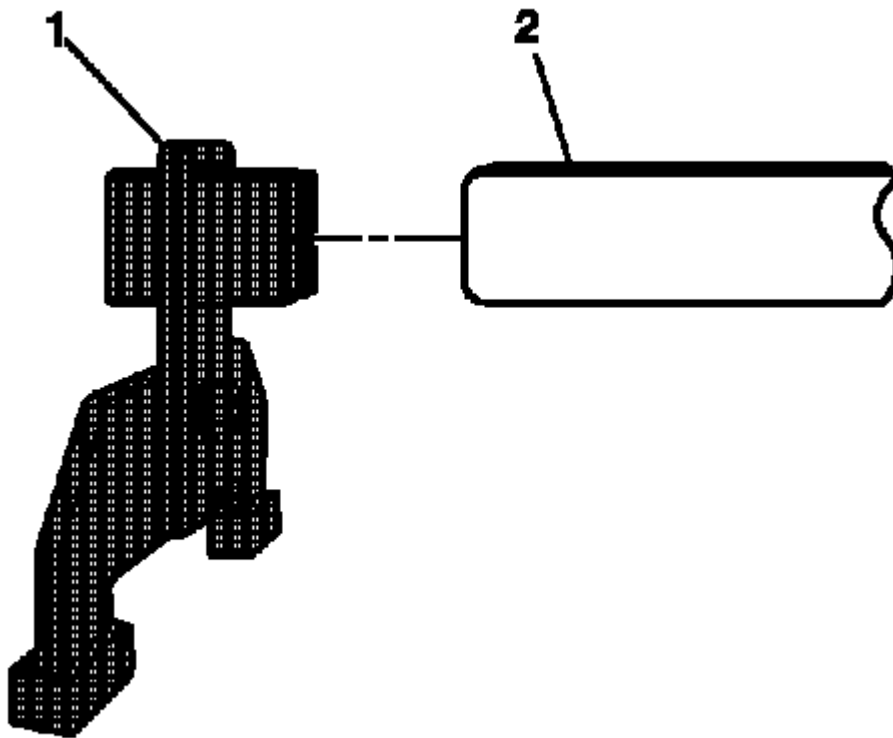
**Fig. 9: View Of Engine Harness Clamp**  
**Courtesy of GENERAL MOTORS CORP.**

7. Remove engine harness clamp, then position harness aside.



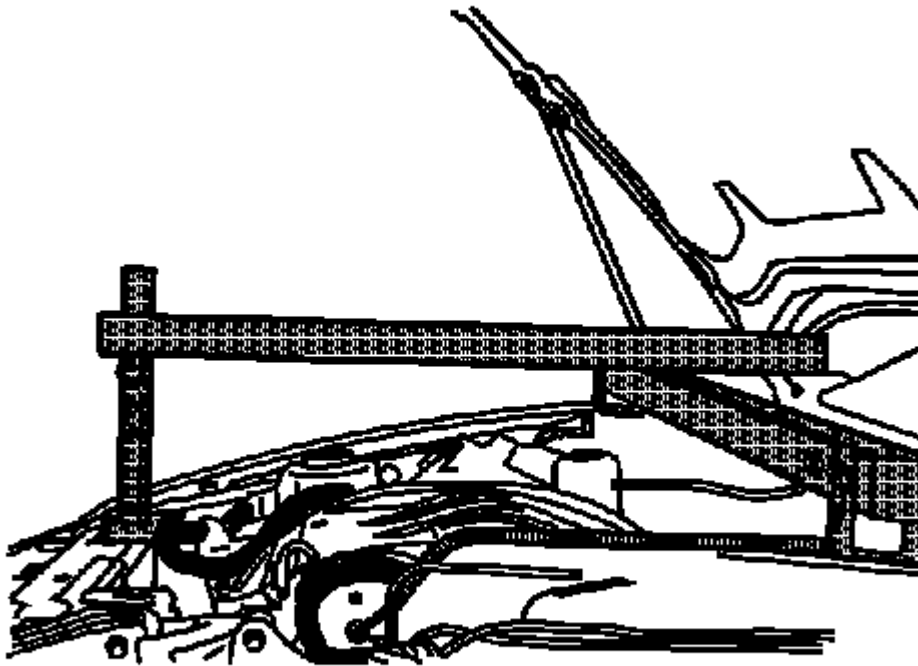
**Fig. 10: Identifying Engine Support Bracket**  
Courtesy of GENERAL MOTORS CORP.

8. Install engine support bracket **J 42451-1** to left cylinder head.



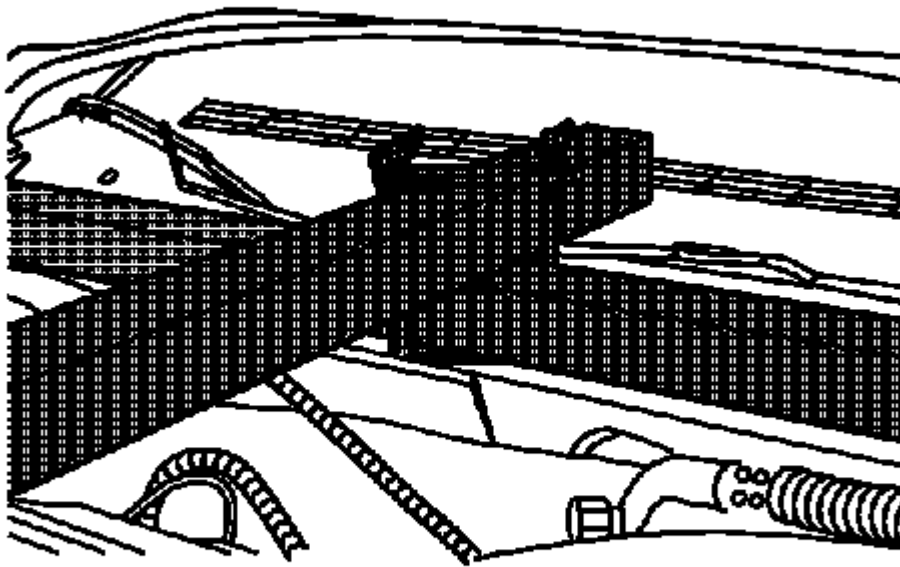
**Fig. 11: Identifying Special Tools J 28467-501 & J 28467-3**  
**Courtesy of GENERAL MOTORS CORP.**

9. Install the engine support fixture legs J-28467-500A (1) and the strut tower tube J-28467-3 (2).



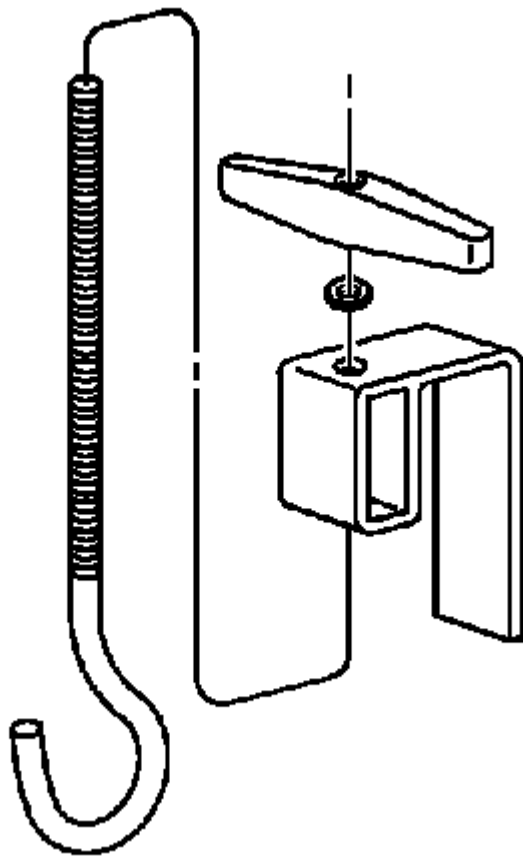
**Fig. 12: View of Radiator Shelf Tube & Strut Tower Tube**  
**Courtesy of GENERAL MOTORS CORP.**

10. Install the front support assembly J-28467-4A and the radiator shelf tube J-28467-2A to the strut tower tube J-28467-3.



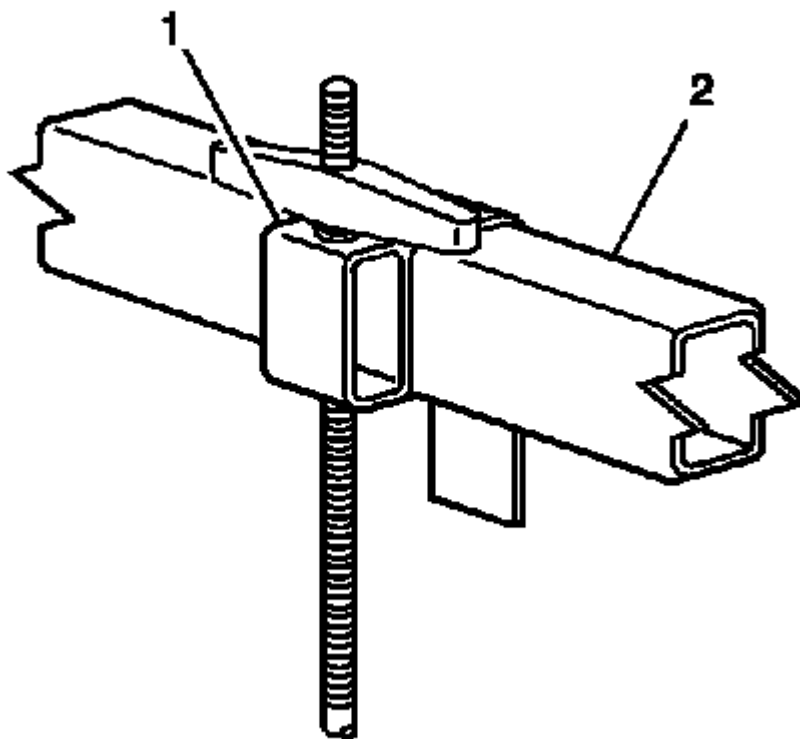
**Fig. 13: View Of Cross Bracket Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

11. Install the cross bracket assembly J-28467-1A to secure the radiator shelf tube J-28467-2A to the strut tower tube J-28467-3.



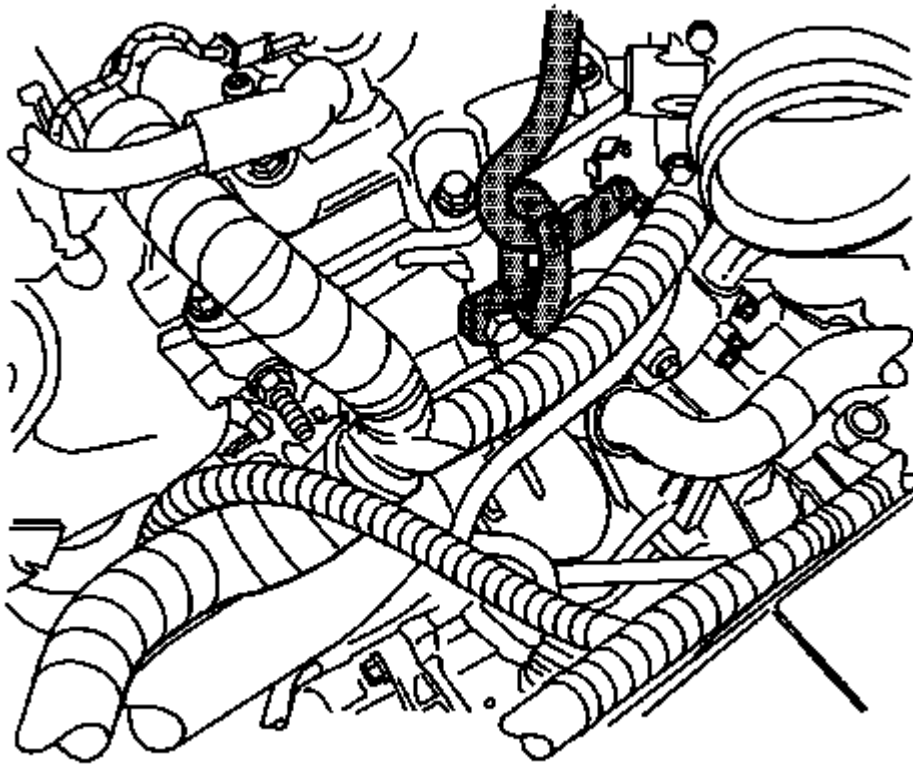
**Fig. 14: View Of Lift Hook Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

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.



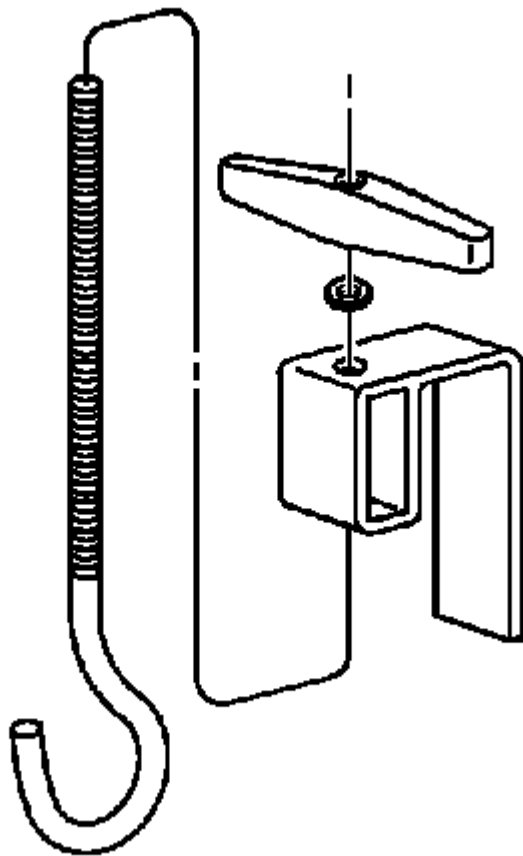
**Fig. 15: Identifying Lift Hook Assembly & Strut Tower Tube**  
Courtesy of GENERAL MOTORS CORP.

13. Install lift hook assembly (1) to the strut tower tube J-28467-3 (2).



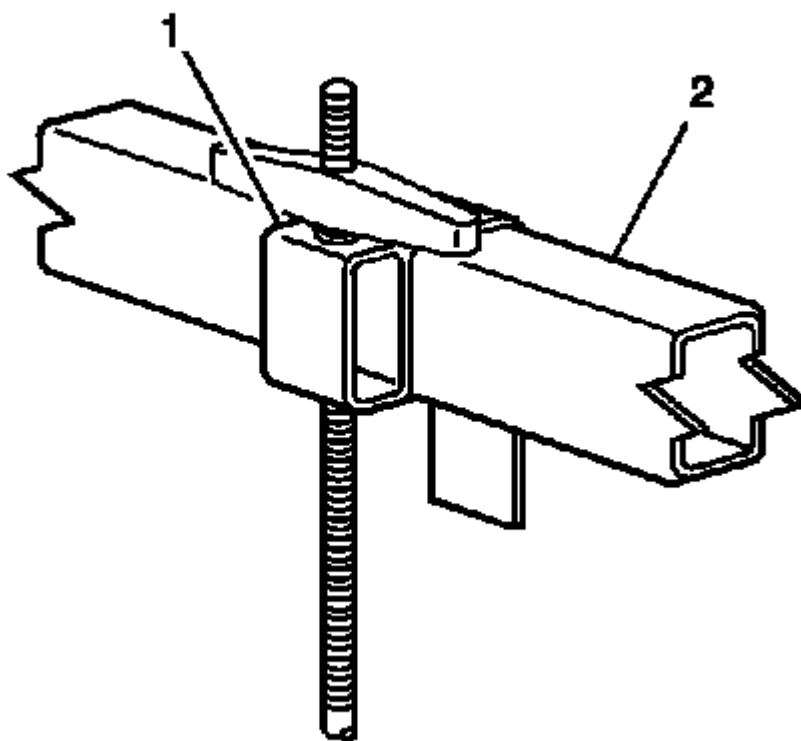
**Fig. 16: Identifying Lift Hook Assembly**  
Courtesy of GENERAL MOTORS CORP.

14. Install lift hook assembly to the left side **J 42451-1** .



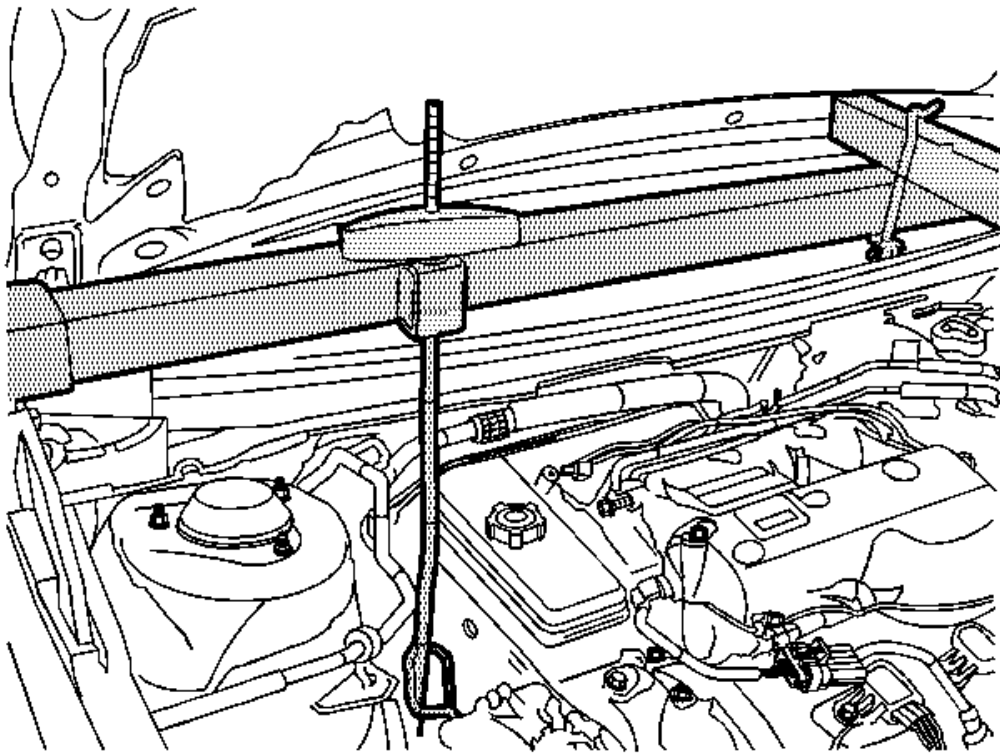
**Fig. 17: View Of Lift Hook Assembly**  
**Courtesy of GENERAL MOTORS CORP.**

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. 18: Identifying Lift Hook Assembly & Strut Tower Tube**  
Courtesy of GENERAL MOTORS CORP.

16. Install lift hook assembly (1) to the strut tower tube J-28467-3 (2).



**Fig. 19: View Of Lift Hook Assembly**  
Courtesy of GENERAL MOTORS CORP.

17. Install lift hook assembly to right side **J 42451-1** .
18. Tighten the J-28467-34 wing nut until all free slack is removed from the J-28467-7A lift hook.

## ENGINE MOUNT INSPECTION

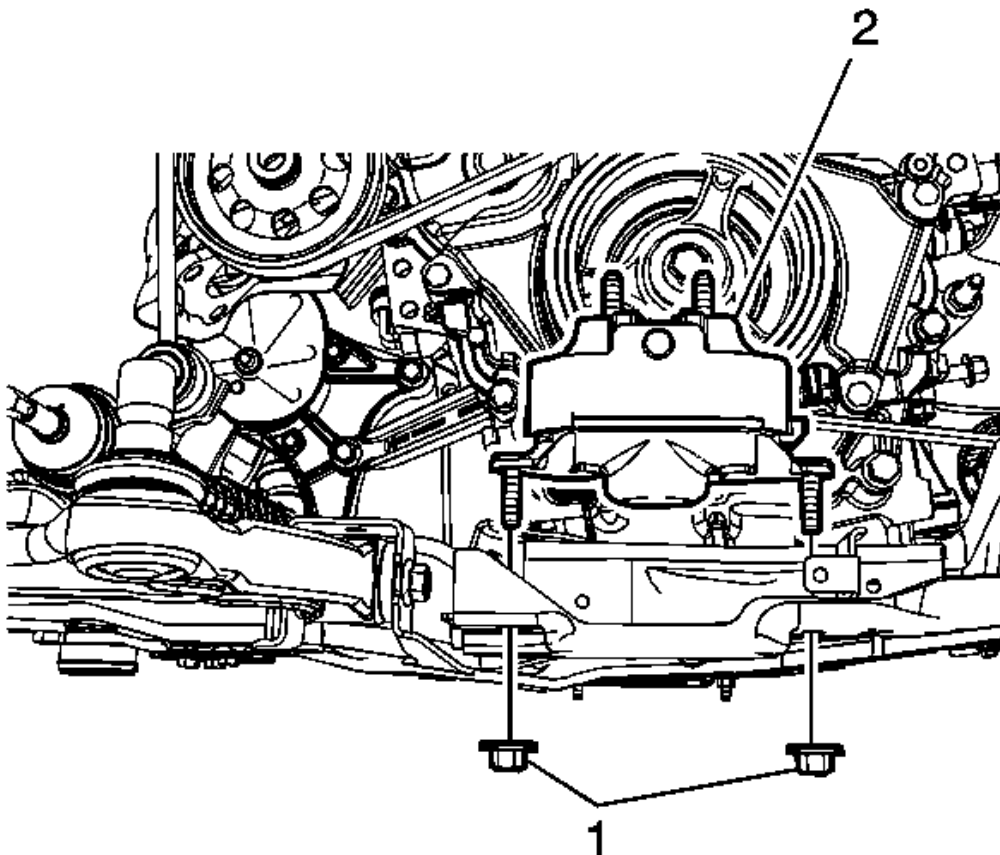
**IMPORTANT:** Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

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, Transmission Front Mount Replacement , Transmission Rear Mount Replacement .

## ENGINE MOUNT REPLACEMENT - RIGHT SIDE

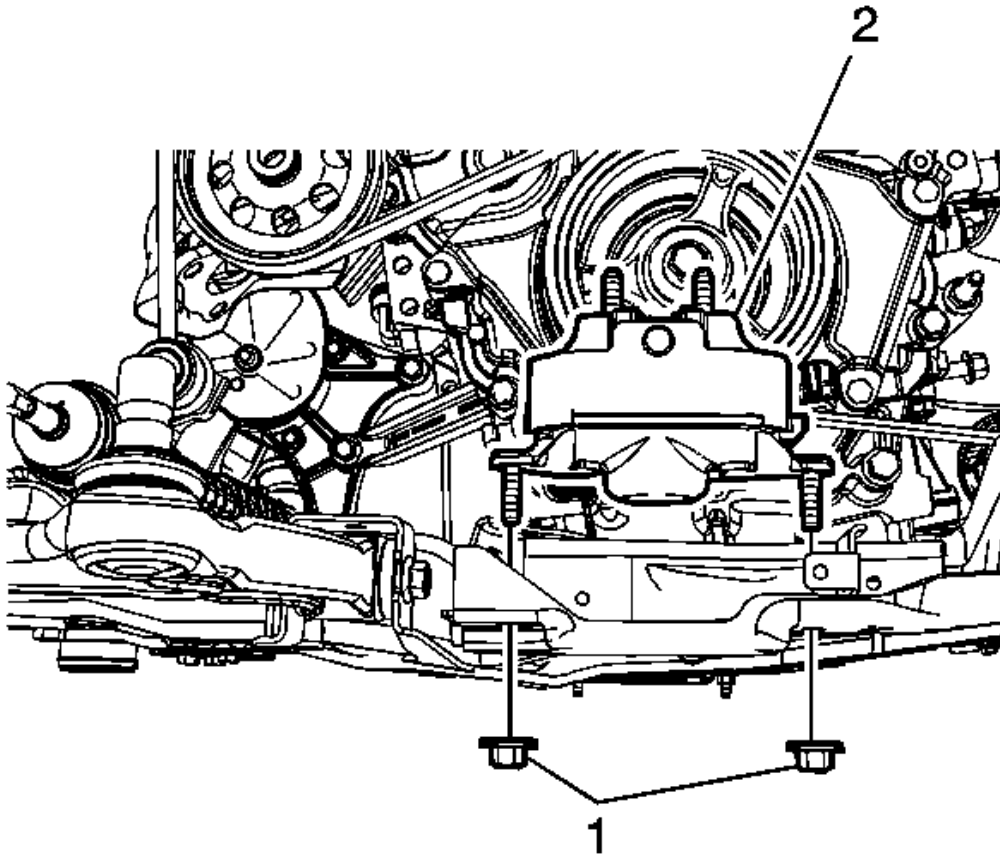
### REMOVAL PROCEDURE



**Fig. 20: Identifying Engine Mount & Nuts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.
2. Remove the engine mount bracket nuts (1).
3. Remove the engine mount (2).

## INSTALLATION PROCEDURE



**Fig. 21: Identifying Engine Mount & Nuts**  
 Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount (2).

**CAUTION:** Refer to Fastener Caution .

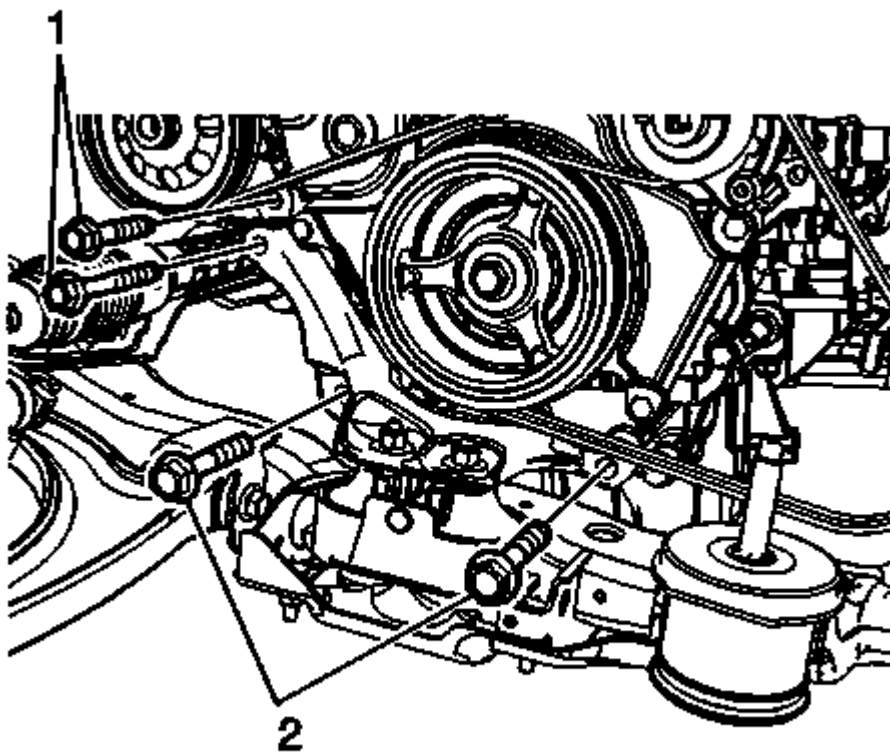
2. Install the engine mount nuts (1).

**Tighten:** Tighten the engine mount nuts to 50 N.m (38 lb ft).

3. Install the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side.

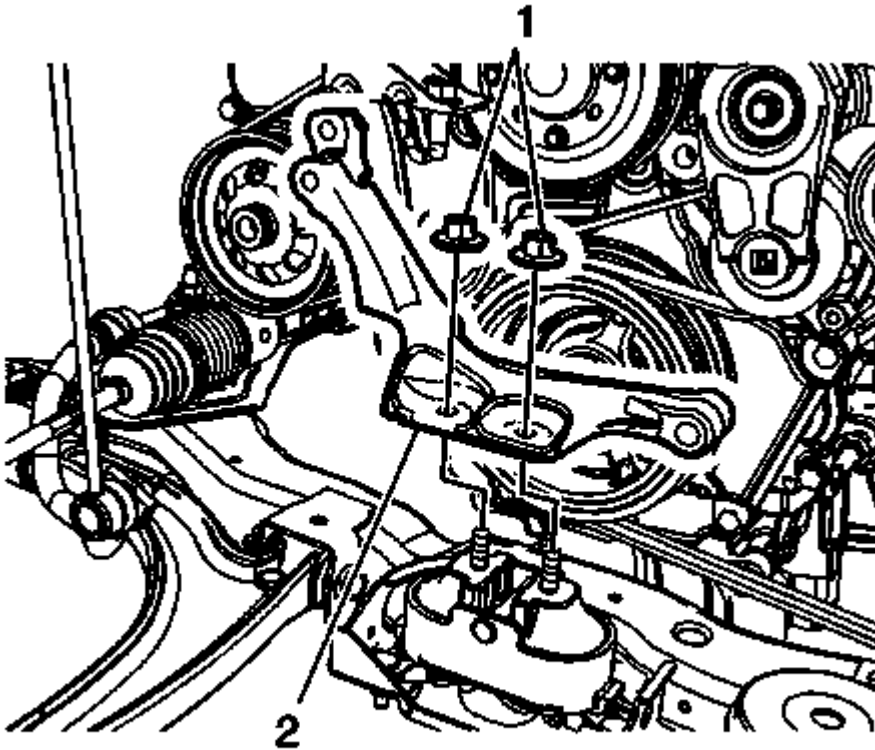
## ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

### REMOVAL PROCEDURE



**Fig. 22: Identifying Engine Mount Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

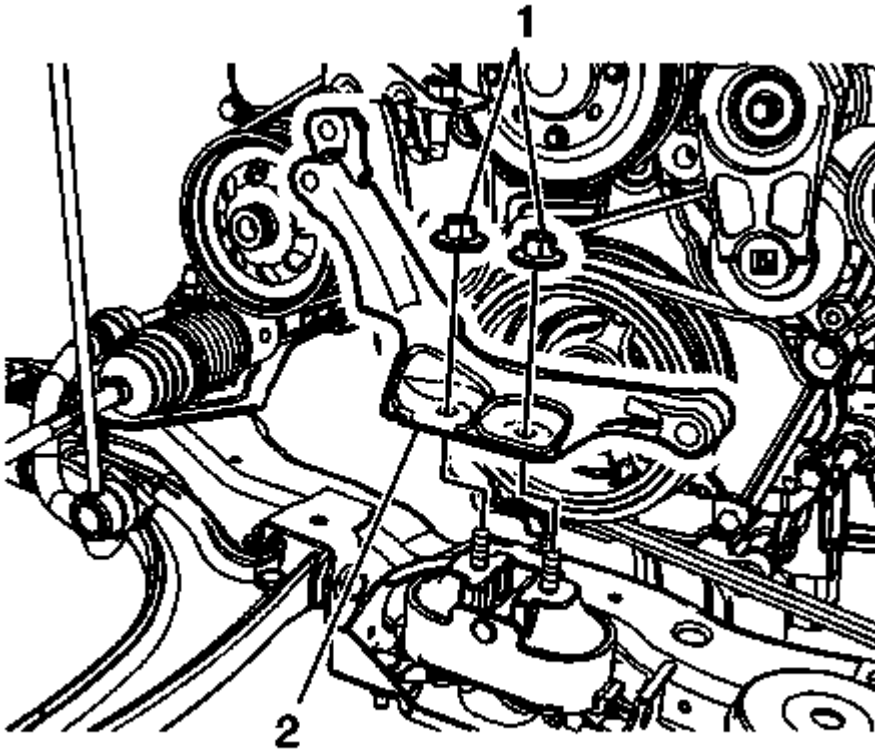
1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Support the engine. Refer to **Engine Support Fixture**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the upper engine mount bracket bolts (1).
5. Remove the lower engine mount bracket bolts (2).



**Fig. 23: Identifying Engine Mount Bracket & Nuts**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the ABS connector clip from the frame.
7. Remove the engine mount bracket nuts (1).
8. Remove the engine mount bracket (2).

## INSTALLATION PROCEDURE

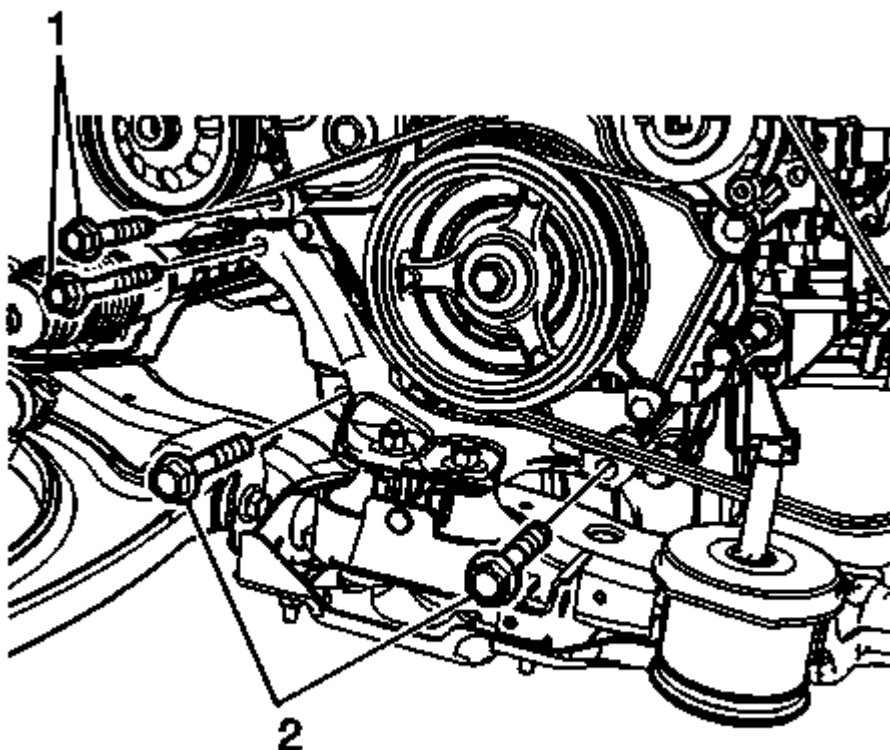


**Fig. 24: Identifying Engine Mount Bracket & Nuts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket (2).

**CAUTION:** Refer to Fastener Caution .

2. Install the engine mount bracket nuts (1) and tighten to 50 N.m (38 lb ft).
3. Install the ABS connector clip to the frame.

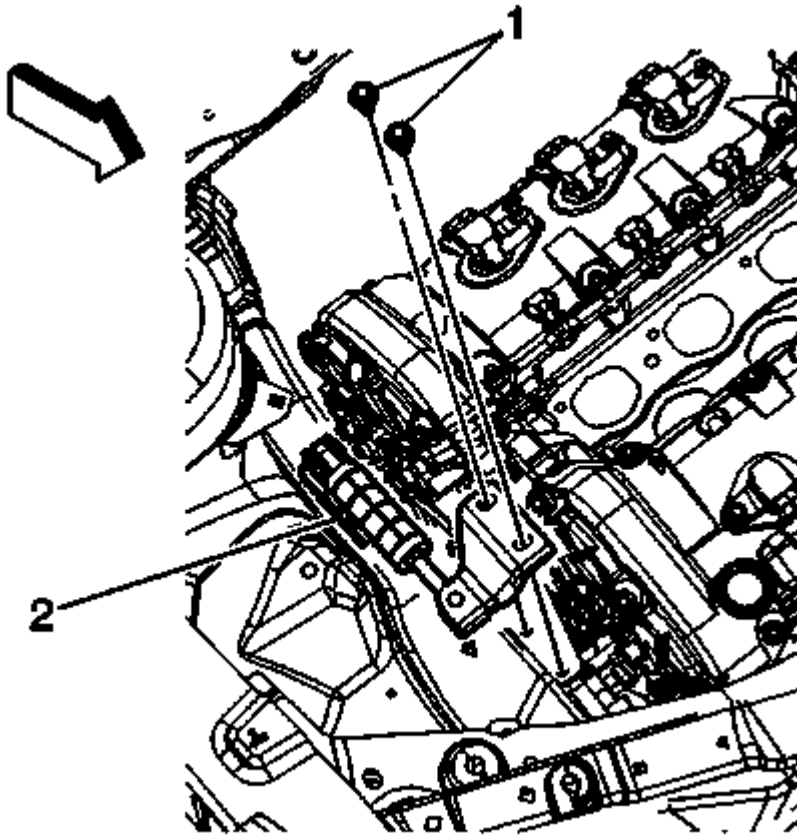


**Fig. 25: Identifying Engine Mount Bracket Bolts**  
 Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount bracket (2).
5. Install the lower engine mount bracket bolts (2) and tighten to 90 N.m (66 lb ft).
6. Install the upper engine mount bracket bolts (1) and tighten to 58 N.m (43 lb ft).
7. Lower the vehicle.
8. Remove the engine support fixture. Refer to **Engine Support Fixture**.
9. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.

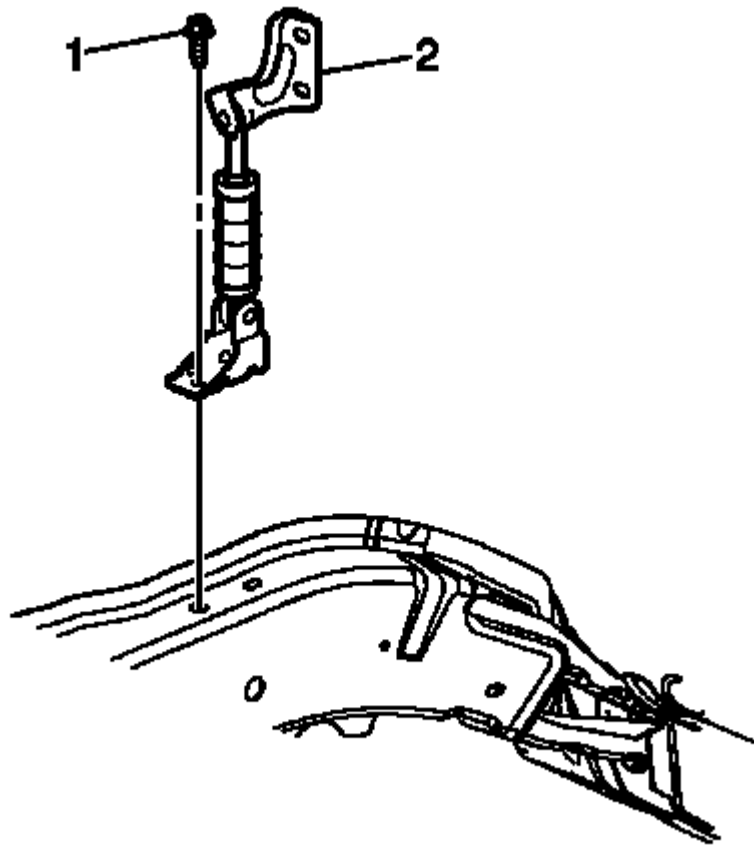
## ENGINE MOUNT SNUBBER REPLACEMENT

### REMOVAL PROCEDURE



**Fig. 26: Identifying Engine Mount Strut & Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

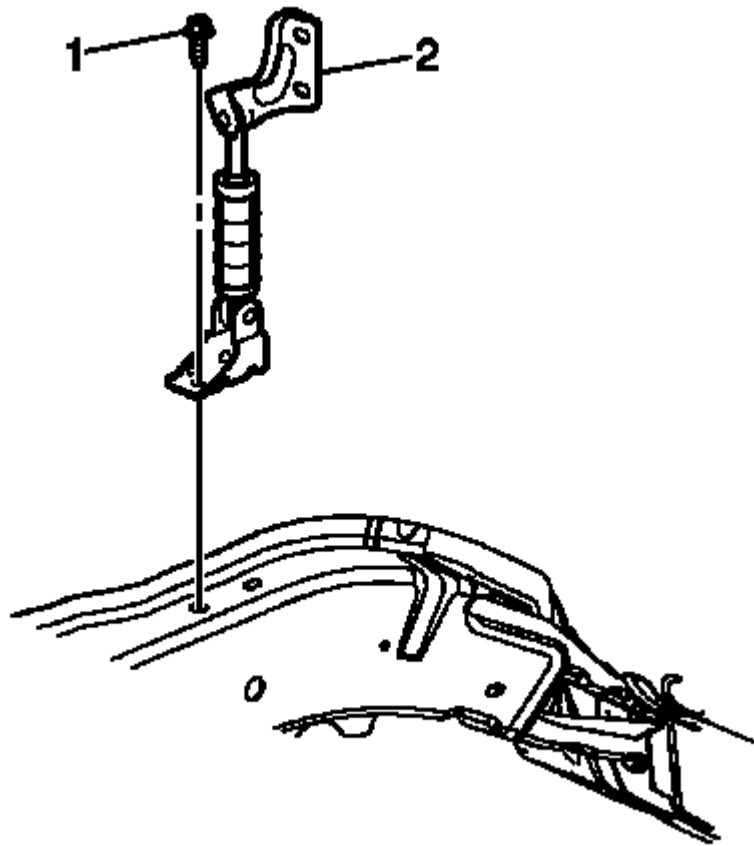
1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the air conditioning (A/C) line retainer and position the A/C line aside.
3. Remove the engine mount snubber to bracket bolts (1).



**Fig. 27: Identifying Strut & Side Rail Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Rotate the snubber (2) vertical then remove engine mount strut to side rail bolts (1).
5. Remove the snubber from vehicle.

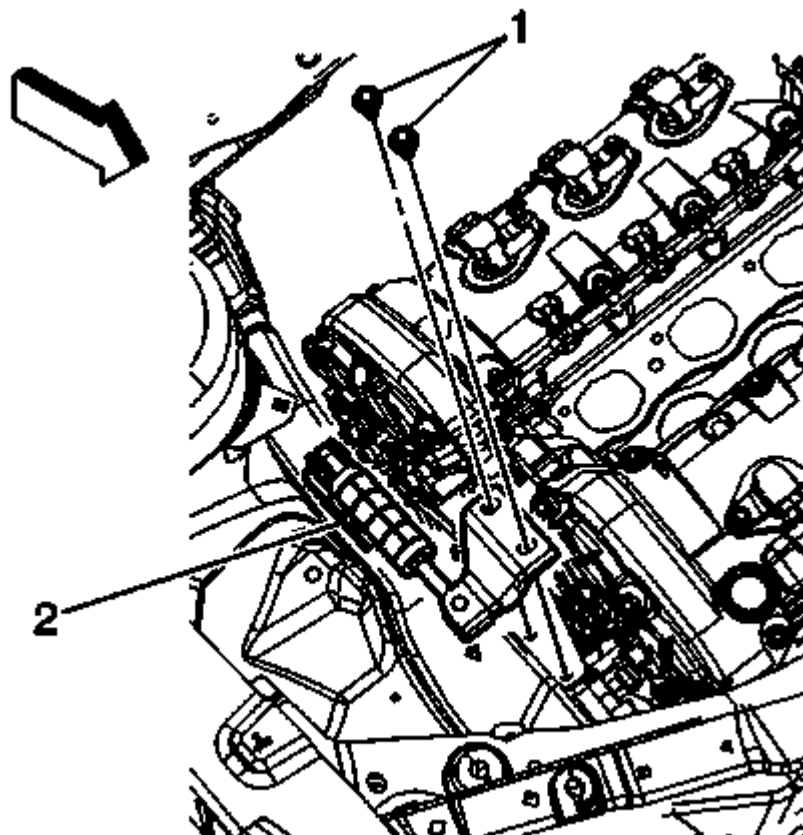
## INSTALLATION PROCEDURE



**Fig. 28: Identifying Strut & Side Rail Bolts**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

1. Position the snubber (2) to the side rail, then install the snubber to side rail bolt (1). Tighten the bolt to 110 N.m (81 lb ft).

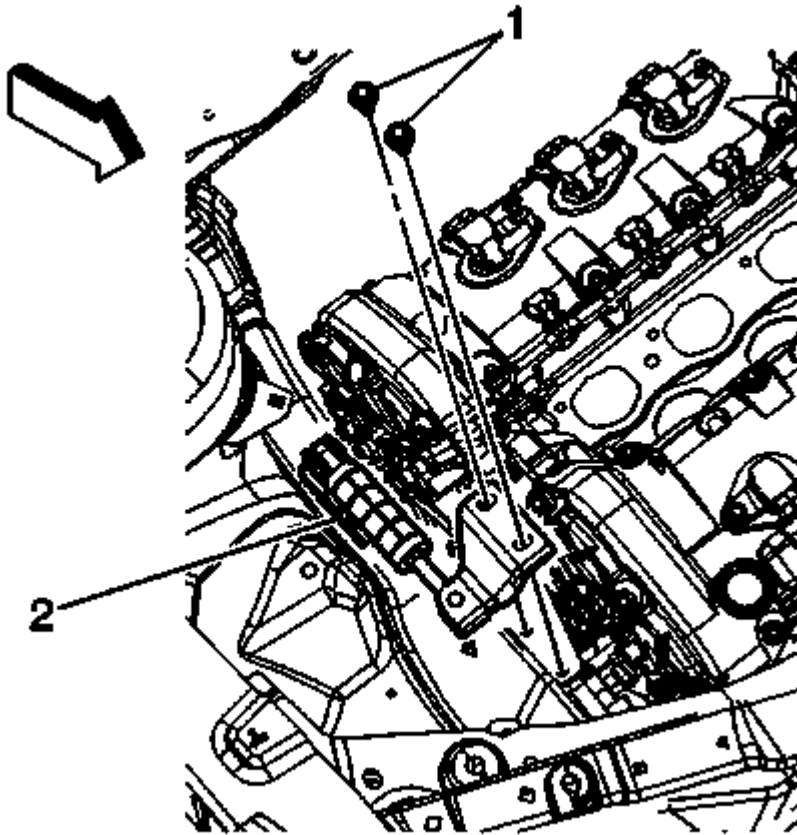


**Fig. 29: Identifying Engine Mount Strut & Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

2. Install the engine mount snubber to bracket bolts (1) and tighten to 25 N.m (18 lb ft).
3. Position the A/C line in place and install the A/C line retainer.
4. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

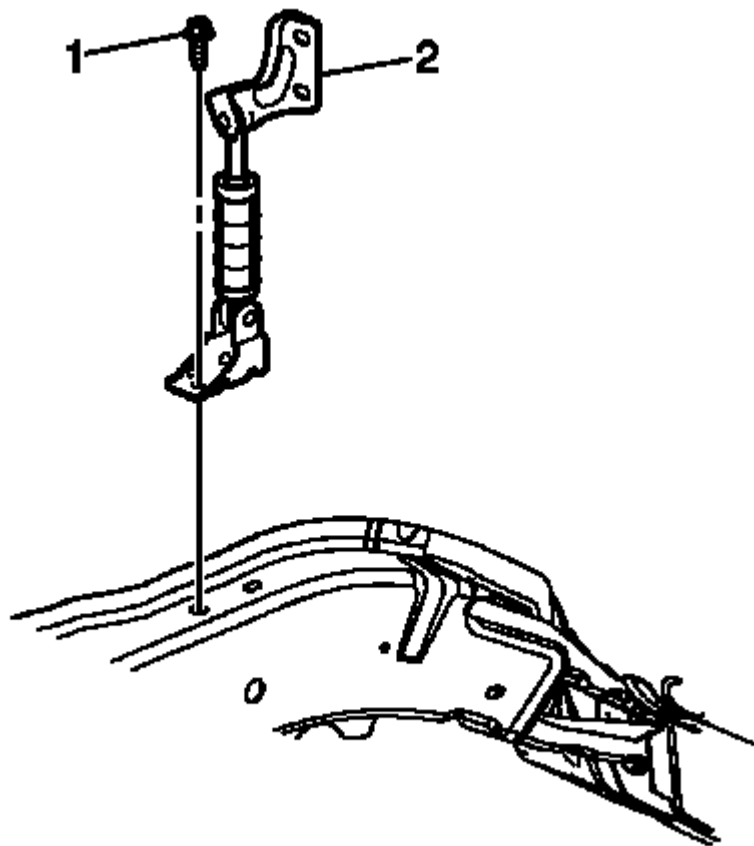
## ENGINE MOUNT SNUBBER BRACKET REPLACEMENT

### REMOVAL PROCEDURE



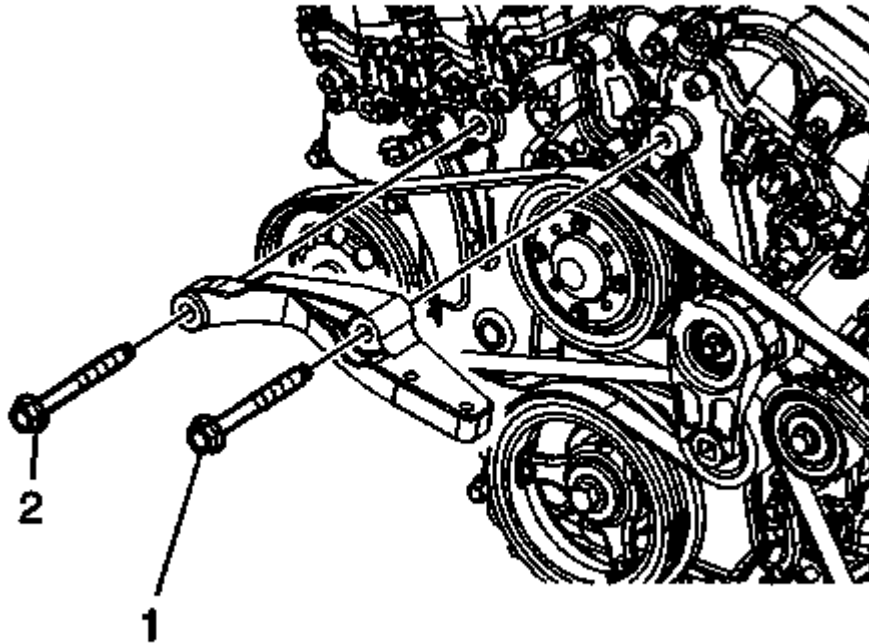
**Fig. 30: Identifying Engine Mount Strut & Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the engine mount snubber to engine mount strut bracket bolts (1).



**Fig. 31: Identifying Strut & Side Rail Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

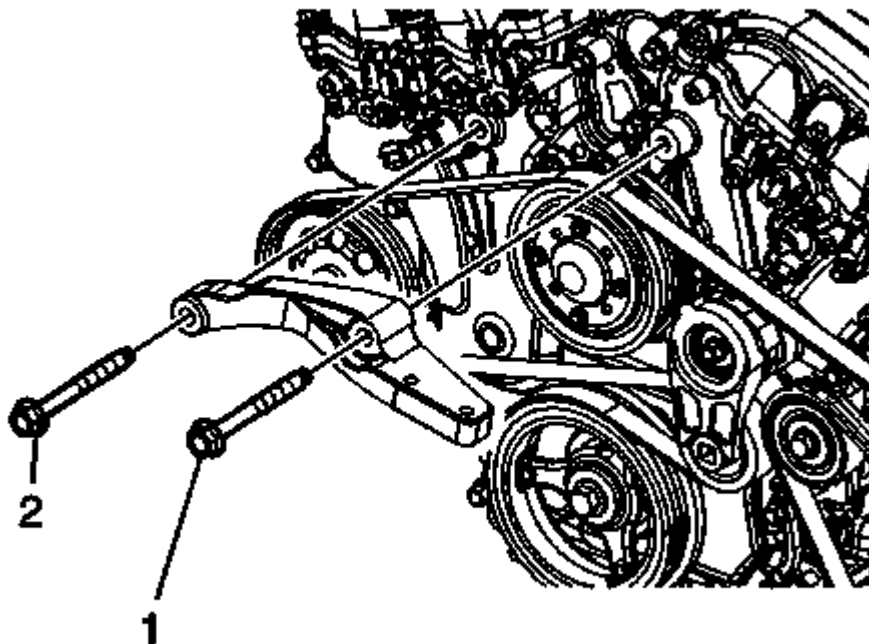
3. Rotate the engine mount snubber (2) to the vertical position.



**Fig. 32: Identifying Engine Mount Strut Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount snubber bracket bolts (1, 2).
5. Remove the engine mount snubber bracket.

## INSTALLATION PROCEDURE



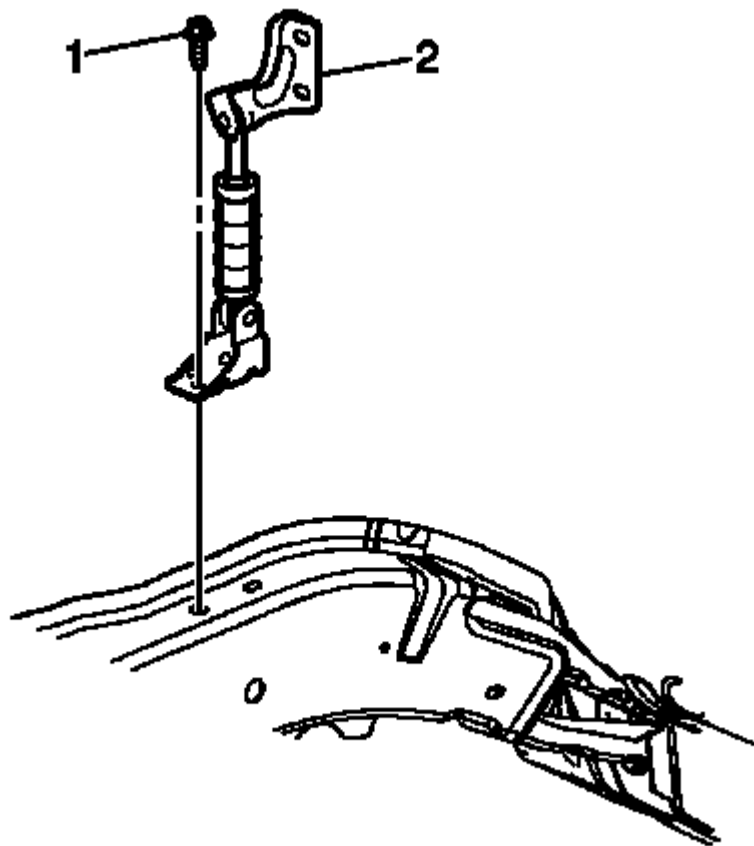
**Fig. 33: Identifying Engine Mount Strut Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Hand tighten both bolts ensuring the bracket is contacting the engine bosses at both bolt locations.

1. Position the engine mount snubber bracket.

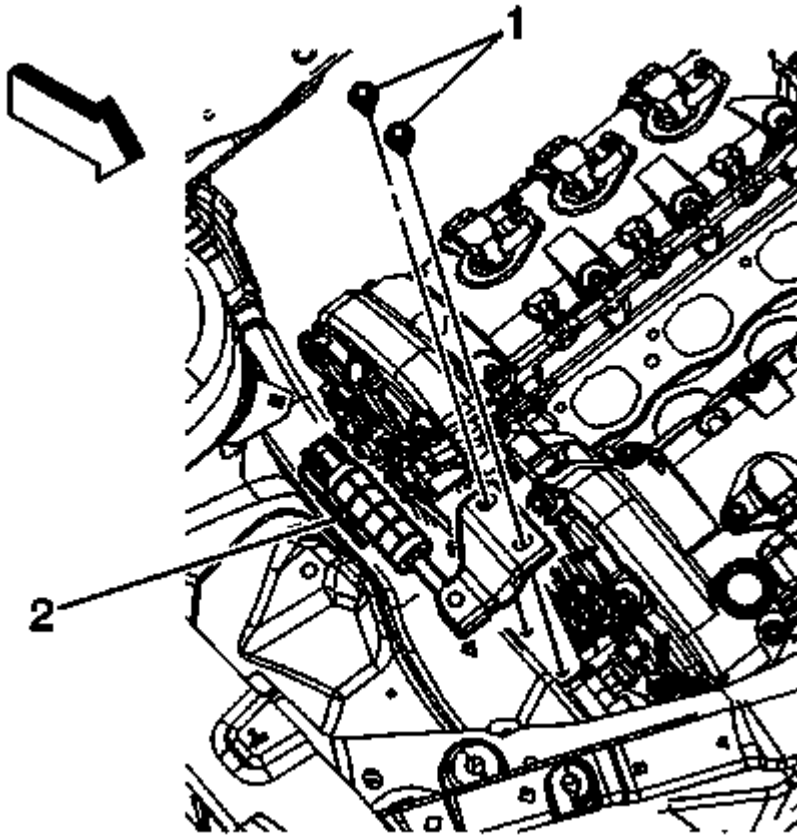
**CAUTION:** Refer to Fastener Caution .

2. Install the engine mount snubber bracket bolts (1, 2).
  - Tighten the bolt (1) to 90 N.m (66 lb ft).
  - Tighten the bolt (2 ) to 90 N.m (66 lb ft).



**Fig. 34: Identifying Strut & Side Rail Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

3. Rotate the engine mount snubber (2) to the horizontal position.

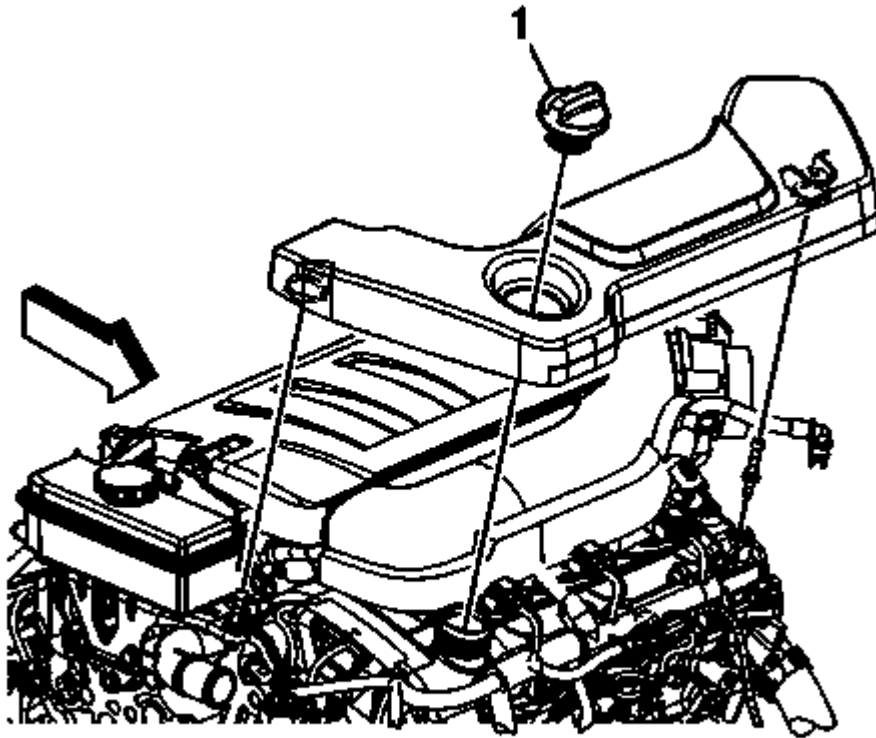


**Fig. 35: Identifying Engine Mount Strut & Bracket Bolts**  
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount snubber to engine mount snubber bracket bolts (1) and tighten to 50 N.m (37 lb ft).
5. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

## **FUEL INJECTOR SIGHT SHIELD REPLACEMENT**

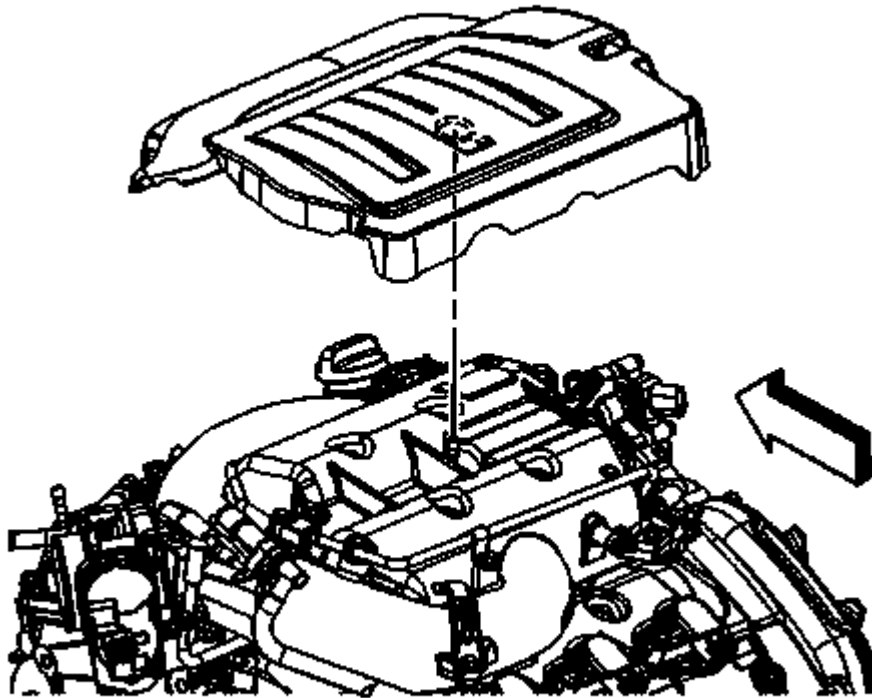
### **REMOVAL PROCEDURE**



**Fig. 36: Identifying Oil Fill Cap**

**Courtesy of GENERAL MOTORS CORP.**

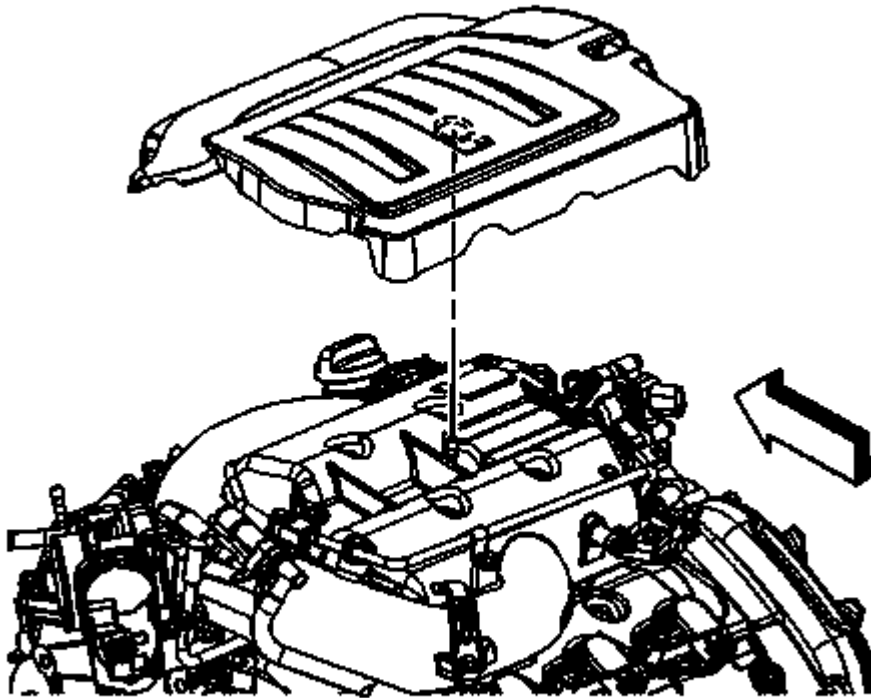
1. Remove the oil fill cap (1).
2. Grasp the cover by the upper left and the lower right corners and lift up, disengaging the cover grommets from the ball studs.



**Fig. 37: Identifying Cover Grommet**  
Courtesy of GENERAL MOTORS CORP.

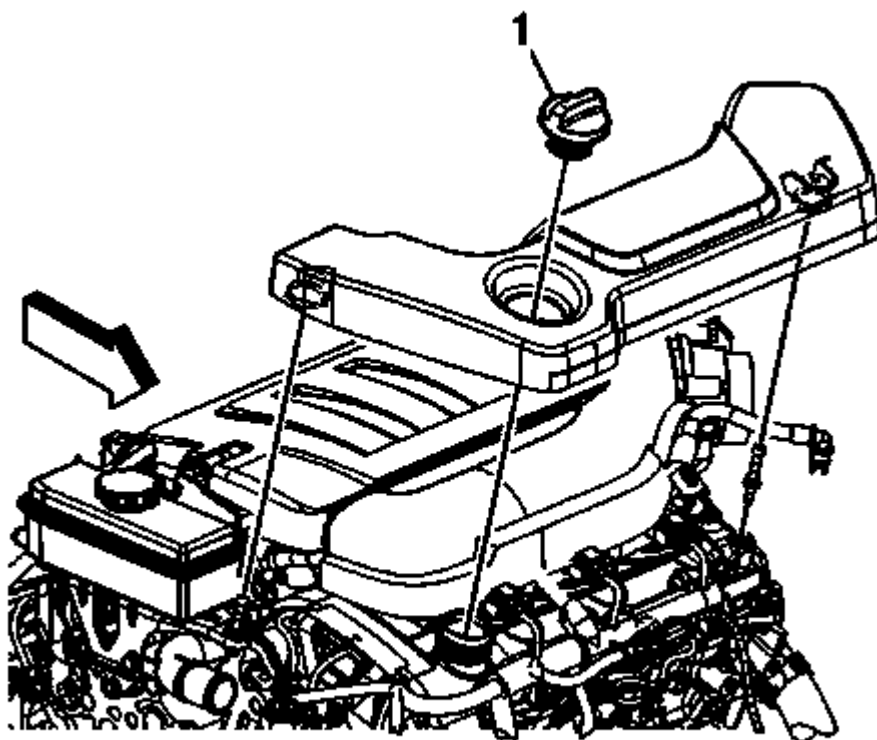
3. If necessary, lift upward on front of cover, then reach under center of cover disengaging the cover grommet for the ball stud.

## INSTALLATION PROCEDURE



**Fig. 38: Identifying Cover Grommet**  
Courtesy of GENERAL MOTORS CORP.

1. If necessary, place the cover into position over the ball stud. Press down near the center of the cover, engaging the cover to the ball stud.



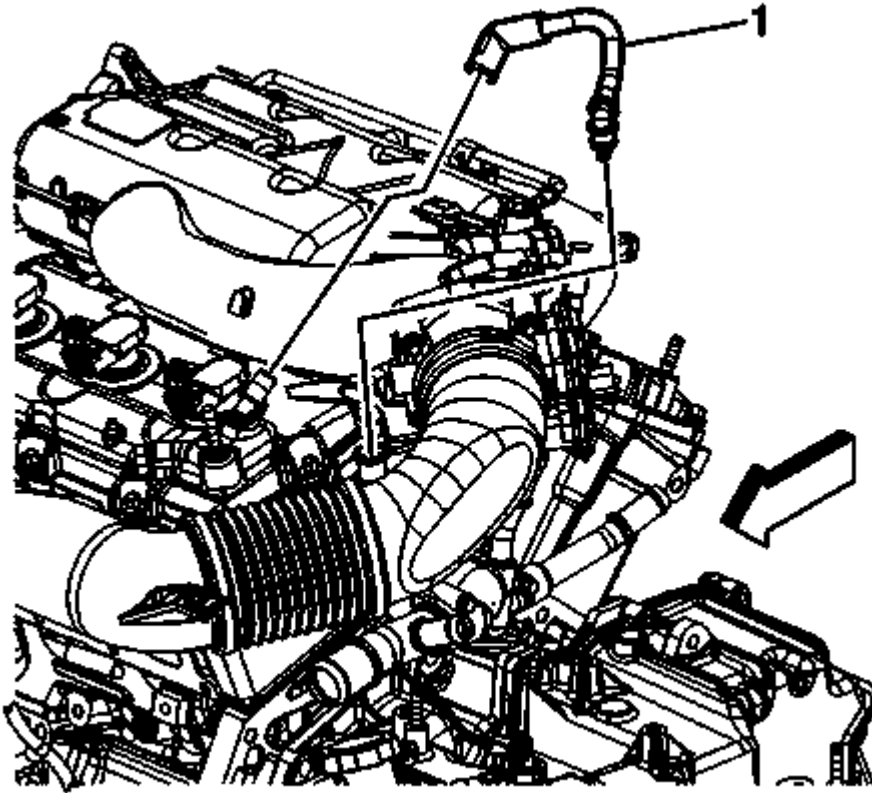
**Fig. 39: Identifying Oil Fill Cap**

Courtesy of GENERAL MOTORS CORP.

2. Place the cover into position over the ball studs. Press down near the upper left and the lower right corners, engaging the cover to the ball studs.
3. Install the oil fill cap (1).

## **POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (FRONT)**

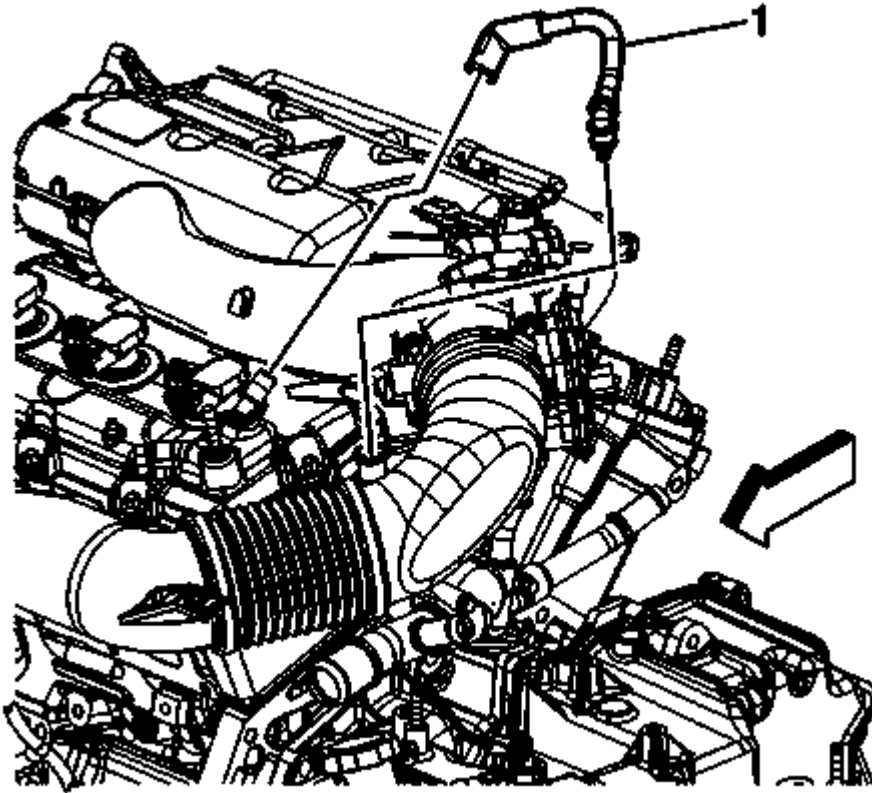
### **REMOVAL PROCEDURE**



**Fig. 40: Identifying PCV Fresh Air Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the positive crankcase ventilation (PCV) fresh air tube from the air cleaner outlet duct.
3. Remove the PCV fresh air tube (1) from the camshaft cover fitting.

## INSTALLATION PROCEDURE

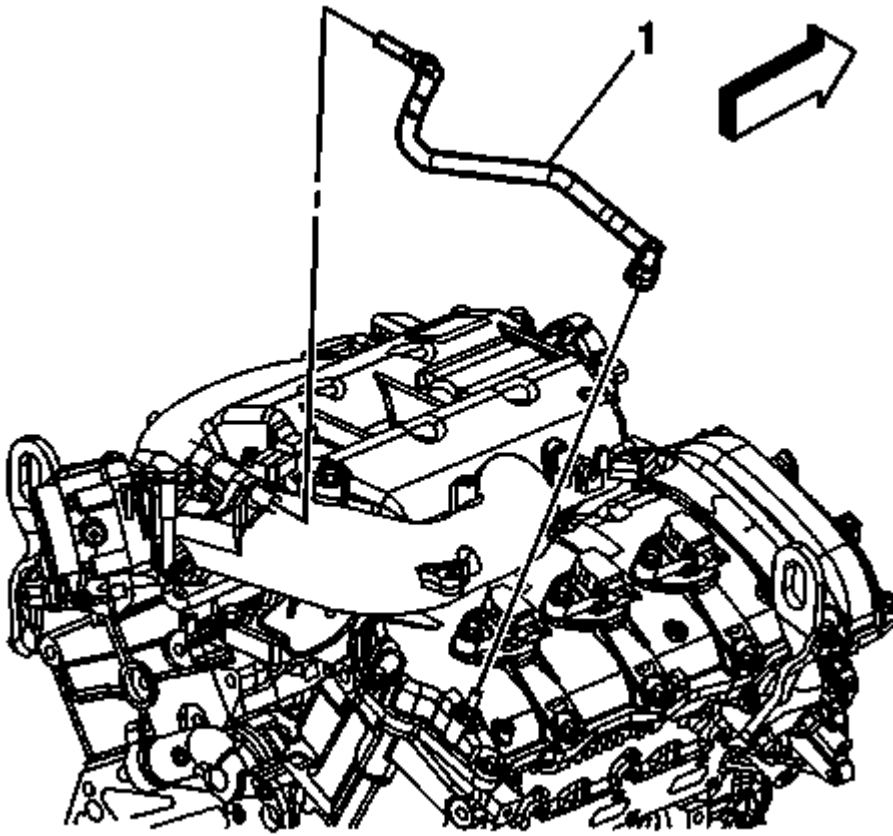


**Fig. 41: Identifying PCV Fresh Air Tube**  
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV fresh air tube (1) to the camshaft cover fitting.
2. Install the PCV fresh air tube to the air cleaner outlet duct.
3. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

## **POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (REAR)**

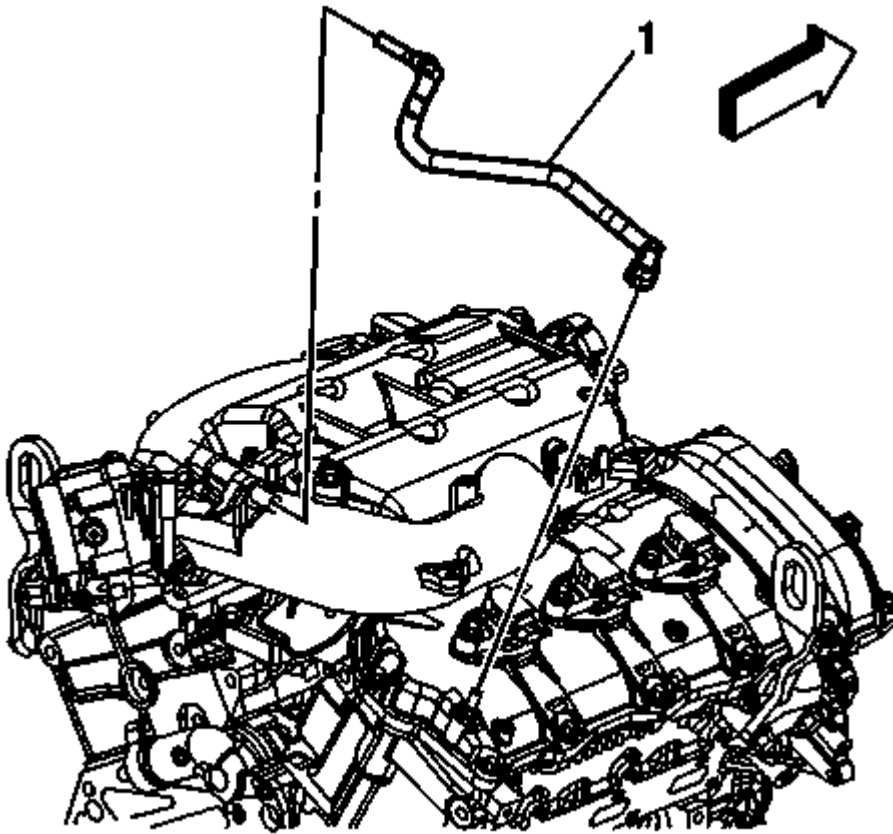
### **REMOVAL PROCEDURE**



**Fig. 42: Identifying PCV Foul Air Pipe**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the positive crankcase ventilation (PCV) foul air tube from the upper intake manifold.
2. Remove the PCV foul air pipe (1) from the camshaft cover fitting.

## INSTALLATION PROCEDURE

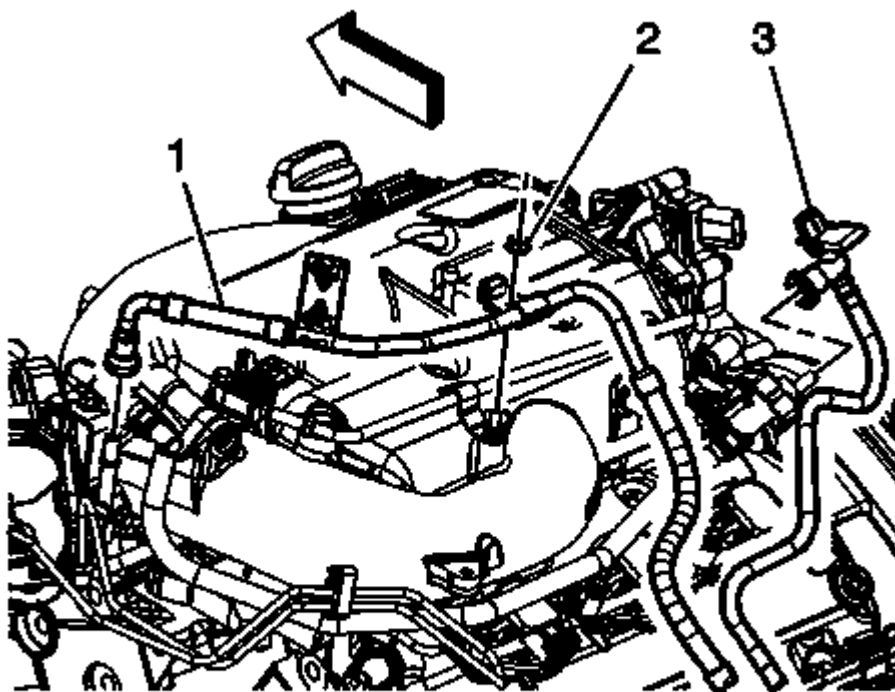


**Fig. 43: Identifying PCV Foul Air Pipe**  
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the PCV foul air tube (intake manifold side) O-ring seals with clean engine oil.
2. Install the PCV foul air pipe (1) to the camshaft cover fitting.
3. Install the PCV foul air tube to the upper intake manifold.

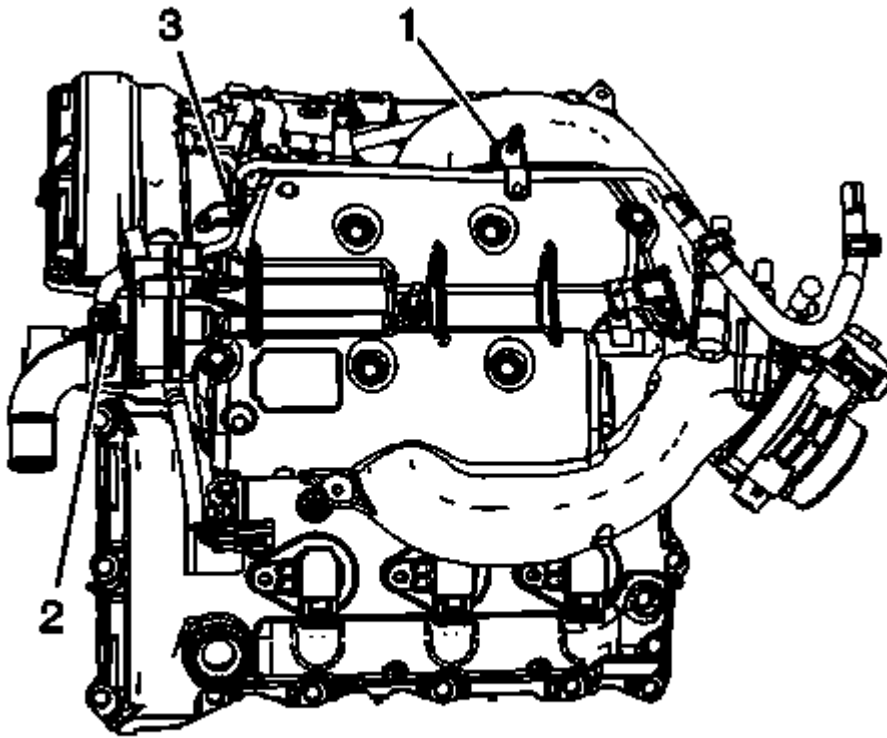
## **UPPER INTAKE MANIFOLD REPLACEMENT**

### **REMOVAL PROCEDURE**



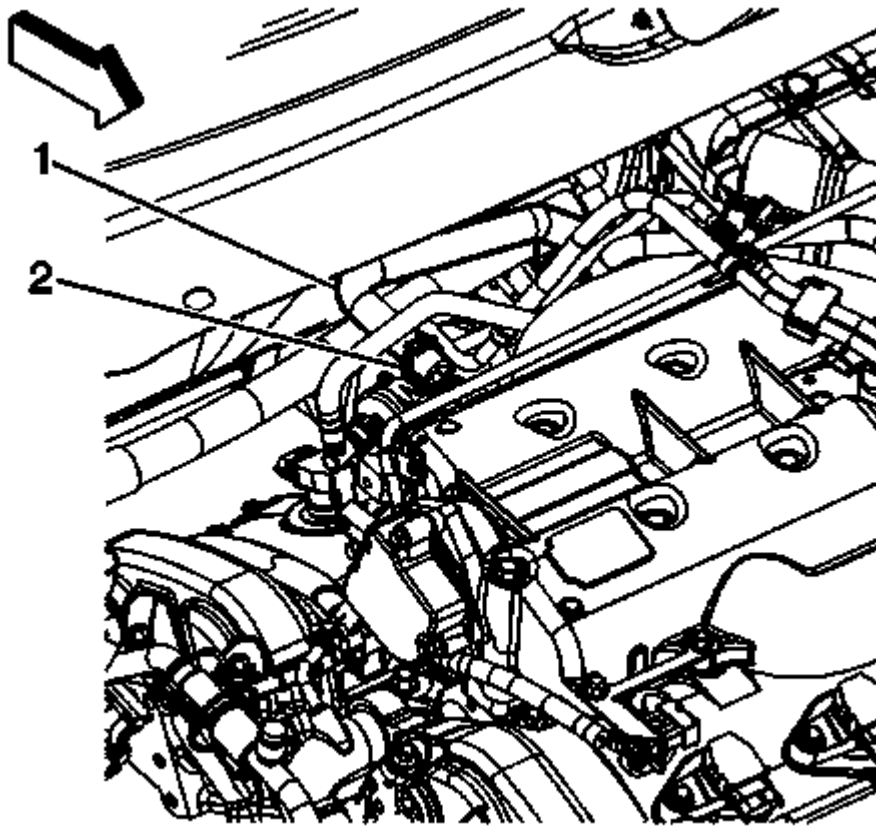
**Fig. 44: Identifying Fuel Feed Pipe Line Components**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
3. Disconnect the fuel feed line (1) quick connect fitting from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
4. Remove the fuel feed pipe line nut (2) and remove the fuel feed line clip from the stud.
5. Reposition the fuel feed line out of the way.



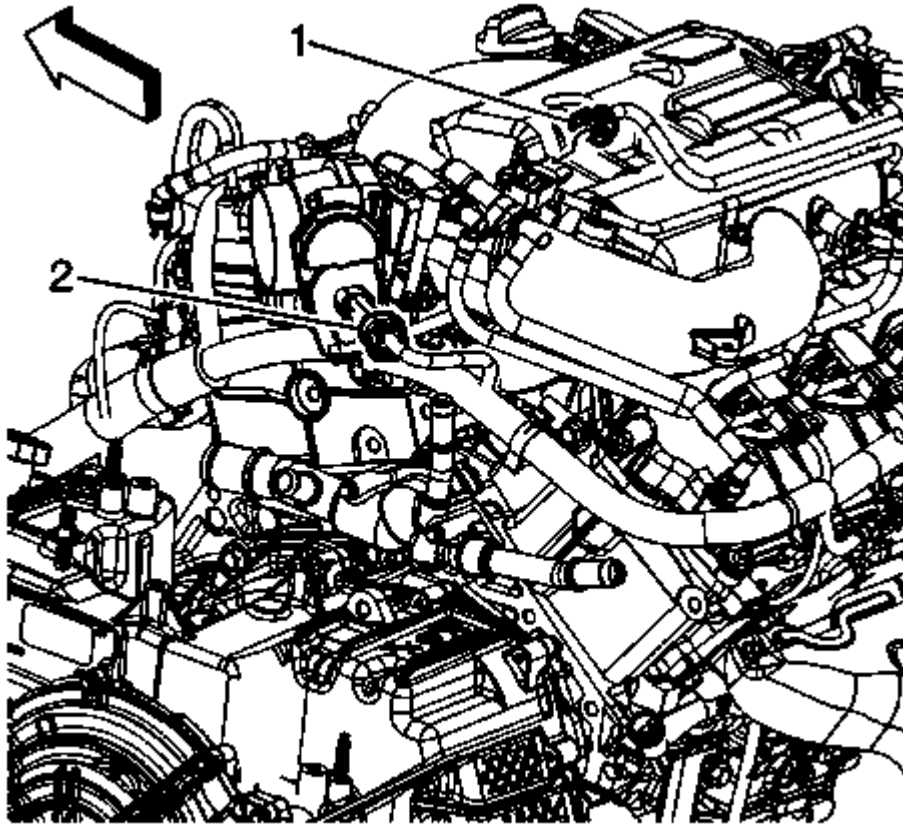
**Fig. 45: Identifying Coolant Air Bleed Hose/Pipe Components**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the coolant air bleed hose/pipe clip bolt (3) from the upper intake manifold.
7. Reposition the coolant air bleed hose clamp (2) at the water outlet.
8. Remove the coolant air bleed hose from the water outlet.
9. Remove the coolant air bleed hose/pipe clip from the upper intake manifold stud and reposition out of the way.



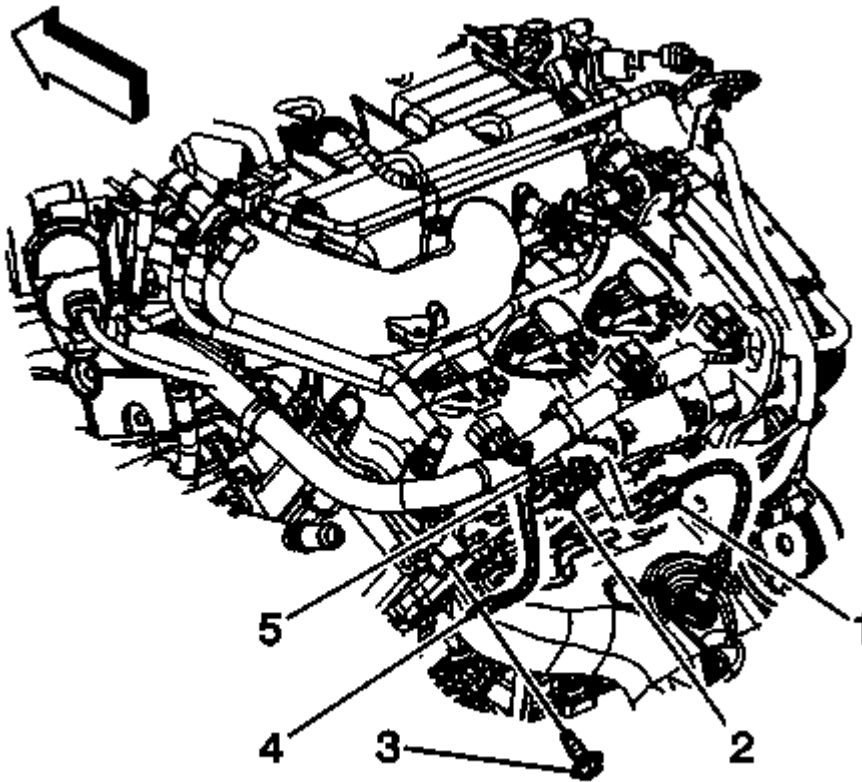
**Fig. 46: Identifying Booster Vacuum Hose & Clamp**  
Courtesy of GENERAL MOTORS CORP.

10. Reposition the brake booster vacuum hose clamp (1) at the upper intake manifold.
11. Remove the brake booster vacuum hose (2) from the upper intake manifold.



**Fig. 47: Identifying MAP Sensor & ETC Electrical Connectors**  
**Courtesy of GENERAL MOTORS CORP.**

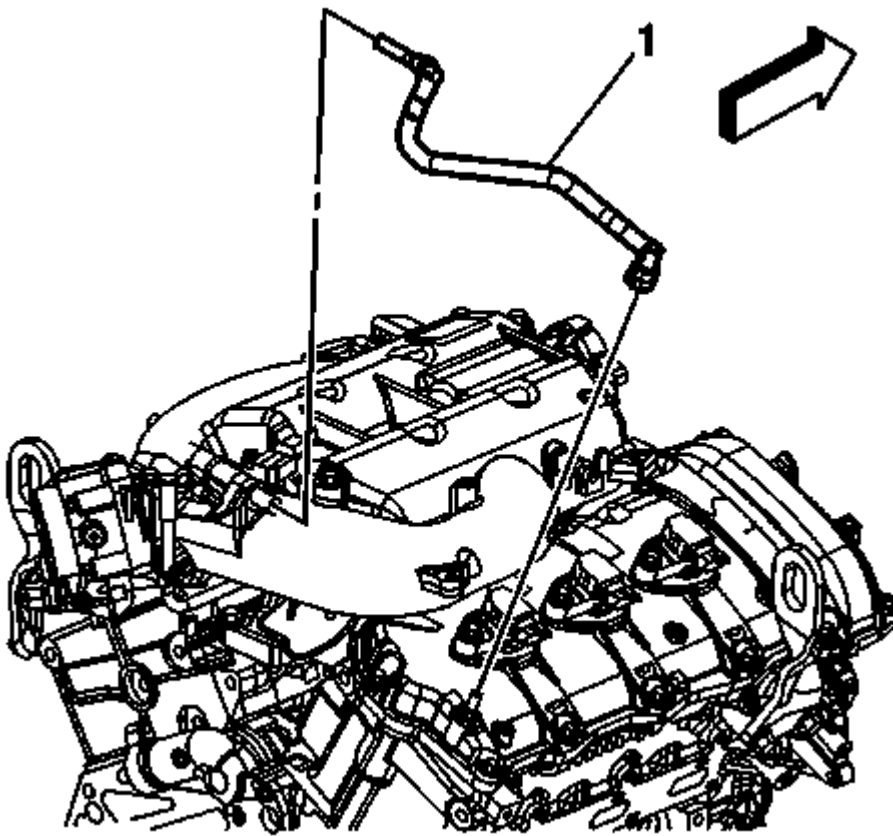
12. Disconnect the engine wiring harness electrical connector (1) from the manifold absolute pressure (MAP) sensor.
13. Disconnect the engine wiring harness electrical connector (2) from the electronic throttle control (ETC).



**Fig. 48: Identifying Intake Manifold Turning Valve & EVAP Canister Purge Solenoid Electrical Connectors**

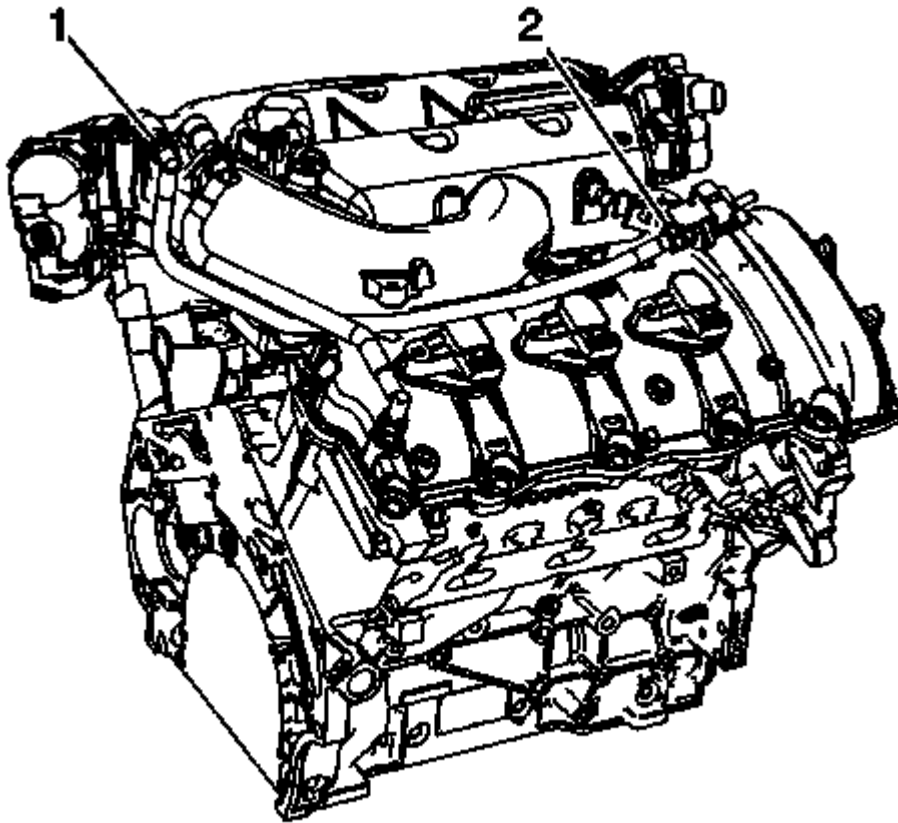
**Courtesy of GENERAL MOTORS CORP.**

14. Disconnect the engine wiring harness electrical connector (1) from the intake manifold tuning valve.
15. Disconnect the engine wiring harness electrical connector (2) from the evaporative emission (EVAP) canister purge solenoid.



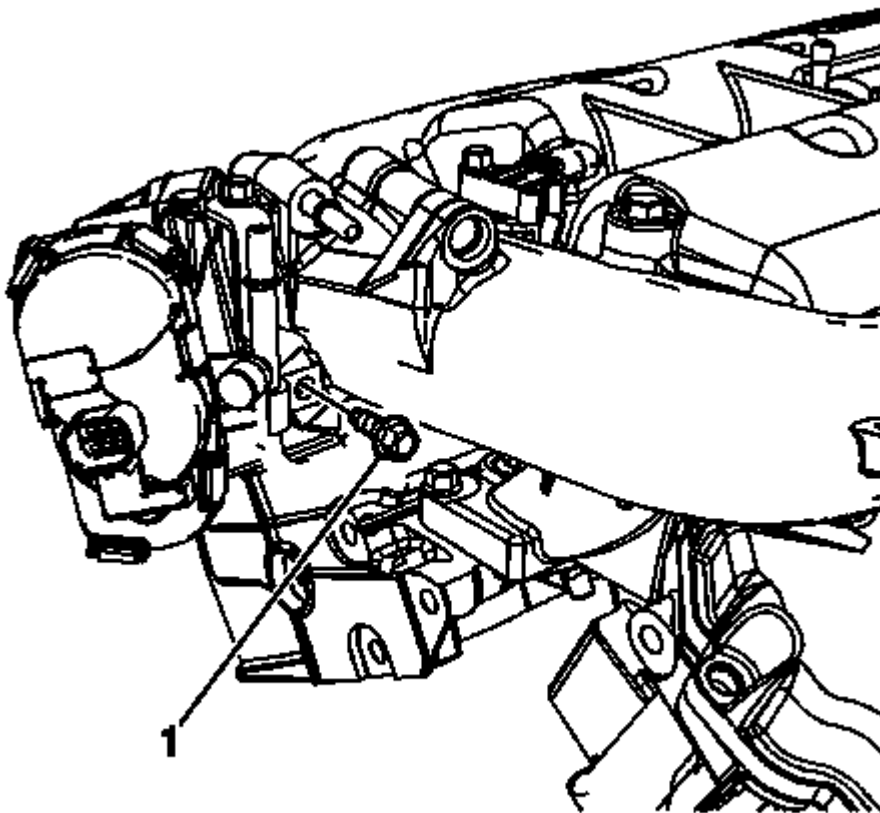
**Fig. 49: Identifying PCV Foul Air Pipe**  
**Courtesy of GENERAL MOTORS CORP.**

16. Disconnect the positive crankcase ventilation (PCV) tube (1) from the upper intake manifold and reposition aside.



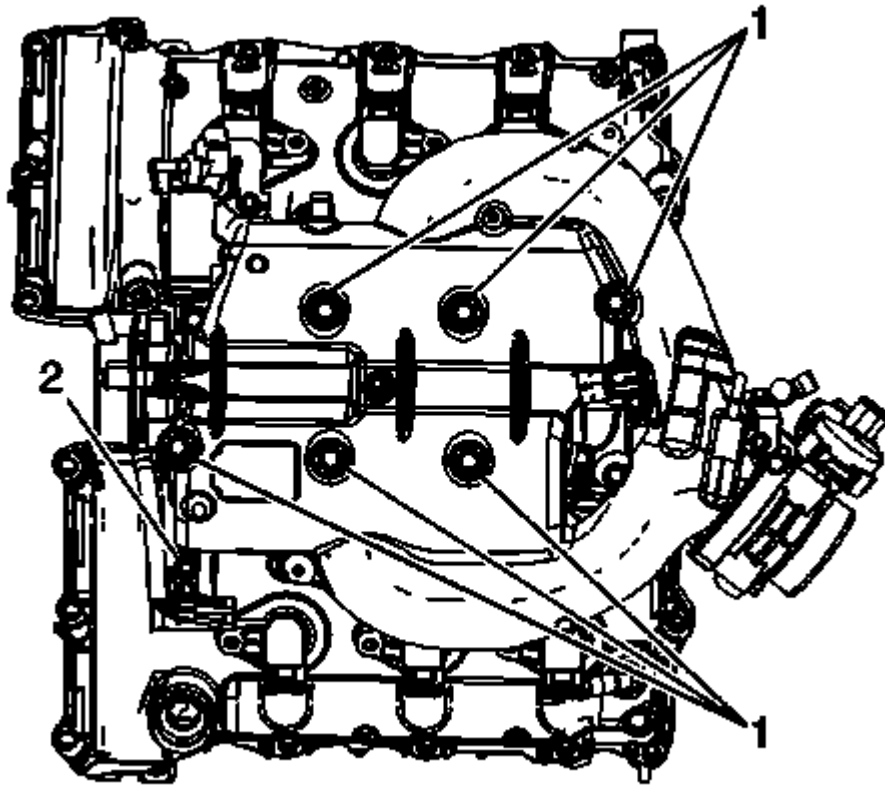
**Fig. 50: Identifying EVAP Canister Purge Solenoid Tube Quick Connect Fittings**  
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the EVAP canister purge solenoid tube quick connect fitting (1) at the upper intake manifold and reposition aside.



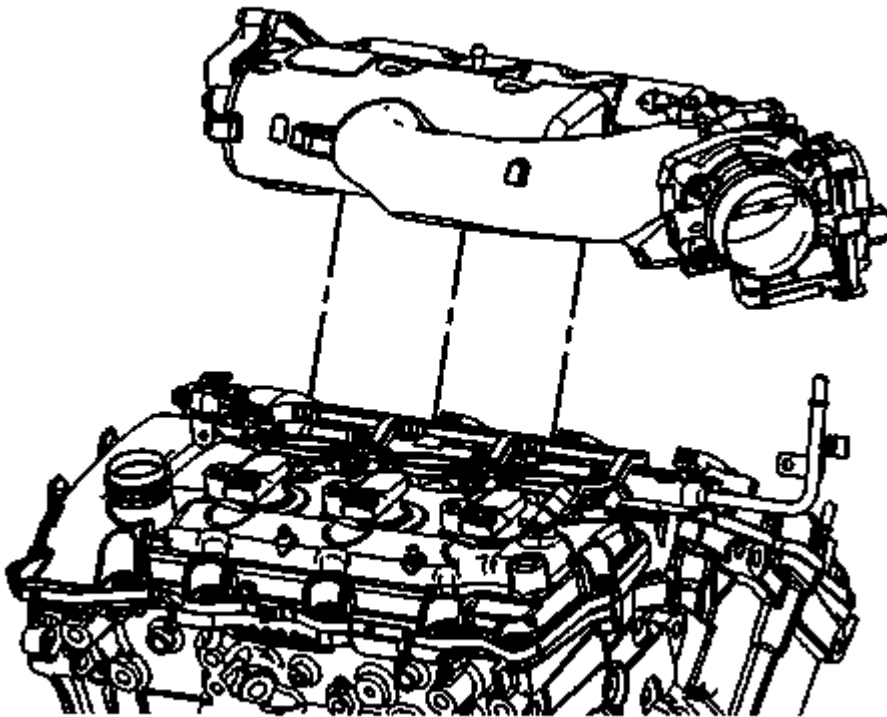
**Fig. 51: Identifying Fuel Rail To Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

18. Remove the fuel rail to bracket bolt (1).



**Fig. 52: Identifying Wiring Harness Electrical Connector & Upper Intake Bolts**  
Courtesy of GENERAL MOTORS CORP.

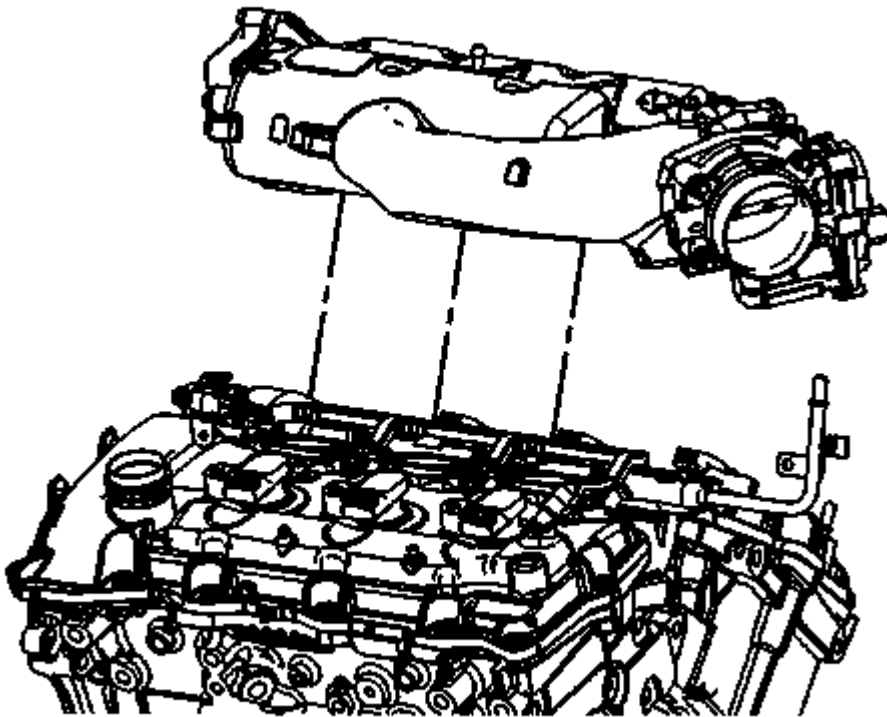
19. Remove the fuel rail wiring harness electrical connector bolt (2) and reposition the harness out of the way.
20. Remove the upper intake bolts (1).



**Fig. 53: Identifying Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

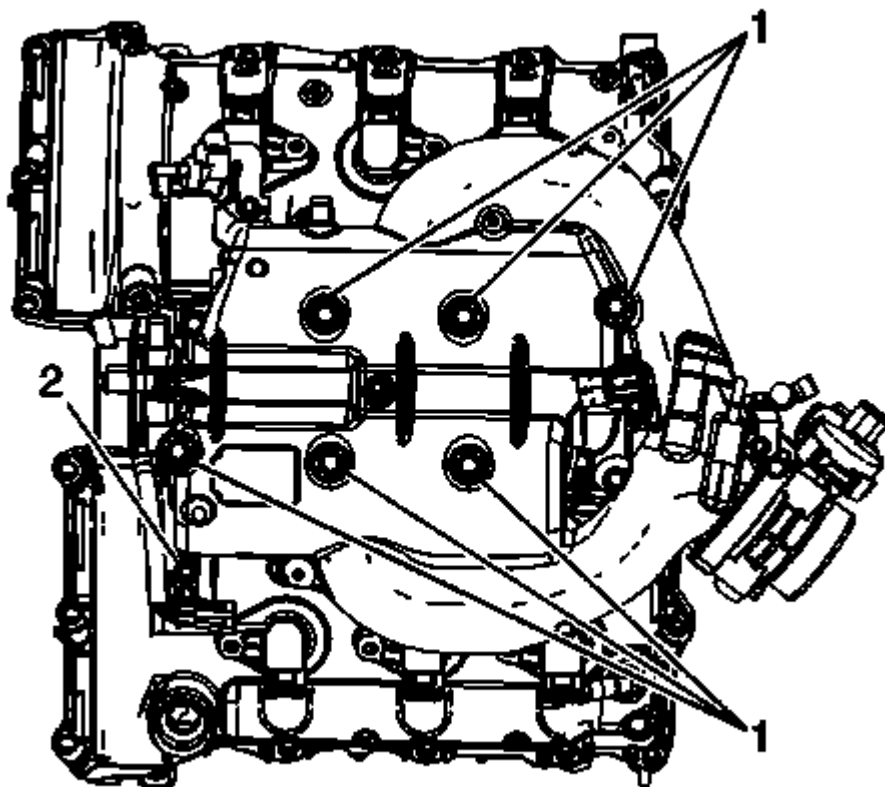
21. Remove the upper intake manifold and gaskets. Discard gaskets.
22. If replacing the upper intake manifold complete the following steps:
  1. Remove the MAP sensor. Refer to **Manifold Absolute Pressure Sensor Replacement**
  2. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
  3. Remove the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
  4. Remove the intake manifold tuning valve. Refer to **Intake Manifold Tuning Valve Replacement** .

## INSTALLATION PROCEDURE



**Fig. 54: Identifying Upper Intake Manifold**  
Courtesy of GENERAL MOTORS CORP.

1. If the upper intake manifold was replaced complete the following steps:
  1. Install the MAP sensor. Refer to **Manifold Absolute Pressure Sensor Replacement**
  2. Install the throttle body. Refer to **Throttle Body Assembly Replacement** .
  3. Install the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
  4. Install the intake manifold tuning valve. Refer to **Intake Manifold Tuning Valve Replacement** .
2. Place NEW upper intake manifold gaskets onto the lower intake manifold.
3. Place the upper intake manifold onto the lower intake manifold.



**Fig. 55: Identifying Wiring Harness Electrical Connector & Upper Intake Bolts**  
Courtesy of GENERAL MOTORS CORP.

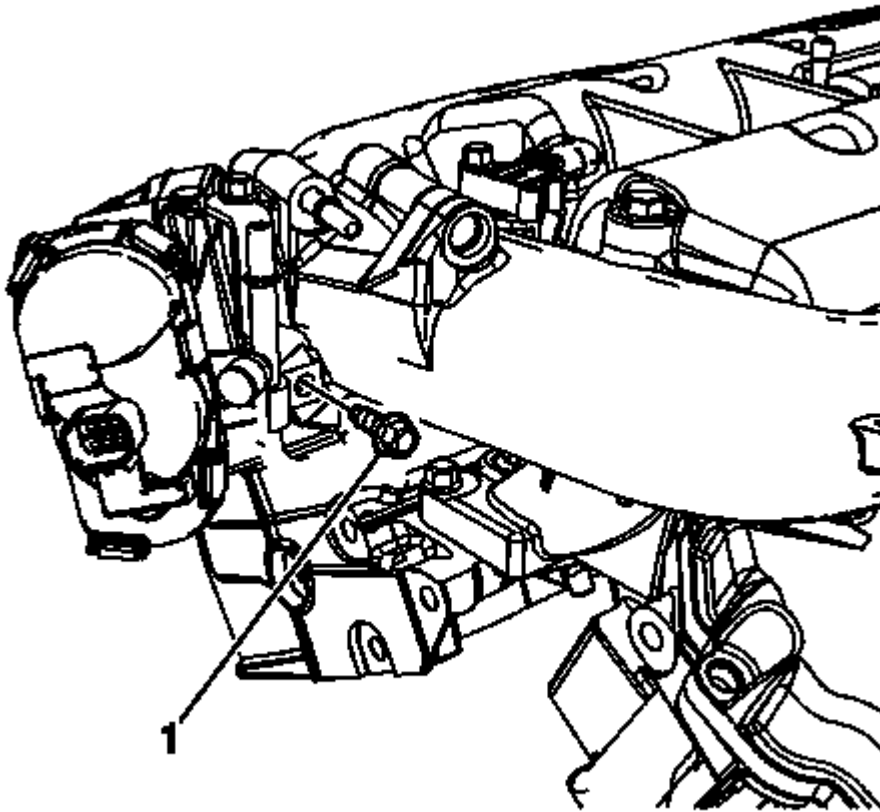
**CAUTION:** Refer to Fastener Caution .

4. Install the upper intake bolts (1).

**Tighten:** Tighten the bolts to 23 N.m (17 lb ft).

5. Position the fuel rail wiring harness and install the fuel rail wiring harness electrical connector bolt (2).

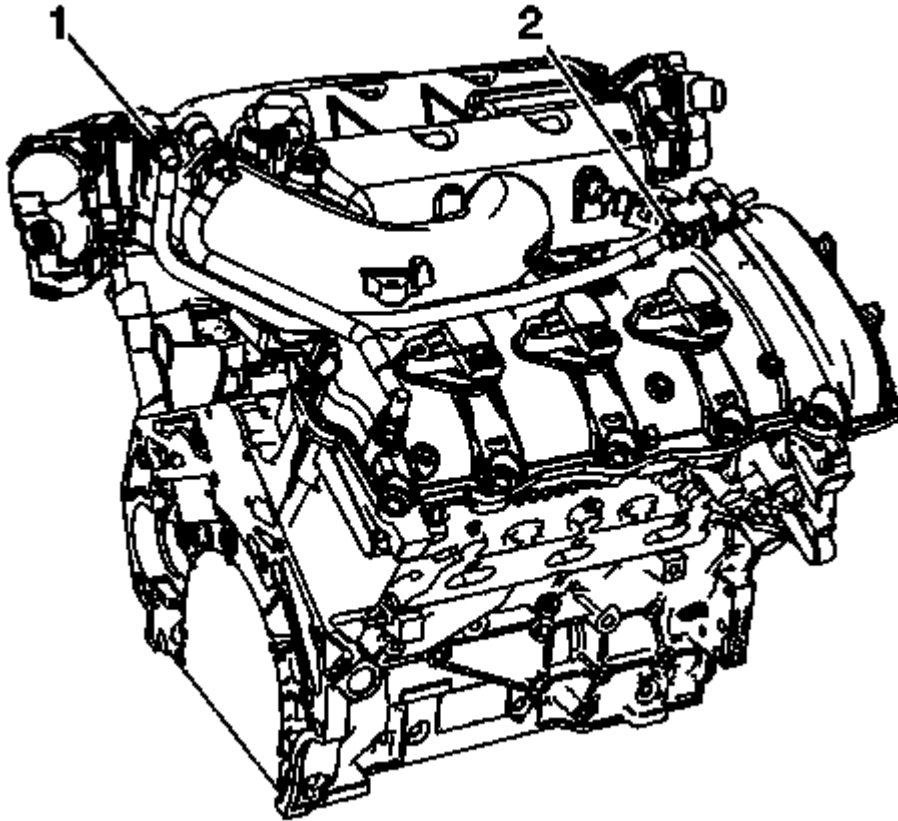
**Tighten:** Tighten the bolt to 10 N.m (89 lb in).



**Fig. 56: Identifying Fuel Rail To Bracket Bolt**  
Courtesy of GENERAL MOTORS CORP.

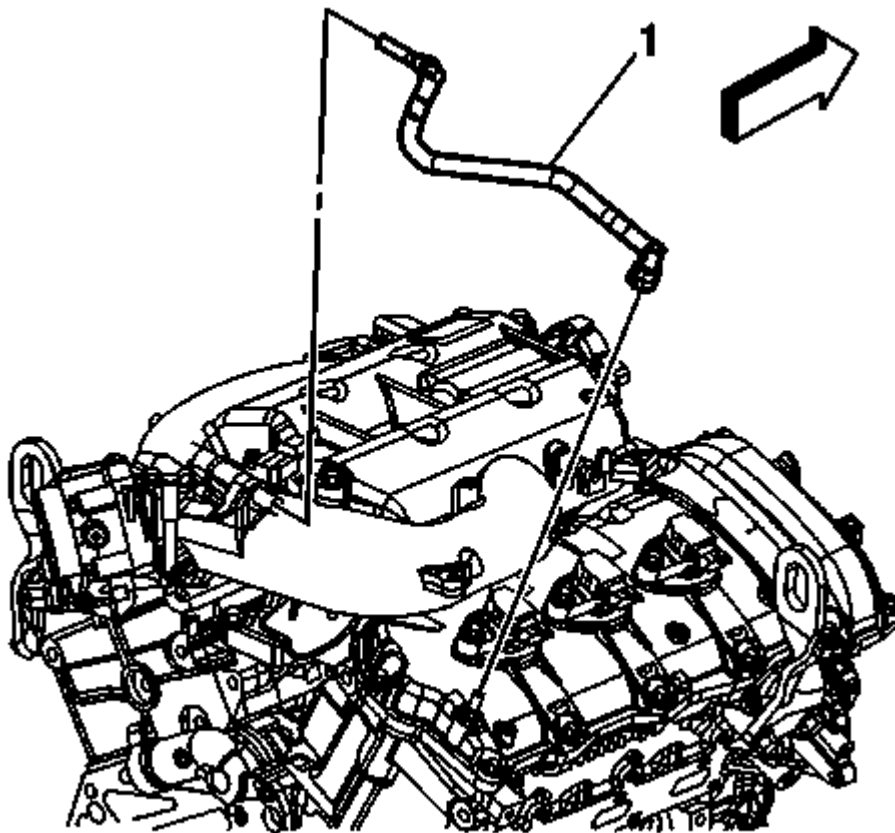
6. Install the fuel rail to bracket bolt (1).

**Tighten:** Tighten the bolt to 10 N.m (89 lb in).



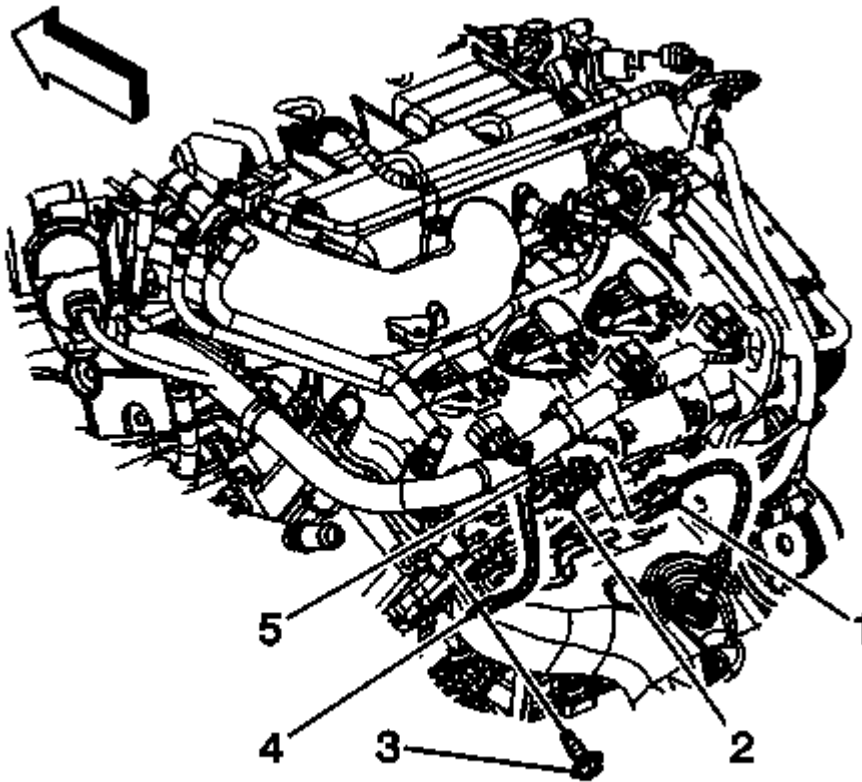
**Fig. 57: Identifying EVAP Canister Purge Solenoid Tube Quick Connect Fittings**  
Courtesy of GENERAL MOTORS CORP.

7. Position and install the EVAP canister purge solenoid tube quick connect fitting (1) to the upper intake manifold.



**Fig. 58: Identifying PCV Foul Air Pipe**  
Courtesy of GENERAL MOTORS CORP.

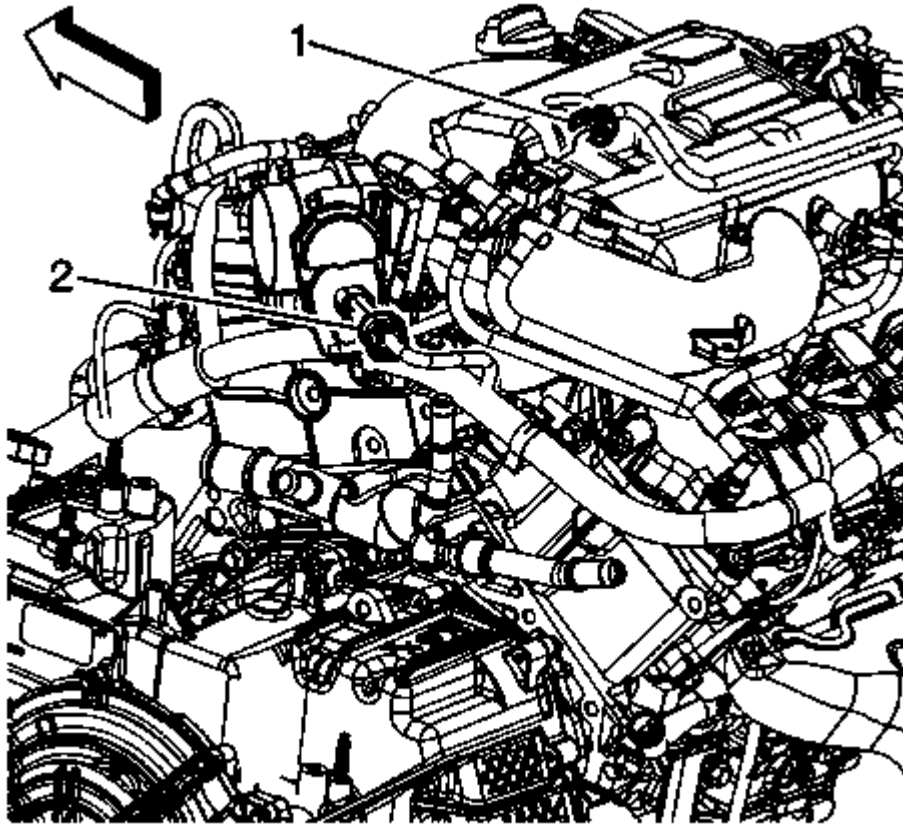
8. Position and install the PCV tube (1) to the upper intake manifold.



**Fig. 59: Identifying Intake Manifold Turning Valve & EVAP Canister Purge Solenoid Electrical Connectors**

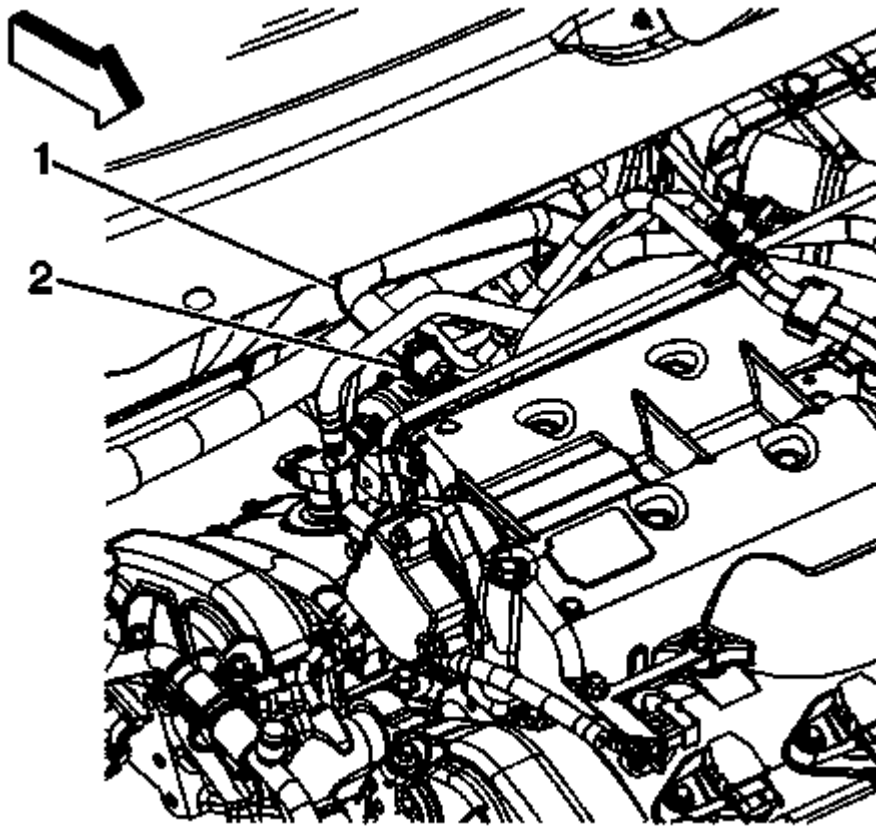
Courtesy of GENERAL MOTORS CORP.

9. Connect the engine wiring harness electrical connector (2) to the EVAP canister purge solenoid.
10. Connect the engine wiring harness electrical connector (1) to the intake manifold tuning valve.



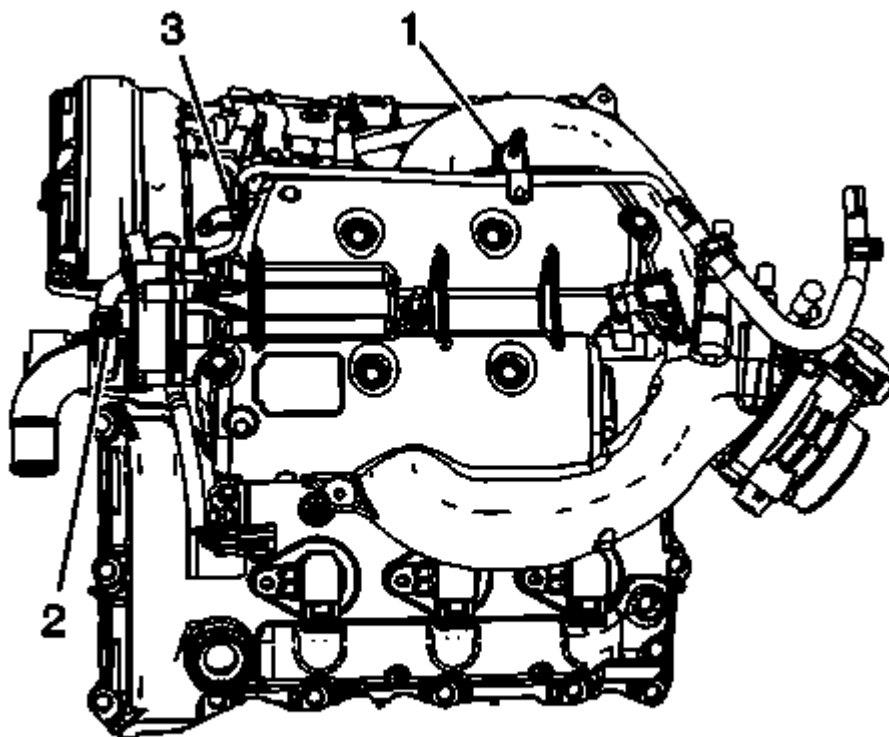
**Fig. 60: Identifying MAP Sensor & ETC Electrical Connectors**  
**Courtesy of GENERAL MOTORS CORP.**

11. Connect the engine wiring harness electrical connector (2) to the ETC.
12. Connect the engine wiring harness electrical connector (1) to the MAP sensor.



**Fig. 61: Identifying Booster Vacuum Hose & Clamp**  
Courtesy of GENERAL MOTORS CORP.

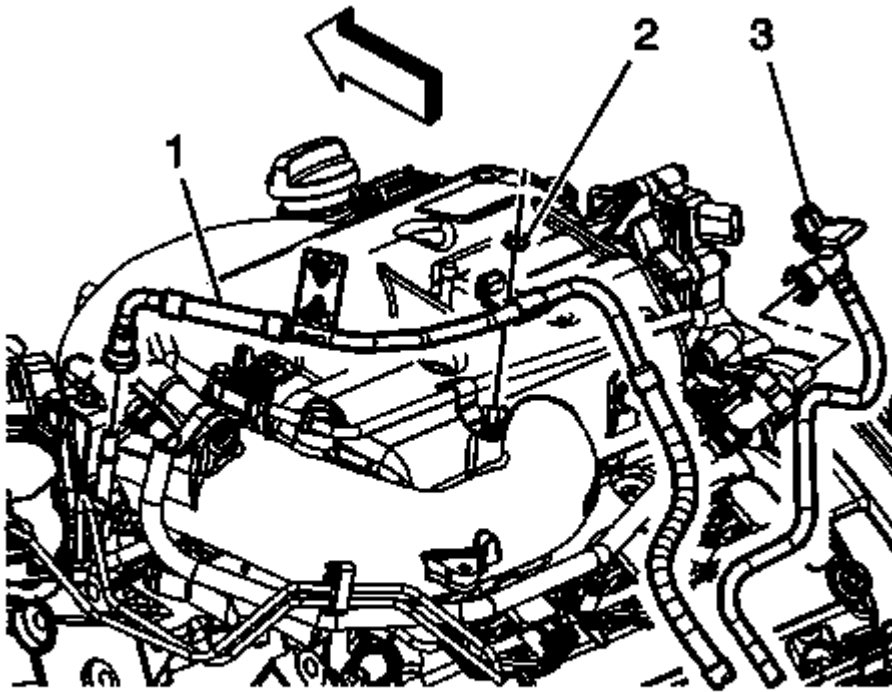
13. Install the brake booster vacuum hose (2) to the upper intake manifold.
14. Position the brake booster vacuum hose clamp (1) at the upper intake manifold.



**Fig. 62: Identifying Coolant Air Bleed Hose/Pipe Components**  
Courtesy of GENERAL MOTORS CORP.

15. Position and install the coolant air bleed hose/pipe clip to the upper intake manifold stud.
16. Install the coolant air bleed hose to the water outlet.
17. Position the coolant air bleed hose clamp (2) at the water outlet.
18. Install the coolant air bleed hose/pipe clip bolt (3) to the upper intake manifold.

**Tighten:** Tighten the bolt to 10 N.m (89 lb in).



**Fig. 63: Identifying Fuel Feed Pipe Line Components**  
Courtesy of GENERAL MOTORS CORP.

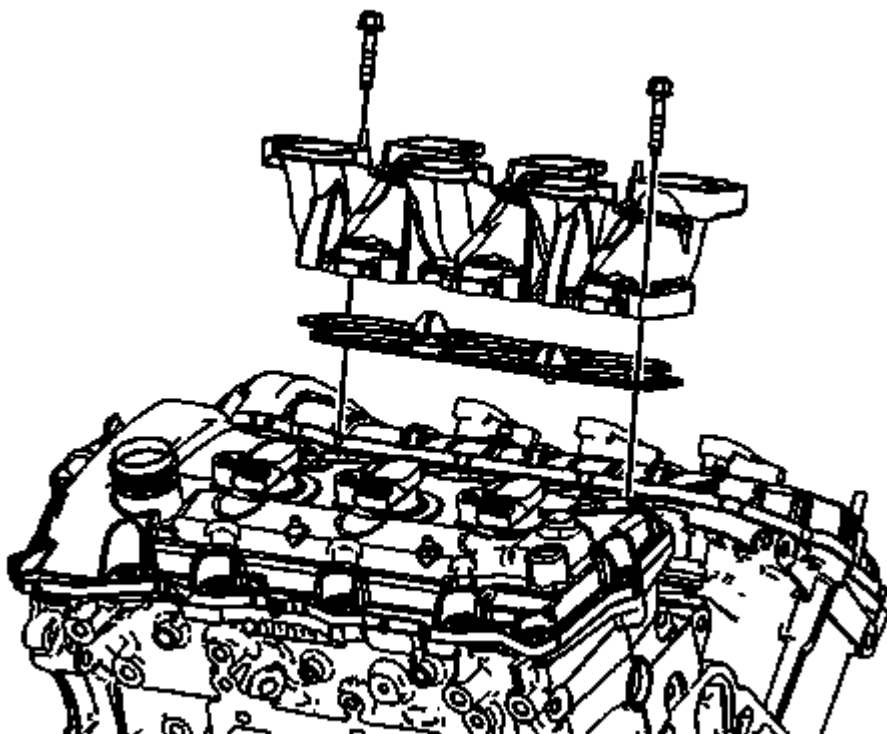
19. Position the fuel feed line and install the fuel feed line clip to the stud.
20. Install the fuel feed line nut (2).

**Tighten:** Tighten the nut to 10 N.m (89 lb in).

21. Connect the fuel feed line (1) quick connect fitting to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
22. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
23. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

## LOWER INTAKE MANIFOLD REPLACEMENT

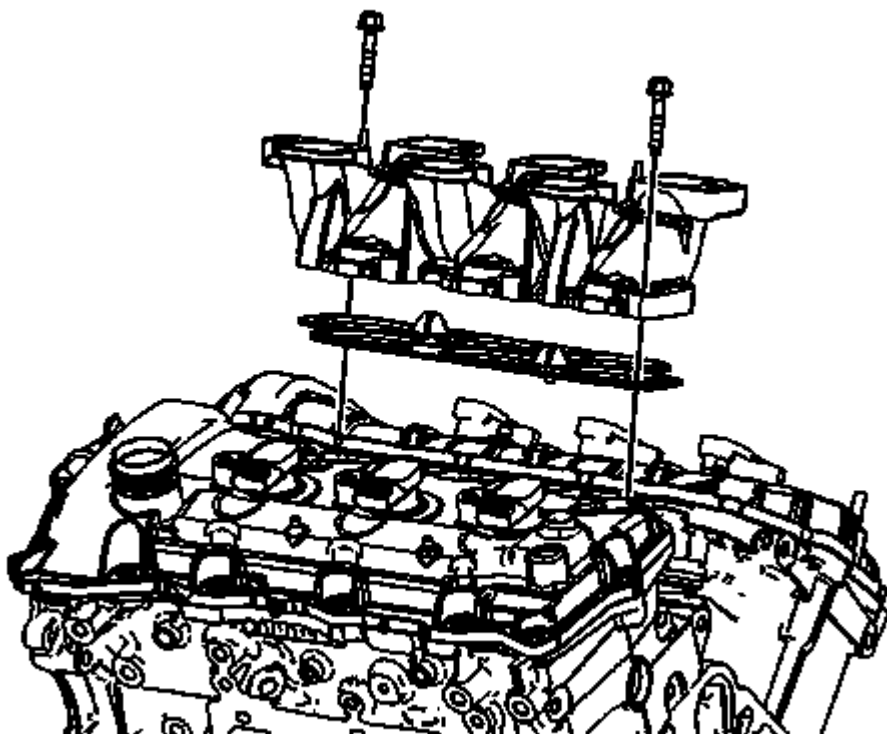
### REMOVAL PROCEDURE



**Fig. 64: View Of Intake Manifold & Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injectors and fuel rail. Refer to **Fuel Injector and Fuel Rail Replacement** .
2. Remove the lower intake manifold bolts.
3. Remove the lower intake manifold and gasket. Discard the gasket.
4. Clean and inspect the intake manifold and sealing surfaces. Refer to **Intake Manifold Cleaning and Inspection** .

## INSTALLATION PROCEDURE



**Fig. 65: View Of Intake Manifold & Gasket**  
Courtesy of GENERAL MOTORS CORP.

1. Place a NEW lower intake manifold gasket onto the cylinder heads.
2. Place the lower intake manifold onto the cylinder heads.

**CAUTION:** Refer to Fastener Caution .

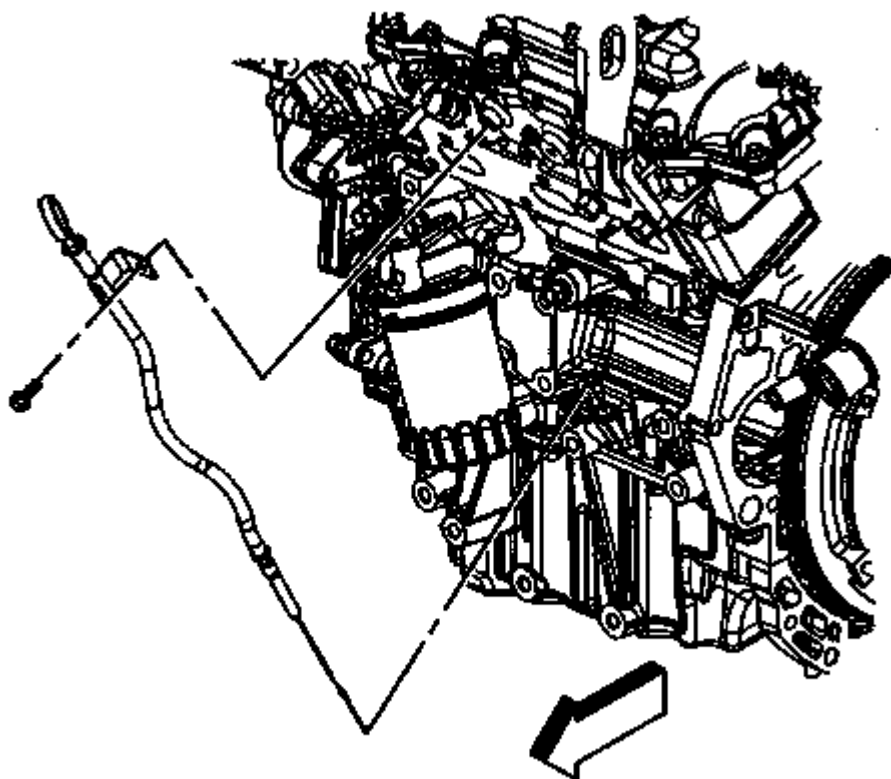
3. Install the lower intake manifold bolts.

**Tighten:** Tighten the bolts to 23 N.m (17 lb ft).

4. Install the fuel injectors and fuel rail. Refer to Fuel Injector and Fuel Rail Replacement .

## OIL LEVEL INDICATOR TUBE REPLACEMENT

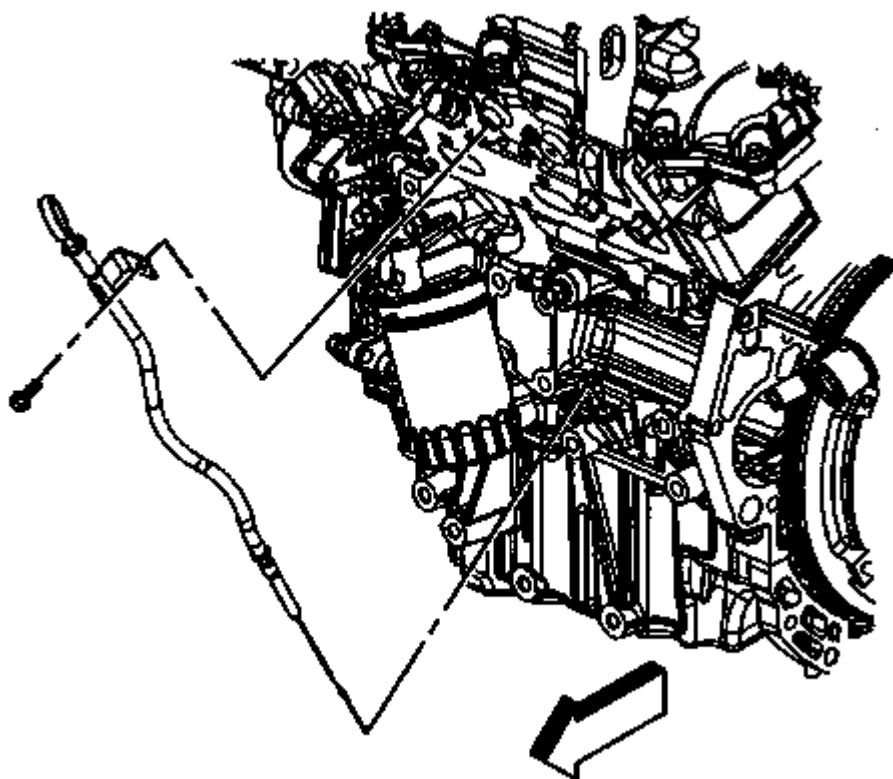
### REMOVAL PROCEDURE



**Fig. 66: Identifying Oil Level Indicator Tube & Bolt**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the Fuel Injector Sight Shield. Refer to **Fuel Injector Sight Shield Replacement**
2. Remove the oil level indicator from the oil level indicator tube.
3. Remove the oil level indicator tube bolt.
4. Remove the oil level indicator tube up through the exhaust manifold.
5. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

## **INSTALLATION PROCEDURE**



**Fig. 67: Identifying Oil Level Indicator Tube & Bolt**  
Courtesy of GENERAL MOTORS CORP.

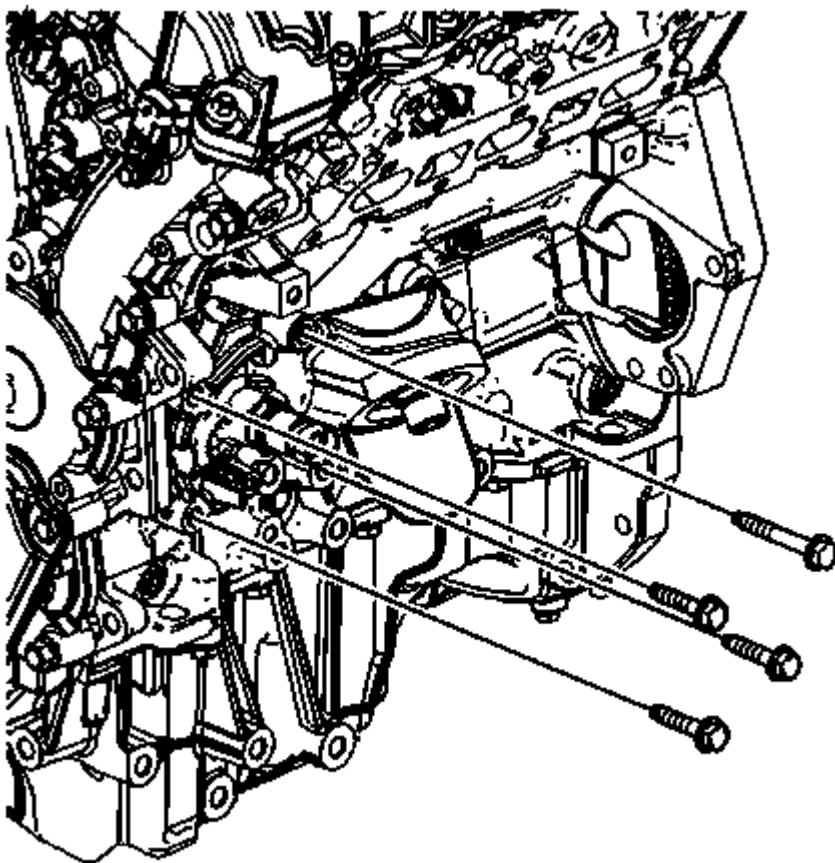
1. Install a new seal on the oil level indicator tube.
2. Install the oil level indicator tube.

**CAUTION:** Refer to Fastener Caution .

3. Install the oil level indicator tube bolt and tighten to 10 N.m (89 lb in).
4. Install the oil level indicator in the oil level indicator tube.
5. Install the Fuel Injector Sight Shield. Refer to Fuel Injector Sight Shield Replacement

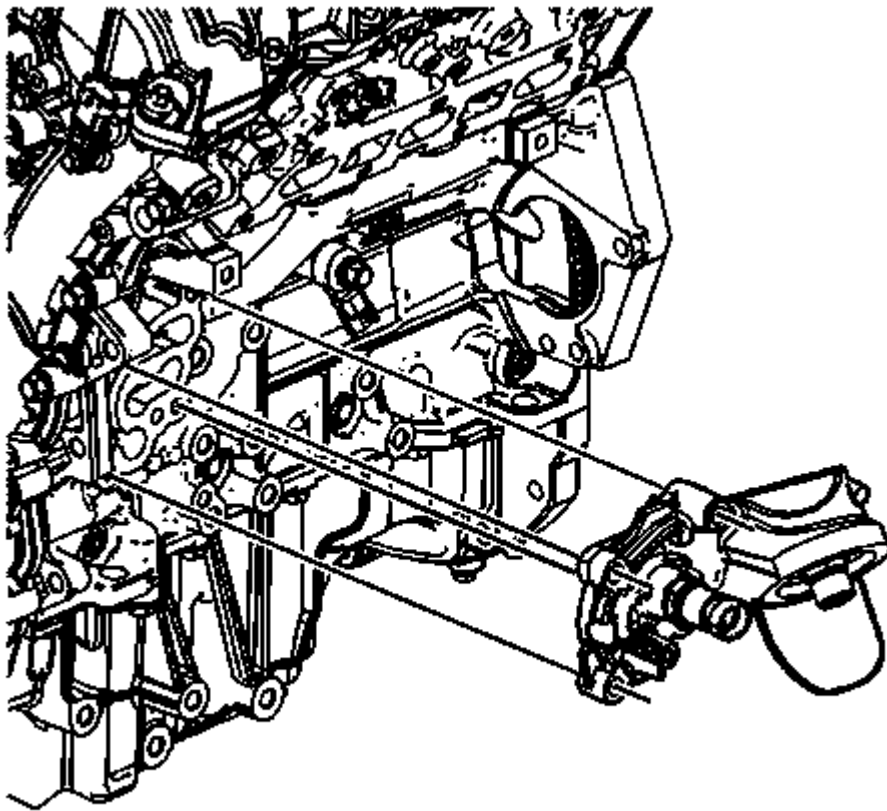
## OIL FILTER ADAPTER REPLACEMENT

### REMOVAL PROCEDURE



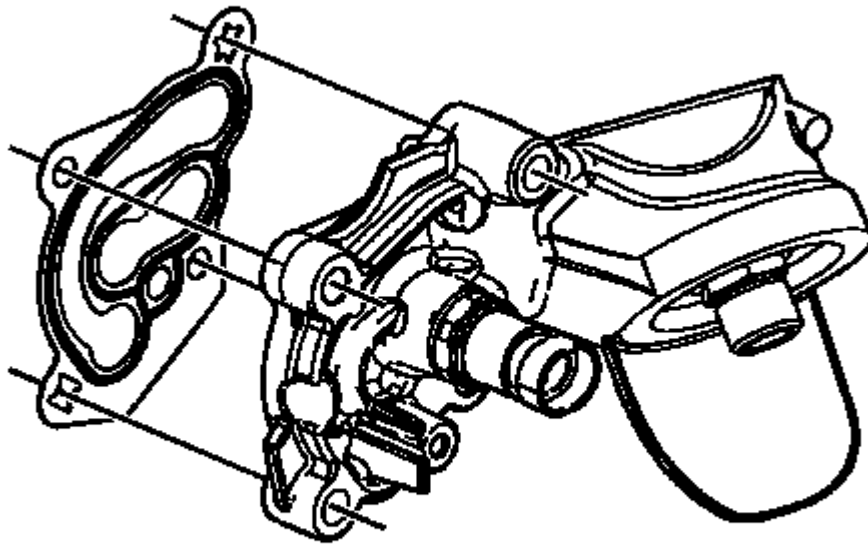
**Fig. 68: Locating Oil Filter Adapter Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator. Refer to **Generator Replacement (LE5 or LE9)** or **Generator Replacement (LY7)**.
2. Remove and properly dispose of the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
3. Disconnect the oil pressure sensor electrical connector.
4. Remove the oil filter adapter bolts from the engine block.



**Fig. 69: Identifying Oil Filter Adapter**  
Courtesy of GENERAL MOTORS CORP.

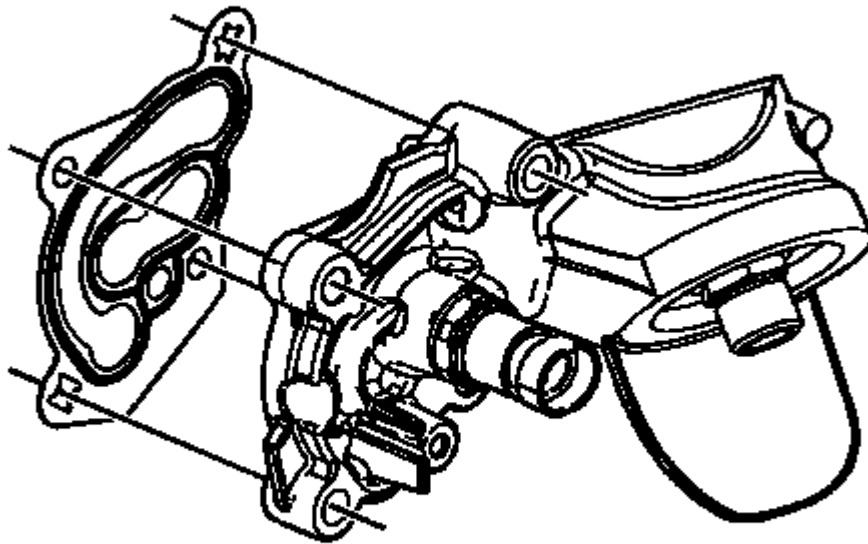
5. Remove the oil filter adapter.



**Fig. 70: View Of Oil Filter Adapter Gasket**  
**Courtesy of GENERAL MOTORS CORP.**

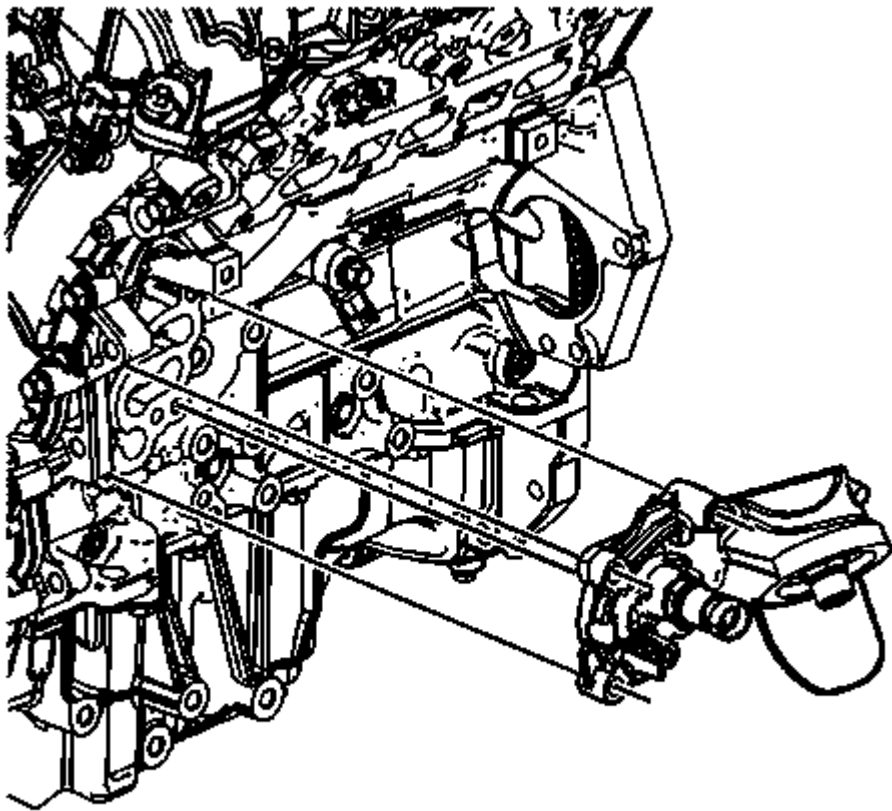
6. Remove and discard the oil filter adapter gasket.

## **INSTALLATION PROCEDURE**



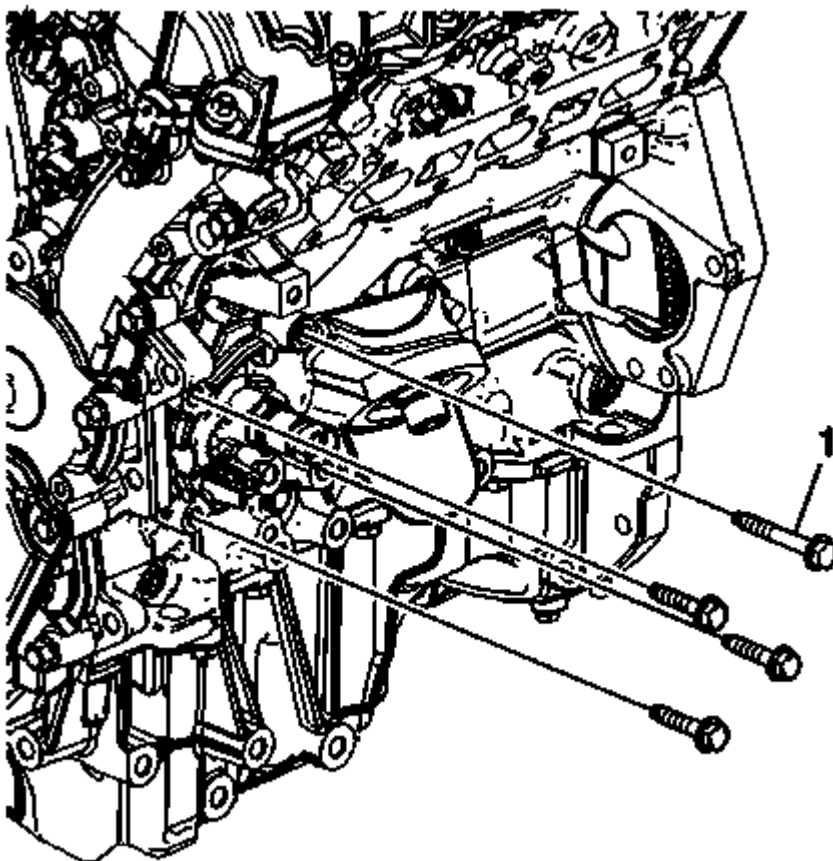
**Fig. 71: View Of Oil Filter Adapter Gasket**  
**Courtesy of GENERAL MOTORS CORP.**

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.



**Fig. 72: Identifying Oil Filter Adapter**  
**Courtesy of GENERAL MOTORS CORP.**

2. Place the oil filter adapter into position.



**Fig. 73: Identifying Correct Position Of Longer Bolt**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

3. Install the oil filter adapter bolts. Ensure the longer bolts (1) is installed in the upper rear position and tighten to 23 N.m (17 lb ft).
4. Install a NEW oil filter. Refer to Engine Oil and Oil Filter Replacement .
5. Install the generator. Refer to Generator Replacement (LY7) .

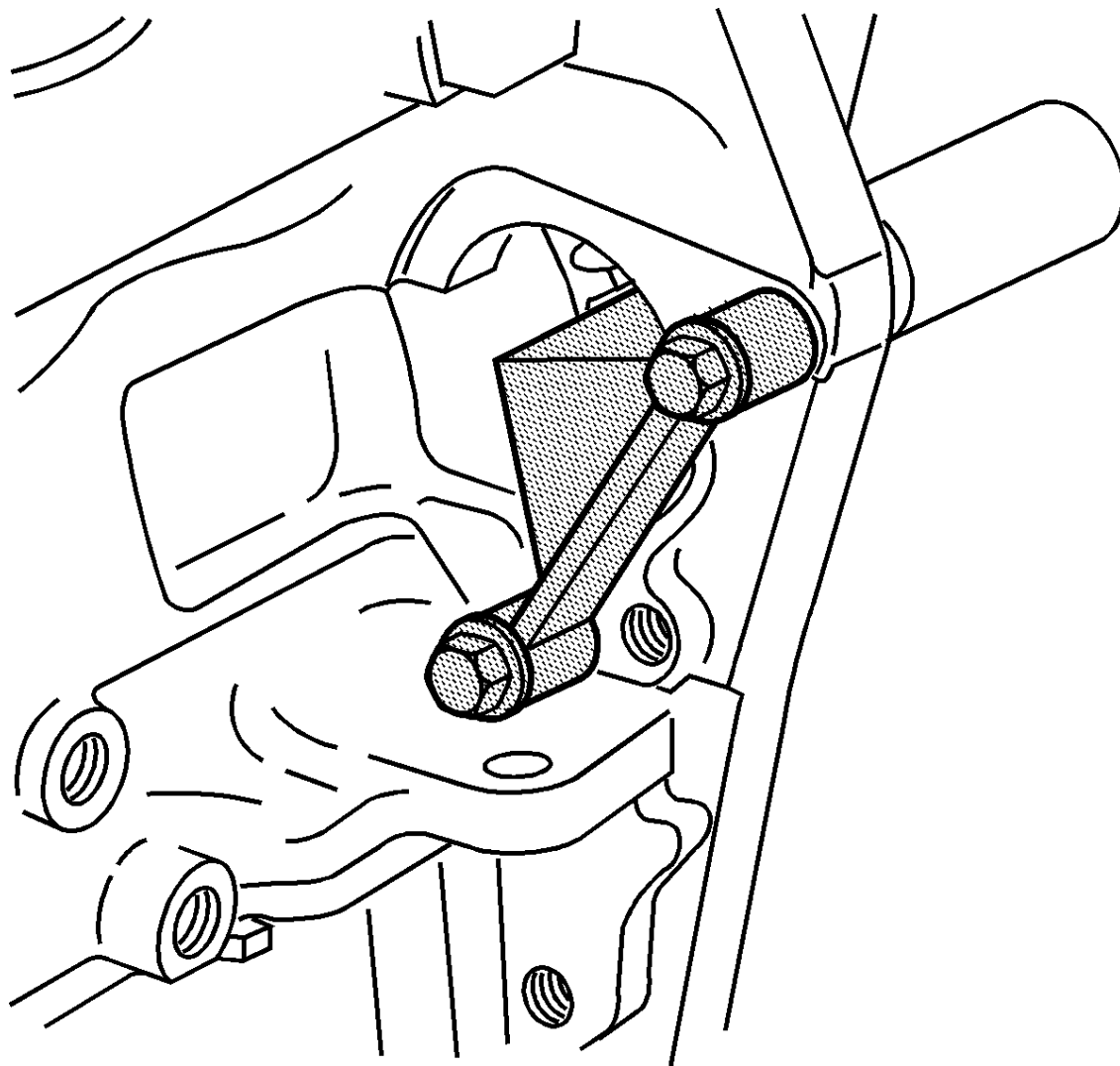
## CRANKSHAFT BALANCER REPLACEMENT

### SPECIAL TOOLS

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

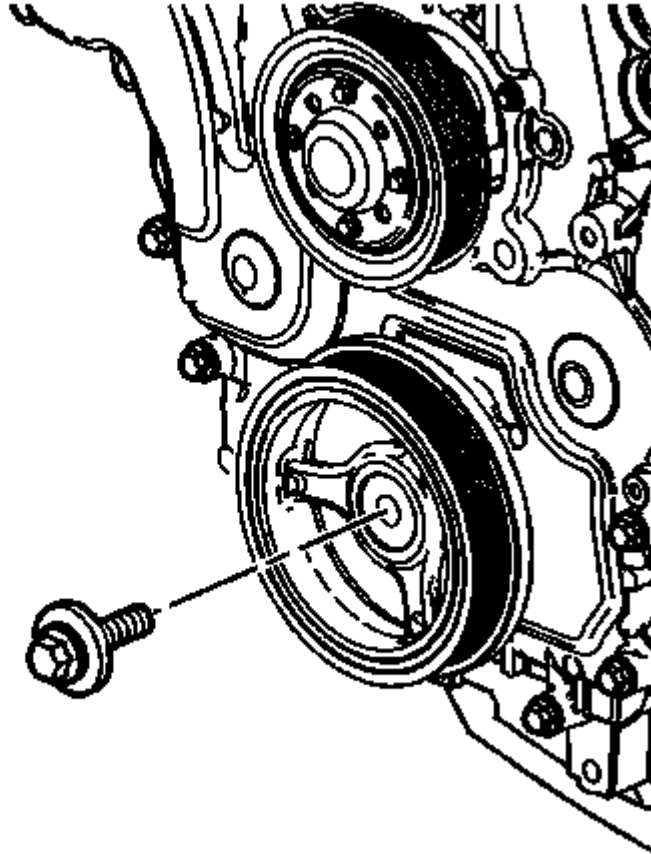
**REMOVAL PROCEDURE**

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Install the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the engine mount. Refer to **Engine Mount Replacement - Right Side**.
4. Remove the starter. Refer to **Starter Replacement (LY7)**.



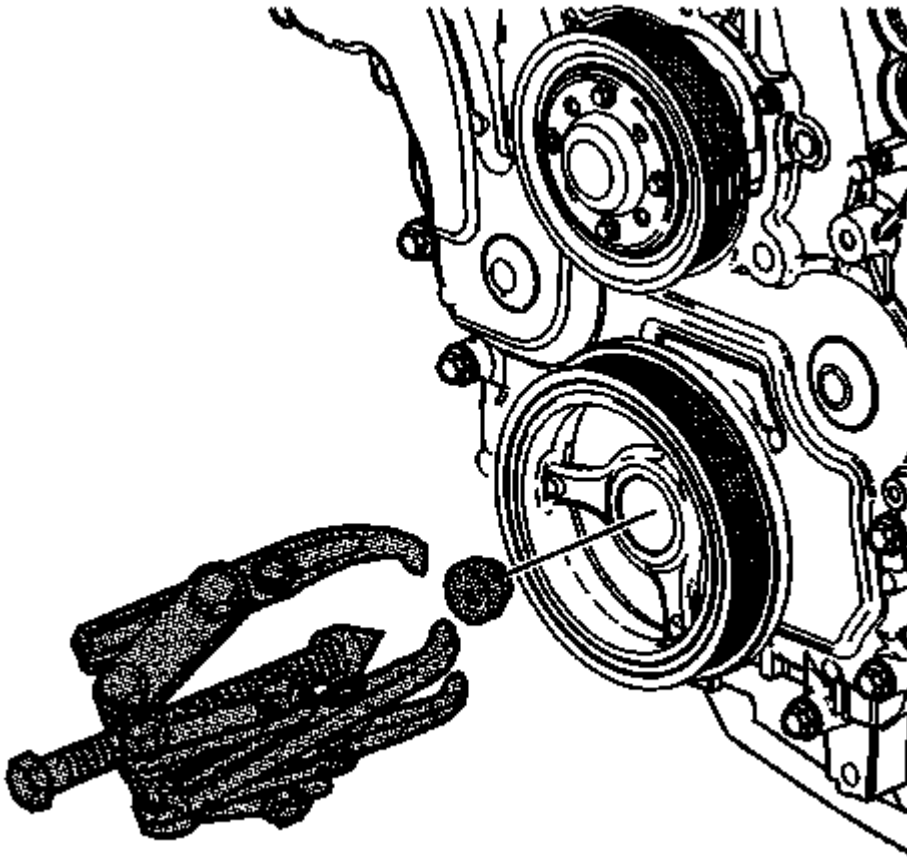
**Fig. 74: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS CORP.

5. Install the **EN 46106** through the starter mounting hole. See **Special Tools**.



**Fig. 75: Identifying Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS CORP.

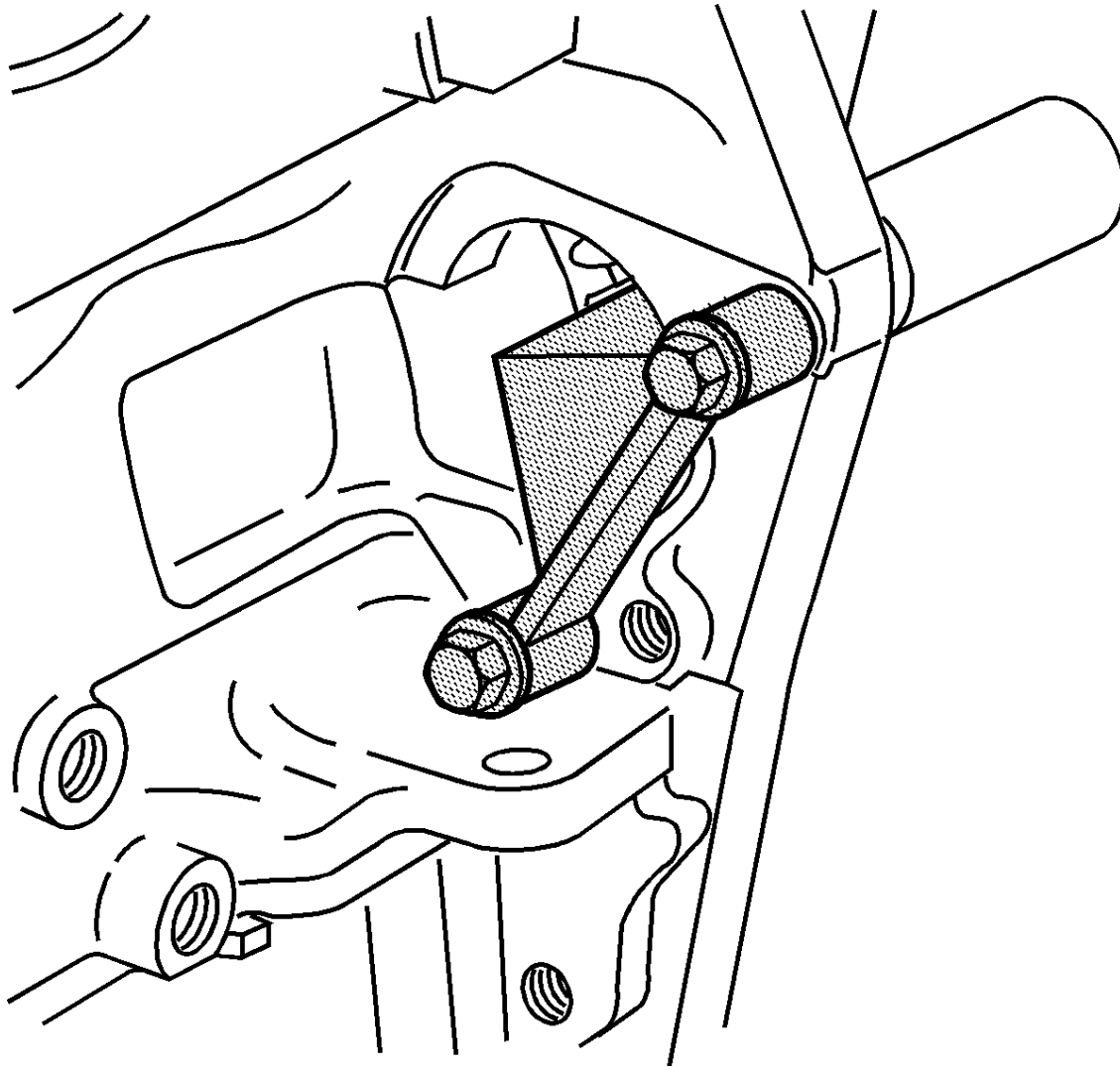
6. Using engine support fixture, lower engine approximately two inches.
7. Remove the crankshaft balancer bolt.



**Fig. 76: View Of Special Tool J 38416-2 In Nose Of Crankshaft**  
Courtesy of GENERAL MOTORS CORP.

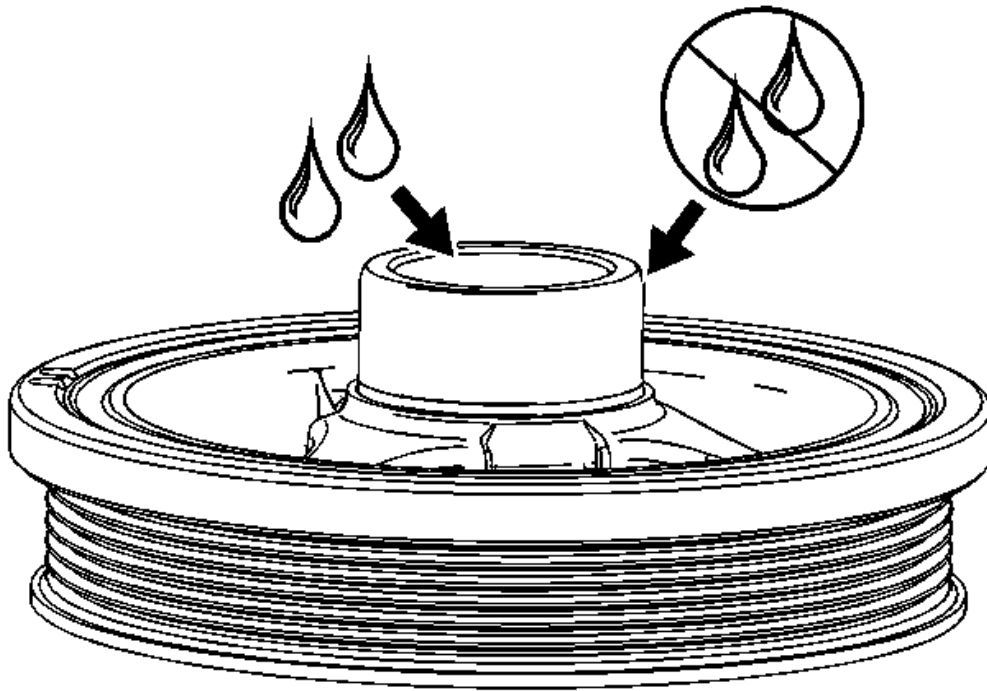
8. Install the **J 38416-2** in the nose of the crankshaft. See **Special Tools** .
9. Install the **J 41816** in order to remove the crankshaft balancer.
10. Tighten the center bolt of the **J 41816** in order to pull the crankshaft balancer off of the crankshaft.
11. Remove the **J 41816** from the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

## INSTALLATION PROCEDURE



**Fig. 77: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS CORP.

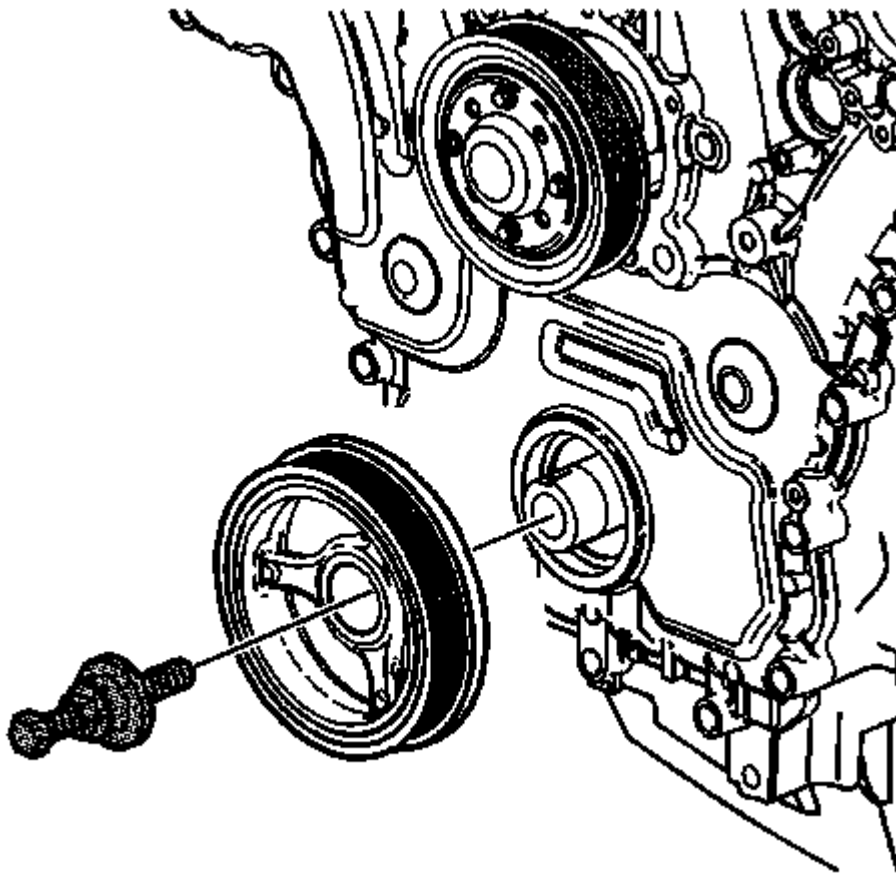
1. The **EN 46106** must be installed onto the flywheel. See **Special Tools** .
2. Use the **J 41998-B** , nut, bearing and washer to install the crankshaft balancer. See **Special Tools** .



**Fig. 78: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer**  
Courtesy of GENERAL MOTORS CORP.

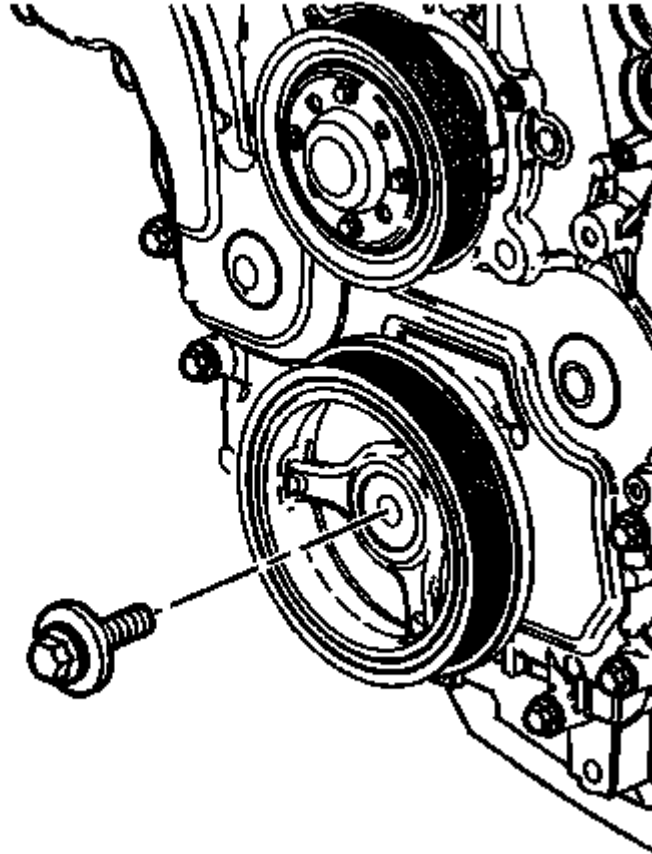
**NOTE:** Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

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



**Fig. 79: View Of Crankshaft Balancer & Installation Tool J 41998-B**  
 Courtesy of GENERAL MOTORS CORP.

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

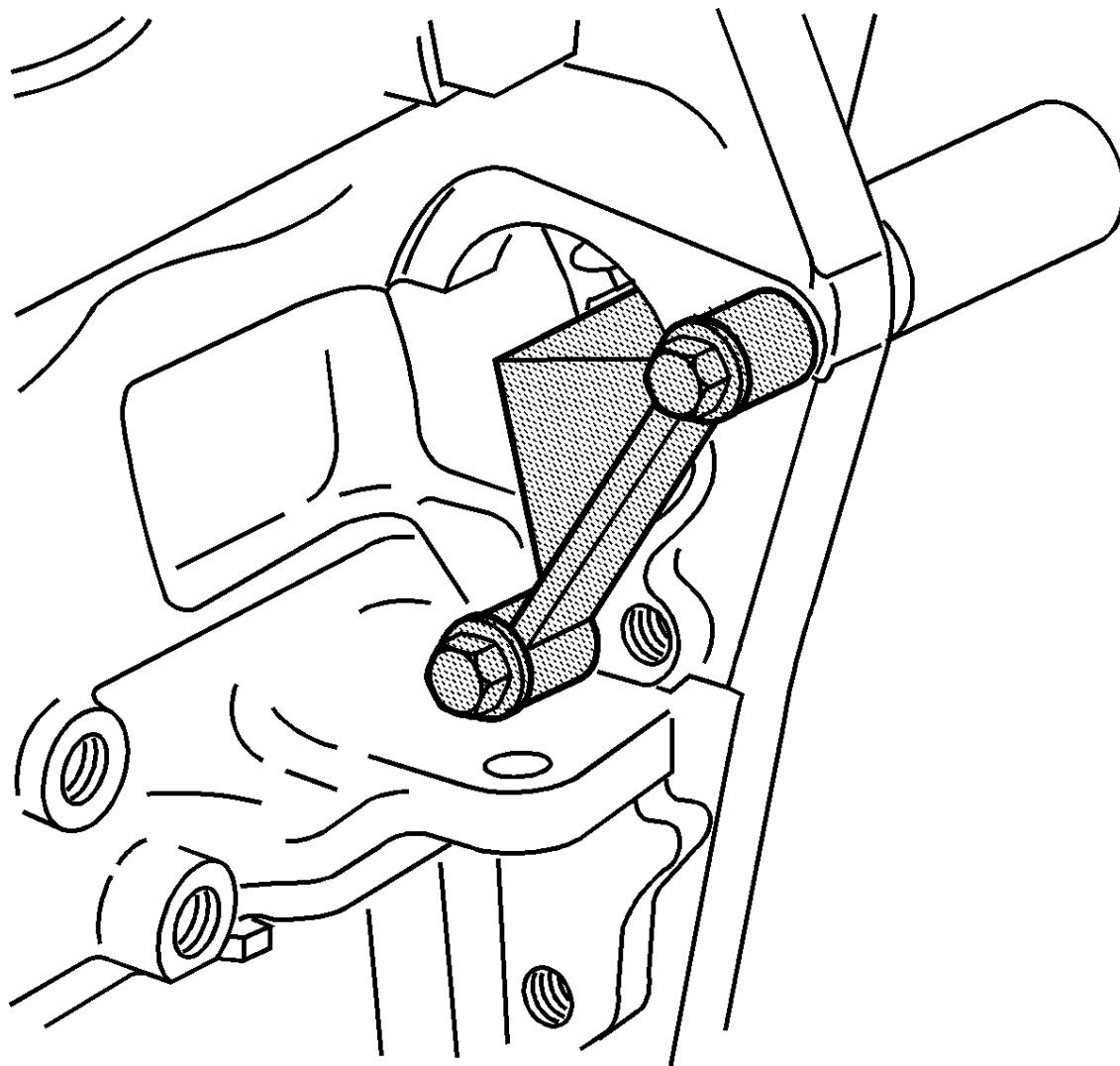


**Fig. 80: Identifying Crankshaft Balancer Bolt**  
Courtesy of GENERAL MOTORS CORP.

8. Install the crankshaft balancer bolt.

**CAUTION:** Refer to Fastener Caution .

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



**Fig. 81: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS CORP.

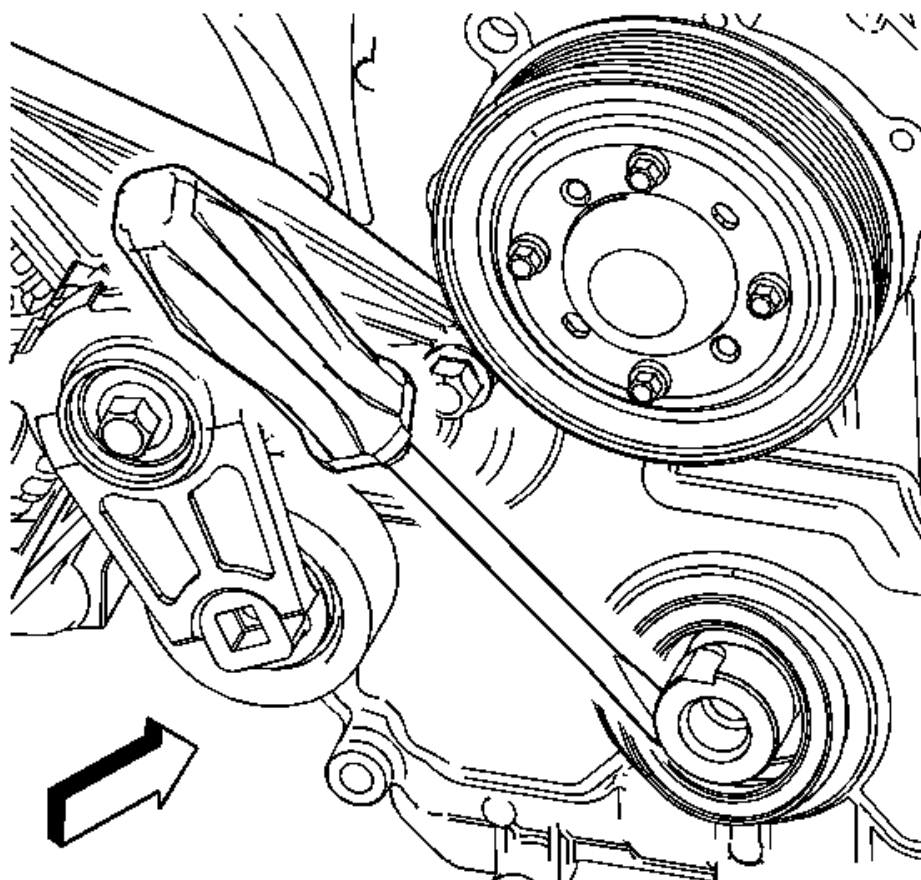
10. Remove the **EN 46106** . See **Special Tools** .
11. Install the starter. Refer to **Starter Replacement (LY7)** .
12. Using engine support fixture, raise the engine into position.
13. Install the engine mount. Refer to **Engine Mount Replacement - Right Side**.
14. Install the drive belt. Refer to **Drive Belt Replacement**.

## CRANKSHAFT FRONT OIL SEAL REPLACEMENT

### SPECIAL TOOLS

**J 29184** Oil Seal Installer. See **Special Tools** .

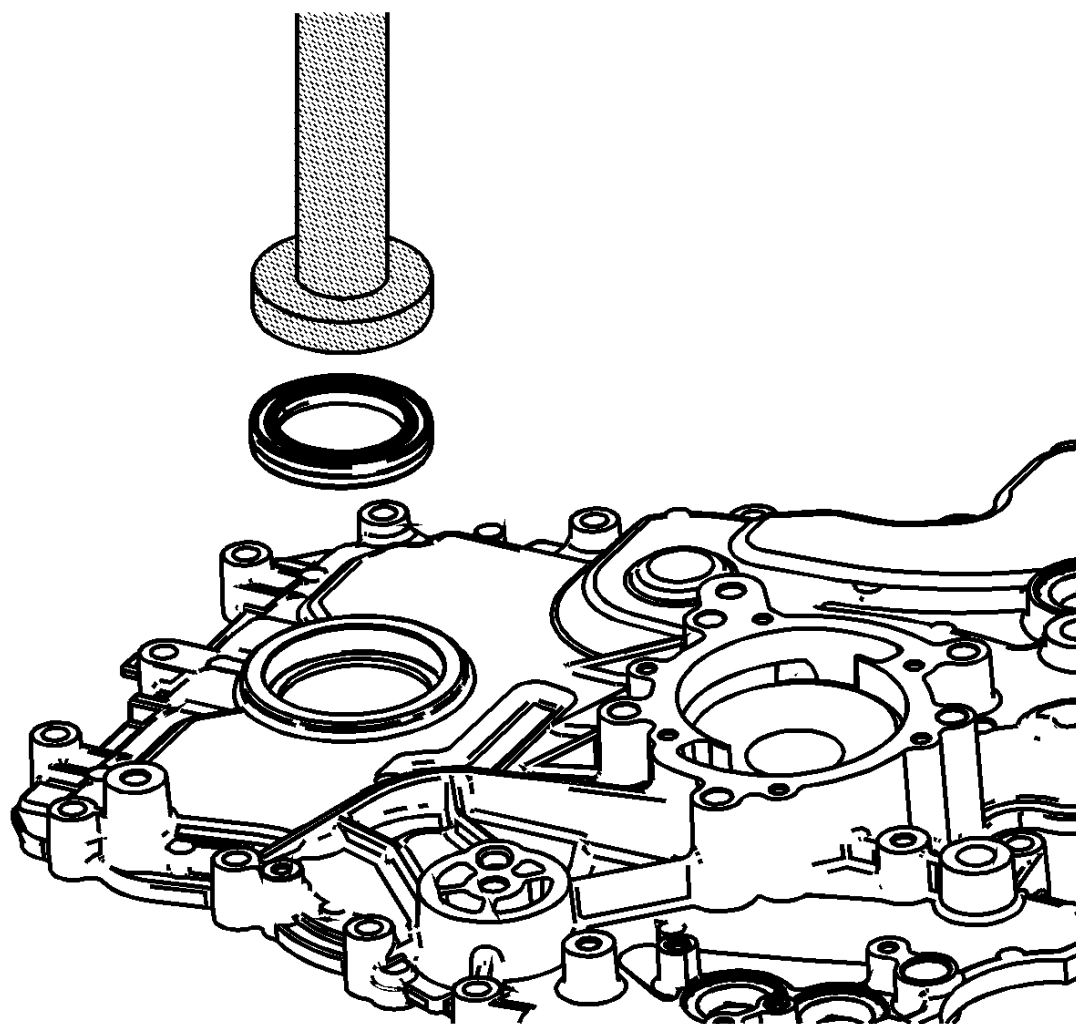
### REMOVAL PROCEDURE



**Fig. 82: Identifying 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. Use care not to damage the engine front cover or the crankshaft.

## INSTALLATION PROCEDURE



**Fig. 83: View of Crankshaft Front Oil Seal Assembly**  
Courtesy of GENERAL MOTORS CORP.

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

1. Use the **J 29184** or equivalent to install the crankshaft front oil seal. See **Special Tools** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

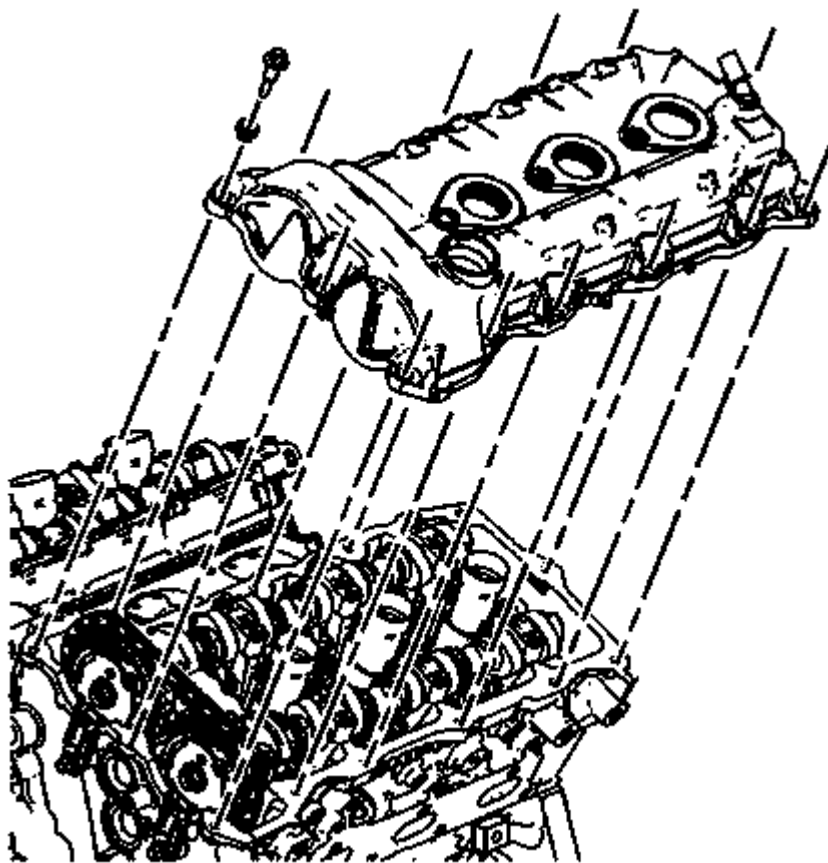
## **CAMSHAFT COVER REPLACEMENT - LEFT SIDE**

### **SPECIAL TOOLS**

**EN 46101** Spark Plug Tube Seal Guide. See **Special Tools** .

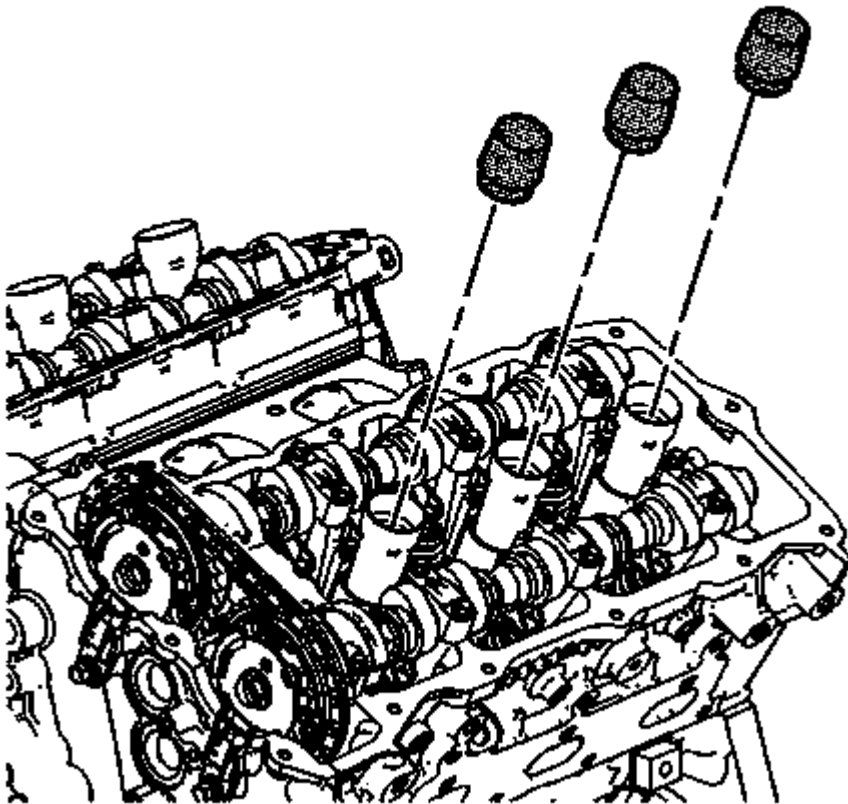
### **REMOVAL PROCEDURE**

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 upper intake manifold. Refer to **Upper Intake Manifold Replacement**.



**Fig. 84: Removing & Installing Left Camshaft Cover**  
Courtesy of GENERAL MOTORS CORP.

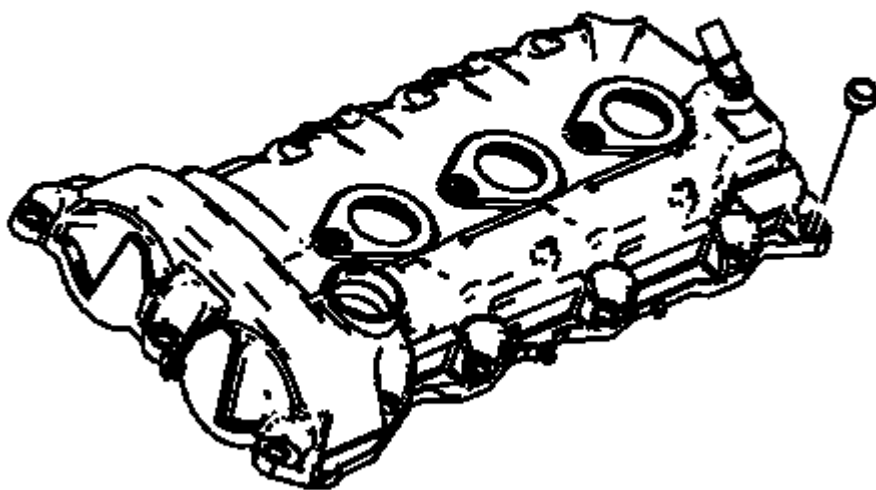
4. Remove the left camshaft cover bolts.
5. Remove the left camshaft cover from the left cylinder head.
6. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .



**Fig. 85: Identifying Special Tool - EN 46101**  
Courtesy of GENERAL MOTORS CORP.

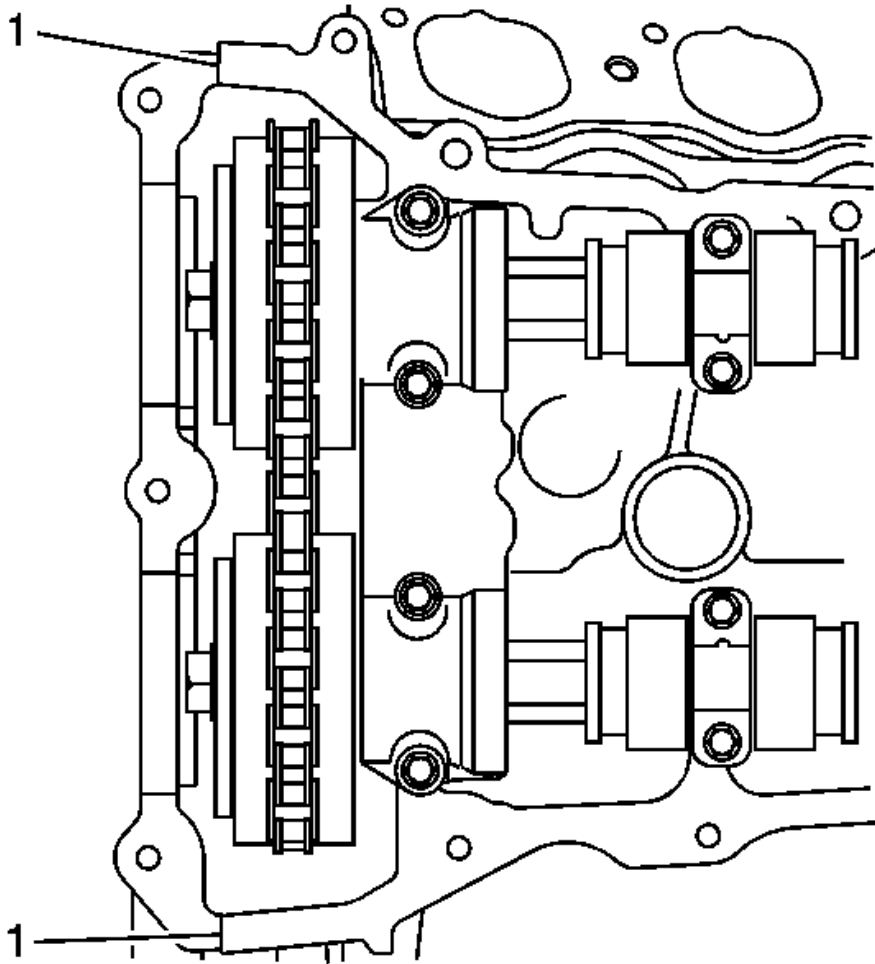
7. Install the **EN 46101** onto the spark plug tubes of the left cylinder head. See **Special Tools** .

## **INSTALLATION PROCEDURE**



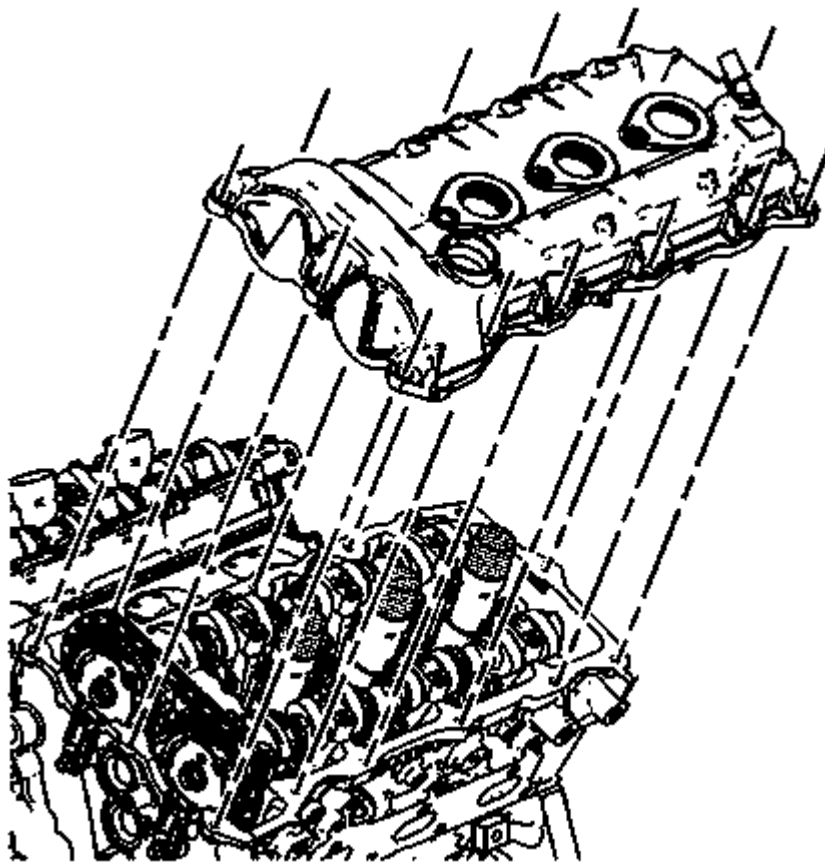
**Fig. 86: Identifying Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS CORP.

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



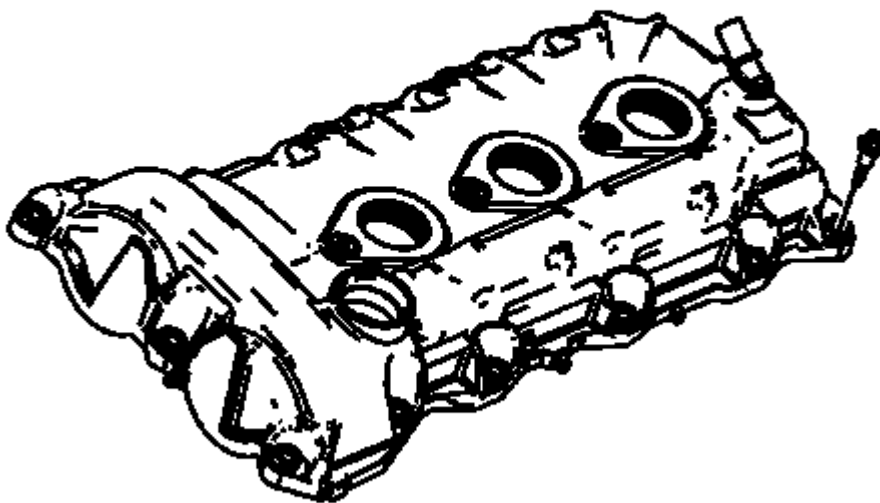
**Fig. 87: Locating Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS CORP.

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant on the engine front cover split lines (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.



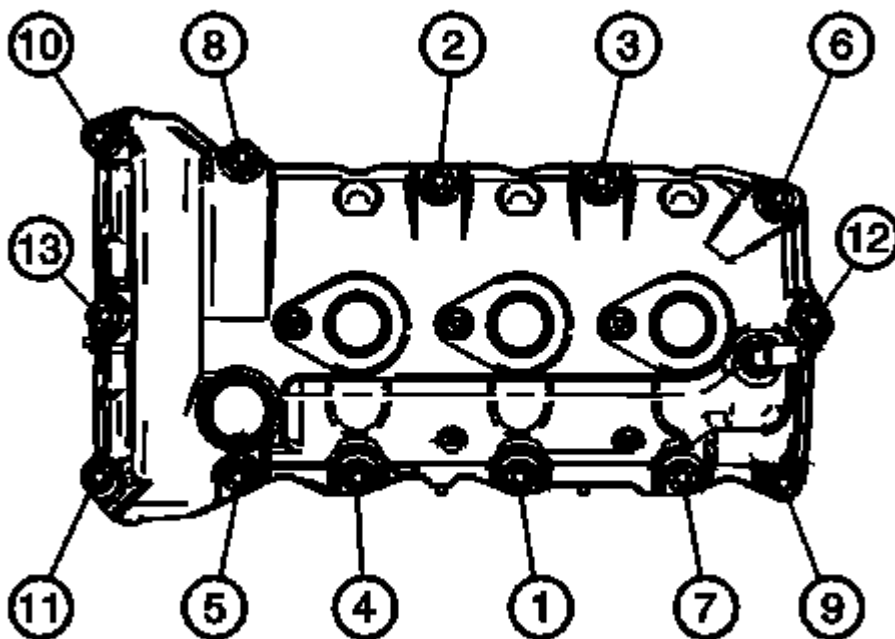
**Fig. 88: Aligning Left Camshaft Cover On Left Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 89: Identifying Left Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

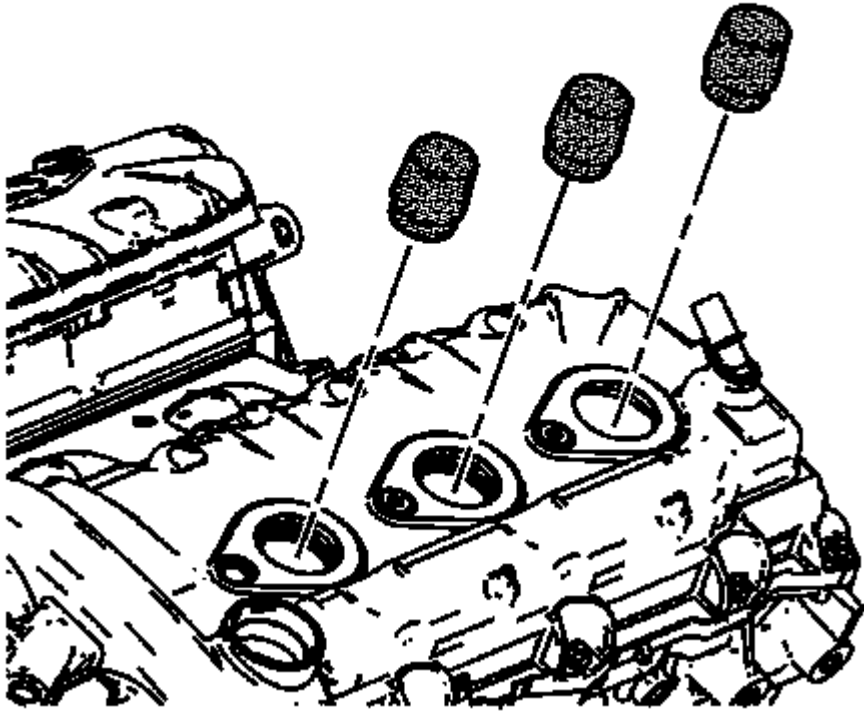
4. Loosely install the left camshaft cover bolts.



**Fig. 90: Identifying Left Camshaft Cover Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

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 upper intake manifold. Refer to Upper Intake Manifold Replacement.



**Fig. 91: Identifying Special Tool - EN 46101**  
Courtesy of GENERAL MOTORS CORP.

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

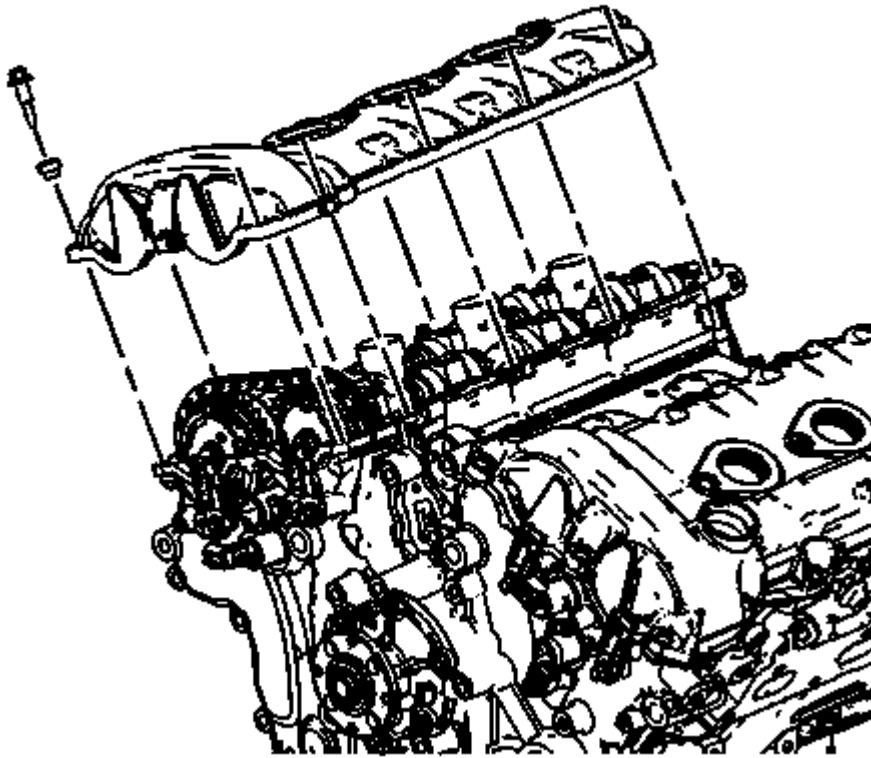
## CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

### SPECIAL TOOLS

**EN 46101** Spark Plug Tube Seal Guide. See **Special Tools** .

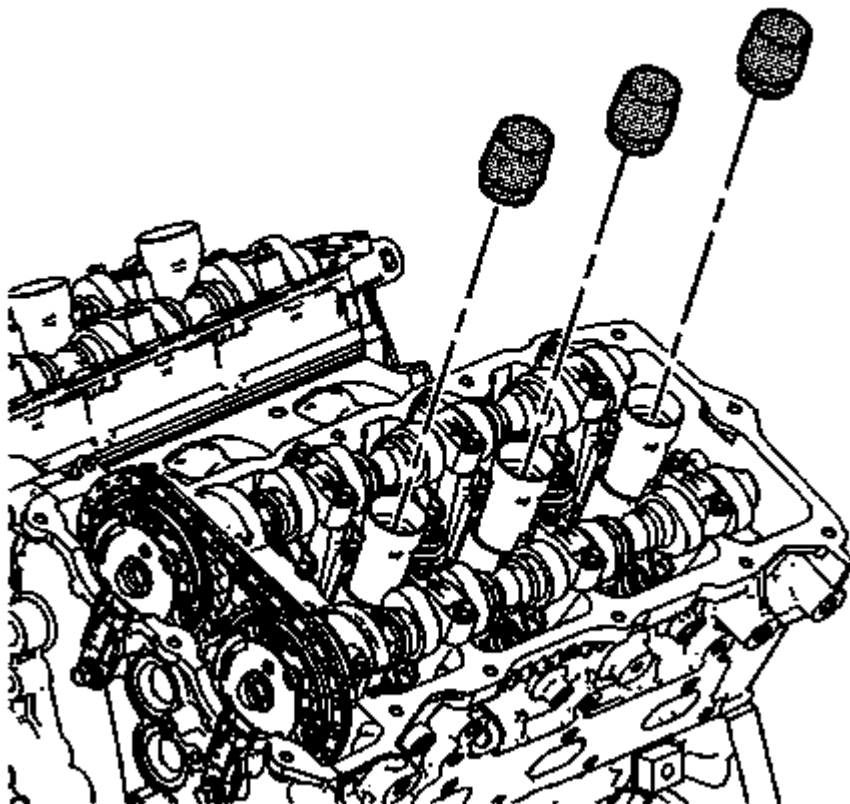
### REMOVAL PROCEDURE

1. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 1** .
2. Remove the upper intake manifold. Refer to **Upper Intake Manifold Replacement**.
3. Unbolt Power Steering Pump, leave the hose power steering pump. **POWER STEERING PUMP REPLACEMENT (LY7)** .
4. Disconnect and remove the engine harness from the camshaft cover.



**Fig. 92: Identifying Right Camshaft Cover & Bolts**  
Courtesy of GENERAL MOTORS CORP.

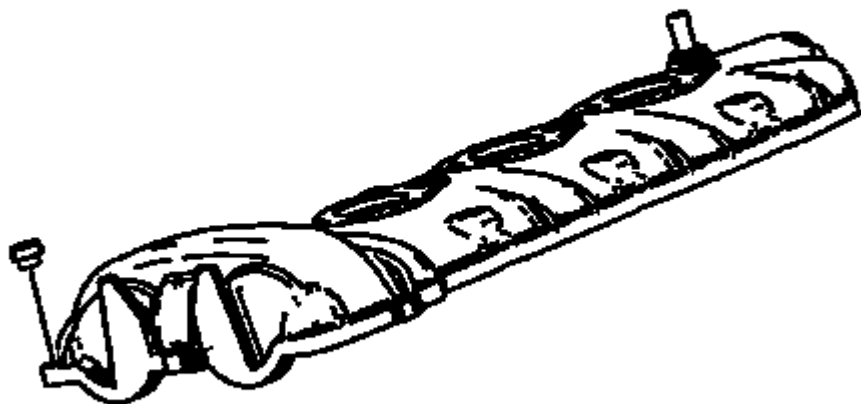
5. Remove the right camshaft cover bolts.
6. Remove the right camshaft cover from the right cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .



**Fig. 93: Identifying Special Tool - EN 46101**  
Courtesy of GENERAL MOTORS CORP.

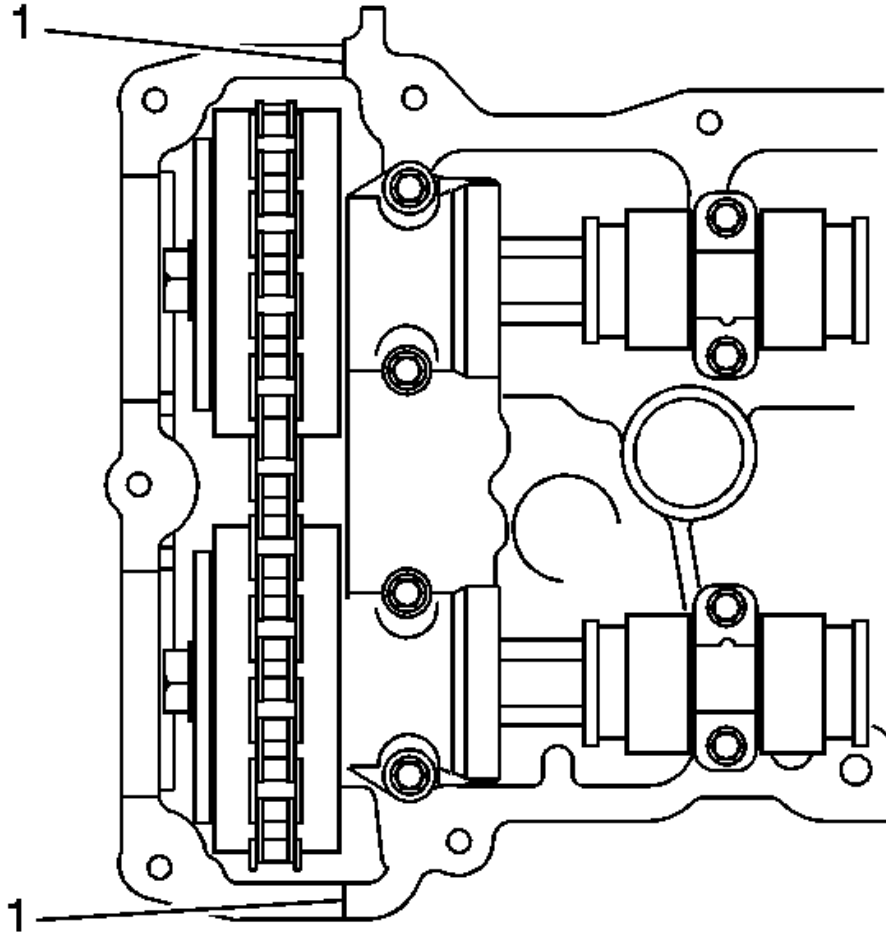
8. Install the **EN 46101** onto the spark plug tubes of the left cylinder head. See **Special Tools** .

## **INSTALLATION PROCEDURE**



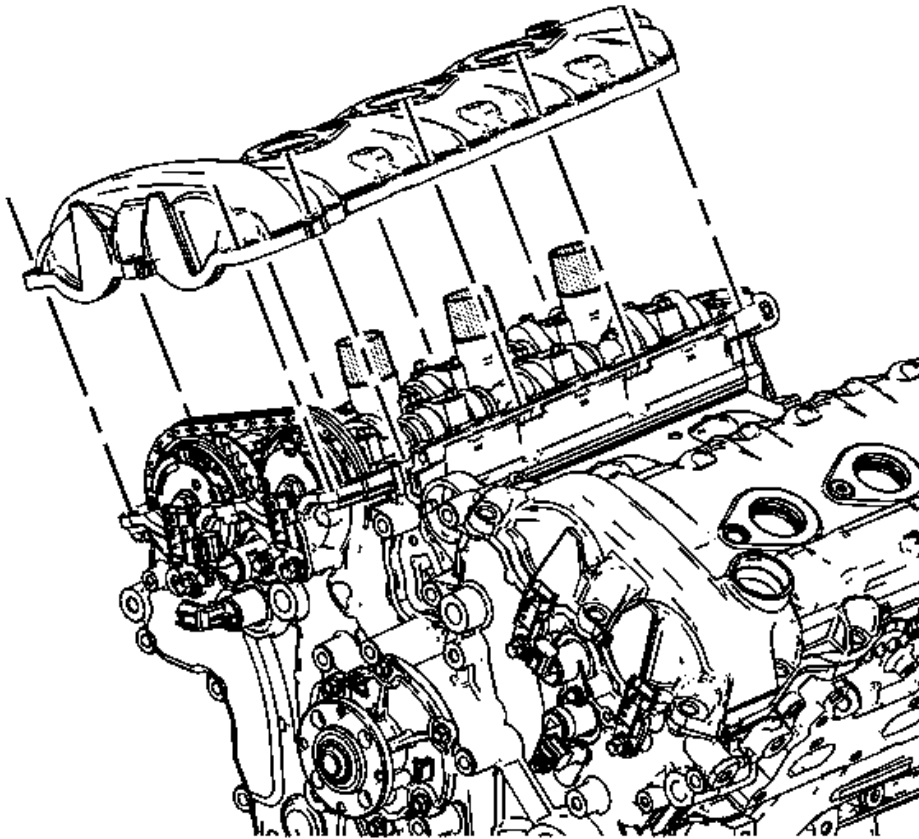
**Fig. 94: Locating Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS CORP.

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



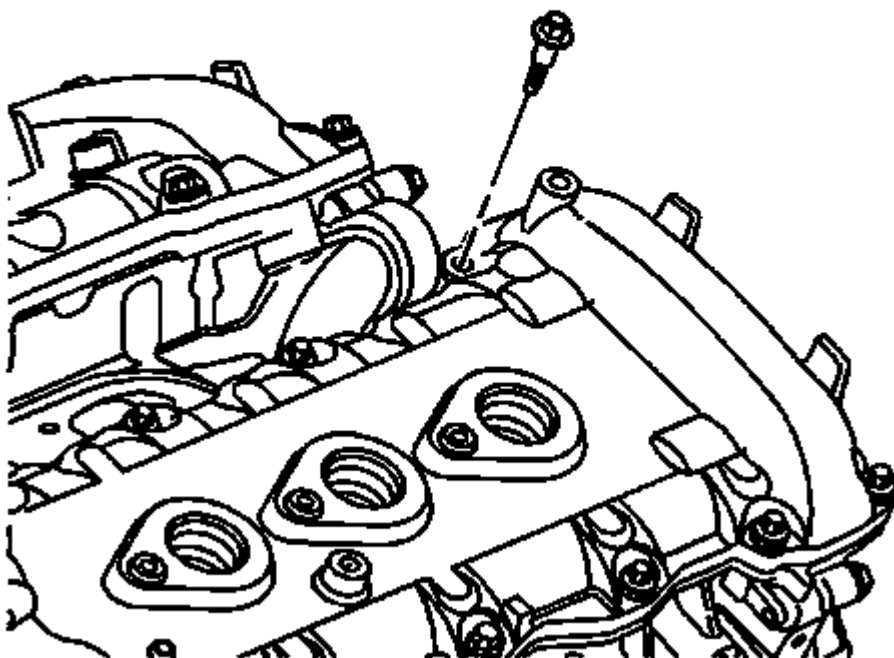
**Fig. 95: Identifying Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS CORP.

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). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.



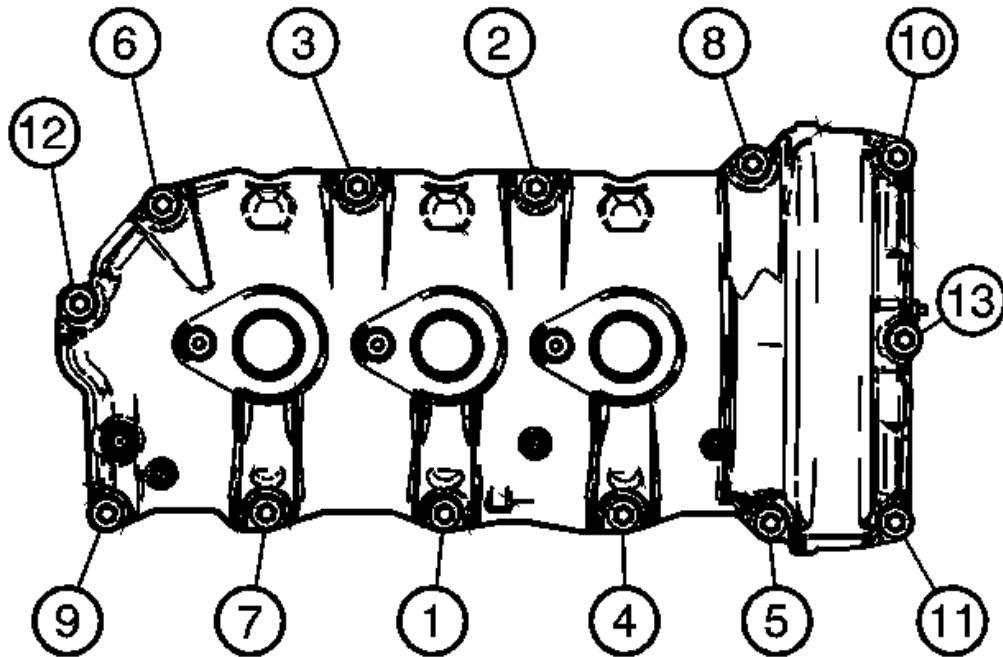
**Fig. 96: View Of Right Camshaft Cover**  
**Courtesy of GENERAL MOTORS CORP.**

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



**Fig. 97: Locating Right Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS CORP.

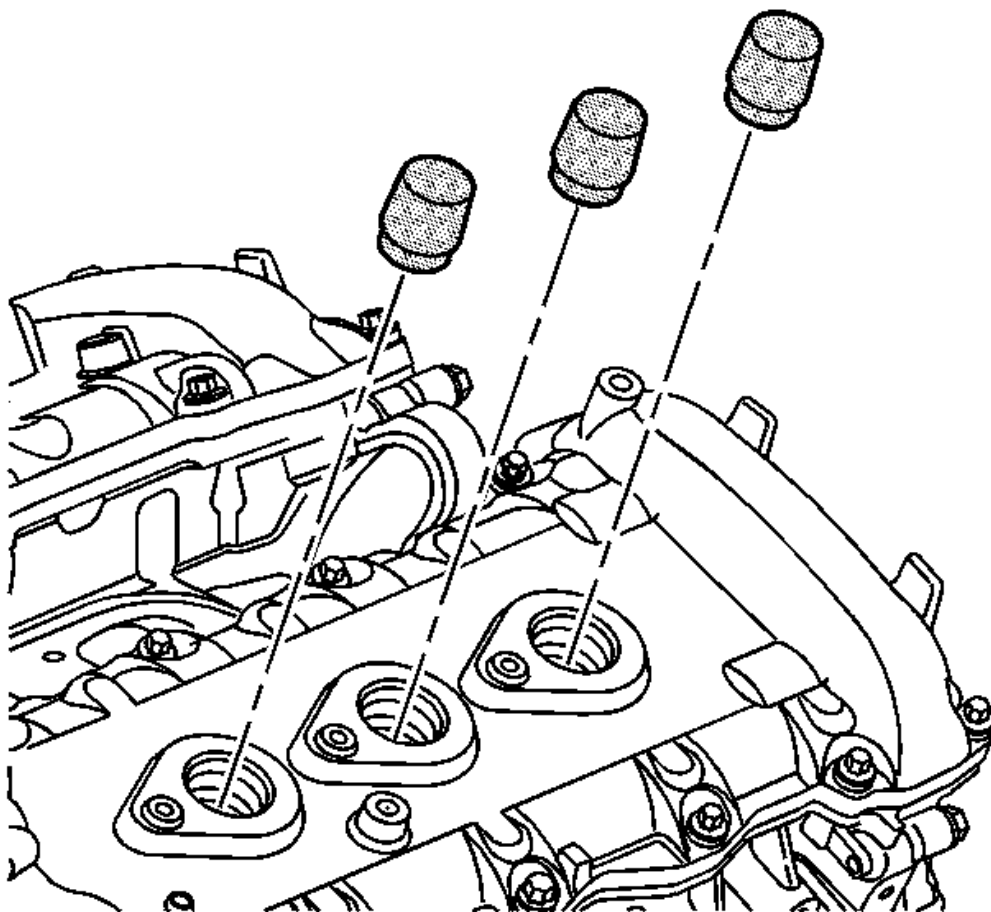
4. Loosely install the right camshaft cover bolts.



**Fig. 98: Identifying Right Camshaft Cover Bolt Tightening Sequence**  
 Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

5. Tighten the right camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
6. Connect and install the engine harness to the camshaft cover.
7. Install the upper intake manifold. Refer to Upper Intake Manifold Replacement.



**Fig. 99: Identifying Special Tool - EN 46101**  
Courtesy of GENERAL MOTORS CORP.

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

## ENGINE FRONT COVER REPLACEMENT

### SPECIAL TOOLS

- **EN 46109** Guide Pin Set. See **Special Tools** .
- **EN-48383** Camshaft Retaining Tools
- **EN-48589** Crankshaft Rotational Socket. See **Special Tools** .

### REMOVAL PROCEDURE

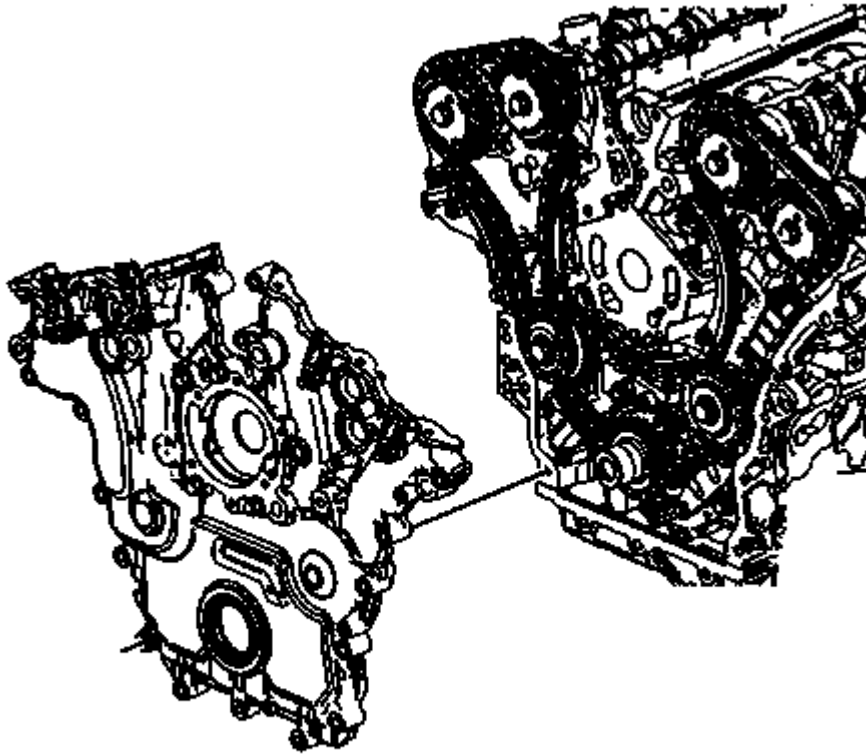
1. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
2. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side** and **Camshaft Cover**

**Replacement - Right Side.**

3. Drain the engine coolant. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling (LY7, LZE, LZ4, LZ9)** .
4. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
5. Remove the water pump.
6. Remove the power steering pump and position aside. Refer to **Power Steering Pump Replacement (LZ4, LZ9)** .
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 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** .
9. Remove the generator. Refer to **Generator Replacement (LY7)** .
10. Remove the water outlet housing.
11. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

Clean the front cover of the components first before installing a support fixture.

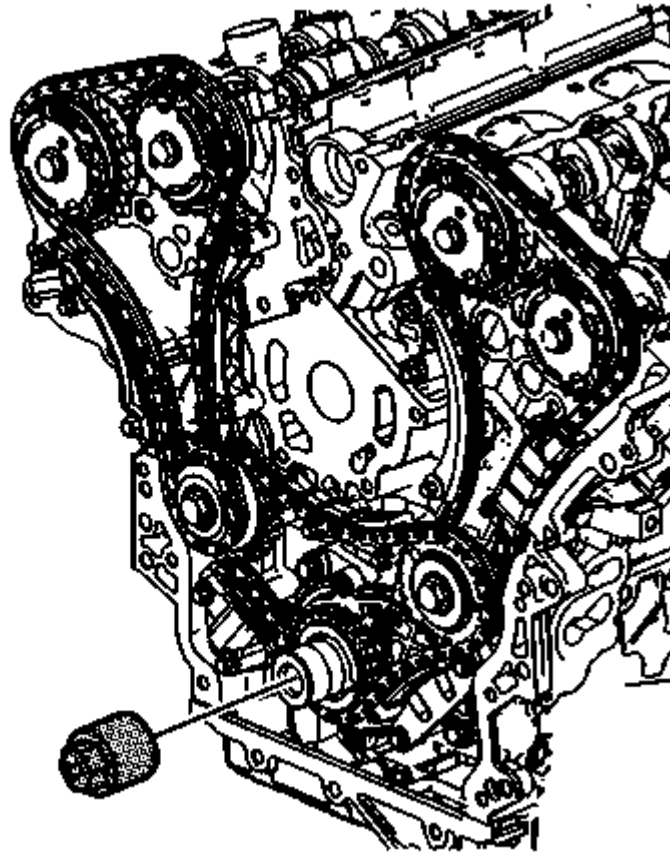
12. Remove the right side engine mount bracket. refer to **Engine Mount Bracket Replacement - Right Side**.
13. Insert a block of hard wood between the frame and the engine. Lower the engine onto the block of wood.



**Fig. 100: View Of Engine Front Cover**  
Courtesy of GENERAL MOTORS CORP.

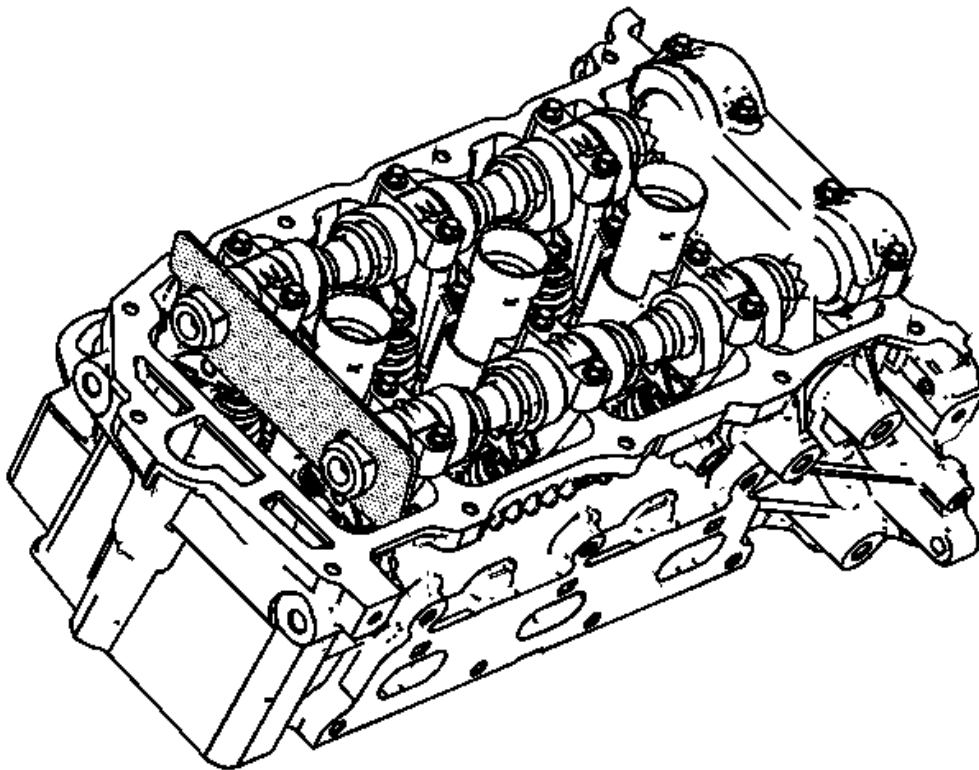
**NOTE:** There are a total of 22 M8 bolts that must be removed and 3 optional M12 bolts that may need to be removed before the front cover will separate from the engine block.

14. Remove the engine front cover. Refer to Engine Front Cover Removal .



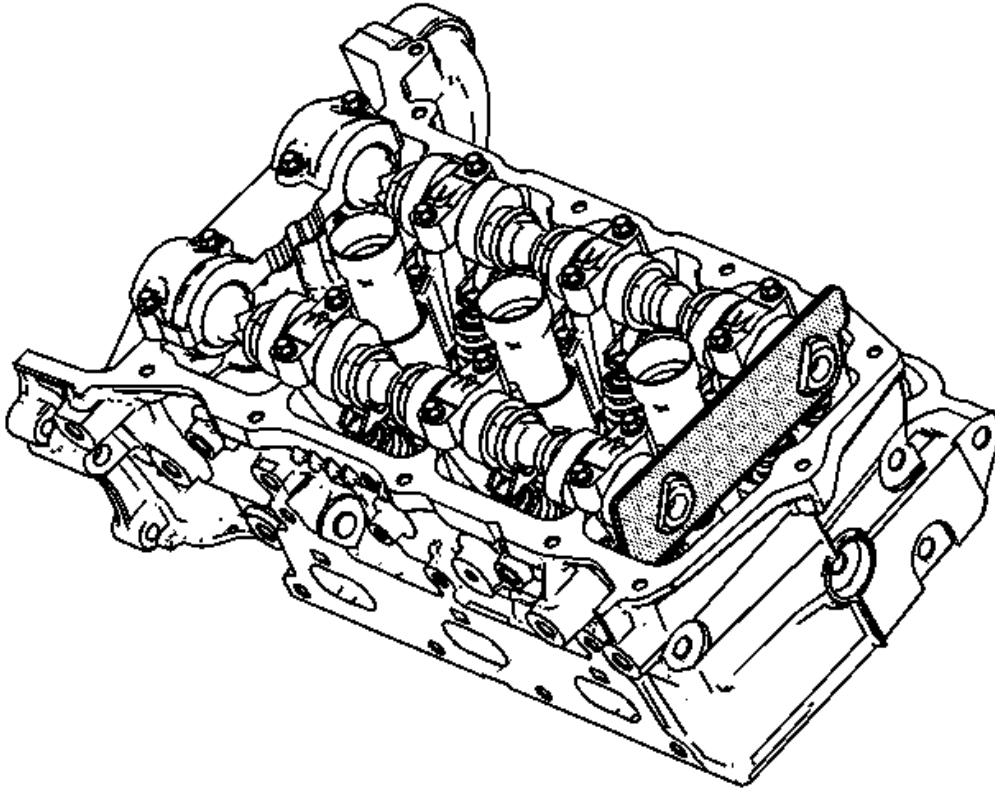
**Fig. 101: Identifying Special Tool - EN 46111**  
Courtesy of GENERAL MOTORS CORP.

15. Using the **EN-48589** , rotate the crankshaft until the left cylinder head camshafts align with the **EN-48383** and the right cylinder head camshafts align with the **EN-48383** . See **Special Tools** .



**Fig. 102: Identifying Special Tool - EN 46105-1 Installed To Right Camshafts**  
Courtesy of GENERAL MOTORS CORP.

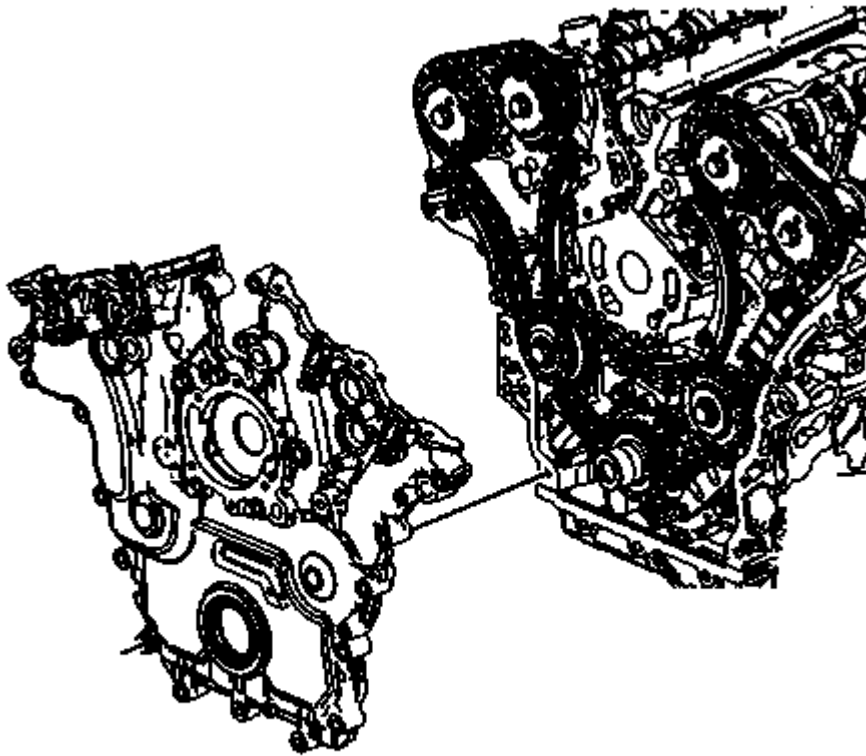
16. Install the **EN-48383** to the right camshafts.



**Fig. 103: Identifying Special Tool - EN 46105-2 Installed To Left Camshafts**  
Courtesy of GENERAL MOTORS CORP.

17. Install the **EN-48383** to the left camshafts.

## **INSTALLATION PROCEDURE**



**Fig. 104: View Of Engine Front Cover**  
 Courtesy of GENERAL MOTORS CORP.

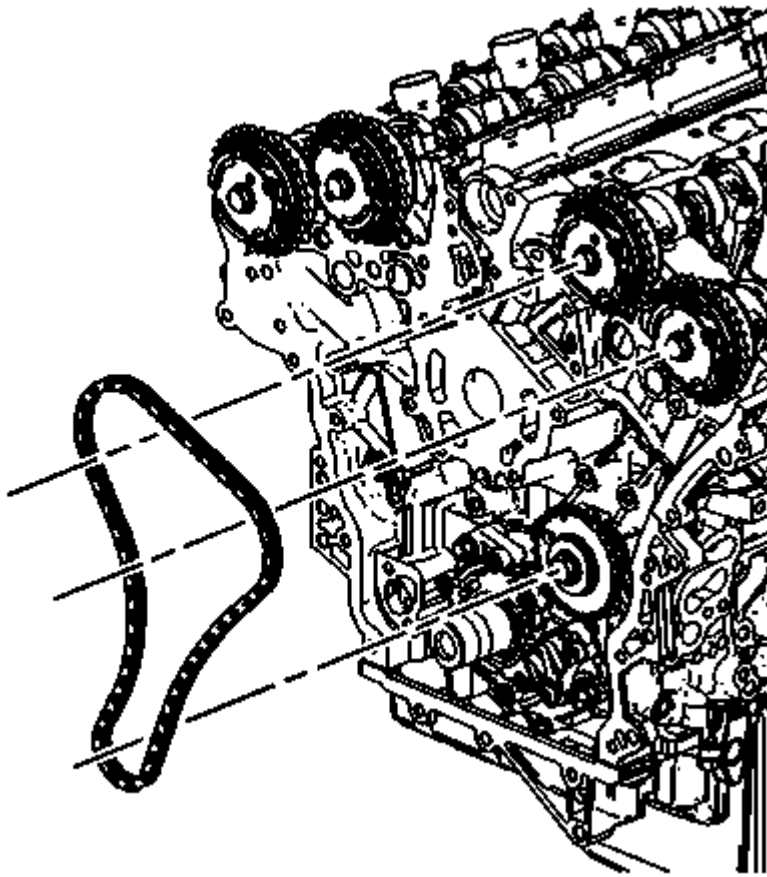
1. Install engine front cover. refer to **Engine Front Cover Installation** .
2. Install the engine oil pan. Refer to **Oil Pan Replacement** .
3. Install the engine coolant thermostat housing.
4. Reinstall the engine support fixture. Refer to **Engine Support Fixture**.
5. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
6. 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** .
7. 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** .
8. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
9. Install the power steering pump.
10. Install the water pump.

11. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
12. Install the camshaft covers. Refer to [Camshaft Cover Replacement - Left Side](#) and [Camshaft Cover Replacement - Right Side](#).
13. Install the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).
14. Refill the engine coolant. Refer to [Cooling System Draining and Filling \(GE 47716 Fill\)](#) or [Cooling System Draining and Filling \(LY7, LZE, LZ4, LZ9\)](#).

## **SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE**

### **REMOVAL PROCEDURE**

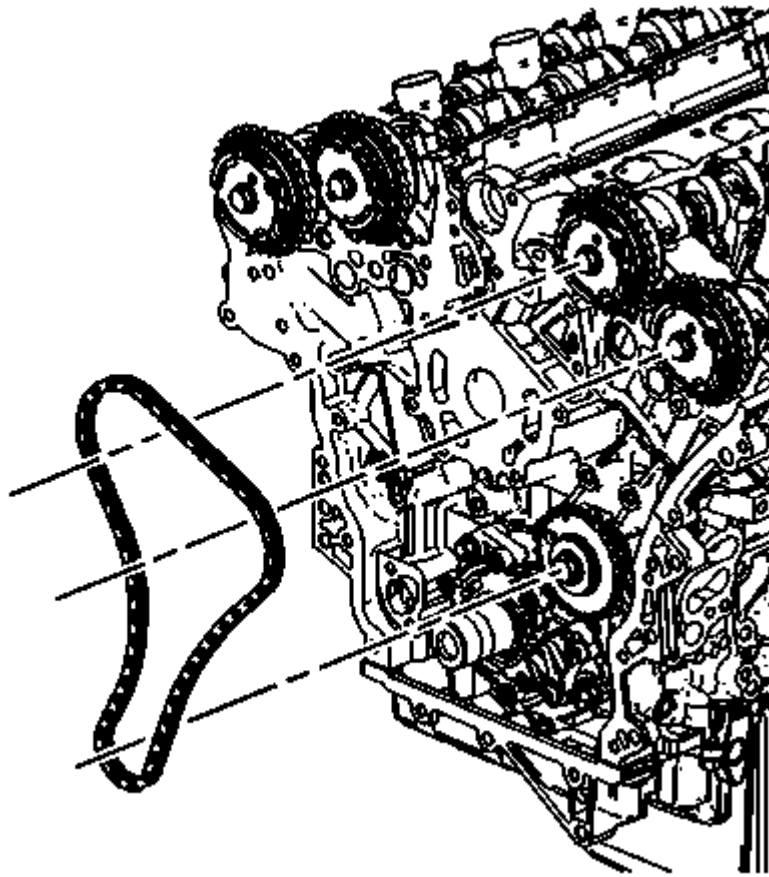
1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Removal - Right Side](#).
3. Remove the right bank secondary camshaft drive chain shoe. Refer to [Secondary Camshaft 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. 105: 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 Removal - 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. 106: View Of Left Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

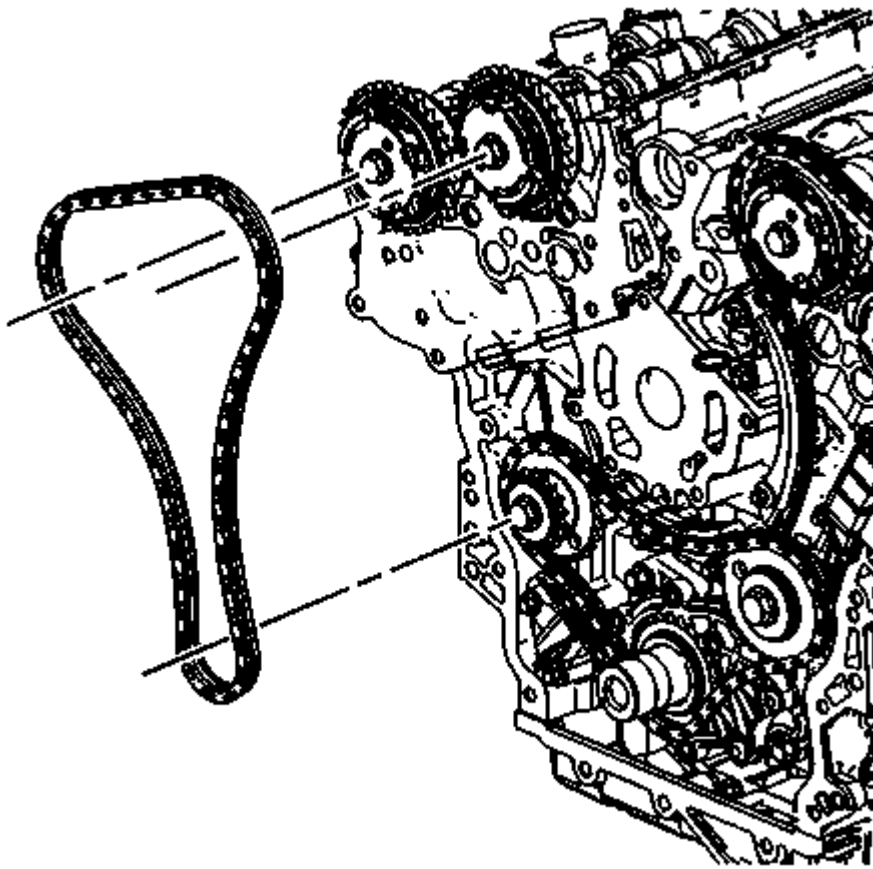
1. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side (LY7 or LP1)** .
2. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
3. Install the 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 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** .
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** .

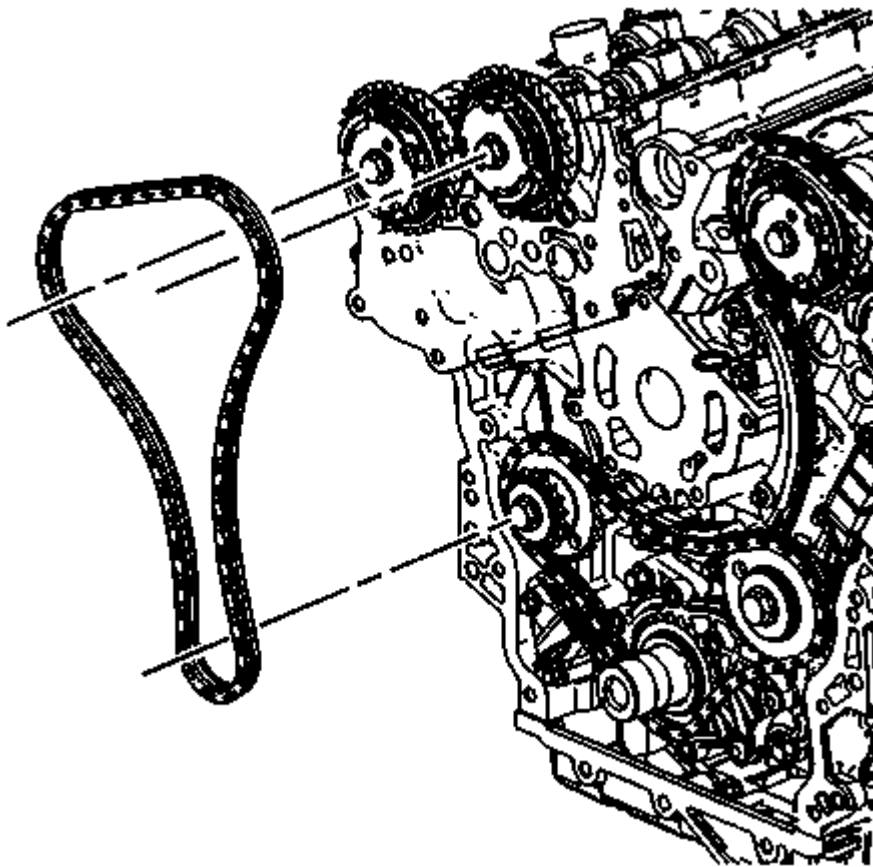


**Fig. 107: View Of Right Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

#### INSTALLATION PROCEDURE

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



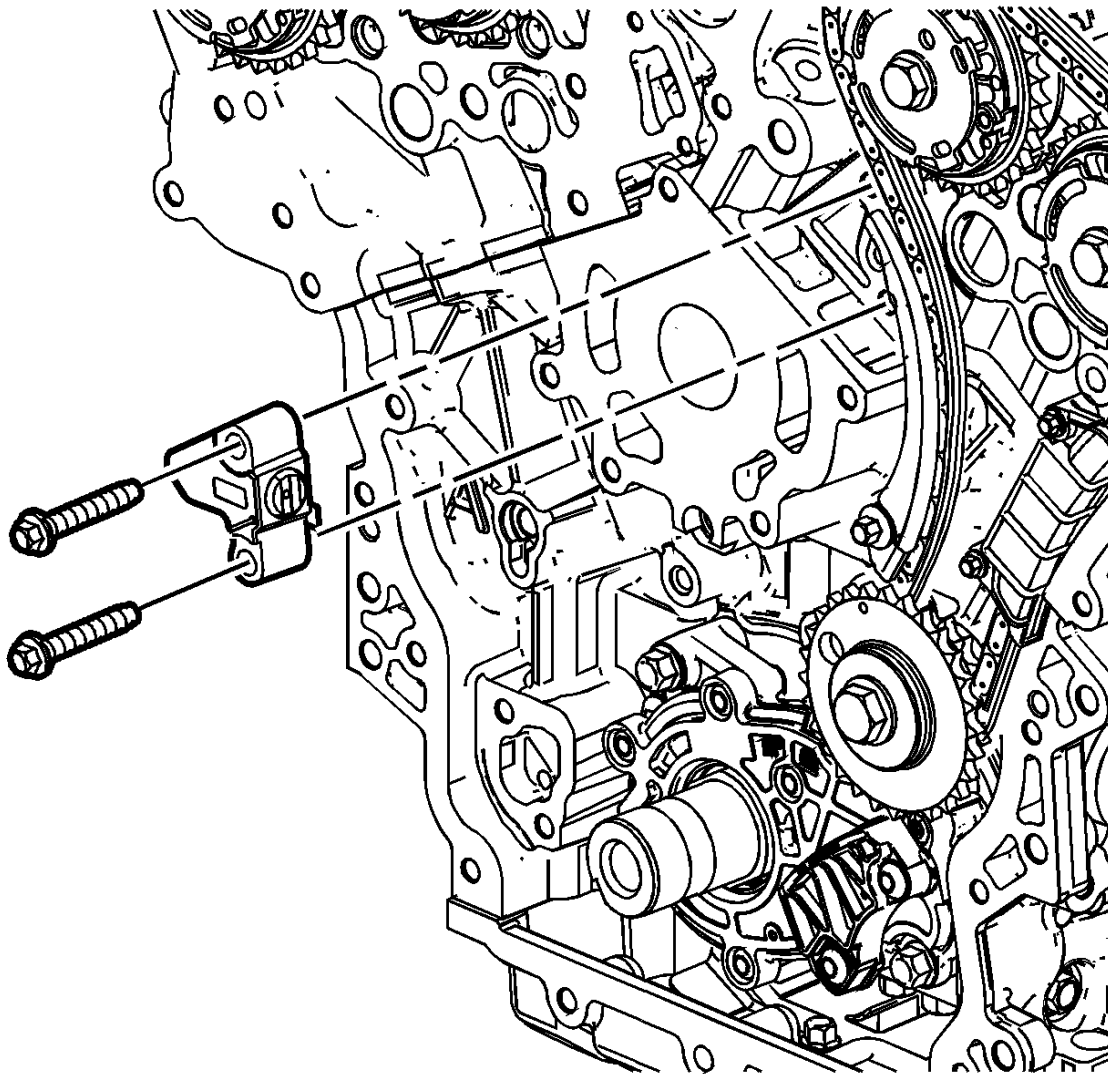
**Fig. 108: View Of Right Bank Secondary Camshaft Drive Chain**  
Courtesy of GENERAL MOTORS CORP.

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 spark plugs. Refer to Spark Plug Replacement .
7. Install the engine front cover. Refer to Engine Front Cover Replacement.

## SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

### REMOVAL PROCEDURE

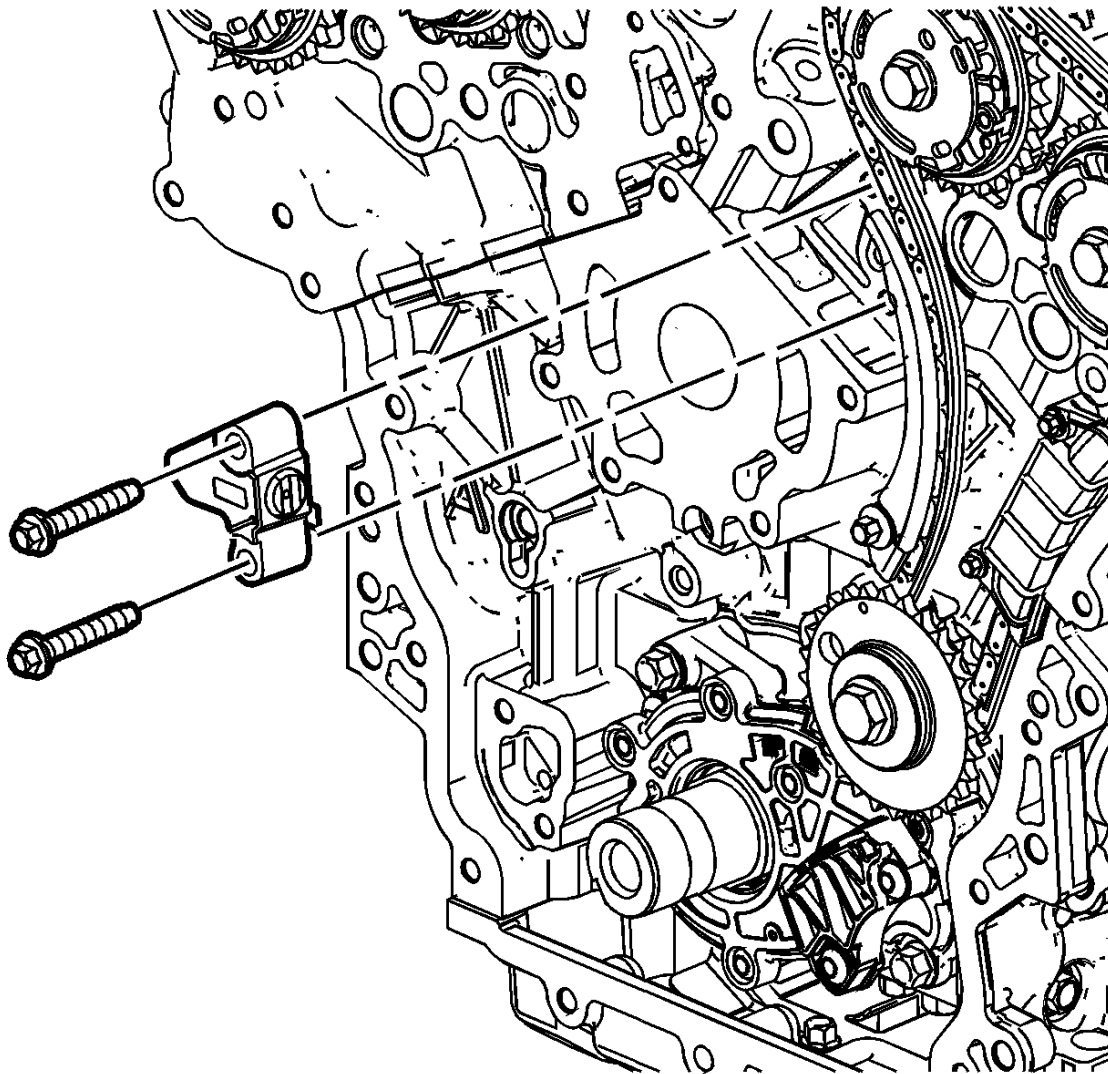
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to Spark Plug Replacement .
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.



**Fig. 109: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

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

## INSTALLATION PROCEDURE



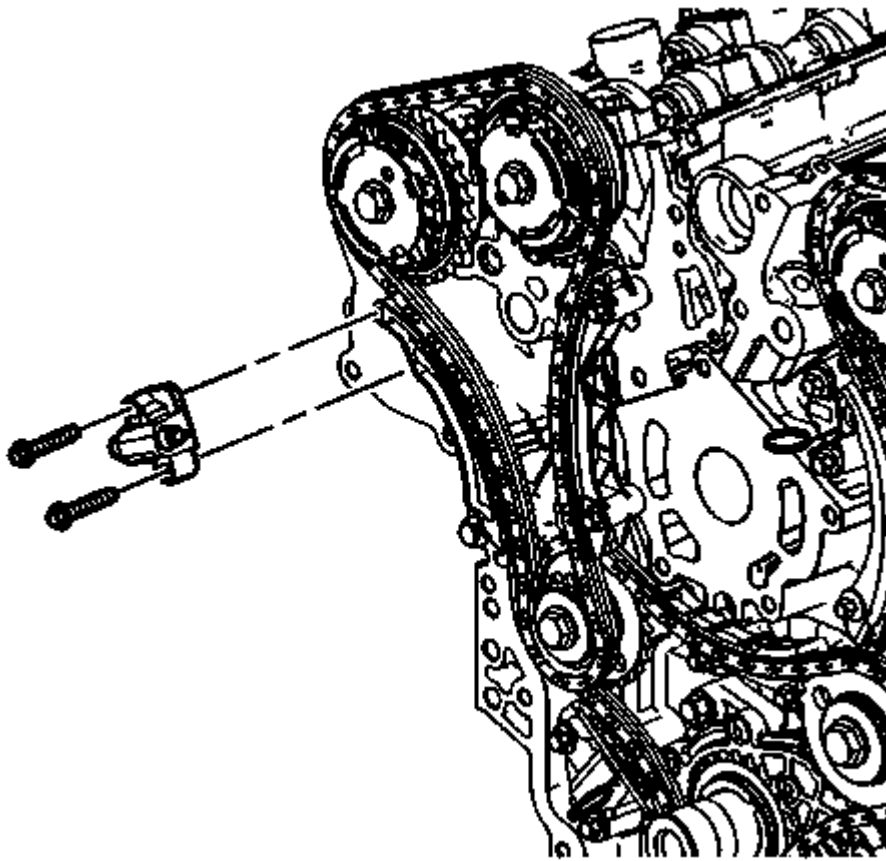
**Fig. 110: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

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

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

### **REMOVAL PROCEDURE**

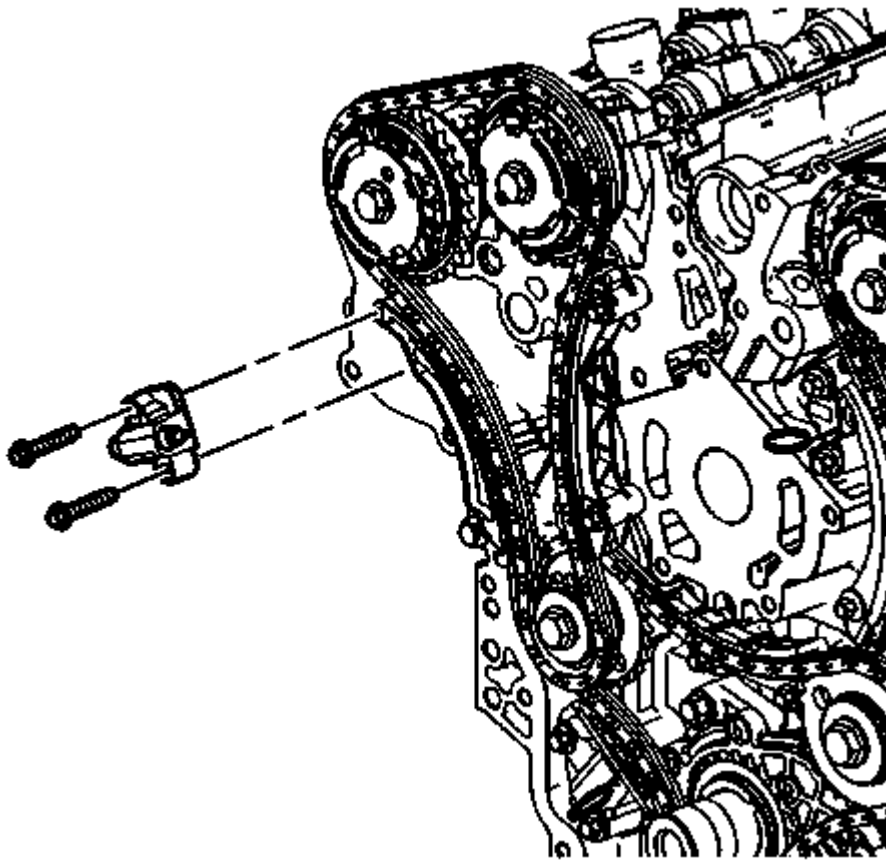
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.



**Fig. 111: View Of Right Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

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

## INSTALLATION PROCEDURE



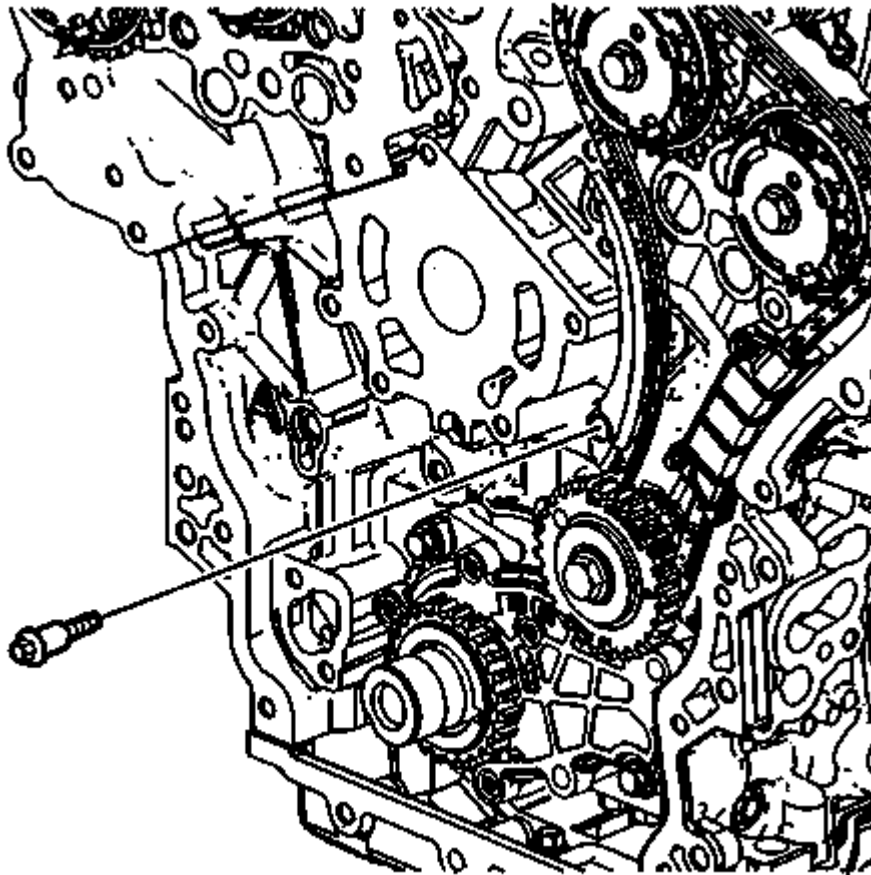
**Fig. 112: View Of Right Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

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

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

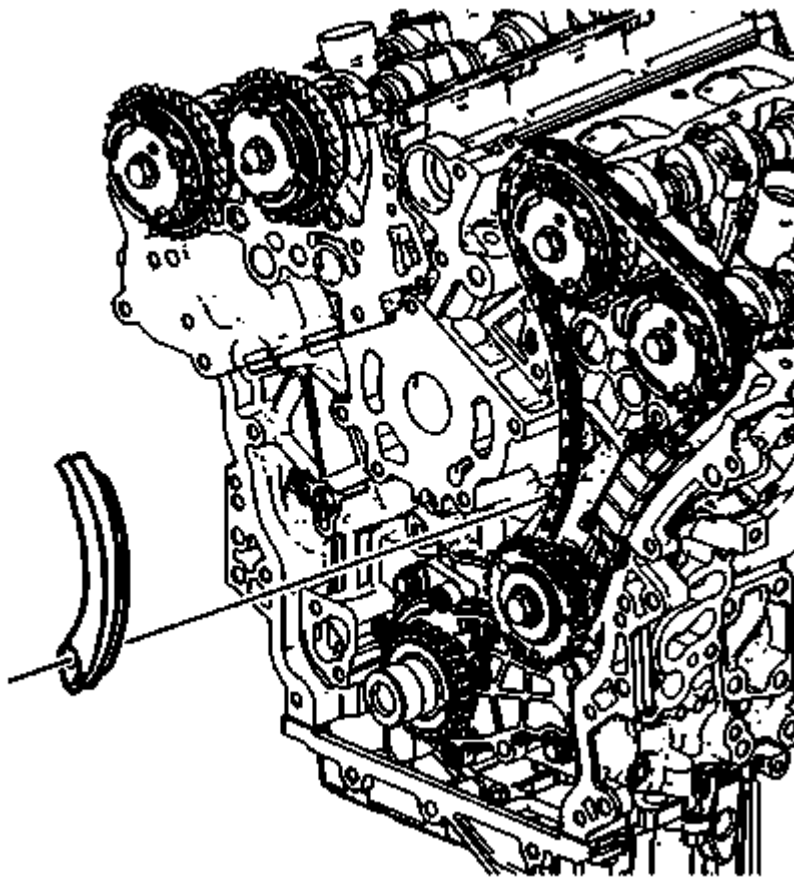
### **REMOVAL PROCEDURE**

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



**Fig. 113: Identifying Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS CORP.

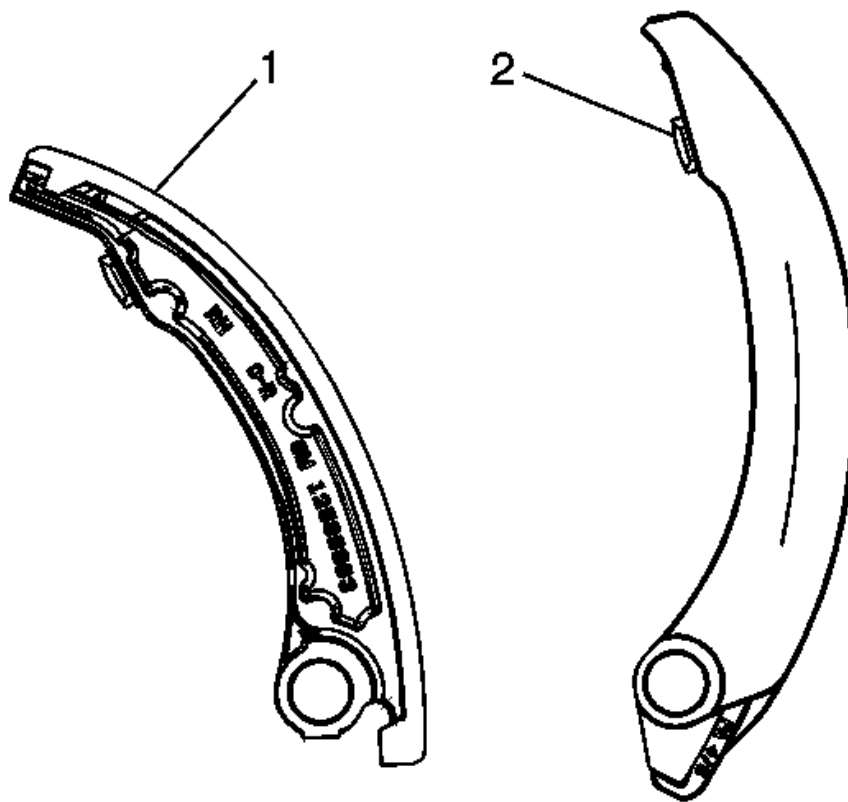
5. Remove the left secondary camshaft drive chain shoe bolt.



**Fig. 114: View Of Left Secondary Camshaft Drive Chain Shoe**  
**Courtesy of GENERAL MOTORS CORP.**

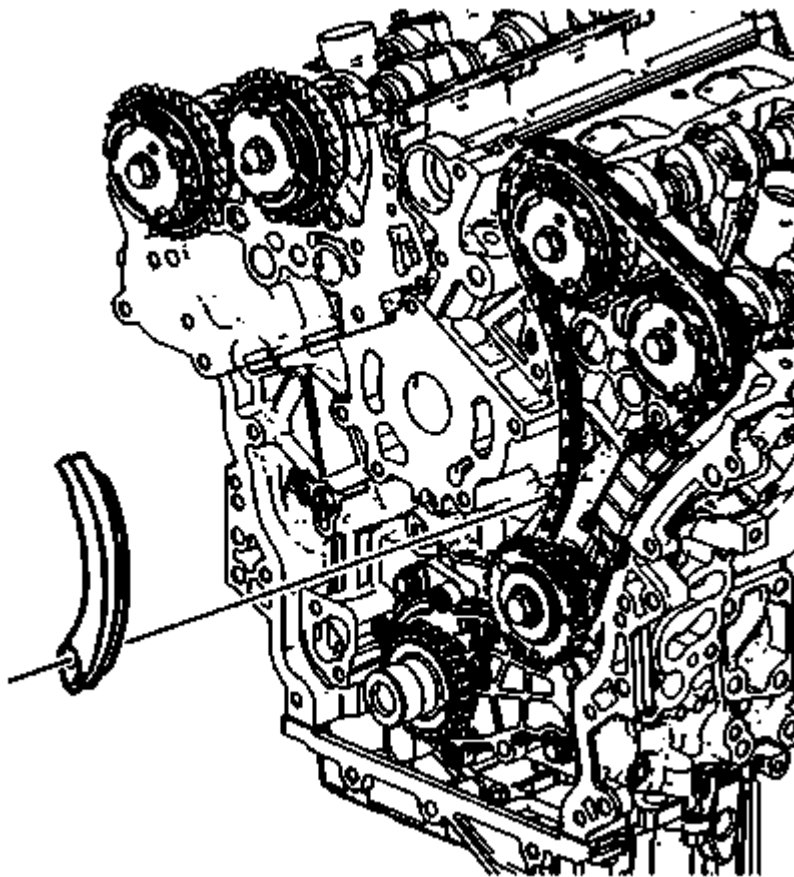
6. Remove the left secondary camshaft drive chain shoe.

## **INSTALLATION PROCEDURE**



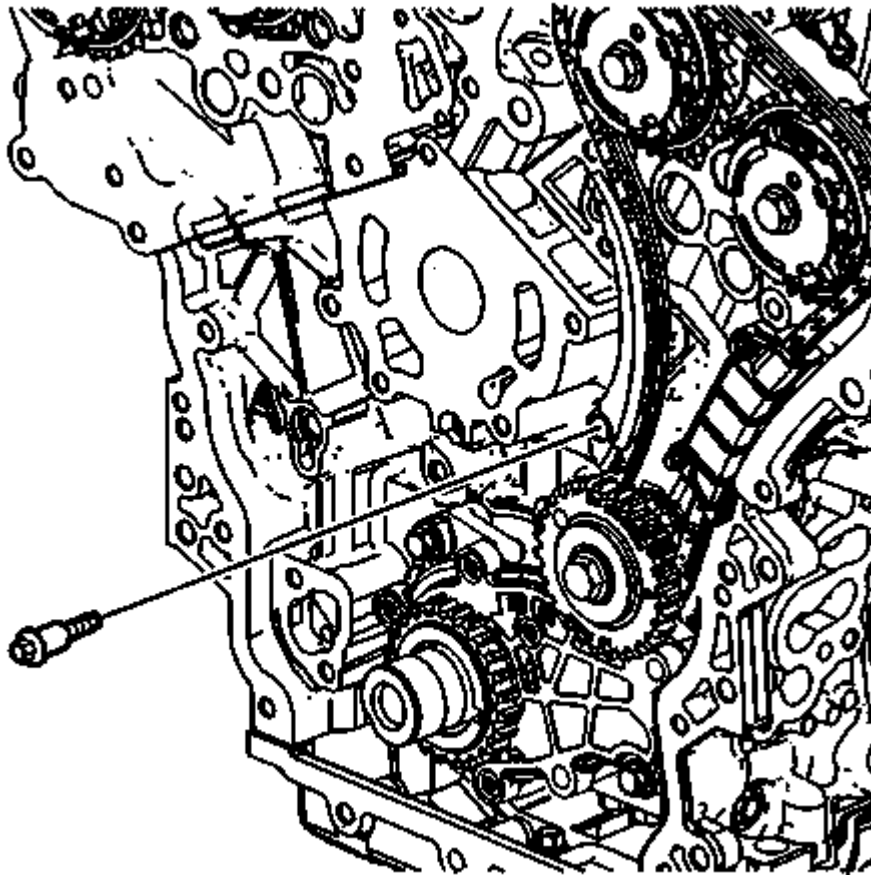
**Fig. 115: Identifying Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain shoe (2) is being installed.



**Fig. 116: View Of Left Secondary Camshaft Drive Chain Shoe**  
**Courtesy of GENERAL MOTORS CORP.**

2. Position the left secondary camshaft drive chain shoe.



**Fig. 117: Identifying Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

3. Install the secondary camshaft drive chain shoe bolt.

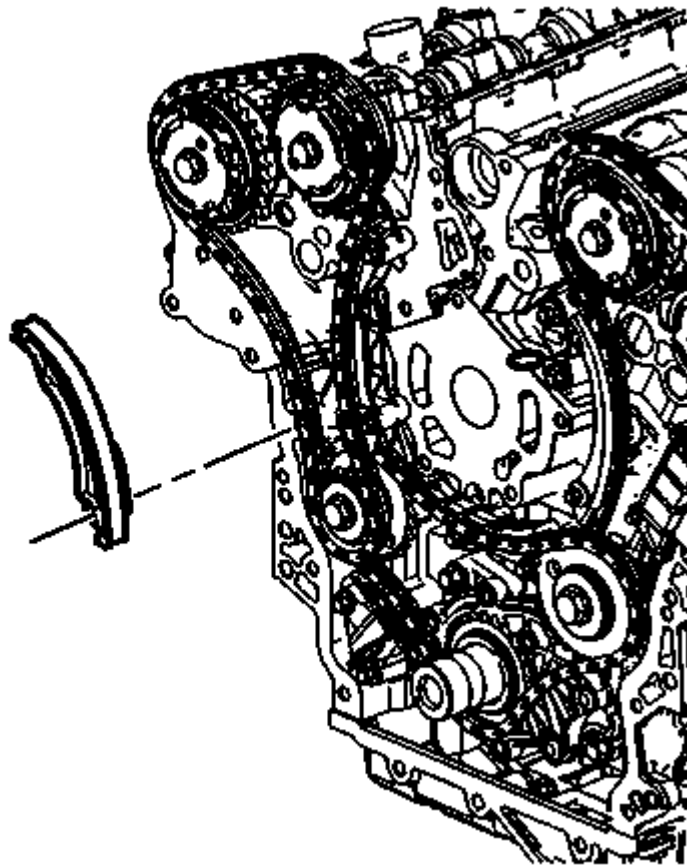
**Tighten:** Tighten the secondary camshaft drive chain shoe bolt to 23 N.m (17 lb ft).

4. Install the left bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Left Side .
5. Install the engine front cover. Refer to Engine Front Cover Replacement.
6. Install the spark plugs. Refer to Spark Plug Replacement .

## SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

### REMOVAL PROCEDURE

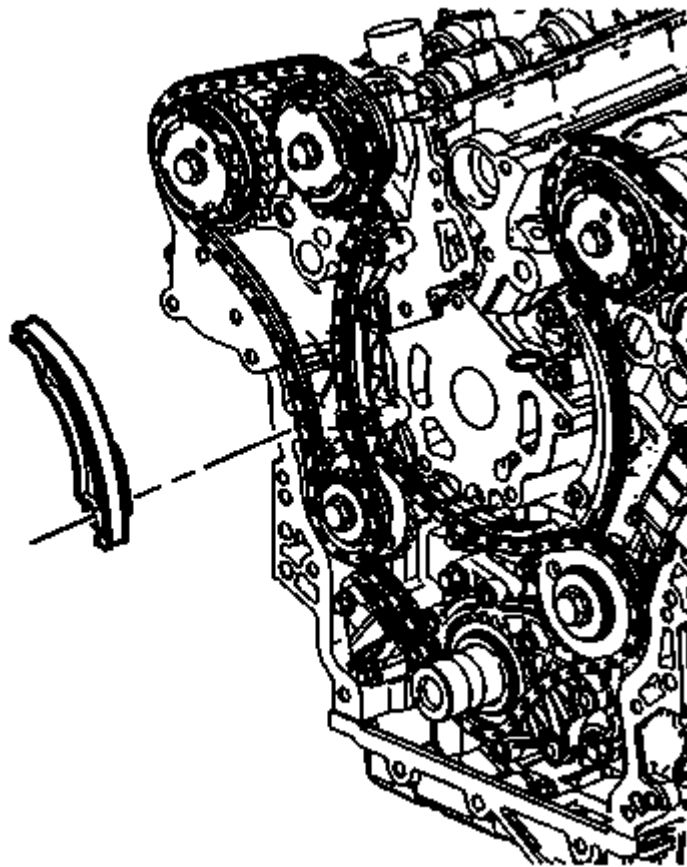
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .



**Fig. 118: View Of Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

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** .
4. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .

## INSTALLATION PROCEDURE



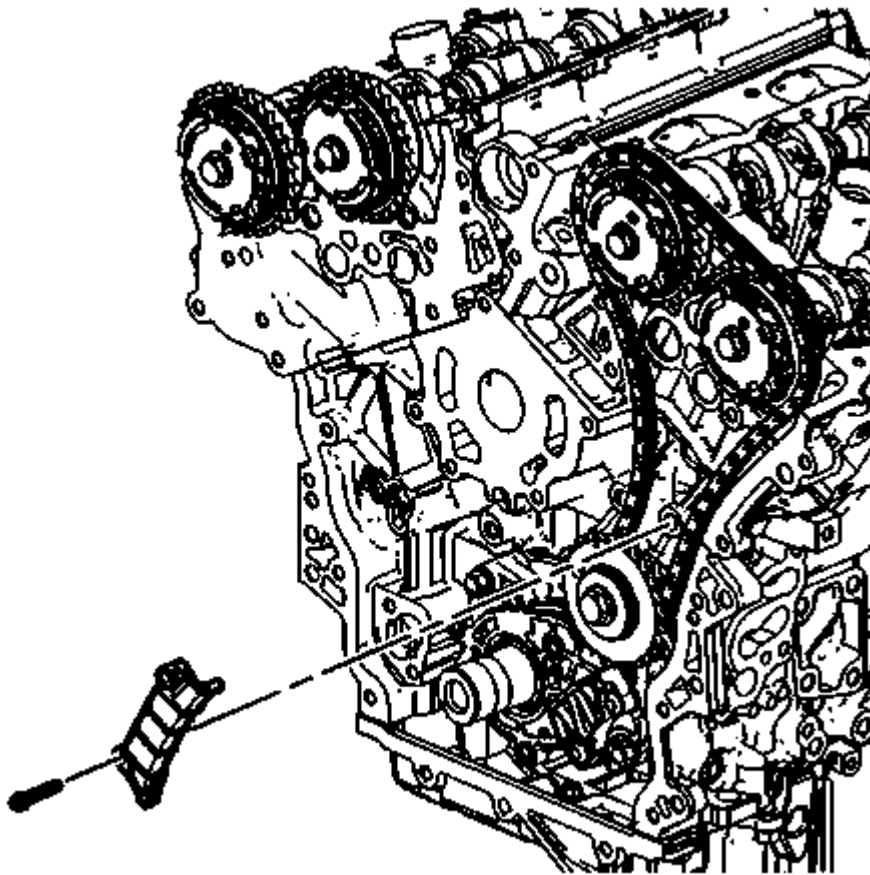
**Fig. 119: View Of Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS CORP.

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 spark plugs. Refer to **Spark Plug Replacement** .
4. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

### REMOVAL PROCEDURE

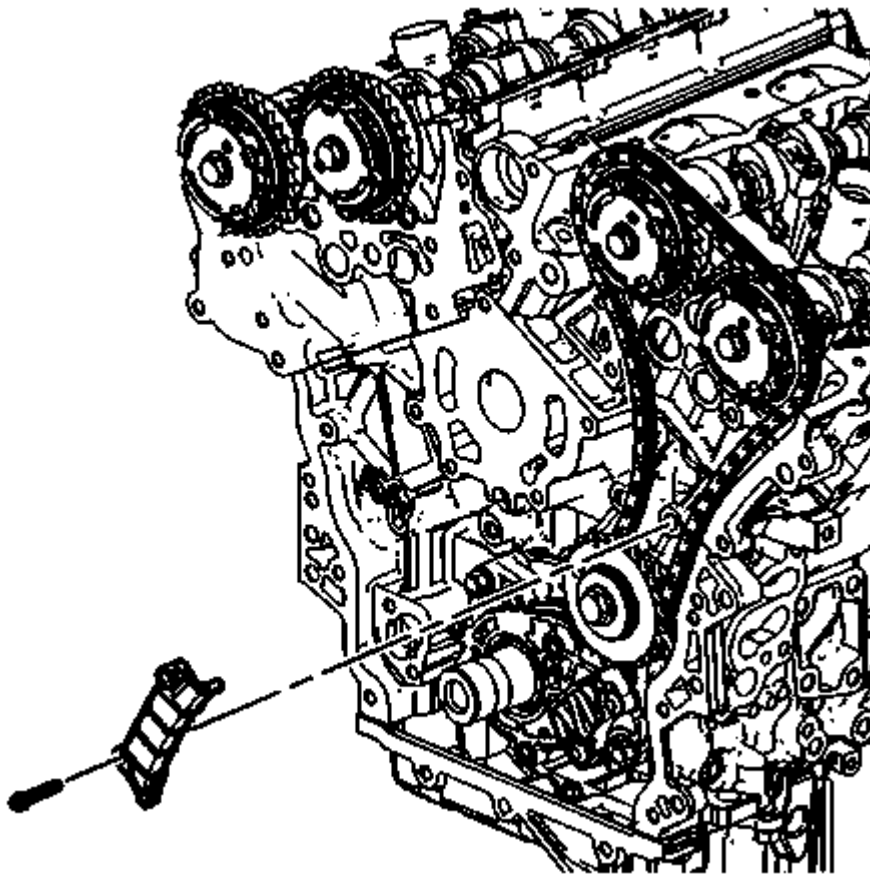
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .



**Fig. 120: View Of Left Bank Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

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

## INSTALLATION PROCEDURE



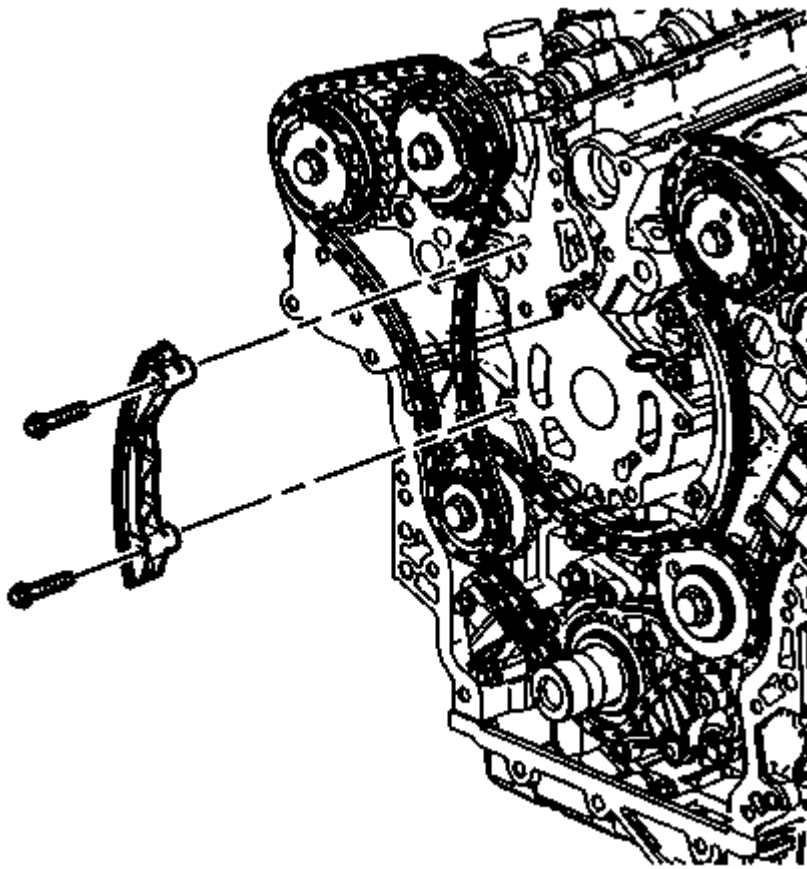
**Fig. 121: View Of Left Bank Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

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 spark plugs. Refer to [Spark Plug Replacement](#) .
4. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

## SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

### REMOVAL PROCEDURE

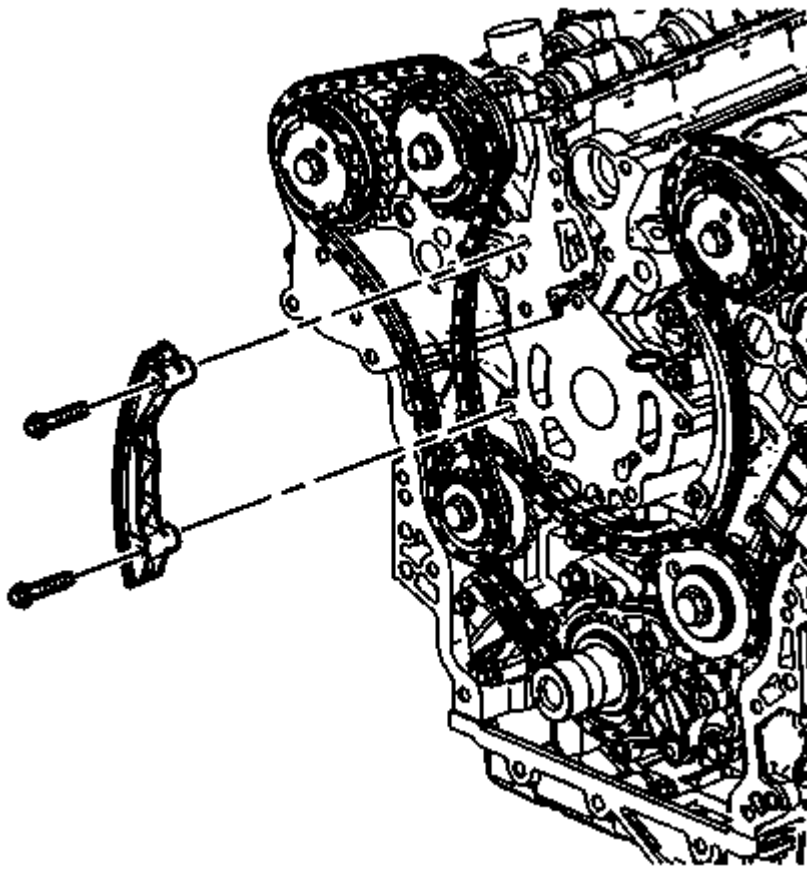
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to [Spark Plug Replacement](#) .
2. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Removal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



**Fig. 122: 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. 123: 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**

### **SPECIAL TOOLS**

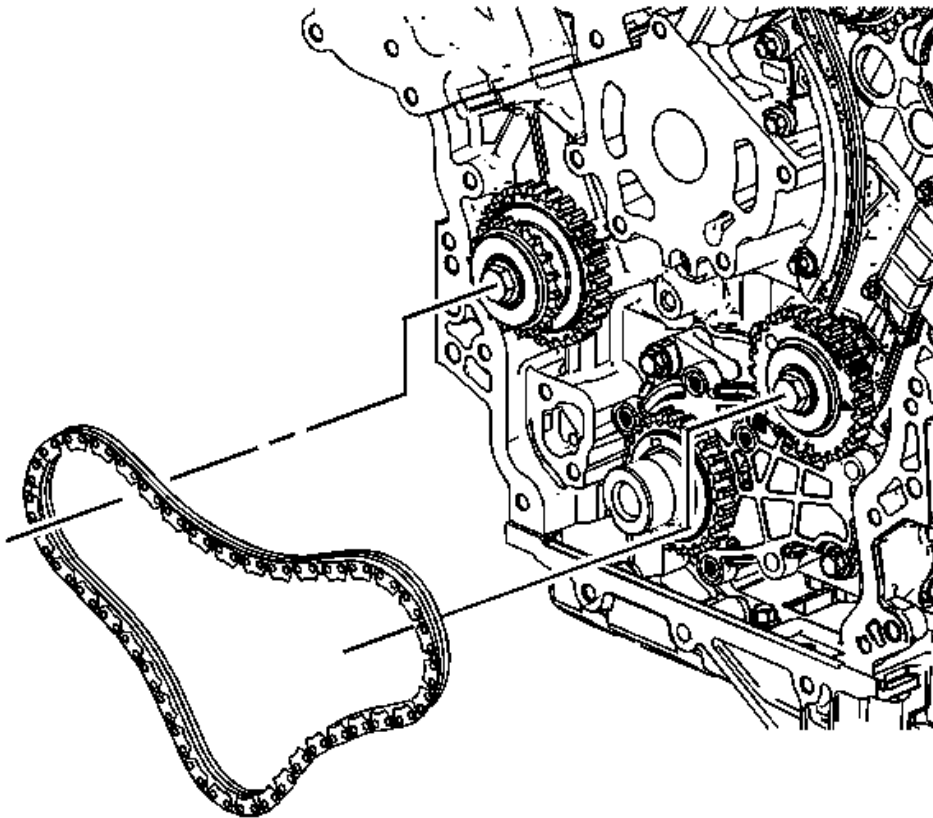
**EN 46111** Crankshaft Rotation Socket

### **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**

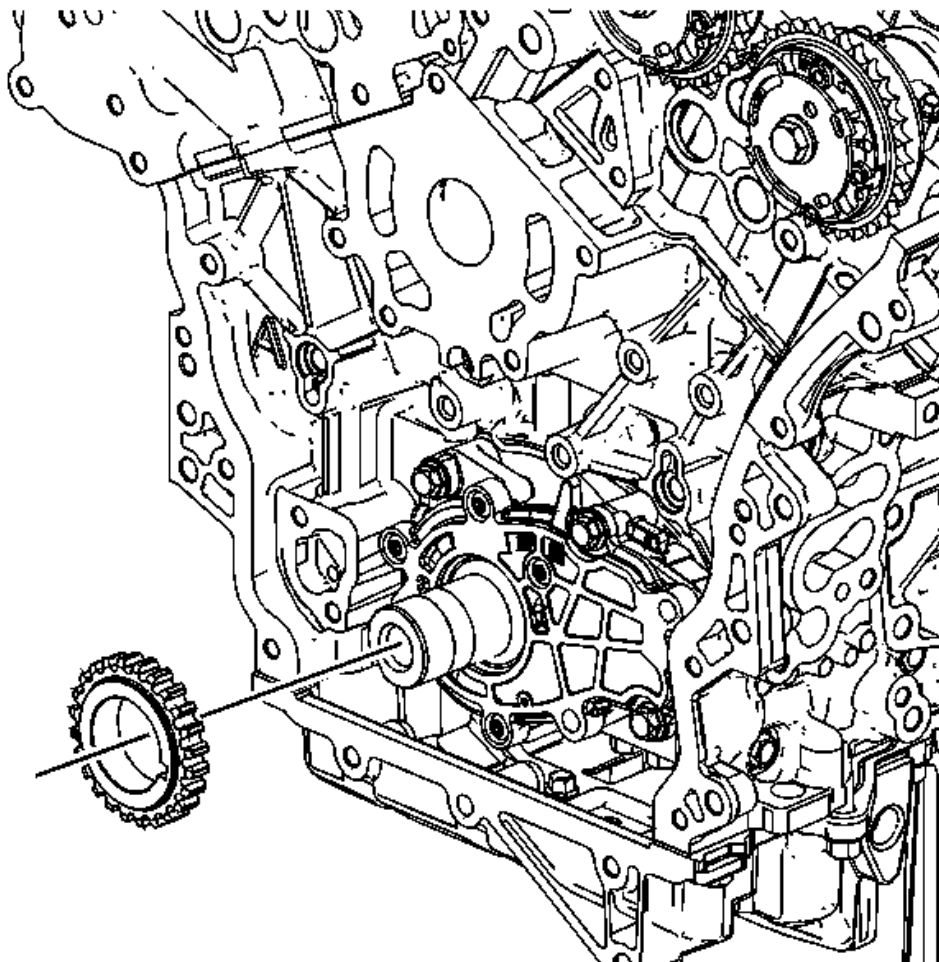
**Tensioner Removal - Right Side .**

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 camshaft drive chain upper guide. Refer to **Primary Timing Chain Guide Removal - Upper** .



**Fig. 124: Identifying Primary Camshaft Timing Chain**  
Courtesy of GENERAL MOTORS CORP.

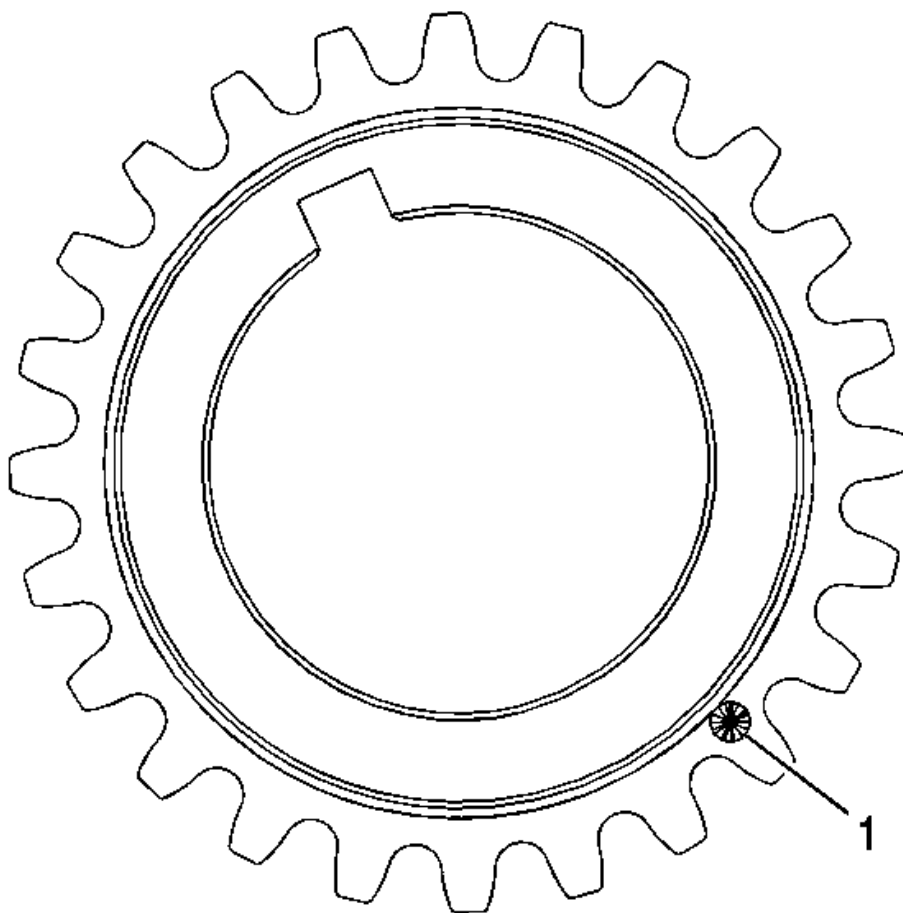
9. Remove the primary camshaft timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .



**Fig. 125: View Of Crankshaft Sprocket**  
Courtesy of GENERAL MOTORS CORP.

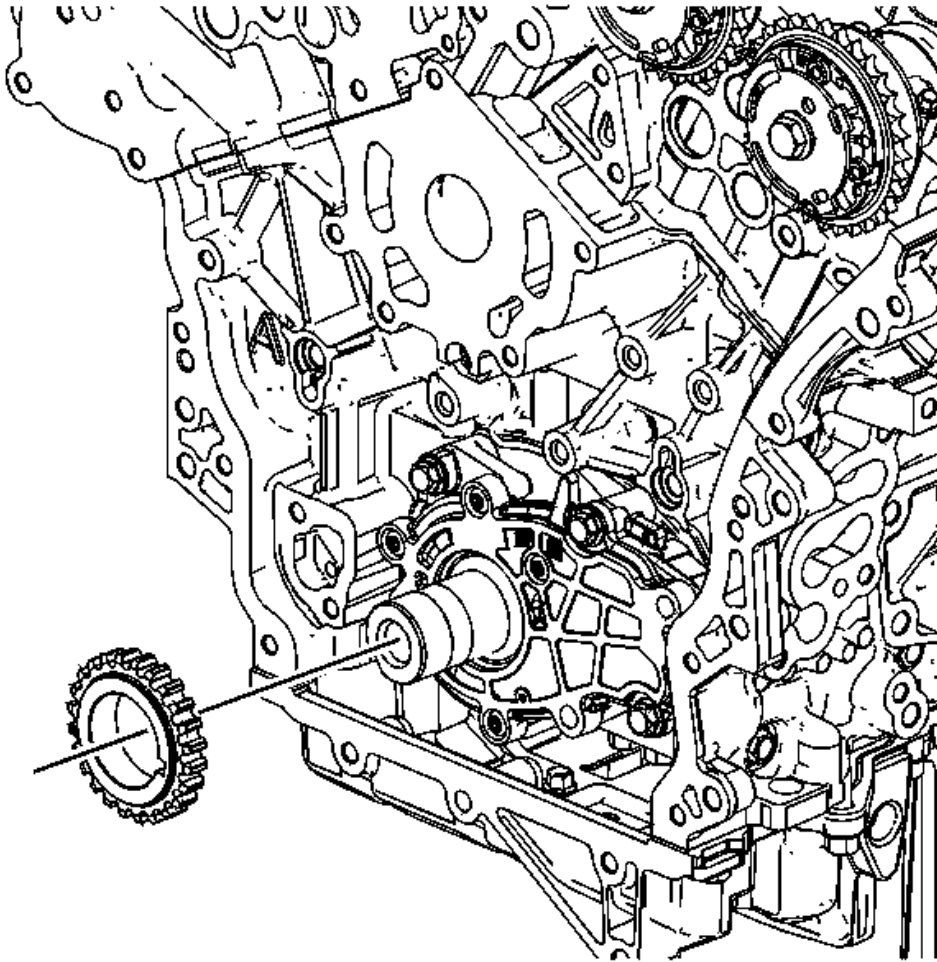
10. Remove the crankshaft sprocket from the nose of the crankshaft.

## INSTALLATION PROCEDURE



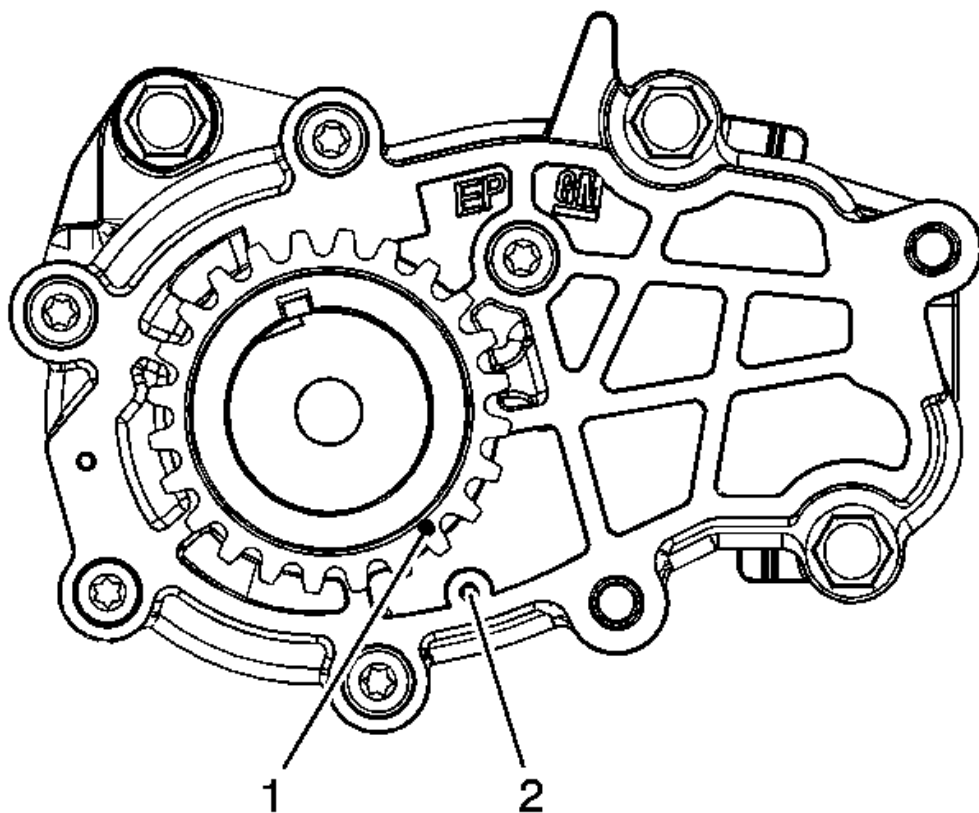
**Fig. 126: Identifying Crankshaft Sprocket Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.



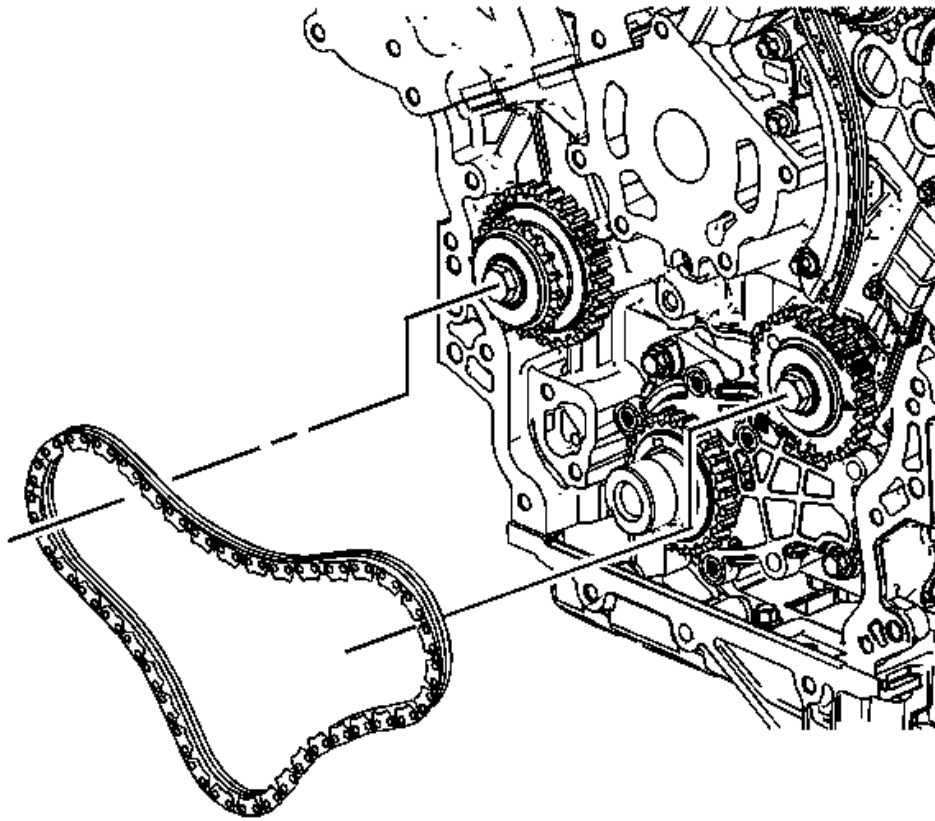
**Fig. 127: View Of Crankshaft Sprocket**  
**Courtesy of GENERAL MOTORS CORP.**

2. Install the crankshaft sprocket on to the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.



**Fig. 128: Identifying Crankshaft Sprocket Timing Mark & Oil Pump Cover Timing Mark**  
Courtesy of GENERAL MOTORS CORP.

5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN 46111** . Refer to **Timing Chain Alignment Diagram** - Stage One.



**Fig. 129: Identifying Primary Camshaft Timing Chain**  
 Courtesy of GENERAL MOTORS CORP.

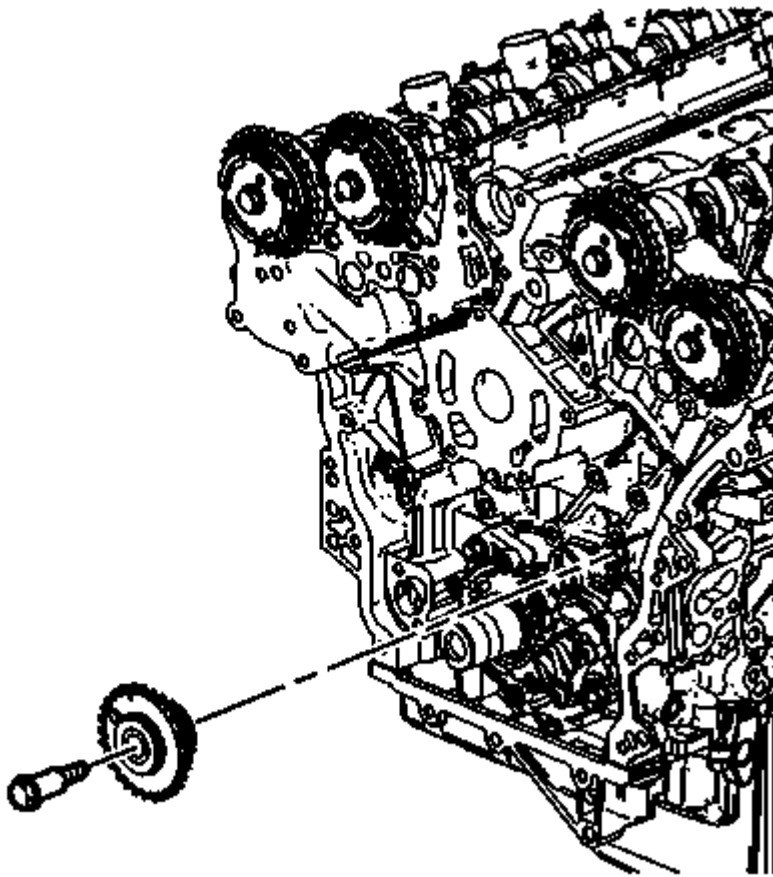
6. Install the primary camshaft timing chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
7. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
8. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
9. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
10. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
11. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
12. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .

13. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
14. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

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

### **REMOVAL PROCEDURE**

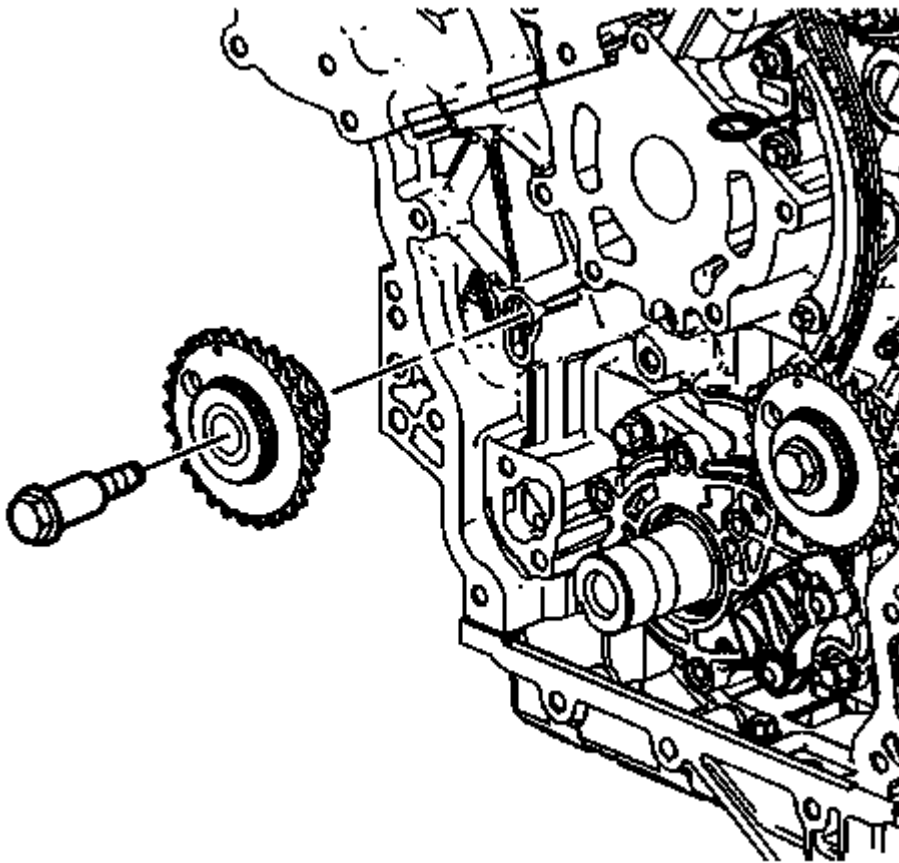
1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to [Spark Plug Replacement](#) .



**Fig. 130: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS CORP.

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](#) .
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** .

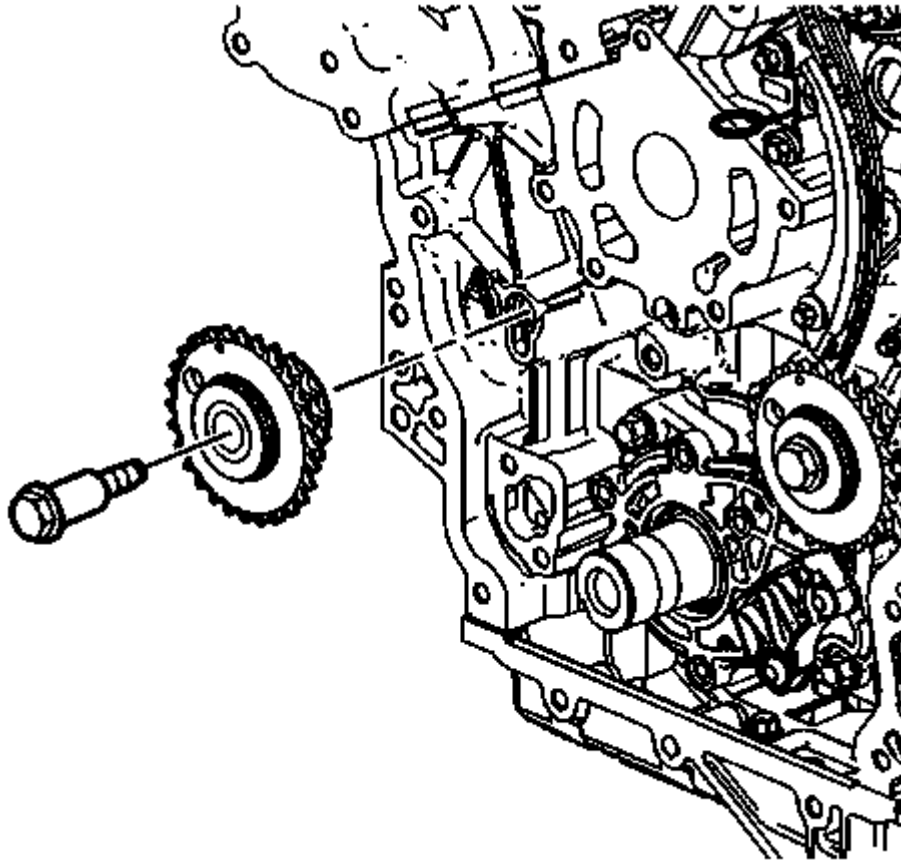


**Fig. 131: View Of Right & Left Camshaft Intermediate Drive Chain Idlers**  
Courtesy of GENERAL MOTORS CORP.

11. 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** .

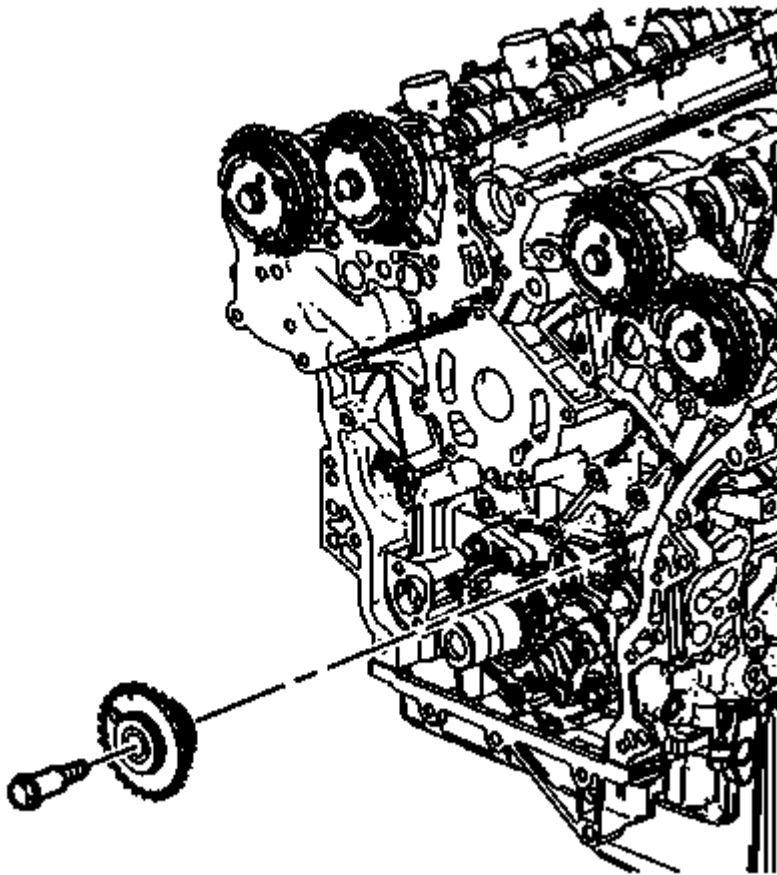
5. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side**.

## INSTALLATION PROCEDURE



**Fig. 132: View Of Right & Left Camshaft Intermediate Drive Chain Idlers**  
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 (LY7 or LP1)**.
  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**.

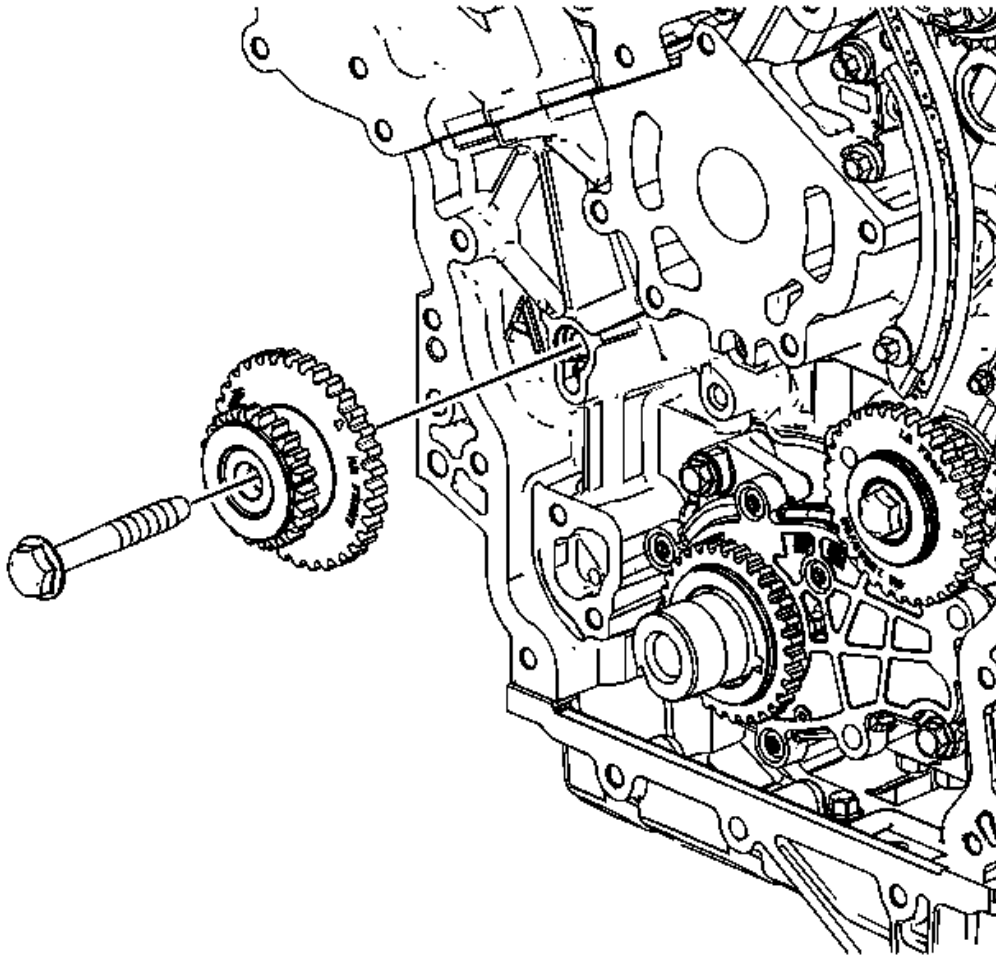


**Fig. 133: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket**  
Courtesy of GENERAL MOTORS CORP.

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**.

## TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

### REMOVAL PROCEDURE

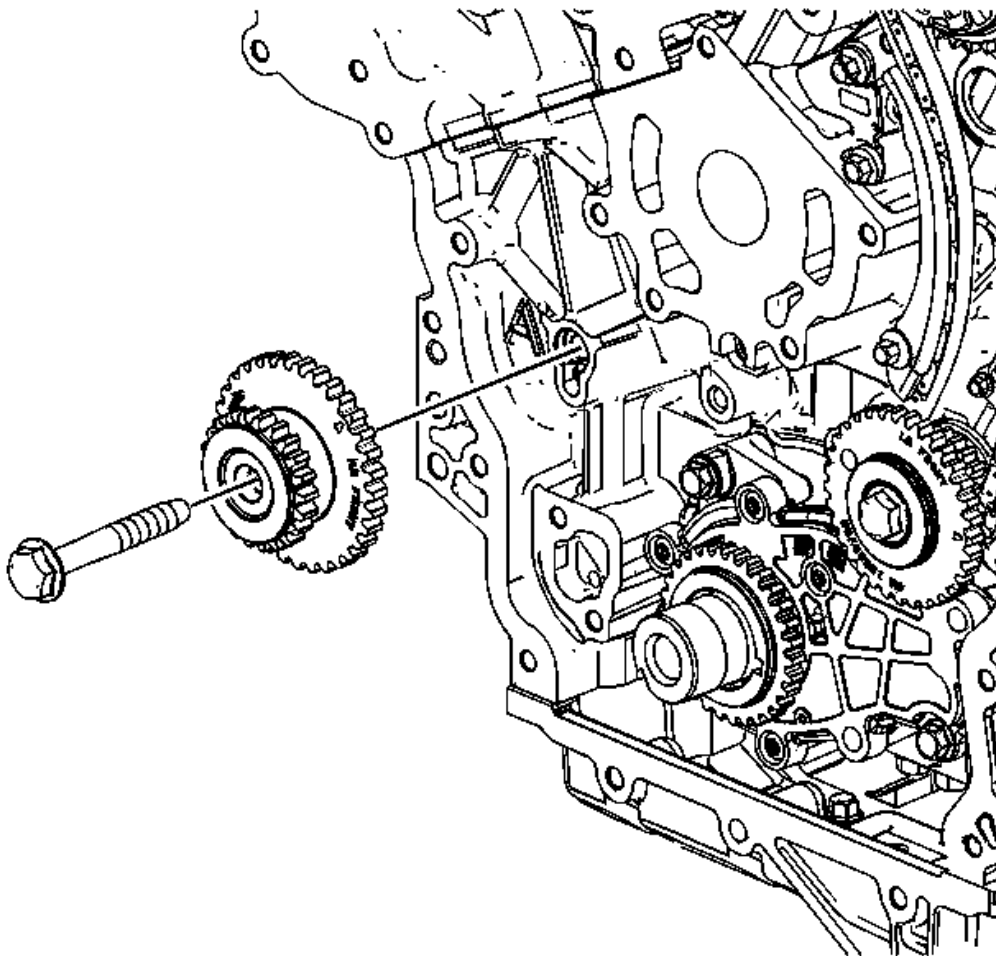


**Fig. 134: Identifying Camshaft Intermediate Drive Chain Idler & Bolt**  
Courtesy of GENERAL MOTORS CORP.

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



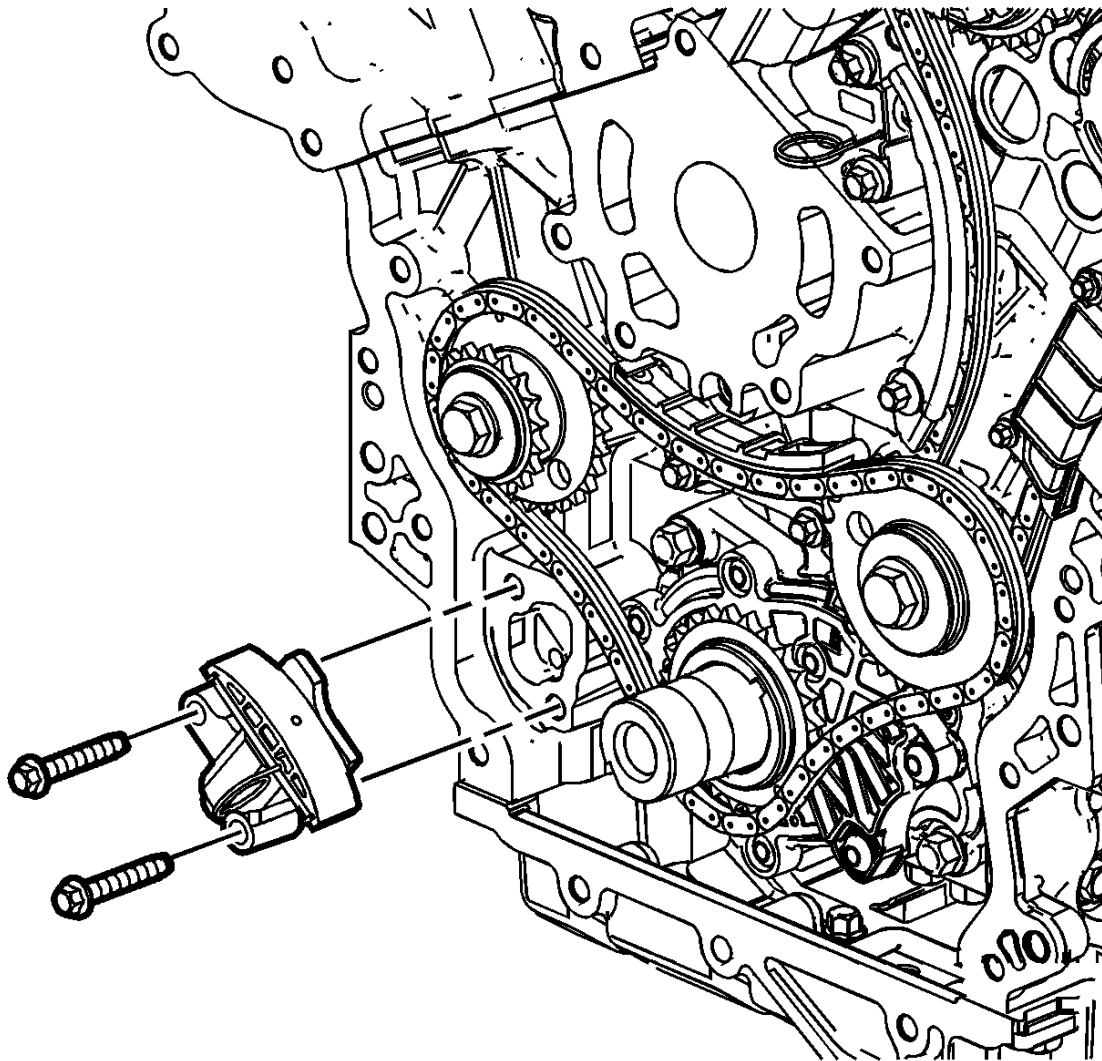
**Fig. 135: Identifying Camshaft Intermediate Drive Chain Idler & Bolt**  
Courtesy of GENERAL MOTORS CORP.

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

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

## **PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT**

### **REMOVAL PROCEDURE**



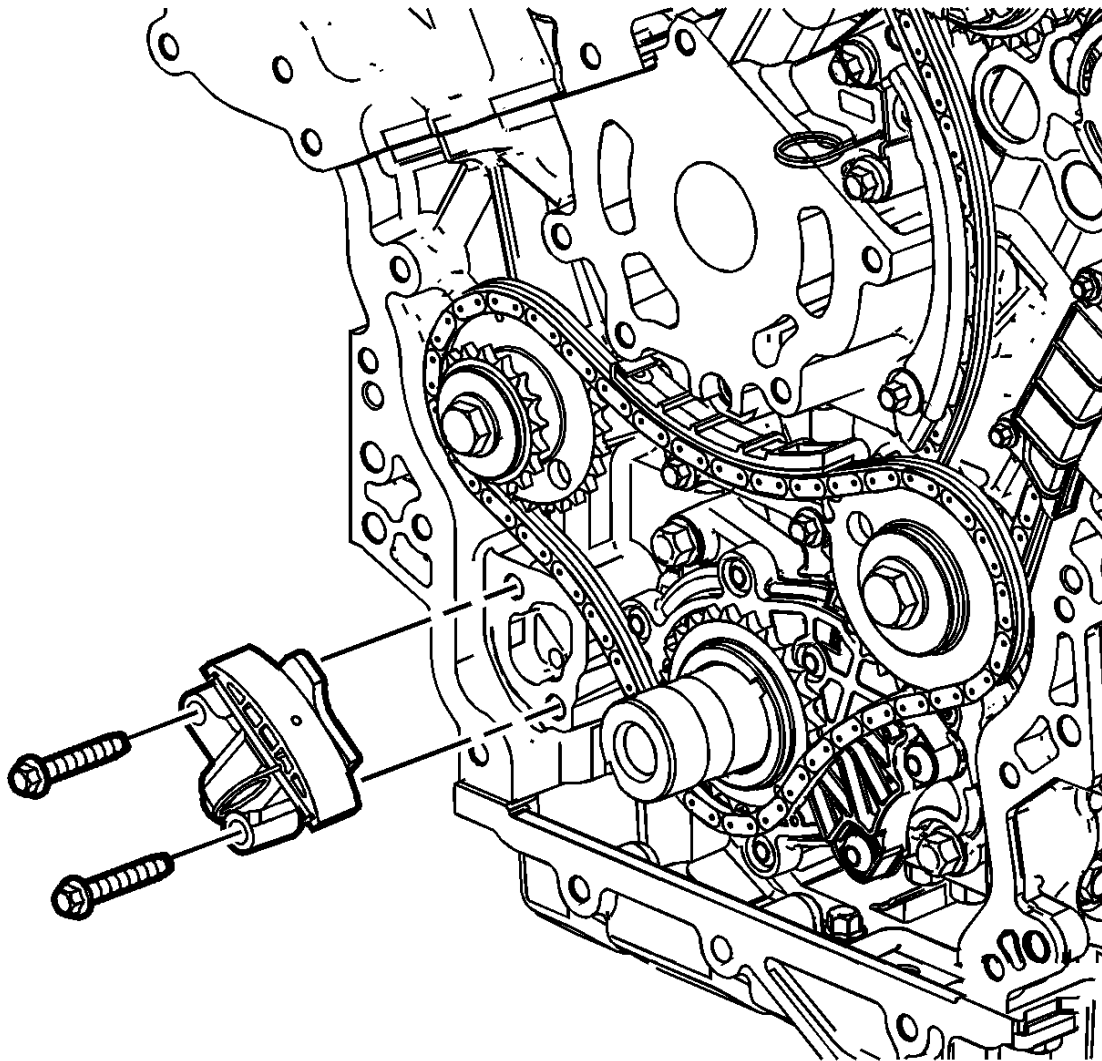
**Fig. 136: View Of Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

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](#).

**IMPORTANT:** If the entire camshaft timing system is not in Stage 2, mark the timing chain and sprockets in order to ensure proper reassembly. Refer to [Timing Chain Alignment Diagram](#) .

3. Remove the primary camshaft drive chain tensioner. Refer to [Primary Camshaft Intermediate Drive Chain Tensioner Removal](#) .

## INSTALLATION PROCEDURE



**Fig. 137: View Of Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS CORP.

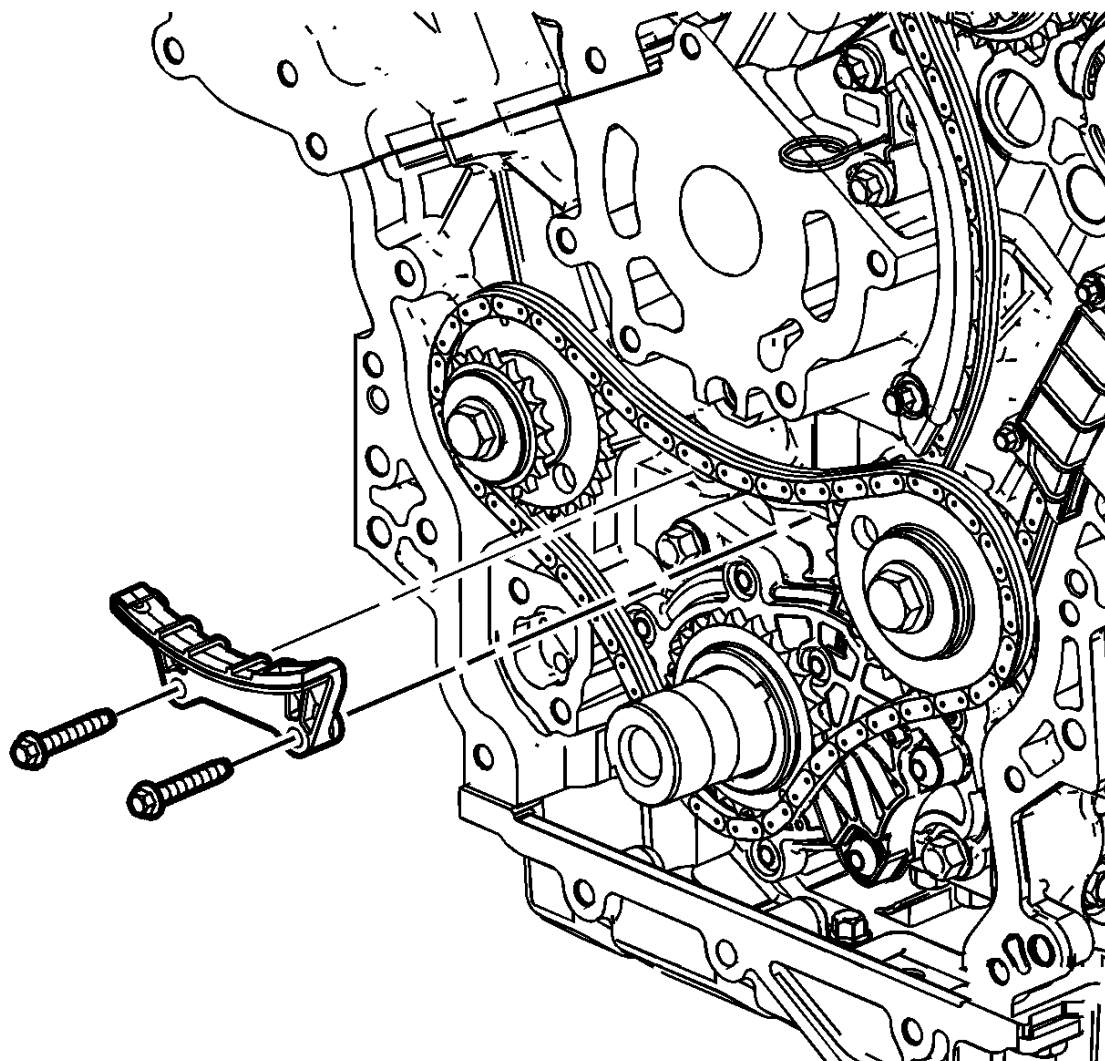
1. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
2. Install the spark plugs. Refer to **Spark Plug Replacement** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

## PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

The primary camshaft drive chain guide is not serviceable separately. If the guide is worn or damaged, the guide must be replaced with the oil pump.

## PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

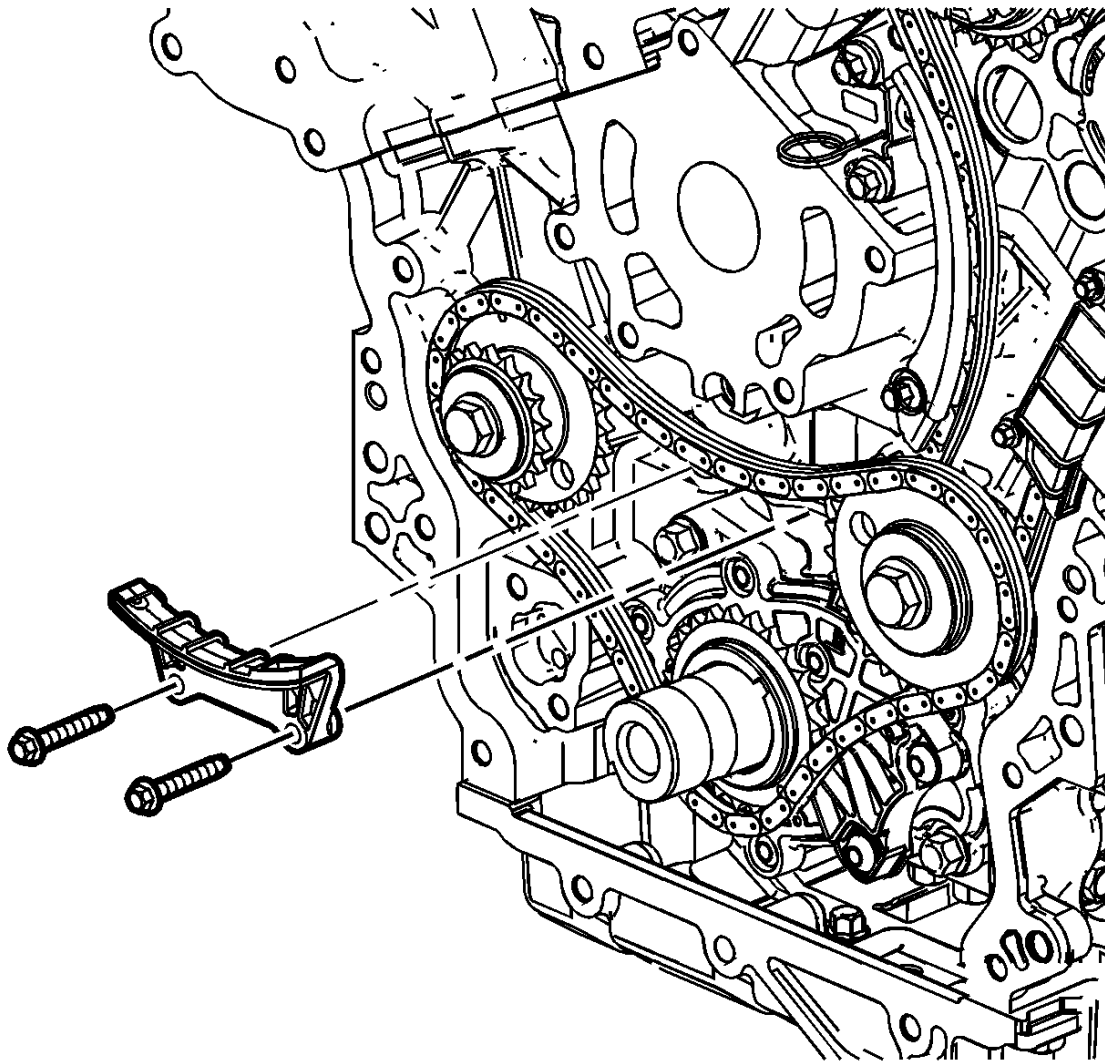
### REMOVAL PROCEDURE



**Fig. 138: View Of Upper Primary Camshaft Drive Chain Guide**  
 Courtesy of GENERAL MOTORS CORP.

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

## INSTALLATION PROCEDURE



**Fig. 139: View Of Upper Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS CORP.

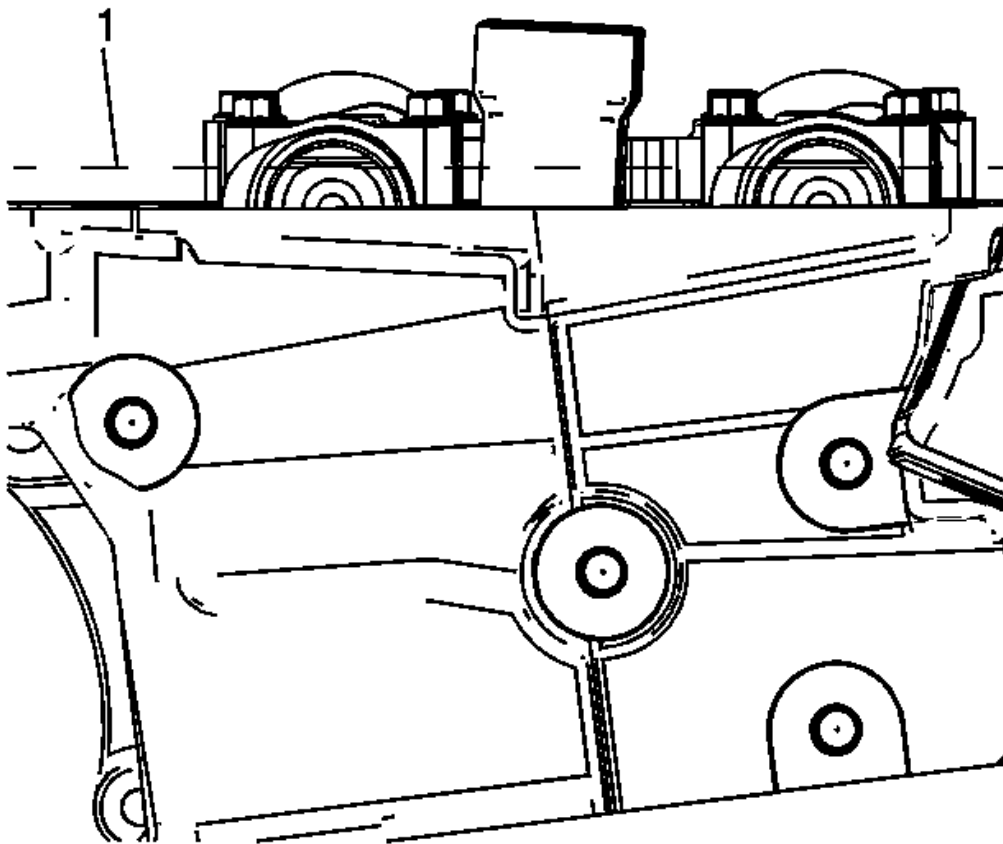
1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
2. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
3. Install the engine front cover. Refer to **Engine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

## **CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST**

### **SPECIAL TOOLS**

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

## REMOVAL PROCEDURE

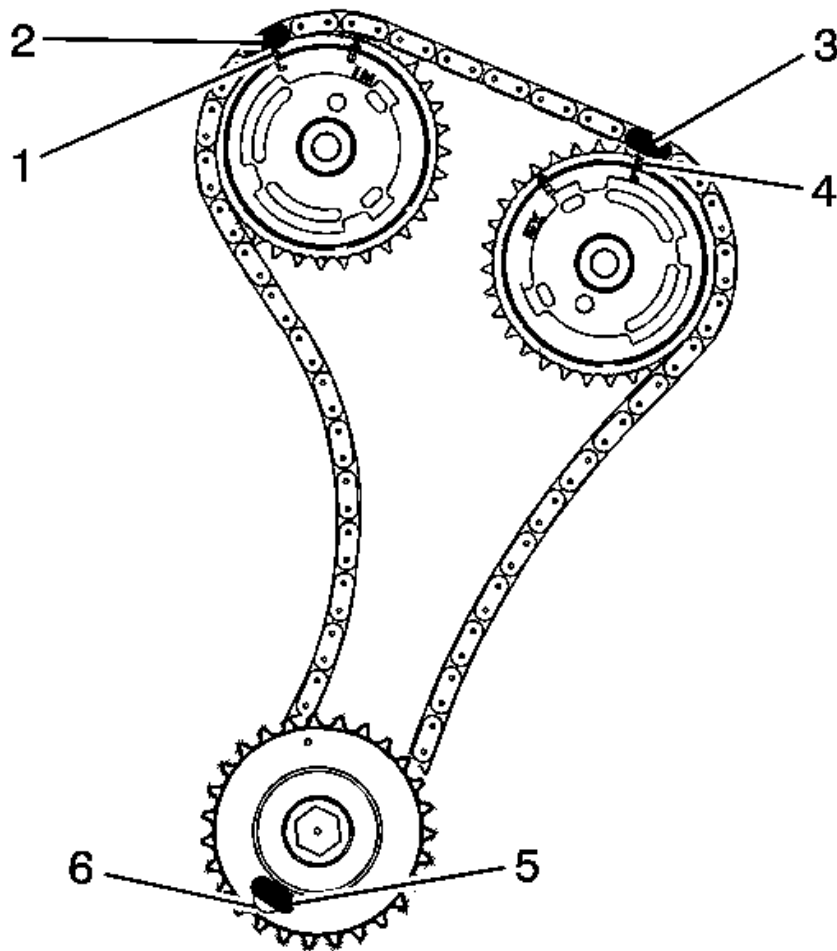


**Fig. 140: View Of Camshaft Flats Parallel With Camshaft Cover Rail**  
Courtesy of GENERAL MOTORS CORP.

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

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

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



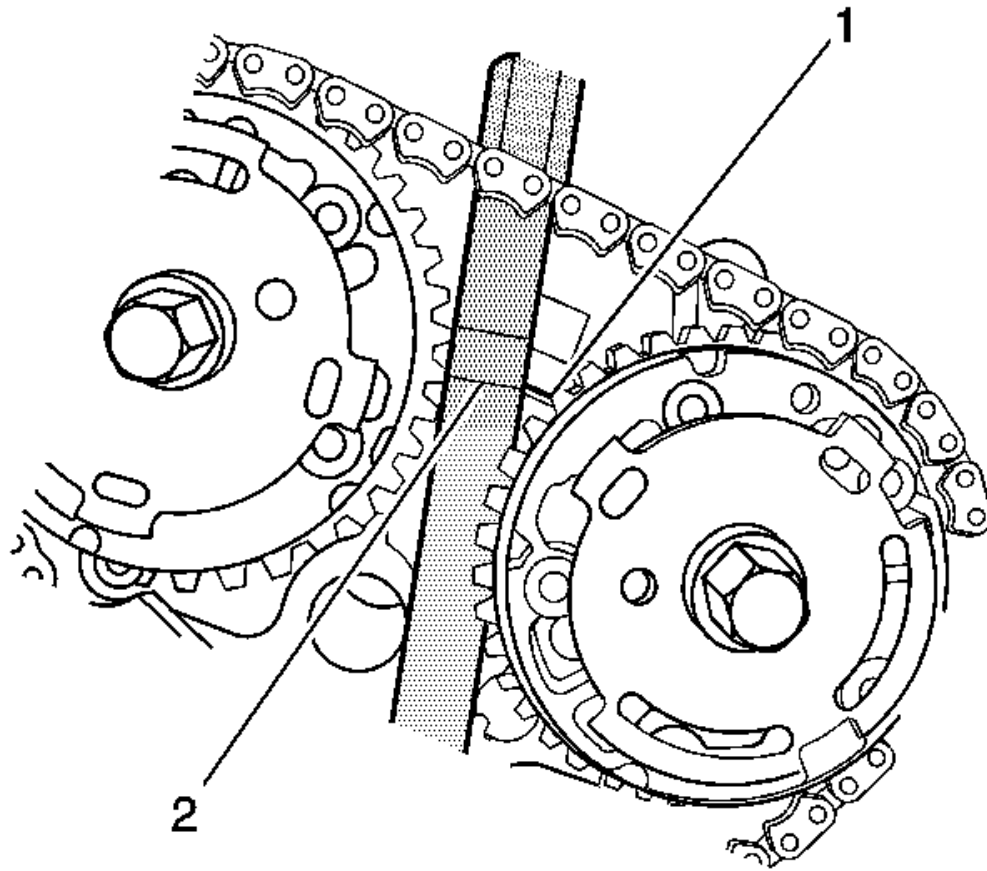
**Fig. 141: Locating Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

**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).

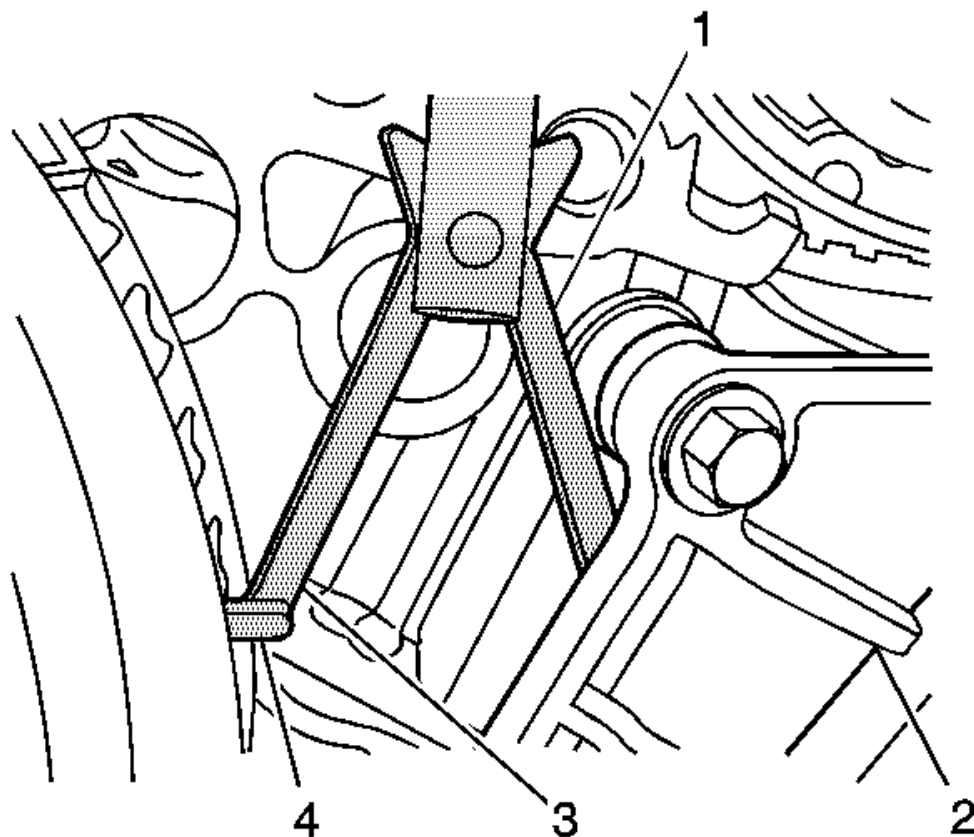
**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

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. 142: View Of Retention Tool & Cylinder Head**  
 Courtesy of GENERAL MOTORS CORP.

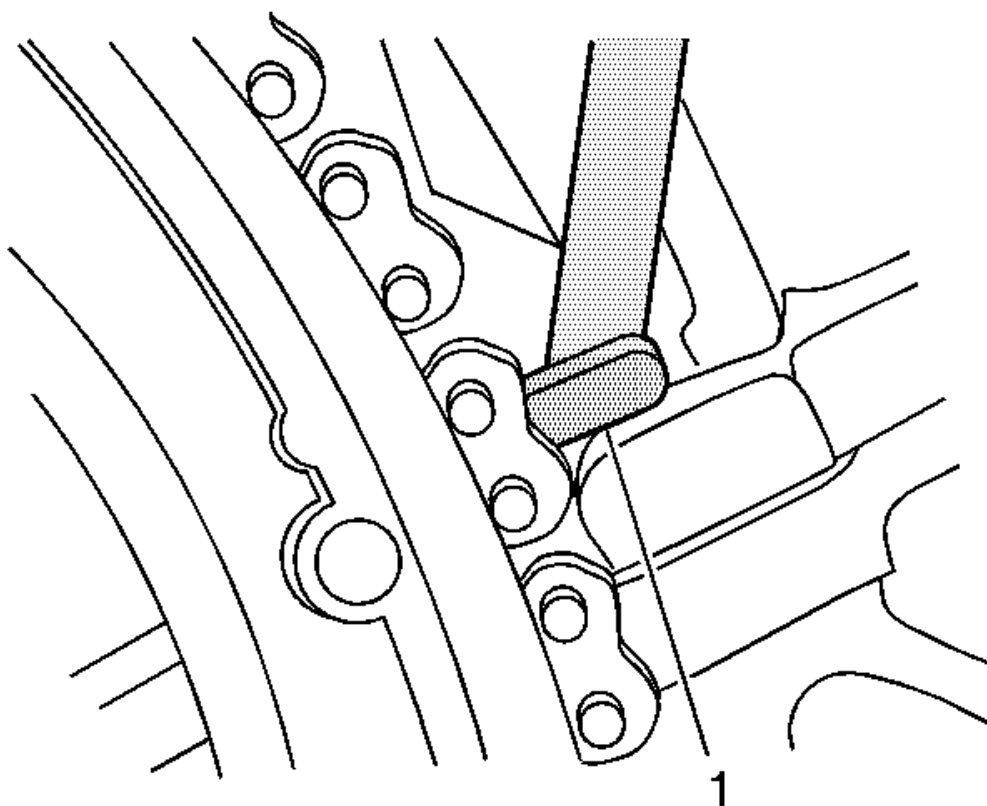
9. Unscrew the **EN-48313**: tool so that the legs of the tool are retracted.
10. Insert the **EN-48313**: tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This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



**Fig. 143: 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.

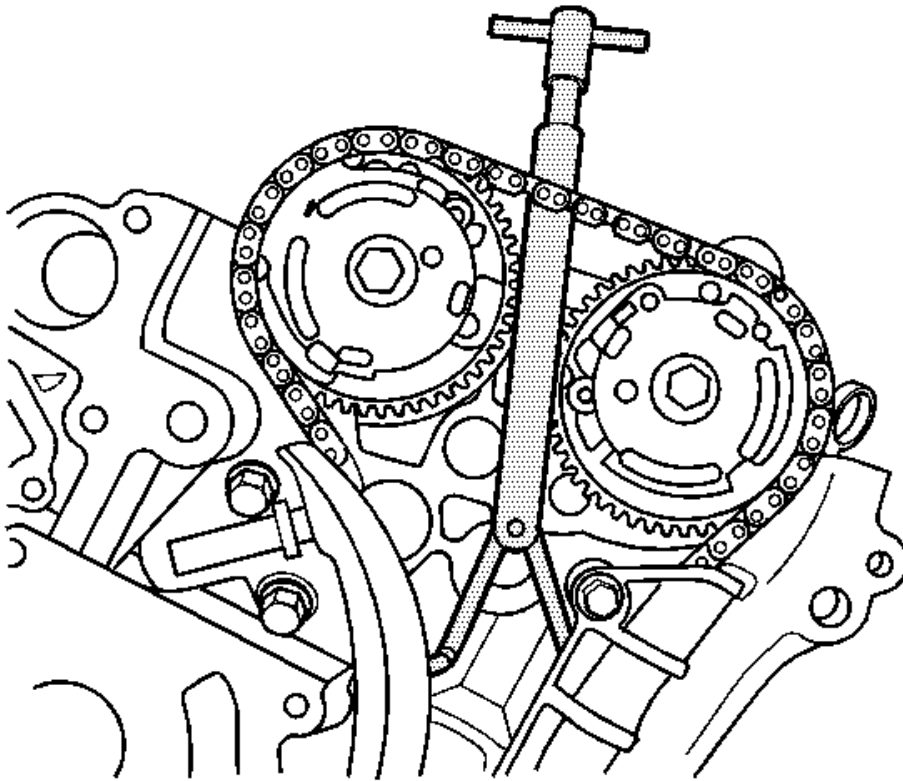
11. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
12. Partially expand the legs (1, 3) of the **EN-48313** tool by turning the T-shaped handle clockwise.
13. Insert the leg of the tool (1) behind the timing chain guide (2).
14. Continue expanding the **EN-48313**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



**Fig. 144: Identifying Foot Of Timing Chain Retention Tool EN-48313**  
Courtesy of GENERAL MOTORS CORP.

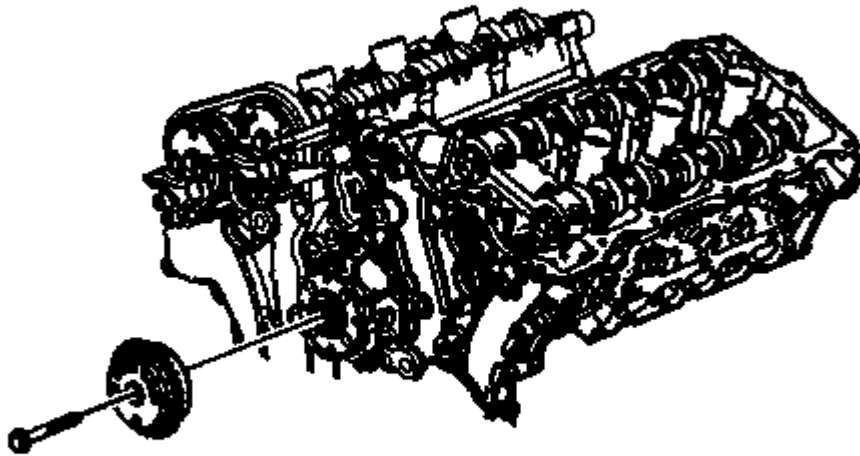
**NOTE:** Ensure that the foot (1) of the EN-48313: tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313: tool.

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. 145: View Of Timing Chain Retention Tool EN-48313**  
Courtesy of GENERAL MOTORS CORP.

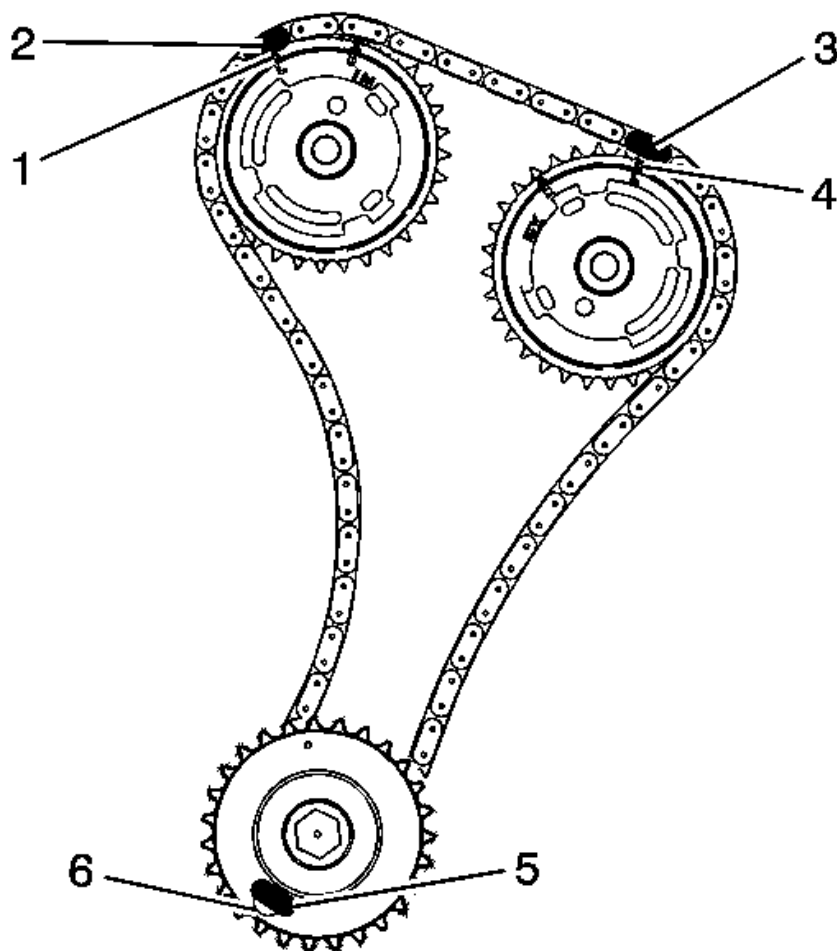
17. The **EN-48313** tool is now properly installed to hold the timing chain in position.



**Fig. 146: View Of 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. Remove the left exhaust camshaft position actuator bolt.
20. Remove the left exhaust camshaft position actuator. When removing the actuator, place the chain on the engine cover side of the actuators.
21. 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.
22. Remove the camshaft thrust washer.
23. 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.

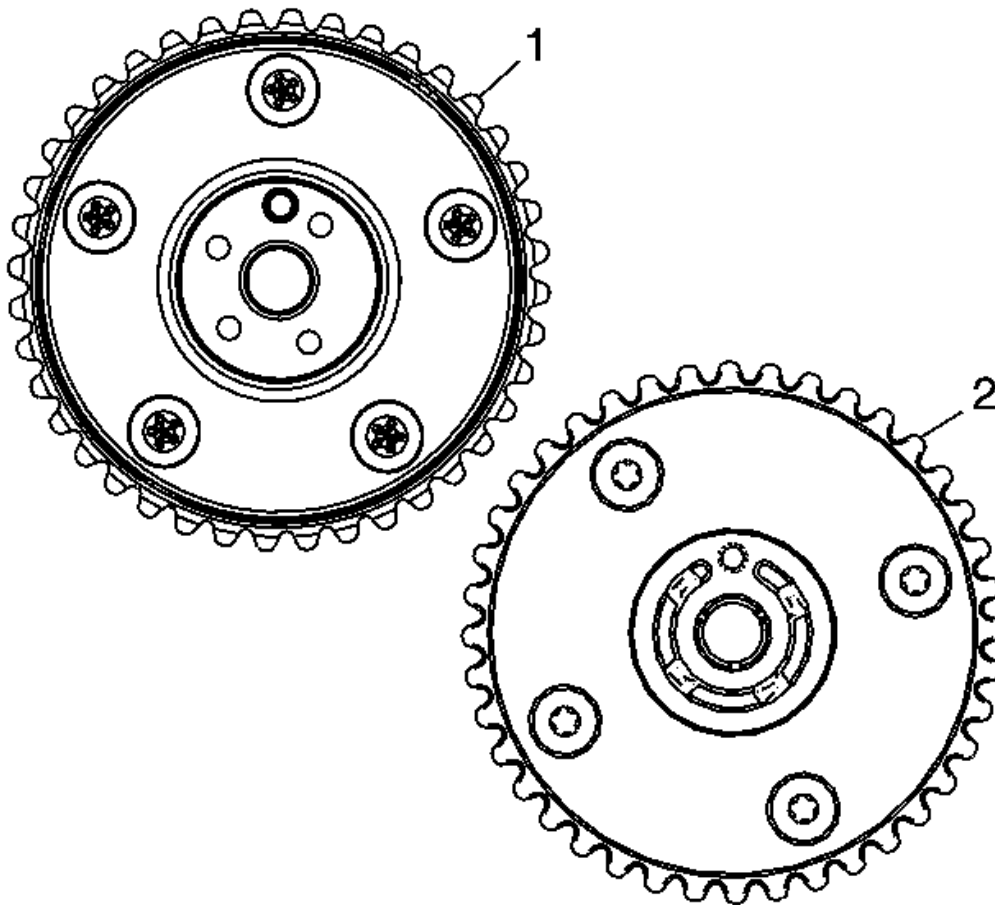
## **INSTALLATION PROCEDURE**



**Fig. 147: 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.

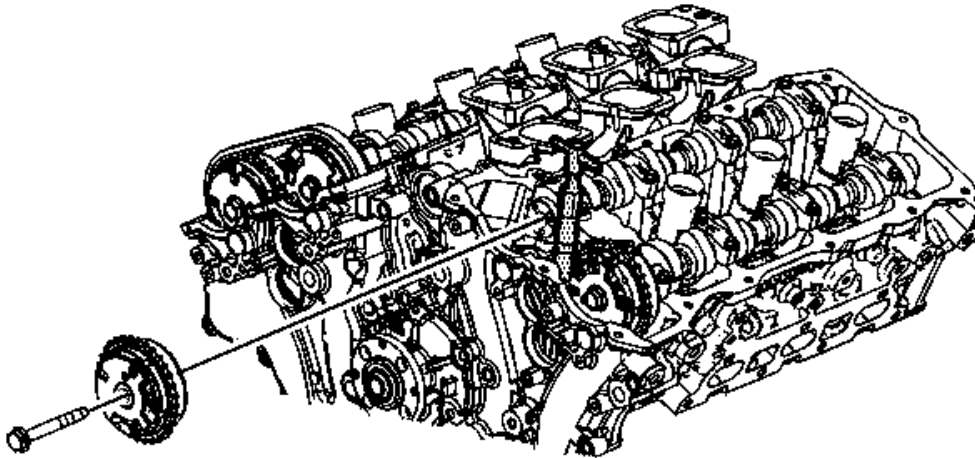


**Fig. 148: Identifying Different Camshaft Position Actuators**  
Courtesy of GENERAL MOTORS CORP.

**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. 149: View Of Exhaust Camshaft Position Actuator Bolt**  
Courtesy of GENERAL MOTORS CORP.

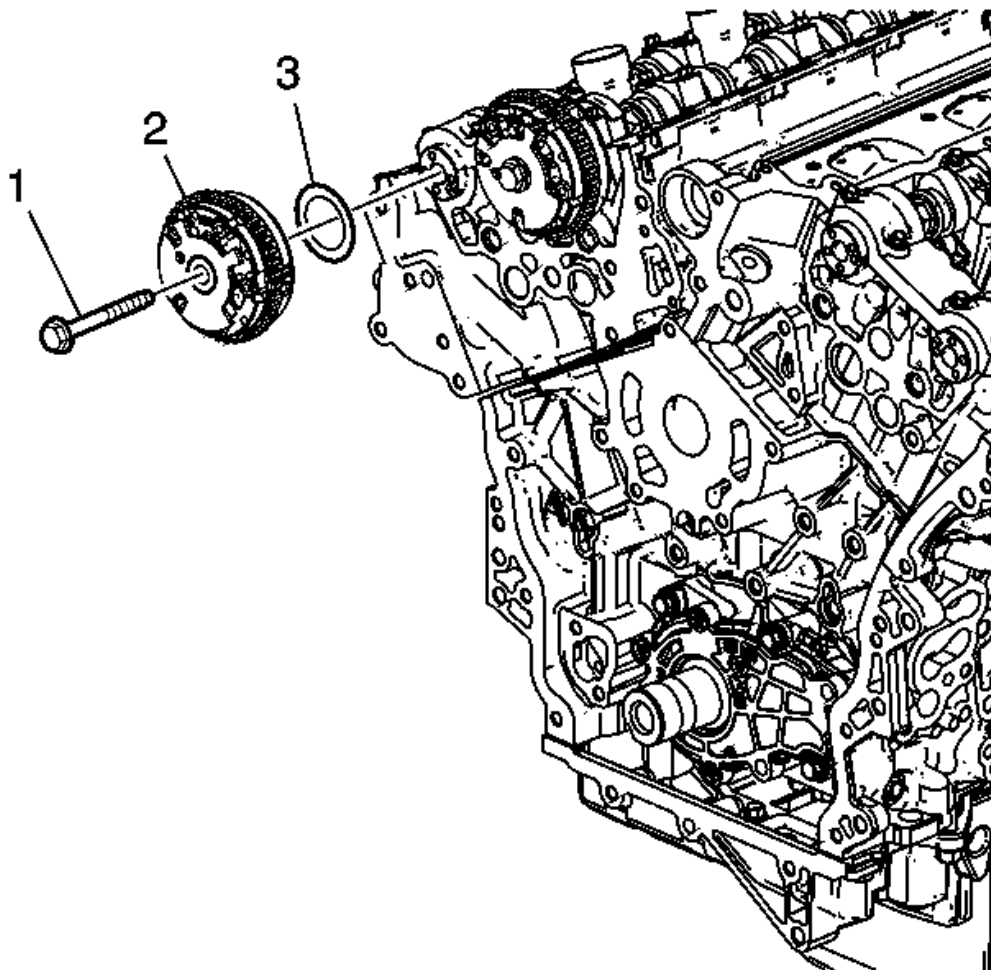
**CAUTION:** Refer to Fastener Caution .

7. Tighten the exhaust camshaft position actuator bolt to 58 N.m (43 lb ft).
8. 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 .
9. 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 .
10. Install the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
11. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.

## **CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1 (RIGHT SIDE)**

## EXHAUST

### REMOVAL PROCEDURE



**Fig. 150: Identifying Camshaft Position Actuator & Bolt**  
Courtesy of GENERAL MOTORS CORP.

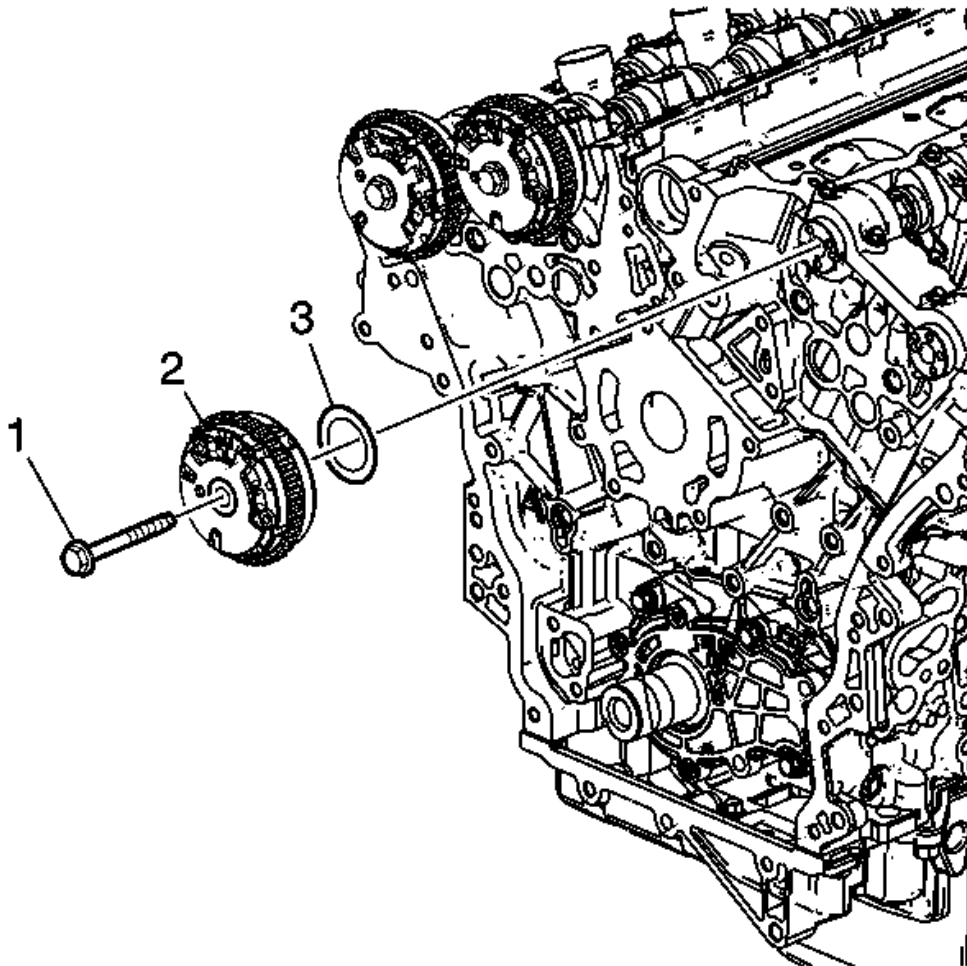
1. Remove the right hand secondary camshaft intermediate drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
3. Remove the right exhaust camshaft position actuator bolt (1).
4. Remove the right exhaust camshaft position actuator (2).
5. Remove the camshaft thrust washer (3), if applicable.

### INSTALLATION PROCEDURE

1. Install the exhaust camshaft position actuator. Refer to **Camshaft Position Actuator Installation - Right**

**Side Exhaust .**

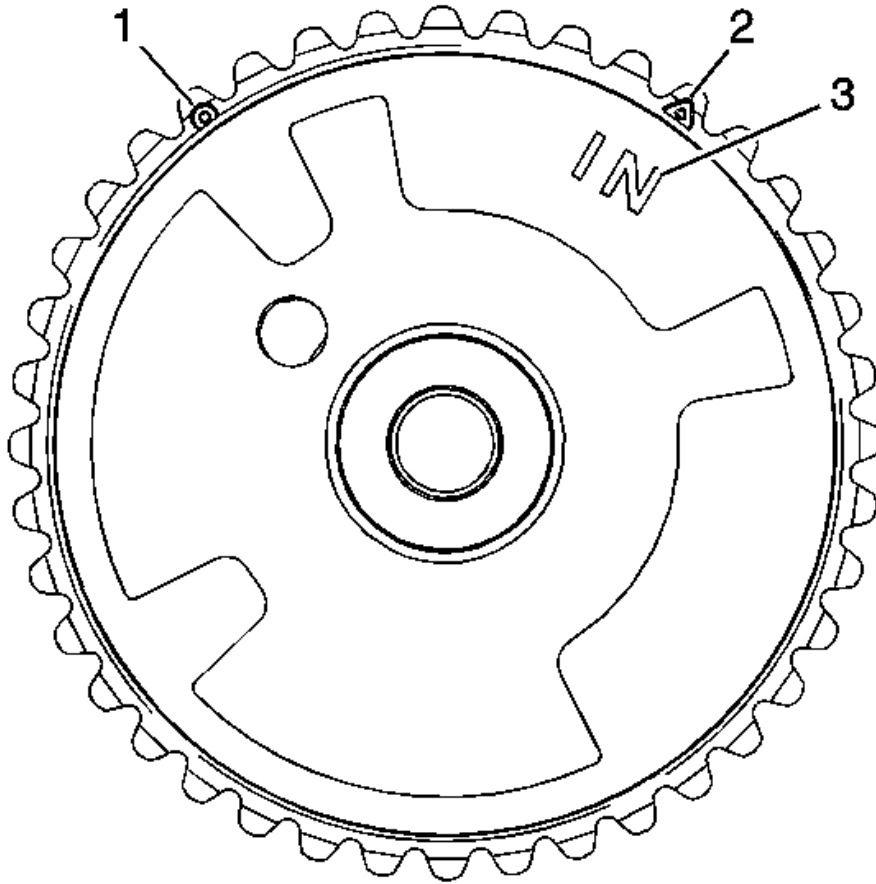
2. Install the right side secondary camshaft intermediate drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side.**

**CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE****REMOVAL PROCEDURE**

**Fig. 151: View Of Camshaft Position Actuator Bolt**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the left exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust.**
2. Remove the intake camshaft position actuator bolt.
3. Remove the left intake camshaft position actuator.

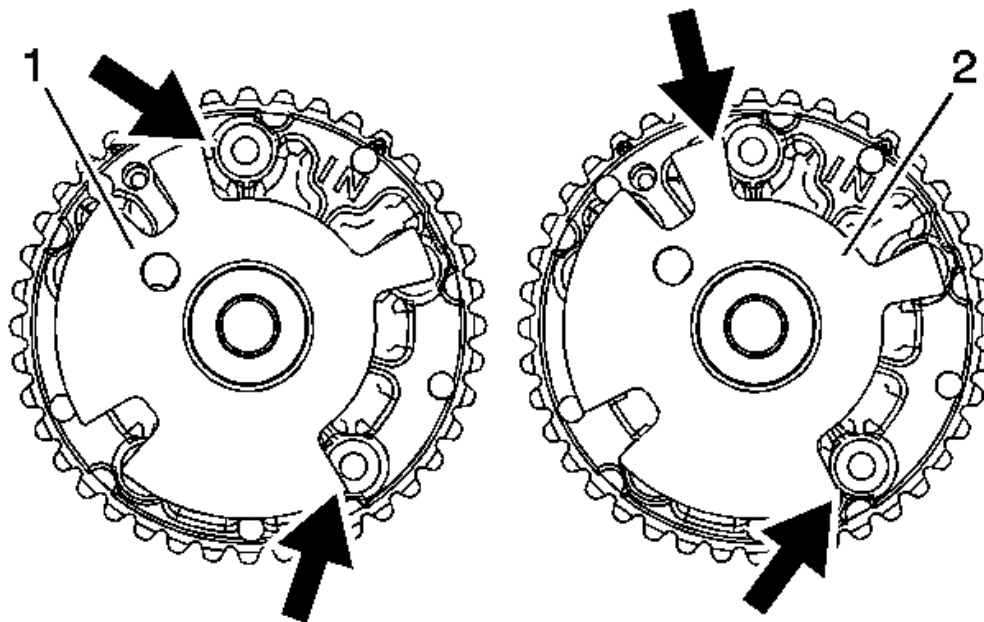
**INSTALLATION PROCEDURE**



**Fig. 152: Identifying Camshaft Position Actuator Marks**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the IN marking (3).

The marking is for an intake camshaft position actuator.

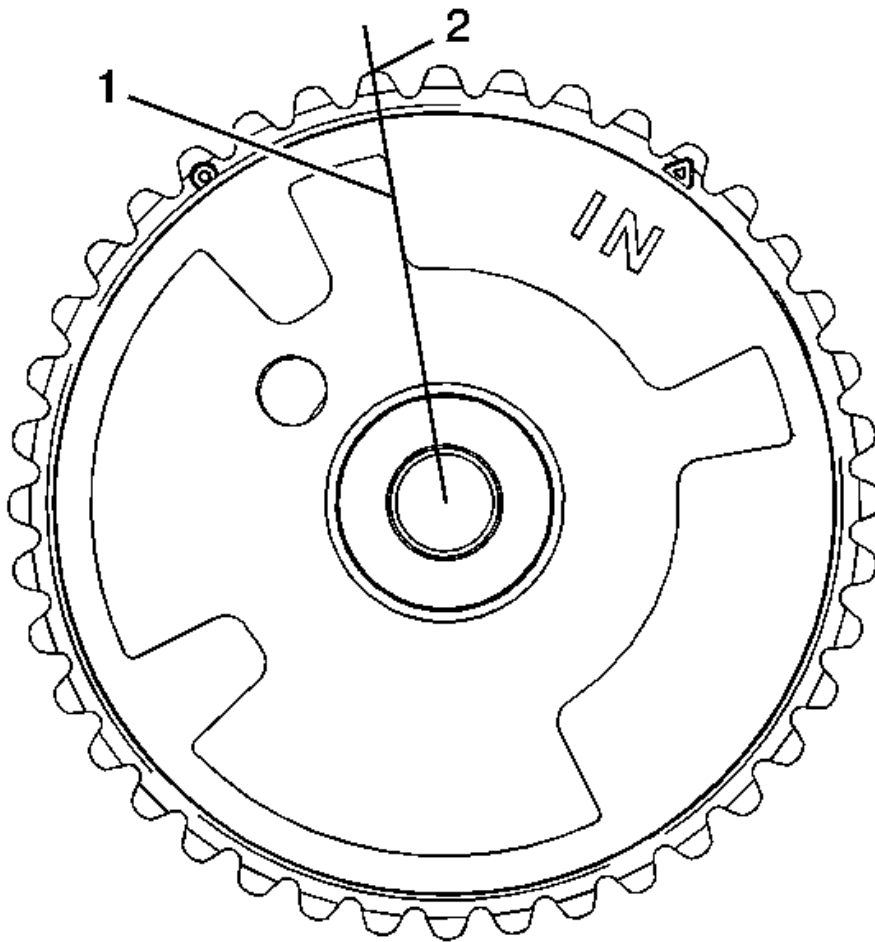


**Fig. 153: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator**

Courtesy of GENERAL MOTORS CORP.

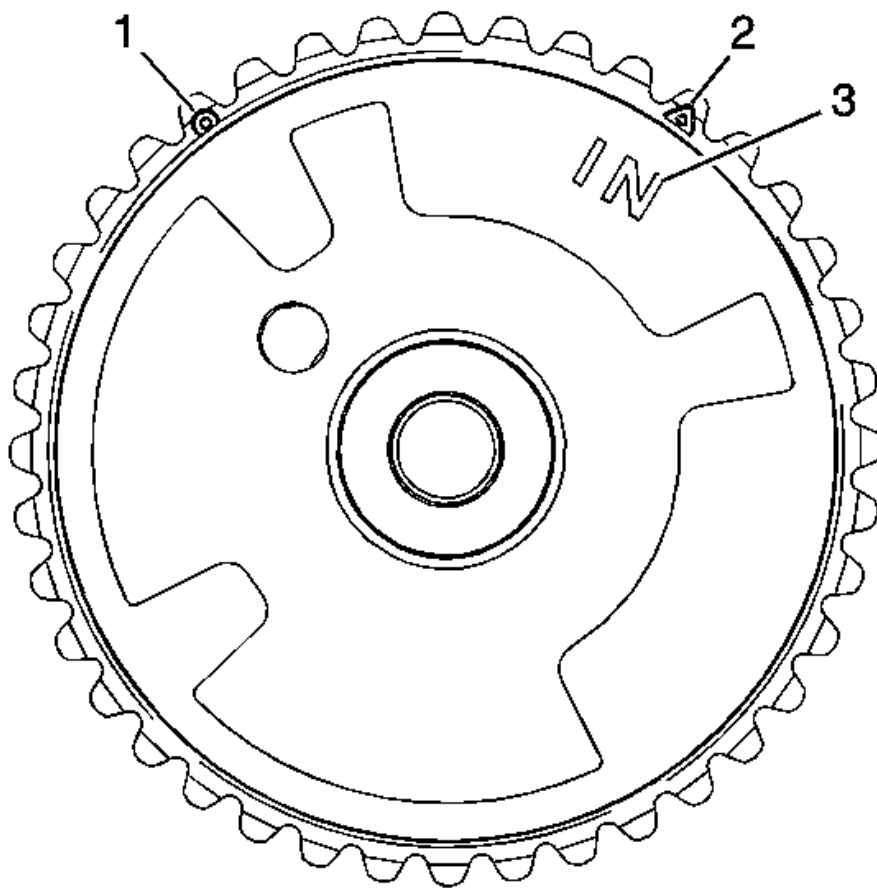
**CAUTION:** Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).



**Fig. 154: View Of Reluctor Wheel Lines Up With Peak**  
Courtesy of GENERAL MOTORS CORP.

3. On the left intake camshaft actuator the edge of the reluctor wheel (1) lines up with the peak (2) of the sprocket tooth.



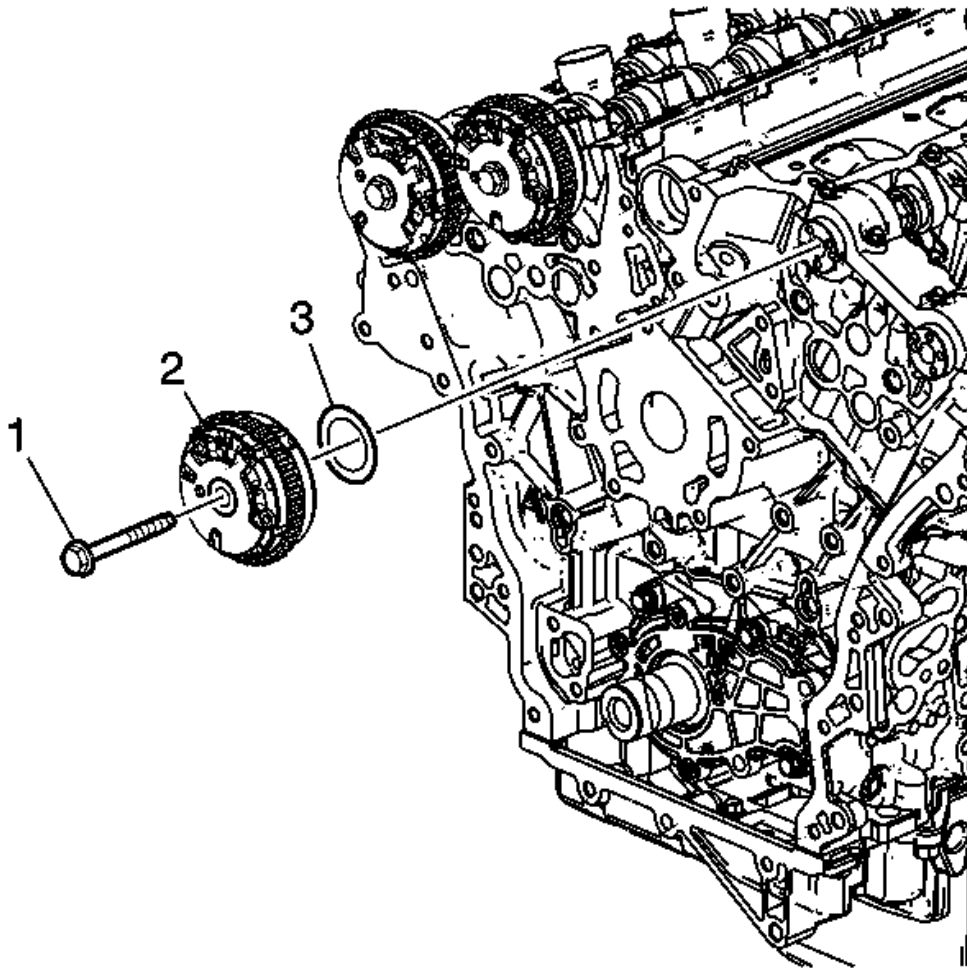
**Fig. 155: Identifying Camshaft Position Actuator Marks**  
Courtesy of GENERAL MOTORS CORP.

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (1).

The circle marking is for alignment to the highlighted timing chain link on the left side of the engine.

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

5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.



**Fig. 156: View Of Camshaft Position Actuator Bolt**  
Courtesy of GENERAL MOTORS CORP.

6. Locate the intake camshaft position actuator to the camshaft and loosely install the bolt.

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

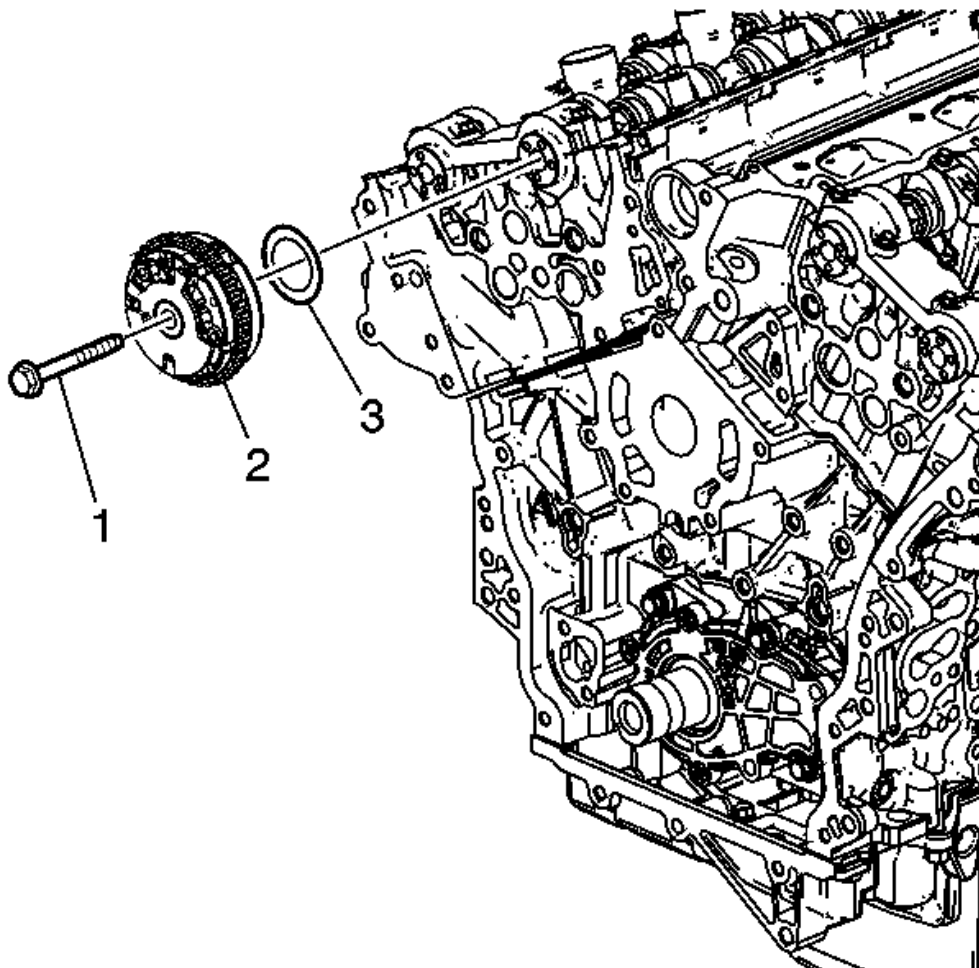
**NOTE:** Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

7. Tighten the camshaft position actuator bolt. Refer to Camshaft Position Actuator Installation - Left Side Intake .
8. Install the left exhaust camshaft actuator. Refer to Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust.

## CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1 (RIGHT SIDE)

## INTAKE

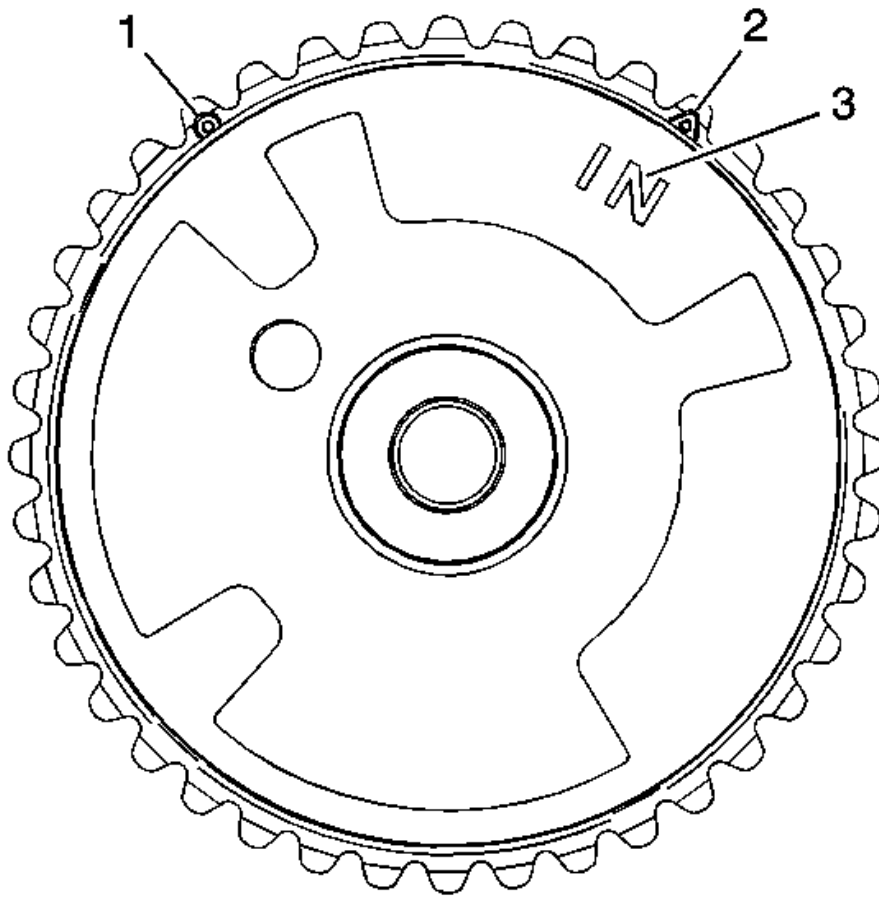
### REMOVAL PROCEDURE



**Fig. 157: Identifying Intake Camshaft Position Actuator & Bolt**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the right exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust**.
2. Remove the intake camshaft position actuator bolt.
3. Remove the right intake camshaft position actuator.

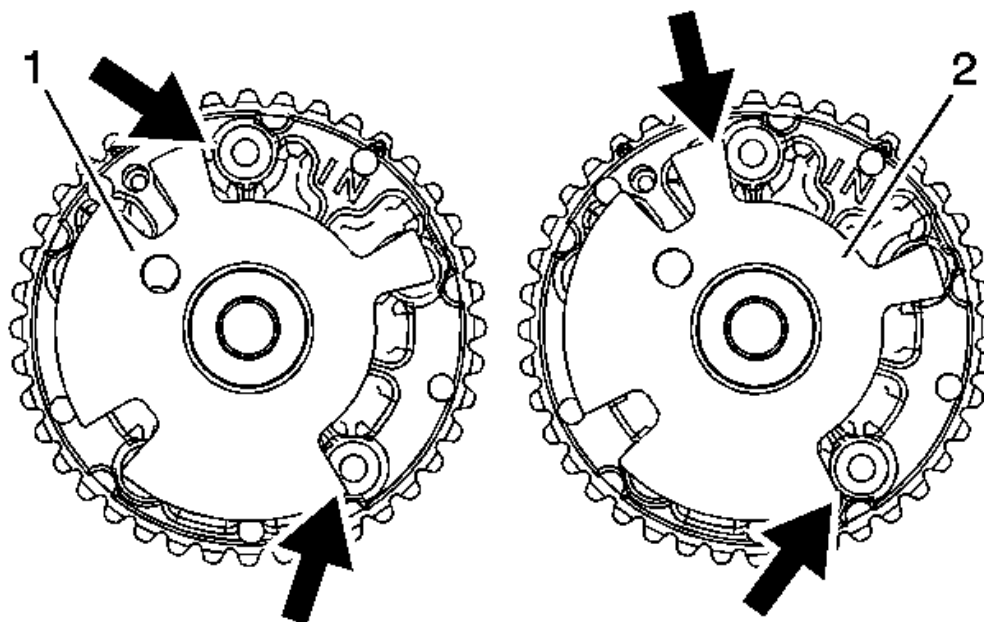
### INSTALLATION PROCEDURE



**Fig. 158: View Of Camshaft Position Actuator Markings**  
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the IN marking (3).

The marking is for an exhaust camshaft position actuator.

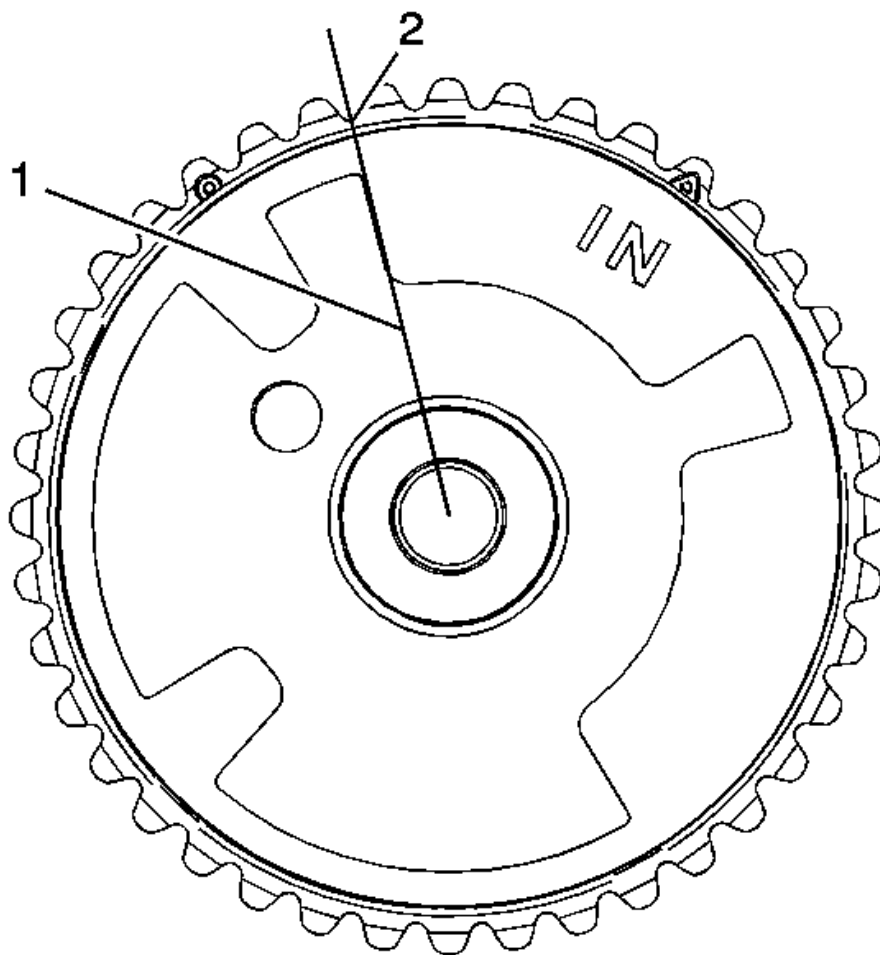


**Fig. 159: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator**

Courtesy of GENERAL MOTORS CORP.

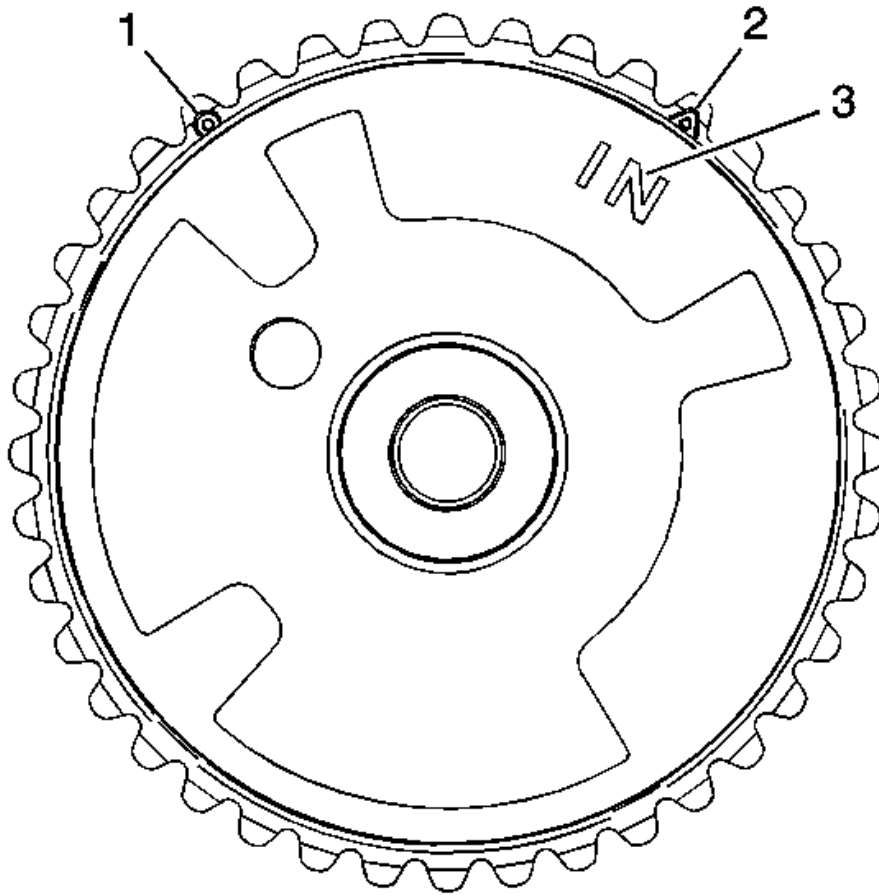
**CAUTION:** Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).



**Fig. 160: View Of Reluctor Wheel & Valley**  
Courtesy of GENERAL MOTORS CORP.

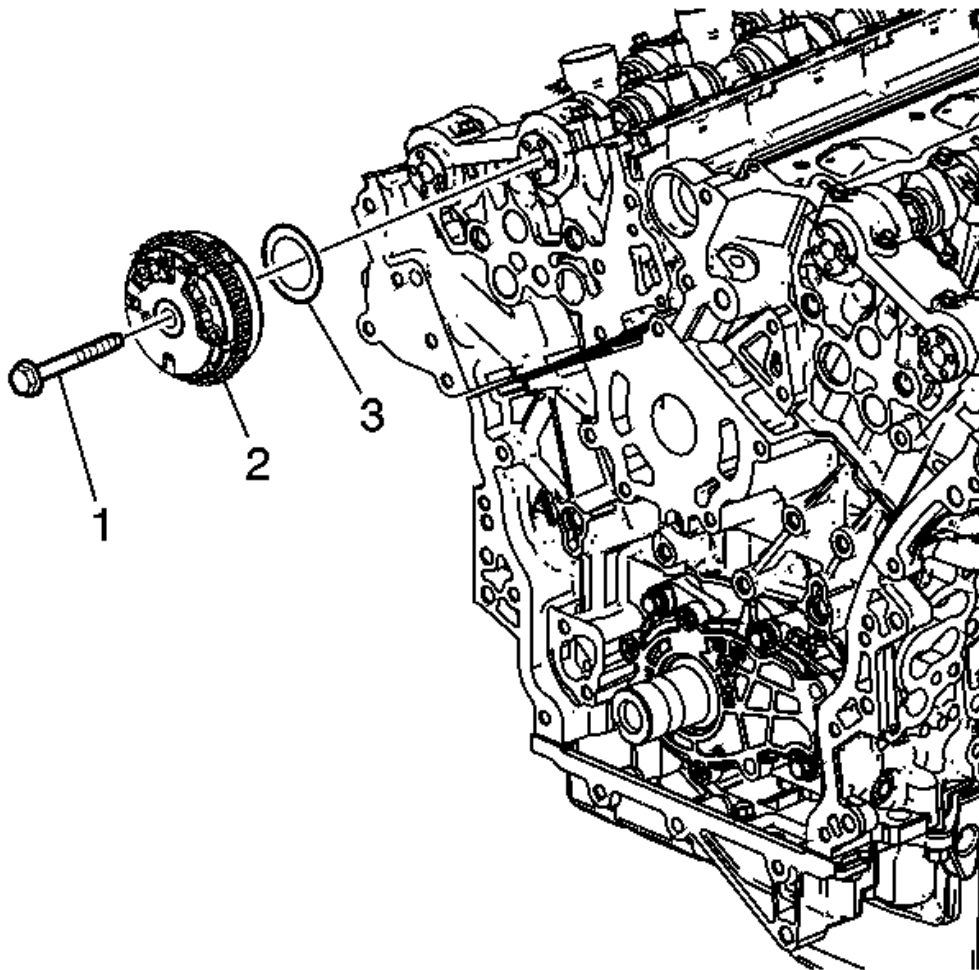
3. On the right intake camshaft actuator the edge of the reluctor wheel (1) lines up with the valley (2) of the sprocket tooth.



**Fig. 161: View Of Camshaft Position Actuator Markings**  
Courtesy of GENERAL MOTORS CORP.

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2).

The triangle marking is for alignment to the highlighted timing chain link on the right side of the engine.



**Fig. 162: Identifying Intake Camshaft Position Actuator & Bolt**  
Courtesy of GENERAL MOTORS CORP.

5. Locate the intake camshaft position actuator to the camshaft and loosely install the bolt.

**CAUTION:** Refer to Fastener Caution .

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

6. Tighten the camshaft position actuator bolt. Refer to Camshaft Position Actuator Installation - Right Side Intake .
7. Install the right exhaust camshaft actuator. Refer to Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust.

## SETTING CAMSHAFT TIMING

**IMPORTANT:** 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.

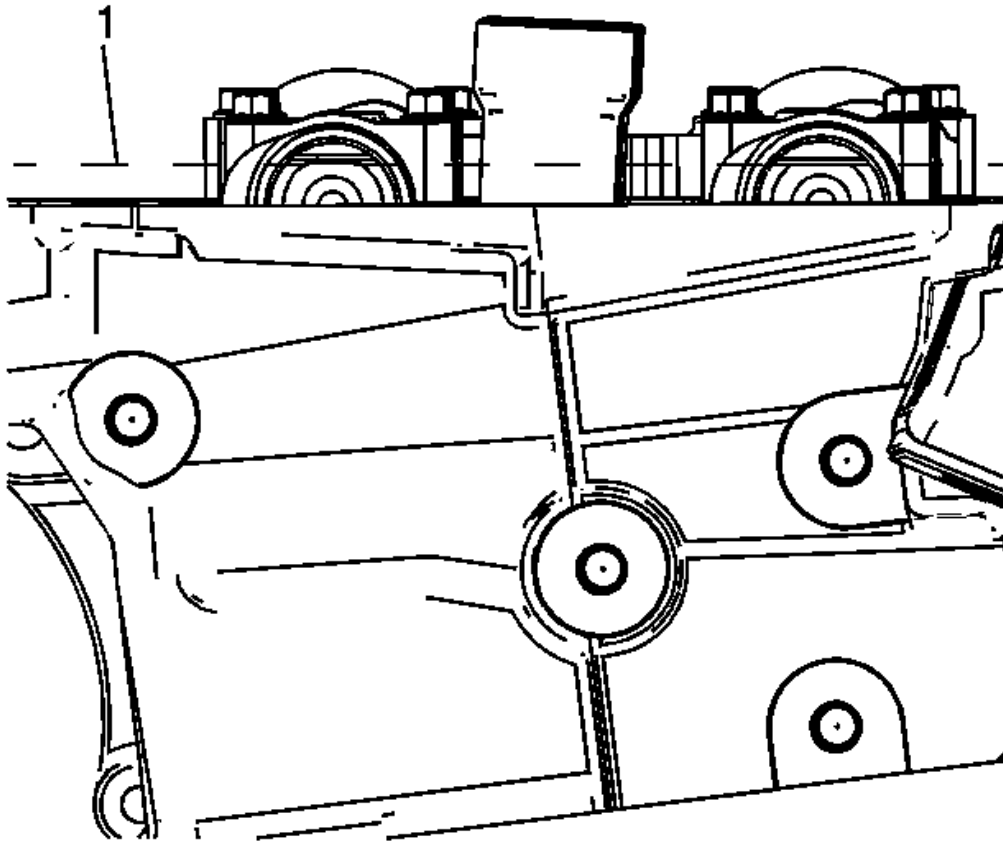
## **CAMSHAFT REPLACEMENT - LEFT SIDE**

### **SPECIAL TOOLS**

- **EN 46108** Timing Chain Retention Tool
- **EN 46111** Crankshaft Rotation Socket

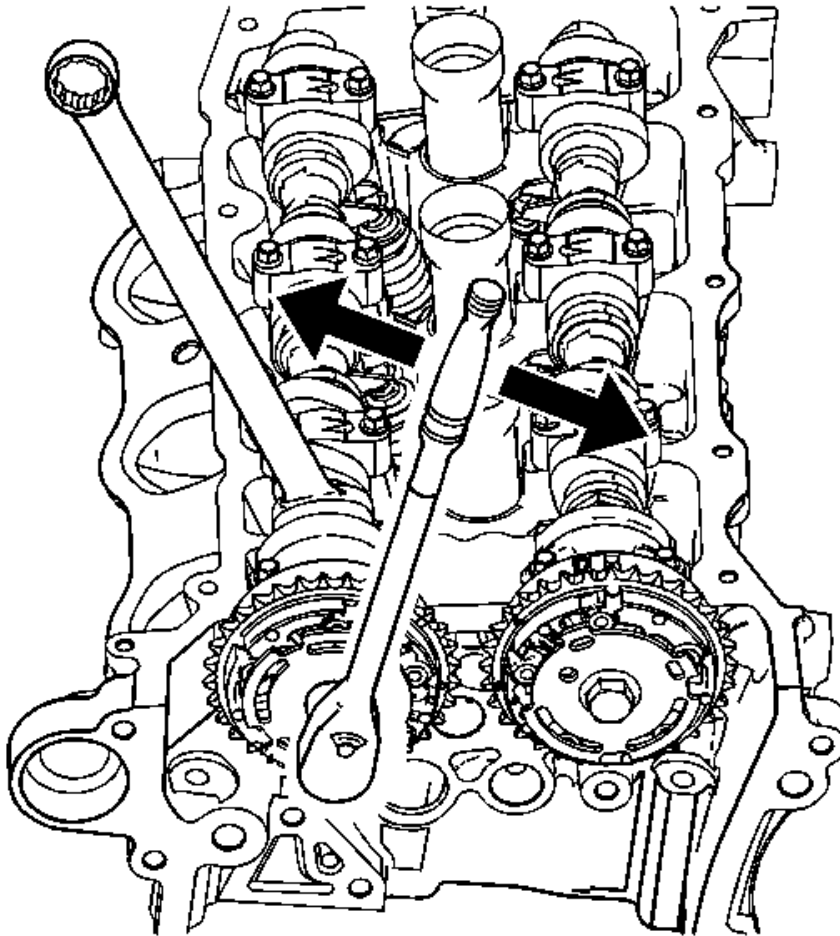
### **REMOVAL PROCEDURE**

1. Remove the lower intake manifold. Refer to Lower Intake Manifold Replacement.
2. Remove the left bank camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
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 crankshaft balancer. Refer to Crankshaft Balancer Replacement.



**Fig. 163: View Of Camshaft Flats Parallel With Camshaft Cover Rail**  
Courtesy of GENERAL MOTORS CORP.

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



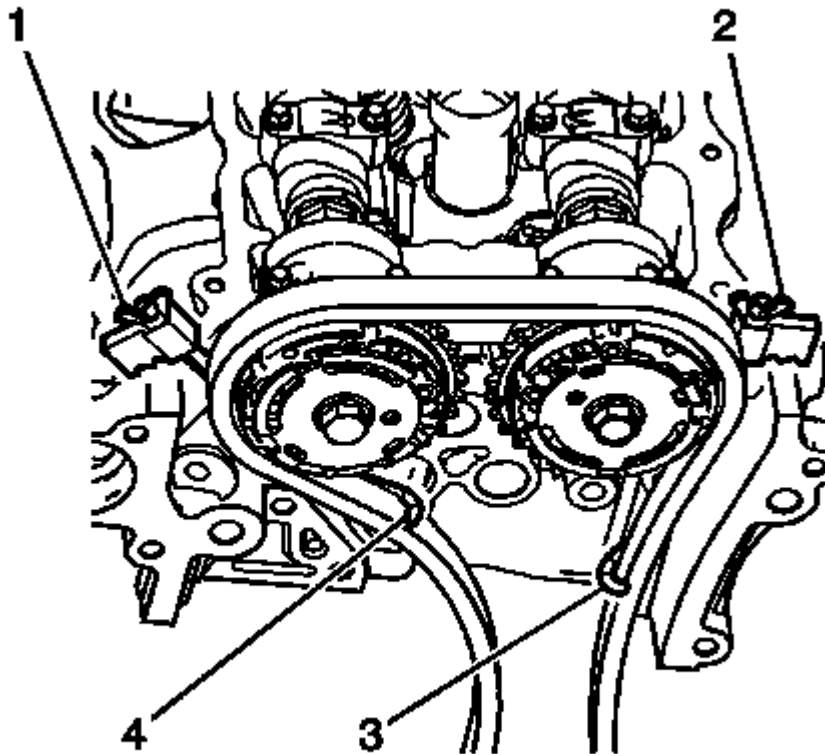
**Fig. 164: Preventing Camshaft/Engine Rotation Using Open-End Wrench**  
Courtesy of GENERAL MOTORS CORP.

**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.

7. Loosen the camshaft position actuator bolt.

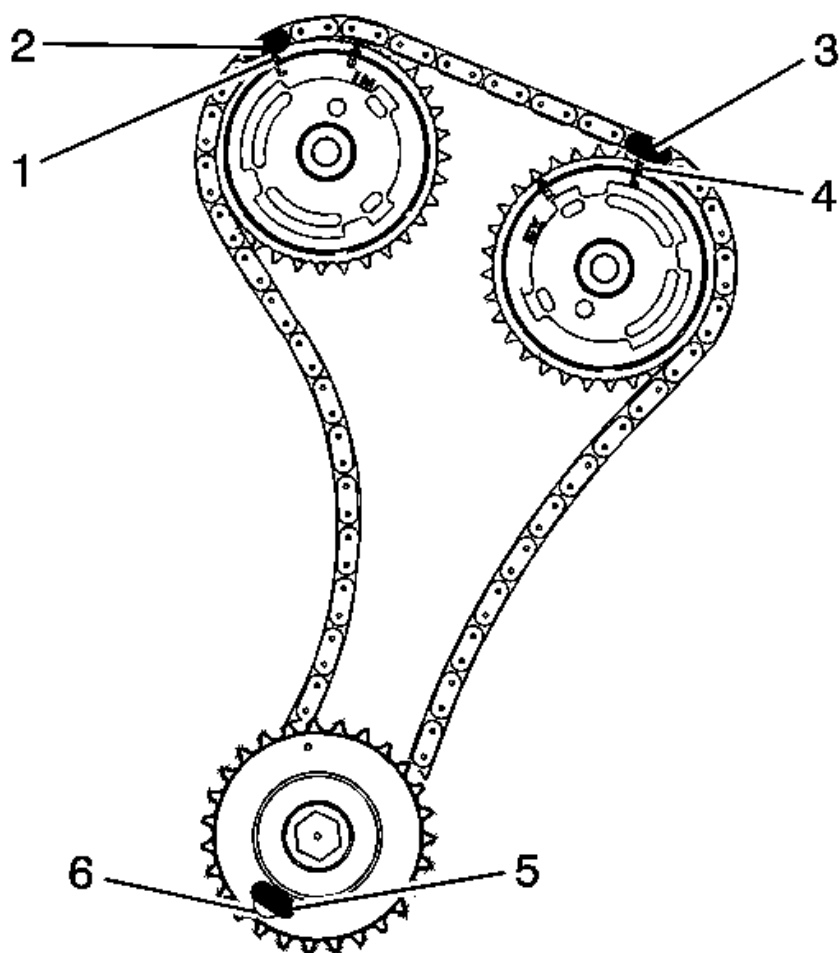


**Fig. 165: Identifying Special Tool - EN 46108**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4).

8. Install the **EN 46108** (1 and 2) in order to retain the timing chain.

Firmly tighten the **EN 46108** nuts.

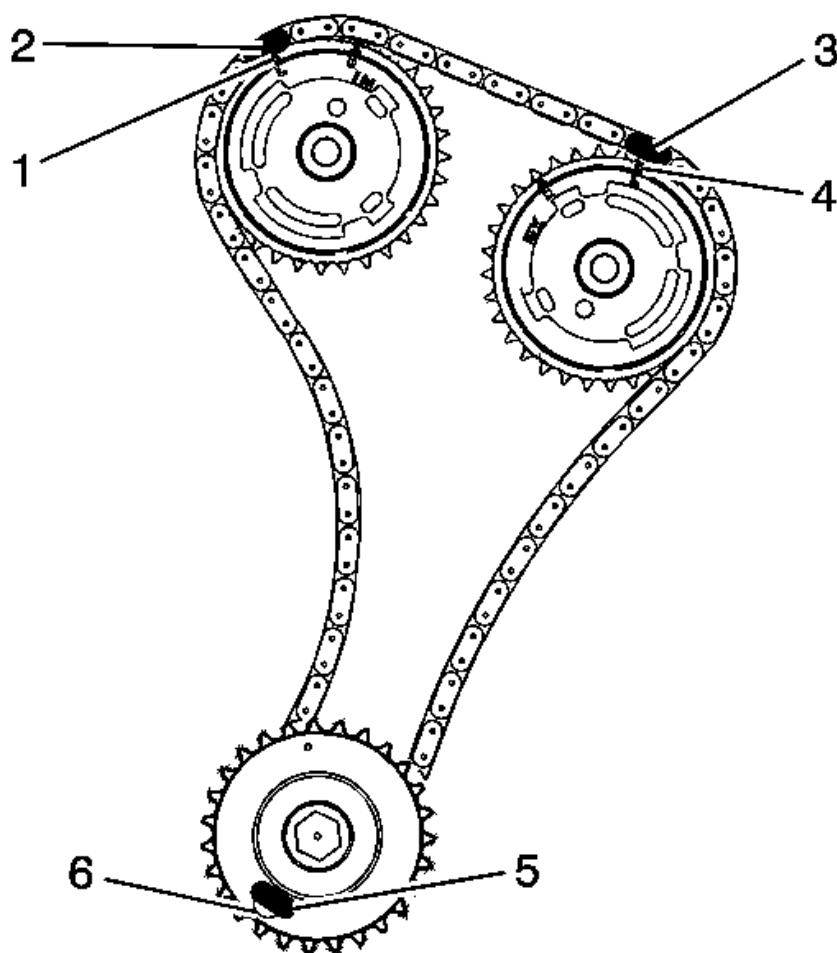


**Fig. 166: Locating Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

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

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

## INSTALLATION PROCEDURE

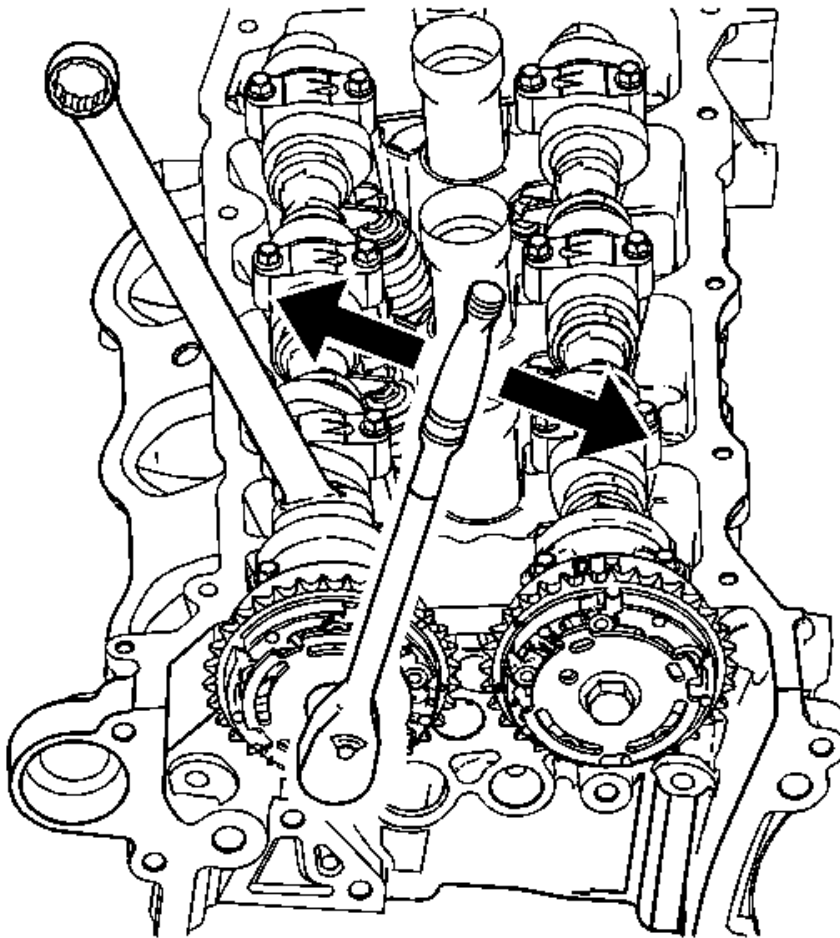


**Fig. 167: Locating Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS CORP.

**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**.



**Fig. 168: Preventing Camshaft/Engine Rotation Using Open-End Wrench**  
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.

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

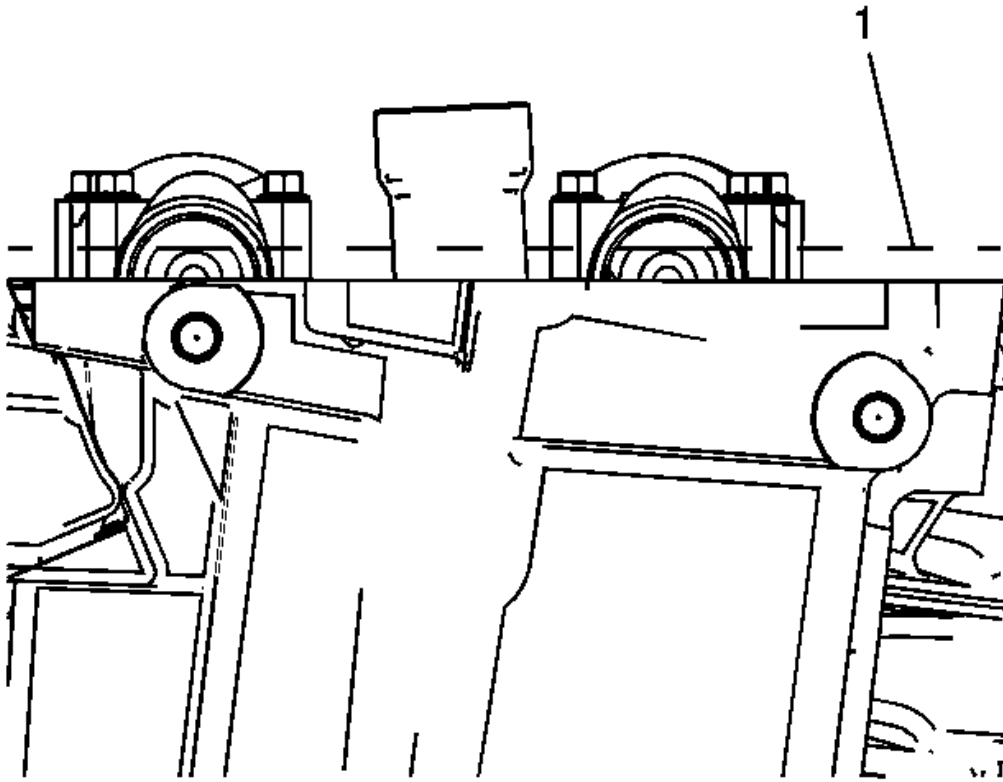
## **CAMSHAFT REPLACEMENT - RIGHT SIDE**

### **SPECIAL TOOLS**

- **EN 46108** Timing Chain Retention Tool
- **EN 46111** Crankshaft Rotation Socket

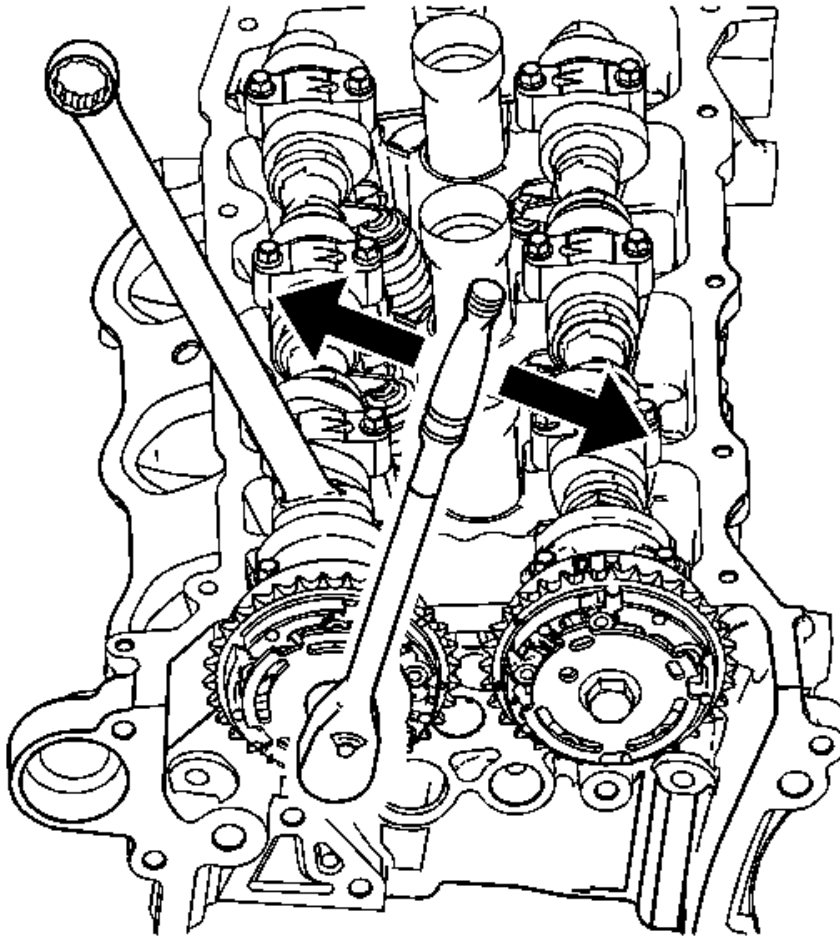
### **REMOVAL PROCEDURE**

1. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
5. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.



**Fig. 169: Identifying Camshaft Neutral (Low Tension) Position**  
Courtesy of GENERAL MOTORS CORP.

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



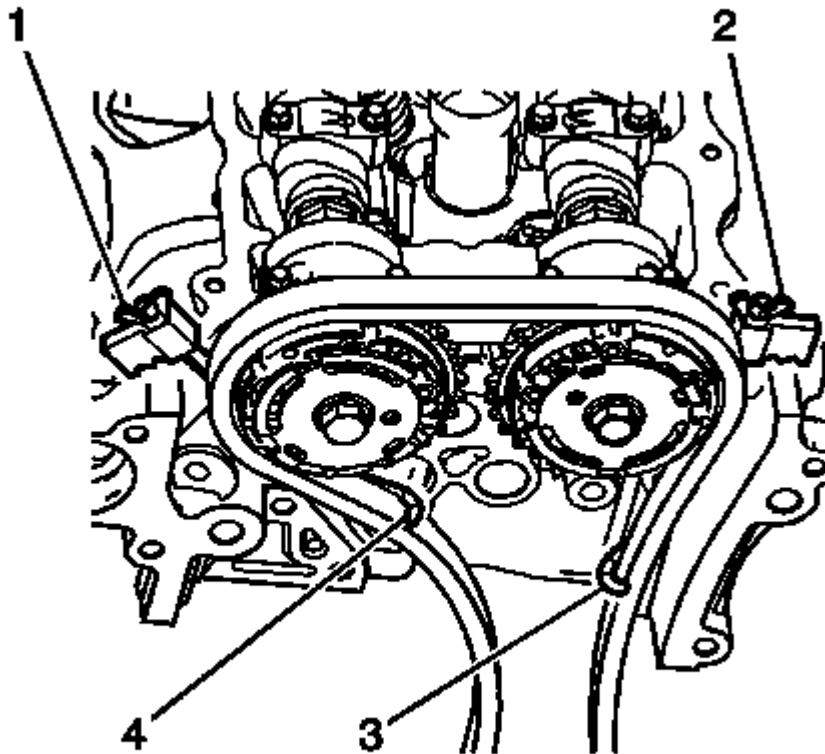
**Fig. 170: Preventing Camshaft/Engine Rotation Using Open-End Wrench**  
Courtesy of GENERAL MOTORS CORP.

**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.

7. Loosen the camshaft position actuator bolt.

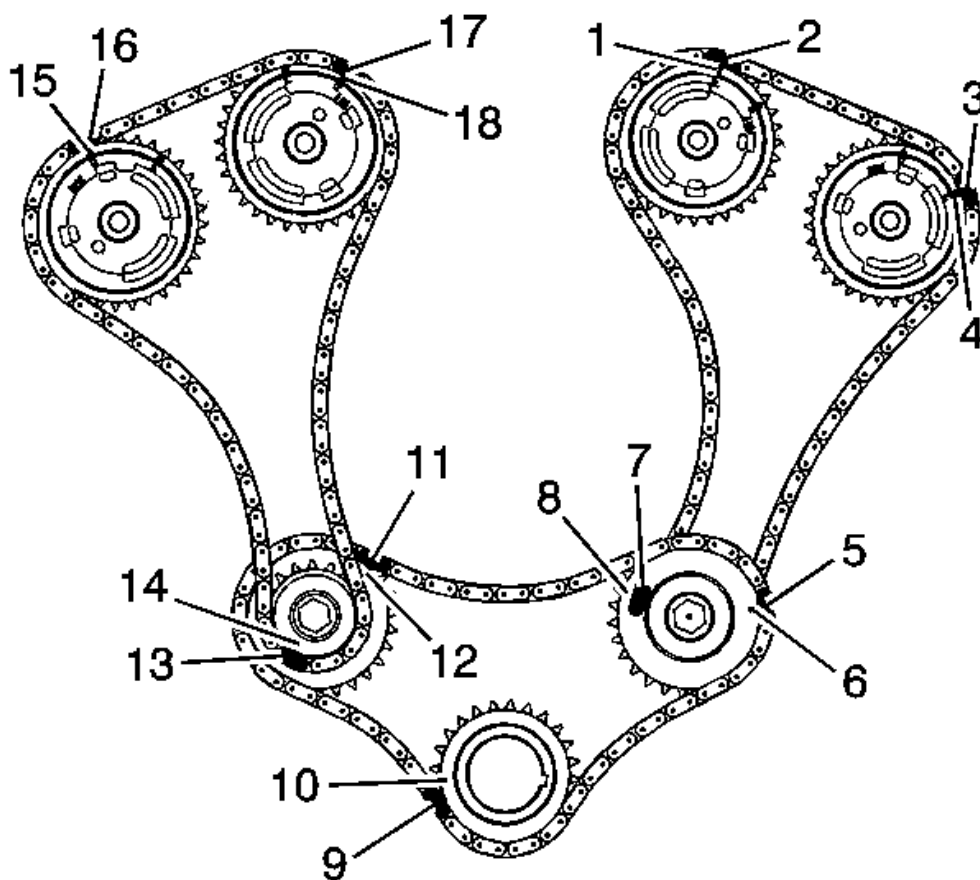


**Fig. 171: Identifying Special Tool - EN 46108**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4).

8. Install the EN 46108 (1 and 2) in order to retain the timing chain.

Firmly tighten the EN 46108 nuts.



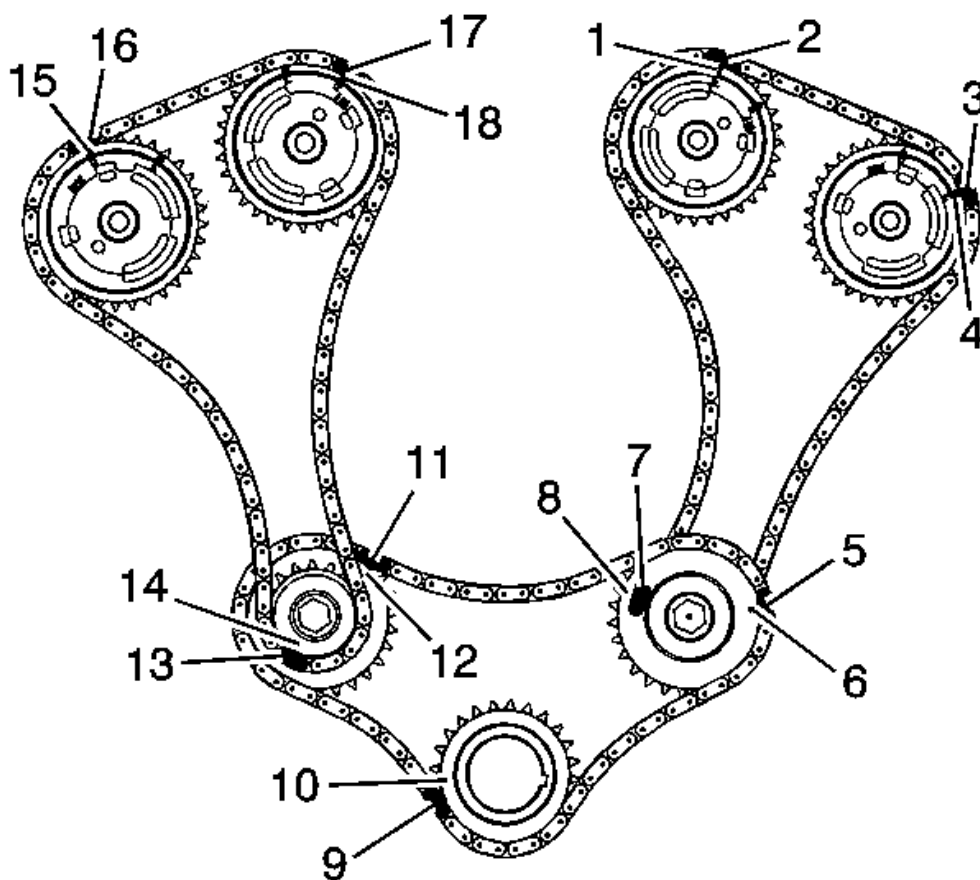
**Fig. 172: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets & Actuators**

Courtesy of GENERAL MOTORS CORP.

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

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

## INSTALLATION PROCEDURE



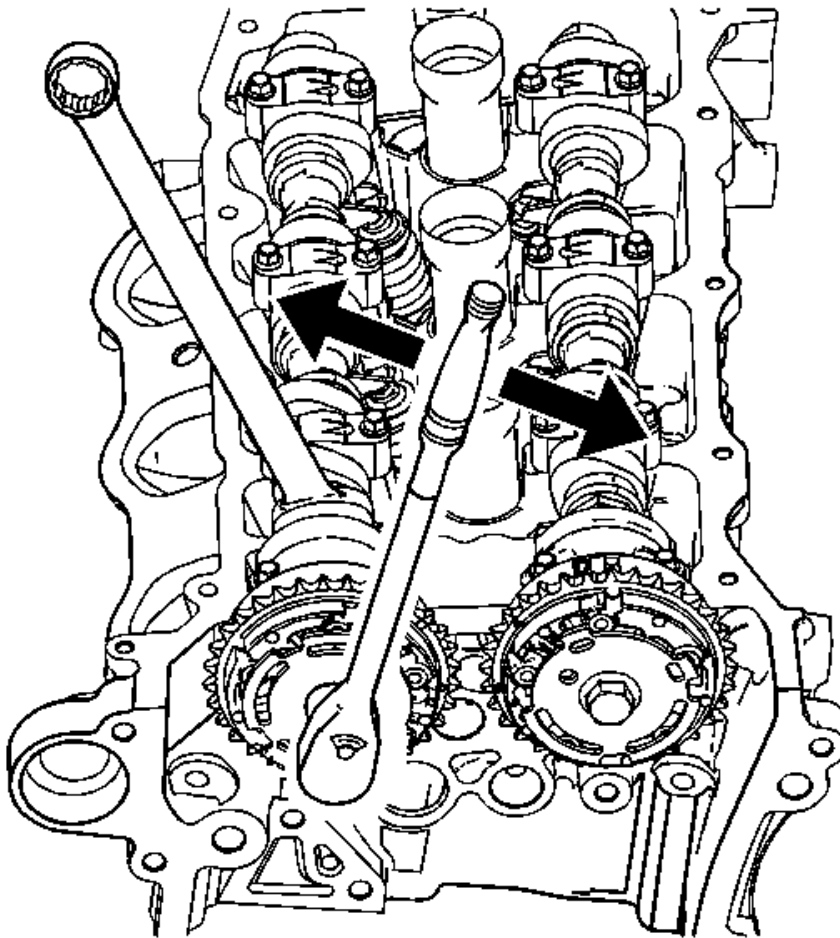
**Fig. 173: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets & Actuators**

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 46108**.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.



**Fig. 174: Preventing Camshaft/Engine Rotation Using Open-End Wrench**  
Courtesy of GENERAL MOTORS CORP.

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

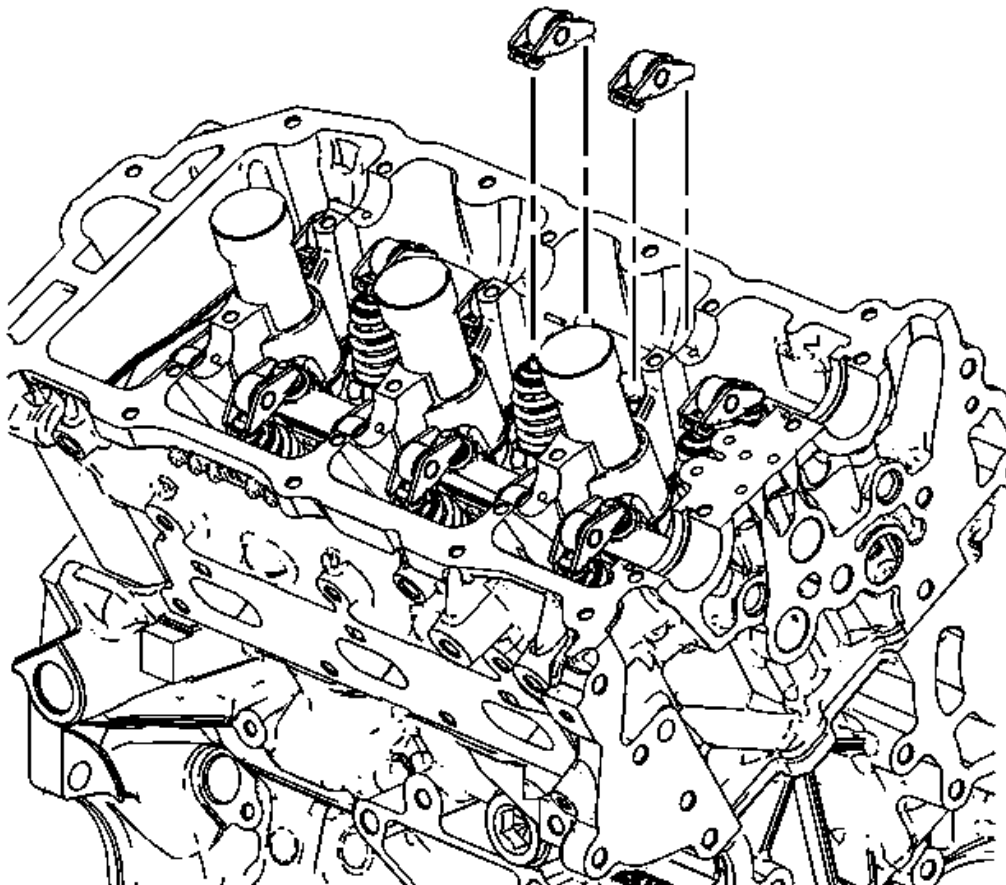
**NOTE:** Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

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.
9. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.

## VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

### REMOVAL PROCEDURE

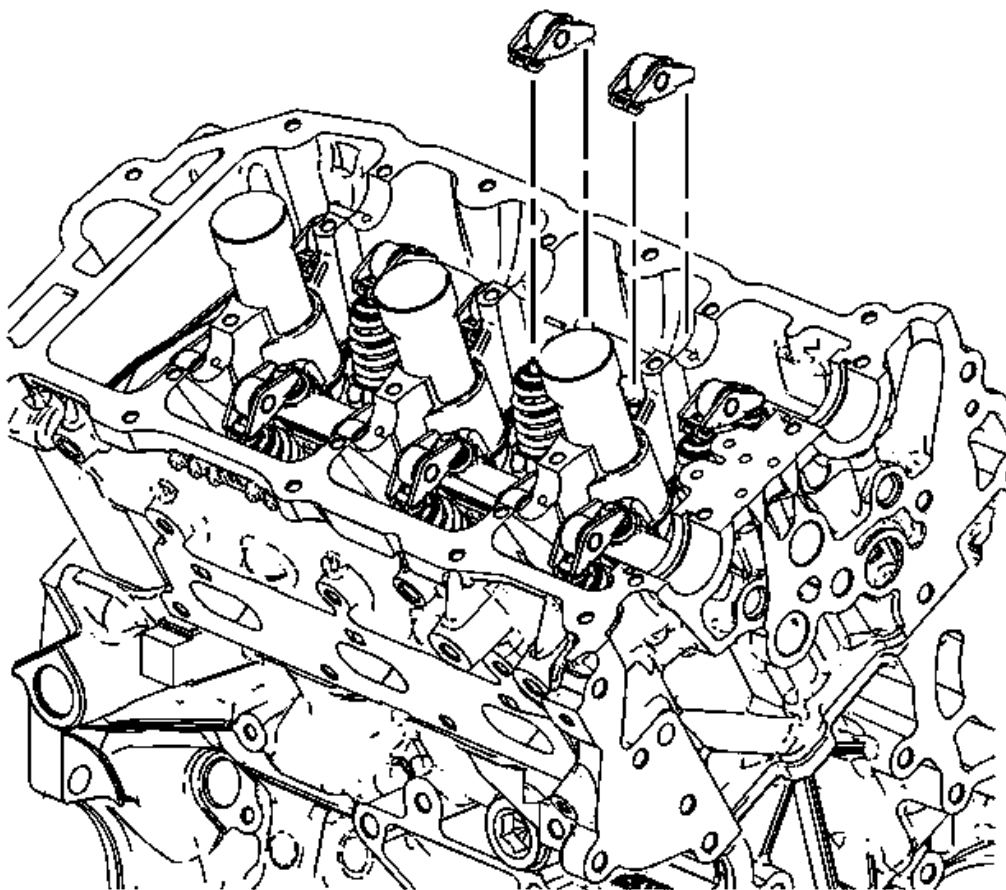
1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.



**Fig. 175: Identifying Valve Rocker Arms**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Left Side.
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



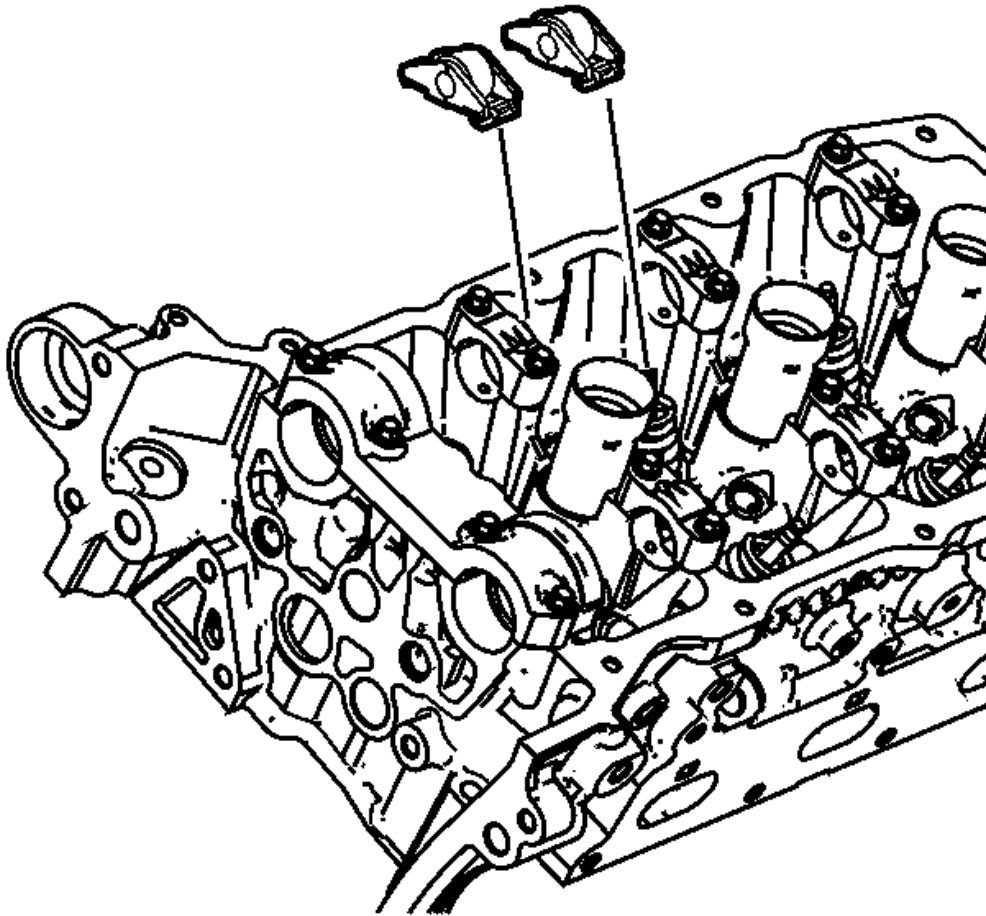
**Fig. 176: Identifying Valve Rocker Arms**  
Courtesy of GENERAL MOTORS CORP.

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

## **VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE**

### **REMOVAL PROCEDURE**

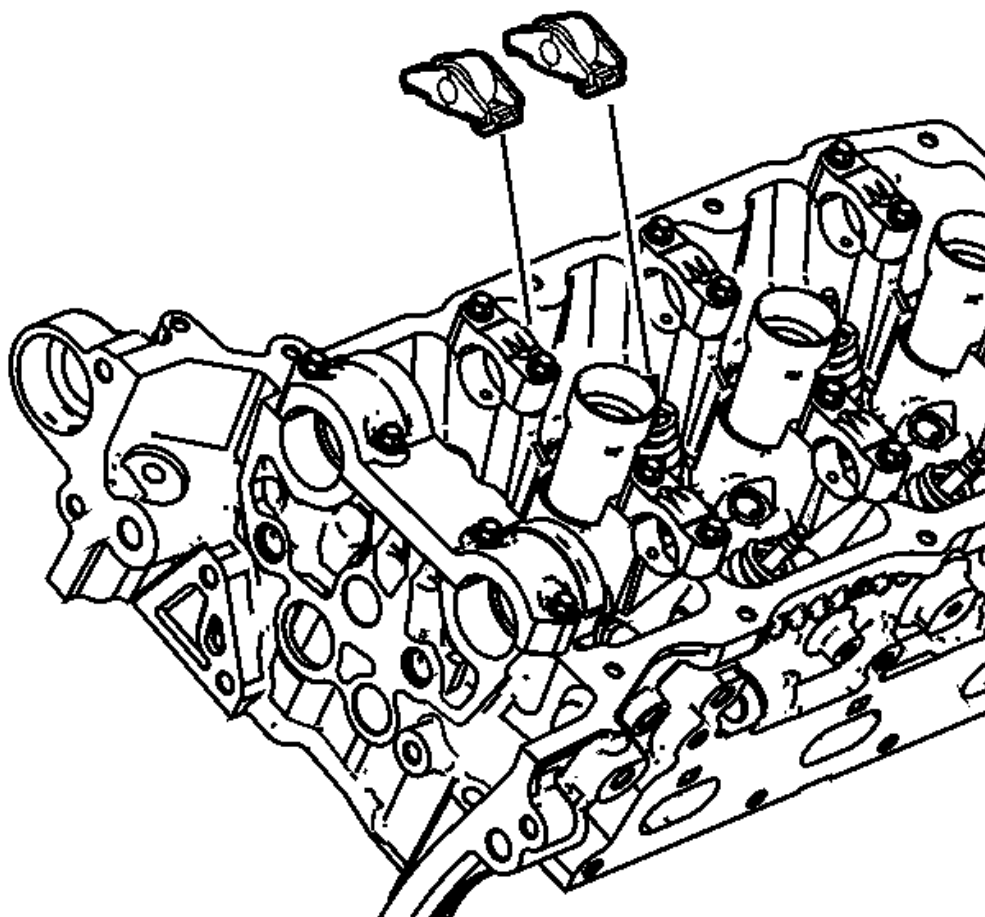
1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Left Side**.



**Fig. 177: View Of Valve Rocker Arm**  
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side** .
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



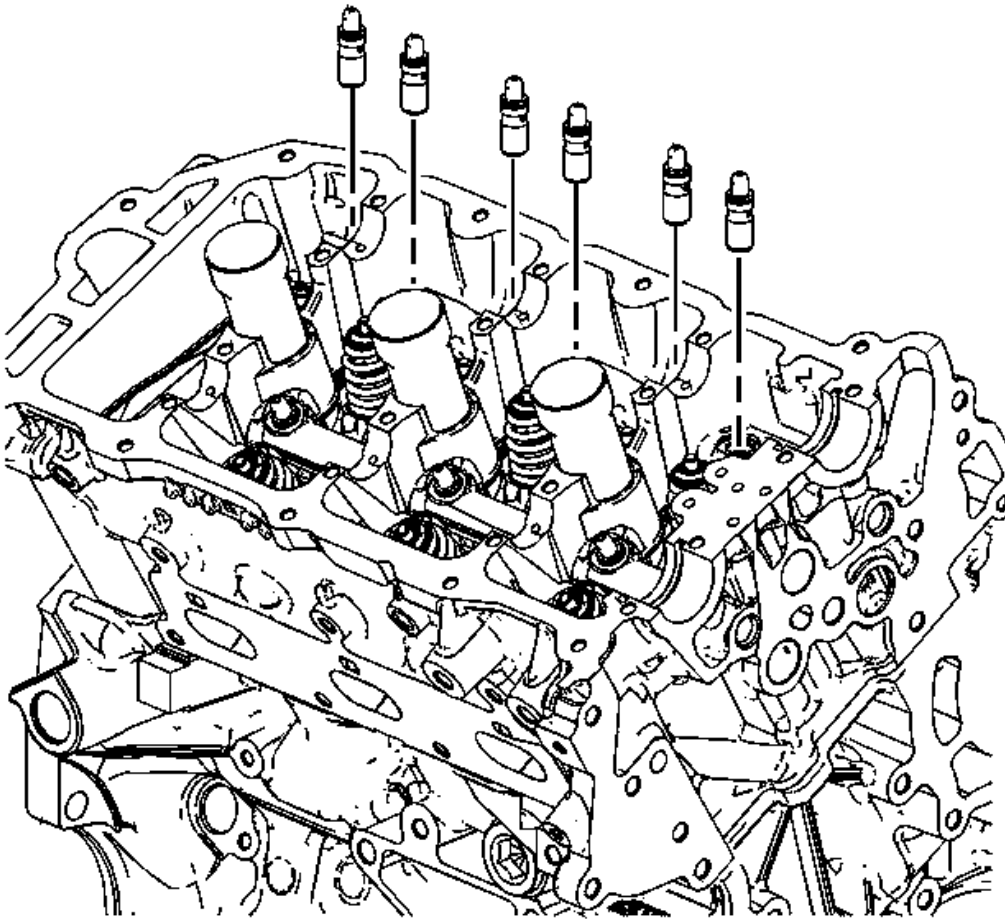
**Fig. 178: View Of Valve Rocker Arm**  
Courtesy of GENERAL MOTORS CORP.

1. Install the rocker arms.
2. Install the applicable camshaft(s). Refer to Valve Rocker Arm Installation - Right Side .

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

### **REMOVAL PROCEDURE**

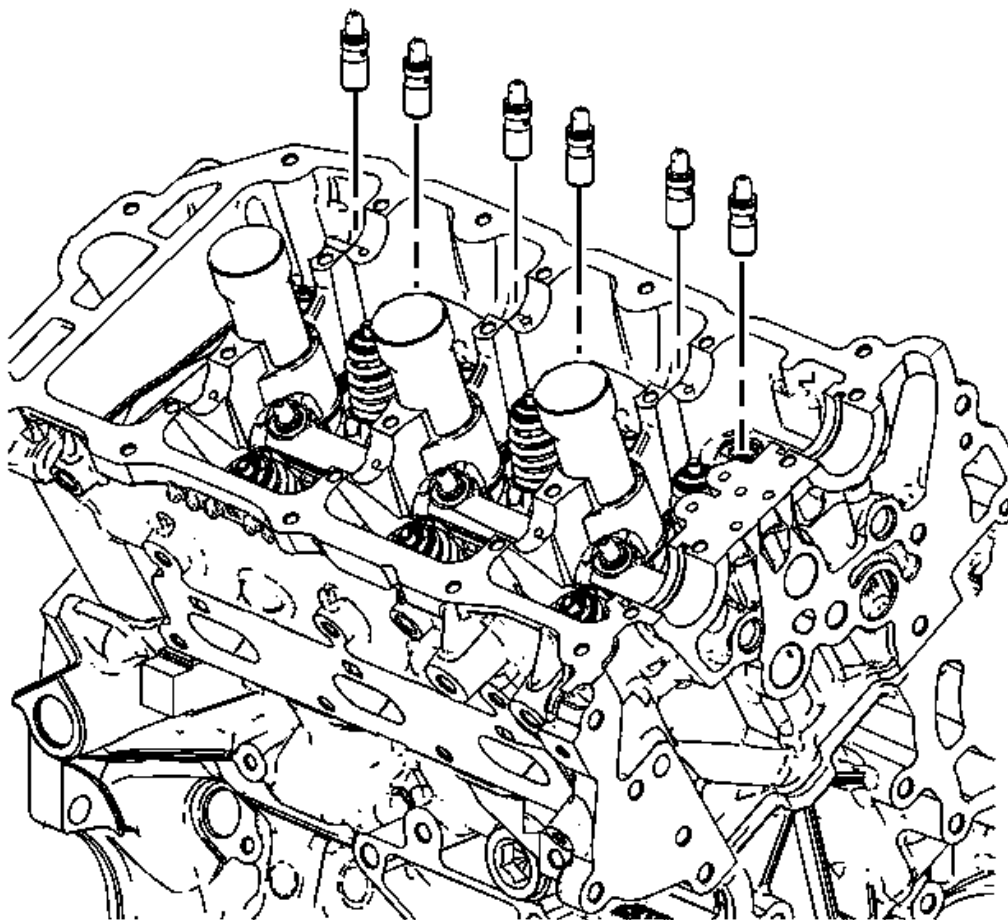
1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Left Side .



**Fig. 179: Identifying Stationary Hydraulic Lash Adjuster (SHLA)**  
Courtesy of GENERAL MOTORS CORP.

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

## INSTALLATION PROCEDURE



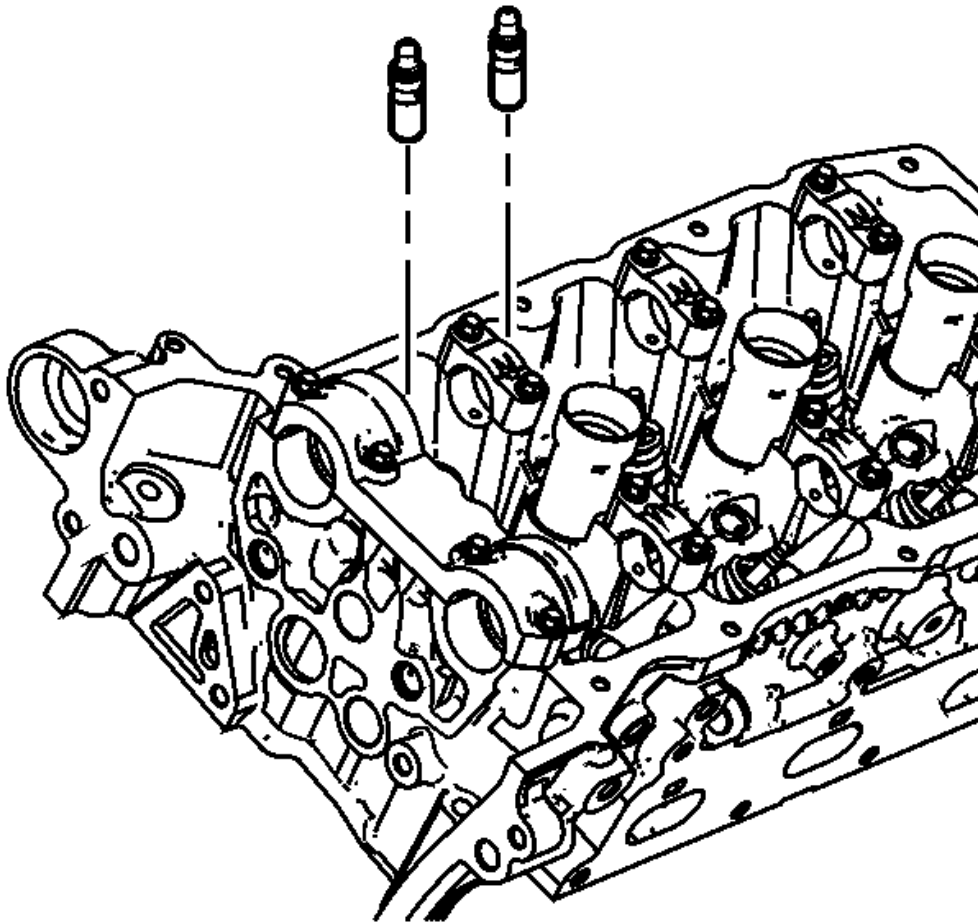
**Fig. 180: Identifying Stationary Hydraulic Lash Adjuster (SHLA)**  
Courtesy of GENERAL MOTORS CORP.

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

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

### **REMOVAL PROCEDURE**

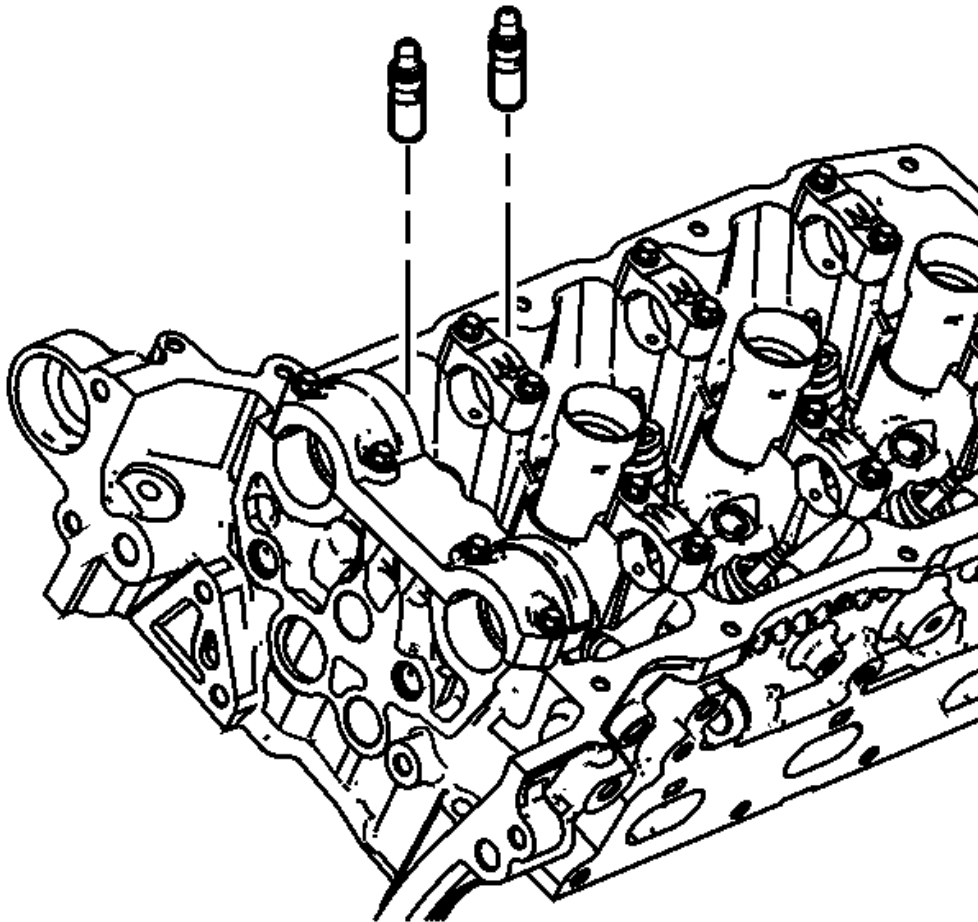
1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Right Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Right Side .



**Fig. 181: View Of Stationary Hydraulic Lash Adjuster (SHLAs)**  
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). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifter Cleaning and Inspection** .

## **INSTALLATION PROCEDURE**



**Fig. 182: View Of Stationary Hydraulic Lash Adjuster (SHLAs)**  
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.

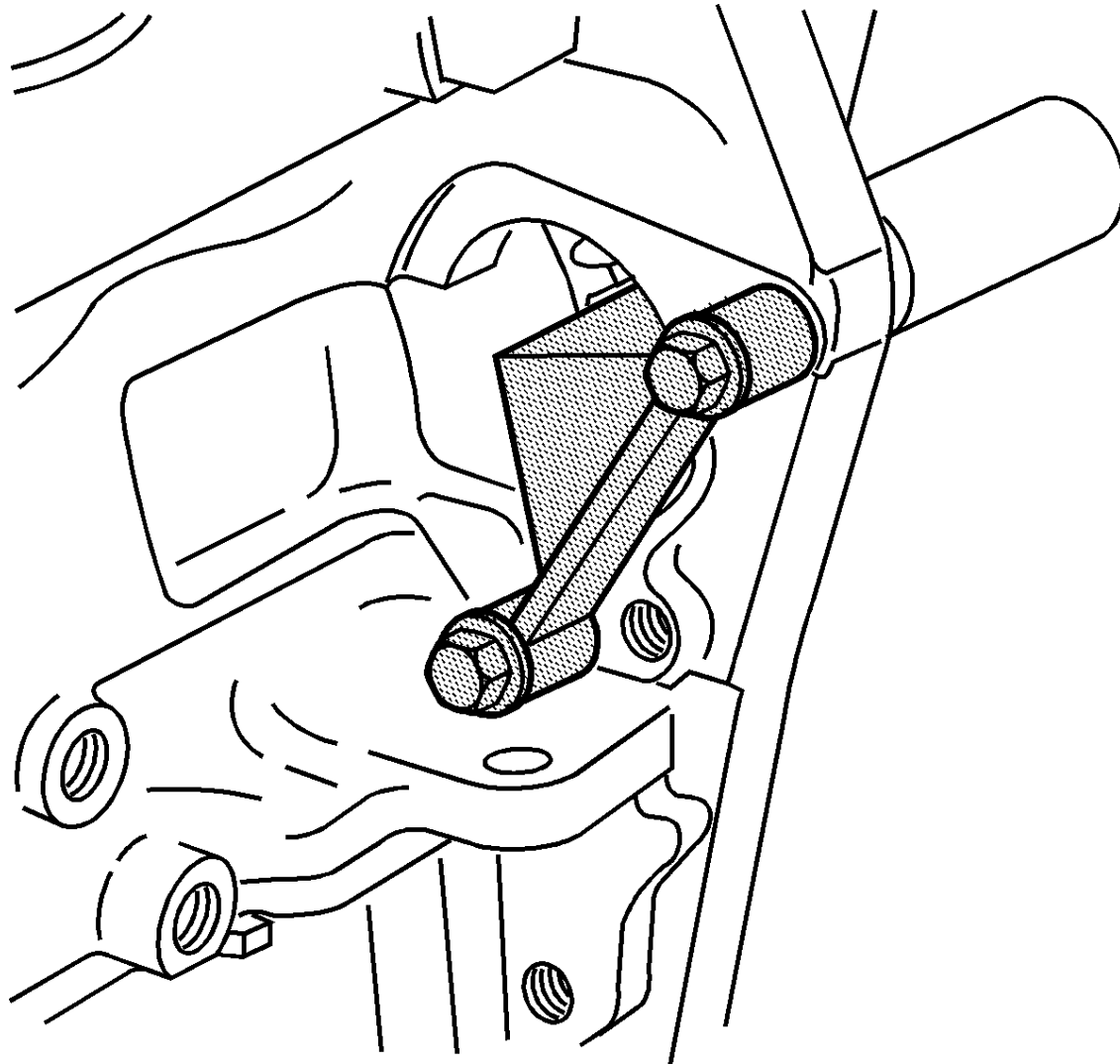
## VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

### SPECIAL TOOLS

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

**REMOVAL PROCEDURE**

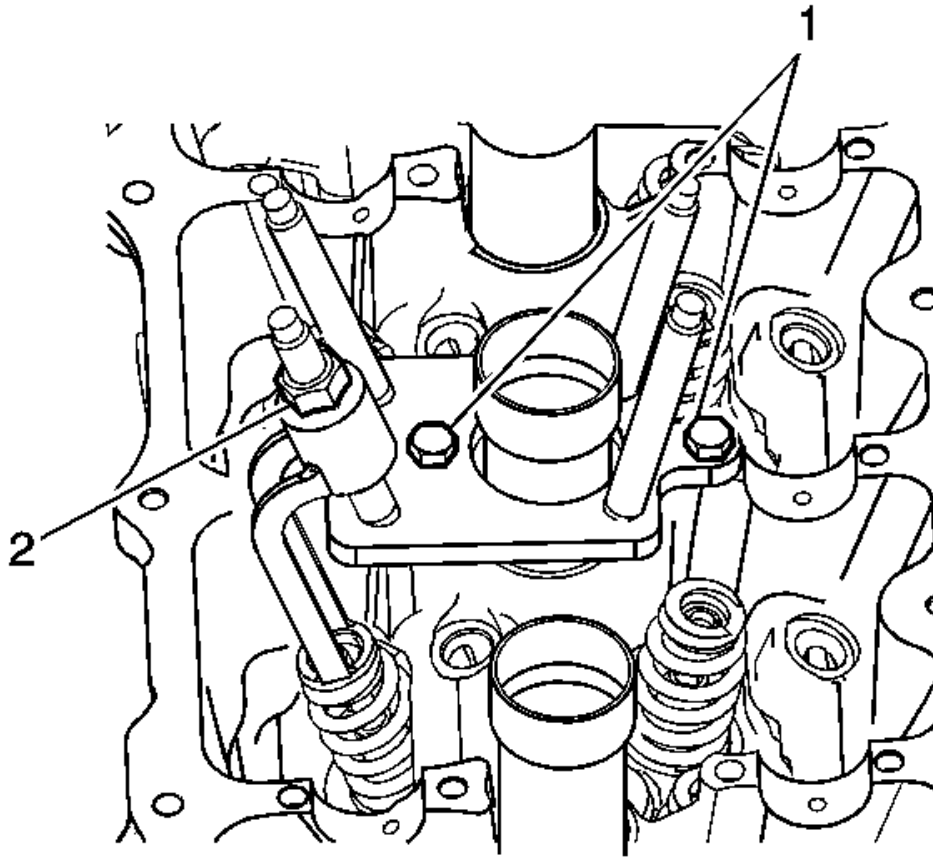
1. Remove the starter motor. Refer to **Starter Replacement (LY7)** .



**Fig. 183: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS CORP.

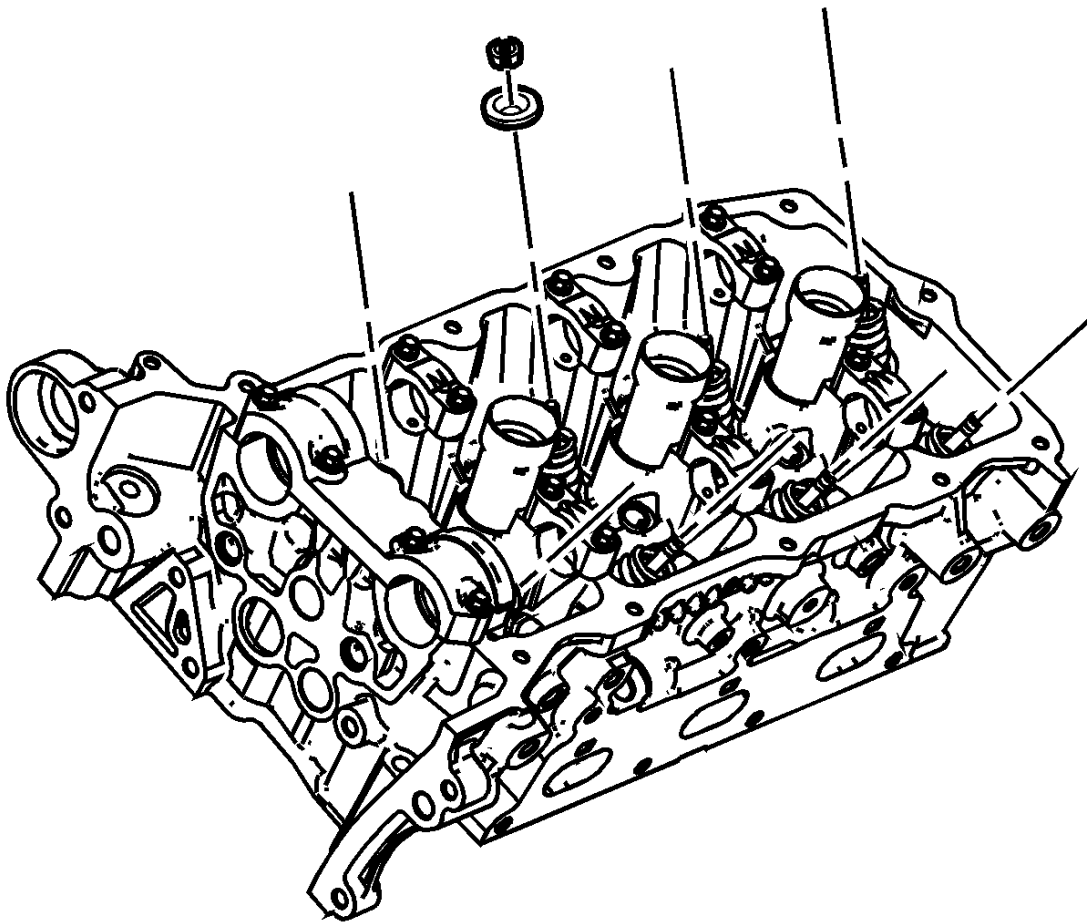
**IMPORTANT:** If the EN 46106 is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required. See **Special Tools** .

2. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Left Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** to the applicable cylinder. See **Special Tools** .
6. Connect the **J 39313** to a compressed air source. See **Special Tools** .



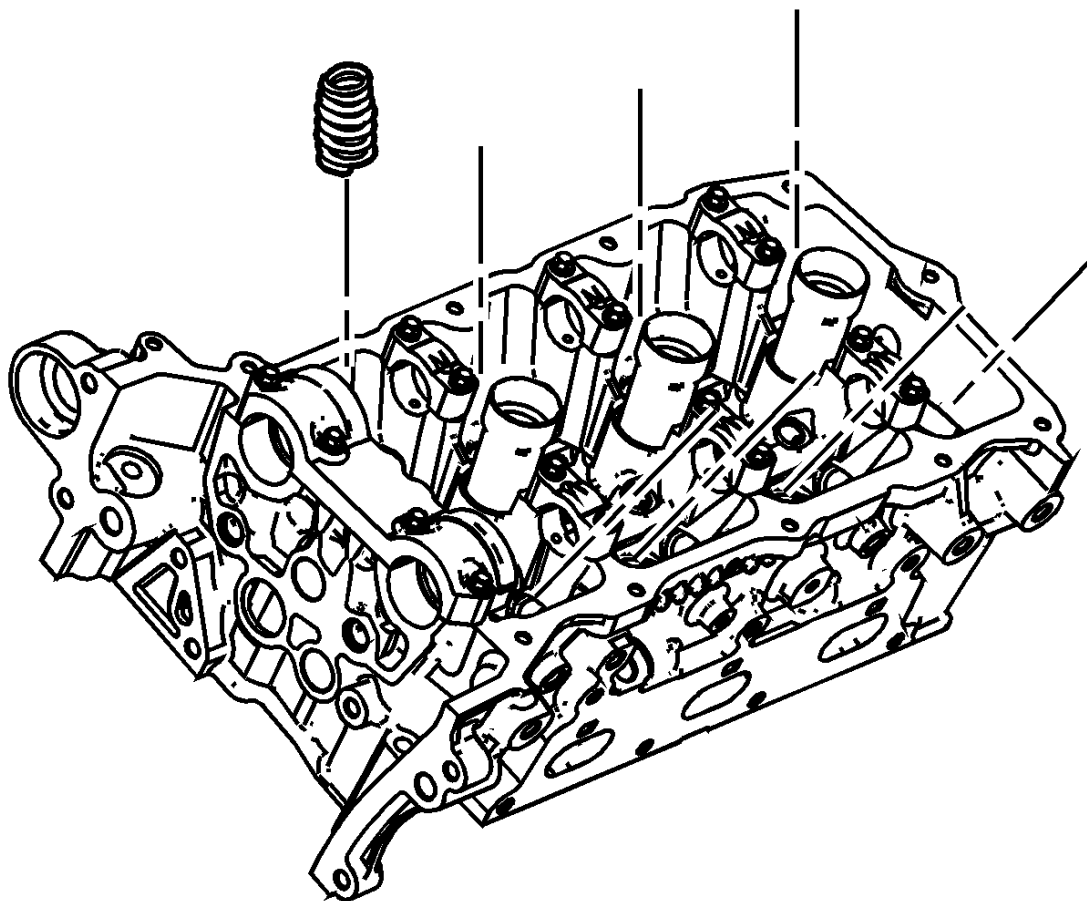
**Fig. 184: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .
8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .



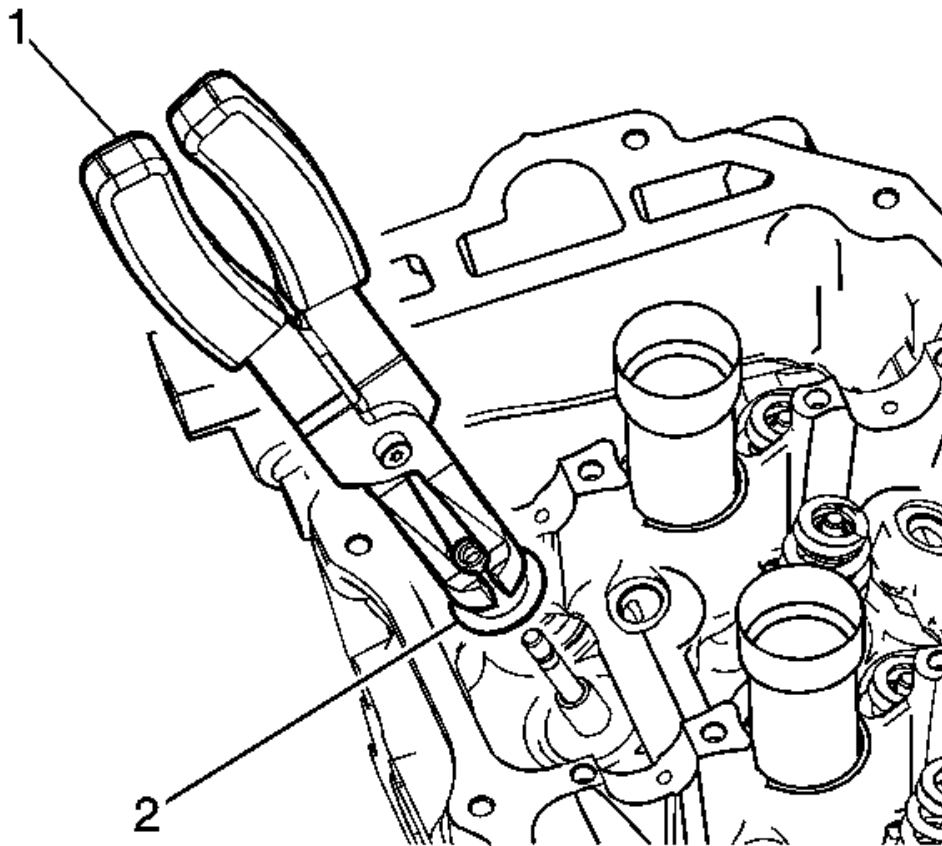
**Courtesy of GENERAL MOTORS CORP.**

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



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

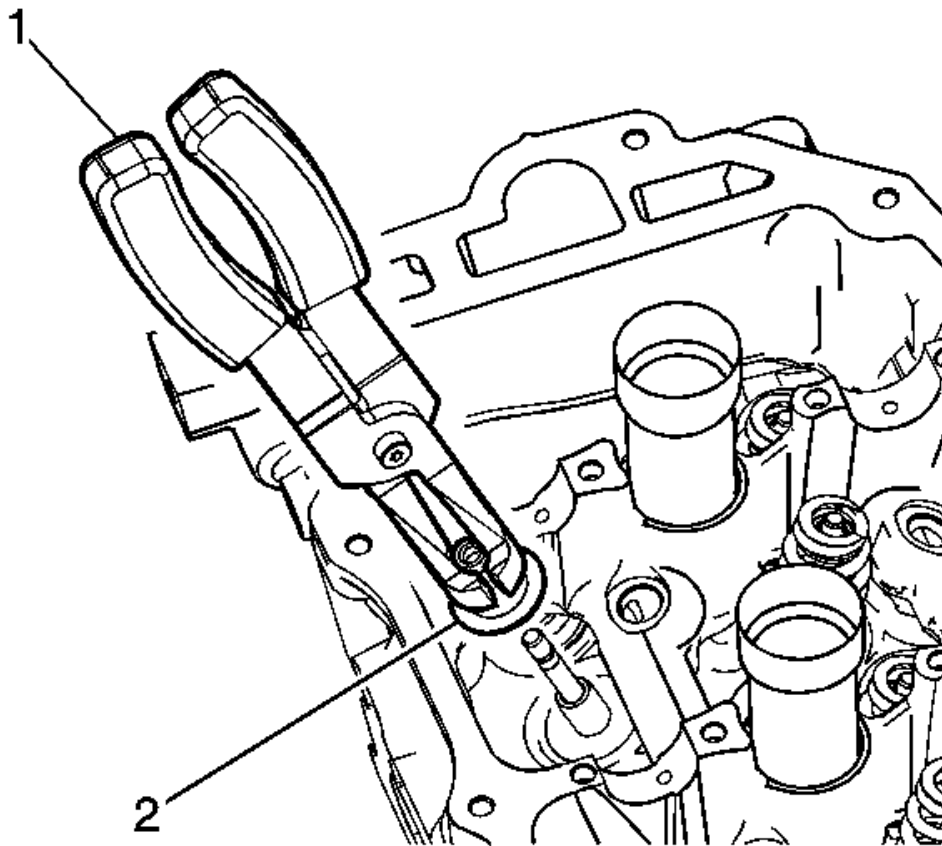
12. Remove the valve spring.



**Fig. 187: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS CORP.

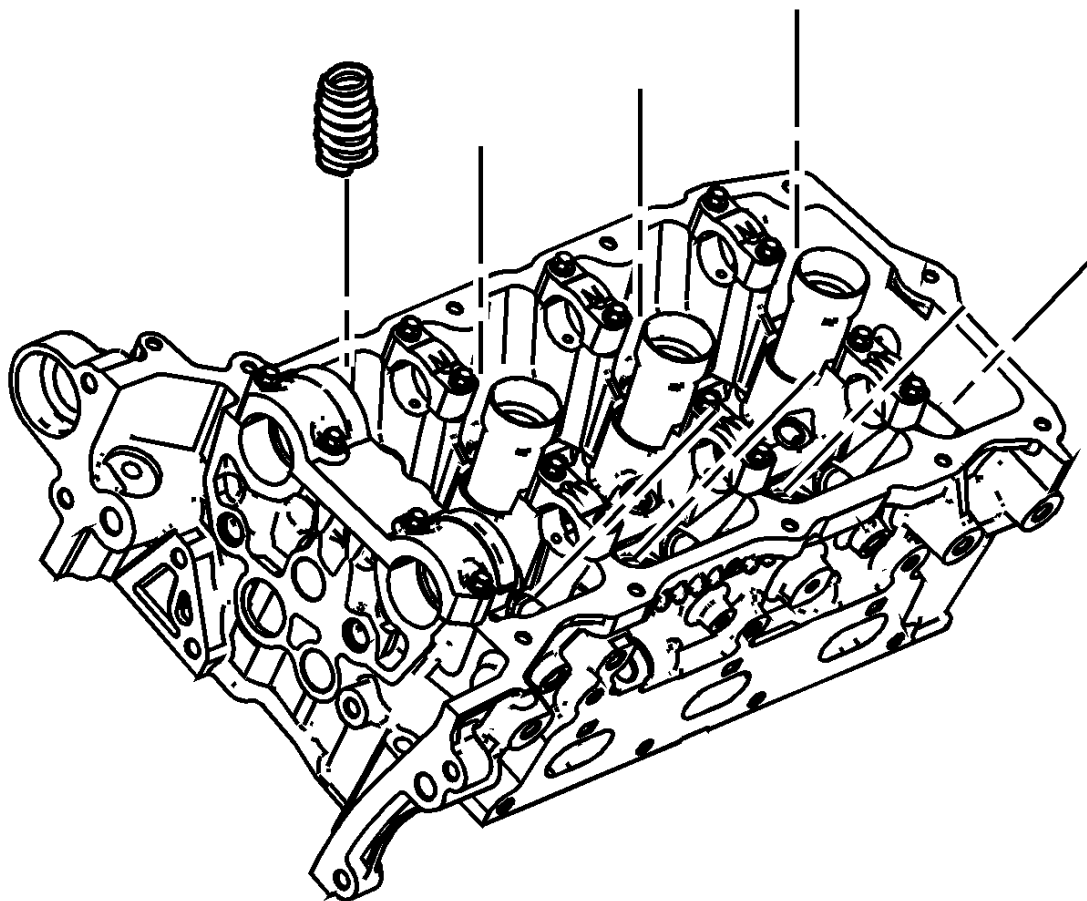
13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

## **INSTALLATION PROCEDURE**



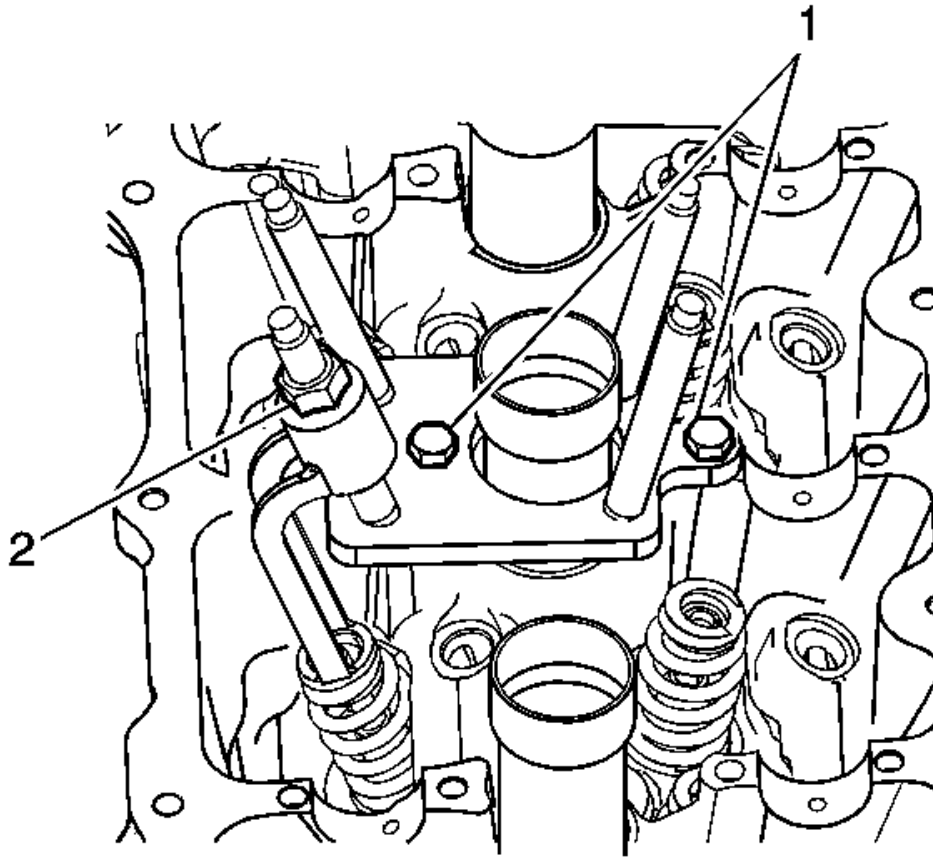
**Fig. 188: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seal (2). See **Special Tools** .



**Fig. 189: View Of Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

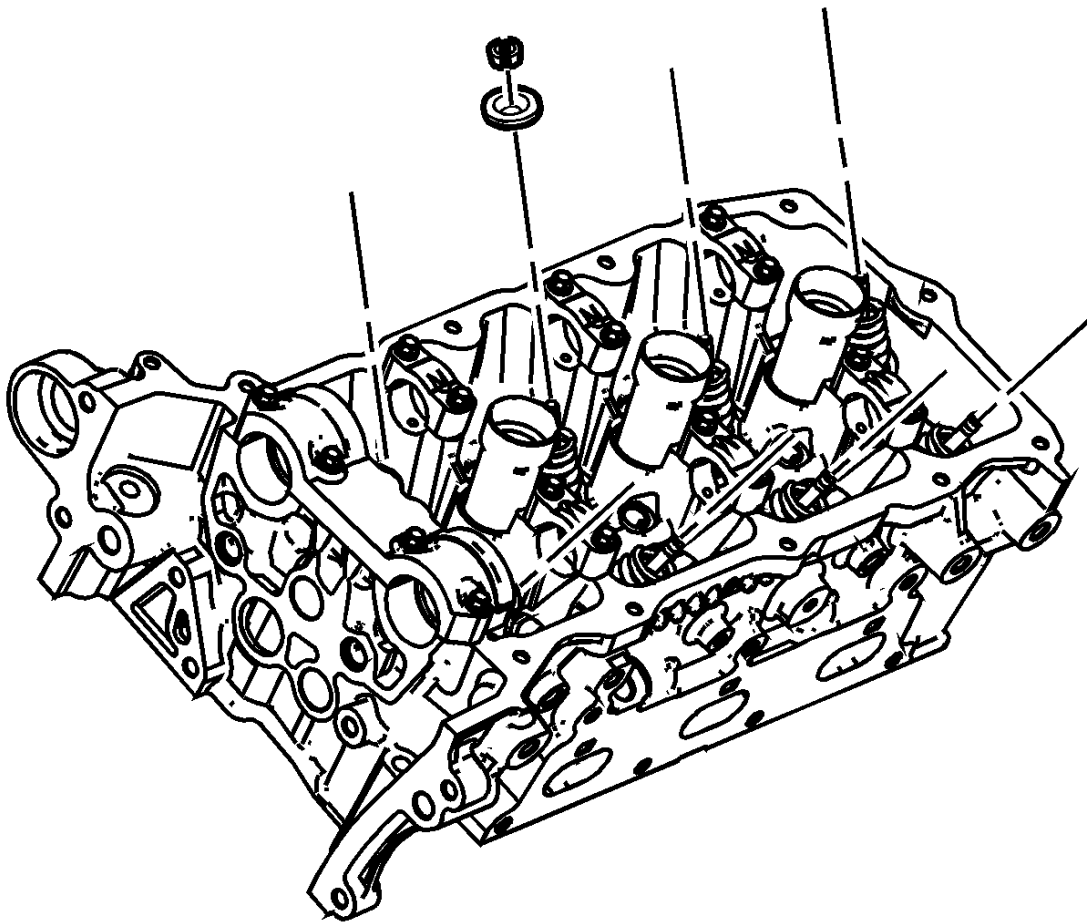
2. Install the valve spring.
3. Install the valve spring retainer.



**Fig. 190: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown. See **Special Tools** .

Tighten the **EN 46110** valve spring compressor nut (2).



**Fig. 191: View Of Valve Spring Keepers**  
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See **Special Tools** .
7. Disconnect the **J 39313** from the compressed air source. See **Special Tools** .
8. Remove the **J 39313** . See **Special Tools** .
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms and camshafts. Refer to **Camshaft Replacement - Left Side**.
11. Remove the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
12. Install the starter motor. Refer to **Starter Replacement (LY7)** .

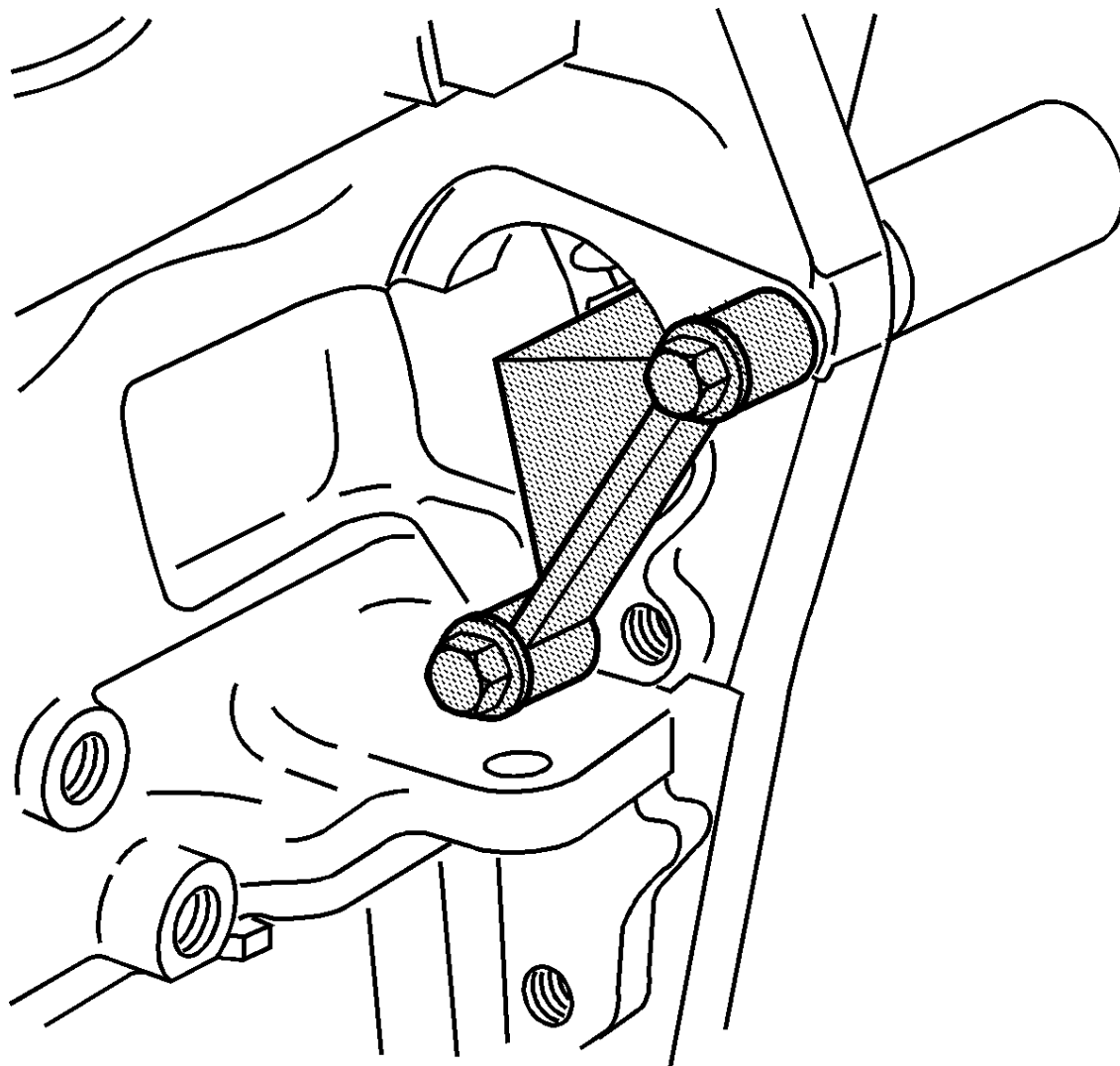
## VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

### SPECIAL TOOLS

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

## REMOVAL PROCEDURE

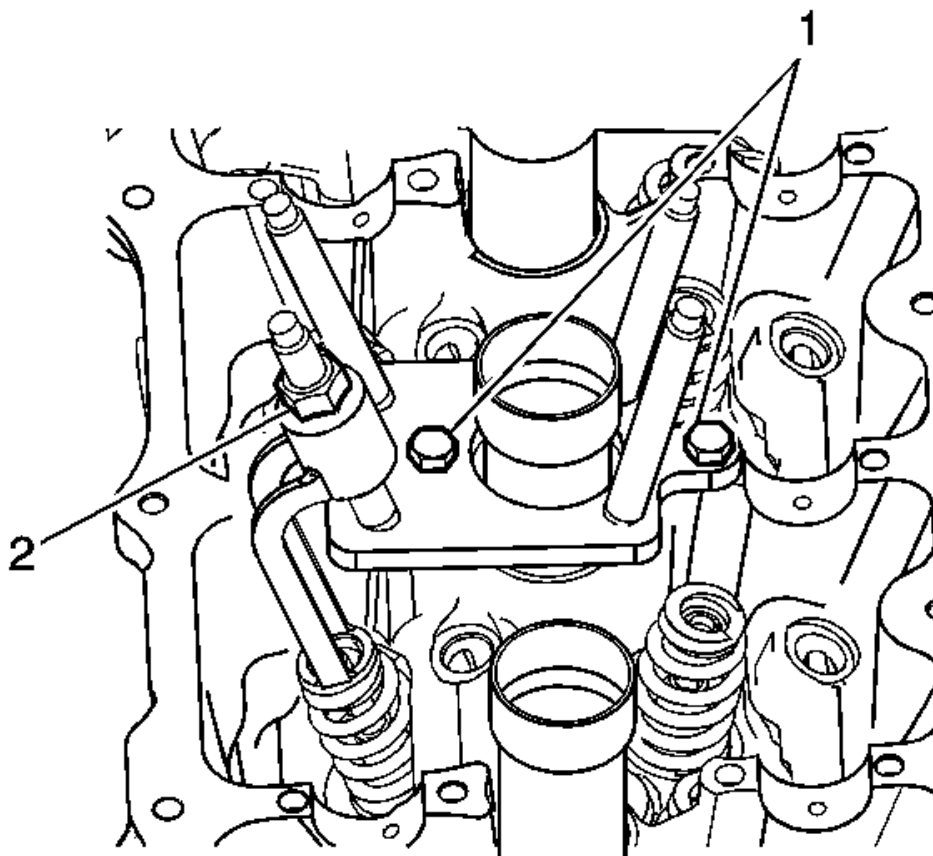
1. Remove the starter motor. Refer to Starter Replacement (LY7) .



**Fig. 192: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS CORP.

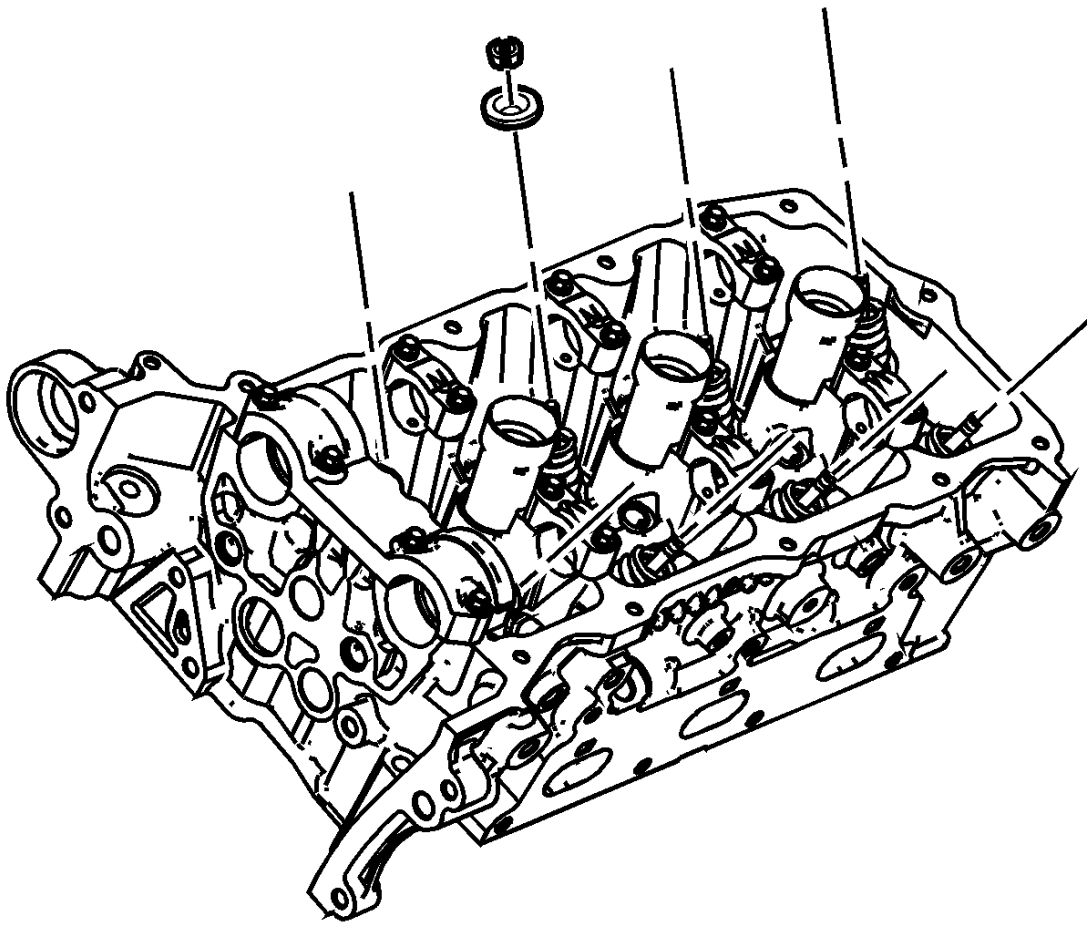
**IMPORTANT:** If the EN 46106 is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required. See Special Tools .

2. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Right Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** to the applicable cylinder. See **Special Tools** .
6. Connect the **J 39313** to a compressed air source. See **Special Tools** .



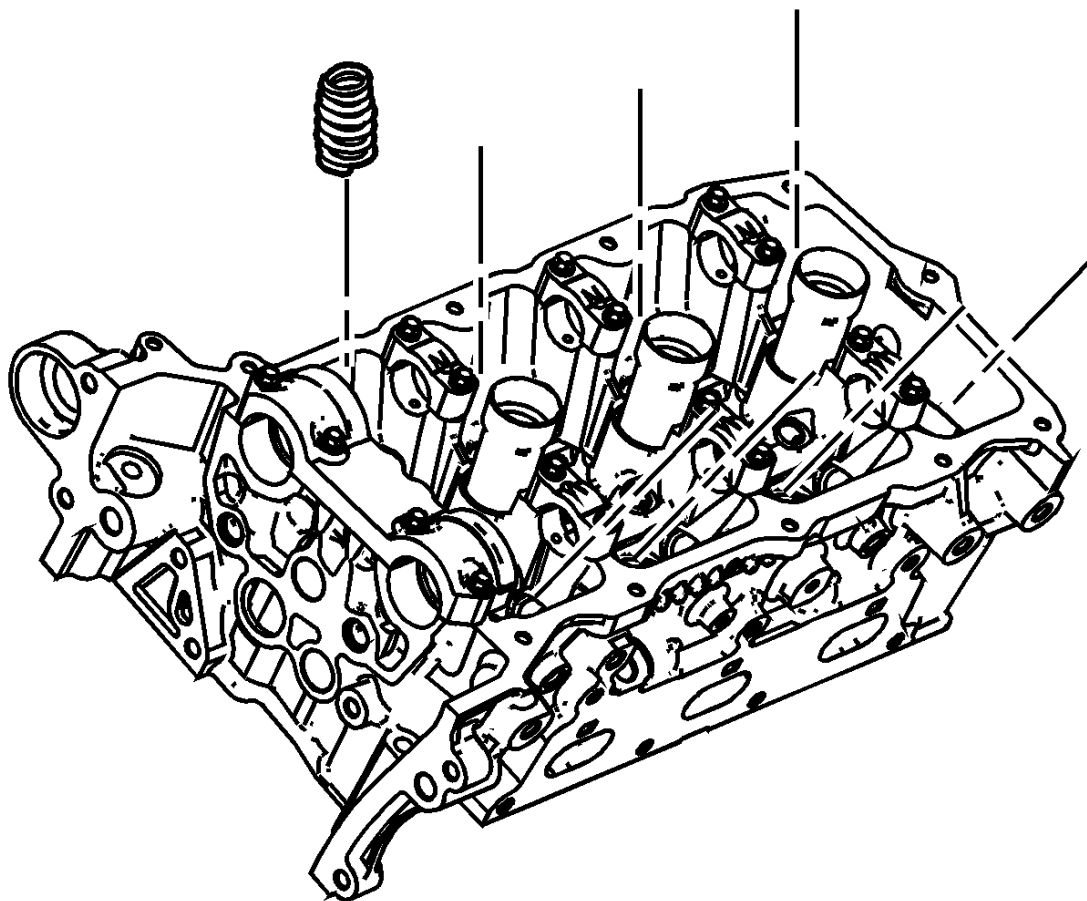
**Fig. 193: View Of Installed Valve Spring Compressor Tool**  
 Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .
8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .



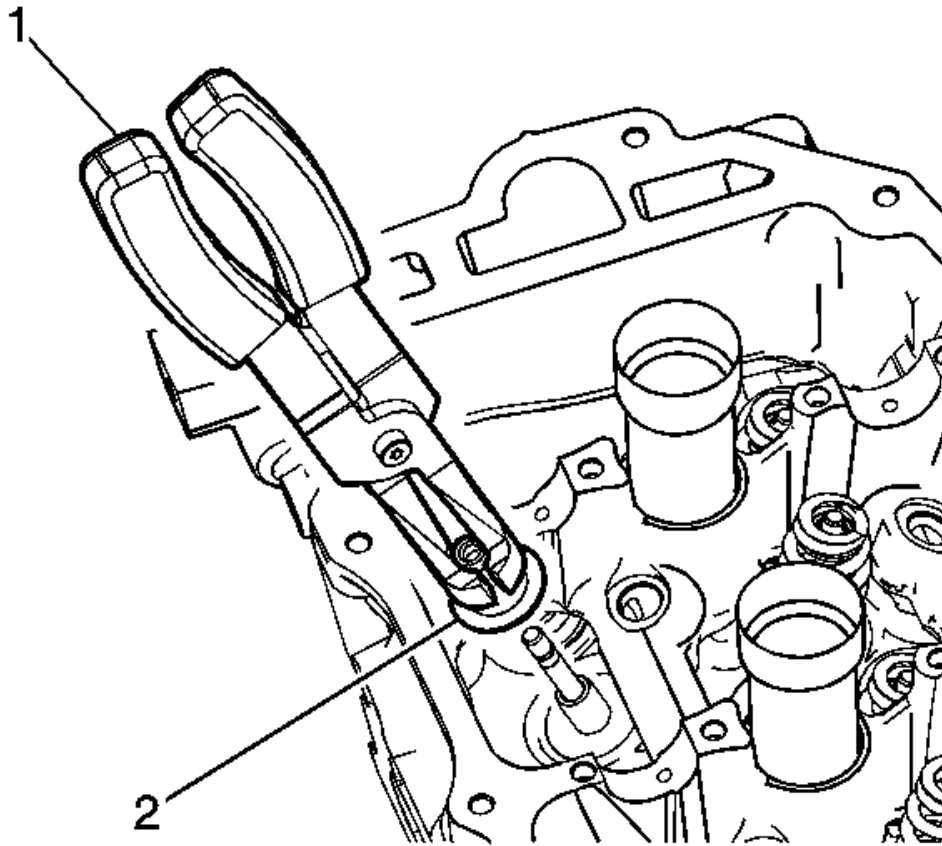
**Fig. 194: View Of Valve Spring Keepers**  
 Courtesy of GENERAL MOTORS CORP.

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



**Fig. 195: View Of Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

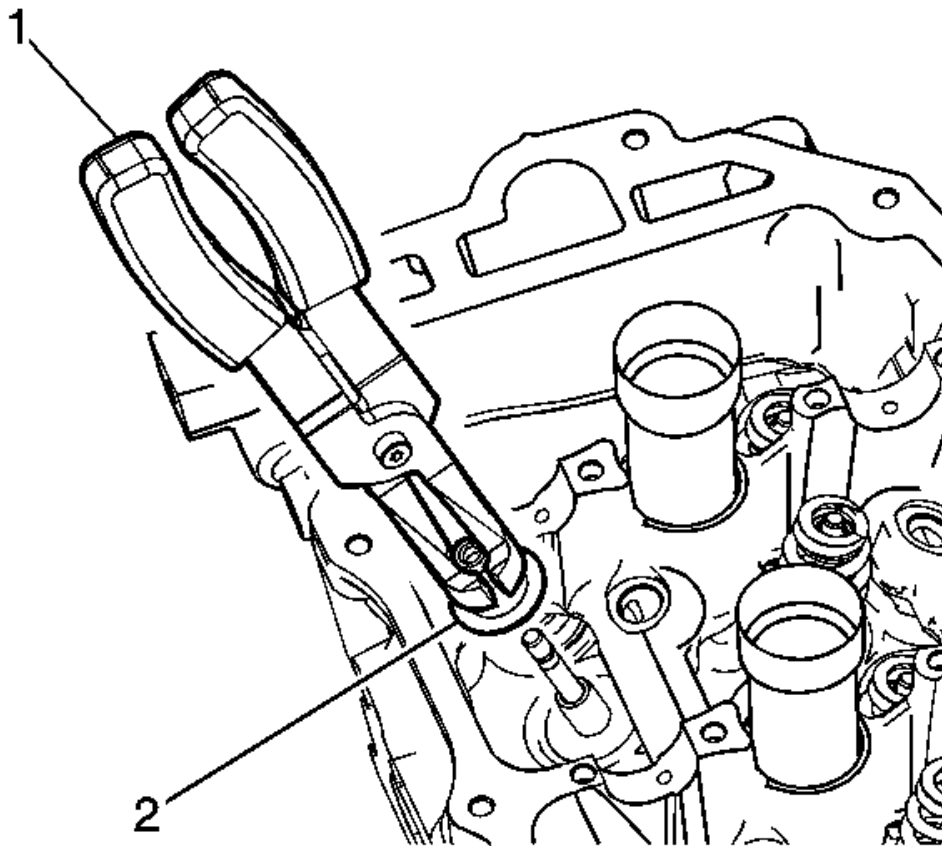
12. Remove the valve springs.



**Fig. 196: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS CORP.

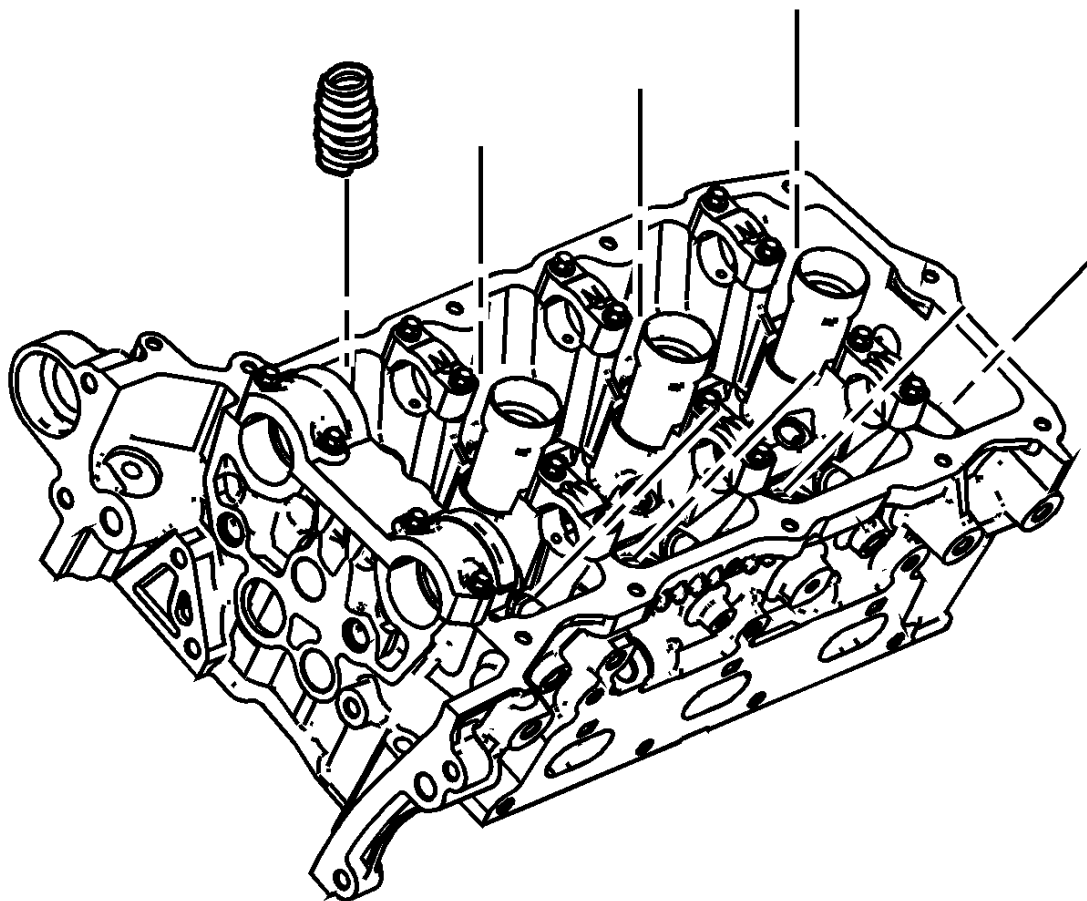
13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

## **INSTALLATION PROCEDURE**



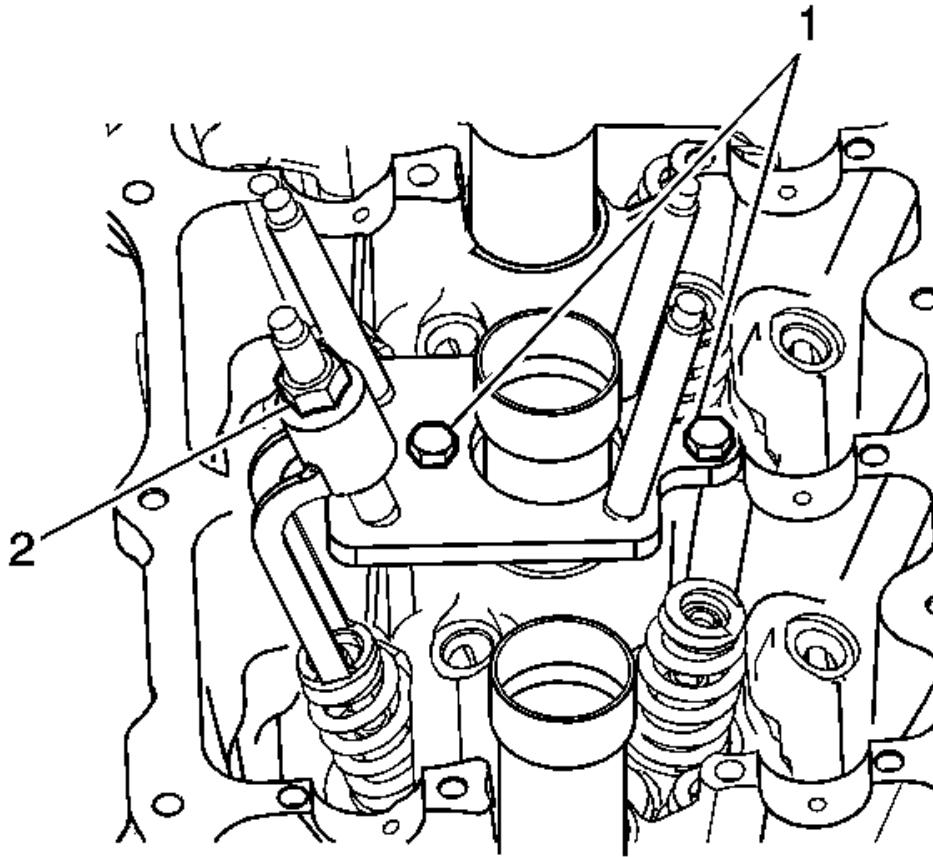
**Fig. 197: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seals (2). See **Special Tools** .



**Fig. 198: View Of Valve Spring**  
Courtesy of GENERAL MOTORS CORP.

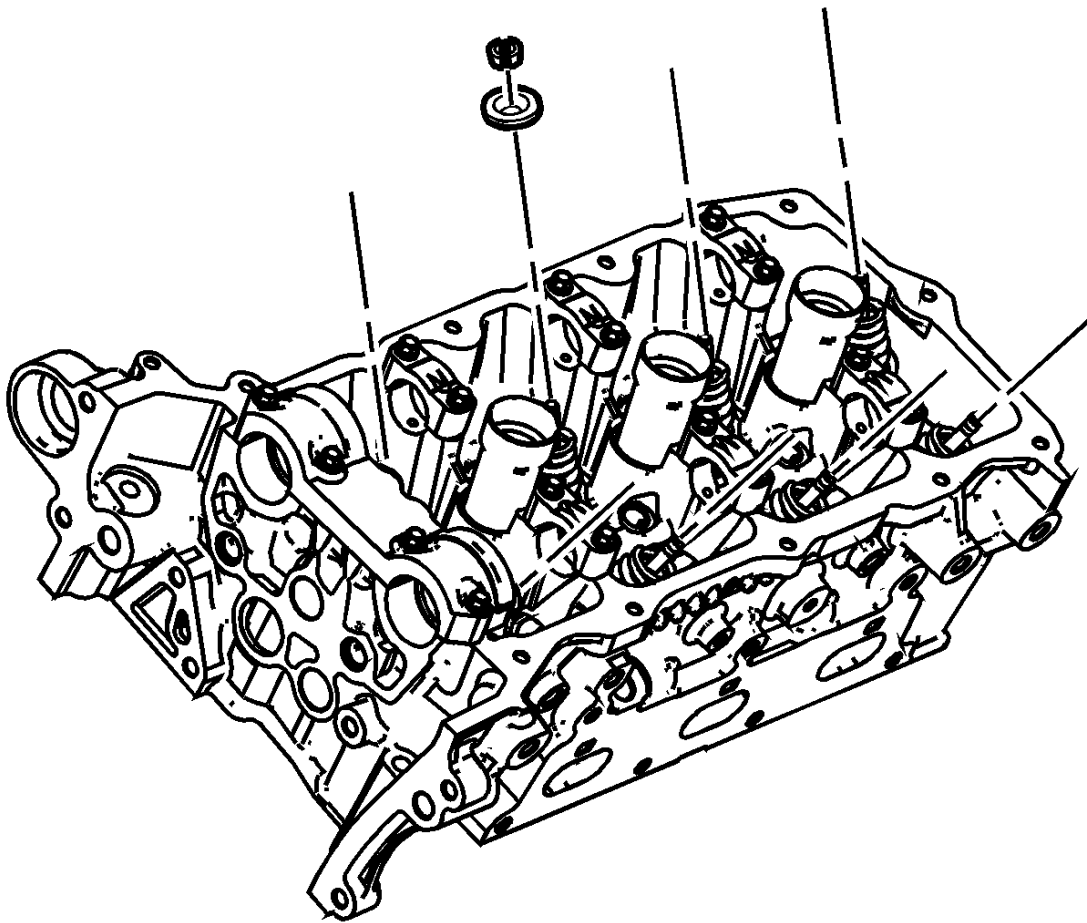
2. Install the valve spring.
3. Install the valve spring retainer.



**Fig. 199: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown. See **Special Tools** .

Tighten the **EN 46110** valve spring compressor nut (2).



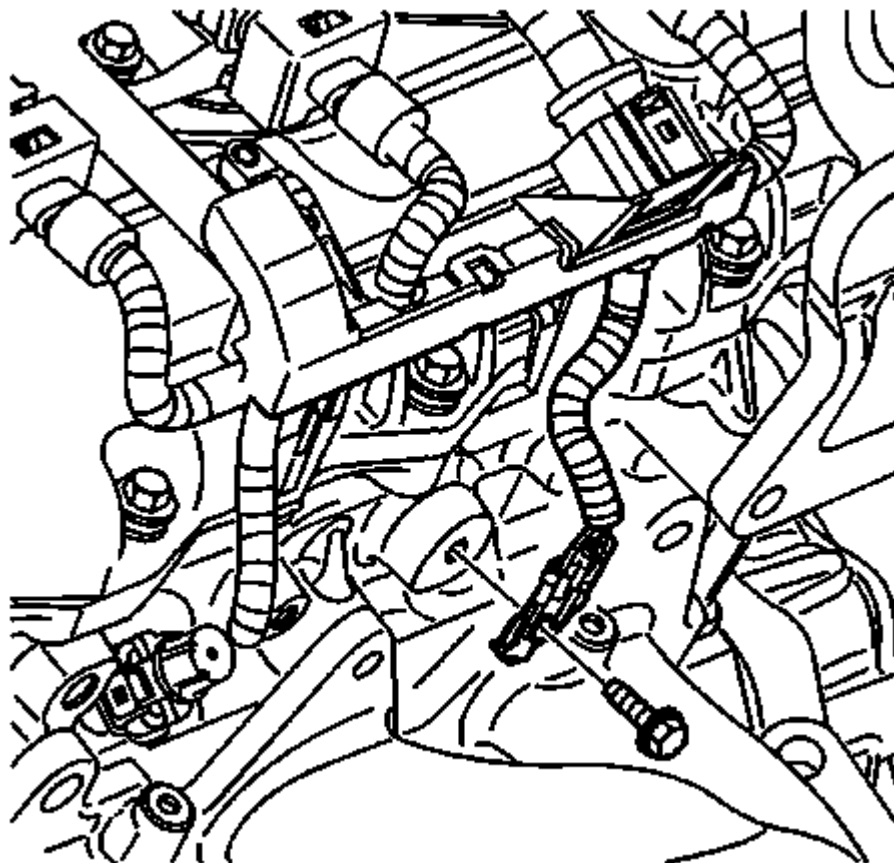
**Fig. 200: View Of Valve Spring Keepers**  
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See Special Tools .
7. Disconnect the **J 39313** from the compressed air source.
8. Remove the **J 39313** .
9. Install the spark plugs. Refer to Spark Plug Replacement .
10. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Right Side.
11. Remove the **EN 46106** . See Special Tools .
12. Install the starter motor. Refer to Starter Replacement (LY7) .

## CYLINDER HEAD REPLACEMENT - LEFT SIDE

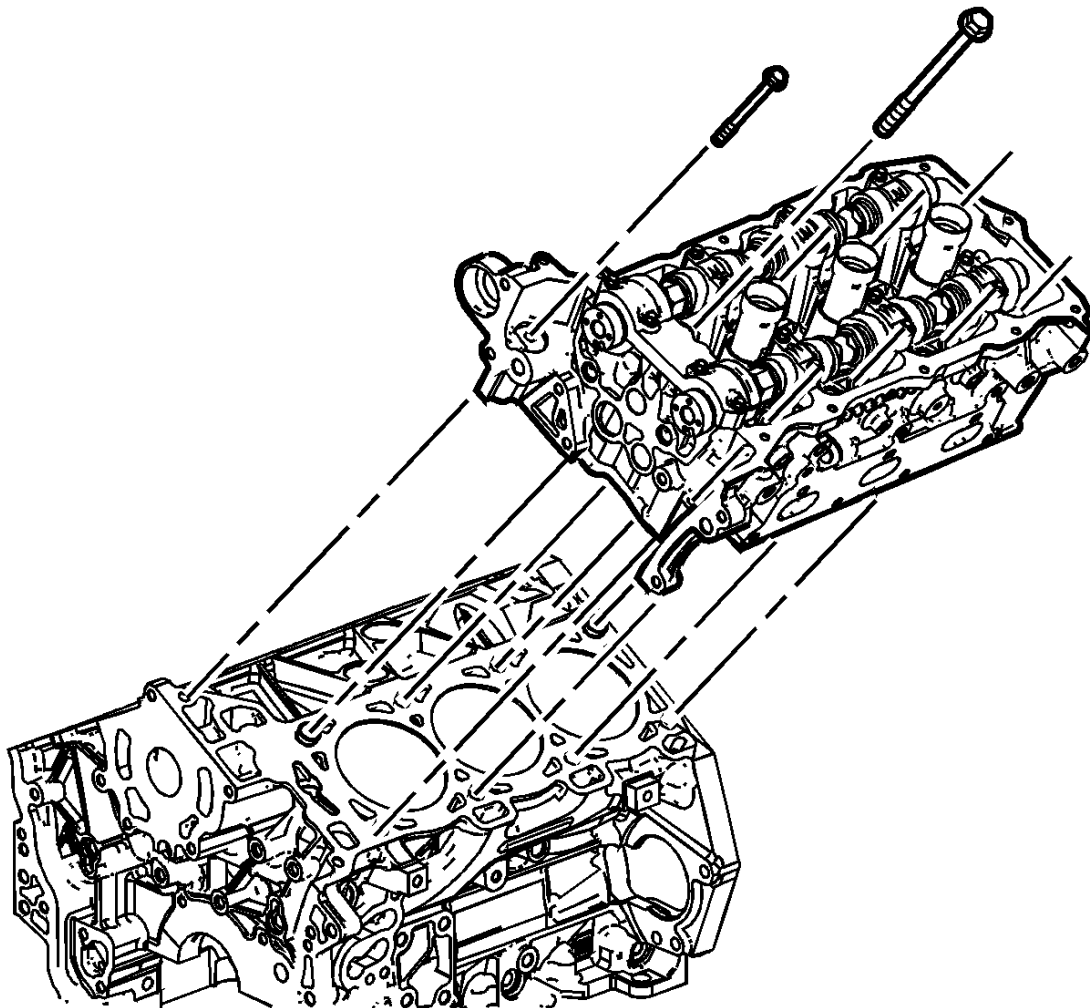
### REMOVAL PROCEDURE

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
2. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
3. Disconnect the coolant temperature sensor electrical connector.



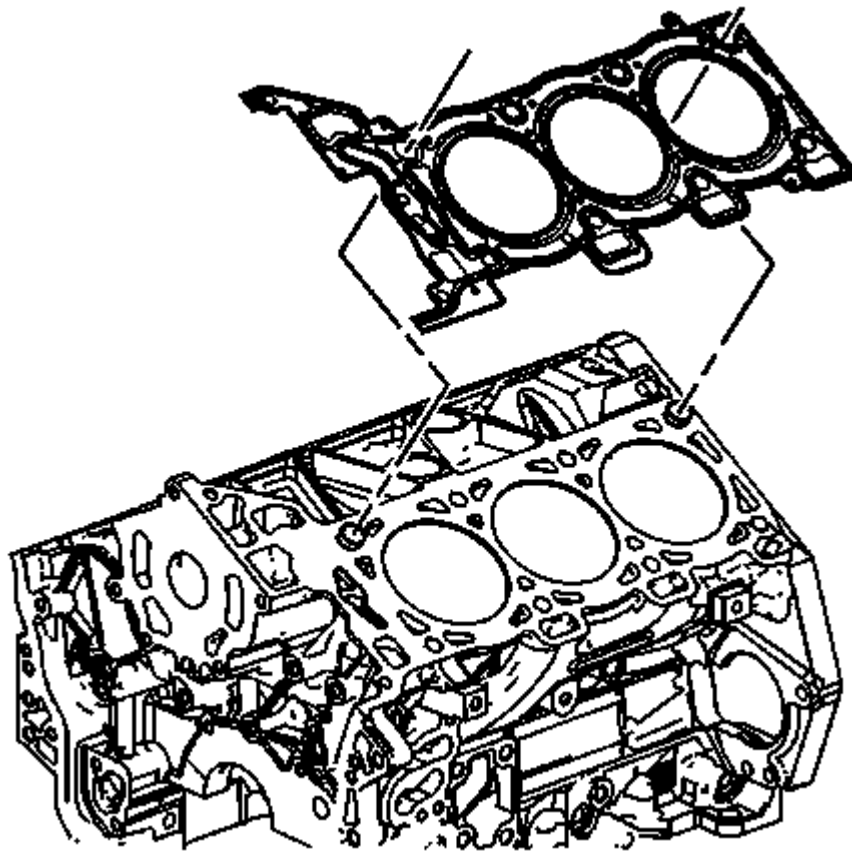
**Fig. 201: View Of Left Cylinder Head Wiring Harness Ground Bolt**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness ground from the cylinder head.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LY7)**.



**Fig. 202: View Of Left Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the cylinder head with the exhaust manifold. Refer to Cylinder Head Removal - Left Side .

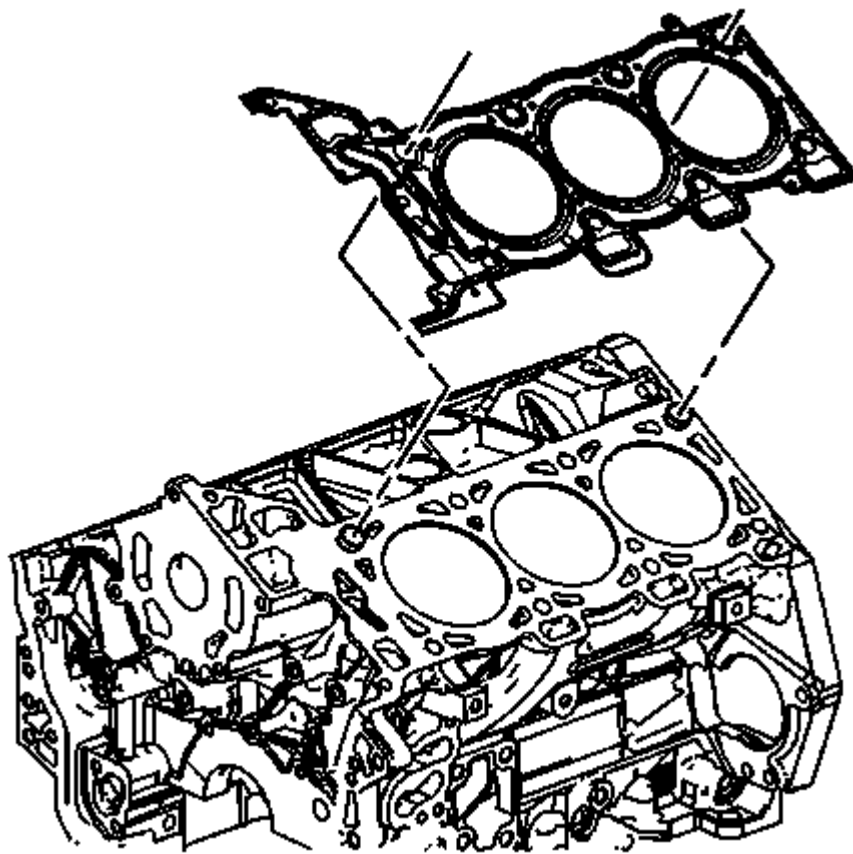


**Fig. 203: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard the cylinder head gasket.
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. If necessary, perform the following steps:
  - Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Left Side .
  - Remove the camshaft. Refer to Camshaft Removal - Left Side .
  - Disassemble the cylinder head. Refer to Cylinder Head Disassemble .

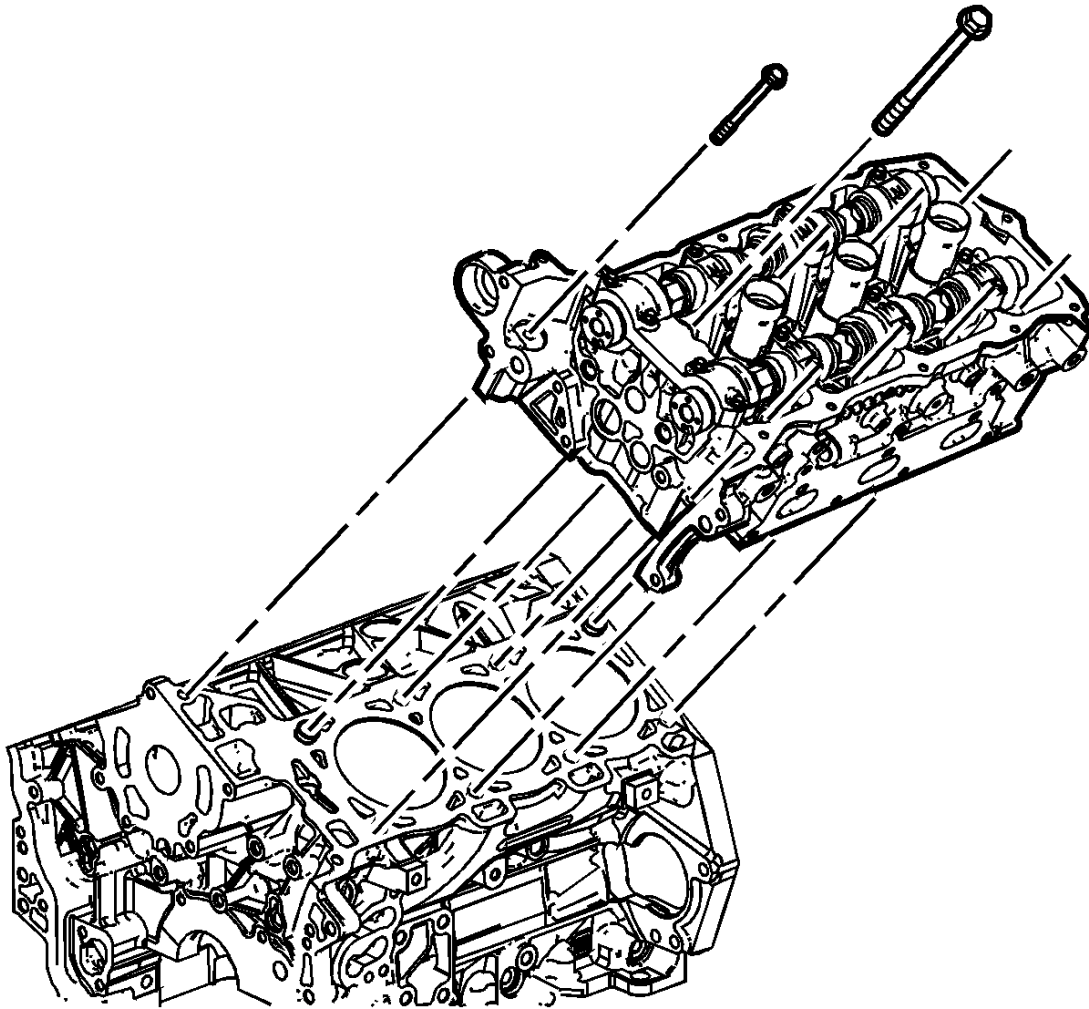
## INSTALLATION PROCEDURE

1. If necessary, perform the following steps:
  - Assemble the cylinder head. Refer to Cylinder Head Assemble .
  - Install the camshaft. Refer to Camshaft Installation - Left Side .
  - Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Left Side .



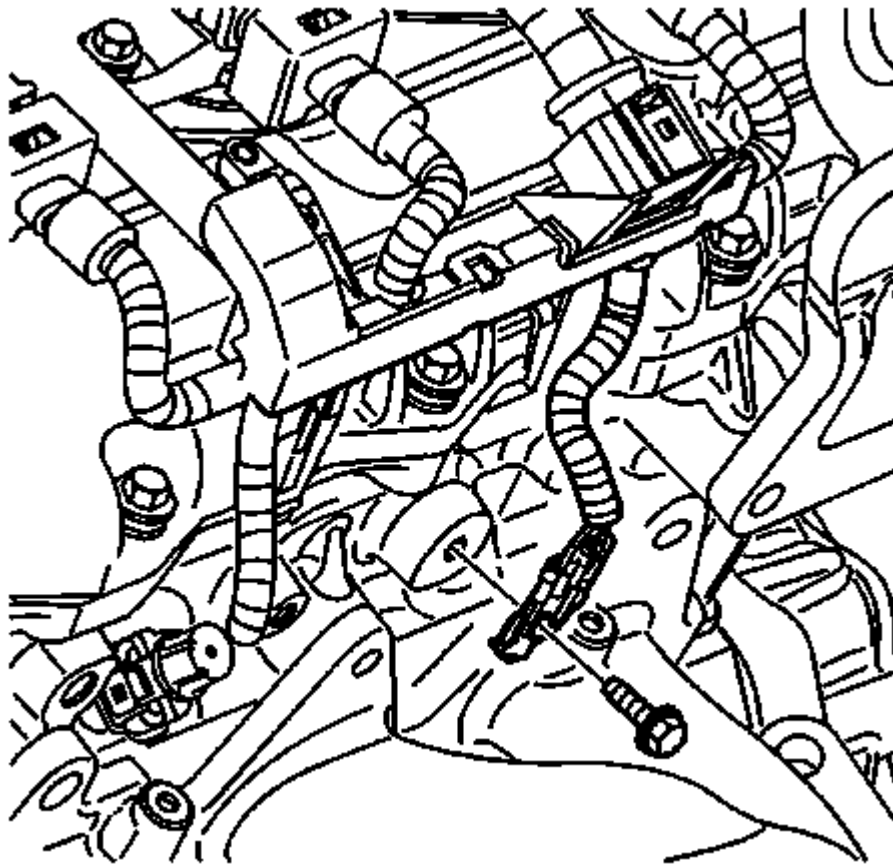
**Fig. 204: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.



**Fig. 205: View Of Left Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side** .
4. Install the catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (LY7)** .



**Fig. 206: View Of Left Cylinder Head Wiring Harness Ground Bolt**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

5. Install the wiring harness ground to the cylinder head.

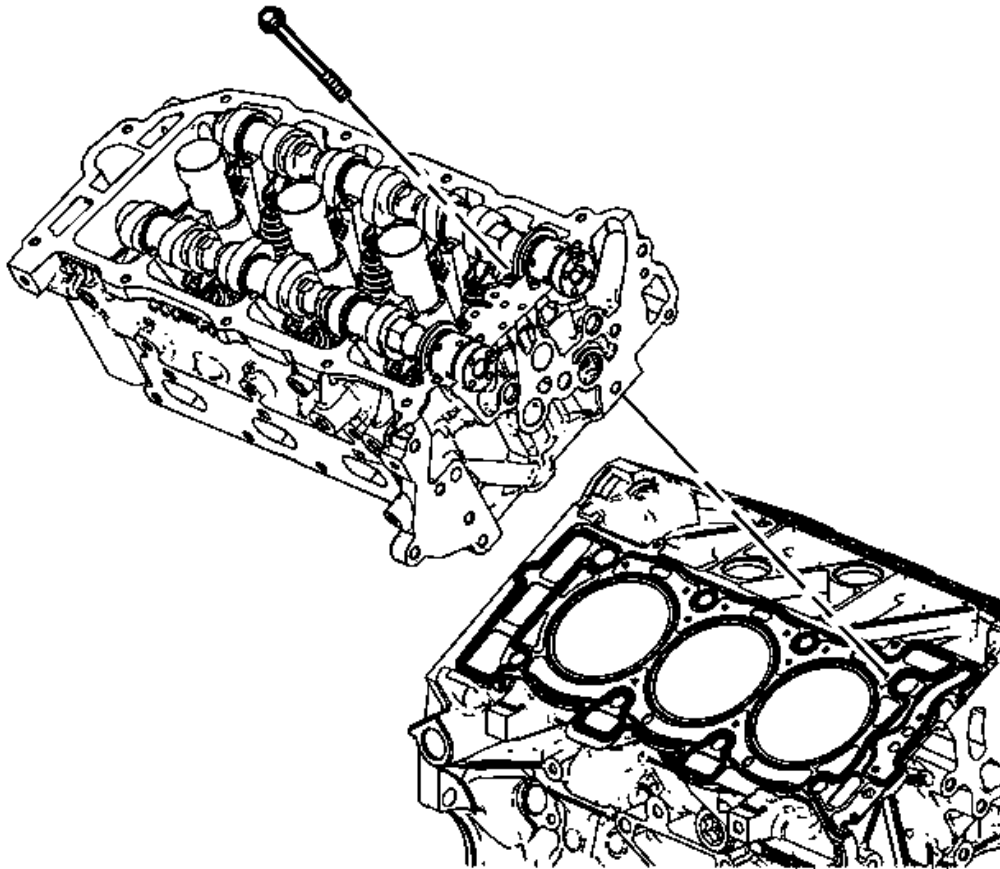
**Tighten:** Tighten the wiring harness ground bolt to 10 N.m (89 lb in).

6. Install the coolant temperature sensor electrical connector.
7. Install the oil level indicator. Refer to Oil Level Indicator Tube Replacement.
8. Install the left bank secondary timing chain. Refer to Secondary Camshaft Intermediate Drive Chain Replacement - Left Side.

## CYLINDER HEAD REPLACEMENT - RIGHT SIDE

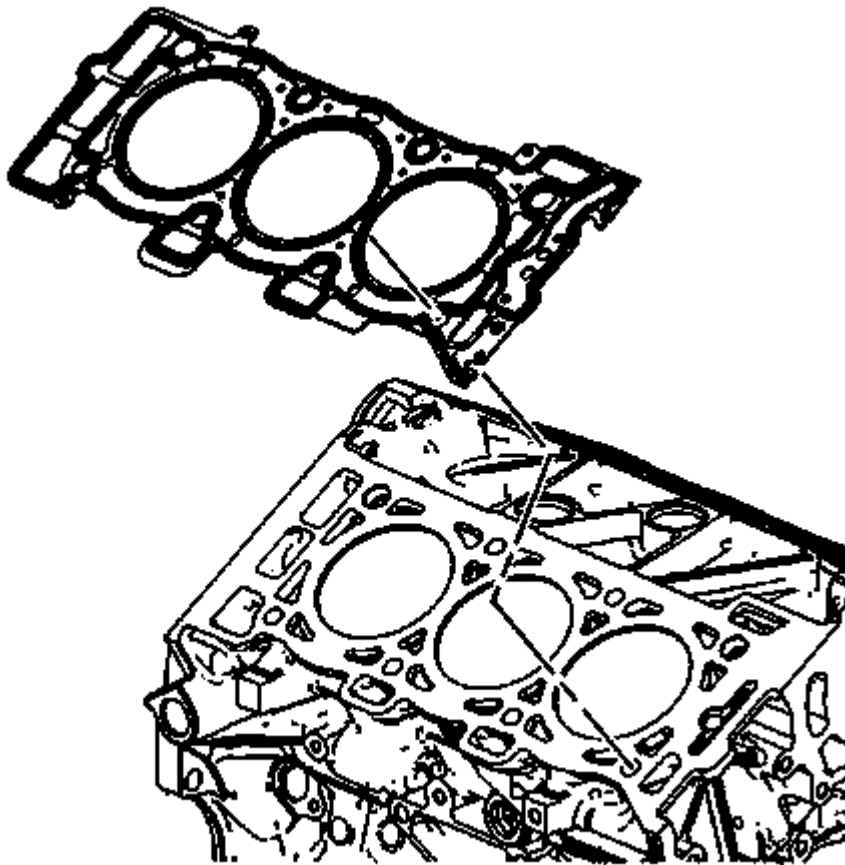
### REMOVAL PROCEDURE

1. Remove the hood. Refer to Hood Replacement .
2. Remove the right bank secondary timing chain. Refer to Secondary Camshaft Intermediate Drive

**Chain Replacement - Right Side.**

**Fig. 207: View Of Right Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

3. With the aid of an assistant, remove the cylinder head with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side** .

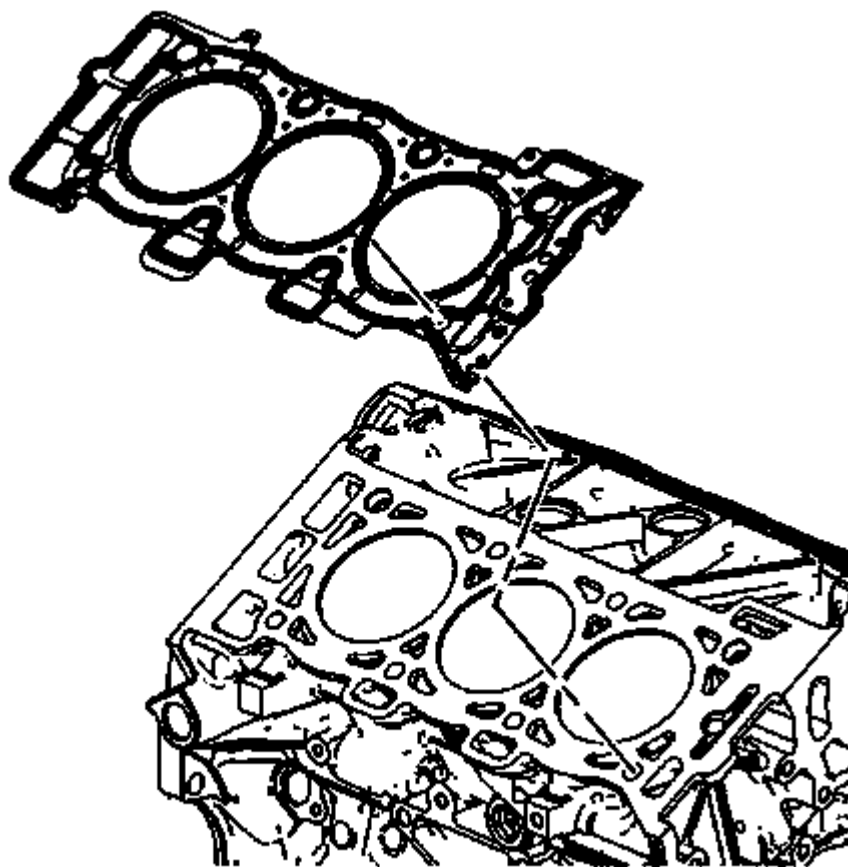


**Fig. 208: View Of Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the cylinder head gasket.
5. 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 .
6. If necessary, perform the following steps:
  - Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Right Side .
  - Remove the camshaft. Refer to Camshaft Removal - Right Side .
  - Disassemble the cylinder head. Refer to Cylinder Head Disassemble .

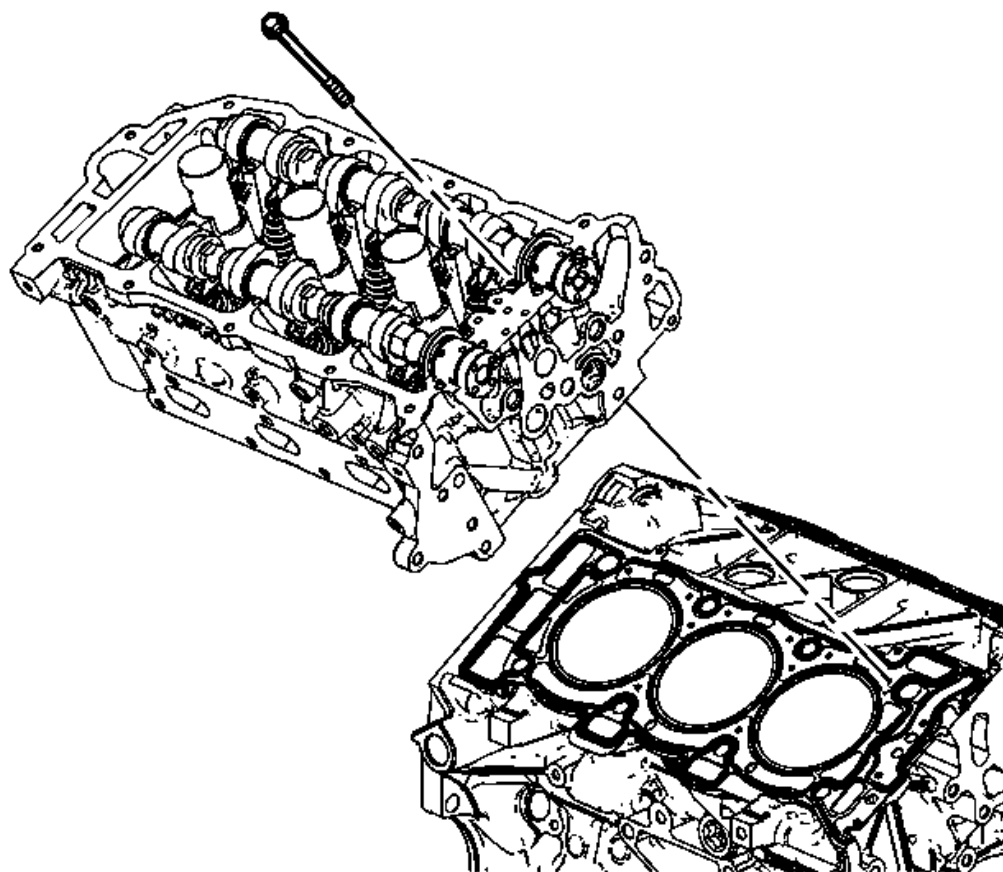
## INSTALLATION PROCEDURE

1. If necessary, perform the following steps:
  - Assemble the cylinder head. Refer to Cylinder Head Assemble .
  - Install the camshaft. Refer to Camshaft Installation - Right Side .
  - Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Right Side .



**Fig. 209: View Of Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.



**Fig. 210: View Of Right Cylinder Head**  
Courtesy of GENERAL MOTORS CORP.

3. With the aid of an assistant, carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Right Side**.
4. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
5. Install the hood. Refer to **Hood Replacement**.

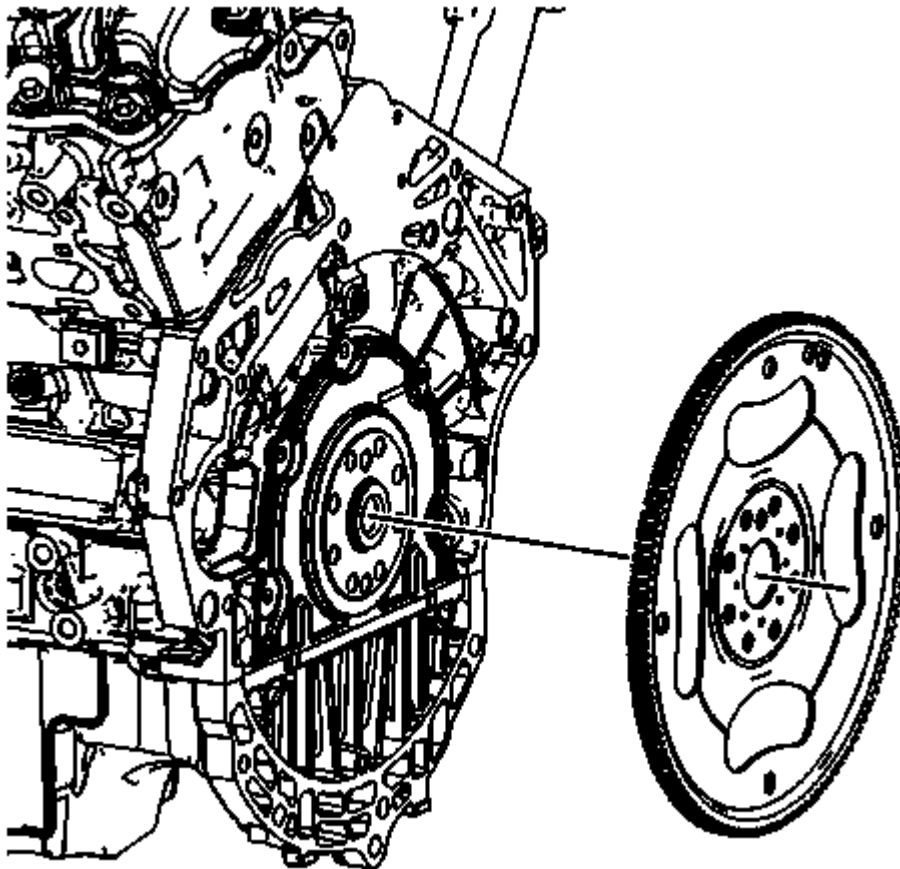
## 2010 ENGINE

### Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - G6

## REPAIR INSTRUCTIONS - ON VEHICLE

### ENGINE FLYWHEEL REPLACEMENT

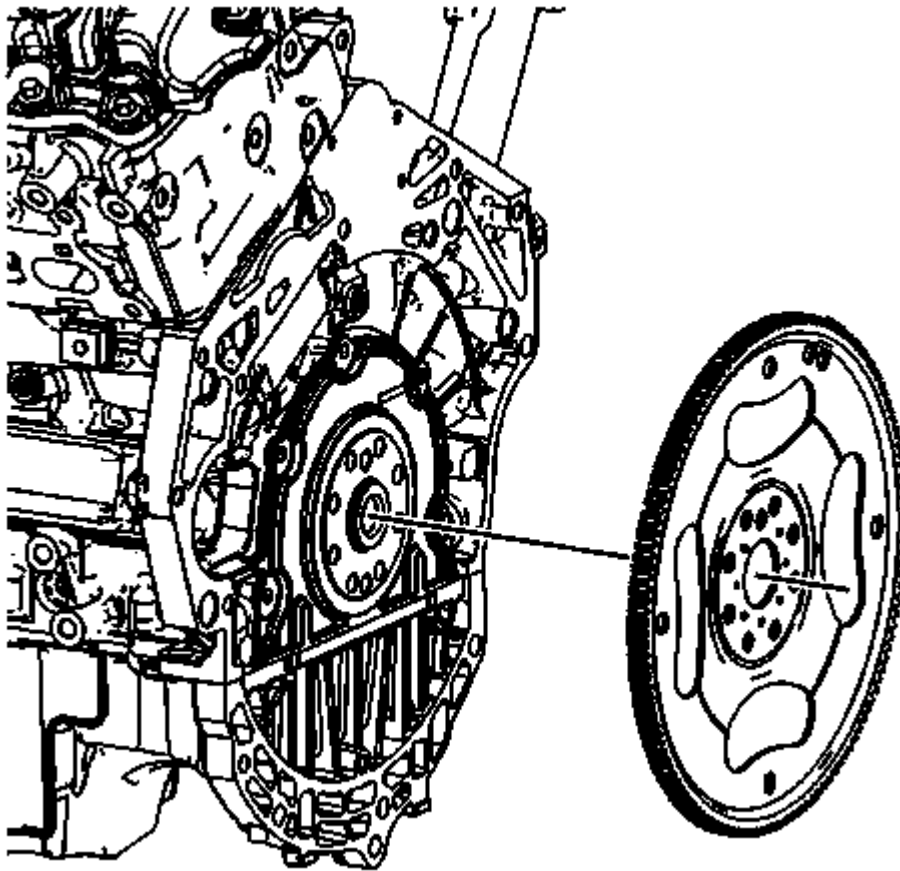
#### Removal Procedure



**Fig. 1: View Of Engine Flywheel**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the transaxle. Refer to [Transmission Replacement](#) .
2. Remove the engine flywheel bolts and 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. Refer to [Starter Replacement \(LY7\)](#) .

#### Installation Procedure



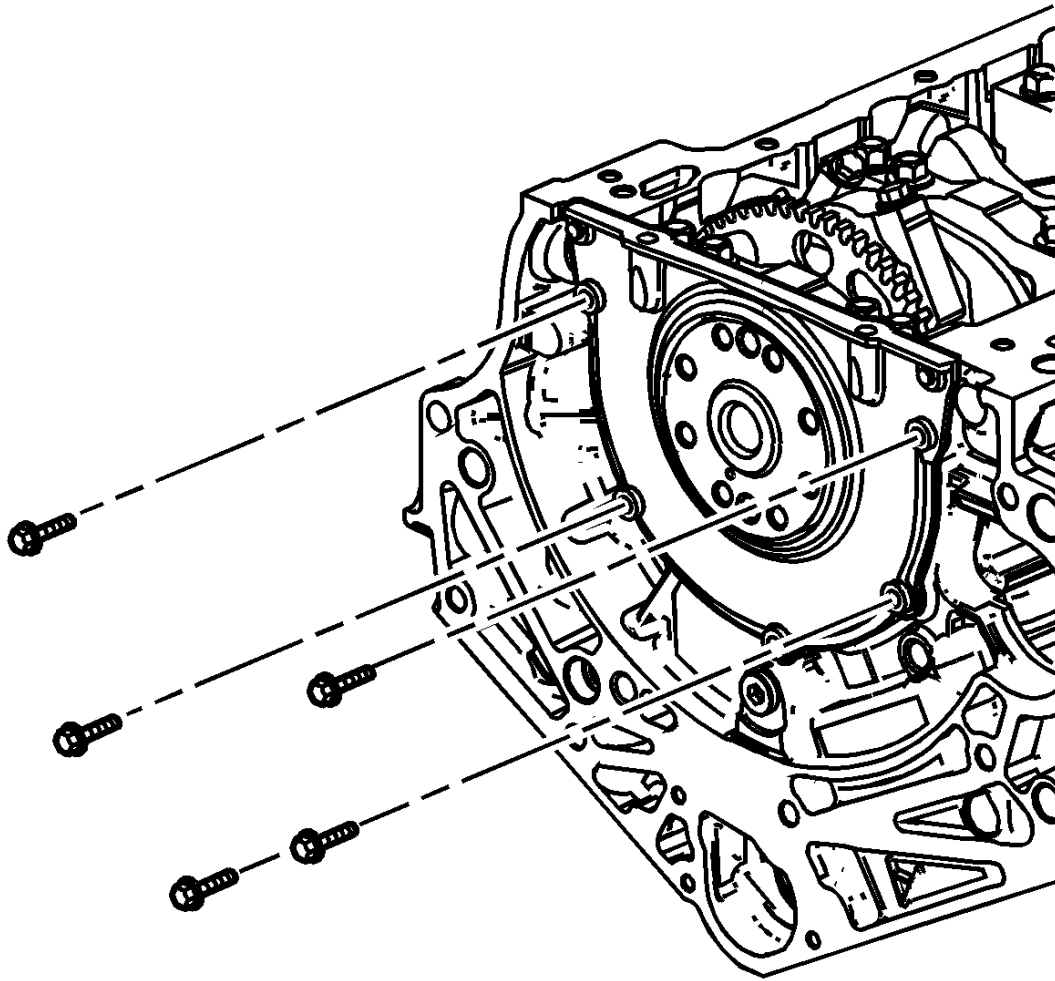
**Fig. 2: View Of Engine Flywheel**  
Courtesy of GENERAL MOTORS CORP.

1. Install the engine flywheel and bolts. Refer to **Engine Flywheel Installation** .
2. Install the transaxle. Refer to **Transmission Replacement** .

## **CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT**

### **Removal Procedure**

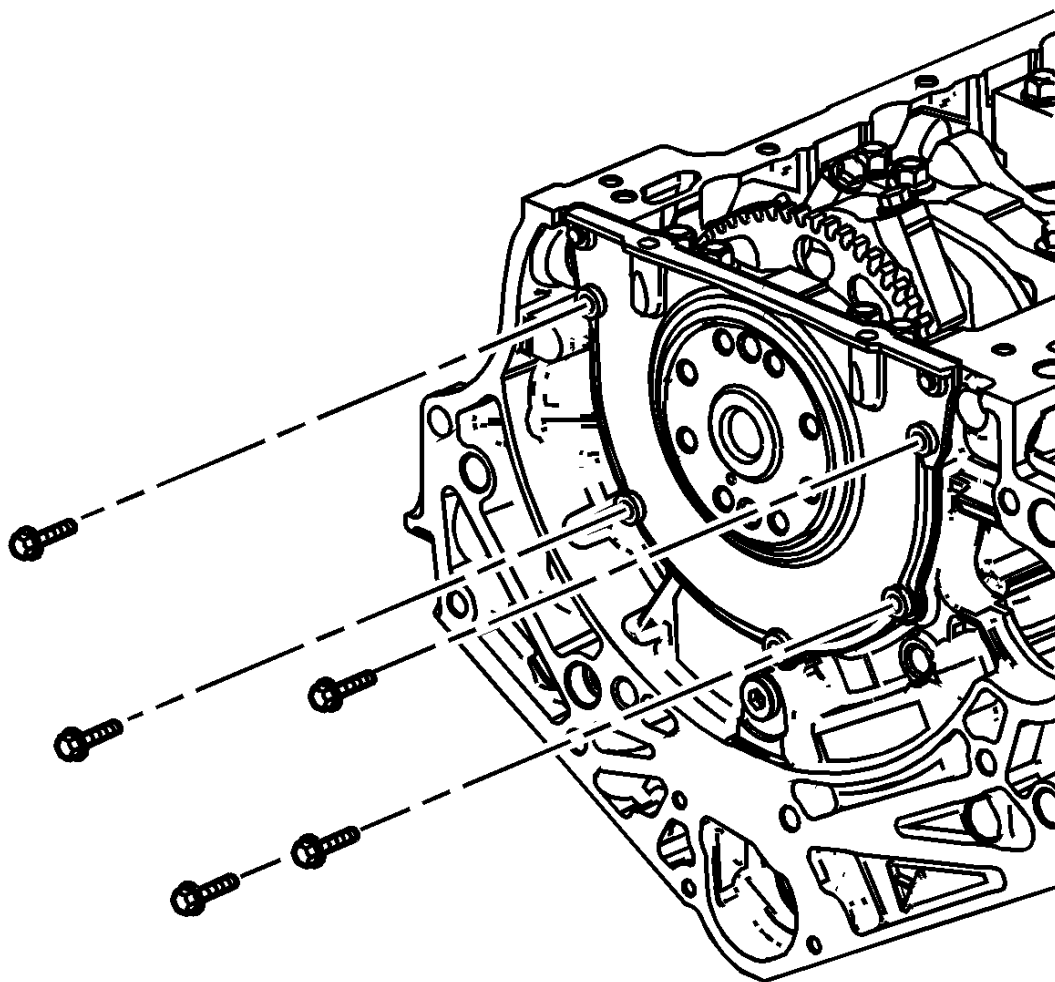
1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.



**Fig. 3: Locating Crankshaft Rear Oil Seal Housing Bolts**  
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

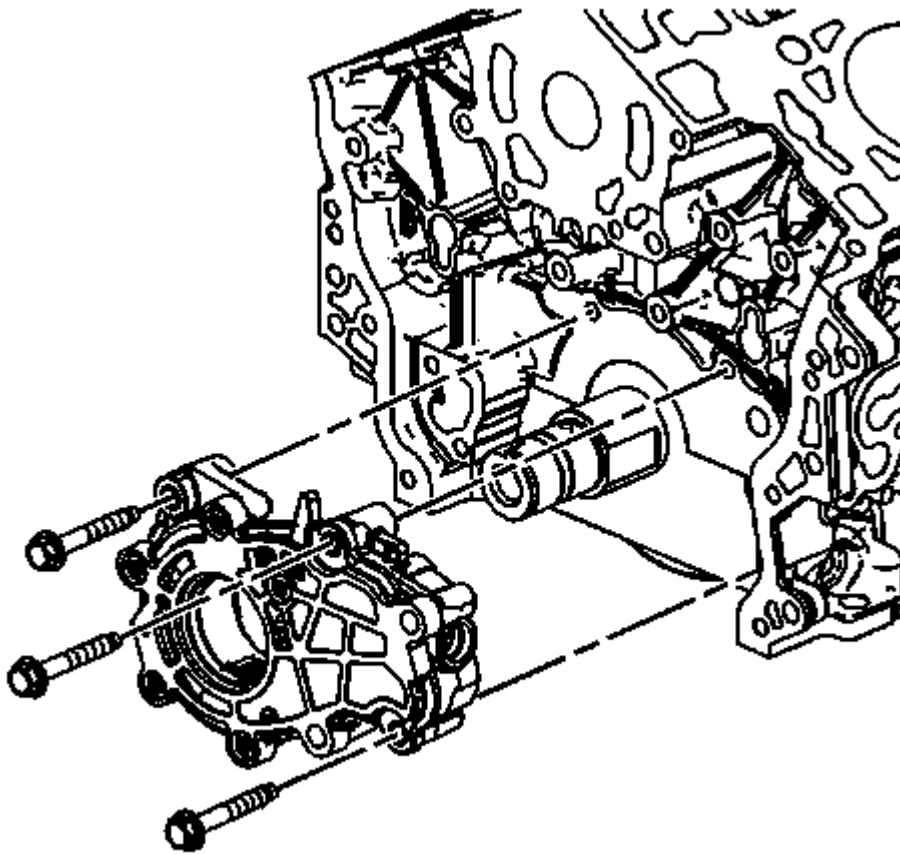


**Fig. 4: Locating Crankshaft Rear Oil Seal Housing Bolts**  
Courtesy of GENERAL MOTORS CORP.

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

## **OIL PUMP REPLACEMENT**

### **Removal Procedure**

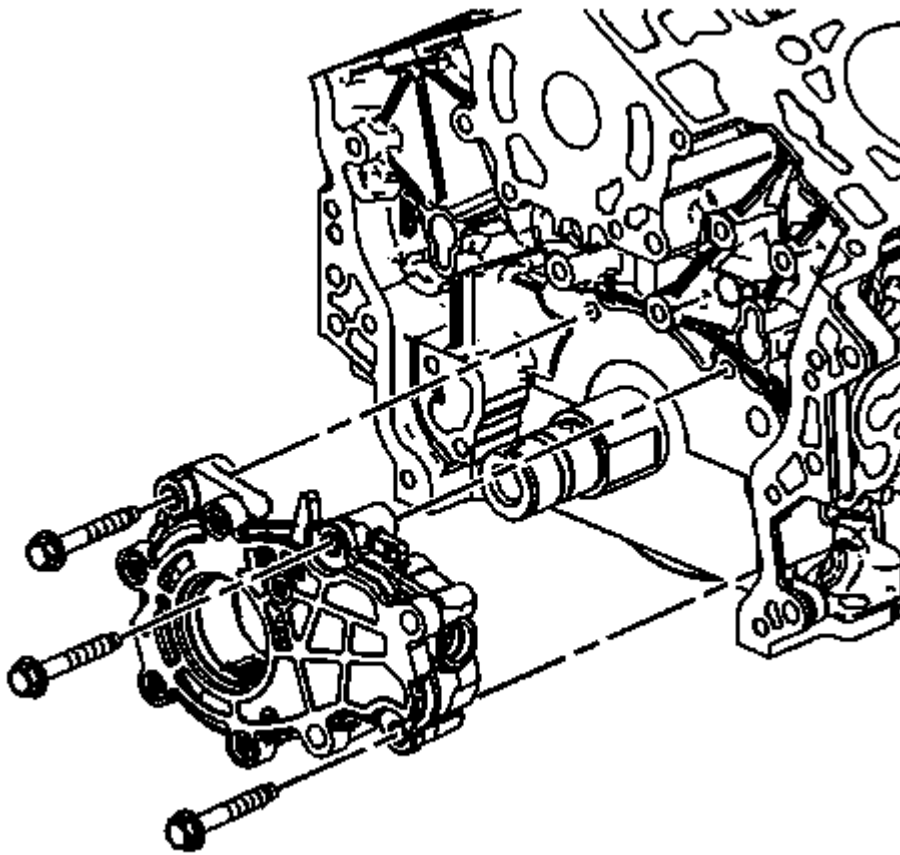


**Fig. 5: Identifying Oil Pump & Bolts**  
Courtesy of GENERAL MOTORS CORP.

**IMPORTANT:** 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 oil pump bolts and the oil pump. Refer to **Oil Pump Removal** .

#### Installation Procedure



**Fig. 6: Identifying Oil Pump & Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump. Refer to **Oil Pump Installation** .
2. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement** .

## **OIL PAN REPLACEMENT**

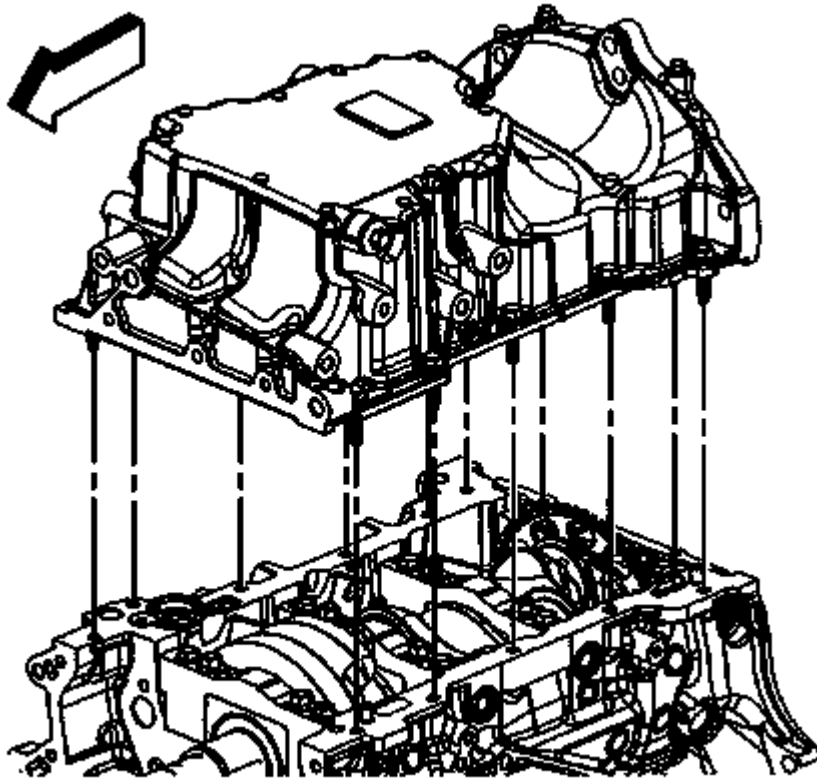
### **Special Tools**

**EN-46109:** Guide Pin Set

### **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** .
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LY7)** .
4. Remove the air conditioning (A/C) compressor bolts and reposition. Refer to **Air Conditioning Compressor Replacement (LY7)** .
5. Remove the front cover. Refer to **Engine Front Cover Replacement**

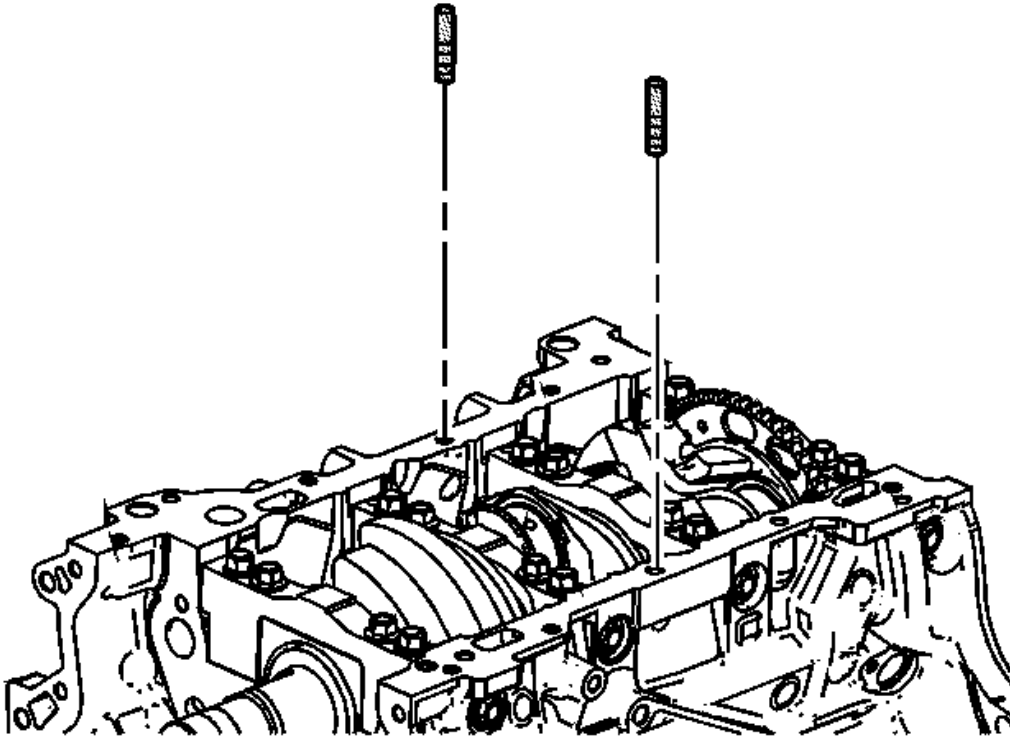
6. Remove the oil pan to transmission bolts



**Fig. 7: Removing/Installing Oil Pan**  
Courtesy of GENERAL MOTORS CORP.

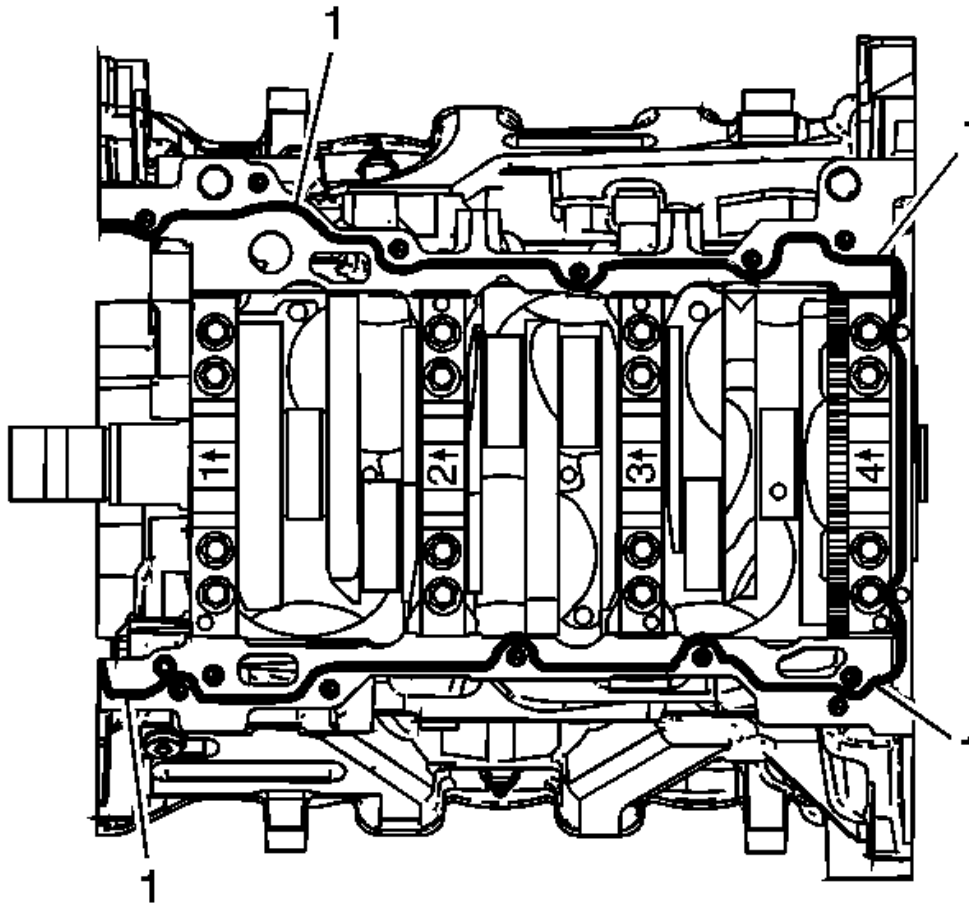
7. Remove the oil pan bolts.
8. Remove the oil pan.
9. Clean the oil pan and the engine block gasket surface. Refer to **Oil Pan Cleaning and Inspection** .

#### **Installation Procedure**



**Fig. 8: Identifying Special Tool - EN 46109 Guides**  
Courtesy of GENERAL MOTORS CORP.

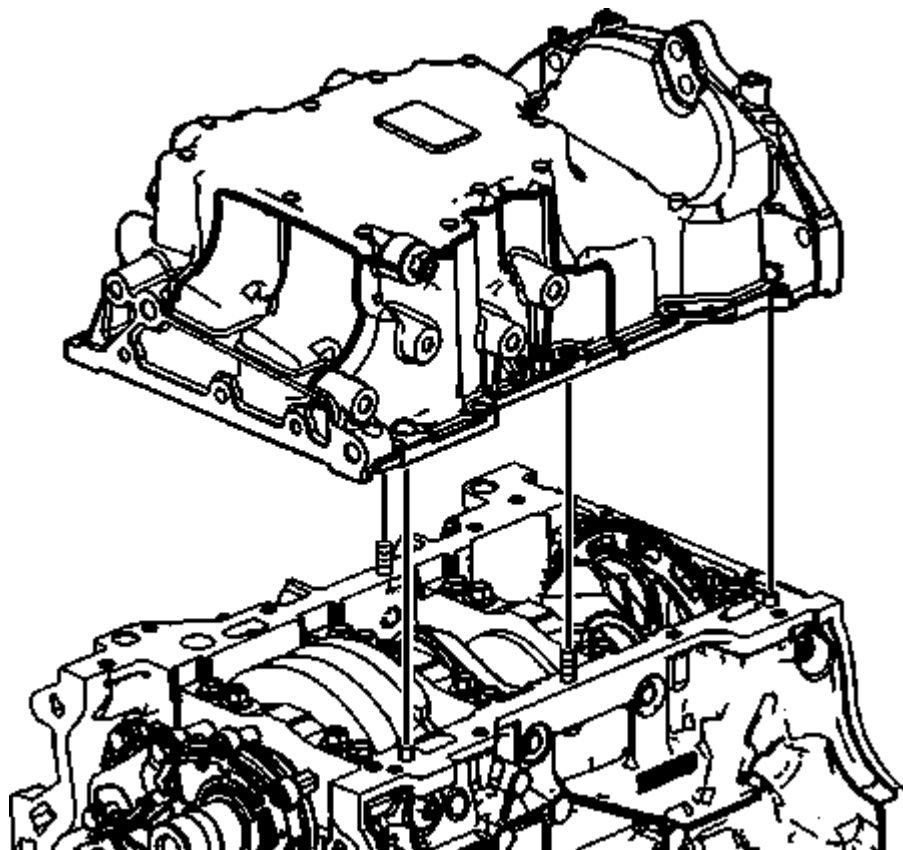
1. Install the 8 mm (0.315 in) guides from the **EN-46109**: set into the center oil pan rail bolt hole on each side of the engine block.



**Fig. 9: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing**

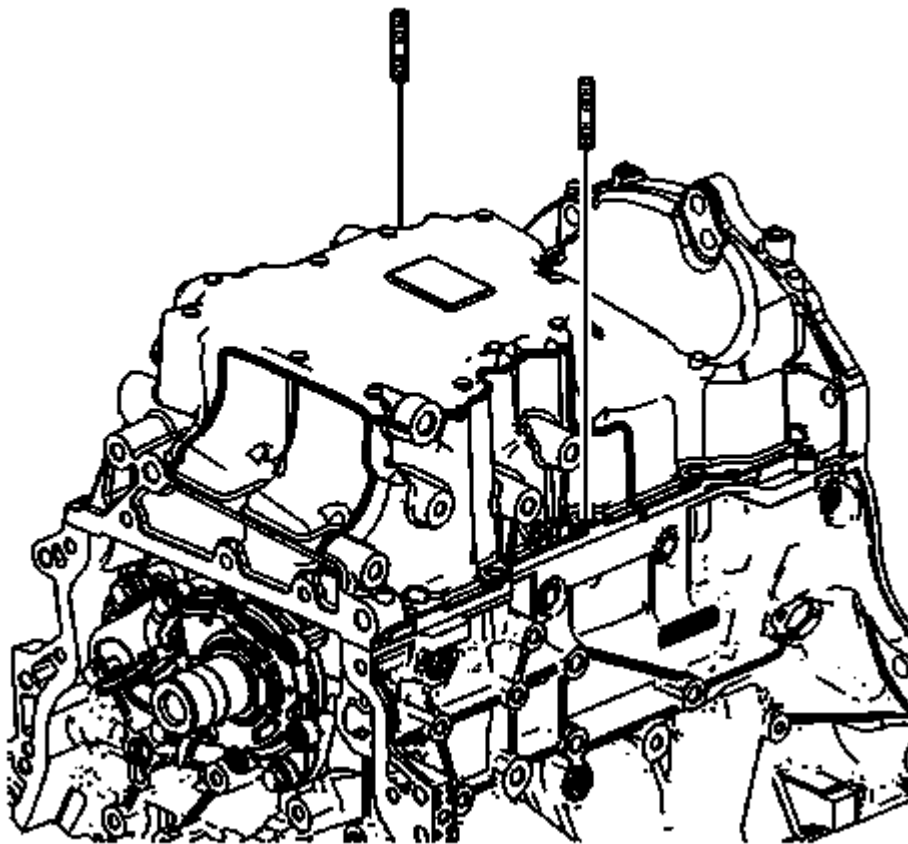
Courtesy of GENERAL MOTORS CORP.

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.



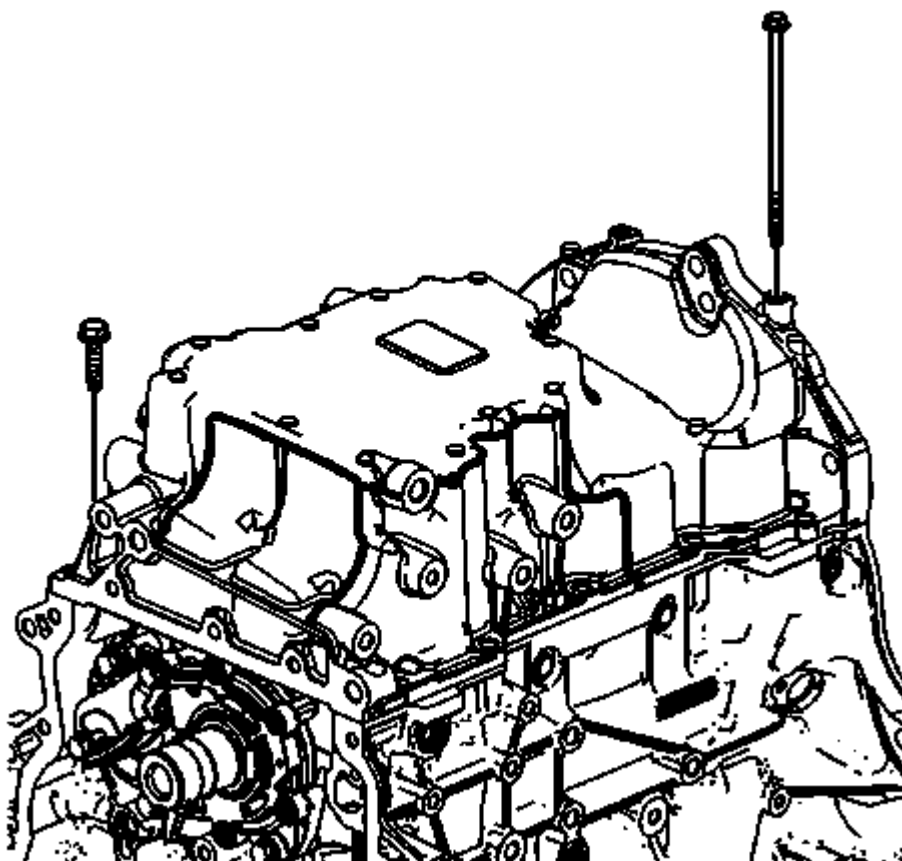
**Fig. 10: Removing/Installing Oil Pan**  
Courtesy of GENERAL MOTORS CORP.

3. Position the oil pan onto the block.



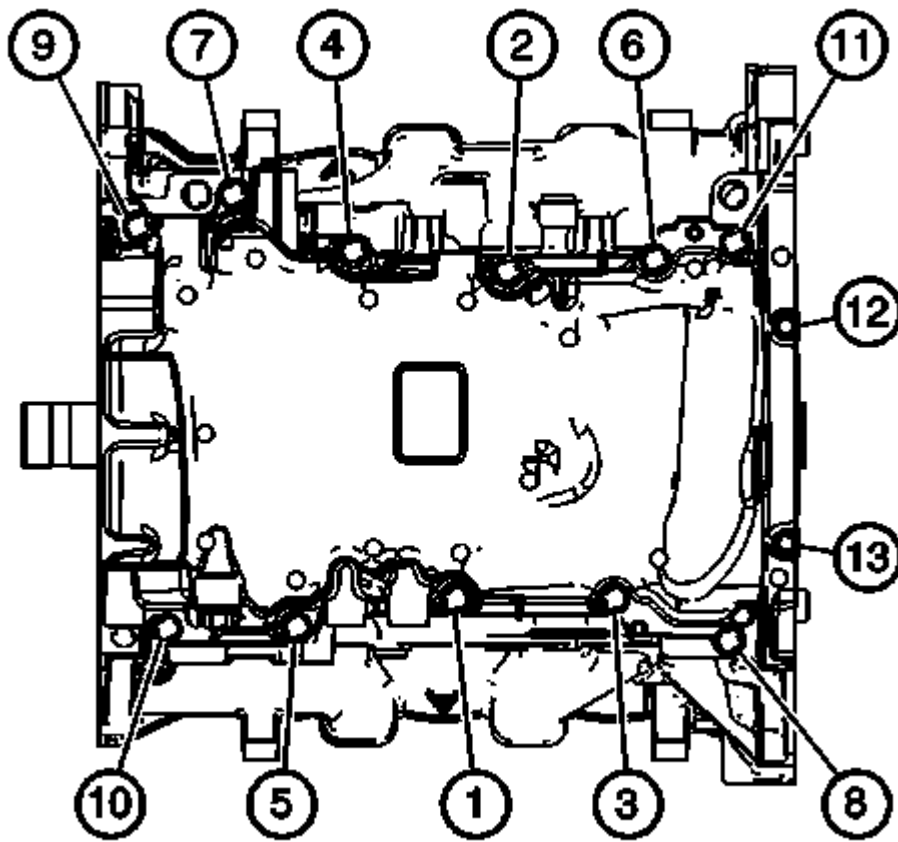
**Fig. 11: Identifying Special Tools - EN 46109**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 12: Locating Oil Pan Bolts**  
Courtesy of GENERAL MOTORS CORP.

5. Loosely install the oil pan bolts.



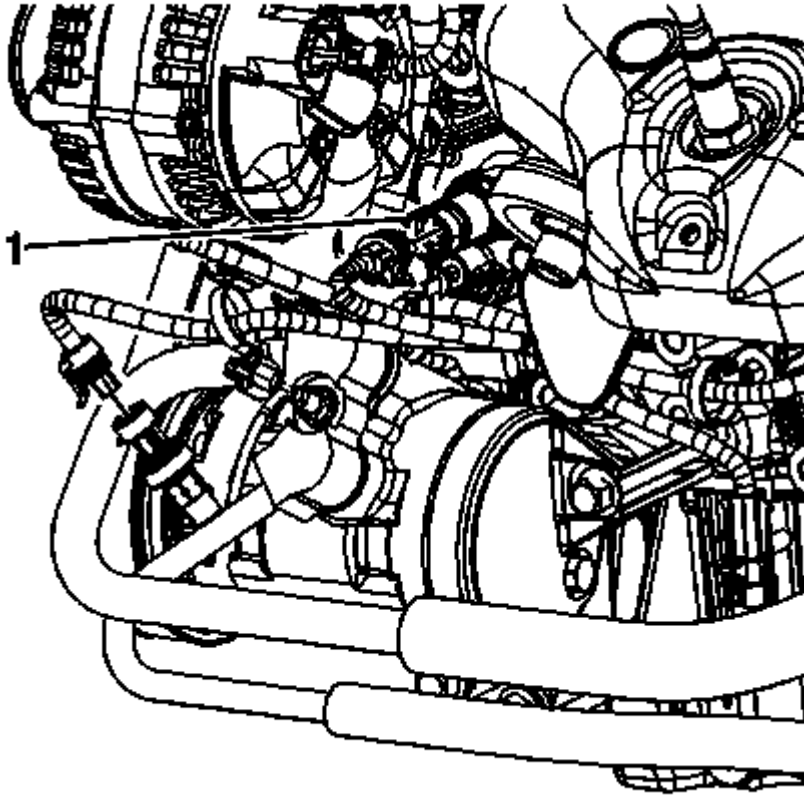
**Fig. 13: Identifying Oil Pan Bolts - Tightening Sequence**  
 Courtesy of GENERAL MOTORS CORP.

**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 (LY7) .
9. Install the catalytic converter. Refer to Catalytic Converter Replacement - Left Side (LY7) .
10. Lower the vehicle. Refer to Lifting and Jacking the Vehicle .
11. Refill the engine oil. Refer to Engine Oil and Oil Filter Replacement.

## ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

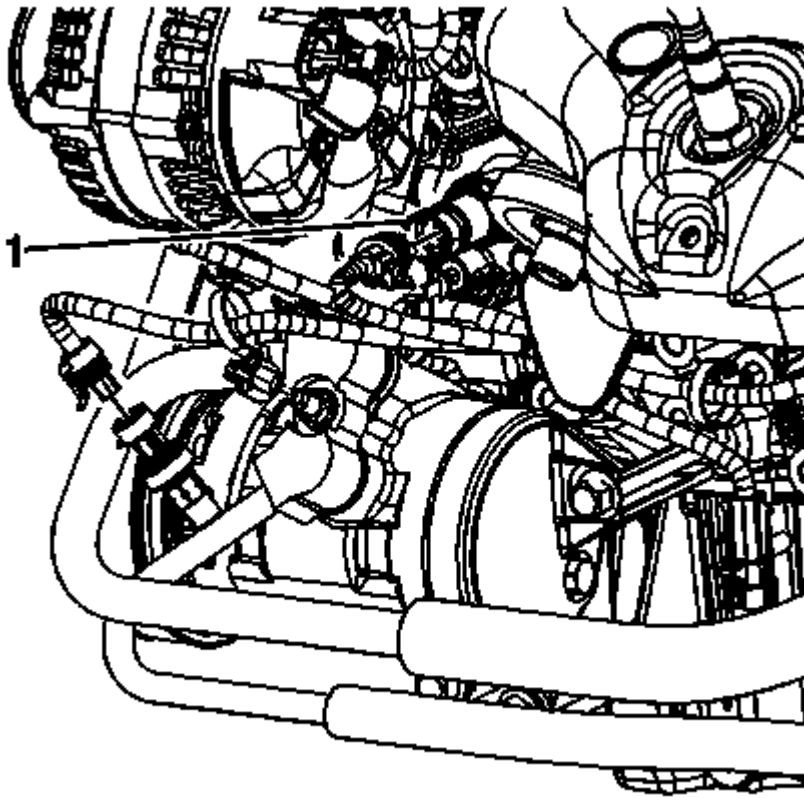
### Special Tools

**J 41712 Oil Pressure Switch Socket****Removal Procedure**

**Fig. 14: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Disconnect the oil pressure sensor electrical connector.
3. Remove the oil pressure sensor (1).

**Installation Procedure**



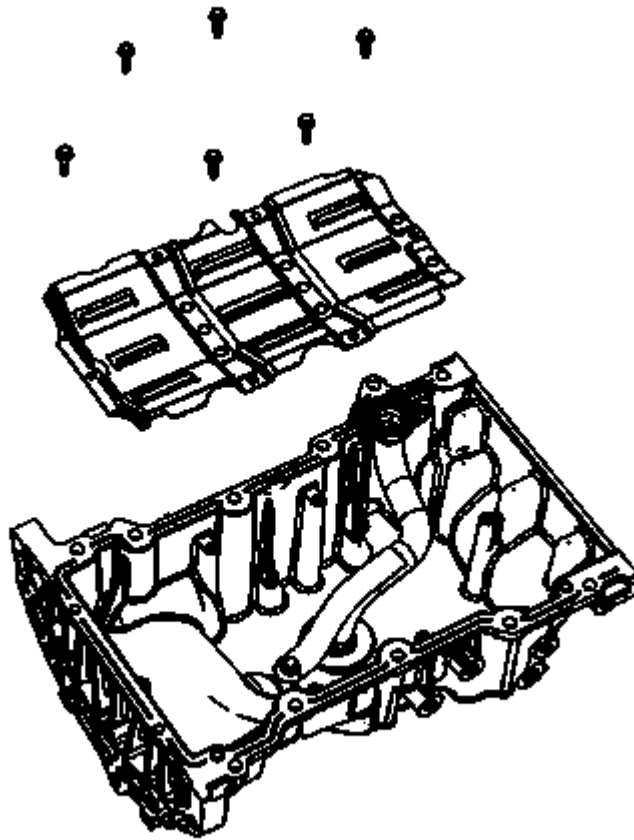
**Fig. 15: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Refer to Fastener Caution .

1. Install the oil pressure sensor (1) and tighten to 20 N.m (15 lb ft).
2. Connect the oil pressure sensor electrical connector.

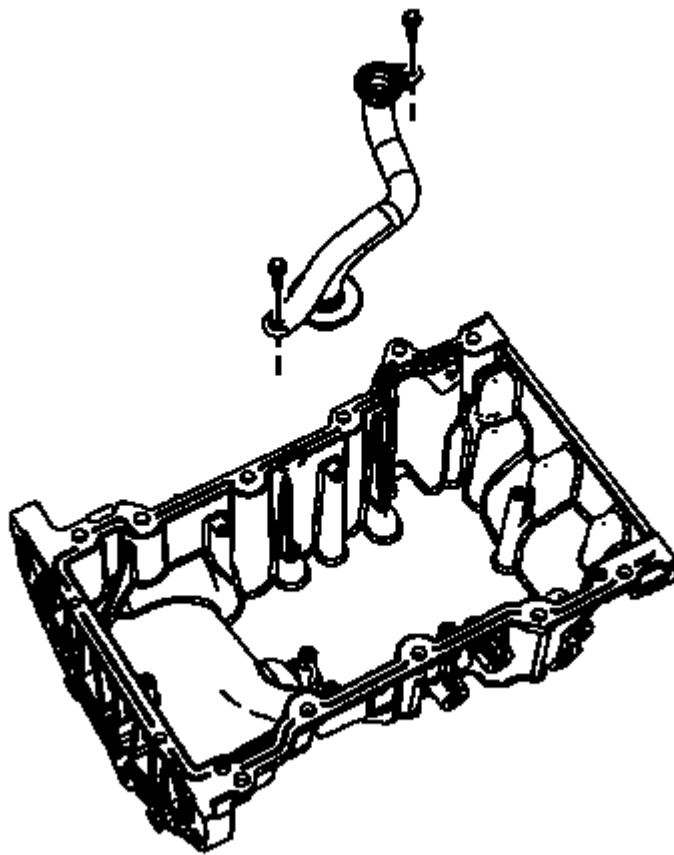
## **OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT**

### **Removal Procedure**



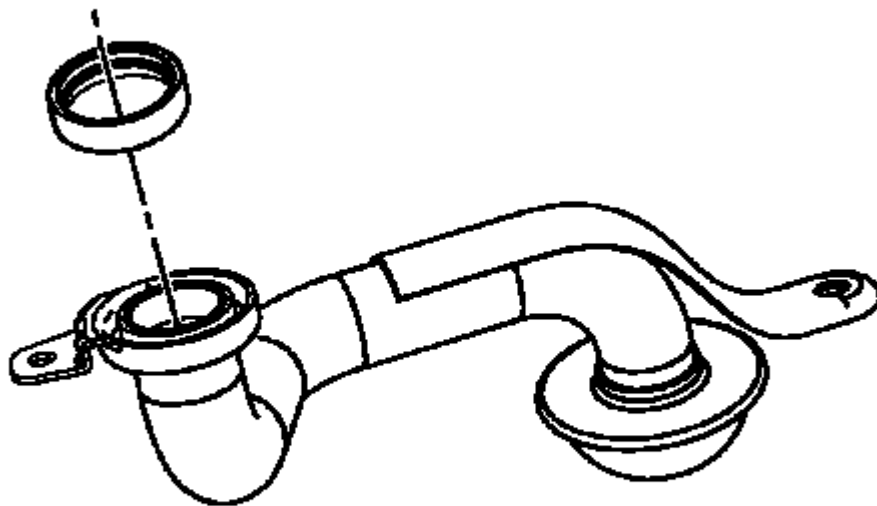
**Fig. 16: Identifying Oil Pan Scraper Bolts**  
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.



**Fig. 17: View Of Oil Suction Pipe & Bolts**  
**Courtesy of GENERAL MOTORS CORP.**

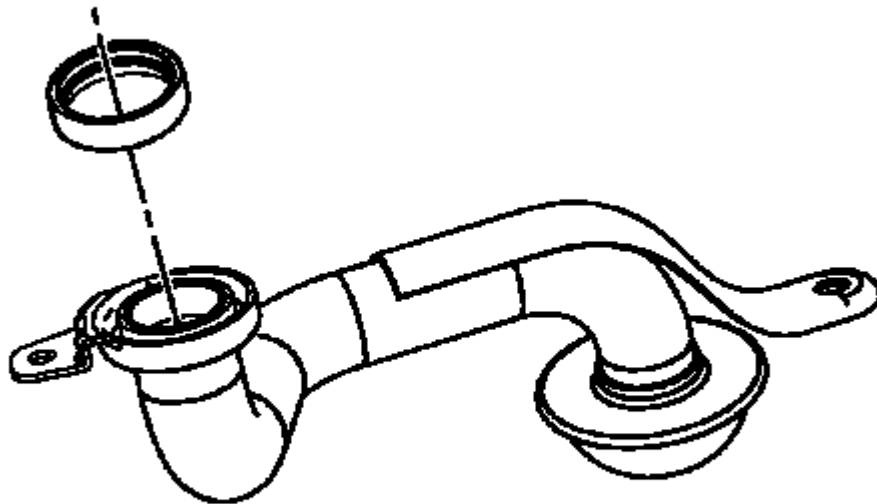
4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.



**Fig. 18: Locating Oil Suction Tube Seal**  
Courtesy of GENERAL MOTORS CORP.

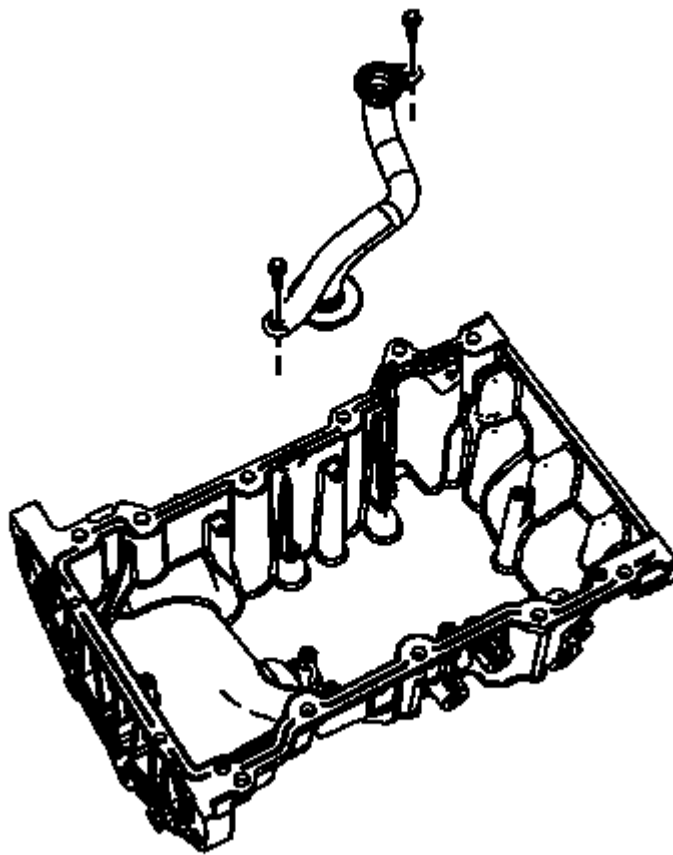
6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

#### **Installation Procedure**



**Fig. 19: Locating Oil Suction Tube Seal**  
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.

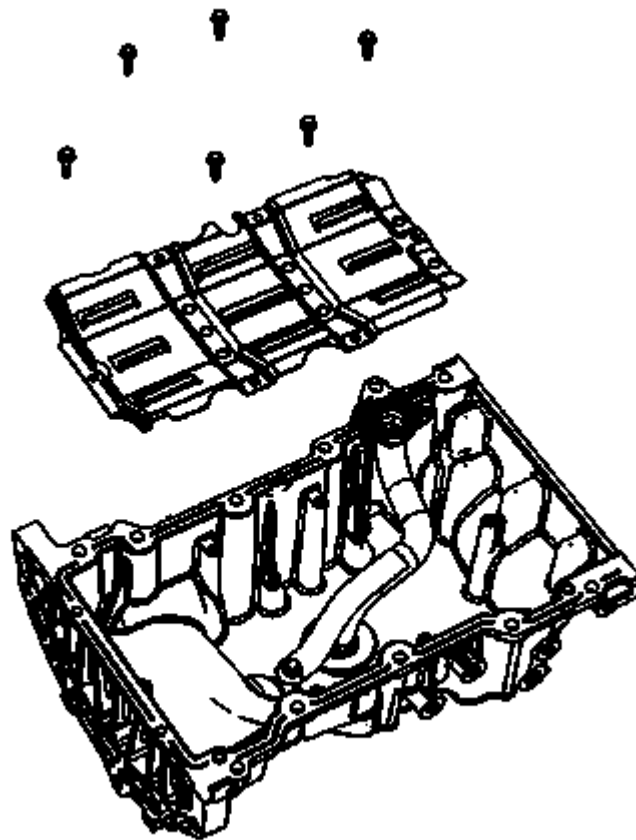


**Fig. 20: View Of Oil Suction Pipe & Bolts**  
Courtesy of GENERAL MOTORS CORP.

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. 21: Identifying Oil Pan Scraper Bolts**  
 Courtesy of GENERAL MOTORS CORP.

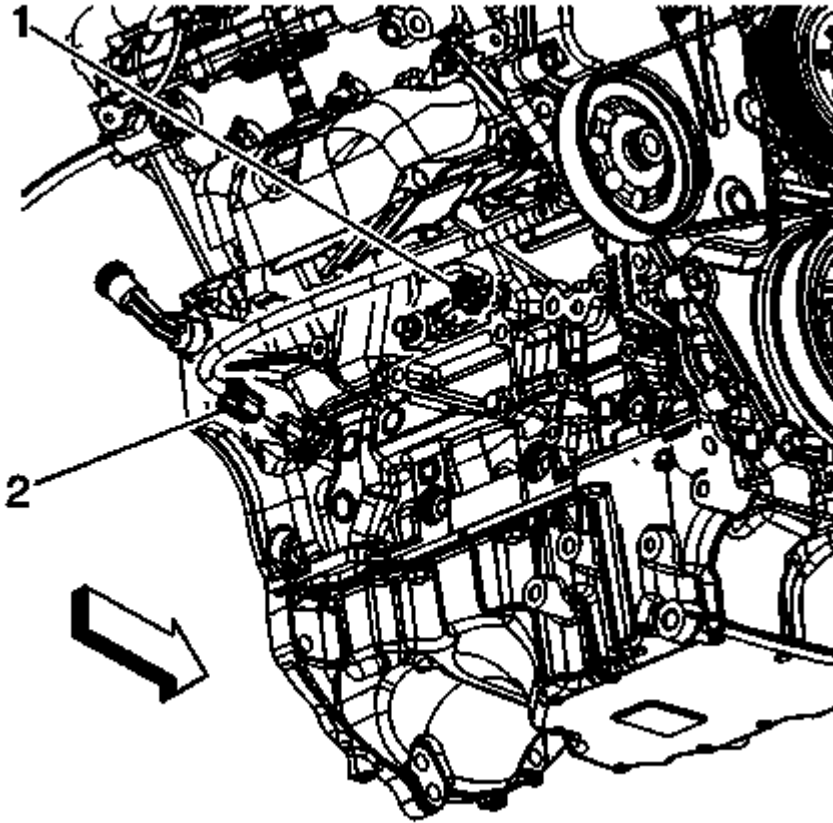
4. Install the oil pan scraper.
5. Install the oil pan scraper bolts and tighten to 10 N.m (89 lb in).
6. Install the oil pan. Refer to **Oil Pan Replacement**.

## ENGINE REPLACEMENT

### Removal Procedure

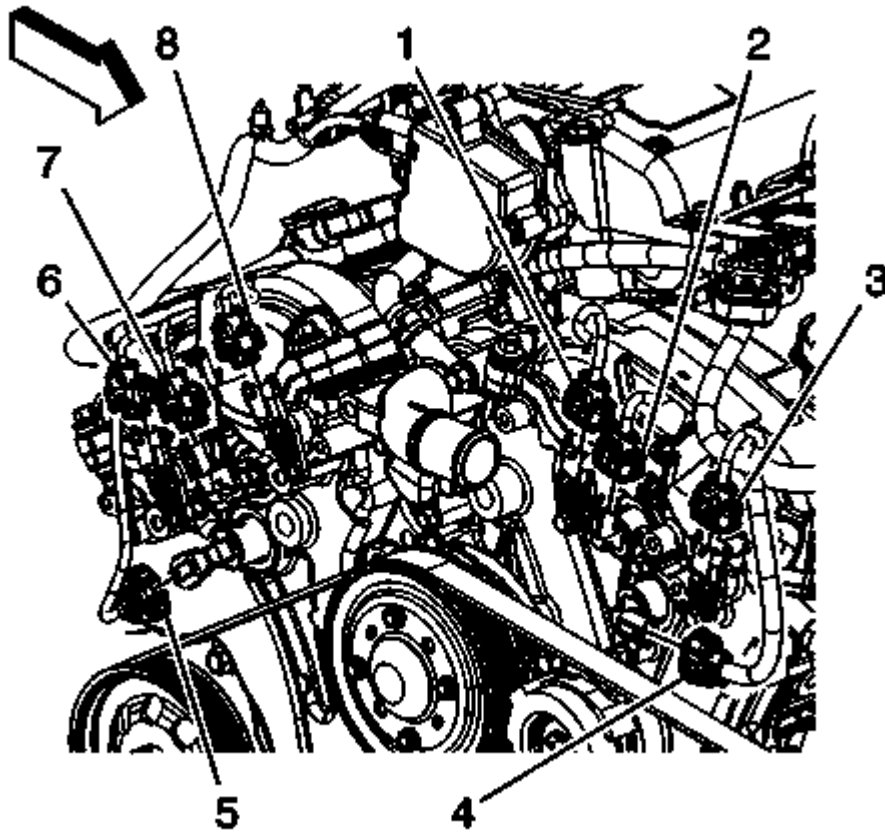
1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold cover. Refer to **Fuel Injector Sight Shield Replacement**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling (LY7, LZE, LZ4, LZ9)**.
4. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
5. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
6. Remove the hood. Refer to **Hood Replacement**.
7. Remove the engine mount snubber. Refer to **Engine Mount Snubber Replacement**.

8. Remove the drive belt. Refer to **Drive Belt Replacement** .
9. Disconnect the front knock sensor (KS).



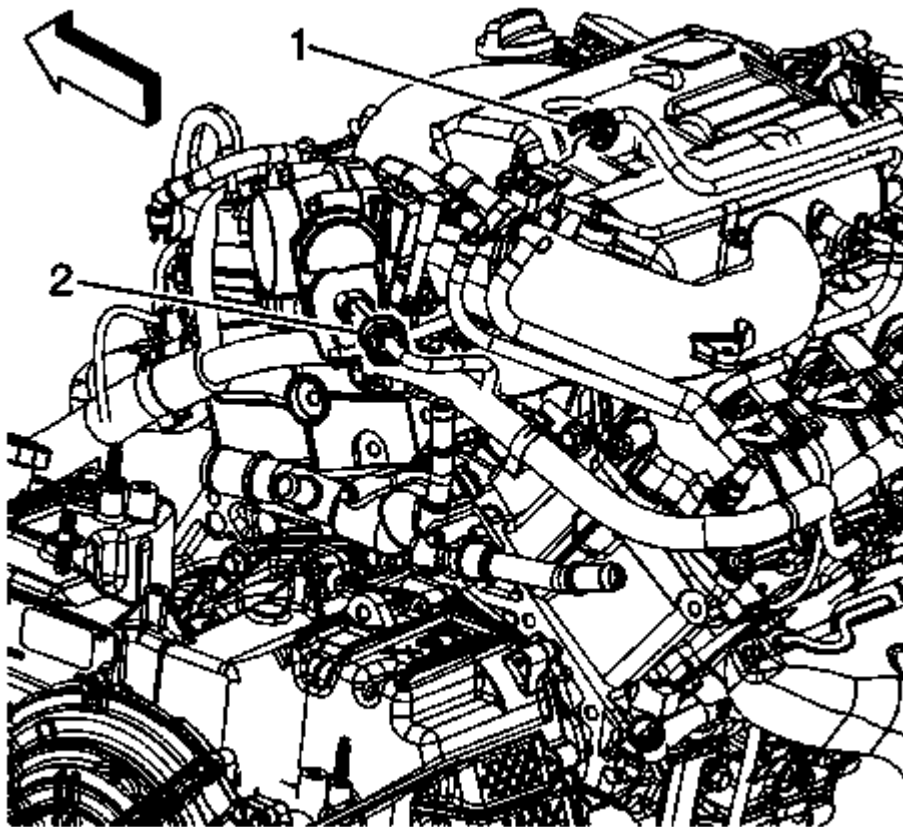
**Fig. 22: Identifying Knock Sensor**  
Courtesy of GENERAL MOTORS CORP.

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



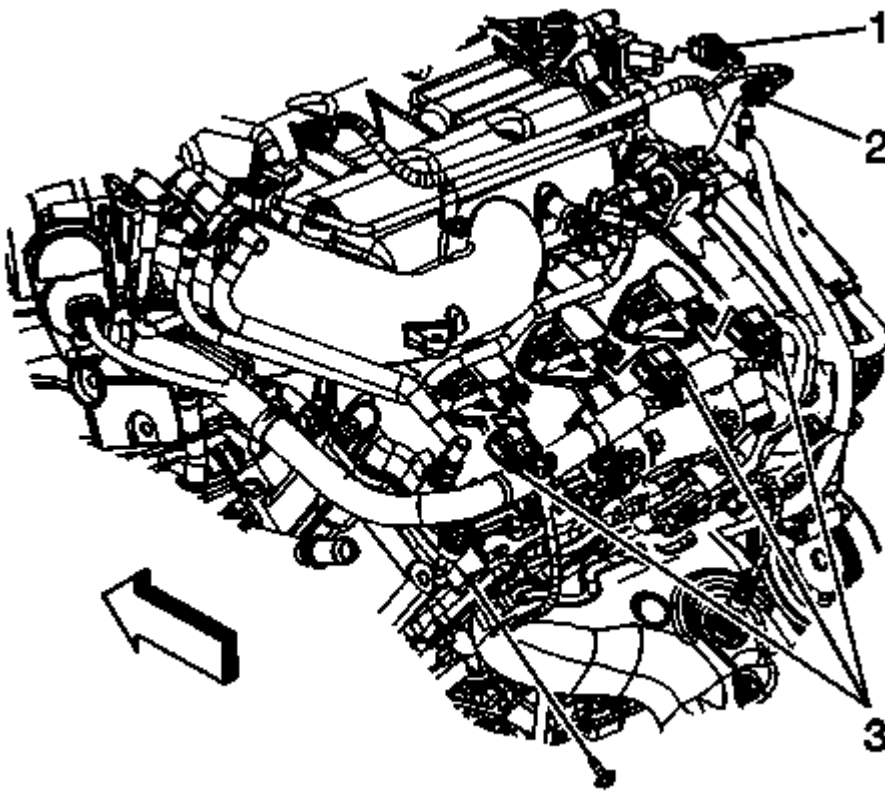
**Fig. 23: Identifying Camshaft Position Sensors**  
Courtesy of GENERAL MOTORS CORP.

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



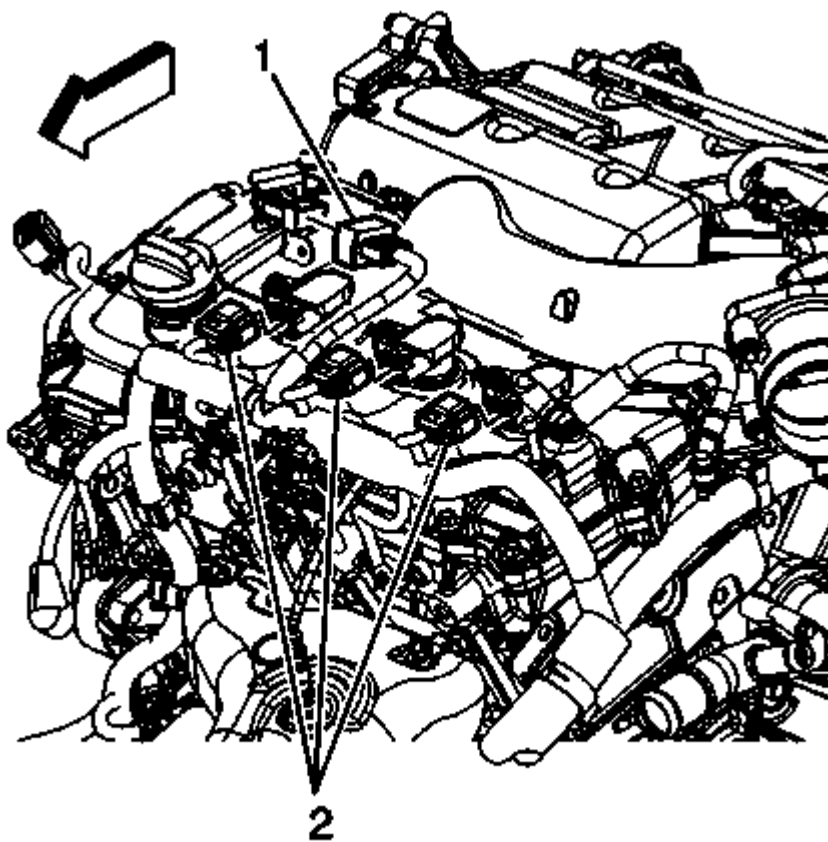
**Fig. 24: Identifying MAP Sensor**  
Courtesy of GENERAL MOTORS CORP.

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



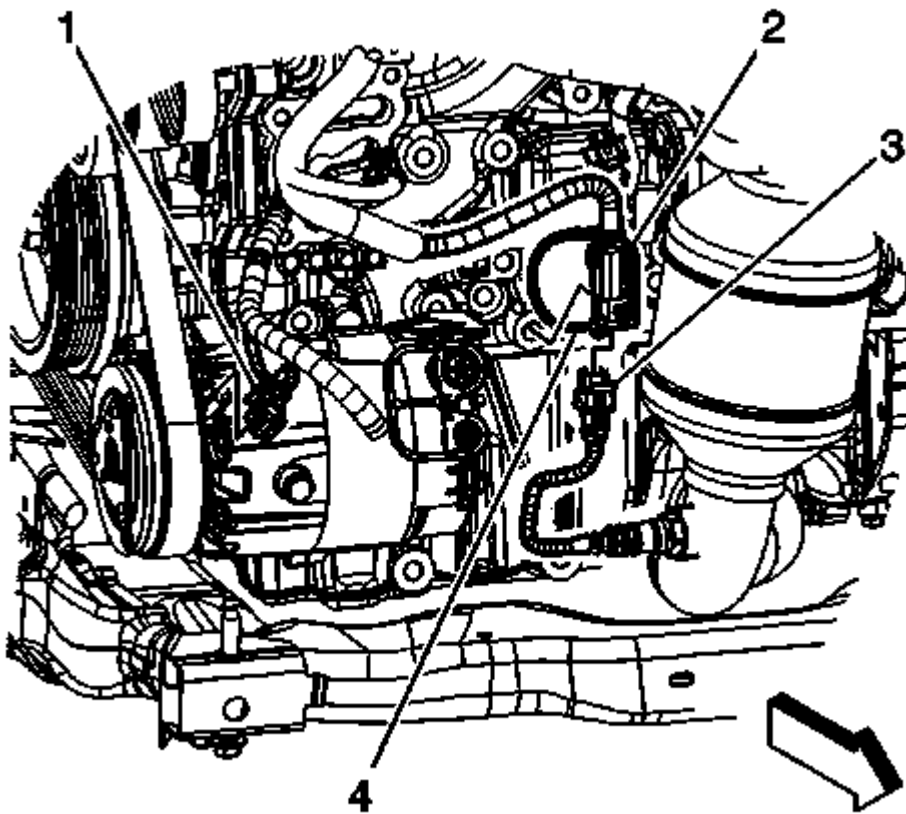
**Fig. 25: Identifying EVAP Canister Purge Solenoid, Ignition Coils & Intake Manifold Tuning Valve**  
Courtesy of GENERAL MOTORS CORP.

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



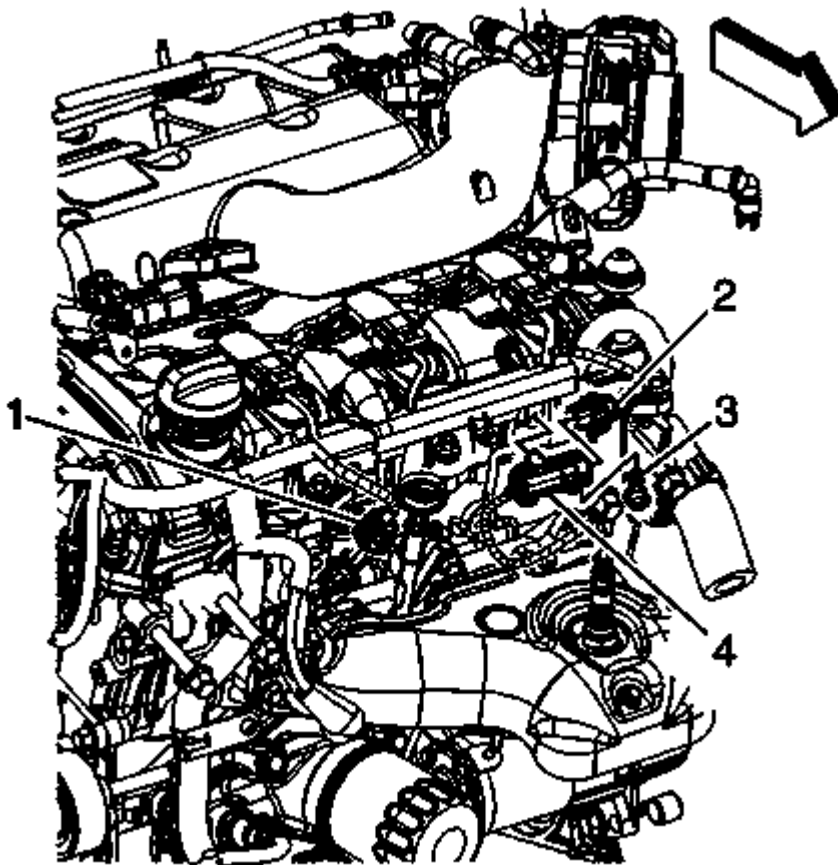
**Fig. 26: Identifying Ignition Coils & Fuel Injector Wiring Harness Connector**  
Courtesy of GENERAL MOTORS CORP.

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



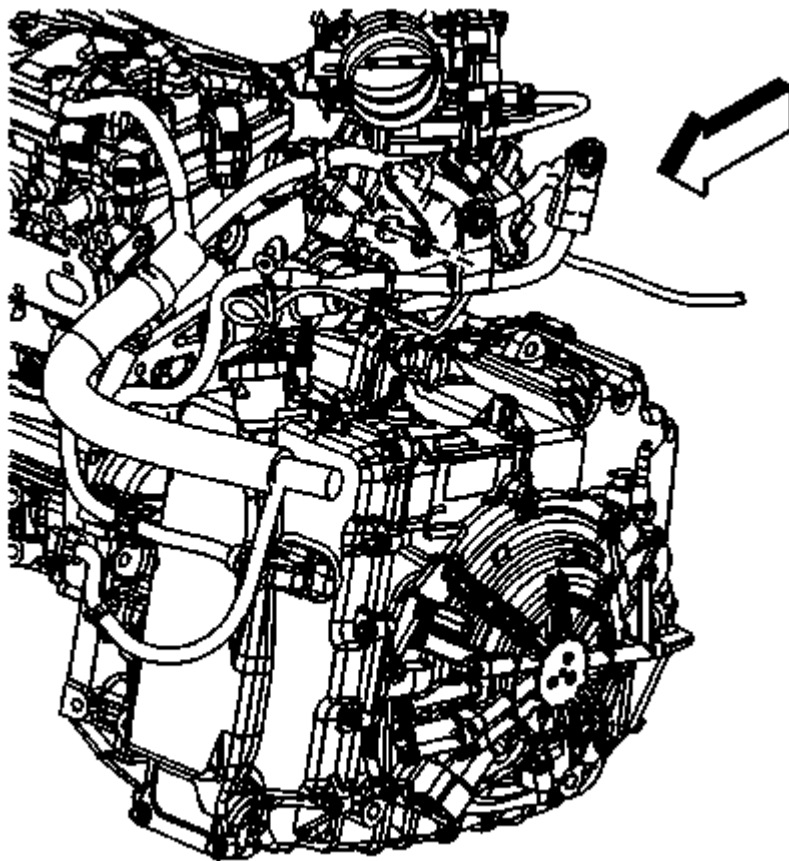
**Fig. 27: Identifying A/C compressor Connector**  
Courtesy of GENERAL MOTORS CORP.

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



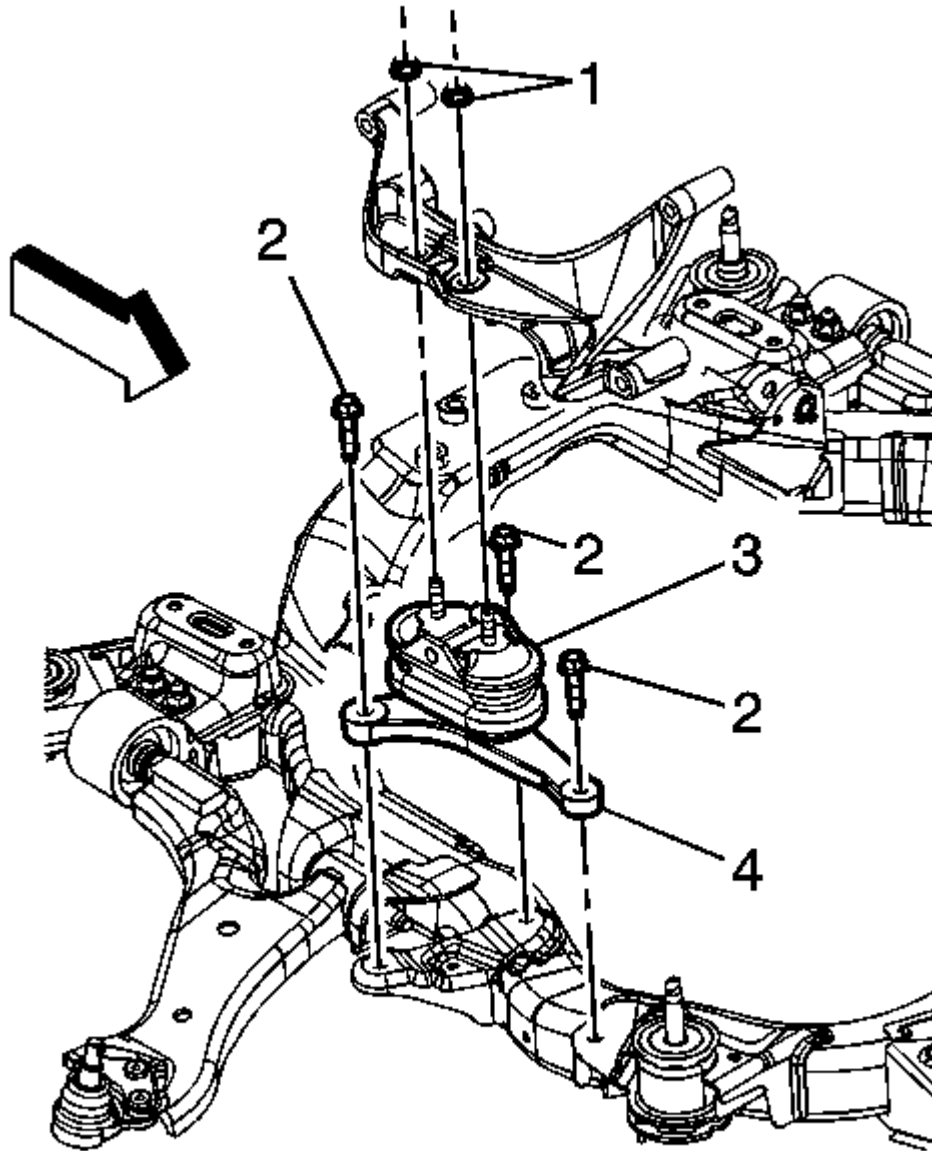
**Fig. 28: Identifying Coolant Temperature Sensor**  
 Courtesy of GENERAL MOTORS CORP.

16. Disconnect the coolant temperature sensor (1).
17. Disconnect the following electrical connectors:
  - The heated oxygen sensor (HO2S)
  - The exhaust gas recirculation (EGR) valve
  - The electronic throttle control
  - The body wiring harness-to-engine harness
18. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
19. Remove the catalytic converters. Refer to **Catalytic Converter Replacement - Left Side (LY7)** and **Catalytic Converter Replacement - Right Side (LY7)** .



**Fig. 29: Identifying Engine Wiring Harness**  
Courtesy of GENERAL MOTORS CORP.

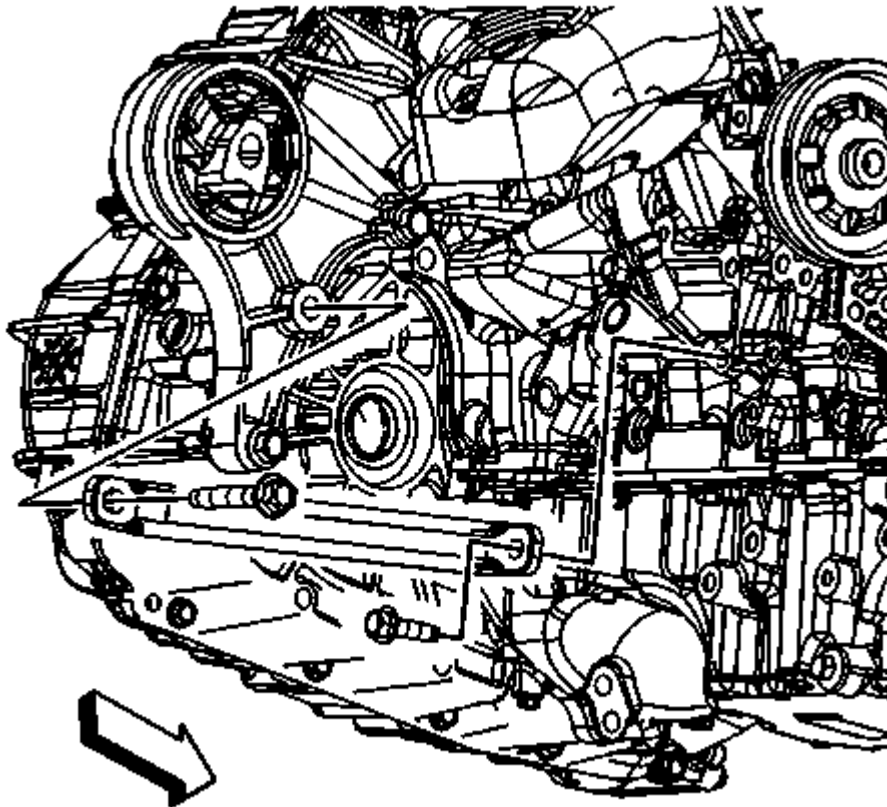
20. Remove the engine wiring harness grounds from the transaxle.



**Fig. 30: Identifying Lower Engine Mount Bolts**  
 Courtesy of GENERAL MOTORS CORP.

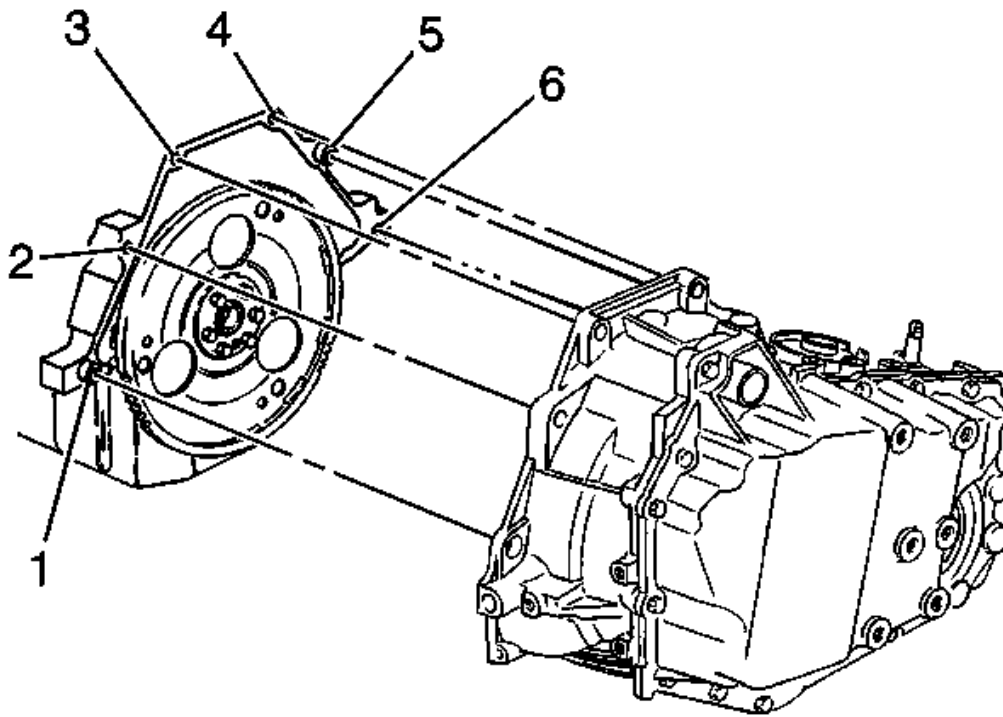
21. Remove the engine mount lower bolts (2).
22. Remove the torque converter covers.
23. Remove the starter motor. Refer to **Starter Replacement (LY7)**.

24. Remove the air conditioning (A/C) compressor. DO NOT discharge the A/C system. Support the compressor. Refer to **Air Conditioning Compressor Replacement (LY7)**.
25. Remove the power steering pump and position aside. Refer to **Power Steering Pump Replacement (LZ4, LZ9)**.
26. Remove the torque converter bolts.
27. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.



**Fig. 31: Identifying Oil Pan Brace Bolt & Brace**  
Courtesy of GENERAL MOTORS CORP.

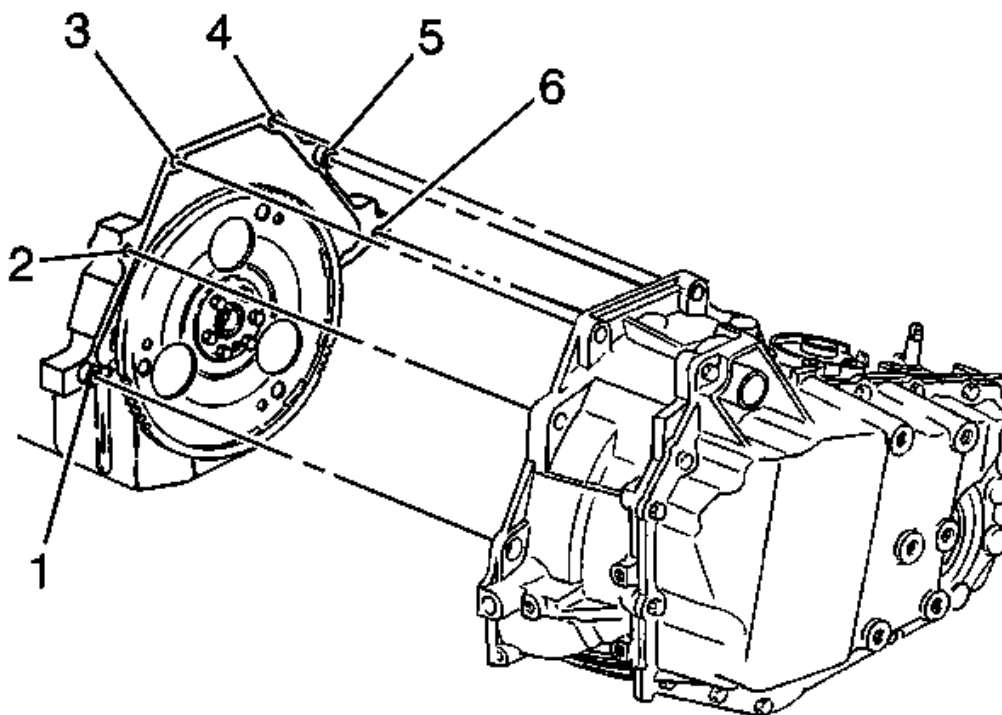
28. Remove the transaxle to oil pan brace bolts and brace.



**Fig. 32: View of Transaxle To Engine Mounting**  
**Courtesy of GENERAL MOTORS CORP.**

29. Remove the lower transaxle-to-engine bolt (6) and the stud (1).
30. Remove the radiator outlet hose from the engine. Refer to **Radiator Outlet Hose Replacement (LY7)** .
31. Lower the vehicle and support the transaxle.
32. Remove the engine coolant thermostat housing from the engine.
33. Remove the vacuum hoses from the upper intake manifold.
34. Remove the brake booster vacuum hose from the upper intake manifold.
35. Remove the fuel lines from the fuel rail. Refer to **Fuel Injector and Fuel Rail Replacement** .
36. Remove the battery ground from the rear of engine.
37. Remove the radiator inlet hose from the engine. Refer to **Radiator Inlet Hose Replacement (LY7)** .
38. Install the engine lifting device to the engine.
39. Remove the upper transaxle-to-engine bolts (3, 4, 5) and the stud (2).
40. Remove the engine from the vehicle.
41. Remove the flywheel. Refer to **Engine Flywheel Replacement**.
42. Install the engine to the engine stand.

## Installation Procedure



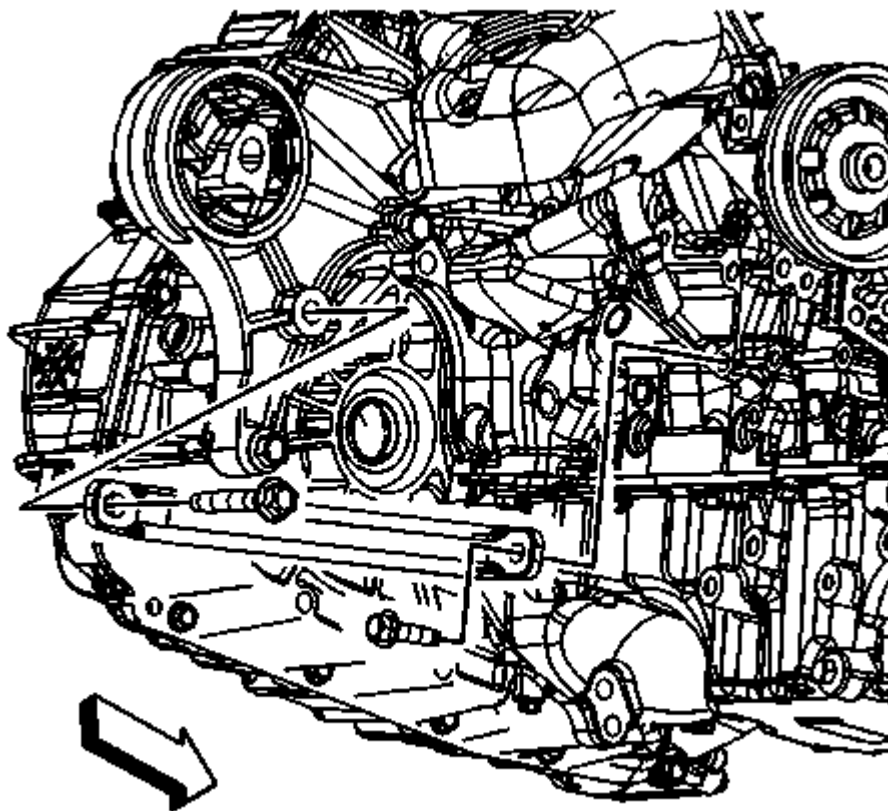
**Fig. 33: View of Transaxle To Engine Mounting**  
Courtesy of GENERAL MOTORS CORP.

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

**CAUTION: Refer to Fastener Caution .**

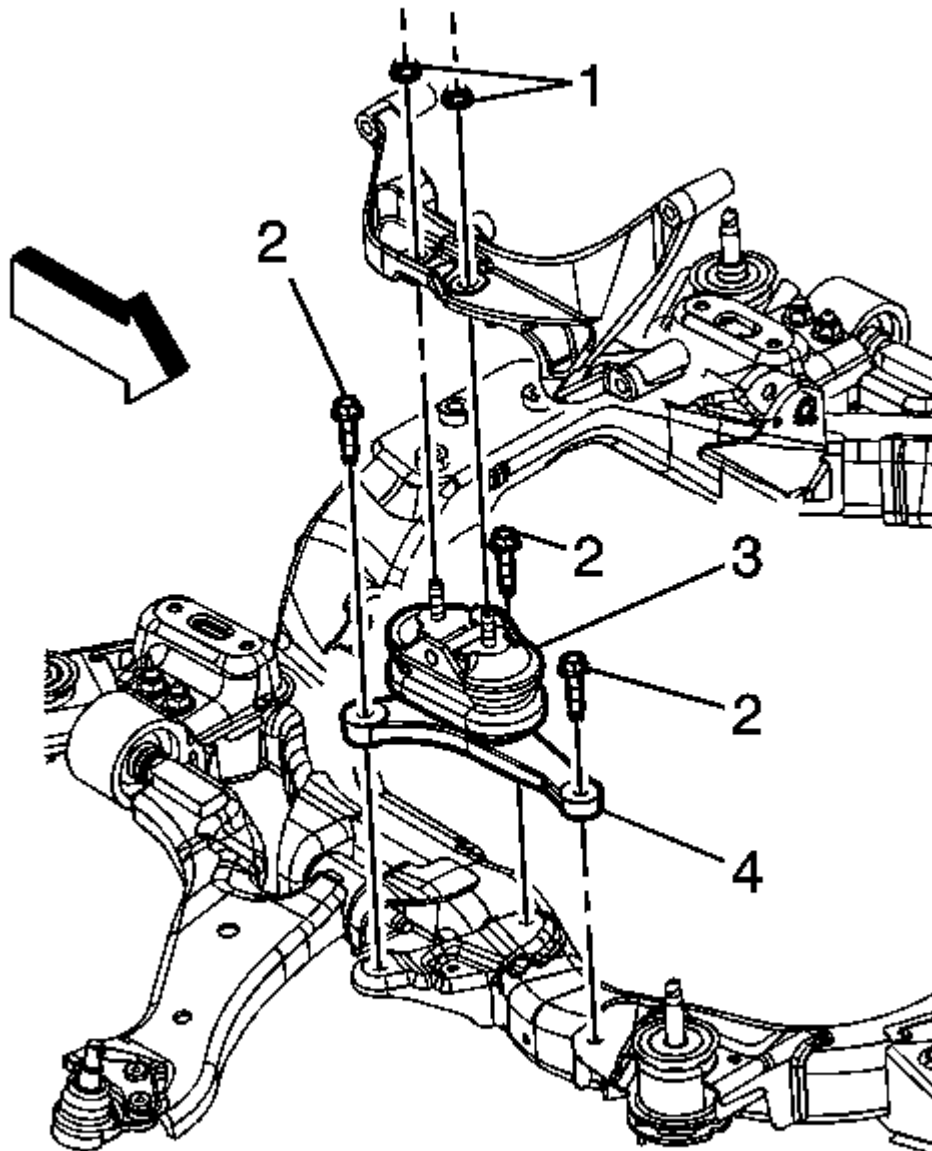
4. Install the upper transaxle-to-engine bolts (3, 4, 5) and the stud (2) and tighten to 75 N.m (55 lb ft).
5. Remove the engine lifting device.
6. Install the radiator inlet hose to the engine. Refer to **Radiator Inlet Hose Replacement (LY7)** .
7. Install the battery ground to the rear of engine.
8. Install the fuel lines to the fuel rail. Refer to **Fuel Injector and Fuel Rail Replacement** .
9. Install the brake booster vacuum hose to the upper intake manifold.

10. Install the vacuum hoses to the upper intake manifold.
11. Install the engine coolant thermostat housing to the engine.
12. Raise the vehicle and remove the transaxle support.
13. Install the radiator outlet hose to the engine. Refer to **Radiator Outlet Hose Replacement (LY7)** .
14. Install the lower transaxle-to-engine bolt (6) and the stud (1) and tighten to 75 N.m (55 lb ft).



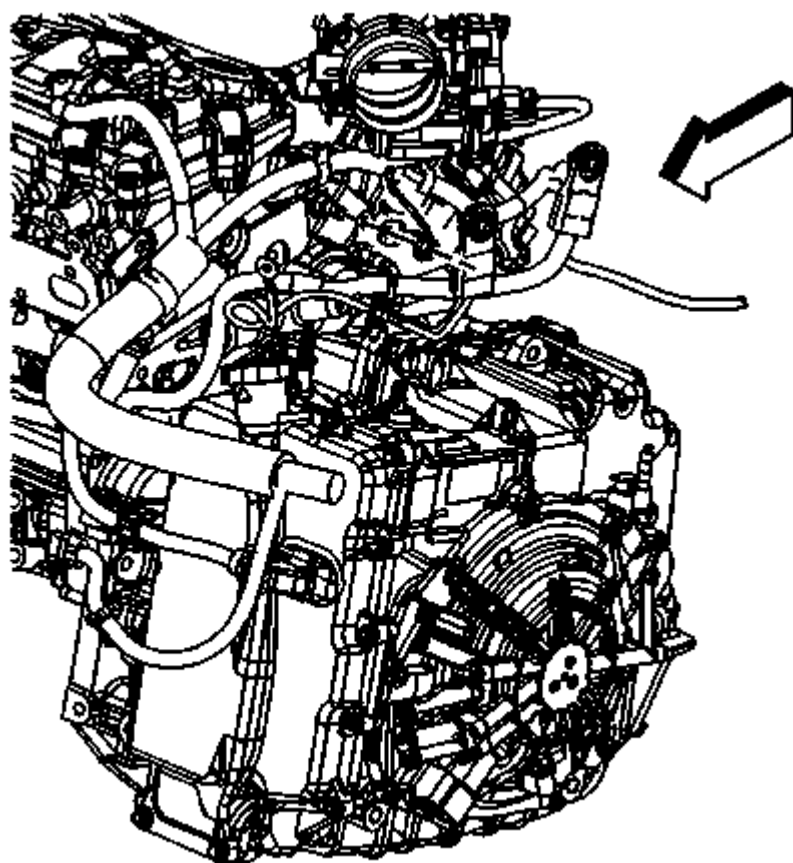
**Fig. 34: Identifying Oil Pan Brace Bolt & Brace**  
Courtesy of GENERAL MOTORS CORP.

15. Position the transaxle to oil pan brace and install the bolts. Tighten the bolts to 50 N.m (37 lb ft).
16. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side** .
17. Install the torque converter bolts.
18. Install the power steering pump. Refer to **Power Steering Pump Replacement (LZ4, LZ9)** .
19. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LY7)** .
20. Install the starter motor. Refer to **Starter Replacement (LY7)** .
21. Install the torque converter covers.



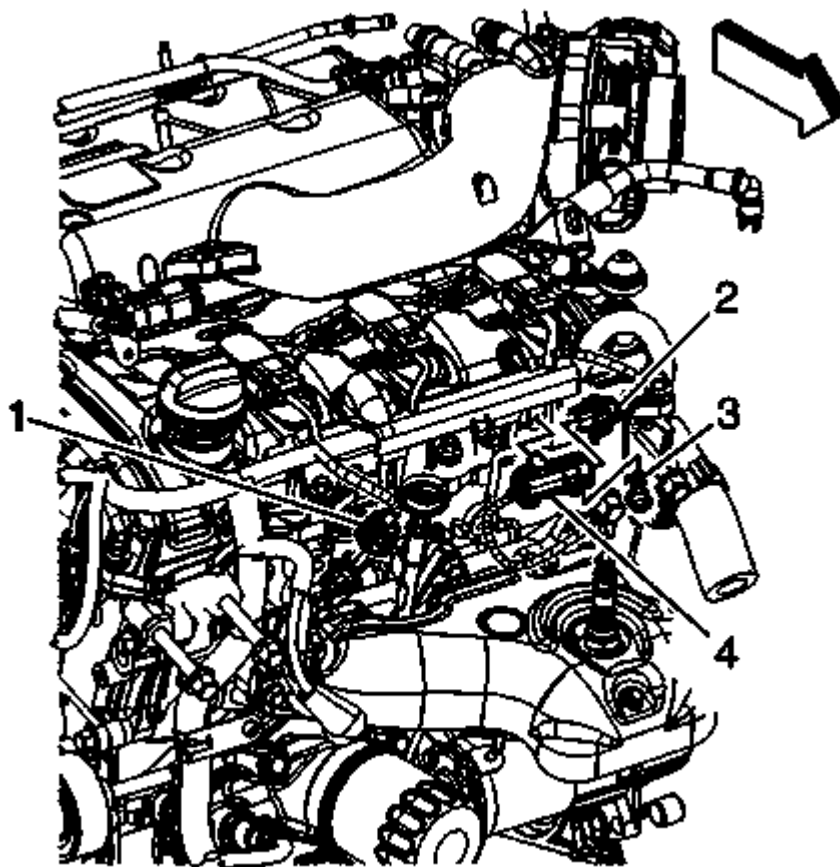
**Fig. 35: Identifying Lower Engine Mount Bolts**  
Courtesy of GENERAL MOTORS CORP.

22. Install the engine mount lower bolts (2) and tighten to 50 N.m (38 lb ft).



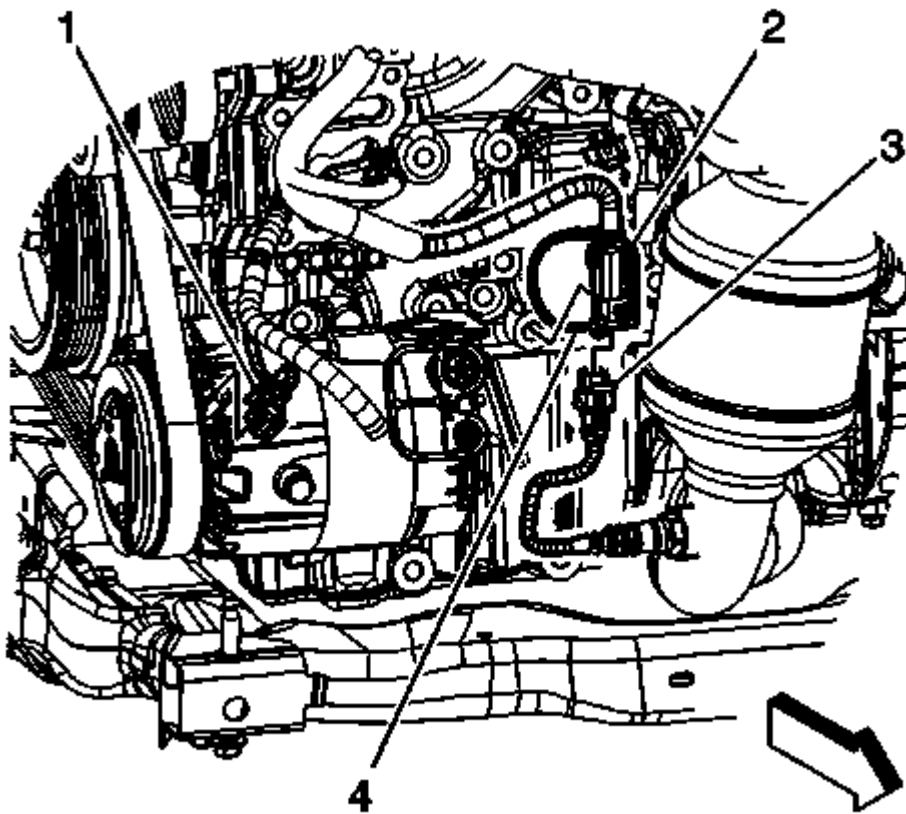
**Fig. 36: Identifying Engine Wiring Harness**  
Courtesy of GENERAL MOTORS CORP.

23. Install the engine wiring harness grounds to the transaxle.
24. Install the engine wiring harness ground nut to the transaxle stud and tighten the nut to 35 N.m (26 lb ft).
25. Install the catalytic converters. Refer to **Catalytic Converter Replacement - Left Side (LY7)** and **Catalytic Converter Replacement - Right Side (LY7)** .
26. Lower the vehicle.
27. Connect the following electrical connectors:
  - The body wiring harness-to-engine harness
  - The electronic throttle control
  - The EGR valve
  - The HO2S



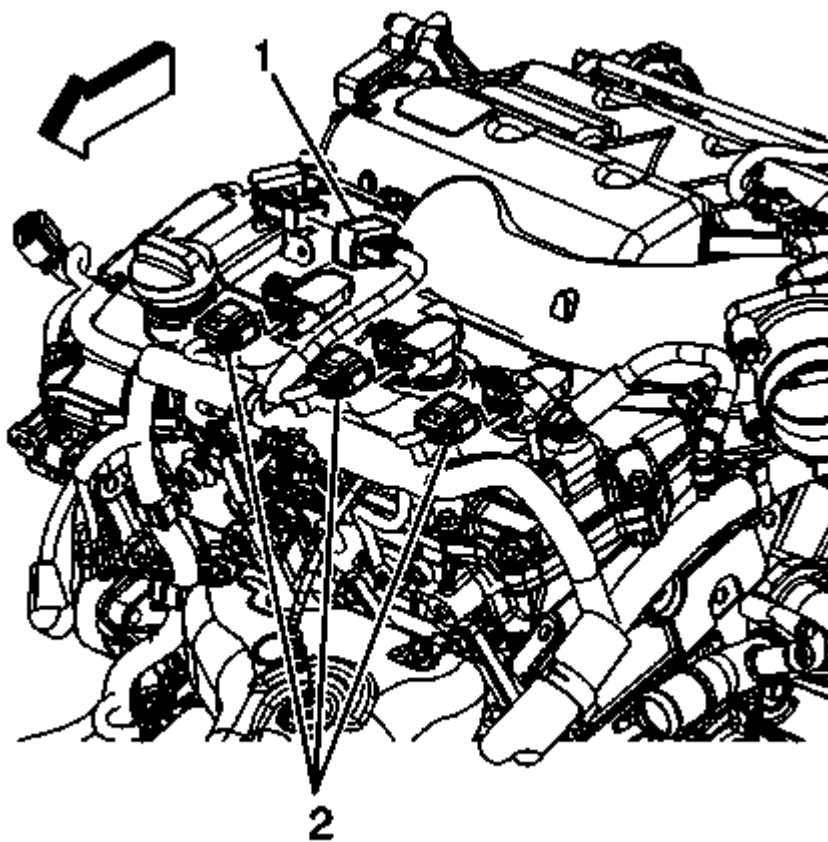
**Fig. 37: Identifying Coolant Temperature Sensor**  
Courtesy of GENERAL MOTORS CORP.

28. Connect the coolant temperature sensor (1).



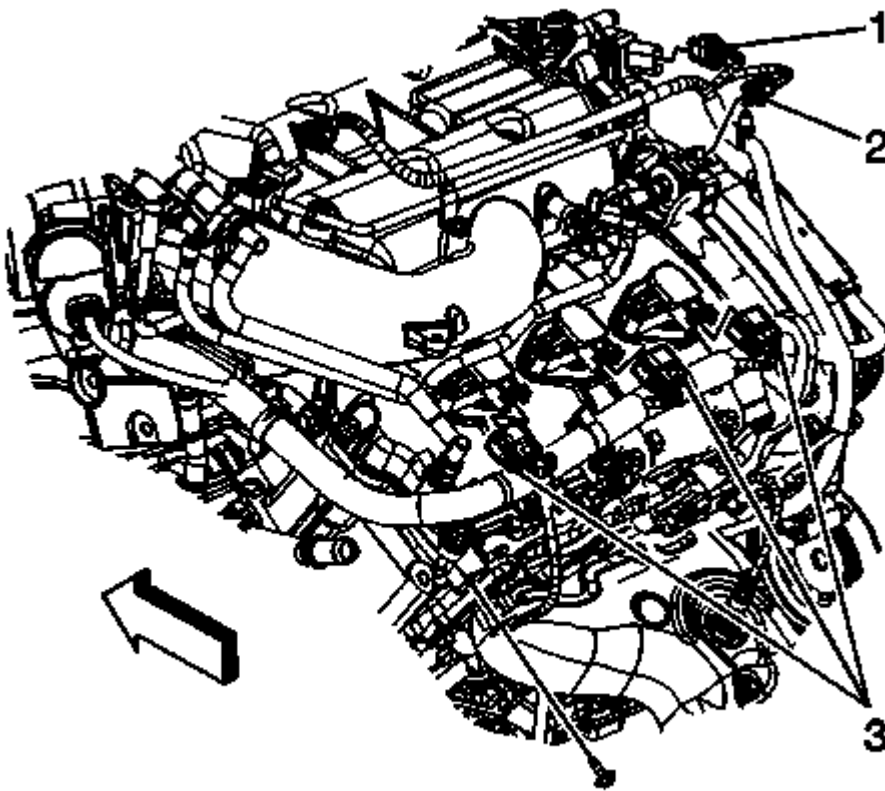
**Fig. 38: Identifying A/C compressor Connector**  
Courtesy of GENERAL MOTORS CORP.

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



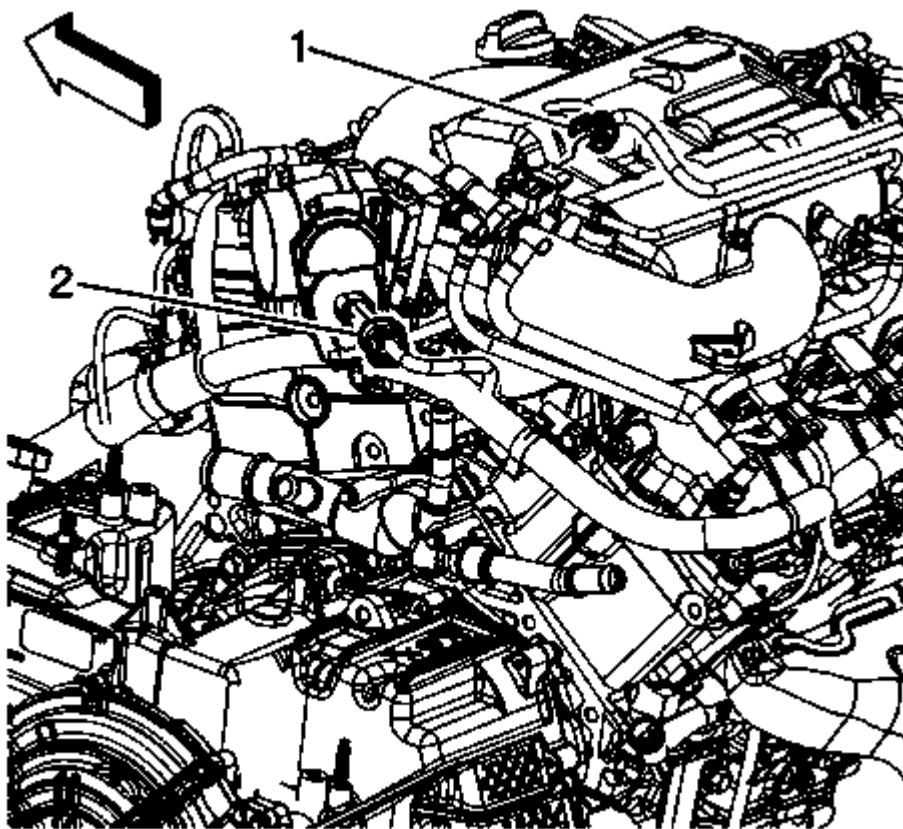
**Fig. 39: Identifying Ignition Coils & Fuel Injector Wiring Harness Connector**  
Courtesy of GENERAL MOTORS CORP.

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



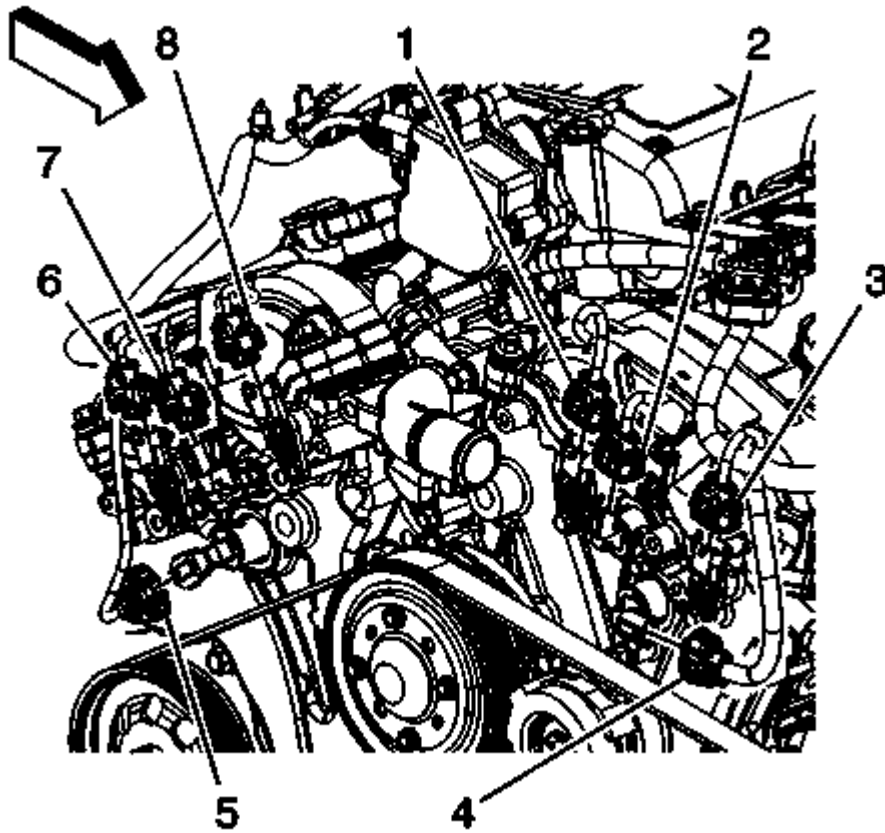
**Fig. 40: Identifying EVAP Canister Purge Solenoid, Ignition Coils & Intake Manifold Tuning Valve**  
Courtesy of GENERAL MOTORS CORP.

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



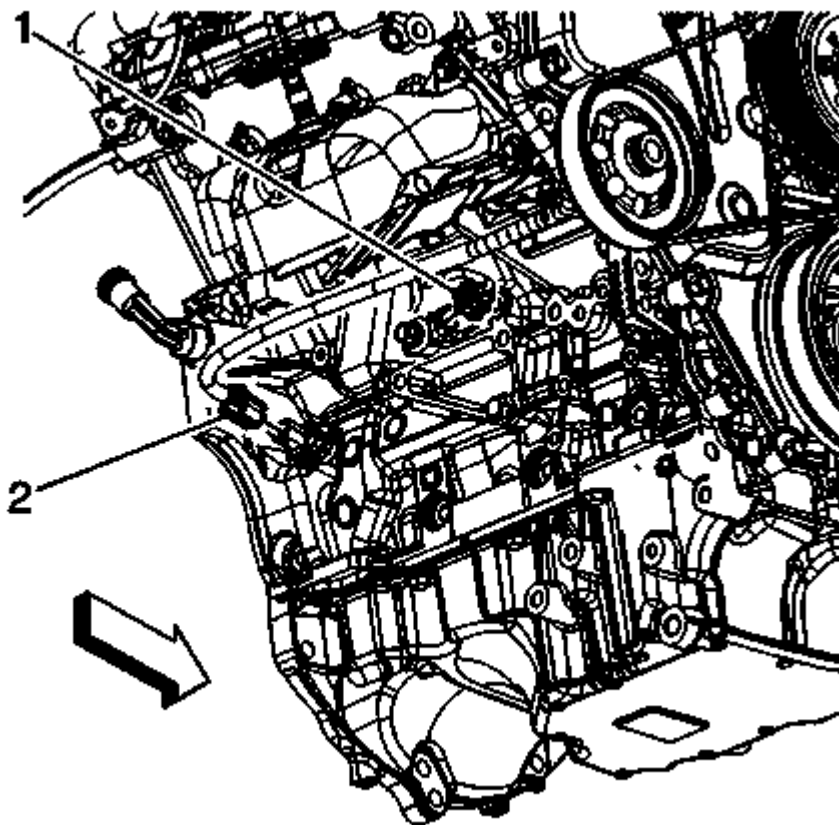
**Fig. 41: Identifying MAP Sensor**  
**Courtesy of GENERAL MOTORS CORP.**

32. Connect the MAP sensor (1).



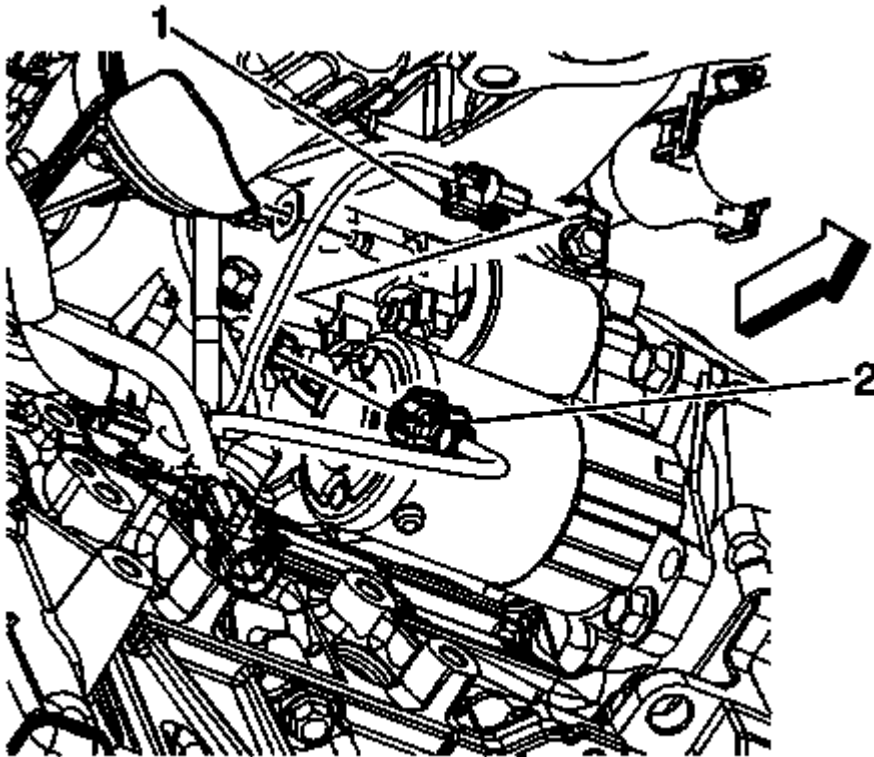
**Fig. 42: Identifying Camshaft Position Sensors**  
Courtesy of GENERAL MOTORS CORP.

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



**Fig. 43: Identifying Knock Sensor**  
Courtesy of GENERAL MOTORS CORP.

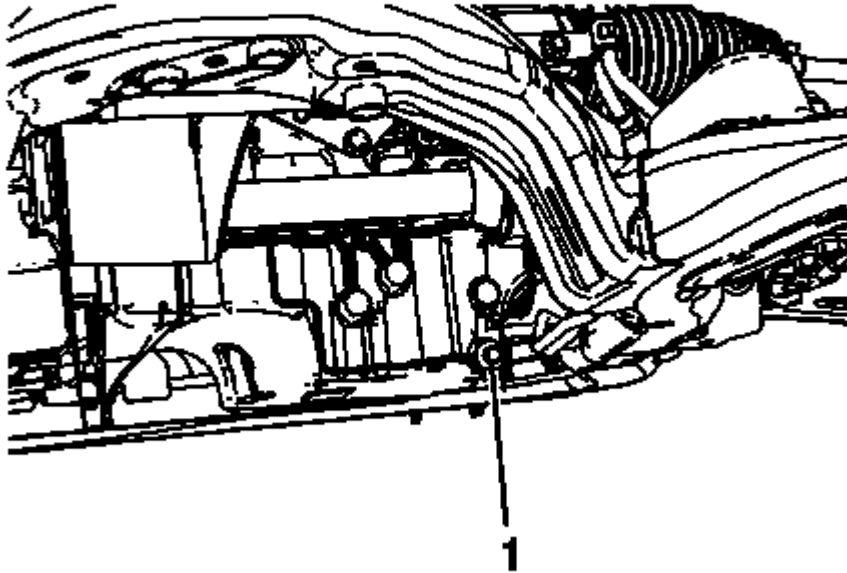
34. Connect the rear KS (1).



**Fig. 44: Identifying Front Knock Sensor**  
Courtesy of GENERAL MOTORS CORP.

35. Connect the front KS (2) and the crank sensor. Refer to **Crankshaft Position Sensor Replacement** .
36. Install the drive belt. Refer to **Drive Belt Replacement** .
37. Install the engine mount snubber. Refer to **Engine Mount Snubber Replacement** .
38. Install the hood. Refer to **Hood Replacement** .
39. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
40. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
41. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement** .
42. Fill cooling system. Refer to **Cooling System Draining and Filling (GE 47716 Fill)** or **Cooling System Draining and Filling (LY7, LZE, LZ4, LZ9)** .
43. Perform a CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .
44. Install the intake manifold cover. Refer to **Fuel Injector Sight Shield Replacement** .
45. Inspect for leaks.

## ENGINE OIL AND OIL FILTER REPLACEMENT

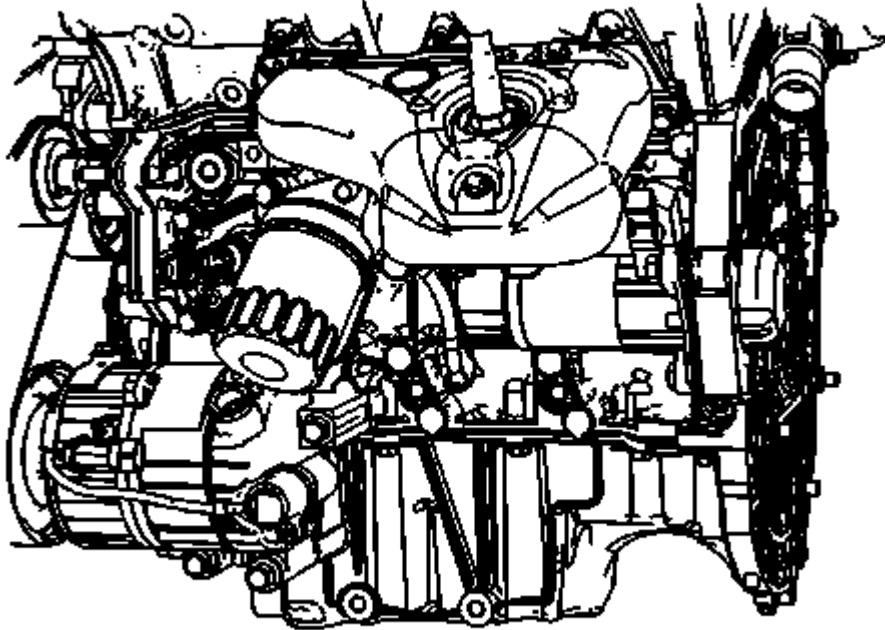
**Removal Procedure**

**Fig. 45: Locating Oil Drain Plug**  
Courtesy of GENERAL MOTORS CORP.

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 (1). Allow the oil to drain completely.

**CAUTION: Refer to Fastener Caution .**

4. Install the oil pan drain plug (1) and tighten to 20 N.m (15 lb ft).



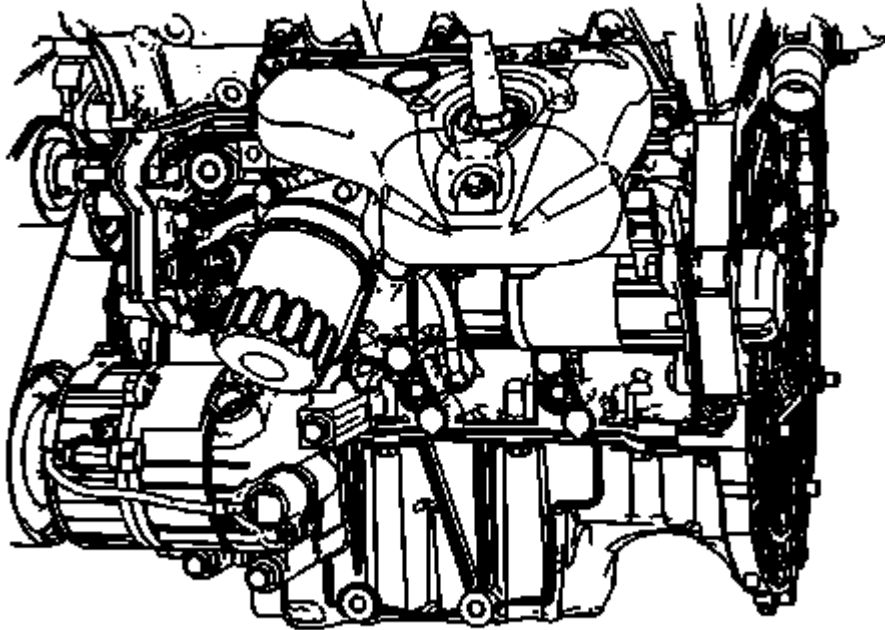
**Fig. 46: View of Oil Filter**

Courtesy of GENERAL MOTORS CORP.

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

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

**Installation Procedure**



**Fig. 47: View of Oil Filter**

**Courtesy of GENERAL MOTORS CORP.**

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Tighten the oil filter 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.