

2006 ENGINE

Engine Mechanical - 3.6L - STS (1 Of 5)

WATER PUMP AND GENERATOR BELT REPLACEMENT

REMOVAL PROCEDURE

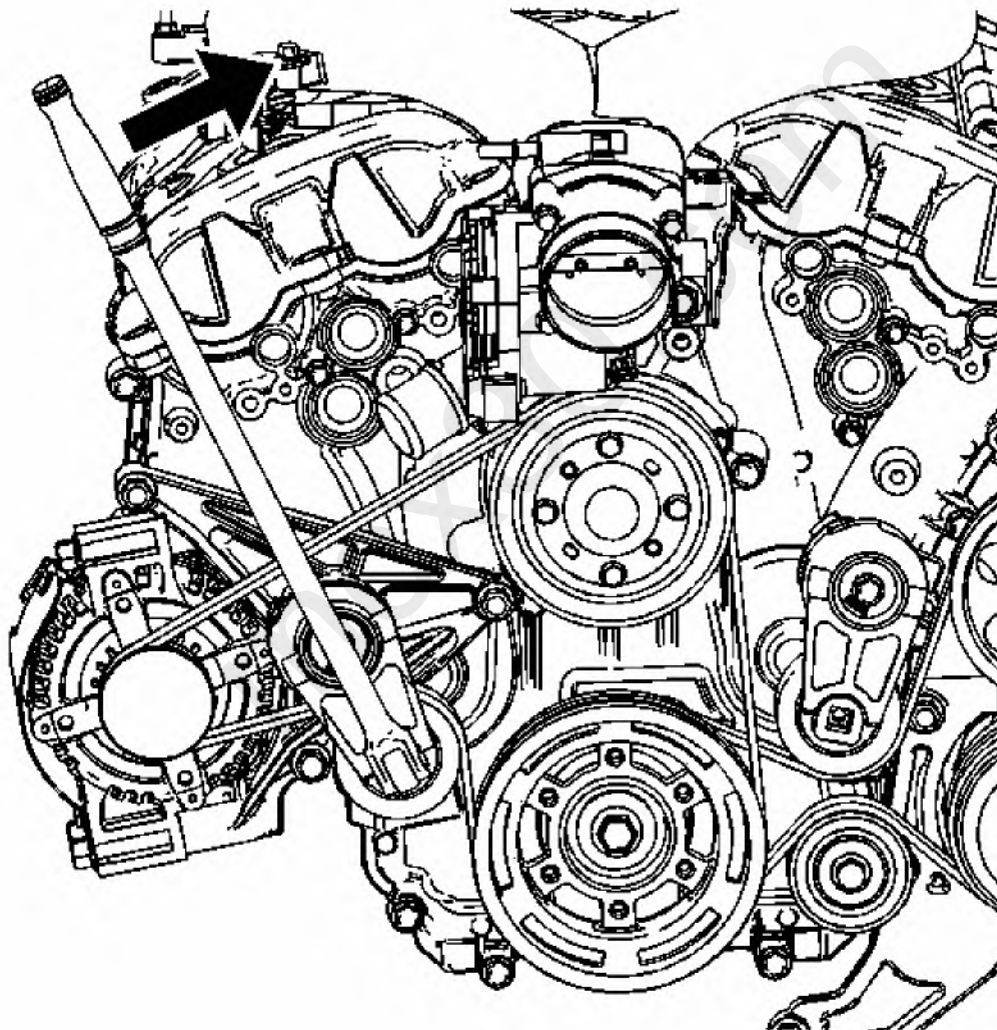


Fig. 1: Rotating Drive Belt Tensioner To Release Drive Belt Tension
Courtesy of GENERAL MOTORS CORP.

1. Remove the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

2. Rotate the drive belt tensioner clockwise to release the drive belt tension.
3. Slide the drive belt off of the water pump pulley.
4. Slowly release the drive belt tensioner.
5. Remove the drive belt from the accessory drive pulleys.

INSTALLATION PROCEDURE

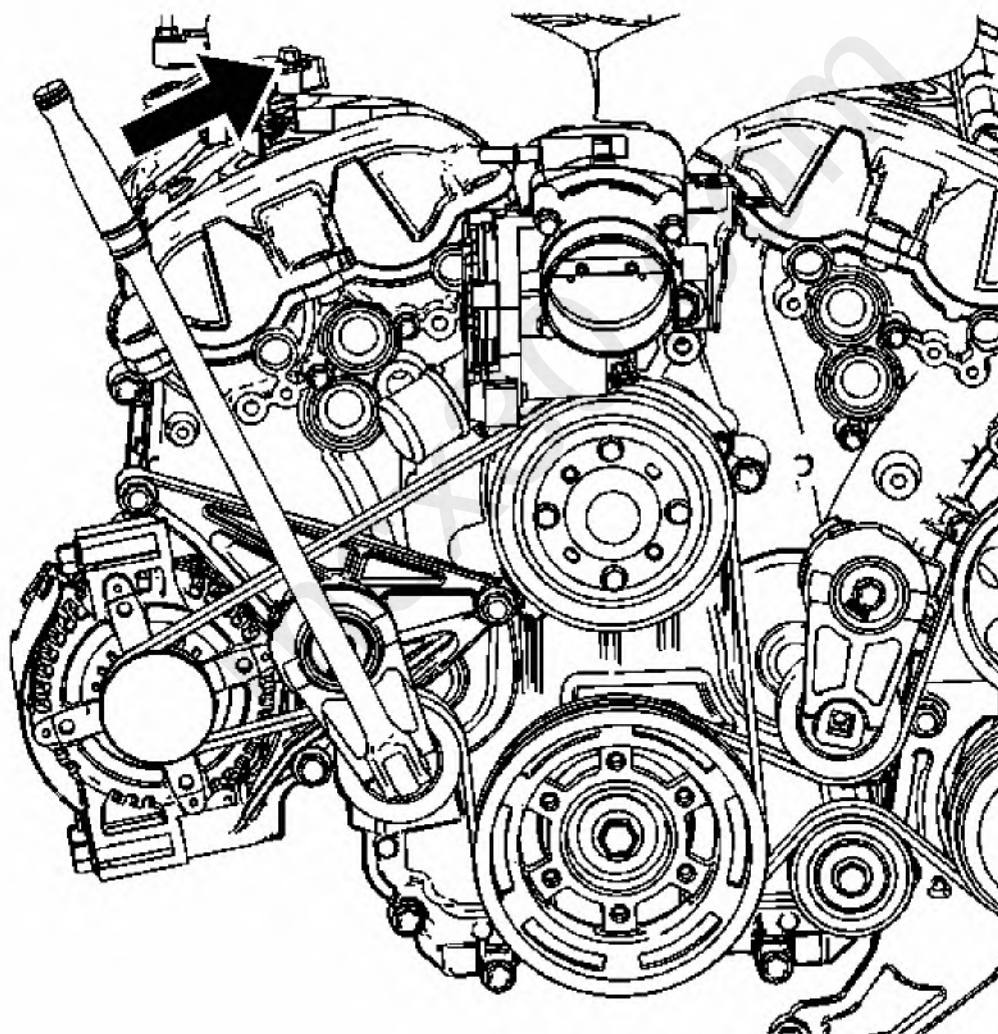


Fig. 2: Rotating Drive Belt Tensioner To Release Drive Belt Tension
Courtesy of GENERAL MOTORS CORP.

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

3. Install the drive belt to the water pump.

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

4. Slowly release the drive belt tensioner.
5. Install the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

AIR CONDITIONING COMPRESSOR AND POWER STEERING PUMP DRIVE BELT REPLACEMENT

REMOVAL PROCEDURE

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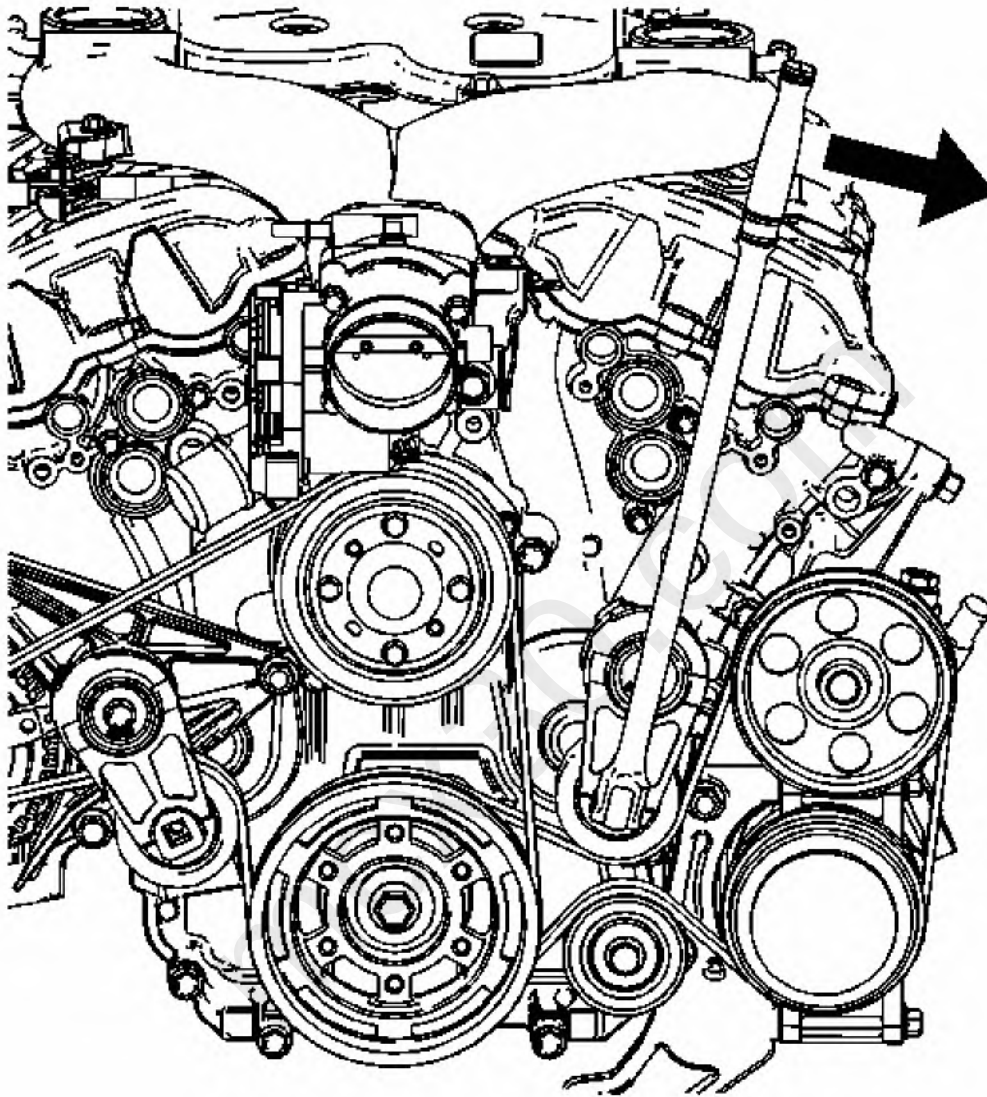


Fig. 3: Rotating Drive Belt Tensioner To Release Drive Belt Tension (Power Steering and Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.
2. Rotate the drive belt tensioner clockwise in order to release the drive belt tension.
3. Remove the drive belt from the power steering pulley.
4. Slowly release the drive belt tensioner.
5. Remove the drive belt from the accessory drive pulleys.

INSTALLATION PROCEDURE

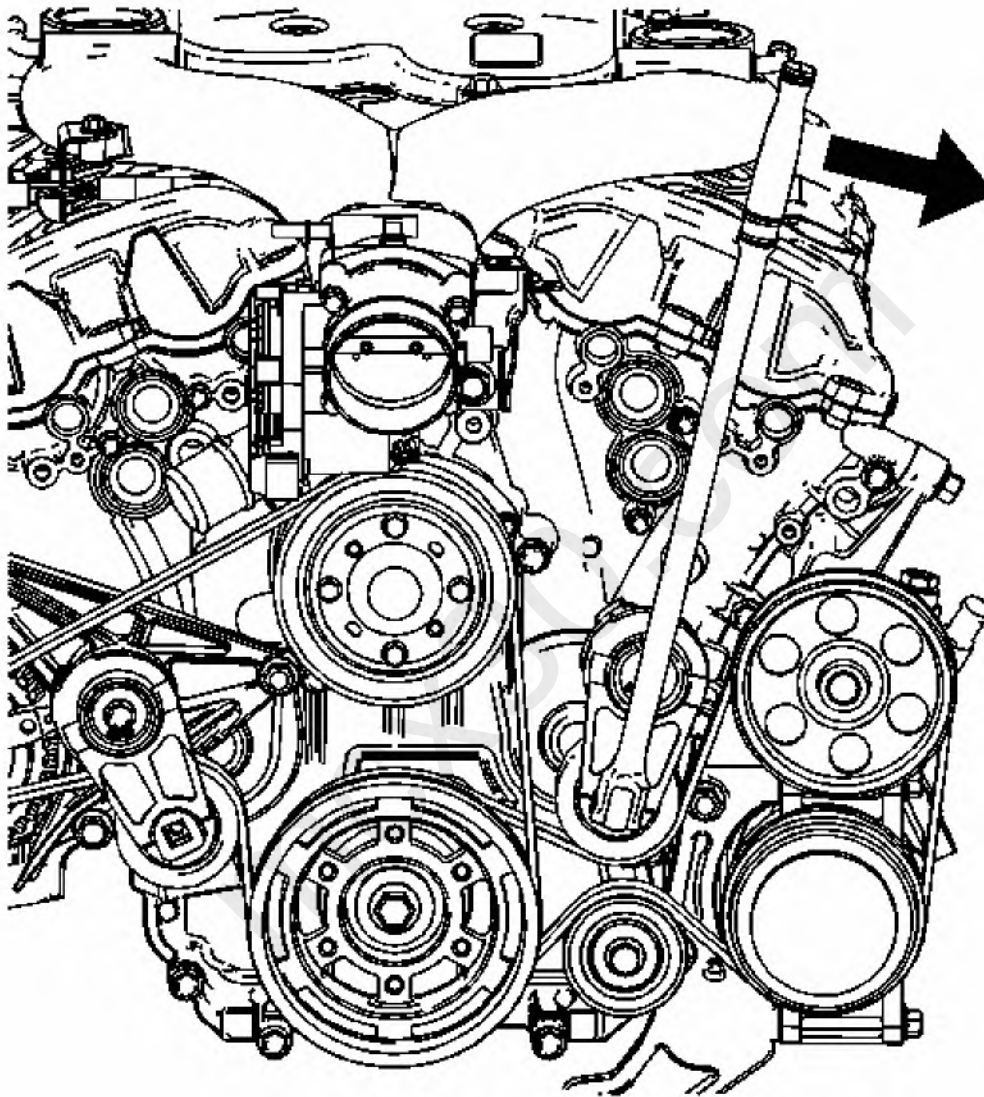


Fig. 4: Rotating Drive Belt Tensioner To Release Drive Belt Tension (Power Steering and Air Conditioning)

Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt to the crankshaft pulley, the idler pulley and the A/C compressor.
2. Rotate the drive belt tensioner clockwise.
3. Install the drive belt to the power steering pulley.
4. Slowly release the drive belt tensioner.

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

5. Install the generator and water pump drive belt. Refer to Water Pump and Generator Belt Replacement.

DRIVE BELT TENSIONER REPLACEMENT - GENERATOR AND WATER PUMP

REMOVAL PROCEDURE

1. Remove the generator and water pump drive belt. Refer to Water Pump and Generator Belt Replacement.

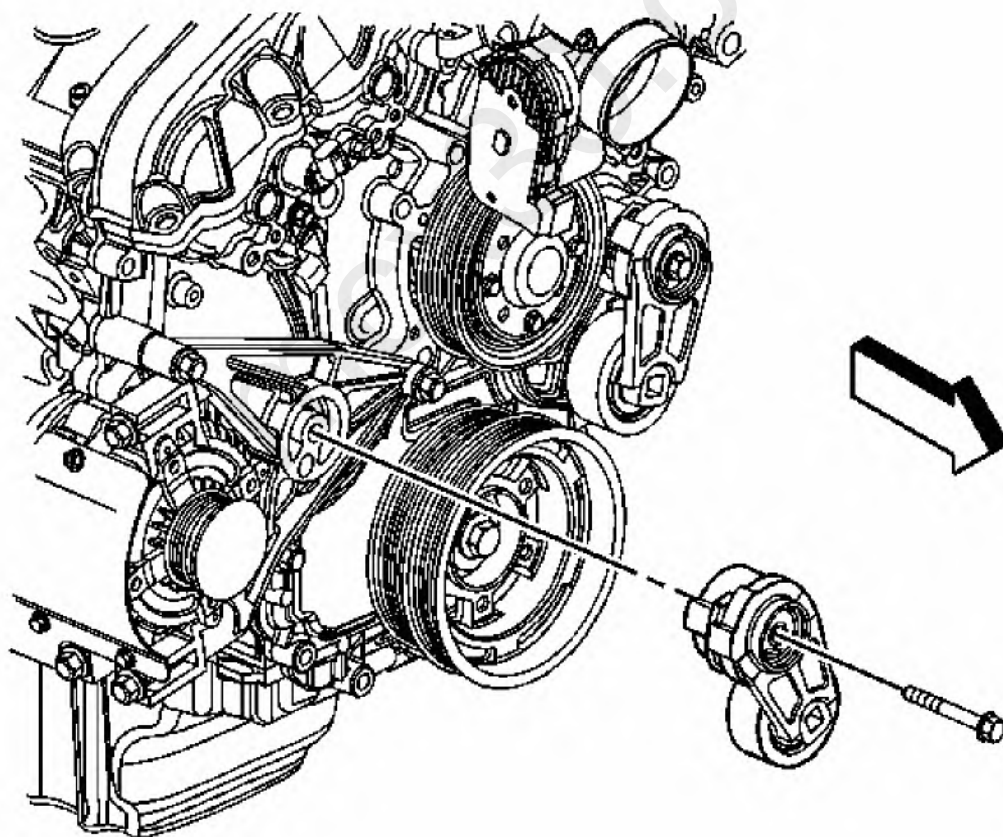


Fig. 5: View Of Generator & Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Loosen the drive belt tensioner bolt.

3. Remove the drive belt tensioner and bolt from the engine.

INSTALLATION PROCEDURE

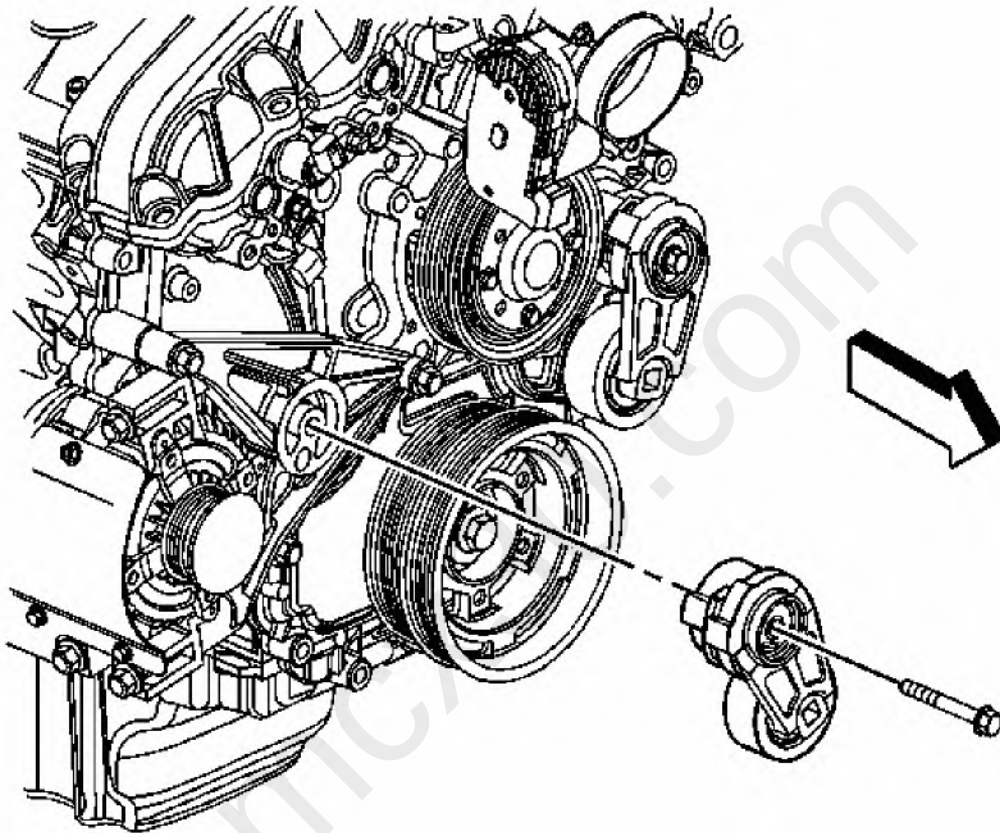


Fig. 6: View Of Generator & Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner and bolt to the engine as an assembly.
2. Ensure that the alignment pin on the rear of the tensioner assembly is aligned with the locating hole on the engine.

NOTE: Refer to Fastener Notice .

3. Install the drive belt tensioner bolt.

Tighten: Tighten the drive belt tensioner bolt to 50 N.m (37 lb ft).

4. Install the generator and water pump drive belt. Refer to Water Pump and Generator Belt Replacement.

DRIVE BELT TENSIONER REPLACEMENT - POWER STEERING AND AIR CONDITIONING

REMOVAL PROCEDURE

1. Remove the generator and water pump drive belt. Refer to Water Pump and Generator Belt Replacement.
2. Remove the power steering and air conditioning drive belt. Refer to Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement.

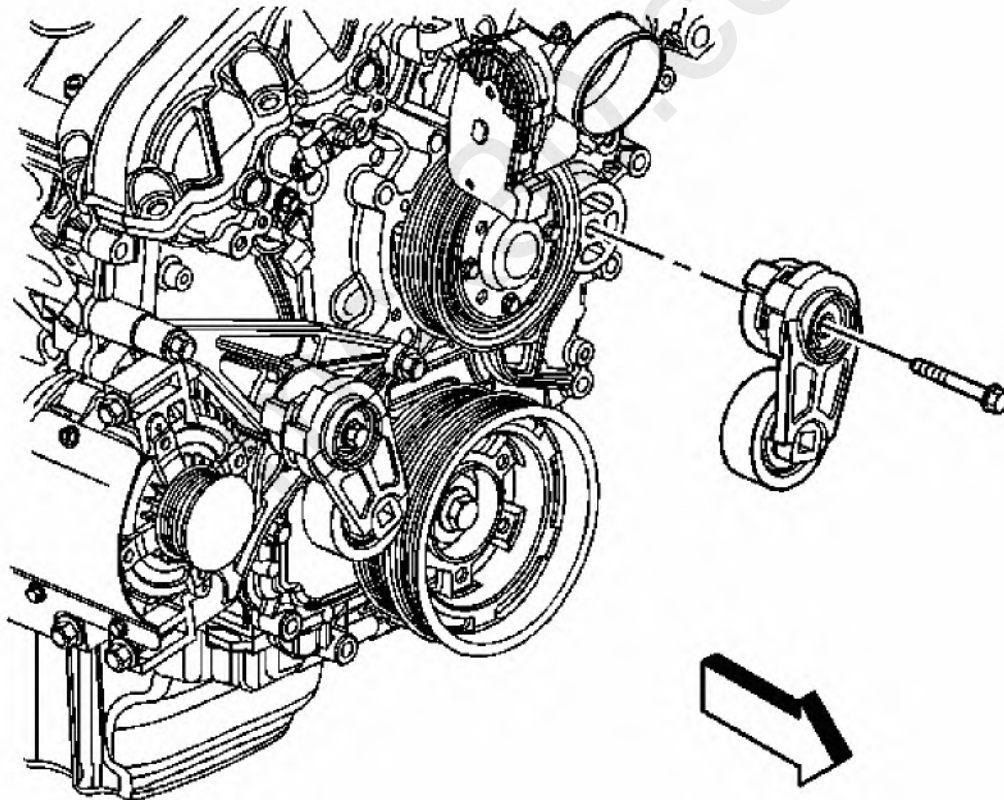


Fig. 7: View Of Power Steering & A/C Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Loosen the drive belt tensioner bolt.
4. Remove the drive belt tensioner and bolt from the engine.

INSTALLATION PROCEDURE

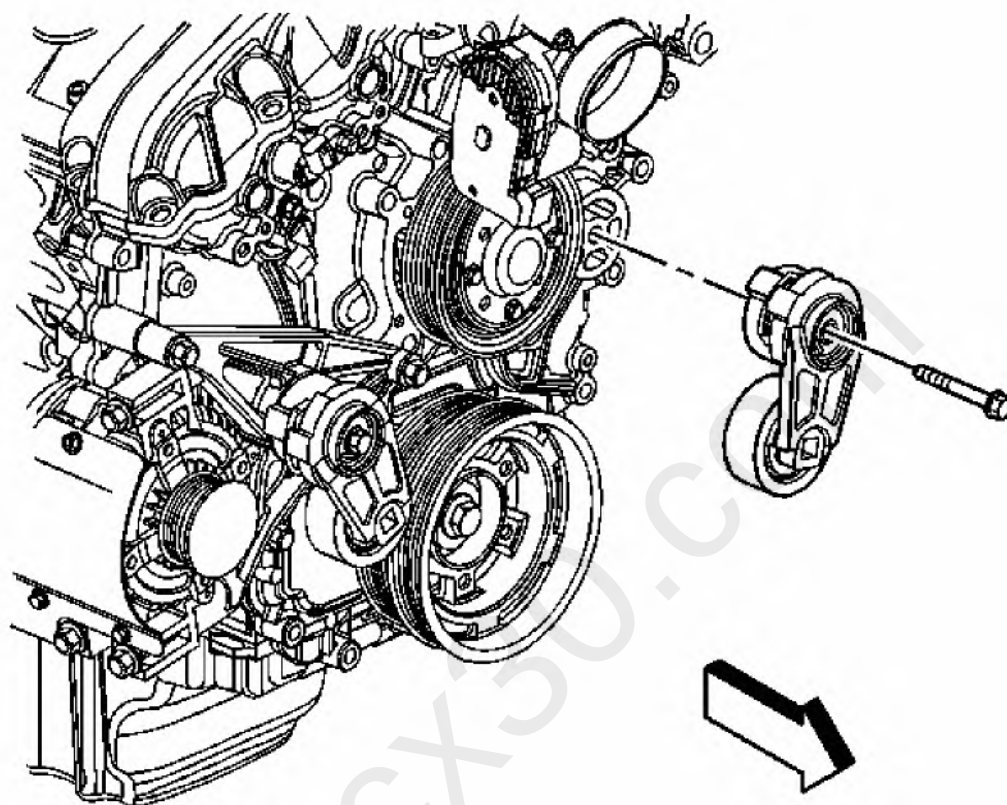


Fig. 8: View Of Power Steering & A/C Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner and bolt to the engine as an assembly.
2. Ensure that the alignment pin on the rear of the tensioner assembly is aligned with the locating hole on the engine.

NOTE: Refer to Fastener Notice .

3. Install the drive belt tensioner bolt.

Tighten: Tighten the drive belt tensioner bolt to 50 N.m (37 lb ft).

4. Install the power steering and air conditioning drive belt. Refer to Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement.
5. Install the generator and water pump drive belt. Refer to Water Pump and Generator

Belt Replacement.

ENGINE SUPPORT FIXTURE

Tools Required

- **J 28467-B** Universal Engine Support Fixture. See Special Tools .
- **J 28467-501** Engine Support Fixture Adapters. See Special Tools .
- **J 36857** Engine Lift Bracket. See Special Tools .

INSTALLATION PROCEDURE

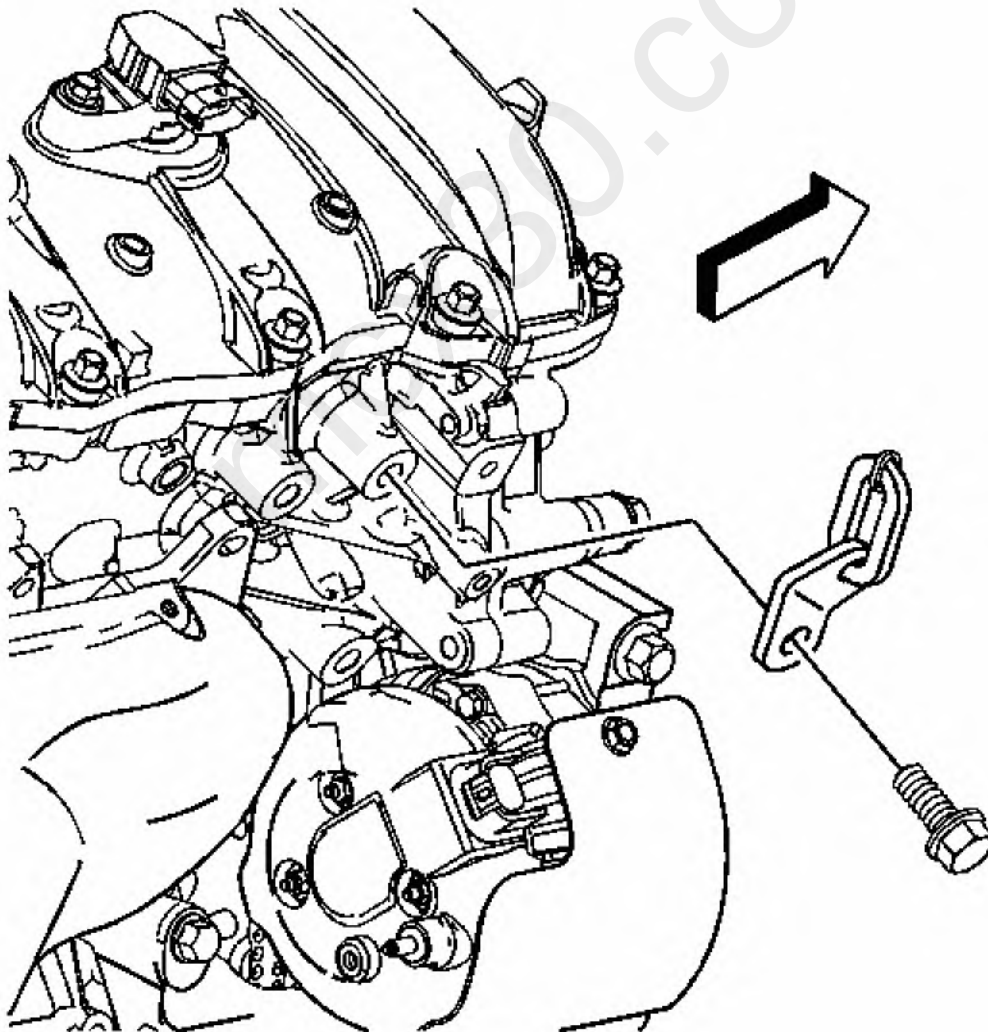


Fig. 9: View Of Engine Lift Bracket - Front Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Refer to **Fastener Notice** .

2. Use a grade 10.9, M10 X 1.5 X 35 bolt (GM P/N 11519182 or equivalent) in order to install an engine lift bracket (OTC #7100, **J 36857** or equivalent) to the front of the right (Bank 1) cylinder head in the location shown. See **Special Tools** .

Tighten: Tighten the bolt to 65 N.m (48 lb ft).

3. Remove the electrical connector bolt and the electrical connector from the rear of the left cylinder head.

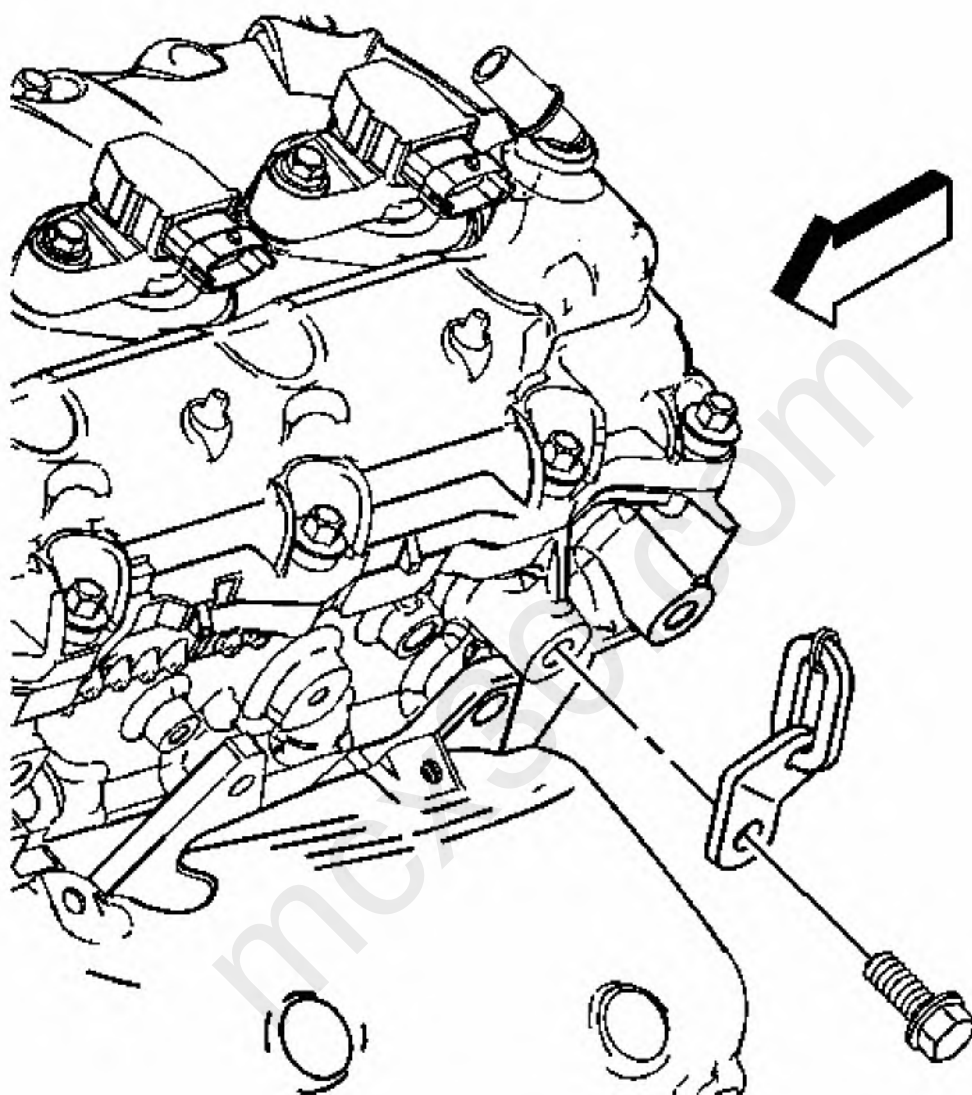


Fig. 10: View Of Engine Lift Bracket - Rear Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

4. Use a grade 10.9, M10 X 1.5 X 35 bolt (GM P/N 11519182 or equivalent) in order to install an engine lift bracket (OTC #7100, **J 36857** or equivalent) to the rear of the left (Bank 2) cylinder head in the location shown. See **Special Tools** .

Tighten: Tighten the bolt to 65 N.m (48 lb ft).

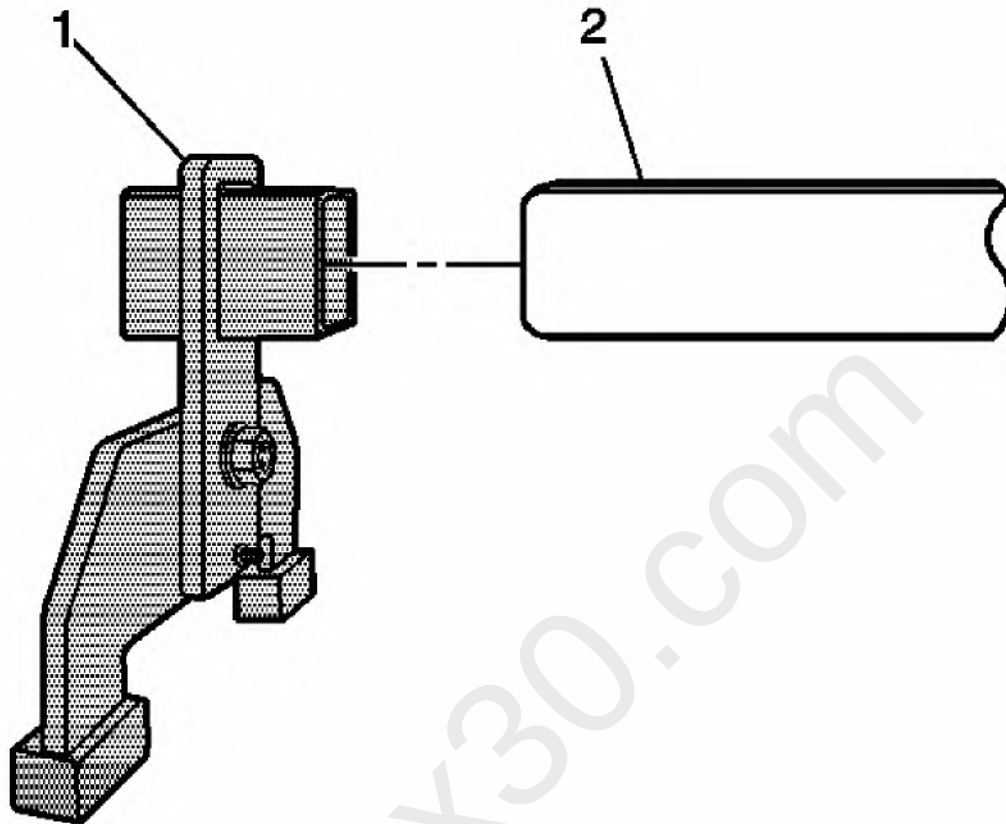


Fig. 11: Identifying J 28467-B & J 28467-3
Courtesy of GENERAL MOTORS CORP.

5. Loosely install the **J 28467-501** (1) to the ends of the strut tower tube **J 28467-3** (2).
See **Special Tools** .

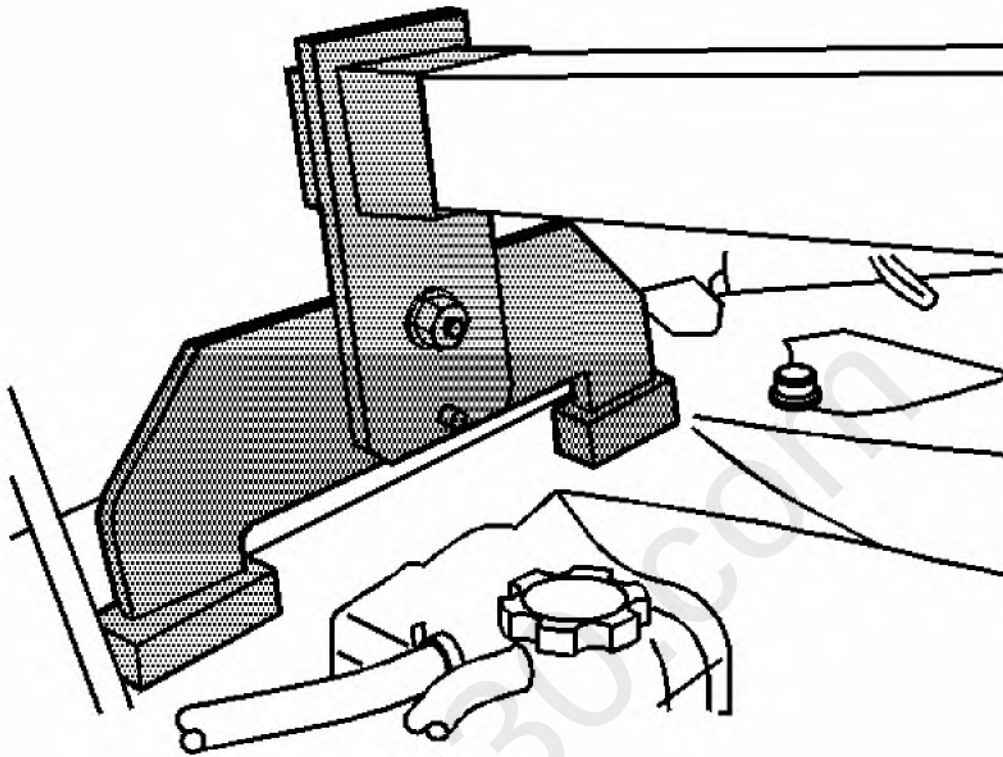


Fig. 12: View Of J 28467-501

Courtesy of GENERAL MOTORS CORP.

6. Place the strut tower tube J 28467-3 and the **J 28467-501** on top of both the left and right fender lips, over the engine rear lift bracket. See **Special Tools** .

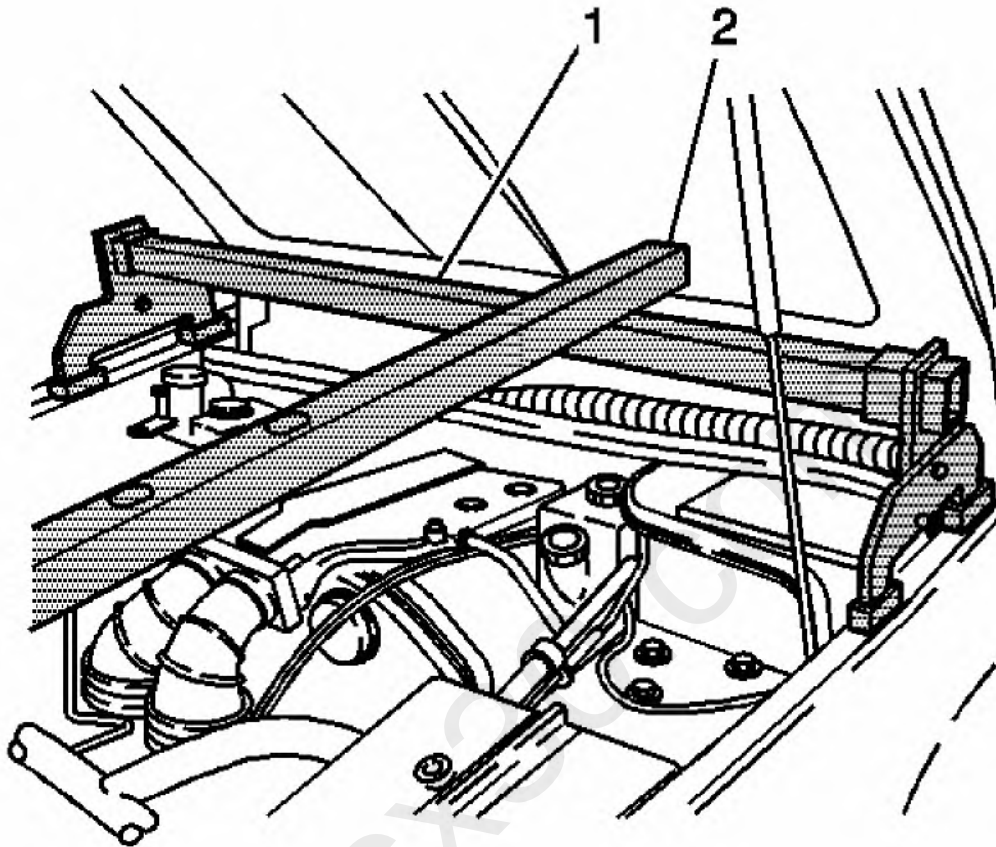


Fig. 13: Identifying J 28467-2A & J 28467-3
Courtesy of GENERAL MOTORS CORP.

7. Install the radiator shelf tube J 28467-2A (2) on top of the strut tower tube J 28467-3 (1) above the engine front (right bank) lift bracket.

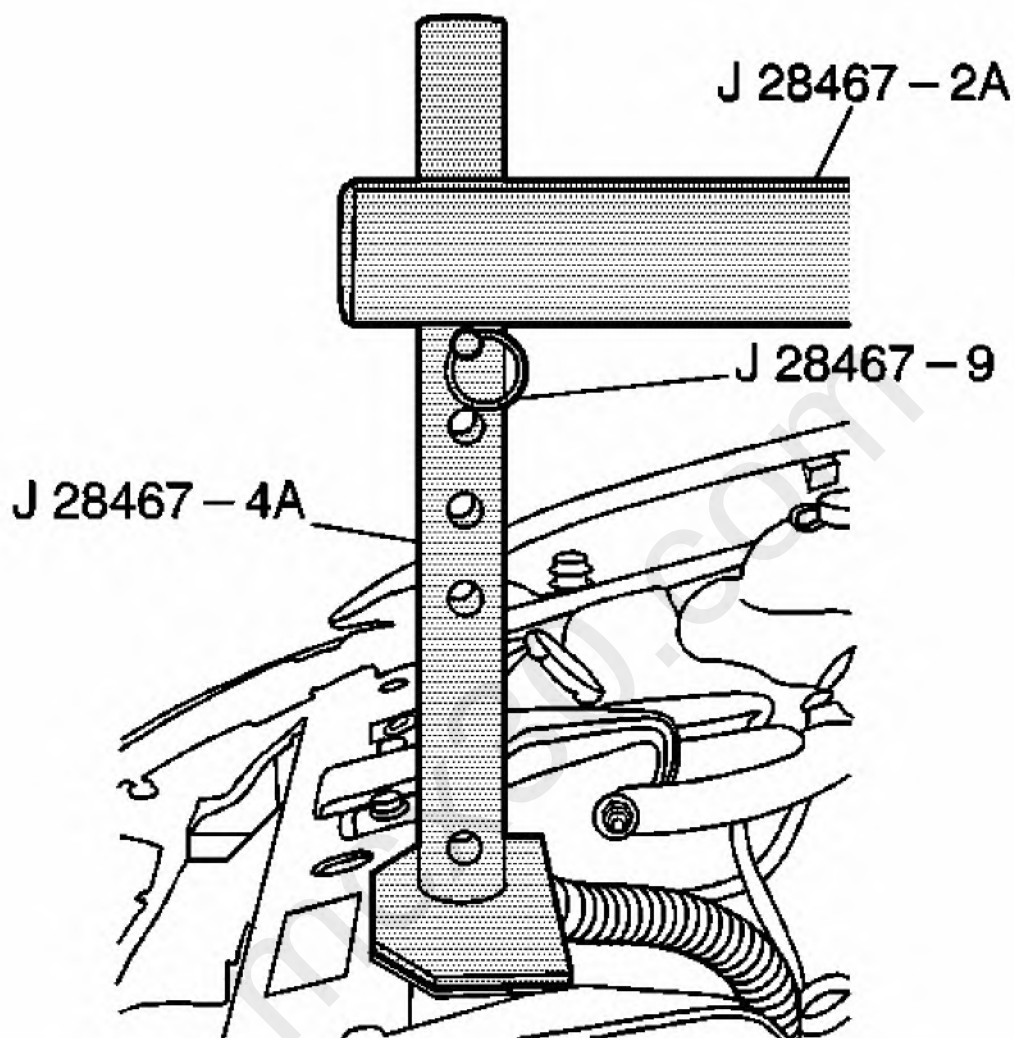


Fig. 14: Identifying Quick Release Pin J 28467-9
Courtesy of GENERAL MOTORS CORP.

8. Install the round tube of the front support assembly J 28467-4A through the large hole in the radiator shelf tube J 28467-2A.
9. Remove the upper tie bar cover.
10. Locate the J 28467-4A front support assembly to the upper tie bar.
11. Install the J 28467-9 7/16 in x 2.0 in quick-release pin through the top hole in the J 28467-4A front support assembly.

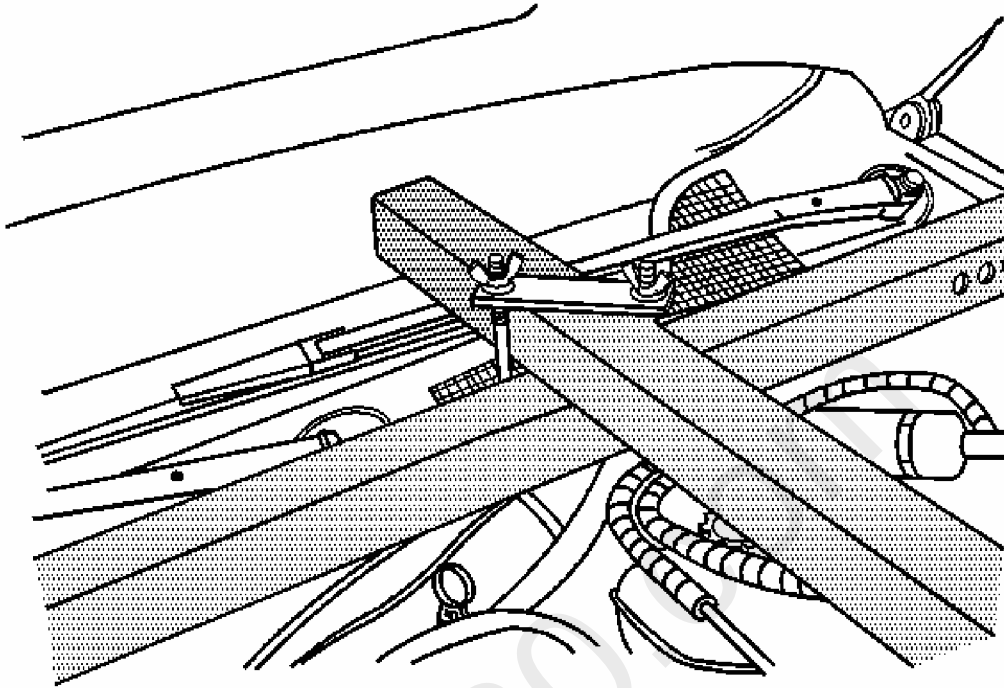


Fig. 15: View of Cross Bracket Assembly with J28467--1A & Nuts
Courtesy of GENERAL MOTORS CORP.

12. Install the J 28467-1A cross bracket assembly.
13. Hand tighten the J 28467-1A cross bracket wing nuts.

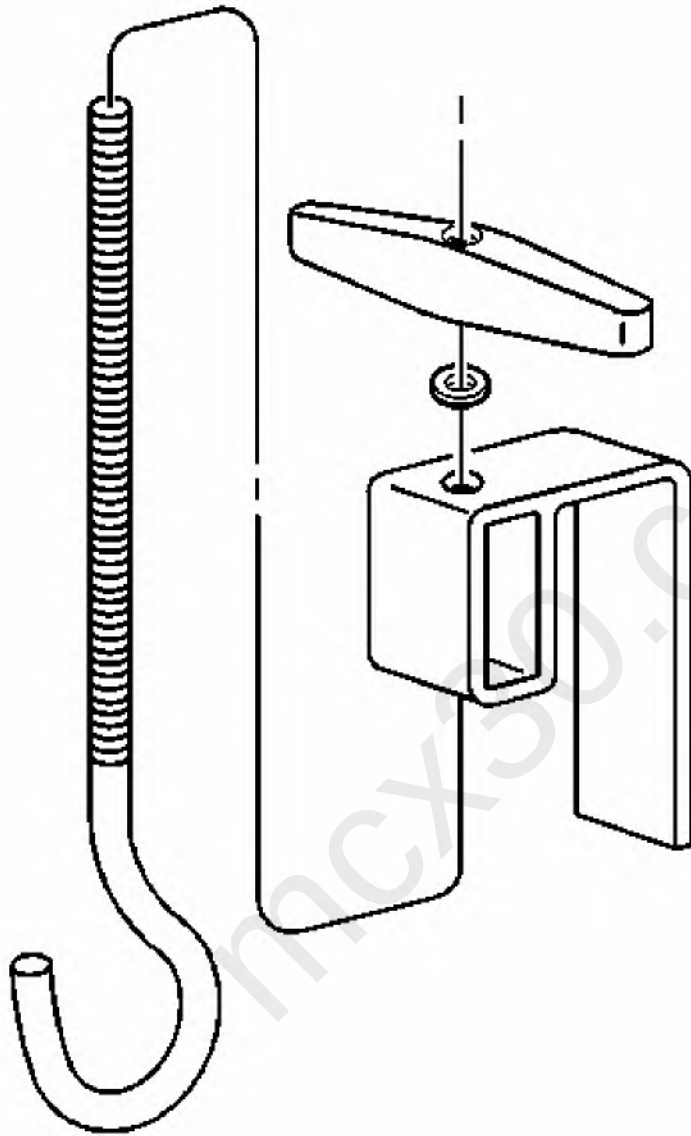


Fig. 16: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

14. Install the J 28467-7A bolt hook through the J 28467-6A bracket.
15. Install the J 28467-34 lift hook wing nut and washer to the J 28467-7A lift hook.
16. Repeat the previous two steps in order to assemble two lift hooks and brackets.

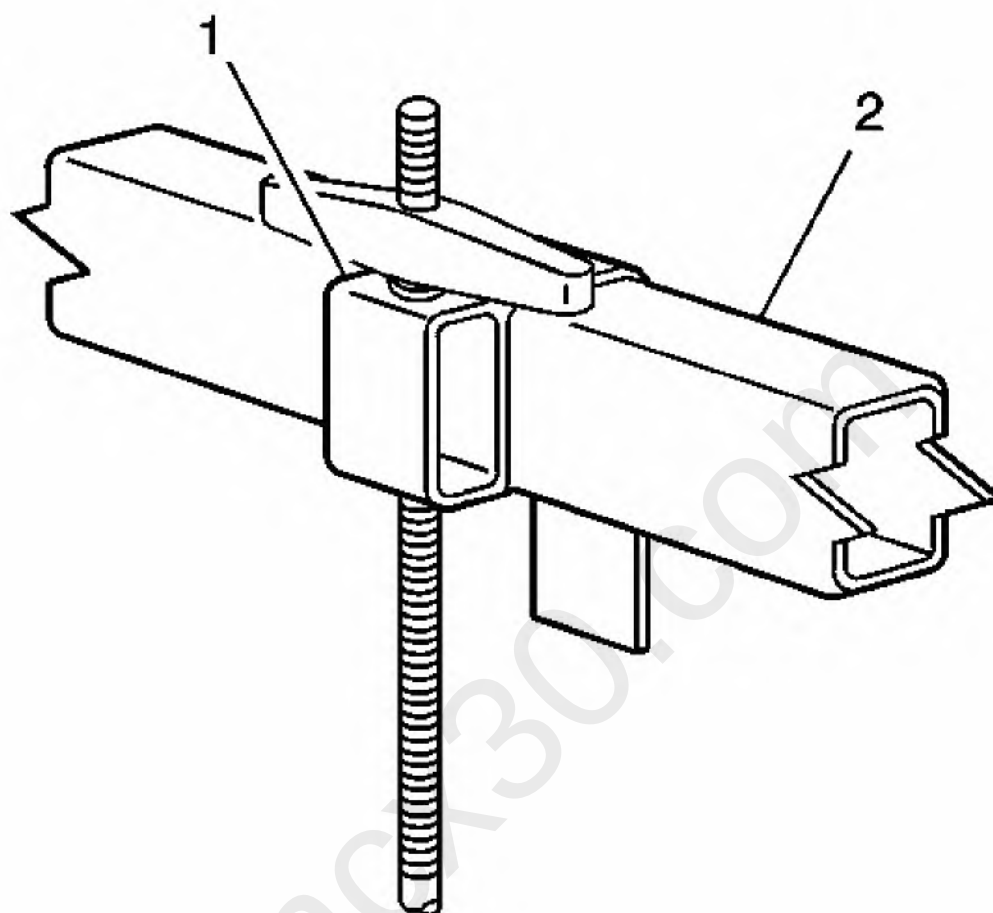


Fig. 17: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar

Courtesy of GENERAL MOTORS CORP.

17. Install one of the lift hook and bracket assemblies (1) to the J 28467-3 strut tower tube (2) above the engine rear lift bracket.
18. Install the lift hook J 28467-7A through the engine rear lift bracket. Ensure the hook does not damage adjacent components.
19. Install the other lift hook and bracket assembly (1) to the J 28467-2A radiator shelf tube (2) above the engine front lift bracket.
20. Install the lift hook J 28467-7A through the engine front lift bracket. Ensure the hook does not damage adjacent components.
21. Hand tighten the lift hook wing nuts J 28467-34 in order to remove all slack from the engine support fixture assembly.

REMOVAL PROCEDURE

1. Remove the **J 28467-B** . See **Special Tools** .
2. Remove the **J 28467-501** . See **Special Tools** .
3. Install the wiring harness electrical connector bracket to the rear of the left (Bank 2) cylinder head.
4. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

ENGINE MOUNT INSPECTION

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

1. Install the engine support fixture. Refer to **Engine Support Fixture**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface 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 GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Engine Mount Replacement - Left Side** or **Engine Mount Replacement - Right Side (w/RWD)** or **Engine Mount Replacement - Right Side (W/AWD)**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE**REMOVAL PROCEDURE**

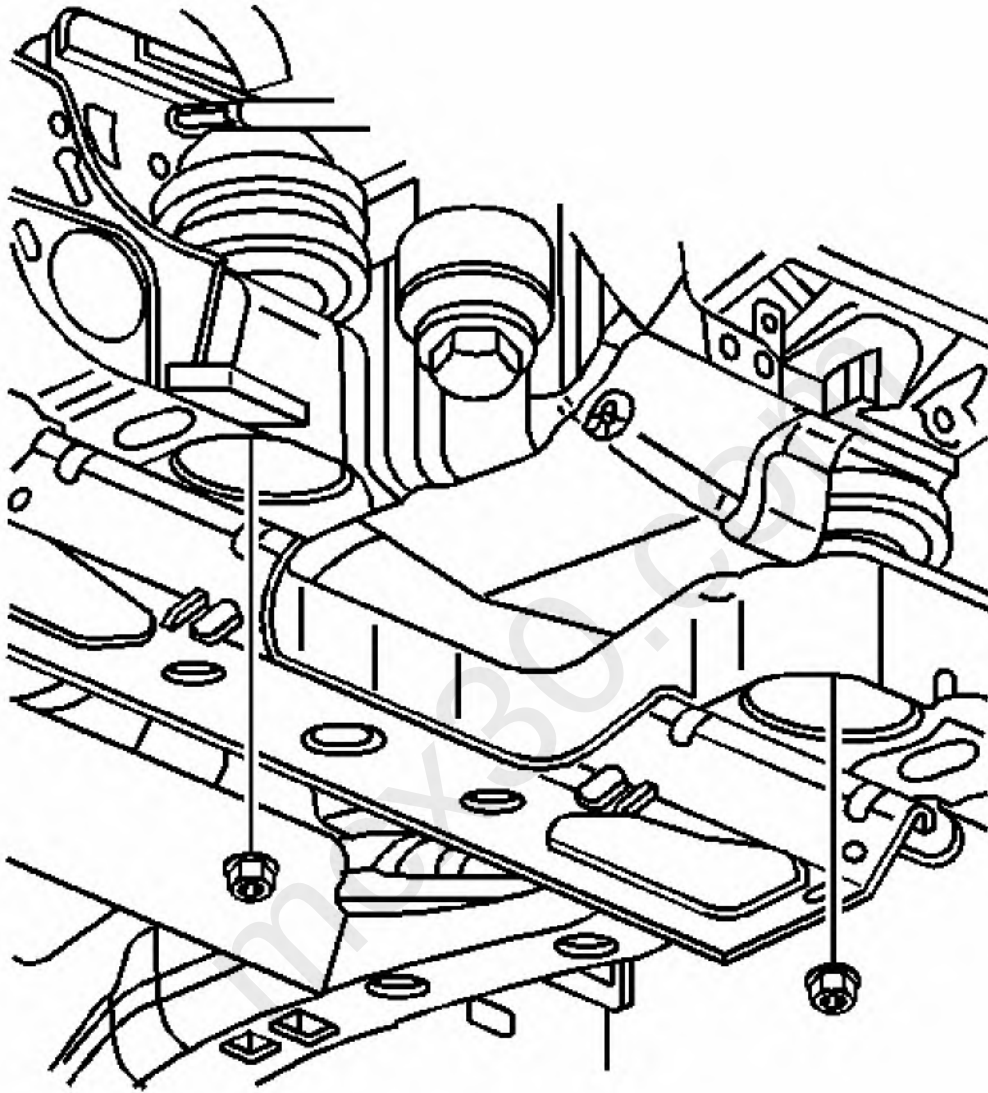


Fig. 18: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Install a screw jack with a block of wood under the oil pan for support.
3. Remove the lower engine mount retaining nut.
4. Raise the engine using the screw jack until the weight is removed from the mount.

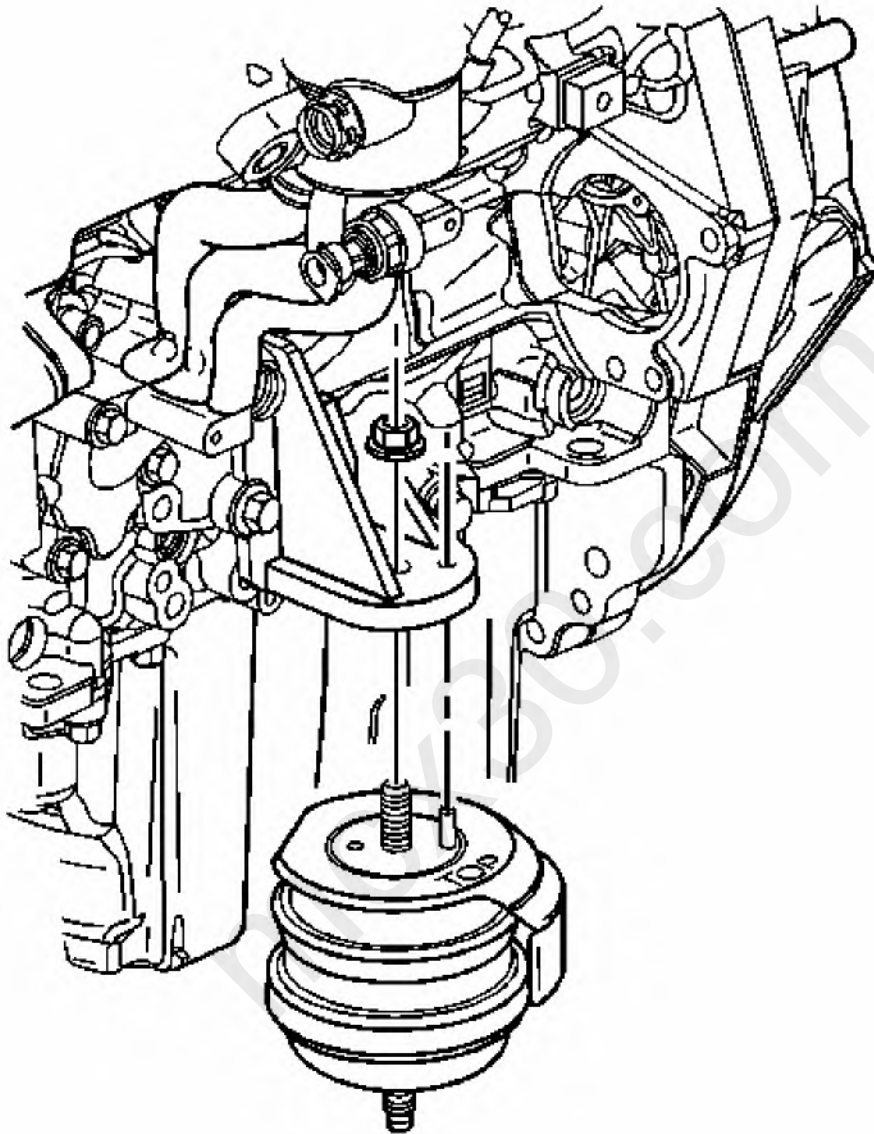


Fig. 19: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the upper engine mount retaining nut.
6. Remove the engine mount from the vehicle.

INSTALLATION PROCEDURE

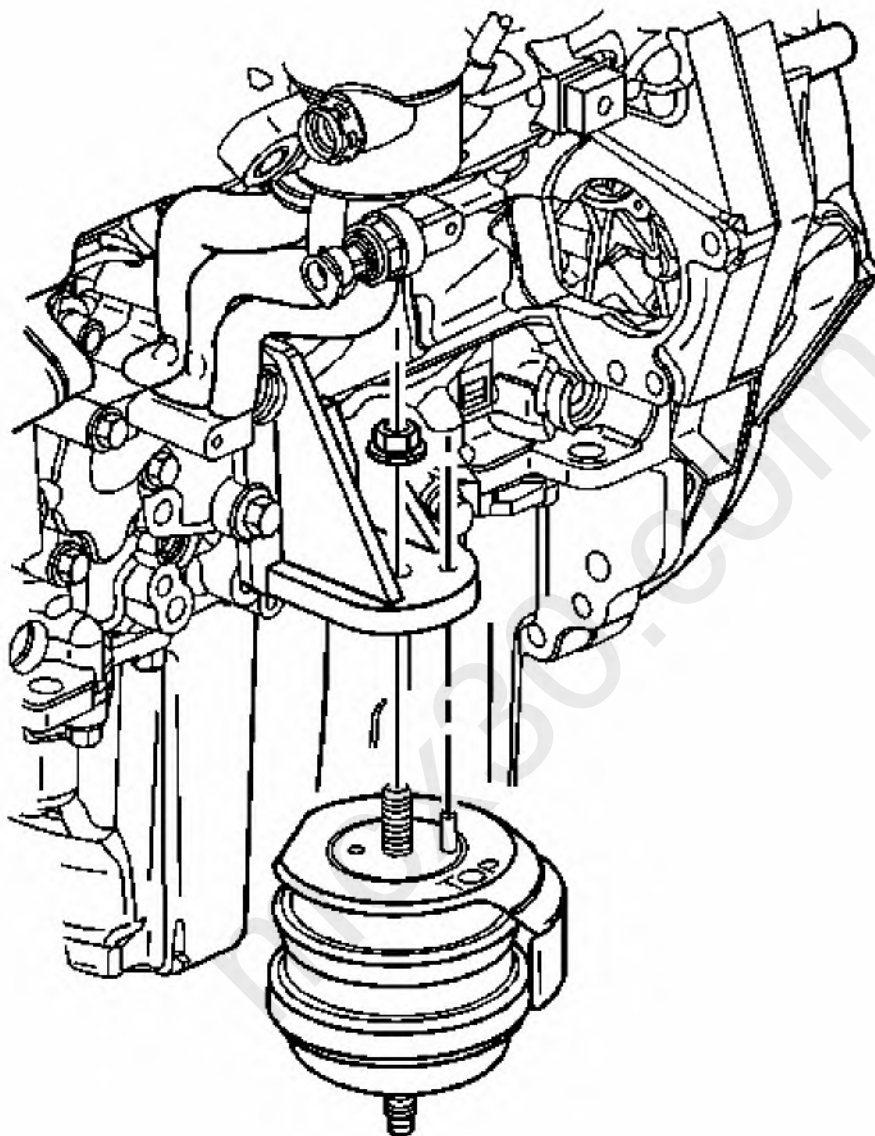


Fig. 20: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the vehicle.

NOTE: Refer to Fastener Notice .

2. Install the upper engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

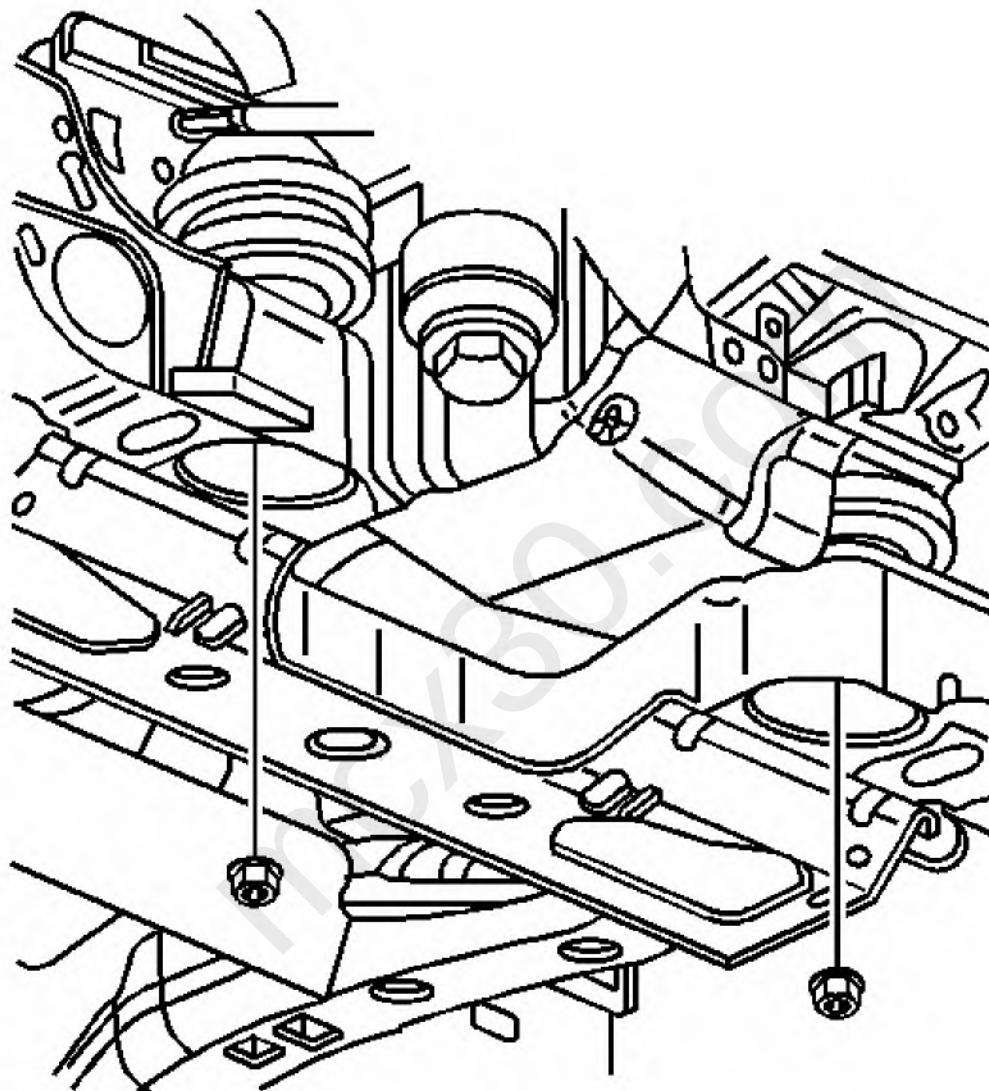


Fig. 21: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

3. Lower the engine using the screw jack until the weight is resting on the mount.
4. Install the engine mount lower retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

5. Remove the screw jack and block of wood from under the oil pan.

6. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (W/RWD)

REMOVAL PROCEDURE

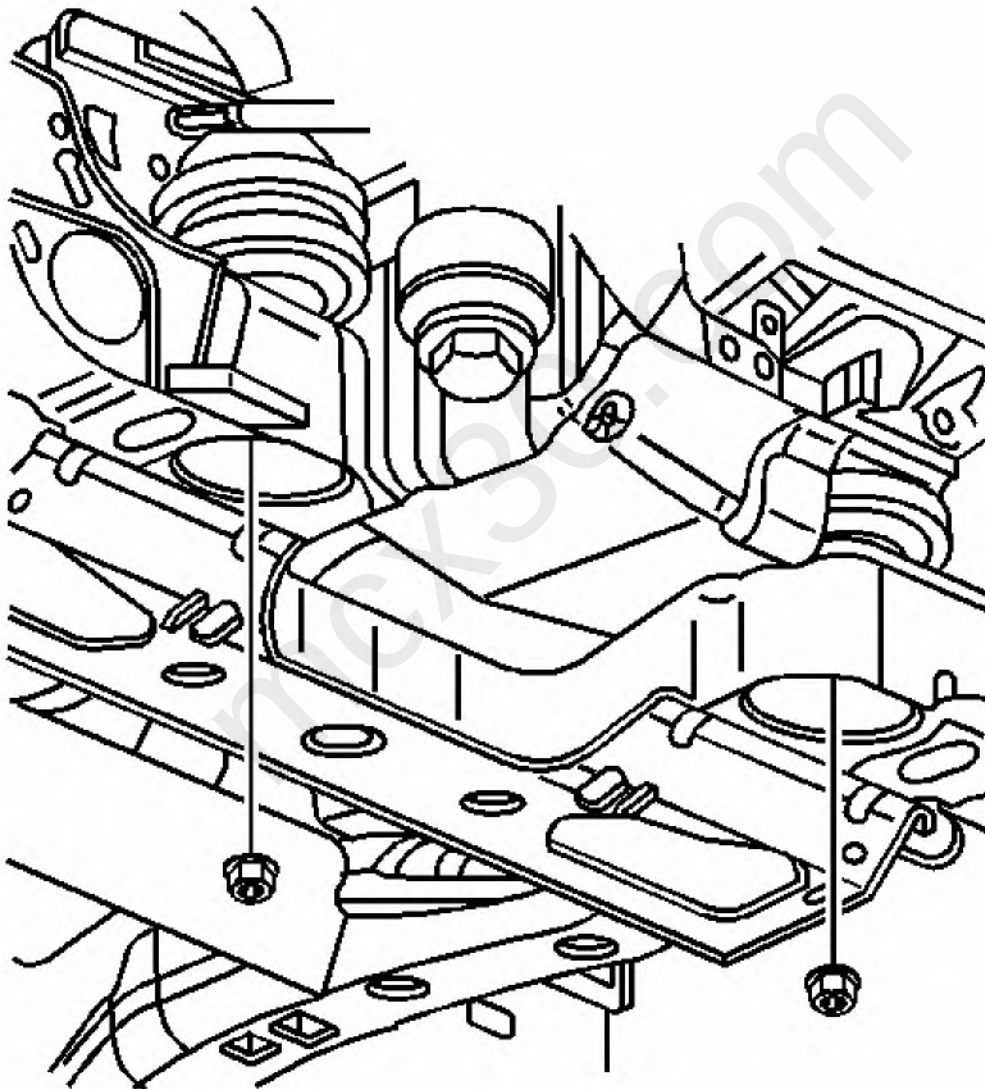


Fig. 22: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
2. Install a screw jack with a block of wood under the oil pan for support.

3. Remove the lower engine mount retaining nut.
4. Raise the engine using the screw jack until the weight is removed from the mount.

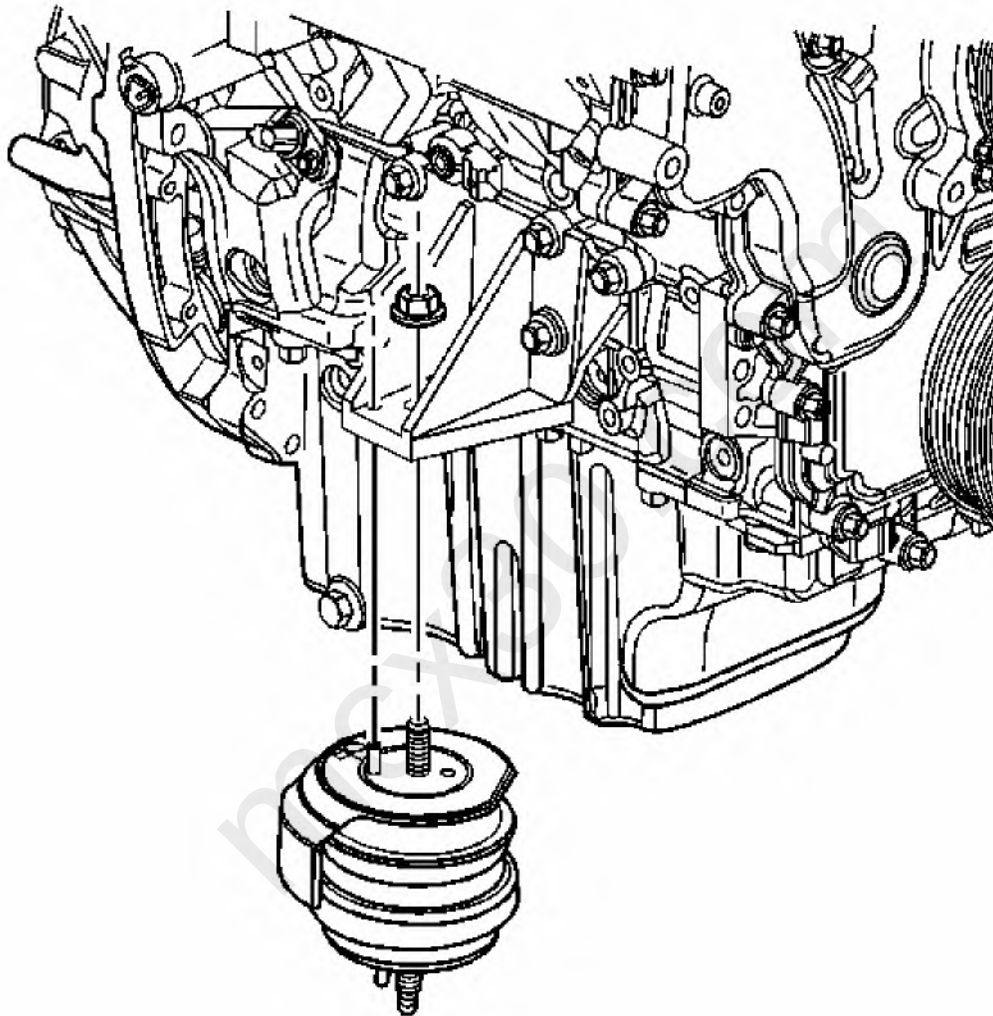


Fig. 23: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the upper engine mount retaining nut.
6. Remove the engine mount from the vehicle.

INSTALLATION PROCEDURE

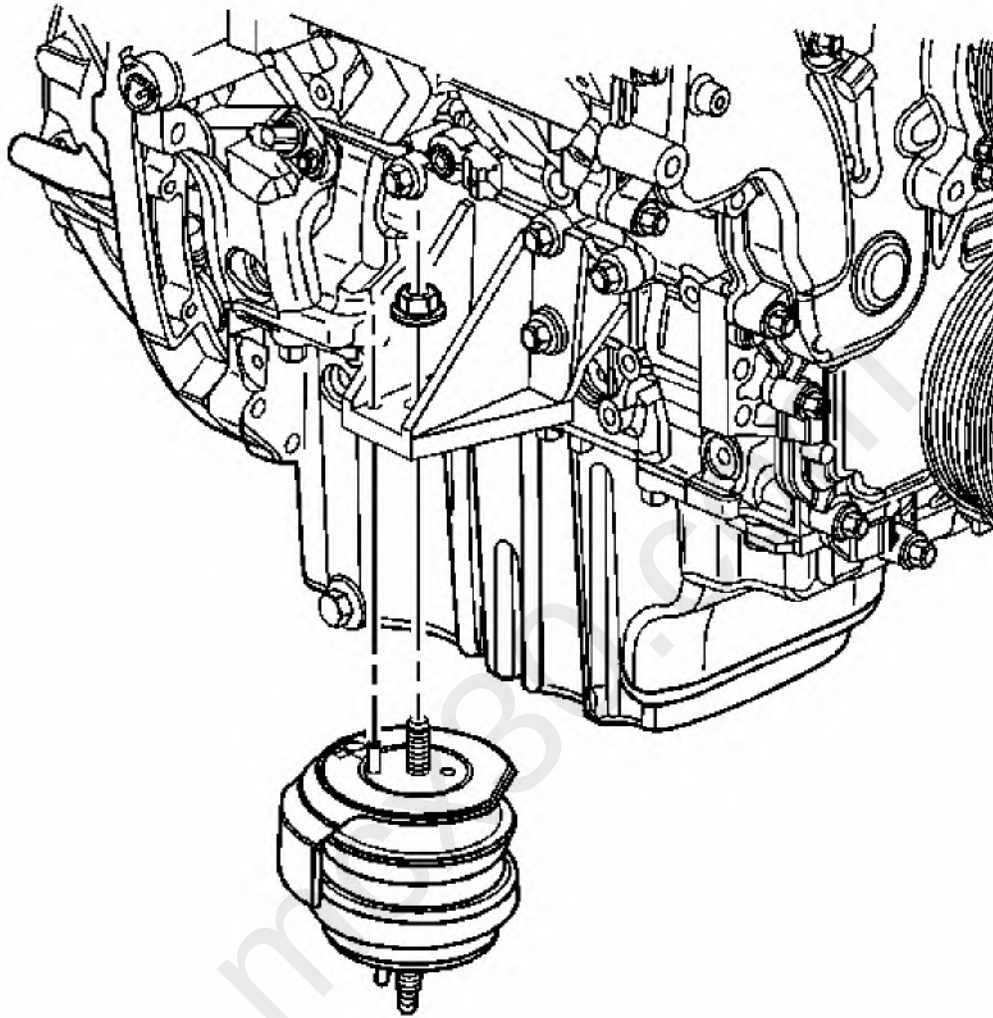


Fig. 24: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the vehicle.

NOTE: Refer to Fastener Notice .

2. Install the upper engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

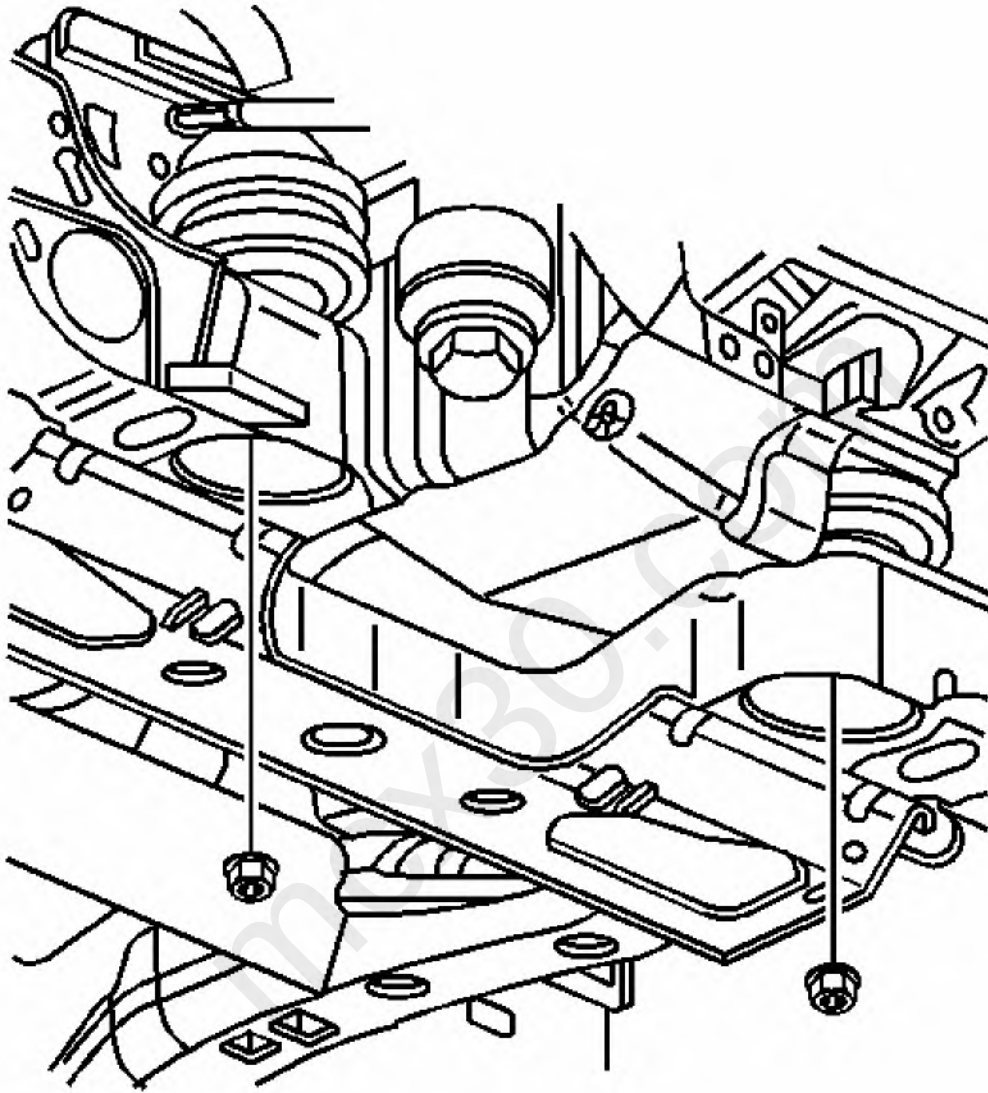


Fig. 25: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

3. Lower the engine using the jack screw until the weight is resting on the mount.
4. Install the engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

5. Remove the jack screw and block of wood from under the oil pan.
6. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (W/AWD)

REMOVAL PROCEDURE

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the right engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side (w/RWD)** or **Engine Mount Bracket Replacement - Right Side (w/AWD)** .

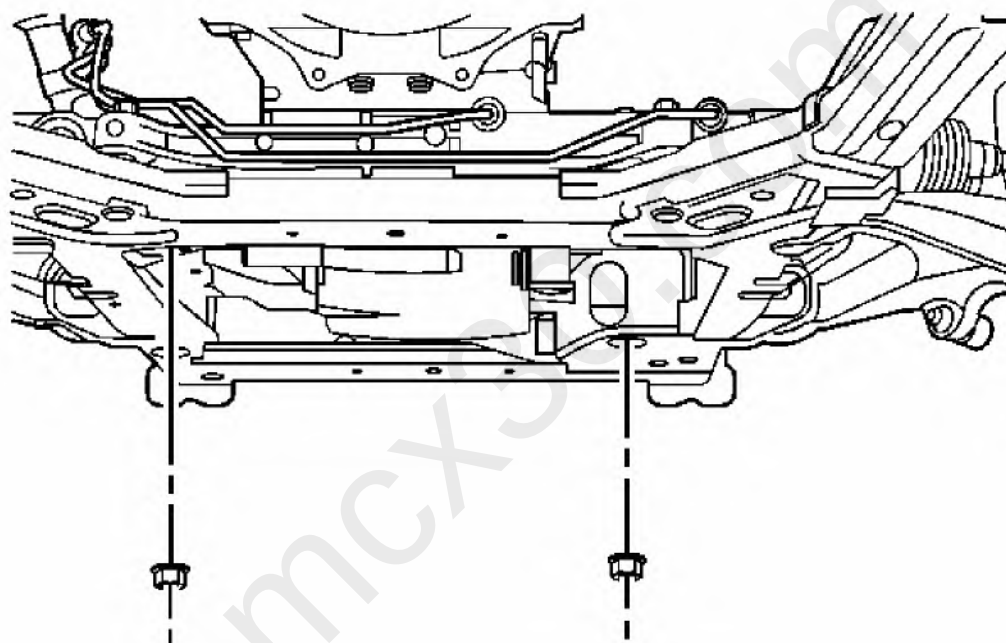


Fig. 26: View Of Engine Mount Lower Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount retaining nut.
4. Remove the engine mount from the vehicle.

INSTALLATION PROCEDURE

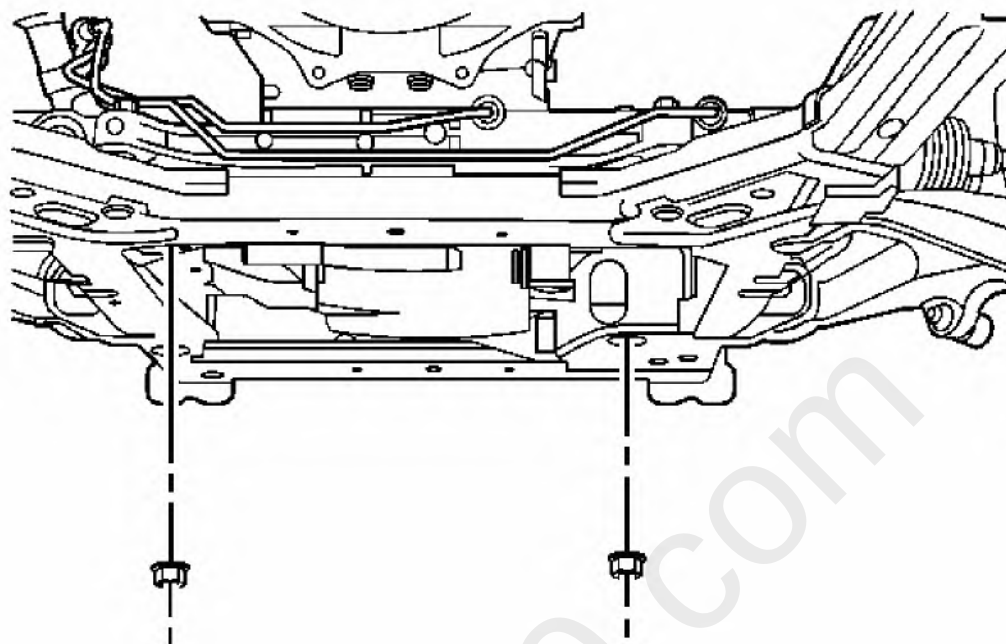


Fig. 27: View Of Engine Mount Lower Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the vehicle.

NOTE: Refer to Fastener Notice .

2. Install the engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

3. Install the right engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side (w/RWD) or Engine Mount Bracket Replacement - Right Side (w/AWD) .
4. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

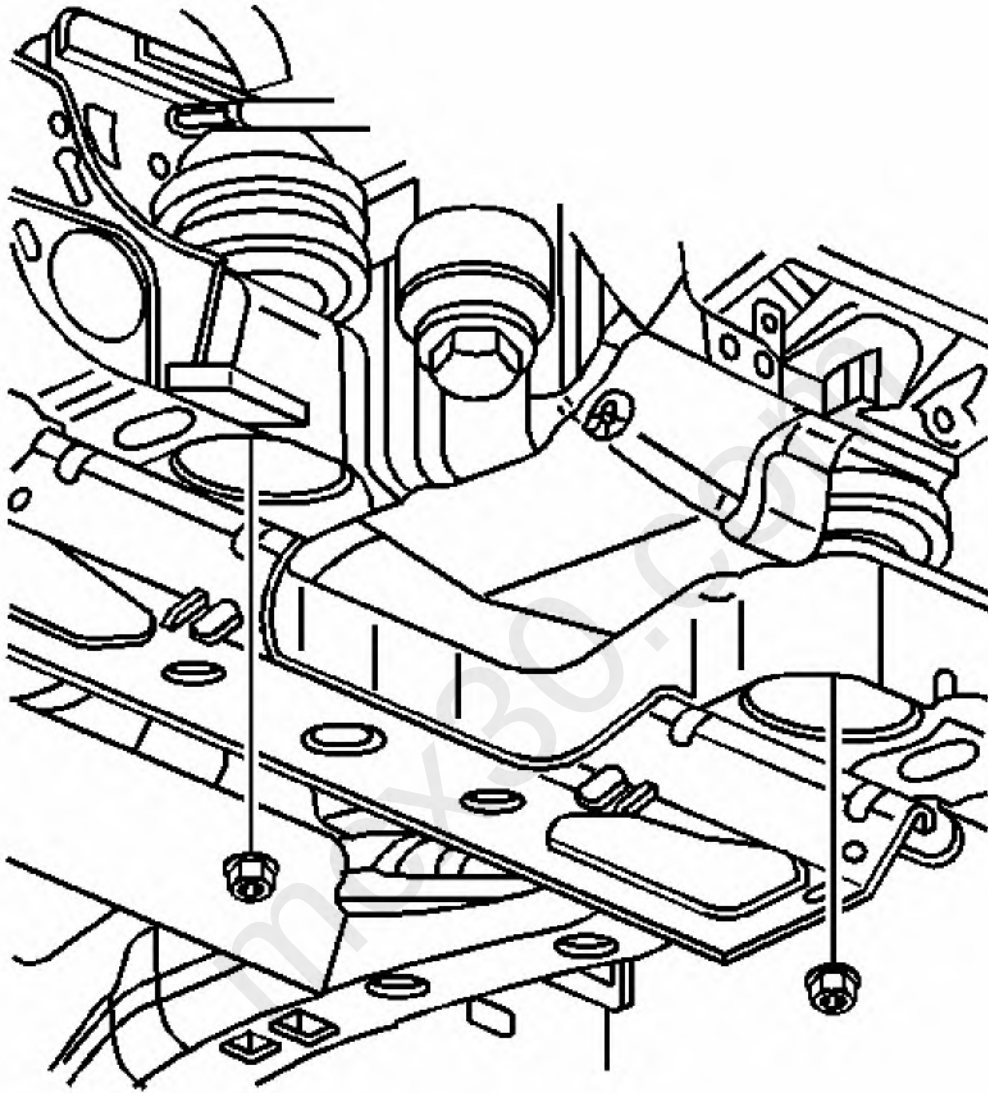


Fig. 28: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Install a screw jack with a block of wood under the oil pan for support.
3. Remove the lower engine mount retaining nut.
4. Raise the engine using the screw jack until the weight is removed from the mount.

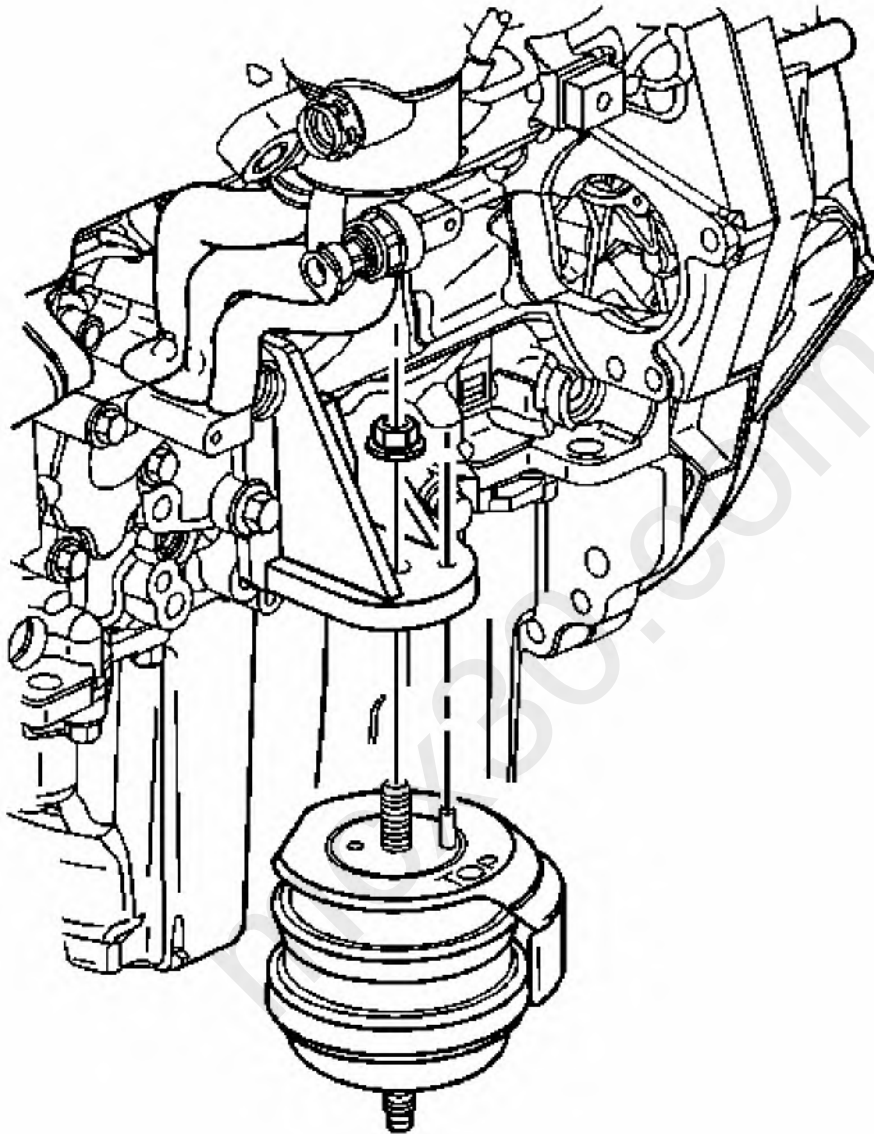


Fig. 29: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the upper engine mount retaining nut.
6. Remove the engine mount from the vehicle.

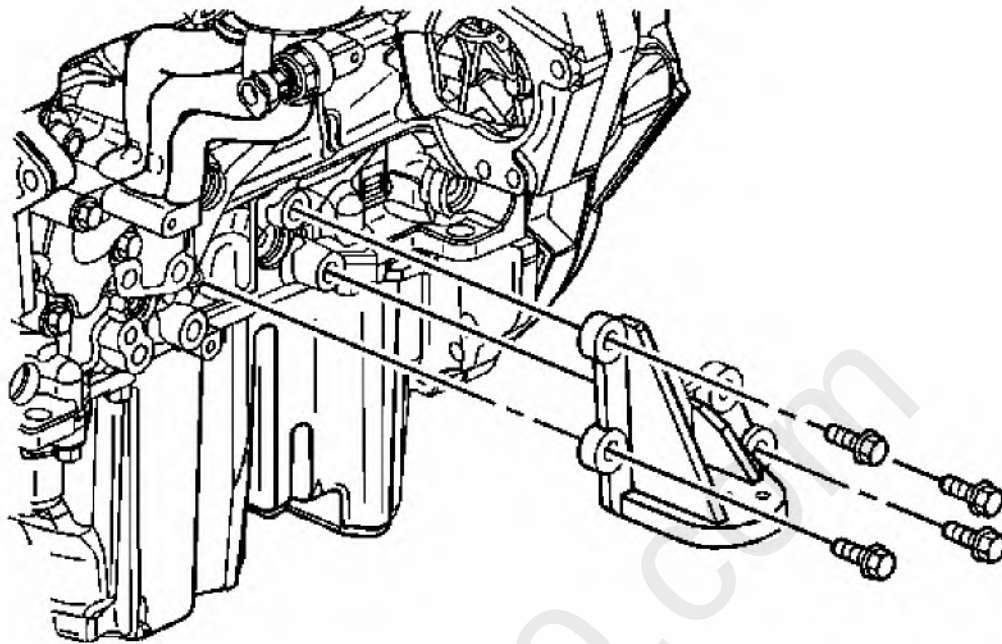


Fig. 30: View Of Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure not to distort or bend the engine mount heat shield.

7. Remove the left engine mount bracket retaining bolts.
8. Remove the left engine mount bracket.

INSTALLATION PROCEDURE

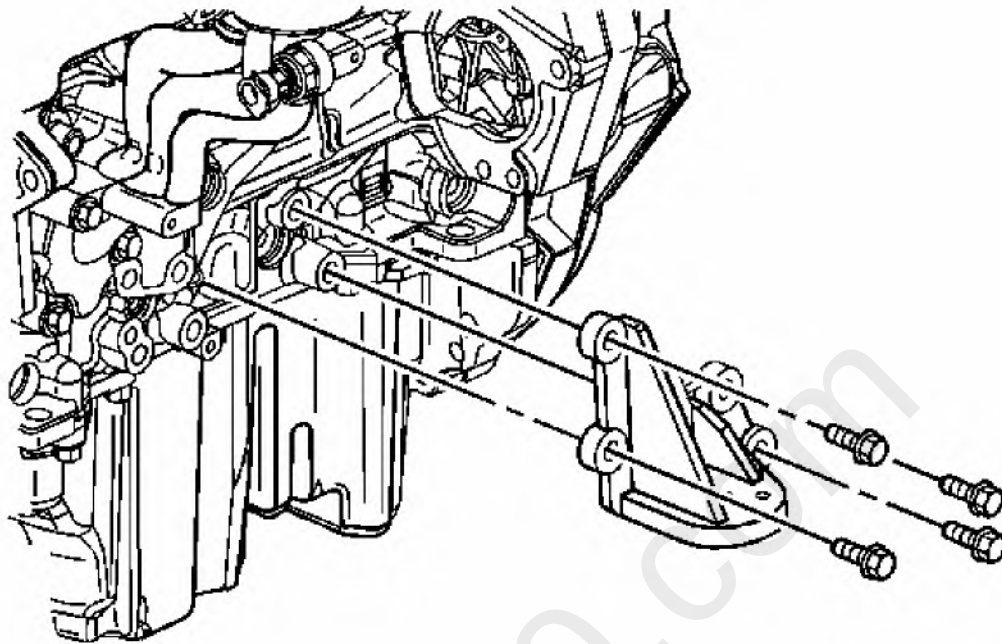


Fig. 31: View Of Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the left engine mount bracket.

NOTE: Refer to Fastener Notice .

2. Install the left engine mount bracket retaining bolts.

Tighten: Tighten the bolts to 60 N.m (44 lb ft).

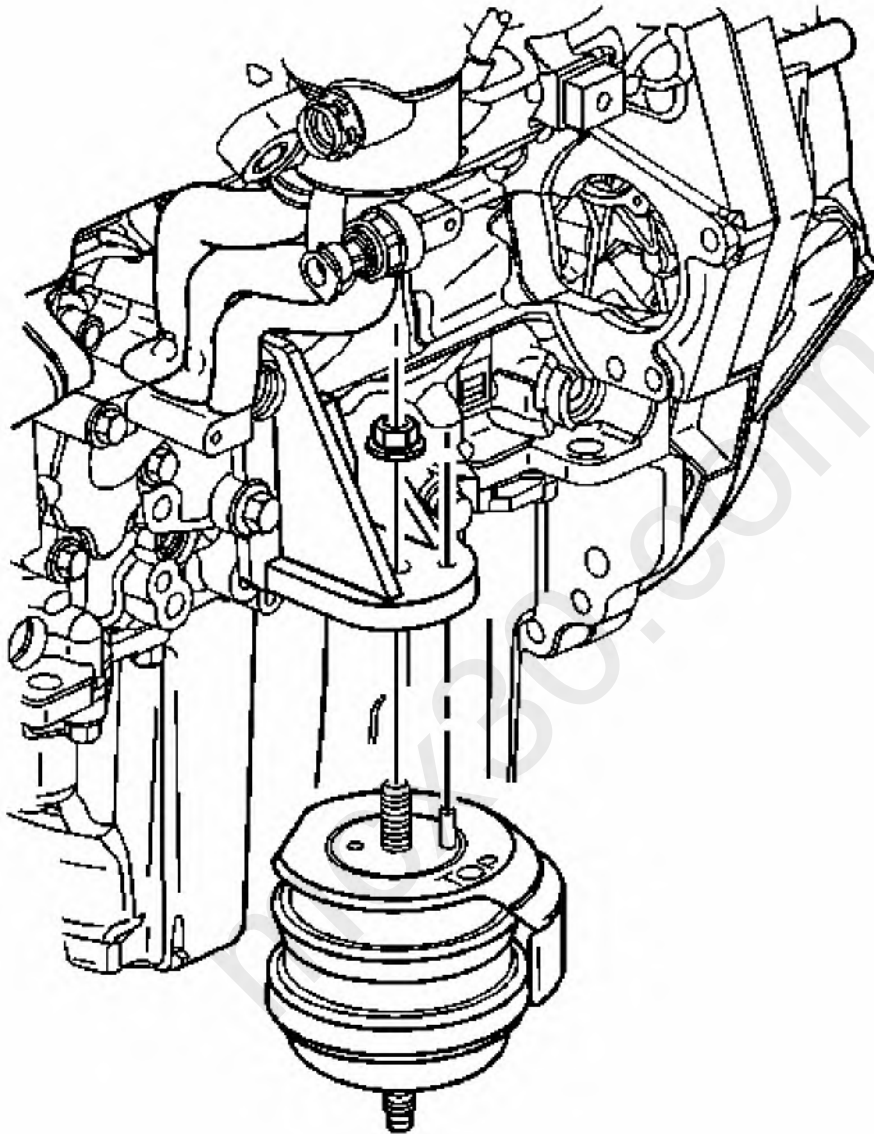


Fig. 32: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount to the vehicle.
4. Install the upper engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

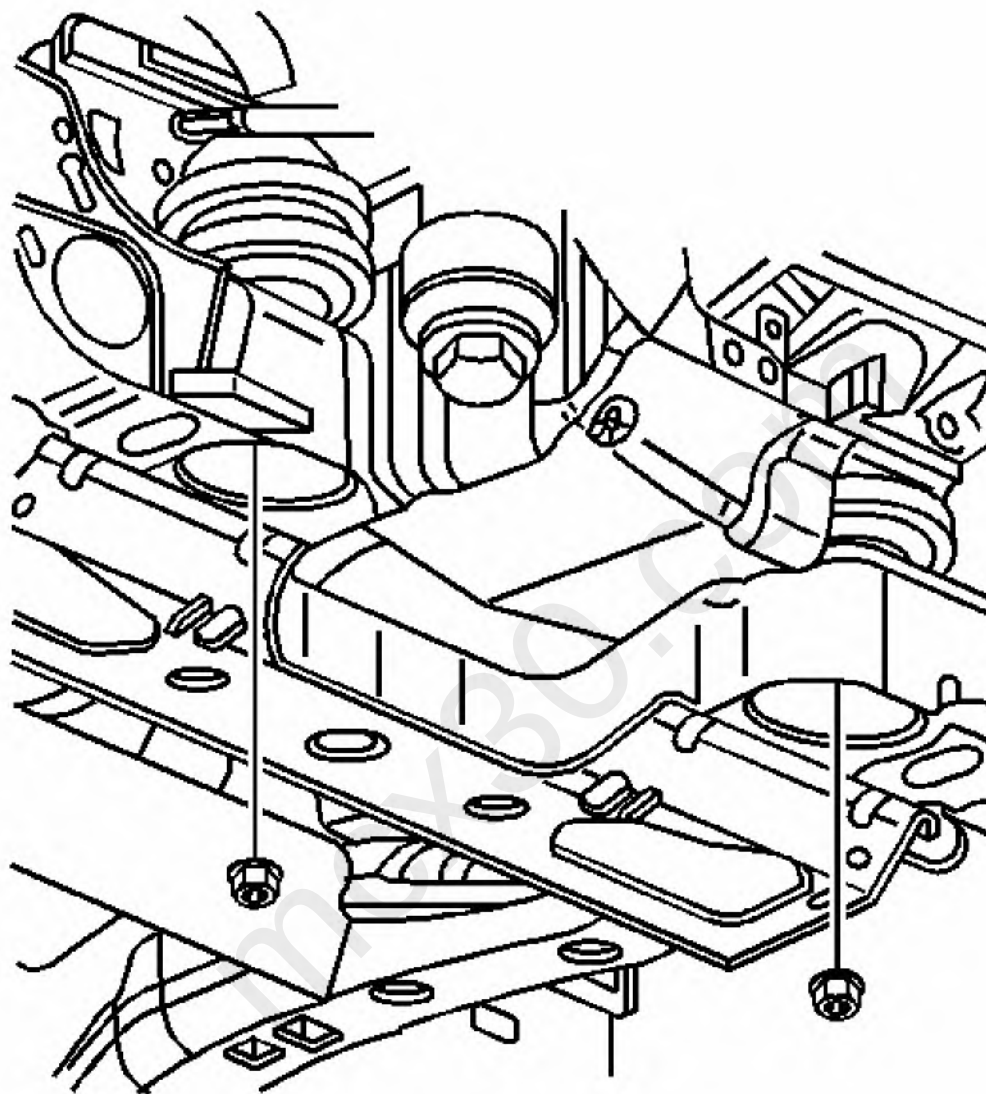


Fig. 33: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

5. Lower the engine using the screw jack until the weight is resting on the mount.
6. Install the engine mount lower retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

7. Remove the screw jack and block of wood from under the oil pan.
8. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (W/RWD)

REMOVAL PROCEDURE

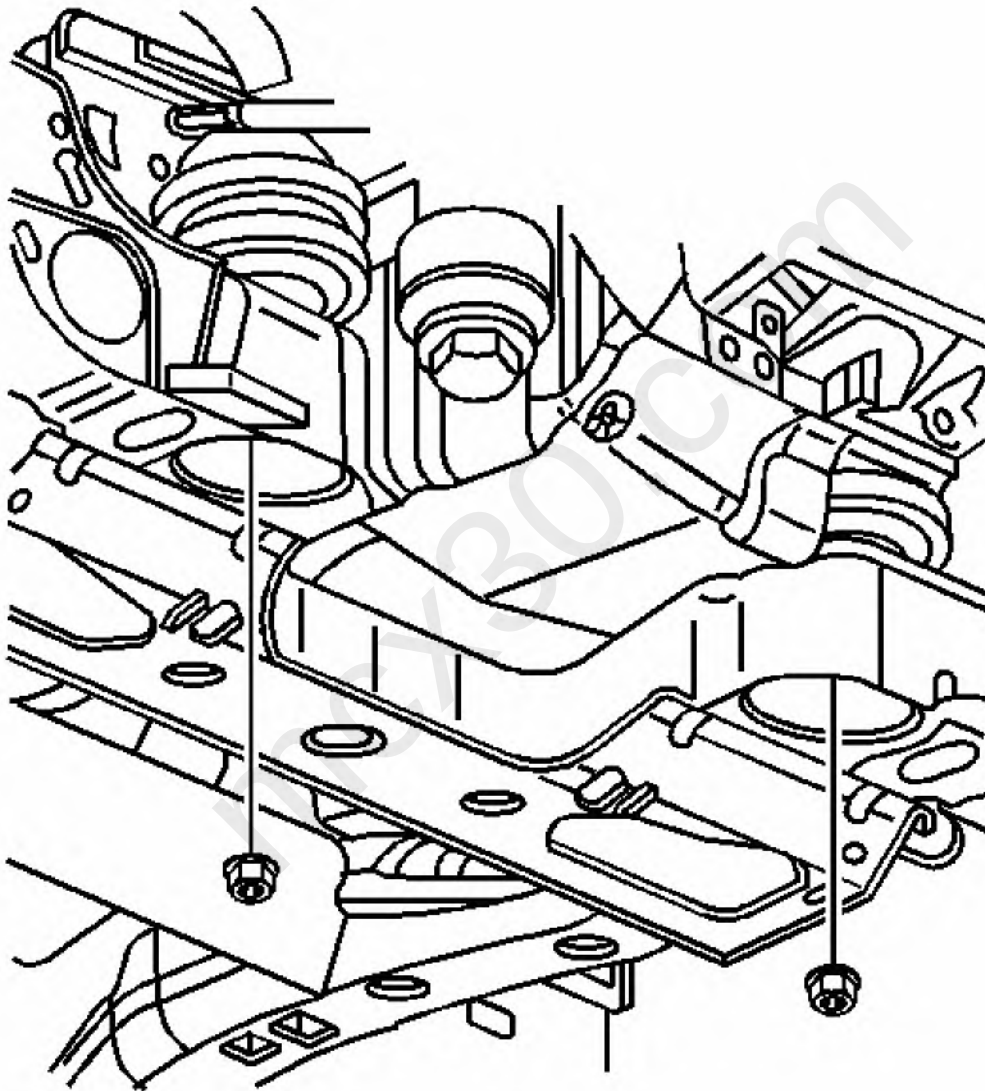


Fig. 34: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Install a screw jack with a block of wood under the oil pan for support.
3. Remove the lower engine mount retaining nut.

4. Raise the engine using the screw jack until the weight is removed from the mount.

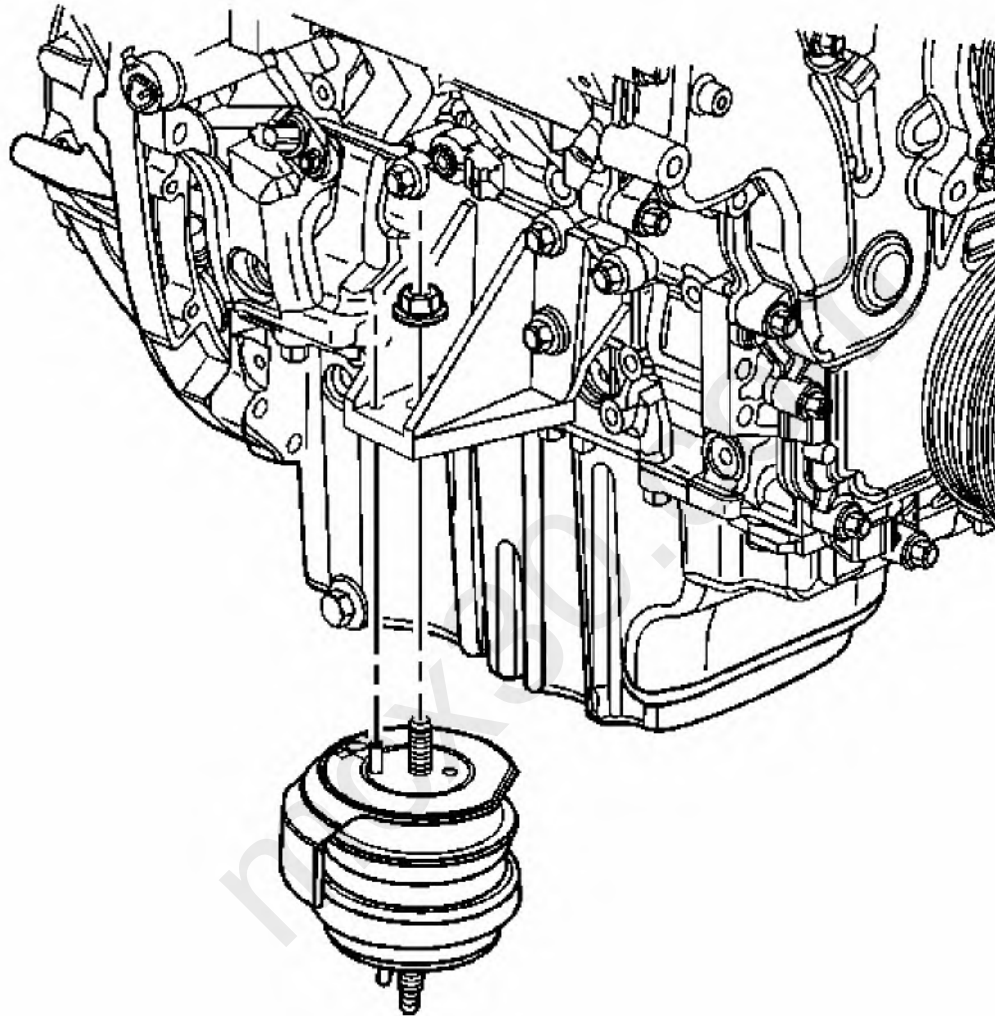


Fig. 35: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the upper engine mount retaining nut.
6. Remove the engine mount from the vehicle.
7. Remove the starter. Refer to **Starter Motor Replacement (LY7)** or **Starter Motor Replacement (LH2)** or **Starter Motor Replacement (LC3)** .

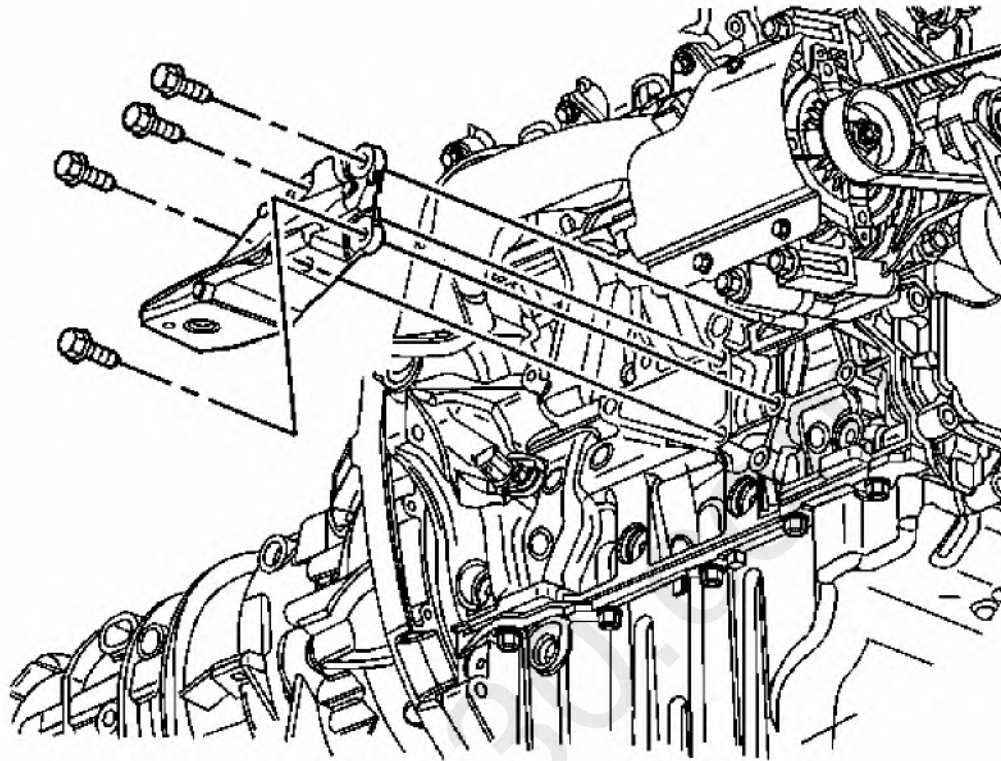


Fig. 36: View Of Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure not to distort or bend the engine mount heat shield.

8. Remove the right engine mount bracket mounting bolts.
9. Remove the engine mount bracket from the vehicle.

INSTALLATION PROCEDURE

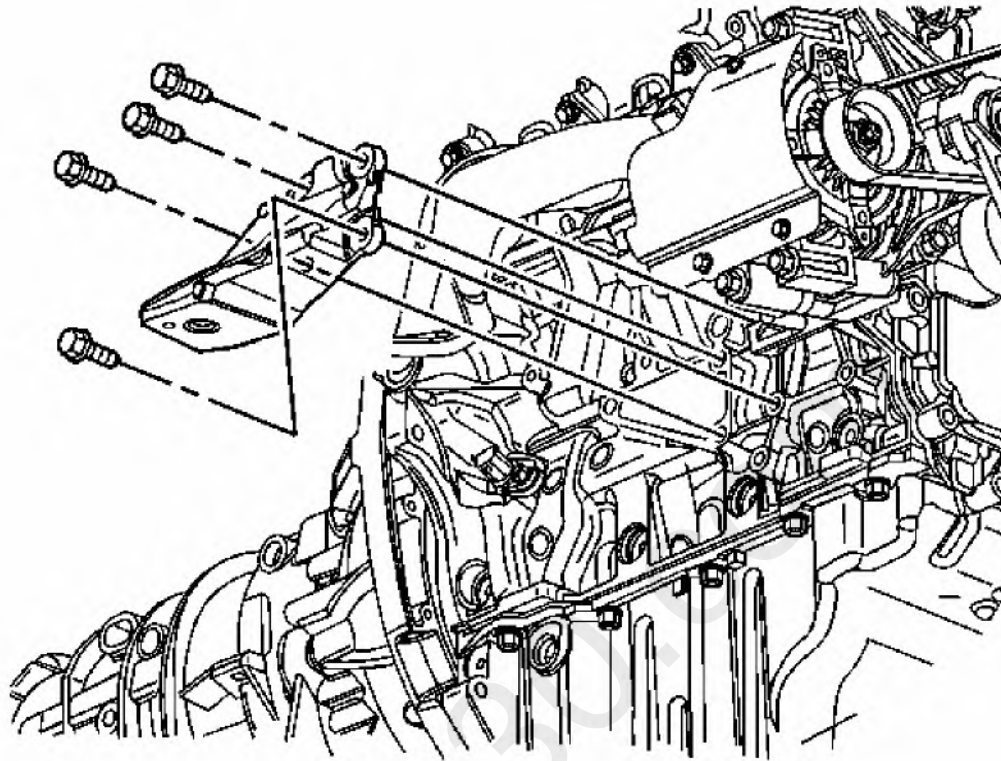


Fig. 37: View Of Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket to the vehicle.

NOTE: Refer to Fastener Notice .

2. Tighten the engine mount bracket mounting bolts.

Tighten: Tighten the bolts to 60 N.m (44 lb ft).

3. Install the starter. Refer to Starter Motor Replacement (LY7) or Starter Motor Replacement (LH2) or Starter Motor Replacement (LC3) .

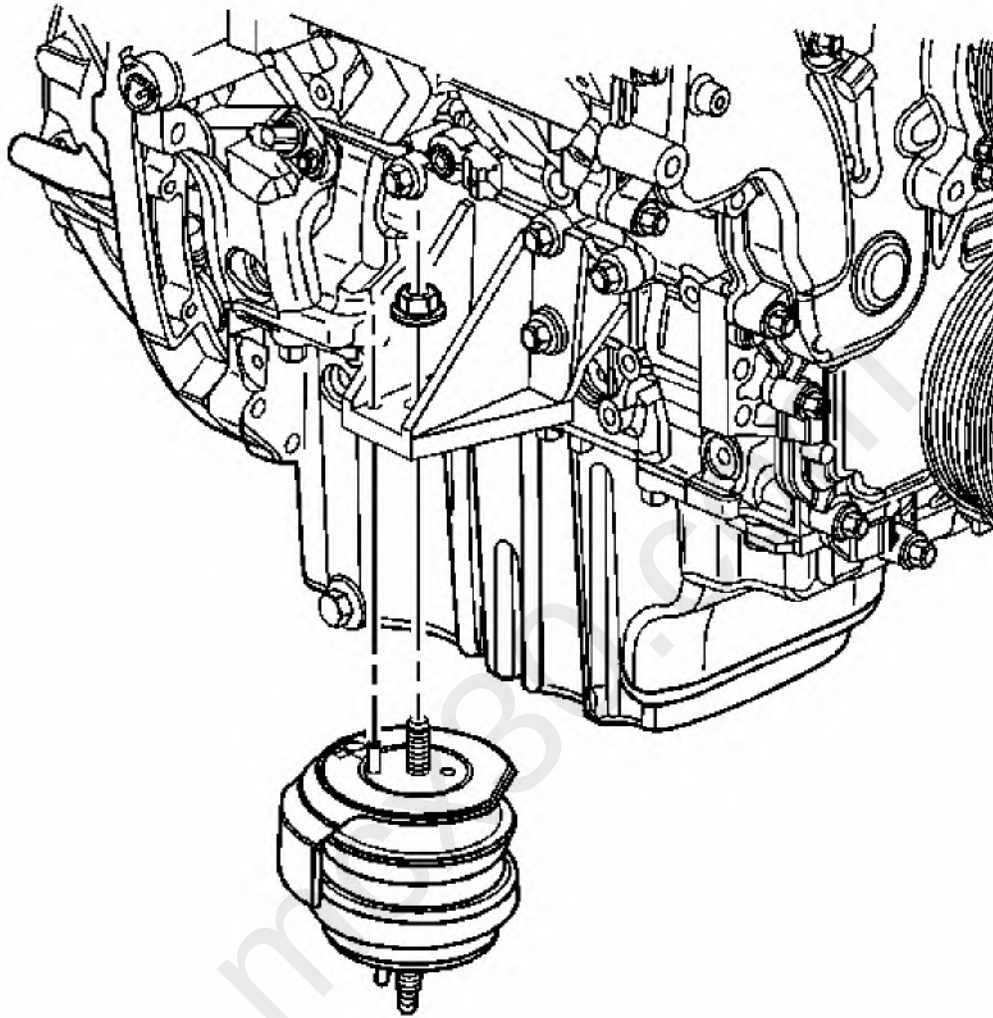


Fig. 38: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount to the vehicle.
5. Install the upper engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

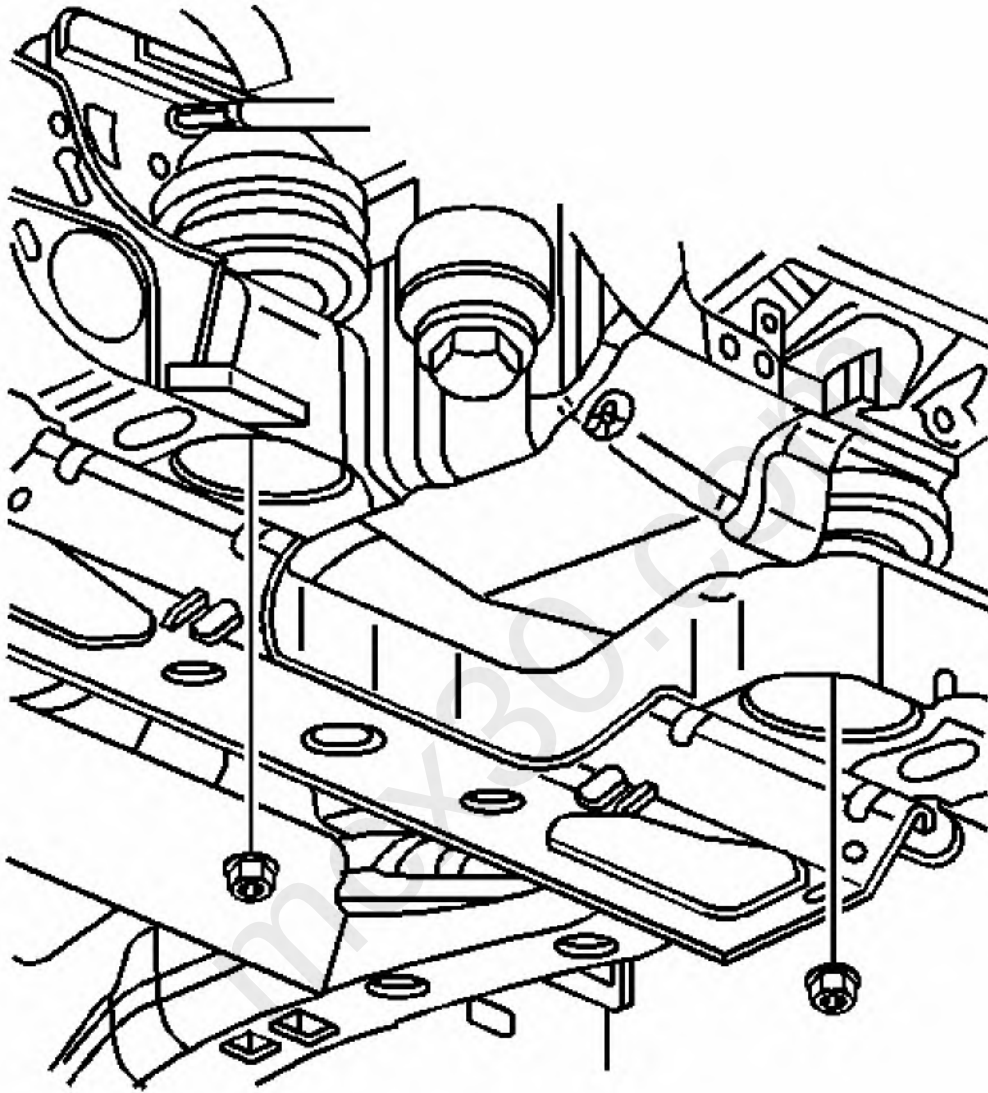


Fig. 39: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

6. Lower the engine using the jack screw until the weight is resting on the mount.
7. Install the engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

8. Remove the screw jack and block of wood from under the oil pan.
9. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (W/AWD)

REMOVAL PROCEDURE

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the right exhaust manifold. Refer to **Exhaust Manifold Removal - Right Side (RWD)** or **Exhaust Manifold Removal - Right Side (AWD)** .
3. Install a screw jack with a block of wood under the oil pan for support.

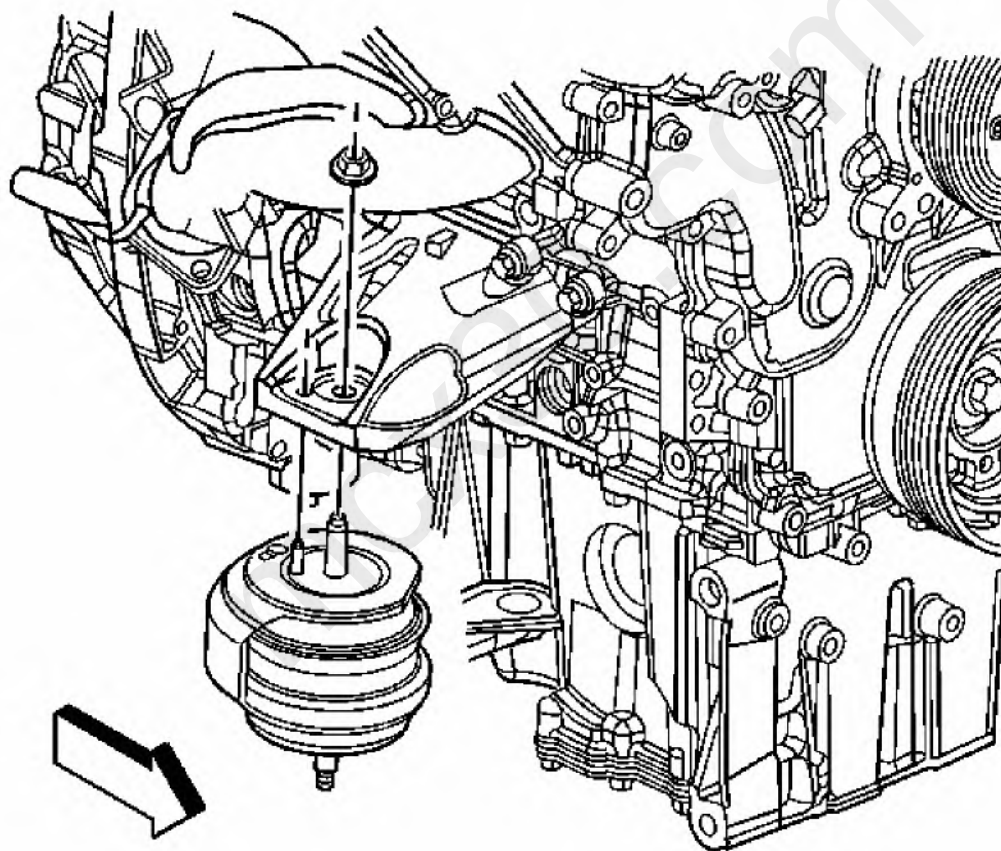


Fig. 40: View Of Right Engine Mount Upper Retaining Nut
Courtesy of GENERAL MOTORS CORP.

4. Remove the right engine mount upper retaining nut.

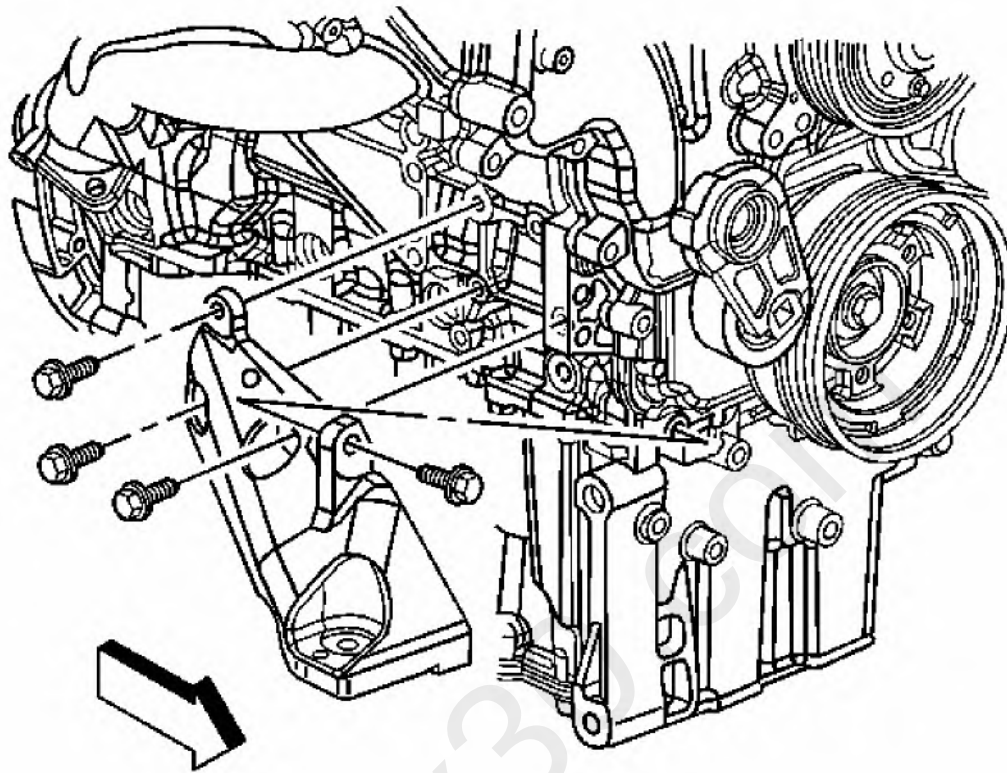


Fig. 41: View Of Right Engine Mount Bracket Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure not to distort or bend the engine mount heat shield.

5. Remove the right engine mount bracket mounting bolts.
6. Remove the engine mount bracket from the vehicle.

INSTALLATION PROCEDURE

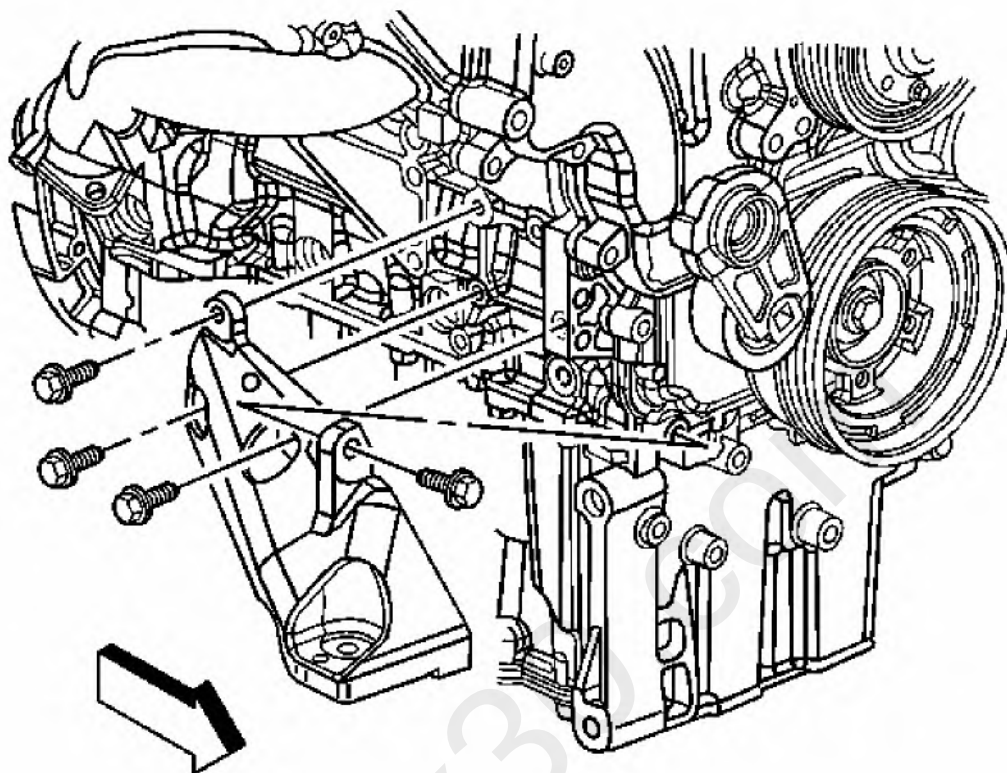


Fig. 42: View Of Right Engine Mount Bracket Mounting Bolts
 Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket to the vehicle.

NOTE: Refer to Fastener Notice .

2. Install the M 10 engine mount bracket mounting bolts.

Tighten: Tighten the bolts to 60 N.m (44 lb ft).

3. Tighten the M 8 engine mount bracket mounting bolt.

Tighten: Tighten the bolts to 38 N.m (28 lb ft).

4. Remove the screw jack.

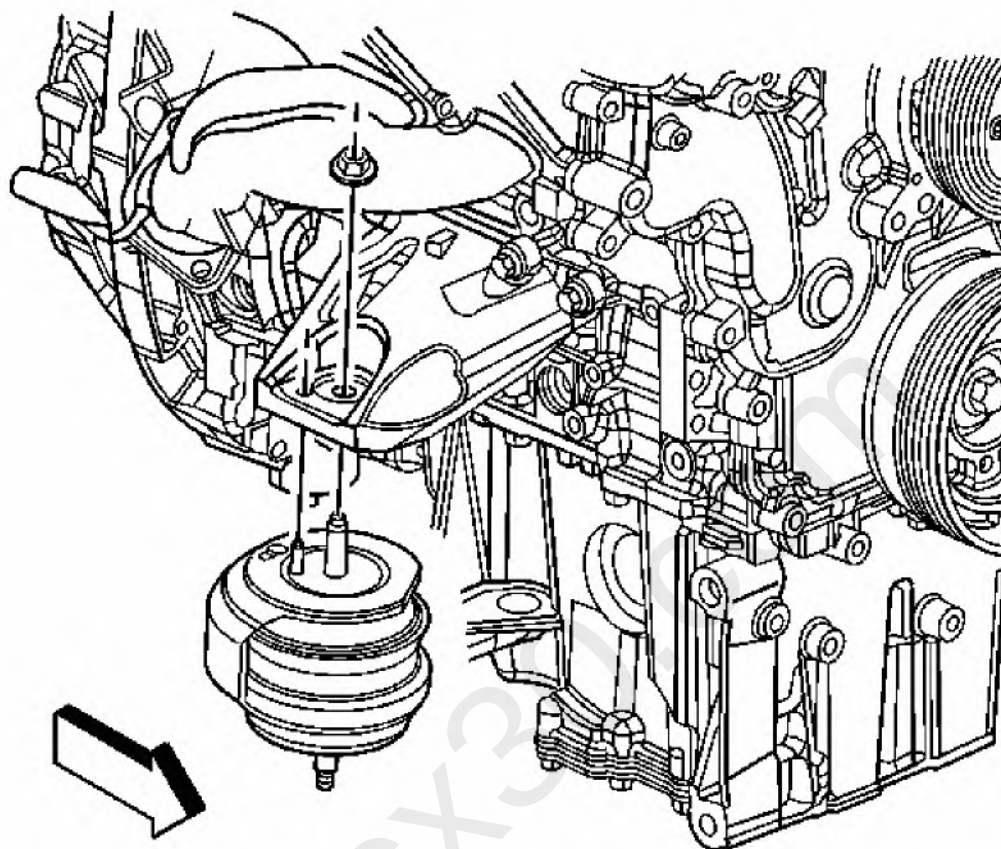


Fig. 43: View Of Right Engine Mount Upper Retaining Nut
Courtesy of GENERAL MOTORS CORP.

5. Install the upper engine mount retaining nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

6. Install the right exhaust manifold. Refer to Exhaust Manifold Removal - Right Side (RWD) or Exhaust Manifold Removal - Right Side (AWD)
7. Lower the vehicle.

FUEL INJECTOR SIGHT SHIELD REPLACEMENT

REMOVAL PROCEDURE

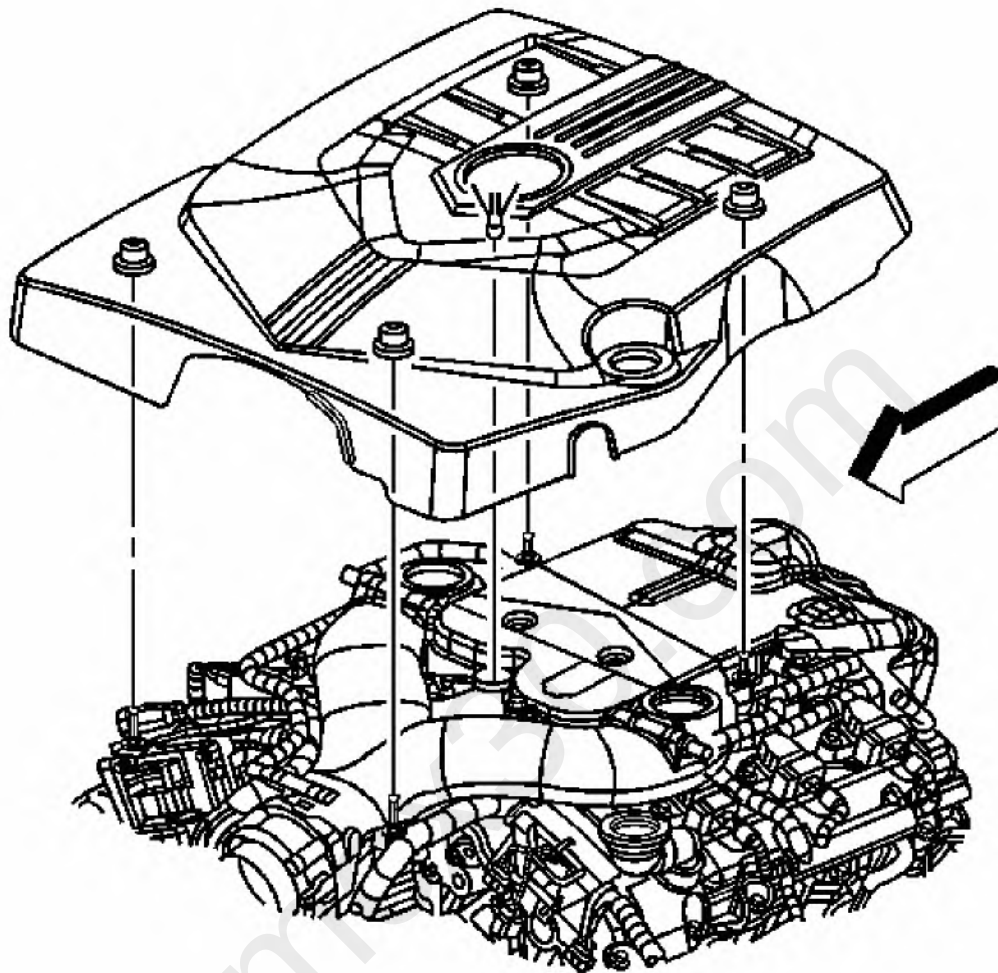


Fig. 44: View Of Engine Cover/Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the cross car brace, if necessary. Refer to **Cross Vehicle Brace Replacement (DX)** .
2. Remove the oil fill cap.
3. Disengage the cover/shield from the ball studs by pulling up firmly on the right rear and left front of the engine cover.
4. Remove the engine cover/sight shield.
5. Remove the front compartment sight shield, if necessary. Refer to **Front Compartment Sight Shields Replacement** .

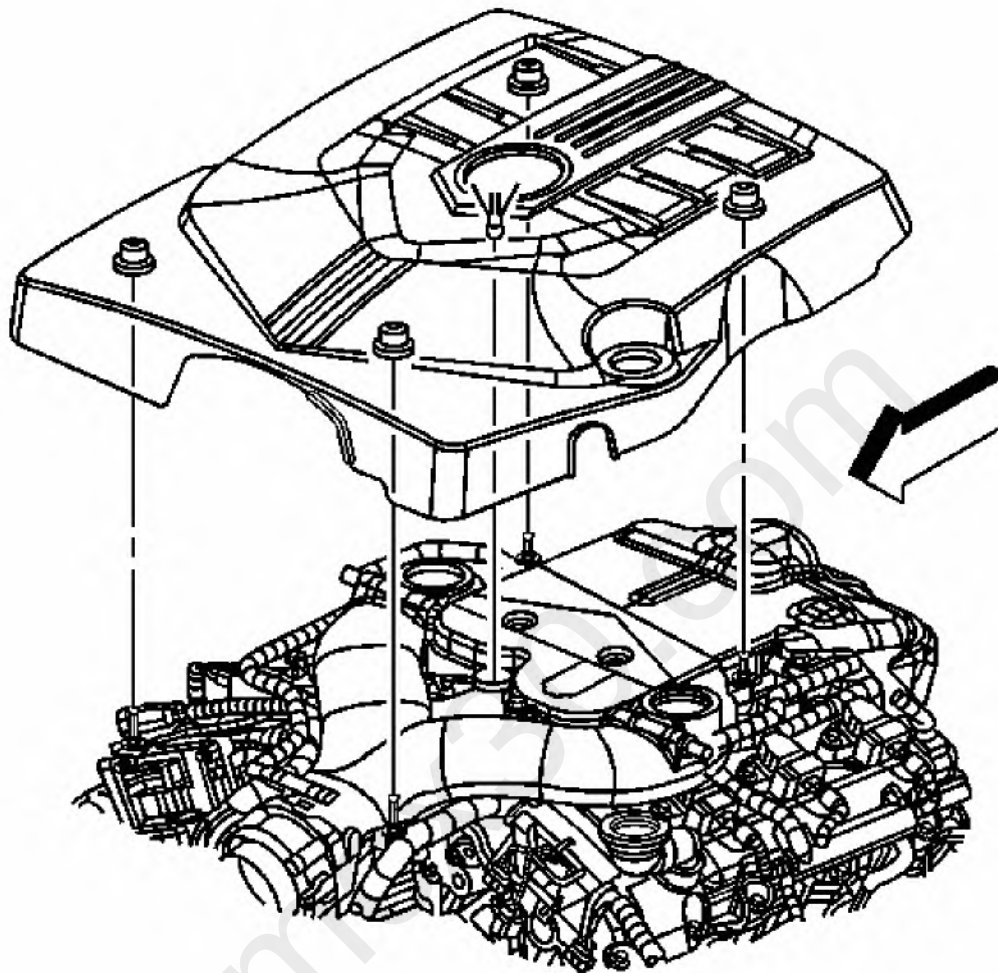


Fig. 45: View Of Engine Cover/Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Install the front compartment sight shield, if necessary. Refer to **Front Compartment Sight Shields Replacement** .
2. Position the engine cover/sight shield over the intake manifold so the grommets are aligned with the ball studs.
3. Press the engine cover/sight shield down firmly near the ball studs in order to install the engine cover/sight shield.
4. Install the oil fill cap.
5. Install the cross car brace, if necessary. Refer to **Cross Vehicle Brace Replacement (DX)** .

CRANKCASE VENTILATION HOSES/PIPES REPLACEMENT

REMOVAL PROCEDURE

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

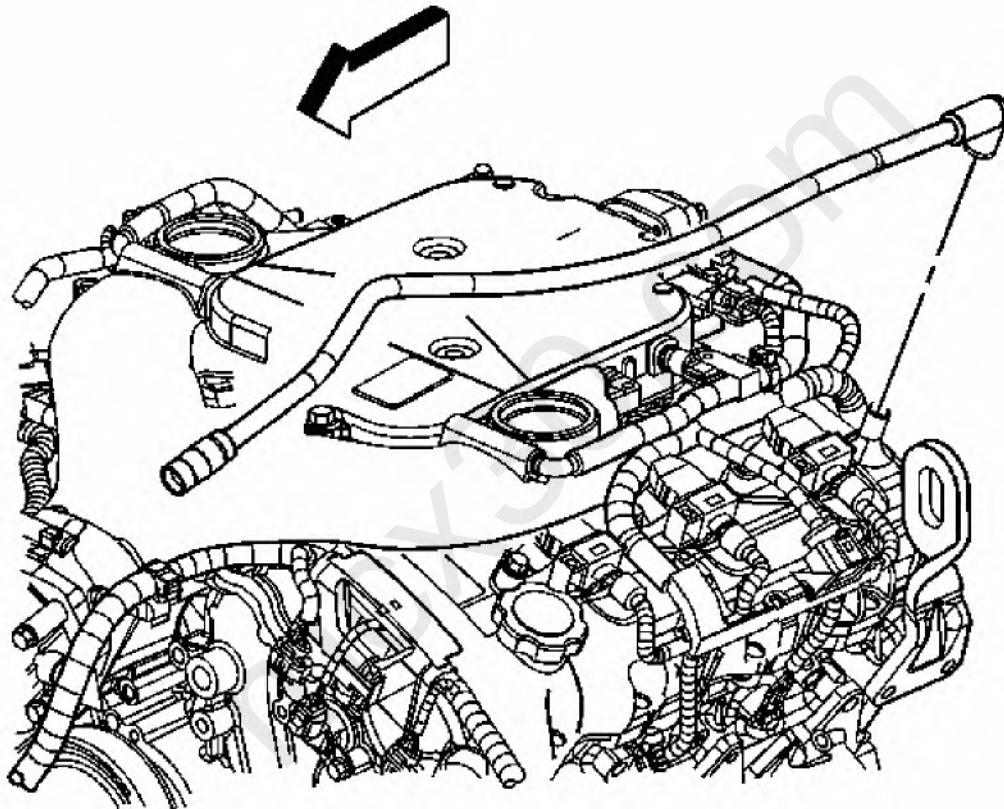


Fig. 46: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the positive crankcase ventilation (PCV) fresh air tube from the left camshaft cover.
3. Remove the PCV fresh air tube from the air inlet.

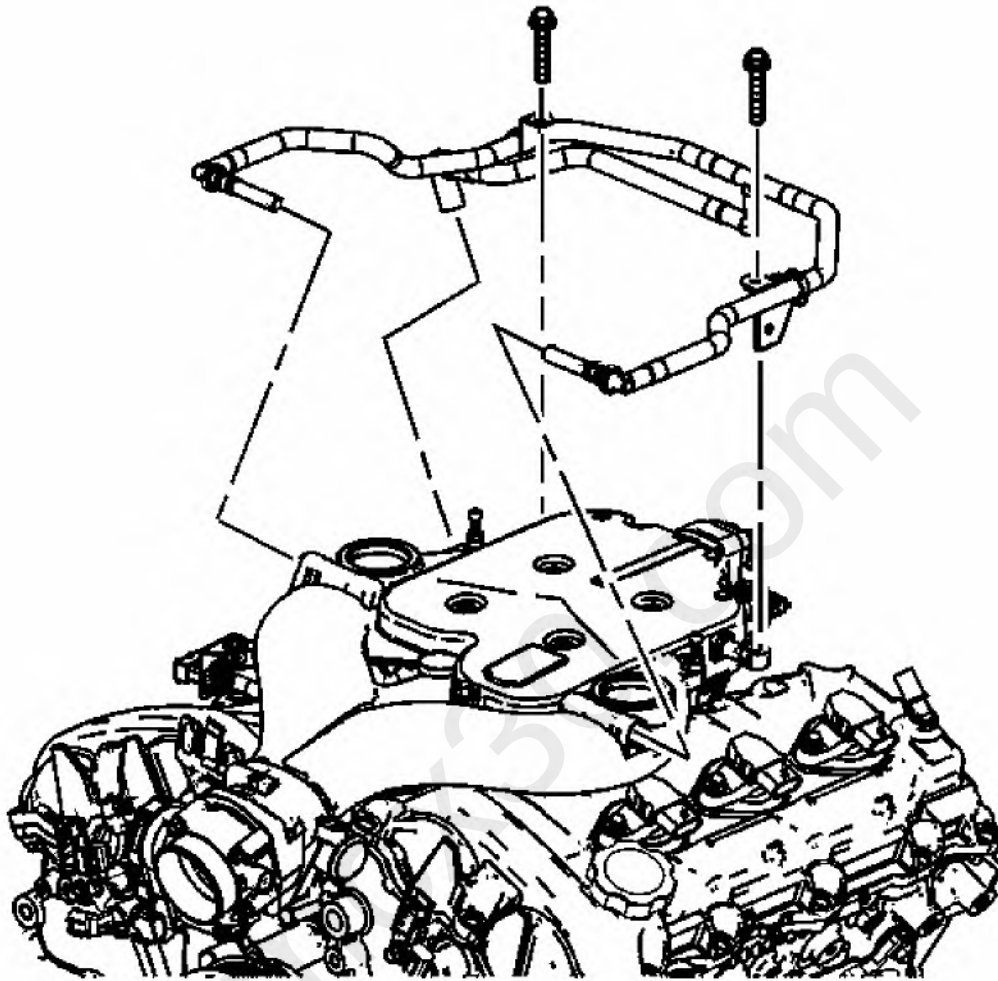


Fig. 47: View Of PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Remove the PCV tube bracket bolts.
5. Remove the PCV dirty air tube from the right camshaft cover.
6. Remove the PCV dirty air tube from the intake manifold.

INSTALLATION PROCEDURE

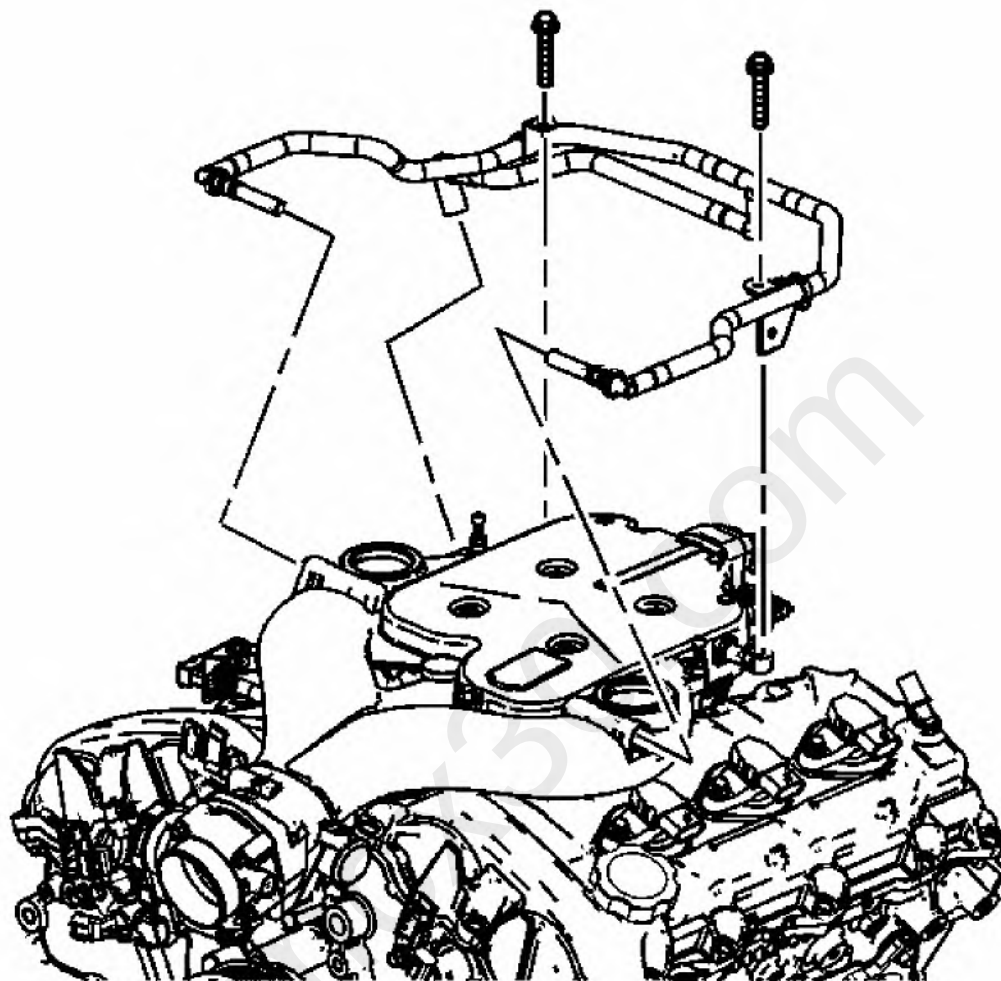


Fig. 48: View Of PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV dirty air tube to the intake manifold.
2. Install the PCV dirty air tube to the right camshaft cover.

NOTE: Refer to Fastener Notice .

3. Install the PCV tube bracket bolts.

Tighten: Tighten the PCV tube bracket bolts to 10 N.m (89 lb in).

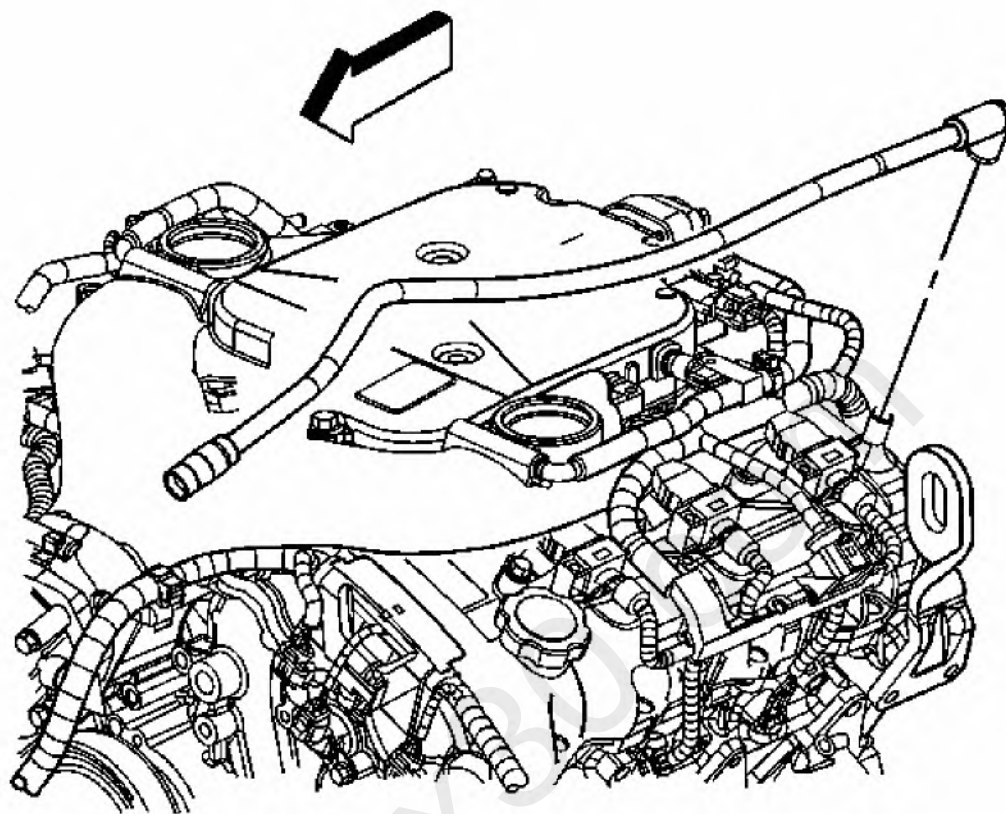


Fig. 49: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Install the PCV fresh air tube to the air inlet.
5. Install the PCV fresh air tube to the left camshaft cover.
6. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

UPPER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

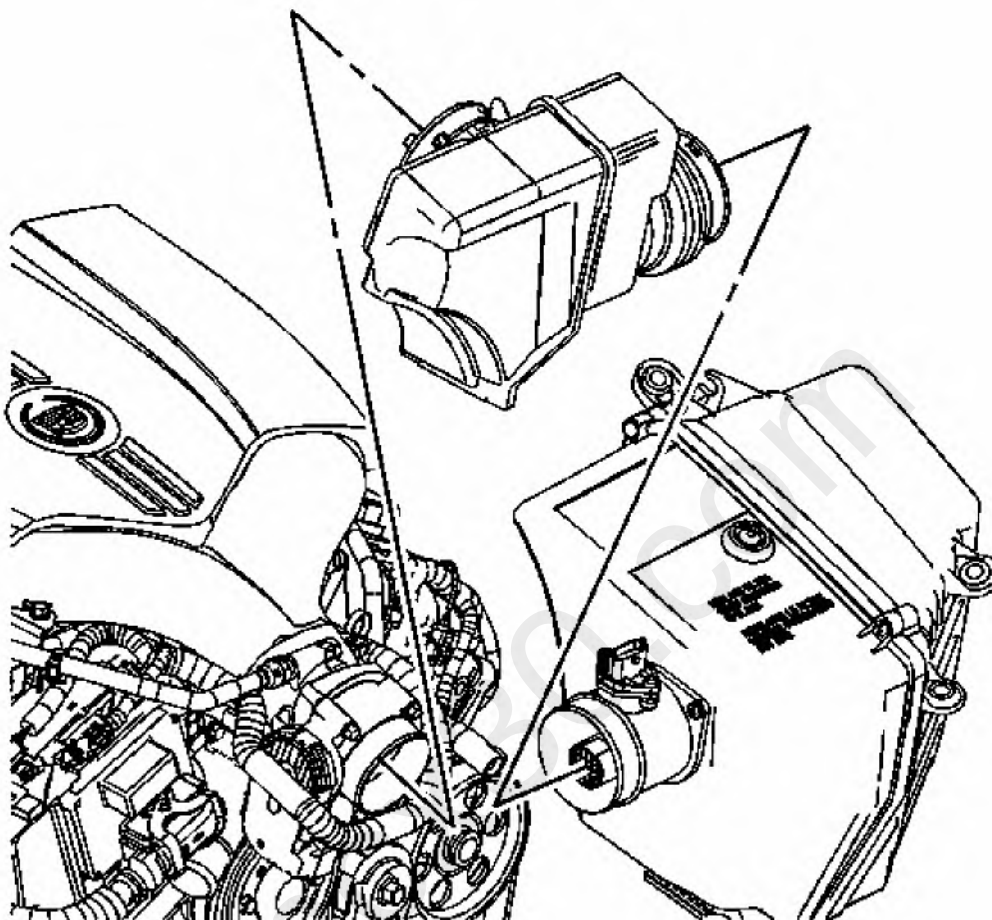


Fig. 50: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

3. Remove the air inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .
4. Disconnect the brake booster vacuum hose from the intake manifold.

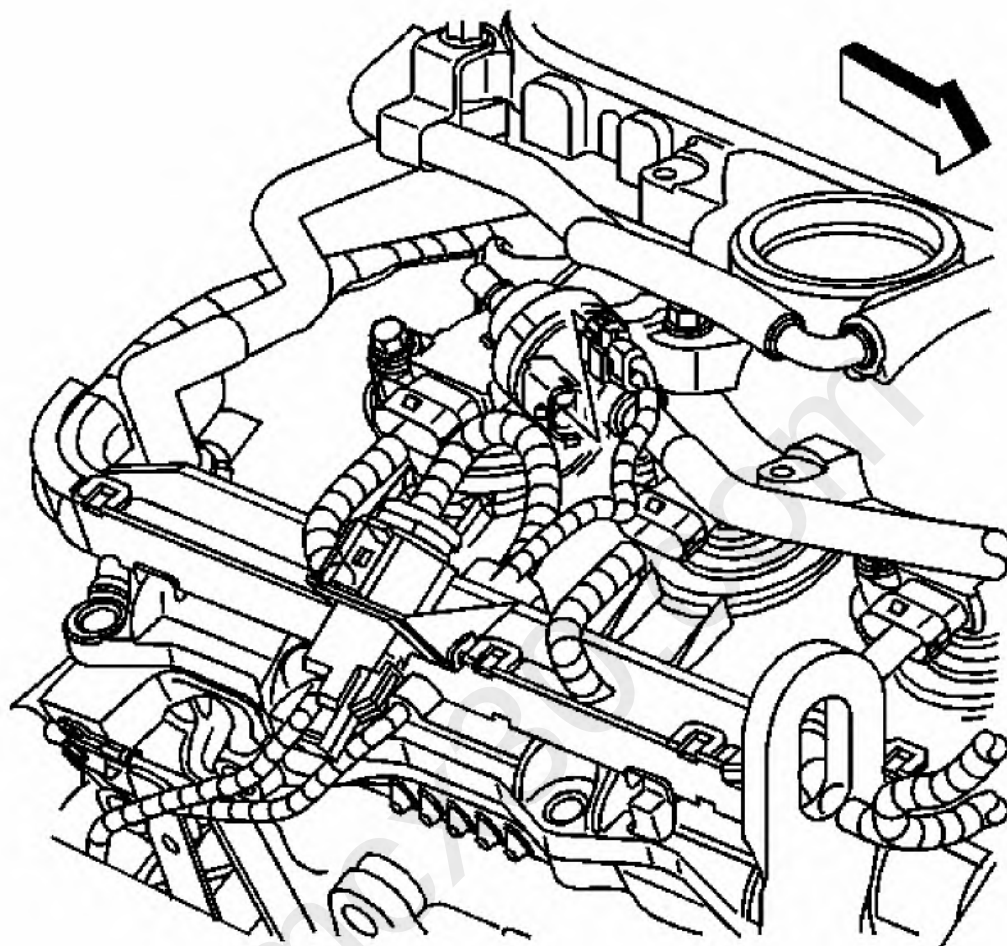


Fig. 51: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the purge solenoid valve electrical connector.

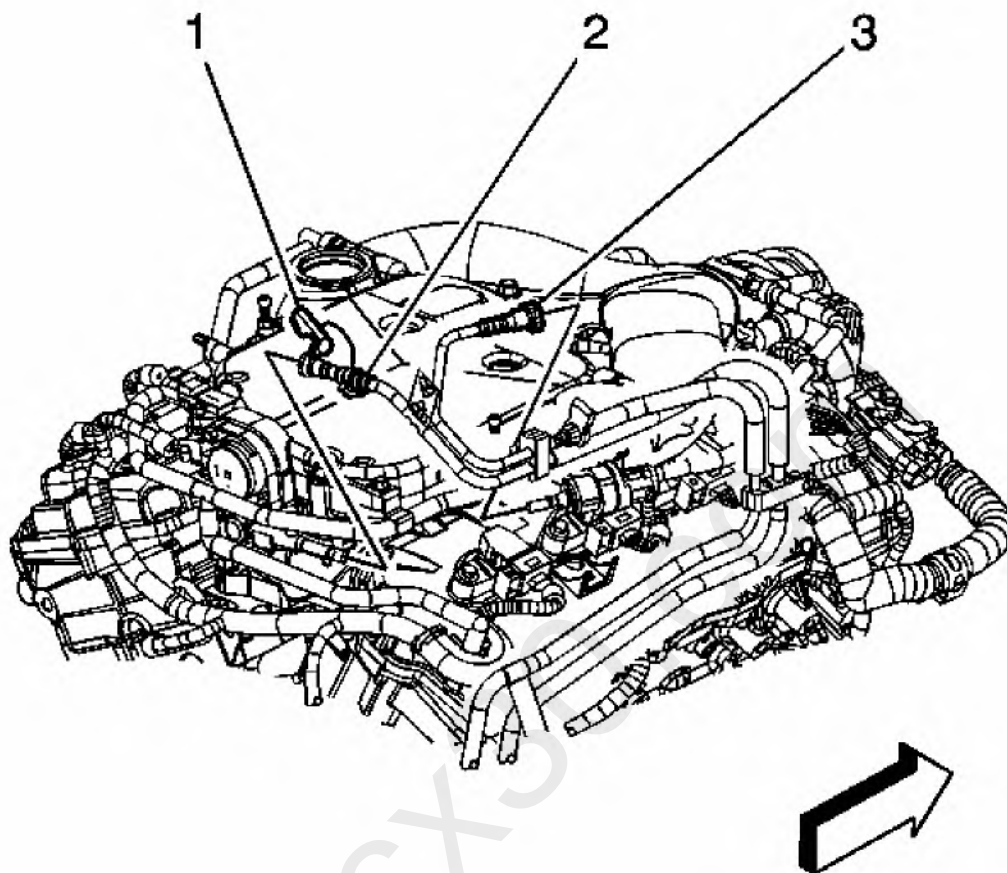


Fig. 52: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the purge line (3) from the purge solenoid valve.

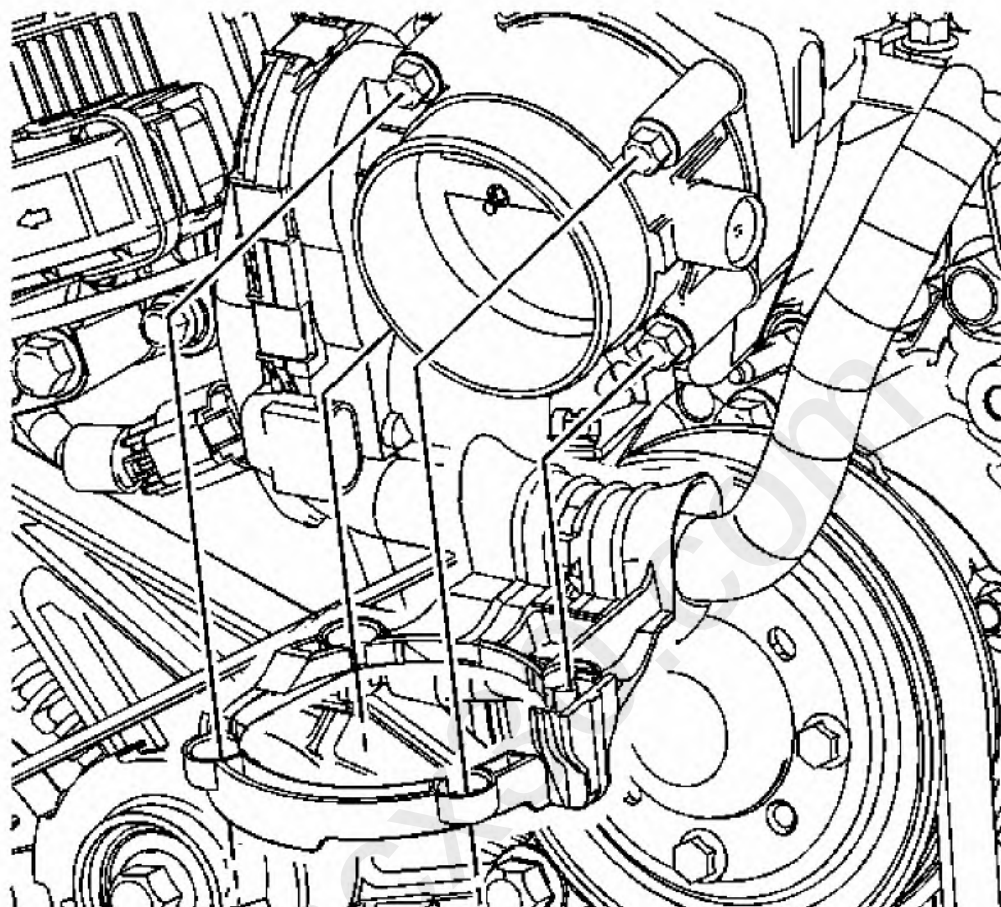


Fig. 53: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

7. Remove the wiring harness retainer.

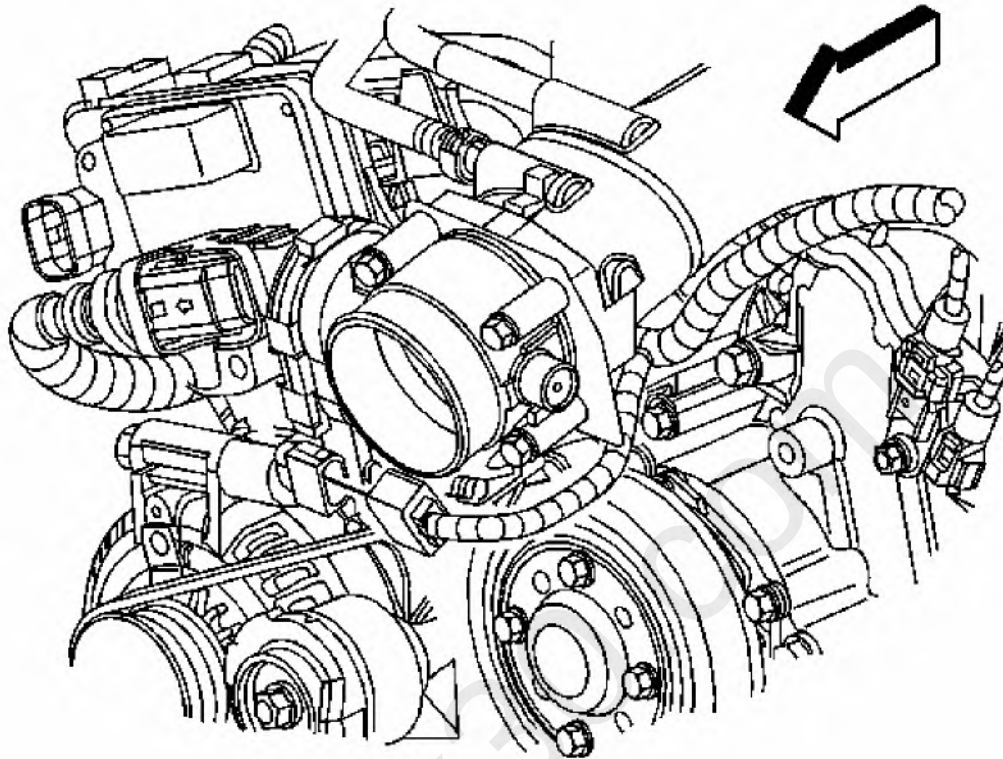


Fig. 54: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the throttle body electrical connector.

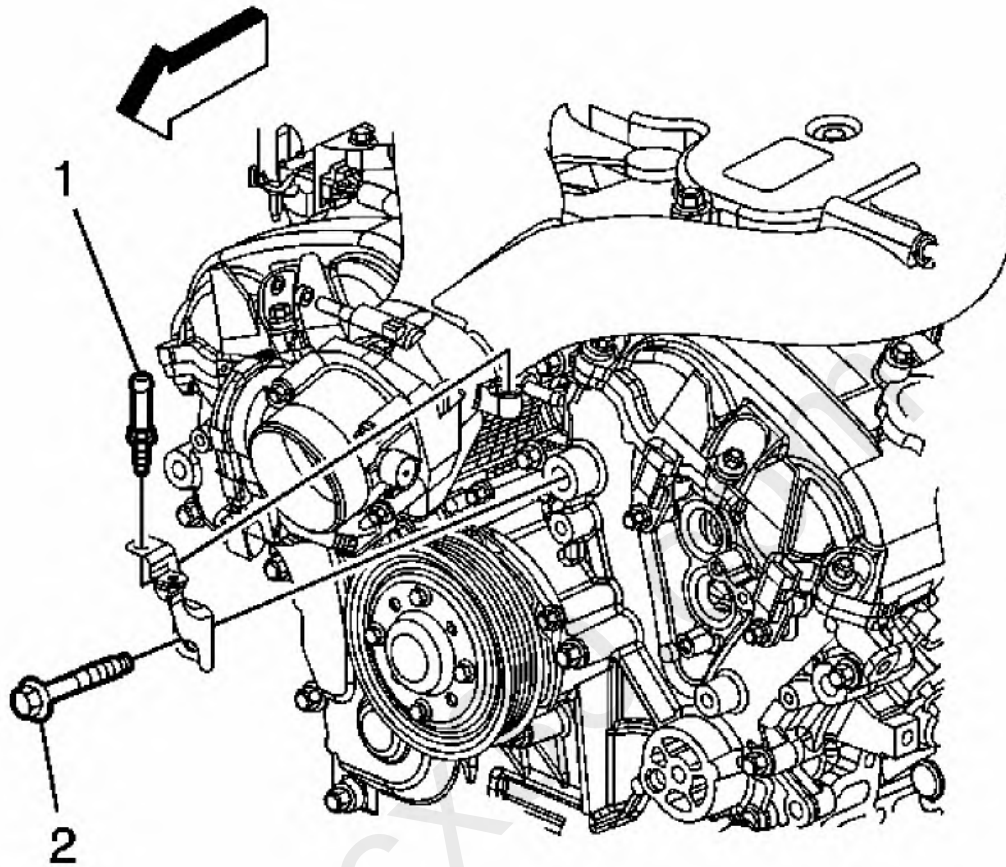


Fig. 55: Identifying Upper Intake Manifold Brace Stud, Bolt & Brace
Courtesy of GENERAL MOTORS CORP.

9. Remove the upper intake manifold brace stud (1), bolt (2), and brace.
10. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

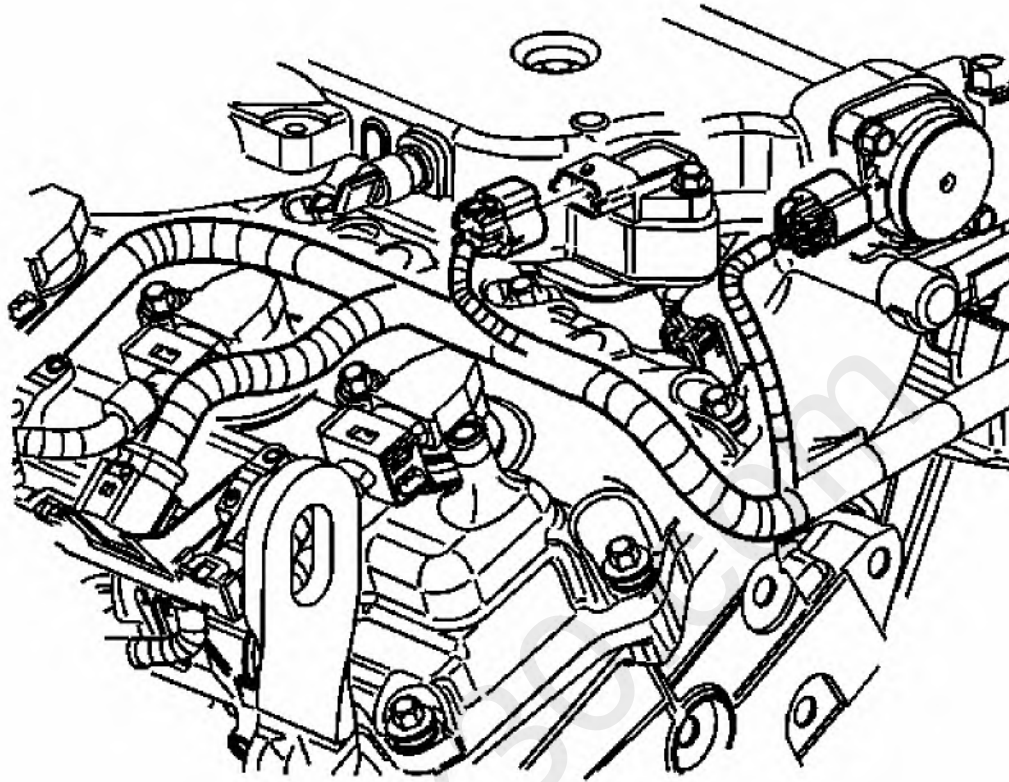


Fig. 56: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the barometric pressure sensor electrical connector.

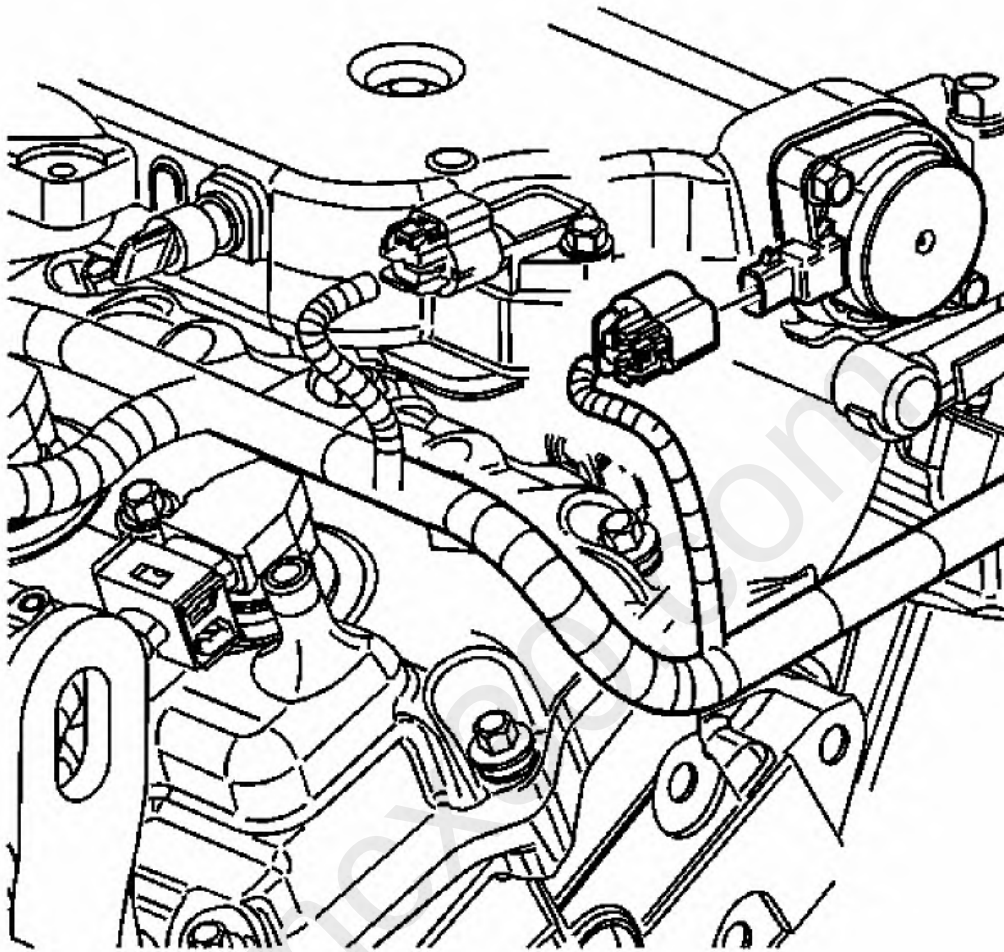


Fig. 57: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

12. Disconnect the intake manifold runner control solenoid electrical connector.

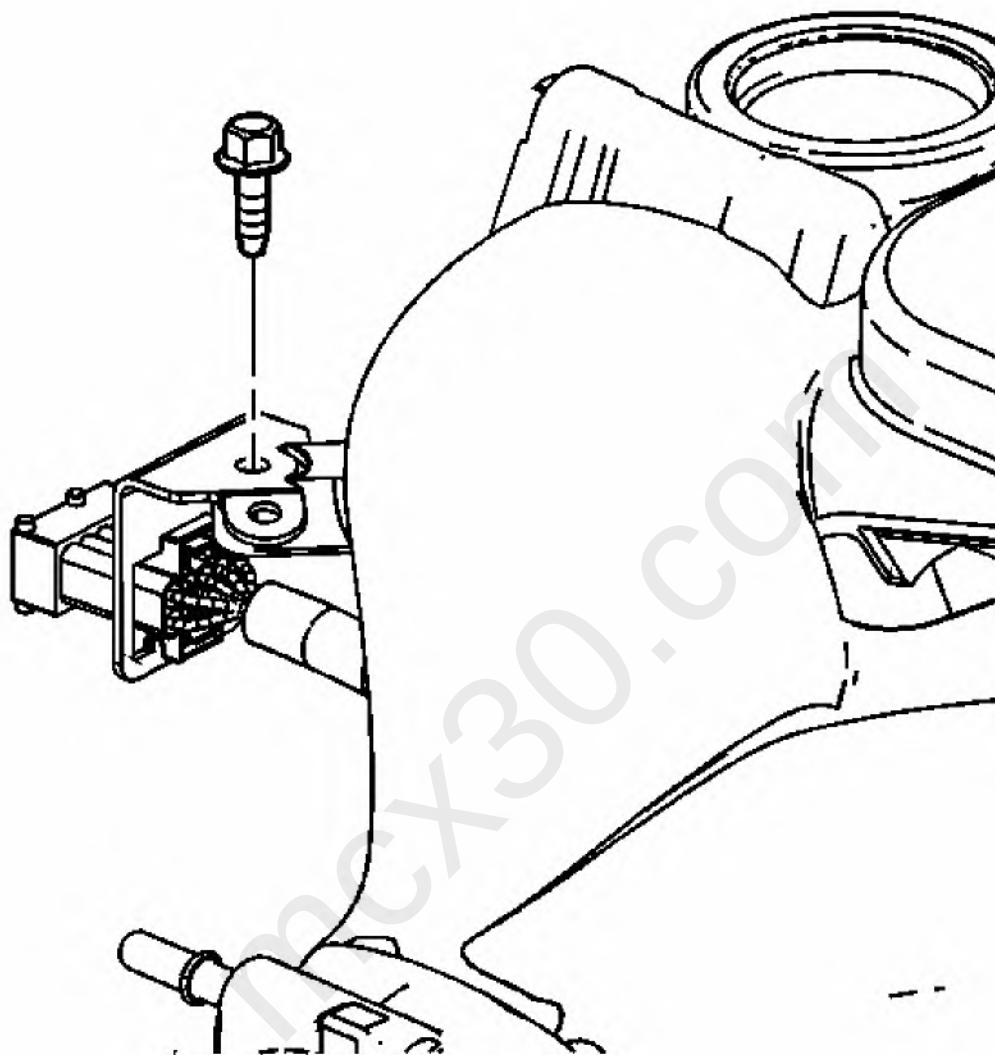


Fig. 58: View Of Injector Harness Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

13. Remove the injector harness bracket bolt.
14. Remove the left bank ignition coil wiring harness from the bracket.

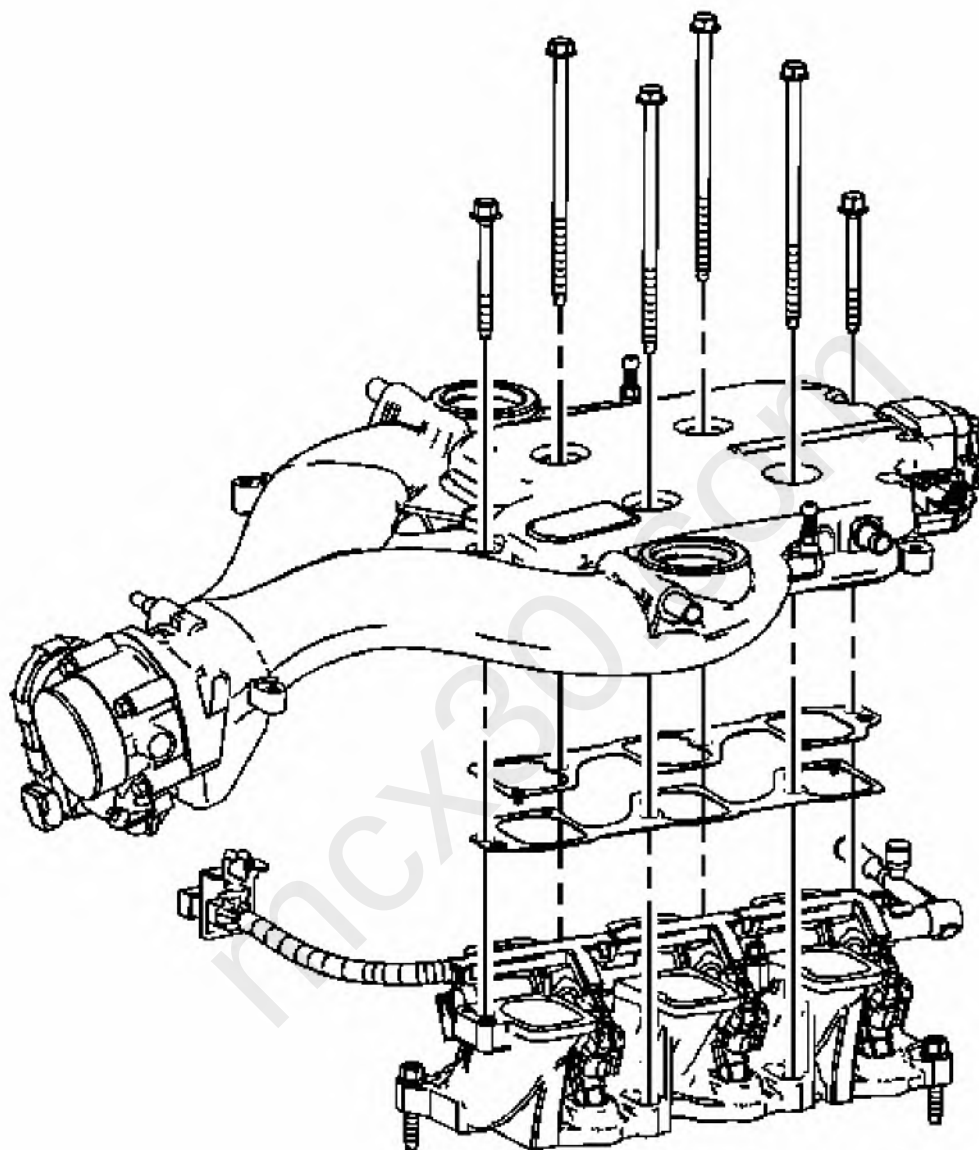


Fig. 59: View Of Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

15. Remove the upper intake manifold bolts. Some deflection of the cowl panel may be necessary to extract the right rear bolt.
16. Remove the upper intake manifold with the throttle body.
17. If the upper intake manifold is being replaced, disassemble the intake manifold. Refer to **Intake Manifold Disassemble** .

18. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

1. If the upper intake manifold is being replaced, assemble the intake manifold. Refer to **Intake Manifold Assemble** .

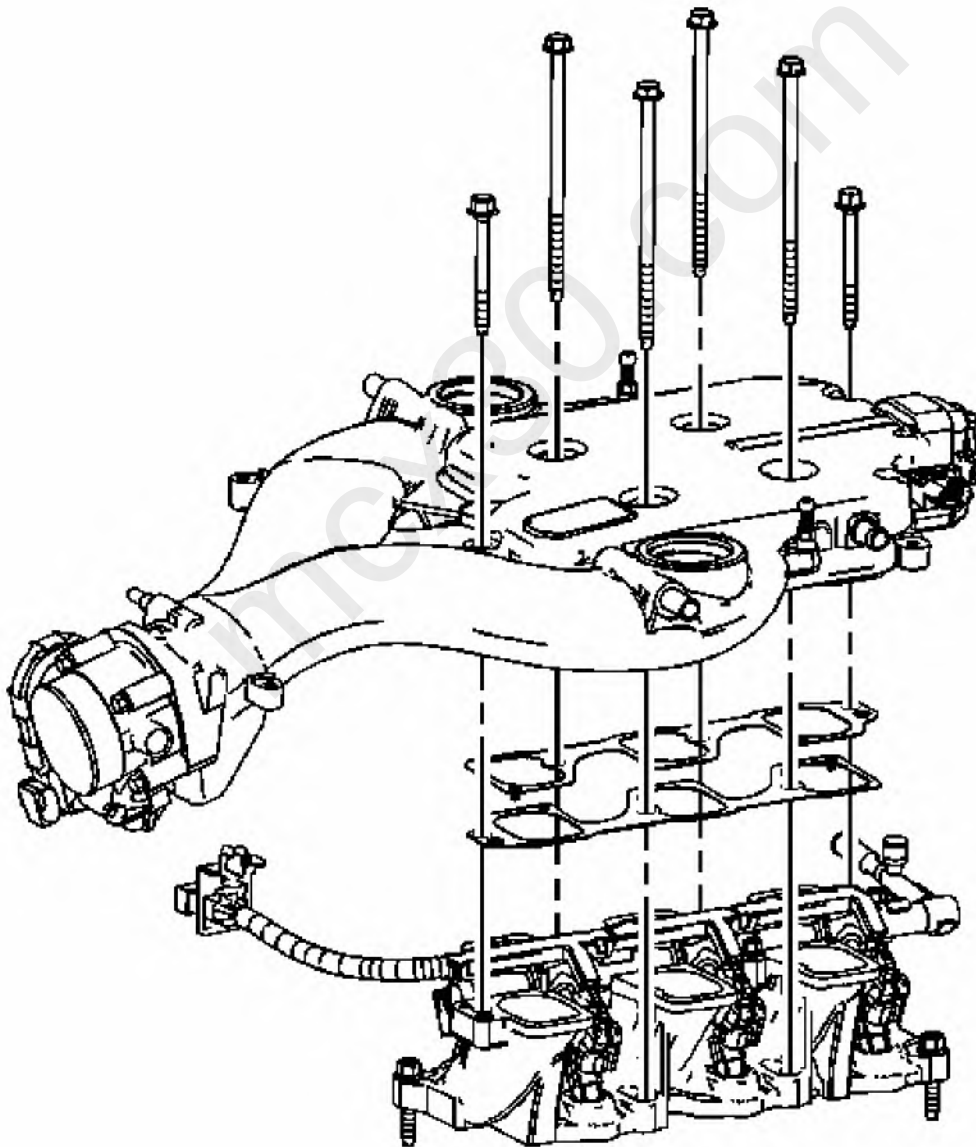


Fig. 60: View Of Upper Intake Manifold

Courtesy of GENERAL MOTORS CORP.

2. Install a NEW upper intake manifold gasket.
3. Install the upper intake manifold.

NOTE: Refer to Fastener Notice .

IMPORTANT: Tighten the intake manifold bolts in a circular pattern starting at the center (long bolts) and moving outward.

4. Install the upper intake manifold bolts.

Tighten: Tighten the upper intake manifold bolts to 23 N.m (17 lb ft).

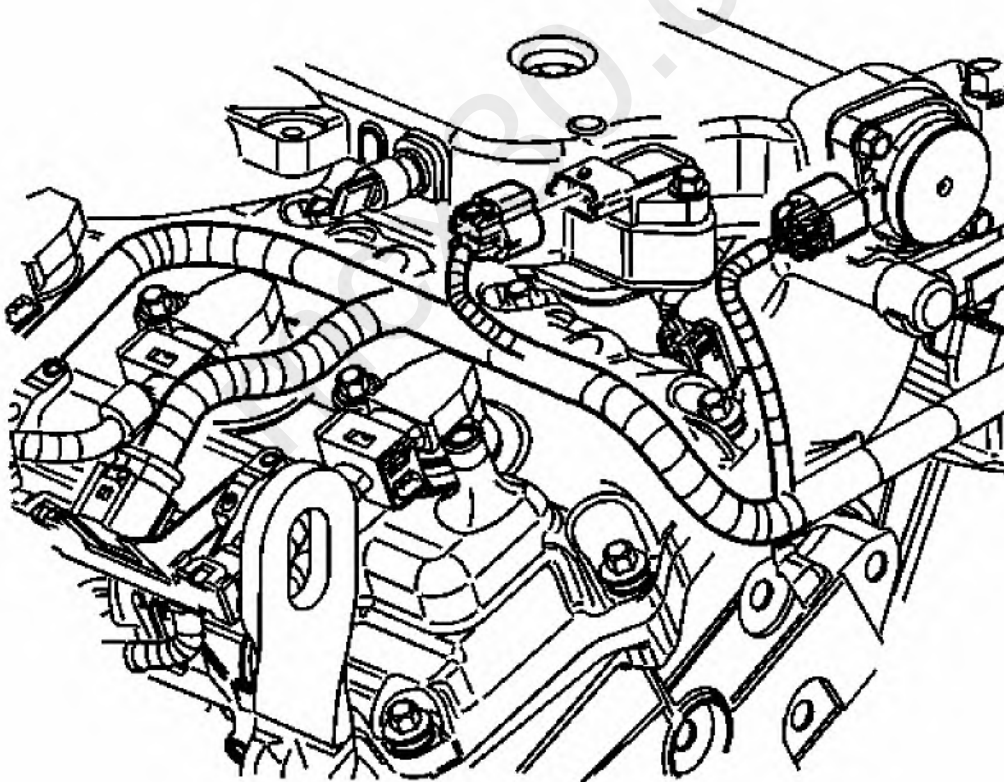


Fig. 61: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the barometric pressure sensor electrical connector.

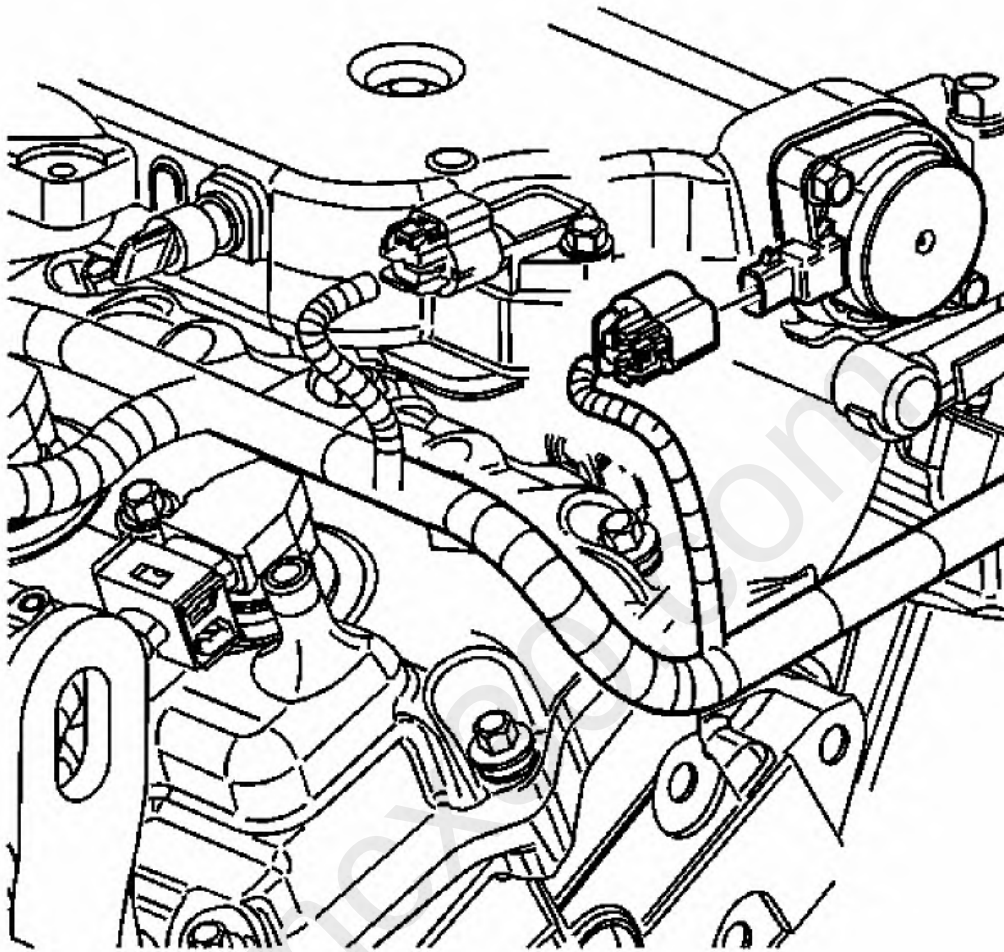


Fig. 62: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

6. Connect the intake manifold runner control solenoid electrical connector.
7. Connect the PCV hose to the right bank camshaft cover.

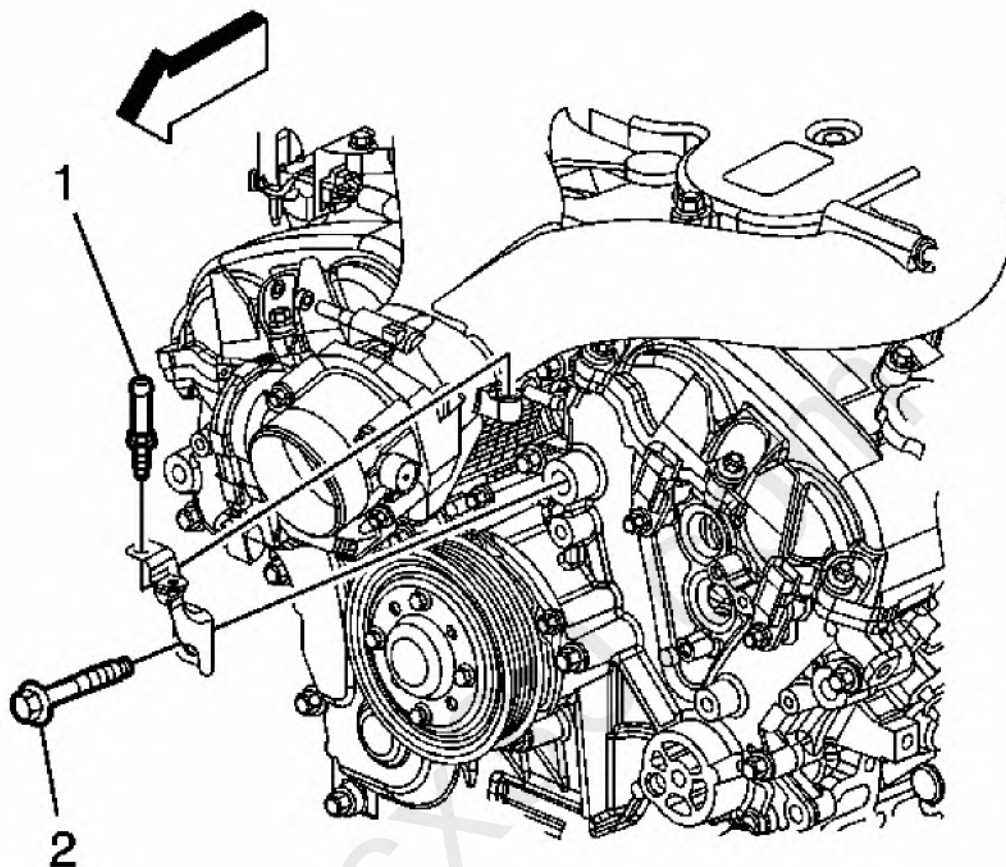


Fig. 63: Identifying Upper Intake Manifold Brace Stud, Bolt & Brace
Courtesy of GENERAL MOTORS CORP.

8. Install the upper intake manifold brace, stud (1) and bolt (2).

Tighten: Tighten the intake manifold brace bolt/stud.

1. Tighten the intake manifold brace bolt (2) to 65 N.m (48 lb ft).
2. Tighten the intake manifold brace stud (1) to 10 N.m (89 lb in).

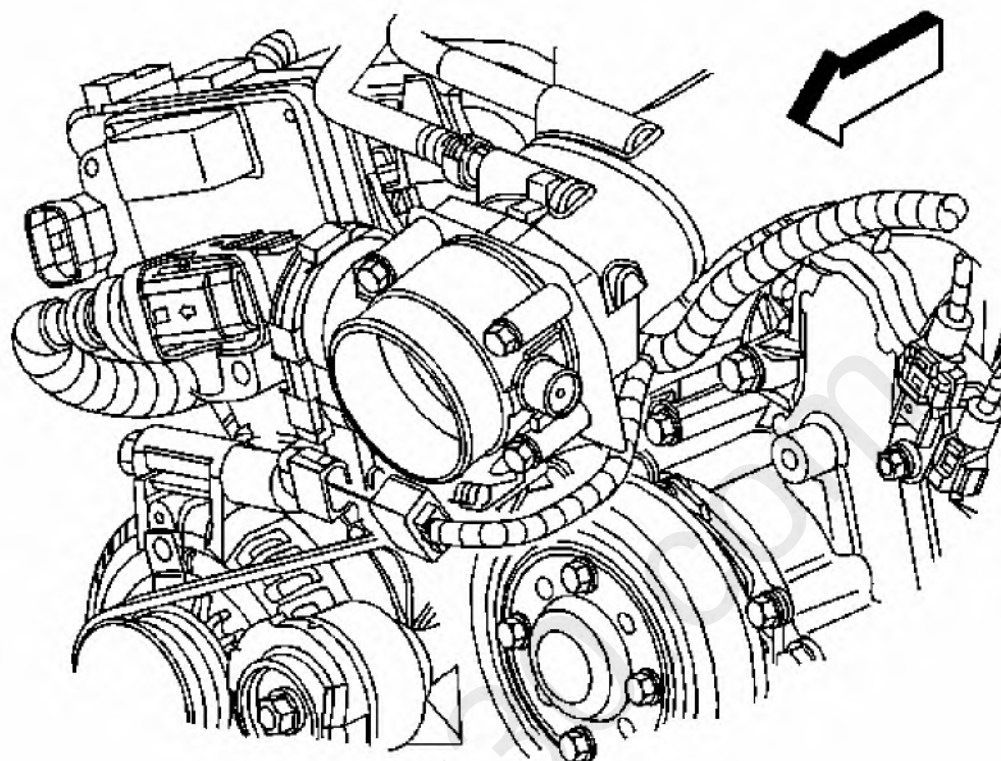


Fig. 64: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure proper engagement of the wiring harness connector. The wiring harness connector must be installed straight onto the component connector and firmly seated. Visually inspect the connector to ensure that the connector latches are engaged and locked. Any damage to the connector or wiring must be repaired. Failure to follow this procedure can lead to an intermittent electrical connection, driveability concerns, and/or wiring harness or wiring harness connector damage or failure.

9. Connect the electrical connector to the throttle body.

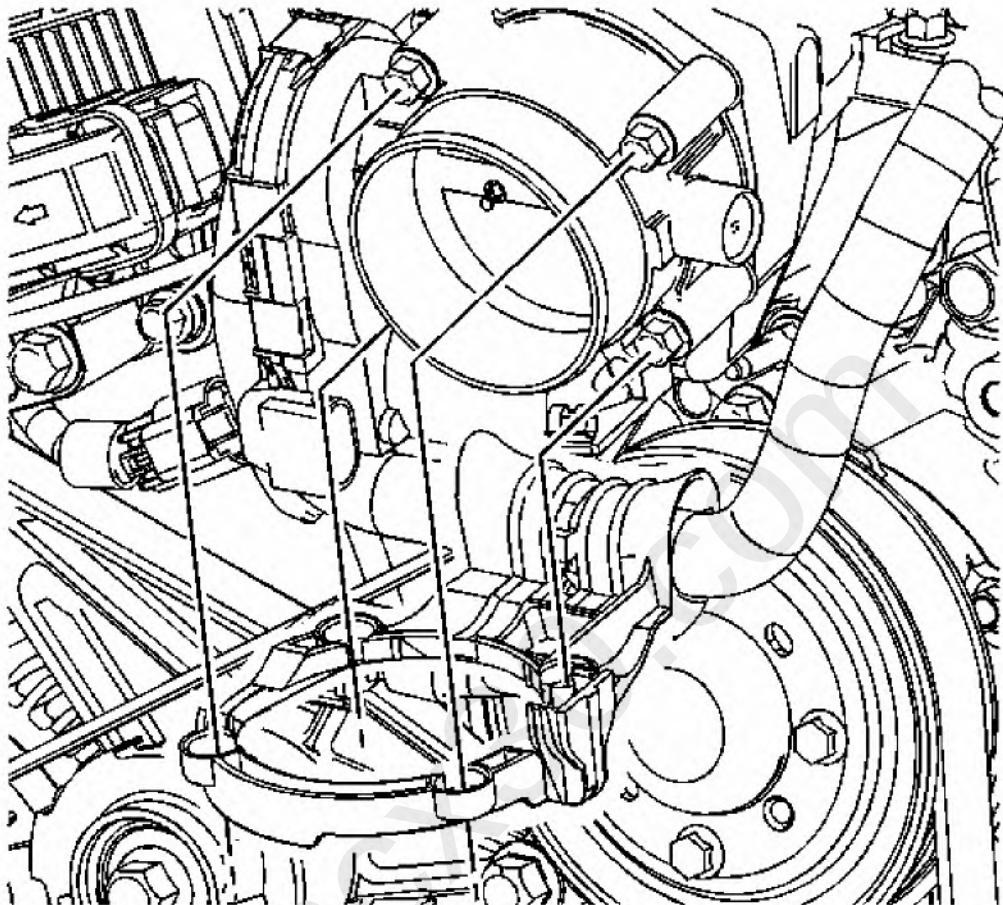


Fig. 65: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

10. Install the wiring harness retainer.

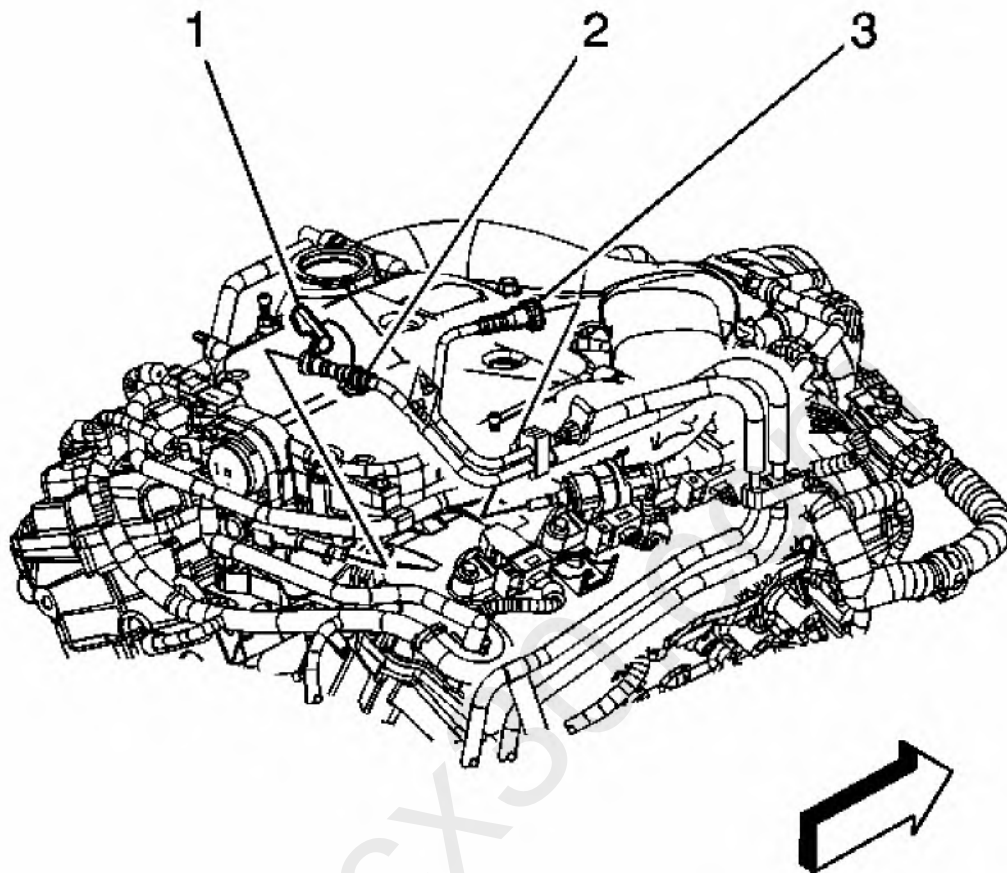


Fig. 66: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

11. Connect the purge line (3) to the purge solenoid valve.

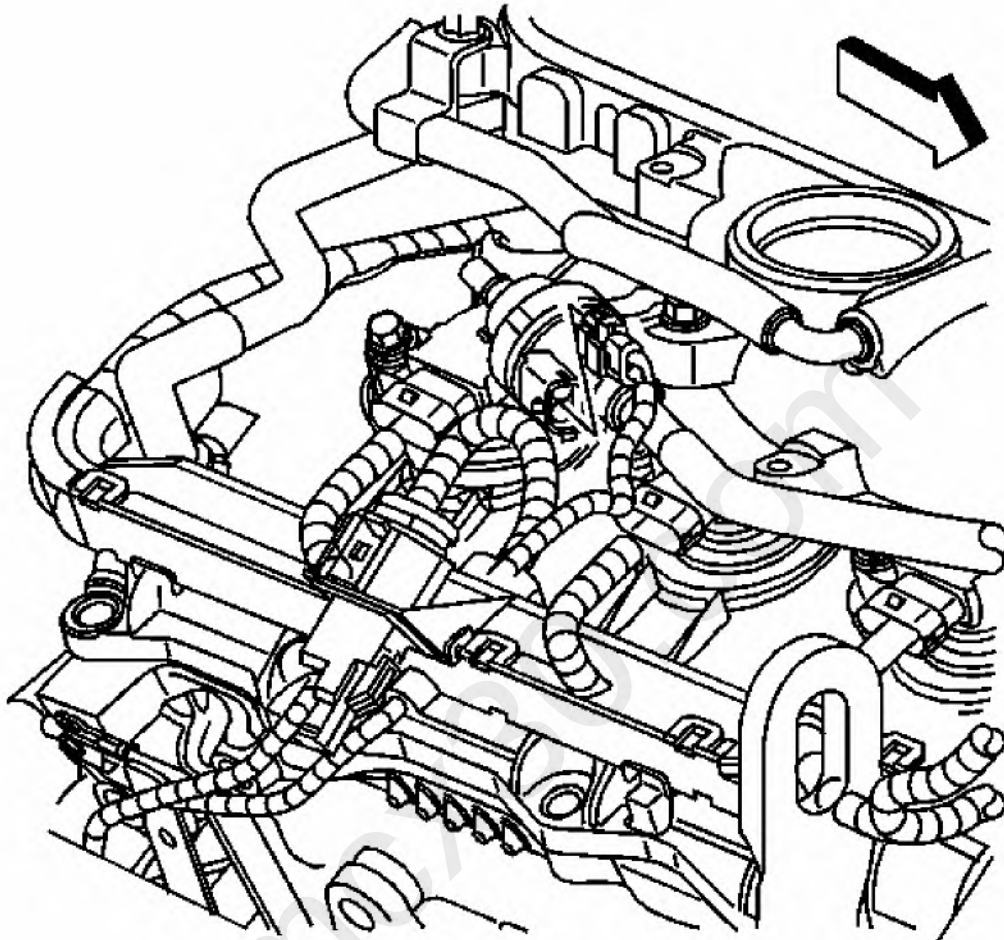


Fig. 67: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Connect the purge solenoid valve electrical connector.
13. Connect the brake booster vacuum hose to the intake manifold.

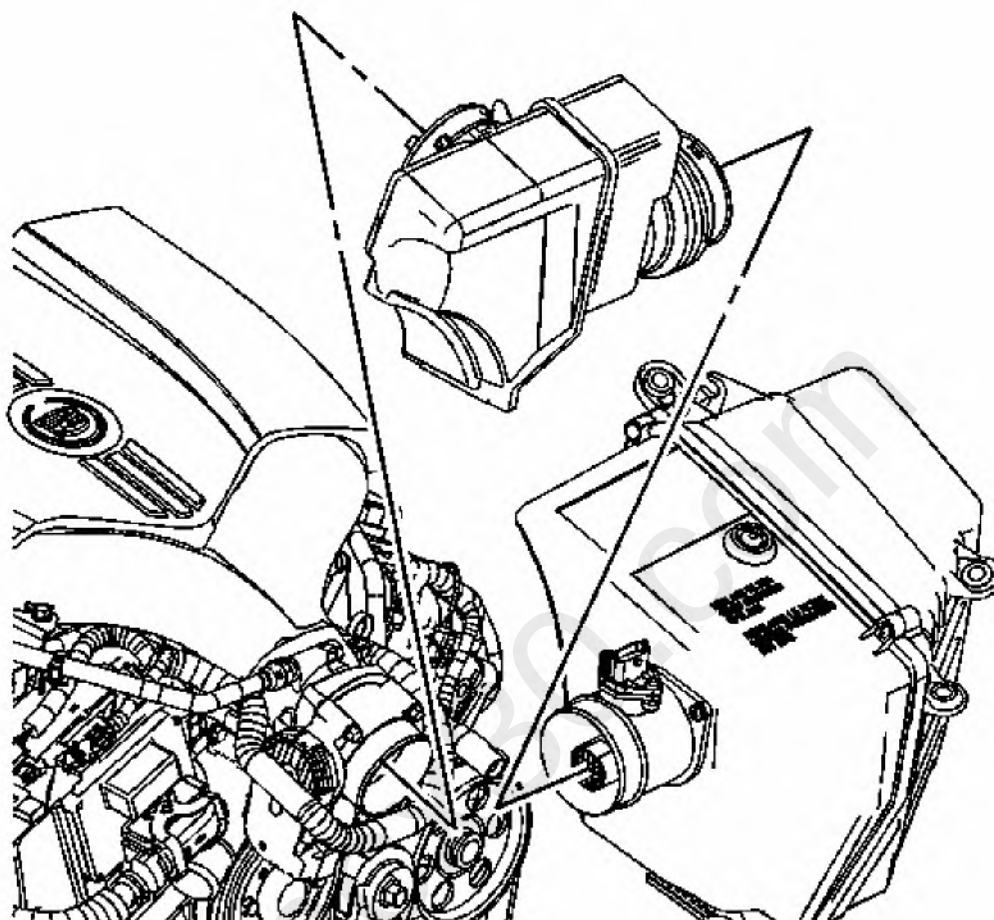


Fig. 68: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

14. Install the air inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .
15. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

LOWER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

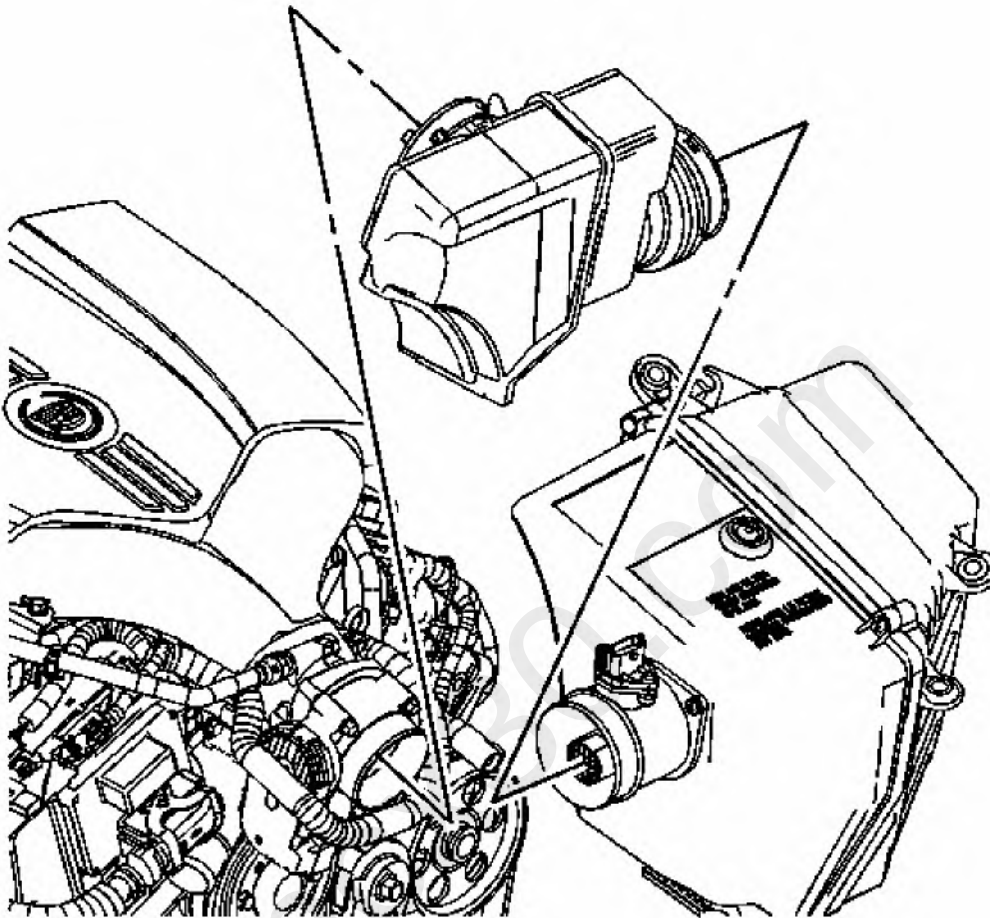


Fig. 69: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

3. Remove the air inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .
4. Note the booster hose routing. Disconnect the brake booster check valve and hose from the brake booster.
5. Reposition the brake booster hose to the intake manifold.

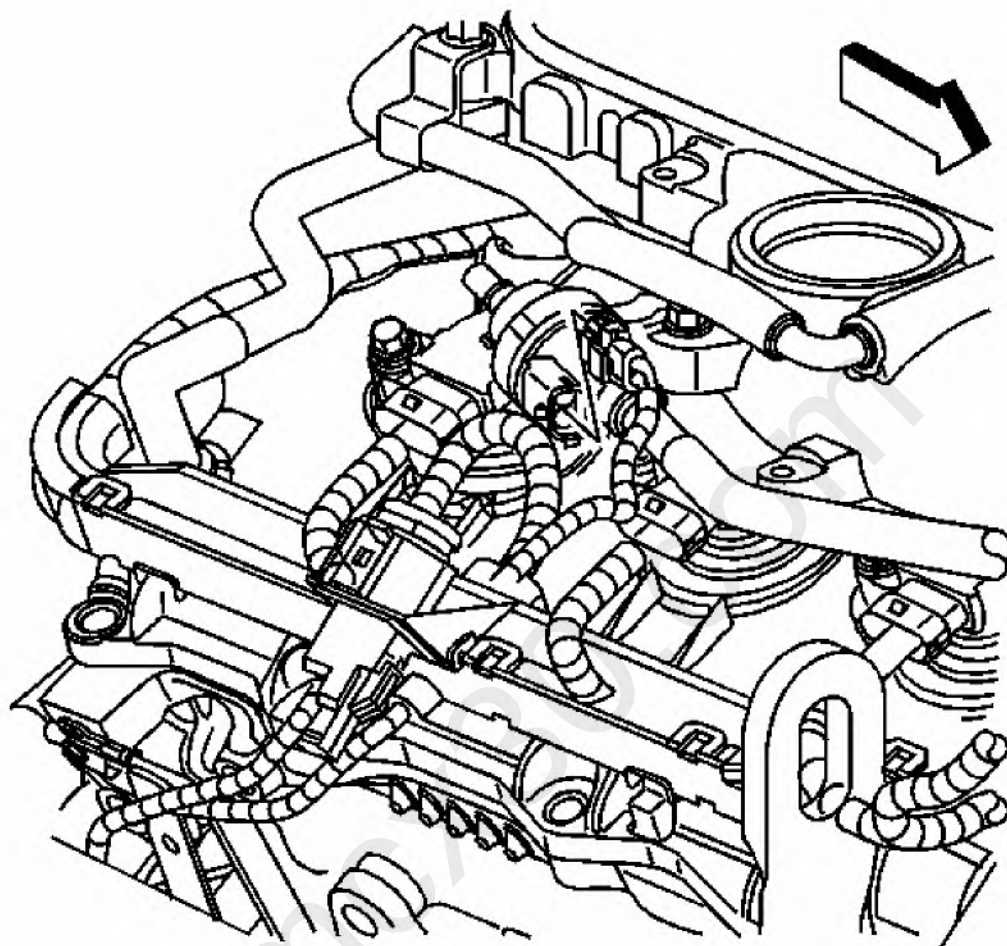


Fig. 70: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the purge solenoid valve electrical connector.

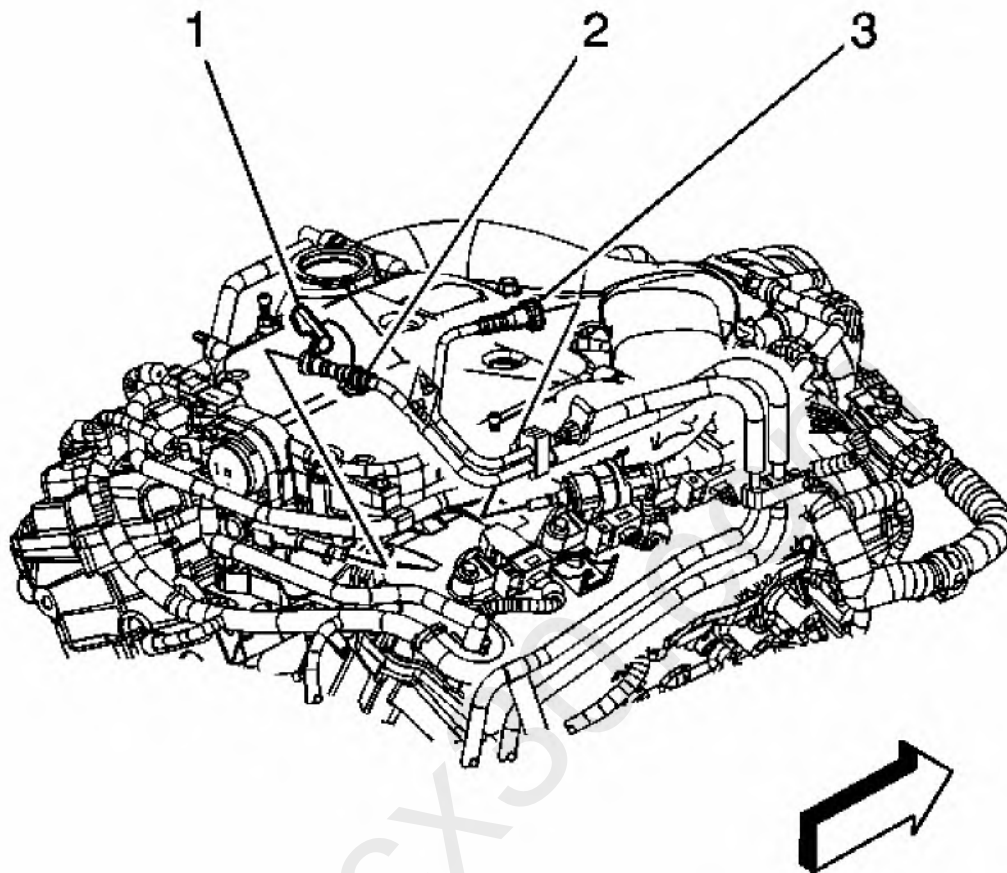


Fig. 71: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the purge line (3) from the purge solenoid valve.

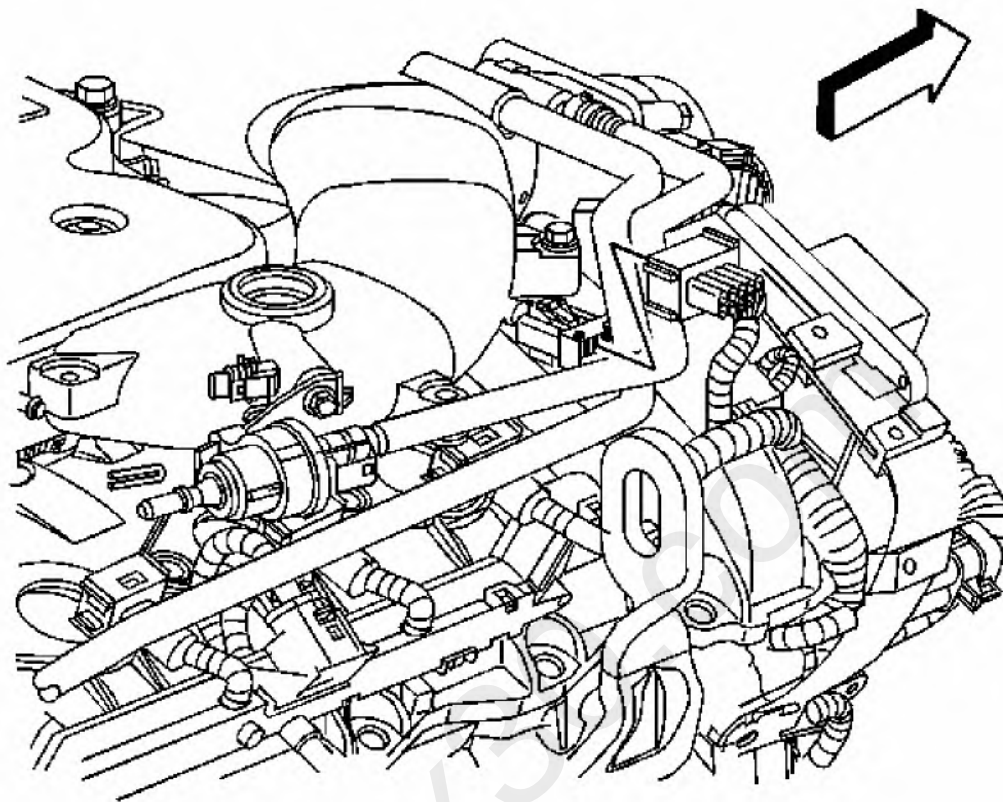


Fig. 72: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel injector harness electrical connector.

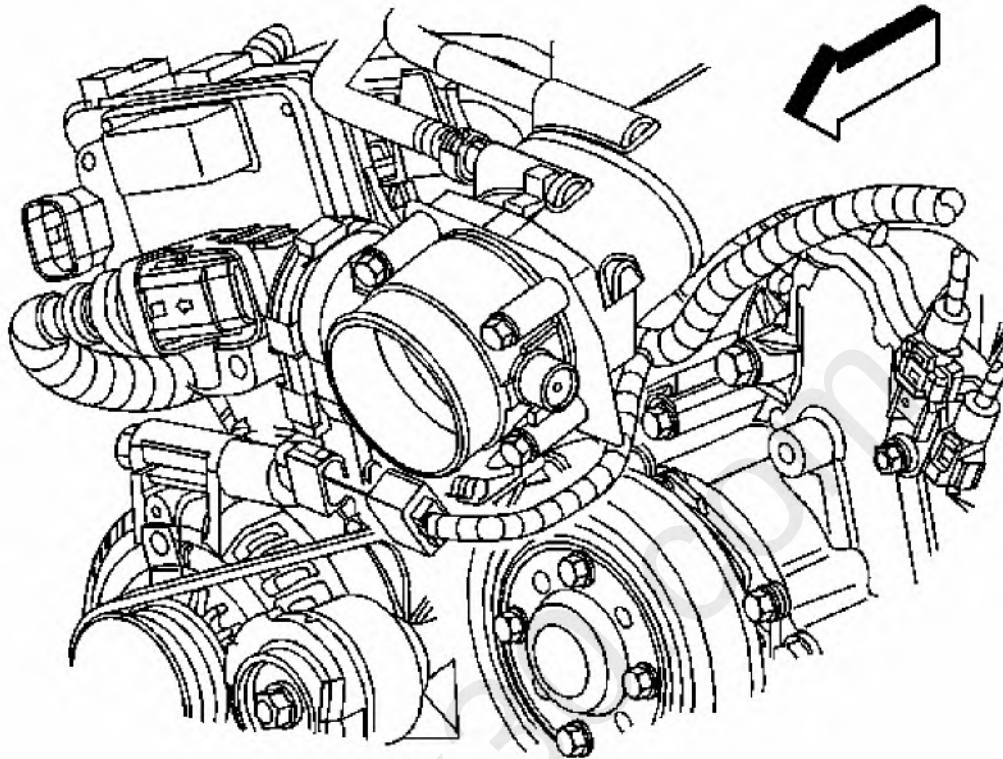


Fig. 73: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the throttle body electrical connector.

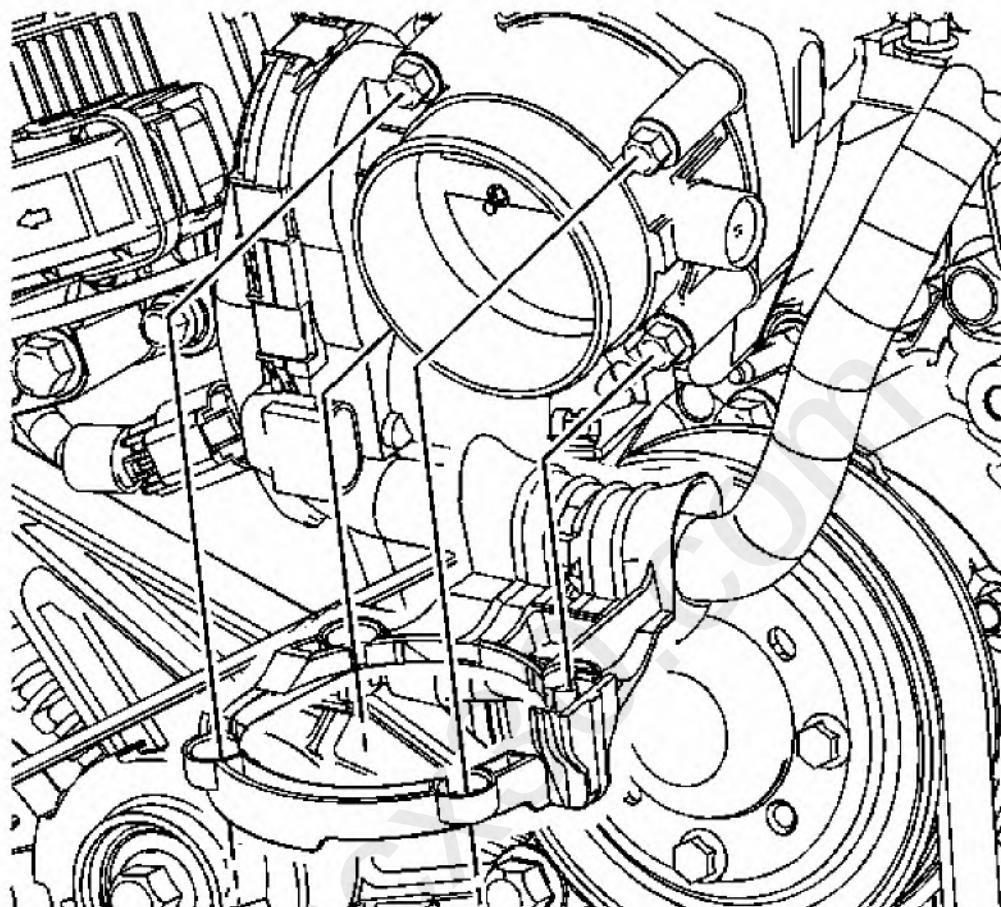


Fig. 74: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

10. Remove the wiring harness retainer.

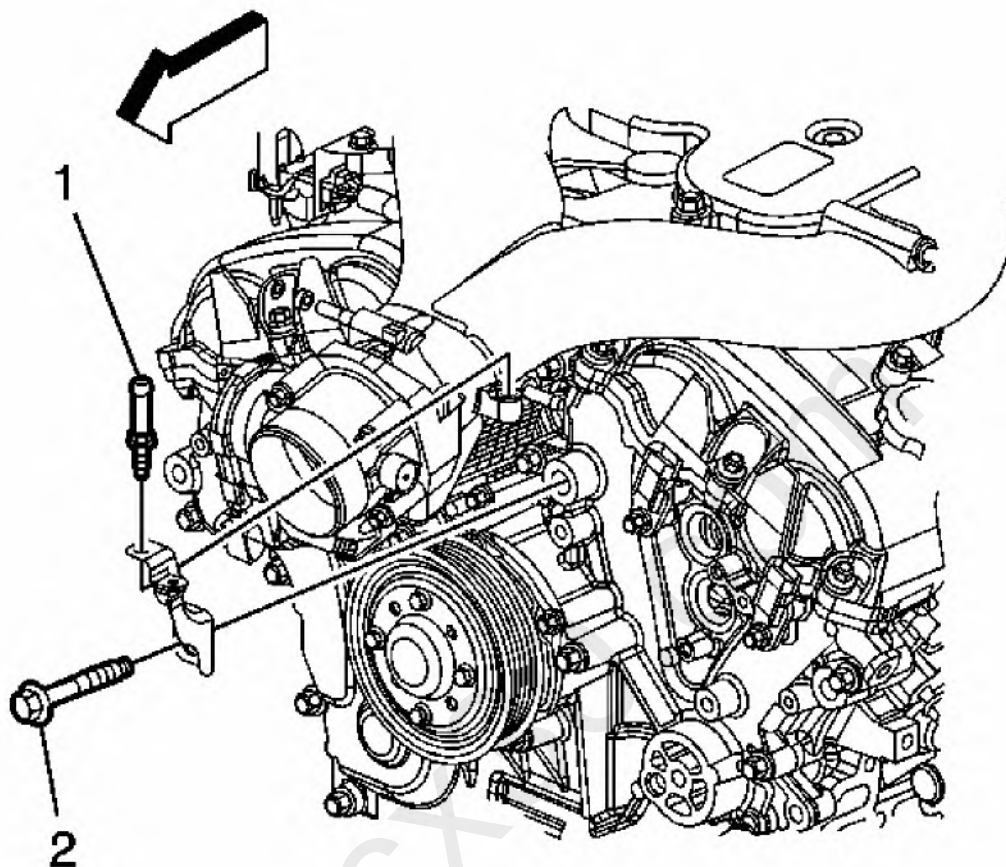


Fig. 75: Identifying Upper Intake Manifold Brace Stud, Bolt & Brace
Courtesy of GENERAL MOTORS CORP.

11. Remove the upper intake manifold brace stud (1) and bolt (2), reposition the brace with the wiring harness.
12. Remove the wiring harness retainer from the right side of the throttle body.
13. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

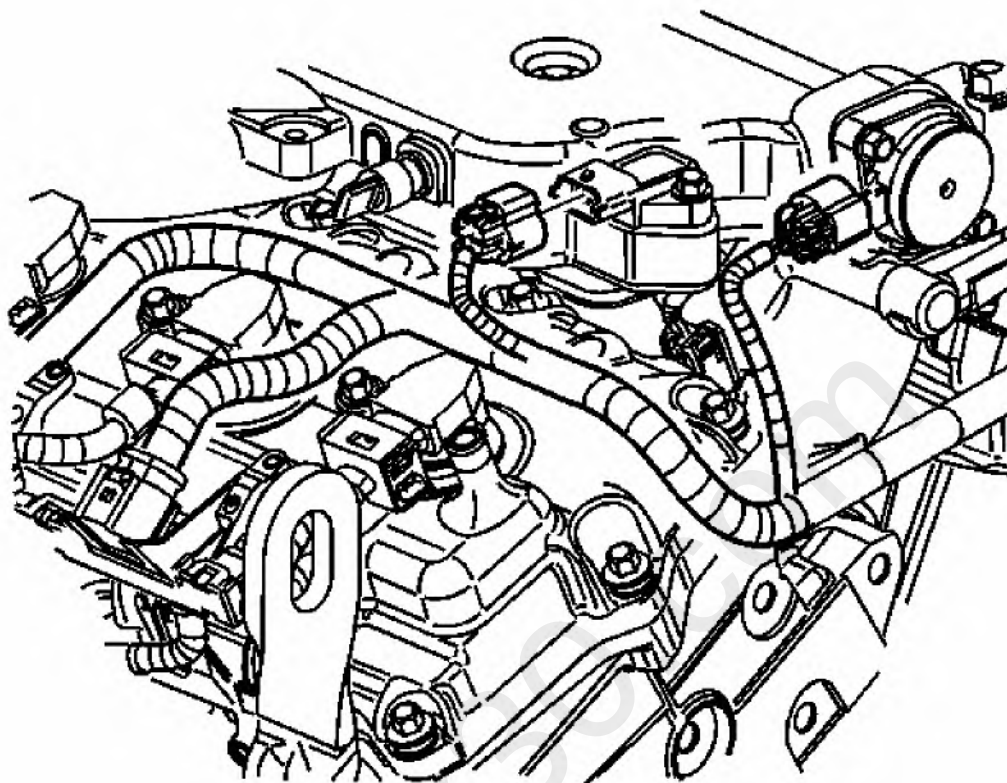


Fig. 76: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the barometric pressure sensor electrical connector.

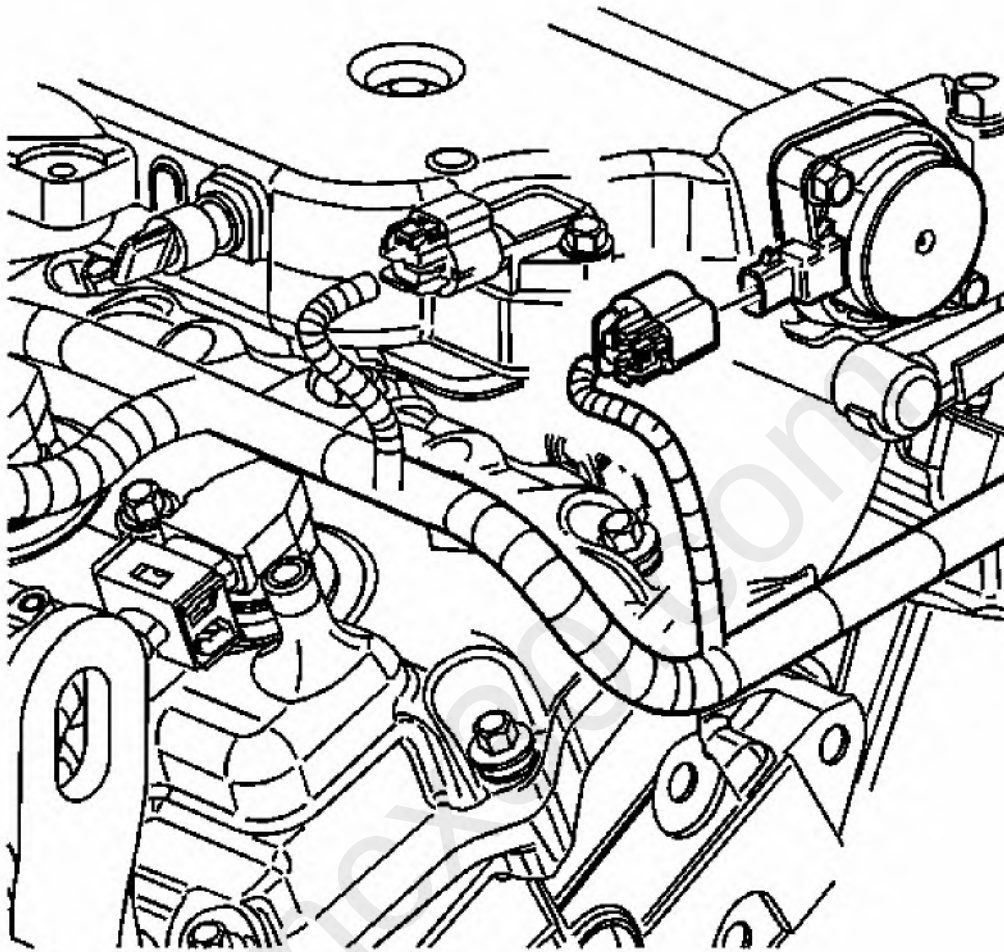


Fig. 77: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

15. Disconnect the intake manifold runner control solenoid electrical connector.
16. Remove the left bank ignition coil wiring harness from the bracket.

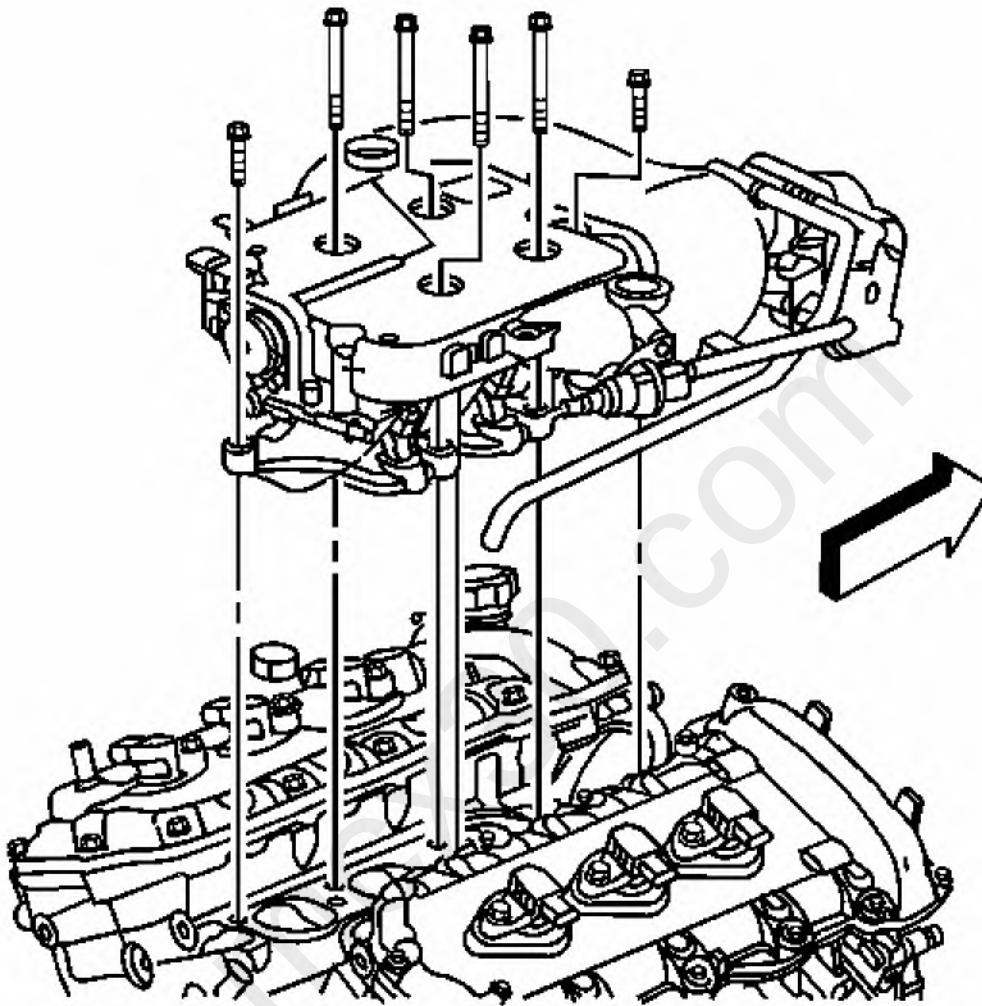


Fig. 78: View Of Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

- IMPORTANT:**
- Do not remove the upper to lower intake manifold bolts.
 - **DO NOT** kink or damage the fuel pipe.

17. Remove the intake manifold bolts.
18. Reposition the intake manifold to gain access to the fuel pipe connector.

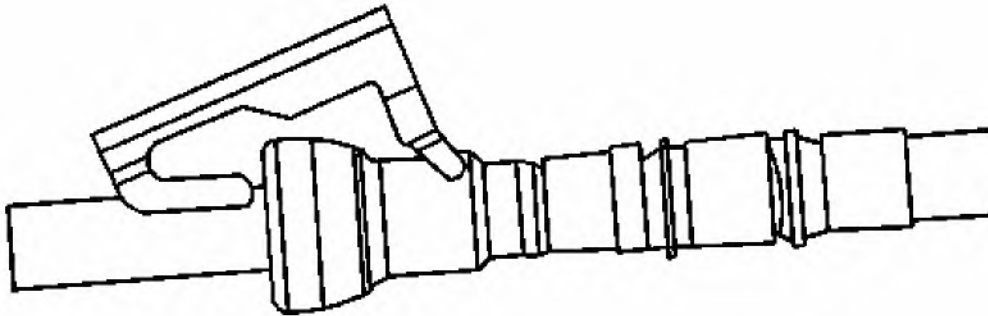


Fig. 79: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

19. Remove the fuel feed pipe retainer.
20. Disconnect the fuel feed pipe from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
21. Disassemble the intake manifold as necessary. Refer to **Intake Manifold Disassemble** .
22. Clean and inspect the intake manifold and the sealing surfaces. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

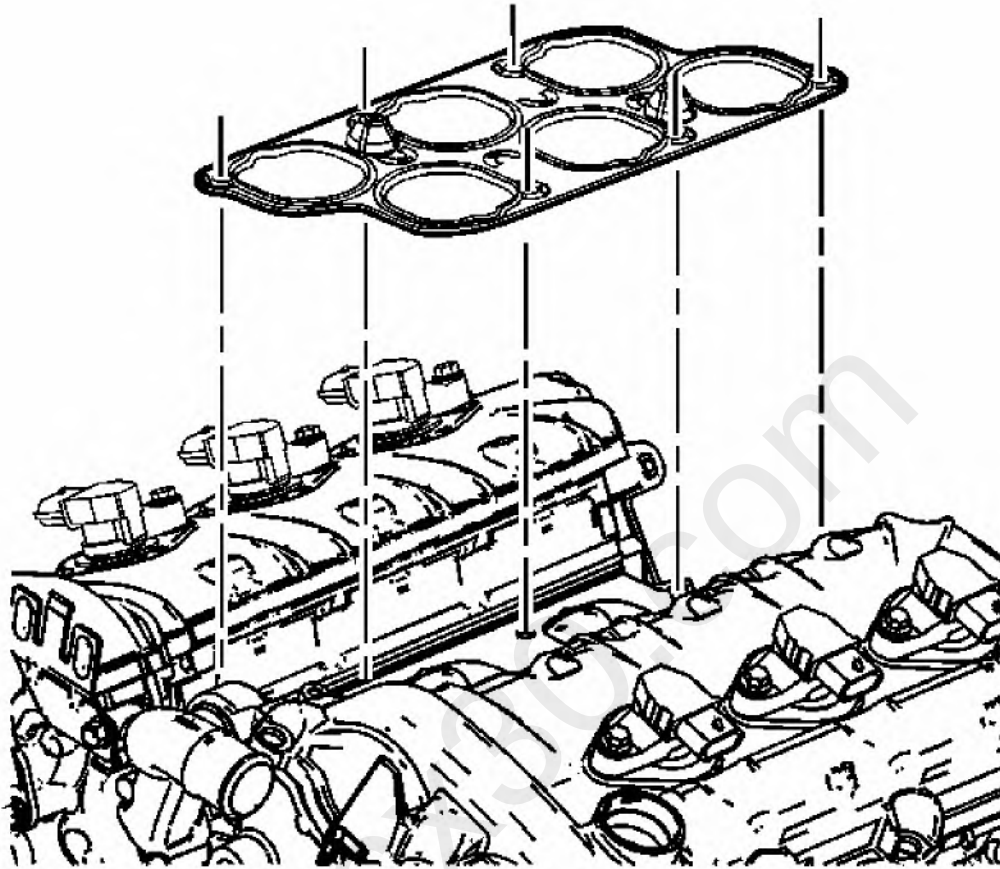


Fig. 80: View Of Lower Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Assemble the intake manifold as necessary. Refer to Intake Manifold Assemble .

IMPORTANT: Inspect and replace the lower intake manifold gasket only if the gasket is worn or damaged.

2. Install the lower intake manifold gasket.

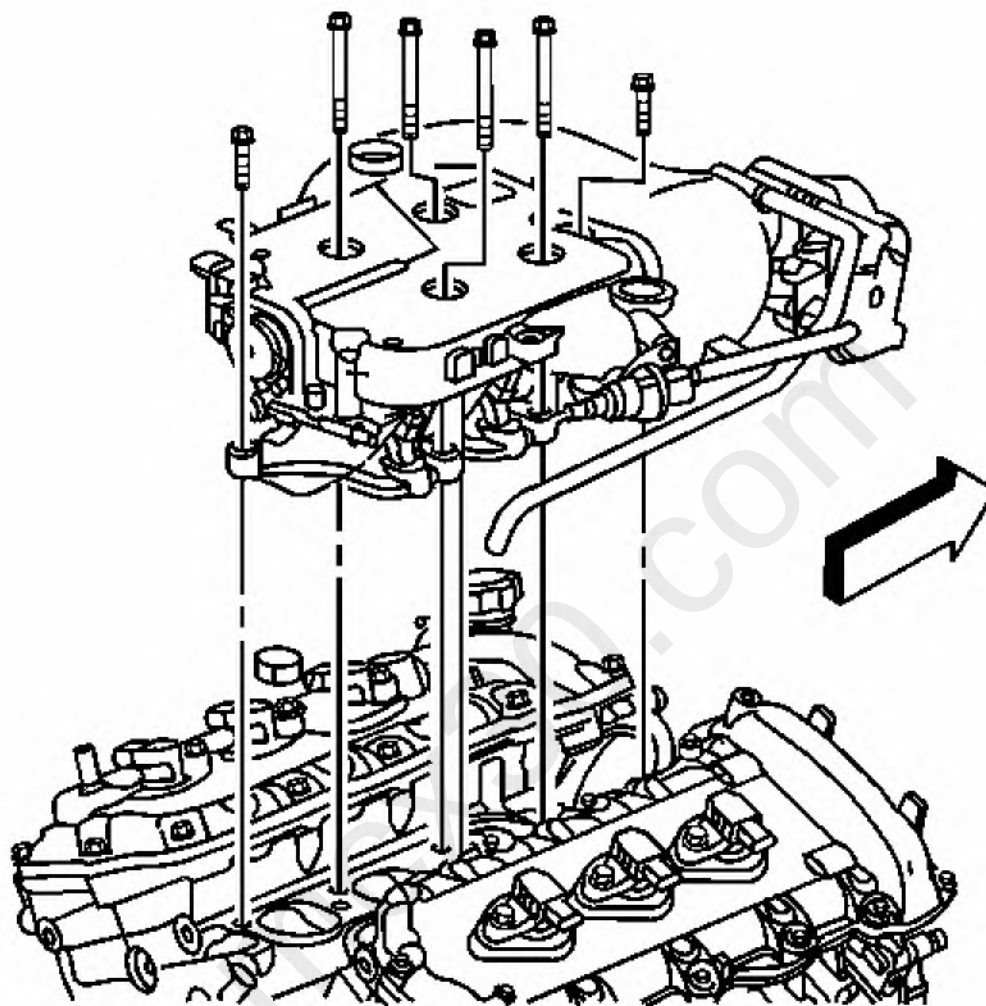


Fig. 81: View Of Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

3. Install the intake manifold. Refer to [Intake Manifold Installation](#) .

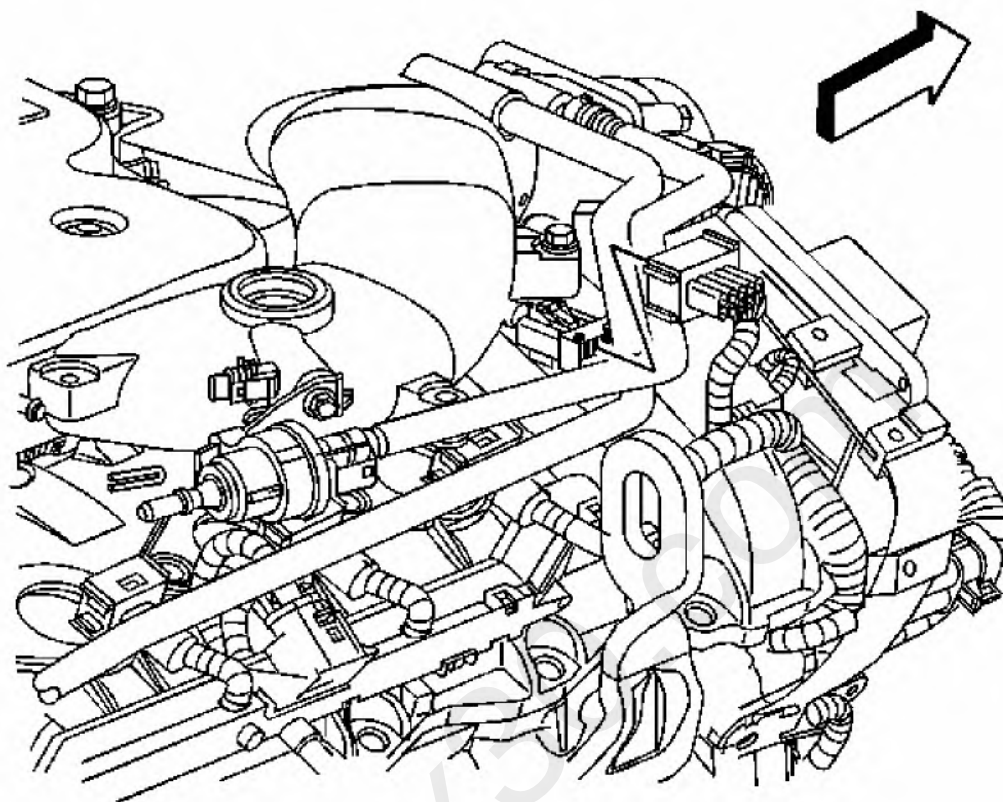


Fig. 82: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel injector harness electrical connector.

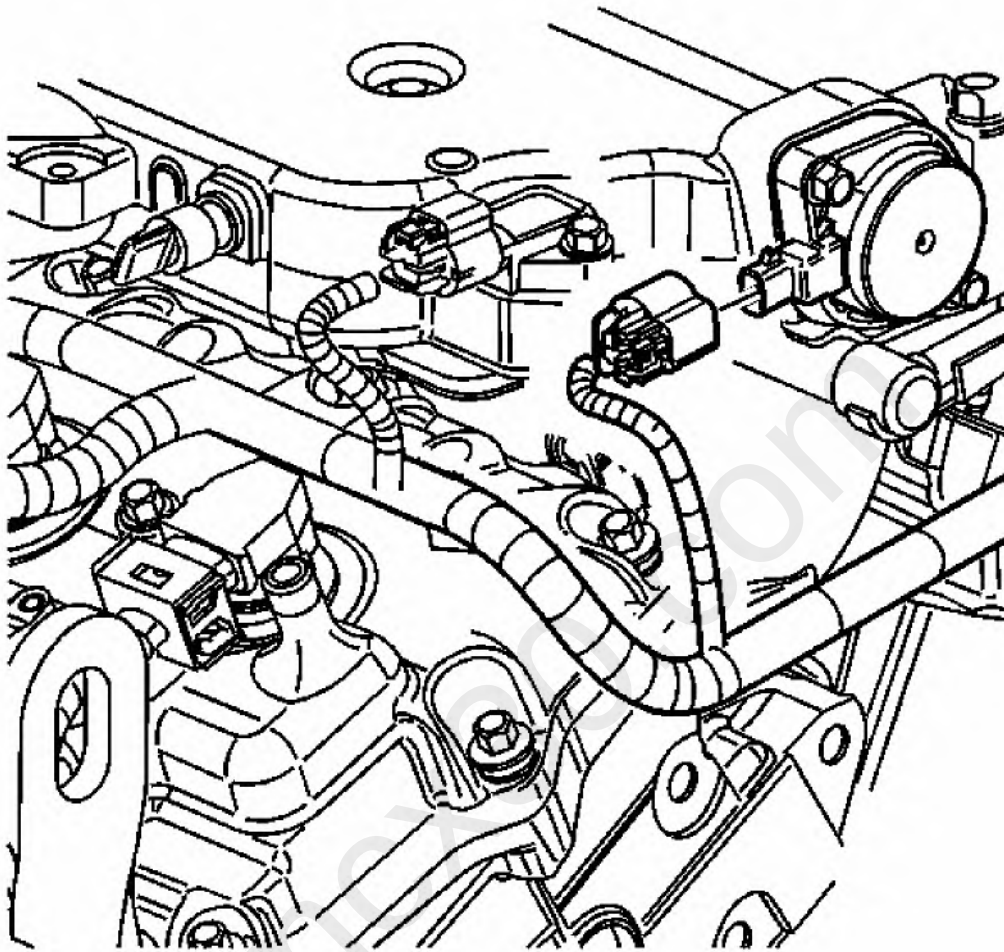


Fig. 83: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

5. Connect the intake manifold runner control solenoid electrical connector.

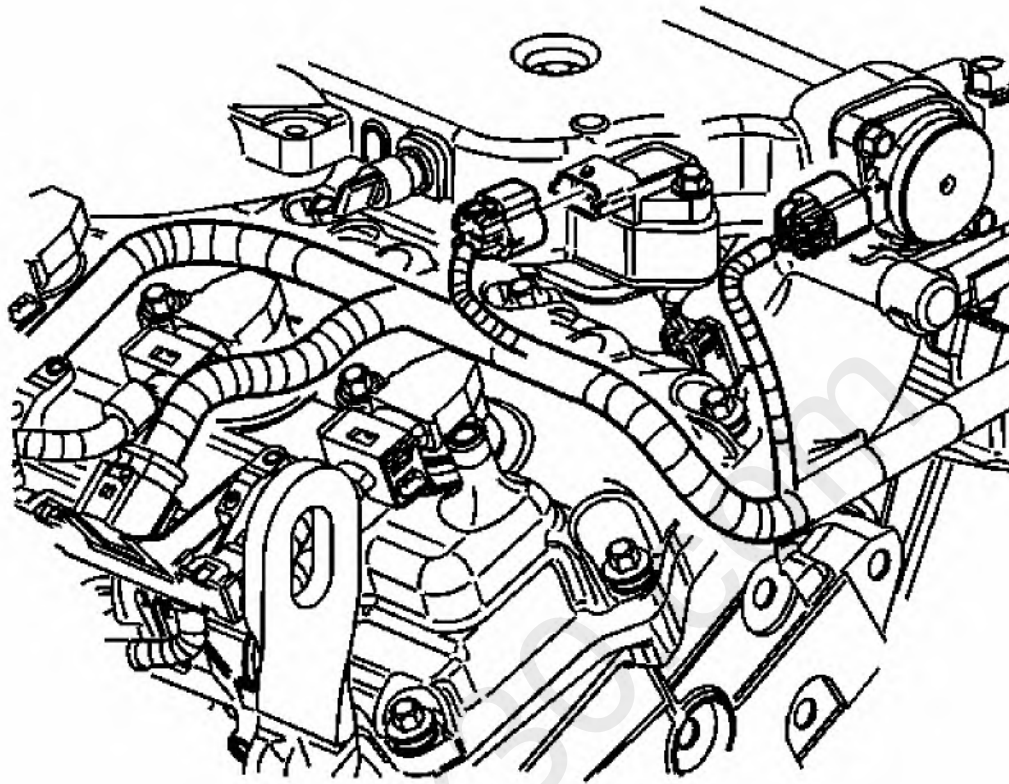


Fig. 84: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the barometric pressure sensor electrical connector.
7. Connect the PCV hose from the right bank camshaft cover.

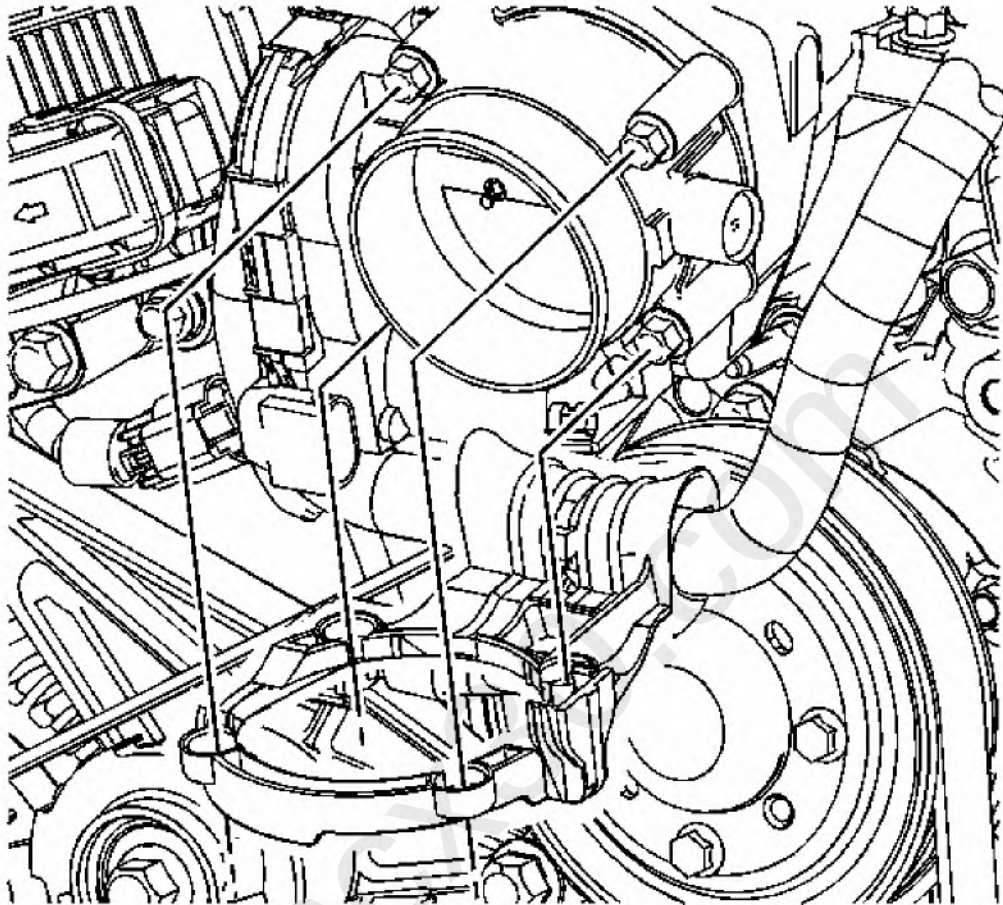


Fig. 85: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

8. Install the wiring harness retainer.

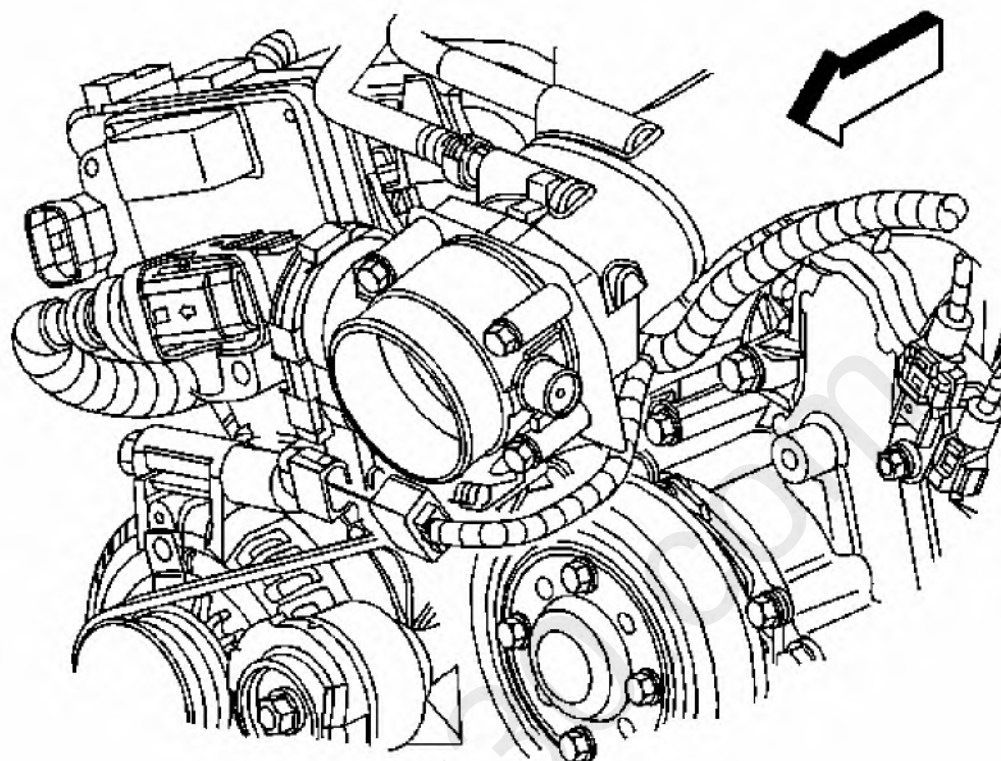


Fig. 86: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure proper engagement of the wiring harness connector. The wiring harness connector must be installed straight onto the component connector and firmly seated. Visually inspect the connector to ensure that the connector latches are engaged and locked. Any damage to the connector or wiring must be repaired. Failure to follow this procedure can lead to an intermittent electrical connection, driveability concerns, and/or wiring harness or wiring harness connector damage or failure.

9. Connect the throttle body electrical connector.

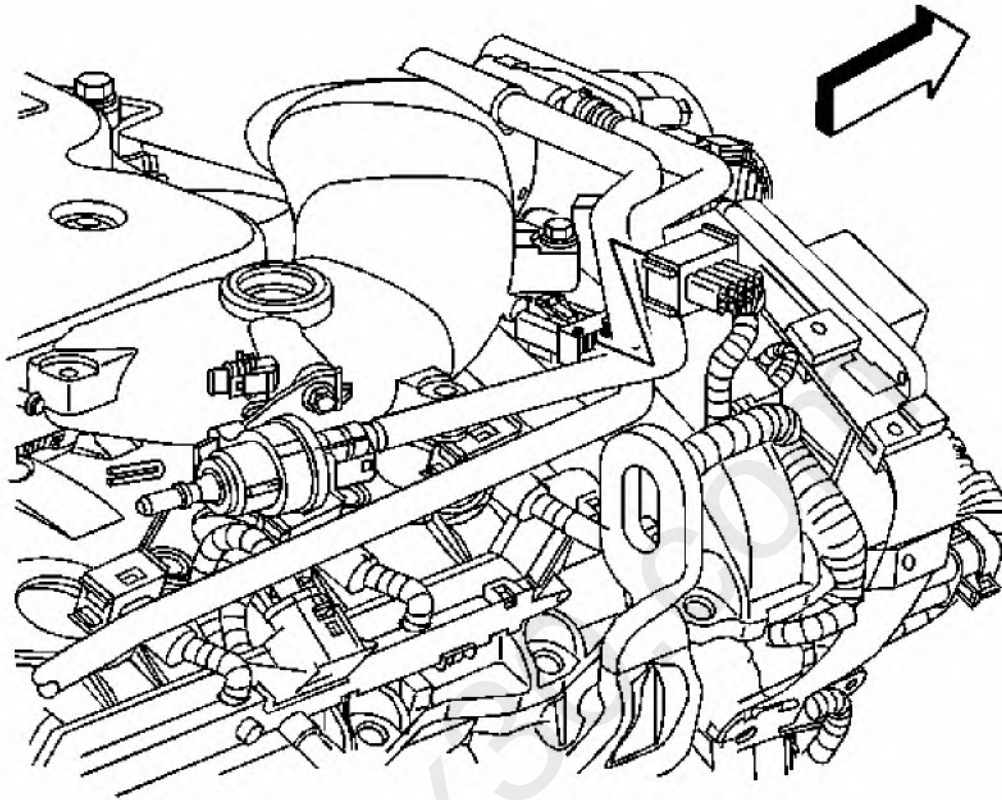


Fig. 87: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

10. Connect the fuel injector harness electrical connector.

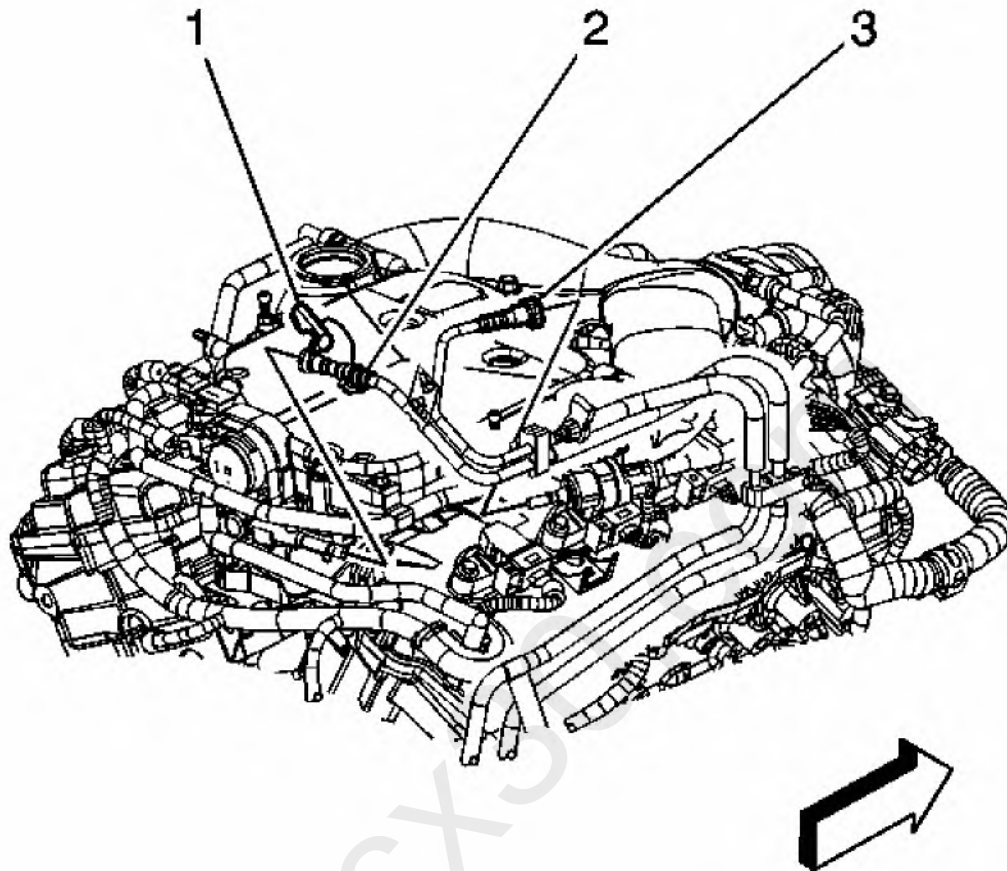


Fig. 88: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

11. Connect the fuel feed pipe (1) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
12. Connect the purge line (3) to the purge solenoid valve.

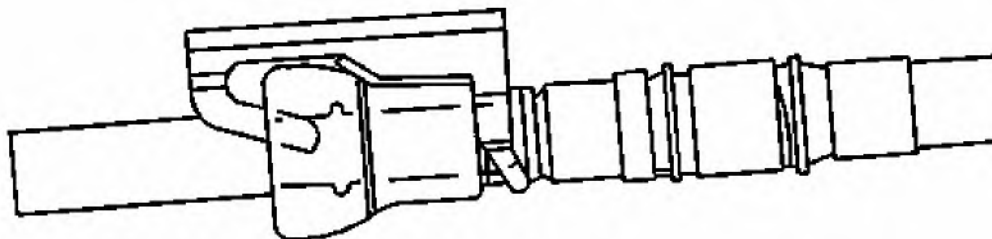


Fig. 89: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

13. Install the fuel pipe retainer.

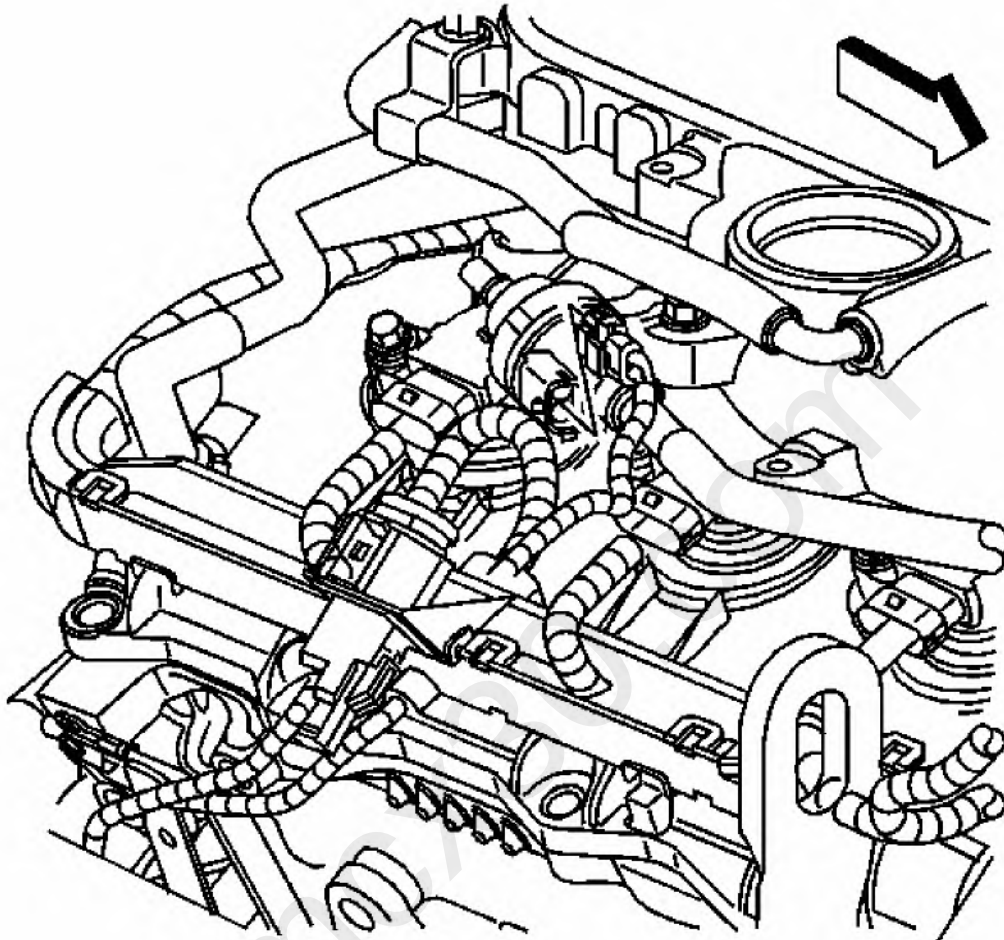


Fig. 90: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the purge solenoid valve electrical connector.
15. Install the brake booster hose and check valve to the brake booster.

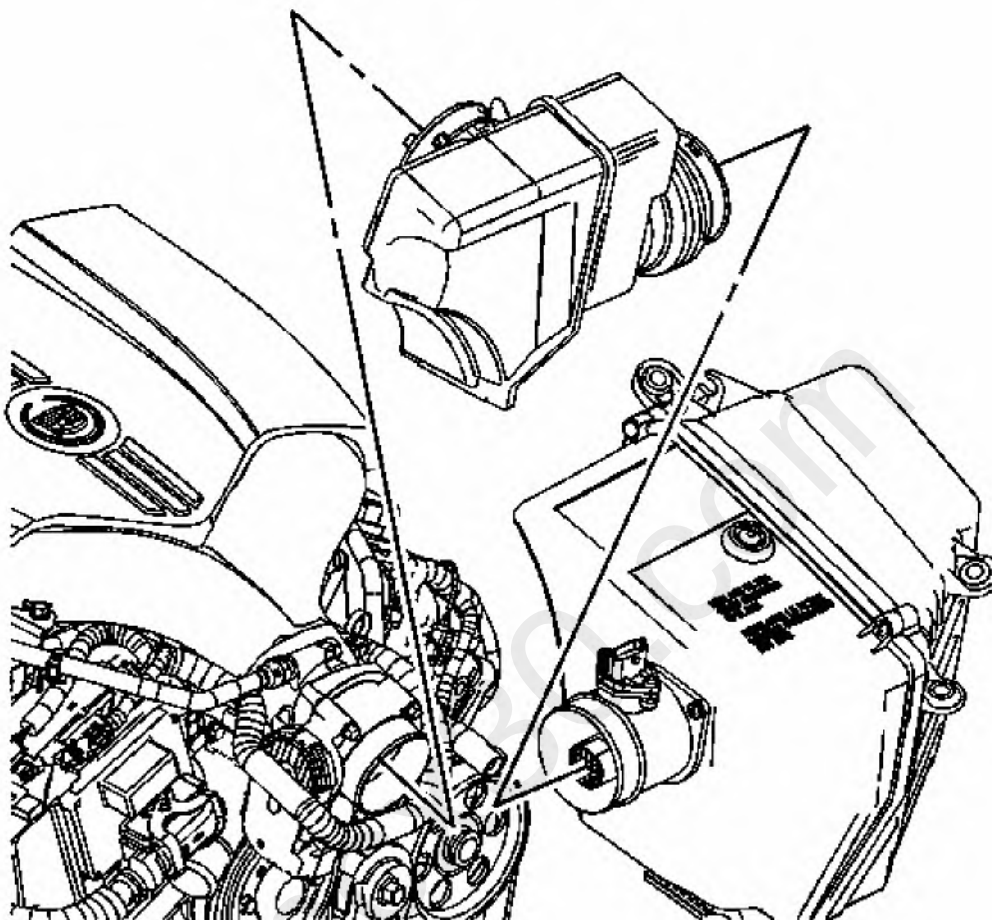


Fig. 91: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

16. Install the air inlet duct. Refer to **Air Cleaner Inlet Duct Replacement** .
17. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

REMOVAL PROCEDURE

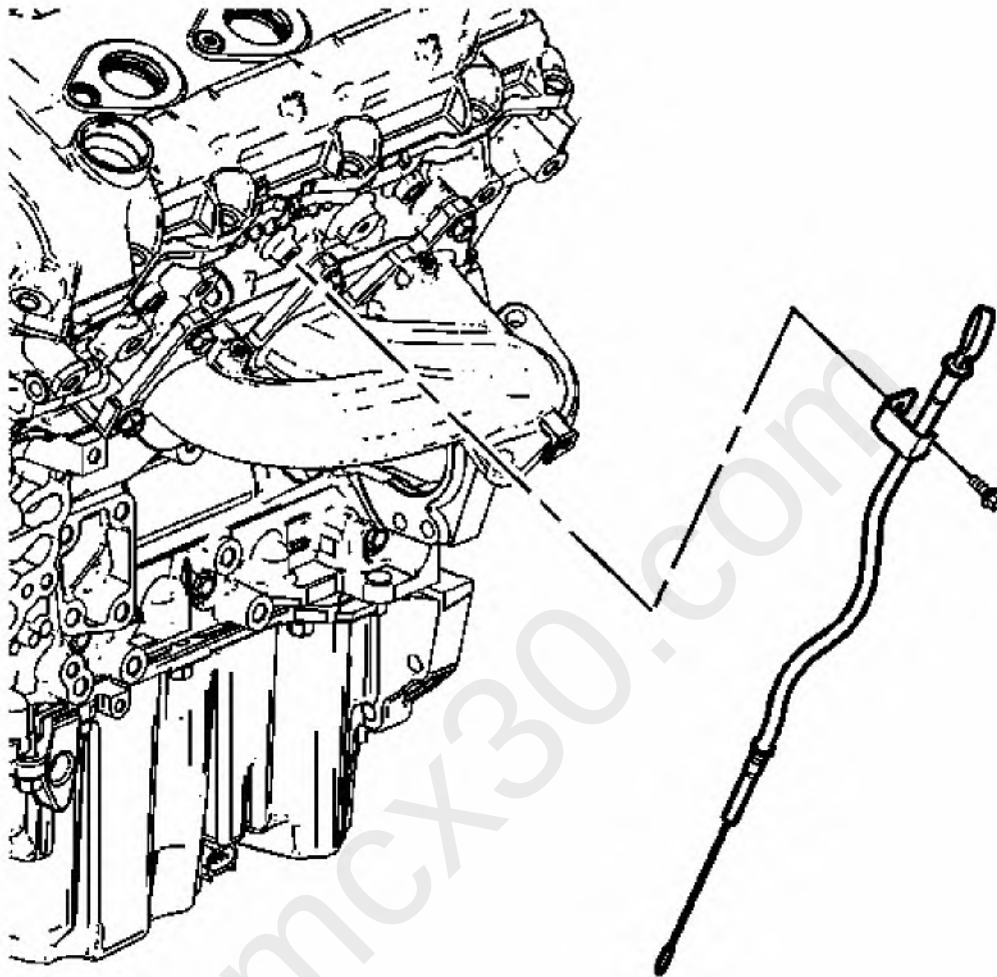


Fig. 92: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement**.
3. Remove the oil level indicator from the oil level indicator tube.
4. Remove the oil level indicator tube bolt.
5. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**.
6. Remove the knock sensor. Refer to **Knock Sensor Replacement - Bank 2**.
7. Remove the heat shield clip from the oil level indicator tube.
8. Lower the vehicle.

IMPORTANT: Note the location and orientation of the secondary (small square) heat shield.

9. Remove the oil level indicator tube up through the exhaust manifold.
10. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

INSTALLATION PROCEDURE

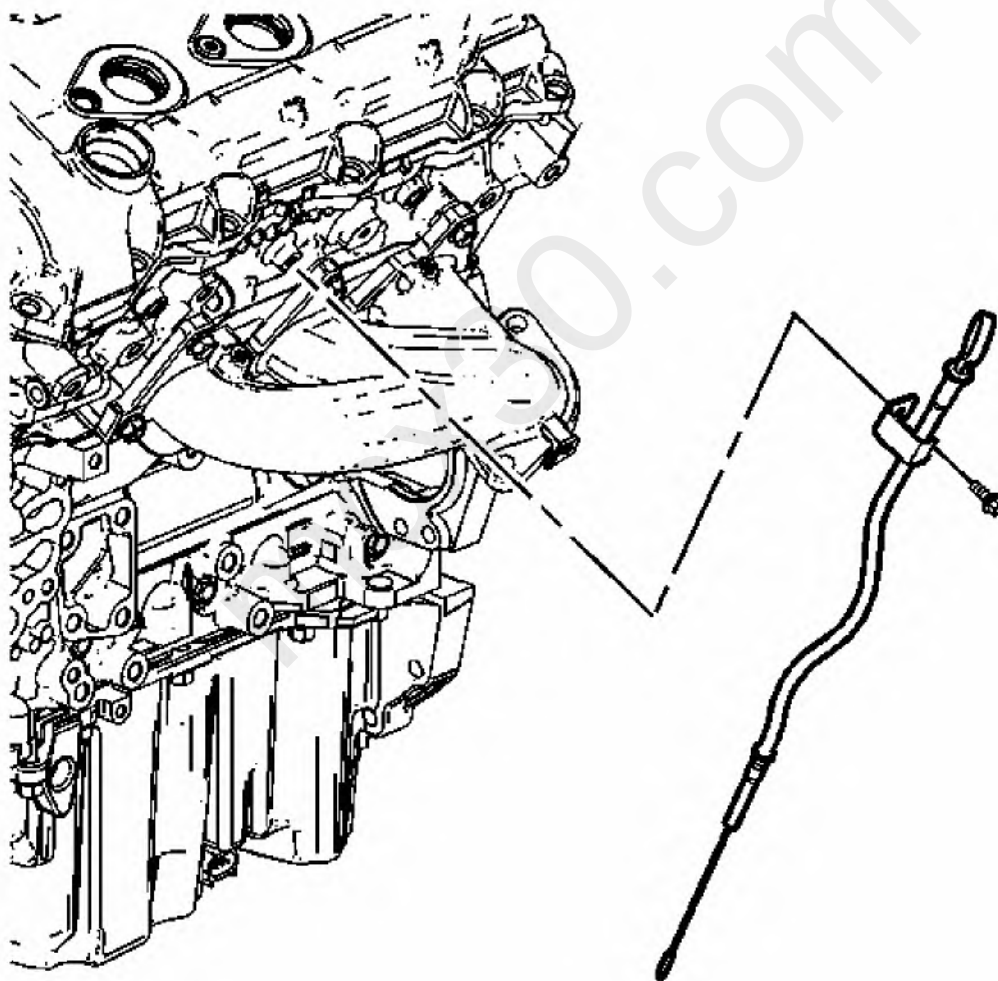


Fig. 93: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure that the secondary (small square) heat shield is properly installed to the oil level indicator tube as noted

during removal.

1. Install the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Installation** .
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Install the knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .
4. Install the heat shield clip to the oil level indicator tube as noted during removal.
5. Lower the vehicle.
6. Install the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

OIL FILTER ADAPTER REPLACEMENT

REMOVAL PROCEDURE

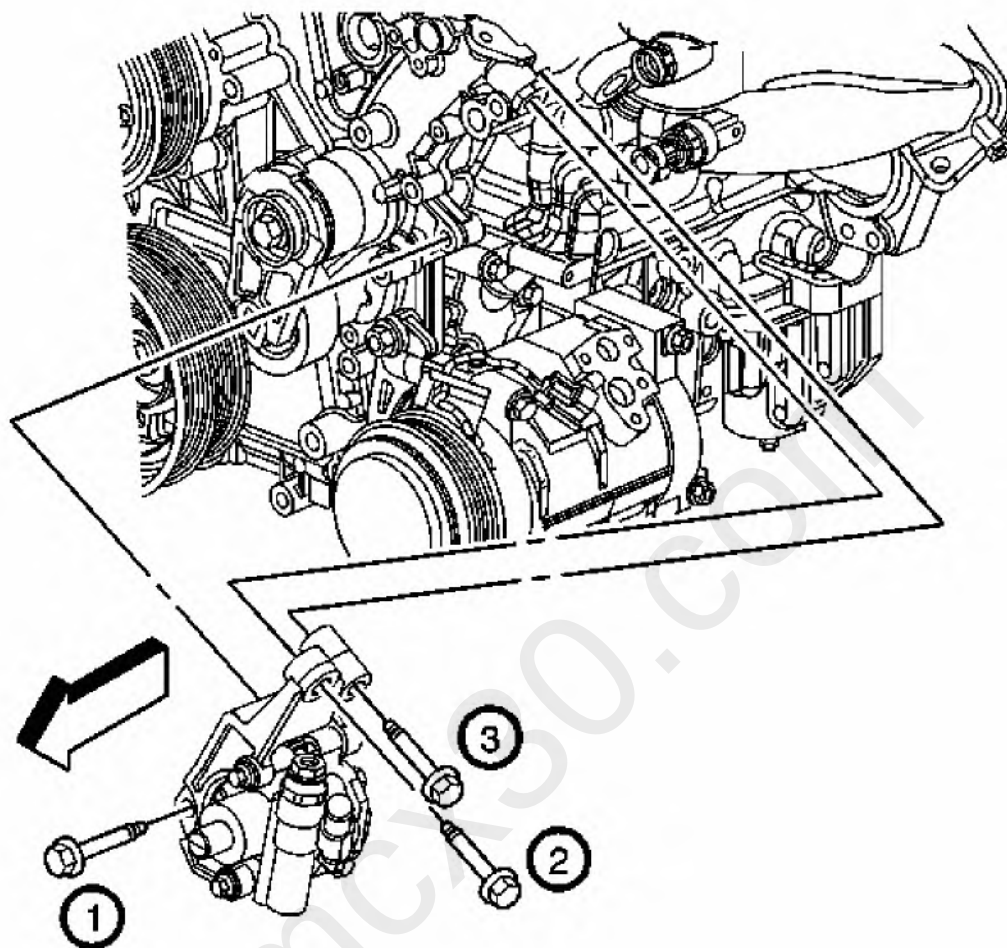


Fig. 94: View Of Power Steering Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement** .
3. Remove the A/C compressor and power steering drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement**.
4. Disconnect the oil pressure sensor electrical connector.

IMPORTANT: Do not disconnect the power steering lines from the power steering pump.

5. Remove the power steering pump bolts (1-3) and position the pump aside in order to

gain access to the oil filter adapter fasteners. Refer to **Power Steering Pump Replacement (LH2)** or **Power Steering Pump Replacement (LY7)** .

6. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

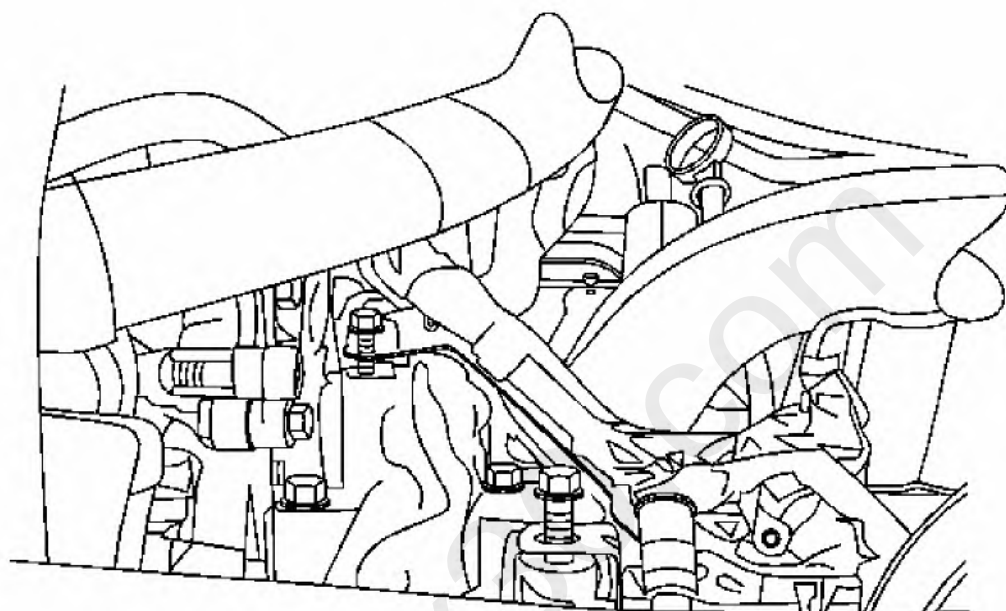


Fig. 95: A/C Compressor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not disconnect the A/C pipes from the A/C compressor.

7. Remove the A/C compressor bolts and reposition the A/C compressor in order to gain access to the oil filter adapter fasteners. Refer to **Compressor Replacement (LY7)** or **Compressor Replacement (LH2)** .
8. Remove the bolts (1) securing the wire harness bracket to the oil filter adapter.

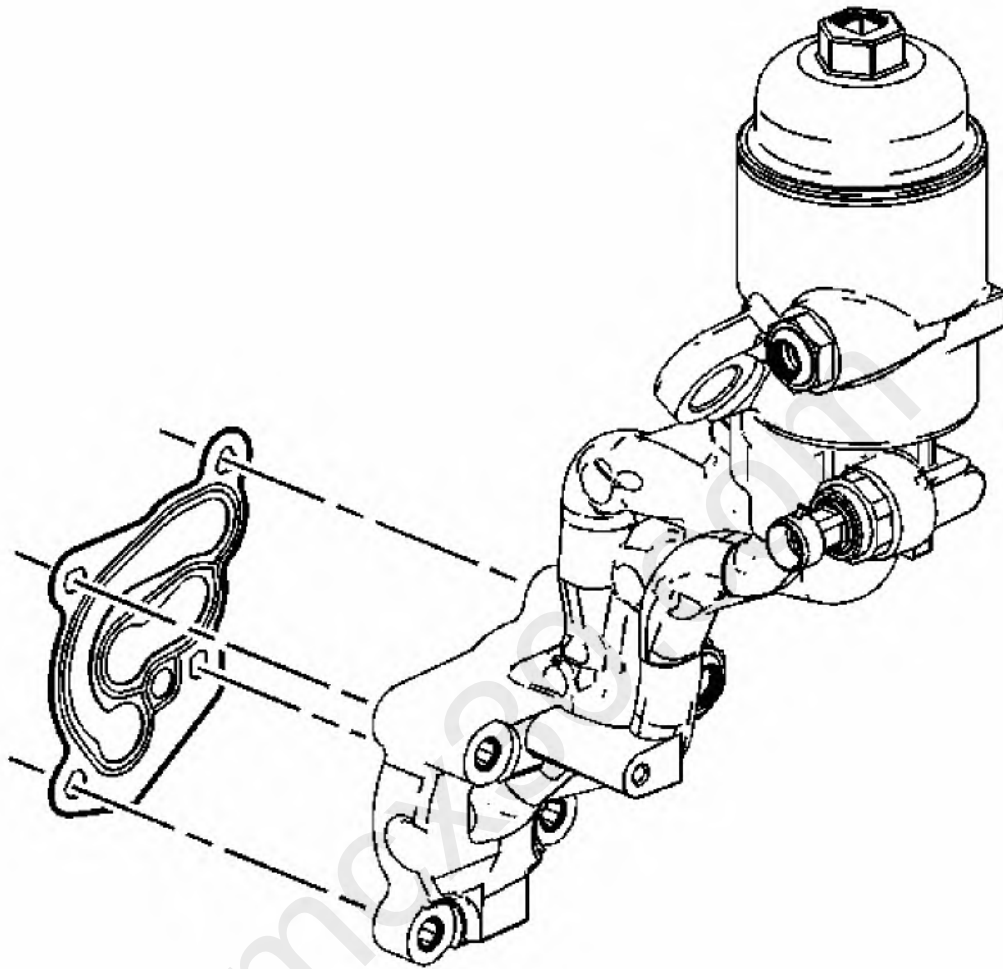


Fig. 96: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

9. Place a drain pan under the vehicle.
10. Remove the oil filter adapter bolts.
11. Lower the vehicle.
12. Remove the oil filter adapter.

INSTALLATION PROCEDURE

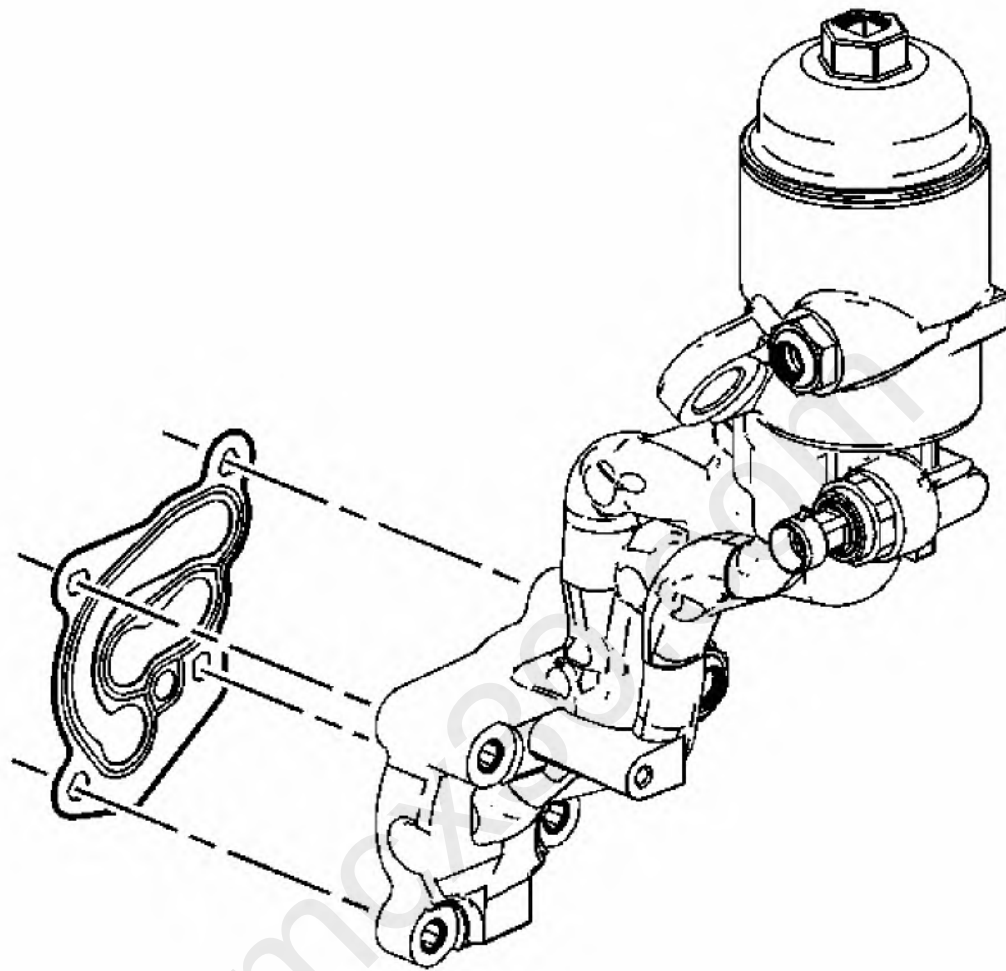


Fig. 97: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter adapter.

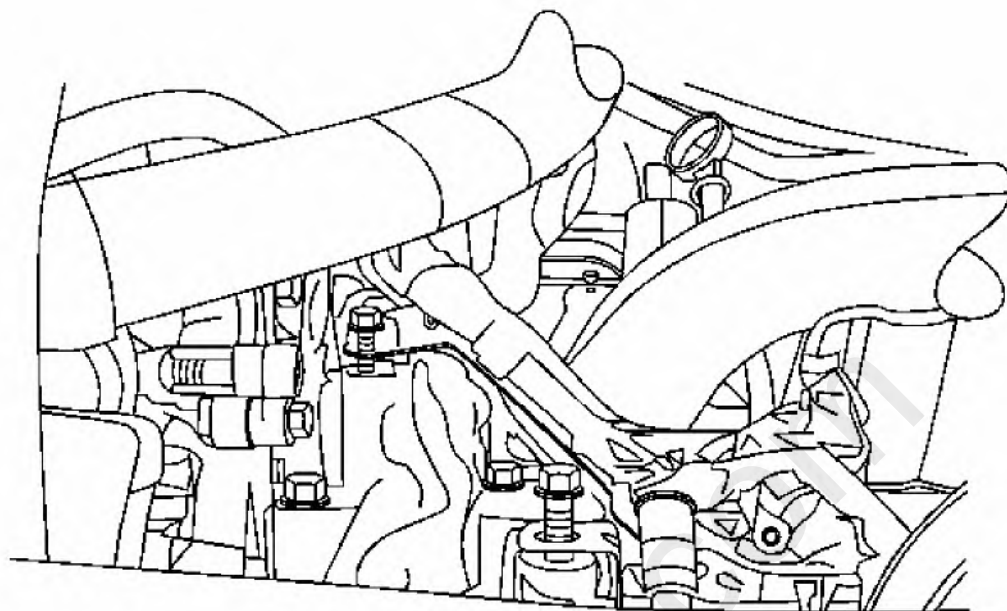


Fig. 98: A/C Compressor
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

2. Install the bolts (1) securing the wire harness bracket to the oil filter adapter.

Tighten:

- Tighten the large wire harness bracket bolt to 23 N.m (17 lb ft).
 - Tighten the small wire harness bracket bolt to 10 N.m (89 lb in).
3. Install the A/C compressor with the A/C pipes to the engine. Refer to **Compressor Replacement (LY7)** or **Compressor Replacement (LH2)** .
 4. Lower the vehicle.

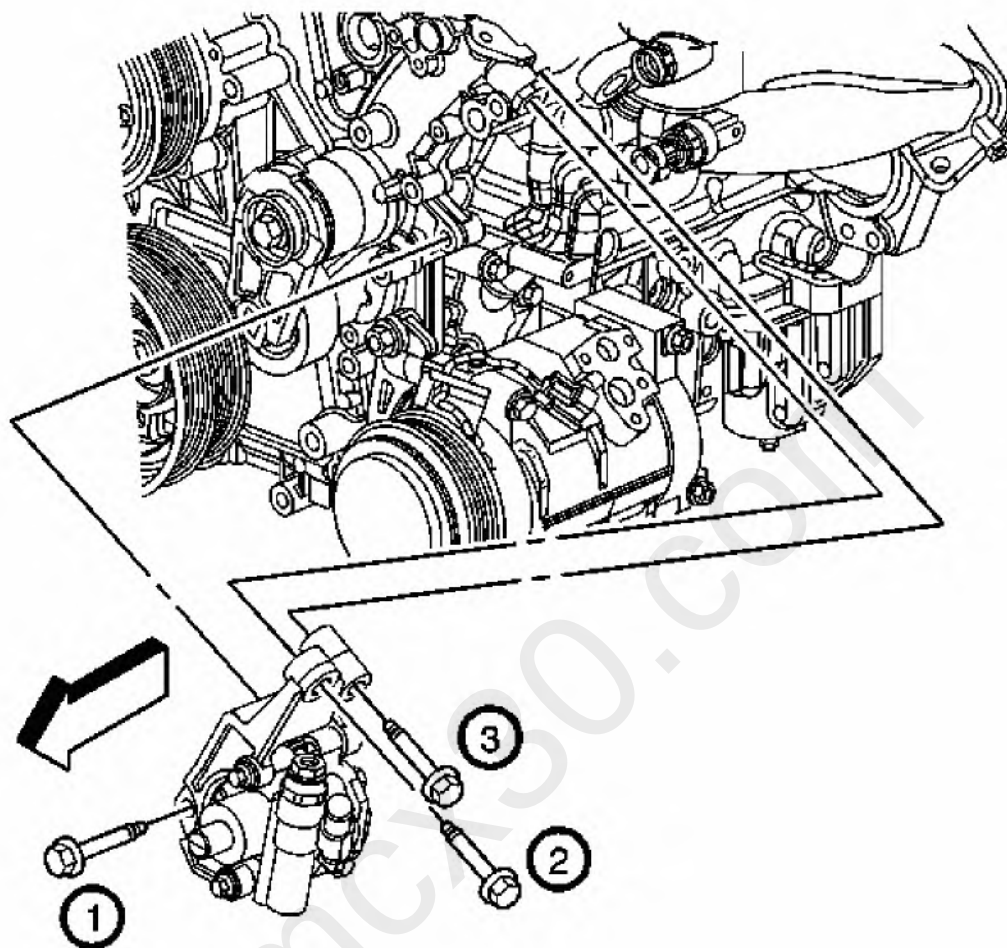


Fig. 99: View Of Power Steering Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the power steering pump bolts (1-3). Refer to **Power Steering Pump Replacement (LH2)** or **Power Steering Pump Replacement (LY7)** .
6. Connect the oil pressure sensor electrical connector.
7. Install the A/C compressor and power steering drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement**.
8. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement** .
9. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
10. Check and add engine oil as necessary.

CRANKSHAFT BALANCER REPLACEMENT

TOOLS REQUIRED

EN-48018 Flywheel Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the A/C compressor and power steering pump drive belt. Refer to **Drive Belt Tensioner Replacement - Generator and Water Pump**.
2. Remove the generator and water pump drive belt. Refer to **Drive Belt Tensioner Replacement - Power Steering and Air Conditioning**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** in General Information.
4. Remove the transmission bell housing inspection hole cover.

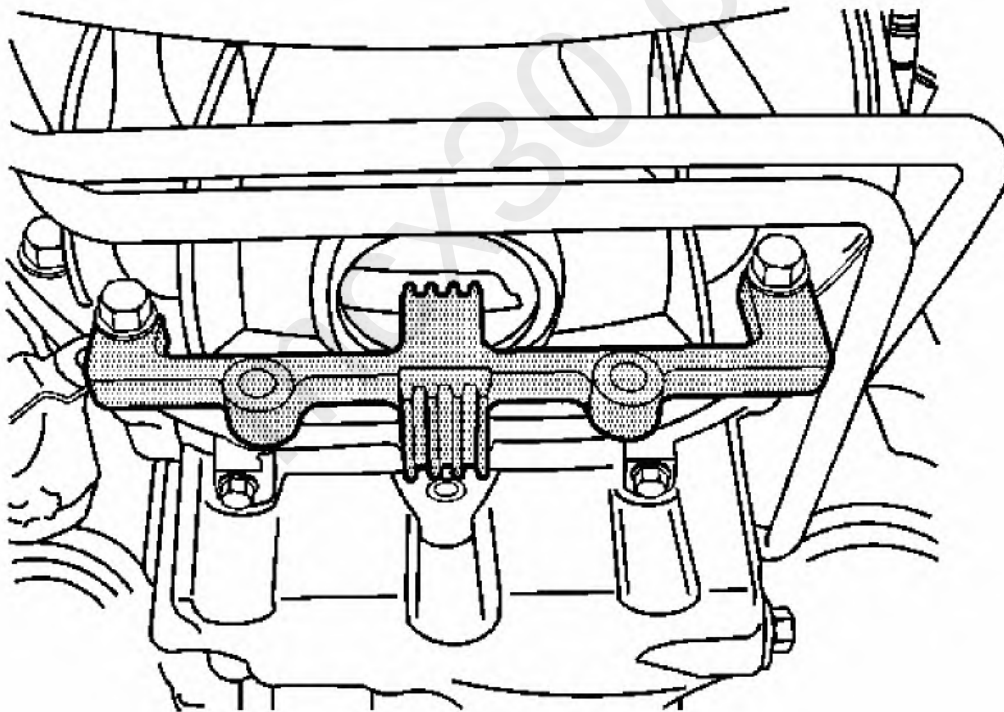


Fig. 100: Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

5. Install the **EN-48018** flywheel holding tool as shown. See **Special Tools** .
6. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .

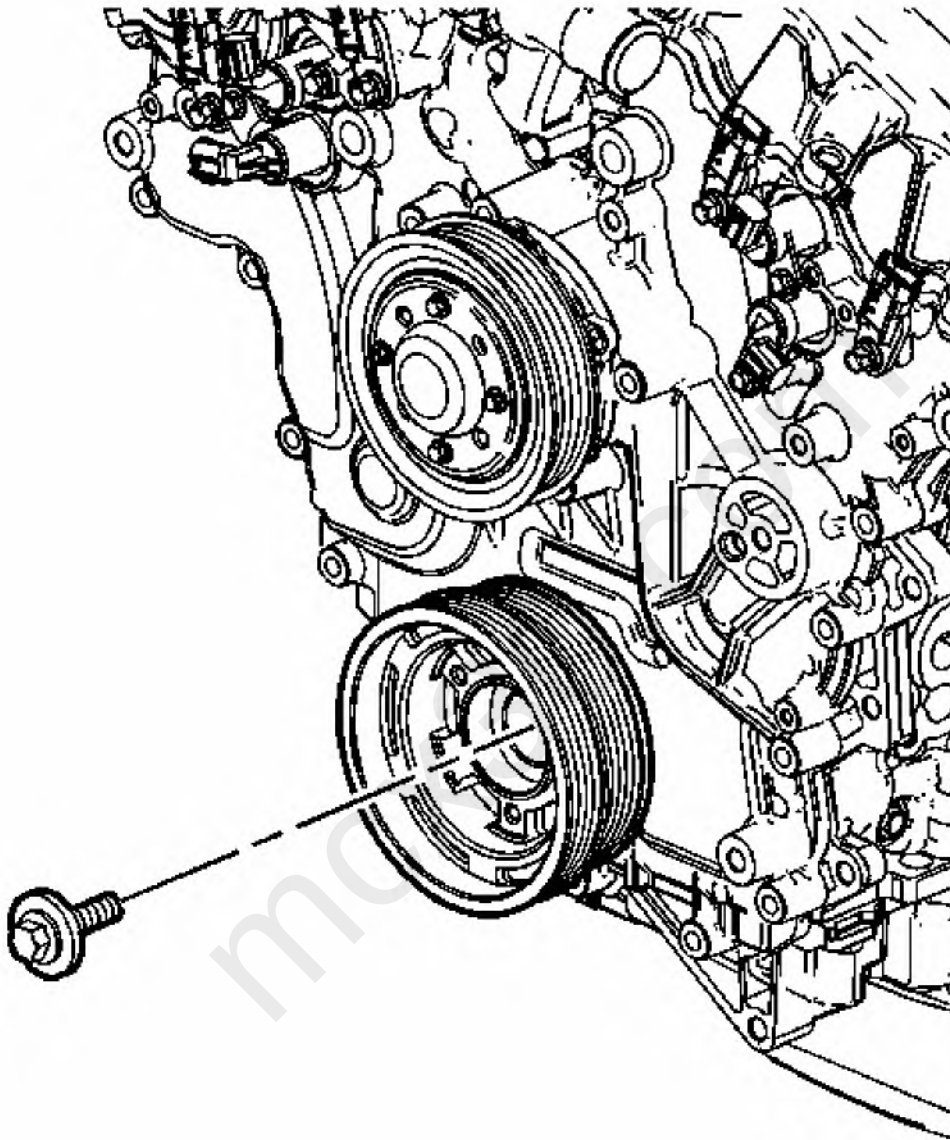


Fig. 101: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft balancer. Refer to Crankshaft Balancer Removal .

INSTALLATION PROCEDURE

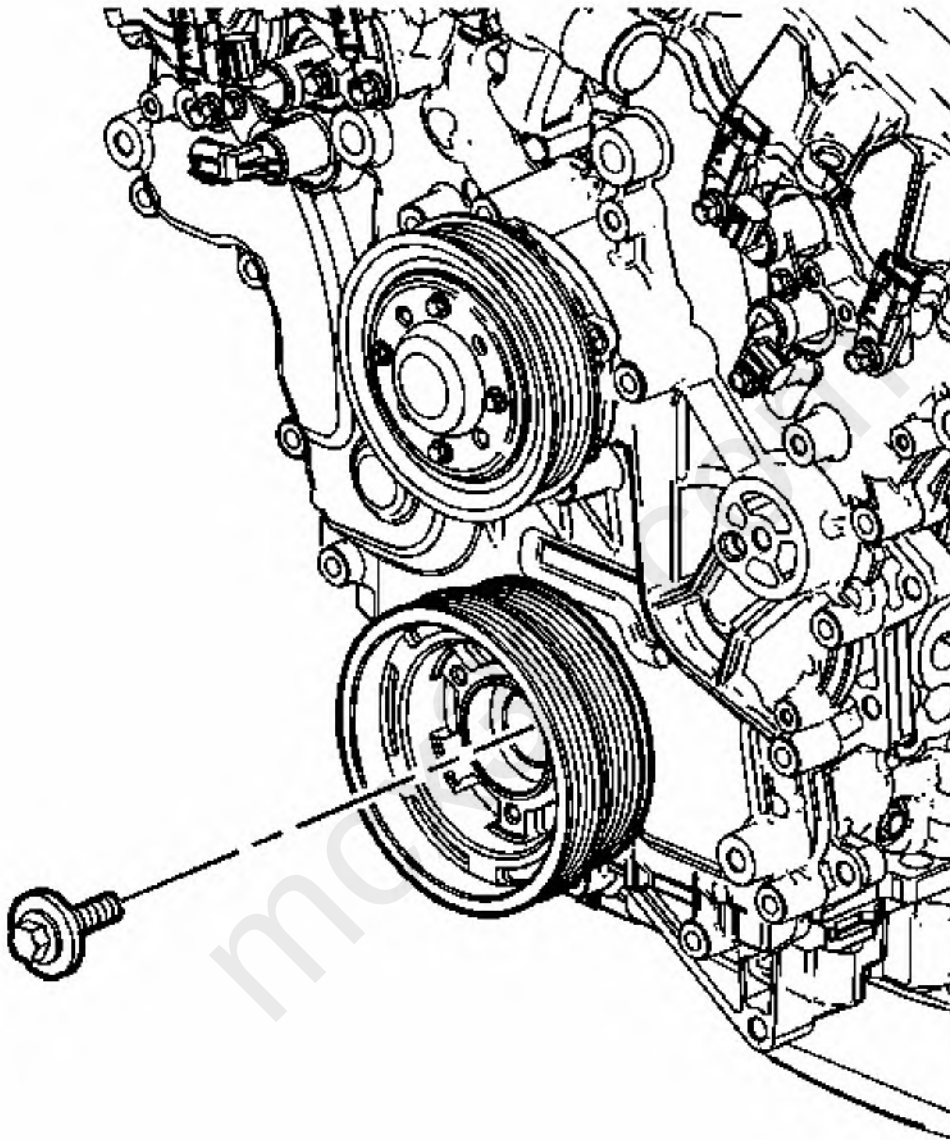


Fig. 102: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
2. Install the front air deflector. Refer to **Front Air Deflector Replacement** .

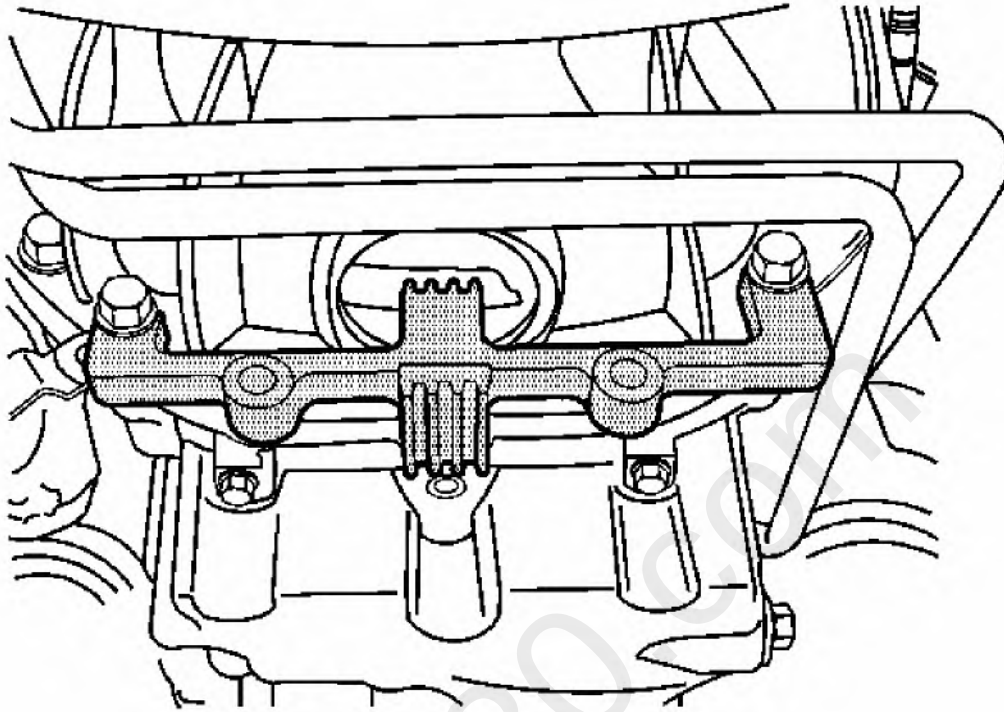


Fig. 103: Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

3. Remove the **EN-48018** flywheel holding tool. See **Special Tools** .
4. Install the transmission bell housing inspection hole cover.
5. Install the generator and water pump drive belt. Refer to **Drive Belt Tensioner Replacement - Power Steering and Air Conditioning**.
6. Install the A/C compressor and power steering pump drive belt. Refer to **Drive Belt Tensioner Replacement - Generator and Water Pump**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

TOOLS REQUIRED

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

REMOVAL PROCEDURE

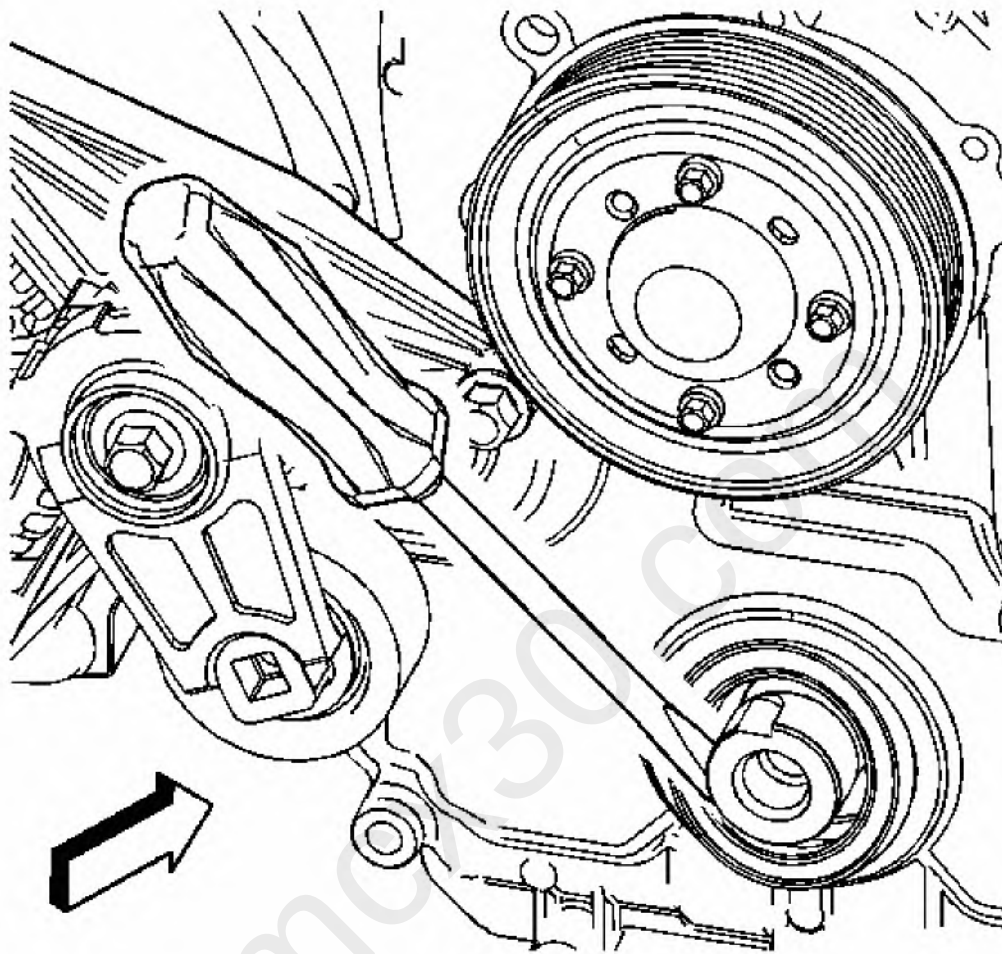


Fig. 104: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the A/C compressor and power steering pump drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement**.
2. Remove the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.
3. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
4. Use a flat-bladed tool in order to remove the crankshaft oil seal.

INSTALLATION PROCEDURE

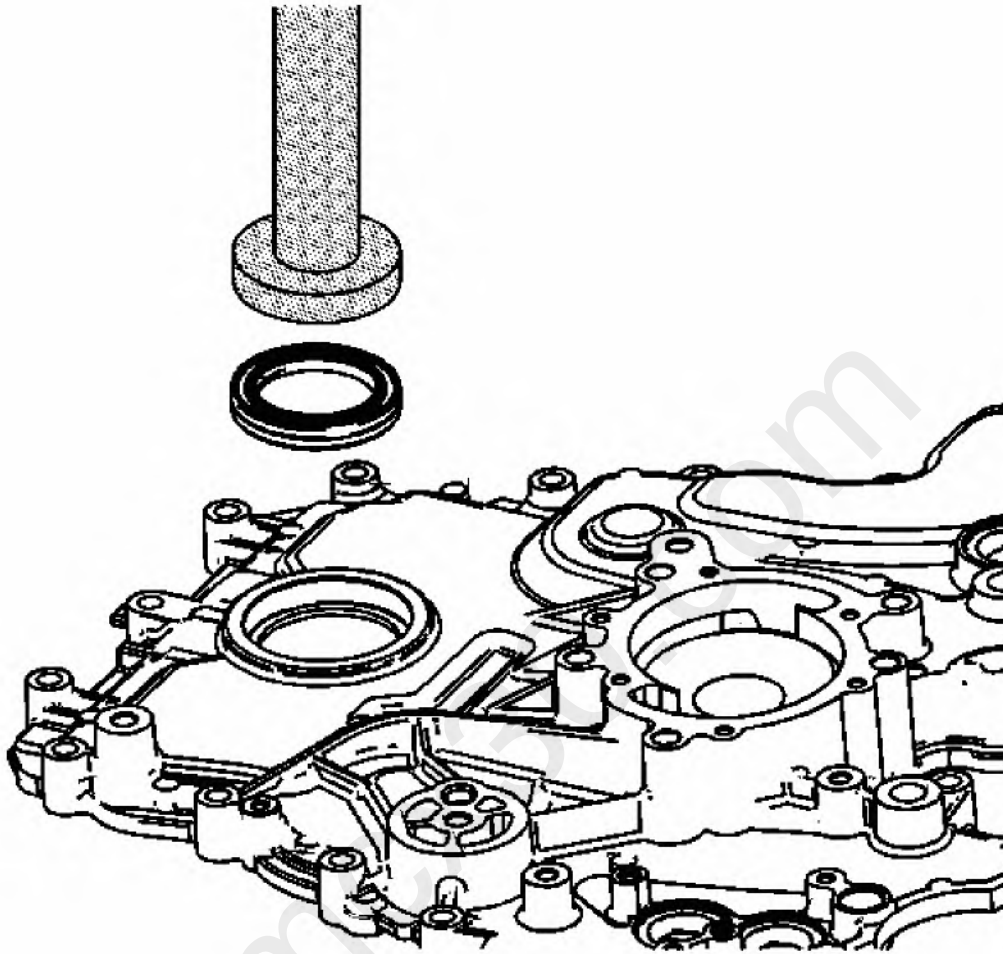


Fig. 105: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

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

1. Use the **J 29184** or equivalent to install the crankshaft front oil seal. See **Special Tools** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
3. Install the generator and water pump drive belt. Refer to **Drive Belt Tensioner Replacement - Power Steering and Air Conditioning**.
4. Install the A/C compressor and power steering pump drive belt. Refer to **Drive Belt Tensioner Replacement - Generator and Water Pump**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

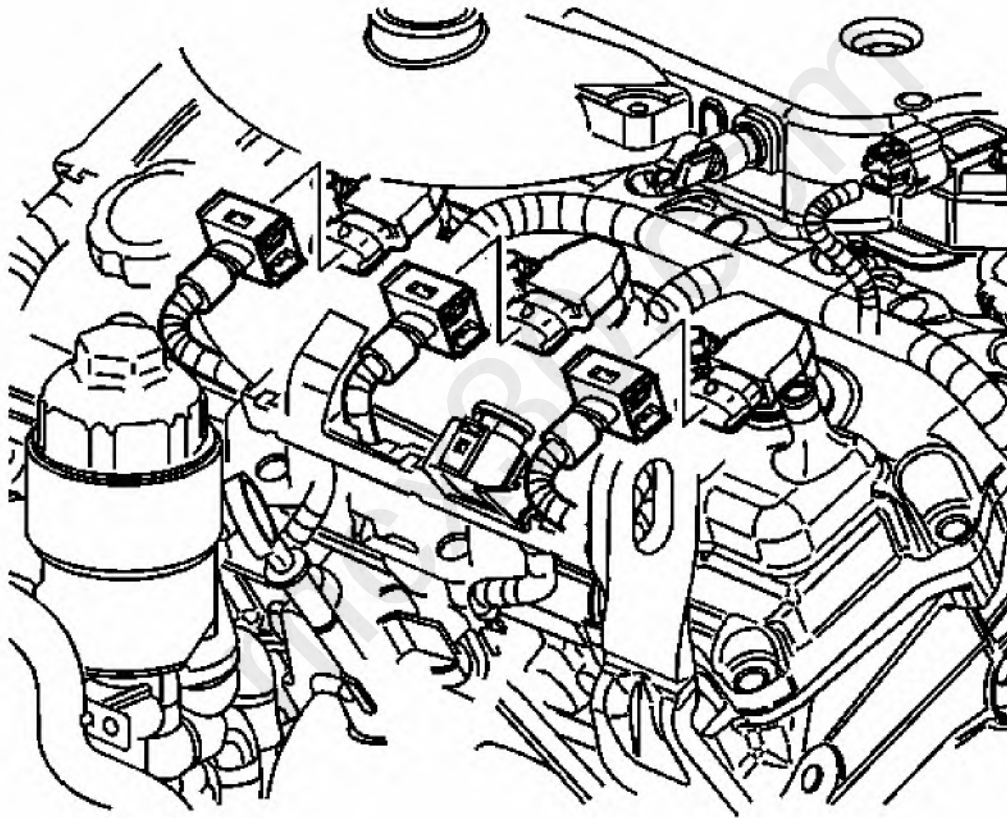


Fig. 106: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the ignition coil electrical connectors.

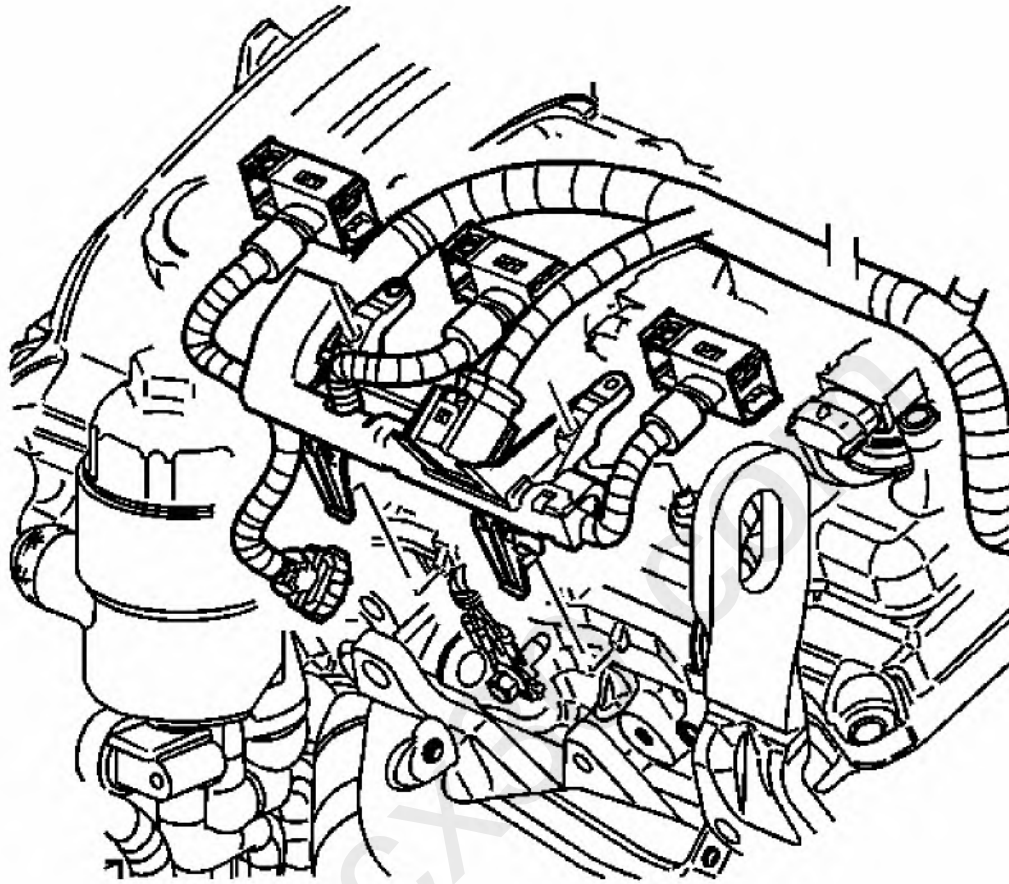


Fig. 107: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
5. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

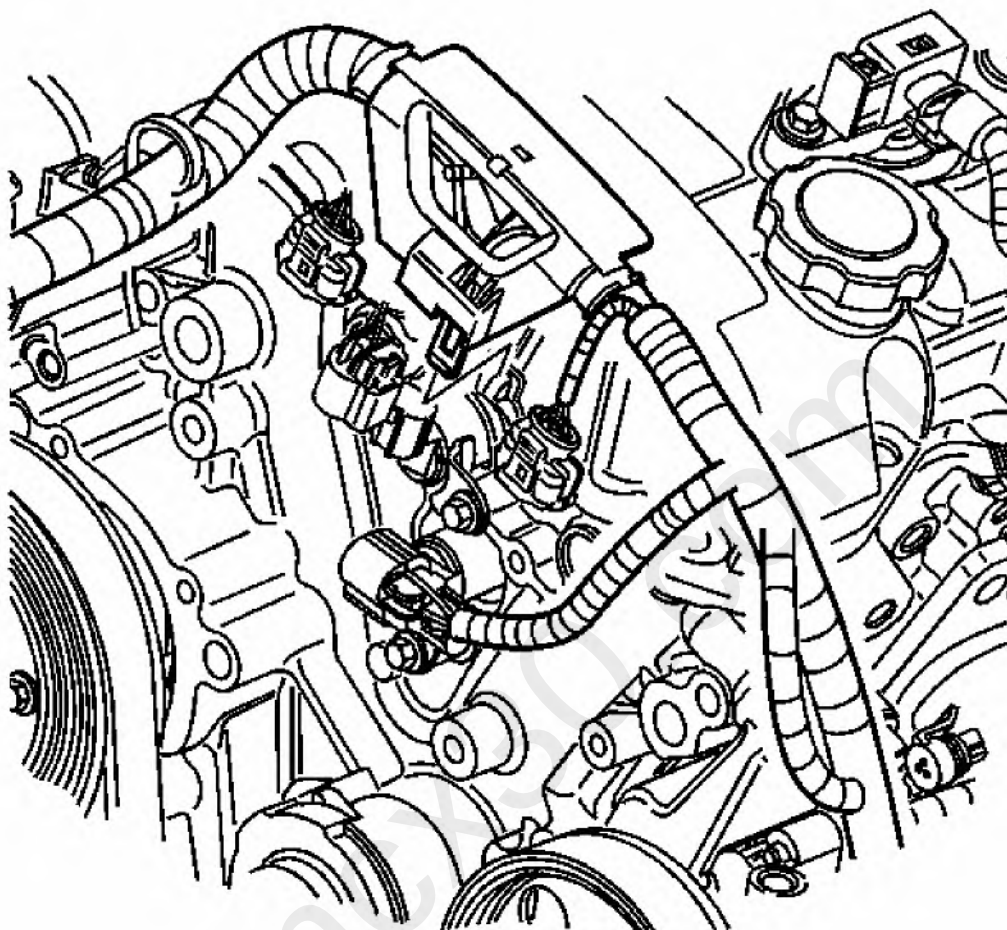


Fig. 108: View Of Left Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: It is not necessary to disconnect the engine front cover electrical connectors.

6. Remove the wiring harness from the front of the camshaft cover.
7. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

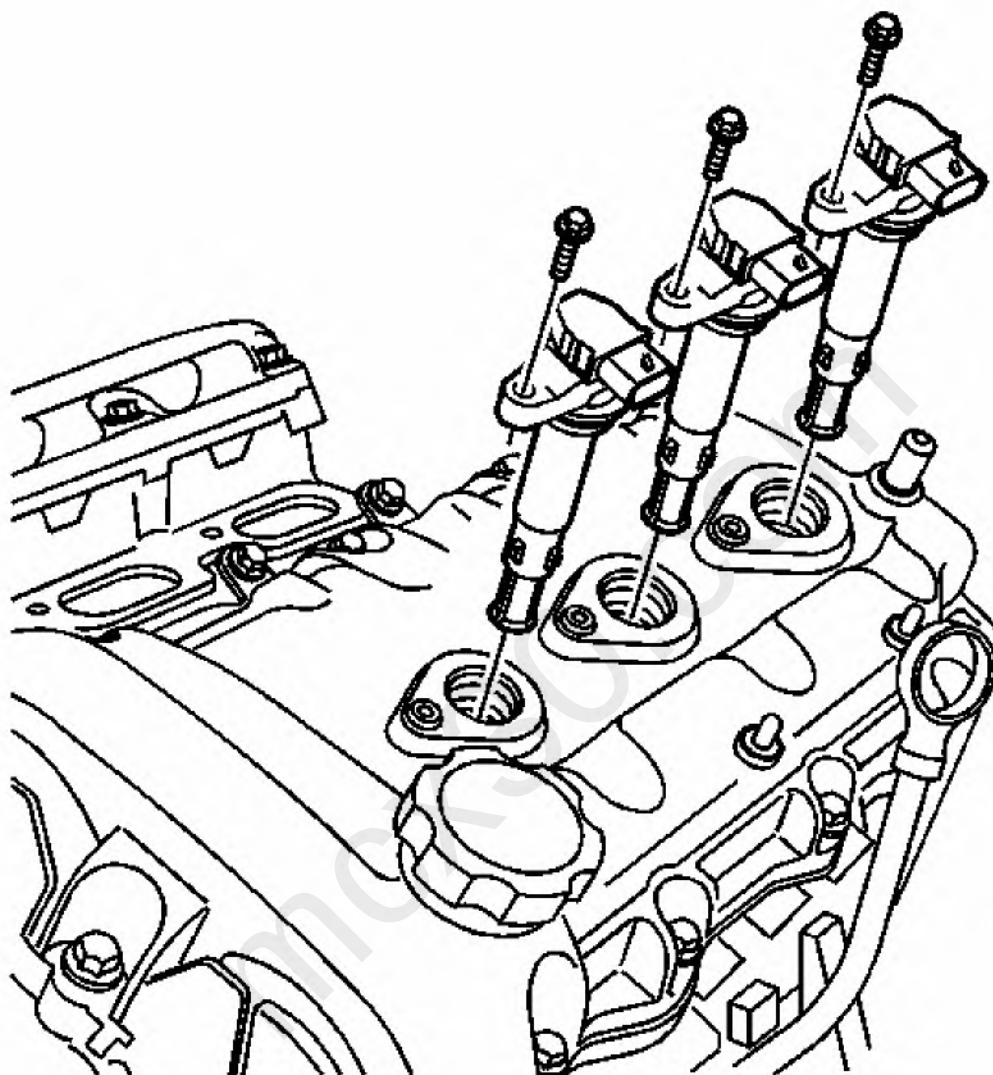


Fig. 109: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coils.

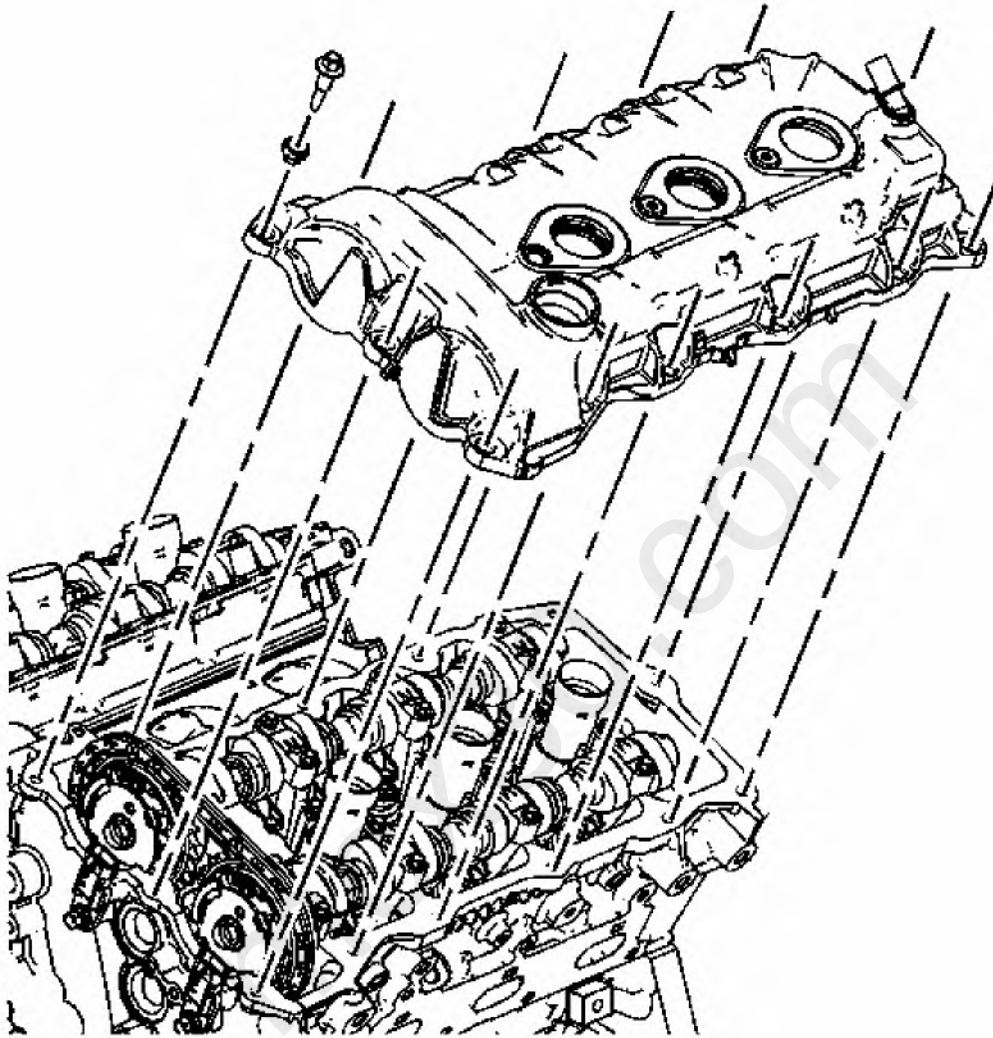


Fig. 110: Removing & Installing Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft cover.
10. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

1. Install a NEW camshaft cover seal and NEW grommets.

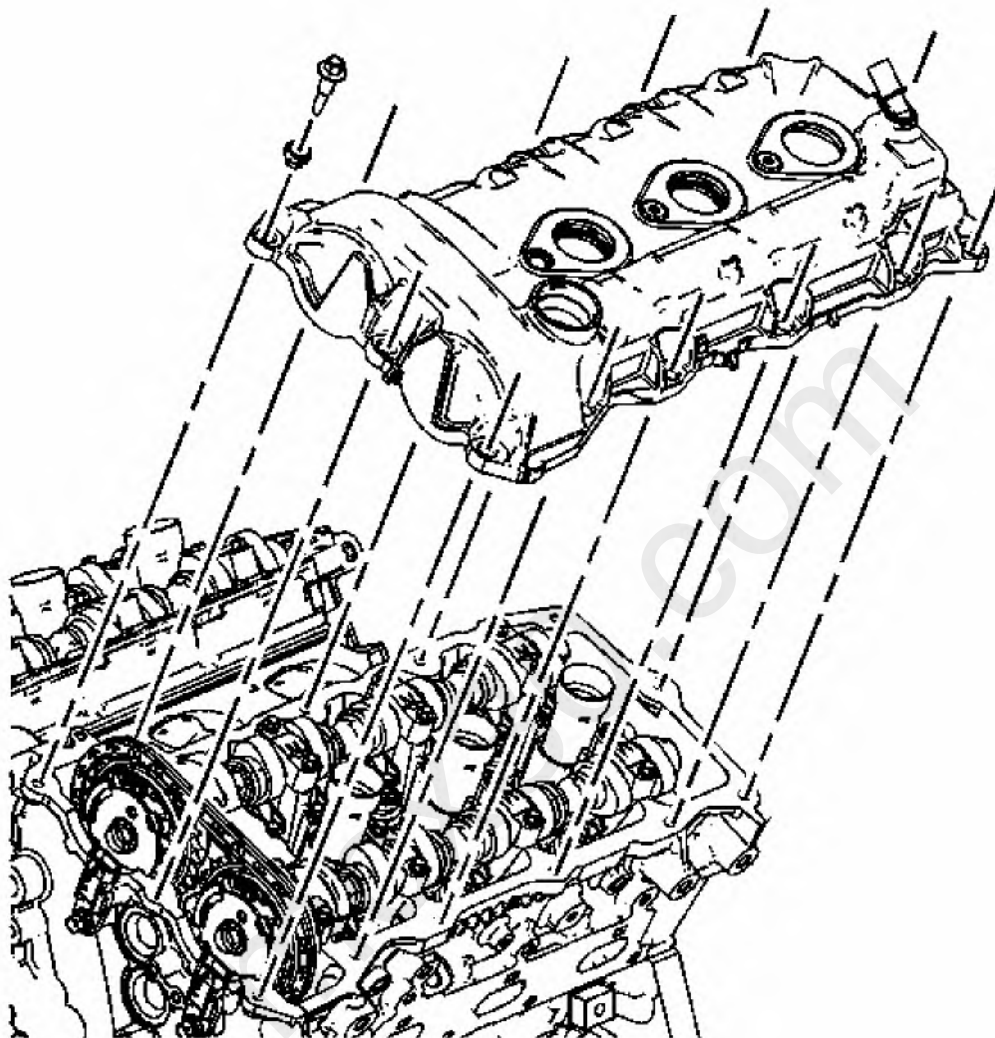


Fig. 111: Removing & Installing Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Left Side** .

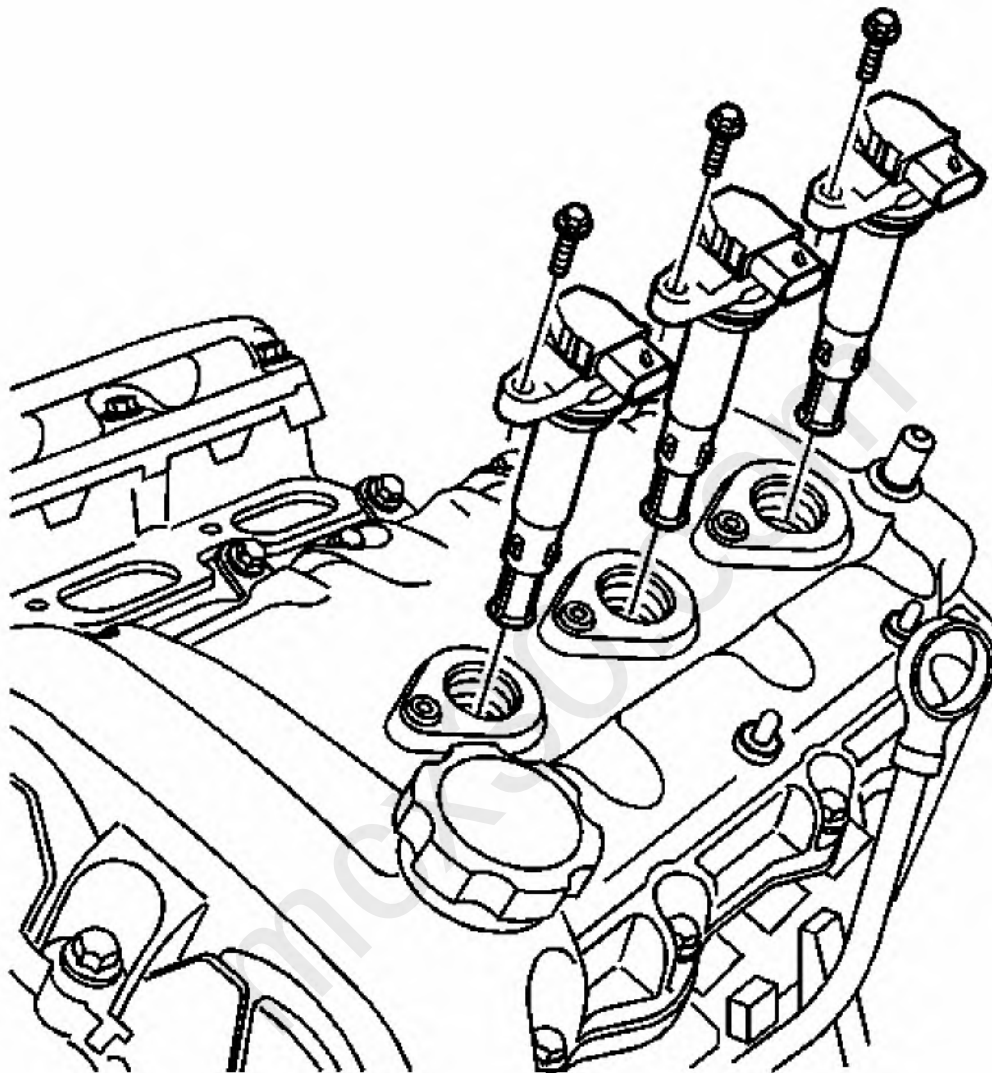


Fig. 112: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils.

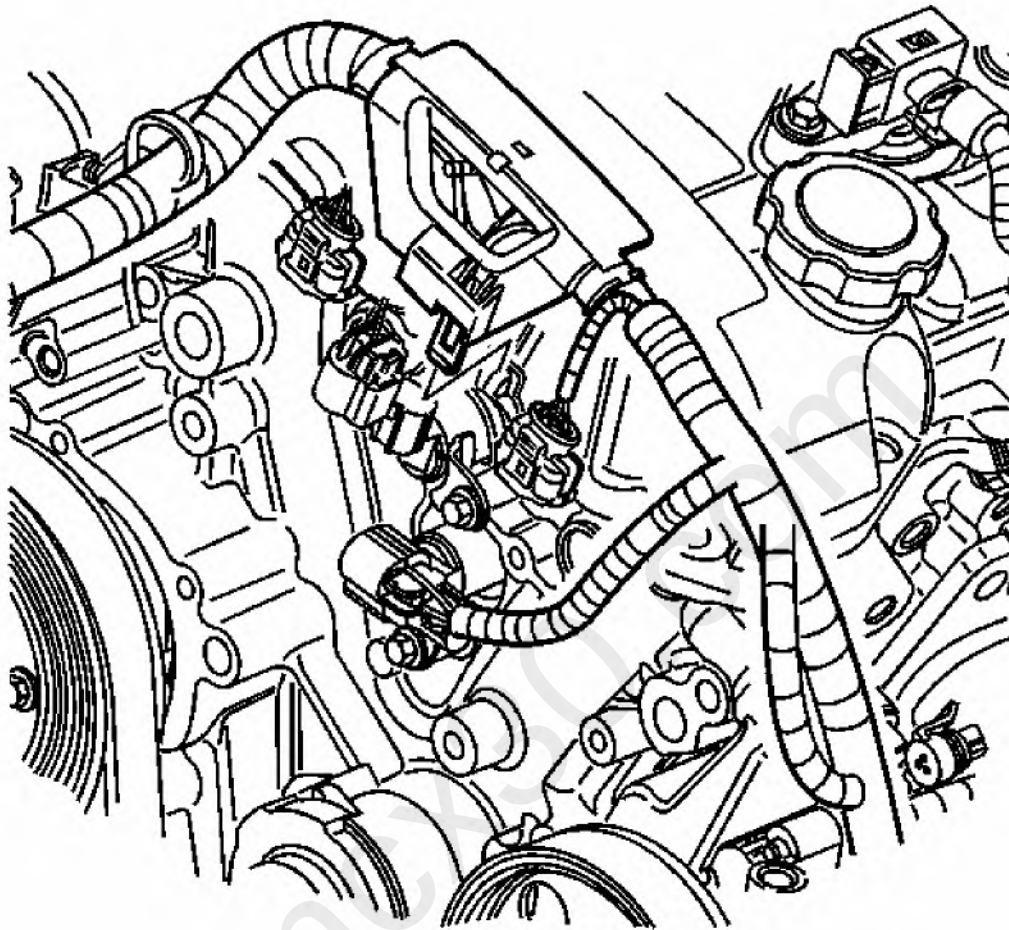


Fig. 113: View Of Left Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness to the front of the camshaft cover.
5. Install the wiring harness conduit retainers to the wiring harness conduit.

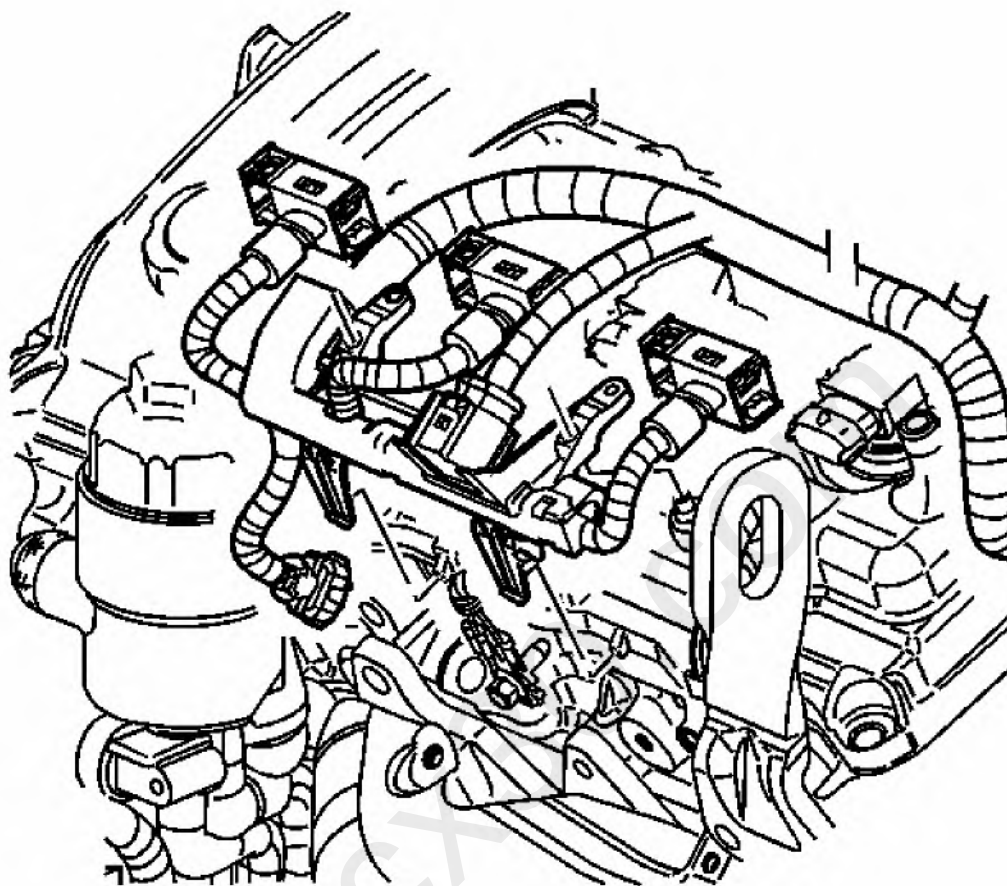


Fig. 114: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

6. Install the wiring harness to the side of the camshaft cover.

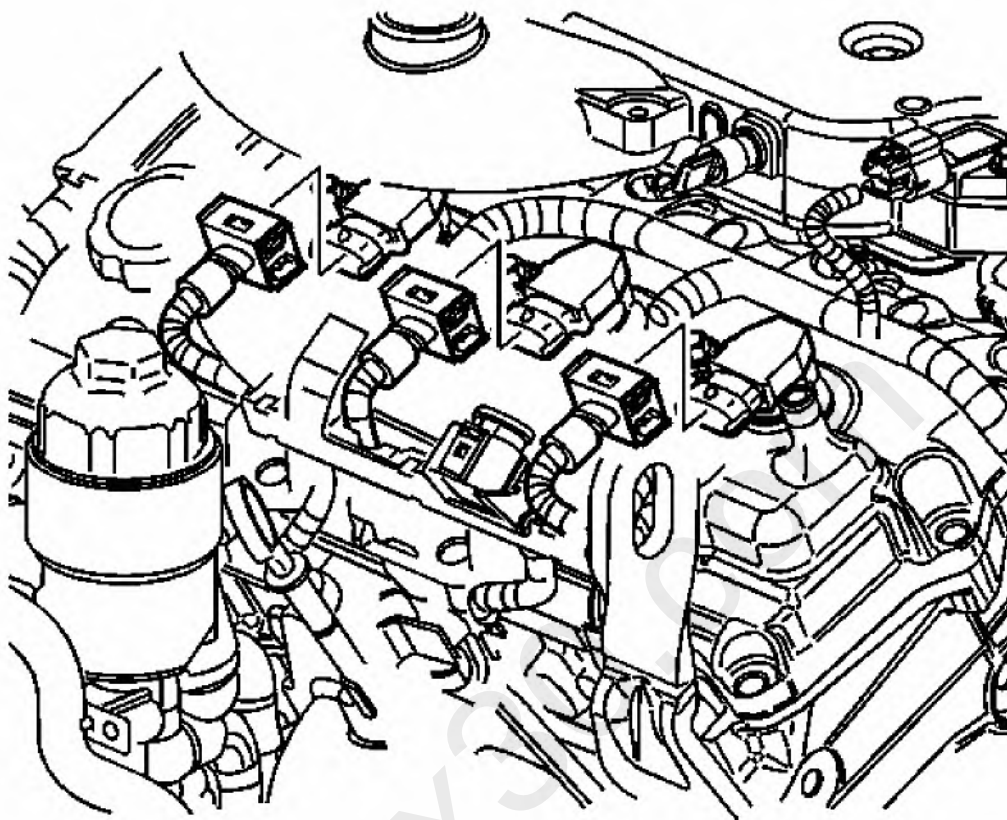


Fig. 115: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the ignition coil electrical connectors.
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
9. Install the engine cover. Refer to **Fuel Injector Sight Shield Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

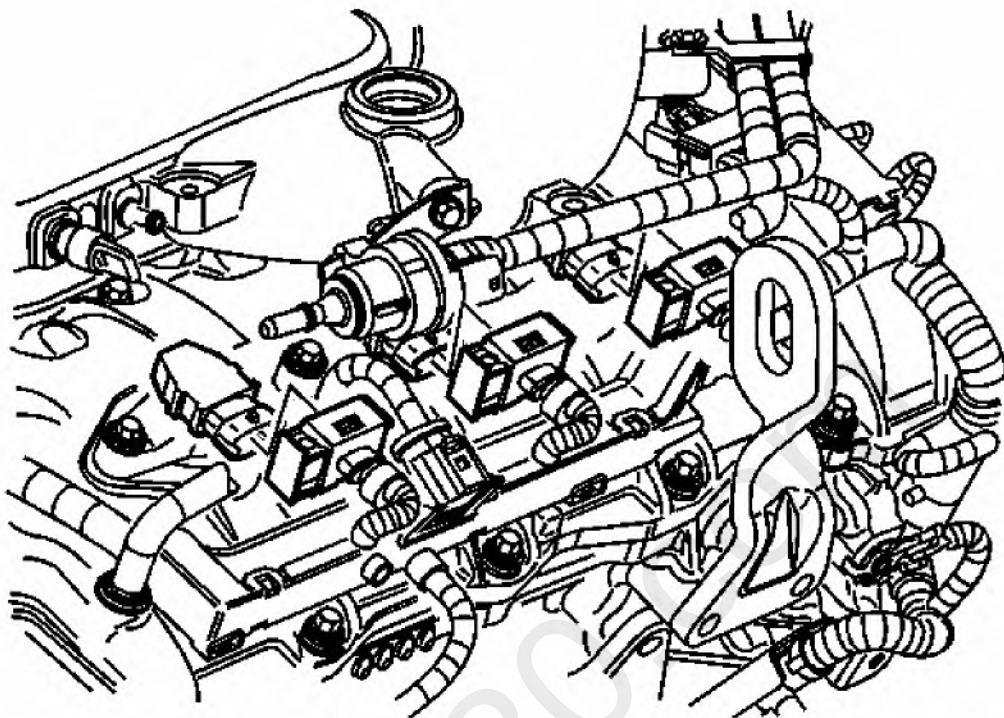


Fig. 116: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the ignition coil electrical connectors.

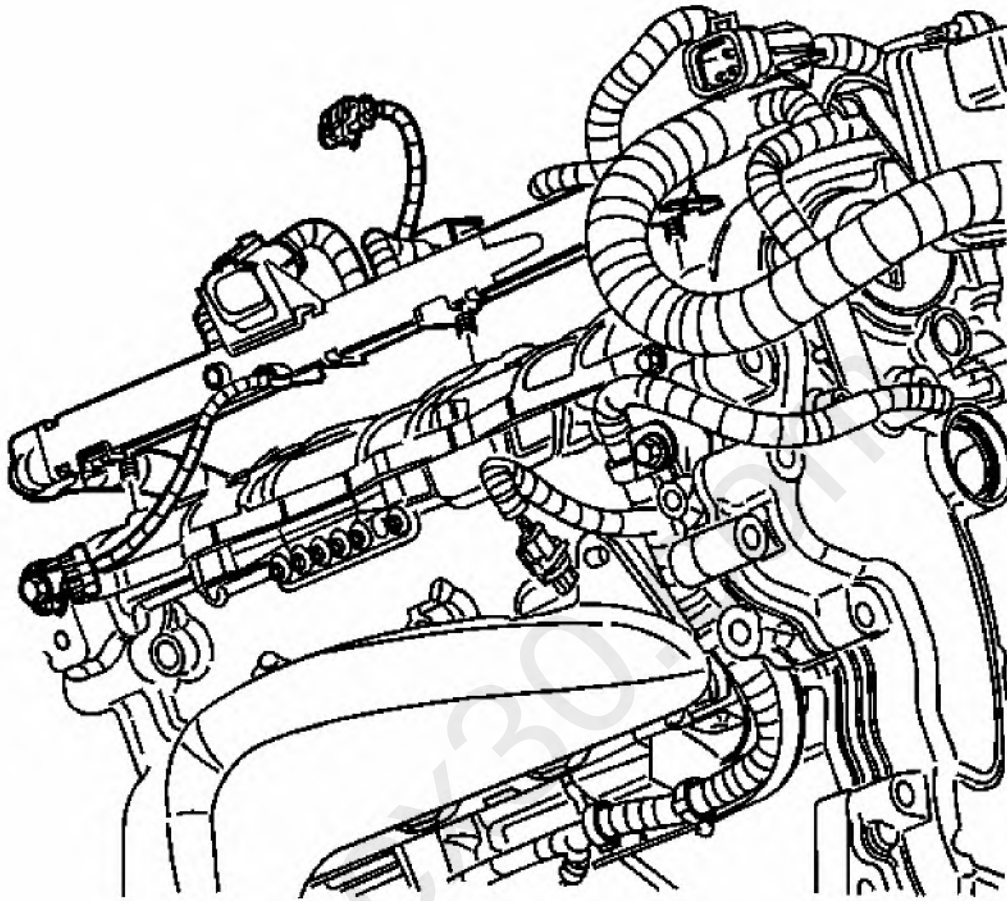


Fig. 117: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
5. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

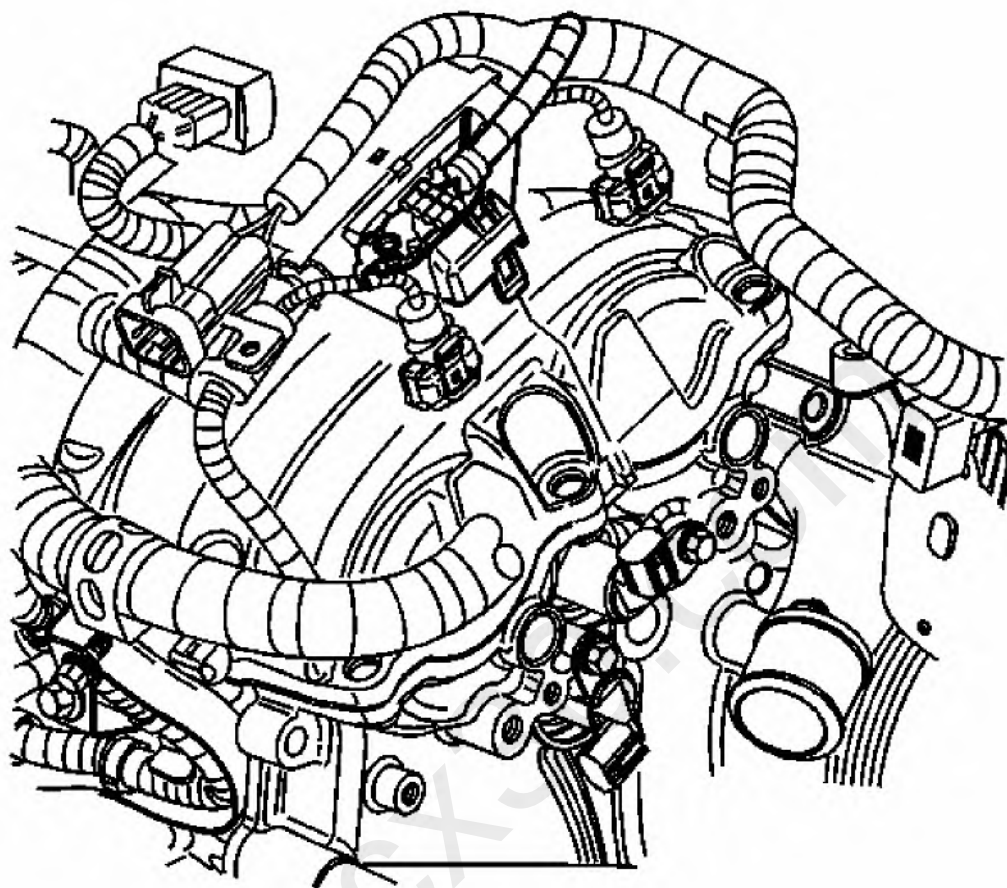


Fig. 118: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: It is not necessary to disconnect the engine front cover electrical connectors.

6. Remove the wiring harness from the front of the camshaft cover.
7. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

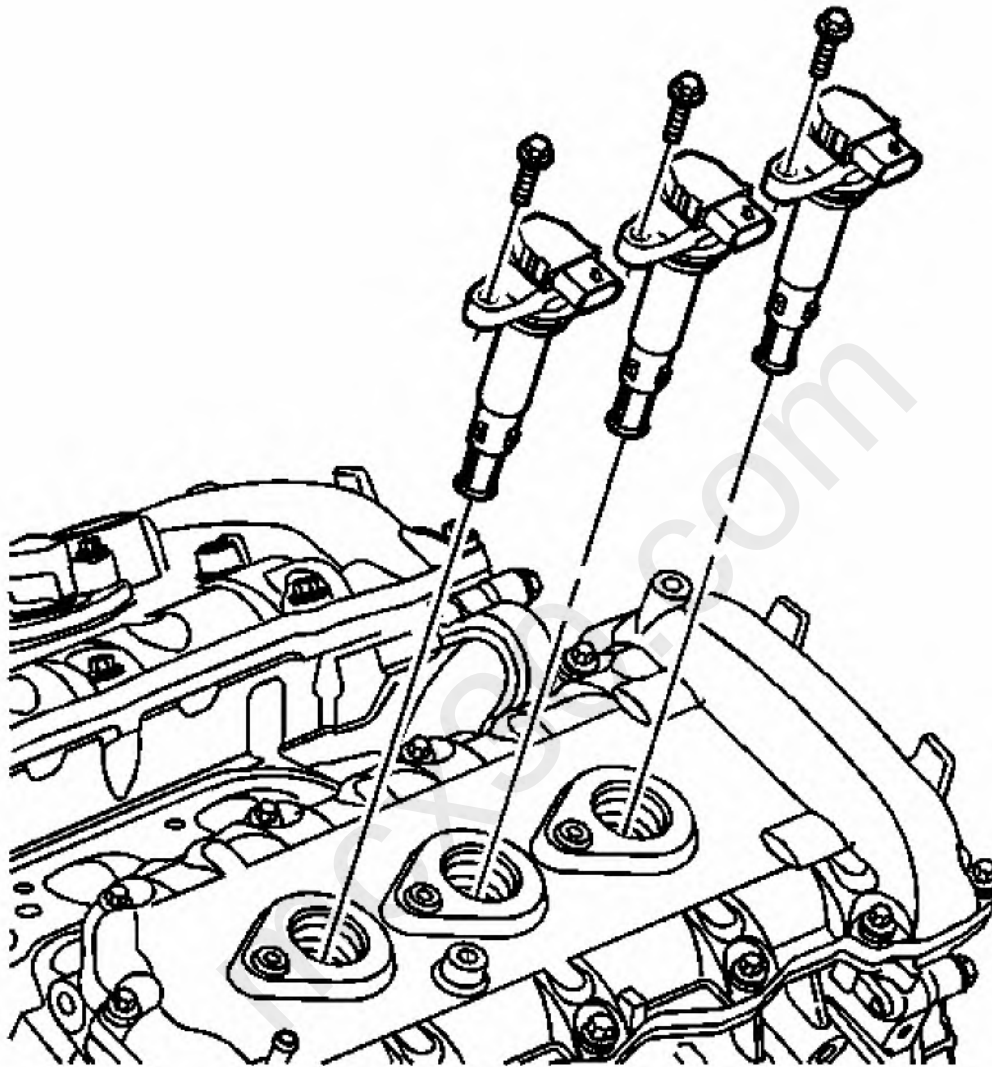


Fig. 119: Ignition Coil View
Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coils.

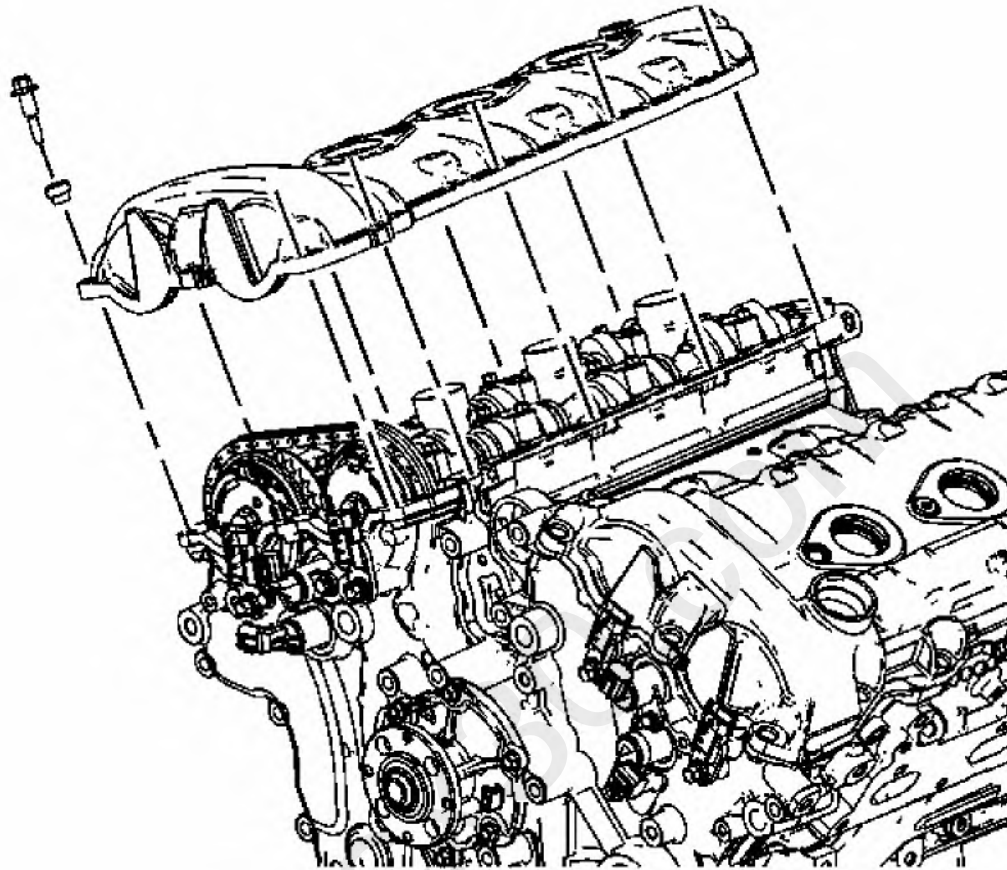


Fig. 120: Removing & Installing Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft cover.
10. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

1. Install a NEW camshaft cover seal and NEW grommets.

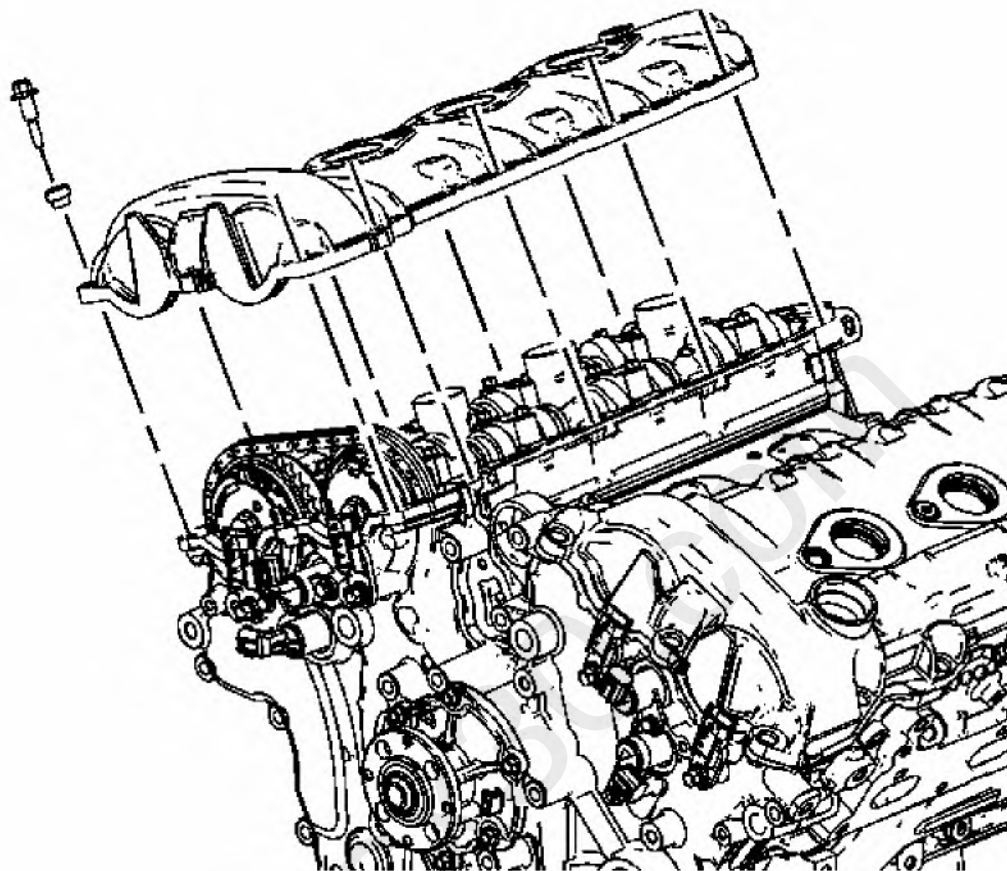


Fig. 121: Removing & Installing Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Right Side** .

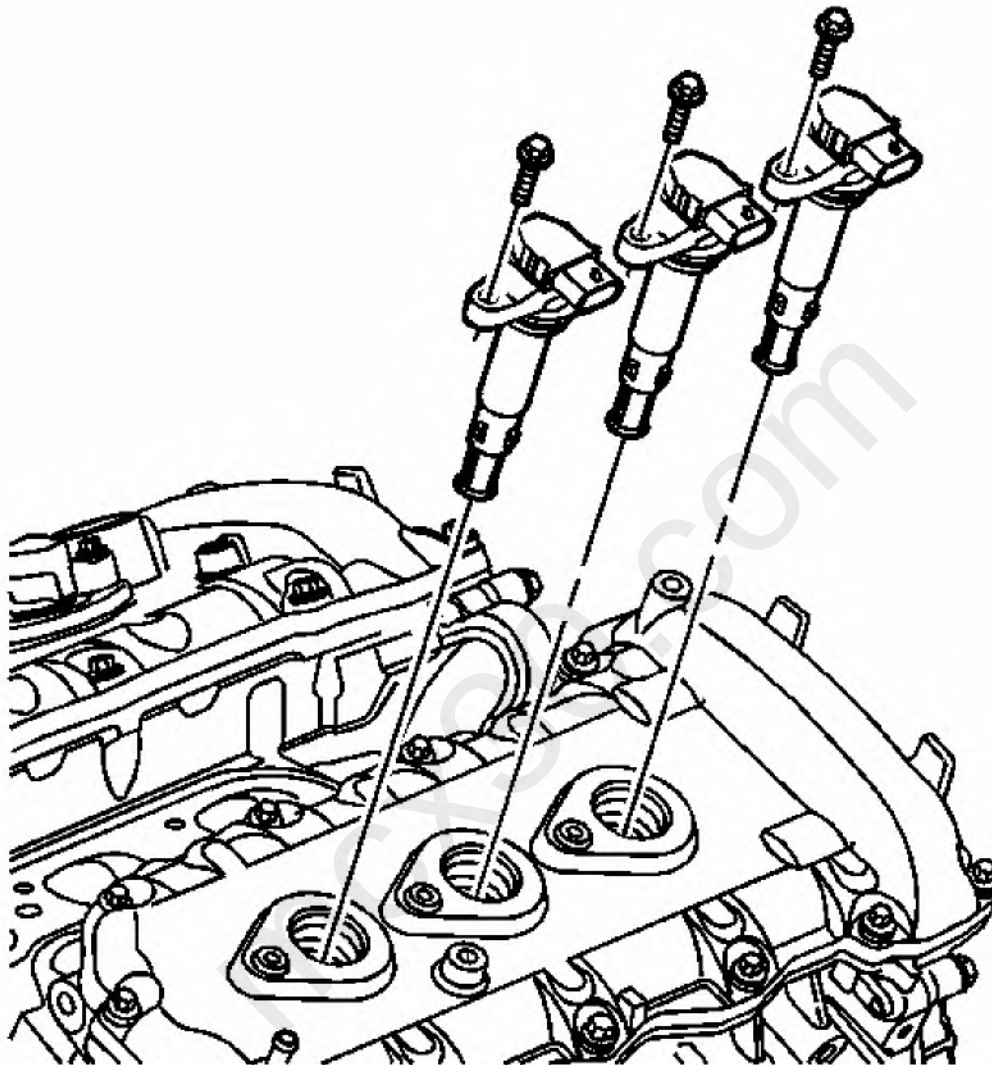


Fig. 122: Ignition Coil View
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils.

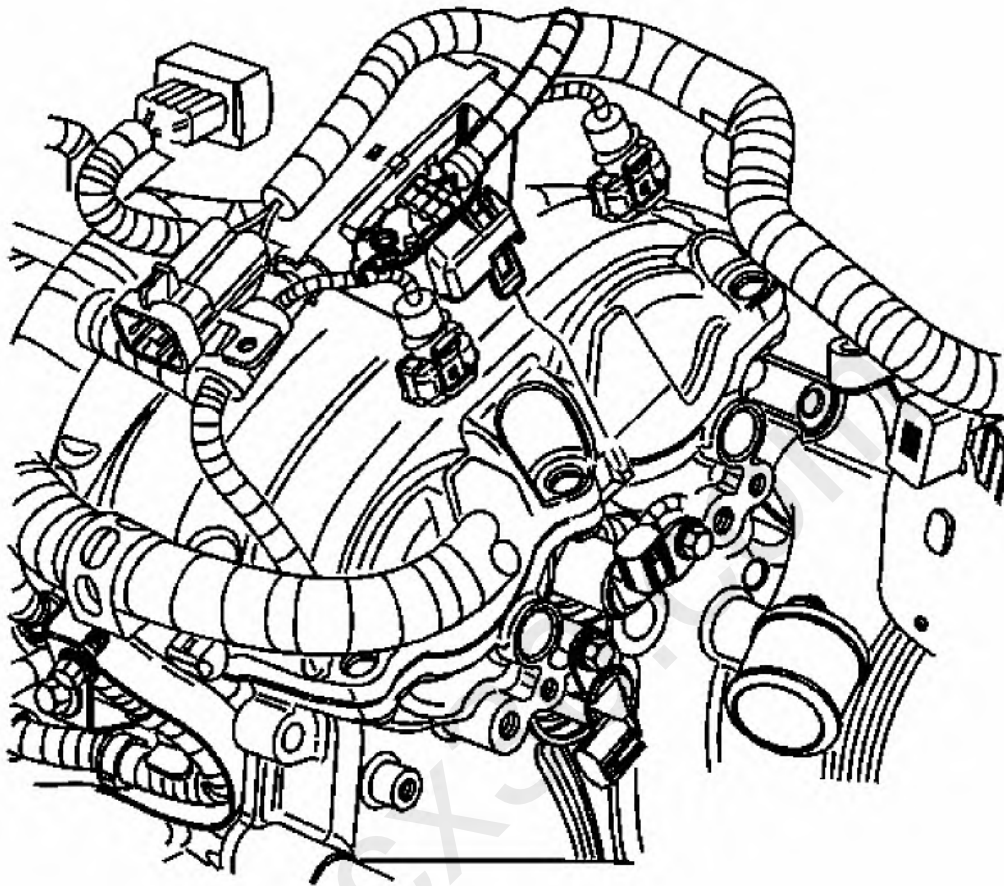


Fig. 123: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness to the front of the camshaft cover.
5. Install the wiring harness conduit retainers to the wiring harness conduit.

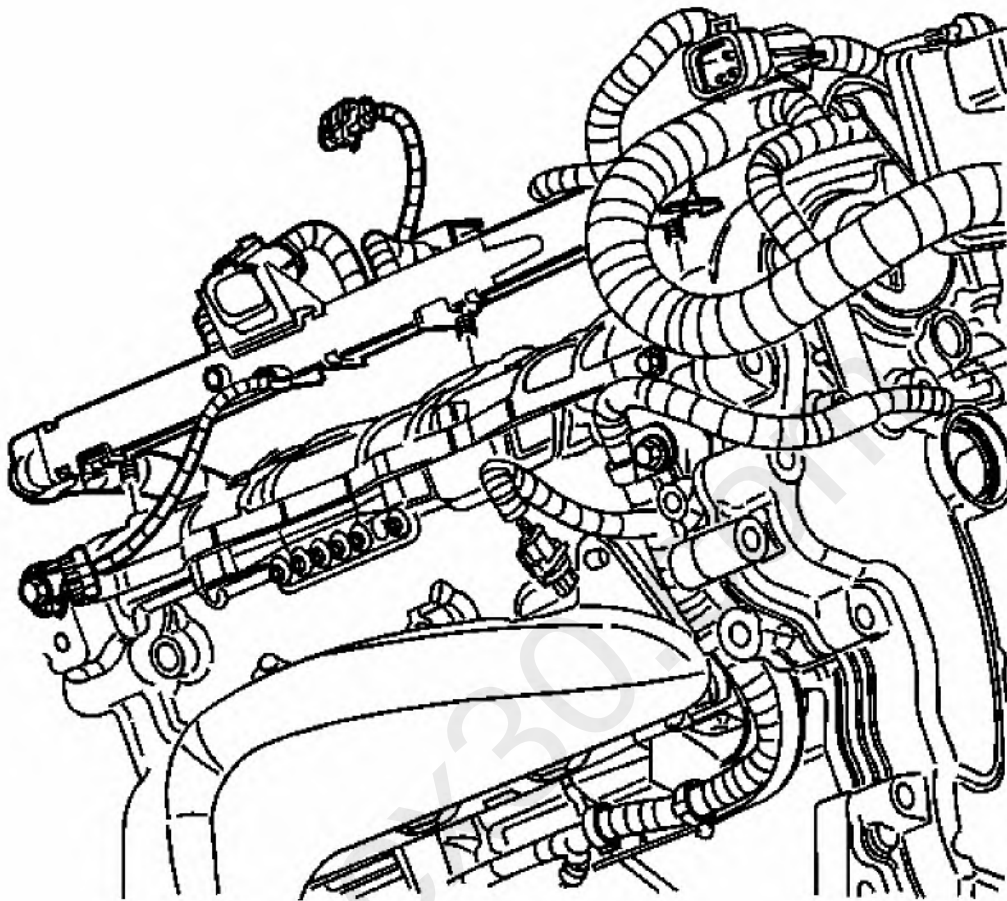


Fig. 124: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

6. Install the wiring harness to the side of the camshaft cover.

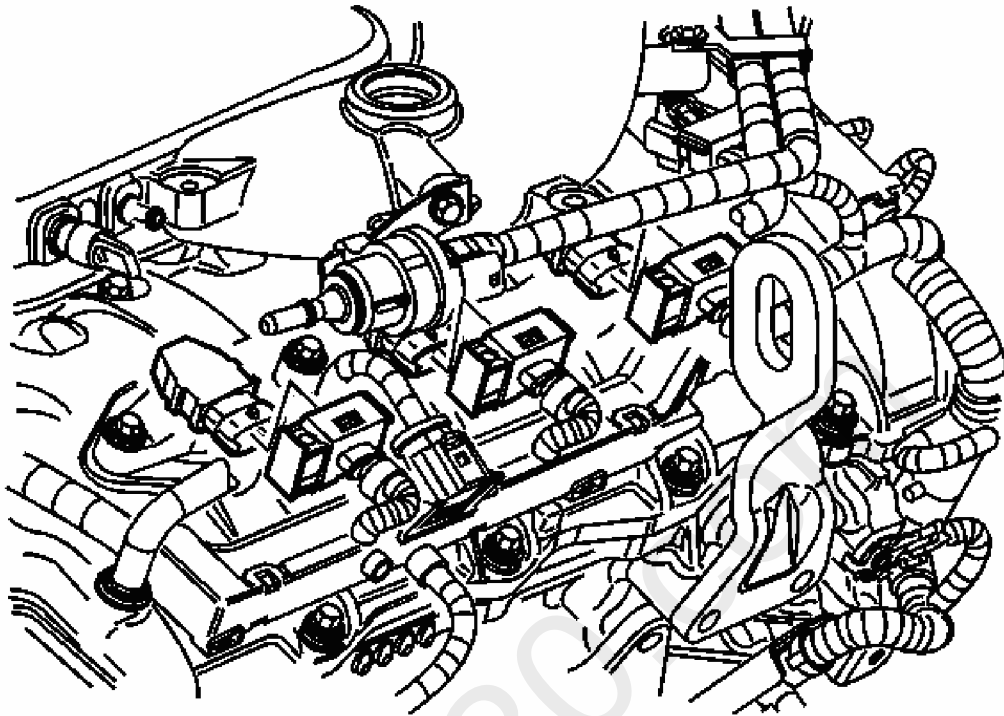


Fig. 125: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the ignition coil electrical connectors.
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
9. Install the engine cover. Refer to **Fuel Injector Sight Shield Replacement**.

ENGINE FRONT COVER REPLACEMENT

TOOLS REQUIRED

EN 46109 Engine Front Cover Installation Guide Pins. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
3. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side** and

Camshaft Cover Replacement - Right Side.

4. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (GE 47719)** .
5. Disconnect the purge vent hose from the water outlet.
6. Remove the water outlet with the radiator hose and reposition aside. Refer to **Water Outlet Housing Replacement (LH2)** or **Water Outlet Housing Replacement (LY7)** or **Water Outlet Housing Replacement (LC3)** .
7. Remove the accessory drive belts. Refer to **Water Pump and Generator Belt Replacement** and **Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement**.
8. Remove the A/C compressor and power steering belt tensioner. Refer to **Drive Belt Tensioner Replacement - Power Steering and Air Conditioning**.
9. Remove the generator bracket with the generator and the belt tensioner. Refer to **Generator Bracket Replacement (LY7)** or **Generator Bracket Replacement (LH2)** or **Generator Bracket Replacement (LC3)** .

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

10. Remove the power steering fluid reservoir and reposition the power steering fluid reservoir in order to provide access.
11. Remove the power steering pump pulley. Refer to **Power Steering Pump Removal** .

IMPORTANT: Do not disconnect the power steering pipes/hoses.

12. Remove the power steering pump upper front bolt and loosen the remaining two bolts. Refer to **Power Steering Pump Removal** .
13. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal** .
14. Remove the oil control valves. 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** .

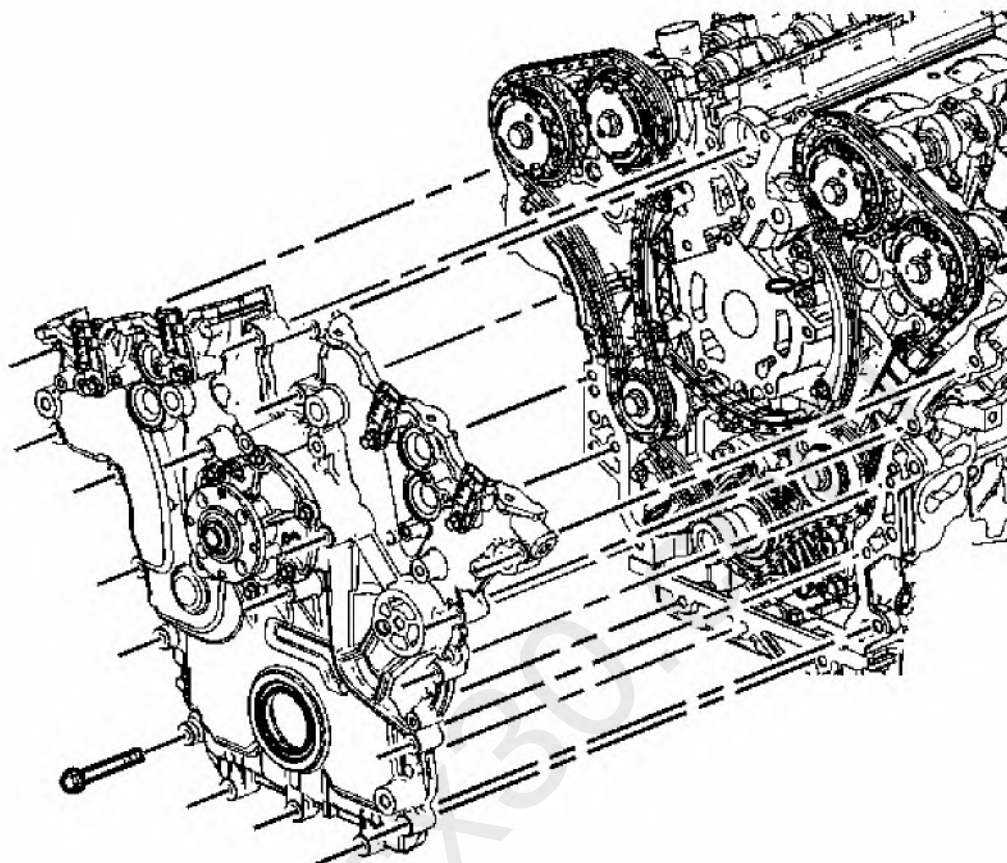


Fig. 126: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

15. Remove the engine front cover with the water pump. Refer to **Engine Front Cover Removal (Second Design)** .
16. Disassemble the engine front cover as necessary. Refer to **Engine Front Cover Disassemble** .

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

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

IMPORTANT: 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.

18. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection** .
19. 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 as necessary. Refer to **Engine Front Cover Assemble** .

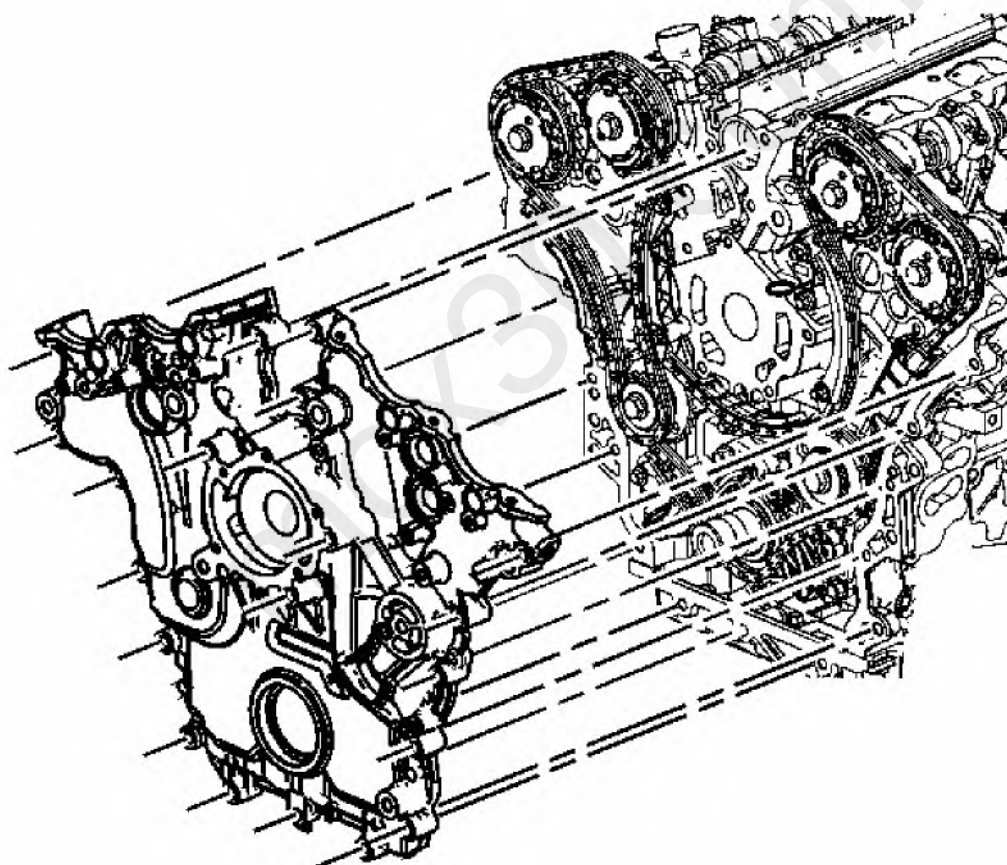


Fig. 127: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Use the **EN 46109** in order to install the engine front cover. See **Special Tools** . Refer to **Engine Front Cover Installation (Second Design)** .
3. Install the oil control valves. 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 .

4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation .**
5. Install the power steering pump. Refer to **Power Steering Pump Installation .**
6. Install the power steering pump pulley. Refer to **Power Steering Pump Installation .**
7. Install the power steering fluid reservoir. Refer to **Remote Power Steering Fluid Reservoir Replacement (LH2)** or **Remote Power Steering Fluid Reservoir Replacement (LY7)** .
8. Install the generator bracket with the generator and the belt tensioner. Refer to **Generator Bracket Replacement (LY7)** or **Generator Bracket Replacement (LH2)** or **Generator Bracket Replacement (LC3)** .
9. Install the A/C compressor and power steering belt tensioner. Refer to **Drive Belt Tensioner Replacement - Power Steering and Air Conditioning.**
10. Install the accessory drive belts. Refer to **Air Conditioning Compressor and Power Steering Pump Drive Belt Replacement** and **Water Pump and Generator Belt Replacement.**
11. Install the water outlet. Refer to **Water Outlet Housing Replacement (LH2)** or **Water Outlet Housing Replacement (LY7)** or **Water Outlet Housing Replacement (LC3)** .
12. Install the purge vent hose to the water outlet.
13. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (GE 47719)** .
14. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side** and **Camshaft Cover Replacement - Right Side.**
15. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement.**
16. Install the engine cover. Refer to **Engine Front Cover Installation (Second Design)** .
17. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (GE 47719)** .
18. Change the engine oil. Refer to **Engine Oil and Oil Filter Replacement .**

SECONDARY CAMSHAFT 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 Camshaft Drive Chain Tensioner Removal - Right Side (Second Design)** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side (Second Design)** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Right Side (Second Design)** .

5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Removal - Right Side (Second Design)** .
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Removal (Second Design)** .
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Camshaft Drive Chain Guide Removal - Upper (Second Design)** .
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Drive Chain Removal (Second Design)** .
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Removal - Right Side (Second Design)** .
10. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Removal - Left Side (Second Design)** .
11. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side (Second Design)** .
12. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Left Side (Second Design)** .
13. Remove the left bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Removal - Left Side (Second Design)** .

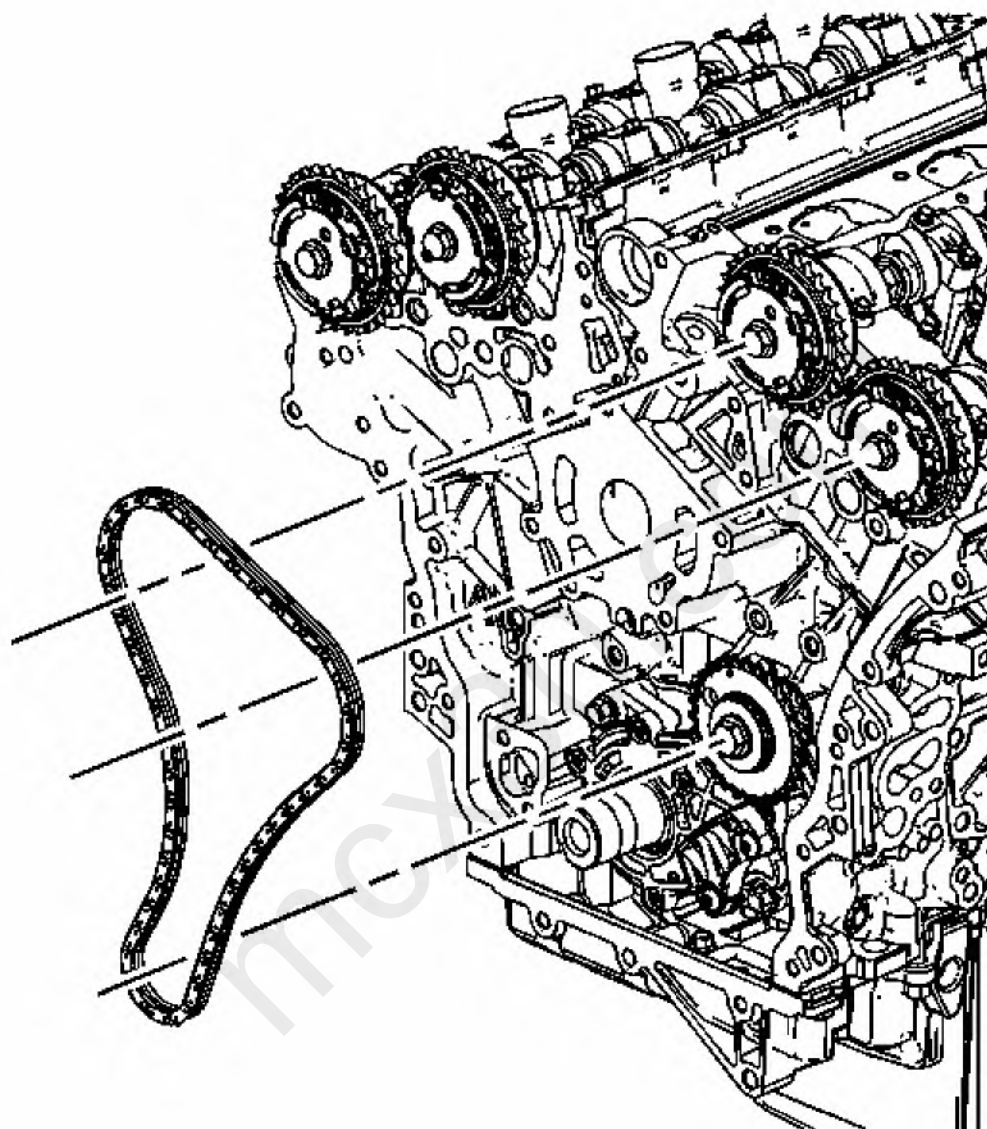


Fig. 128: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

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

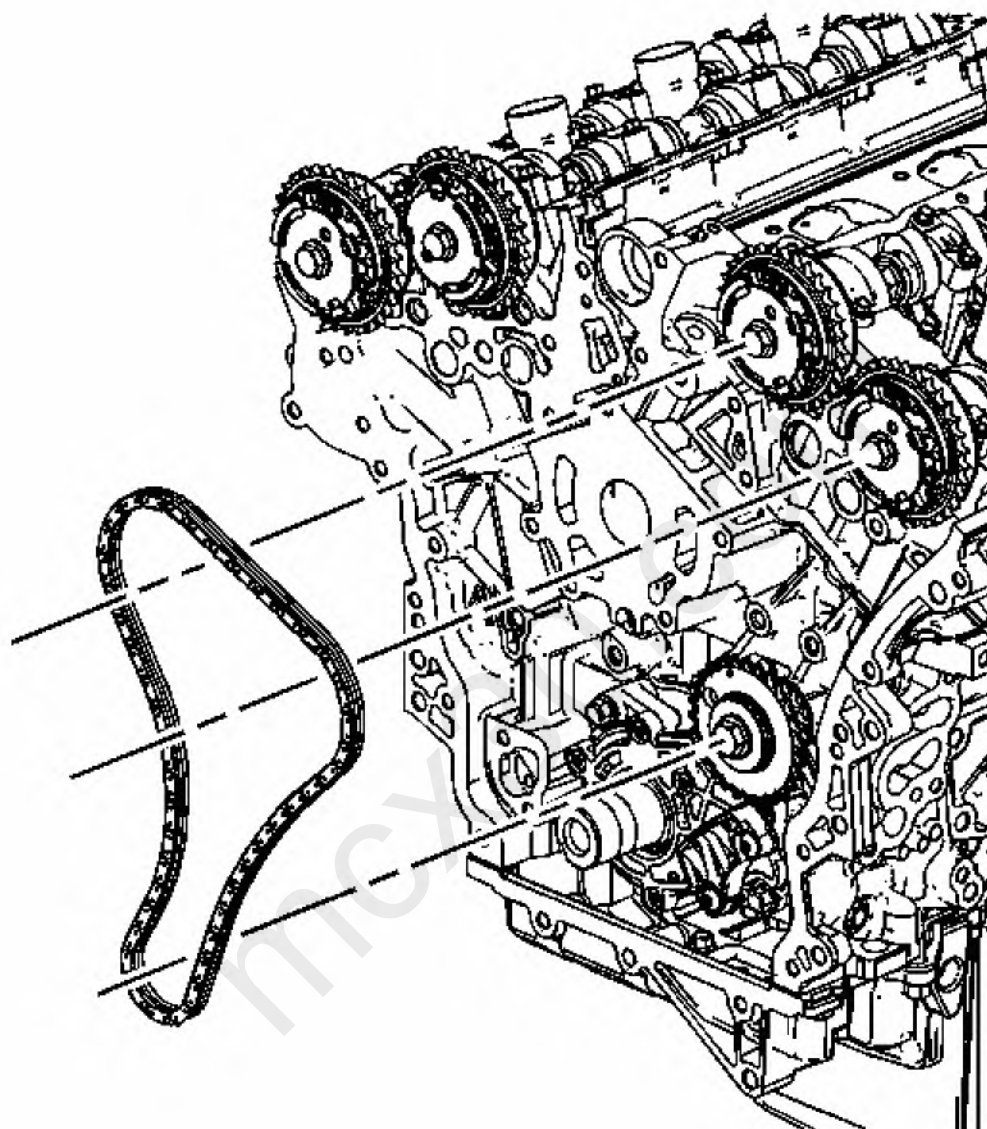


Fig. 129: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Installation - Left Side (Second Design)** .
2. Install the left bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Installation - Left Side (Second Design)** .
3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Installation - Left Side (Second Design)** .

4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side (Second Design)** .
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Left Side (Second Design)** .
6. Install the right bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Installation - Right Side (Second Design)** .
7. Install the primary camshaft drive chain. Refer to **Primary Camshaft Drive Chain Installation (Second Design)** .
8. Install the primary upper camshaft drive chain guide. Refer to **Primary Camshaft Drive Chain Guide Installation - Upper (Second Design)** .
9. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Installation (Second Design)** .
10. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Installation - Right Side (Second Design)** .
11. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Installation - Right Side (Second Design)** .
12. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side (Second Design)** .
13. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Right Side (Second Design)** .
14. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT 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 Camshaft Drive Chain Tensioner Removal - Right Side (Second Design)** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side (Second Design)** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Right Side (Second Design)** .

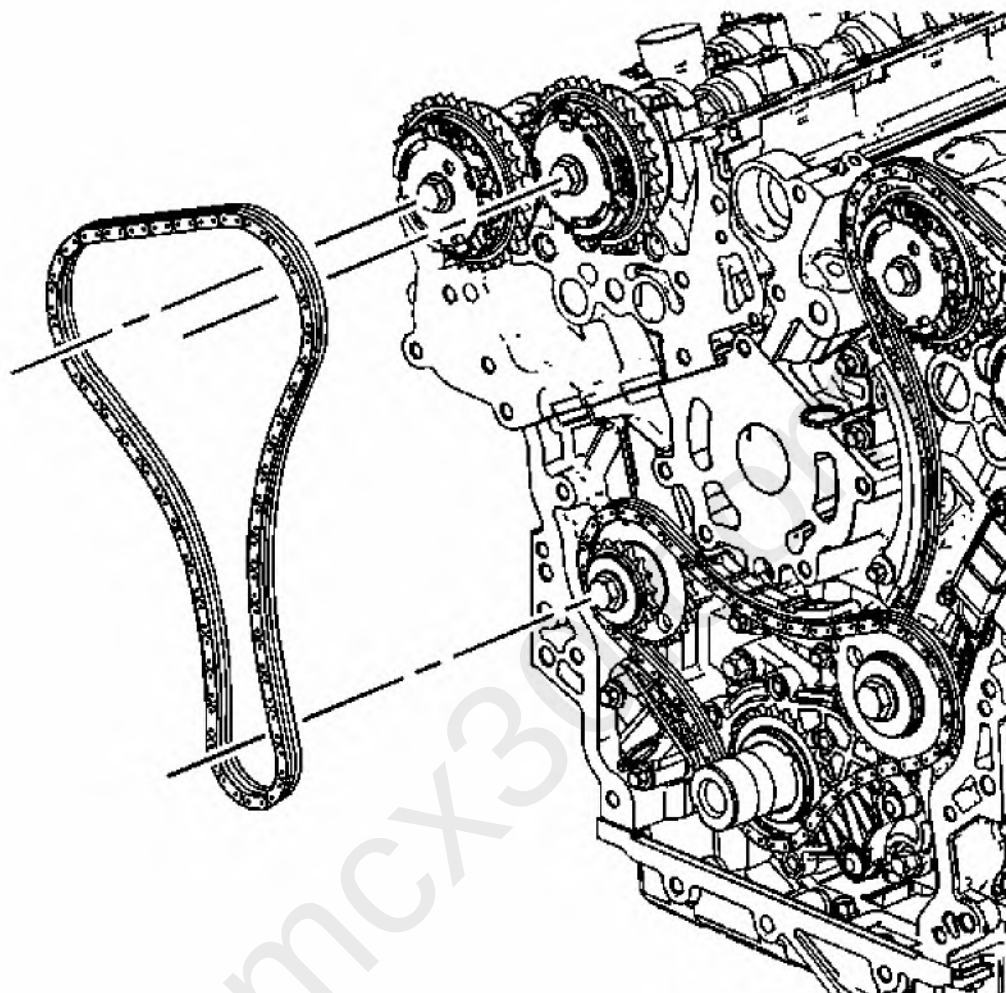


Fig. 130: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Removal - Right Side (Second Design)** .

INSTALLATION PROCEDURE

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

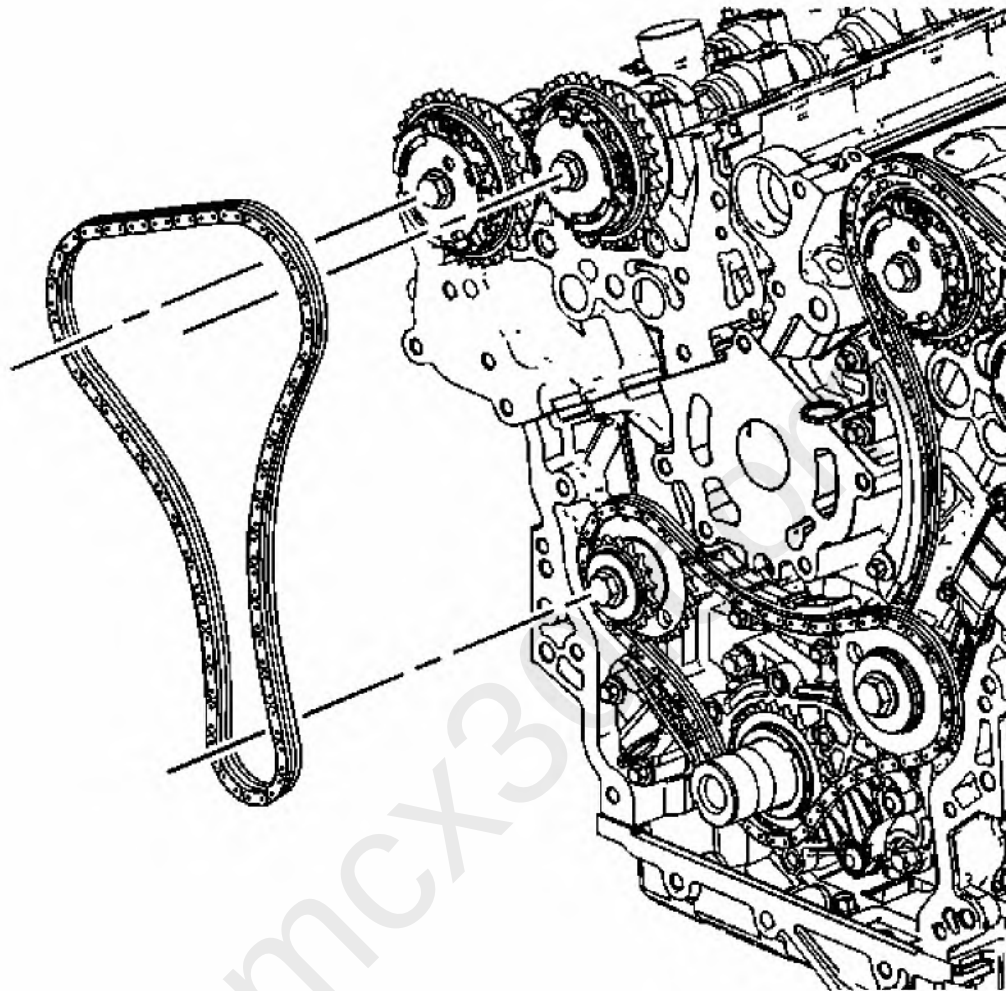


Fig. 131: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

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

SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

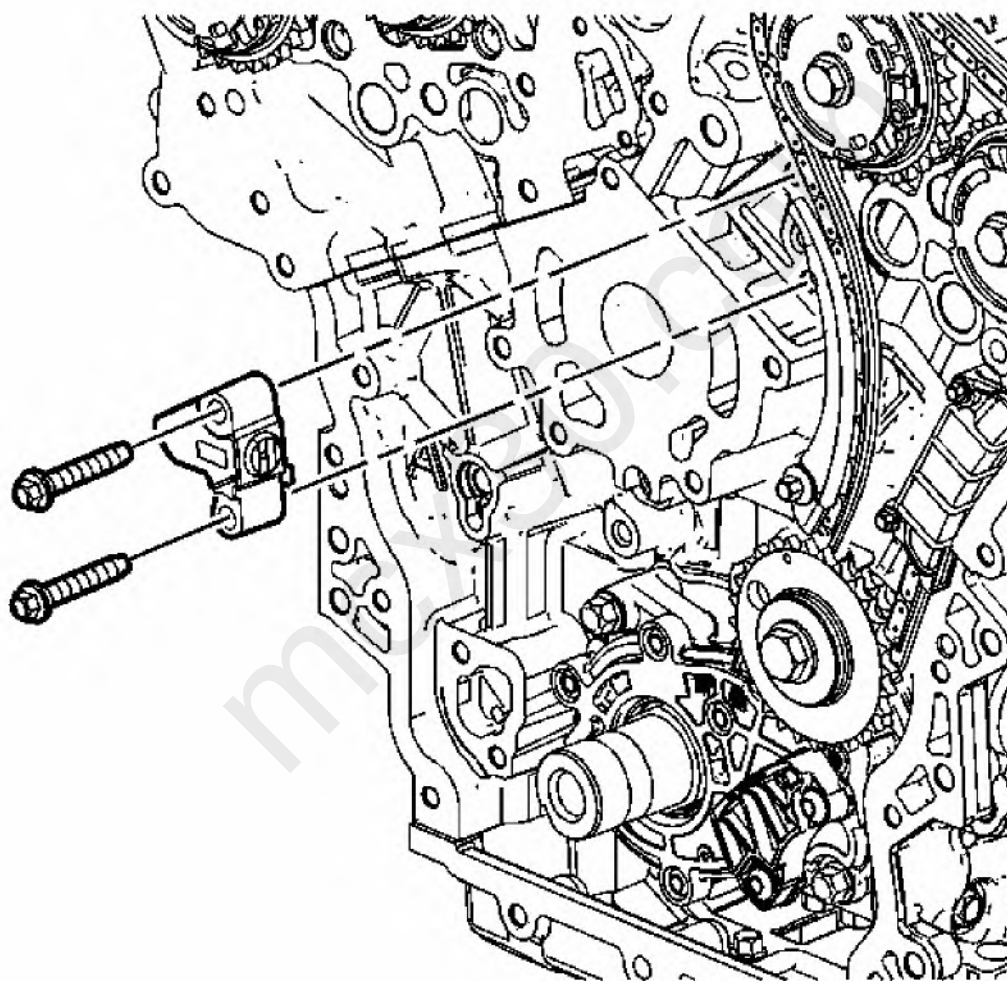


Fig. 132: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to Secondary Camshaft Drive Chain Tensioner Removal - Left Side (Second Design).

INSTALLATION PROCEDURE

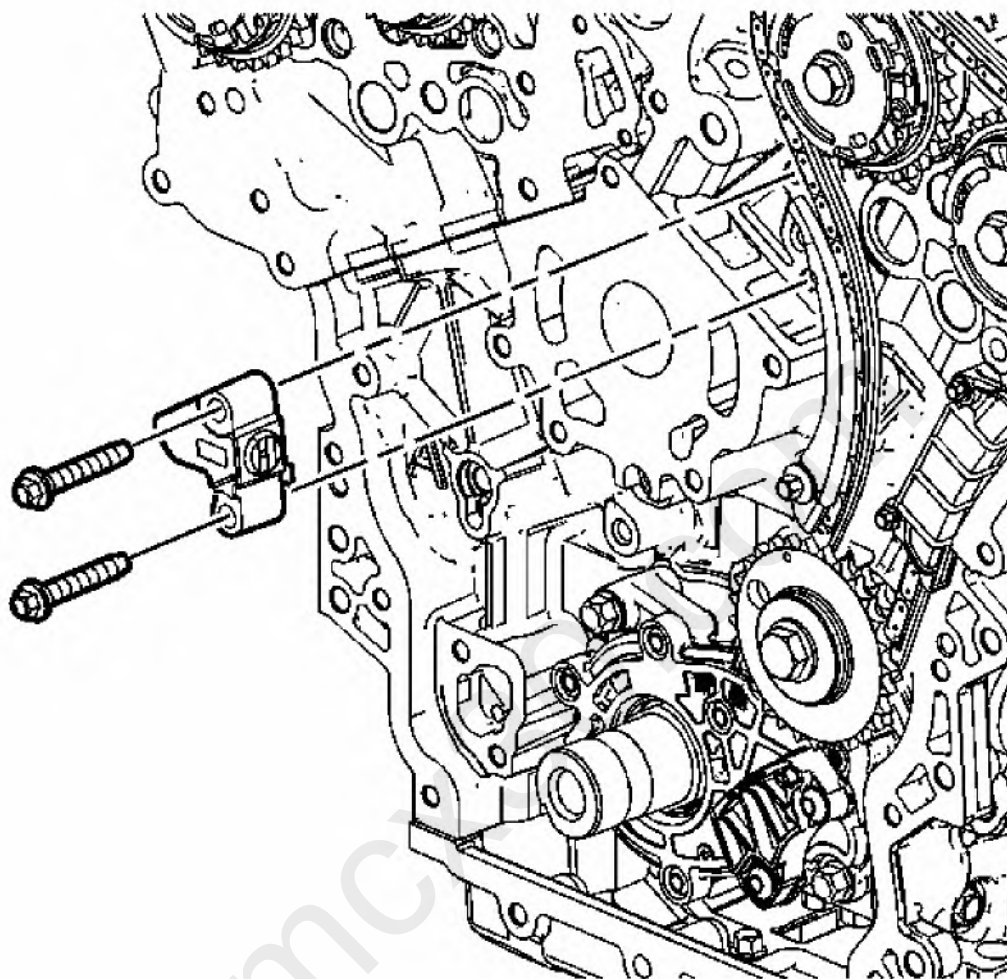


Fig. 133: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Left Side (Second Design)** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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

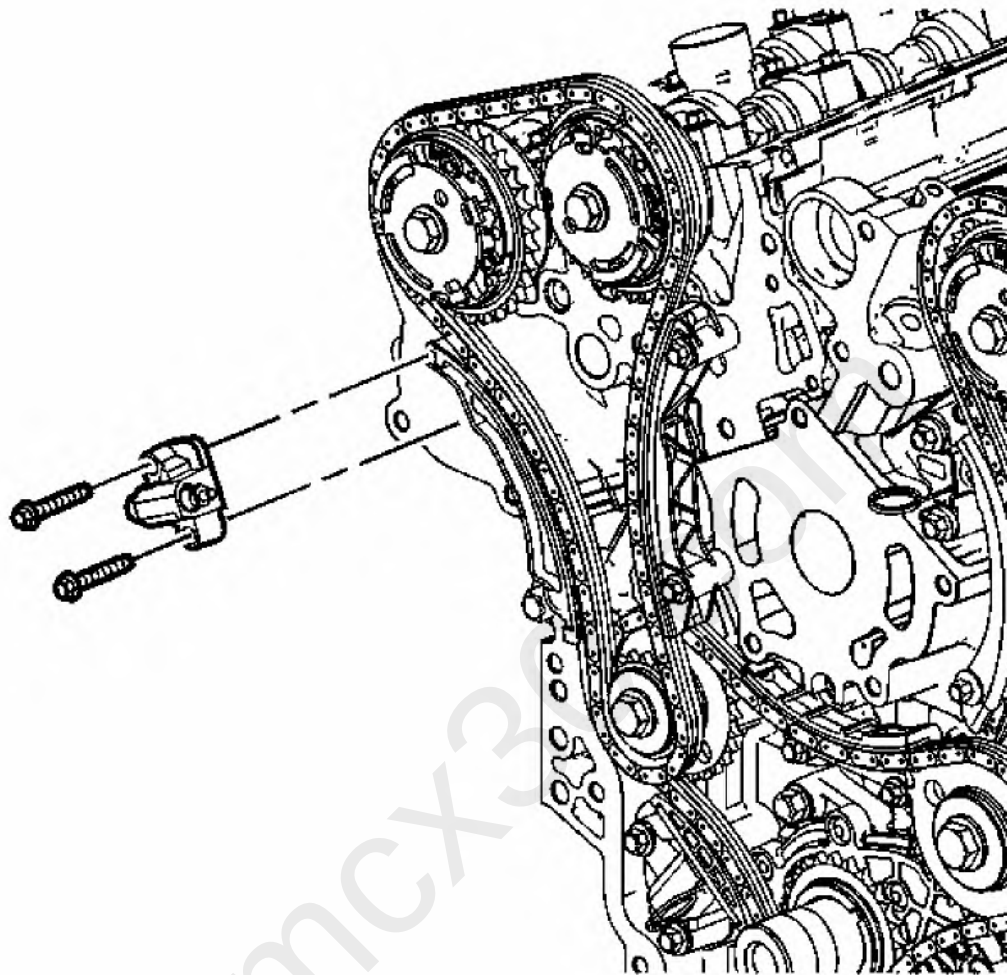


Fig. 134: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Removal - Right Side (Second Design)** .

INSTALLATION PROCEDURE

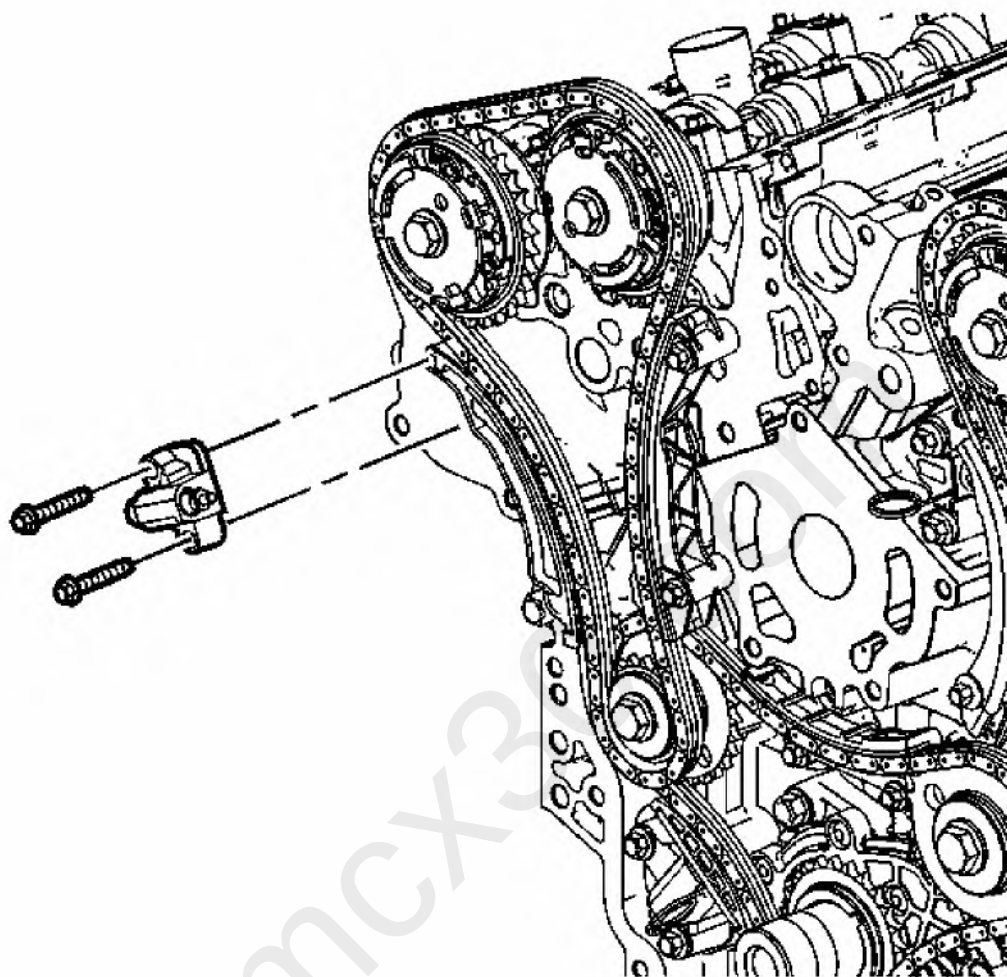


Fig. 135: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

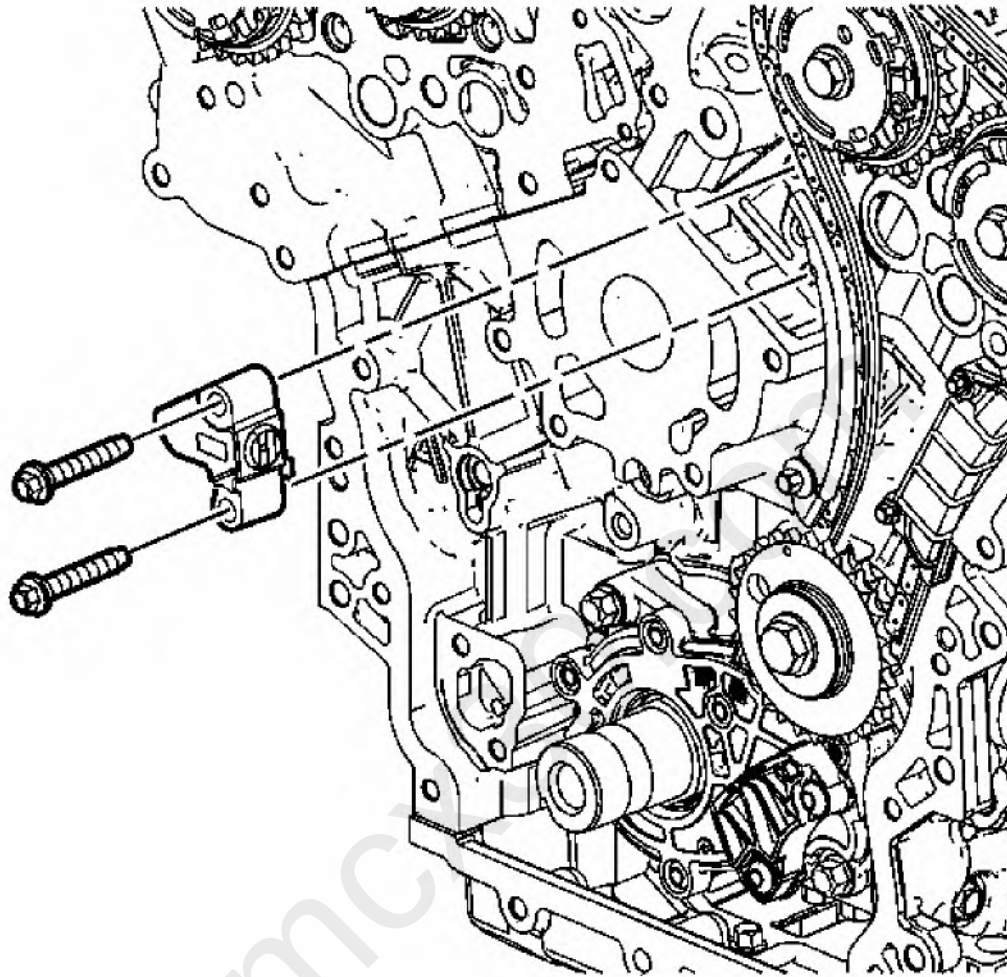


Fig. 136: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Removal - Left Side (Second Design)** .

INSTALLATION PROCEDURE

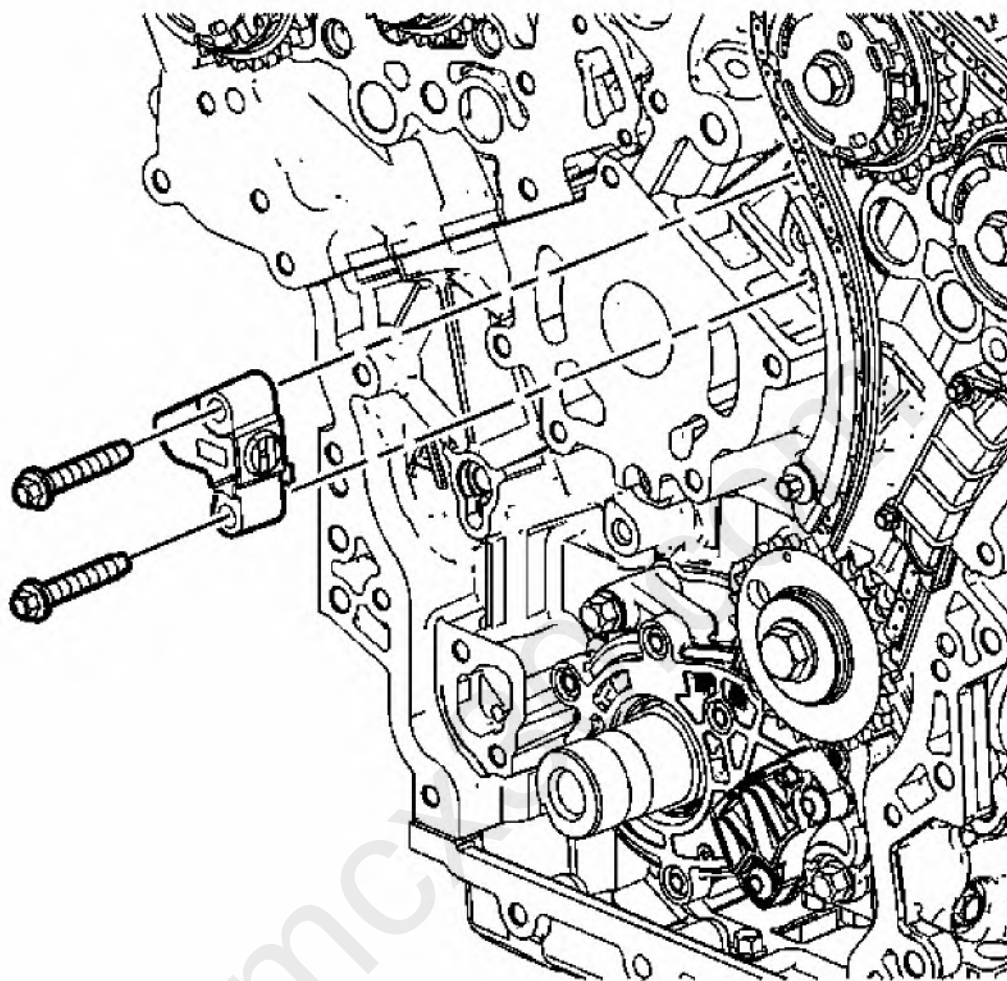


Fig. 137: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Left Side (Second Design)** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

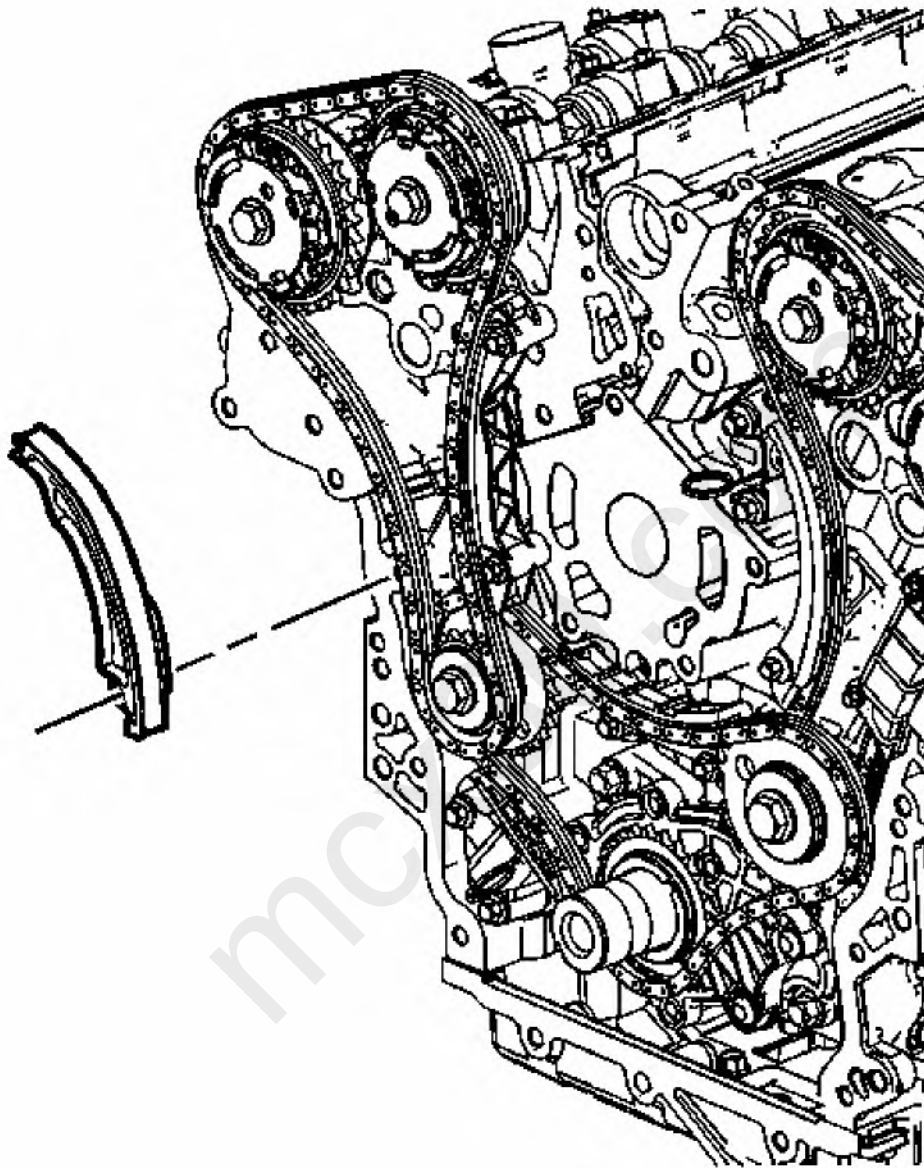


Fig. 138: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

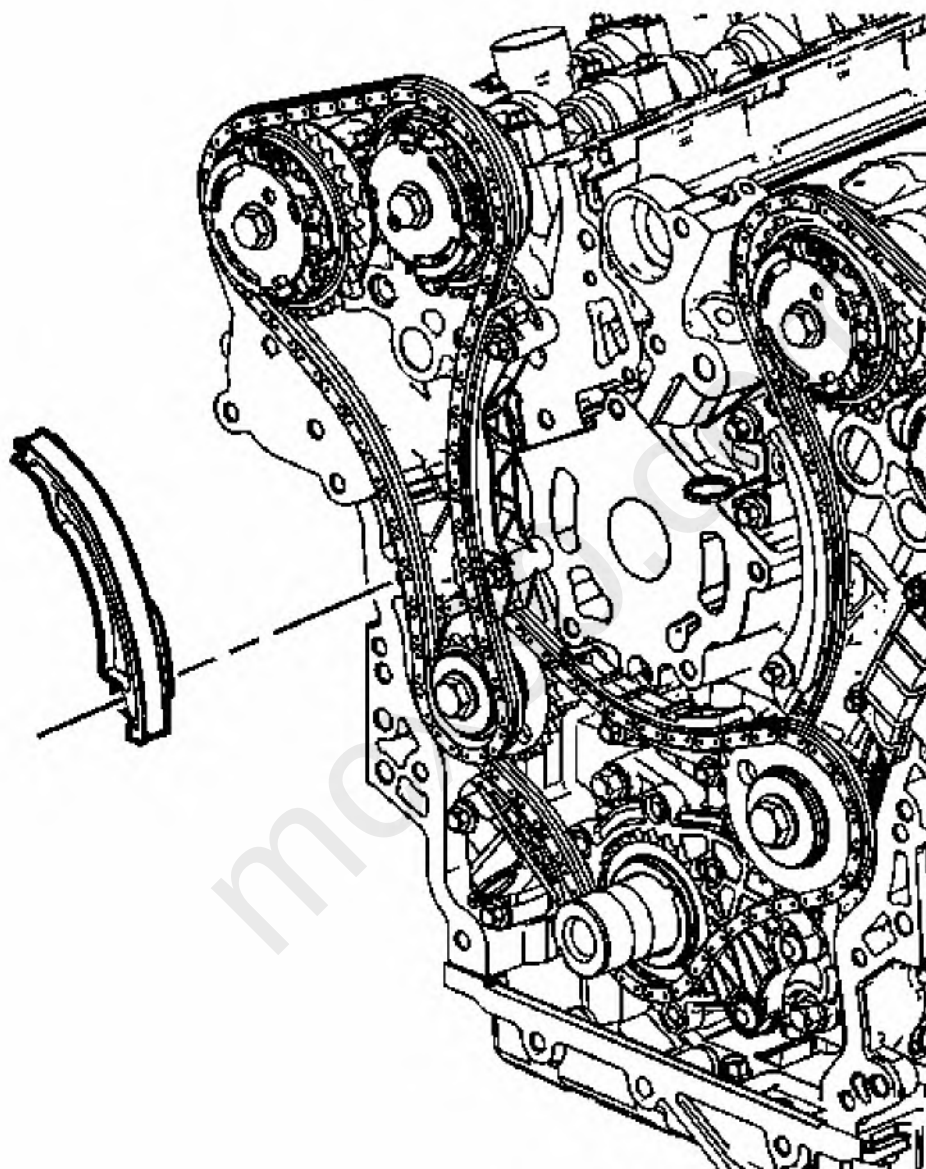


Fig. 139: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side (Second Design)** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Right Side (Second Design)** .

3. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY CAMSHAFT DRIVE 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 Camshaft Drive Chain Tensioner Removal - Left Side (Second Design).

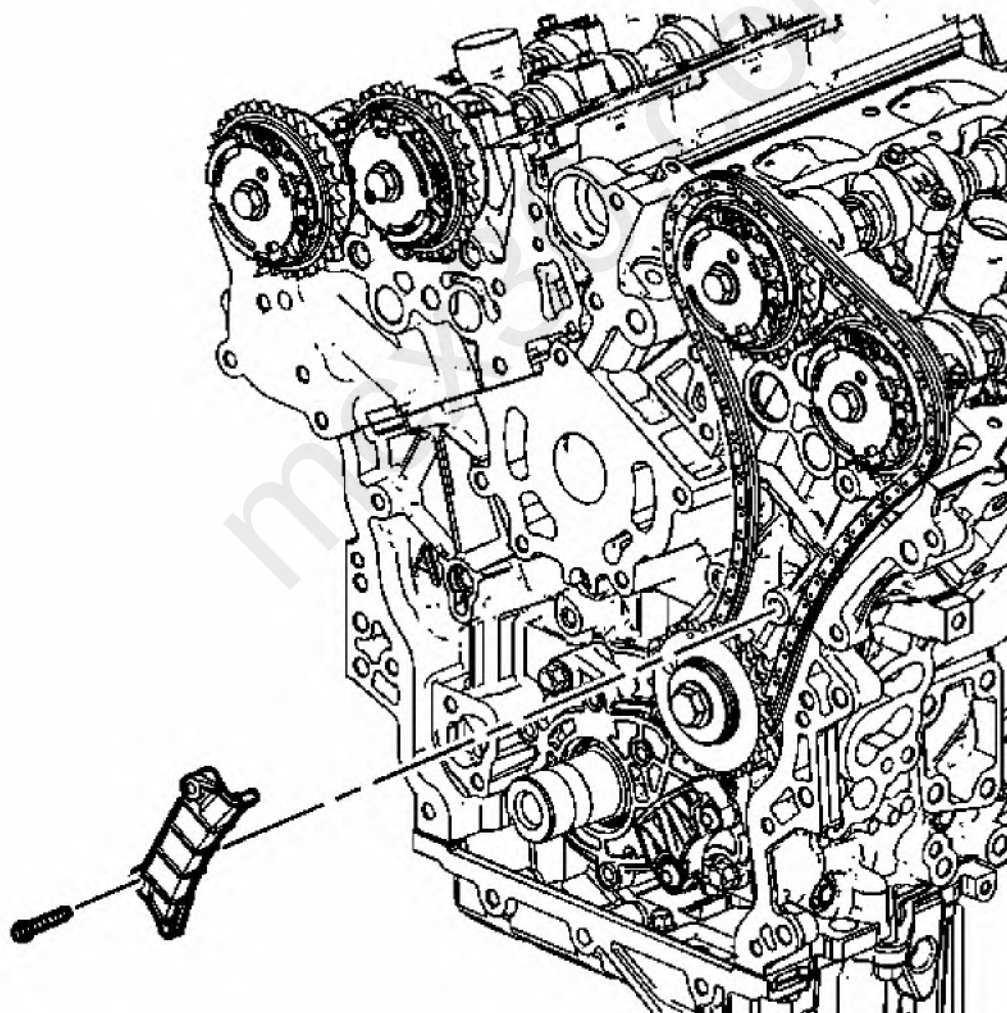


Fig. 140: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Left Side (Second Design)** .

INSTALLATION PROCEDURE

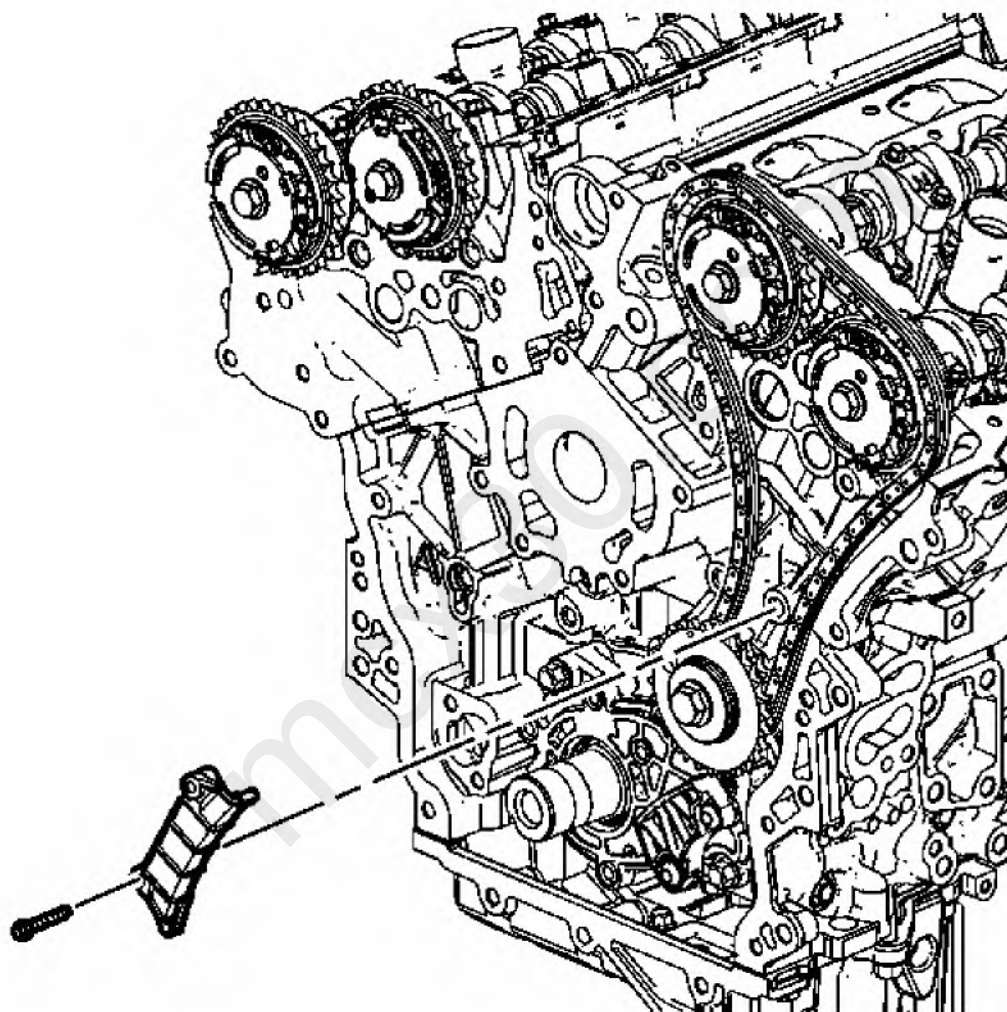


Fig. 141: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

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

SECONDARY CAMSHAFT DRIVE CHAIN GUIDE 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 Camshaft Drive Chain Tensioner Removal - Right Side (Second Design) .

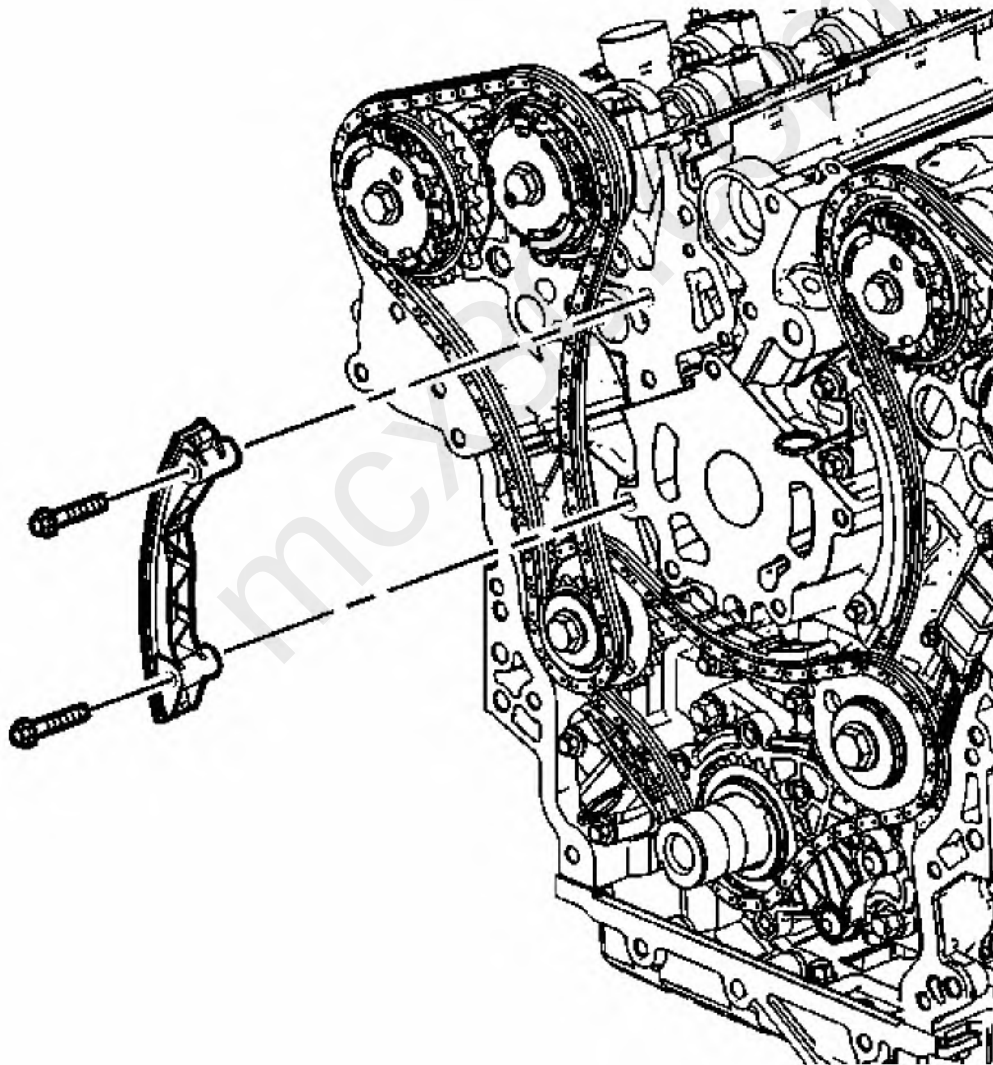


Fig. 142: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Right Side (Second Design)** .

INSTALLATION PROCEDURE

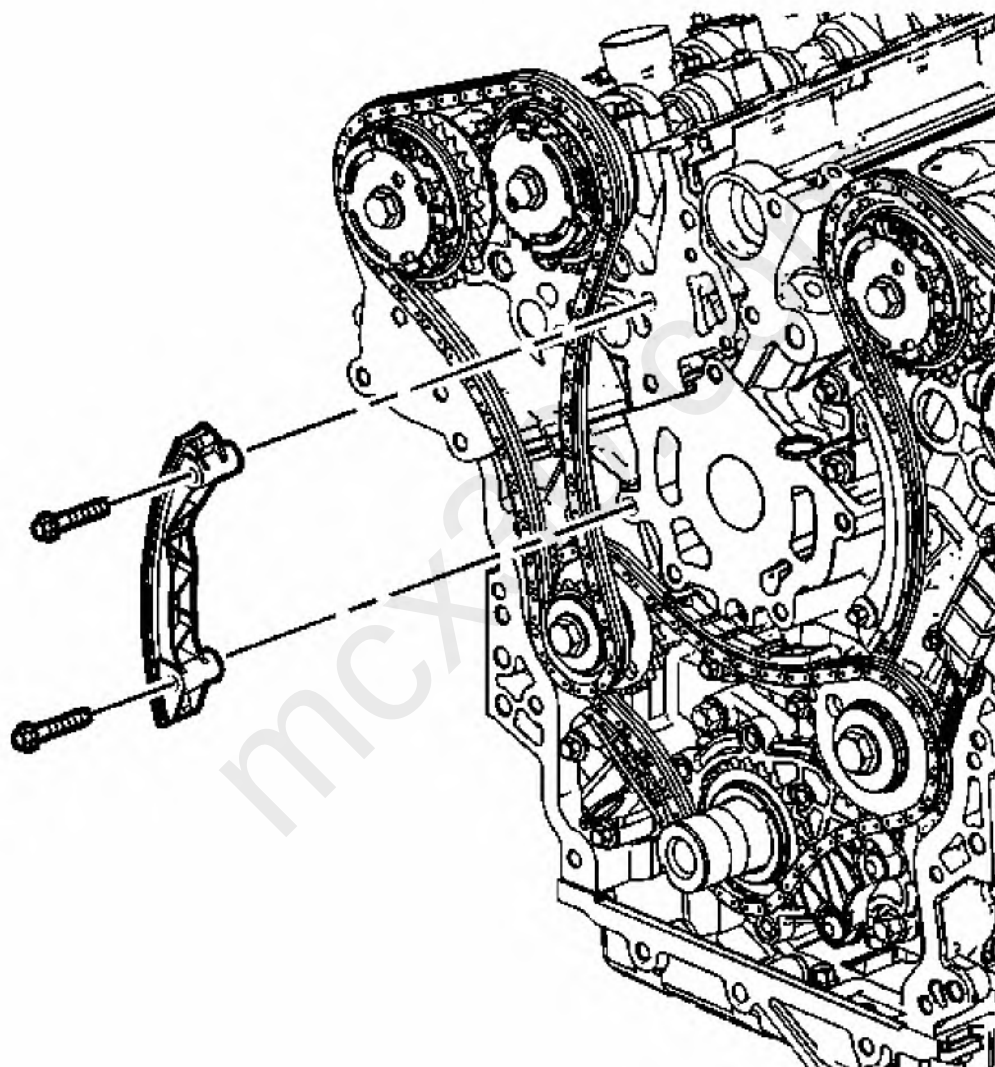


Fig. 143: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Installation - Right Side (Second Design)** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Right Side (Second Design)** .

3. Install the engine front cover. Refer to **Engine Front Cover 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 Camshaft Drive Chain Tensioner Removal - Right Side (Second Design)** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side (Second Design)** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Removal - Right Side (Second Design)** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Removal - Right Side (Second Design)** .
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Removal (Second Design)** .
7. Remove the primary camshaft drive chain upper guide. **Primary Camshaft Drive Chain Guide Removal - Upper (Second Design)** .

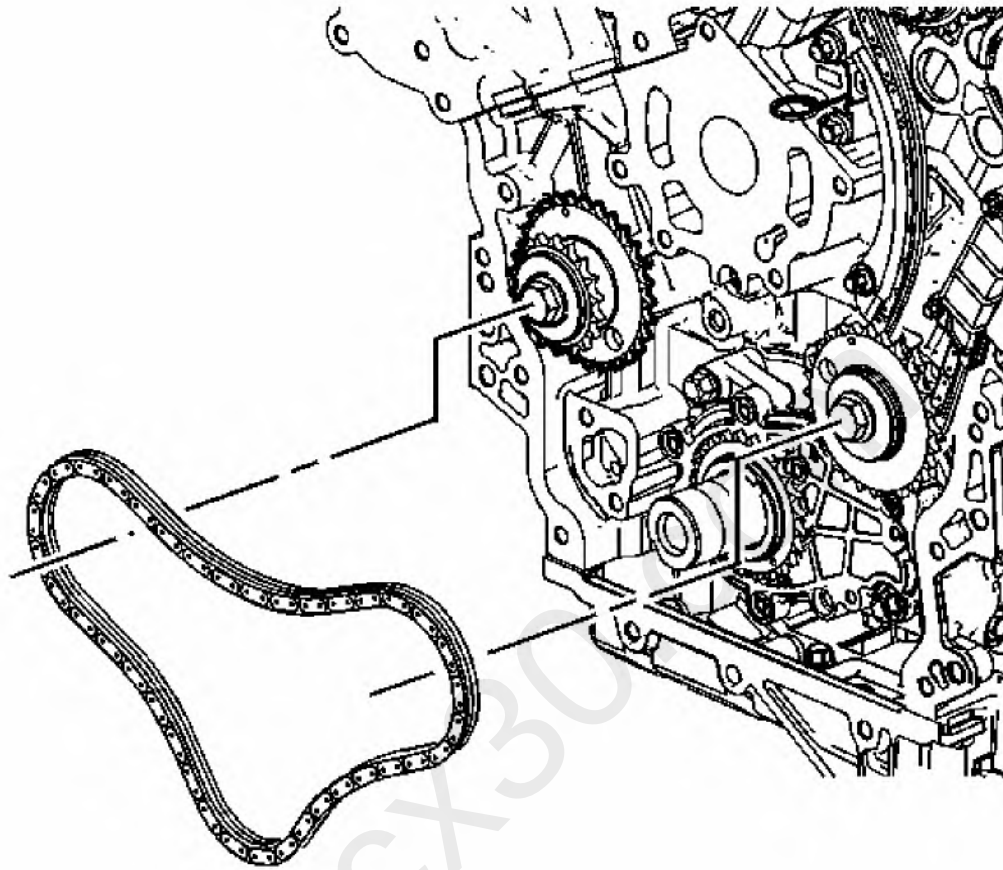


Fig. 144: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Remove the primary camshaft timing chain. Refer to **Secondary Camshaft Drive Chain Removal - Right Side (Second Design)** .

INSTALLATION PROCEDURE

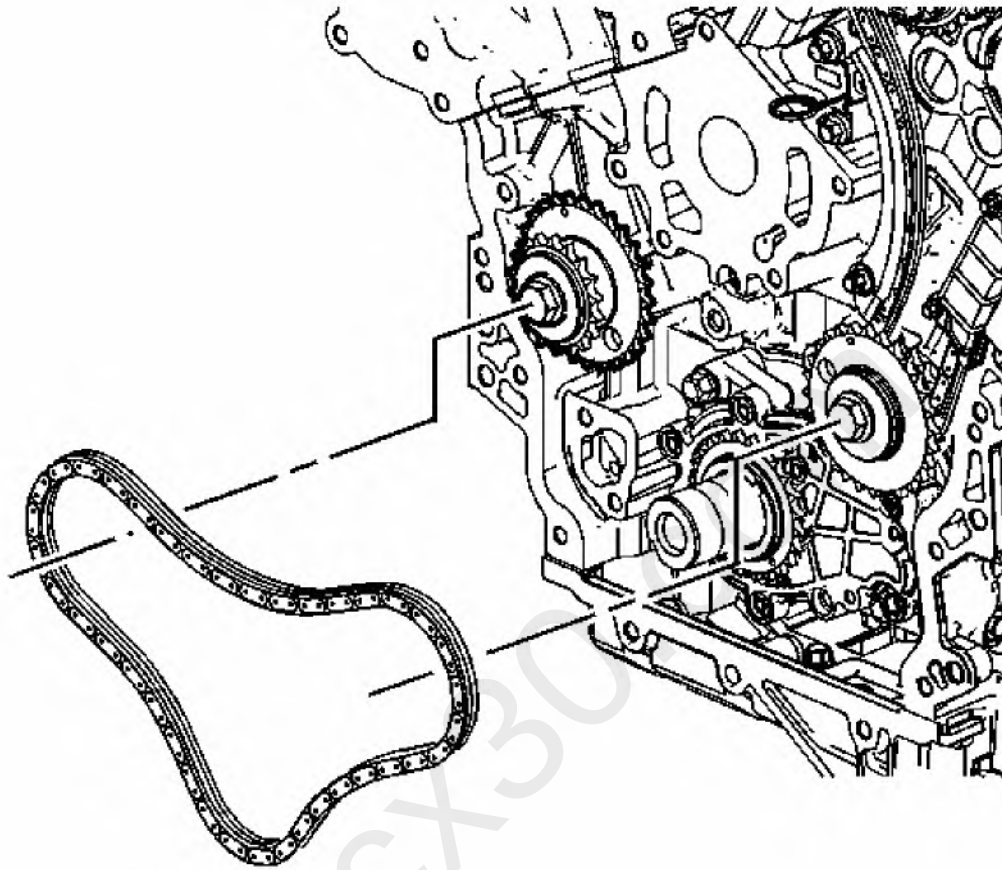


Fig. 145: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the primary camshaft timing chain. Refer to **Primary Camshaft Drive Chain Installation (Second Design)** .
2. Install the primary upper camshaft drive chain guide. Refer to **Primary Camshaft Drive Chain Guide Installation - Upper (Second Design)** .
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Installation (Second Design)** .
4. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Installation - Right Side (Second Design)** .
5. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Camshaft Drive Chain Guide Installation - Right Side (Second Design)** .
6. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side (Second Design)** .

7. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Right Side (Second Design)** .
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT INTERMEDIATE DRIVE CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

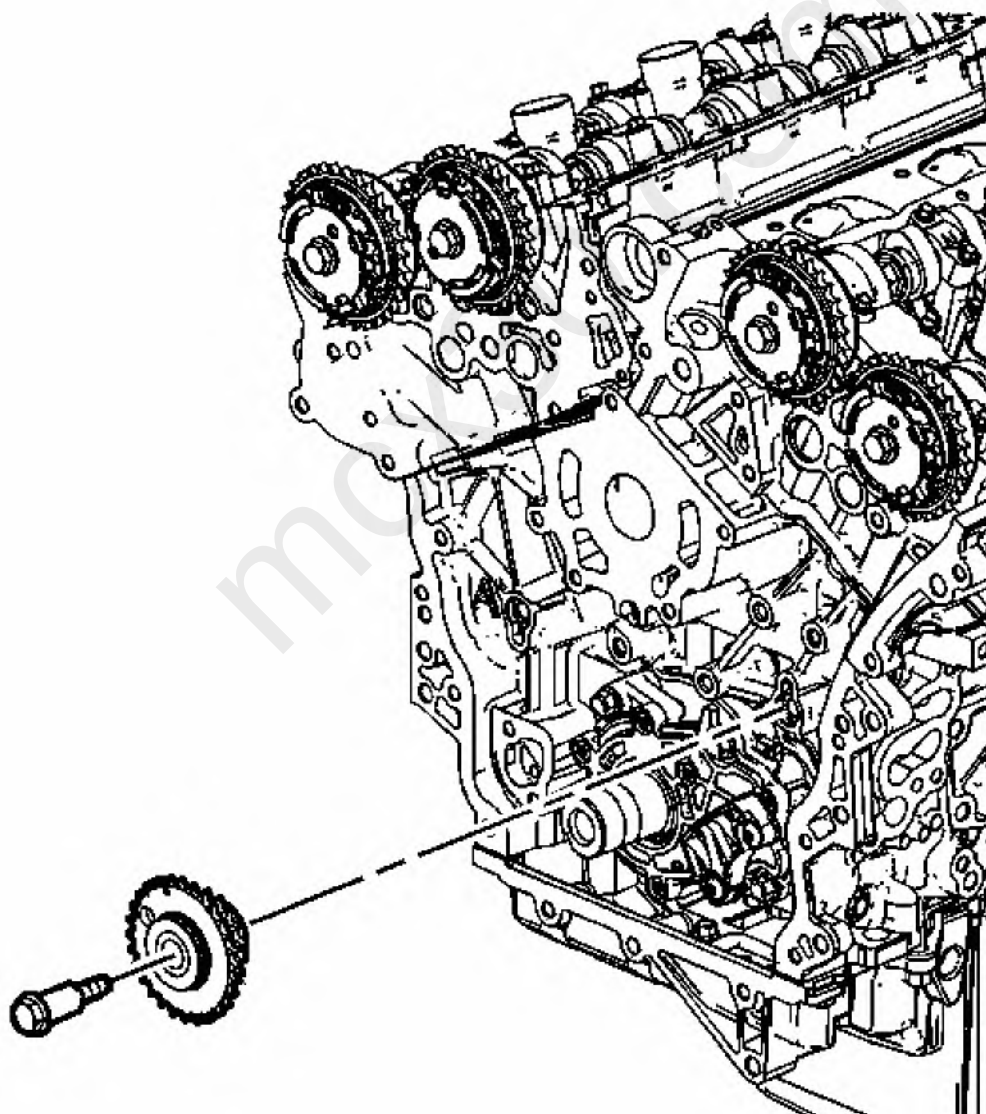


Fig. 146: View Of Left Camshaft Intermediate Drive Chain Idler

Courtesy of GENERAL MOTORS CORP.

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

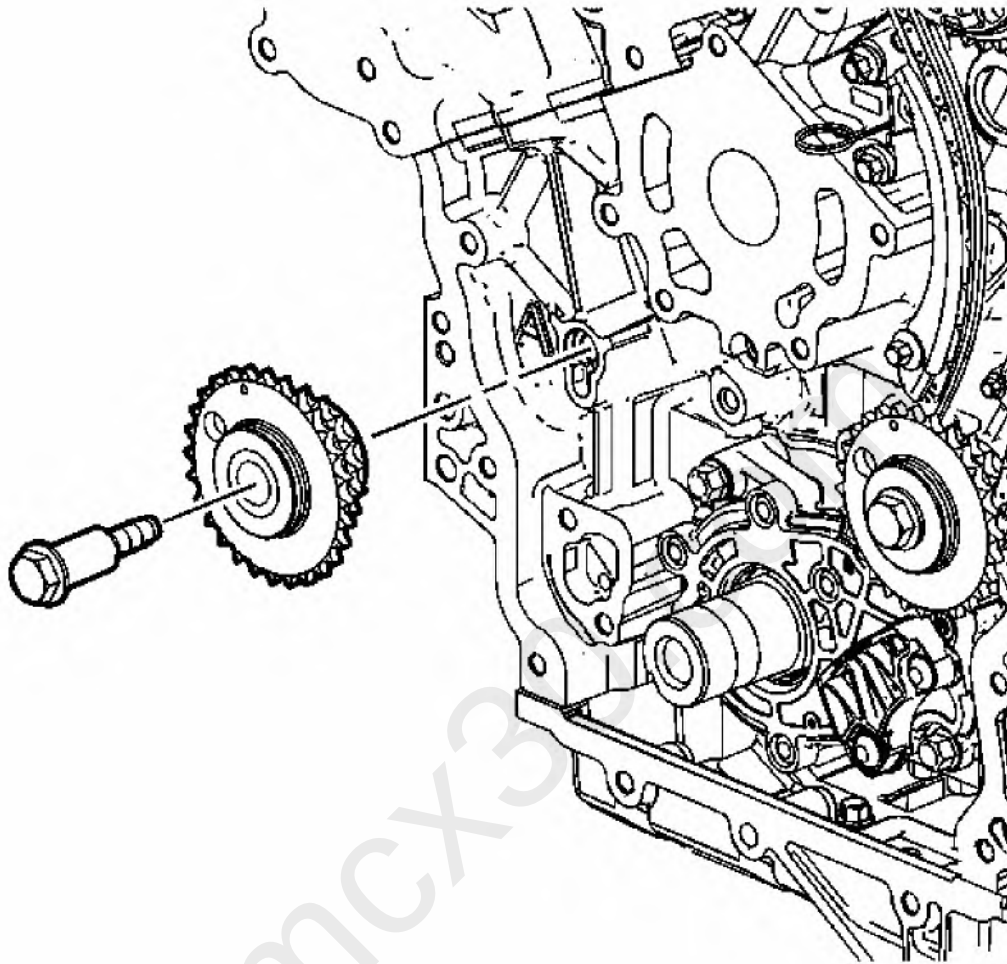


Fig. 147: View Of Right And Left Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS CORP.

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

5. Remove the left bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Removal - Left Side (Second Design)** .

INSTALLATION PROCEDURE

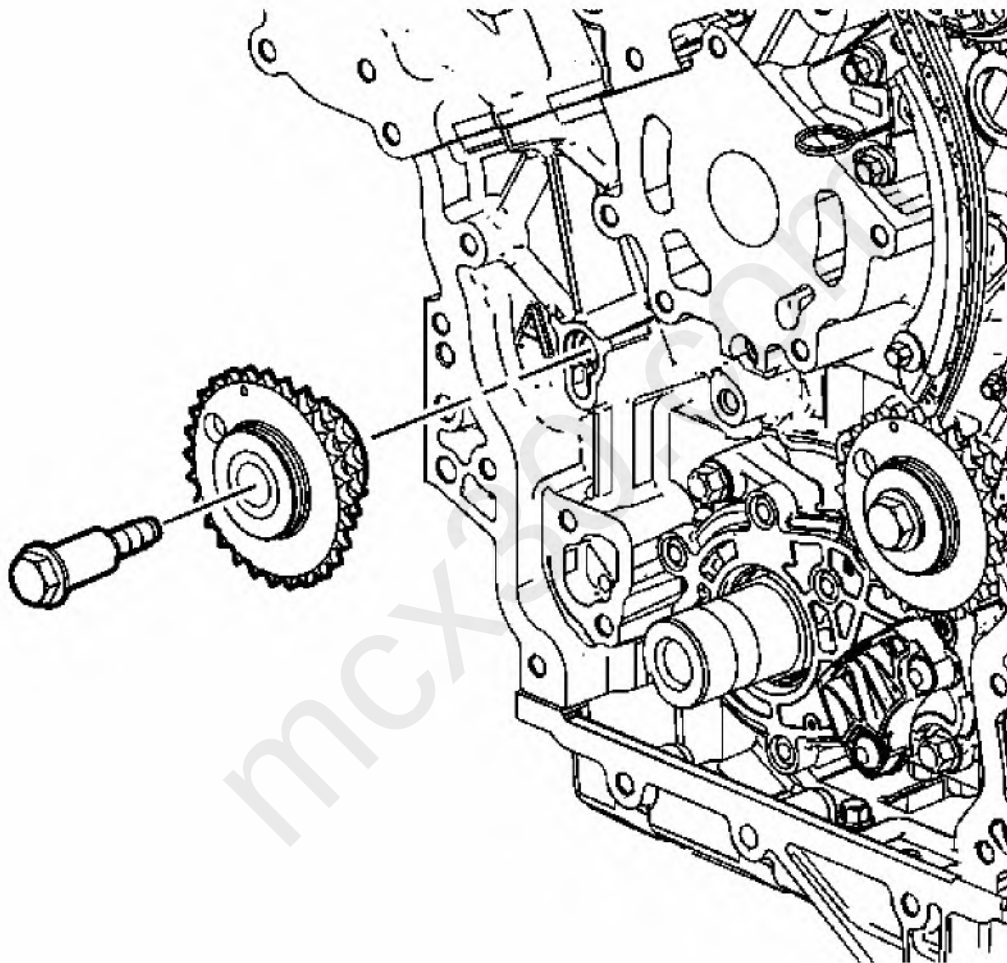


Fig. 148: View Of Right And Left Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS CORP.

1. If you are servicing the left bank idler sprocket, perform the following steps:
 1. Install the left bank camshaft intermediate drive chain idler. Refer to **Camshaft Intermediate Drive Chain Idler Installation - Left Side (Second Design)** .
 2. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Drive Chain Installation - Left Side (Second Design)** .
 3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary**

Camshaft Drive Chain Guide Installation - Left Side (Second Design) .

4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side (Second Design) .**
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Drive Chain Tensioner Installation - Left Side (Second Design) .**

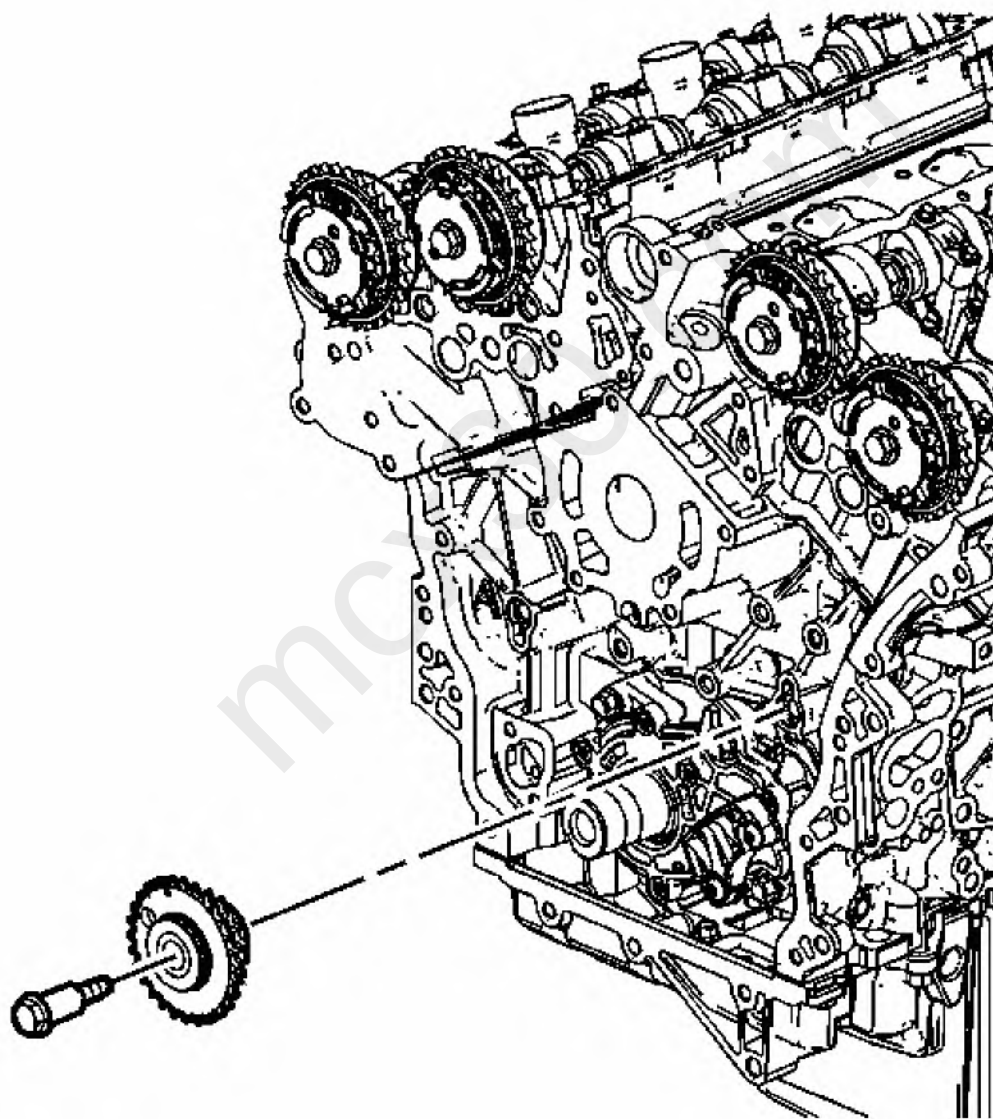


Fig. 149: View Of Left Camshaft Intermediate Drive Chain Idler
Courtesy of GENERAL MOTORS CORP.

2. Install the right bank camshaft intermediate drive chain idler. Refer to **Camshaft**

Intermediate Drive Chain Idler Installation - Right Side (Second Design) .

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

PRIMARY CAMSHAFT DRIVE CHAIN TENSIONER REPLACEMENT

REMOVAL PROCEDURE

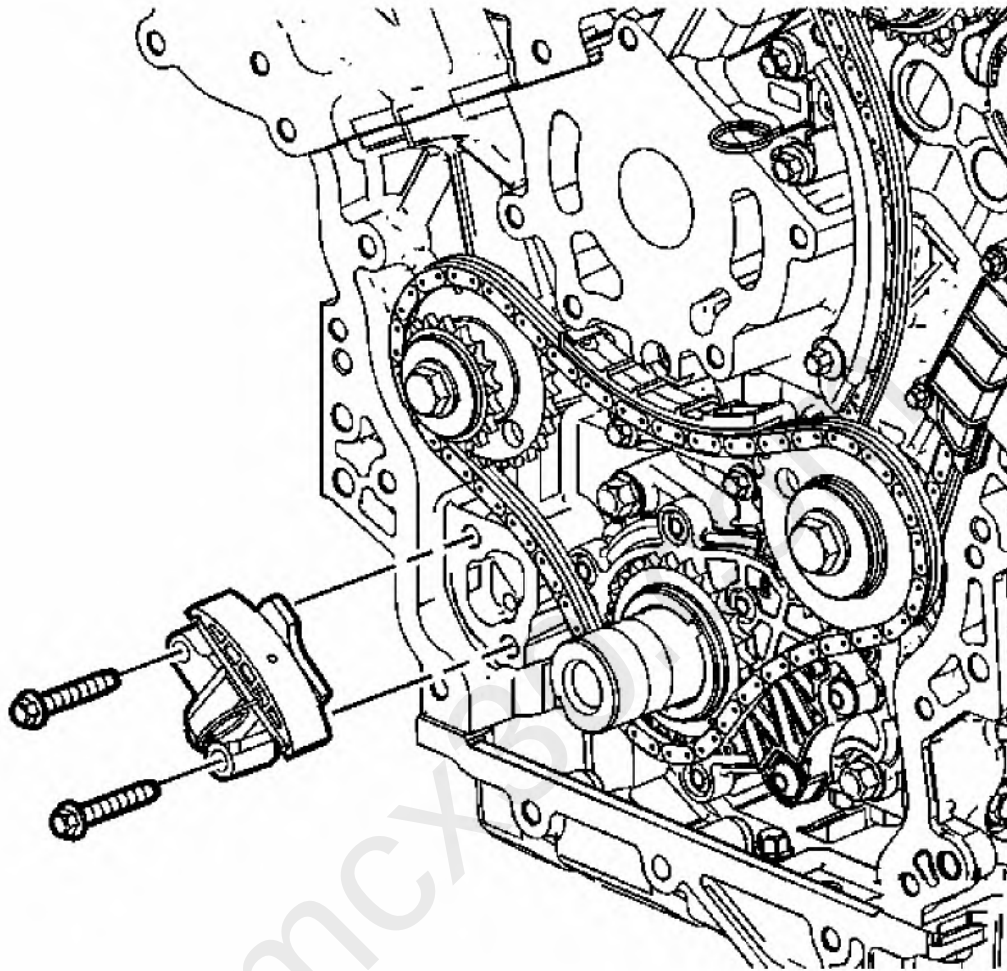


Fig. 150: View Of Primary Camshaft Drive Chain Tensioners
Courtesy of GENERAL MOTORS CORP.

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

IMPORTANT: If the entire camshaft timing system is not in Stage 2, Camshaft Timing Drive Chain Alignment Diagram (First Design) or Camshaft Timing Drive Chain Alignment Diagram (Second Design), mark the timing chain and sprockets in order to ensure proper reassembly.

2. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Drive Chain Tensioner Removal (Second Design).

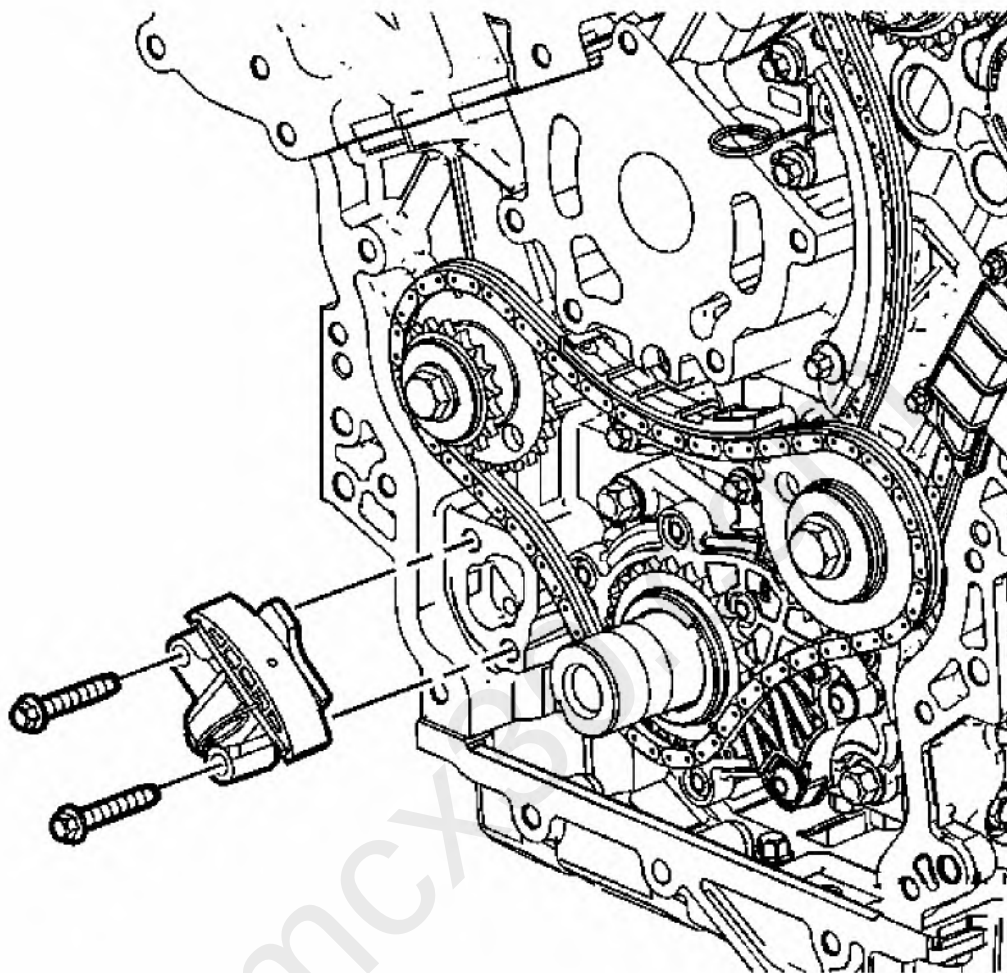


Fig. 151: View Of Primary Camshaft Drive Chain Tensioners
Courtesy of GENERAL MOTORS CORP.

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

PRIMARY CAMSHAFT DRIVE CHAIN GUIDE REPLACEMENT - LOWER

REMOVAL PROCEDURE

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

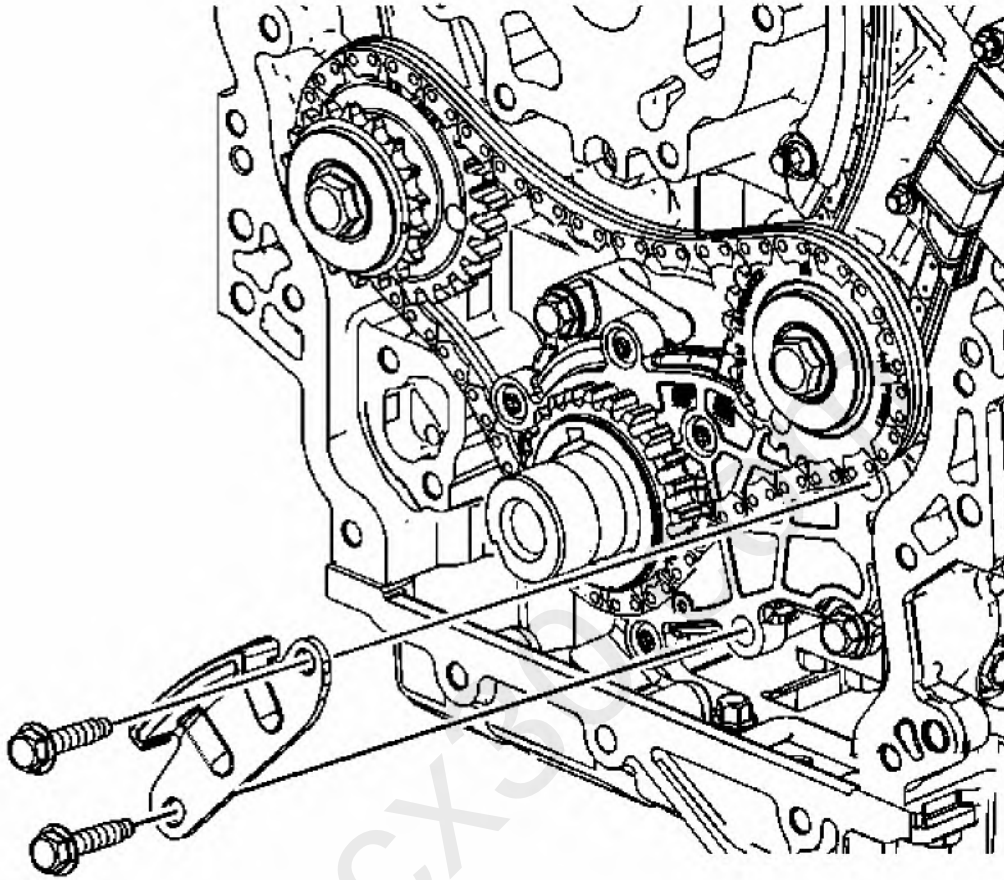


Fig. 152: Primary Camshaft Drive Chain Lower Guide
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

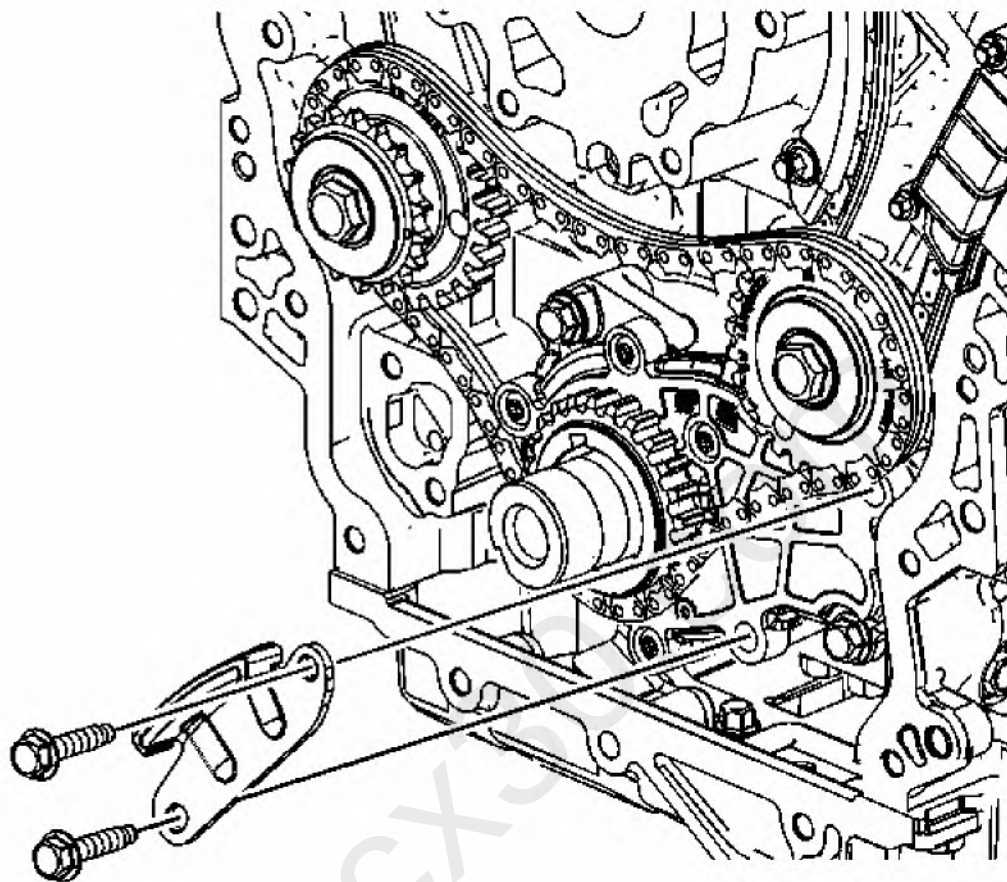


Fig. 153: Primary Camshaft Drive Chain Lower Guide
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Refer to Fastener Notice .

2. Install the primary camshaft drive chain lower guide bolts.

Tighten: Tighten the primary camshaft drive chain lower guide bolts to 23 N.m (17 lb ft).

3. Install the primary camshaft drive chain tensioner. Refer to Primary Camshaft Drive Chain Tensioner Replacement.

PRIMARY CAMSHAFT DRIVE CHAIN GUIDE REPLACEMENT - UPPER

REMOVAL PROCEDURE

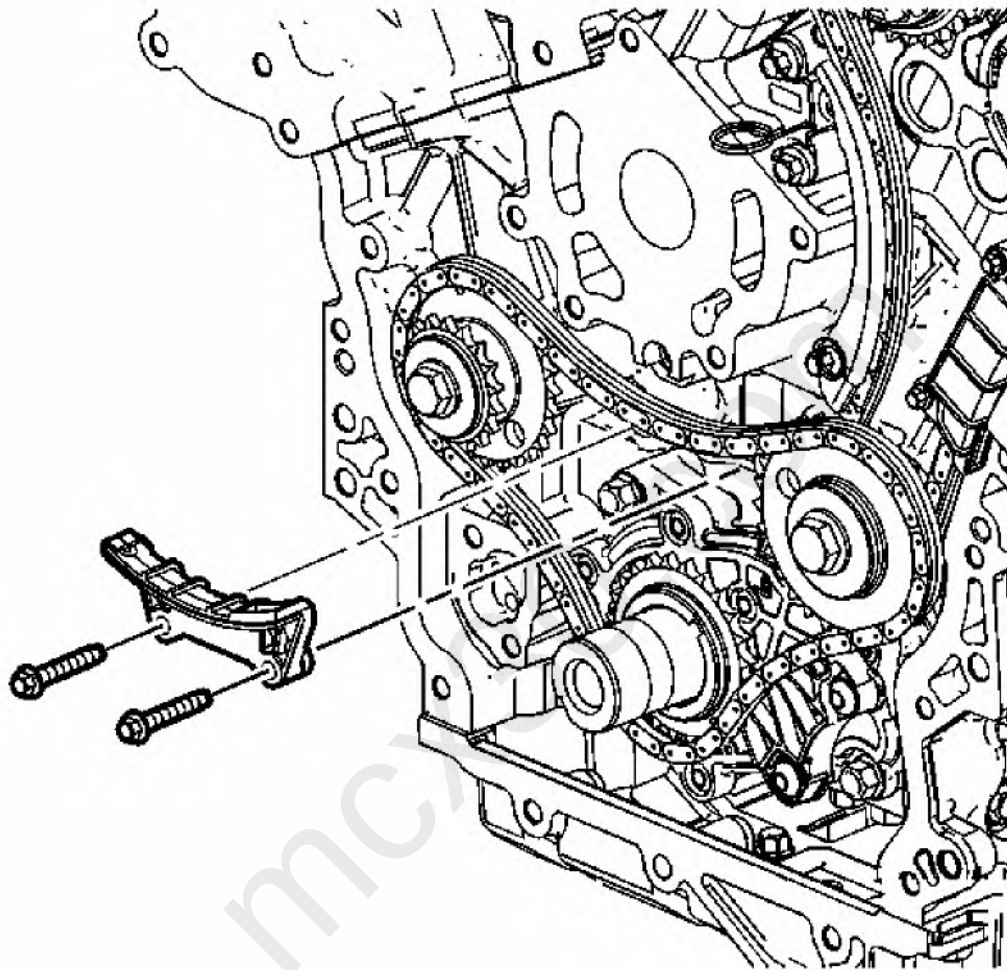


Fig. 154: View Of Upper Primary Camshaft Drive Chain Guides
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Removal (Second Design)**.
3. Remove the primary upper camshaft drive chain guide. Refer to **Primary Camshaft Drive Chain Guide Removal - Upper (Second Design)**.

INSTALLATION PROCEDURE

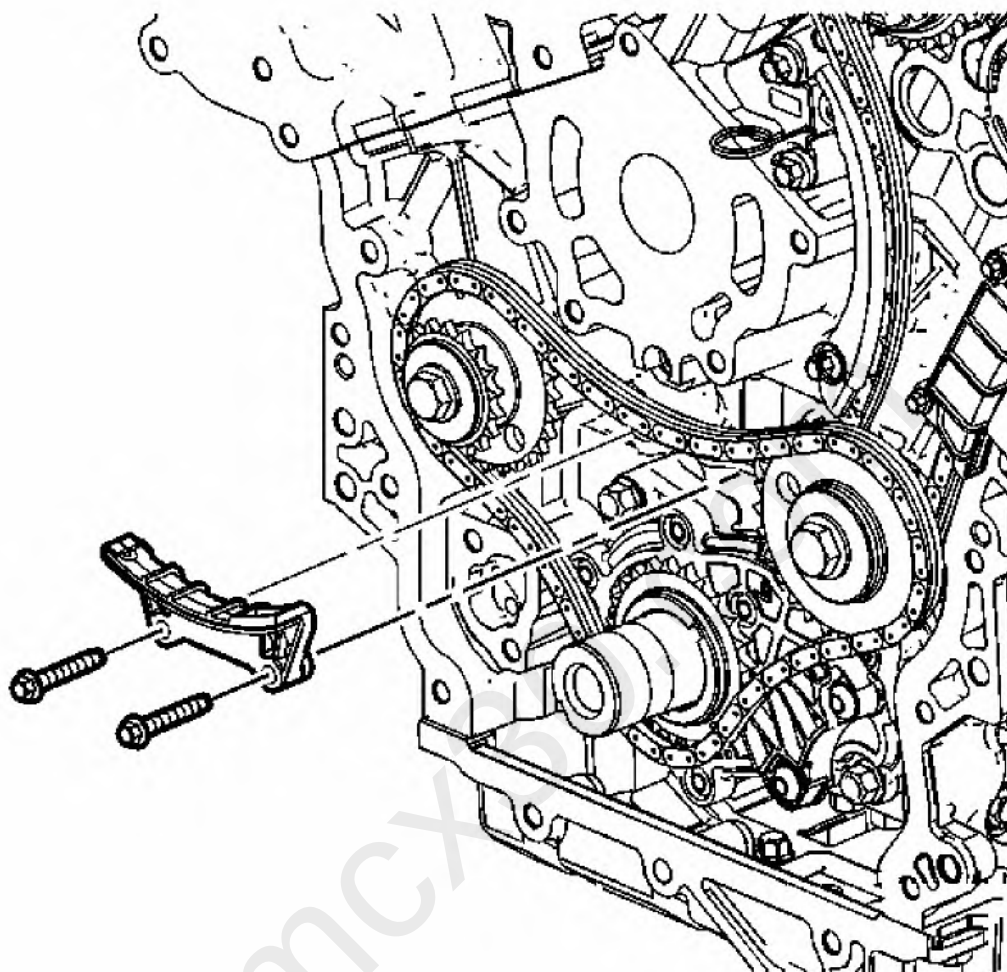


Fig. 155: View Of Upper Primary Camshaft Drive Chain Guides
Courtesy of GENERAL MOTORS CORP.

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Camshaft Drive Chain Guide Installation - Upper (Second Design)** .
2. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Drive Chain Tensioner Installation (Second Design)** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

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

TOOLS REQUIRED

EN 46108 Timing Chain Retention Tool. See **Special Tools** .

REMOVAL PROCEDURE

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

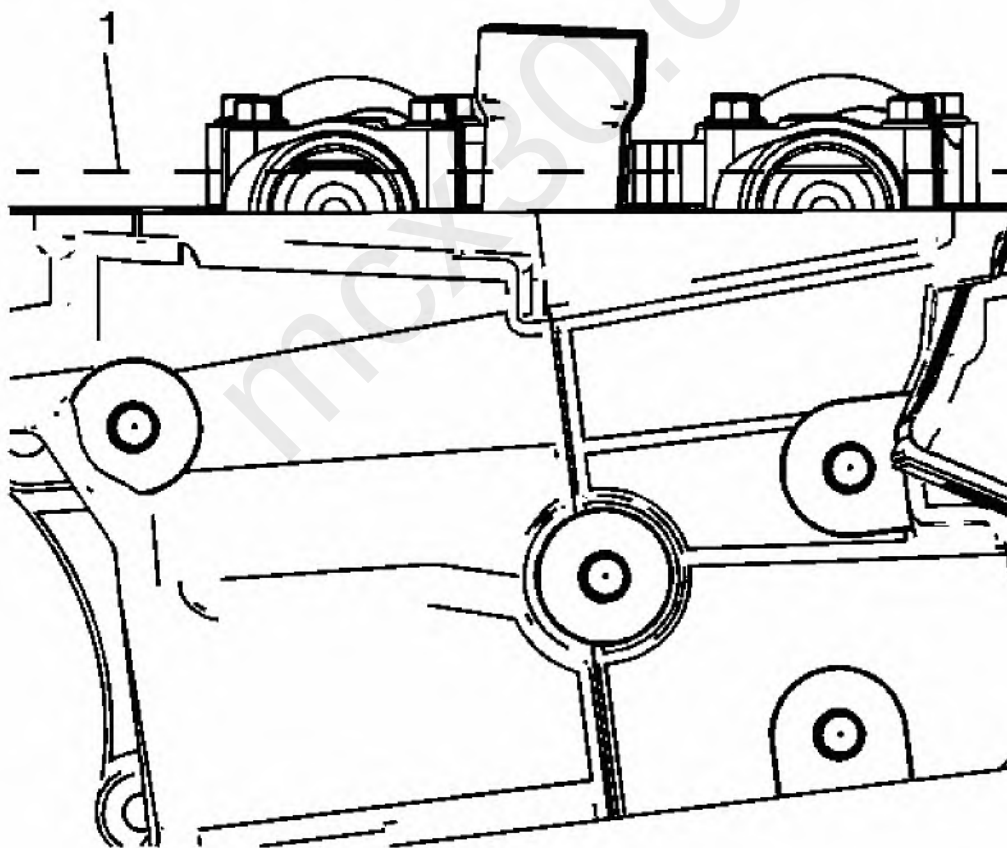


Fig. 156: Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Rotate the crankshaft balancer in a clockwise rotation ONLY.

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

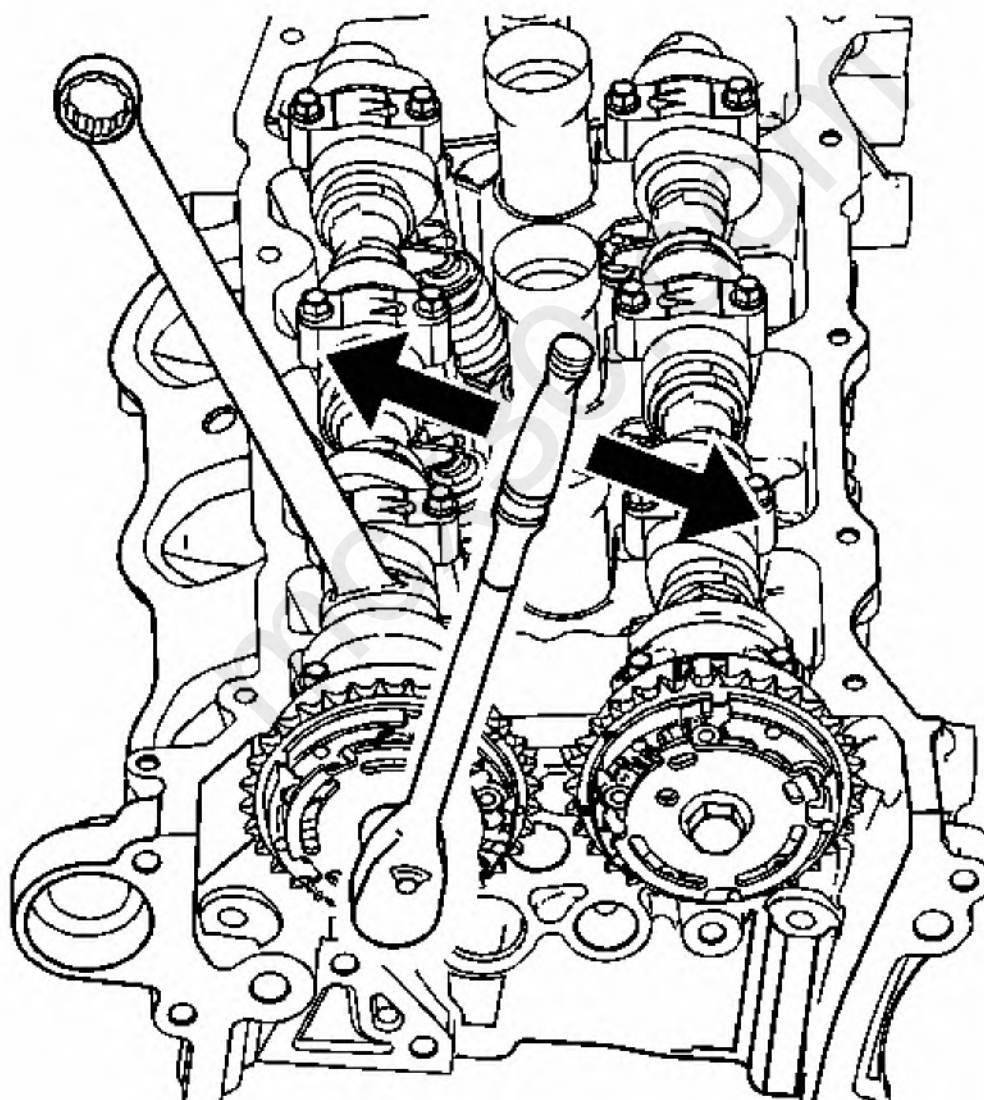


Fig. 157: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

IMPORTANT:

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

6. Loosen the camshaft position actuator bolt.

IMPORTANT: Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4). See Special Tools .

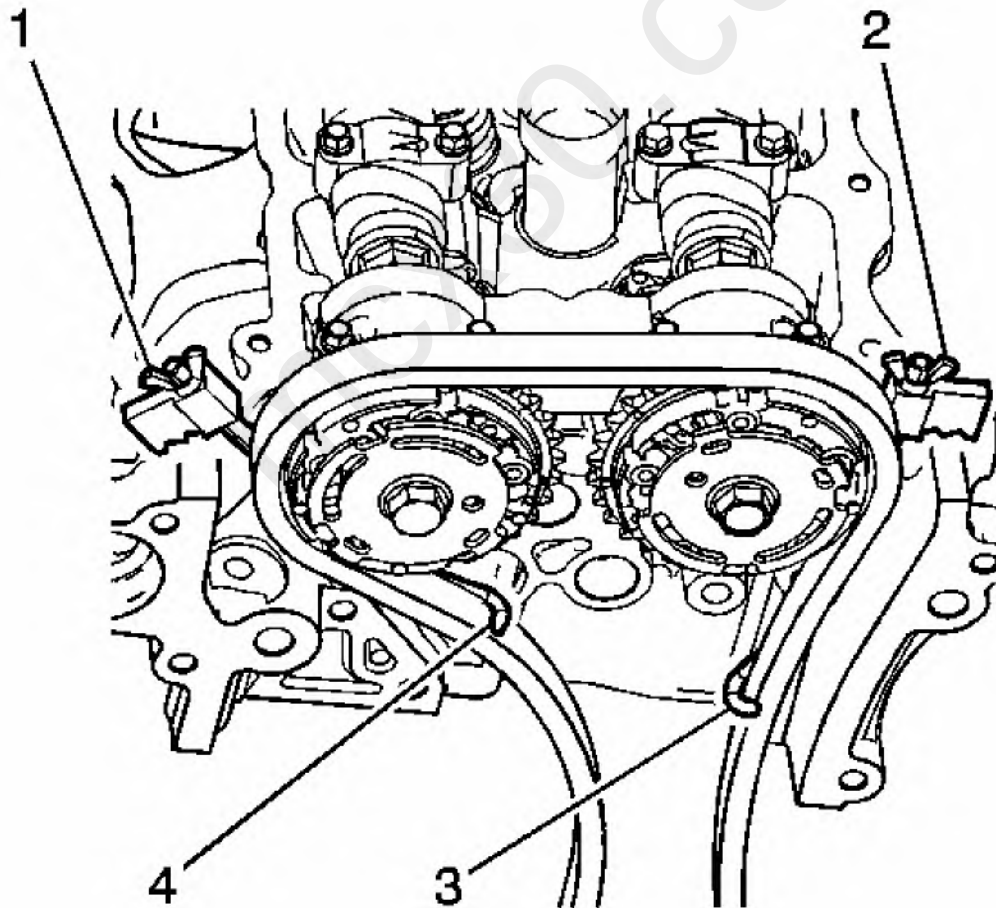


Fig. 158: Identifying EN 46108
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46108** (1 and 2) in order to retain the timing chain. See **Special Tools** .
- Firmly tighten the **EN 46108** nuts. See **Special Tools** .

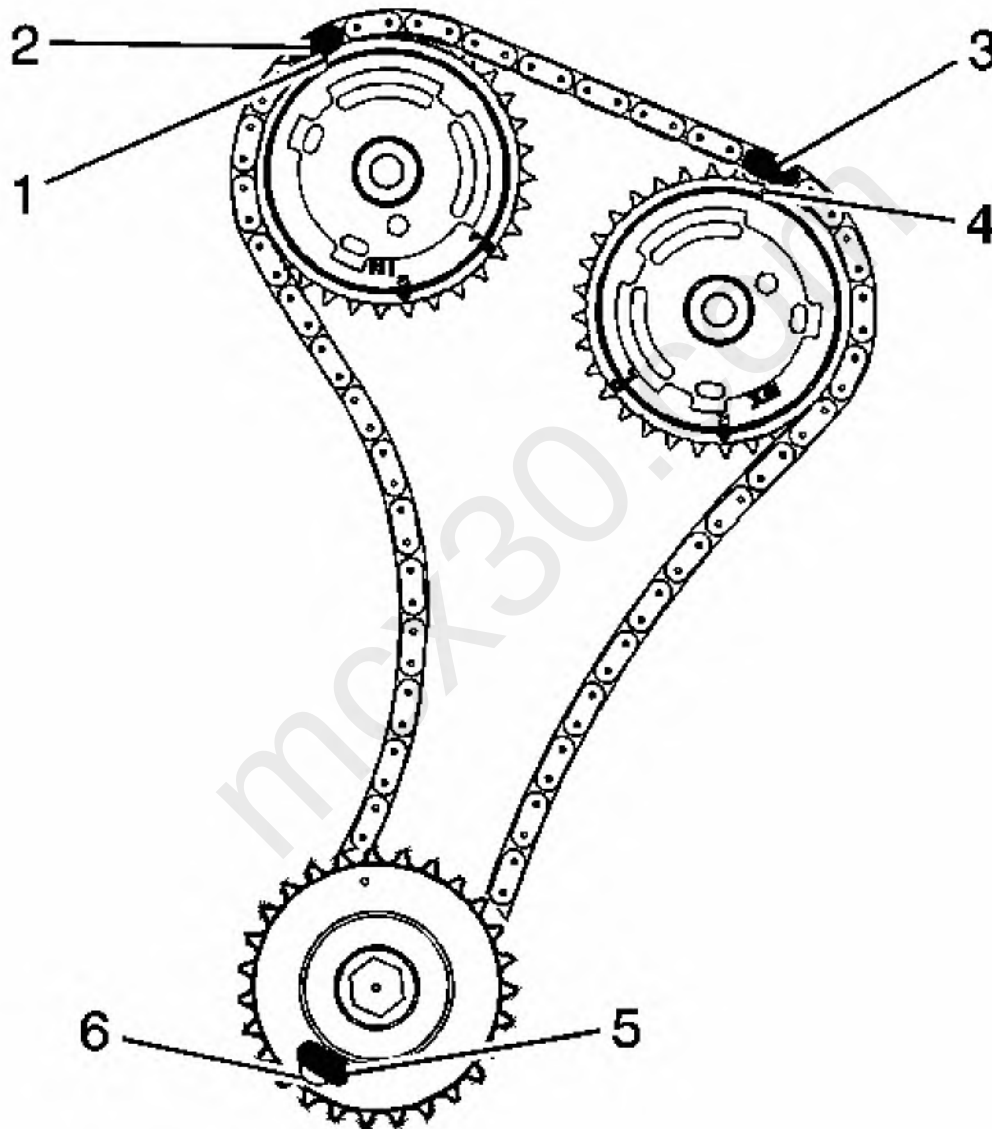


Fig. 159: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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

8. Mark the timing chain and the respective locations on the camshaft position actuators (1-4).
9. Remove the camshaft position actuator bolt.
10. Remove the left exhaust camshaft position actuator.

INSTALLATION PROCEDURE

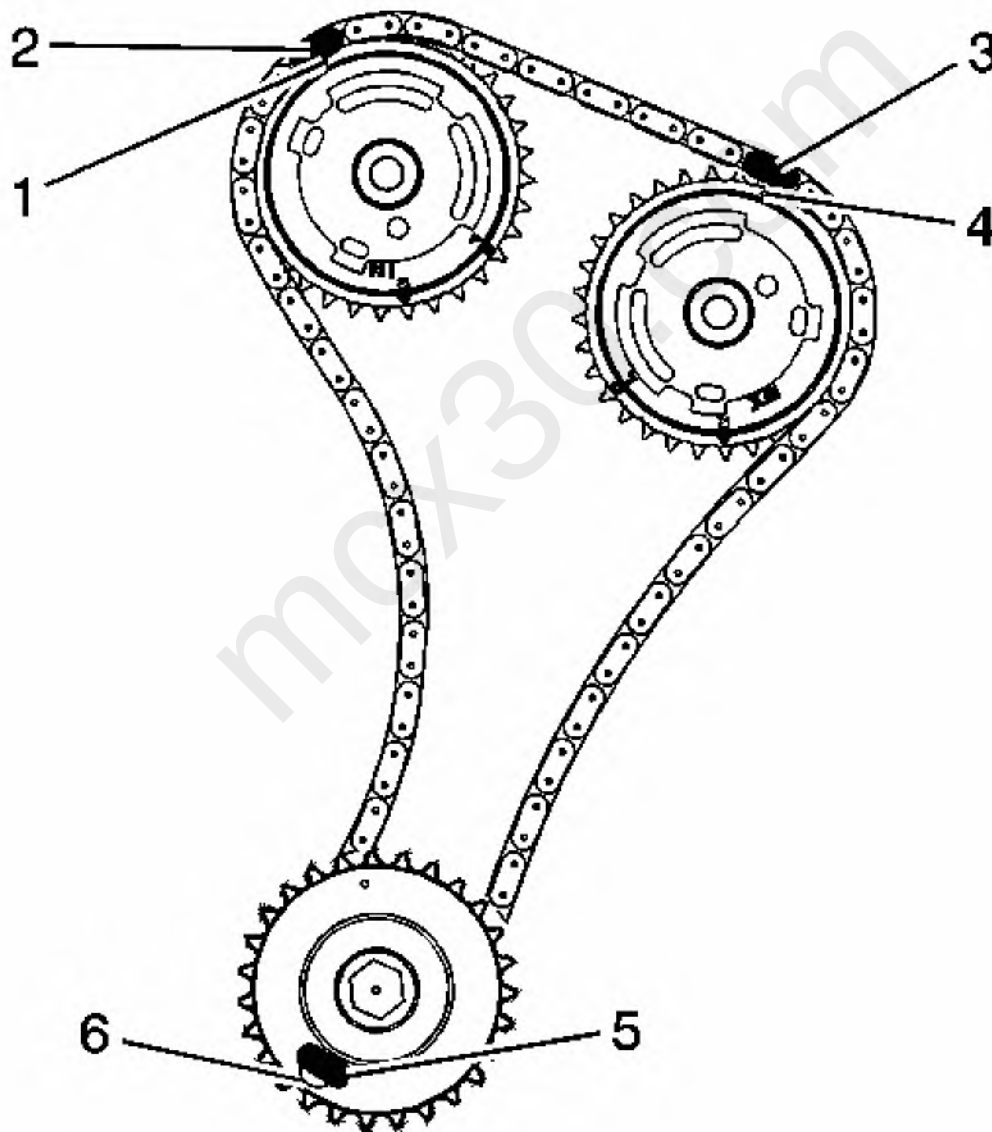


Fig. 160: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

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

1. Locate the camshaft position actuator to the camshaft and loosely install the bolt.
2. Remove the **EN 46108** . See **Special Tools** .

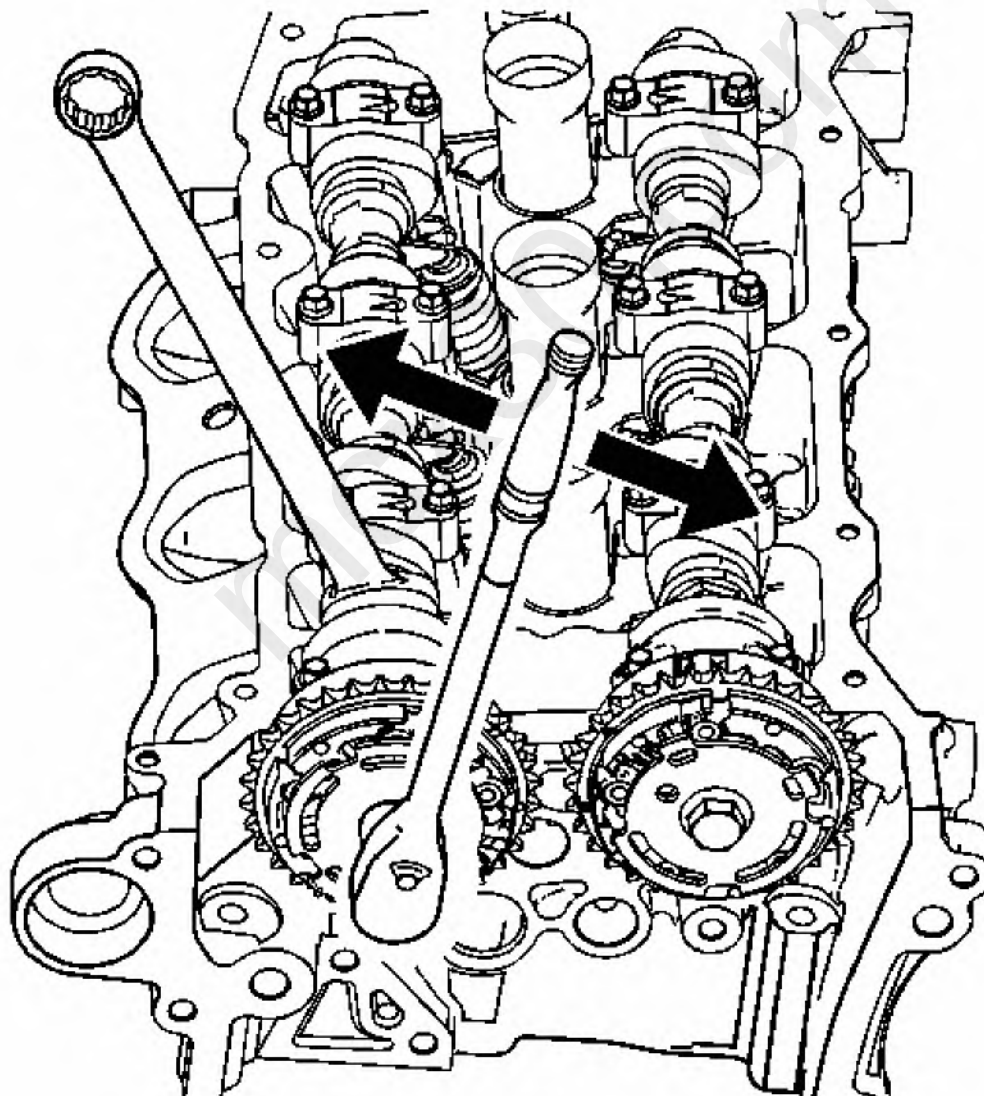


Fig. 161: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

3. Tighten the camshaft position actuator bolt. Refer to Camshaft Position Actuator Installation - Left Side Exhaust (Second Design) .
4. Install the camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake .
5. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake .
6. Install the camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
7. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.

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

TOOLS REQUIRED

EN 46108 Timing Chain Retention Tool. See Special Tools .

REMOVAL PROCEDURE

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

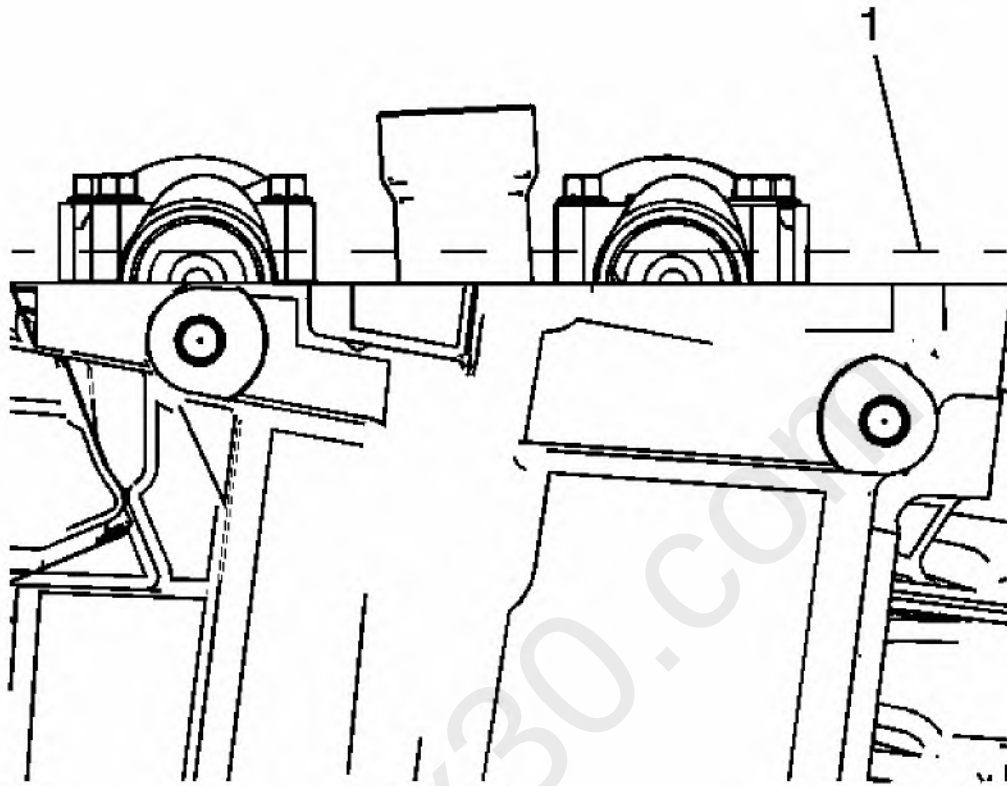


Fig. 162: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Rotate the crankshaft balancer in a clockwise rotation ONLY.

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

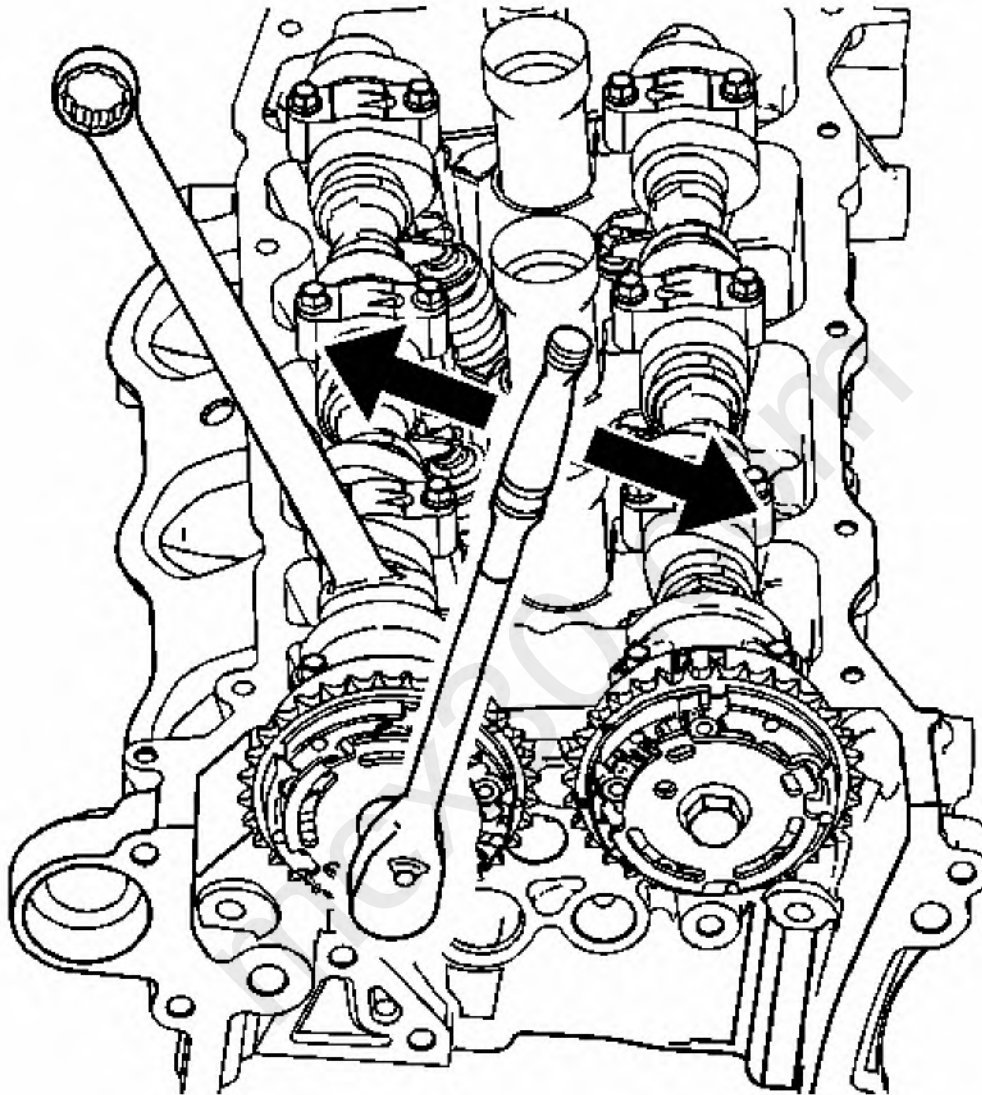


Fig. 163: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

IMPORTANT:

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

6. Loosen the camshaft position actuator bolt.

IMPORTANT: Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4). See Special Tools .

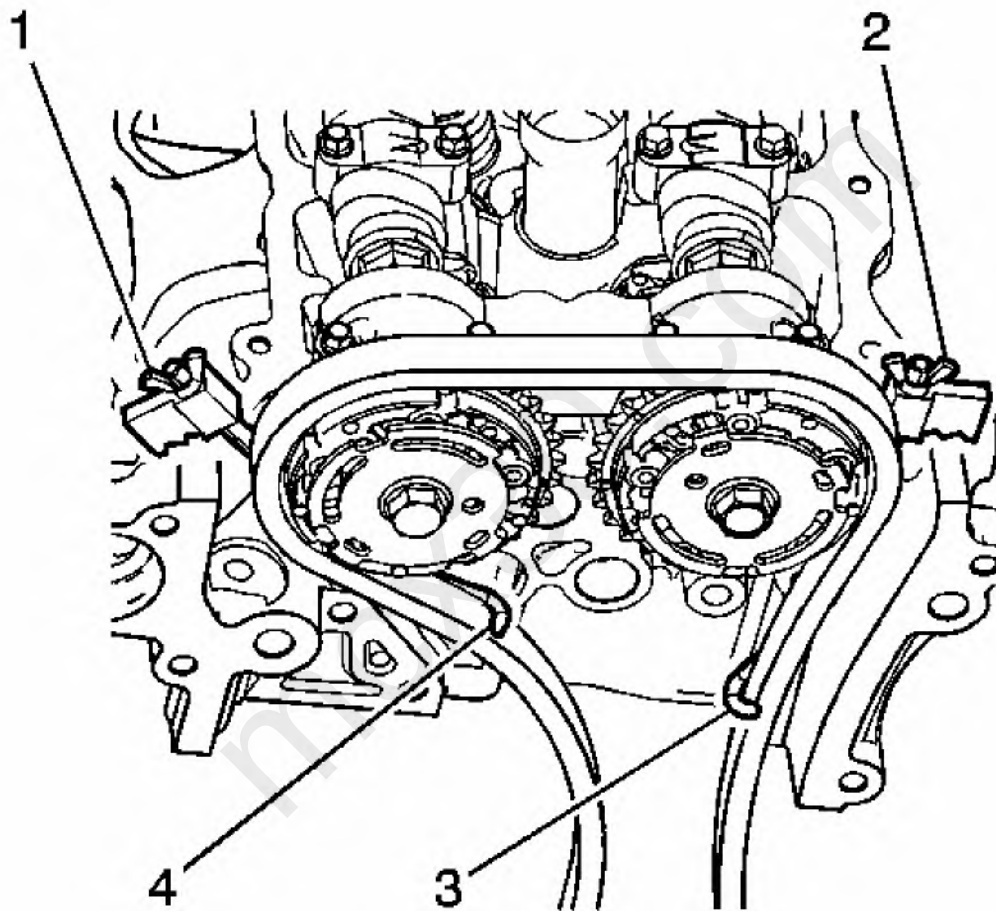


Fig. 164: Identifying EN 46108
Courtesy of GENERAL MOTORS CORP.

7. Install the EN 46108 (1 and 2) in order to retain the timing chain. See Special Tools .

Firmly tighten the EN 46108 nuts. See Special Tools .

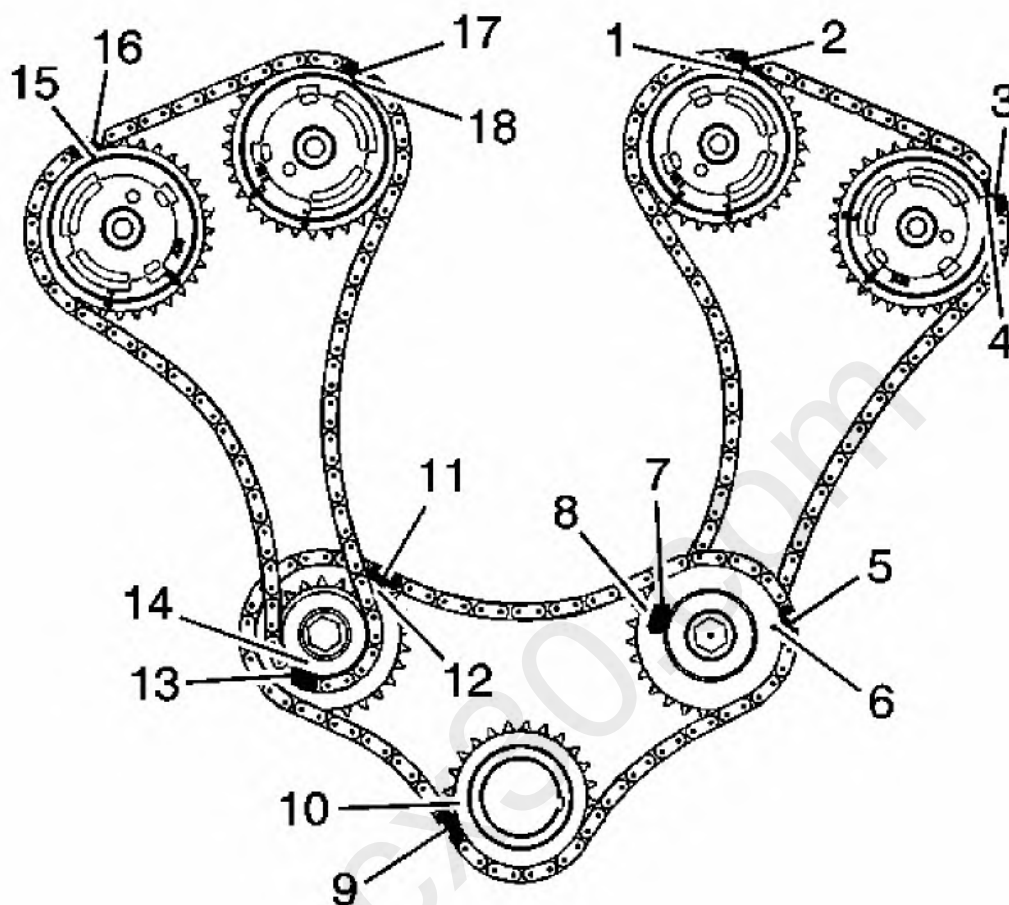


Fig. 165: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS CORP.

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

8. Mark the timing chain and the respective locations on camshaft position actuators (15-18).
9. Remove the right exhaust camshaft position actuator bolt.
10. Remove the right exhaust camshaft actuator.

INSTALLATION PROCEDURE

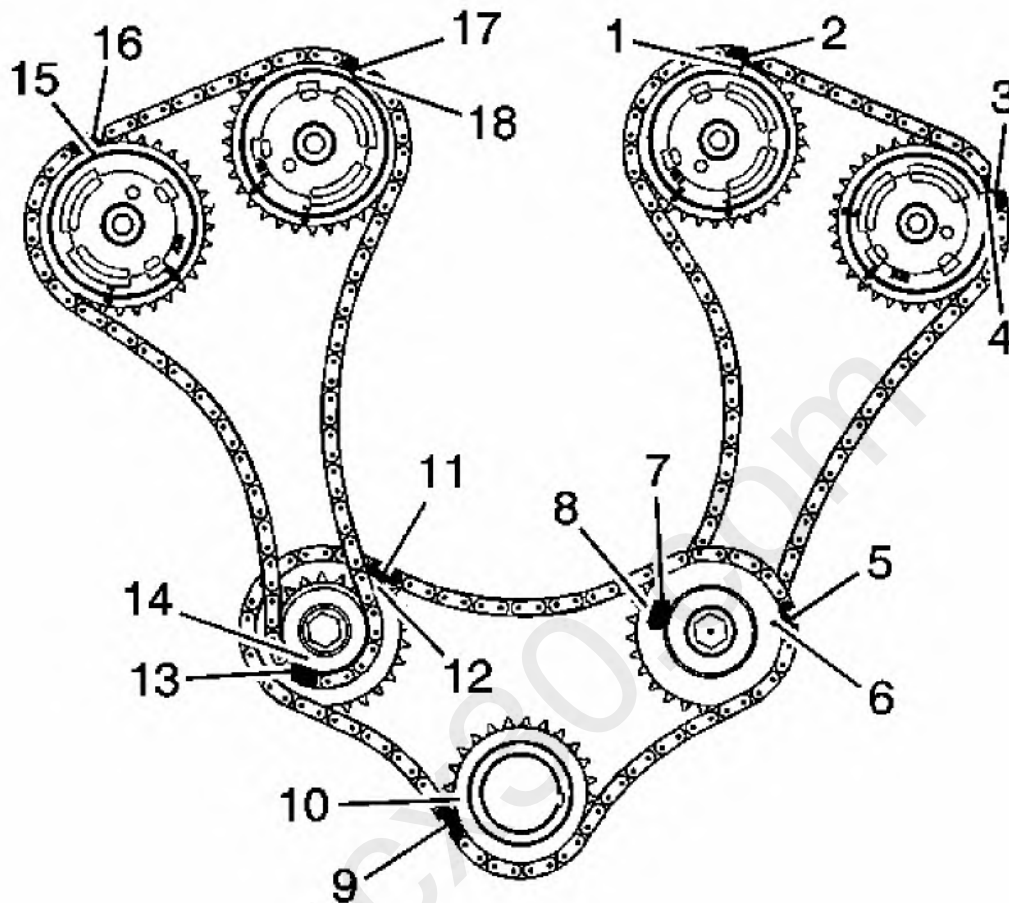


Fig. 166: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

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

1. Assemble the camshaft actuator to the camshaft.
2. Loosely install the camshaft actuator bolt.
3. Remove the **EN 46108** . See **Special Tools** .

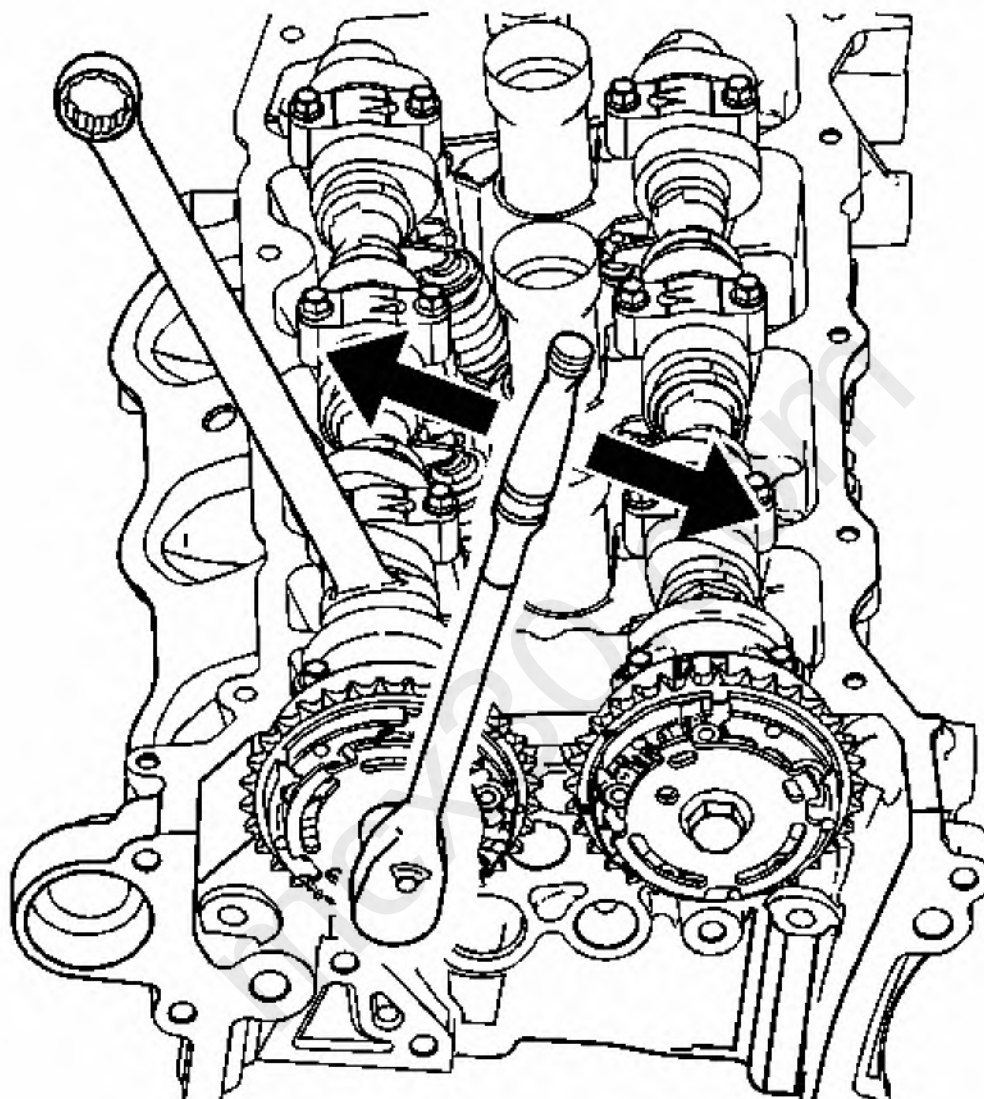


Fig. 167: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

4. Tighten the camshaft position actuator. Refer to Camshaft Position Actuator Installation - Right Side Exhaust (Second Design) .

5. Install the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
6. Install the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
7. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

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

REMOVAL PROCEDURE

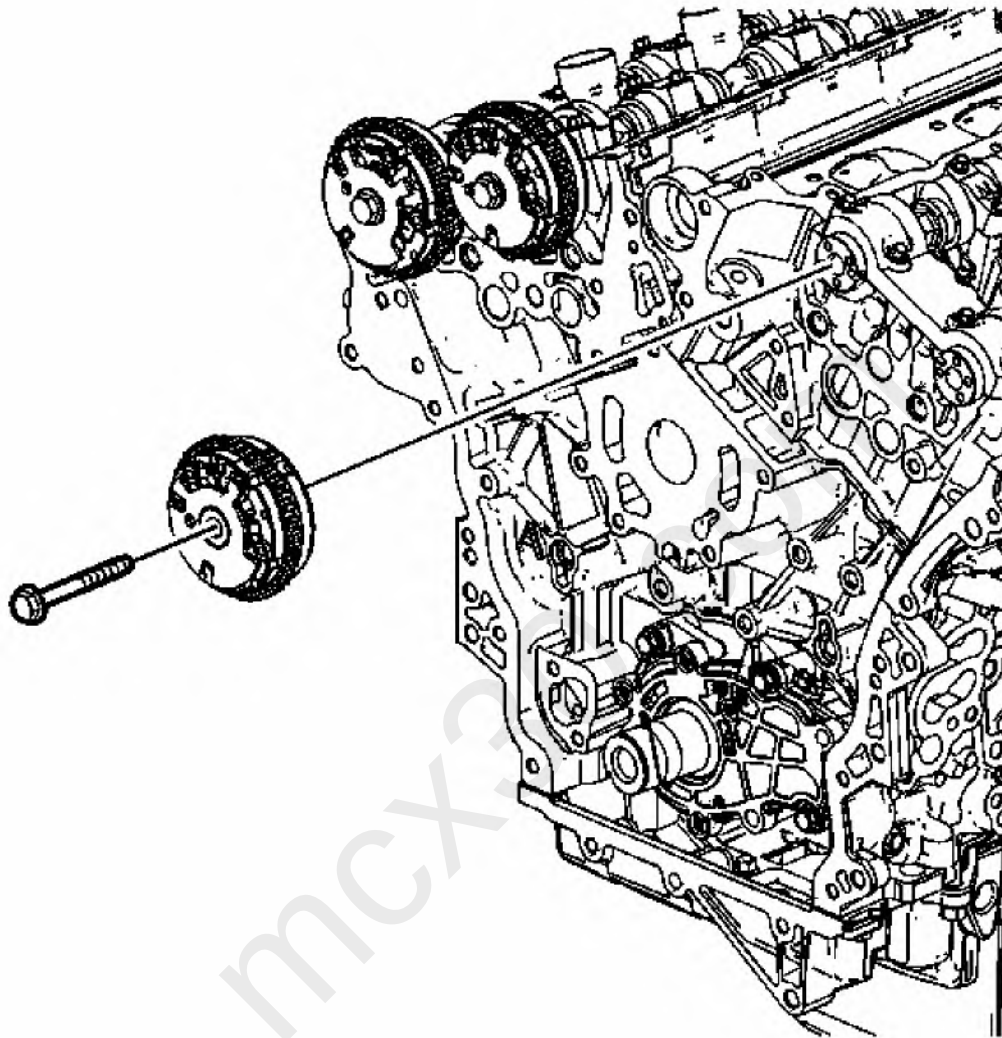


Fig. 168: Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

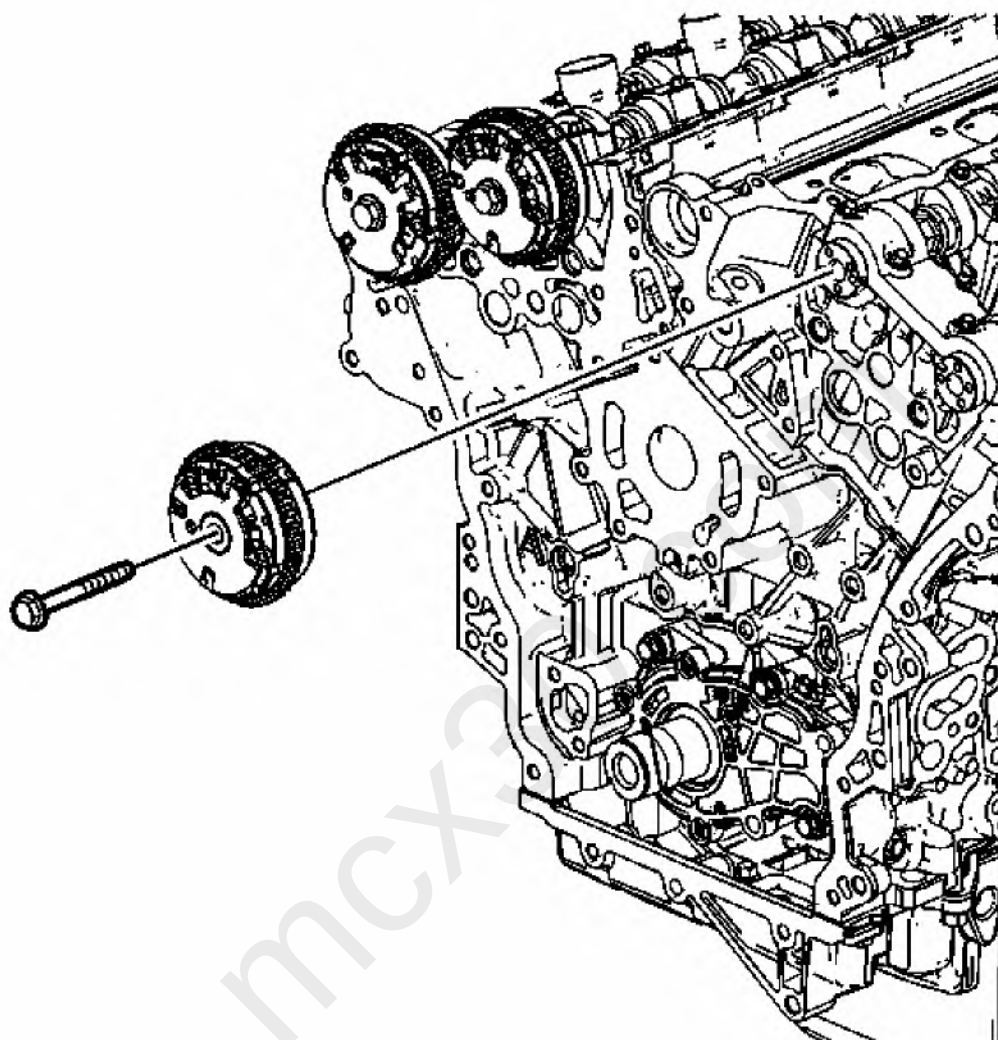


Fig. 169: Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

2. Tighten the camshaft position actuator bolt. Refer to Camshaft Position Actuator Installation - Left Side Intake (Second Design) .

3. Install the left exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust.**

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

REMOVAL PROCEDURE

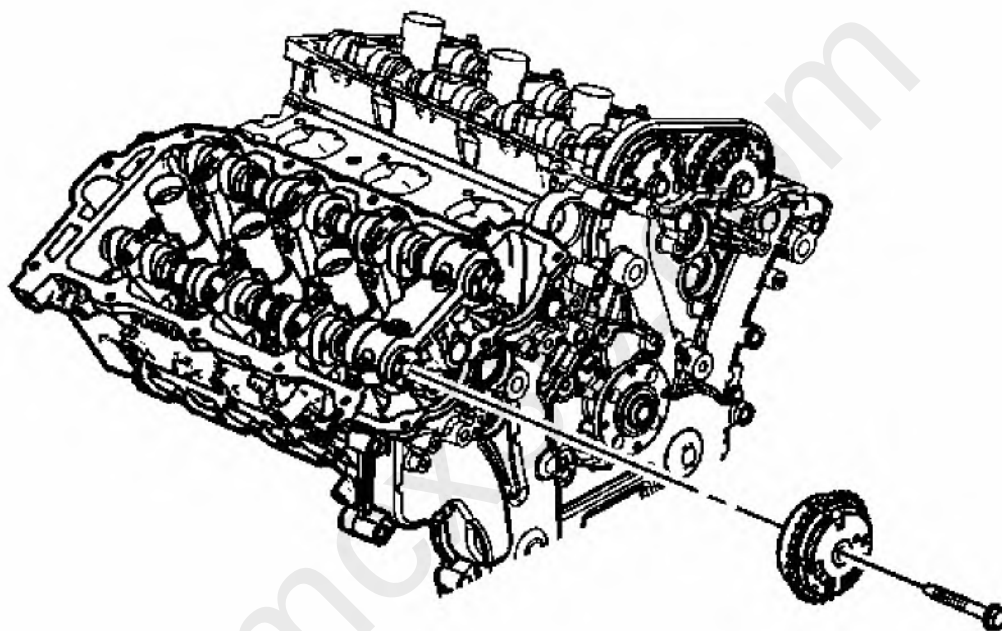


Fig. 170: Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

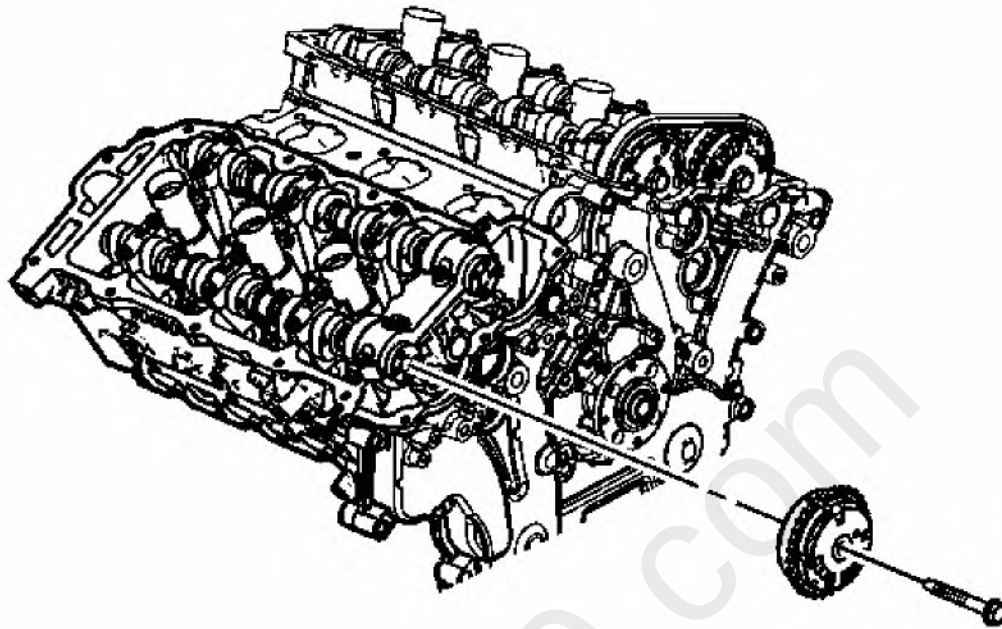


Fig. 171: Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

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

SETTING CAMSHAFT TIMING

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

be confirmed.

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

CAMSHAFT REPLACEMENT - LEFT SIDE

TOOLS REQUIRED

EN 46108 Timing Chain Retention Tool. See **Special Tools** .

REMOVAL PROCEDURE

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

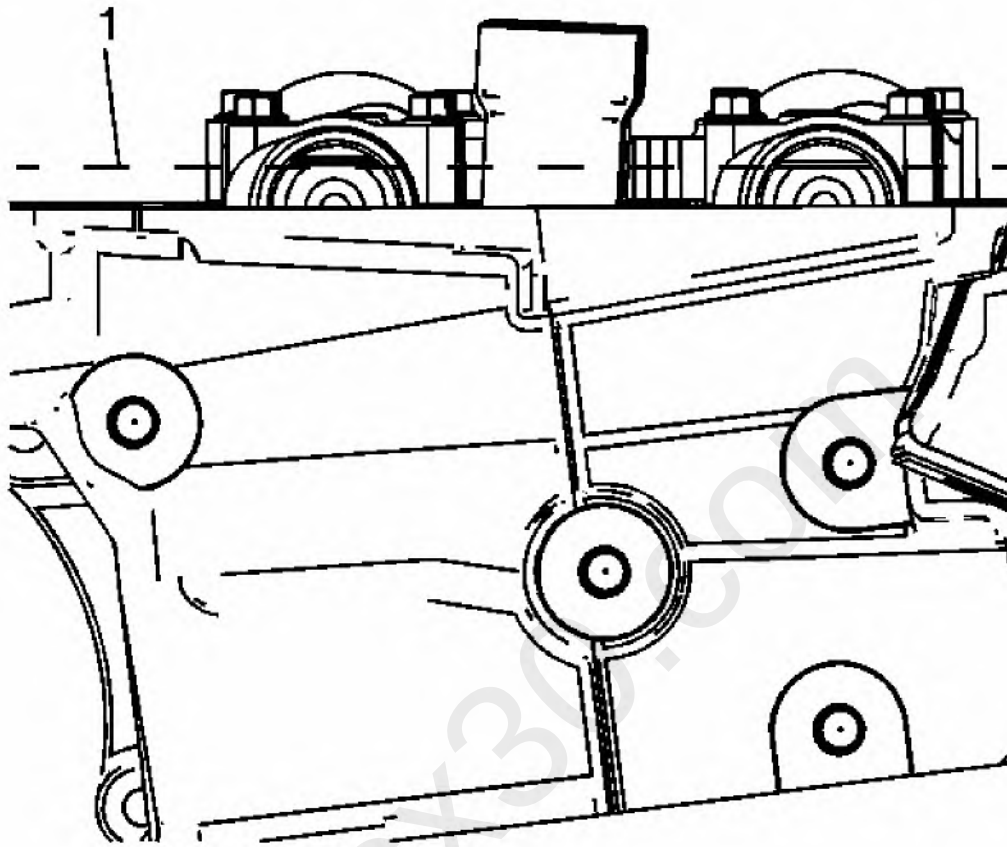


Fig. 172: Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Rotate the crankshaft balancer in a clockwise rotation ONLY.

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

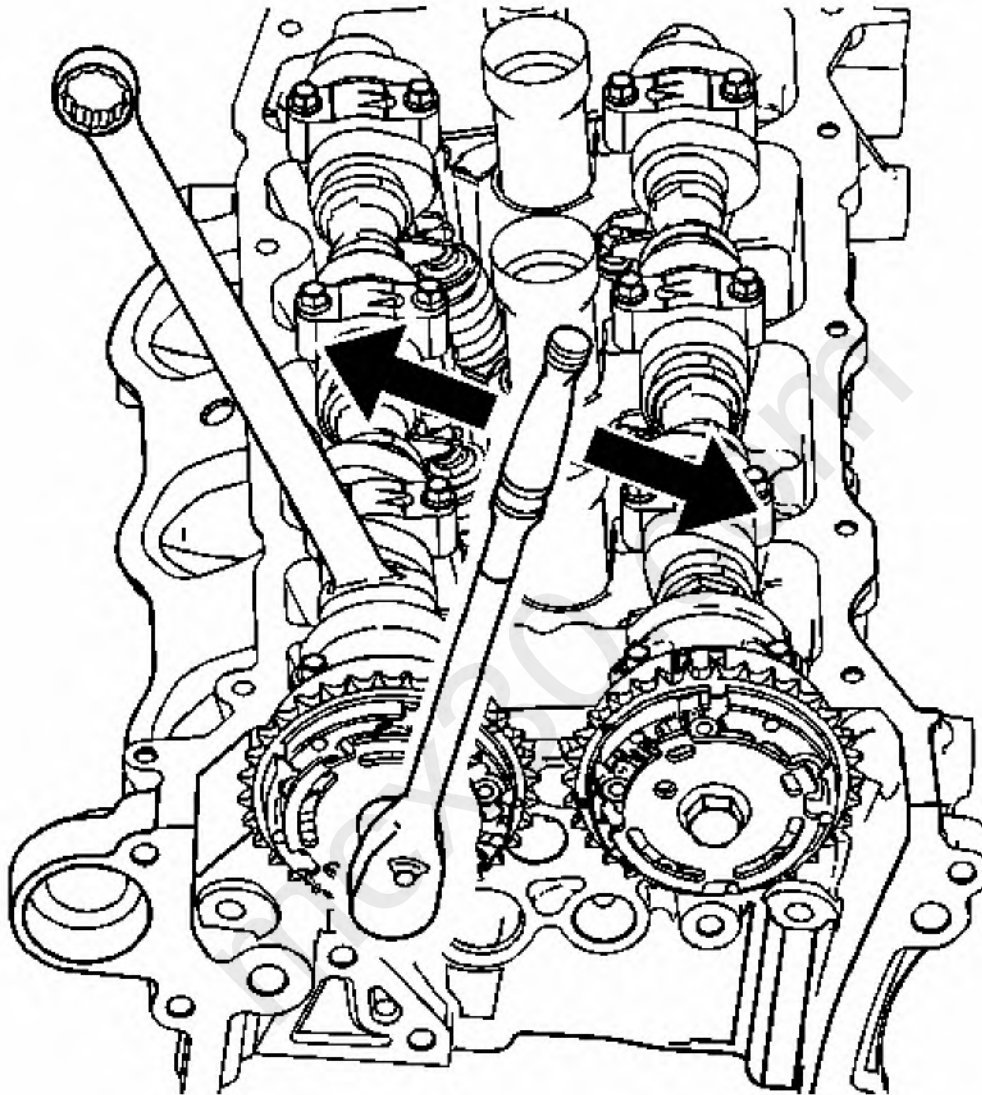


Fig. 173: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

IMPORTANT:

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

6. Loosen the camshaft position actuator bolt.

IMPORTANT: Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4). See Special Tools .

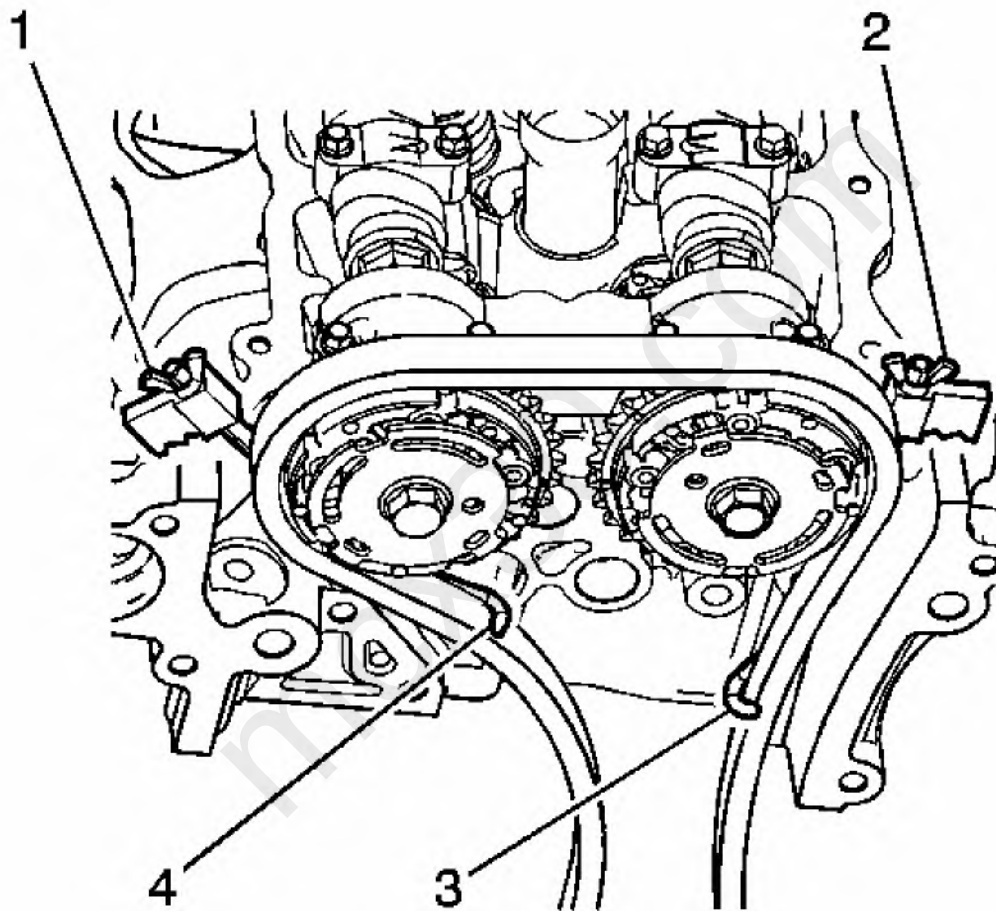


Fig. 174: Identifying EN 46108
Courtesy of GENERAL MOTORS CORP.

7. Install the EN 46108 (1 and 2) in order to retain the timing chain. See Special Tools .

Firmly tighten the EN 46108 nuts. See Special Tools .

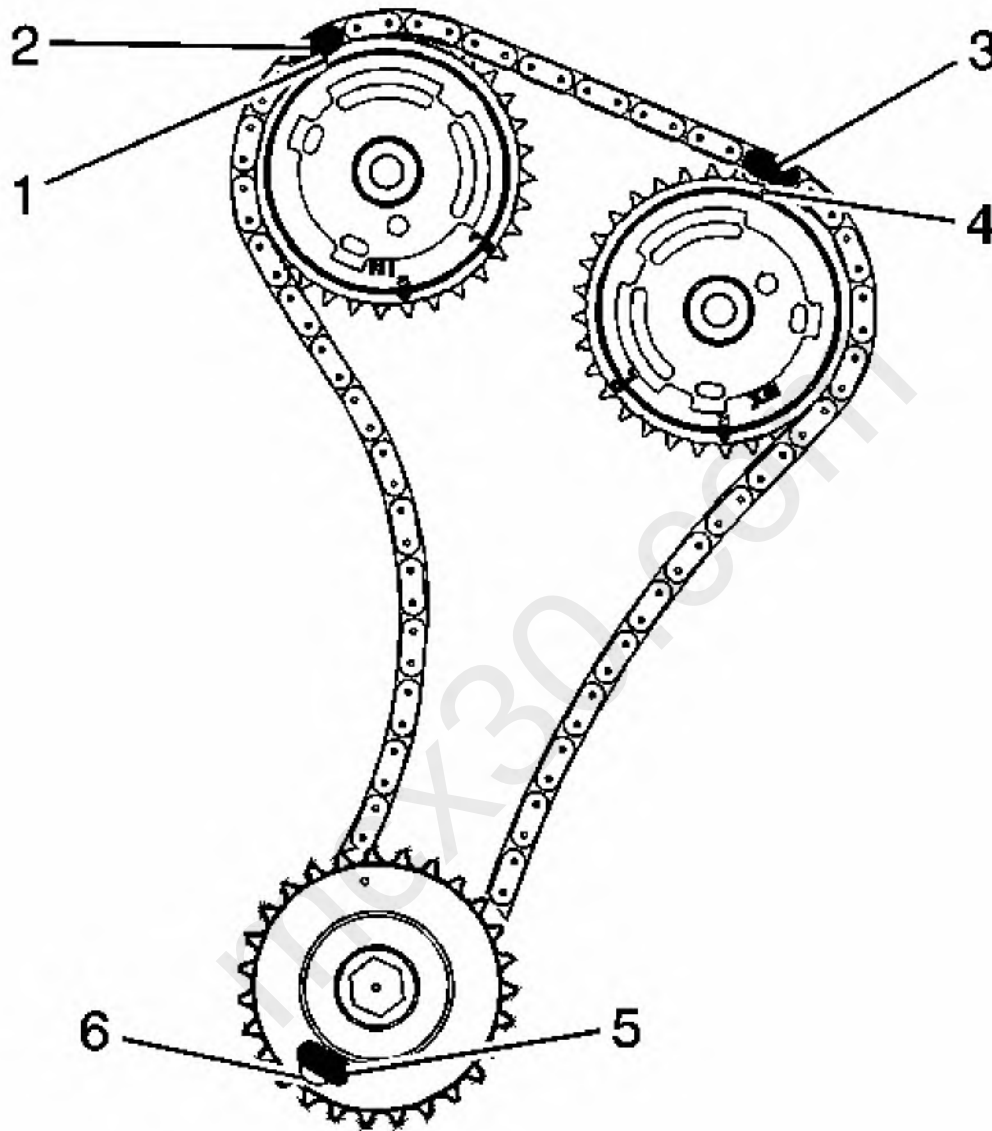


Fig. 175: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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

8. Mark the timing chain and the respective locations on the camshaft position actuators (1-4).
9. Remove the camshaft position actuator bolt.

10. Remove the camshafts. Refer to **Camshaft Removal - Left Side** .

INSTALLATION PROCEDURE

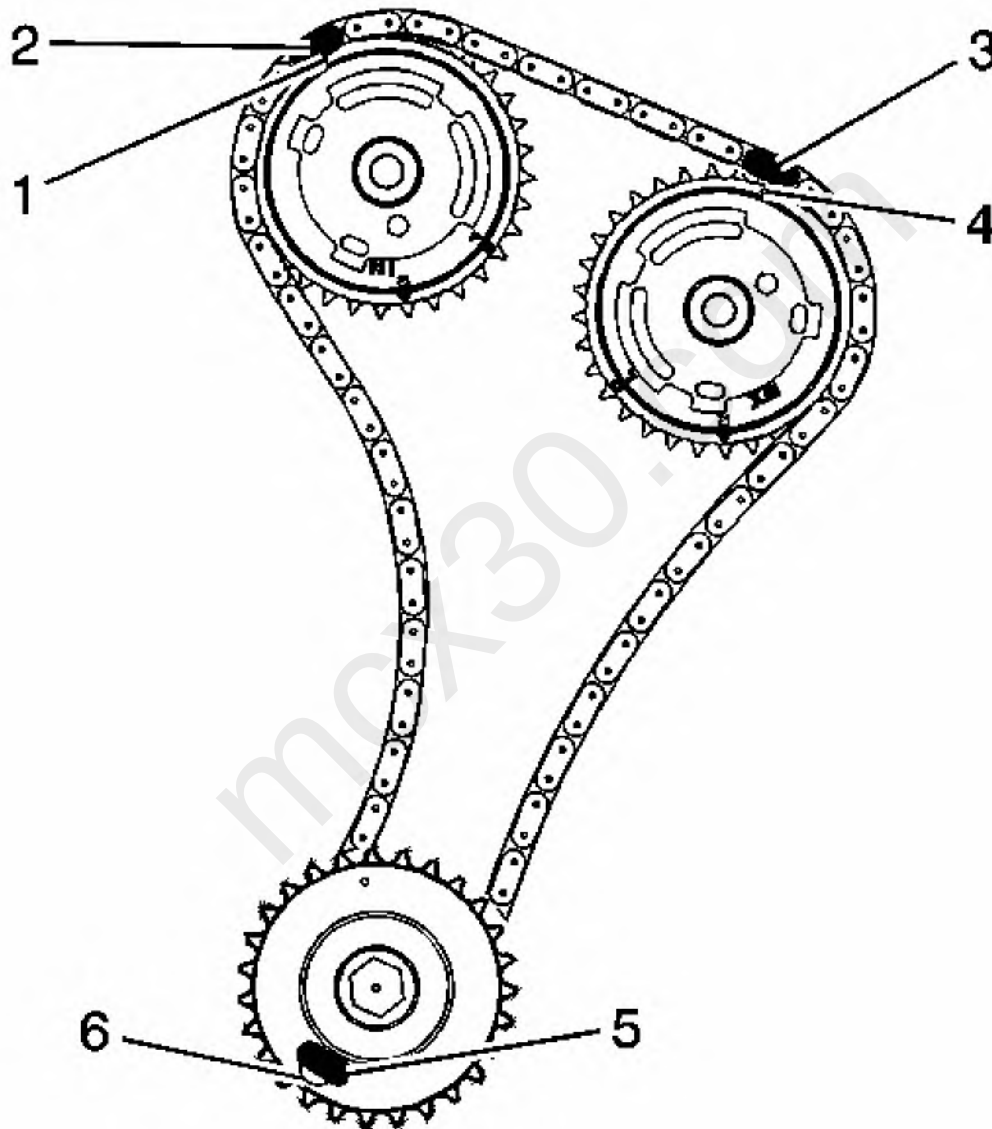


Fig. 176: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Ensure that the marks on the camshaft position actuator and the timing chain (1-4) are aligned.

- **DO NOT** tighten the camshaft position actuator bolt at this time.

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Left Side** .
3. Remove the **EN 46108** . See **Special Tools** .

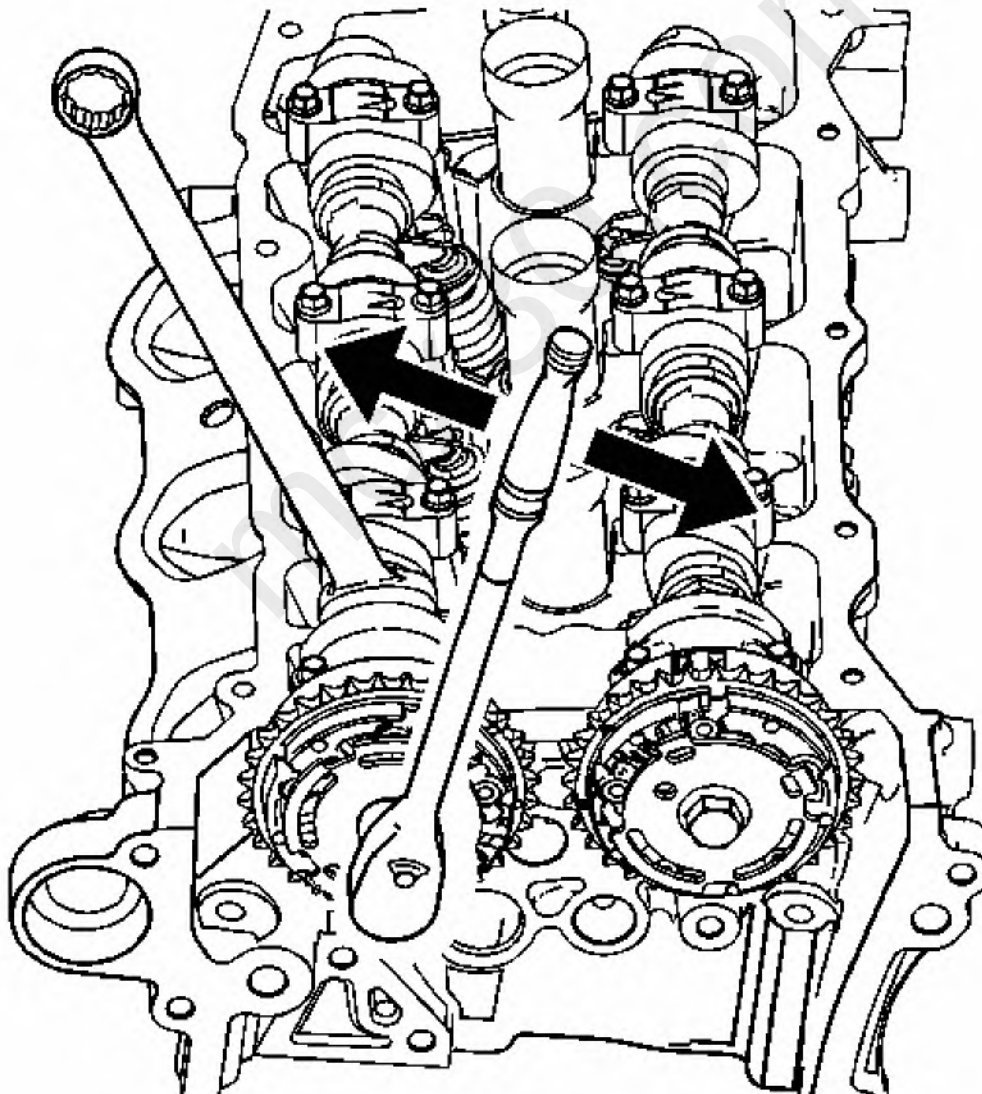


Fig. 177: Preventing Camshaft/Engine Rotation Using Open-End Wrench

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

4. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Left Side Intake (Second Design) and Camshaft Position Actuator Installation - Left Side Exhaust (Second Design) .
5. Install the intake camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake .
6. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake .
7. Install the camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
8. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement.

CAMSHAFT REPLACEMENT - RIGHT SIDE

TOOLS REQUIRED

EN 46108 Timing Chain Retention Tool. See Special Tools .

REMOVAL PROCEDURE

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

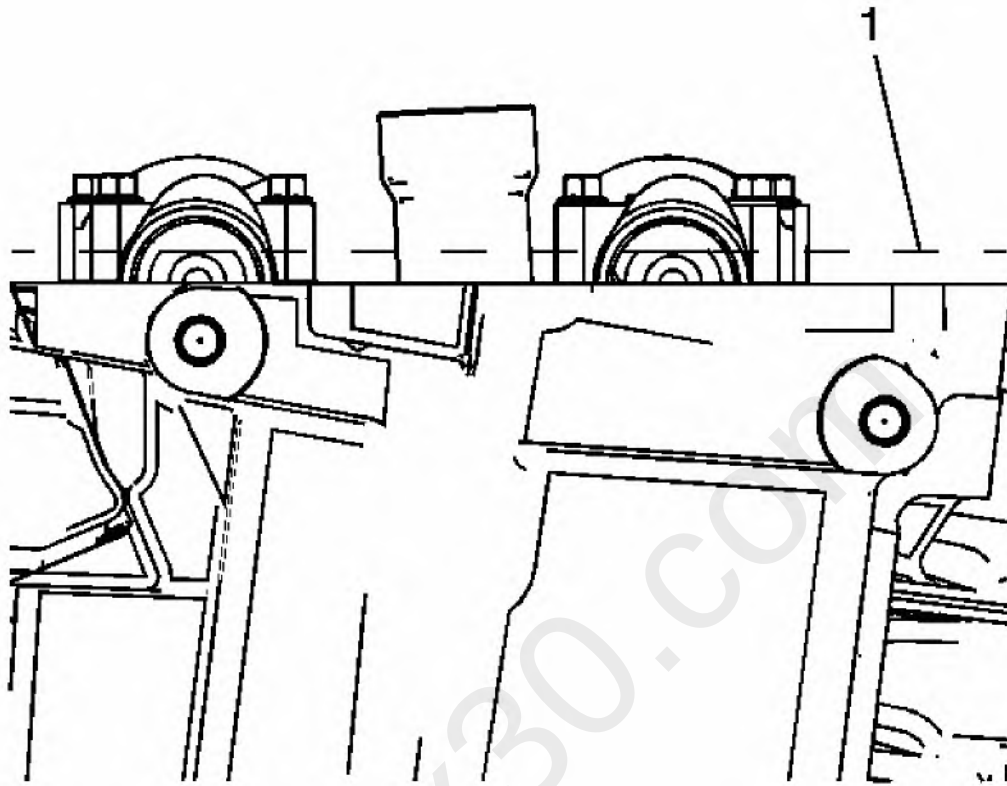


Fig. 178: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Rotate the crankshaft balancer in a clockwise rotation ONLY.

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

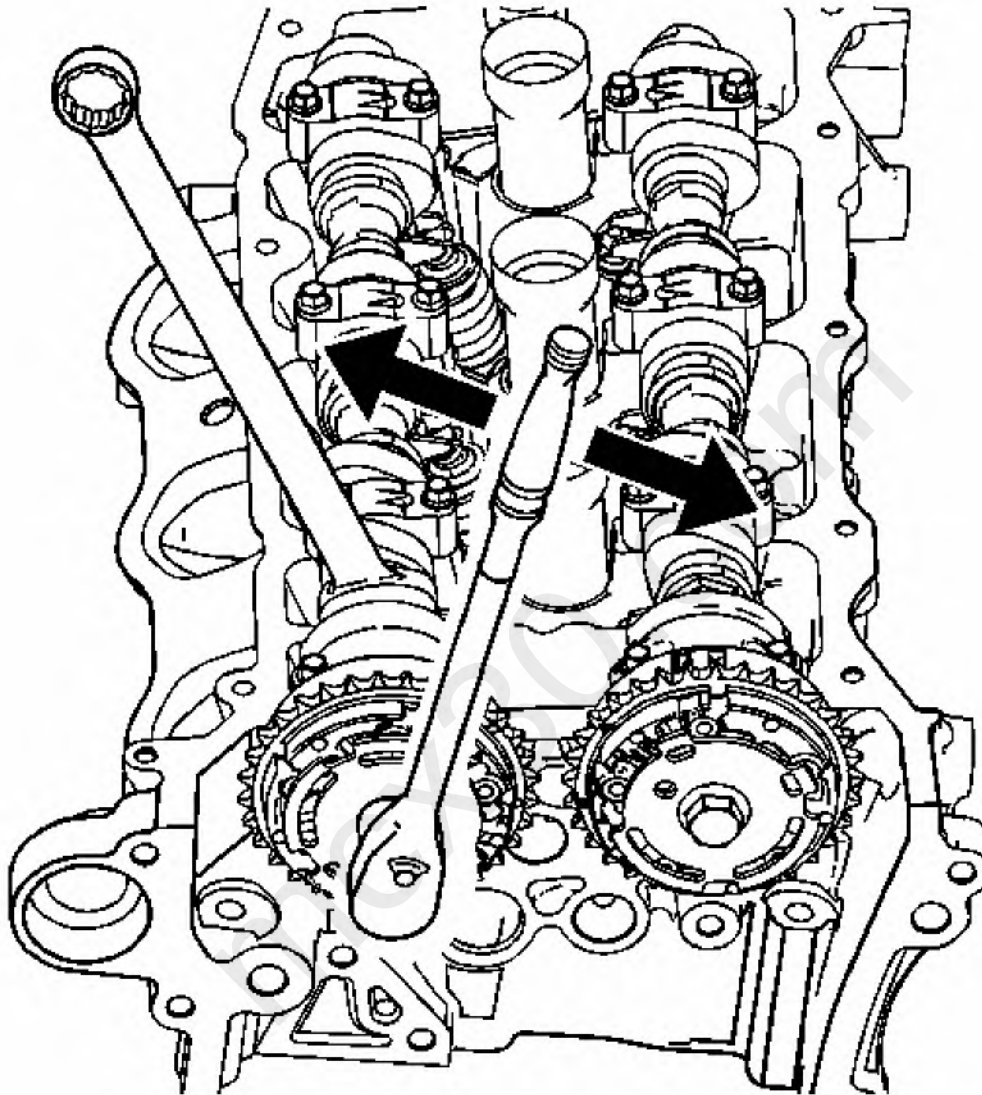


Fig. 179: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

IMPORTANT:

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

6. Loosen the camshaft position actuator bolt.

IMPORTANT: Ensure that the tips of the EN 46108 are fully engaged into the timing chain (3 and 4). See Special Tools .

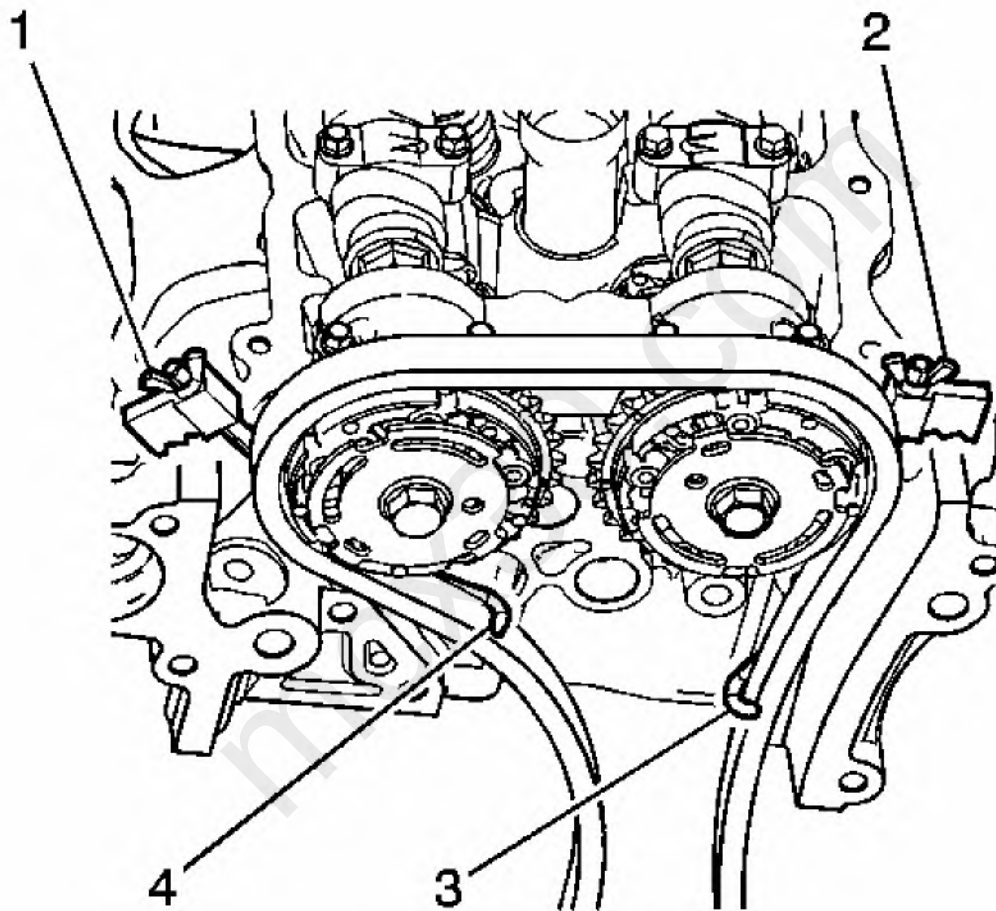


Fig. 180: Identifying EN 46108
Courtesy of GENERAL MOTORS CORP.

7. Install the EN 46108 (1 and 2) in order to retain the timing chain. See Special Tools .

Firmly tighten the EN 46108 nuts. See Special Tools .

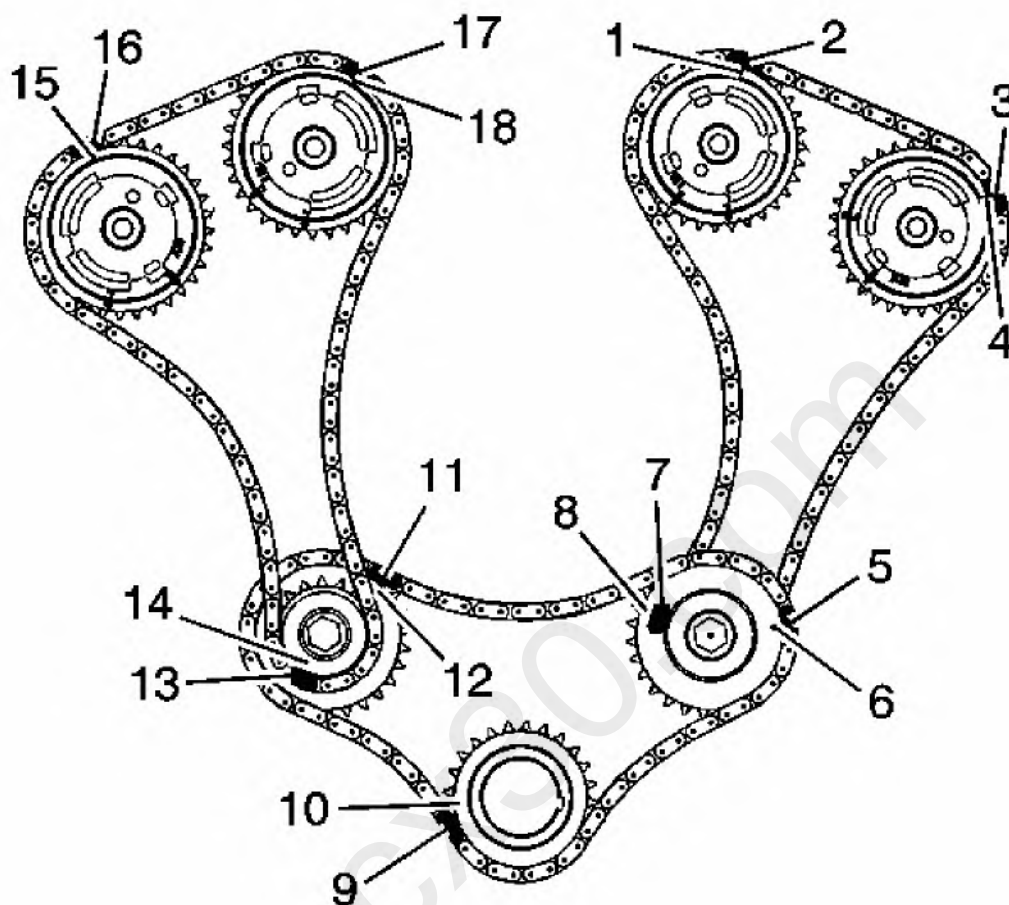


Fig. 181: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS CORP.

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

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

INSTALLATION PROCEDURE

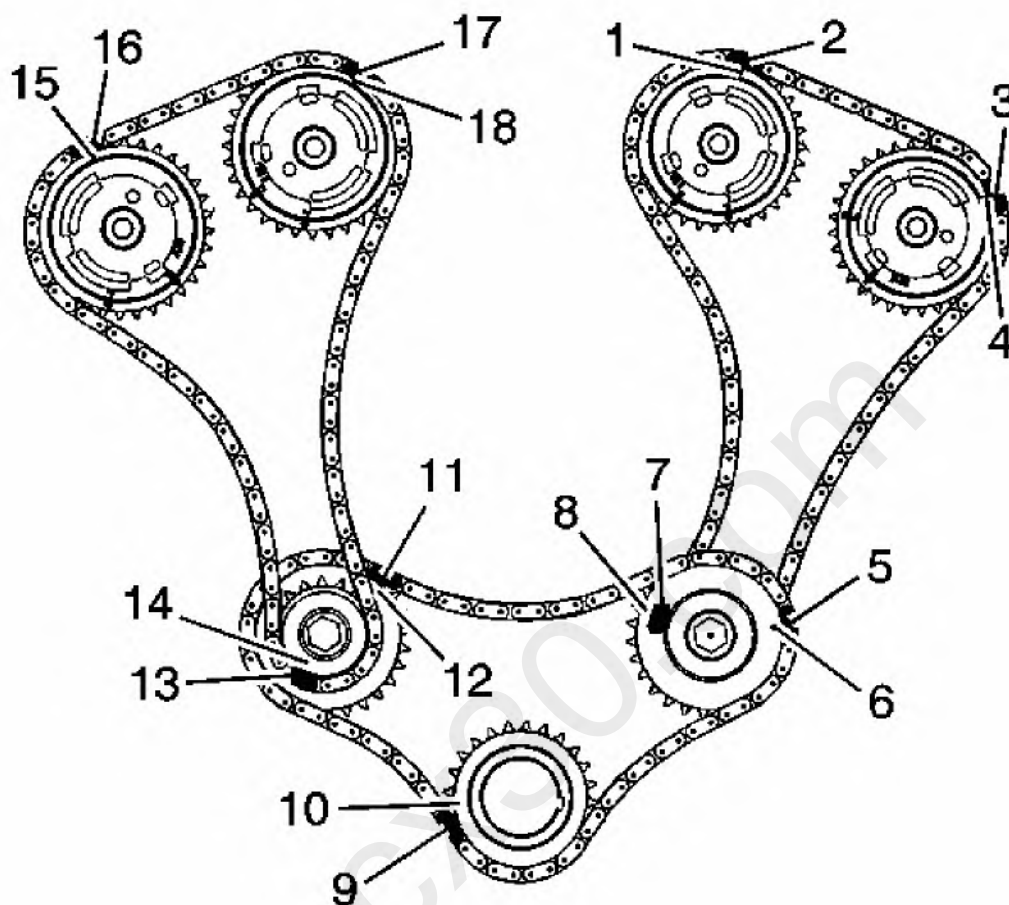


Fig. 182: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

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

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Right Side**.
3. Remove the EN 46108. See **Special Tools**.

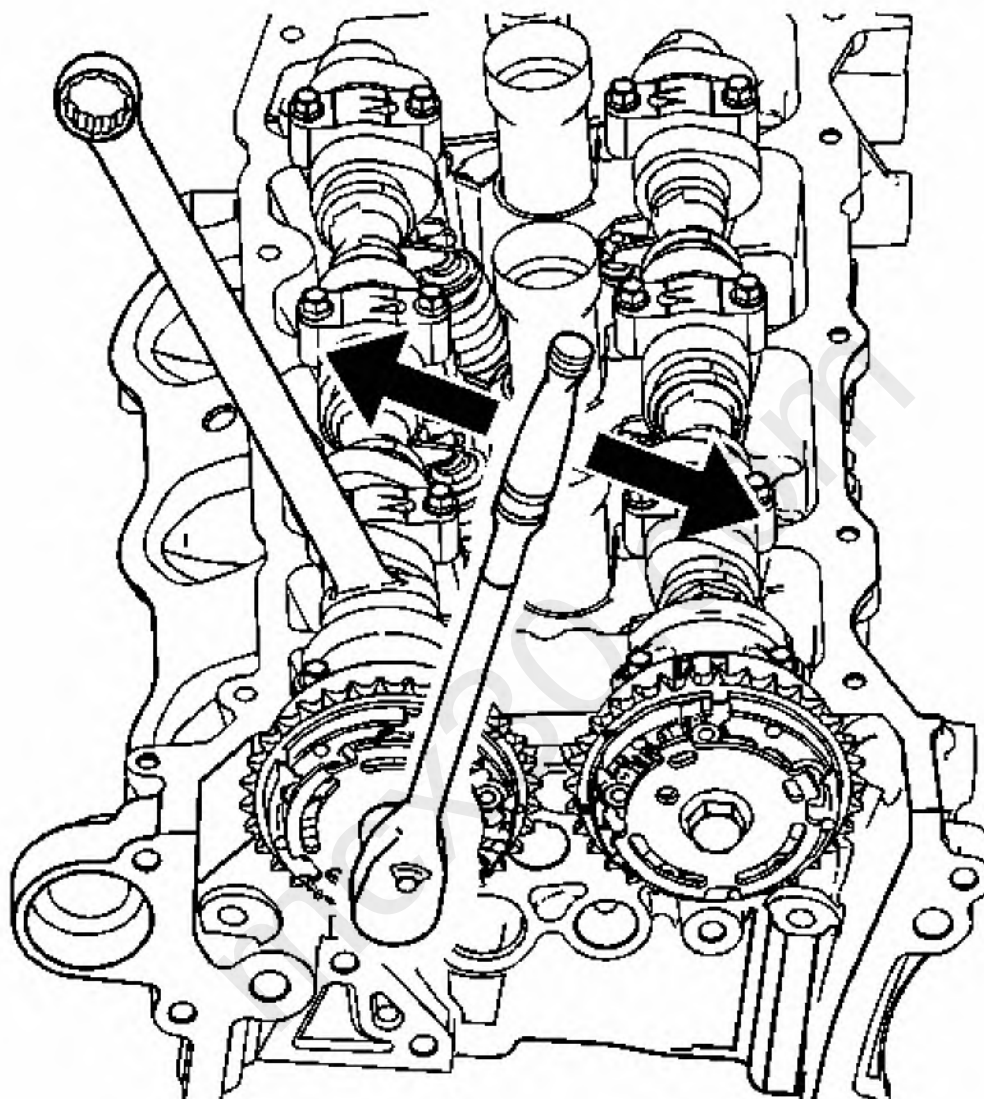


Fig. 183: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Torque Reaction Against Timing Drive Chain Notice .

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

4. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Right Side Intake (Second Design) and Camshaft Position

Actuator Installation - Right Side Exhaust (Second Design) .

5. Install the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .**
6. Install the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .**
7. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side.**
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement.**

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

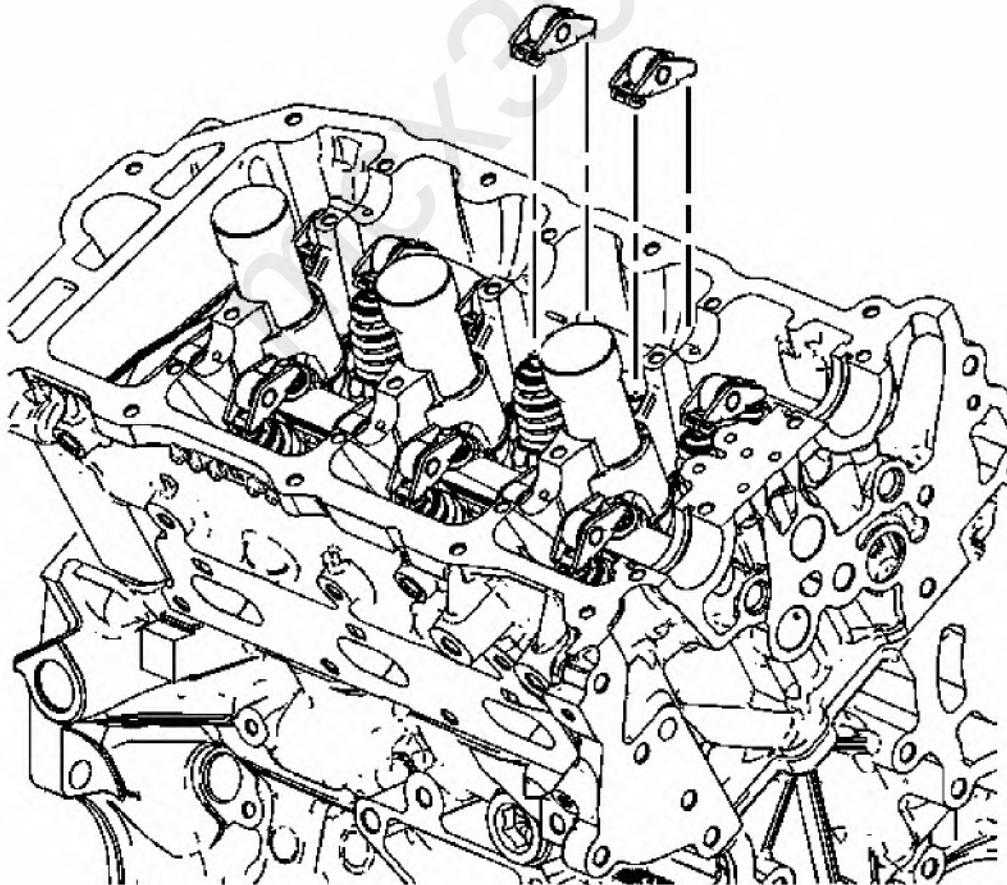


Fig. 184: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Left Side .
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection and Valve Lifters Cleaning and Inspection .

INSTALLATION PROCEDURE

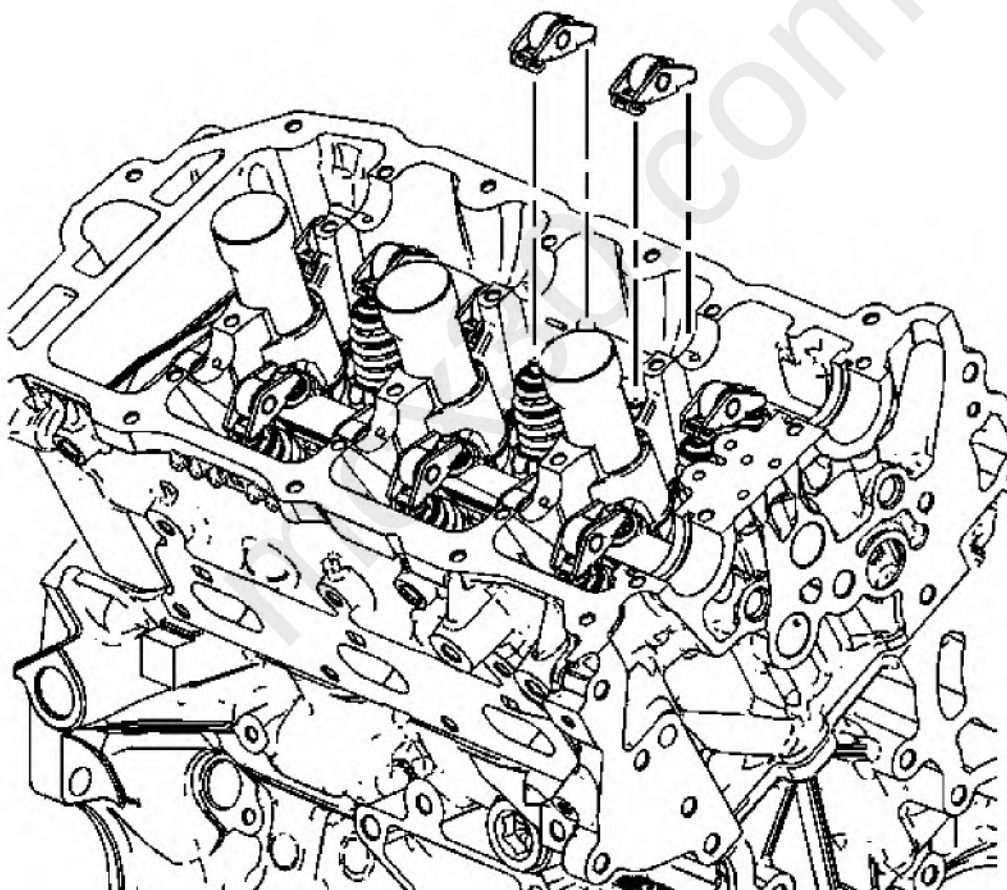


Fig. 185: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

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

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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

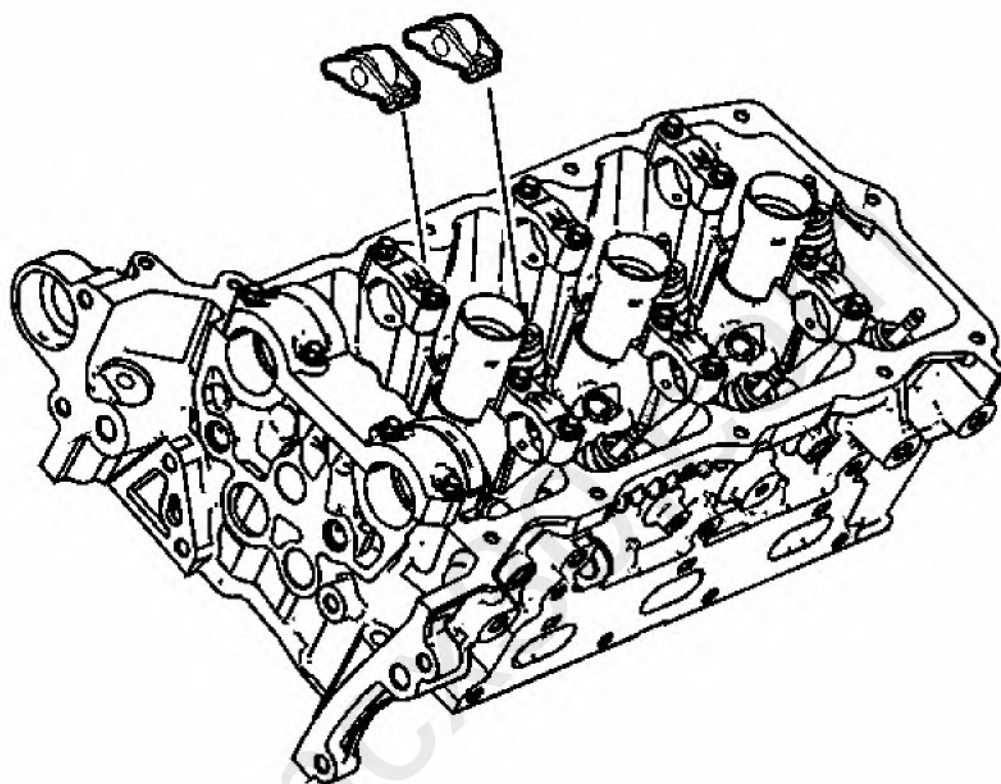


Fig. 186: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side**.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifters Cleaning and Inspection**.

INSTALLATION PROCEDURE

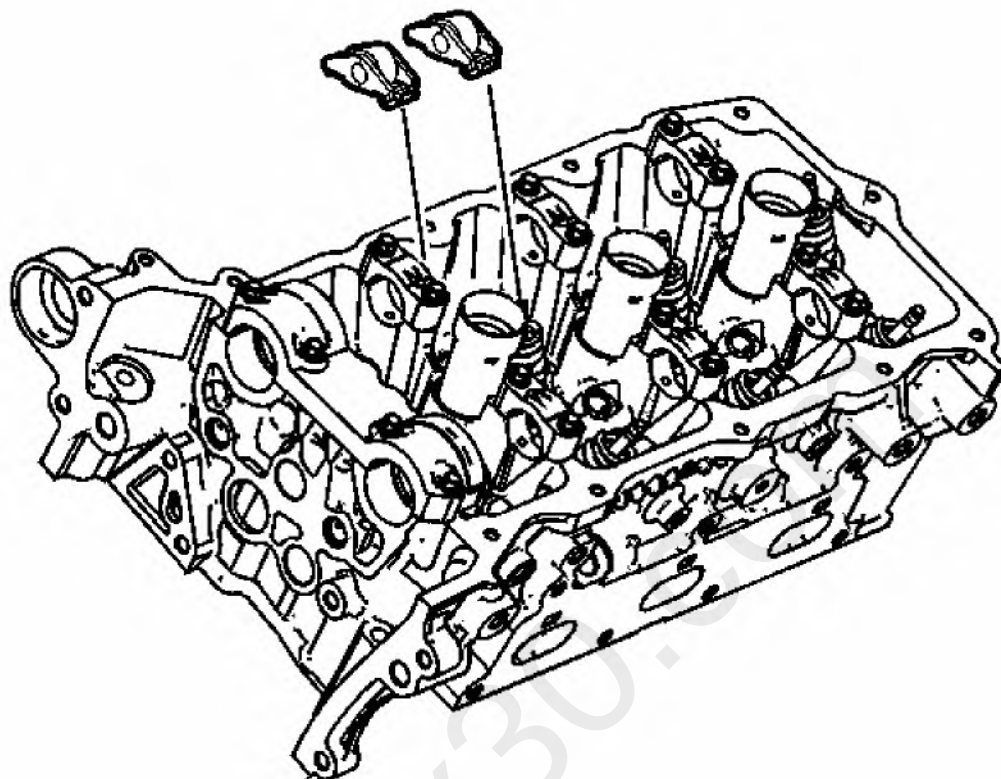


Fig. 187: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

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

VALVE LIFTER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

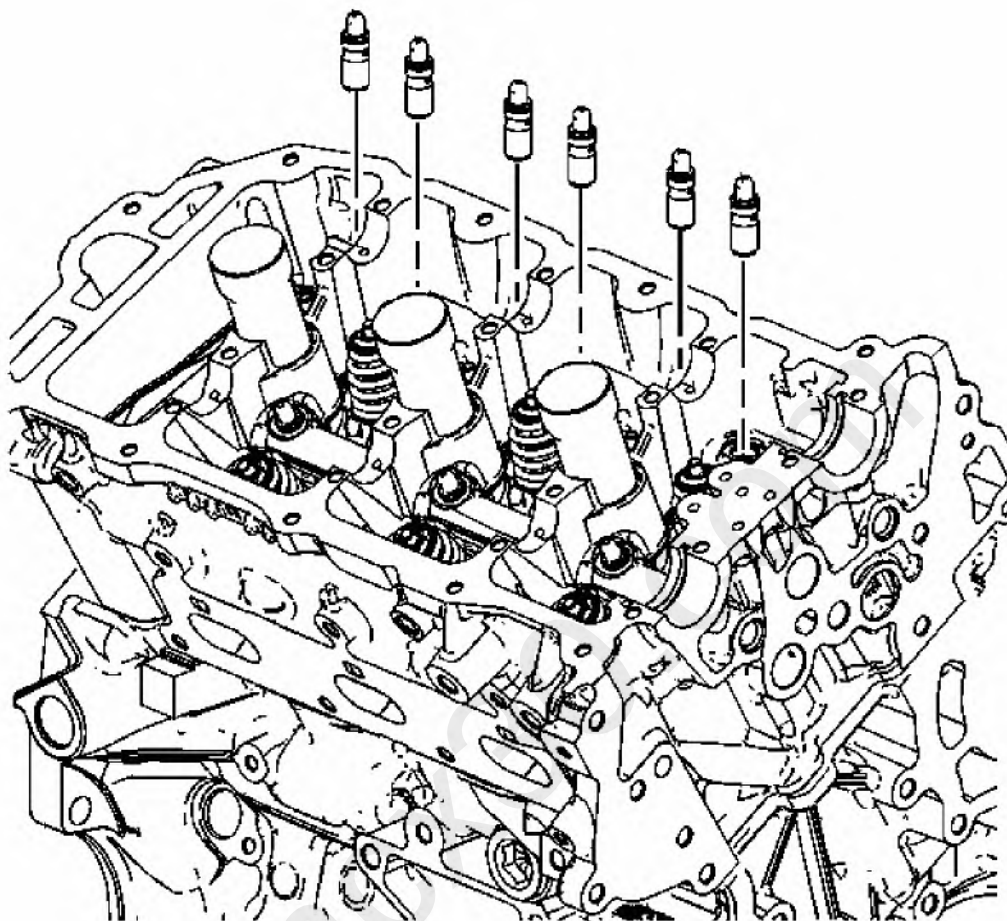


Fig. 188: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

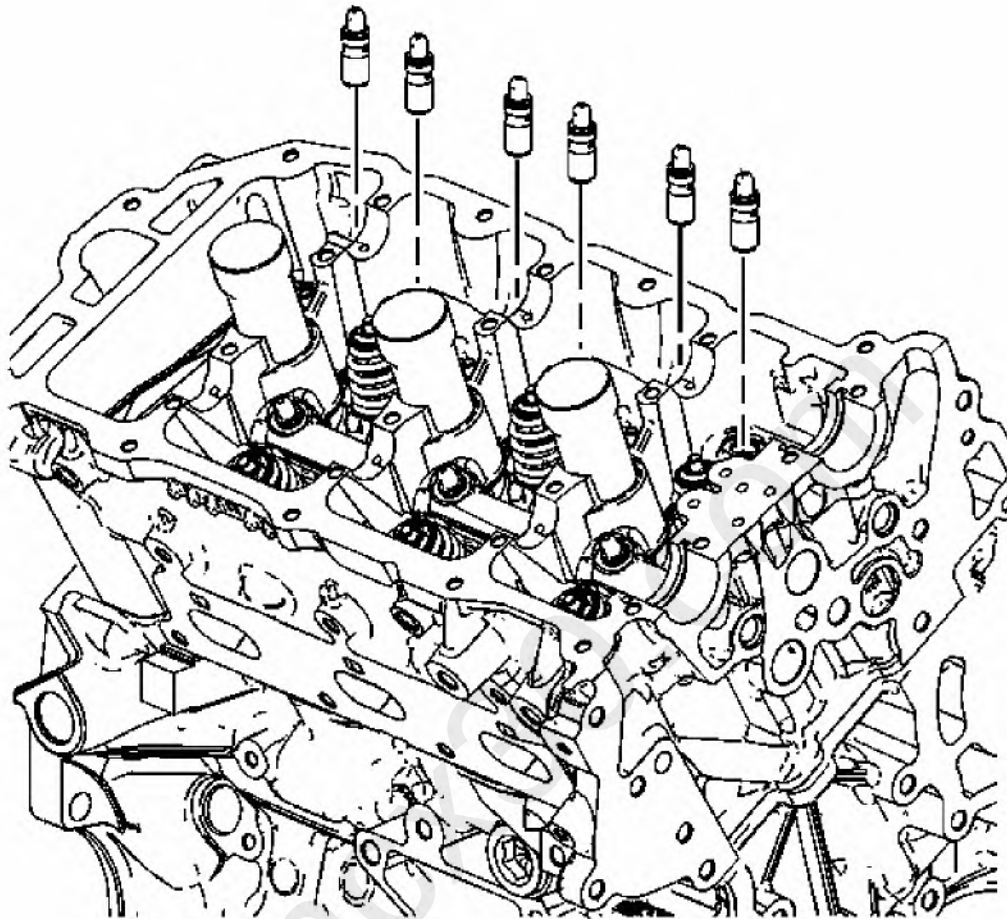


Fig. 189: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS CORP.

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

VALVE LIFTER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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

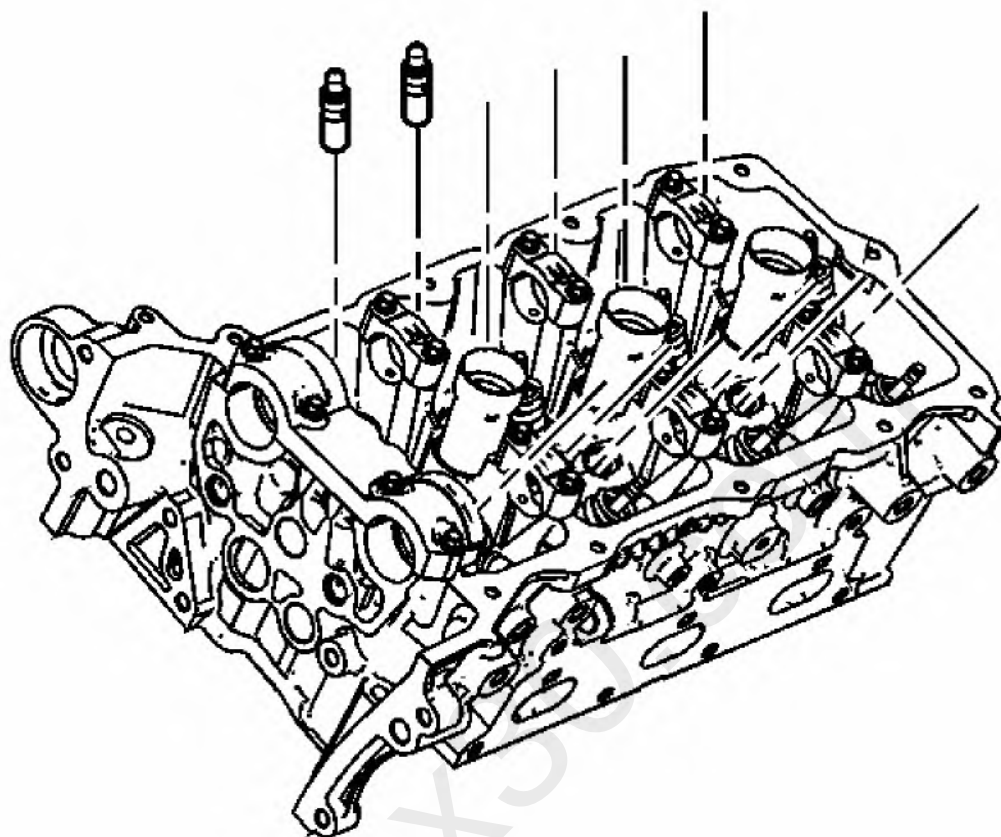


Fig. 190: View Of SHLAs
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

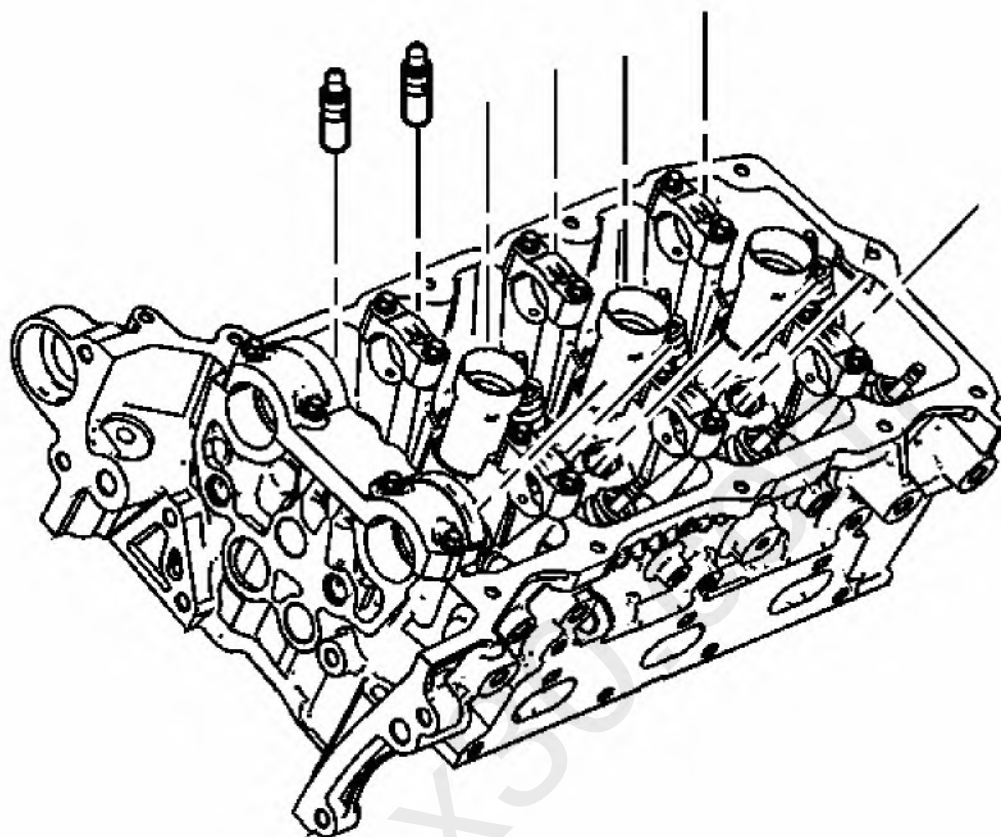


Fig. 191: View Of SHLAs
Courtesy of GENERAL MOTORS CORP.

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Tools Required

- EN 46106 Flywheel Holding Tool. See **Special Tools** .
- EN 46110 On-Vehicle Valve Spring Compressor. See **Special Tools** .
- EN 46116 Valve Stem Seal Remover/Installer. See **Special Tools** .
- EN 46117 Valve Stem Key Remover/Installer. See **Special Tools** .

- **J 39313** Spark Plug Port Adapter. See Special Tools .

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to Starter Motor Replacement (LY7) or Starter Motor Replacement (LH2) or Starter Motor Replacement (LC3) .

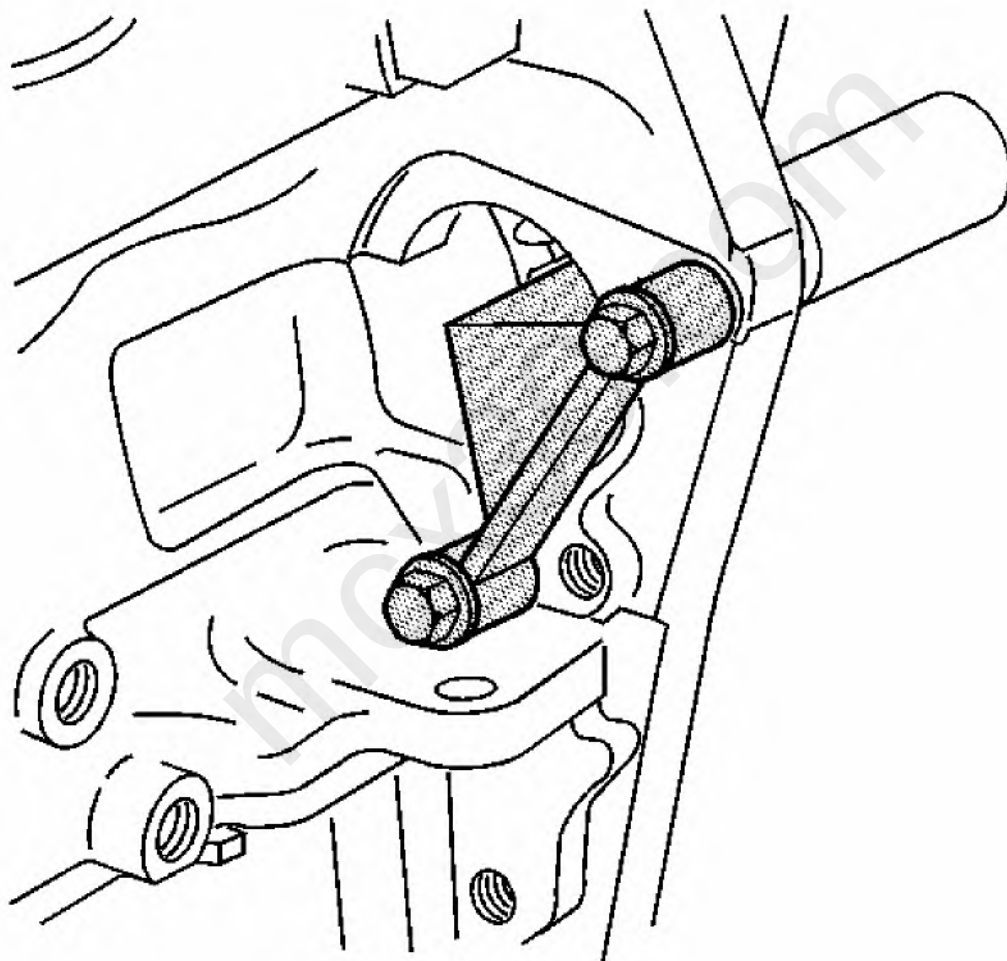


Fig. 192: View Of Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

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

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

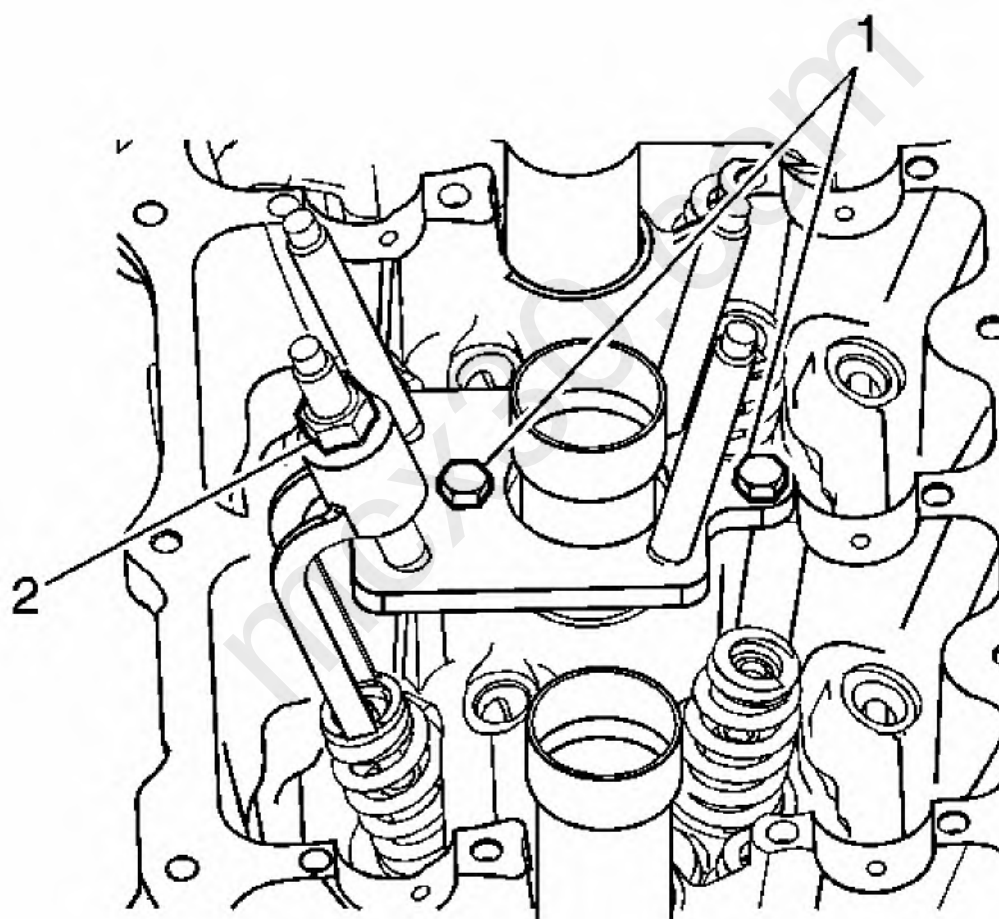


Fig. 193: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not

properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

NOTE: Do not compress the valve springs less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

8. Tighten the EN 46110 valve spring compressor nut (2). See Special Tools .

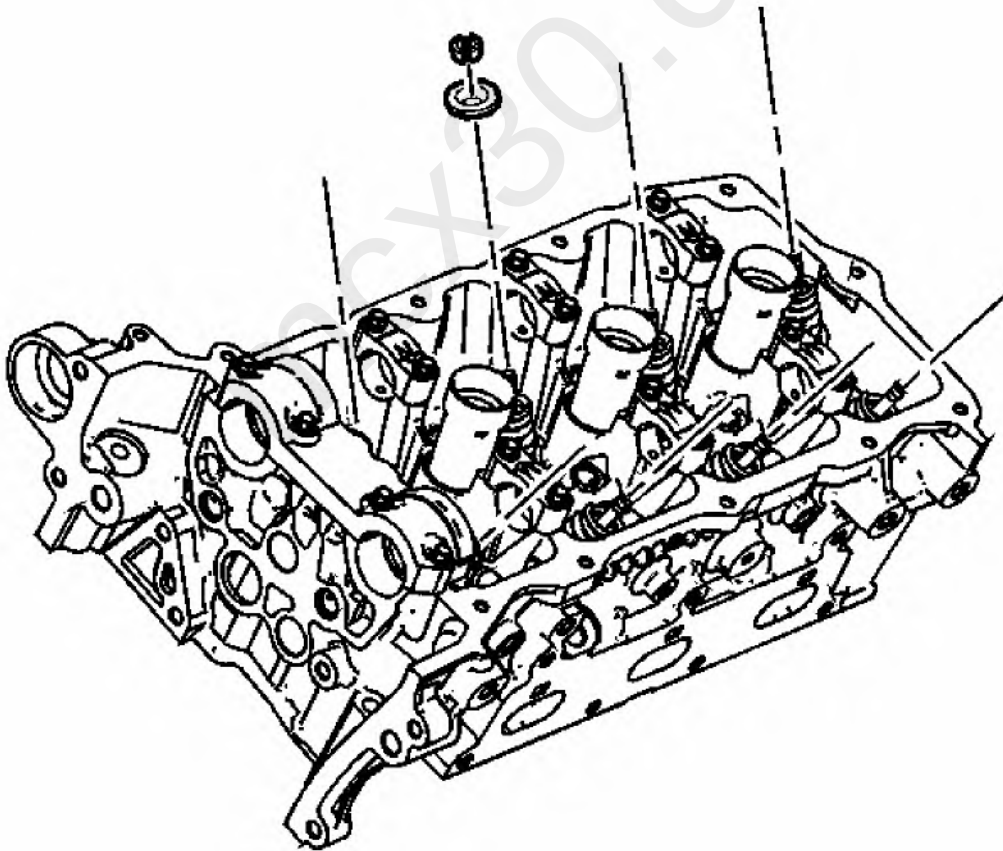


Fig. 194: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Using the **EN 46117** , remove the valve keepers. See **Special Tools** .
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

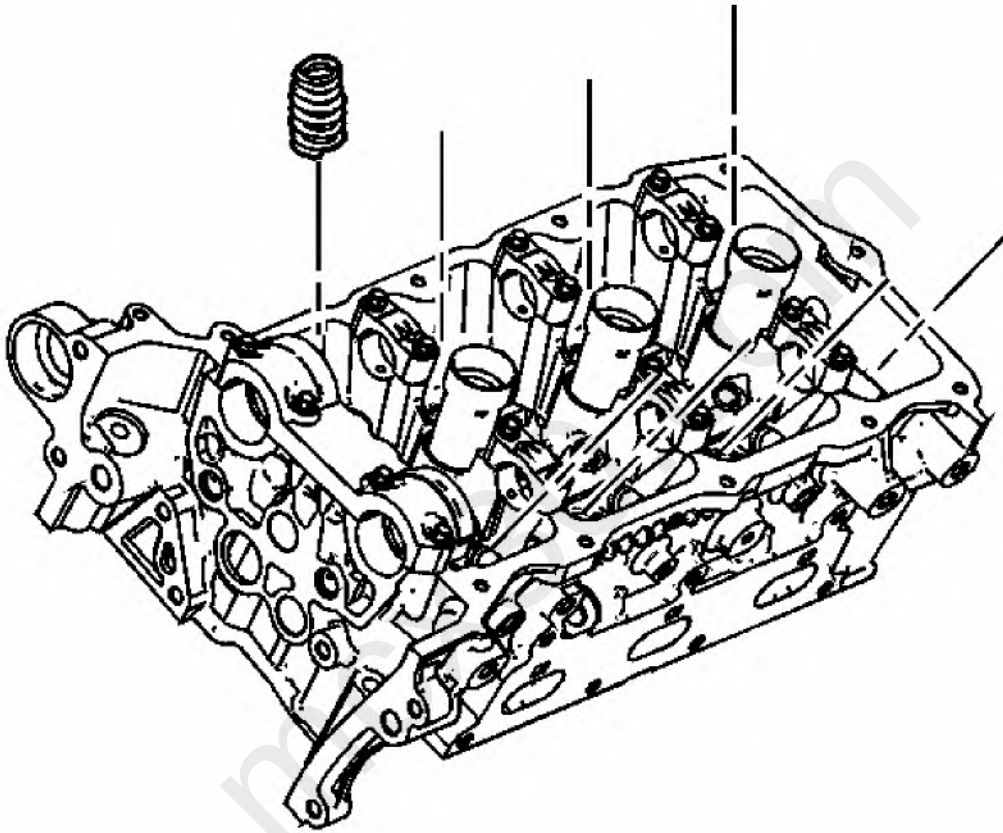


Fig. 195: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve spring.

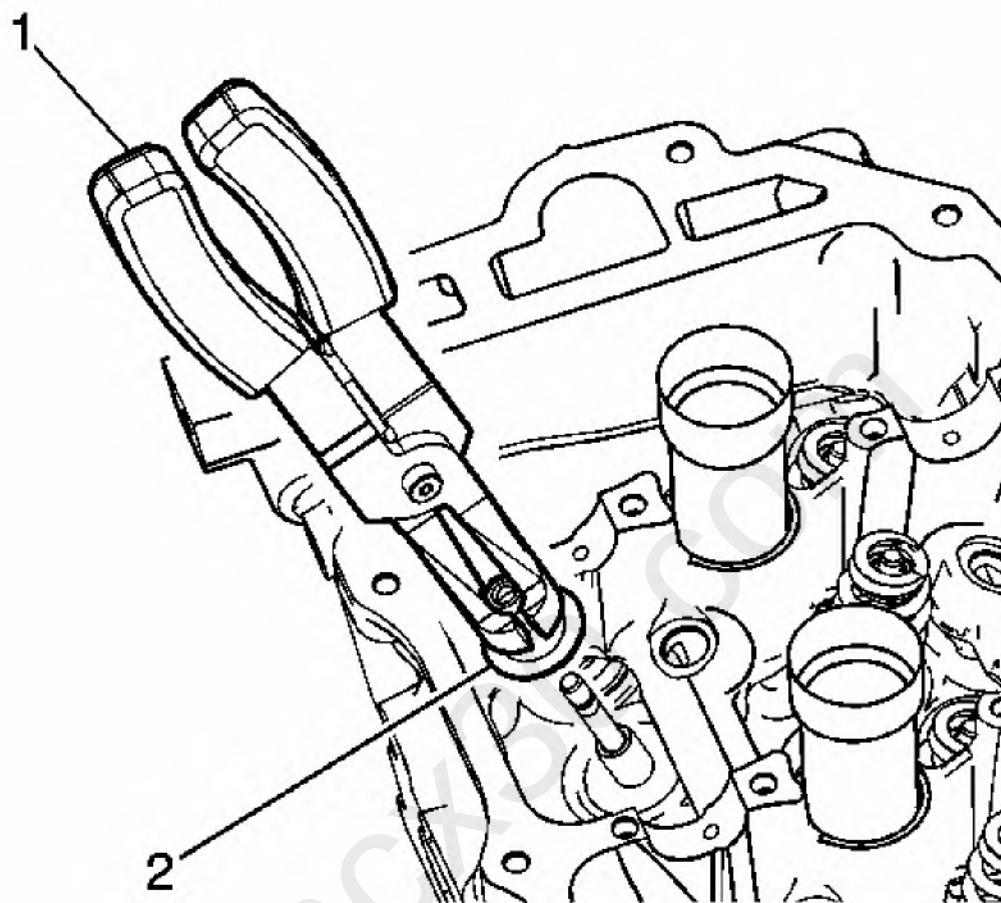


Fig. 196: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

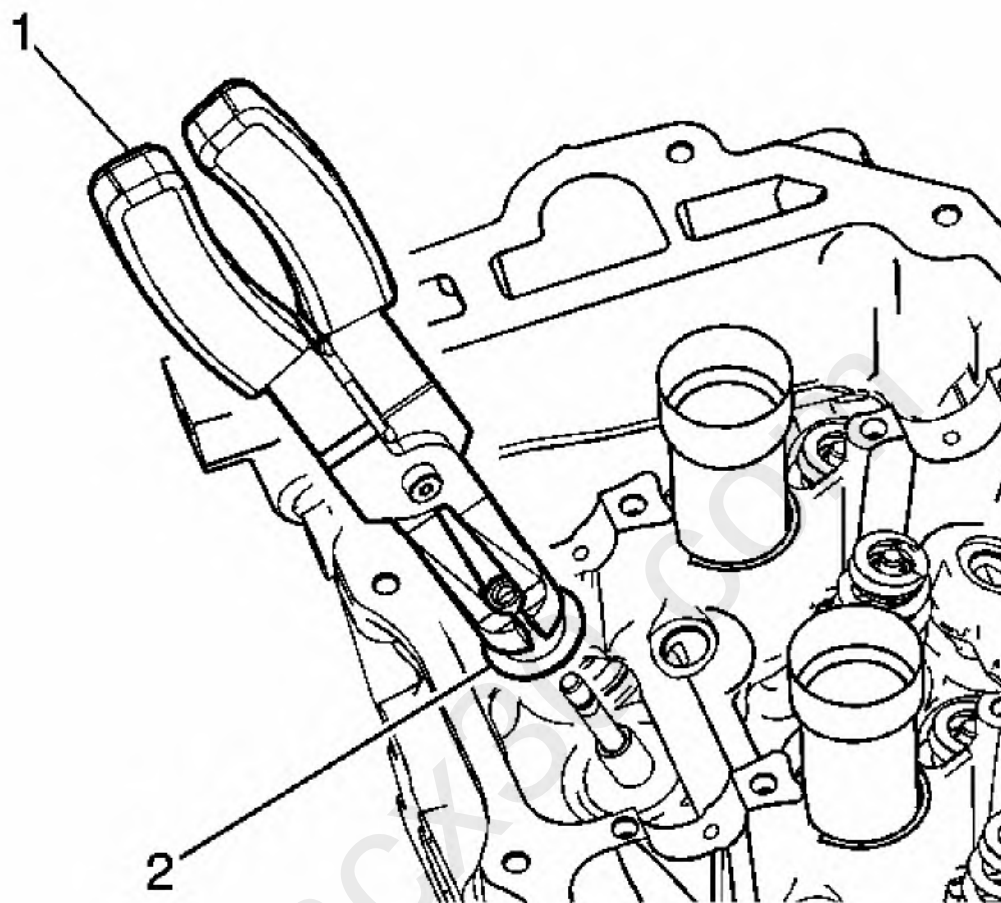


Fig. 197: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

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

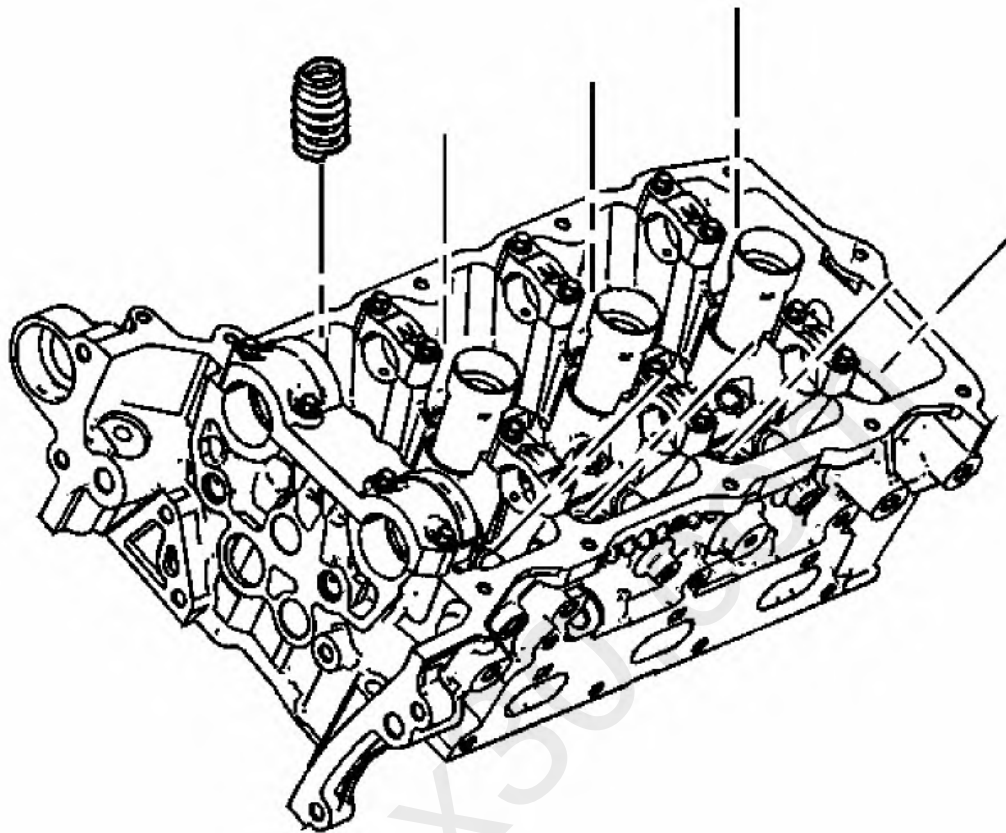


Fig. 198: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

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

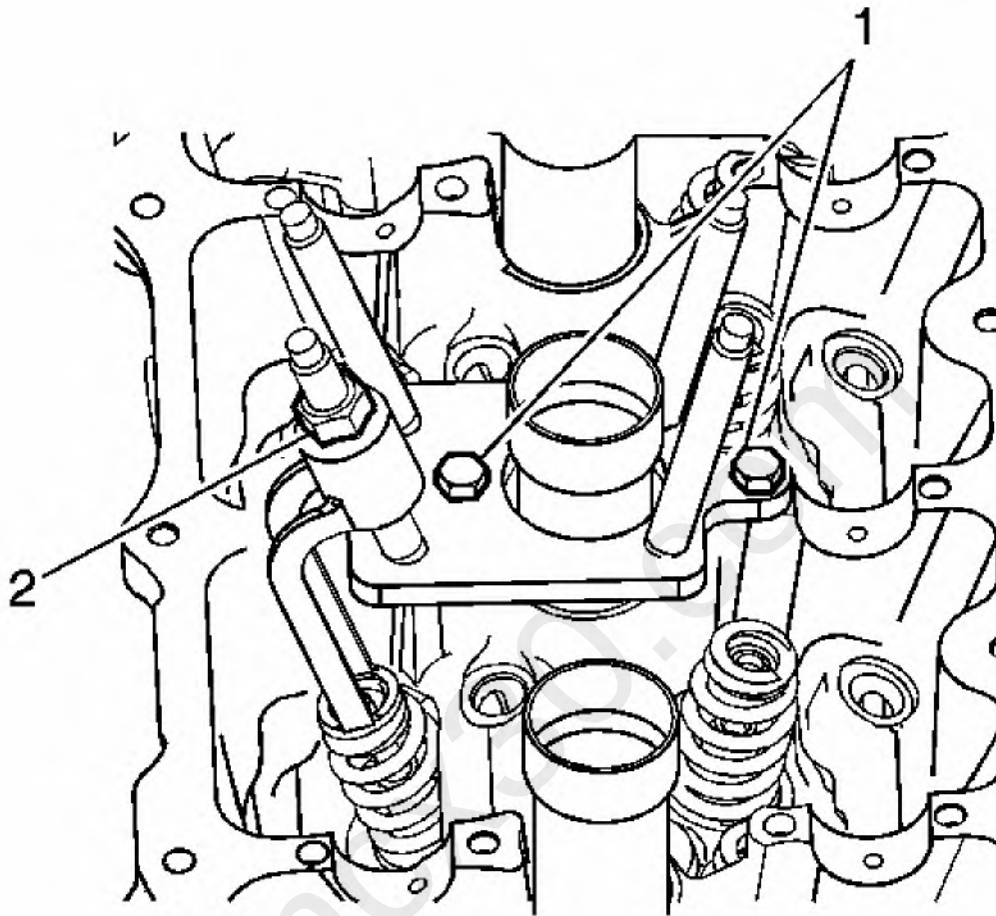


Fig. 199: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

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

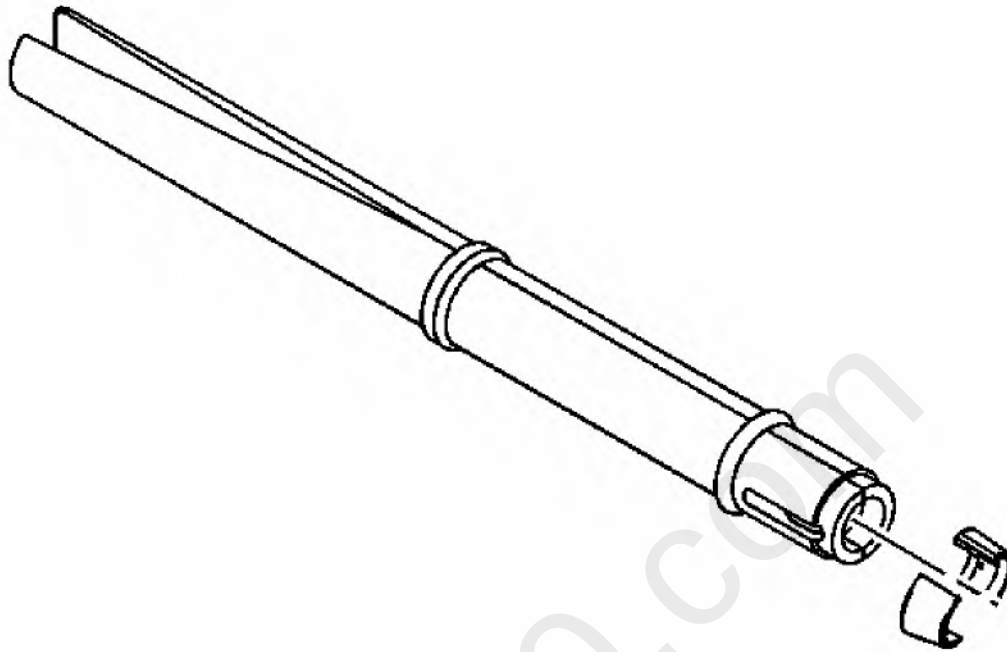


Fig. 200: Installing Valve Keepers With EN 46117
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure proper directional placement of valve keepers in the EN 46117 . See **Special Tools** . The valve keepers must be installed with the tapered end towards the valve stem seal.

5. With the spring compressed, install the valve keepers into the EN 46117 . See **Special Tools** .

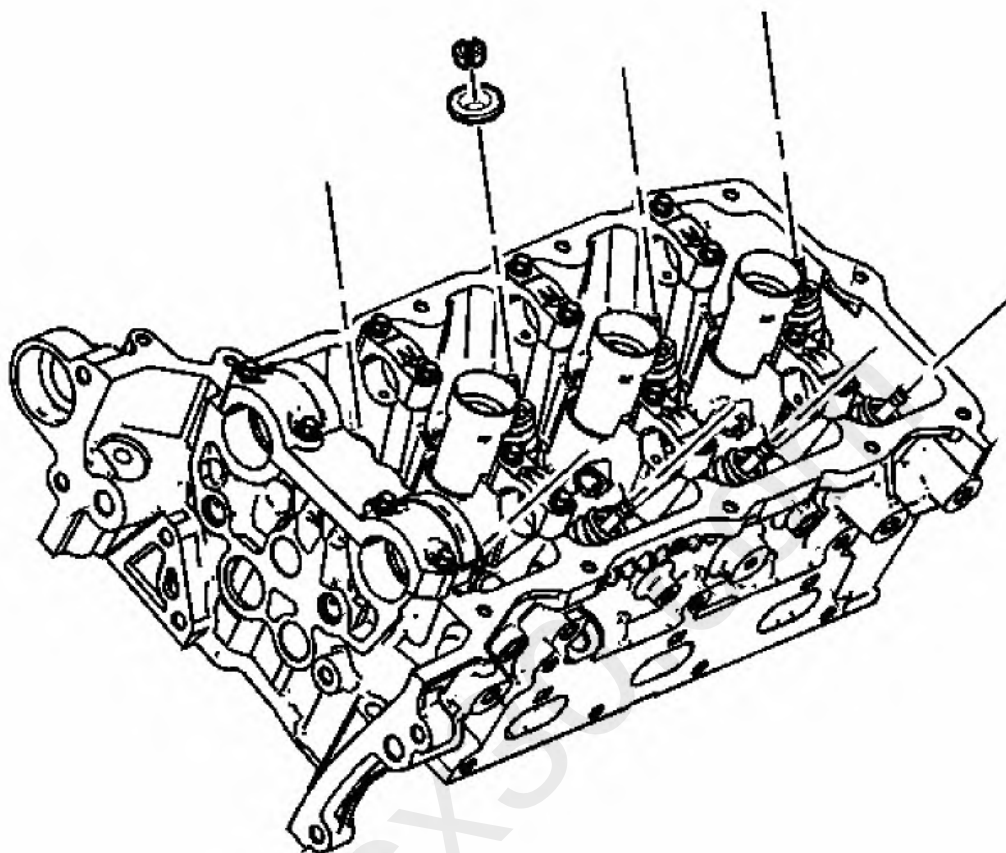


Fig. 201: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

6. Install the valve spring keepers.
7. Remove the **EN 46110** . See Special Tools .
8. Disconnect the **J 39313** from the compressed air source. See Special Tools .
9. Remove the **J 39313** . See Special Tools .
10. Install the spark plugs. Refer to Spark Plug Replacement .
11. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Left Side.
12. Remove the **EN 46106** in order to prevent crankshaft rotation. See Special Tools .
13. Install the starter motor. Refer to Starter Motor Replacement (LY7) or Starter Motor Replacement (LH2) or Starter Motor Replacement (LC3) .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Tools Required

- EN 46106 Flywheel Holding Tool. See Special Tools .
- EN 46110 On-Vehicle Valve Spring Compressor. See Special Tools .
- EN 46116 Valve Stem Seal Remover/Installer. See Special Tools .
- EN 46117 Valve Stem Key Remover/Installer. See Special Tools .
- J 39313 Spark Plug Port Adapter. See Special Tools .

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to Starter Motor Replacement (LY7) or Starter Motor Replacement (LH2) or Starter Motor Replacement (LC3) .

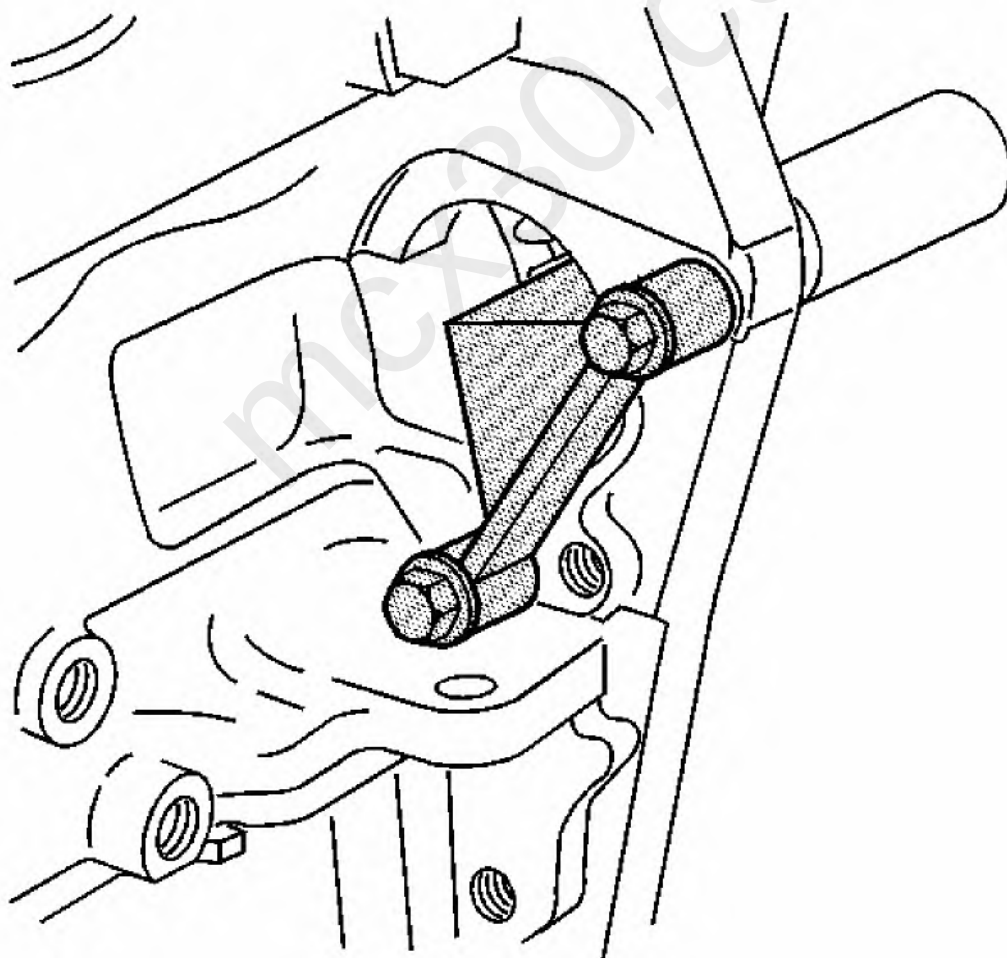


Fig. 202: View Of Tool EN 46106

Courtesy of GENERAL MOTORS CORP.

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

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

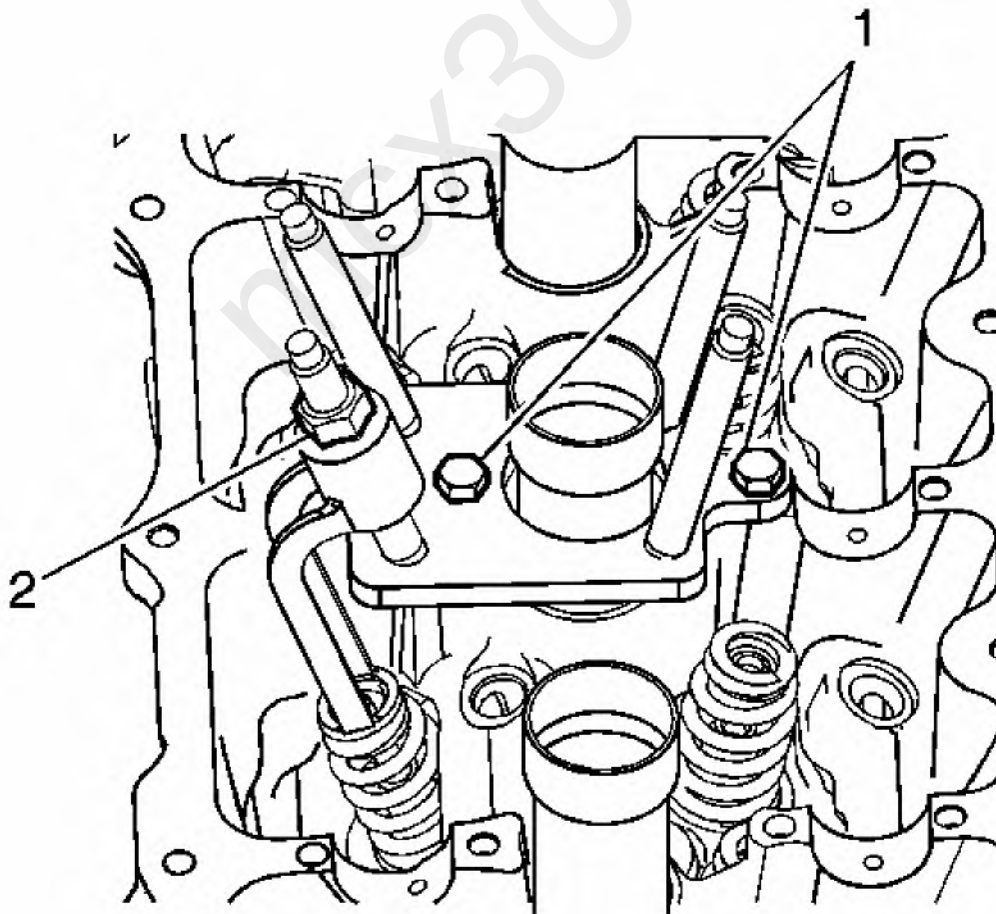


Fig. 203: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

NOTE: Do not compress the valve springs less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

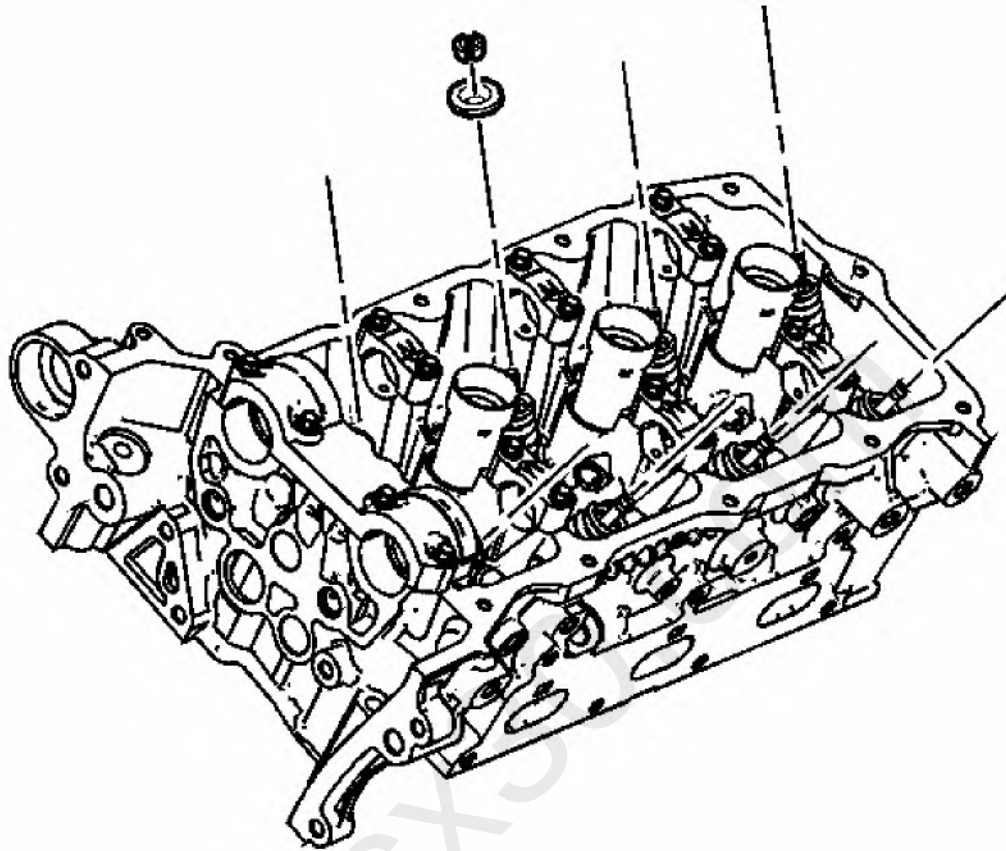


Fig. 204: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Using the **EN 46117** remove the valve keepers. See **Special Tools** .
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

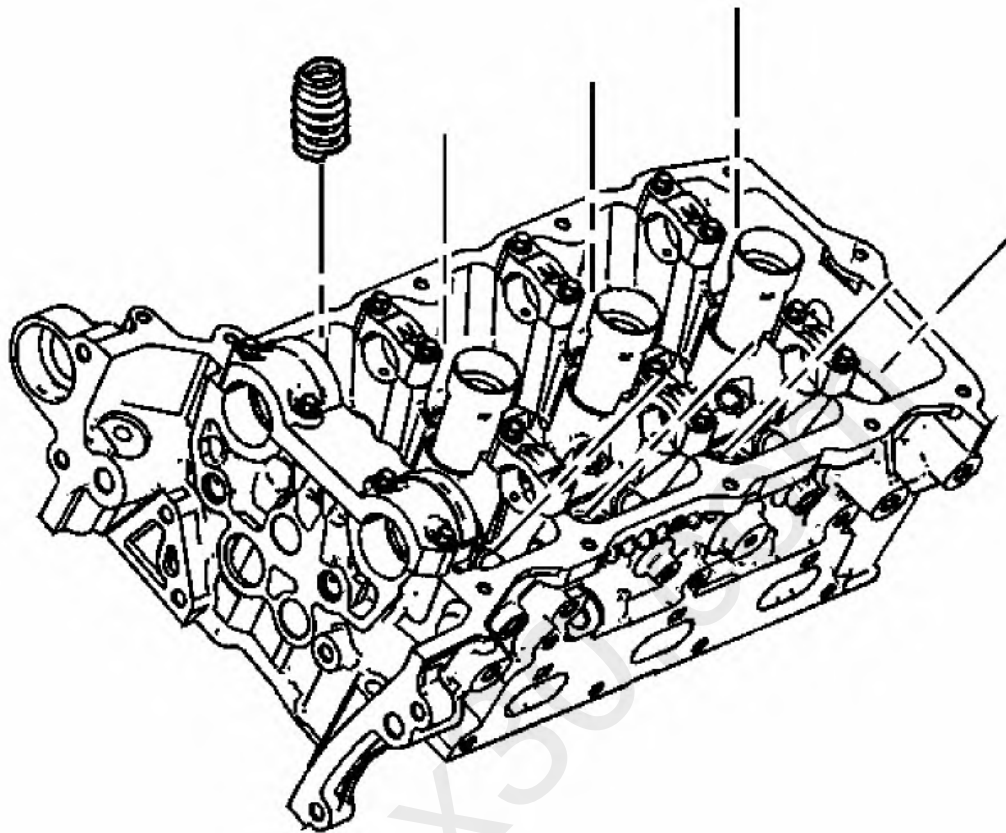


Fig. 205: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve springs.

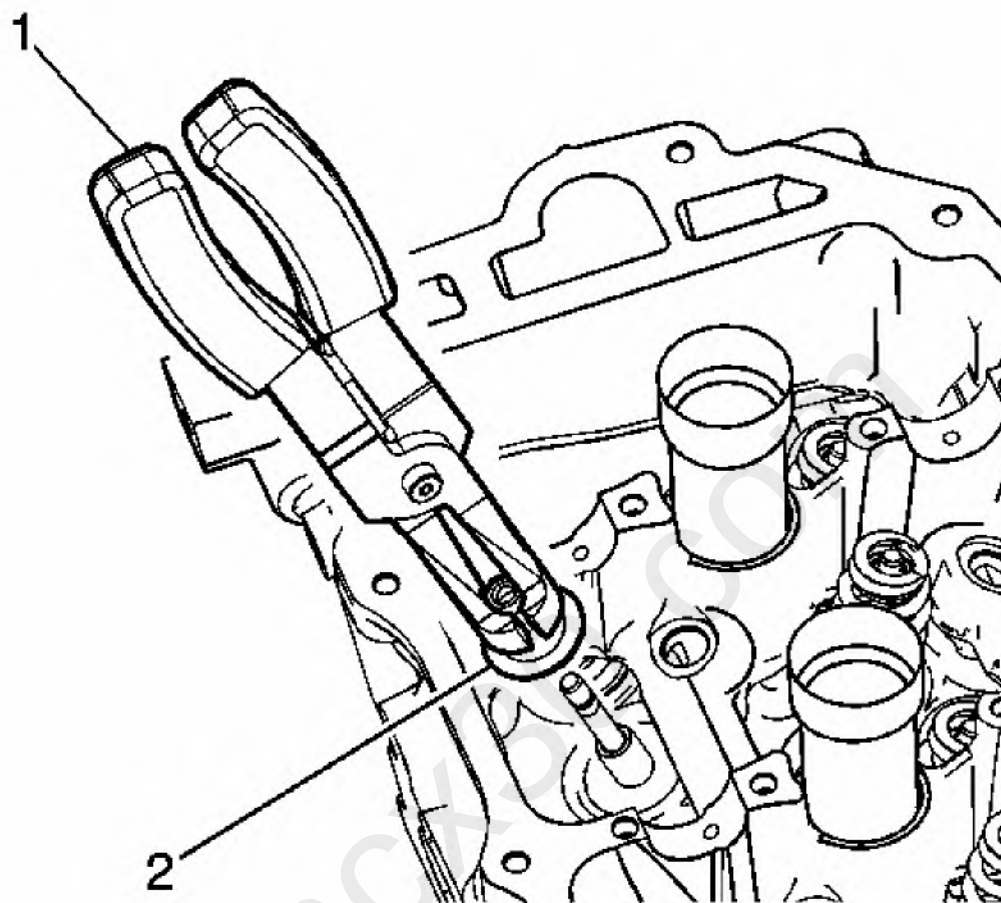


Fig. 206: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

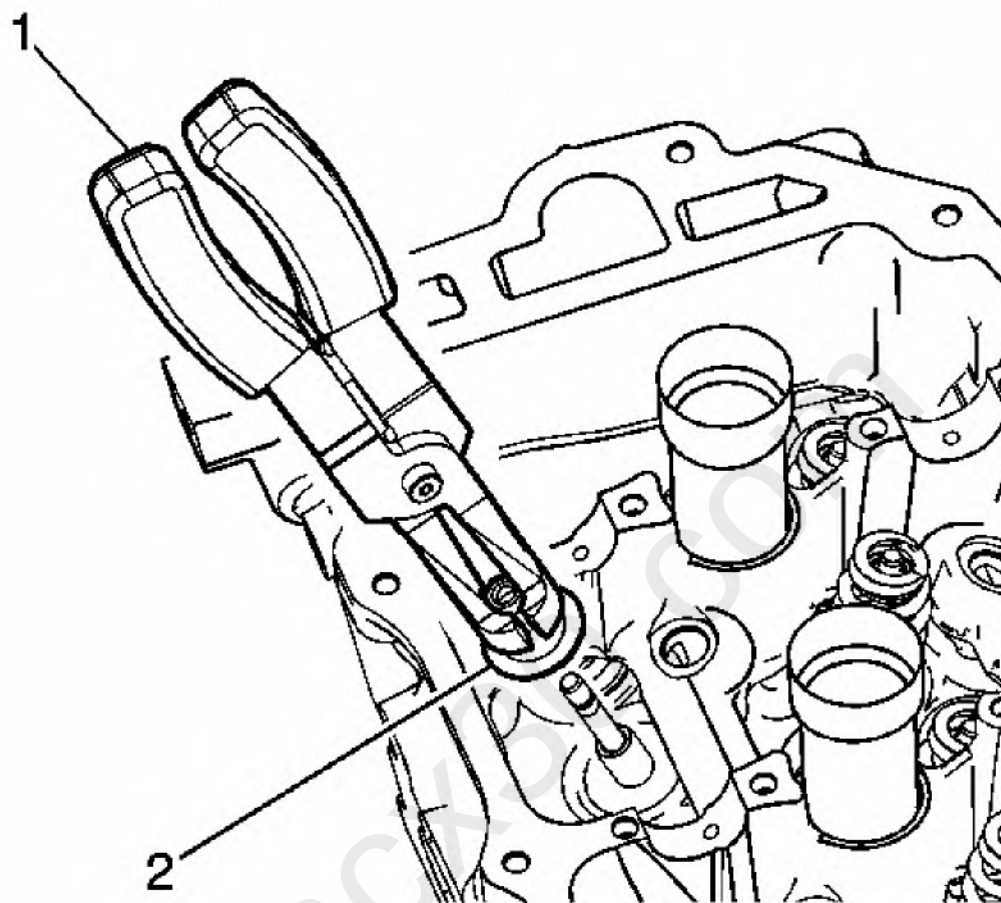


Fig. 207: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

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

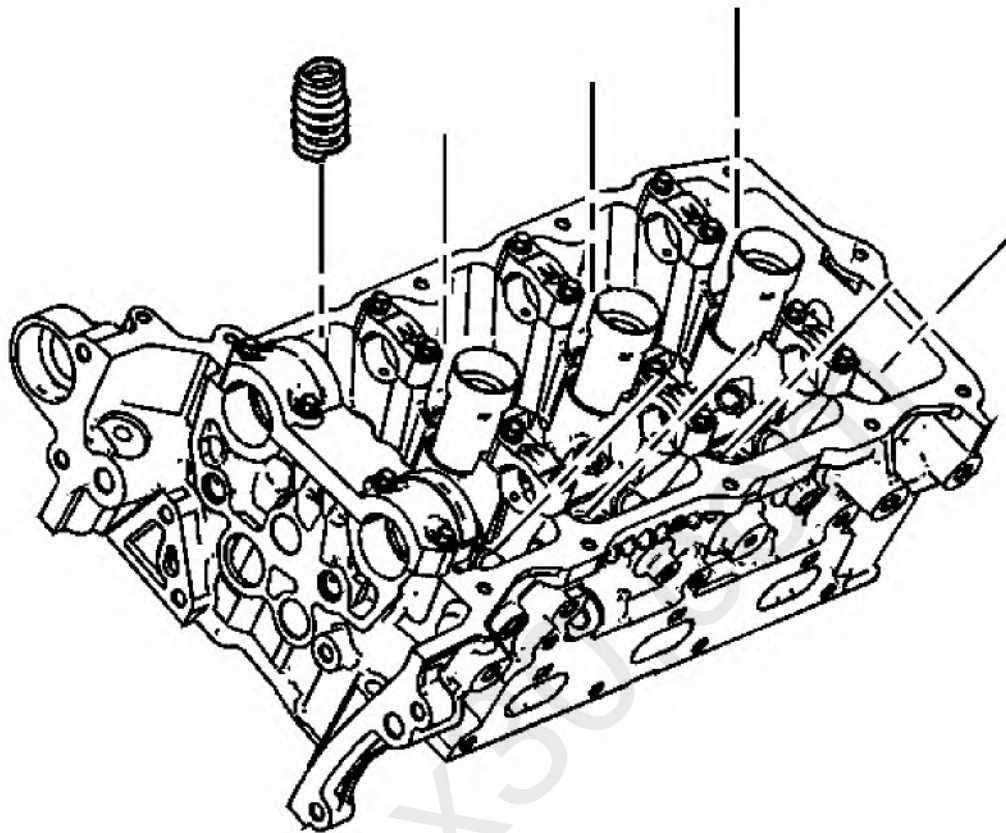


Fig. 208: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

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

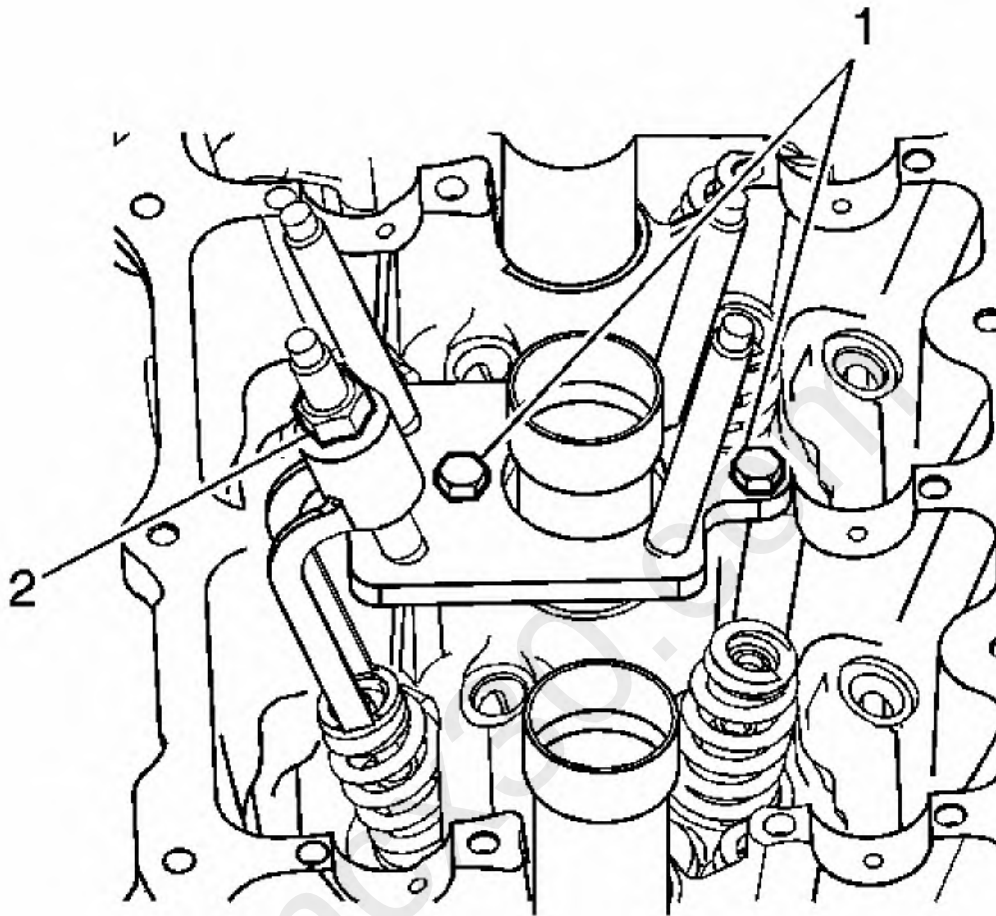


Fig. 209: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

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

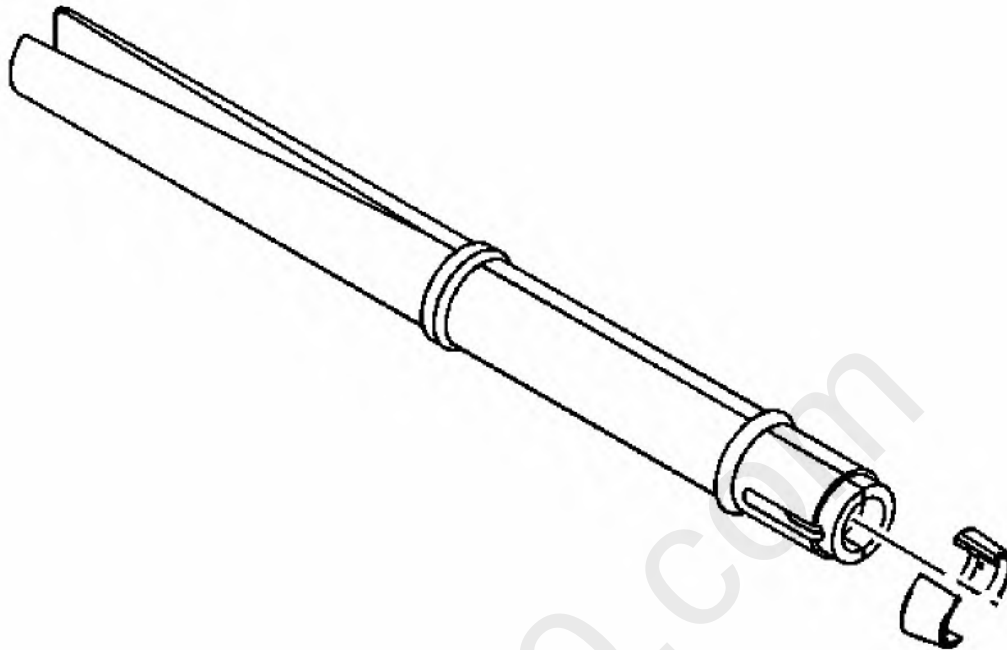


Fig. 210: Installing Valve Keepers With EN 46117
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure proper directional placement of valve keepers in the EN 46117 . See **Special Tools** . The valve keepers must be installed with the tapered end towards the valve stem seal.

5. With the spring compressed, install the valve keepers into the EN 46117 . See **Special Tools** .

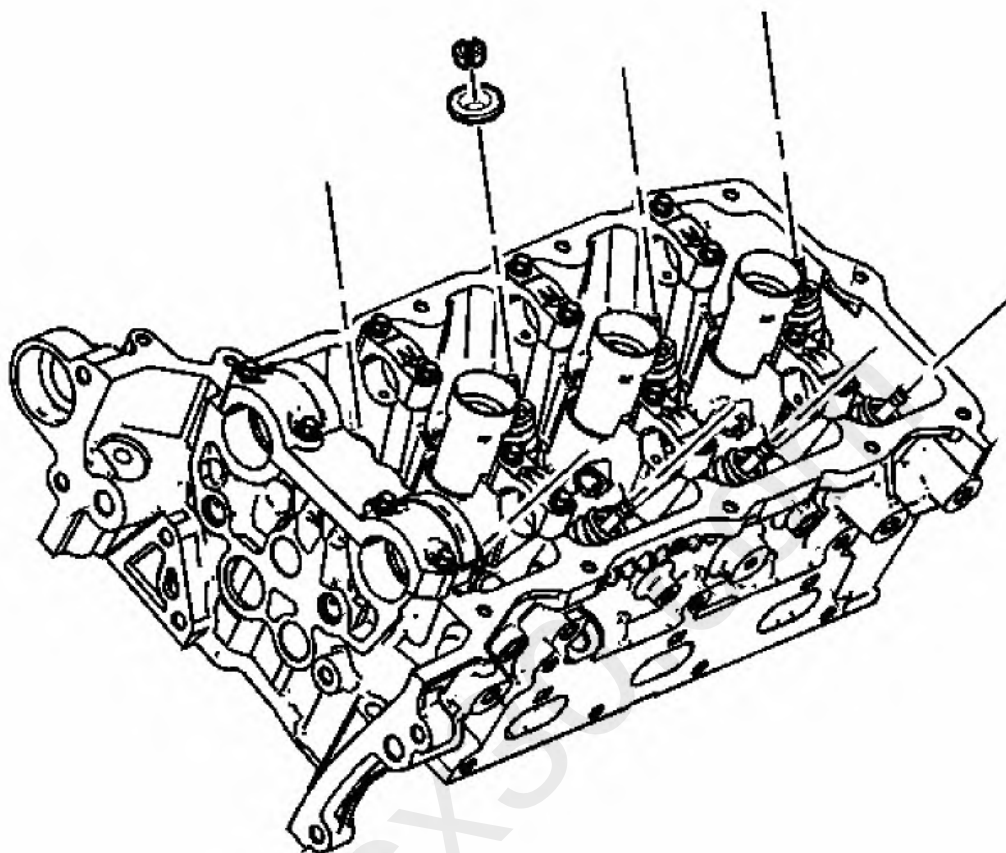


Fig. 211: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

6. Install the valve spring keepers.
7. Remove the **EN 46110** . See **Special Tools** .
8. Disconnect the **J 39313** from the compressed air source. See **Special Tools** .
9. Remove the **J 39313** . See **Special Tools** .
10. Install the spark plugs. Refer to **Spark Plug Replacement** .
11. Install the rocker arms and camshafts. Refer to **Camshaft Replacement - Right Side**.
12. Remove the **EN 46106** . See **Special Tools** .
13. Install the starter motor. Refer to **Starter Motor Replacement (LY7)** or **Starter Motor Replacement (LH2)** or **Starter Motor Replacement (LC3)** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Drive Chain Replacement - Left Side**.
2. Remove the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.

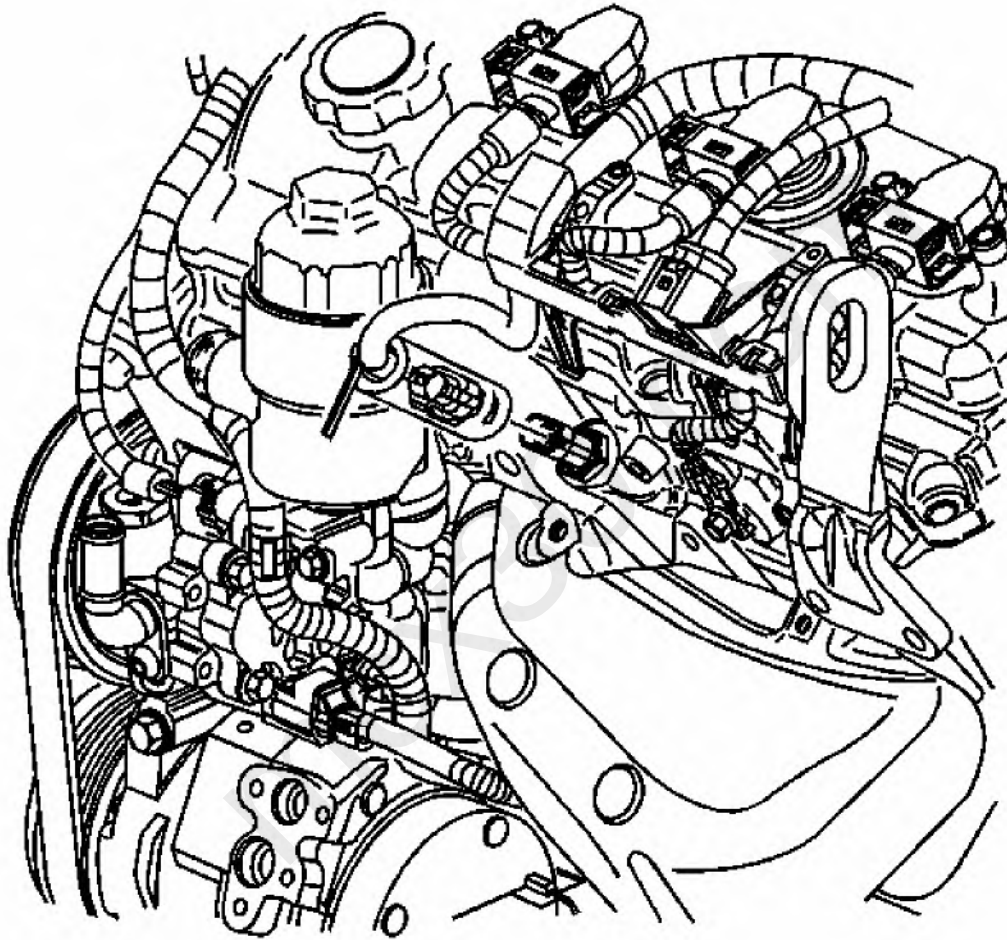


Fig. 212: View Of Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Remove the heat shield from the coolant temperature sensor and disconnect the coolant temperature sensor electrical connector.

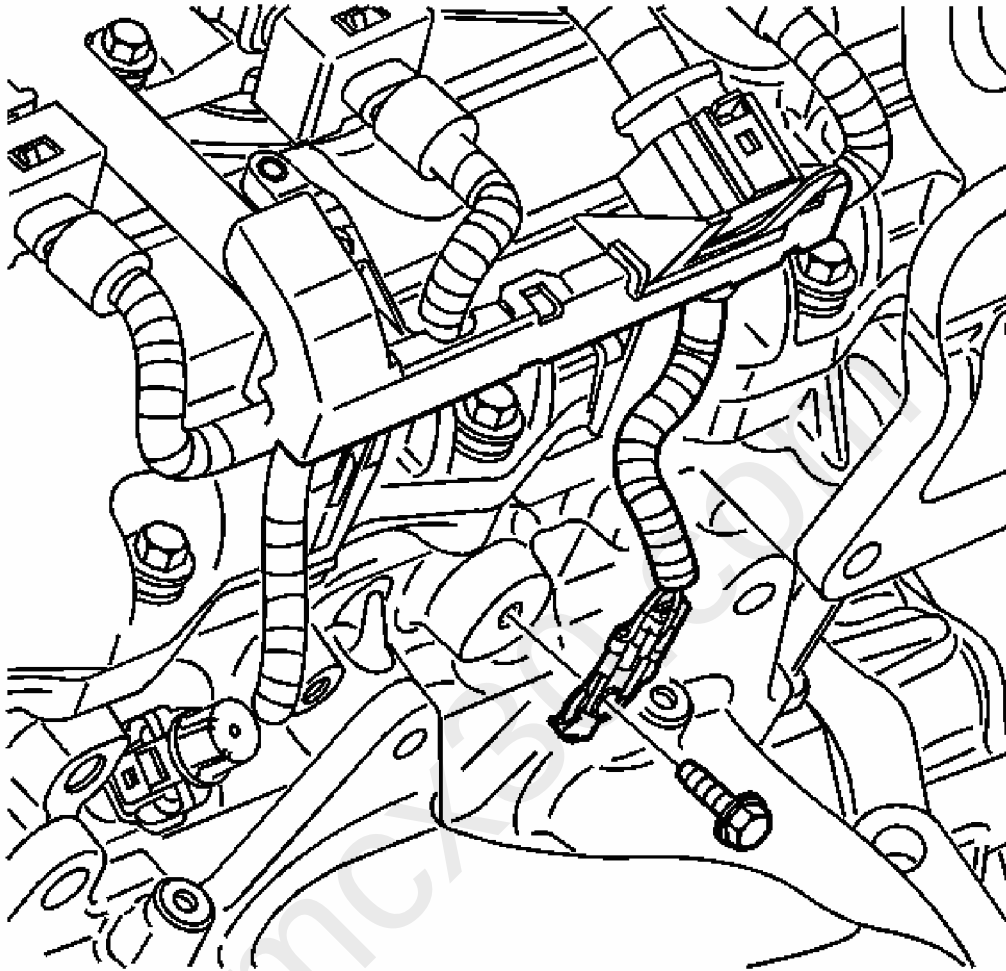


Fig. 213: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness ground from the cylinder head.
5. Disconnect the wiring harness electrical connector located at the side of the cylinder head.
6. Remove the wiring harness connector bracket from the side of the cylinder head.

IMPORTANT: DO NOT disconnect the power steering pipes and/or hoses.

7. Remove the power steering pump bolts. Refer to **Power Steering Pump Removal** .
8. Remove the surge tank hose from the bracket at the rear of the cylinder head.

9. Remove the wiring harness bracket from the rear of the cylinder head.
10. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LY7)**.
11. Remove the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.

IMPORTANT: Do not remove the oil filter adapter.

12. Remove the oil filter adapter upper bolt.

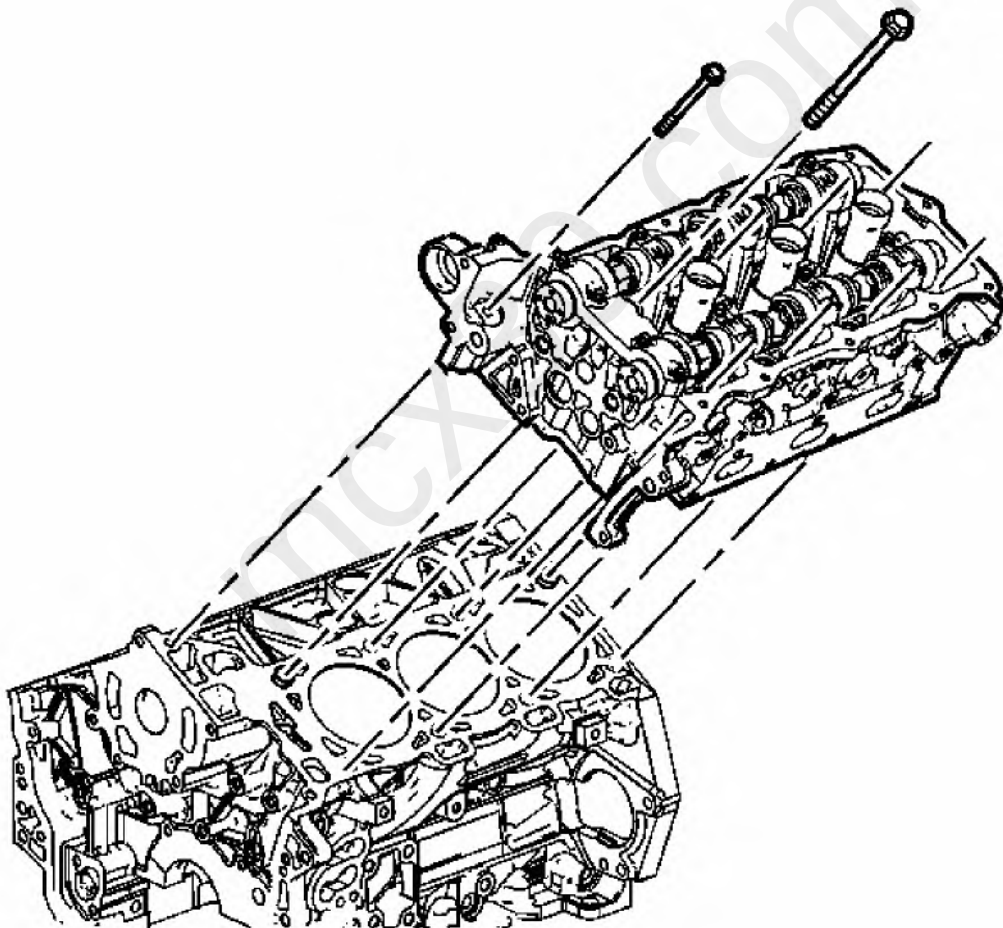


Fig. 214: View Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

13. Remove the cylinder head with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side**.

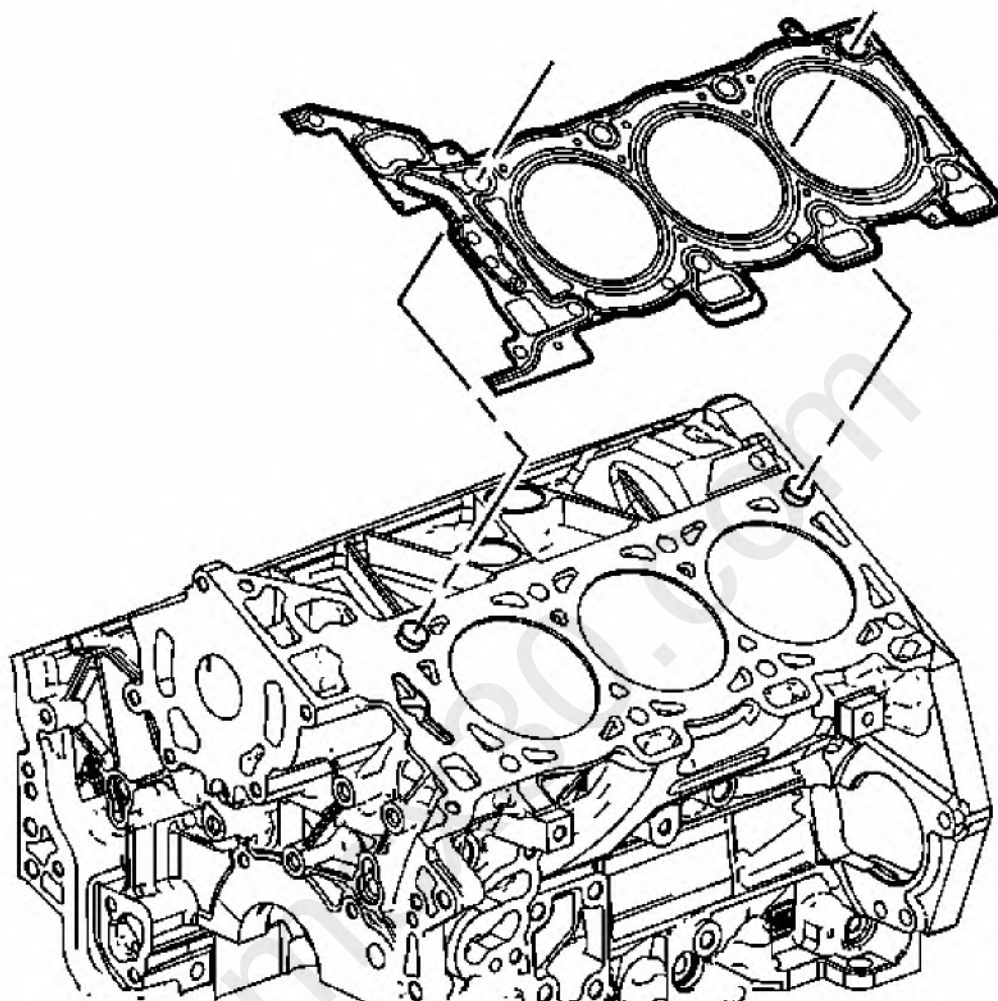


Fig. 215: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

14. Remove and discard the cylinder head gasket.
15. 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**.
16. If necessary, perform the following steps:
 - Remove the exhaust manifold from the cylinder head. Refer to **Exhaust Manifold Removal - Left Side**.
 - Disassemble the cylinder head. Refer to **Cylinder Head Disassemble**.

1. If necessary, perform the following steps:

- Assemble the cylinder head. Refer to **Cylinder Head Assemble** .
- Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Left Side** .

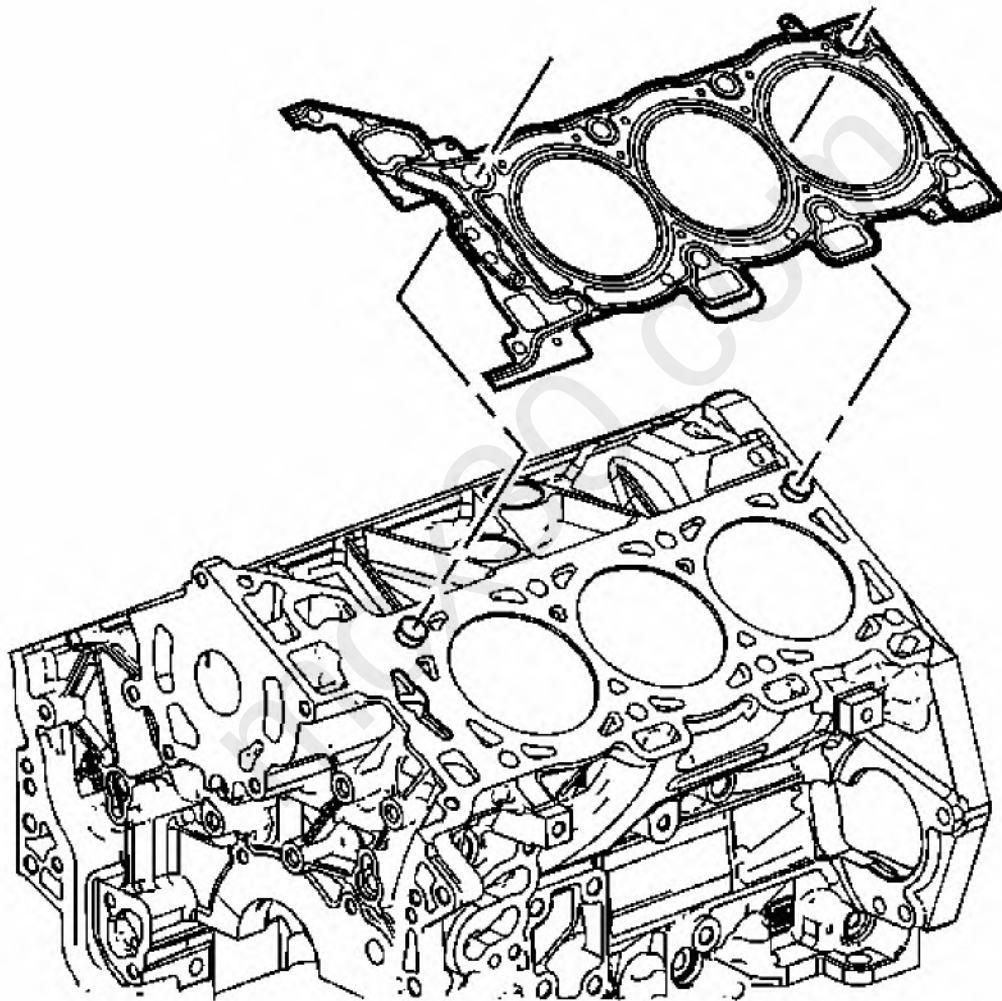


Fig. 216: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.

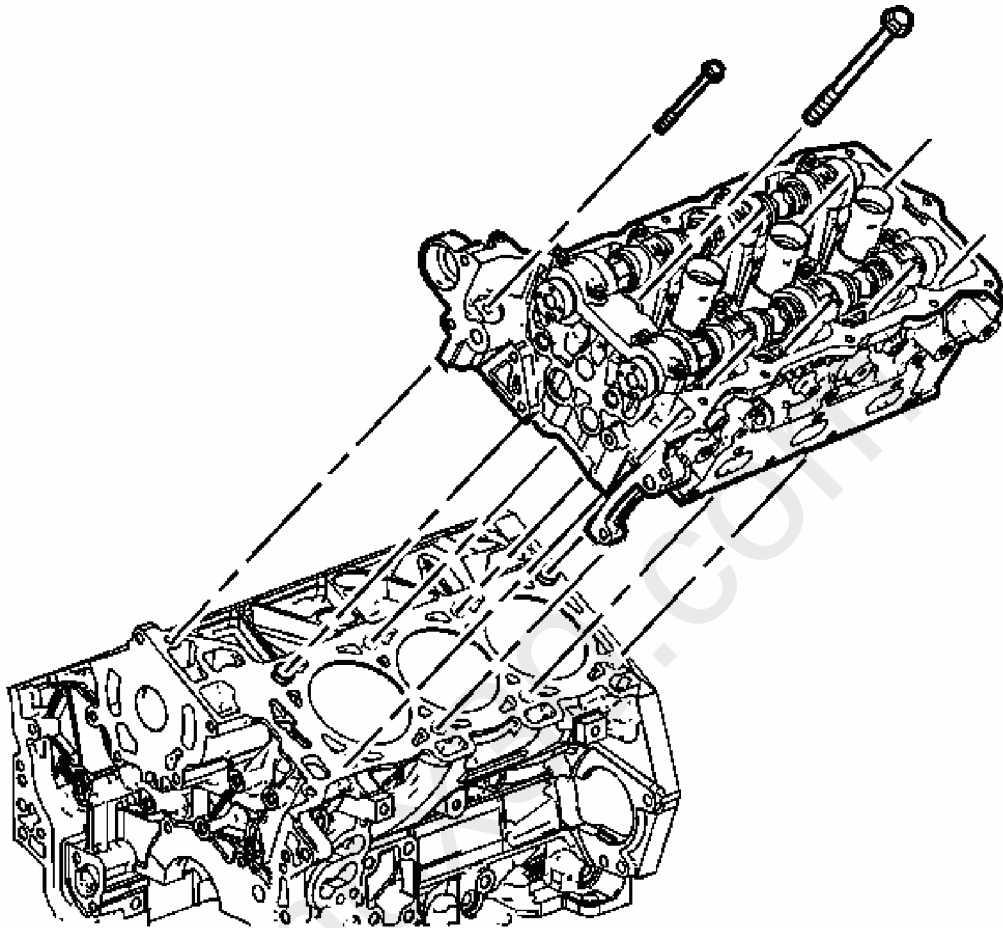


Fig. 217: View Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side** .
4. Install the oil filter adapter upper bolt. Refer to **Oil Filter Adapter Installation** .
5. Install the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.
6. Install the catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (LY7)** .
7. Install the wiring harness bracket to the rear of the cylinder head.
8. Install the surge tank hose to the bracket at the rear of the cylinder head.
9. Install the power steering pump bolts. Refer to **Power Steering Pump Installation** .
10. Install the wiring harness connector bracket from the side of the cylinder head.
11. Disconnect the wiring harness electrical connector located at the side of the cylinder

head.

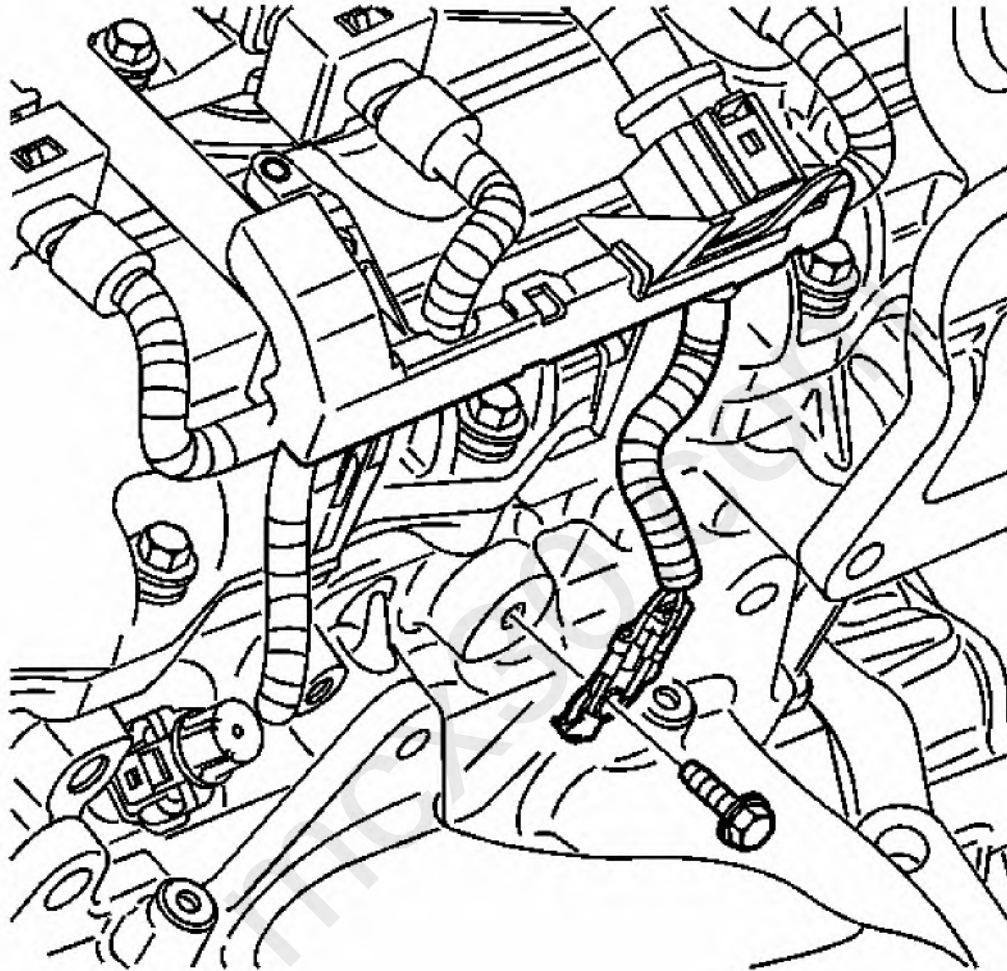


Fig. 218: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

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

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

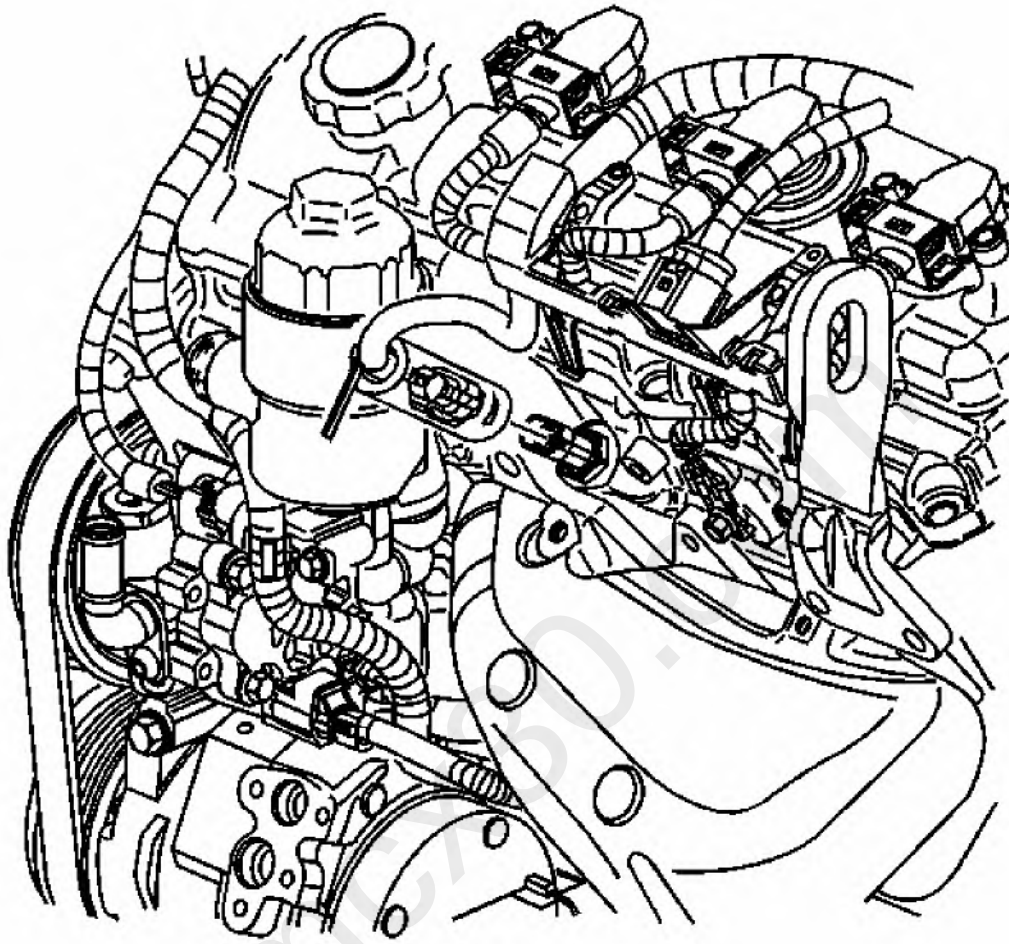


Fig. 219: View Of Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Install the coolant temperature sensor electrical connector heat shield.
14. Install the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.
15. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Drive Chain Replacement - Left Side**.