

2014 ENGINE

Engine Mechanical - 3.6L (LFX) - Repair Instructions - On Vehicle - LaCrosse

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

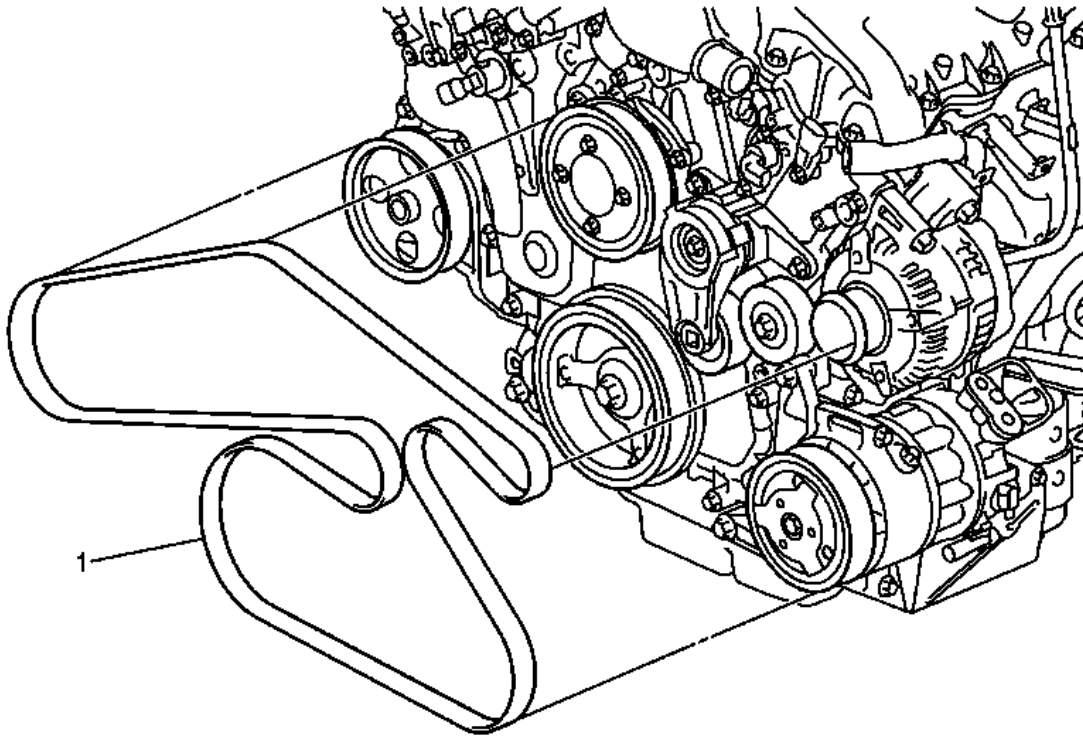


Fig. 1: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

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

DRIVE BELT TENSIONER REPLACEMENT

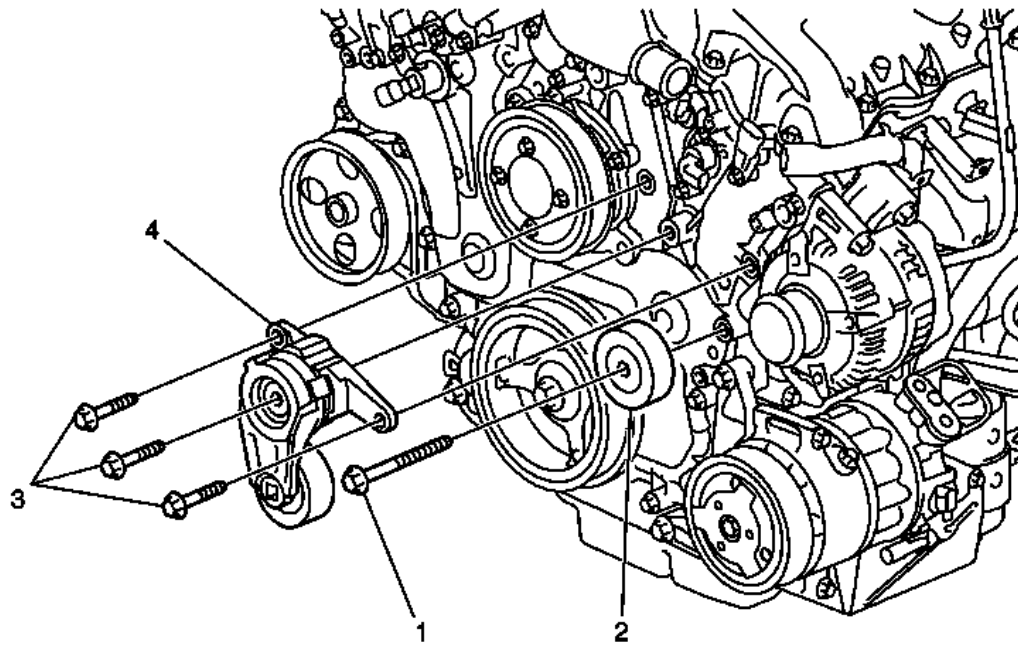


Fig. 2: View Of Drive Belt Tensioner, Idler Pulley & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

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

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

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

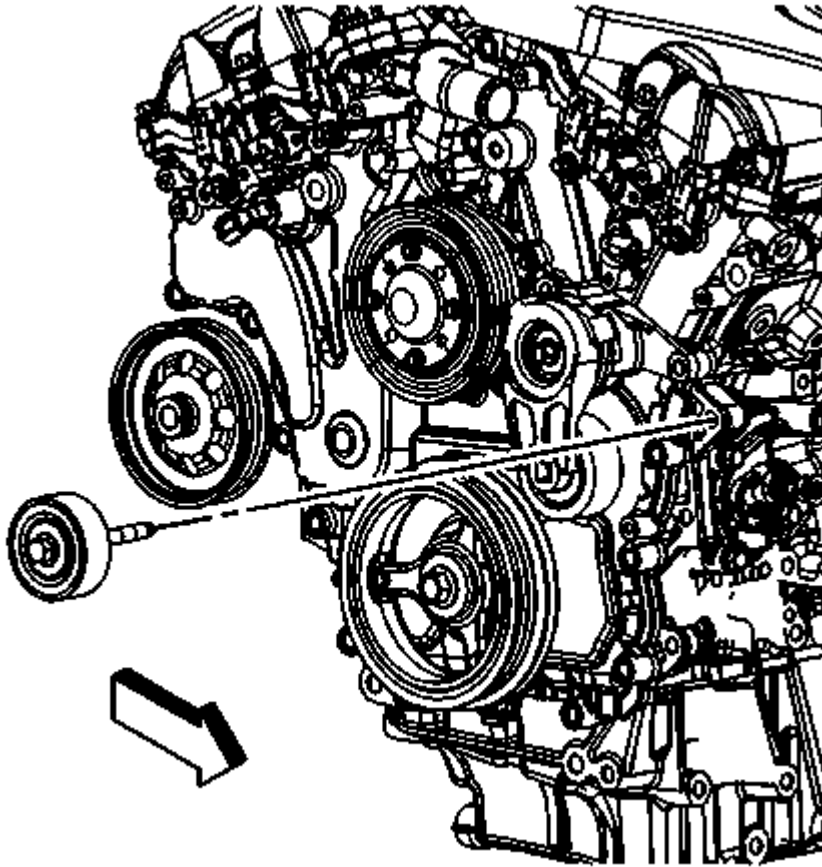


Fig. 3: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

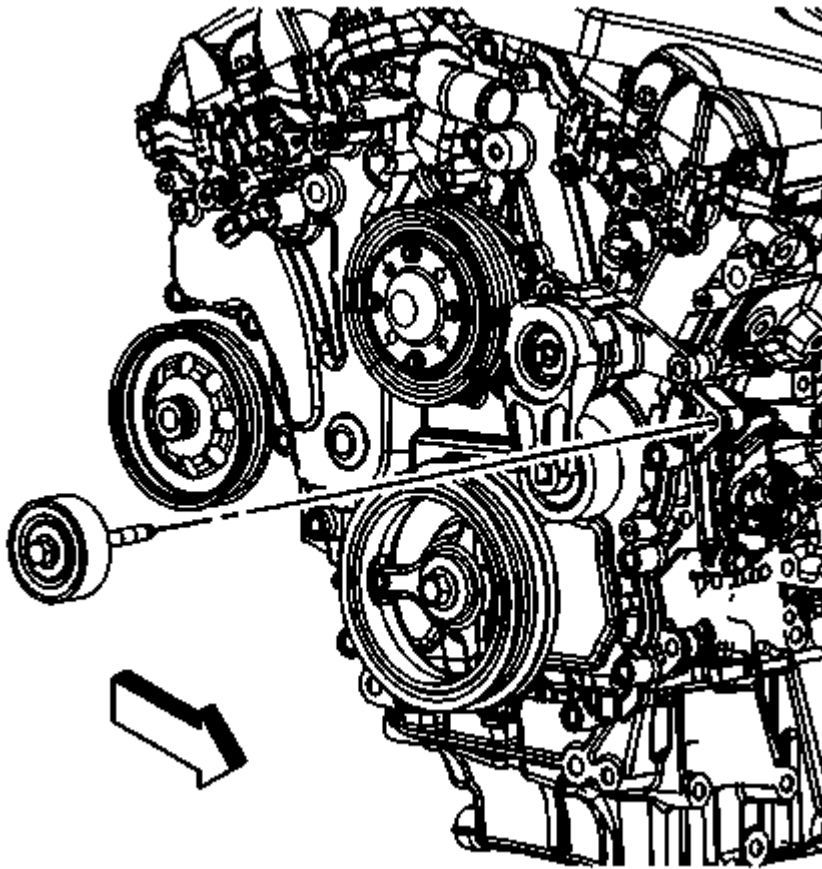


Fig. 4: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt idler pulley.

CAUTION: Refer to Fastener Caution .

2. Install the drive belt idler pulley bolt.

Tighten

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

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

ENGINE SUPPORT FIXTURE

Special Tools

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

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

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

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

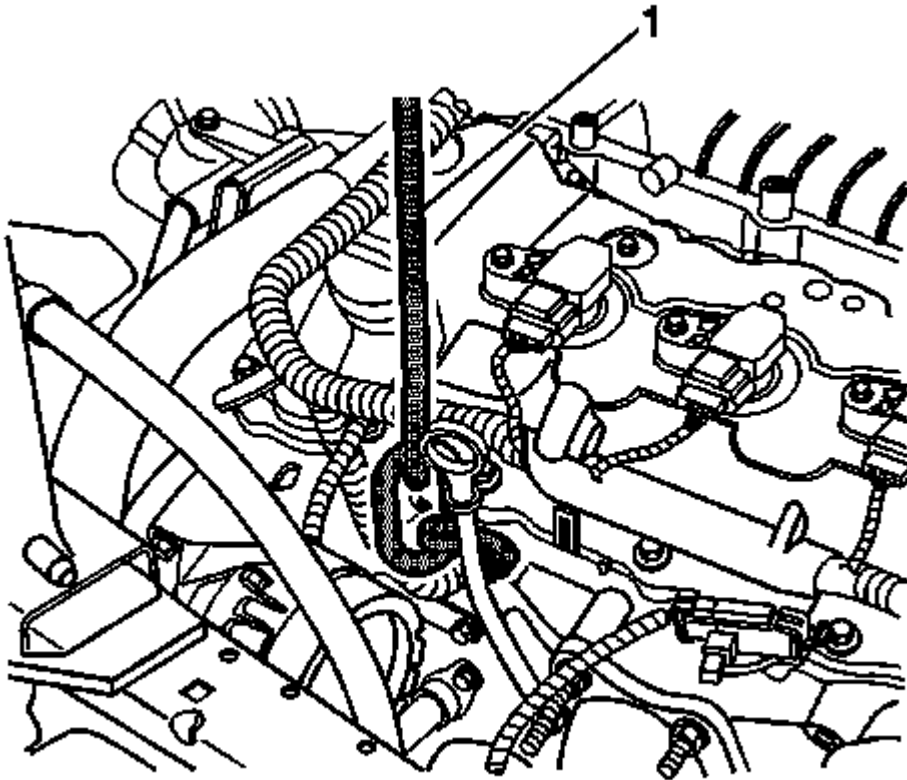


Fig. 5: View Of Engine Lift Bracket (Right Cylinder Head)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

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

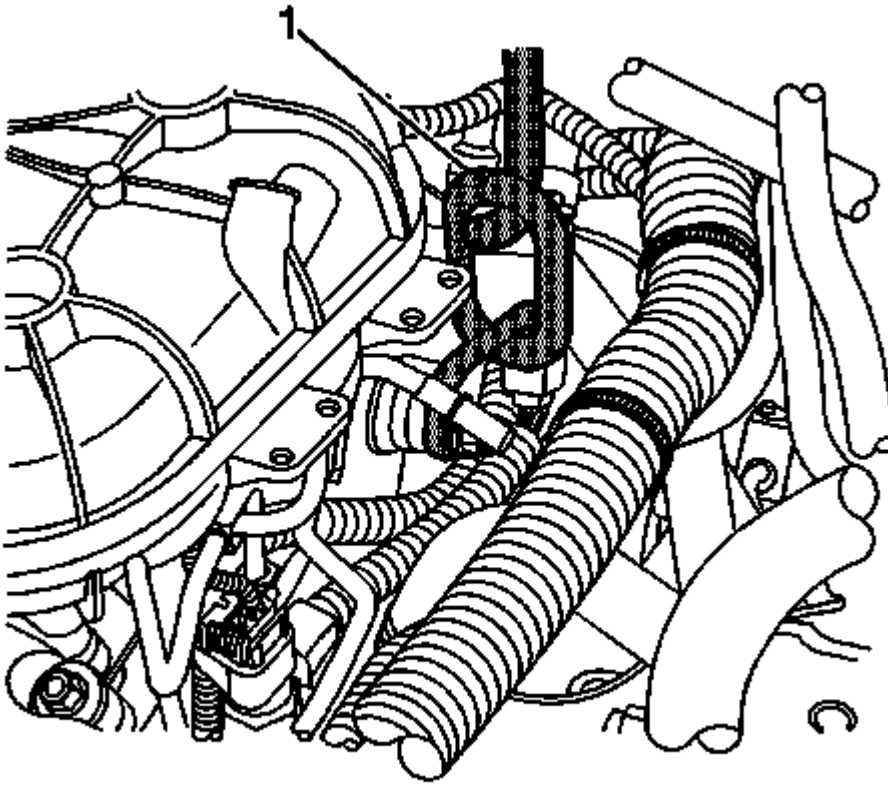


Fig. 6: Identifying Engine Lift Bracket (Left Cylinder Head)
Courtesy of GENERAL MOTORS COMPANY

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

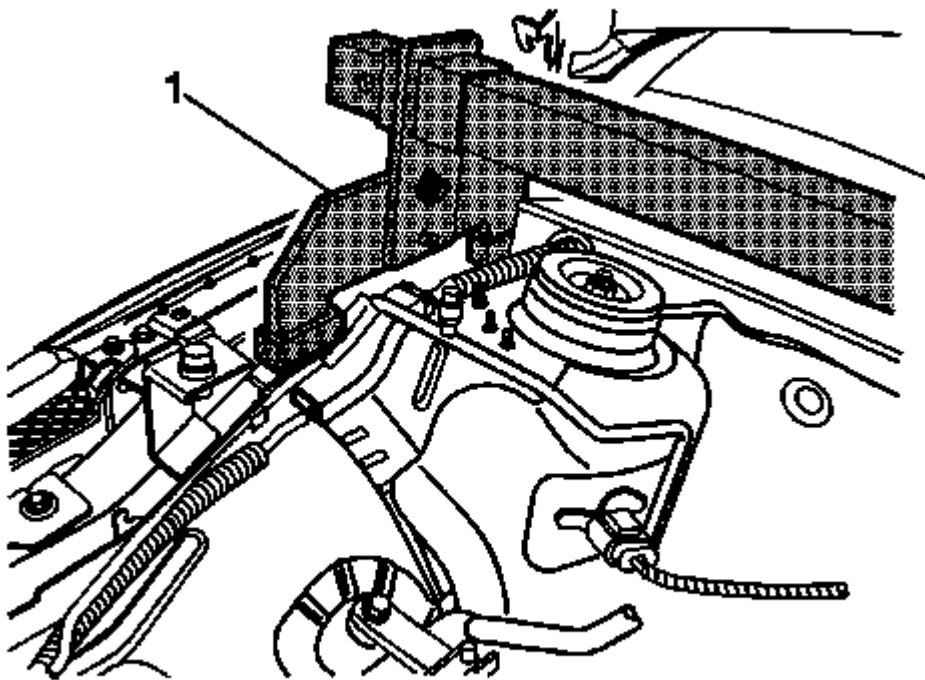


Fig. 7: Universal Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

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

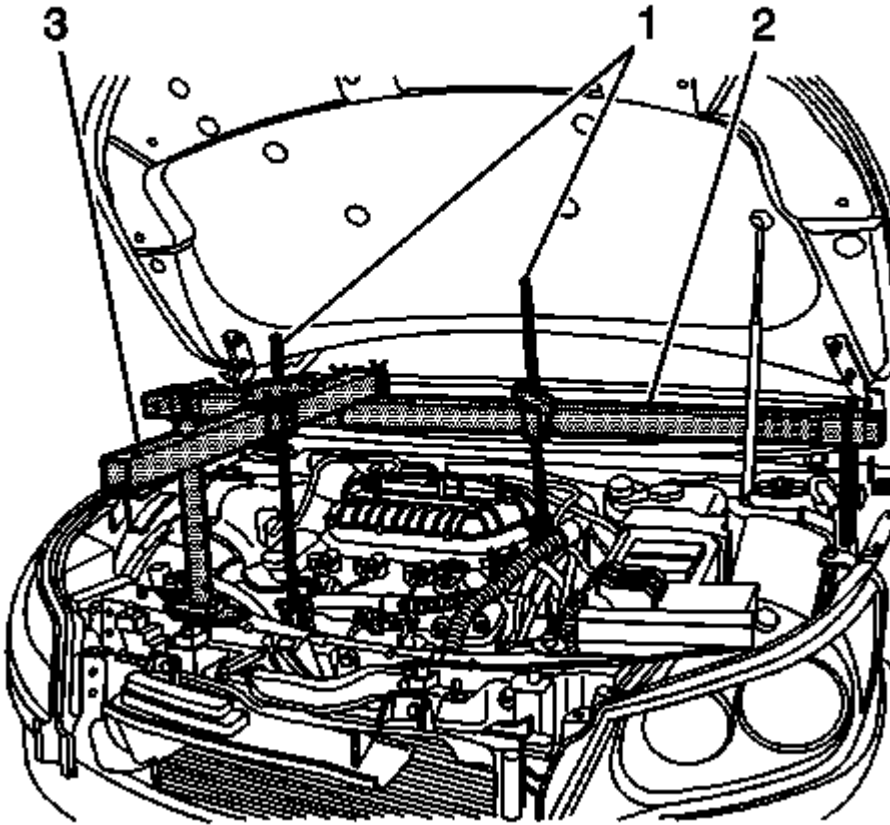


Fig. 8: Support Hooks

Courtesy of GENERAL MOTORS COMPANY

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

ENGINE MOUNT INSPECTION

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

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

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

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

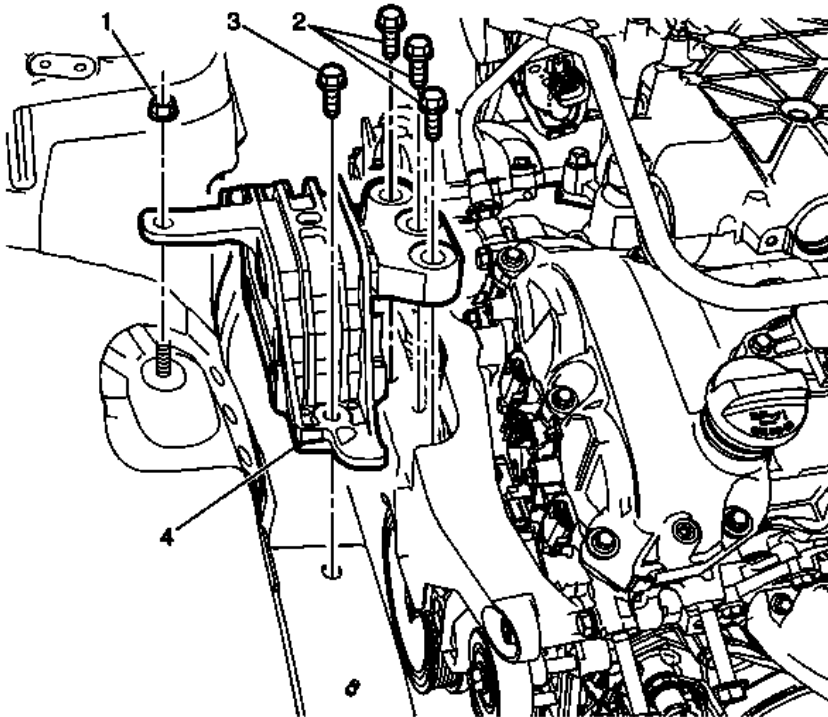


Fig. 9: View Of Engine Mount - Right Side

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Right Side

Callout	Component Name
Preliminary Procedures	
1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LFW or LFX)</u>. 2. Install engine support fixture. Refer to <u>Engine Support Fixture</u>. 3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation. If all powertrain mounts are replaced, perform "Powertrain Mount Balancing". Refer to the appropriate engine section.	
	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	NOTE: Perform the "Powertrain Mount Balancing-lower". Refer to the appropriate engine section.
1	Tighten 62 (46 lb ft)
2	Engine Mount Fastener (Qty: 3) Tighten 50 (37 lb ft) +60-75°
3	Engine Mount Fastener (Qty: 2) Tighten 62 (46 lb ft)
4	Engine Mount

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

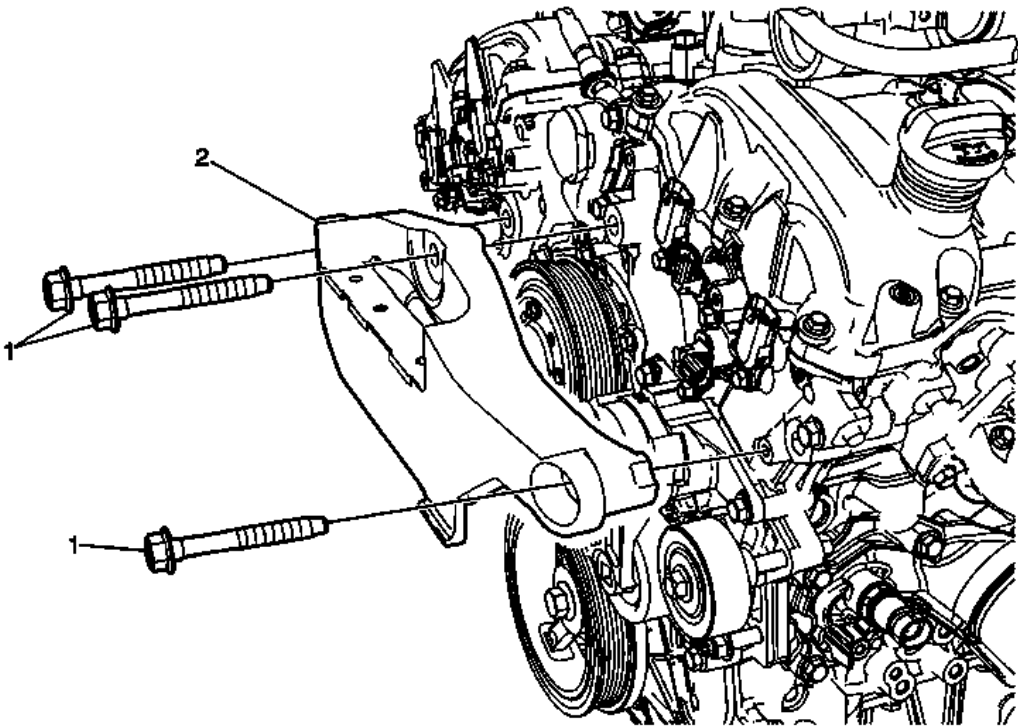


Fig. 10: Identifying Engine Mount Bracket - Right Side
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedures	

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

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

INTAKE MANIFOLD COVER REPLACEMENT

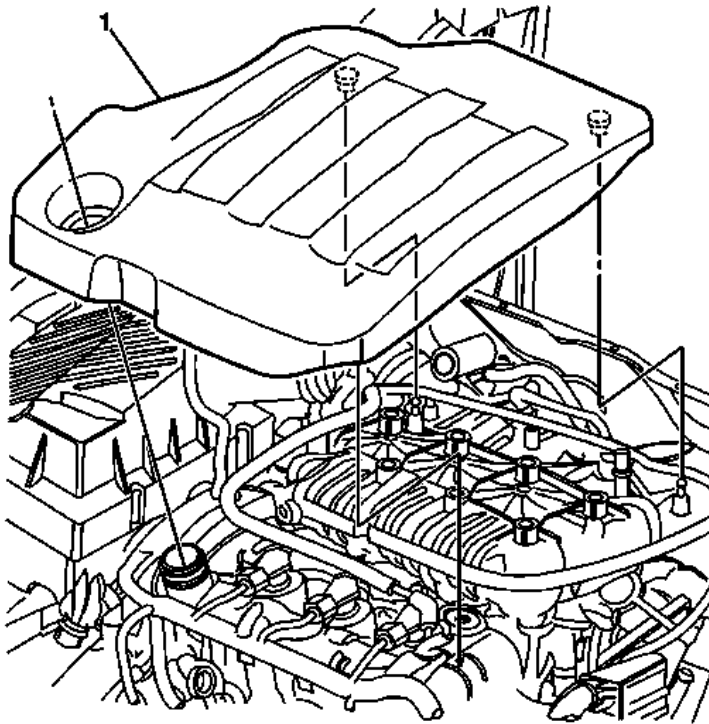


Fig. 11: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
	Intake Manifold Cover

Procedure

1

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

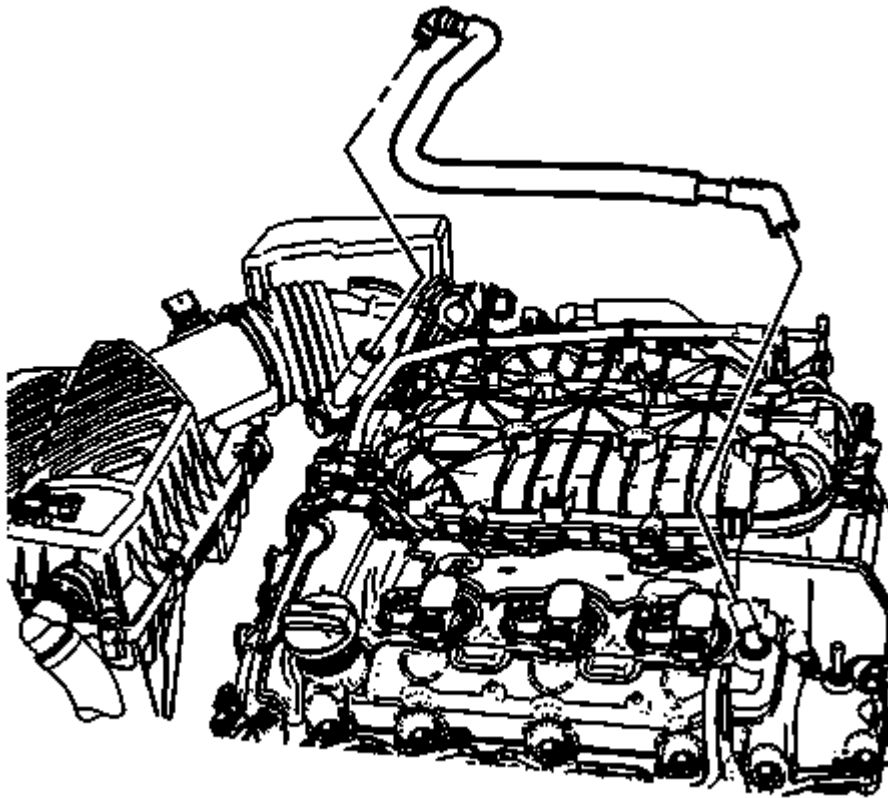
POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT (LF1, LFW OR LFX)**Removal Procedure**

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

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

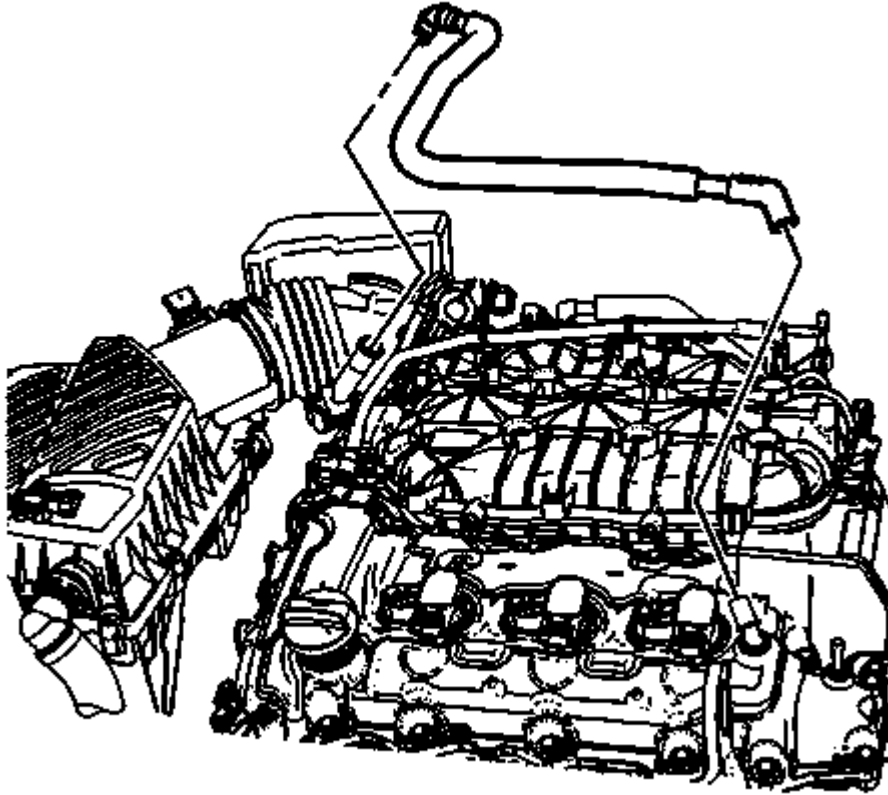
Installation Procedure

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

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

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

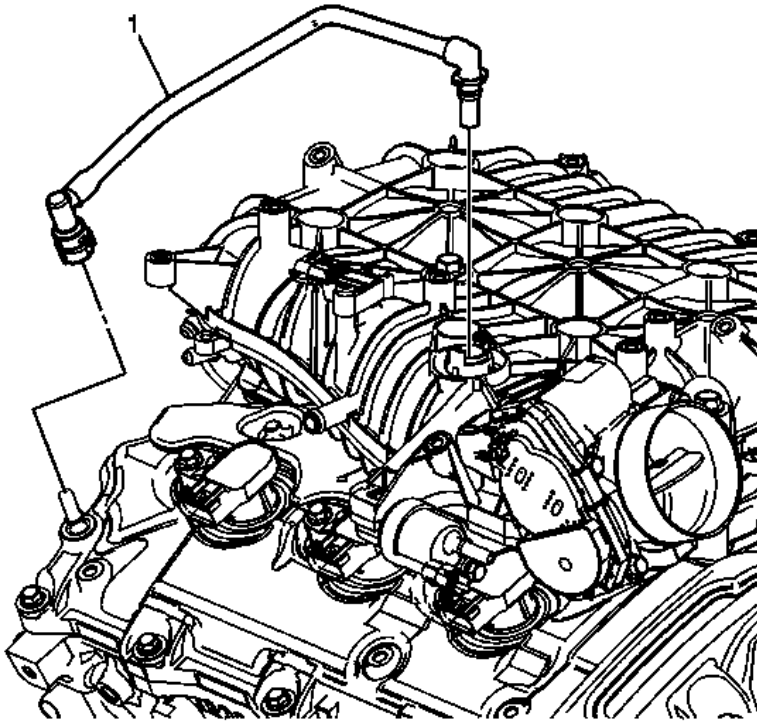


Fig. 14: Positive Crankcase Ventilation Tube Replacement - Rear
Courtesy of GENERAL MOTORS COMPANY

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

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

INTAKE MANIFOLD REPLACEMENT (LF1, LFW OR LFX)

Removal Procedure

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

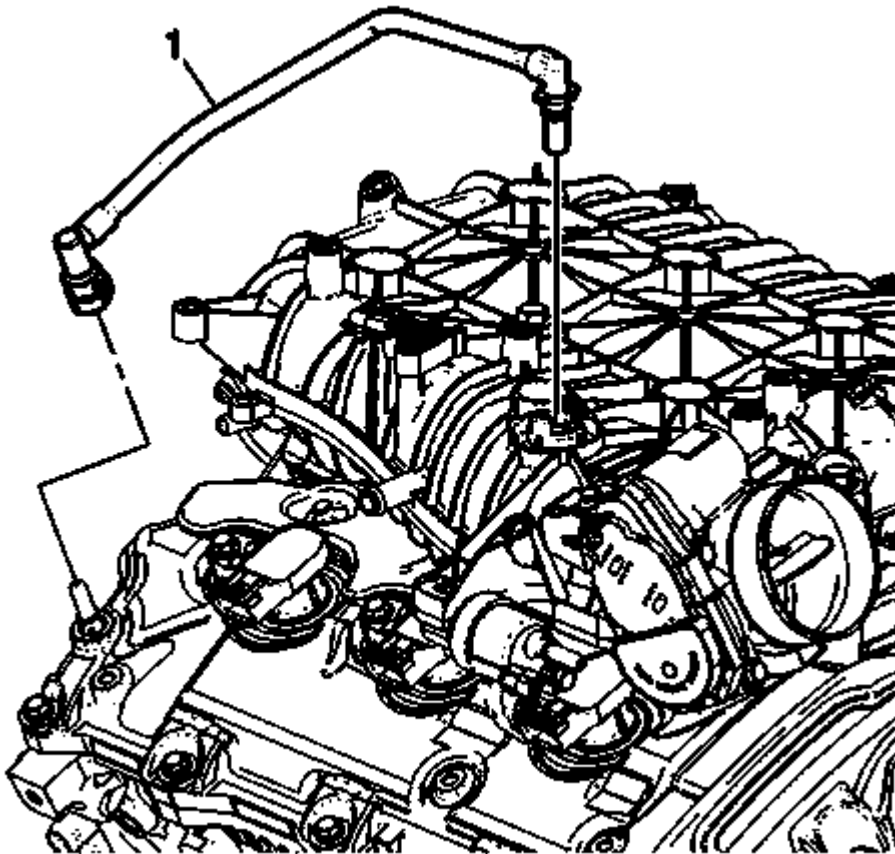


Fig. 15: View Of Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

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

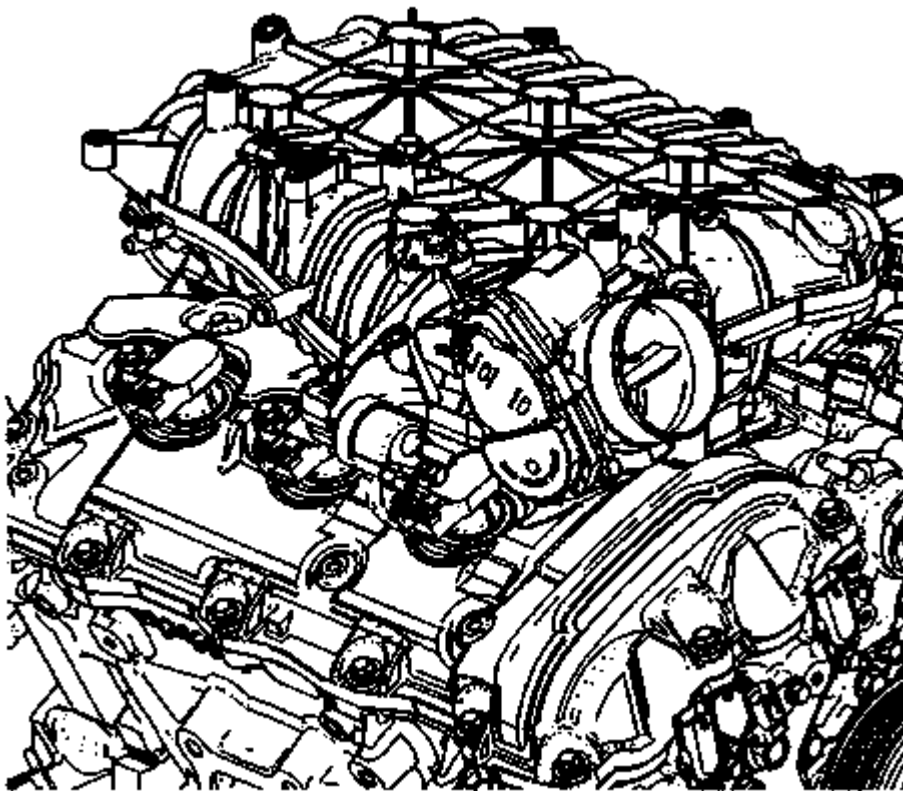


Fig. 16: Identifying Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

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

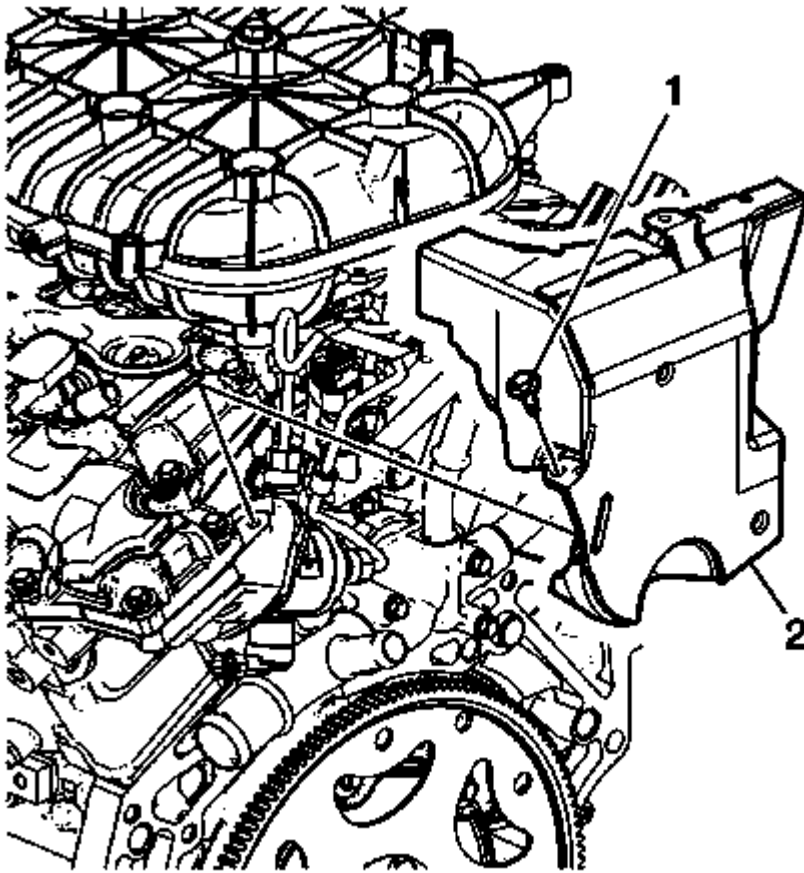


Fig. 17: View Of Fuel Pump Cover & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

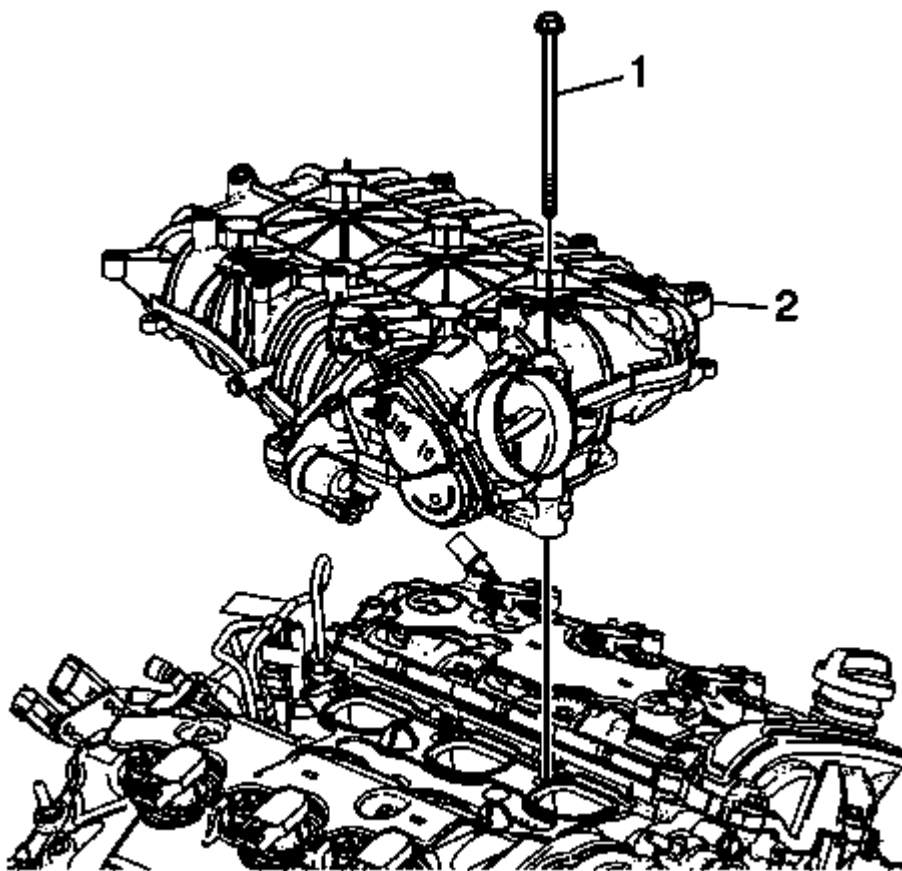


Fig. 18: View Of Intake Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

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

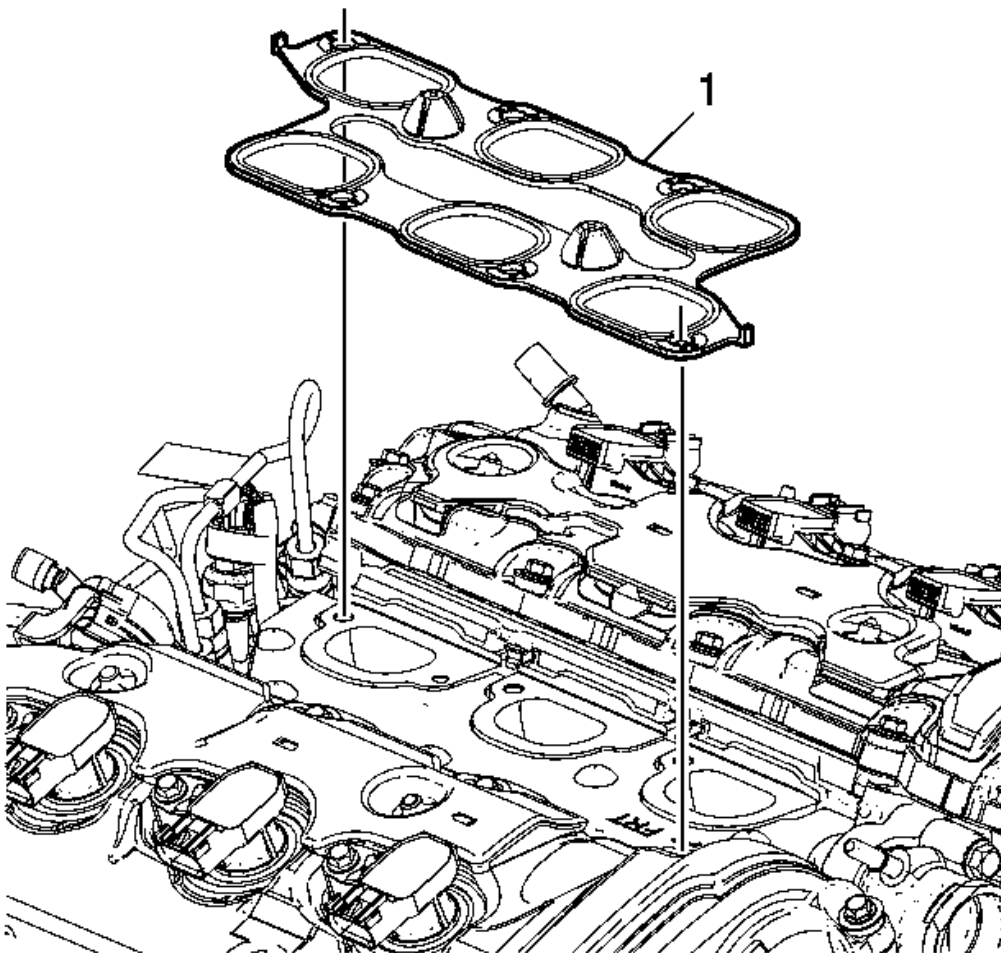


Fig. 19: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

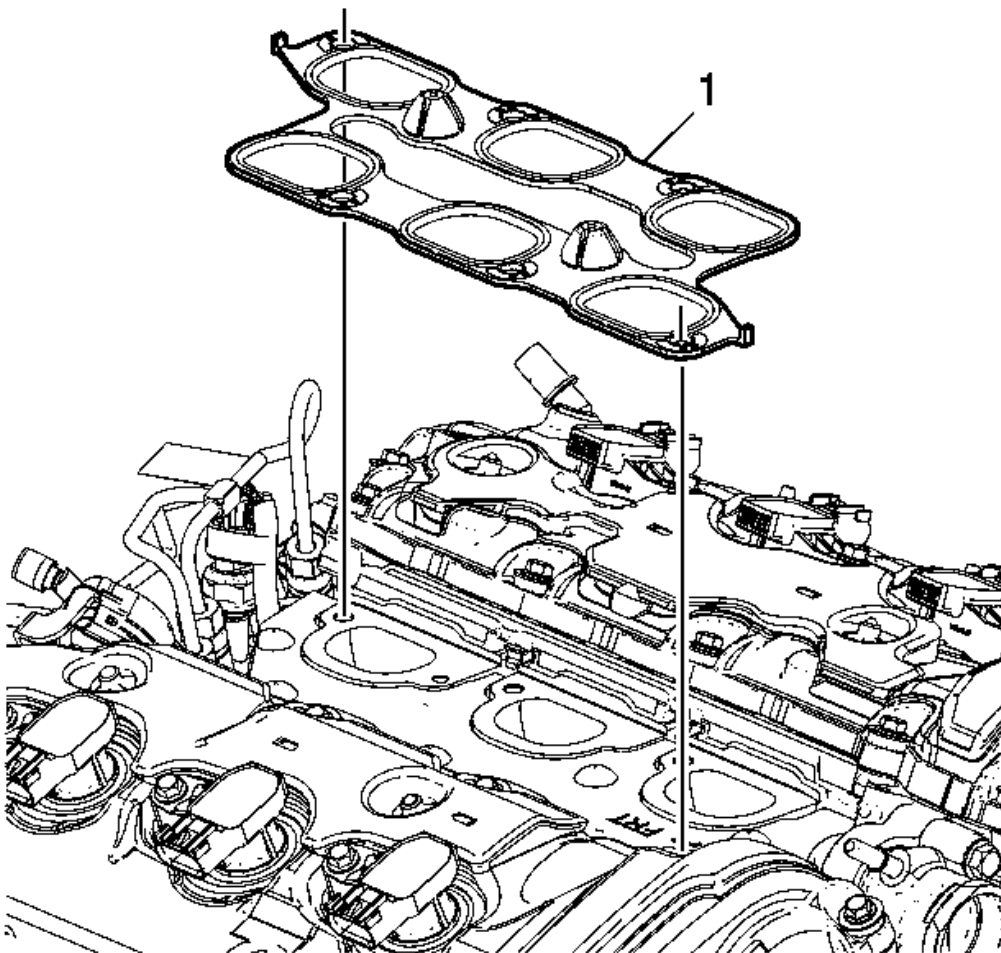


Fig. 20: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

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

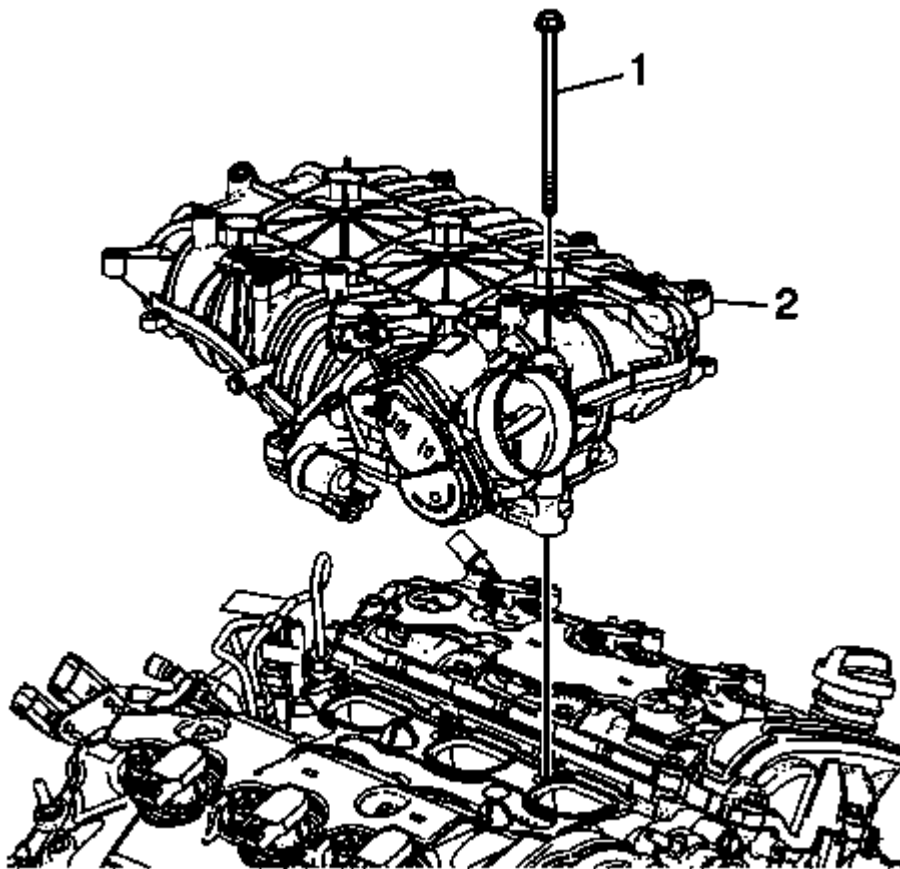


Fig. 21: View Of Intake Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold assembly (2).

CAUTION: Refer to Fastener Caution

3. Install the intake manifold bolts (1).

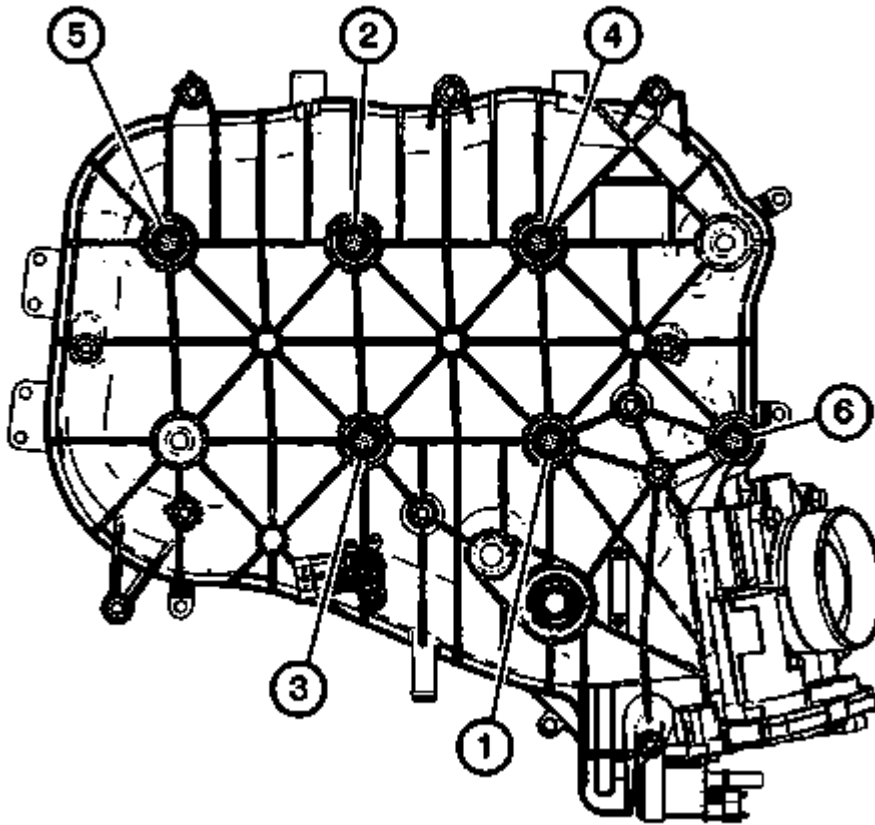


Fig. 22: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

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

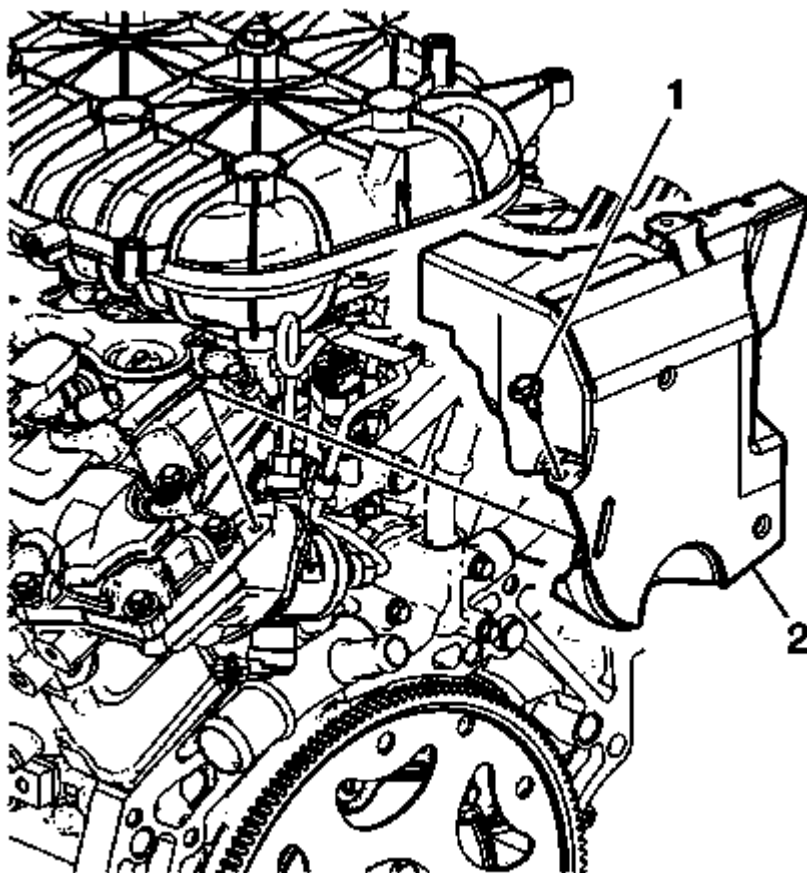


Fig. 23: View Of Fuel Pump Cover & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

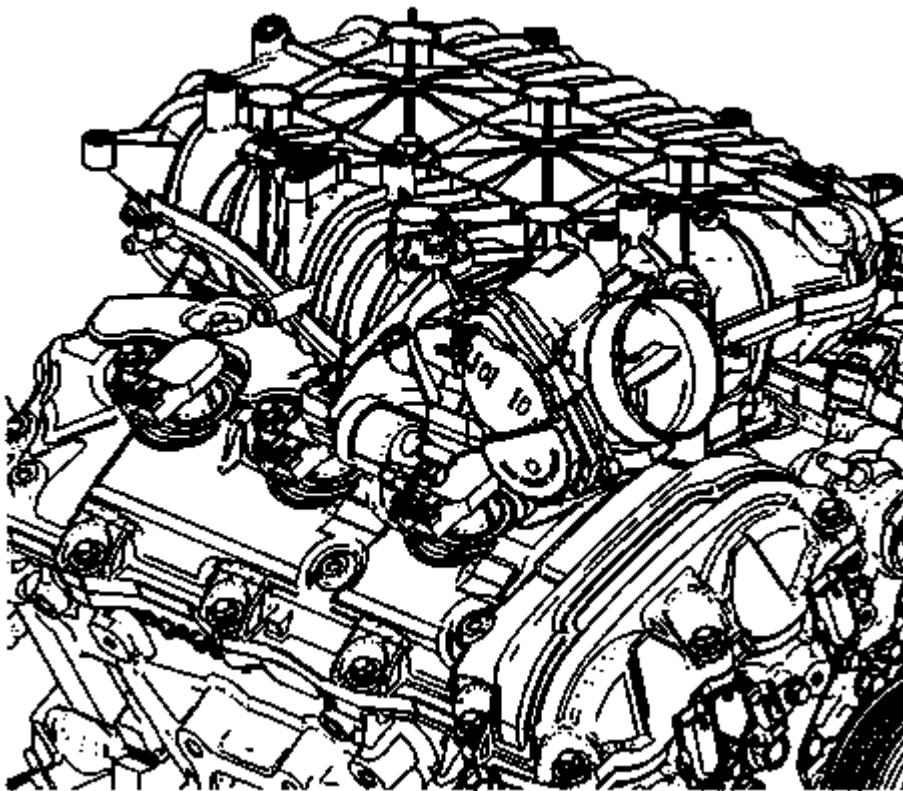


Fig. 24: Identifying Evaporative Emission Hose
Courtesy of GENERAL MOTORS COMPANY

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

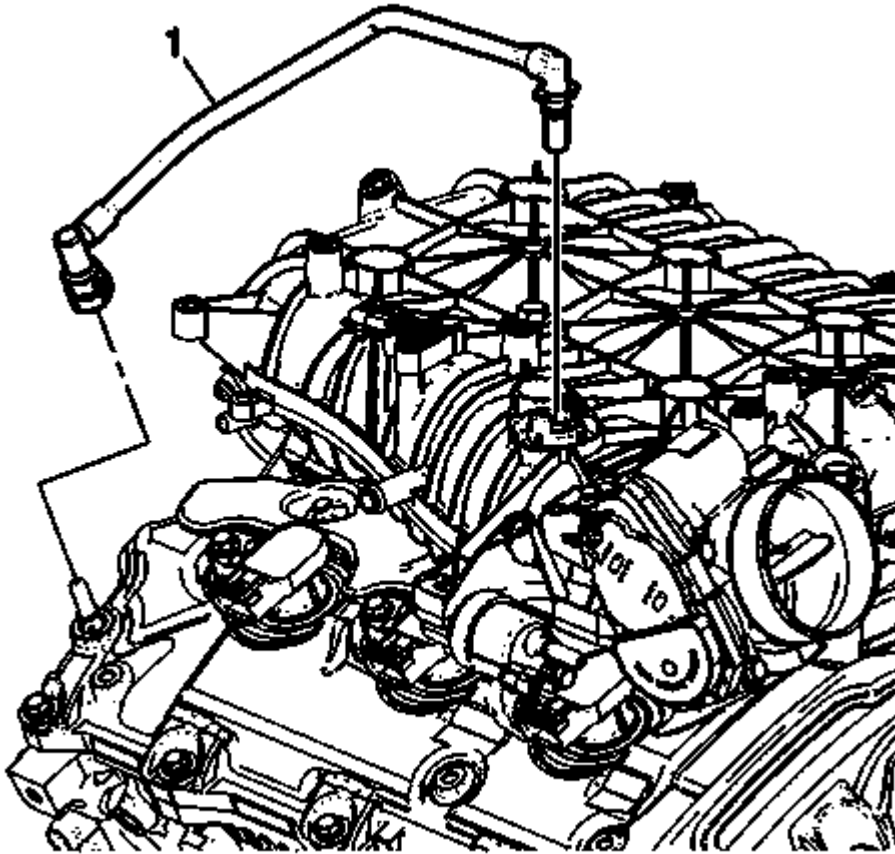


Fig. 25: View Of Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

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

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

Removal Procedure

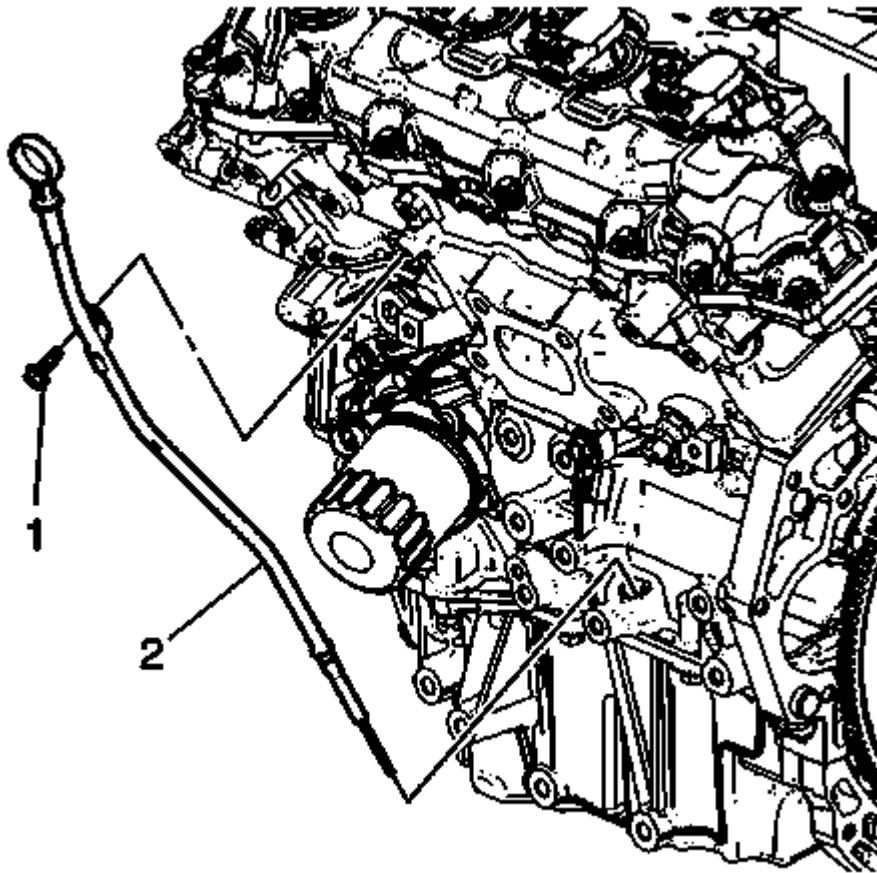


Fig. 26: View Of Oil Level Indicator Tube Components
Courtesy of GENERAL MOTORS COMPANY

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

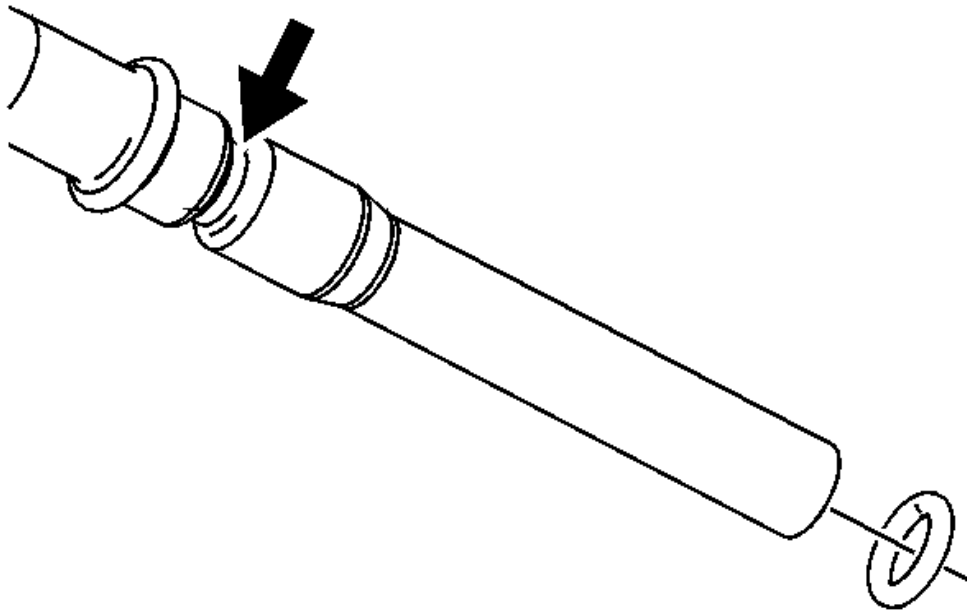


Fig. 27: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

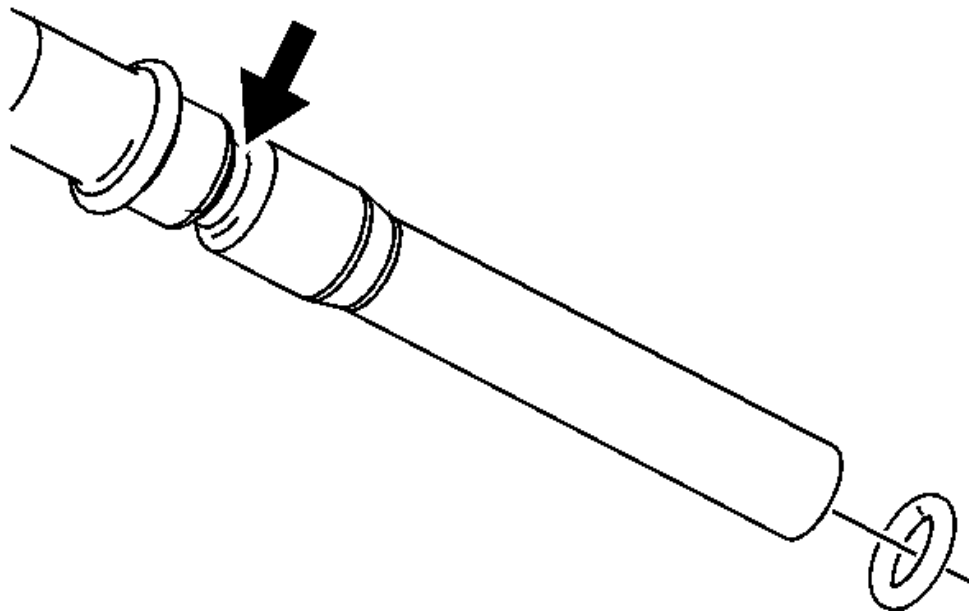


Fig. 28: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

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

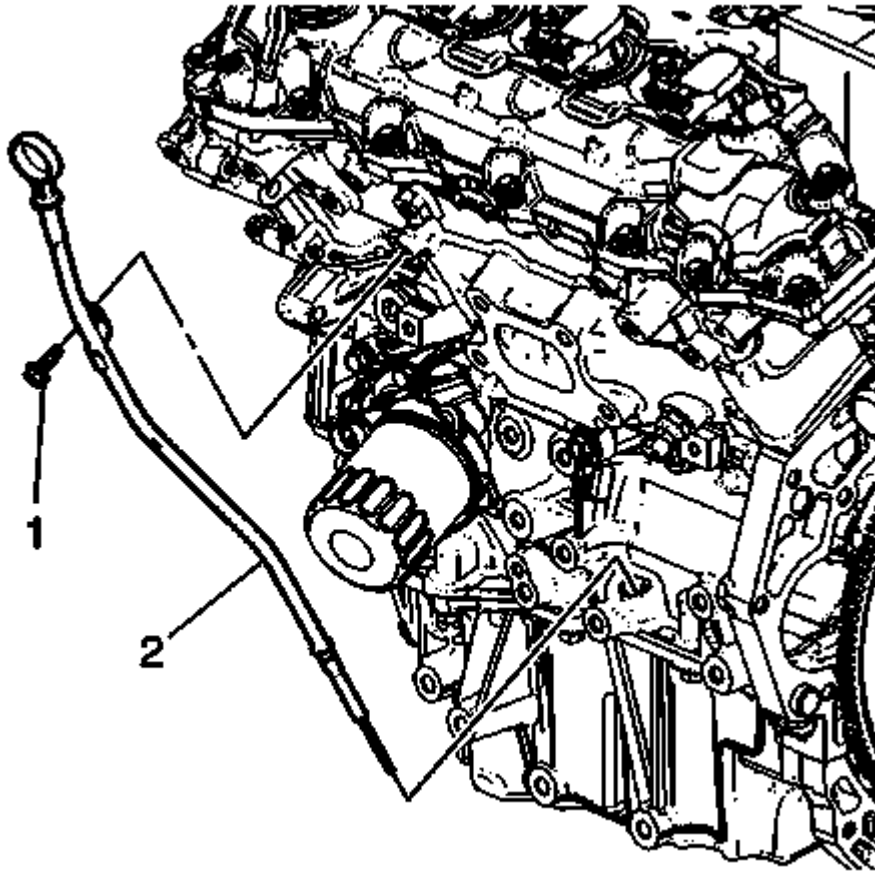


Fig. 29: View Of Oil Level Indicator Tube Components
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

OIL FILTER ADAPTER REPLACEMENT

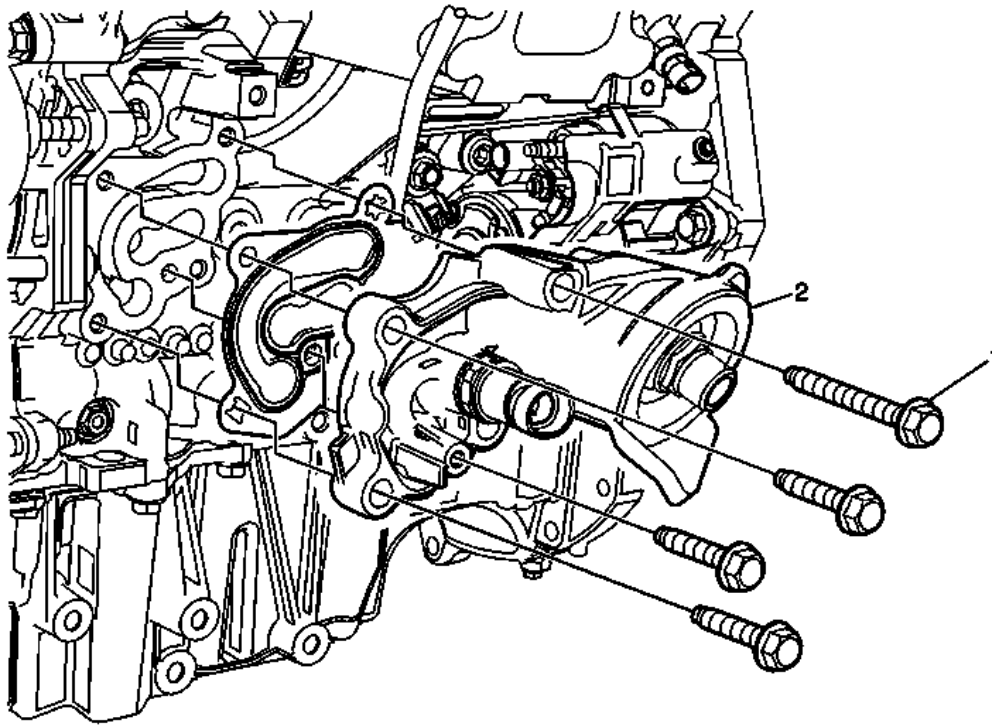


Fig. 30: Oil Filter Adapter & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Oil Filter Adapter Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the generator. Refer to Generator Replacement (V6). 2. Remove the oil filter. Refer to Engine Oil and Oil Filter Replacement (LF1, LFW or LFX).	
1	Oil Filter Adapter Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u>. Tighten 25 N.m (18 lb ft)
2	Oil Filter Adapter Procedure 1. Replace oil filter adapter gasket. 2. Disconnect electrical connector as needed. 3. Transfer components as necessary.

CRANKSHAFT BALANCER REPLACEMENT**Special Tools**

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

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

Removal Procedure

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

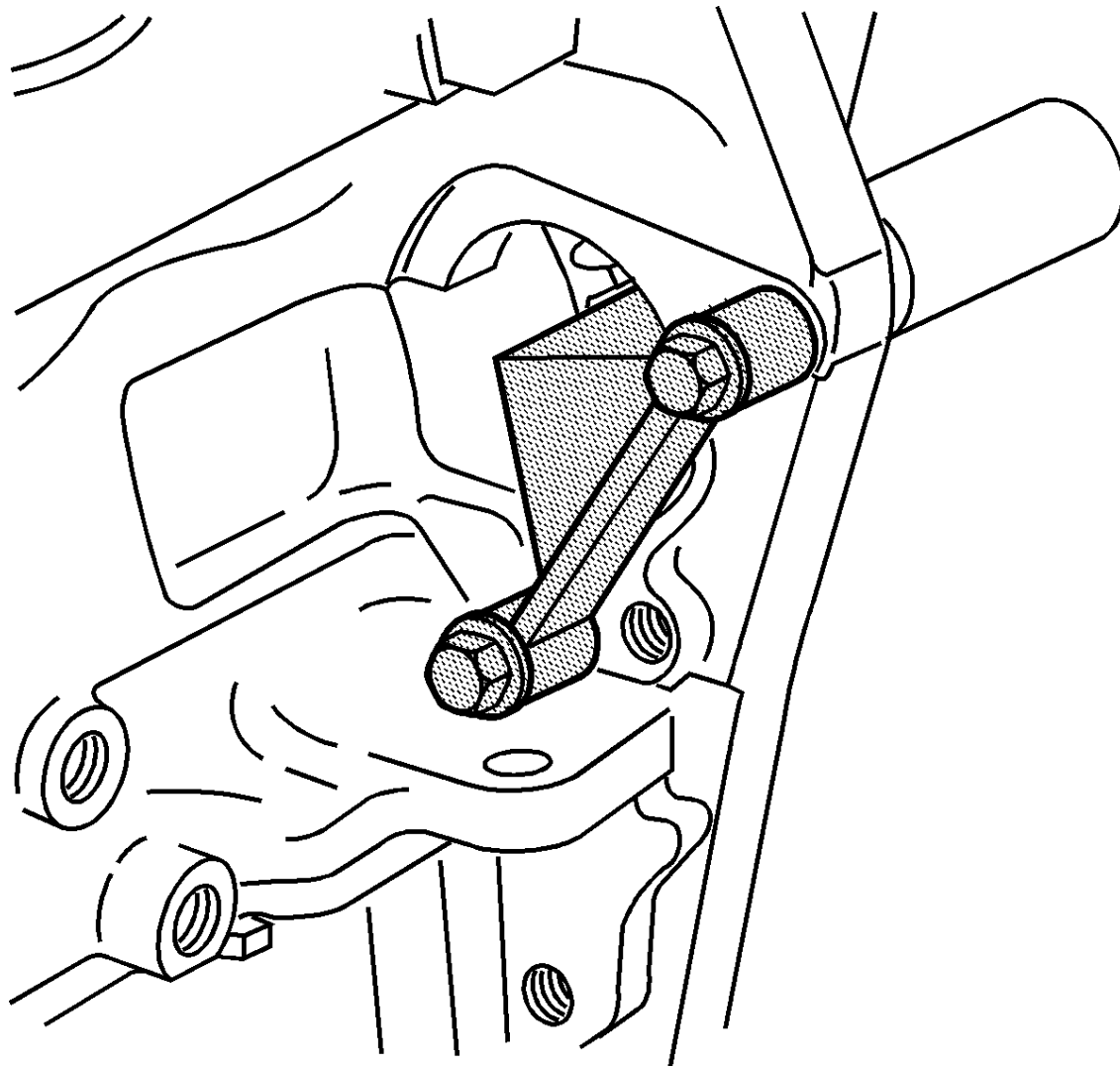


Fig. 31: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

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

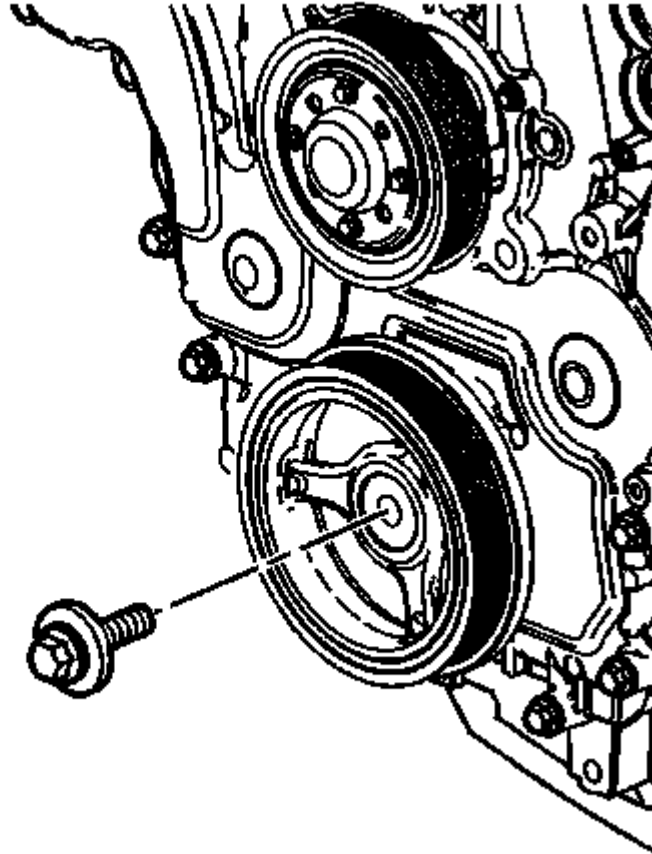


Fig. 32: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

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

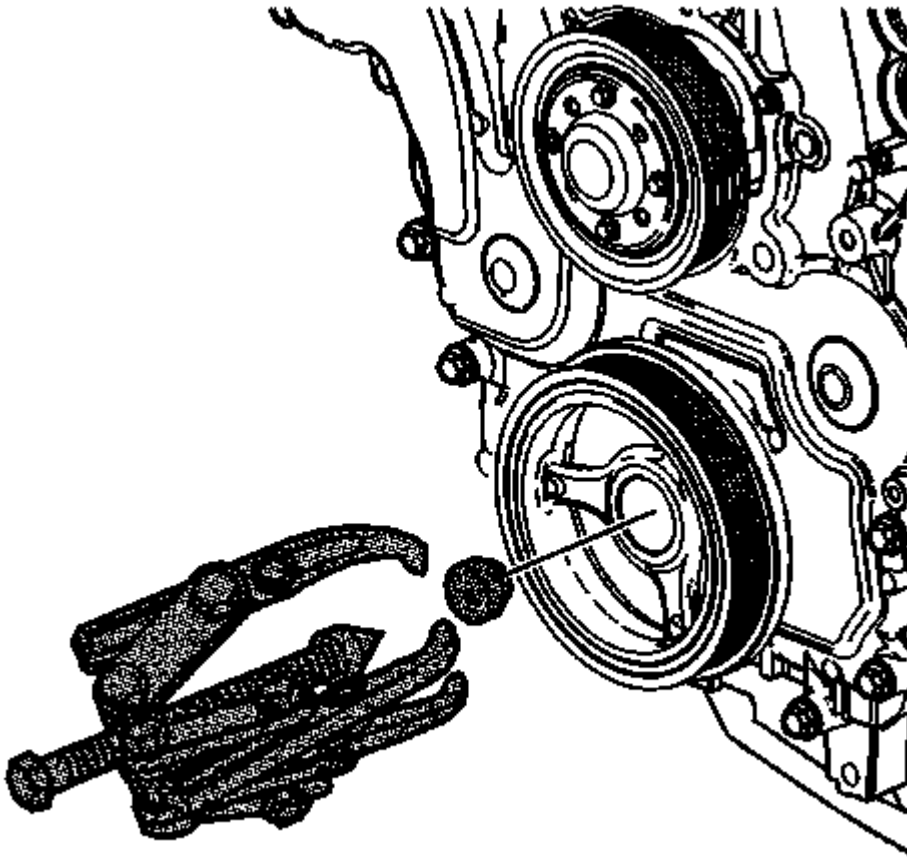


Fig. 33: Crankshaft Button & Remover
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

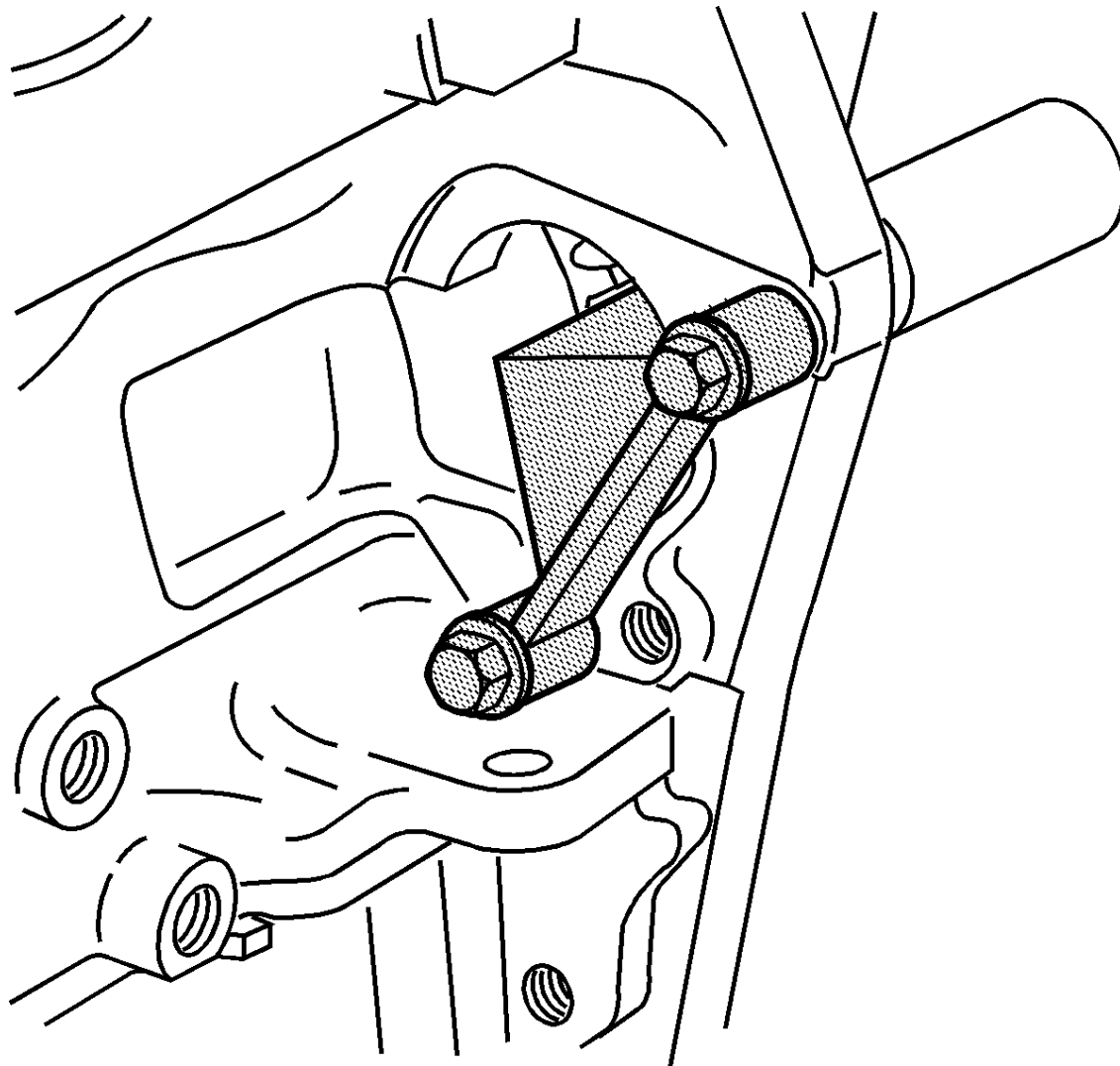


Fig. 34: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

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

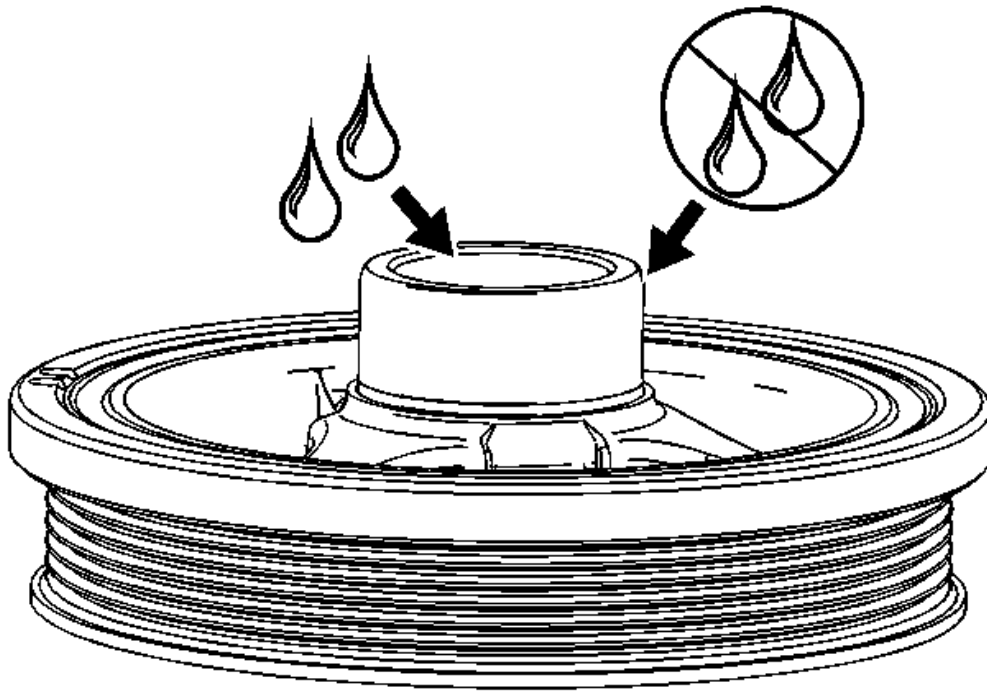


Fig. 35: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

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

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

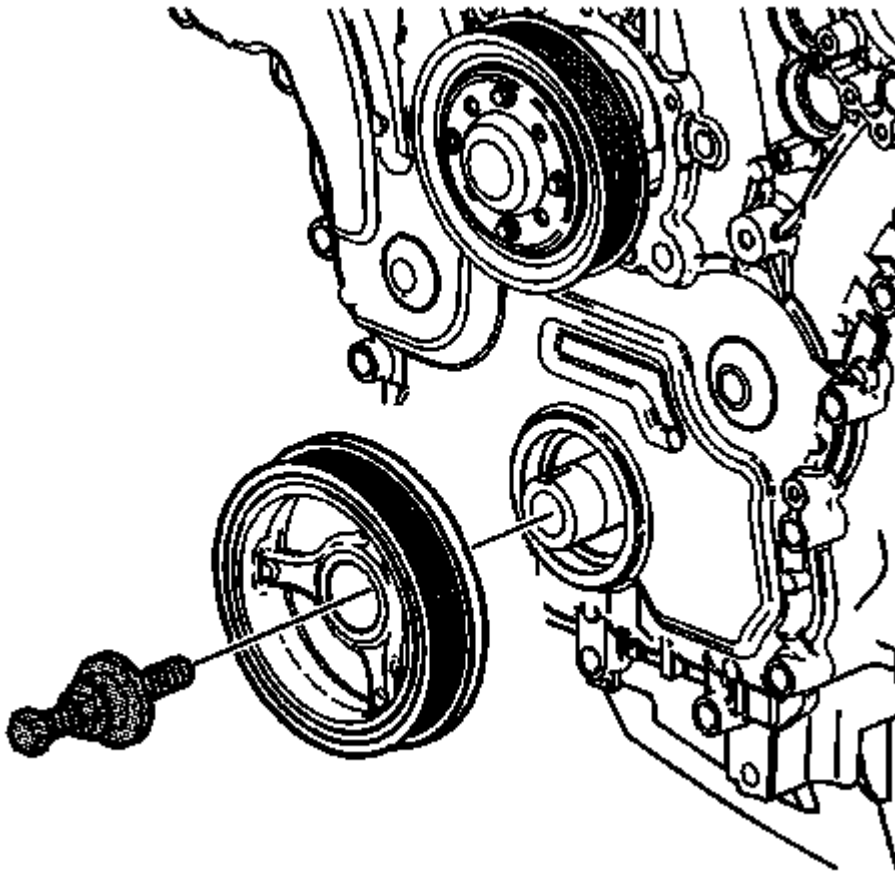


Fig. 36: View Of Crankshaft Balancer & Installation Tool
Courtesy of GENERAL MOTORS COMPANY

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

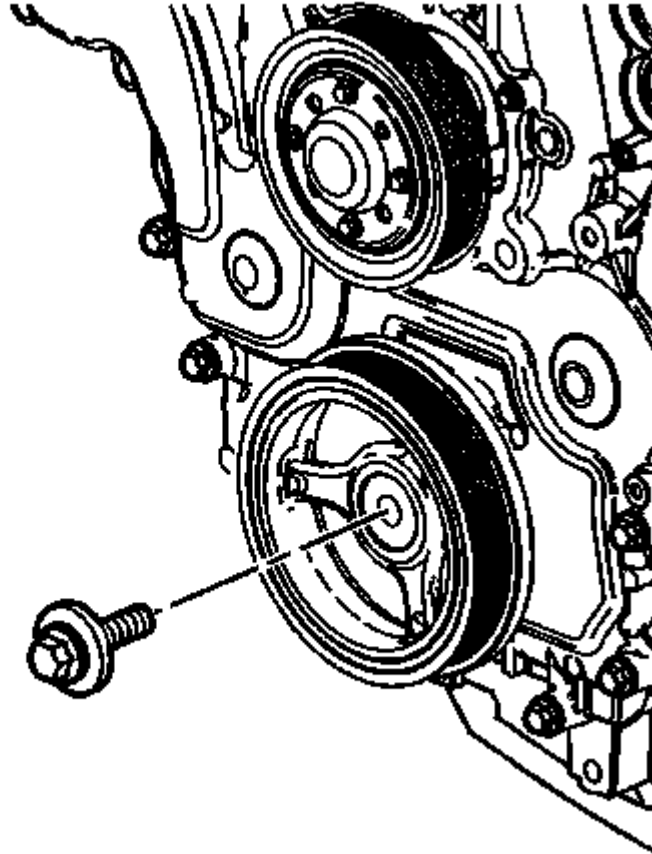


Fig. 37: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

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

8. Install the NEW crankshaft balancer bolt.

CAUTION: Refer to Fastener Caution .

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

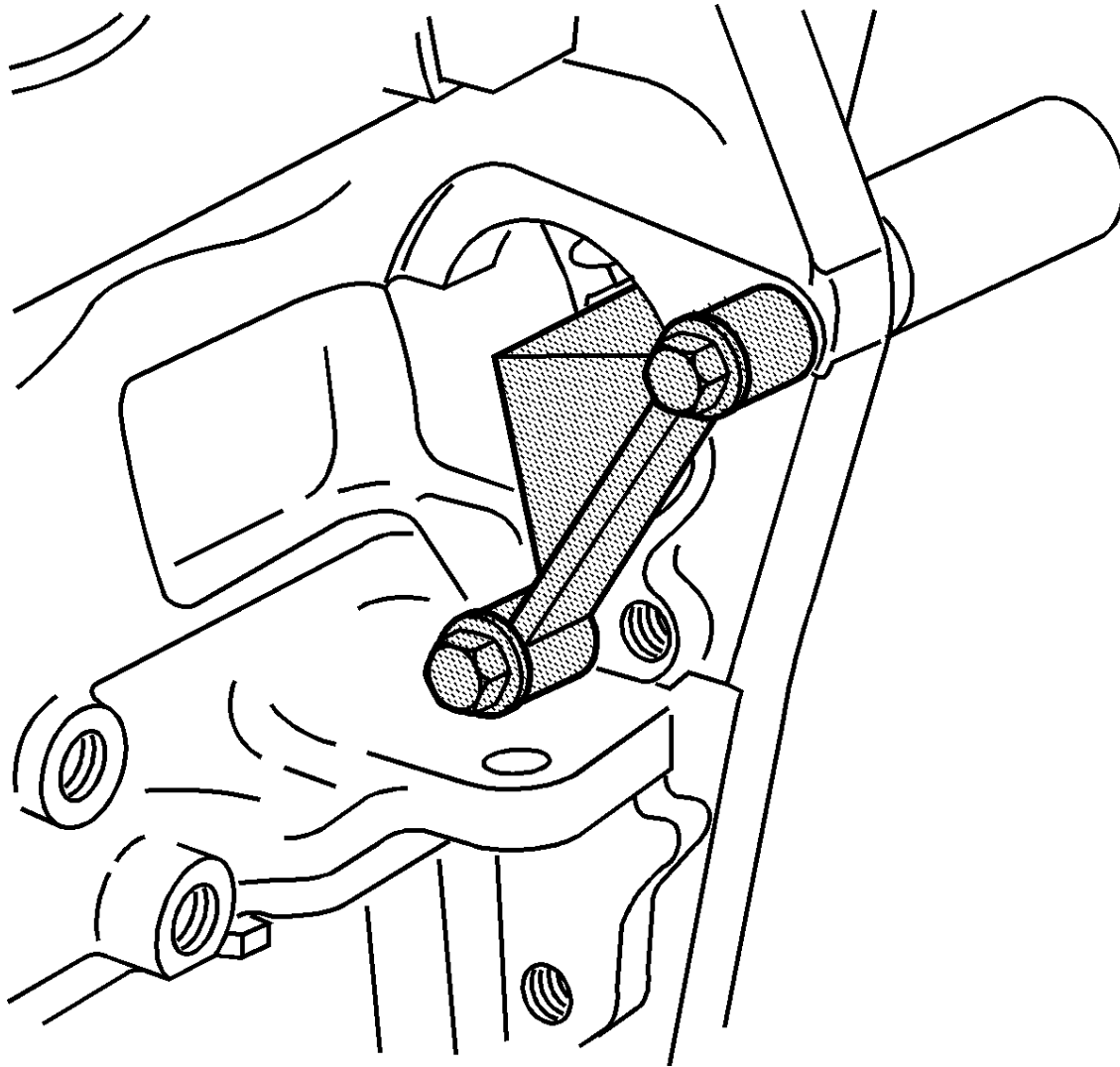


Fig. 38: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

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

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-29184 Oil Seal Installer

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

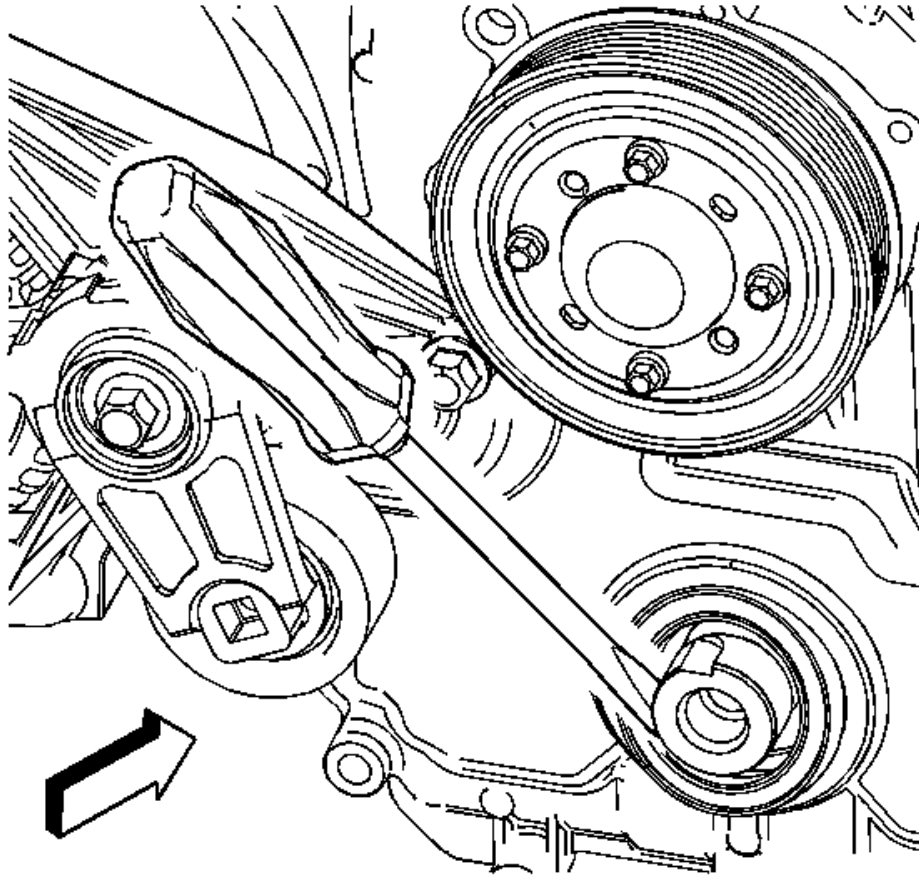
Removal Procedure

Fig. 39: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

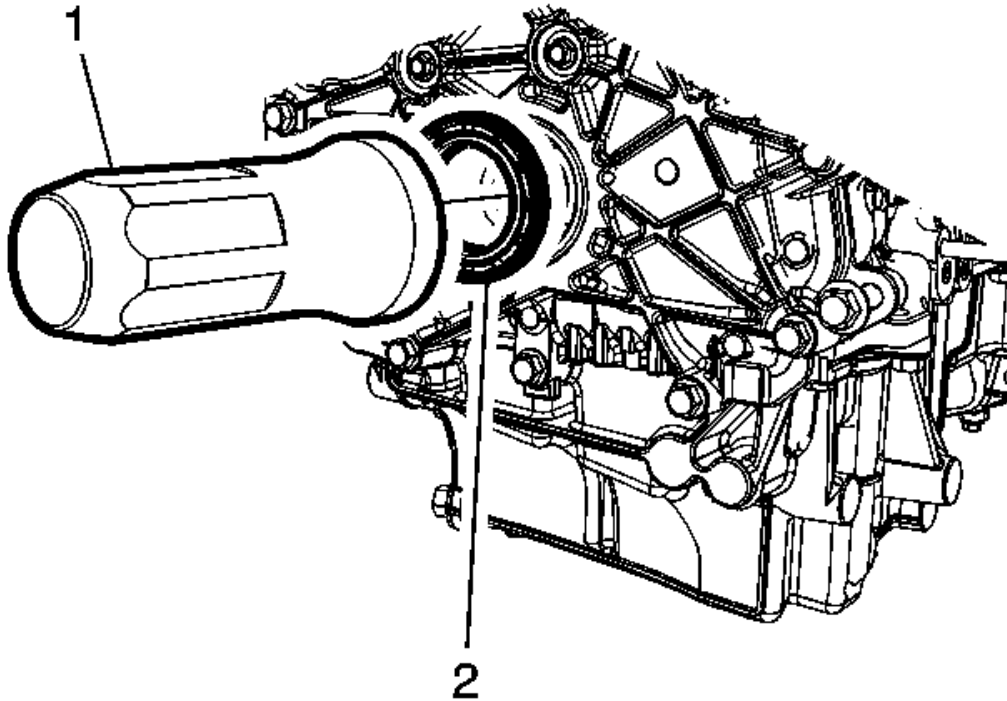


Fig. 40: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

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

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

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

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

Removal Procedure

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

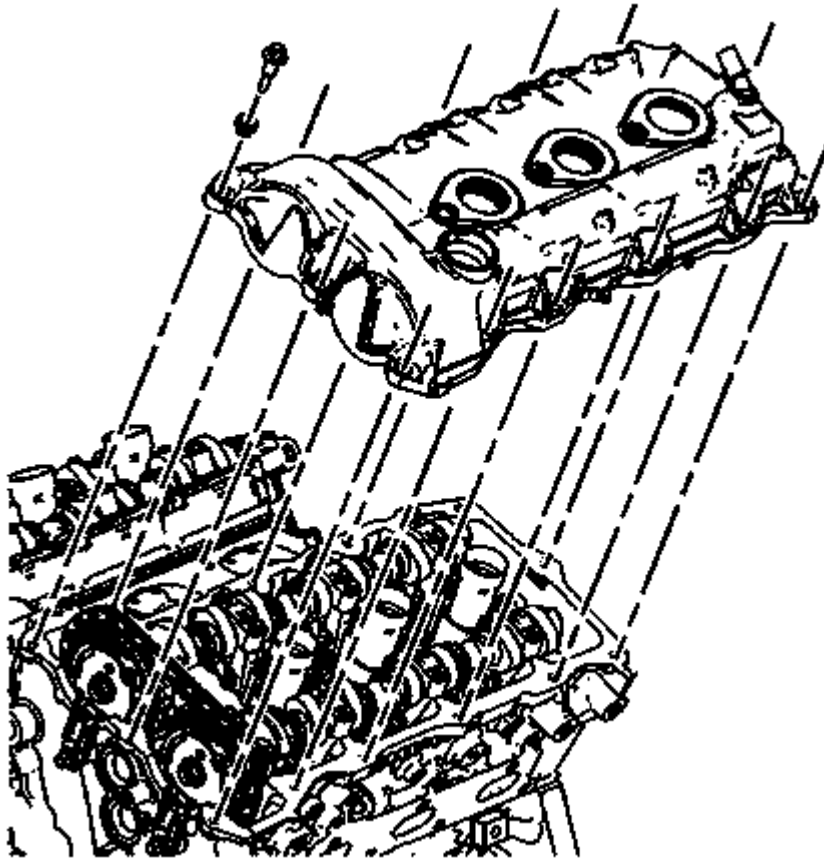


Fig. 41: View Of Left Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

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

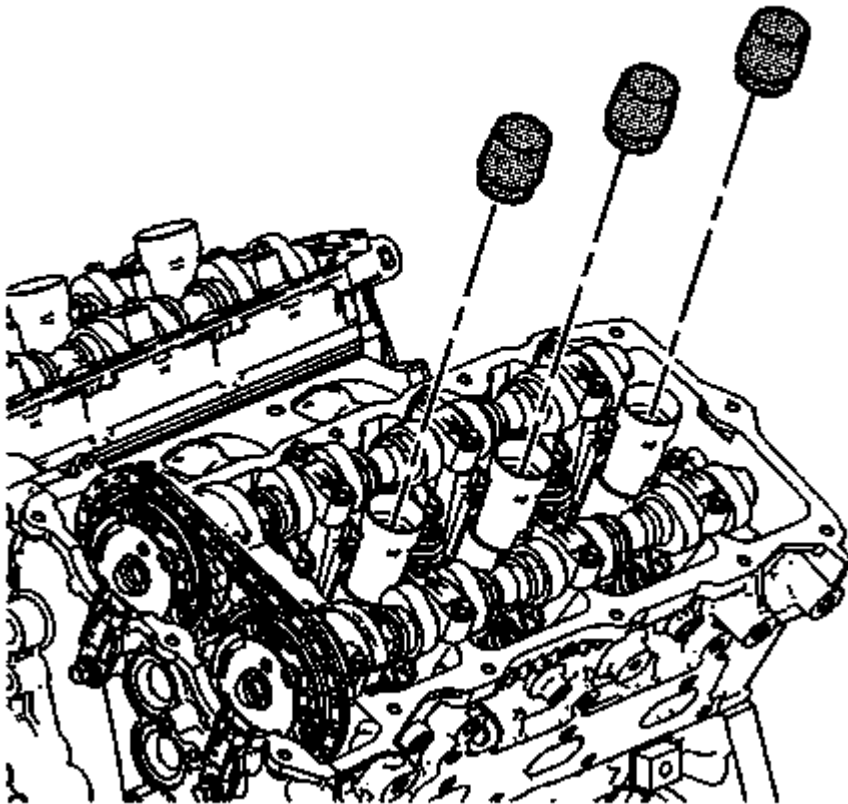


Fig. 42: Plugging Spark Plug Holes
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

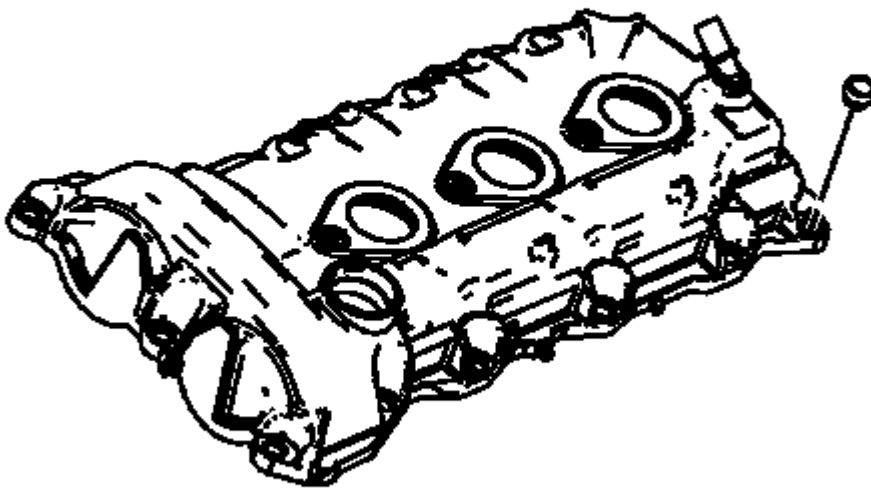


Fig. 43: Identifying Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

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

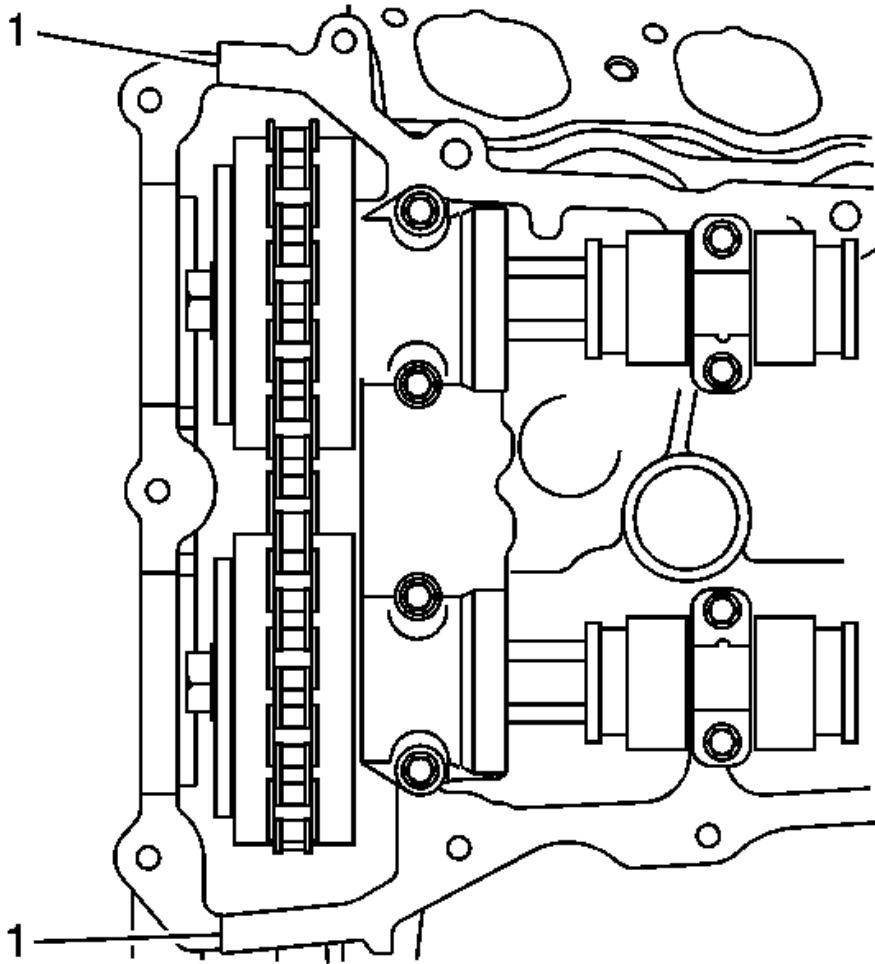


Fig. 44: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

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

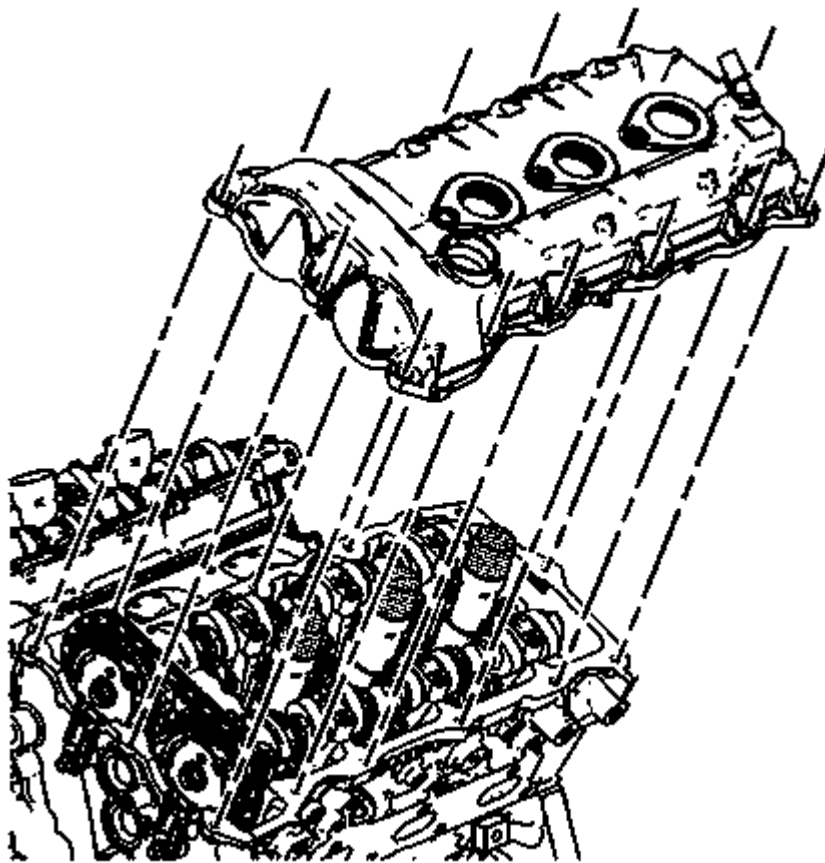


Fig. 45: Aligning Left Camshaft Cover On Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

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

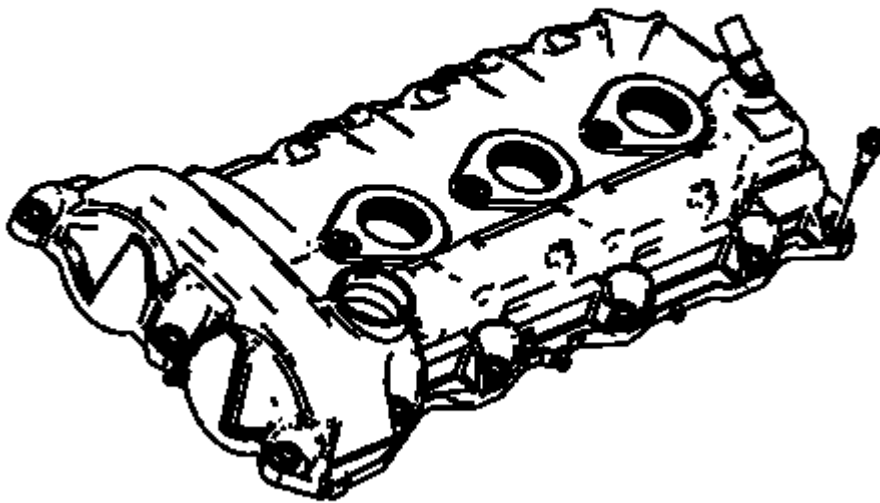


Fig. 46: Identifying Left Camshaft Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Loosely install the left camshaft cover bolts.

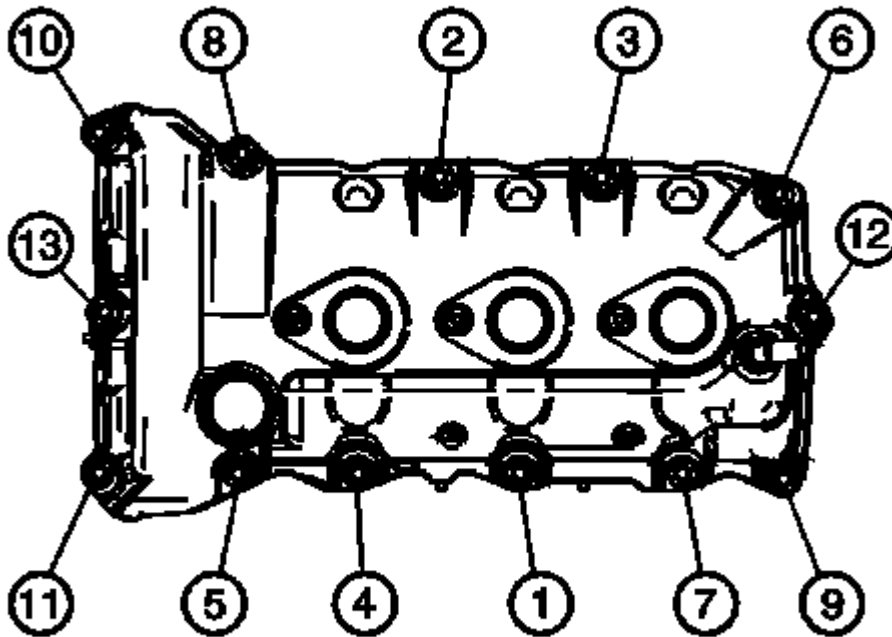


Fig. 47: Tightening Sequence For Left Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

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

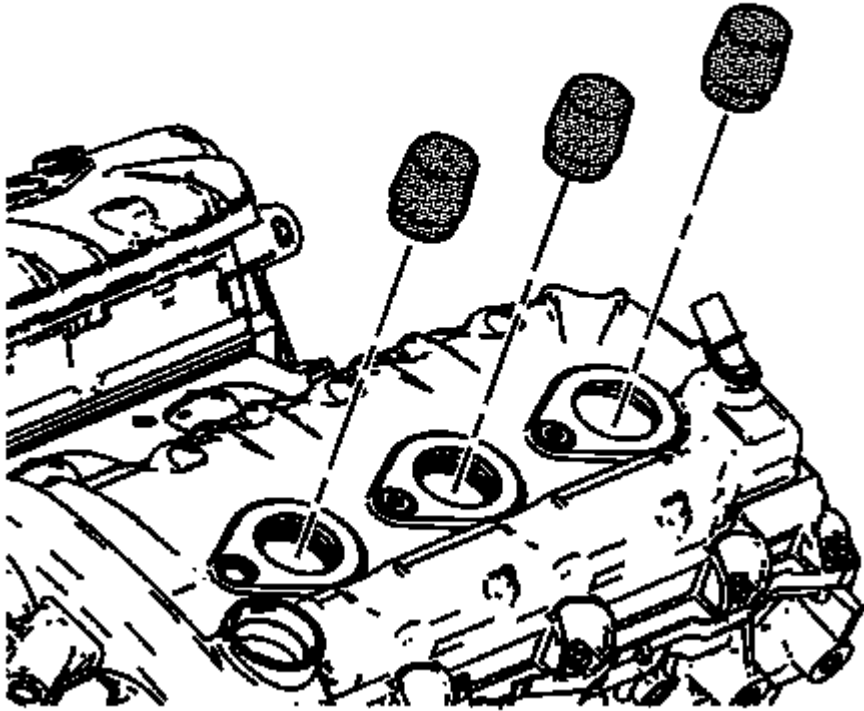


Fig. 48: Spark Plug Tube Plugs

Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

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

Removal Procedure

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

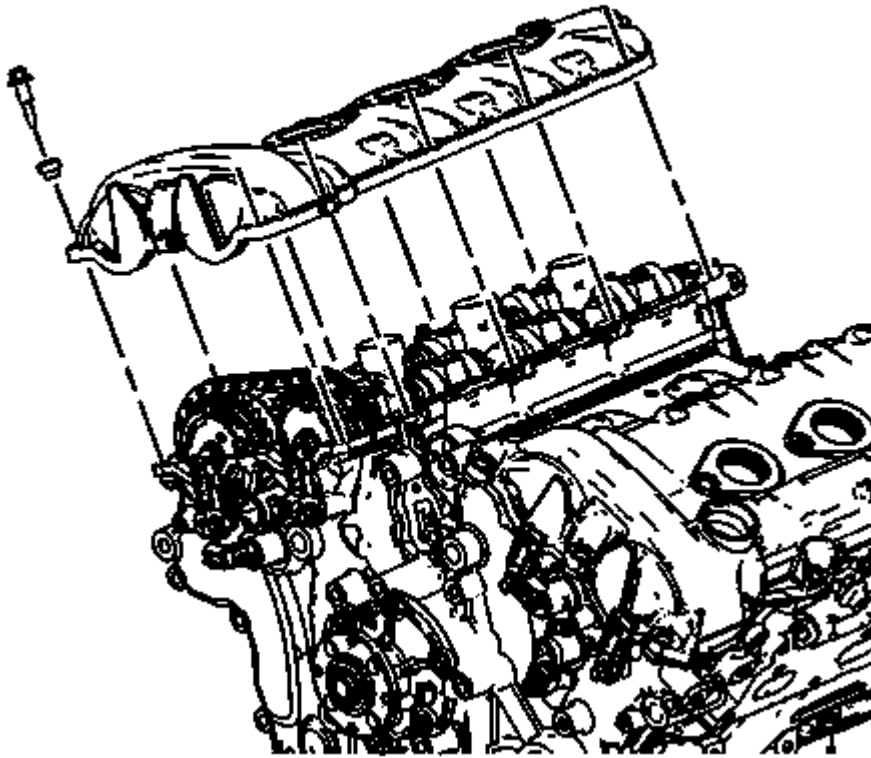


Fig. 49: Identifying Right Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

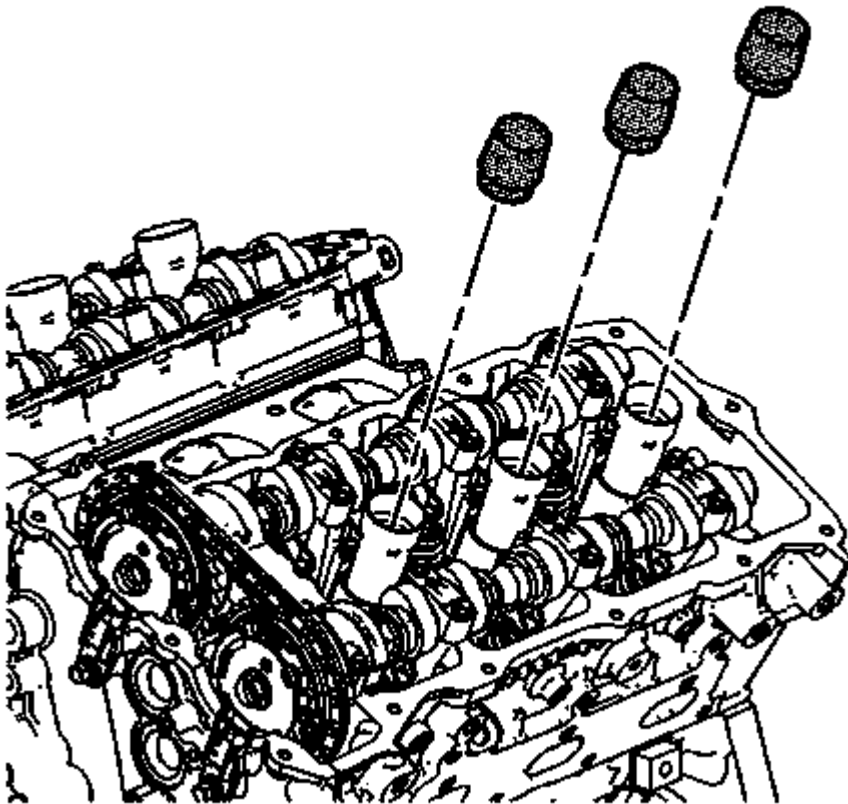


Fig. 50: Plugging Spark Plug Holes
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

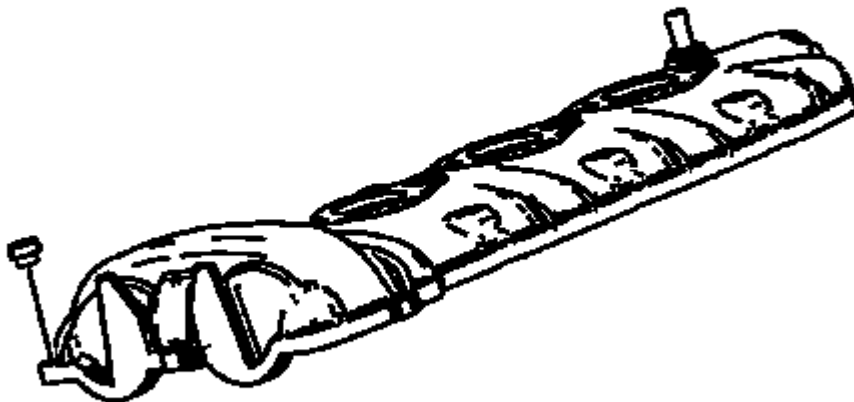


Fig. 51: Locating Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

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

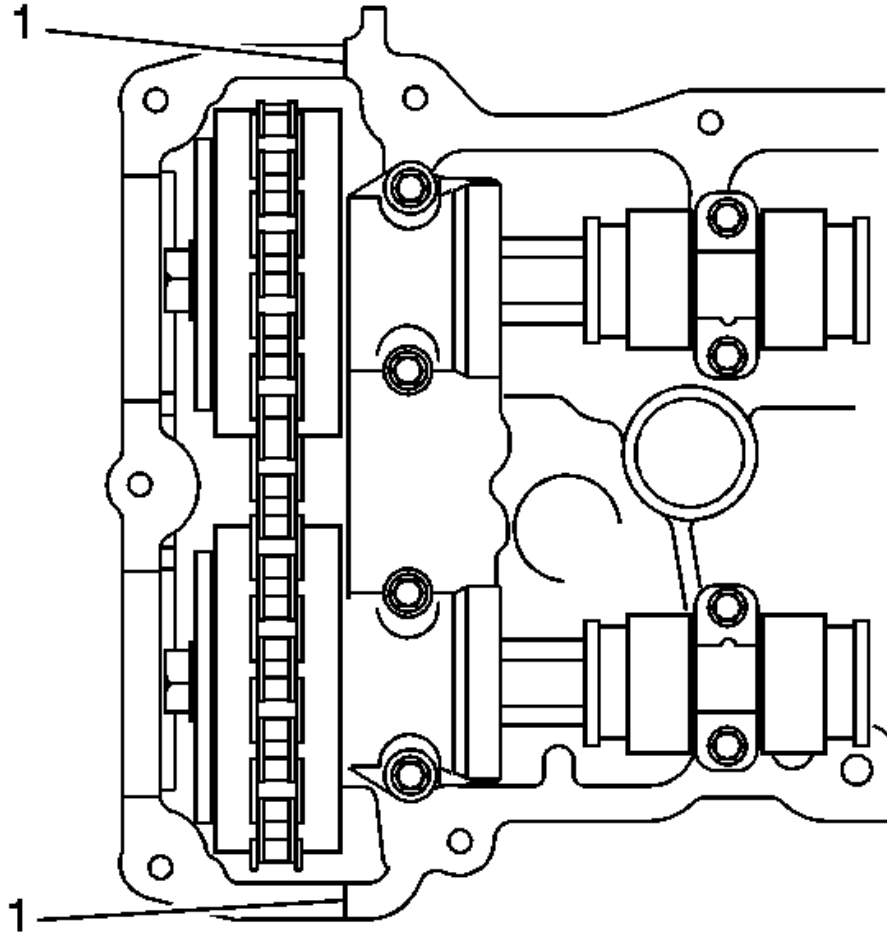


Fig. 52: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

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

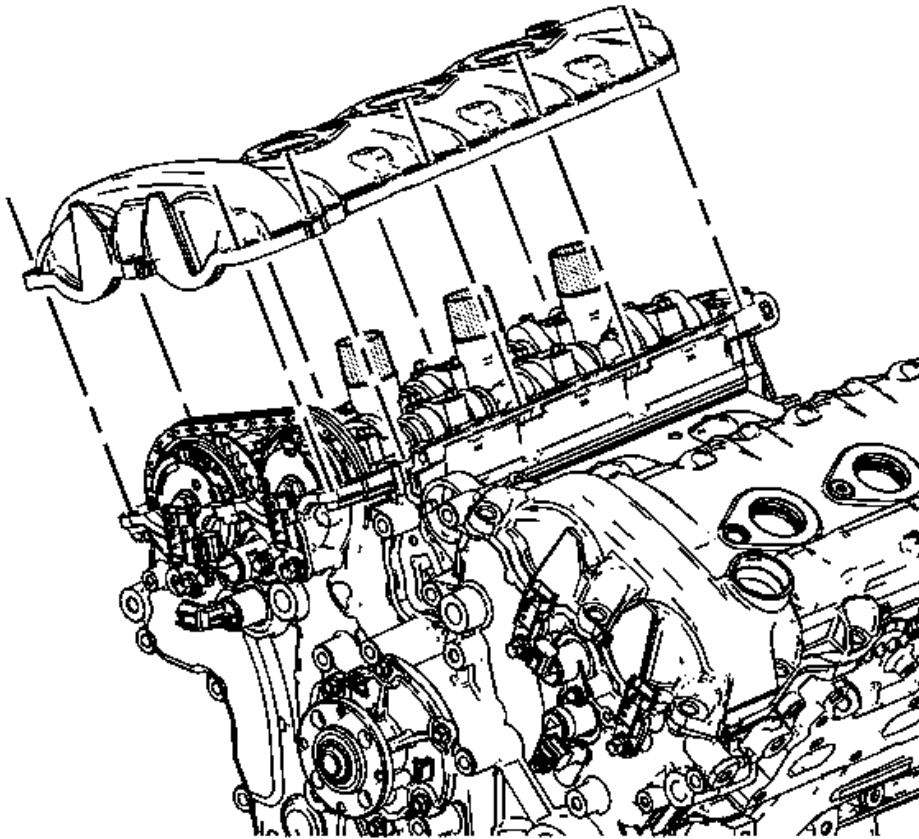


Fig. 53: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

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

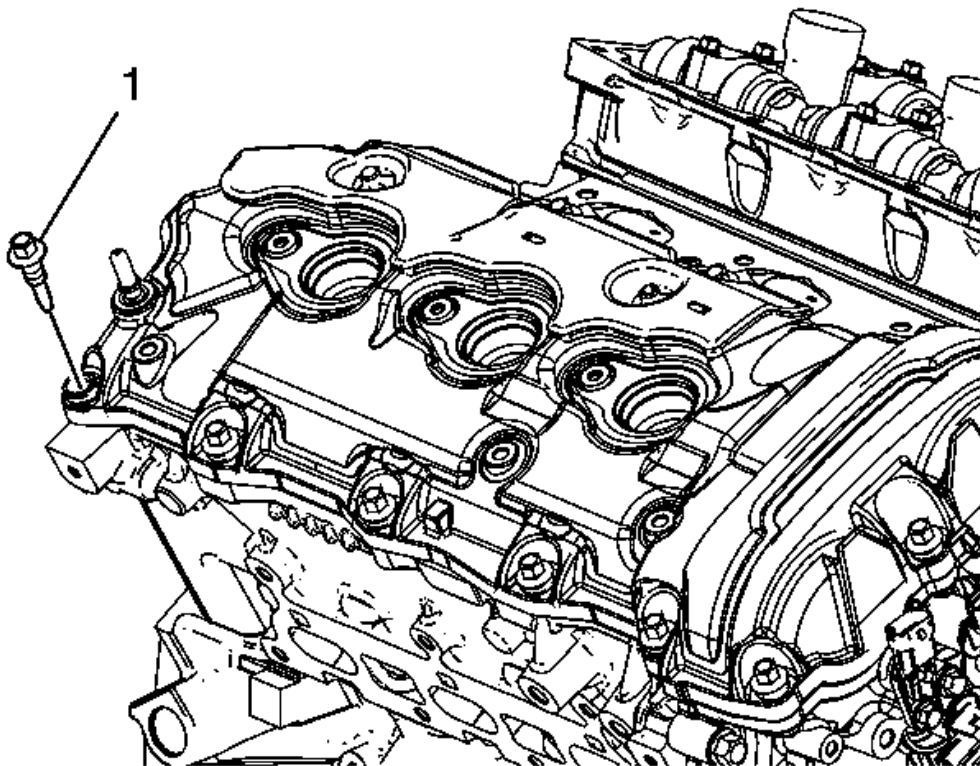


Fig. 54: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Loosely install the right camshaft cover bolts.

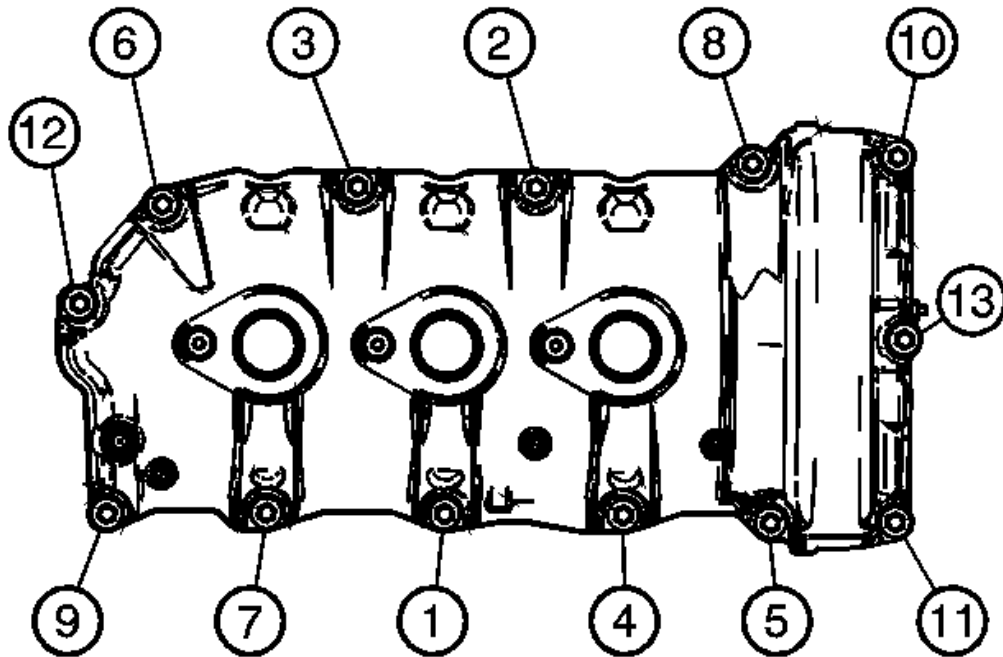


Fig. 55: Tightening Sequence for Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

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

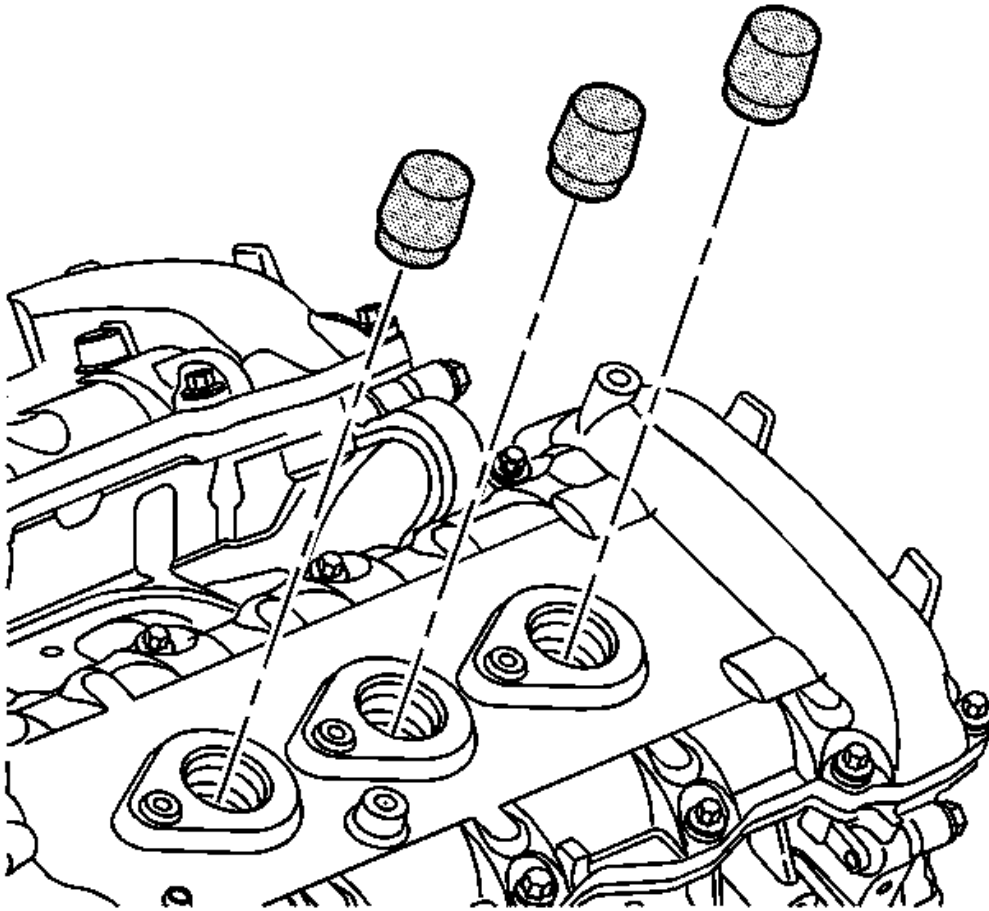


Fig. 56: Spark Plug Tube Seal Guides
Courtesy of GENERAL MOTORS COMPANY

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

ENGINE FRONT COVER REPLACEMENT

Special Tools

EN-46109 Engine Front Cover Installation Guide Pins

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

Removal Procedure

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

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

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

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

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

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

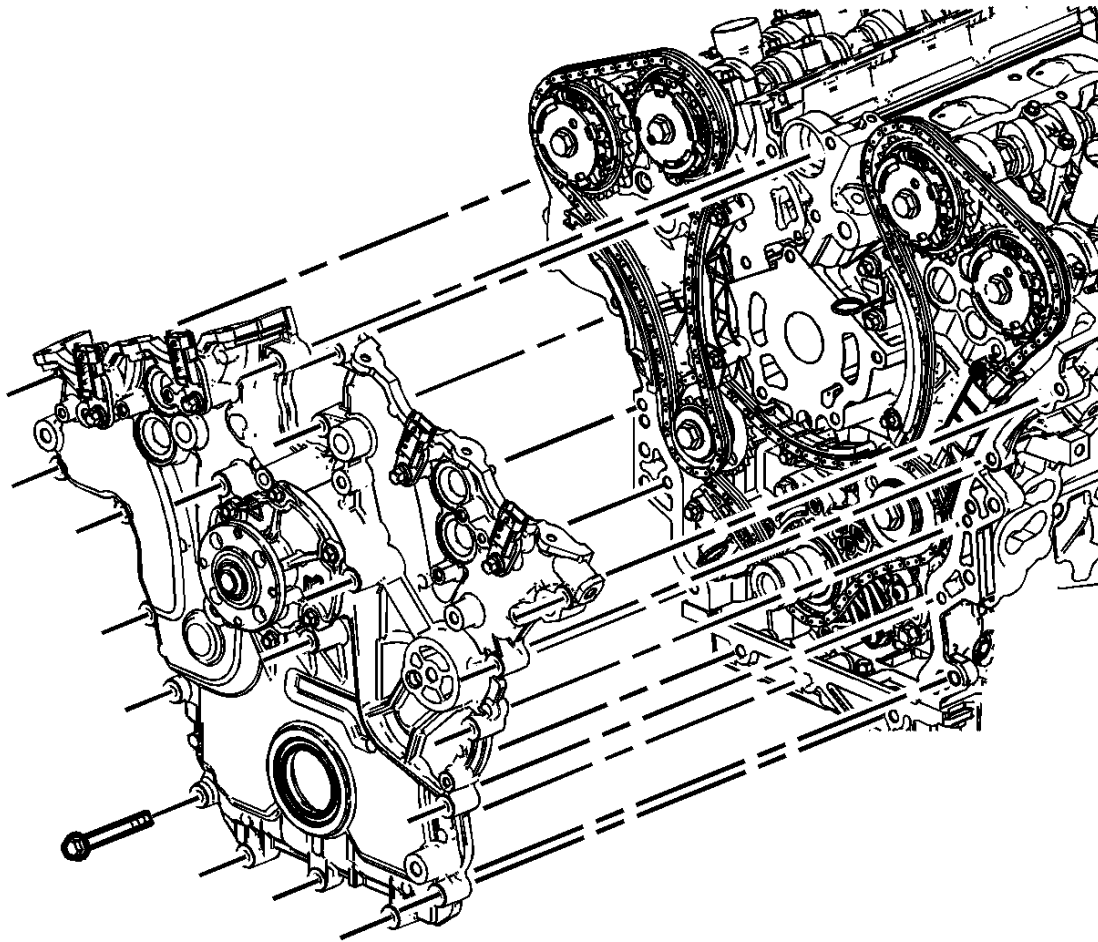


Fig. 57: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

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

Inspection .

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

Installation Procedure

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

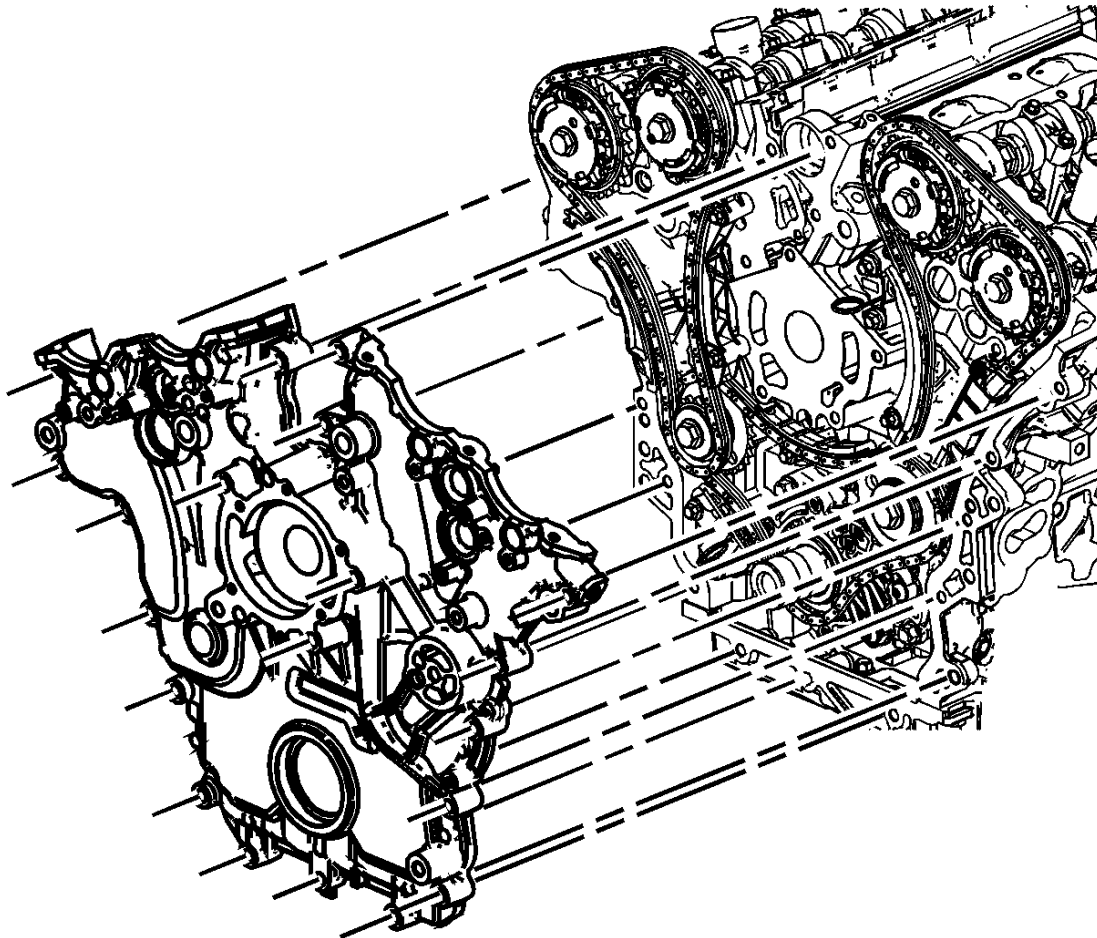


Fig. 58: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

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

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

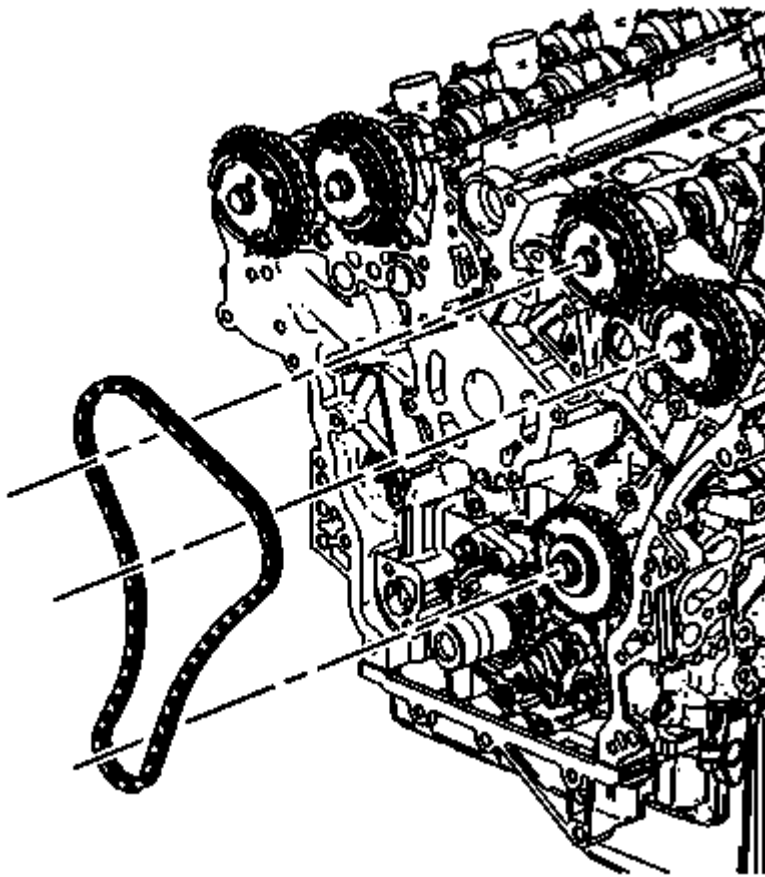


Fig. 59: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

14. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain 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

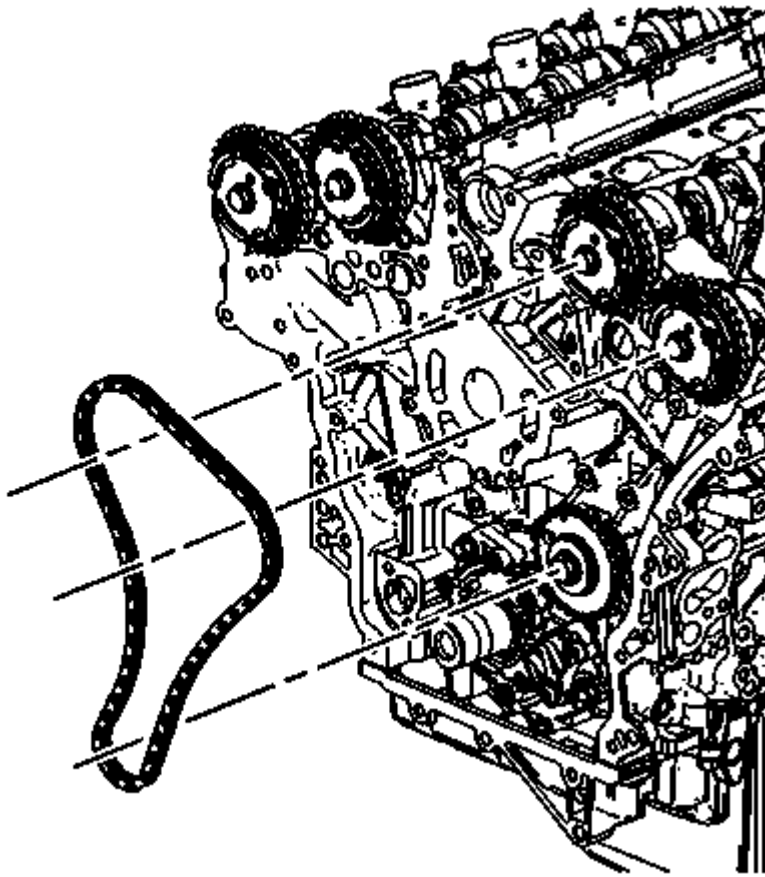


Fig. 60: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

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

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Removal Procedure

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

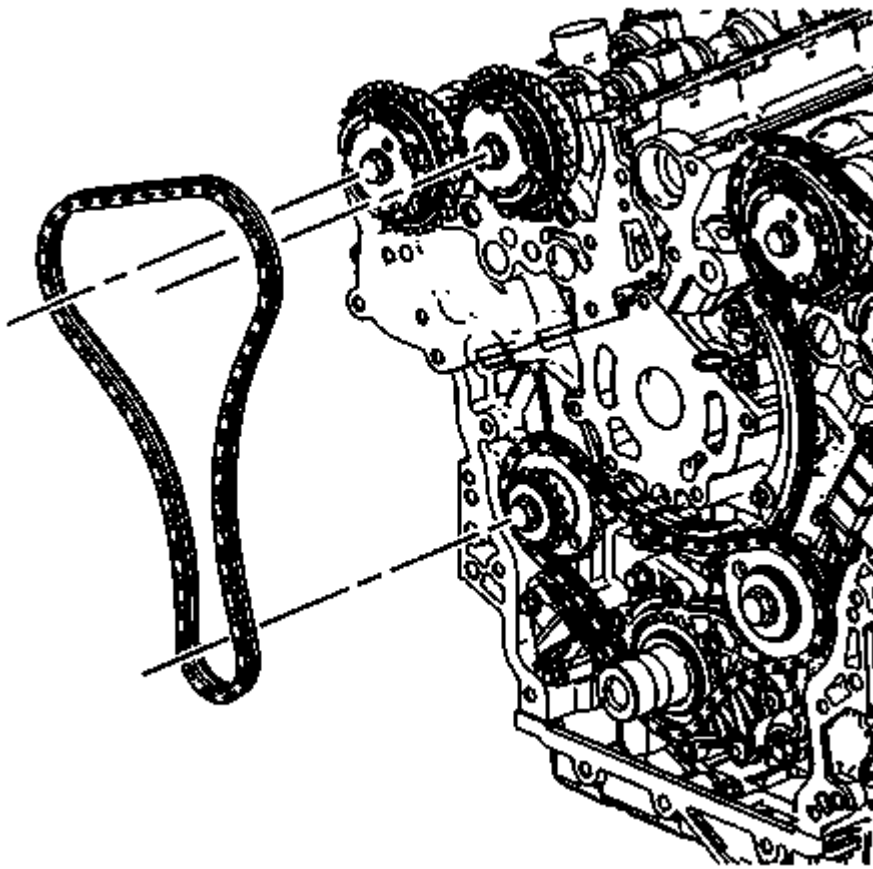


Fig. 61: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right bank secondary camshaft drive chain.

Installation Procedure

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

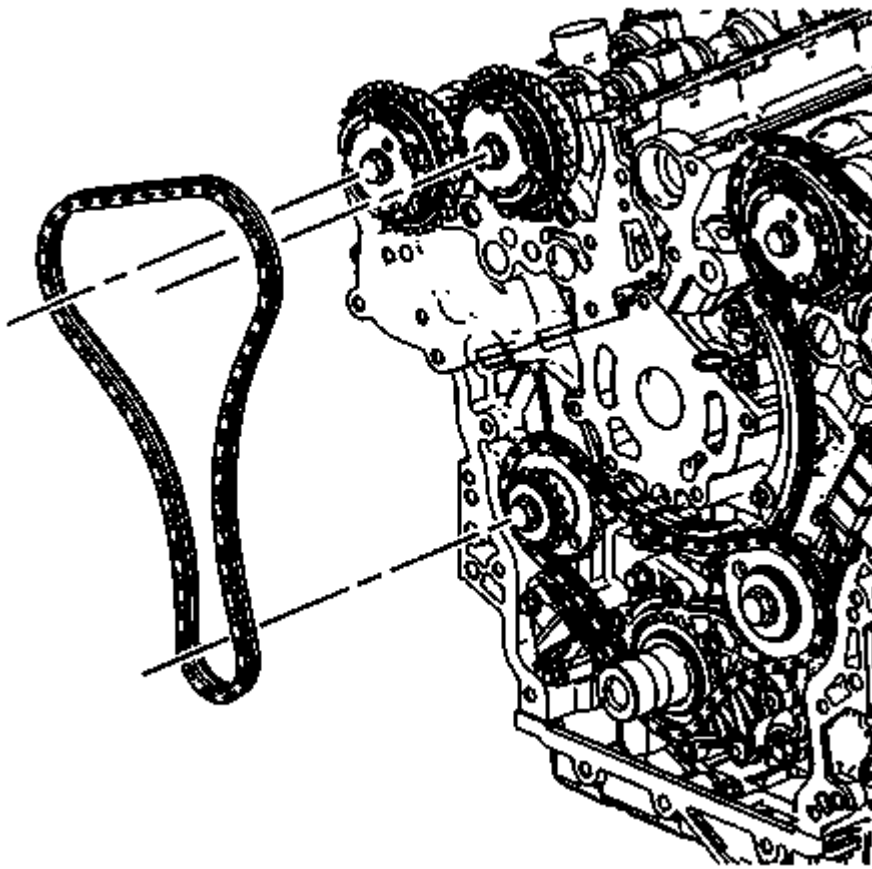


Fig. 62: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

Removal Procedure

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

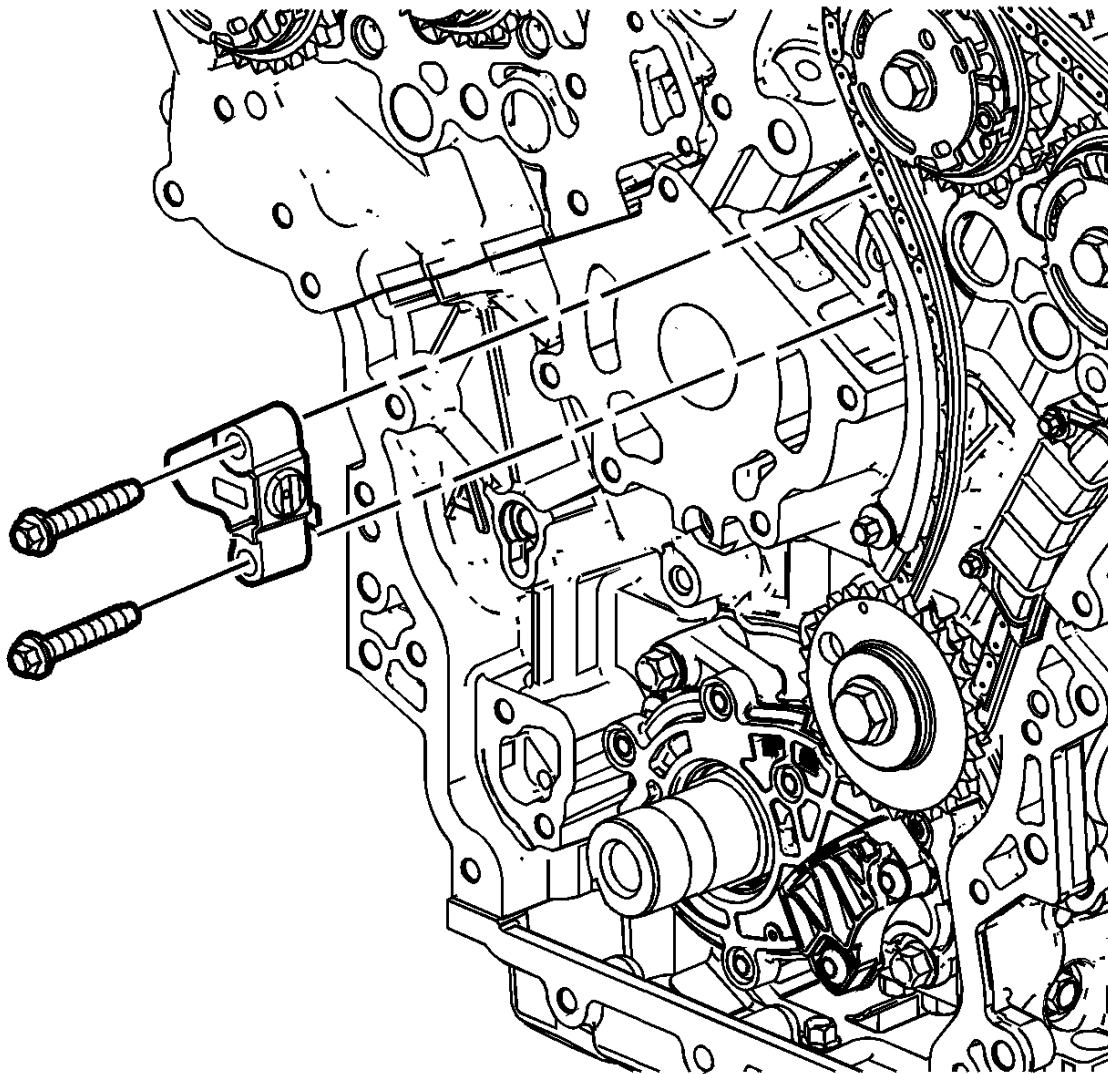


Fig. 63: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

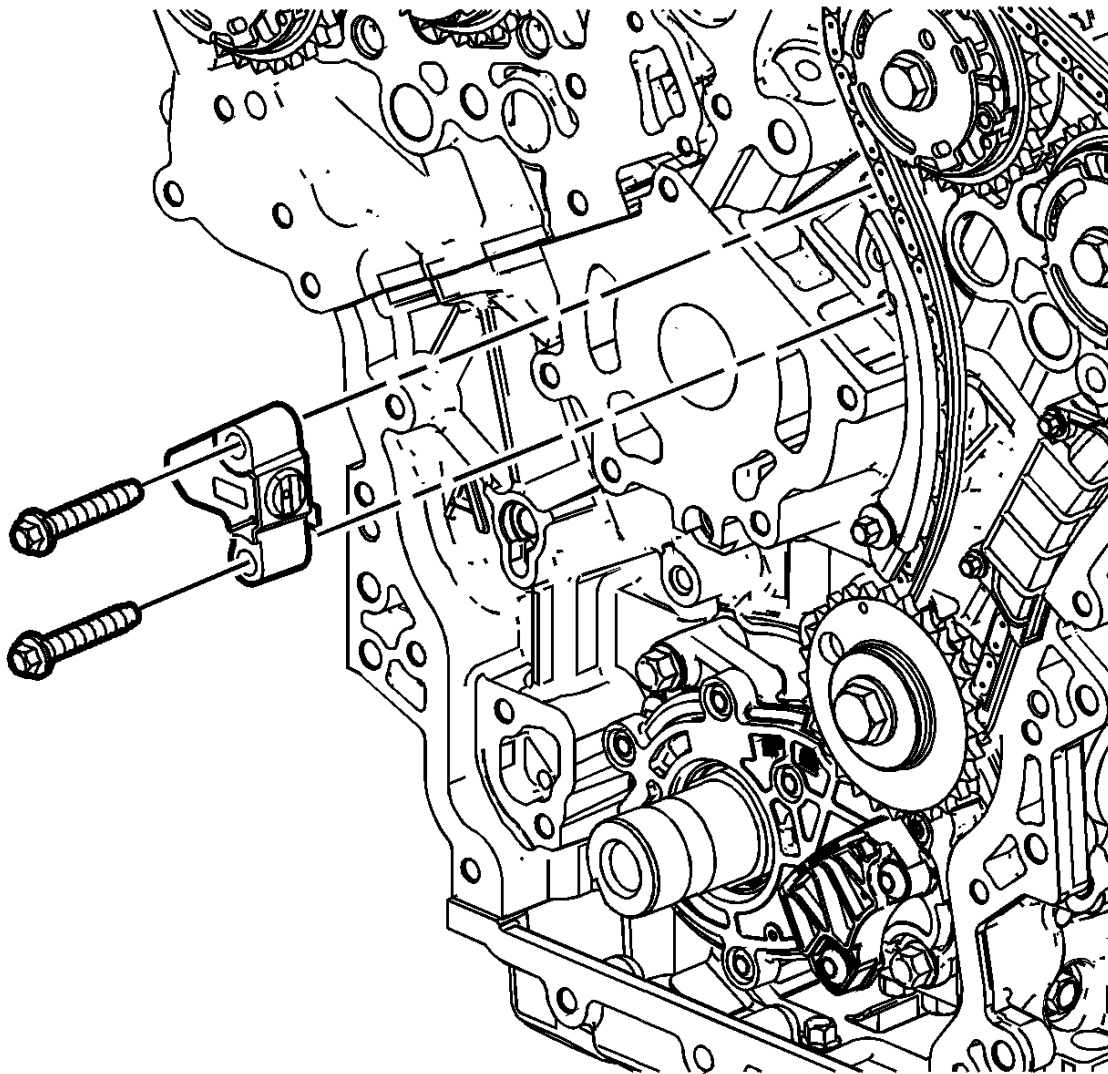


Fig. 64: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

Removal Procedure

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

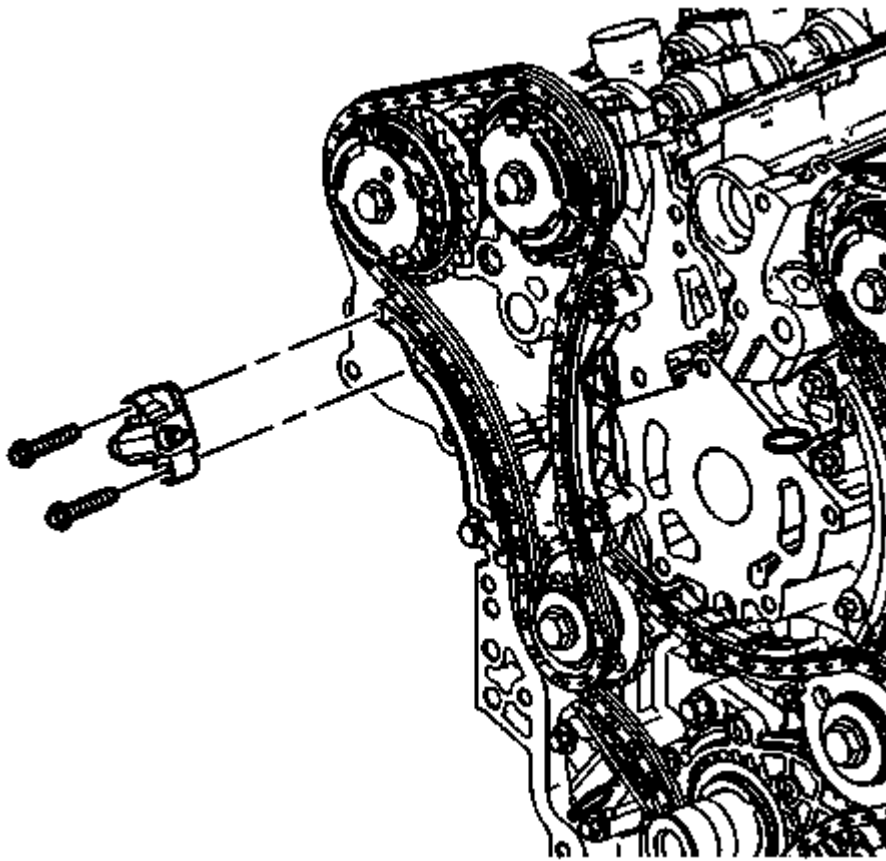


Fig. 65: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

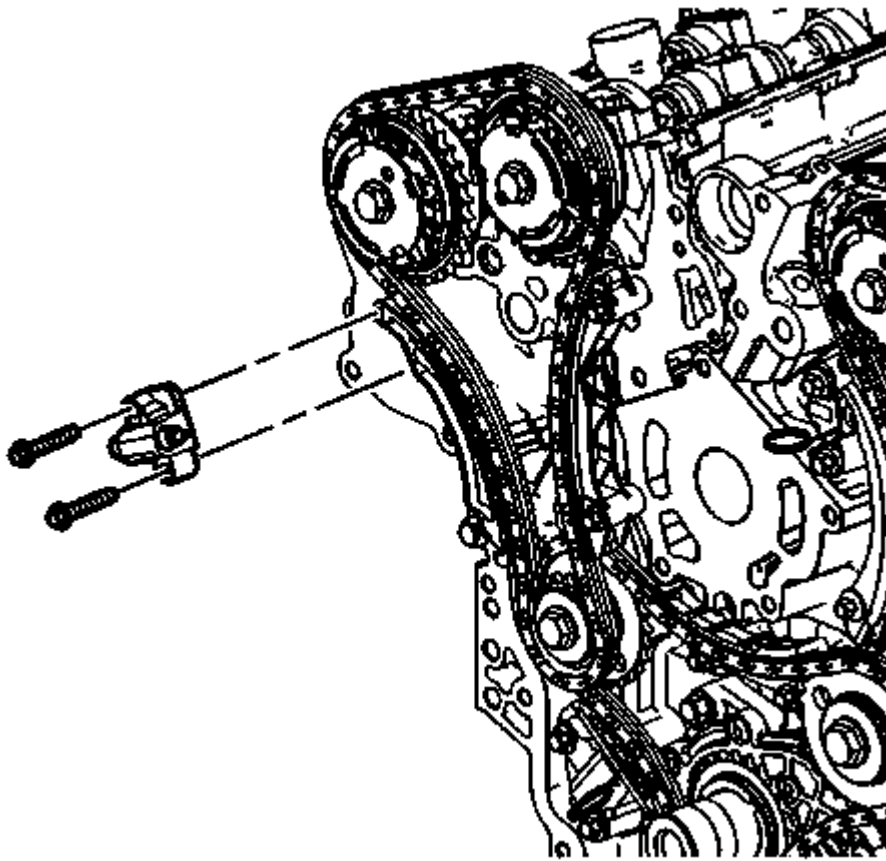


Fig. 66: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

Removal Procedure

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

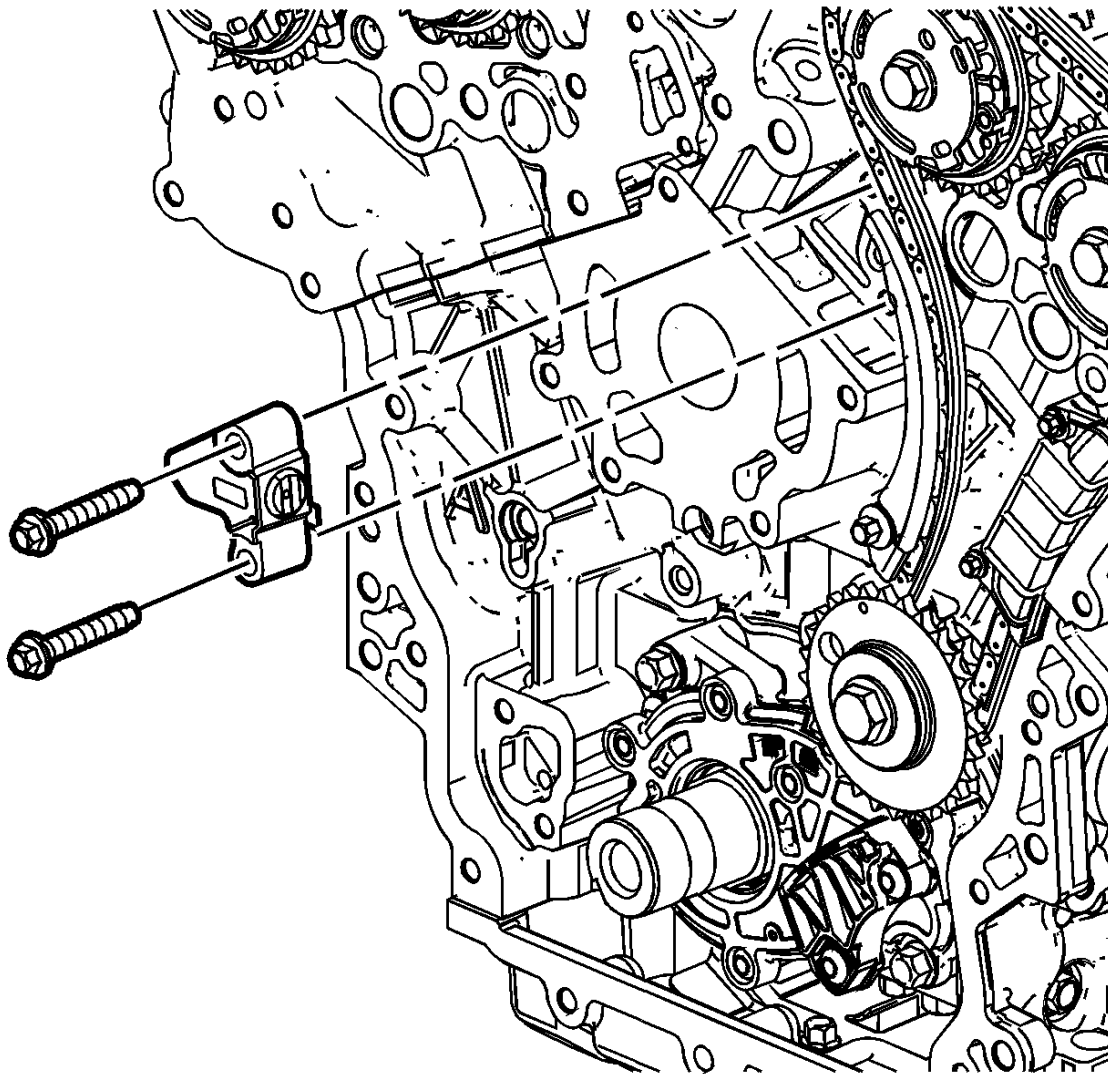


Fig. 67: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

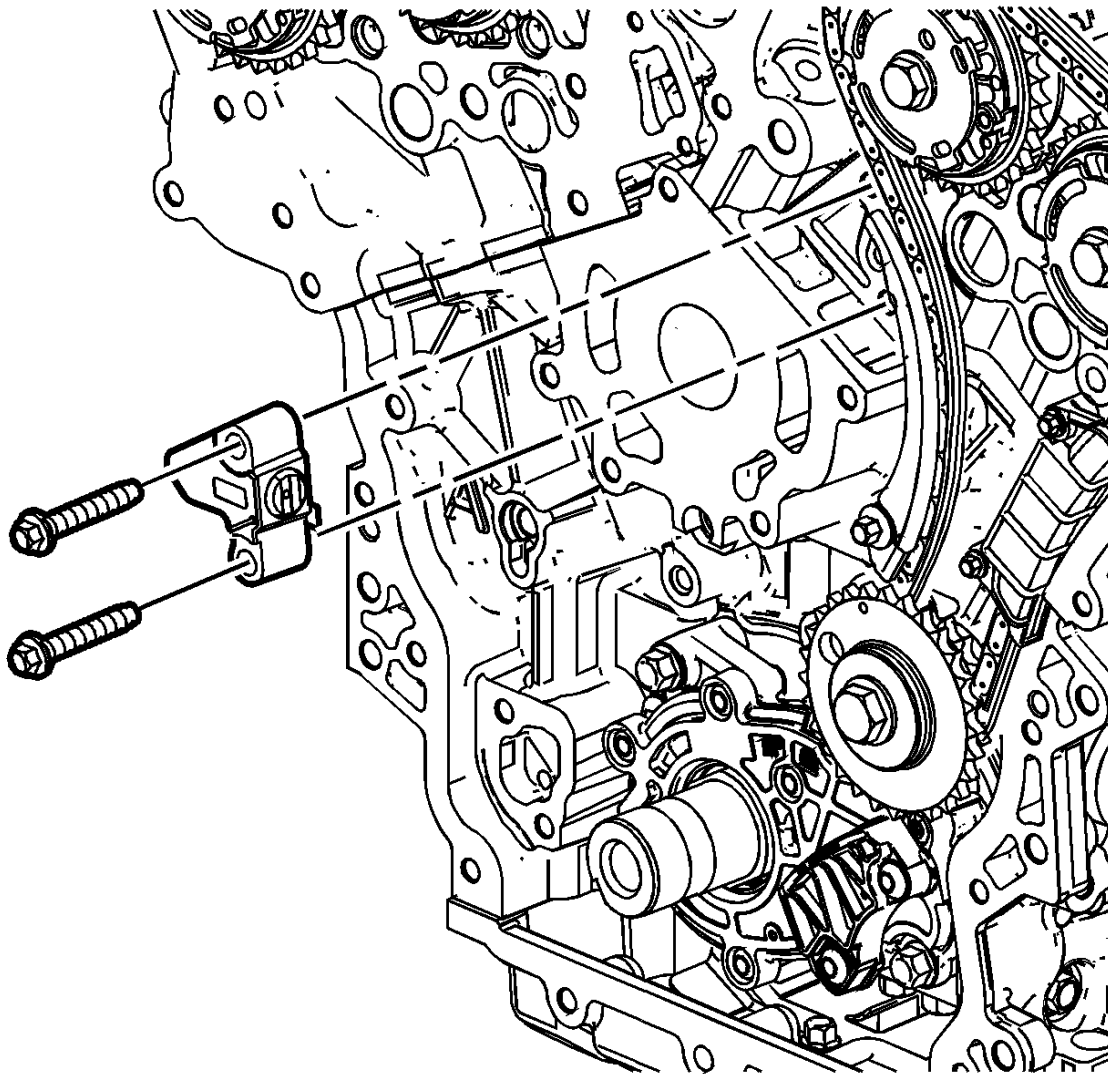


Fig. 68: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Removal Procedure

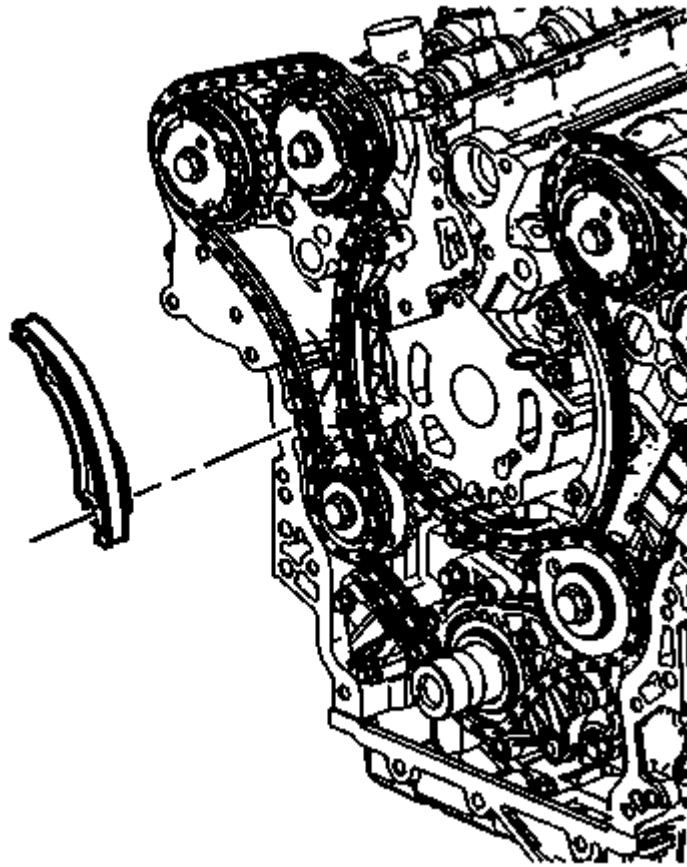


Fig. 69: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

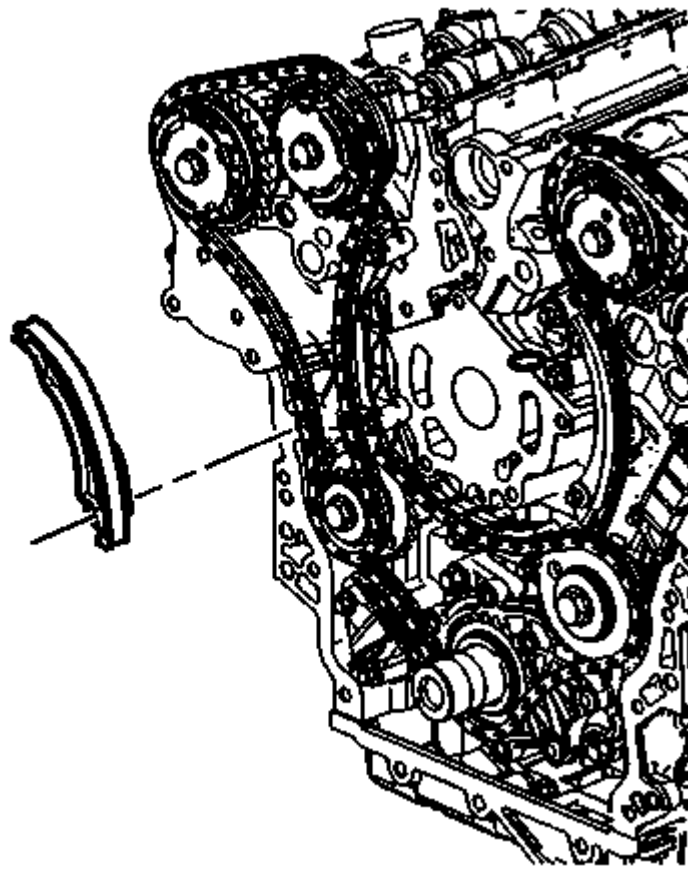


Fig. 70: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

Removal Procedure

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

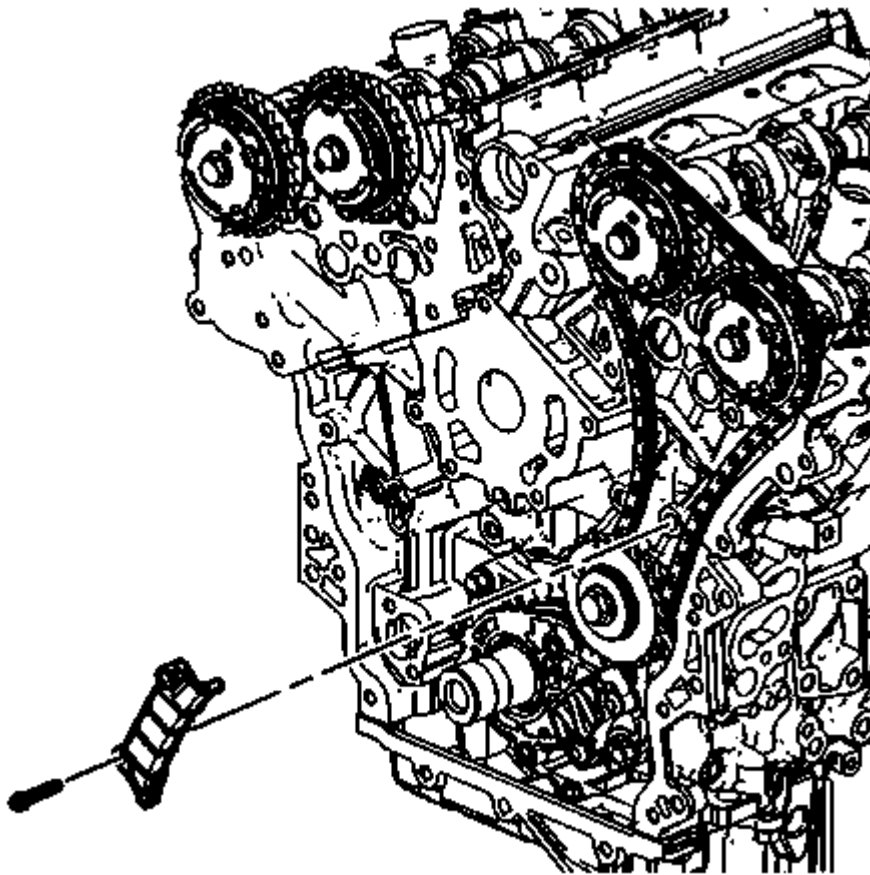


Fig. 71: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

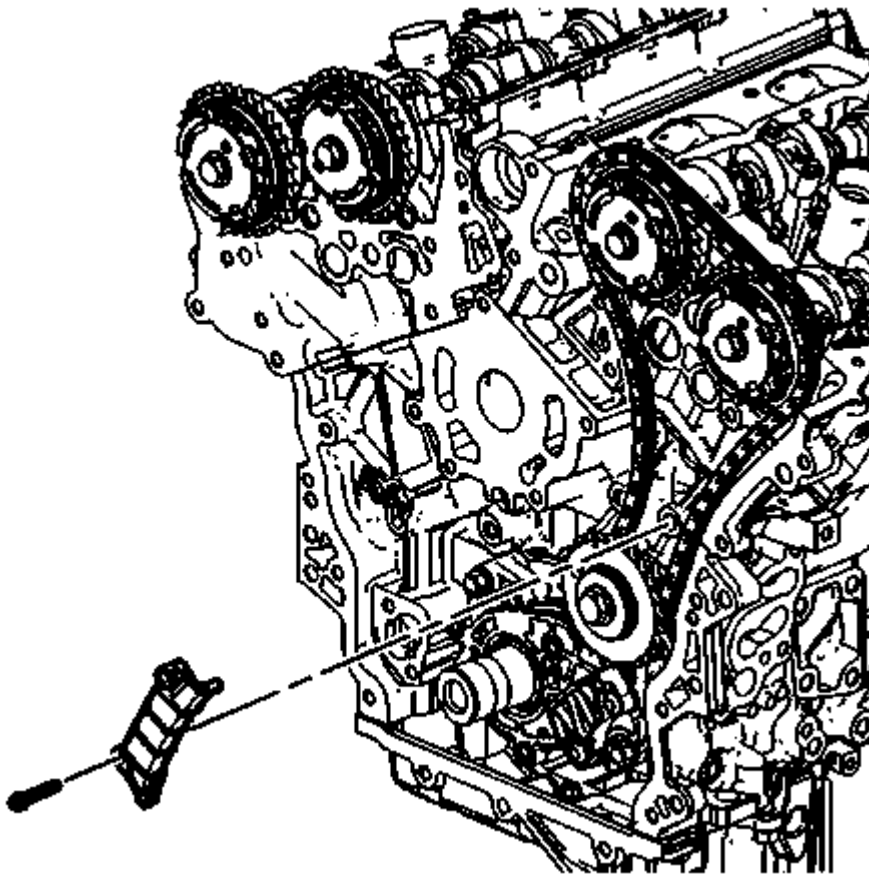


Fig. 72: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

Removal Procedure

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

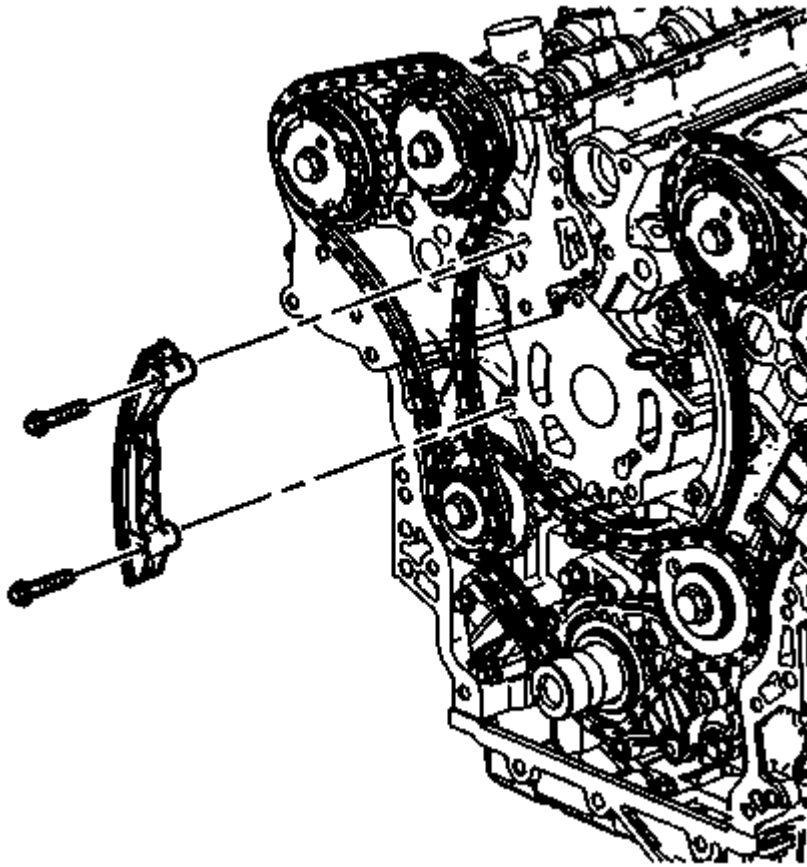


Fig. 73: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

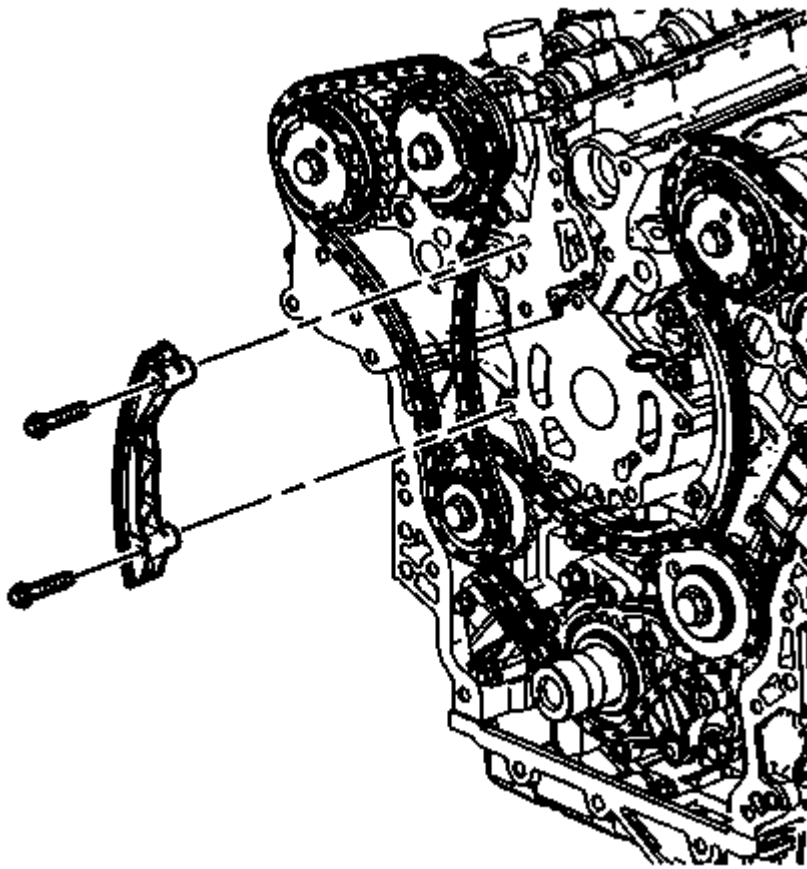


Fig. 74: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Removal Procedure

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

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

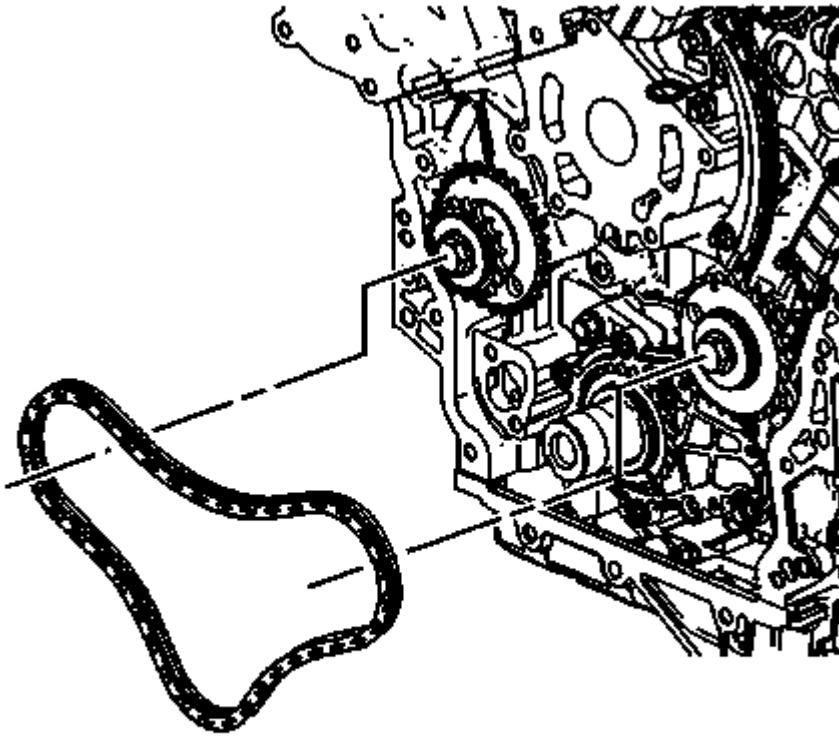


Fig. 75: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

8. Remove the primary camshaft timing chain.

Installation Procedure

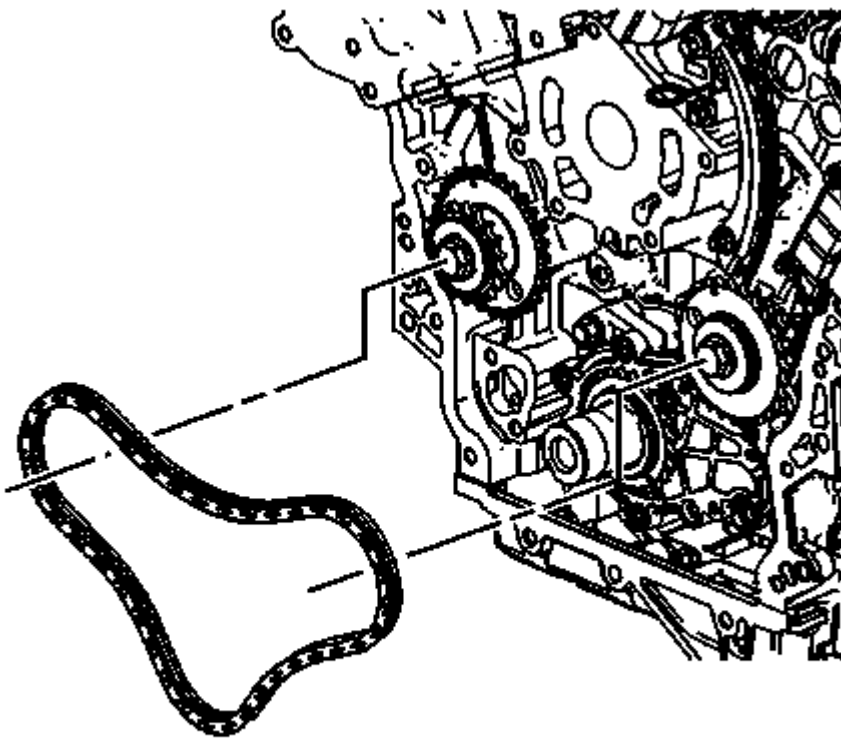


Fig. 76: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

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

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

Removal Procedure

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. 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

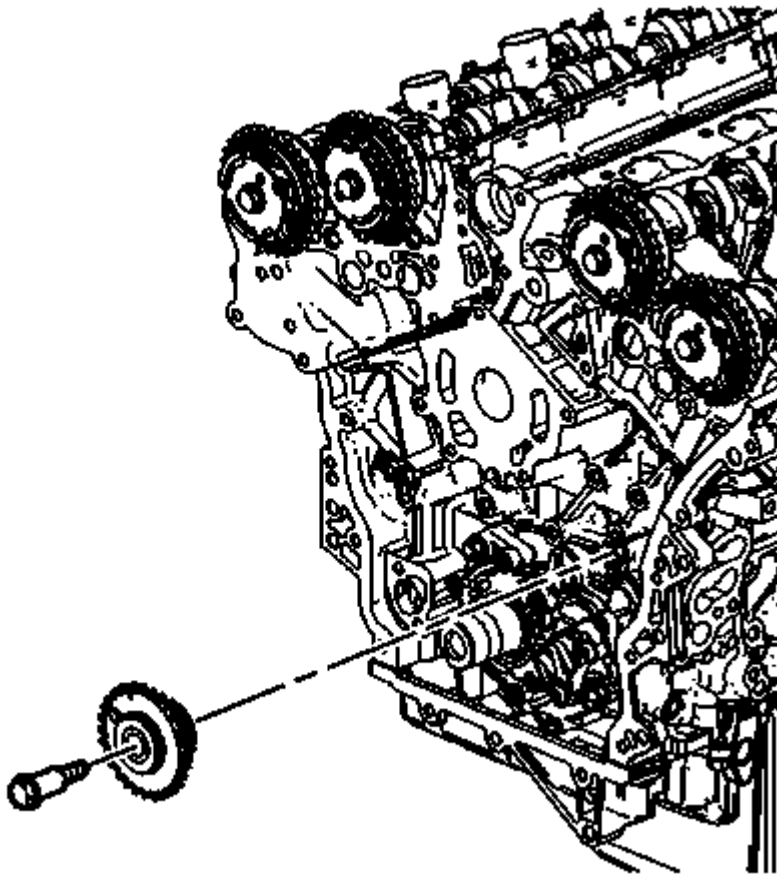


Fig. 77: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

Chain Tensioner Installation .

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

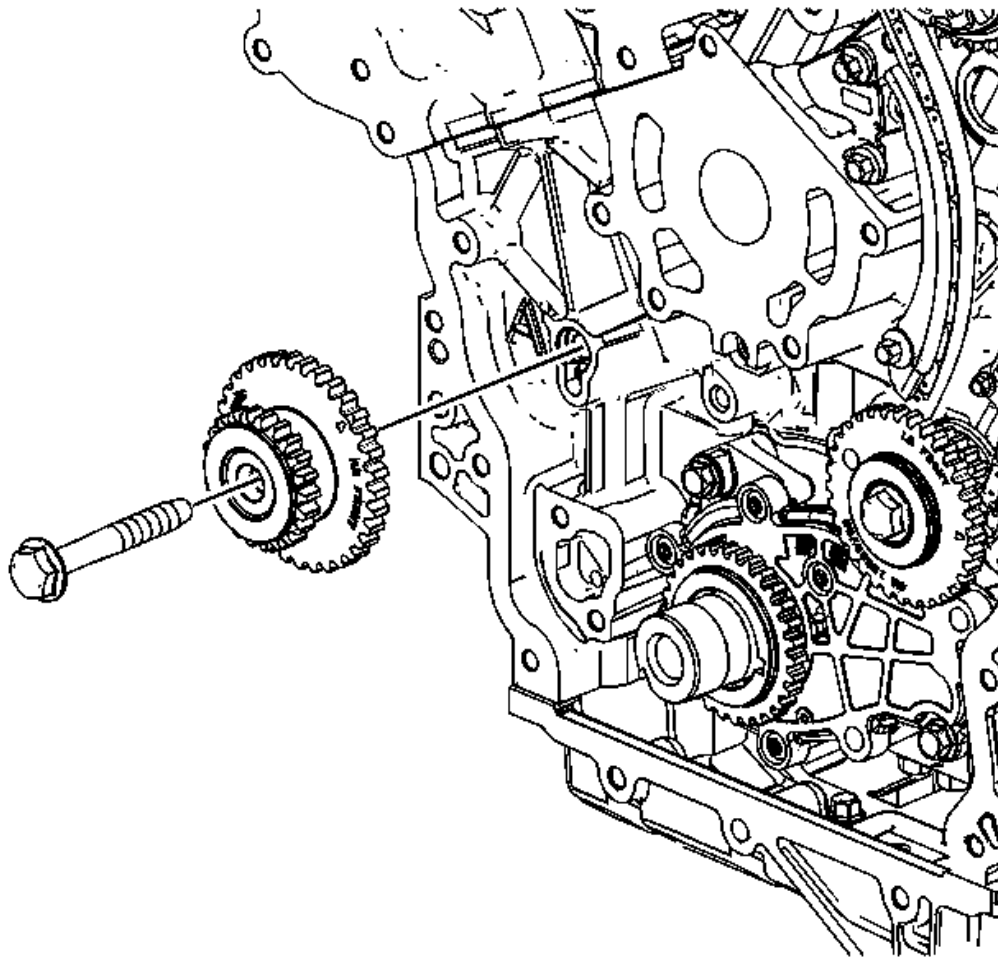
TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE**Removal Procedure**

Fig. 78: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

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

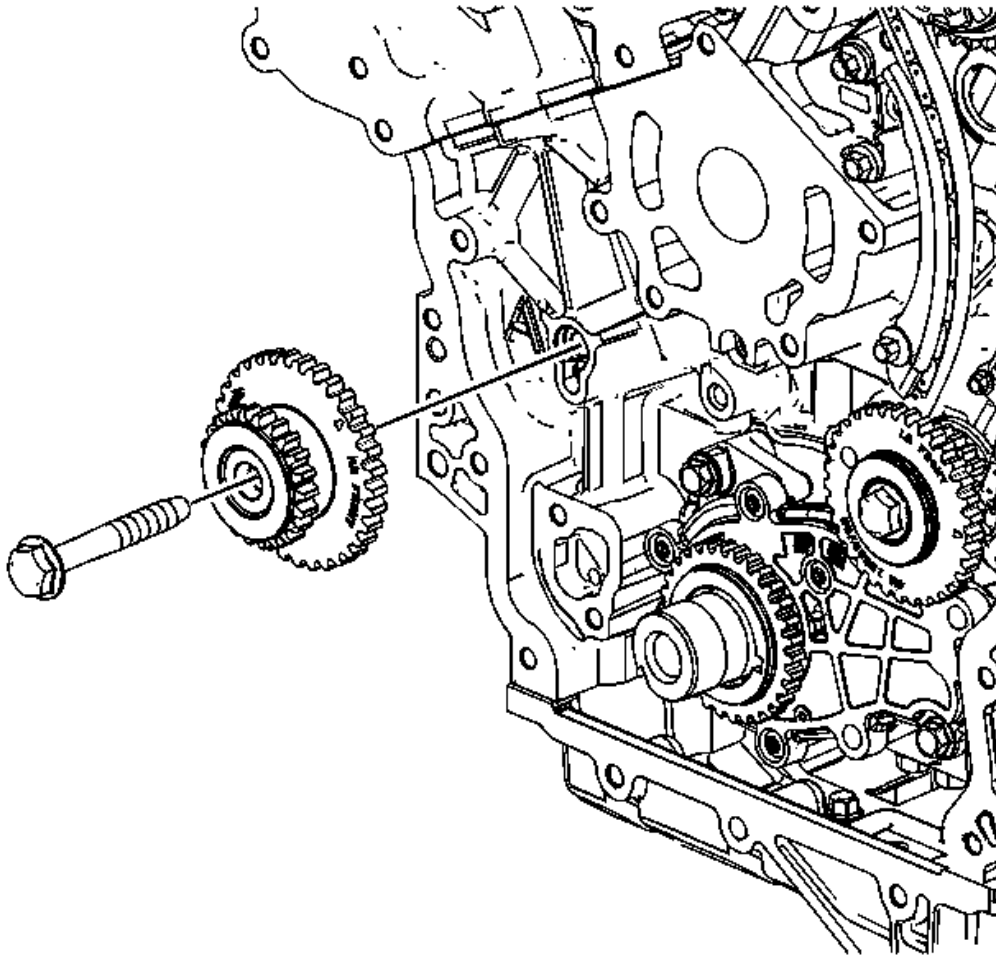


Fig. 79: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

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

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

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

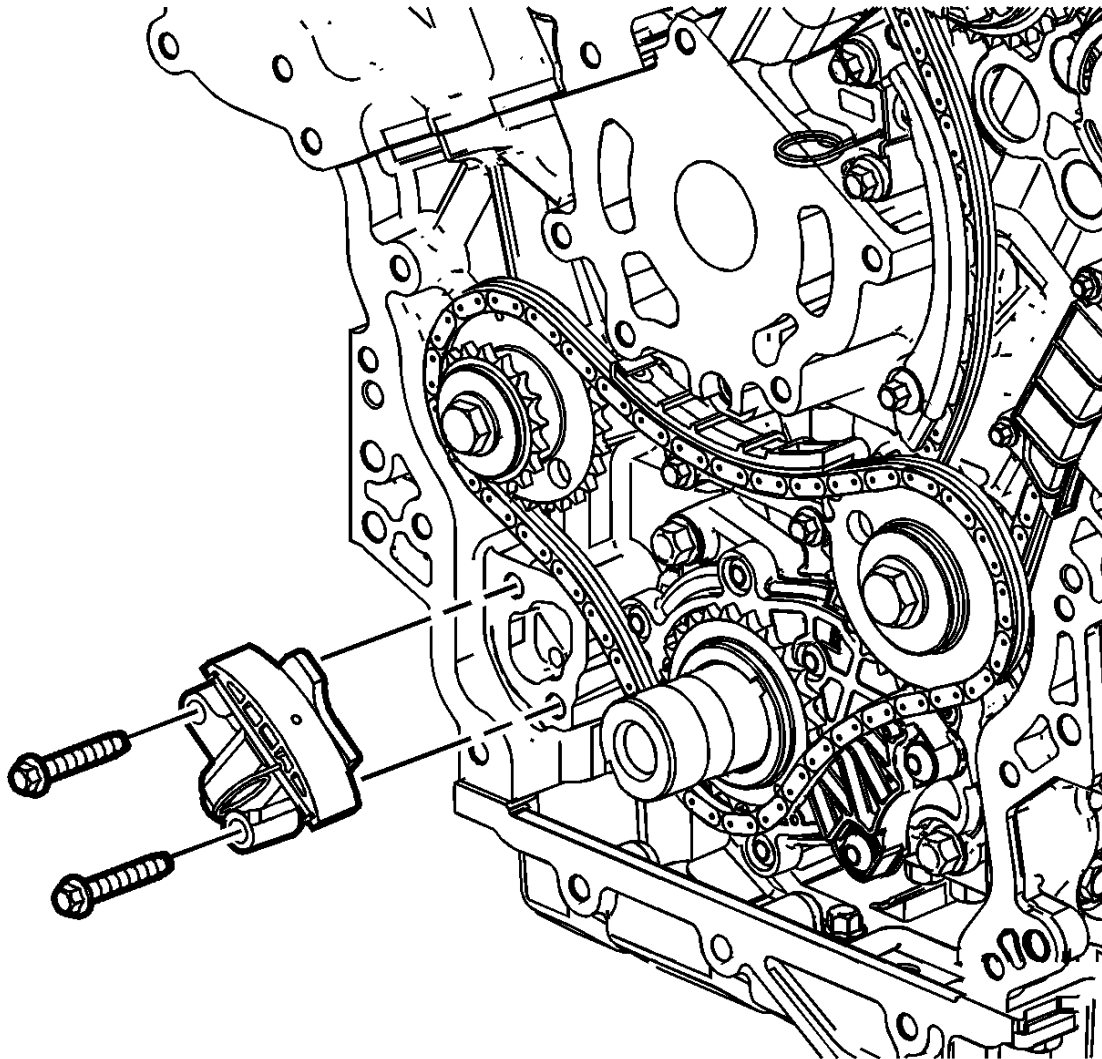


Fig. 80: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

ensure proper reassembly.

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

Installation Procedure

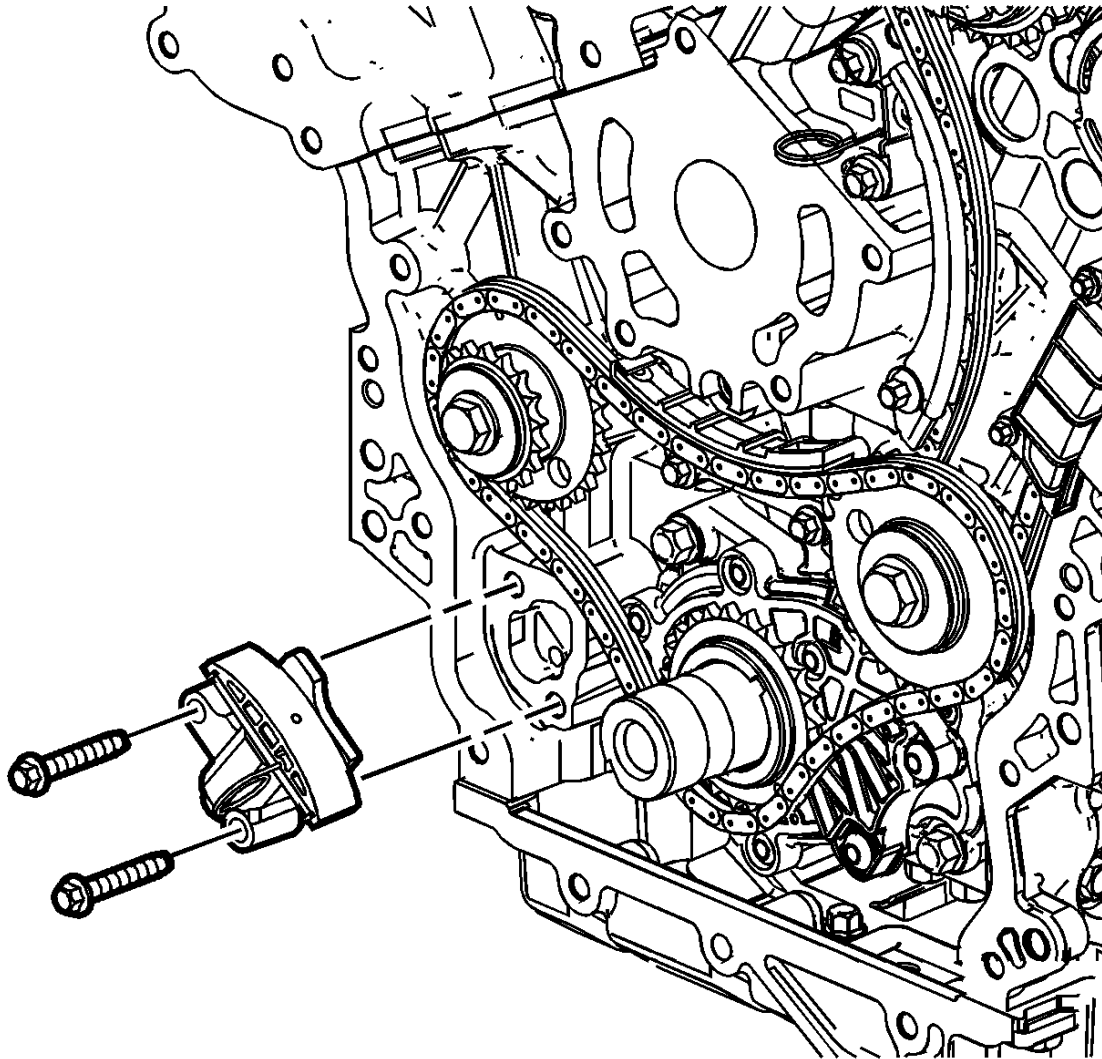


Fig. 81: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

Removal Procedure

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

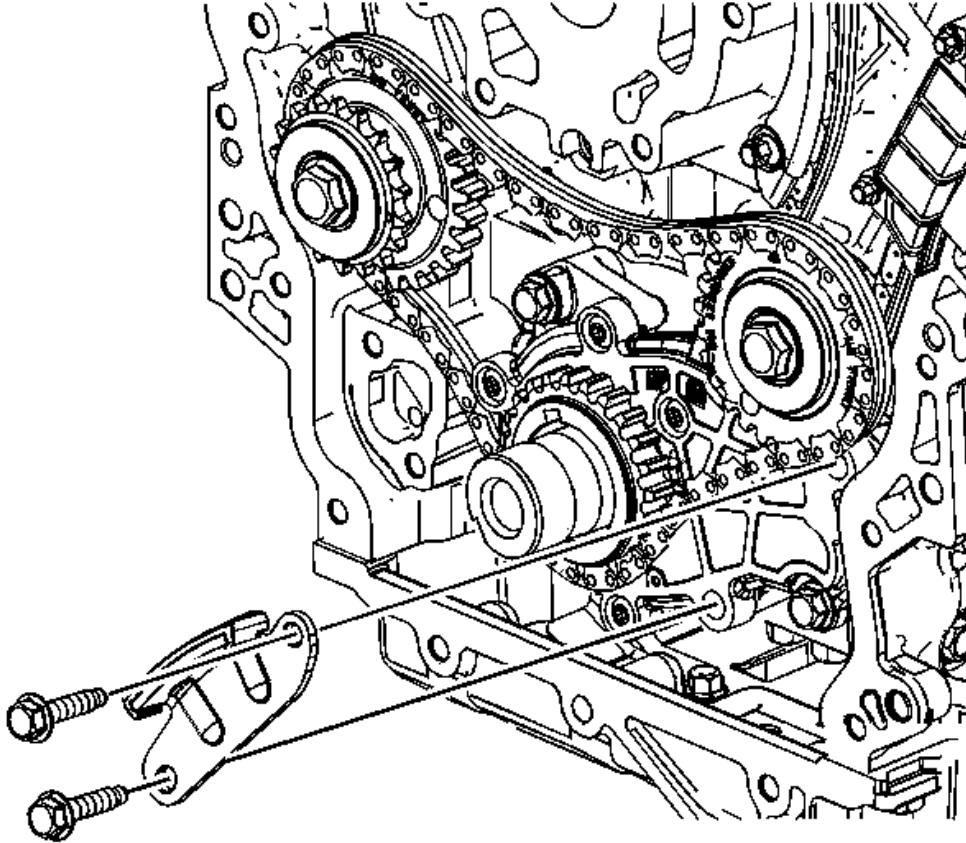


Fig. 82: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

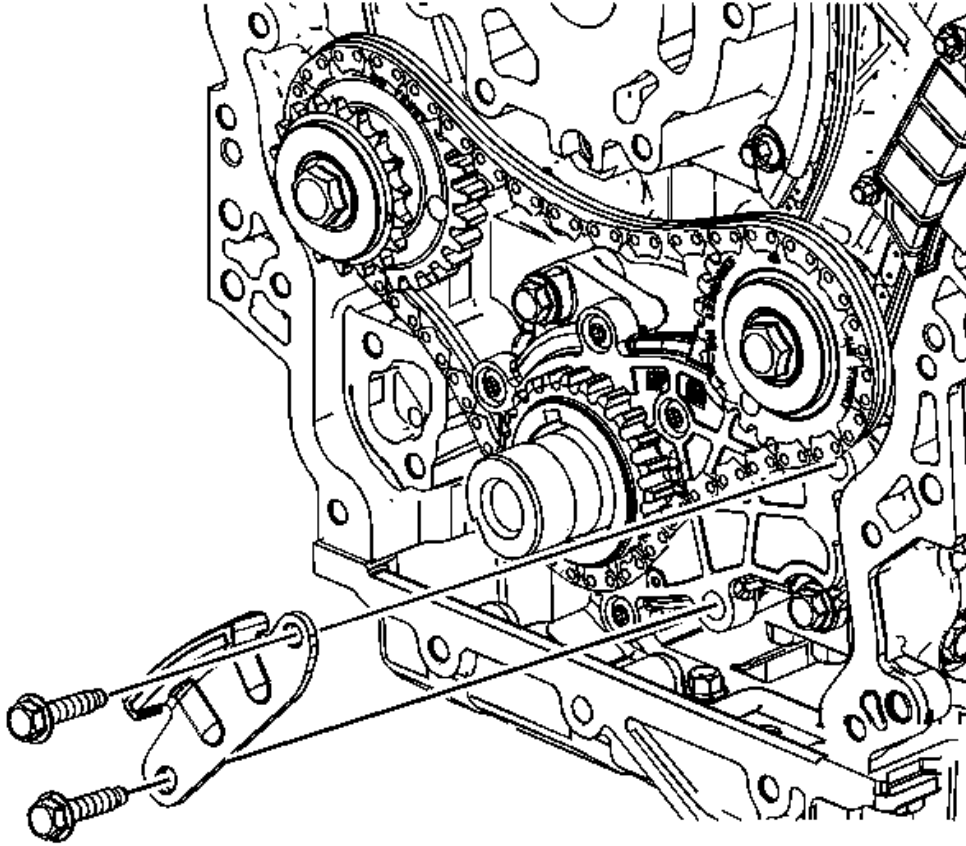


Fig. 83: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

Removal Procedure

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

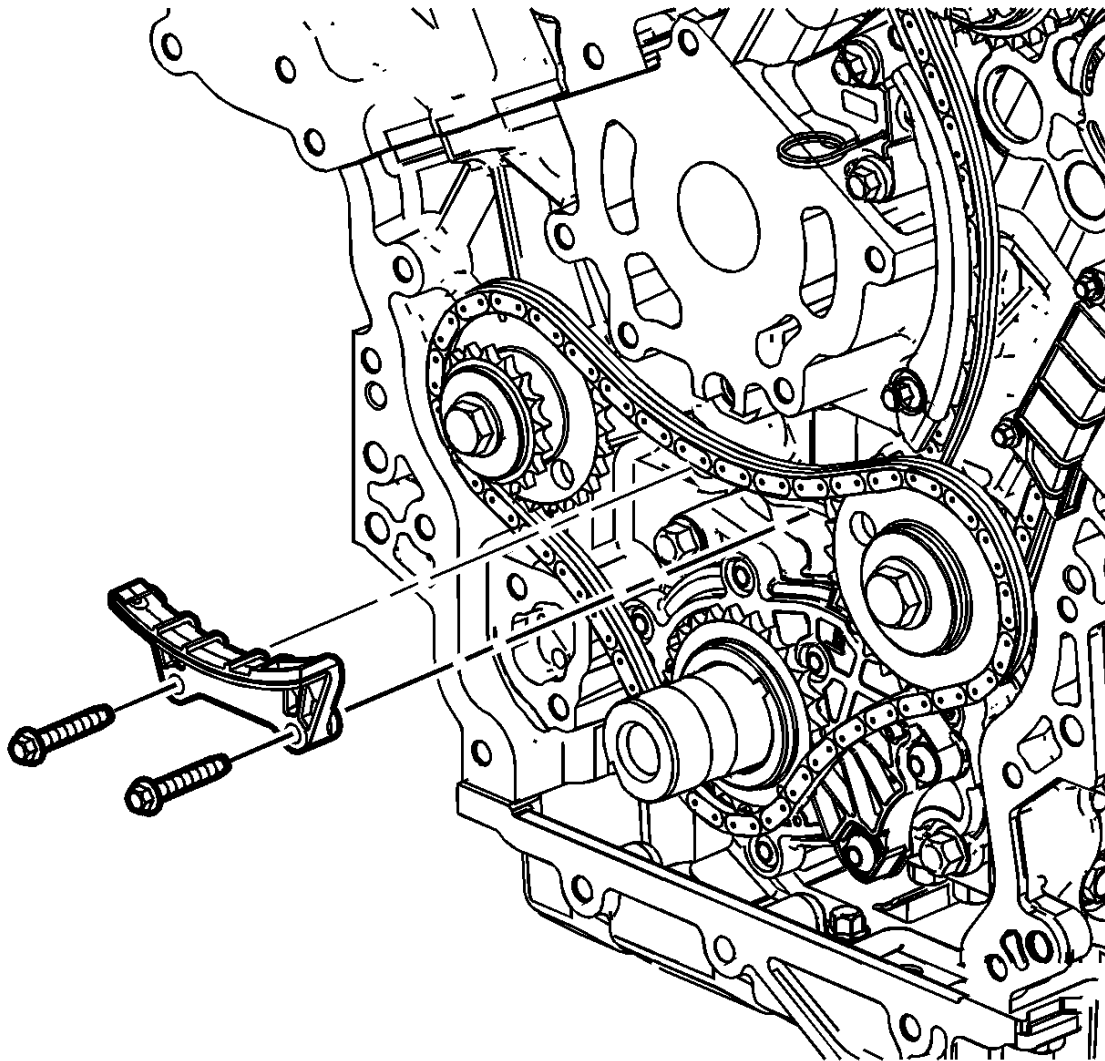


Fig. 84: View Of Upper Primary Camshaft Drive Chain Guide
 Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

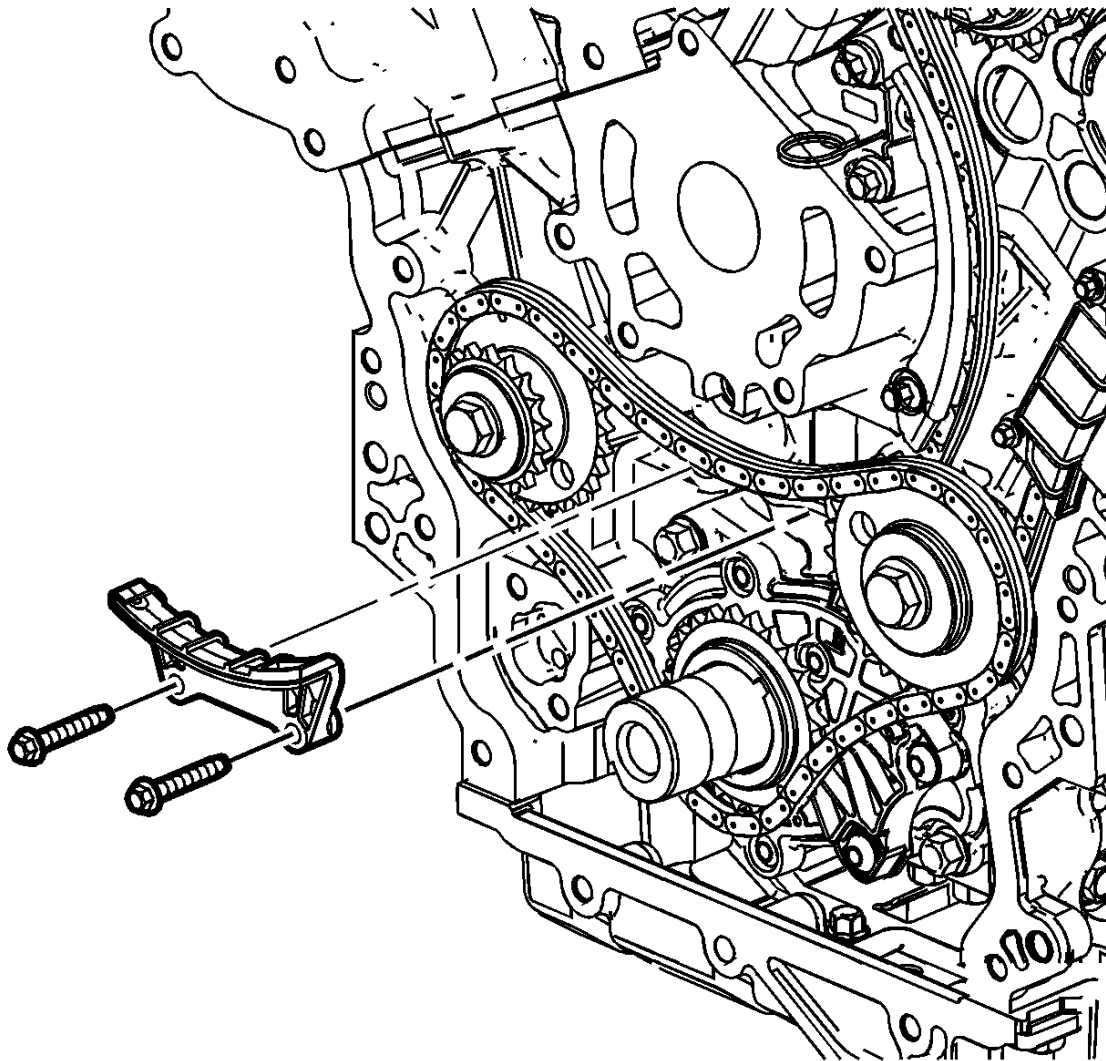


Fig. 85: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide 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**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

Special Tools

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

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

Removal Procedure

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

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

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

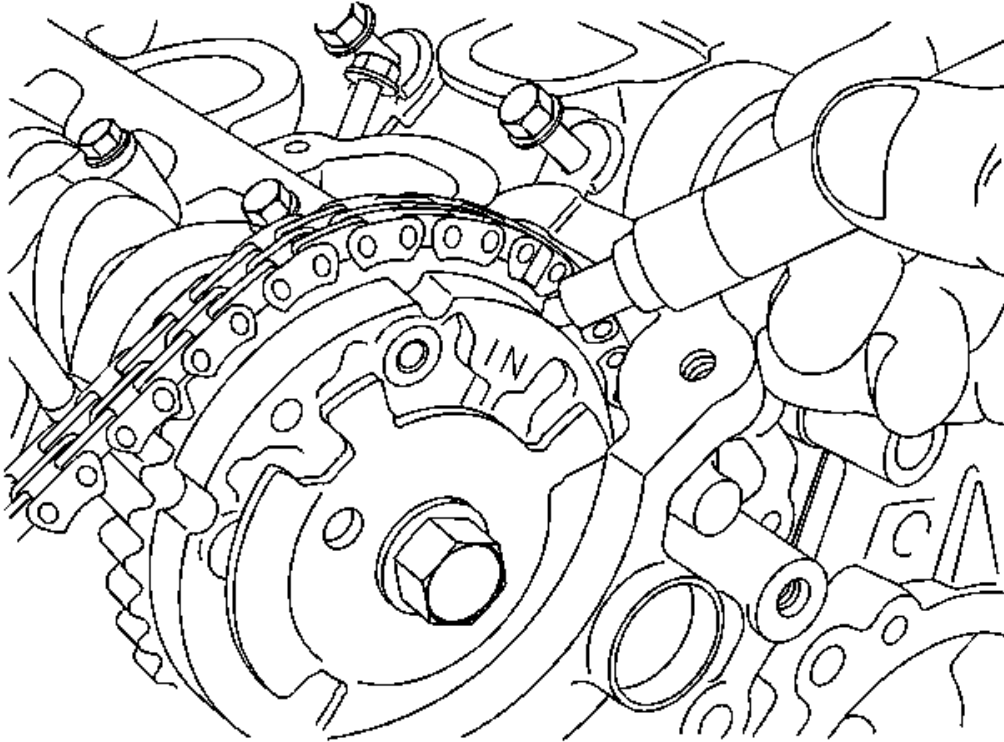


Fig. 86: Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS COMPANY

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

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

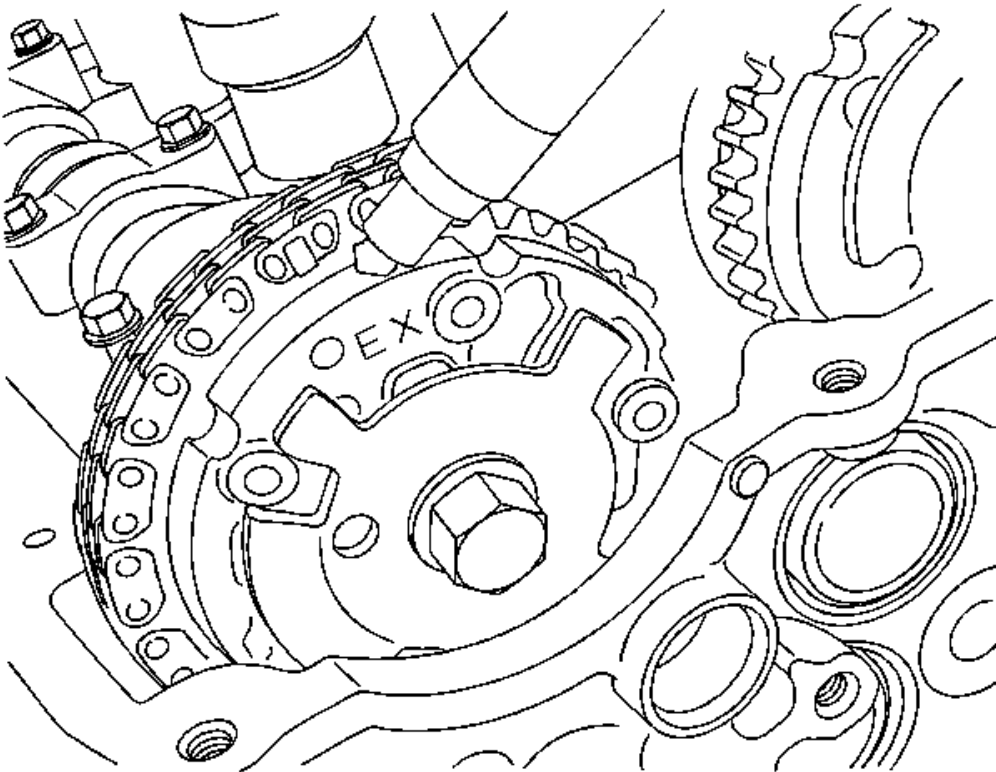


Fig. 87: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS COMPANY

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

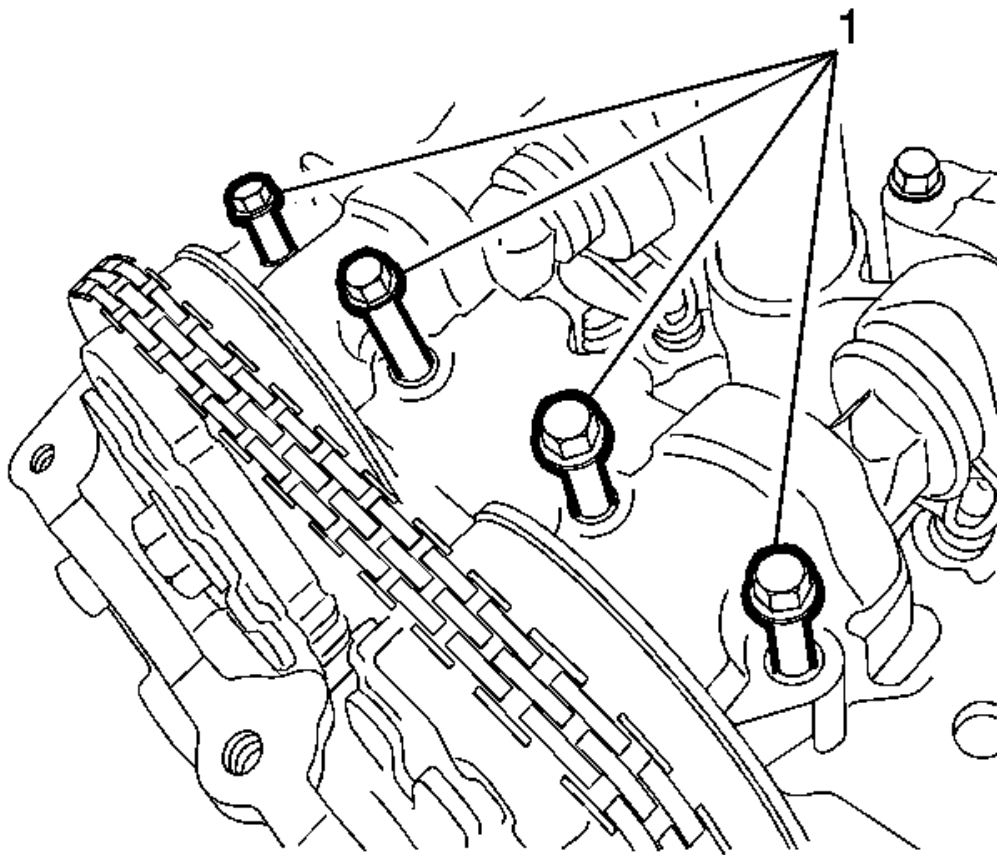


Fig. 88: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

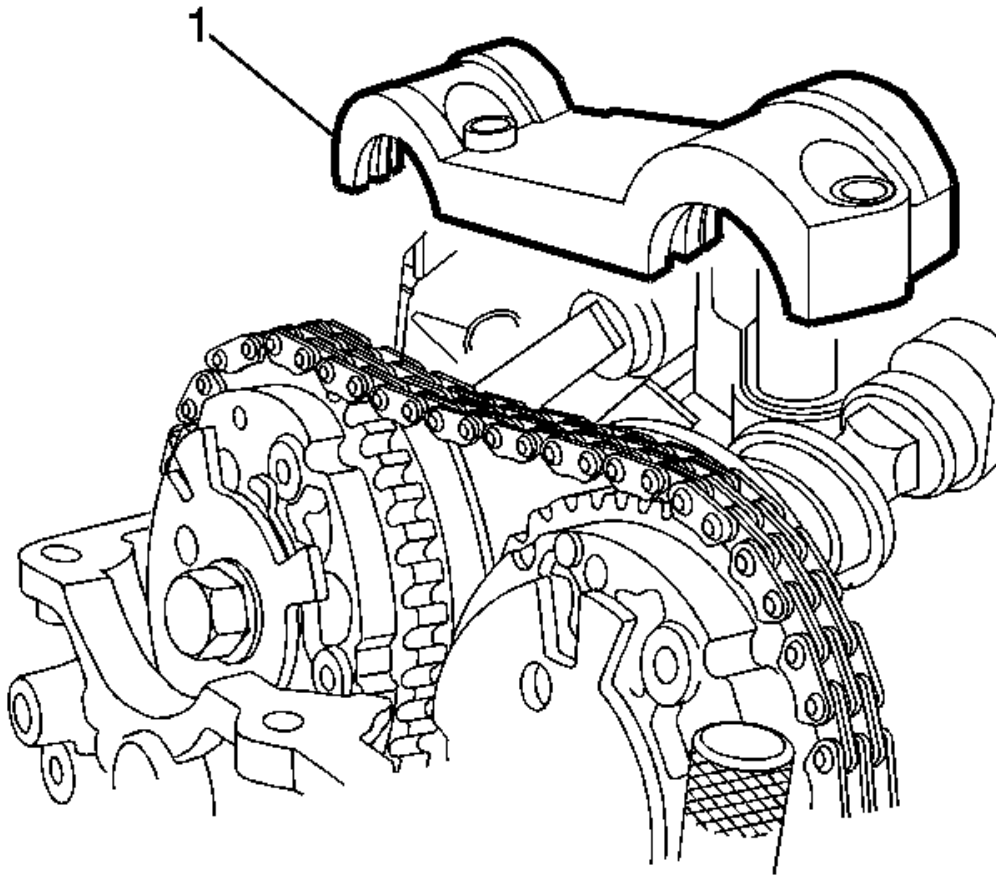


Fig. 89: View Of Camshaft Front Cap
Courtesy of GENERAL MOTORS COMPANY

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

11. Remove the camshaft front cap (1).

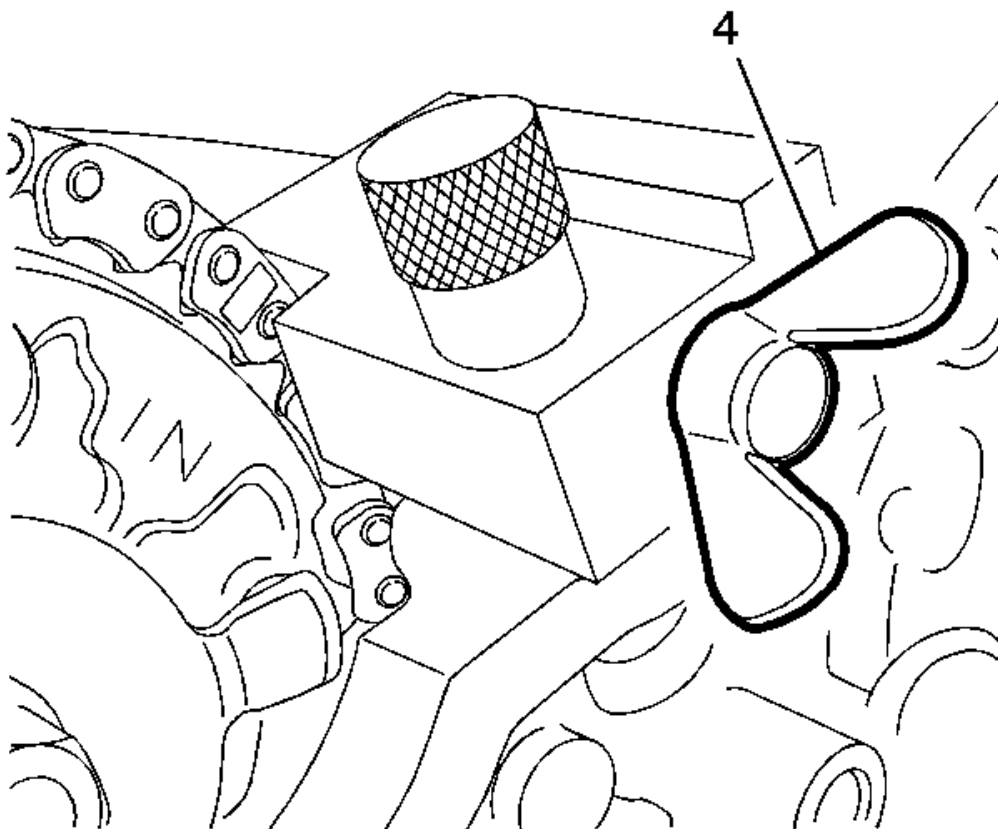


Fig. 90: Retainer Wingnut

Courtesy of GENERAL MOTORS COMPANY

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

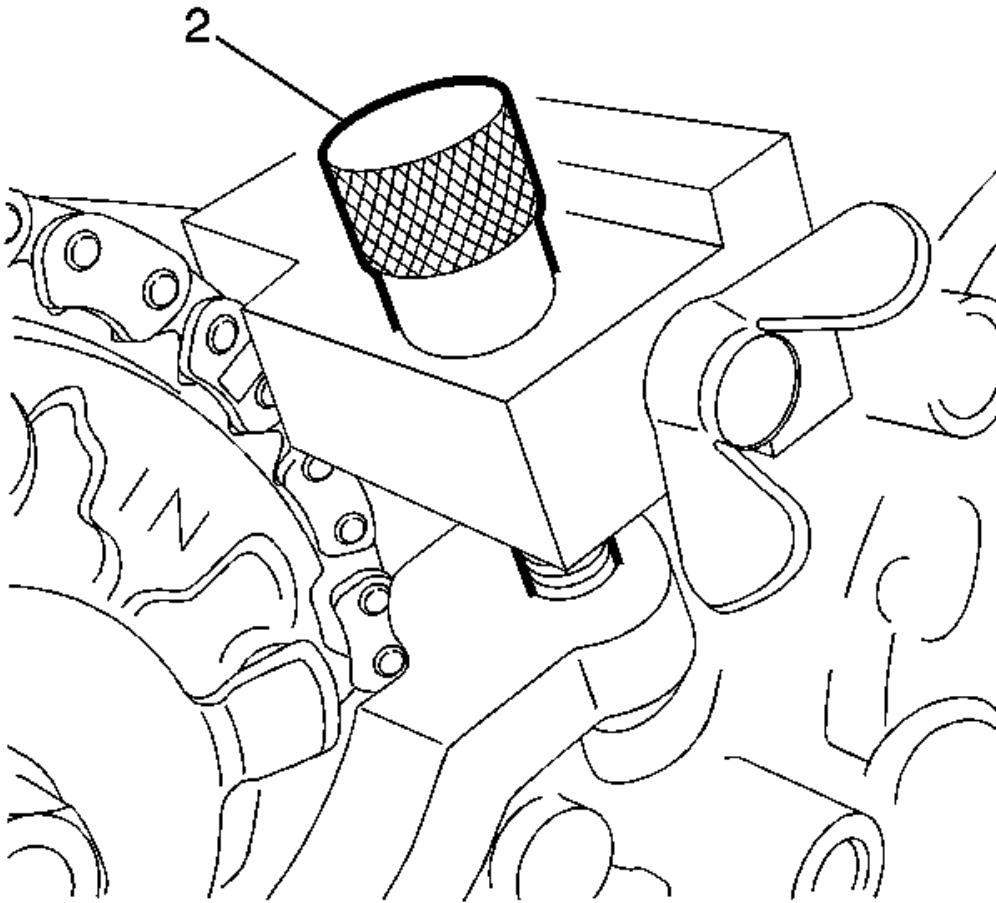


Fig. 91: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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

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

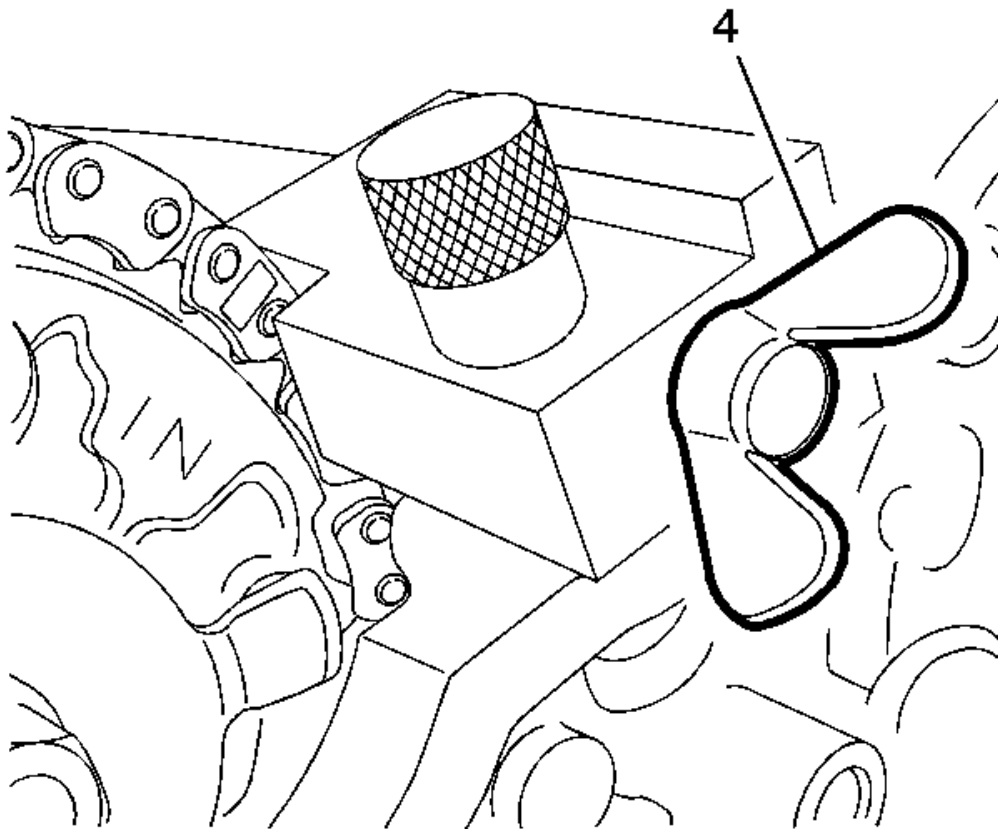


Fig. 92: Retainer Wingnut

Courtesy of GENERAL MOTORS COMPANY

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

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

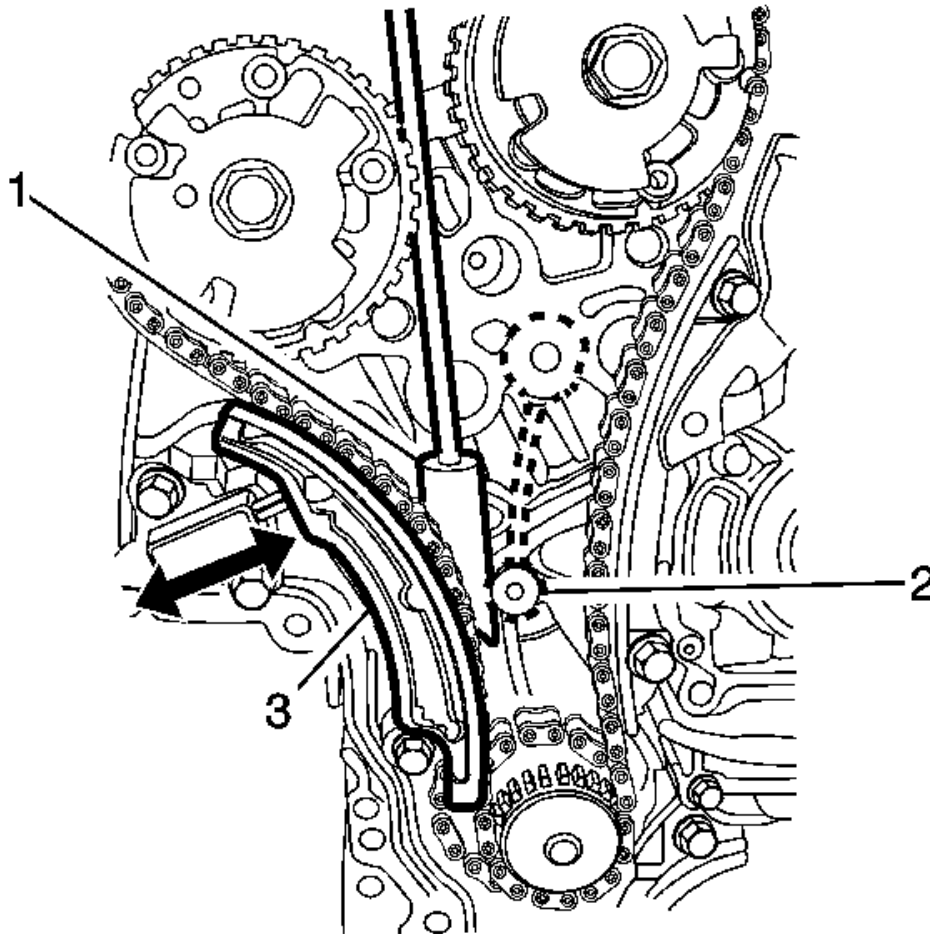


Fig. 93: Retainer Wedge

Courtesy of GENERAL MOTORS COMPANY

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

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

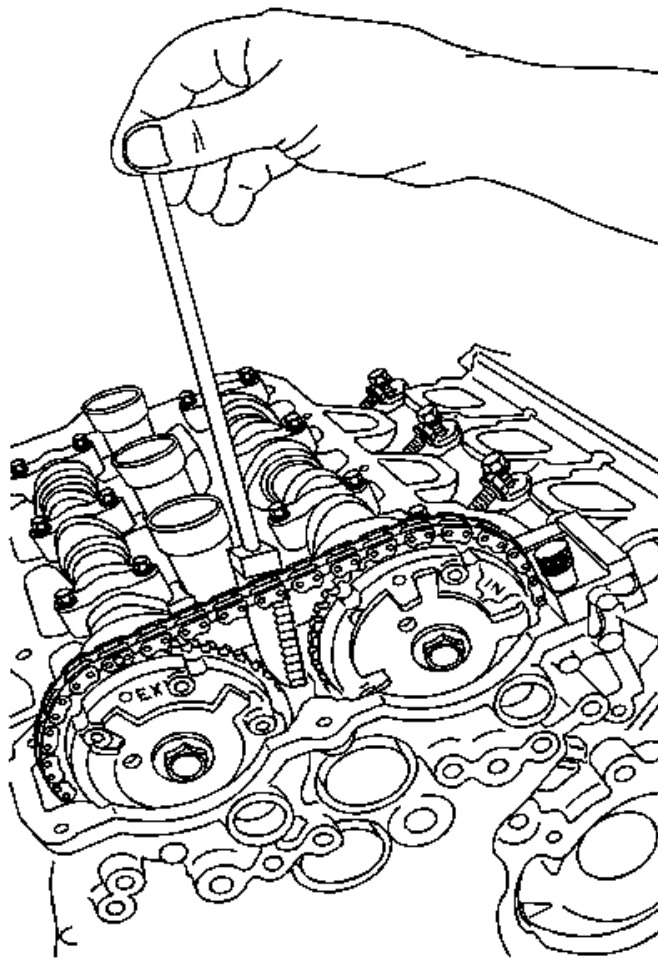


Fig. 94: Inserting Retainer

Courtesy of GENERAL MOTORS COMPANY

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

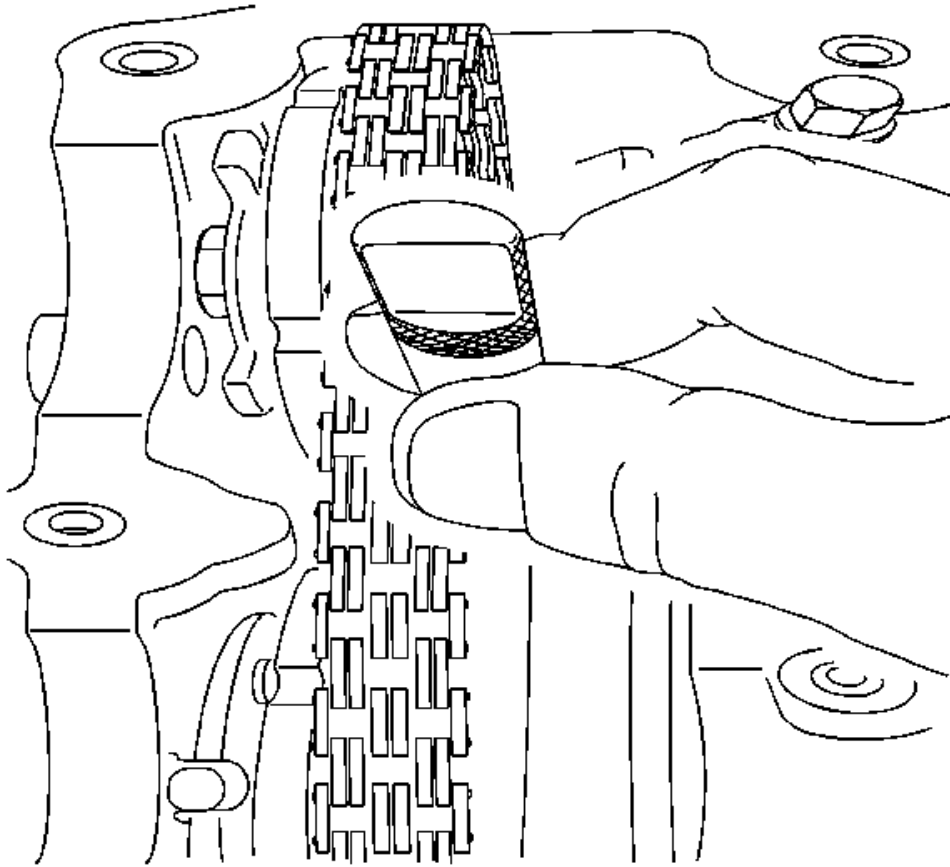


Fig. 95: Orienting Retainer Teeth

Courtesy of GENERAL MOTORS COMPANY

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

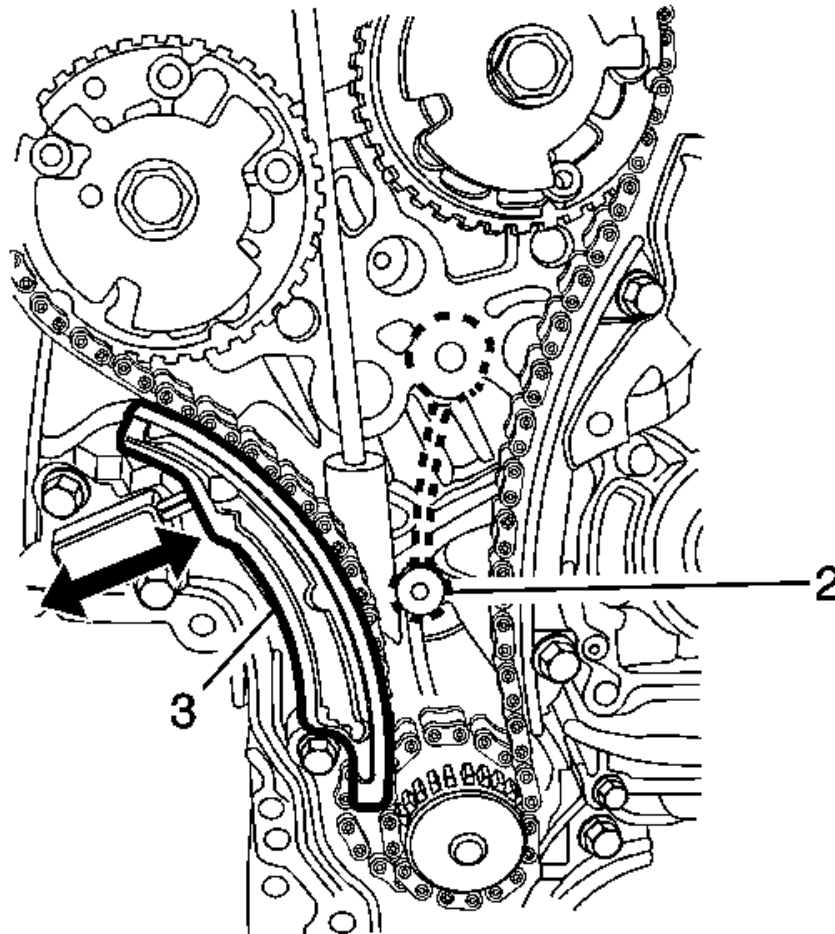


Fig. 96: Wedge, Timing Chain And Belt Casting
Courtesy of GENERAL MOTORS COMPANY

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

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

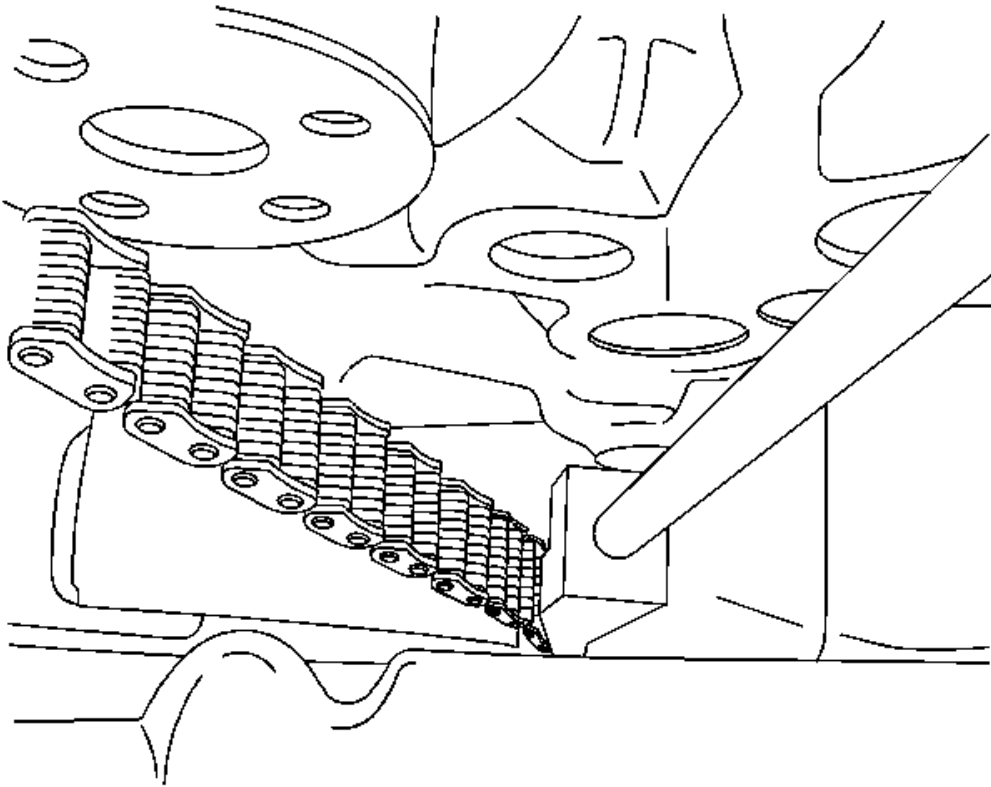


Fig. 97: Positioning Wedge

Courtesy of GENERAL MOTORS COMPANY

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

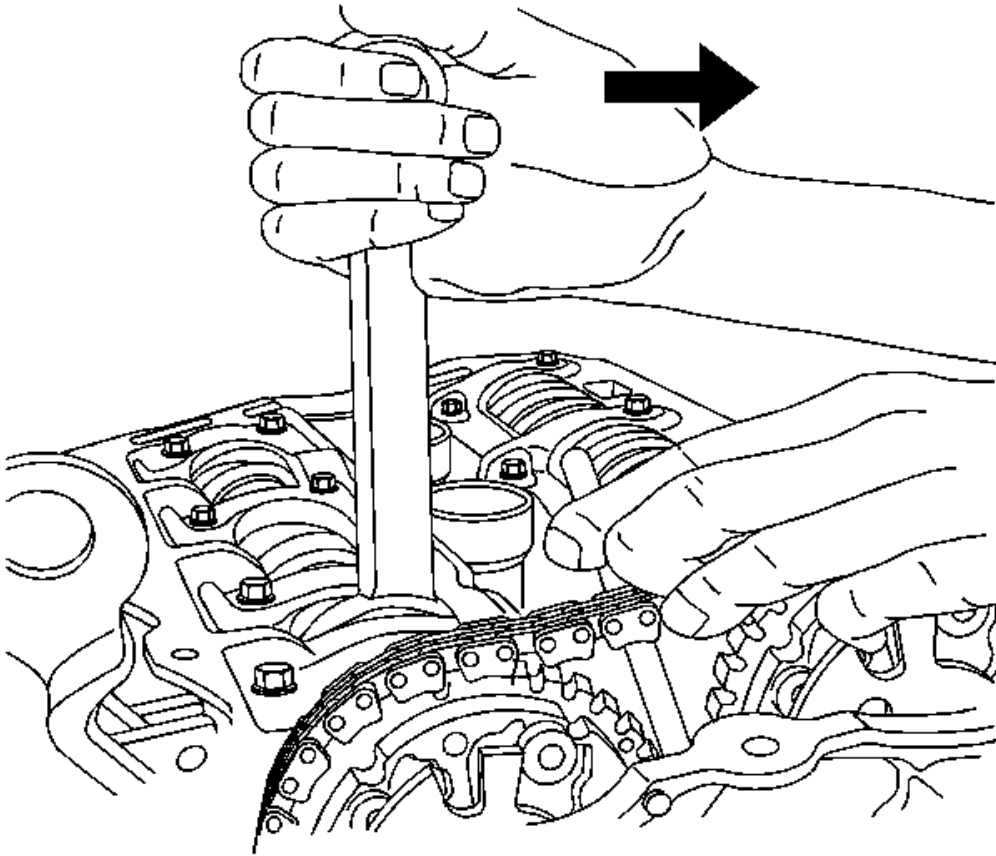


Fig. 98: Rotating Camshaft

Courtesy of GENERAL MOTORS COMPANY

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

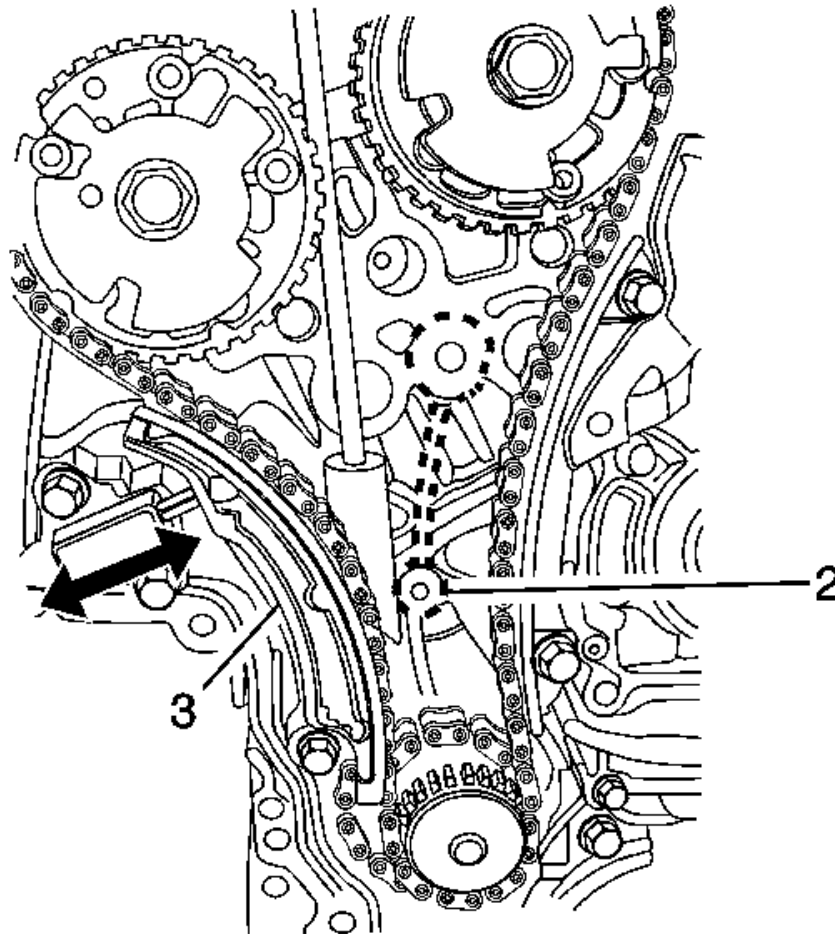


Fig. 99: Opening Gap Between Chain & Internal Rib In Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

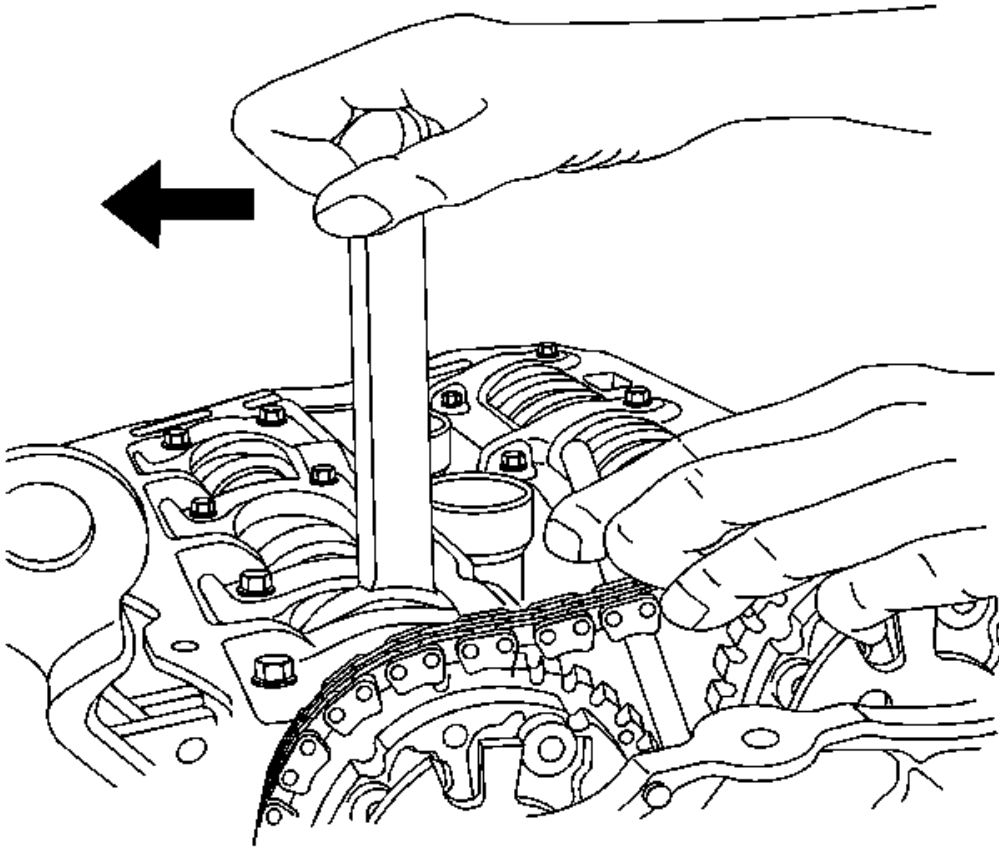


Fig. 100: Releasing Force On Wrench
Courtesy of GENERAL MOTORS COMPANY

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

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

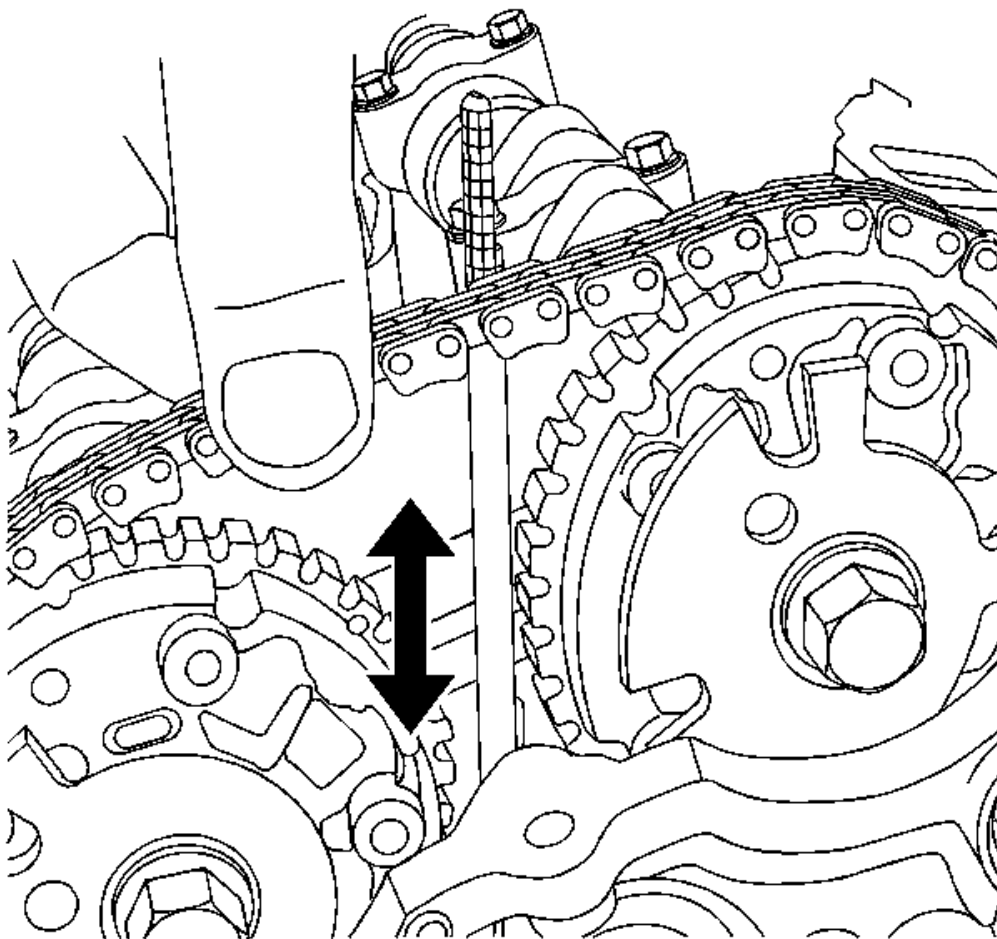


Fig. 101: Slack In Timing Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

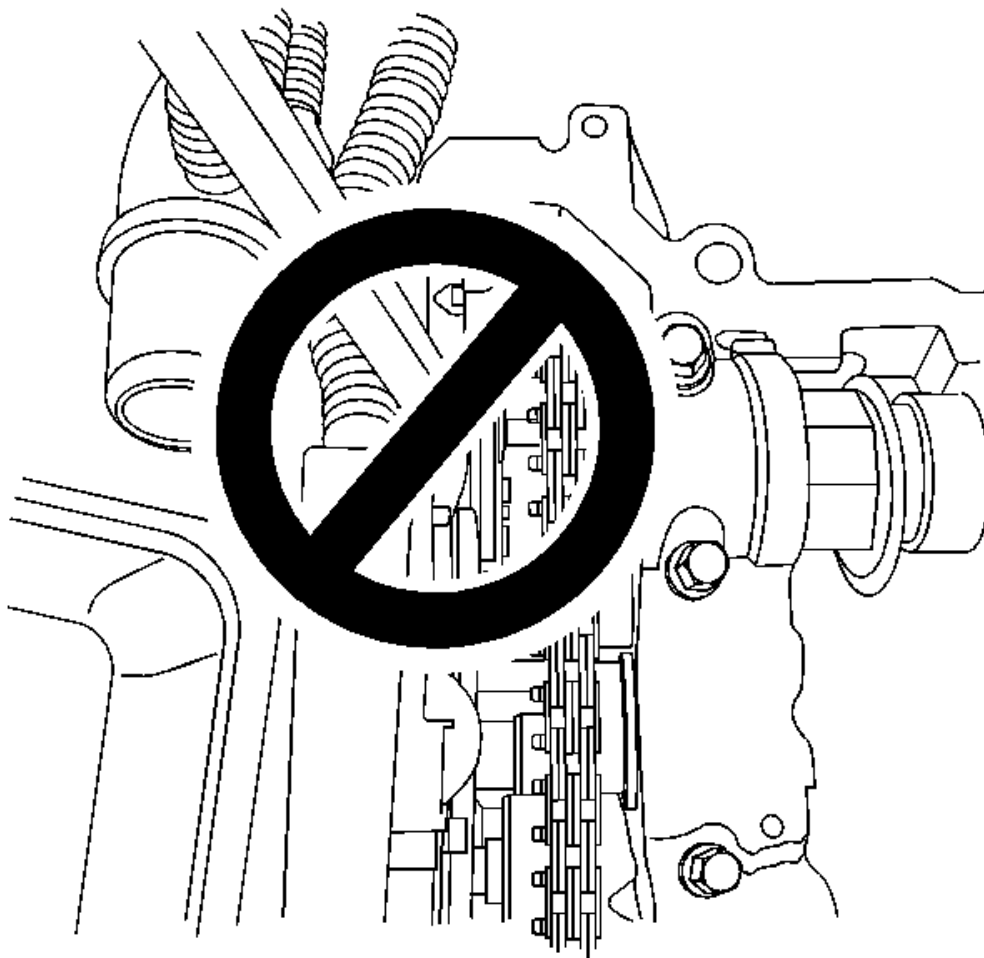


Fig. 102: Do Not Pry Warning

Courtesy of GENERAL MOTORS COMPANY

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

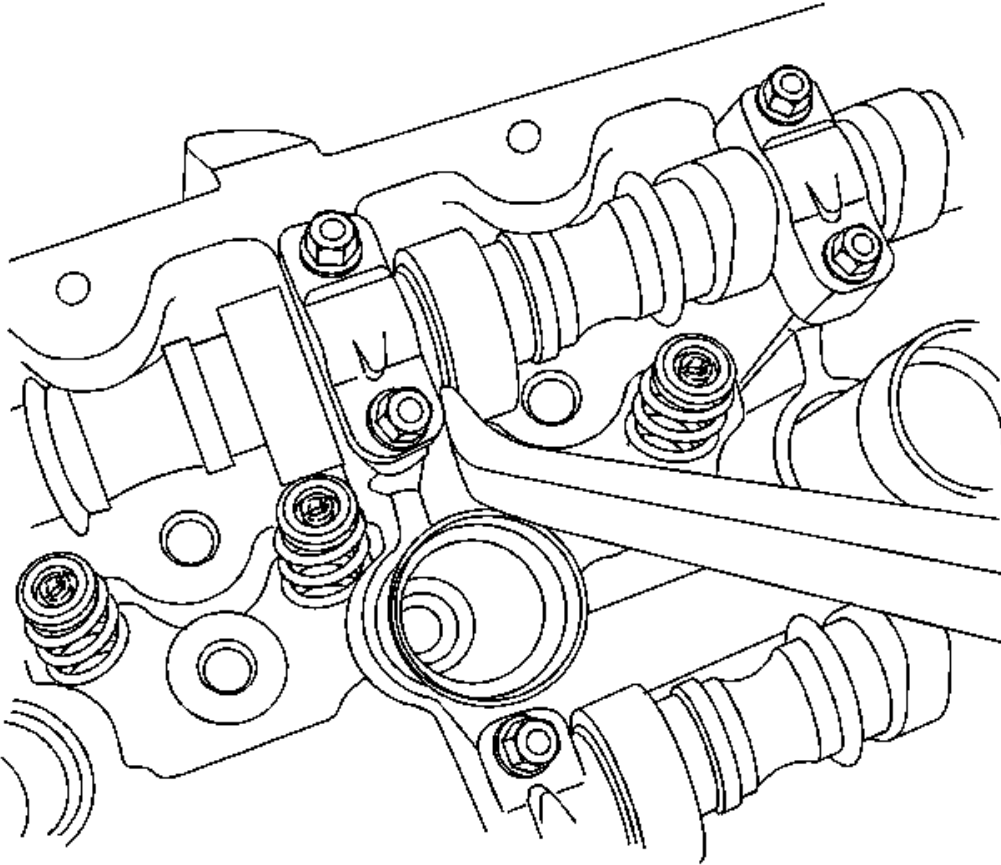


Fig. 103: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

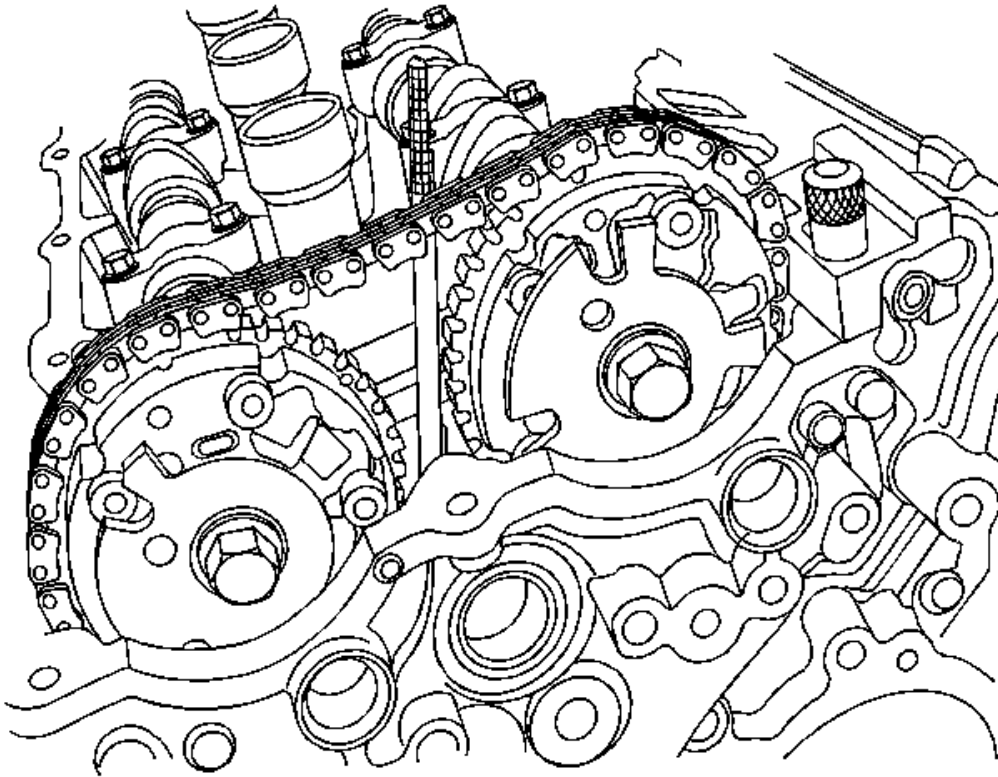


Fig. 104: Retainer Position

Courtesy of GENERAL MOTORS COMPANY

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

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

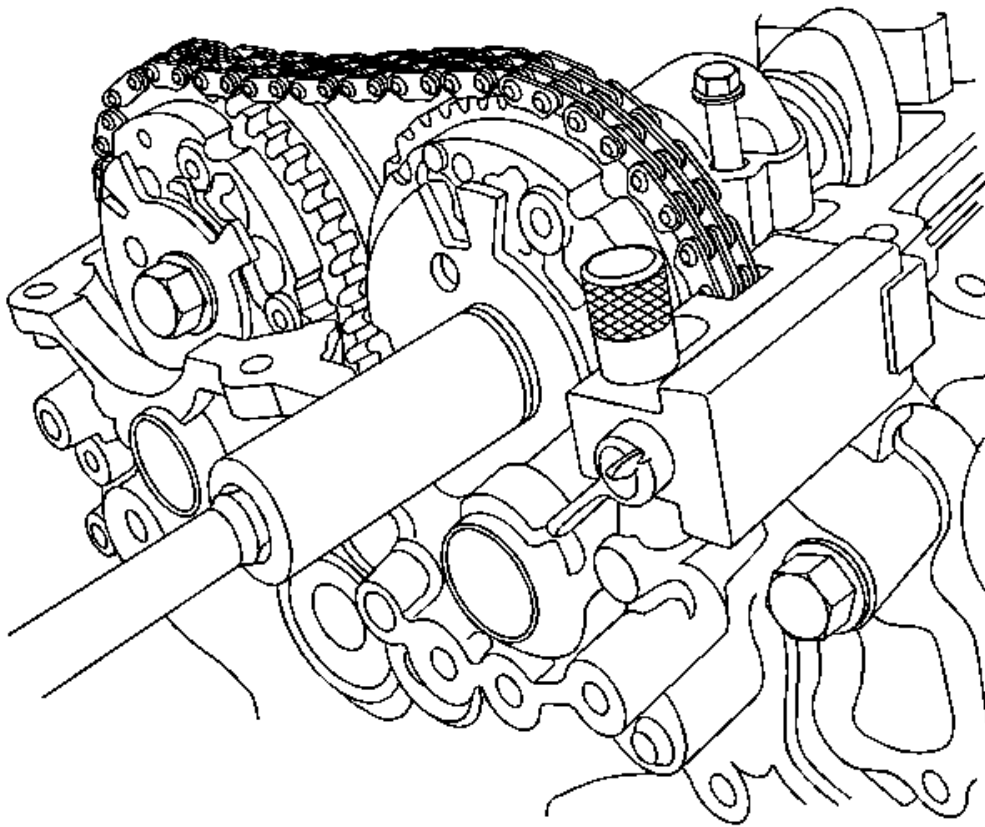


Fig. 105: View Of Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

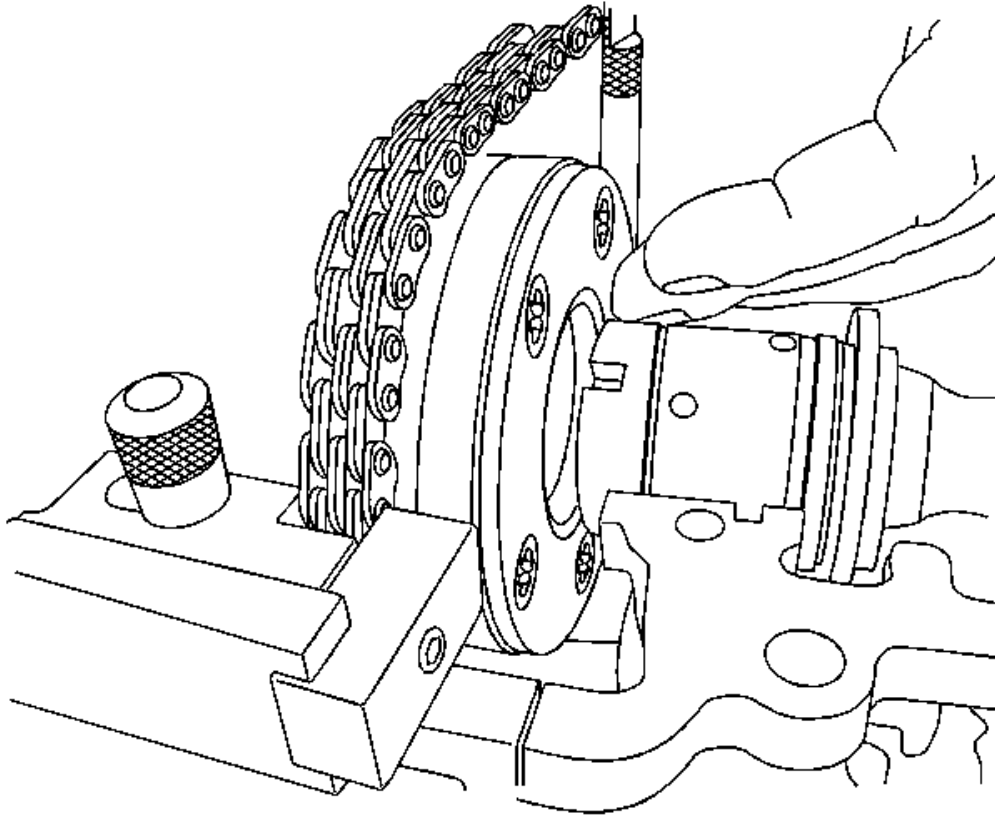


Fig. 106: Sliding Camshaft Position Actuator Off End Of Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

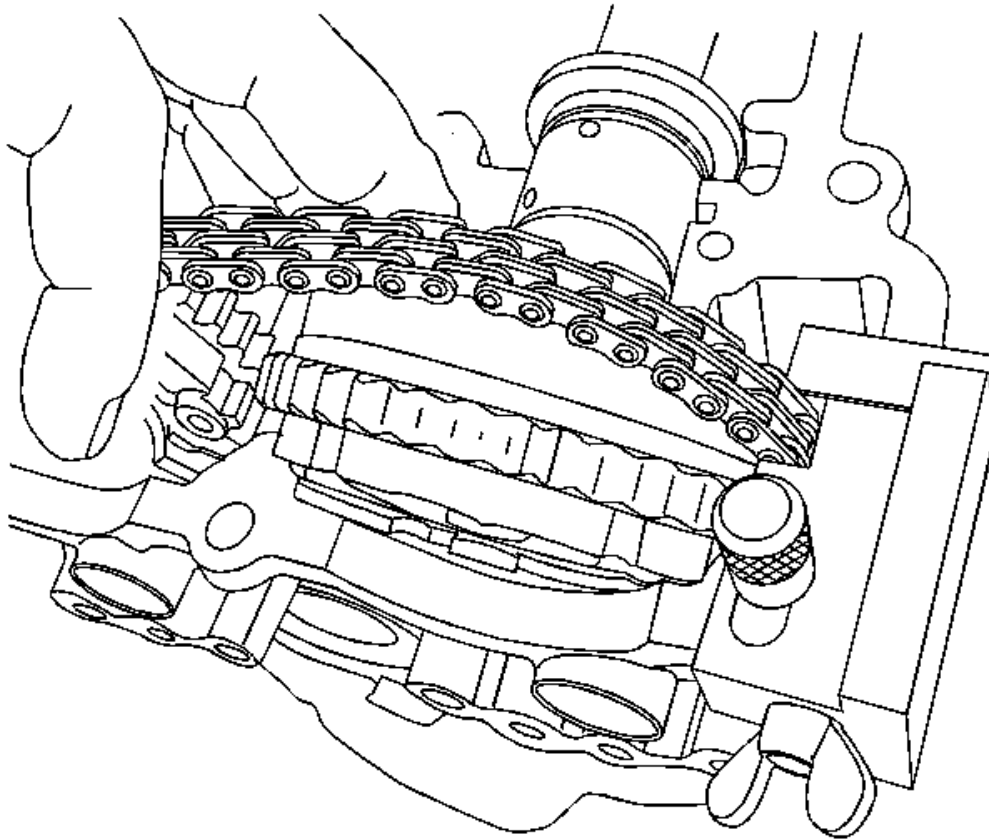


Fig. 107: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Installation Procedure

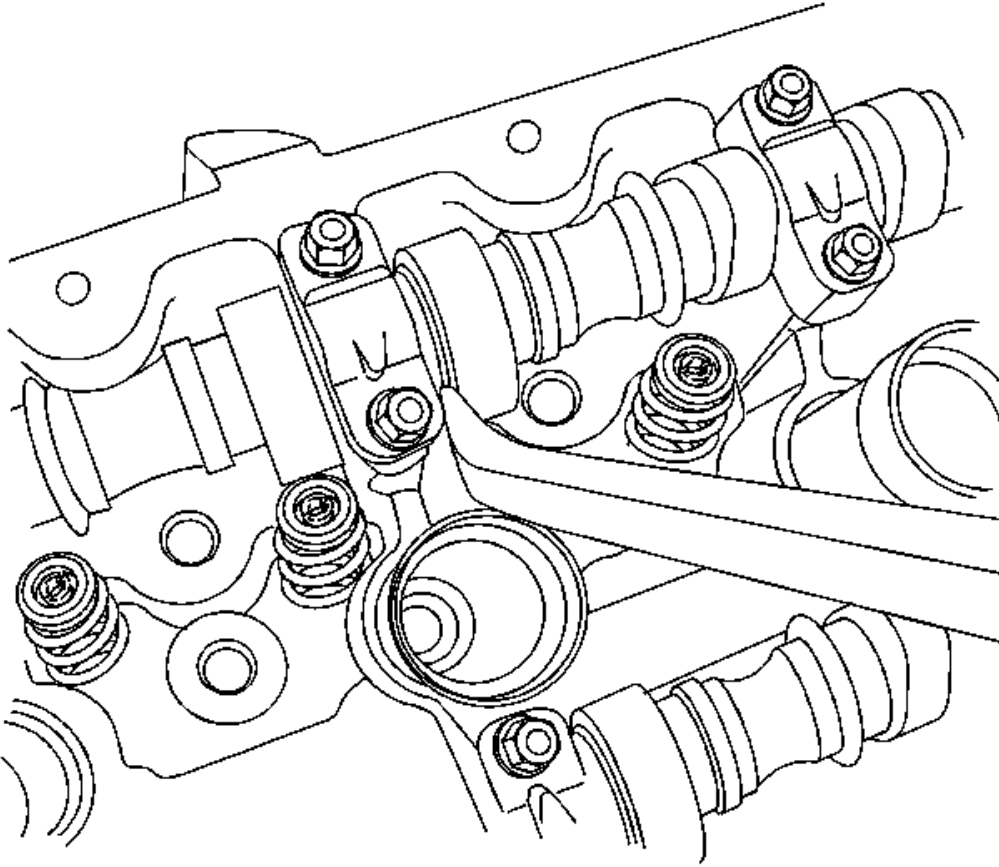


Fig. 108: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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

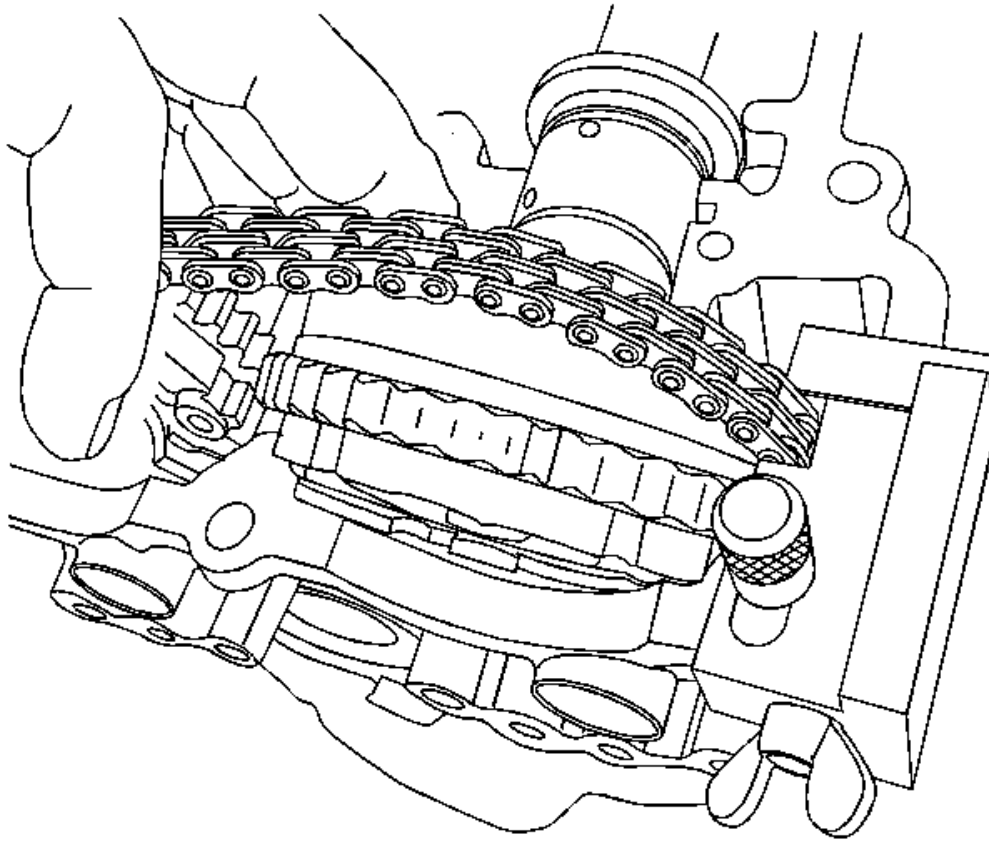


Fig. 109: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

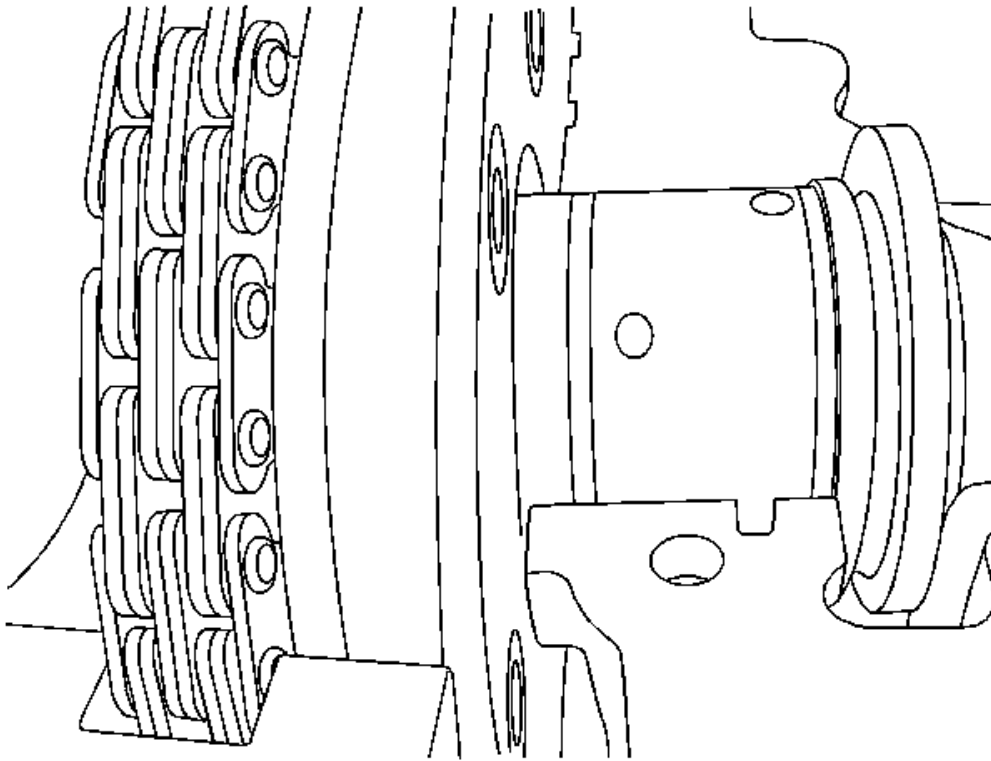


Fig. 110: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

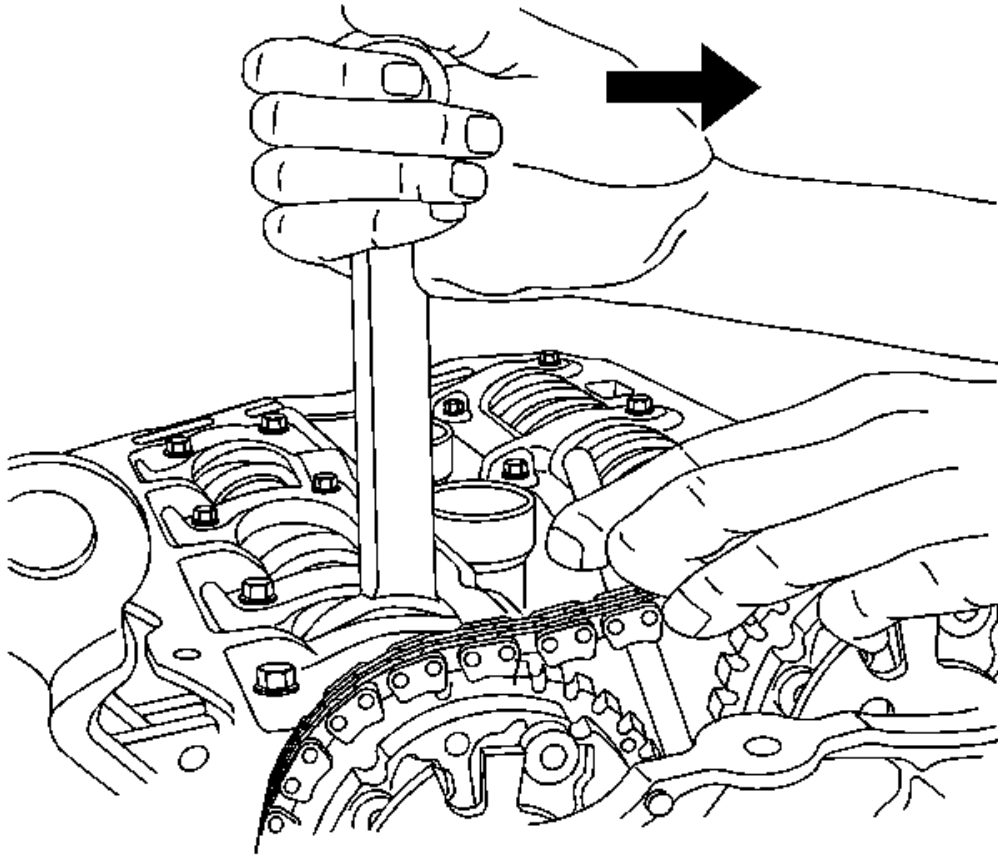


Fig. 111: Rotating Camshaft

Courtesy of GENERAL MOTORS COMPANY

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

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

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

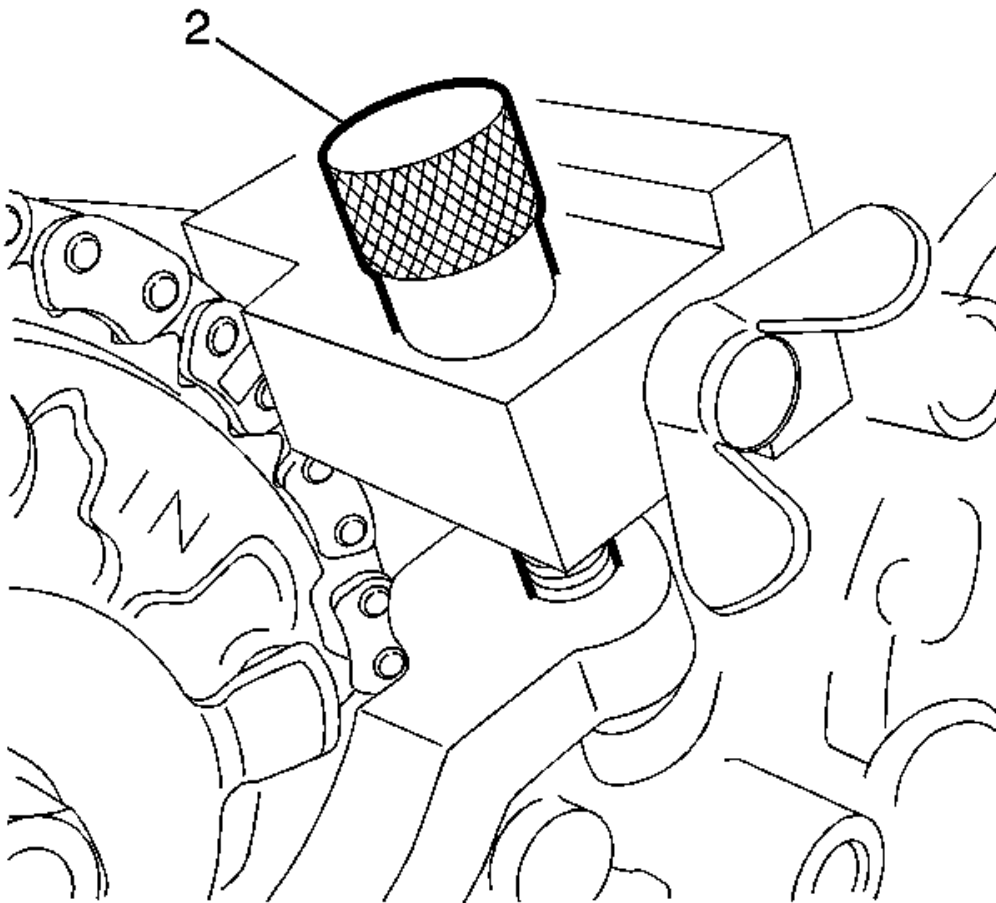


Fig. 112: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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

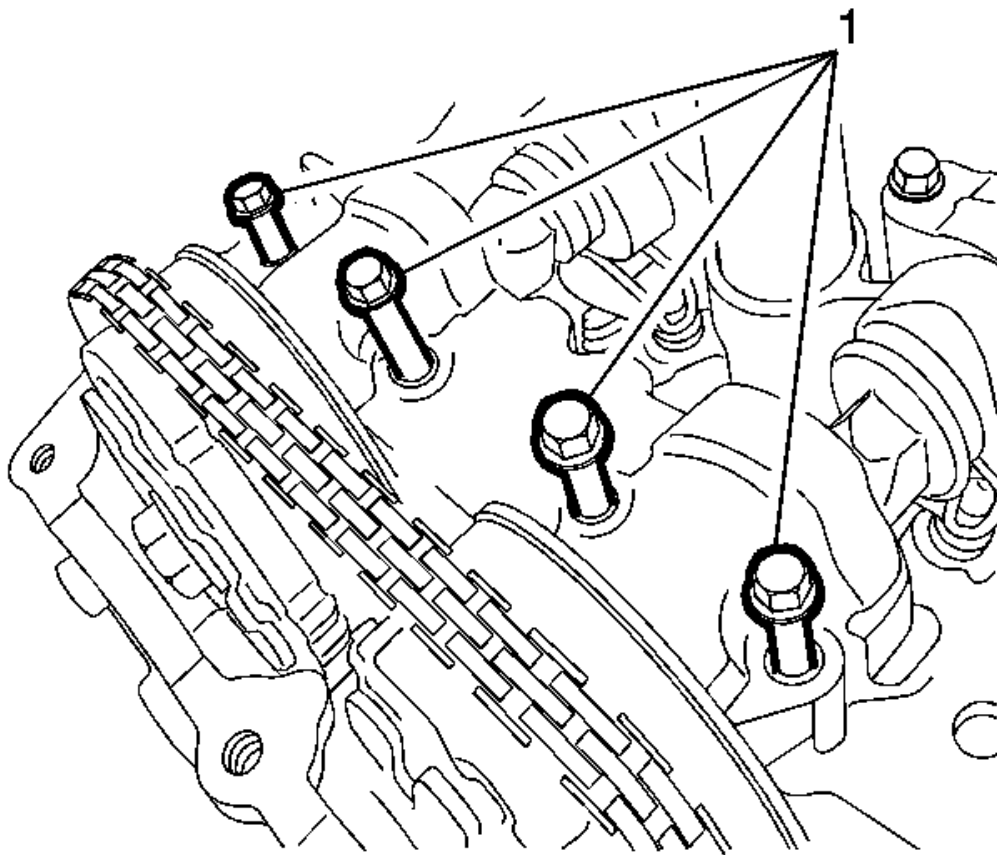


Fig. 113: Identifying Camshaft Front Cap & Bolts
 Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

Special Tools**EN-48313** Timing Chain Retention Tool

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

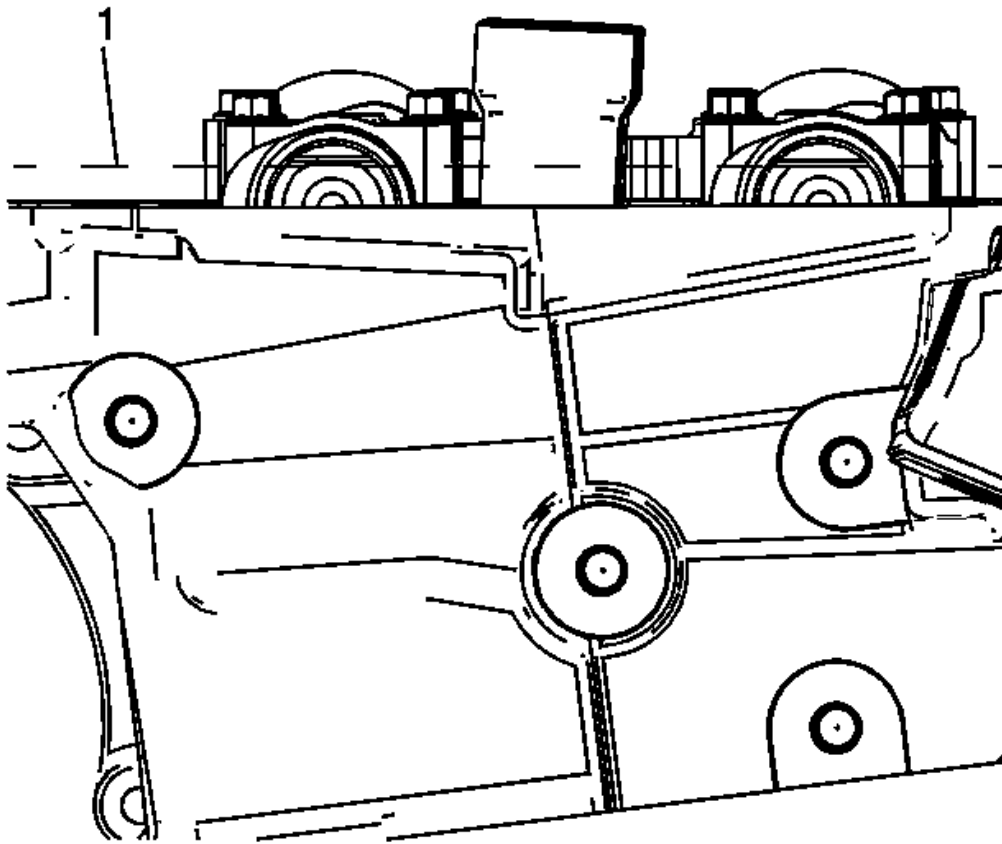
Removal Procedure

Fig. 114: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
2. 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** .
3. 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**.

4. 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).

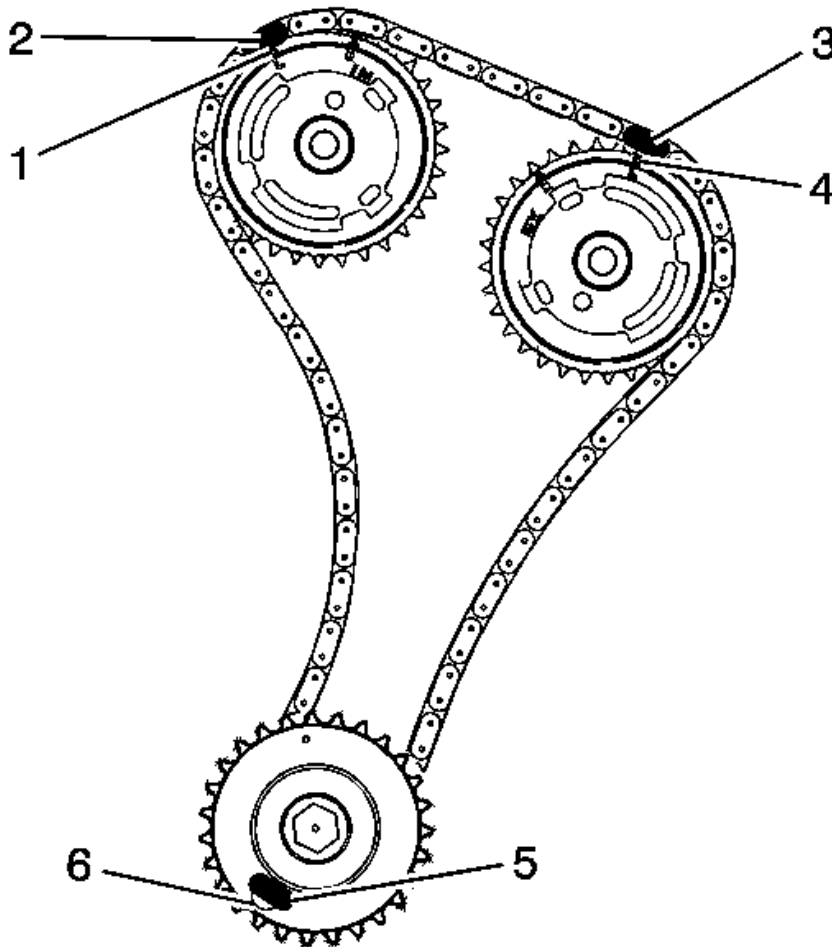


Fig. 115: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

5. 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).
6. 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 .

7. 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.

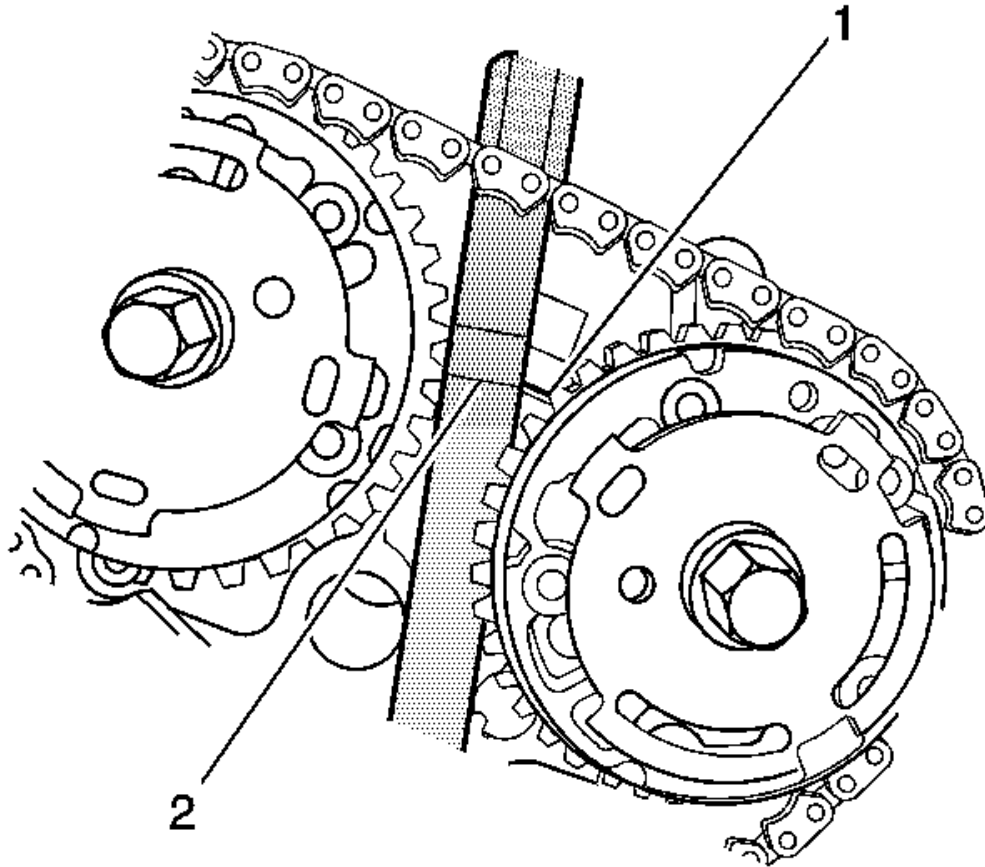


Fig. 116: Inserting Timing Chain Retention Tool

Courtesy of GENERAL MOTORS COMPANY

8. Unscrew the **EN-48313** tool so that the legs of the tool are retracted.
9. 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.

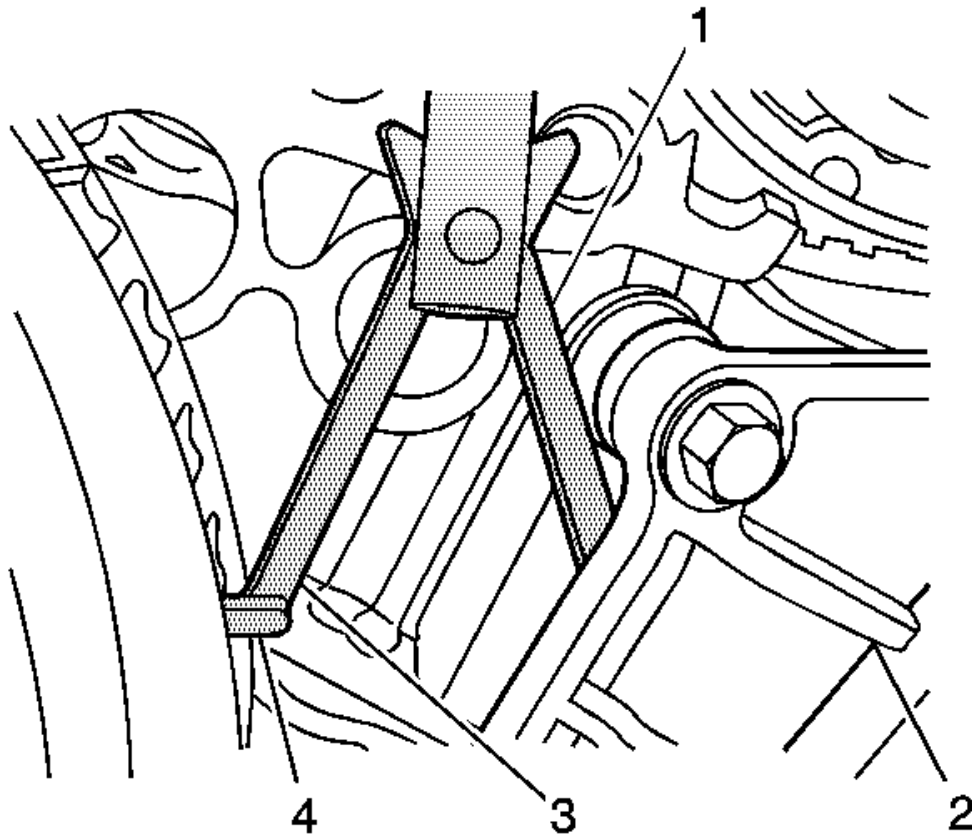


Fig. 117: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

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

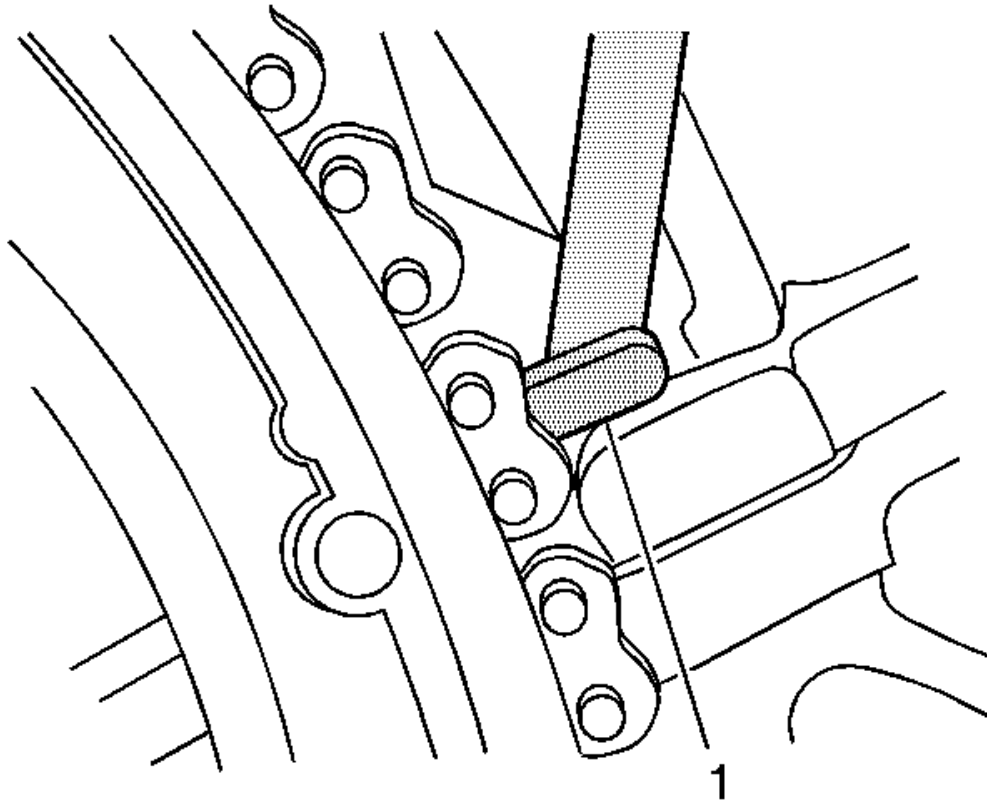


Fig. 118: Foot Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

14. Hand tighten the **EN-48313** tool.
15. 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.

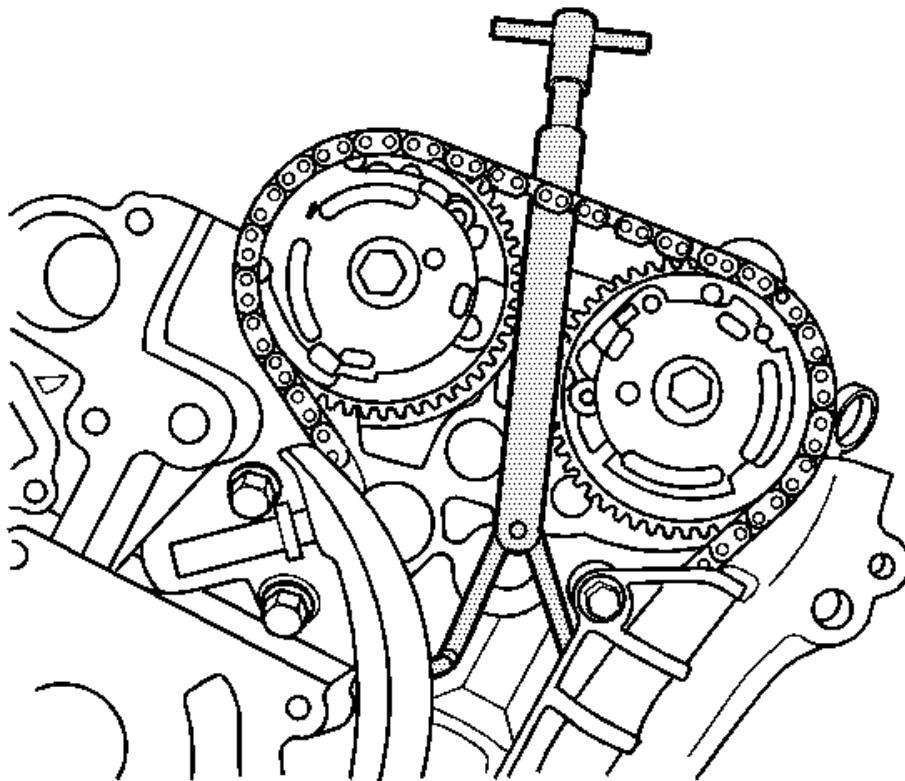


Fig. 119: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

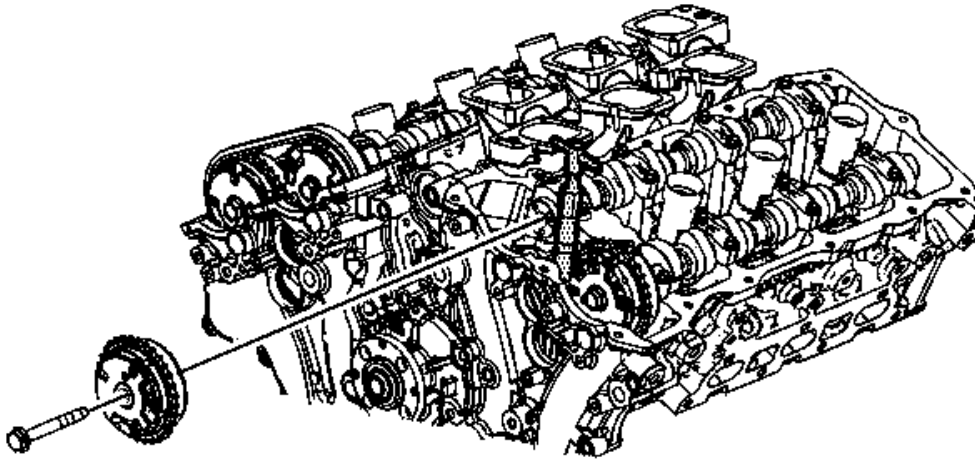


Fig. 120: View Of Exhaust Camshaft Position Actuator Bolt
 Courtesy of GENERAL MOTORS COMPANY

17. 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.
18. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
19. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
20. 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.
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.

Installation Procedure

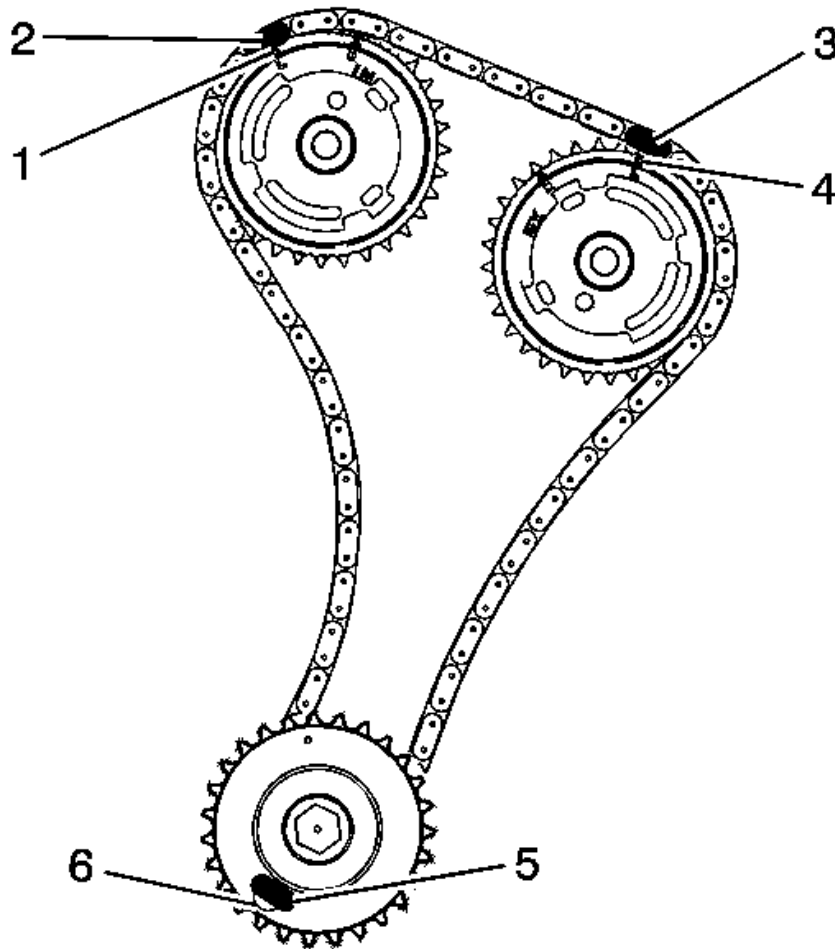


Fig. 121: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

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

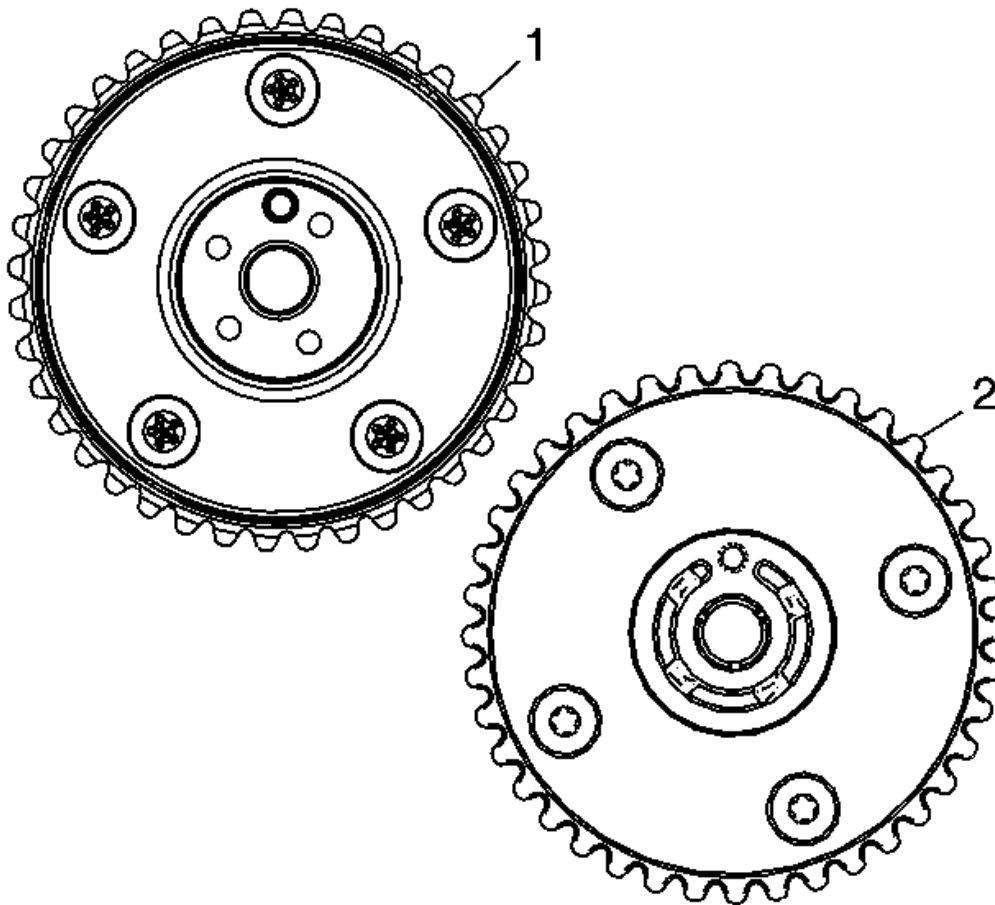


Fig. 122: Identifying Camshaft Position Actuators

Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

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

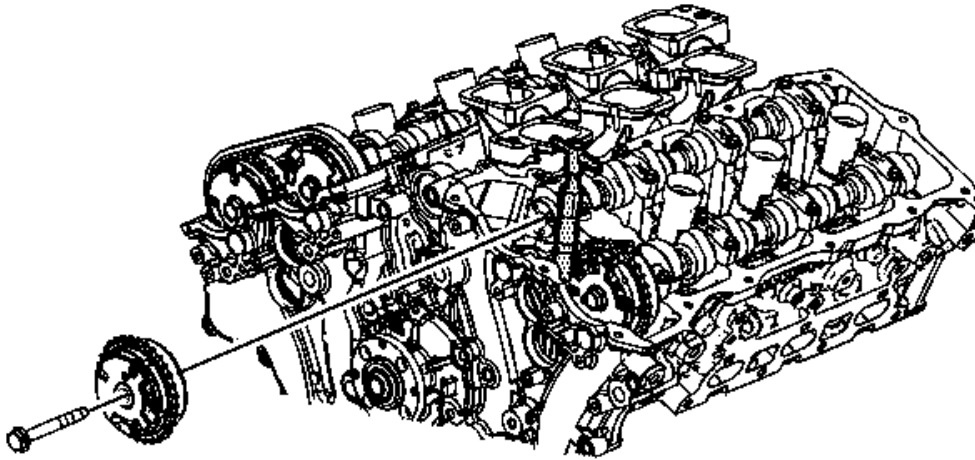


Fig. 123: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

SETTING CAMSHAFT TIMING

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

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

CAMSHAFT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the fuel pump. Refer to Fuel Pump Replacement.
2. Remove the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2.

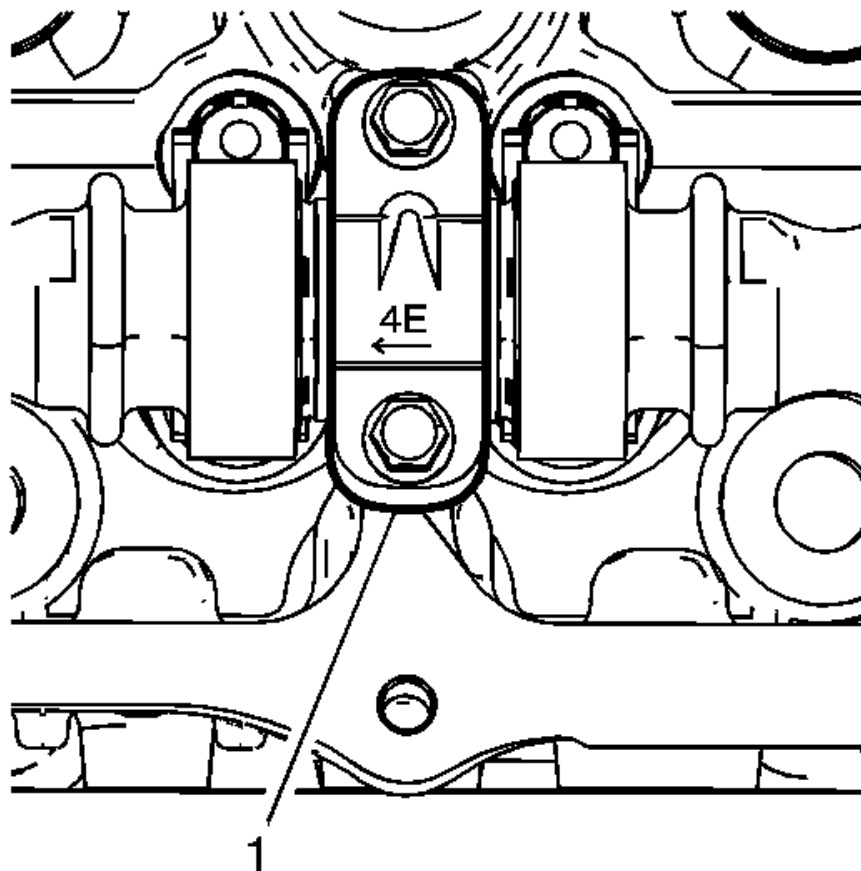


Fig. 124: Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
- The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

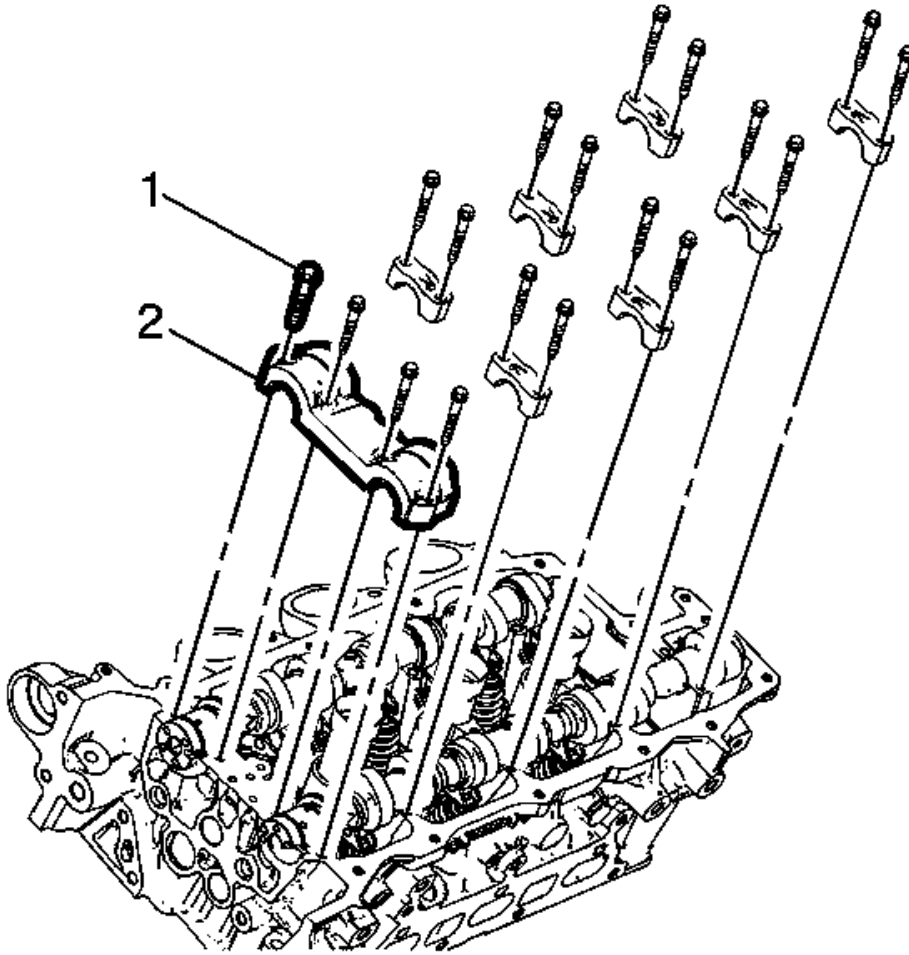


Fig. 125: Bearing Cap Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft bearing cap bolts (1).
5. Remove the camshaft bearing caps (2).

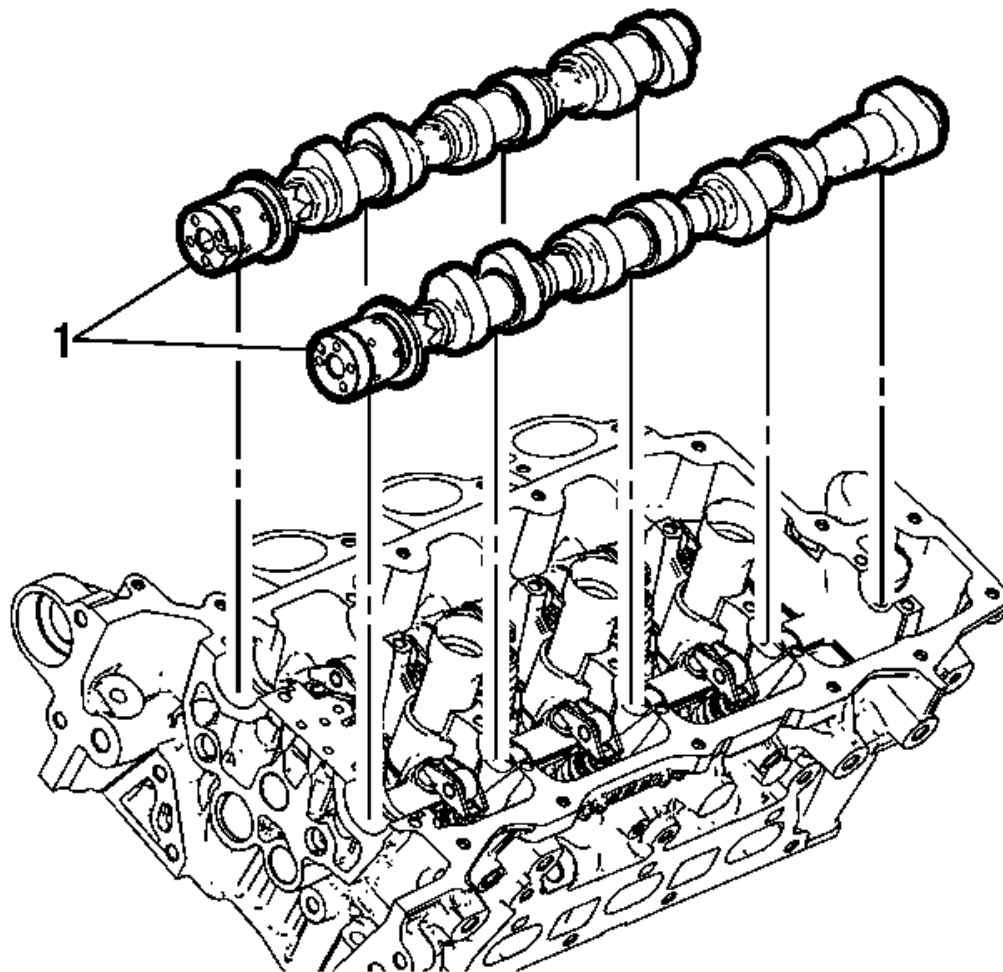


Fig. 126: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the camshafts upon removal to ensure installation is in the correct position.

6. Remove the camshafts (1).

Installation Procedure

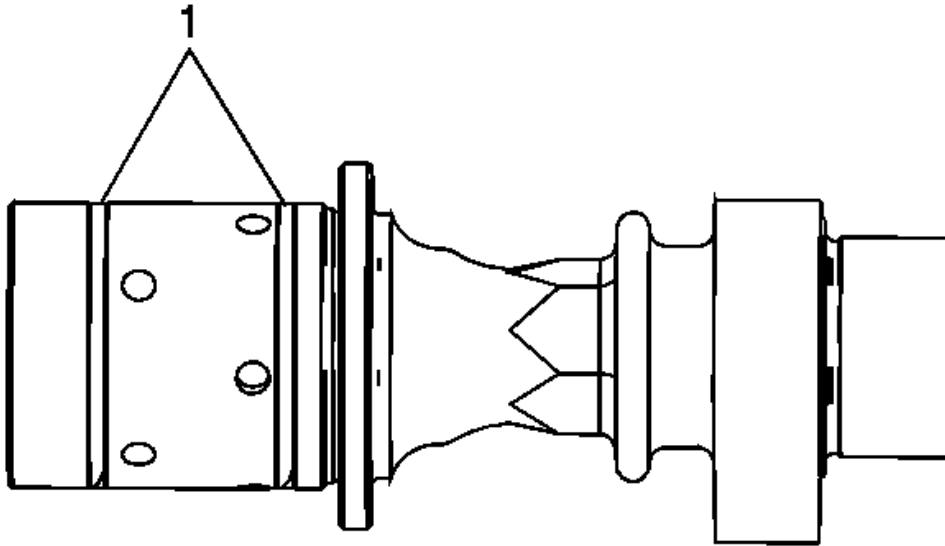


Fig. 127: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

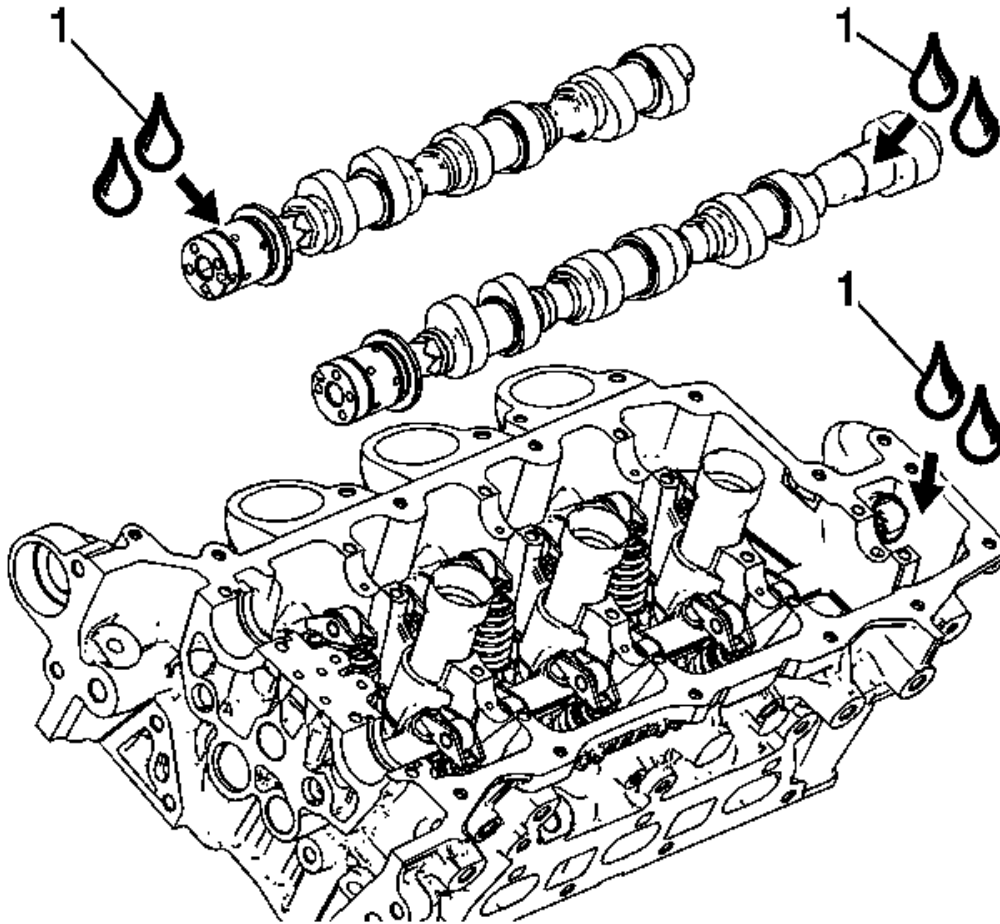


Fig. 128: Camshaft Journal Lubrication Points

Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the left cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

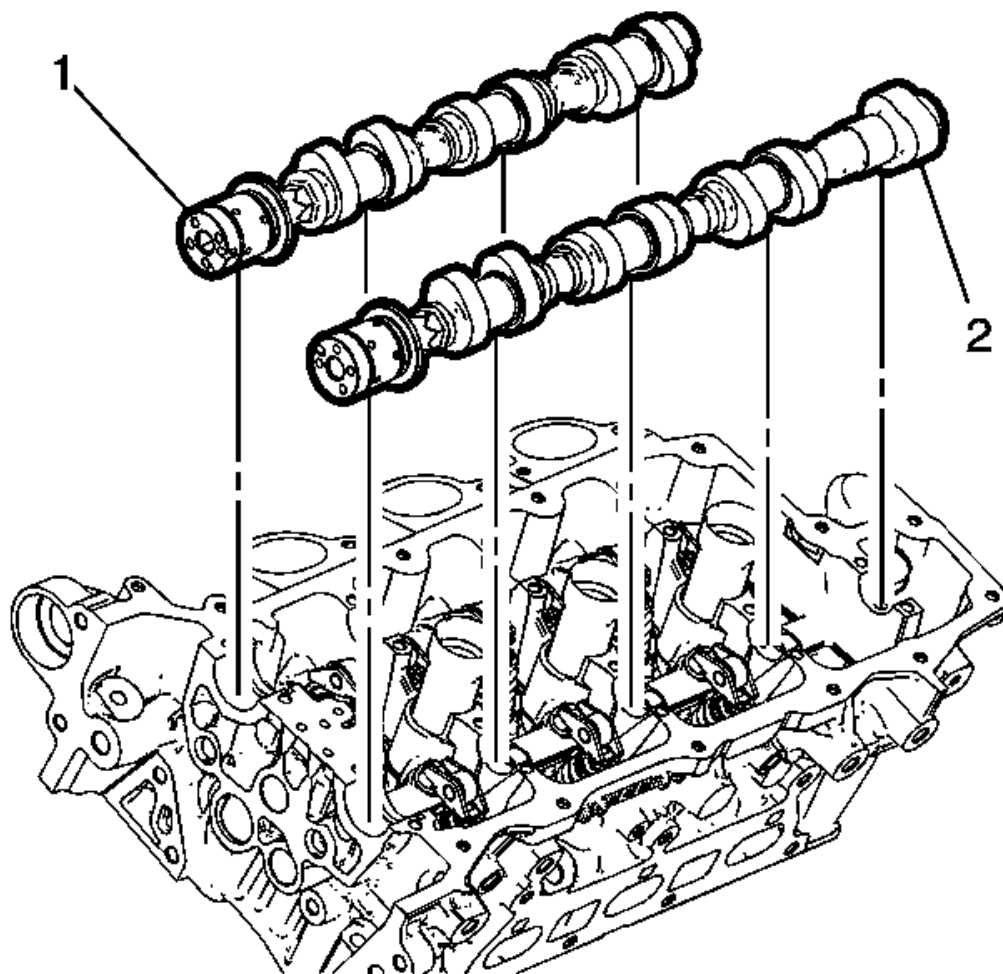


Fig. 129: Camshaft Intake And Exhaust Positioning Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake (1) and left exhaust (2) camshafts in position in the left cylinder head.

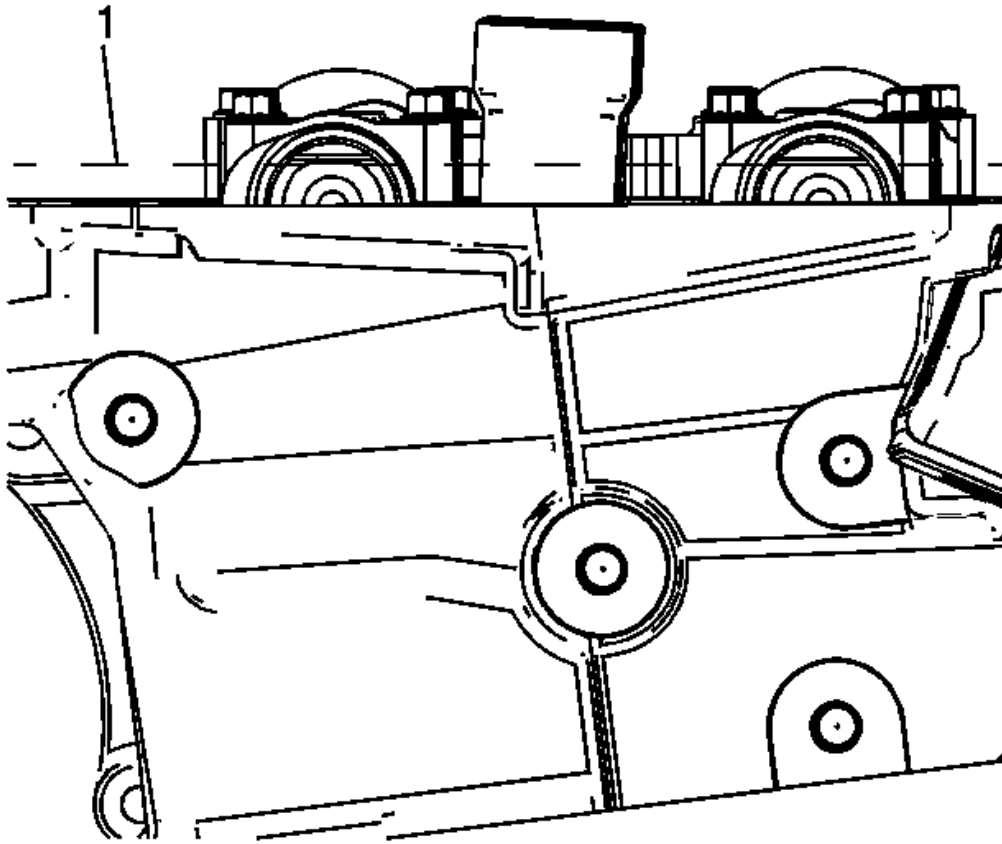


Fig. 130: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

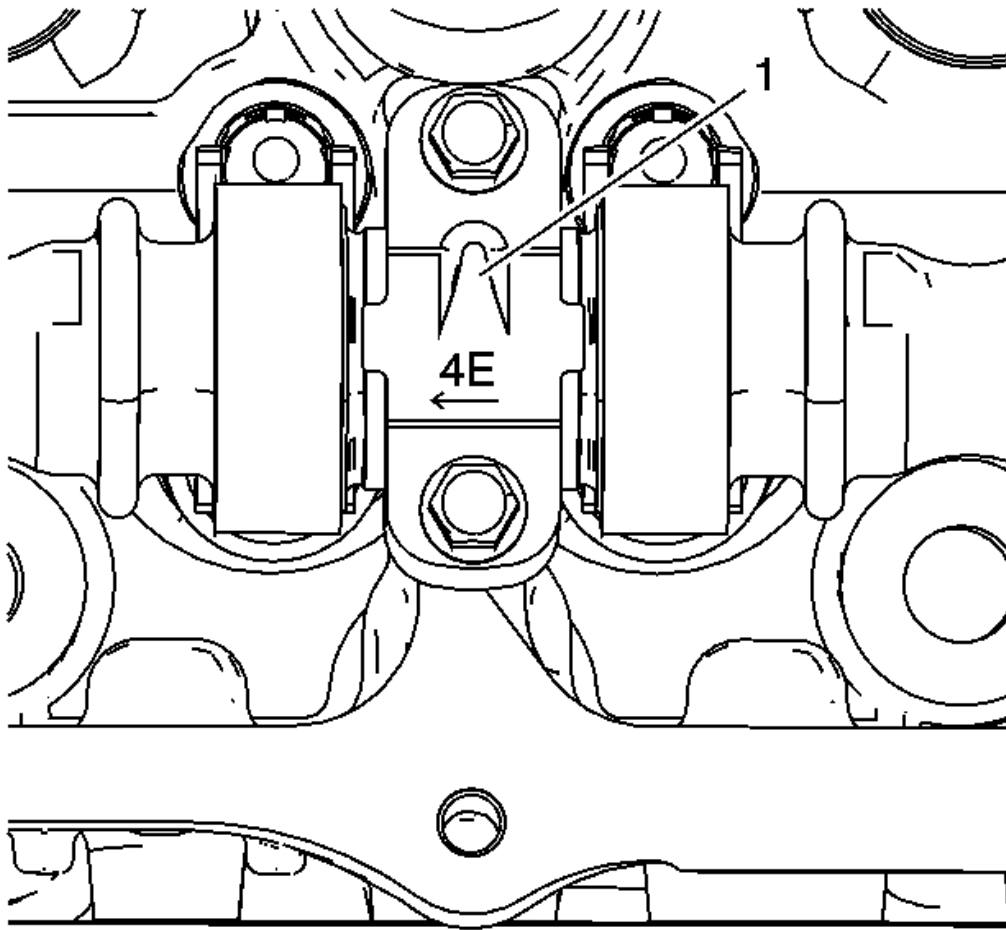


Fig. 131: Left Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

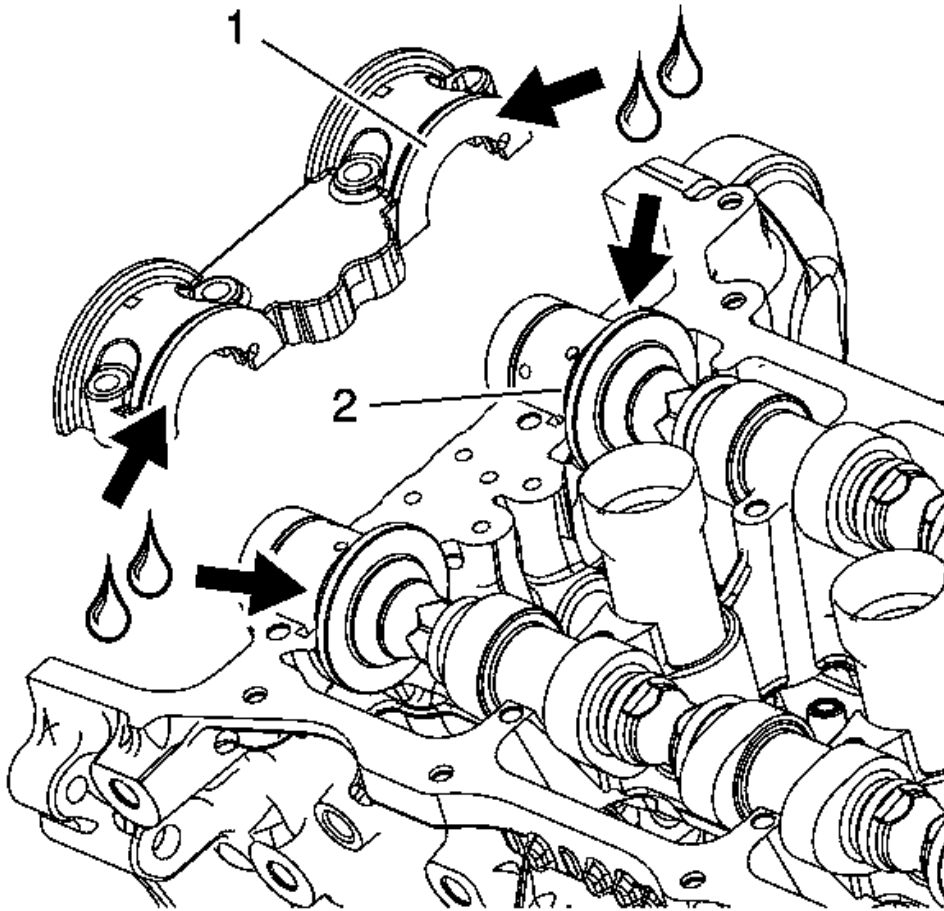


Fig. 132: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

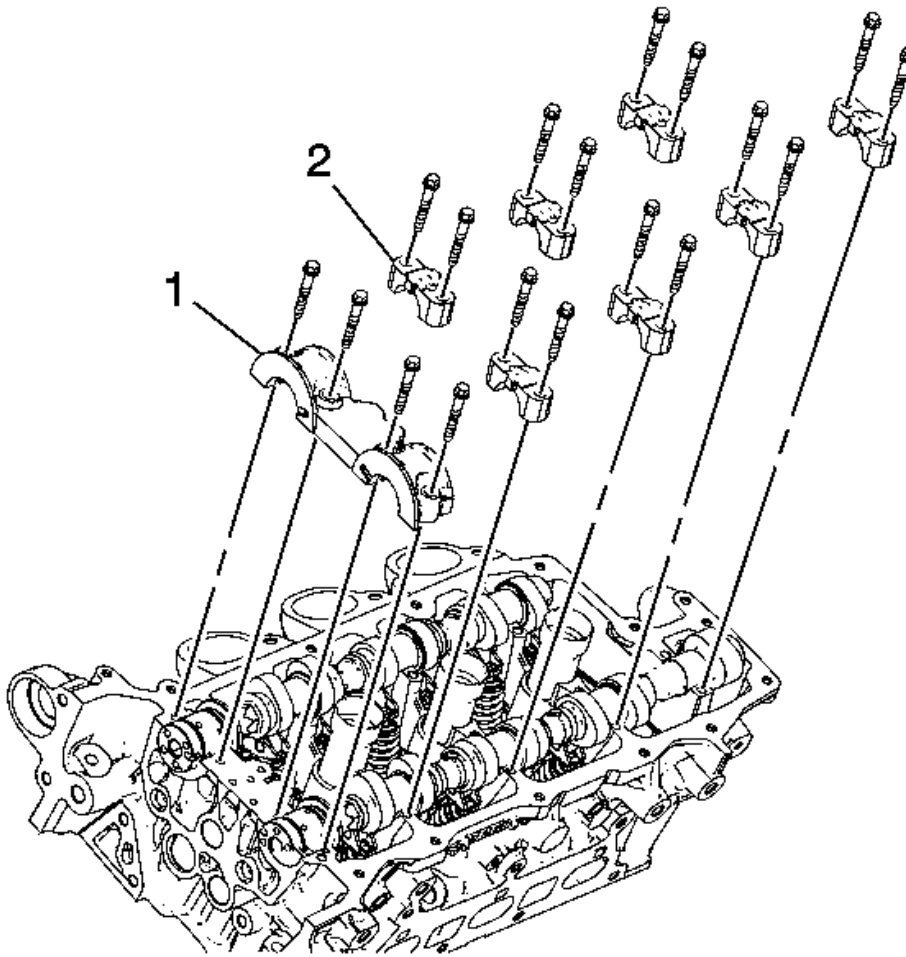


Fig. 133: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

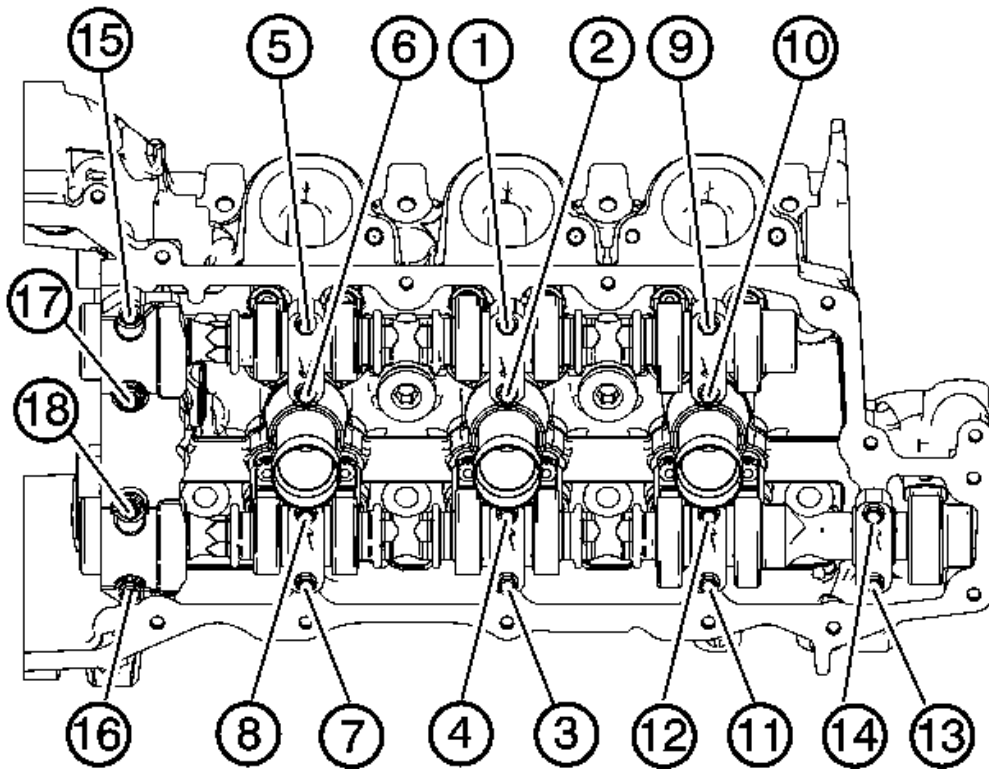


Fig. 134: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2.
15. Install the fuel pump. Refer to Fuel Pump Replacement .

CAMSHAFT REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 .

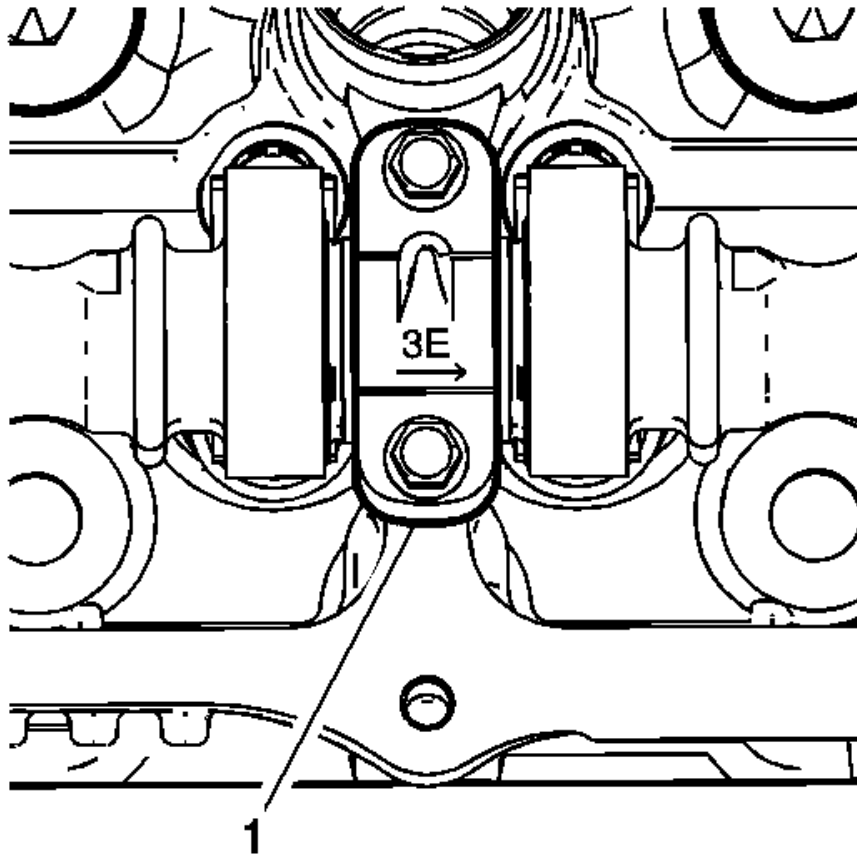


Fig. 135: Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

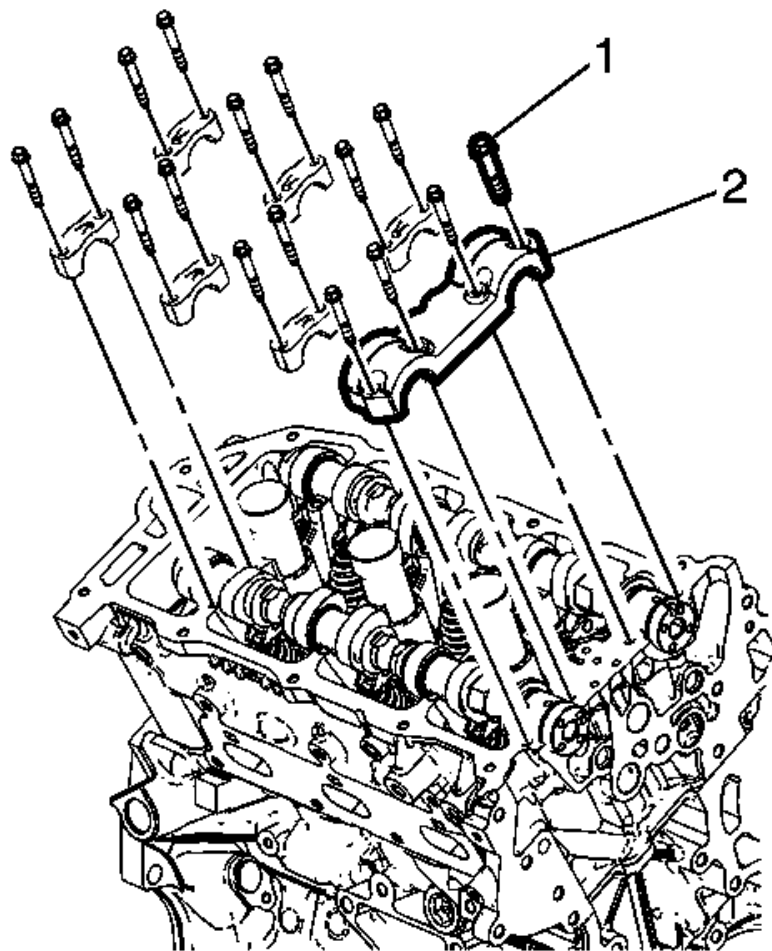


Fig. 136: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).

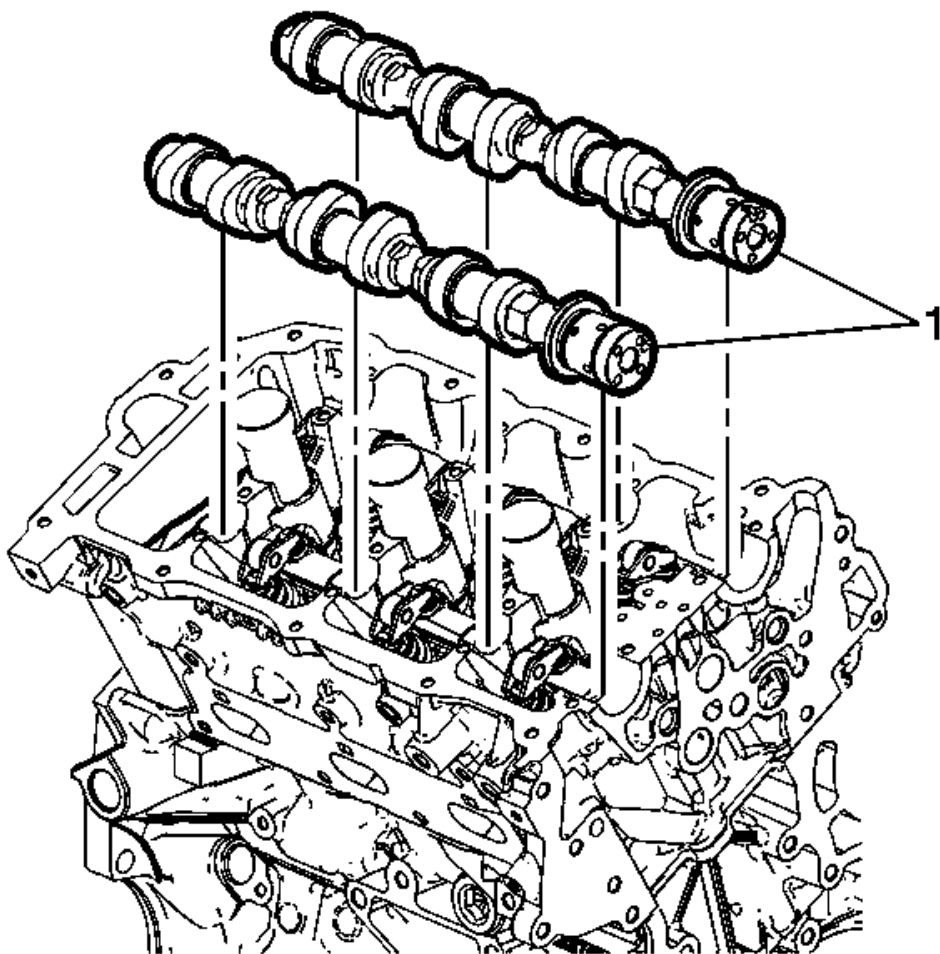


Fig. 137: Camshafts

Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

5. Remove the camshafts (1).

Installation Procedure

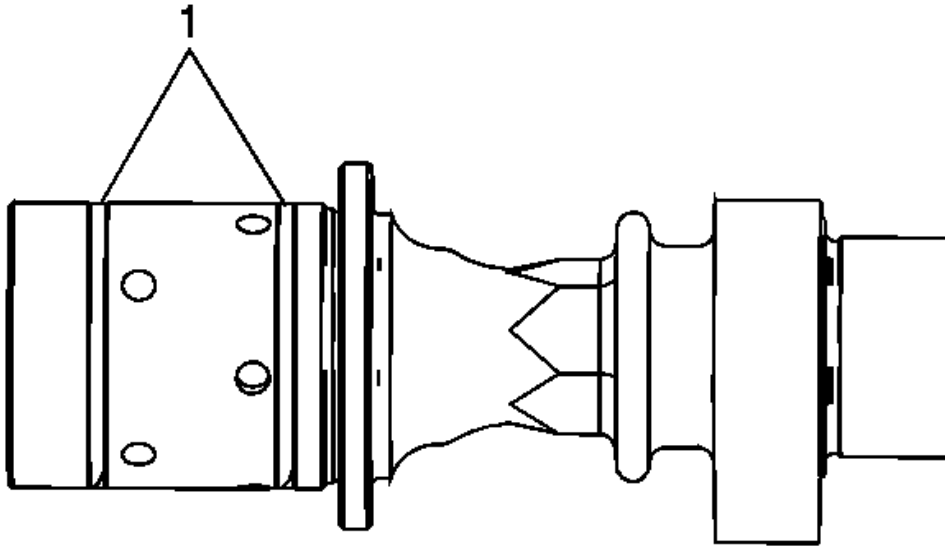


Fig. 138: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

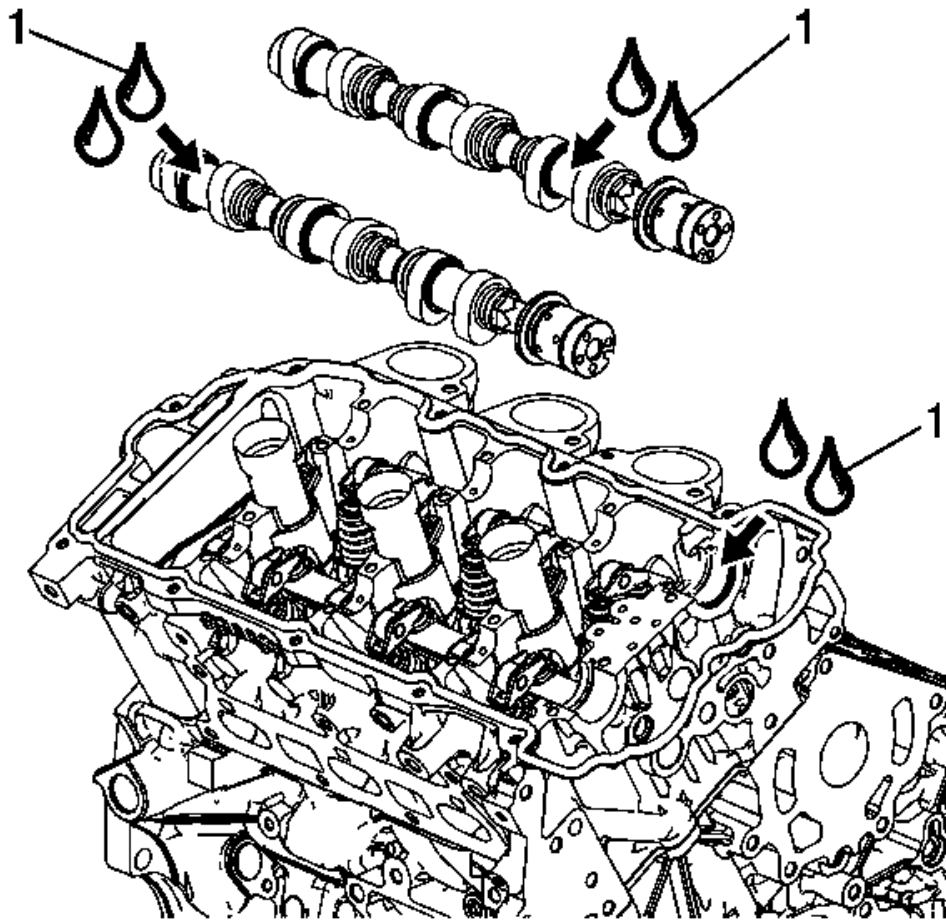


Fig. 139: Right Cylinder Head Camshaft Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

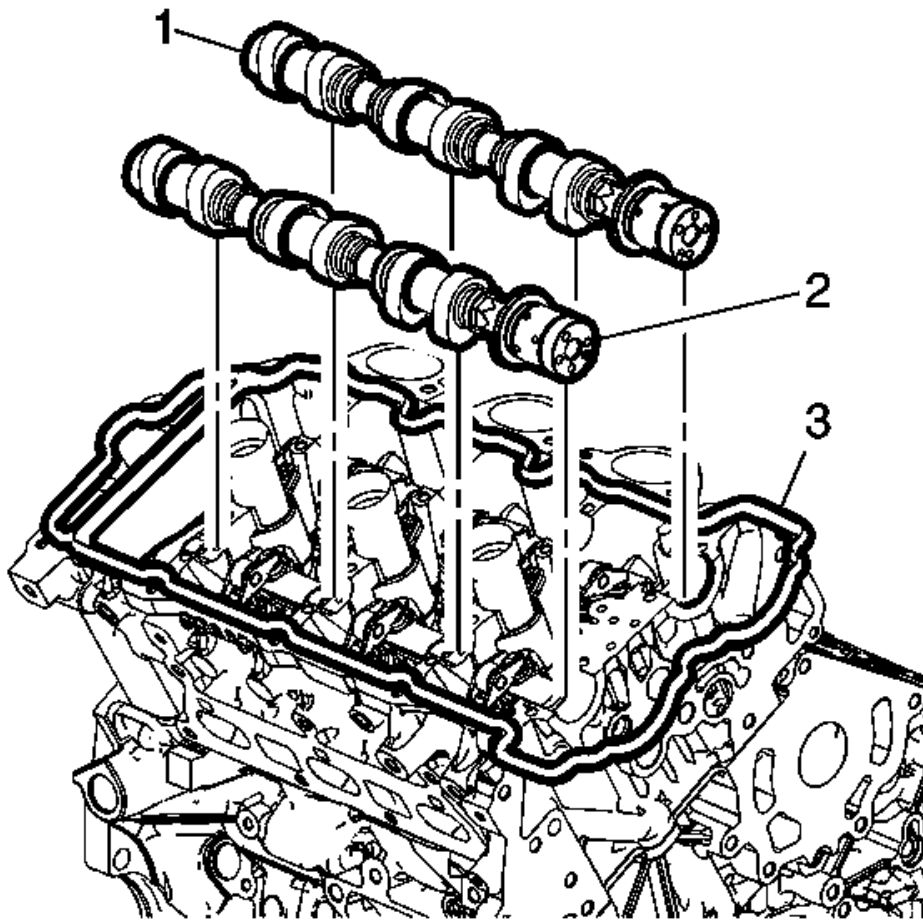


Fig. 140: Right Cylinder Head Camshaft Intake And Exhaust Positioning Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).

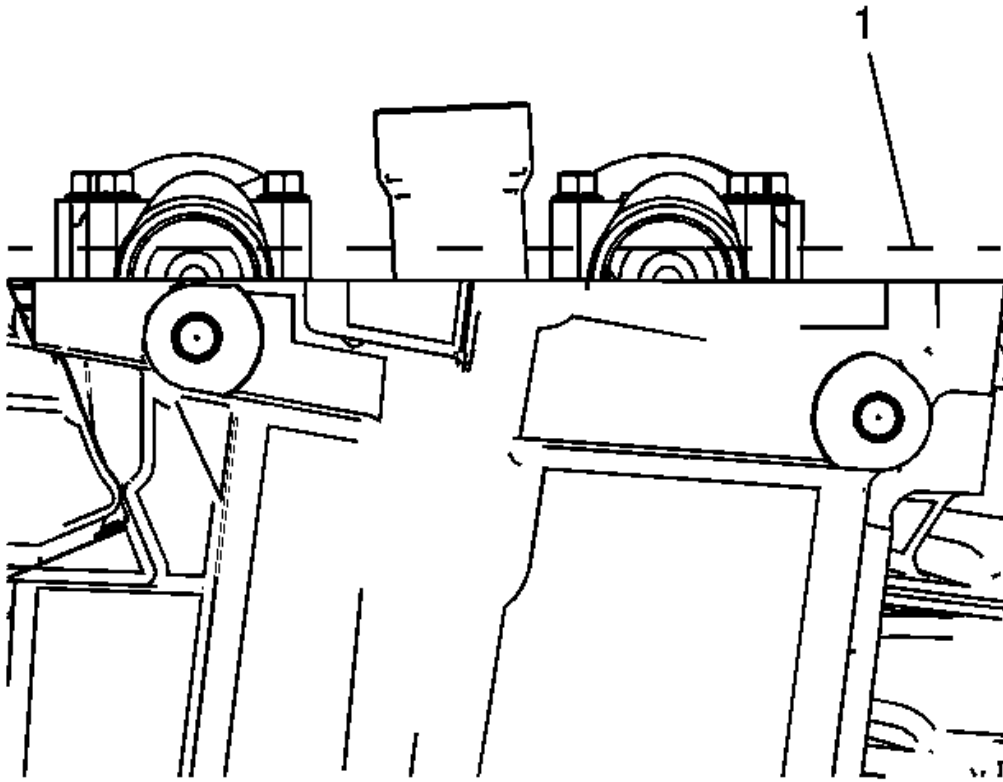


Fig. 141: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

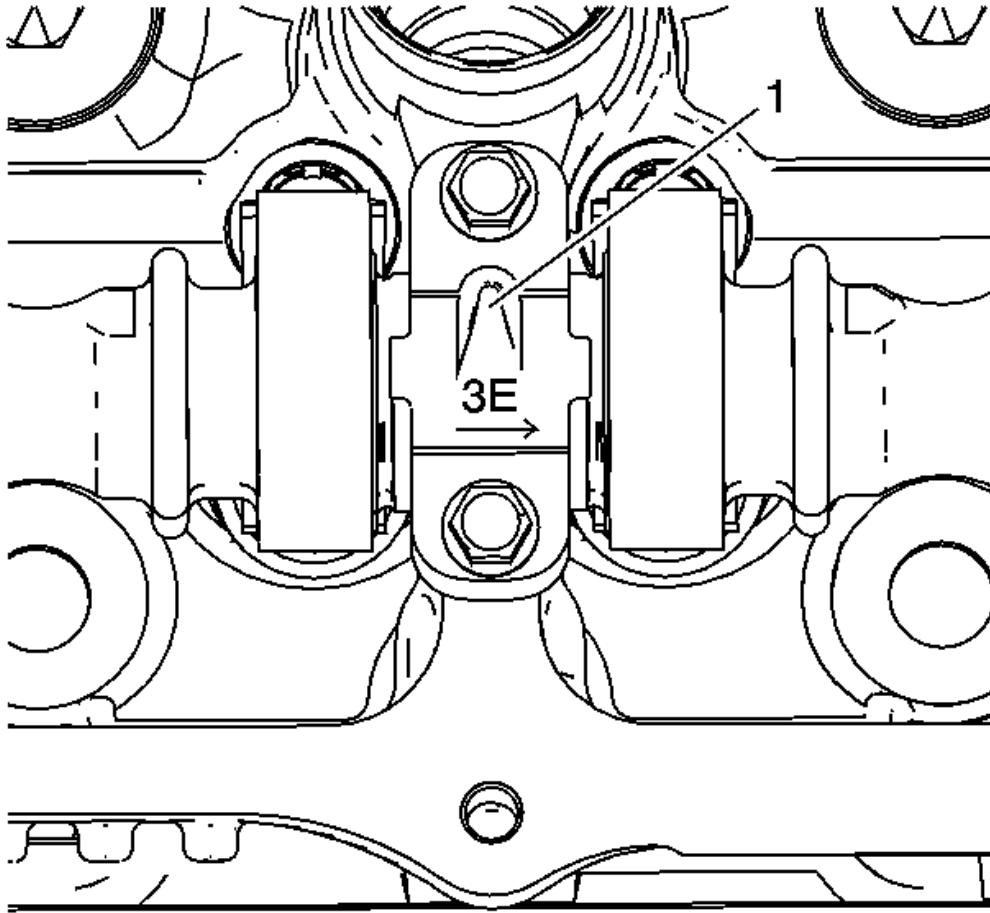


Fig. 142: Right Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

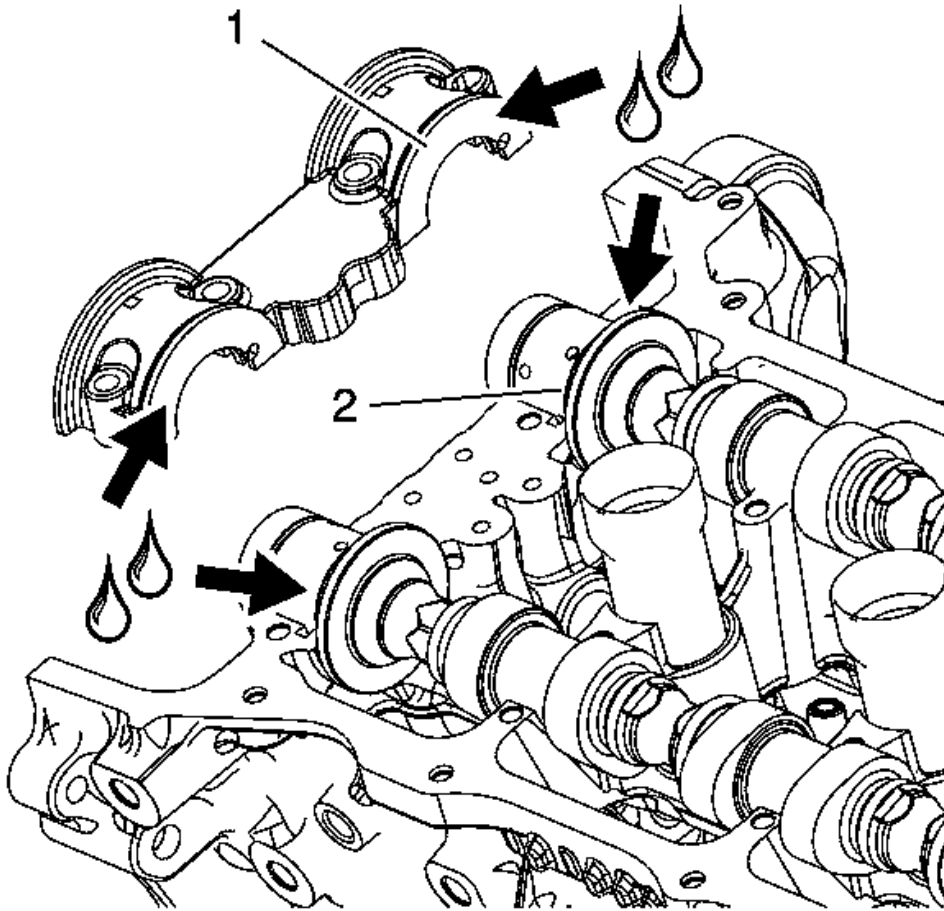


Fig. 143: Camshaft Bearing Cap And Camshaft Thrust Surface
 Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

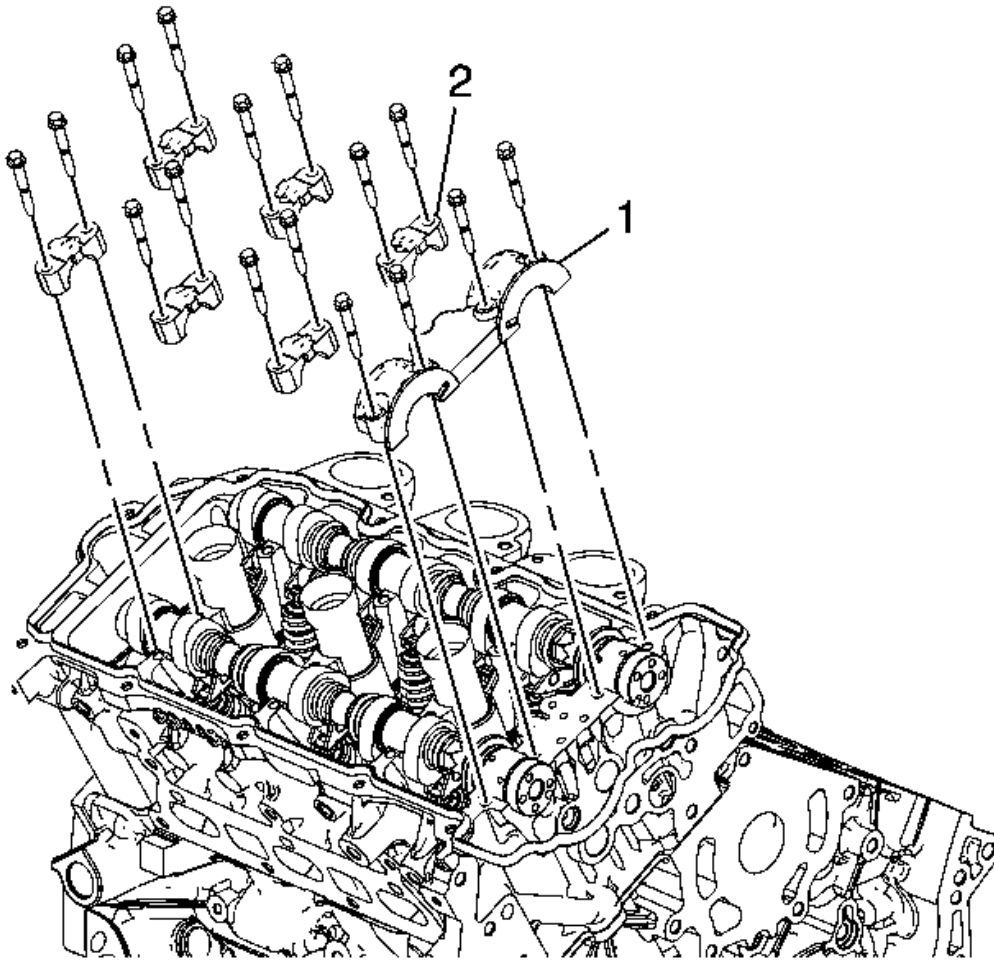


Fig. 144: Camshaft Bearing Caps And Bolts
 Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

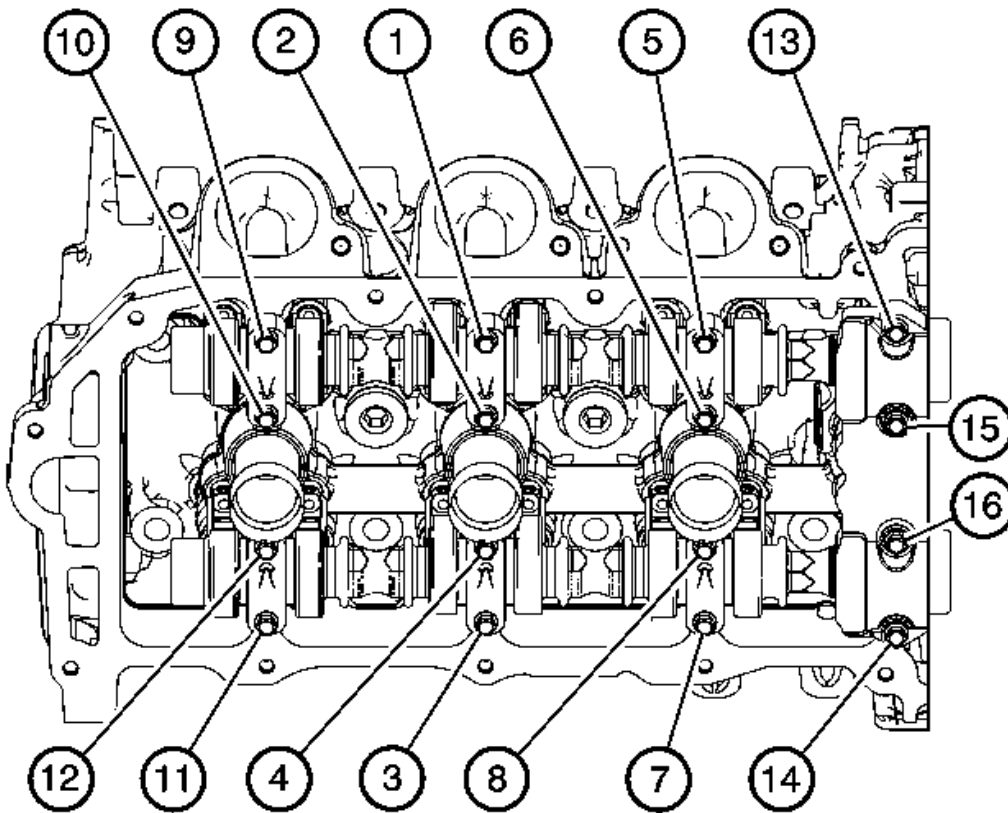


Fig. 145: Camshaft Bearing Cap Bolts Tighten Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 .

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

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

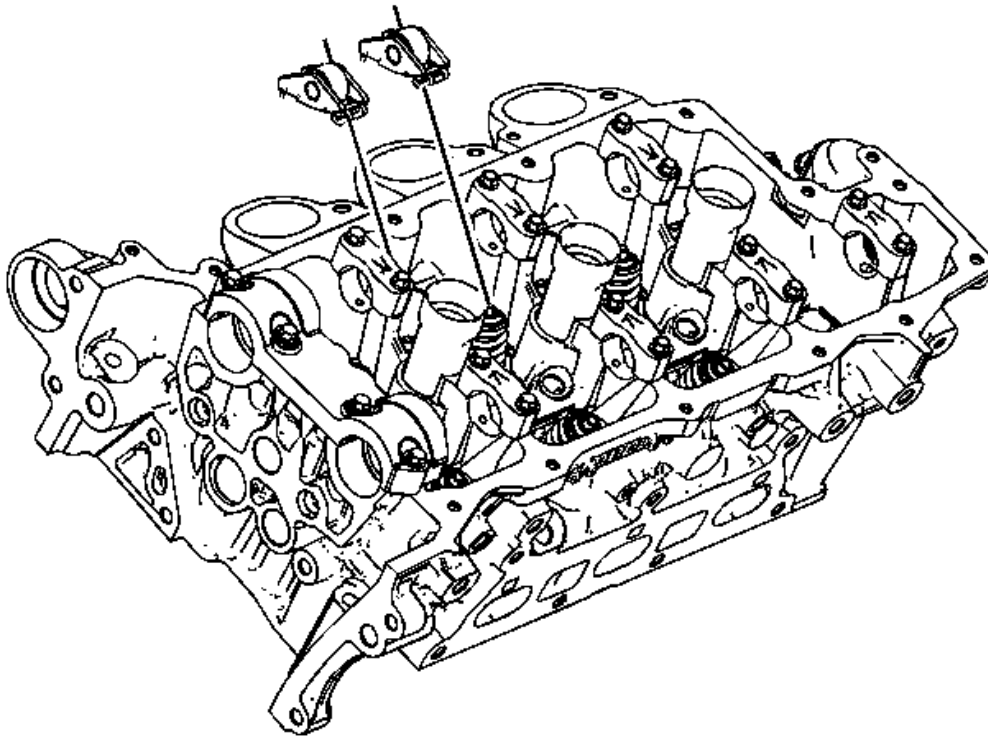


Fig. 146: View Of Valve Rocker Arm - Left Side
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

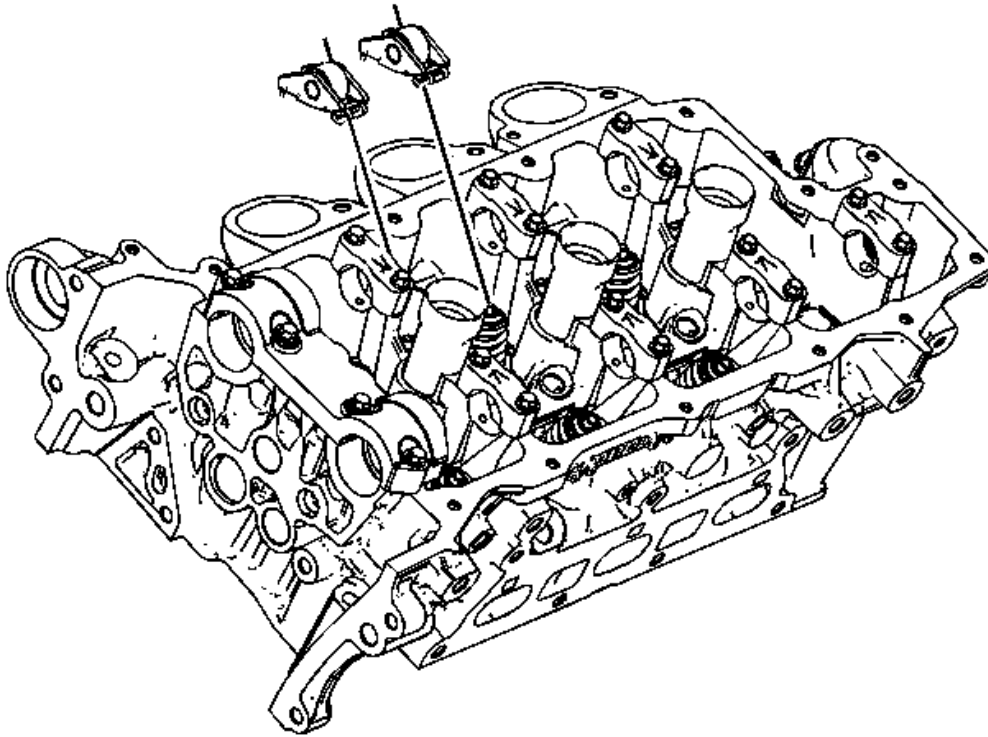


Fig. 147: View Of Valve Rocker Arm - Left Side
Courtesy of GENERAL MOTORS COMPANY

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

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

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

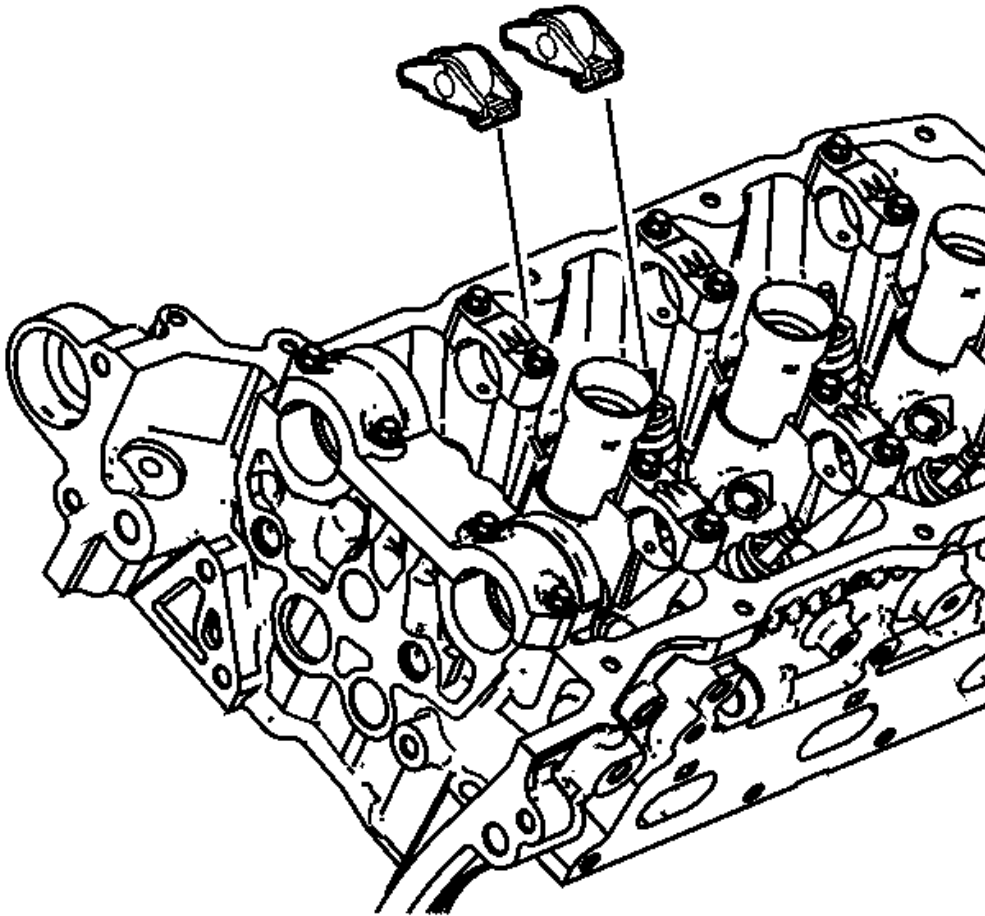


Fig. 148: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

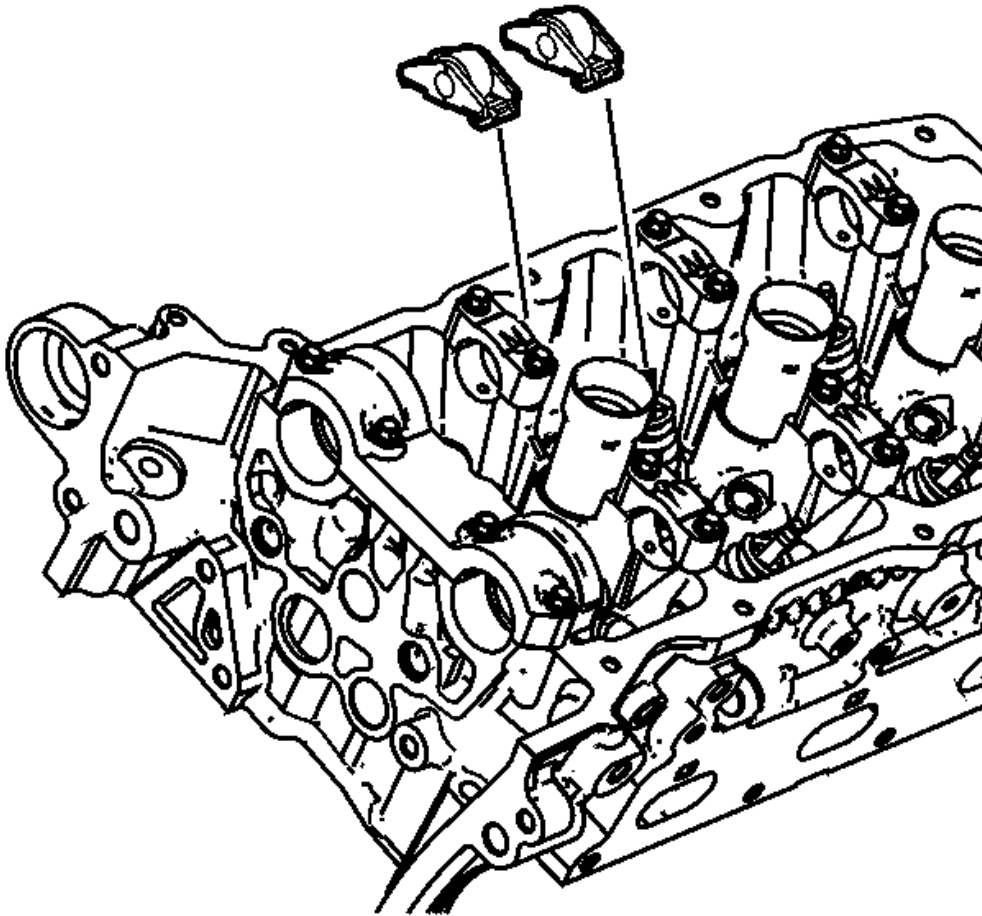


Fig. 149: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

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

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

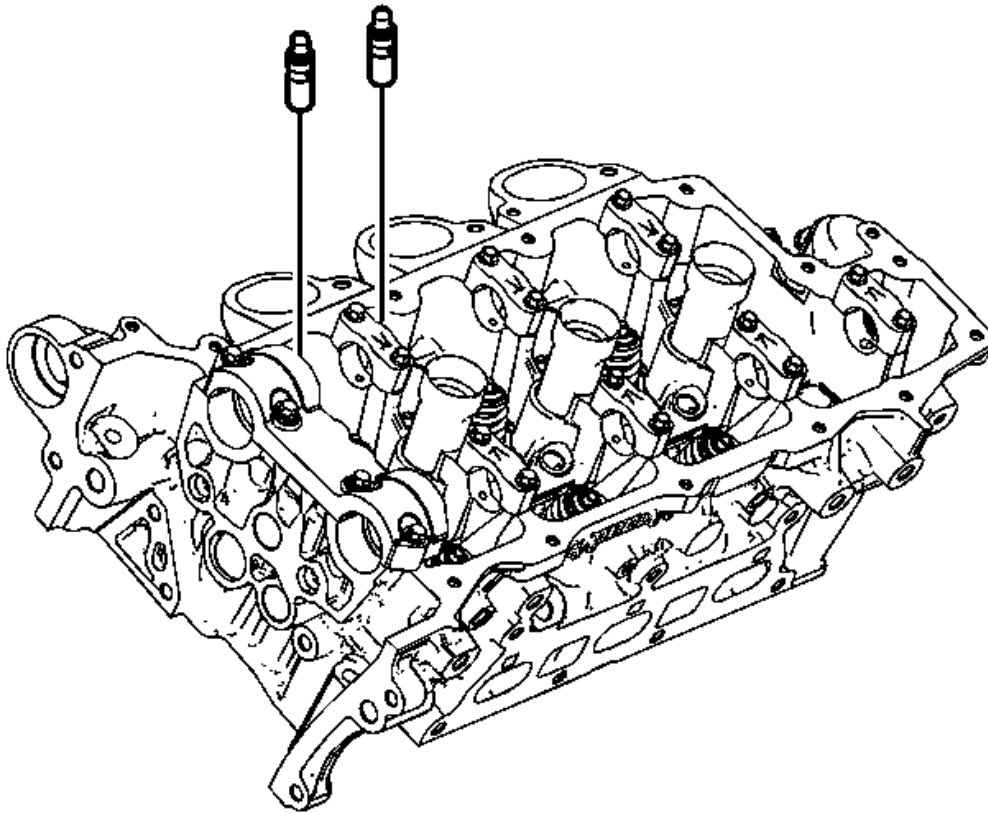


Fig. 150: Valve Lifter Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

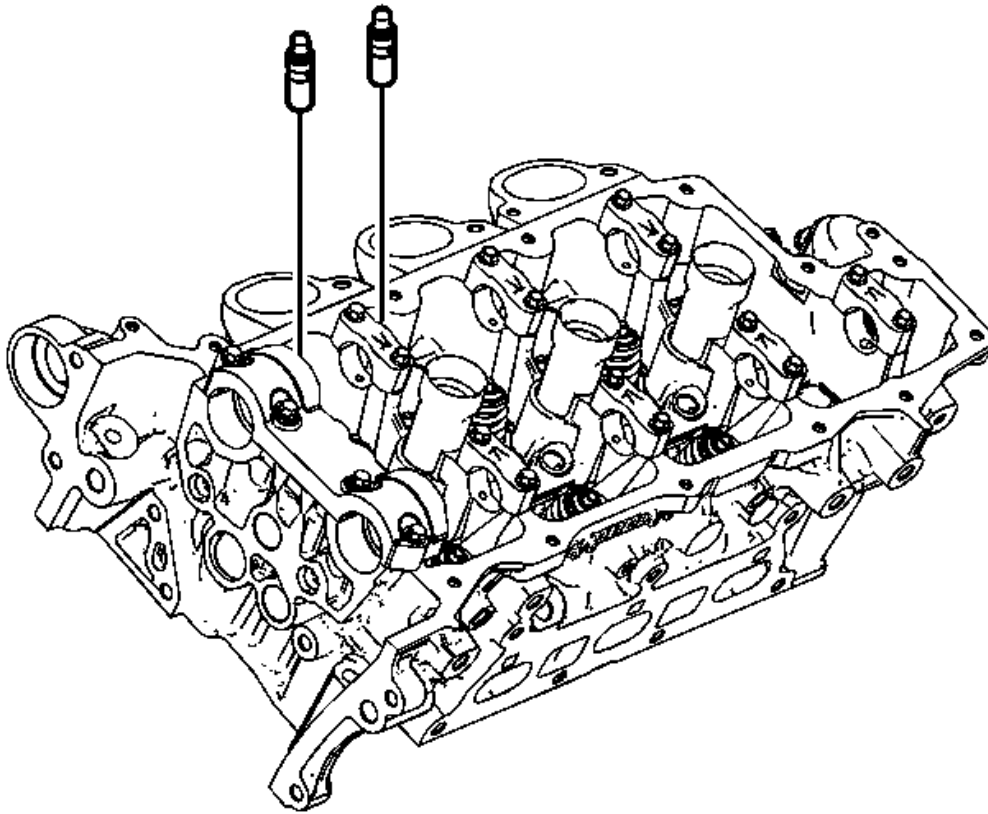


Fig. 151: Valve Lifter Removal - Left Side
 Courtesy of GENERAL MOTORS COMPANY

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

VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

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

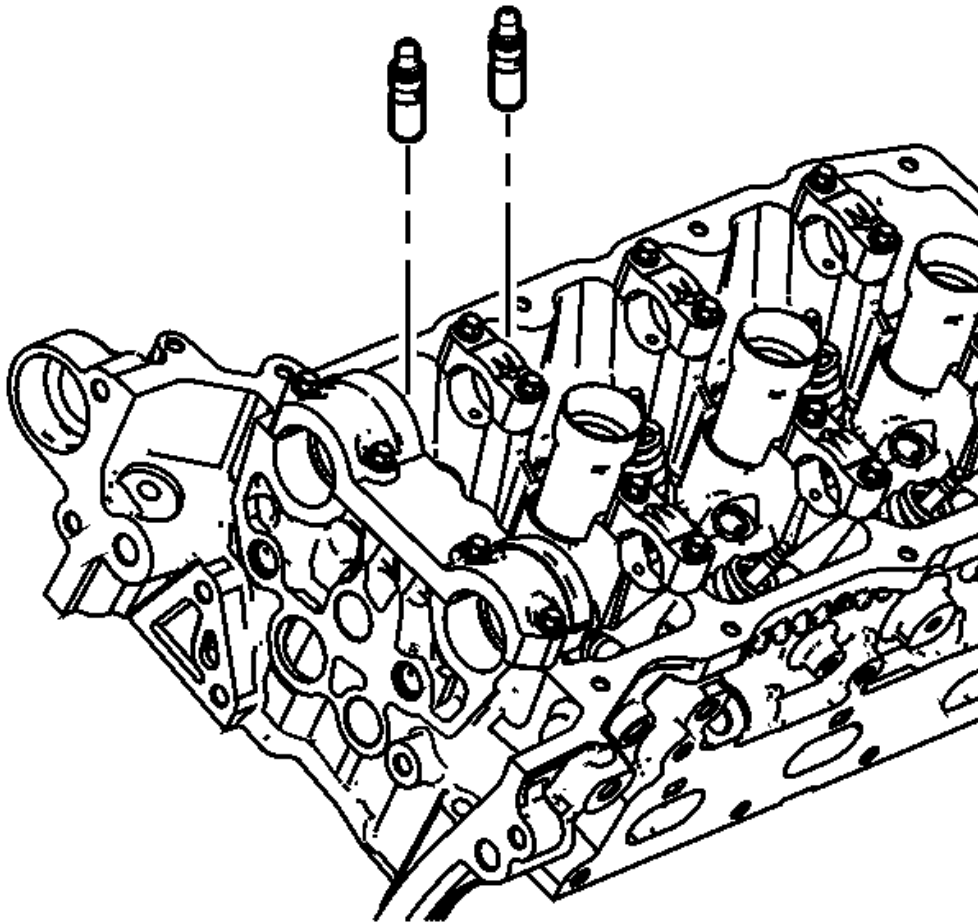


Fig. 152: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

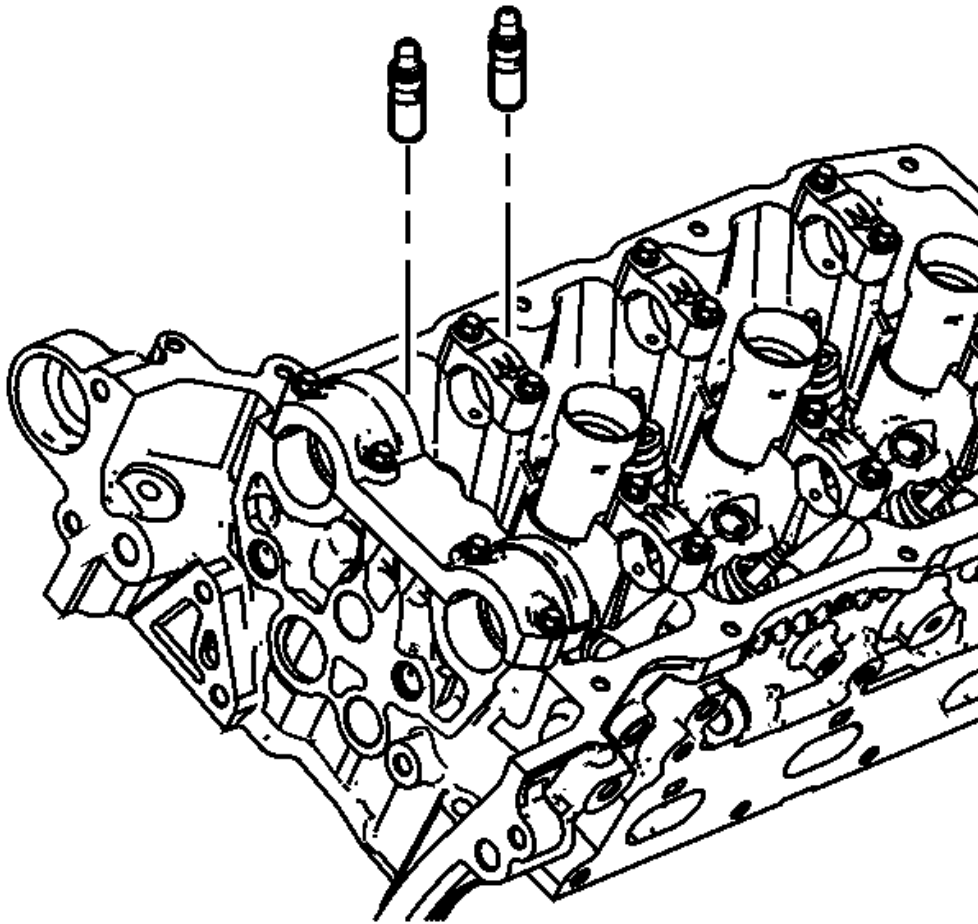


Fig. 153: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

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

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

Removal Procedure

NOTE: This procedure is not used in Brazil.

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

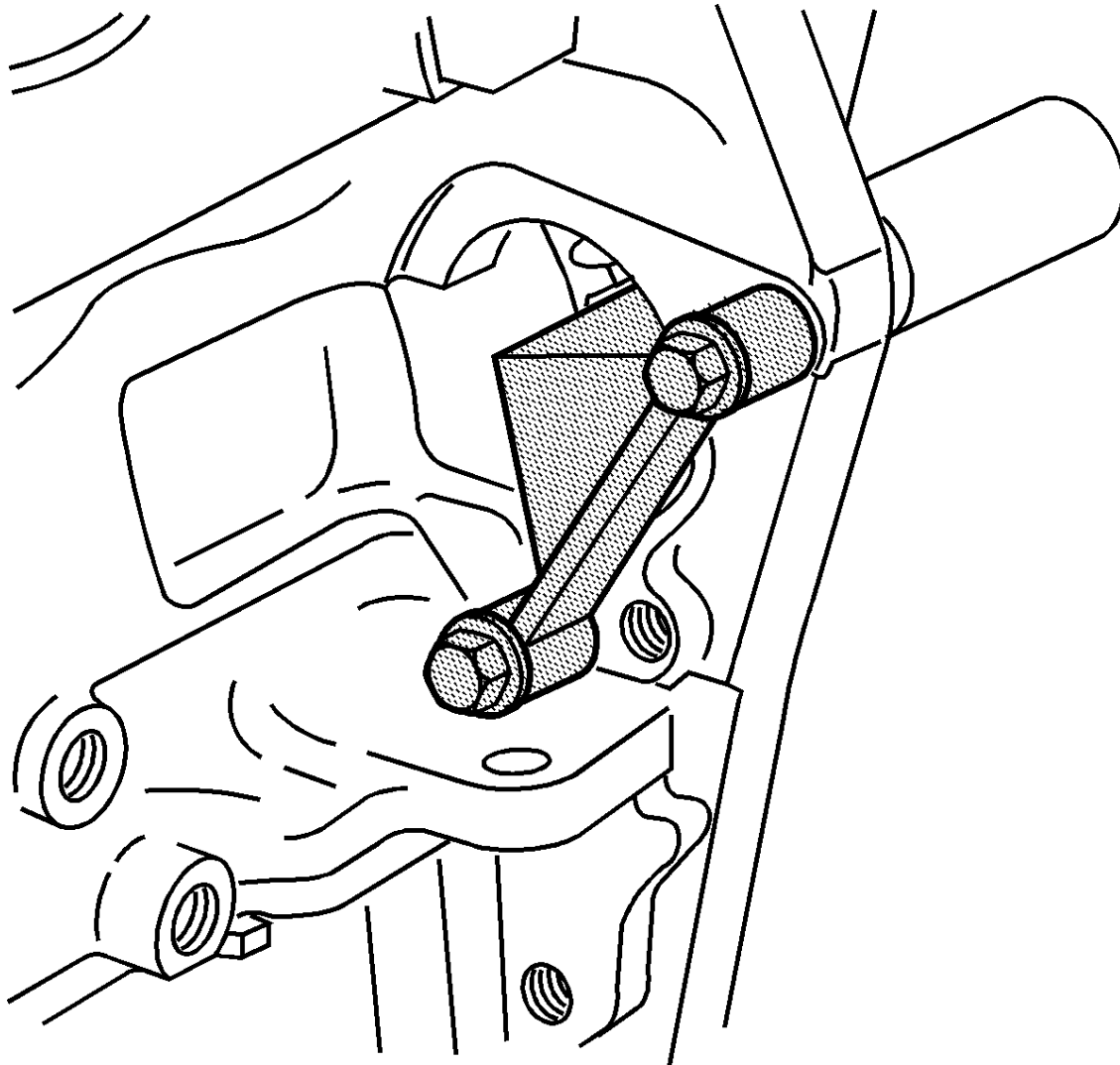


Fig. 154: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

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

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to Spark Plug Replacement.

5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

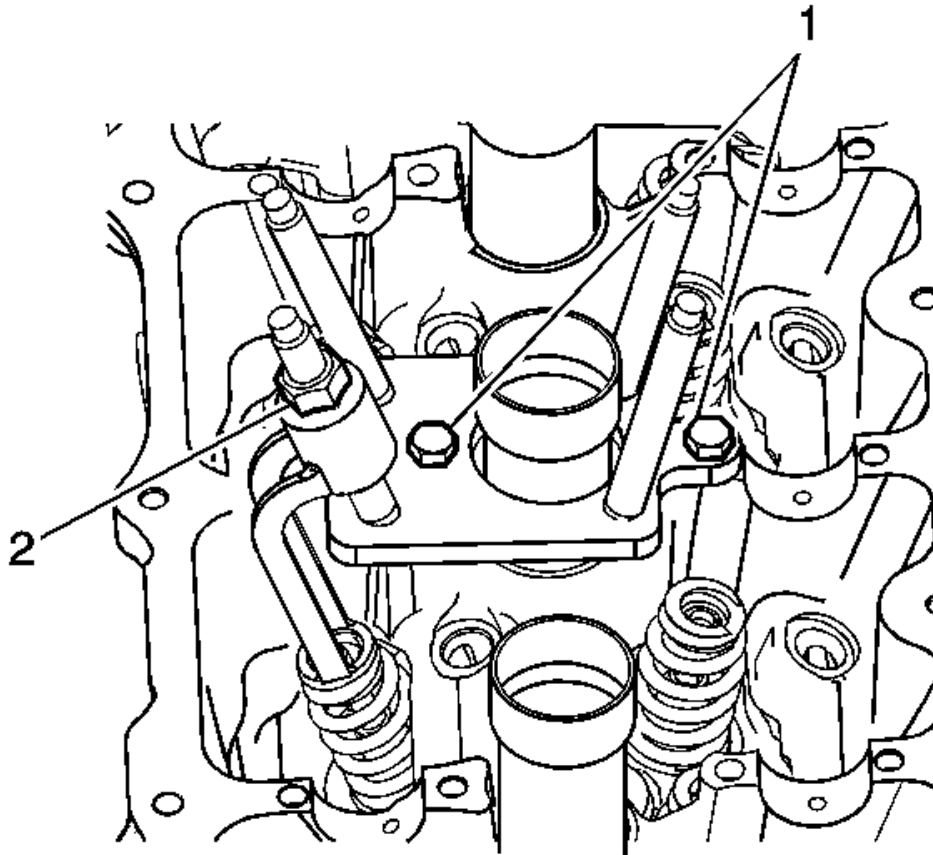


Fig. 155: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

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

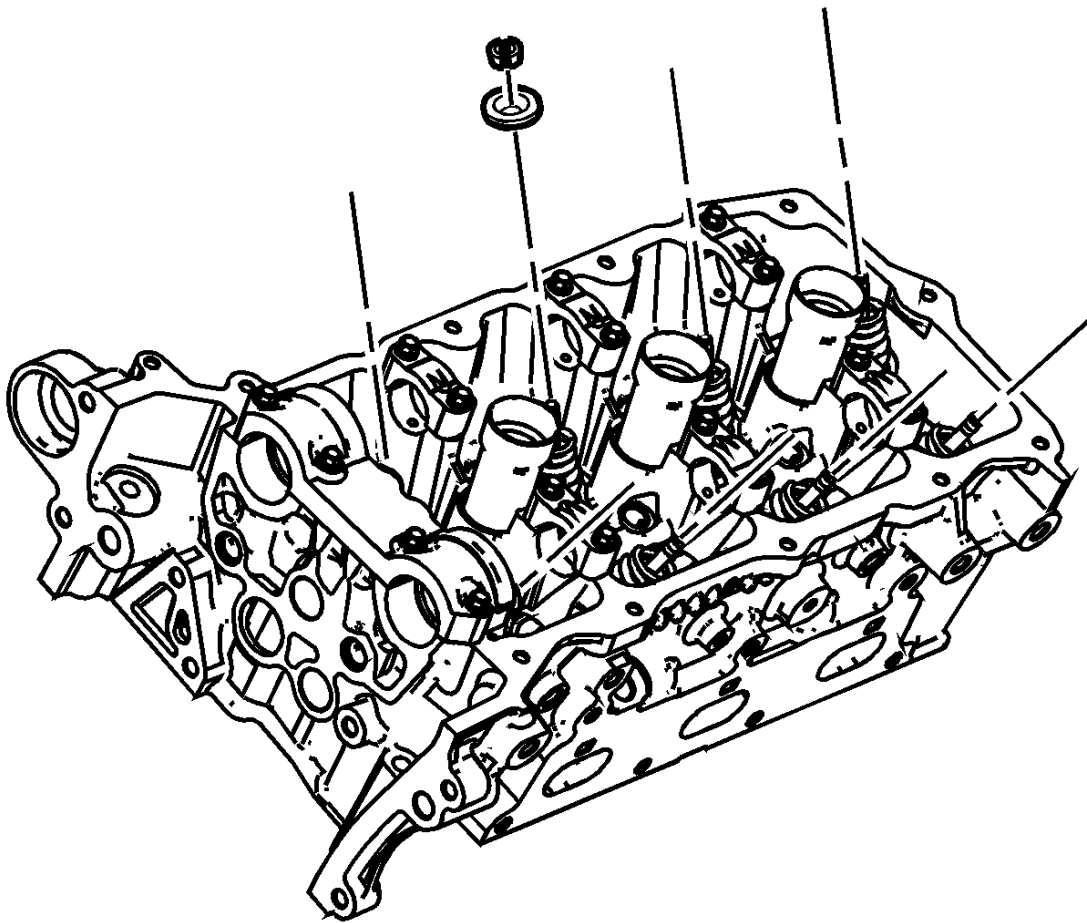


Fig. 156: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

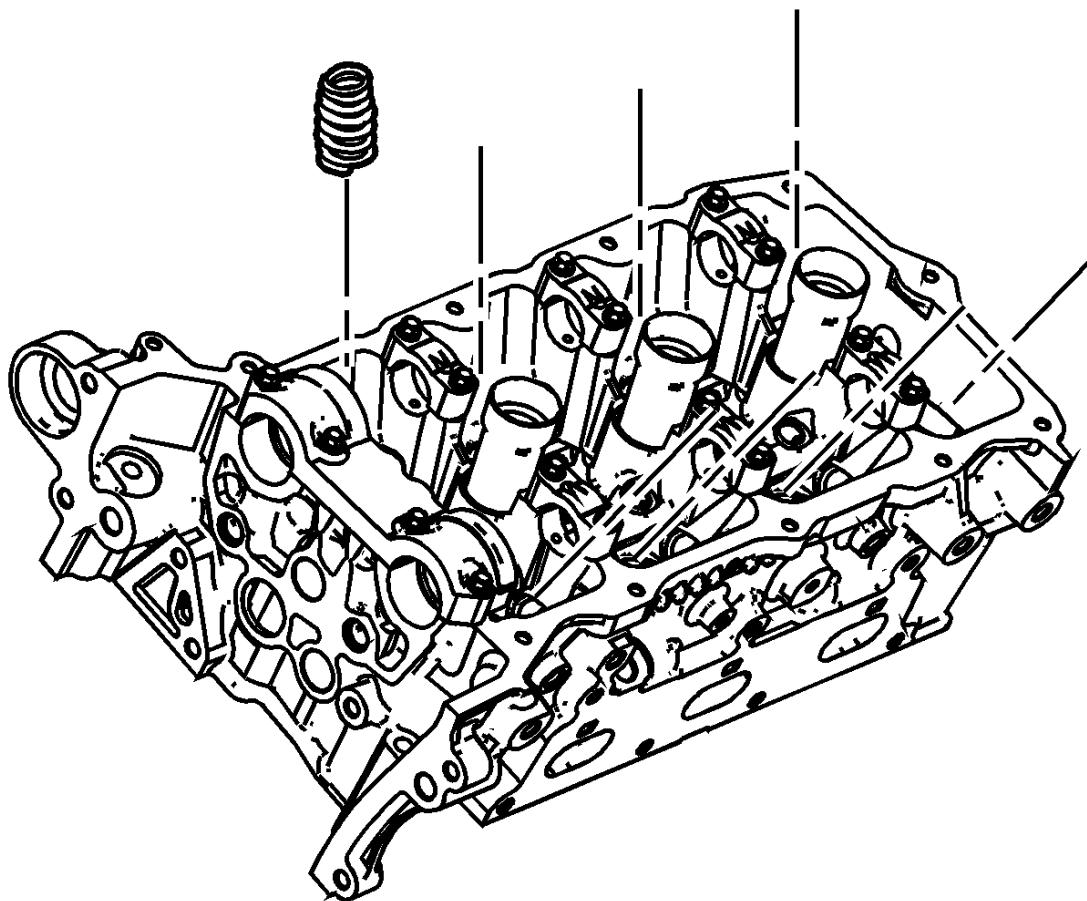


Fig. 157: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

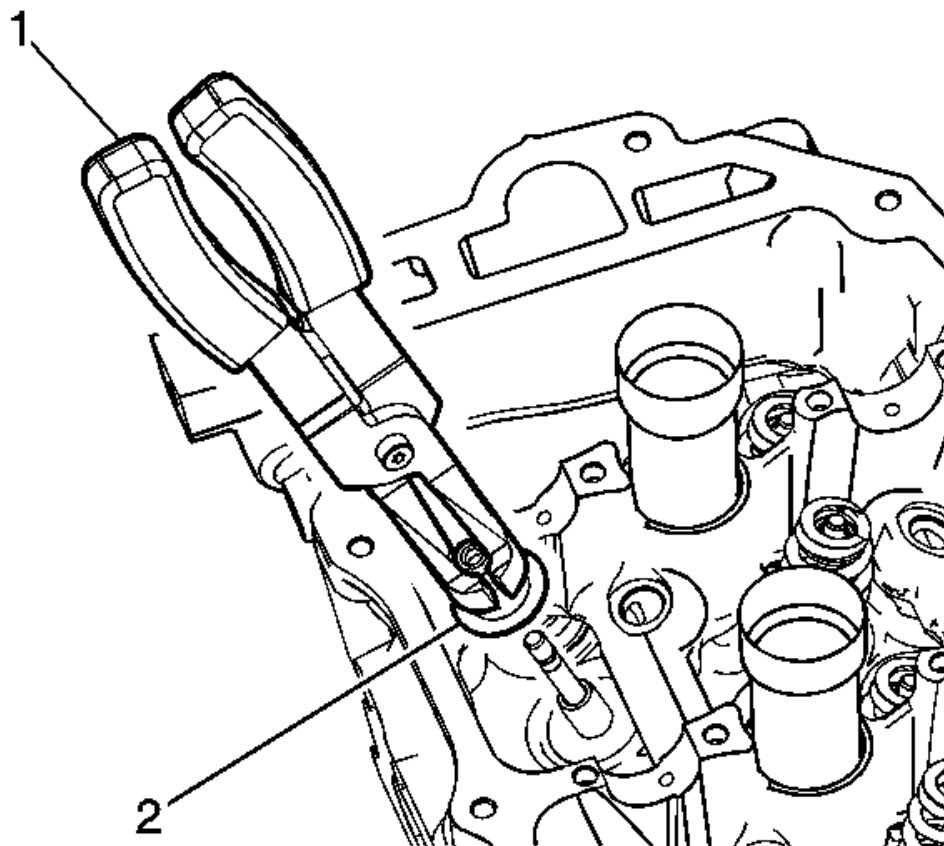


Fig. 158: Valve Stem Seal & Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

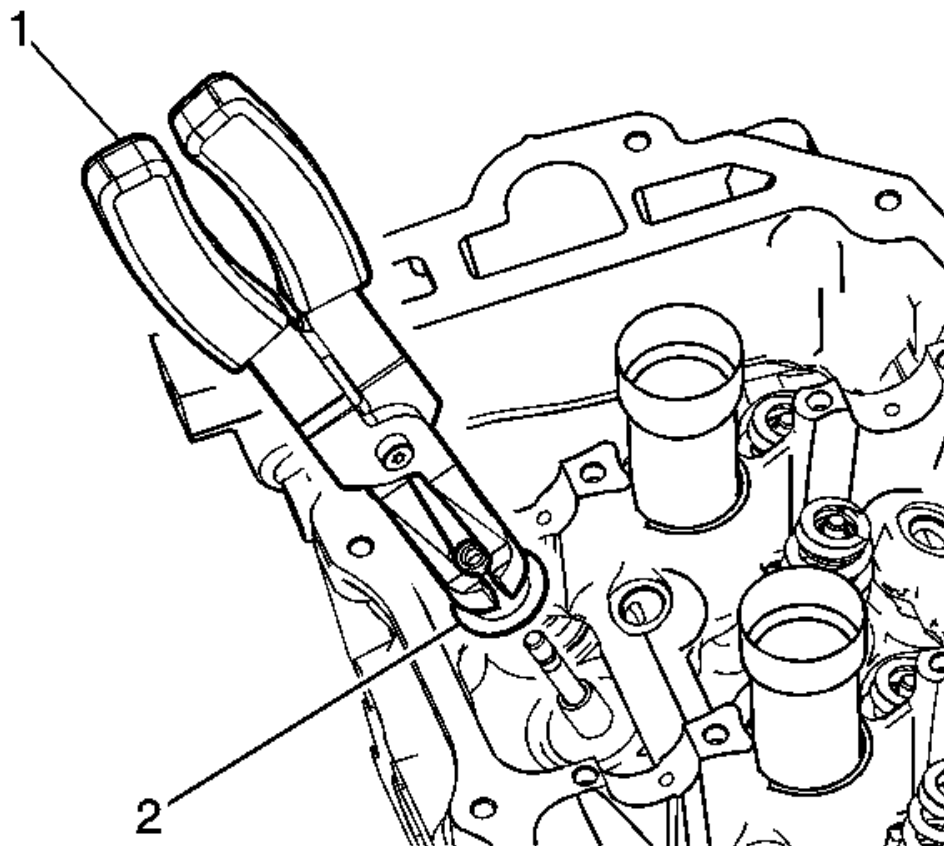


Fig. 159: Valve Stem Seal & Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

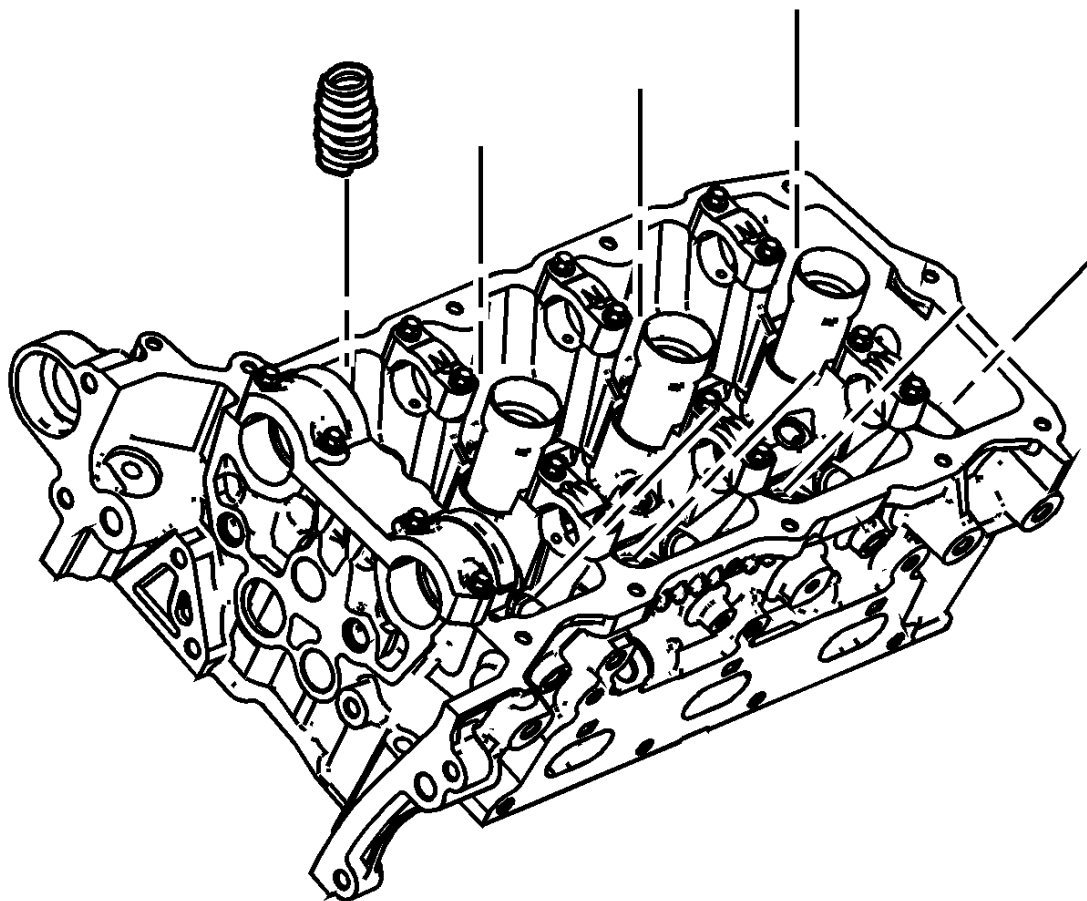


Fig. 160: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

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

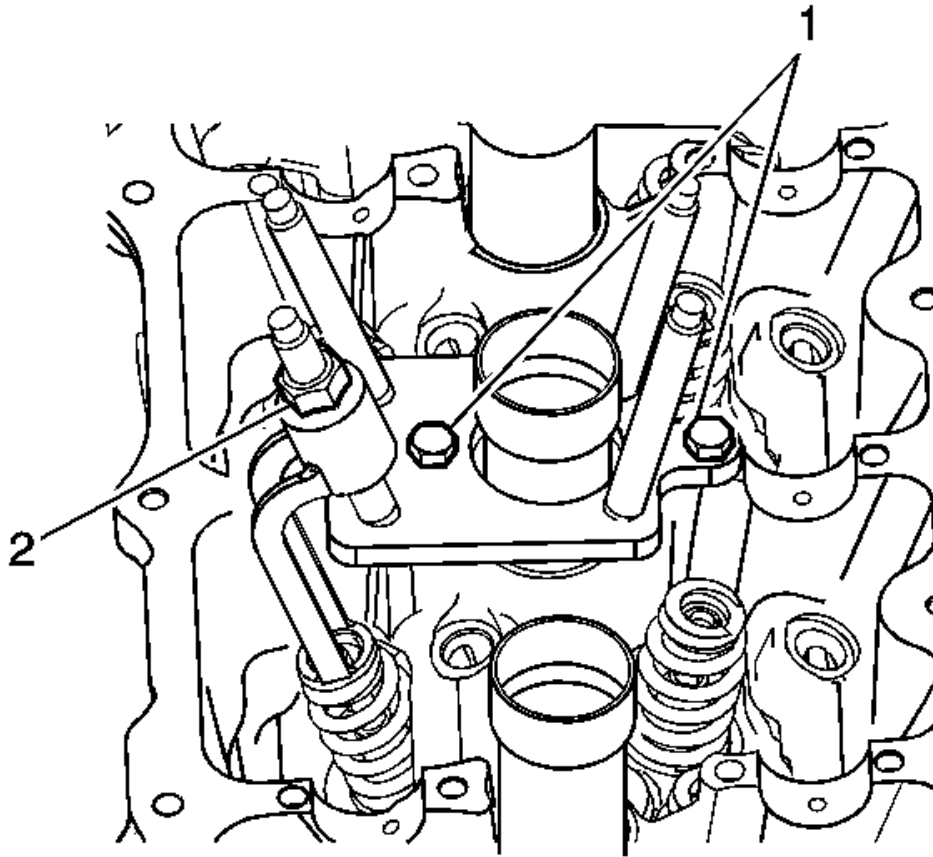


Fig. 161: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

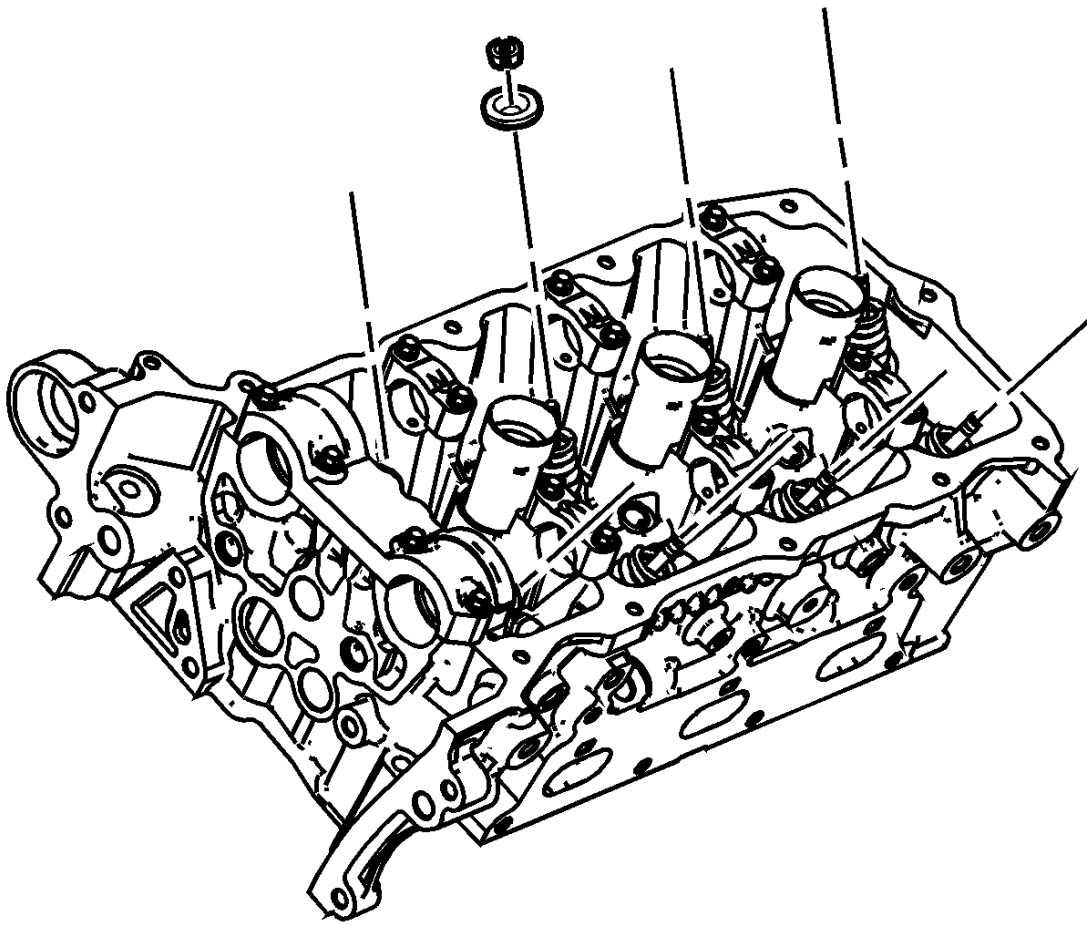


Fig. 162: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

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

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

Removal Procedure

NOTE: This procedure is not used in Brazil.

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

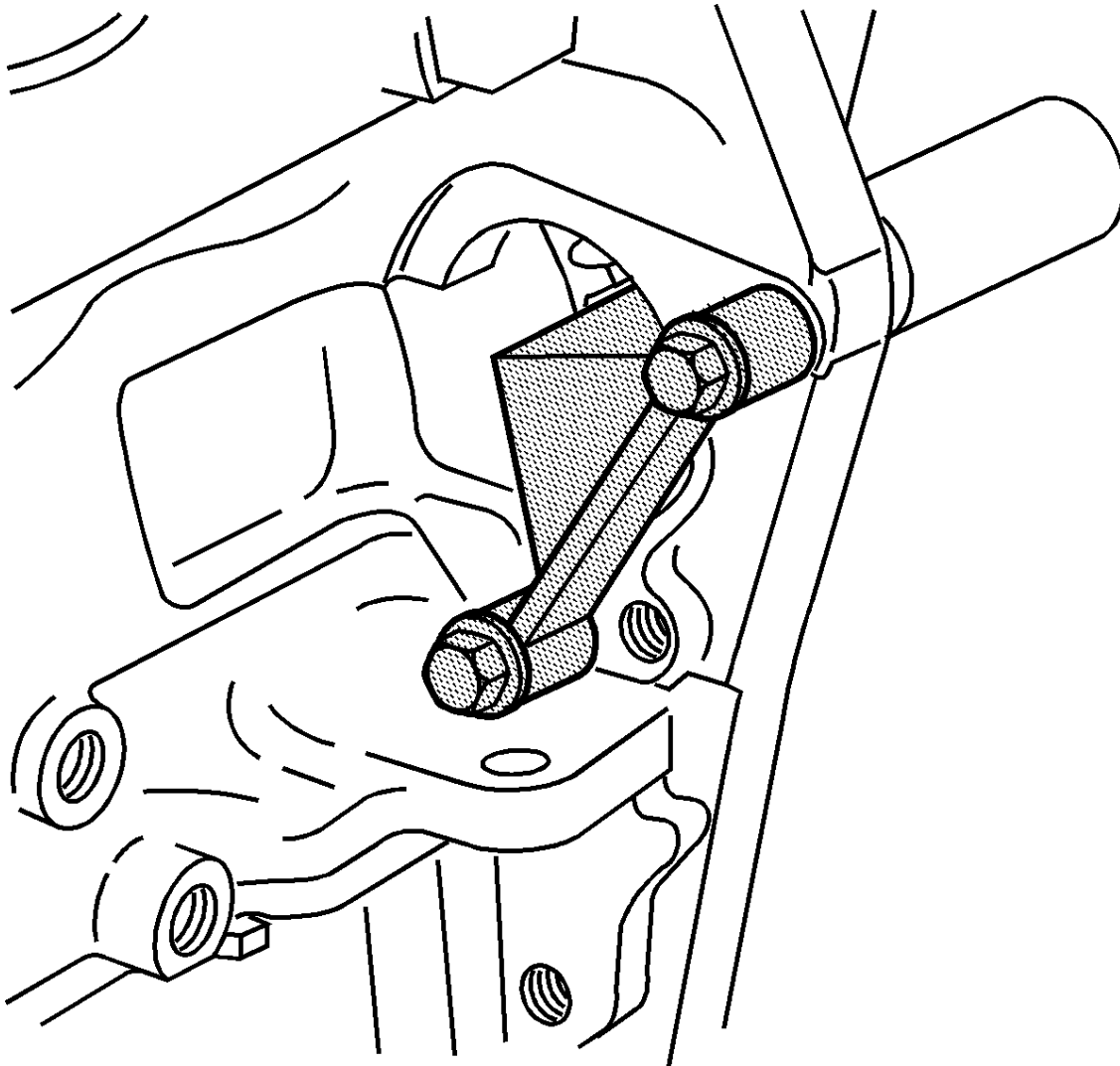


Fig. 163: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

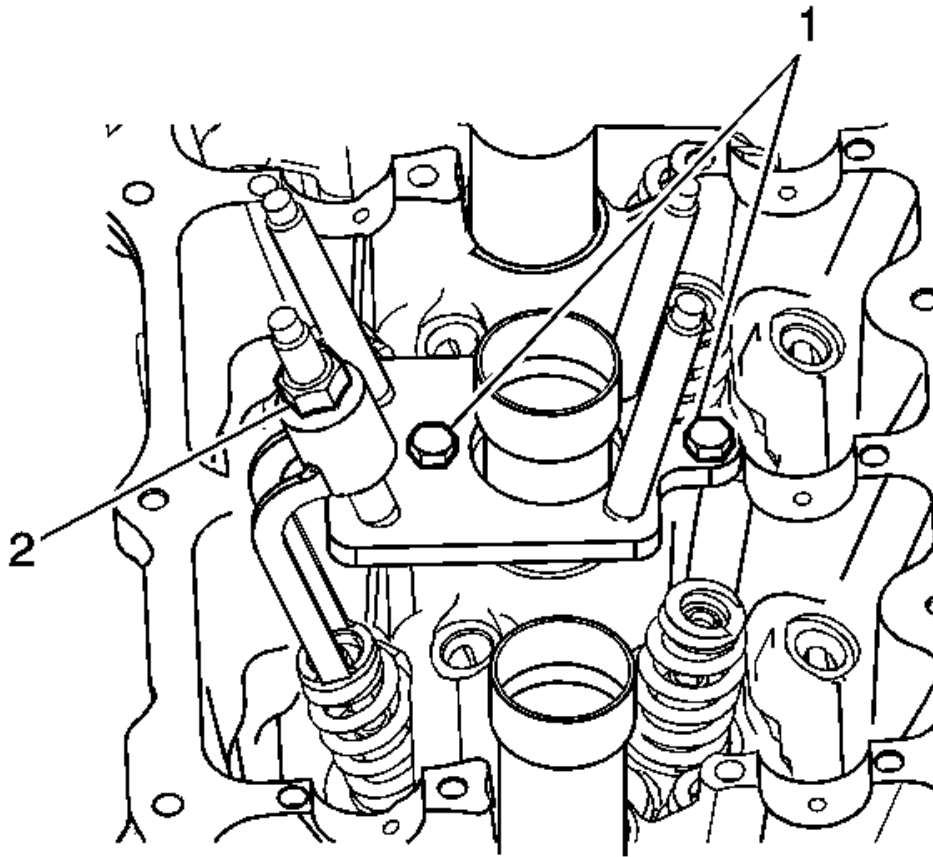


Fig. 164: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

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

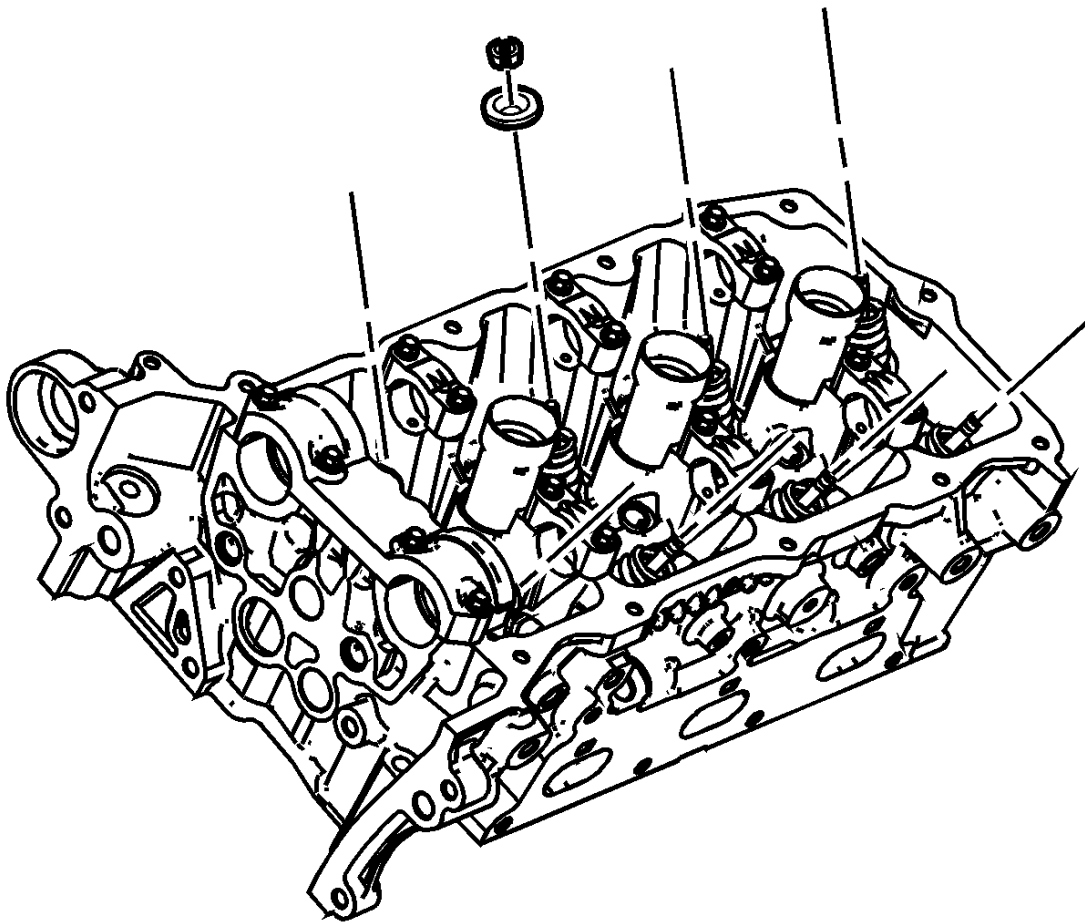


Fig. 165: View Of Valve Spring Keepers
 Courtesy of GENERAL MOTORS COMPANY

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

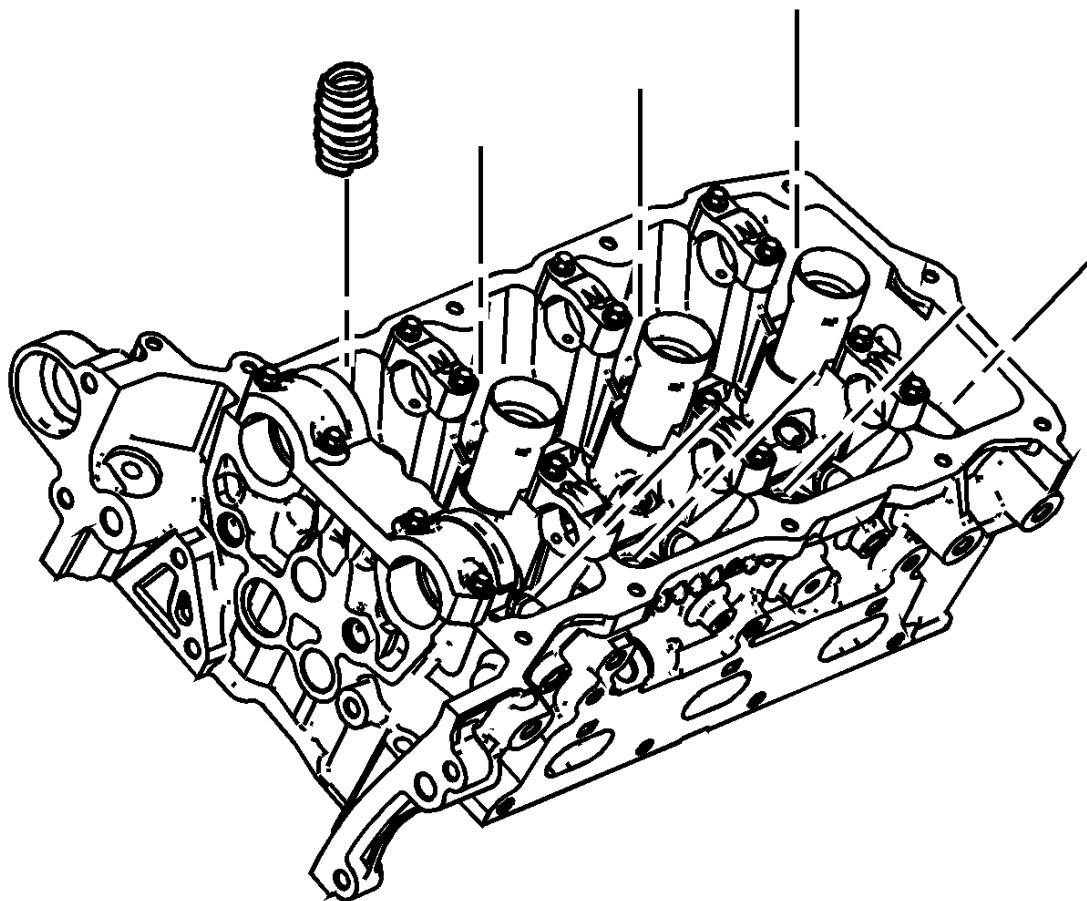


Fig. 166: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

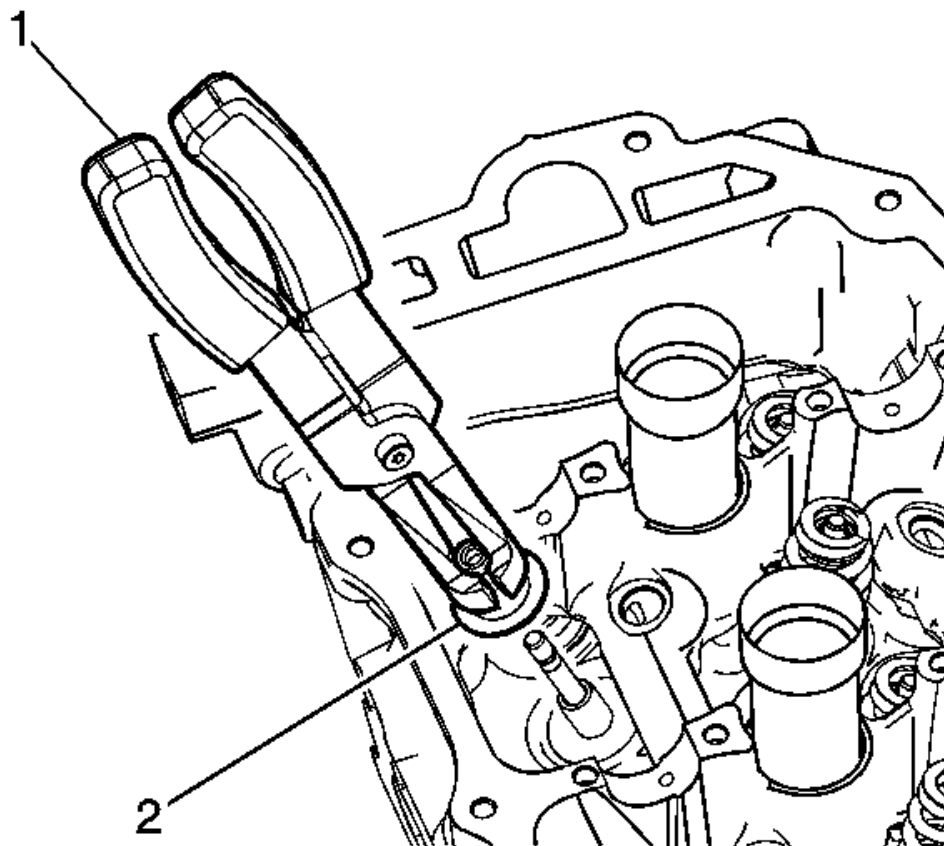


Fig. 167: Valve Stem Seal & Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

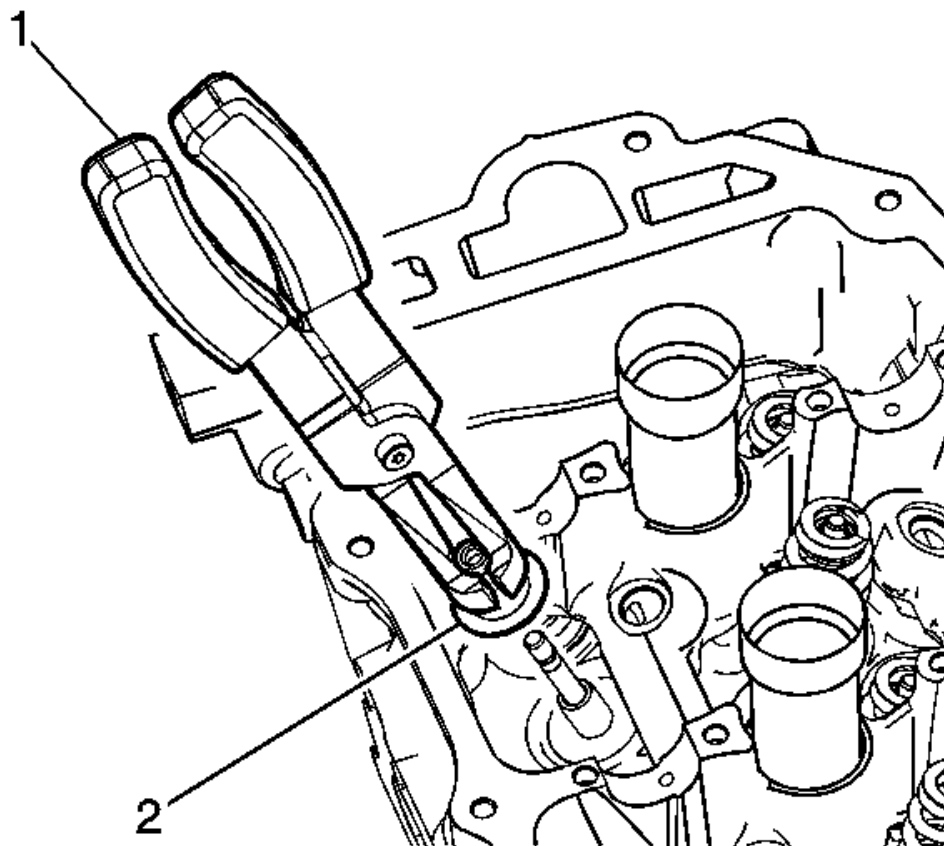


Fig. 168: Valve Stem Seal & Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

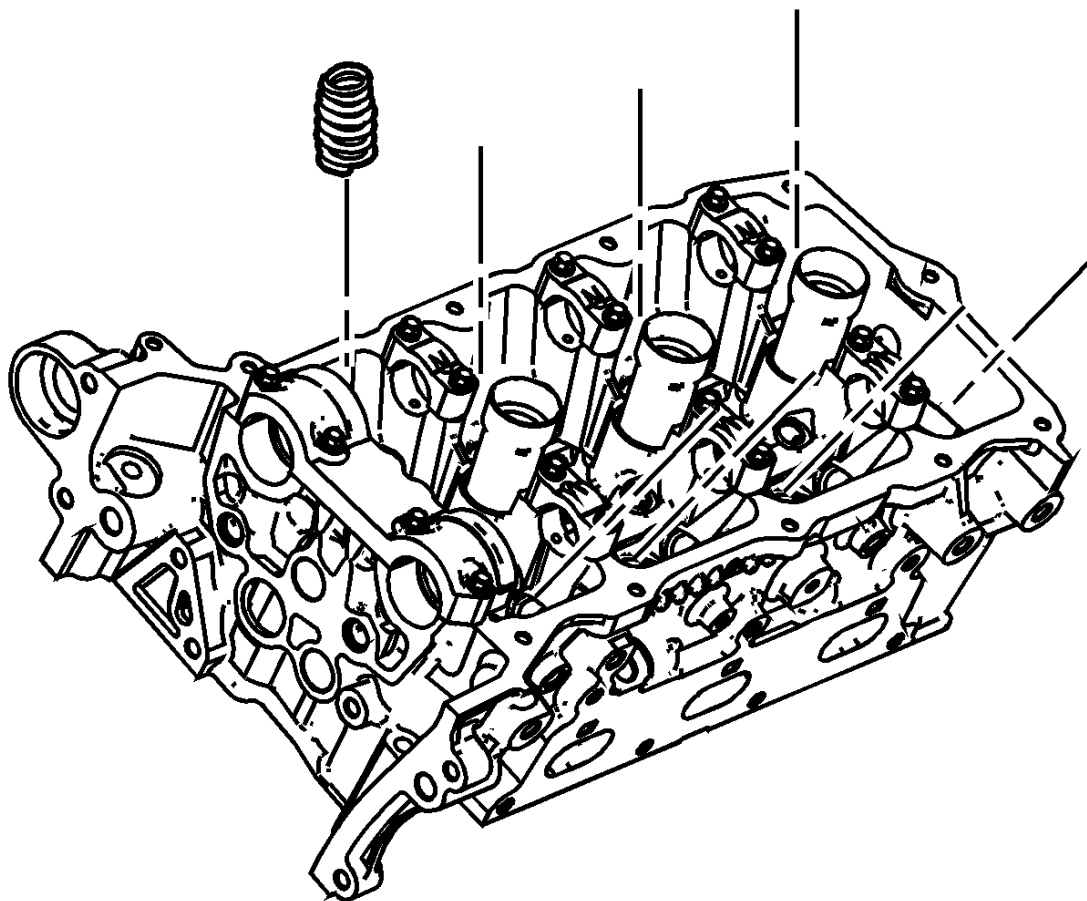


Fig. 169: View Of Valve Spring

Courtesy of GENERAL MOTORS COMPANY

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

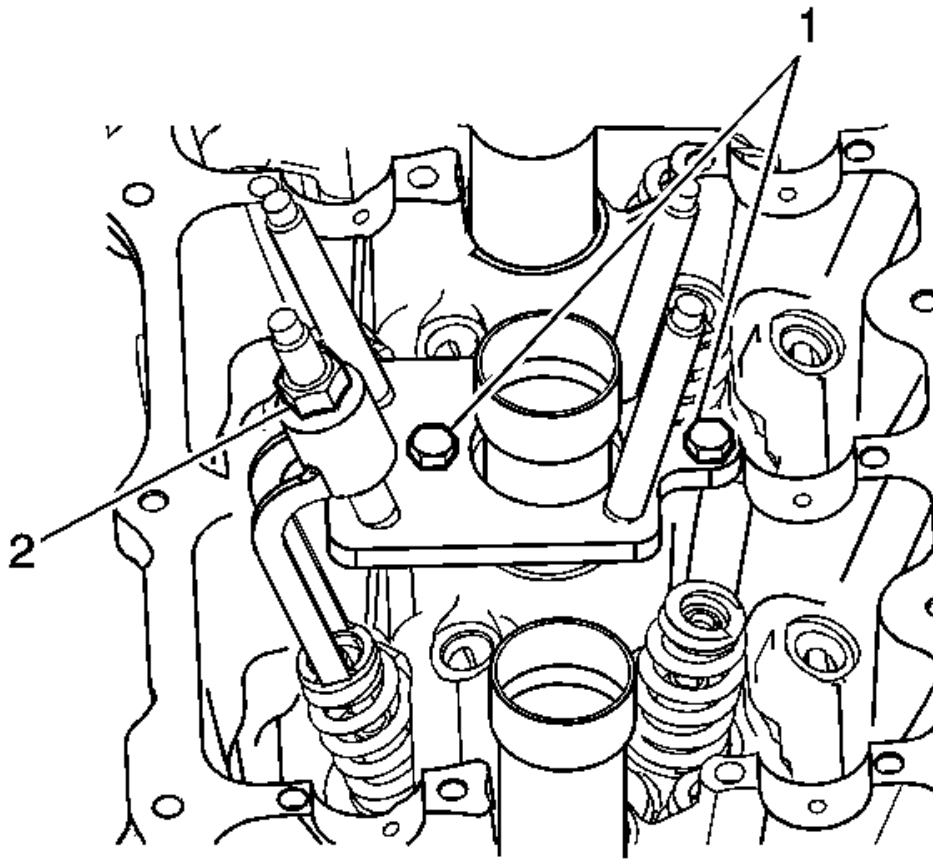


Fig. 170: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

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

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

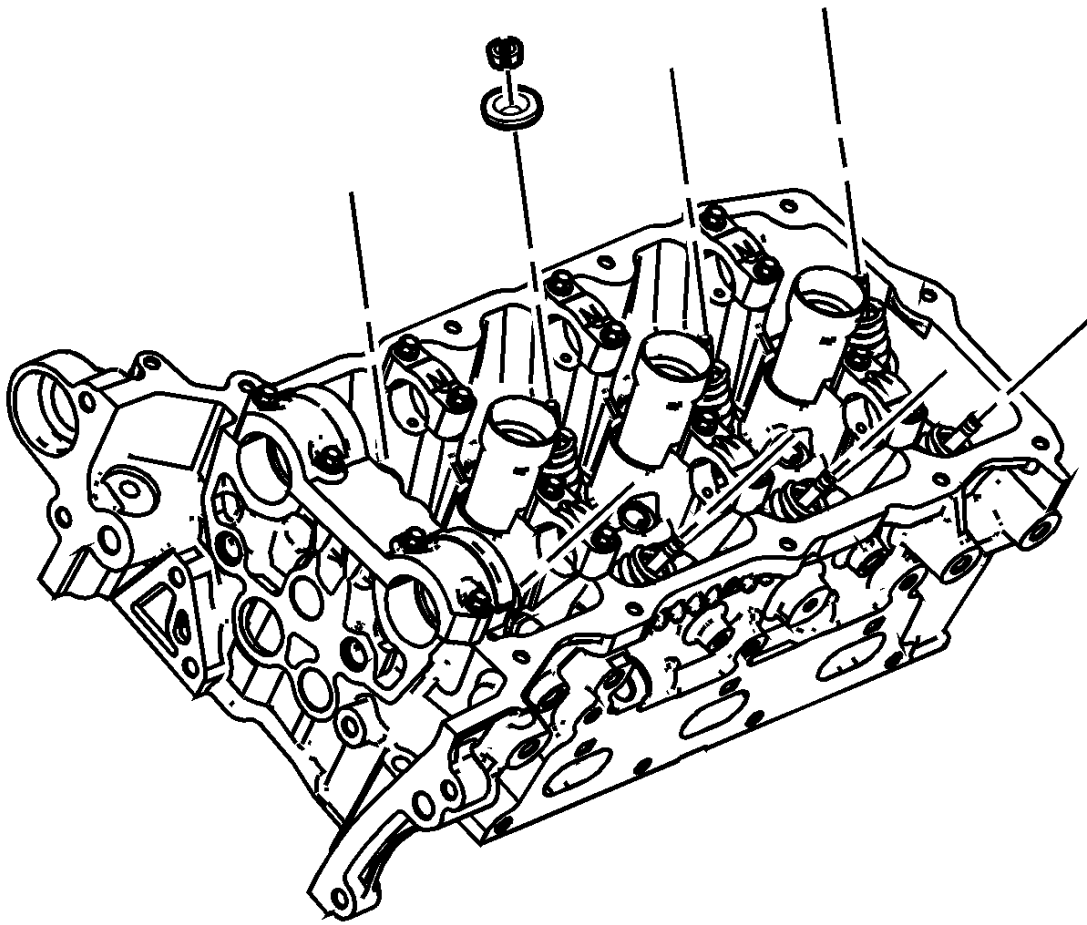


Fig. 171: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

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

Special Tools

EN-45059 Angle Meter

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

Removal Procedure

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

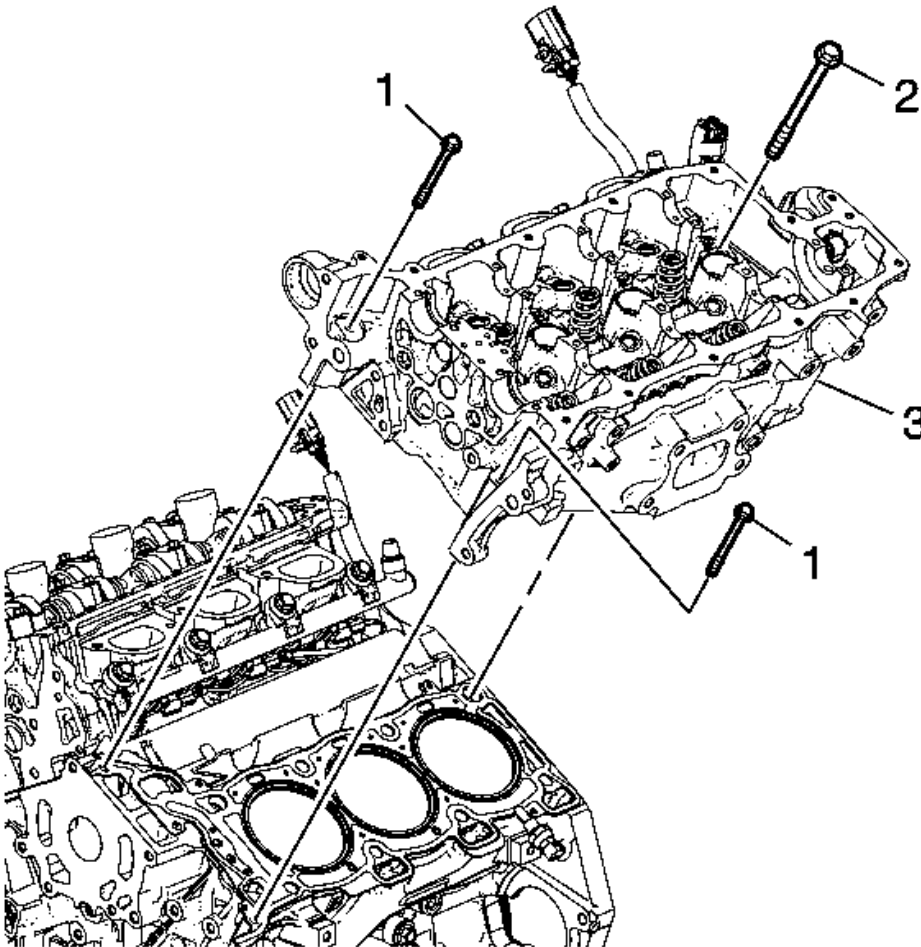


Fig. 172: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

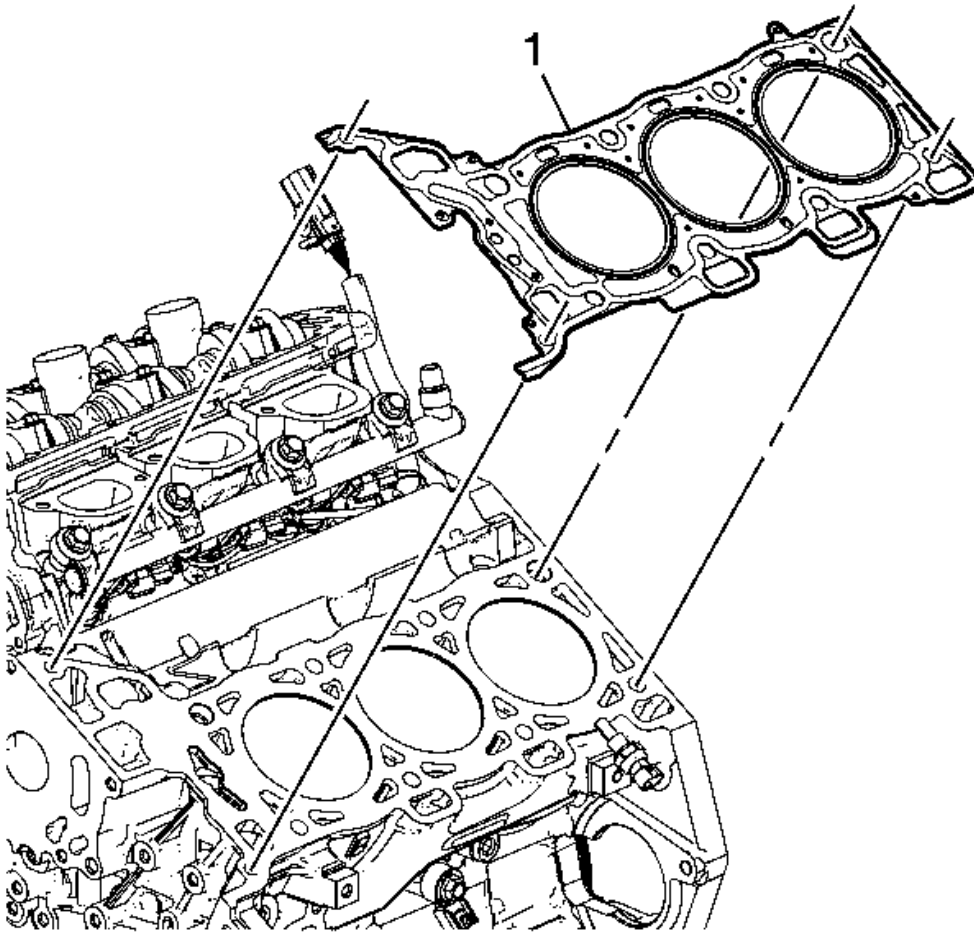


Fig. 173: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

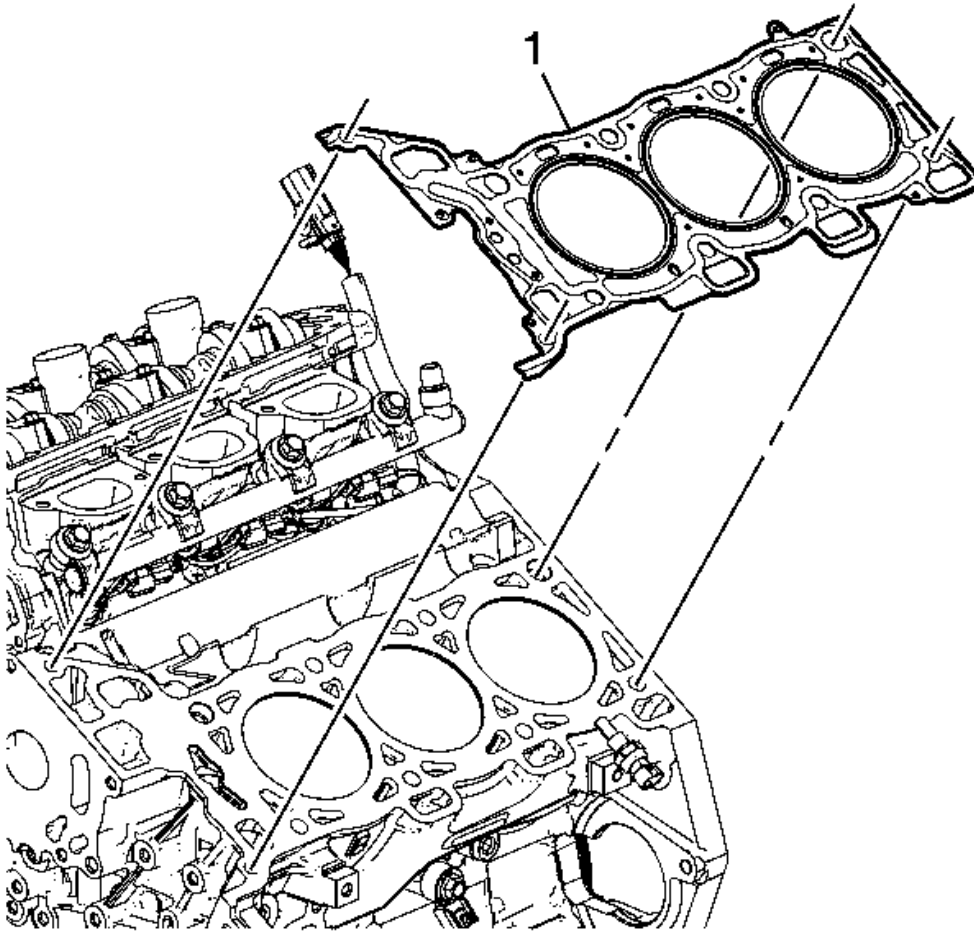


Fig. 174: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

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

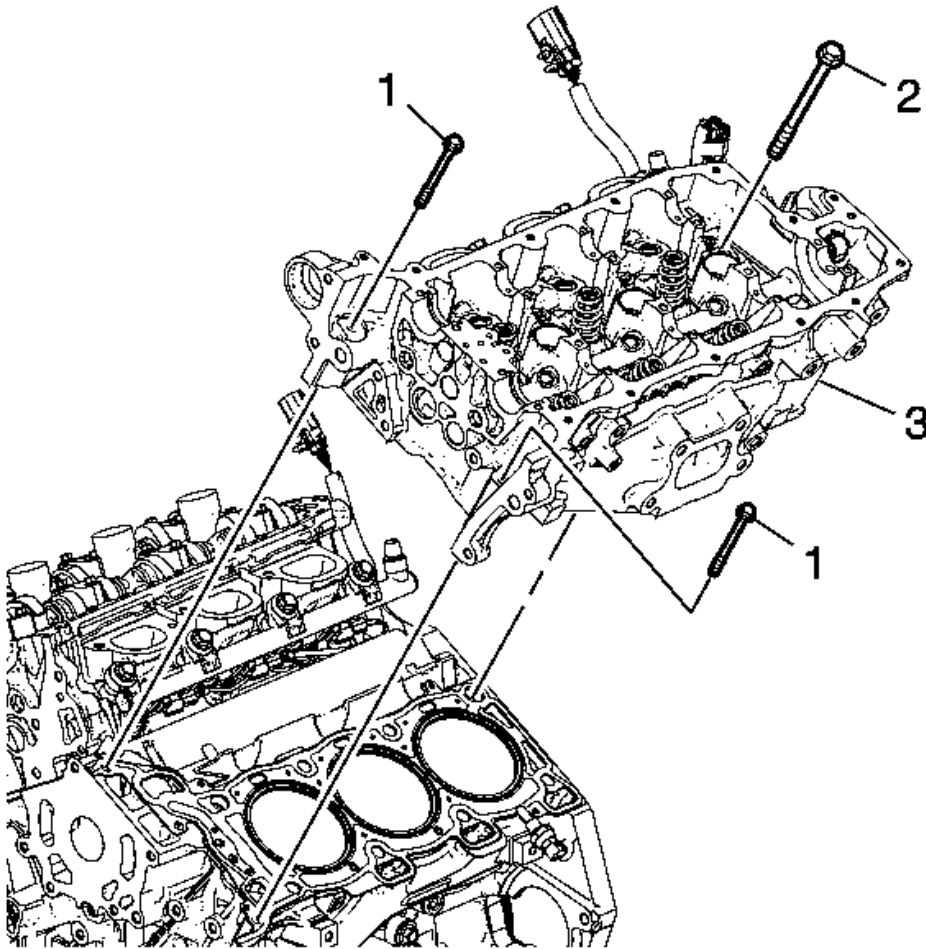


Fig. 175: View Of Left Cylinder Head & Bolts
 Courtesy of GENERAL MOTORS COMPANY

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

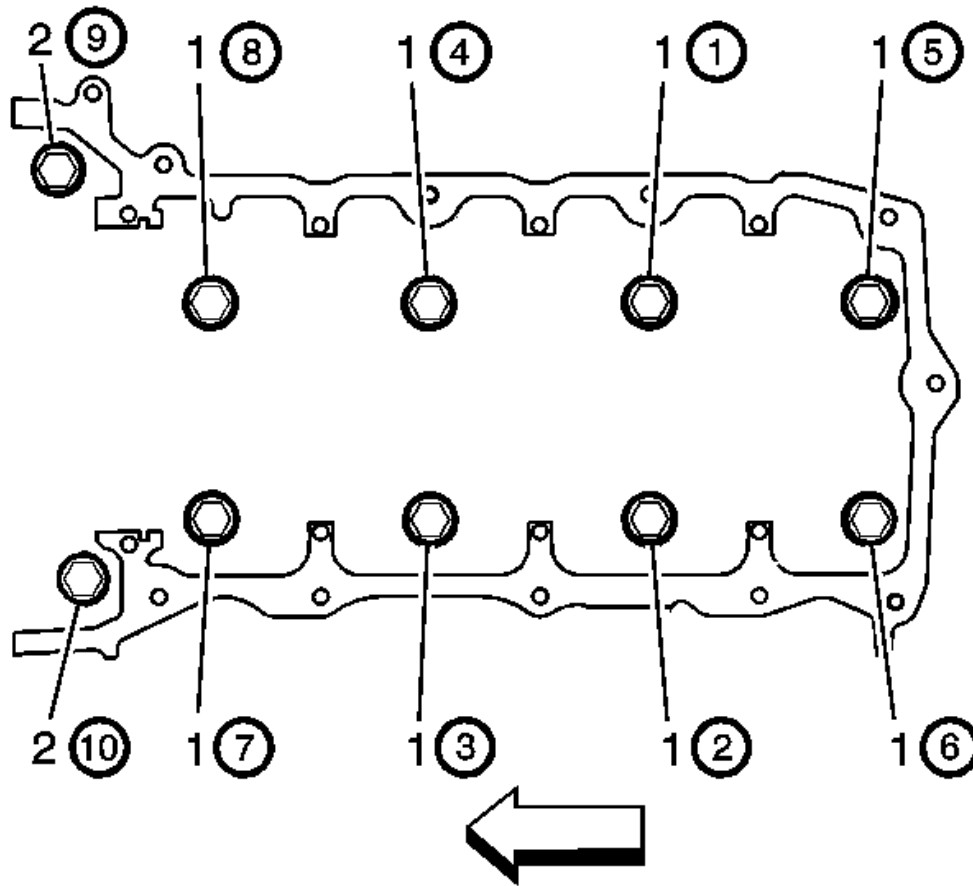


Fig. 176: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE:

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

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

EN-45059 meter.

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

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

Special Tools

EN-45059 Angle Meter

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

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement (With AWD at Tank)**, **Fuel Feed Pipe Replacement (LFW or LFX)**.
3. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFW or LFX)**.
4. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LFX-Rear)**.
6. Remove the heater inlet and outlet hoses. Refer to **Heater Inlet Hose Replacement (LFX)**, and **Heater Outlet Hose Replacement (LFX)**.
7. Remove the two ground wires attached to the front and rear of the cylinder head.

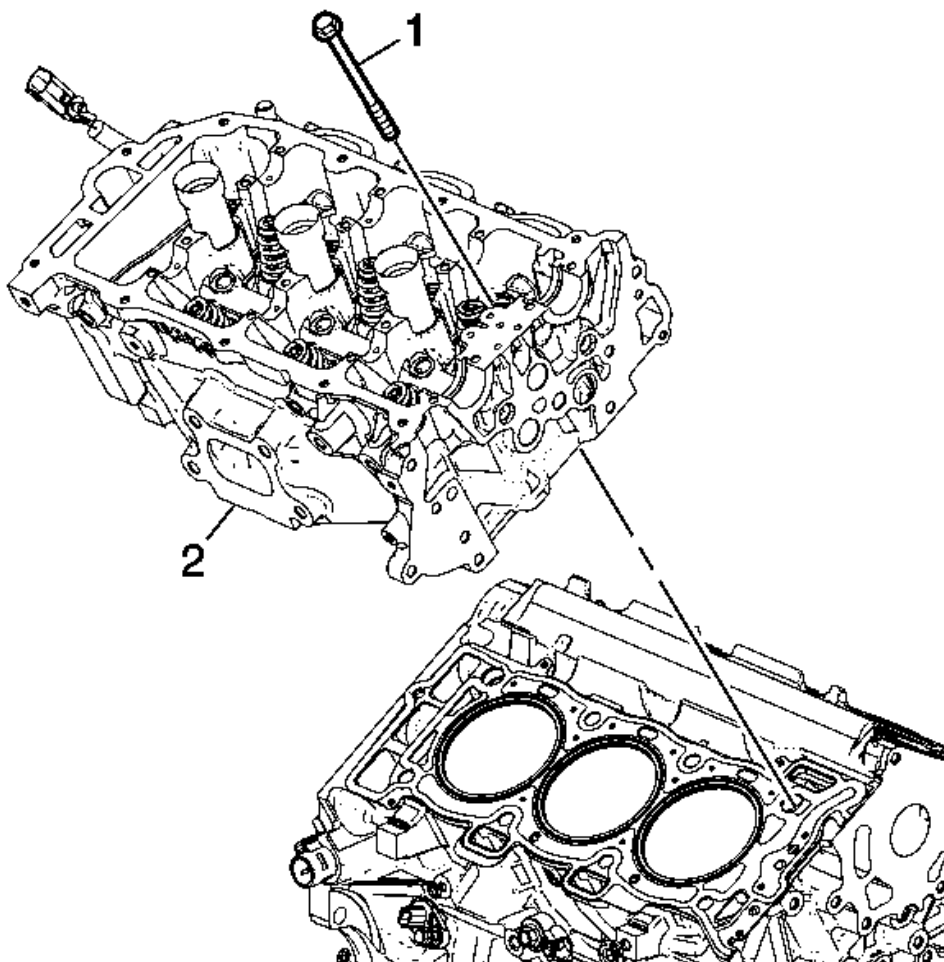


Fig. 177: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the right cylinder head bolts (1).
9. Remove the right cylinder head (2).

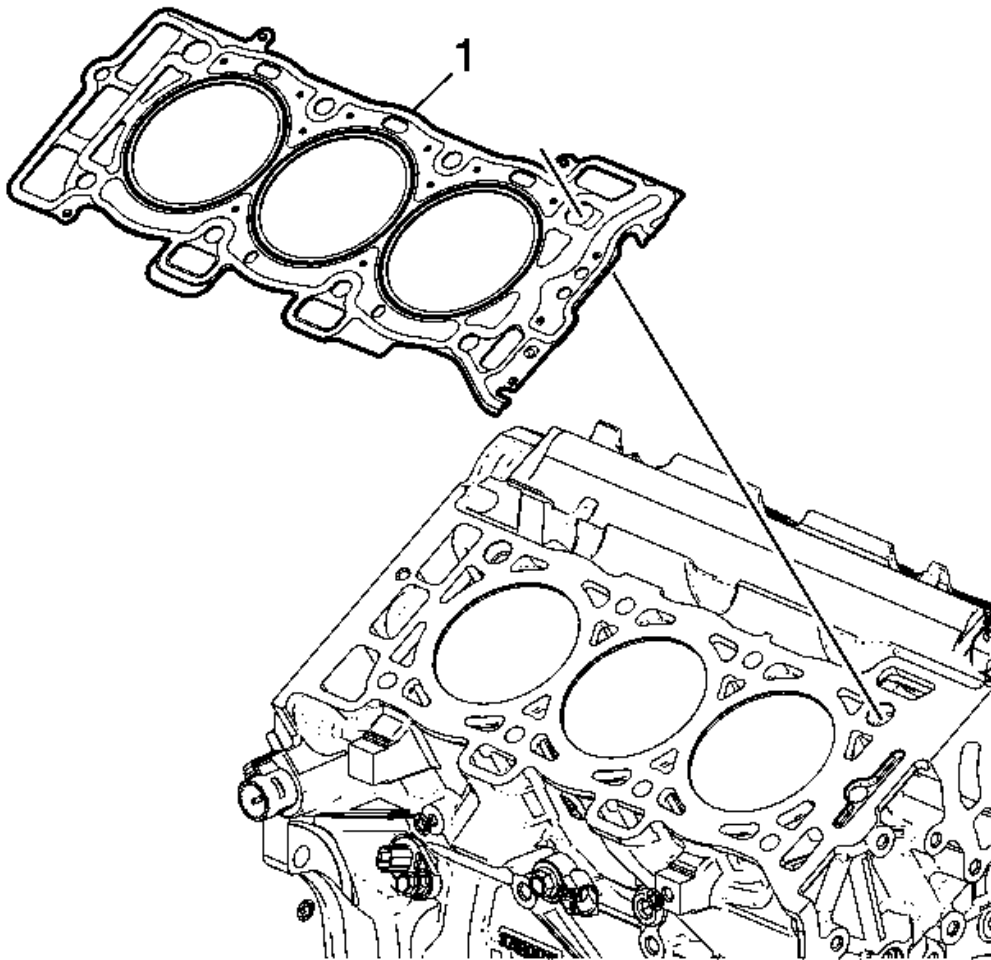


Fig. 178: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Remove and discard the cylinder head gasket (1).
11. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** , and **Engine Block Cleaning and Inspection** .
12. Disassemble the cylinder head if needed . Refer to **Cylinder Head Disassemble** .

Installation Procedure

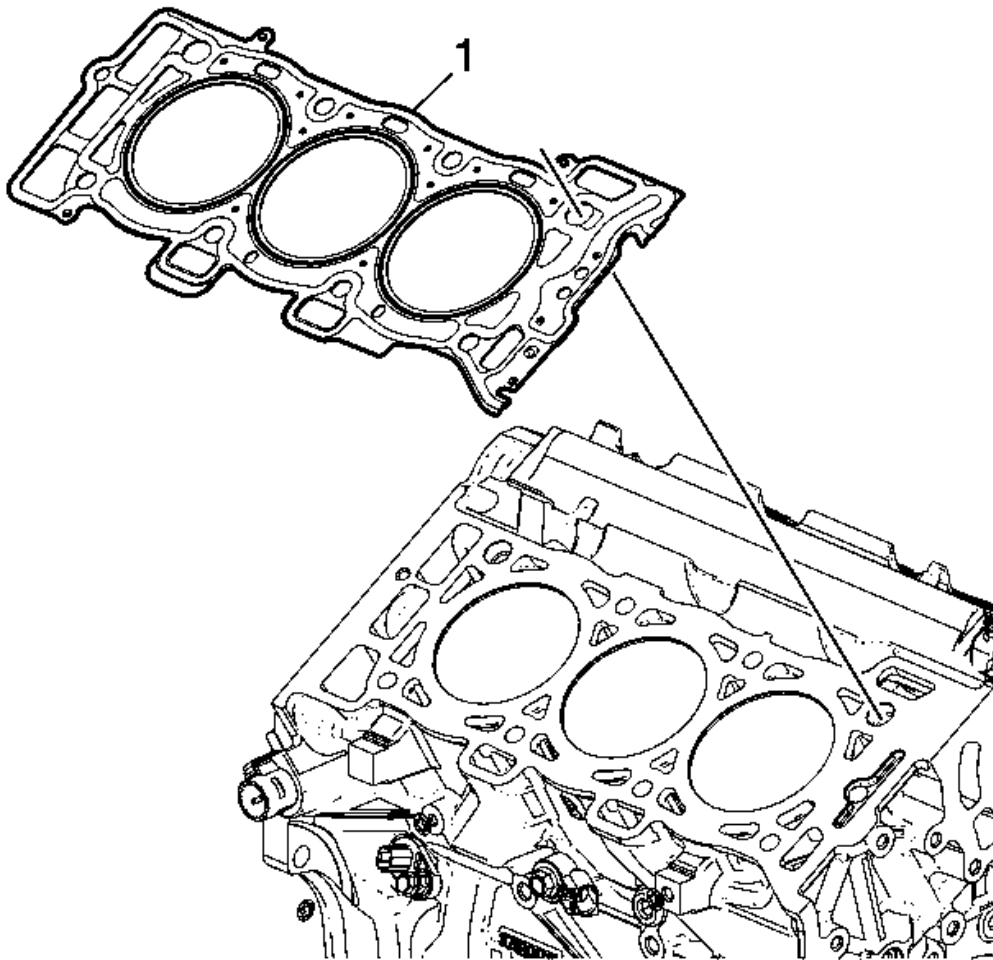


Fig. 179: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

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

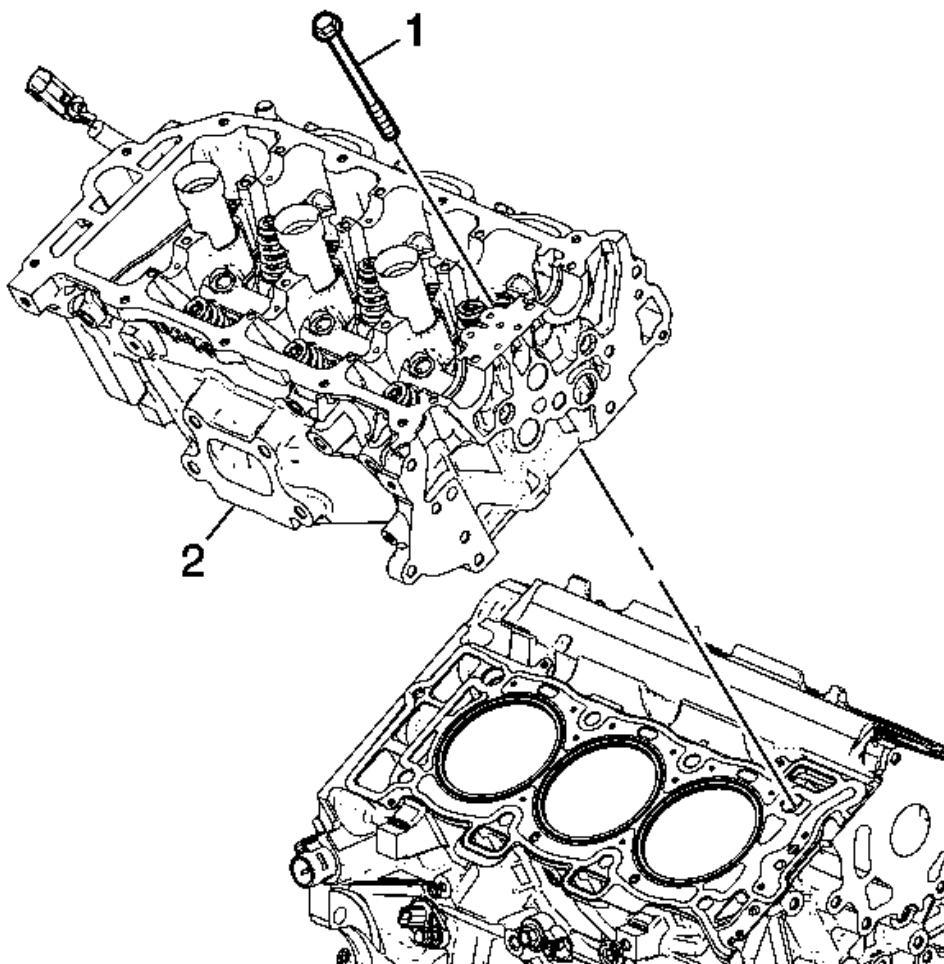


Fig. 180: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

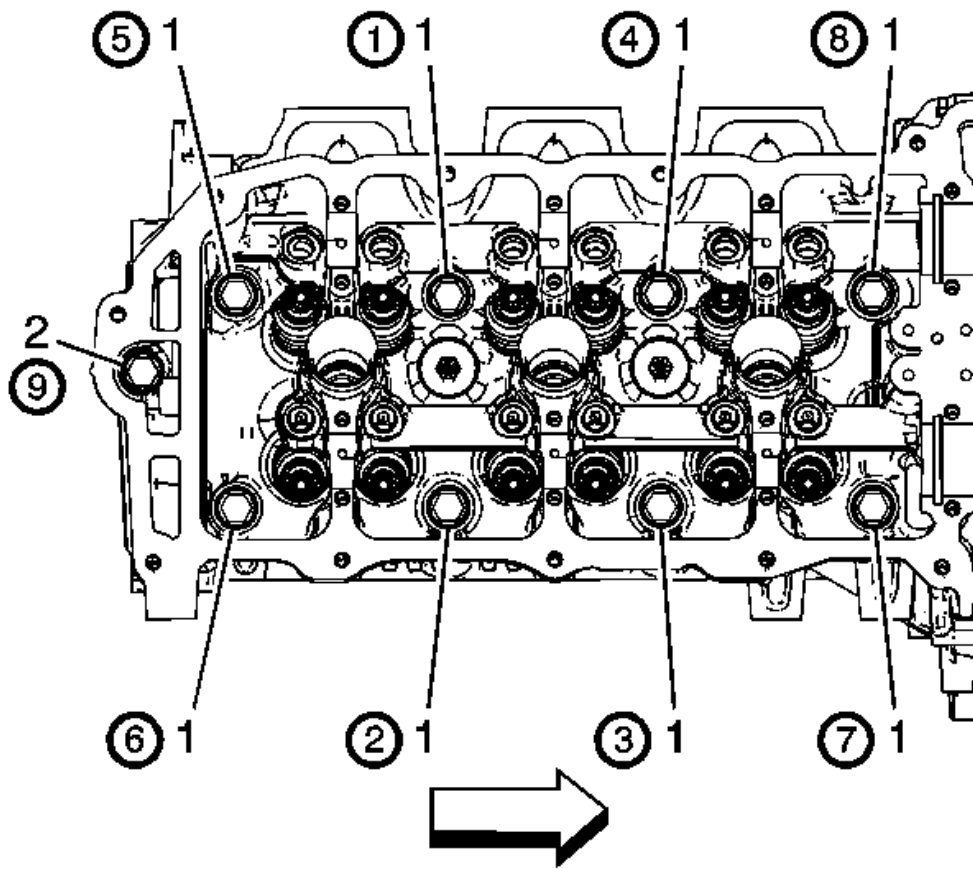


Fig. 181: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE:

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

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

meter.

7. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
8. Install the two ground wires to the front and rear of the cylinder head and tighten to 25 (18 lb ft).
9. Install the heater inlet and outlet hoses. Refer to **Heater Inlet Hose Replacement (LFX)** , and **Heater Outlet Hose Replacement (LFX)** .
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LFX-Rear)** .
11. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LFW or LFX)** .
12. Install the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement (With AWD at Tank)** , **Fuel Feed Pipe Replacement (LFW or LFX)** .
13. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

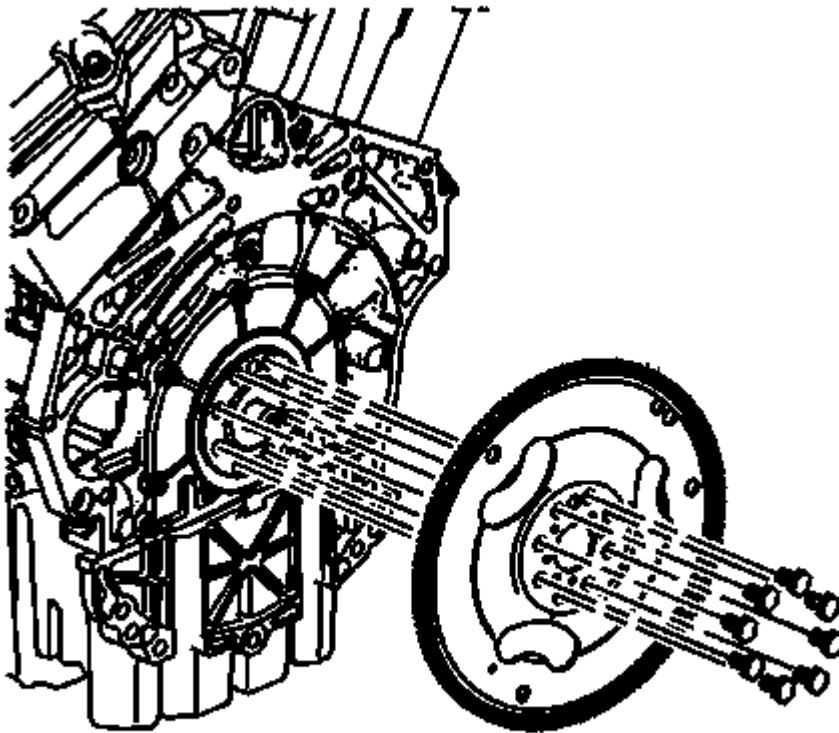


Fig. 182: View Of Engine Flywheel
 Courtesy of GENERAL MOTORS COMPANY

1. Remove the transmission. Refer to [Transmission Replacement \(AWD\)](#) , [Transmission Replacement \(FWD\)](#) .
2. Remove the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Removal](#) .
3. Clean and inspect the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Cleaning and Inspection](#) . If the flex plate teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive.

Installation Procedure

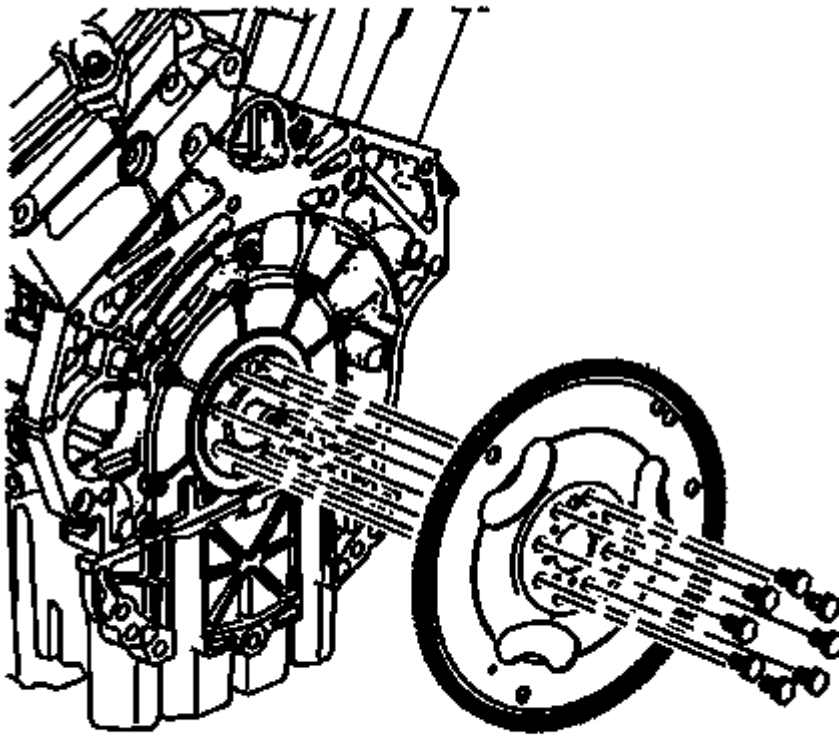


Fig. 183: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Install the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Installation](#) .
2. Install the transmission. Refer to [Transmission Replacement \(AWD\)](#) , [Transmission Replacement \(FWD\)](#) .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Removal Procedure

1. Remove the engine flywheel.

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

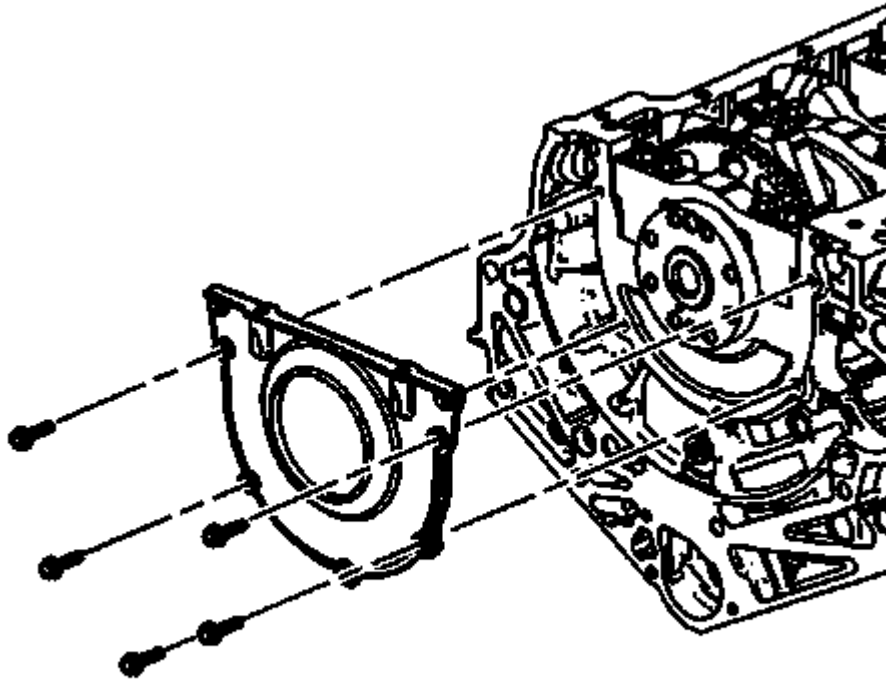


Fig. 184: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

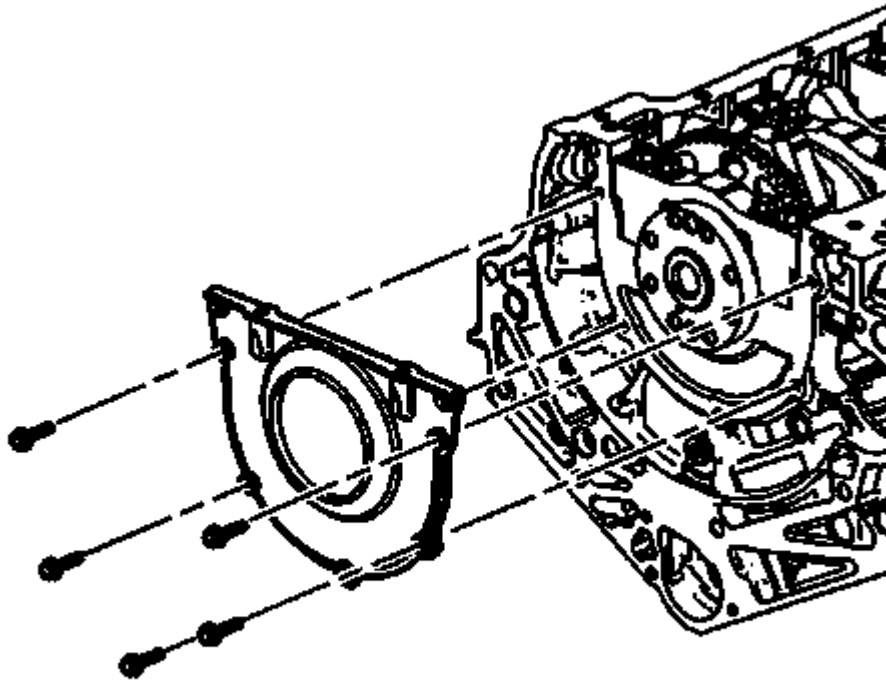


Fig. 185: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

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

OIL PUMP REPLACEMENT

Removal Procedure

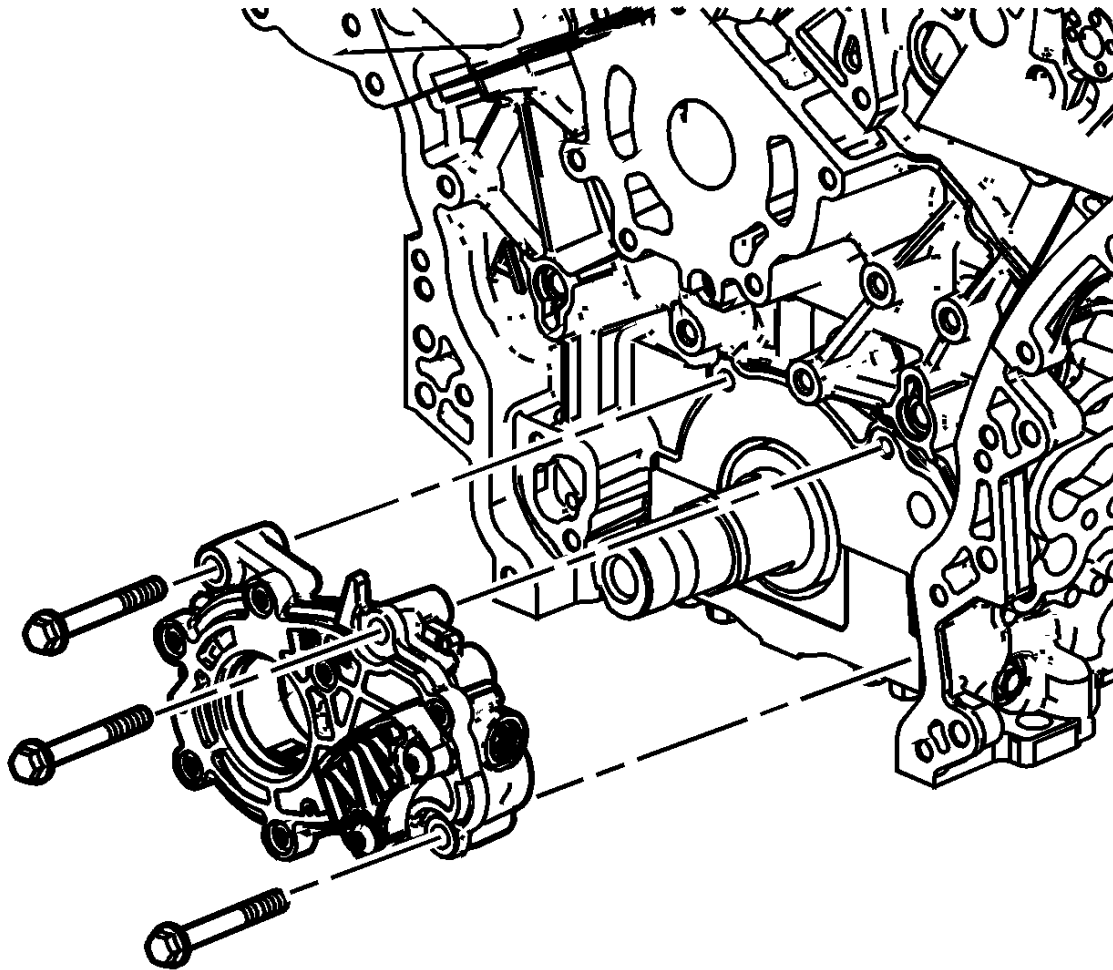


Fig. 186: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove the left bank idler sprocket.

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

Installation Procedure

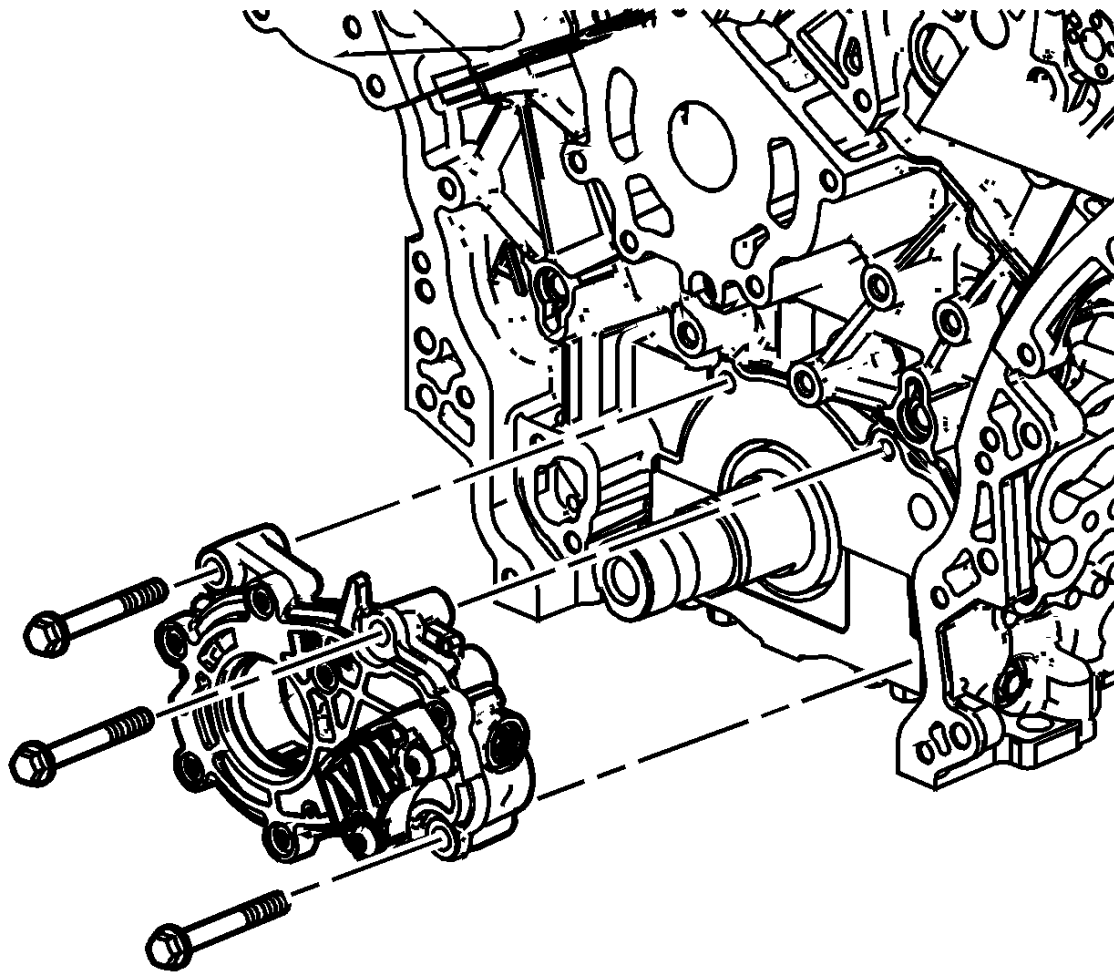


Fig. 187: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

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

OIL PAN REPLACEMENT

Special Tools

EN-46109 Guide Pin Set

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

Removal Procedure

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

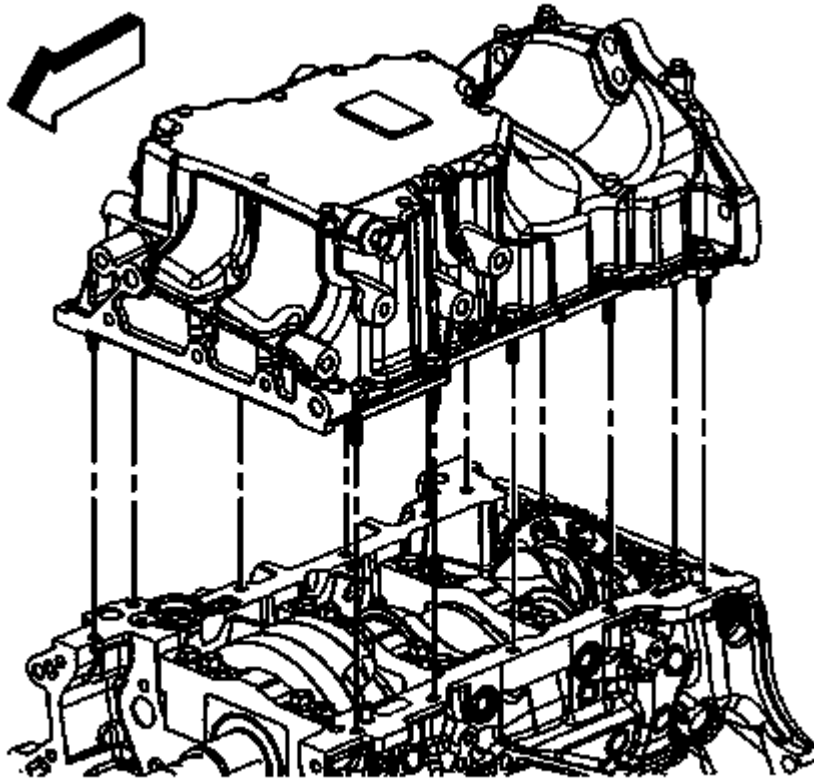


Fig. 188: Removing/Installing Oil Pan
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

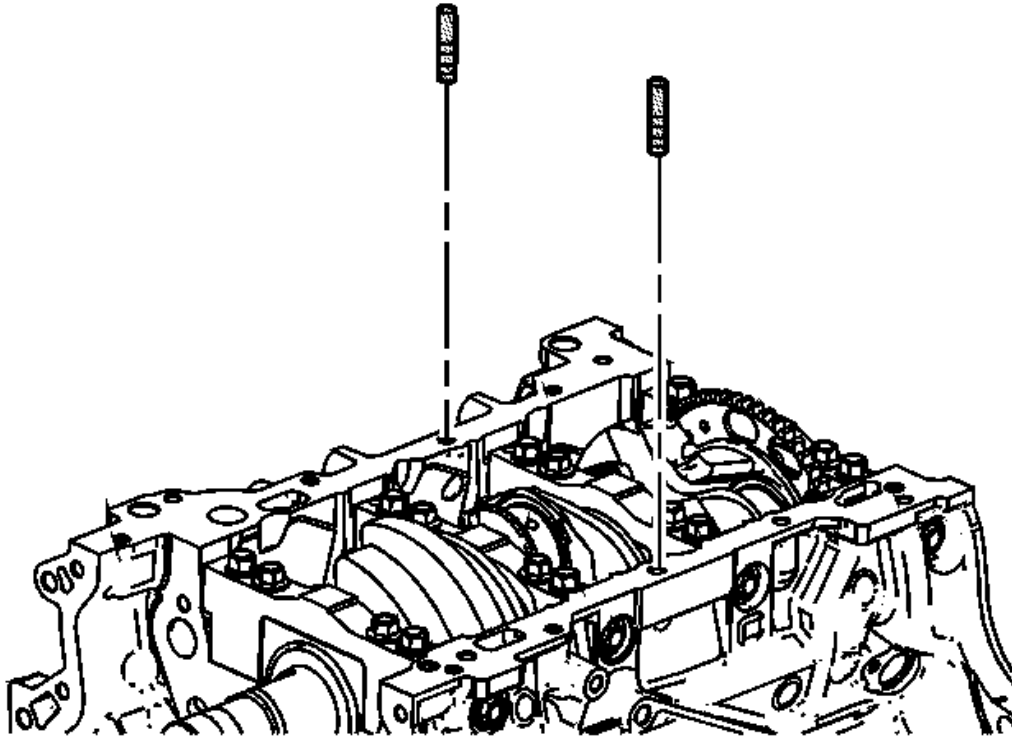


Fig. 189: Identifying Guide Pin Set
Courtesy of GENERAL MOTORS COMPANY

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

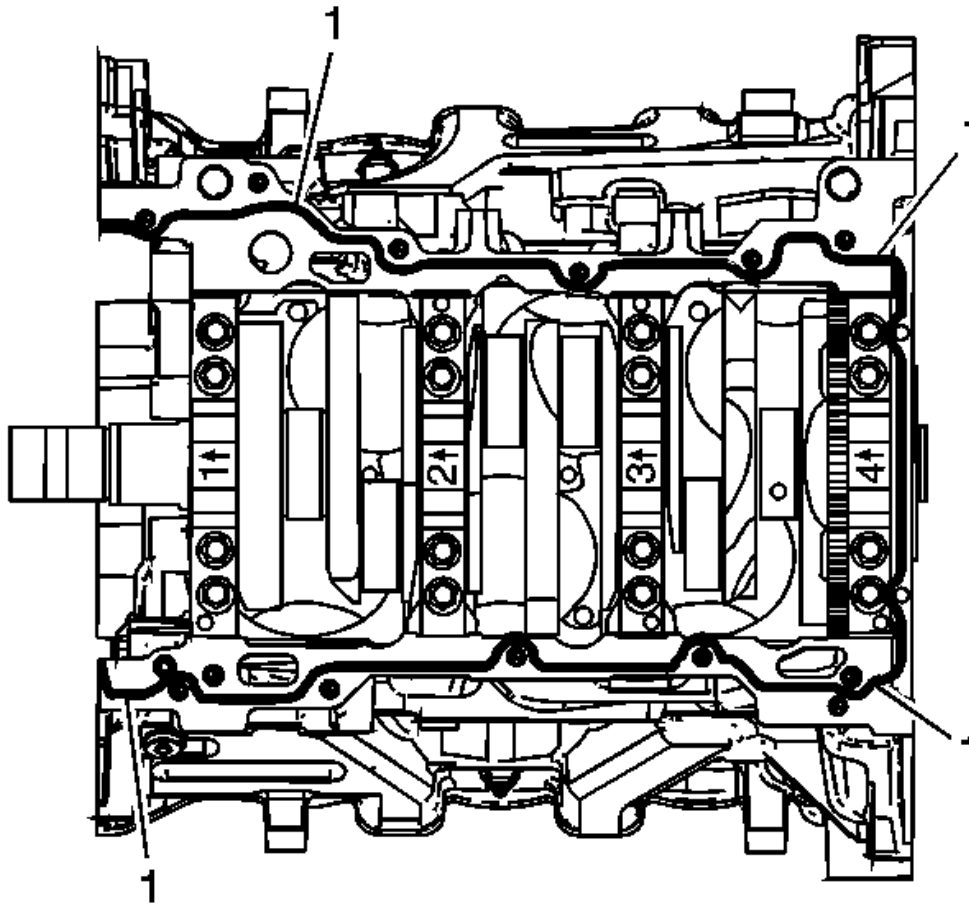


Fig. 190: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

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

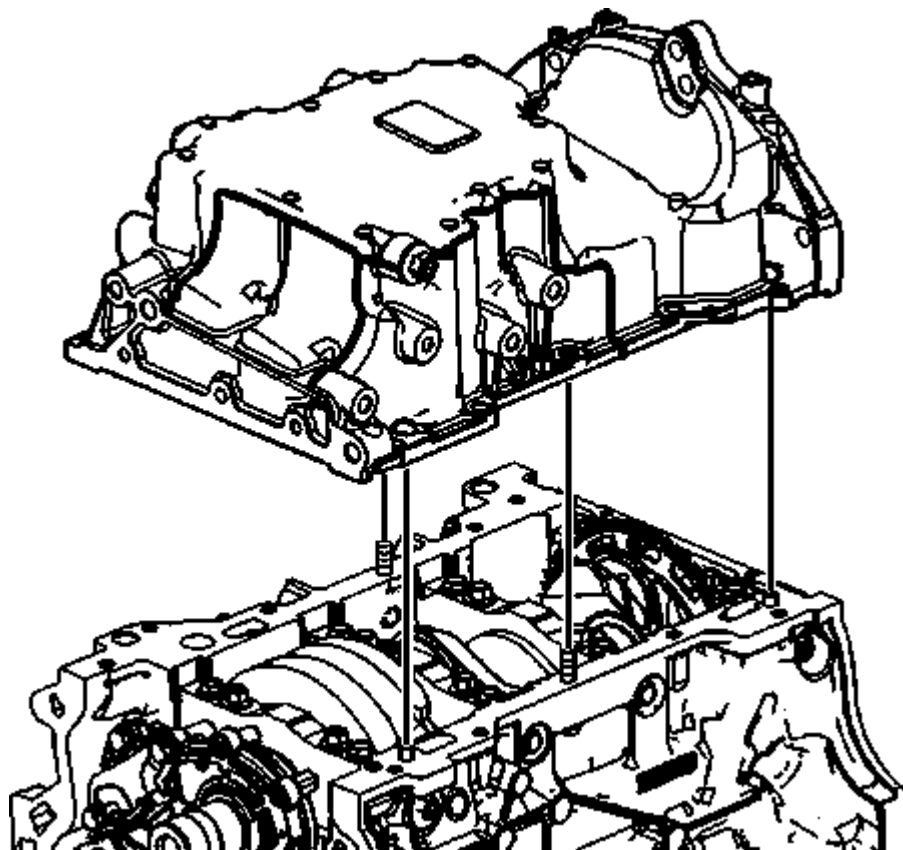


Fig. 191: Removing/Installing Oil Pan

Courtesy of GENERAL MOTORS COMPANY

3. Position the oil pan onto the block.

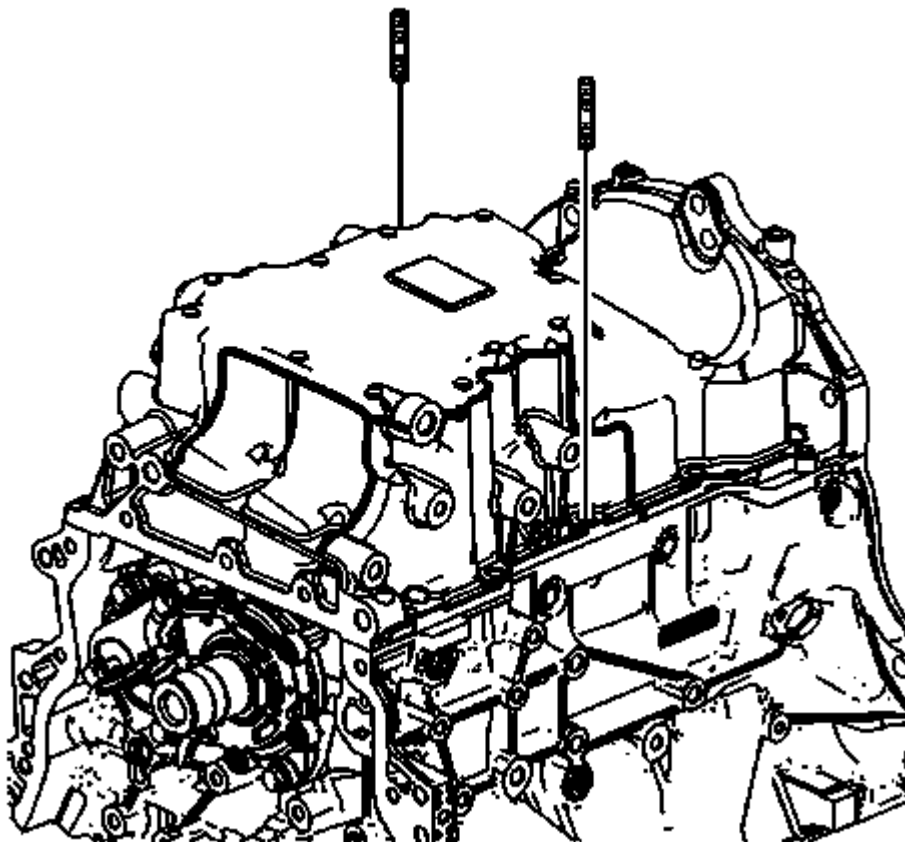


Fig. 192: View Of Engine Block Guides
Courtesy of GENERAL MOTORS COMPANY

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

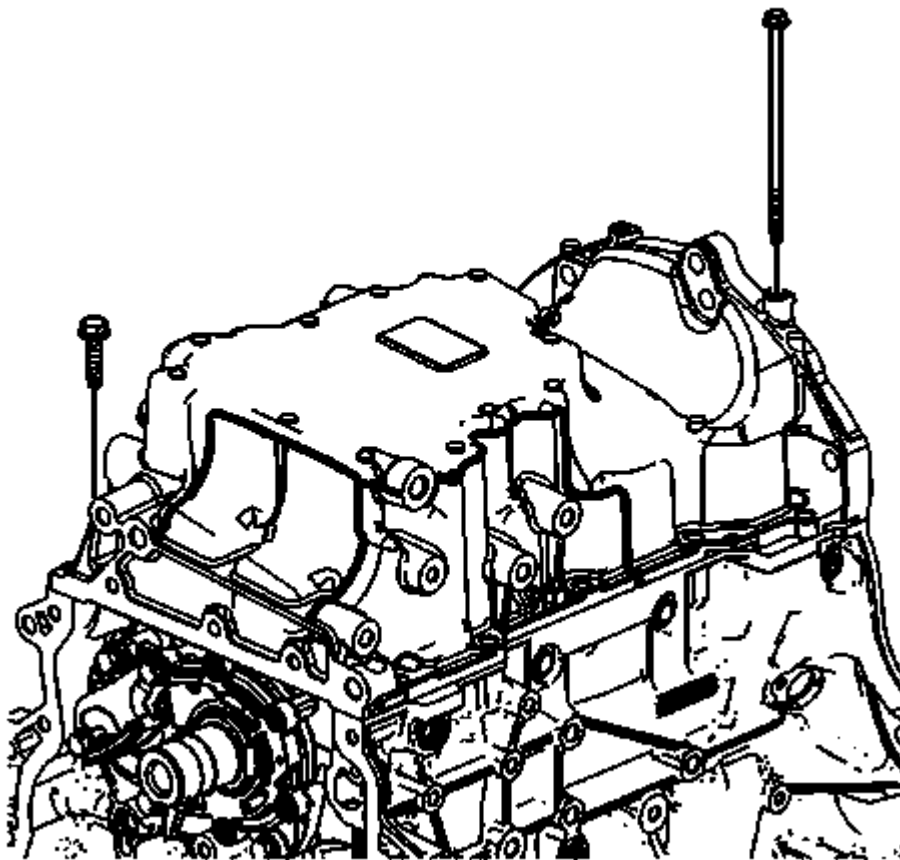


Fig. 193: Locating Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the oil pan bolts.

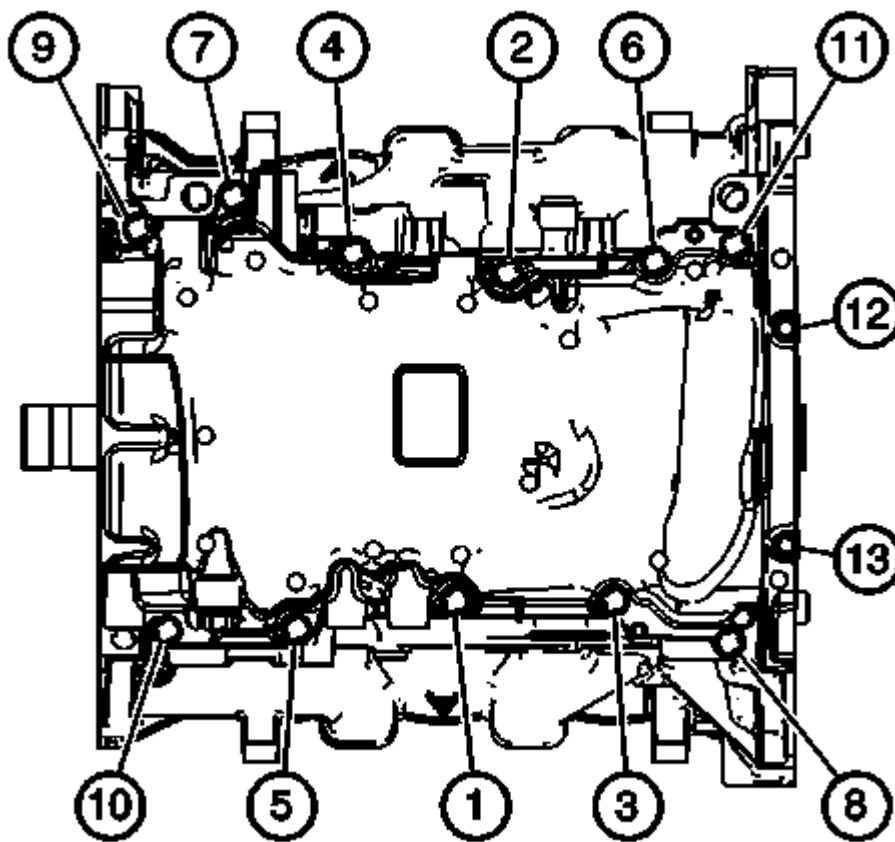


Fig. 194: Identifying Oil Pan Bolts - Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

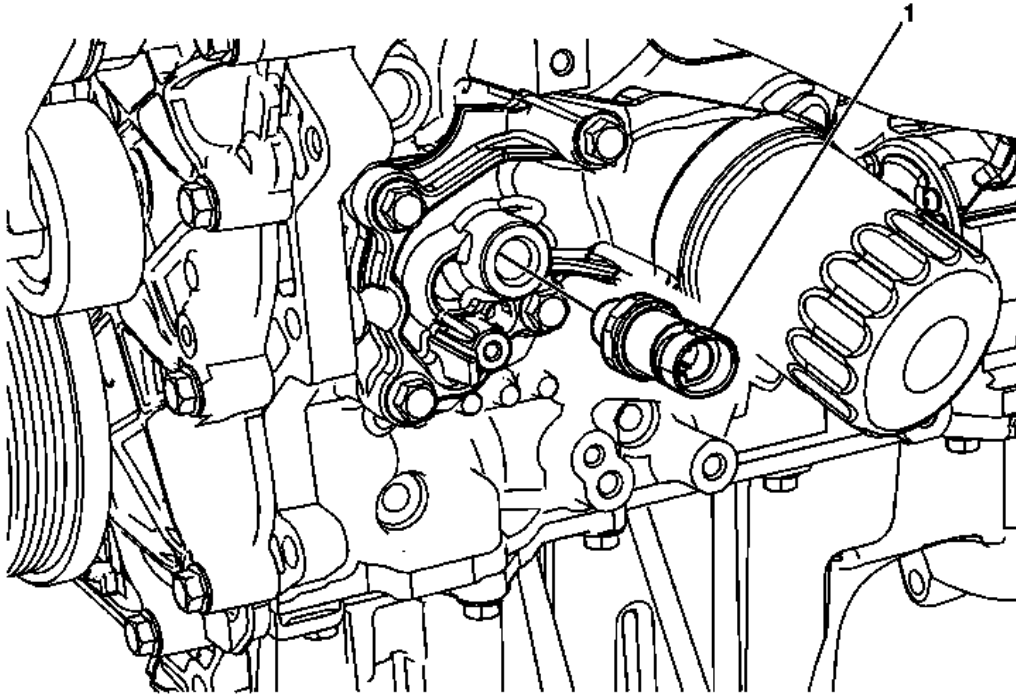


Fig. 195: Identifying Engine Oil Pressure Sensor And/Or Switch (LF1, LFW or LFX)

Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Sensor and/or Switch Replacement

Callout	Component Name
Preliminary Procedure	
Remove the generator. Refer to <u>Generator Replacement (V6)</u> .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure 1. Disconnect the oil pressure sensor electrical connector. 2. Transfer components as necessary. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to <u>Special Tools</u> .

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

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

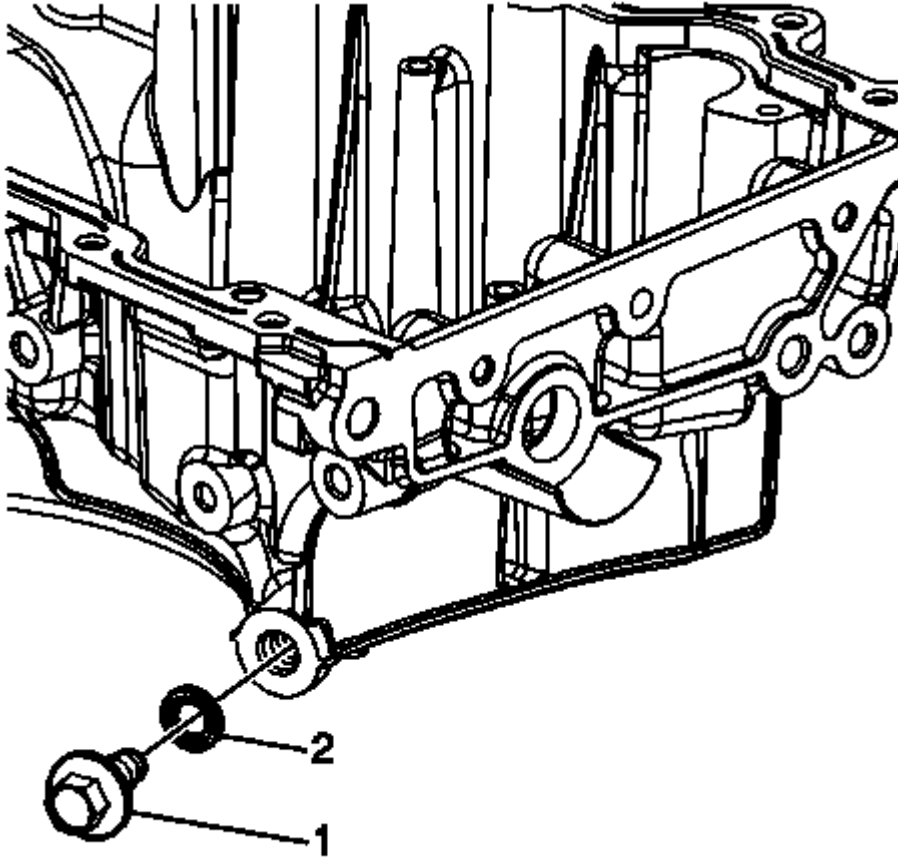


Fig. 196: Oil Pan Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan drain plug (1) and seal (2).

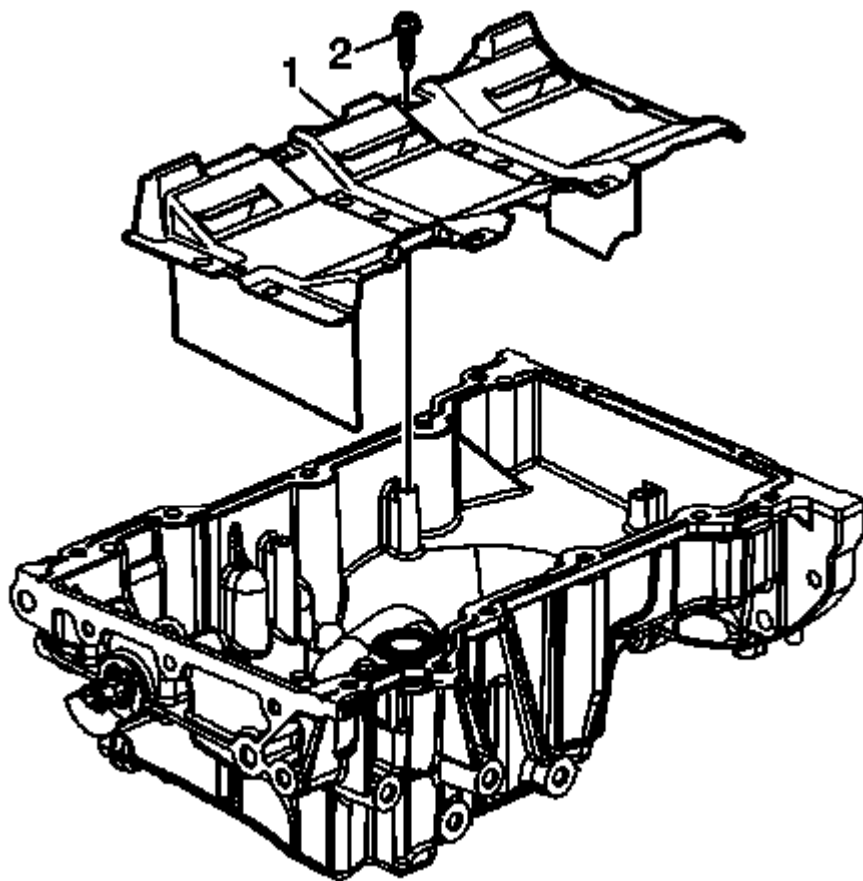


Fig. 197: Oil Pan Scraper

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan scraper bolts (2).
4. Remove the oil pan scraper (1).

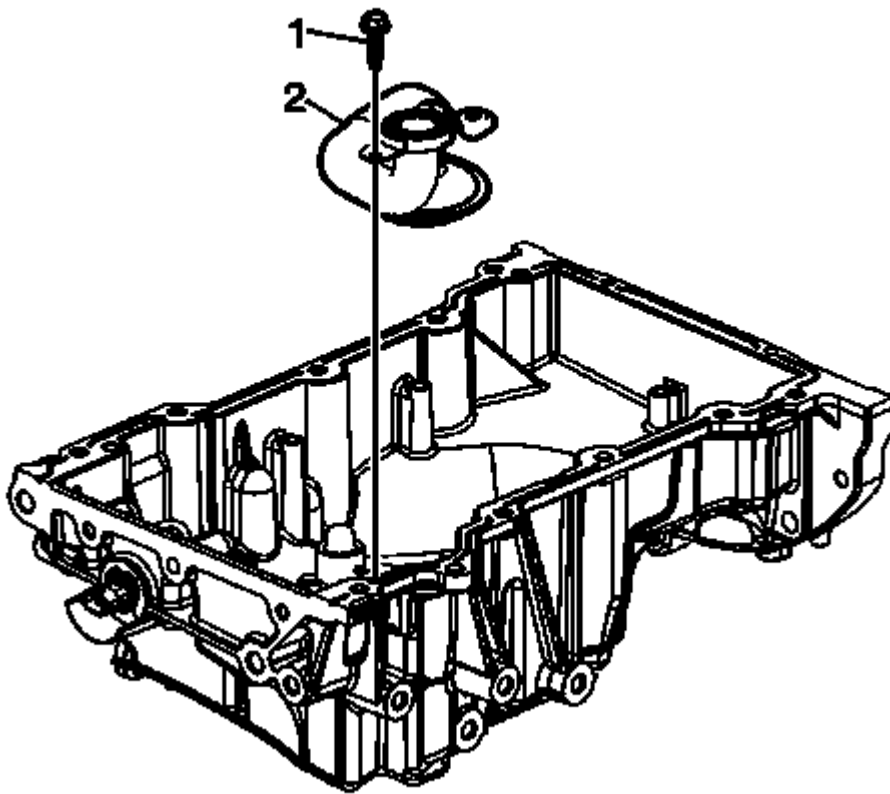


Fig. 198: Oil Suction Pipe Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil suction pipe bolts (1).
6. Remove the oil suction pipe (2).

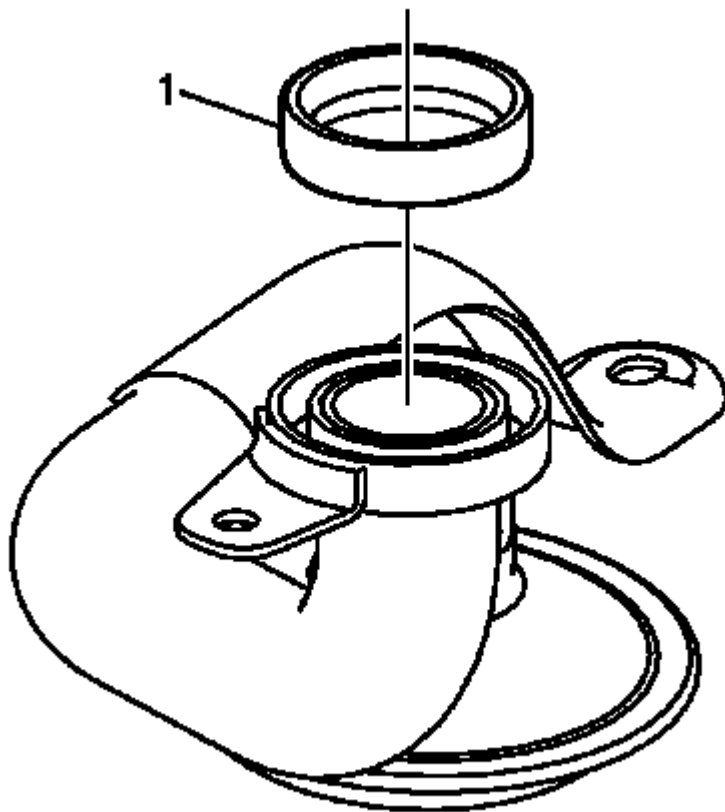


Fig. 199: Oil Suction Pipe Seal

Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil suction pipe seal (1).

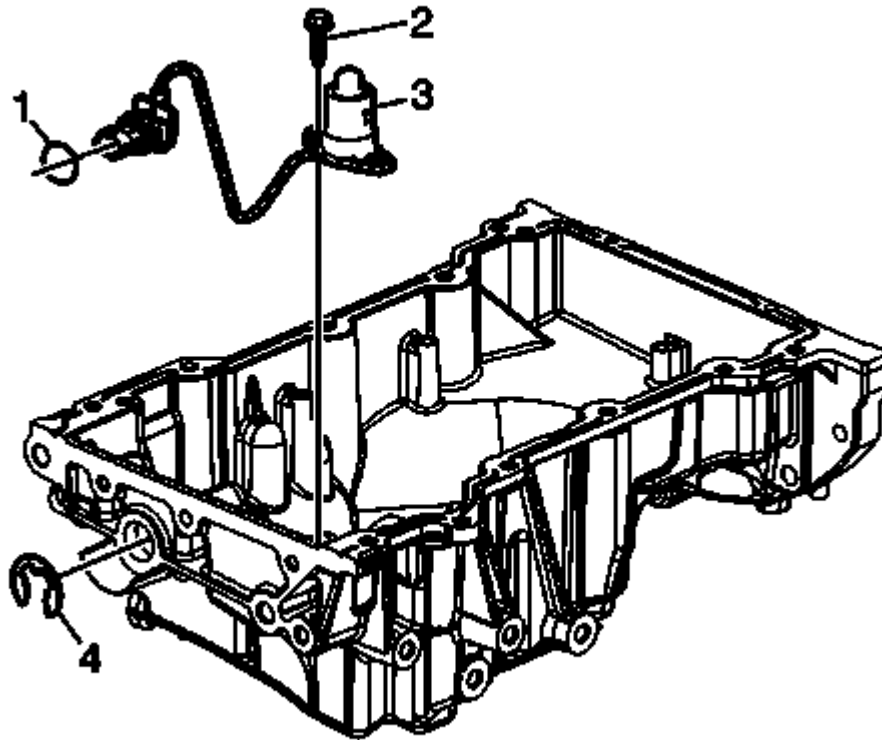


Fig. 200: Engine Oil Level Switch Seal

Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine oil level switch clip (4)
9. Remove the engine oil level switch bolt (2).
10. Remove the engine oil level switch (3).
11. Remove the engine oil level switch seal (1).

Installation Procedure

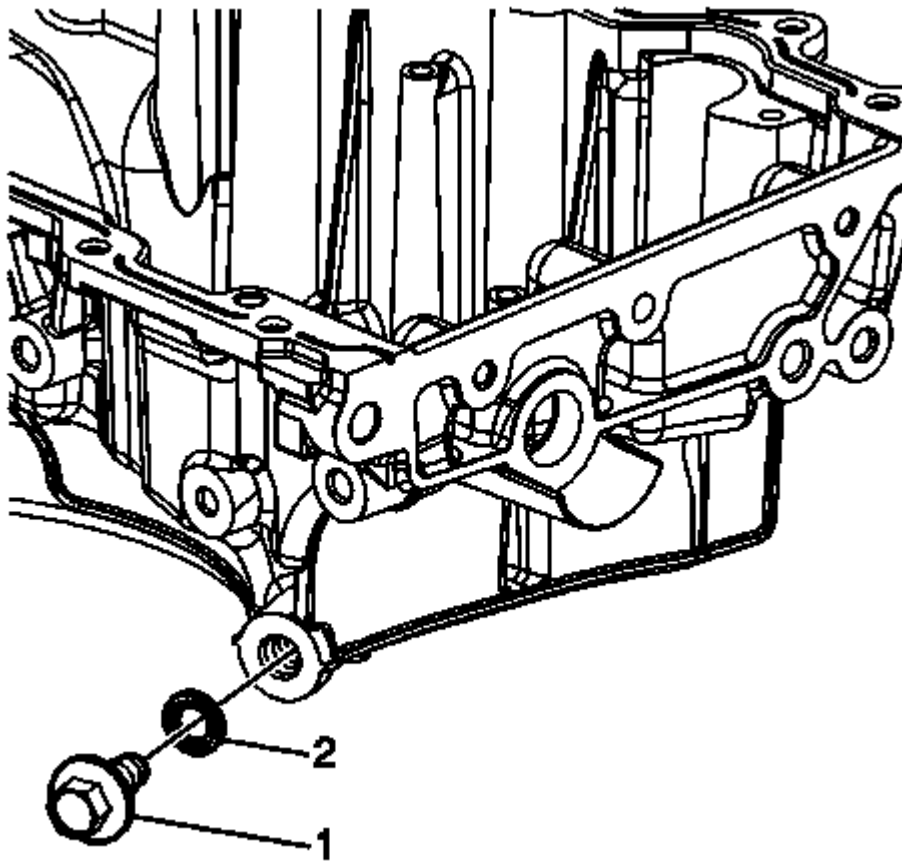


Fig. 201: Oil Pan Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug (1) and NEW O-ring seal (2) and tighten to 25 N.m (18 lb ft).

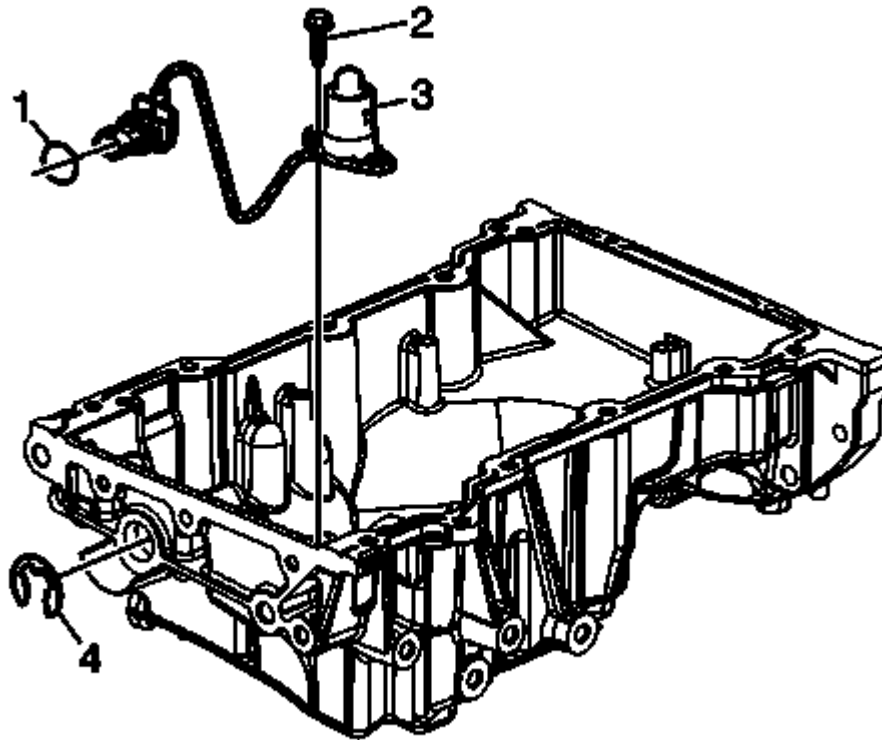


Fig. 202: Engine Oil Level Switch Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW engine oil level switch seal (1).
3. Install the engine oil level switch (3).
4. Install the engine oil level switch bolts (2) and tighten to 10 N.m (89 lb in).
5. Install NEW engine oil level switch clip (4).

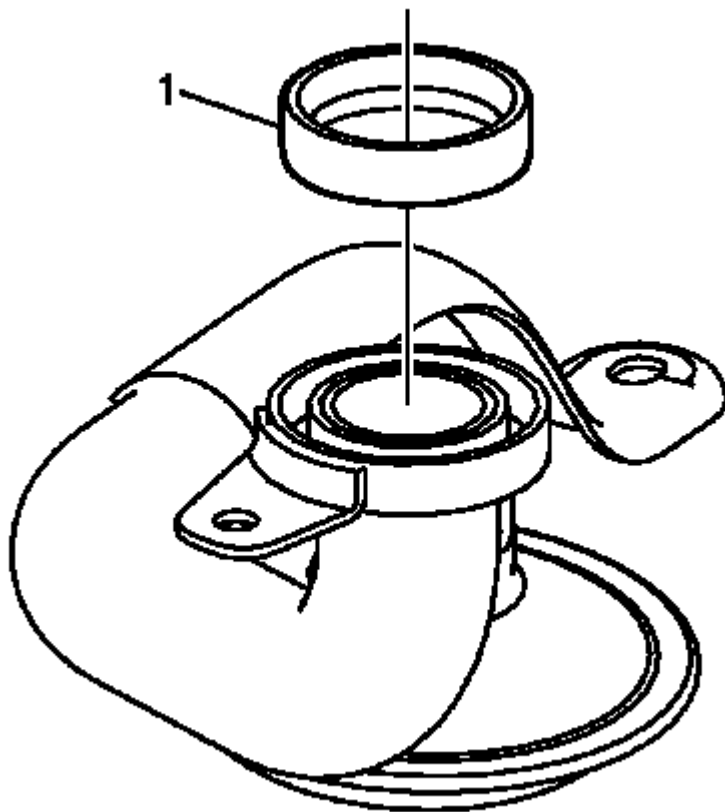


Fig. 203: Oil Suction Pipe Seal

Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW oil suction pipe seal (1).

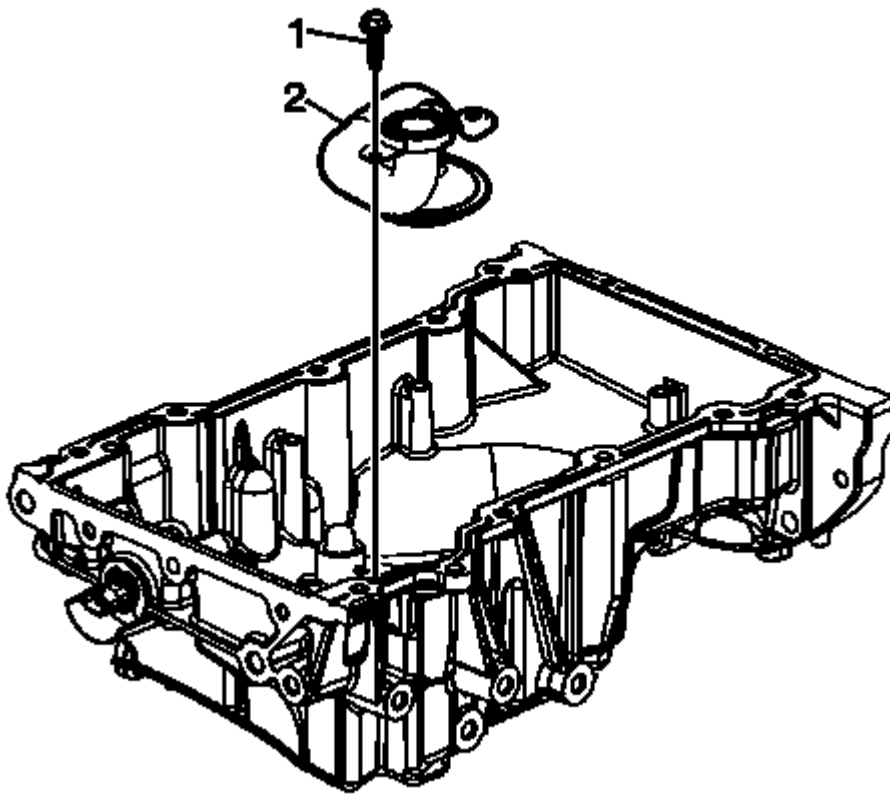


Fig. 204: Oil Suction Pipe Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Install the oil suction pipe (2).
8. Install the oil suction pipe bolts (1) and tighten to 10 N.m (89 lb in).

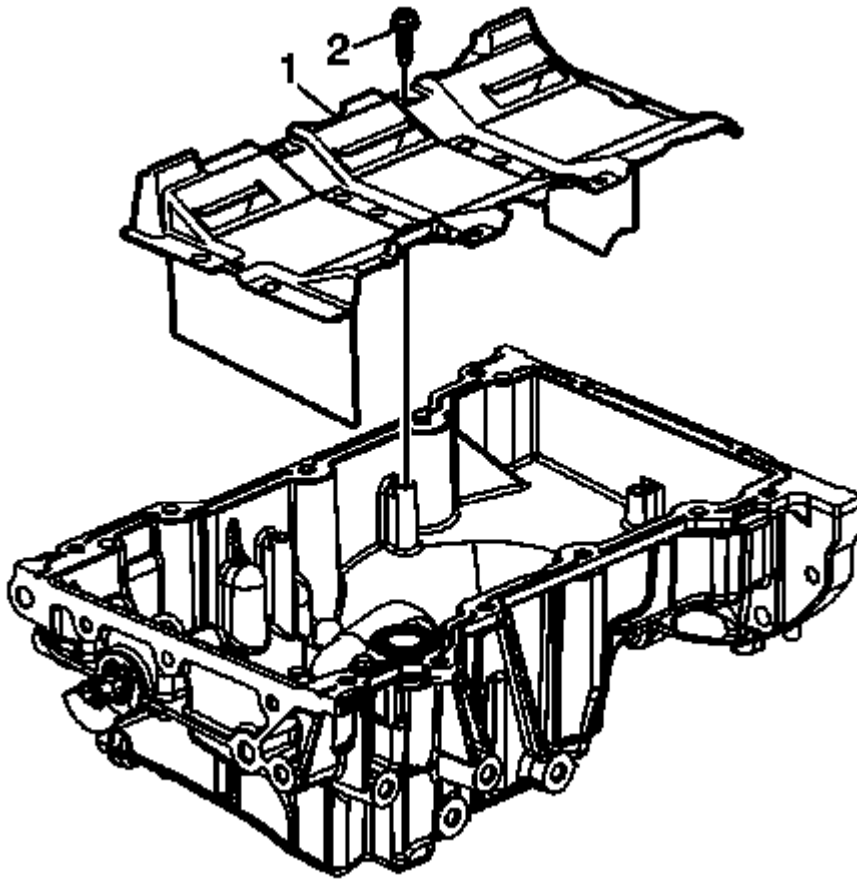


Fig. 205: Oil Pan Scraper

Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pan scraper (1).
10. Install the oil pan scraper bolts (2) and tighten to 10 N.m (89 lb in).
11. Install the oil pan. Refer to **Oil Pan Replacement**.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

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

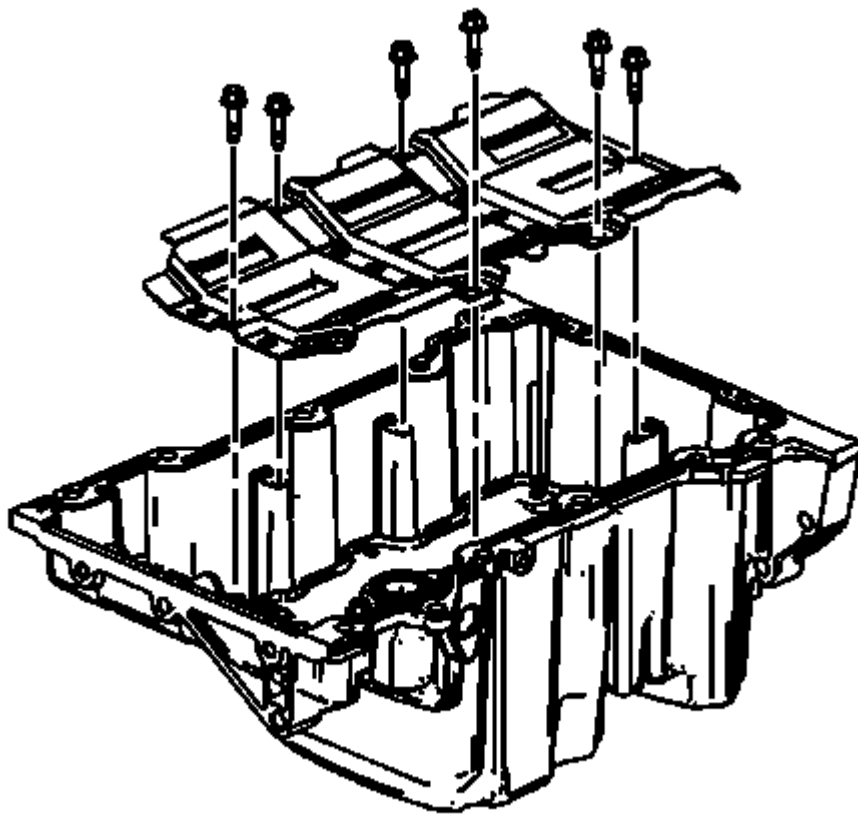


Fig. 206: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS COMPANY

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

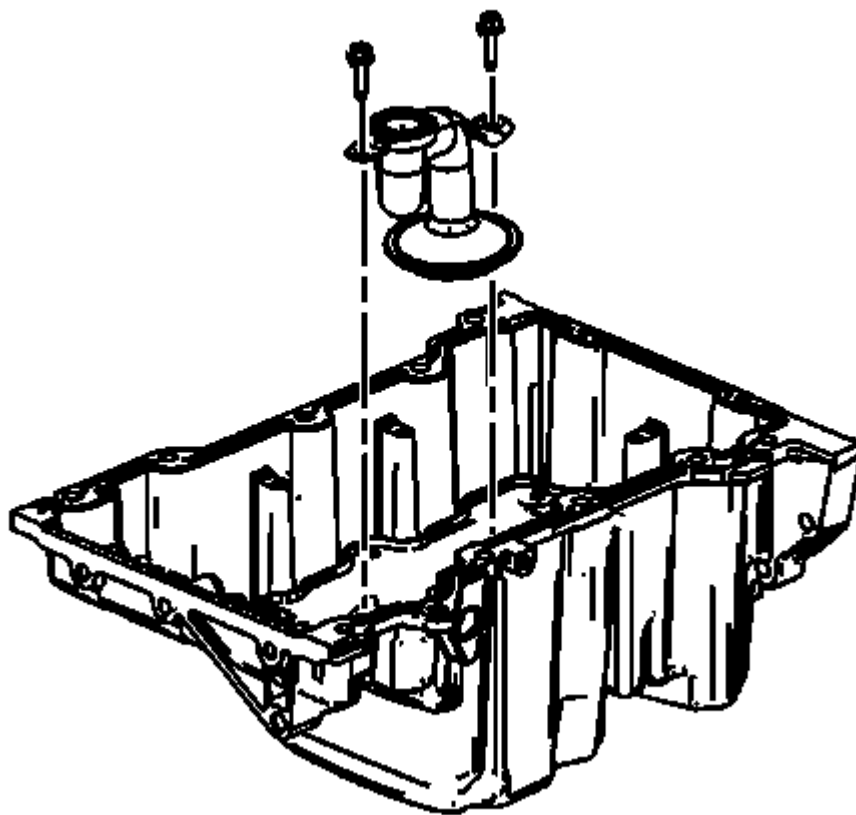


Fig. 207: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

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

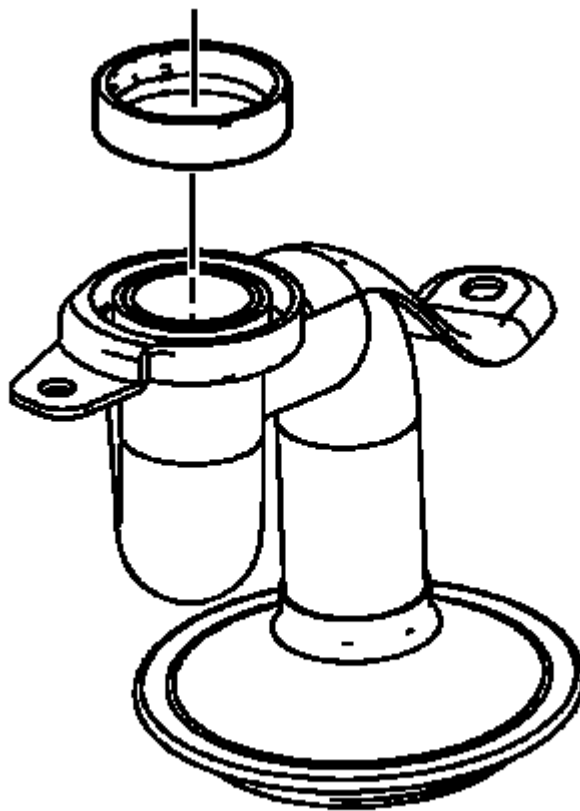


Fig. 208: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

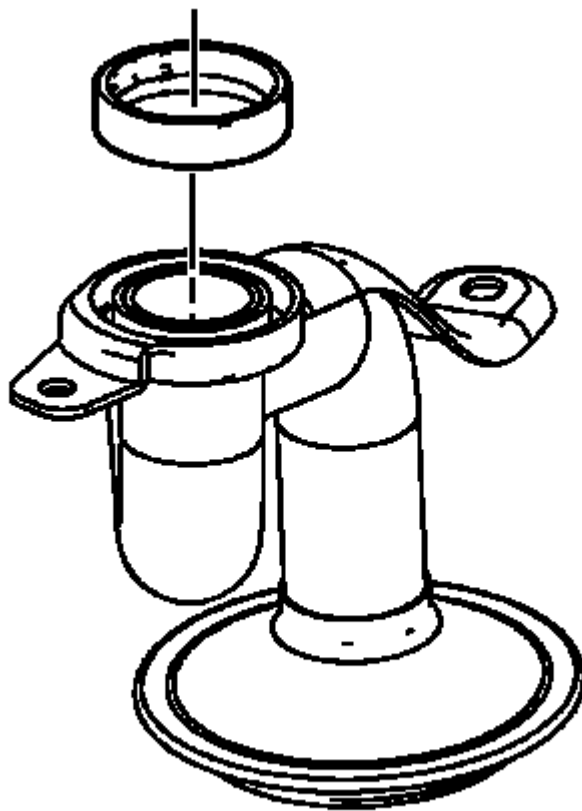


Fig. 209: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS COMPANY

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

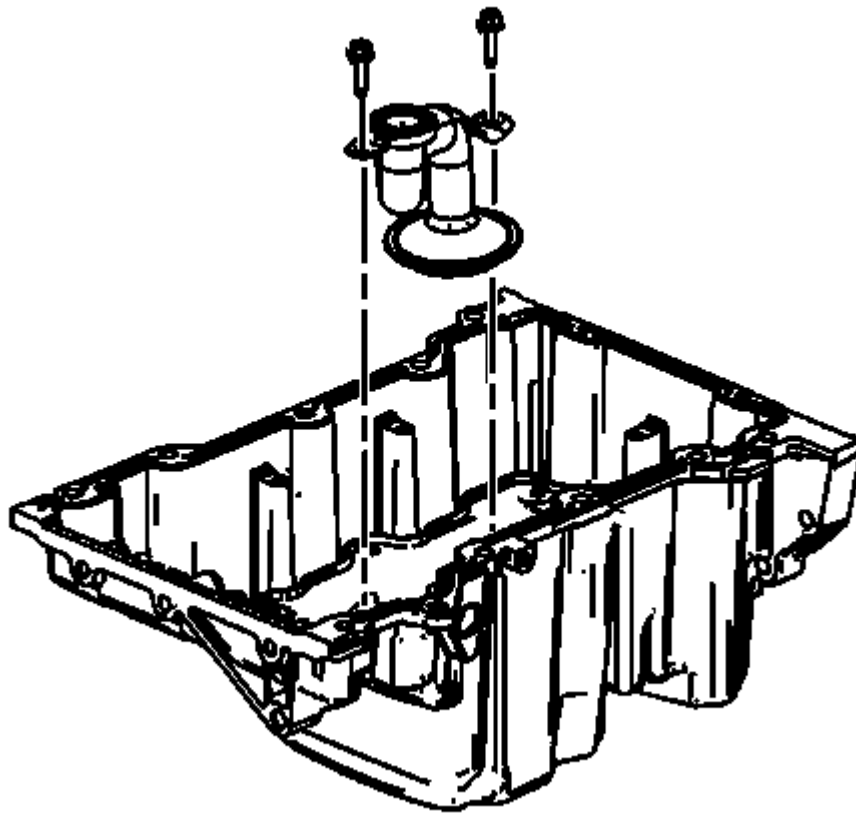


Fig. 210: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe.

CAUTION: Refer to Fastener Caution .

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

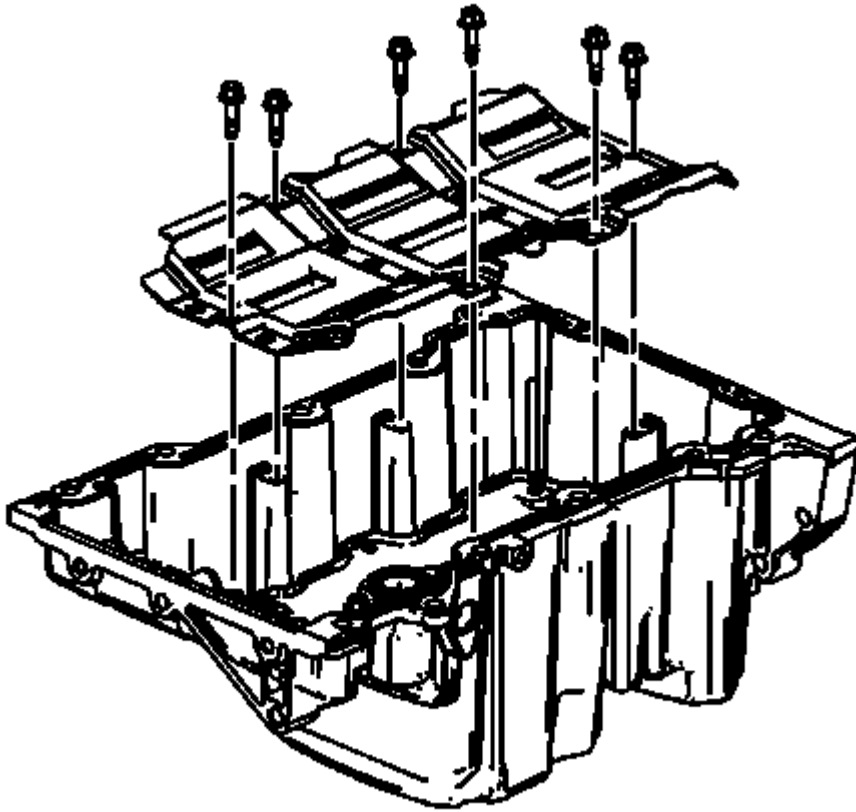


Fig. 211: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS COMPANY

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

ENGINE REPLACEMENT

Removal Procedure

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

8. Disconnect the front knock sensor (KS).

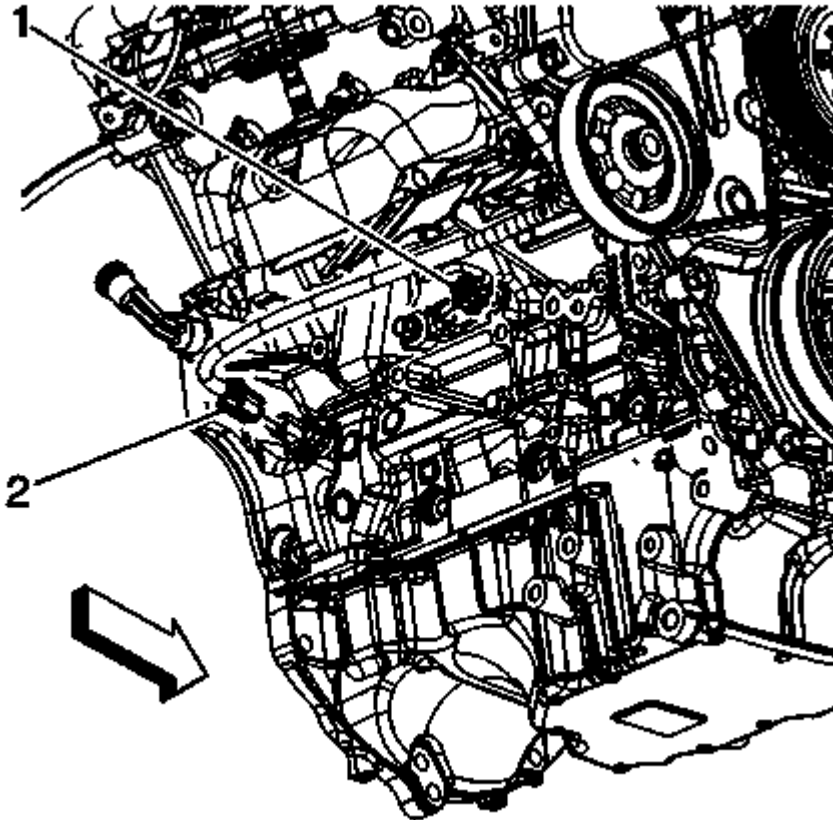


Fig. 212: Identifying CKP Sensor & Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

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

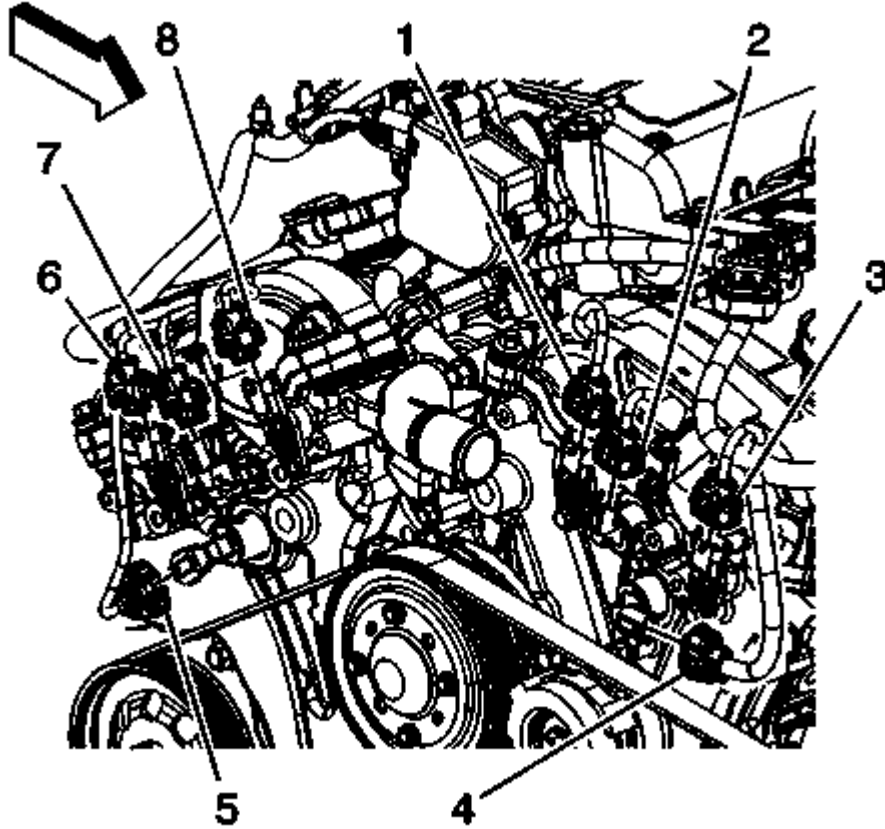


Fig. 213: Identifying Camshaft Position Sensors
 Courtesy of GENERAL MOTORS COMPANY

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

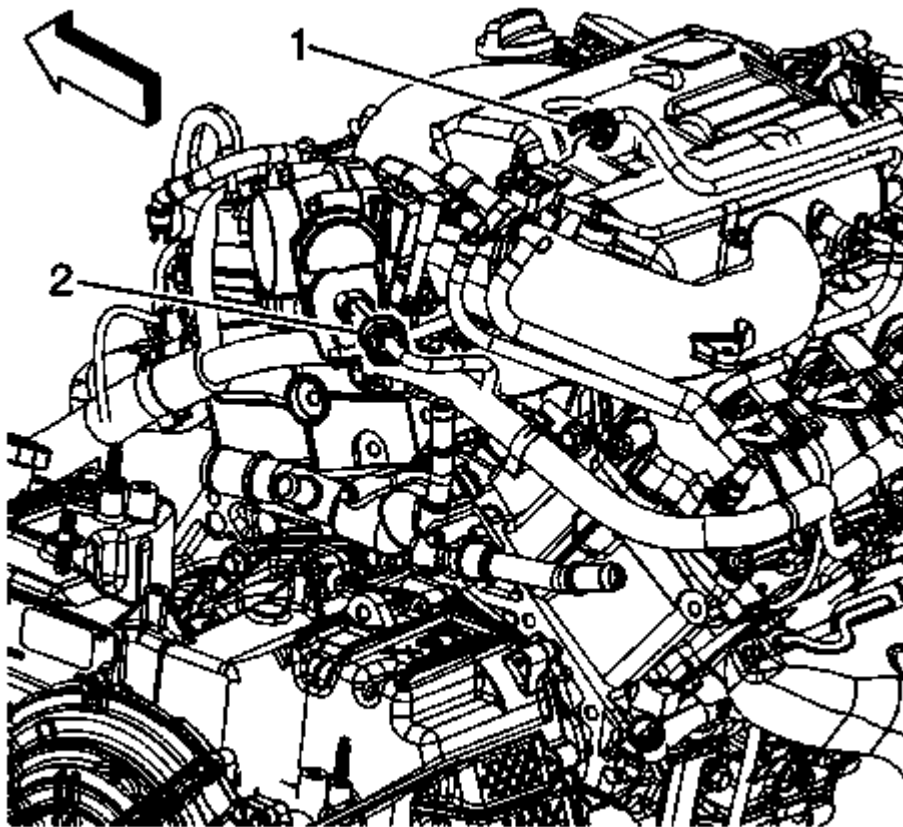


Fig. 214: Identifying MAP Sensor & ETC Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

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

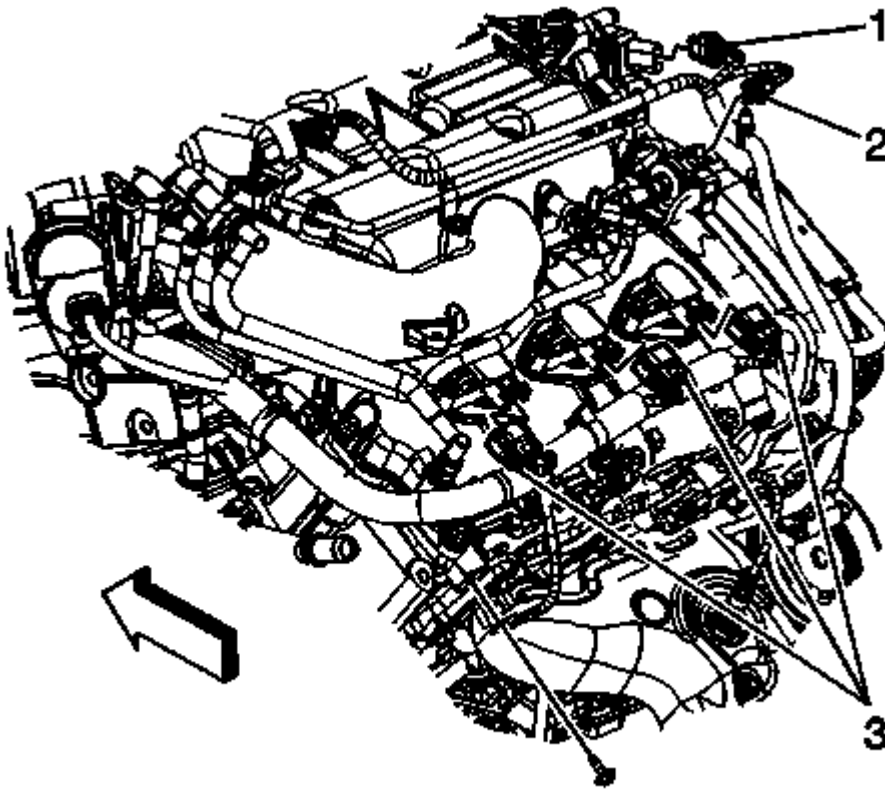


Fig. 215: Identifying EVAP Canister Purge Solenoid, Ignition Coils & Intake Manifold Tuning Valve

Courtesy of GENERAL MOTORS COMPANY

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

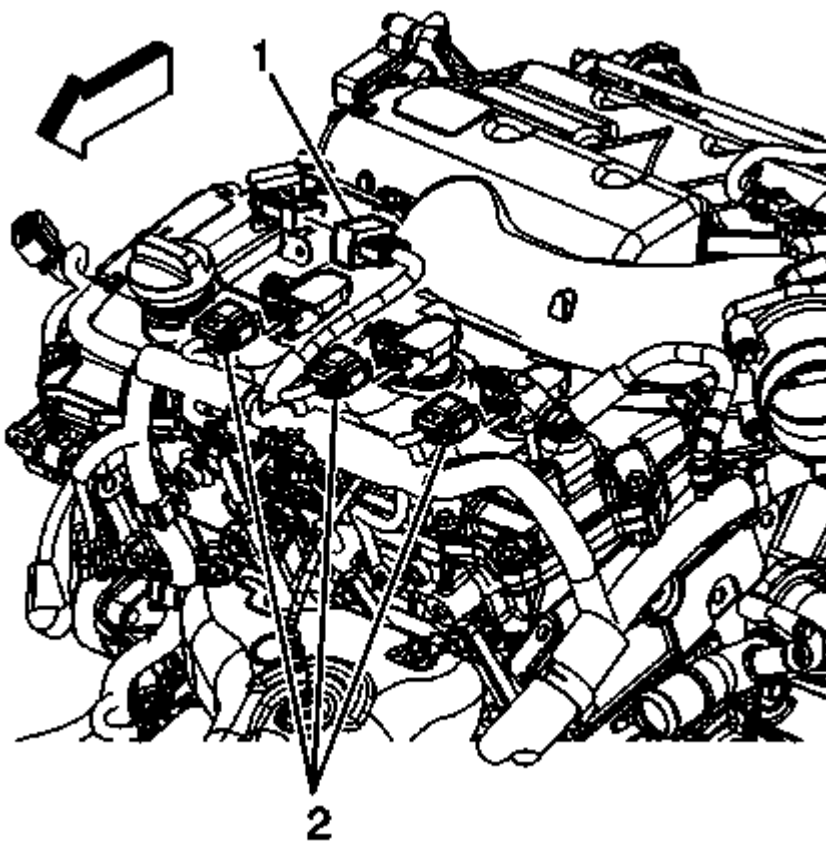


Fig. 216: Identifying Ignition Coils & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

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

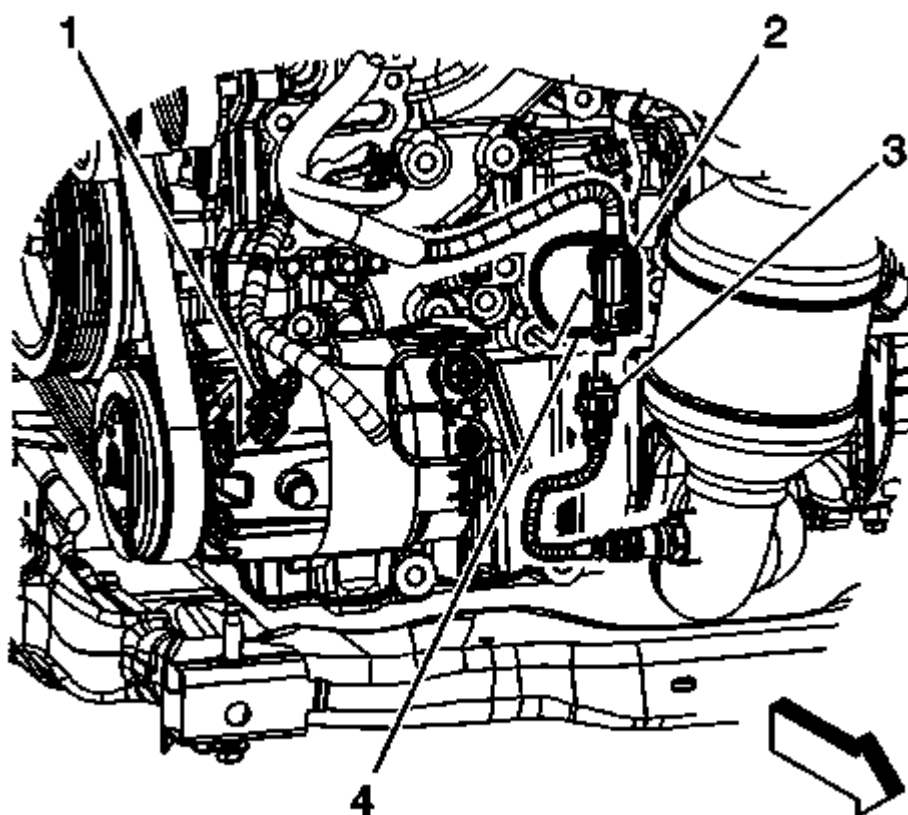


Fig. 217: Electrical Connectors - Left Side
Courtesy of GENERAL MOTORS COMPANY

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

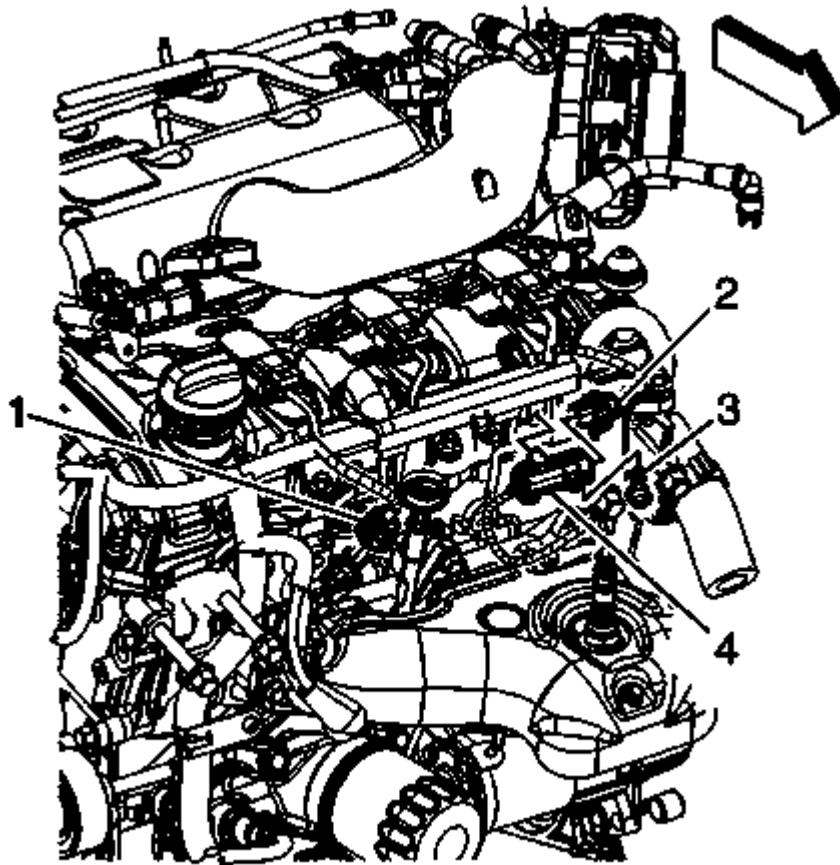


Fig. 218: Identifying ECT & HO2S Wiring Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

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

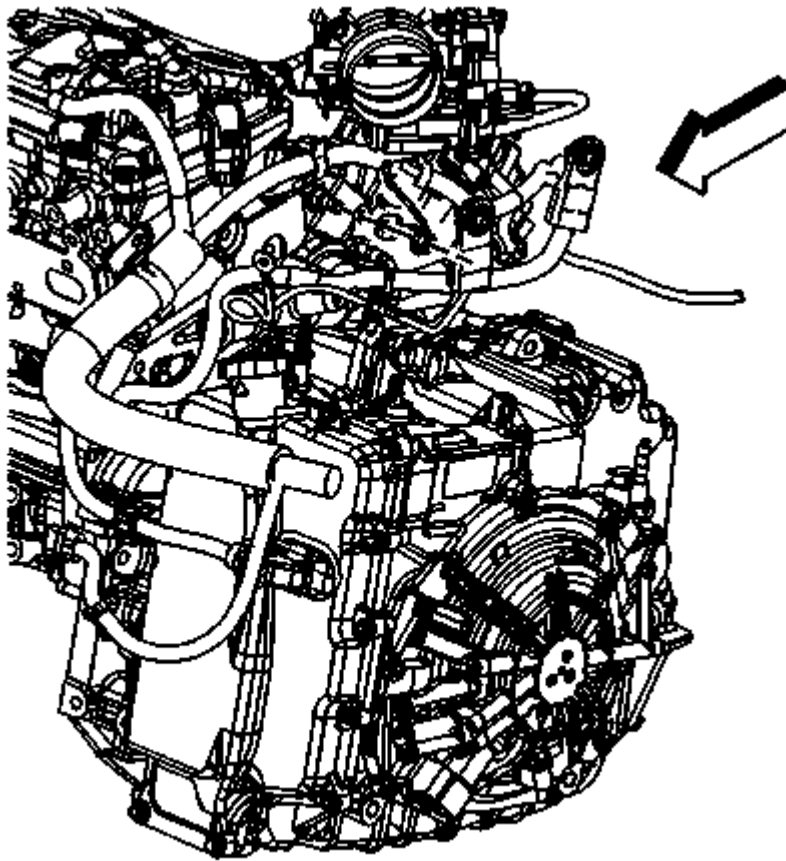


Fig. 219: Identifying Engine Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

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

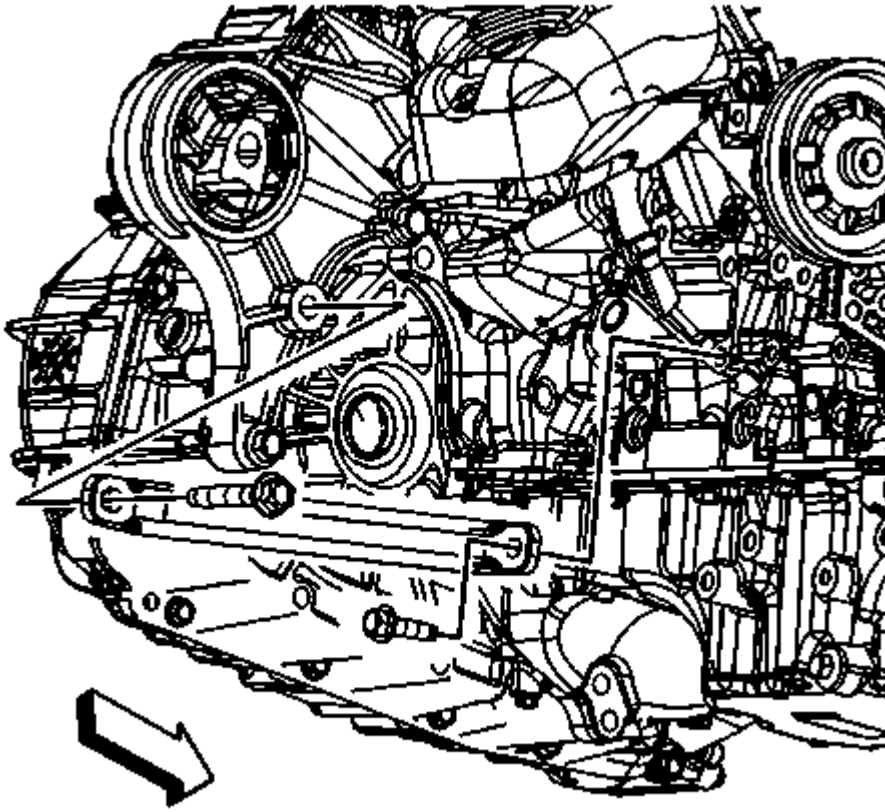


Fig. 220: Identifying Oil Pan Brace Bolt & Brace
Courtesy of GENERAL MOTORS COMPANY

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

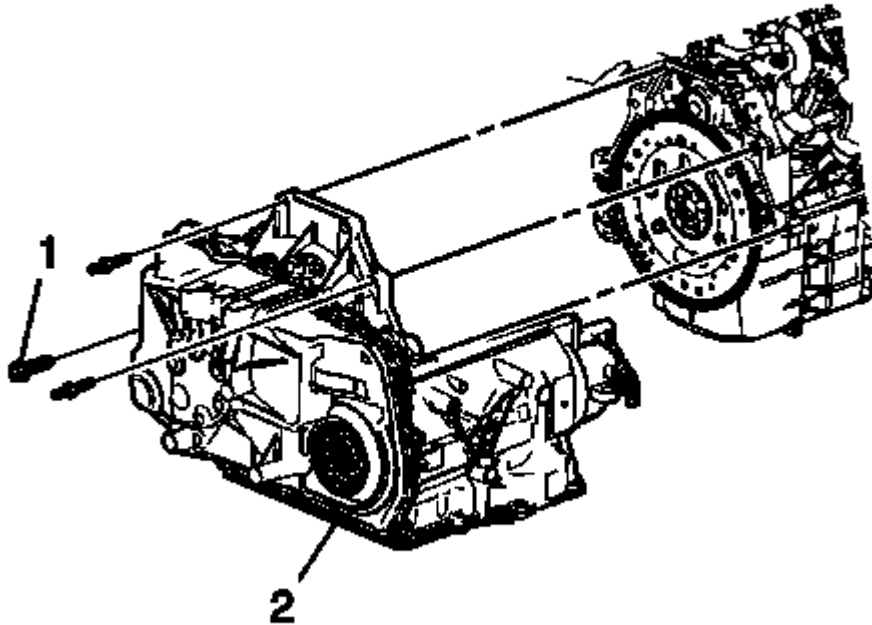


Fig. 221: Transaxle-To-Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

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

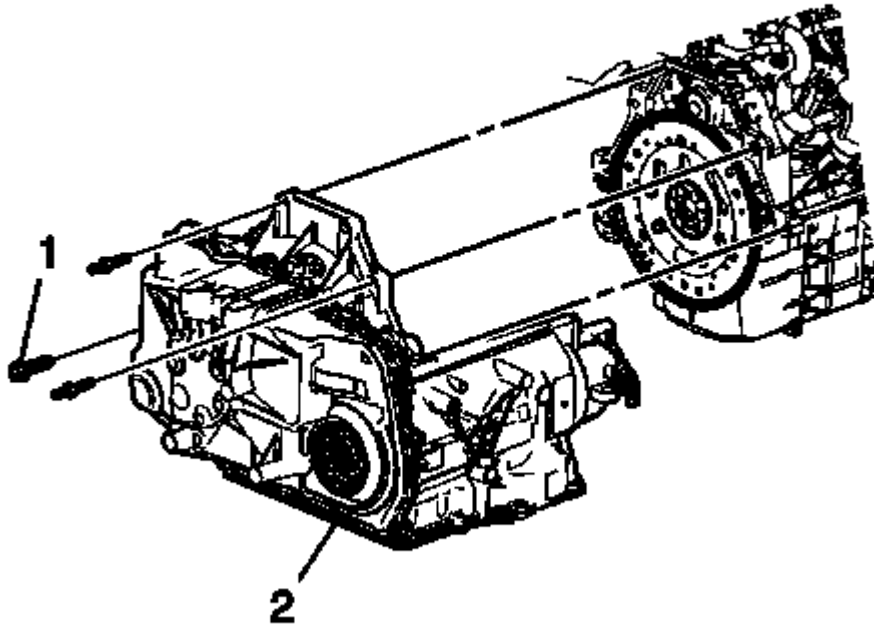
Installation Procedure

Fig. 222: Transaxle-To-Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine from the engine stand.
2. Install the flywheel.
3. Install the engine to the vehicle.

CAUTION: Refer to Fastener Caution .

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

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

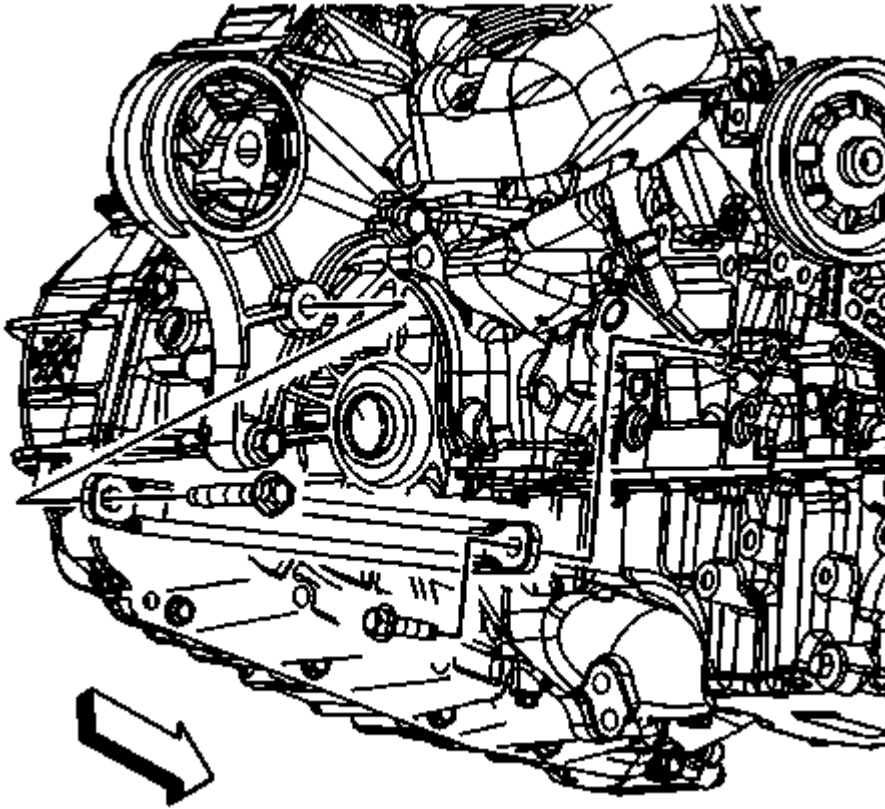


Fig. 223: Identifying Oil Pan Brace Bolt & Brace
Courtesy of GENERAL MOTORS COMPANY

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

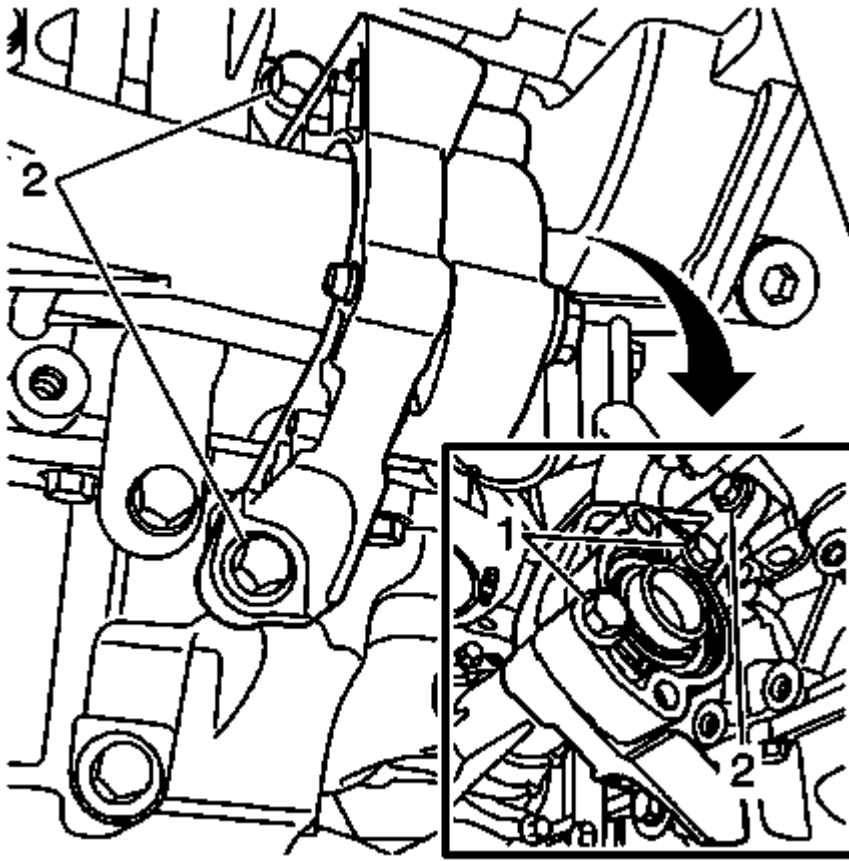


Fig. 224: Transfer Case Bracket And Bolts

Courtesy of GENERAL MOTORS COMPANY

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

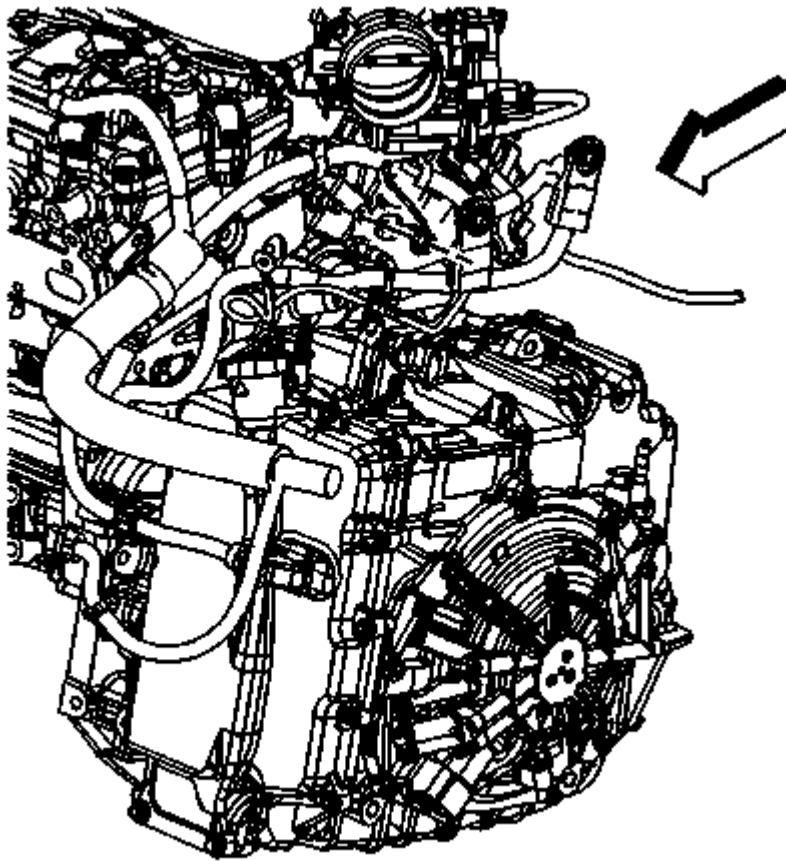


Fig. 225: Identifying Engine Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

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

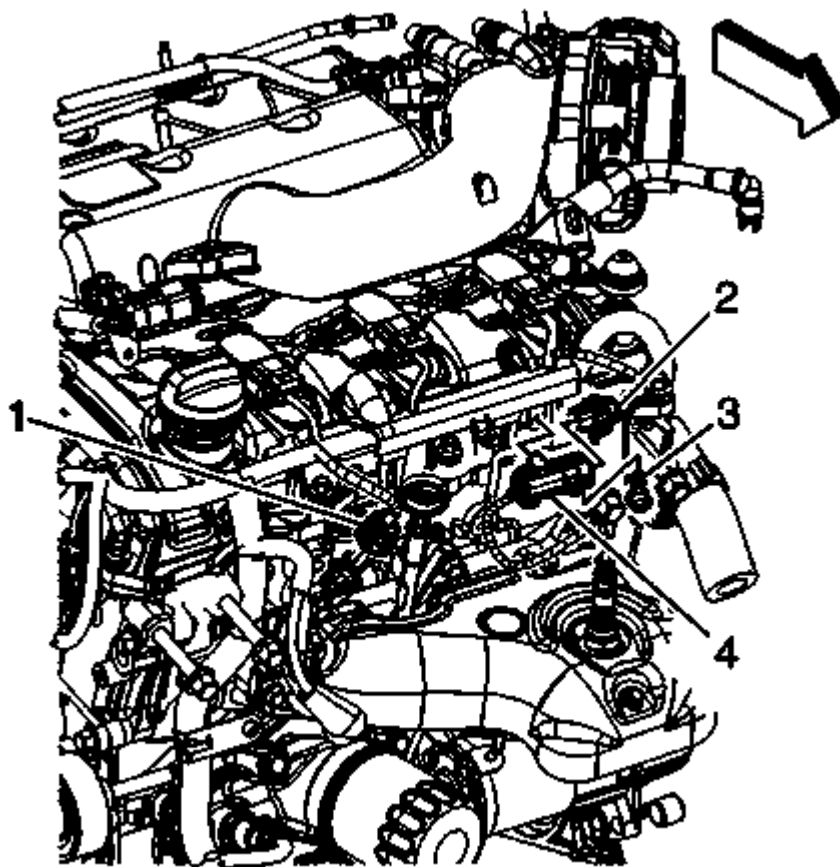


Fig. 226: Identifying ECT & HO2S Wiring Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

29. Connect the coolant temperature sensor (1).

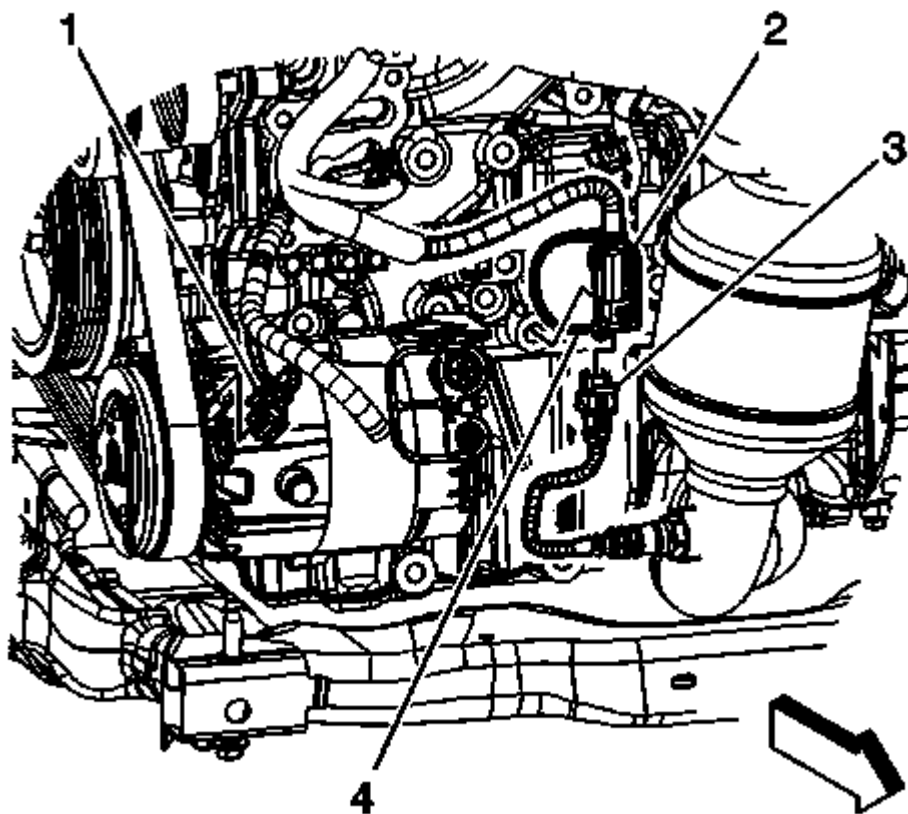


Fig. 227: Electrical Connectors - Left Side
Courtesy of GENERAL MOTORS COMPANY

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

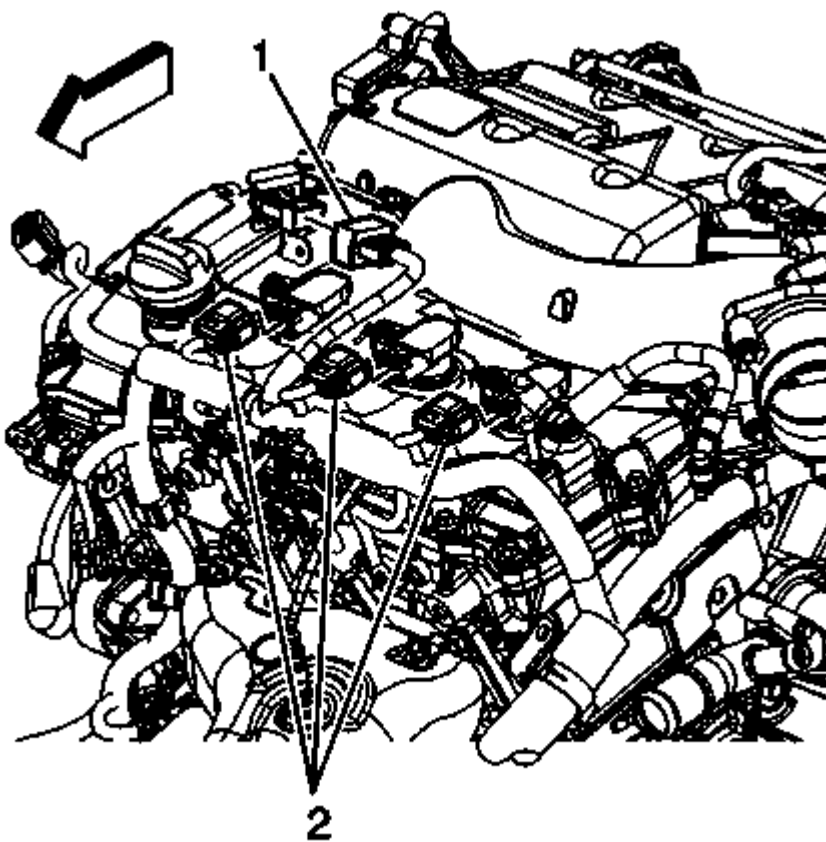


Fig. 228: Identifying Ignition Coils & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

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

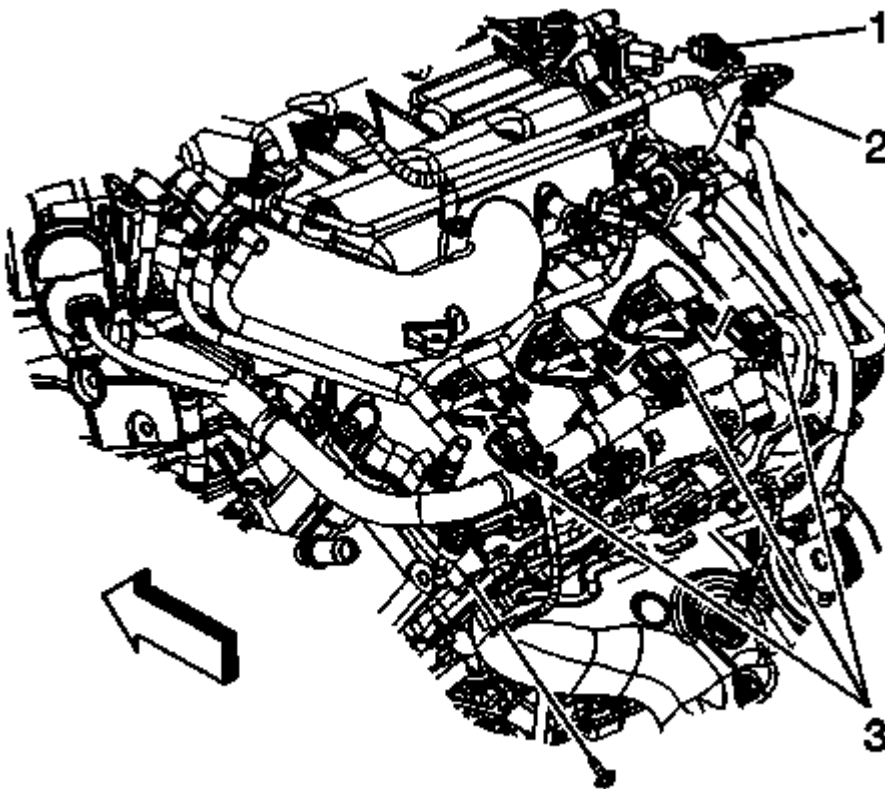


Fig. 229: Identifying EVAP Canister Purge Solenoid, Ignition Coils & Intake Manifold Tuning Valve

Courtesy of GENERAL MOTORS COMPANY

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

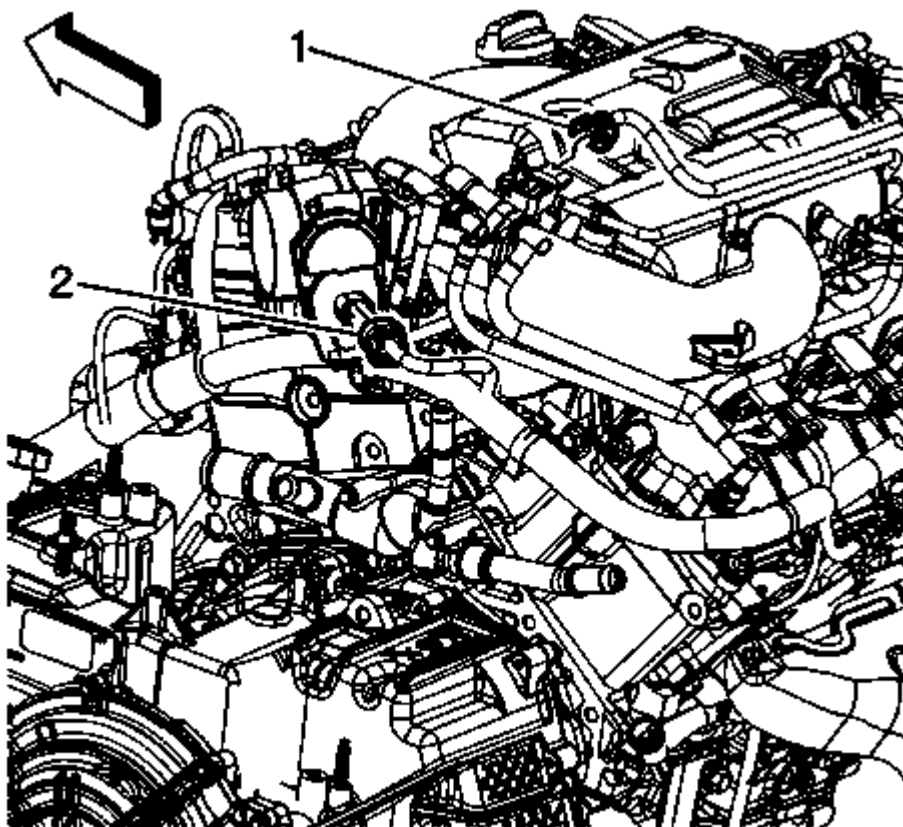


Fig. 230: Identifying MAP Sensor & ETC Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

33. Connect the MAP sensor (1).

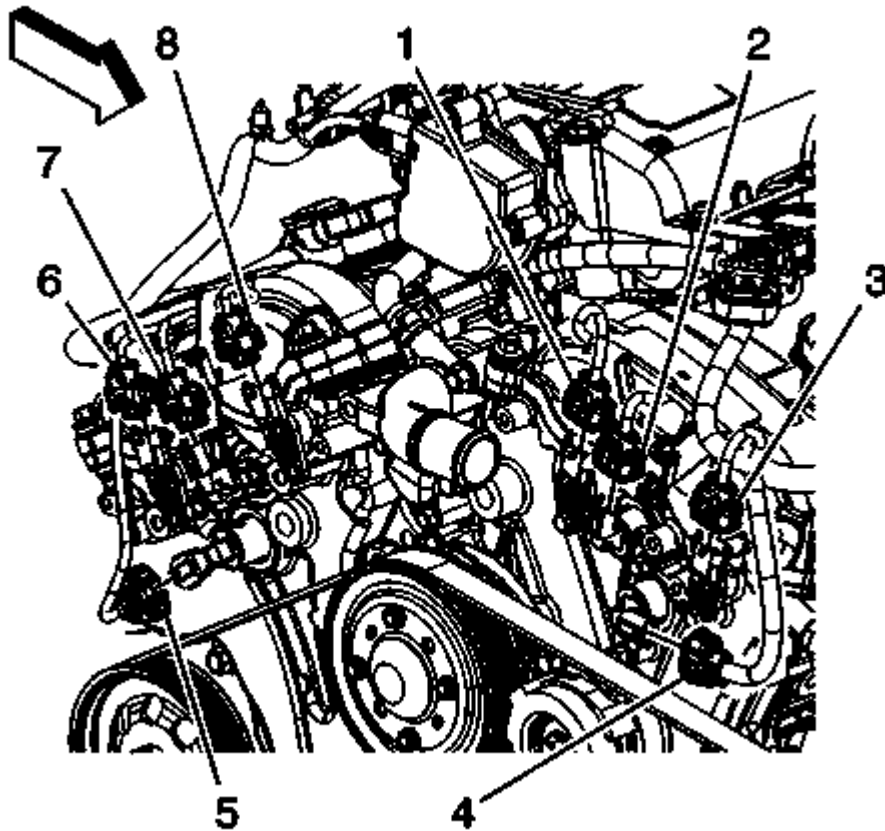


Fig. 231: Identifying Camshaft Position Sensors
Courtesy of GENERAL MOTORS COMPANY

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

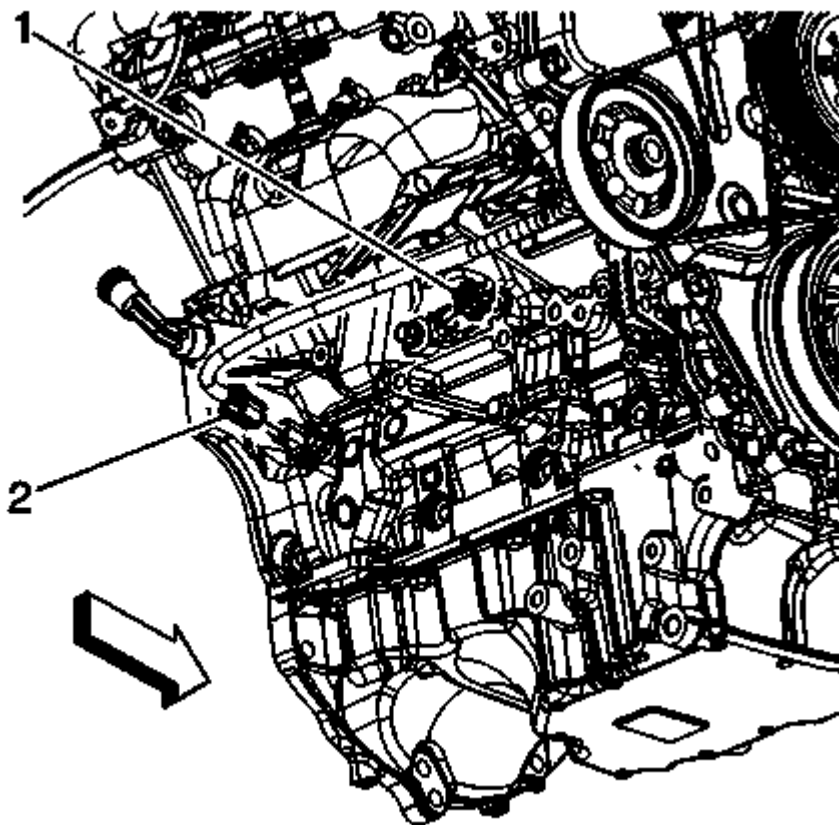


Fig. 232: Identifying CKP Sensor & Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

35. Connect the rear KS (1).

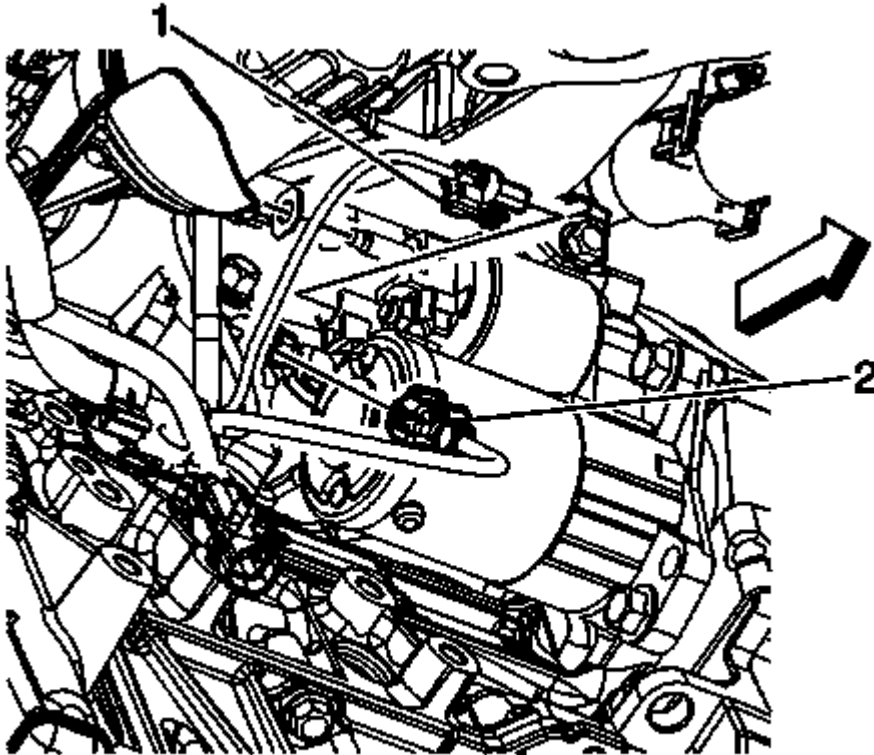


Fig. 233: Identifying Front Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

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

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

Removal Procedure

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

CAUTION: Refer to **Fastener Caution** .

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

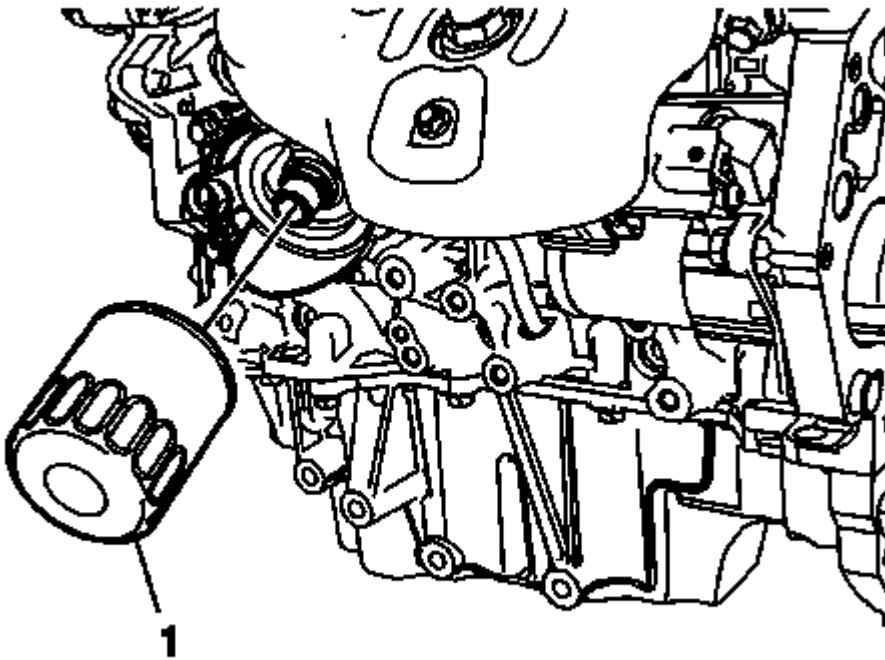


Fig. 234: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

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

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

Installation Procedure

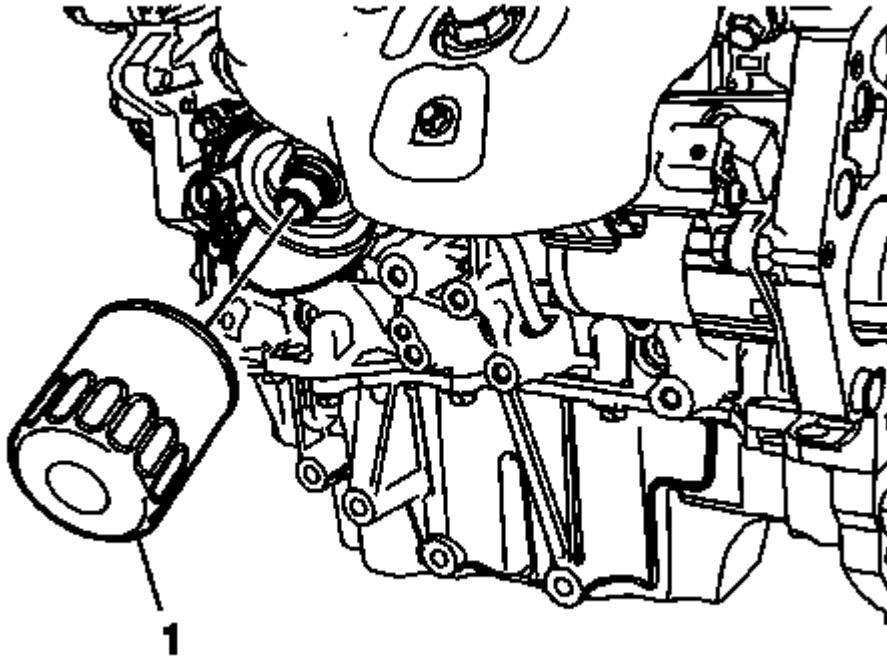


Fig. 235: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

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