2011 ENGINE

Engine Mechanical - 4.6L - Repair Instructions - On Vehicle - Lucerne

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

Removal Procedure

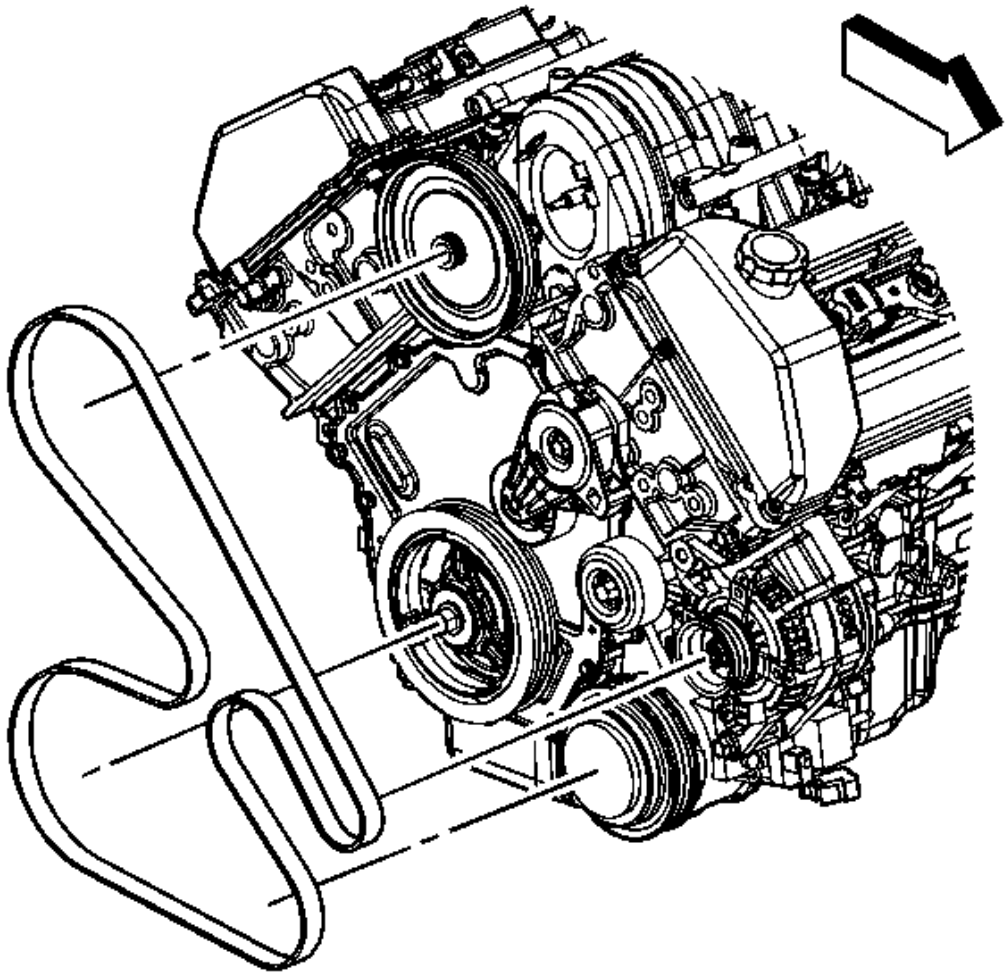


Fig. 1: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

 © 2011 Mitchell Repair Information Company, LLC.

1. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
2. Install a 1/2 inch drive breaker to the drive belt tensioner.
3. Push down on the breaker bar in order to release the tension.
4. Remove the drive belt from the power steering pump.
5. Slowly return the tensioner to the original position.
6. Remove the belt from the lower pulley and idlers.
7. Partially raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

Installation Procedure

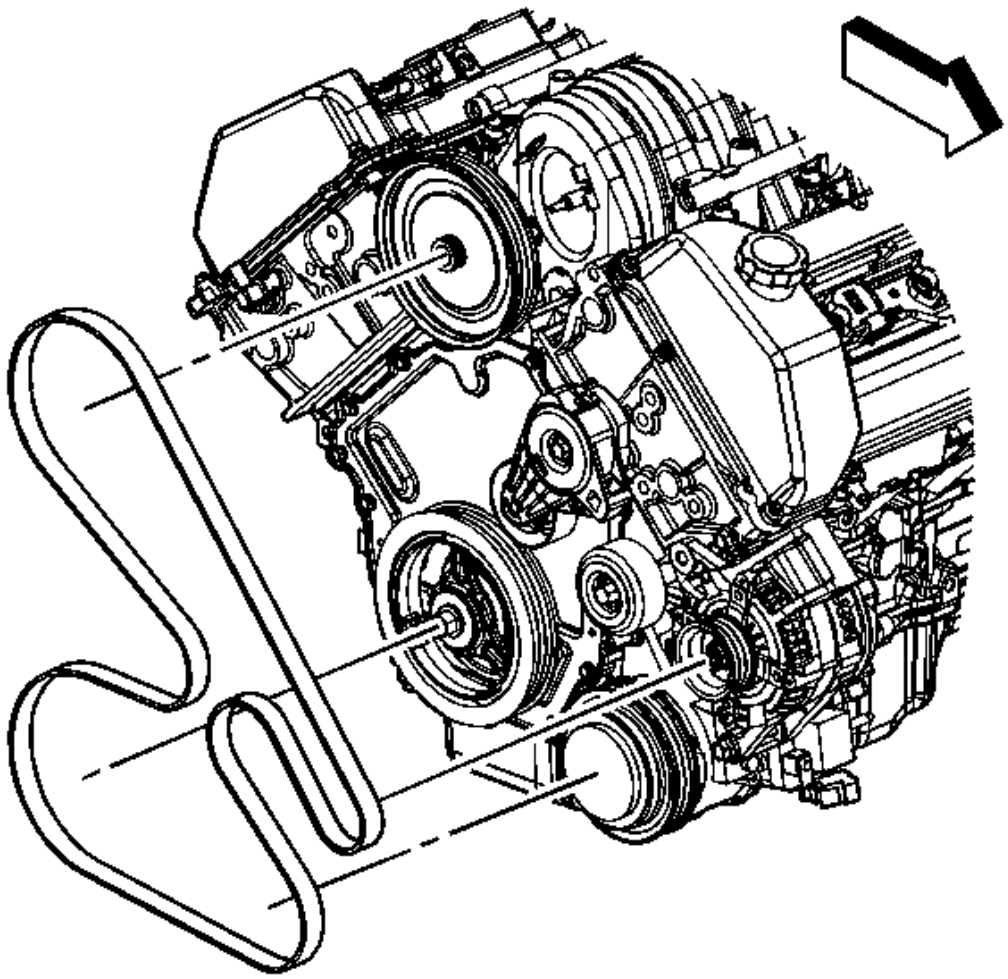


Fig. 2: Identifying Drive Belt Routing

 © 2011 Mitchell Repair Information Company, LLC.

Courtesy of GENERAL MOTORS COMPANY

1. Route the drive belt around all the pulleys except for the power steering pump.
2. Lower the vehicle.
3. Install a 1/2 inch drive breaker bar to the drive belt tensioner.
4. Push down on the breaker bar in order to release the tension and route the belt around the power steering pump pulley.

   Ensure the belt is seated on all pulleys.

5. Slowly return the tensioner to its original position.
6. After drive belt installation, inspect the drive belt for the proper routing and correct alignment.
7. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
8. Start the engine and check for proper belt and accessory operation.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

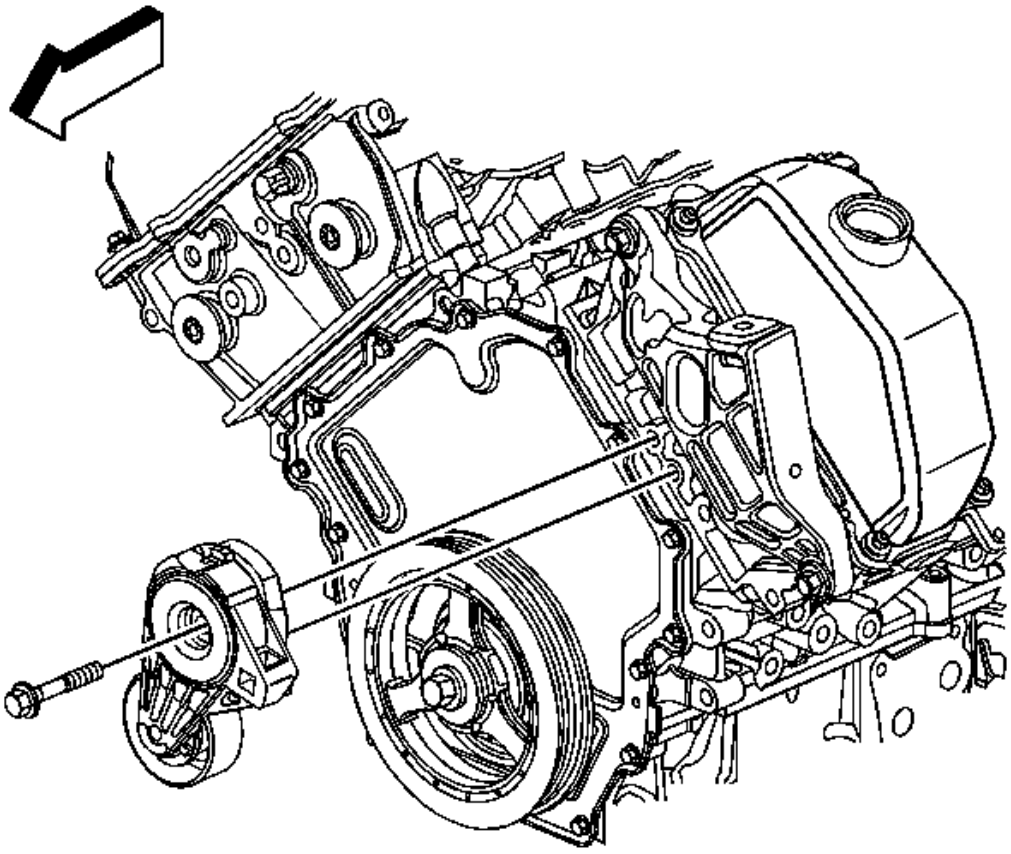


Fig. 3: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
4. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
5. Disconnect the A/C compressor suction hose from the A/C evaporator hose. Discard seal and reposition hose.
6. Remove the drive belt tensioner bolt.
7. Remove the drive belt tensioner.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

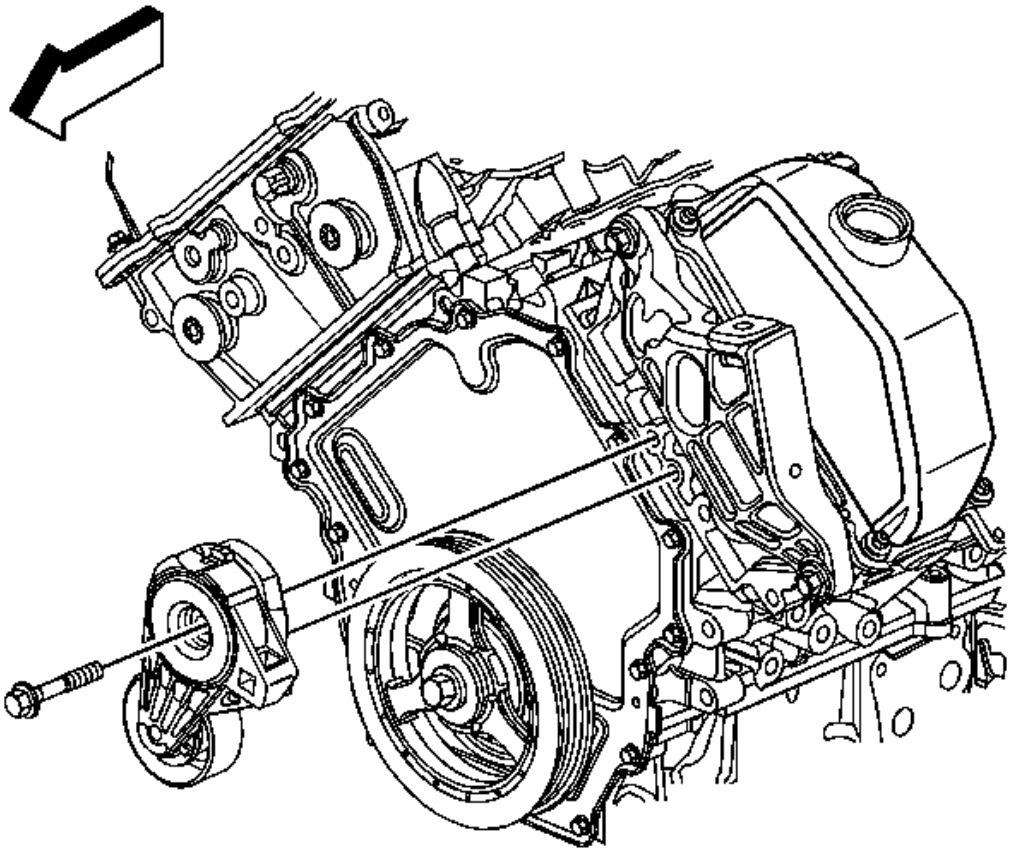


Fig. 4: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Position the drive belt tensioner to the left cylinder head. Ensure the anti-rotation pin is in the hole.

   CAUTION: Refer to Fastener Caution .

2. Install the drive belt tensioner bolt.

   Tighten

   Tighten the bolt to 50 N.m (37 lb ft).

3. Install the drive belt. Refer to **Drive Belt Replacement**.
4. Install new seal. Connect the A/C compressor suction hose to the A/C evaporator hose.

 © 2011 Mitchell Repair Information Company, LLC.

5. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
6. Install the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

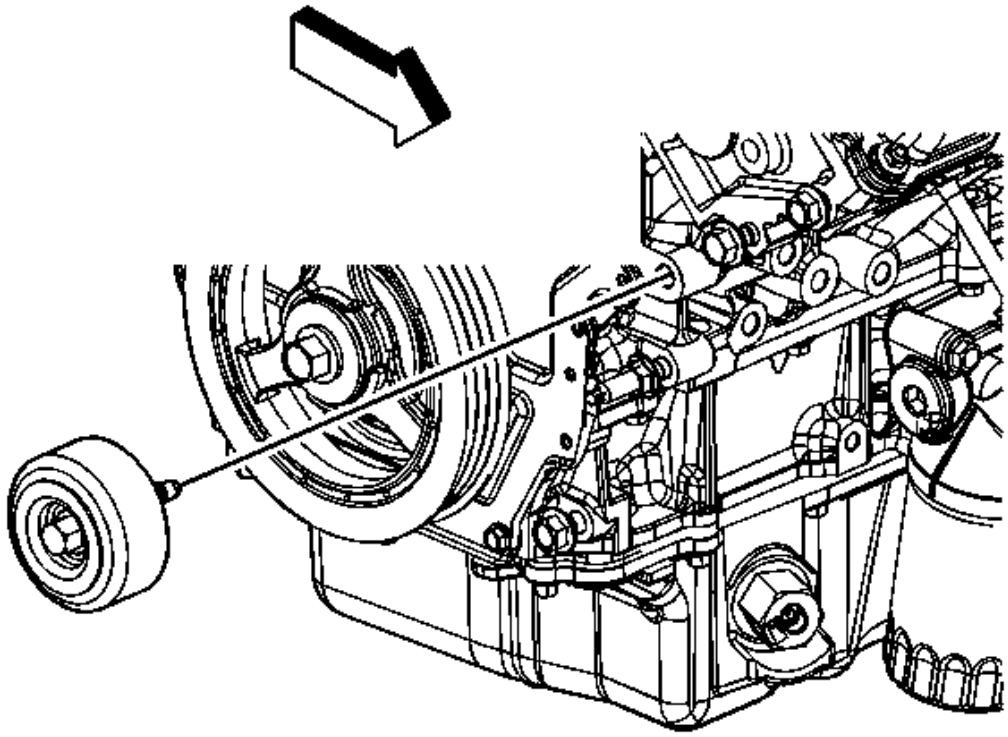


Fig. 5: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

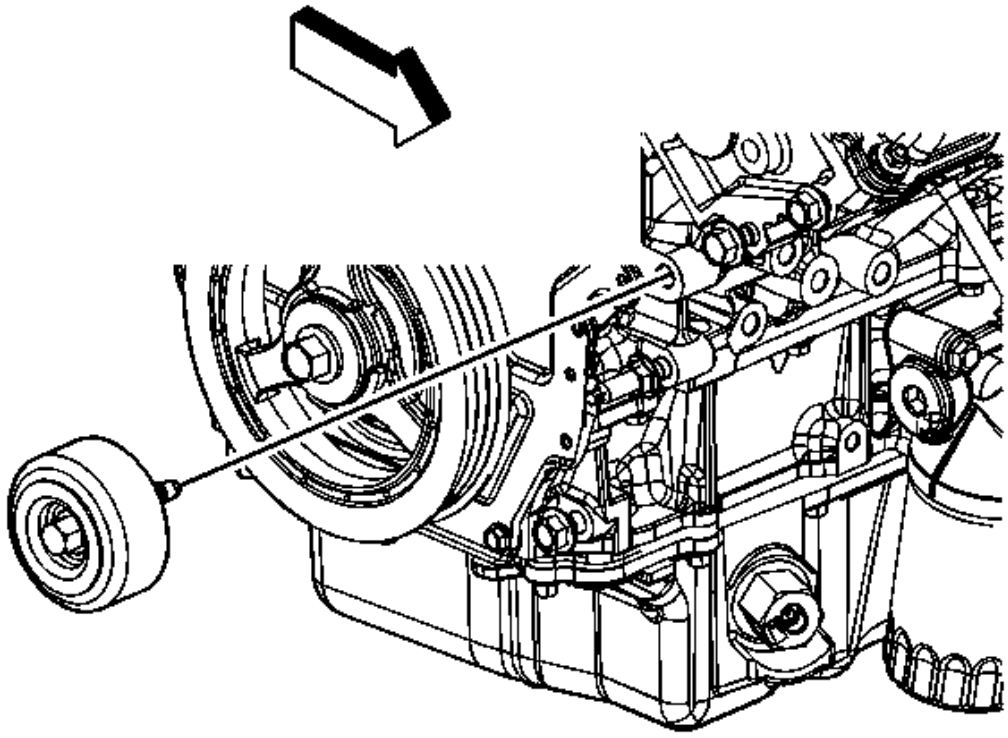


Fig. 6: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

1. Position the drive belt idler pulley to the engine and finger starter the pulley bolt.

   CAUTION: Refer to Fastener Caution .

2. Tighten the drive belt idler pulley bolt.

   Tighten

   Tighten the bolt to 50 N.m (37 lb ft).

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

ENGINE SUPPORT FIXTURE

Special Tools

 © 2011 Mitchell Repair Information Company, LLC.

- **J 28467-B** Universal Engine Support Fixture
- **J 28467-501** Engine Support Fixture Adapters

Installation Procedure

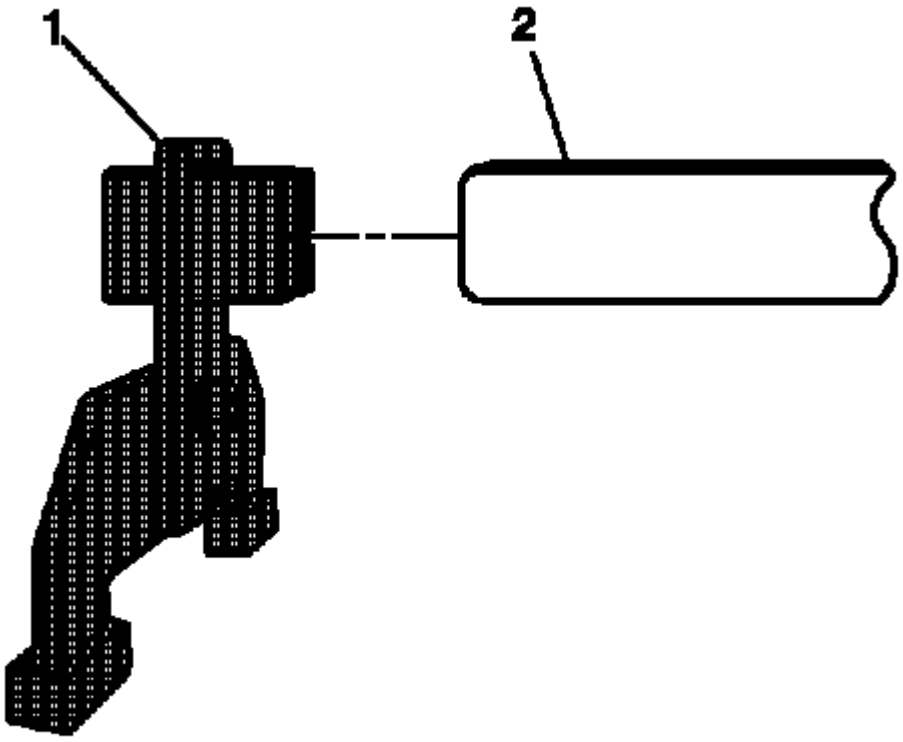


Fig. 7: Universal Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air inlet grille. Refer to **Air Inlet Grille Panel Replacement** .
2. Install the J 28467-3 strut tower tube (2) into the **J 28467-501** (1).

 © 2011 Mitchell Repair Information Company, LLC.

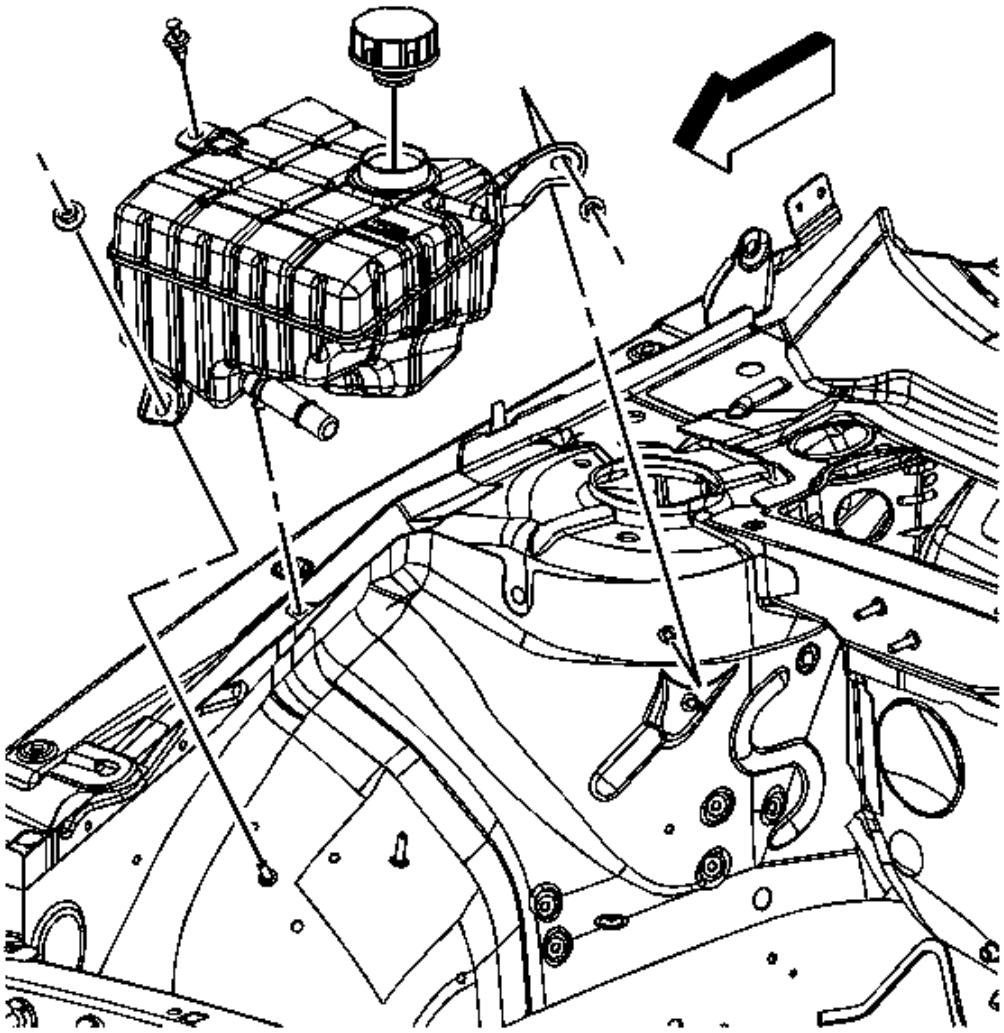


Fig. 8: Identifying Surge Tank
Courtesy of GENERAL MOTORS COMPANY

3. Remove the surge tank nuts and push pin retainer.
4. Remove the surge tank from the studs and position the tank aside.

 © 2011 Mitchell Repair Information Company, LLC.

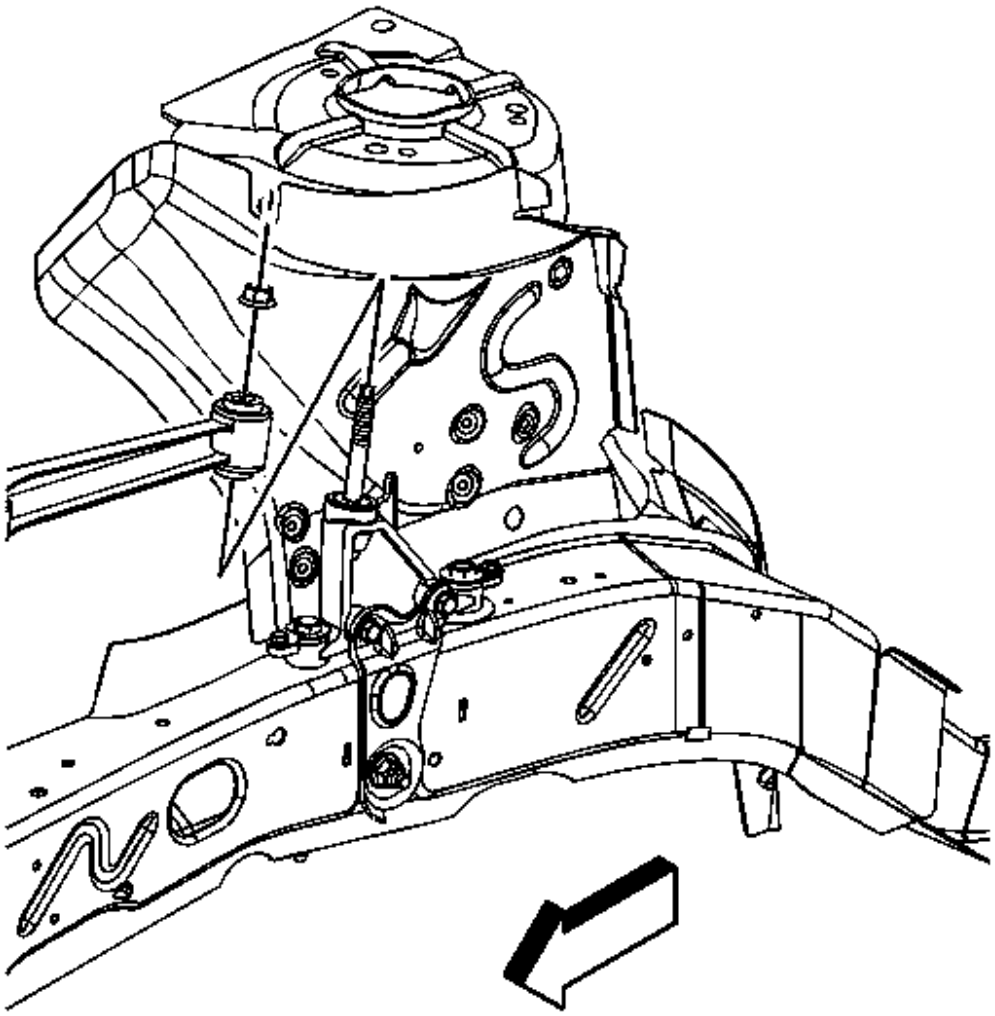


Fig. 9: Engine Mount Strut Brace Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine mount strut brace nut.

 © 2011 Mitchell Repair Information Company, LLC.

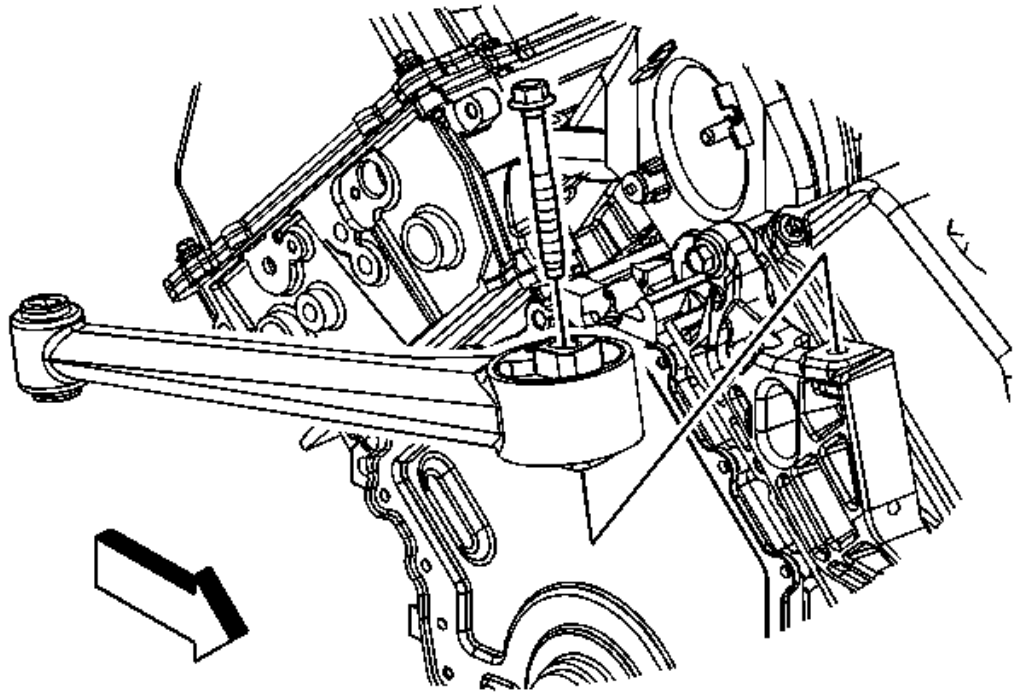


Fig. 10: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine mount strut bolt.
7. Remove the engine mount strut.
8. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

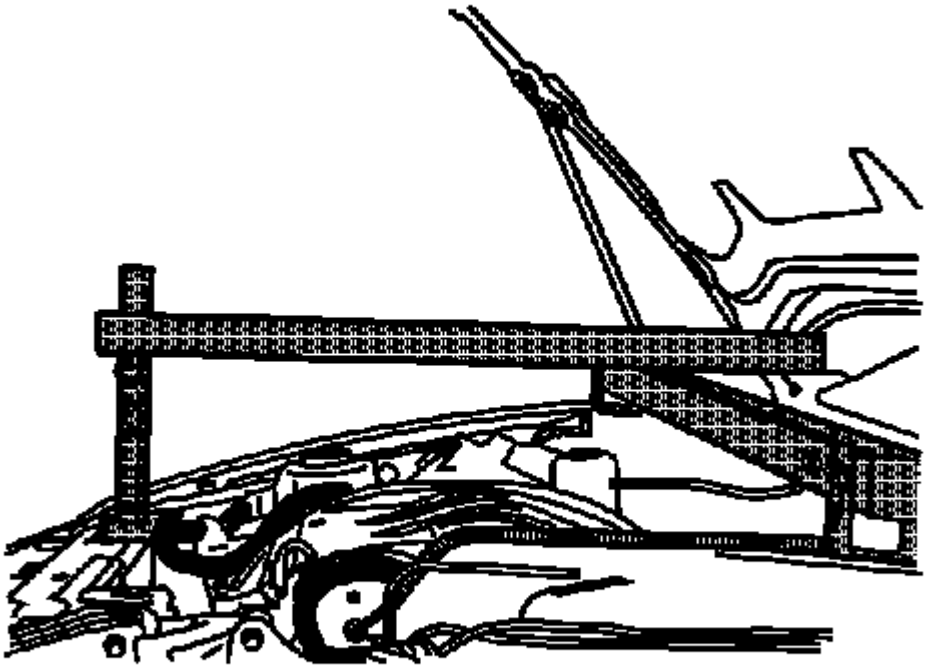


Fig. 11: View of Radiator Shelf Tube & Strut Tower Tube
Courtesy of GENERAL MOTORS COMPANY

9. Install the J 28467-2A radiator shelf tube on top of the J 28467-3 strut tower tube.

 © 2011 Mitchell Repair Information Company, LLC.

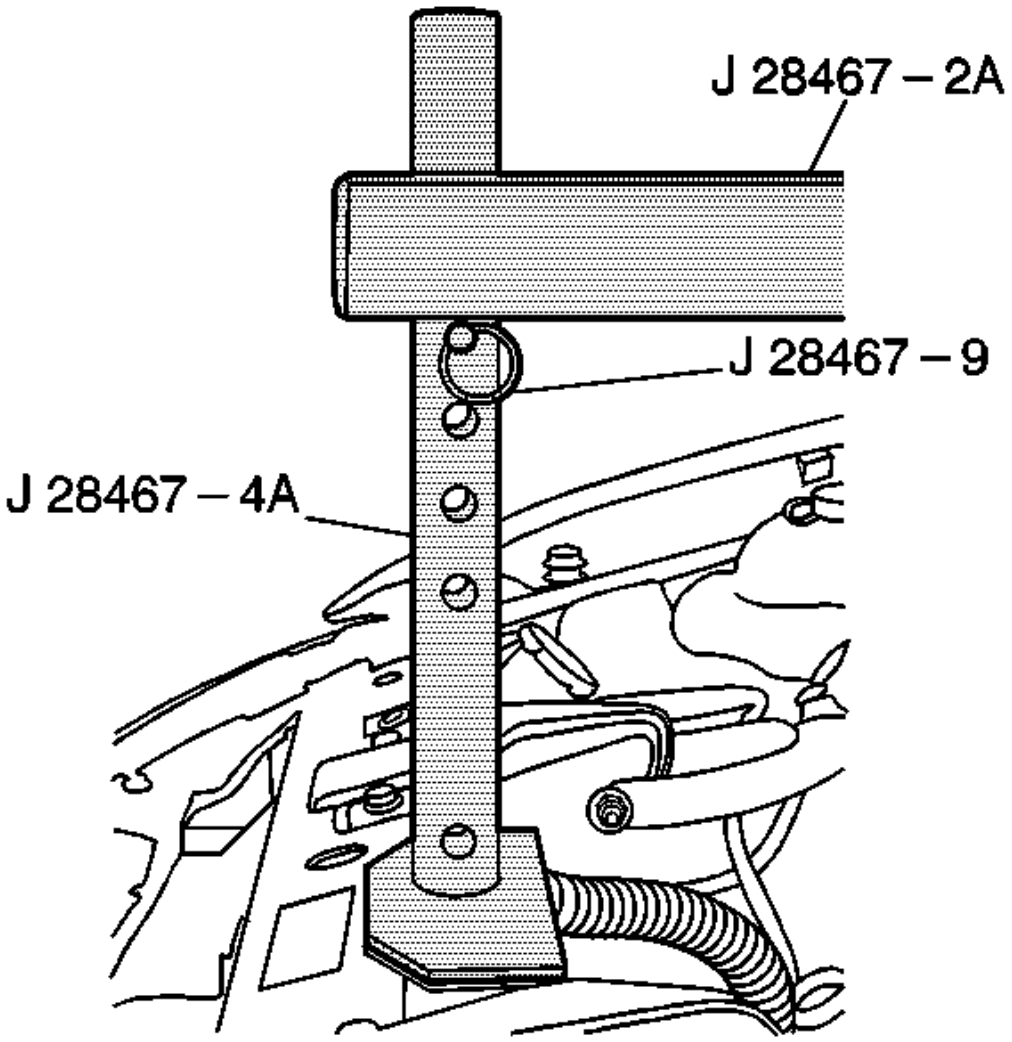


Fig. 12: Positioning Front Engine Support Assembly
Courtesy of GENERAL MOTORS COMPANY

10. Install the round tube of the J 28467-4A front support assembly through the large hole in the J 28467-2A radiator shelf tube. The hole used in the J 28467-2A radiator shelf tube depends on the vehicle application.
11. Place the rubber padded foot of the J 28467-4A front support assembly on the upper tie bar.
12. Install the J 28467-9 7/16 in x 2.0 in quick release pin through the hole in the J 28467-4A front support assembly in order to level the J 28467-2A radiator shelf tube.

 © 2011 Mitchell Repair Information Company, LLC.

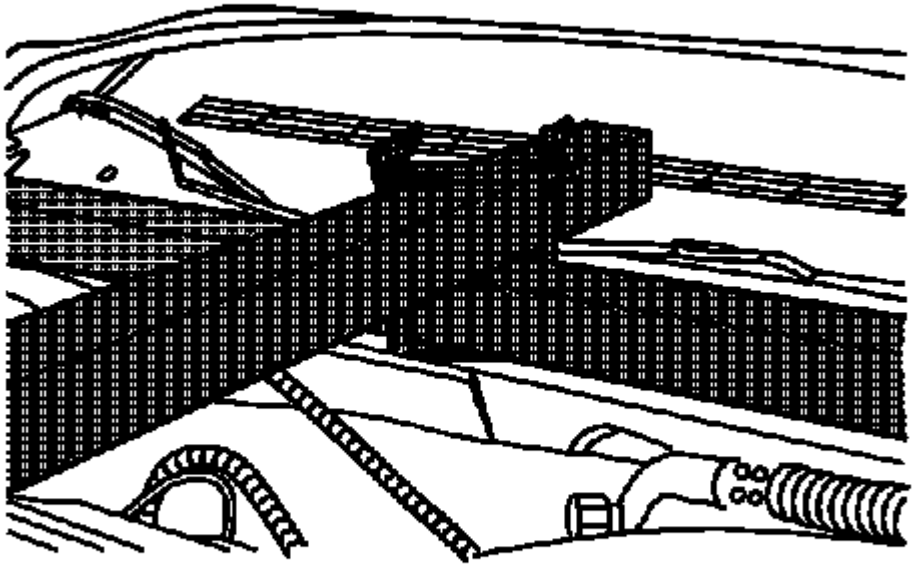


Fig. 13: View of Cross Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

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

 © 2011 Mitchell Repair Information Company, LLC.

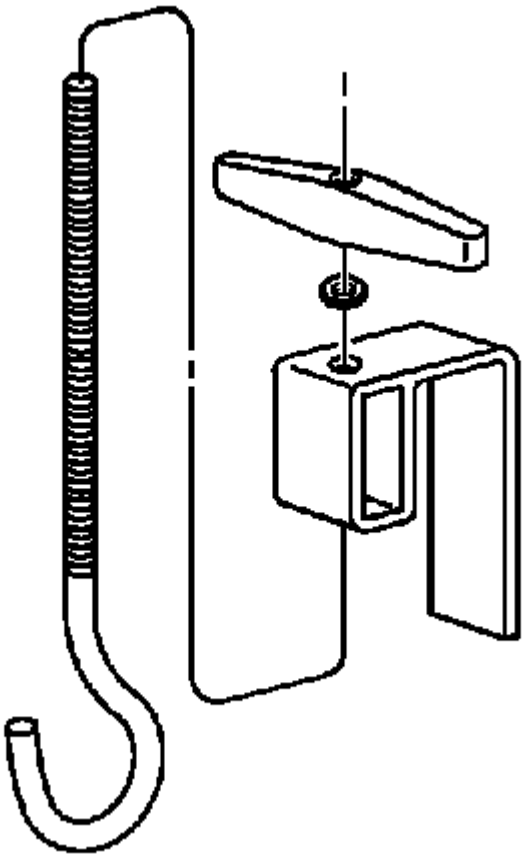


Fig. 14: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Install the J 28467-7A lift hook through the J 28467-6A lift hook bracket.
16. Install the 1/2 in lift hook washer and J 28467-34 lift hook wing nut onto the J 28467-7A lift hook.

 © 2011 Mitchell Repair Information Company, LLC.

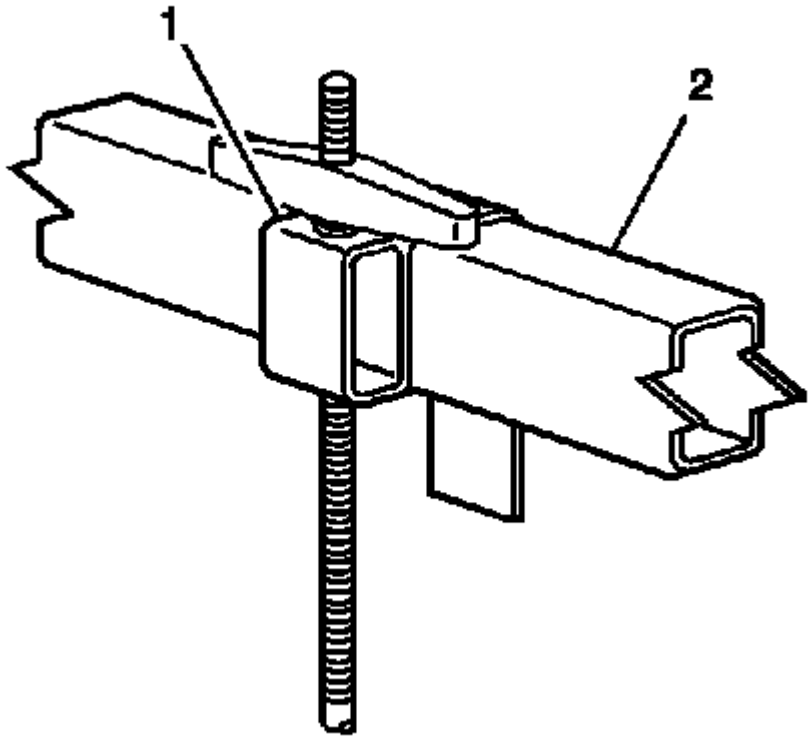


Fig. 15: View Of Lift Hook & radiator shelf tube Assembly
Courtesy of GENERAL MOTORS COMPANY

17. Install the J 28467-6A assembled lift hook bracket (1) over the J 28467-3 strut tower tube (2).
18. Adjust the J 28467-6A assembled lift hook bracket (1) in order to align the hook with the rear engine lift hook bracket.

 © 2011 Mitchell Repair Information Company, LLC.

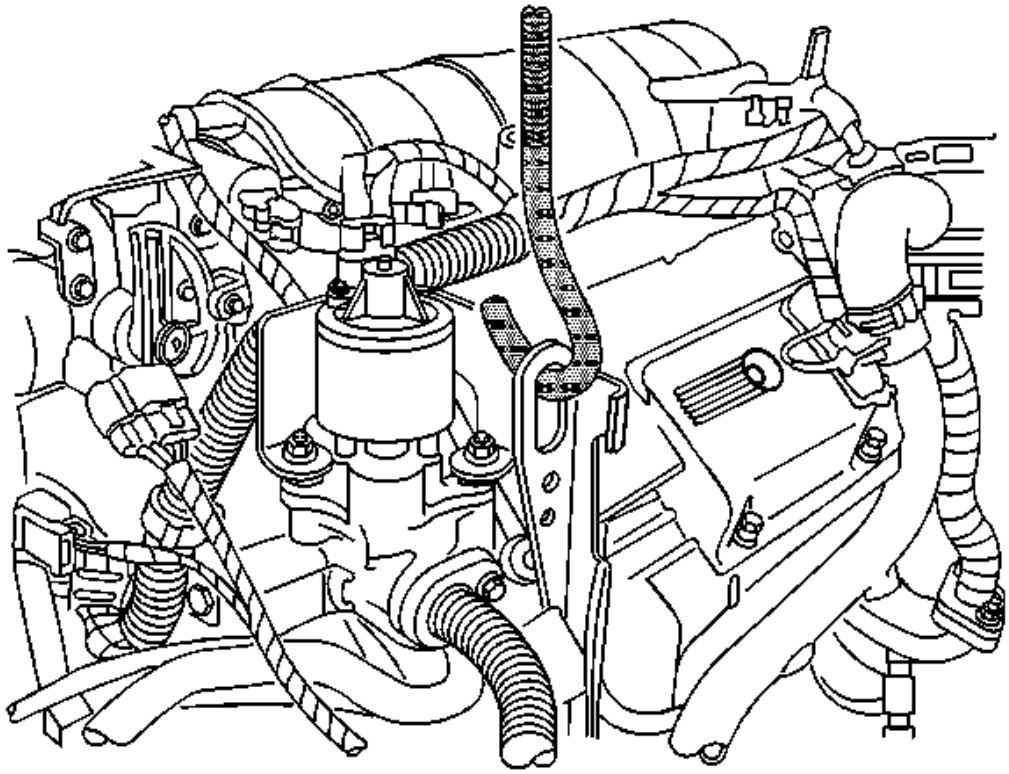


Fig. 16: Locating Engine Lift Hook Through Lift Hook Bracket
Courtesy of GENERAL MOTORS COMPANY

19. Install the J 28467-7A lift hook through the rear engine lift hook bracket. Ensure the hook does not damage the surrounding components.
20. Repeat steps 18 and 19.

 © 2011 Mitchell Repair Information Company, LLC.

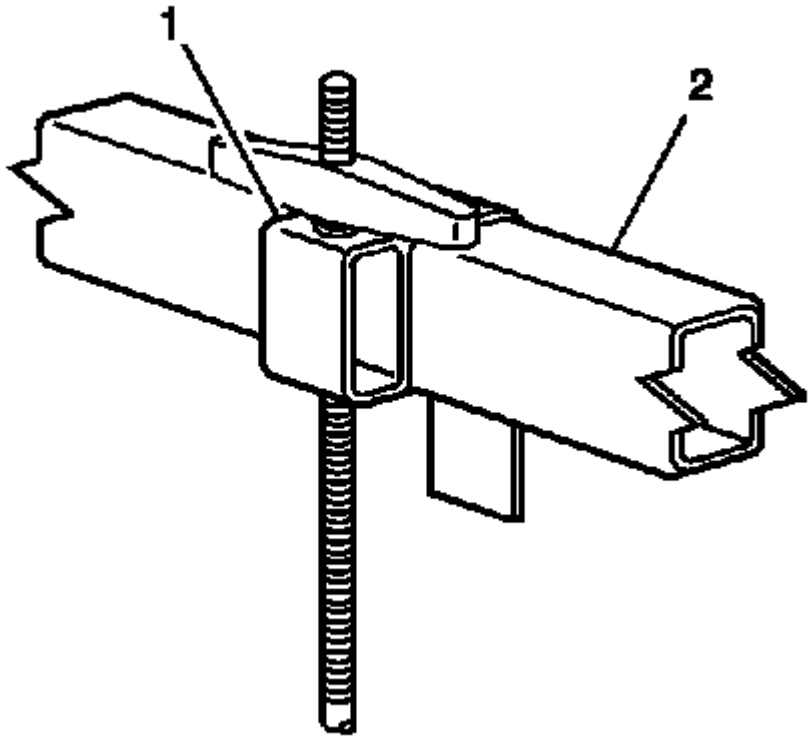


Fig. 17: View Of Lift Hook & radiator shelf tube Assembly
Courtesy of GENERAL MOTORS COMPANY

21. Install the J 28467-6A assembled lift hook bracket (1) over the J 28467-2A radiator shelf tube (2).
22. Adjust the J 28467-6A assembled lift hook bracket (1) in order to align the hook with the torque strut bracket.

 © 2011 Mitchell Repair Information Company, LLC.

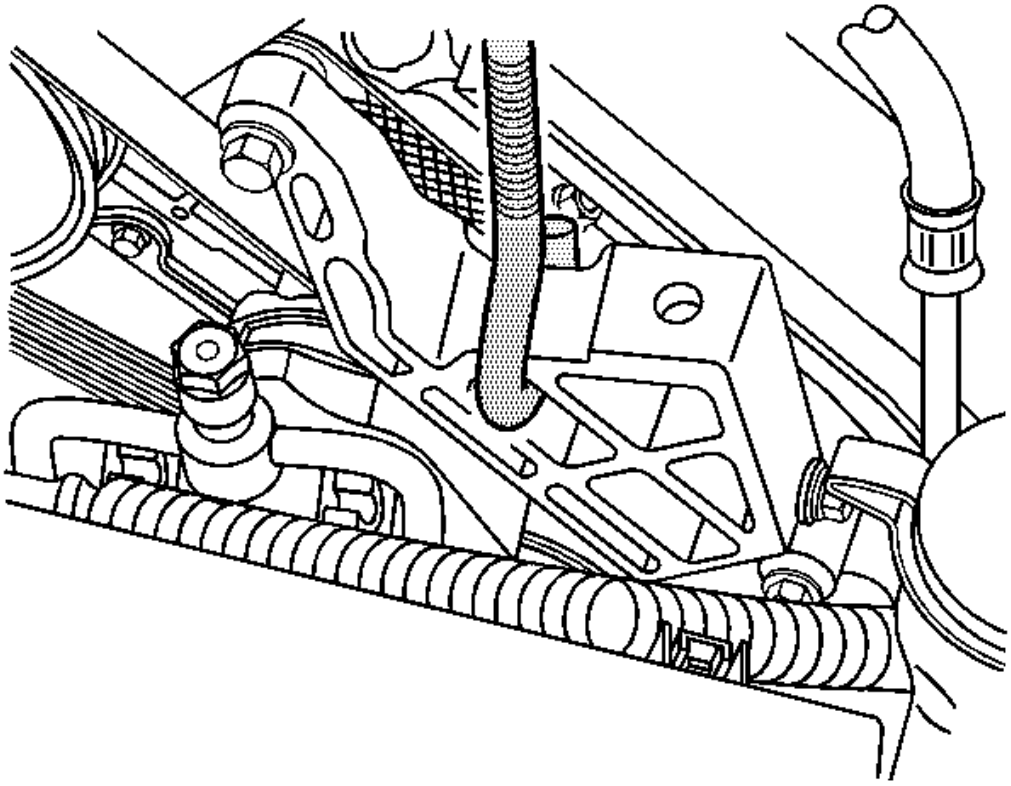


Fig. 18: Engine Lift Hook
Courtesy of GENERAL MOTORS COMPANY

23. Install the J 28467-7A lift hook through the engine mount strut bracket. Ensure the hook does not damage the surrounding components.
24. Hand tighten the J 28467-34 lift hook wing nuts securely to remove all slack from the engine support fixture assembly.

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

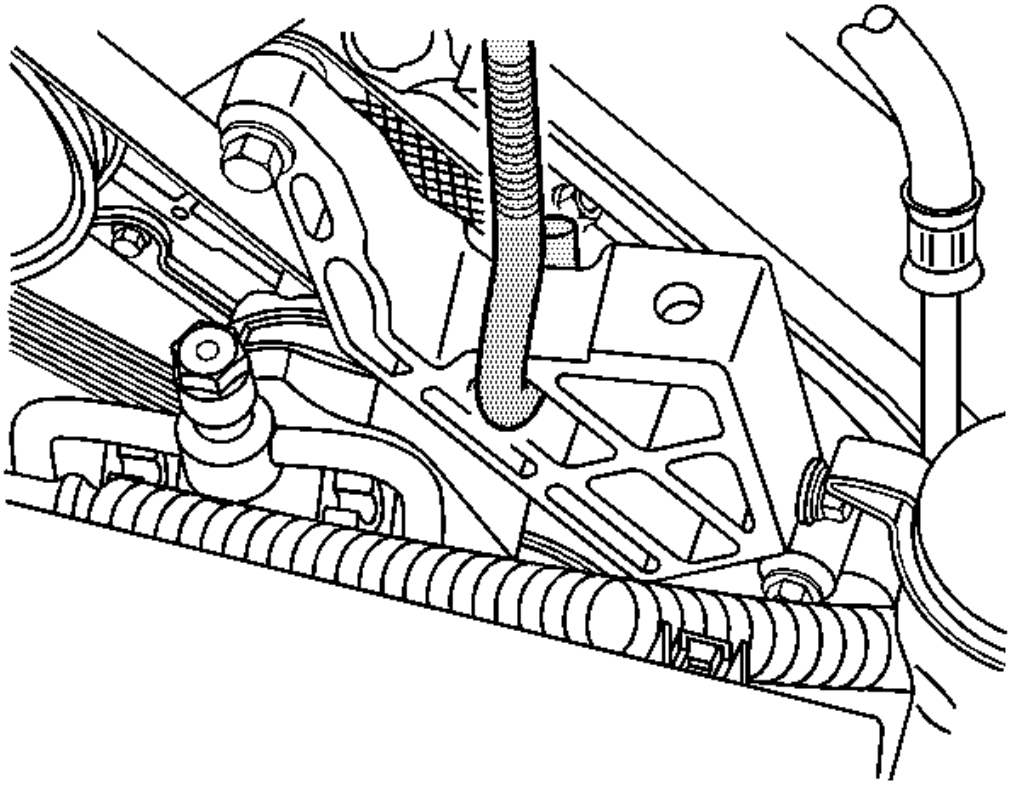


Fig. 19: Engine Lift Hook
Courtesy of GENERAL MOTORS COMPANY

1. Remove the J 28467-7A lift hook from the engine mount strut bracket.
2. Remove the **J 28467-B** .
3. Remove the **J 28467-501** .

 © 2011 Mitchell Repair Information Company, LLC.

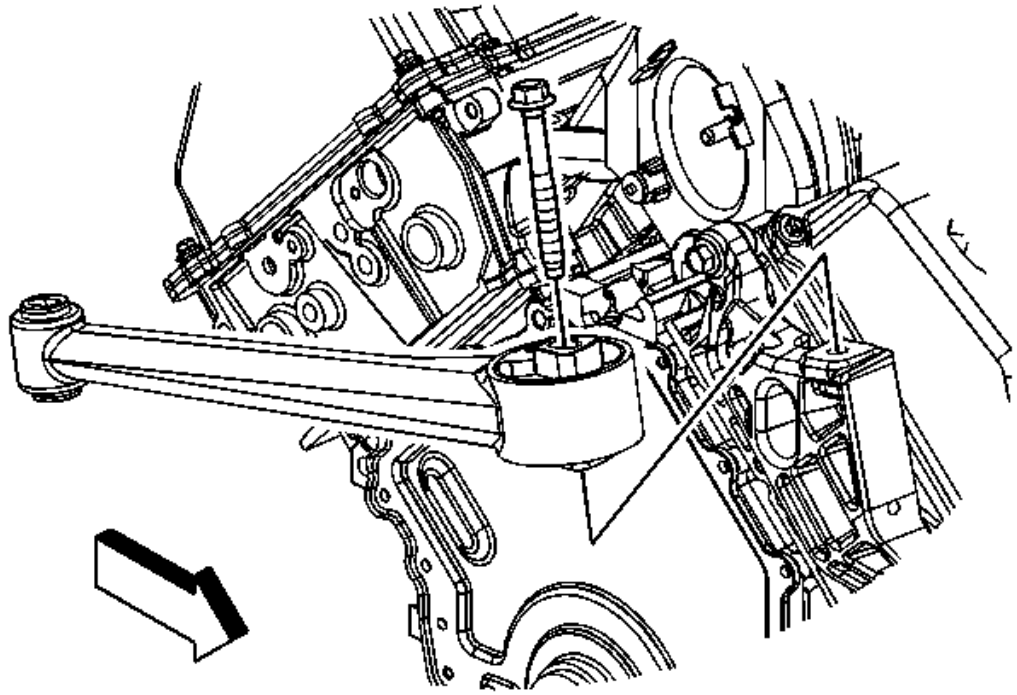


Fig. 20: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine mount strut.

CAUTION: Refer to Fastener Caution .

5. Install the engine mount strut bolt.

Tighten

Tighten the bolt to 70 N.m (52 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

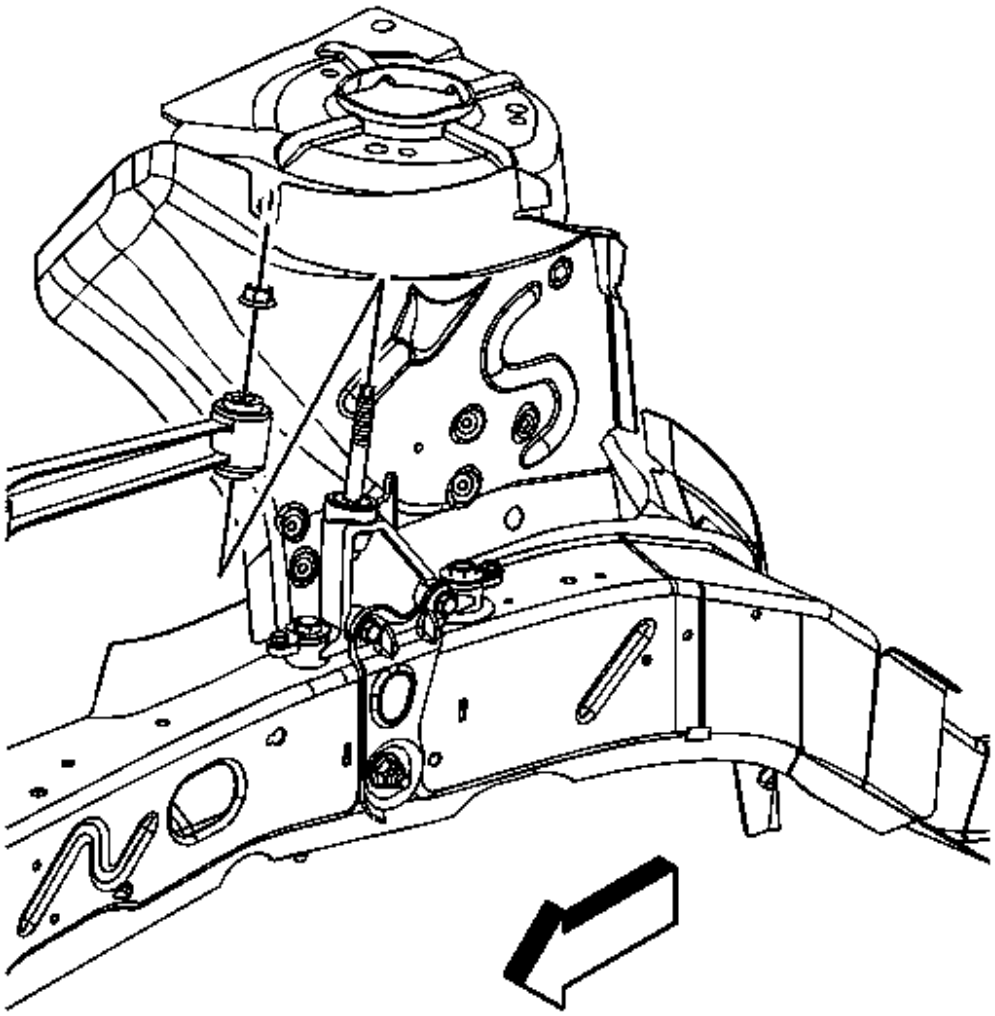


Fig. 21: Engine Mount Strut Brace Nut
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine mount strut nut.

Tighten

Tighten the nut to 70 N.m (52 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

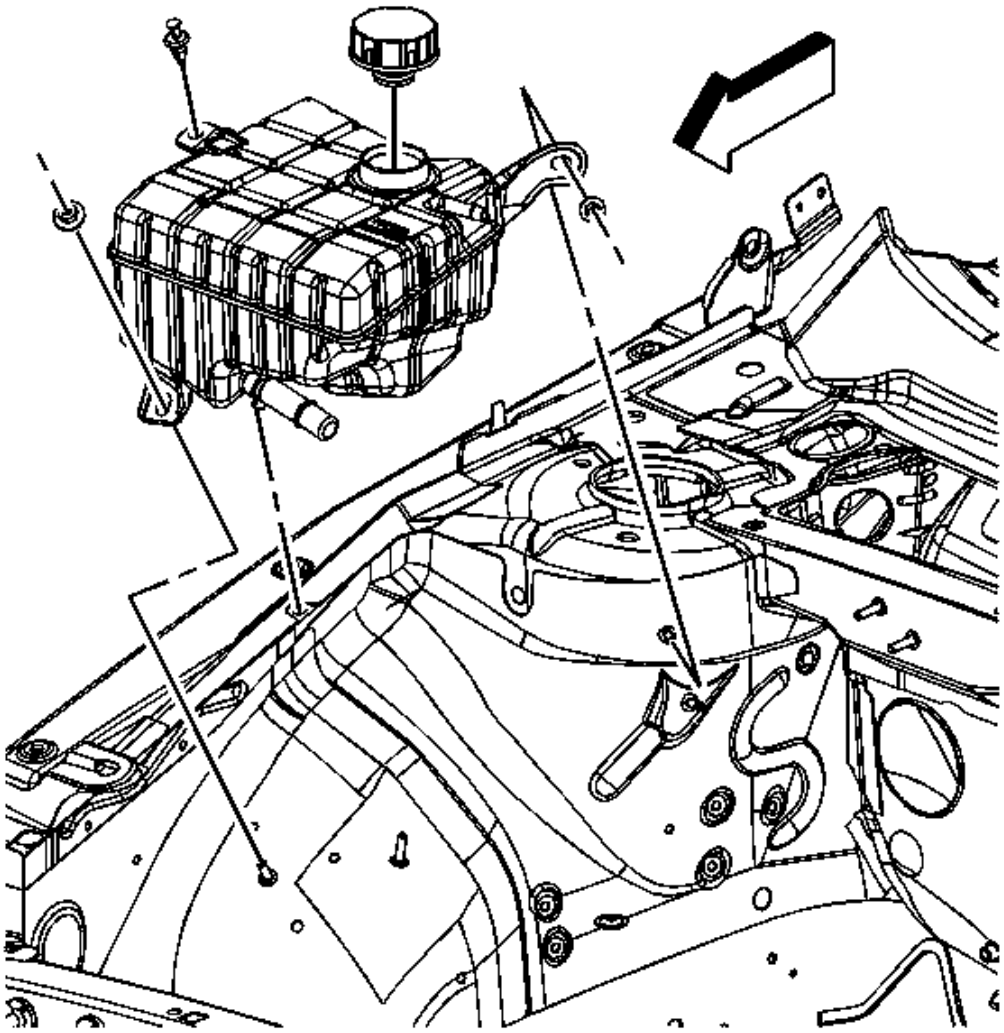


Fig. 22: Identifying Surge Tank
Courtesy of GENERAL MOTORS COMPANY

7. Position the surge tank to the studs.
8. Install the surge tank nuts and push pin retainer.

Tighten

Tighten the nuts to 6 N.m (53 lb in).

9. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

10. Install the air inlet grille. Refer to **Air Inlet Grille Panel Replacement** .

ENGINE FRONT MOUNT REPLACEMENT

Removal Procedure

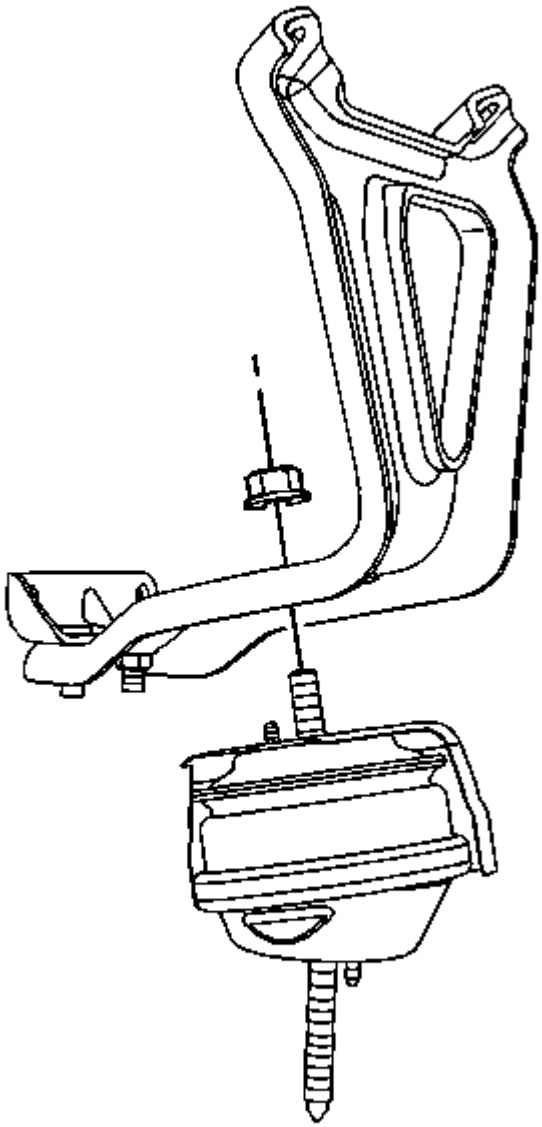


Fig. 23: Identifying Front Engine Mount
Courtesy of GENERAL MOTORS COMPANY

 © 2011 Mitchell Repair Information Company, LLC.

1. Remove the engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.
2. Remove the front engine mount to engine mount bracket nut.
3. Remove the front engine mount.

Installation Procedure

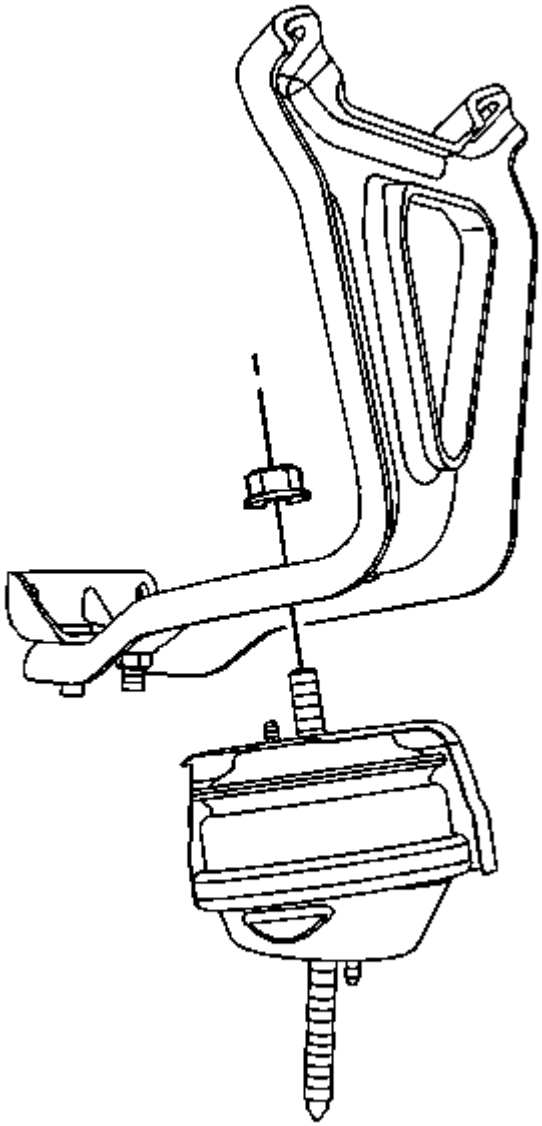


Fig. 24: Identifying Front Engine Mount

 © 2011 Mitchell Repair Information Company, LLC.

Courtesy of GENERAL MOTORS COMPANY

1. Install the front engine mount stud through the hole in the front engine mount bracket.
2. Install the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

CAUTION: Refer to Fastener Caution .

3. Install the front engine mount to engine mount bracket nut.

Tighten

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

4. Install the frame. Refer to **Drivetrain and Front Suspension Frame Replacement (3.9L)** .

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.
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 Front Mount Replacement**, or **Engine Mount Replacement - Right Side**.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

 © 2011 Mitchell Repair Information Company, LLC.

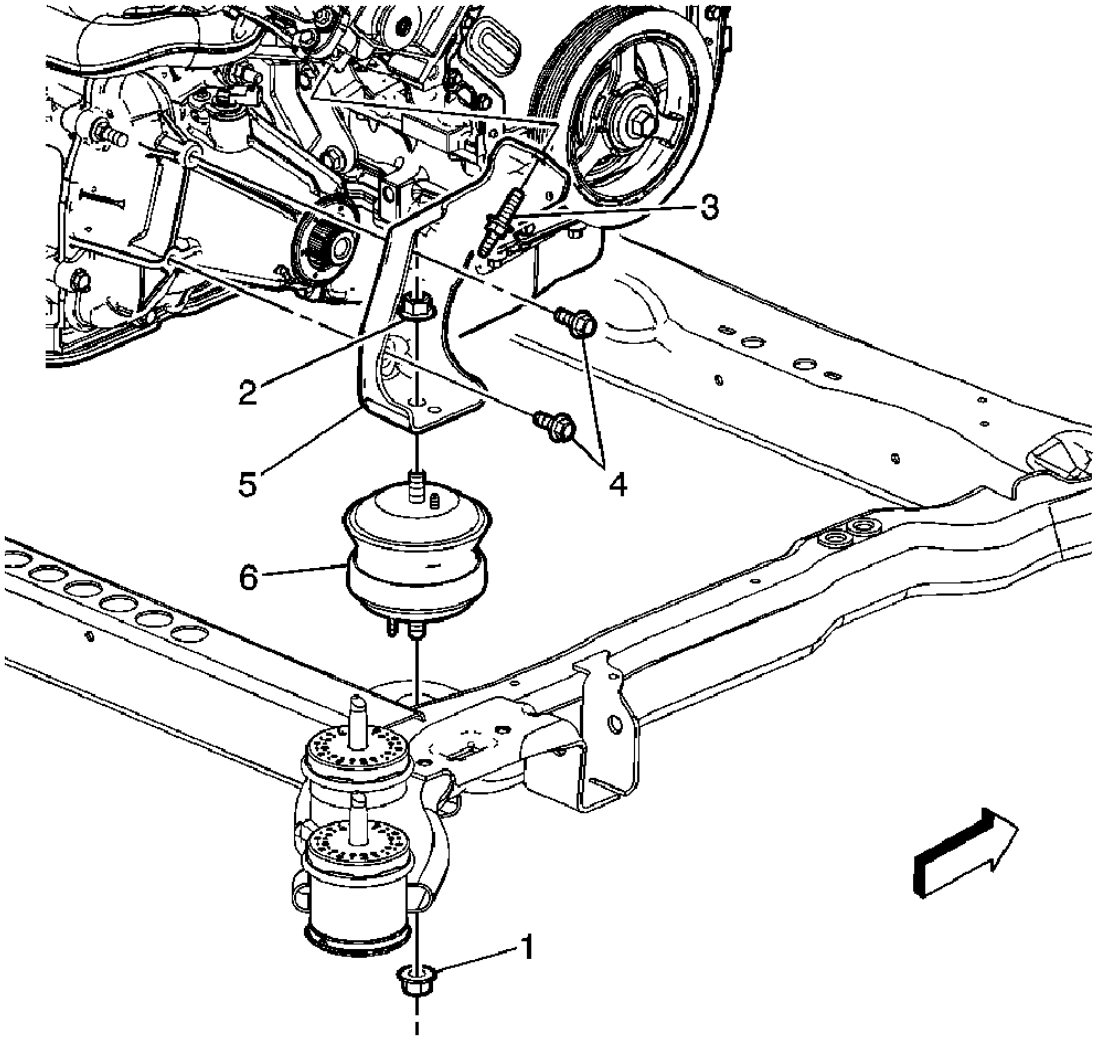


Fig. 25: View Of Rear Transmission Mount
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Right Side

Callout	Component Name
Preliminary Procedures 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** . 3. Support the transaxle with a suitable stand.	
1	Lower Engine Mount Nut **CAUTION:** **Refer to Fastener Caution .**

 © 2011 Mitchell Repair Information Company, LLC.

	Tighten 80 N.m (59 lb ft)
2	Upper Engine Mount Nut **Tighten** 80 N.m (59 lb ft)
3	Engine Mount Bracket to Engine Stud **Tighten** 73 N.m (54 lb ft)
4	Engine Mount Bracket to Transaxle Bolt (Qty: 2) **Tighten** 73 N.m (54 lb ft)
5	Engine Mount Bracket
6	Engine Mount

ENGINE FRONT MOUNT BRACKET REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

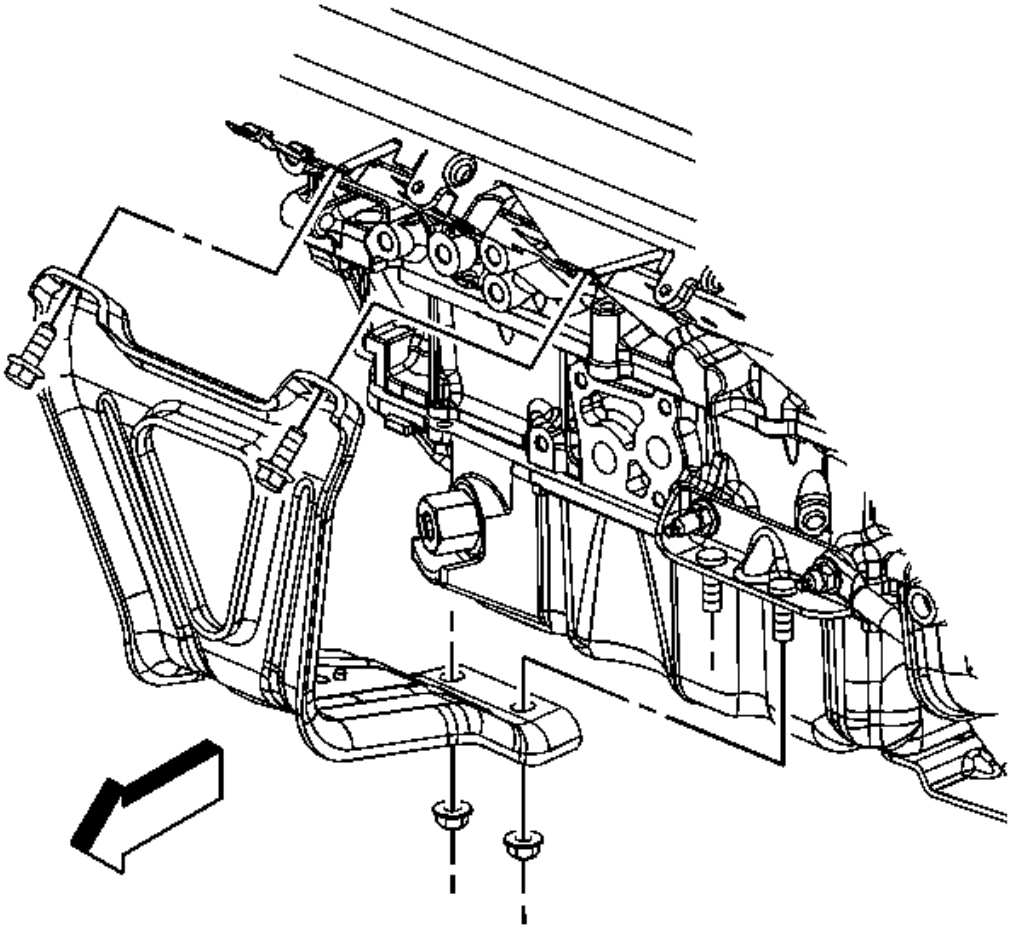


Fig. 26: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the front frame.
2. Remove the engine mount bracket to cylinder head bolts.
3. Remove the upper engine mount bracket to lower engine mount bracket nuts.
4. Remove the upper engine mount bracket.

 © 2011 Mitchell Repair Information Company, LLC.

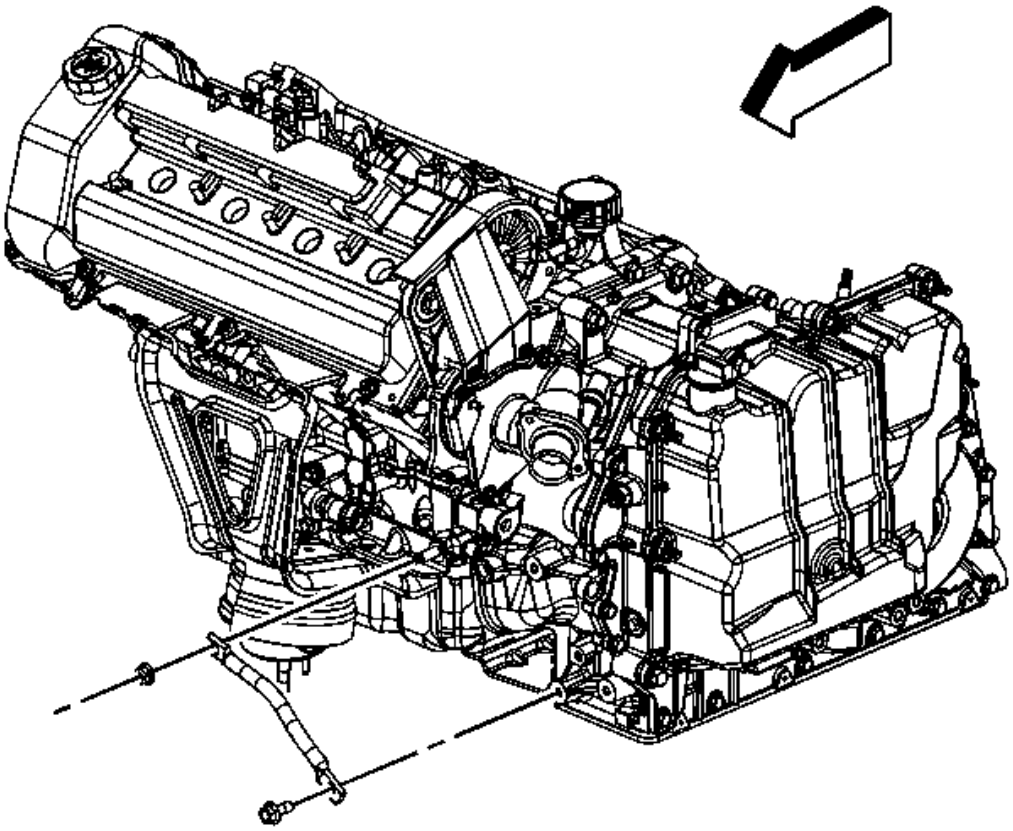


Fig. 27: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the transaxle brace bolt.

 © 2011 Mitchell Repair Information Company, LLC.

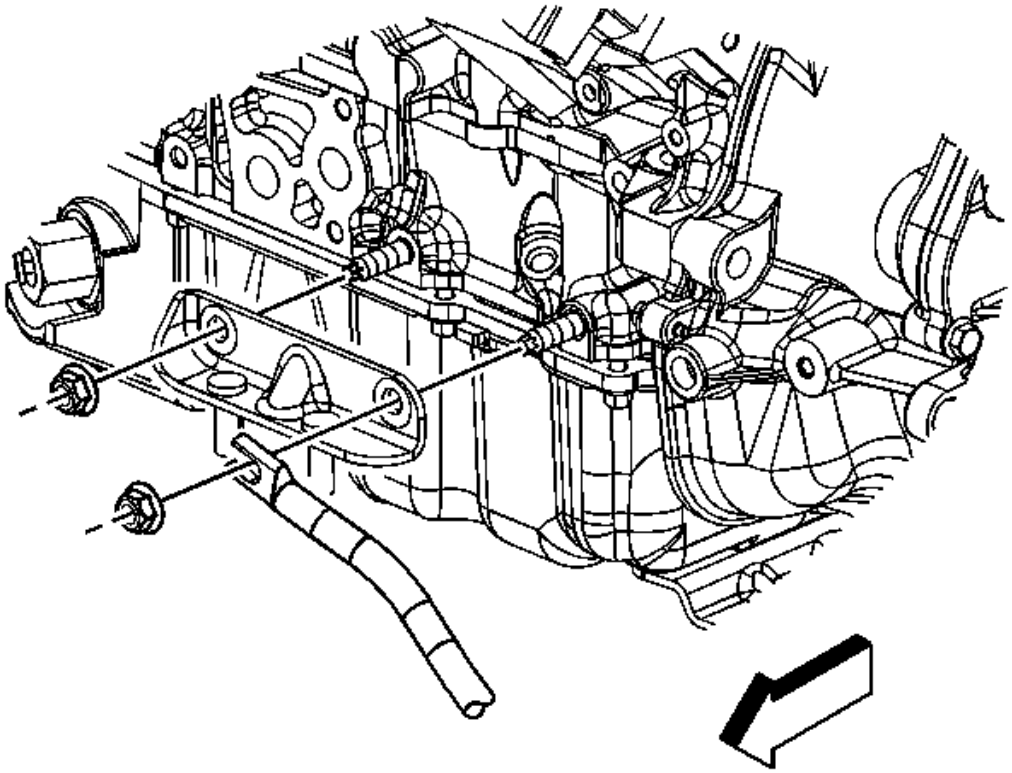


Fig. 28: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the lower engine mount bracket to engine stud nuts.
7. Remove the transaxle brace.
8. Remove the lower engine mount bracket.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

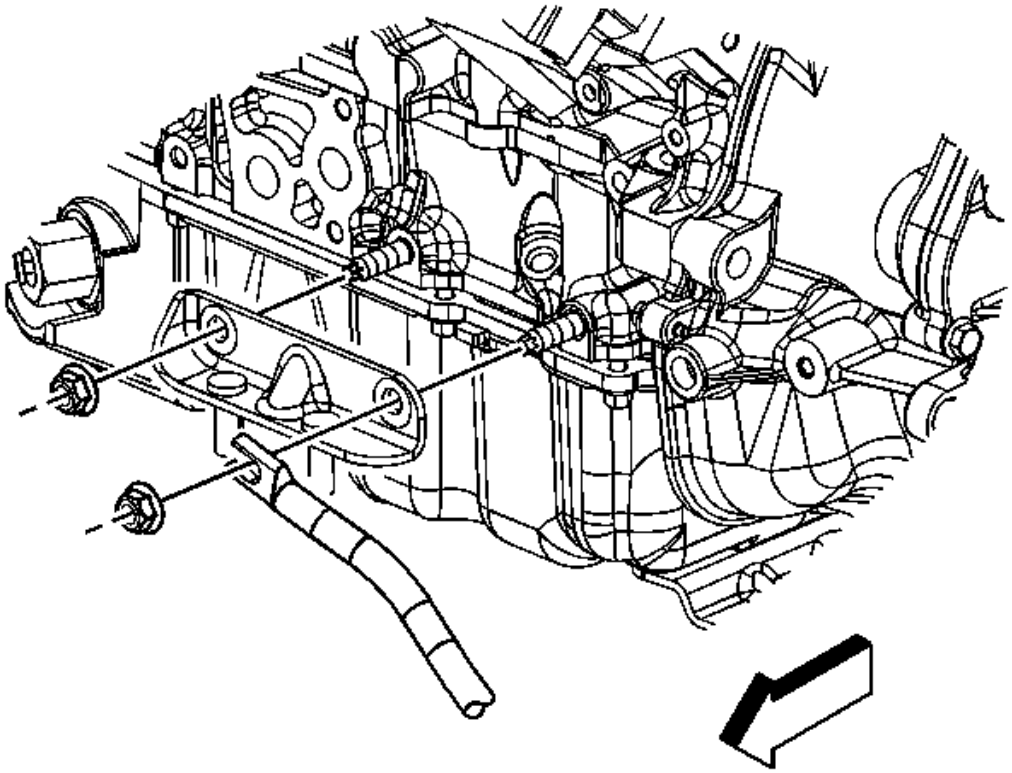


Fig. 29: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Install the lower engine mount bracket onto the engine studs.
2. Install the transaxle brace.
3. Install the lower engine mount bracket to engine stud nuts finger tight.

 © 2011 Mitchell Repair Information Company, LLC.

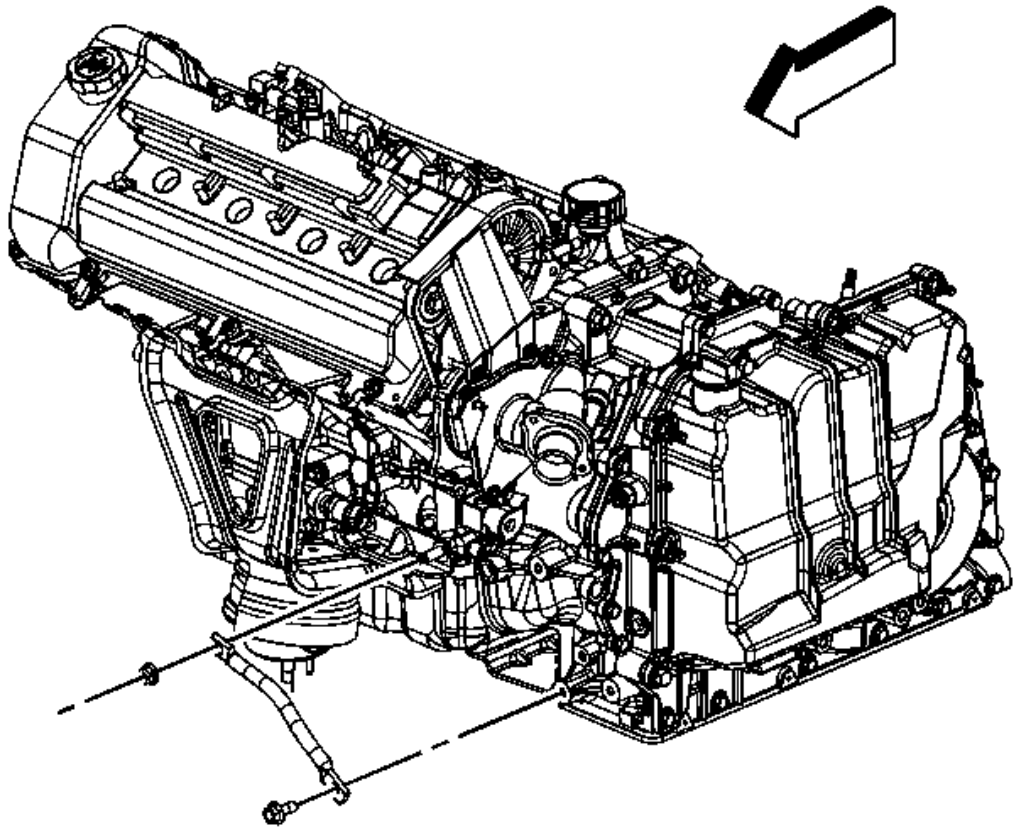


Fig. 30: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the transaxle brace bolt.

Tighten

- Tighten the transaxle brace bolt to 50 N.m (37 lb ft).
- Tighten the lower engine mount bracket to engine stud nuts to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

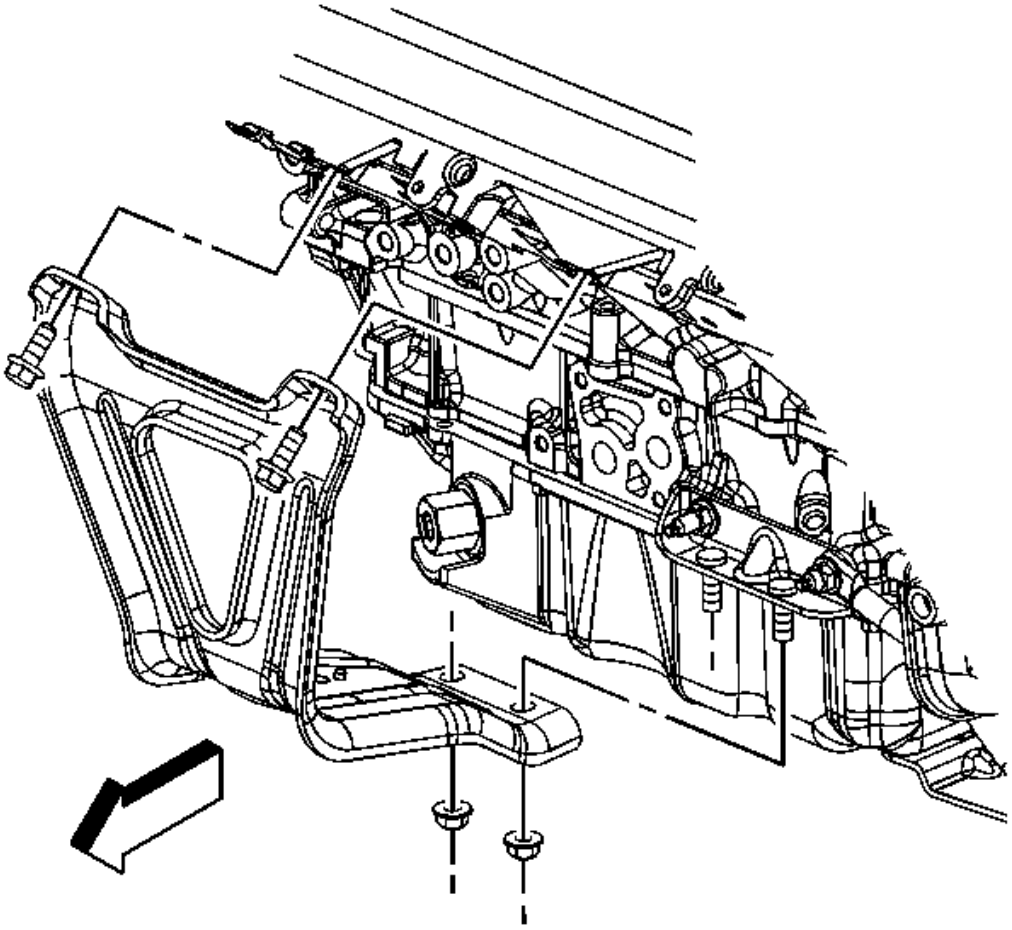


Fig. 31: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the upper engine mount bracket onto the studs.
6. Install the engine mount bracket to cylinder head bolts.

Tighten

Tighten the bolts to 50 N.m (37 lb ft).

7. Install the upper engine mount bracket to lower engine mount bracket nuts.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the nuts to 50 N.m (37 lb ft).

8. Install the front frame.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

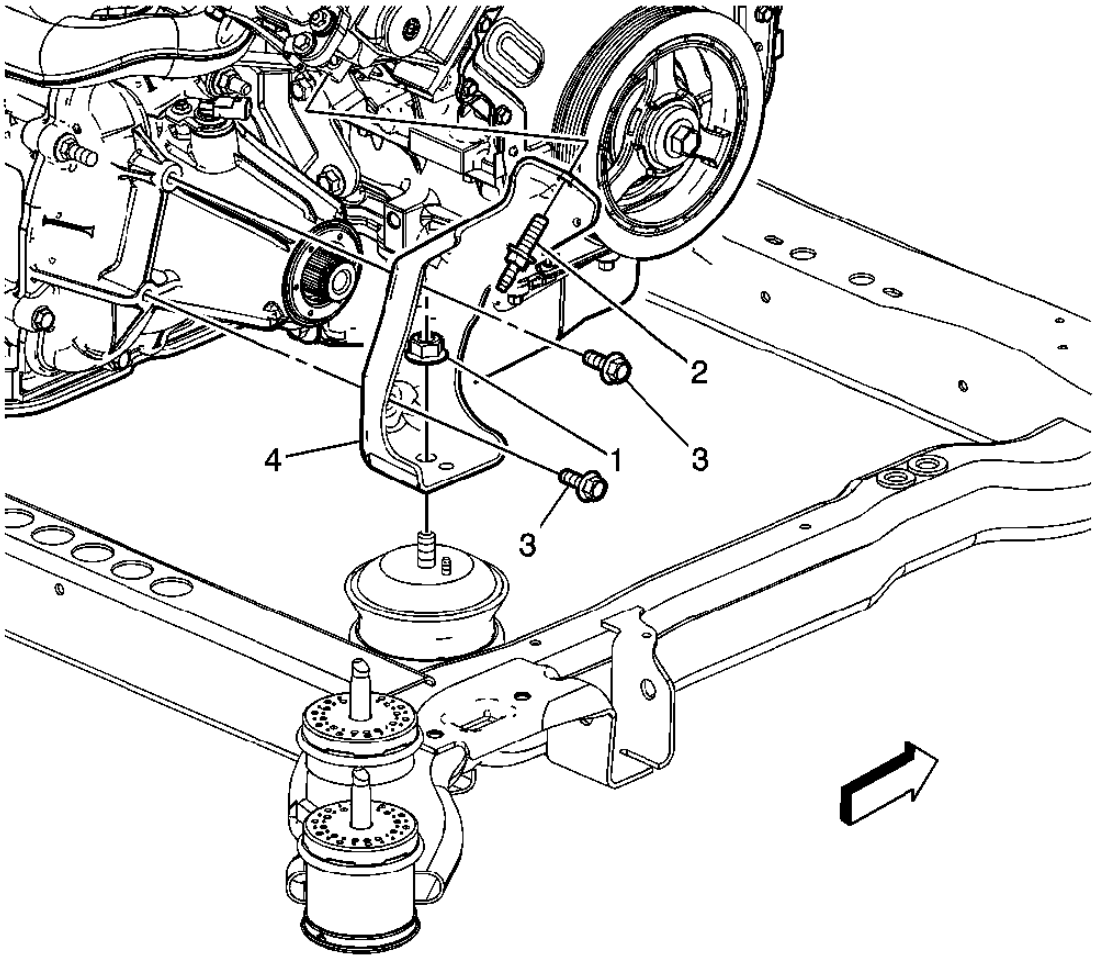


Fig. 32: View Of Rear Transmission Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedures 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** . 3. Support the transaxle with a suitable stand.	
	Engine Mount Upper Nut

 © 2011 Mitchell Repair Information Company, LLC.

1	**CAUTION:** **Refer to Fastener Caution .** **Tighten** 80 N.m (59 lb ft)
2	Engine Mount Bracket To Engine Stud **Tighten** 73 N.m (54 lb ft)
3	Engine Mount Bracket To Transaxle Bolt (Qty: 2) **Tighten** 73 N.m (54 lb ft)
4	Engine Mount Bracket

ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE

Removal Procedure

© 2011 Mitchell Repair Information Company, LLC.

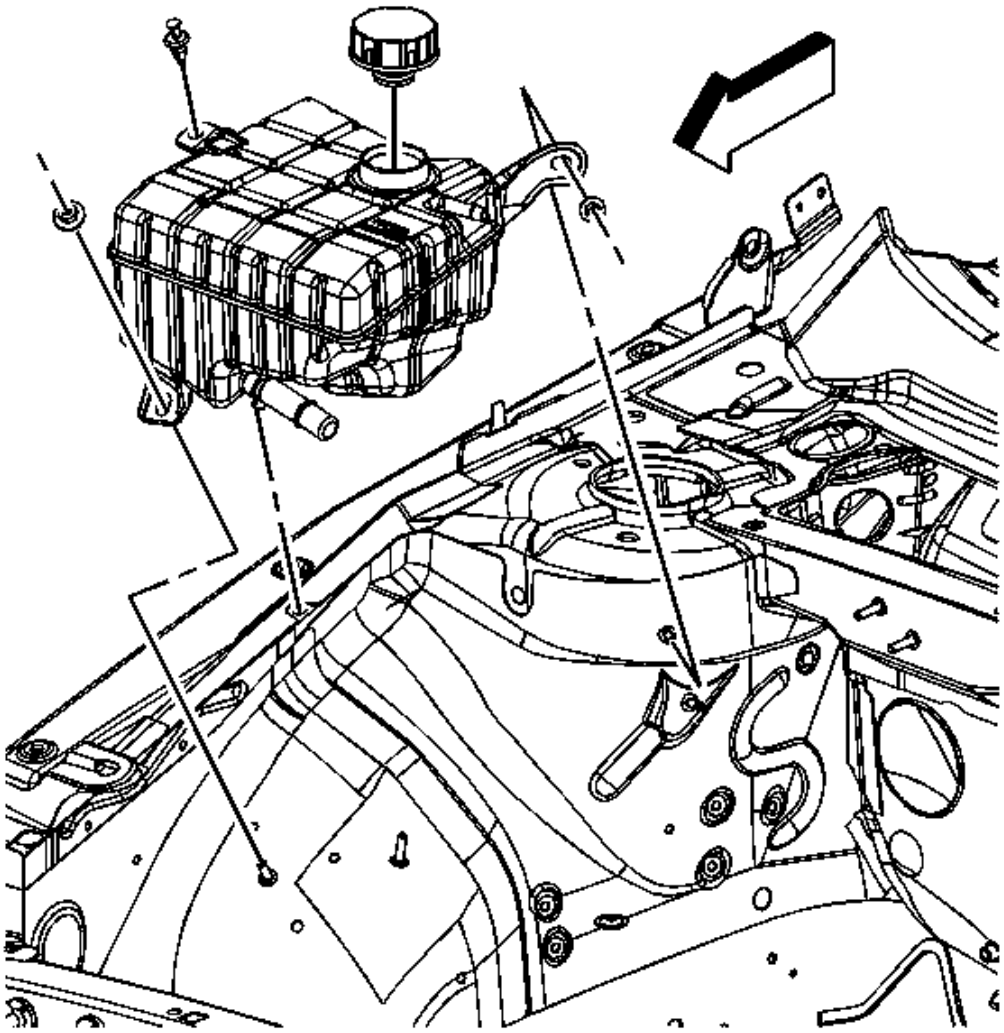


Fig. 33: Identifying Surge Tank
Courtesy of GENERAL MOTORS COMPANY

1. Remove the surge tank nuts and push pin retainer.
2. Remove the surge tank from the studs and position the tank aside.

 © 2011 Mitchell Repair Information Company, LLC.

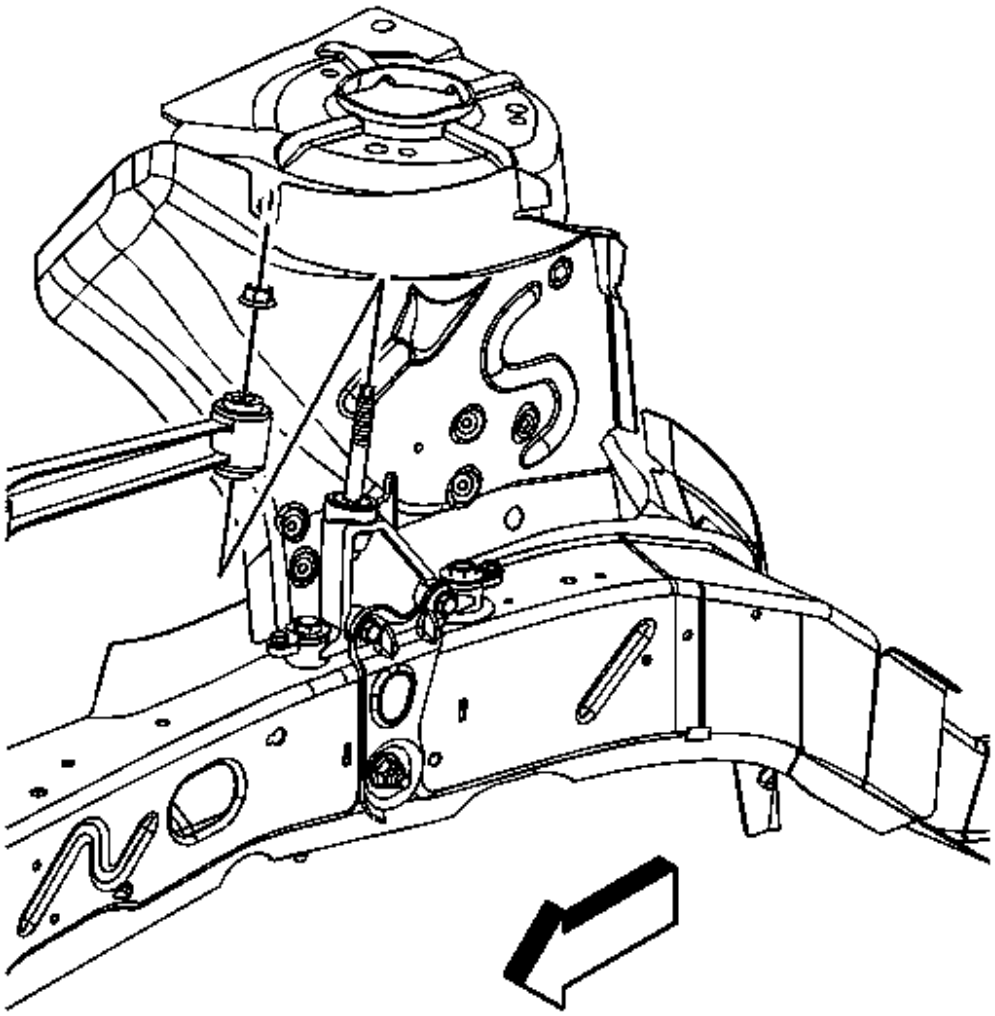


Fig. 34: Engine Mount Strut Brace Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount strut brace nut.

 © 2011 Mitchell Repair Information Company, LLC.

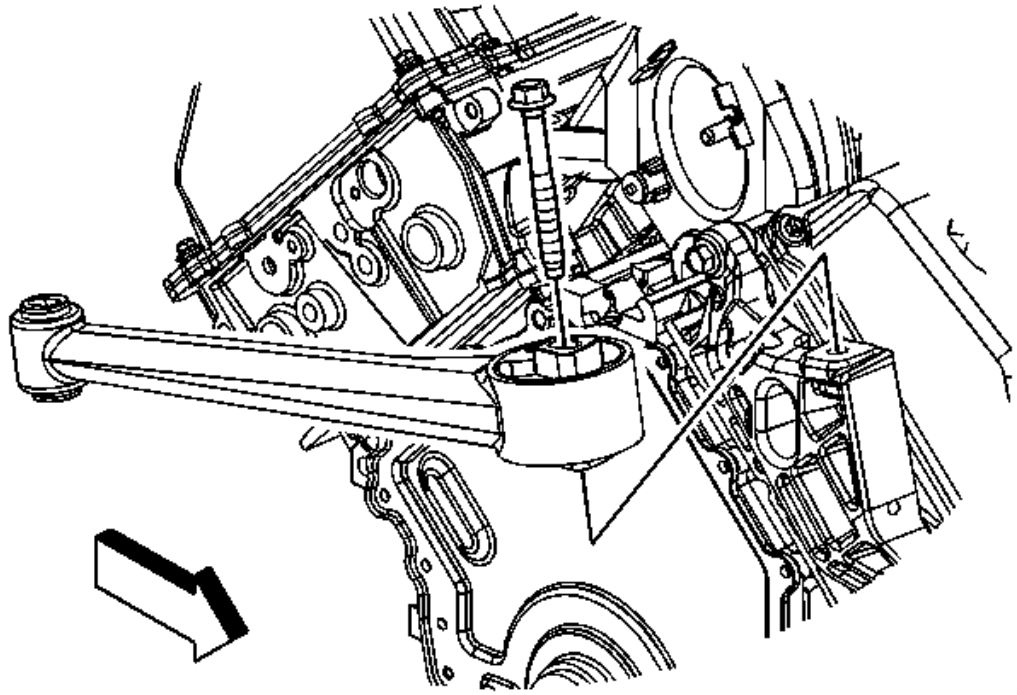


Fig. 35: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine mount strut bolt.
5. Remove the engine mount strut.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

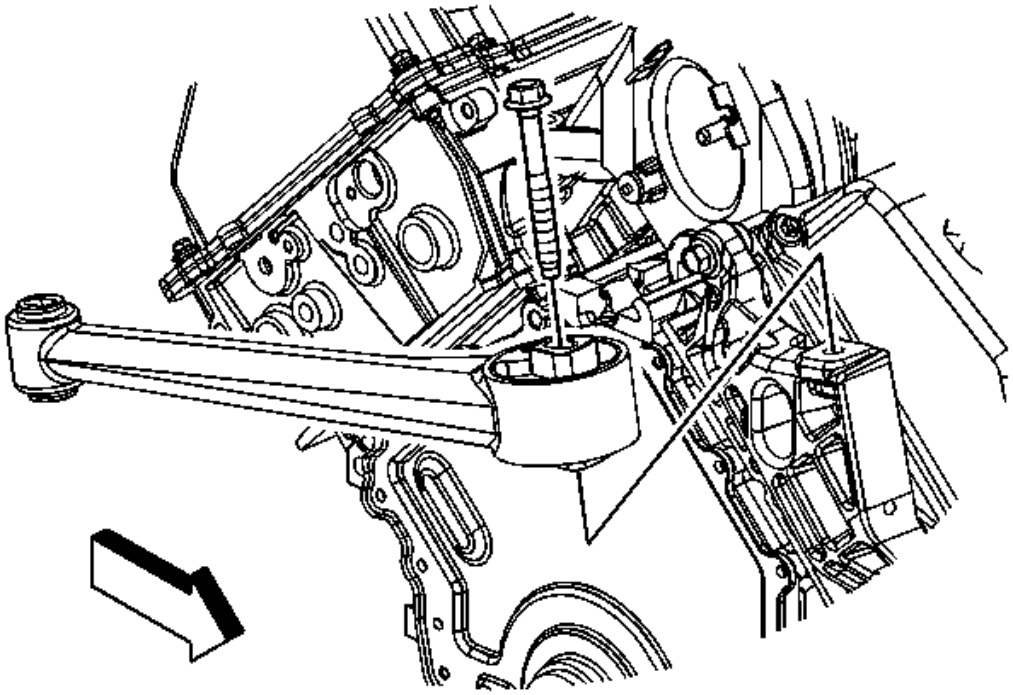


Fig. 36: Identifying Engine Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine mount strut.

   CAUTION: Refer to Fastener Caution .

2. Install the engine mount strut bolt.

   Tighten

   Tighten the bolt to 70 N.m (52 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

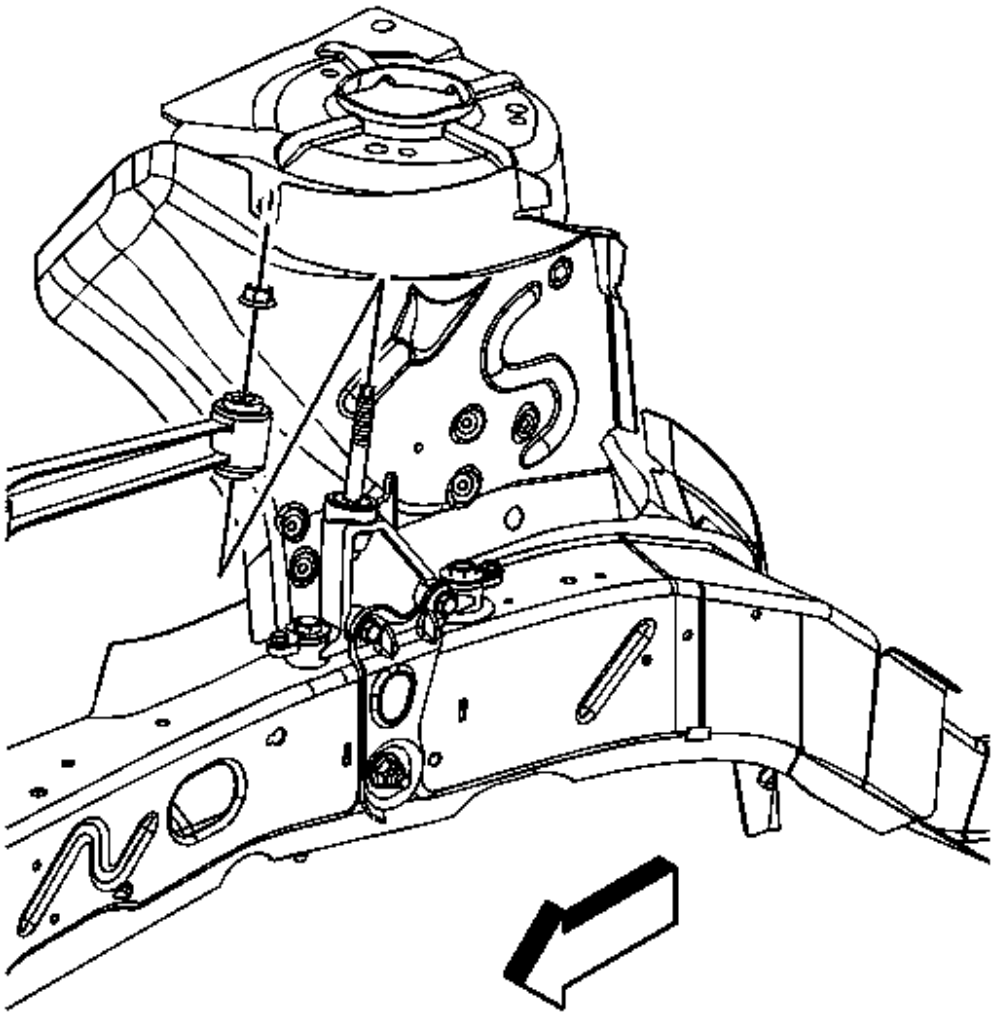


Fig. 37: Engine Mount Strut Brace Nut
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine mount strut nut.

Tighten

Tighten the nut to 70 N.m (52 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

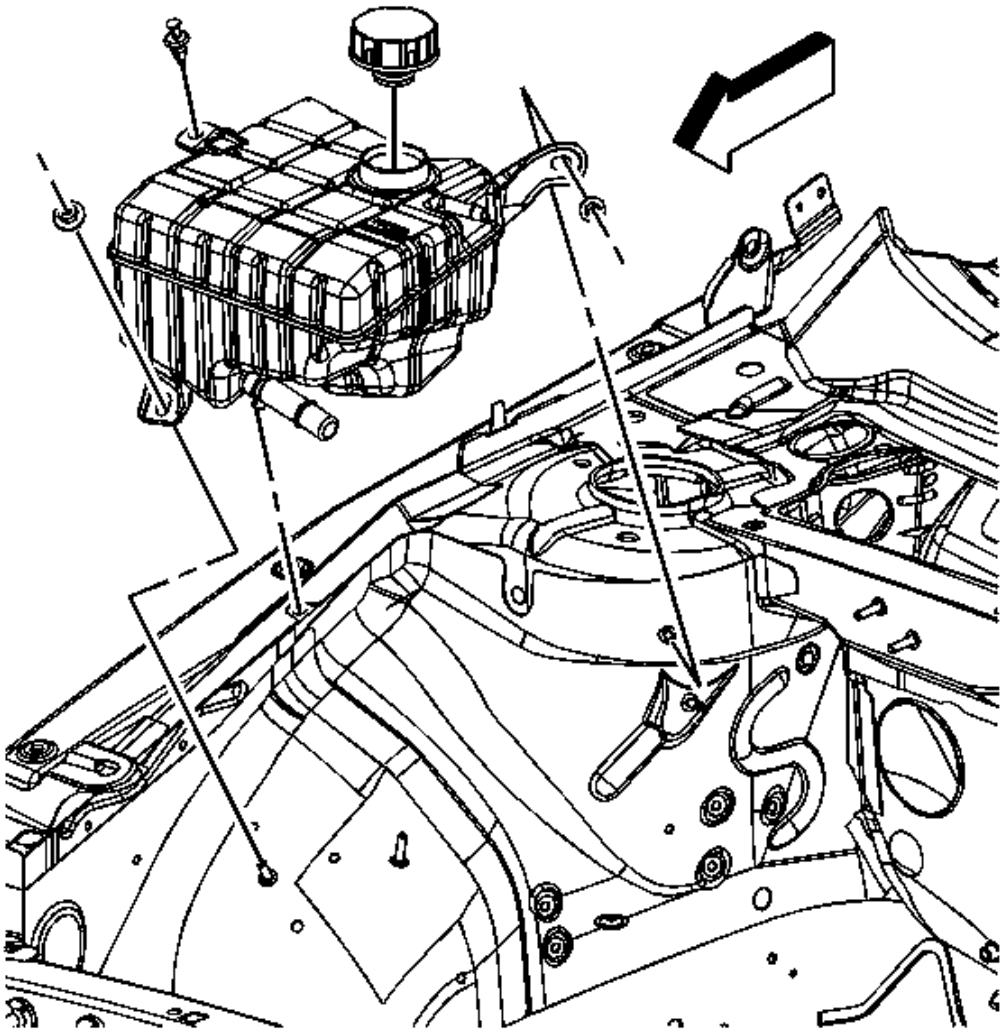


Fig. 38: Identifying Surge Tank
Courtesy of GENERAL MOTORS COMPANY

4. Position the surge tank to the studs.
5. Install the surge tank nuts and push pin retainer.

Tighten

Tighten the nuts to 6 N.m (53 lb in).

ENGINE MOUNT STRUT BRACKET REPLACEMENT - RIGHT SIDE

 © 2011 Mitchell Repair Information Company, LLC.

Removal Procedure

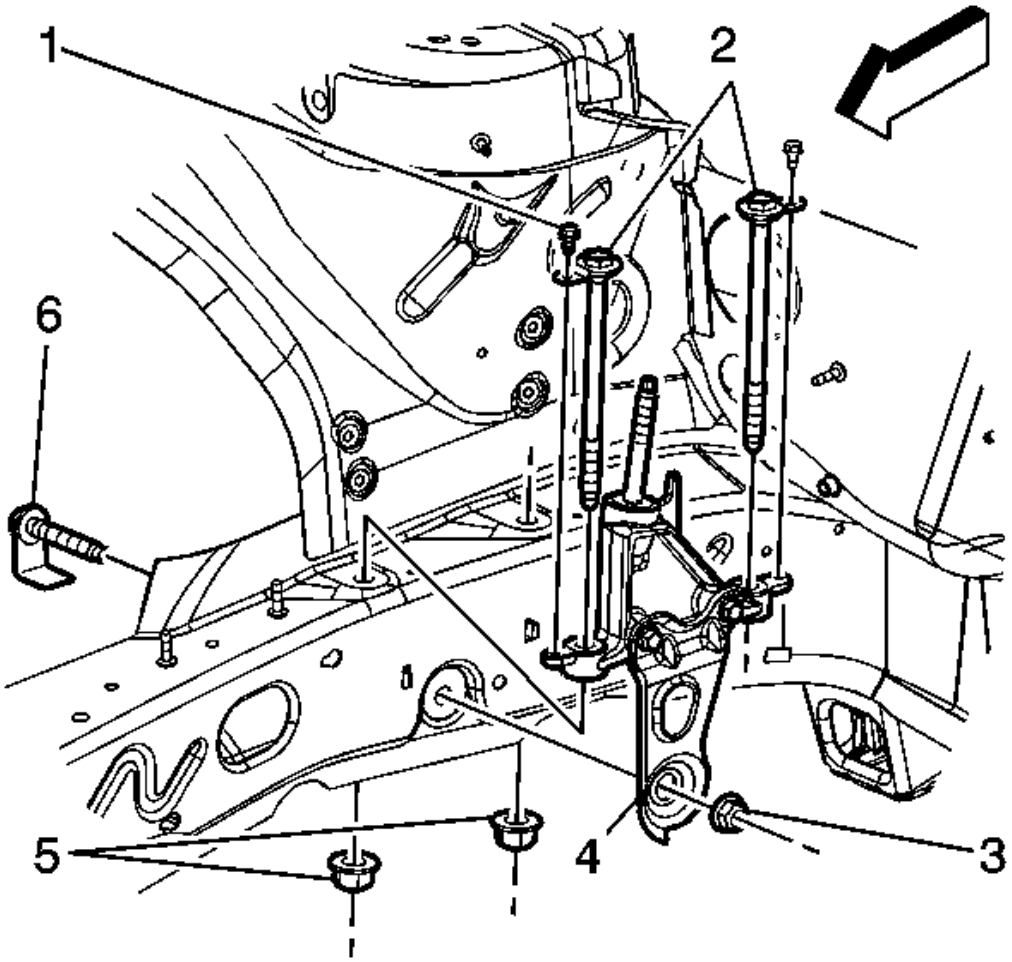


Fig. 39: View Of Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
2. Remove the right front wheel and tire. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the engine mount strut bracket bolts (1).
4. Remove the strut bracket nut (3).
5. Remove the strut bracket bolt (6).
6. Remove the strut bracket nuts (5).
7. Remove the strut bracket bolts (2).

 © 2011 Mitchell Repair Information Company, LLC.

8. Remove the strut bracket (4).

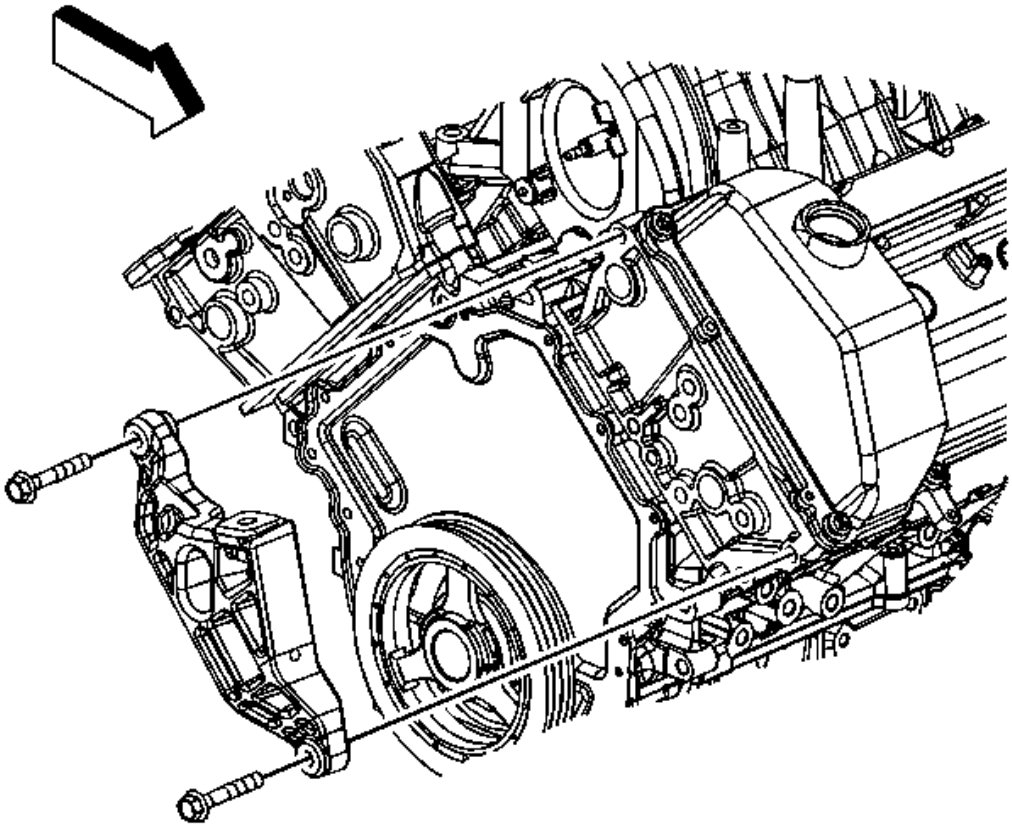


Fig. 40: Engine Mount Strut Bracket To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine mount strut bracket to engine bolts.
10. Remove the engine mount strut bracket.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

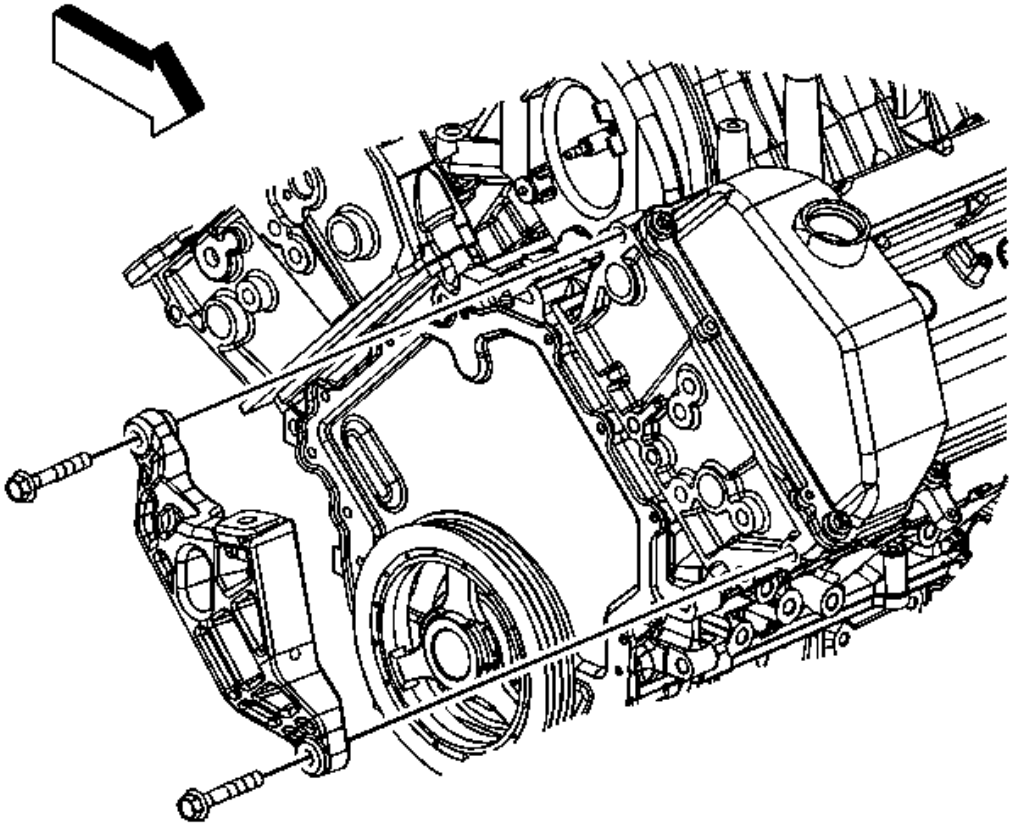


Fig. 41: Engine Mount Strut Bracket To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the engine mount strut bracket to the cylinder head.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount strut bracket to engine bolts.

Tighten

Tighten the bolts to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

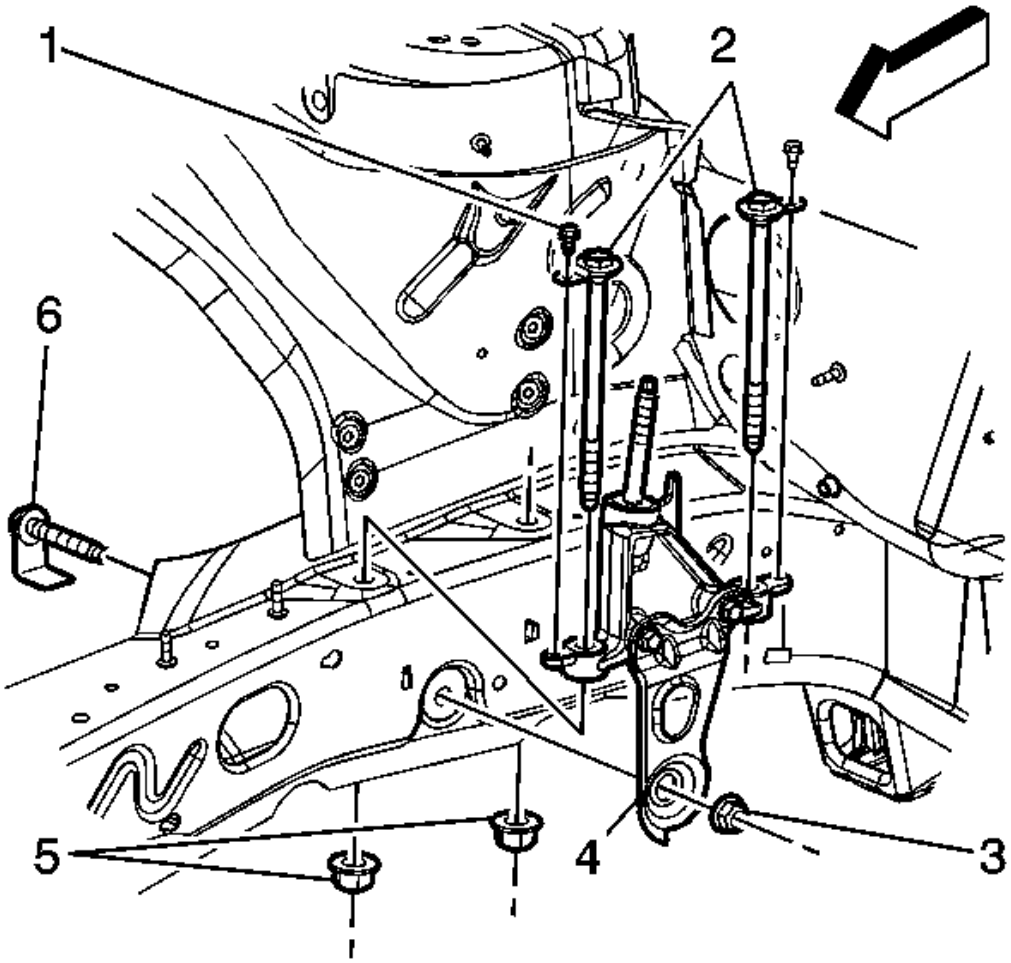


Fig. 42: View Of Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Position the engine mount strut bracket (4) to the front compartment rail.
4. Install the strut bracket bolts (2).
5. Install the strut bracket bolt (6).
6. Install the strut bracket nut (3).

Tighten

Tighten the nut to 70 N.m (52 lb ft).

7. Install the strut bracket nuts (5).

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the nuts to 70 N.m (52 lb ft).

8. Install the strut bracket bolts (1).

Tighten

Tighten the bolts to 9 N.m (80 lb in).

9. Install the right front wheel and tire. Refer to **Tire and Wheel Removal and Installation** .
10. Install the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.

ENGINE LIFT BRACKET REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

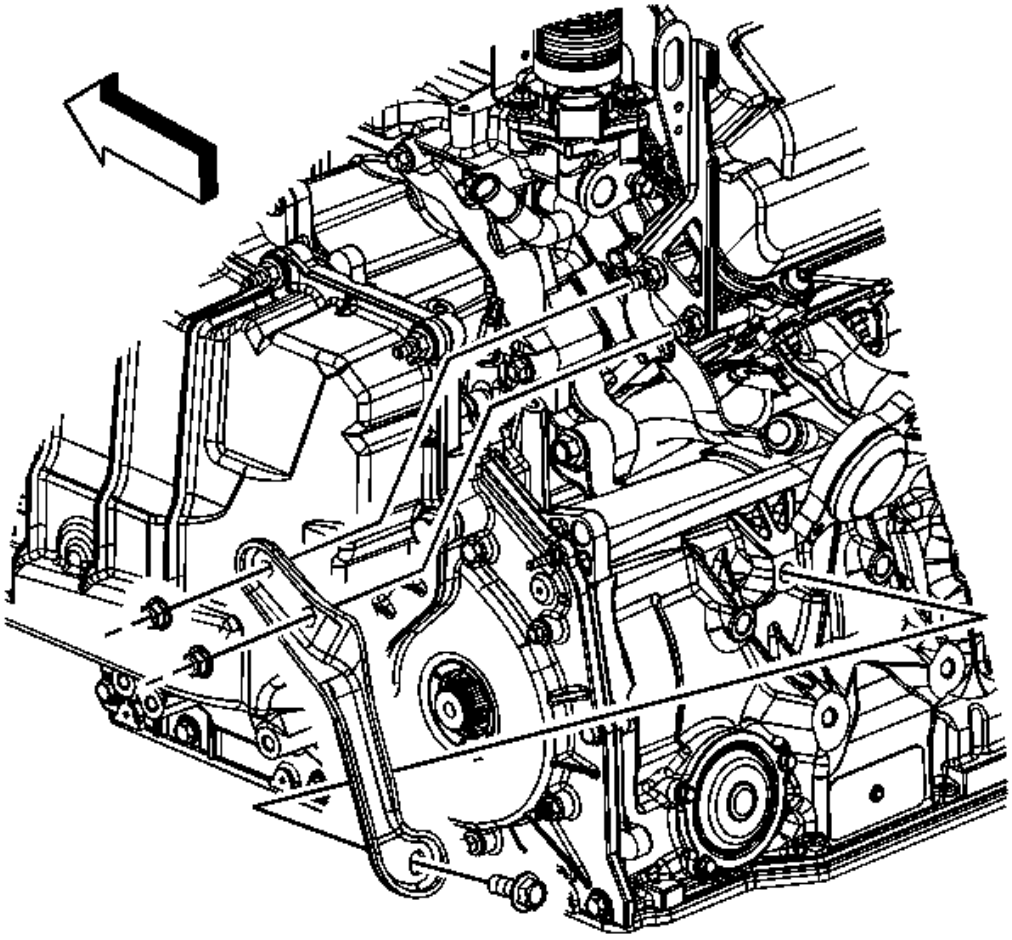


Fig. 43: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the transaxle brace lower bolt.
3. Lower the vehicle.
4. Remove the transaxle brace nuts.

 © 2011 Mitchell Repair Information Company, LLC.

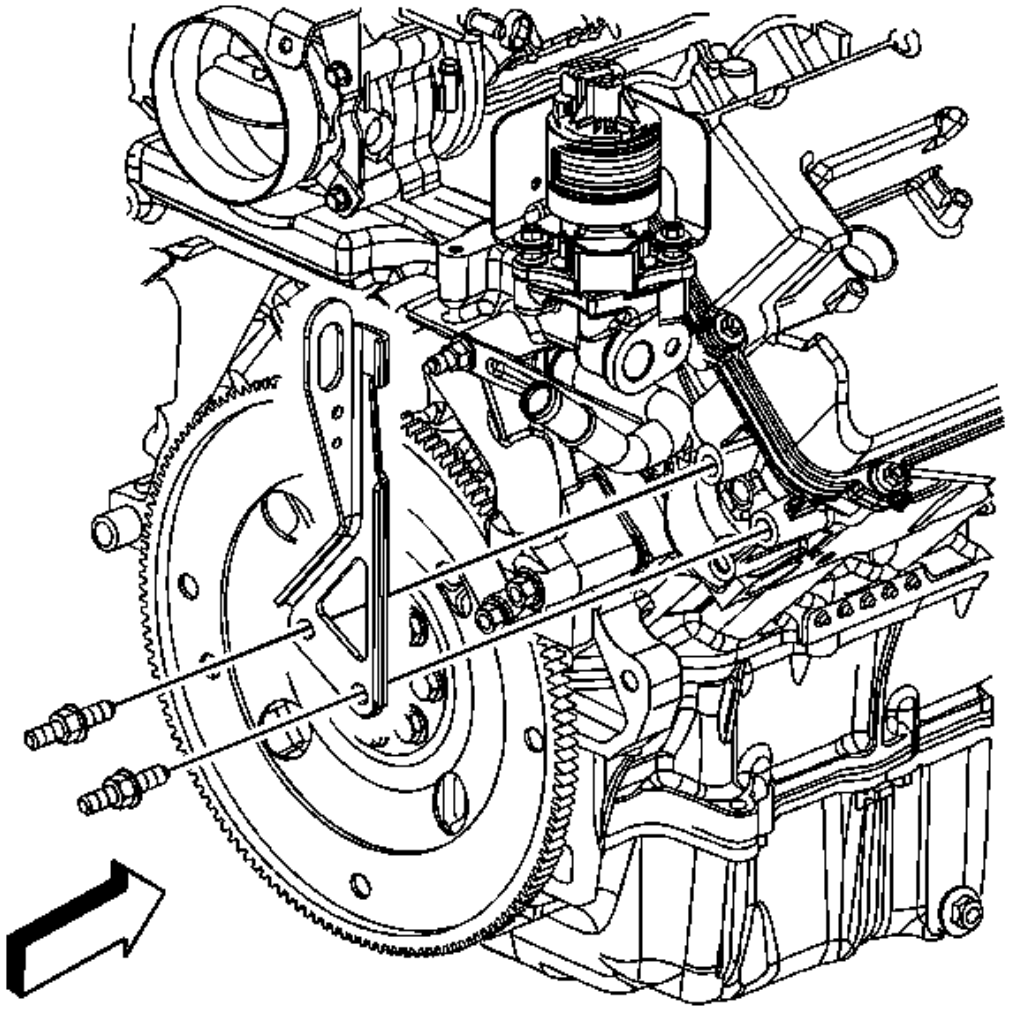


Fig. 44: Identifying Engine Rear Lift Bracket Studs
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine lift bracket studs.
6. Remove the engine lift bracket.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

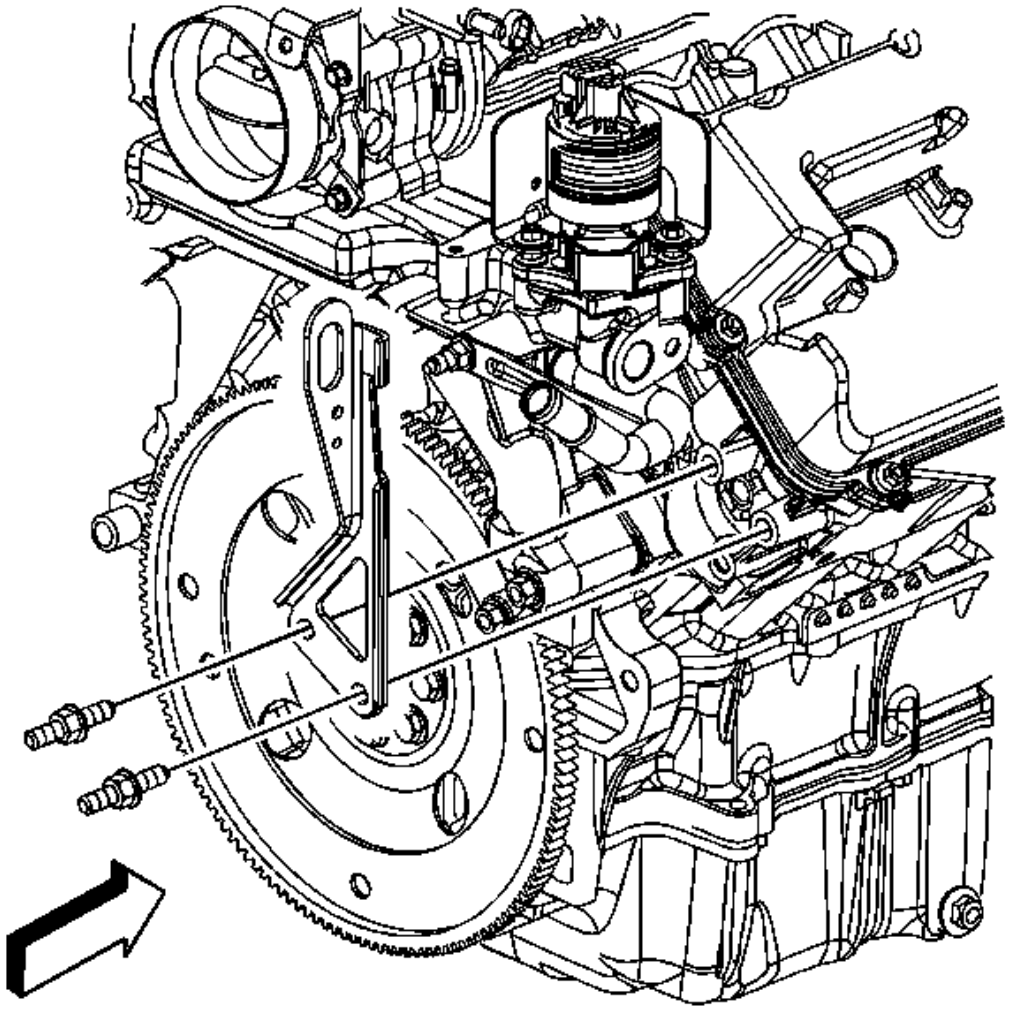


Fig. 45: Identifying Engine Rear Lift Bracket Studs
Courtesy of GENERAL MOTORS COMPANY

1. Position the engine lift bracket to the cylinder head.

CAUTION: Refer to Fastener Caution .

2. Install the engine lift bracket studs.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the studs to 50 N.m (37 lb ft).

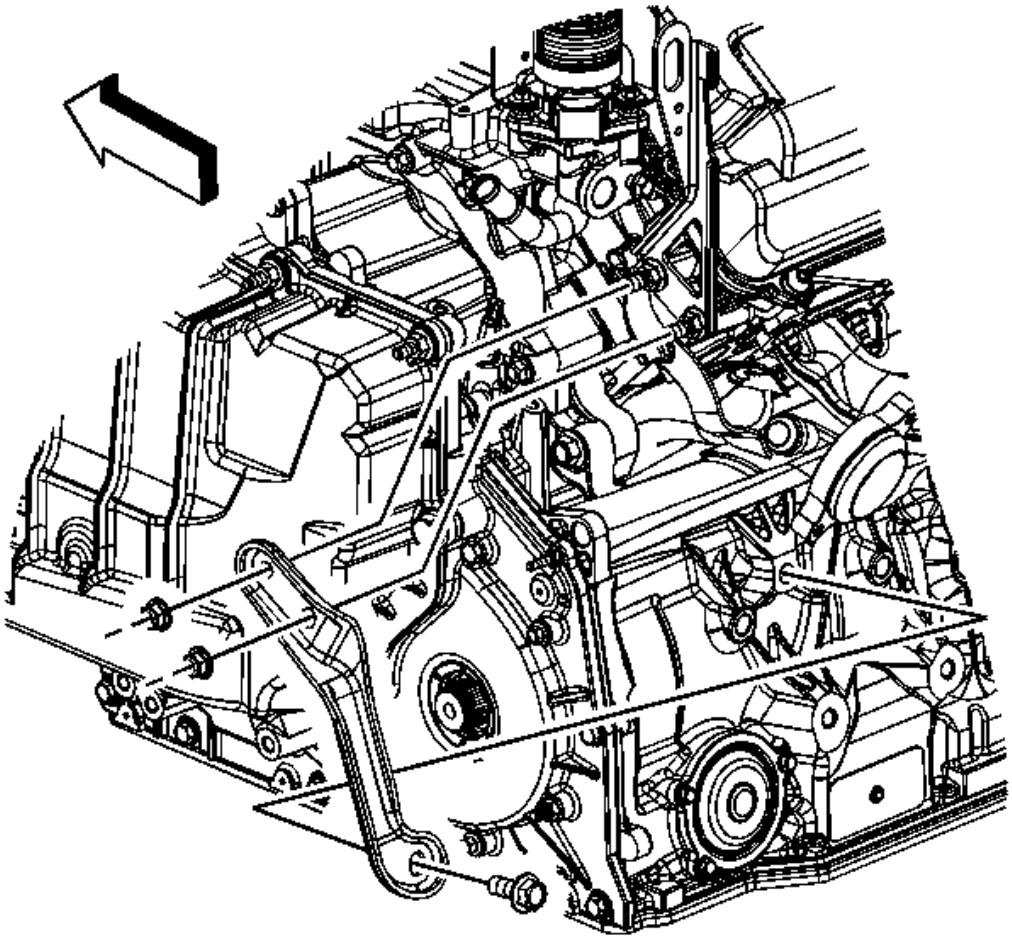


Fig. 46: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Install the transaxle brace onto the lift bracket studs.
4. Install the transaxle brace nuts until sung.
5. Raise the vehicle.
6. Install the transaxle brace bolt.

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

7. Lower the vehicle.
8. Tighten the transaxle brace nuts.

Tighten

Tighten the nuts to 50 N.m (37 lb ft).

FUEL INJECTOR SIGHT SHIELD REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

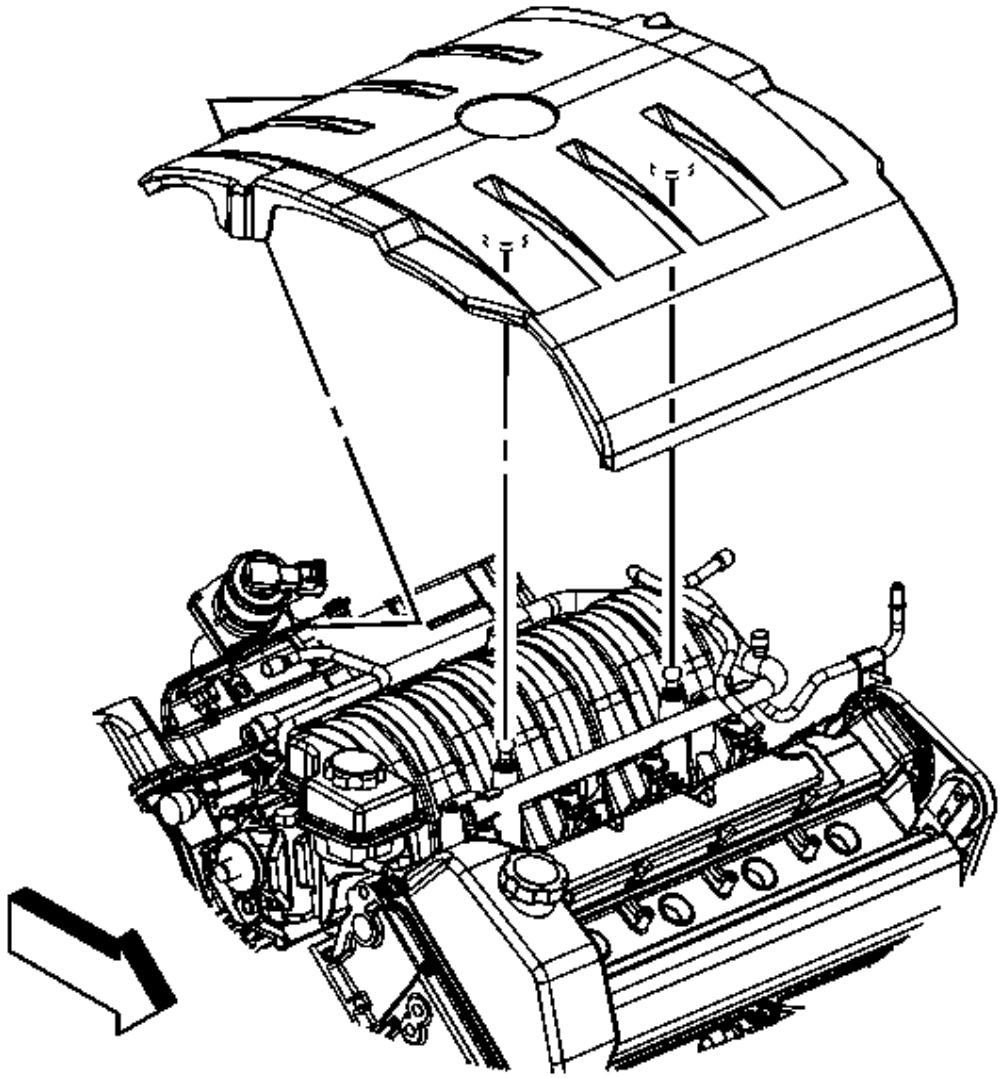


Fig. 47: Identifying Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS COMPANY

1. Grasp the intake manifold sight shield cover at the left side, lift up in order to disengage the cover from the ball stud.
2. Grasp the intake manifold sight shield cover at the right side, lift up in order to disengage the cover from the ball stud.
3. Remove the intake manifold sight shield cover from under the tab on the secondary air injection (AIR) check valve bracket.

 © 2011 Mitchell Repair Information Company, LLC.

4. Remove the intake manifold sight shield cover.

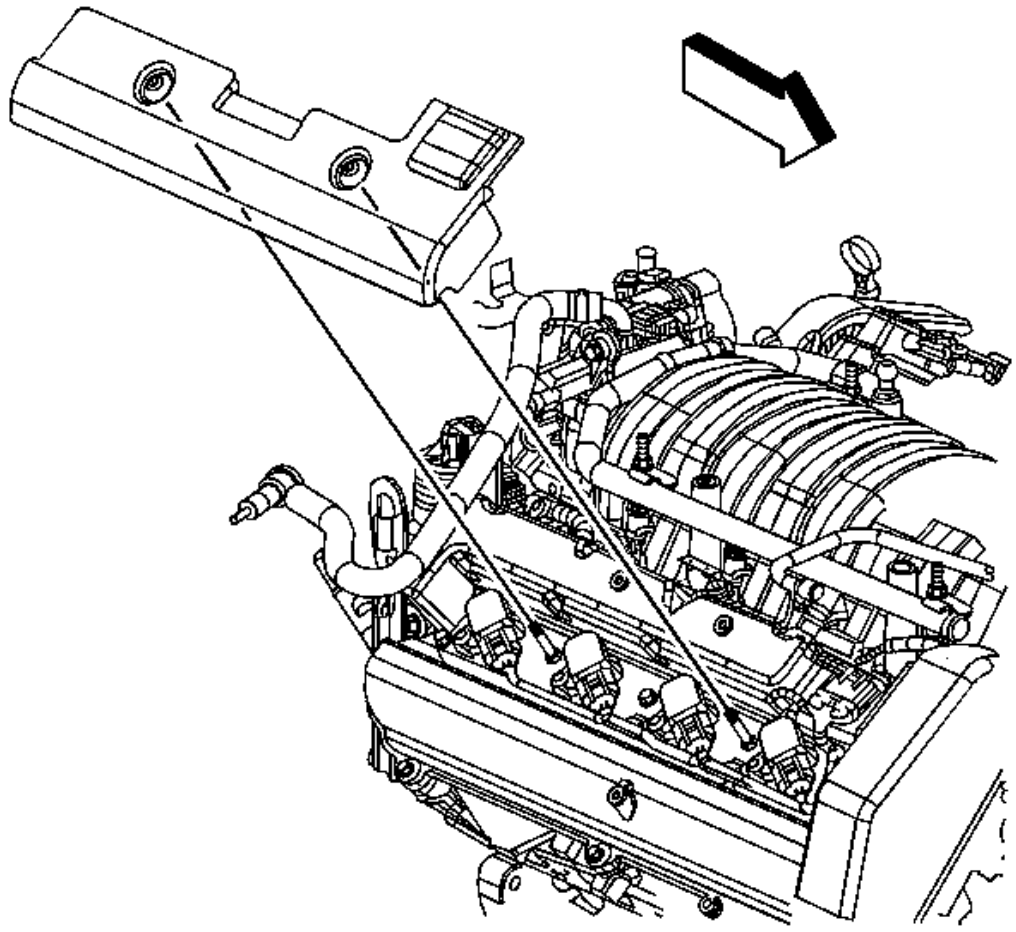


Fig. 48: Identifying Rear Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS COMPANY

5. If necessary to remove the rear intake manifold sight shield perform the following steps, remove the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .
6. Grasp the rear intake manifold sight shield cover and lift up in order to disengage the cover from the ball studs.
7. Remove the rear intake manifold sight shield cover.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

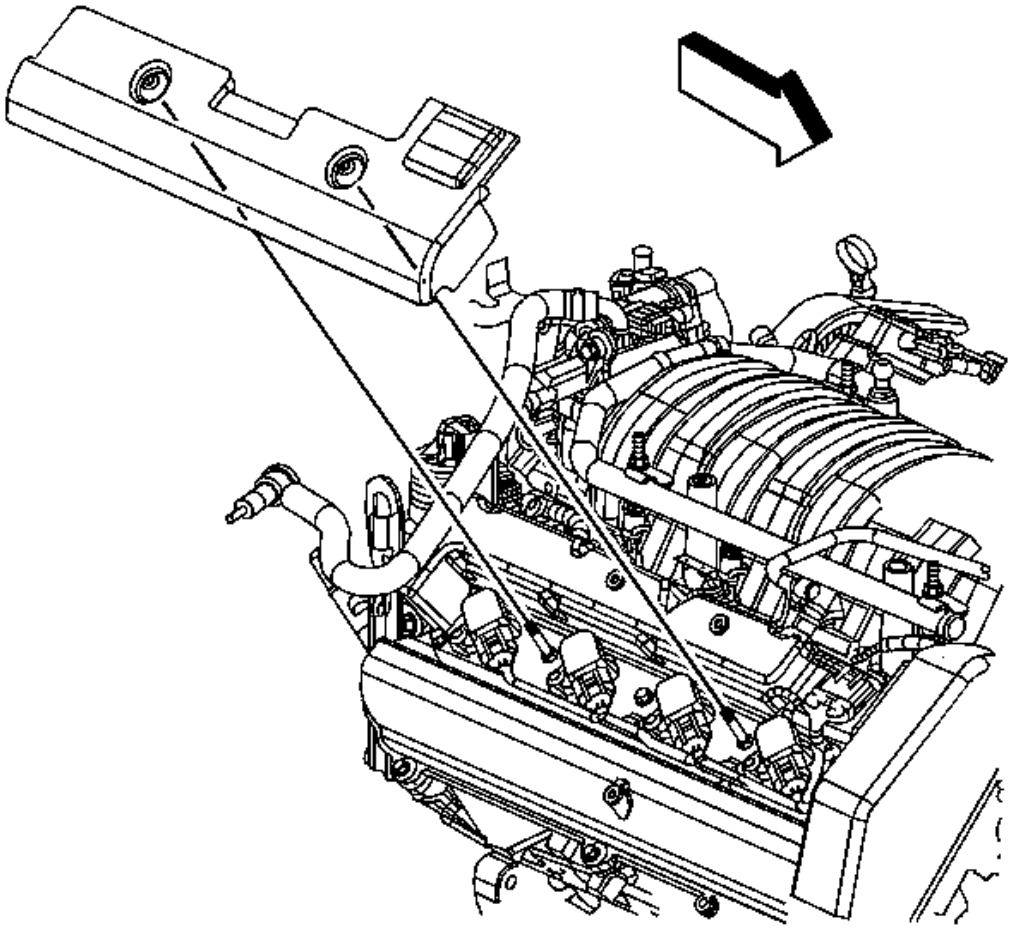


Fig. 49: Identifying Rear Intake Manifold Sight Shield
Courtesy of GENERAL MOTORS COMPANY

1. If necessary to install the rear intake manifold sight shield perform the following steps, position the rear intake manifold sight shield cover over the ball studs.
2. Press down on the rear intake manifold sight shield cover over the balls stud in order to engage the cover to the ball studs.
3. Install the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

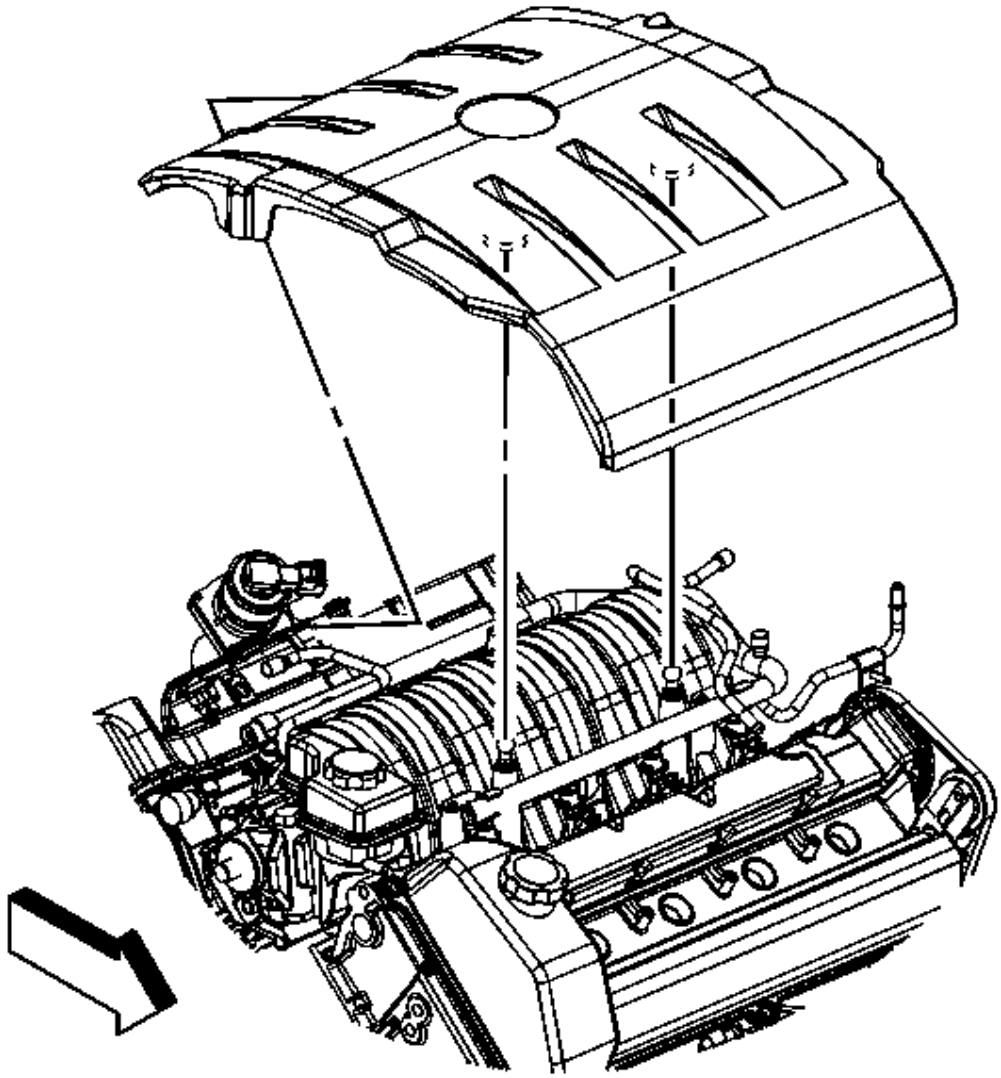


Fig. 50: Identifying Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold sight shield cover under the tab on the AIR check valve bracket.
5. Position the intake manifold sight shield cover over the ball studs.
6. Press down on the intake manifold sight shield cover over the balls stud in order to engage the cover to the ball studs.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

 © 2011 Mitchell Repair Information Company, LLC.

Removal Procedure

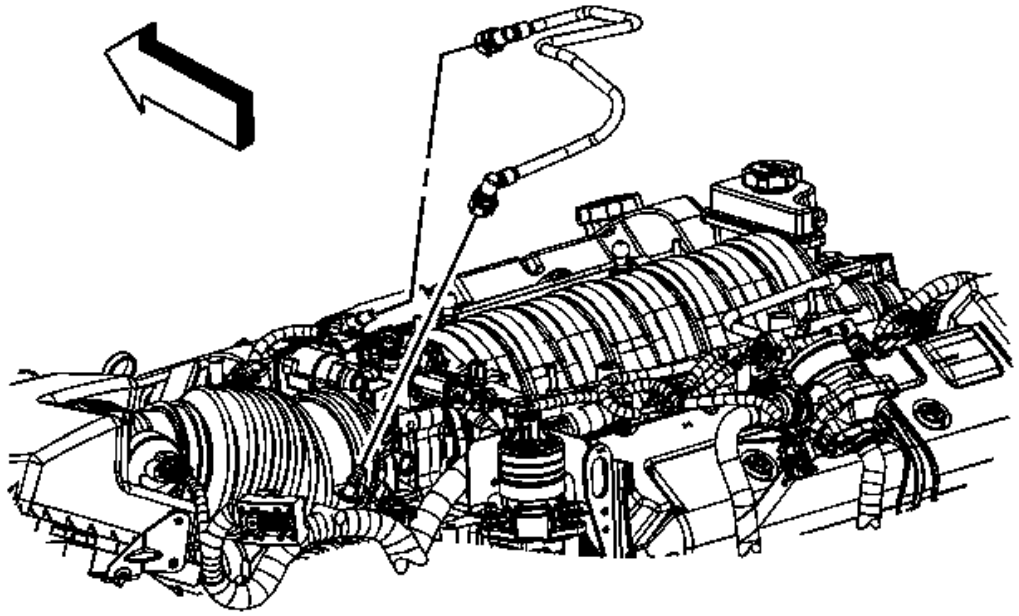


Fig. 51: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. If servicing the positive ventilation crankcase (PCV) fresh air tube, perform the following steps, disconnect the PCV fresh air tube quick connect fitting at the left camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
3. Disconnect the PCV fresh air tube quick connect fitting at the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service** .
4. Remove the PCV fresh air tube from under the brake booster vacuum hose and evaporative emission (EVAP) purge solenoid.

 © 2011 Mitchell Repair Information Company, LLC.

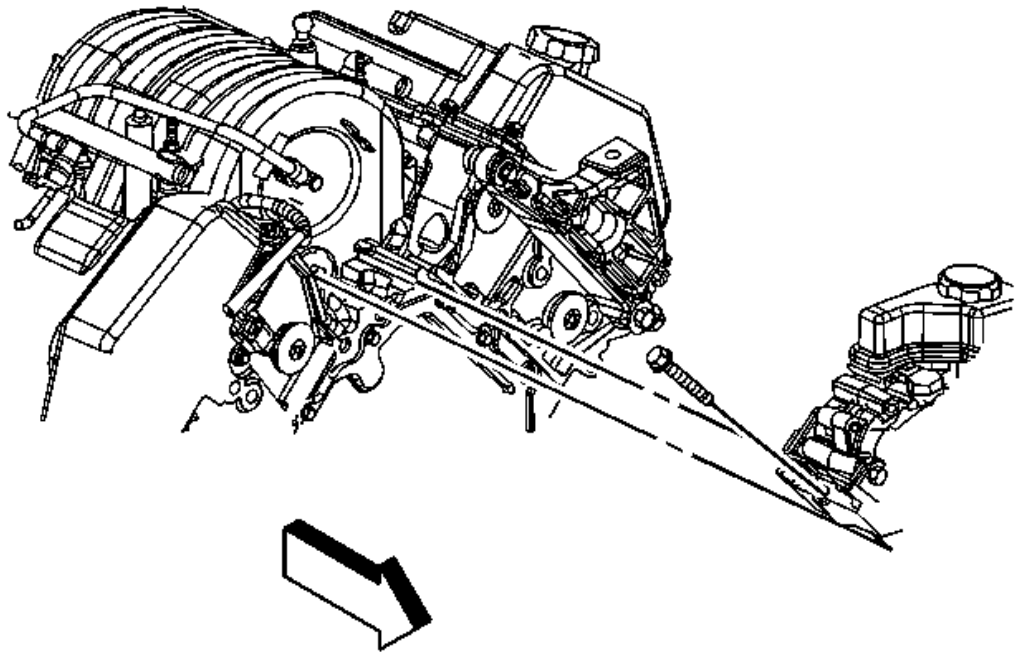


Fig. 52: View Of Power Steering Pump
Courtesy of GENERAL MOTORS COMPANY

5. If servicing the PCV foul air tube, perform the following steps, remove the drive belt. Refer to **Drive Belt Replacement**.
6. Remove the power steering pump bolt.
7. With the power steering hoses attached, Carefully position the power steering pump aside.

 © 2011 Mitchell Repair Information Company, LLC.

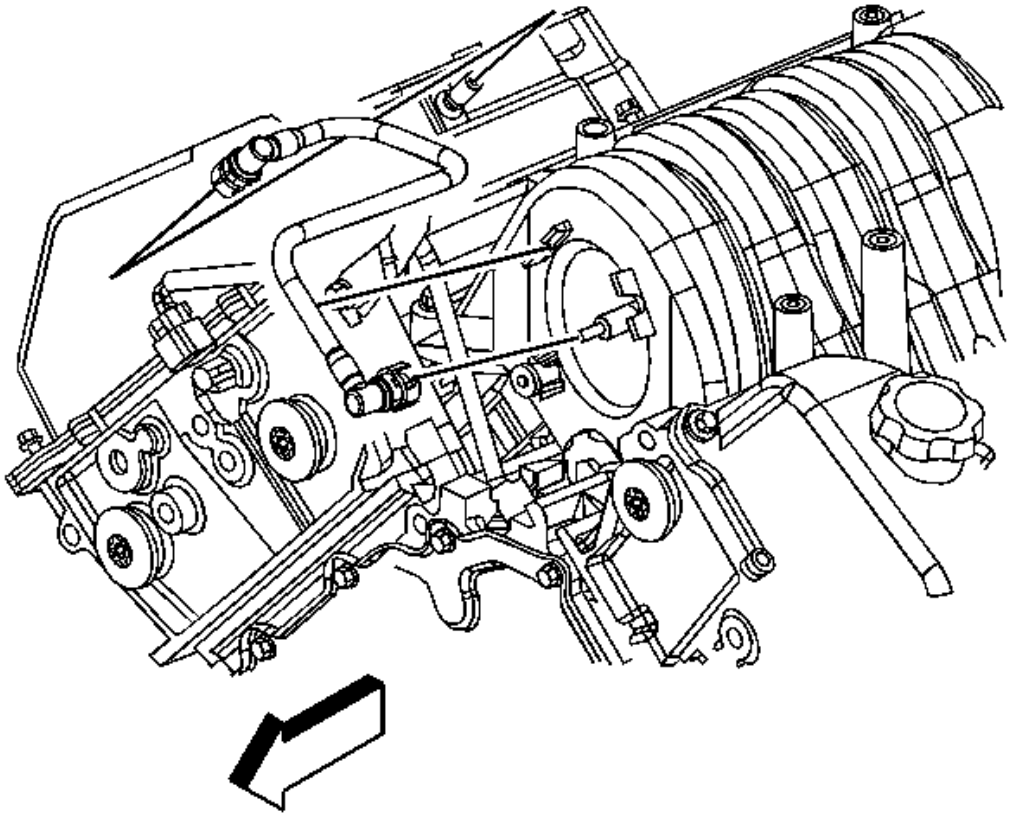


Fig. 53: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the PCV foul air tube quick connect fitting at the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Disconnect the PCV foul air tube quick connect fitting at the intake manifold fitting. Refer to **Plastic Collar Quick Connect Fitting Service** .
10. Remove the PCV foul air tube from the retaining features on the intake manifold.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

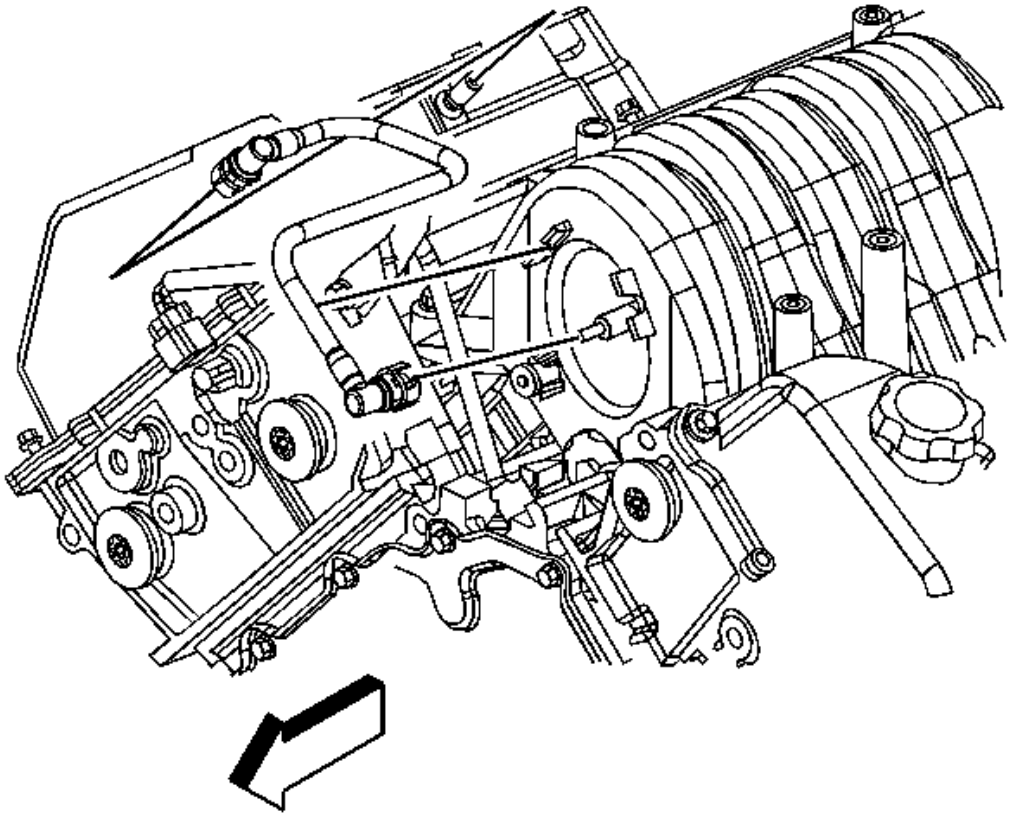


Fig. 54: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

1. If servicing the PCV foul air tube, perform the following steps, connect the PCV foul air tube quick connect fitting to the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
2. Connect the PCV foul air tube quick connect fitting at the intake manifold fitting. Refer to **Plastic Collar Quick Connect Fitting Service** .
3. Install the PCV foul air tube to the retaining features on the intake manifold.

 © 2011 Mitchell Repair Information Company, LLC.

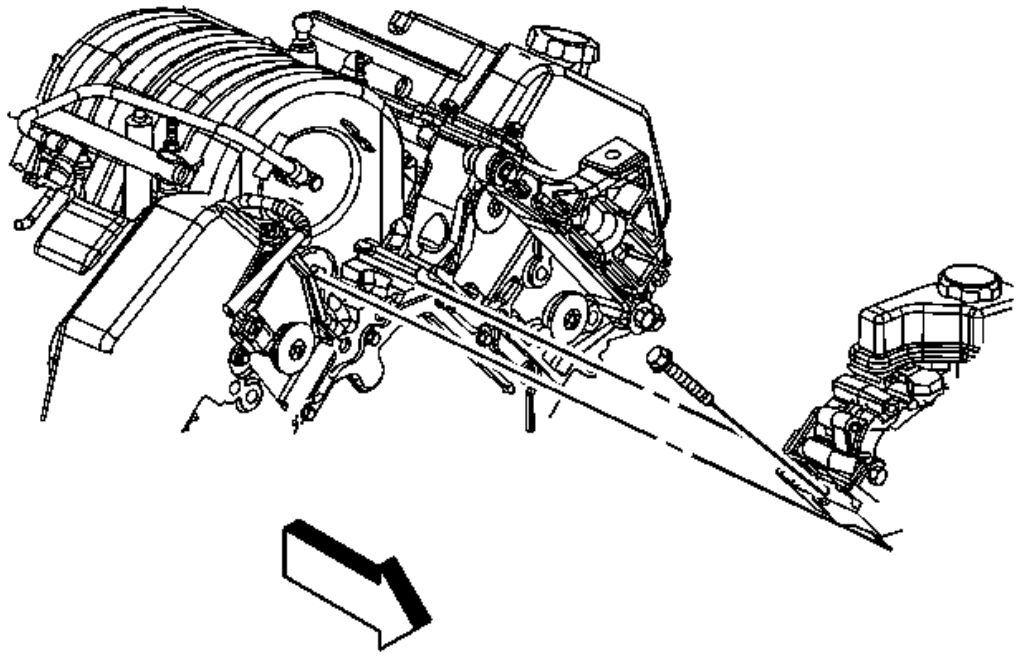


Fig. 55: View Of Power Steering Pump
Courtesy of GENERAL MOTORS COMPANY

4. Install the power steering pump into position.

CAUTION: Refer to Fastener Caution .

5. Install the power steering pump bolt.

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

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

 © 2011 Mitchell Repair Information Company, LLC.

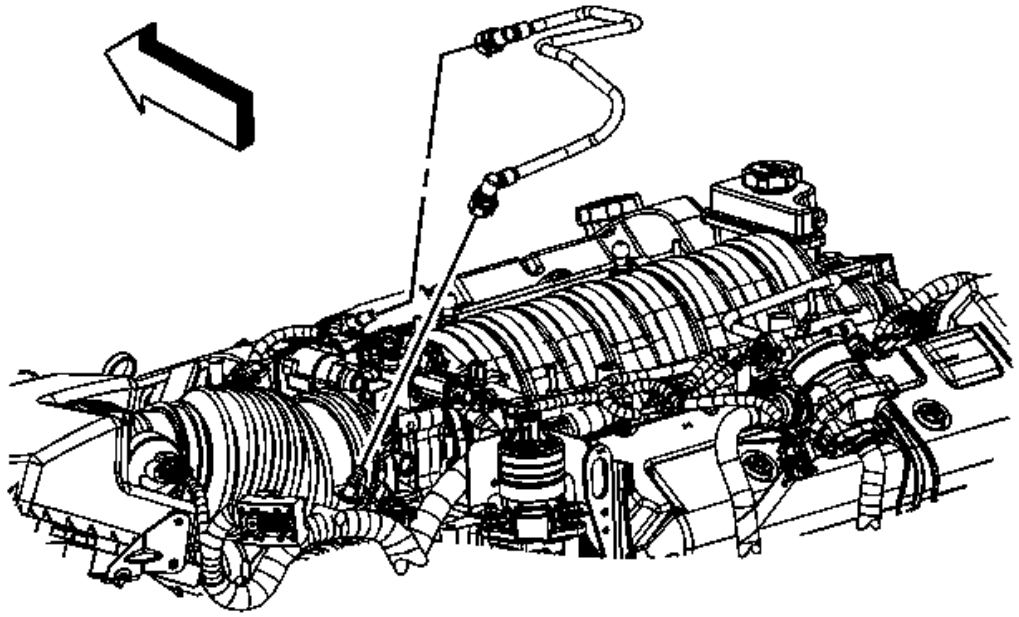


Fig. 56: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

7. If servicing the PCV fresh air tube, perform the following steps, route the PCV fresh air tube under the brake booster vacuum hose and EVAP purge solenoid.
8. Connect the PCV fresh air tube quick connect fitting at the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service** .
9. Connect the PCV fresh air tube quick connect fitting at the left camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
10. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

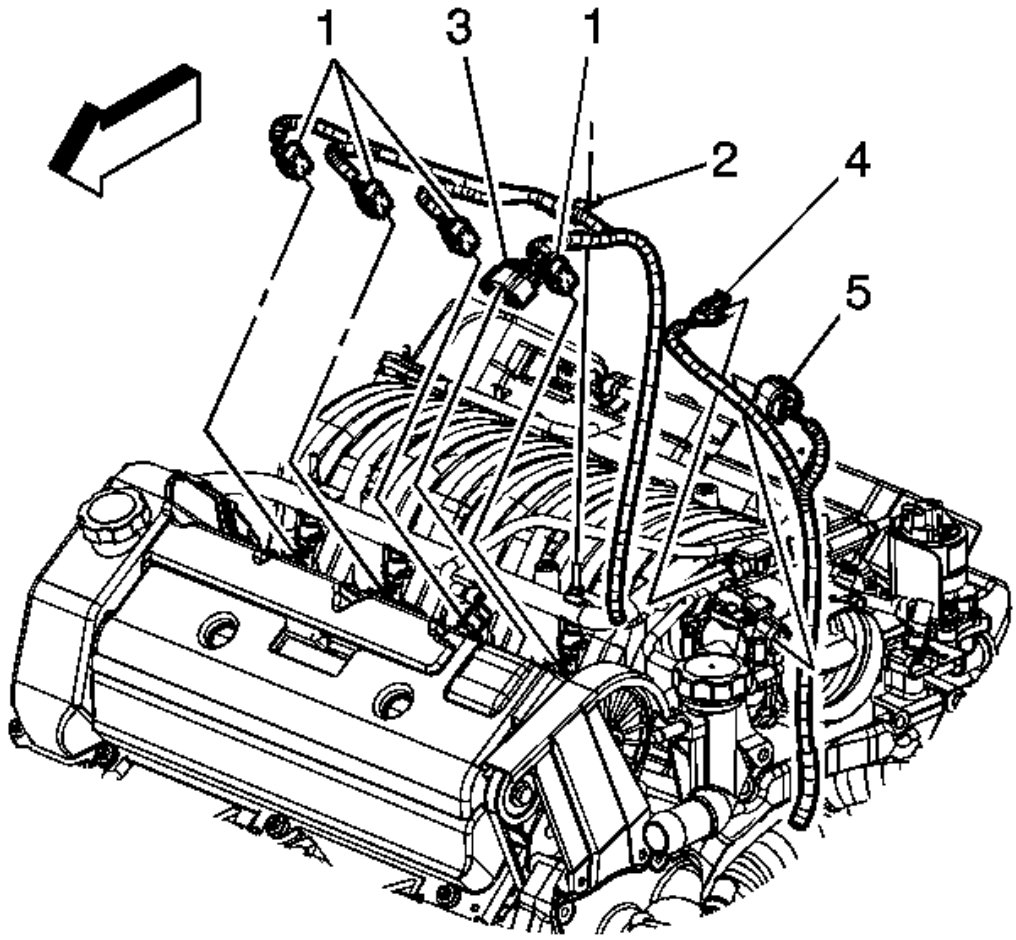


Fig. 57: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injector sight shield cover. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Disconnect the front ignition coil module engine harness electrical connector (3).
4. Disconnect the front fuel injectors engine harness electrical connectors (1).

 © 2011 Mitchell Repair Information Company, LLC.

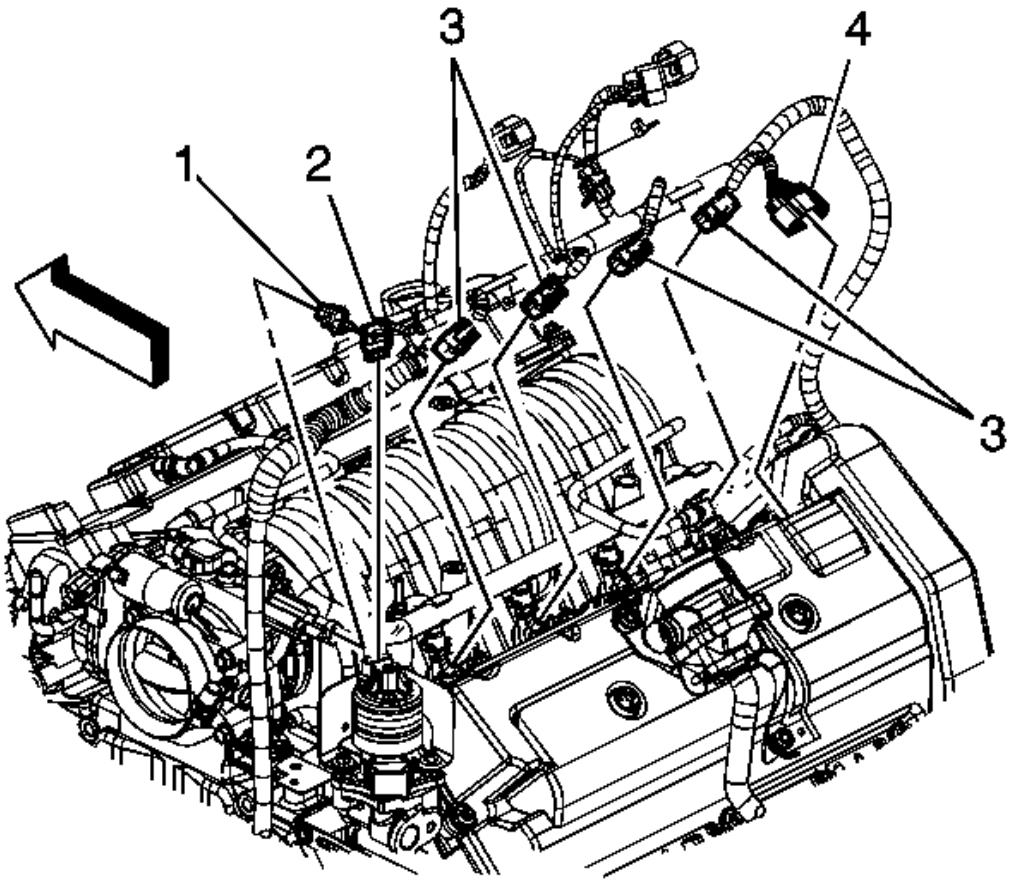


Fig. 58: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the rear ignition coil module engine harness electrical connector (4).
6. Disconnect the rear fuel injectors engine harness electrical connectors (3).

 © 2011 Mitchell Repair Information Company, LLC.

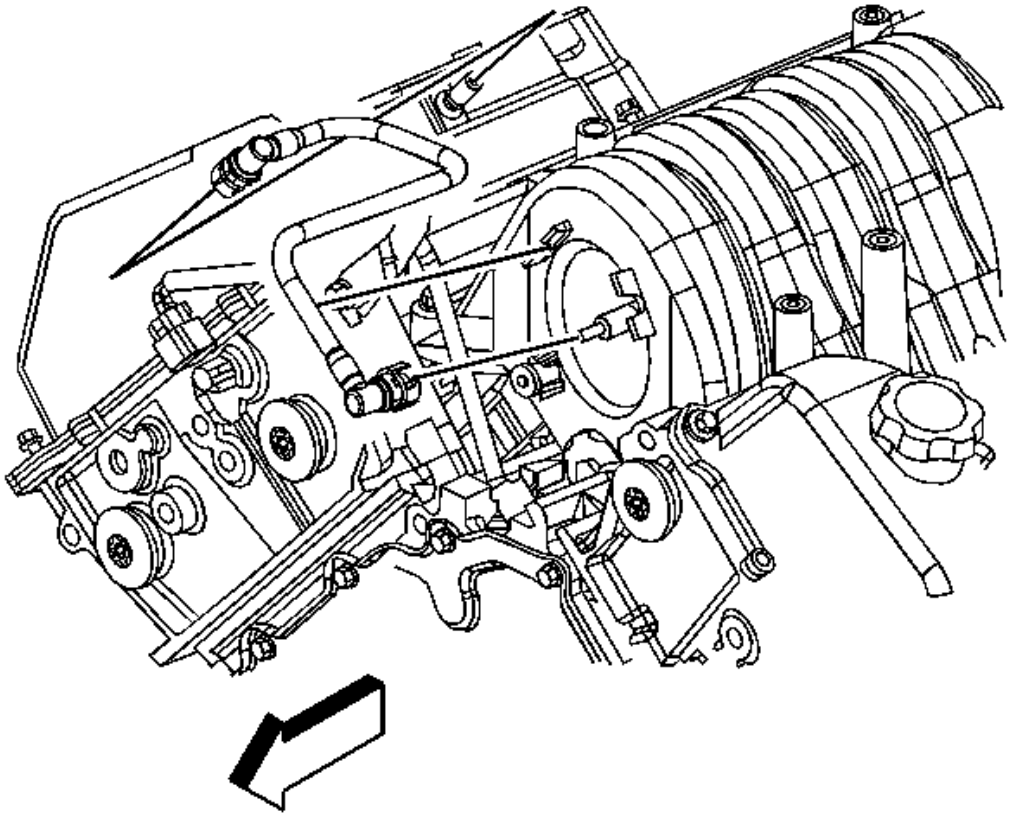


Fig. 59: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the positive crankcase ventilation (PCV) foul air tube quick connect fitting from the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

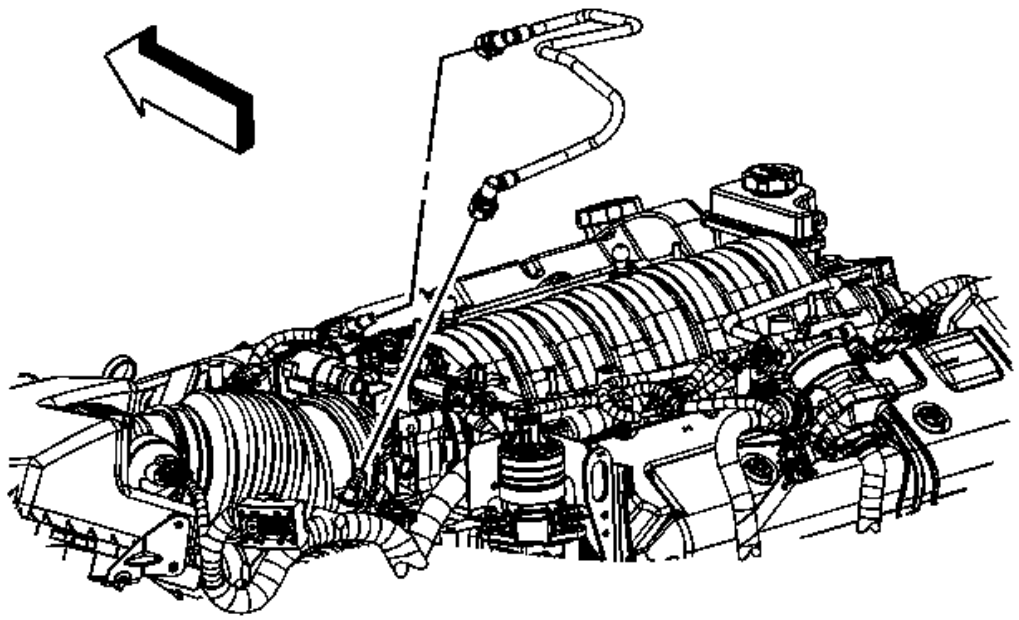


Fig. 60: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the PCV fresh air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

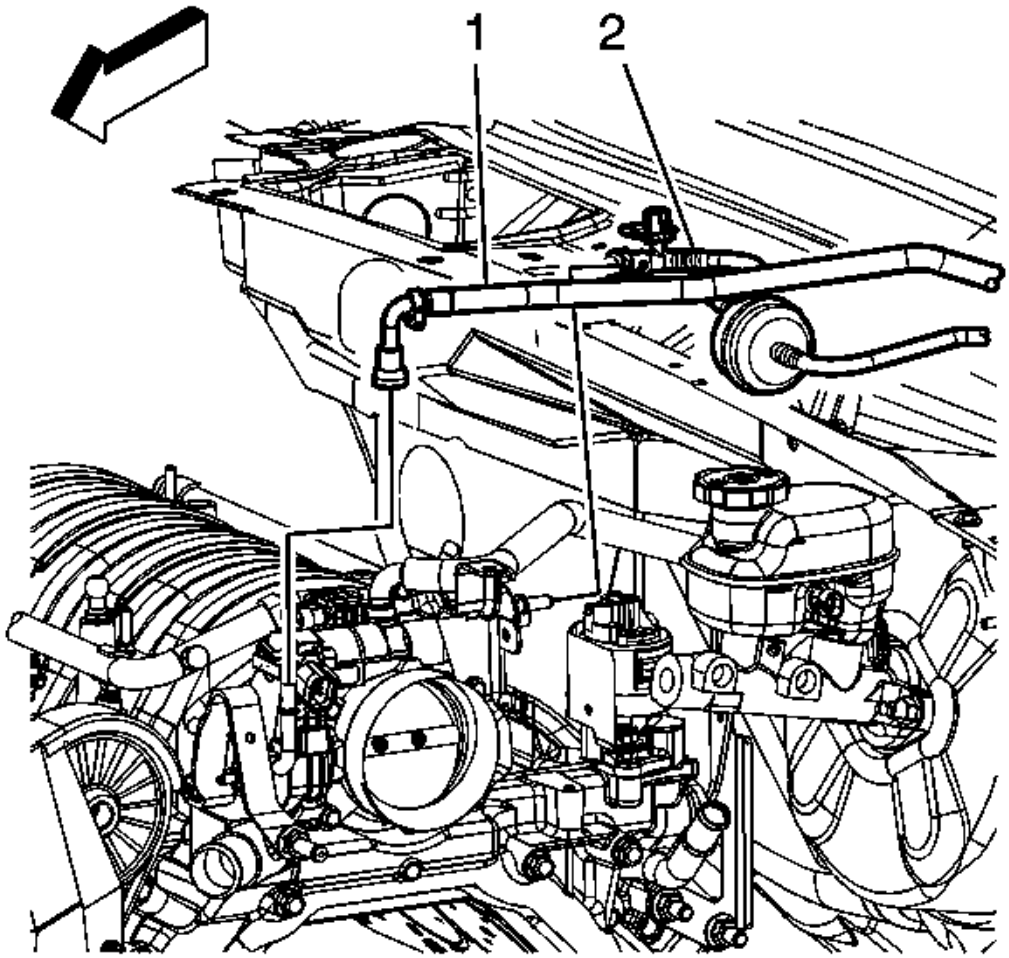


Fig. 61: Fuel Feed & EVAP Line
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the fuel feed line (1) quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

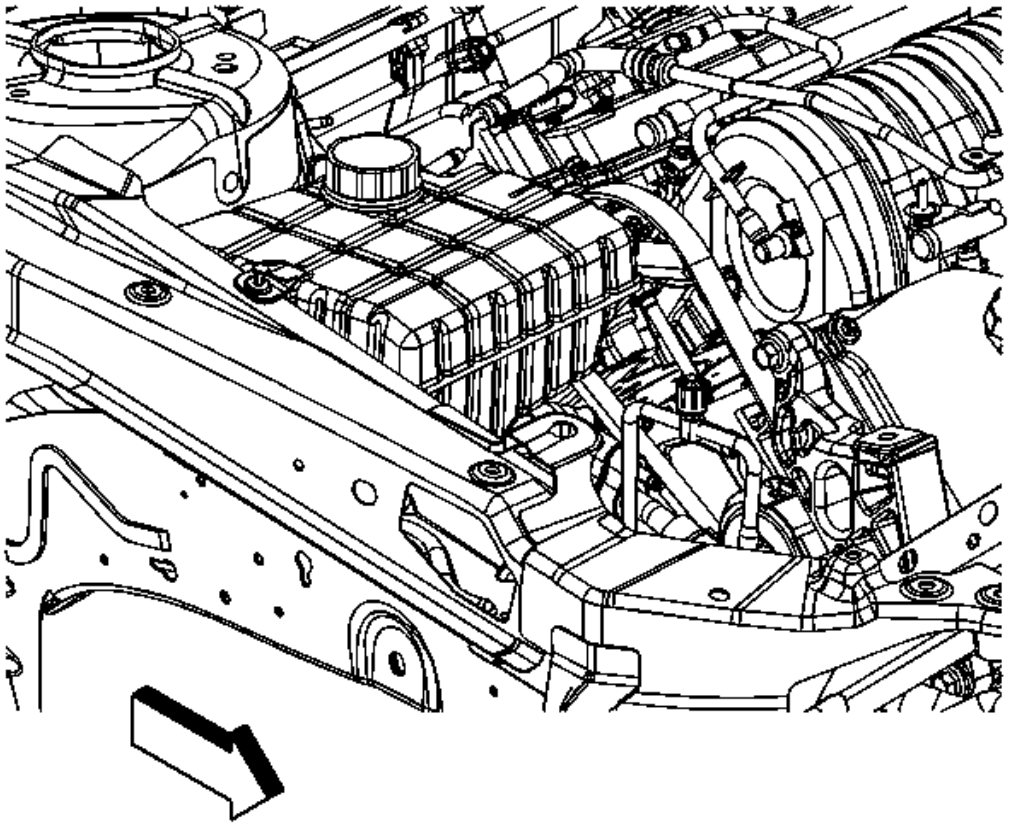


Fig. 62: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Reposition the radiator surge tank inlet hose/pipe clamp at the surge tank.
11. Remove the surge tank inlet hose/pipe from the surge tank.

 © 2011 Mitchell Repair Information Company, LLC.

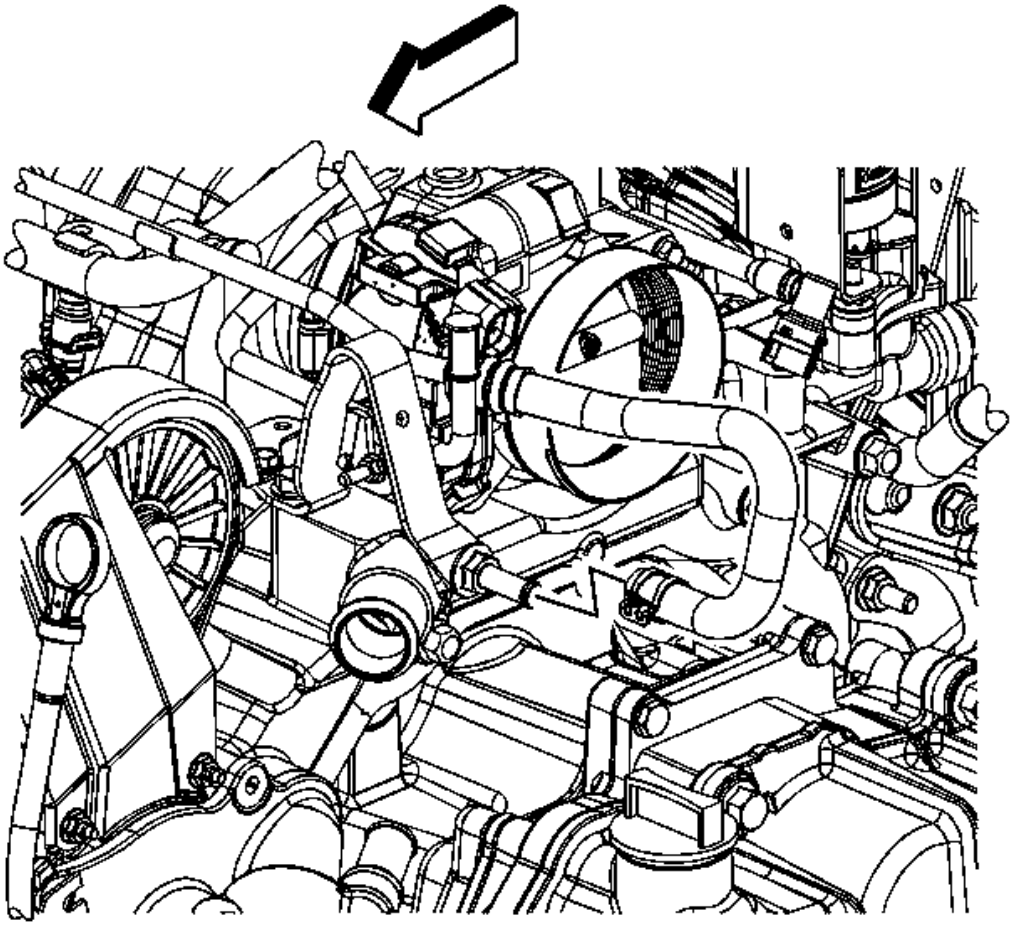


Fig. 63: View Of Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

12. Reposition the radiator surge tank inlet hose/pipe clamp at the engine.
13. Remove the surge tank inlet hose/pipe from the engine fitting.

 © 2011 Mitchell Repair Information Company, LLC.

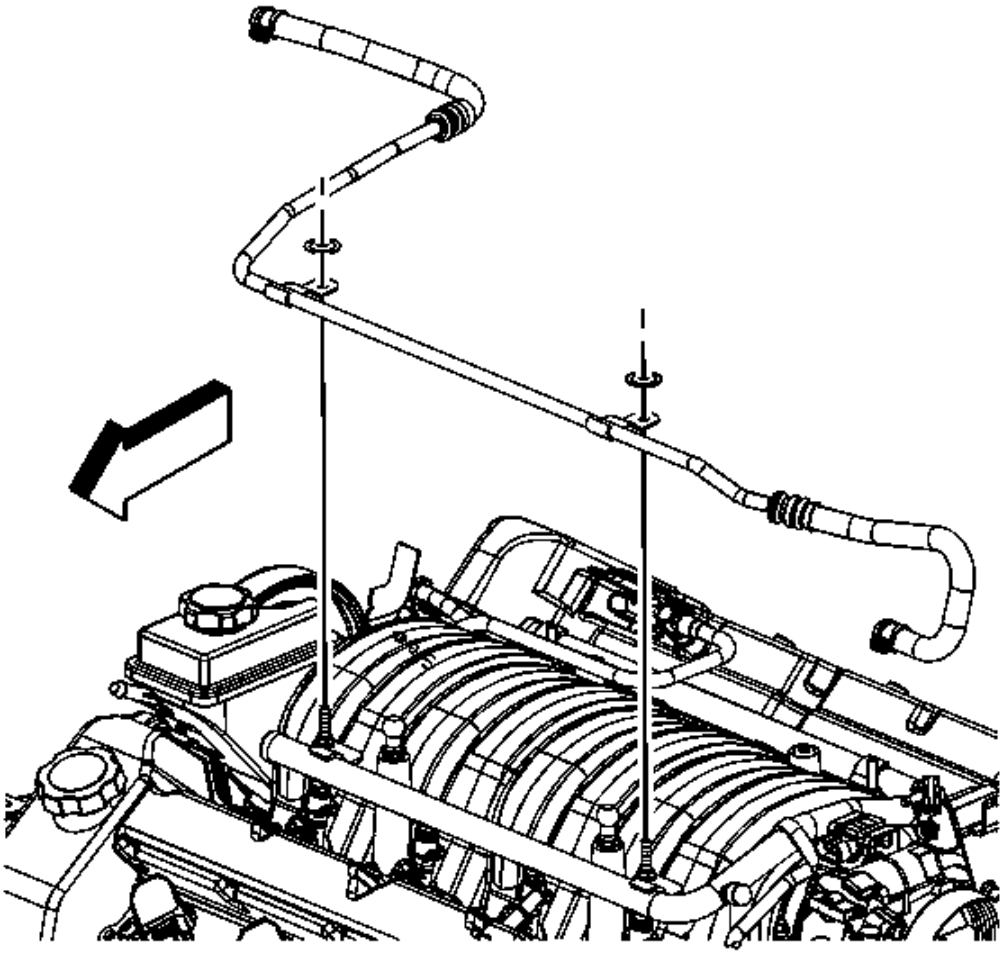


Fig. 64: Identifying Surge Tank Inlet Hose/Pipe & Clips
Courtesy of GENERAL MOTORS COMPANY

14. Remove the 2 pushnuts securing the surge tank inlet hose/pipe to the fuel rail studs.
15. Remove the surge tank inlet hose/pipe from the fuel rail studs.
16. Remove the engine harness retainer from the fuel rail stud.

 © 2011 Mitchell Repair Information Company, LLC.

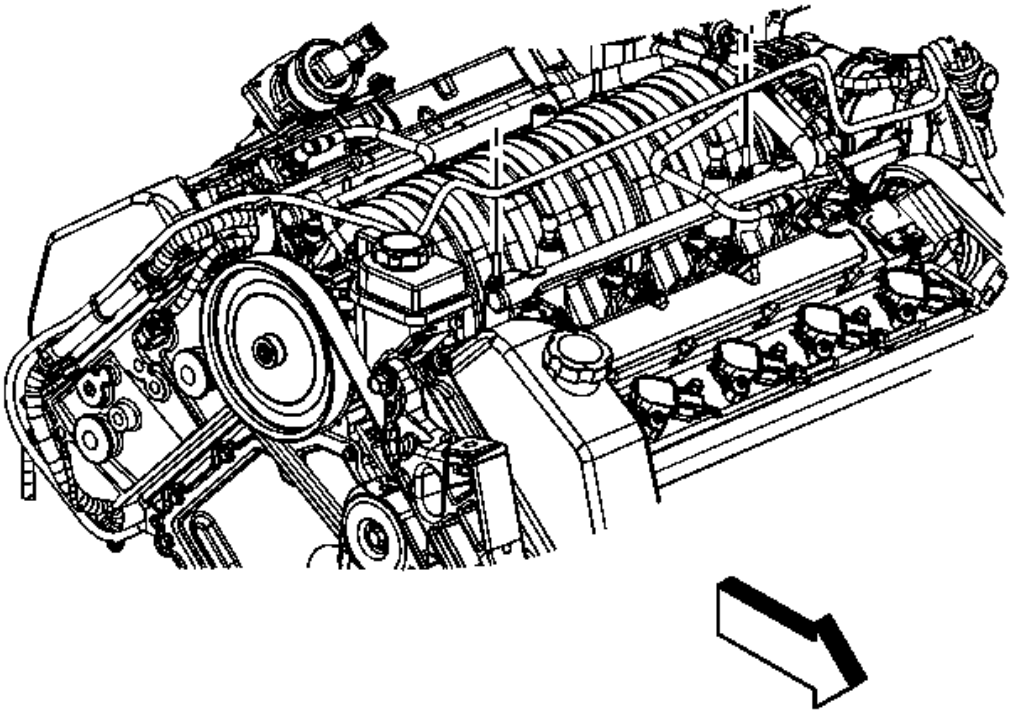


Fig. 65: Locating Coolant Heater Cord Tabs
Courtesy of GENERAL MOTORS COMPANY

17. Remove the coolant heater cord tabs from the fuel rail studs, if equipped.

 © 2011 Mitchell Repair Information Company, LLC.

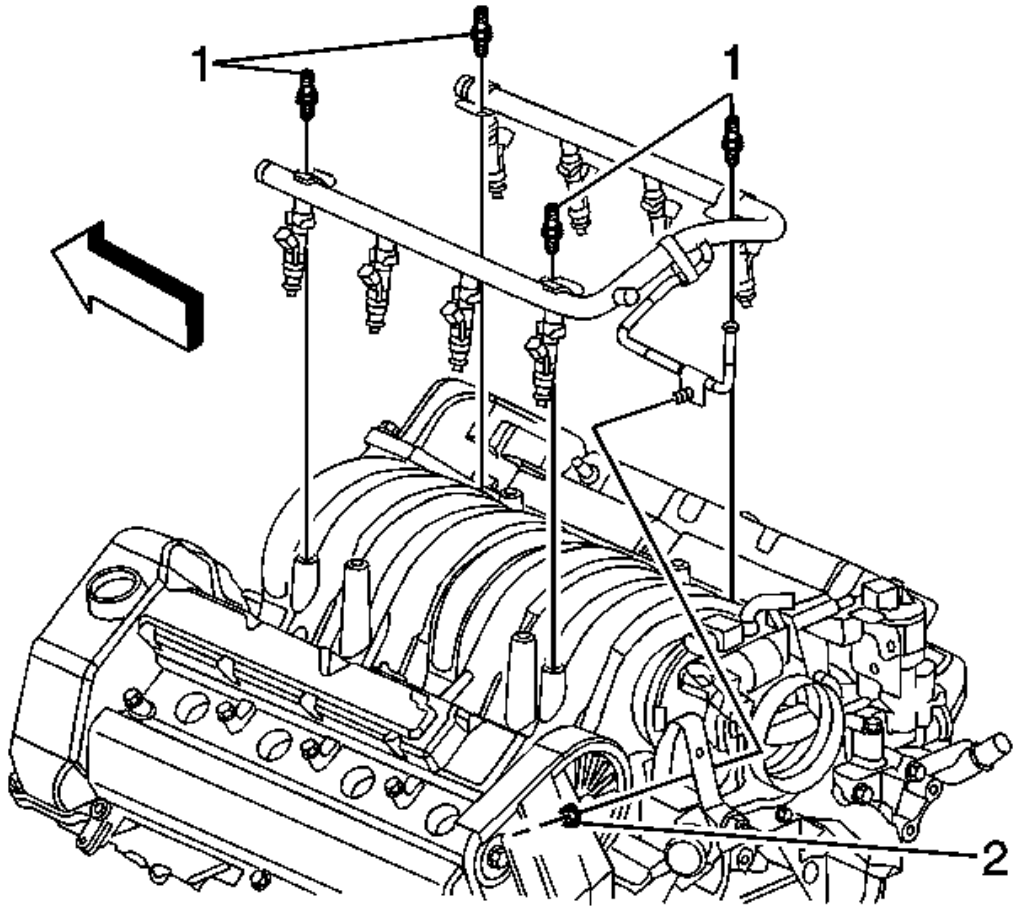


Fig. 66: View Of Fuel Rail, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove the fuel rail bracket nut at the rear left lift bracket.
19. Remove the fuel rail studs.
20. Remove the fuel rail.

 © 2011 Mitchell Repair Information Company, LLC.

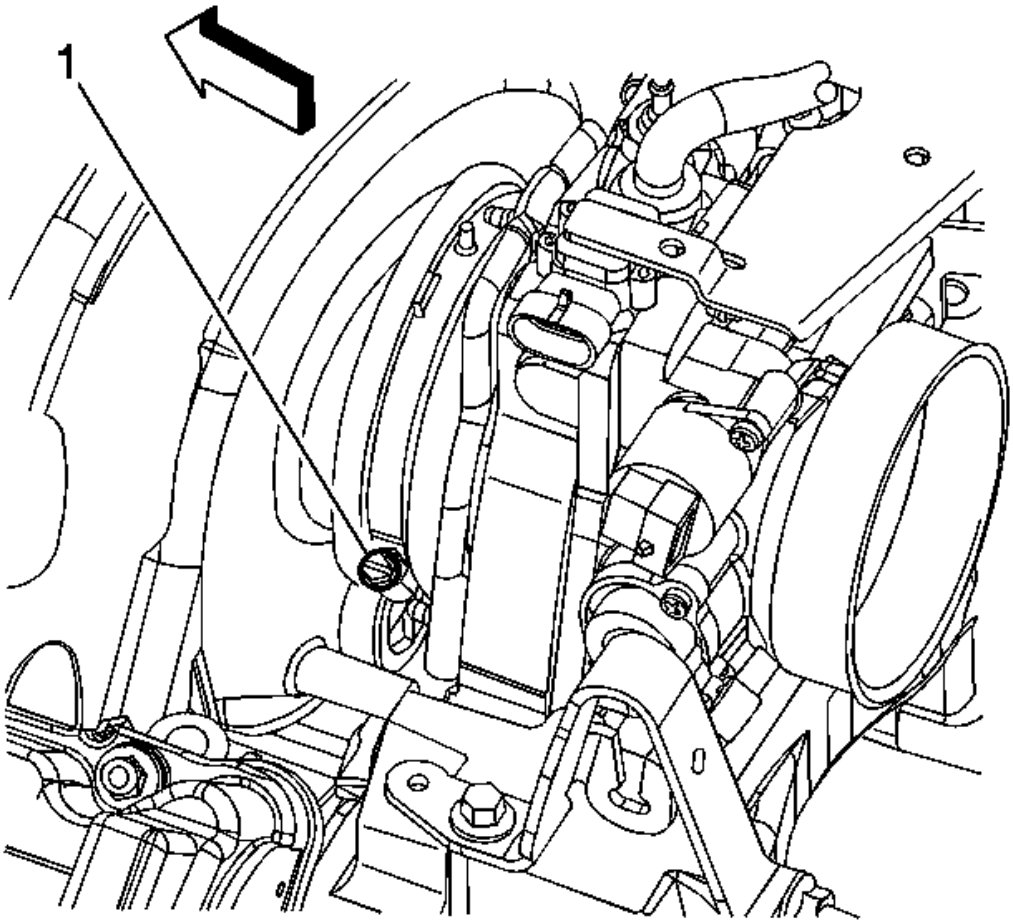


Fig. 67: Locating Plenum Duct Clamp Screw
Courtesy of GENERAL MOTORS COMPANY

21. Loosen the plenum duct clamp screw (1) at the water pump housing.

 © 2011 Mitchell Repair Information Company, LLC.

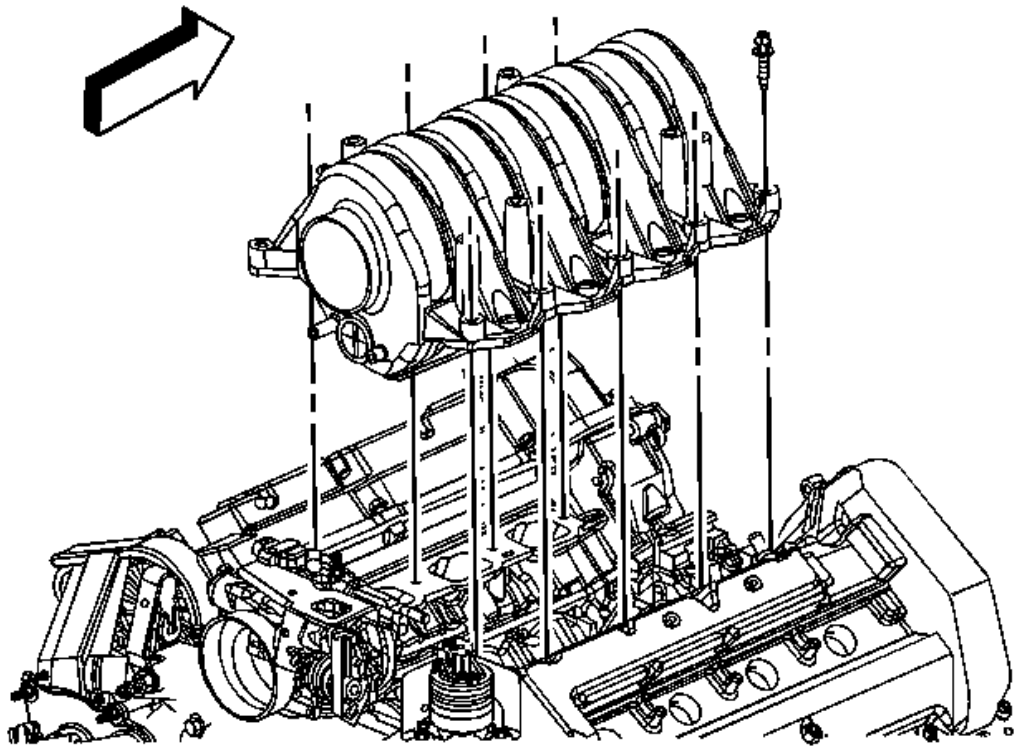


Fig. 68: View Of Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

22. Remove intake manifold bolts.
23. Position the power steering aside. Refer to **Power Steering Pump Replacement (L37)** .
24. Remove the intake manifold.
25. Disconnect the PCV foul air tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
26. Remove the PCV foul air tube from the retaining features on the intake manifold.
27. Remove and discard the old seals.
28. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

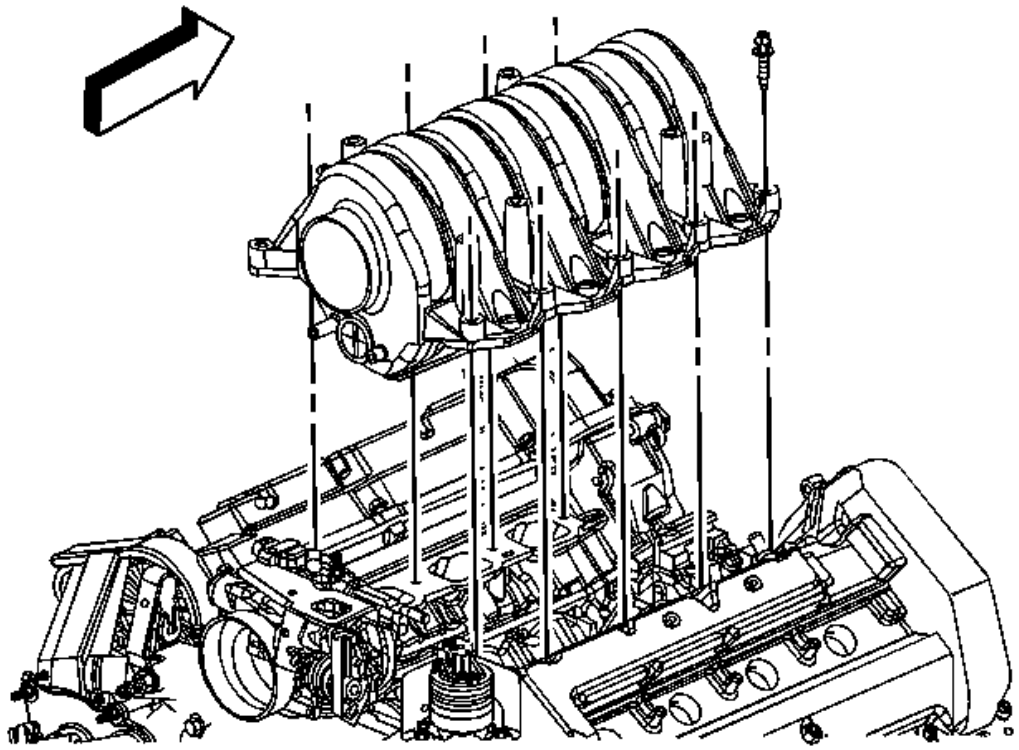


Fig. 69: View Of Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Install the new intake manifold seals.
2. Connect the PCV foul air tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
3. Install the PCV foul air tube to the retaining features on the intake manifold.
4. Lightly grease the inside edge of the rubber plenum duct on the water pump housing.
5. Install the intake manifold.
6. Install intake manifold bolts until snug.

 © 2011 Mitchell Repair Information Company, LLC.

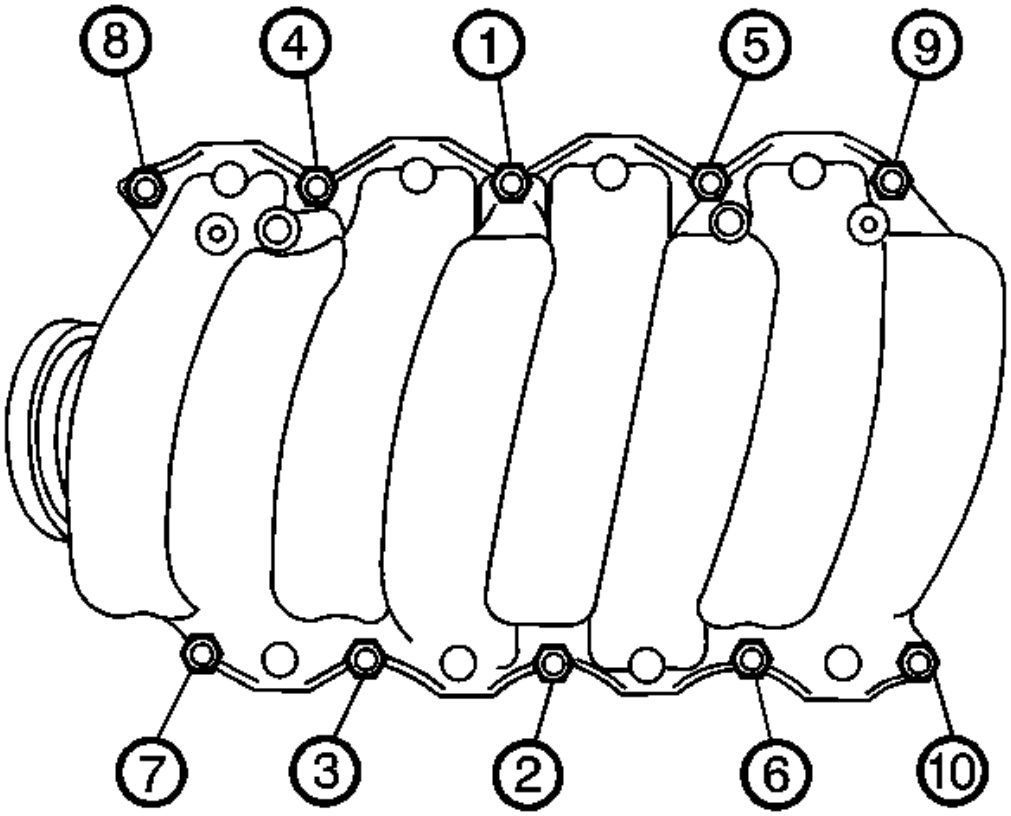


Fig. 70: View of Intake Manifold Bolt Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the intake manifold bolts.

   Tighten

   Tighten the bolts in the sequence shown to 10 N.m (89 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

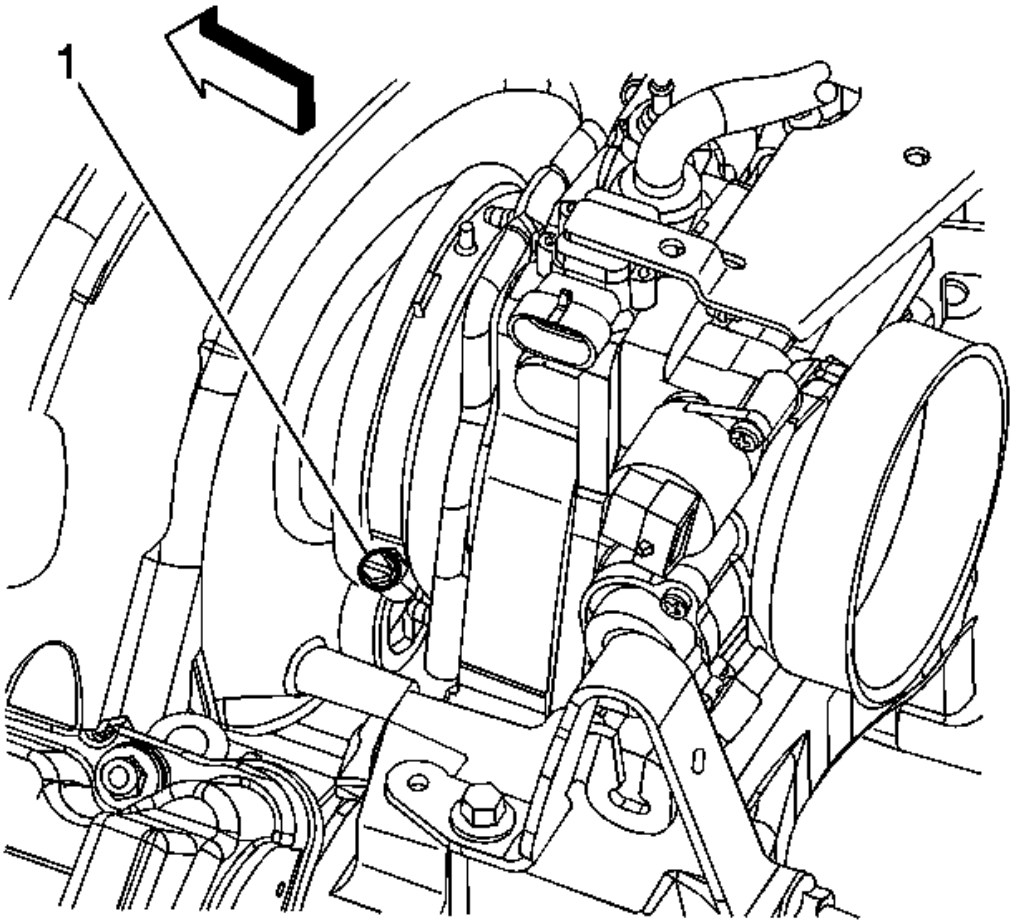


Fig. 71: Locating Plenum Duct Clamp Screw
Courtesy of GENERAL MOTORS COMPANY

8. Ensure that the intake manifold is fully installed into the plenum duct on the water pump housing.
9. Install the power steering pump. Refer to **Power Steering Pump Replacement (L37)** .
10. Tighten the plenum duct clamp screw (1) at the water pump housing.

Tighten

Tighten the screw to 2.75 N.m (24 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

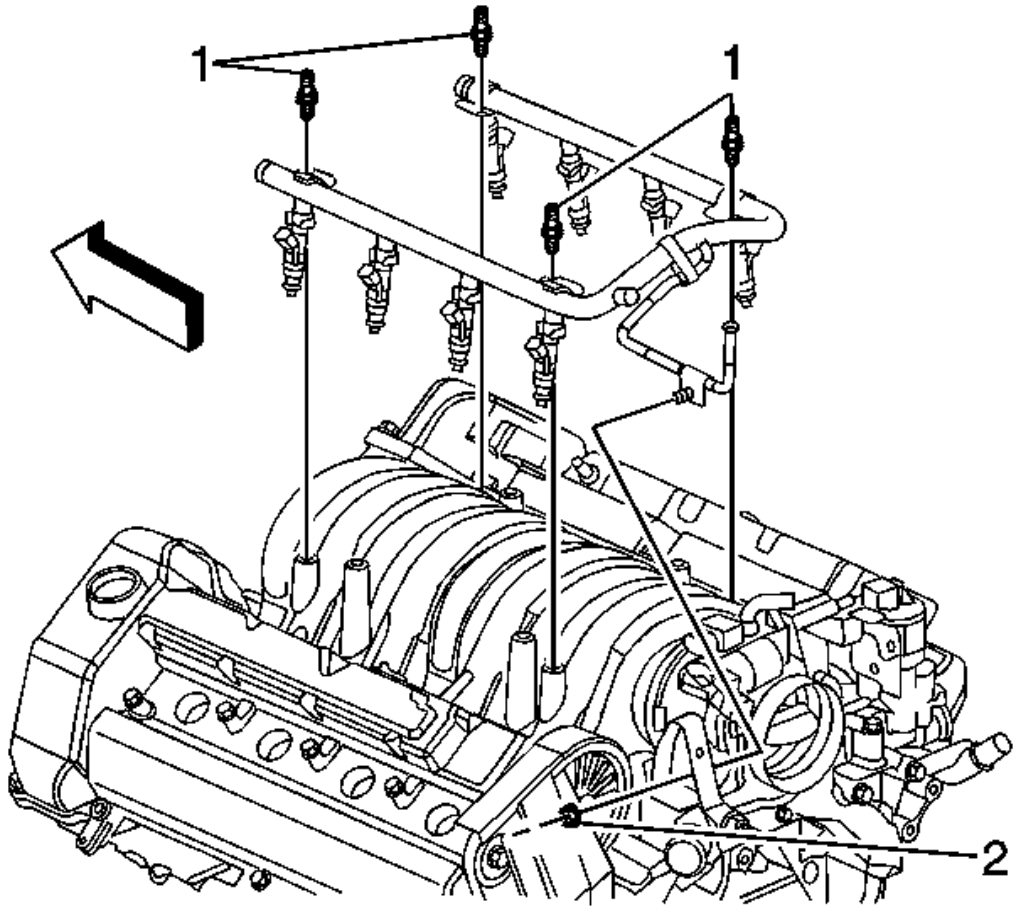


Fig. 72: View Of Fuel Rail, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Lubricate the fuel injector lower O-ring seals with clean engine oil.
12. Install the fuel rail.
13. Install the fuel rail studs.

Tighten

Tighten the studs to 10 N.m (89 lb in).

14. Install the fuel rail bracket nut at the rear left lift bracket.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

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

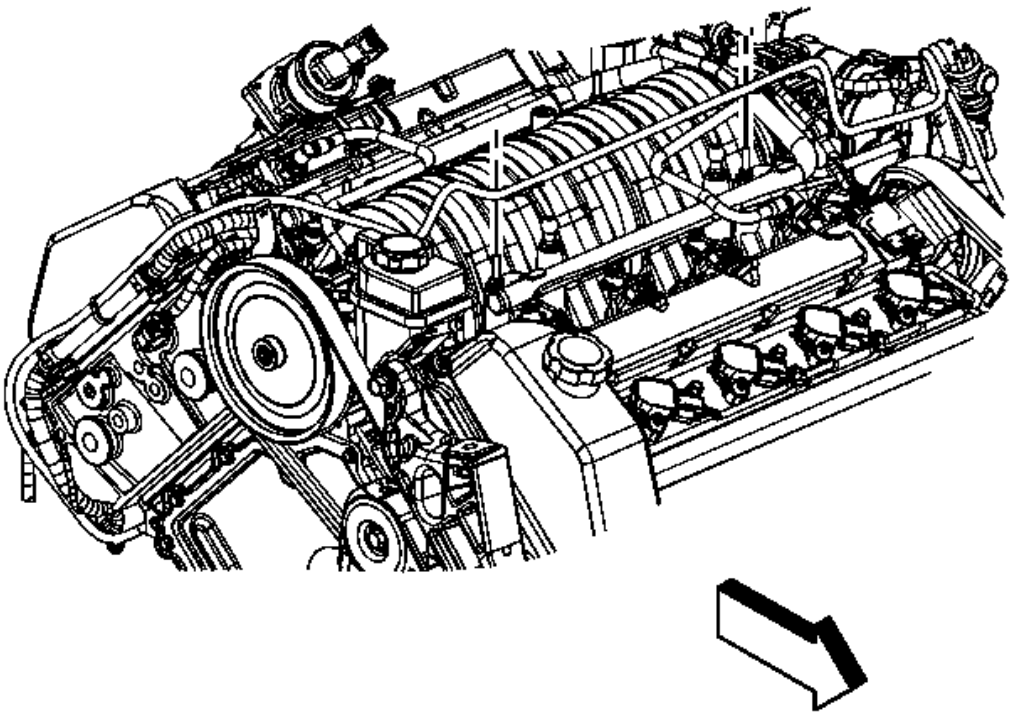


Fig. 73: Locating Coolant Heater Cord Tabs
Courtesy of GENERAL MOTORS COMPANY

15. Install the coolant heater cord tabs to the fuel rail studs, if equipped.

 © 2011 Mitchell Repair Information Company, LLC.

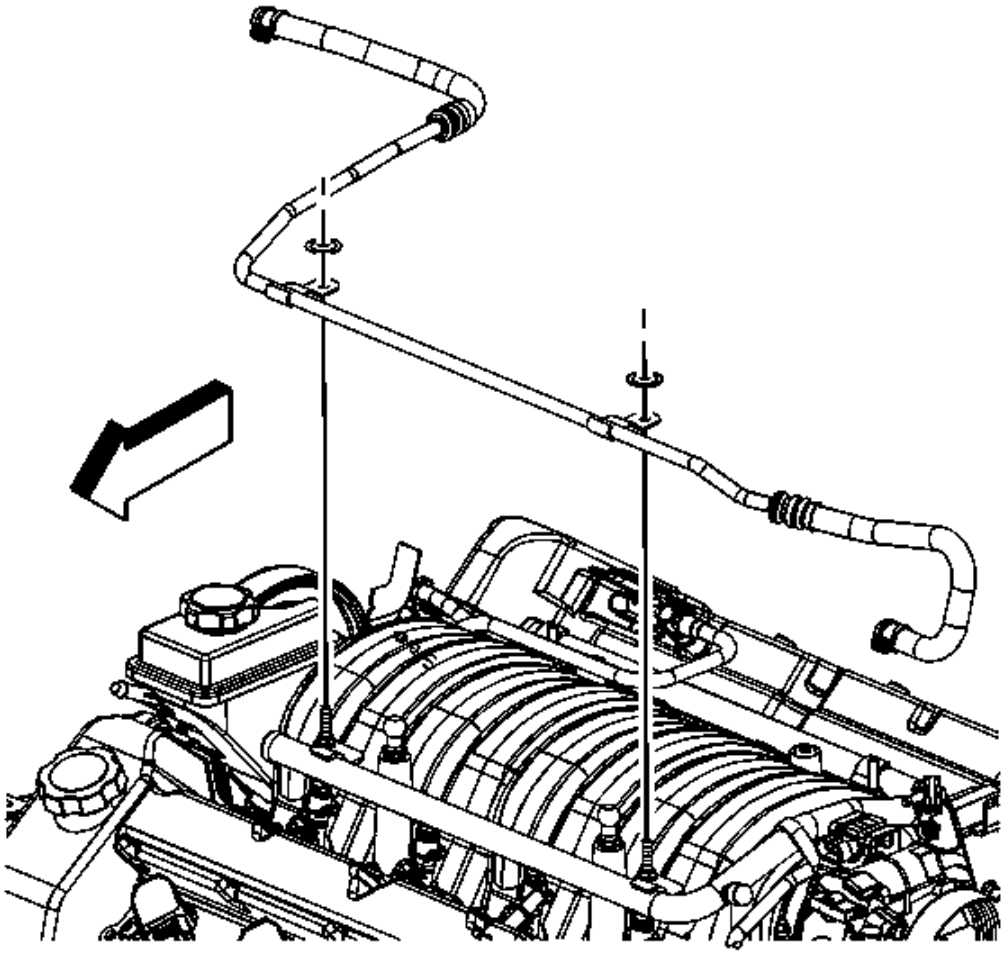


Fig. 74: Identifying Surge Tank Inlet Hose/Pipe & Clips
Courtesy of GENERAL MOTORS COMPANY

16. Install the engine harness retainer to the fuel rail stud.
17. Install the surge tank inlet hose/pipe to the fuel rail studs.
18. Install the 2 pushnuts securing the surge tank inlet hose/pipe to the fuel rail studs.

 © 2011 Mitchell Repair Information Company, LLC.

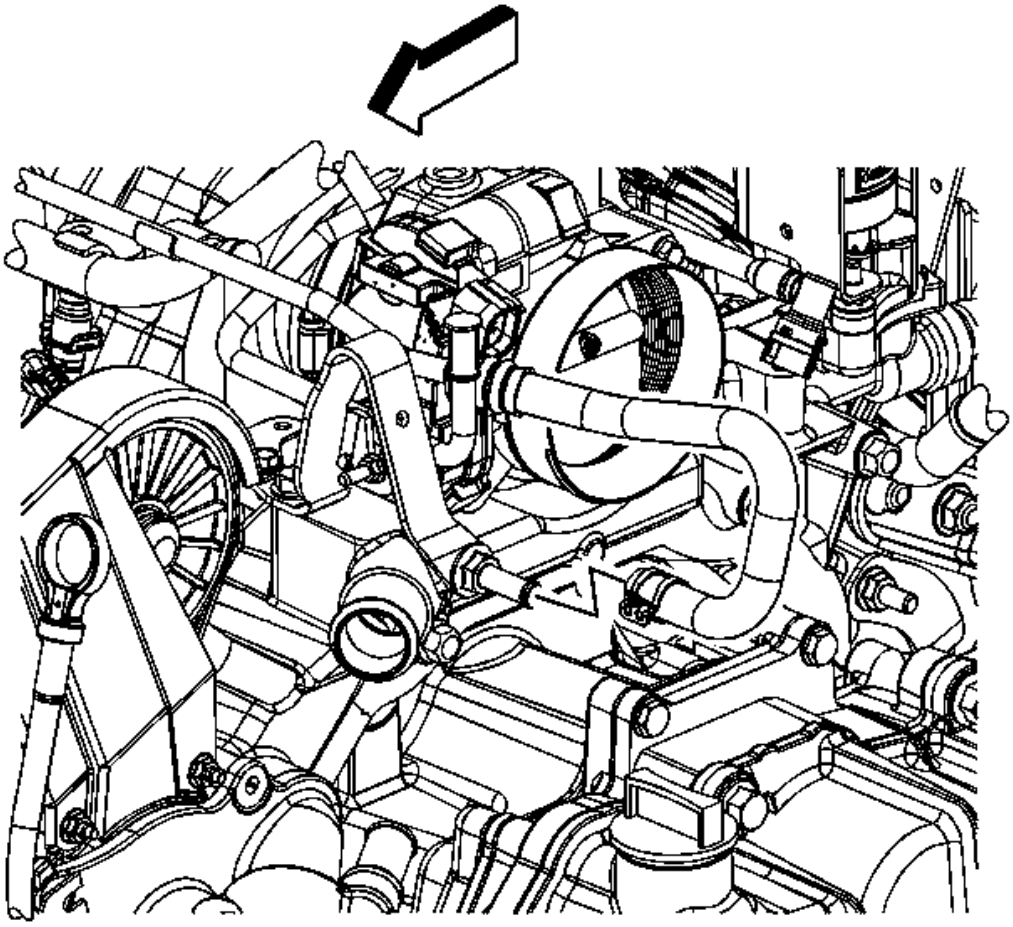


Fig. 75: View Of Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

19. Install the surge tank inlet hose/pipe to the engine fitting.
20. Position the radiator surge tank inlet hose/pipe clamp at the engine.

 © 2011 Mitchell Repair Information Company, LLC.

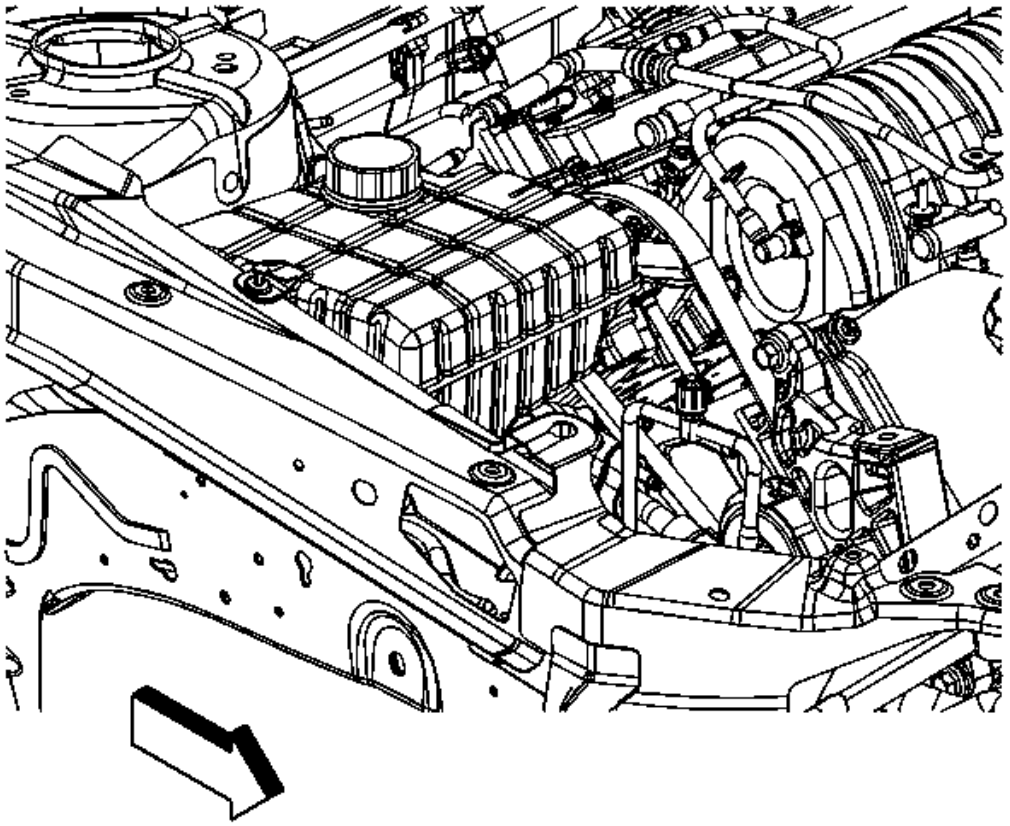


Fig. 76: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

21. Install the surge tank inlet hose/pipe to the surge tank.
22. Position the radiator surge tank inlet hose/pipe clamp at the surge tank.

 © 2011 Mitchell Repair Information Company, LLC.

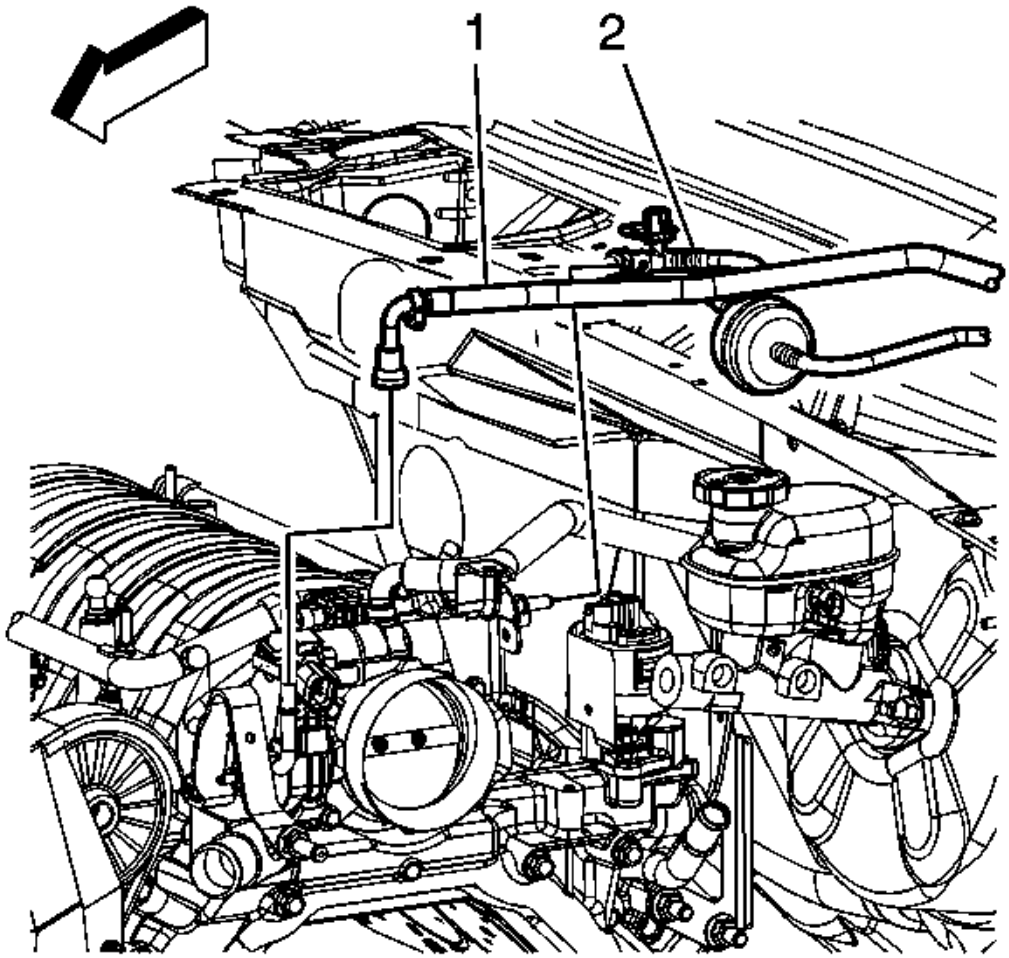


Fig. 77: Fuel Feed & EVAP Line
Courtesy of GENERAL MOTORS COMPANY

23. Connect the fuel feed line (1) quick connect fitting at the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

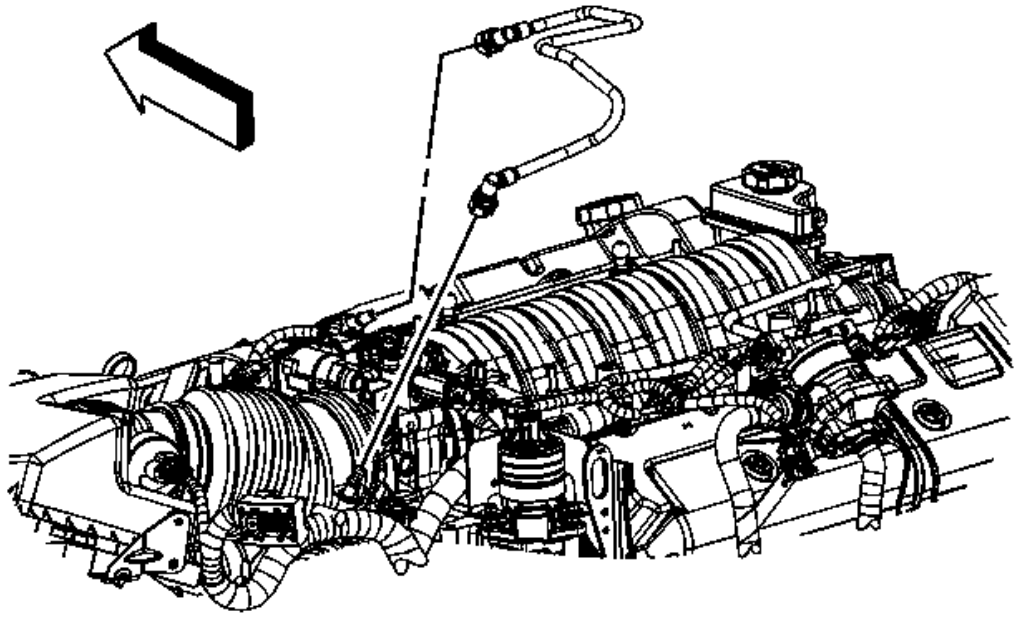


Fig. 78: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

24. Connect the PCV fresh air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

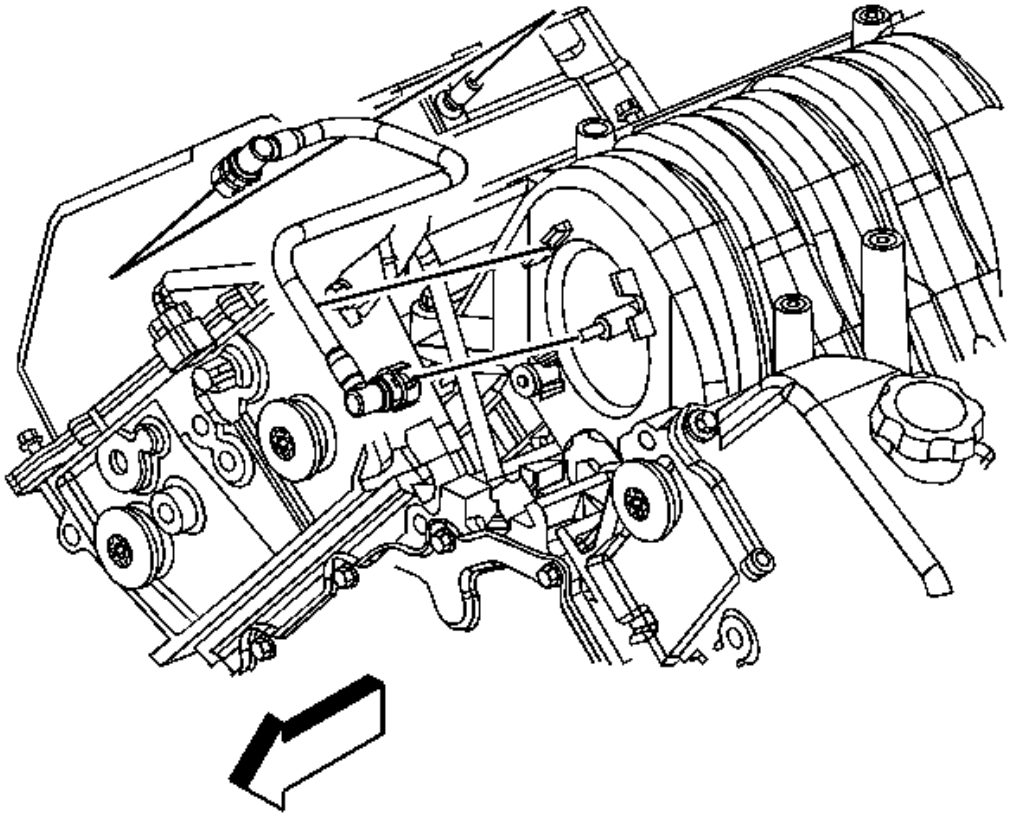


Fig. 79: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

25. Connect the PCV foul air tube quick connect fitting to the right camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

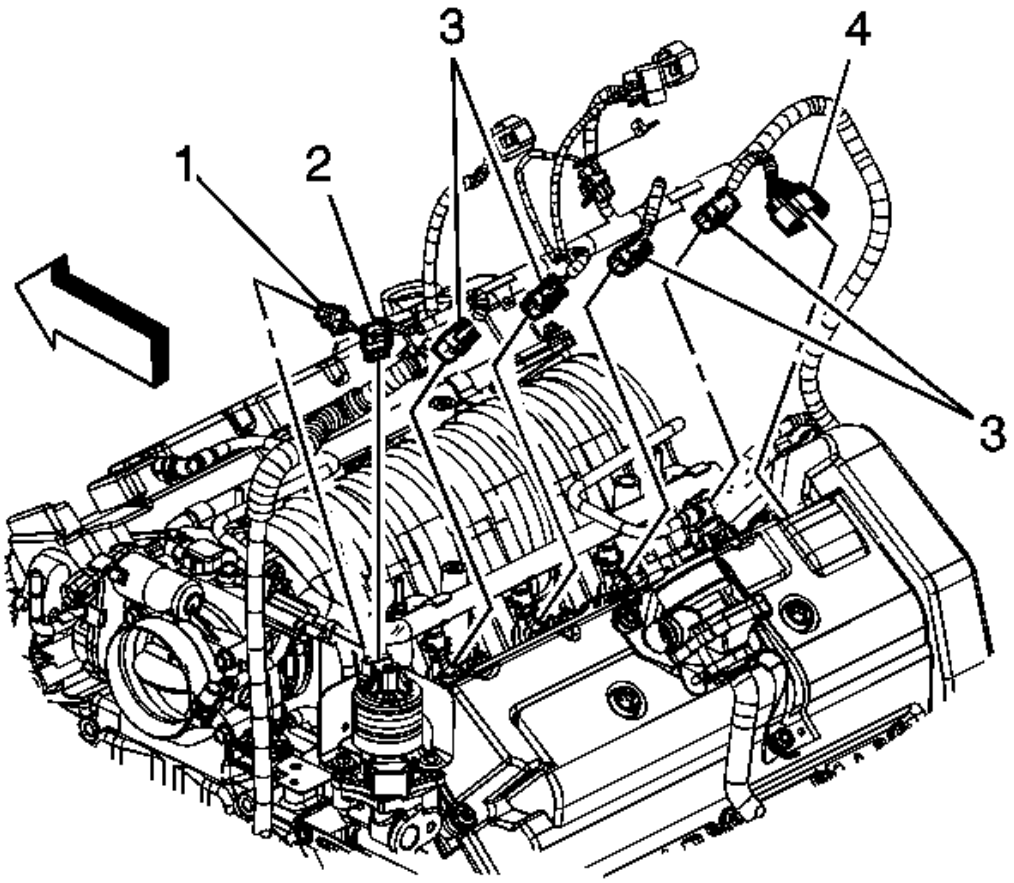


Fig. 80: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

26. Connect the rear fuel injectors engine harness electrical connectors (3).
27. Connect the rear ignition coil module engine harness electrical connector (4).

 © 2011 Mitchell Repair Information Company, LLC.

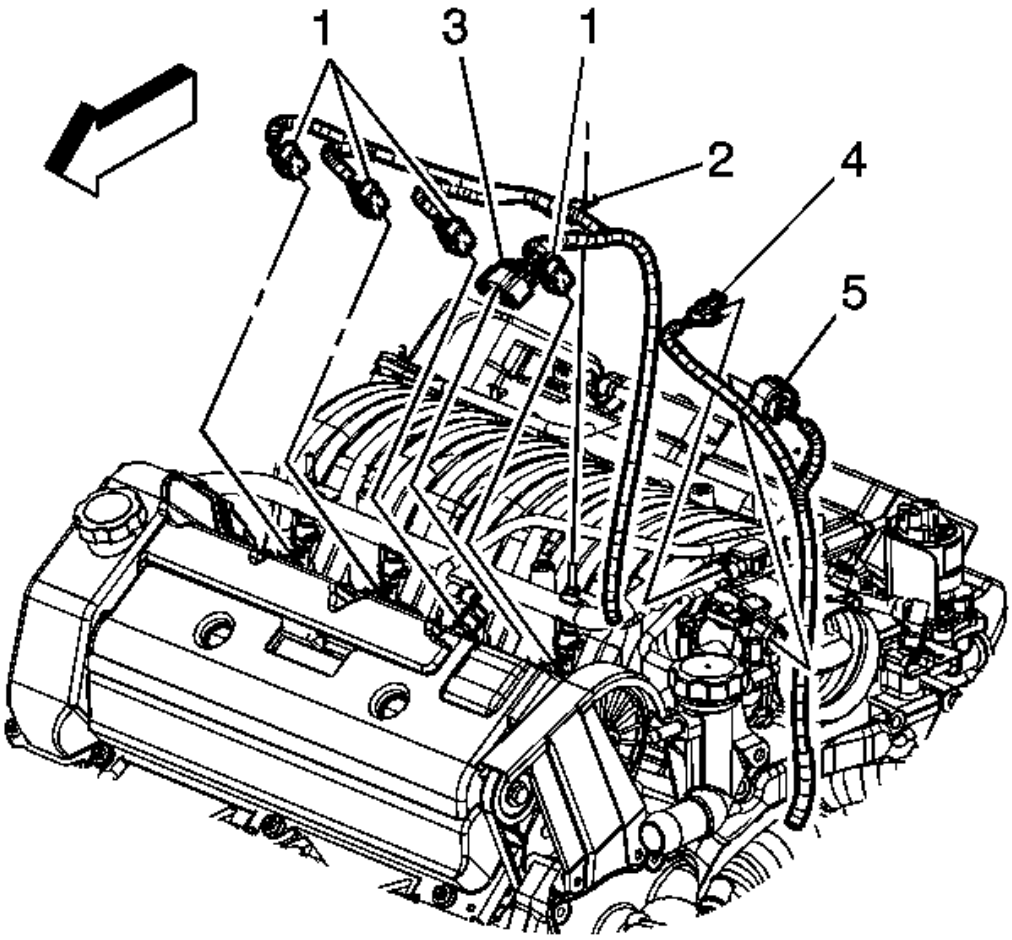


Fig. 81: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

28. Connect the front fuel injectors engine harness electrical connectors (1).
29. Connect the front ignition coil module engine harness electrical connector (3).
30. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
31. Install the fuel injector sight shield cover. Refer to **Fuel Injector Sight Shield Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

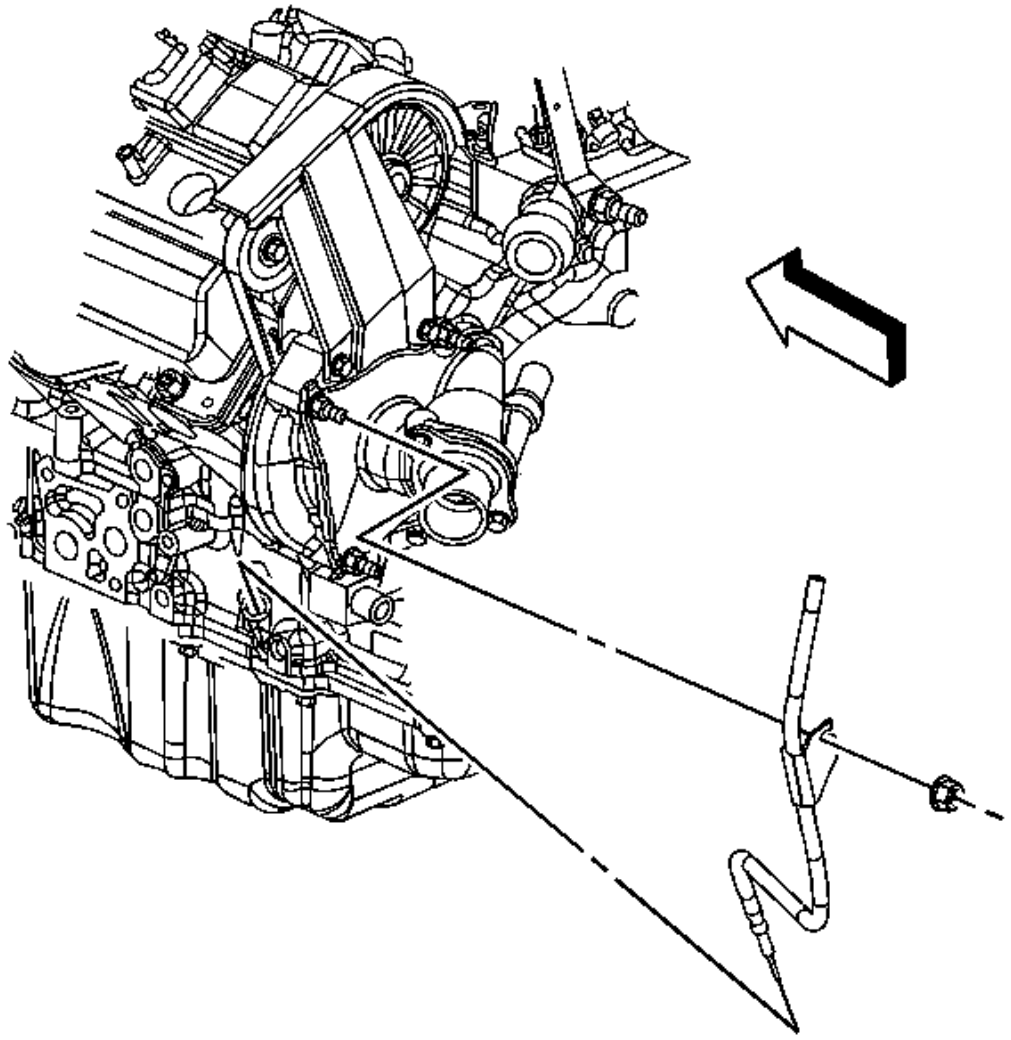


Fig. 82: Identifying Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

1. Remove the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.
2. Remove the oil level indicator.
3. Loosen the oil level indicator tube nut.
4. Remove the oil level indicator tube.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

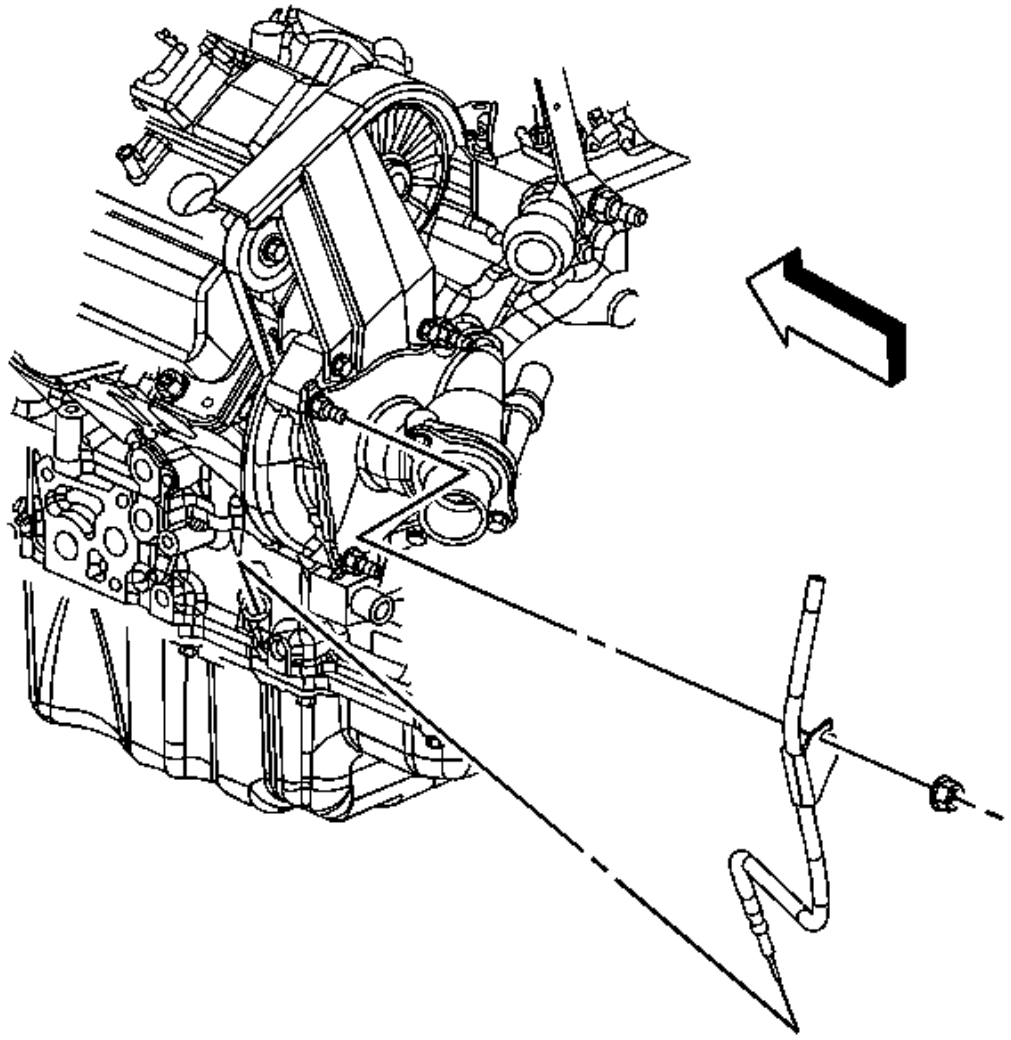


Fig. 83: Identifying Oil Level Indicator Tube
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the oil level indicator tube O-ring seal with clean engine oil.
2. Install the oil level indictor tube into the lower crankcase opening.

CAUTION: Refer to Fastener Caution .

3. Slide the indicator tube behind the tube nut. Tighten the nut.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

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

4. Install the oil level indicator.
5. Install the front engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

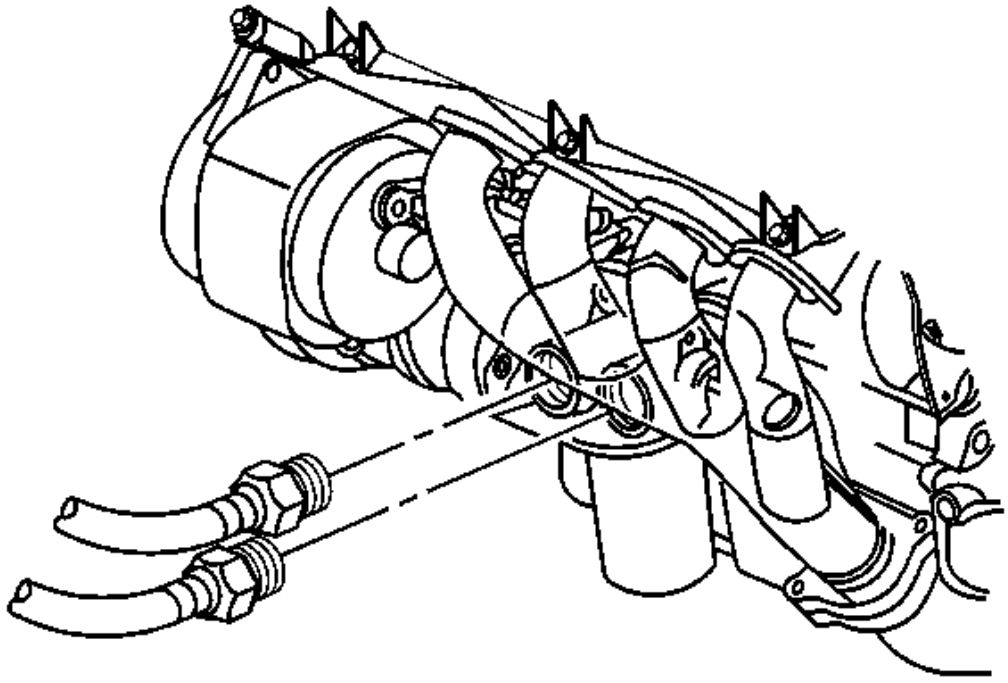


Fig. 84: View of Engine Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the air deflector. Refer to **Front Air Deflector Replacement** .

NOTE: Engine oil cooler quick connect fittings must be replaced whenever they are removed from the engine oil filter adapter.

 © 2011 Mitchell Repair Information Company, LLC.

3. If equipped, remove the engine oil cooler quick connect fittings from the engine oil filter adapter, with the oil pipes still attached.

   If not equipped with an engine oil cooler, go to step 7.

4. Remove the dust cover from the quick connect joint.

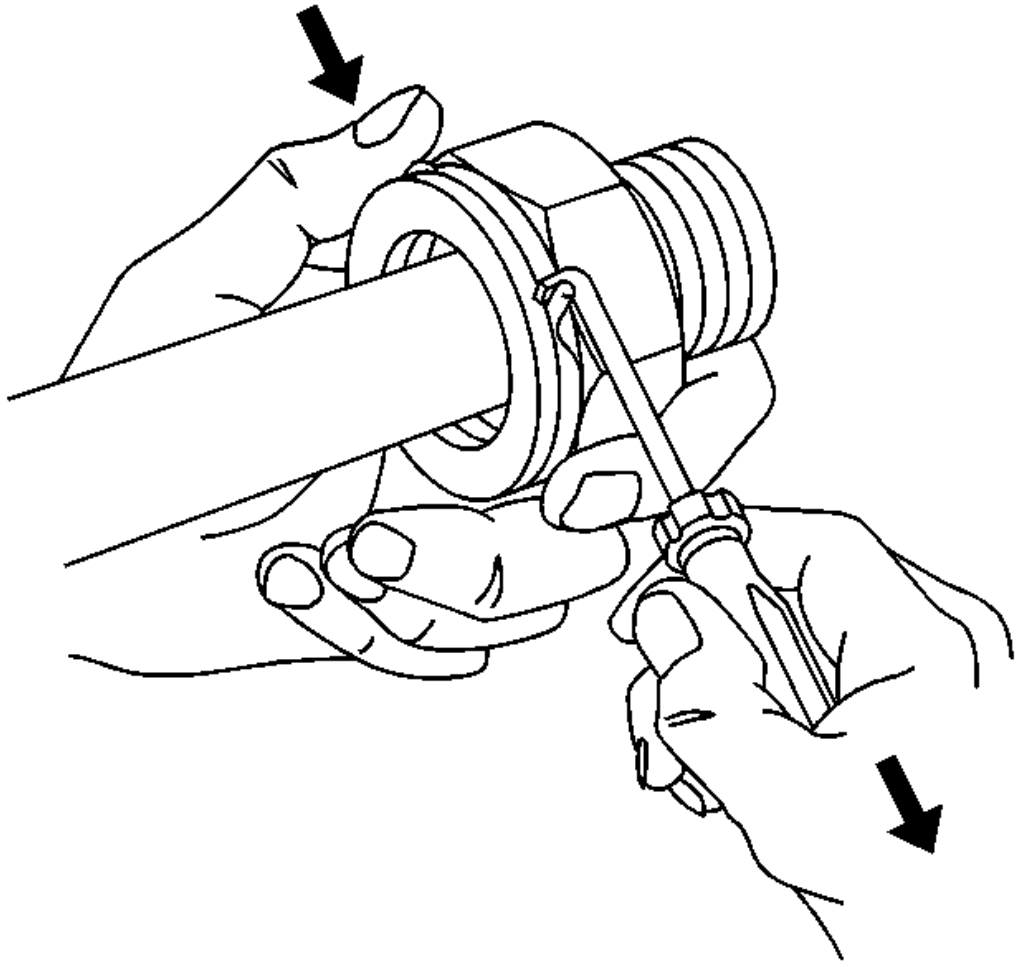


Fig. 85: View Of Internal Spring Clips
Courtesy of GENERAL MOTORS COMPANY

5. Remove the internal spring clips from the engine oil cooler fittings.

 © 2011 Mitchell Repair Information Company, LLC.

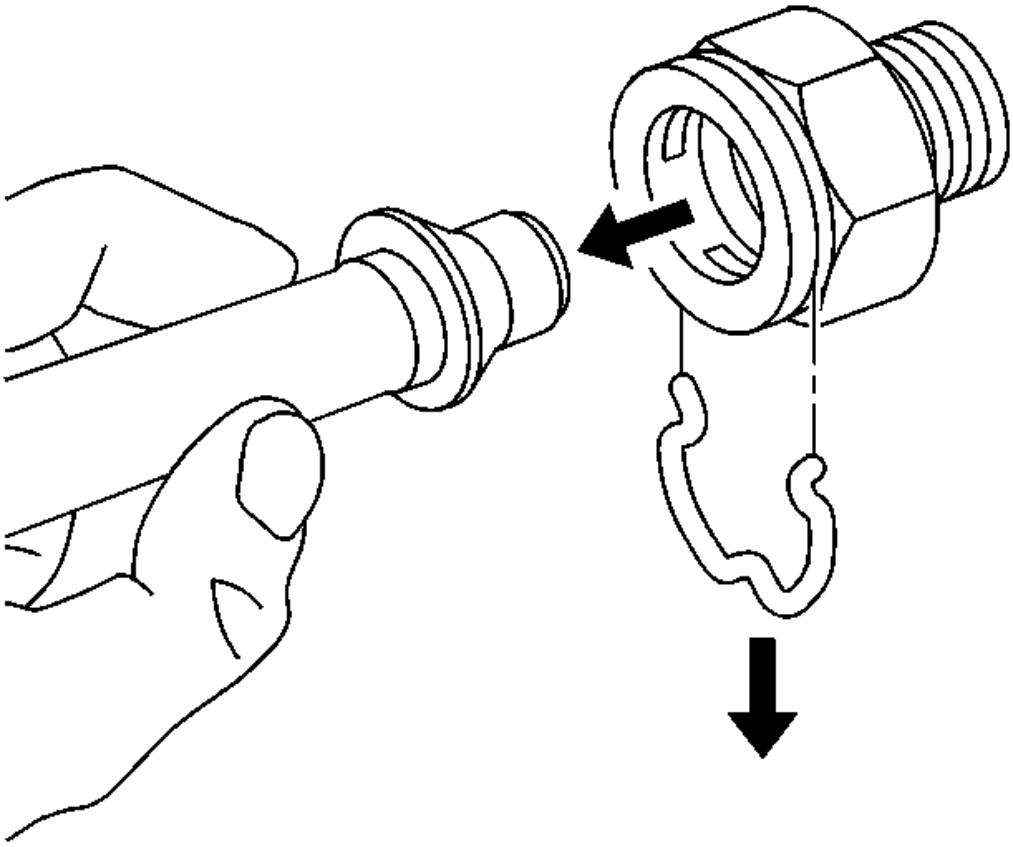


Fig. 86: View of Engine Cooler Pipes & Fittings
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine oil cooler pipes from the cooler fittings.

 © 2011 Mitchell Repair Information Company, LLC.

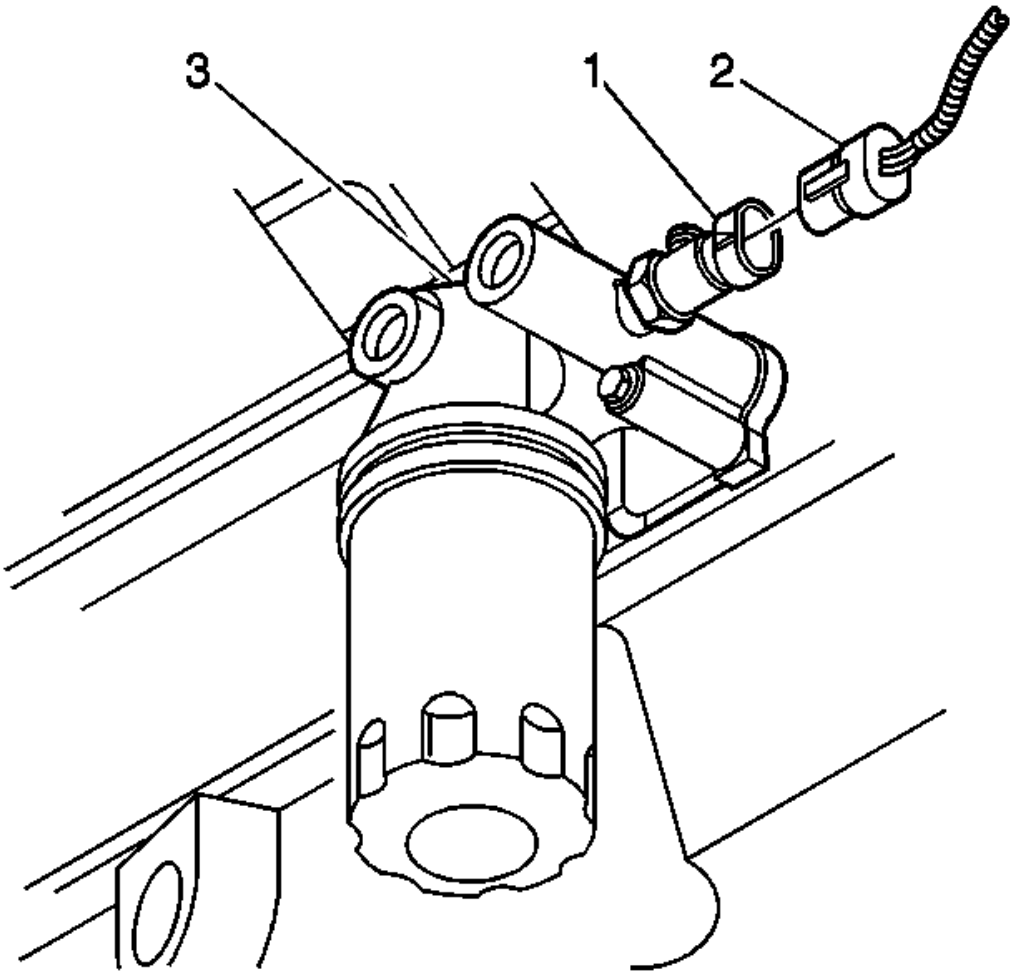


Fig. 87: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the electrical connector (2) from the engine oil pressure switch (1).

 © 2011 Mitchell Repair Information Company, LLC.

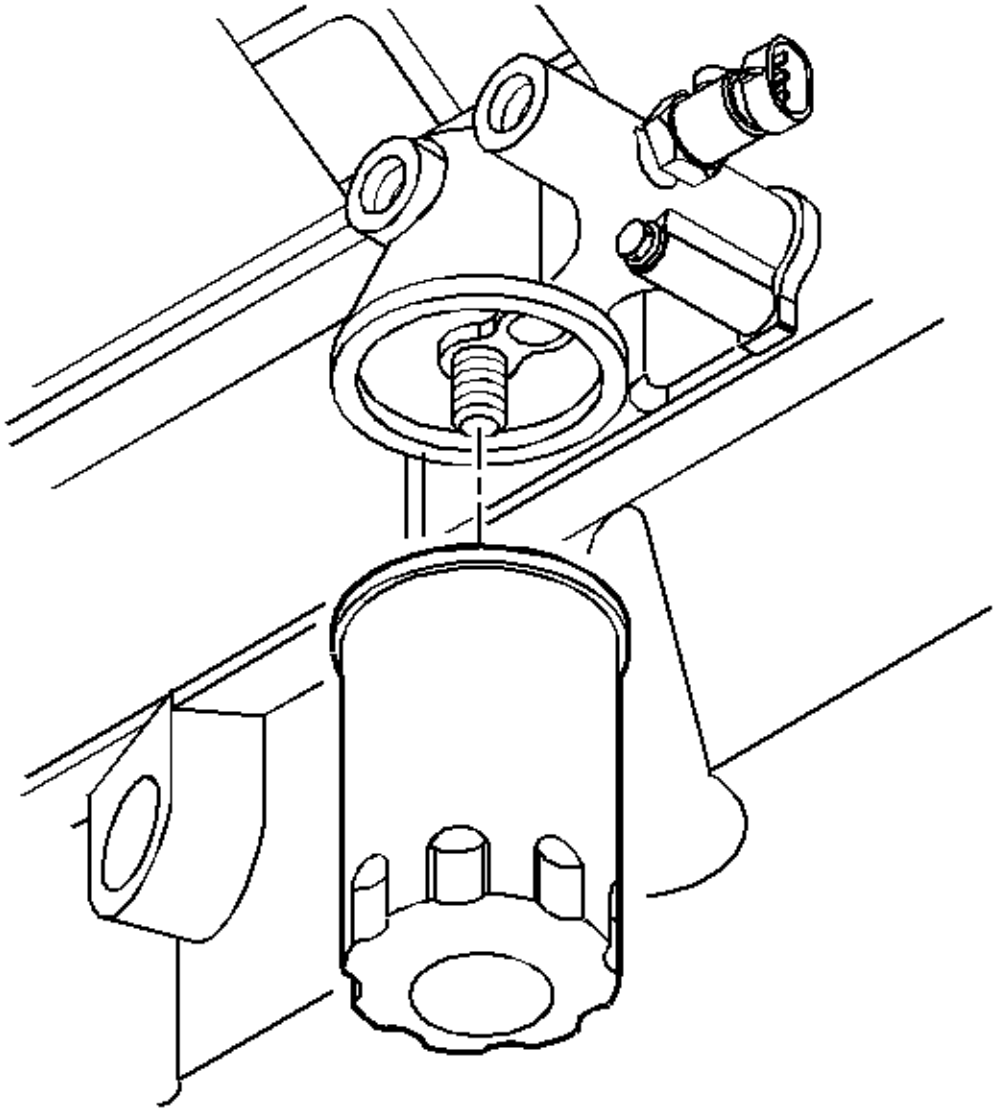


Fig. 88: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil filter.

 © 2011 Mitchell Repair Information Company, LLC.

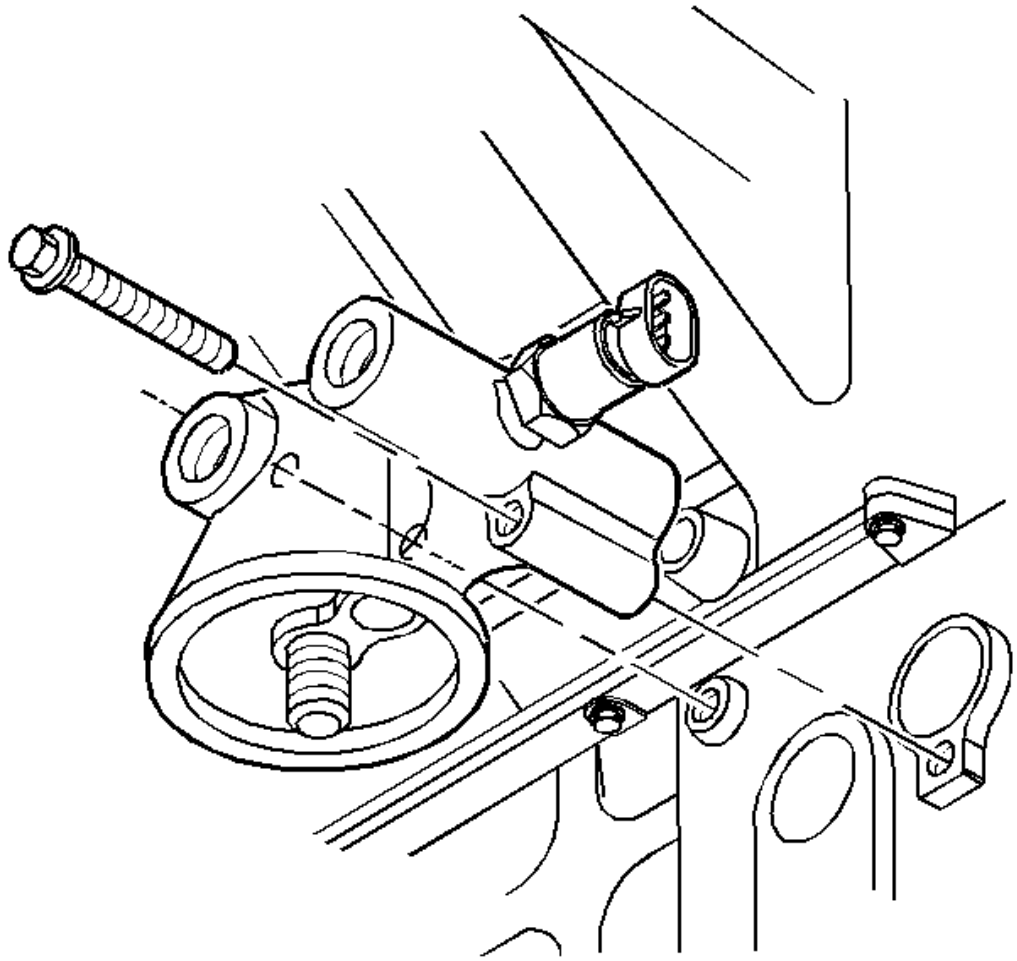


Fig. 89: Identifying Adapter Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 2 adapter mounting bolts.
10. Remove the adapter and discard the O-rings.
11. Remove the engine oil pressure switch from the oil filter adapter.
12. Clean and inspect the oil filter adapter. Refer to **Oil Filter Adapter Cleaning and Inspection (with Oil Cooler)** , **Oil Filter Adapter Cleaning and Inspection (without Oil Cooler)** .

Installation Procedure

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

1. Install the engine oil pressure switch to the oil filter adapter.

   Tighten

   Tighten the engine oil pressure switch to 16 N.m (12 lb ft).

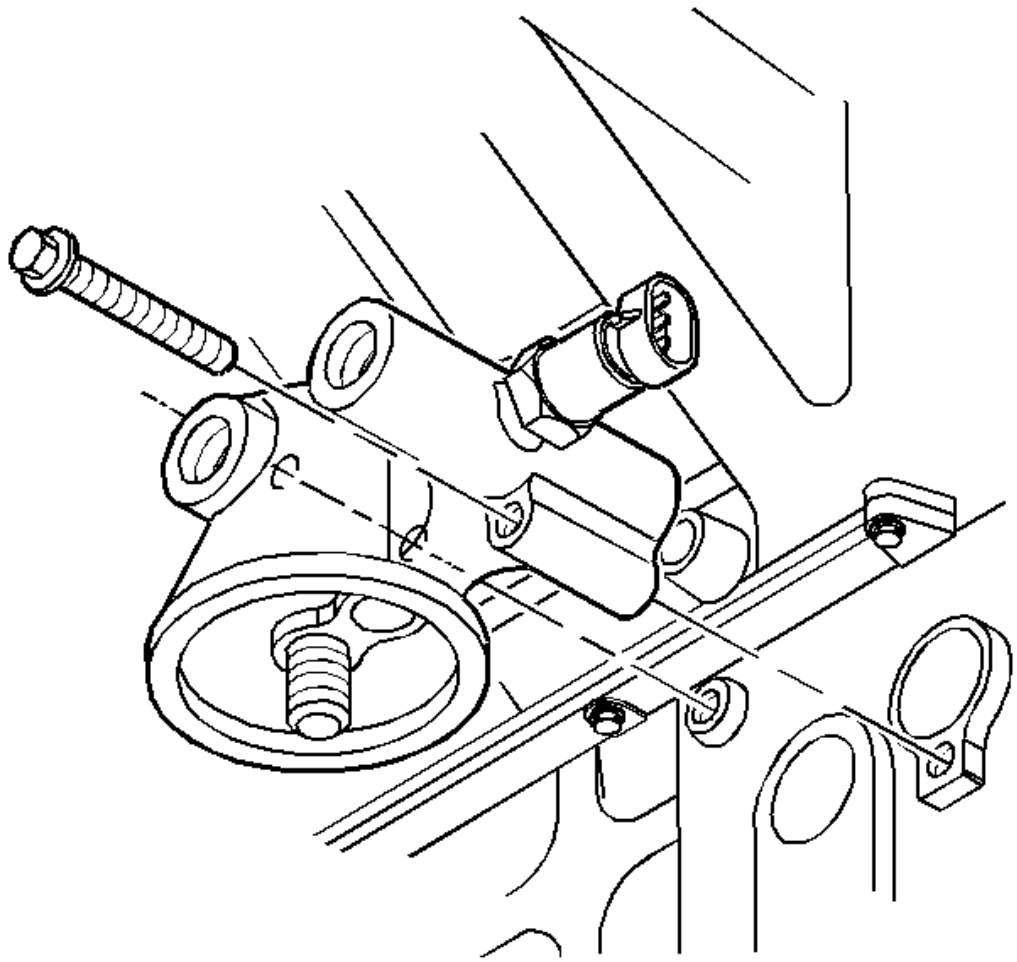


Fig. 90: Identifying Adapter Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the new O-rings. Petrolatum may be used to retain the O-rings in the adapter.
3. Install the 2 bolts attaching the oil filter adapter to the engine block.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the oil filter adapter bolts to 25 N.m (18 lb ft).

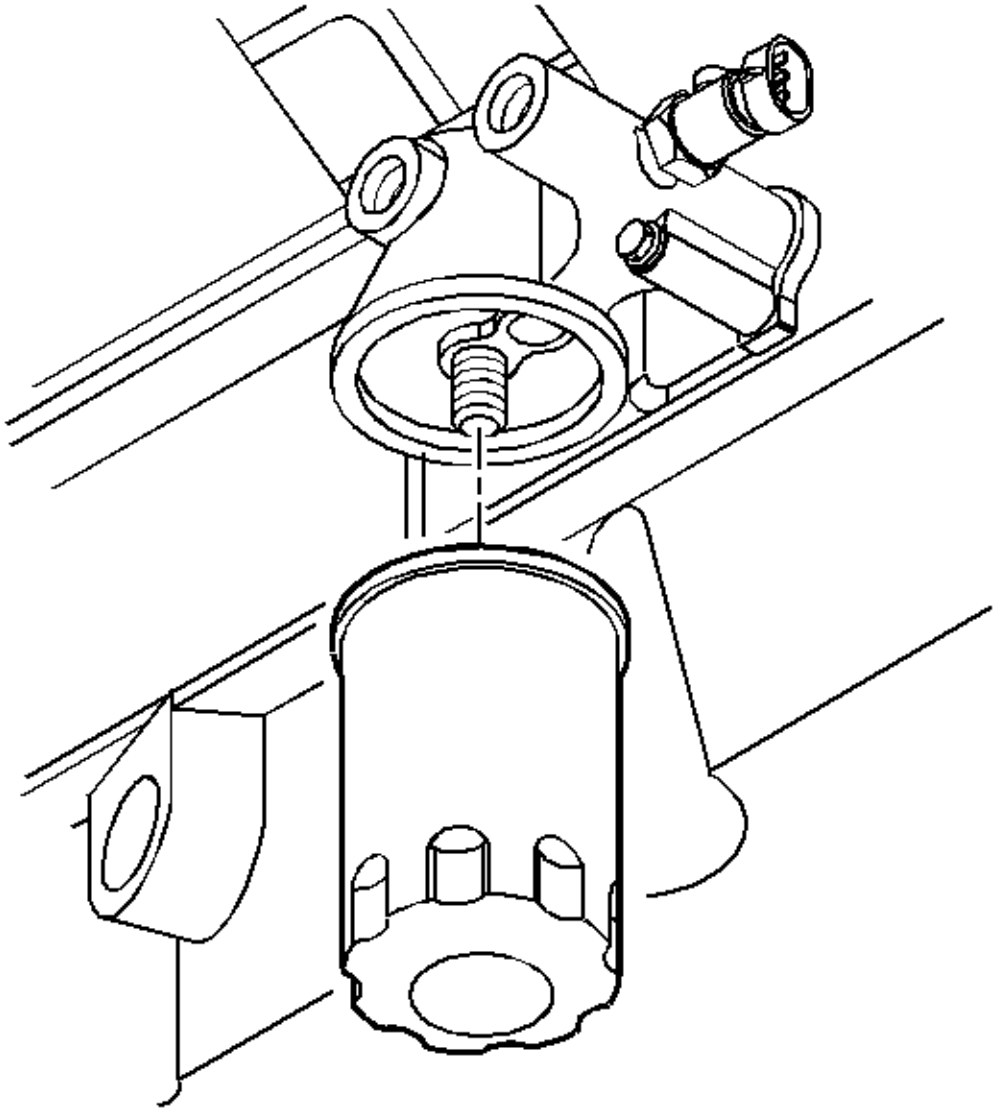


Fig. 91: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS COMPANY

4. Lightly oil the replacement oil filter gasket with clean oil.

 © 2011 Mitchell Repair Information Company, LLC.

NOTE: Fill the oil filter with the engine oil.

5. Install the oil filter.

   Tighten

   Tighten the oil filter to 32 N.m (24 lb ft).

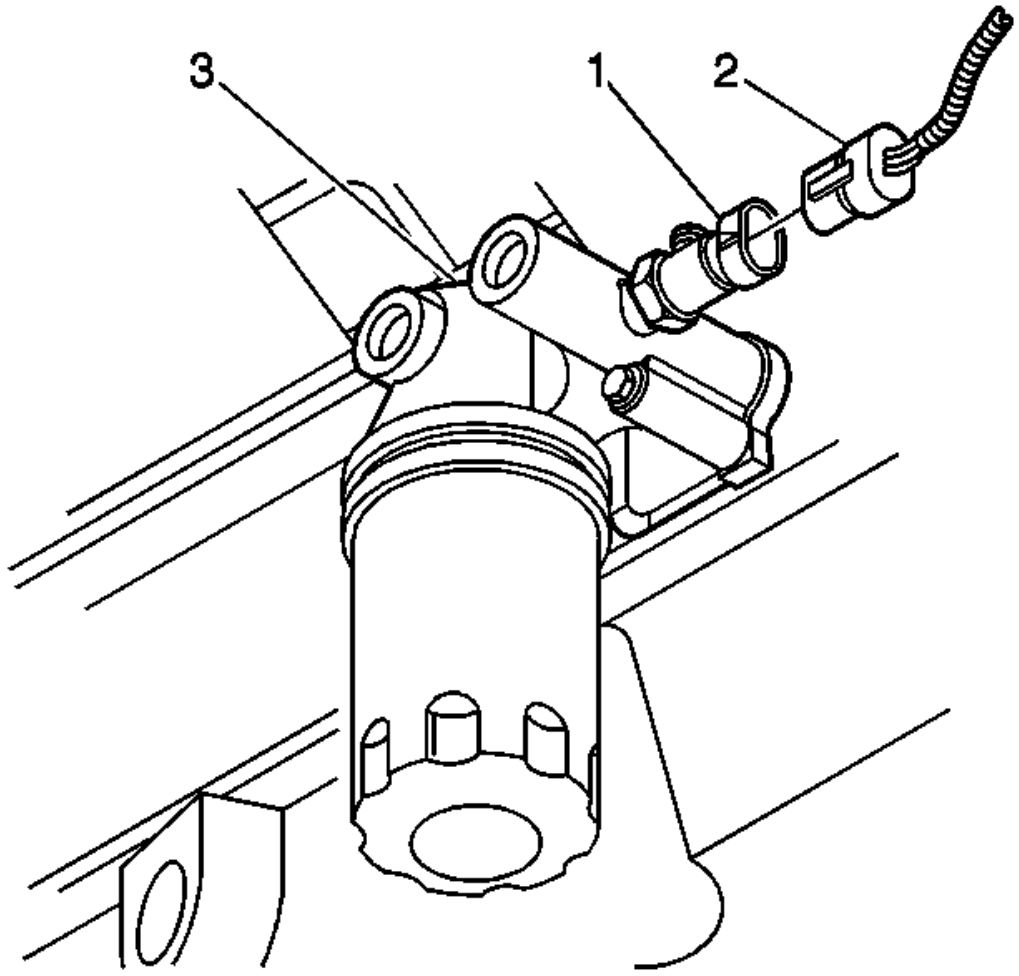


Fig. 92: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the electrical connector (2) to the engine oil pressure switch (1).

 © 2011 Mitchell Repair Information Company, LLC.

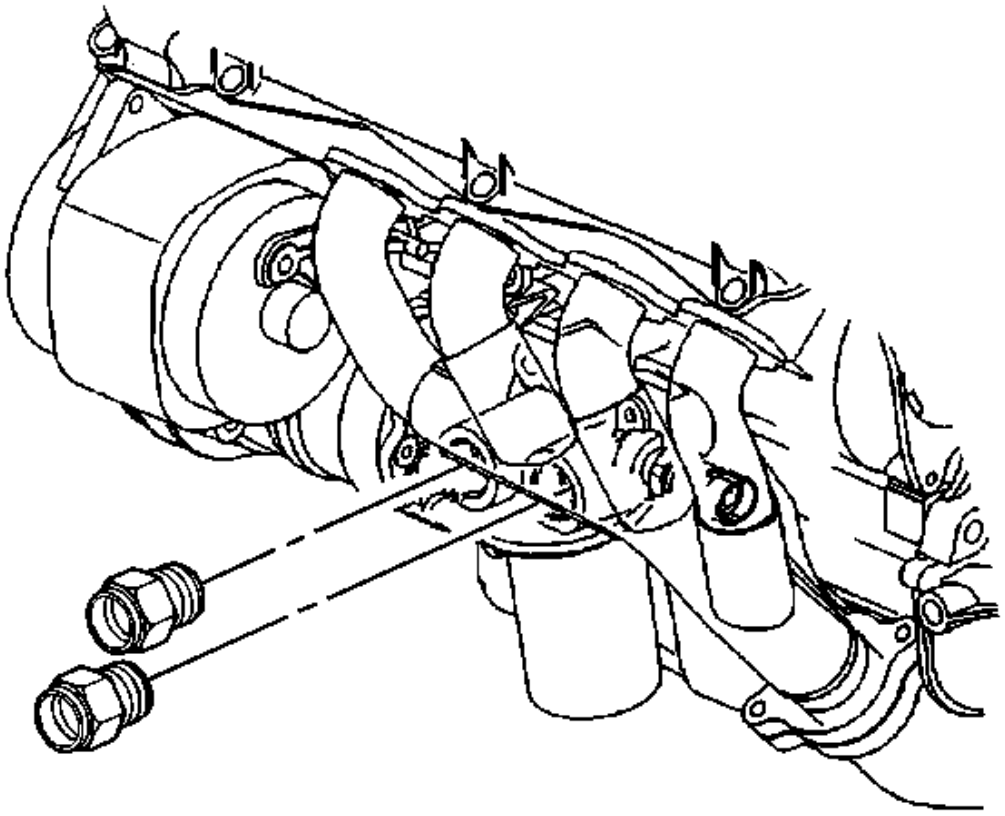


Fig. 93: View of Engine Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine oil cooler quick connect fittings must be replaced whenever they are removed from the engine oil filter adapter.

7. If equipped, install the engine oil cooler quick connect fittings to the engine oil filter adapter.

   If not equipped with an engine oil cooler, proceed to step 1.

   Tighten

   Tighten the engine oil cooler quick connect fittings to 18 N.m (13 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

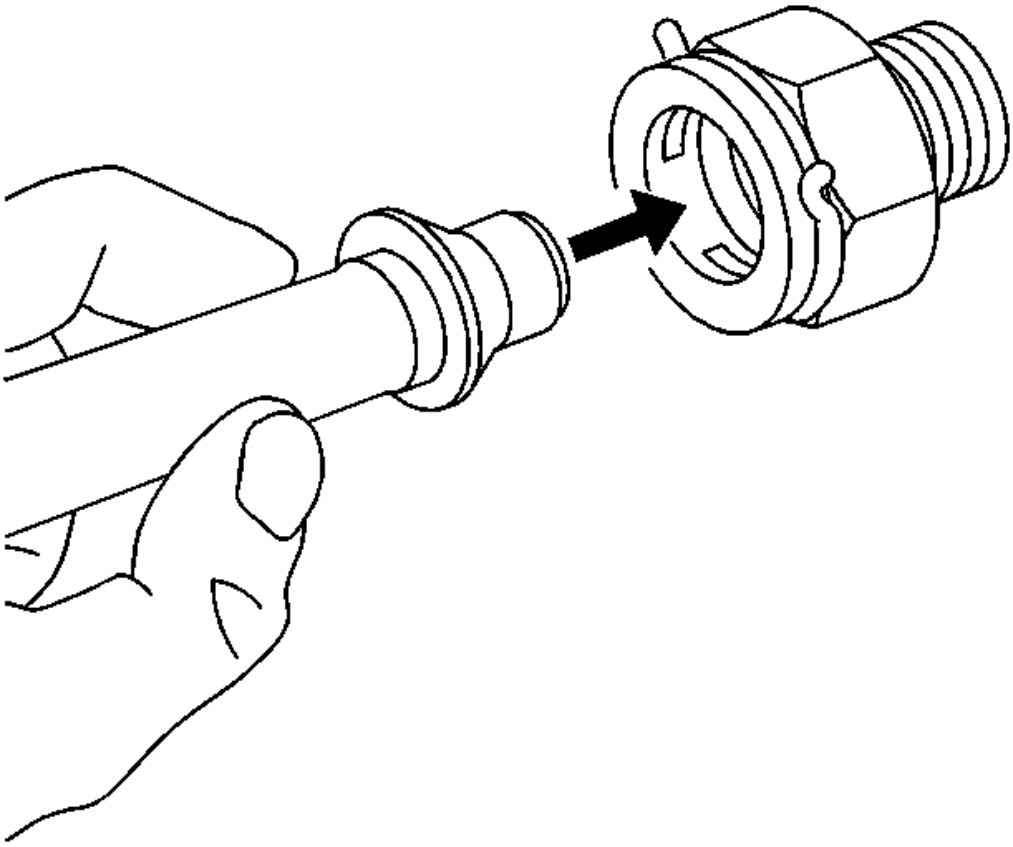


Fig. 94: View of Engine Oil Cooler Pipes & Oil Cooler Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

8. Push the engine oil cooler pipes fully into the oil cooler quick connect fittings, until a "click" is heard.
9. Tug gently on the cooler pipes to ensure proper retention.
10. Slide the dust cover over the quick connect joint.
11. Install the air deflector. Refer to **Front Air Deflector Replacement** .
12. Lower the vehicle.
13. Adjust the engine oil level to the full mark.
14. Inspect for oil leaks after engine start up.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **J 45059** Angle Meter

 © 2011 Mitchell Repair Information Company, LLC.

- **J 41816** Crankshaft Balancer Remover
- **J 41998-B** Crankshaft Balancer Installer
- **J 44214** Flywheel Holder

Removal Procedure

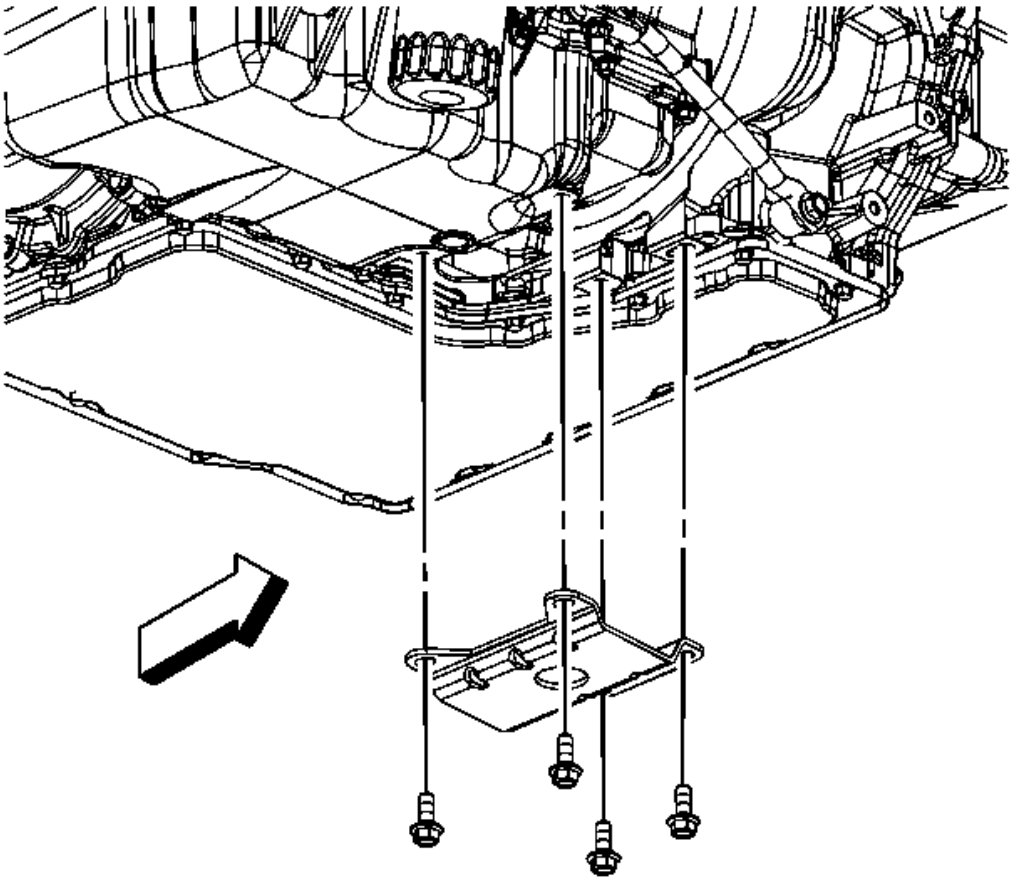


Fig. 95: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the transaxle to engine brace bolts.
3. Remove the transaxle to engine brace.

 © 2011 Mitchell Repair Information Company, LLC.

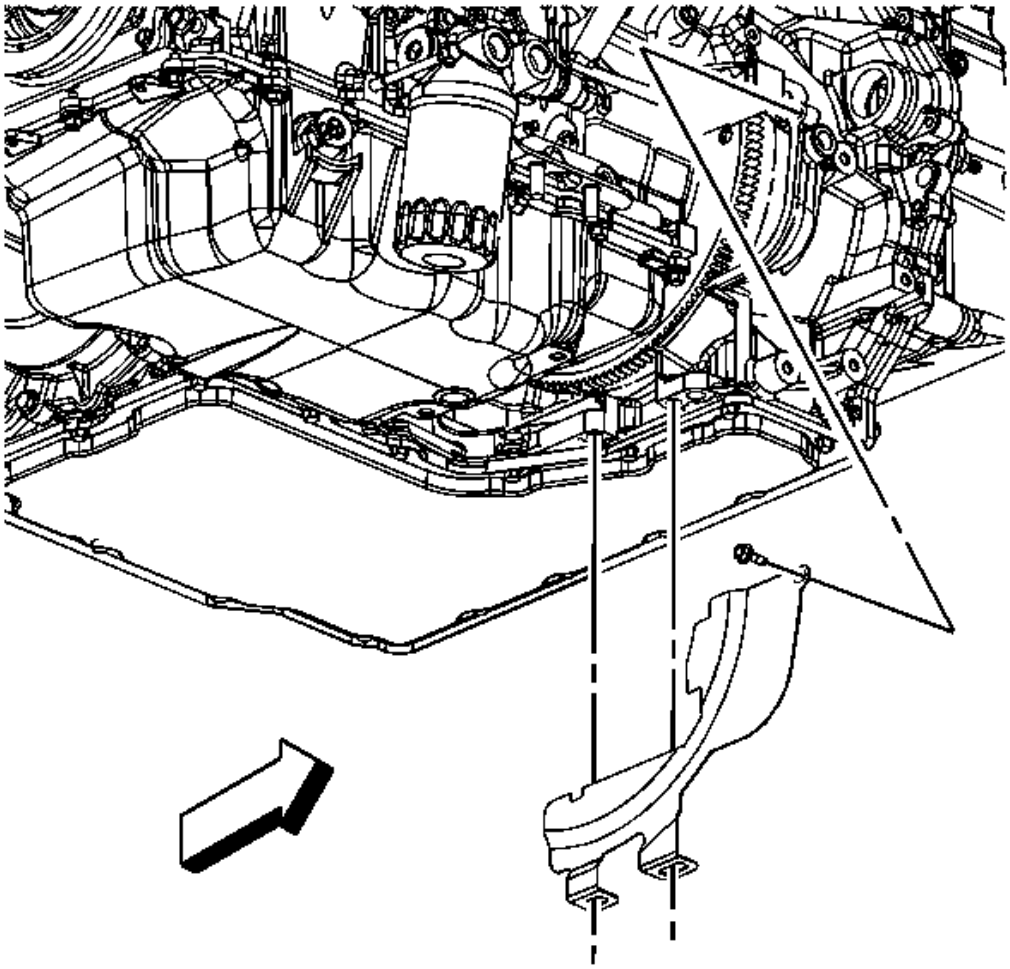


Fig. 96: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove the torque converter cover bolt.
5. Remove the torque converter cover.

 © 2011 Mitchell Repair Information Company, LLC.

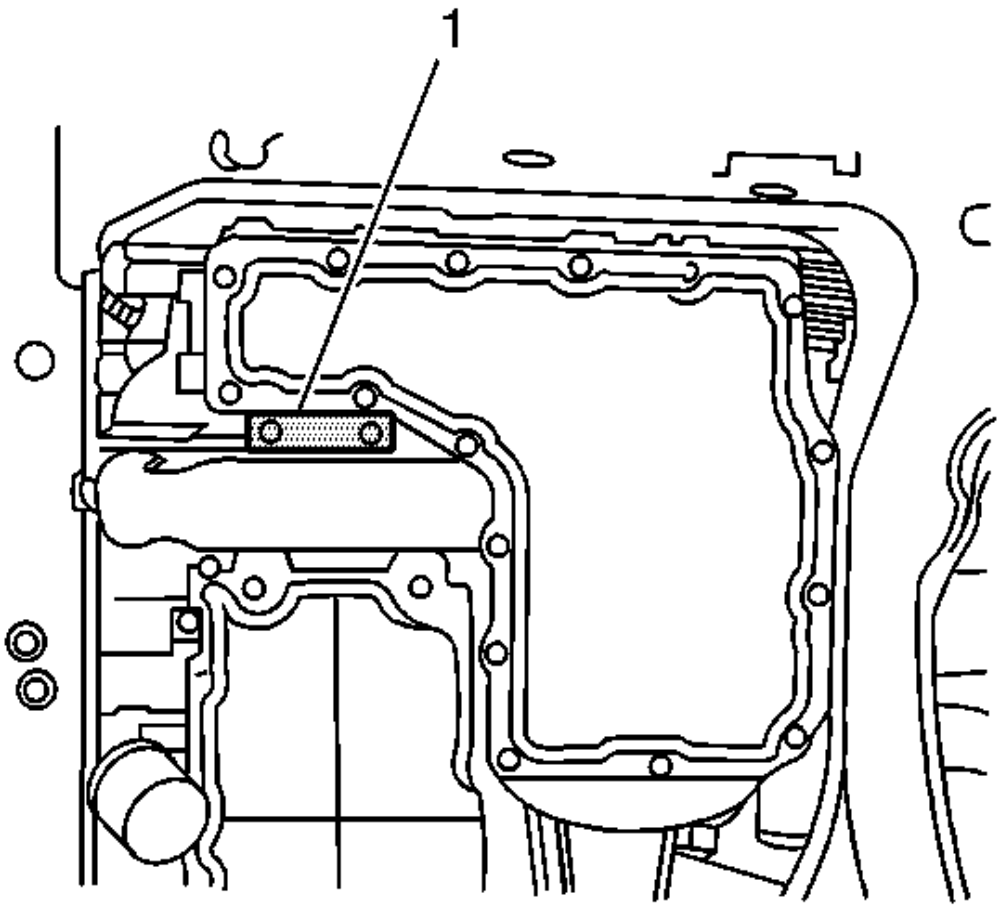


Fig. 97: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

6. Install the **J 44214** (1).
7. Remove the crankshaft balancer bolt.
8. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .
9. Support the frame with a suitable adjustable jack.
10. Loosen the right side frame bolts.
11. Lower the frame in order to obtain clearance for the **J 41816** below the body rail.

 © 2011 Mitchell Repair Information Company, LLC.

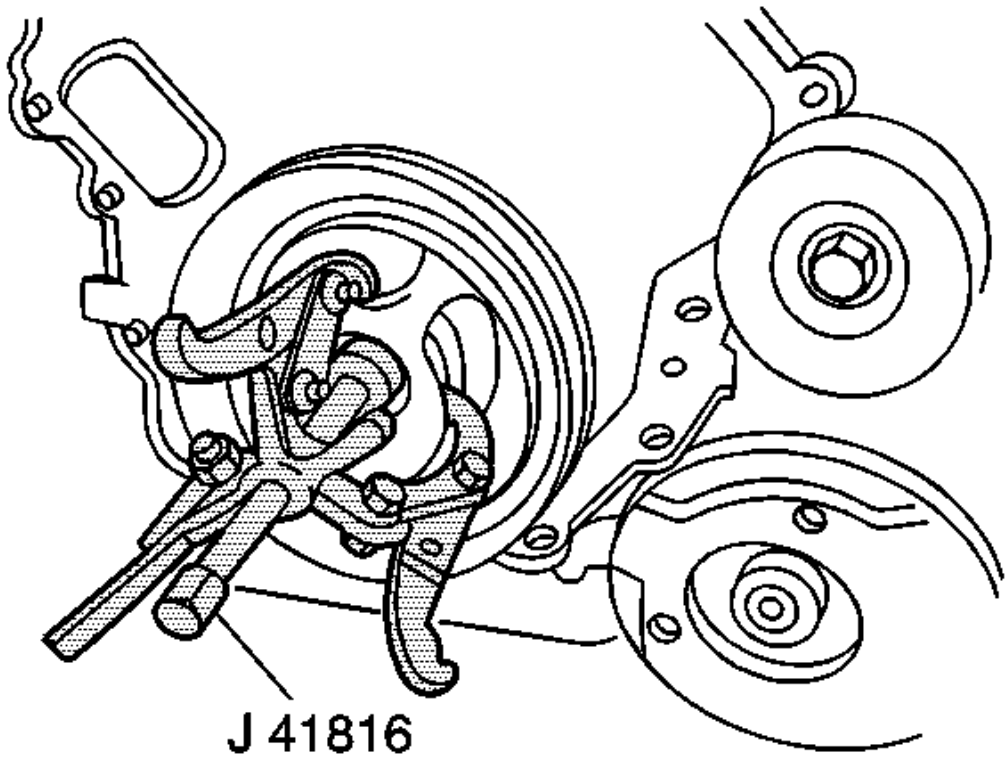


Fig. 98: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

12. Place the remover pilot into the end of the crankshaft.
13. Remove the crankshaft balancer using the **J 41816** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

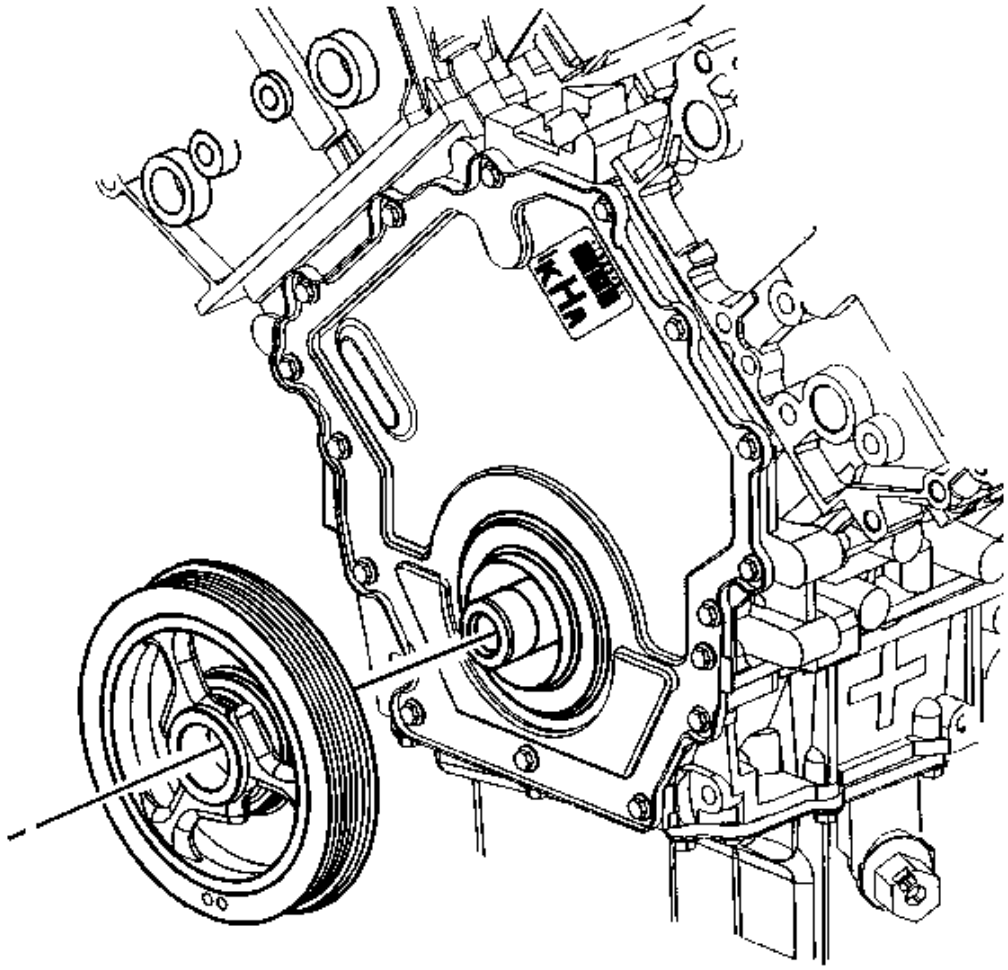


Fig. 99: View of Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Position the crankshaft balancer on the nose of the crankshaft.

 © 2011 Mitchell Repair Information Company, LLC.

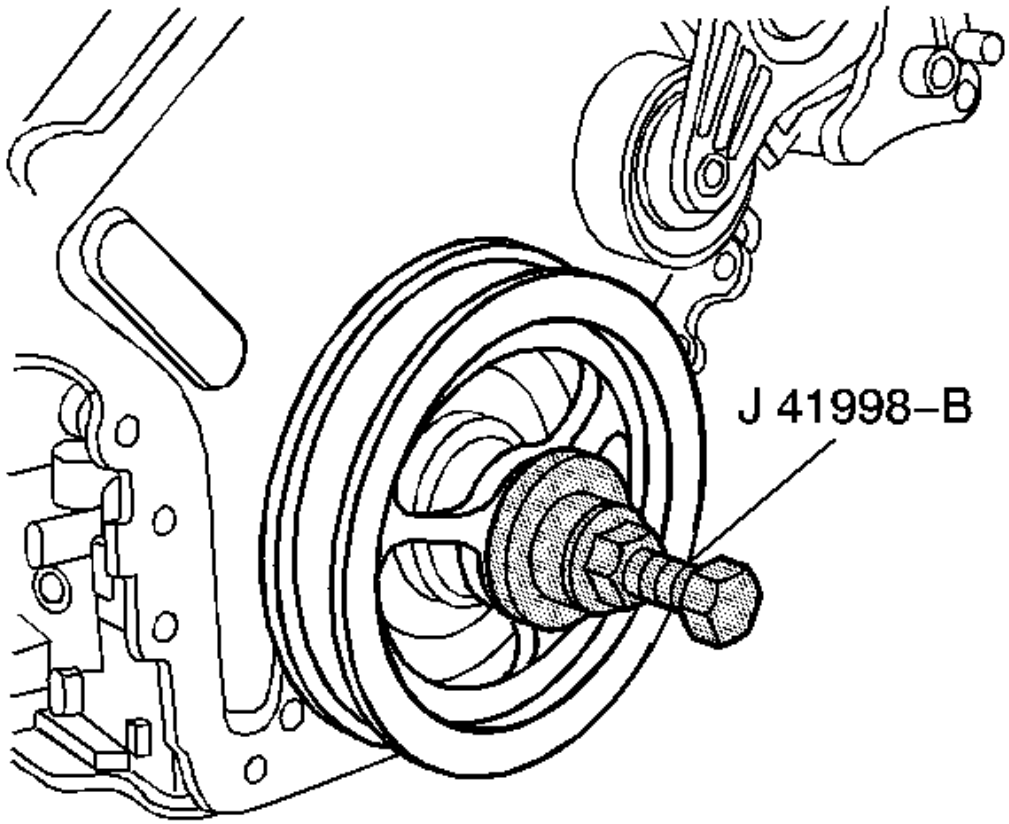


Fig. 100: Pressing Crankshaft Balancer Into Place
Courtesy of GENERAL MOTORS COMPANY

2. Press the crankshaft balancer in place using the **J 41998-B** .

 © 2011 Mitchell Repair Information Company, LLC.

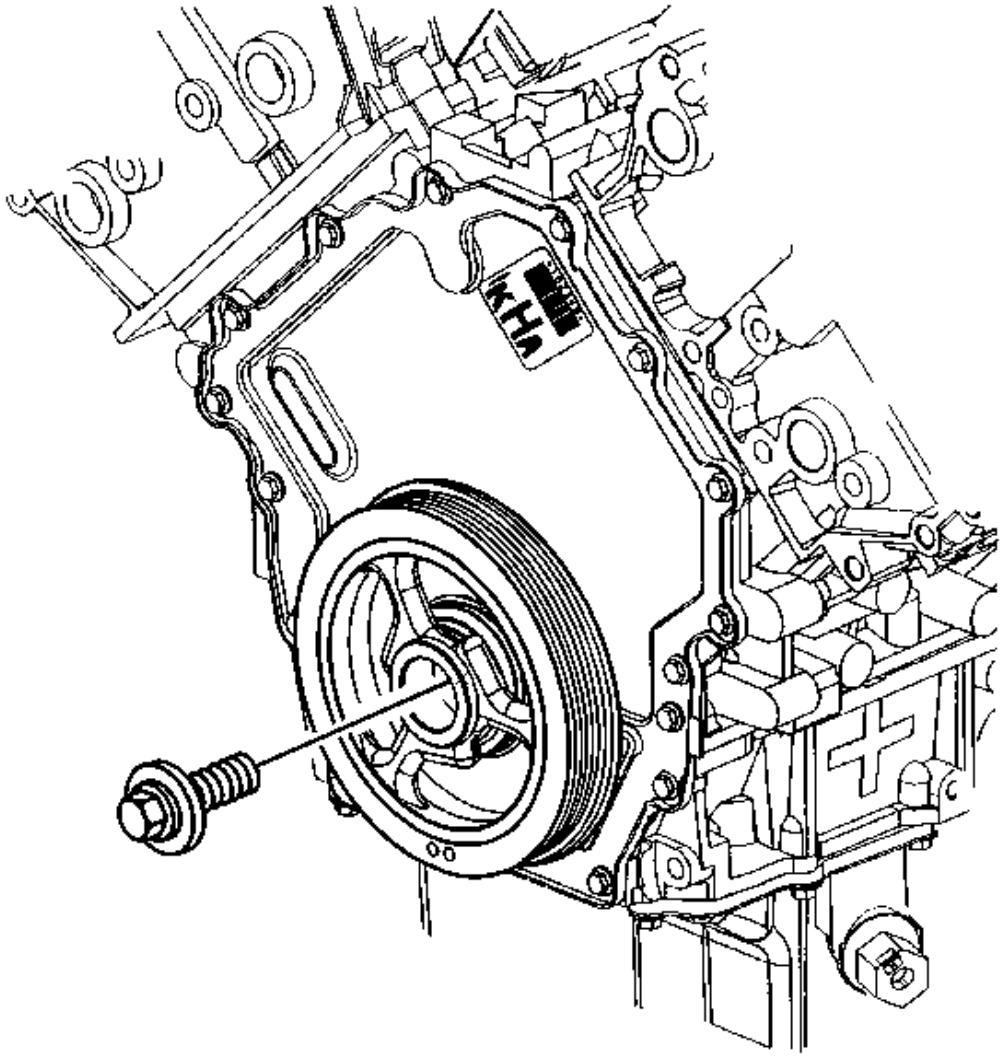


Fig. 101: View of Crankshaft Balancer Bolt Threads
Courtesy of GENERAL MOTORS COMPANY

3. Clean the crankshaft balancer bolt threads.
4. Apply engine oil to the crankshaft balancer bolt threads.

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

5. Install the crankshaft balancer bolt.

   Tighten

   - Tighten the bolt a first pass to 50 N.m (37 lb ft).
   - Tighten the bolt a final pass an additional 120 degrees using the **J 45059** .
6. Raise the frame into position.
7. Install the right side frame bolts.

   Tighten

   Tighten the bolts to 181 N.m (133 lb ft).

8. Install the front fascia. Refer to **Front Bumper Fascia Replacement** .
9. Remove the support(s) from the frame.

 © 2011 Mitchell Repair Information Company, LLC.

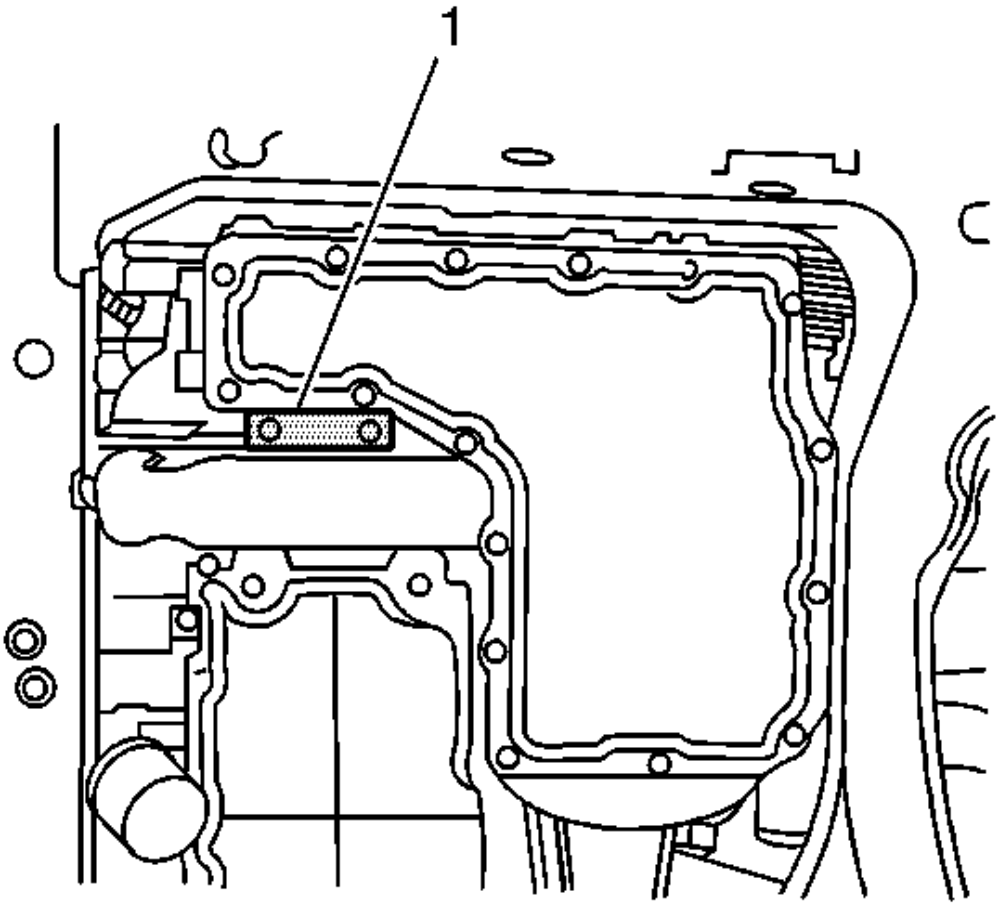


Fig. 102: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **J 44214** (1).

 © 2011 Mitchell Repair Information Company, LLC.

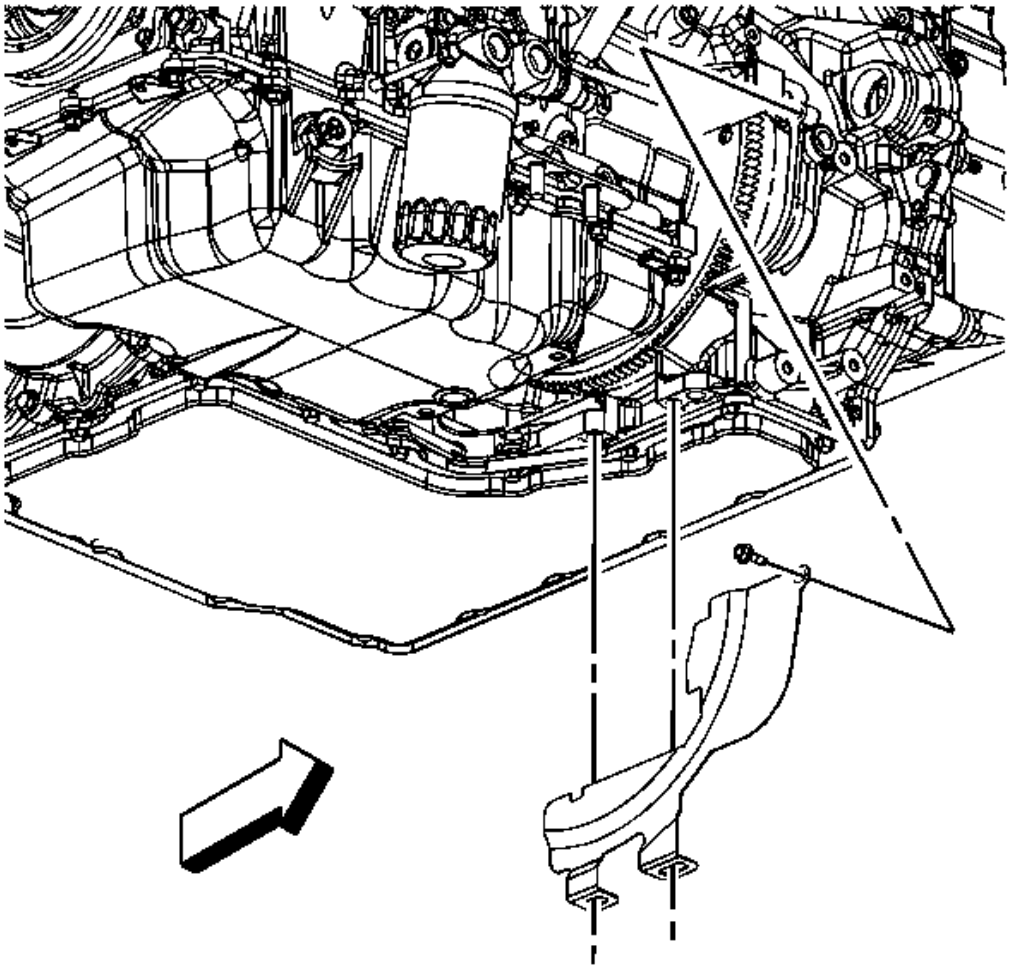


Fig. 103: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS COMPANY

11. Position the torque converter cover.
12. Install the torque converter cover bolt.

Tighten

Tighten the bolt to 12 N.m (106 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

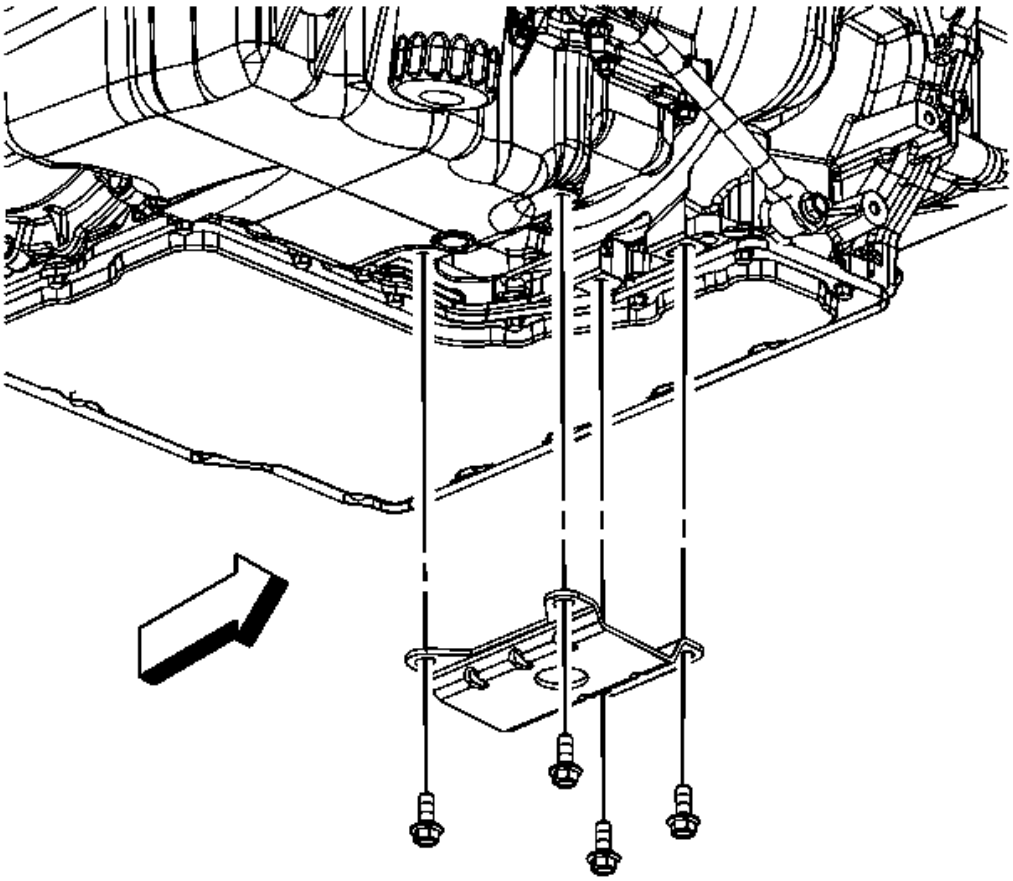


Fig. 104: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the transaxle to engine brace.
14. Install the transaxle to engine brace bolts.

    Tighten

    Tighten the bolts to 47 N.m (35 lb ft).

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

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

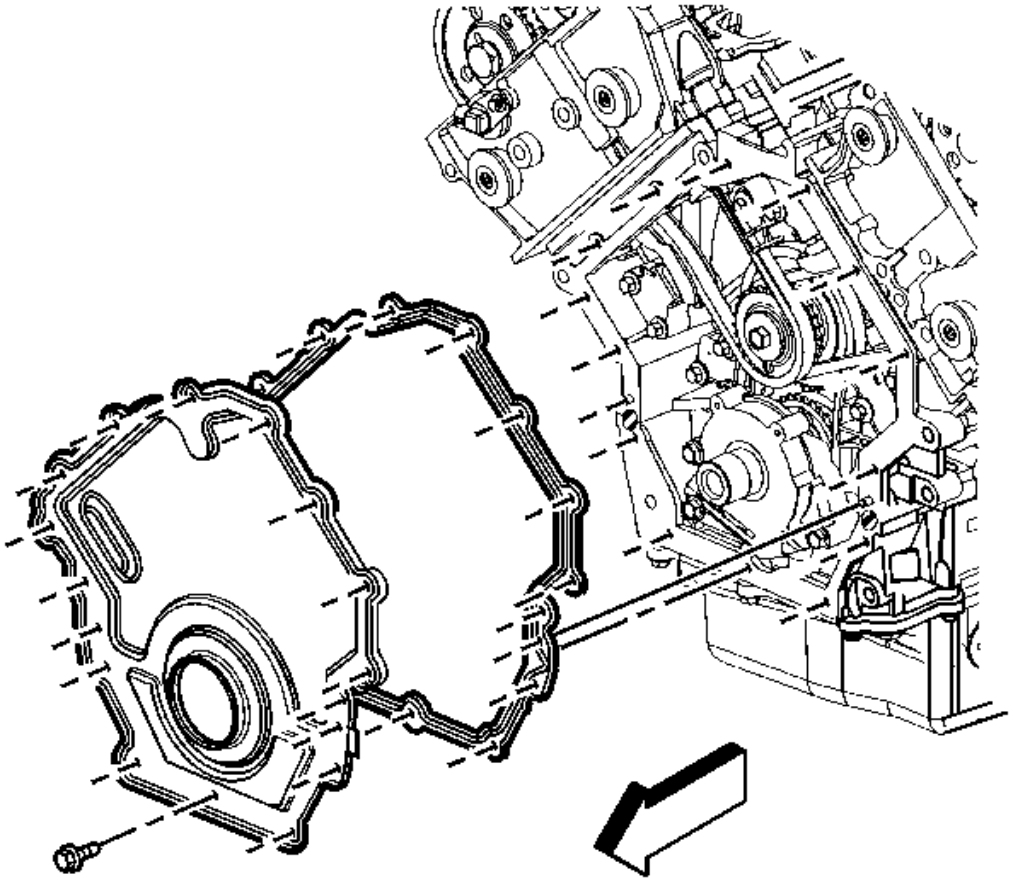


Fig. 105: View of Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the engine front cover bolts.
4. Remove the engine front cover and gasket. The gasket is reusable. Do not discard unless it is damaged.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

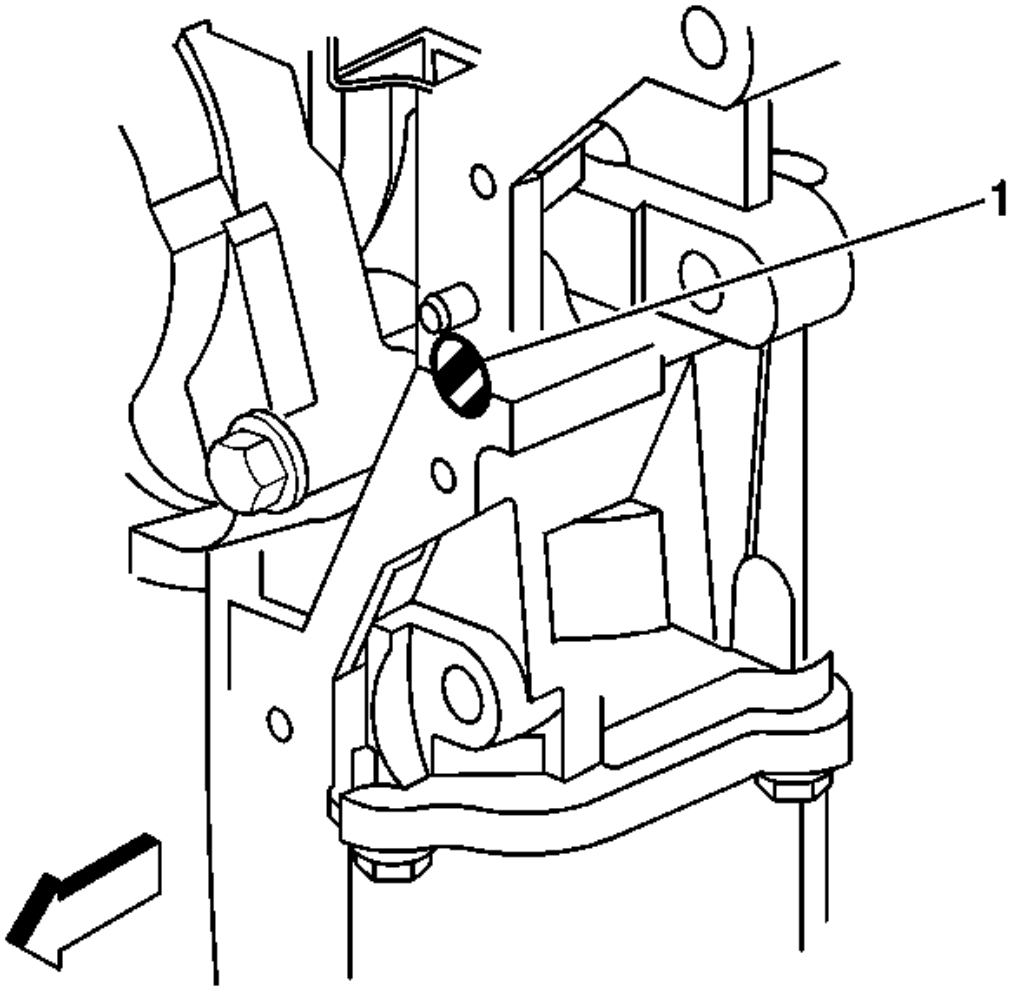


Fig. 106: Identifying Split Line of the Upper & Lower Crankcases
Courtesy of GENERAL MOTORS COMPANY

1. Place a small amount of sealant at the split line of the upper and lower crankcases (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

 © 2011 Mitchell Repair Information Company, LLC.

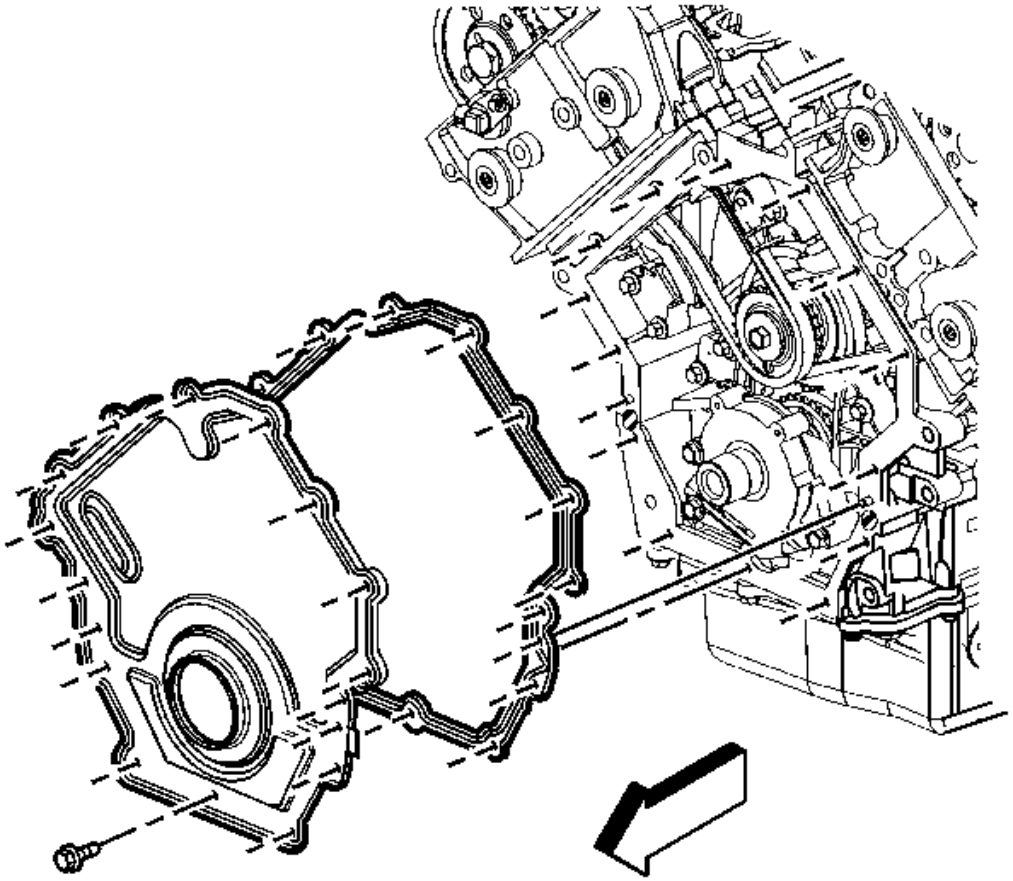


Fig. 107: View of Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Place the engine front cover gasket over the crankcase dowel pins.
3. Place the engine front cover in position on the crankcase.
4. Apply threadlock to the engine front cover bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
5. Install the engine front cover bolts until snug.

 © 2011 Mitchell Repair Information Company, LLC.

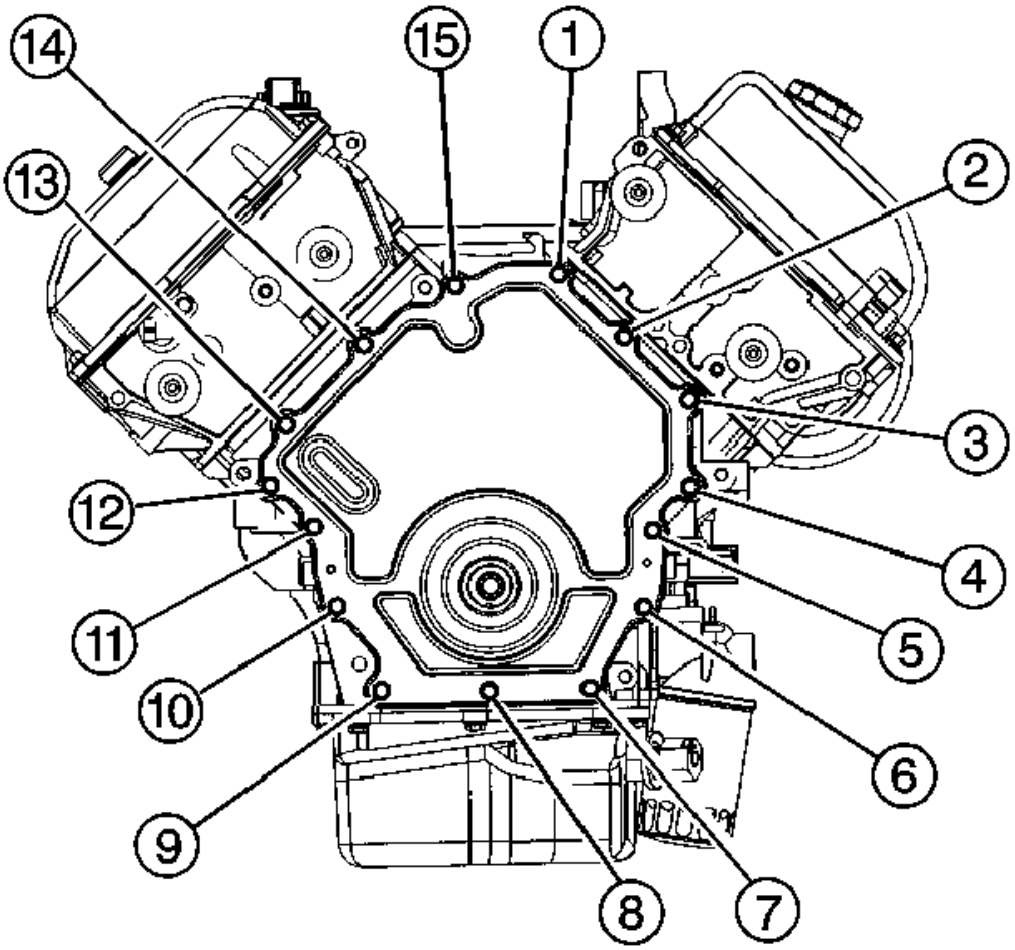


Fig. 108: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the engine front cover bolts.

   Tighten

   Tighten the bolts in the sequence to 10 N.m (89 lb in).

7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

 © 2011 Mitchell Repair Information Company, LLC.

8. Install the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement**.

OIL PUMP REPLACEMENT

Special Tools

J 45059 Angle Meter

Removal Procedure

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

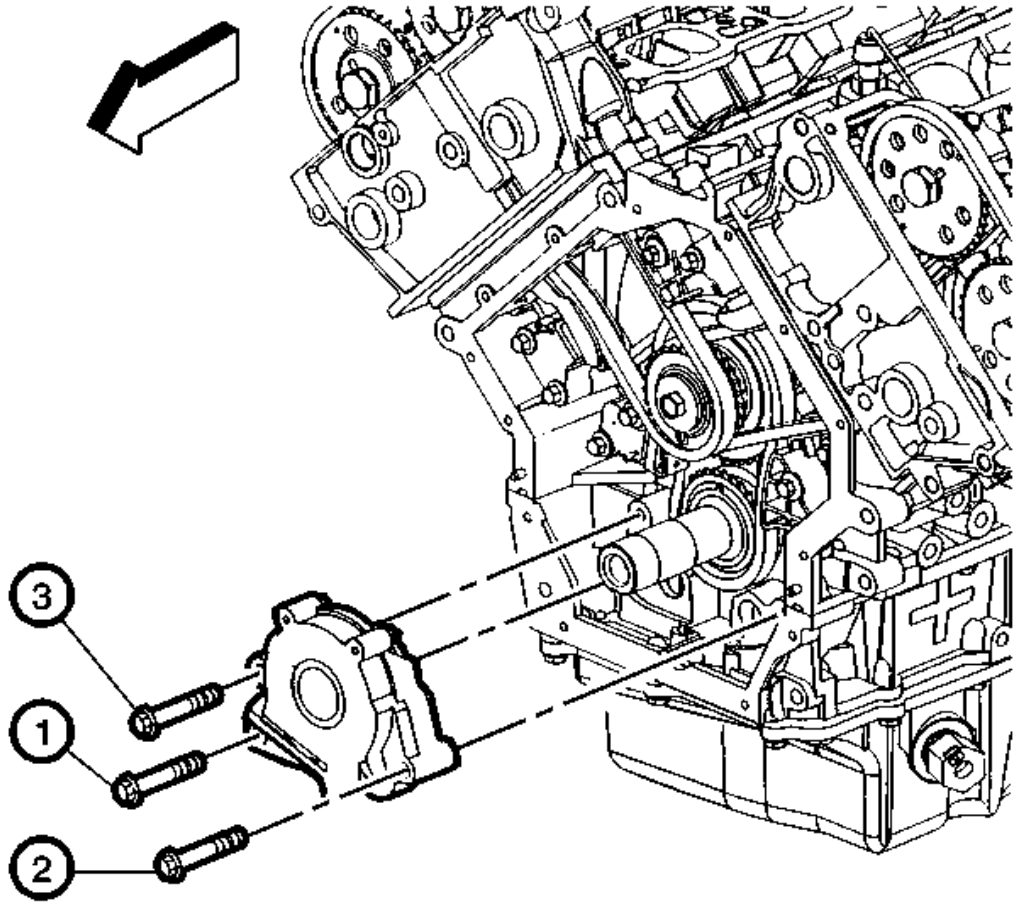


Fig. 109: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

 © 2011 Mitchell Repair Information Company, LLC.

2. Remove the 3 oil pump assembly retaining bolts (1, 2, 3) identified by the larger head size.
3. Slide the oil pump assembly off the nose of the crankshaft with the drive collar in place.
4. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

Installation Procedure

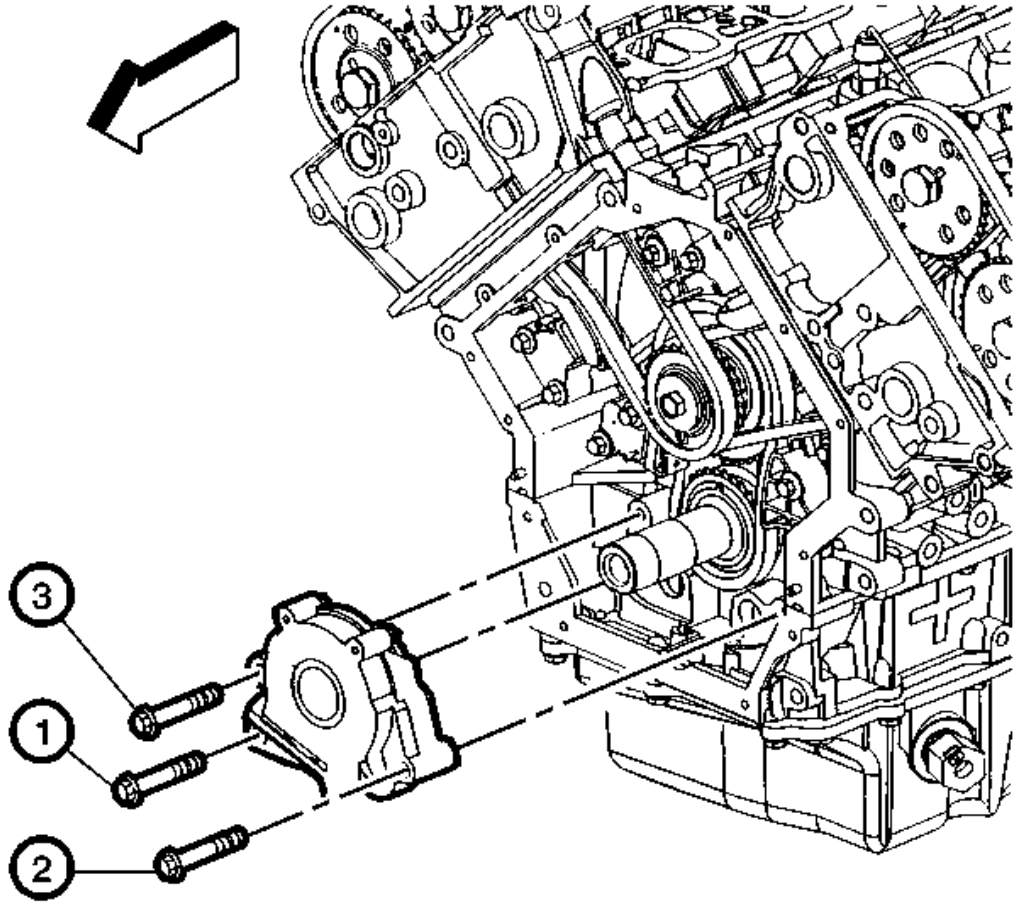


Fig. 110: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pump drive spacer into the oil pump so that the drive flat engages the pump rotor.
2. Position the oil pump on the crankshaft.
3. Install the retaining bolts.

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

4. Apply upward pressure on the pump while tightening the three retaining bolts. Tighten the bolts in the sequence (1, 2, 3) shown.

   Tighten

   - First Pass

     Tighten the oil pump mounting bolts in sequence to 10 N.m (89 lb in).

   - Final Pass

     Tighten the oil pump mounting bolts in sequence an additional 35 degrees using the **J 45059** .

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

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

1. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.

 © 2011 Mitchell Repair Information Company, LLC.

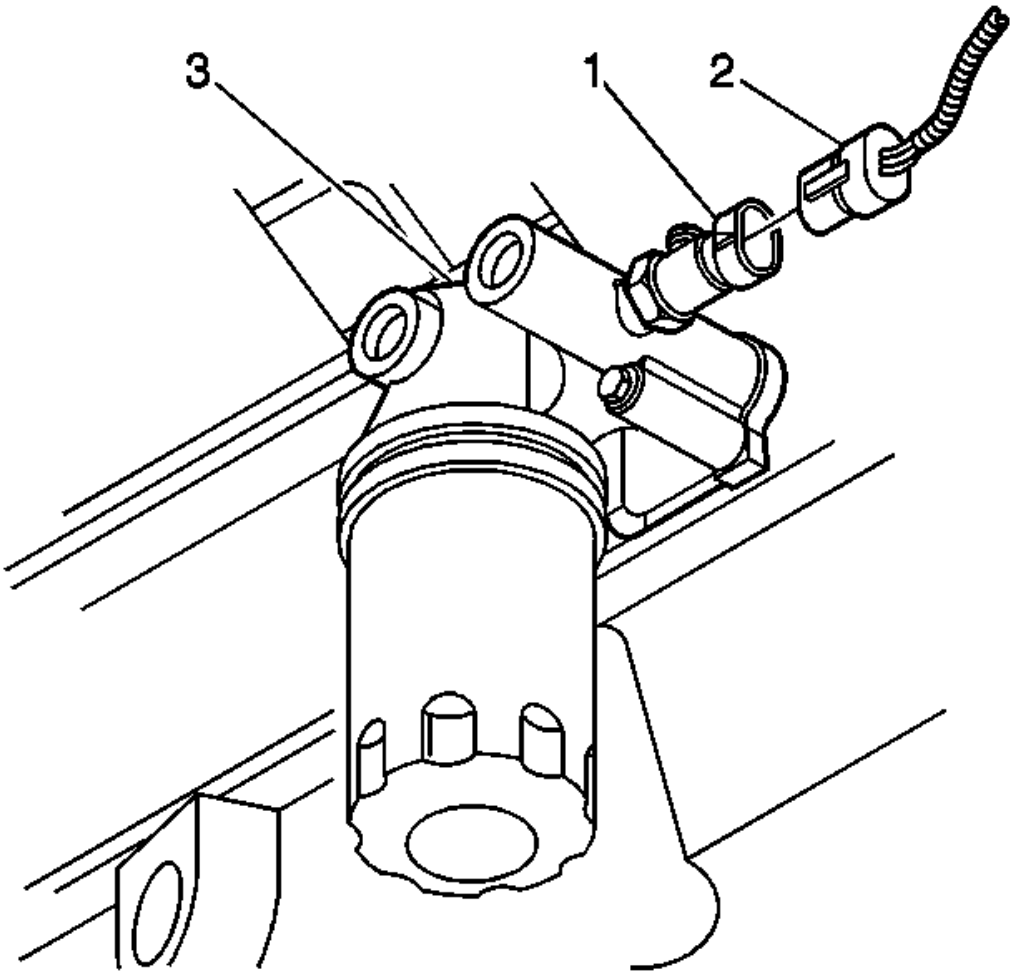


Fig. 111: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil pressure switch (1) from the oil filter adapter (3).

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

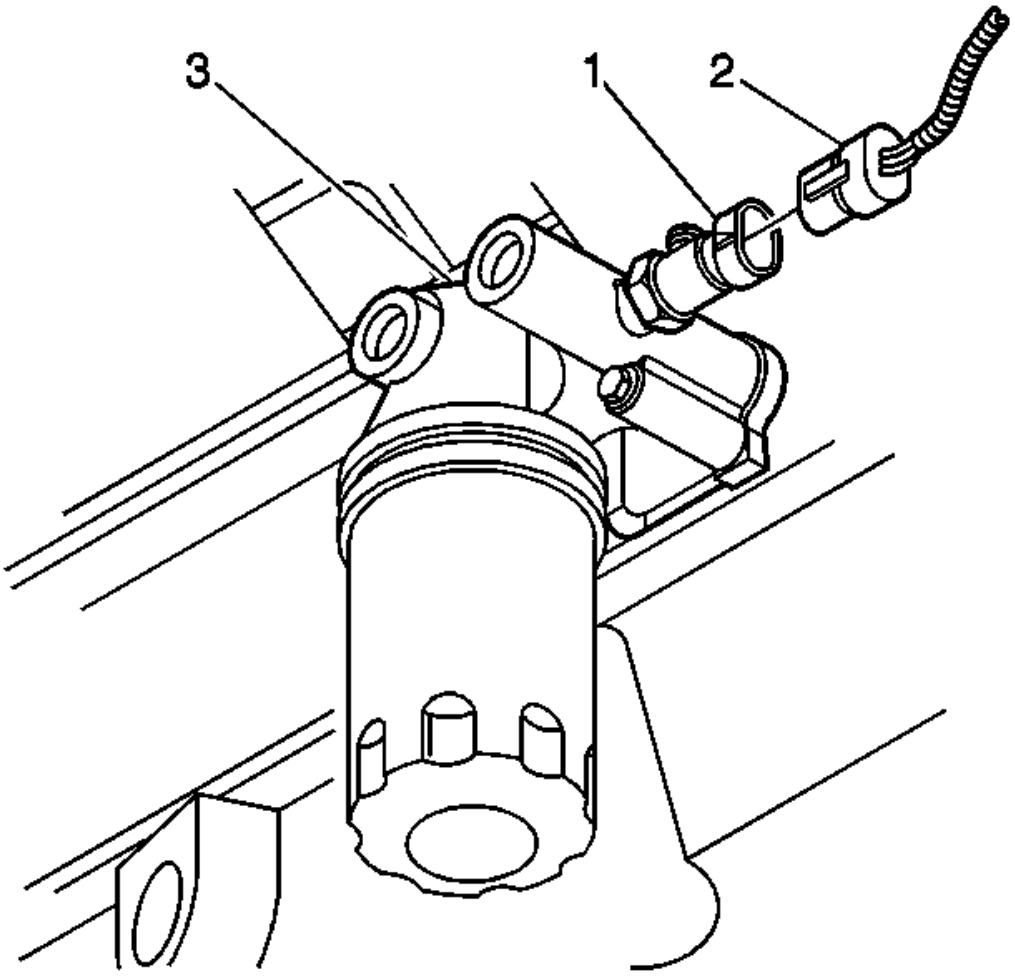


Fig. 112: View of Engine Oil Pressure Switch & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the engine oil pressure switch (1) to the oil filter adapter (3).

   Tighten

   Tighten the engine oil pressure switch to 16 N.m (12 lb ft).

2. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.

 © 2011 Mitchell Repair Information Company, LLC.

3. Lower the vehicle.
4. Adjust the engine oil level to the full mark.
5. Inspect for oil leaks after engine start up.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

1. Remove the air conditioning (A/C) compressor. Refer to **Air Conditioning Compressor Replacement (L37)** .
2. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

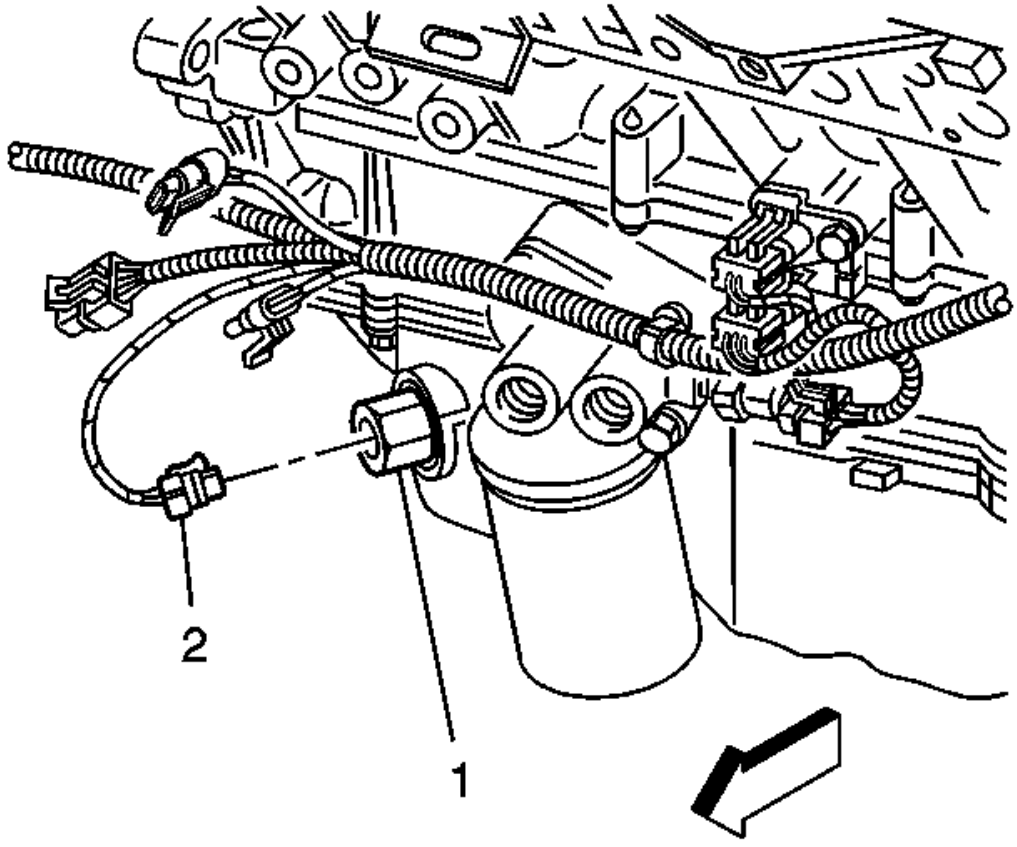


Fig. 113: View of Engine Oil Level Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector (2) from the engine oil level sensor (1).

 © 2011 Mitchell Repair Information Company, LLC.

4. Remove the engine oil level sensor (1) from the oil pan.

Installation Procedure

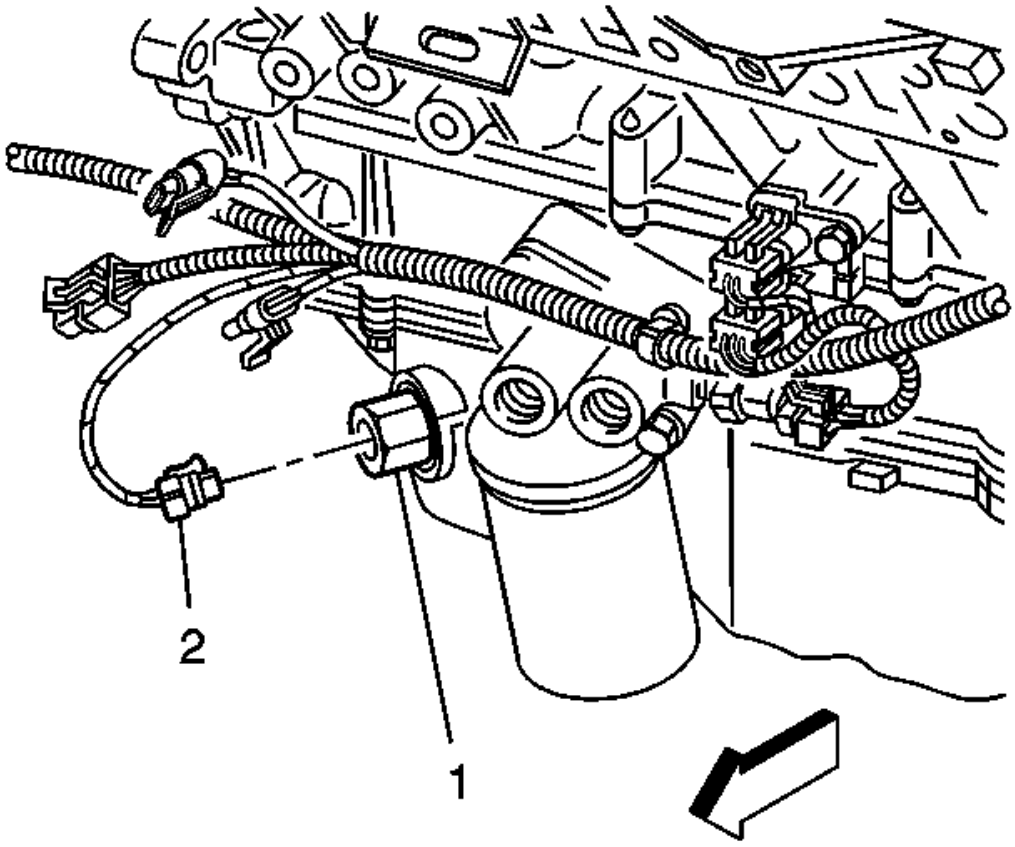


Fig. 114: View of Engine Oil Level Sensor & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

 © 2011 Mitchell Repair Information Company, LLC.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil level sensor (1) into the oil pan.

   Tighten

   Tighten the engine oil level sensor to 20 N.m (15 lb ft).

2. Connect the electrical connector (2) to the engine oil level sensor (1).
3. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
4. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (L37)** .
5. Inspect for oil leaks after engine start up.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

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

 © 2011 Mitchell Repair Information Company, LLC.

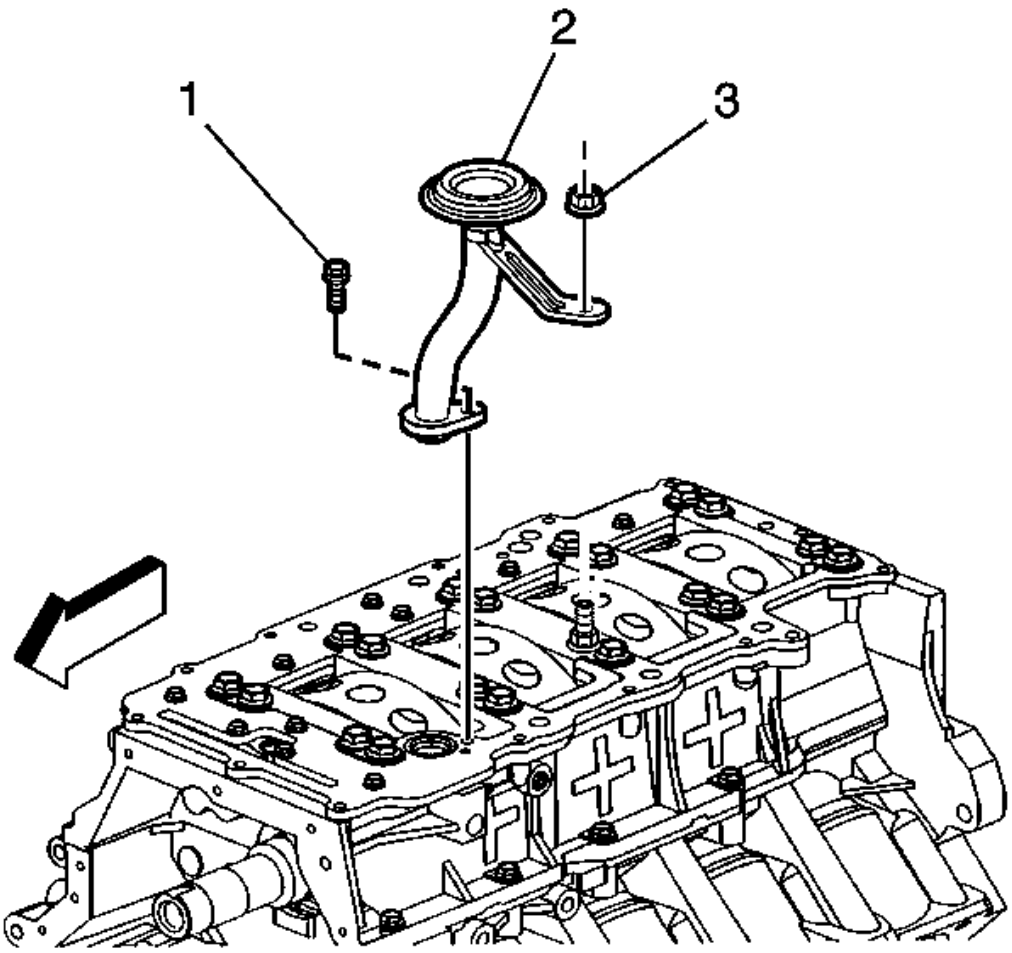


Fig. 115: Identifying Oil Pump Pickup Tube Support Nut, Oil Manifold Mounting Bolt, & Oil Pump Pickup Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pump pickup tube support nut (3) from the main bearing stud.
3. Remove the mounting bolt (1) from the oil manifold plate.
4. Remove the oil pump pickup tube (2).

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

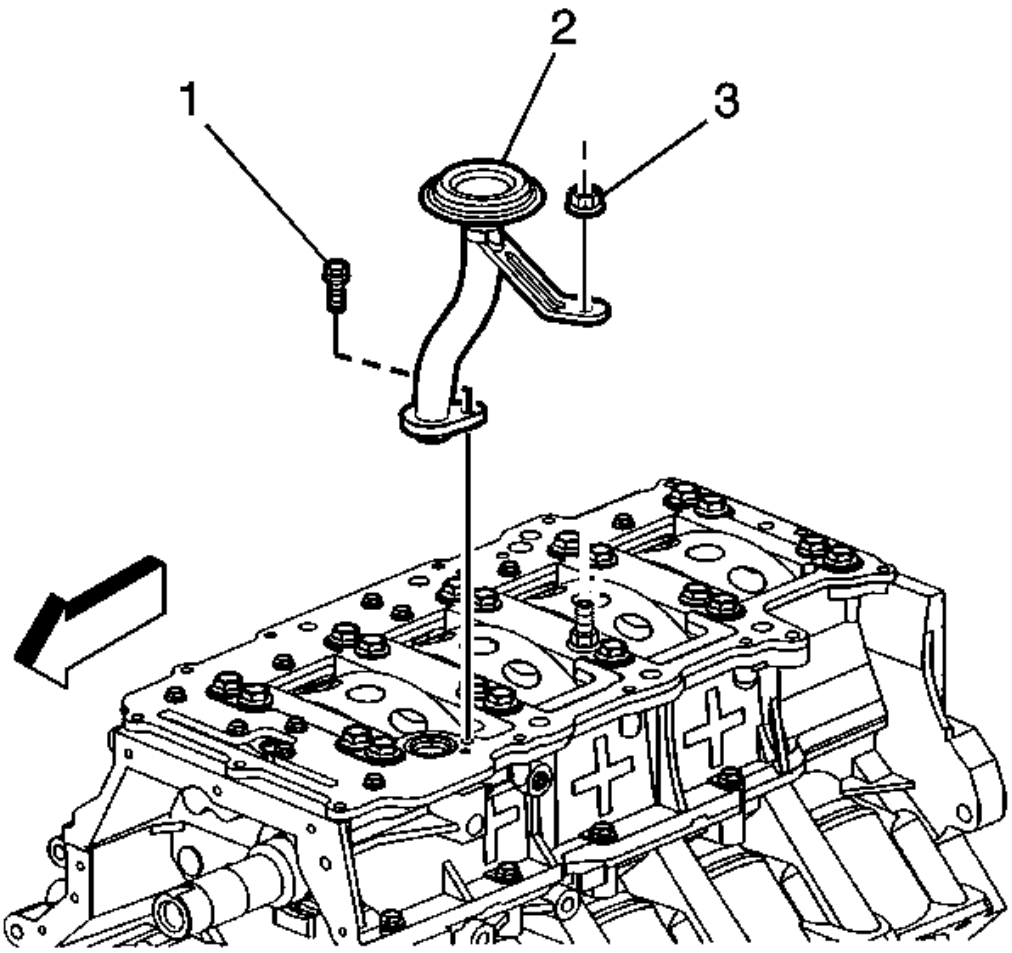


Fig. 116: Identifying Oil Pump Pickup Tube Support Nut, Oil Manifold Mounting Bolt, & Oil Pump Pickup Tube
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the silicone seal in the oil manifold plate.

   With a twisting motion, install the end of the oil pump pick-up tube (2).

   CAUTION: Refer to Fastener Caution .

2. Install the oil pump pick-up retaining bolt (1) and nut (3).

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

- Tighten the oil pump pick-up tube nut to 24 N.m (18 lb ft).
- Tighten the oil pump pick-up tube bolt to 10 N.m (89 lb in).

3. Install the oil pan. Refer to **Oil Pan Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

- **J 38823** Water Pump Drive Pulley Installer
- **J 38825** Water Pump Drive Pulley Remover

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

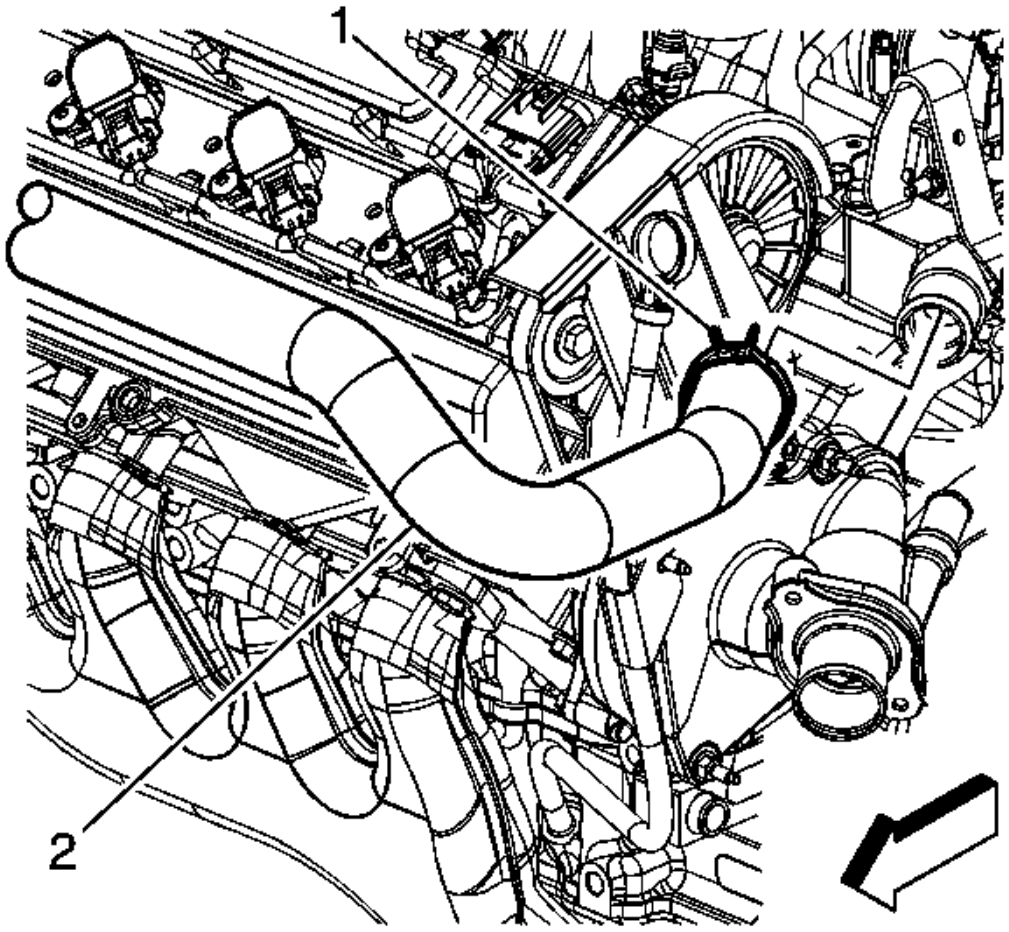


Fig. 117: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the upper tie bar. Refer to **Front End Upper Tie Bar Replacement** .
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** , **Cooling System Draining and Filling (Static Fill)** .
4. Reposition the radiator inlet hose clamp (1).
5. Remove the radiator inlet hose (2) from the water pump housing.

 © 2011 Mitchell Repair Information Company, LLC.

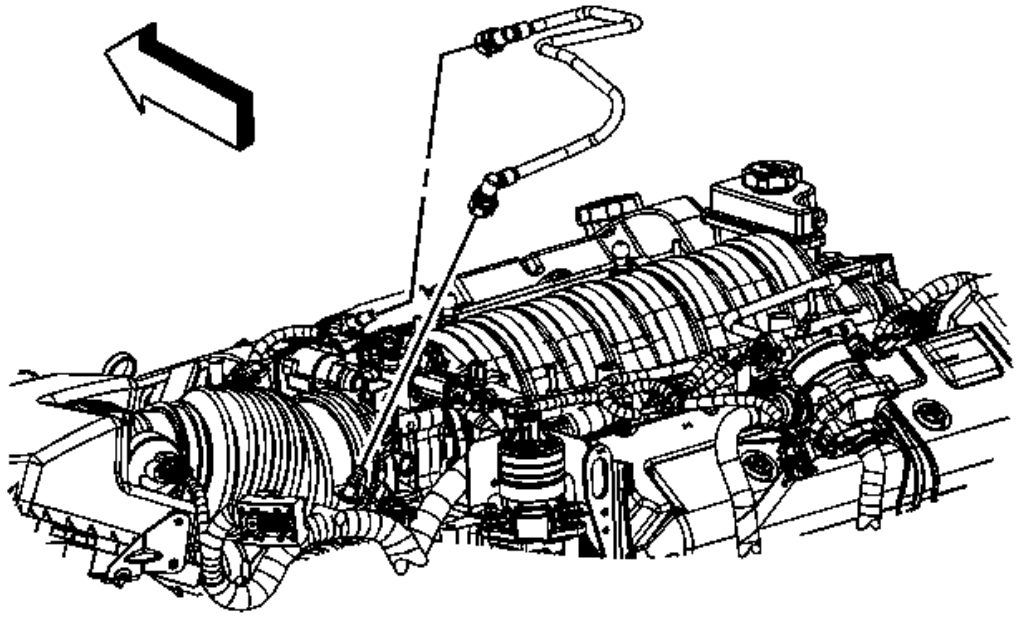


Fig. 118: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the positive crankcase ventilation (PCV) fresh air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
7. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .

 © 2011 Mitchell Repair Information Company, LLC.

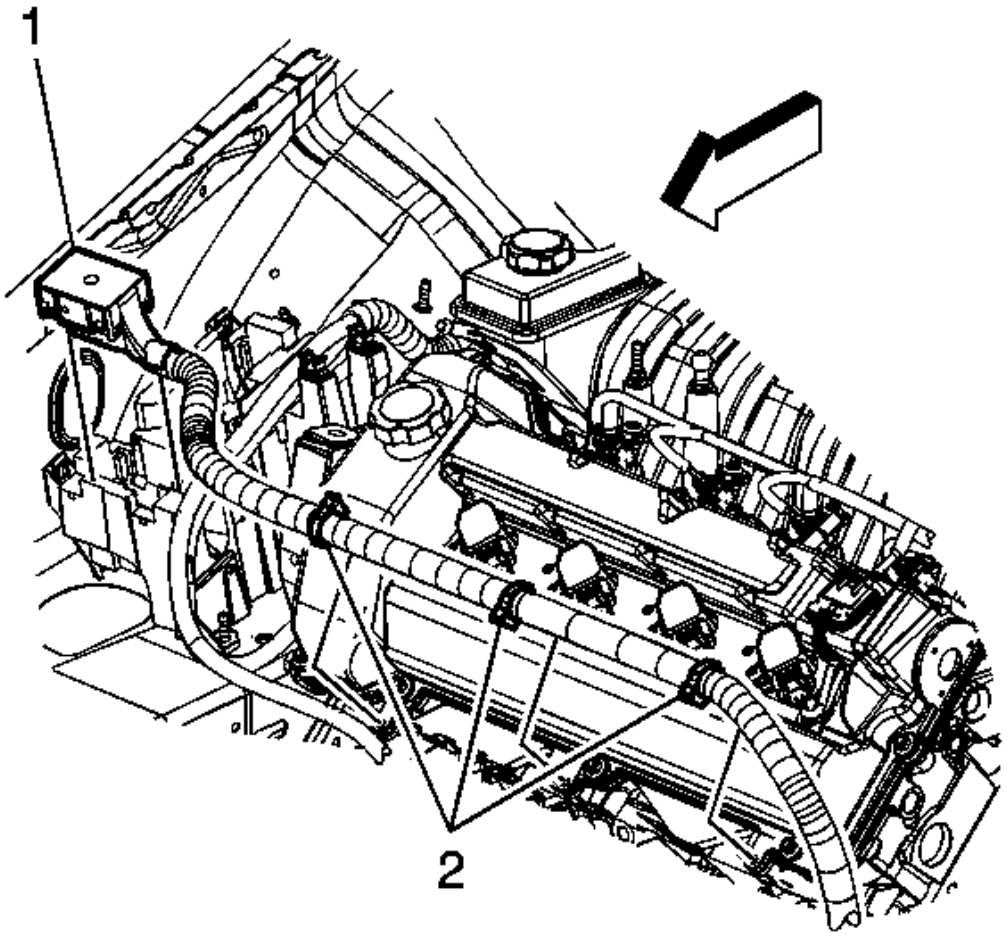


Fig. 119: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine harness clips (2) from the camshaft cover and position the harness aside.

 © 2011 Mitchell Repair Information Company, LLC.

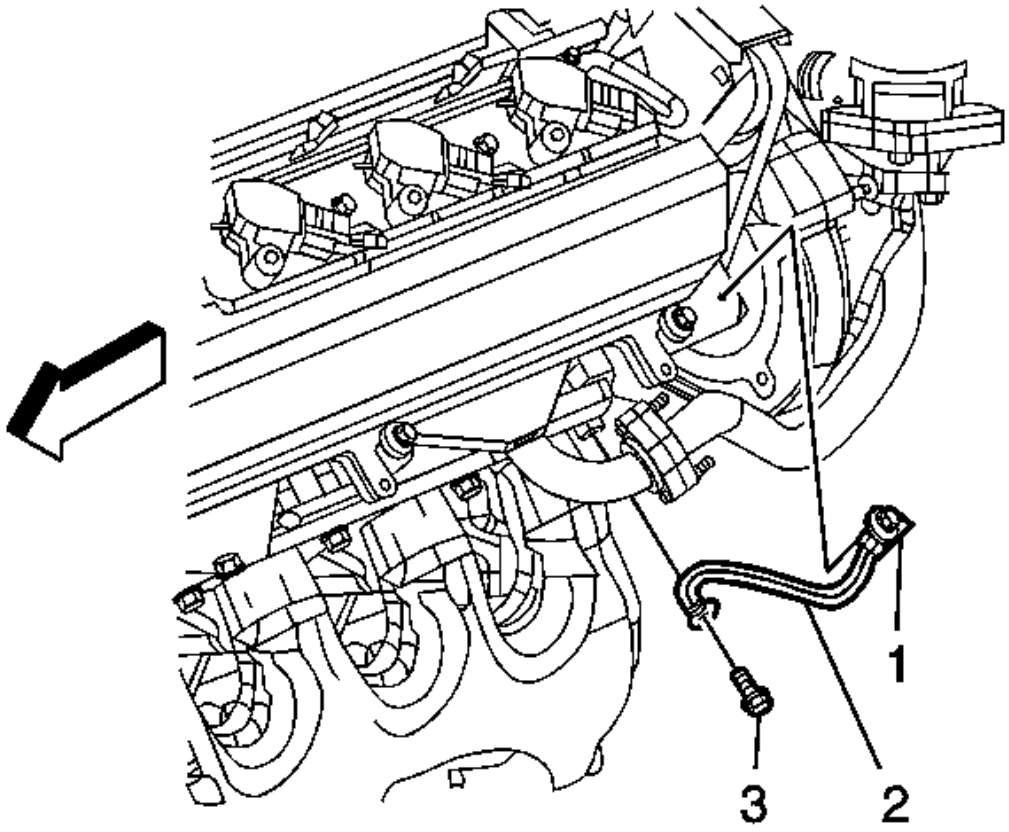


Fig. 120: Identifying ICM Wiring Harness Ground
Courtesy of GENERAL MOTORS COMPANY

9. Loosen the ignition control module (ICM) wiring harness ground bolt (1) from the camshaft cover.
10. Remove the ground wire terminal/bolt from the camshaft cover.

 © 2011 Mitchell Repair Information Company, LLC.

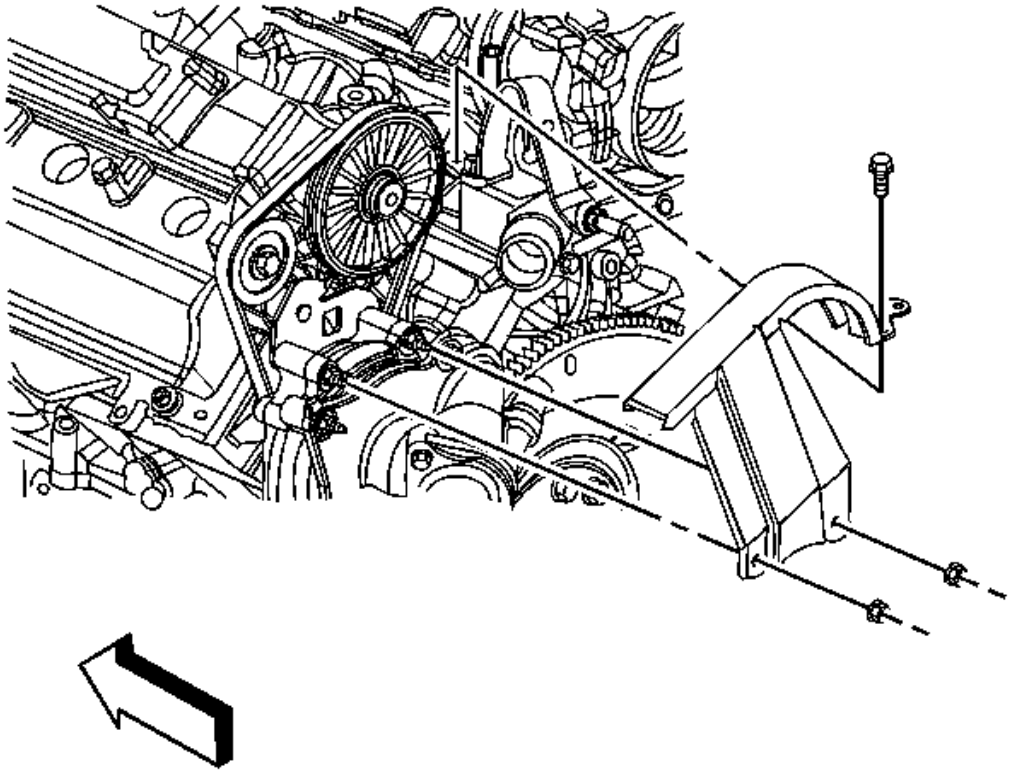


Fig. 121: View Of Water Pump Drive Belt Tensioner Shield
Courtesy of GENERAL MOTORS COMPANY

11. Remove the water pump drive belt tensioner shield bolt/nuts.
12. Remove the water pump drive belt shield.
13. Remove the water pump drive belt from the pulleys.

 © 2011 Mitchell Repair Information Company, LLC.

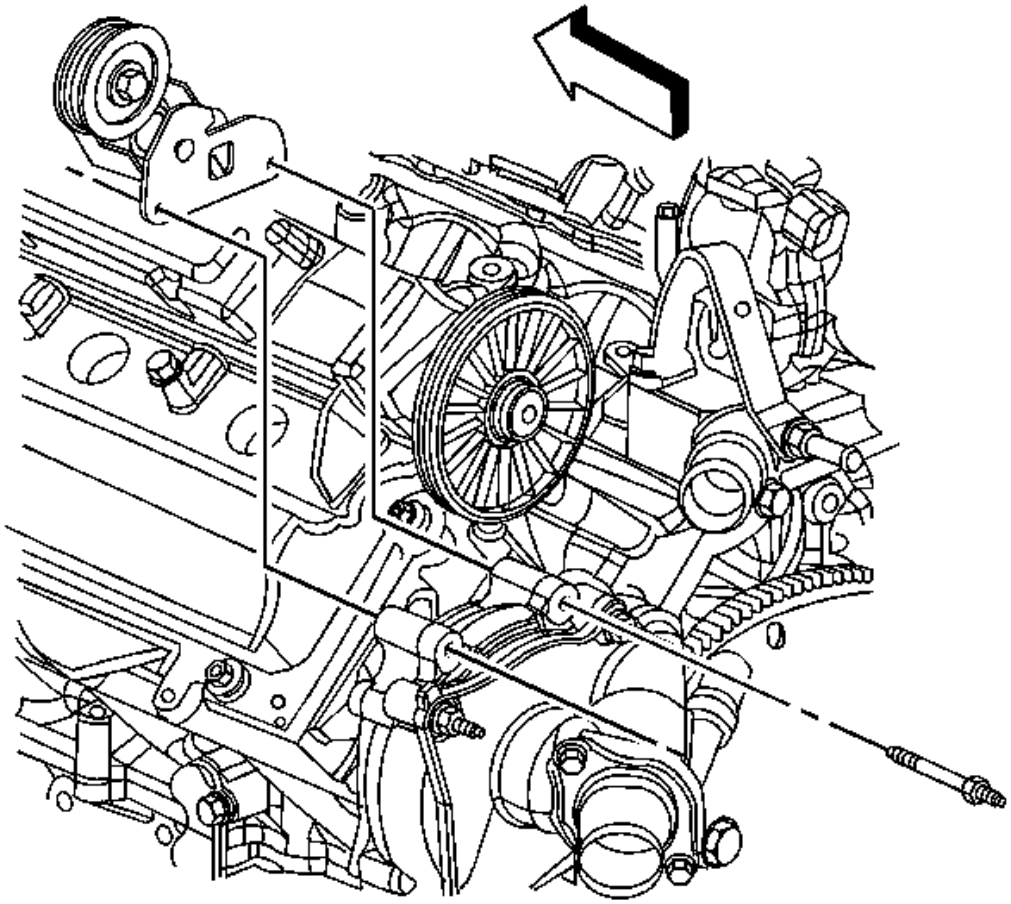


Fig. 122: View Of Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

14. Remove the water pump drive belt tensioner studs.
15. Remove the water pump belt tensioner.

 © 2011 Mitchell Repair Information Company, LLC.

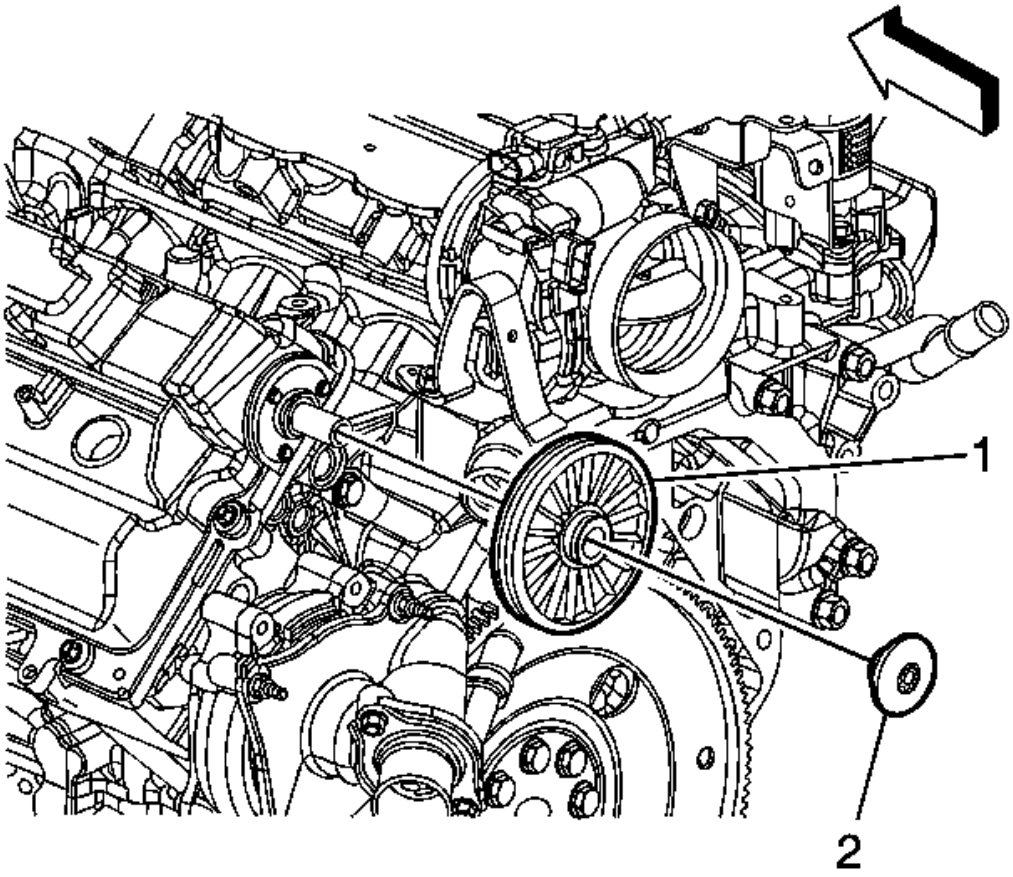


Fig. 123: Identifying Plastic Dust Cap
Courtesy of GENERAL MOTORS COMPANY

16. Remove the plastic dust cap (2) from the end of the intake camshaft.

 © 2011 Mitchell Repair Information Company, LLC.

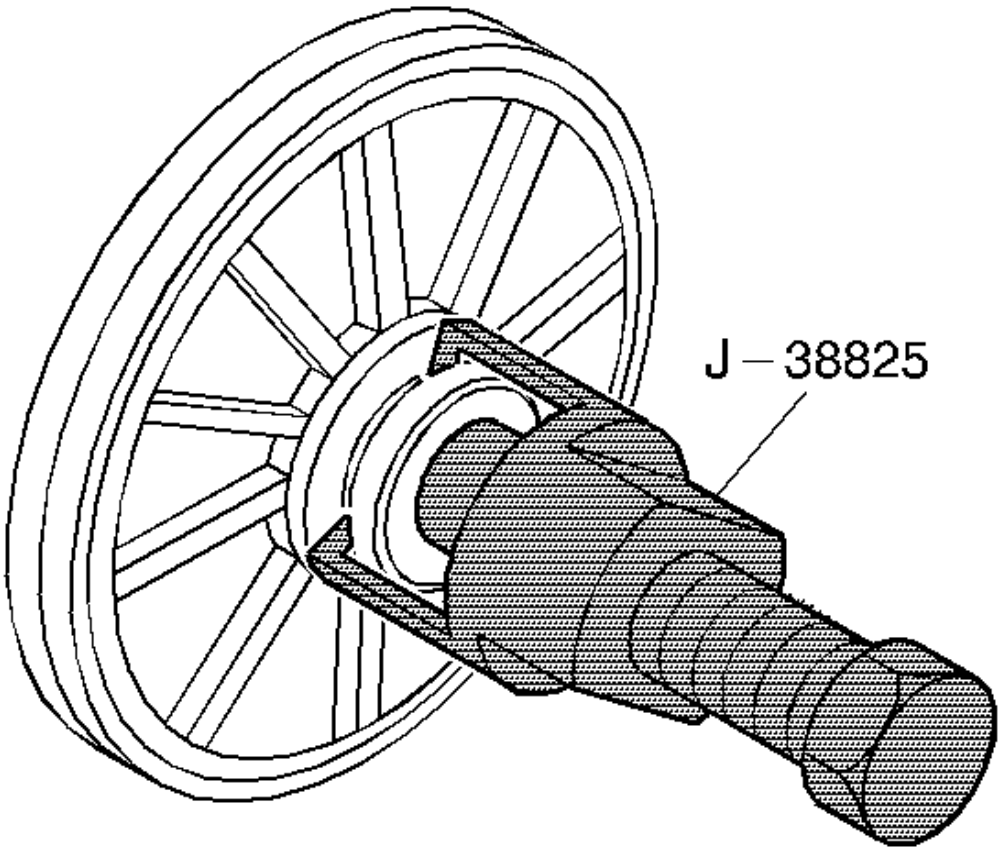


Fig. 124: View of J 38825
Courtesy of GENERAL MOTORS COMPANY

17. Remove the water pump pulley from the intake camshaft using the **J 38825** .

 © 2011 Mitchell Repair Information Company, LLC.

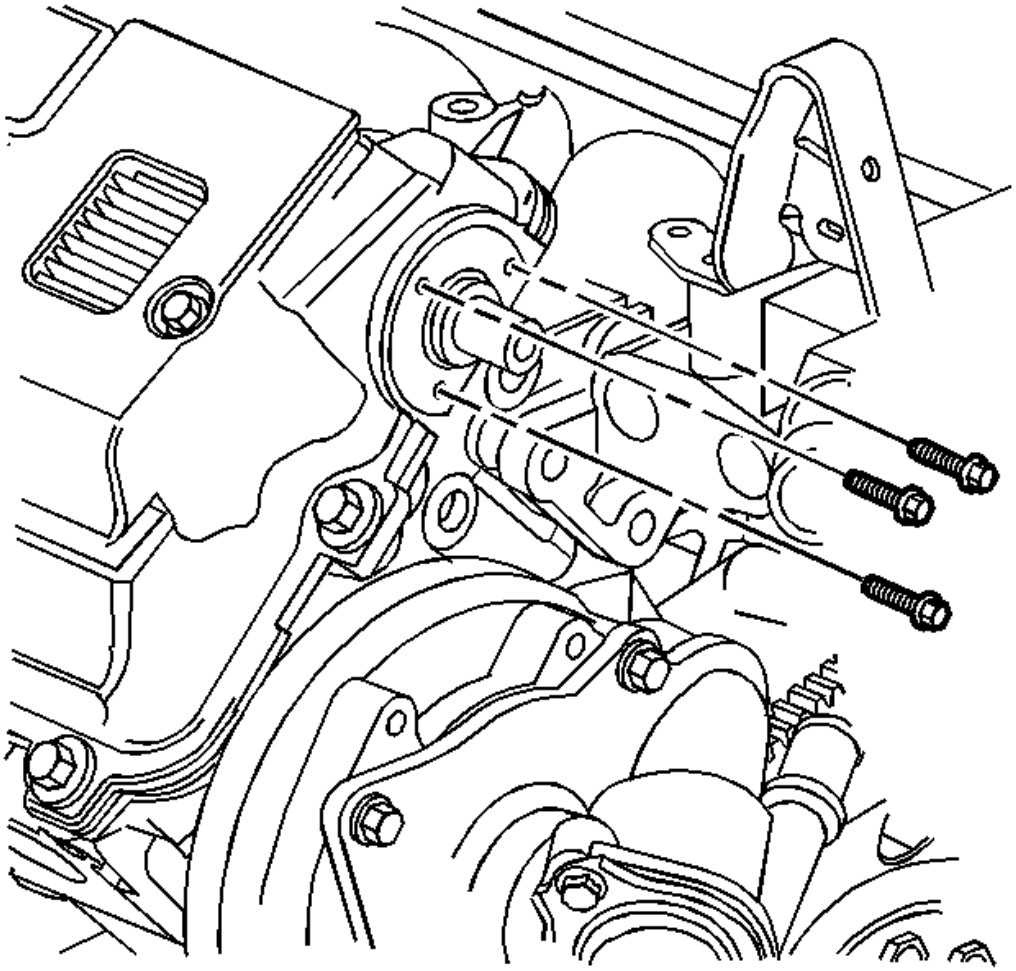


Fig. 125: Identifying Camshaft Seal Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove the camshaft seal bolts.

 © 2011 Mitchell Repair Information Company, LLC.

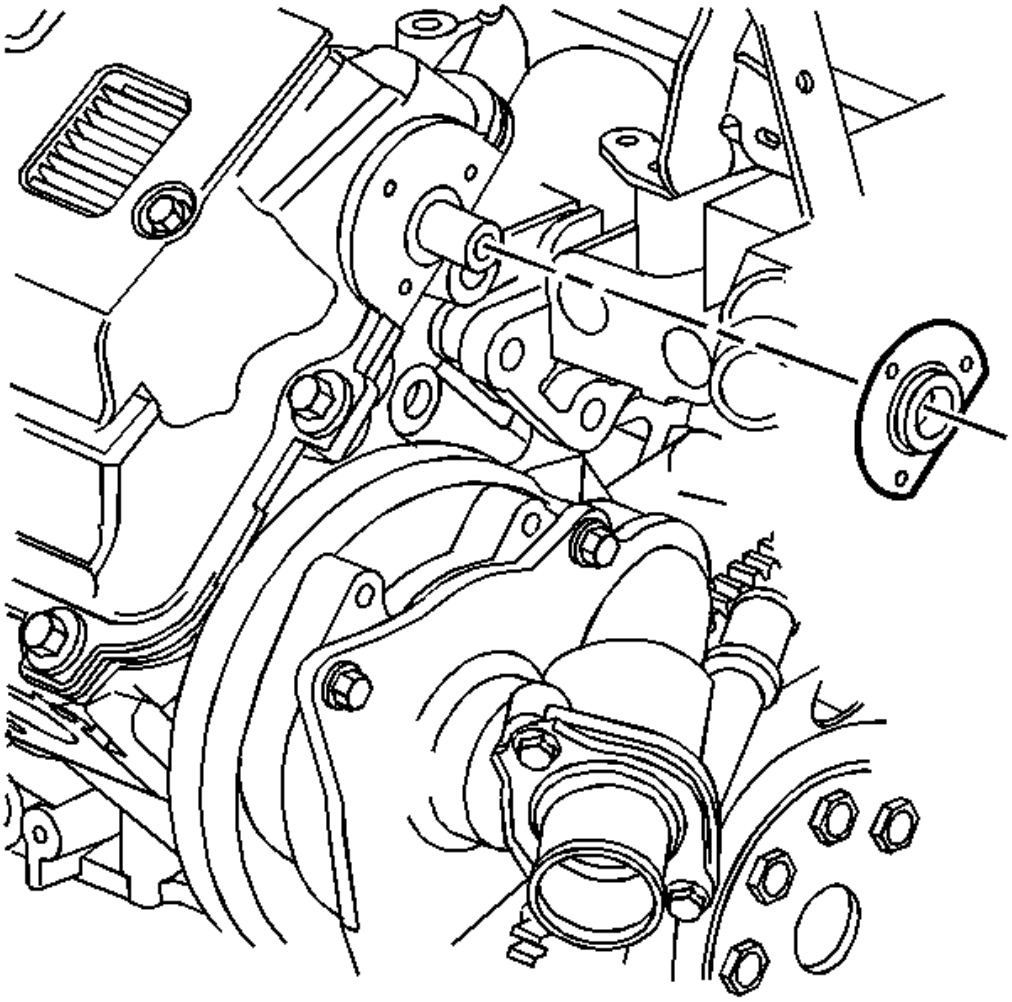


Fig. 126: View of Camshaft Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT reuse the camshaft seal.

19. Remove and discard the camshaft seal.

 © 2011 Mitchell Repair Information Company, LLC.

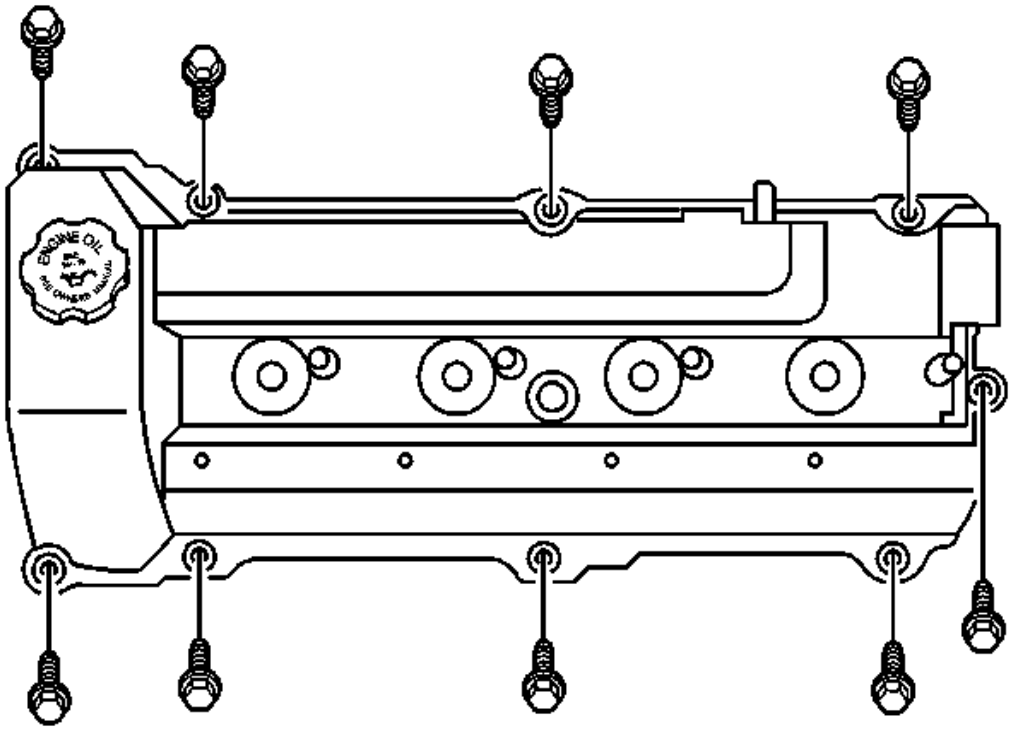


Fig. 127: View of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Loosen the camshaft cover bolts.

 © 2011 Mitchell Repair Information Company, LLC.

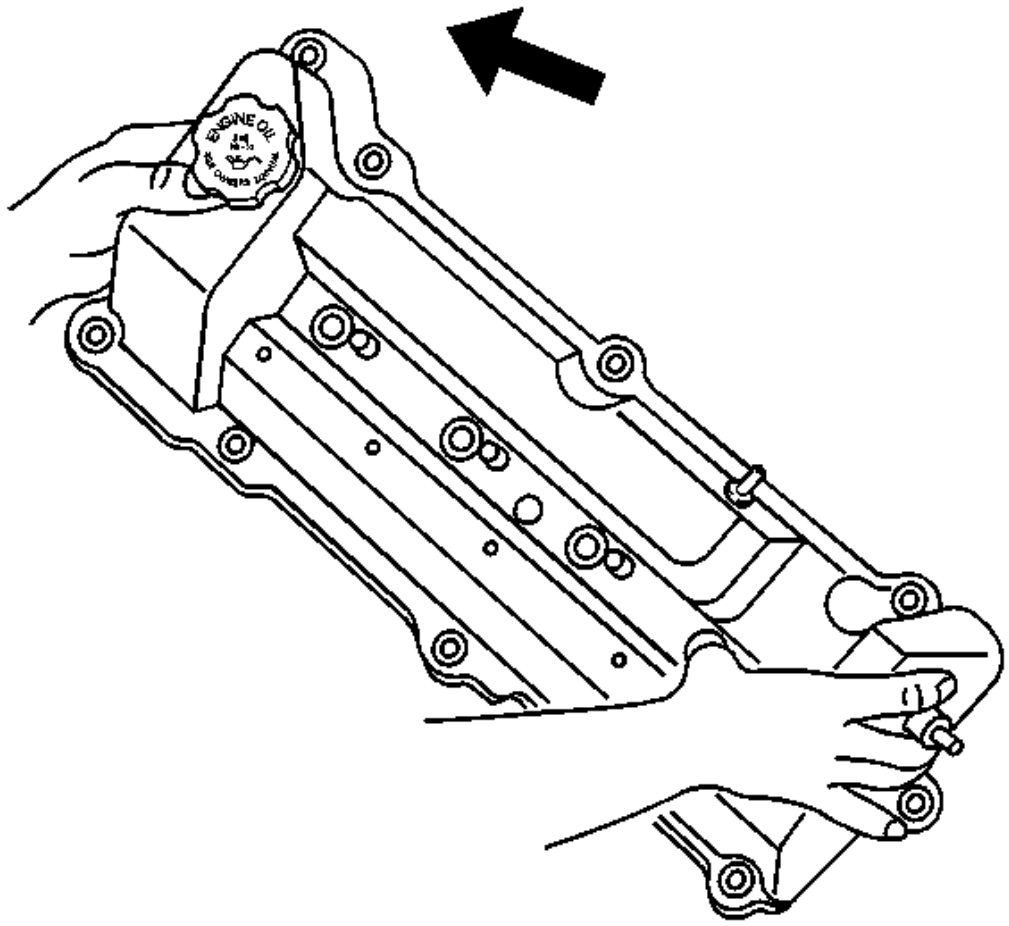


Fig. 128: Identifying Camshaft Drive End of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

21. Lift the camshaft drive end of the cover up.

 © 2011 Mitchell Repair Information Company, LLC.

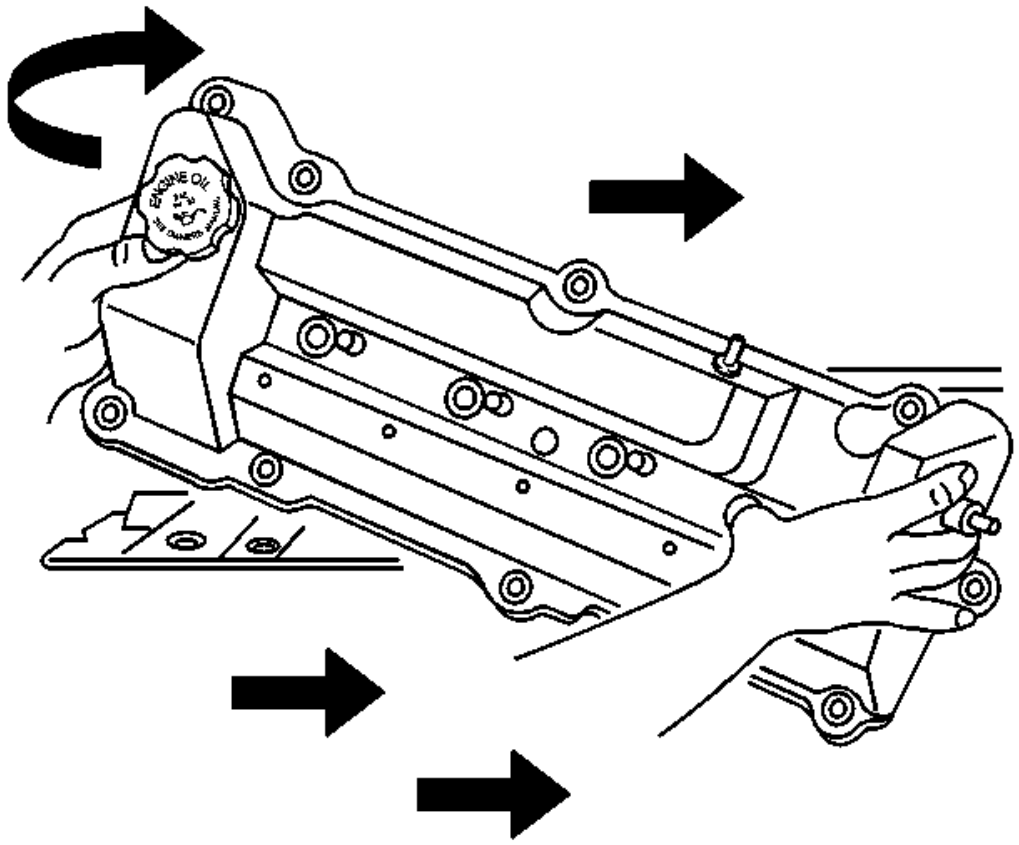


Fig. 129: Moving Left Camshaft Cover Rearward
Courtesy of GENERAL MOTORS COMPANY

22. Move the camshaft cover reward in order to clear the water pump drive shaft.
23. Discard the camshaft cover perimeter seals and spark plug seals if there is any evidence of damage or if the seal comes out of the groove in the cover during removal.
24. Clean and inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

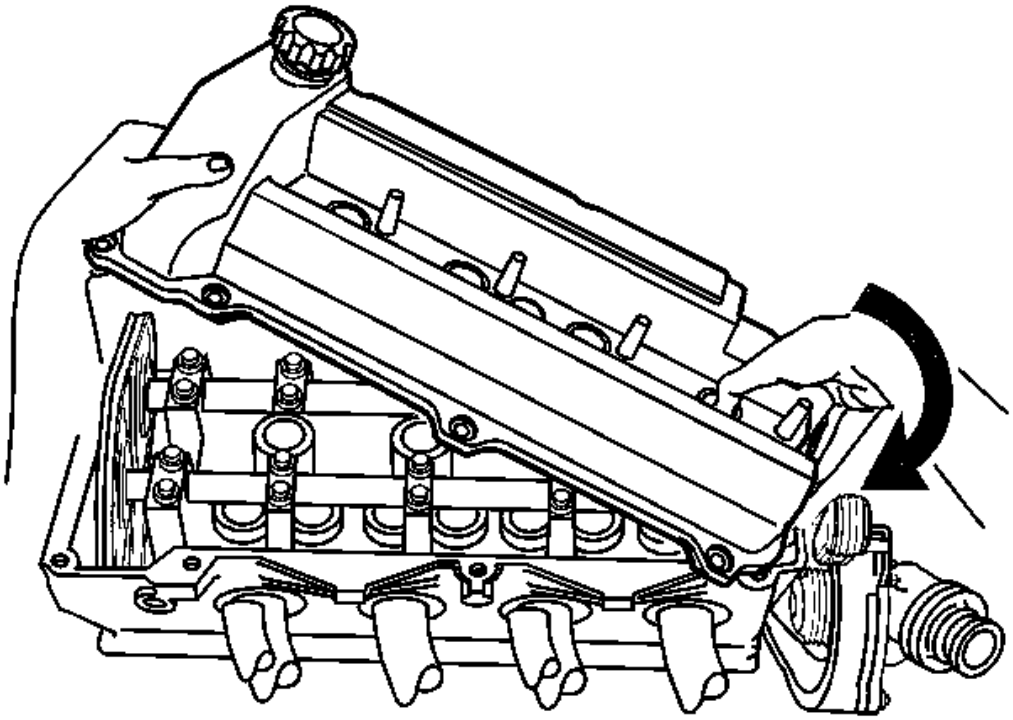


Fig. 130: View of Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: Be careful to prevent the exposed section of the camshaft cover seal from being damaged by the edge of the cylinder head casting.

1. Install the camshaft cover seal as required.
2. Install the camshaft cover end over the intake camshaft end.

 © 2011 Mitchell Repair Information Company, LLC.

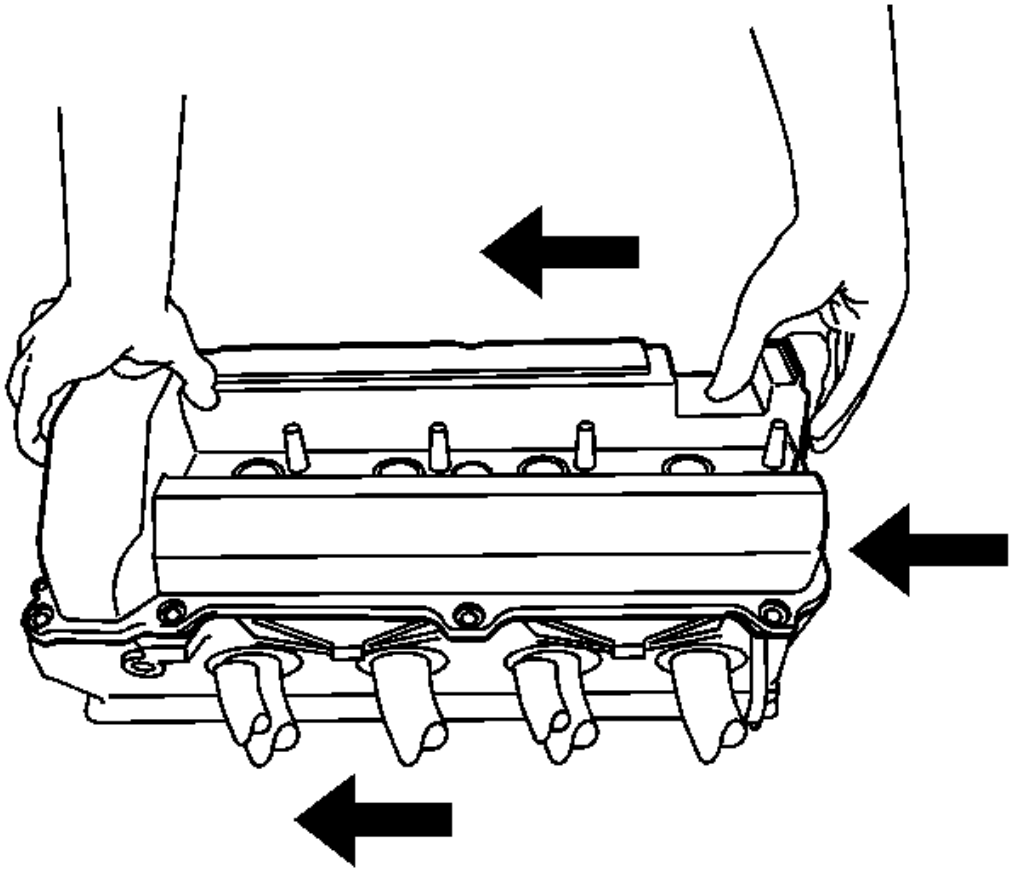


Fig. 131: Proper Positioning of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Work the camshaft cover into position by pivoting the cover down and to the left allowing the cover to clear the camshaft drive chain and then aligning the bolt holes.

 © 2011 Mitchell Repair Information Company, LLC.

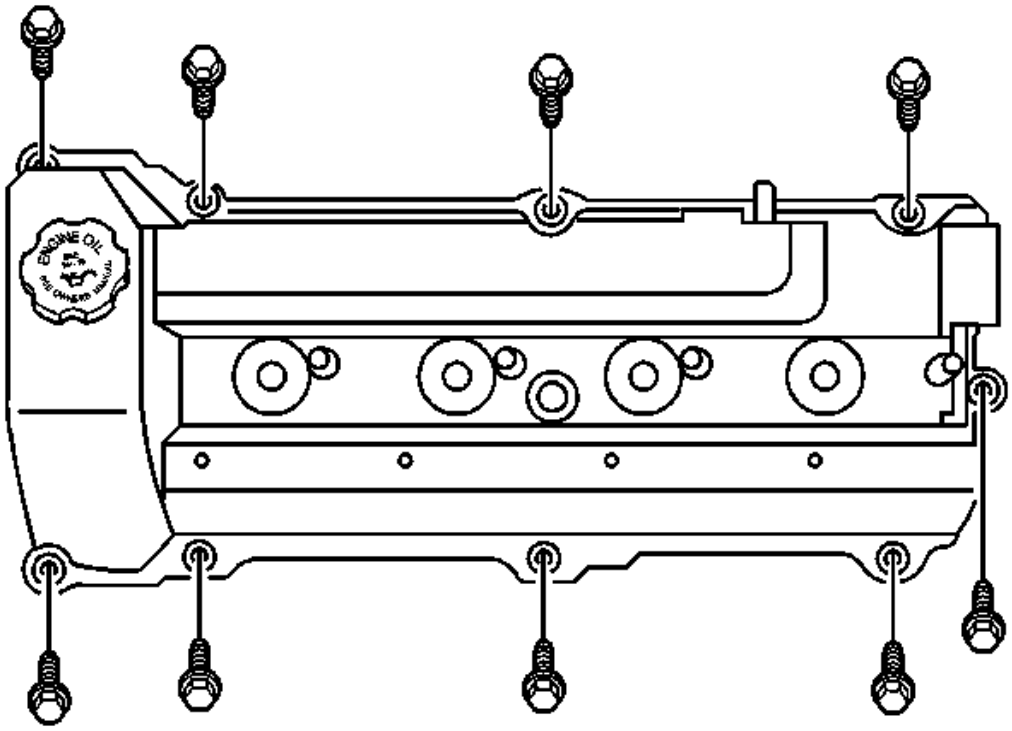


Fig. 132: View of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the camshaft cover bolts.

   Tighten

   Tighten the bolts to 10 N.m (89 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

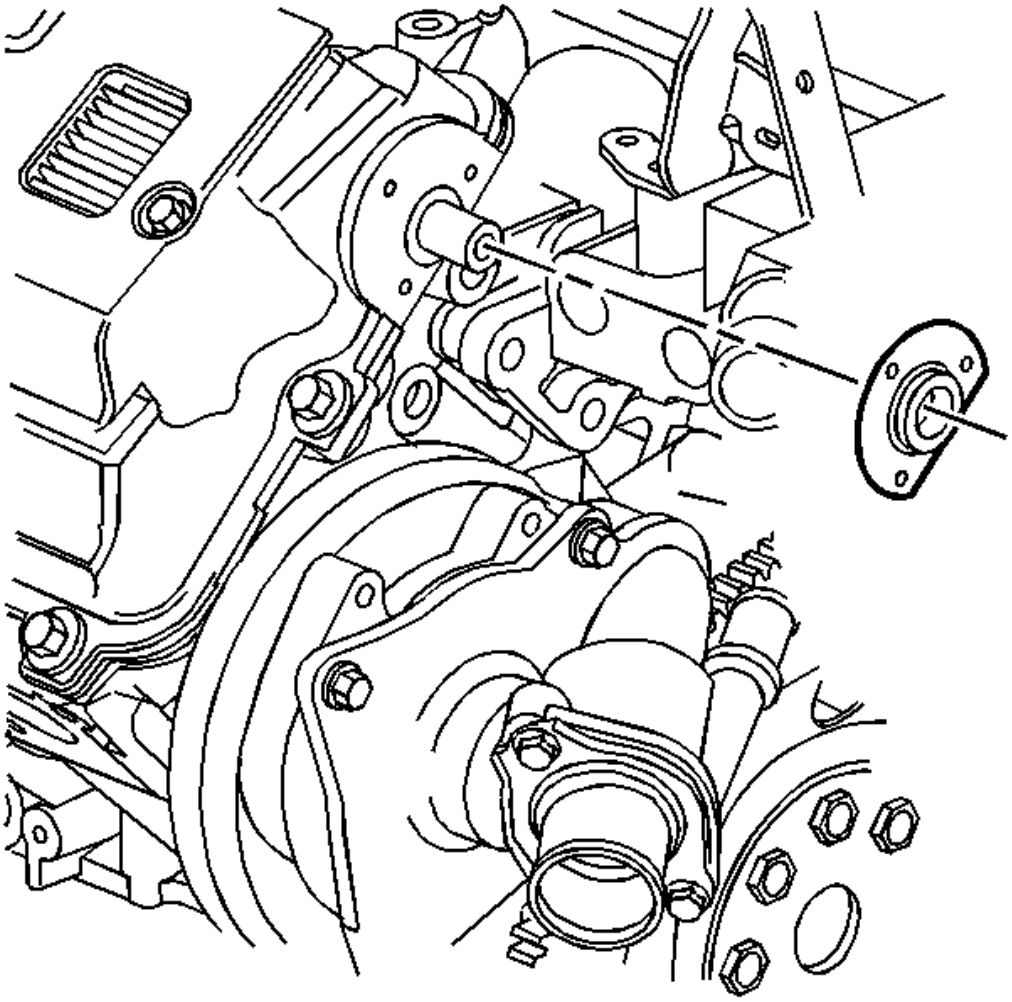


Fig. 133: View of Camshaft Seal
Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW camshaft seal as follows:
    1. Lubricate the camshaft seal lip with engine oil.
    2. Push the camshaft seal into position around the camshaft using the protective sleeve supplied with the seal.

 © 2011 Mitchell Repair Information Company, LLC.

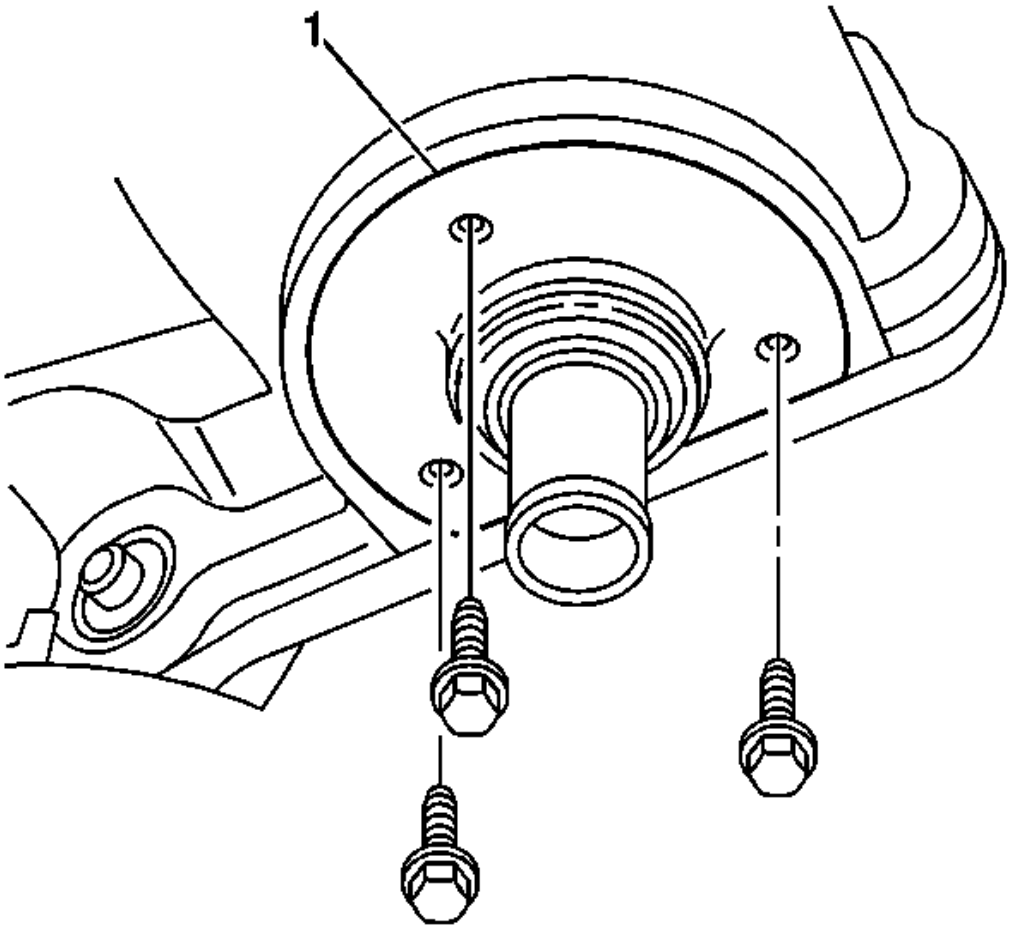


Fig. 134: Identifying Camshaft Seal Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Coat the threads of the camshaft seal bolts with sealant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
7. Install the camshaft seal (1) bolts.

Tighten

Tighten the bolts to 3 N.m (27 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

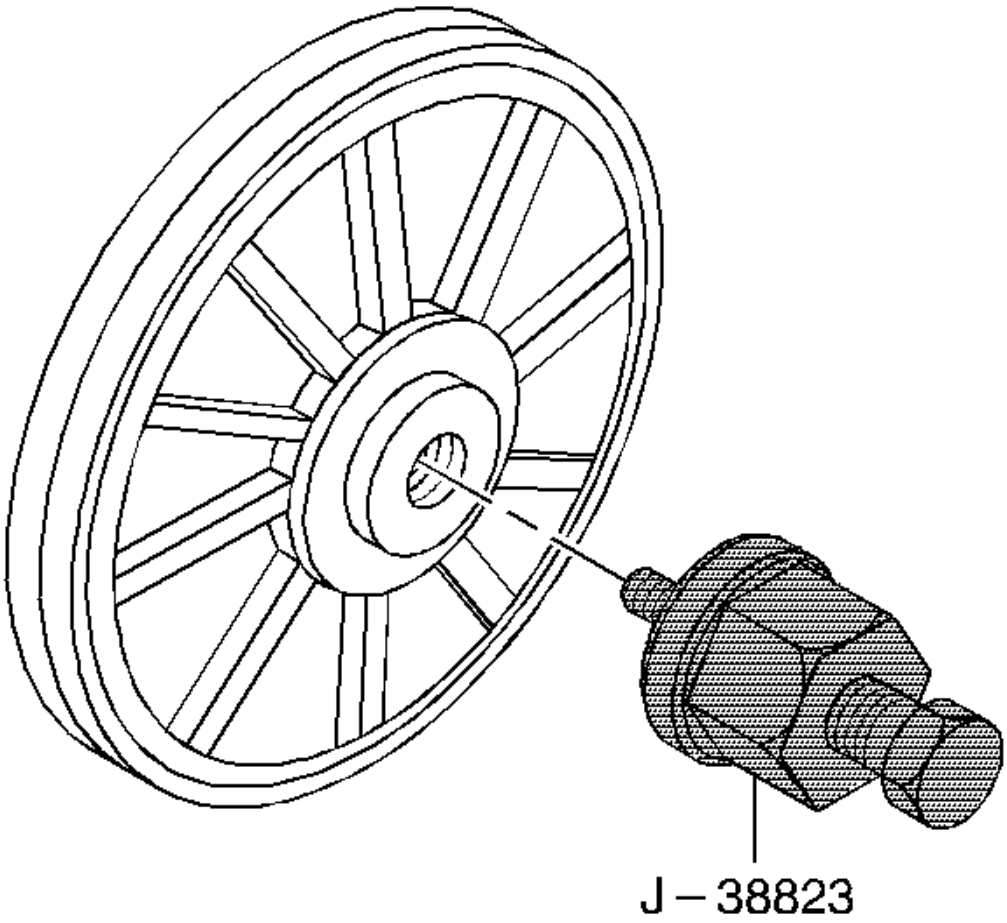


Fig. 135: Installing Water Pump Pulley
Courtesy of GENERAL MOTORS COMPANY

8. Install the water pump drive pulley onto the intake camshaft.
9. Install the water pump pulley using the **J 38823** . During installation, the tool will bottom out on the camshaft at the proper depth.

 © 2011 Mitchell Repair Information Company, LLC.

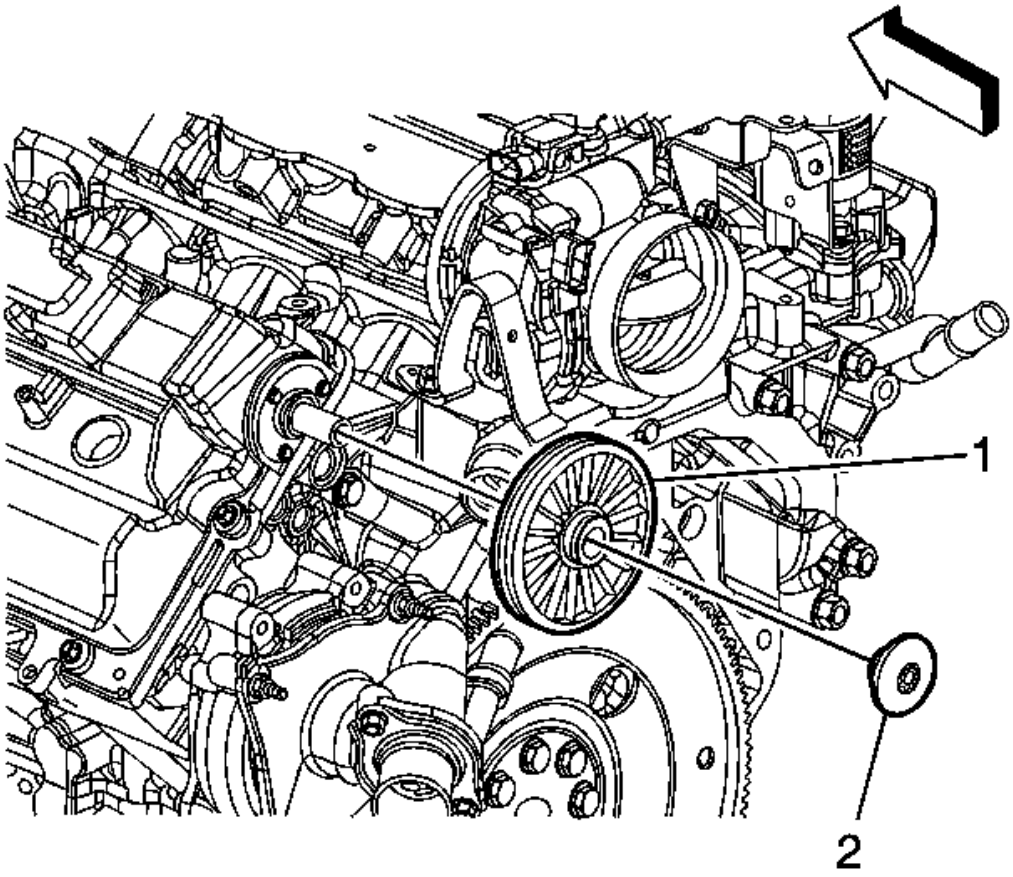


Fig. 136: Identifying Plastic Dust Cap
Courtesy of GENERAL MOTORS COMPANY

10. Install the plastic dust cap (2) into the end of the camshaft.

 © 2011 Mitchell Repair Information Company, LLC.

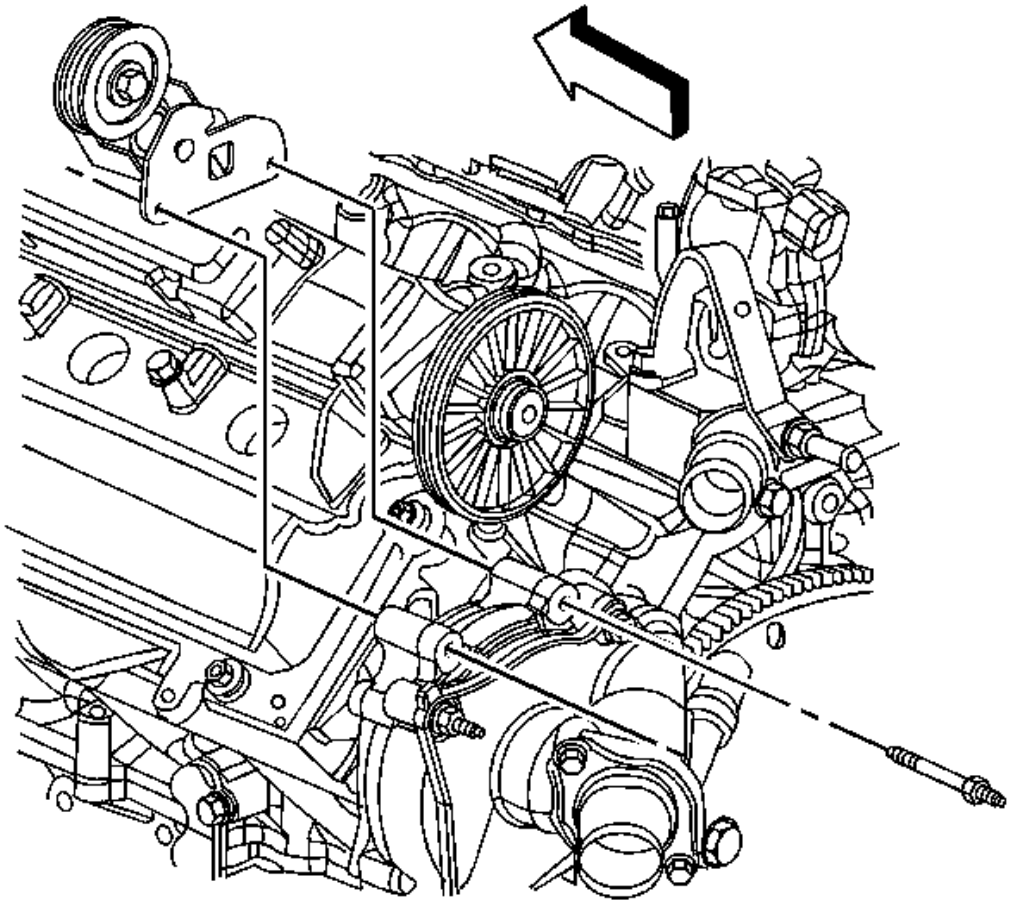


Fig. 137: View Of Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Position the water pump drive belt tensioner to the water pump housing.
12. Install the water pump drive belt tensioner studs.

Tighten

Tighten the studs to 10 N.m (89 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

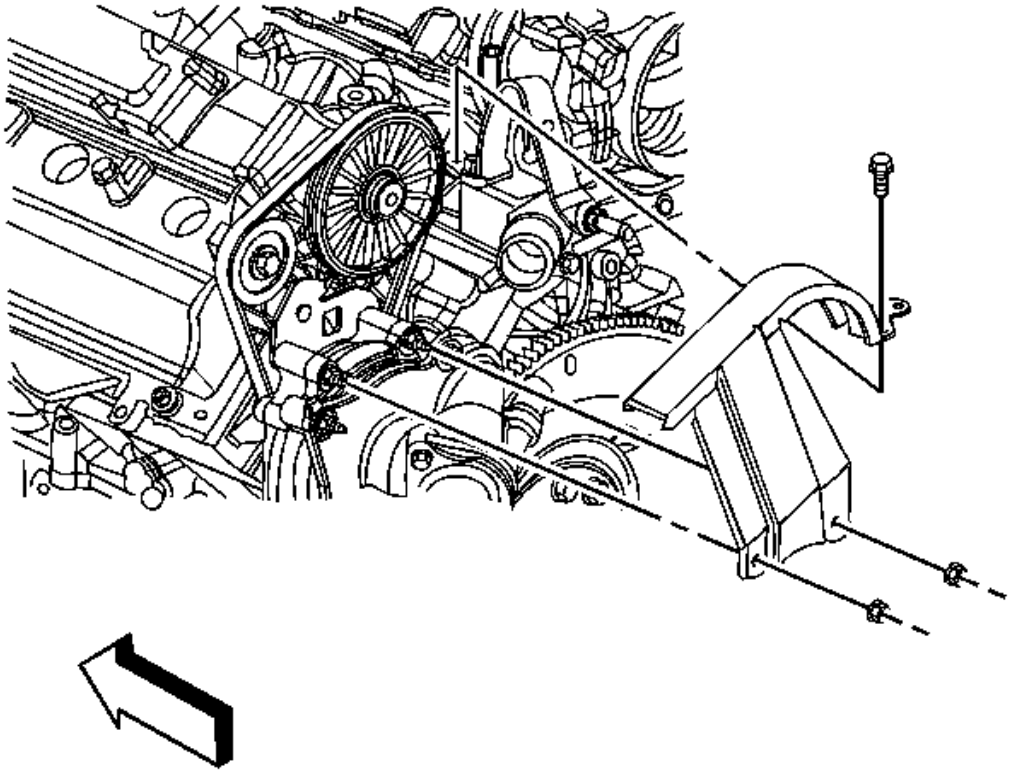


Fig. 138: View Of Water Pump Drive Belt Tensioner Shield
Courtesy of GENERAL MOTORS COMPANY

13. Install the water pump drive belt over the pulleys.
14. Install the water pump drive belt shield over the tensioner studs.
15. Install the water pump drive belt shield bolt/nuts.

Tighten

Tighten the bolt/nuts to 10 N.m (89 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

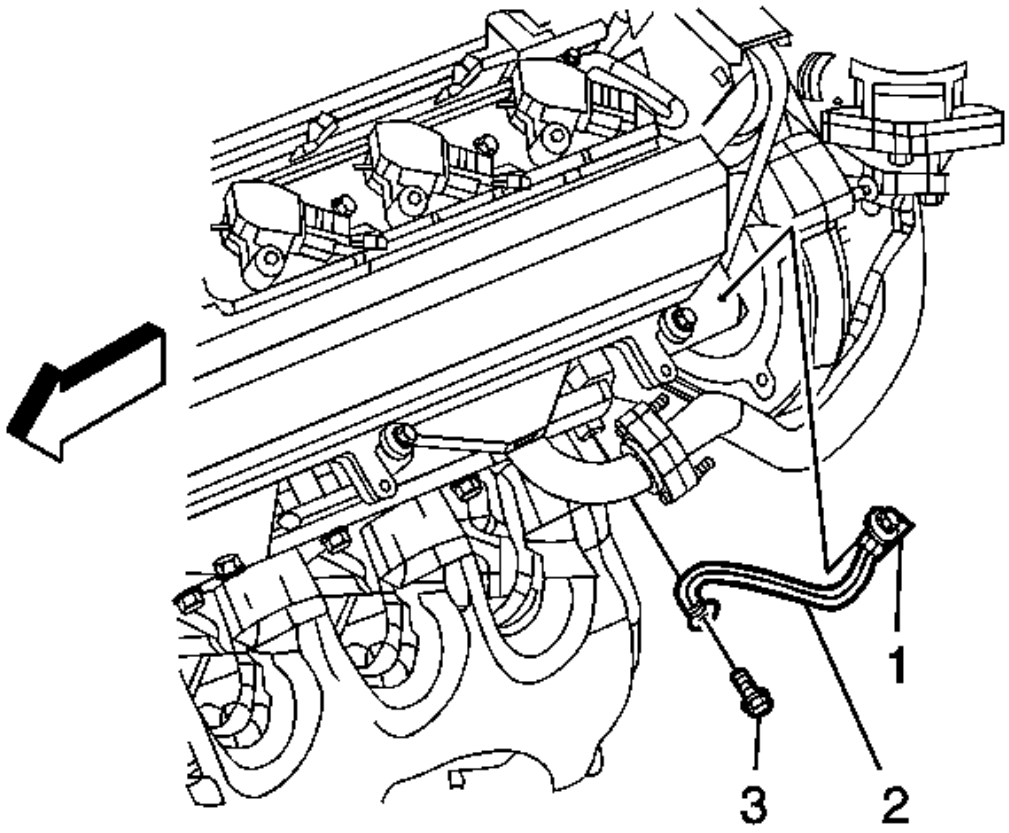


Fig. 139: Identifying ICM Wiring Harness Ground
Courtesy of GENERAL MOTORS COMPANY

16. Position the ground wire terminal/bolt to the camshaft cover.
17. Tighten the ignition control module (ICM) wiring harness ground bolt (1) to the camshaft cover.

Tighten

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

 © 2011 Mitchell Repair Information Company, LLC.

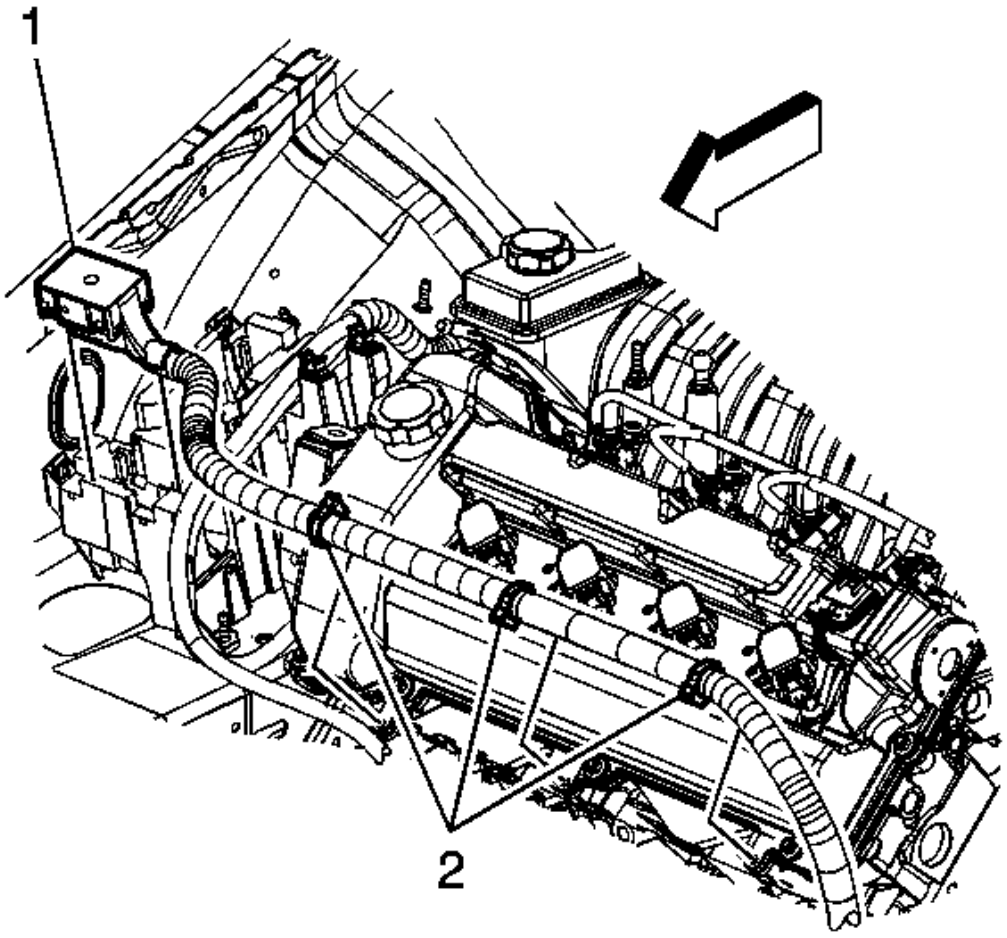


Fig. 140: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS COMPANY

18. Position the engine harness and install the engine harness clips (2) to the camshaft cover.
19. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .

 © 2011 Mitchell Repair Information Company, LLC.

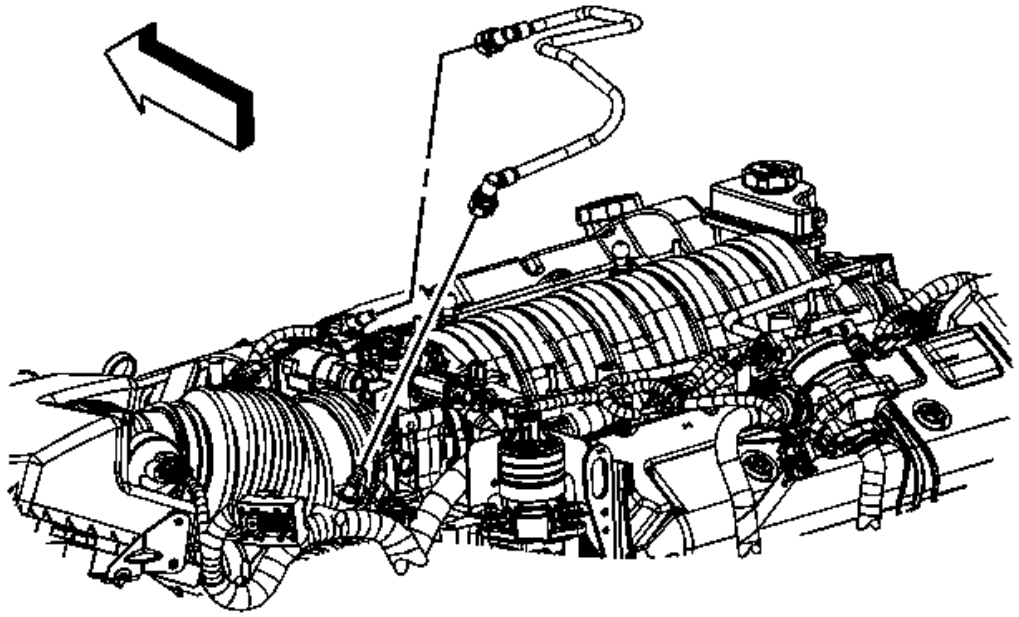


Fig. 141: Identifying PCV Fresh Air Tube
Courtesy of GENERAL MOTORS COMPANY

20. Connect the PCV fresh air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service**

 © 2011 Mitchell Repair Information Company, LLC.

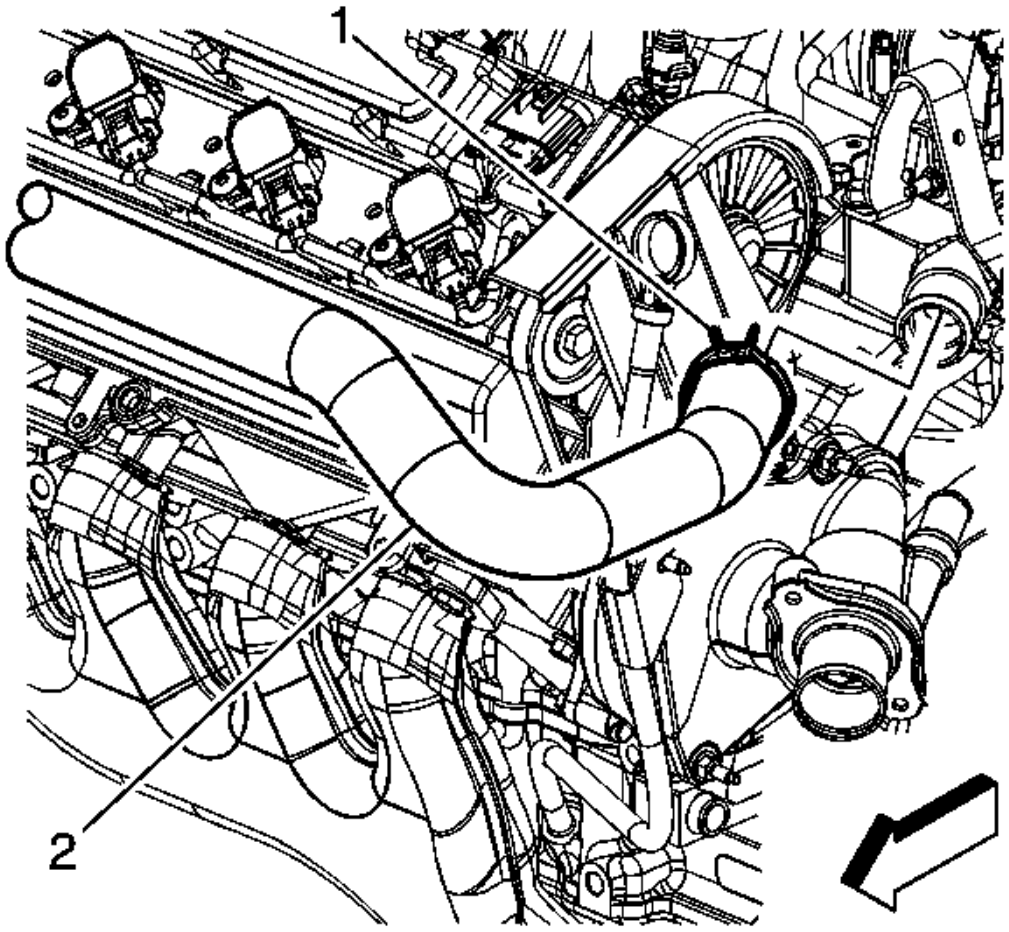


Fig. 142: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

21. Install the radiator inlet hose (2) to the water pump housing.
22. Position the radiator inlet hose clamp (1).
23. Install the upper tie bar. Refer to **Front End Upper Tie Bar Replacement** .
24. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** , **Cooling System Draining and Filling (Static Fill)** .
25. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

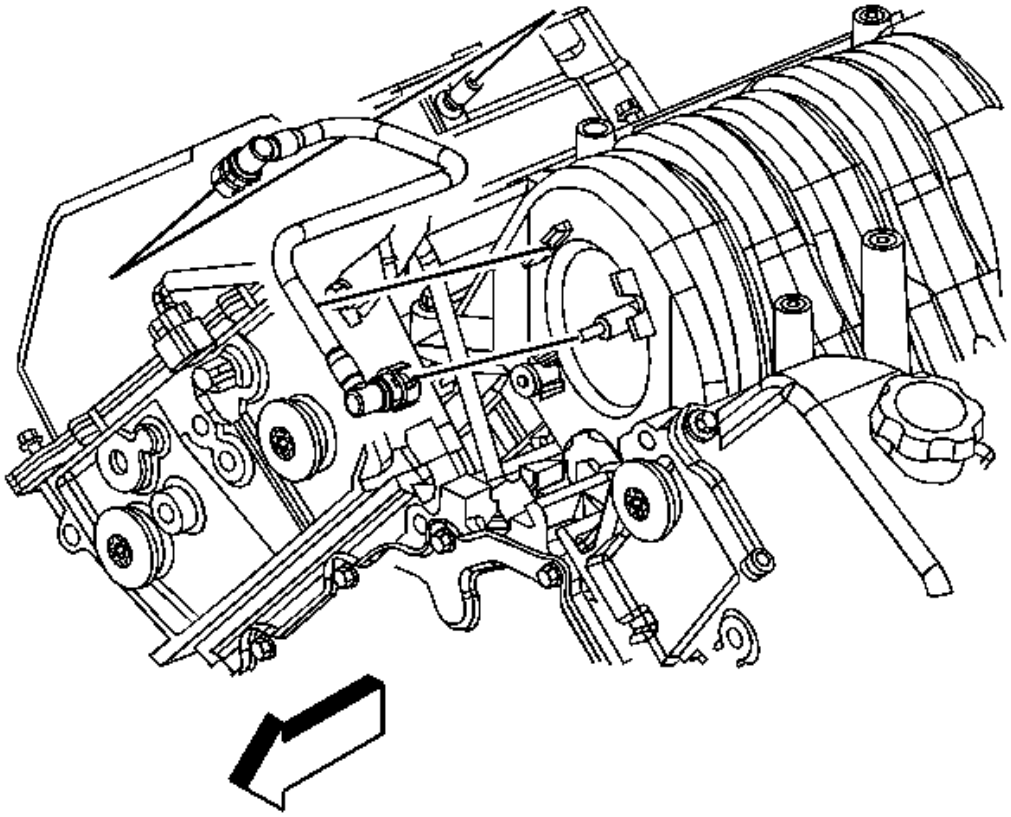


Fig. 143: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the secondary air injection (AIR) check valve. Refer to **Secondary Air Injection Check Valve Replacement** .
3. Disconnect the positive crankcase ventilation (PCV) foul air tube quick connect fitting from the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
4. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 1** .

 © 2011 Mitchell Repair Information Company, LLC.

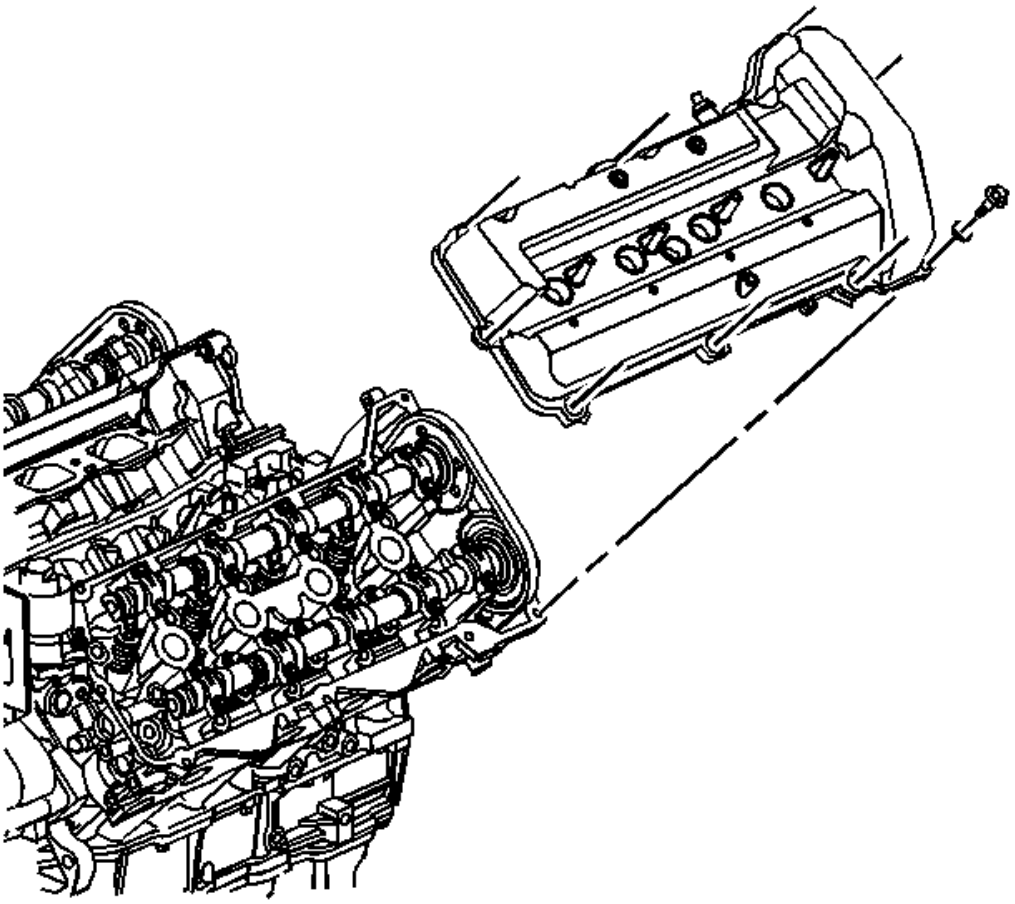


Fig. 144: Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the camshaft cover bolts.
6. Remove the camshaft cover.
7. Discard the camshaft cover perimeter seals and spark plug seals if there is any evidence of damage or if the seal comes out of the groove in the cover during removal.
8. Clean and inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

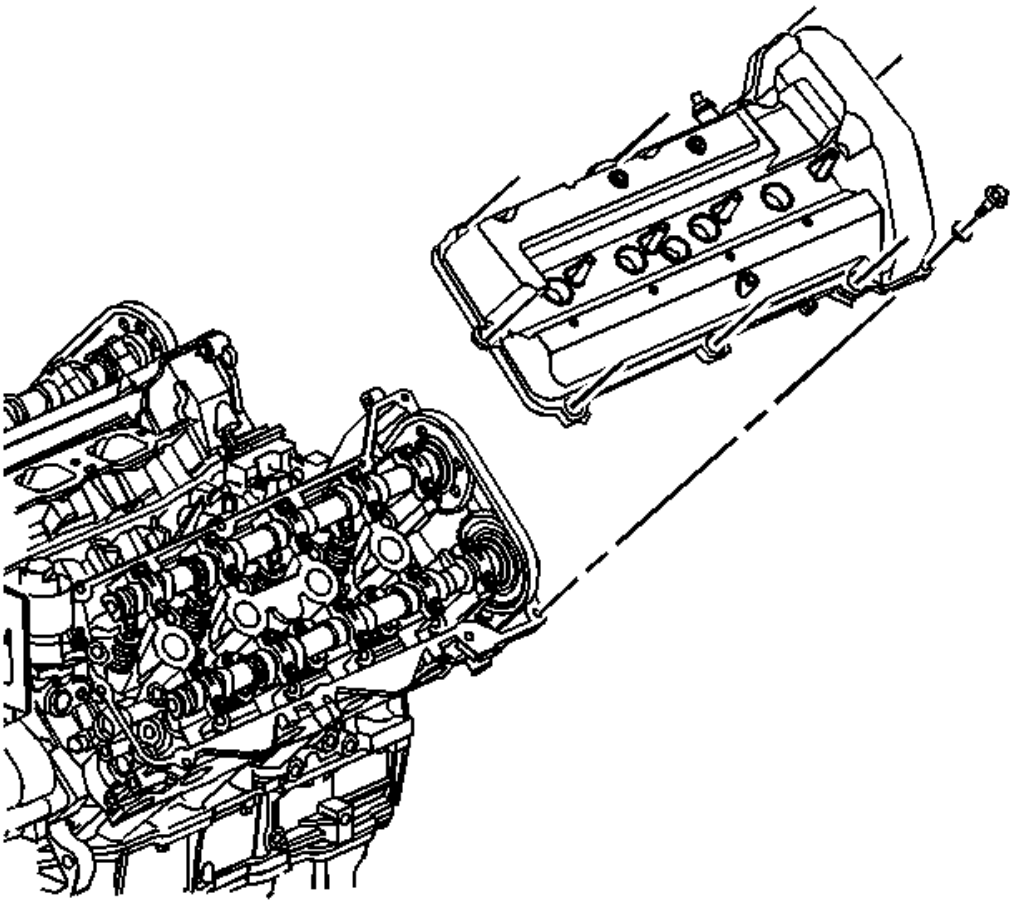


Fig. 145: Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

NOTE: Be careful to prevent the exposed section of the camshaft cover seal from being damaged by the edge of the cylinder head casting.

1. Install the camshaft cover seal as required.
2. Install the camshaft cover.

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the bolts to 10 N.m (89 lb in).

4. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 1** .

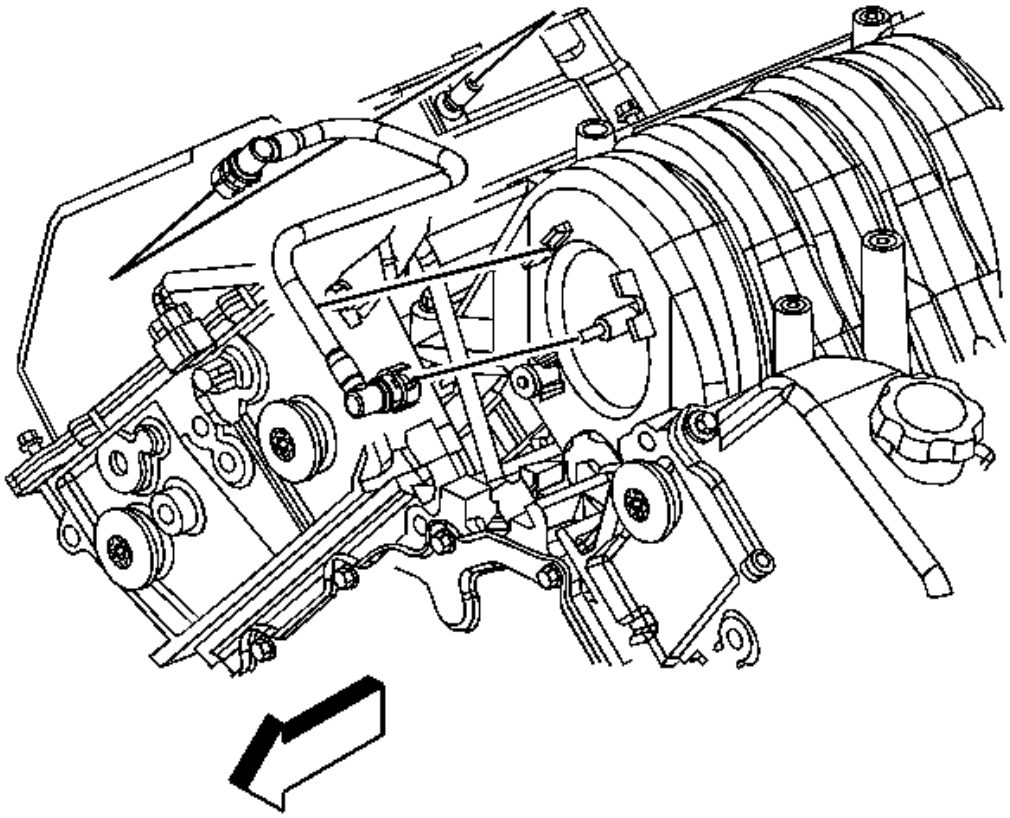


Fig. 146: Identifying PCV Foul Air Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Connect the PCV foul air tube quick connect fitting to the camshaft cover. Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Install the AIR check valve. Refer to **Secondary Air Injection Check Valve Replacement** .
7. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

Special Tools

 © 2011 Mitchell Repair Information Company, LLC.

J 44212 Camshaft Holding Tool

Removal Procedure

1. Remove the right secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Remove the left secondary drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**.
3. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

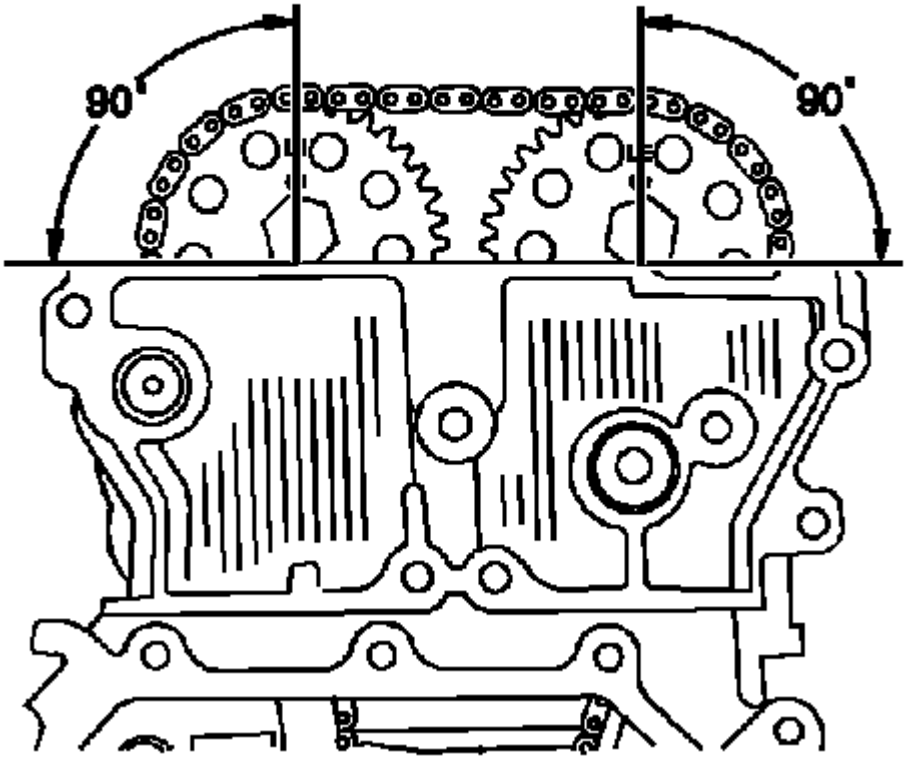


Fig. 147: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

4. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

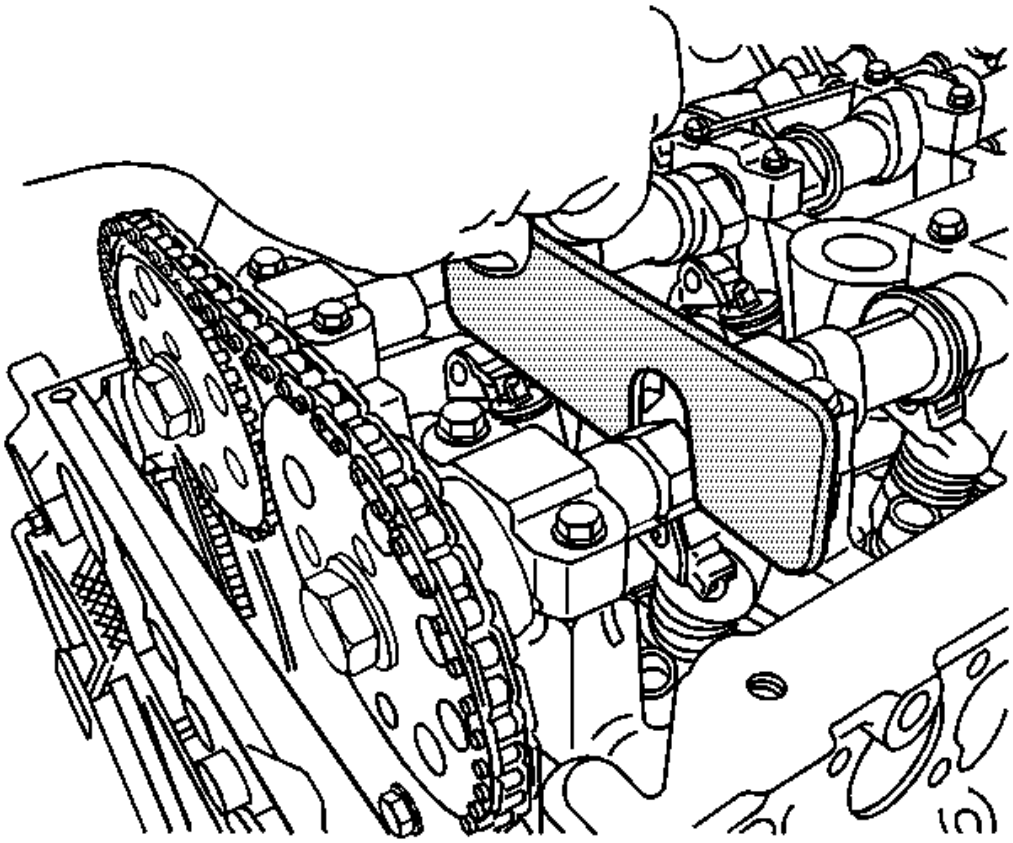


Fig. 148: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

5. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

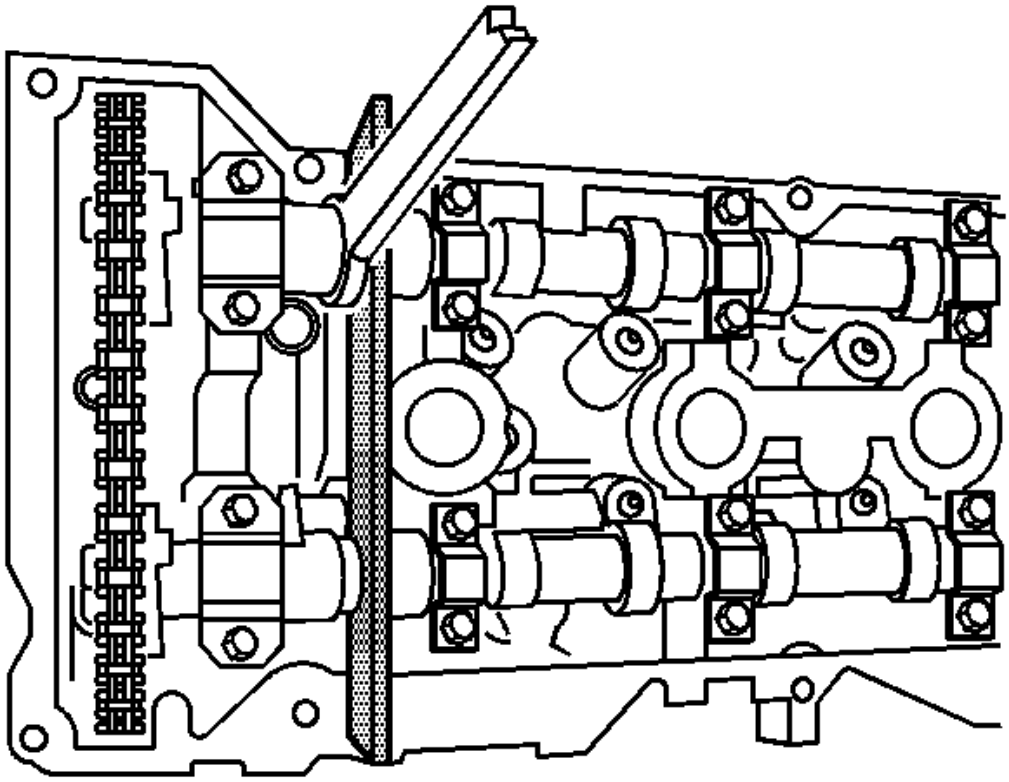


Fig. 149: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

6. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

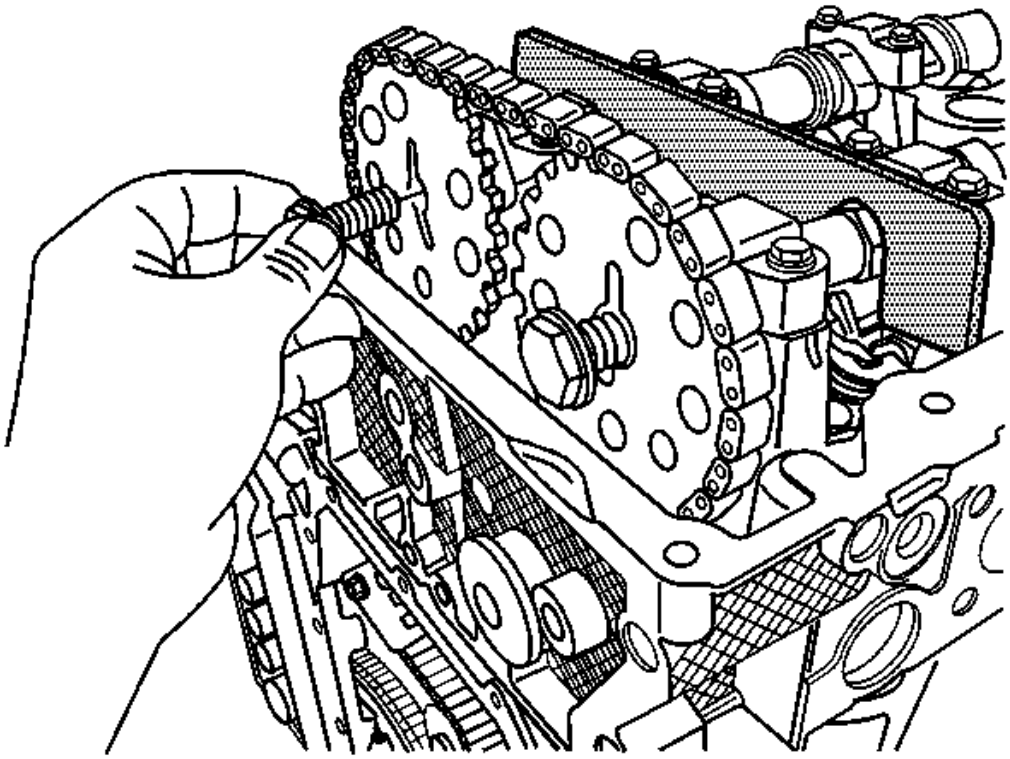


Fig. 150: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the left intake camshaft sprocket bolt.
8. Slide the left intake camshaft sprocket off of the camshaft and remove the left secondary camshaft drive chain from the camshaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

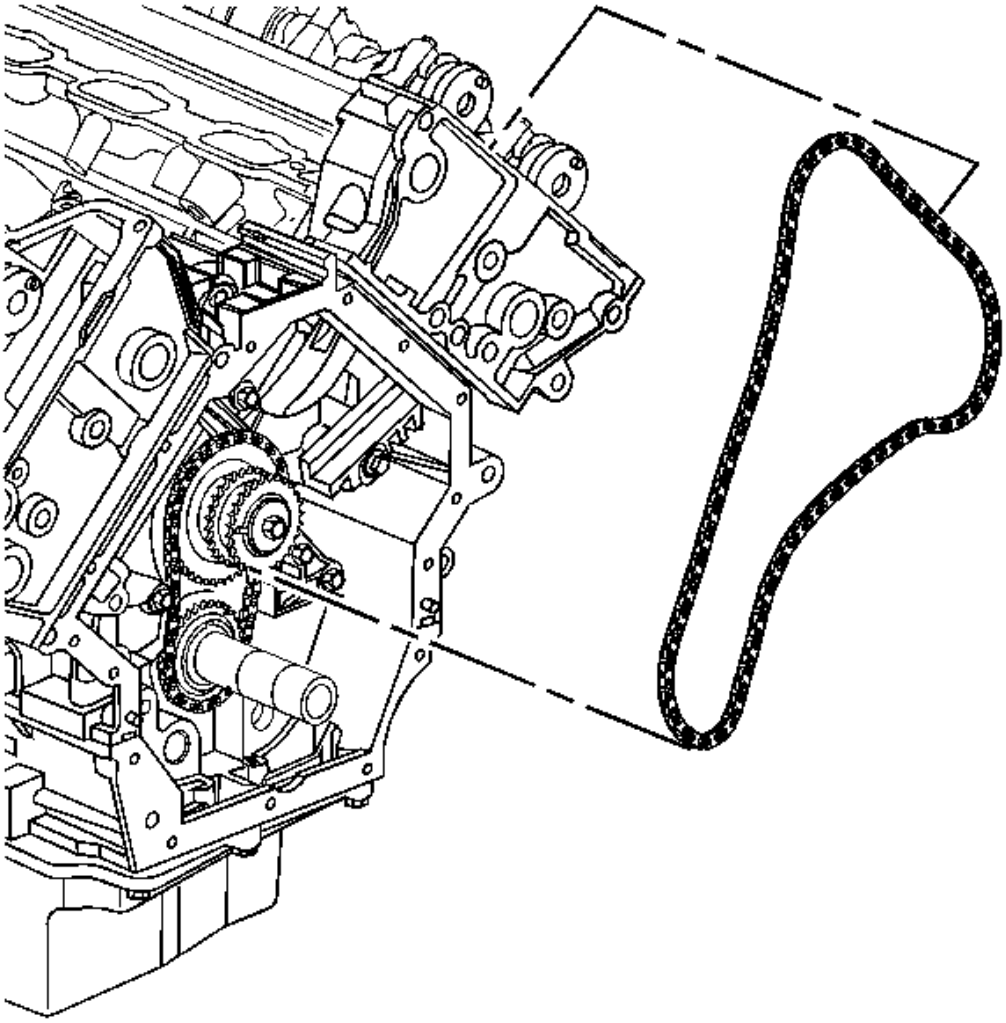


Fig. 151: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

9. Lift the left secondary camshaft drive chain from the camshaft intermediate drive shaft sprocket teeth.
10. Remove the left secondary camshaft drive chain from the engine.
11. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

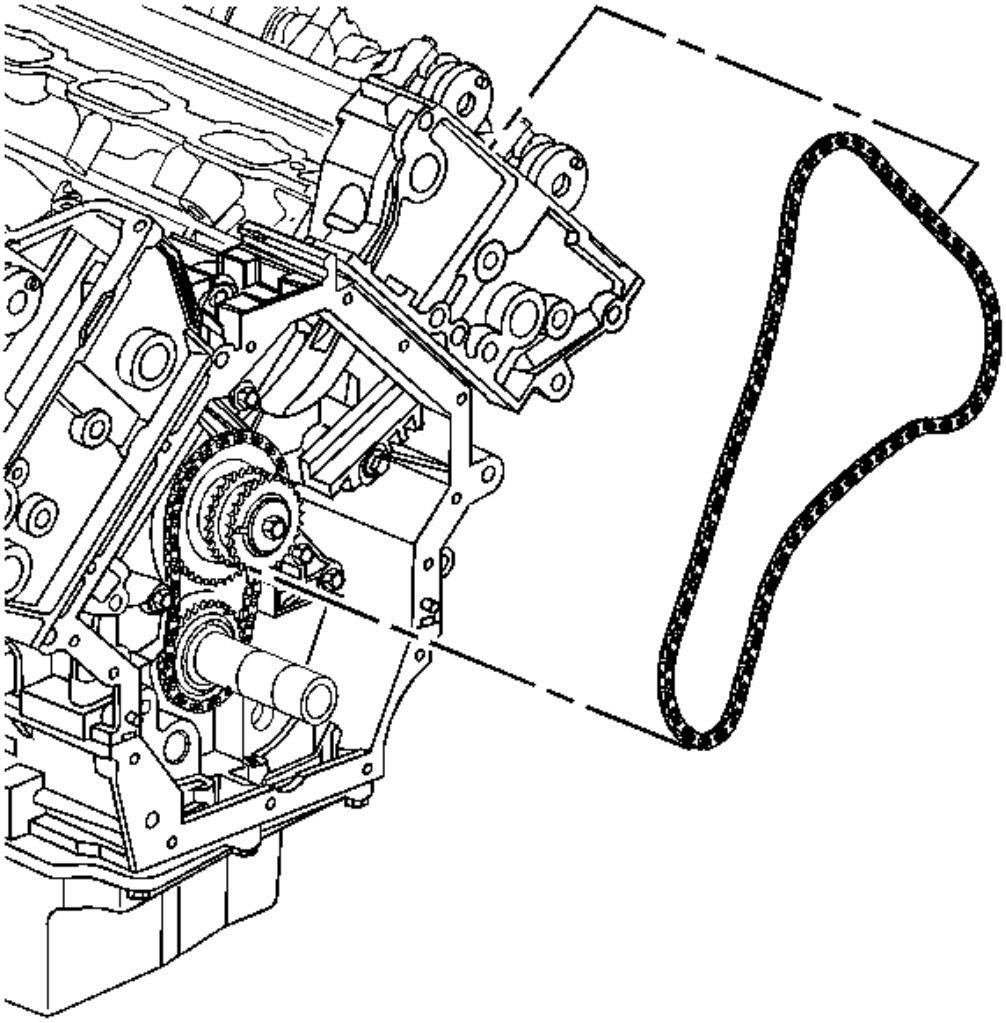


Fig. 152: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

1. Install the left secondary camshaft drive chain by sliding the chain down through the left cylinder head and placing the chain on the left exhaust camshaft sprocket.
2. Route the left secondary camshaft drive chain around the inner row of the camshaft intermediate drive shaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

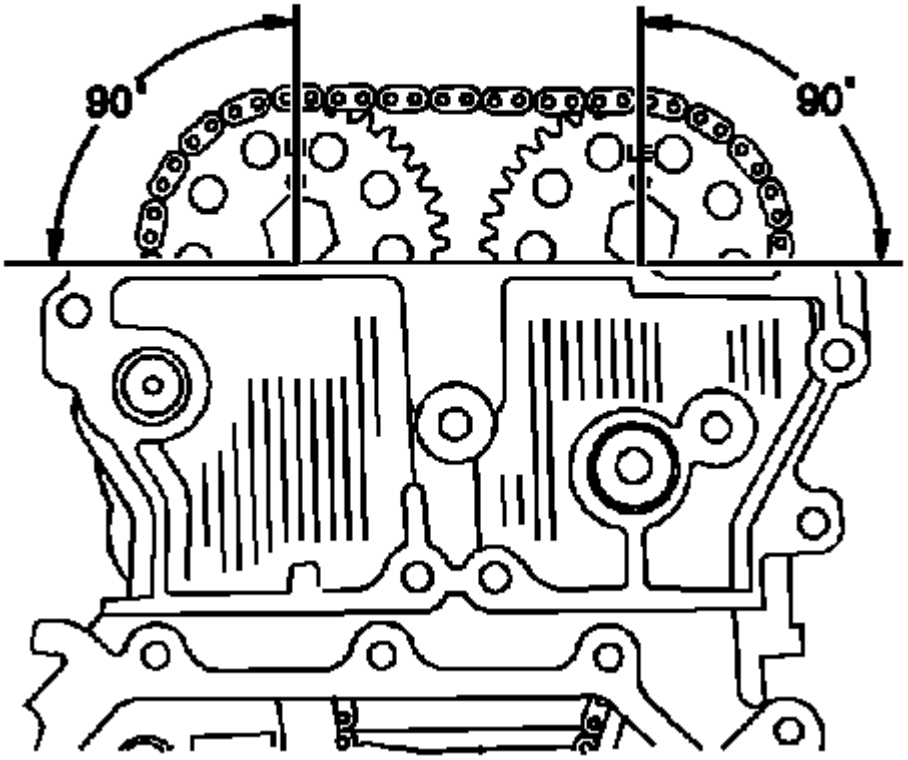


Fig. 153: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Install the left intake camshaft sprocket into the left secondary camshaft drive chain.
4. Install the left intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LI (left intake) engages the intake camshaft pin.

 © 2011 Mitchell Repair Information Company, LLC.

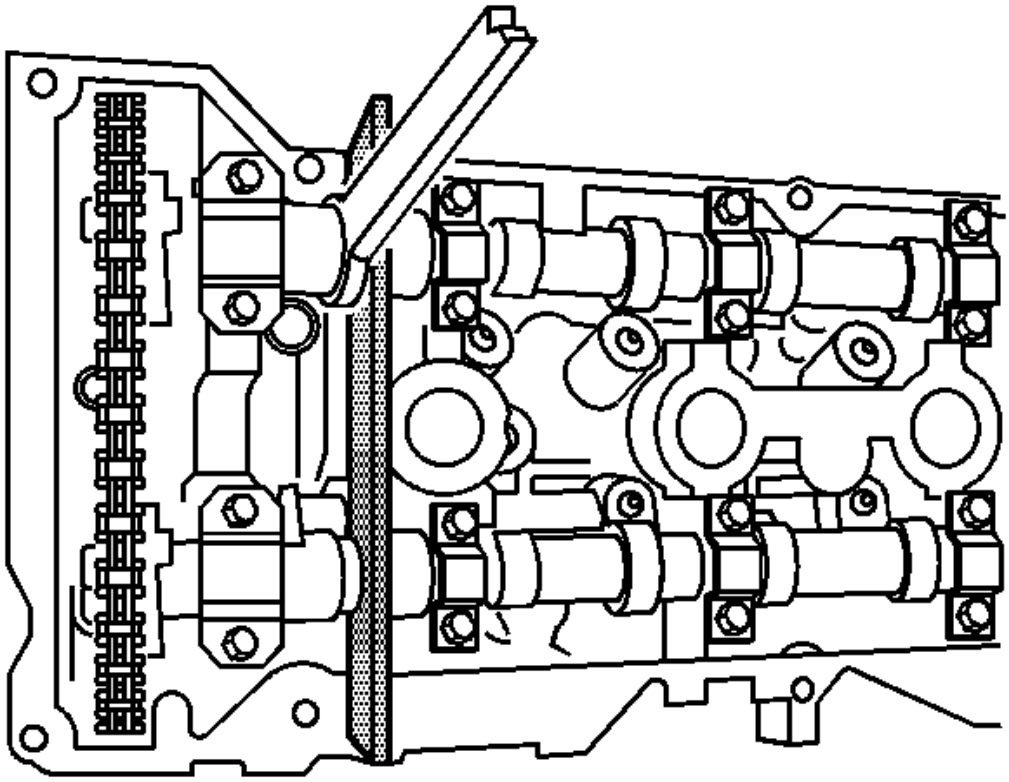


Fig. 154: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

CAUTION: Refer to Fastener Caution .

6. Install the left intake camshaft sprocket bolt.

Tighten

Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

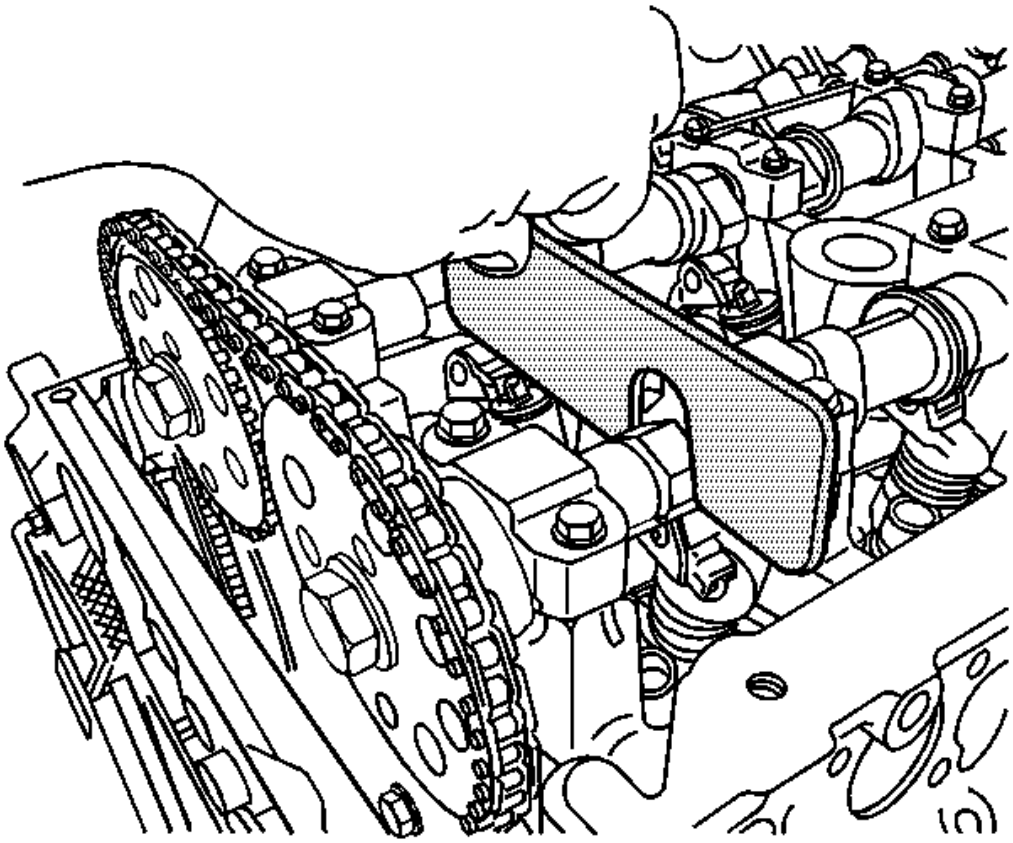


Fig. 155: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **J 44212** from the camshafts.
8. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
9. Install the left secondary drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**.
10. Install the right secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Special Tools

J 44212 Camshaft Holding Tool

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side**.
2. Remove the camshaft position (CMP) sensor. Refer to **Camshaft Position Sensor Replacement** .
3. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

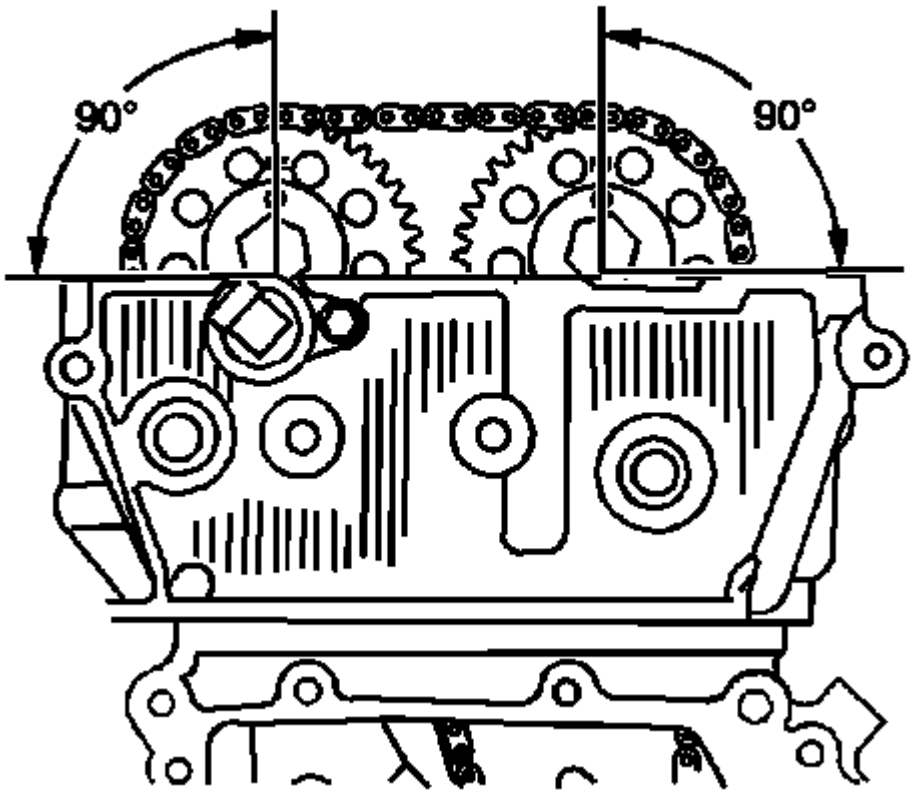


Fig. 156: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

4. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

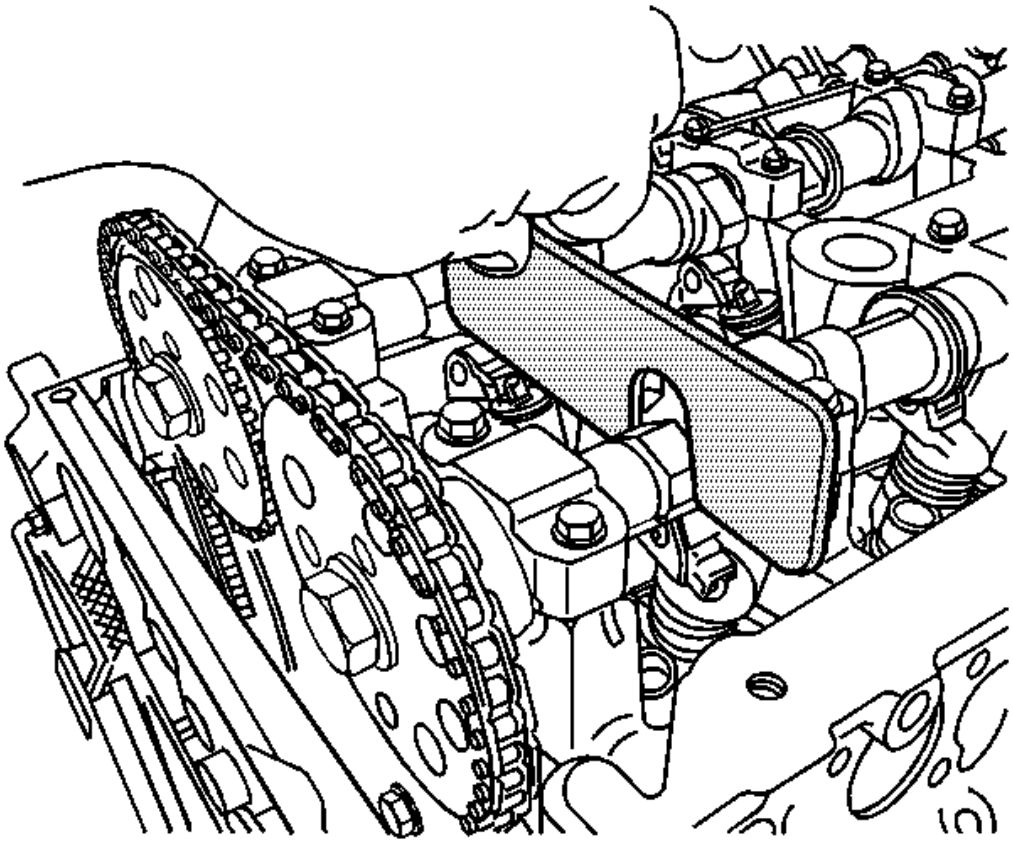


Fig. 157: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

5. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

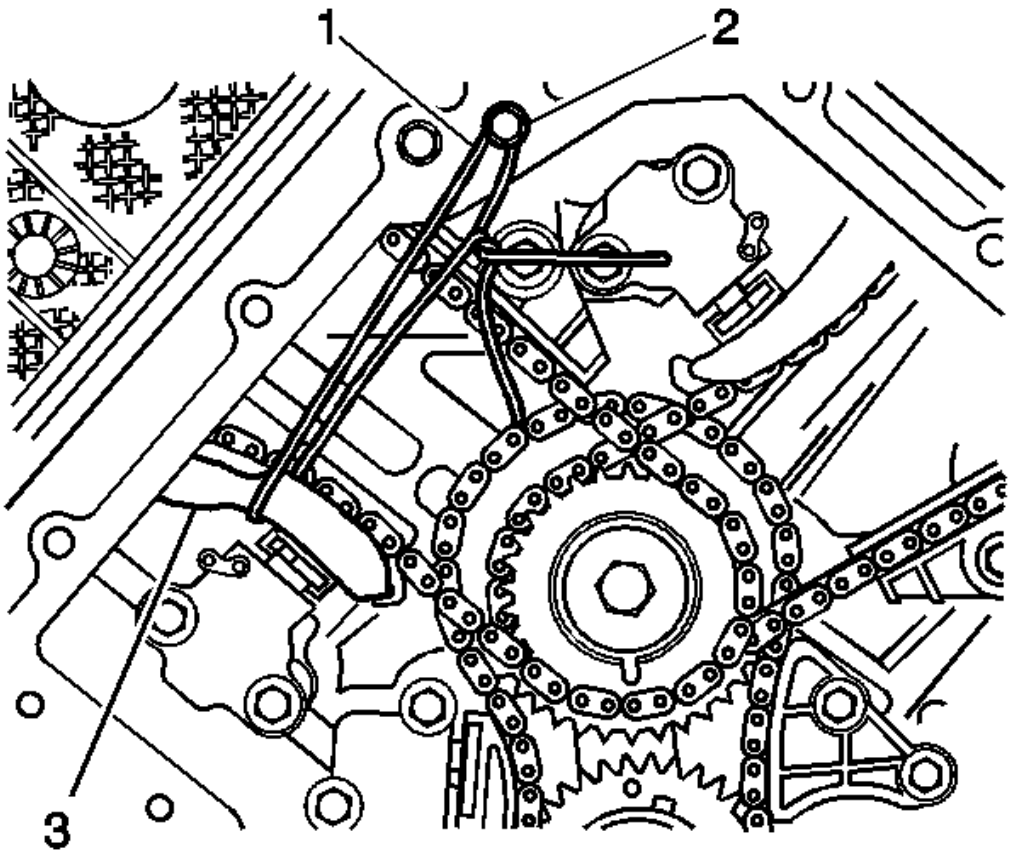


Fig. 158: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
7. Remove the engine front cover bolt (2) from the front of the engine.

 © 2011 Mitchell Repair Information Company, LLC.

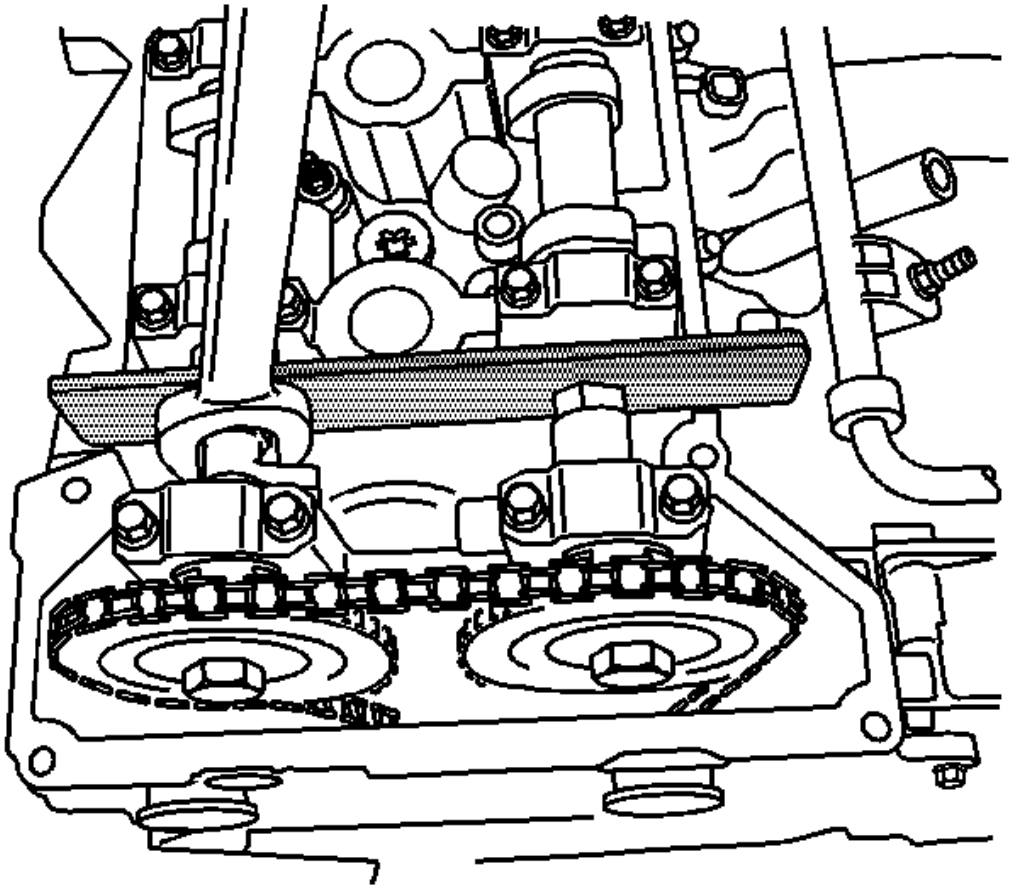


Fig. 159: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

8. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

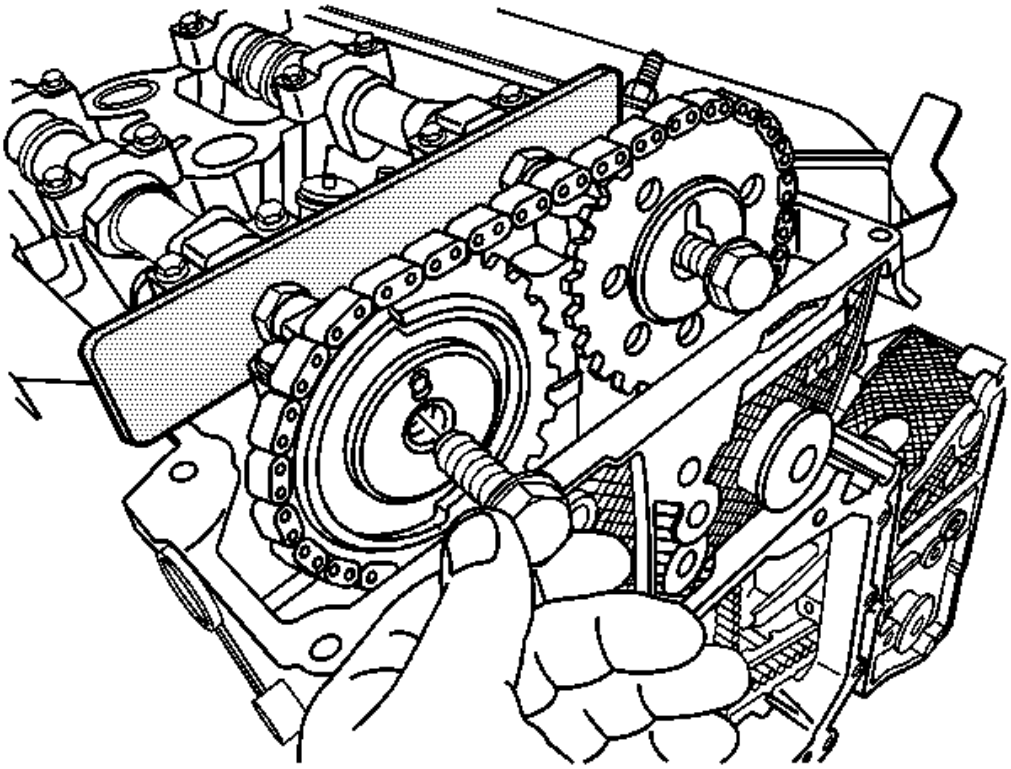


Fig. 160: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the right exhaust camshaft sprocket bolt.
10. Slide the right exhaust camshaft sprocket off of the camshaft and remove the right secondary camshaft drive chain from the camshaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

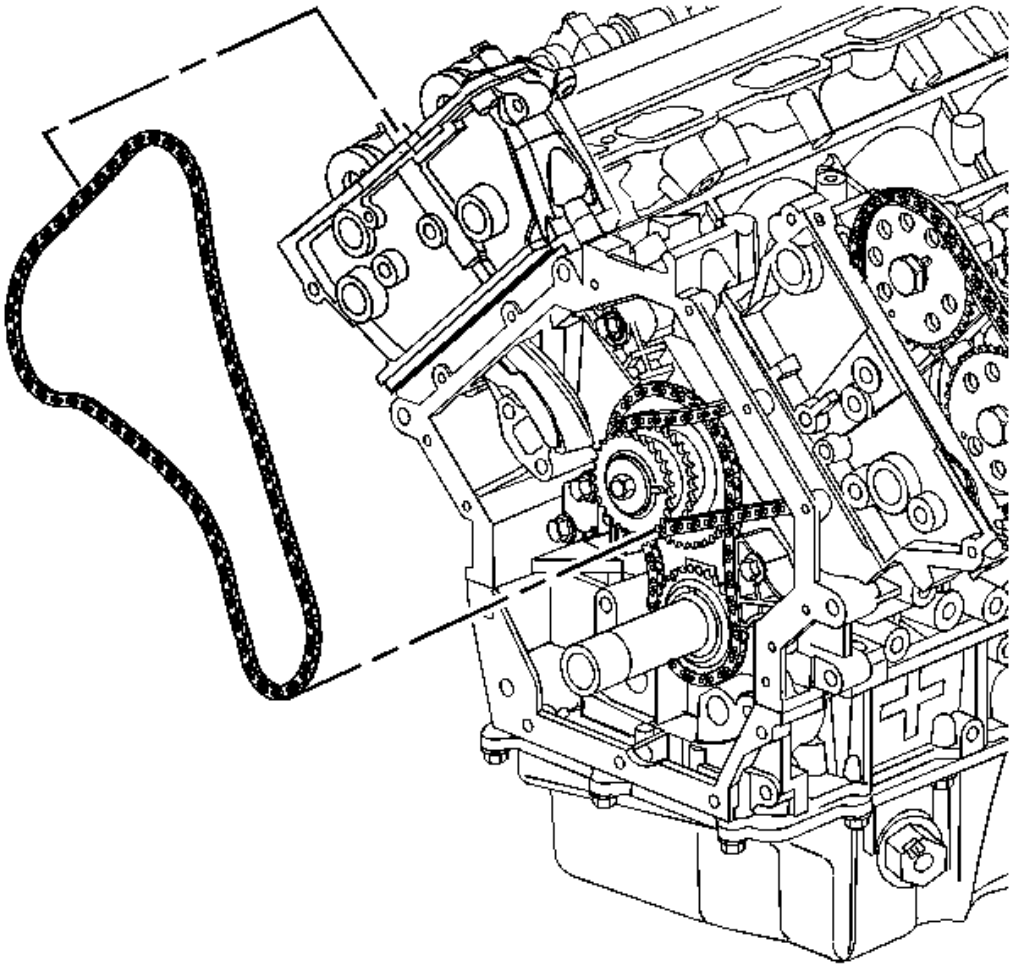


Fig. 161: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

11. Lift the right secondary camshaft drive chain from the camshaft intermediate drive shaft sprocket teeth.
12. Remove the right secondary camshaft drive chain from the engine.
13. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

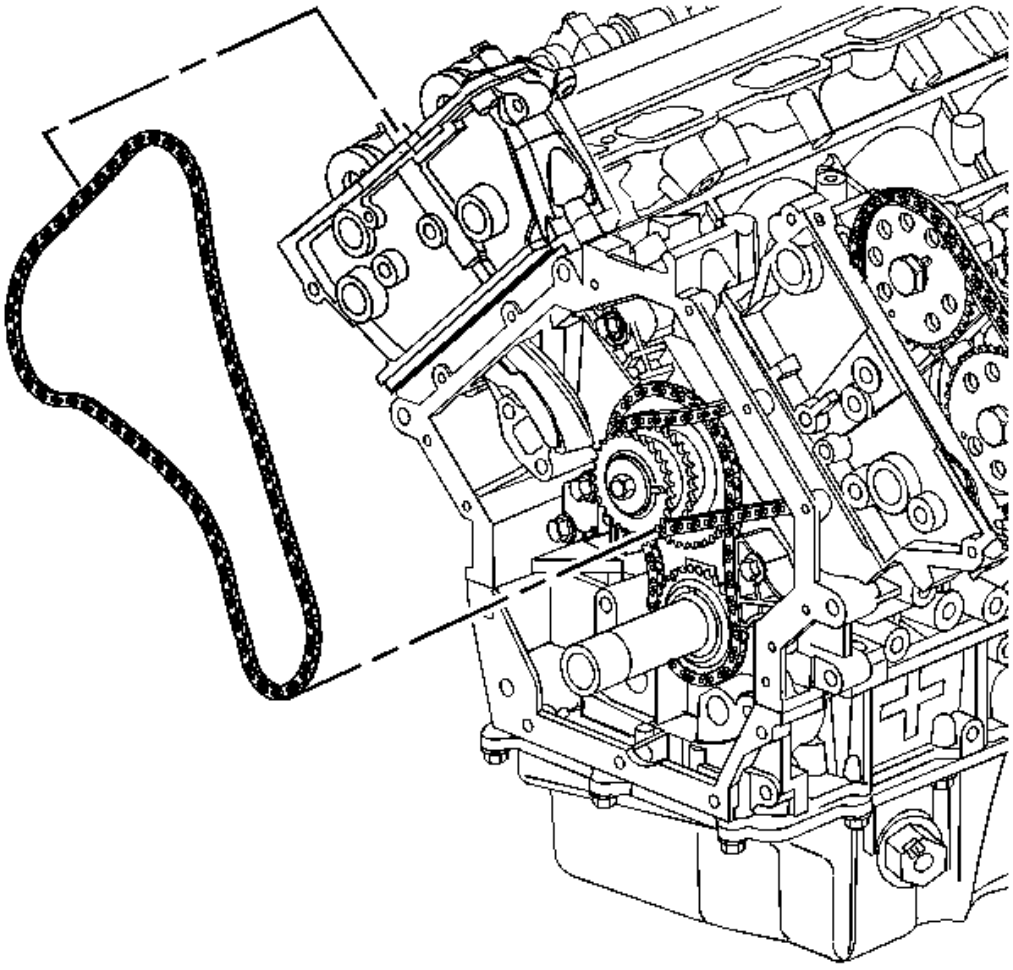


Fig. 162: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

1. Install the right secondary camshaft drive chain by sliding the chain down through the right cylinder head and placing the chain on the right intake camshaft sprocket.
2. Route the right secondary camshaft drive chain around the outer row of the camshaft intermediate drive shaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

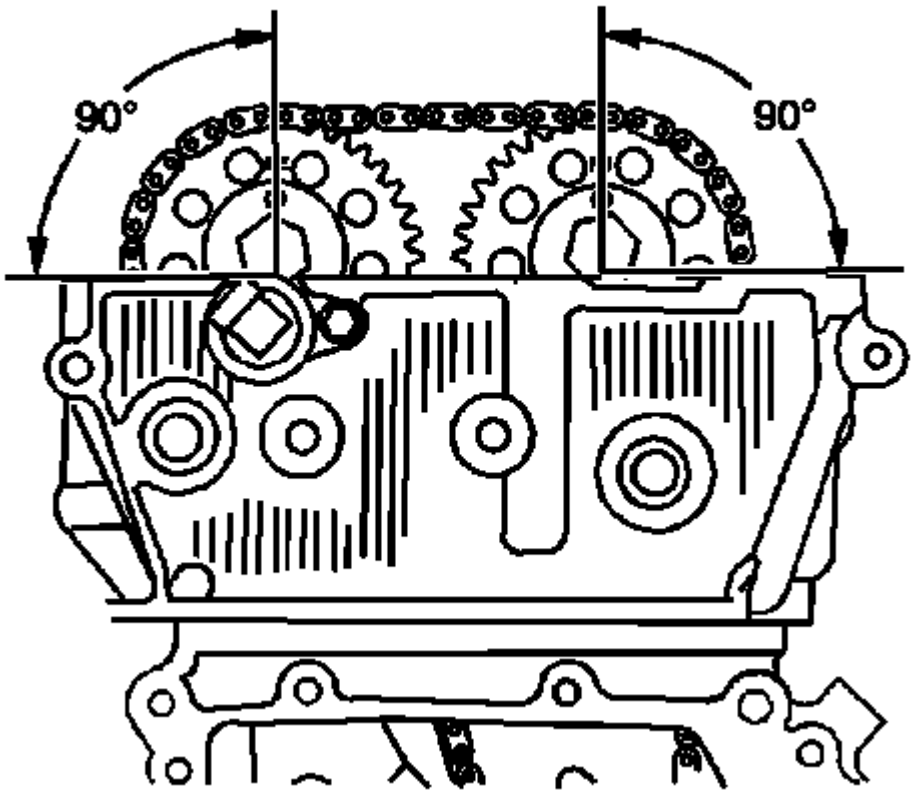


Fig. 163: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Install the right exhaust camshaft sprocket into the right secondary camshaft drive chain.
4. Install the right exhaust camshaft sprocket onto the camshaft. The camshaft sprocket notch marked RE (right exhaust) engages the exhaust camshaft pin.

 © 2011 Mitchell Repair Information Company, LLC.

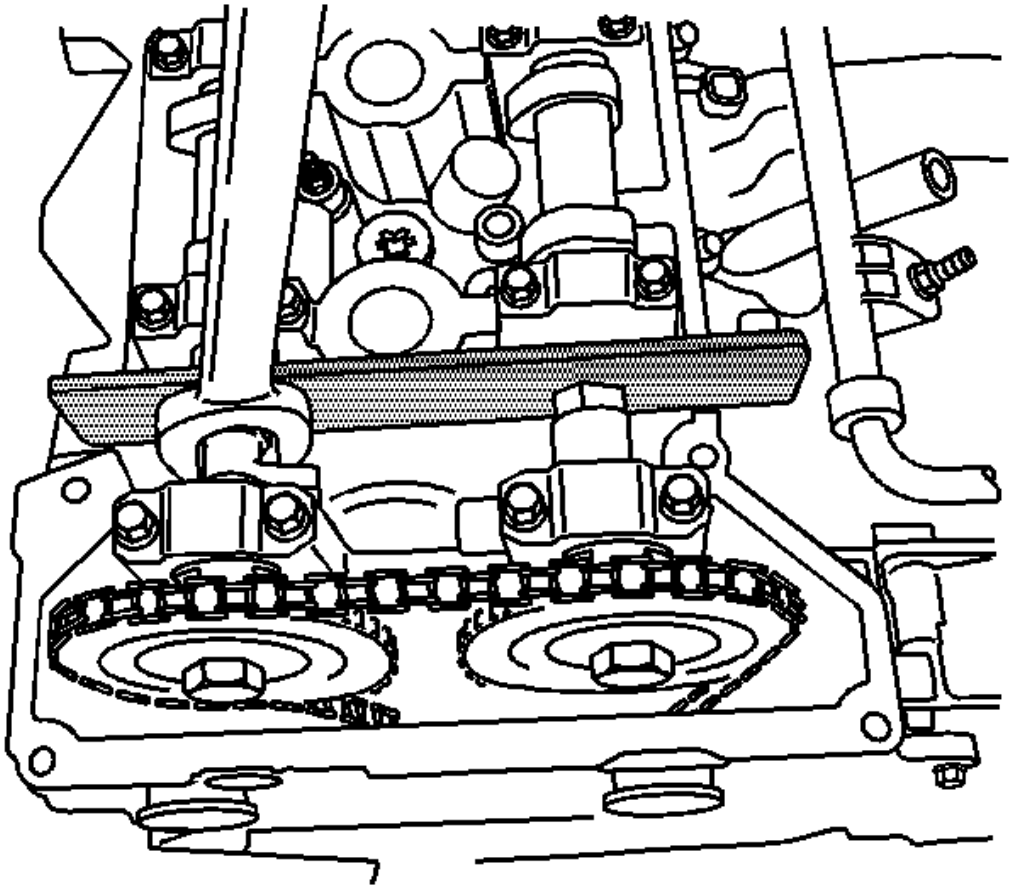


Fig. 164: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

CAUTION: Refer to Fastener Caution .

6. Install the right exhaust camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

7. Install the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side**.

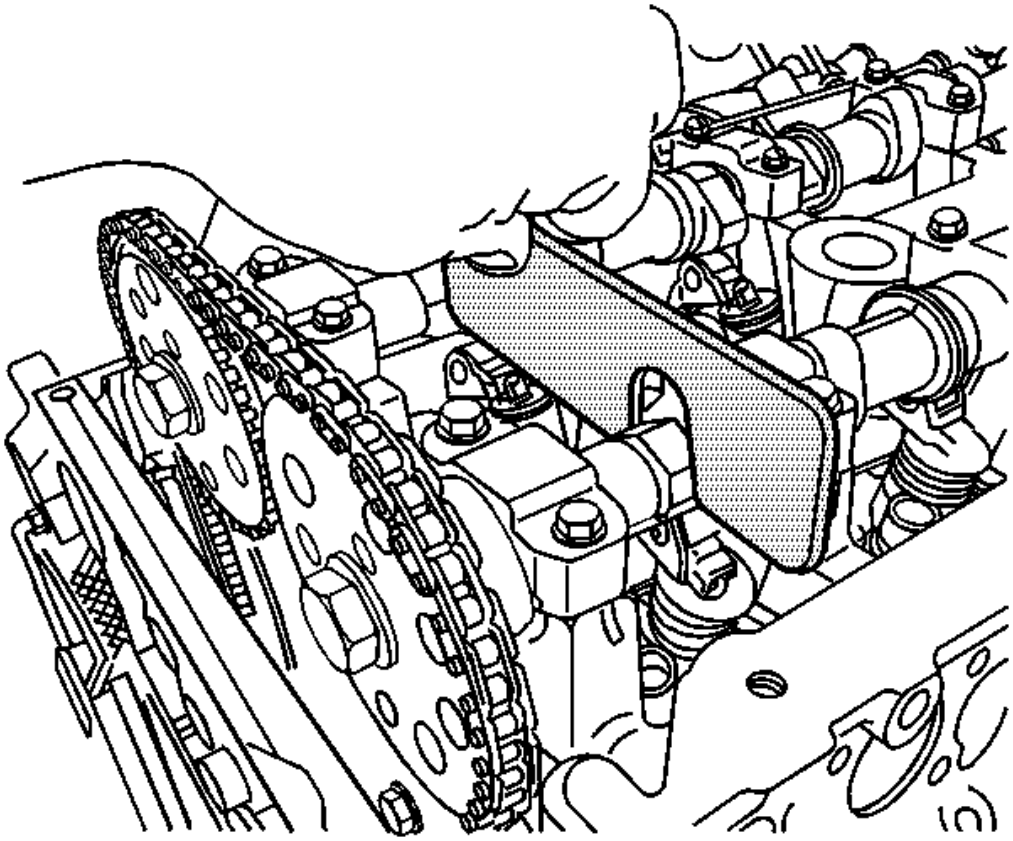


Fig. 165: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **J 44212** from the camshafts.
9. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
10. Install the CMP sensor. Refer to **Camshaft Position Sensor Replacement** .

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

 © 2011 Mitchell Repair Information Company, LLC.

Special Tools

J 39946 Crankshaft Socket - 4.0L and 4.6L

Removal Procedure

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

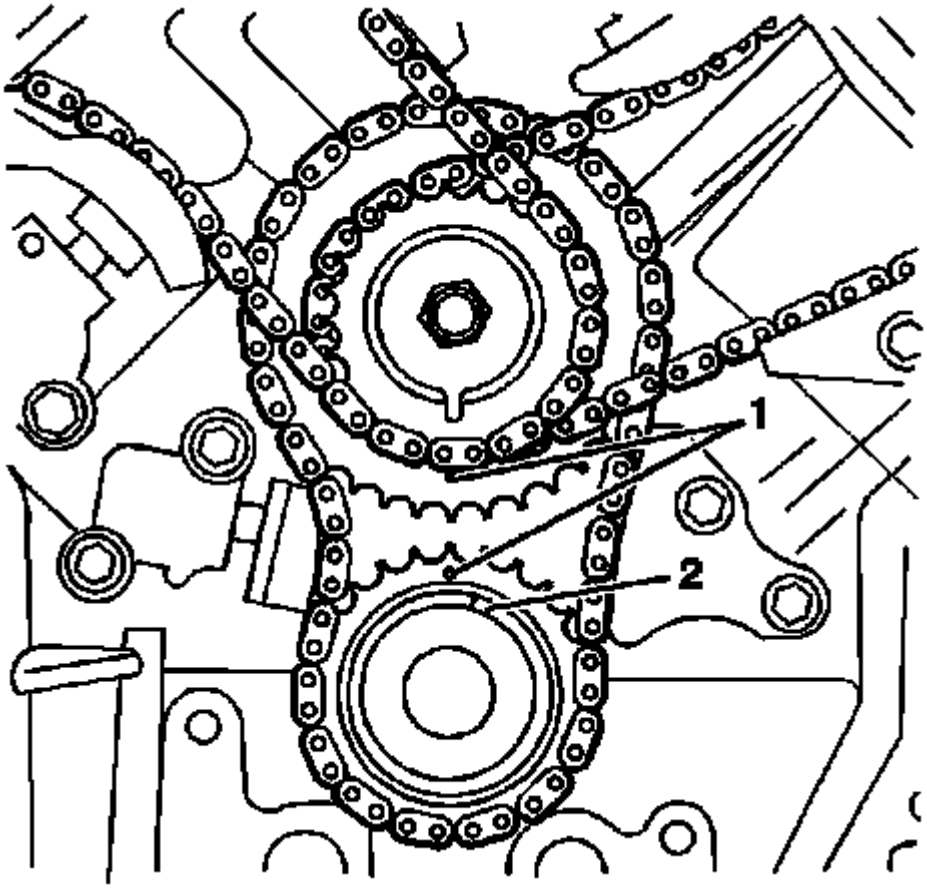


Fig. 166: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: Aligning the primary timing marks will locate the left camshafts in a neutral position, preventing them from rotating when the tensioner is removed.

2. Align the primary timing marks (1) using the **J 39946** .

 © 2011 Mitchell Repair Information Company, LLC.

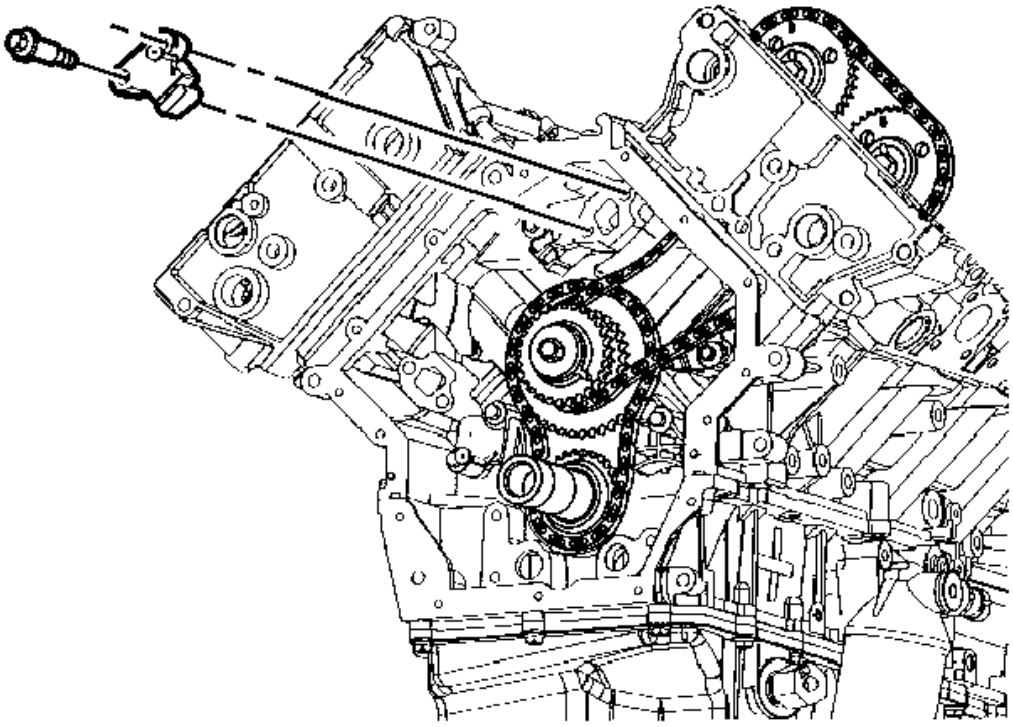


Fig. 167: Identifying Left Secondary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 bolts attaching the left secondary camshaft drive chain tensioner to the engine block.
4. Remove the left secondary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
5. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

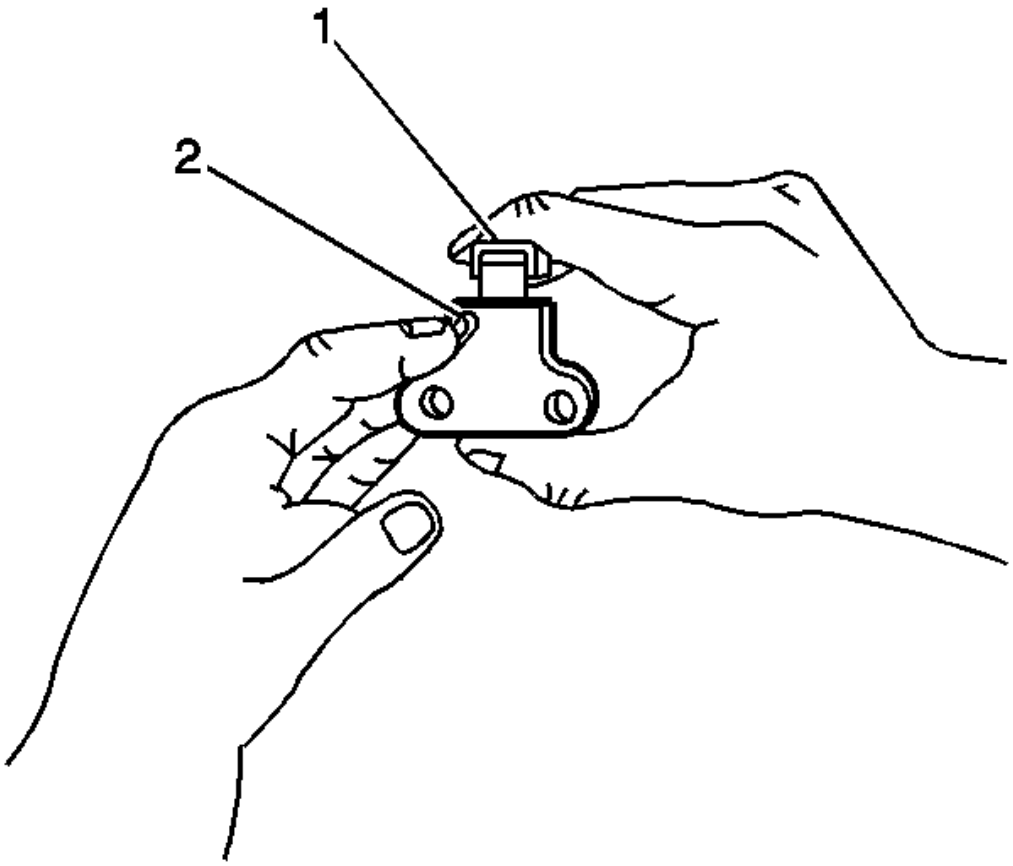


Fig. 168: View Of Tensioner Shoe & Ratchet Lever
Courtesy of GENERAL MOTORS COMPANY

1. Collapse the left secondary camshaft chain tensioner using the following procedure:
    1. Rotate the ratchet release lever (2) counterclockwise and hold.
    2. Collapse the tensioner shoe (1) and hold.
    3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

 © 2011 Mitchell Repair Information Company, LLC.

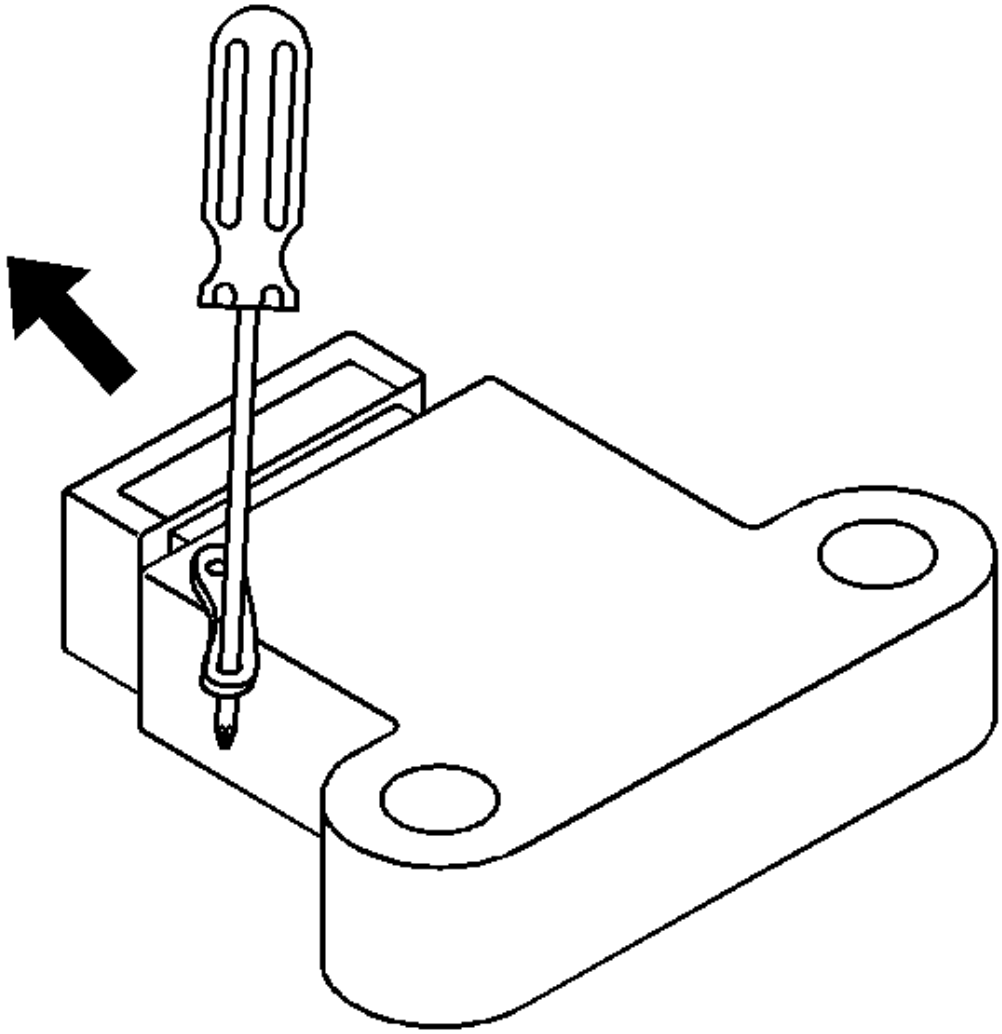


Fig. 169: Locking Tensioner Shoe In Collapsed Position
Courtesy of GENERAL MOTORS COMPANY

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

 © 2011 Mitchell Repair Information Company, LLC.

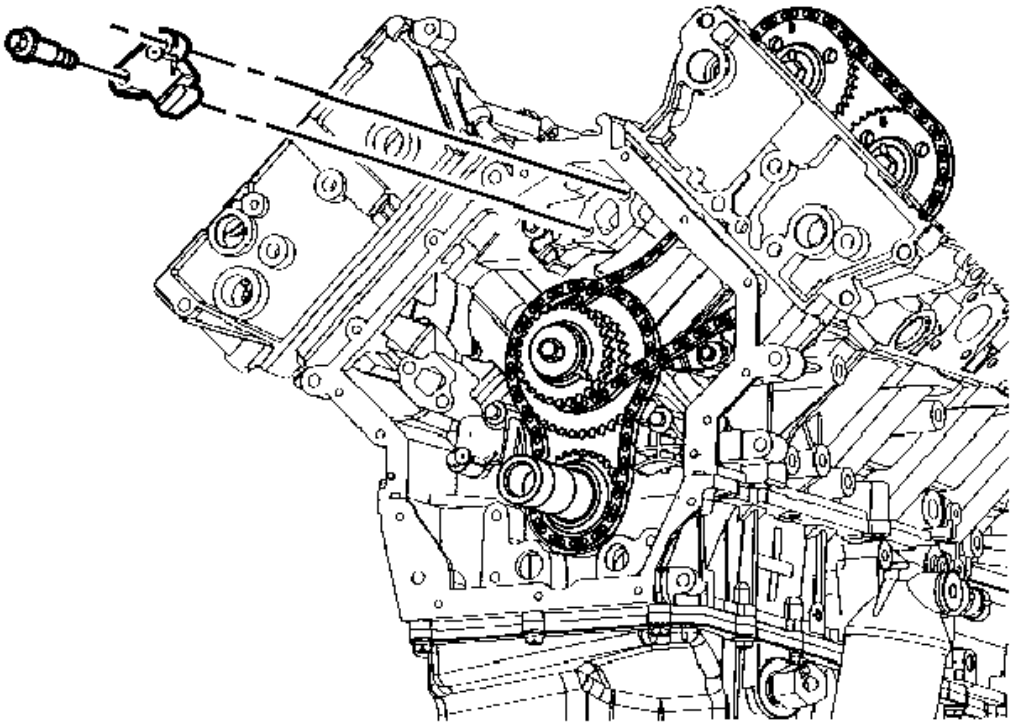


Fig. 170: Identifying Left Secondary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure the tensioner release lever is facing outward.

5. Install the left secondary camshaft drive chain tensioner and retaining bolts.

   Tighten

   Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.
7. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

 © 2011 Mitchell Repair Information Company, LLC.

Special Tools

J 39946 Crankshaft Socket - 4.0L and 4.6L

Removal Procedure

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

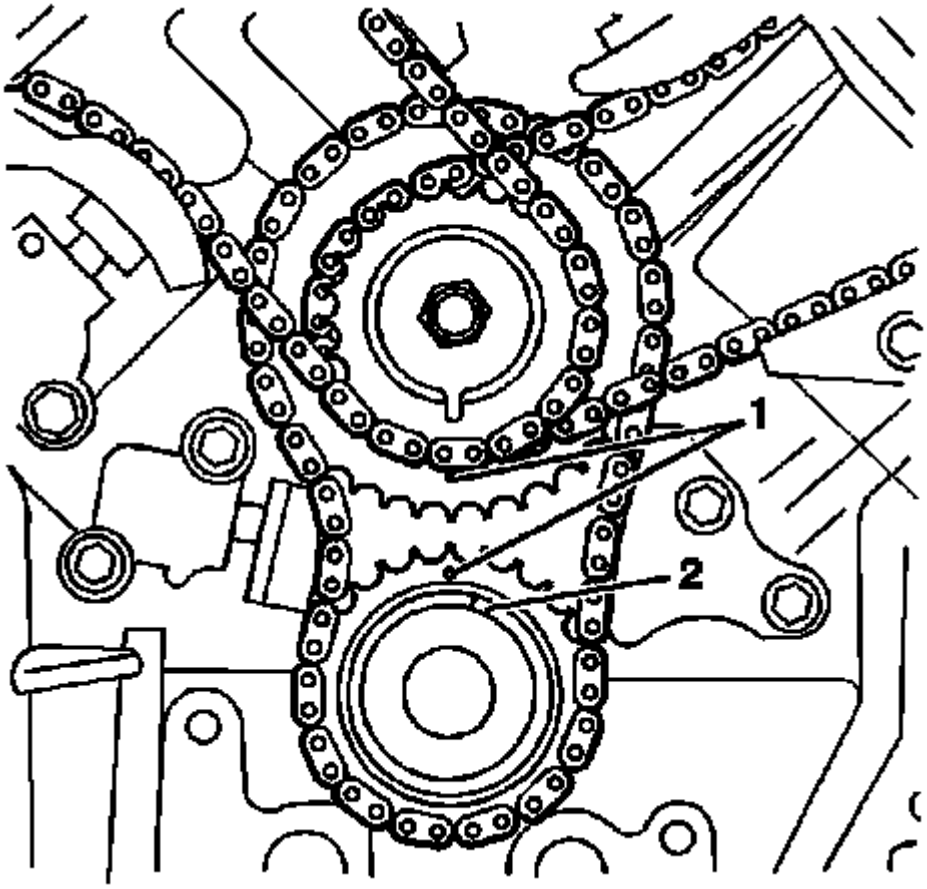


Fig. 171: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

2. Align the primary timing marks (1) using the **J 39946** .

 © 2011 Mitchell Repair Information Company, LLC.

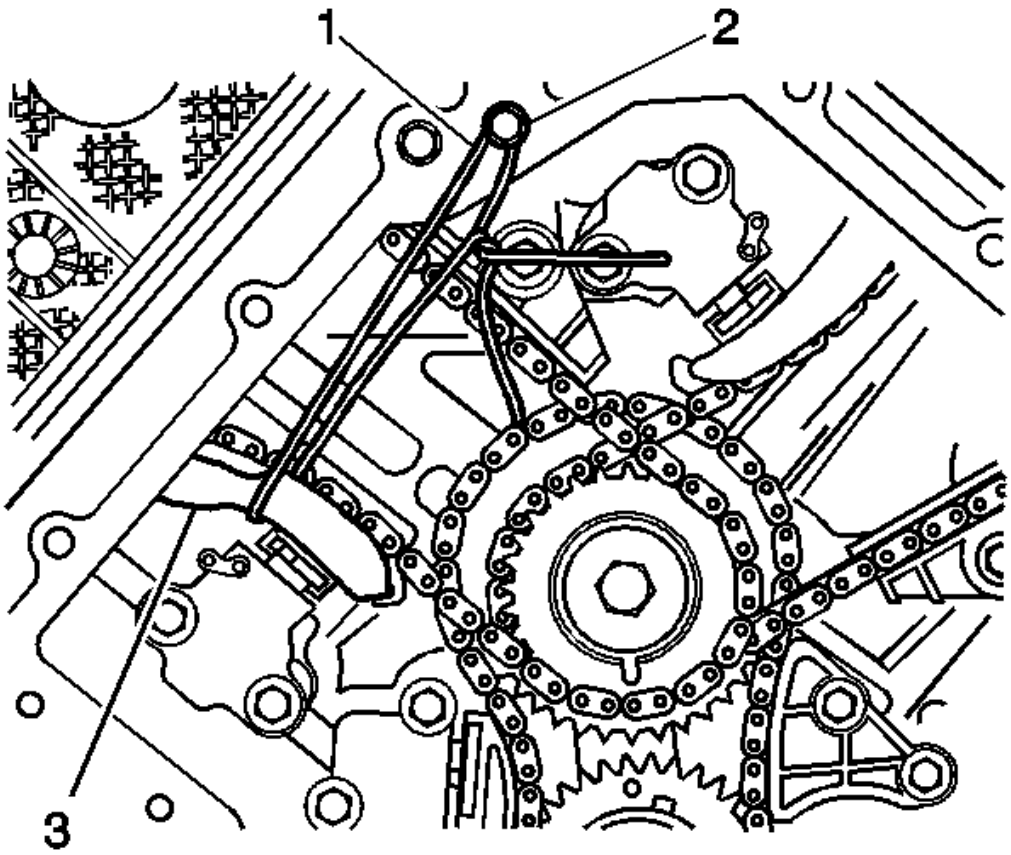


Fig. 172: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install an engine front cover bolt (2) into the front of the engine.

NOTE: Securing the right secondary camshaft drive chain shoe will prevent the right camshaft drive sprocket teeth from skipping on the right secondary timing chain.

4. Wrap mechanics wire (1) tightly around both the right secondary camshaft drive chain shoe (3) and the front cover bolt (2).

 © 2011 Mitchell Repair Information Company, LLC.

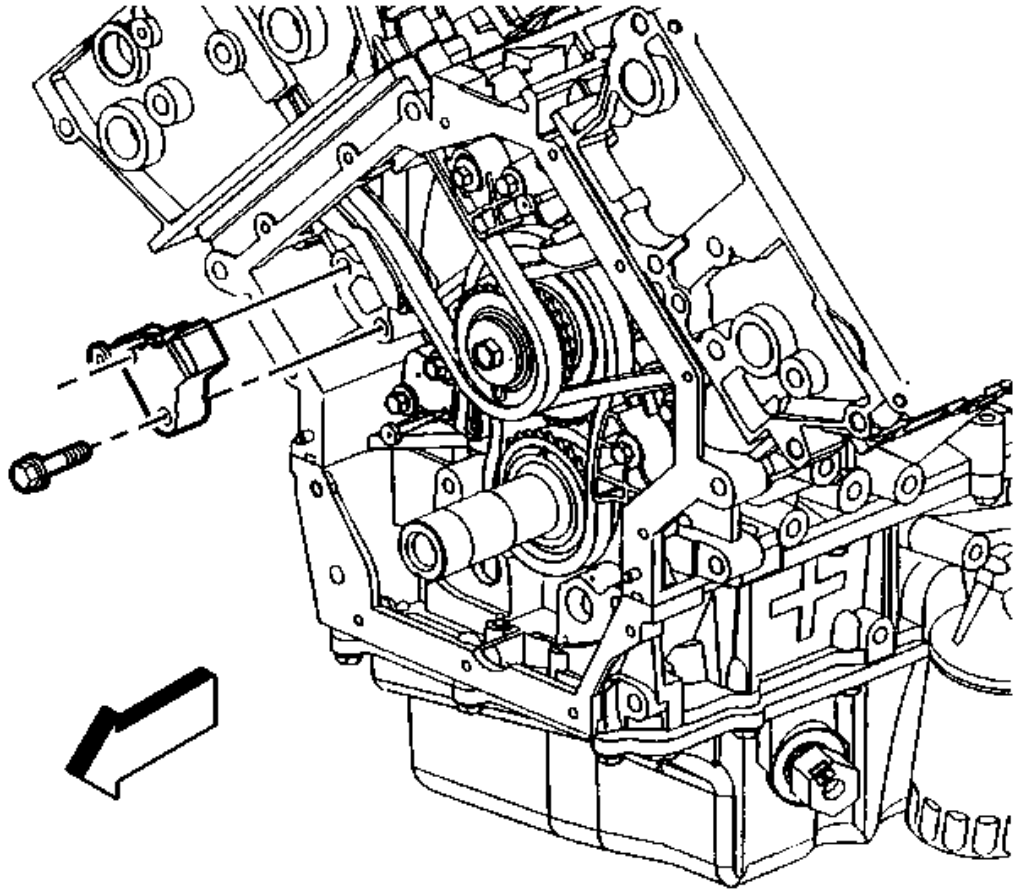


Fig. 173: Identifying Right Secondary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 bolts attaching the right secondary camshaft drive chain tensioner to the engine block.
6. Remove the right secondary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
7. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

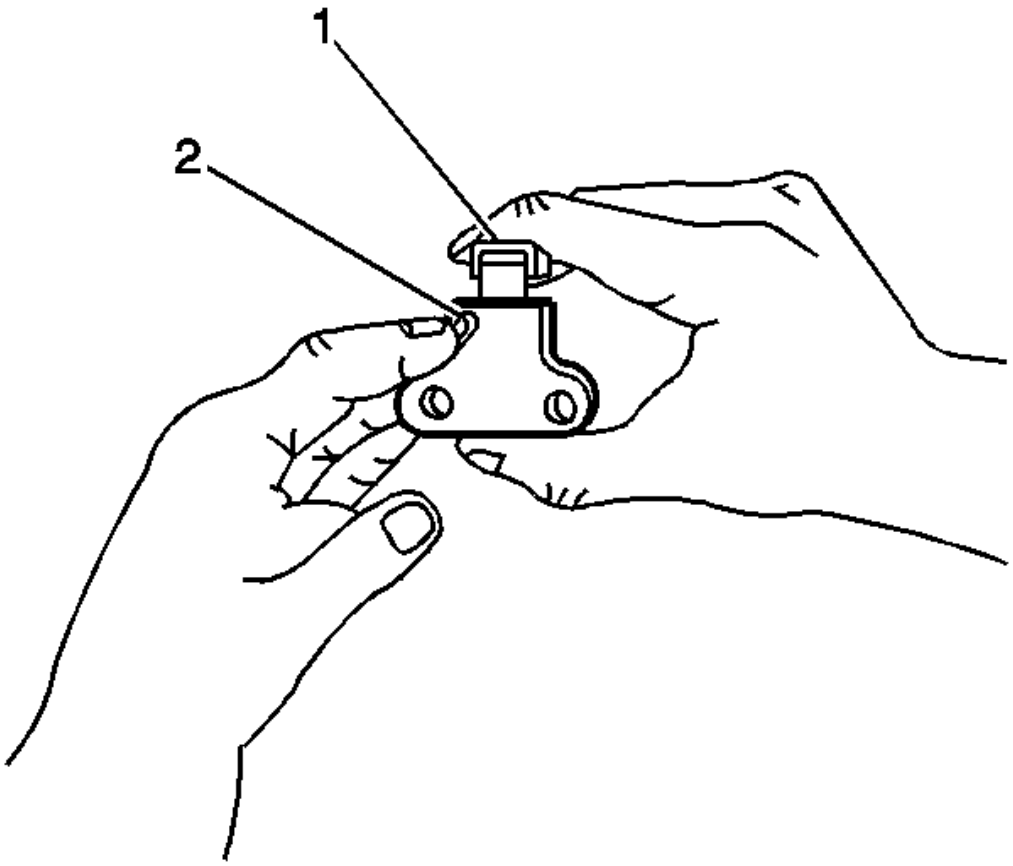


Fig. 174: View Of Tensioner Shoe & Ratchet Lever
Courtesy of GENERAL MOTORS COMPANY

1. Collapse the right secondary camshaft chain tensioner using the following procedure:
    1. Rotate the ratchet release lever (2) counterclockwise and hold.
    2. Collapse the tensioner shoe (1) and hold.
    3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

 © 2011 Mitchell Repair Information Company, LLC.

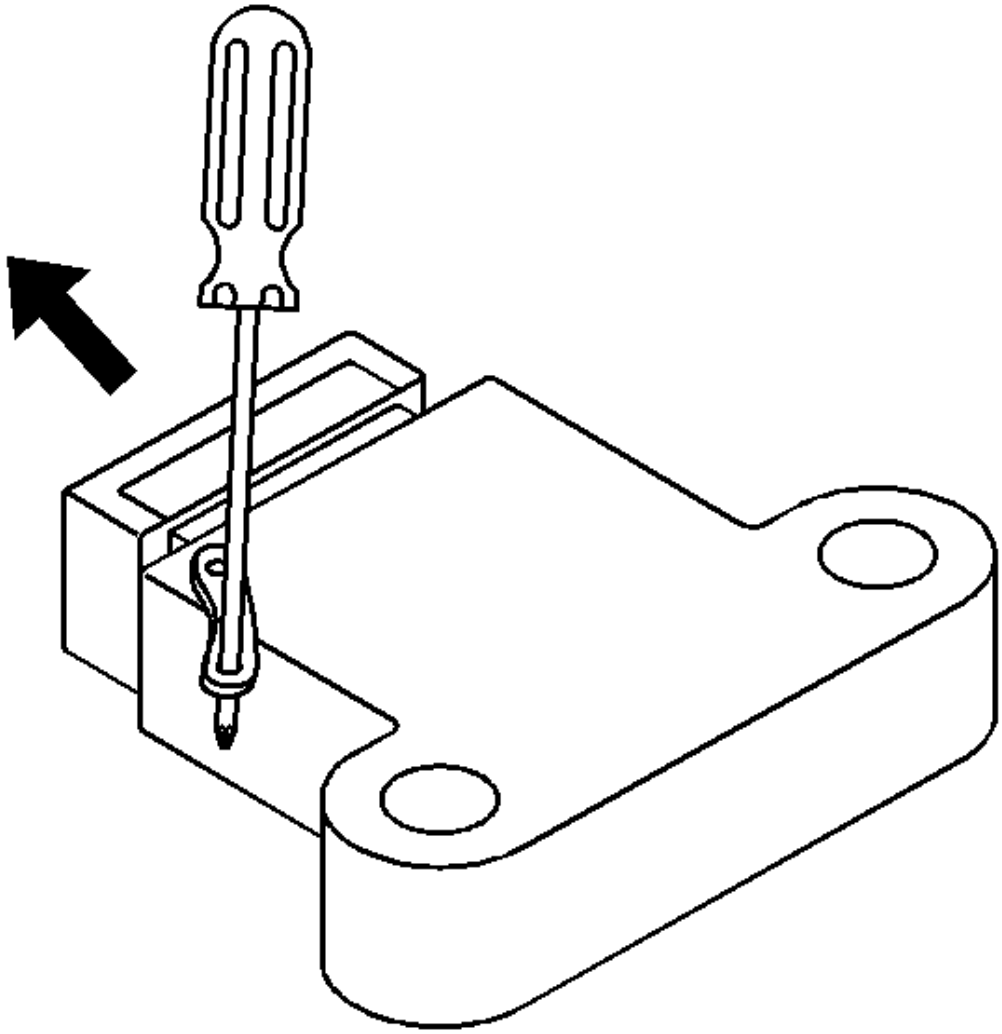


Fig. 175: Locking Tensioner Shoe In Collapsed Position
Courtesy of GENERAL MOTORS COMPANY

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

 © 2011 Mitchell Repair Information Company, LLC.

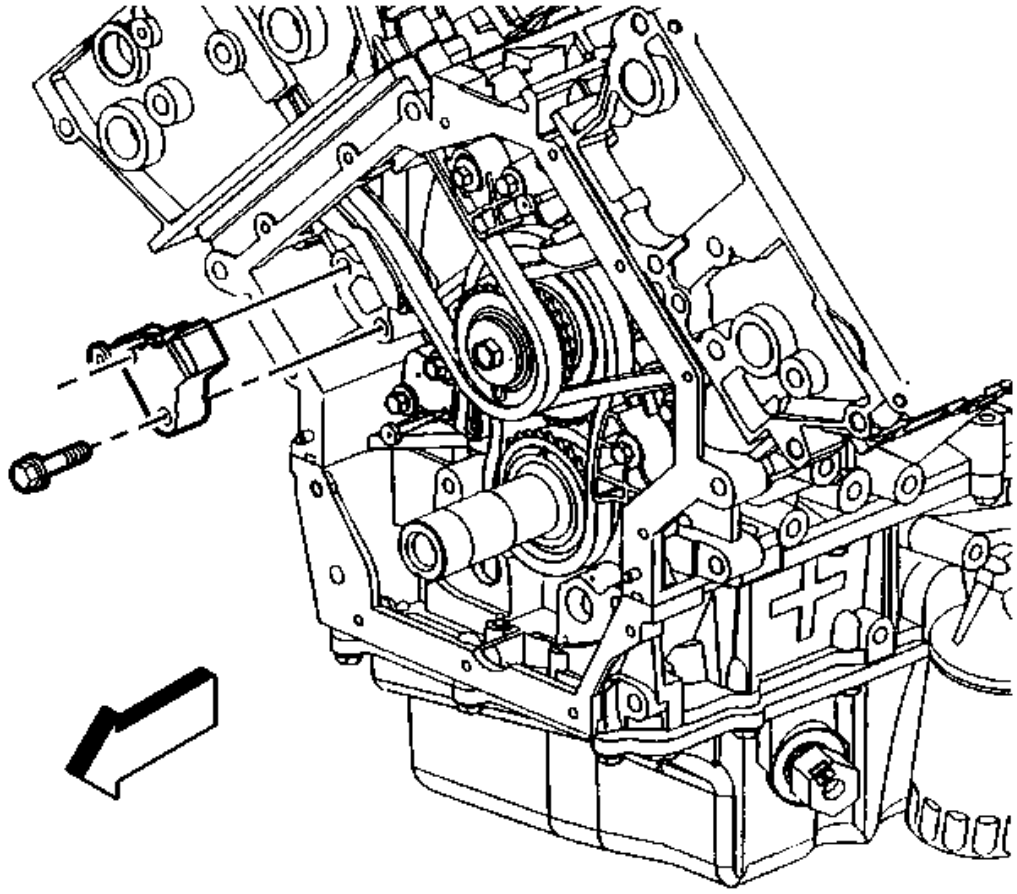


Fig. 176: Identifying Right Secondary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure the tensioner release lever is facing outward.

5. Install the right secondary camshaft drive chain tensioner and retaining bolts.

   Tighten

   Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.

 © 2011 Mitchell Repair Information Company, LLC.

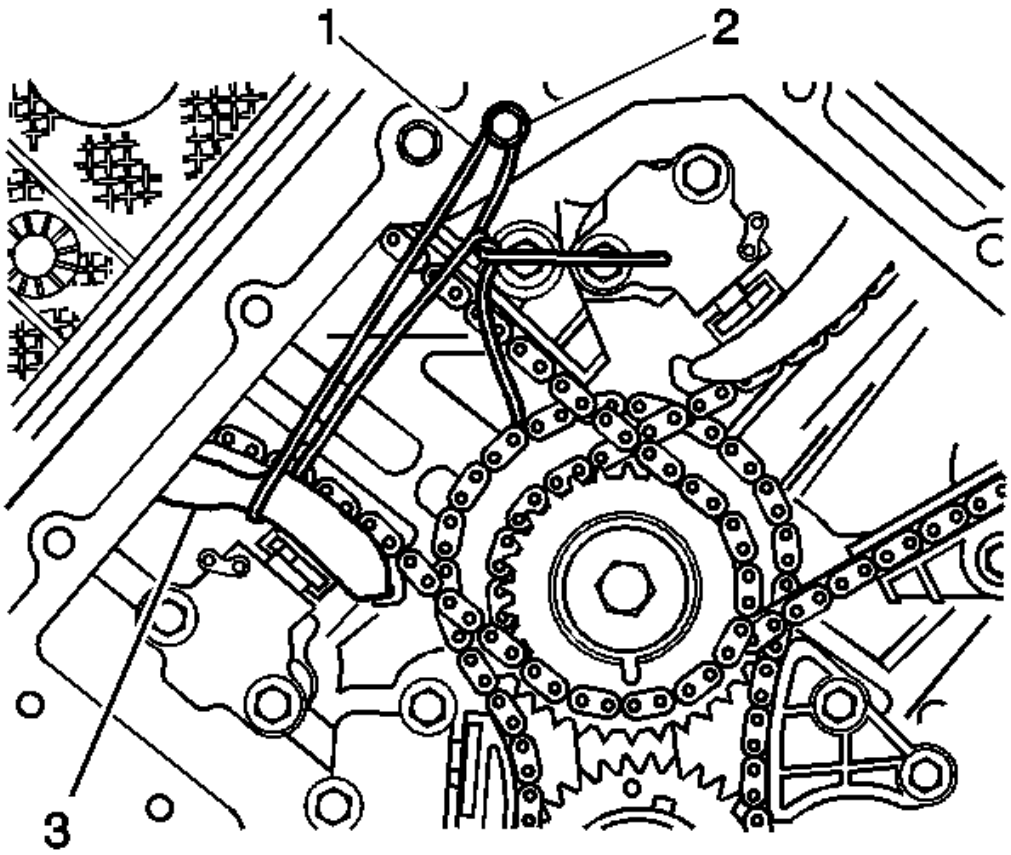


Fig. 177: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
8. Remove the engine front cover bolt (2) from the front of the engine.
9. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

Special Tools

J 44212 Camshaft Holding Tool

Removal Procedure

1. Remove the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate**

 © 2011 Mitchell Repair Information Company, LLC.

Drive Chain Tensioner Replacement - Left Side.

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

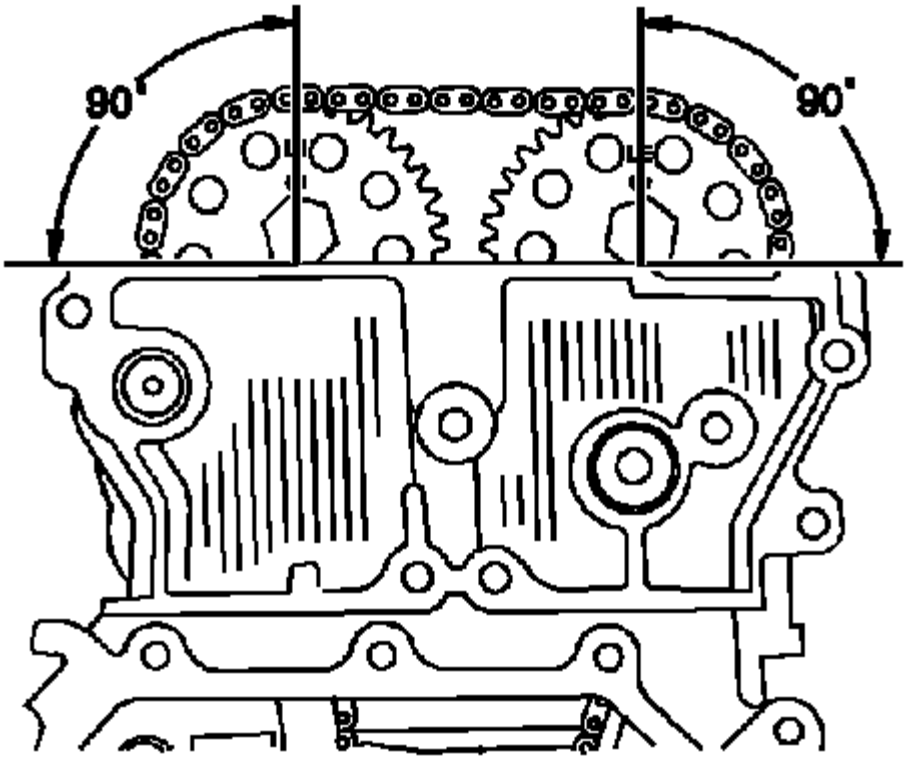


Fig. 178: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

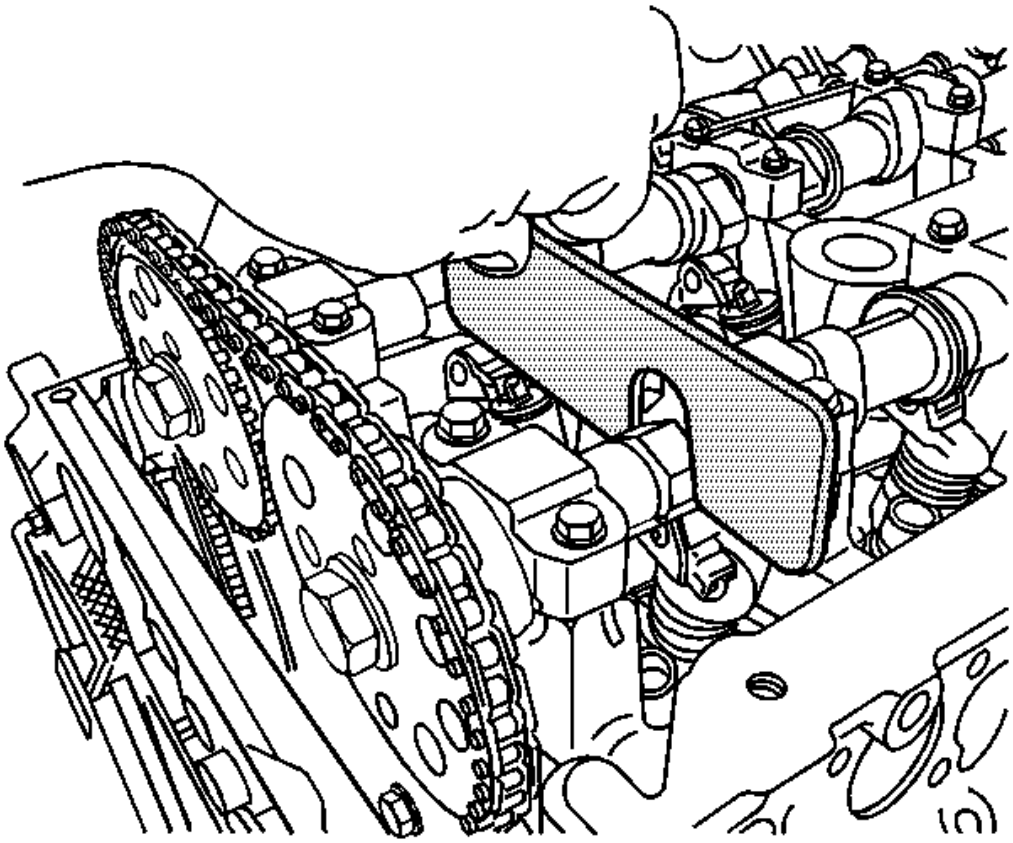


Fig. 179: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

4. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

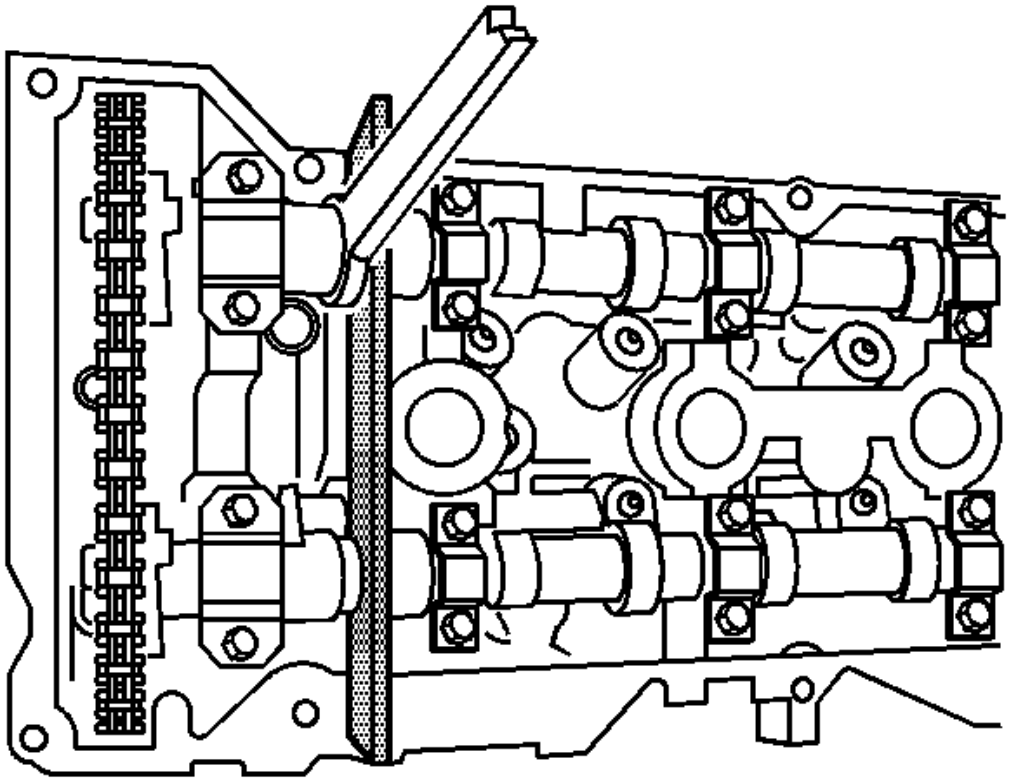


Fig. 180: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

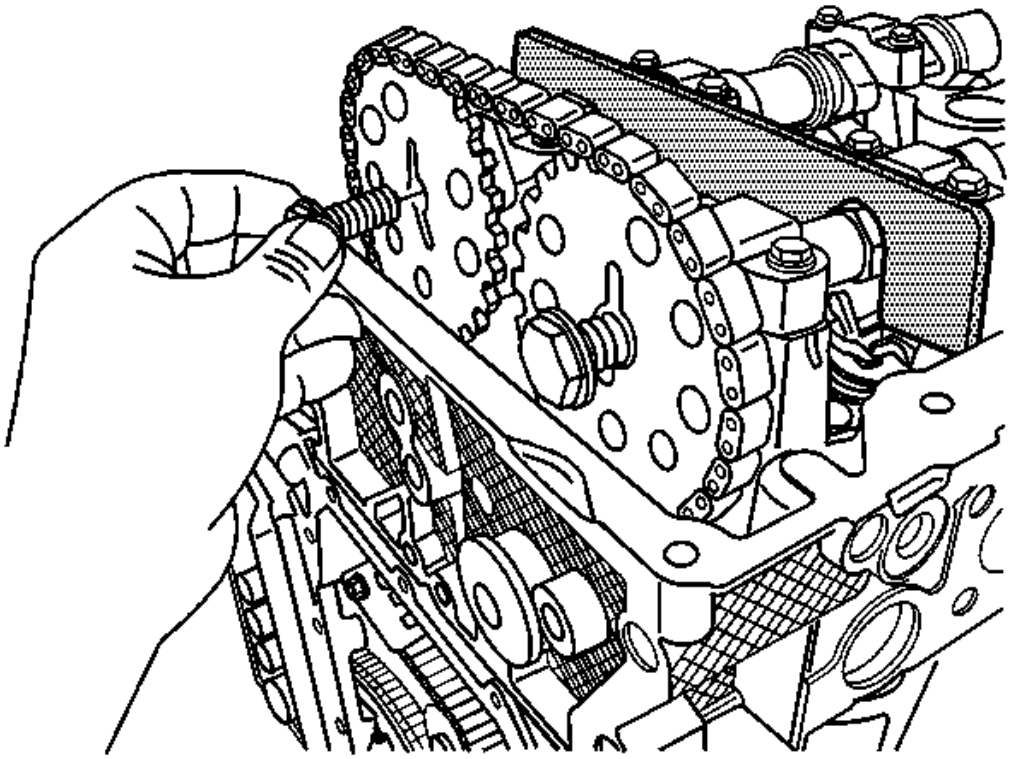


Fig. 181: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the left intake camshaft sprocket bolt.
7. Slide the left intake camshaft sprocket off of the camshaft and remove the left secondary drive chain from the camshaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

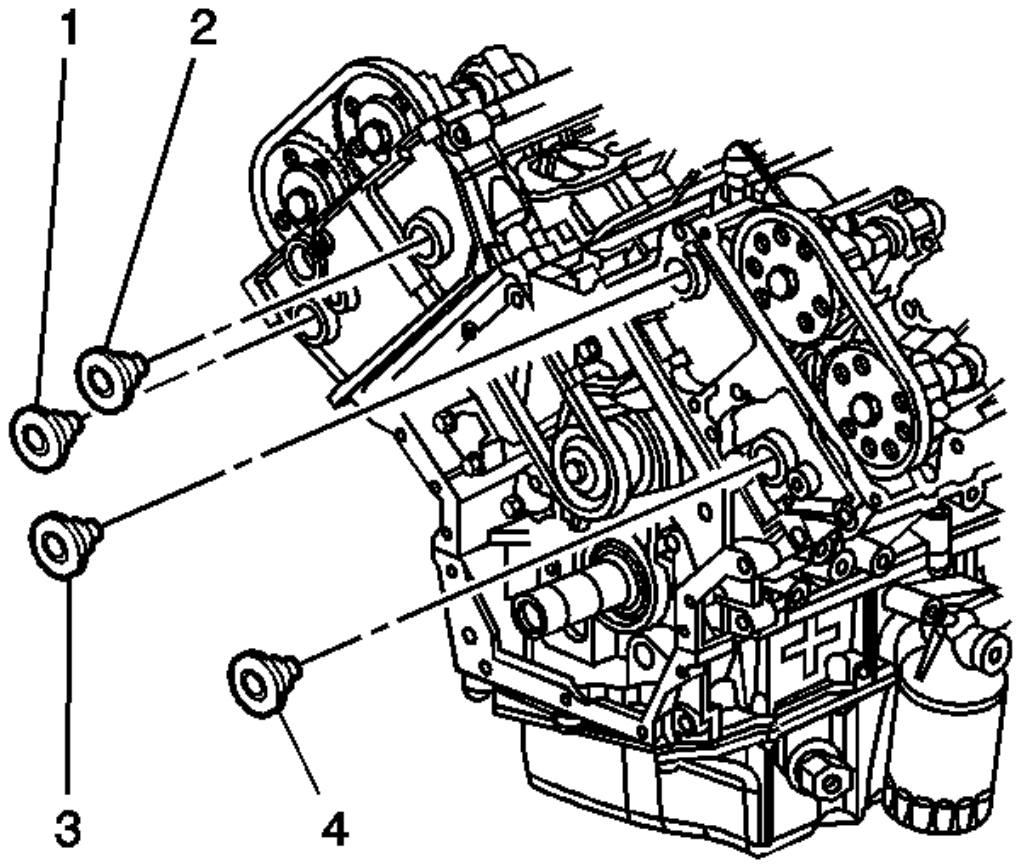


Fig. 182: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

8. Remove the left secondary camshaft drive chain shoe access plug (3) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

 © 2011 Mitchell Repair Information Company, LLC.

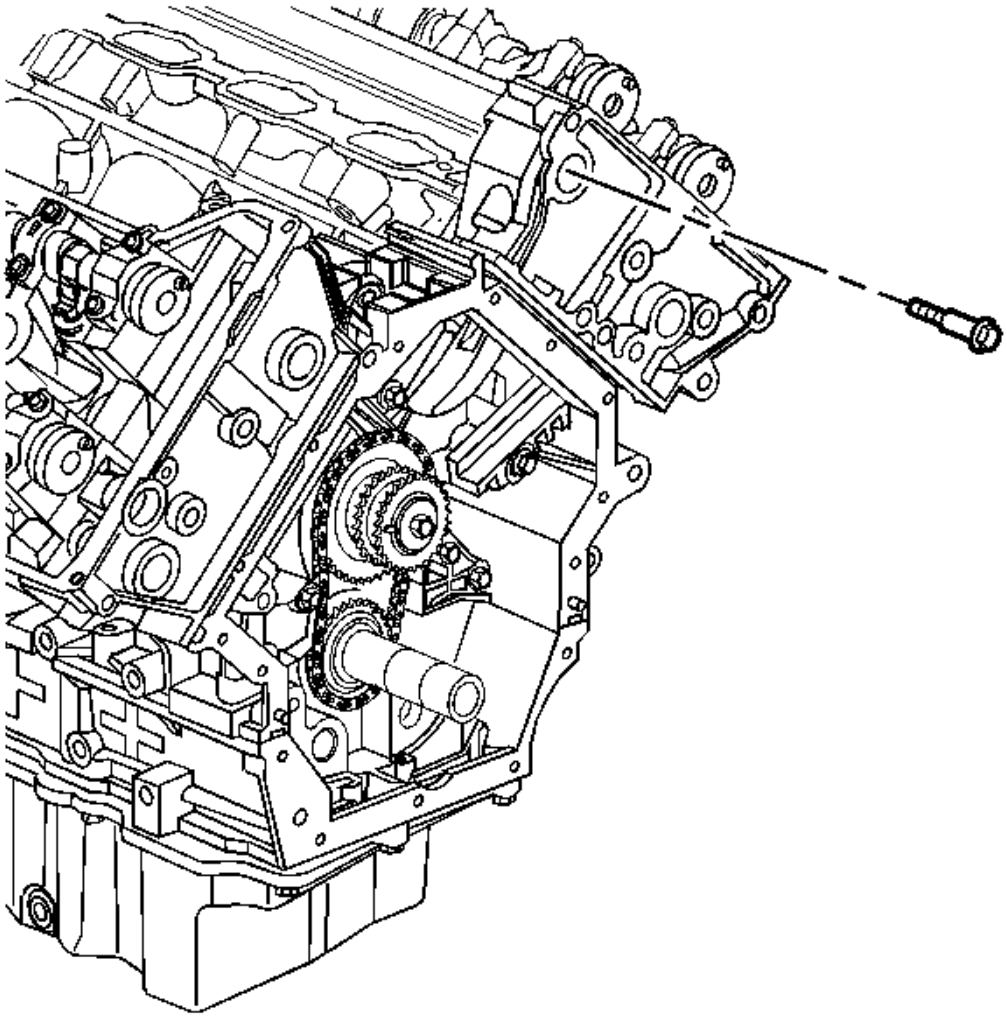


Fig. 183: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

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

 © 2011 Mitchell Repair Information Company, LLC.

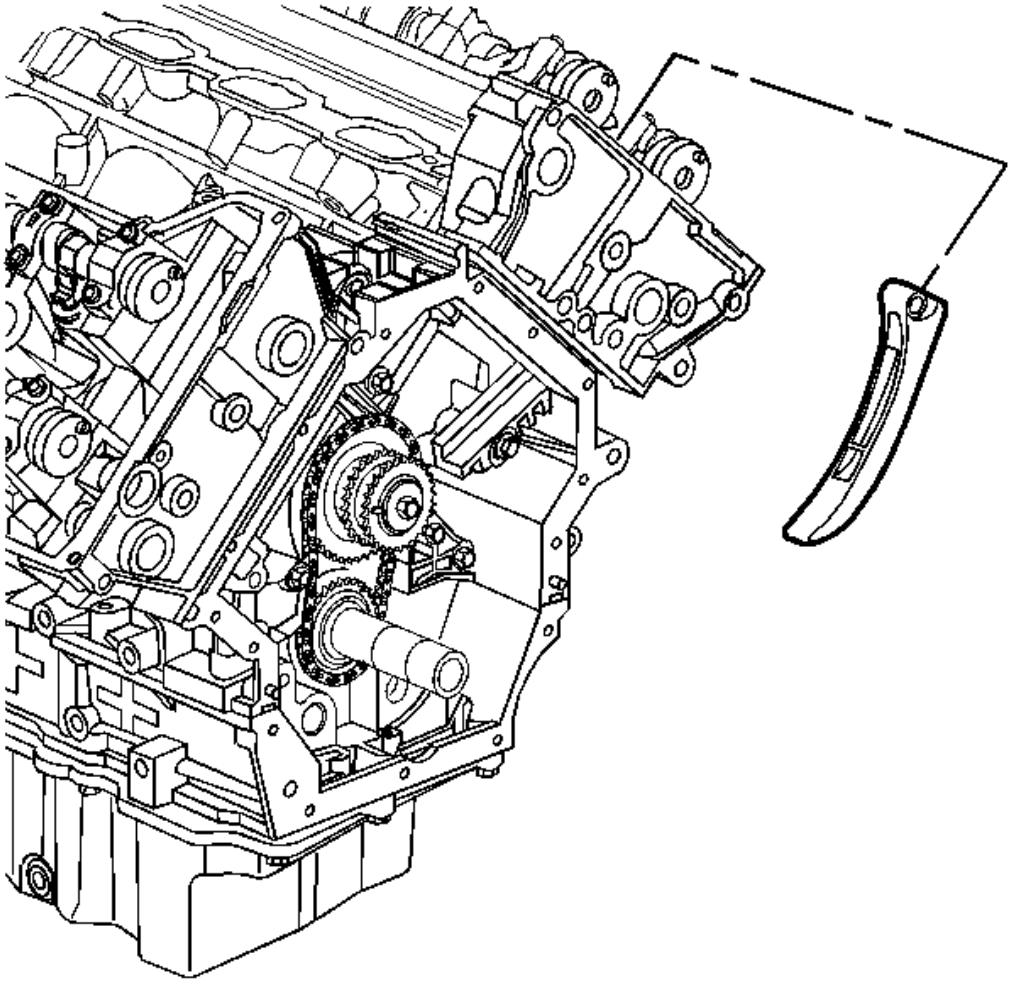


Fig. 184: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

10. Remove the left secondary camshaft drive chain shoe.
11. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

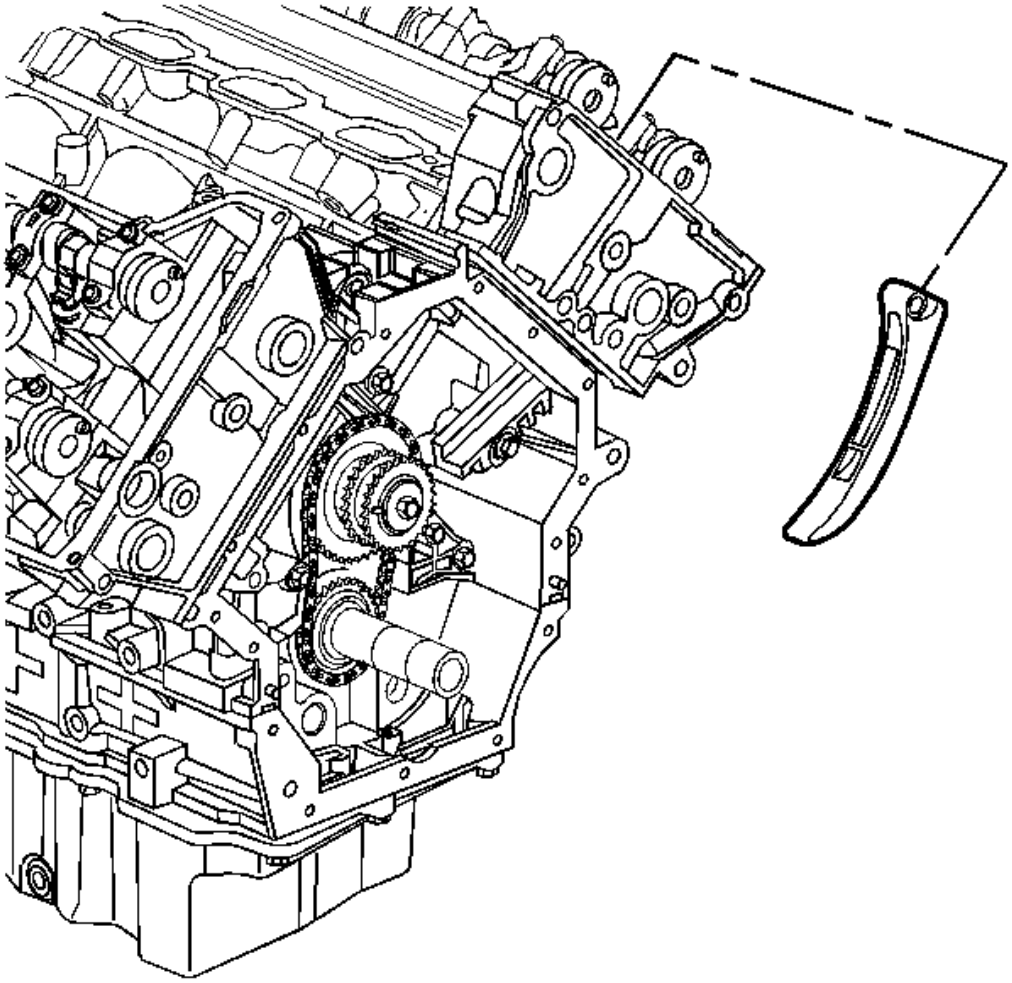


Fig. 185: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Position the left secondary camshaft drive chain shoe in through the top of the cylinder head.

 © 2011 Mitchell Repair Information Company, LLC.

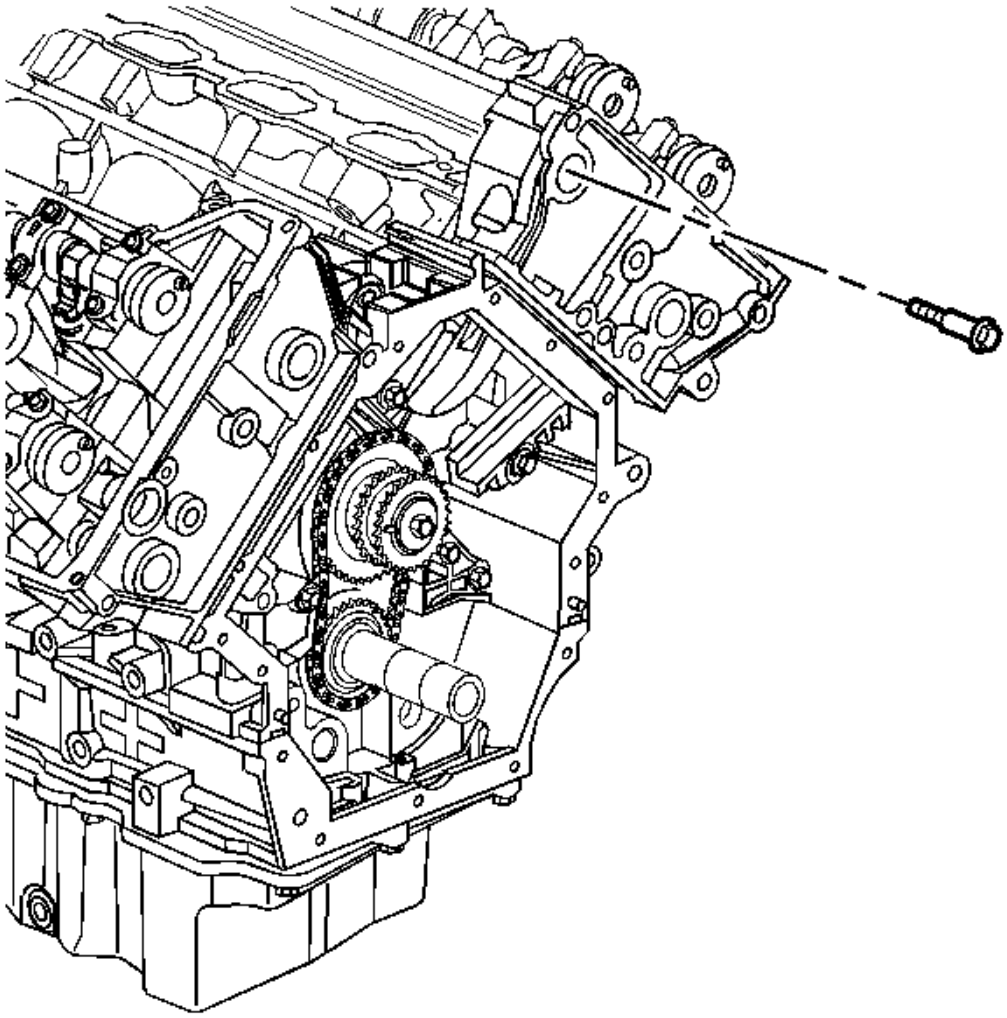


Fig. 186: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the left secondary camshaft drive chain shoe bolt.

Tighten

Tighten the secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

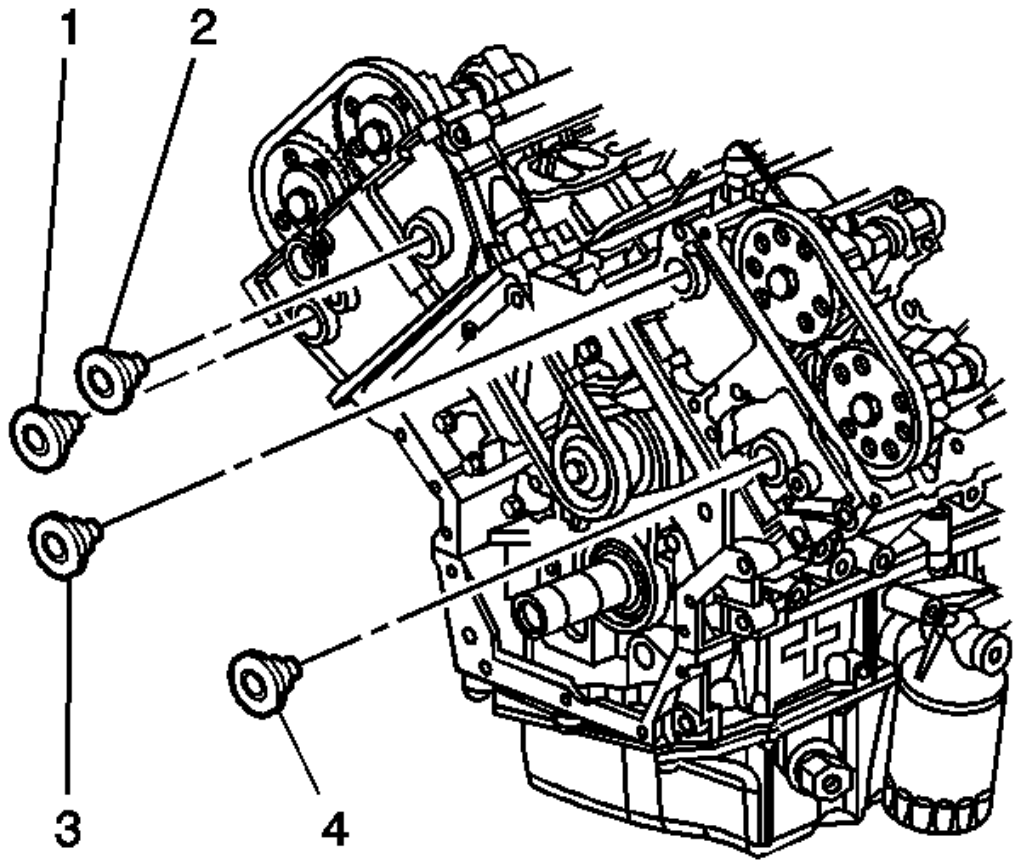


Fig. 187: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

3. Install the left secondary camshaft drive chain shoe access plug (3) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten

Tighten the secondary camshaft drive chain shoe access plug to 4.5 N.m (40 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

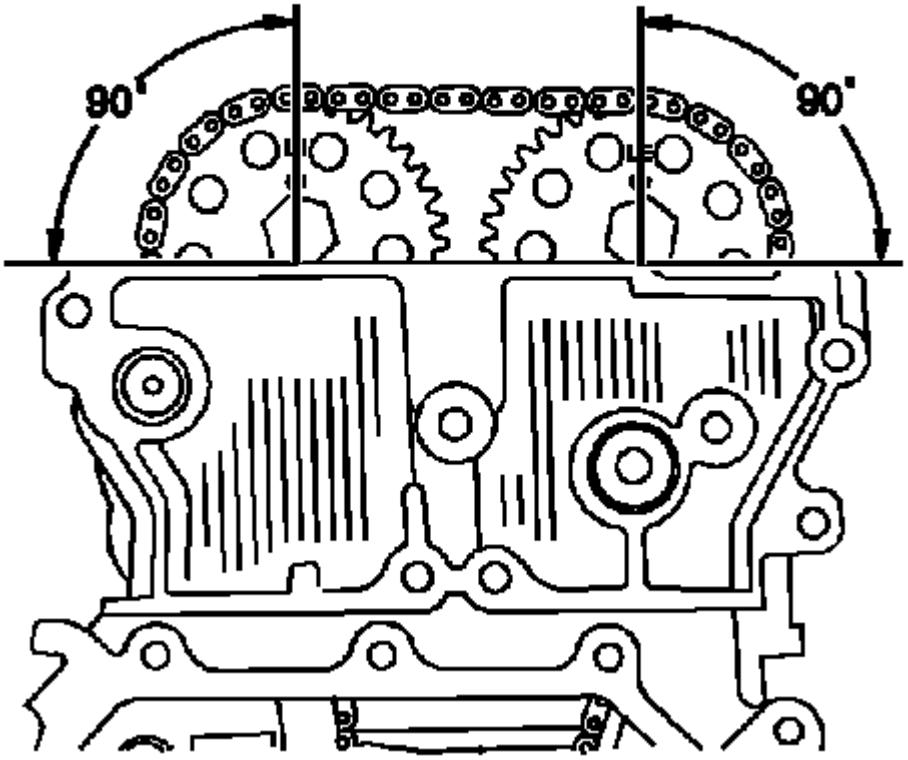


Fig. 188: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

4. Install the left intake camshaft sprocket into the left secondary camshaft drive chain.
5. Install the left intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LI (left intake) engages the intake camshaft pin.

 © 2011 Mitchell Repair Information Company, LLC.

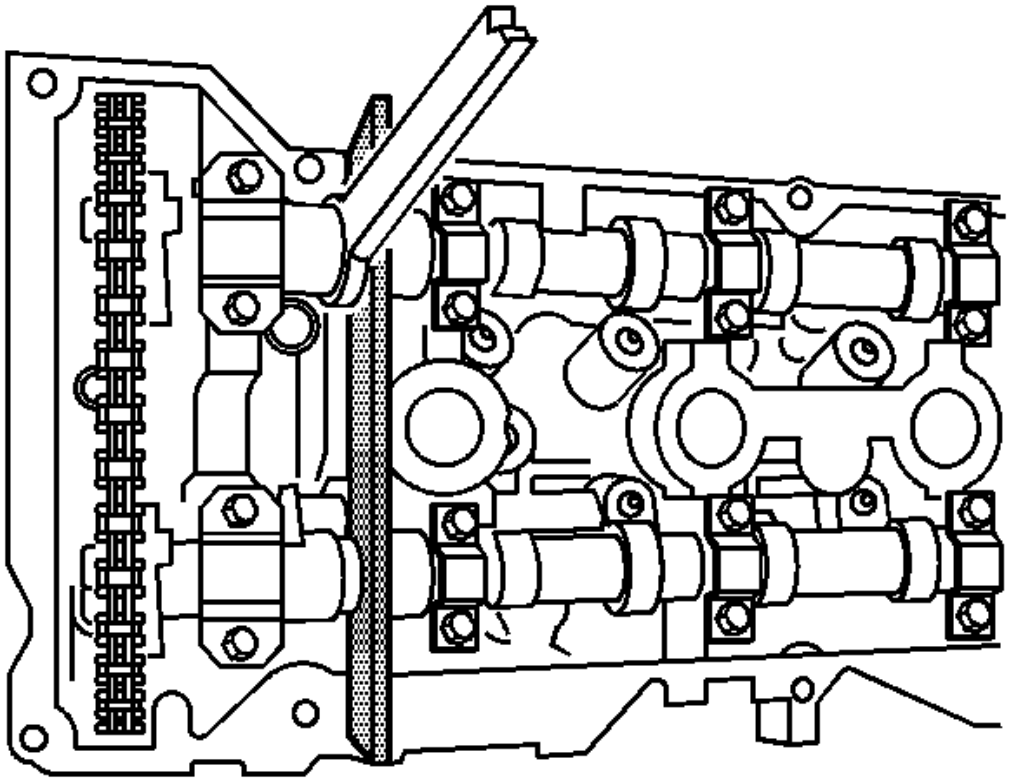


Fig. 189: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

6. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

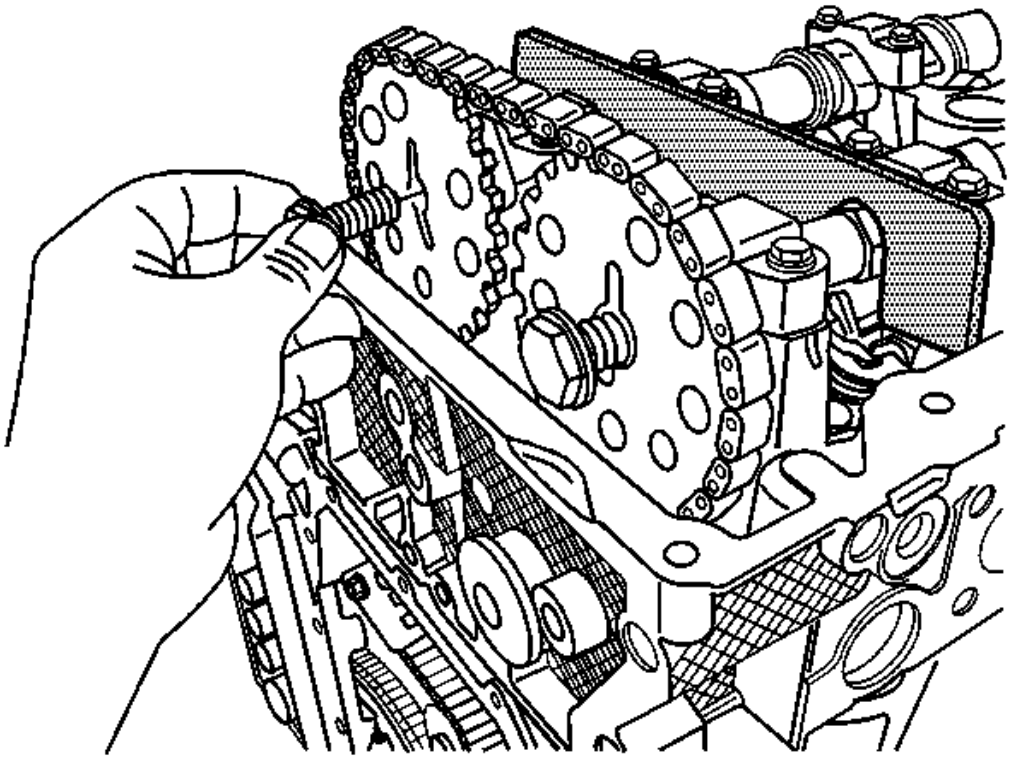


Fig. 190: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install the left intake camshaft sprocket bolt.

   Tighten

   Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

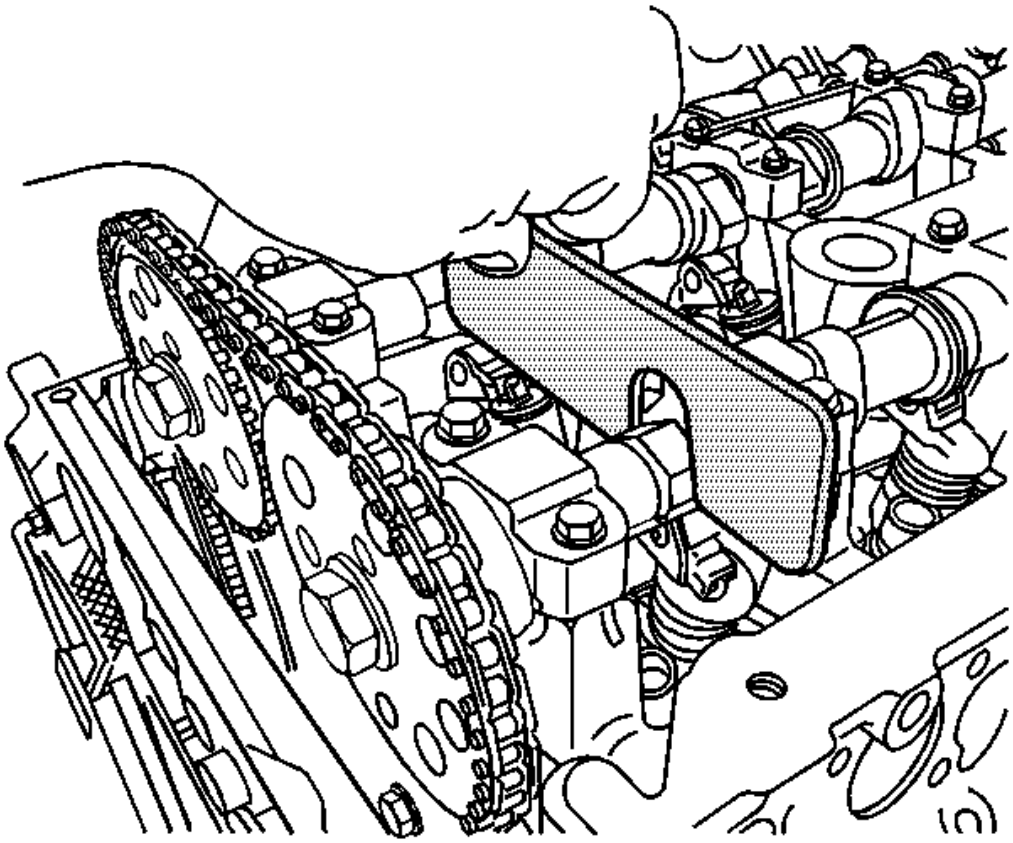


Fig. 191: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **J 44212** from the camshafts.
9. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
10. Install the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Special Tools

J 44212 Camshaft Holding Tool

Removal Procedure

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate**

 © 2011 Mitchell Repair Information Company, LLC.

Drive Chain Tensioner Replacement - Right Side.

2. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

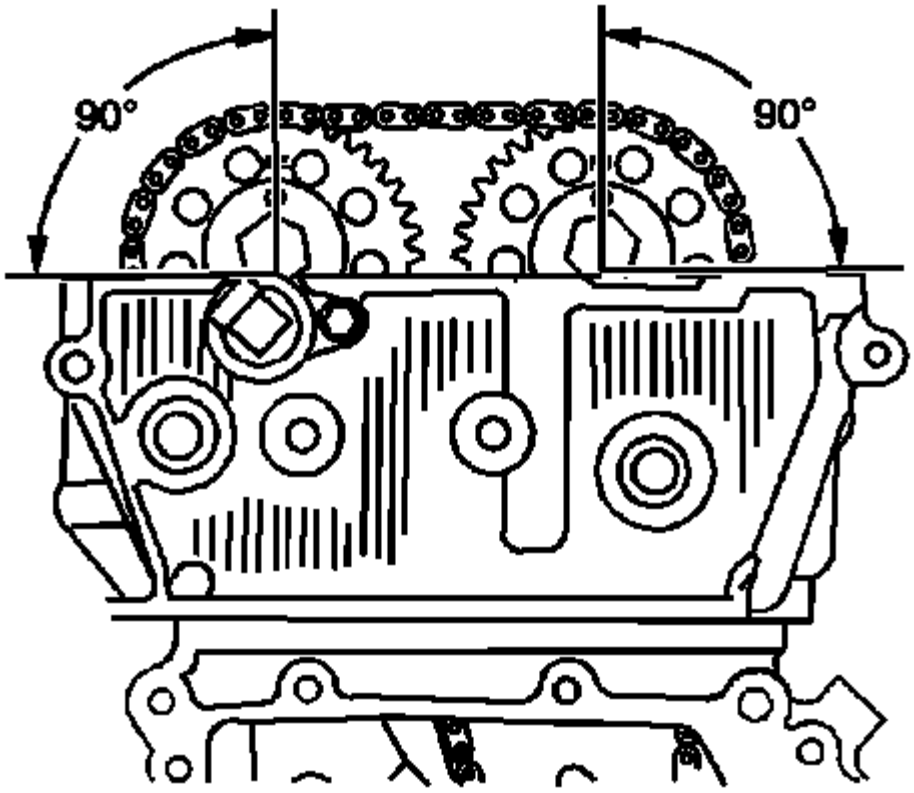


Fig. 192: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

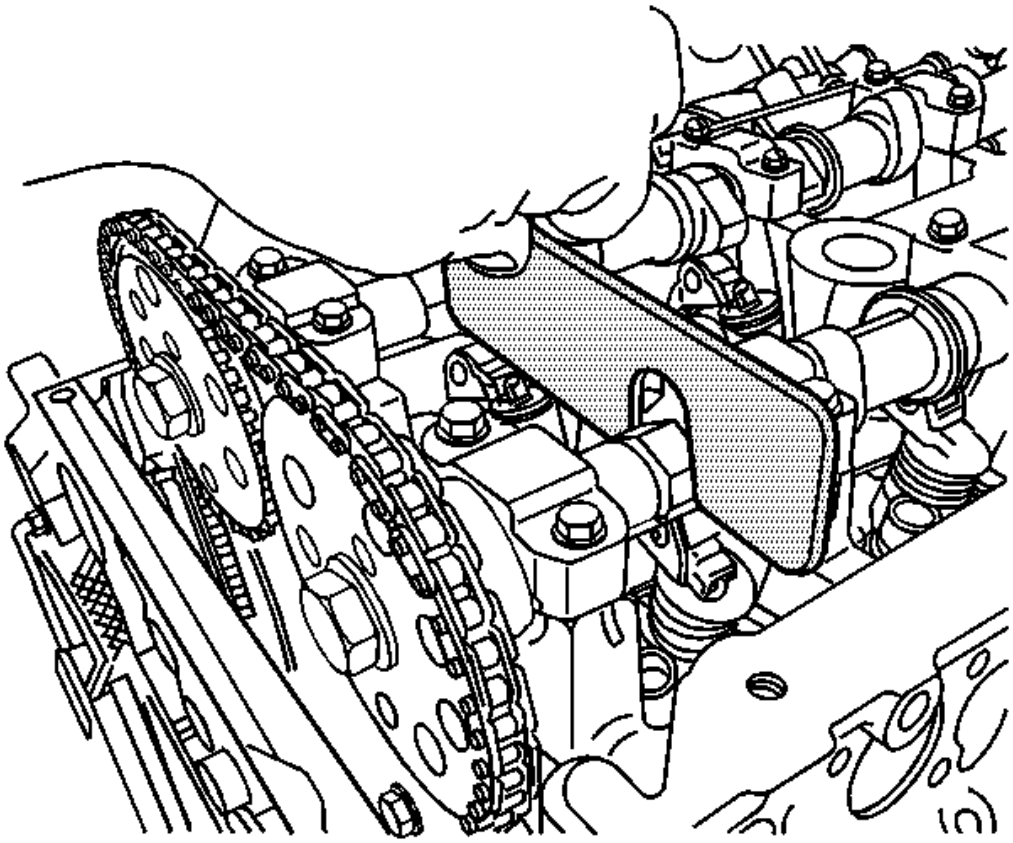


Fig. 193: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: The camshaft holding tools must be installed on the camshafts to prevent camshaft rotation. When performing service to the valve train and/or timing components, valve spring pressure can cause the camshafts to rotate unexpectedly and can cause personal injury.

4. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

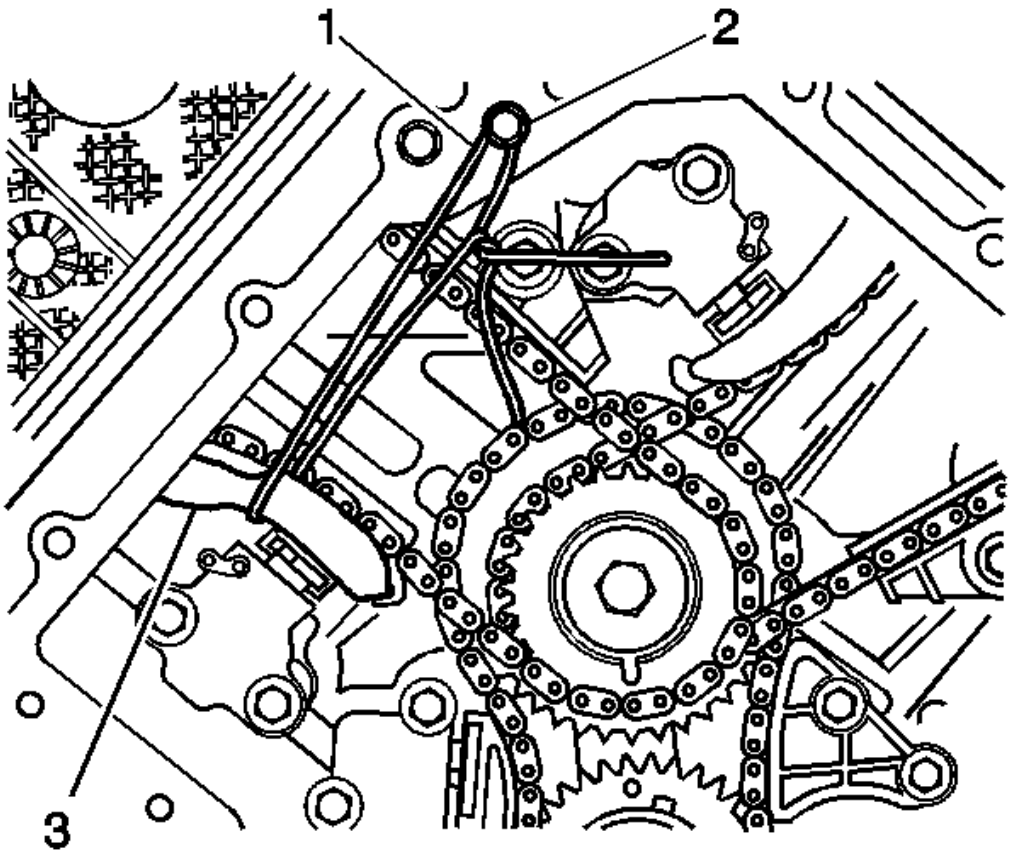


Fig. 194: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
6. Remove the engine front cover bolt (2) from the front of the engine.

 © 2011 Mitchell Repair Information Company, LLC.

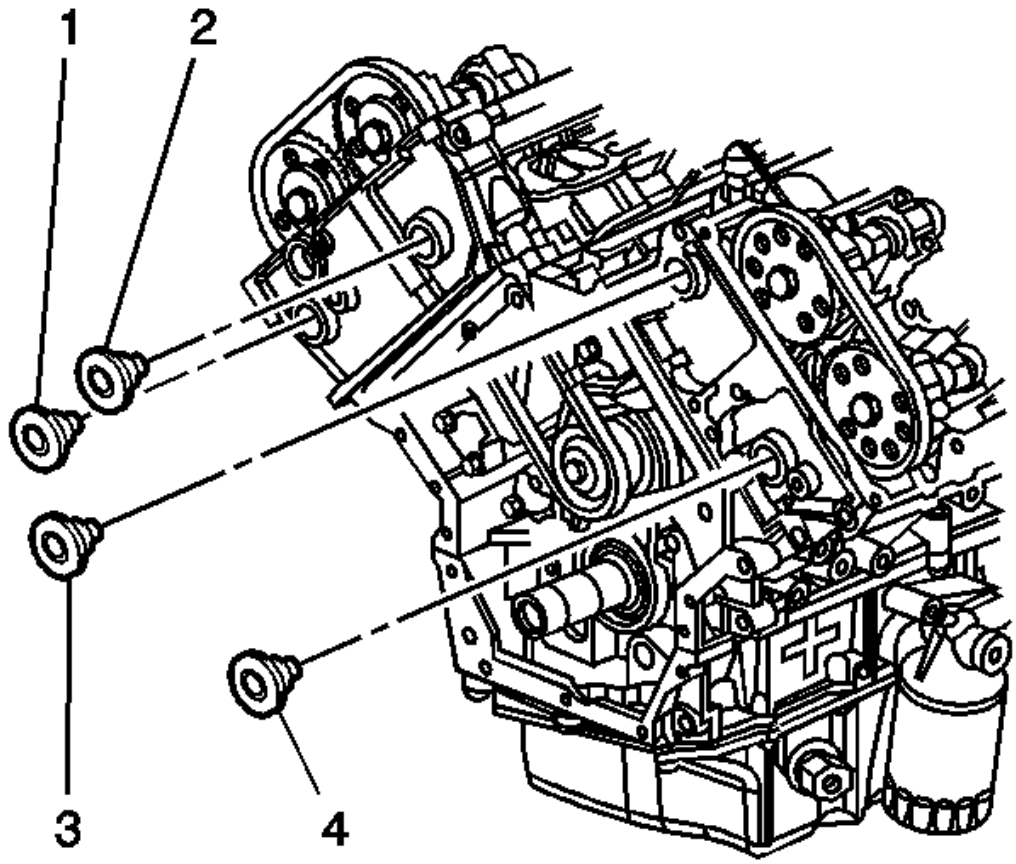


Fig. 195: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

7. Remove the right secondary camshaft drive chain shoe access plug (1) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

 © 2011 Mitchell Repair Information Company, LLC.

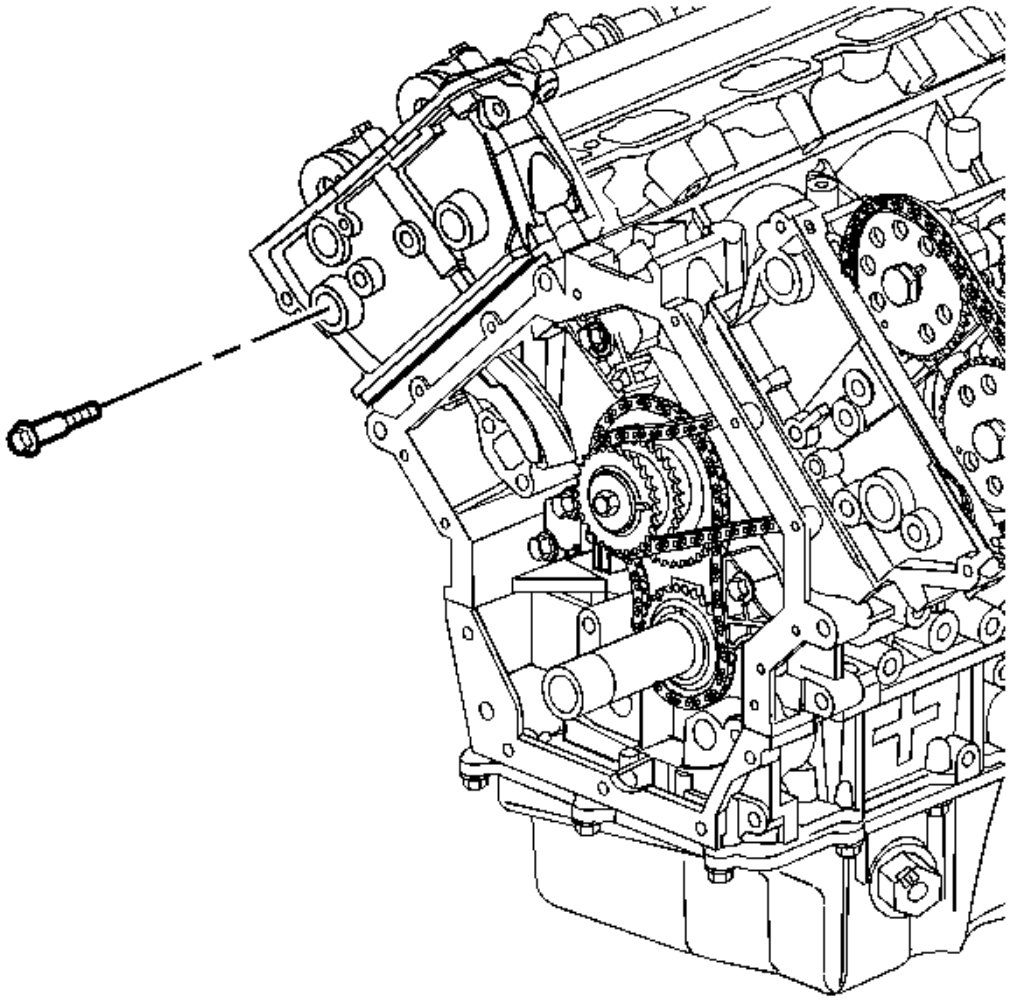


Fig. 196: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the right secondary camshaft drive chain shoe bolt.

 © 2011 Mitchell Repair Information Company, LLC.

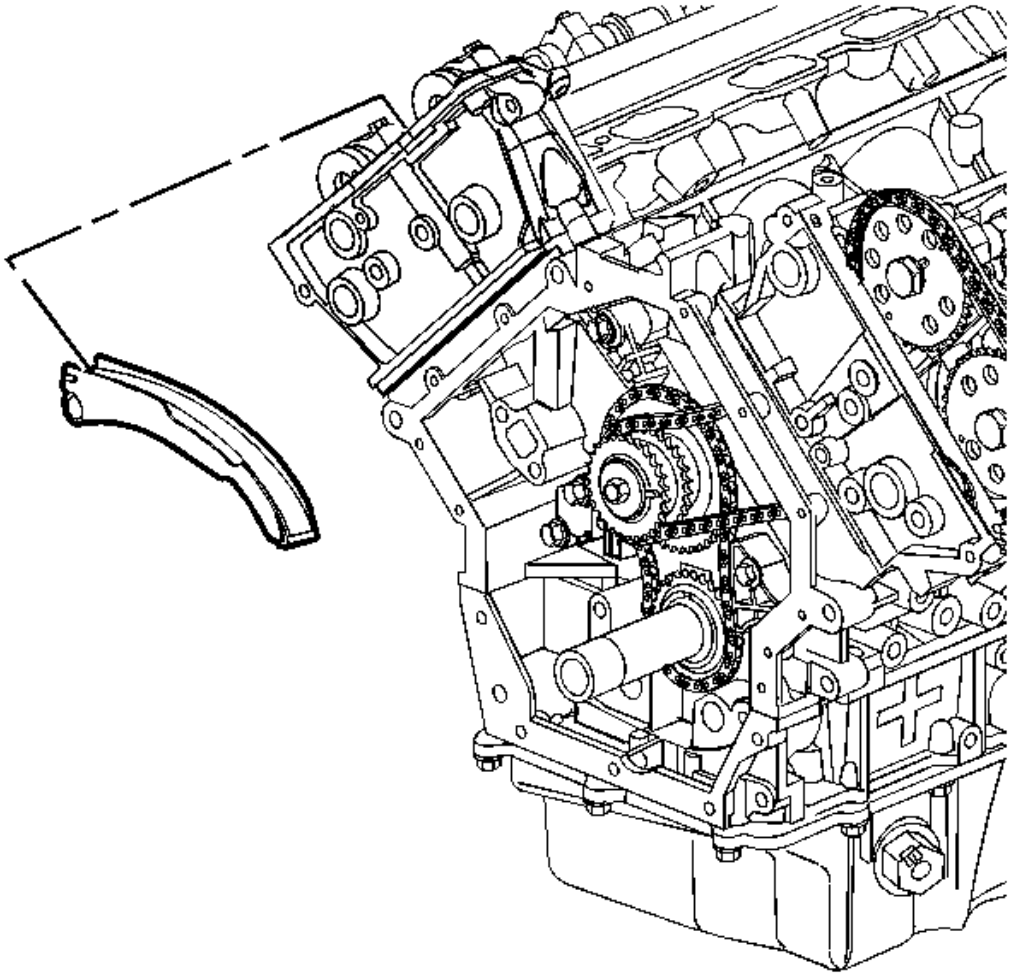


Fig. 197: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

9. Remove the right secondary camshaft drive chain shoe.
10. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

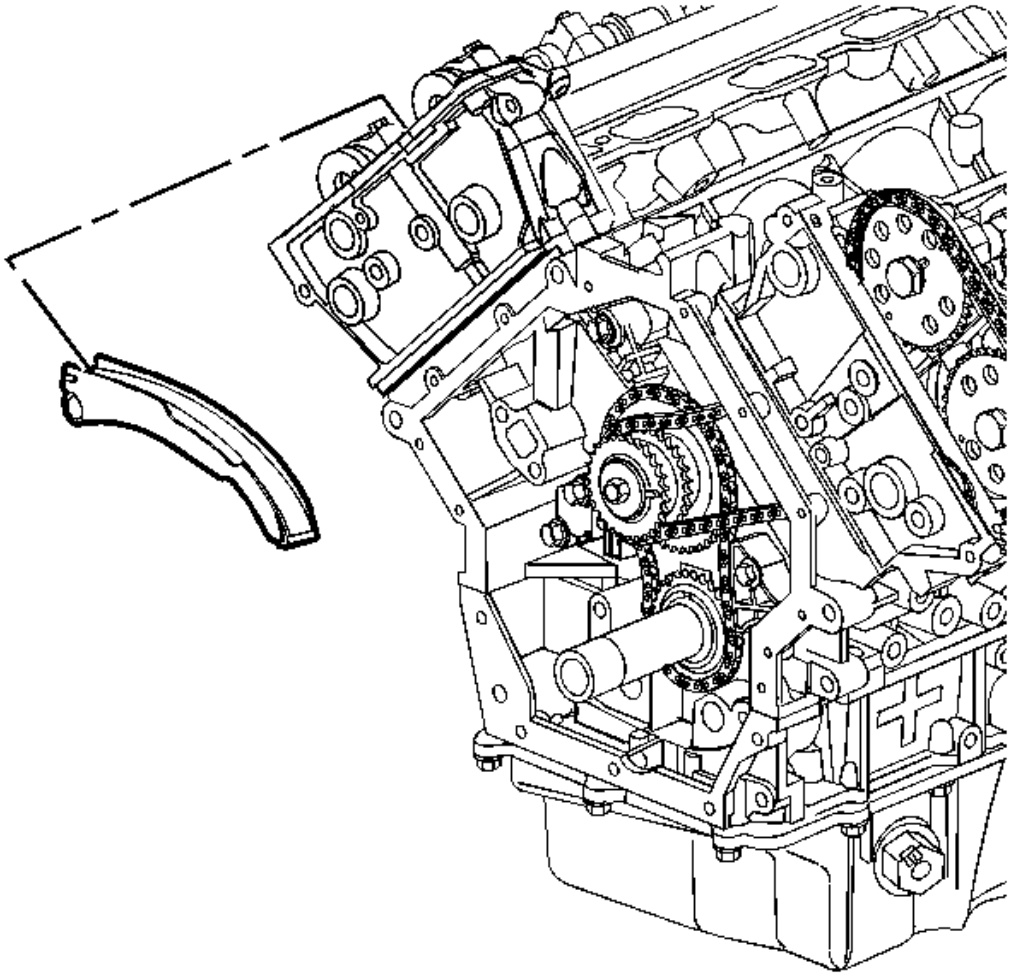


Fig. 198: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Position the right secondary camshaft drive chain shoe in through the front cover area.

 © 2011 Mitchell Repair Information Company, LLC.

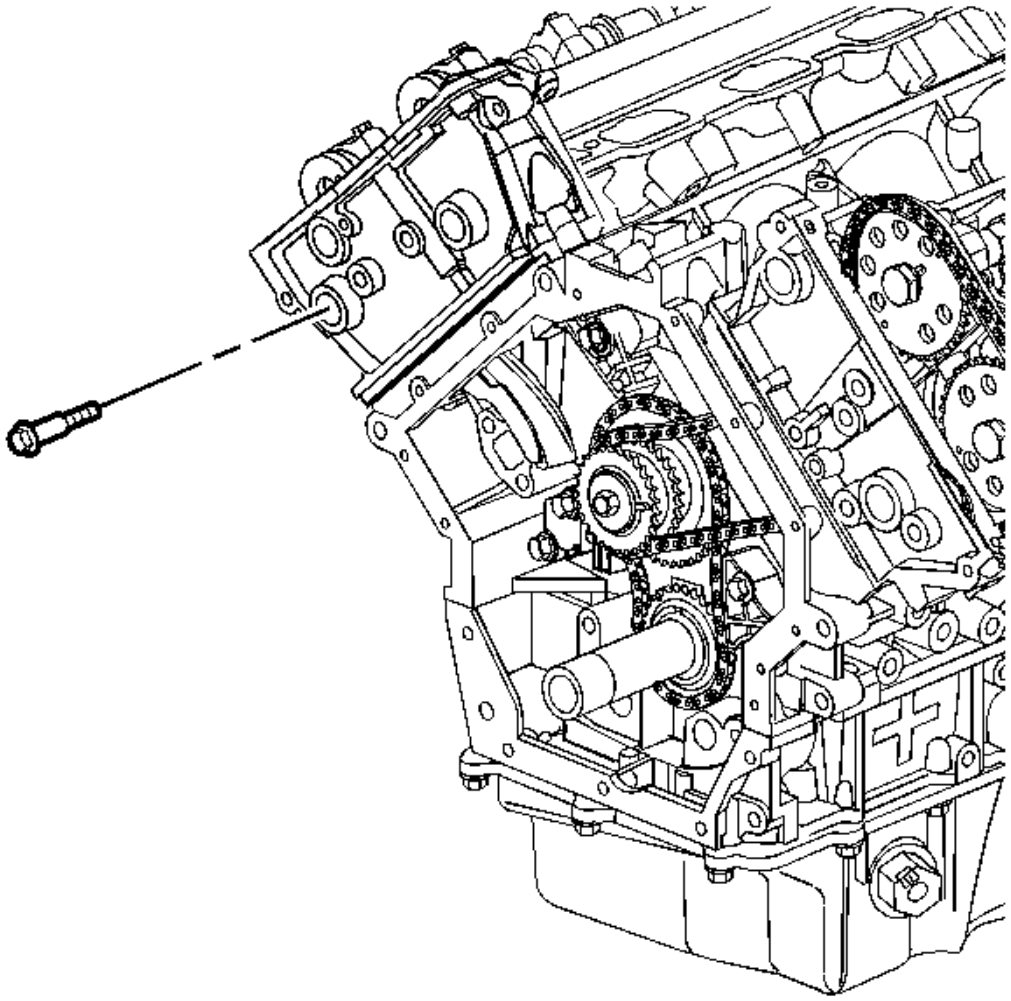


Fig. 199: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the right secondary camshaft drive chain shoe bolt.

Tighten

Tighten the secondary camshaft drive chain shoe bolt to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

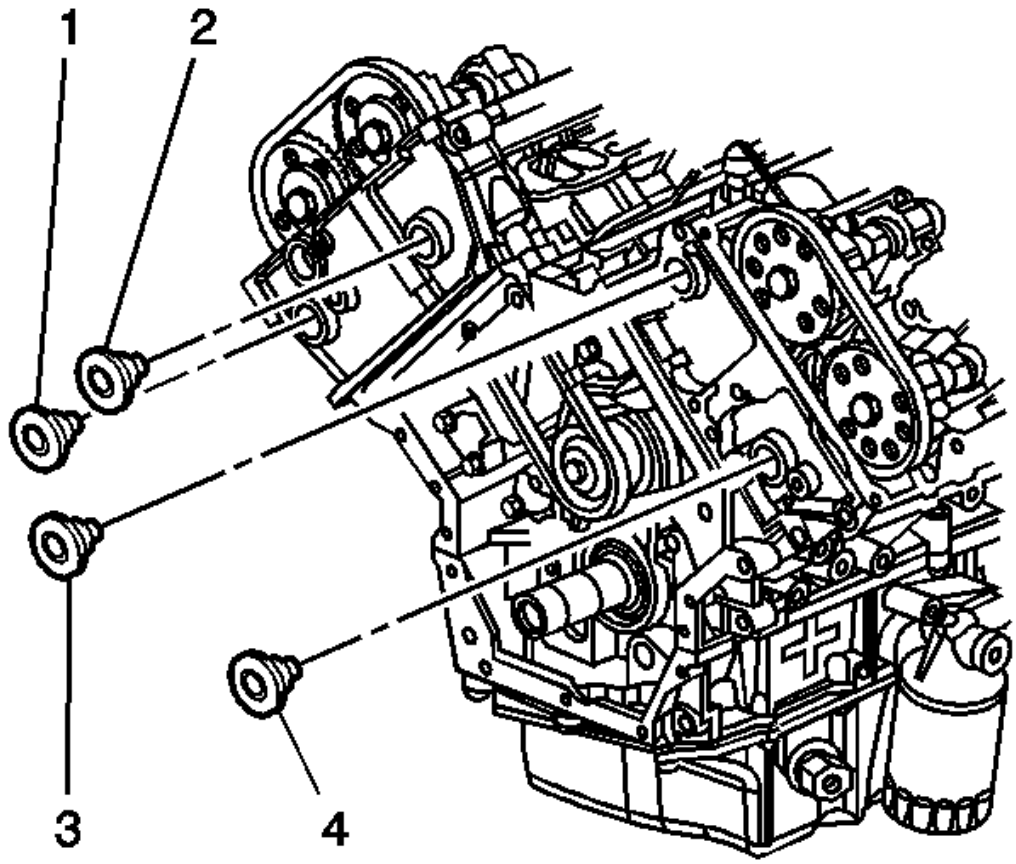


Fig. 200: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

3. Install the right secondary camshaft drive chain shoe access plug (1) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

   Tighten

   Tighten the secondary camshaft drive chain shoe access plug to 4.5 N.m (40 lb in).

4. Install the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

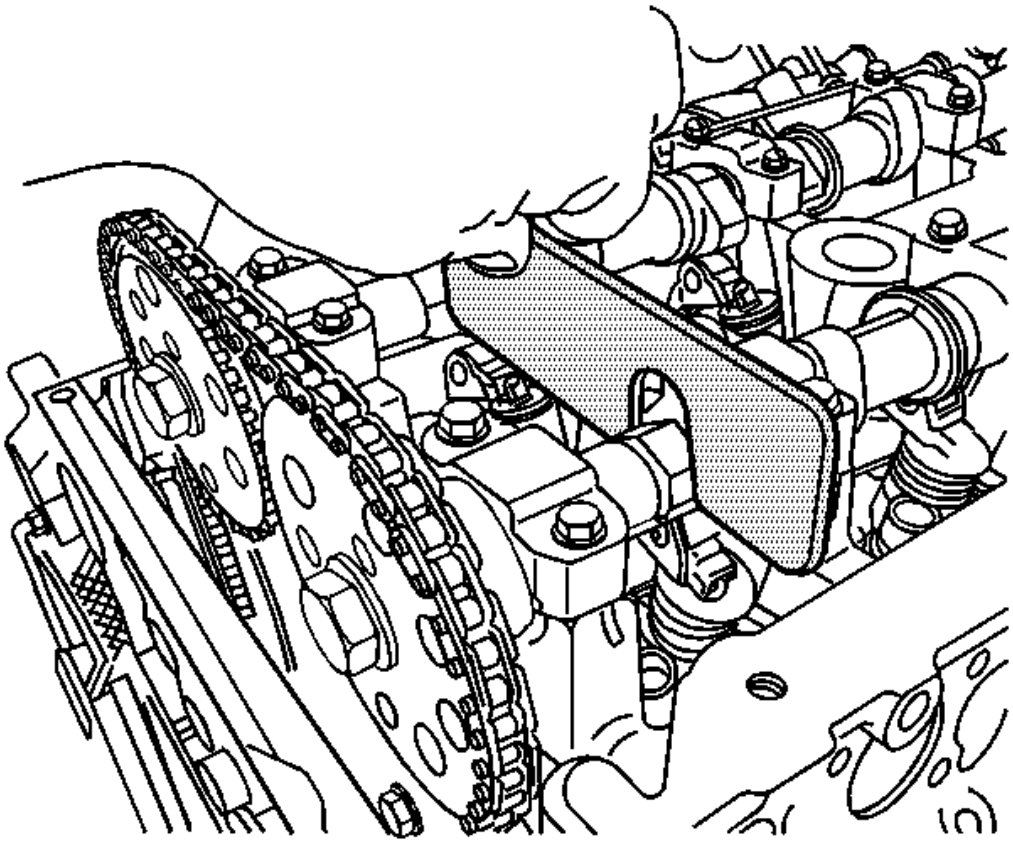


Fig. 201: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **J 44212** from the camshafts.
6. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

Special Tools

J 44212 Camshaft Holding Tool

Removal Procedure

1. Remove the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**.
2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

 © 2011 Mitchell Repair Information Company, LLC.

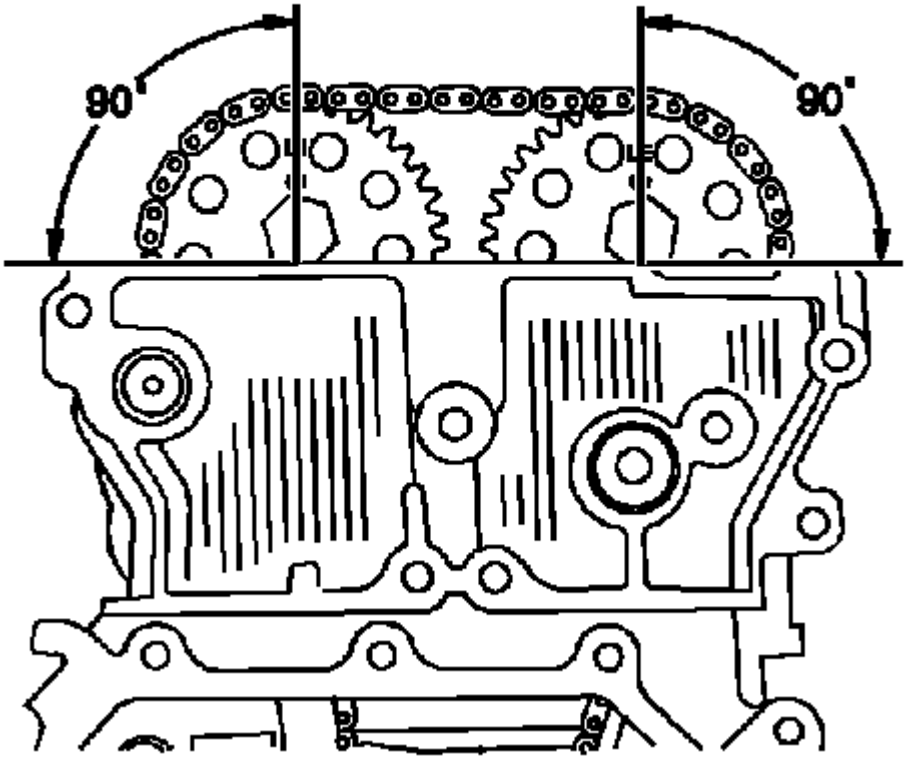


Fig. 202: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

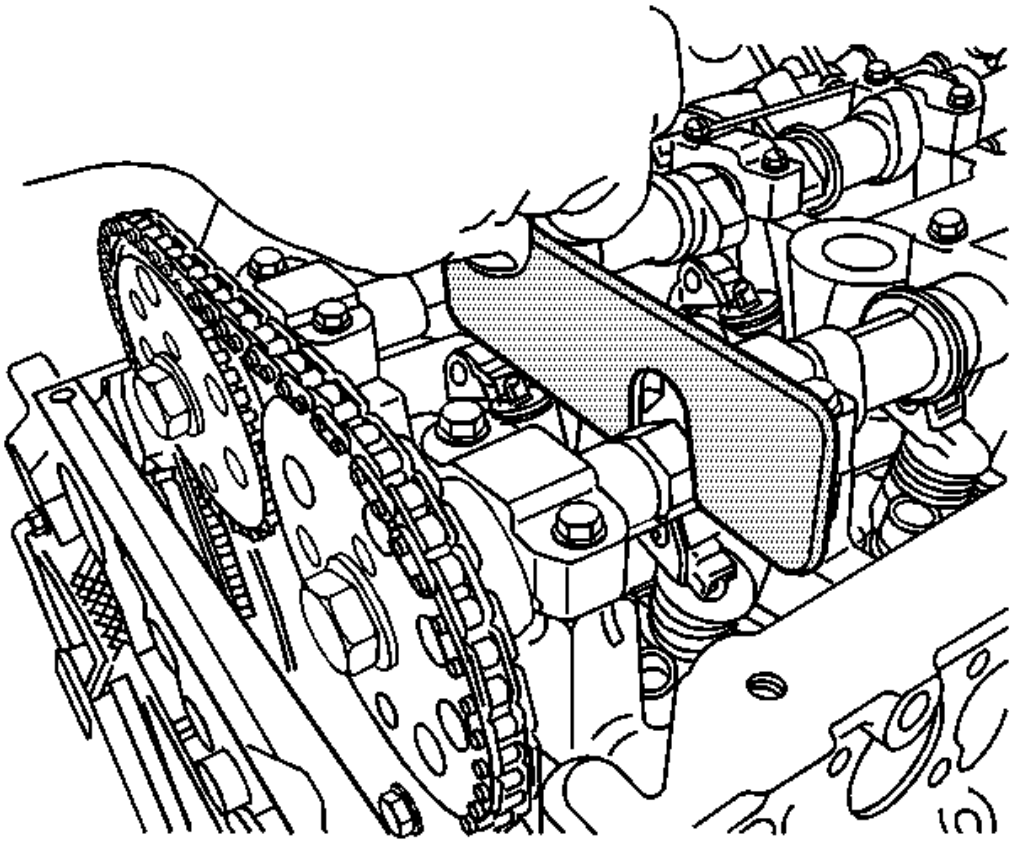


Fig. 203: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: The camshaft holding tools must be installed on the camshafts to prevent camshaft rotation. When performing service to the valve train and/or timing components, valve spring pressure can cause the camshafts to rotate unexpectedly and can cause personal injury.

4. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

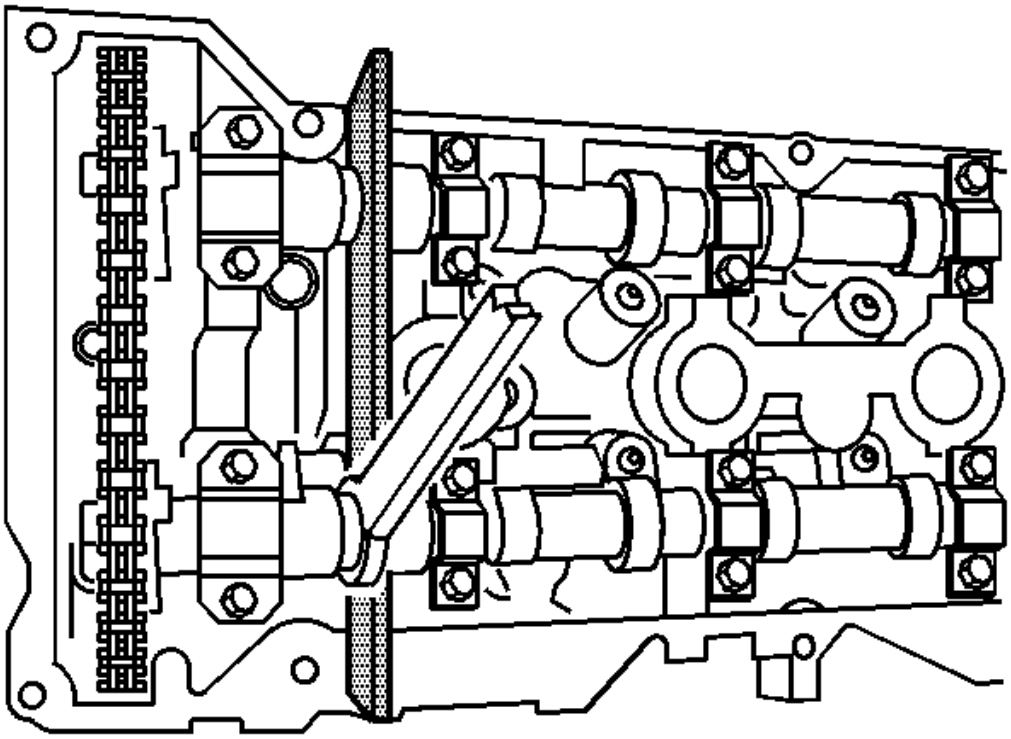


Fig. 204: Securing Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

5. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

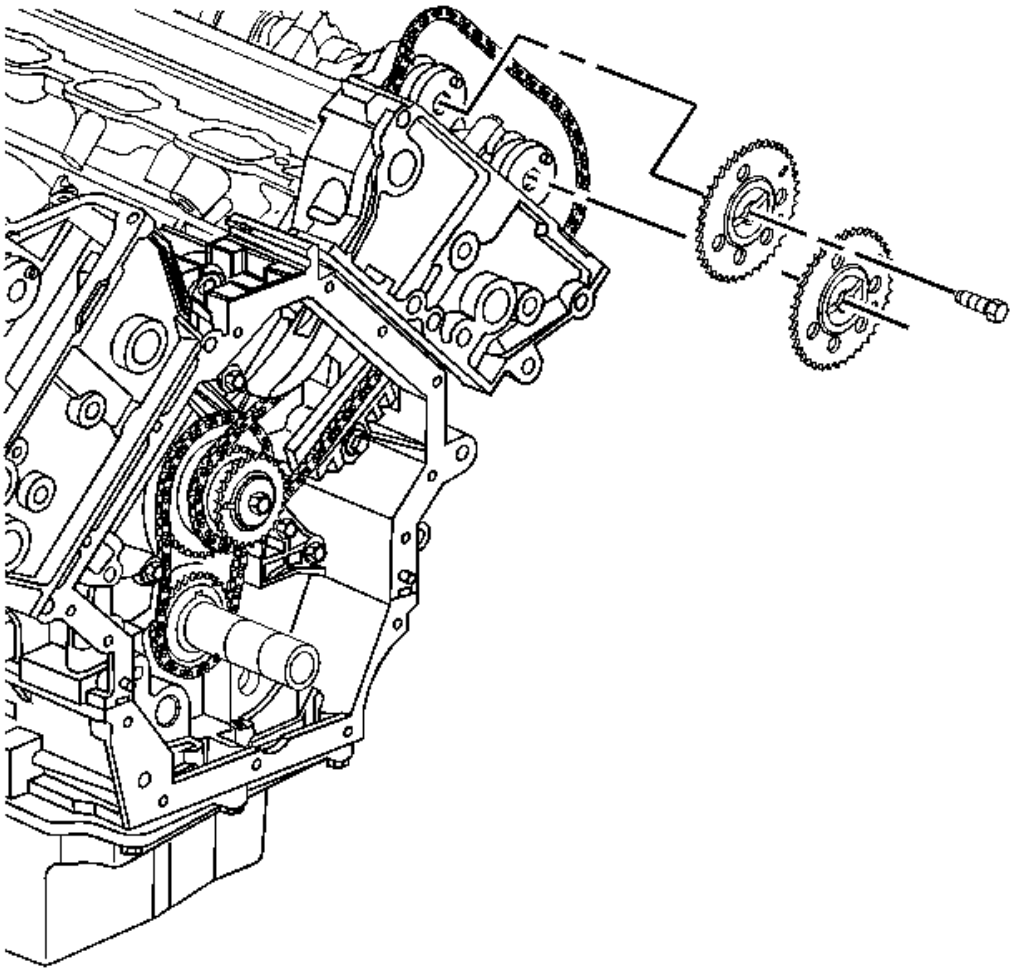


Fig. 205: Identifying Left Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the left exhaust camshaft sprocket bolt.
7. Slide the left exhaust camshaft sprocket off of the camshaft and remove the left secondary drive chain from the camshaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

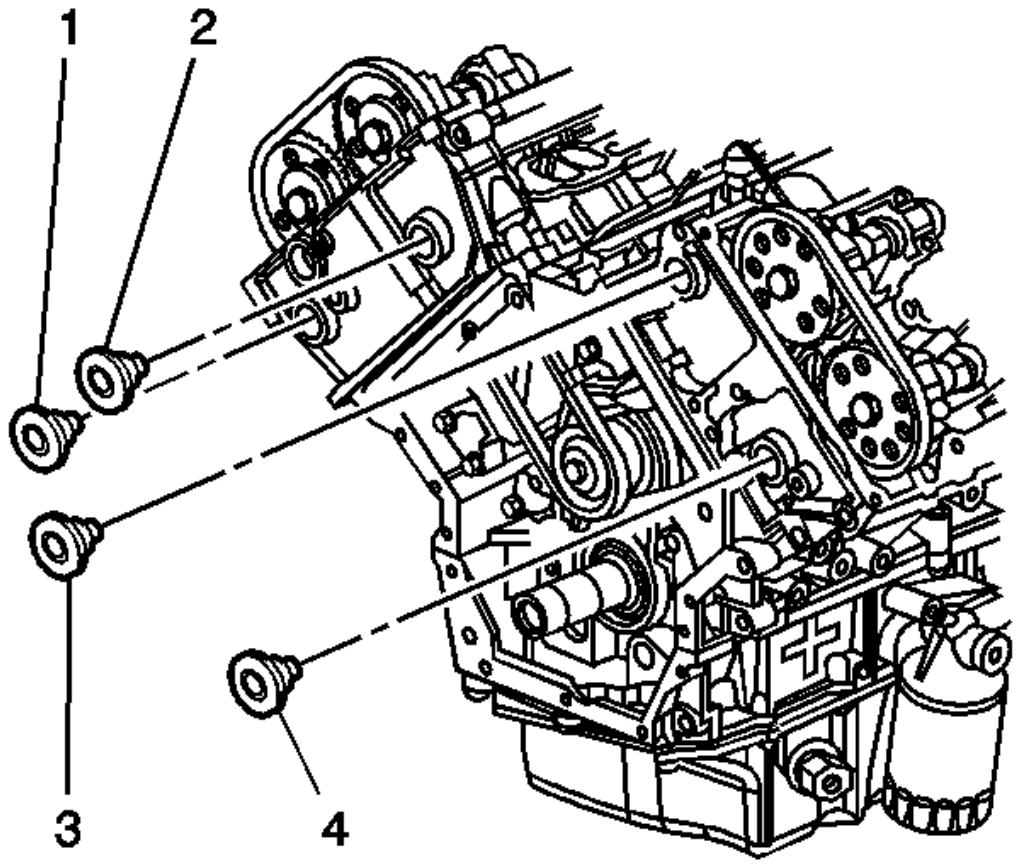


Fig. 206: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

8. Remove the left secondary camshaft drive chain guide access plug (4) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

 © 2011 Mitchell Repair Information Company, LLC.

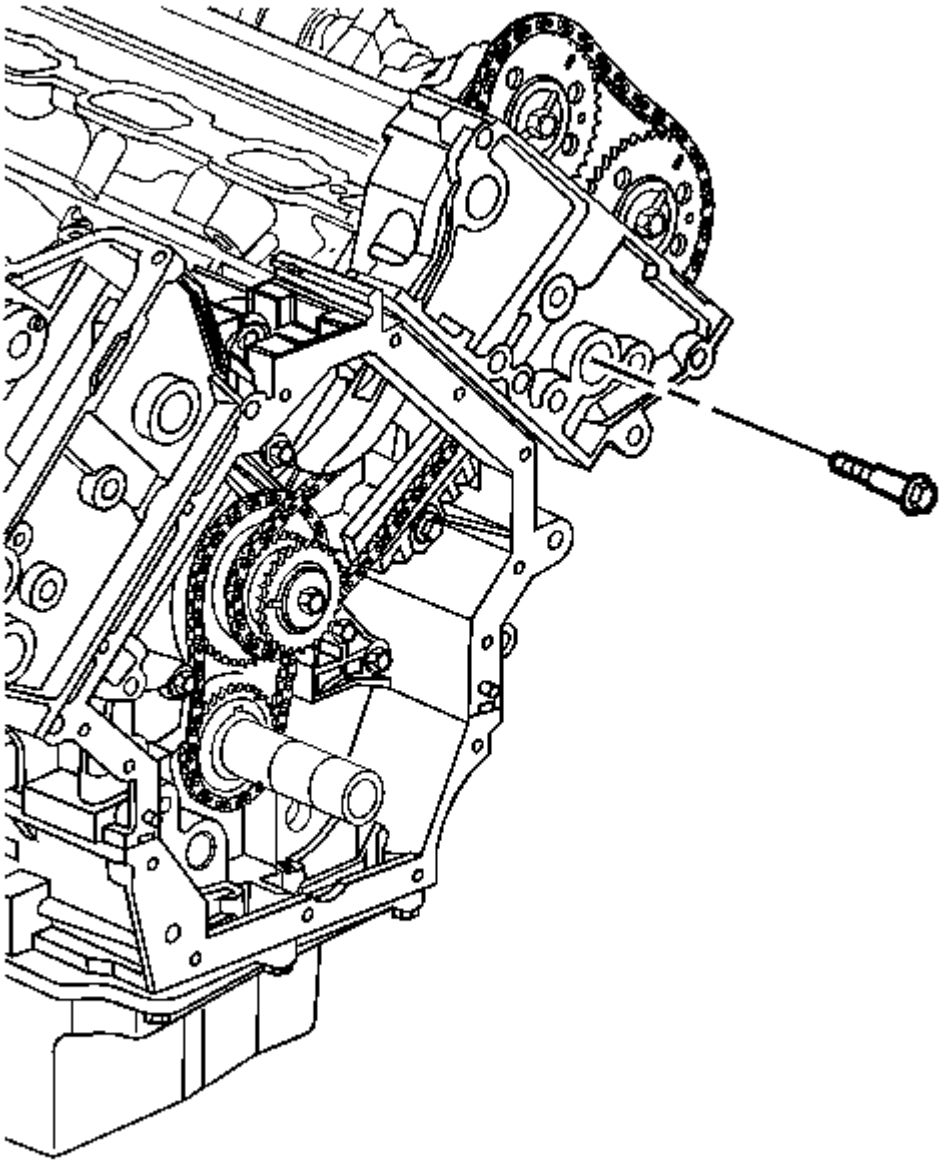


Fig. 207: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the upper left secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

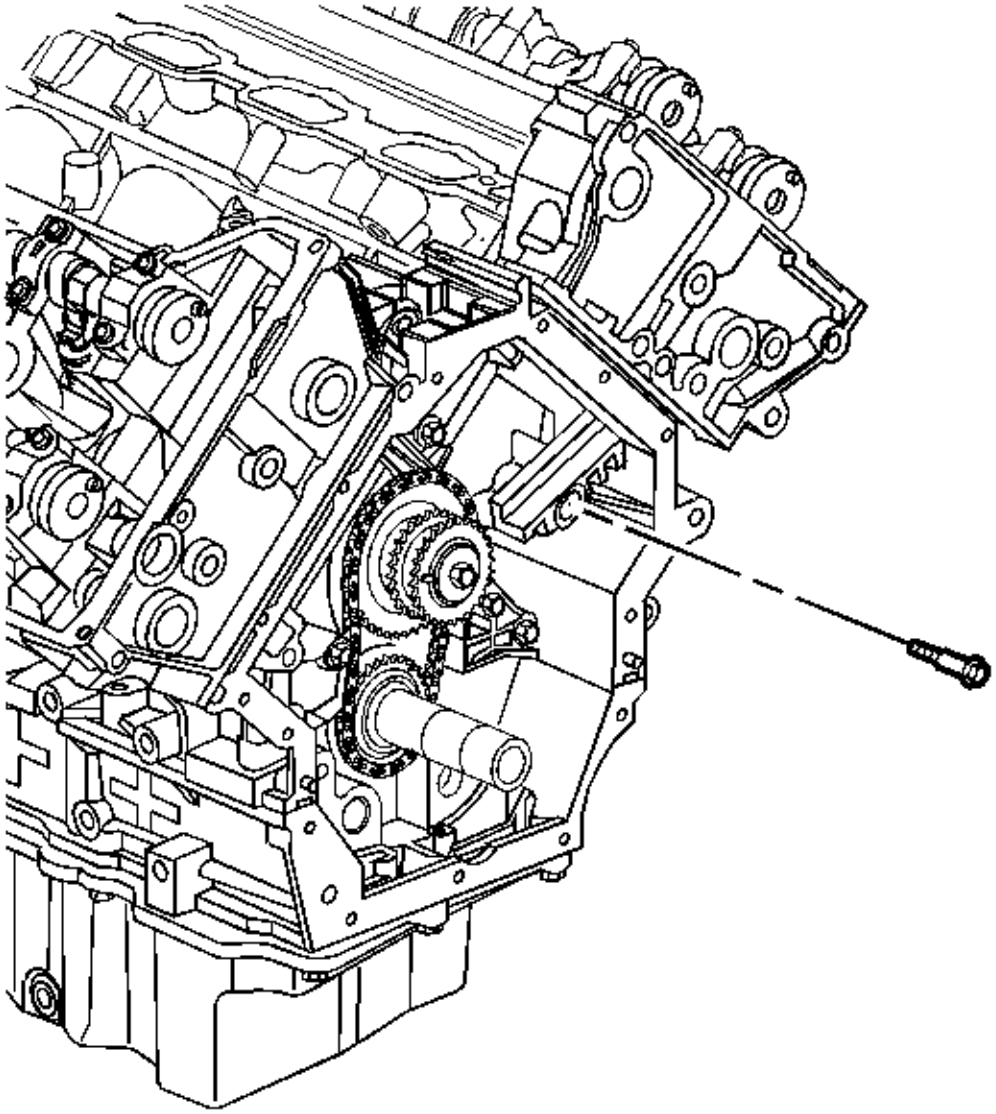


Fig. 208: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the lower left secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

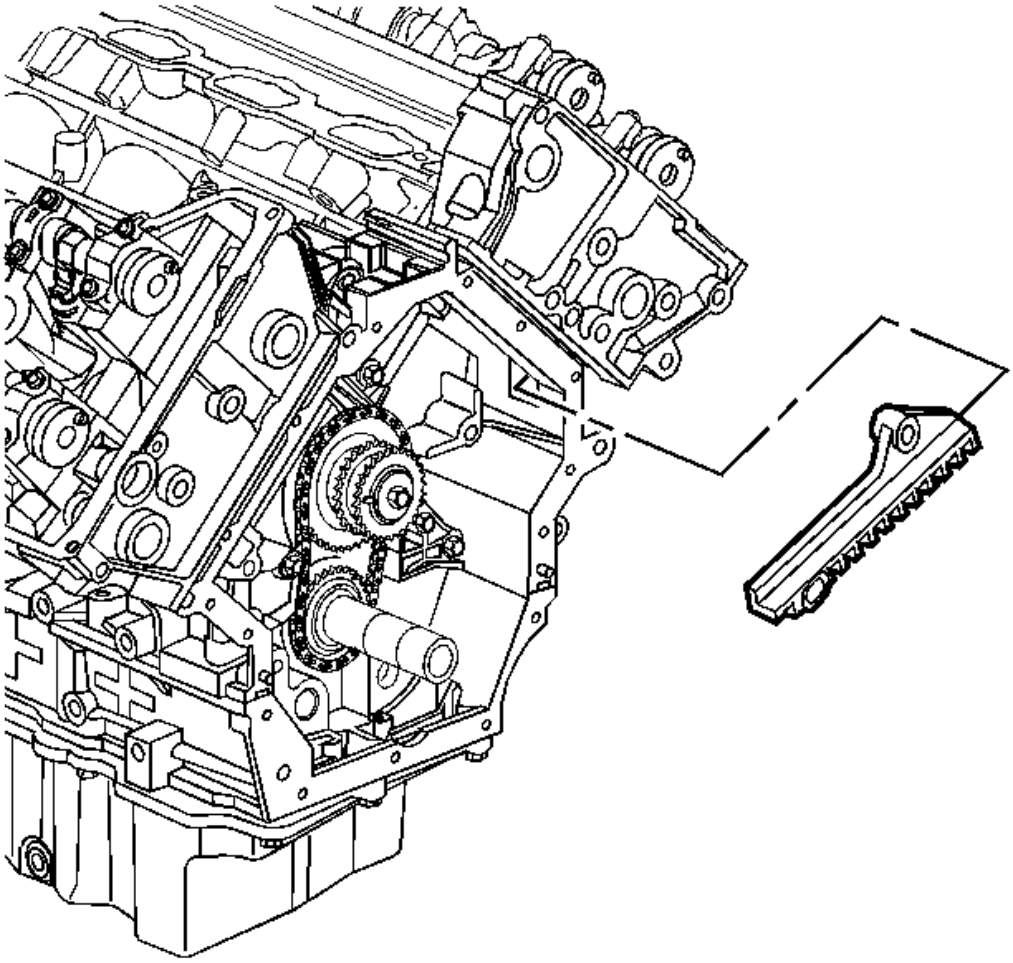


Fig. 209: Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

11. Remove the left secondary camshaft drive chain guide.
12. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

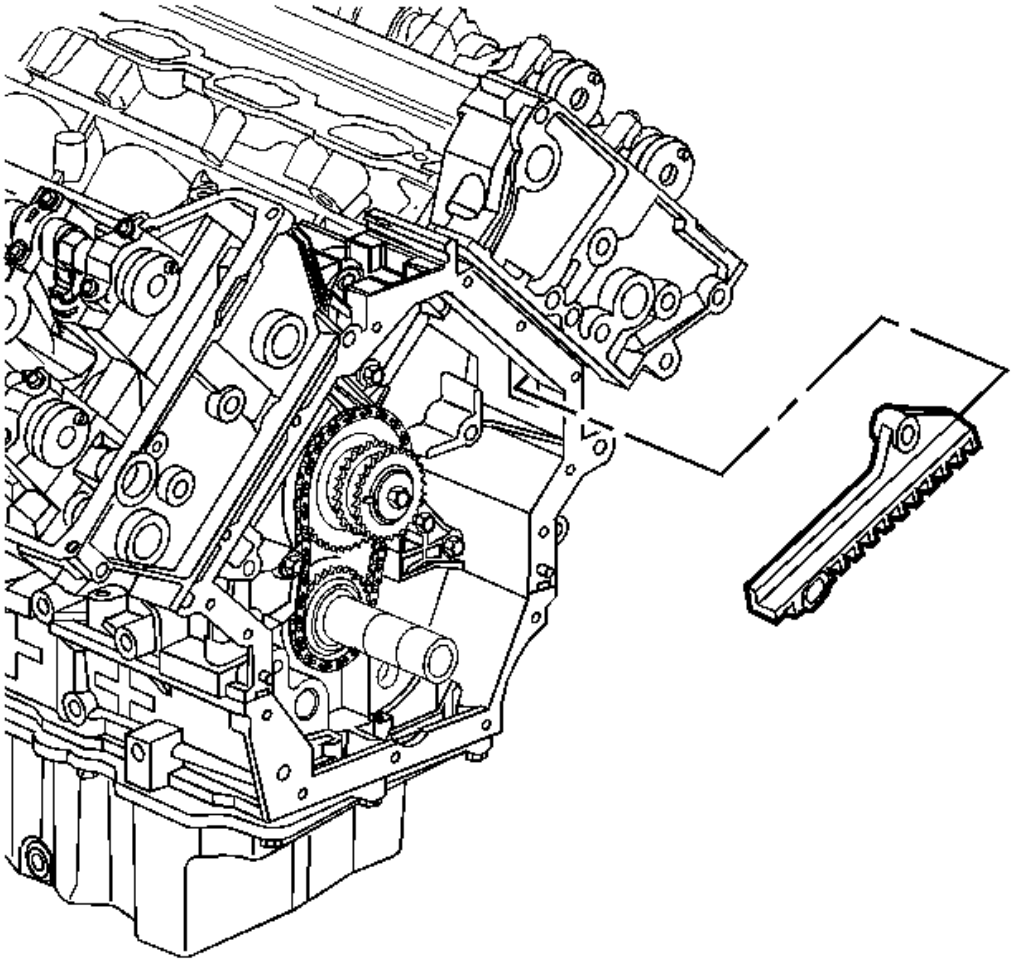


Fig. 210: Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Position the left secondary camshaft drive chain guide in through the top of the cylinder head.

 © 2011 Mitchell Repair Information Company, LLC.

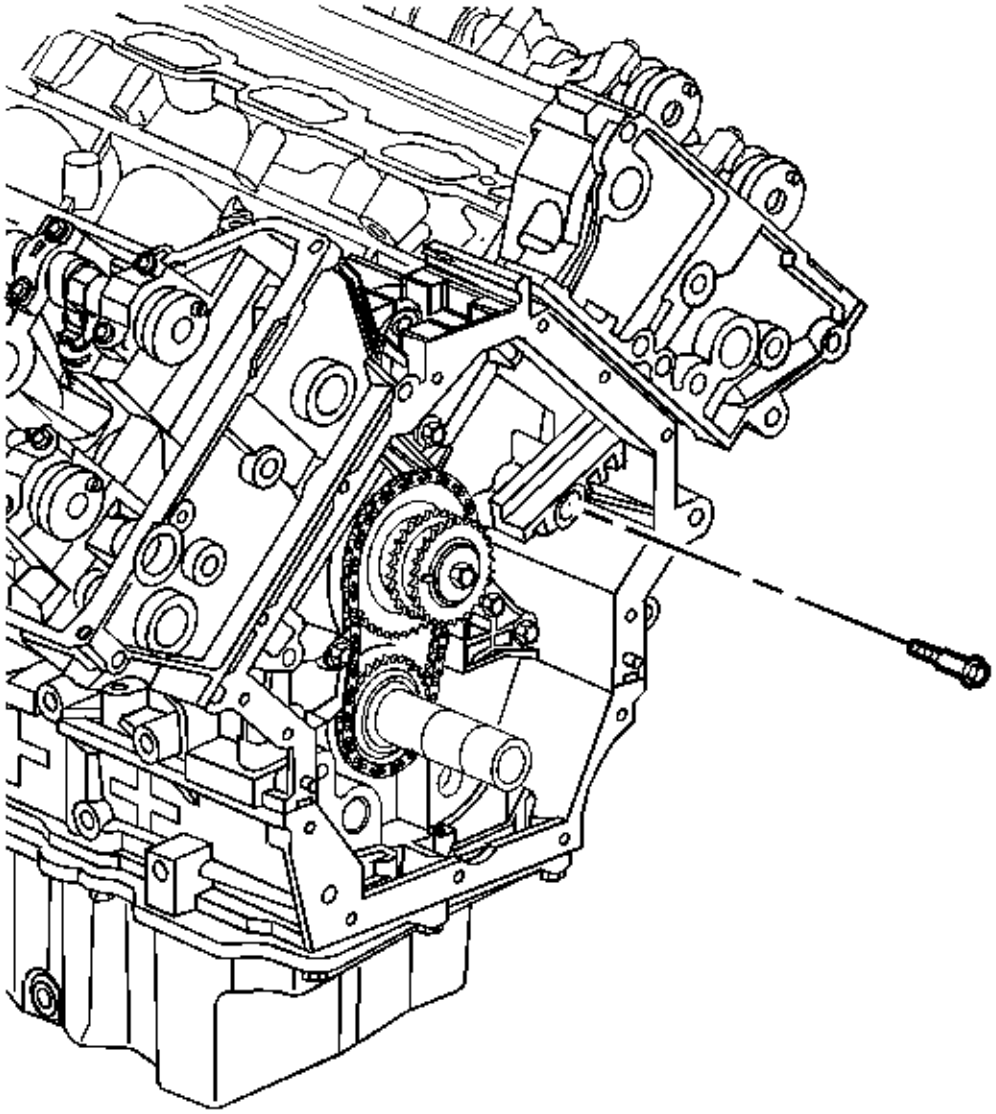


Fig. 211: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosely install the lower left secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

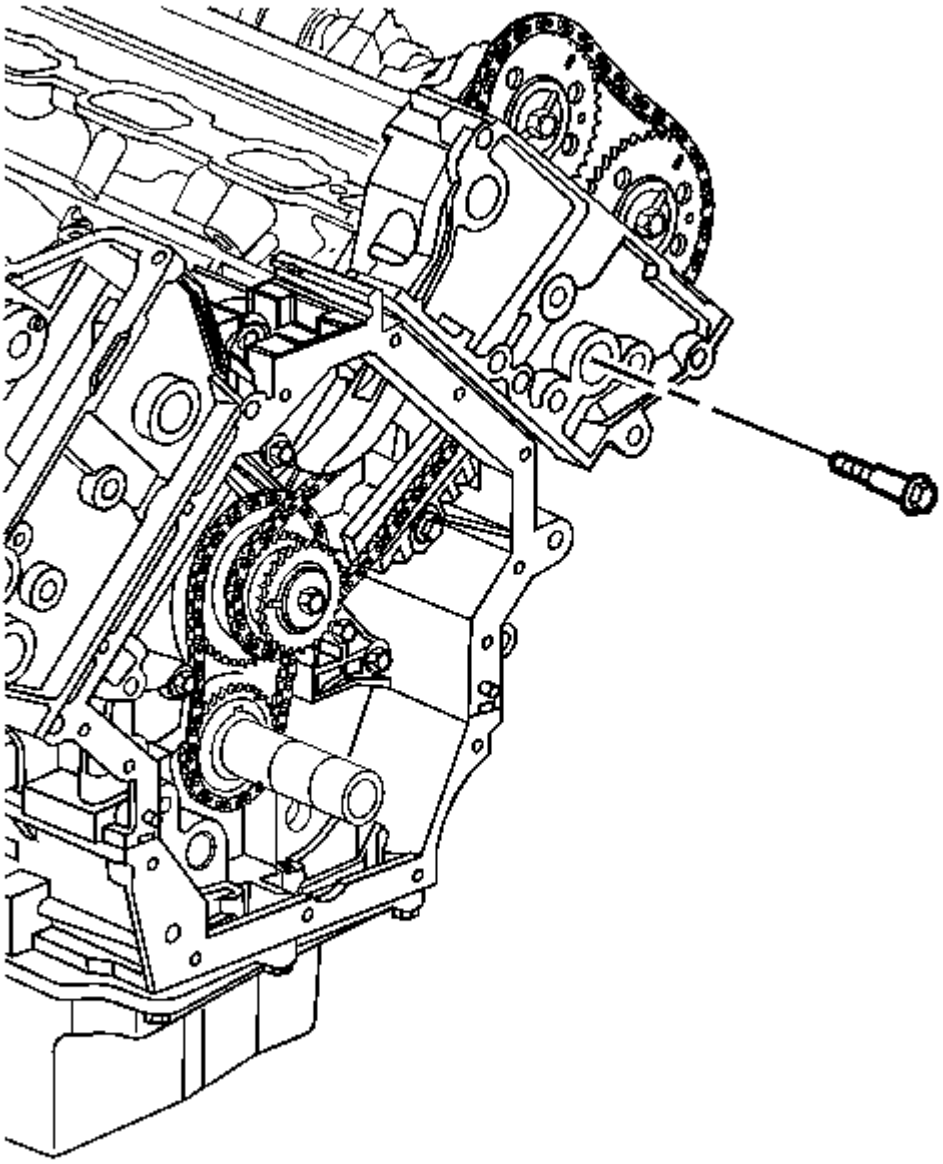


Fig. 212: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

3. Install the upper left secondary camshaft drive chain guide bolt.

   Tighten

   Tighten the secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

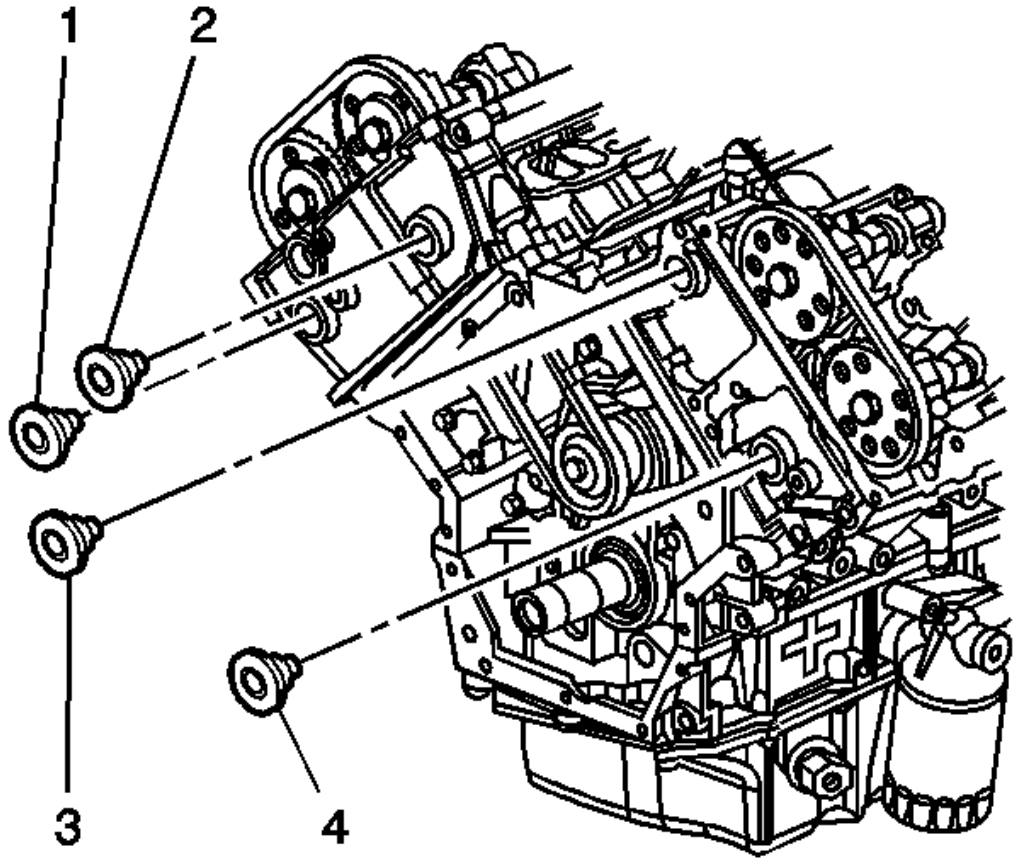


Fig. 213: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

4. Install the left secondary camshaft drive chain guide access plug (4) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

   Tighten

   Tighten the secondary camshaft drive chain guide access plug to 4.5 N.m (40 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

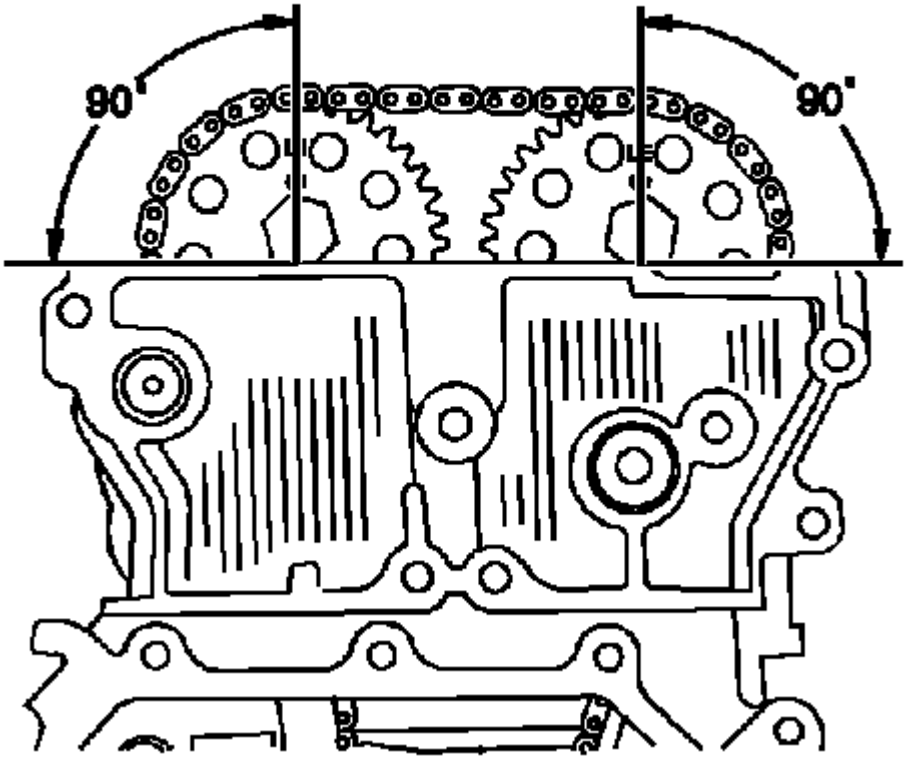


Fig. 214: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

5. Install the left exhaust camshaft sprocket into the left secondary camshaft drive chain.
6. Install the left exhaust camshaft sprocket onto the camshaft. The camshaft sprocket notch marked LE (left exhaust) engages the exhaust camshaft pin.

 © 2011 Mitchell Repair Information Company, LLC.

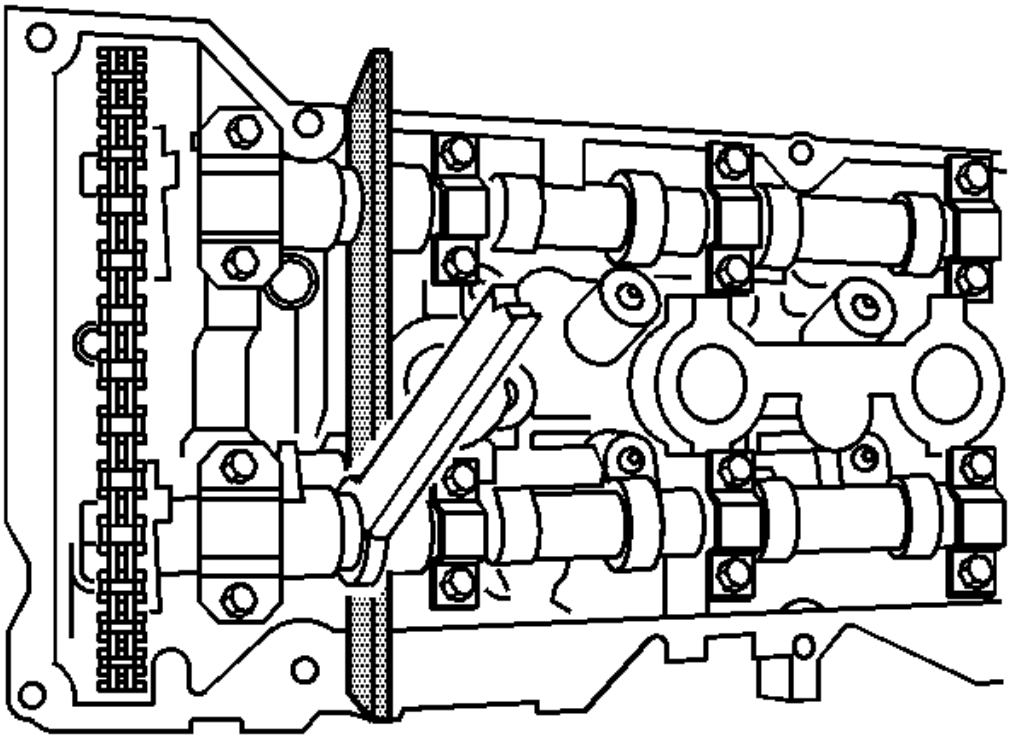


Fig. 215: Securing Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

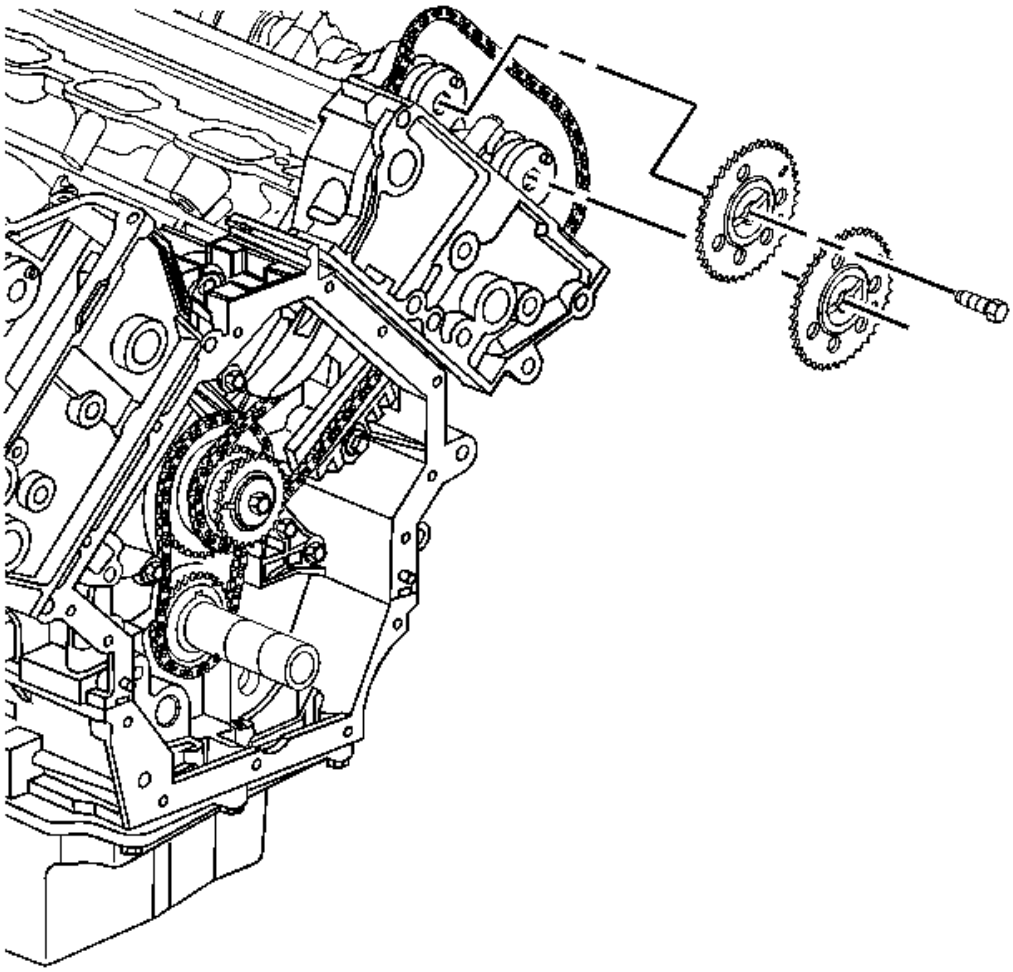


Fig. 216: Identifying Left Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the left exhaust camshaft sprocket bolt.

   Tighten

   Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

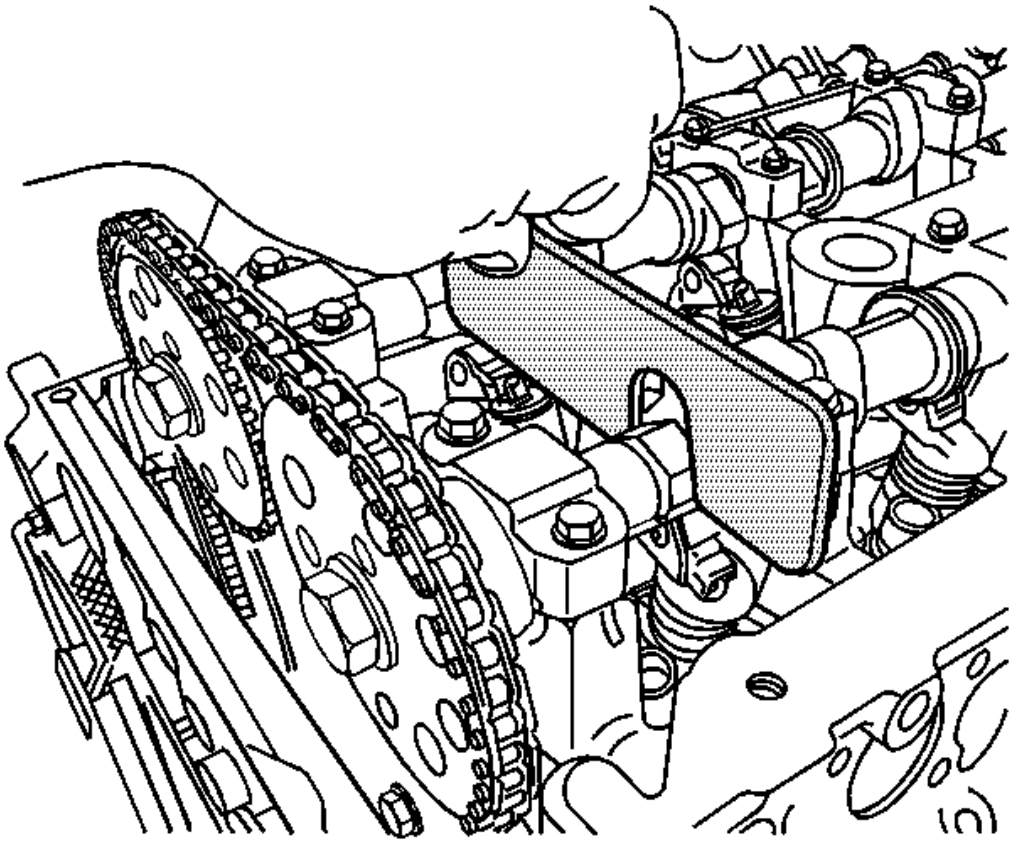


Fig. 217: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **J 44212** from the camshafts.
10. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
11. Install the left secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

Special Tools

J 44212 Camshaft Holding Tool

Removal Procedure

1. Remove the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate**

 © 2011 Mitchell Repair Information Company, LLC.

Drive Chain Tensioner Replacement - Right Side.

2. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

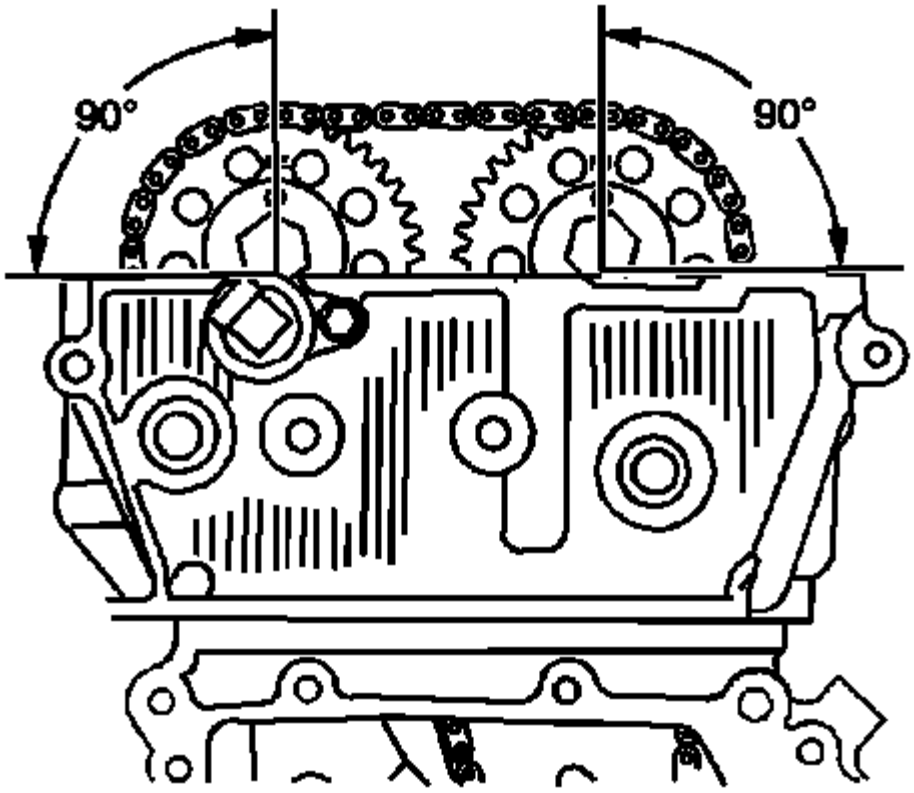


Fig. 218: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Ensure both camshaft sprocket drive pins are at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

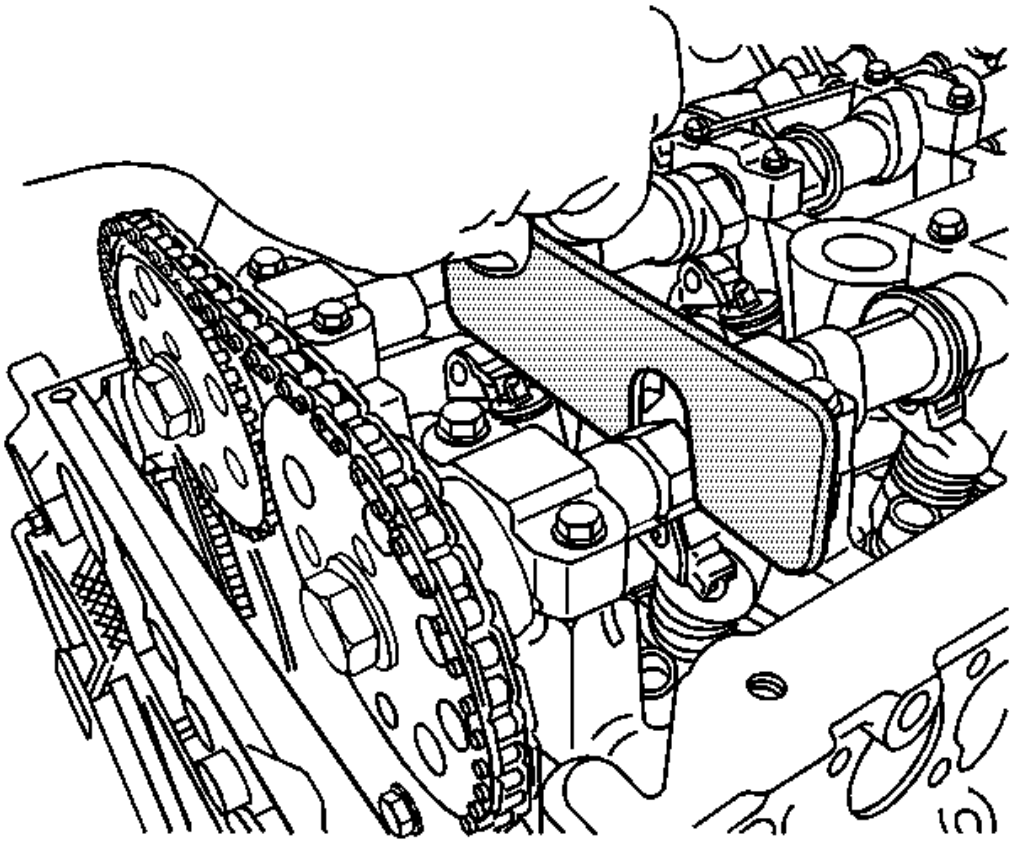


Fig. 219: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

4. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

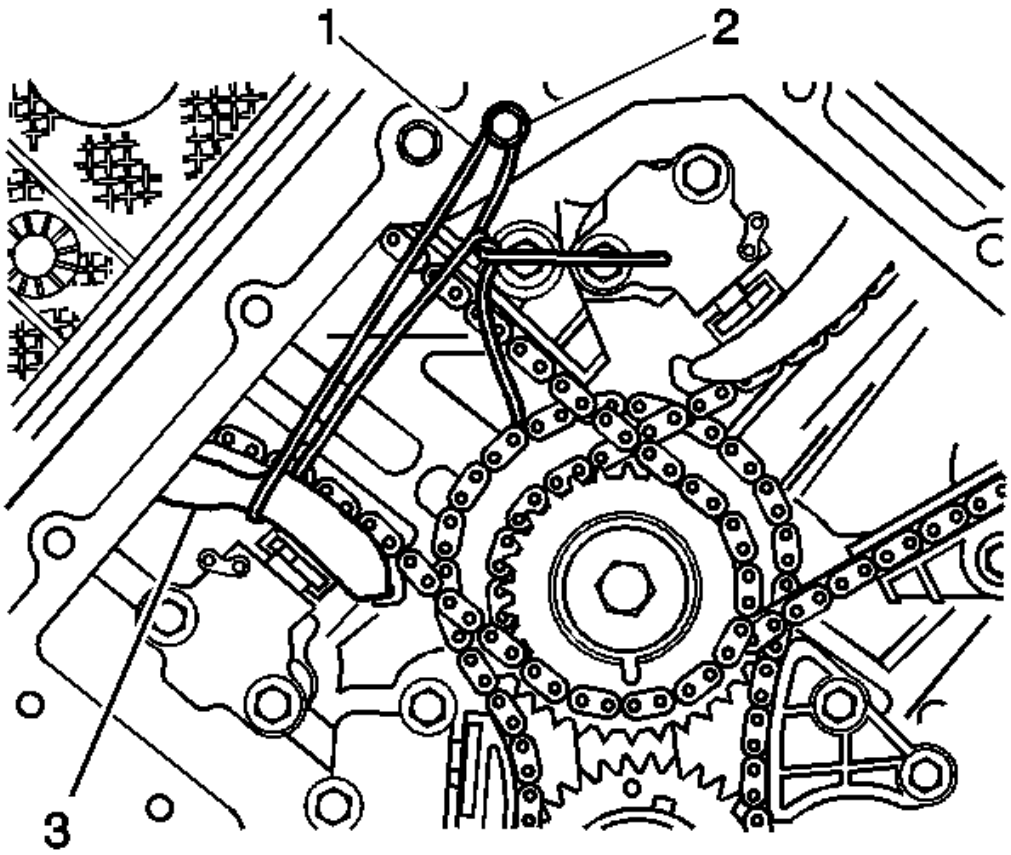


Fig. 220: View Of Mechanics Wire, Right Secondary Camshaft Drive Chain Shoe & Front Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the mechanics wire (1) supporting the right secondary camshaft drive chain shoe (3).
6. Remove the engine front cover bolt (2) from the front of the engine.

 © 2011 Mitchell Repair Information Company, LLC.

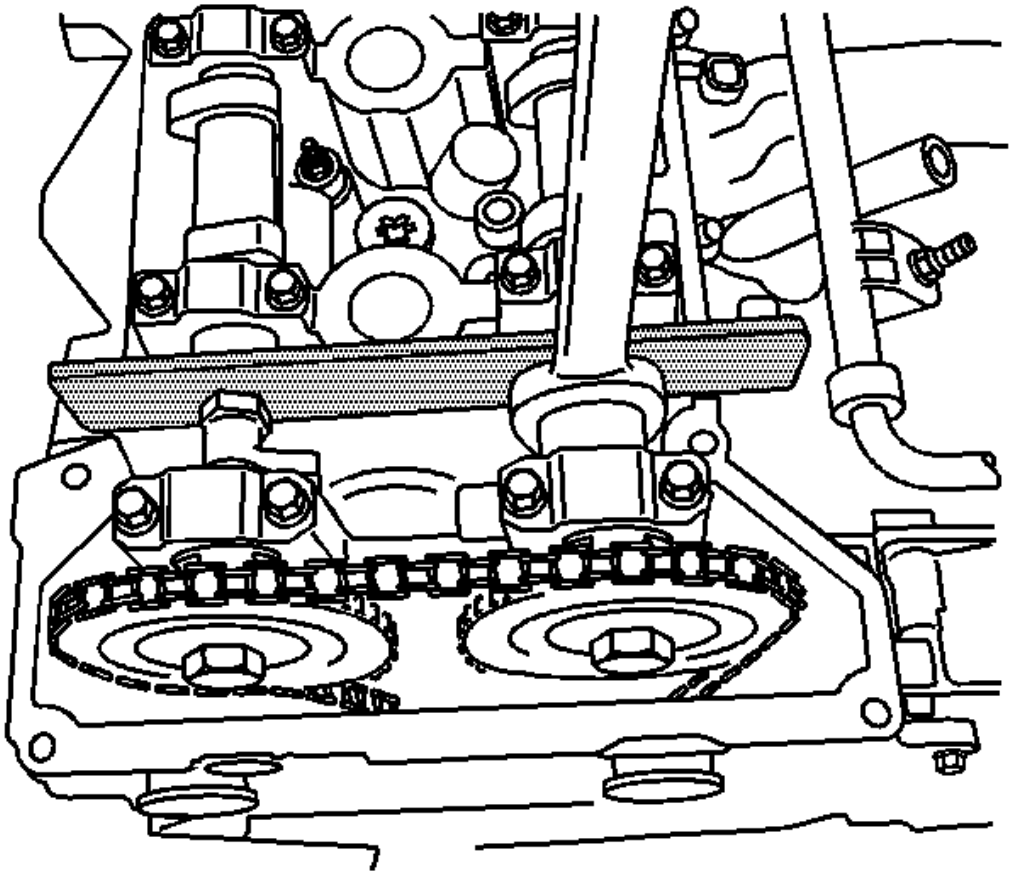


Fig. 221: Securing Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when removing the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

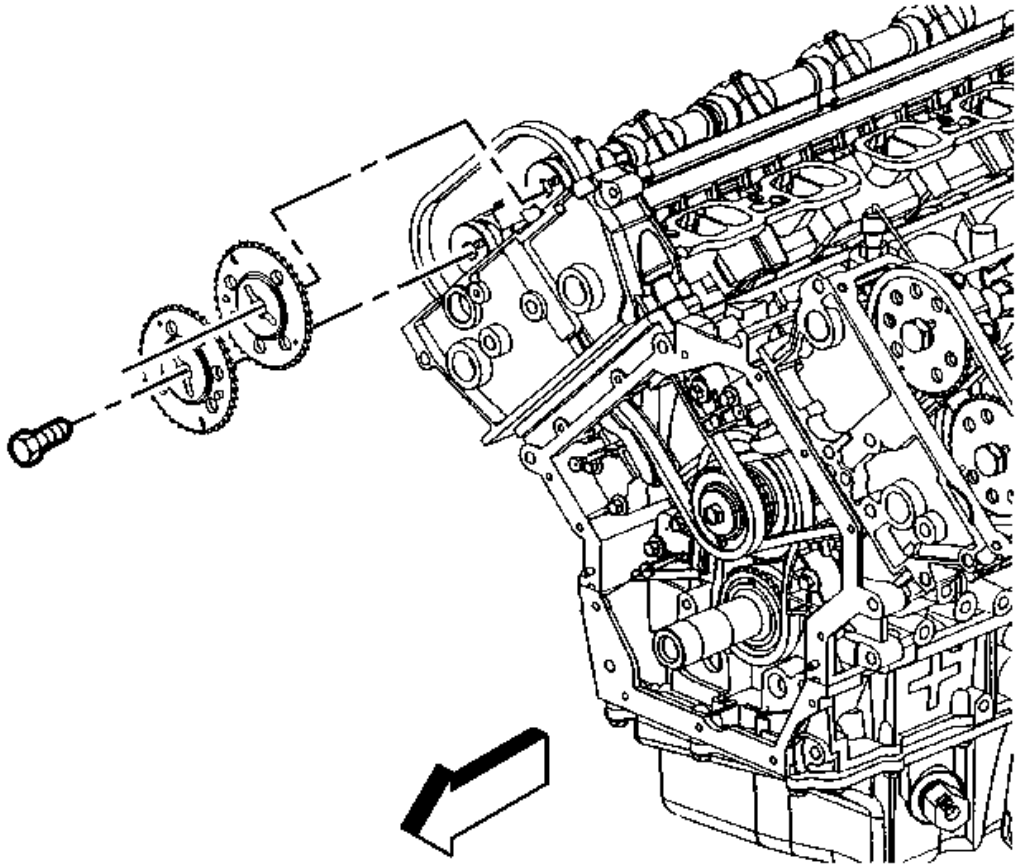


Fig. 222: Identifying Right Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the right intake camshaft sprocket bolt.
9. Slide the right intake camshaft sprocket off of the camshaft and remove the right secondary drive chain from the camshaft sprocket teeth.

 © 2011 Mitchell Repair Information Company, LLC.

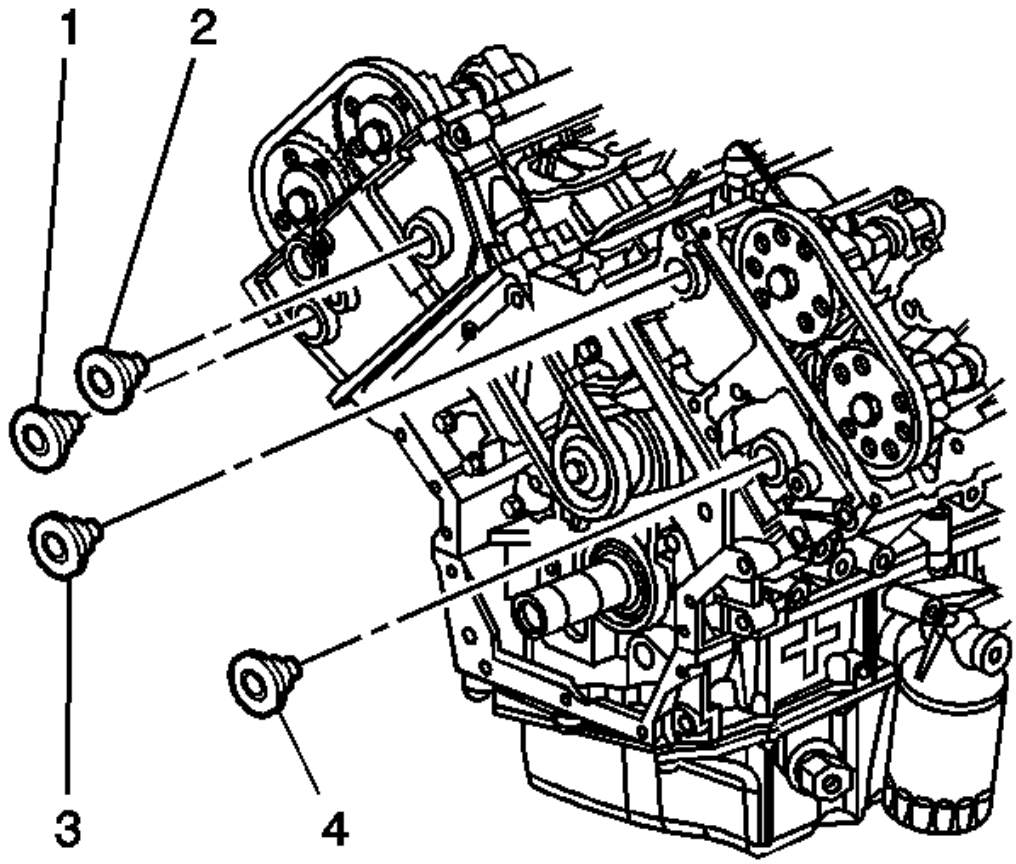


Fig. 223: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

10. Remove the right secondary camshaft drive chain guide access plug (2) located in the cylinder head. Ensure the O-ring seal remains attached to the access plug.

 © 2011 Mitchell Repair Information Company, LLC.

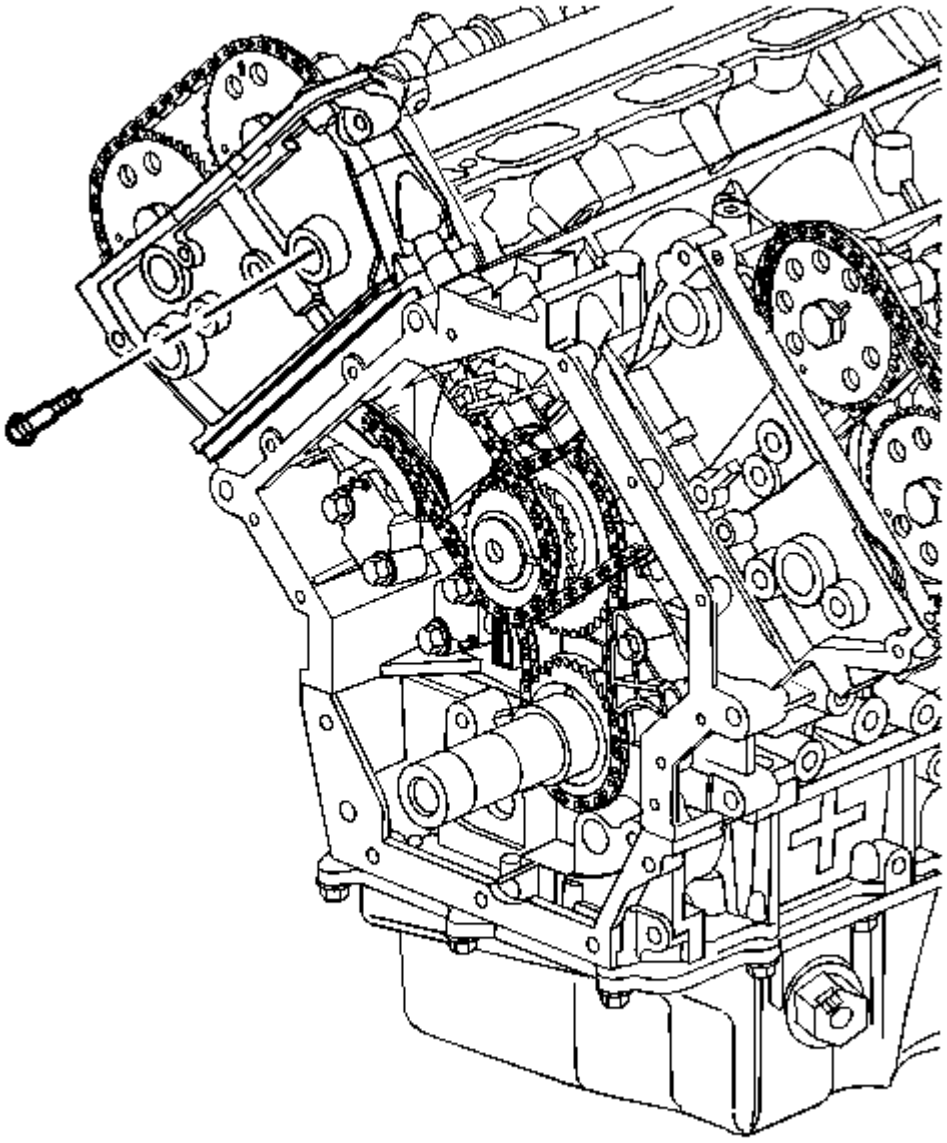


Fig. 224: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Remove the upper right secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

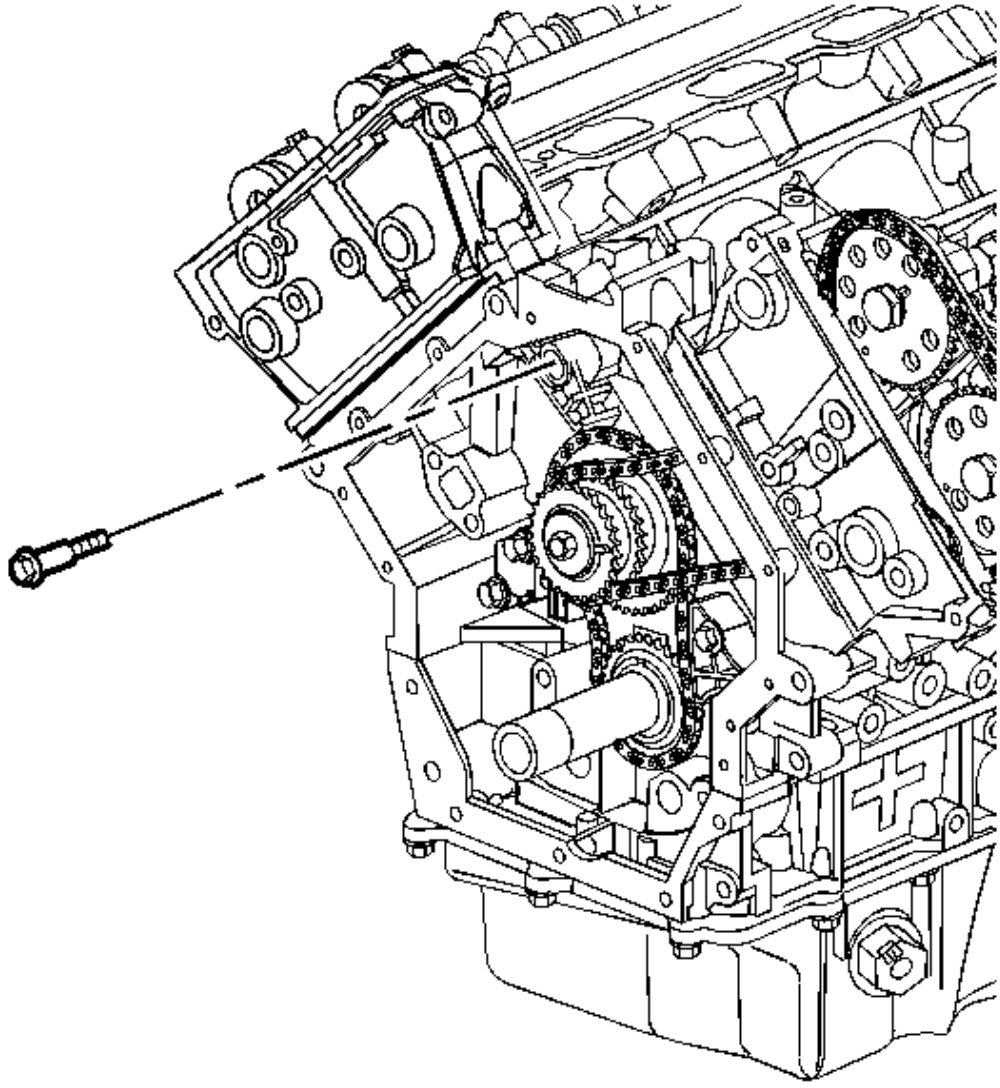


Fig. 225: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the lower right secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

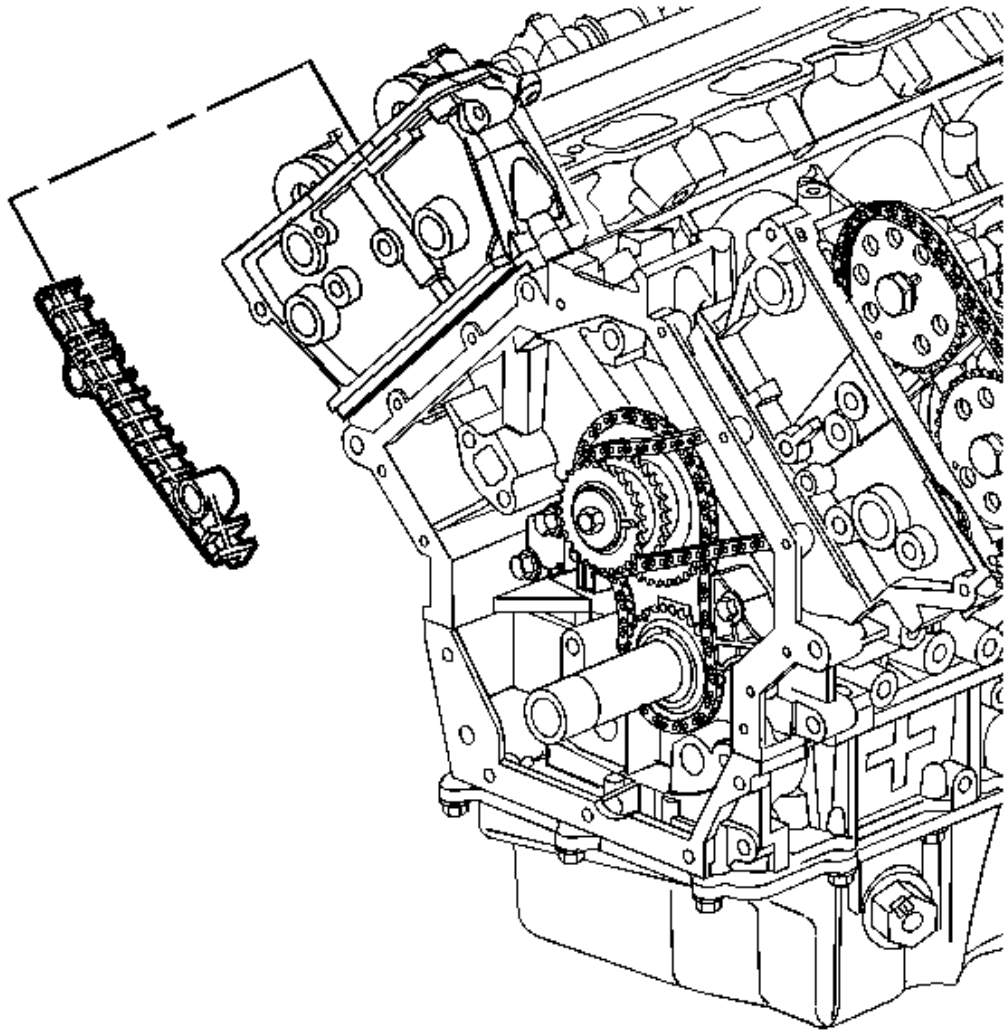


Fig. 226: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

13. Remove the right secondary camshaft drive chain guide.
14. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

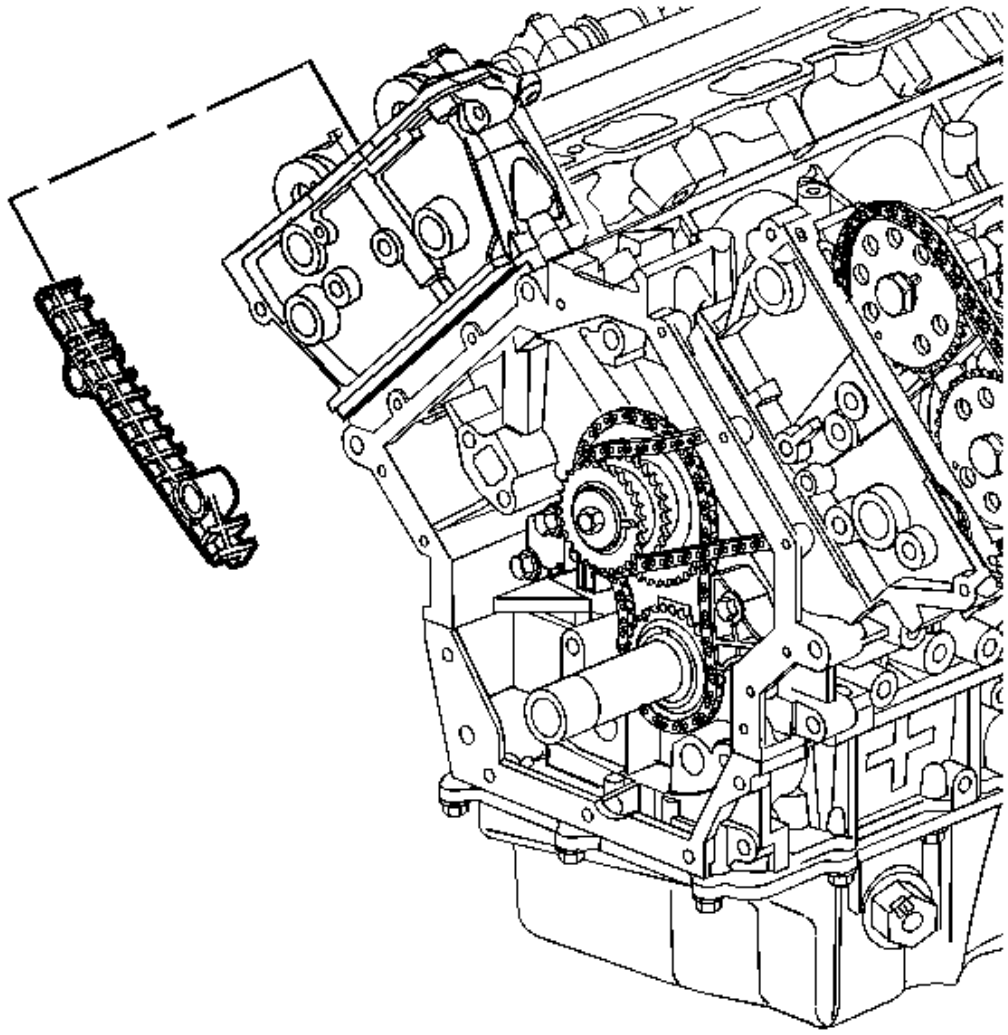


Fig. 227: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Position the right secondary camshaft drive chain guide in through the top of the cylinder head.

 © 2011 Mitchell Repair Information Company, LLC.

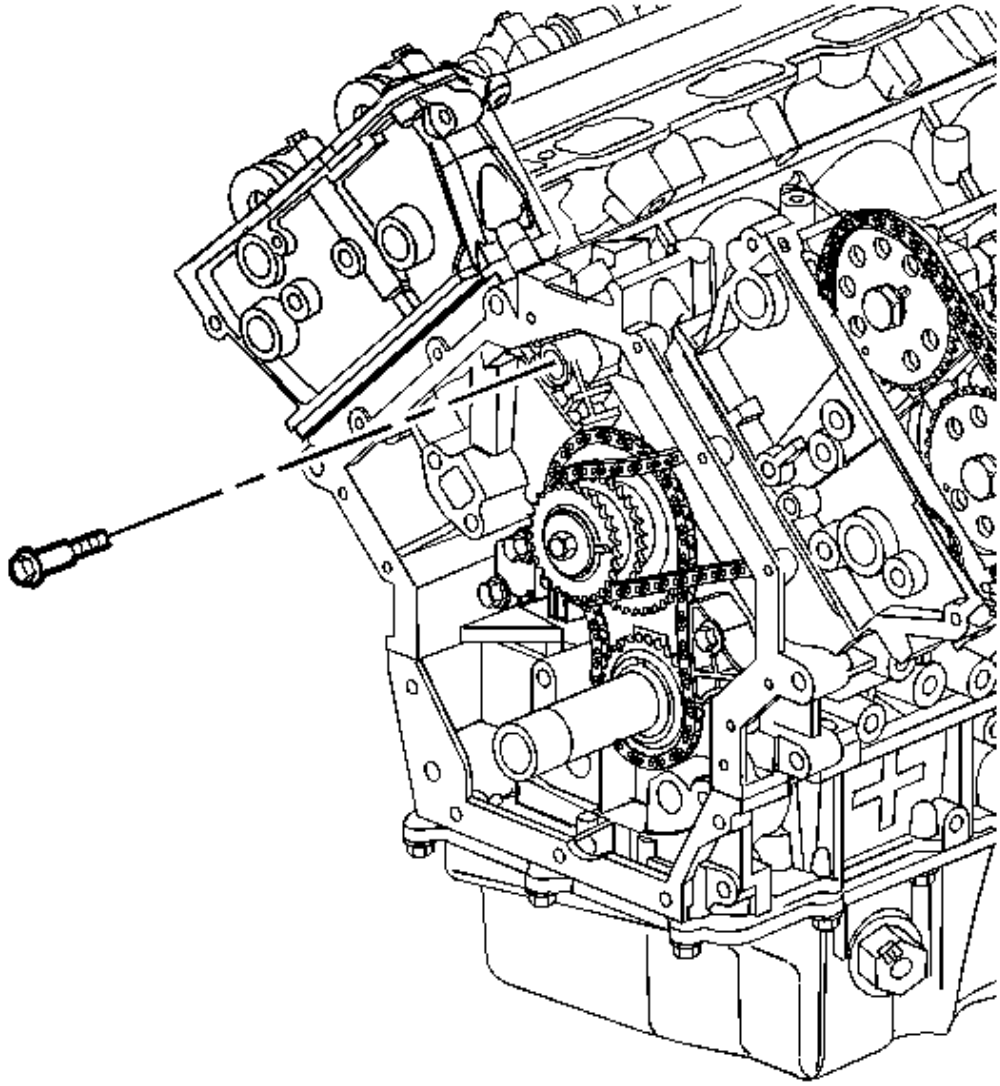


Fig. 228: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosely install the lower right secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

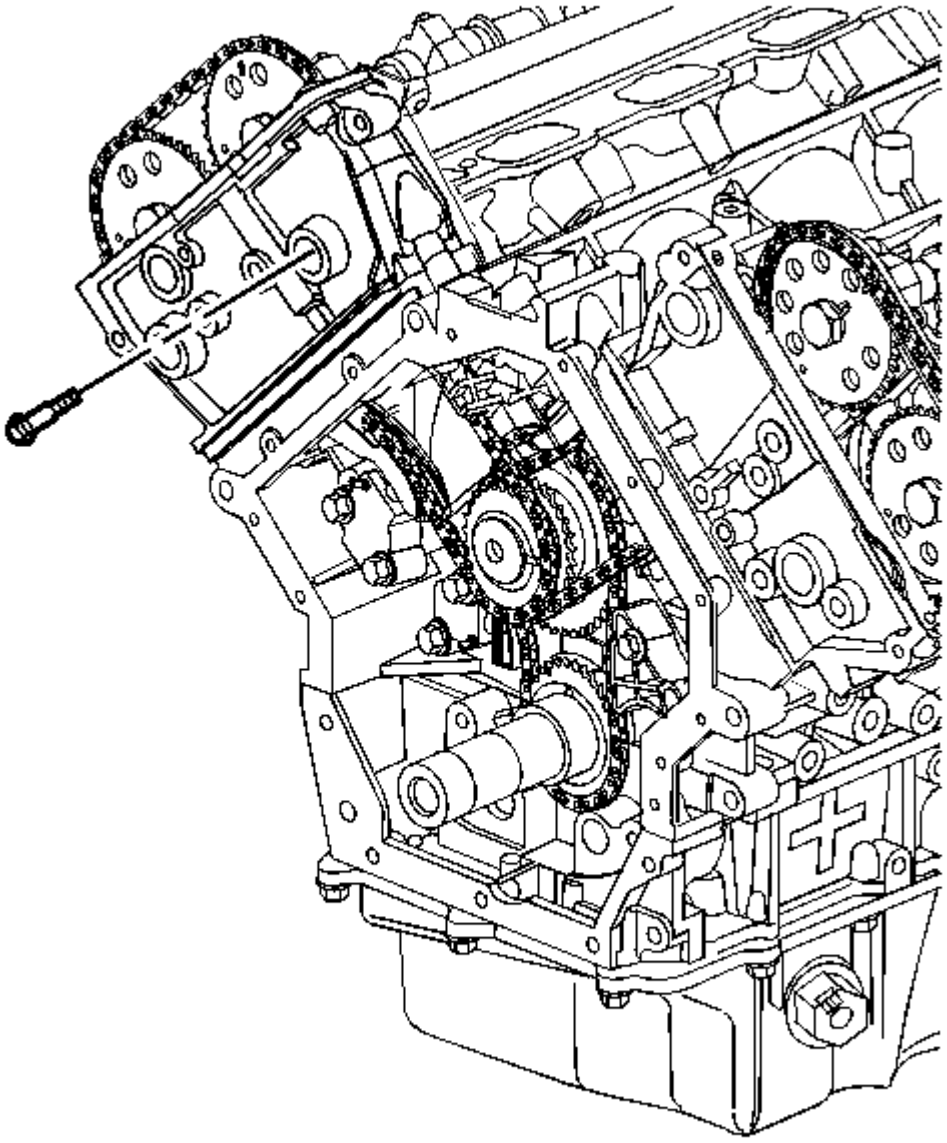


Fig. 229: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the upper right secondary camshaft drive chain guide bolt.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the secondary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

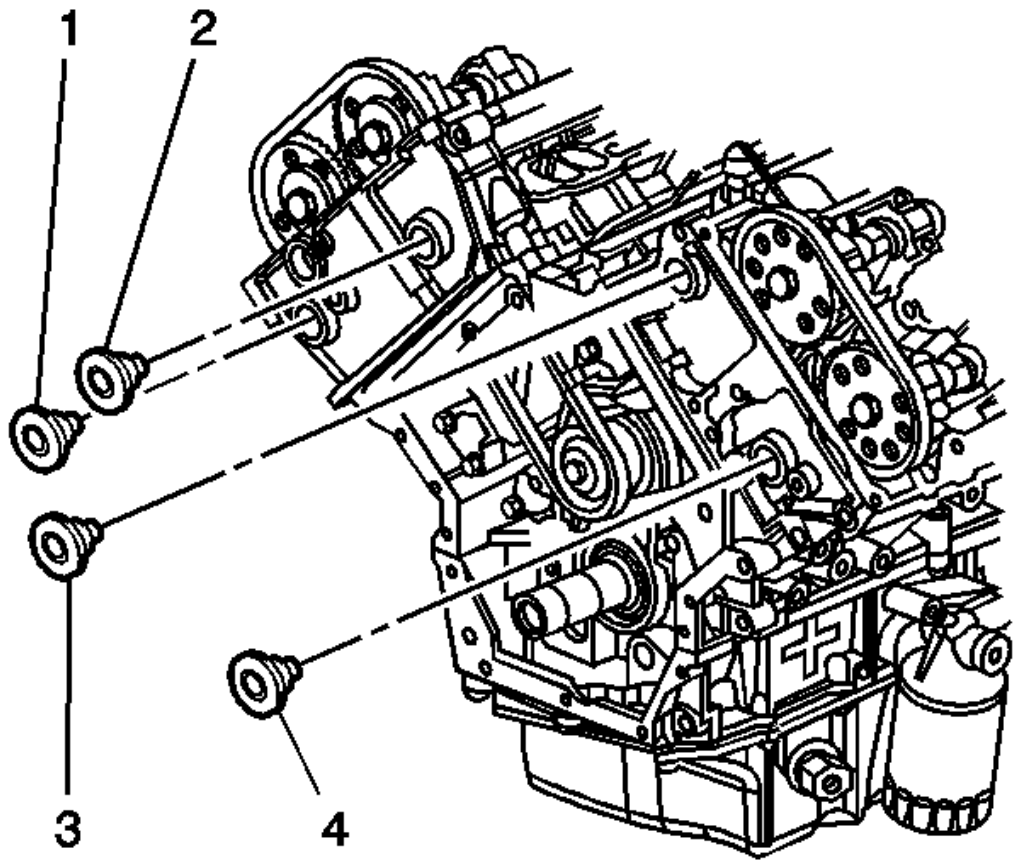


Fig. 230: Locating Camshaft Drive Chain Shoe Access Plugs On Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

4. Install the right secondary camshaft drive chain guide access plug (2) located in the cylinder head. Ensure the O-ring seal is attached to the access plug.

Tighten

Tighten the secondary camshaft drive chain guide access plug to 4.5 N.m (40 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

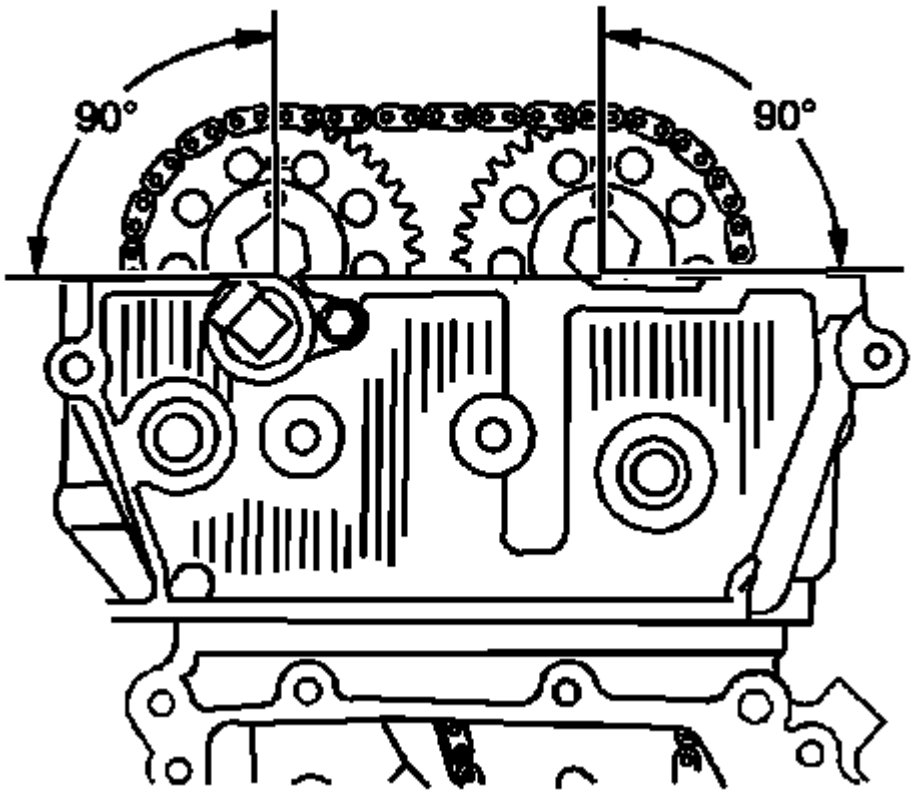


Fig. 231: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

5. Install the right intake camshaft sprocket into the right secondary camshaft drive chain.
6. Install the right intake camshaft sprocket onto the camshaft. The camshaft sprocket notch marked RI (right intake) engages the intake camshaft pin.

 © 2011 Mitchell Repair Information Company, LLC.

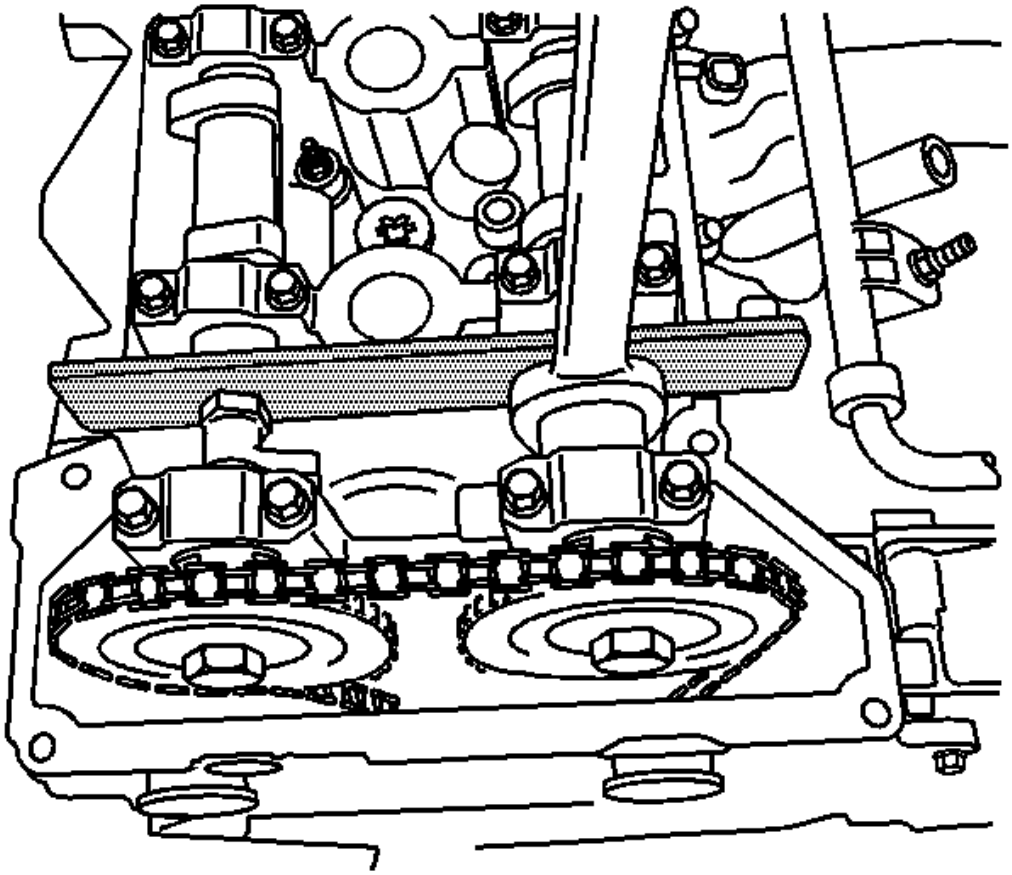


Fig. 232: Securing Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

7. Use an open end wrench on the hex cast into the camshaft in order to prevent the camshaft from rotating when tightening the camshaft sprocket bolt.

 © 2011 Mitchell Repair Information Company, LLC.

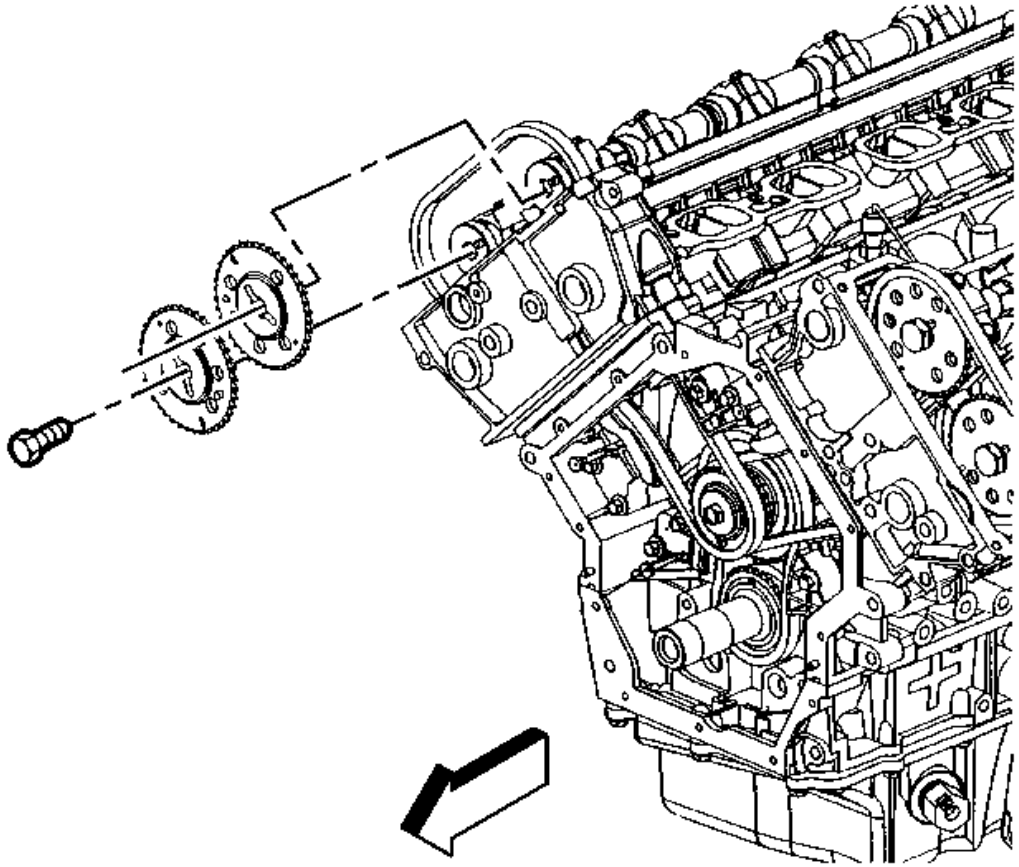


Fig. 233: Identifying Right Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the right intake camshaft sprocket bolt.

   Tighten

   Tighten the camshaft sprocket bolt to 120 N.m (89 lb ft).

9. Install the right secondary camshaft drive chain tensioner. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

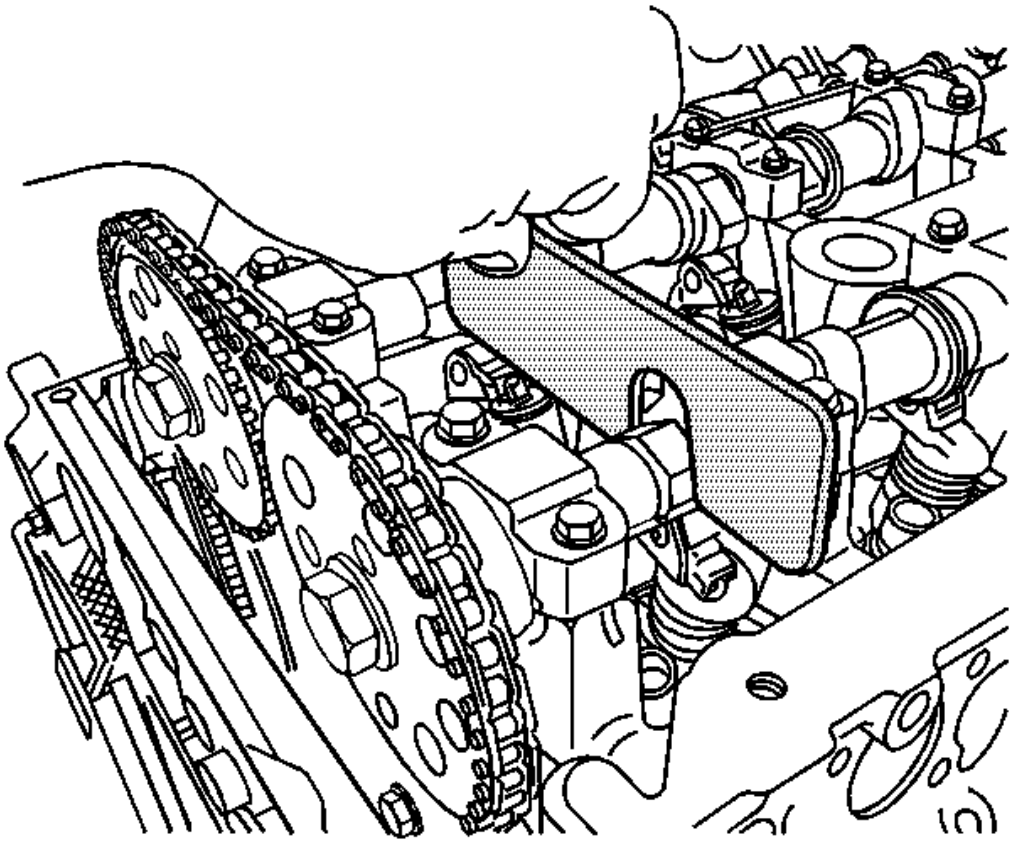


Fig. 234: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **J 44212** from the camshafts.
11. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Special Tools

J 39946 Crankshaft Socket - 4.0L and 4.6L

Removal Procedure

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

 © 2011 Mitchell Repair Information Company, LLC.

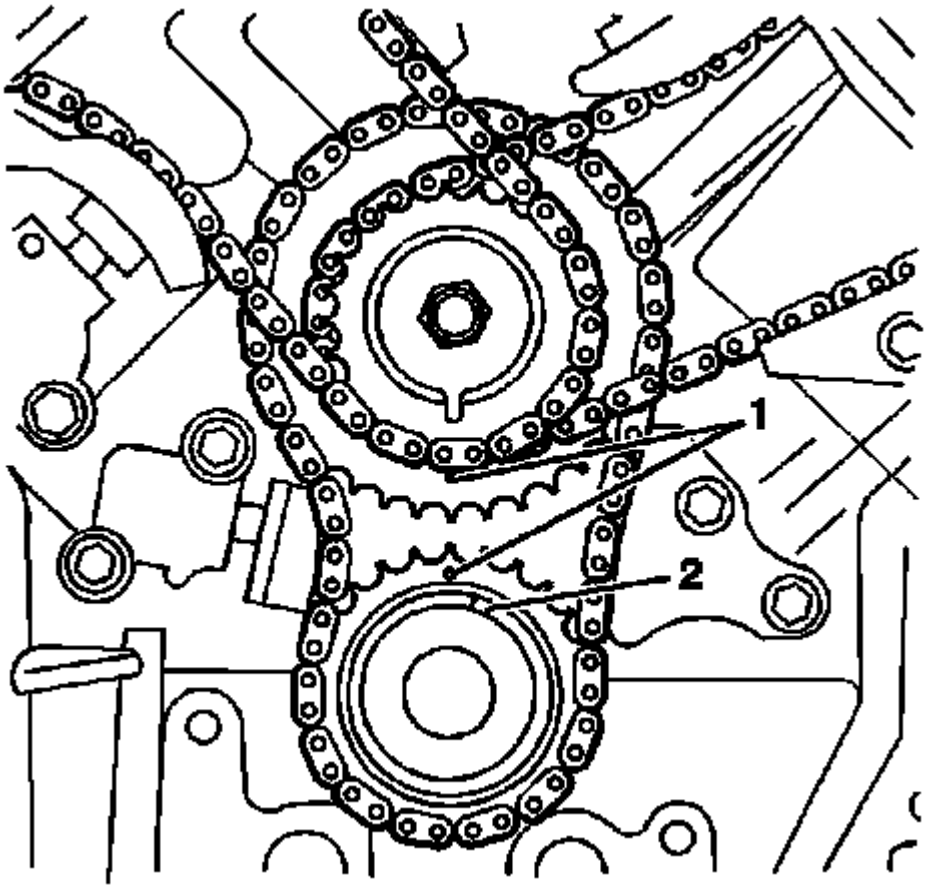


Fig. 235: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

2. Align the primary timing marks (1) using the **J 39946** .

 © 2011 Mitchell Repair Information Company, LLC.

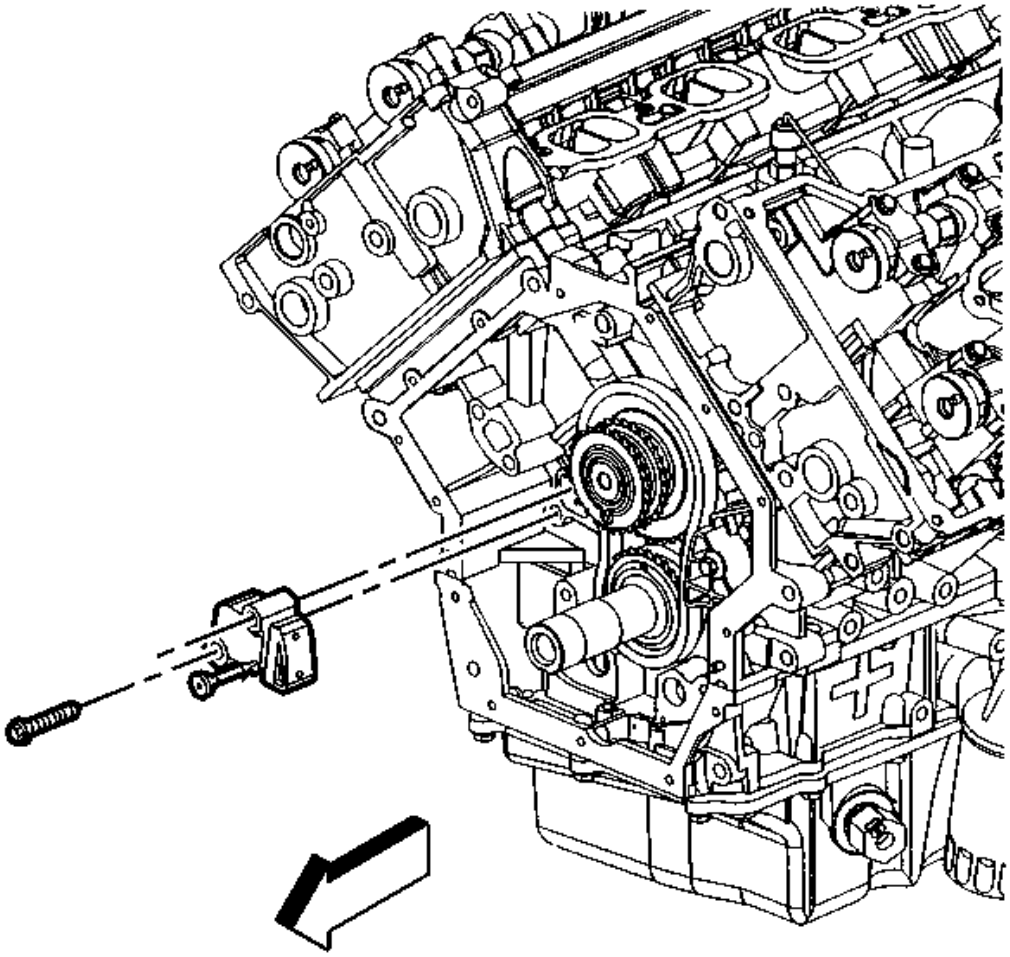


Fig. 236: Identifying Primary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 bolts attaching the primary camshaft drive chain tensioner to the engine block.
4. Remove the primary camshaft drive chain tensioner, allowing the tensioner to expand as you remove it.
5. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

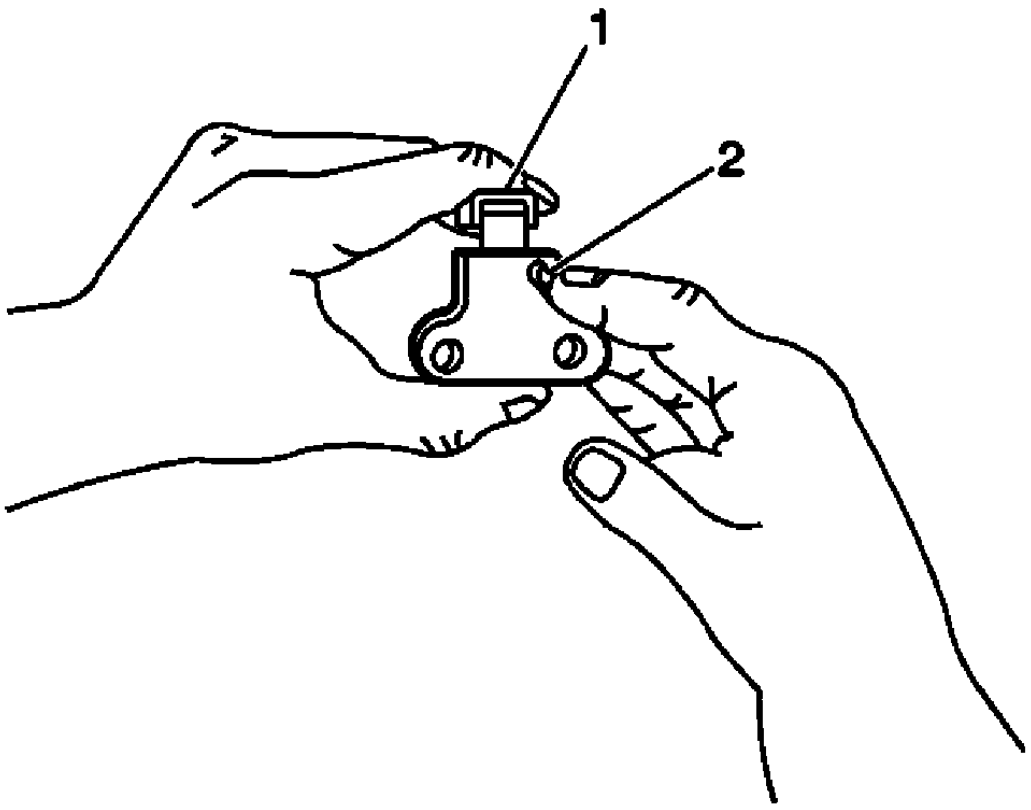


Fig. 237: View Of Primary Camshaft Drive Chain Tensioner Shoe & Ratchet Lever
Courtesy of GENERAL MOTORS COMPANY

1. Collapse the primary camshaft drive chain tensioner using the following procedure:
    1. Rotate the ratchet release lever (2) clockwise and hold.
    2. Collapse the tensioner shoe (1) and hold.
    3. Release the ratchet lever (2).
2. Slowly release the pressure on the shoe (1), until the ratchet lever (2) moves to the first detent and a "click" is heard and felt.
3. Collapse the tensioner shoe (1) and hold.

 © 2011 Mitchell Repair Information Company, LLC.

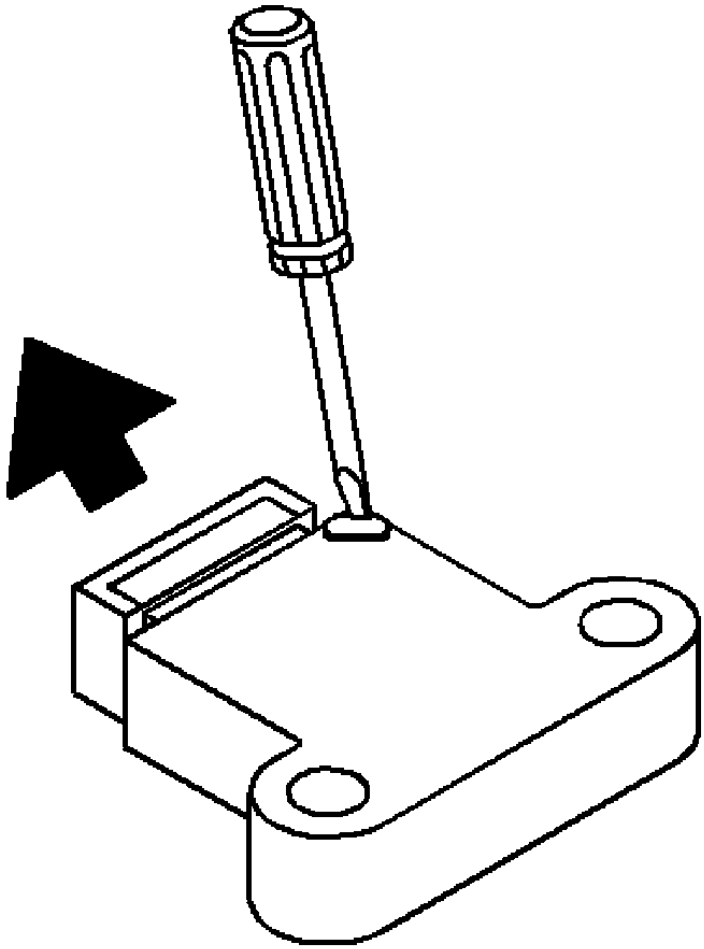


Fig. 238: Locking Primary Camshaft Drive Chain Tensioner Shoe Into Collapsed Position
Courtesy of GENERAL MOTORS COMPANY

4. Insert a pin through the hole in the release lever in order to lock the tensioner shoe in the collapsed position.

 © 2011 Mitchell Repair Information Company, LLC.

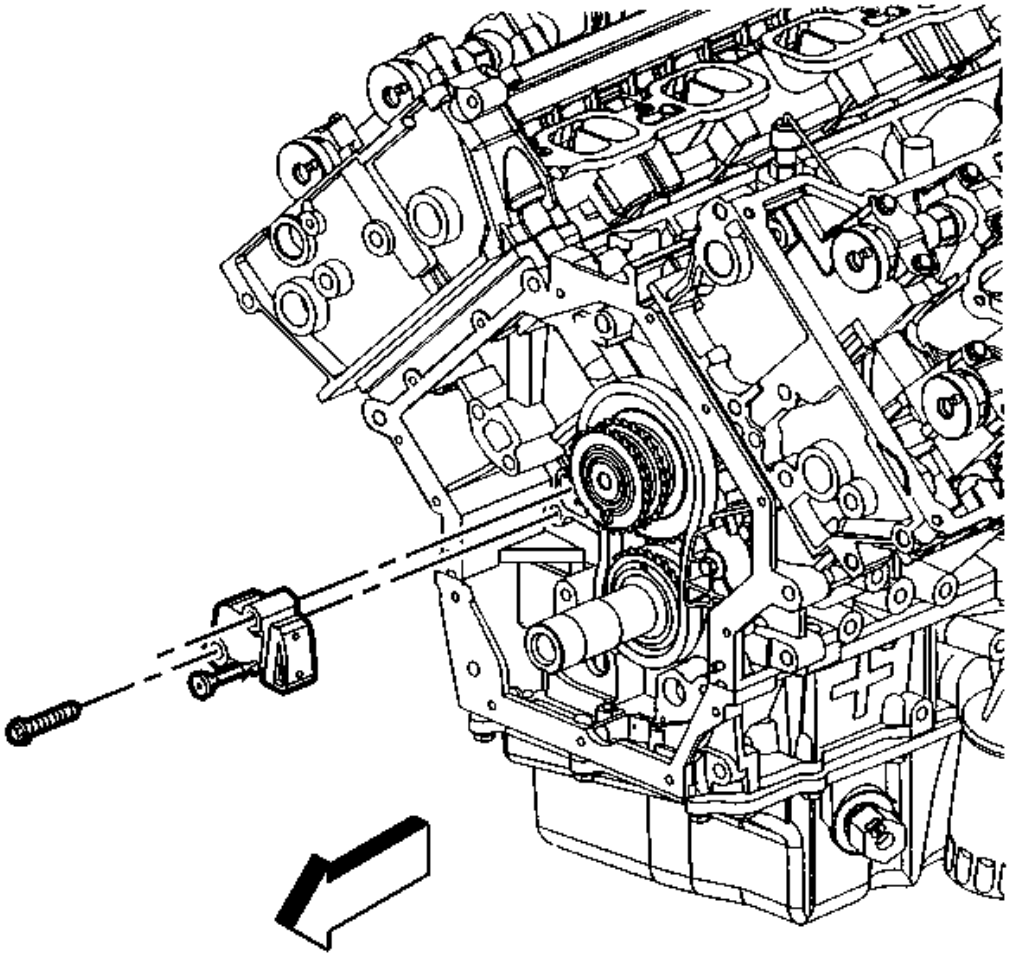


Fig. 239: Identifying Primary Camshaft Drive Chain Tensioner to Engine Block Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure the tensioner release lever is facing outward.

5. Install the primary camshaft drive chain tensioner and retaining bolts.

Tighten

Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

6. Remove the pin holding the tensioner to tighten any slack in the timing chain.

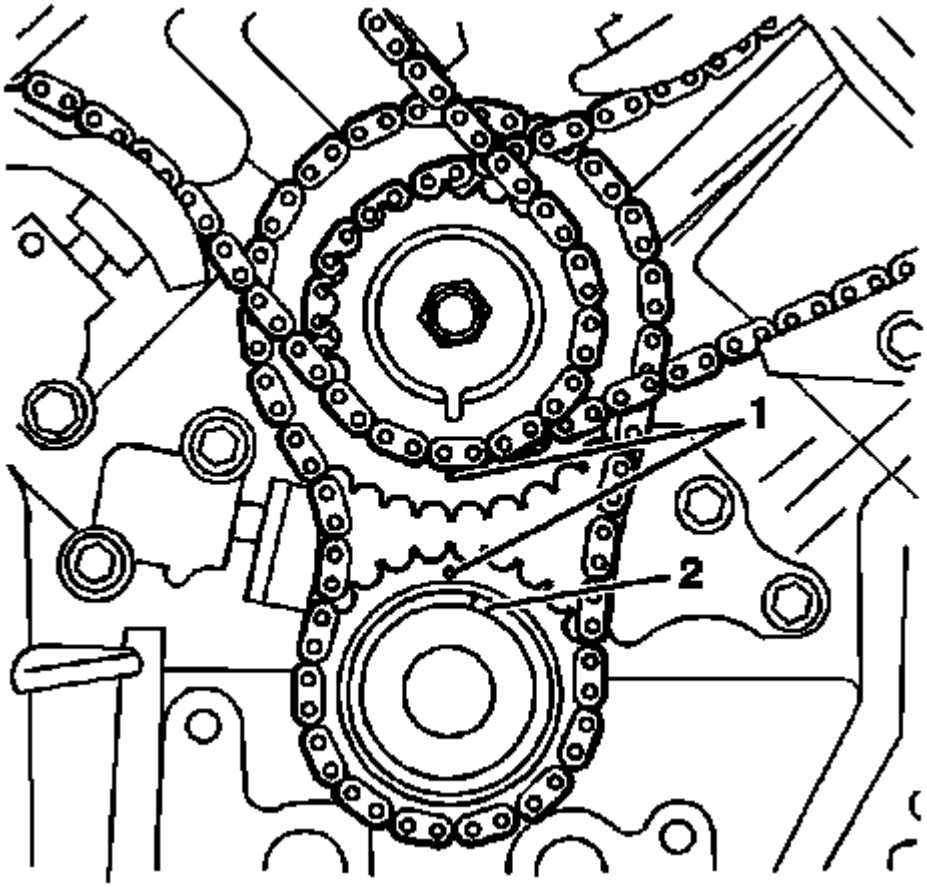


Fig. 240: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

7. Ensure the primary timing marks (1) are aligned vertically.
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT

Removal Procedure

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

 © 2011 Mitchell Repair Information Company, LLC.

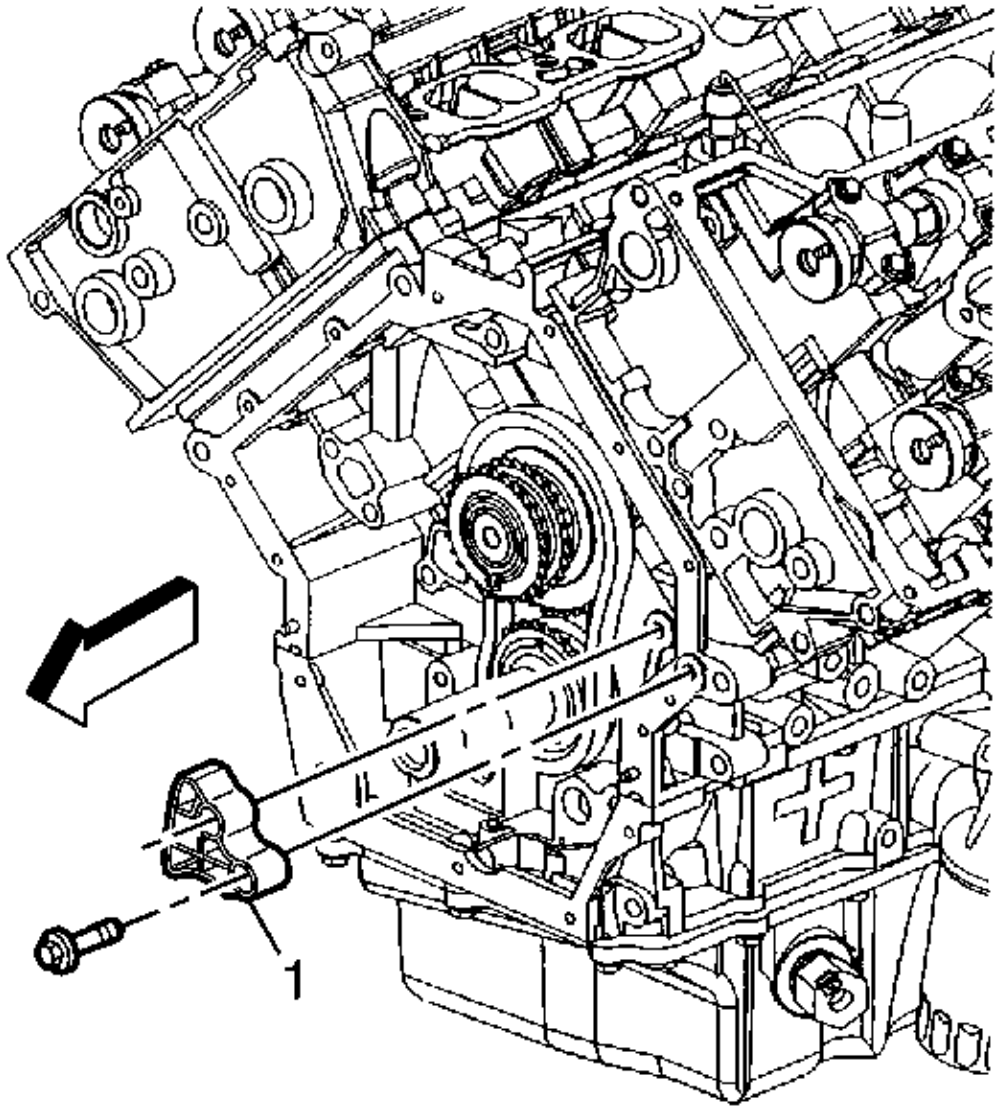


Fig. 241: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the two bolts attaching the primary camshaft drive chain guide (1) to the engine block.
3. Remove the primary camshaft drive chain guide (1).
4. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

 © 2011 Mitchell Repair Information Company, LLC.

Installation Procedure

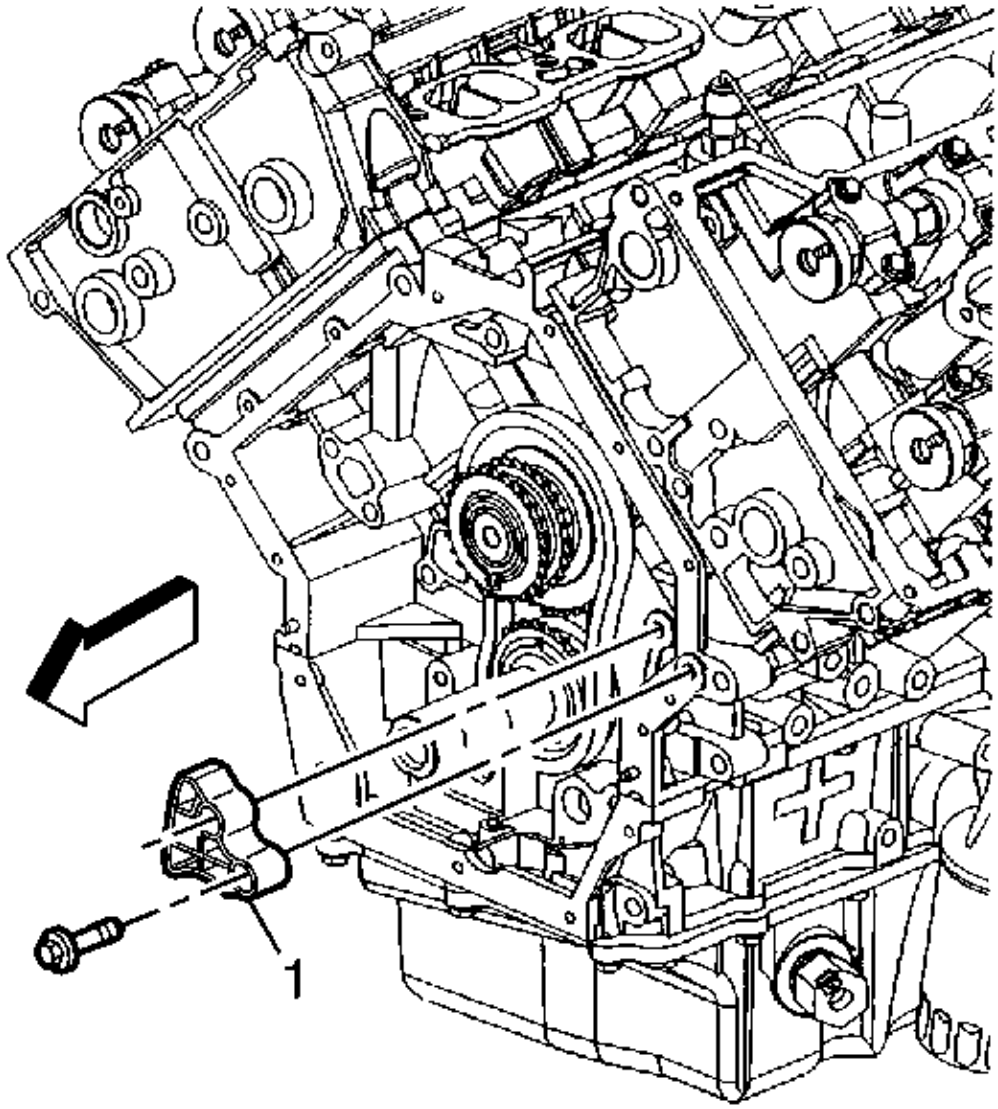


Fig. 242: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

1. Install the primary camshaft drive chain guide (1) and retaining bolts.

   Tighten

   Tighten the primary camshaft drive chain guide bolts to 25 N.m (18 lb ft).

2. Install the front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Special Tools

J 39946 Crankshaft Socket - 4.0L and 4.6L

Removal Procedure

1. Remove the oil pump. Refer to **Oil Pump Replacement**.

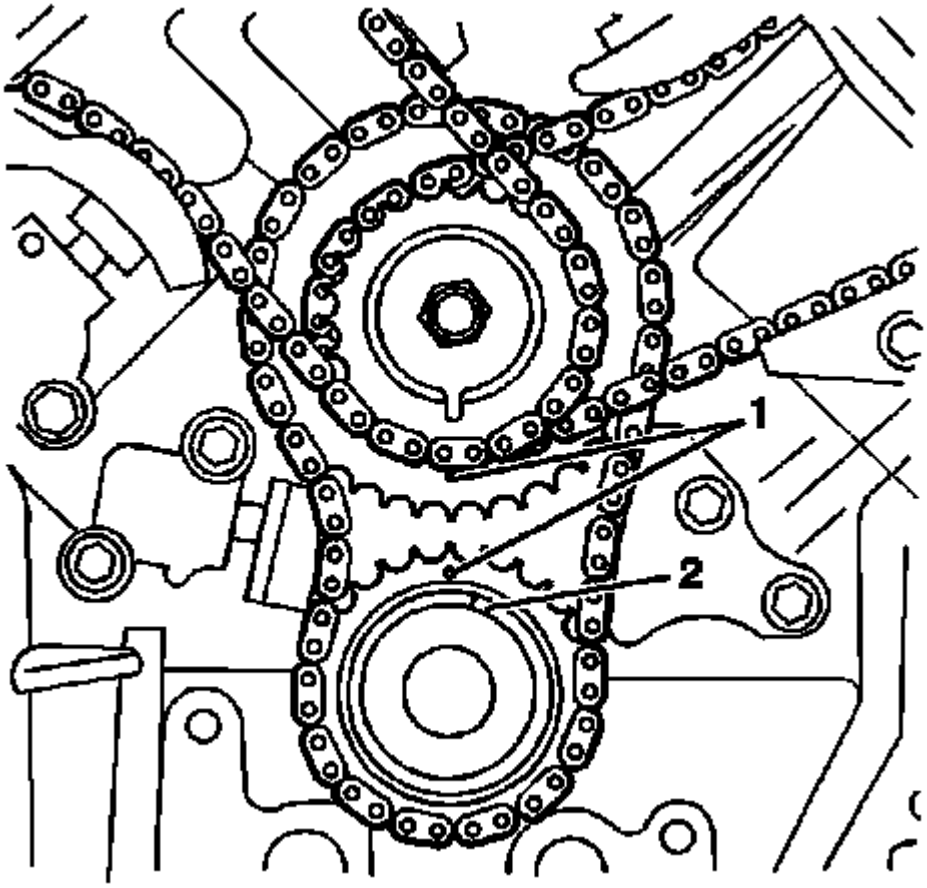


Fig. 243: Identifying Primary Timing Gear Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

2. Align the primary timing marks (1) using the **J 39946** .

 © 2011 Mitchell Repair Information Company, LLC.

3. Remove the secondary camshaft drive chains. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**, and **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
4. Remove the primary drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

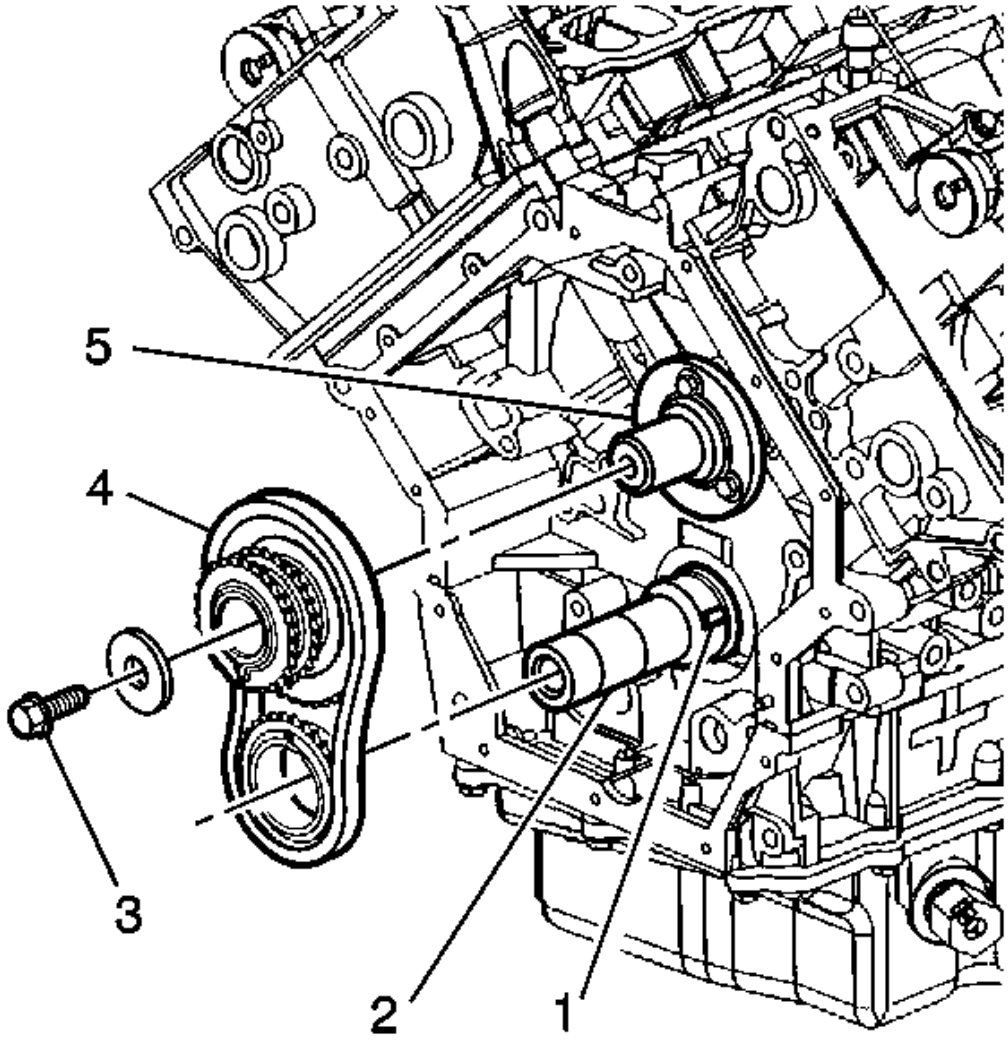


Fig. 244: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft intermediate sprocket retaining bolt (3).
6. Remove the following as an assembly:

 © 2011 Mitchell Repair Information Company, LLC.

- The primary camshaft drive chain (4)
- The crankshaft sprocket
- The camshaft intermediate sprocket

7. Clean and inspect the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

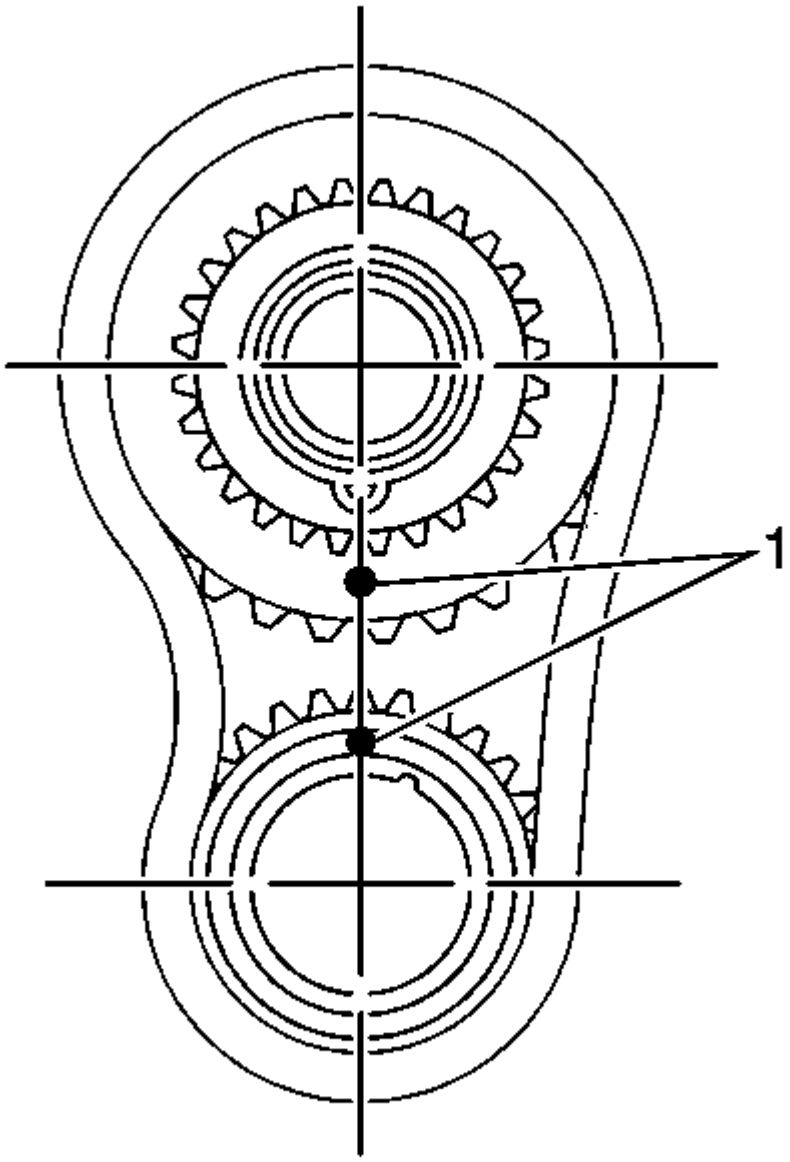


Fig. 245: Aligning Timing Marks Of Camshaft Intermediate & Crankshaft Sprockets
Courtesy of GENERAL MOTORS COMPANY

1. Align the timing marks (1) of the camshaft intermediate and crankshaft sprockets. The marks should be aligned vertically in the installed position.
2. Install the primary camshaft drive chain on the drive sprockets.
3. Make sure that the number 1 piston is at top dead center (TDC) and the crankshaft keyway is

 © 2011 Mitchell Repair Information Company, LLC.

approximately at the 1 o'clock position.

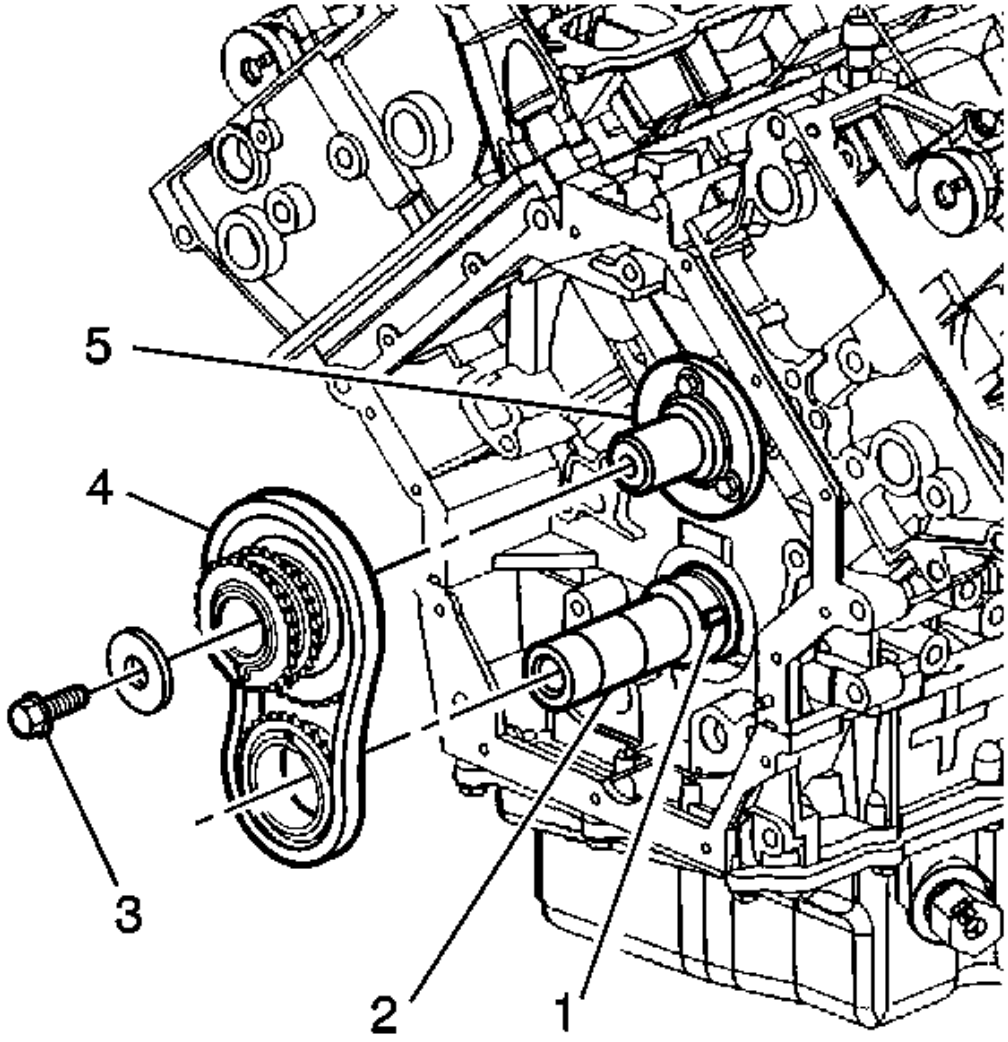


Fig. 246: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 39946** to align the crankshaft key (1) with the drive sprocket.
5. Install the following as an assembly:
    - The primary camshaft drive chain (4)
    - The crankshaft sprocket
    - The camshaft intermediate sprocket

 © 2011 Mitchell Repair Information Company, LLC.

CAUTION: Refer to Fastener Caution .

6. Install the camshaft intermediate sprocket retaining bolt (3).

   Tighten

   Tighten the camshaft intermediate sprocket retaining bolt to 60 N.m (44 lb ft).

   NOTE: DO NOT remove the pin holding the tensioner until the secondary timing chains are installed.

7. Install the primary drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.
8. Install the secondary camshaft drive chains. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**, and **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
9. Remove the pin from the primary timing chain tensioner release lever.

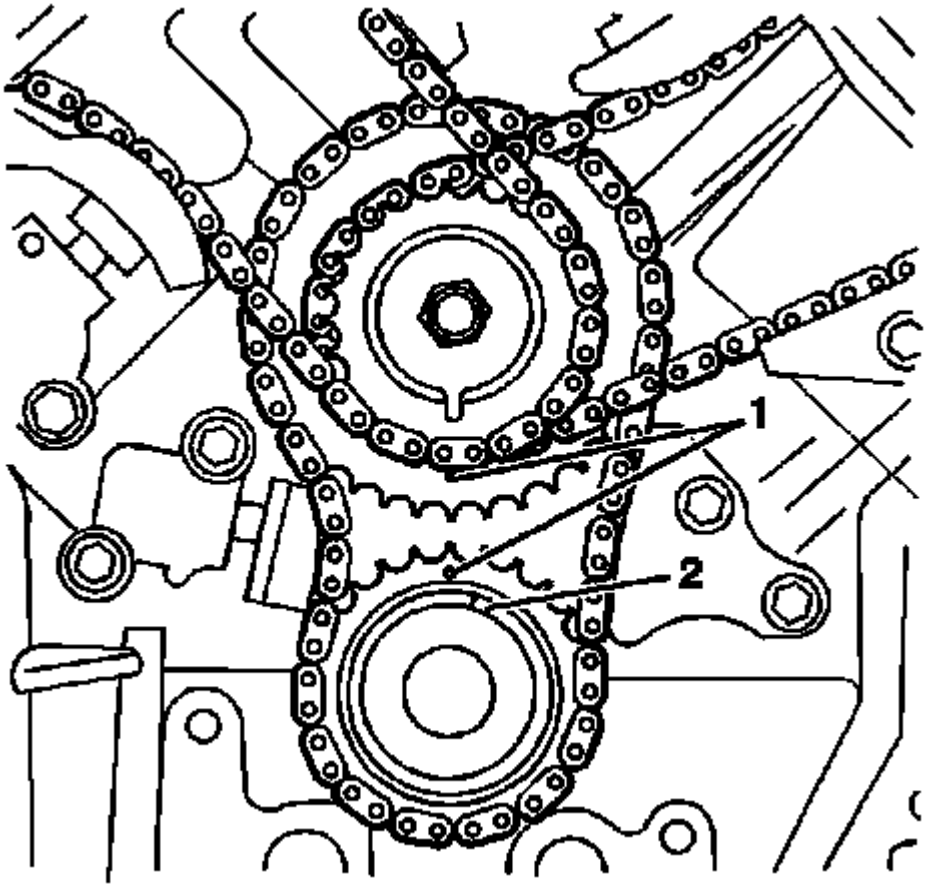


Fig. 247: Identifying Primary Timing Gear Alignment Marks

 © 2011 Mitchell Repair Information Company, LLC.

Courtesy of GENERAL MOTORS COMPANY

10. Ensure the primary timing marks (1) are aligned vertically.
11. Install the oil pump. Refer to **Oil Pump Replacement**.

CAMSHAFT INTERMEDIATE DRIVE SHAFT REPLACEMENT

Removal Procedure

1. Remove the camshaft intermediate drive shaft sprocket. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

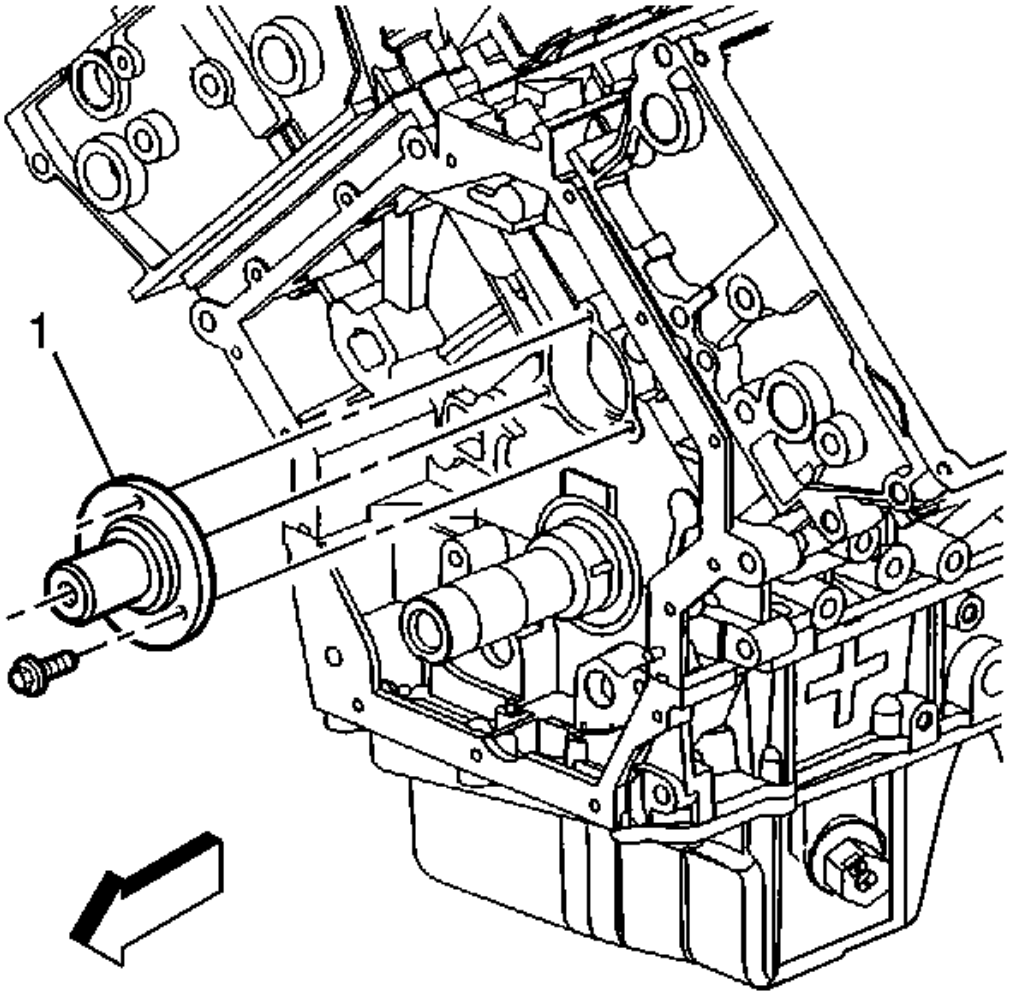


Fig. 248: Identifying Camshaft Intermediate Driveshaft

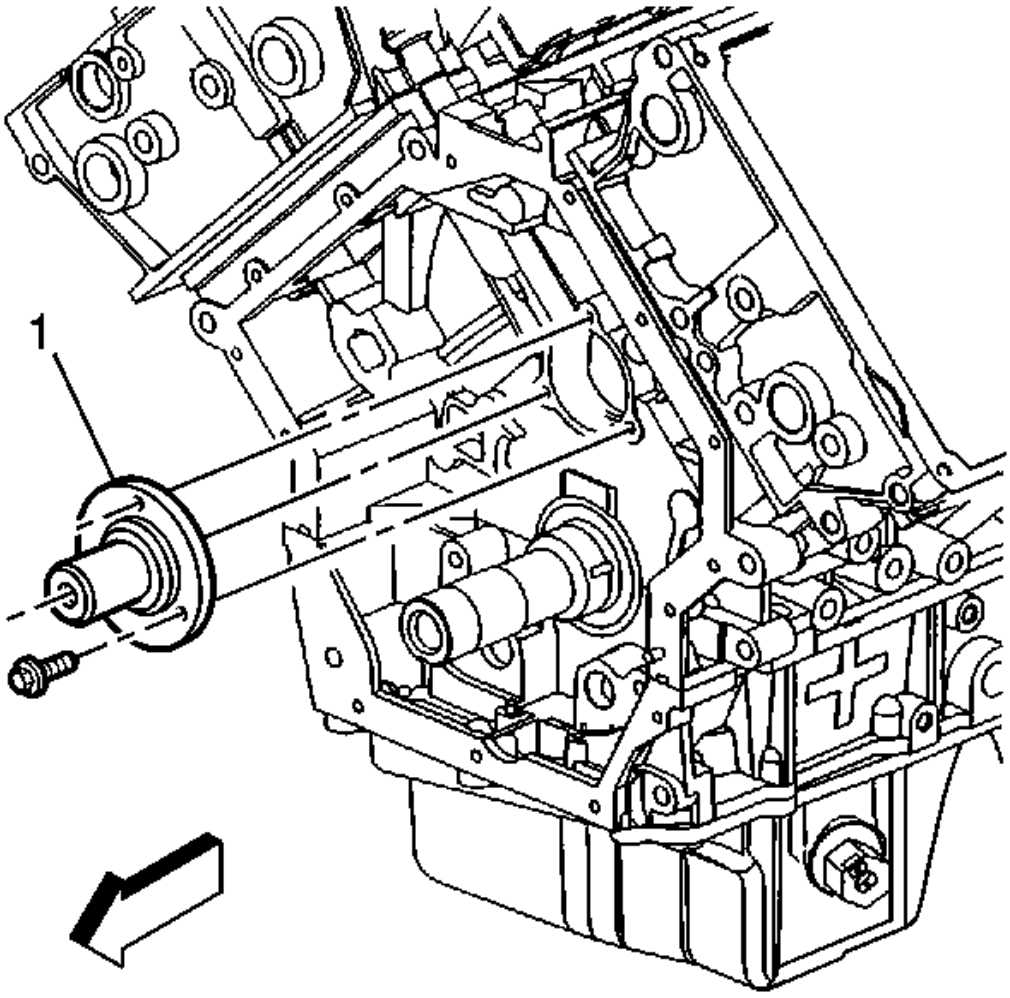
 © 2011 Mitchell Repair Information Company, LLC.

Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft intermediate drive shaft should not be removed unless wear is evident.

2. Remove the camshaft intermediate drive shaft retaining bolts.
3. Remove the camshaft intermediate drive shaft (1) from the engine.
4. Clean and inspect the camshaft intermediate driveshaft. Refer to **Camshaft Intermediate Drive Shaft Cleaning and Inspection** .

Installation Procedure



 © 2011 Mitchell Repair Information Company, LLC.

Fig. 249: Identifying Camshaft Intermediate Driveshaft
Courtesy of GENERAL MOTORS COMPANY

1. Position the camshaft intermediate drive shaft (1) to the engine, aligning the bolt holes.

   CAUTION: Refer to Fastener Caution .

2. Install the camshaft intermediate drive shaft retaining bolts.

   Tighten

   Tighten the camshaft intermediate drive shaft retaining bolts to 15 N.m (11 lb ft).

3. Install the camshaft intermediate drive shaft sprocket. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

SETTING CAMSHAFT TIMING

Special Tools

- **J 39946** Crankshaft Rotation Socket
- **J 44214** Flywheel Holder

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 the following procedure should be observed since one crankshaft rotation will not provide conditions where correct timing can be confirmed.

The camshafts and crankshaft events are correctly timed when the relationships shown exist. The following procedure explains how to establish this condition. Correct timing exists when the crank sprocket and the intermediate shaft sprocket have their timing marks aligned and all four camshaft drive pins are perpendicular (90 degrees) to the cylinder head surface.

1. Remove the following components for access:
   - The left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
   - The right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
   - The engine front cover. Refer to **Engine Front Cover Replacement**.
   - The three chain tensioners. Refer to **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Left Side**,, **Secondary Camshaft Intermediate Drive Chain Tensioner Replacement - Right Side**,, **Primary Camshaft Intermediate Drive Chain Tensioner Replacement** (the tensioners may be in their installed positions but must be fully retracted).
   - The oil pump. Refer to **Oil Pump Replacement**.

 © 2011 Mitchell Repair Information Company, LLC.

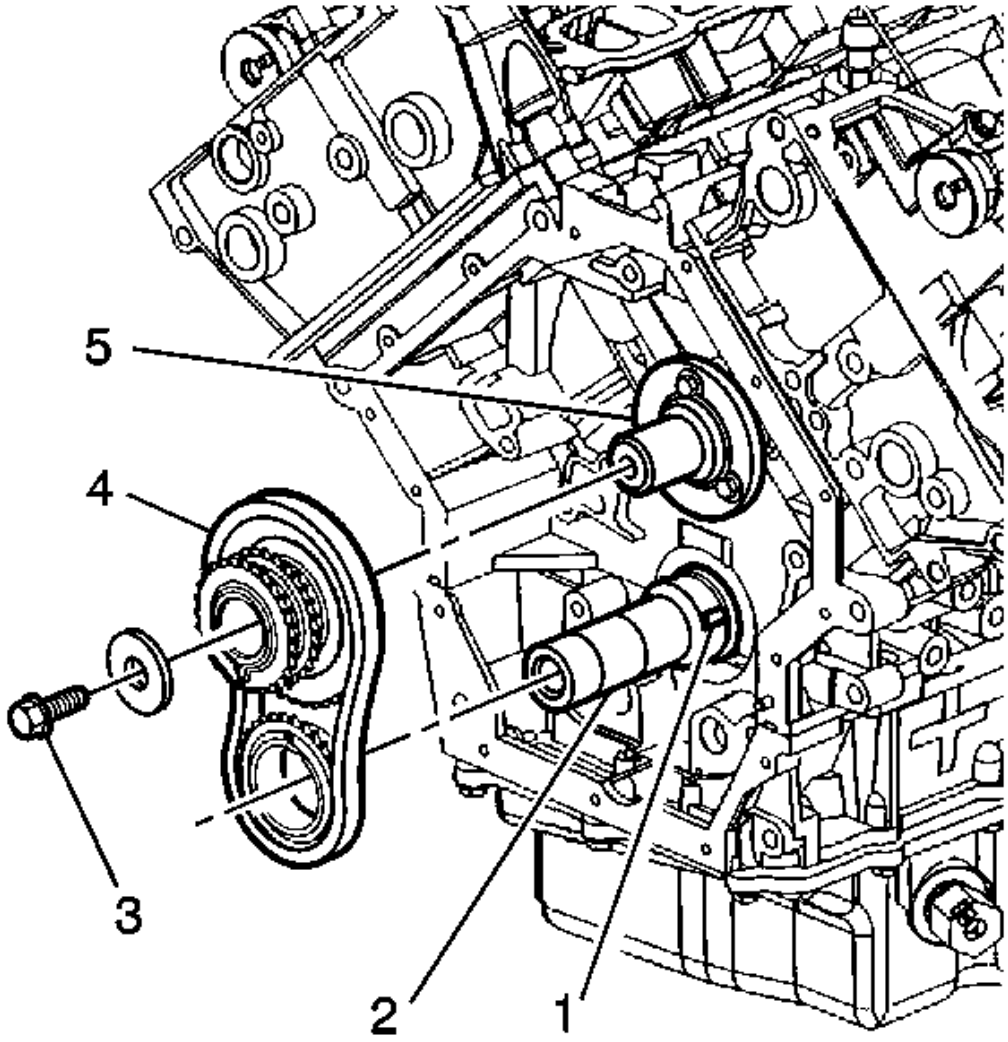


Fig. 250: Identifying Camshaft Intermediate Sprocket Retaining Bolt & Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

2. The primary and secondary chain guides should be reinstalled if previously removed.
3. Rotate the crankshaft (2) until the sprocket drive key (1) is at approximately the 1 o'clock position. Use the **J 39946** to rotate the crankshaft (2).
4. Install the crankshaft and the intermediate shaft sprockets to the primary drive chain with their timing marks adjacent to each other.
5. Install the crank and intermediate sprocket assembly (4) over their respective shafts.
6. Rotate the crankshaft (2) as necessary to engage the crankshaft key (1) in the sprocket without changing

 © 2011 Mitchell Repair Information Company, LLC.

the relationship of the timing marks to each other. Use the **J 39946** to rotate the crankshaft (2).

CAUTION: Refer to Fastener Caution .

7. Install the camshaft intermediate sprocket bolt (3).

   Tighten

   Tighten the camshaft intermediate sprocket bolt to 60 N.m (44 lb ft).

8. Install the primary camshaft drive chain tensioner or release the tensioner shoe.

   Tighten

   Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).

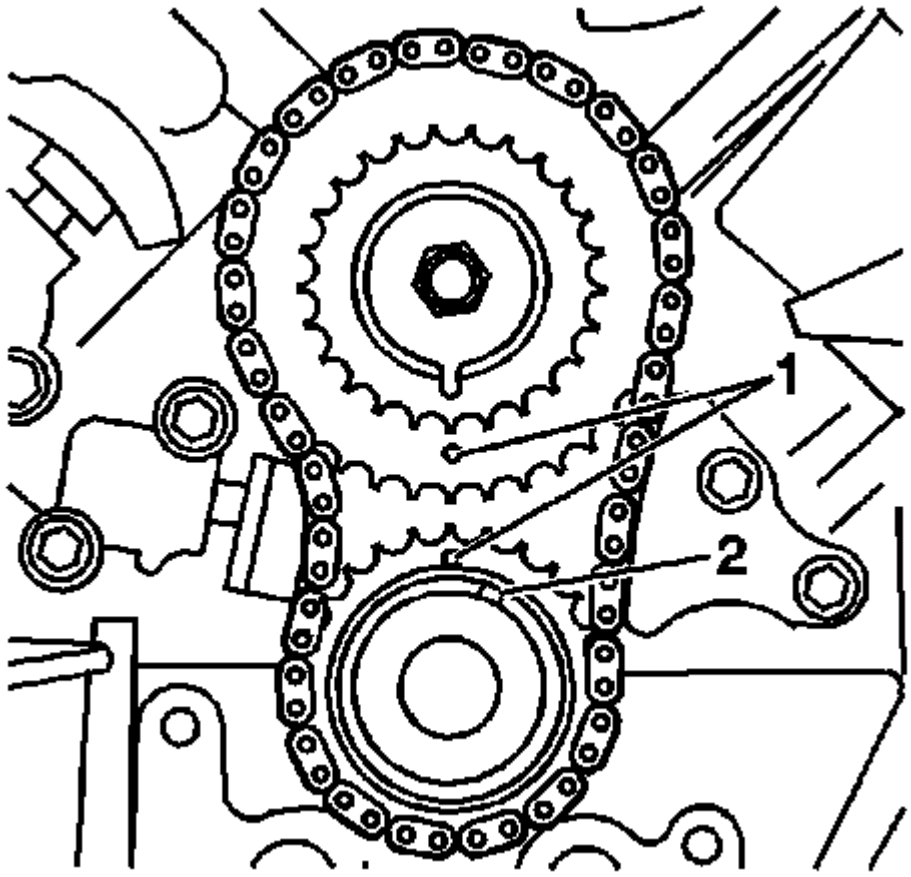


Fig. 251: Ensuring Vertical Timing Mark Alignment
Courtesy of GENERAL MOTORS COMPANY

9. Ensure the timing marks (1) are aligned vertically.

 © 2011 Mitchell Repair Information Company, LLC.

10. Install the **J 44214** to lock the crankshaft in this position. If the engine is on a stand, an alternate method should be devised.

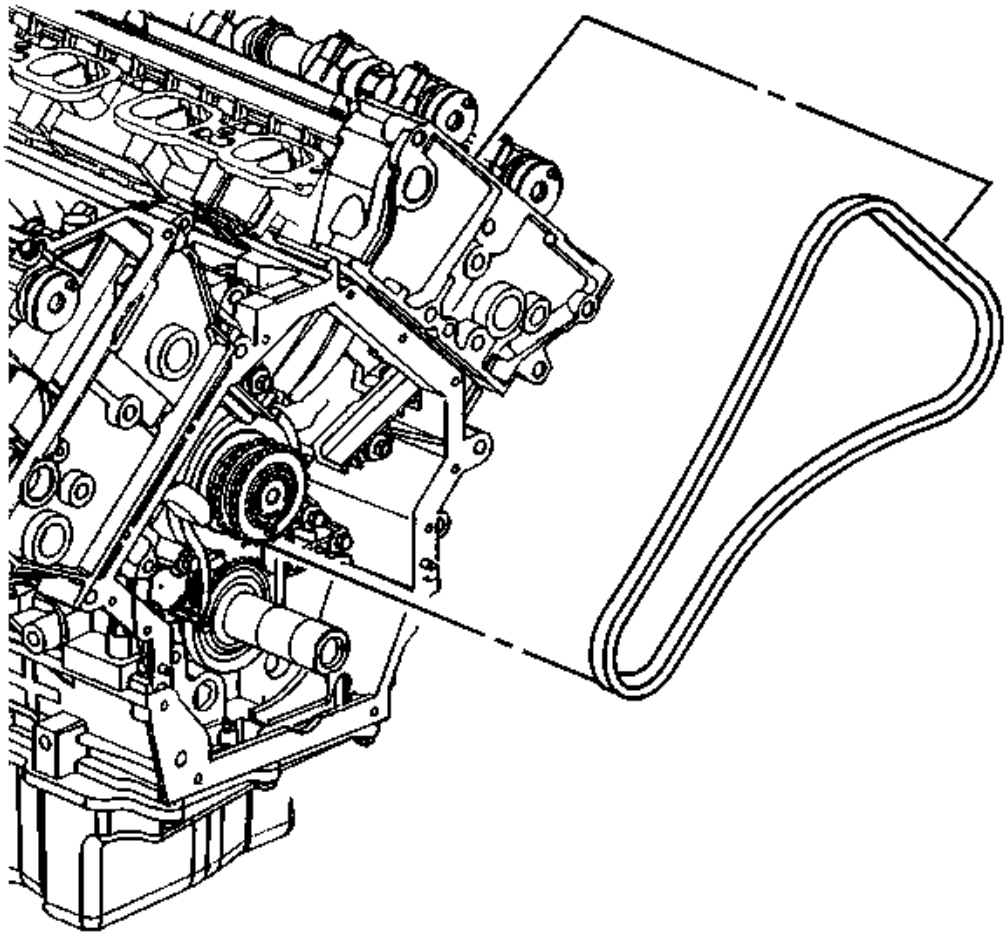


Fig. 252: View of Secondary Drive Chain
Courtesy of GENERAL MOTORS COMPANY

11. Route the secondary drive chain for the LH cylinder head over the inner row of intermediate shaft teeth.

 © 2011 Mitchell Repair Information Company, LLC.

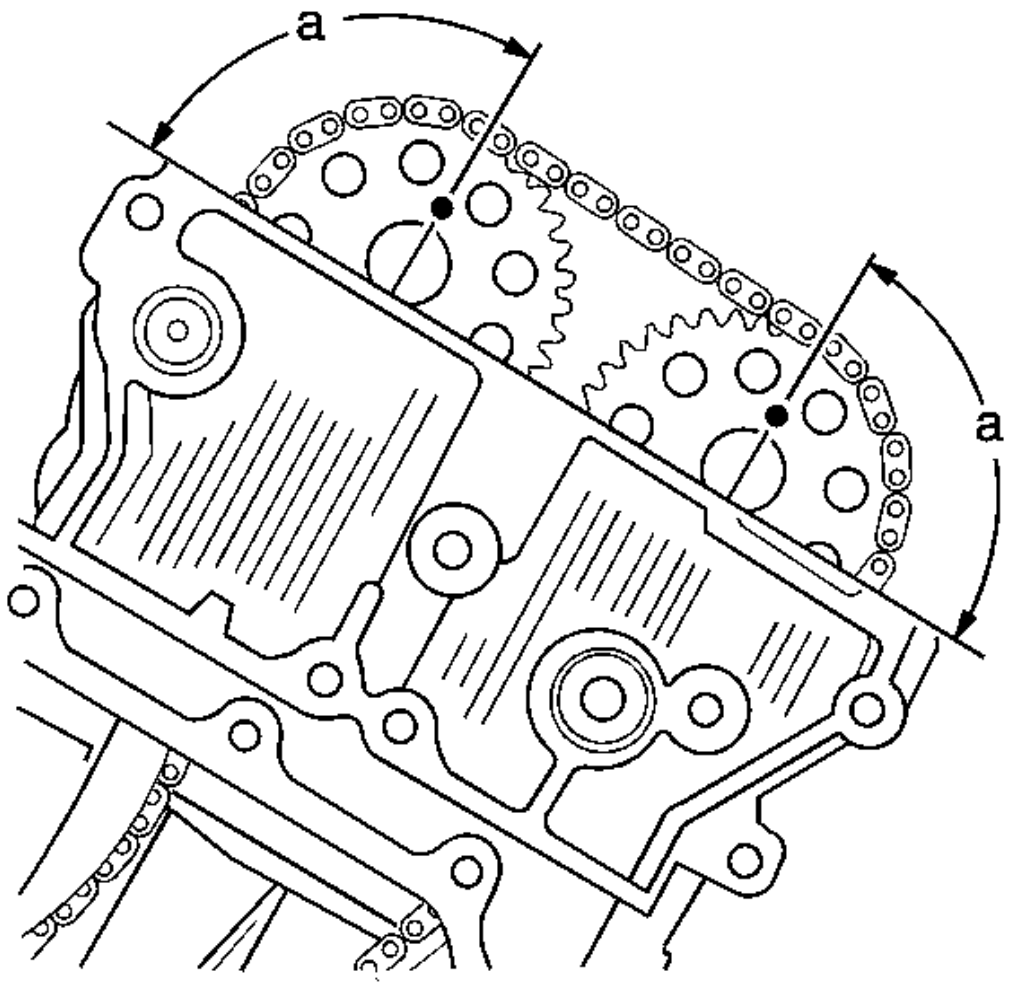


Fig. 253: Routing Secondary Drive Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: The RE camshaft sprocket must contain the camshaft position sensor pick-up.

12. Route the secondary drive chain over the chain guide and install the exhaust camshaft sprocket to the chain such that the camshaft drive pin engages the sprocket notch marked LE (left head exhaust). There should be no slack in the lower section of the chain and the camshaft drive pin must be perpendicular to the cylinder head face.
13. Install the intake camshaft sprocket into the chain so that the sprocket notch marked LI (left head intake) engages the camshaft drive pin while the pin remains perpendicular to the cylinder head face. A hex is

 © 2011 Mitchell Repair Information Company, LLC.

cast into the camshafts behind the lobes for cylinder -1 (or -2, LH) so that an open end wrench may be used to provide minor repositioning of the camshafts.

14. Loosely install the exhaust camshaft sprocket retainer bolt.
15. Loosely install the intake camshaft sprocket retainer bolt.

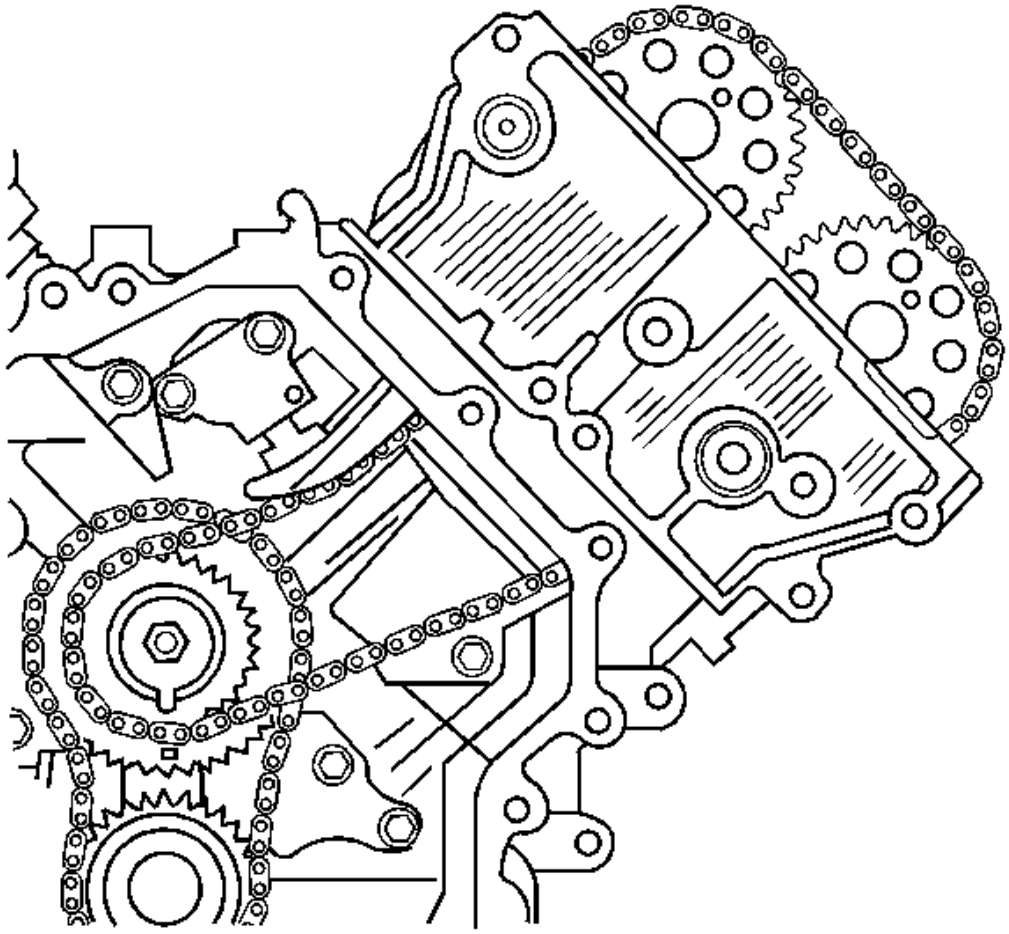


Fig. 254: View Of Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

16. Install the secondary camshaft drive chain tensioner or release the tension on the shoe.

Tighten

- Tighten the secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft).
- Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

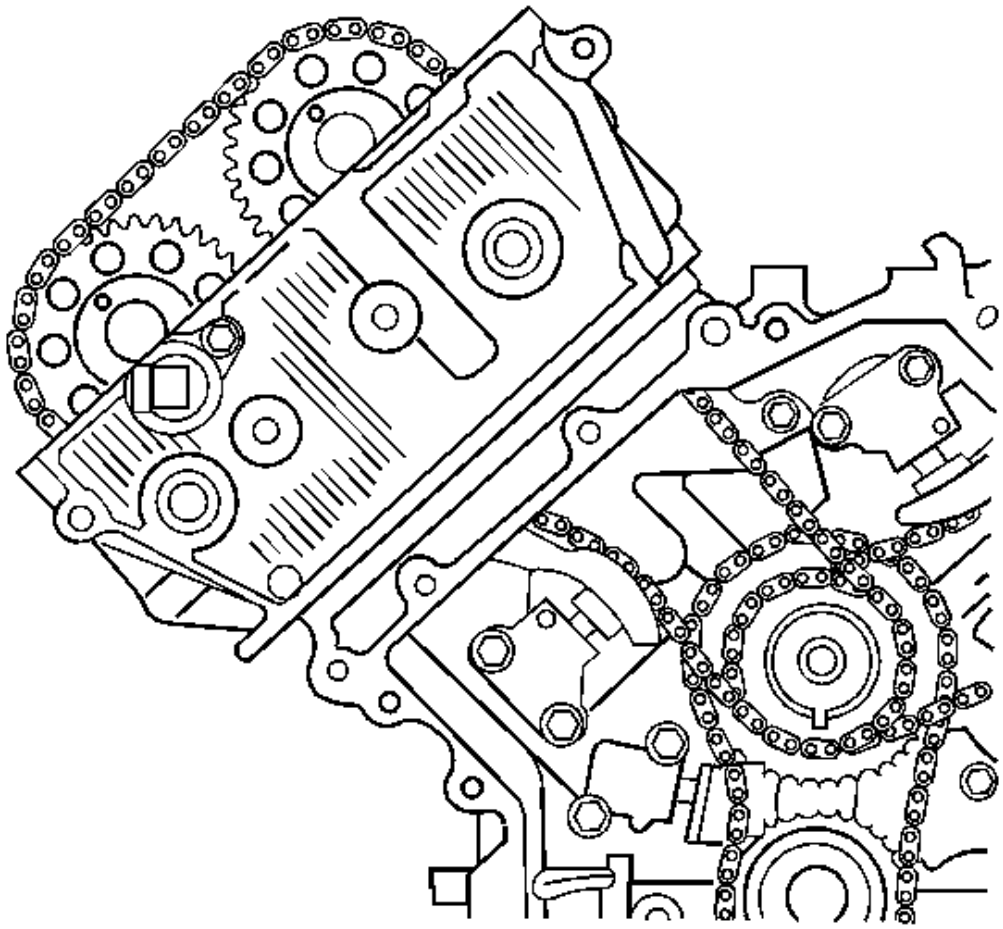


Fig. 255: Routing of Secondary Drive Chain for Right Side Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: The RE camshaft sprocket must contain the camshaft position sensor pick-up.

17. Route the secondary drive chain for the right side cylinder head over the outer row of the intermediate shaft teeth and repeat steps 11 through 15 for right side camshafts. Right side camshaft sprockets are identified as RI (right intake) and RE (right exhaust). In addition the RE sprocket must contain the camshaft position sensor pickup.

 © 2011 Mitchell Repair Information Company, LLC.

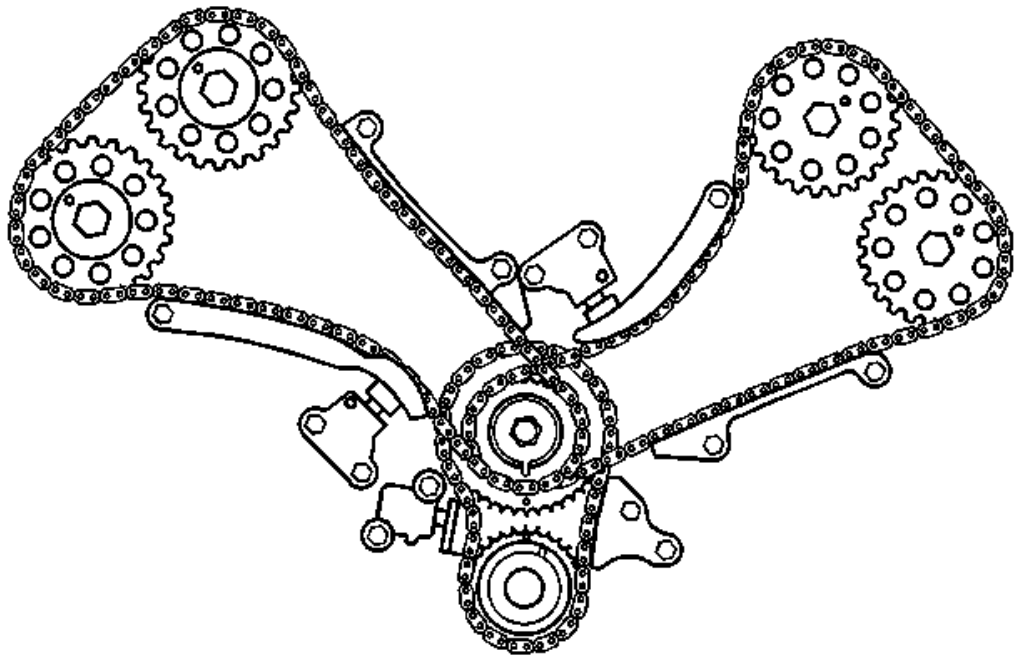


Fig. 256: Proper Alignment of Timing Marks
Courtesy of GENERAL MOTORS COMPANY

18. Ensure all timing marks are properly aligned.
19. Install the following components:
    - The oil pump. Refer to **Oil Pump Replacement**.
    - The engine front cover. Refer to **Engine Front Cover Replacement**.
    - The right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
    - The left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

CAMSHAFT REPLACEMENT - LEFT SIDE

Special Tools

- **EN 46327** Timing Chain Retention Tool
- **J 45059** Angle Meter
- **J 44212** Camshaft Holding Tool

Removal Procedure

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

 © 2011 Mitchell Repair Information Company, LLC.

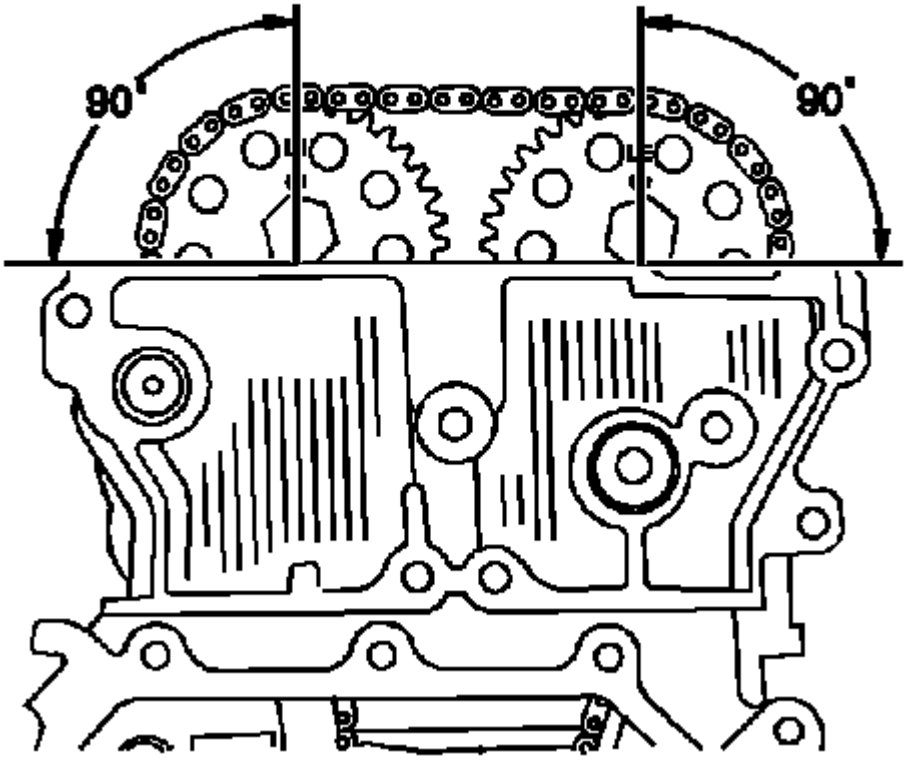


Fig. 257: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft to TDC of the # 1 cylinders compression stroke, both camshaft sprocket drive pins should be at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

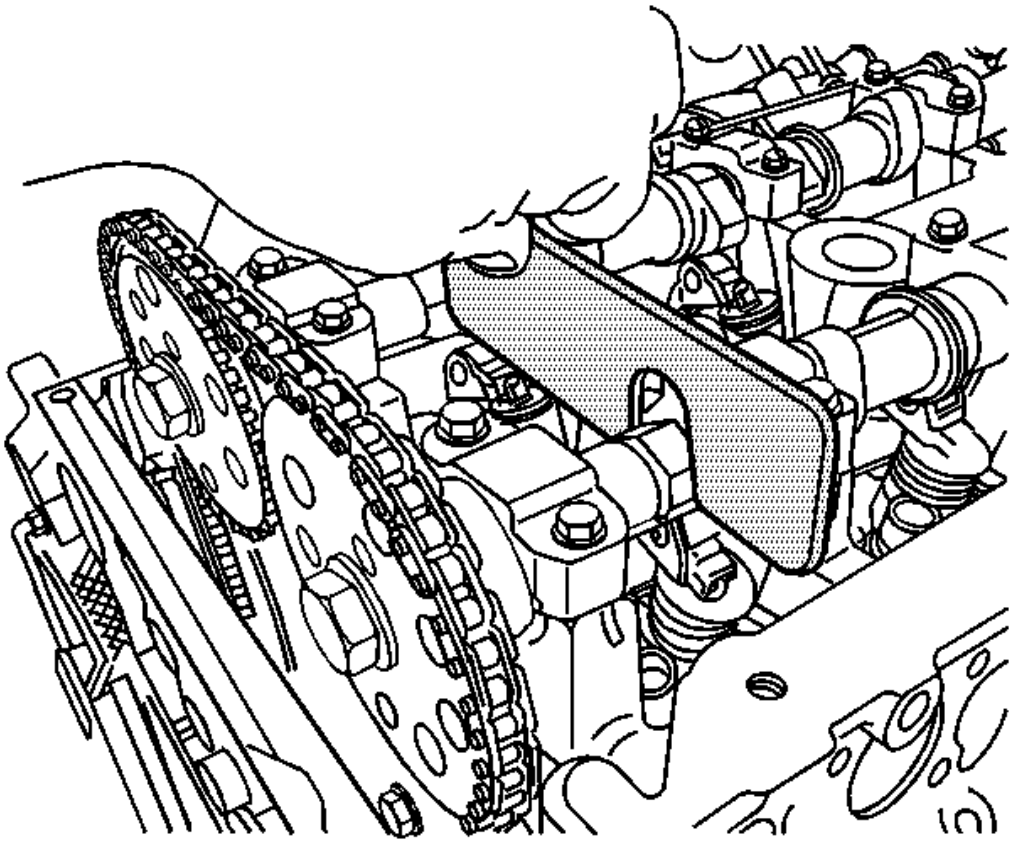


Fig. 258: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

3. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

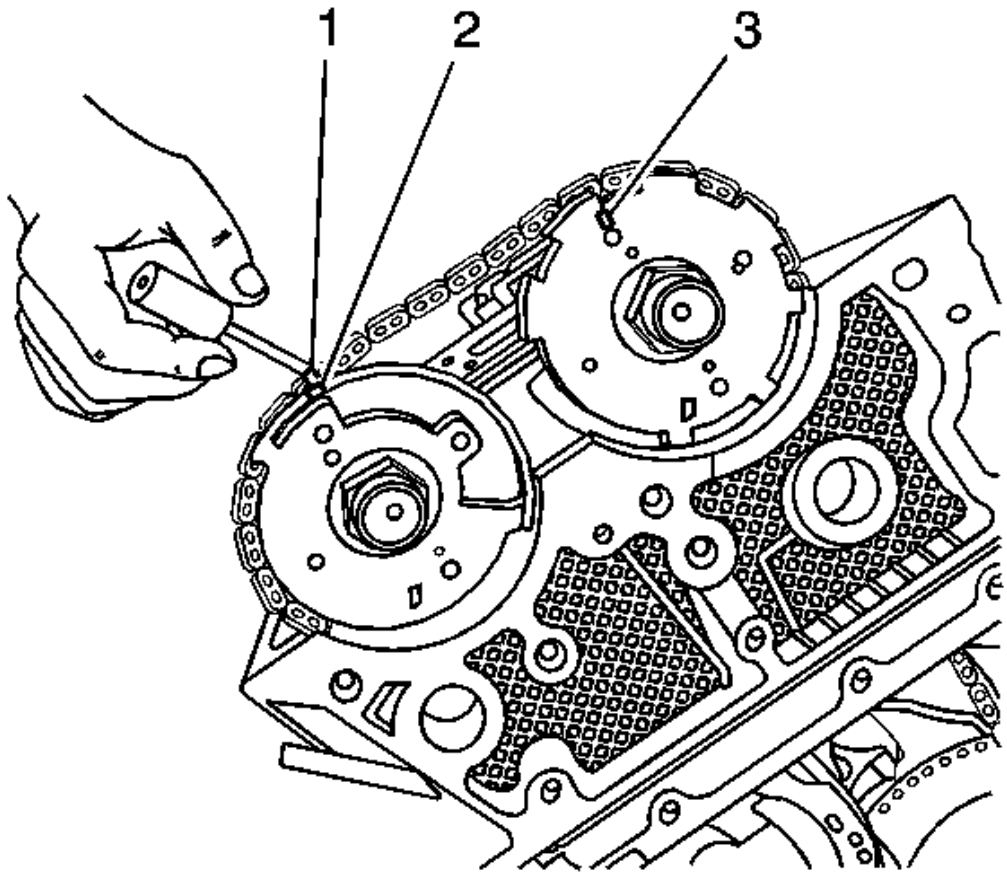


Fig. 259: Using A Paint Stick To Create A Mark On The Timing Chain Link Adjacent To Each Camshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

4. Use a paint stick to create a mark (1) on the timing chain link adjacent to each camshaft sprocket timing mark (2, 3).

 © 2011 Mitchell Repair Information Company, LLC.

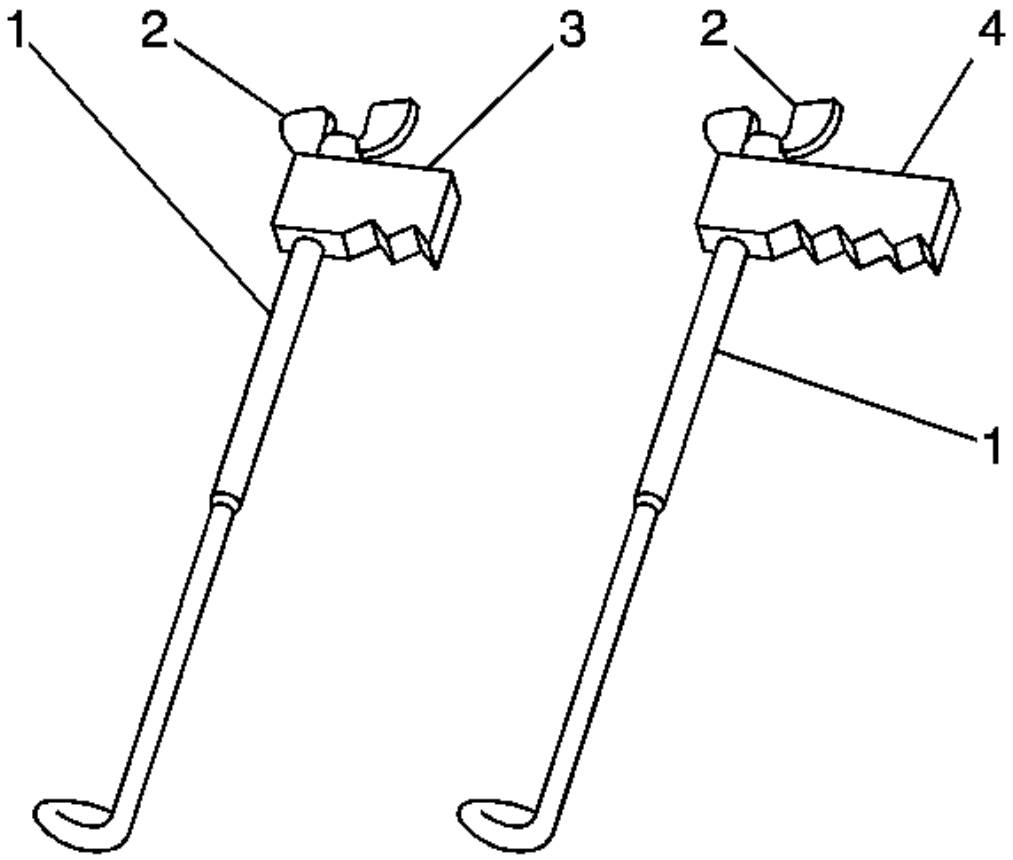


Fig. 260: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

5. Install both **EN 46327** (1) to the engine using the following step:

   Rotate the wing nut (2) of the **EN 46327** (3) to the top of its travel.

 © 2011 Mitchell Repair Information Company, LLC.

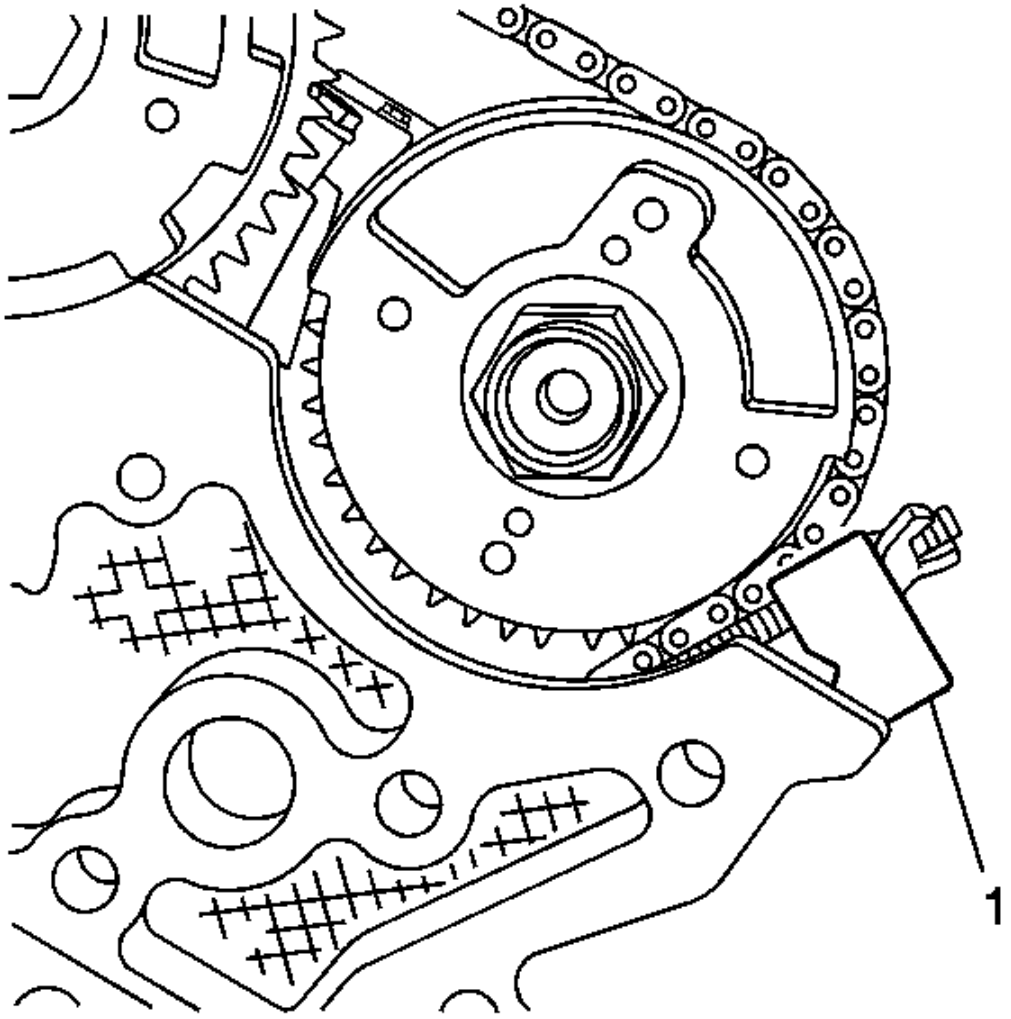


Fig. 261: Positioning Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

6. Position the bottom retention tool on the cylinder head with the V-notch of the block (1) adjacent to the left exhaust camshaft sprocket and chain.

 © 2011 Mitchell Repair Information Company, LLC.

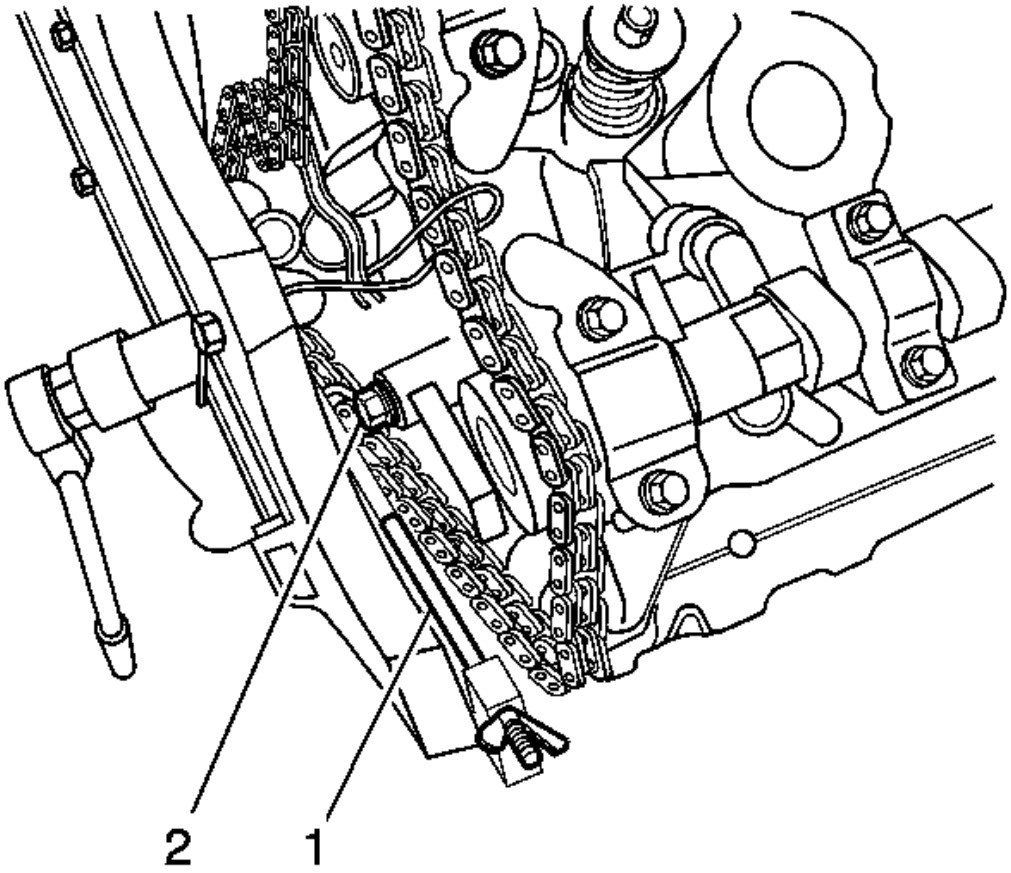


Fig. 262: Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS COMPANY

7. Insert the hook end (2) into a secondary timing chain link as shown.

 © 2011 Mitchell Repair Information Company, LLC.

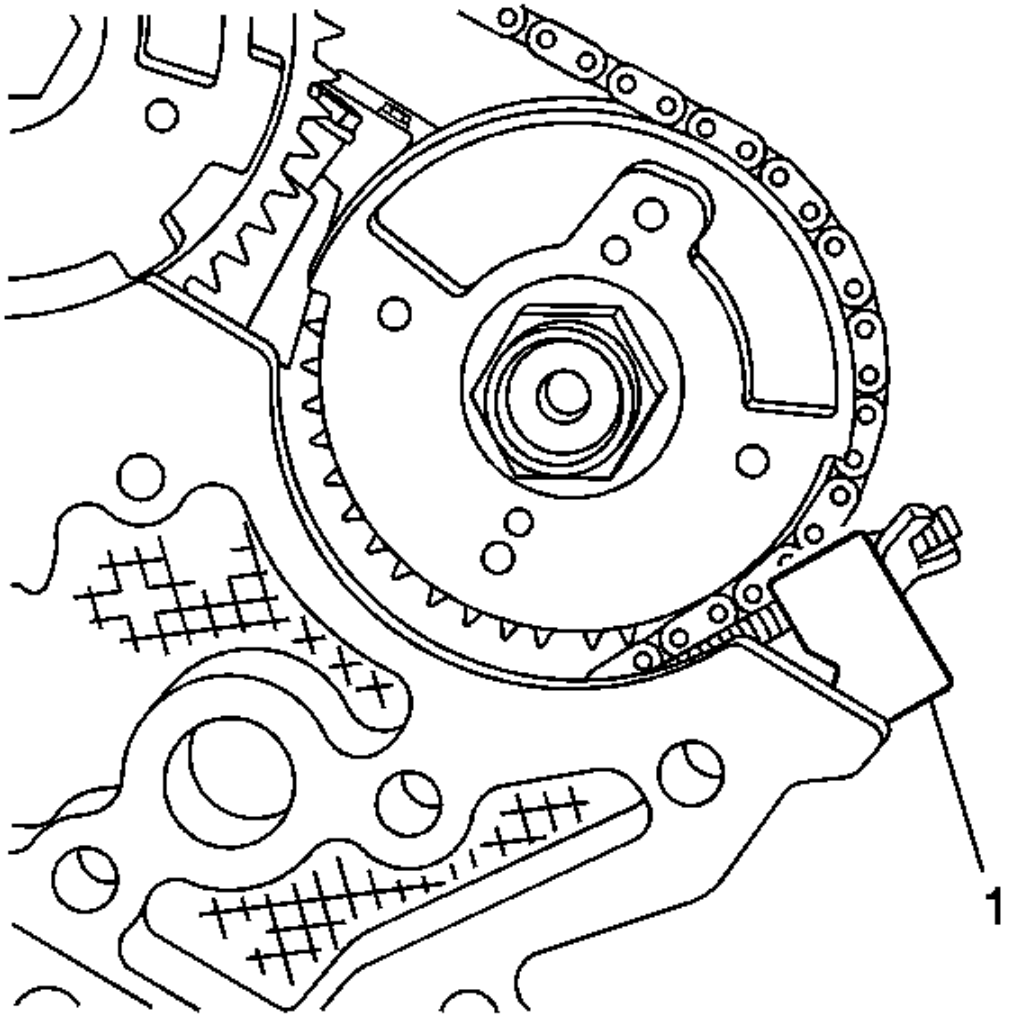


Fig. 263: Positioning Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

8. Rotate the wing nut until it contacts the retention tool block (1). DO NOT tighten the wing nut at this time.

 © 2011 Mitchell Repair Information Company, LLC.

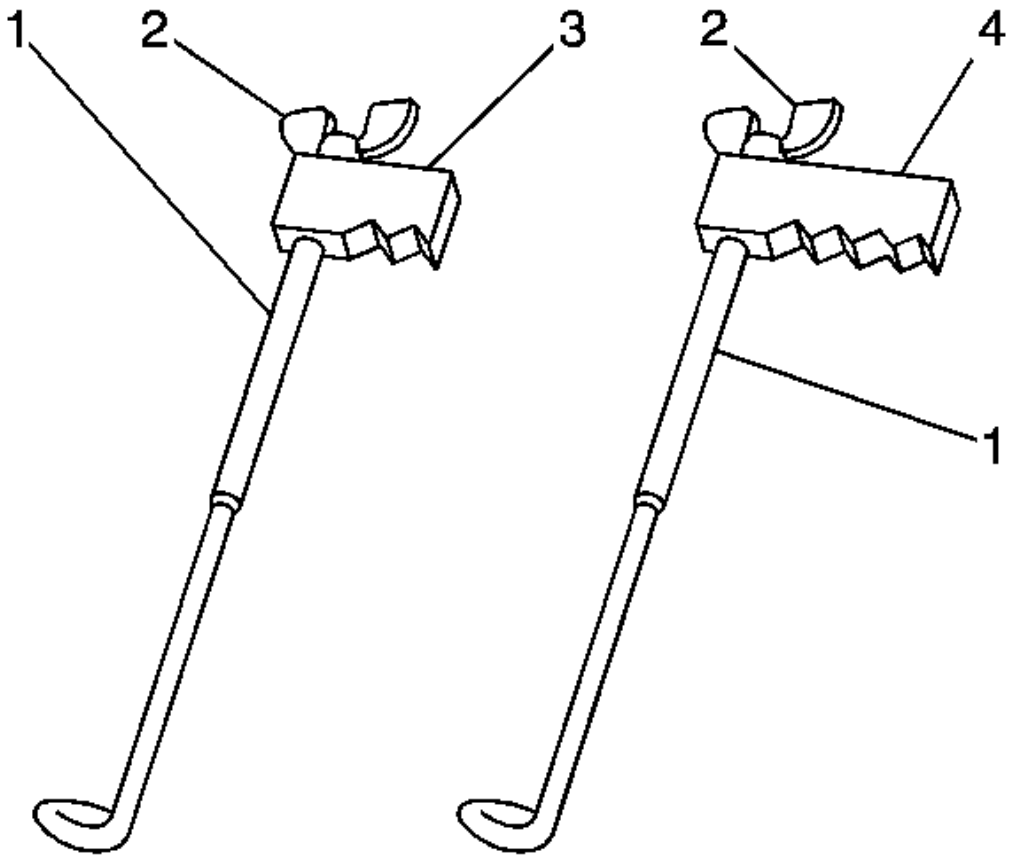


Fig. 264: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

9. Rotate the wing nut (2) of the **EN 46327** (4) to the top of its travel.

 © 2011 Mitchell Repair Information Company, LLC.

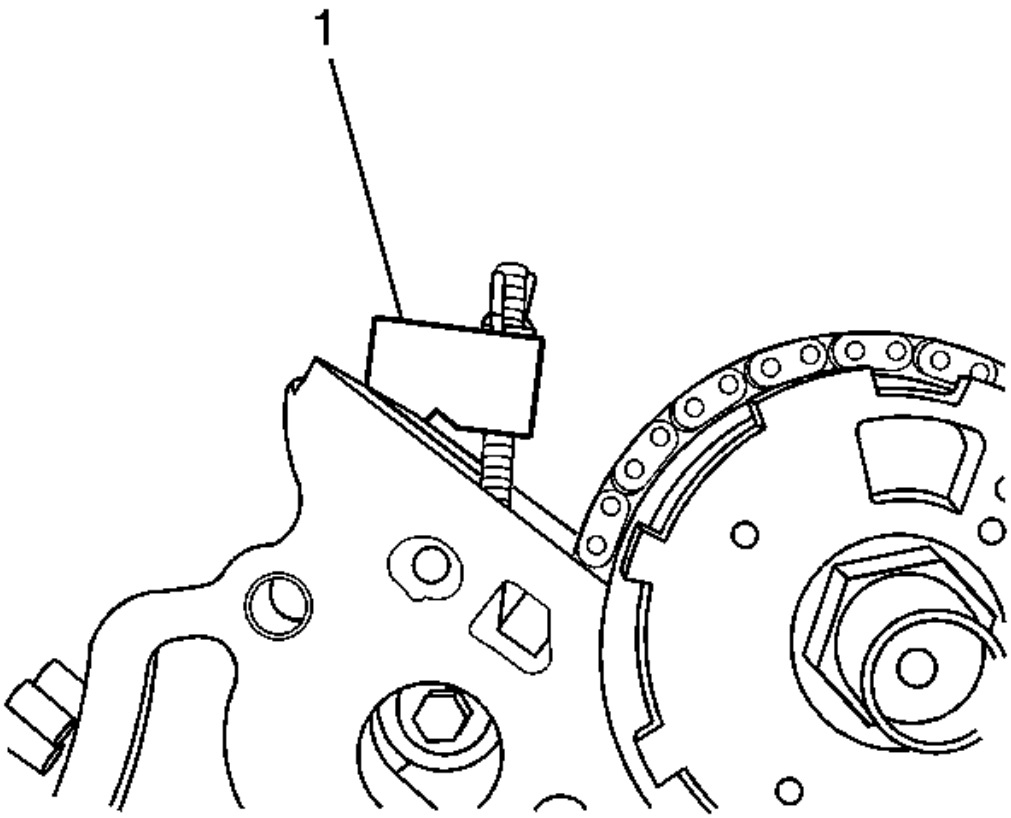


Fig. 265: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

10. Position the top retention tool on the cylinder head with the V-notch of the block (1) adjacent to the left intake camshaft sprocket and chain.

 © 2011 Mitchell Repair Information Company, LLC.

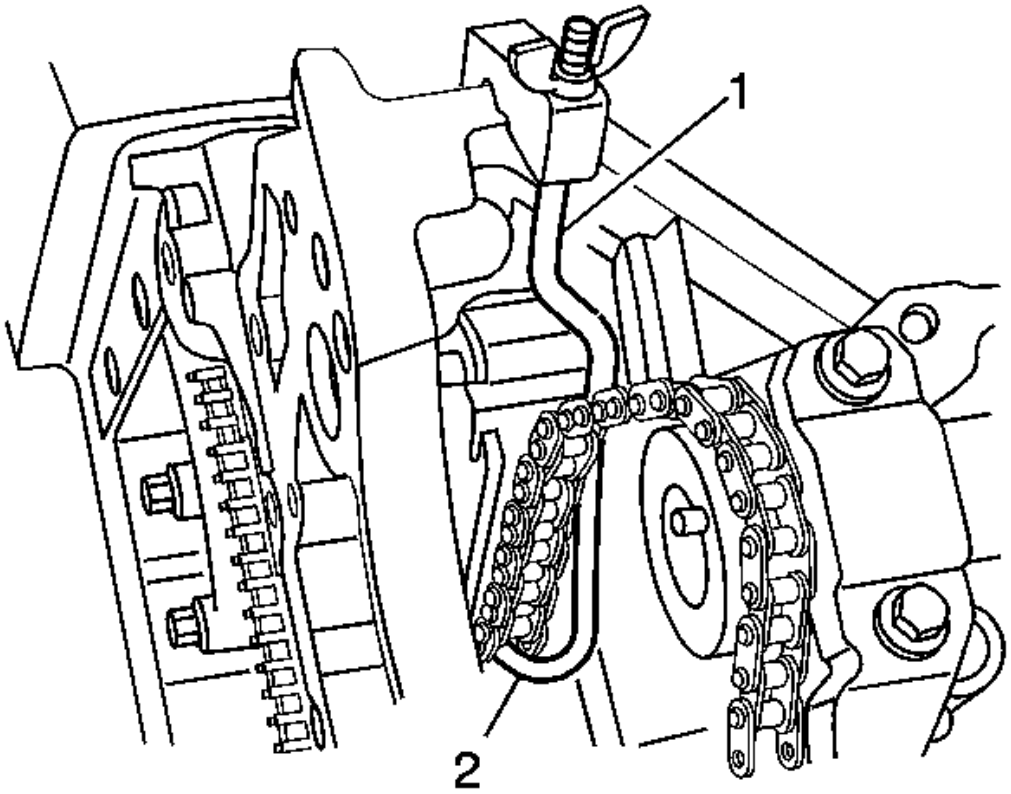


Fig. 266: View Of Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS COMPANY

11. Insert the hook end (2) into a secondary timing chain link as shown.

 © 2011 Mitchell Repair Information Company, LLC.

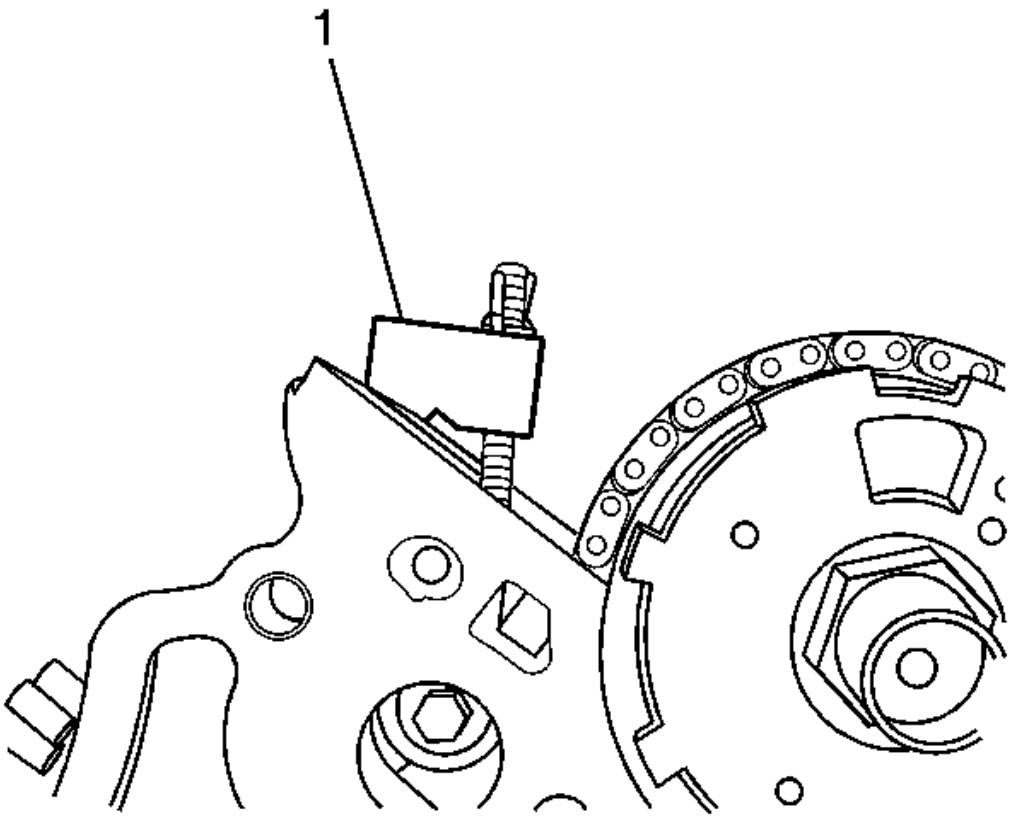


Fig. 267: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

12. Rotate the wing nut until it contacts the retention tool block (1). Alternately tighten both wing nuts to retain the chain.

 © 2011 Mitchell Repair Information Company, LLC.

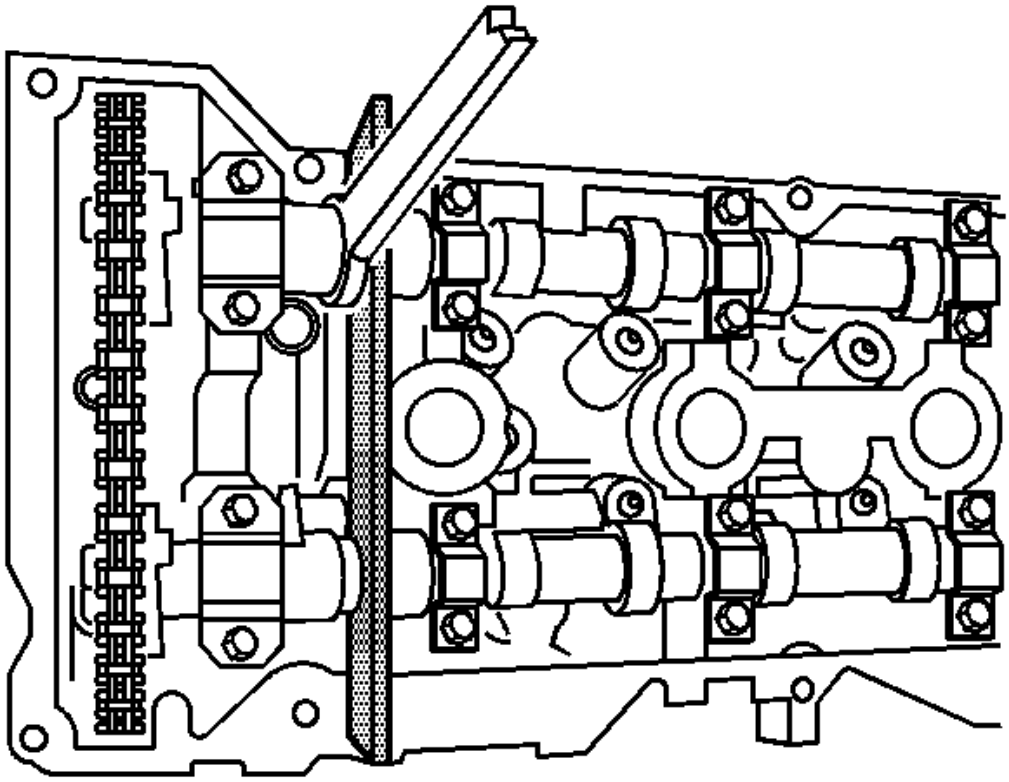


Fig. 268: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when removing the camshaft sprocket bolts.
14. Remove the camshaft sprocket bolts.
15. Remove the camshaft sprockets.

 © 2011 Mitchell Repair Information Company, LLC.

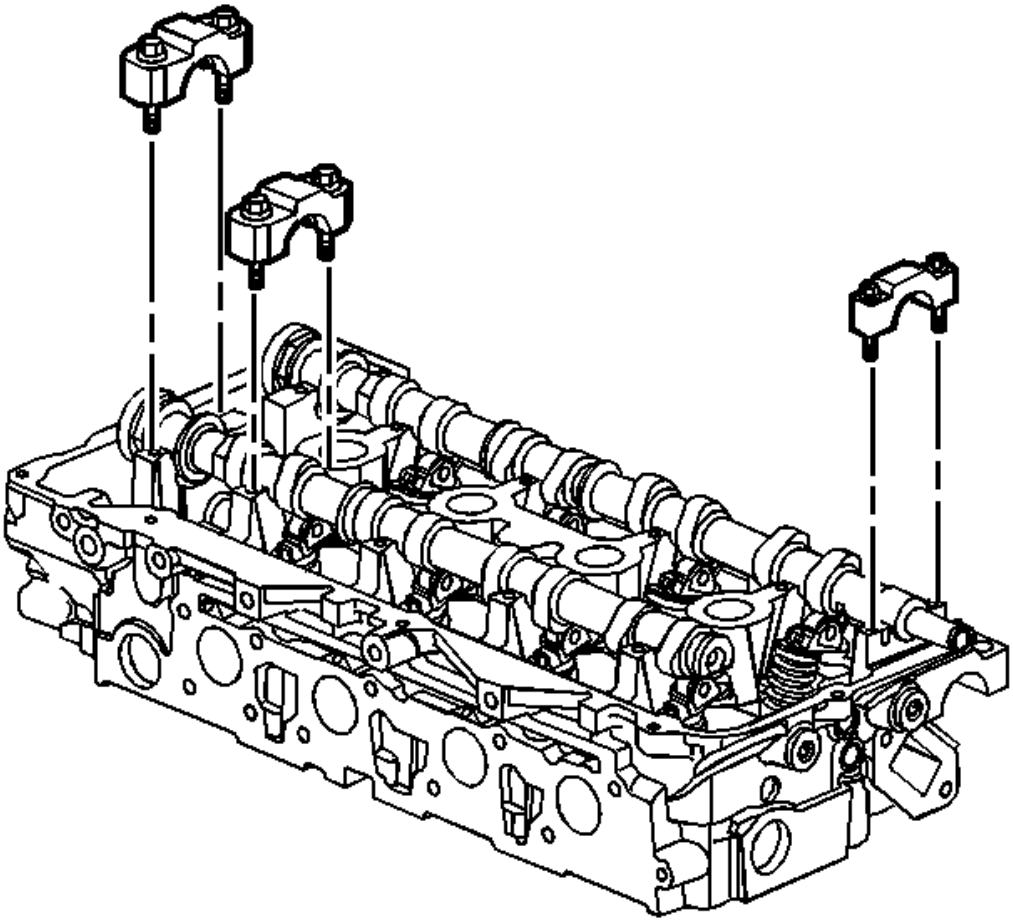


Fig. 269: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

16. Alternately loosen the camshaft bearing cap bolts a few turns at a time until all valve spring pressure has been released.
17. Remove the camshaft bearing caps.
18. Remove the **J 44212** from the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

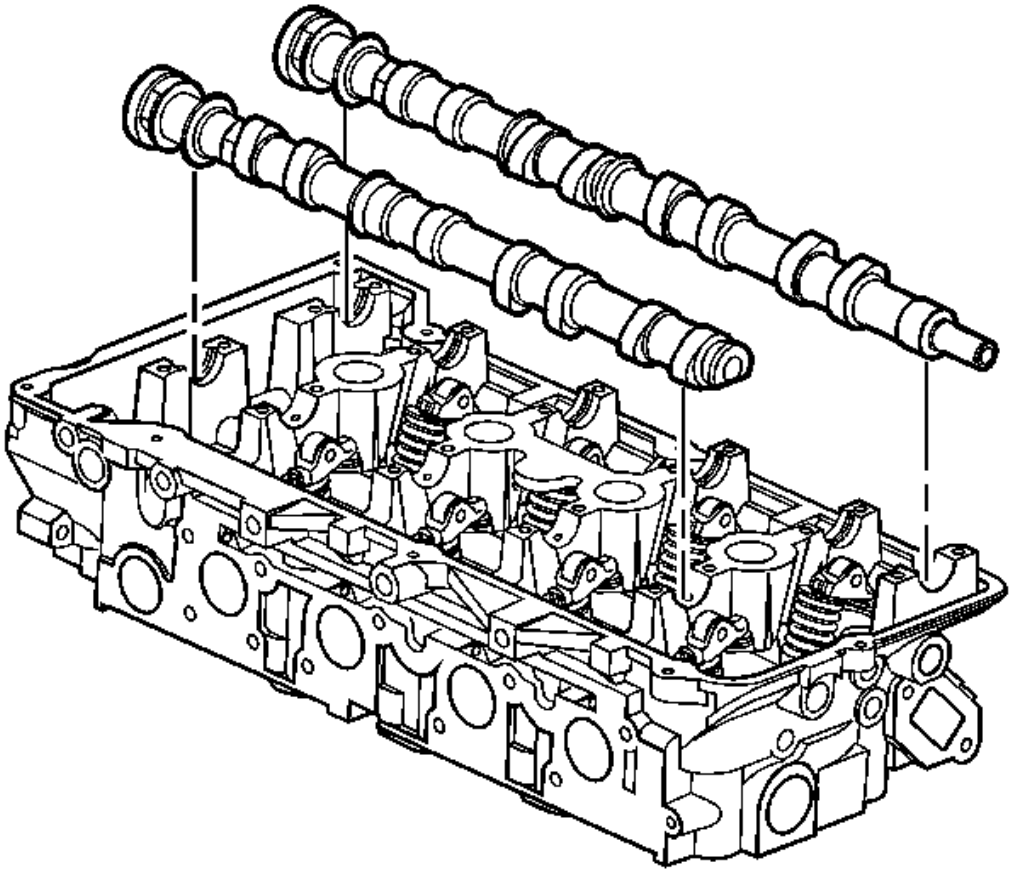


Fig. 270: View of Camshafts
Courtesy of GENERAL MOTORS COMPANY

19. Remove the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

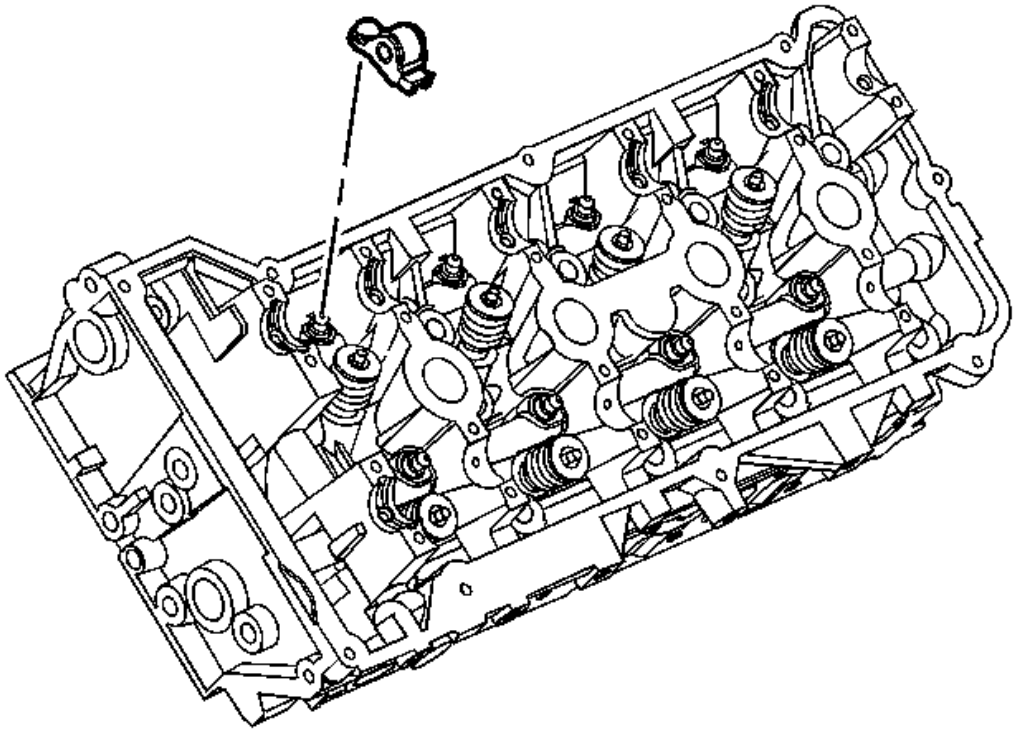


Fig. 271: Identifying Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

20. Remove the camshaft followers.
21. Clean and inspect the camshafts. Refer to **Camshaft Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

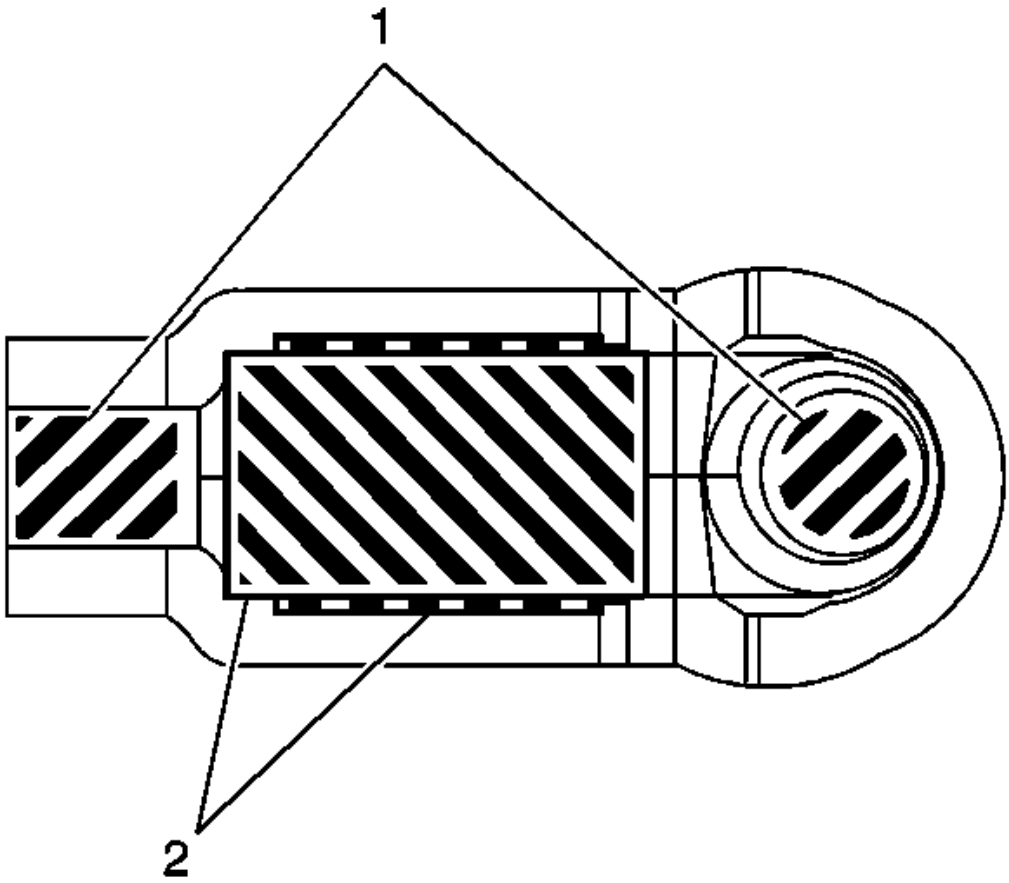


Fig. 272: Identifying Roller Pivot Pocket & Valve Slot Areas Of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

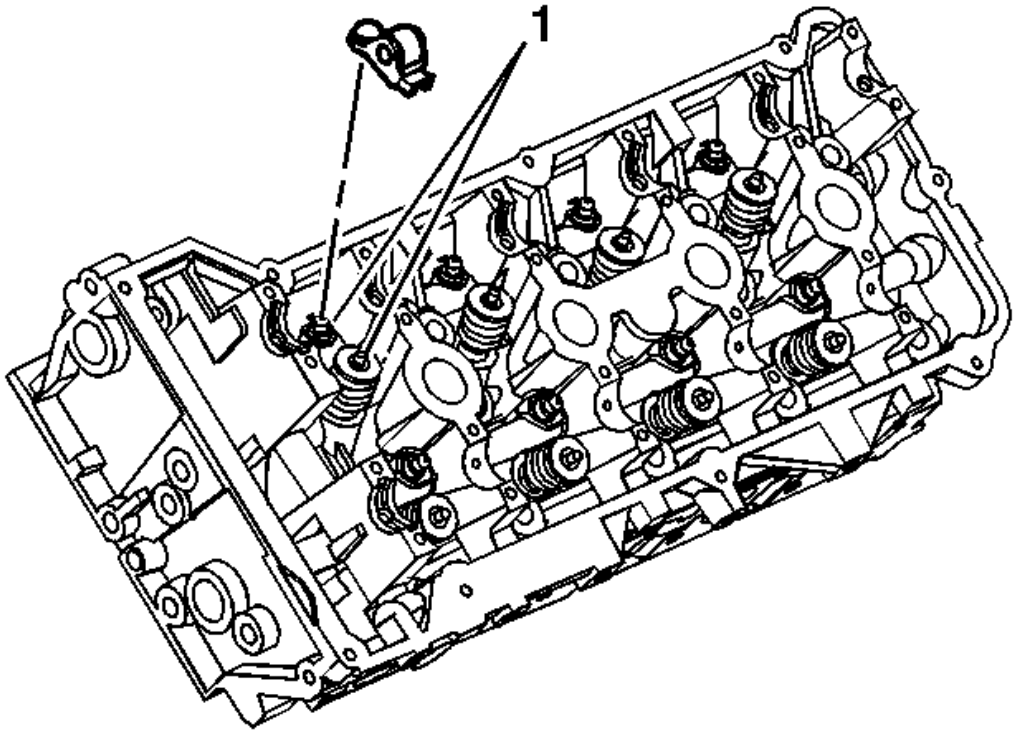


Fig. 273: Identifying the Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and the stationary hydraulic lash adjusters (SHLA) (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Clean the camshaft carriers with a clean, lint-free cloth.

 © 2011 Mitchell Repair Information Company, LLC.

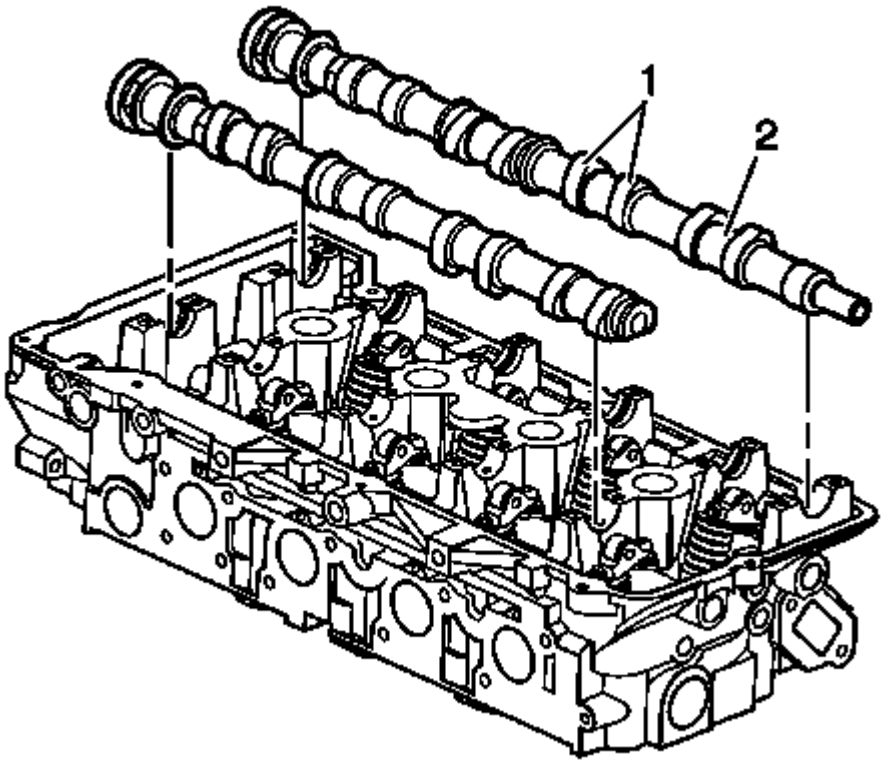


Fig. 274: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the camshaft carriers, camshaft lobes (1) and the camshaft journals (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
5. Place the camshaft in the camshaft carriers with the camshaft sprocket drive pins near the top of their rotation and the camshaft lobes in a neutral position. The camshafts can be identified by a stamping near the rear journal. For example: L-EXH is defined as Left bank Exhaust.

 © 2011 Mitchell Repair Information Company, LLC.

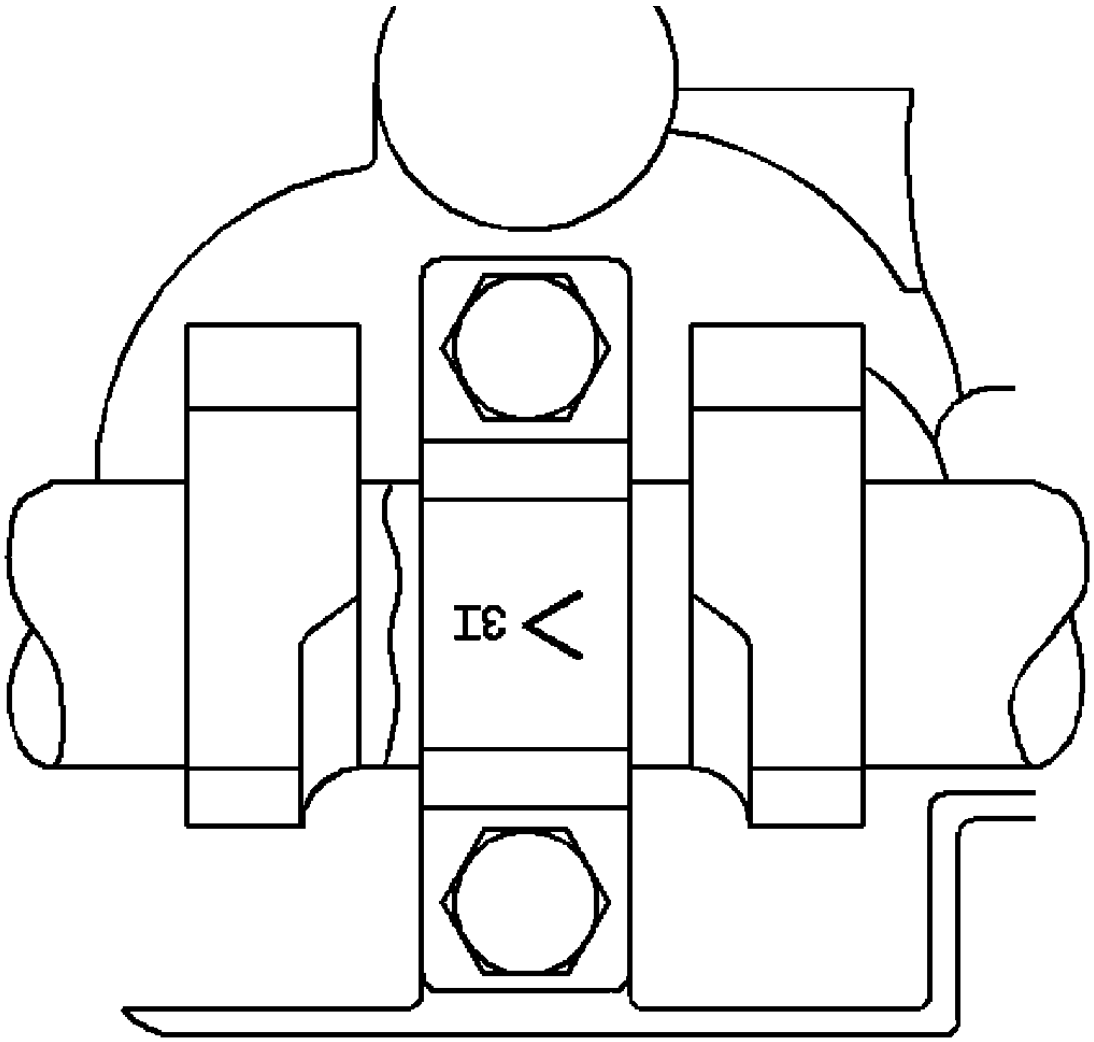


Fig. 275: Identifying Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

6. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The arrow should point to the front of the engine.
    - The number indicates the position from the front of the engine.
    - The "E" indicates the exhaust camshaft.
    - The "I" indicates the Intake camshaft.
7. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

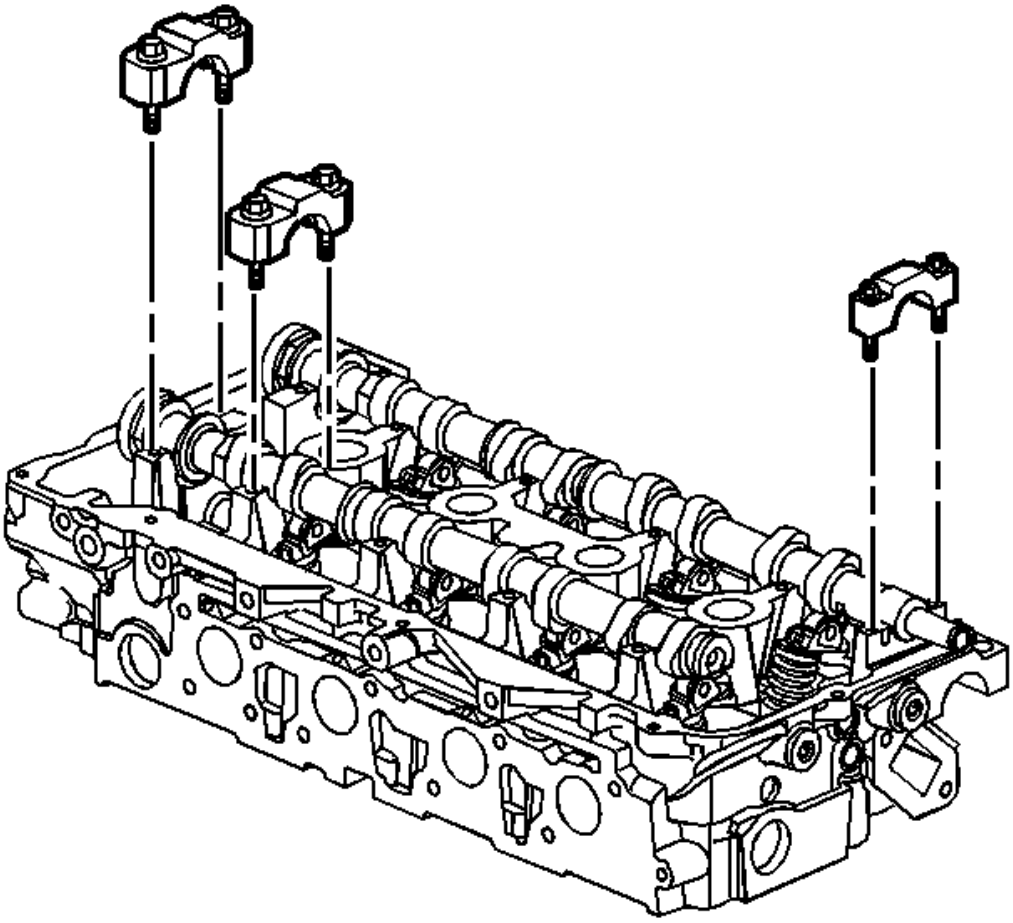


Fig. 276: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing caps according to the identification marks.

 © 2011 Mitchell Repair Information Company, LLC.

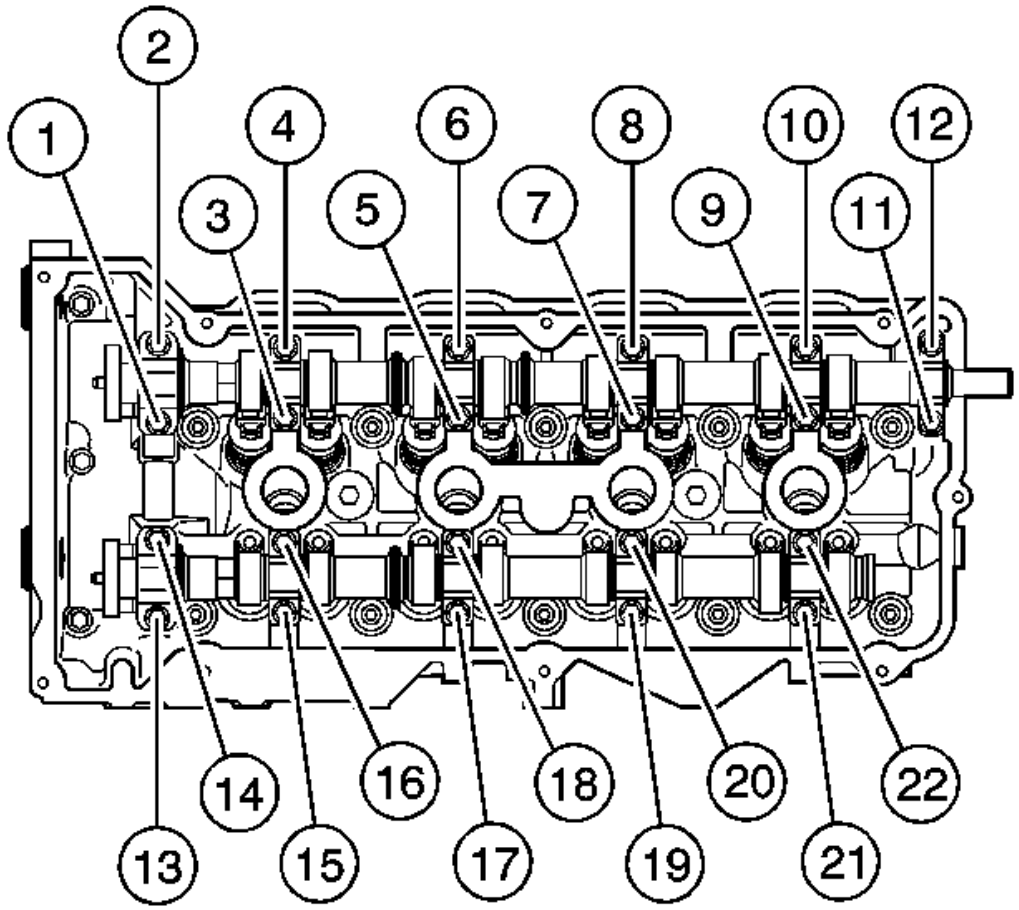


Fig. 277: Camshaft Bearing Cap Bolt Installation Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Install the camshaft bearing cap bolts in sequence.

Tighten

1. Alternately hand tighten the camshaft bearing cap bolts a few turns at a time until all caps are fully seated.
2. Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).
3. Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059**

 © 2011 Mitchell Repair Information Company, LLC.

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

10. Align the camshafts.

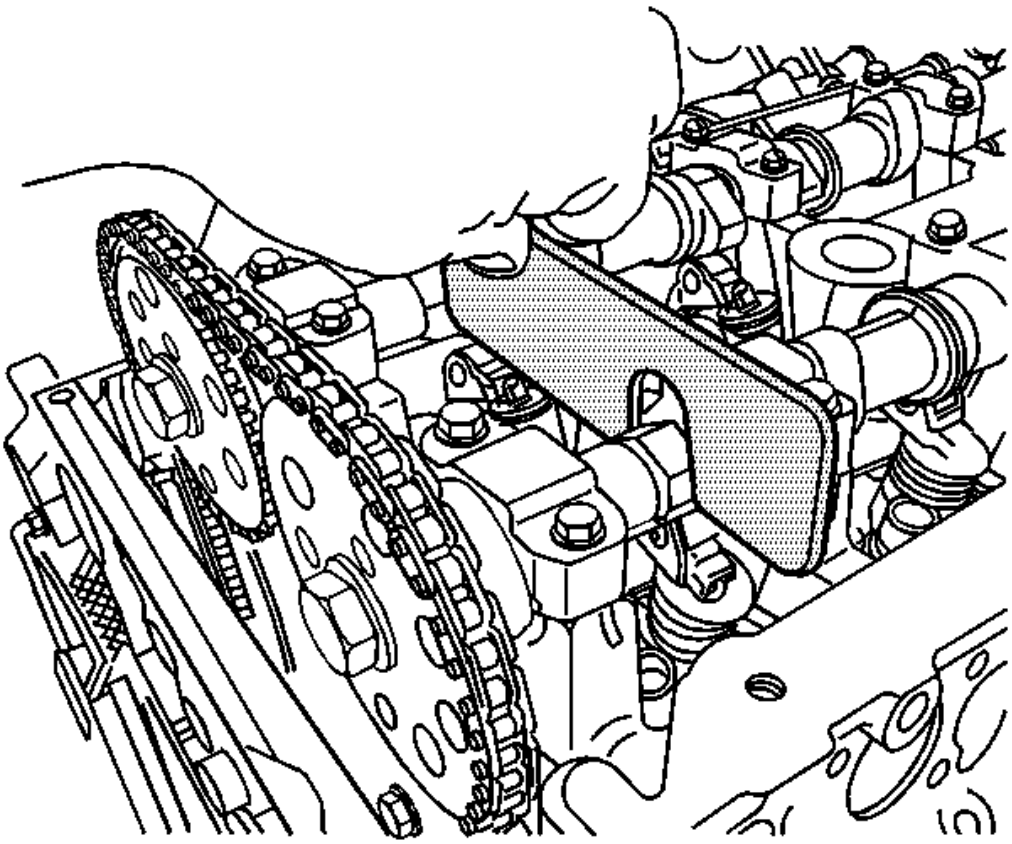


Fig. 278: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

11. Install the **J 44212** over the camshafts.

NOTE: Ensure the camshaft sprockets properly engage the camshaft sprocket drive pins and camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

12. Install the intake and exhaust camshaft sprockets aligning the paint marks made during disassembly. Ensure that the camshaft sprockets align with the pins of the camshafts.

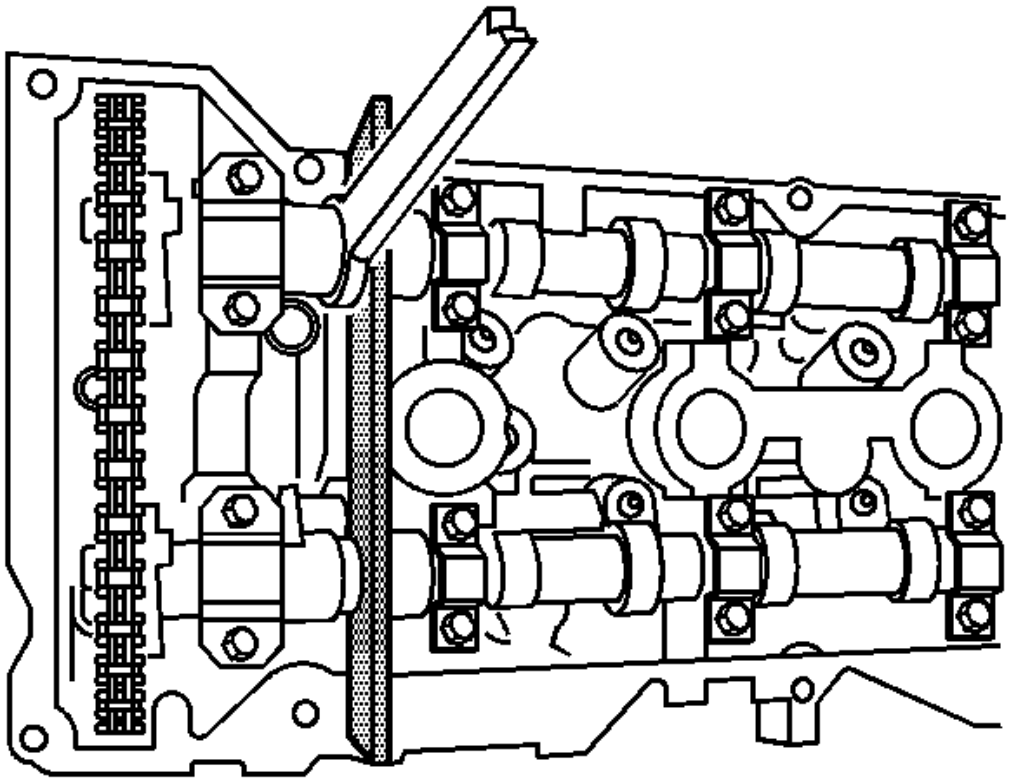


Fig. 279: Holding Camshaft
Courtesy of GENERAL MOTORS COMPANY

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when tightening the camshaft sprocket bolts.

 © 2011 Mitchell Repair Information Company, LLC.

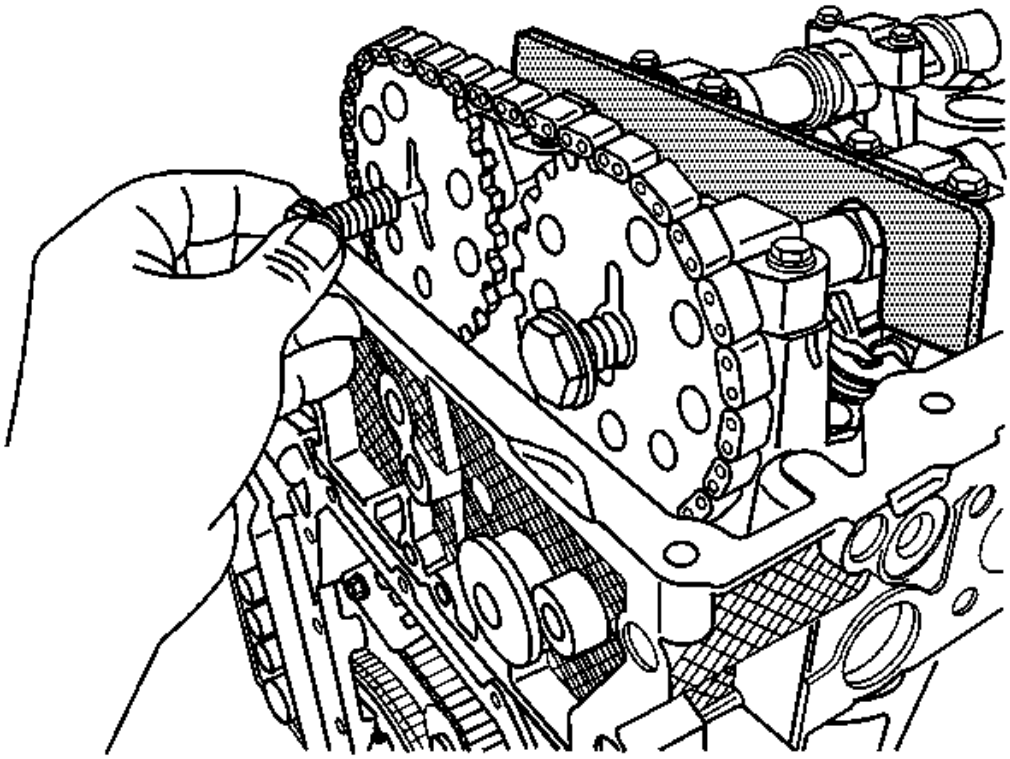


Fig. 280: Identifying Left Intake Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Install the camshaft sprocket bolts.

    Tighten

    Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

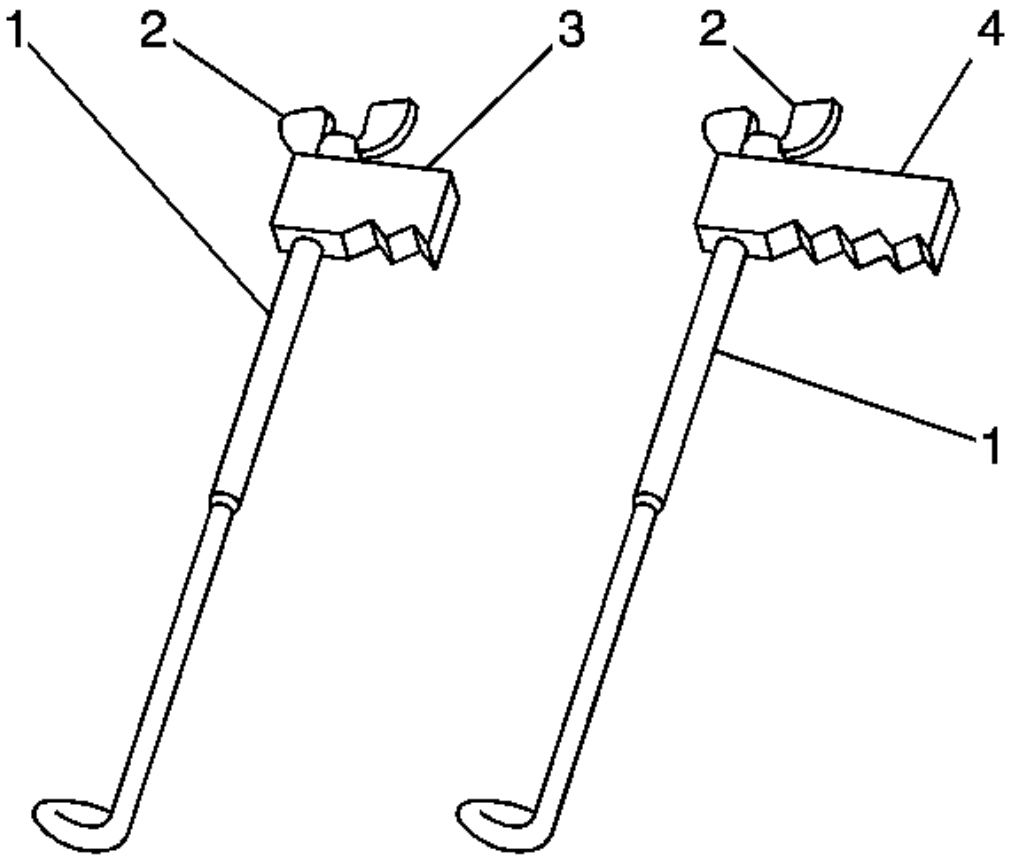


Fig. 281: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **EN 46327** (1).

 © 2011 Mitchell Repair Information Company, LLC.

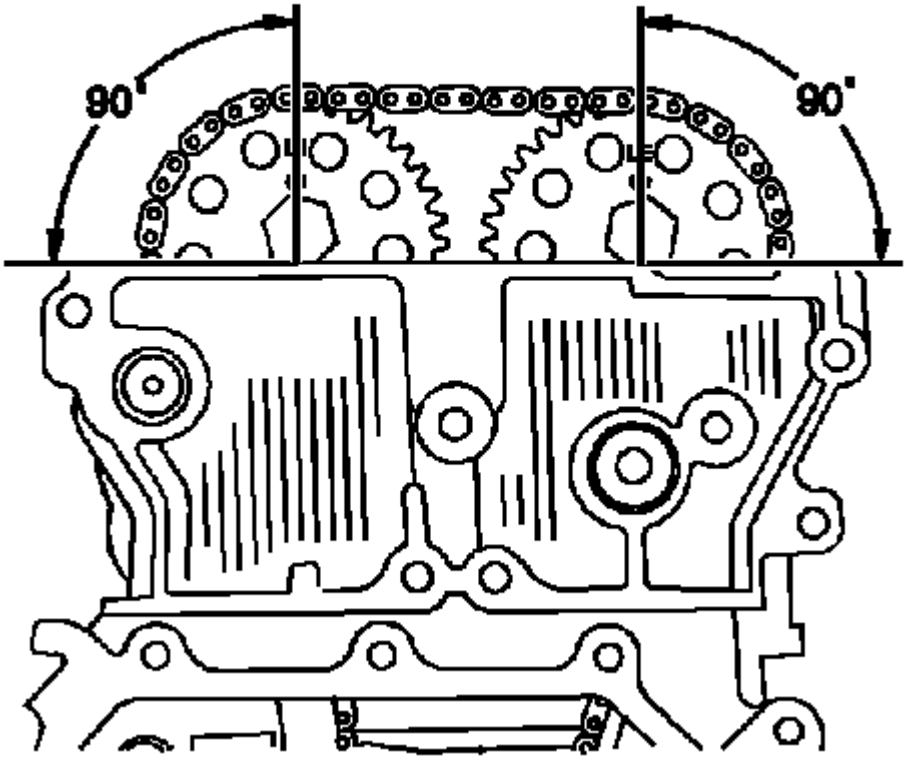


Fig. 282: Ensuring Camshaft Sprocket Pins Are At Top Of Rotation
Courtesy of GENERAL MOTORS COMPANY

16. Verify the camshaft sprocket alignment.

 © 2011 Mitchell Repair Information Company, LLC.

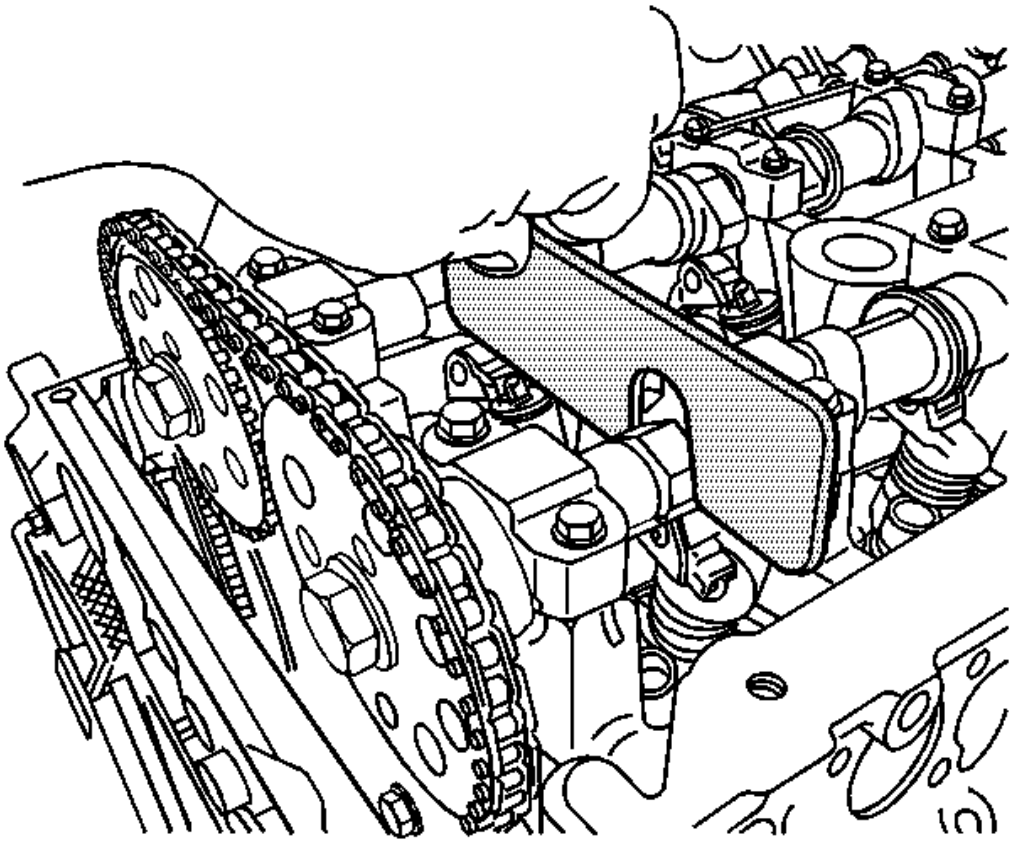


Fig. 283: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove the **J 44212** from the camshafts.
18. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

CAMSHAFT REPLACEMENT - RIGHT SIDE

Special Tools

- **EN 46327** Timing Chain Retention Tool
- **J 45059** Angle Meter
- **J 44212** Camshaft Holding Tool

Removal Procedure

1. Remove the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

2. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .

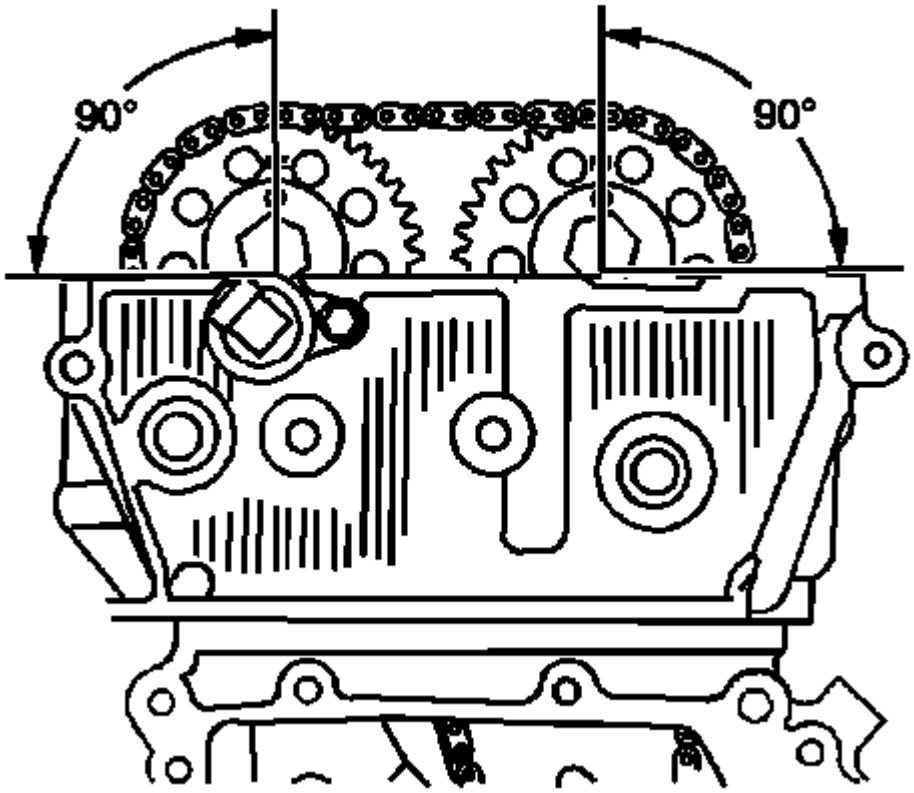


Fig. 284: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft to TDC of the # 1 cylinders compression stroke, both camshaft sprocket drive pins should be at the top of their rotation.

 © 2011 Mitchell Repair Information Company, LLC.

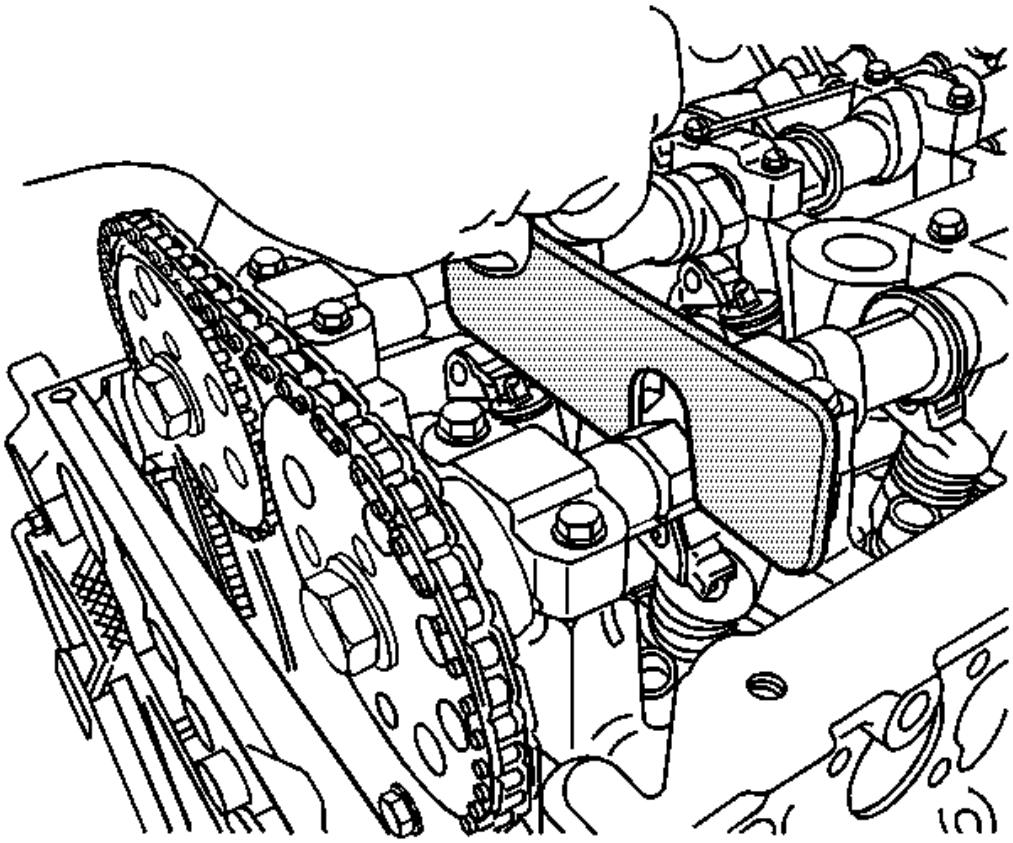


Fig. 285: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

4. Install the **J 44212** over the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

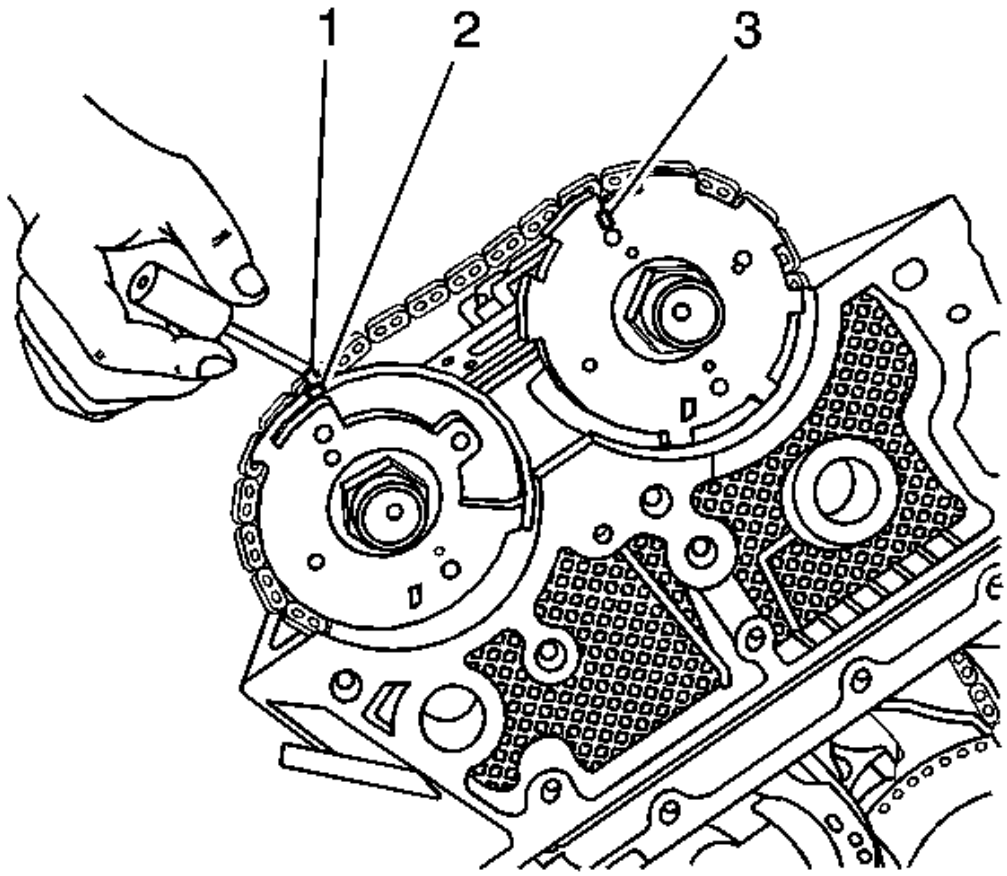


Fig. 286: Using A Paint Stick To Create A Mark On The Timing Chain Link Adjacent To Each Camshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

5. Use a paint stick to create a mark (1) on the timing chain link adjacent to each camshaft sprocket timing mark (2, 3).

 © 2011 Mitchell Repair Information Company, LLC.

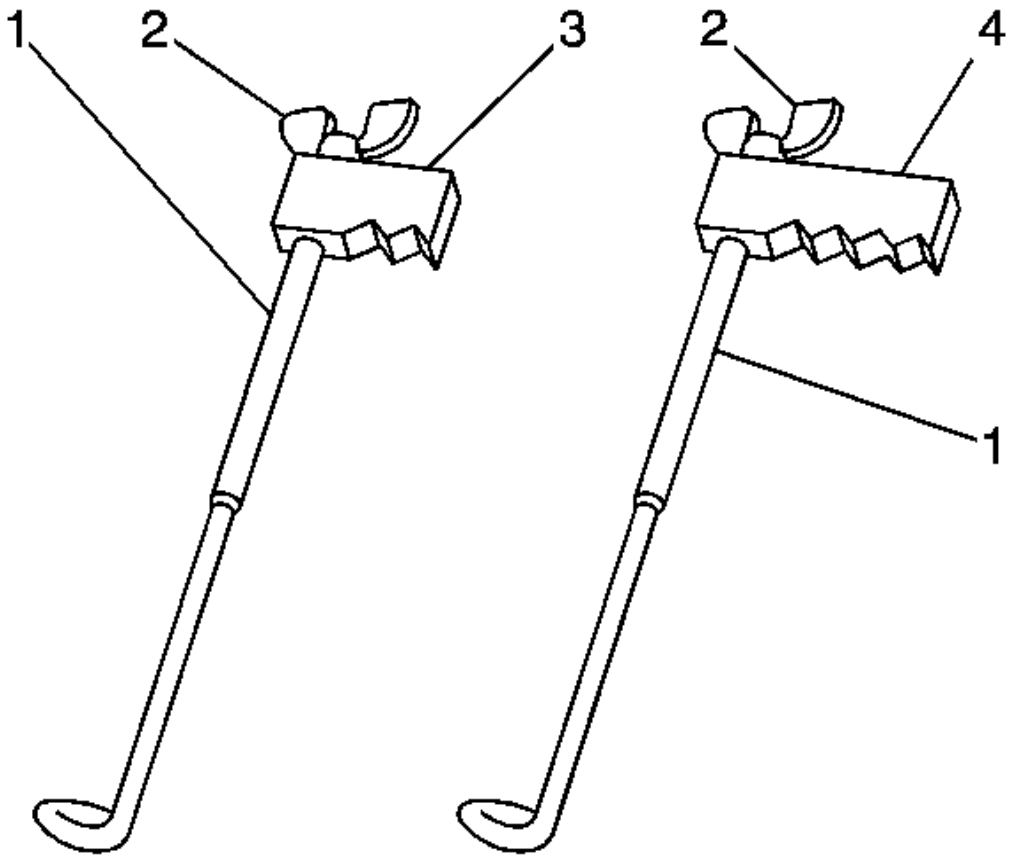


Fig. 287: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

6. Install both **EN 46327** (1) to the engine using the following step:

   Rotate the wing nut (2) of the **EN 46327** (3) to the top of its travel.

 © 2011 Mitchell Repair Information Company, LLC.

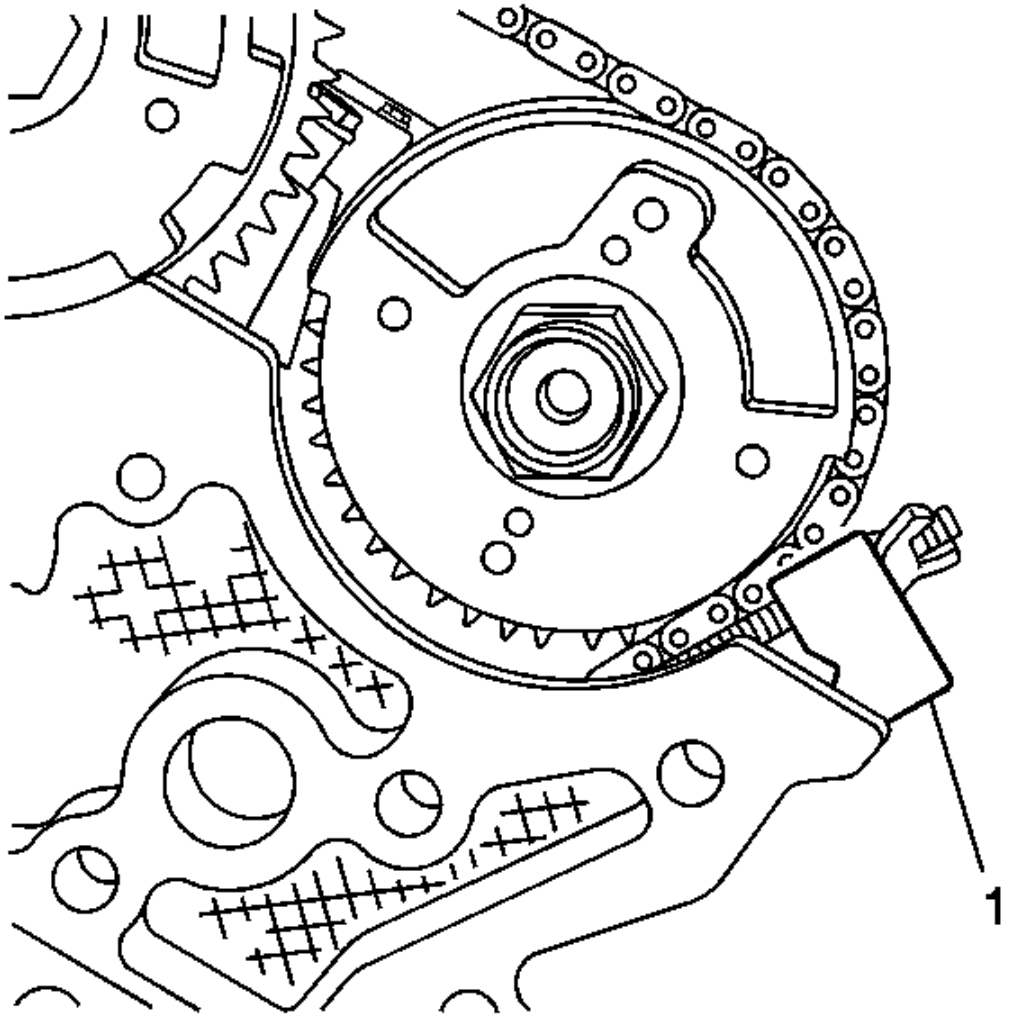


Fig. 288: Positioning Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Position the bottom retention tool on the cylinder head with the V-notch of the block (1) adjacent to the right exhaust camshaft sprocket and chain.

 © 2011 Mitchell Repair Information Company, LLC.

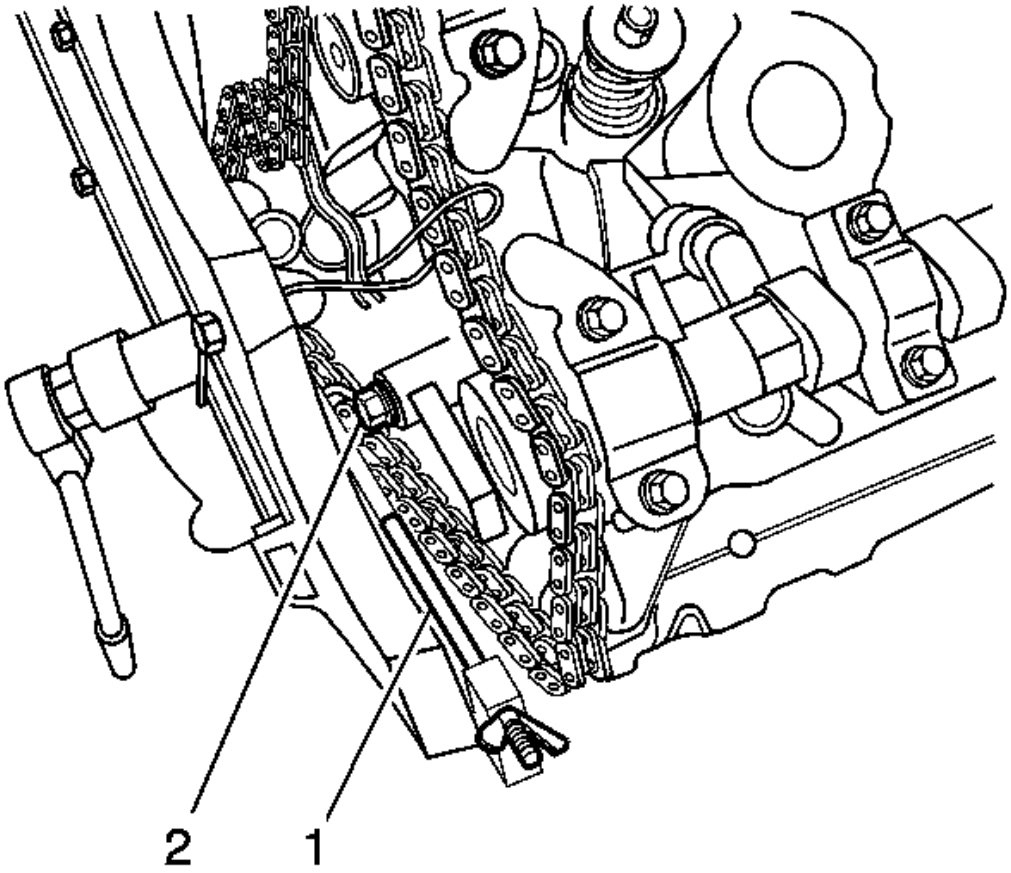


Fig. 289: Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS COMPANY

8. Insert the hook end (2) into a secondary timing chain link as shown.

 © 2011 Mitchell Repair Information Company, LLC.

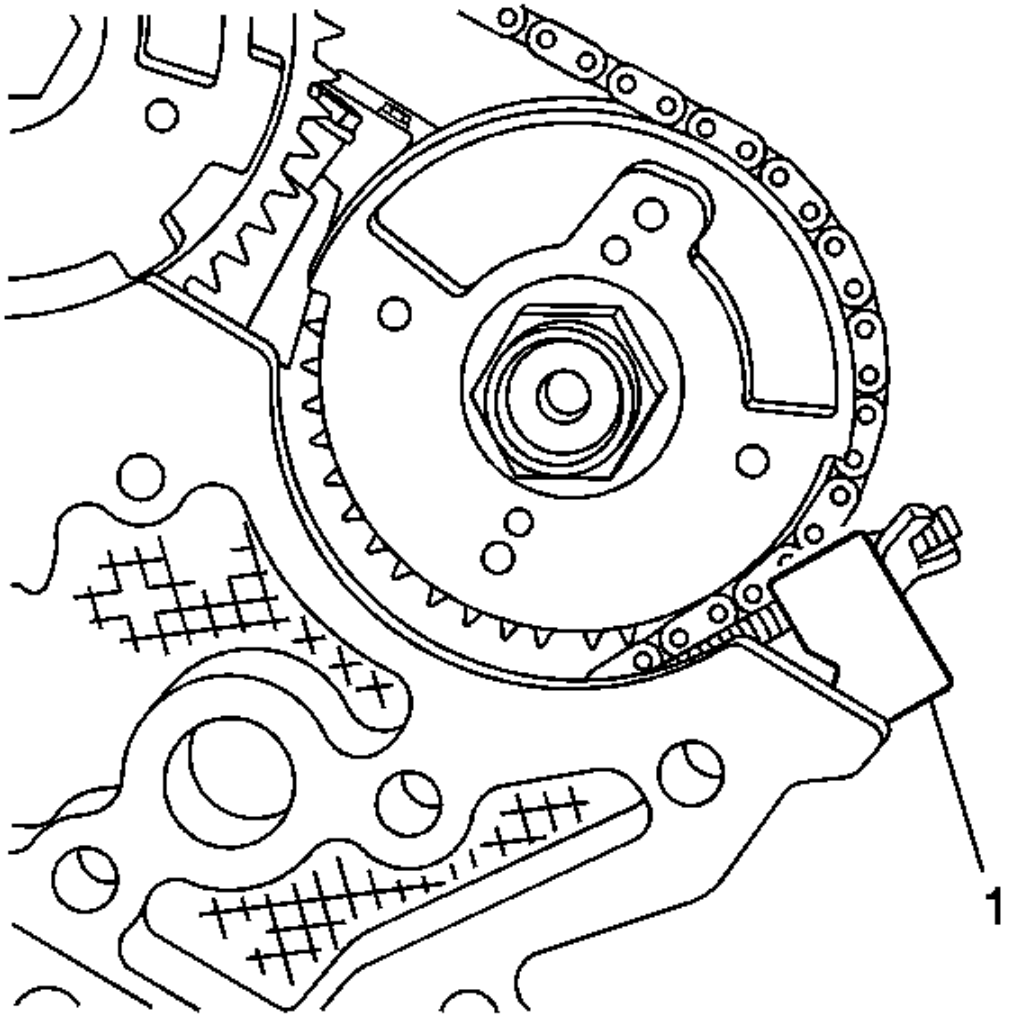


Fig. 290: Positioning Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

9. Rotate the wing nut until it contacts the retention tool block (1). DO NOT tighten the wing nut at this time.

 © 2011 Mitchell Repair Information Company, LLC.

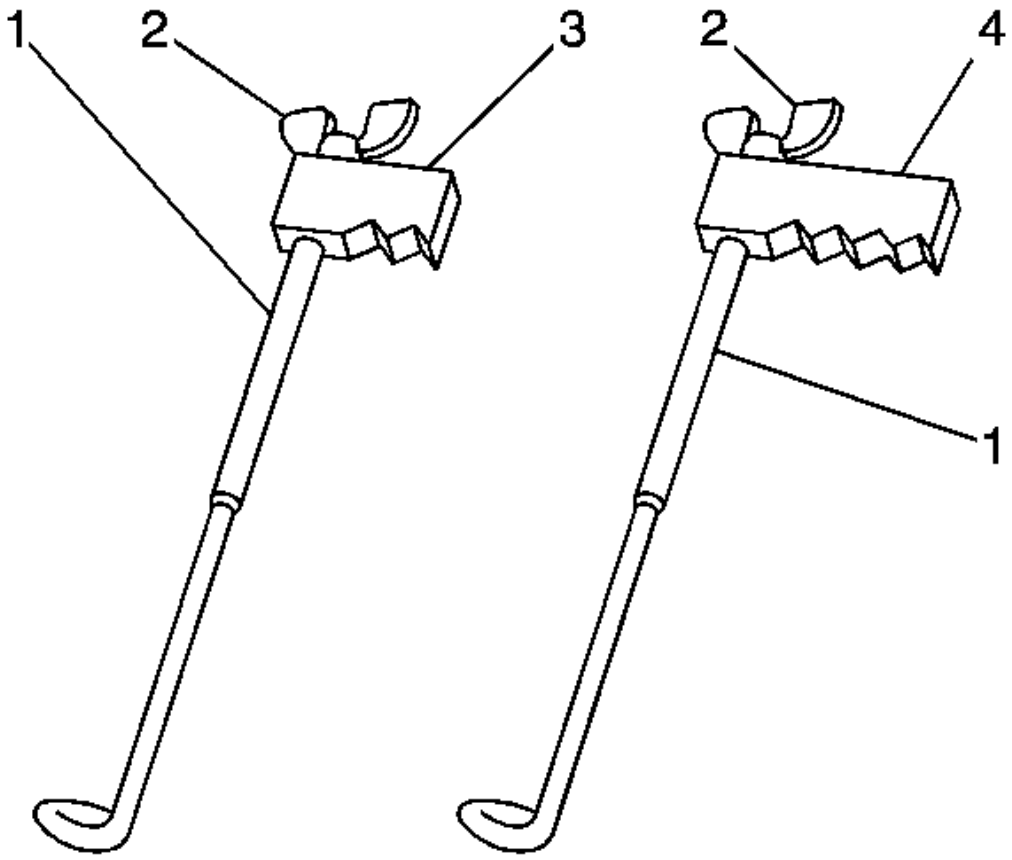


Fig. 291: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

10. Rotate the wing nut (2) of the **EN 46327** (4) to the top of its travel.

 © 2011 Mitchell Repair Information Company, LLC.

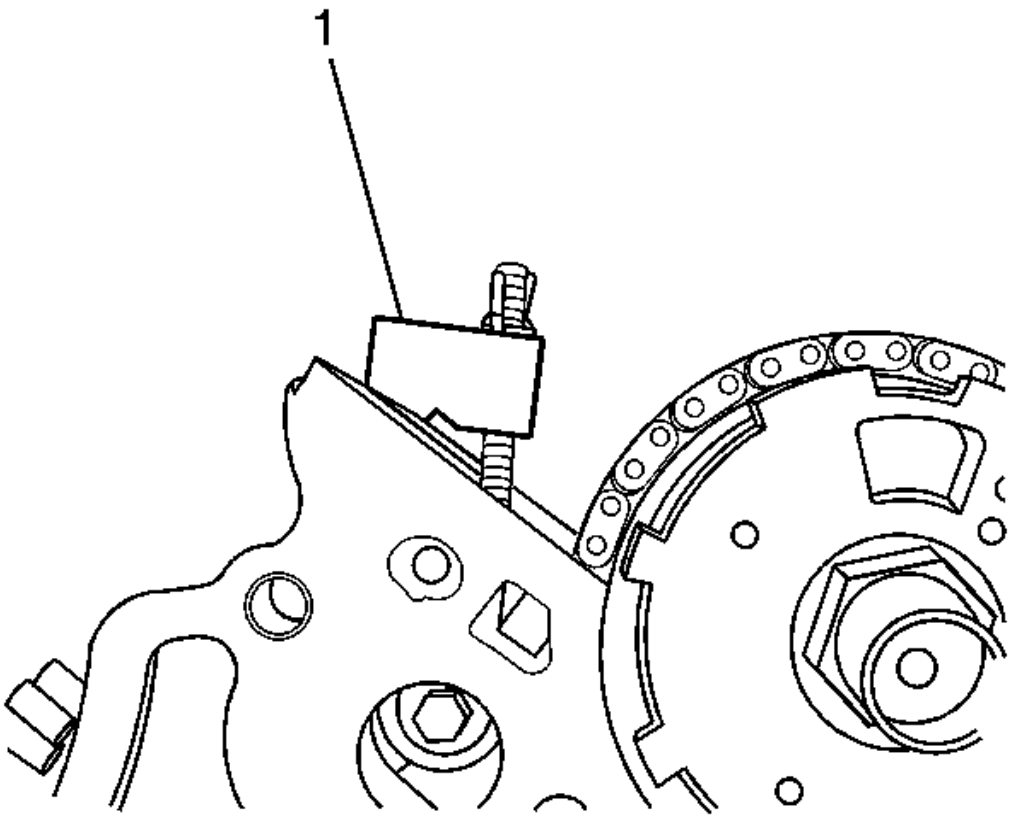


Fig. 292: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

11. Position the top retention tool on the cylinder head with the V-notch of the block (1) adjacent to the right intake camshaft sprocket and chain.

 © 2011 Mitchell Repair Information Company, LLC.

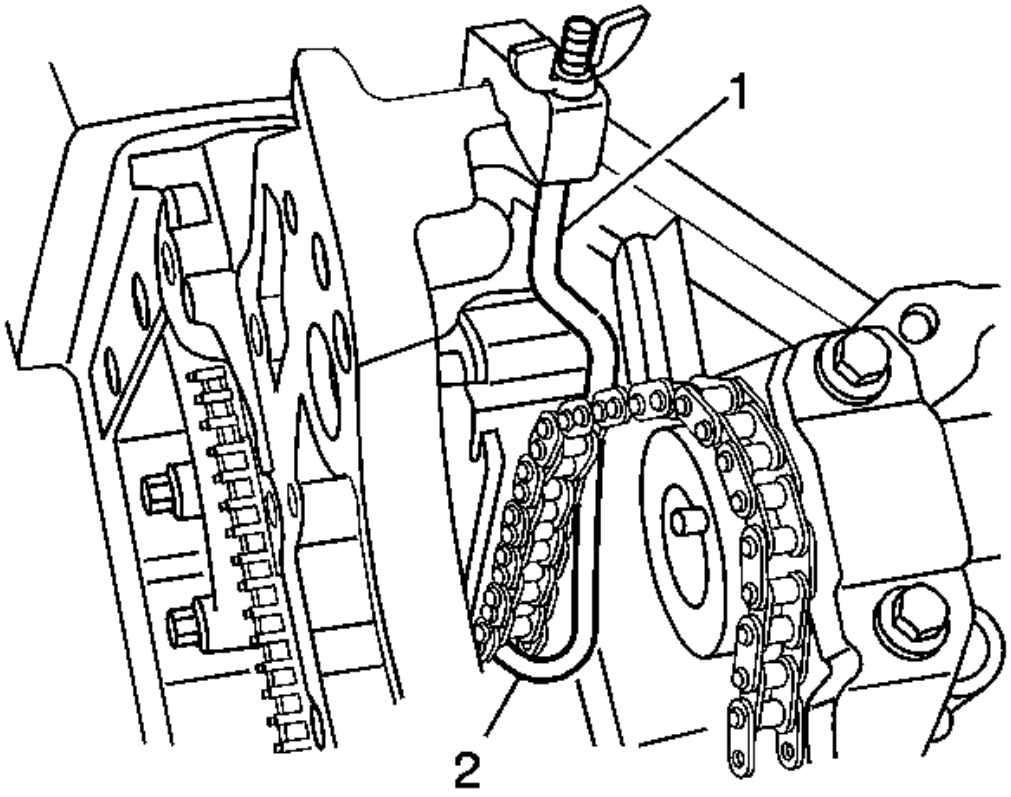


Fig. 293: View Of Hook End In Secondary Timing Chain Link
Courtesy of GENERAL MOTORS COMPANY

12. Insert the hook end (2) into a secondary timing chain link as shown.

 © 2011 Mitchell Repair Information Company, LLC.

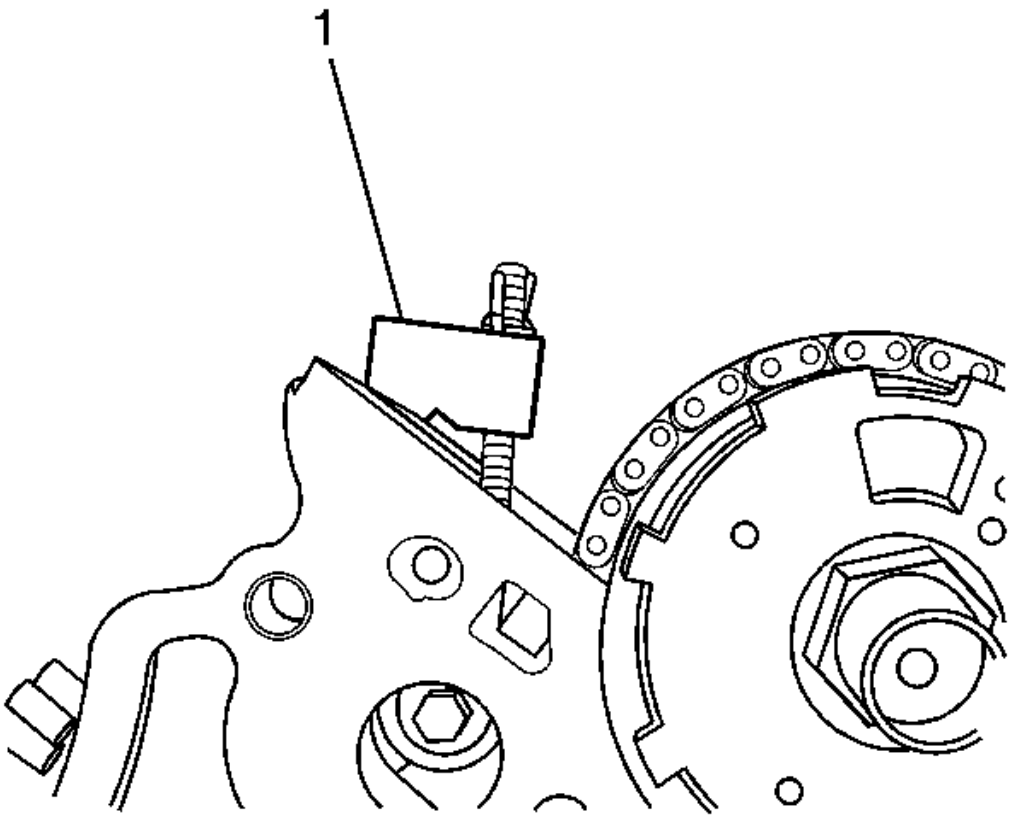


Fig. 294: Positioning Top Retention Tool On Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

13. Rotate the wing nut until it contacts the retention tool block (1). Alternately tighten both wing nuts to retain the chain.

 © 2011 Mitchell Repair Information Company, LLC.

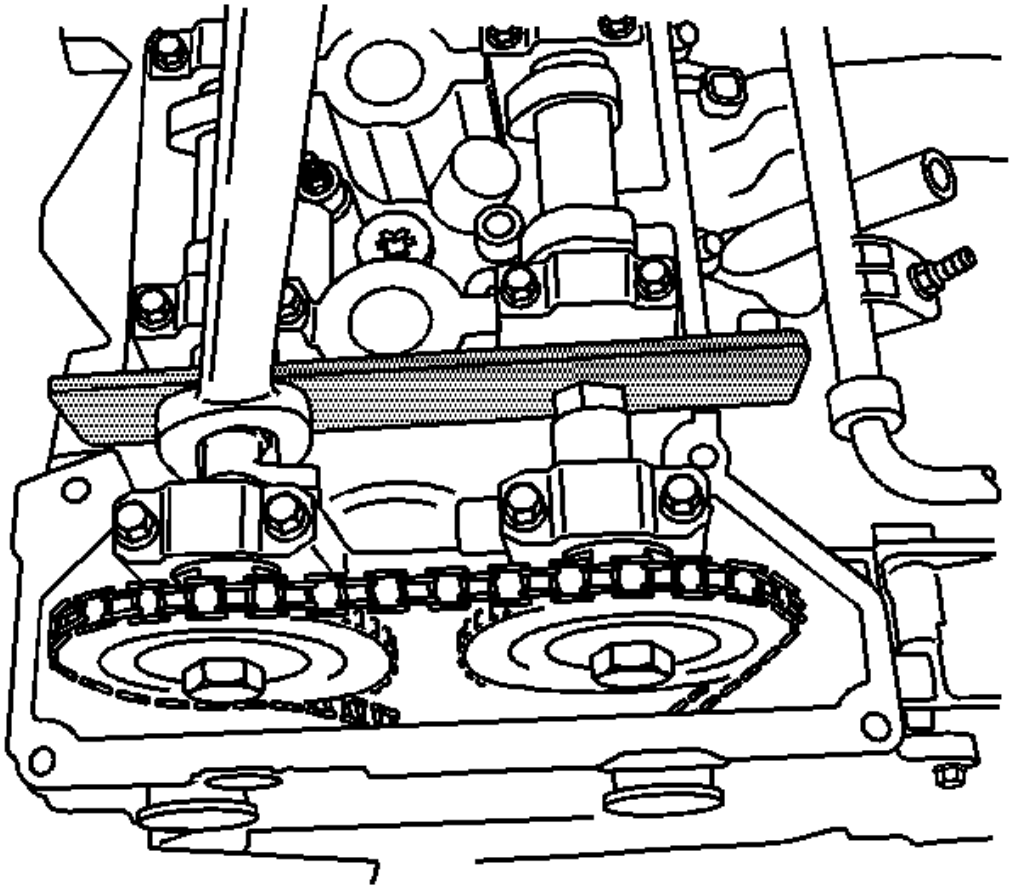


Fig. 295: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

14. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when removing the camshaft sprocket bolts.

 © 2011 Mitchell Repair Information Company, LLC.

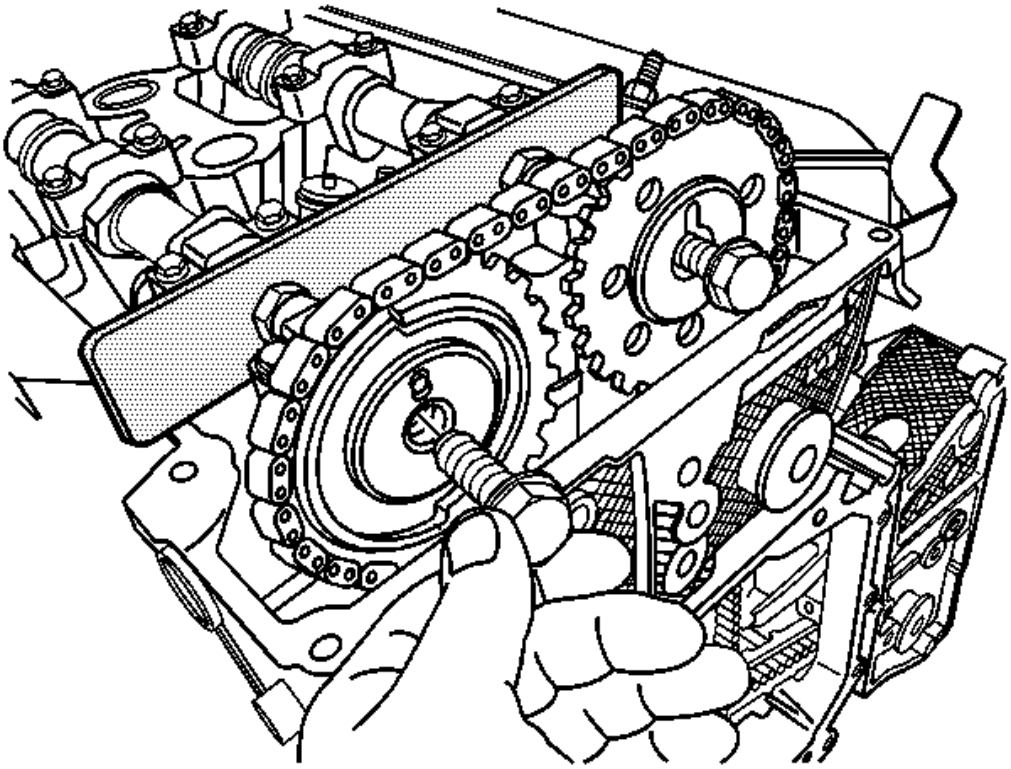


Fig. 296: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Remove the camshaft sprocket bolts.
16. Remove the camshaft sprockets.

 © 2011 Mitchell Repair Information Company, LLC.

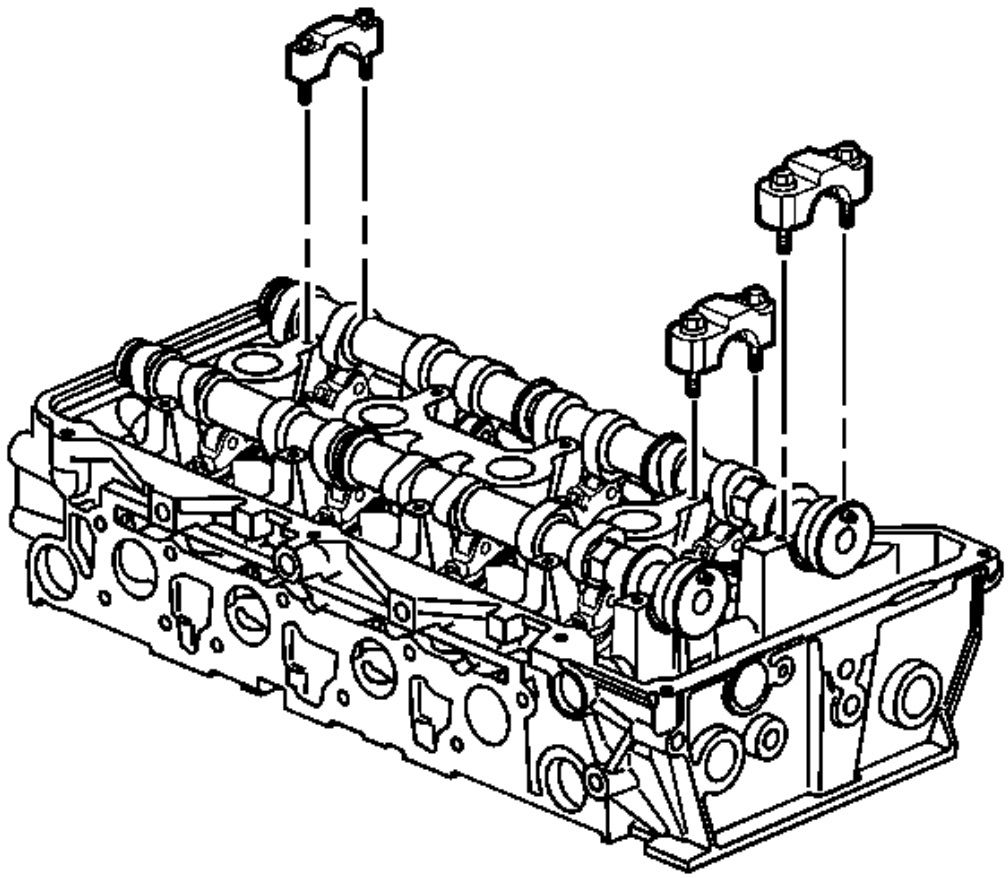


Fig. 297: View of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

17. Alternately loosen the camshaft bearing cap bolts a few turns at a time until all valve spring pressure has been released.
18. Remove the camshaft bearing caps.
19. Remove the **J 44212** from the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

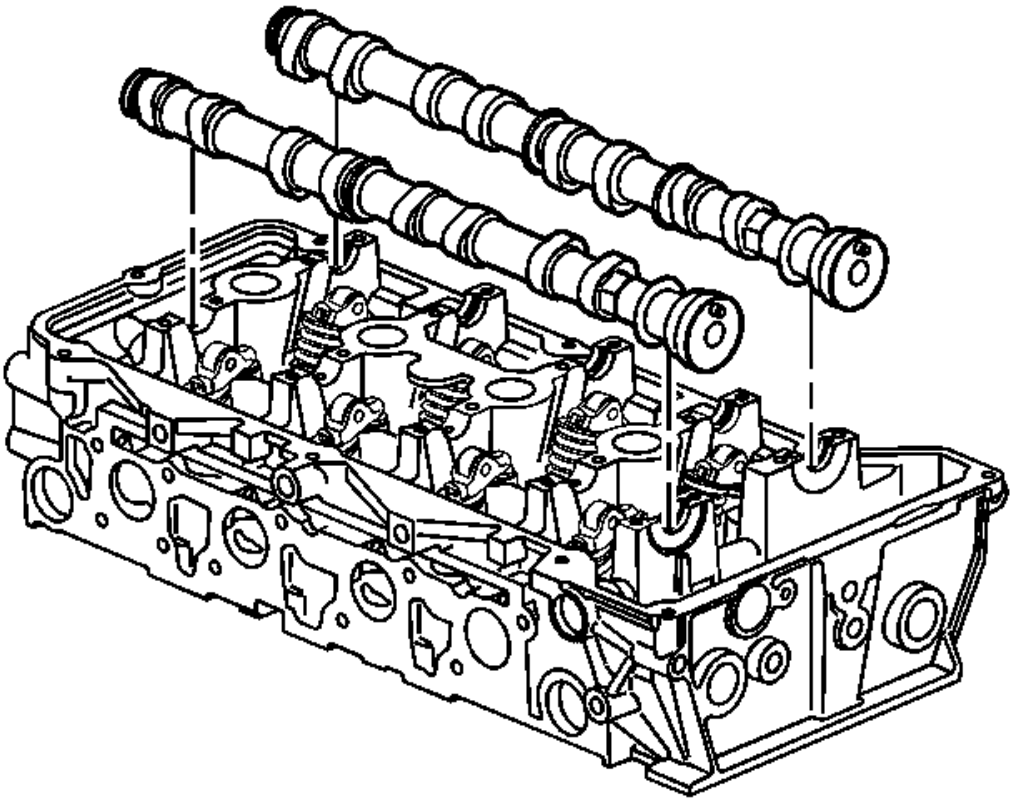


Fig. 298: View of Camshafts
Courtesy of GENERAL MOTORS COMPANY

20. Remove the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

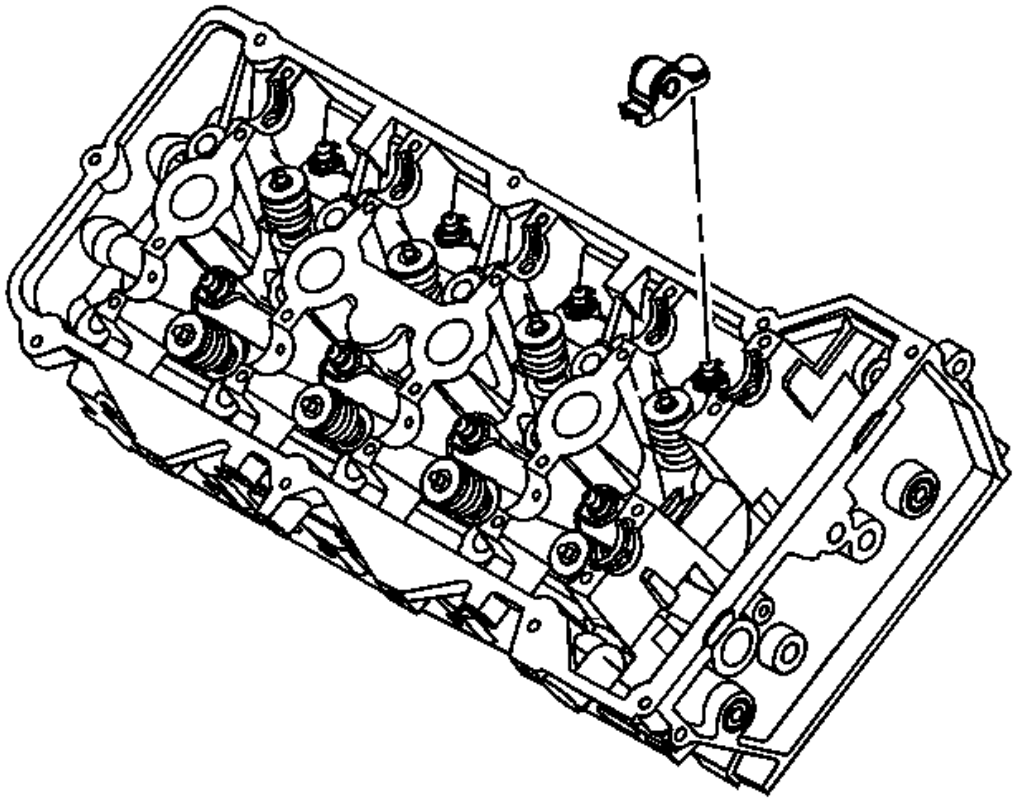


Fig. 299: View of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

21. Remove the camshaft followers.
22. Clean and inspect the camshafts. Refer to **Camshaft Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

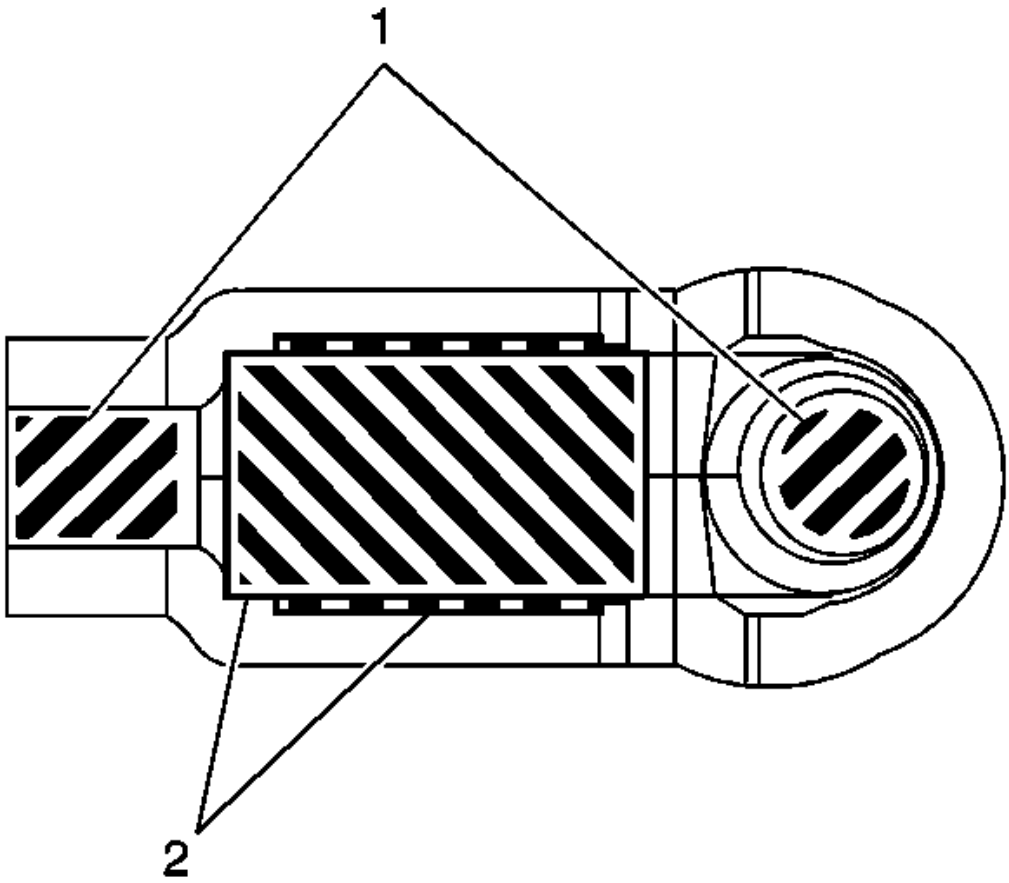


Fig. 300: Identifying Roller Pivot Pocket & Valve Slot Areas Of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

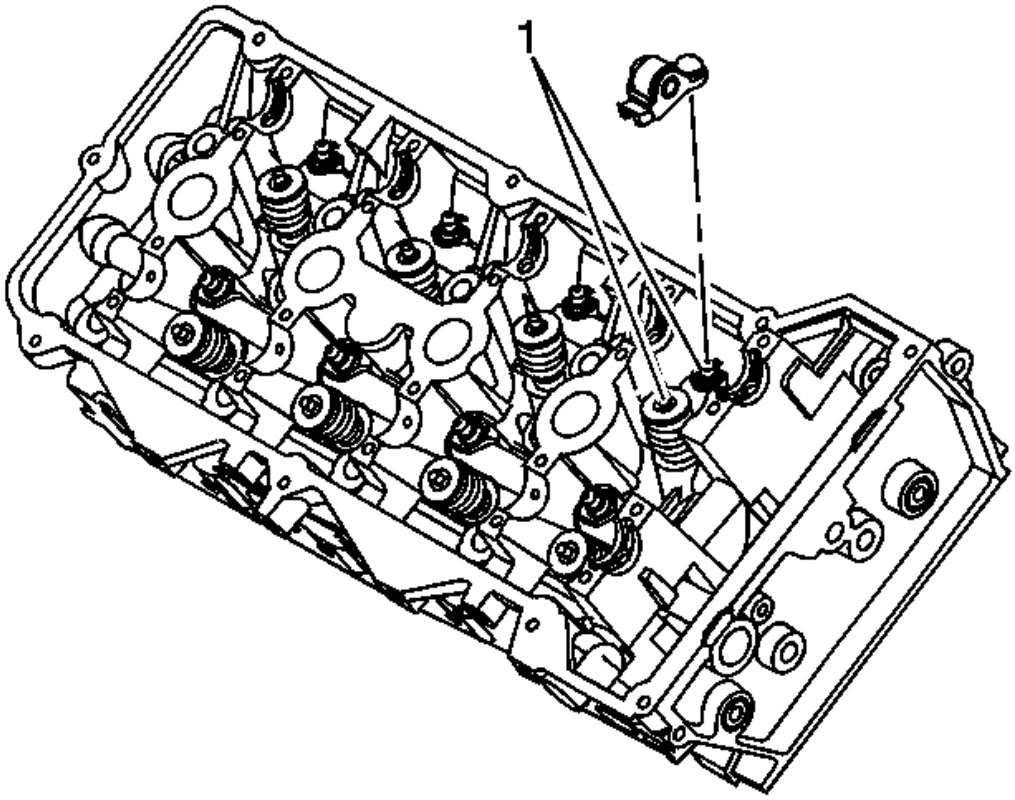


Fig. 301: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and the stationary hydraulic lash adjusters (SHLA) (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Clean the camshaft carriers with a clean, lint-free cloth.

 © 2011 Mitchell Repair Information Company, LLC.

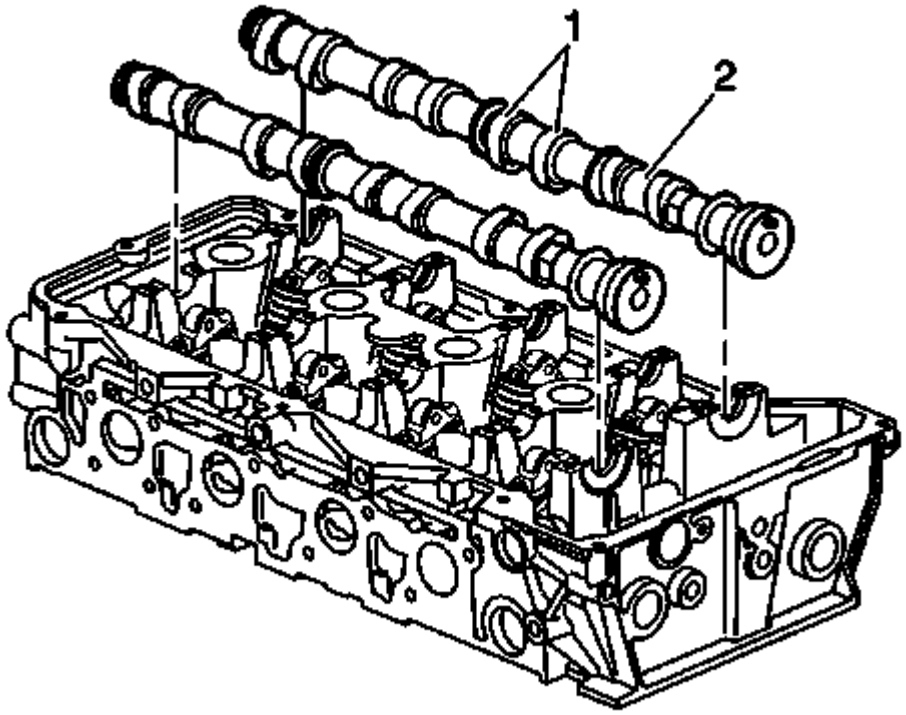


Fig. 302: Identifying Camshaft Lobes & Journals
Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the camshaft carriers, camshaft lobes (1) and the camshaft journals (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
5. Place the camshaft in the camshaft carriers with the camshaft sprocket drive pins near the top of their rotation and the camshaft lobes in a neutral position. The camshafts can be identified by a stamping near the rear journal. For example: R-EXH is defined as Right bank Exhaust.

 © 2011 Mitchell Repair Information Company, LLC.

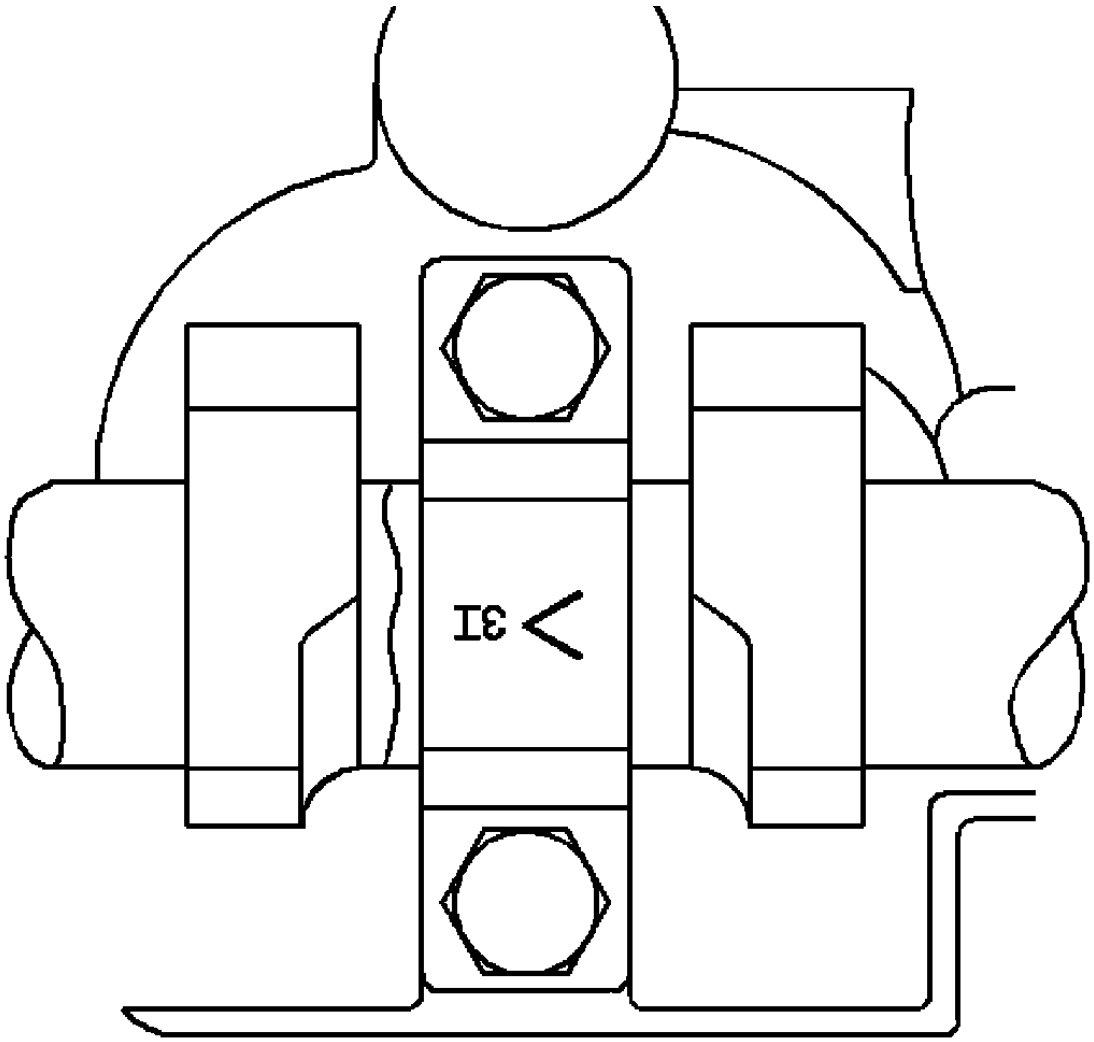


Fig. 303: Identifying Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

6. Observe the markings on the camshaft bearing caps. Each camshaft bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The arrow should point to the front of the engine.
    - The number indicates the position from the front of the engine.
    - The "E" indicates the exhaust camshaft.
    - The "I" indicates the Intake camshaft.
7. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

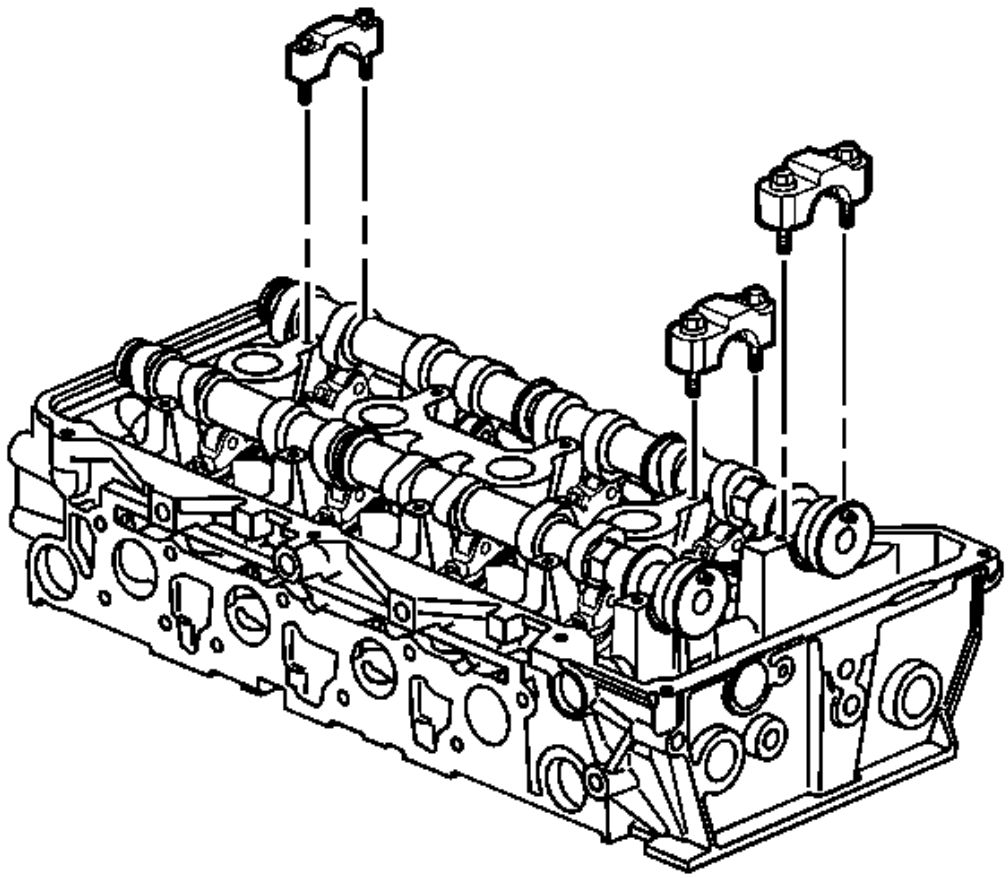


Fig. 304: View of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing caps according to the identification marks.

 © 2011 Mitchell Repair Information Company, LLC.

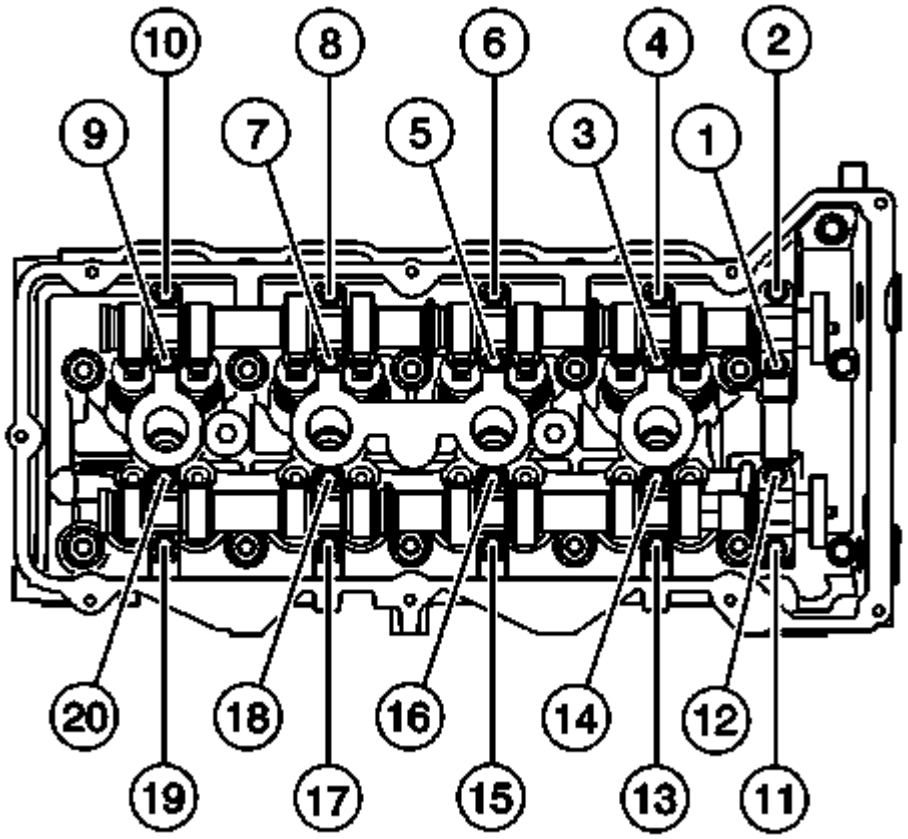


Fig. 305: Identifying Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Install the camshaft bearing cap bolts in sequence.

   Tighten

   1. Alternately hand tighten the camshaft bearing cap bolts a few turns at a time until all caps are fully seated.
   2. Tighten the camshaft bearing cap bolts to 5 N.m (44 lb in).
   3. Tighten the camshaft bearing cap bolts an additional 30 degrees using the **J 45059** .

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

10. Align the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

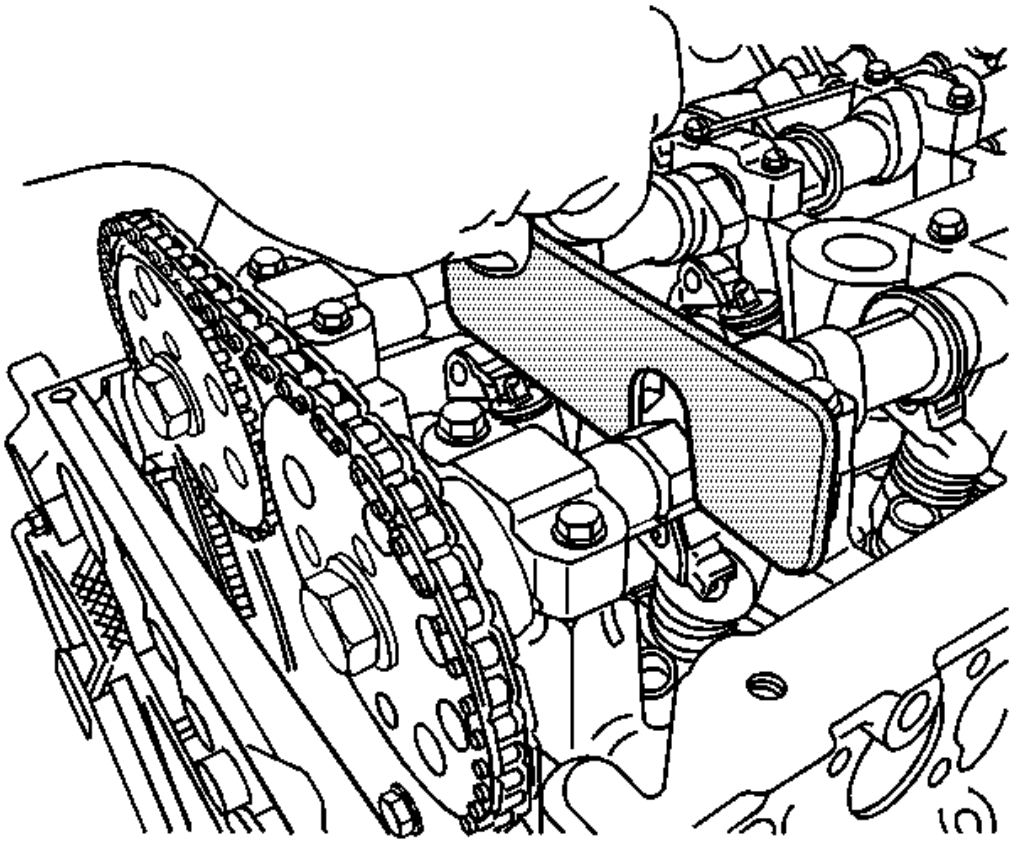


Fig. 306: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Holding Tool Warning .

11. Install the **J 44212** over the camshafts.

NOTE: Ensure the camshaft sprockets properly engage the camshaft sprocket drive pins and camshafts.

12. Install the intake and exhaust camshaft sprockets aligning the paint marks made during disassembly. Ensure that the camshaft sprockets align with the pins of the camshafts.

 © 2011 Mitchell Repair Information Company, LLC.

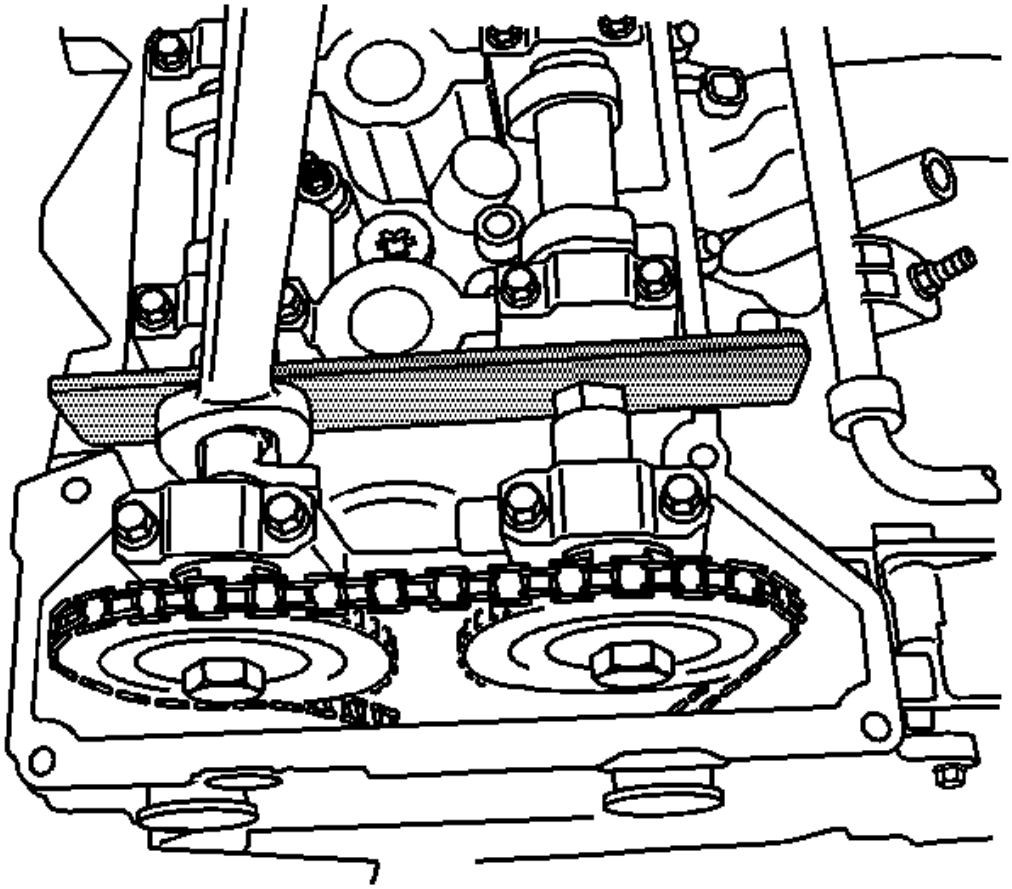


Fig. 307: Securing Camshaft Using An Open End Wrench
Courtesy of GENERAL MOTORS COMPANY

13. Use an open wrench on the hex cast into the camshafts in order to prevent the camshafts from rotating when tightening the camshaft sprocket bolts.

 © 2011 Mitchell Repair Information Company, LLC.

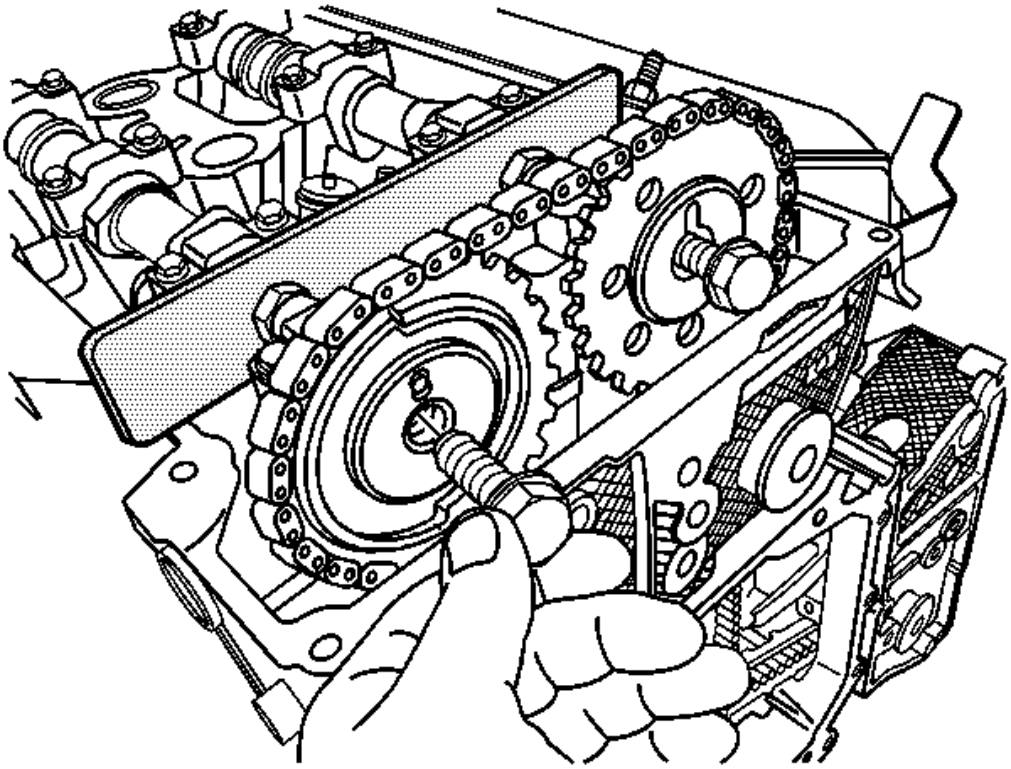


Fig. 308: Identifying Right Exhaust Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Install the camshaft sprocket bolts.

Tighten

Tighten the camshaft sprocket bolts to 120 N.m (89 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

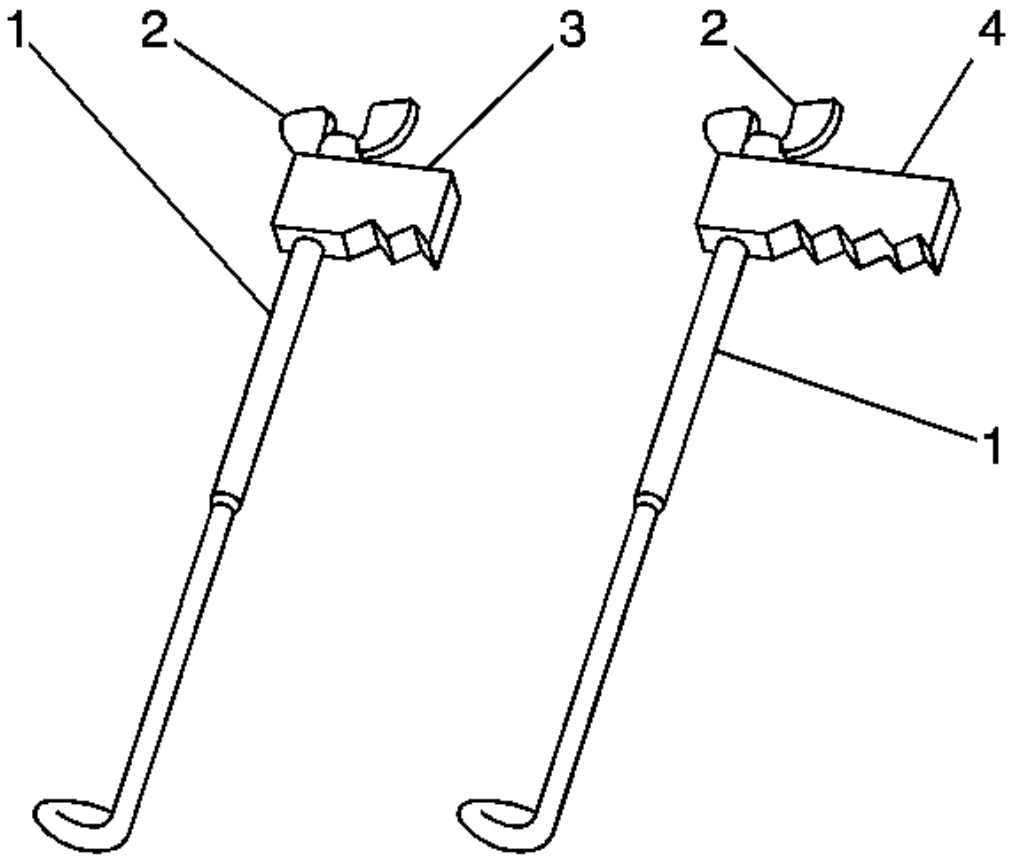


Fig. 309: Identifying Timing Chain Retention Tool Components
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **EN 46327** (1).

 © 2011 Mitchell Repair Information Company, LLC.

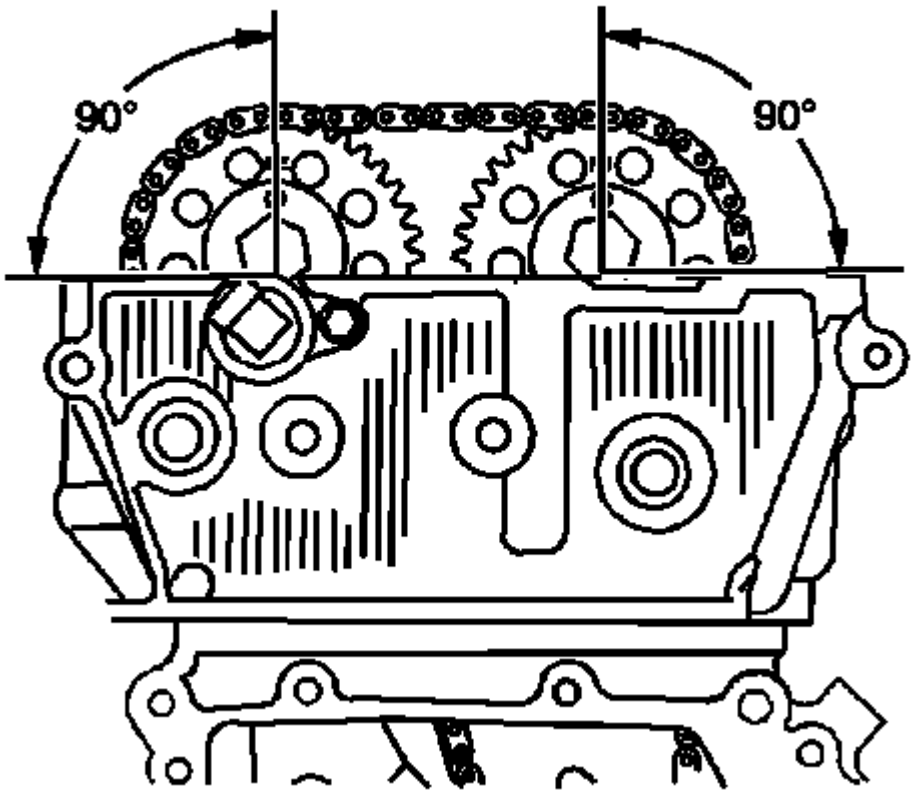


Fig. 310: Ensuring Camshaft Sprocket Drive Pins Are At Top Of Their Rotation
Courtesy of GENERAL MOTORS COMPANY

16. Verify the camshaft sprocket alignment.

 © 2011 Mitchell Repair Information Company, LLC.

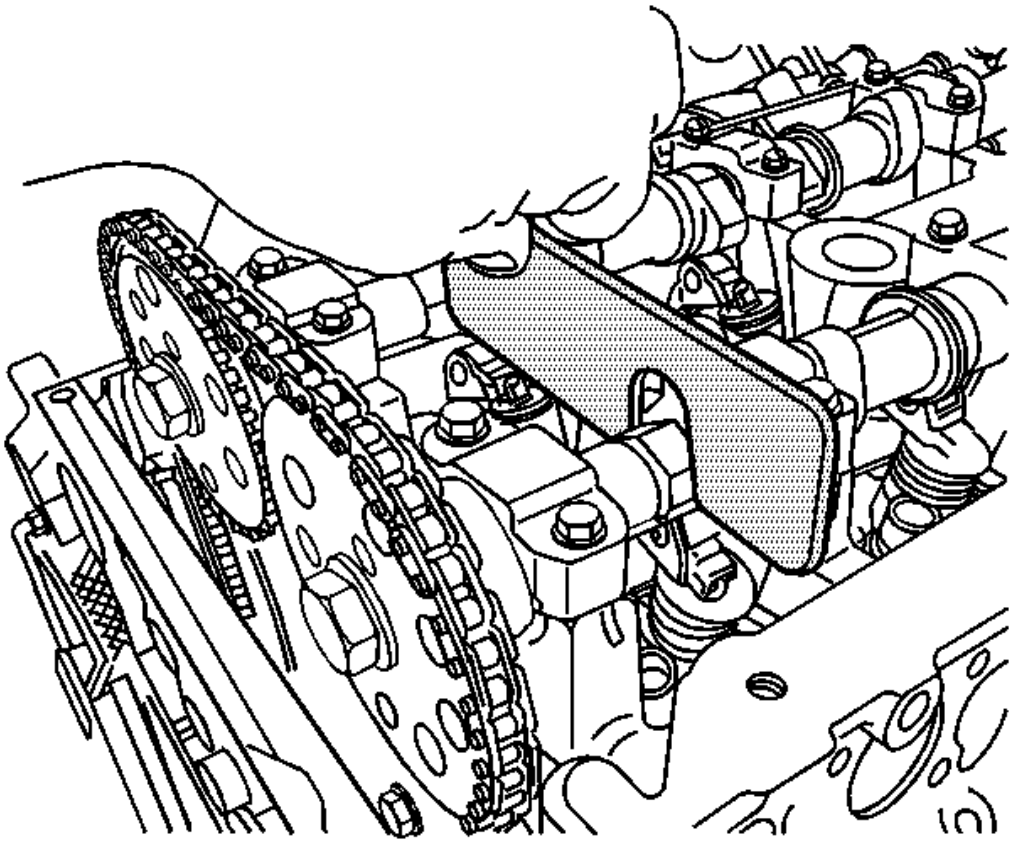


Fig. 311: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove the **J 44212** from the camshafts.
18. Install the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .
19. Install the right camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the left camshafts. Refer to **Camshaft Replacement - Left Side**.

 © 2011 Mitchell Repair Information Company, LLC.

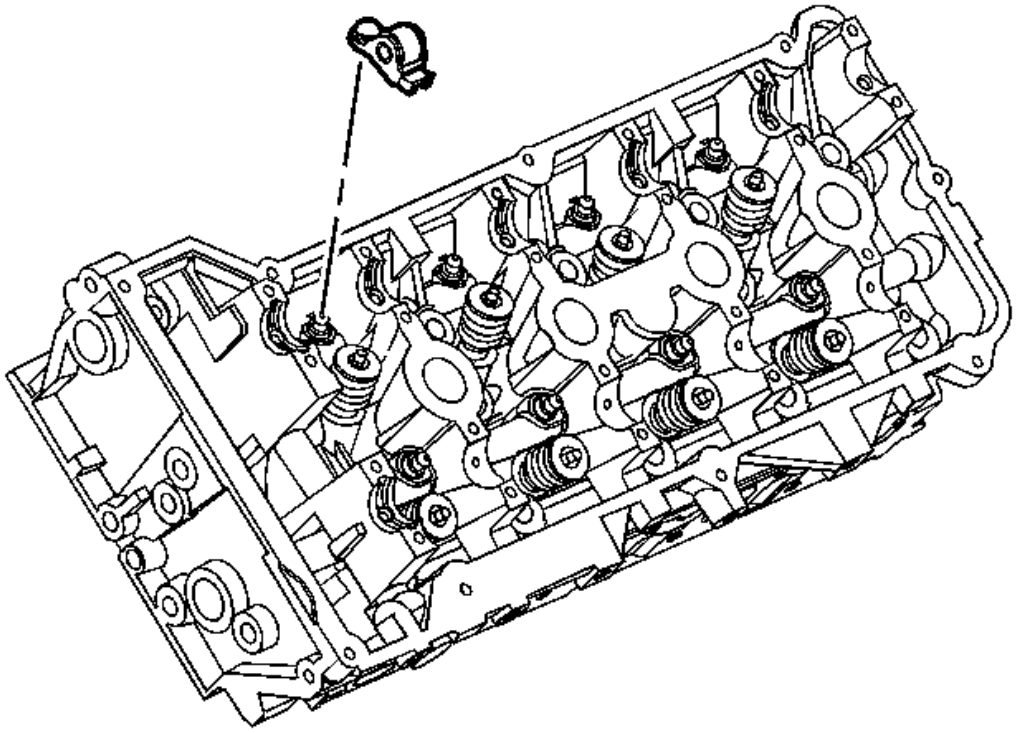


Fig. 312: Identifying Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: If the followers are being reused, arrange them so that they may be put back in their original locations.

2. Remove the camshaft followers.
3. Clean and inspect the rocker arms. Refer to **Valve Rocker Arm Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

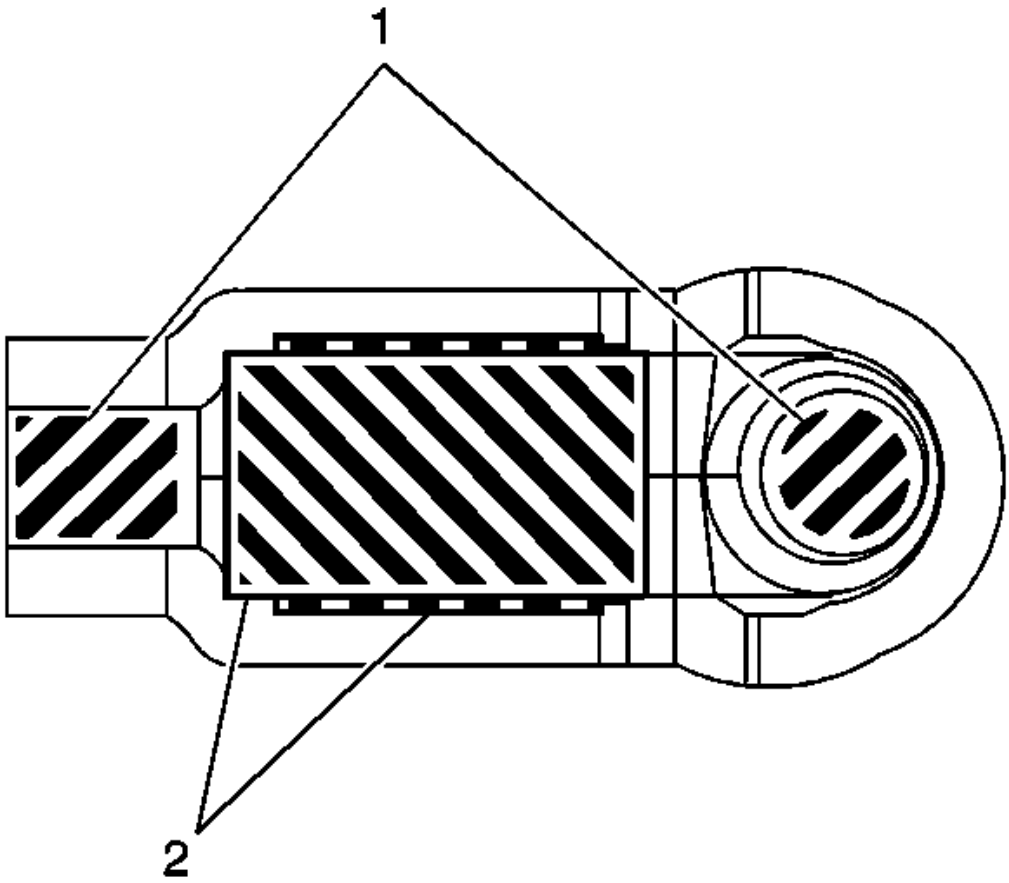


Fig. 313: Identifying Roller Pivot Pocket & Valve Slot Areas Of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

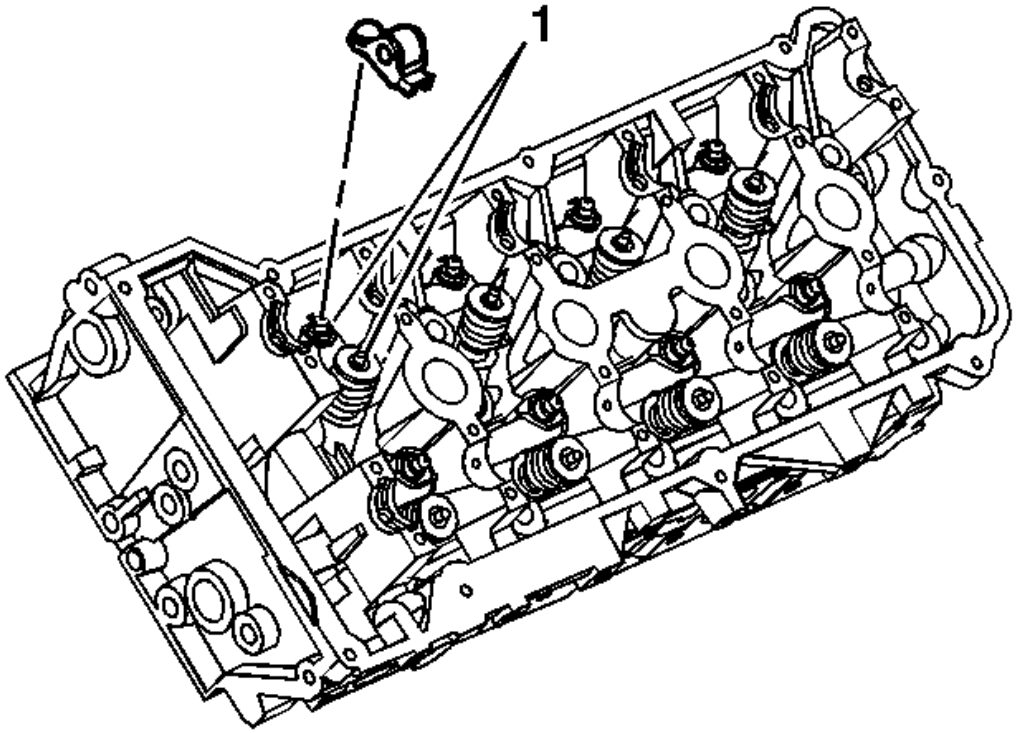


Fig. 314: Identifying the Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip (1) and the SHLA (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Install the left camshafts. Refer to **Camshaft Replacement - Left Side**.

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the right camshafts. Refer to **Camshaft Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

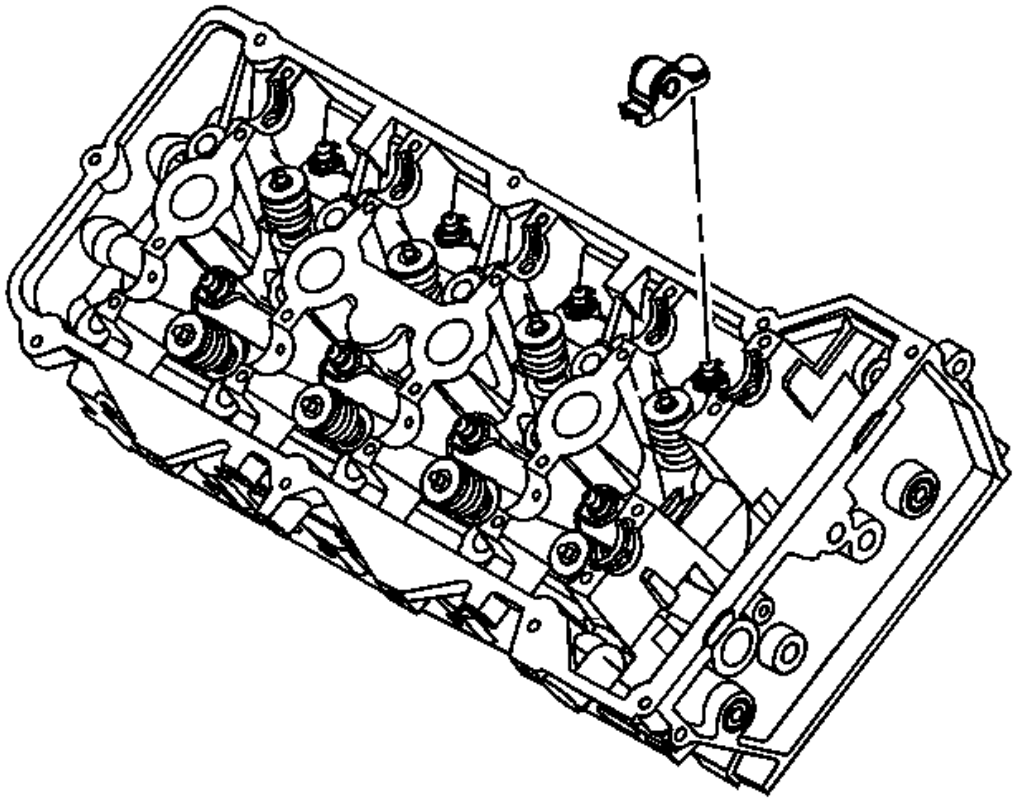


Fig. 315: View of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: If the followers are being reused, arrange them so that they may be put back in their original locations.

2. Remove the camshaft followers.
3. Clean and inspect the rocker arms. Refer to **Valve Rocker Arm Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

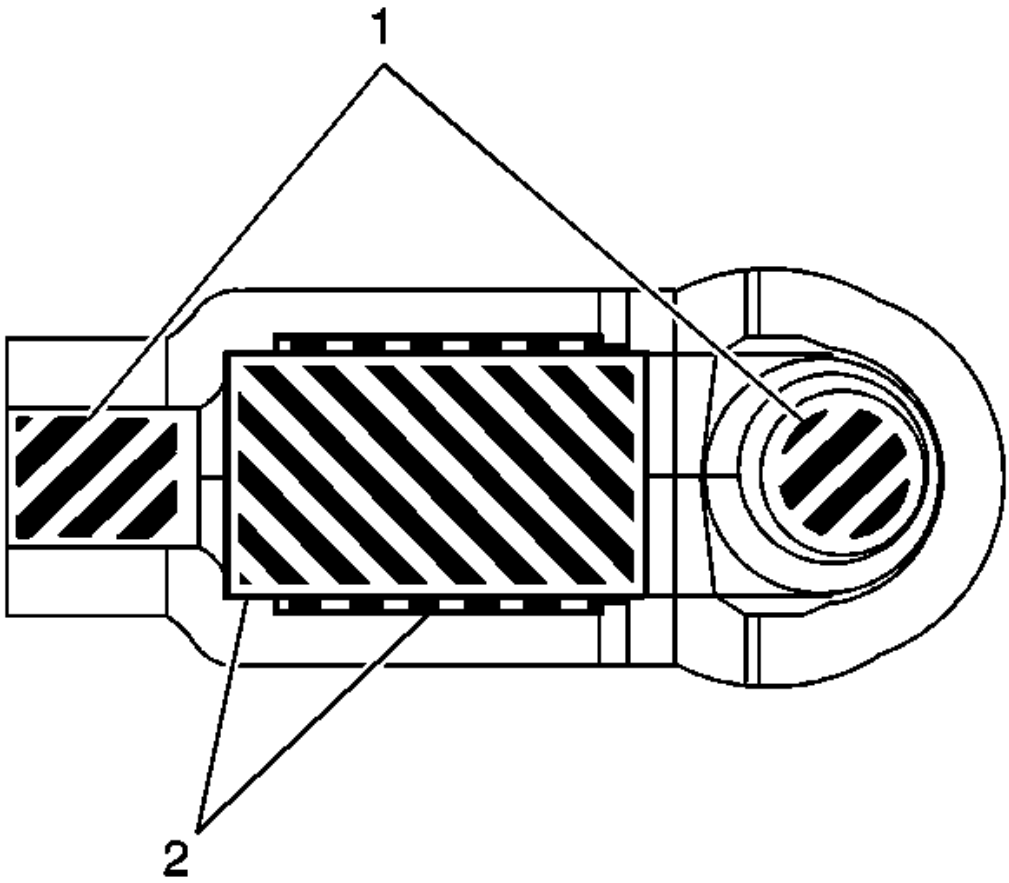


Fig. 316: Identifying Roller Pivot Pocket & Valve Slot Areas Of Camshaft Followers
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the roller pivot pocket (2) and valve slot areas (1) of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

 © 2011 Mitchell Repair Information Company, LLC.

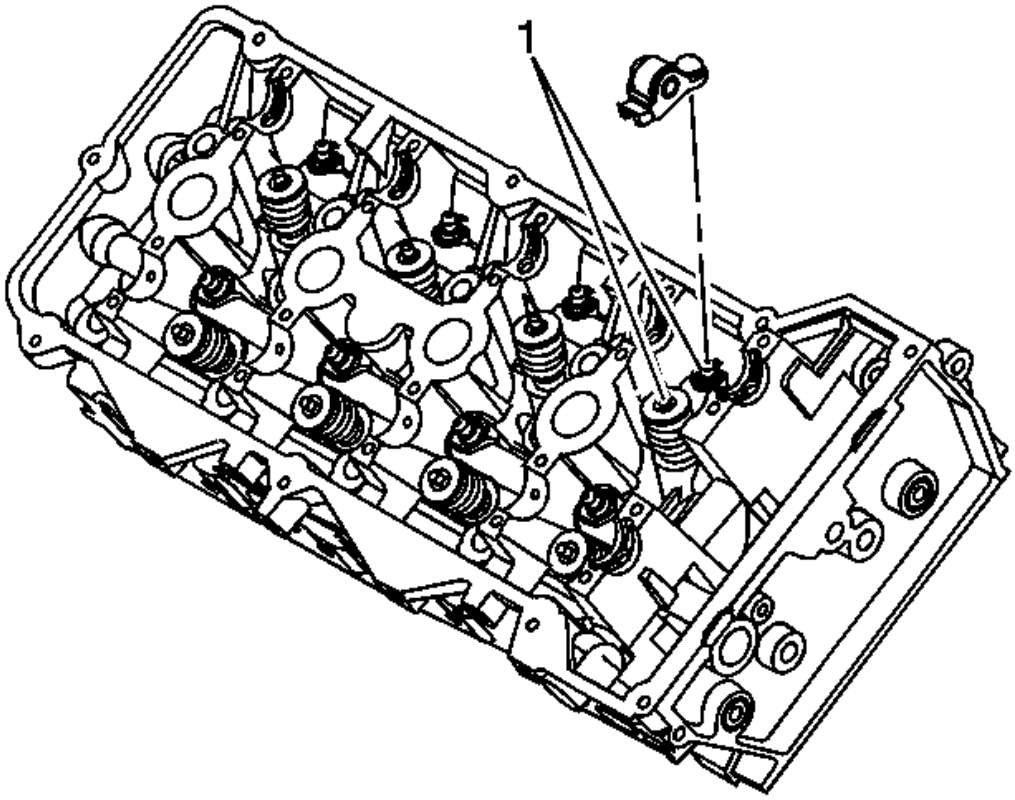


Fig. 317: Identifying Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip (1) and the SHLA (1). The rounded head of the follower goes on the SHLA, while the flat end goes on the valve tip.
3. Install the right camshafts. Refer to **Camshaft Replacement - Right Side**.

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the left valve rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.

 © 2011 Mitchell Repair Information Company, LLC.

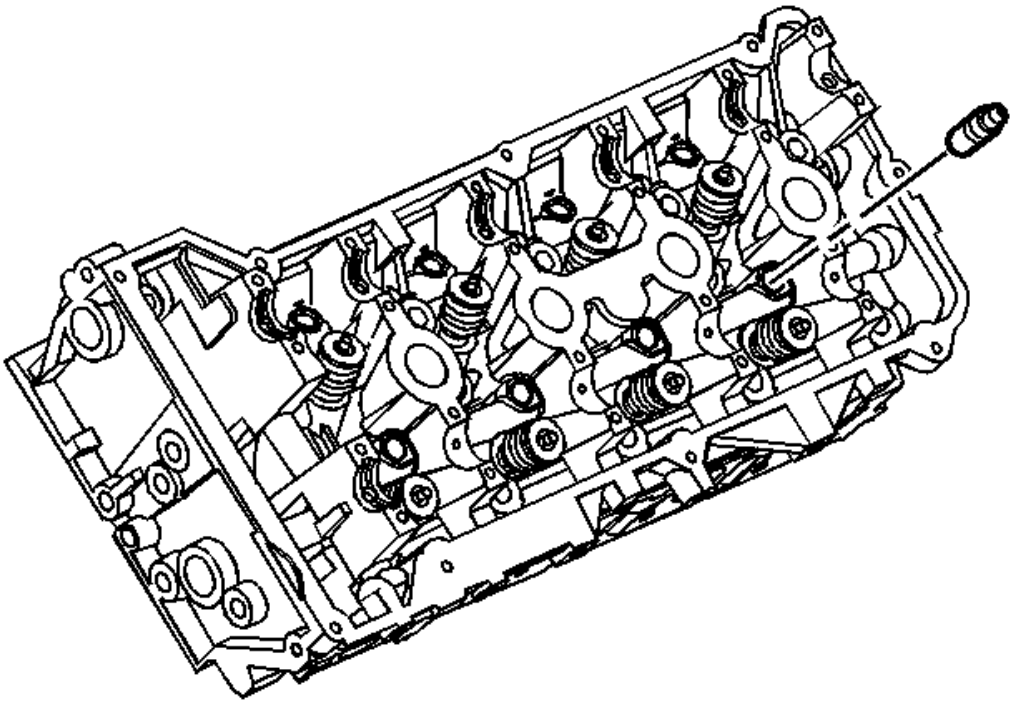


Fig. 318: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the stationary hydraulic lash adjusters (SHLA) from the bores.
3. Clean and inspect the valve lifters. Refer to **Valve Lifter Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

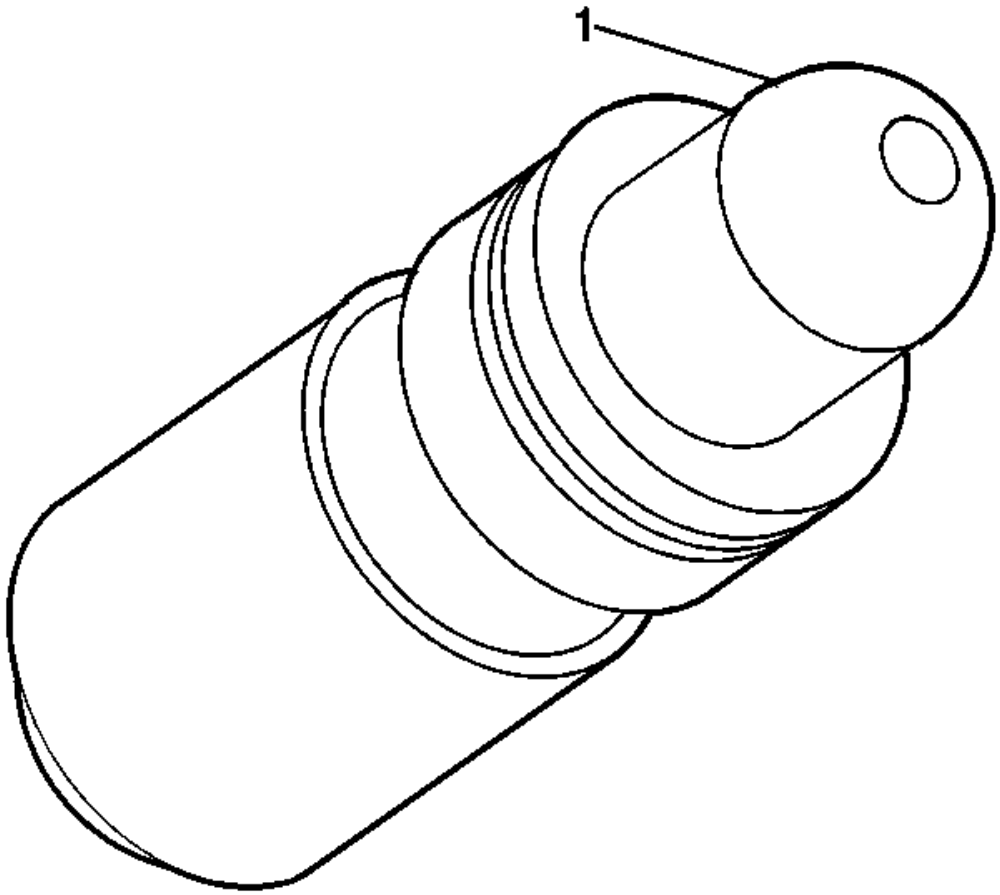


Fig. 319: View Of Valve Lifter
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

 © 2011 Mitchell Repair Information Company, LLC.

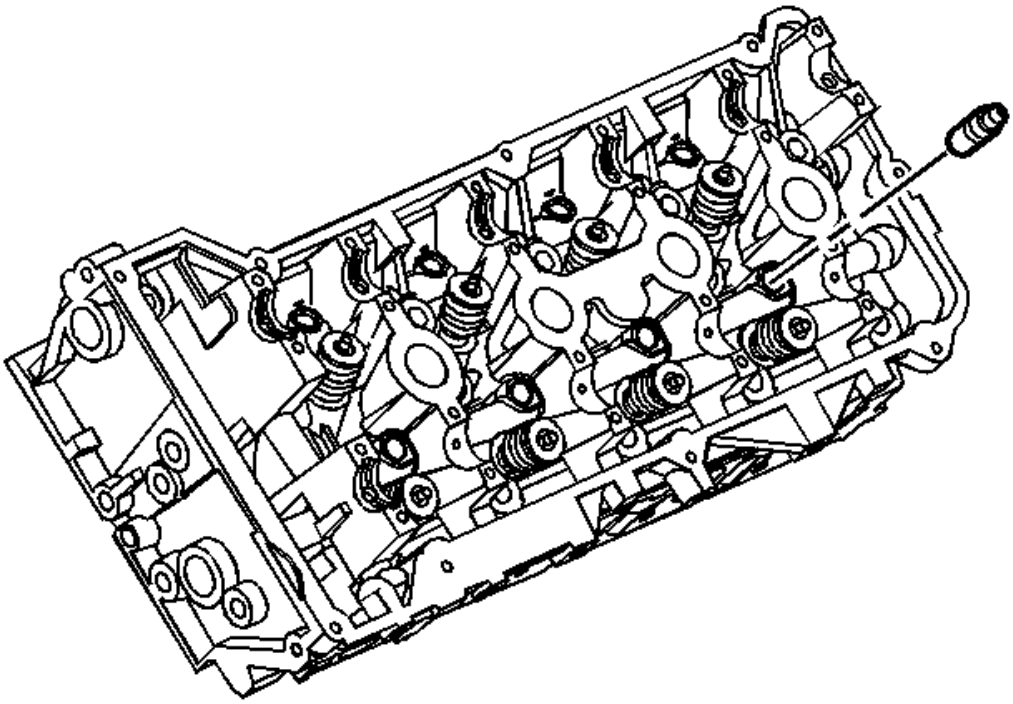


Fig. 320: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS COMPANY

2. Install the new SHLA's into the bores.
3. Install the left valve rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.

VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the right valve rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

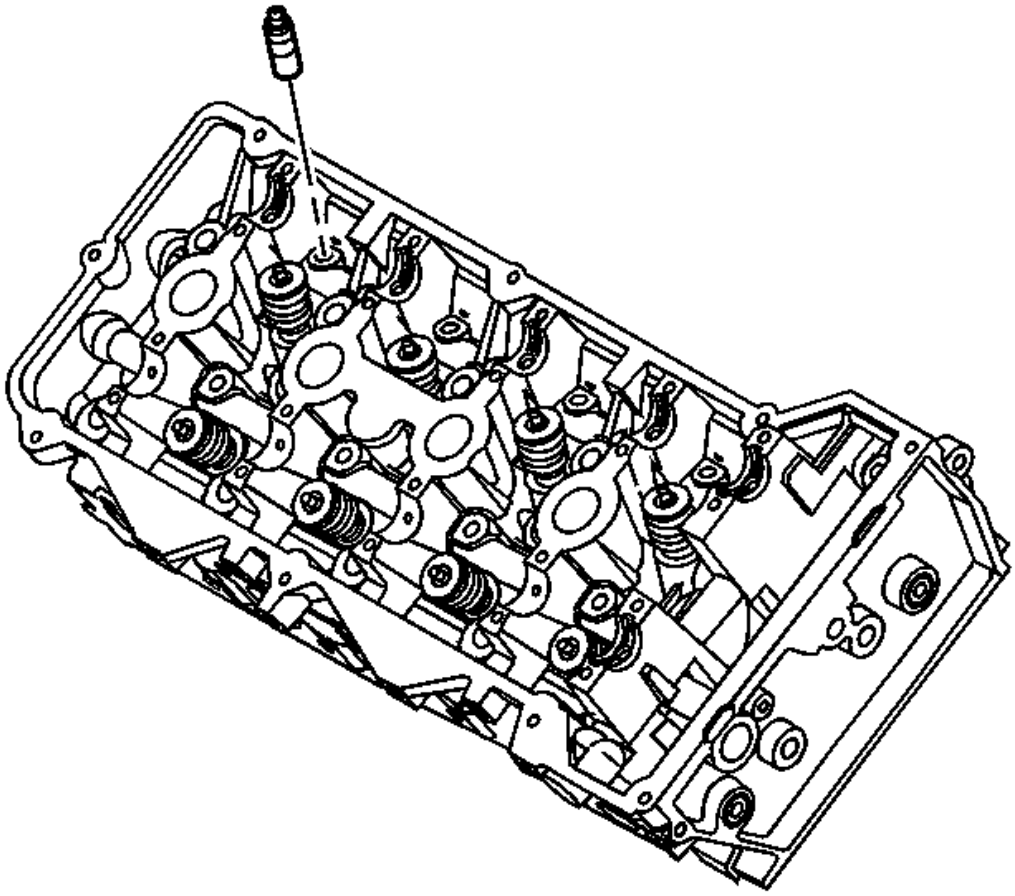


Fig. 321: View of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Remove the stationary hydraulic lash adjusters (SHLA) from the bores.
3. Clean and inspect the valve lifters. Refer to **Valve Lifter Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

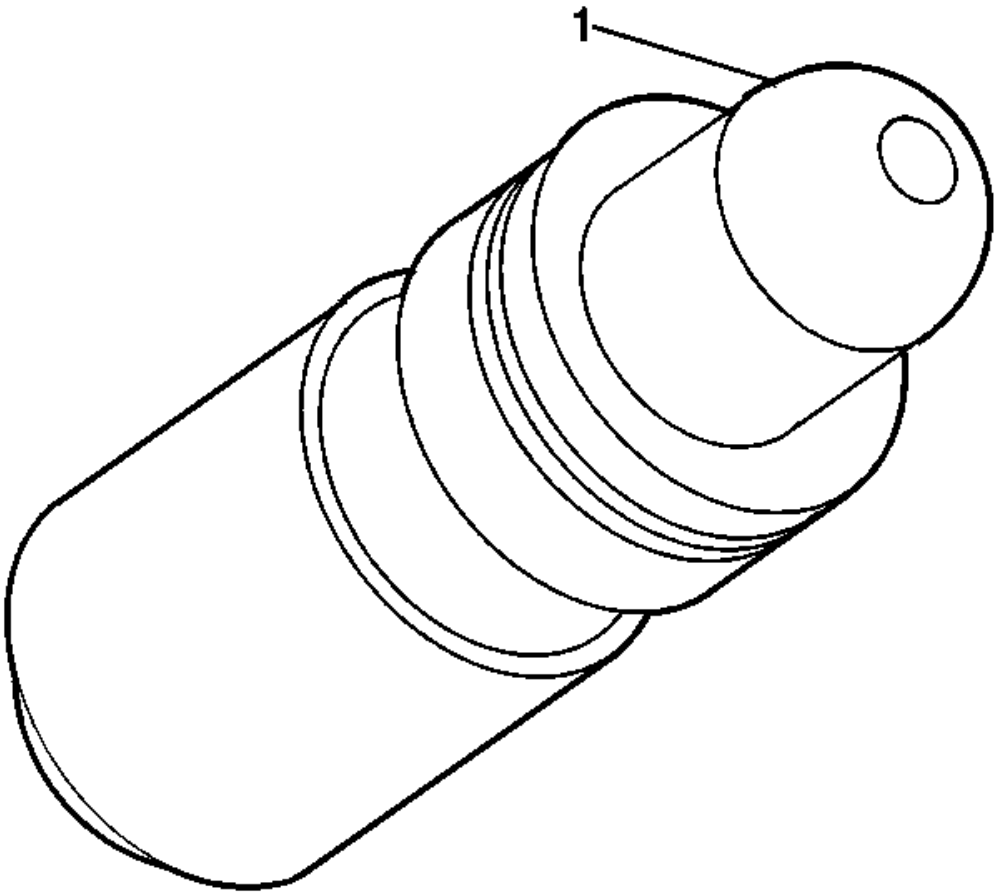


Fig. 322: View Of Valve Lifter
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.

 © 2011 Mitchell Repair Information Company, LLC.

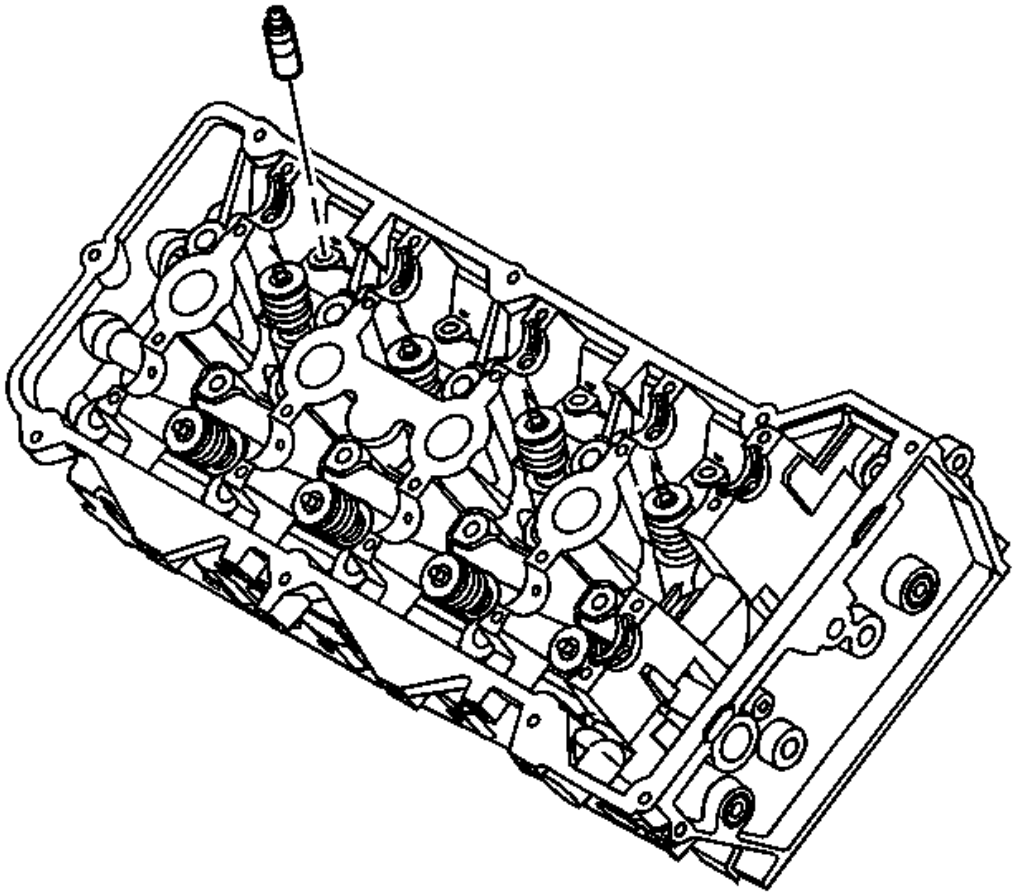


Fig. 323: View of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Install the new SHLA's into the bores.
3. Install the right valve rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

- **J 38820** Valve Stem Seal Remover and Installer
- **J 39313** Spark Plug Port Adapter
- **J 43059** On-Vehicle Valve Retainer Remover/Installer
- **J 44211** Valve Spring Compressor
- **J 44214** Flywheel Holder

 © 2011 Mitchell Repair Information Company, LLC.

Removal Procedure

1. Remove the left camshafts. Refer to **Camshaft Replacement - Left Side**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

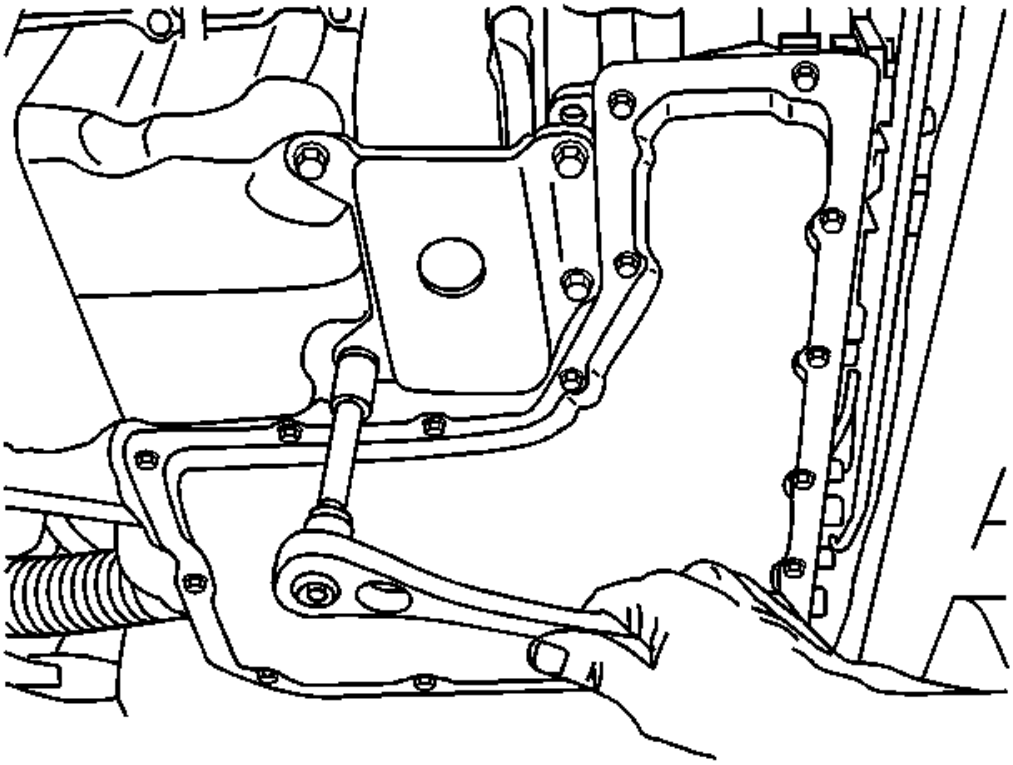


Fig. 324: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS COMPANY

3. Remove the brace between the engine oil pan and the transaxle case.
4. Remove the torque converter cover. Refer to **Torque Converter Cover Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

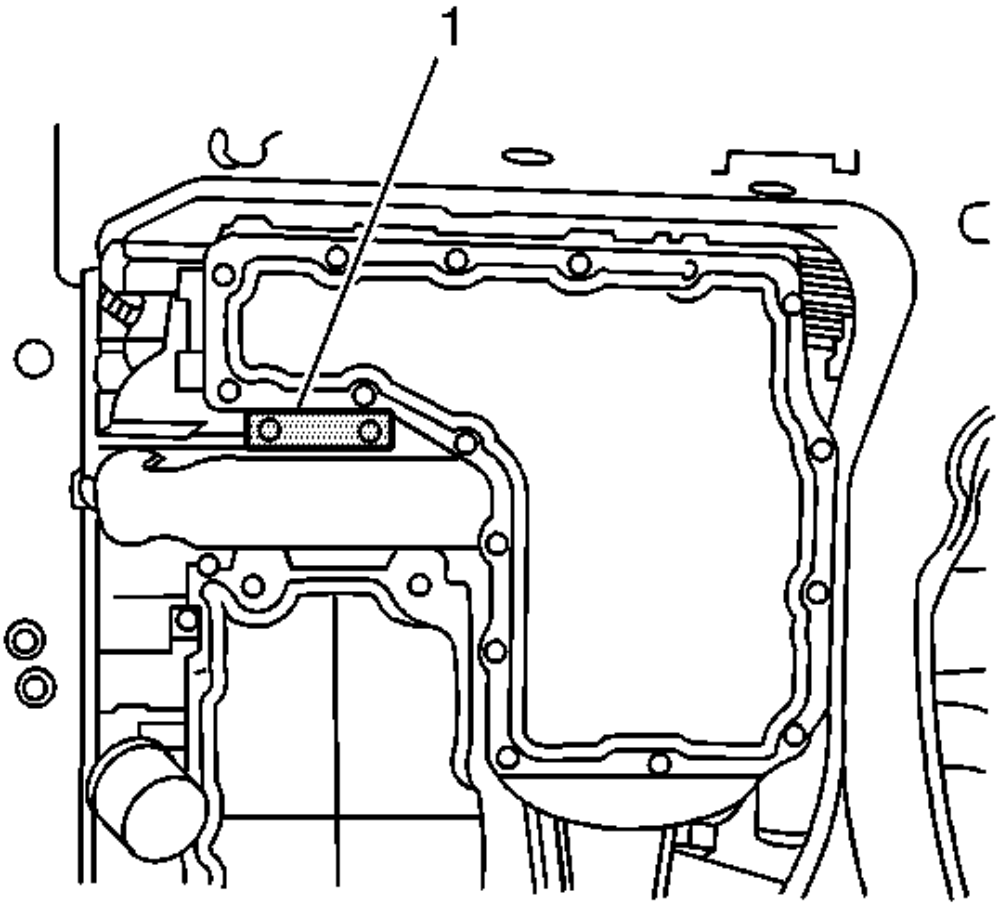


Fig. 325: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

5. Install the **J 44214** (1).
6. Lower the vehicle.

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

7. Remove the spark plug from the cylinder being worked on.

 © 2011 Mitchell Repair Information Company, LLC.

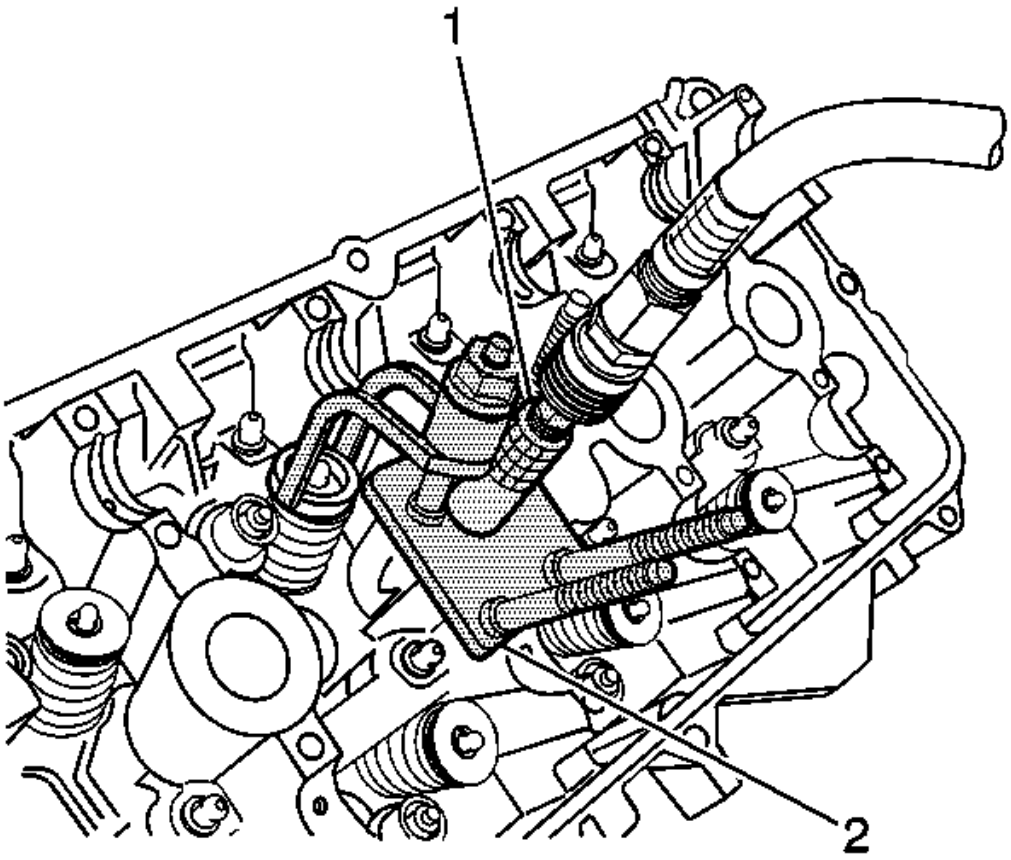


Fig. 326: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

8. Install the base plate of the **J 44211** (2) over the spark plug hole of the cylinder to be serviced.
9. Install the **J 39313** (1) in the spark plug hole.
10. Apply constant air pressure to the **J 39313** (1) in order to keep the valve closed.
11. Install the arm and swivel nut of the **J 44211** (2) over the stud corresponding to the valve to be serviced.

WARNING: Refer to Compressed Valve Spring Warning .

12. Tighten the swivel nut of the **J 44211** (2) down only enough to allow access for removal of the valve locks.
13. Remove the valve locks. A magnet is the most suitable tool for this activity.
14. Loosen the swivel nut of the **J 44211** (2) and swing the arm away from the valve spring retainer.

 © 2011 Mitchell Repair Information Company, LLC.

15. Remove the valve spring retainer and valve spring.

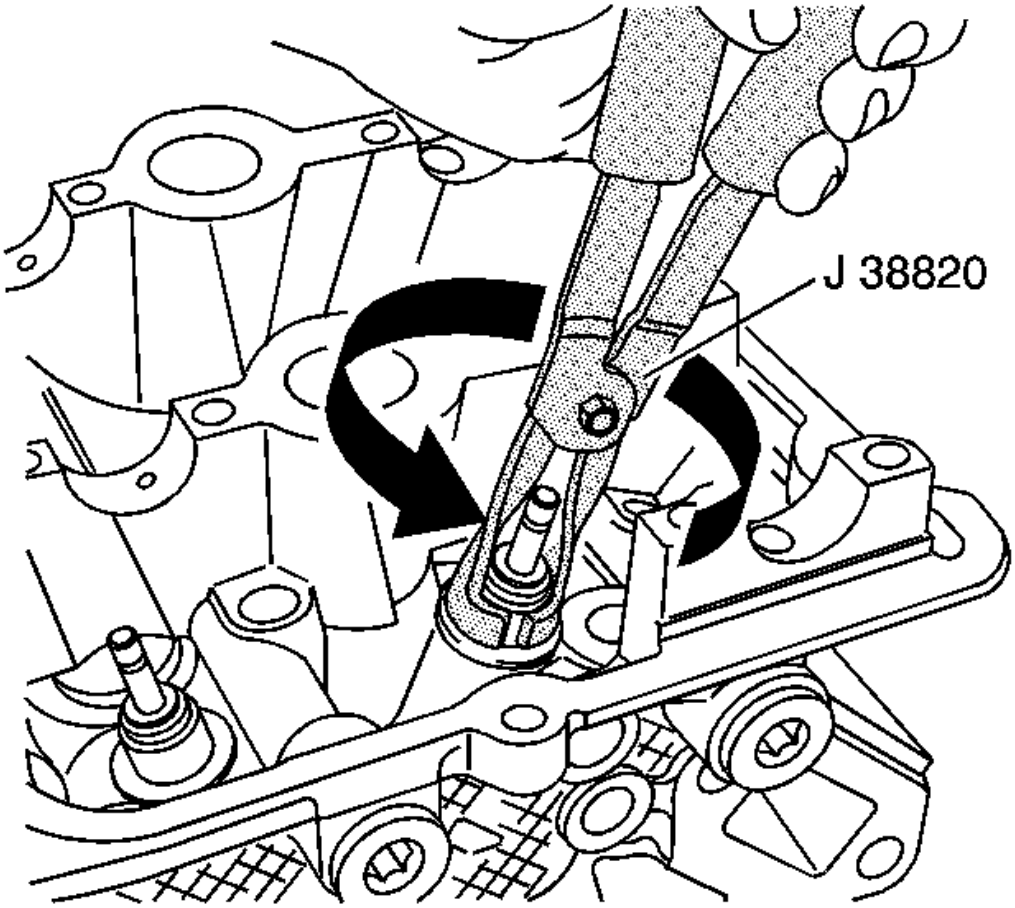


Fig. 327: Replacing Valve Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: The valve stem seal should not be removed unless replacement is required.

16. Use the **J 38820** in order to grip the seal. Remove the seal by exerting a twisting, pulling motion. Discard the old valve stem seal.
17. Inspect and measure the valve spring. Refer to **Valve Spring Inspection and Measurement** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

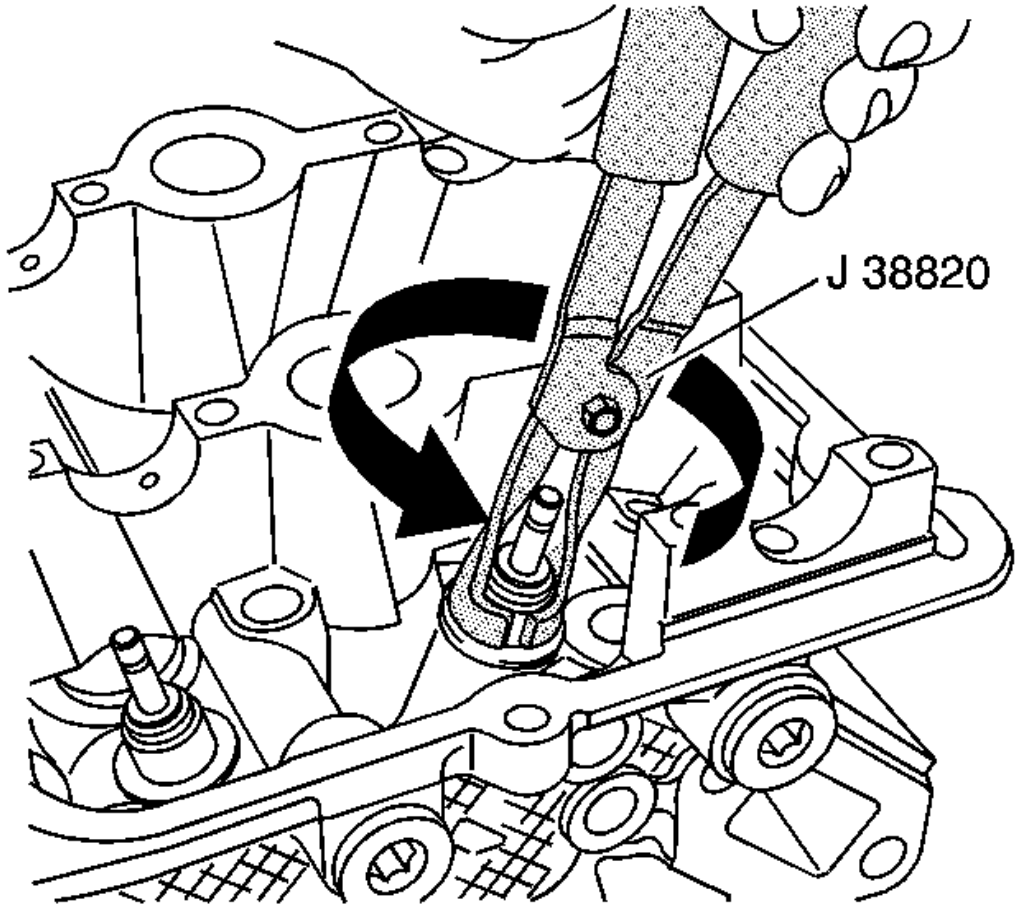


Fig. 328: Replacing Valve Seal
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve stem and the inner diameter of the new seal with clean engine oil.

NOTE: Install a seal protector over the valve stem prior to installing the valve stem seal.

2. Using a twisting pushing motion install the NEW valve stem seal using the **J 38820** .
3. Install the valve spring retainer and valve spring.

 © 2011 Mitchell Repair Information Company, LLC.

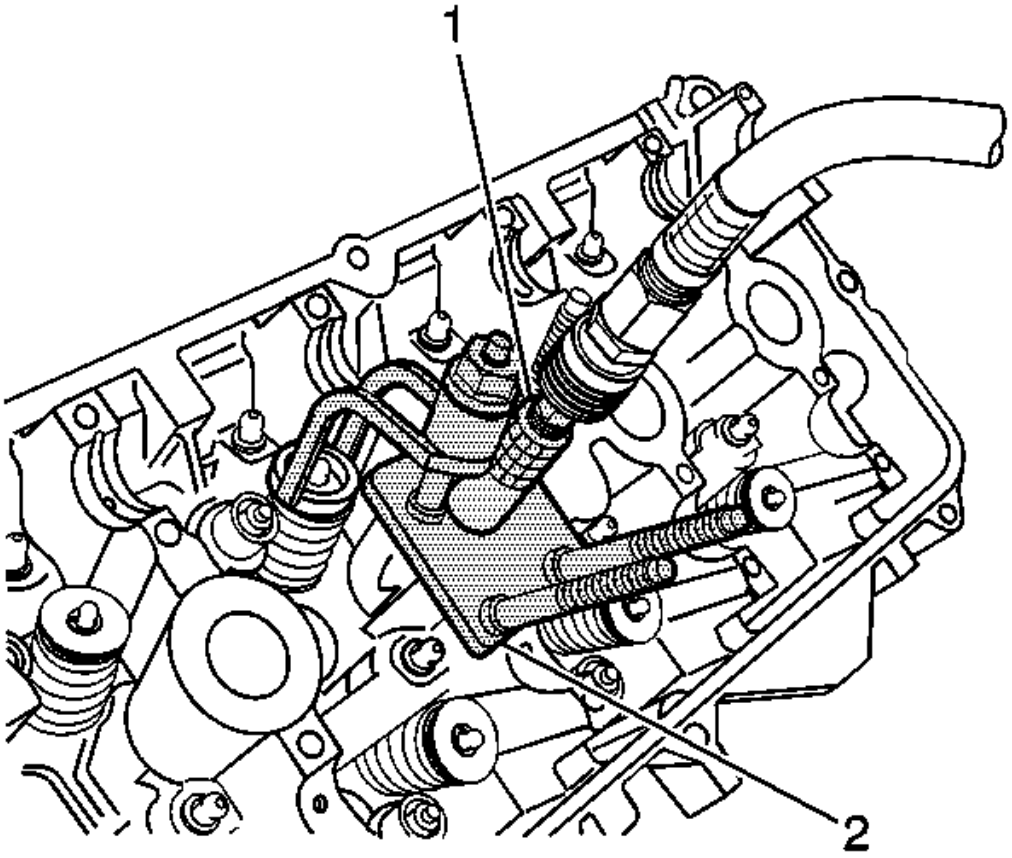


Fig. 329: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Compressed Valve Spring Warning .

4. Swing the arm over the valve spring retainer and tighten the swivel nut of the **J 44211** (2) down only enough to allow access for installation of the valve locks.
5. Position the valve locks to the valve stem retainer groove using the **J 43059** .
6. Remove the swivel nut and arm of the **J 44211** (2).
7. Install the arm and swivel nut of the **J 44211** (2) over the stud of any other valves being serviced and repeat removal steps 12 through 17 and installation steps 1 through 7.
8. Relieve the air pressure to the cylinder being serviced.
9. Remove the **J 39313** (1) from the spark plug hole.

 © 2011 Mitchell Repair Information Company, LLC.

10. Remove the base plate of the **J 44211** (2).
11. Install the spark plug. Refer to **Spark Plug Replacement** .
12. Repeat removal steps 7 through 17 and installation steps 1 through 11 on any other cylinders being serviced.
13. Install the left camshafts. Refer to **Camshaft Replacement - Left Side**.
14. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

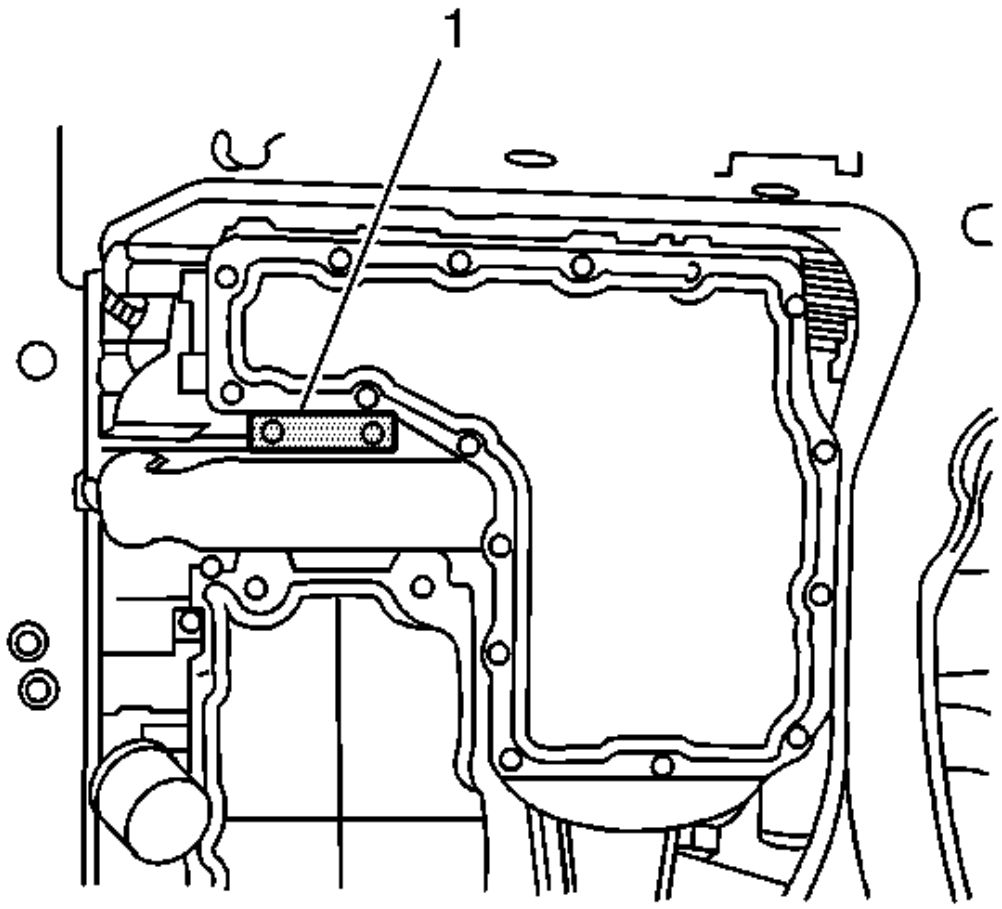


Fig. 330: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **J 44214** (1).
16. Install the torque converter cover. Refer to **Torque Converter Cover Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

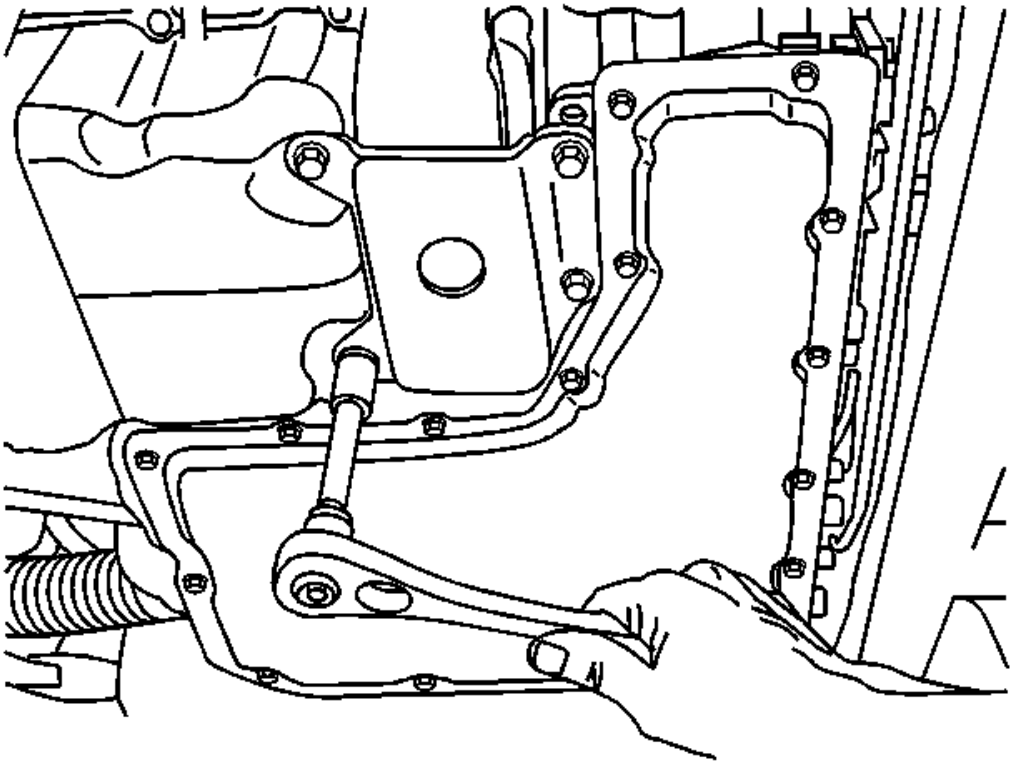


Fig. 331: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

17. Install the oil pan to transaxle brace.

    Tighten

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

18. Lower the vehicle.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

- **J 38820** Valve Stem Seal Remover and Installer

 © 2011 Mitchell Repair Information Company, LLC.

- **J 39313** Spark Plug Port Adapter
- **J 43059** Valve Retainer Remover/Installer
- **J 44211** On-Vehicle Valve Spring Compressor
- **J 44214** Flywheel Holder

Removal Procedure

1. Remove the right camshafts. Refer to **Camshaft Replacement - Right Side**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

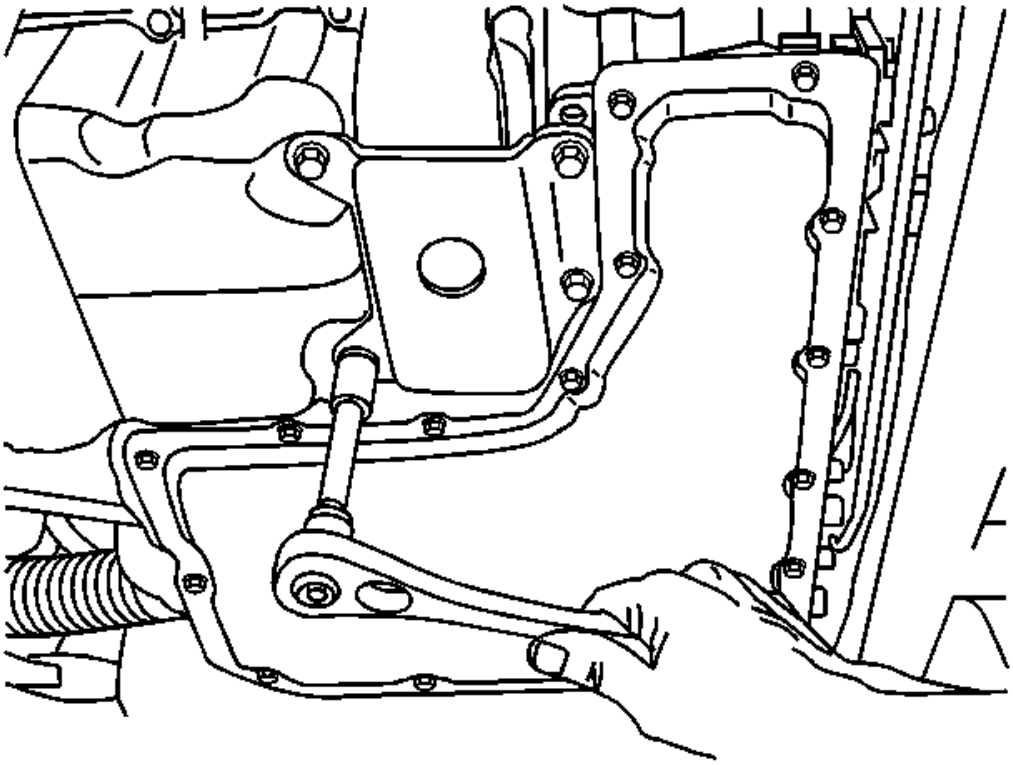


Fig. 332: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS COMPANY

3. Remove the brace between the engine oil pan and the transaxle case.
4. Remove the torque converter cover. Refer to **Torque Converter Cover Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

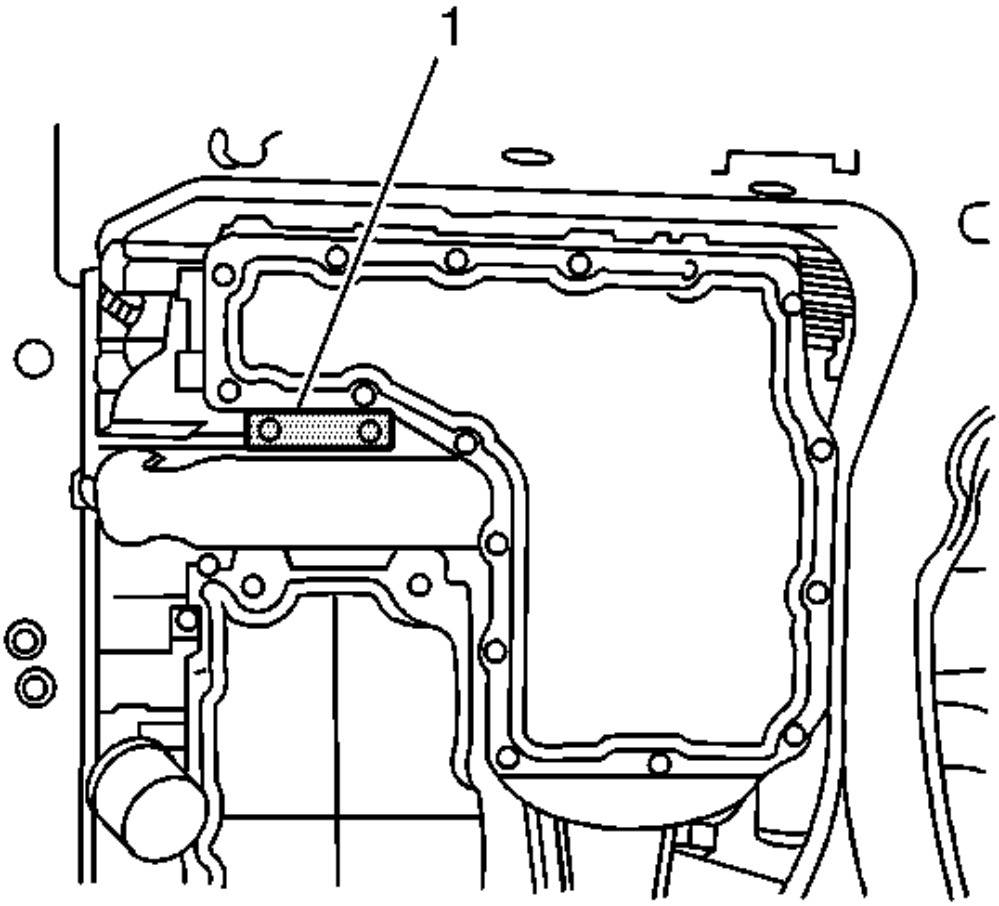


Fig. 333: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

5. Install the **J 44214** (1).
6. Lower the vehicle.

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

7. Remove the spark plug from the cylinder being worked on.

 © 2011 Mitchell Repair Information Company, LLC.

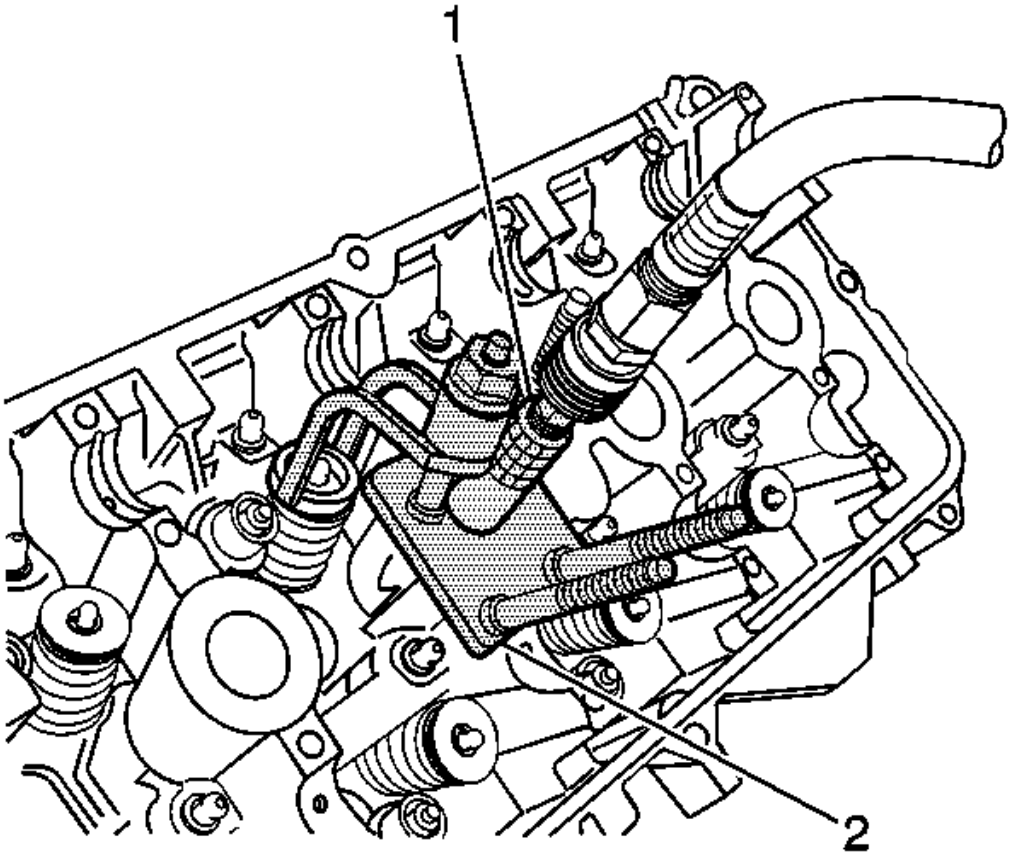


Fig. 334: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

8. Install the base plate of the **J 44211** (2) over the spark plug hole of the cylinder to be serviced.
9. Install the **J 39313** (1) in the spark plug hole.
10. Apply constant air pressure to the **J 39313** (1) in order to keep the valve closed.
11. Install the arm and swivel nut of the **J 44211** (2) over the stud corresponding to the valve to be serviced.

WARNING: Refer to Compressed Valve Spring Warning .

12. Tighten the swivel nut of the **J 44211** (2) down only enough to allow access for removal of the valve locks.
13. Remove the valve locks. A magnet is the most suitable tool for this activity.
14. Loosen the swivel nut of the **J 44211** (2) and swing the arm away from the valve spring retainer.

 © 2011 Mitchell Repair Information Company, LLC.

15. Remove the valve spring retainer and valve spring.

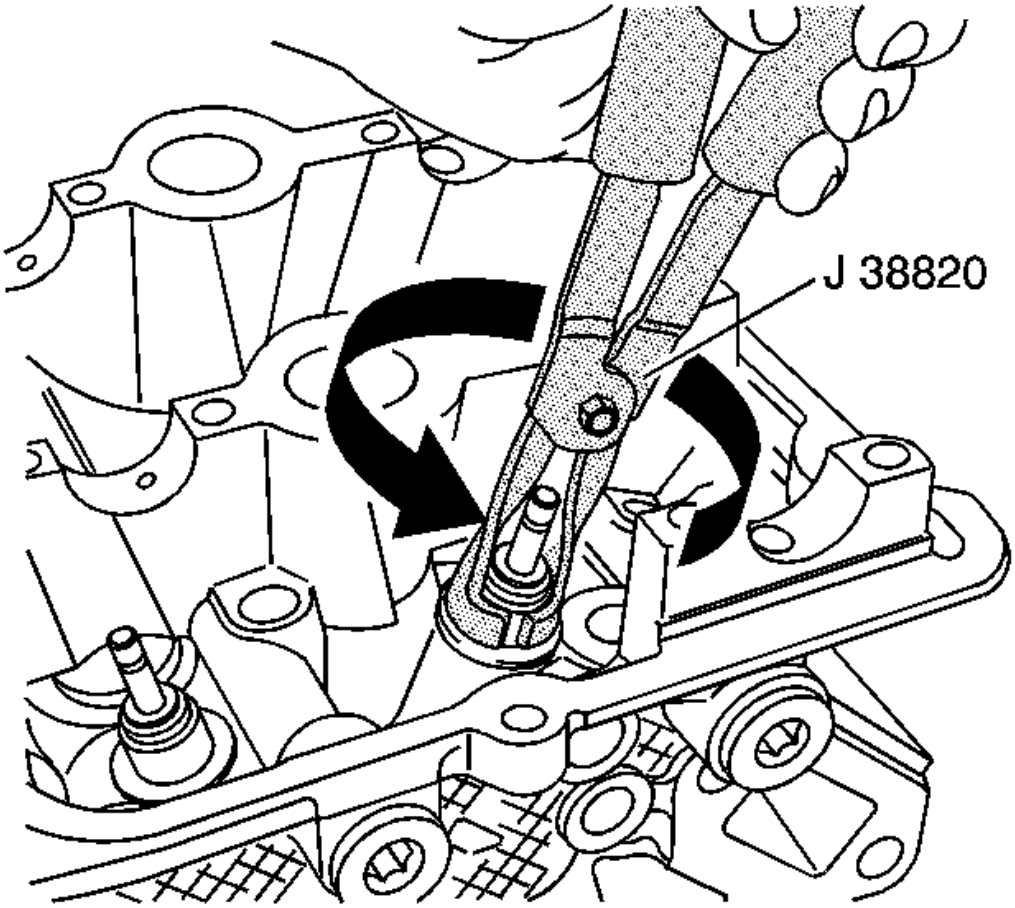


Fig. 335: Replacing Valve Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: The valve stem seal should not be removed unless replacement is required.

16. Use the **J 38820** in order to grip the seal. Remove the seal by exerting a twisting, pulling motion. Discard the old valve stem seal.
17. Inspect and measure the valve spring. Refer to **Valve Spring Inspection and Measurement** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

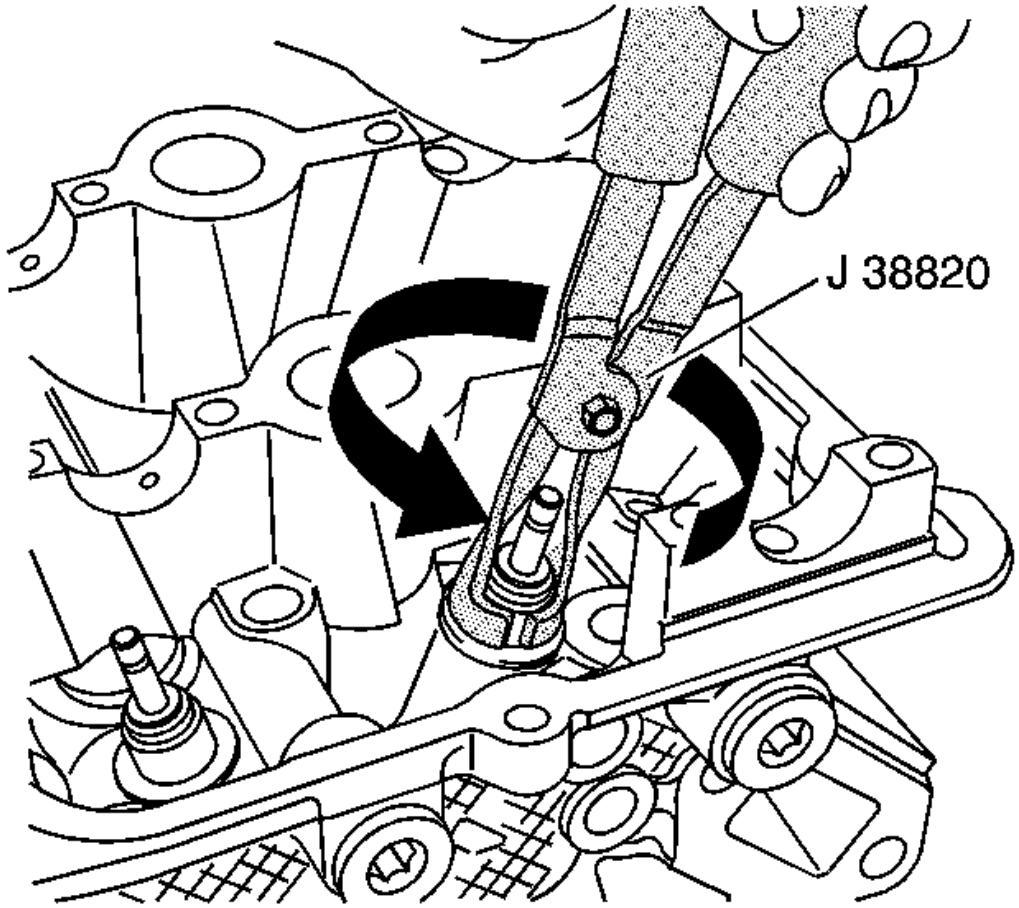


Fig. 336: Replacing Valve Seal
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve stem and the inner diameter of the new seal with clean engine oil.

NOTE: Install a seal protector over the valve stem prior to installing the valve stem seal.

2. Using a twisting pushing motion install the NEW valve stem seal using the **J 38820** .
3. Install the valve spring retainer and valve spring.

 © 2011 Mitchell Repair Information Company, LLC.

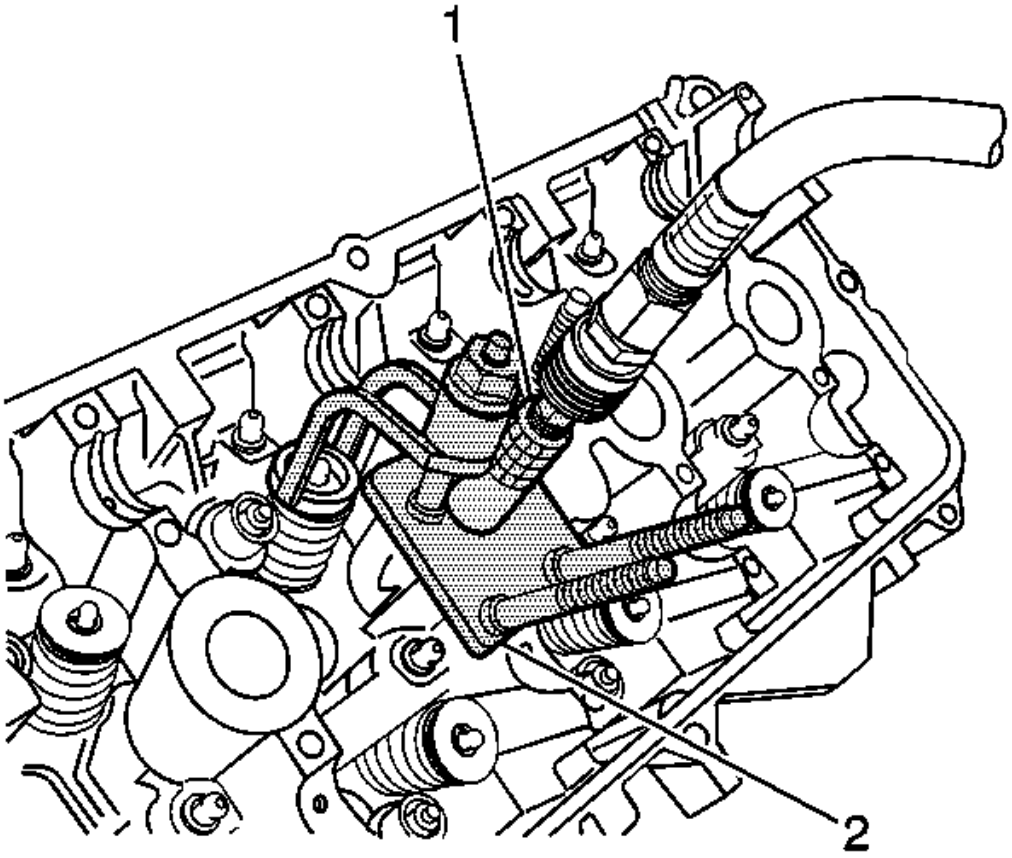


Fig. 337: View Of Base Plate Installed Over The Spark Plug Hole For Changing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Compressed Valve Spring Warning .

4. Swing the arm over the valve spring retainer and tighten the swivel nut of the **J 44211** (2) down only enough to allow access for installation of the valve locks.
5. Position the valve locks to the valve stem retainer groove using the **J 43059** .
6. Remove the swivel nut and arm of the **J 44211** (2).
7. Install the arm and swivel nut of the **J 44211** (2) over the stud of any other valves being serviced and repeat removal steps 12 through 17 and installation steps 1 through 7.
8. Relieve the air pressure to the cylinder being serviced.
9. Remove the **J 39313** (1) from the spark plug hole.

 © 2011 Mitchell Repair Information Company, LLC.

10. Remove the base plate of the **J 44211** (2).
11. Install the spark plug. Refer to **Spark Plug Replacement** .
12. Repeat removal steps 7 through 17 and installation steps 1 through 11 on any other cylinders being serviced.
13. Install the right camshafts. Refer to **Camshaft Replacement - Right Side**.
14. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

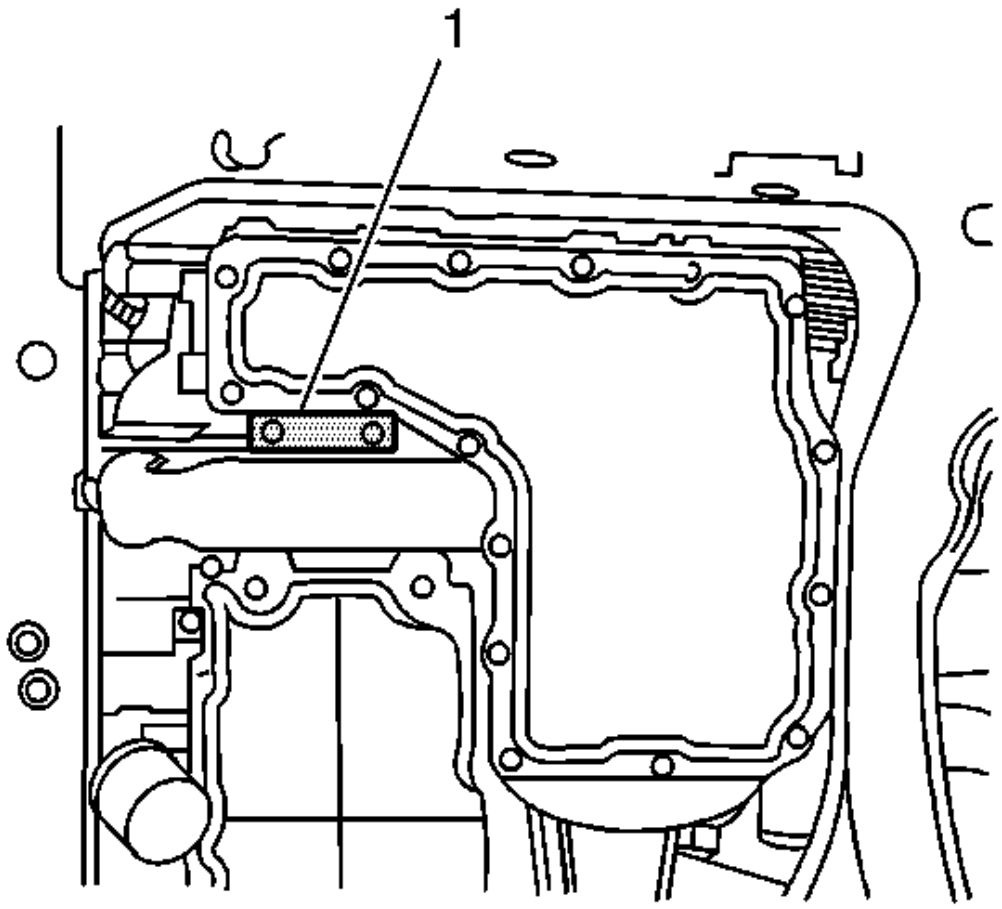


Fig. 338: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **J 44214** (1).
16. Install the torque converter cover. Refer to **Torque Converter Cover Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

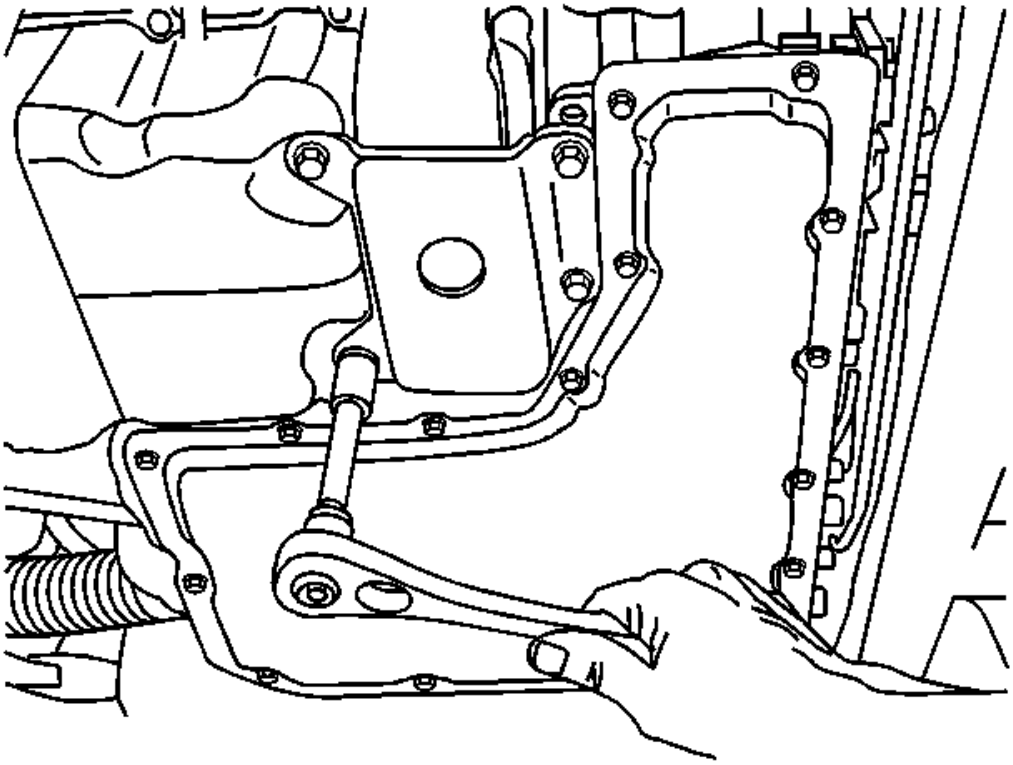


Fig. 339: View Of Brace Between The Engine Oil Pan And The Transaxle Case
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

17. Install the oil pan to transaxle brace.

    Tighten

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

18. Lower the vehicle.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

- **J 28410** Gasket Remover

 © 2011 Mitchell Repair Information Company, LLC.

- **J 45059** Angle Meter

Removal Procedure

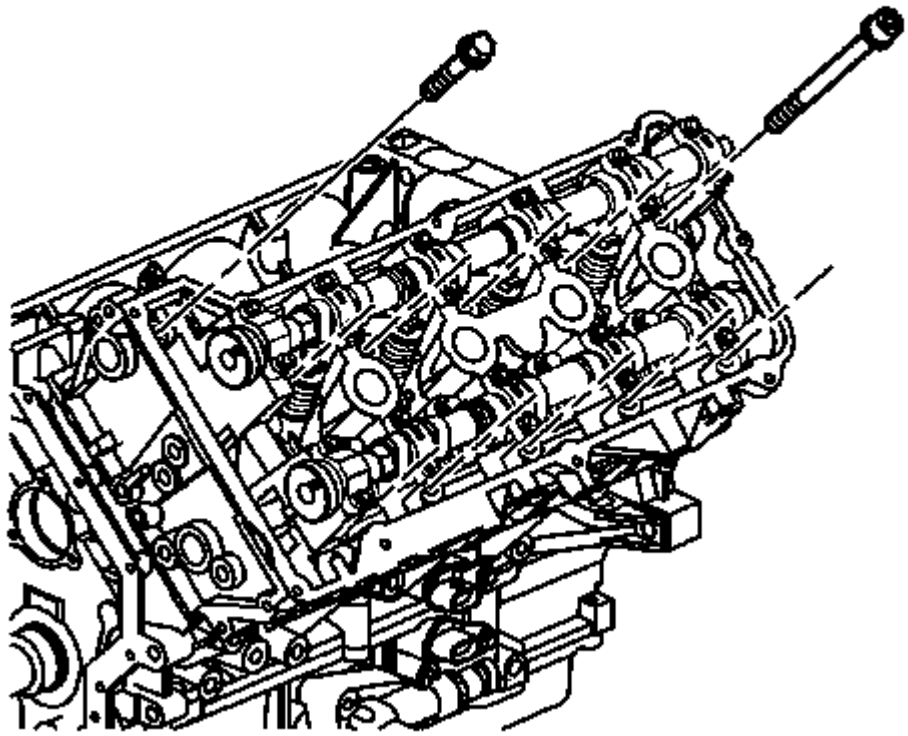


Fig. 340: View of M6 External Drive Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (L37)** .
2. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
3. Remove the generator. Refer to **Generator Replacement (V8)** .
4. Remove the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (L37)** .
5. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
6. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
7. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
8. Remove the left secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
9. Remove the 3 M6 cylinder head bolts.

 © 2011 Mitchell Repair Information Company, LLC.

NOTE: DO NOT reuse the M11 cylinder head bolts.

10. Remove and discard the 10 M11 cylinder head bolts.

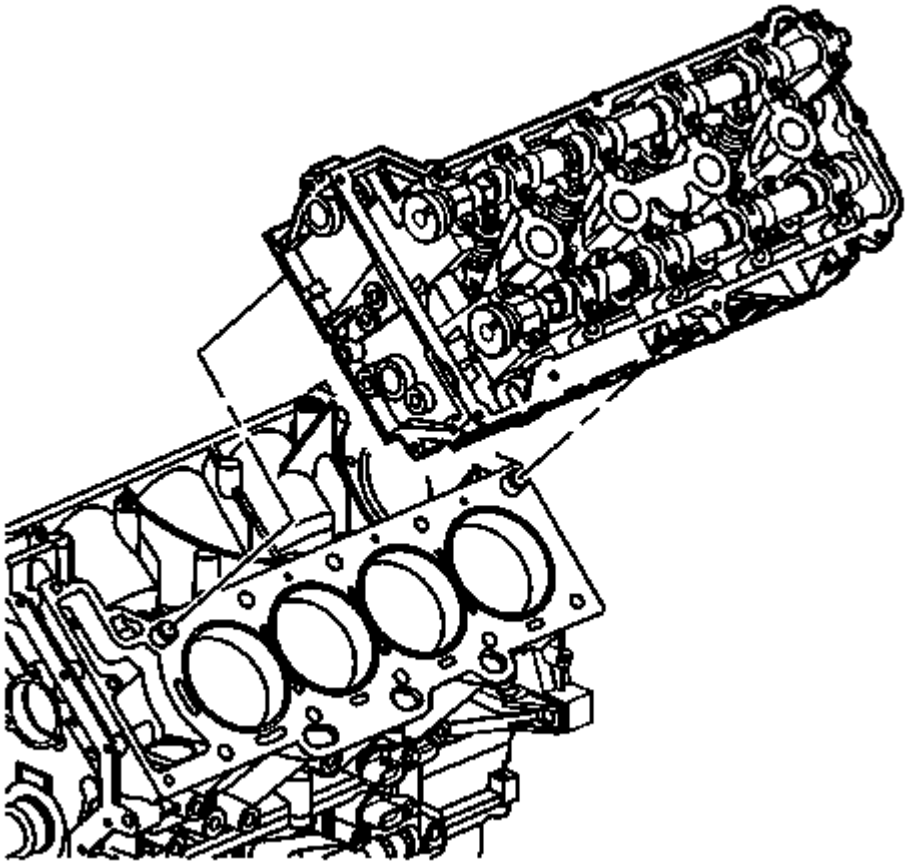


Fig. 341: View Of Cylinder Head With Alignment Dowels - Left
Courtesy of GENERAL MOTORS COMPANY

11. Remove the left cylinder head. Make sure that no locating pins are stuck in the cylinder head.

NOTE: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do so could cause false torque readings during reassembly.

12. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

 © 2011 Mitchell Repair Information Company, LLC.

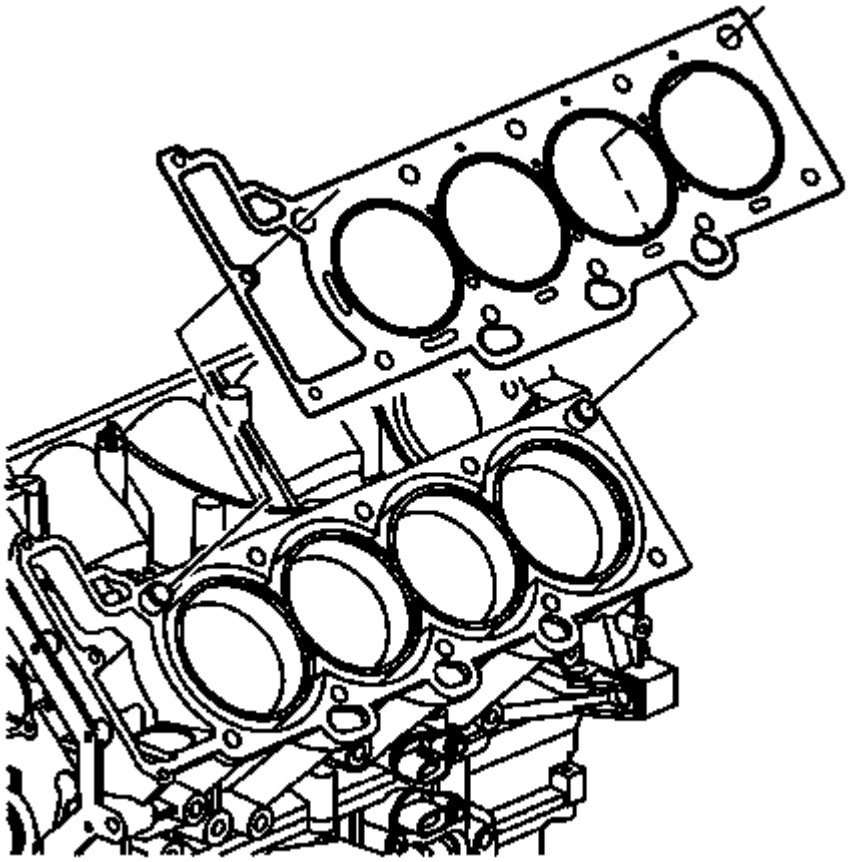


Fig. 342: View of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT reuse the cylinder head gasket.

13. Remove and discard the left cylinder head gasket.
14. Remove all remaining gasket material from the cylinder head and cylinder block using the **J 28410** .
15. Place the cylinder head on a clean, flat surface with the combustion chambers face-up in order to prevent damage to the deck face.
16. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

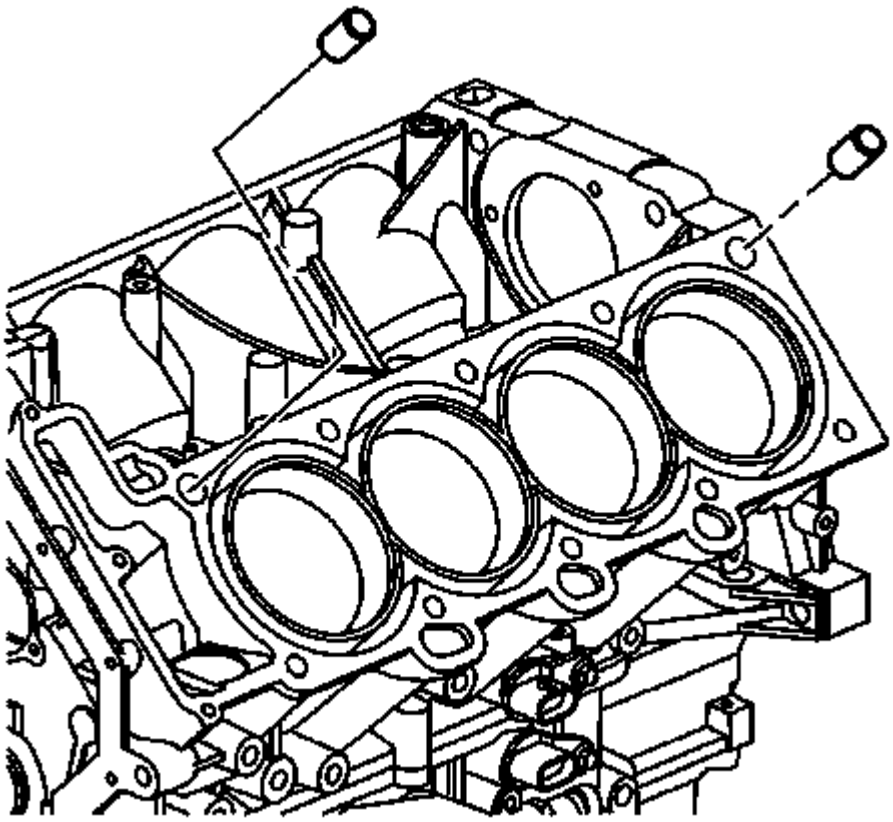


Fig. 343: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS COMPANY

1. Make sure all the cylinder head locating pins are securely installed in the cylinder block deck face.

NOTE: Failure to remove all the old thread sealant material from the cylinder block could cause false torque readings.

2. Make sure all old thread sealant material is removed from the cylinder head bolt holes in the cylinder block.

 © 2011 Mitchell Repair Information Company, LLC.

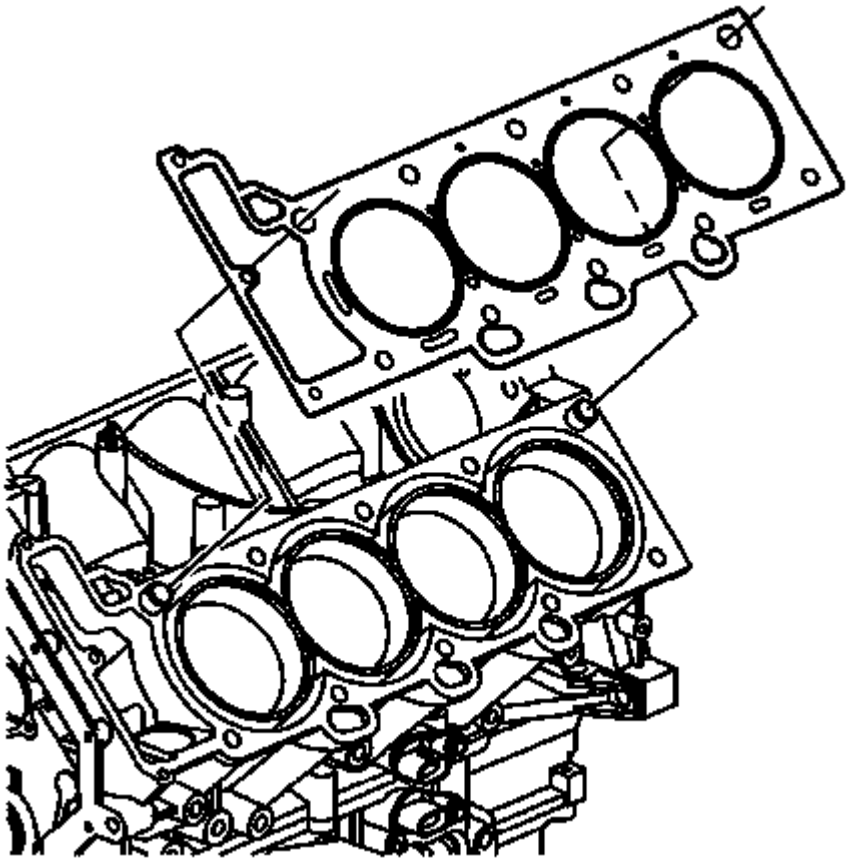


Fig. 344: View of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW cylinder head gasket using the locating pins for retention.

 © 2011 Mitchell Repair Information Company, LLC.

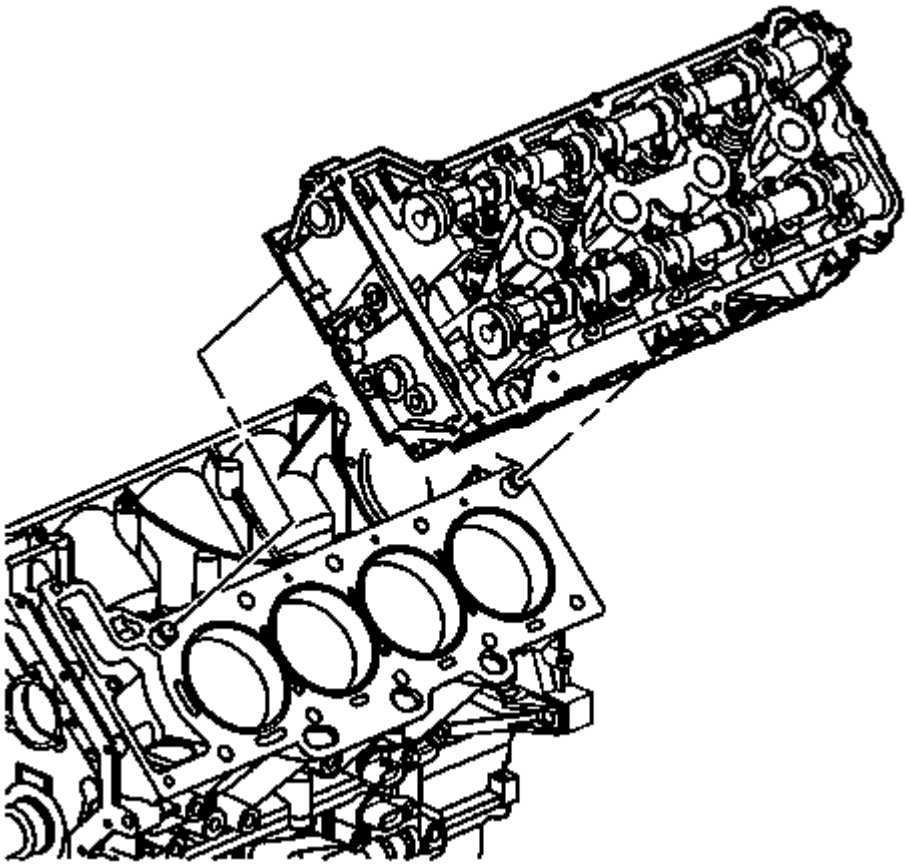


Fig. 345: View Of Cylinder Head With Alignment Dowels - Left
Courtesy of GENERAL MOTORS COMPANY

4. Align the cylinder head with the locating pins.
5. Place the cylinder head in position on the cylinder block.

 © 2011 Mitchell Repair Information Company, LLC.

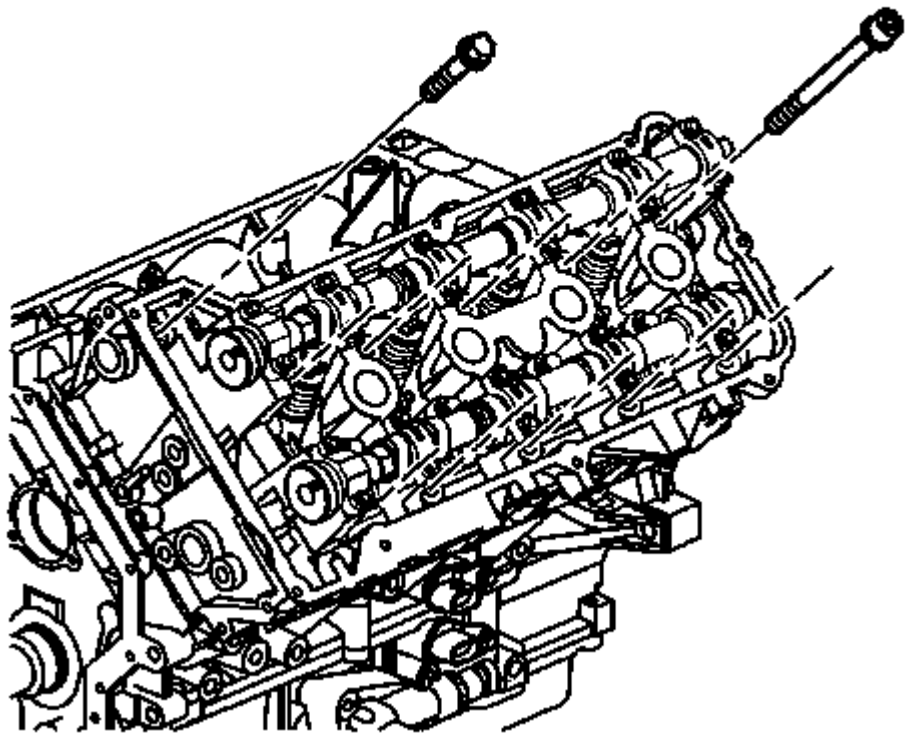


Fig. 346: View of M6 External Drive Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install 10 NEW M11 cylinder head bolts until snug.
7. Install the 3 M6 cylinder head bolts until snug.

 © 2011 Mitchell Repair Information Company, LLC.

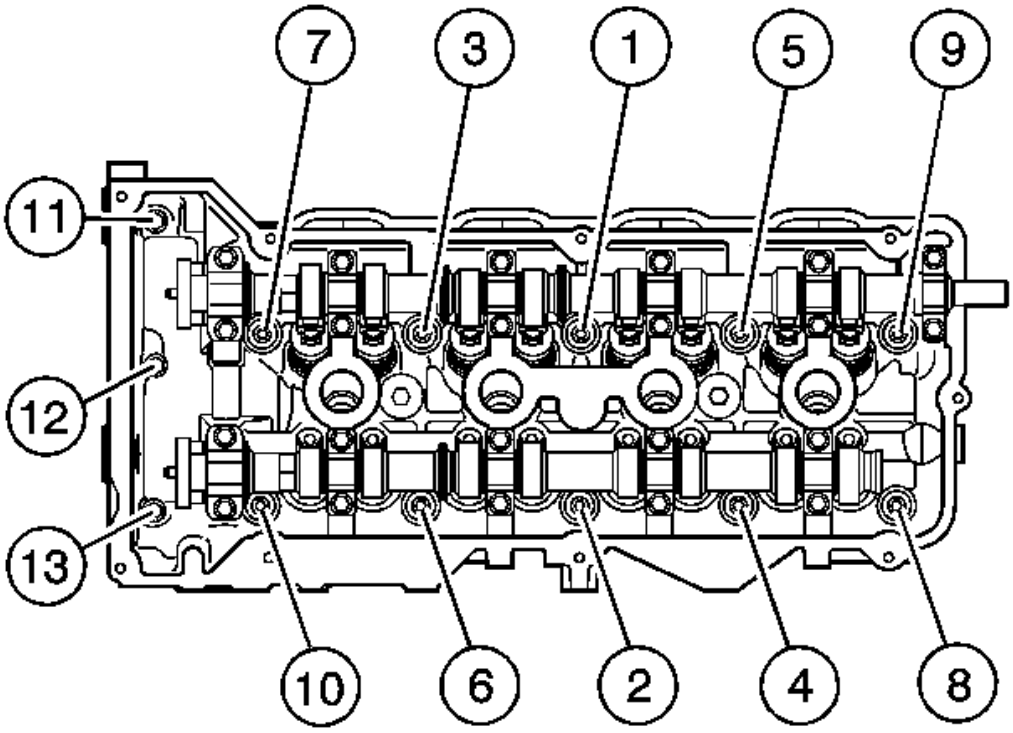


Fig. 347: Identifying Left Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the 10 M11 cylinder head bolts.

   Tighten

   1. Tighten the bolts (1-10) a first pass in the sequence shown to 30 N.m (22 lb ft).
   2. Tighten the bolts a second pass in the sequence shown an additional 70 degrees using the **J 45059** .
   3. Tighten the bolts a third pass in the sequence shown an additional 60 degrees using the **J 45059** .
   4. Tighten the bolts a final pass in the sequence shown an additional 45 degrees (total 175 degrees) using the **J 45059** .
9. Tighten the 3 M6 bolts cylinder head.

   Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the bolts to 12 N.m (106 lb in).

10. Install the left secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
11. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
12. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.
14. Install the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (L37)** .
15. Install the generator. Refer to **Generator Replacement (V8)** .
16. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
17. Install the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (L37)** .

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

- **J 28410** Gasket Remover
- **J 45059** Angle Meter

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

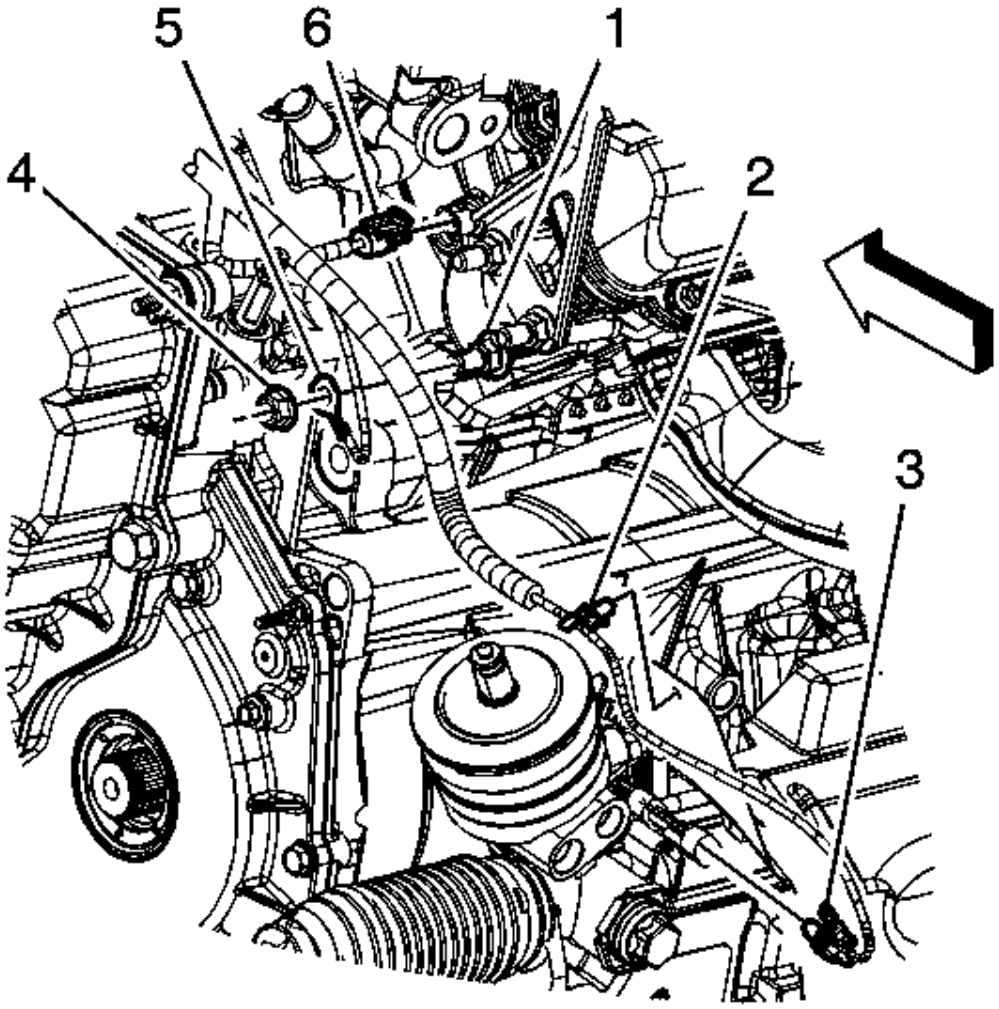


Fig. 348: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (L37)** .
2. Remove the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (L37)** .
3. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
4. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
5. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
6. Remove the right secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.

 © 2011 Mitchell Repair Information Company, LLC.

7. Disconnect the engine harness electrical connector (6) from the engine coolant temperature (ECT) sensor.
8. Remove the engine harness ground terminal nut (4).
9. Remove the engine harness ground terminal (5).

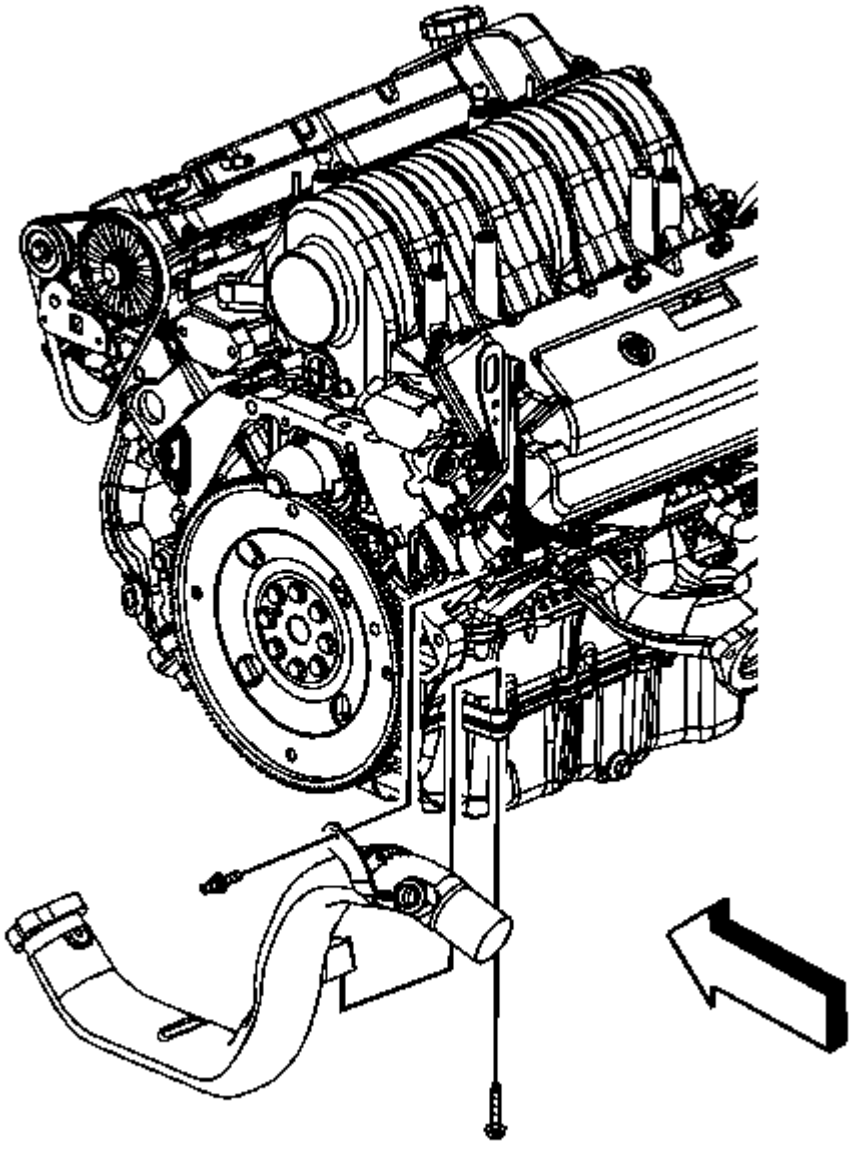


Fig. 349: Identifying Front Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS COMPANY

 © 2011 Mitchell Repair Information Company, LLC.

10. Remove the stud attaching the exhaust manifold front pipe to the cylinder head.
11. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

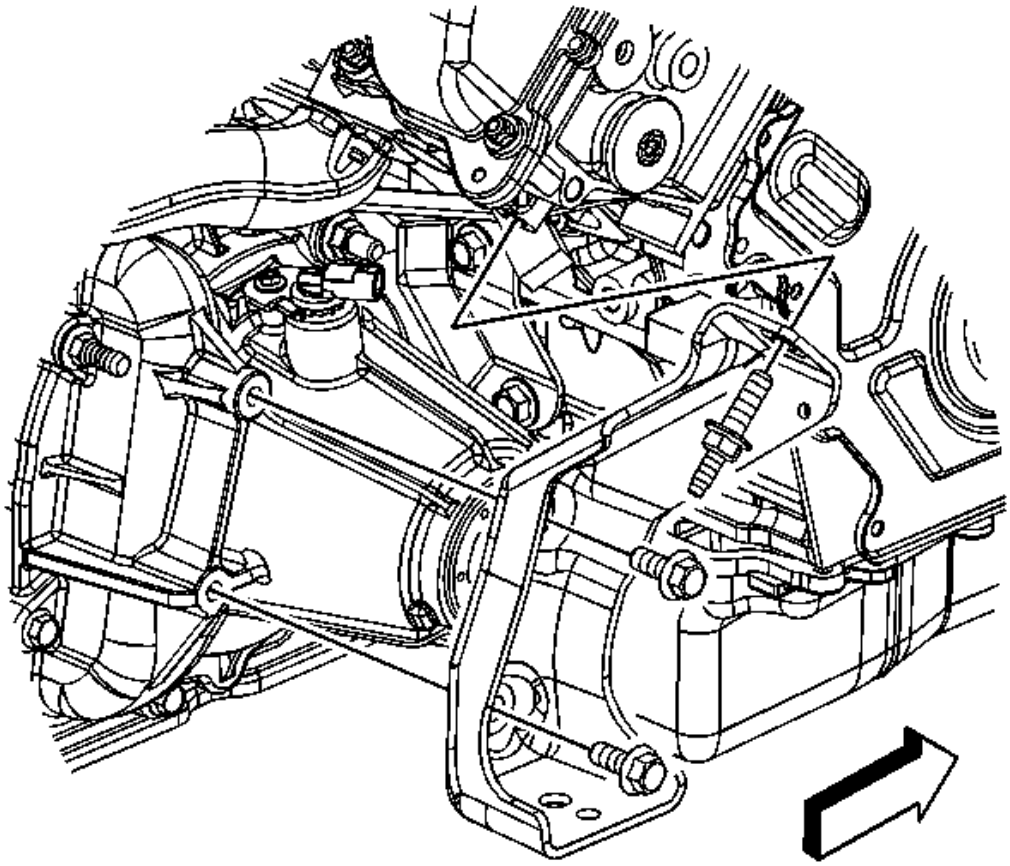


Fig. 350: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Remove the stud attaching the right engine mount bracket to the cylinder head.
13. Loosen the bolts attaching the engine mount bracket to the transaxle.

 © 2011 Mitchell Repair Information Company, LLC.

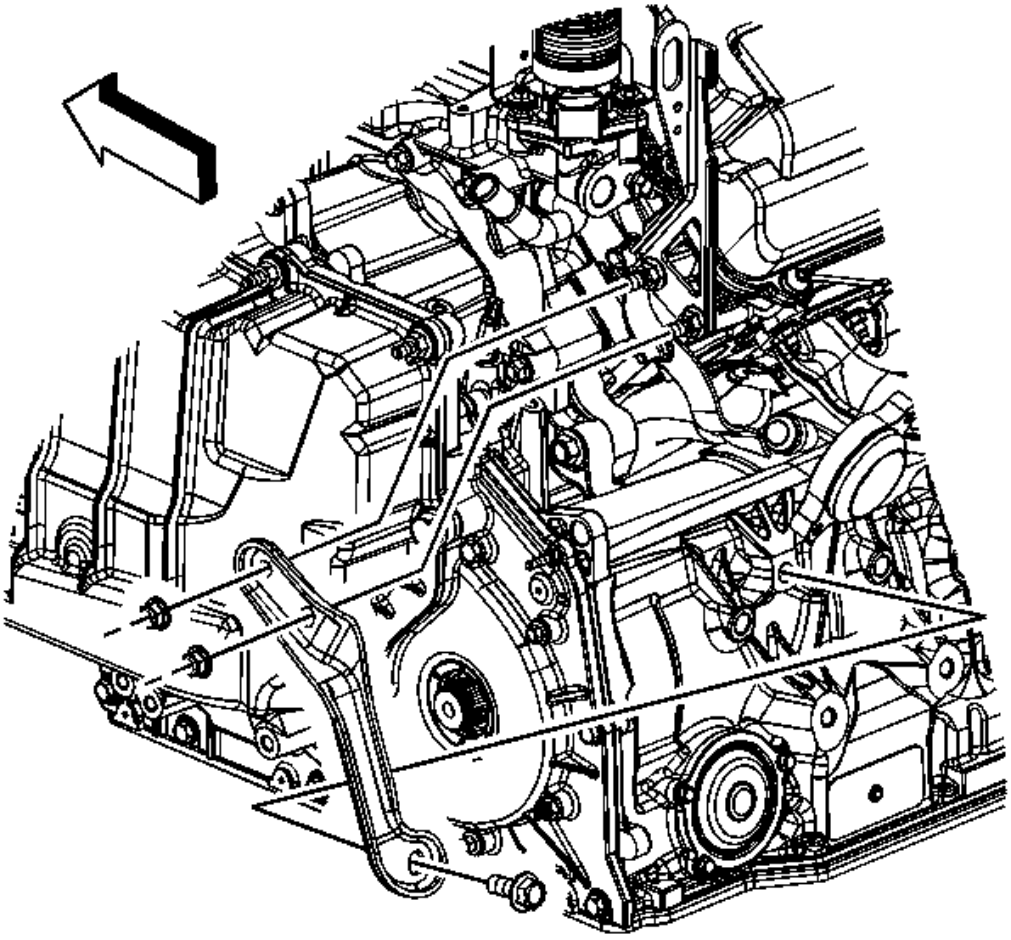


Fig. 351: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

14. Remove the bolt attaching the transaxle brace to the transaxle.
15. Lower the vehicle.
16. Remove the nuts attaching the transaxle brace to the lift bracket studs.
17. Remove the transaxle brace.

 © 2011 Mitchell Repair Information Company, LLC.

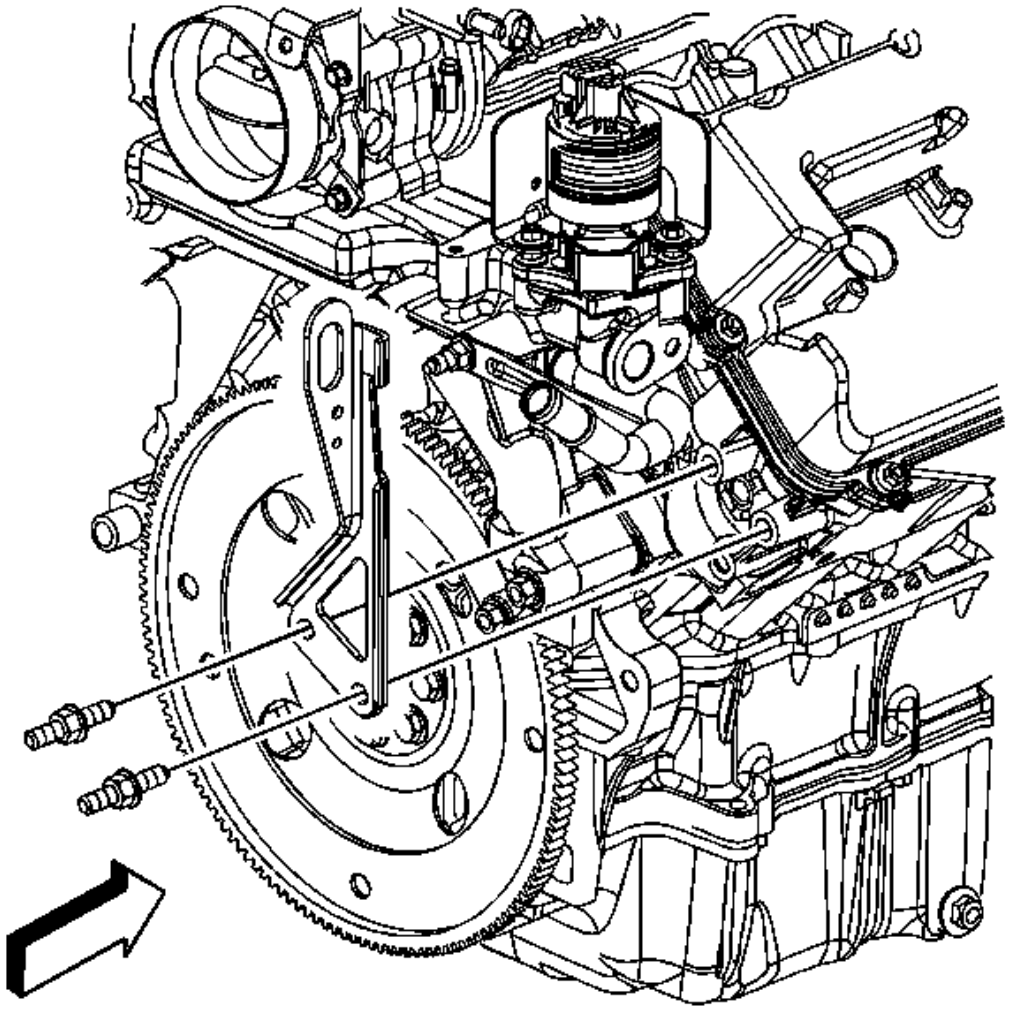


Fig. 352: Identifying Engine Rear Lift Bracket Studs
Courtesy of GENERAL MOTORS COMPANY

18. Remove the rear lift bracket studs.
19. Remove the rear lift bracket.

 © 2011 Mitchell Repair Information Company, LLC.

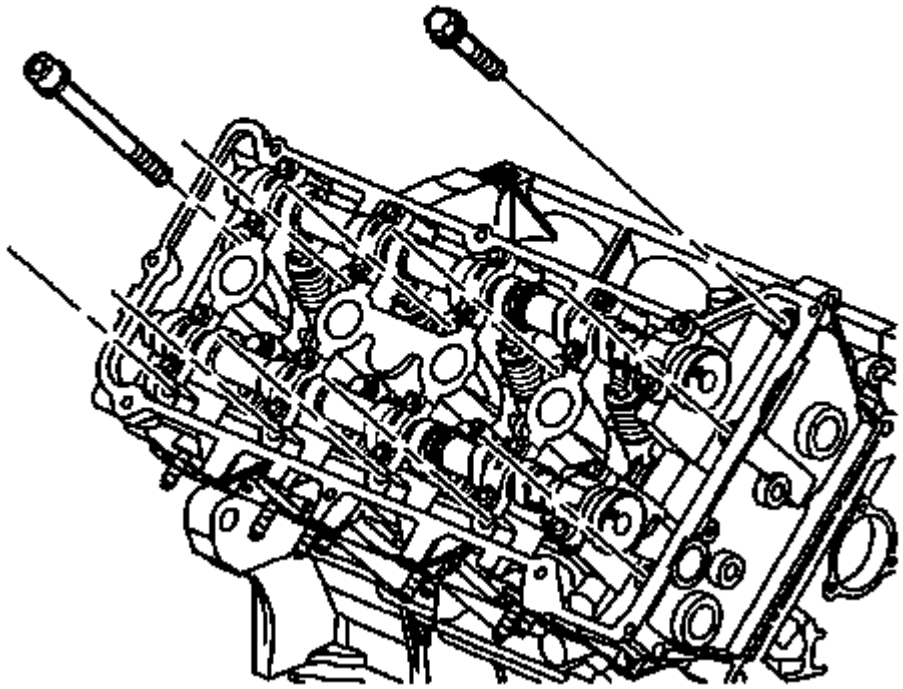


Fig. 353: Identifying M6 External Drive Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Remove the 3 M6 cylinder head bolts.

NOTE: DO NOT reuse the M11 cylinder head bolts.

21. Remove and discard the 10 M11 cylinder head bolts.

 © 2011 Mitchell Repair Information Company, LLC.

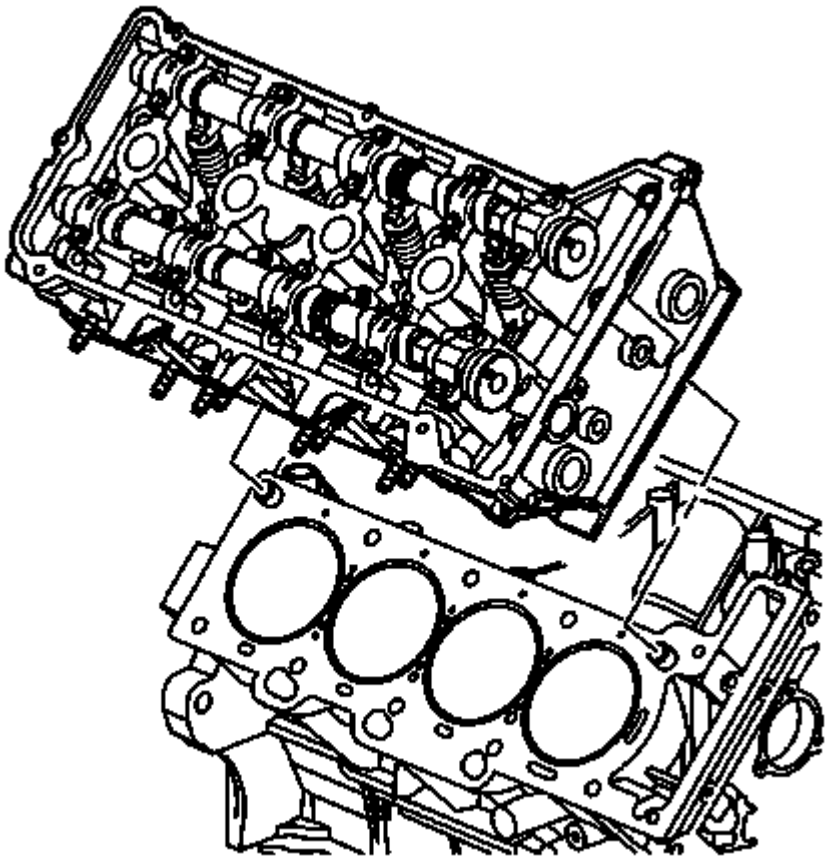


Fig. 354: View Of Cylinder Head With Alignment Dowels - Right
Courtesy of GENERAL MOTORS COMPANY

22. Remove the right cylinder head. Make sure that no locating pins are stuck in the cylinder head.

NOTE: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do so could cause false torque readings during reassembly.

23. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

 © 2011 Mitchell Repair Information Company, LLC.

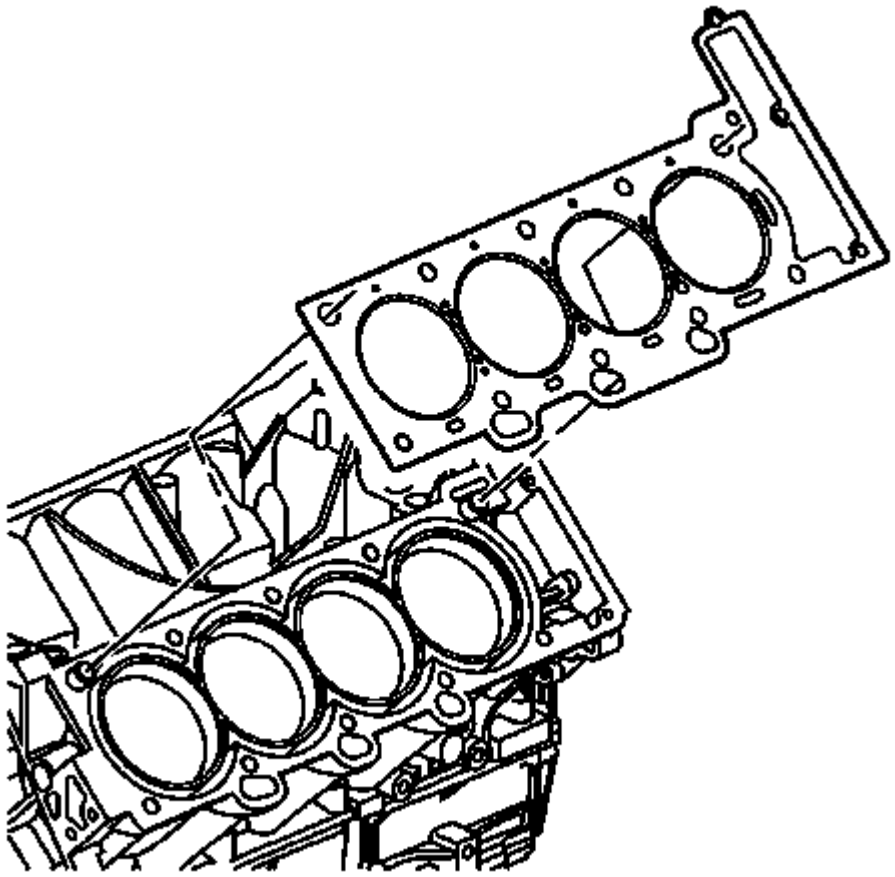


Fig. 355: View of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT reuse the cylinder head gasket.

24. Remove and discard the right cylinder head gasket.
25. Remove all remaining gasket material from the cylinder head and cylinder block using the **J 28410** .
26. Place the cylinder head on a clean, flat surface with the combustion chambers face-up in order to prevent damage to the deck face.
27. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

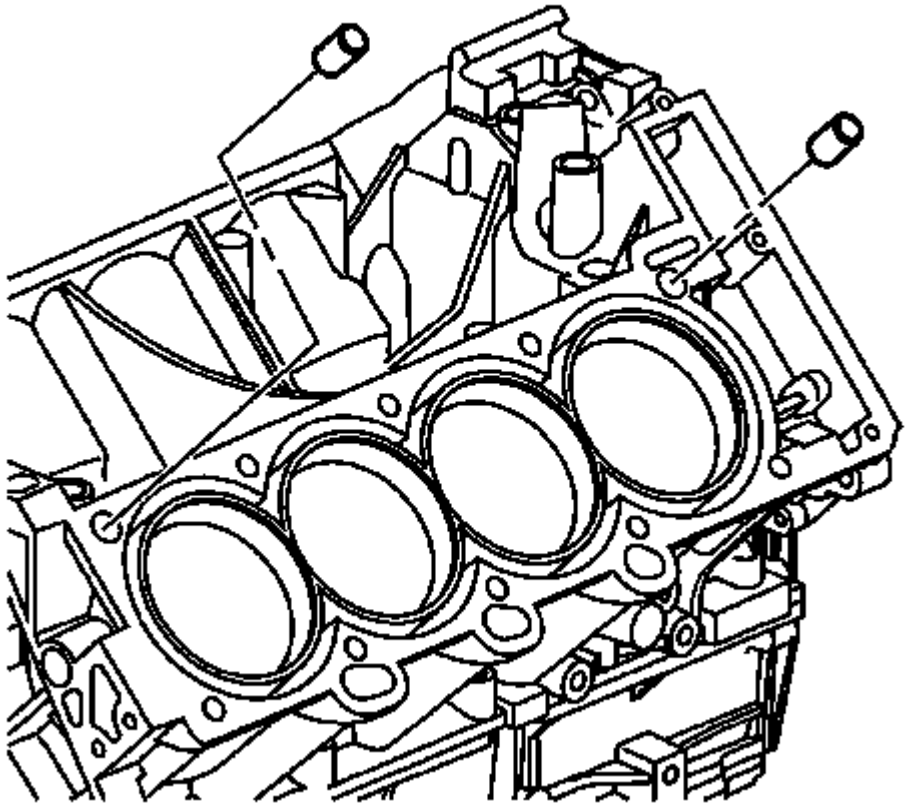


Fig. 356: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS COMPANY

1. Make sure the locating pins are securely mounted in the cylinder block deck face.

NOTE: Failure to remove all the old thread sealant material from the cylinder block could cause false torque readings.

2. Make sure any old thread sealant material is removed from the cylinder head bolt holes in the cylinder block.

 © 2011 Mitchell Repair Information Company, LLC.

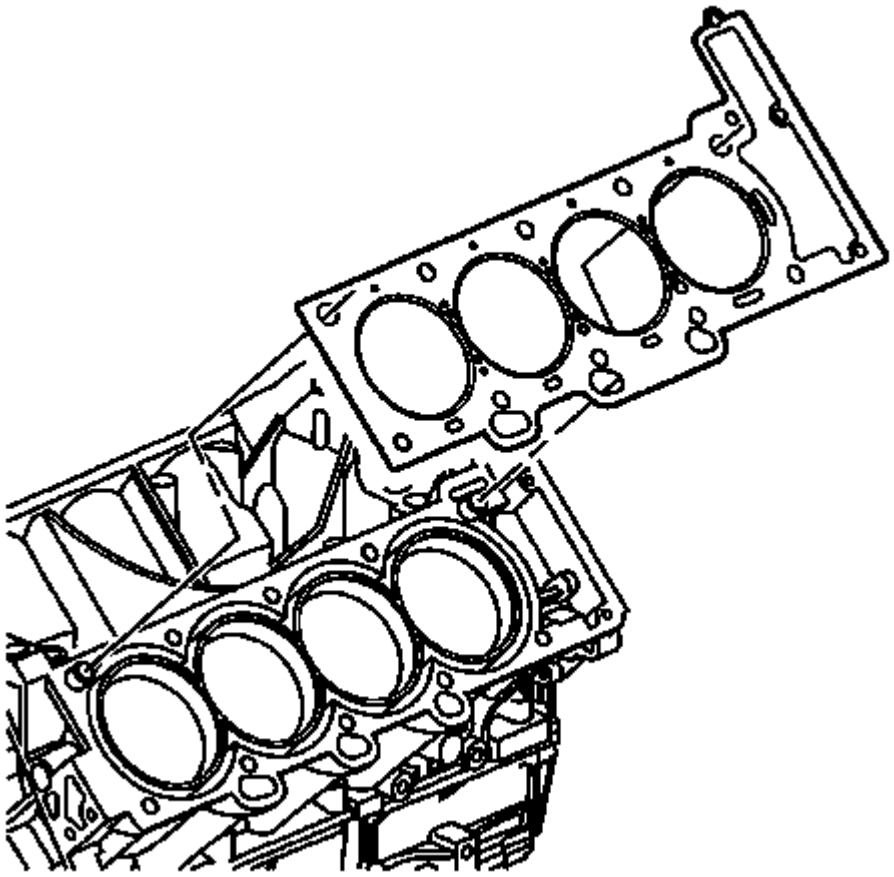


Fig. 357: View of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW cylinder head gasket using the locating pins for retention.

 © 2011 Mitchell Repair Information Company, LLC.

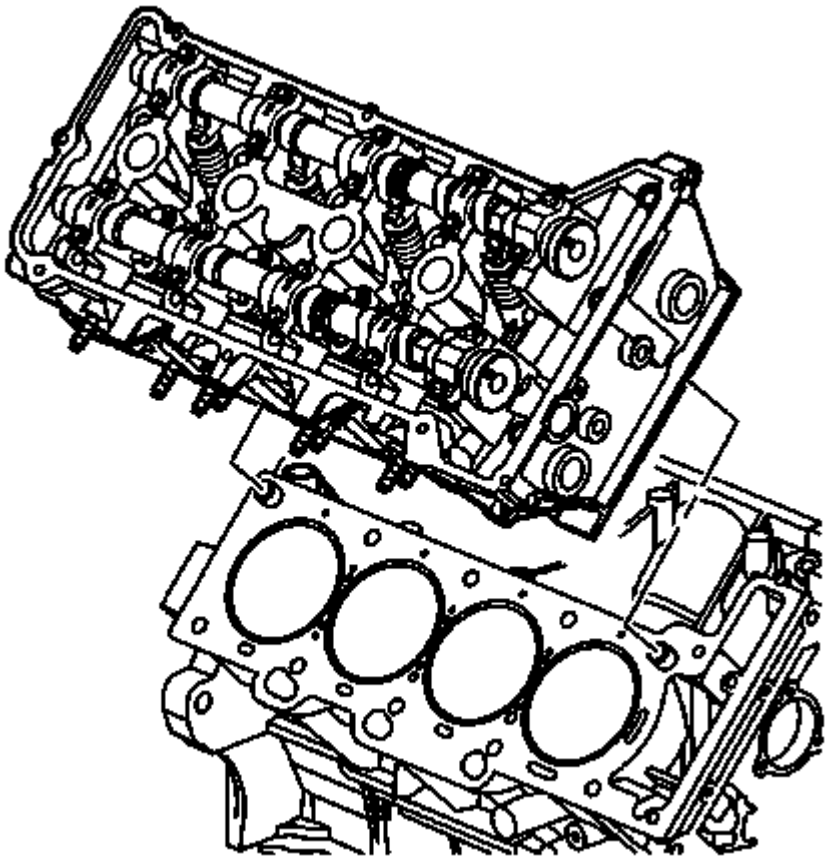


Fig. 358: View Of Cylinder Head With Alignment Dowels - Right
Courtesy of GENERAL MOTORS COMPANY

4. Align the cylinder head with the locating pins.
5. Place the cylinder head in position on the cylinder block.

 © 2011 Mitchell Repair Information Company, LLC.

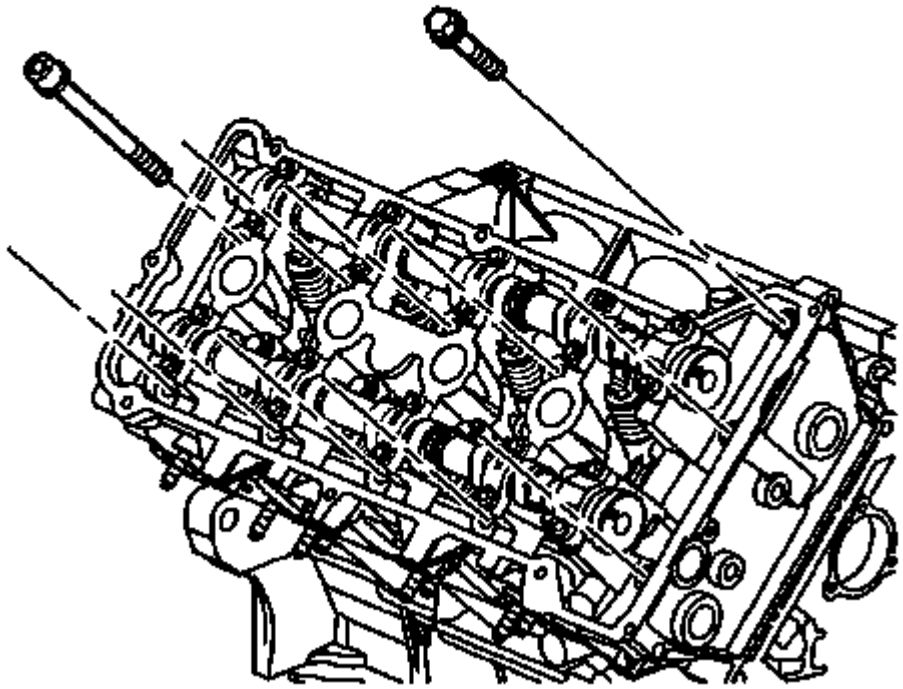


Fig. 359: Identifying M6 External Drive Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install NEW M11 cylinder head bolts until snug.
7. Install the M6 cylinder head bolts until snug.

 © 2011 Mitchell Repair Information Company, LLC.

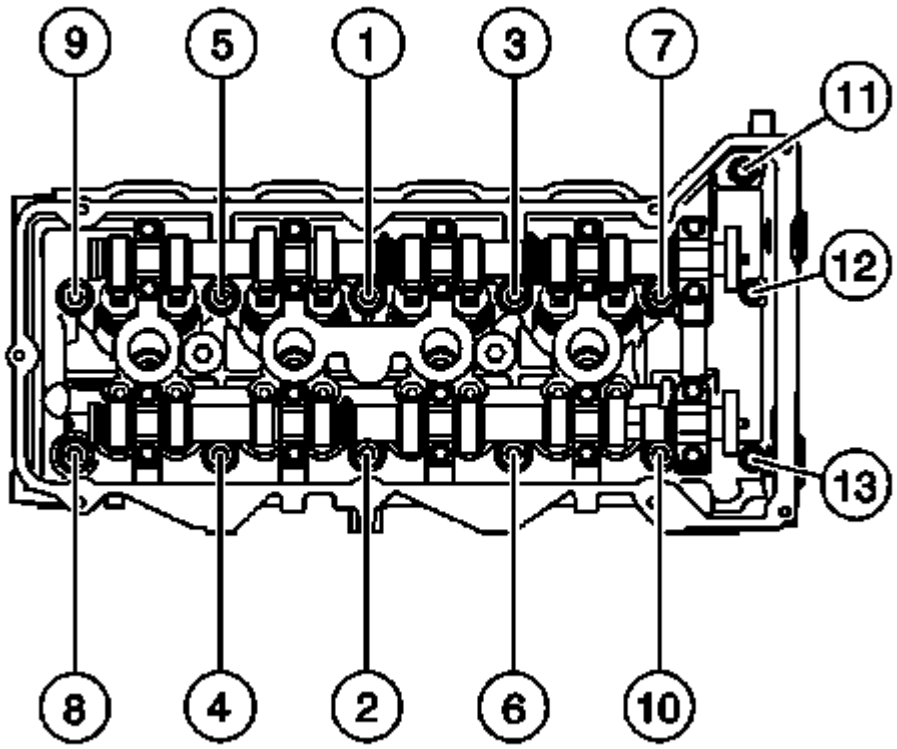


Fig. 360: Identifying Right Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the M11 cylinder head bolts.

   Tighten

   1. Tighten the bolts (1-10) a first pass in the sequence shown to 30 N.m (22 lb ft).
   2. Tighten the bolts a second pass in the sequence shown an additional 70 degrees using the **J 45059** .
   3. Tighten the bolts a third pass in the sequence shown an additional 60 degrees using the **J 45059** .
   4. Tighten the bolts a final pass in the sequence shown an additional 45 degrees (total 175 degrees) using the **J 45059** .
9. Tighten the M6 cylinder head bolts.

   Tighten

   Tighten the bolts to 12 N.m (106 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

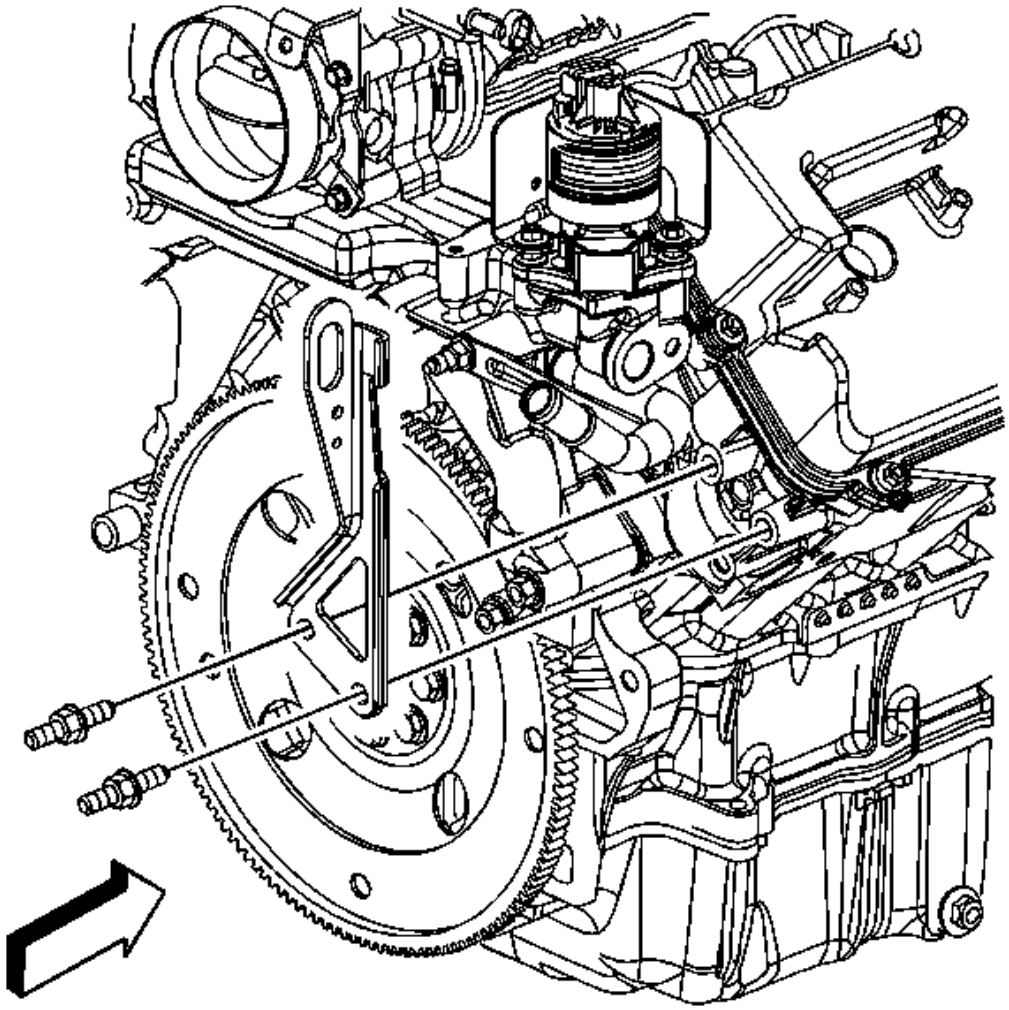


Fig. 361: Identifying Engine Rear Lift Bracket Studs
Courtesy of GENERAL MOTORS COMPANY

10. Position the rear lift bracket to the cylinder head.
11. Install the rear lift bracket studs.

Tighten

Tighten the studs to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

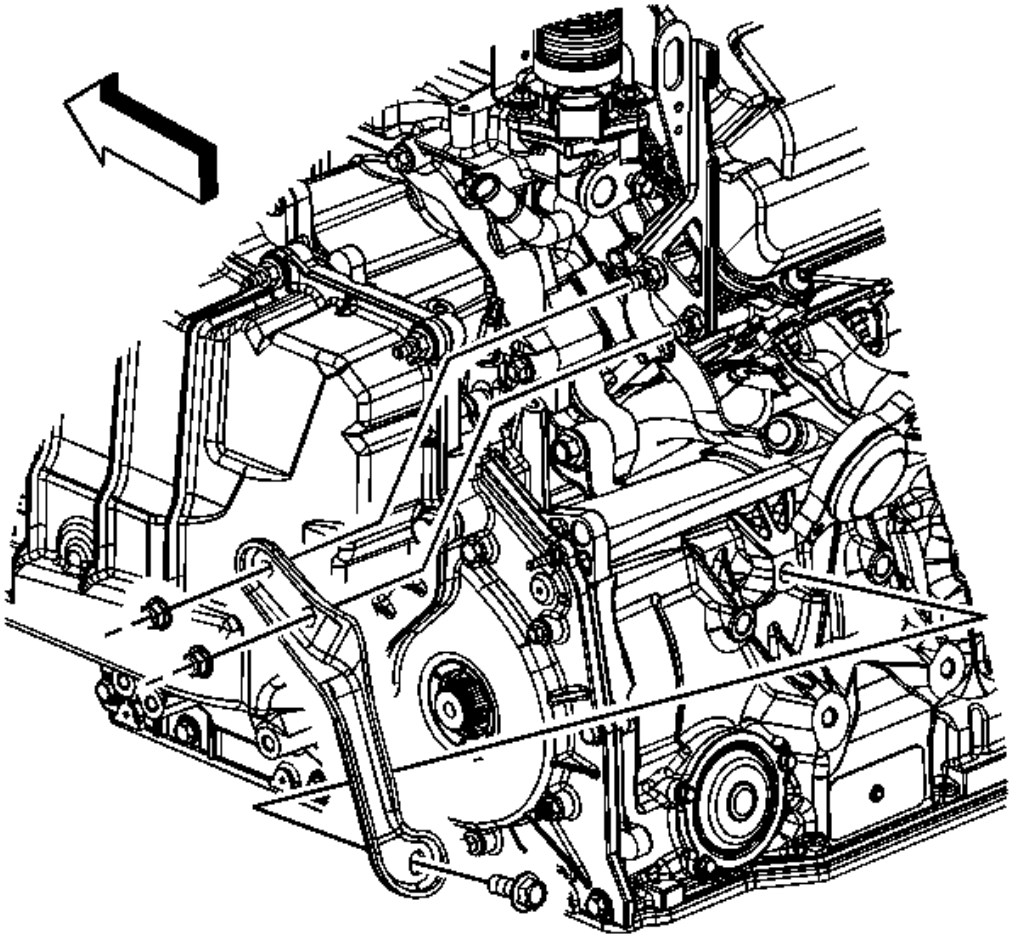


Fig. 362: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Install the transaxle brace to the lift bracket studs.
13. Install the nuts attaching the transaxle brace to the lift bracket studs.

Tighten

Tighten the nuts to 50 N.m (37 lb ft).

14. Raise the vehicle.
15. Install the bolt attaching the transaxle brace to the transaxle.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the bolt to 50 N.m (37 lb ft).

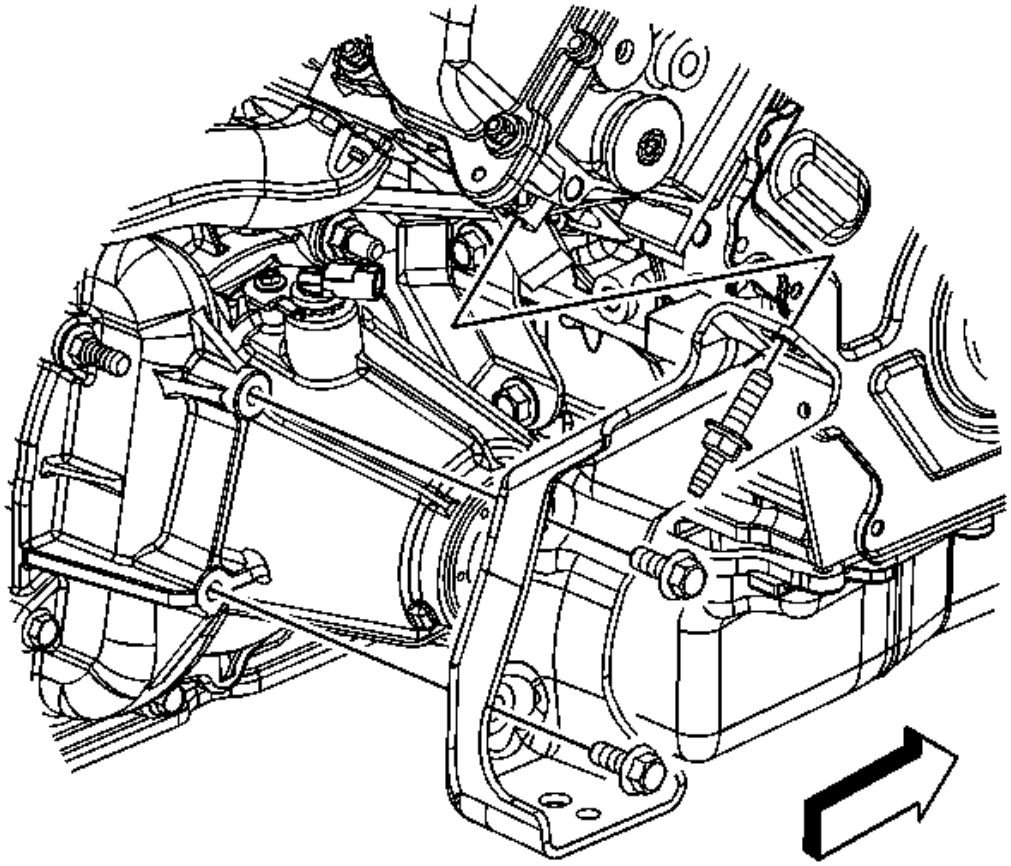


Fig. 363: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

16. Install the stud attaching the right engine mount bracket to the cylinder head.

    Tighten

    Tighten the bolt to 73 N.m (54 lb ft).

17. Tighten the bolts attaching the engine mount bracket to the transaxle.

    Tighten

    Tighten the bolt to 73 N.m (54 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

18. Lower the vehicle.

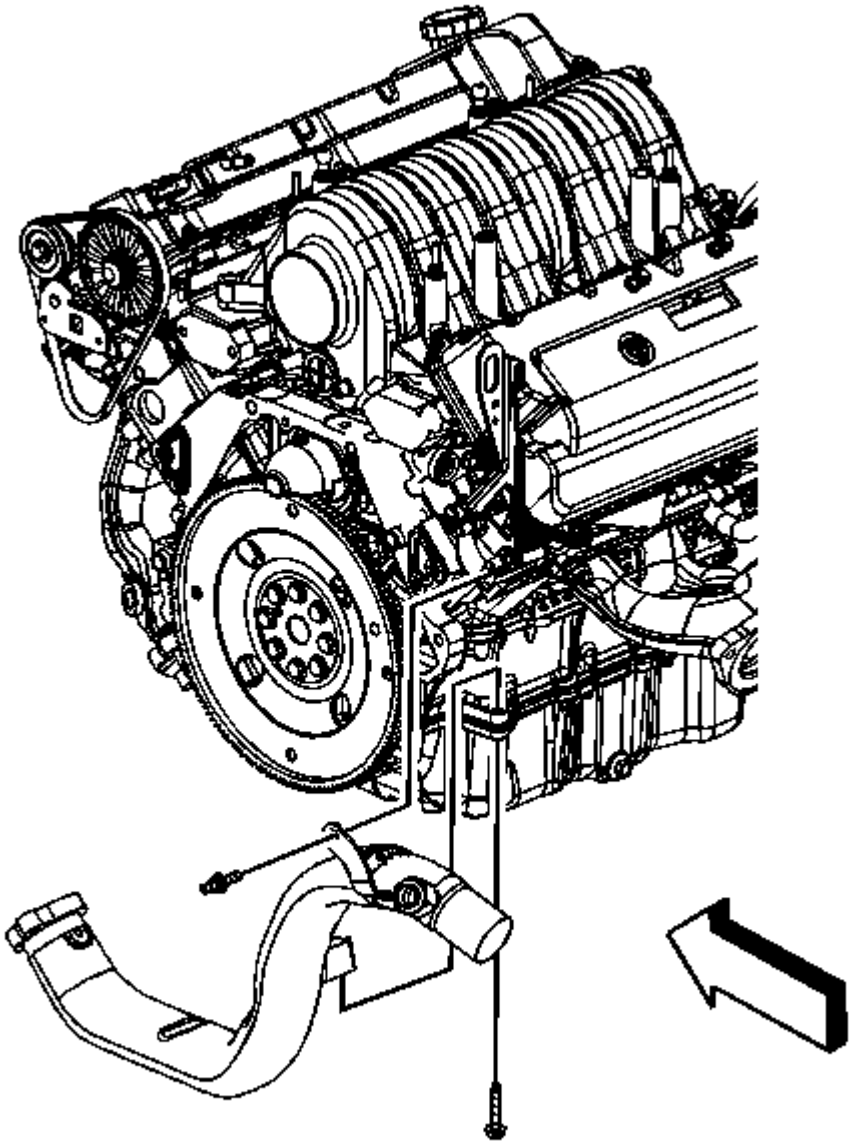


Fig. 364: Identifying Front Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS COMPANY

19. Install the stud attaching the exhaust manifold front pipe to the cylinder head.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the stud to 25 N.m (18 lb ft).

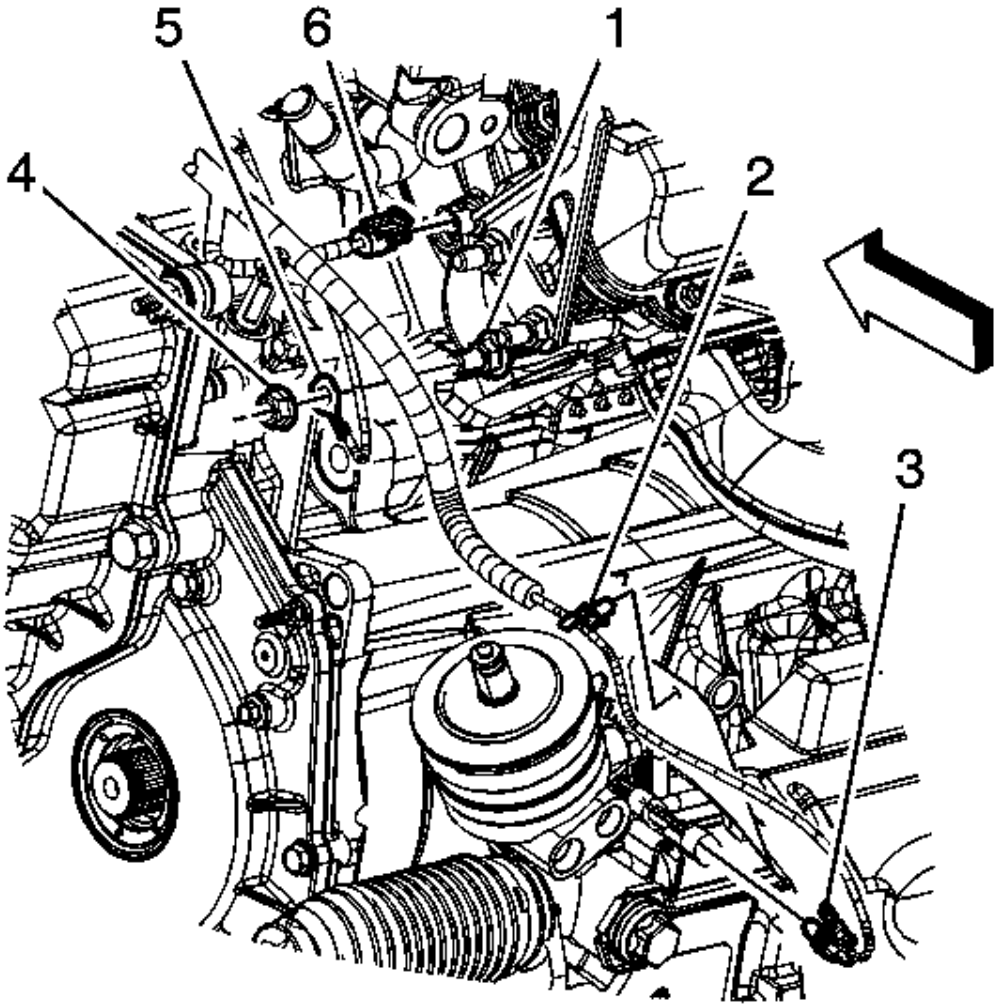


Fig. 365: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

20. Install the engine harness ground terminal (5) onto the stud (1).
21. Install the engine harness ground terminal nut (4).

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the nut to 17 N.m (13 lb ft).

22. Connect the engine harness electrical connector (6) to the ECT sensor.
23. Install the right secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
24. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
25. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
26. Install the intake manifold. Refer to **Intake Manifold Replacement**.
27. Install the water crossover. Refer to **Engine Coolant Crossover Pipe Replacement (L37)** .
28. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (L37)** .

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- **J 45059** Angle Meter
- **J 44214** Flywheel Holder

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

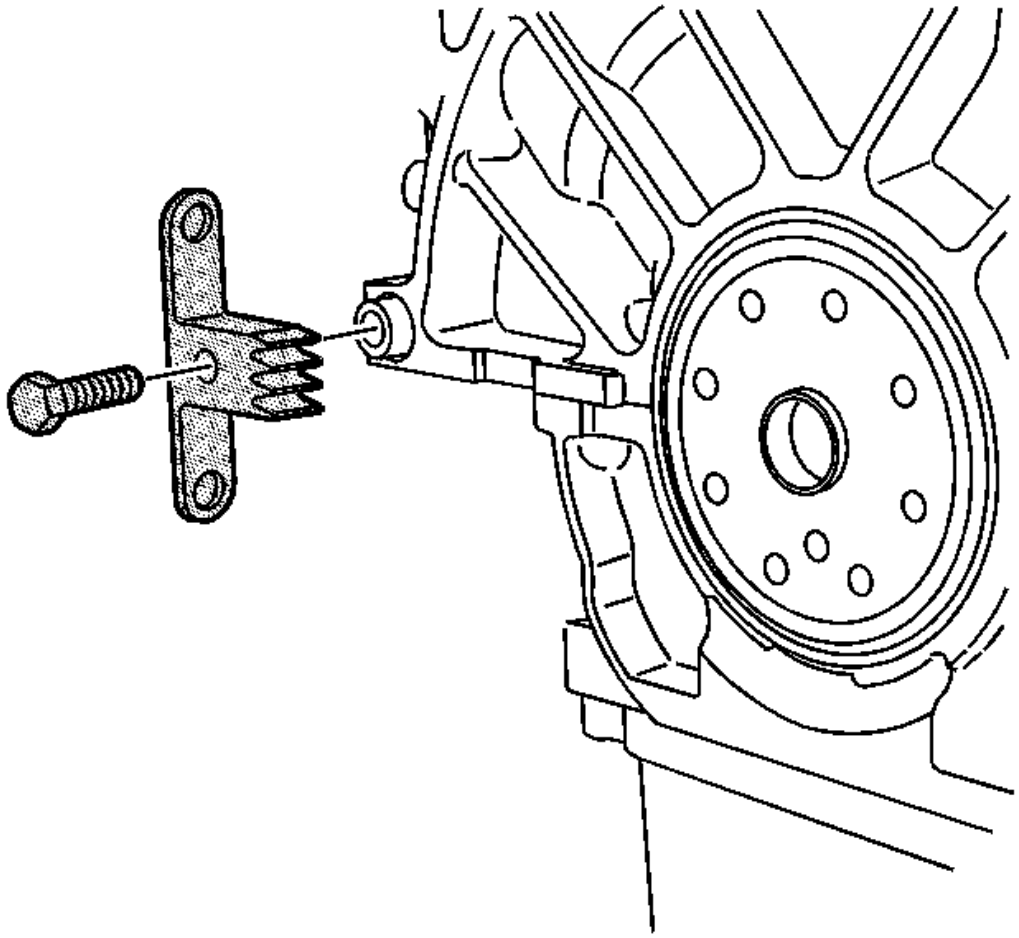


Fig. 366: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transaxle. Refer to **Transmission Replacement** .
2. Install the **J 44214** to the engine block.

 © 2011 Mitchell Repair Information Company, LLC.

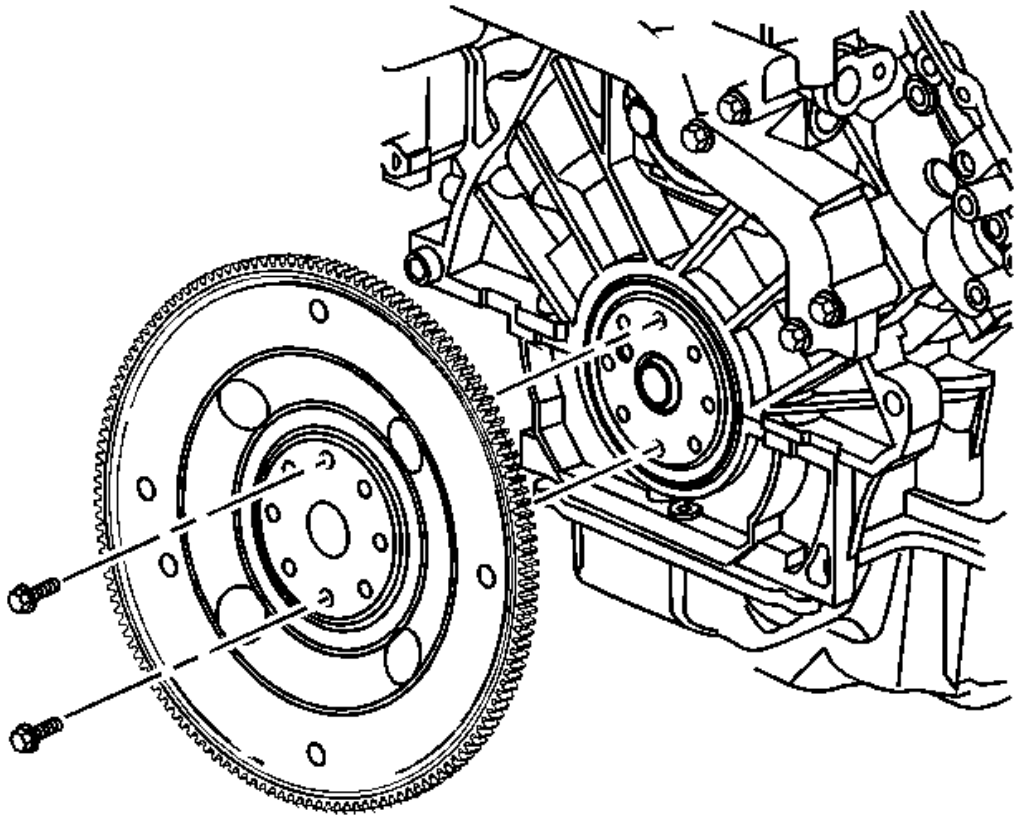


Fig. 367: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the flywheel bolts.
4. Remove all but one of the flywheel bolts, leaving the one bolt at the top of the crankshaft.
5. Grasp the engine flywheel with one hand and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.
6. Clean and inspect the engine flywheel. Refer to **Engine Flywheel Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

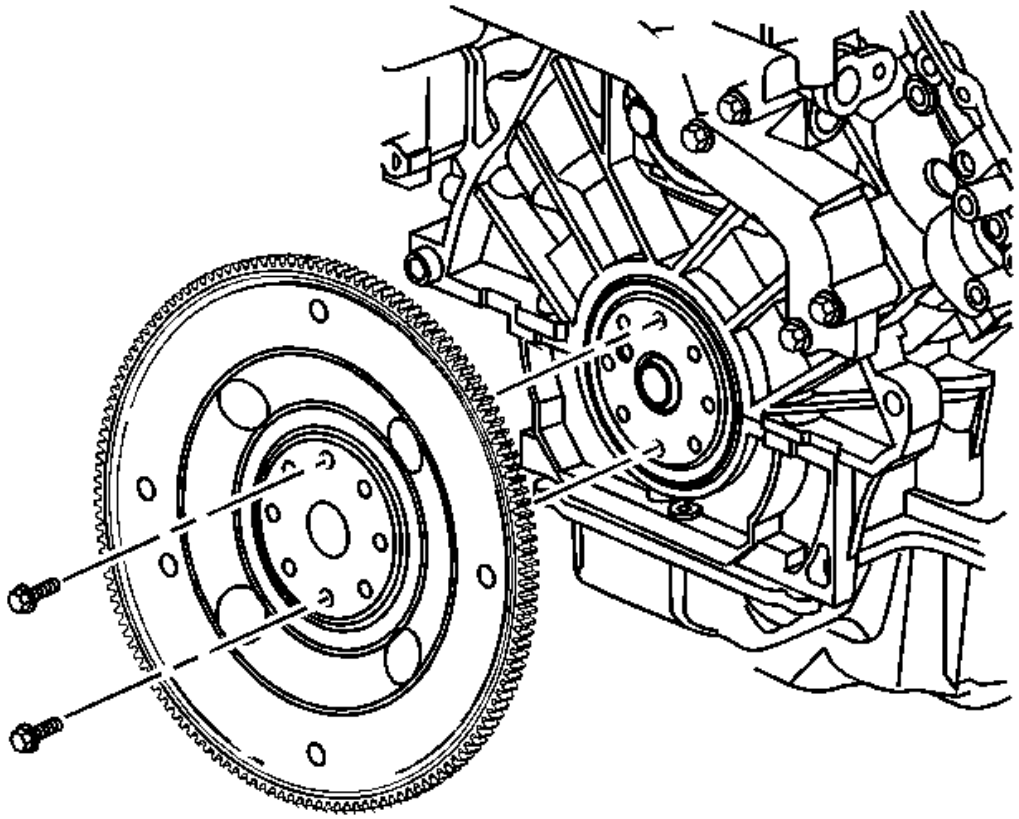


Fig. 368: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Apply sealant to the flywheel bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Place the engine flywheel in position against the crankshaft.

CAUTION: Refer to Fastener Caution .

3. Install the flywheel bolts.

Tighten

- Tighten the bolts a first pass to 30 N.m (22 lb ft).
- Tighten the bolts a final pass an additional 50 degrees using the **J 45059** .

 © 2011 Mitchell Repair Information Company, LLC.

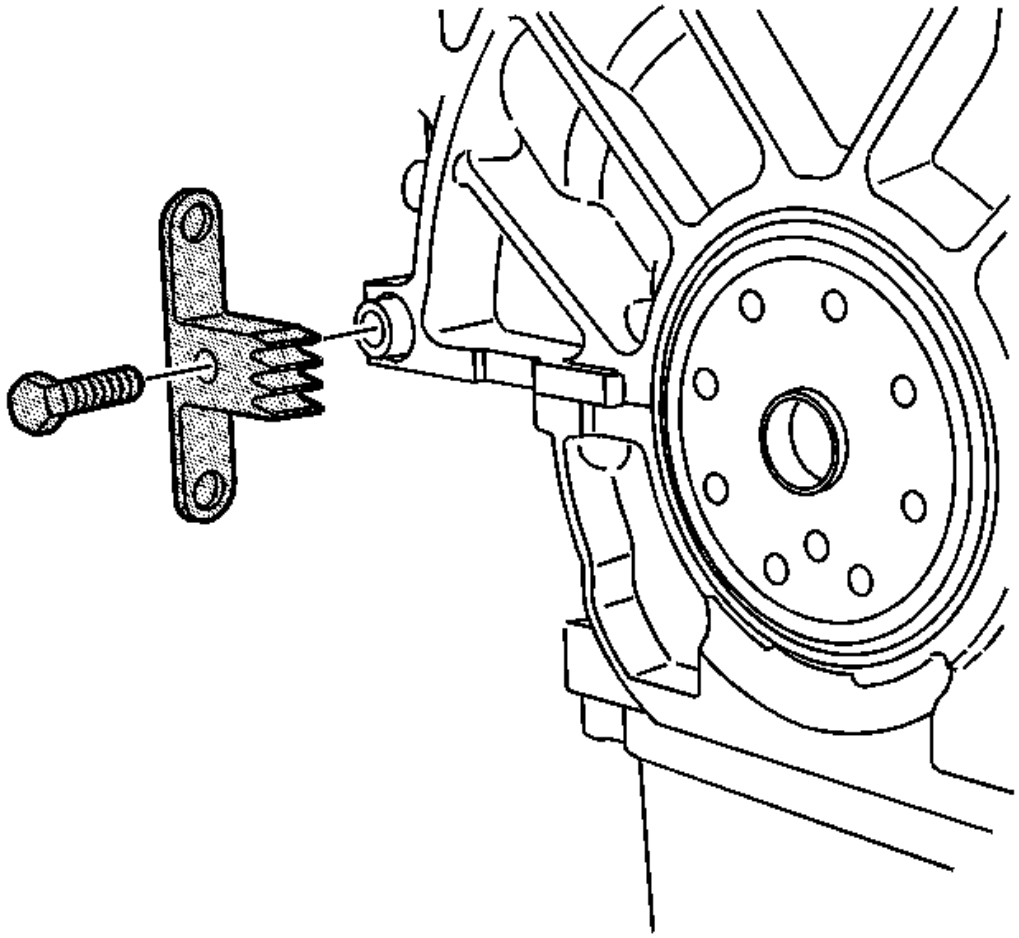


Fig. 369: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **J 44214** from the engine block.
5. Install the transaxle. Refer to **Transmission Replacement** .

OIL PAN REPLACEMENT

Special Tools

EN 46109 Engine Front Cover Installation Guide Pins

Removal Procedure

 © 2011 Mitchell Repair Information Company, LLC.

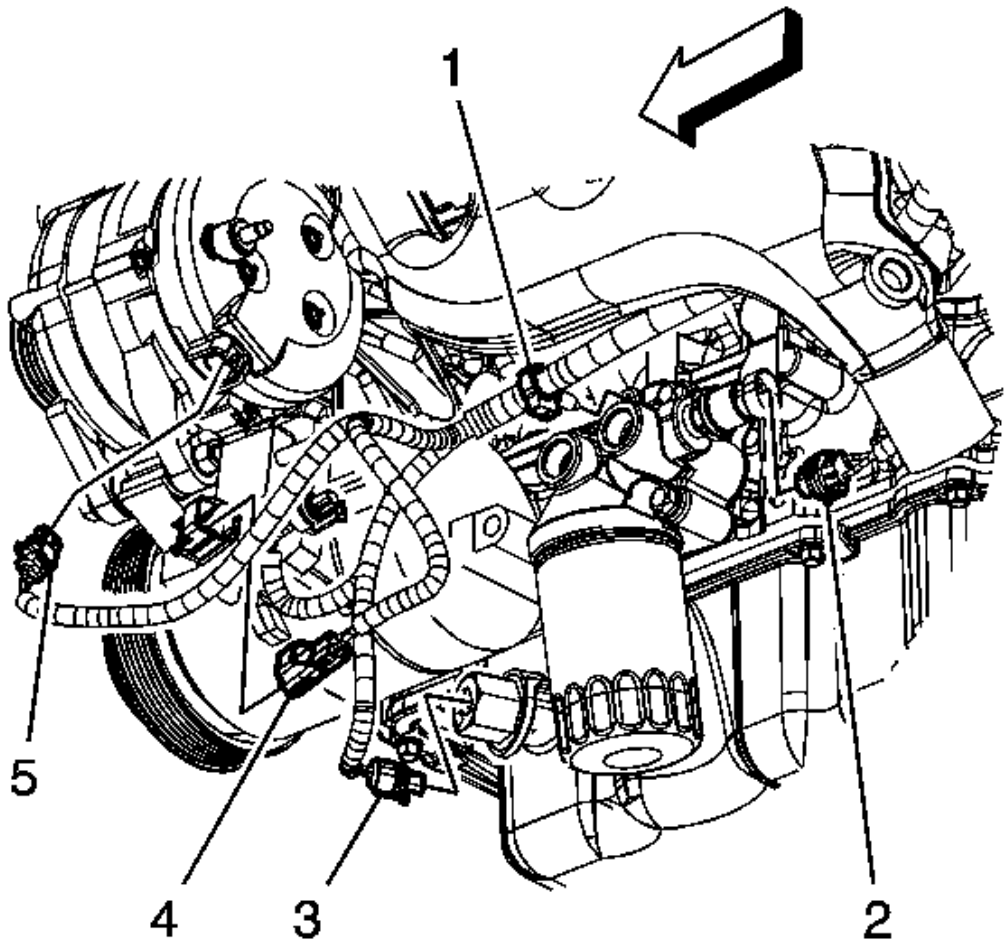


Fig. 370: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the front exhaust manifold pipe. Refer to **Exhaust Manifold Front Pipe Replacement (L37)** .
3. Disconnect the engine harness electrical connector (2) from the oil level sensor.

 © 2011 Mitchell Repair Information Company, LLC.

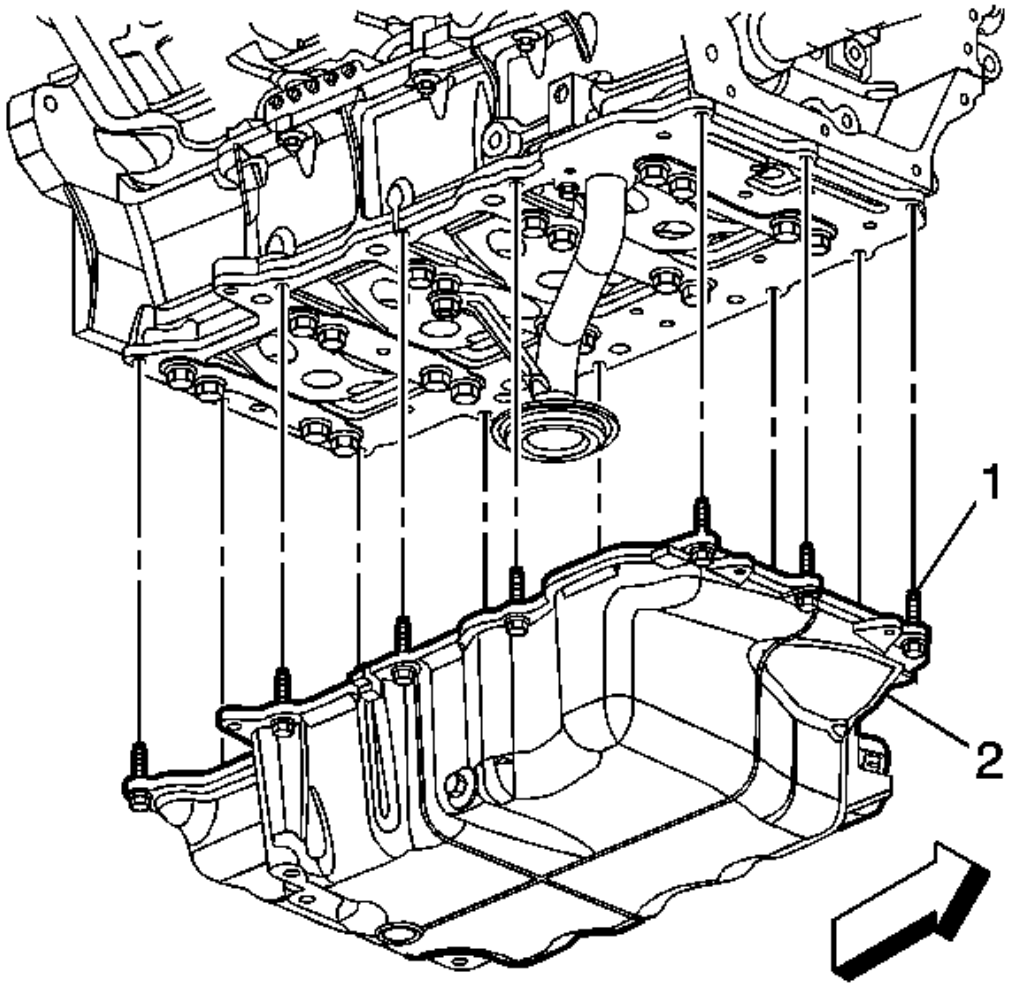


Fig. 371: View Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the oil pan bolts (1).
5. Remove the oil pan (2) and discard the oil pan gasket.
6. Clean and inspect the oil pan, if necessary. Refer to **Oil Pan Cleaning and Inspection** .

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

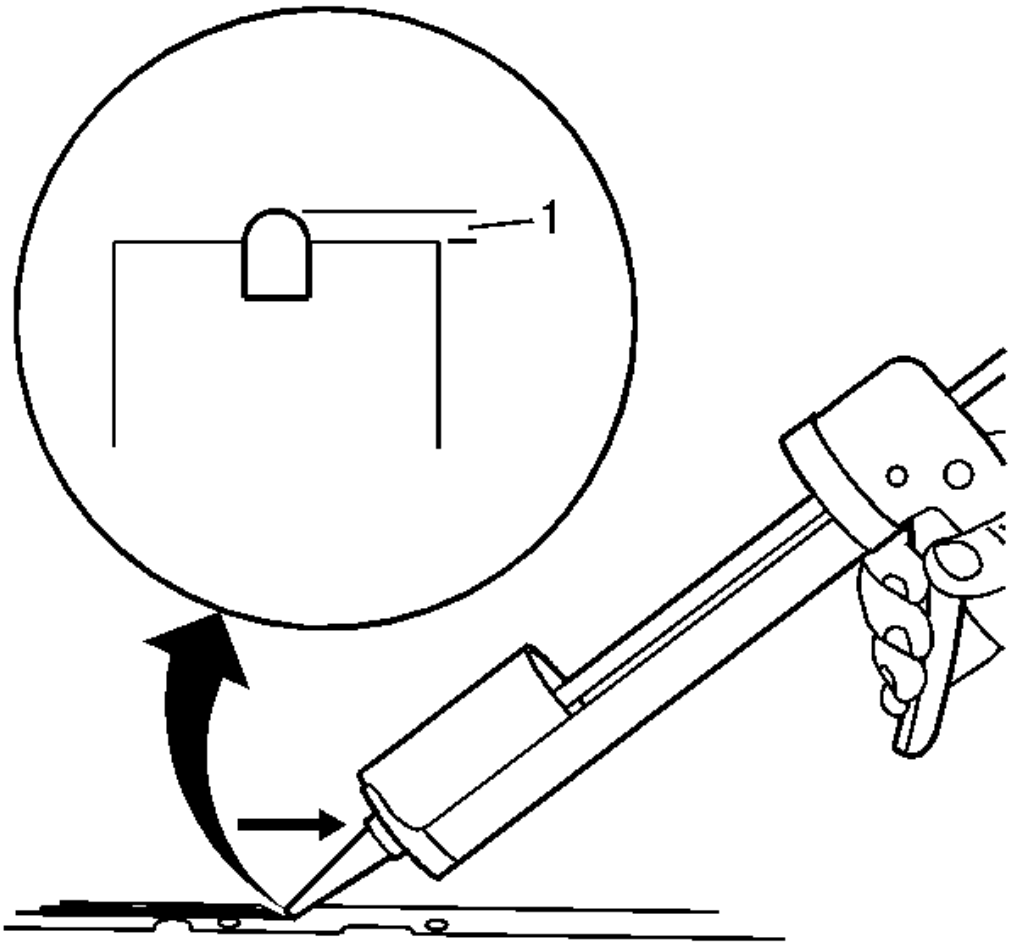


Fig. 372: Applying RTV Sealant
Courtesy of GENERAL MOTORS COMPANY

1. Completely fill and slightly overfill the oil pan seal groove with a continuous bead of RTV sealant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Ensure the RTV sealant is higher than the oil pan sealing surface (1) by 3 mm (0.118 in).

 © 2011 Mitchell Repair Information Company, LLC.

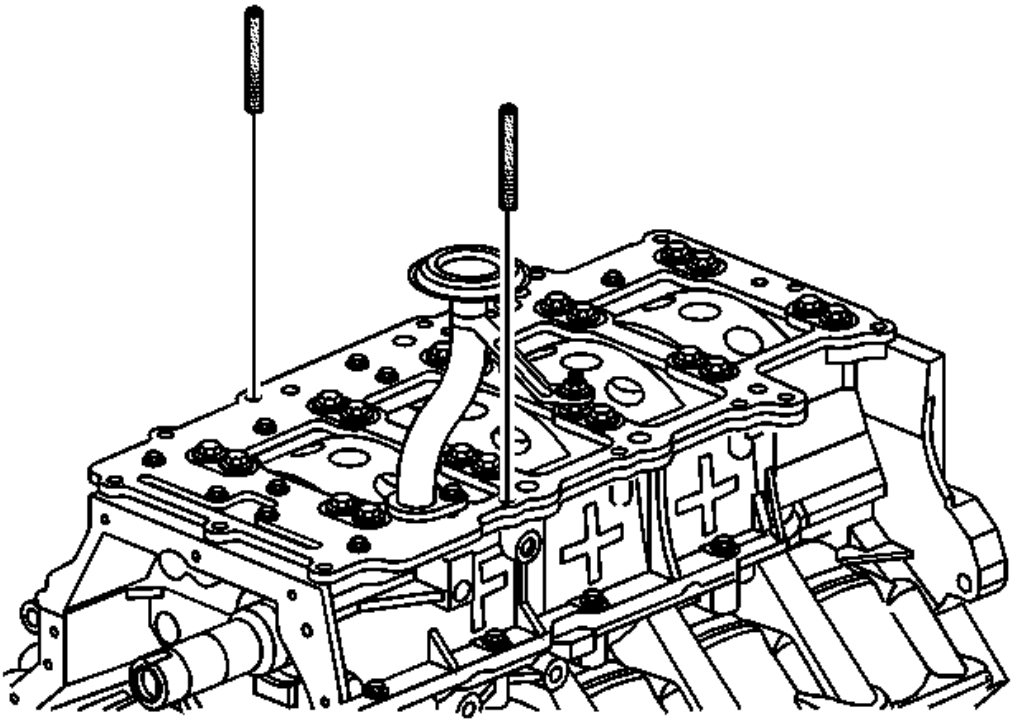


Fig. 373: Guide Pins
Courtesy of GENERAL MOTORS COMPANY

3. To prevent shifting of the oil pan, install one **EN 46109** into the bolt hole in each side of the lower crankcase.

 © 2011 Mitchell Repair Information Company, LLC.

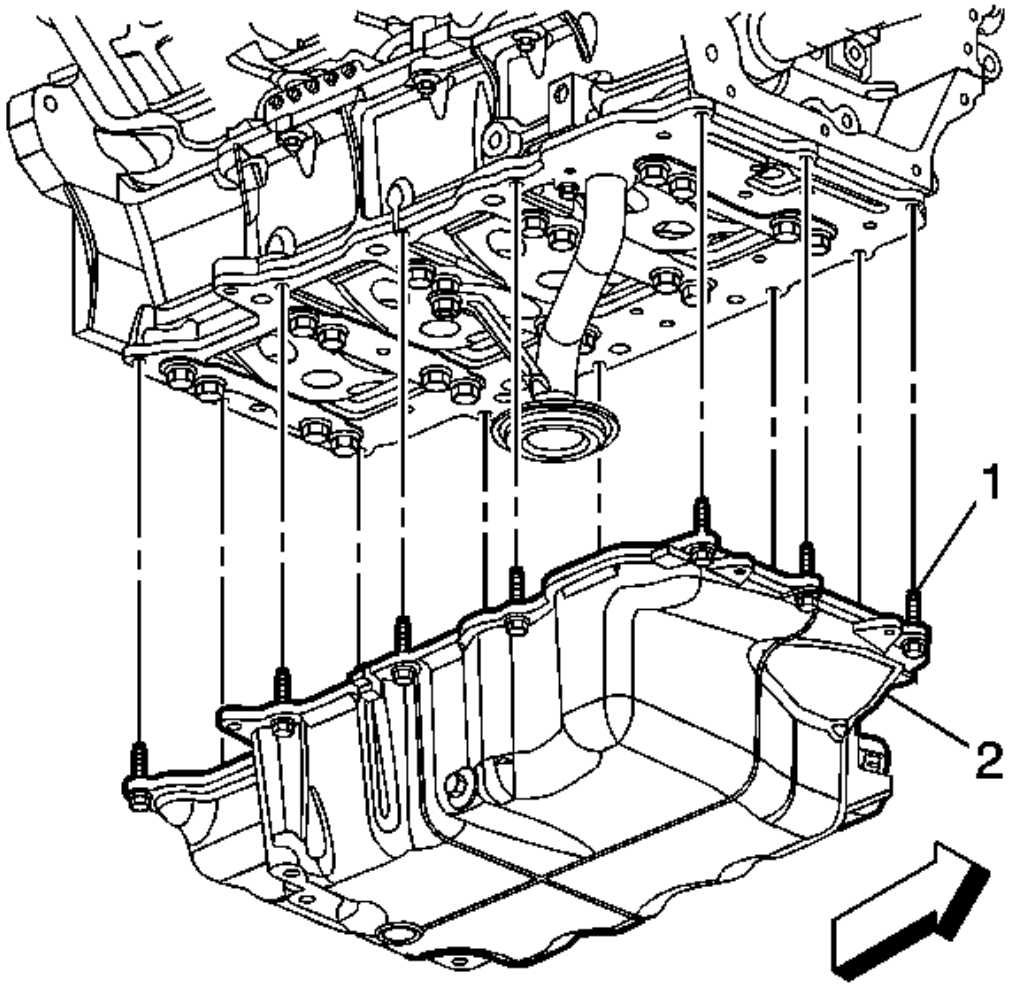


Fig. 374: View Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Position the oil pan (2) to the lower crankcase and finger start the oil pan bolts (1).

 © 2011 Mitchell Repair Information Company, LLC.

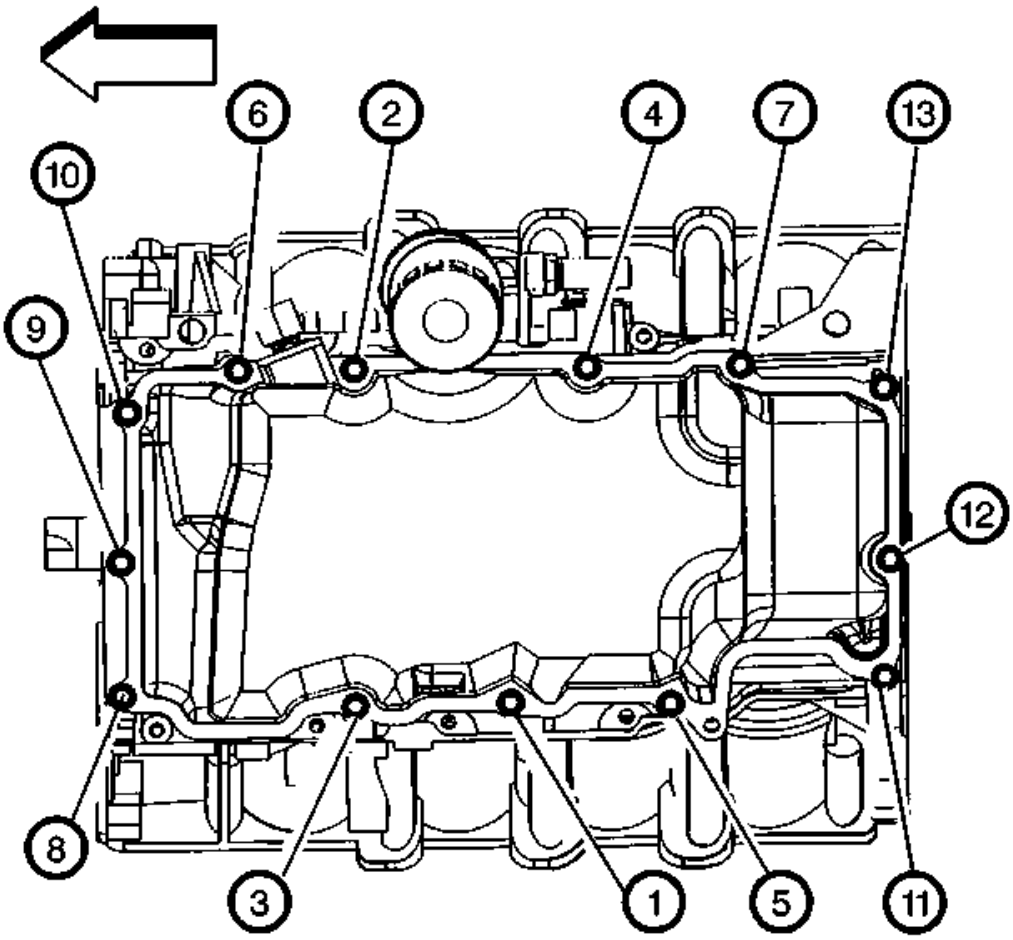


Fig. 375: Installing Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the oil pan bolts.

Tighten

1. Tighten the bolts a first pass to 8 N.m (71 lb in).
2. Tighten the bolts a final pass to 12 N.m (106 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

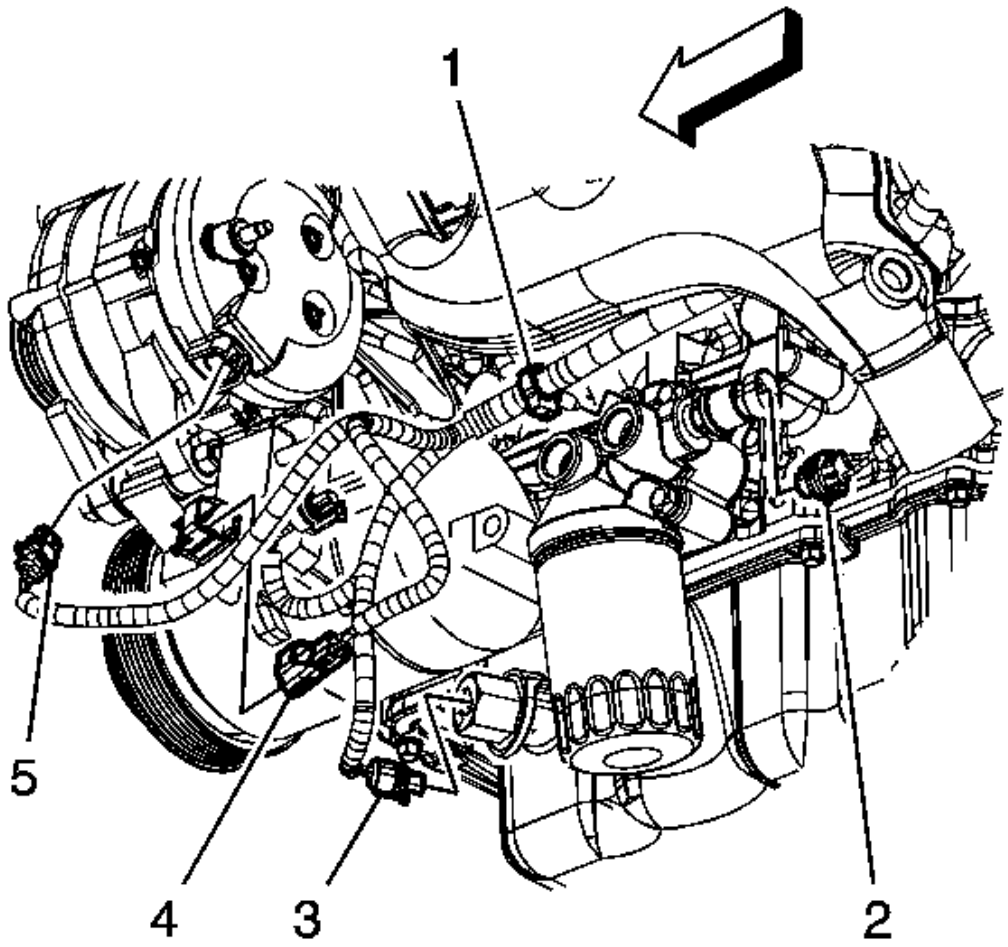


Fig. 376: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

6. Connect the engine harness electrical connector (2) to the oil level sensor.
7. Install the front exhaust manifold pipe. Refer to **Exhaust Manifold Front Pipe Replacement (L37)**
8. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

- **EN-48072** Sealant Applicator
- **J 42841-A** Crankshaft Rear Oil Seal Remover

 © 2011 Mitchell Repair Information Company, LLC.

- **J 45930-A** Crankshaft Rear Oil Seal Installer

Removal Procedure

1. Remove the transaxle. Refer to **Transmission Replacement** .
2. Remove the flywheel. Refer to **Engine Flywheel Replacement**.

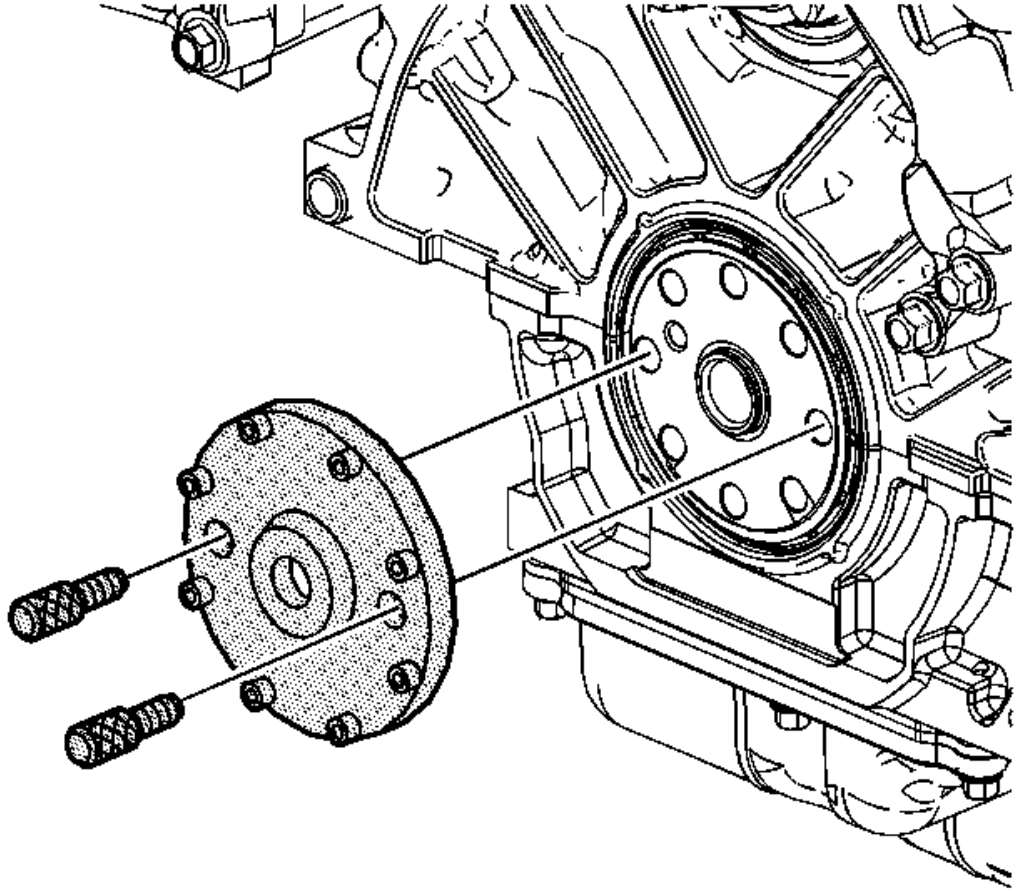


Fig. 377: Removing Rear Crankshaft Oil Seal
Courtesy of GENERAL MOTORS COMPANY

3. Place the **J 42841-A** on to the crankshaft.
4. Install the **J 42841-A** retaining bolts.

 © 2011 Mitchell Repair Information Company, LLC.

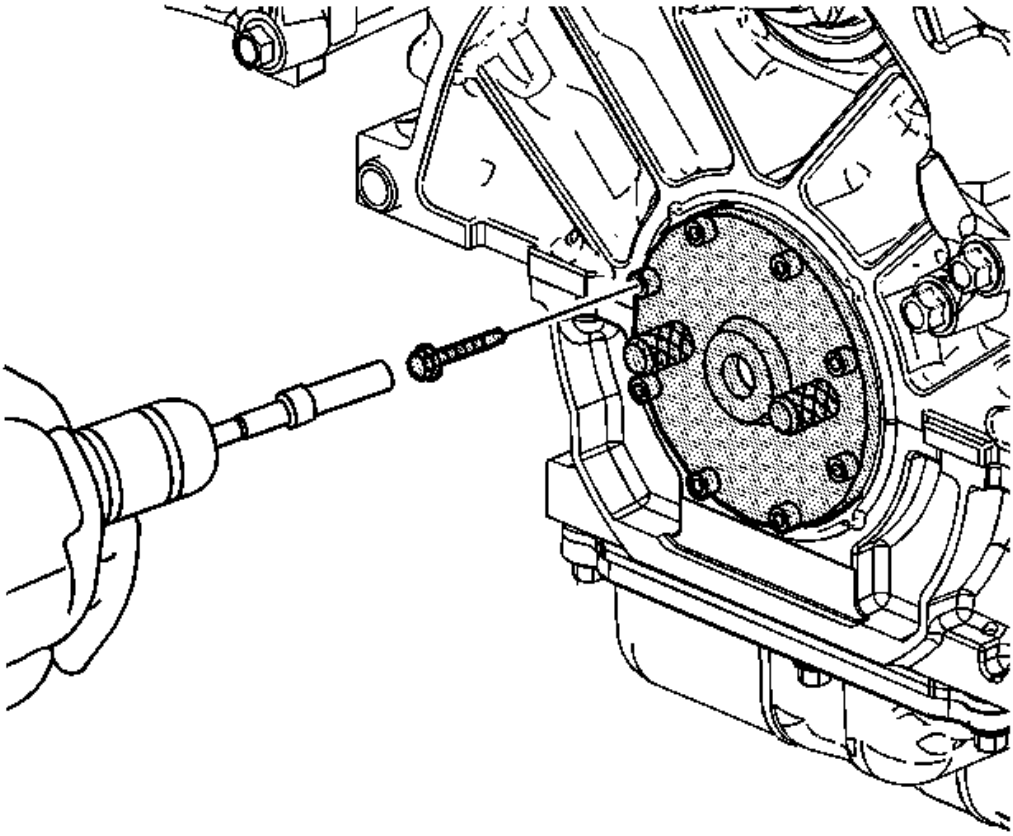


Fig. 378: Placing Screws into Seal
Courtesy of GENERAL MOTORS COMPANY

5. Using a drill motor, variable speed preferred, with a socket adapter, install eight one-inch self-drilling screws into the seal using the guide holes in the removal tool. When drilling, make sure you reduce the drill speed when the screw begins threading into the seal.

 © 2011 Mitchell Repair Information Company, LLC.

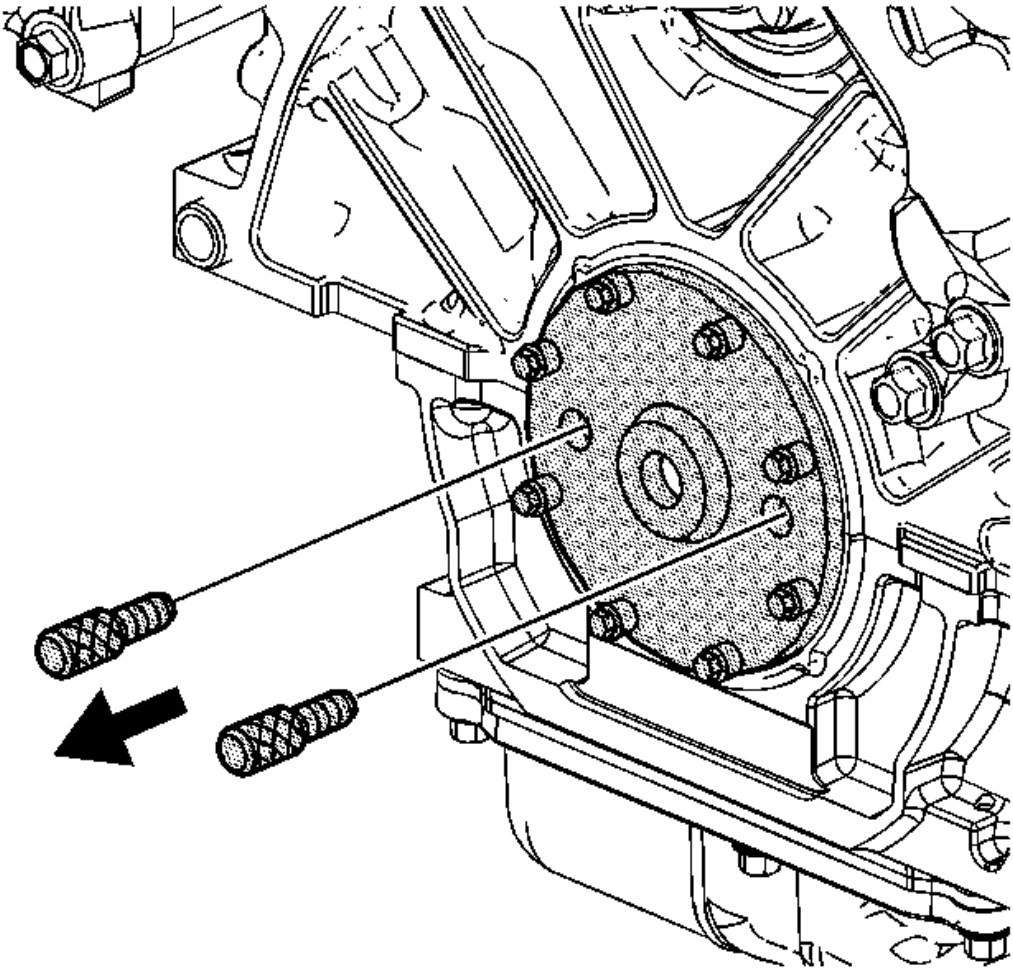


Fig. 379: Rear Oil Seal Remover Plate Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

6. With all eight removal screws installed, remove the **J 42841-A** retaining bolts.

 © 2011 Mitchell Repair Information Company, LLC.

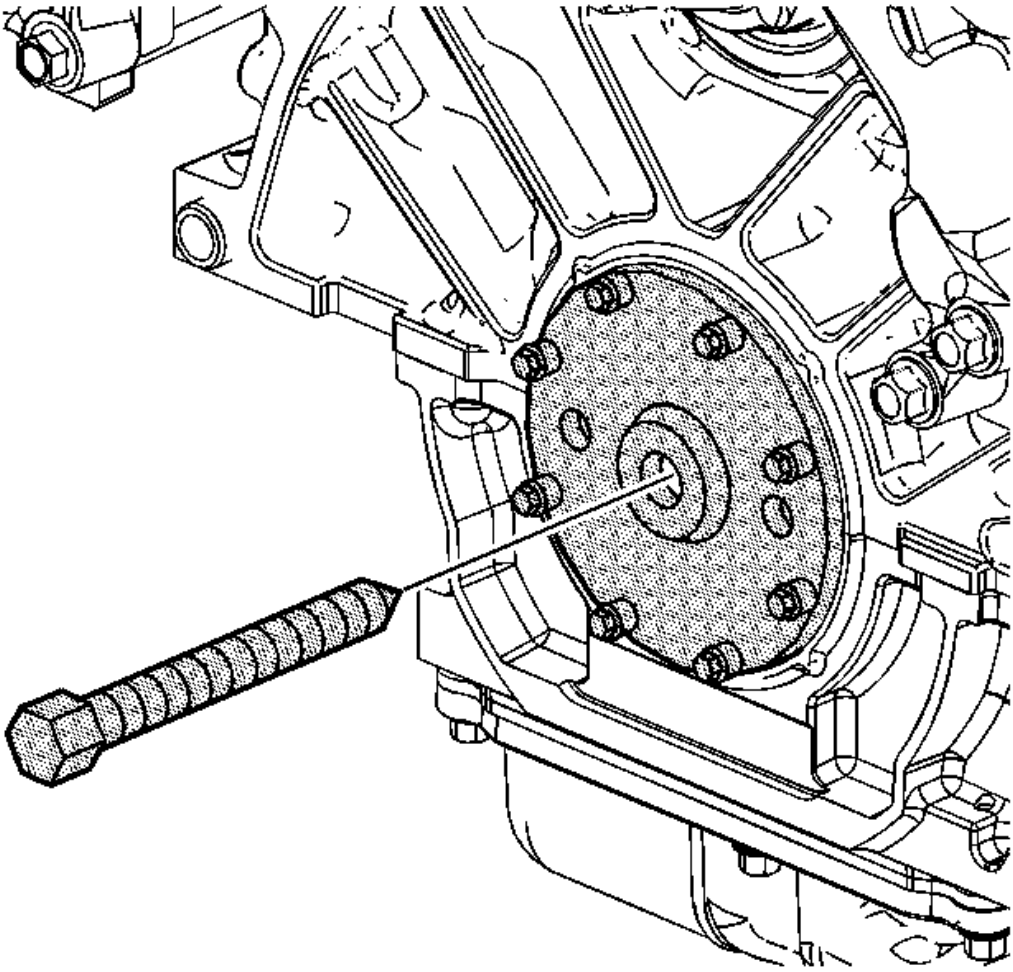


Fig. 380: Installing Center Forcing Screw
Courtesy of GENERAL MOTORS COMPANY

7. Install the center screw to the **J 42841-A** .

 © 2011 Mitchell Repair Information Company, LLC.

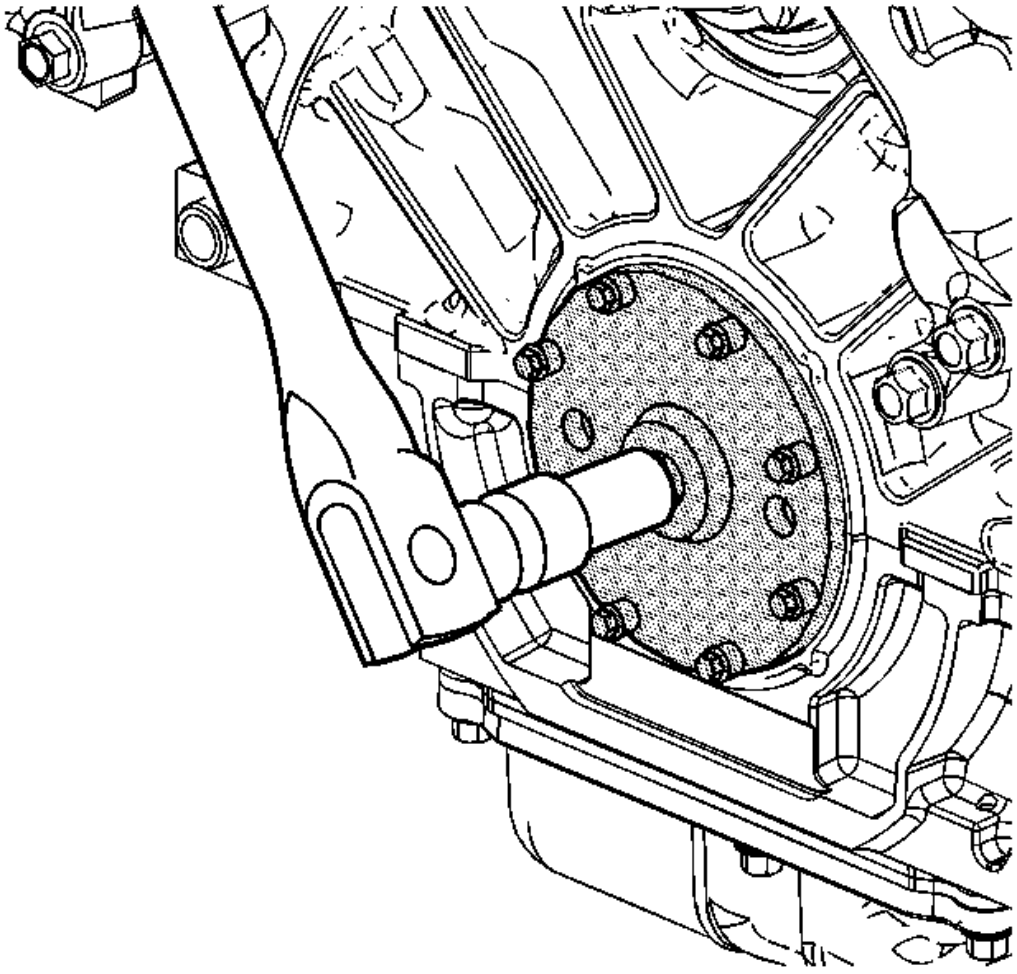


Fig. 381: View Of Center Screw On Removal Tool
Courtesy of GENERAL MOTORS COMPANY

8. Tighten the center screw on the **J 42841-A** to pull the seal assembly off the end of the crankshaft.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

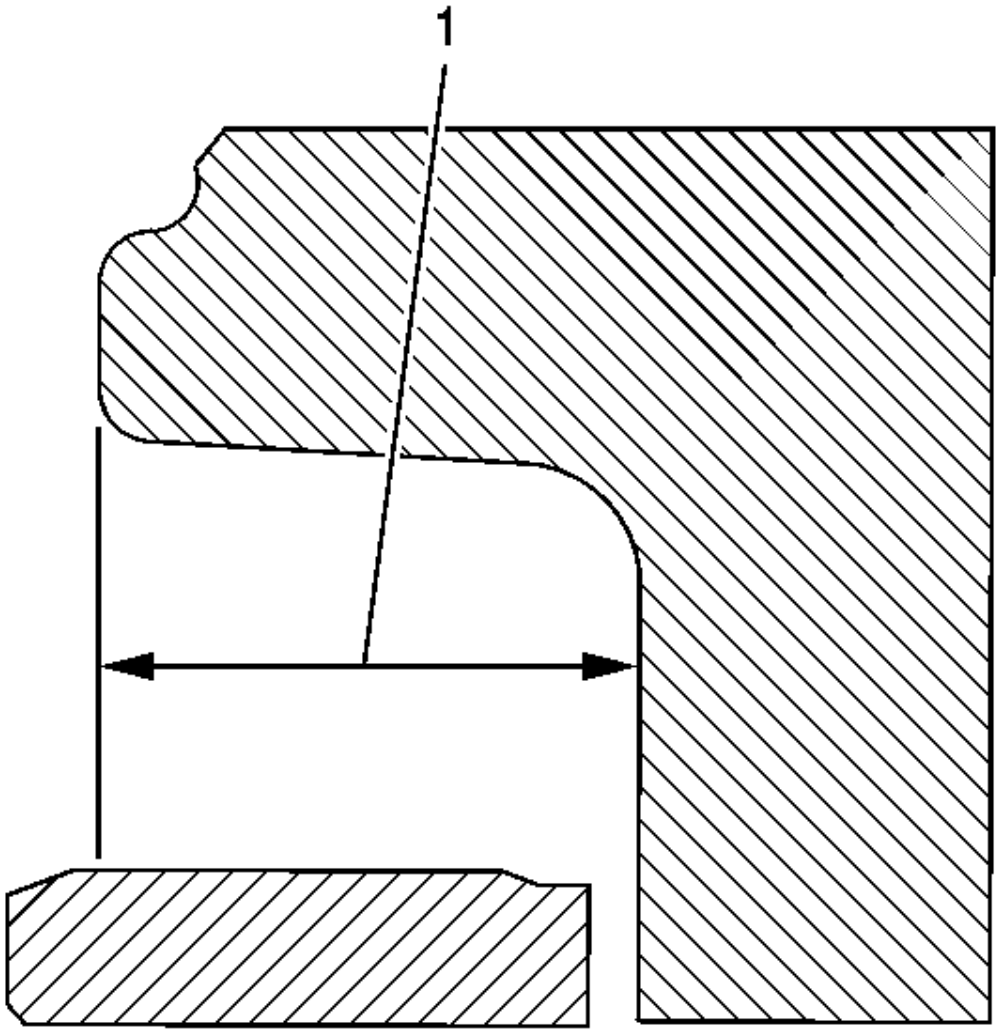


Fig. 382: Checking Oil Seal Bore Depth
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- **The EN-48072 must be used to ensure even application of the sealant in the bore and to prevent blockage of the drain back hole.**
- **Ensure components that are being sealed with RTV sealant are assembled within 20 minutes. Components assembled after the RTV sealant has skinned-over, approximately 20 minutes, will not bond properly.**
- **Although originally equipped with a lip-style crankshaft rear oil seal,**

 © 2011 Mitchell Repair Information Company, LLC.

engines built from March 1, 1996 through 1999 should use the cassette-style crankshaft rear oil seal.

1. Ensure the engine block where the crankshaft rear oil seal is installed is a deep bore (1).
   - A deep bore of approximately 15 mm (0.5906 in) was used on engines from March 1, 1996 and later.
   - A shallow bore of approximately 8 mm (0.3150 in) was used on engines from 1993 through February 29, 1996. This block would use a lip-style crankshaft rear oil seal and the for installation.

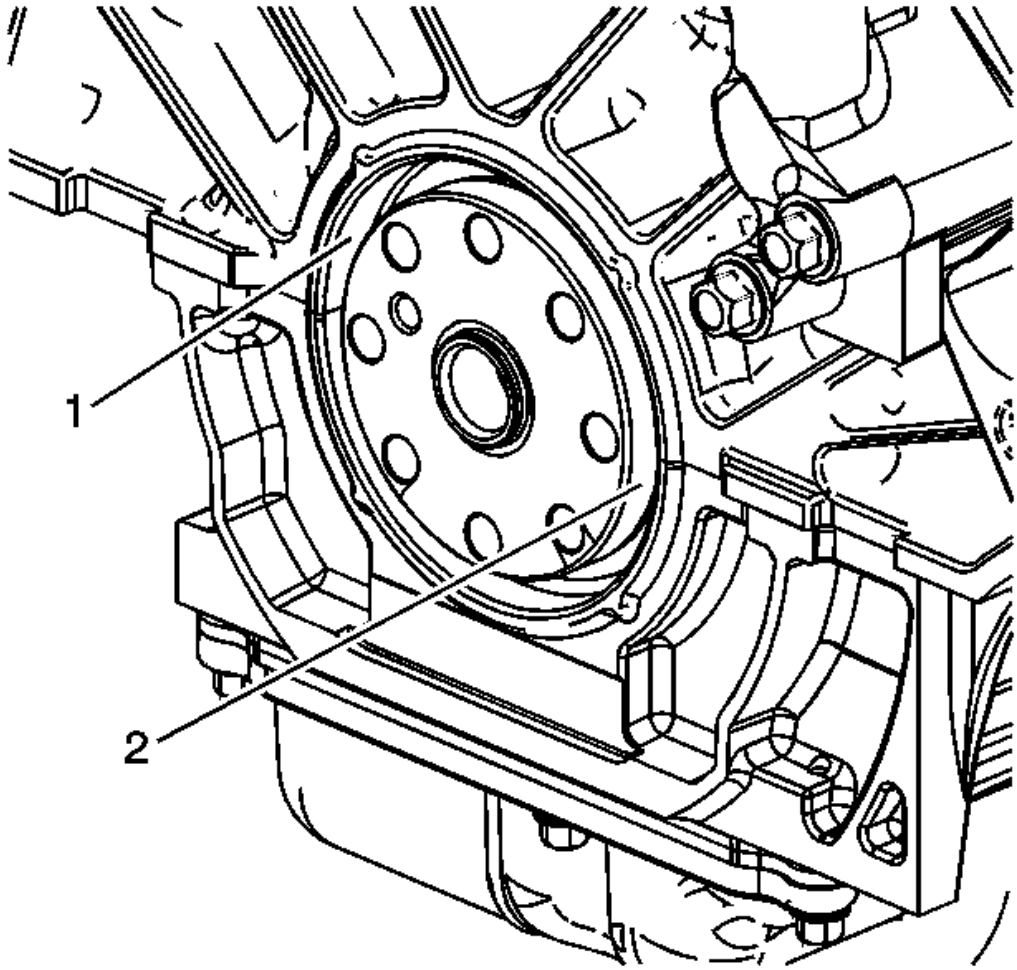


Fig. 383: Identifying Rear Crankshaft Seal Bore & Flange
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the engine block bore (1) and the crankshaft flange (2) for the damage. Repair or replace any

 © 2011 Mitchell Repair Information Company, LLC.

damaged components.

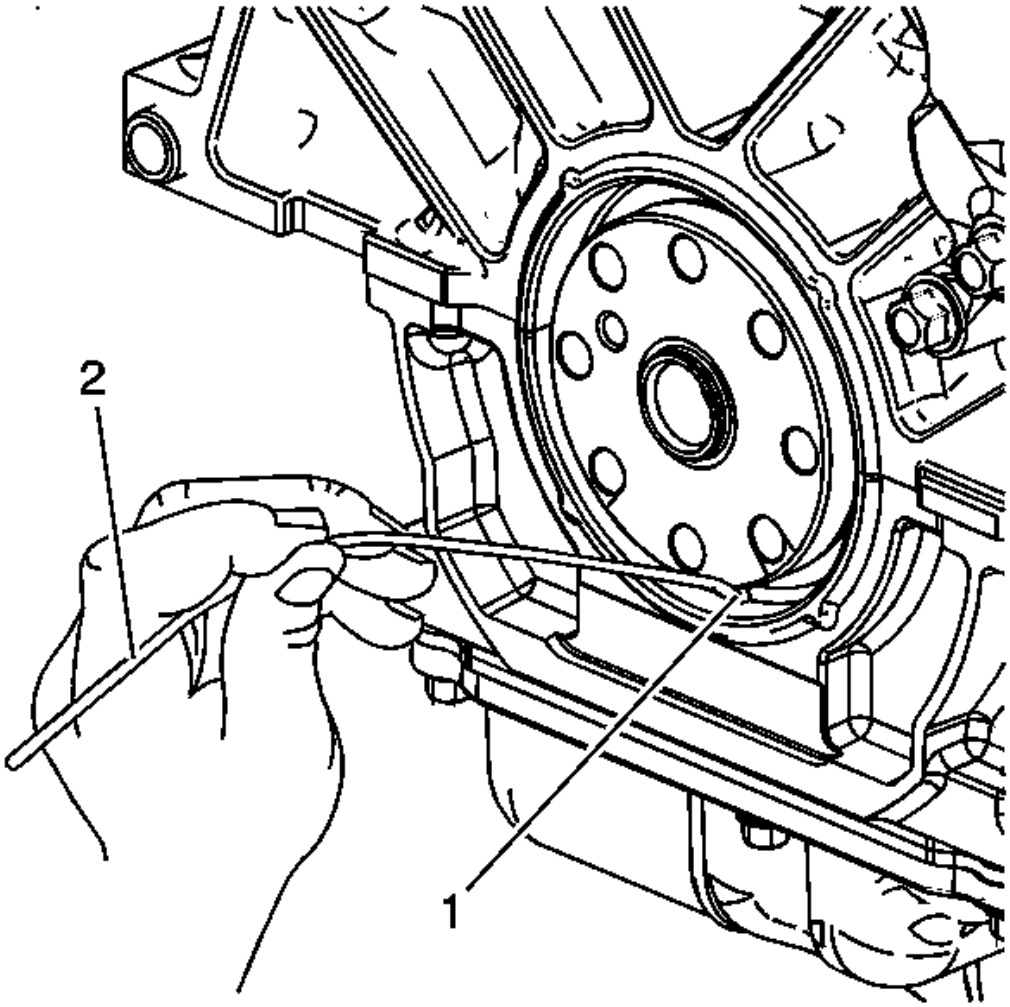


Fig. 384: Identifying Rear Oil Seat Drain
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the oil drain-back hole (1) is clear of debris using a wire or an unbound plastic tie wrap (2).

 © 2011 Mitchell Repair Information Company, LLC.

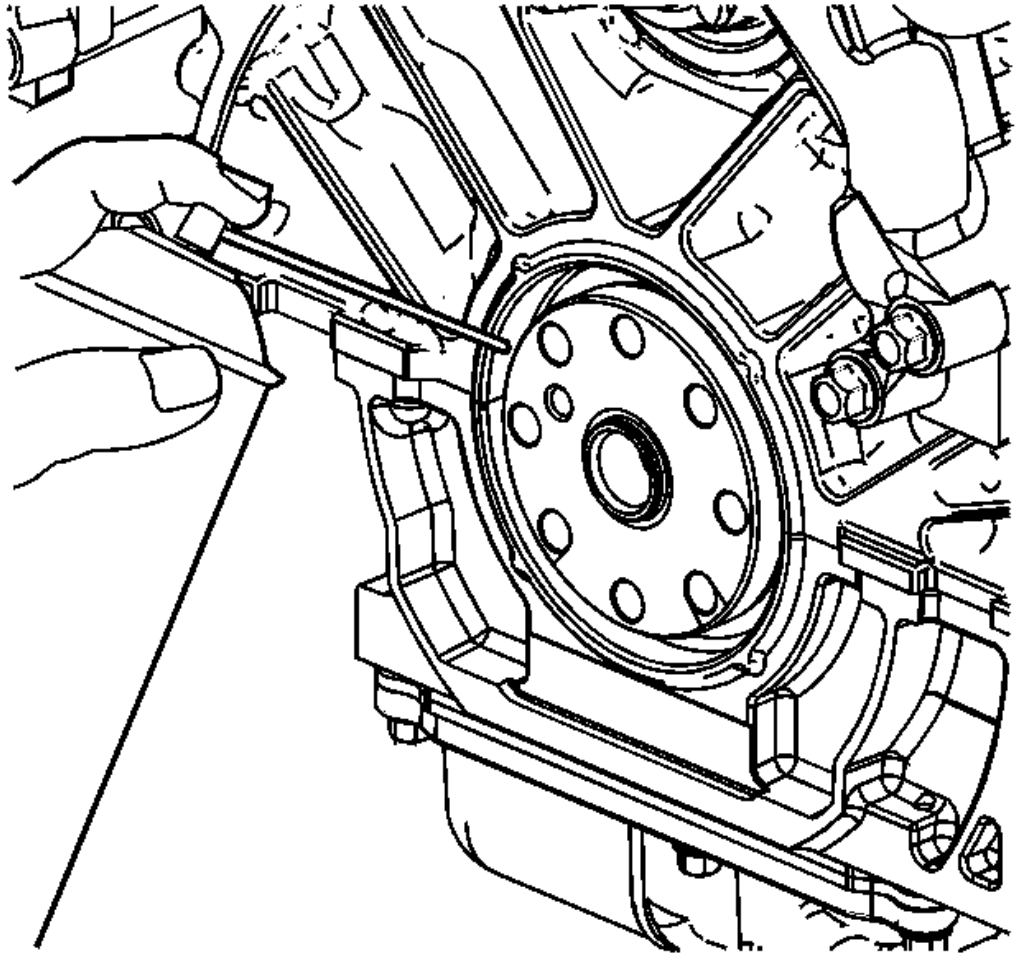


Fig. 385: Cleaning Rear Crankshaft Seal Bore
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: In order to ensure proper bonding of the sealant the bore must be clean and dry.

4. Clean the bore in the block with cleaner solvent GM P/N 12378392 or 12346139 (Canadian P/N 88901247).

 © 2011 Mitchell Repair Information Company, LLC.

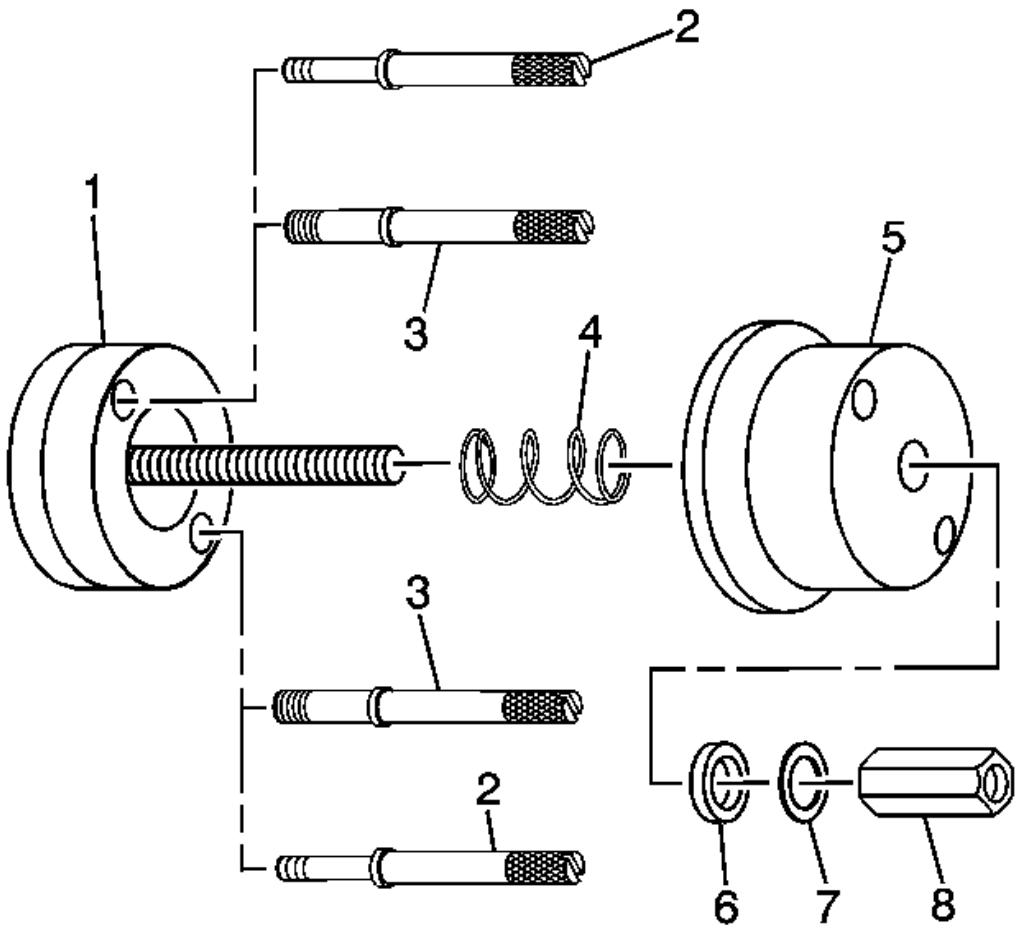


Fig. 386: Identifying Tool Set Components
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

5. Remove the proper sized bolts from the **J 45930-A** . Use the bolts (2) 8 mm or the bolts (3) 11 mm.

 © 2011 Mitchell Repair Information Company, LLC.

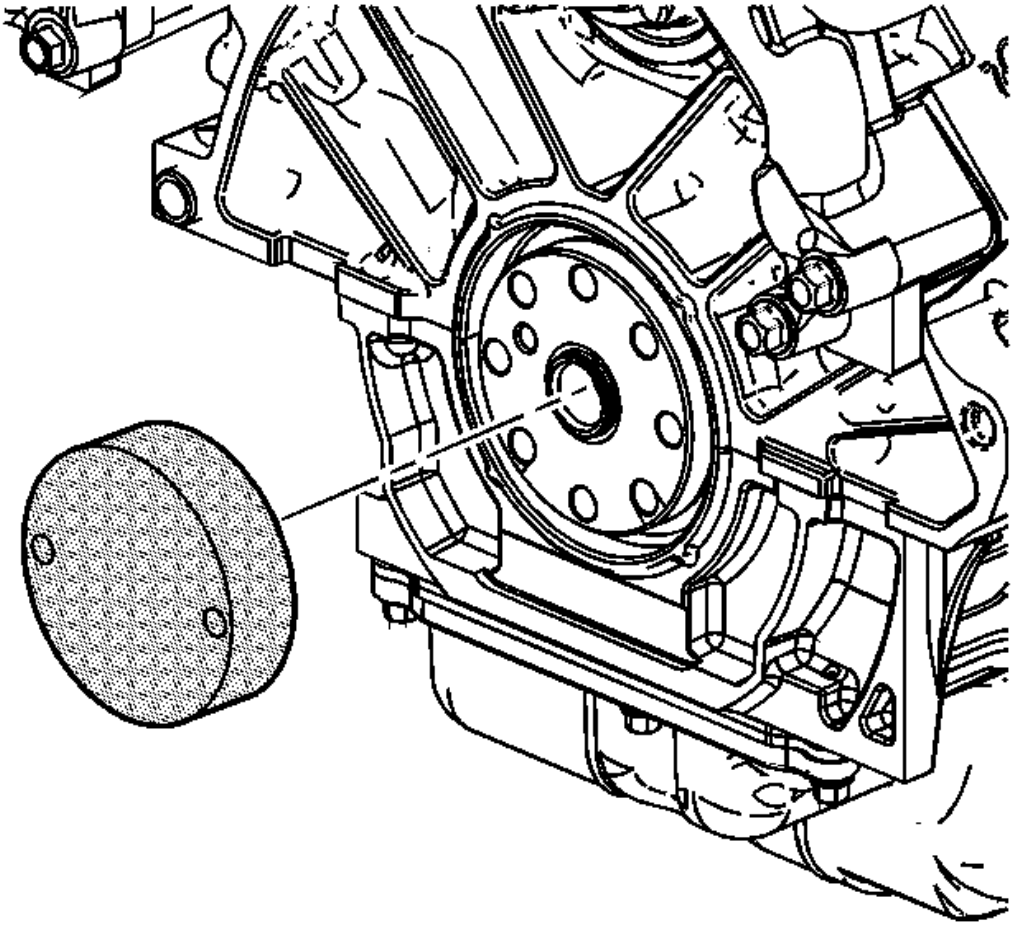


Fig. 387: Identifying Rear Seal Pilot Base
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-48072** pilot base onto the crankshaft. The hub on the crankshaft will fit into the recess on the inboard side of the **EN-48072** pilot base.

 © 2011 Mitchell Repair Information Company, LLC.

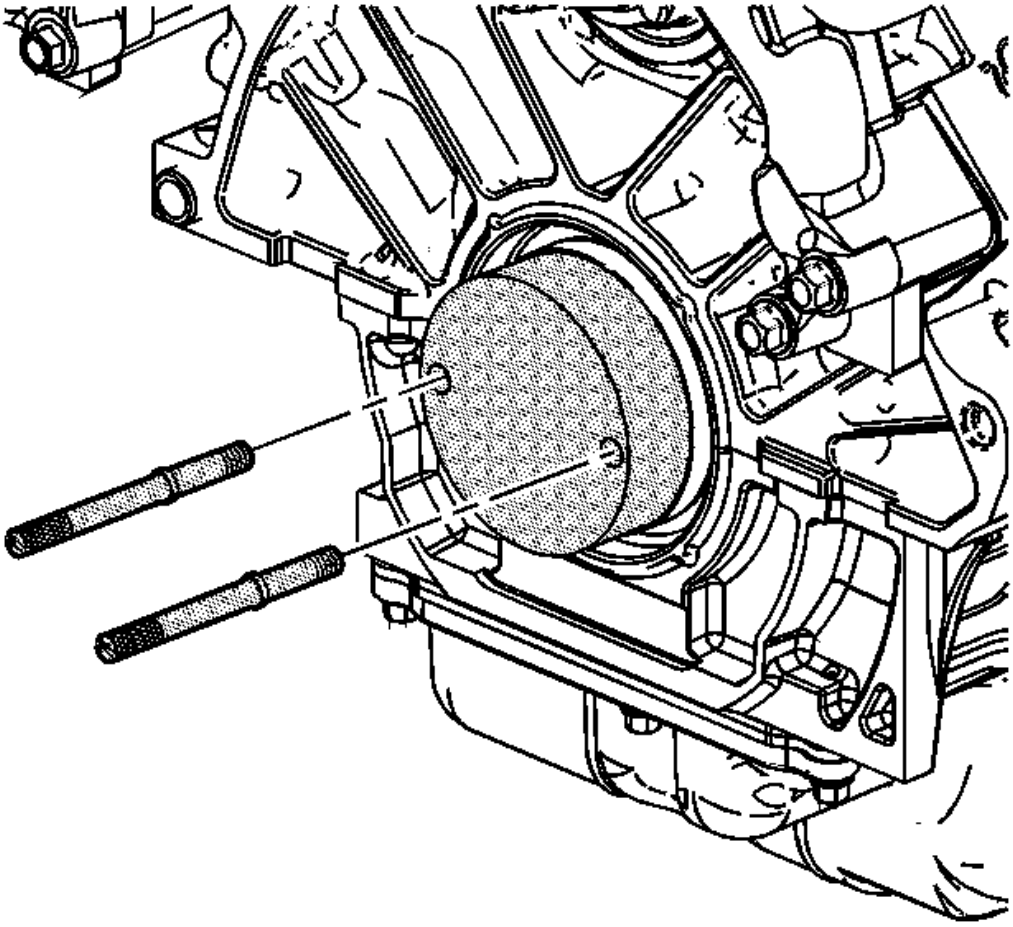


Fig. 388: View Of Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

7. Use the proper bolts from the **J 45930-A** to retain the **EN-48072** pilot base in place.

 © 2011 Mitchell Repair Information Company, LLC.

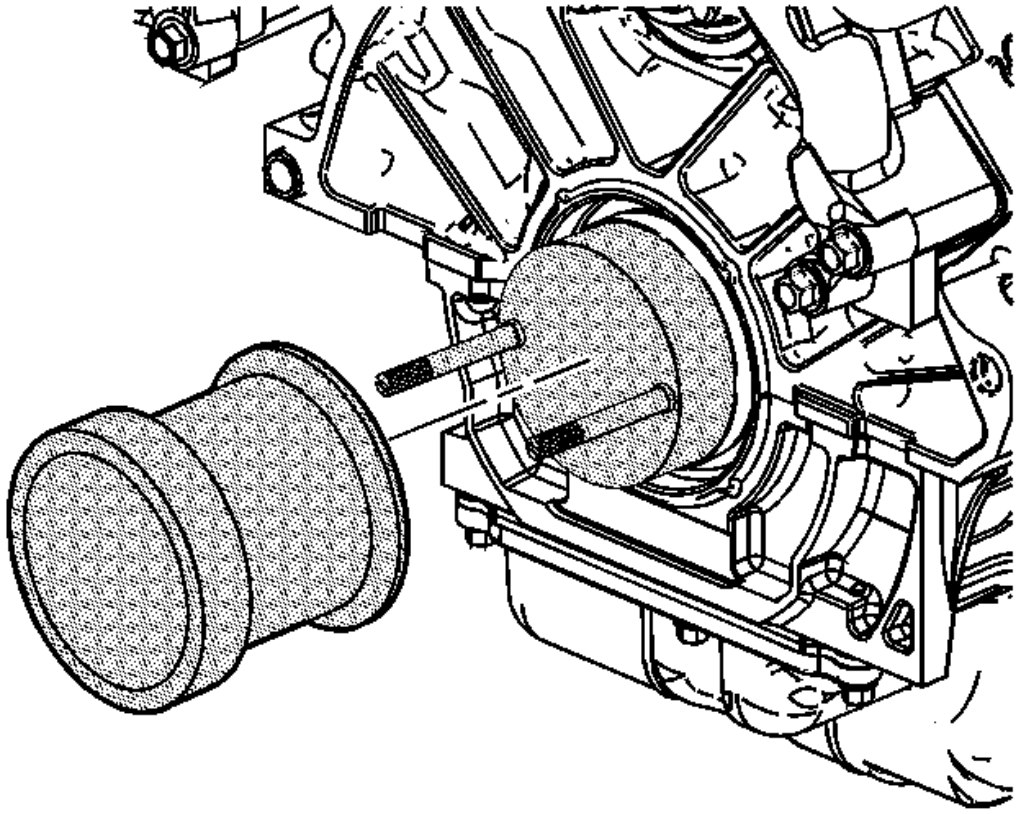


Fig. 389: View Of Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-48072** applicator housing over the **EN-48072** pilot base. Ensure the **EN-48072** applicator housing bottoms in the bore of the block.

 © 2011 Mitchell Repair Information Company, LLC.

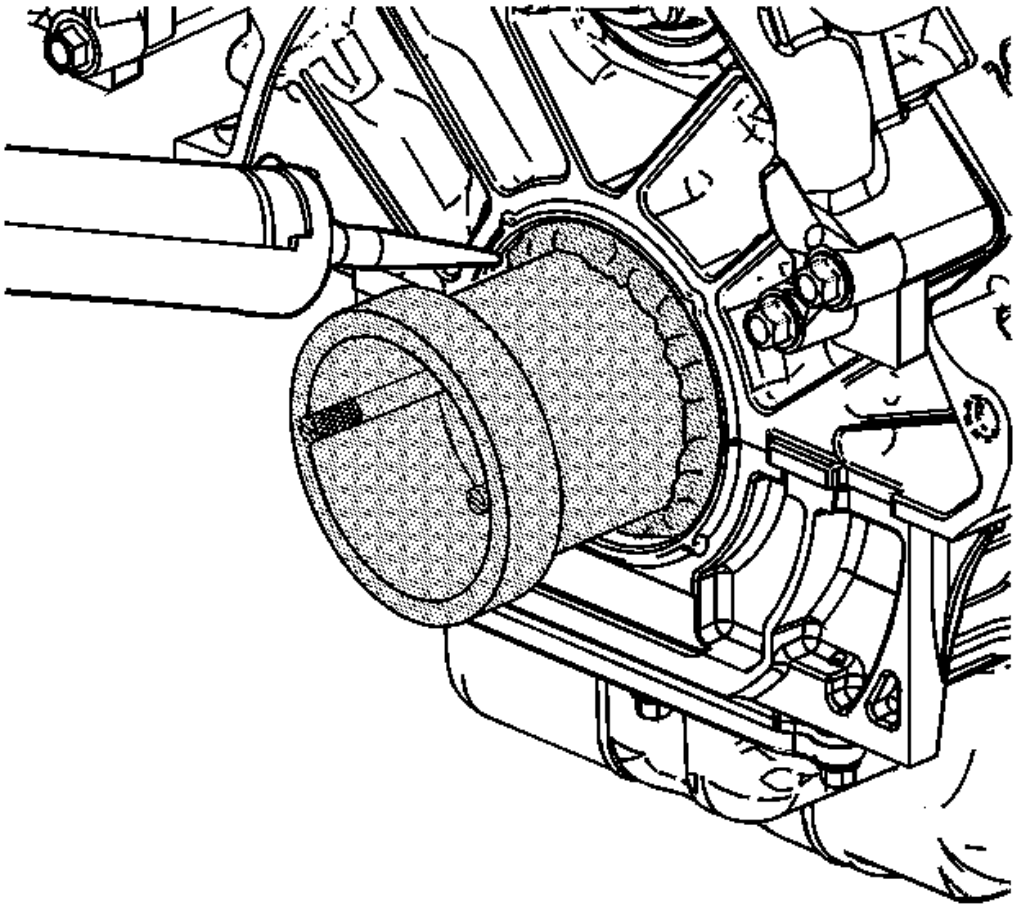


Fig. 390: Applying Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The sealant must not block the drain back hole. Blockage of the drain back hole can lead to oil leakage.

9. Apply the sealant GM P/N 12378521 (Canadian P/N 88901148) to the bore outer diameter in the block. Ensure the sealant does not block the drain hole.

 © 2011 Mitchell Repair Information Company, LLC.

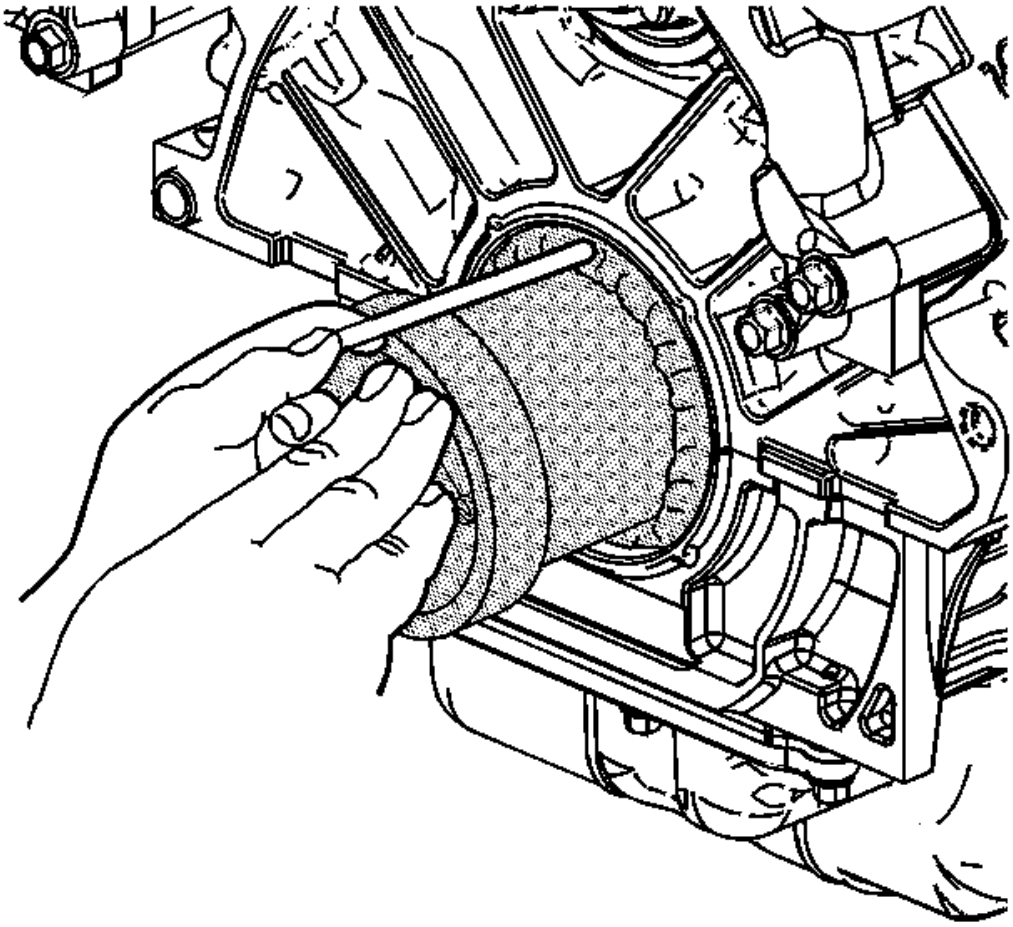


Fig. 391: Spreading Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Apply steady even pressure to the EN-48072 applicator housing.

10. Using a suitable tool spread the sealant within the bore to ensure an even coating across the bore.

 © 2011 Mitchell Repair Information Company, LLC.

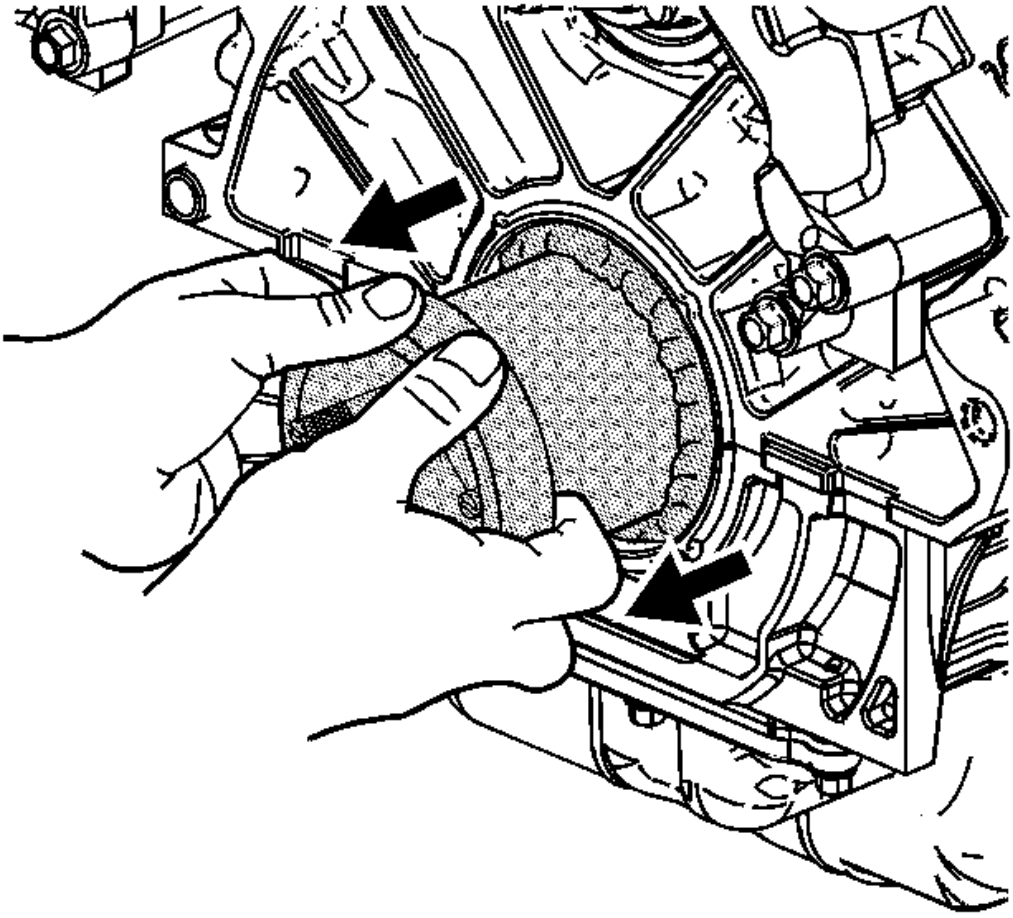


Fig. 392: Removing Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: In order to apply an even coat of the sealant do not twist or turn the EN-48072 applicator housing as it is pulled away from the bottom of the bore.

11. Using both hands, slowly and evenly, pull the **EN-48072** applicator housing out of the bore and remove it from the **EN-48072** pilot base.

 © 2011 Mitchell Repair Information Company, LLC.

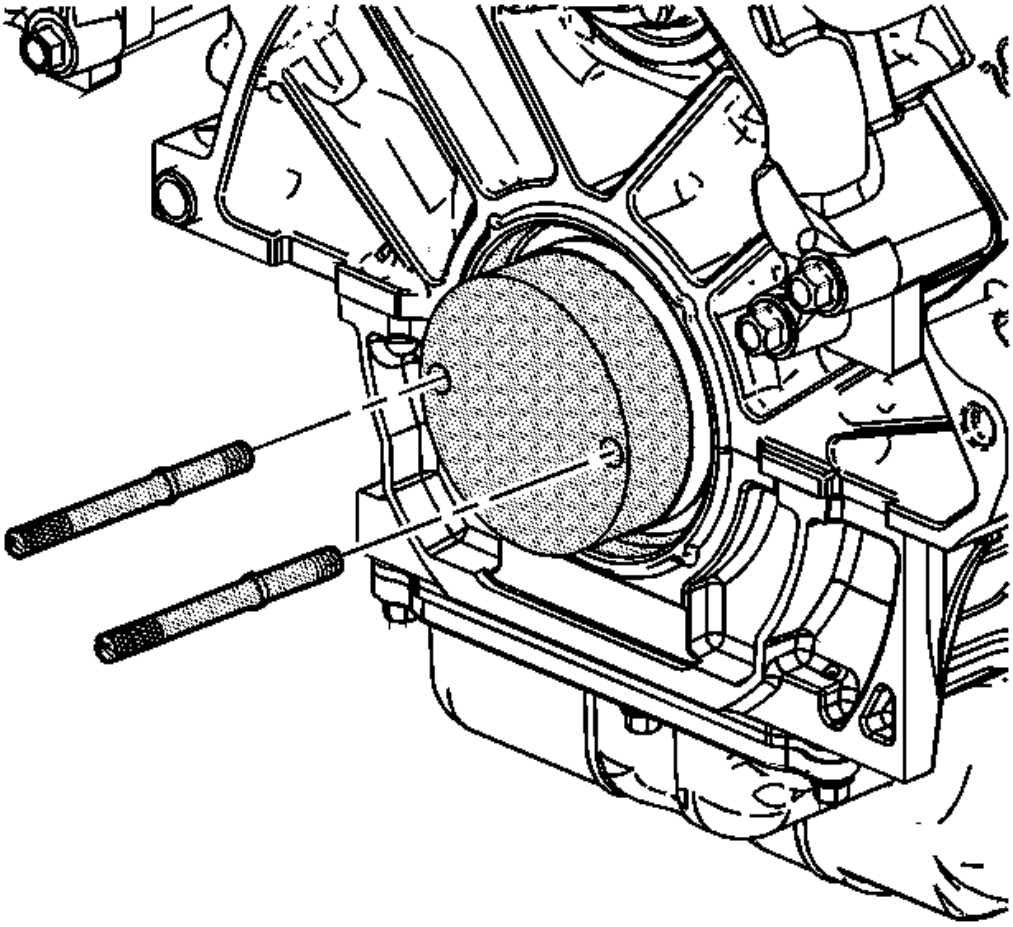


Fig. 393: Identifying Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the **J 45930-A** bolts from the **EN-48072** pilot base.

 © 2011 Mitchell Repair Information Company, LLC.

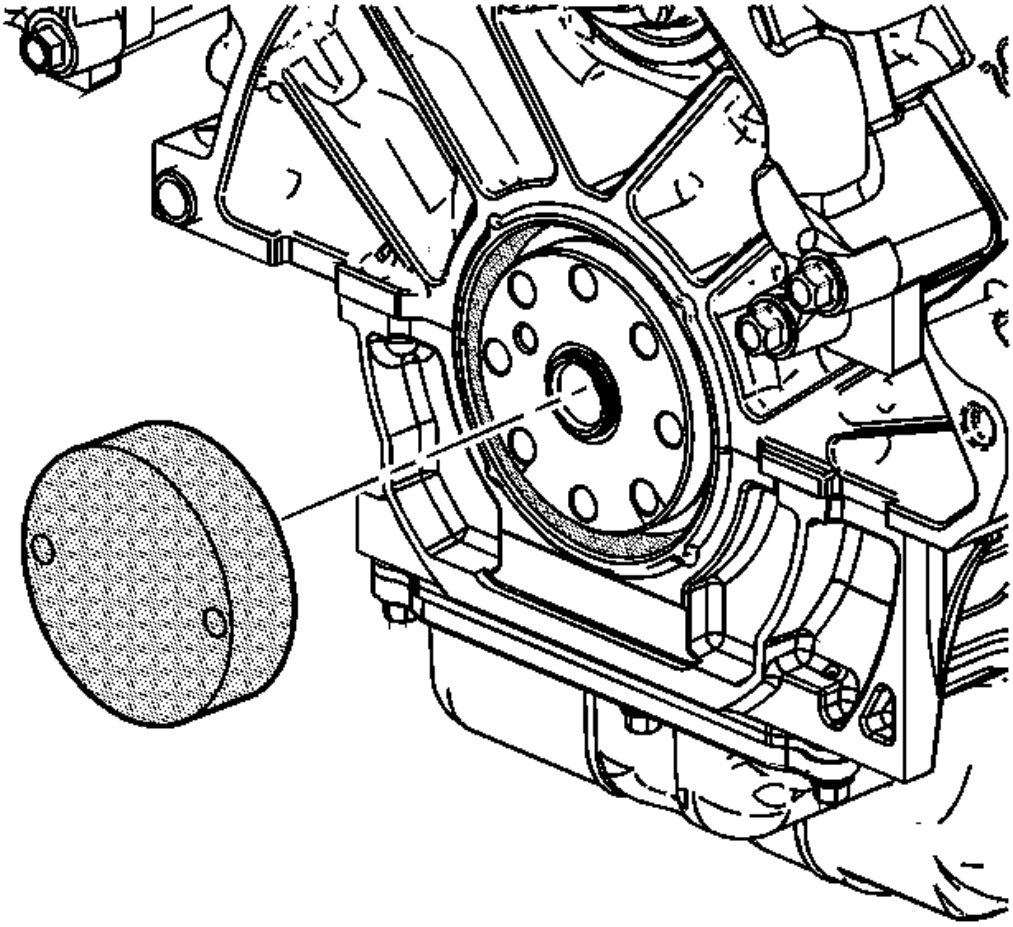


Fig. 394: View Of Rear Seal Pilot Base
Courtesy of GENERAL MOTORS COMPANY

13. Remove the **EN-48072** pilot base.

 © 2011 Mitchell Repair Information Company, LLC.

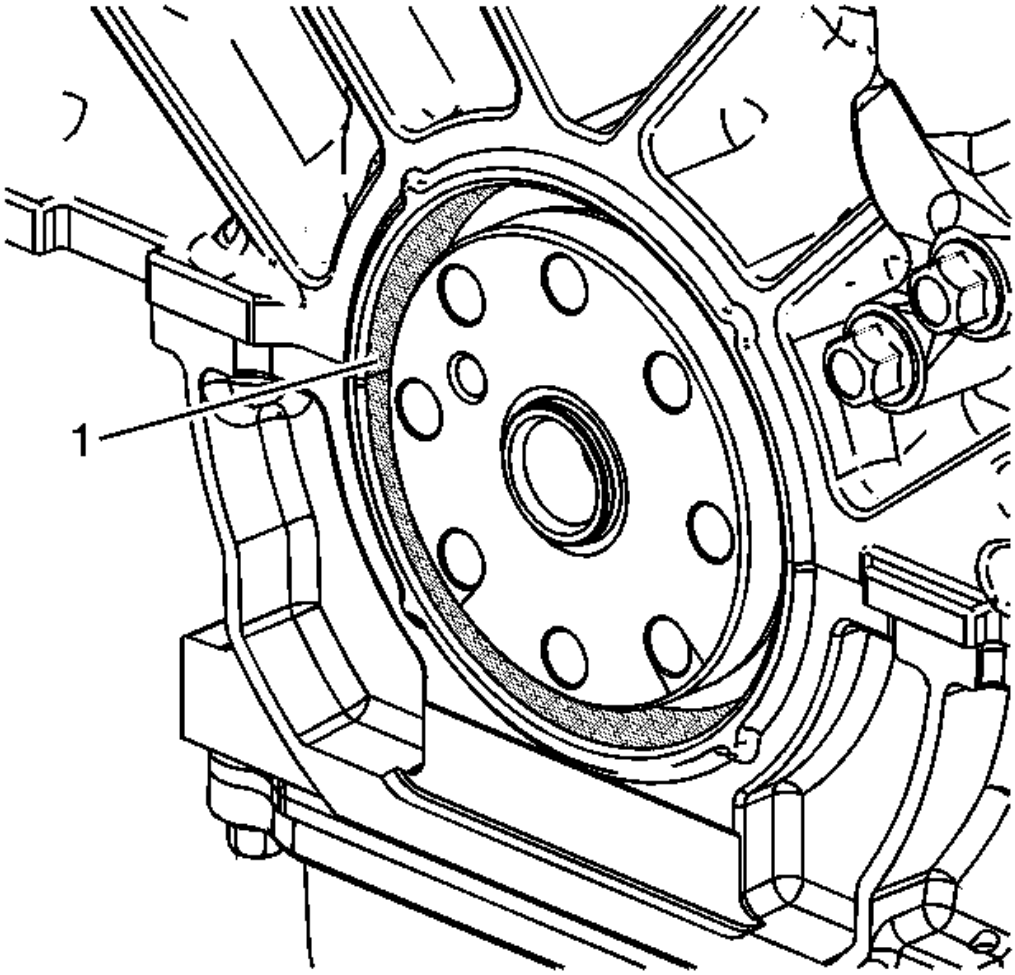


Fig. 395: Spreading Sealant Across Bore Of Block
Courtesy of GENERAL MOTORS COMPANY

14. Ensure that the sealant (1) is evenly spread across the bore of the block.

 © 2011 Mitchell Repair Information Company, LLC.

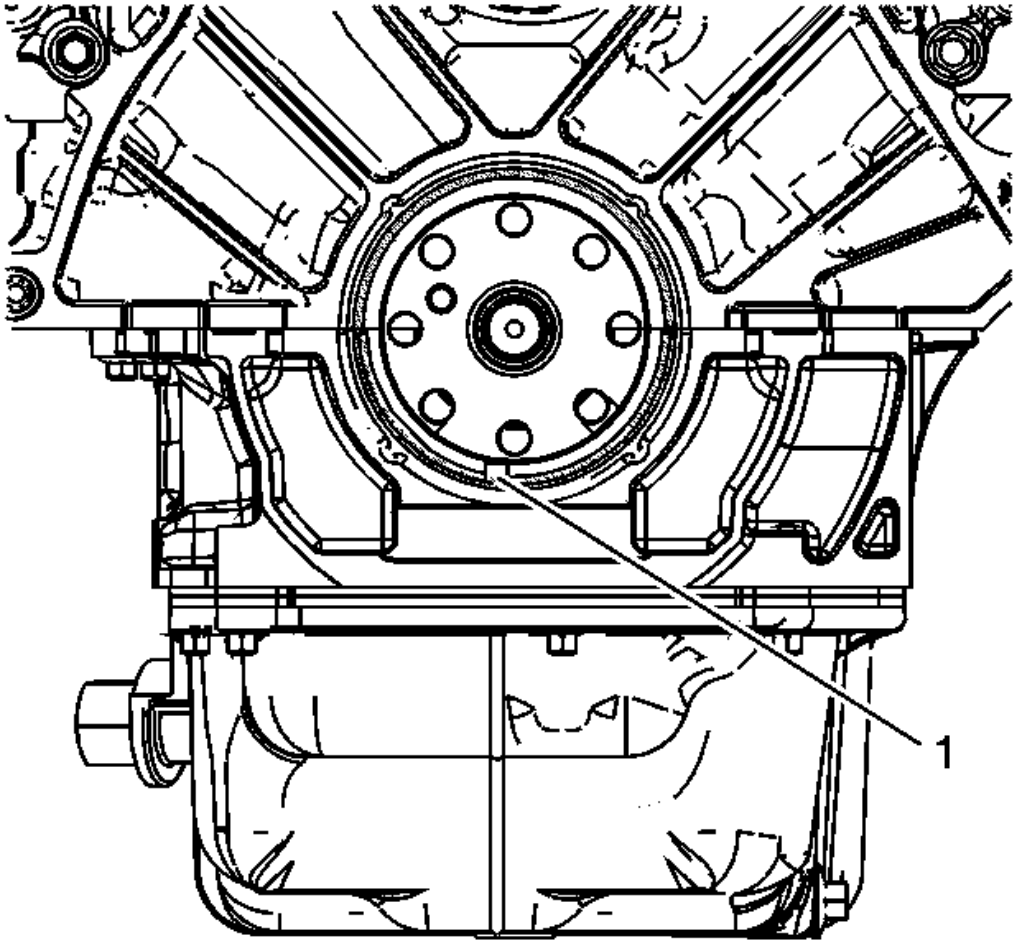


Fig. 396: Checking Seal Bore Drain Back Hole
Courtesy of GENERAL MOTORS COMPANY

15. Ensure the drain back hole (1) is clear of the sealant.

 © 2011 Mitchell Repair Information Company, LLC.

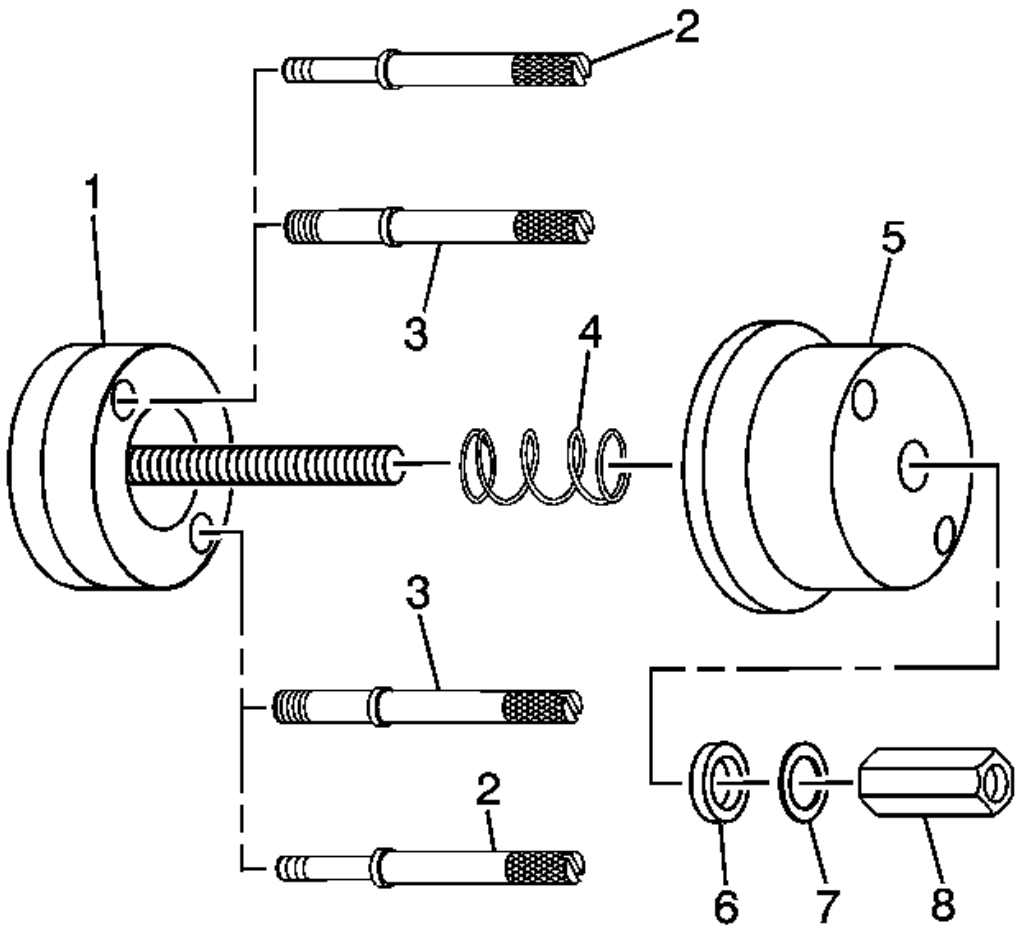


Fig. 397: Identifying Tool Set Components
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- **Beginning with the model year 2006 the flywheel/flexplate crankshaft bolt hole thread was changed from 8 x 1.25 mm to 11 x 1.5 mm. The J 45930-A will service the cassette seals installed on engines from March 1, 1996 to 2006. If a J 45930 is to be used on a 2006 or later engine the update kit, J 45930-10, must be used to convert the J 45930 to a J 45930-A .**
- **Crankshaft rear oil seal and engine flywheel installation requires adequate space for installation. If the engine stand does not allow suitable space to use the J 45930-A install the crankshaft rear oil seal and engine flywheel with the engine properly supported on the floor or on a bench.**

 © 2011 Mitchell Repair Information Company, LLC.

- **Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.**

16. Ensure the proper size of bolt (2) 8 mm or (3) 11 mm is being installed in the **J 45930-A** .

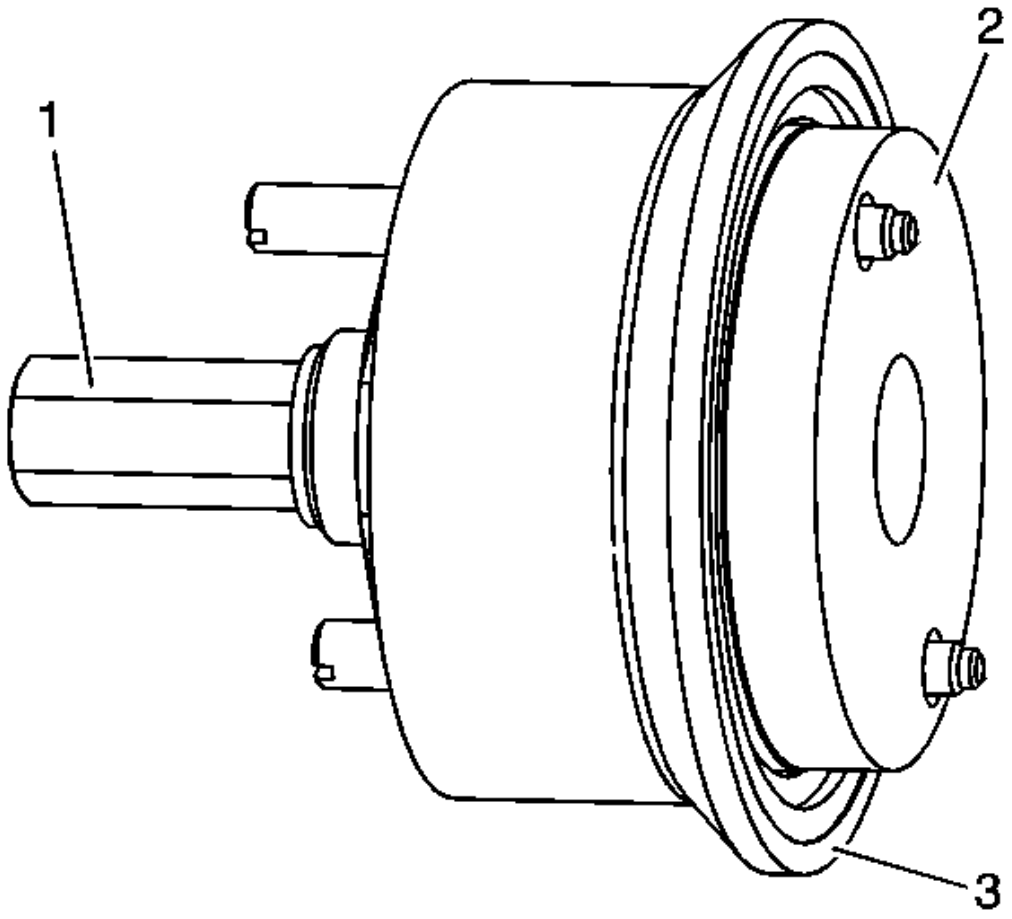


Fig. 398: Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS COMPANY

17. Turn the center nut (1) of the **J 45930-A** until the center hub (2) protrudes approximately 15 mm (0.591 in) beyond the outer plate (3).

 © 2011 Mitchell Repair Information Company, LLC.

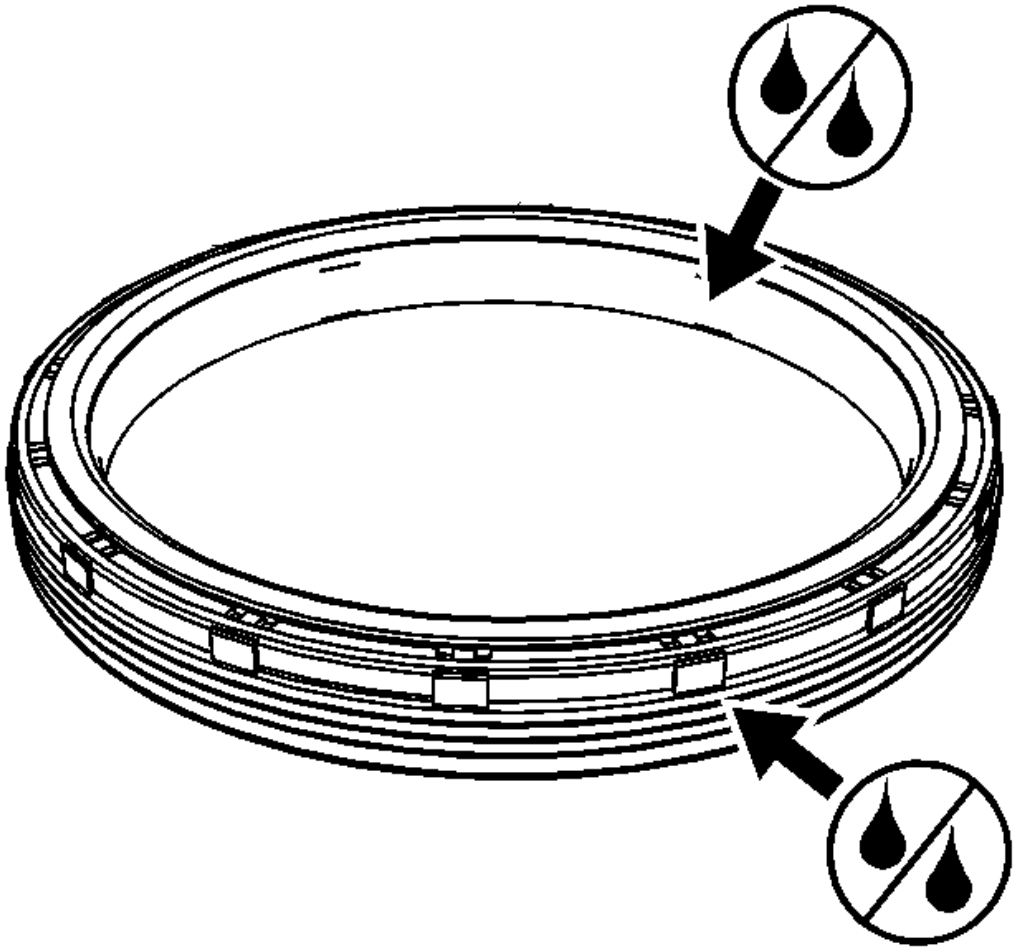


Fig. 399: Identifying Rear Seal Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: DO NOT use any lubricant in order to install the crankshaft rear oil seal. Do not use any lubricant on the coating pre-applied to the inner diameter of the crankshaft rear oil seal. The coating is a sealant that must not be contaminated. Do not use any lubricant on the outer diameter of the crankshaft rear oil seal. The sealant applied to the bore of the engine block will not properly bond to a lubricated crankshaft rear oil seal.

18. Do not lubricate any part of the new cassette style crankshaft rear oil seal.

 © 2011 Mitchell Repair Information Company, LLC.

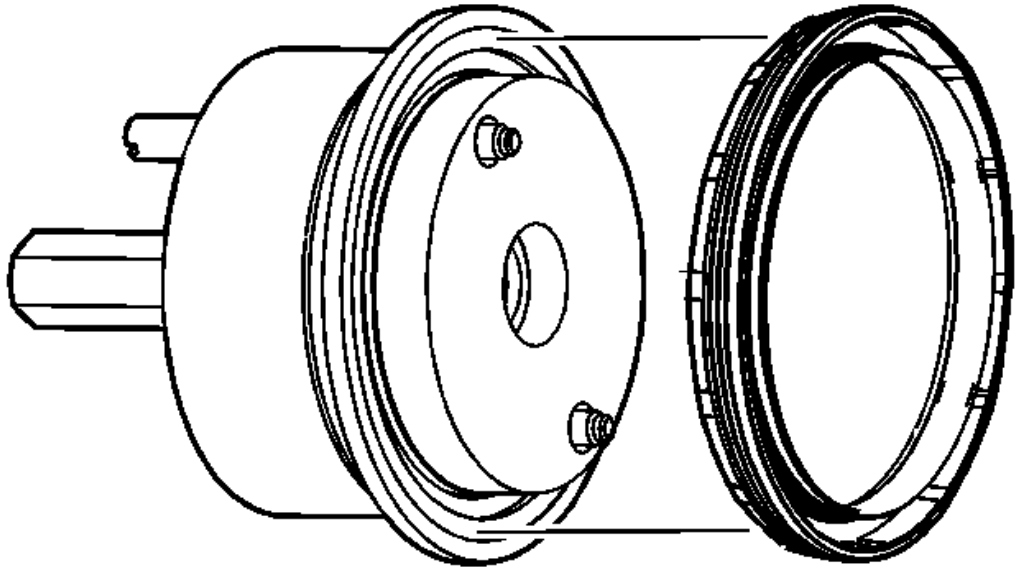


Fig. 400: Cassette Style Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

19. Install the new cassette style crankshaft rear oil seal onto the center hub of the **J 45930-A** .

 © 2011 Mitchell Repair Information Company, LLC.

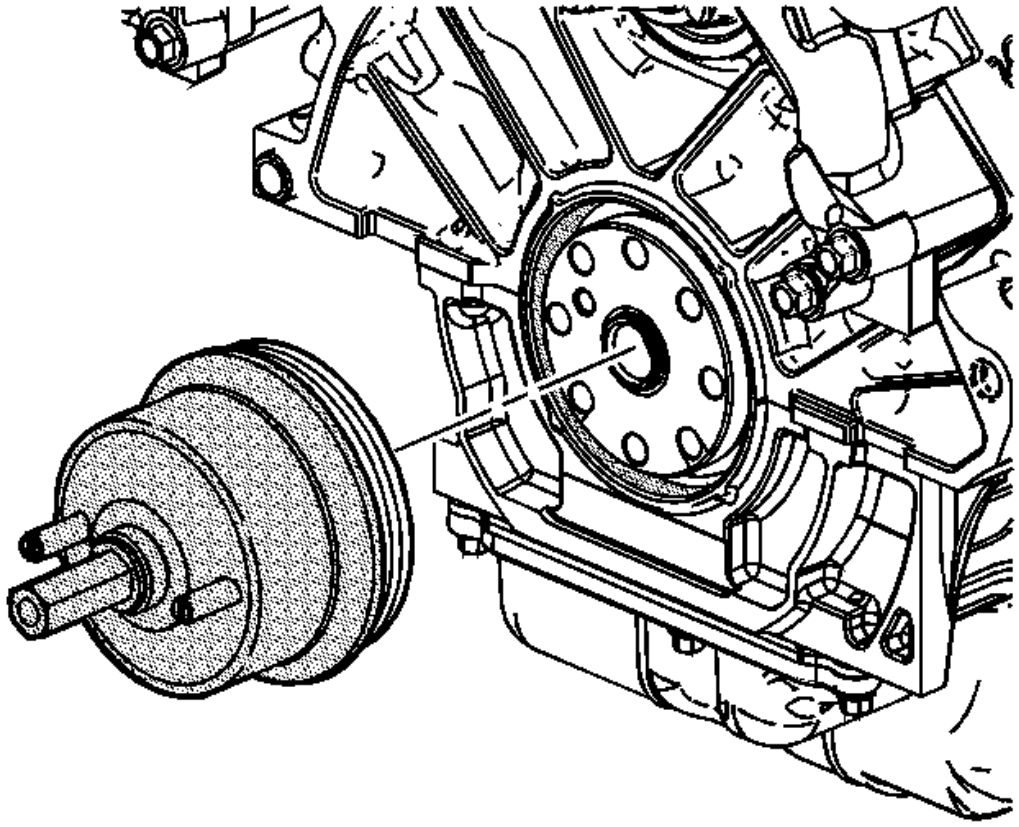


Fig. 401: Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS COMPANY

20. Thread the two **J 45930-A** mounting bolts into the crankshaft flywheel bolt holes.

 © 2011 Mitchell Repair Information Company, LLC.

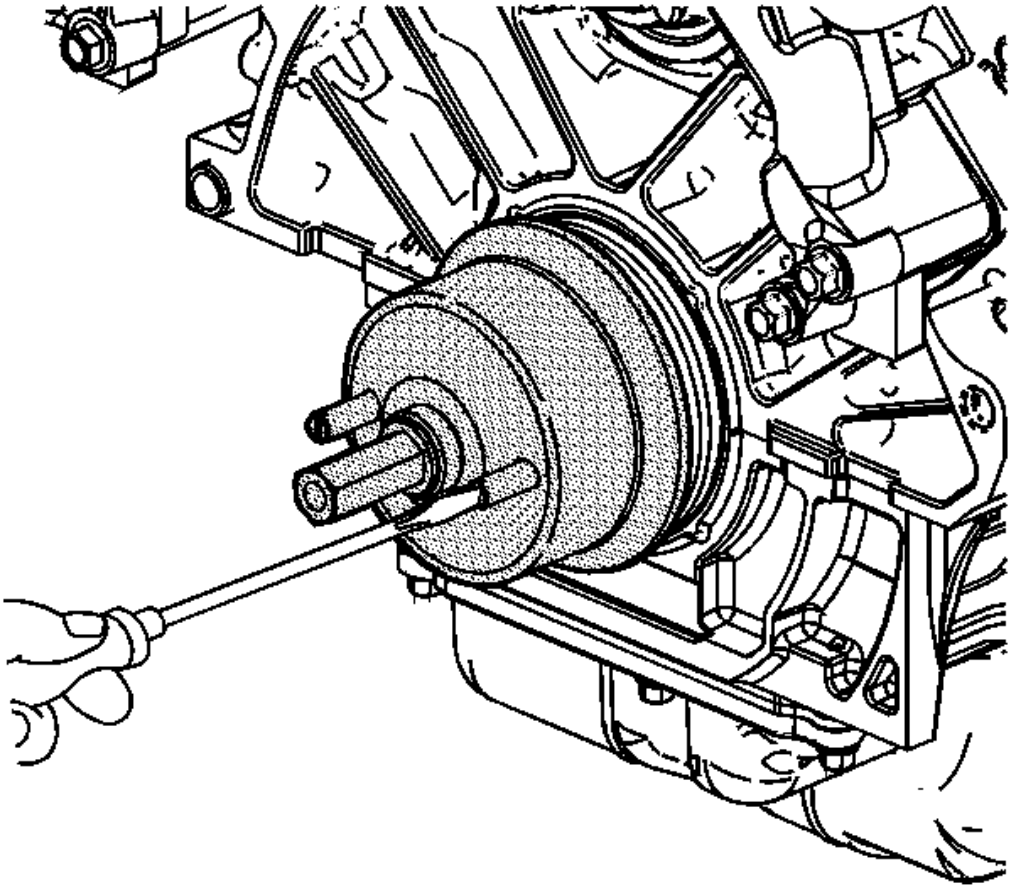


Fig. 402: Checking Seal Installer Tightness
Courtesy of GENERAL MOTORS COMPANY

21. Tighten the two mounting bolts until the **J 45930-A** is firmly mounted on the crankshaft.

 © 2011 Mitchell Repair Information Company, LLC.

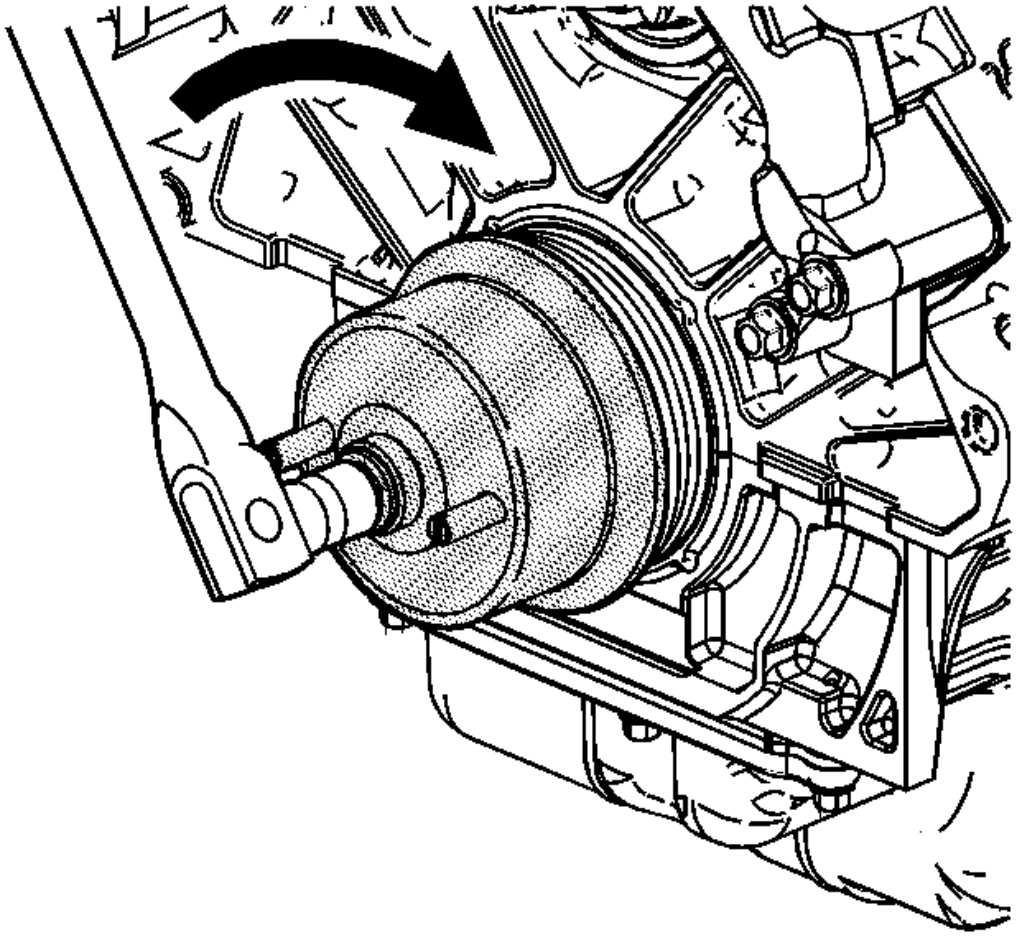


Fig. 403: Installing Crankshaft Rear Seal
Courtesy of GENERAL MOTORS COMPANY

22. Install the new cassette style crankshaft rear oil seal by turning the nut of the **J 45930-A** until the drive portion of the **J 45930-A** bottoms against the crankcase.

 © 2011 Mitchell Repair Information Company, LLC.

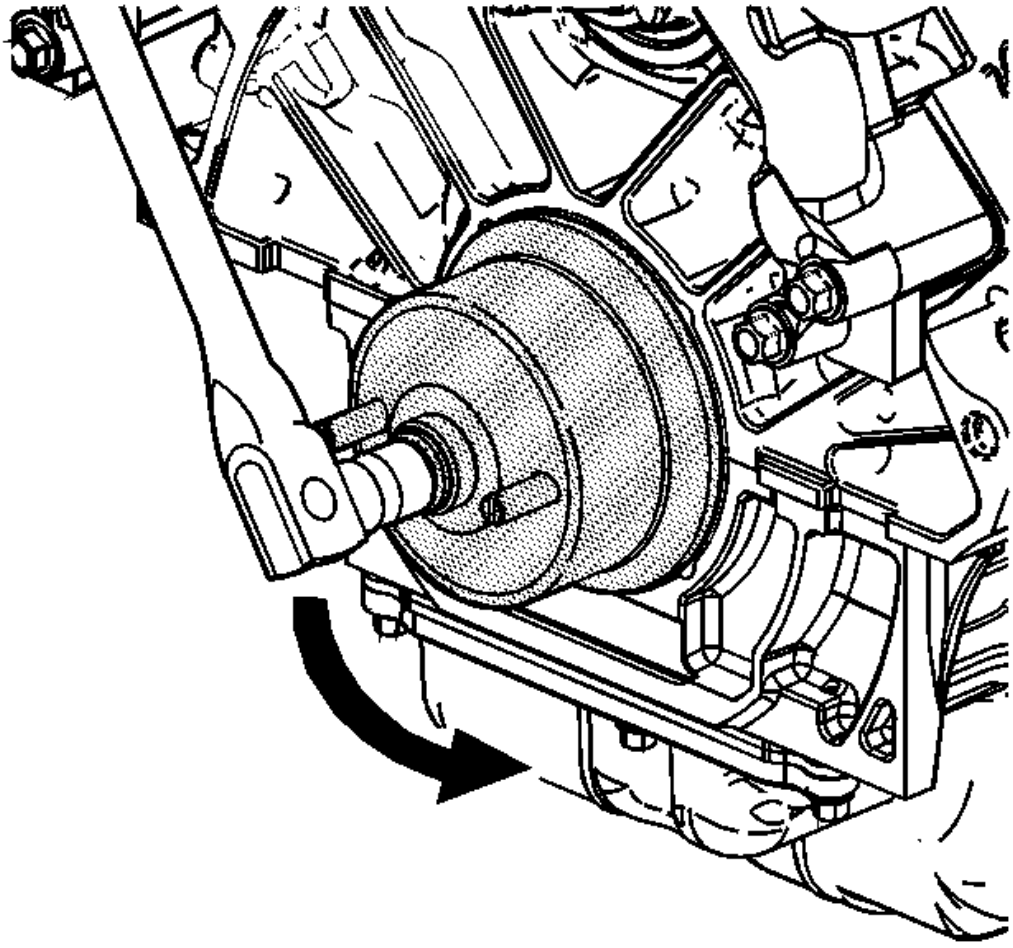


Fig. 404: Loosening Seal Installer Center Nut
Courtesy of GENERAL MOTORS COMPANY

23. Loosen the center nut to release pressure on the crankcase.

 © 2011 Mitchell Repair Information Company, LLC.

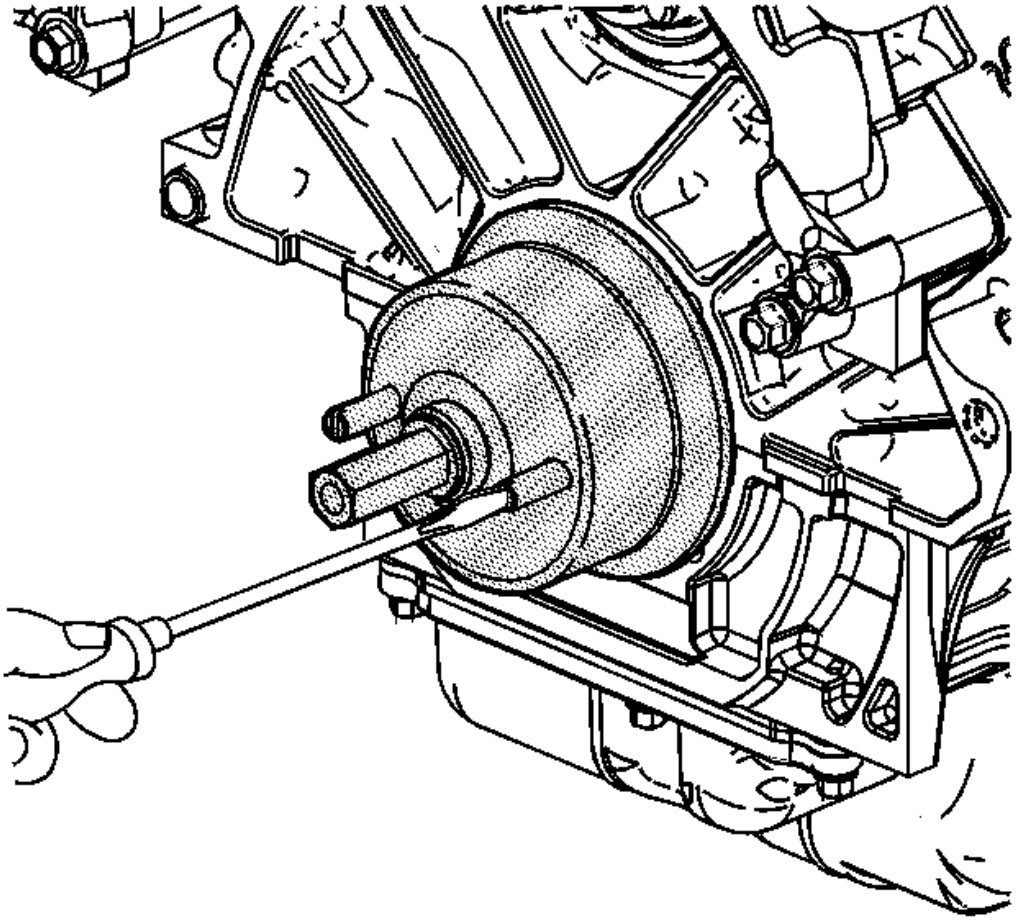


Fig. 405: Loosening Seal Installer Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

24. Loosen the two mounting bolts.

 © 2011 Mitchell Repair Information Company, LLC.

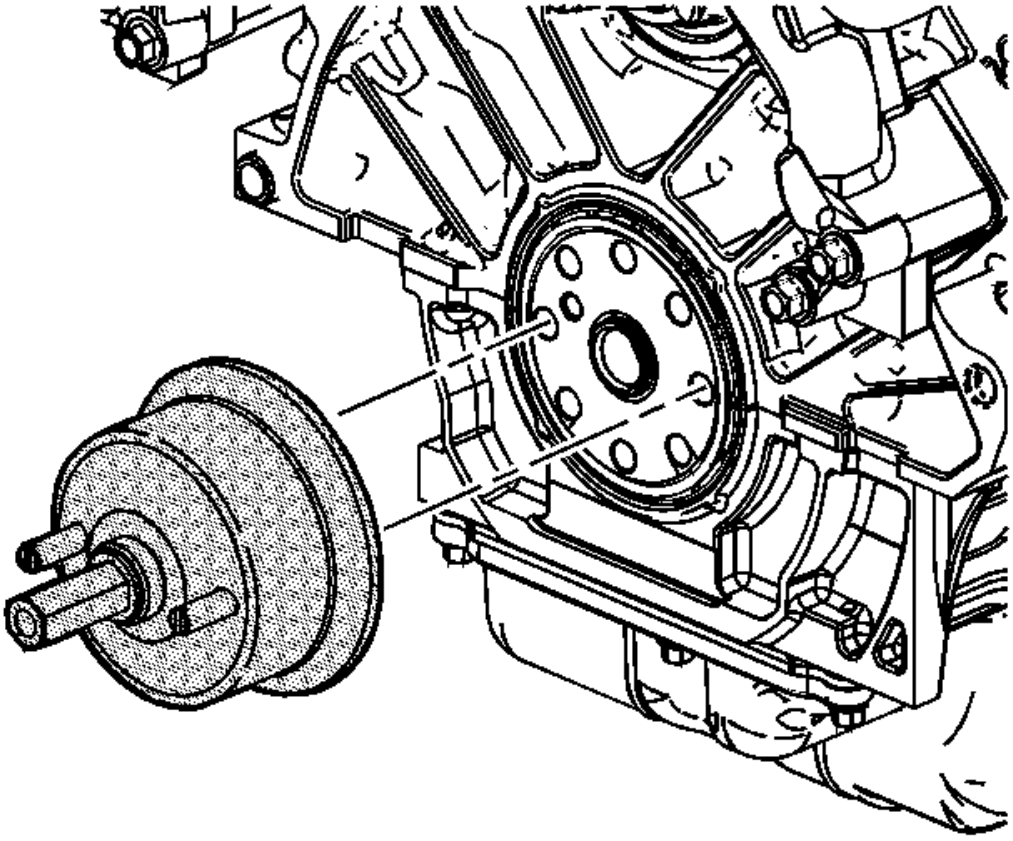


Fig. 406: Crankshaft Rear Seal Installer
Courtesy of GENERAL MOTORS COMPANY

25. Remove the **J 45930-A** from the crankshaft.
26. Wipe off any excessive sealant from the block.

 © 2011 Mitchell Repair Information Company, LLC.

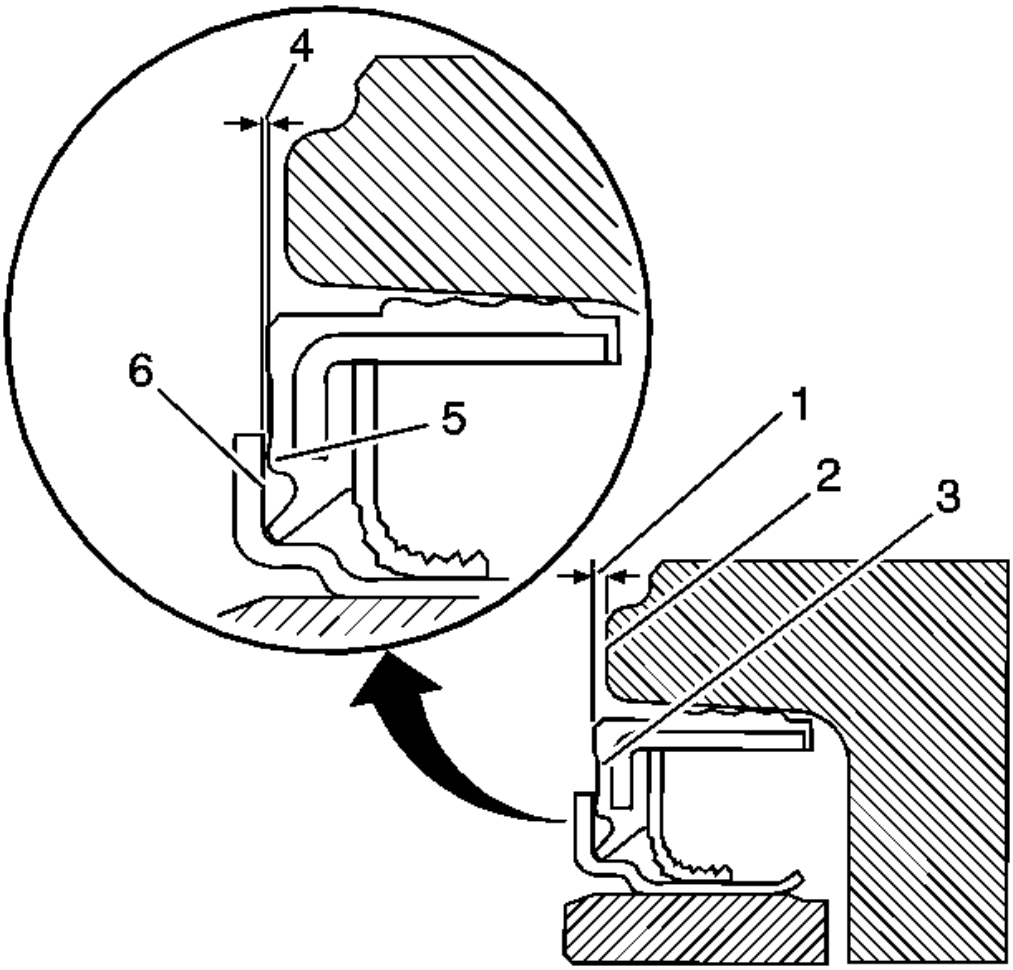


Fig. 407: View Of Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

27. Ensure the new cassette style crankshaft rear oil seal is installed properly.
    - The outer surface of the seal (3) should be 0.500-0.800 mm (0.0197-0.0315 in) (1) below the surface of the engine block (2).
    - The inner surface of the sleeve (6) should be 0.400-0.900 mm (0.0158-0.0354 in) (4) below the surface of the outer surface of the seal (5).
    - The installed seal and sleeve need to be parallel to the block by 0.000-0.500 mm (0.000-0.0197 in).
28. Clean all tools to remove any residual sealant.
29. Install the flywheel. Refer to **Engine Flywheel Replacement**.
30. Install the transaxle. Refer to **Transmission Replacement** .

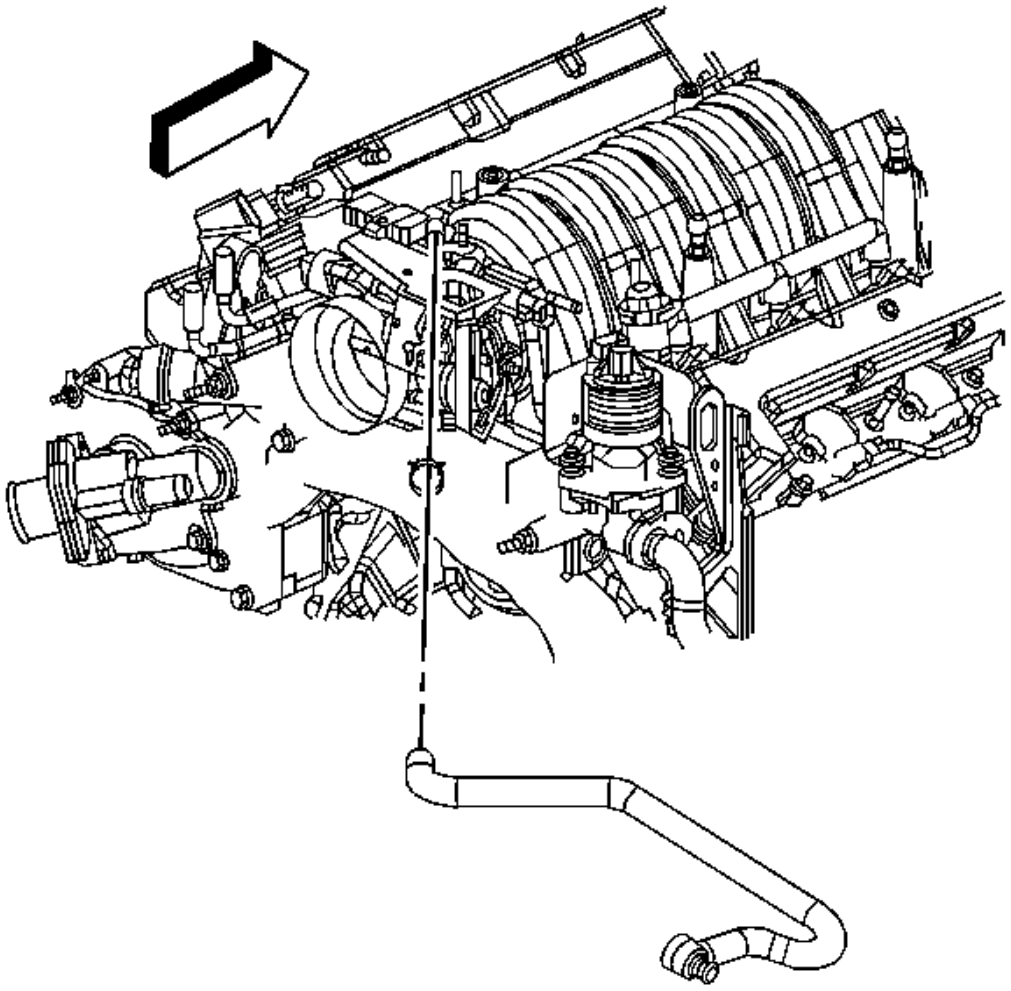
 © 2011 Mitchell Repair Information Company, LLC.

ENGINE REPLACEMENT

Special Tools

- **J 37097-A** Hose Clamp Remover/Installer
- **J 38185** Hose Clamp Pliers
- **J 39580** Universal Engine Support Table
- **J 41623-B** Cooler Quick Connect Tool
- **J 42640** Steering Column Lock Pin

Removal Procedure



 © 2011 Mitchell Repair Information Company, LLC.

Fig. 408: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Recover the air conditioning (A/C) refrigerant system. Refer to **Refrigerant Recovery and Recharging** .
4. Reposition the brake booster vacuum hose clamp at the engine port.
5. Disconnect the brake booster vacuum hose from the vacuum connection and position aside.

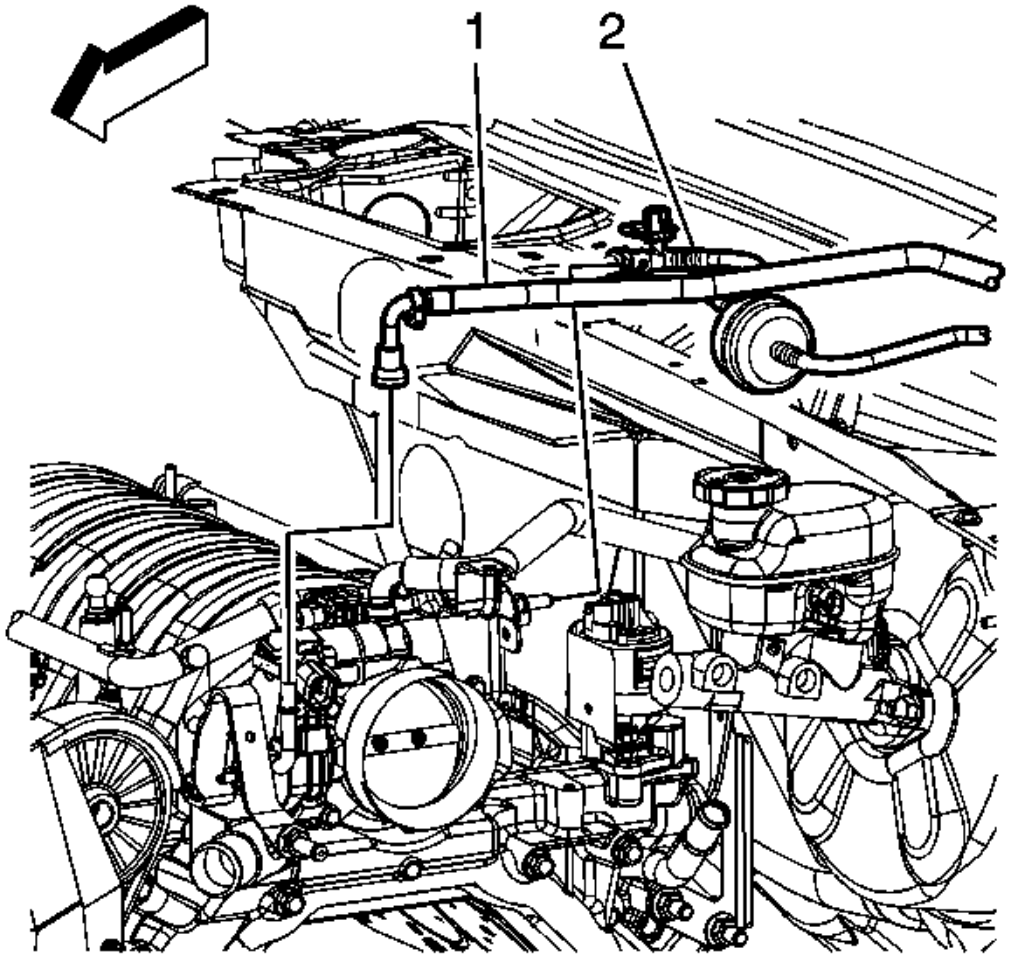


Fig. 409: Fuel Feed & EVAP Line
Courtesy of GENERAL MOTORS COMPANY

 © 2011 Mitchell Repair Information Company, LLC.

6. Disconnect the fuel feed and evaporative emission (EVAP) line quick-connect fittings (1, 2). Refer to **Metal Collar Quick Connect Fitting Service** , and **Plastic Collar Quick Connect Fitting Service** .
7. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
8. Remove the air cleaner. Refer to **Air Cleaner Assembly Replacement** .

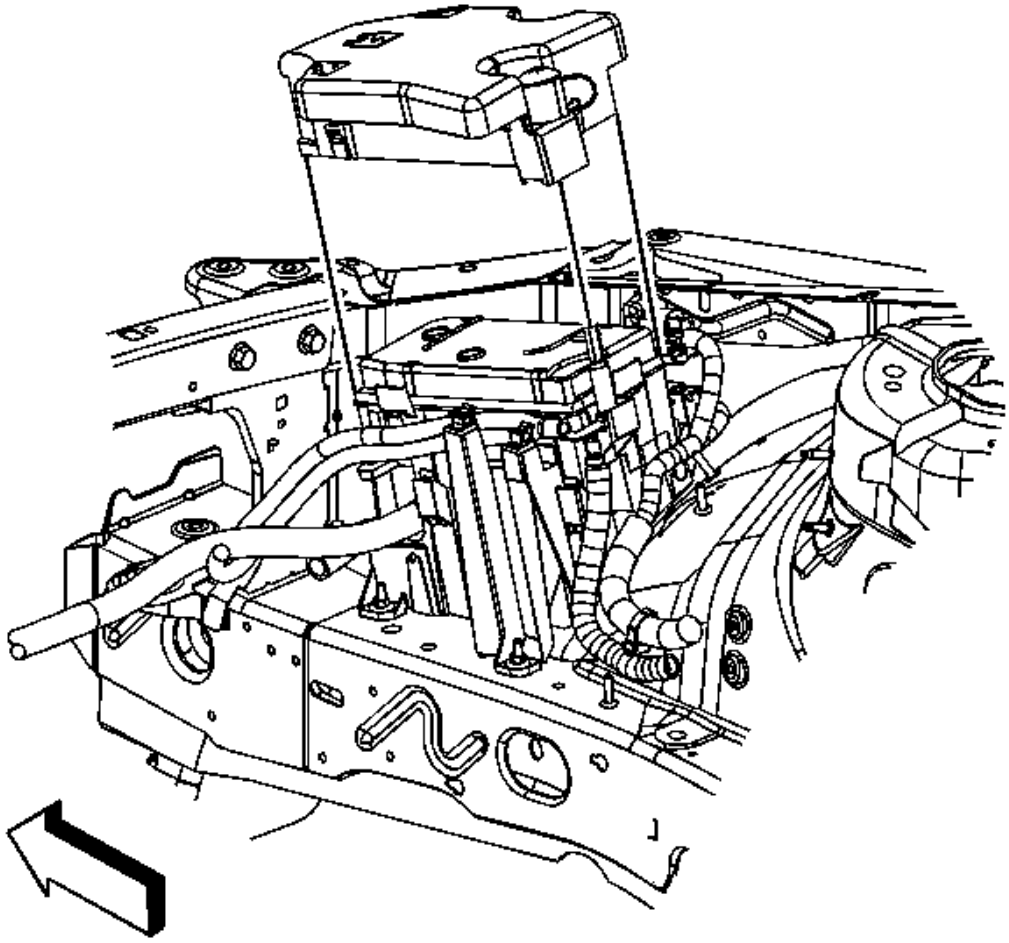


Fig. 410: View Of Junction Block Cover
Courtesy of GENERAL MOTORS COMPANY

9. Disengage the junction block cover lock tabs.
10. Remove the junction block cover.

 © 2011 Mitchell Repair Information Company, LLC.

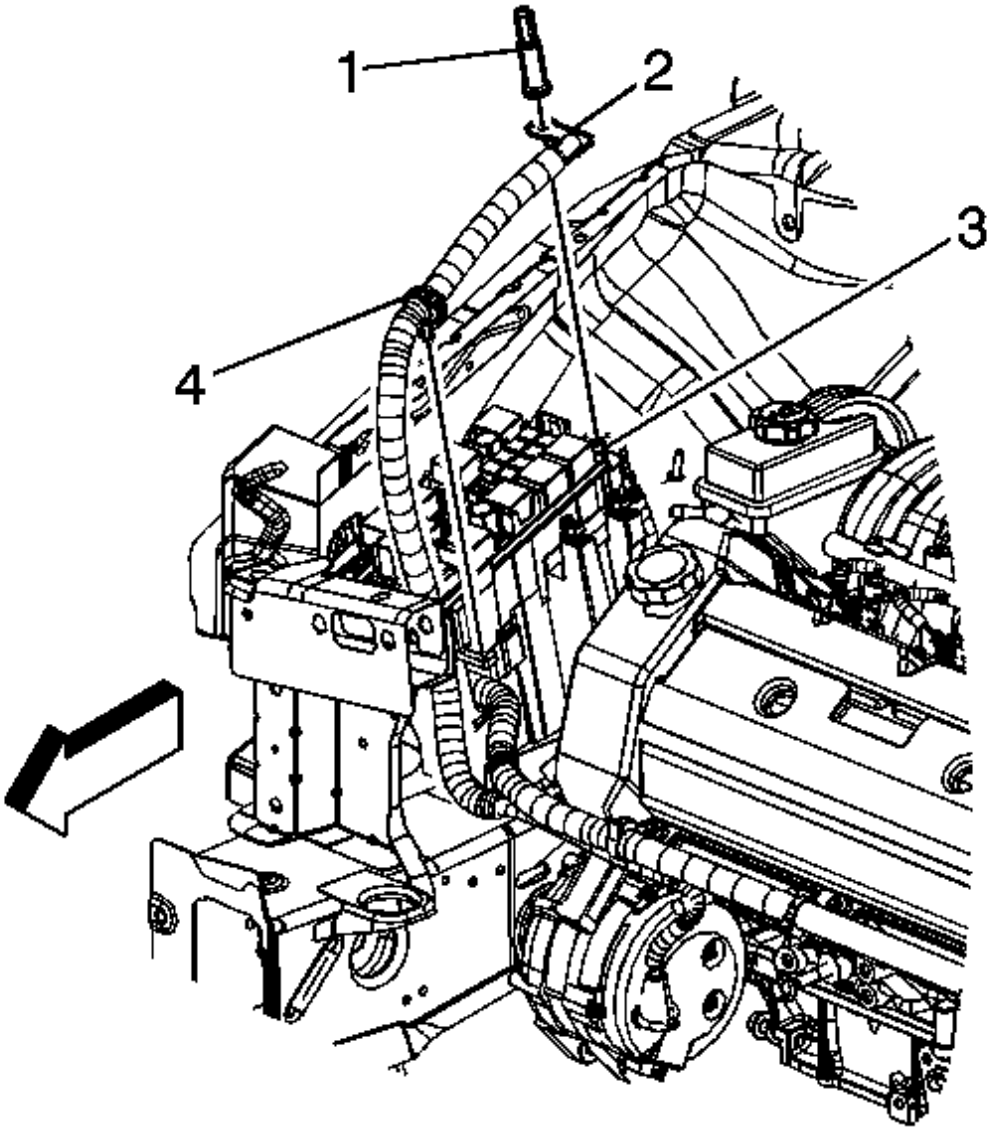


Fig. 411: Identifying Starter Solenoid Cable To Bussed Electrical Center (BEC)
Courtesy of GENERAL MOTORS COMPANY

11. Remove the nut (1) securing the starter cable to the bussed electrical center (BEC).
12. Remove the starter cable clip (4) from the BEC.
13. Remove the starter cable from the BEC terminal and secure to the top of the engine.

 © 2011 Mitchell Repair Information Company, LLC.

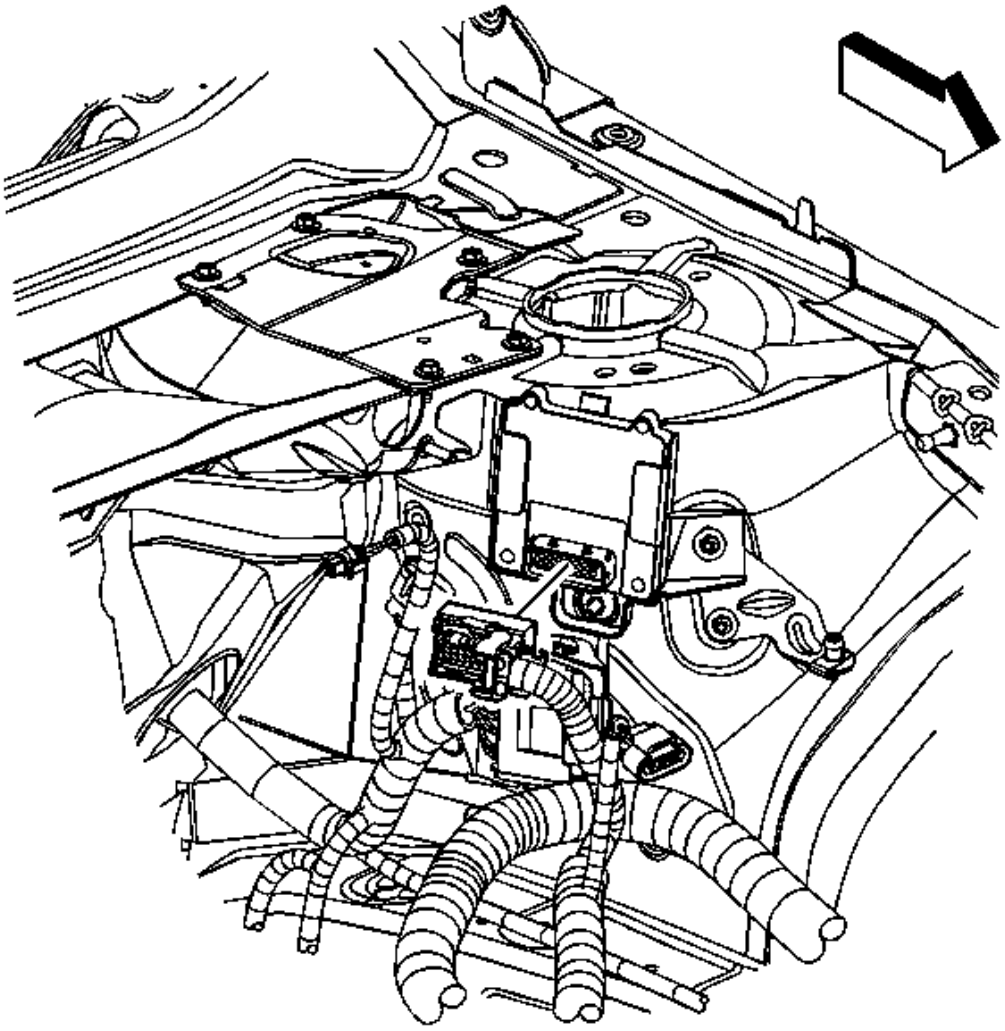


Fig. 412: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

14. Disengage the lever lock.
15. Disconnect the engine harness electrical connector from the transaxle control module (TCM).

 © 2011 Mitchell Repair Information Company, LLC.

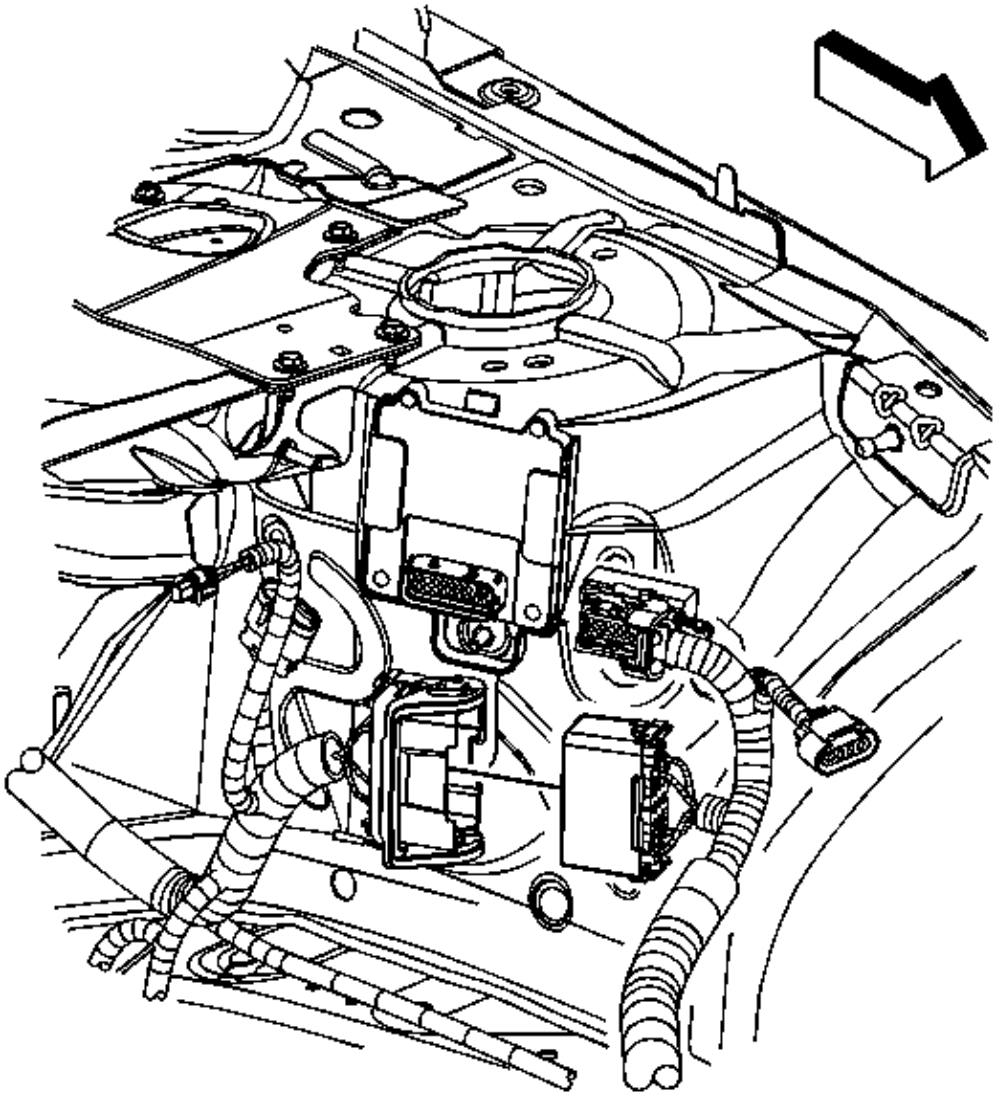


Fig. 413: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

16. Disengage the lever lock.
17. Disconnect the engine harness electrical connector from the body harness electrical connector.
18. Secure the TCM and engine harness wiring branches to the engine.

 © 2011 Mitchell Repair Information Company, LLC.

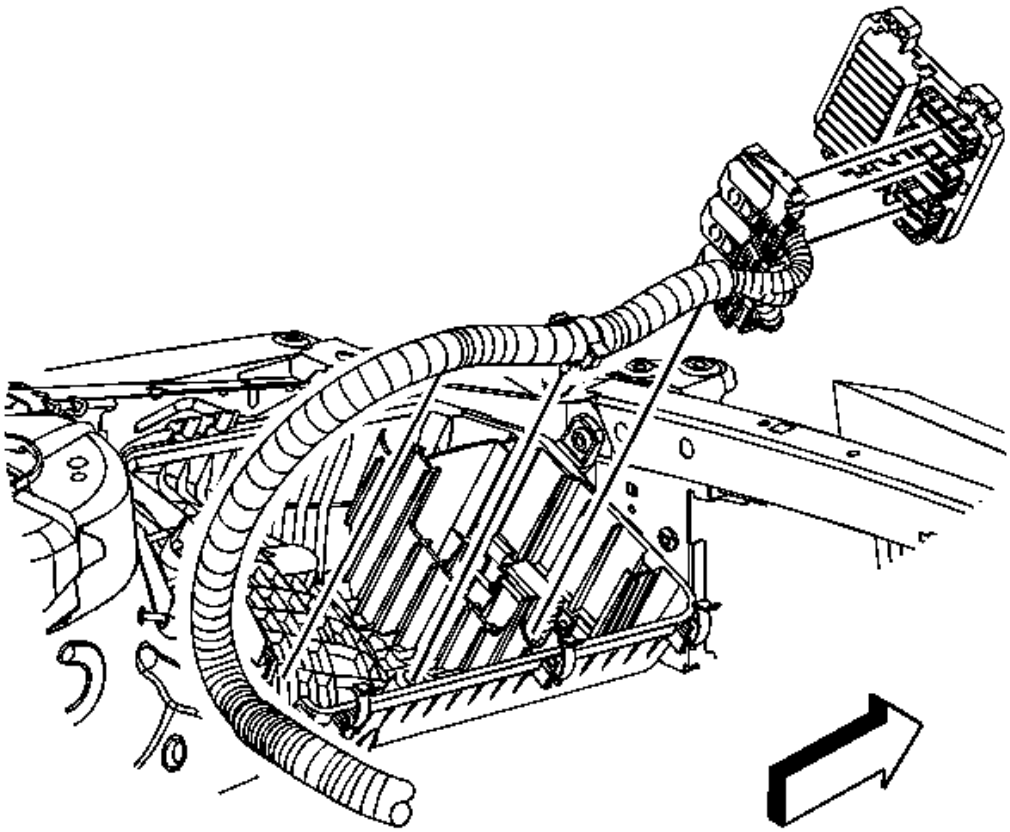


Fig. 414: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

19. Disengage the lever locks.
20. Disconnect the engine harness electrical connectors from the engine control module (ECM).

 © 2011 Mitchell Repair Information Company, LLC.

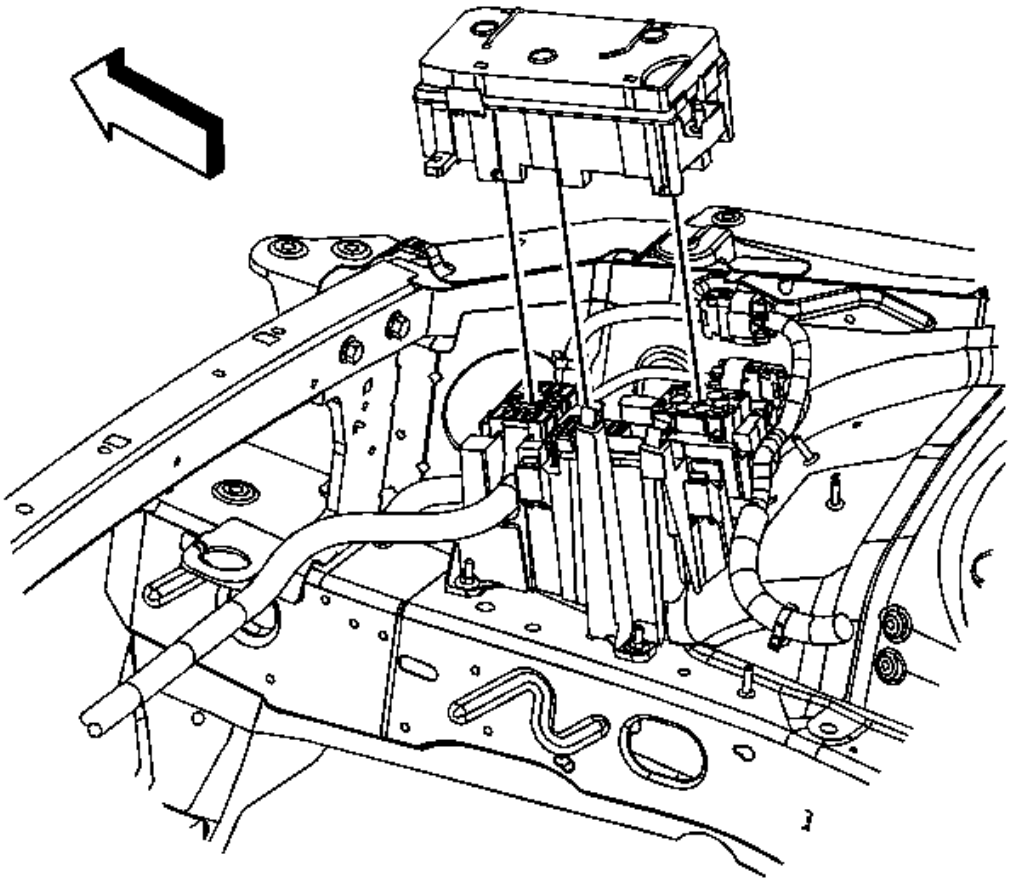


Fig. 415: Locating Junction Block
Courtesy of GENERAL MOTORS COMPANY

21. Remove the junction block bolts.
22. Remove the junction block.

 © 2011 Mitchell Repair Information Company, LLC.

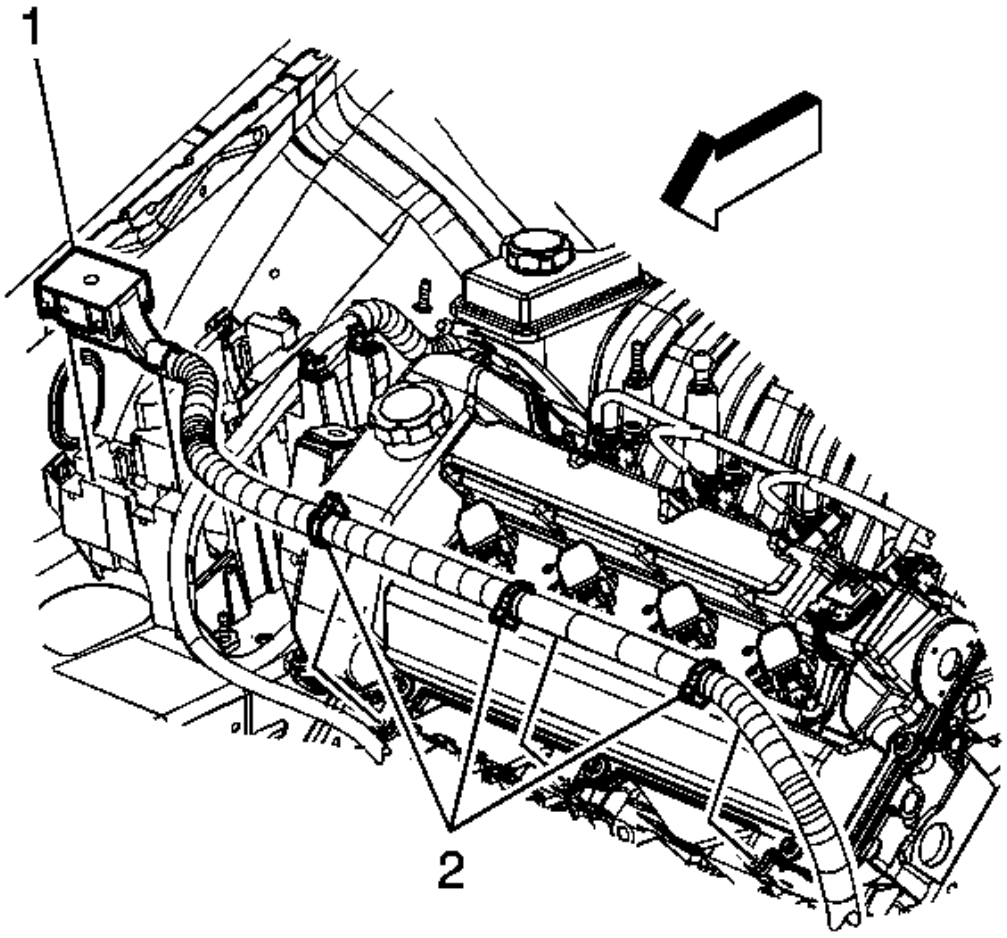


Fig. 416: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS COMPANY

23. Remove the engine harness (1) from the BEC.

 © 2011 Mitchell Repair Information Company, LLC.

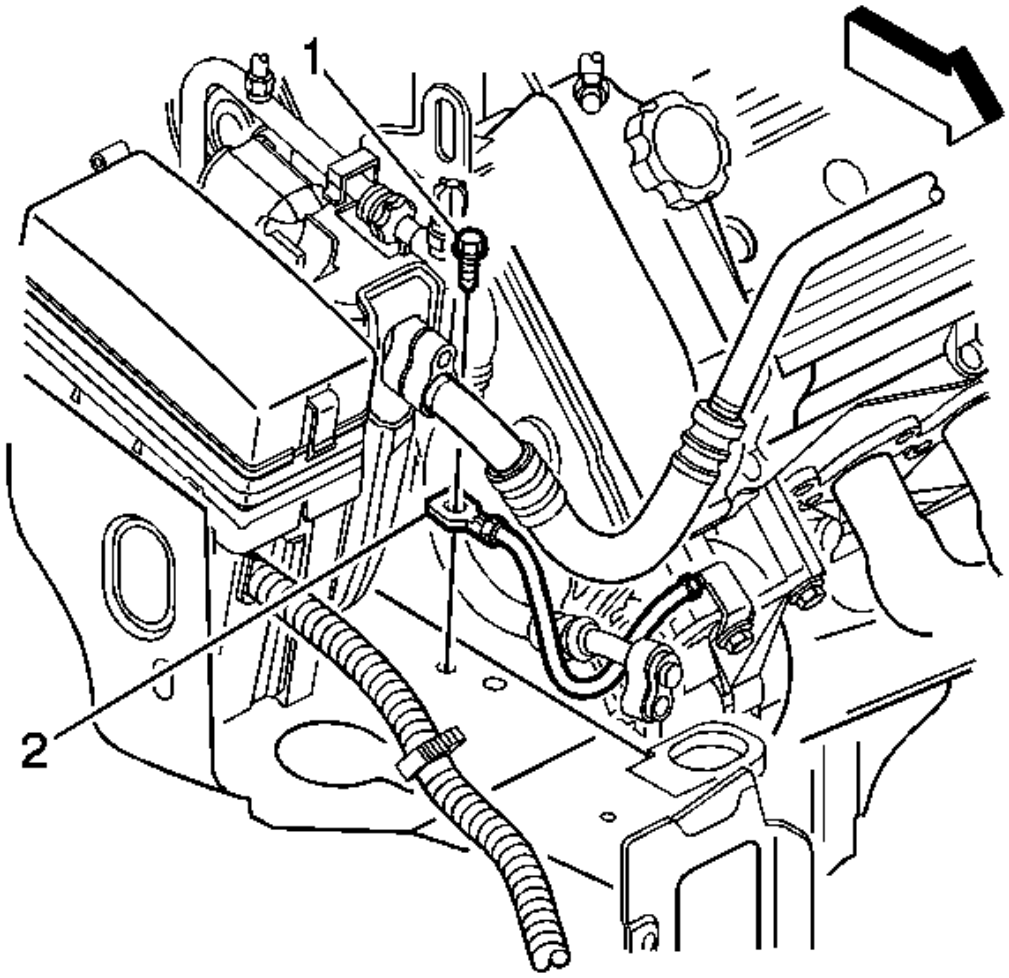


Fig. 417: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS COMPANY

24. Remove the engine ground strap bolt (1) from the right side frame rail.
25. Secure the ground strap to the engine.

 © 2011 Mitchell Repair Information Company, LLC.

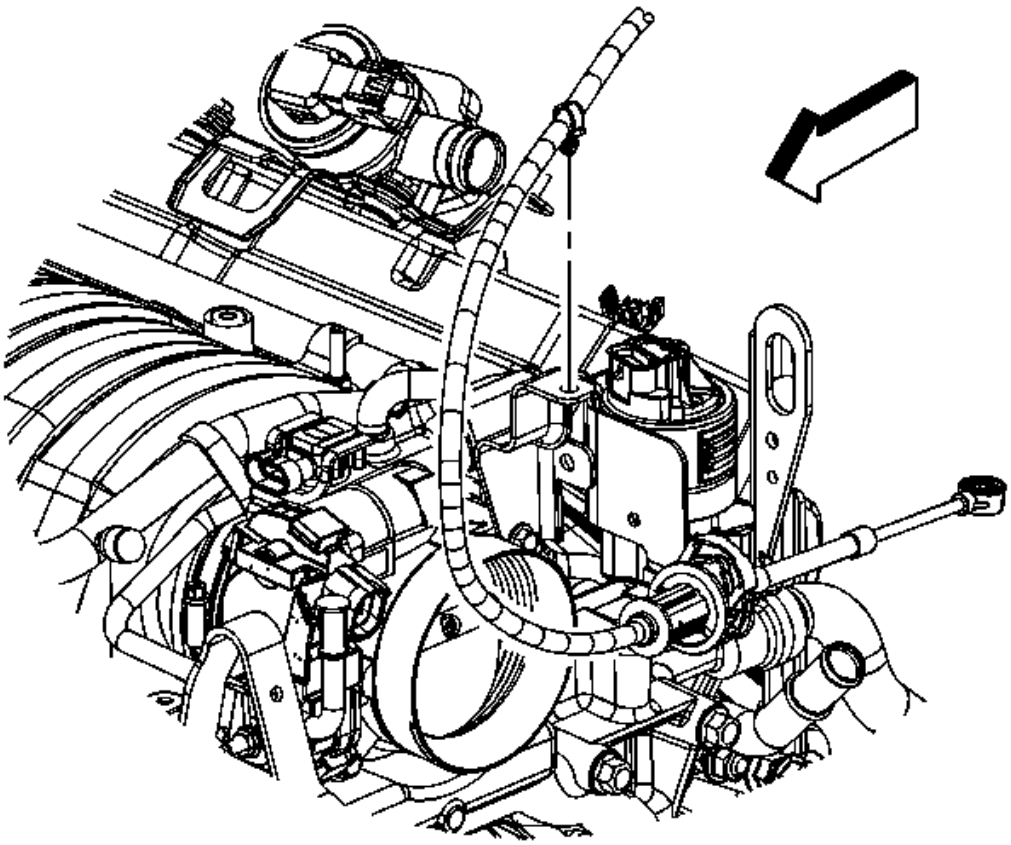


Fig. 418: Identifying Transaxle Shift Cable
Courtesy of GENERAL MOTORS COMPANY

26. Remove the transaxle shift cable clip from the shift cable bracket.

 © 2011 Mitchell Repair Information Company, LLC.

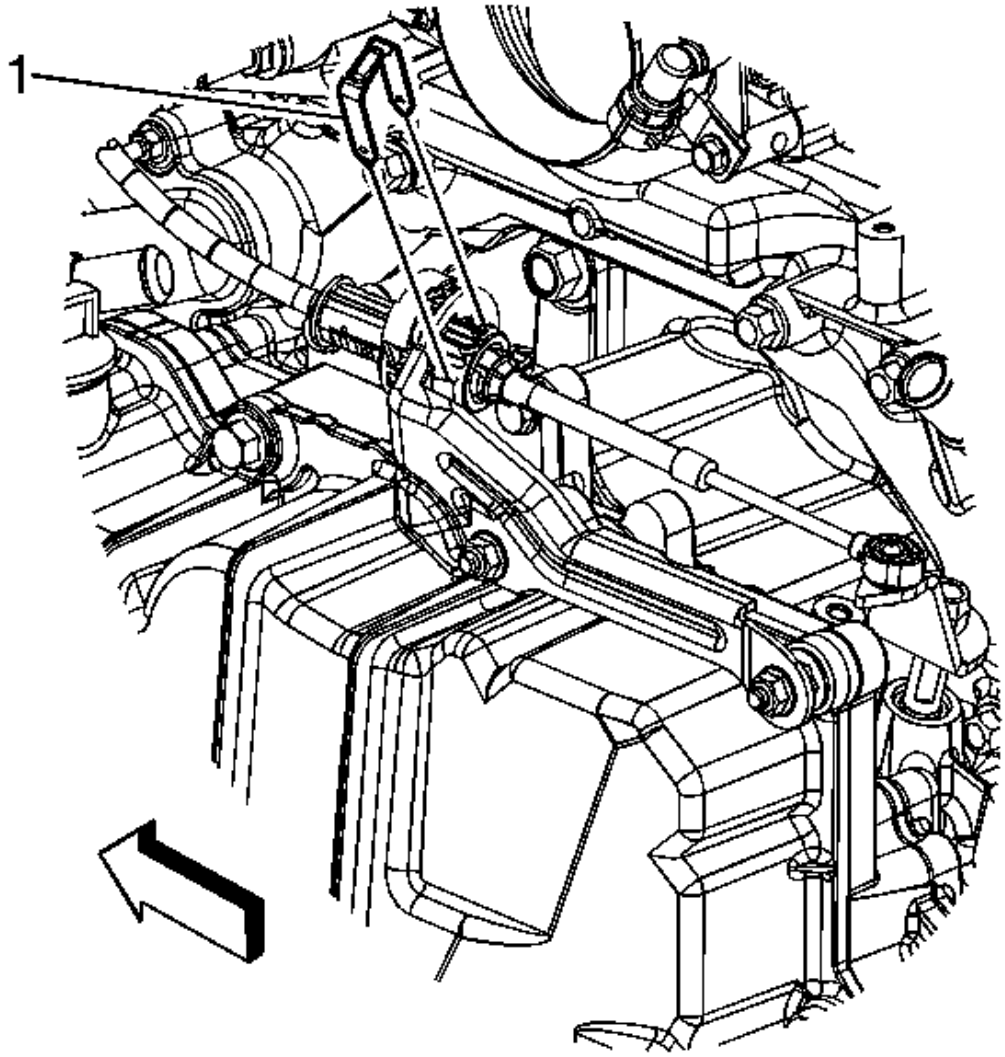


Fig. 419: Identifying Transaxle Shift Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

27. Remove the transaxle shift cable retainer (1).

 © 2011 Mitchell Repair Information Company, LLC.

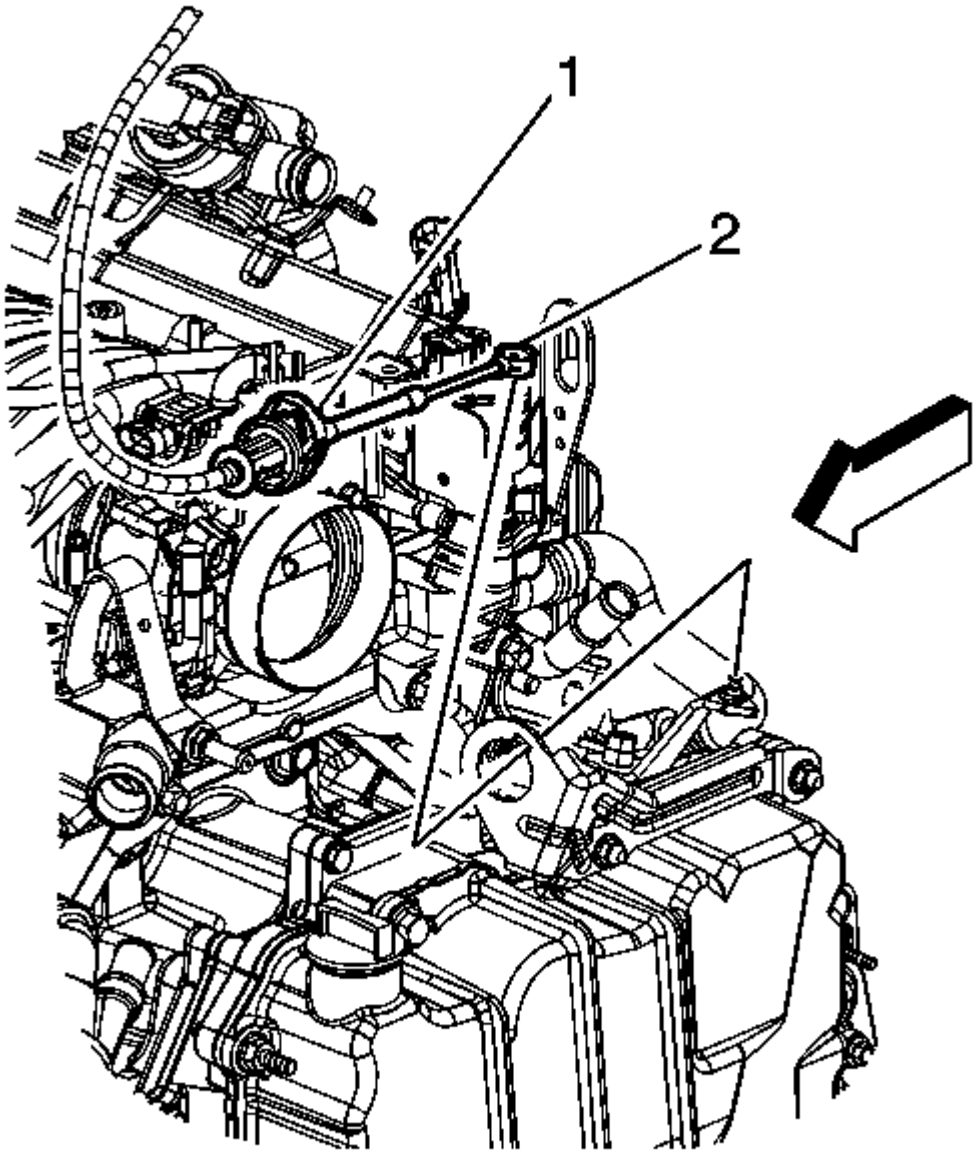


Fig. 420: View Of Transaxle Shift Cable
Courtesy of GENERAL MOTORS COMPANY

28. Disconnect the transaxle shift cable end (2) from the range selector lever (1).
29. Remove the transaxle shift cable from the bracket and position the cable aside.
30. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** , **Cooling System Draining and Filling (Static Fill)** .

 © 2011 Mitchell Repair Information Company, LLC.

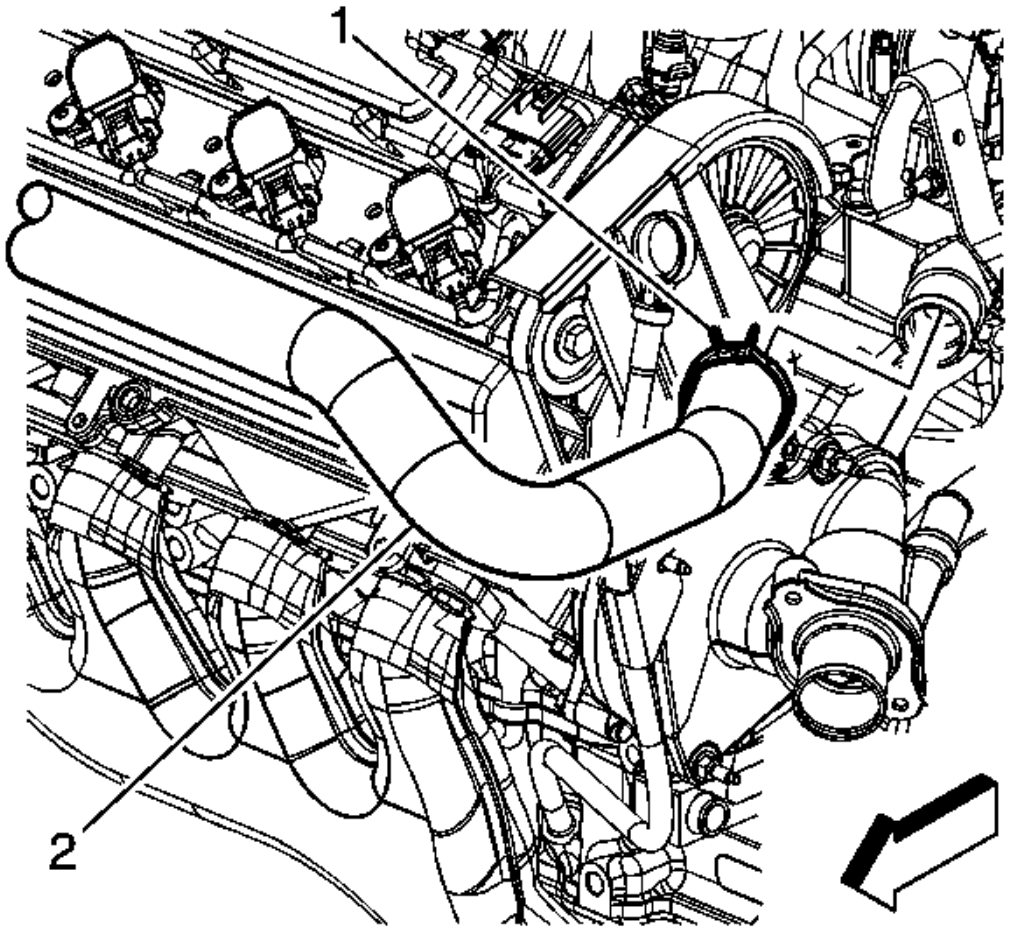


Fig. 421: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

31. Using the **J 37097-A** reposition the radiator inlet hose clamp (1).
32. Remove the radiator inlet hose (2) from the water pump housing and position aside.

 © 2011 Mitchell Repair Information Company, LLC.

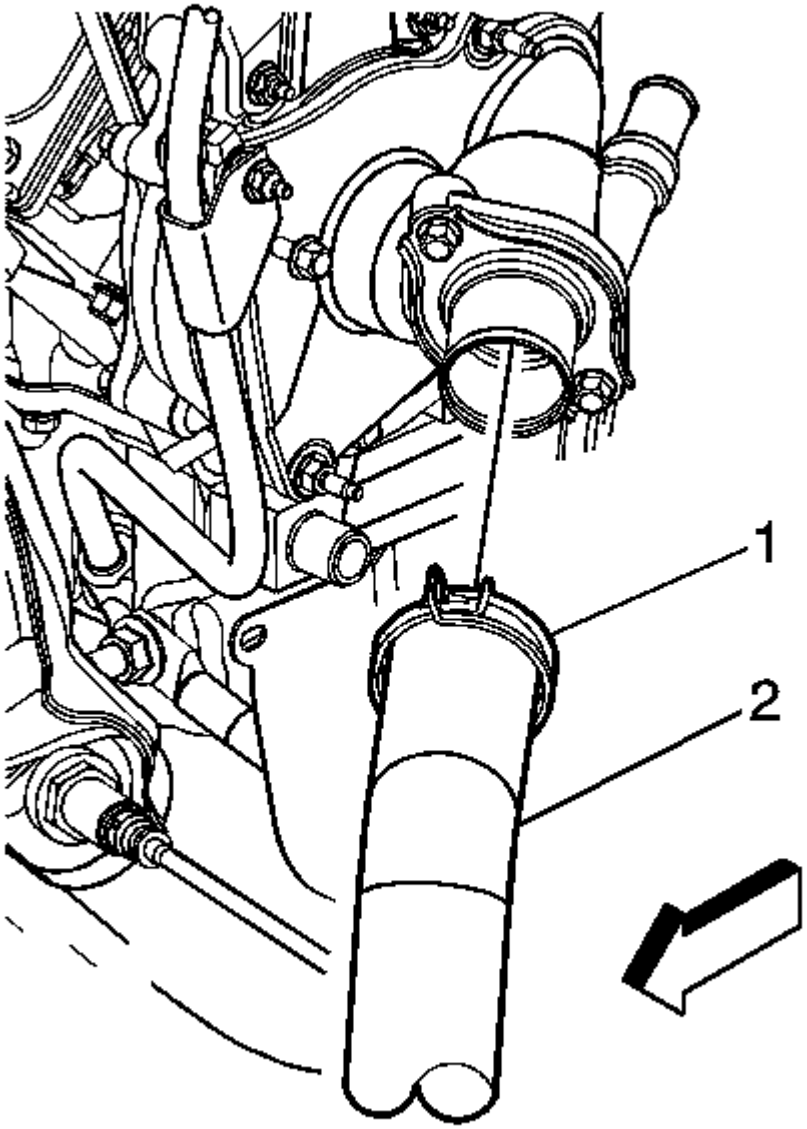


Fig. 422: View Of Radiator Outlet Hose At Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

33. Using the **J 38185** reposition the radiator outlet hose clamp (1).
34. Remove the radiator outlet hose (2) from the thermostat housing and position aside.

 © 2011 Mitchell Repair Information Company, LLC.

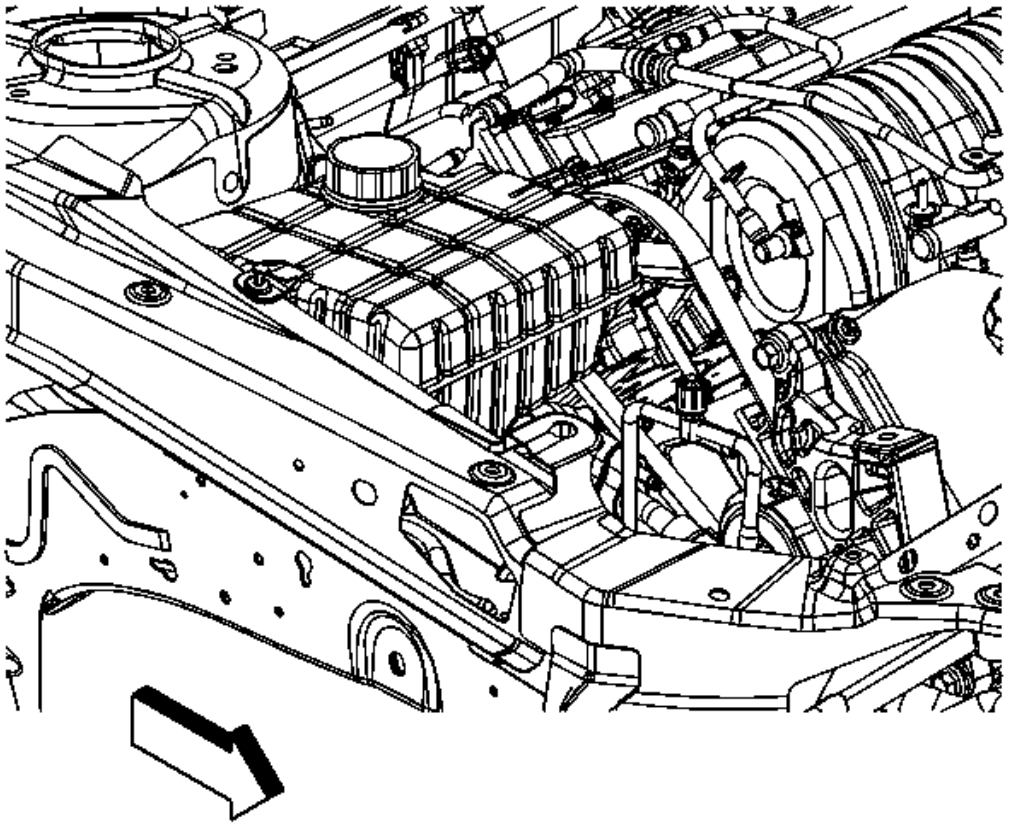


Fig. 423: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

35. Reposition the radiator surge tank inlet hose clamp at the surge tank.
36. Remove the surge tank inlet hose from the surge tank.

 © 2011 Mitchell Repair Information Company, LLC.

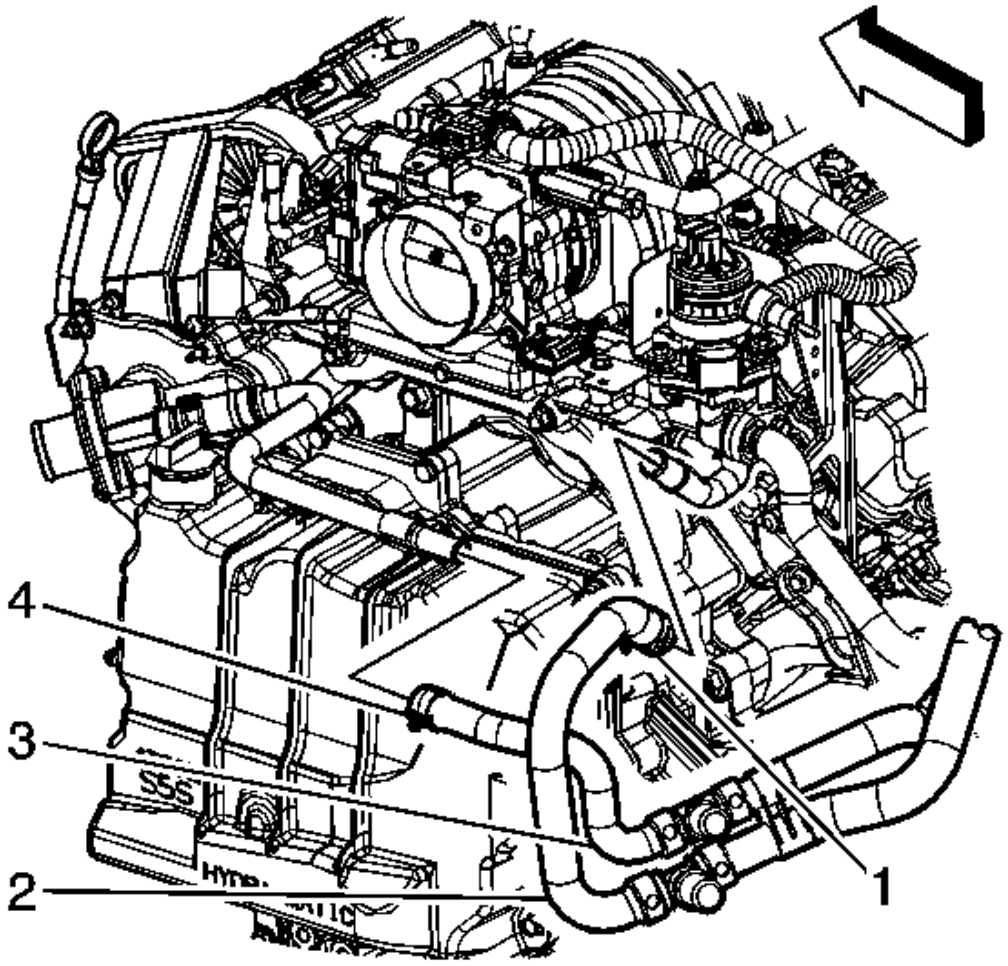


Fig. 424: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

37. Reposition the heater inlet (1) and outlet (2) hose clamps at the heater pipes.
38. Remove the heater inlet (2) and outlet (3) hoses from the heater pipes.

 © 2011 Mitchell Repair Information Company, LLC.

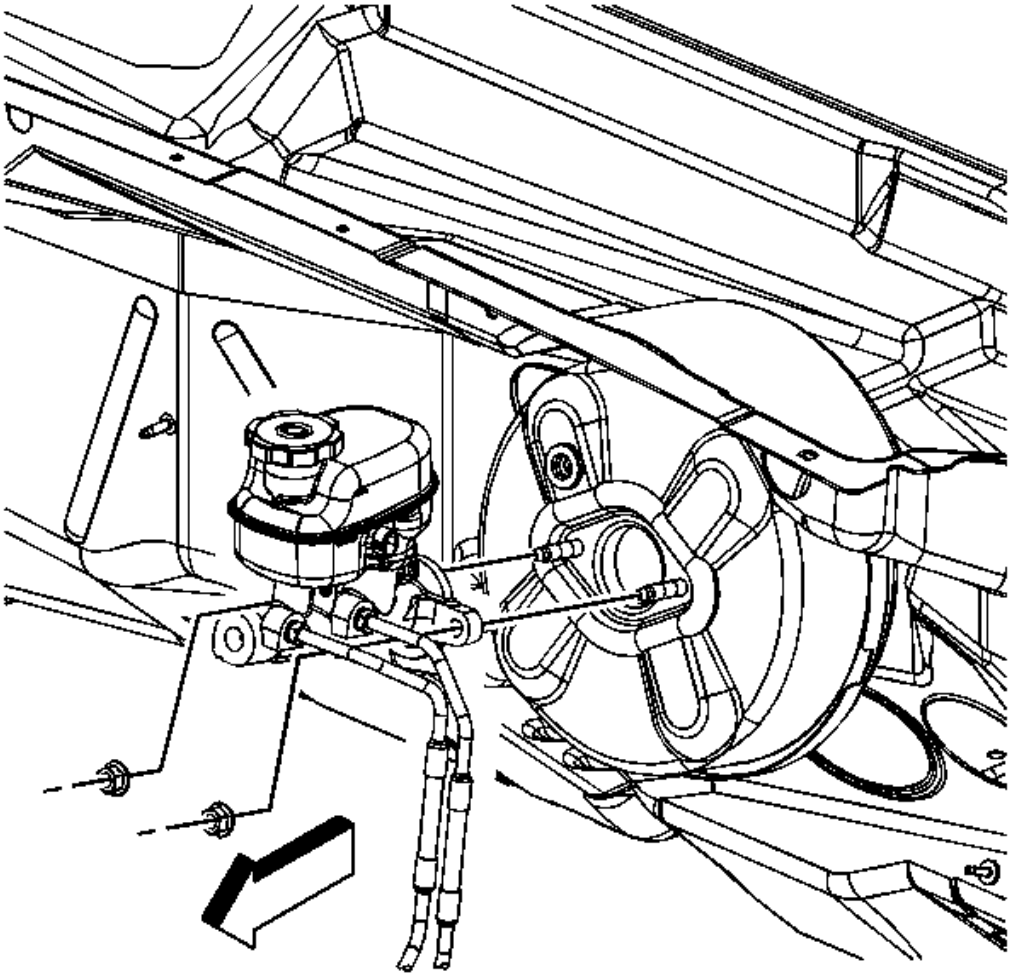


Fig. 425: View Of Master Cylinder & Brake Booster
Courtesy of GENERAL MOTORS COMPANY

39. Remove the master cylinder nuts and master cylinder from the brake booster.
40. Reposition the master cylinder and secure the master cylinder to the engine.

 © 2011 Mitchell Repair Information Company, LLC.

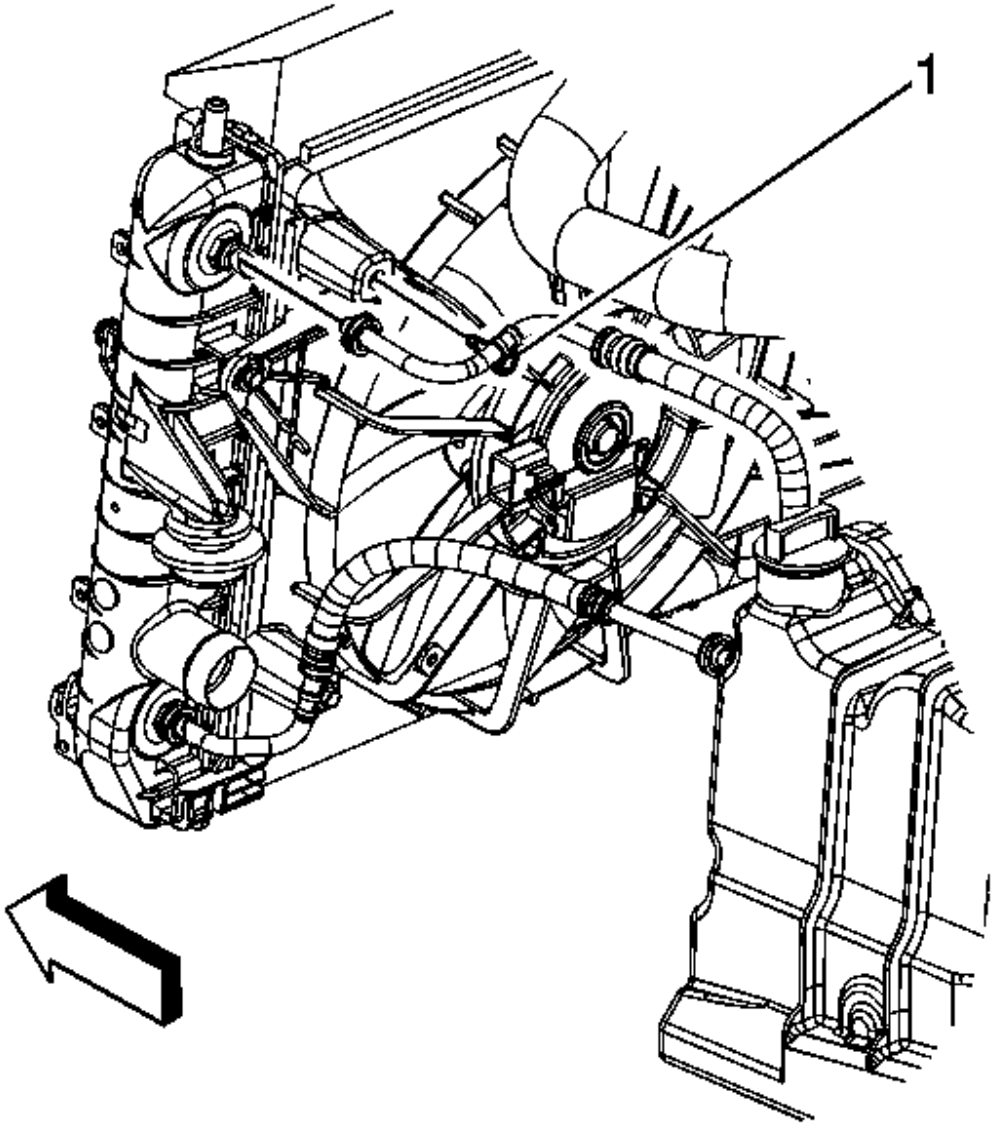


Fig. 426: Identifying Upper Transaxle Oil Cooler Pipe Bolt & Bolt
Courtesy of GENERAL MOTORS COMPANY

41. Loosen the upper transaxle oil cooler pipe bolt (1) from the fan shroud.
42. Slide the plastic caps off the transaxle oil cooler pipe quick connect fittings.
43. Remove the right front engine mount strut bolt.
44. Disconnect the transaxle oil cooler pipes from the radiator using the **J 41623-B** .

 © 2011 Mitchell Repair Information Company, LLC.

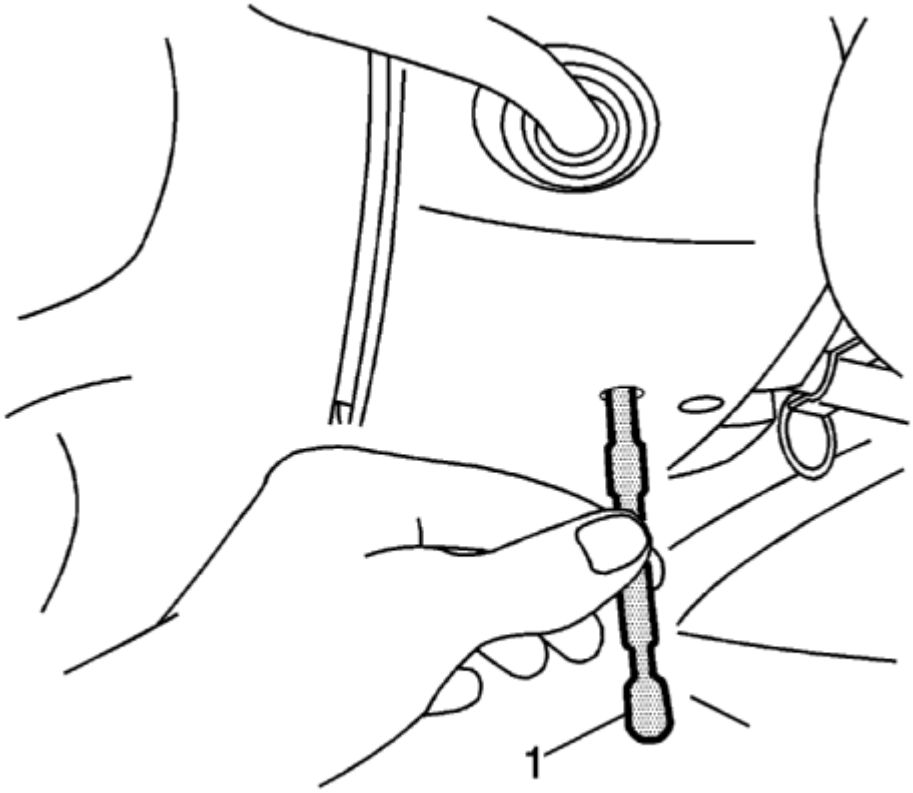


Fig. 427: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

 © 2011 Mitchell Repair Information Company, LLC.

45. Lock the steering column by installing the **J 42640** into the underside of the steering column.

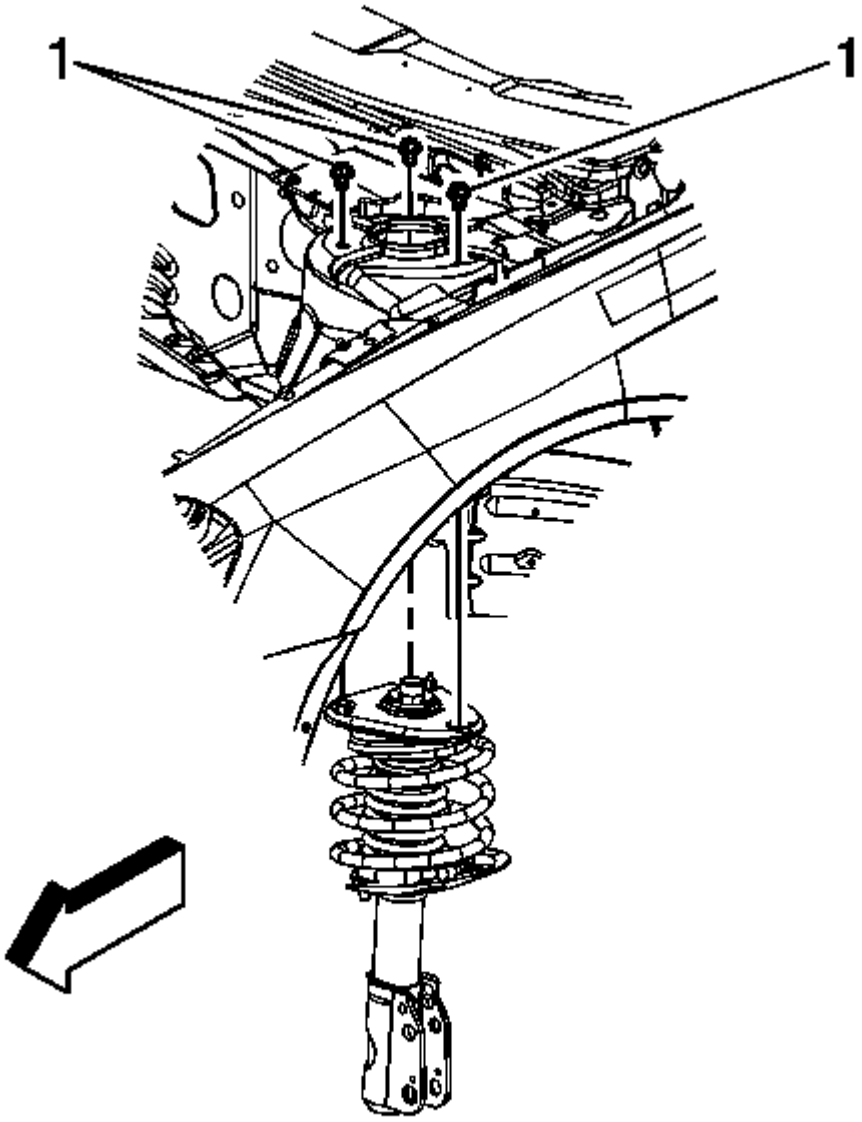


Fig. 428: Locating Strut Tower Bolts
Courtesy of GENERAL MOTORS COMPANY

46. Remove the left and right side strut tower bolts (1). (Left side shown, right side similar.)
47. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

 © 2011 Mitchell Repair Information Company, LLC.

48. Remove the rear exhaust manifold pipe. Refer to **Exhaust Manifold Rear Pipe Replacement (L37)** .
49. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation** .

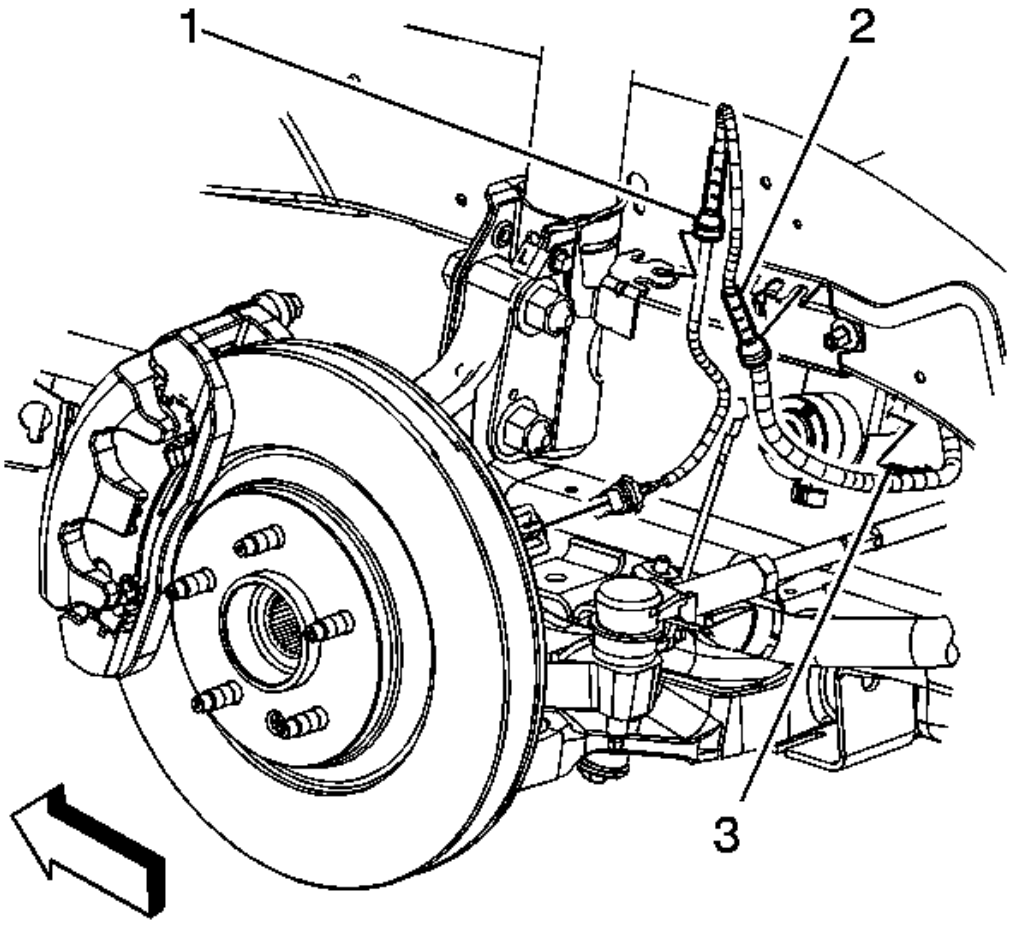


Fig. 429: Identifying Engine Harness Grommets & Clips
Courtesy of GENERAL MOTORS COMPANY

50. Remove the engine harness grommet (2) from the frame rail bracket.
51. Remove the engine harness clip (3) from the ride lever sensor bracket.

 © 2011 Mitchell Repair Information Company, LLC.

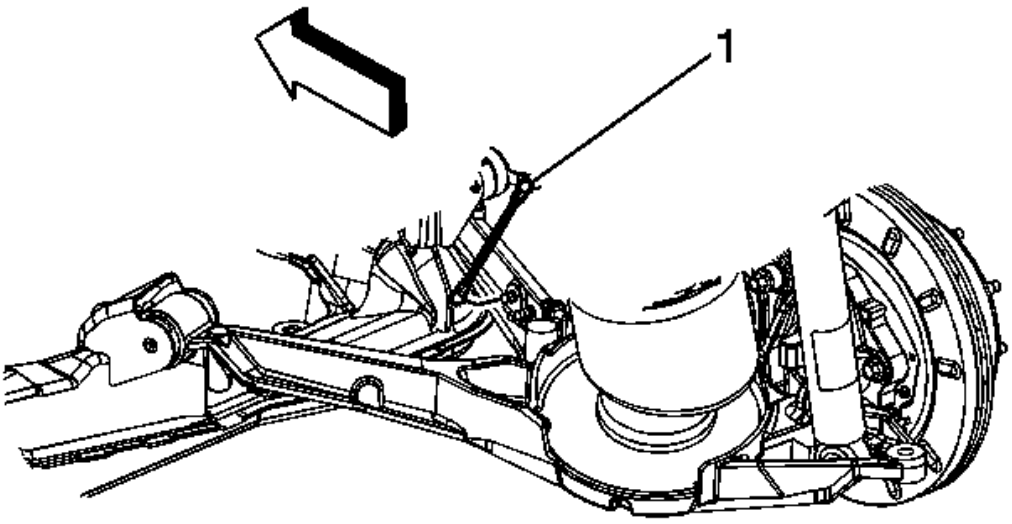


Fig. 430: Identifying Electronic Suspension Front Position Sensor Link
Courtesy of GENERAL MOTORS COMPANY

52. Disconnect the electronic suspension front position sensor link from the lower control arms ball stud, if equipped.

 © 2011 Mitchell Repair Information Company, LLC.

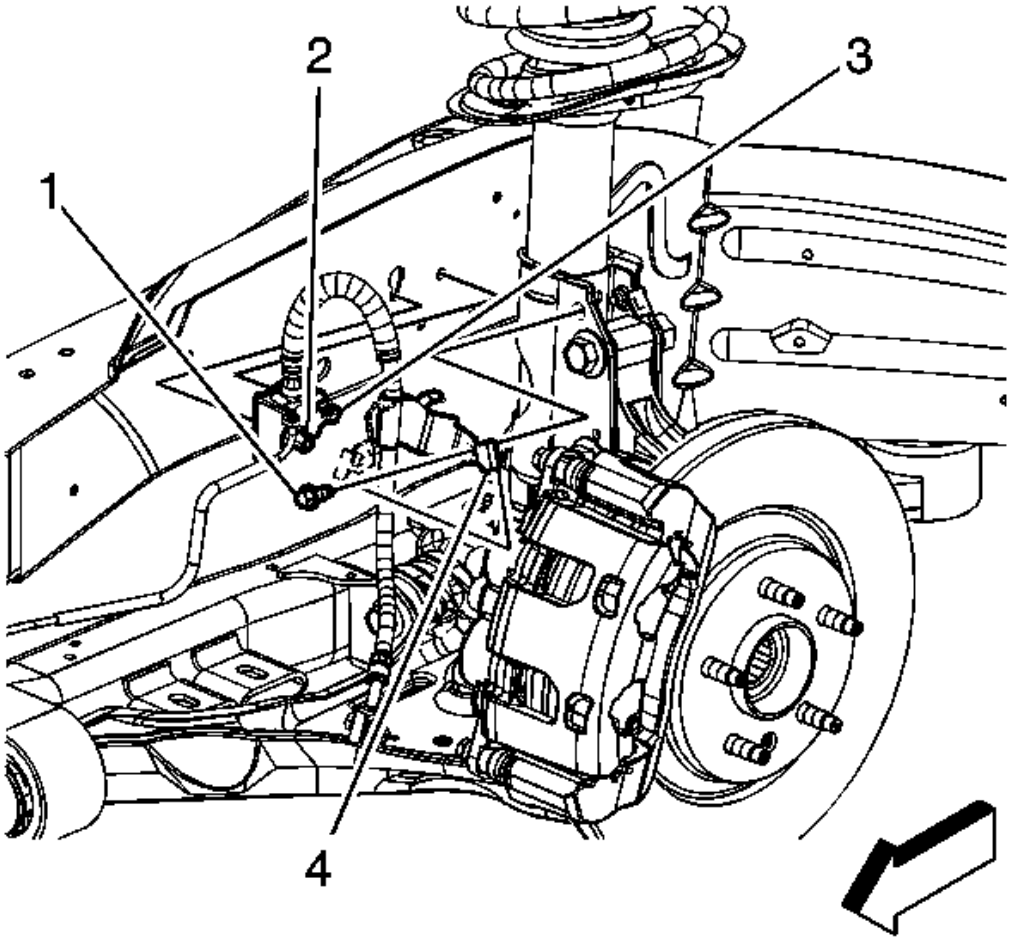


Fig. 431: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

53. Loosen the nut (2) securing the left front brake pipe bracket (4) to the body frame rail.
54. Remove the front brake pipe bracket (4) from the body frame rail.

 © 2011 Mitchell Repair Information Company, LLC.

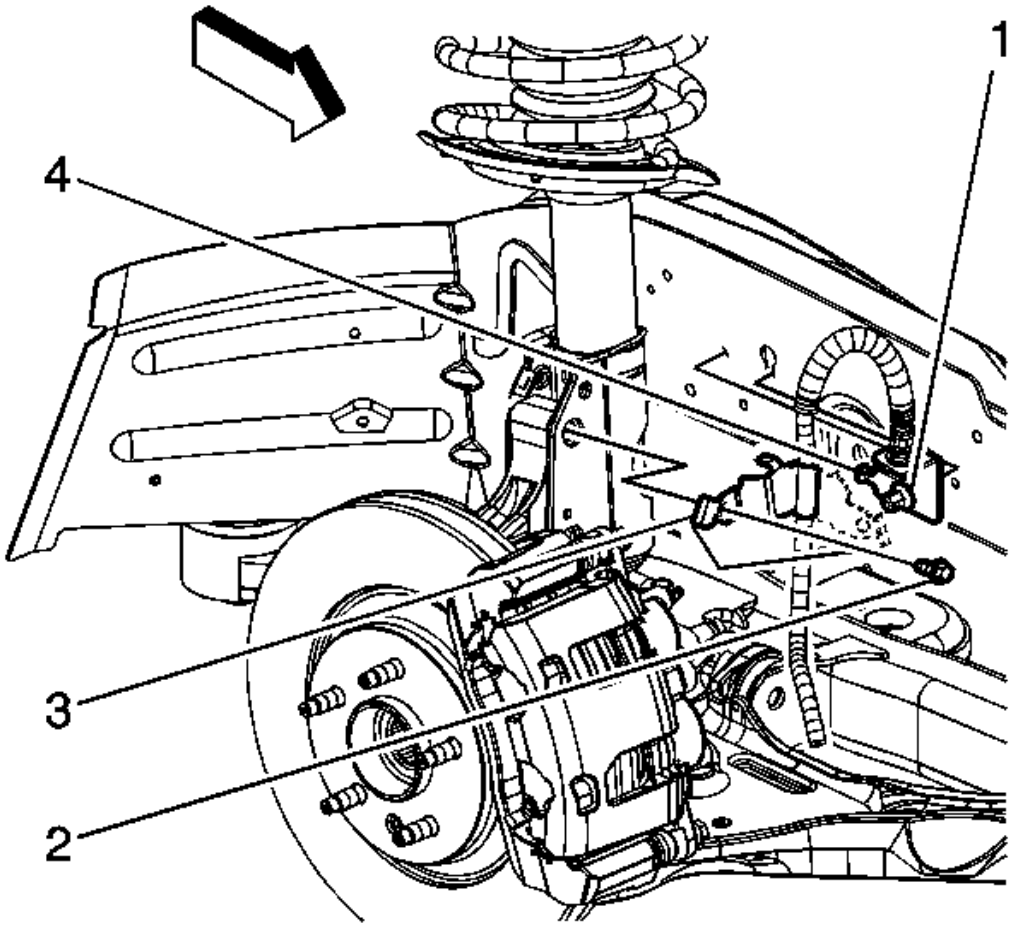


Fig. 432: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

55. Loosen the nut (1) securing the right front brake pipe bracket (4) to the body frame rail.
56. Remove the front brake pipe bracket (4) from the body frame rail.

 © 2011 Mitchell Repair Information Company, LLC.

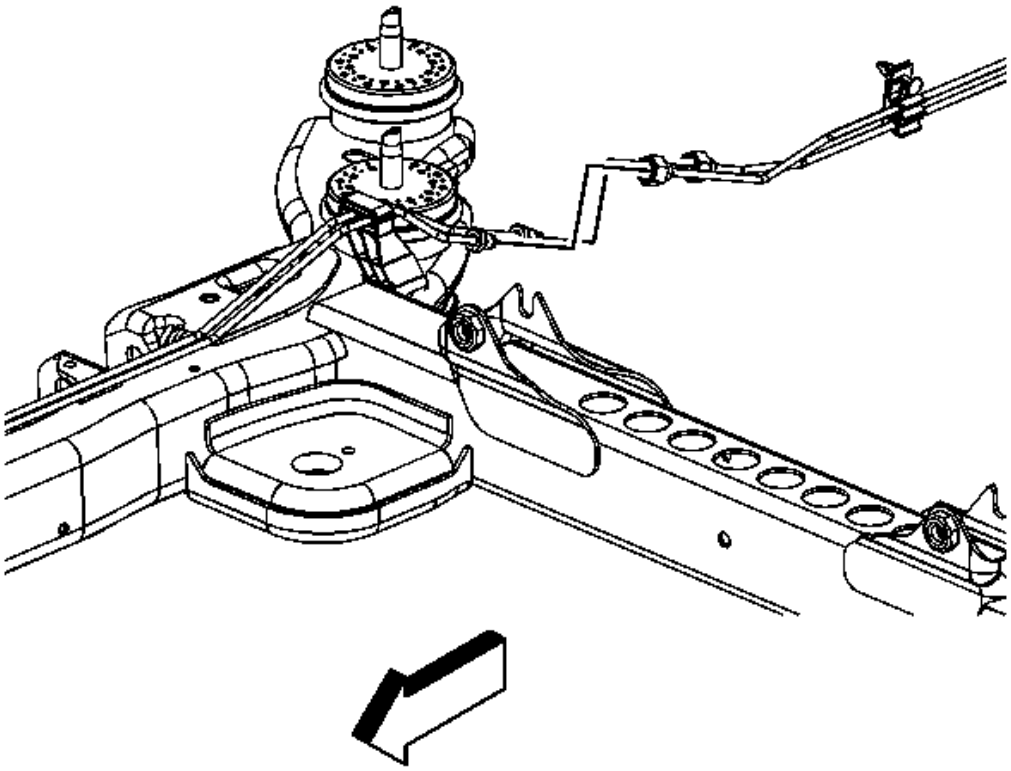


Fig. 433: Identifying Rear Brake Pipes/Lines
Courtesy of GENERAL MOTORS COMPANY

57. Disconnect the rear brake pipes from the front brake pipes.
58. Plug the open brake lines in order to prevent fluid loss and/or system contamination.

 © 2011 Mitchell Repair Information Company, LLC.

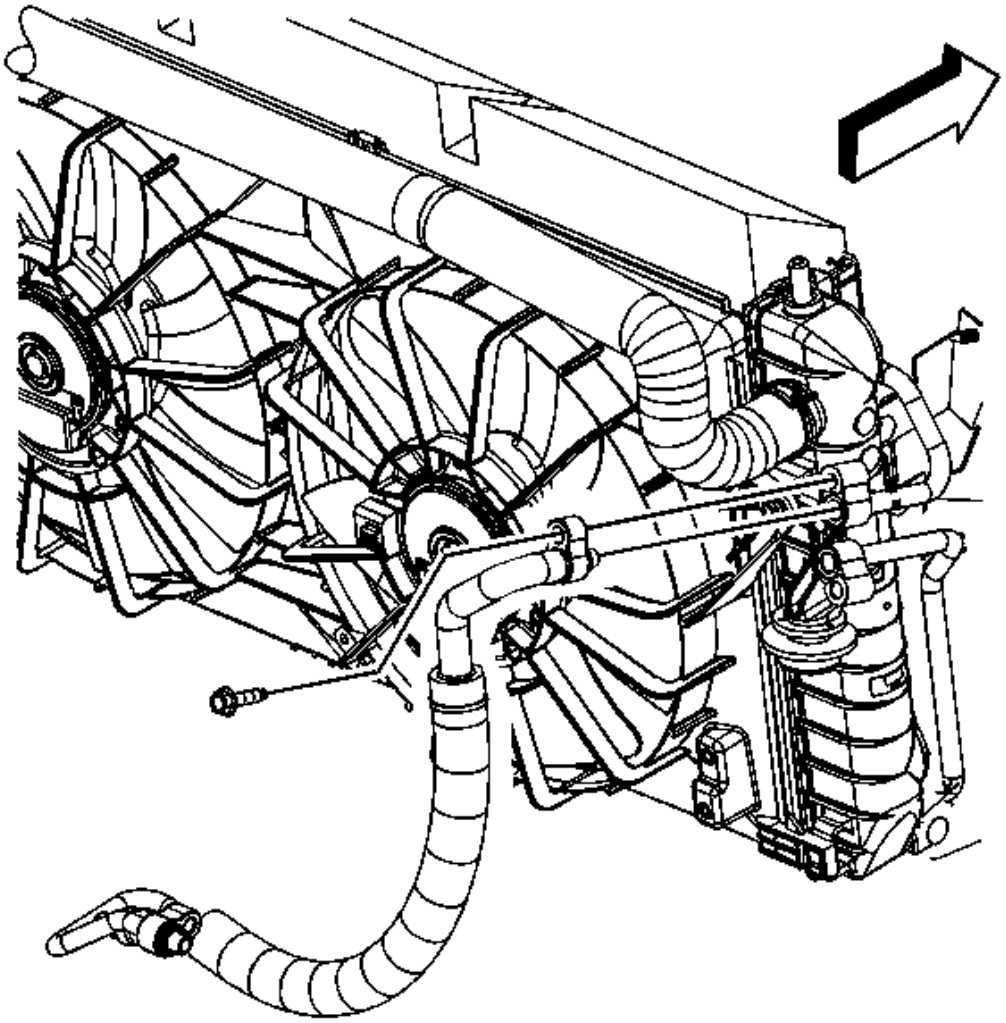


Fig. 434: View Of A/C Discharge Hose & Condenser
Courtesy of GENERAL MOTORS COMPANY

59. Remove the A/C compressor discharge hose bolt at the condenser.
60. Remove the A/C compressor discharge hose from the condenser and secure to the engine.
61. Plug the A/C condenser discharge port.

 © 2011 Mitchell Repair Information Company, LLC.

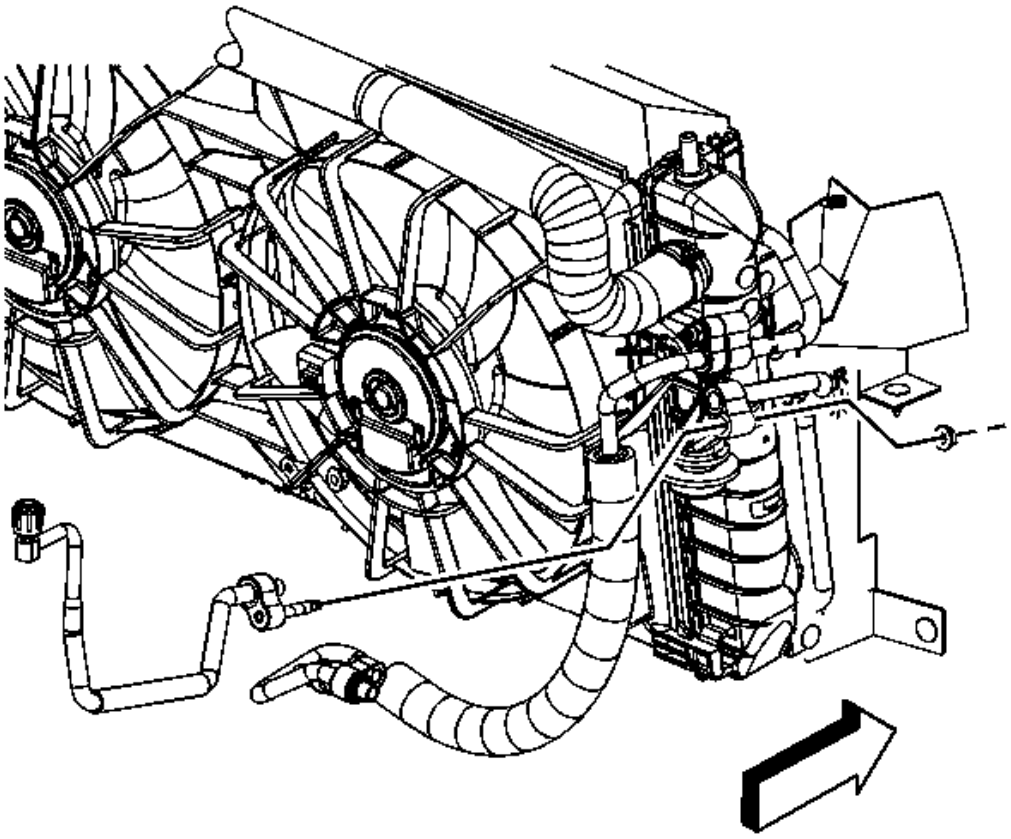


Fig. 435: View Of A/C Suction Hose & Condenser
Courtesy of GENERAL MOTORS COMPANY

62. Remove the A/C compressor suction hose nut at the condenser.
63. Remove the A/C compressor suction hose from the condenser and secure to the engine.
64. Plug the A/C condenser suction port.

 © 2011 Mitchell Repair Information Company, LLC.

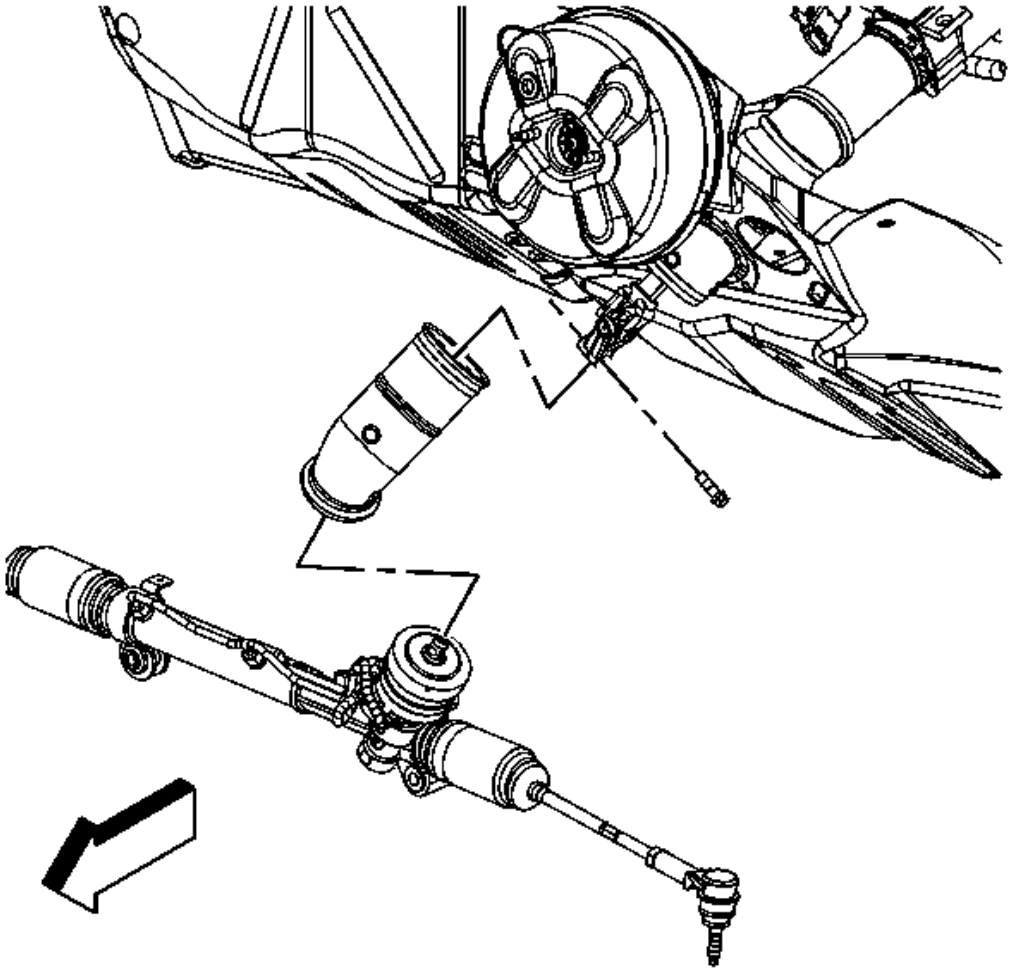


Fig. 436: Identifying Steering Gear & Related Attachments
Courtesy of GENERAL MOTORS COMPANY

WARNING: Failure to disconnect intermediate shaft from rack and pinion stub shaft can result in damage to steering gear and/or intermediate shaft. This damage can cause loss of steering control which could result in personal injury.

65. Remove the intermediate steering shaft cover.
66. Remove the intermediate shaft pinch bolt.
67. Remove the intermediate shaft from the steering gear.

 © 2011 Mitchell Repair Information Company, LLC.

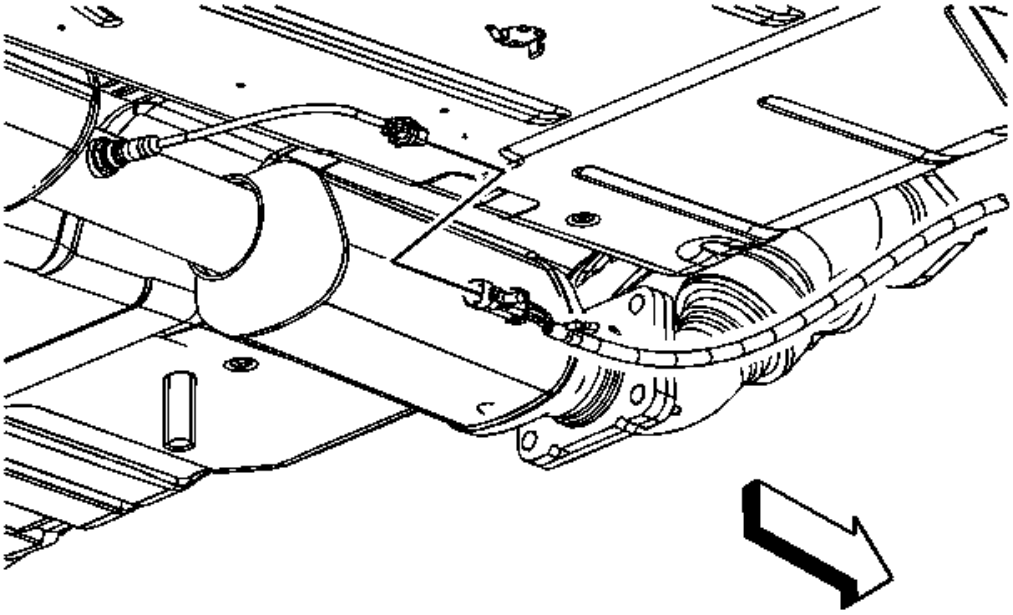


Fig. 437: Identifying Oxygen Sensor Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS COMPANY

68. Remove the oxygen sensor wiring harness heat shield. Refer to **Oxygen Sensor Wiring Harness Heat Shield Replacement** .
69. Disconnect the engine harness electrical connector from the heated oxygen sensor (HO2S).

 © 2011 Mitchell Repair Information Company, LLC.

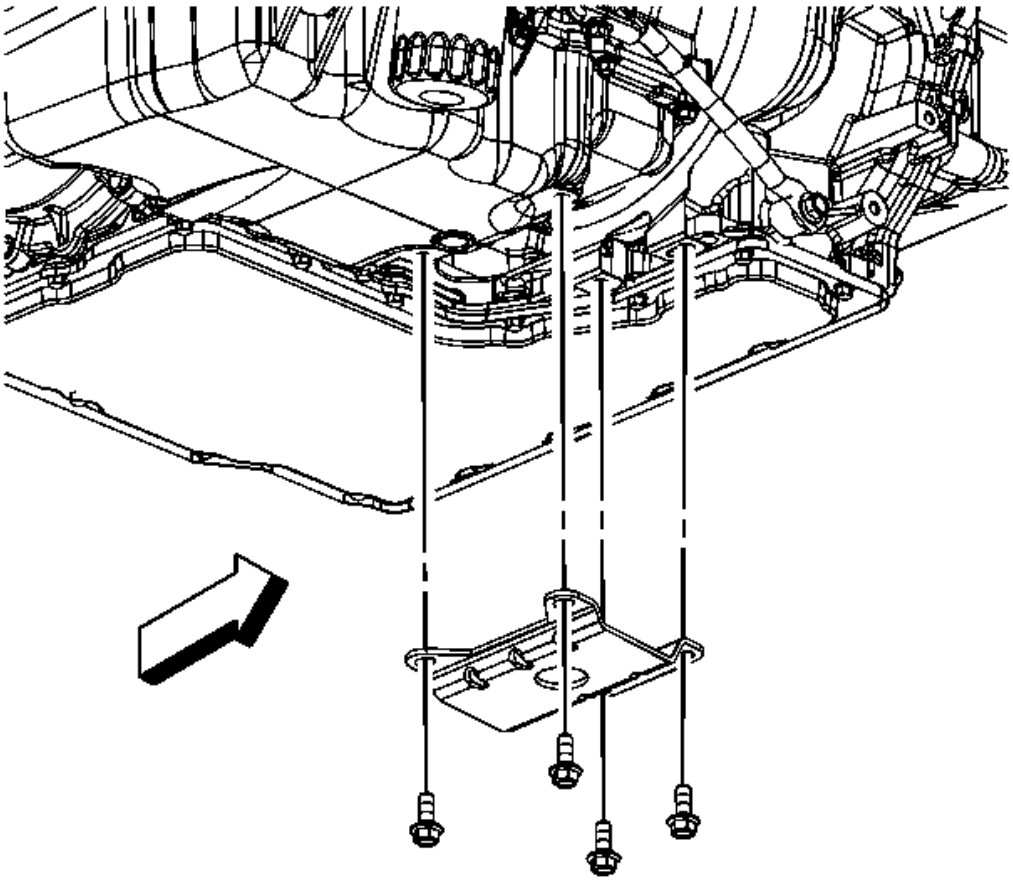


Fig. 438: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

70. Remove the transaxle brace bolts.
71. Remove the transaxle brace.

 © 2011 Mitchell Repair Information Company, LLC.

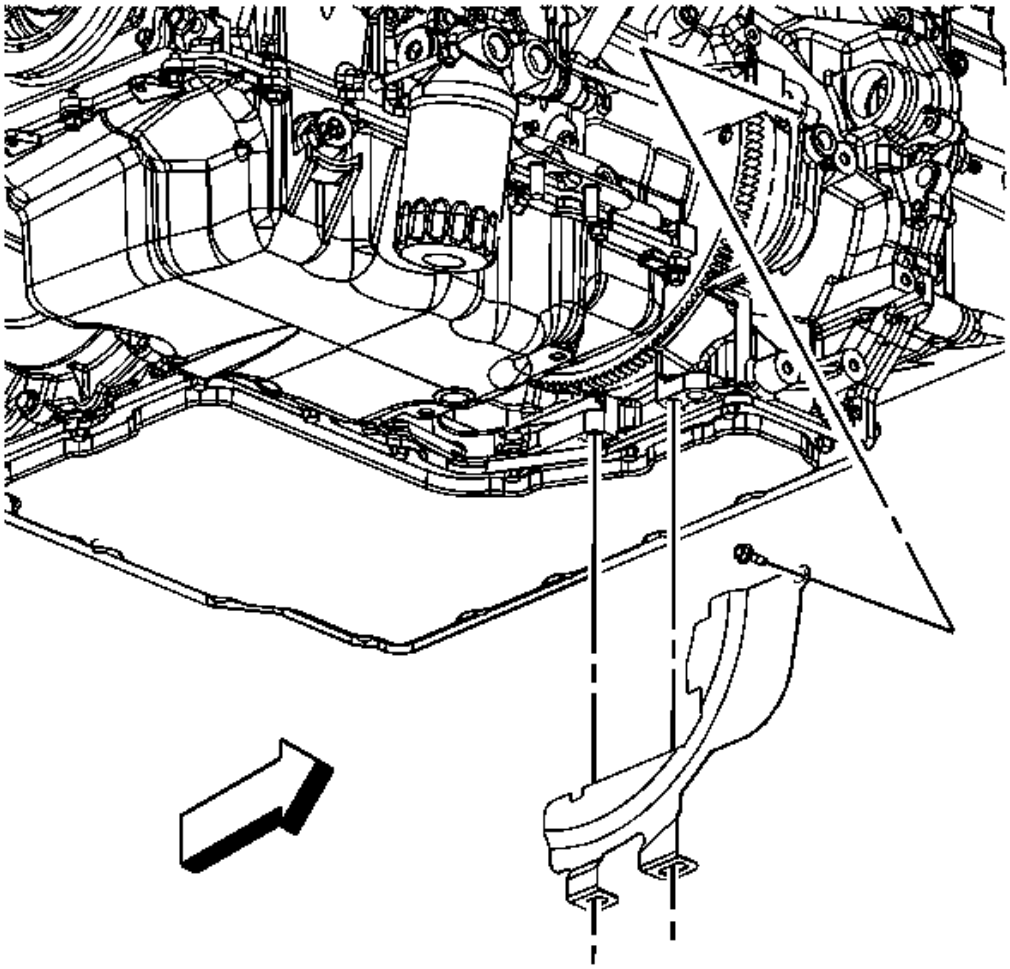


Fig. 439: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS COMPANY

72. Remove the torque converter cover bolt.
73. Remove the torque converter cover.

 © 2011 Mitchell Repair Information Company, LLC.

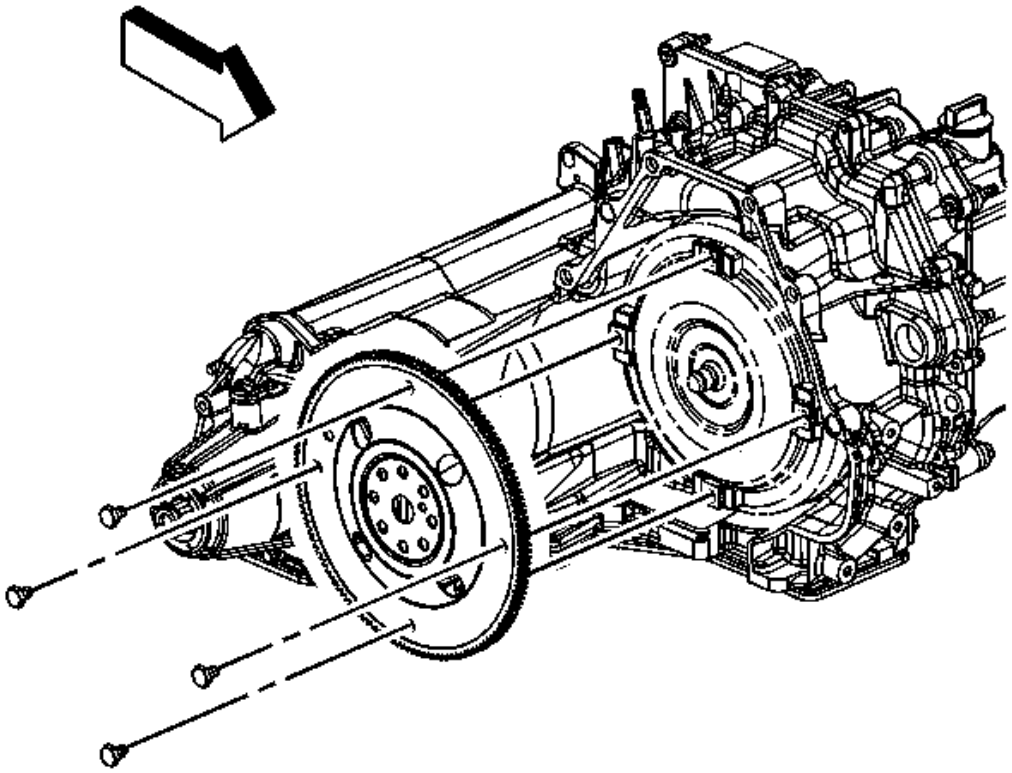


Fig. 440: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the flywheel to torque converter relationship prior to removal of the bolts.

74. Remove the flywheel to torque converter bolts. (Engine removed for clarity).

 © 2011 Mitchell Repair Information Company, LLC.

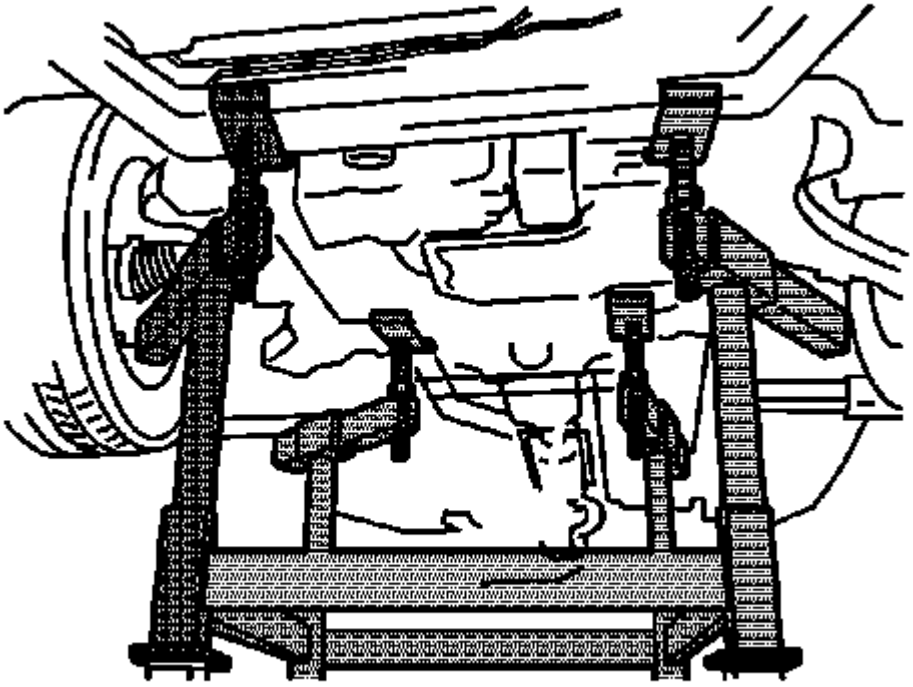


Fig. 441: Identifying Utility Stand
Courtesy of GENERAL MOTORS COMPANY

75. Position the **J 39580** under the frame.
76. Lower the vehicle onto the **J 39580** .

 © 2011 Mitchell Repair Information Company, LLC.

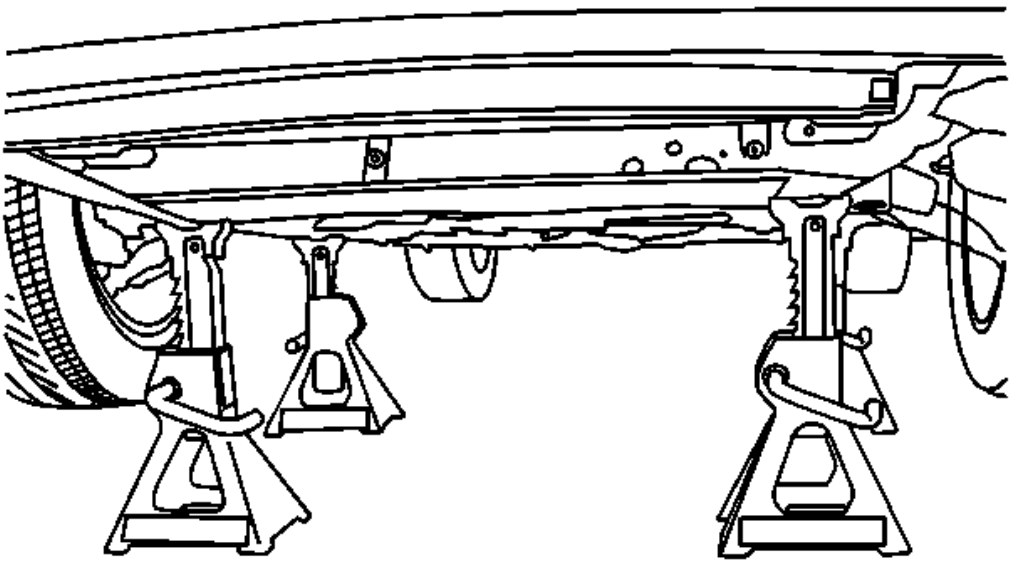


Fig. 442: Locating Jackstands Under Engine Frame
Courtesy of GENERAL MOTORS COMPANY

77. If the **J 39580** is not available. Support the powertrain with four suitable jackstands.
78. Place a 2 in x 4 in block of wood between the front of the engine oil pan and the engine frame.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

79. Secure the front hoist pads to the vehicle.
80. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

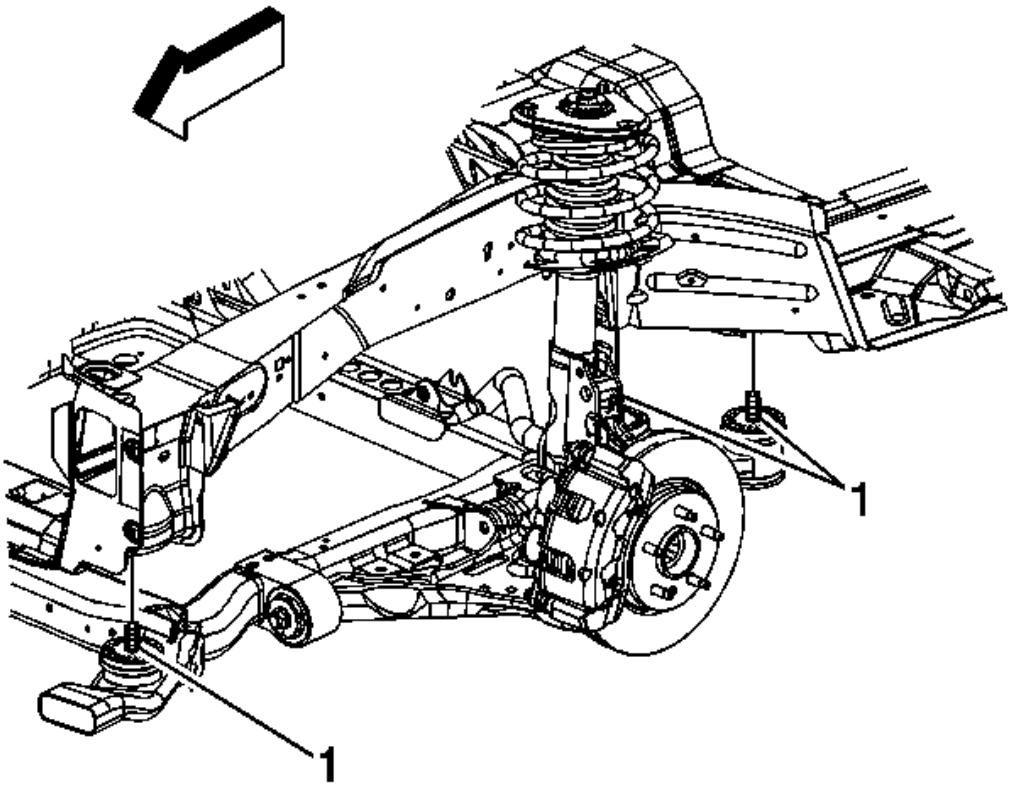


Fig. 443: Identifying Rearward Engine Frame-To-Body Bolts
Courtesy of GENERAL MOTORS COMPANY

81. Remove the 6 bolts (1) attaching the frame to the body. (Left side shown, right side similar).

NOTE: Ensure clearance is maintained between the engine/transaxle assembly and the following:

- **The A/C compressor components**
- **The brake pipes**
- **The heater hoses**
- **The radiator hoses**
- **The wheel speed sensor leads**
- **The wiring harnesses**

82. Carefully raise the vehicle in order to clear the supported engine/transaxle assembly.
83. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

 © 2011 Mitchell Repair Information Company, LLC.

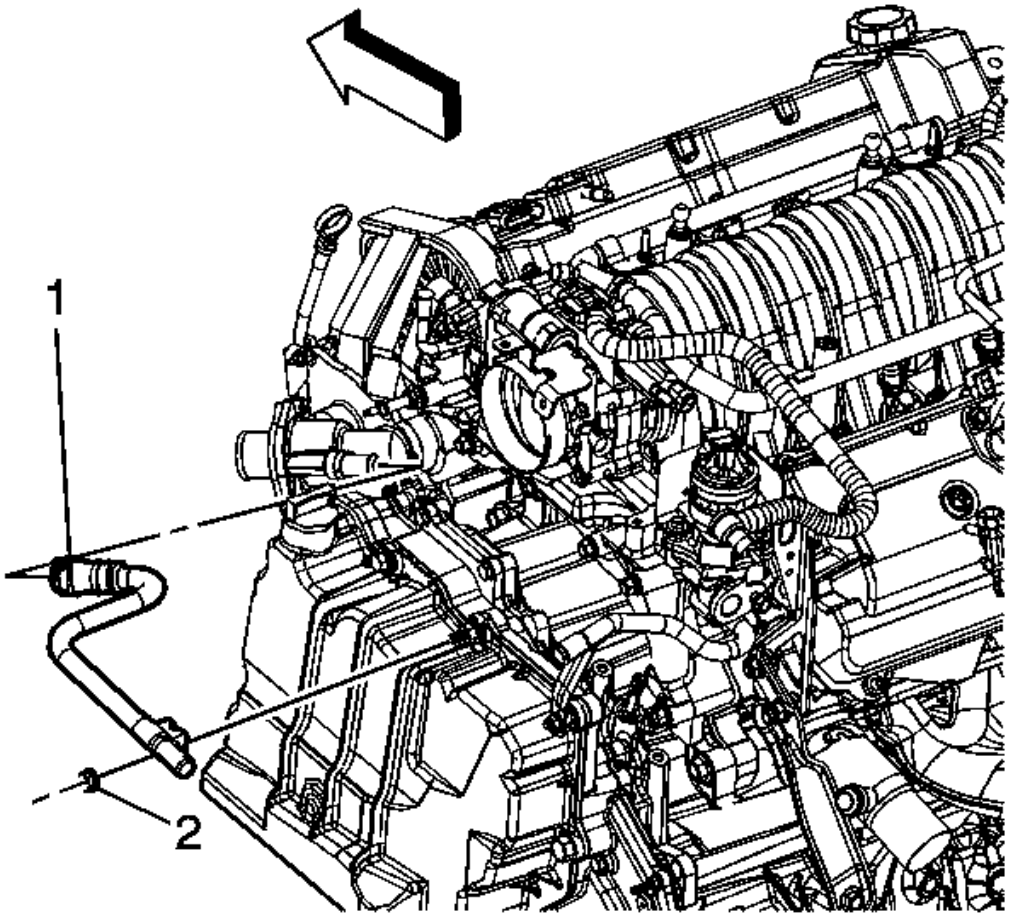


Fig. 444: Identifying Heater Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

84. Remove the heater outlet pipe nut (2) from the transaxle stud.
85. Reposition the heater outlet pipe clamp (1) at the water pump housing.
86. Remove the heater outlet pipe.

 © 2011 Mitchell Repair Information Company, LLC.

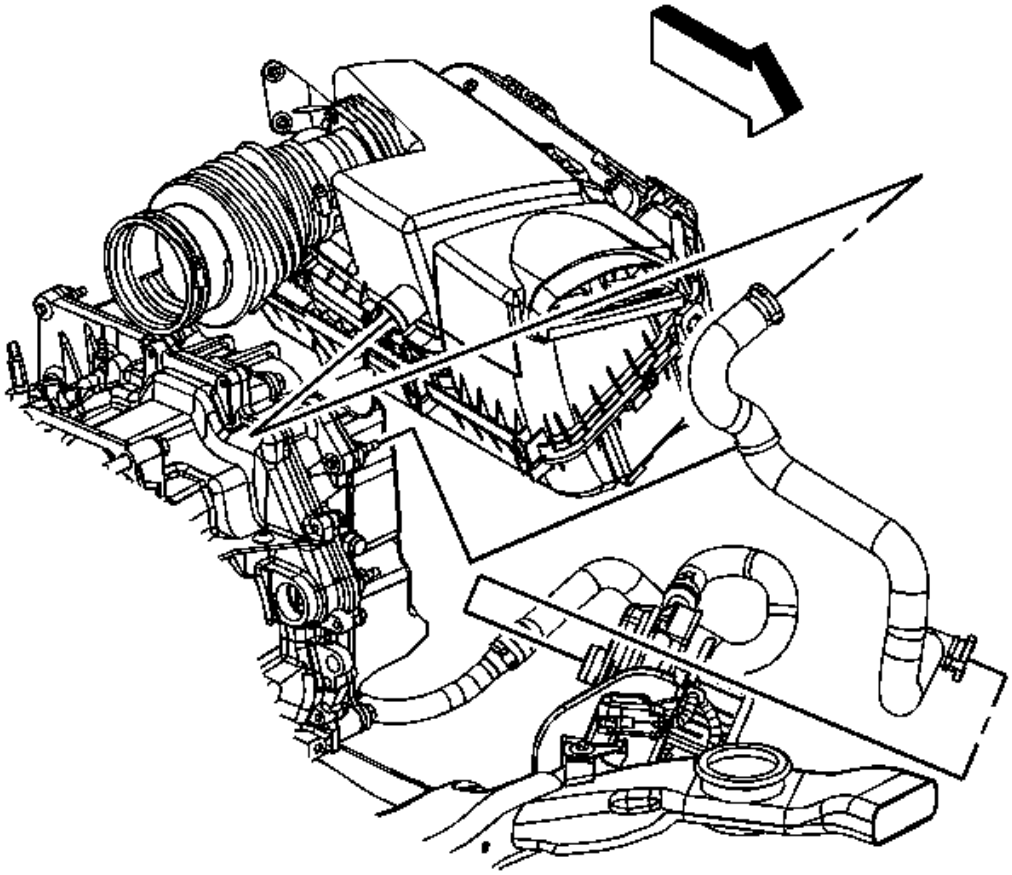


Fig. 445: Identifying Secondary AIR Pump Inlet Tube/Hose
Courtesy of GENERAL MOTORS COMPANY

87. Remove the secondary air injection (AIR) inlet hose retainer from the transaxle stud.
88. Disconnect the AIR inlet hose quick connect fitting from the AIR pump. Refer to **Plastic Collar Quick Connect Fitting Service** .
89. Remove the AIR inlet hose.

 © 2011 Mitchell Repair Information Company, LLC.

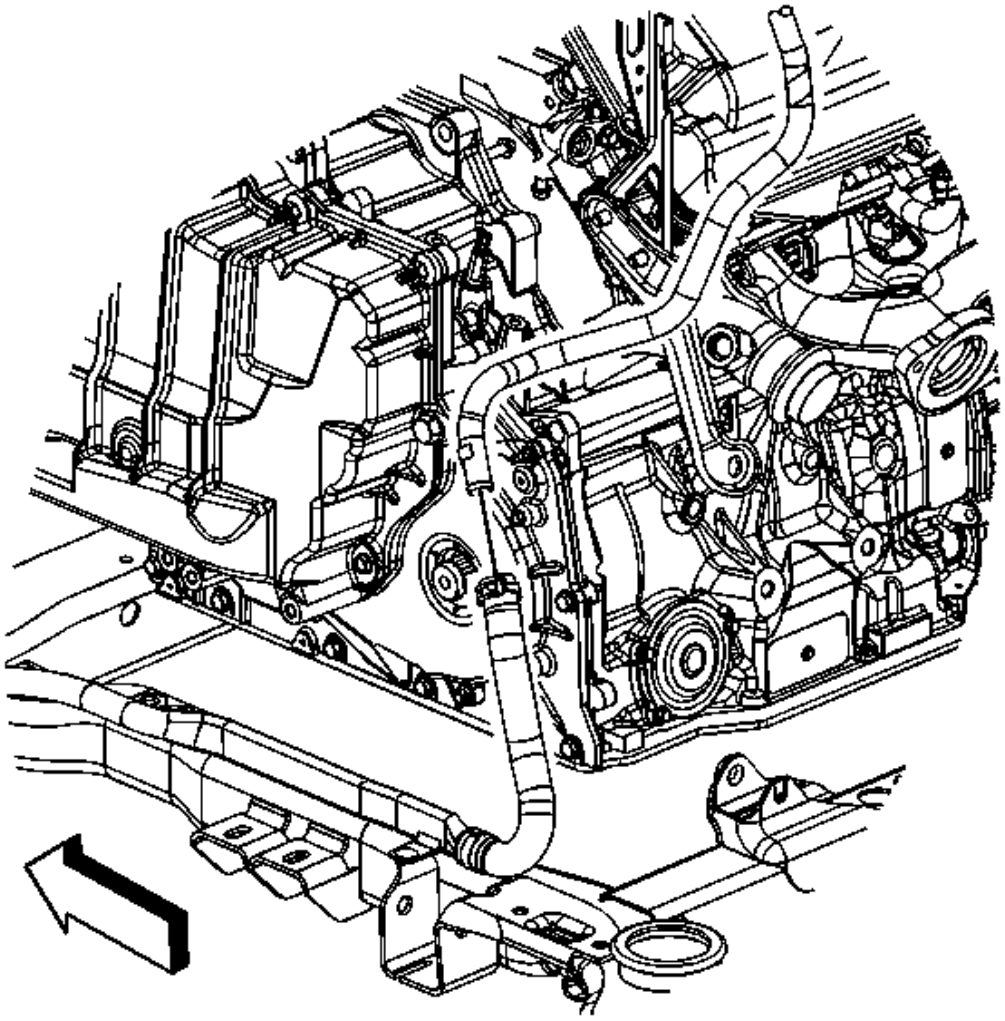


Fig. 446: View Of AIR Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

90. Reposition the AIR outlet hose clamp at the AIR outlet pipe.
91. Separate the AIR outlet hose from the outlet pipe.

 © 2011 Mitchell Repair Information Company, LLC.

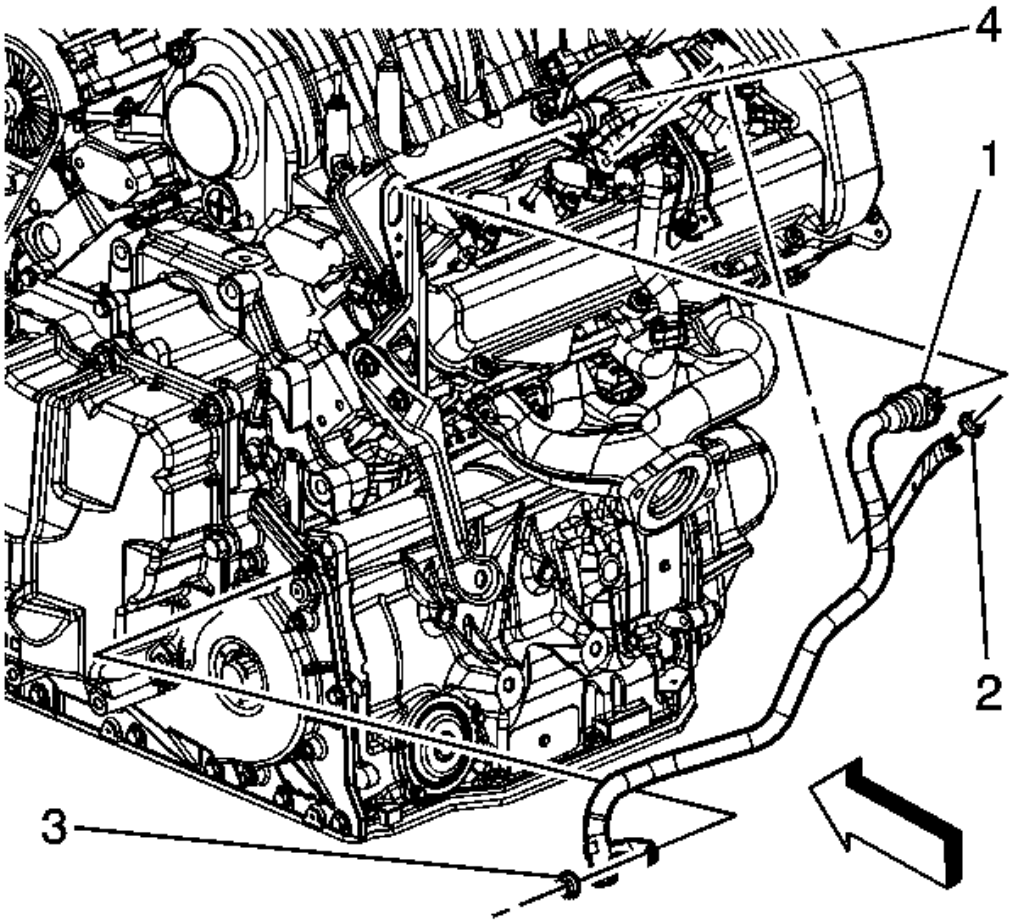


Fig. 447: View Of AIR Pipe Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

92. Remove the AIR pipe outlet pipe nut (3) from the transaxle stud.
93. Remove the AIR pipe outlet pipe nut (2) from the check valve bracket stud.
94. Disconnect the AIR outlet pipe quick connect fitting from the check valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
95. Remove the AIR outlet pipe from the studs.

 © 2011 Mitchell Repair Information Company, LLC.

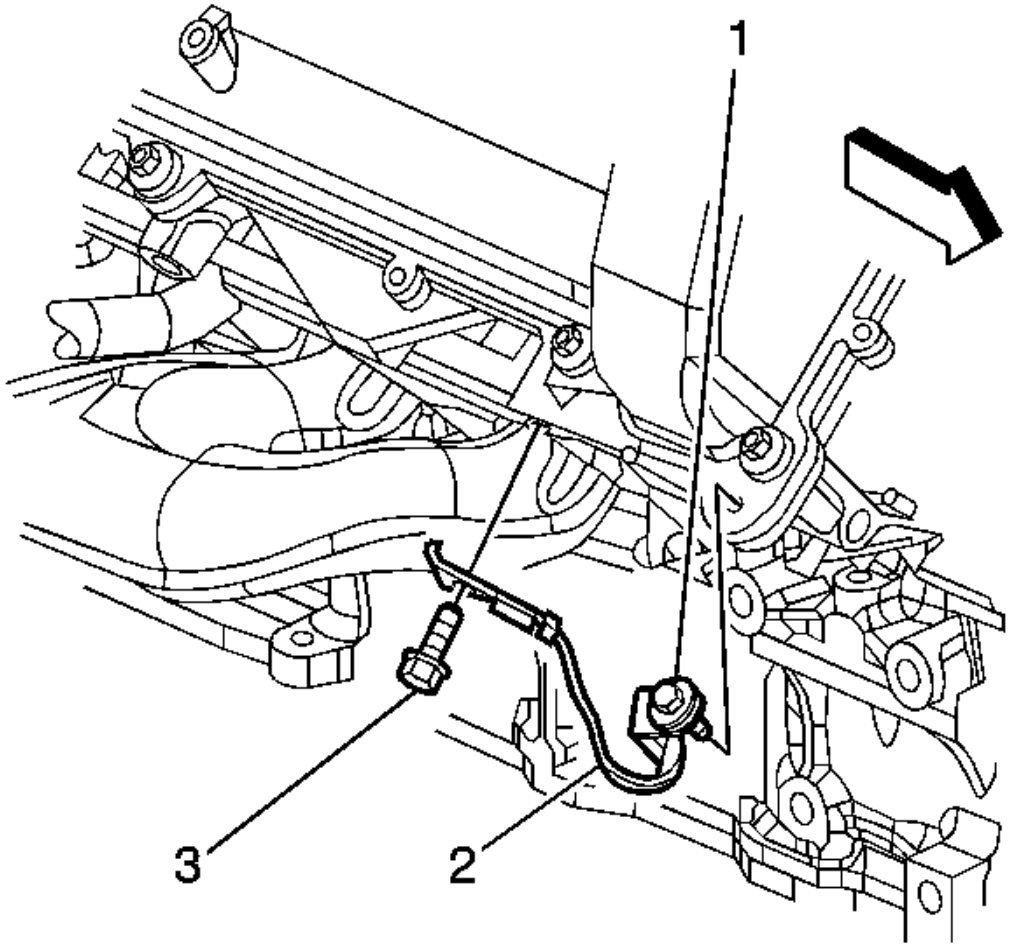


Fig. 448: Locating ICM Ground Strap & Bolt
Courtesy of GENERAL MOTORS COMPANY

96. Remove the ignition control module (ICM) ground strap bolt (3) from the right cylinder head.
97. Remove the ICM ground strap (2) from the cylinder head.

 © 2011 Mitchell Repair Information Company, LLC.

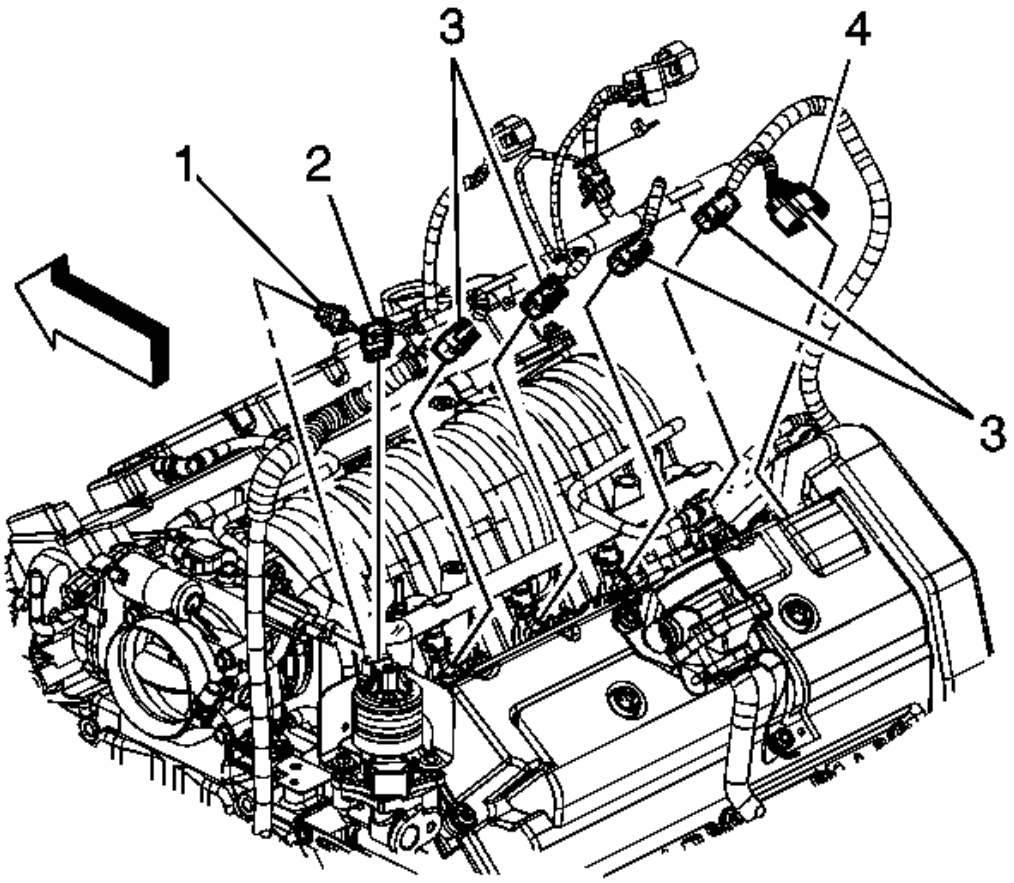


Fig. 449: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

98. Disconnect the following engine harness electrical connectors from the rear of the engine:
    - The EVAP solenoid (1)
    - The exhaust gas recirculation (EGR) valve (2)
    - The fuel injectors (3)
    - The ICM (4)

 © 2011 Mitchell Repair Information Company, LLC.

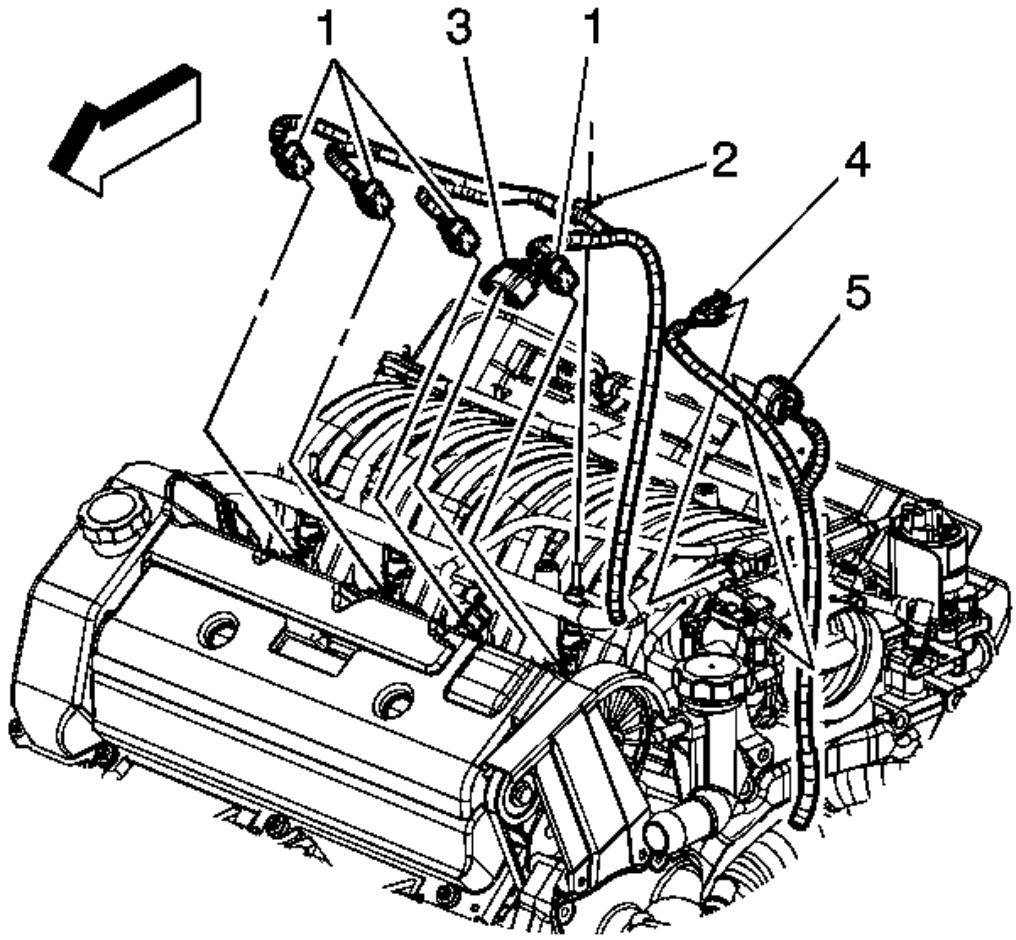


Fig. 450: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

99. Disconnect the following engine harness electrical connectors from the front of the engine:
    - The fuel injectors (1)
    - The ICM (3)
    - The manifold absolute pressure (MAP) sensor (4)
    - the throttle actuator (5)
100. Remove the engine harness clip (2) from the fuel rail stud.

 © 2011 Mitchell Repair Information Company, LLC.

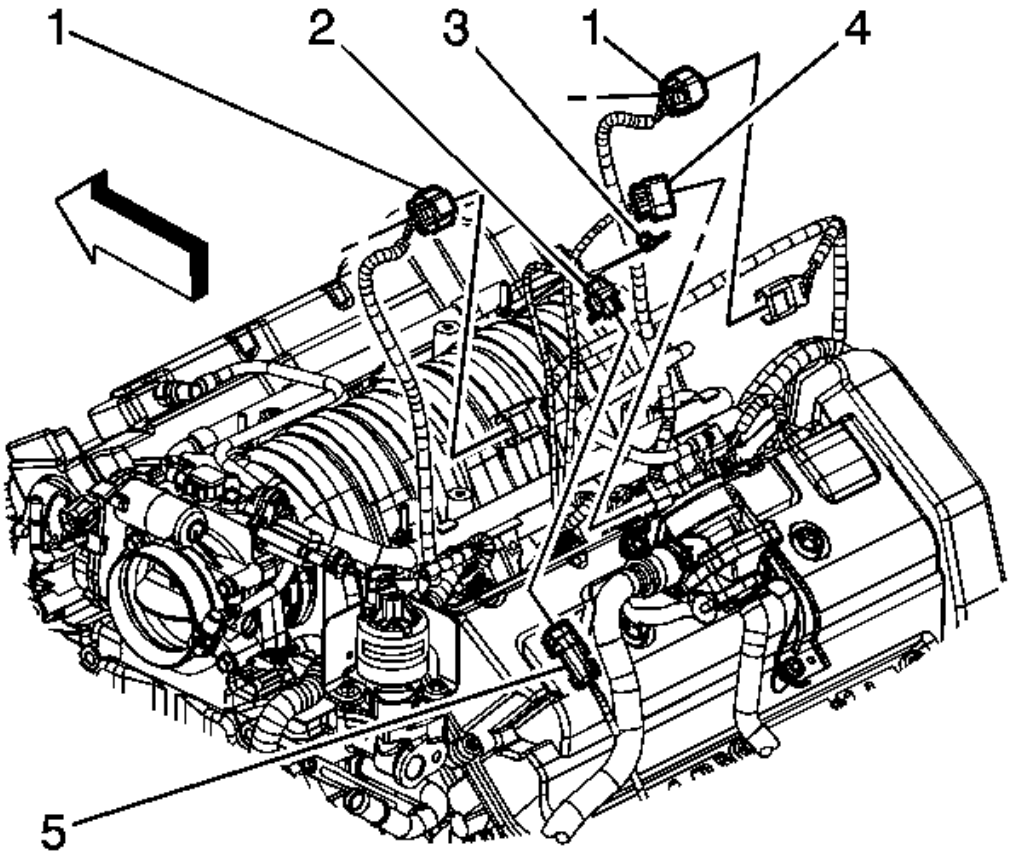


Fig. 451: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

101. Disconnect the following engine harness electrical connectors from the top of the engine:
    - The starter inline (1)
    - The AIR check valve (4)

 © 2011 Mitchell Repair Information Company, LLC.

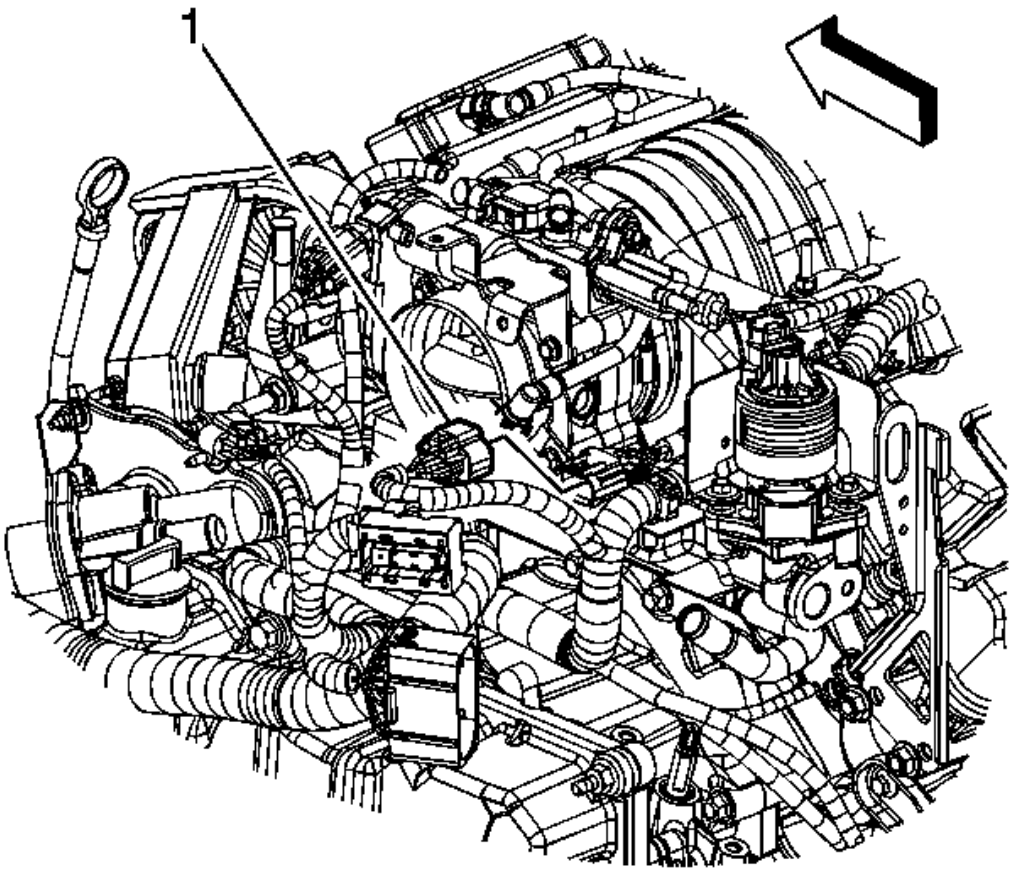


Fig. 452: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

102. Disconnect the engine harness electrical connector (1) from the engine valley jumper harness electrical connector.

 © 2011 Mitchell Repair Information Company, LLC.

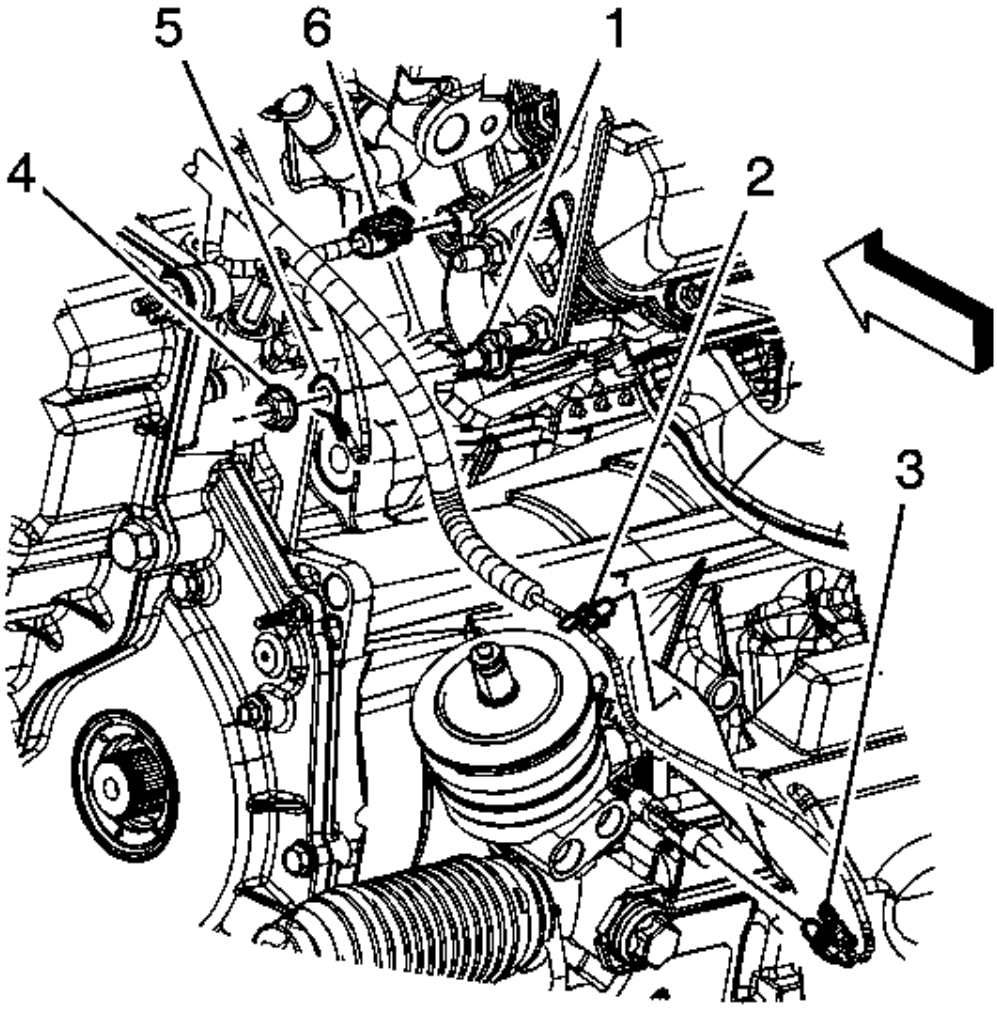


Fig. 453: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

103. Disconnect the engine harness electrical connector (3) from the power steering sensor.
104. Remove the engine harness clip (2) from the steering gear shield.
105. Remove the engine harness ground nut (4).
106. Remove the engine harness ground (5).
107. Disconnect the engine harness electrical connector (6) from the engine coolant temperature (ECT) sensor.

 © 2011 Mitchell Repair Information Company, LLC.

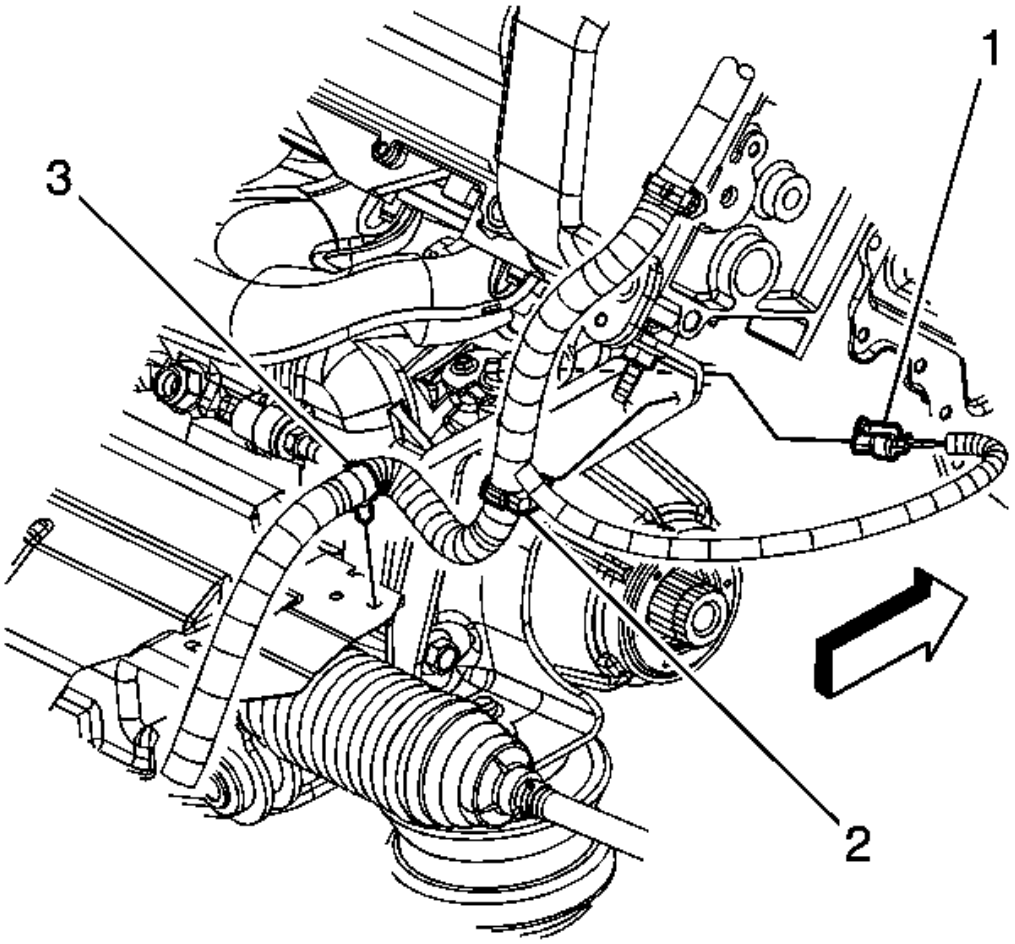


Fig. 454: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

108. Disconnect the engine harness electrical connector (1) from the vehicle speed sensor (VSS).
109. Remove the engine harness clips (2, 3) from the rear engine mount bracket and steering gear shield.

 © 2011 Mitchell Repair Information Company, LLC.

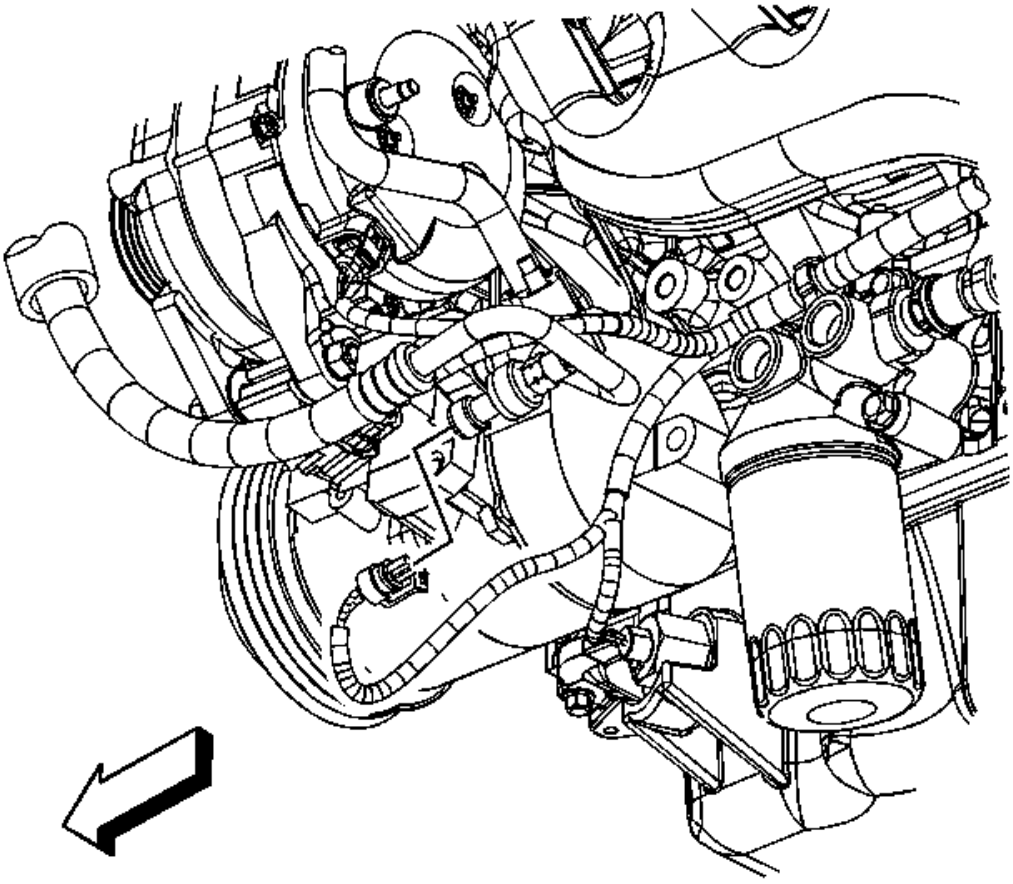


Fig. 455: View OF Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

110. Disconnect the engine harness electrical connector from the A/C pressure sensor.

 © 2011 Mitchell Repair Information Company, LLC.

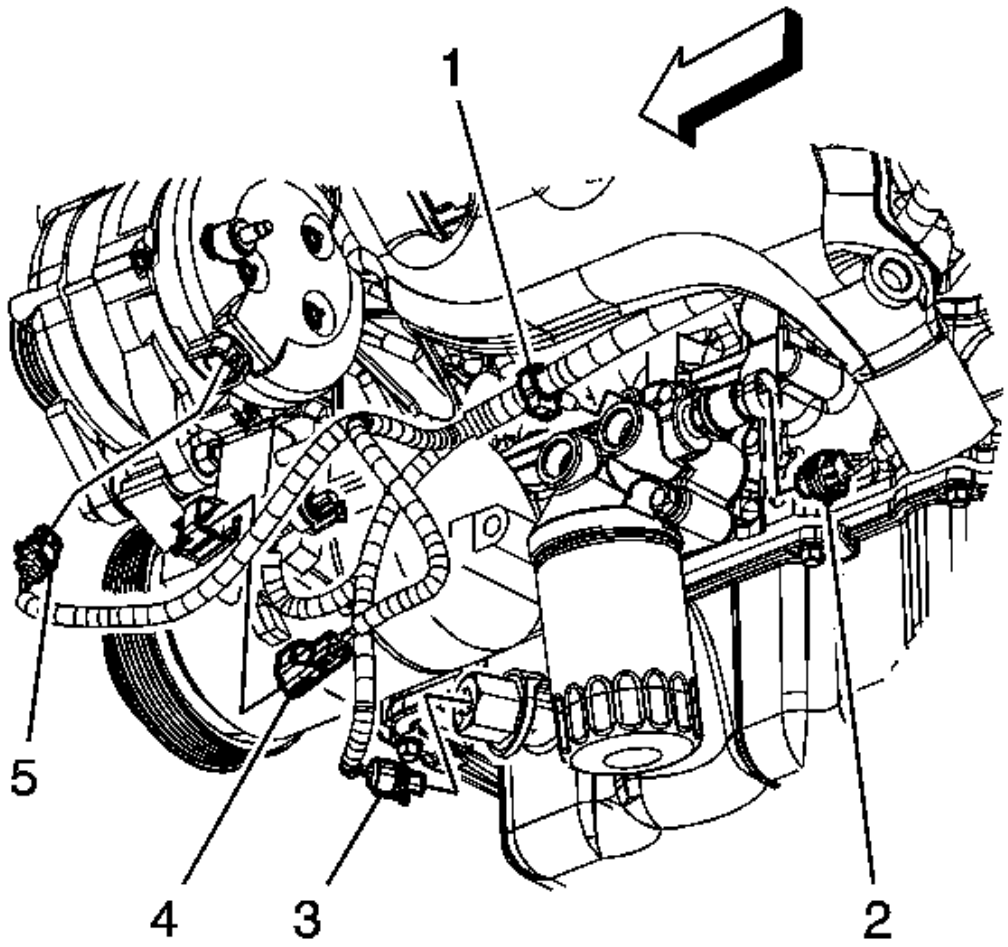


Fig. 456: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

111. Remove the engine harness clip (1) from the boss on the engine block.
112. Disconnect the following engine harness electrical connectors:
    - The oil pressure sensor (2)
    - The oil level sensor (3)
    - The A/C compressor (4)
    - The generator (5)

 © 2011 Mitchell Repair Information Company, LLC.

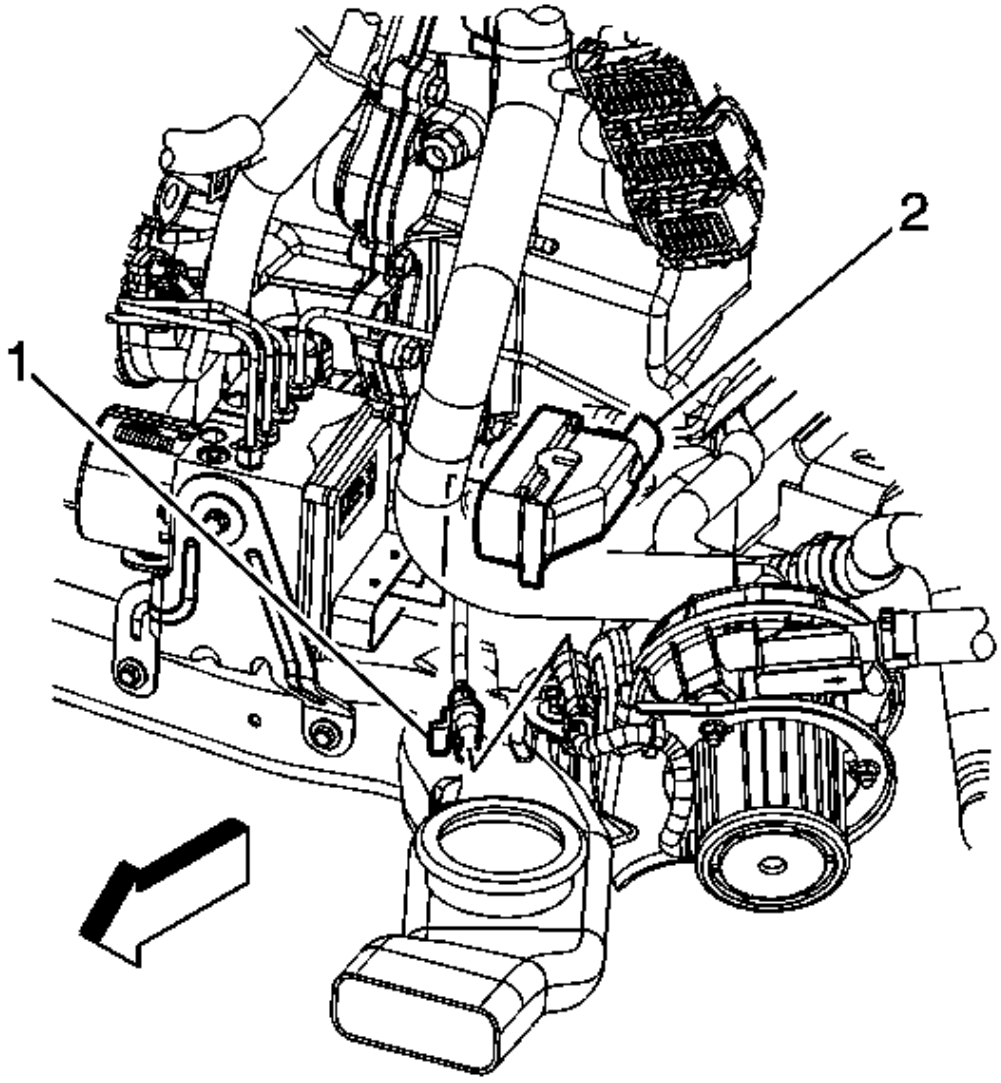


Fig. 457: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

113. Disconnect the engine harness electrical connectors from the following:
    - The AIR pump (1)
    - The brake modulator (2)

 © 2011 Mitchell Repair Information Company, LLC.

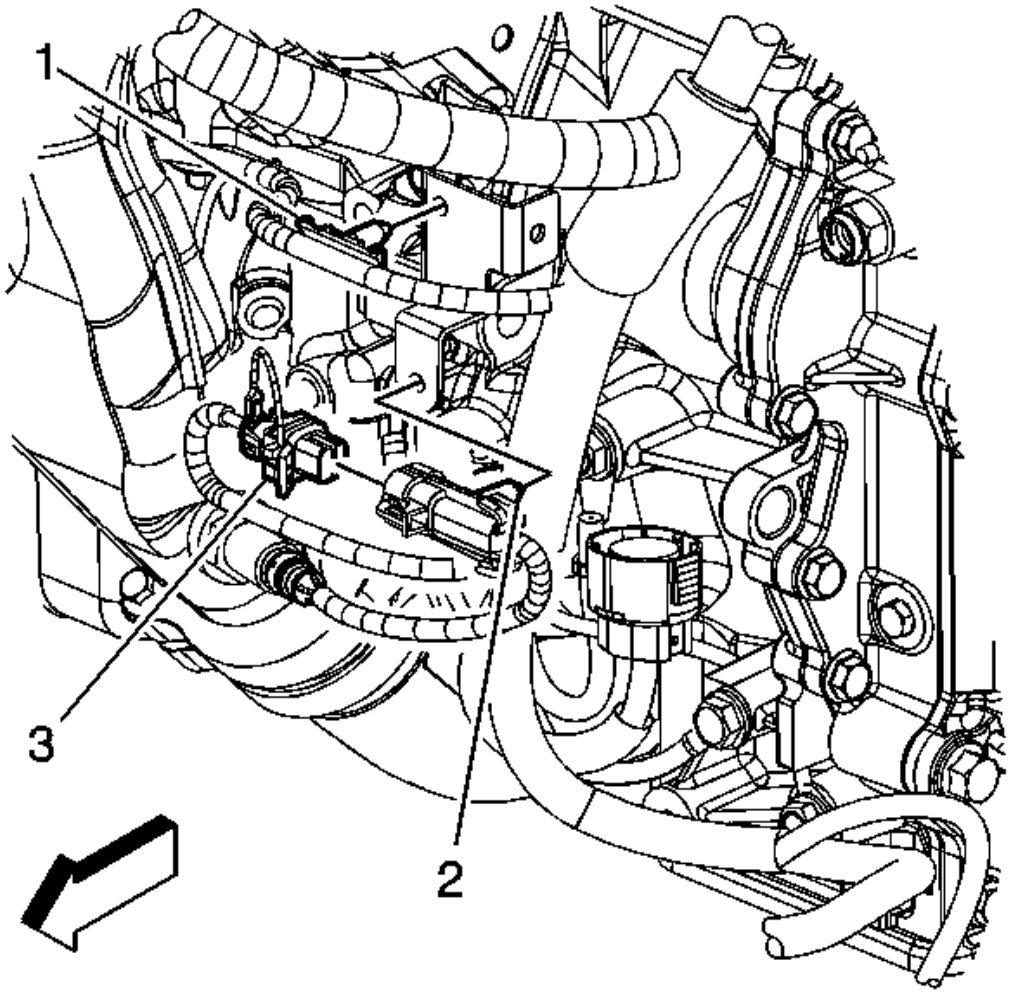


Fig. 458: View Of Engine Harness Electrical Connector & Clips
Courtesy of GENERAL MOTORS COMPANY

114. Remove the engine harness clip (1) from the engine bracket.
115. Remove the connector position assurance (CPA) retainer.
116. Disconnect the engine harness electrical connector (3) from the HO2S.

 © 2011 Mitchell Repair Information Company, LLC.

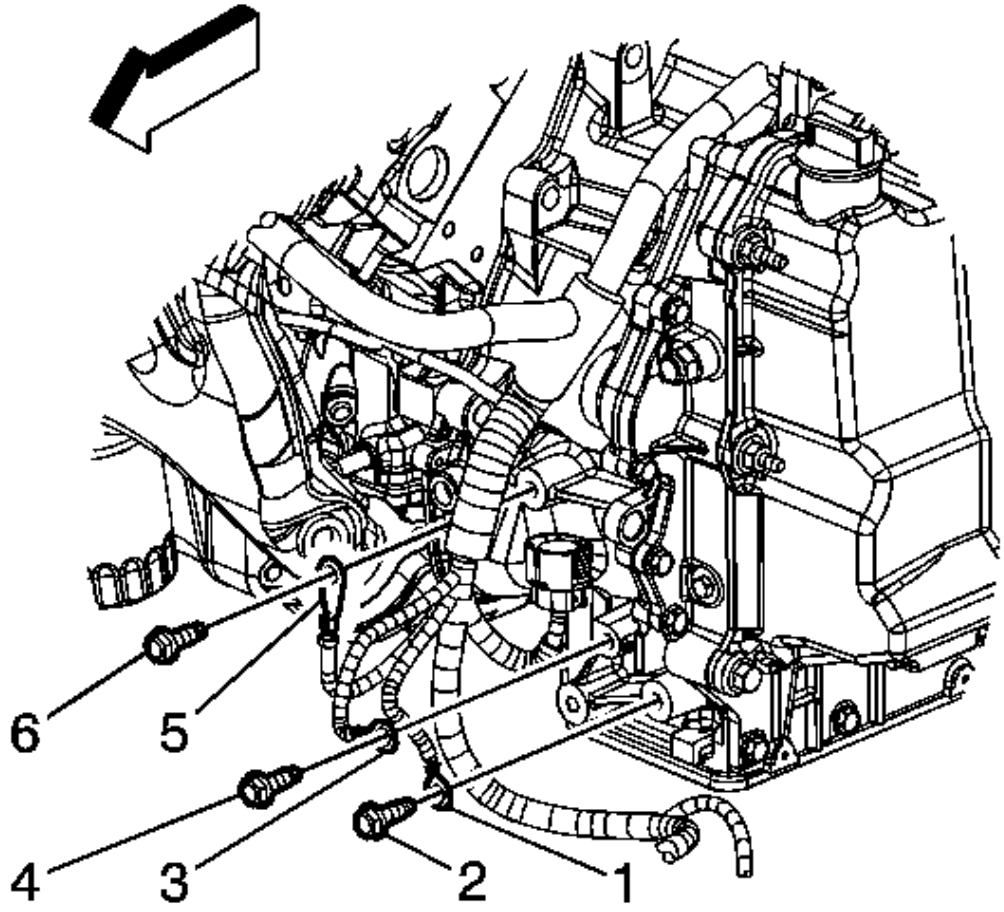


Fig. 459: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

117. Disconnect the engine harness electrical connector from the transaxle.
118. Remove the engine harness ground bolts (2, 4, and 6).
119. Gather all the branches of the engine harness and remove the engine harness from the engine.

 © 2011 Mitchell Repair Information Company, LLC.

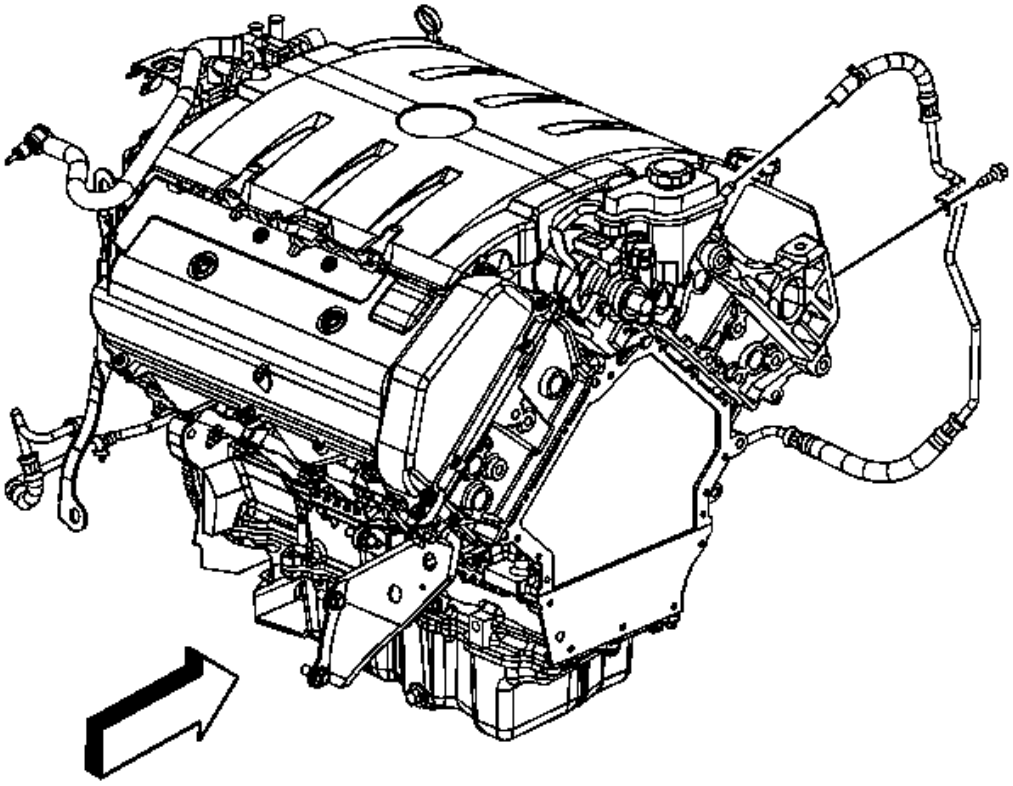


Fig. 460: Identifying Power Steering Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

120. Reposition the power steering outlet hose clamp at the pump reservoir.
121. Remove the power steering outlet hose from the reservoir.
122. Remove the power steering outlet pipe bolt from the engine mount strut bracket.

 © 2011 Mitchell Repair Information Company, LLC.

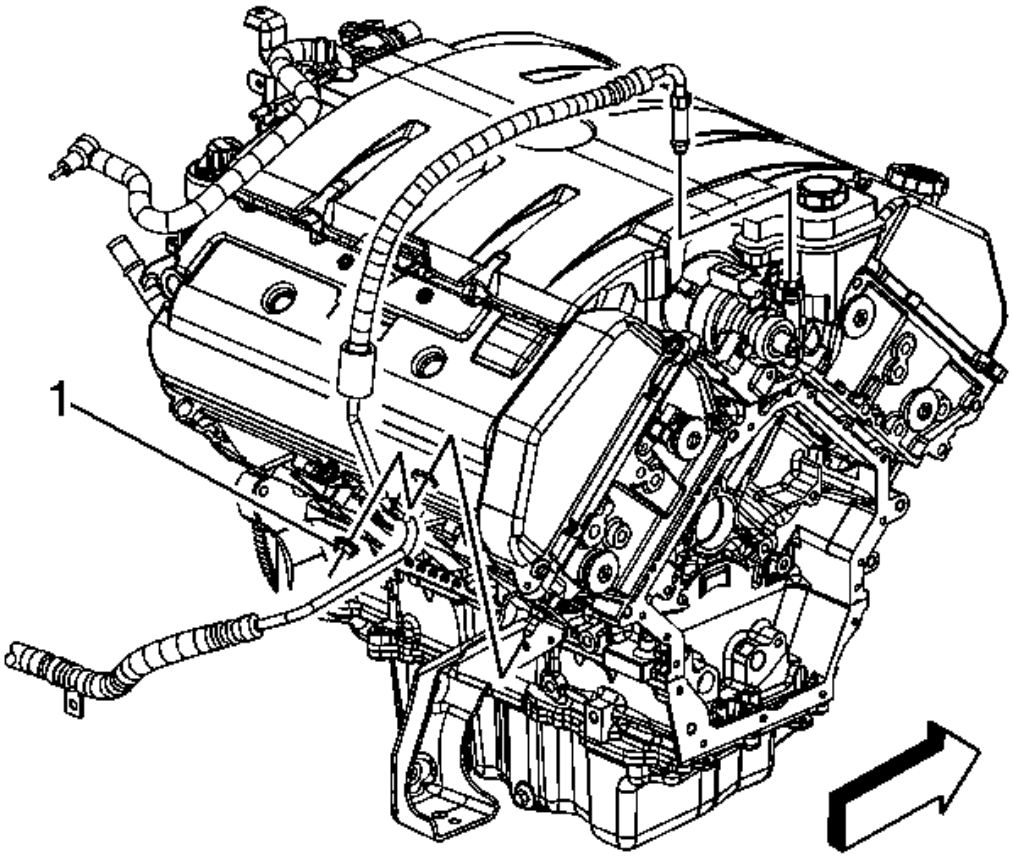


Fig. 461: Identifying Power Steering Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

123. Remove the power steering inlet pipe fitting from the power steering pump.
124. Remove the power steering inlet pipe nut (1) from the rear engine mount bracket stud.
125. Remove the power steering inlet pipe bracket from the stud.

 © 2011 Mitchell Repair Information Company, LLC.

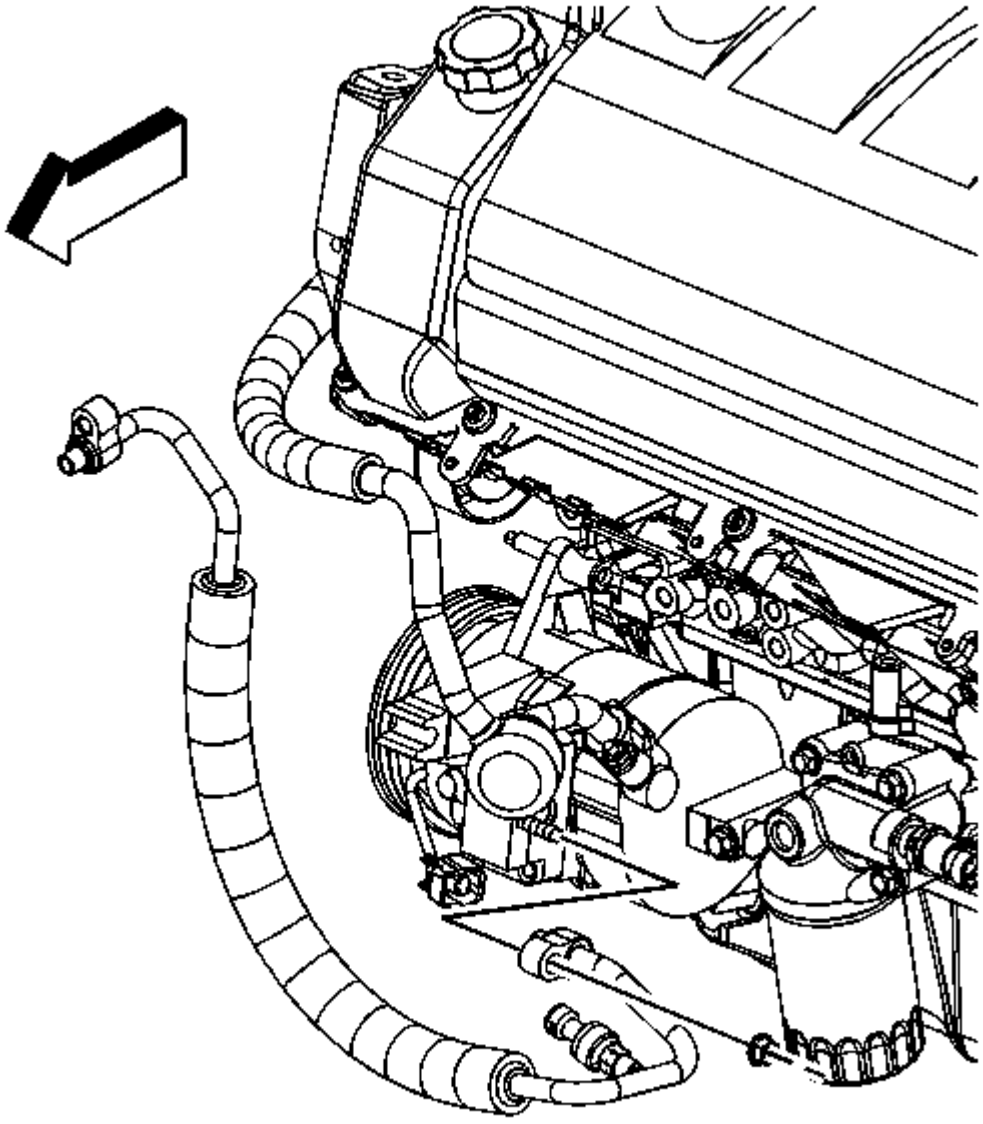


Fig. 462: View Of A/C Compressor Discharge Hose
Courtesy of GENERAL MOTORS COMPANY

126. Remove the A/C compressor discharge hose nut at the compressor.
127. Unsecure the hose from the engine and remove the A/C compressor discharge hose.
128. Plug the A/C compressor discharge port.

 © 2011 Mitchell Repair Information Company, LLC.

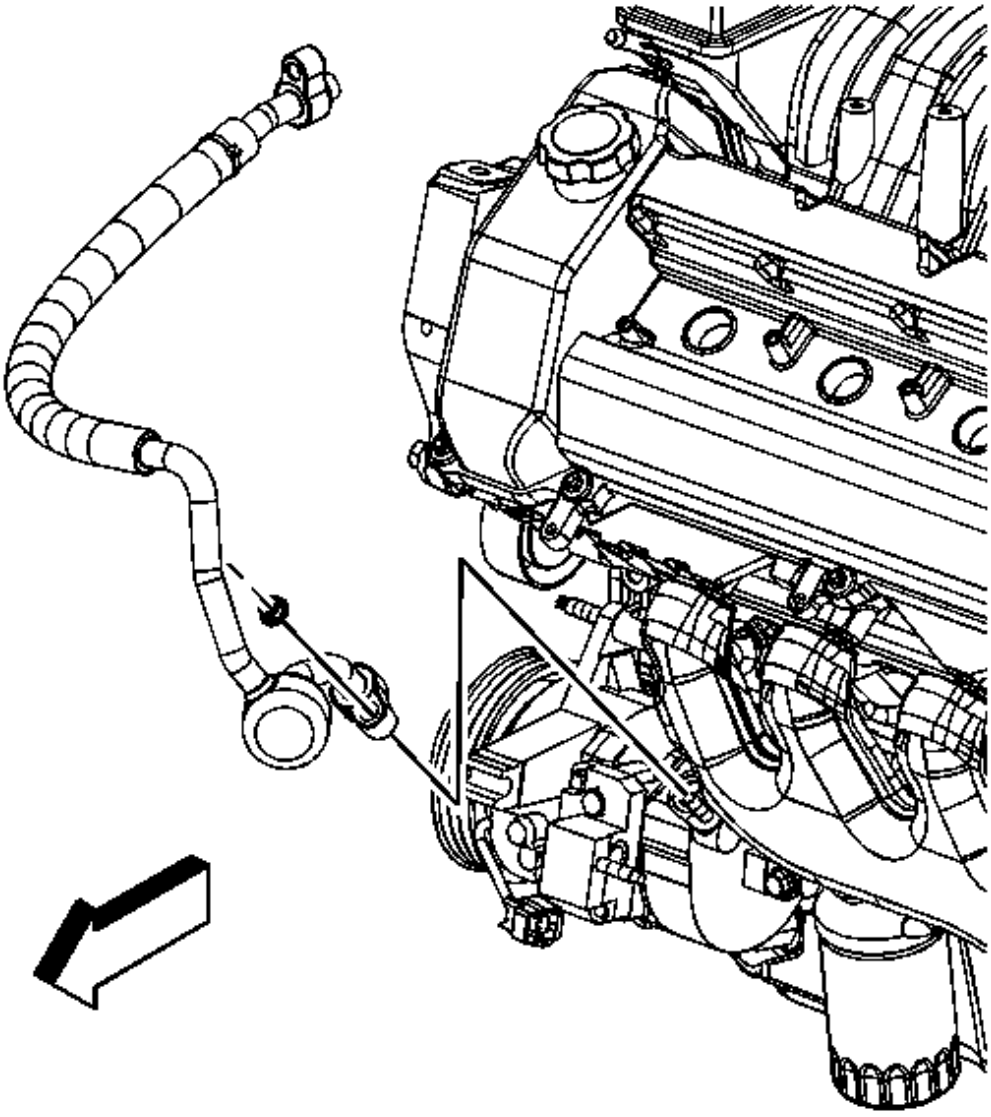


Fig. 463: View Of A/C Compressor Suction Hose
Courtesy of GENERAL MOTORS COMPANY

129. Remove the A/C compressor suction hose nut at the compressor.
130. Unsecure the hose from the engine and remove the A/C compressor suction hose.
131. Plug the A/C compressor suction port.

 © 2011 Mitchell Repair Information Company, LLC.

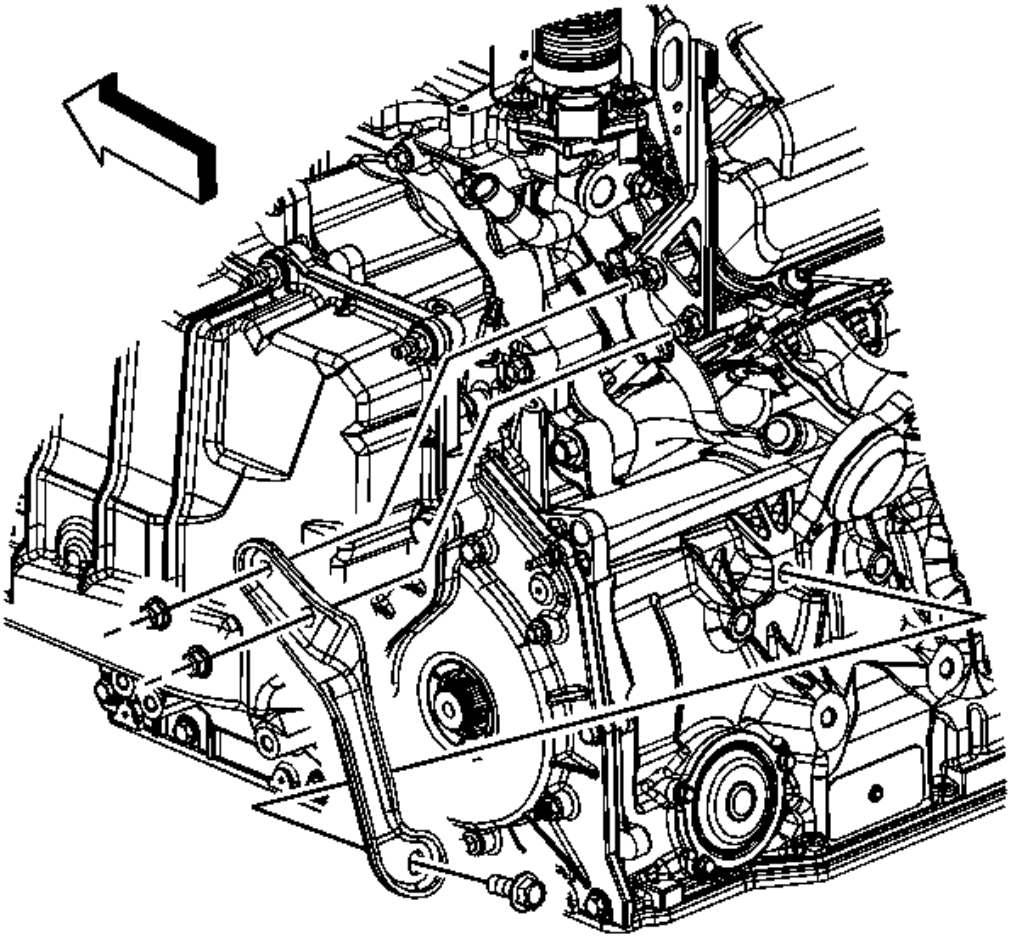


Fig. 464: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

132. Remove the transaxle brace bolt.
133. Remove the transaxle brace nuts.
134. Remove the transaxle brace.

 © 2011 Mitchell Repair Information Company, LLC.

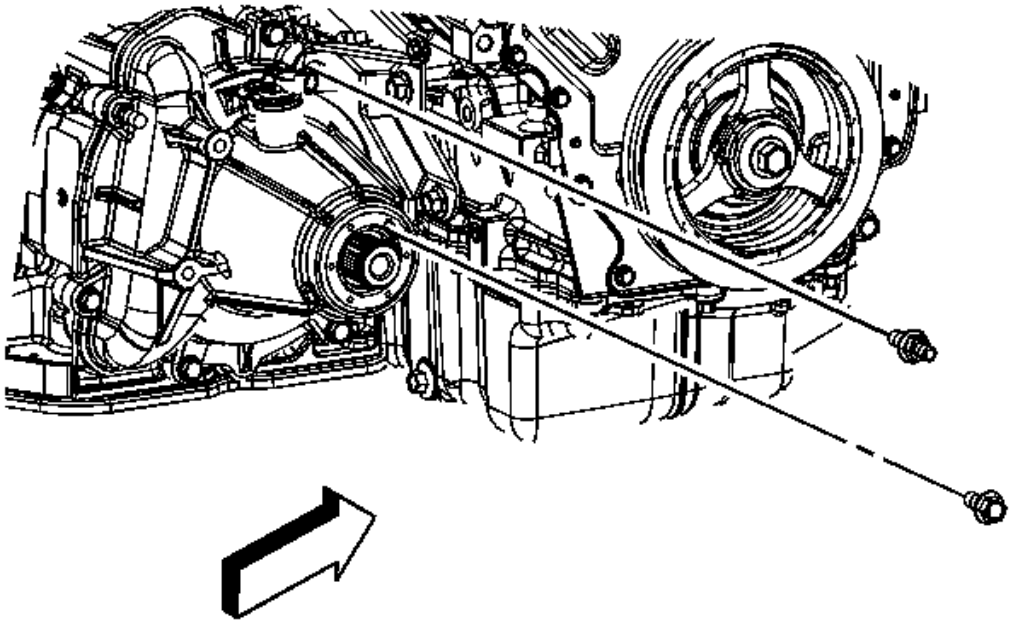


Fig. 465: Identifying Transaxle Brace Bolt/Stud
Courtesy of GENERAL MOTORS COMPANY

135. Remove the transaxle brace bolt/stud to the transaxle.

 © 2011 Mitchell Repair Information Company, LLC.

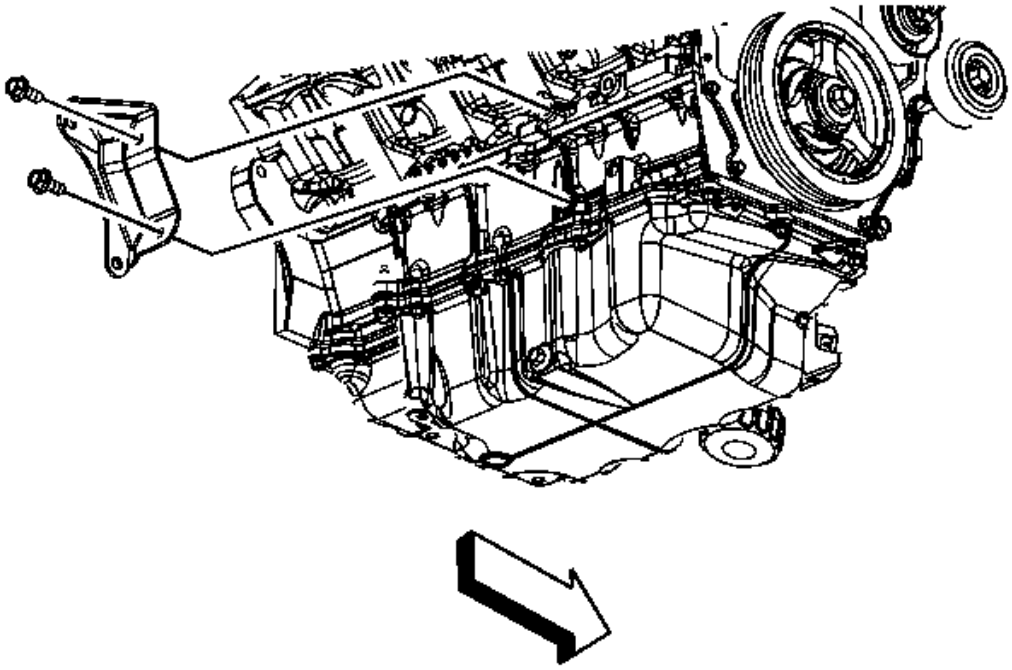


Fig. 466: Identifying Transaxle Brace Bolts & Bolts
Courtesy of GENERAL MOTORS COMPANY

136. Remove the transaxle brace bolts to the engine.
137. Remove the transaxle brace.

 © 2011 Mitchell Repair Information Company, LLC.

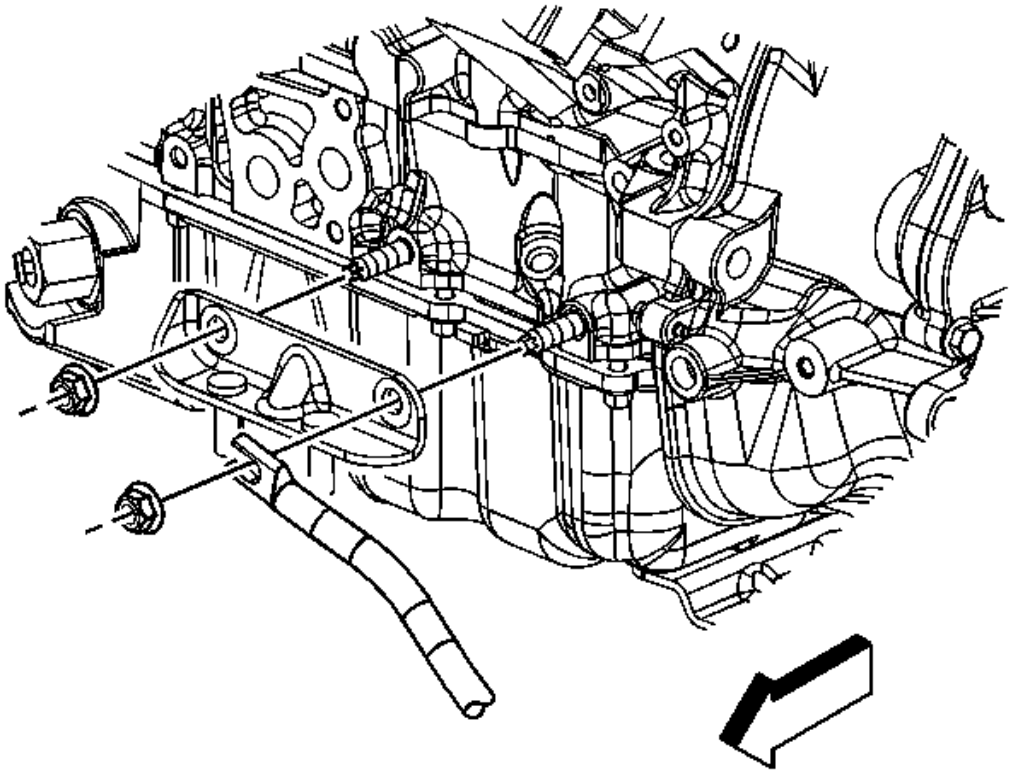


Fig. 467: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS COMPANY

138. Loosen the front engine mount bracket nut with the transaxle brace behind it.

 © 2011 Mitchell Repair Information Company, LLC.

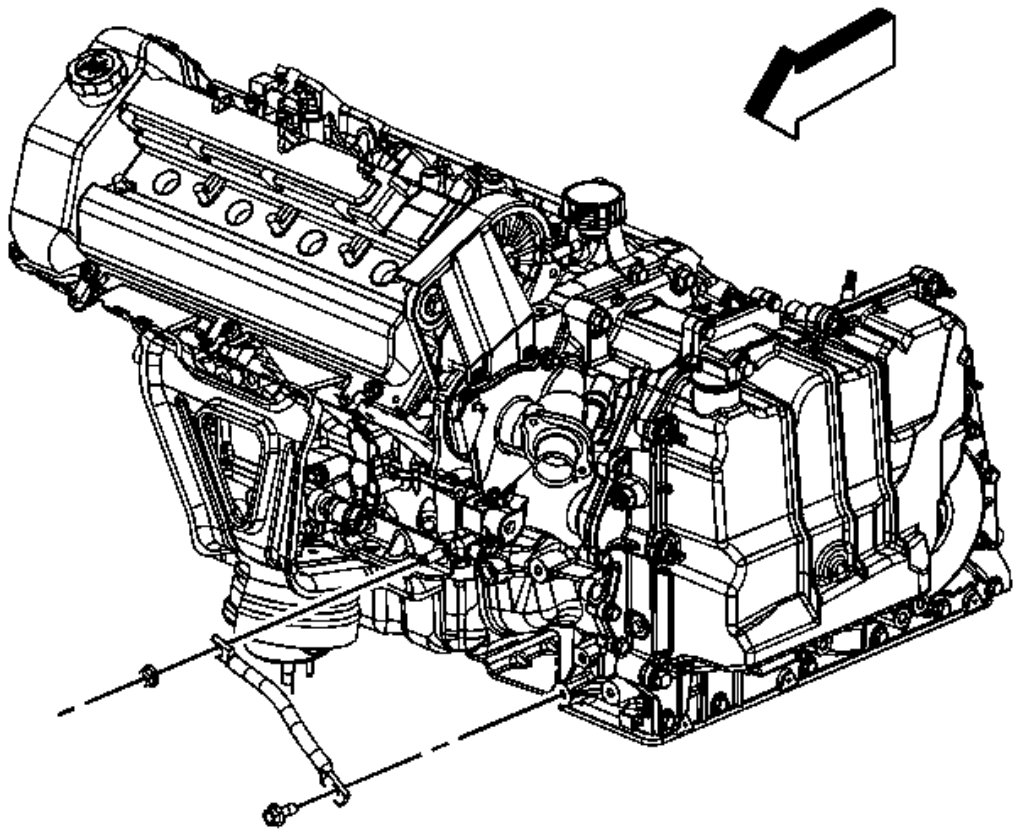


Fig. 468: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

139. Remove the transaxle brace bolt.
140. Remove the transaxle brace.

 © 2011 Mitchell Repair Information Company, LLC.

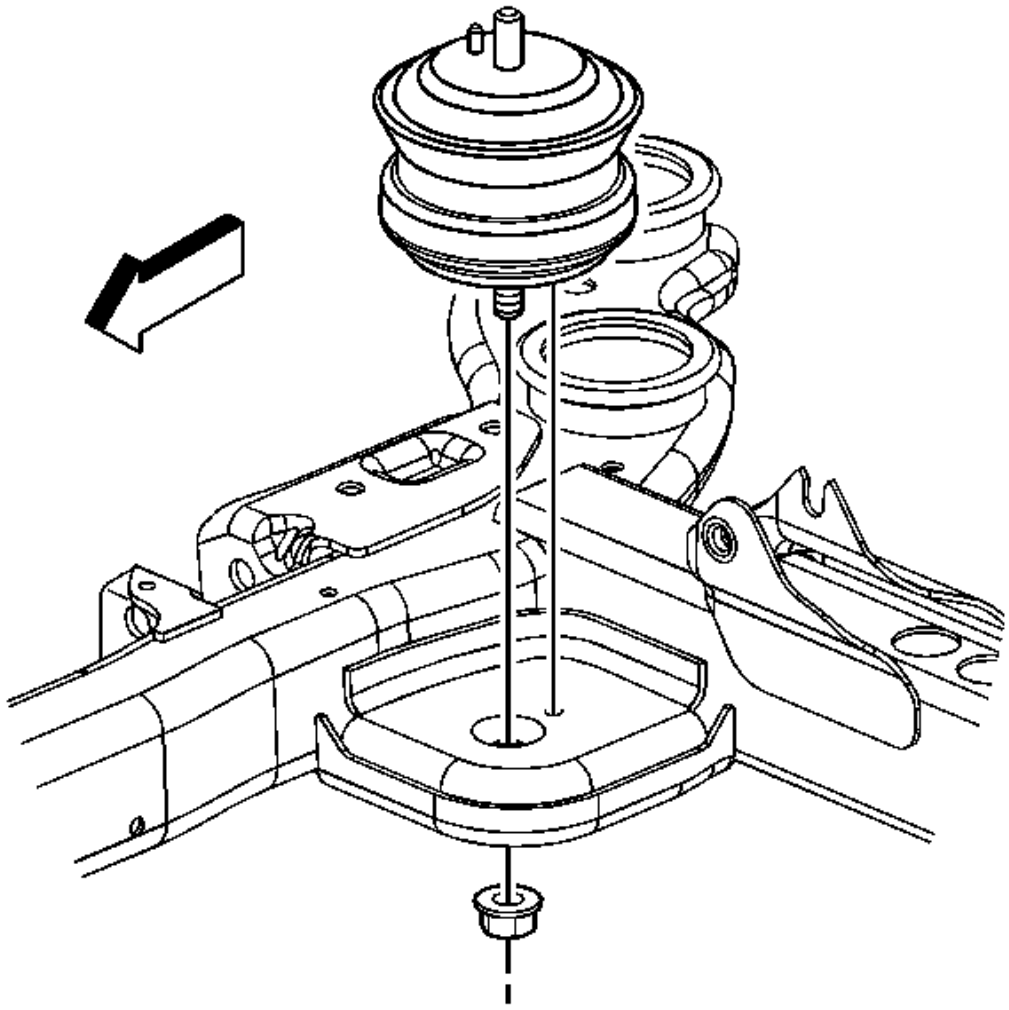


Fig. 469: View Of Right Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS COMPANY

141. Install an engine lift chain to the engine lift brackets and attach an engine lifting device.
142. Remove the rear engine mount to frame nut.

 © 2011 Mitchell Repair Information Company, LLC.

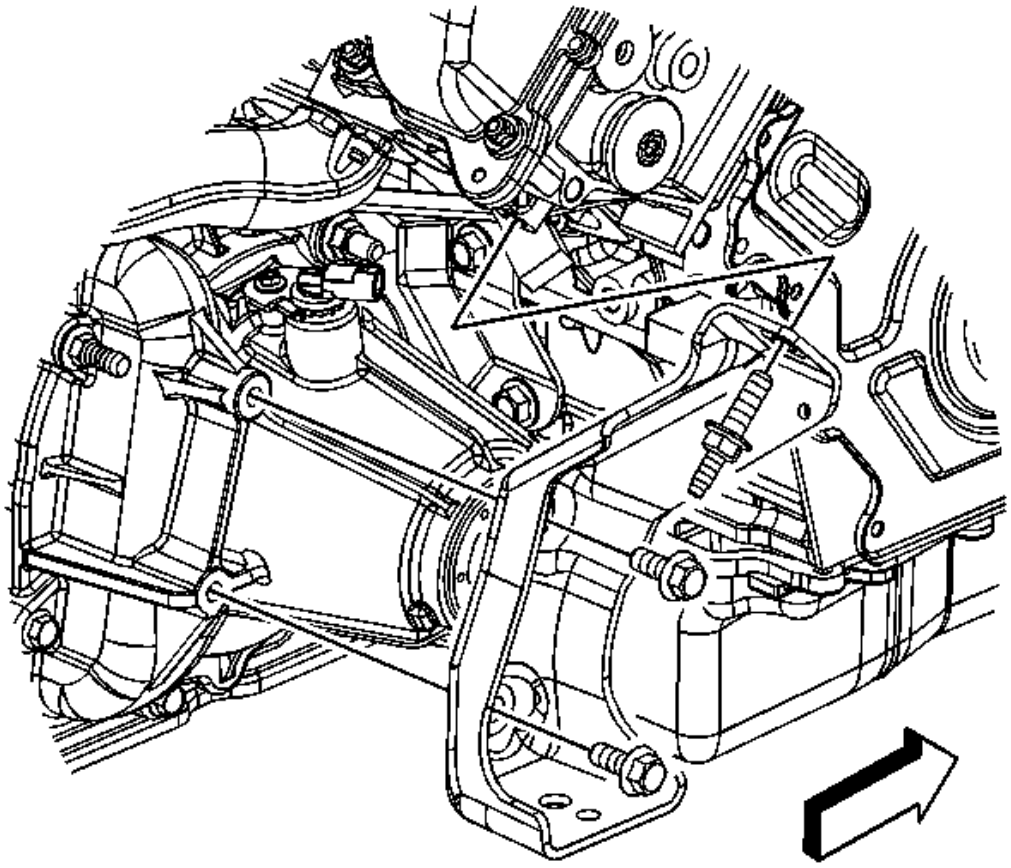


Fig. 470: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

143. Remove the rear engine mount bracket bolts and stud.
144. Remove the rear engine mount bracket.

 © 2011 Mitchell Repair Information Company, LLC.

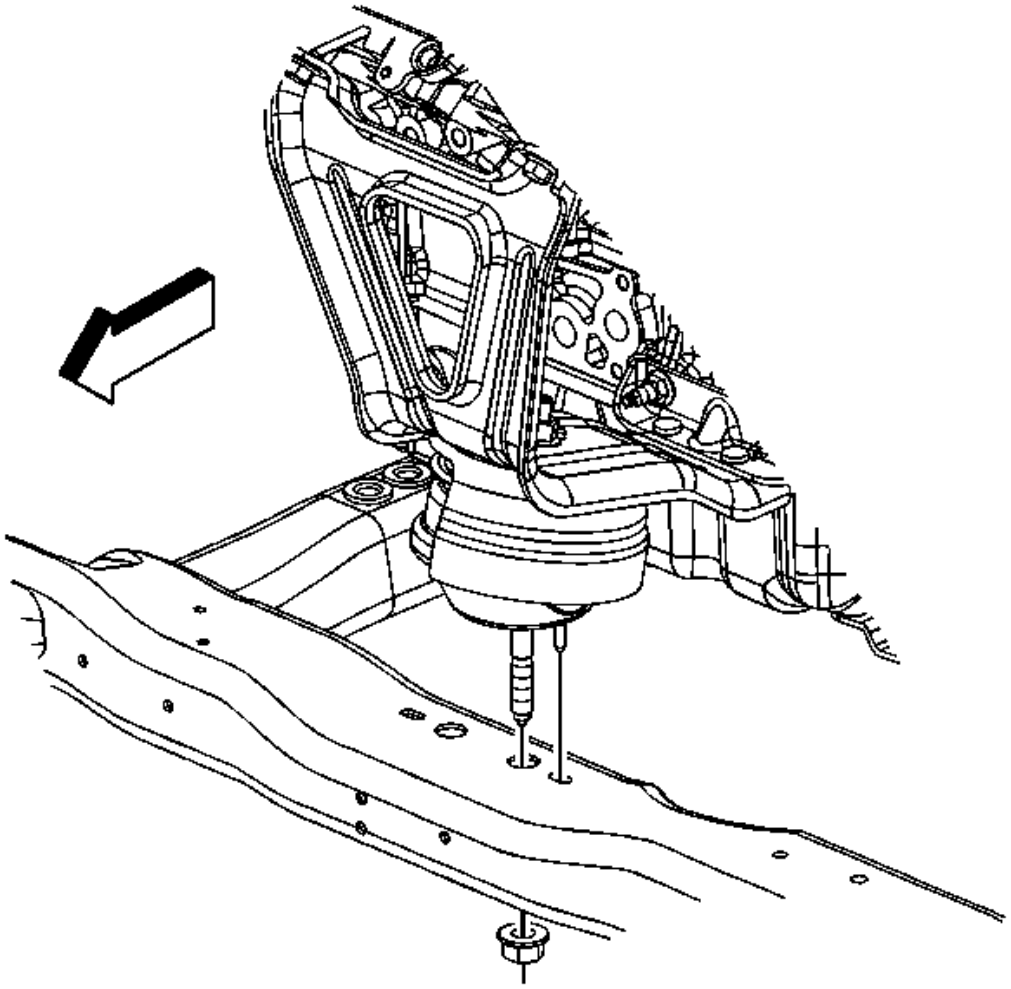


Fig. 471: Identifying Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS COMPANY

145. Remove the front engine mount to frame nut.

 © 2011 Mitchell Repair Information Company, LLC.

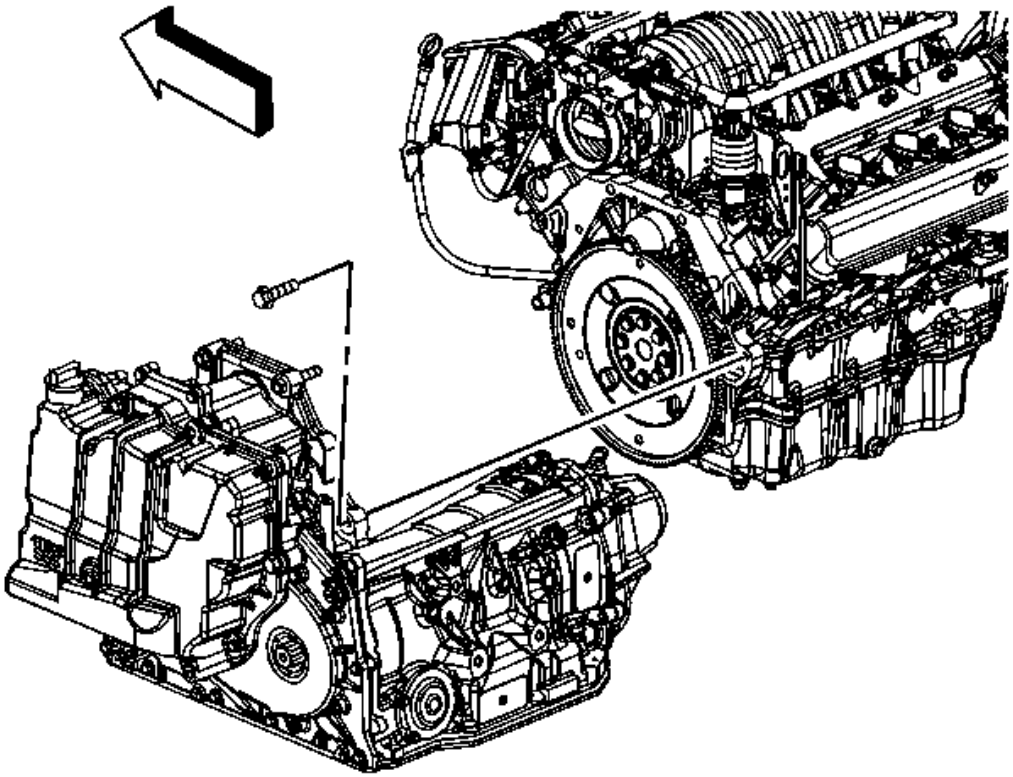


Fig. 472: Identifying Rear Transaxle Bolt
Courtesy of GENERAL MOTORS COMPANY

146. Remove the rear transaxle bolt.

 © 2011 Mitchell Repair Information Company, LLC.

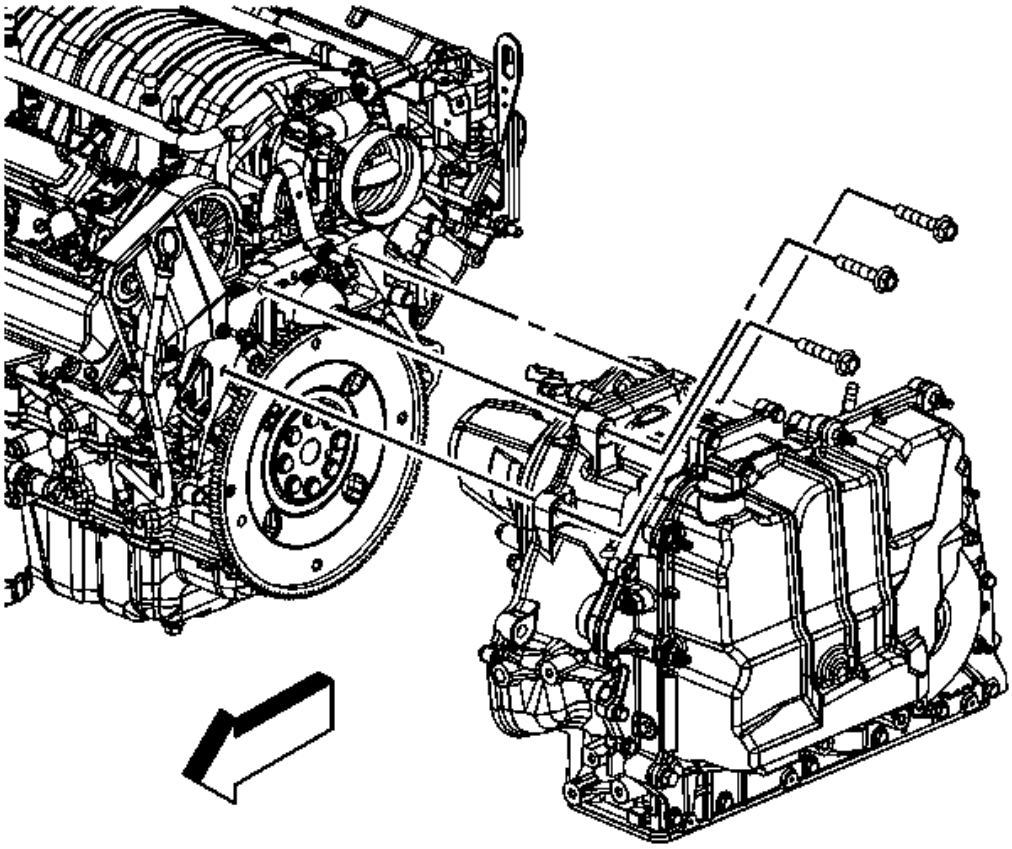


Fig. 473: Identifying Upper Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

147. Remove the upper transaxle bolts.
148. Separate the engine from the transaxle.
149. Raise the engine from the supported frame and transaxle assembly.

 © 2011 Mitchell Repair Information Company, LLC.

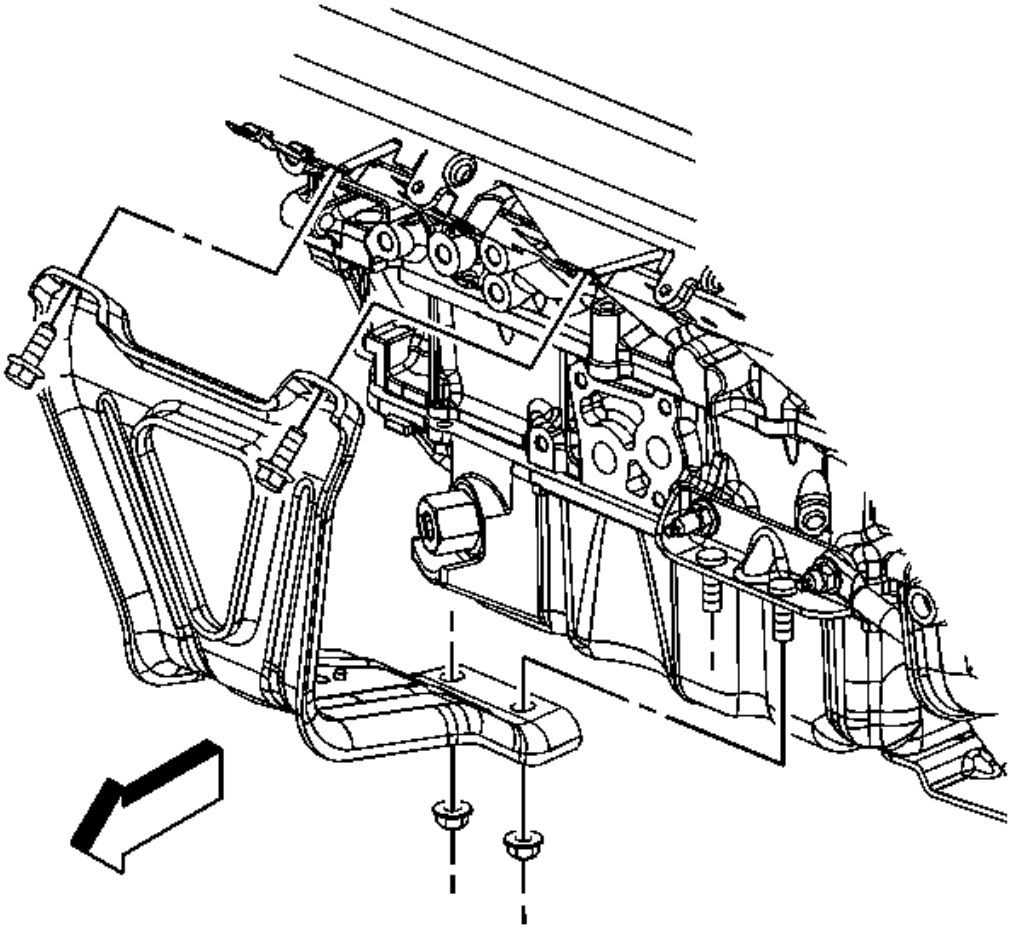


Fig. 474: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS COMPANY

150. Remove the front engine mount bracket bolts/nuts.
151. Remove the front engine mount bracket.
152. Install the engine assembly to a suitable engine stand.

Installation Procedure

 © 2011 Mitchell Repair Information Company, LLC.

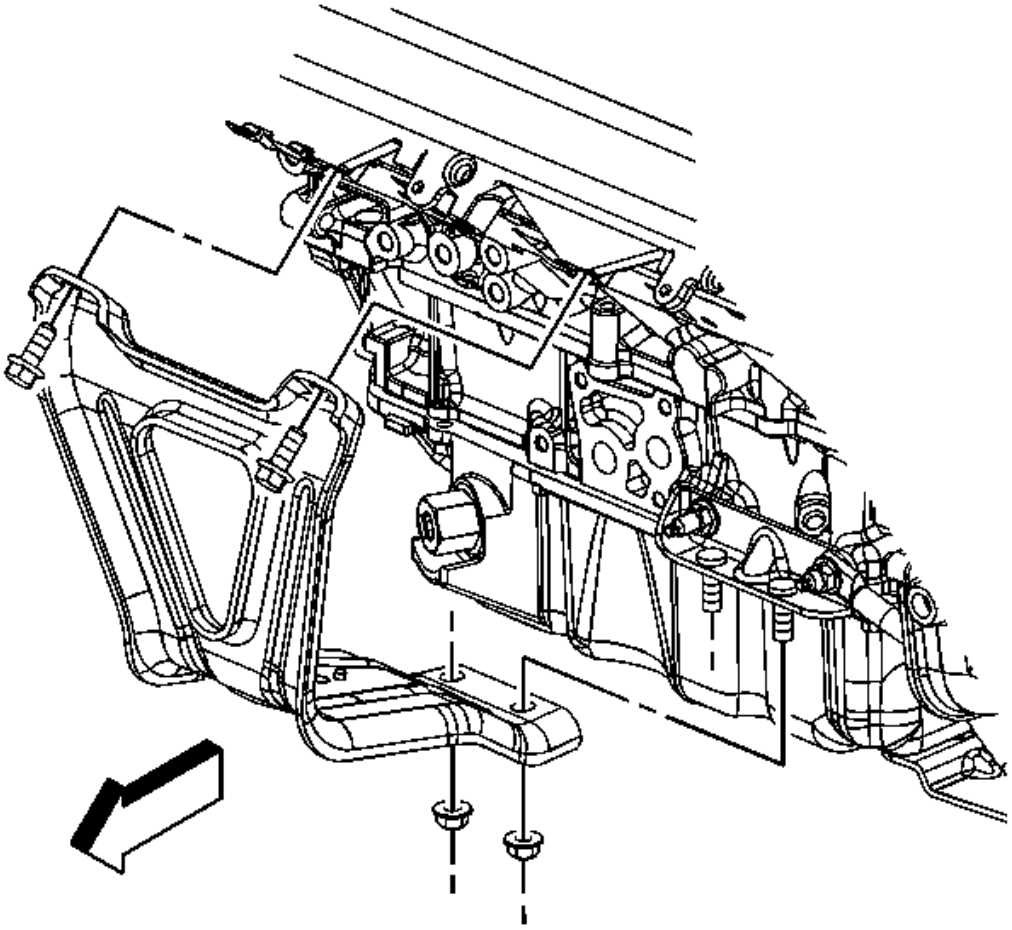


Fig. 475: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Install the front engine mount bracket.

   CAUTION: Refer to Fastener Caution .

2. Install the front engine mount bracket bolts/nuts.

   Tighten

   Tighten the bolts/nuts 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

3. Install an engine lift chain to the engine lift brackets and attach an engine lifting device.
4. Remove the engine assembly from the engine stand.

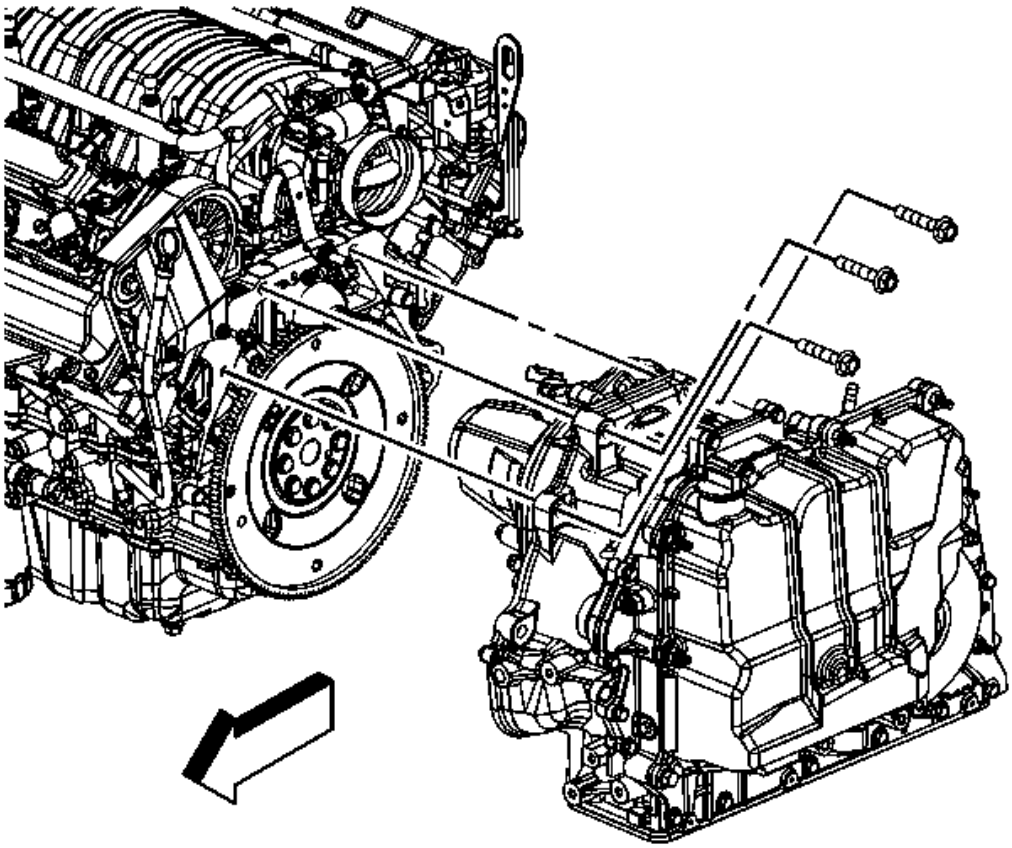


Fig. 476: Identifying Upper Transaxle Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Carefully position and install the engine to the supported frame and transaxle, aligning the engine dowel pins to the transaxle.
6. Install the upper transaxle bolts.

Tighten

Tighten the bolts to 75 N.m (55 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

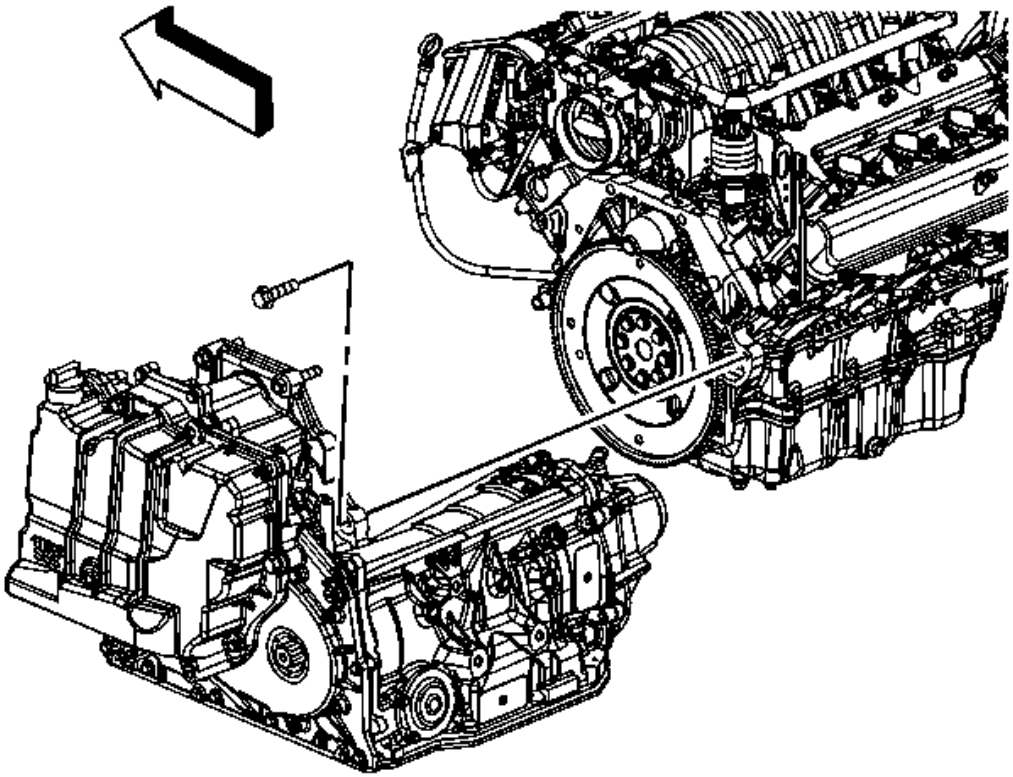


Fig. 477: Identifying Rear Transaxle Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear transaxle bolt.

   Tighten

   Tighten the bolt to 75 N.m (55 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

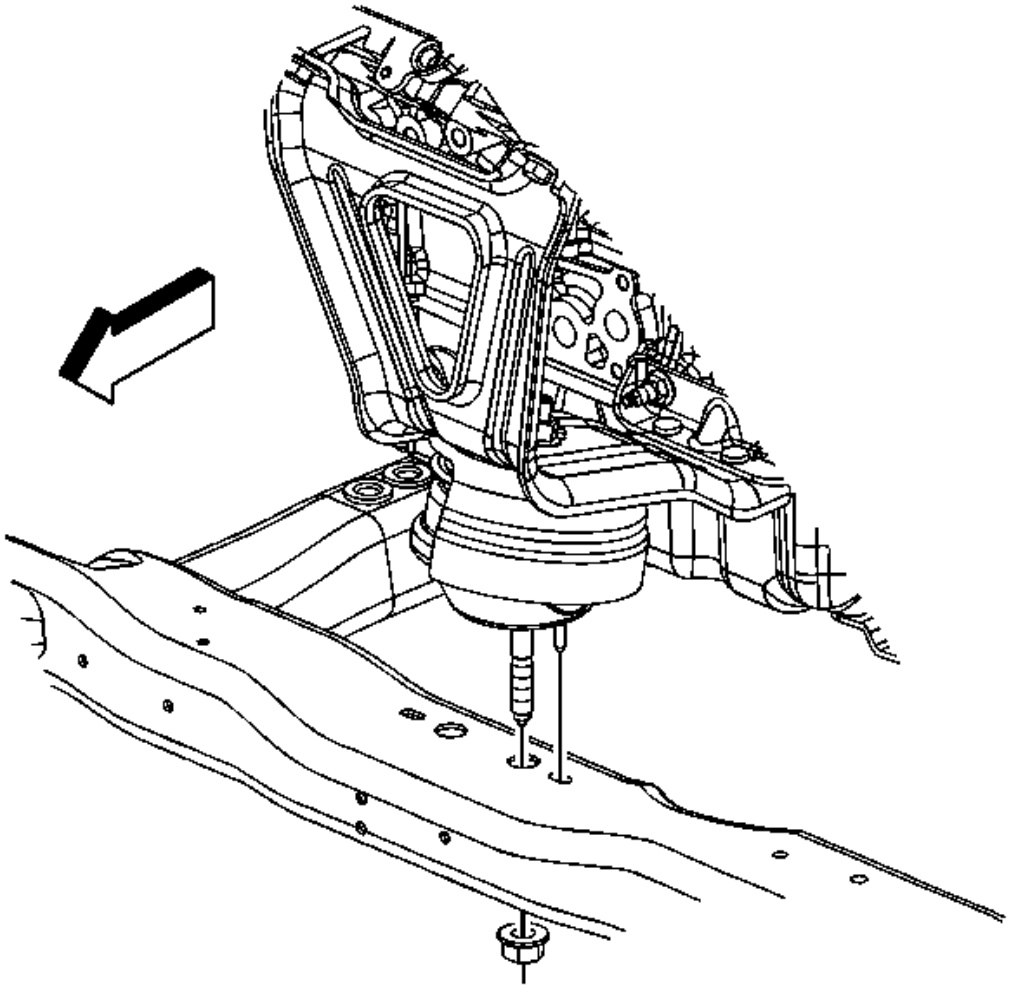


Fig. 478: Identifying Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS COMPANY

8. Install the front engine mount to frame nut.

   Tighten

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

 © 2011 Mitchell Repair Information Company, LLC.

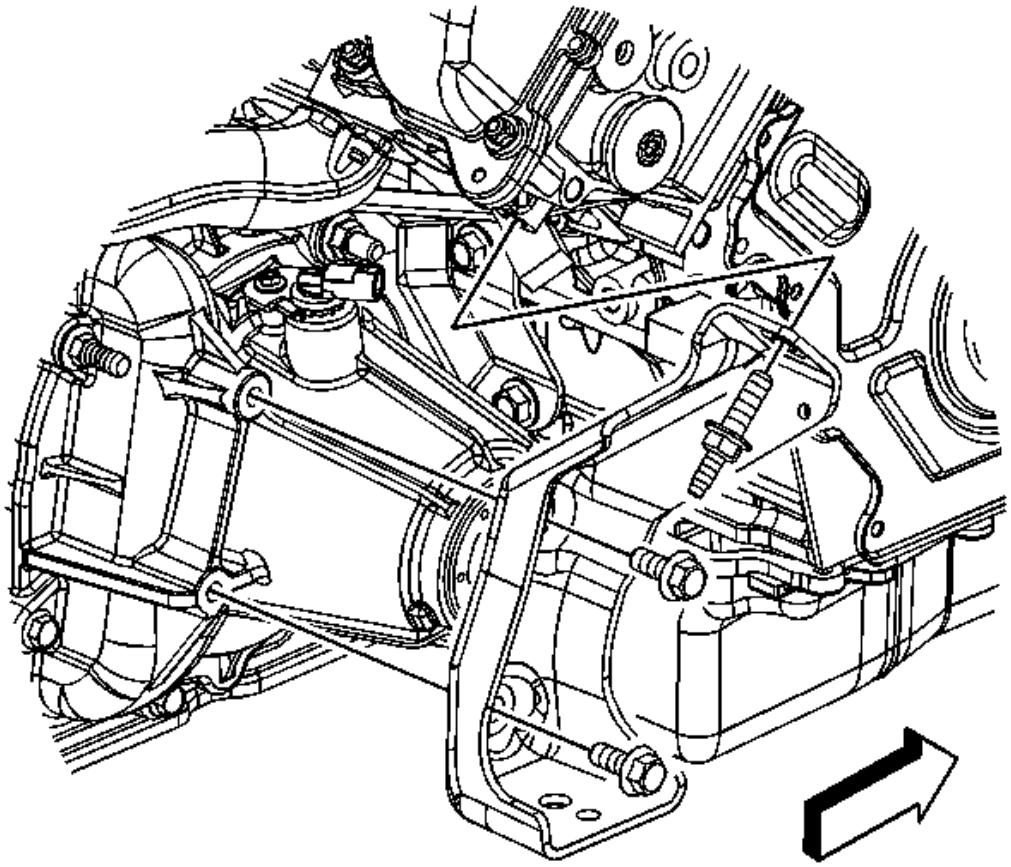


Fig. 479: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

9. Position the rear engine mount bracket to the engine and transaxle.
10. Install the rear engine mount bracket bolts and stud.

Tighten

Tighten the bolts/stud to 73 N.m (54 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

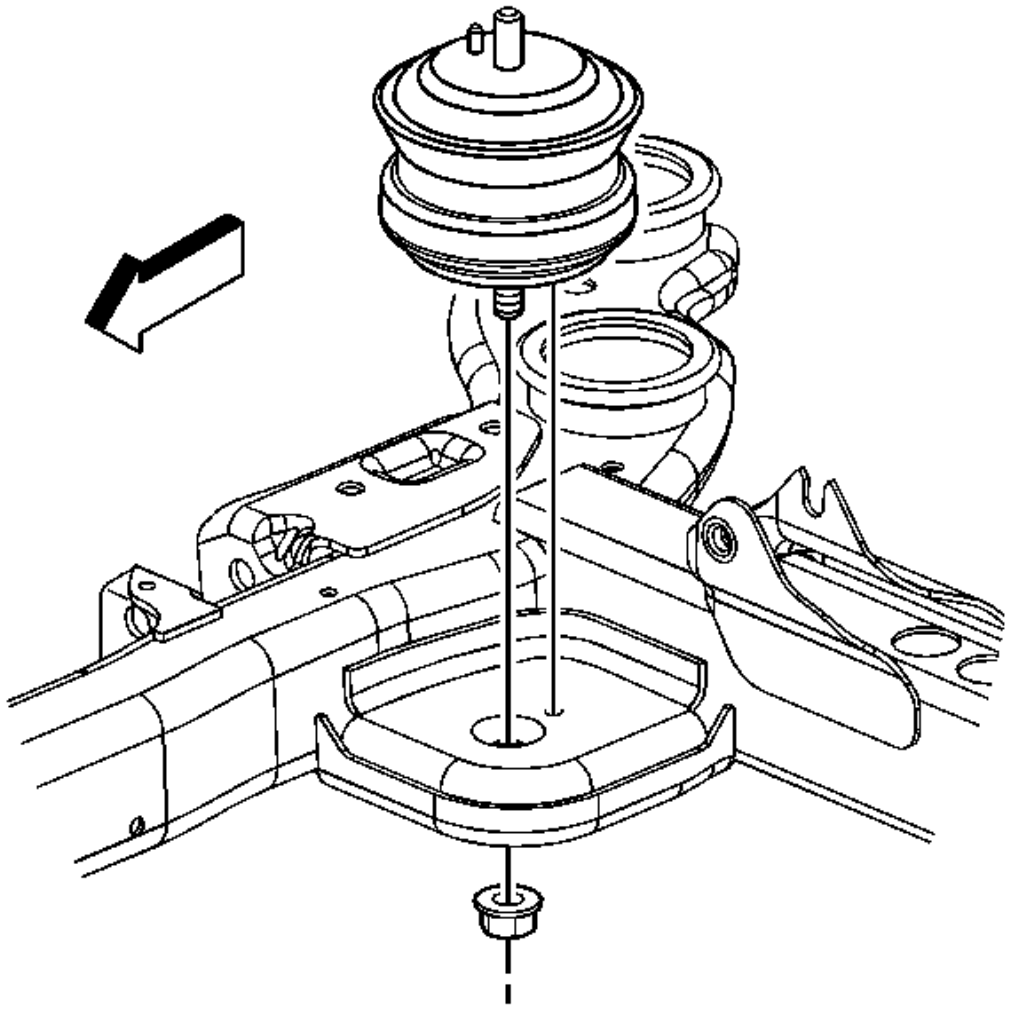


Fig. 480: View Of Right Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS COMPANY

11. Install the rear engine mount to frame nut.

    Tighten

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

12. Remove the engine lifting device and lift chain.

 © 2011 Mitchell Repair Information Company, LLC.

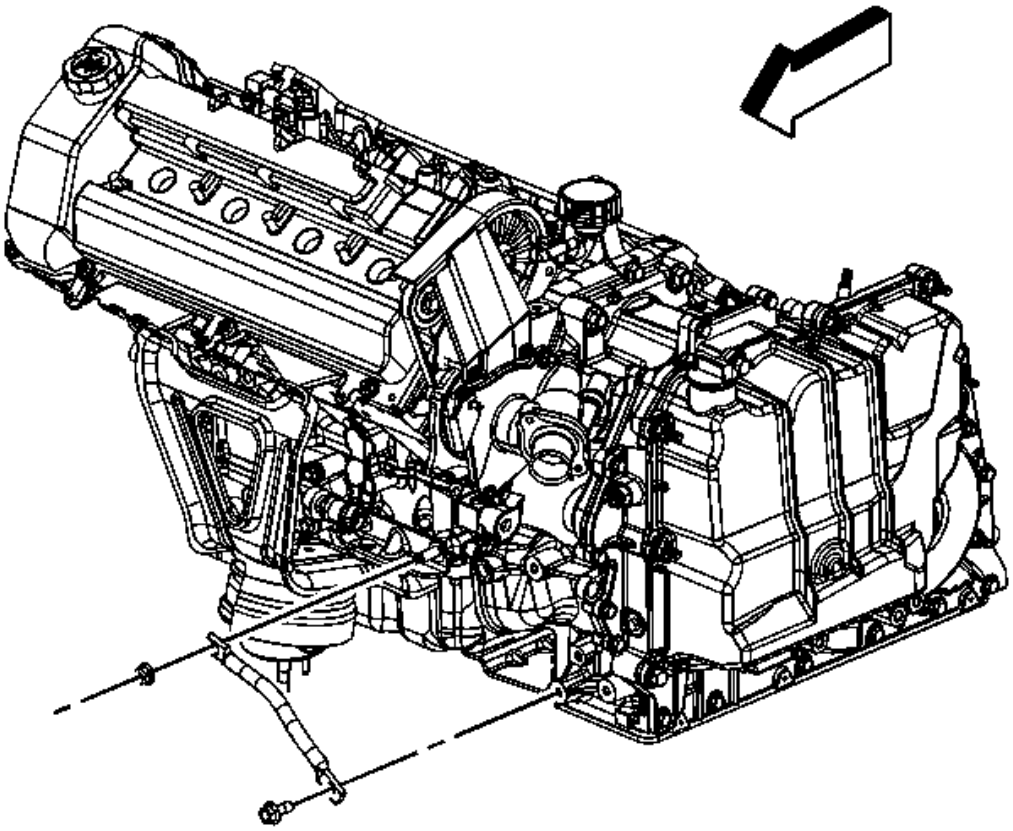


Fig. 481: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the transaxle brace.
14. Install the transaxle brace bolt.

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

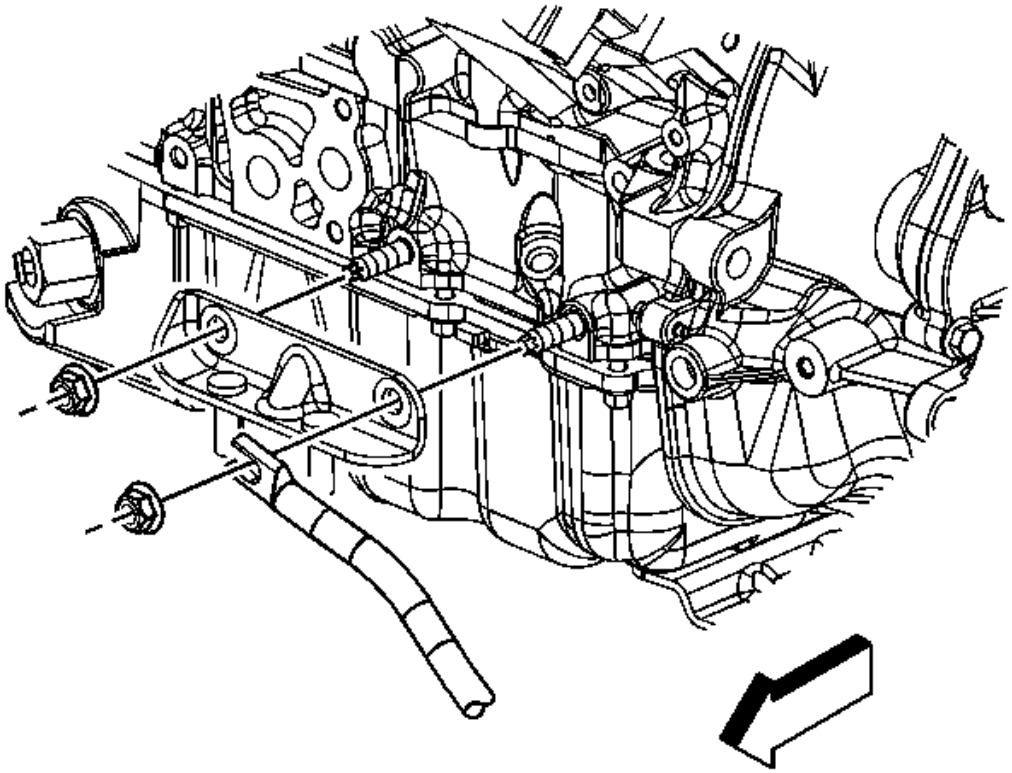


Fig. 482: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front engine mount bracket nut with the transaxle brace behind it.

    Tighten

    Tighten the nut to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

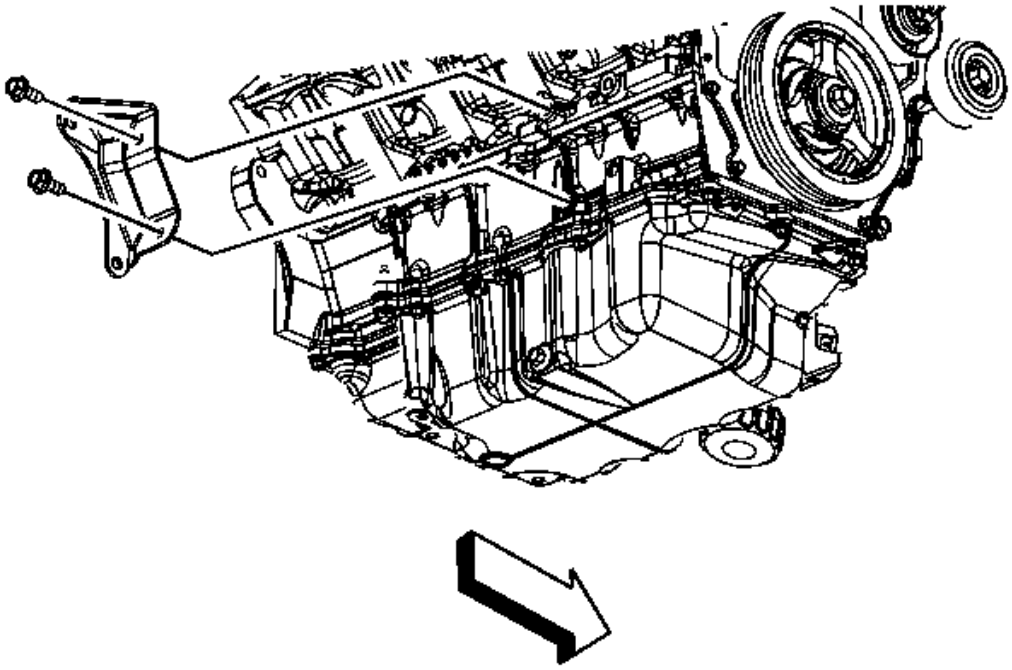


Fig. 483: Identifying Transaxle Brace Bolts & Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Position the transaxle brace to the engine and transaxle.
17. Install the transaxle brace bolts to the engine.

Tighten

Tighten the bolts to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

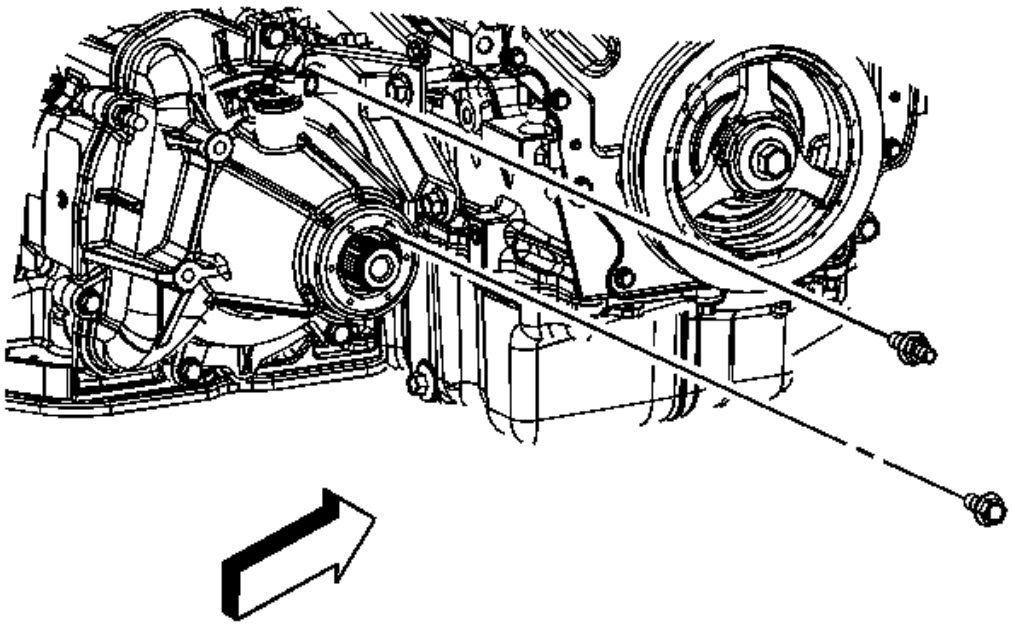


Fig. 484: Identifying Transaxle Brace Bolt/Stud
Courtesy of GENERAL MOTORS COMPANY

18. Install the transaxle brace bolt/stud to the transaxle.

    Tighten

    Tighten the bolt/stud to 50 N.m (37 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

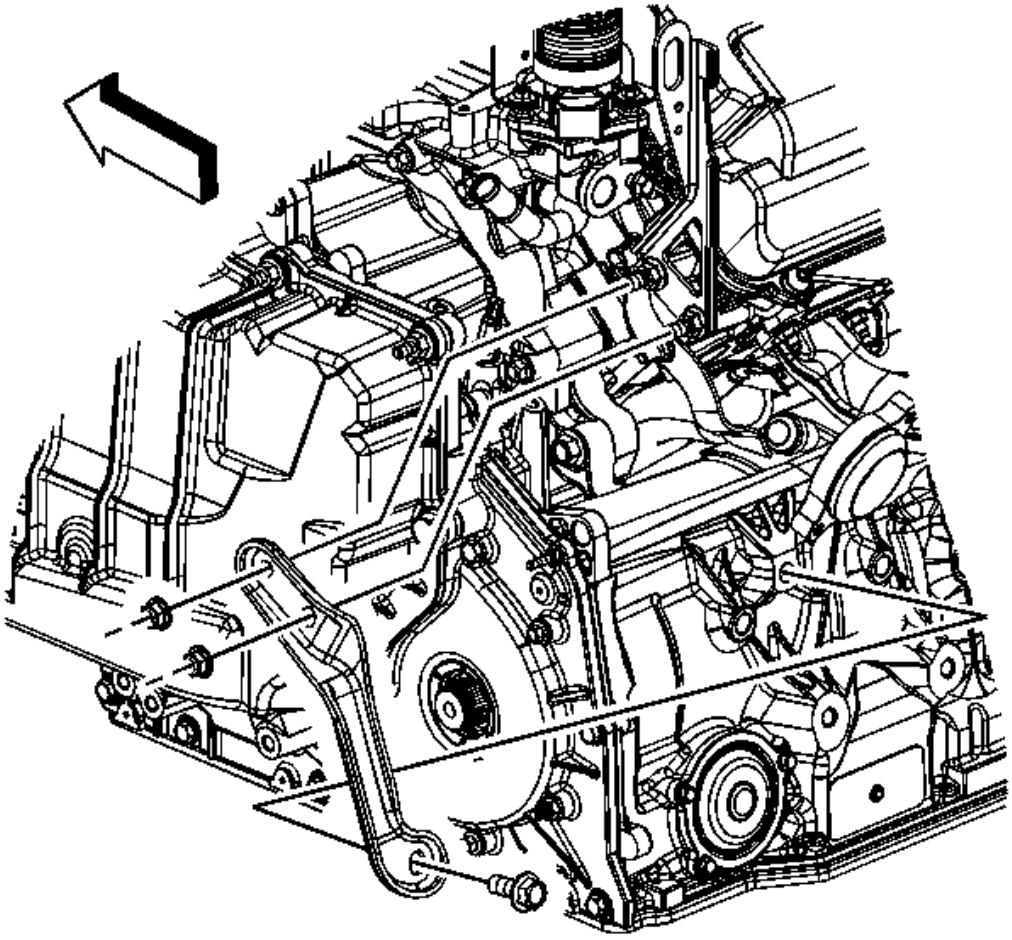


Fig. 485: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

19. Install the transaxle brace to the lift bracket studs.
20. Install the transaxle brace bolt.

Tighten

Tighten the bolt to 50 N.m (37 lb ft).

21. Install the transaxle brace nuts.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the nut to 50 N.m (37 lb ft).

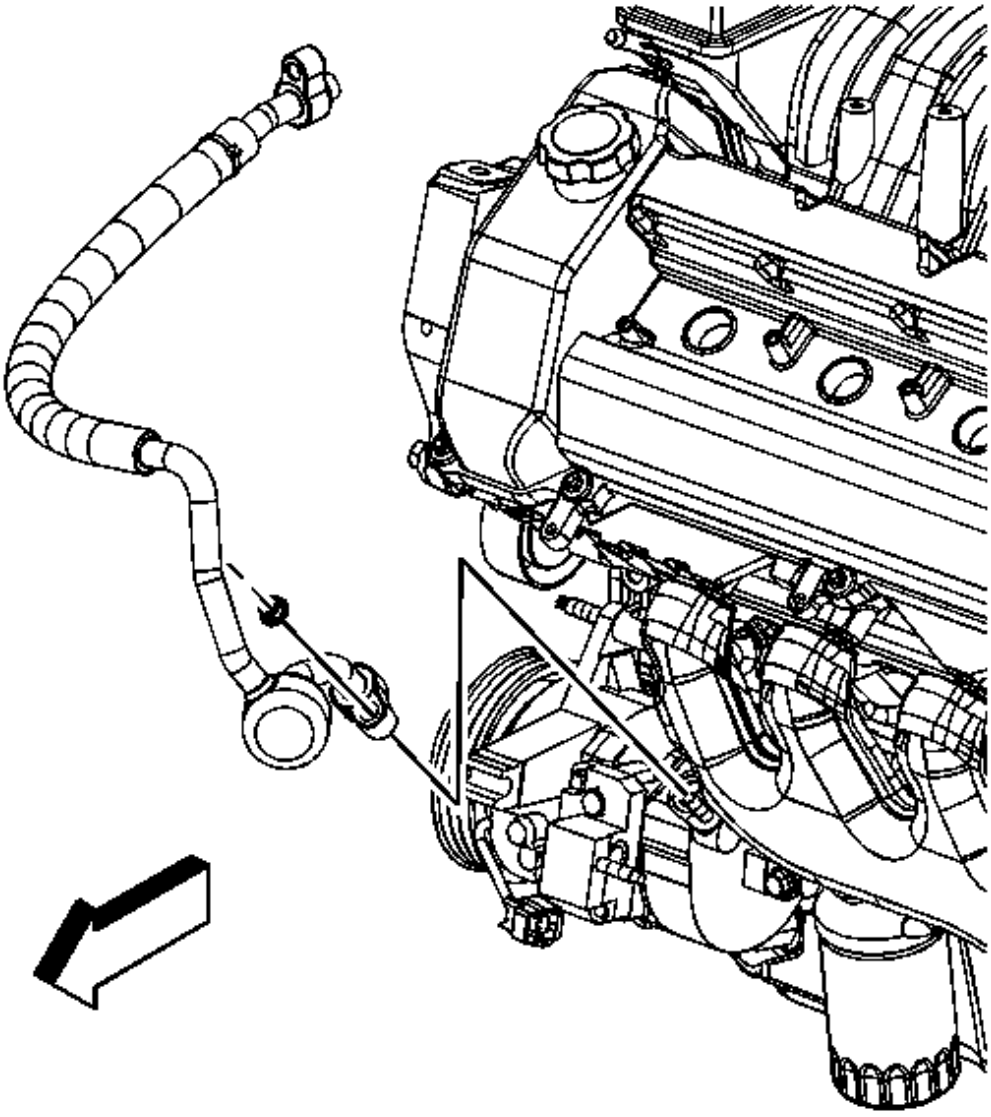


Fig. 486: View Of A/C Compressor Suction Hose
Courtesy of GENERAL MOTORS COMPANY

22. Remove the plug from the A/C compressor suction port.
23. Remove and discard the old sealing washer from the compressor end of the suction hose.
24. Install a NEW sealing washer to the compressor end of the suction hose.

 © 2011 Mitchell Repair Information Company, LLC.

25. Install the A/C compressor suction hose the compressor.
26. Install the A/C compressor suction hose nut at the compressor.

    Tighten

    Tighten the nut to 16 N.m (12 lb ft).

27. Secure the suction hose to the engine.

 © 2011 Mitchell Repair Information Company, LLC.

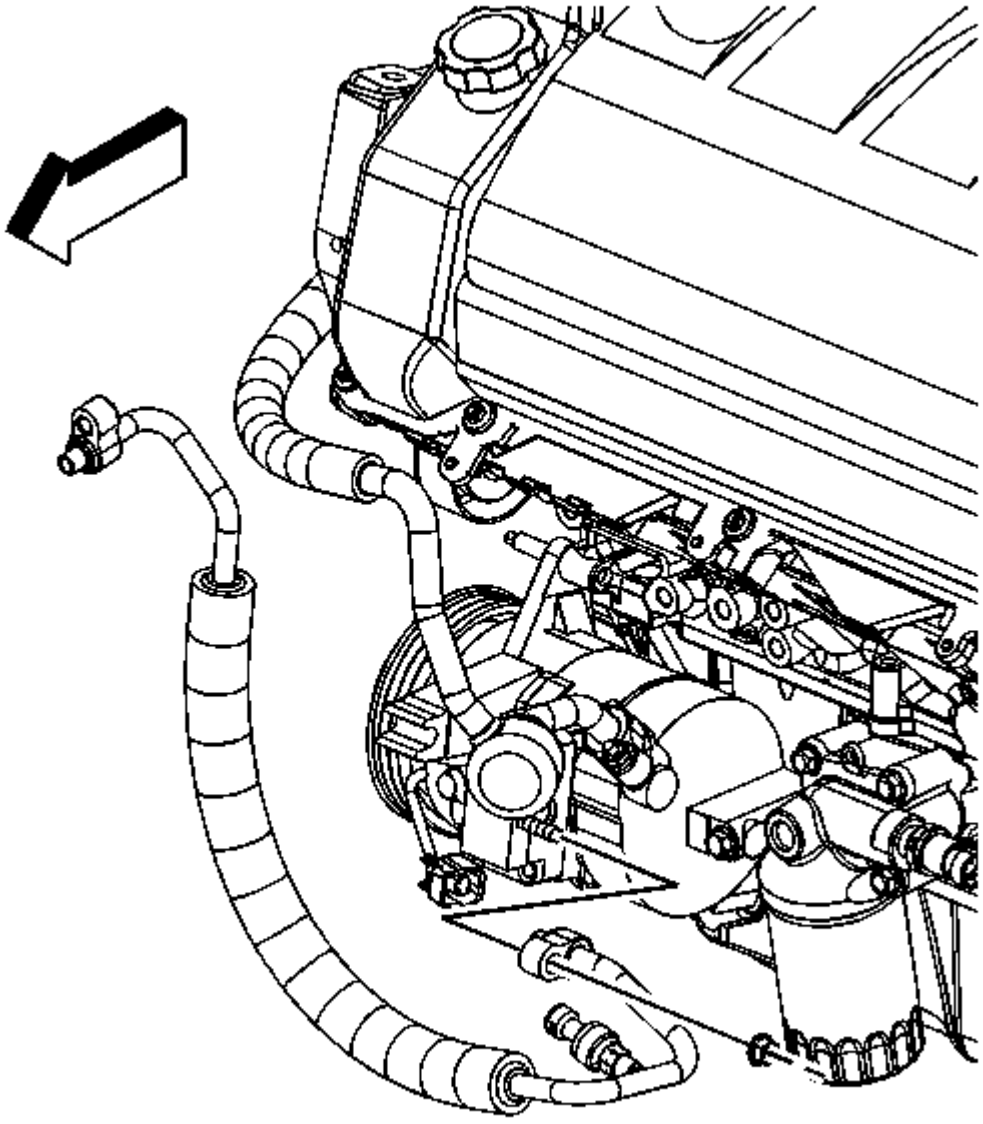


Fig. 487: View Of A/C Compressor Discharge Hose
Courtesy of GENERAL MOTORS COMPANY

28. Remove the plug from the A/C compressor discharge port.
29. Remove and discard the old sealing washer from the compressor end of the discharge hose.
30. Install a NEW sealing washer to the compressor end of the discharge hose.
31. Install the A/C compressor discharge hose the compressor.

 © 2011 Mitchell Repair Information Company, LLC.

32. Install the A/C compressor discharge hose nut at the compressor.

    Tighten

    Tighten the nut to 16 N.m (12 lb ft).

33. Secure the discharge hose to the engine.

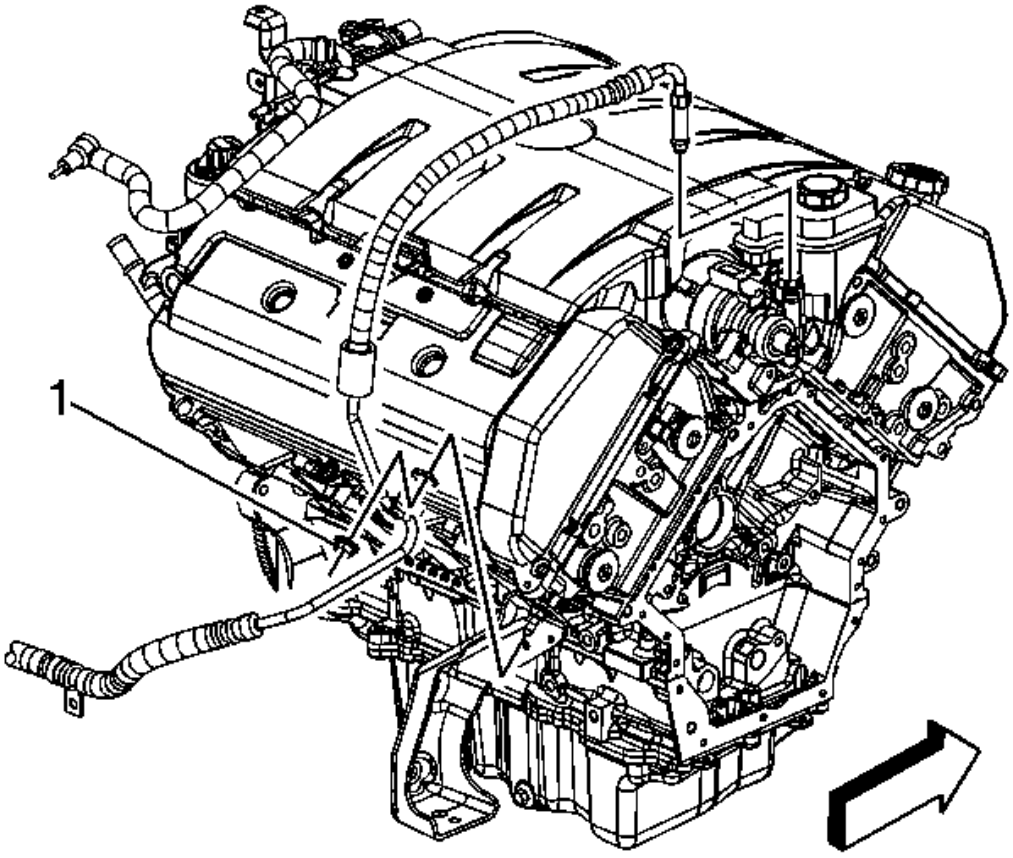


Fig. 488: Identifying Power Steering Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

34. Install the power steering inlet pipe fitting to the power steering pump.

    Tighten

    Tighten the fitting to 27 N.m (20 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

35. Install the power steering inlet pipe bracket to the stud.
36. Install the power steering inlet pipe nut (1) to the rear engine mount bracket stud.

Tighten

Tighten the nut to 9 N.m (80 lb in).

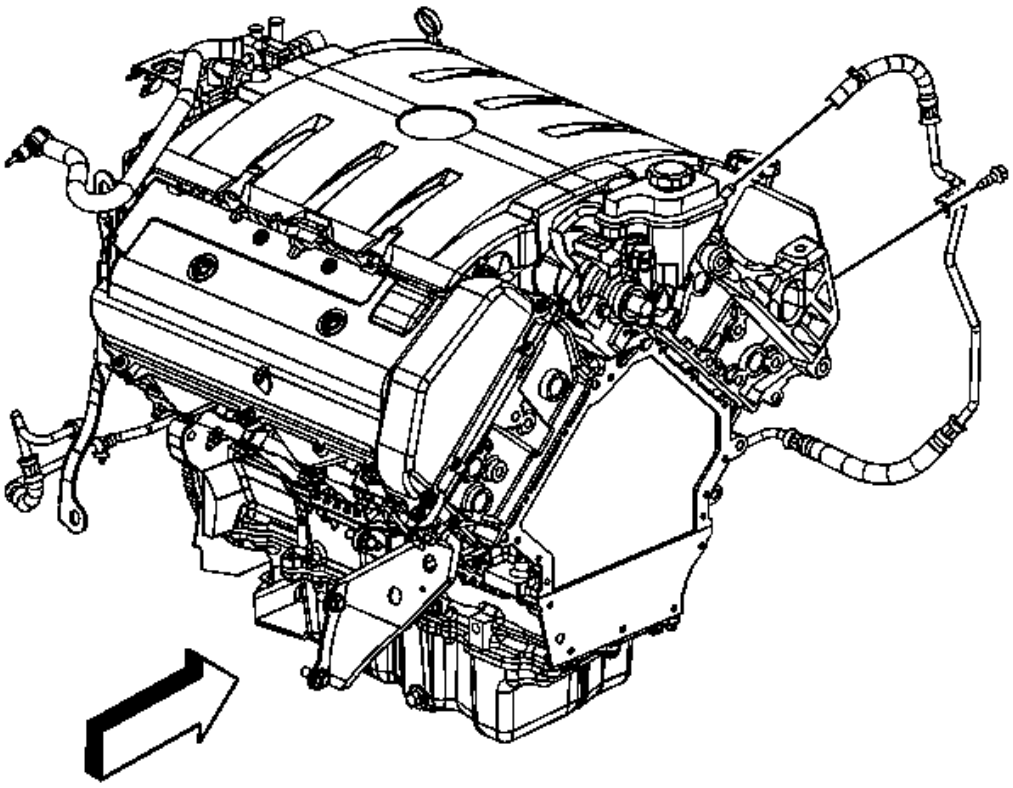


Fig. 489: Identifying Power Steering Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

37. Install the power steering outlet hose to the reservoir.
38. Position the power steering outlet hose clamp at the pump reservoir.
39. Install the power steering outlet pipe bolt to the engine mount strut bracket.

Tighten

Tighten the bolt to 9 N.m (80 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

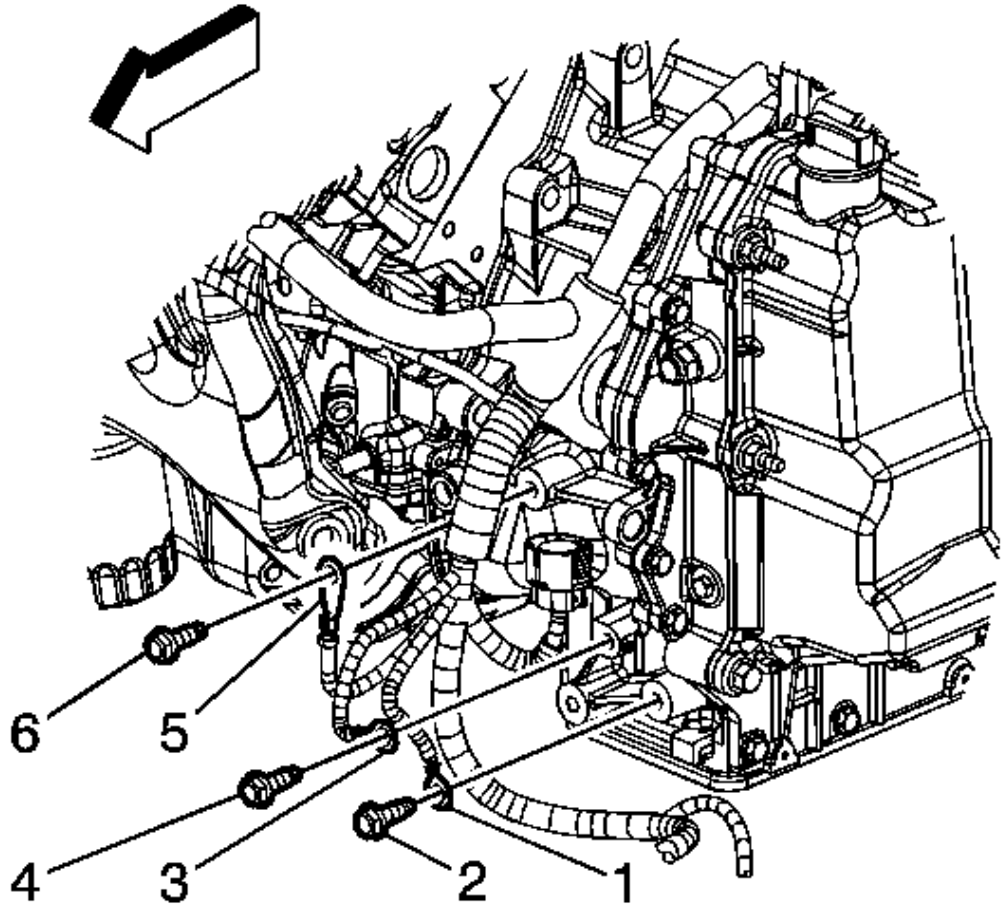


Fig. 490: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

40. Install the engine harness to the engine.
41. Position the engine harness grounds (1, 3, and 5) to the engine block.
42. Install the engine harness ground bolts (2, 4, and 6).

Tighten

Tighten the bolts to 25 N.m (18 lb ft).

43. Connect the engine harness electrical connector to the transaxle.

 © 2011 Mitchell Repair Information Company, LLC.

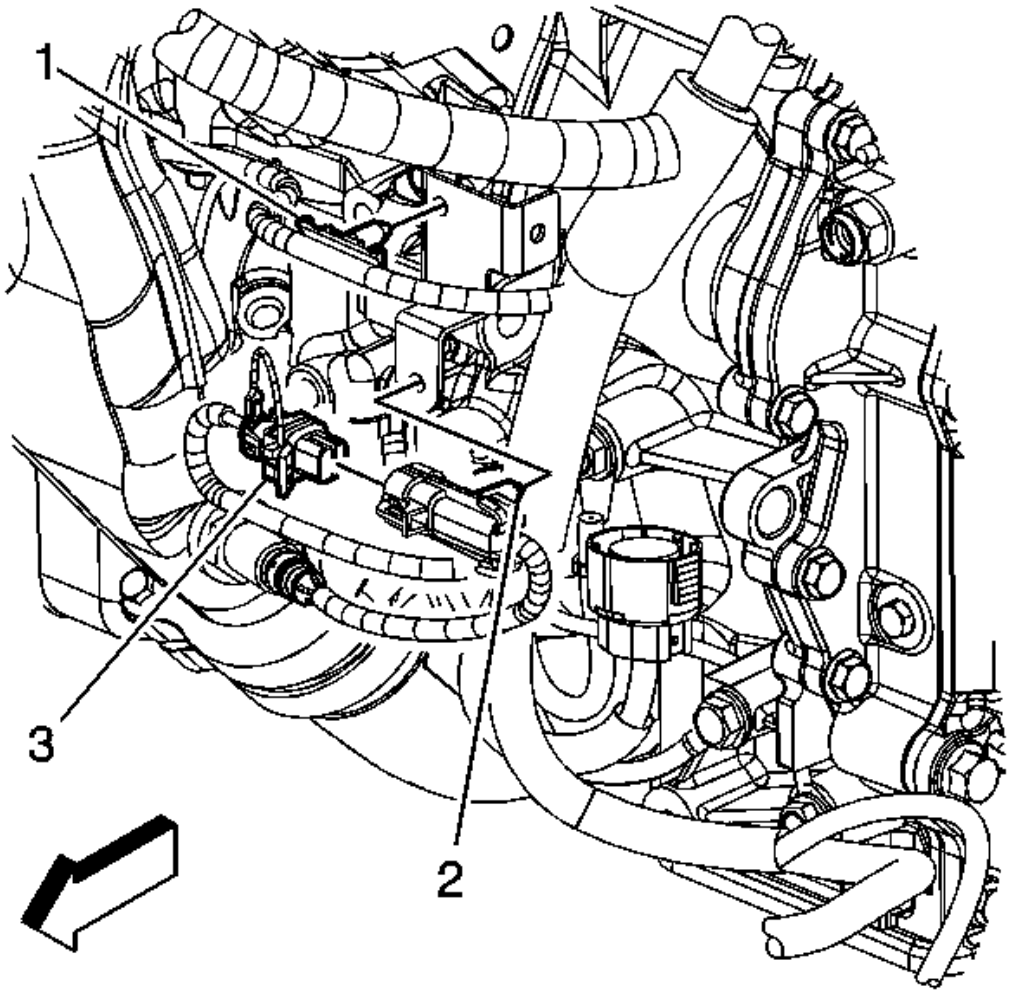


Fig. 491: View Of Engine Harness Electrical Connector & Clips
Courtesy of GENERAL MOTORS COMPANY

44. Connect the engine harness electrical connector (3) to the HO2S.
45. Install the CPA retainer.
46. Install the engine harness clip (1) to the engine bracket.

 © 2011 Mitchell Repair Information Company, LLC.

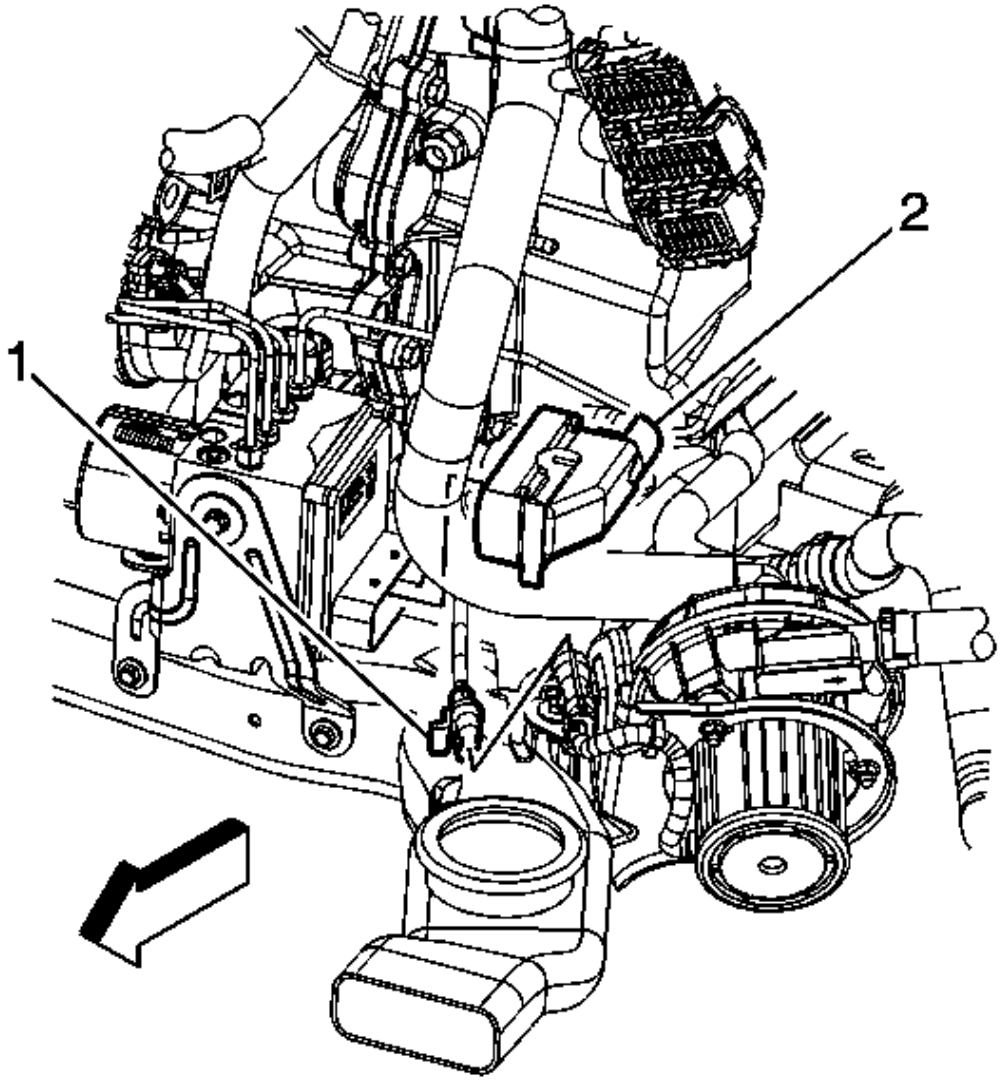


Fig. 492: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

47. Connect the engine harness electrical connectors to the following:
    - The AIR pump (1)
    - The brake modulator (2)

 © 2011 Mitchell Repair Information Company, LLC.

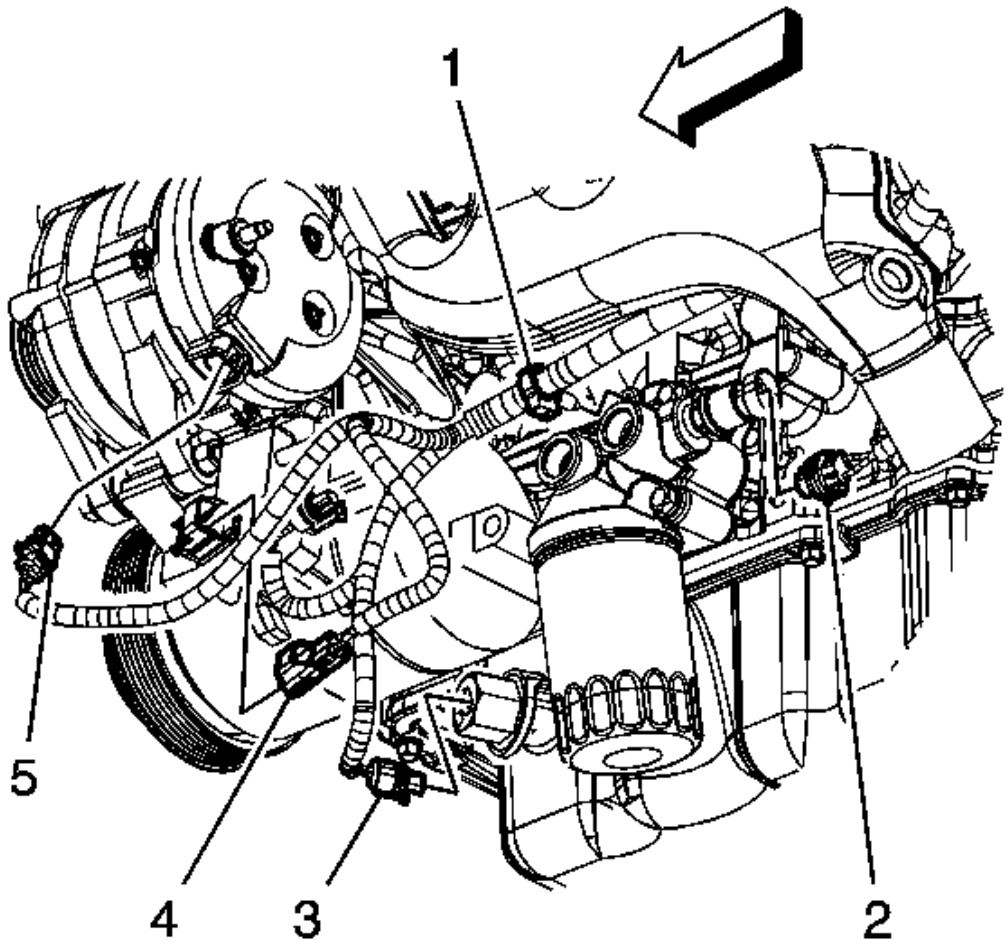


Fig. 493: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

48. Install the engine harness clip (1) to the boss on the engine block.
49. Connect the following engine harness electrical connectors:
    - The oil pressure sensor (2)
    - The oil level sensor (3)
    - The A/C compressor (4)
    - The generator (5)

 © 2011 Mitchell Repair Information Company, LLC.

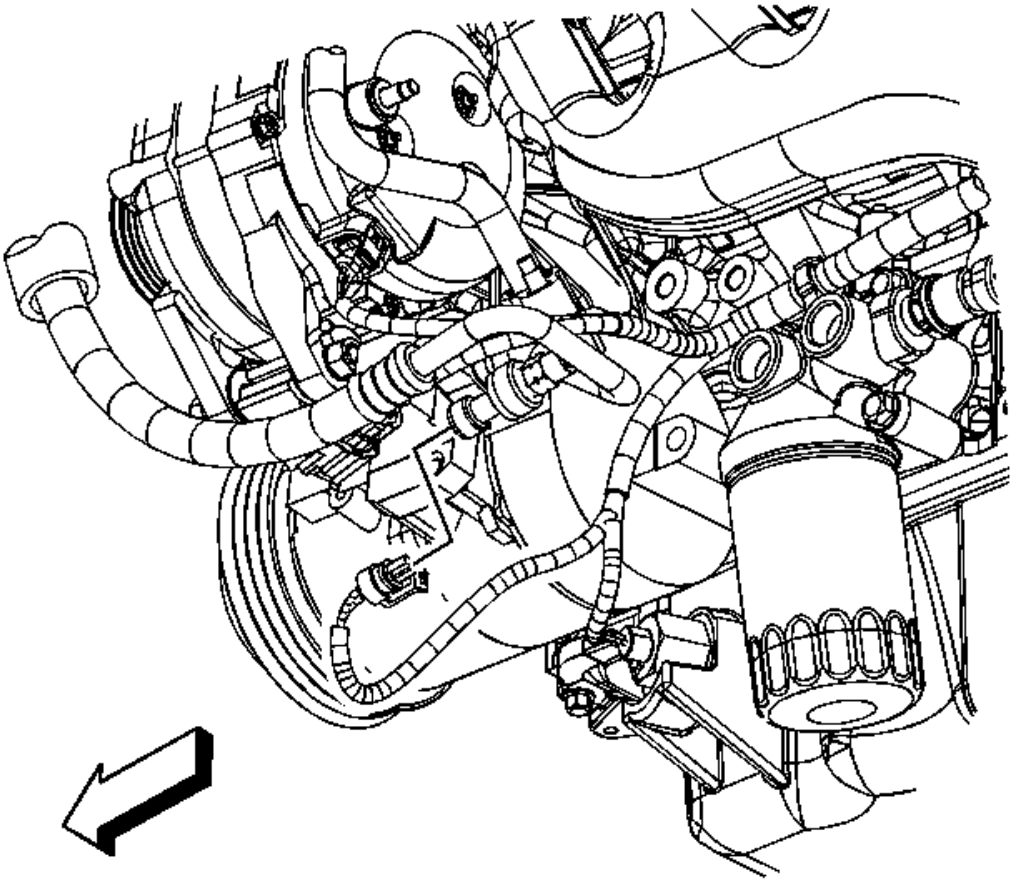


Fig. 494: View OF Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

50. Connect the engine harness electrical connector to the A/C pressure sensor.

 © 2011 Mitchell Repair Information Company, LLC.

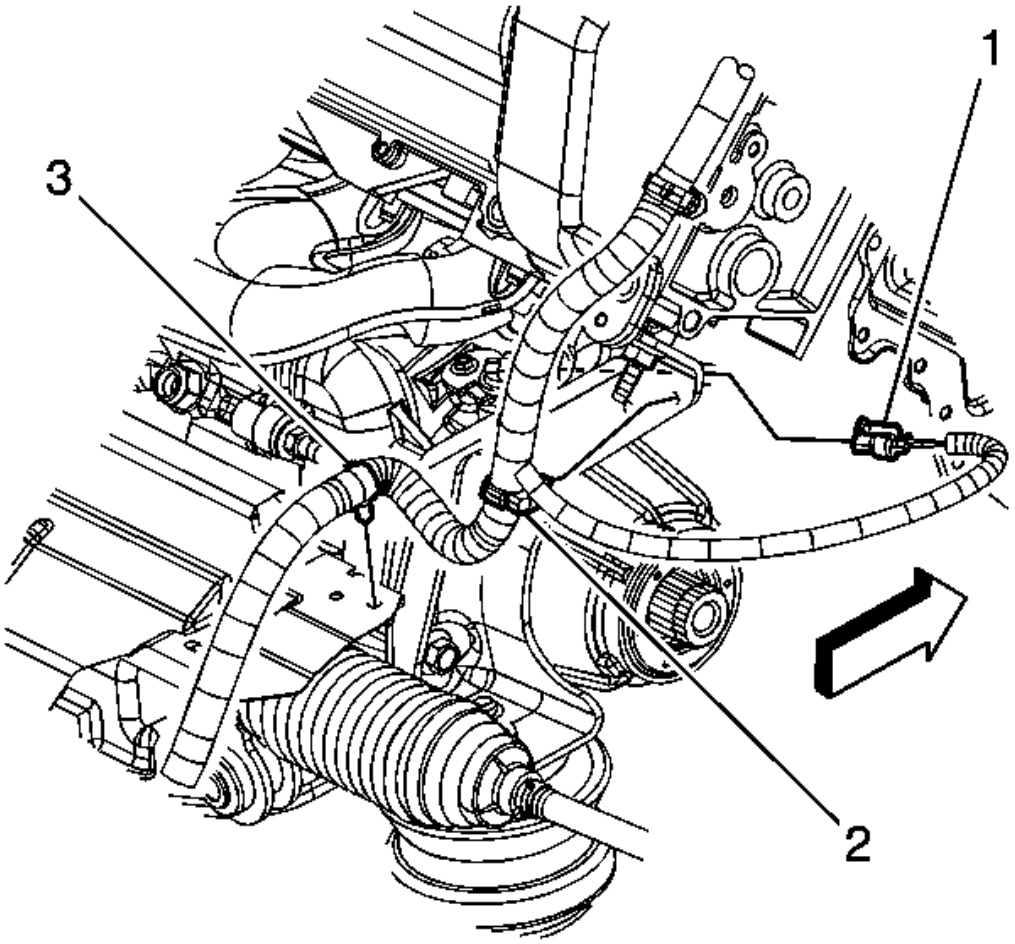


Fig. 495: Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

51. Connect the engine harness electrical connector (1) to the VSS.
52. Install the engine harness clips (2, 3) to the rear engine mount bracket and steering gear shield.

 © 2011 Mitchell Repair Information Company, LLC.

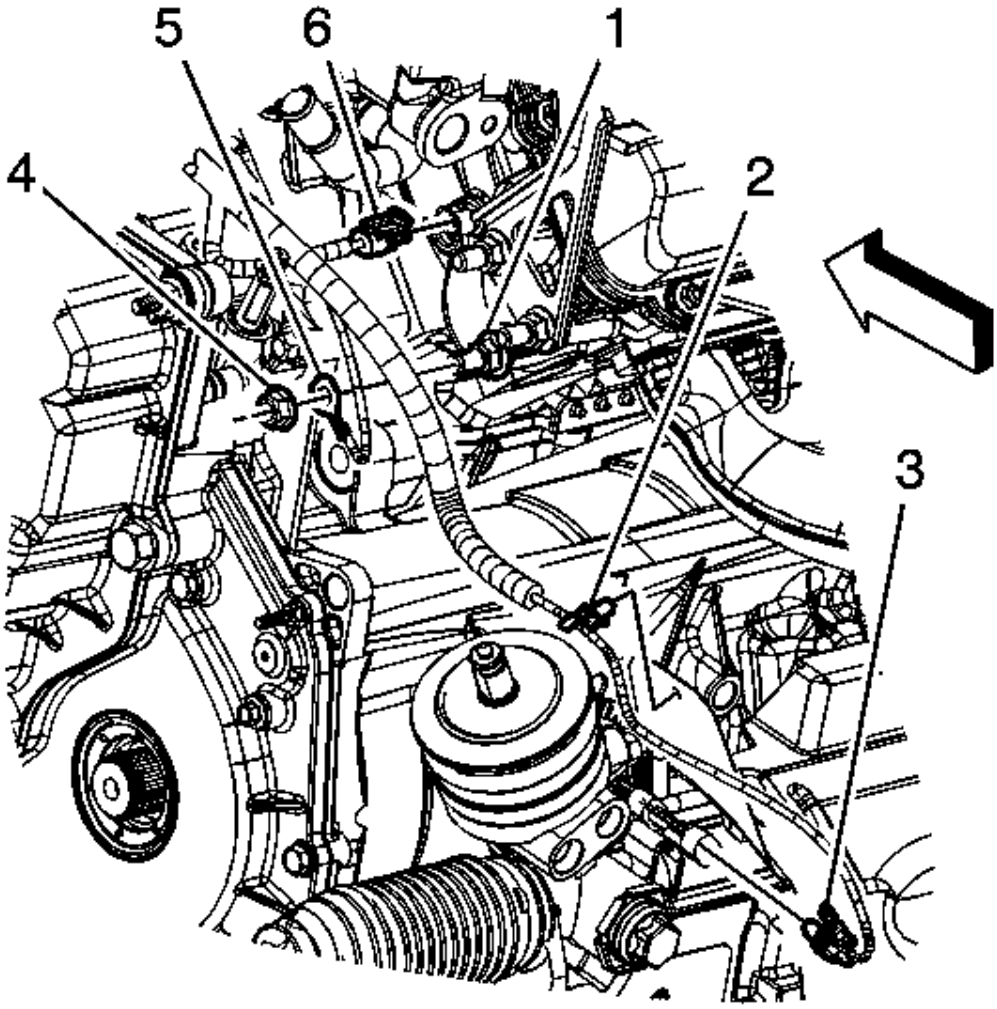


Fig. 496: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

53. Connect the engine harness electrical connector (6) to the ECT sensor.
54. Install the engine harness ground (5) to the stud.
55. Install the engine harness ground nut (4).

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

56. Install the engine harness clip (2) to the steering gear shield.
57. Connect the engine harness electrical connector (3) to the power steering sensor.

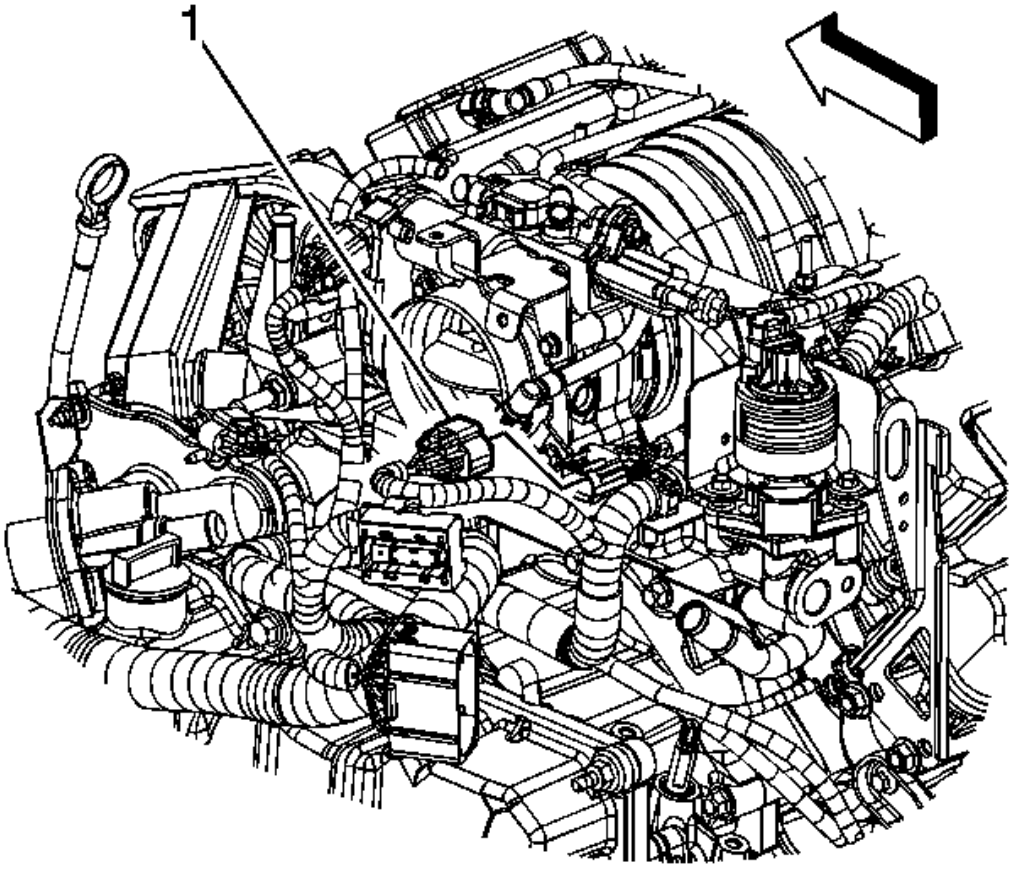


Fig. 497: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

58. Connect the engine harness electrical connector (1) to the engine valley jumper harness electrical connector.

 © 2011 Mitchell Repair Information Company, LLC.

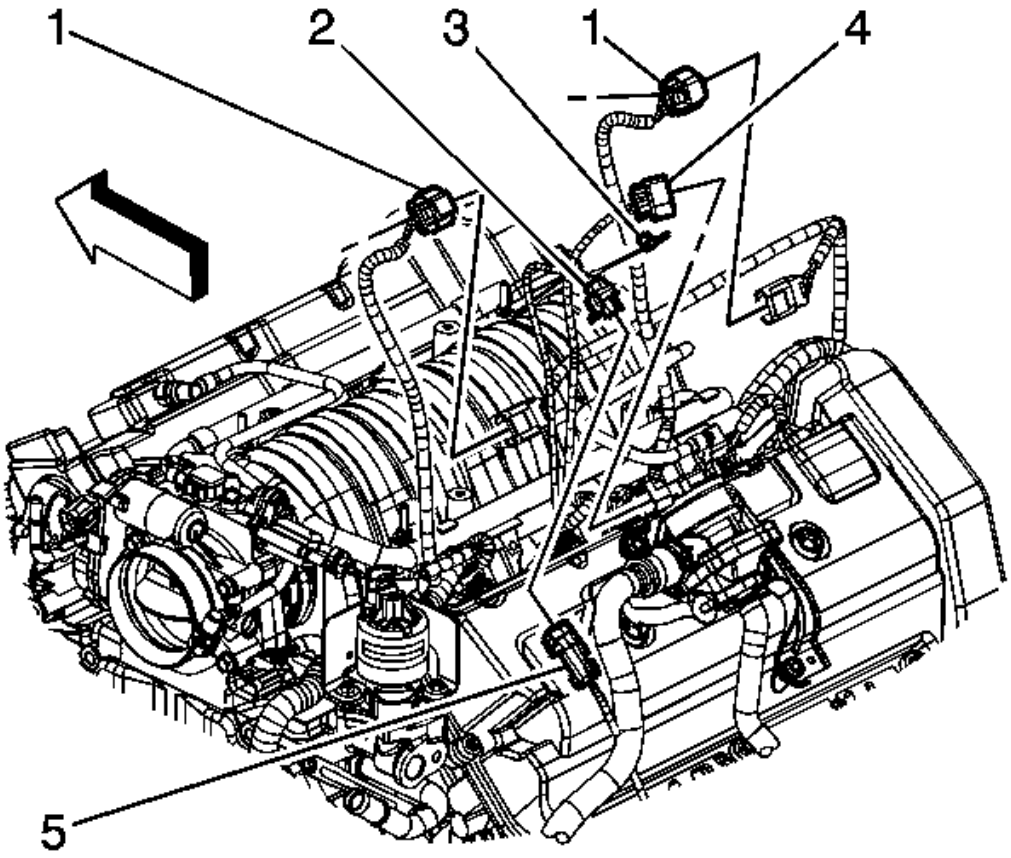


Fig. 498: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

59. Connect the following engine harness electrical connectors to the top of the engine:
    - The starter inline (1)
    - The AIR check valve (4)

 © 2011 Mitchell Repair Information Company, LLC.

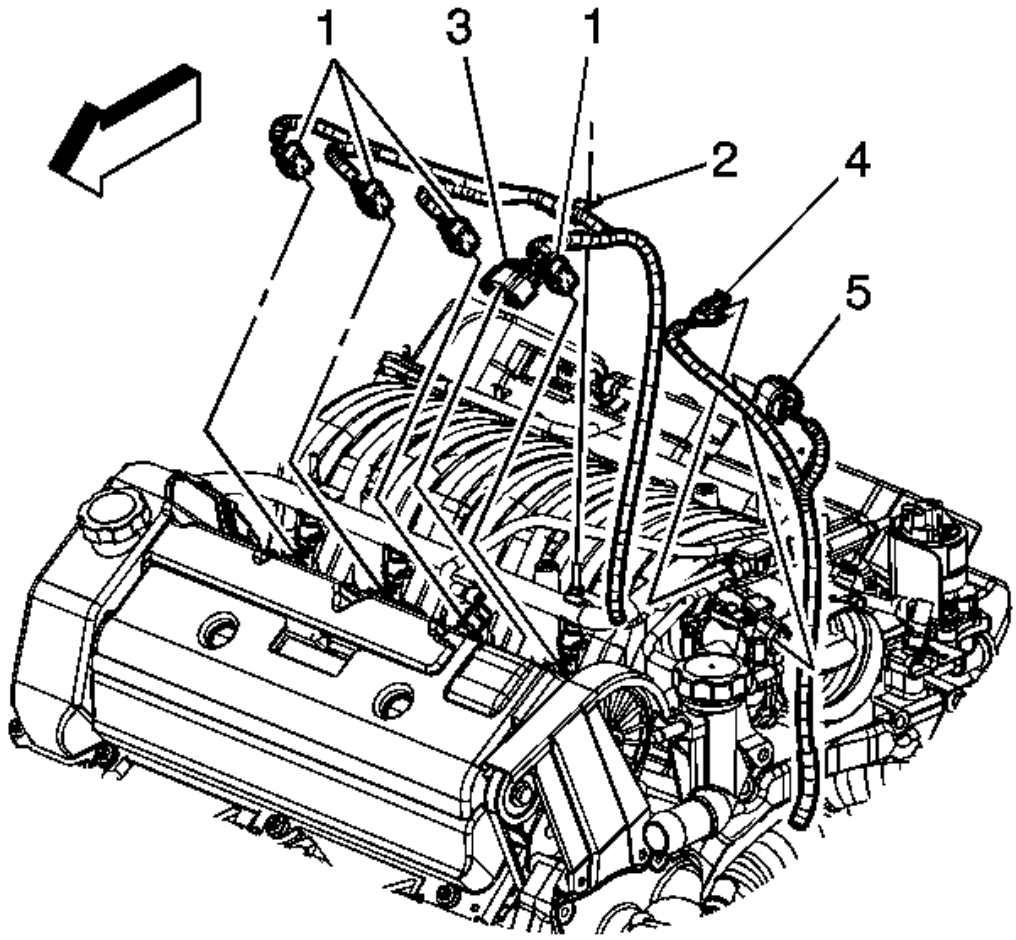


Fig. 499: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

60. Connect the following engine harness electrical connectors to the front of the engine:
    - The fuel injectors (1)
    - The ICM (3)
    - The MAP sensor (4)
    - the throttle actuator (5)
61. Install the engine harness clip (2) to the fuel rail stud.

 © 2011 Mitchell Repair Information Company, LLC.

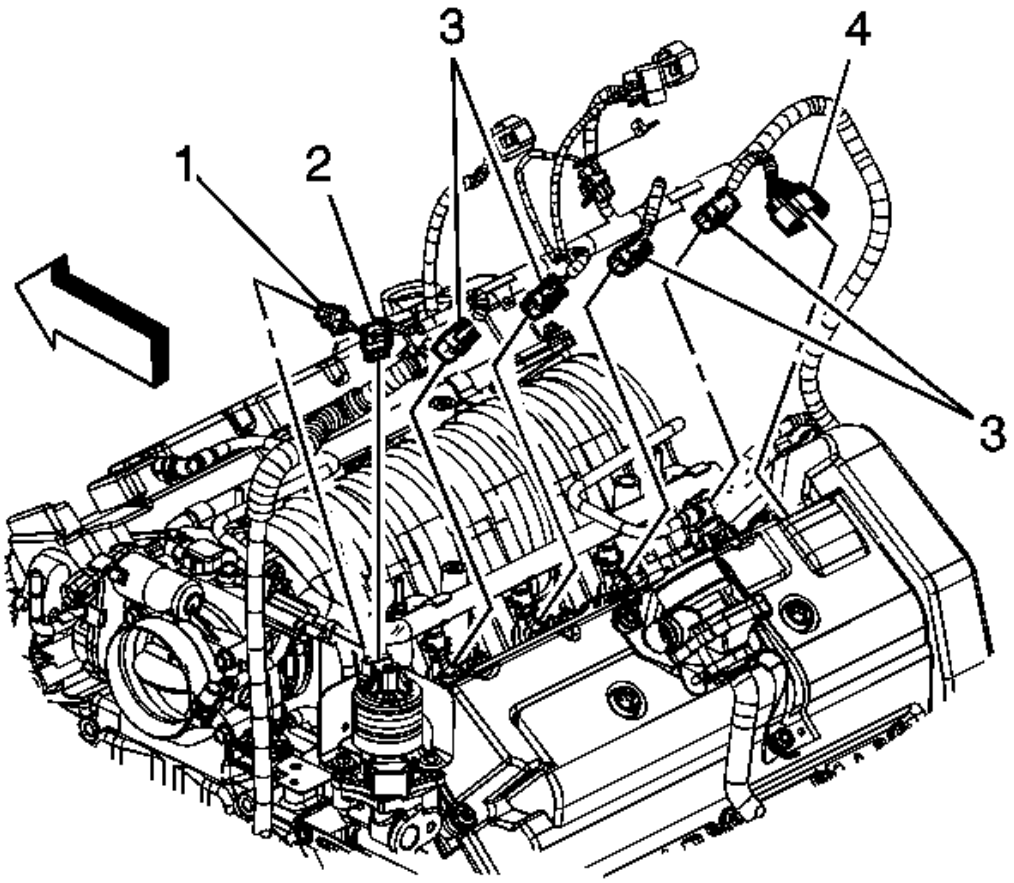


Fig. 500: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

62. Connect the following engine harness electrical connectors to the rear of the engine:
    - The EVAP solenoid (1)
    - The EGR valve (2)
    - The fuel injectors (3)
    - The ICM (4)

 © 2011 Mitchell Repair Information Company, LLC.

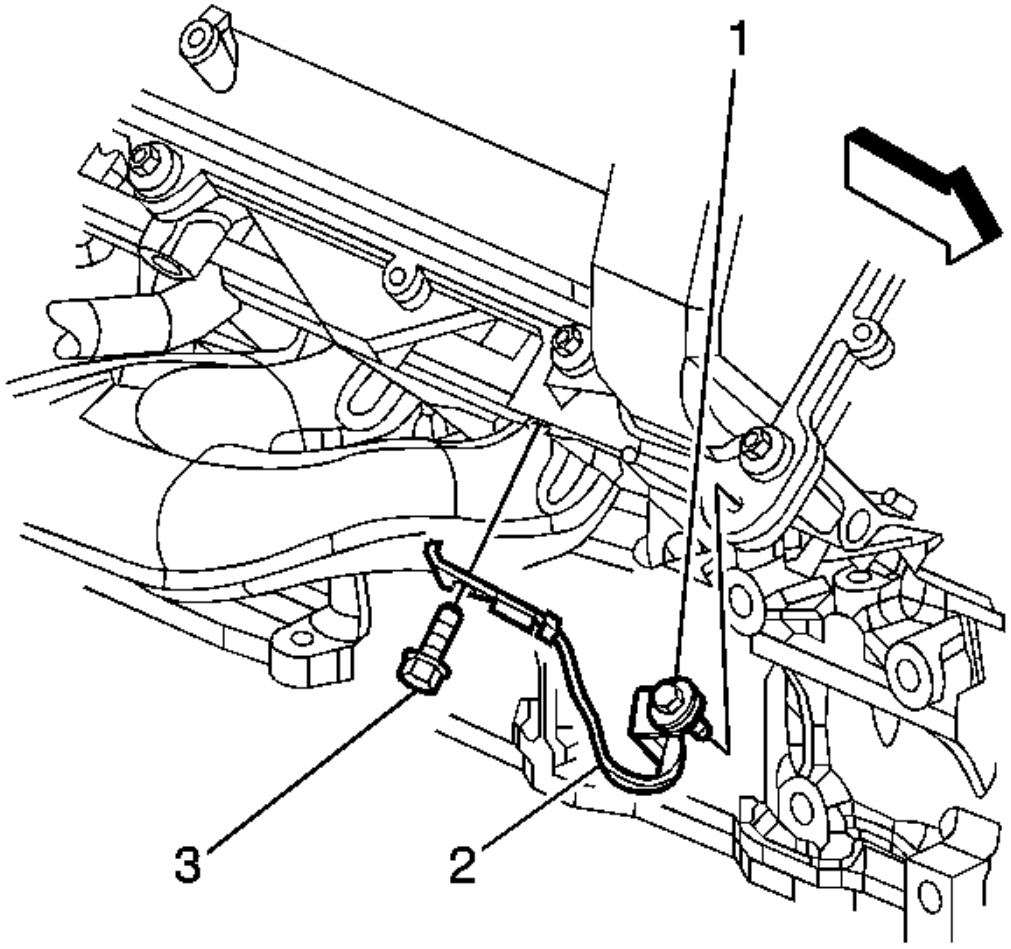


Fig. 501: Locating ICM Ground Strap & Bolt
Courtesy of GENERAL MOTORS COMPANY

63. Position the ICM ground strap (2) to the cylinder head.
64. Install the ICM ground strap bolt (3) to the right cylinder head.

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

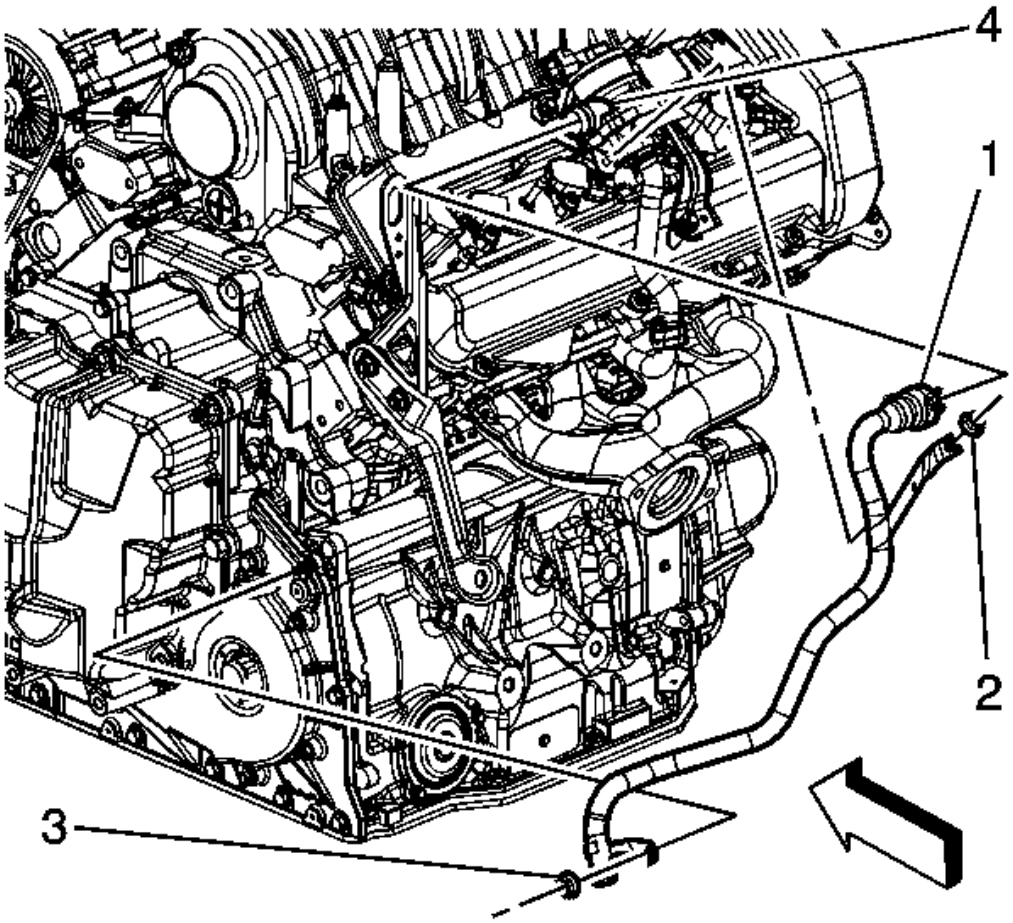


Fig. 502: View Of AIR Pipe Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

65. Install the AIR pipe over the studs.
66. Connect the AIR outlet pipe quick connect fitting to the check valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
67. Install the AIR pipe outlet pipe nut (2) to the check valve bracket stud.

    Tighten

    Tighten the nut to 9 N.m (80 lb in).

68. Install the AIR pipe outlet pipe nut (3) to the transaxle stud.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the nut to 9 N.m (80 lb in).

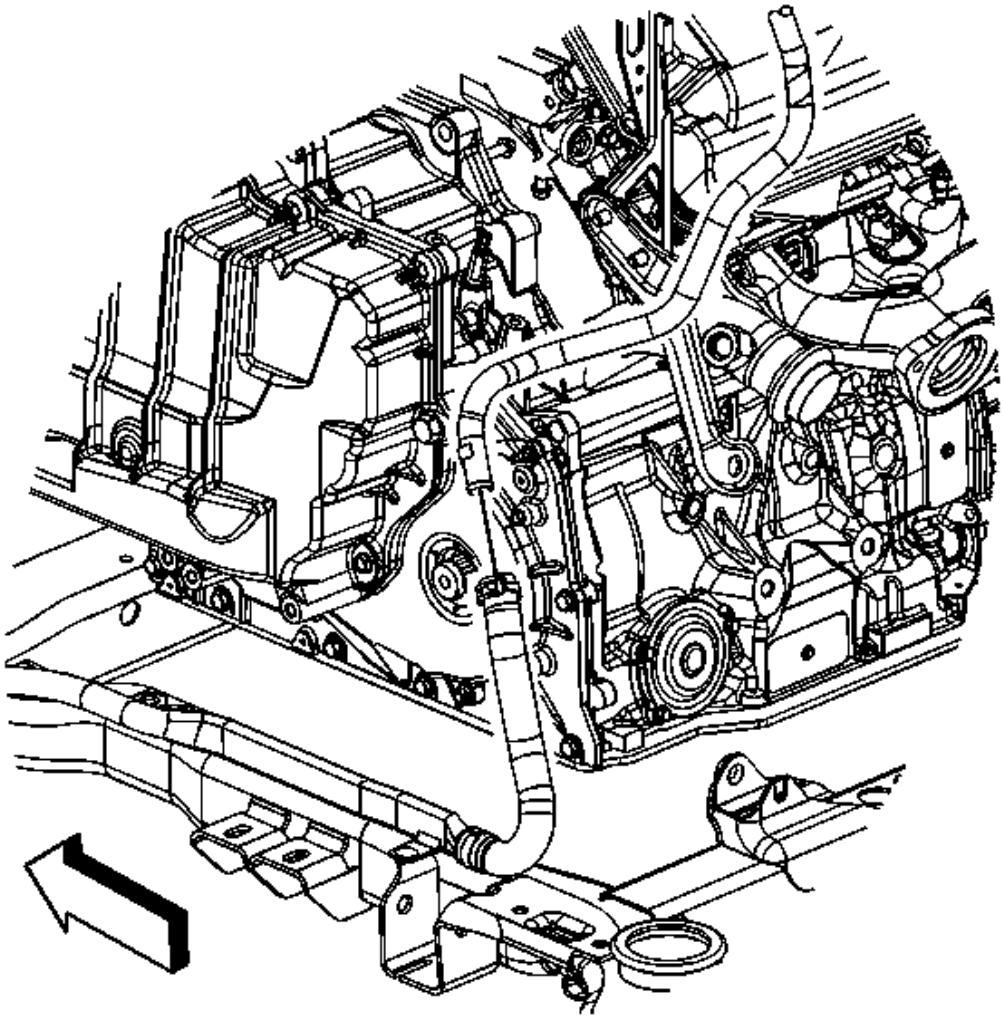


Fig. 503: View Of AIR Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

69. Connect the AIR outlet hose to the AIR outlet pipe.
70. Position the AIR outlet hose clamp at the AIR outlet pipe.

 © 2011 Mitchell Repair Information Company, LLC.

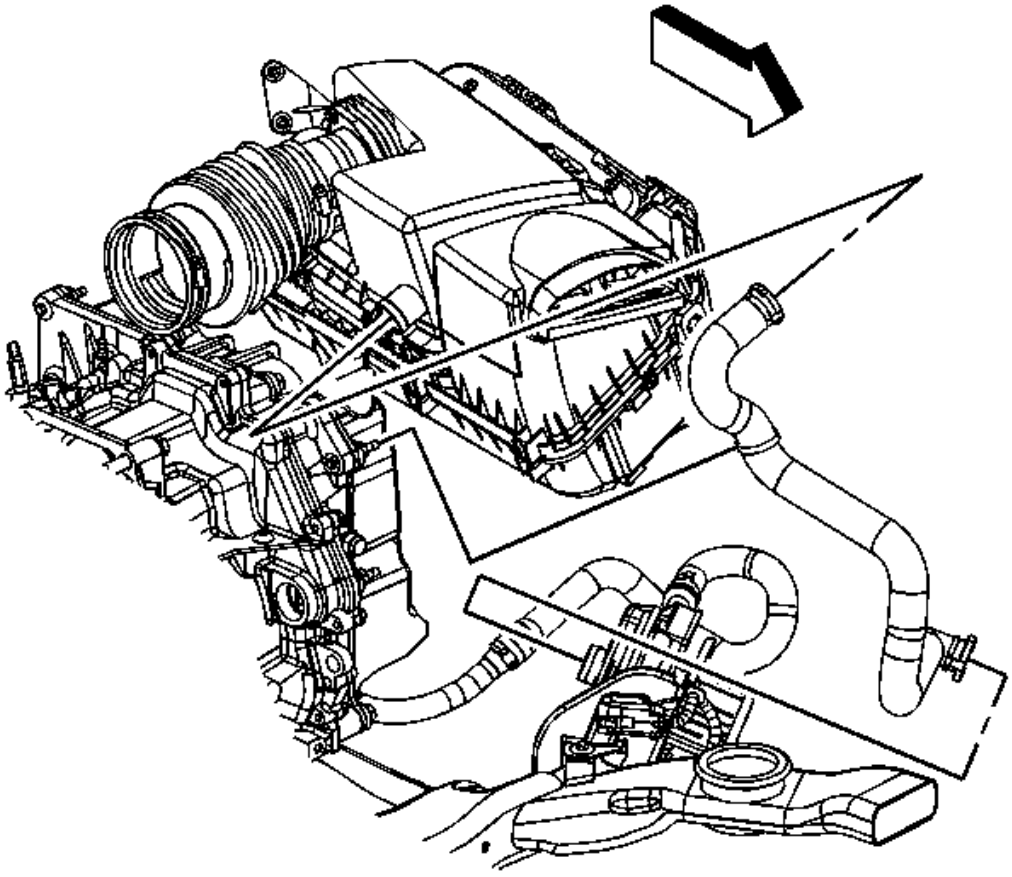


Fig. 504: Identifying Secondary AIR Pump Inlet Tube/Hose
Courtesy of GENERAL MOTORS COMPANY

71. Install the AIR inlet hose.
72. Connect the AIR inlet hose quick connect fitting to the AIR pump. Refer to **Plastic Collar Quick Connect Fitting Service** .
73. Install the AIR inlet hose retainer to the transaxle stud.

 © 2011 Mitchell Repair Information Company, LLC.

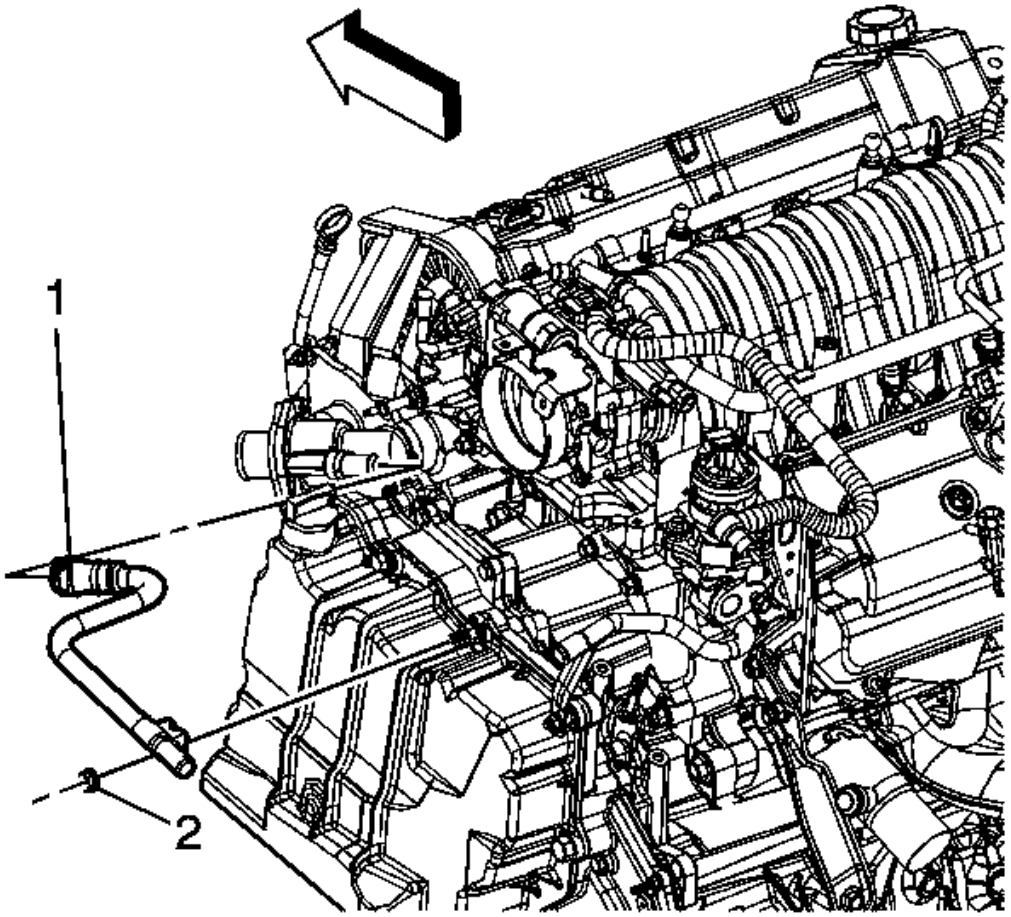


Fig. 505: Identifying Heater Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

74. Install the heater outlet pipe to the engine and stud.
75. Install the heater outlet pipe nut (2) to the transaxle stud.

Tighten

Tighten the nut to 25 N.m (18 lb ft).

76. Position the heater outlet pipe clamp (1) at the water pump housing.

 © 2011 Mitchell Repair Information Company, LLC.

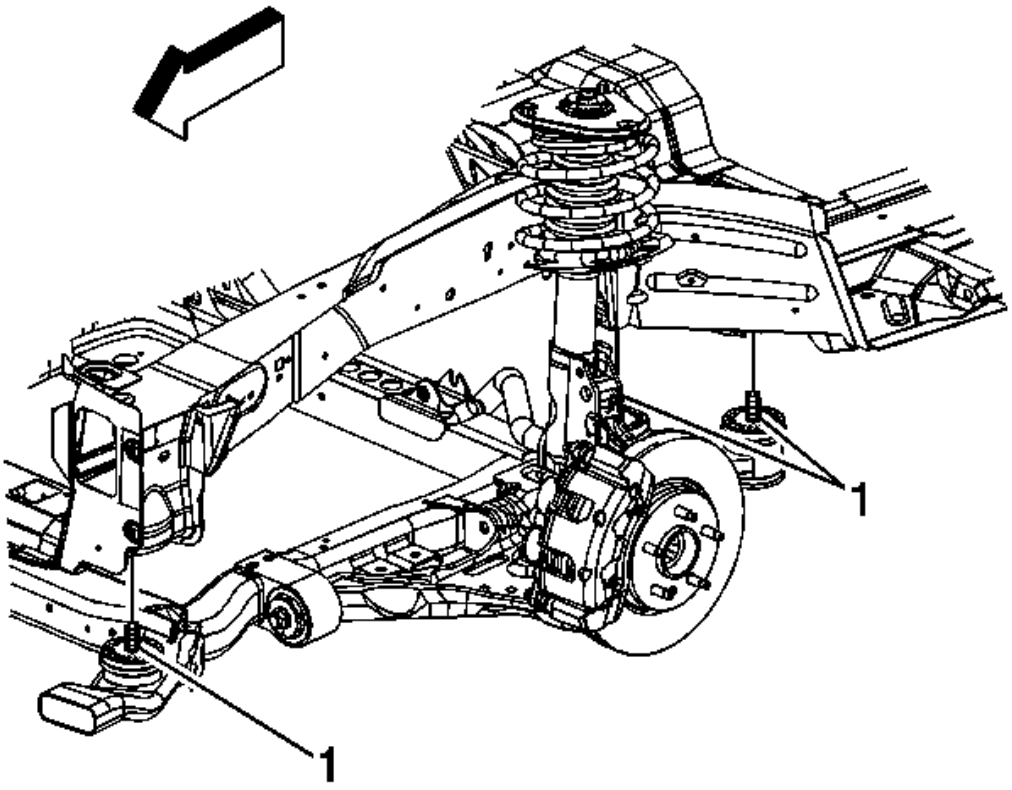


Fig. 506: Identifying Rearward Engine Frame-To-Body Bolts
Courtesy of GENERAL MOTORS COMPANY

77. Position the engine/transaxle assembly under the vehicle.

NOTE: Ensure clearance is maintained between the engine/transaxle assembly and the following:

- **The A/C compressor components**
- **The brake pipes**
- **The heater hoses**
- **The radiator hoses**
- **The wheel speed sensor leads**
- **The wiring harnesses**

78. Carefully lower the vehicle over the engine/transaxle assembly, aligning the struts to the strut towers.
79. Install the 6 bolts (1) attaching the frame to the body. (Left side shown, right side similar).

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the bolts to 191 N.m (141 lb ft).

80. Install the front fascia. Refer to **Front Bumper Fascia Replacement** .

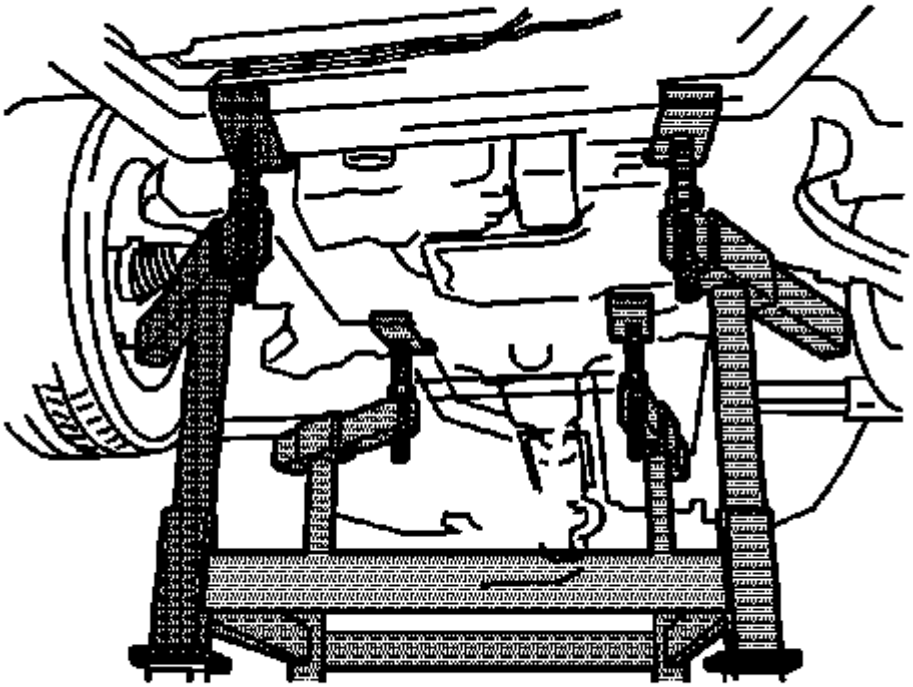


Fig. 507: Identifying Utility Stand
Courtesy of GENERAL MOTORS COMPANY

81. Raise the vehicle off of the **J 39580** or the jack stands.
82. Remove the **J 39580** or jack stands from under the frame.

 © 2011 Mitchell Repair Information Company, LLC.

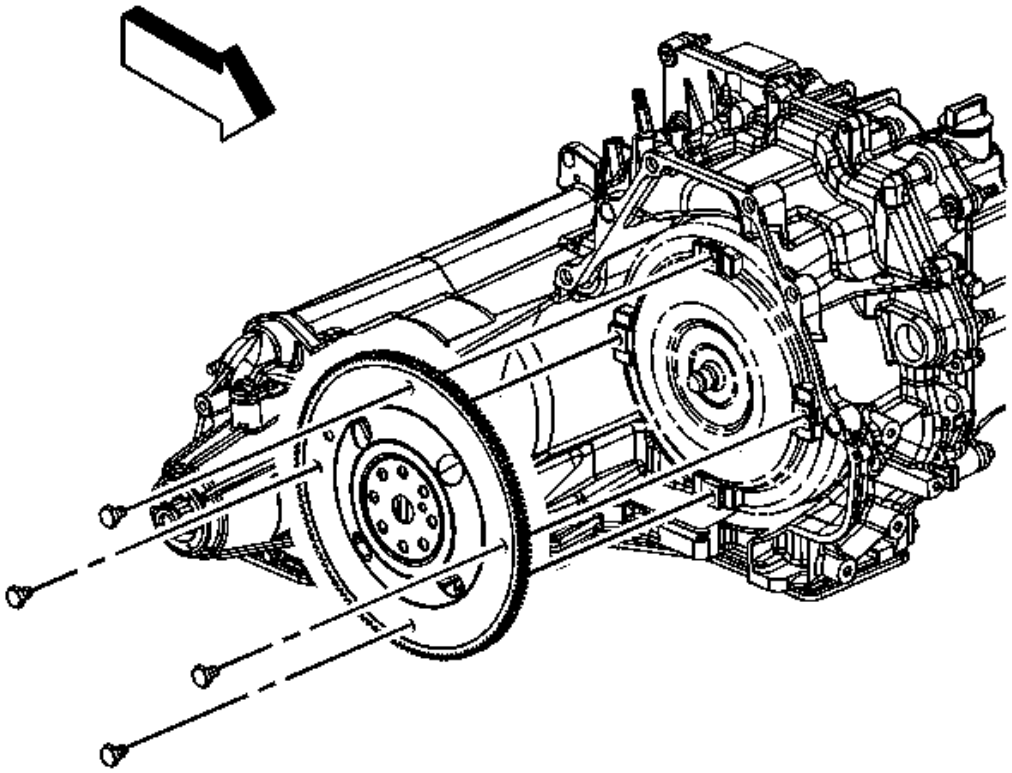


Fig. 508: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS COMPANY

83. Align the flywheel with the marks made during the removal.
84. Install the flywheel to torque converter bolts. (Engine removed for clarity).

Tighten

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

 © 2011 Mitchell Repair Information Company, LLC.

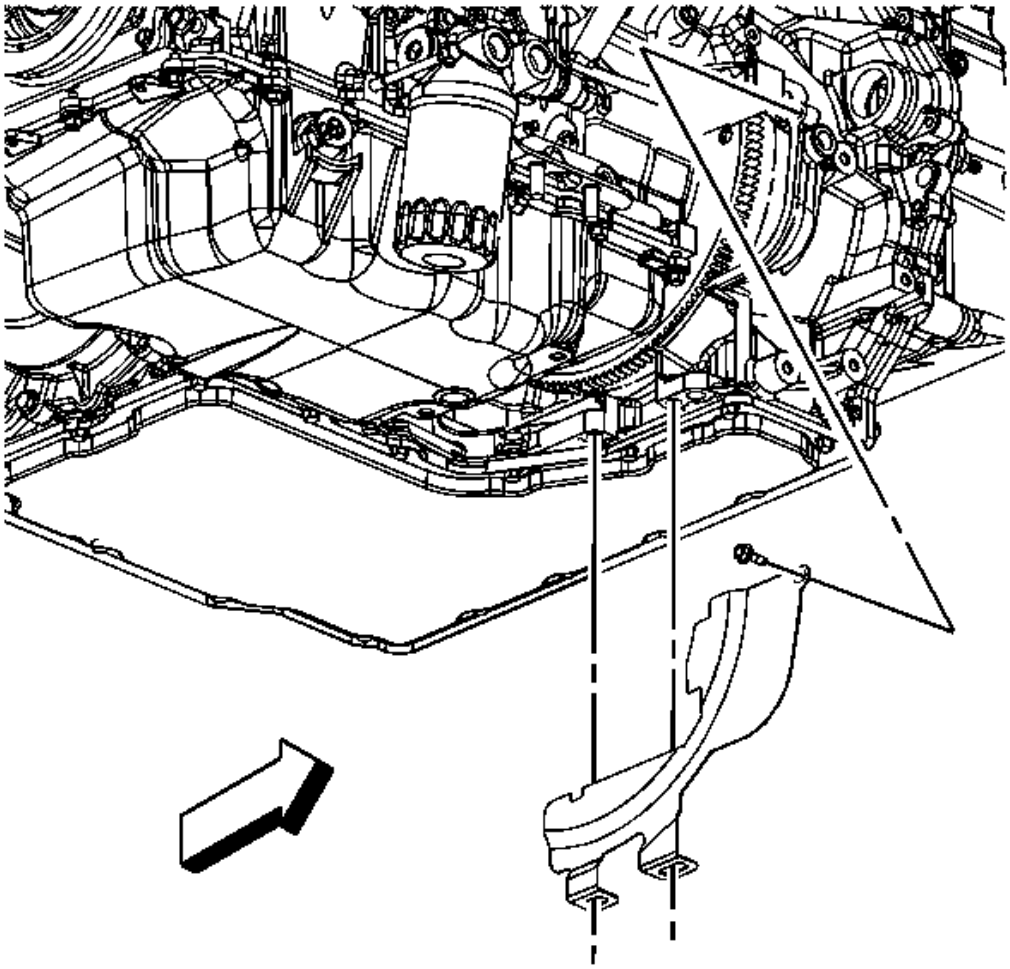


Fig. 509: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS COMPANY

85. Position the torque converter cover.
86. Install the torque converter cover bolt.

Tighten

Tighten the bolt to 12 N.m (106 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

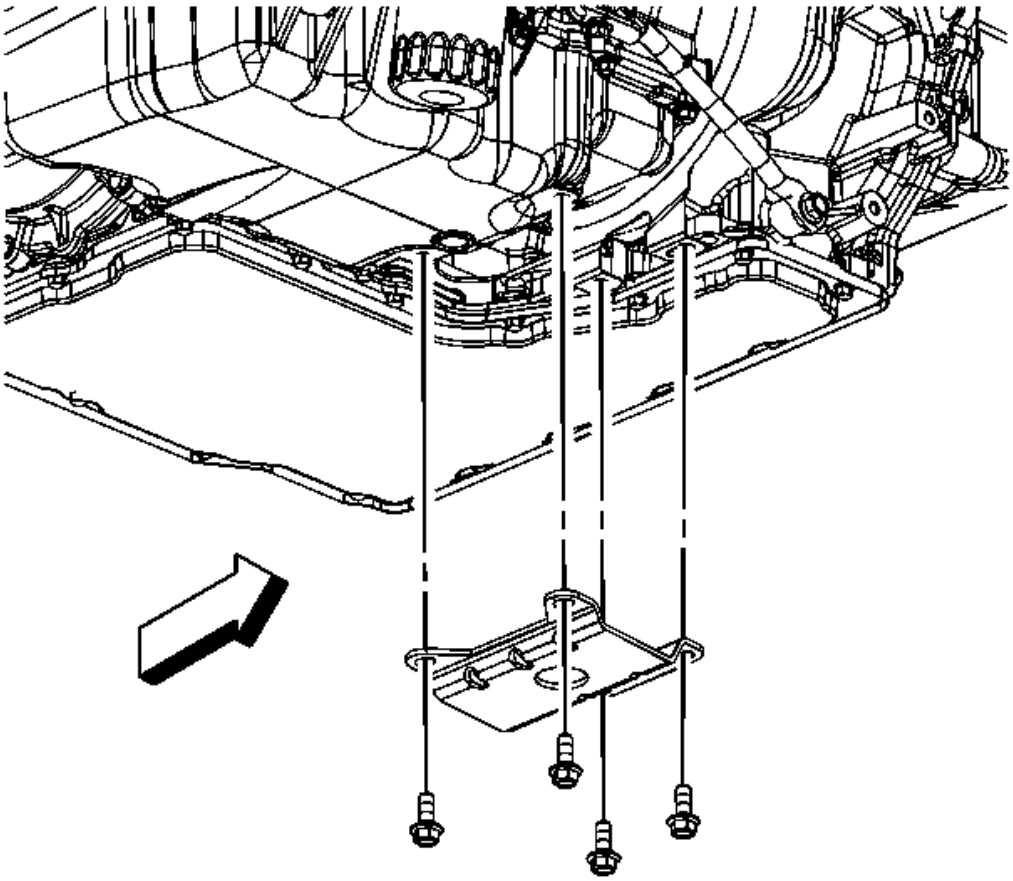


Fig. 510: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

87. Install the transaxle brace.
88. Install the transaxle brace bolts.

Tighten

Tighten the bolts to 47 N.m (35 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

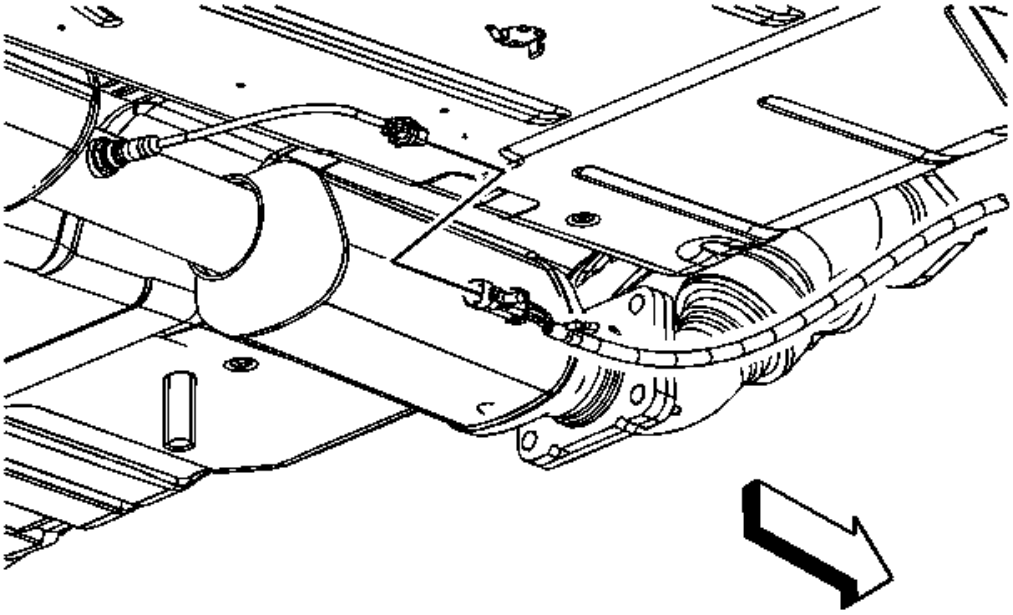


Fig. 511: Identifying Oxygen Sensor Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS COMPANY

89. Connect the engine harness electrical connector to the HO2S.
90. Install the oxygen sensor wiring harness heat shield. Refer to **Oxygen Sensor Wiring Harness Heat Shield Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

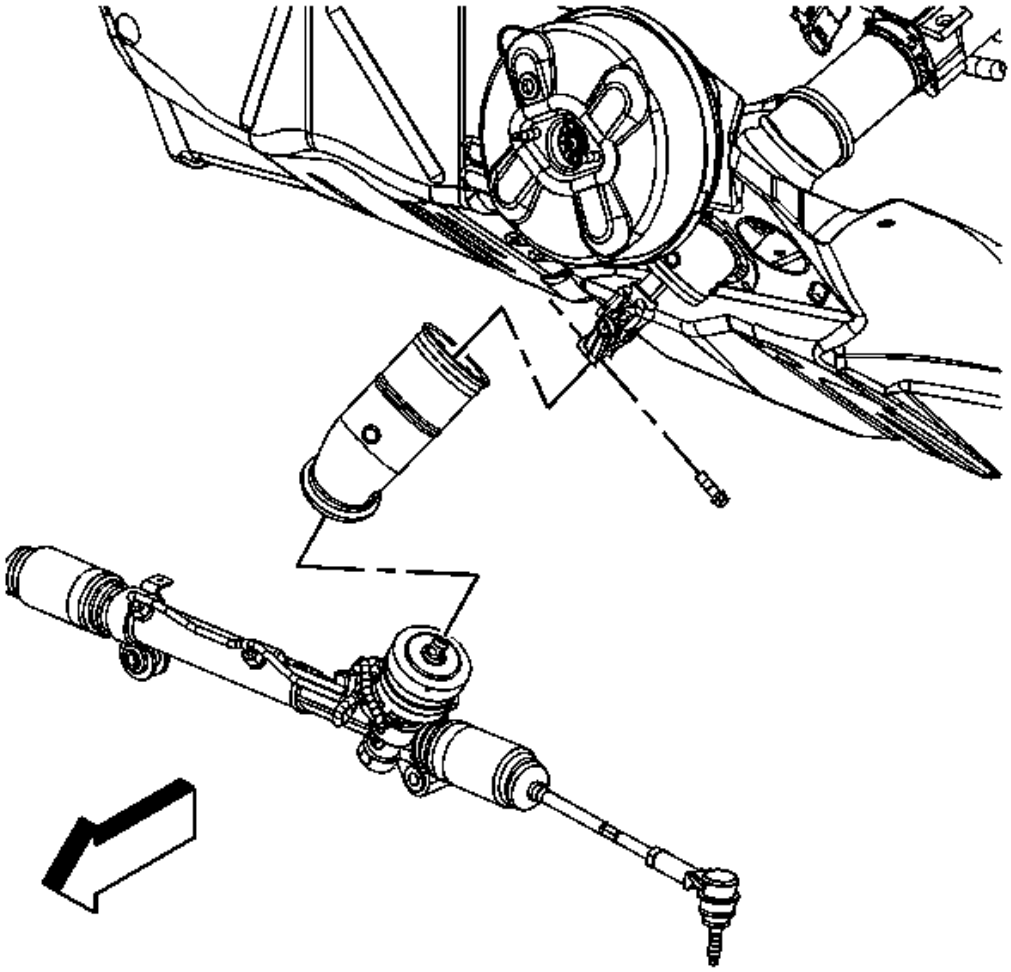


Fig. 512: Identifying Steering Gear & Related Attachments
Courtesy of GENERAL MOTORS COMPANY

WARNING: When installing the intermediate shaft make sure that the shaft is seated prior to pinch bolt installation. If the pinch bolt is inserted into the coupling before shaft installation, the two mating shafts may disengage. Disengagement of the two mating shafts will cause loss of steering control which could result in personal injury.

91. Install the intermediate shaft to the steering gear.
92. Install the intermediate shaft pinch bolt.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the bolt to 45 N.m (33 lb ft).

93. Install the intermediate steering shaft cover.

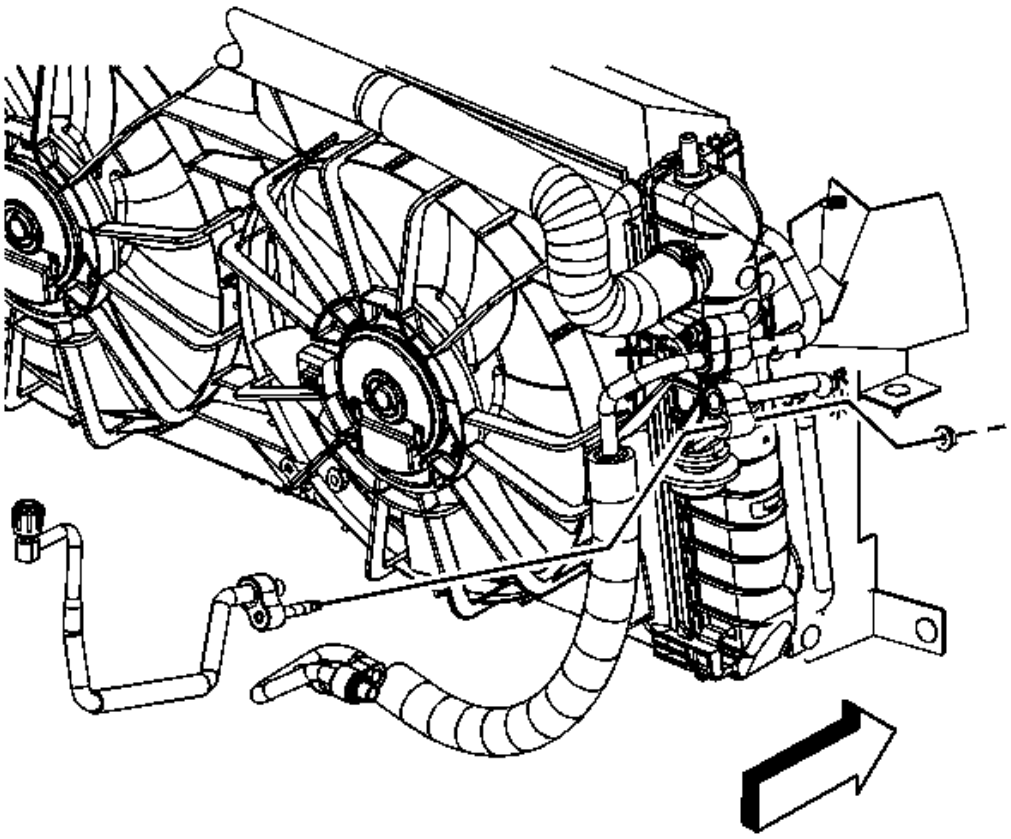


Fig. 513: View Of A/C Suction Hose & Condenser
Courtesy of GENERAL MOTORS COMPANY

94. Remove the plug from the A/C condenser suction port.
95. Unsecure the A/C compressor suction hose from the engine.
96. Remove and discard the old sealing washer from the condenser end of the suction hose.
97. Install a NEW sealing washer to the condenser end of the suction hose.
98. Install the A/C compressor suction hose to the condenser.
99. Install the A/C compressor suction hose nut.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the nut to 16 N.m (12 lb ft).

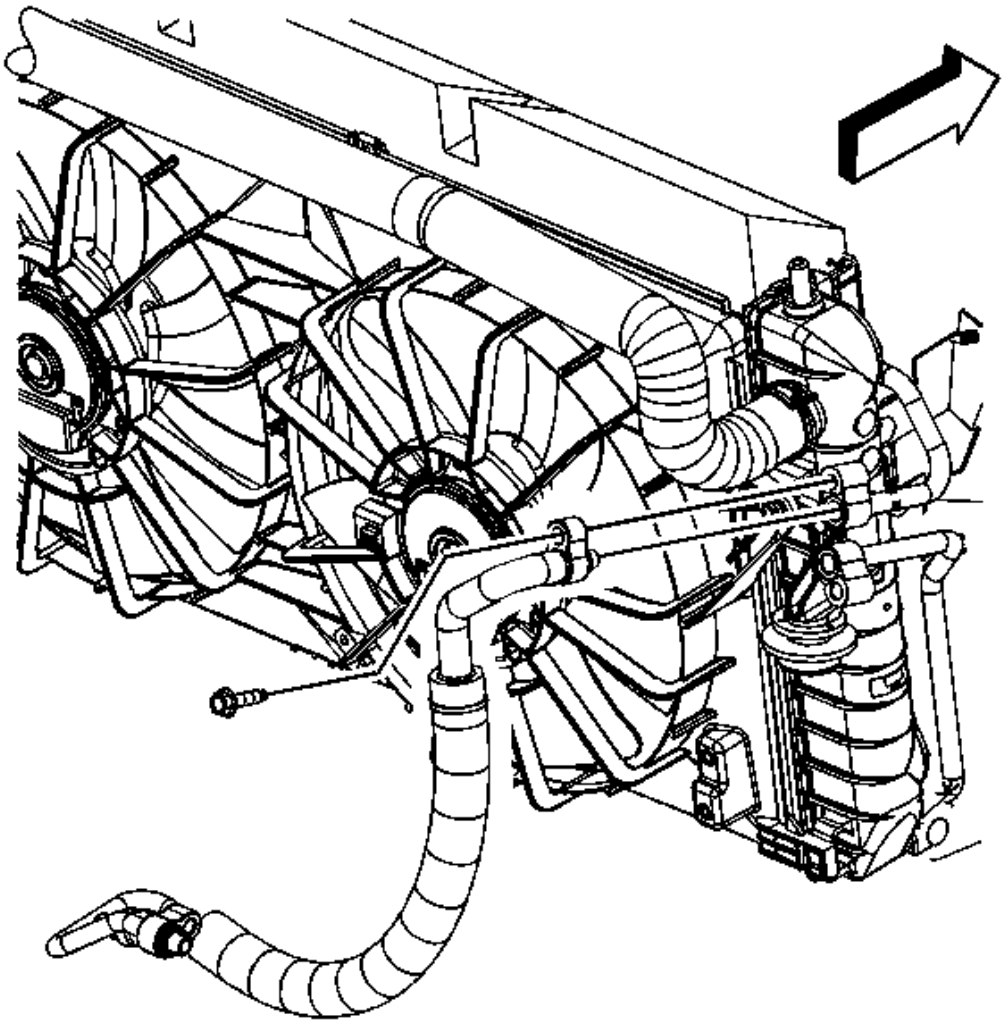


Fig. 514: View Of A/C Discharge Hose & Condenser
Courtesy of GENERAL MOTORS COMPANY

100. Remove the plug from the A/C condenser discharge port.
101. Unsecure the A/C compressor discharge hose from the engine.
102. Remove and discard the old sealing washer from the condenser end of the discharge hose.
103. Install a NEW sealing washer to the condenser end of the discharge hose.
104. Install the A/C compressor discharge hose to the condenser.

 © 2011 Mitchell Repair Information Company, LLC.

105. Install the A/C compressor discharge hose nut.

Tighten

Tighten the nut to 16 N.m (12 lb ft).

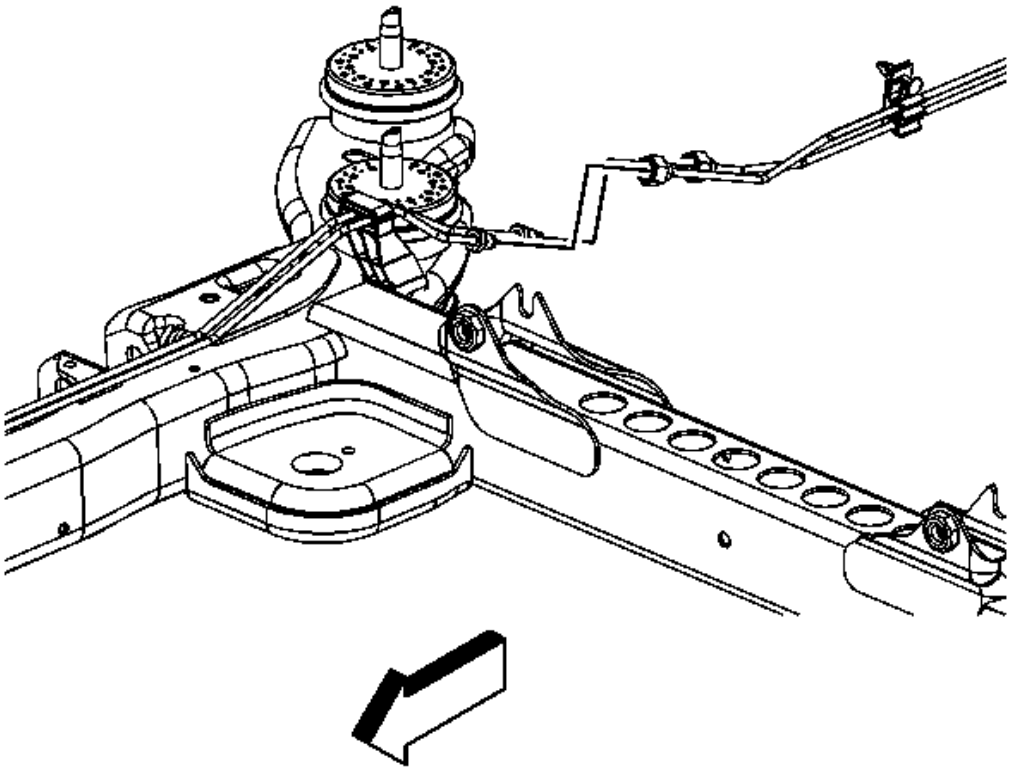


Fig. 515: Identifying Rear Brake Pipes/Lines
Courtesy of GENERAL MOTORS COMPANY

106. Remove the plugs from the open brake lines.
107. Connect the rear brake pipes to the front brake pipes.

Tighten

Tighten the fittings to 20 N.m (15 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

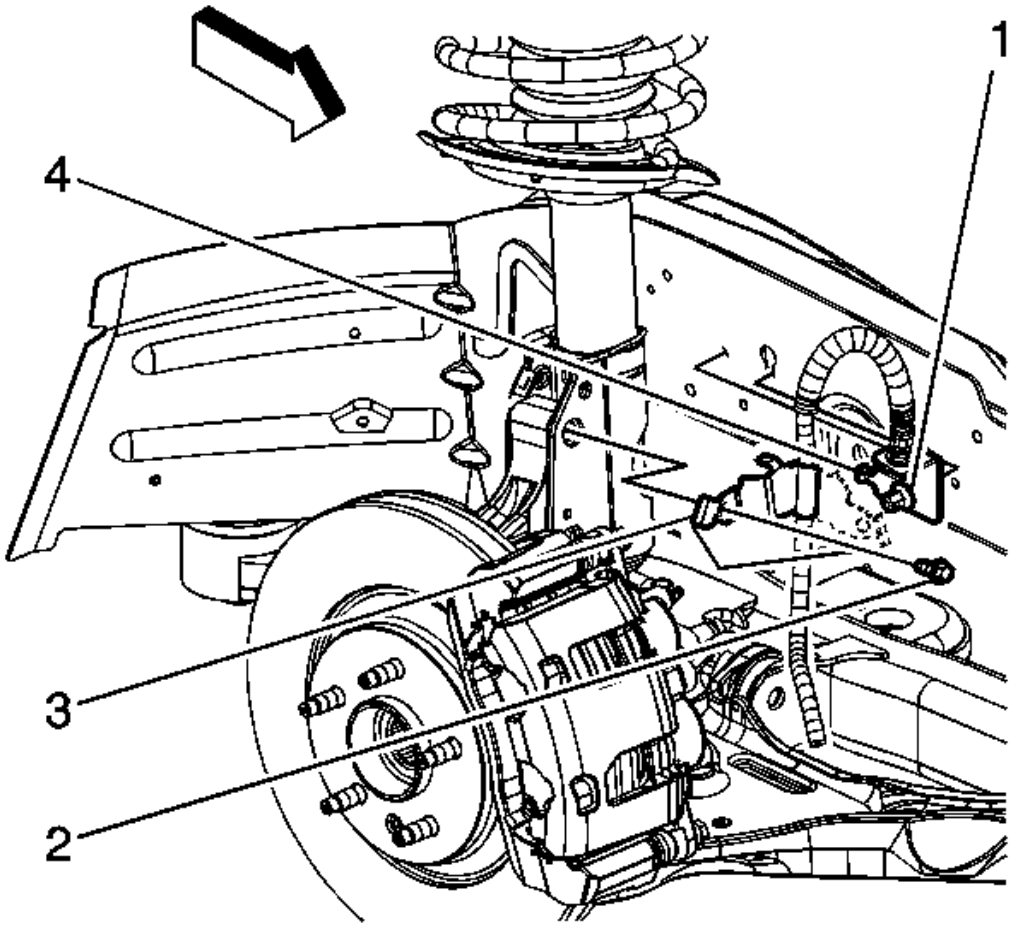


Fig. 516: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

108. Install the front brake pipe bracket (4) to the body frame rail.
109. Tighten the nut (1) securing the right front brake pipe bracket (4) to the body frame rail.

Tighten

Tighten the nut to 9 N.m (80 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

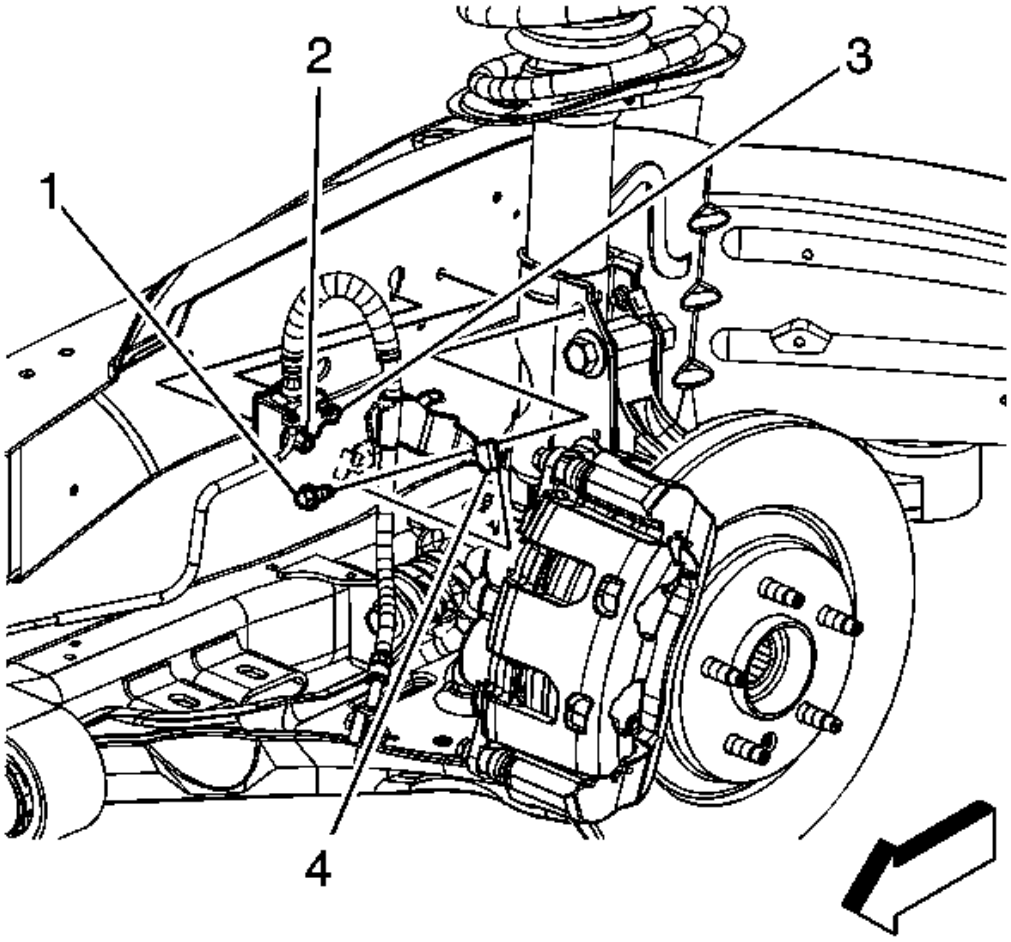


Fig. 517: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

110. Install the front brake pipe bracket (4) to the body frame rail.
111. Tighten the nut (2) securing the left front brake pipe bracket (4) to the body frame rail.

Tighten

Tighten the nut to 9 N.m (80 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

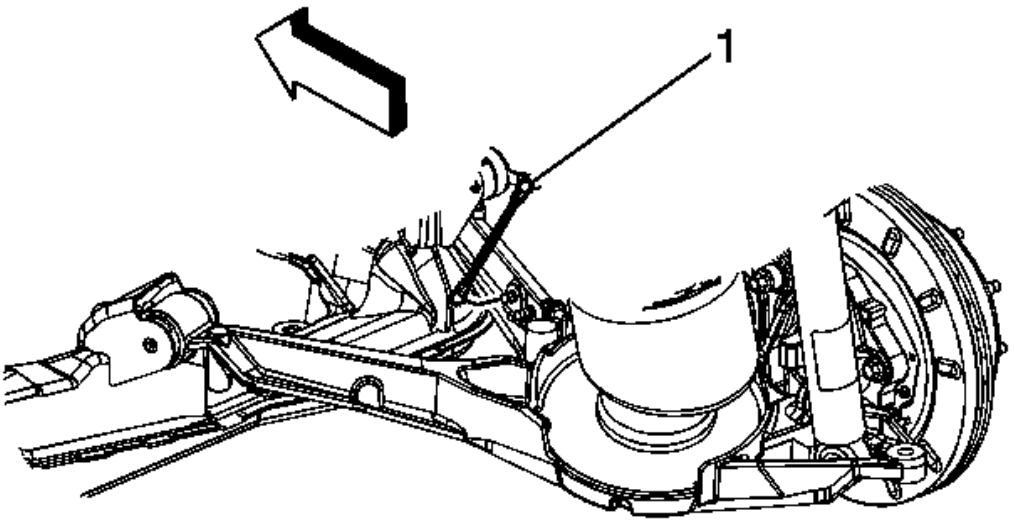


Fig. 518: Identifying Electronic Suspension Front Position Sensor Link
Courtesy of GENERAL MOTORS COMPANY

112. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
113. Connect the electronic suspension front position sensor link to the lower control arms ball stud, if equipped.

 © 2011 Mitchell Repair Information Company, LLC.

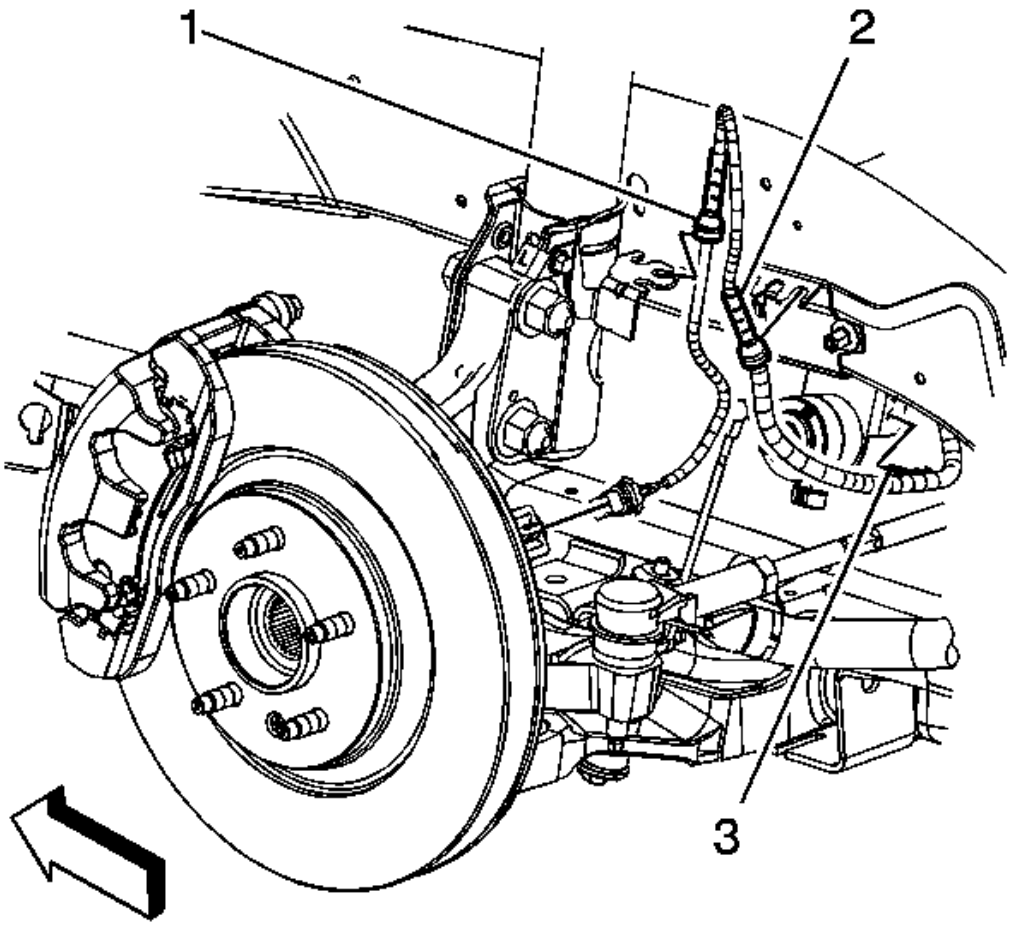


Fig. 519: Identifying Engine Harness Grommets & Clips
Courtesy of GENERAL MOTORS COMPANY

114. Install the engine harness clip (3) to the ride lever sensor bracket.
115. Install the engine harness grommet (2) to the frame rail bracket.
116. Install the front wheels. Refer to **Tire and Wheel Removal and Installation** .
117. Install the rear exhaust manifold pipe. Refer to **Exhaust Manifold Rear Pipe Replacement (L37)** .
118. Lower the vehicle.

 © 2011 Mitchell Repair Information Company, LLC.

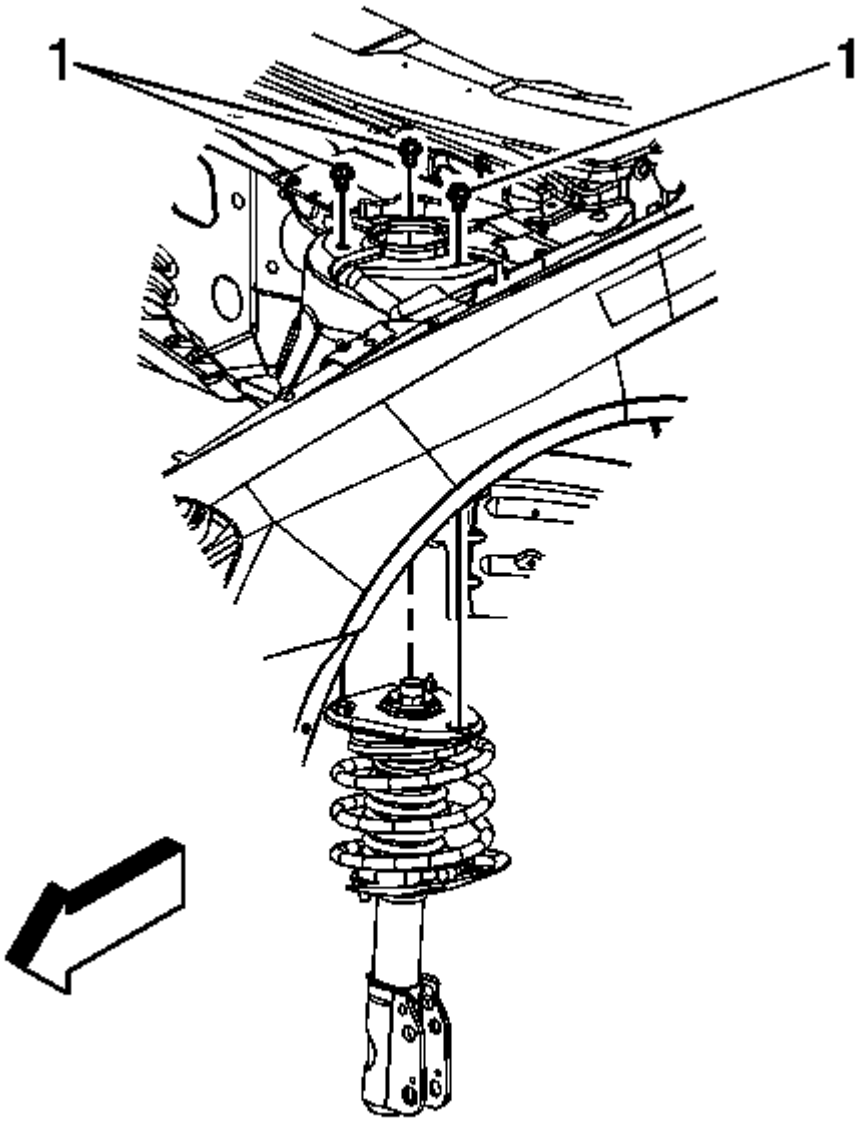


Fig. 520: Locating Strut Tower Bolts
Courtesy of GENERAL MOTORS COMPANY

119. Install the left and right side strut tower bolts (1). (Left side shown, right side similar).

Tighten

Tighten the bolts to 40 N.m (30 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

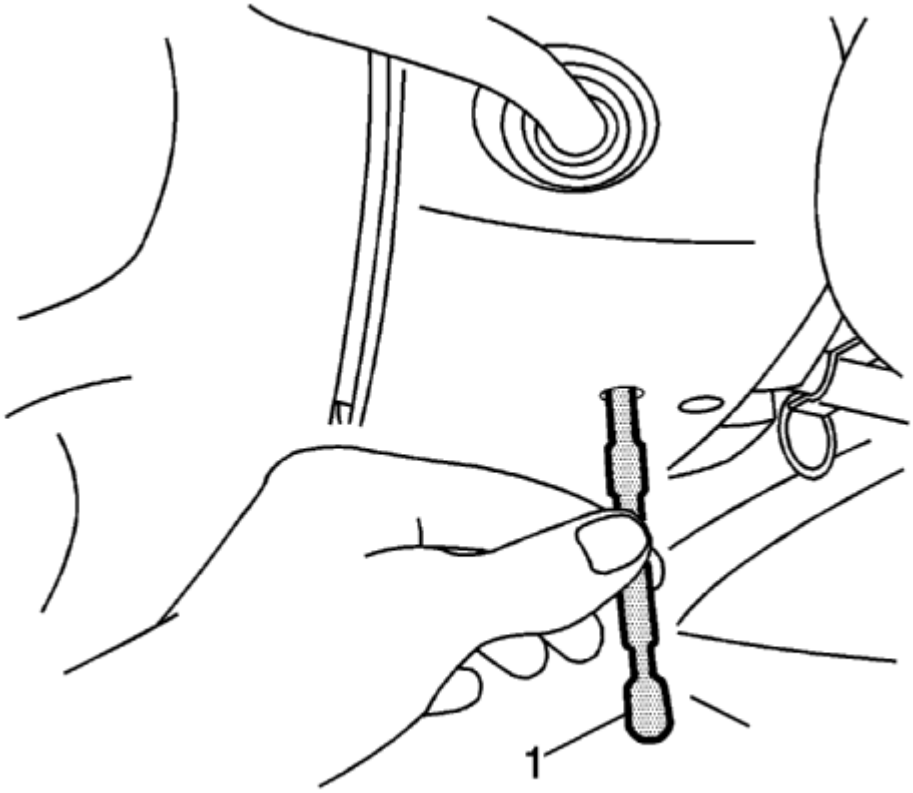


Fig. 521: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

120. Remove the **J 42640** from the steering column.

 © 2011 Mitchell Repair Information Company, LLC.

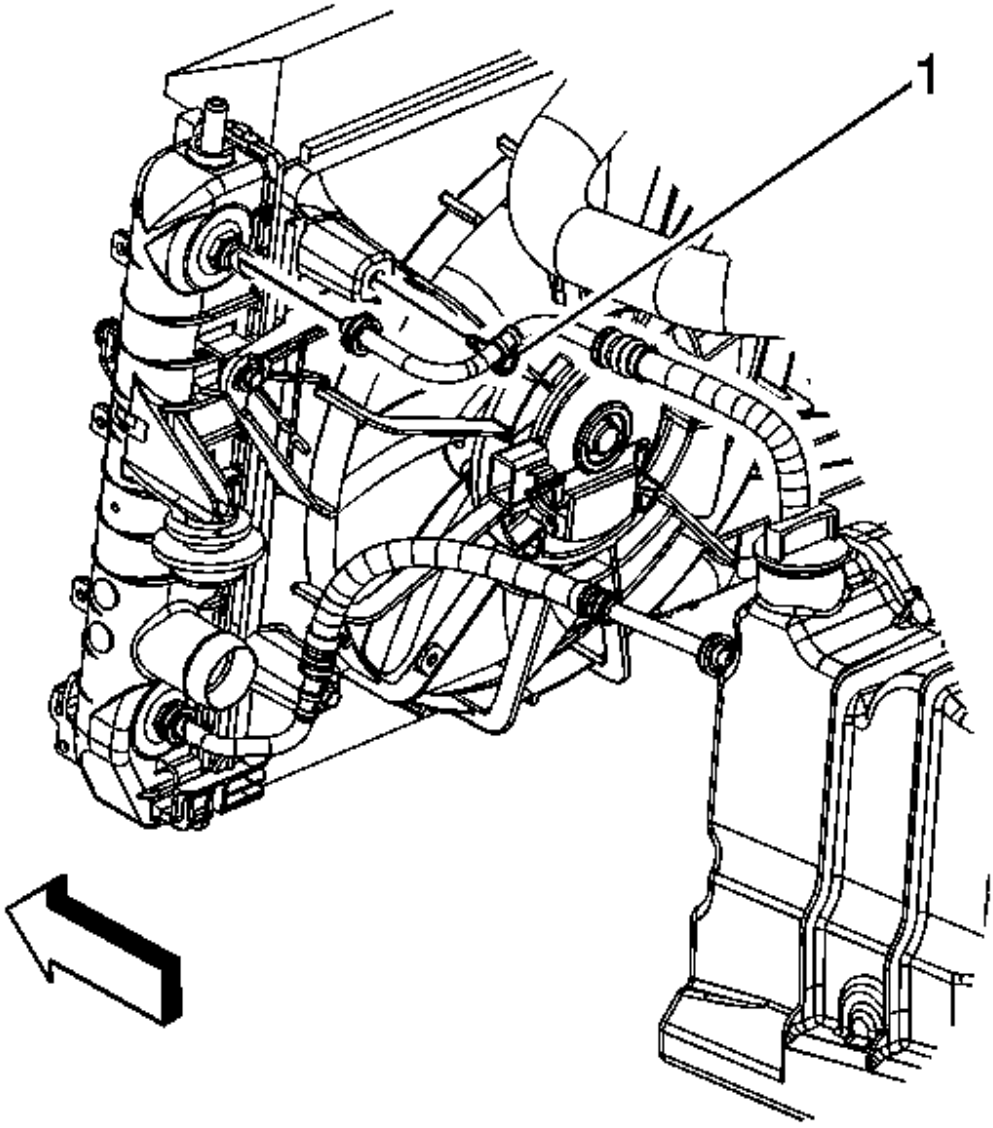


Fig. 522: Identifying Upper Transaxle Oil Cooler Pipe Bolt & Bolt
Courtesy of GENERAL MOTORS COMPANY

121. Connect the transaxle oil cooler pipes to the radiator.
122. Slide the plastic caps onto the transaxle oil cooler pipe quick connect fittings.
123. Tighten the upper transaxle oil cooler pipe bolt (1) to the fan shroud.

Tighten

 © 2011 Mitchell Repair Information Company, LLC.

Tighten the bolt to 6 N.m (53 lb in).

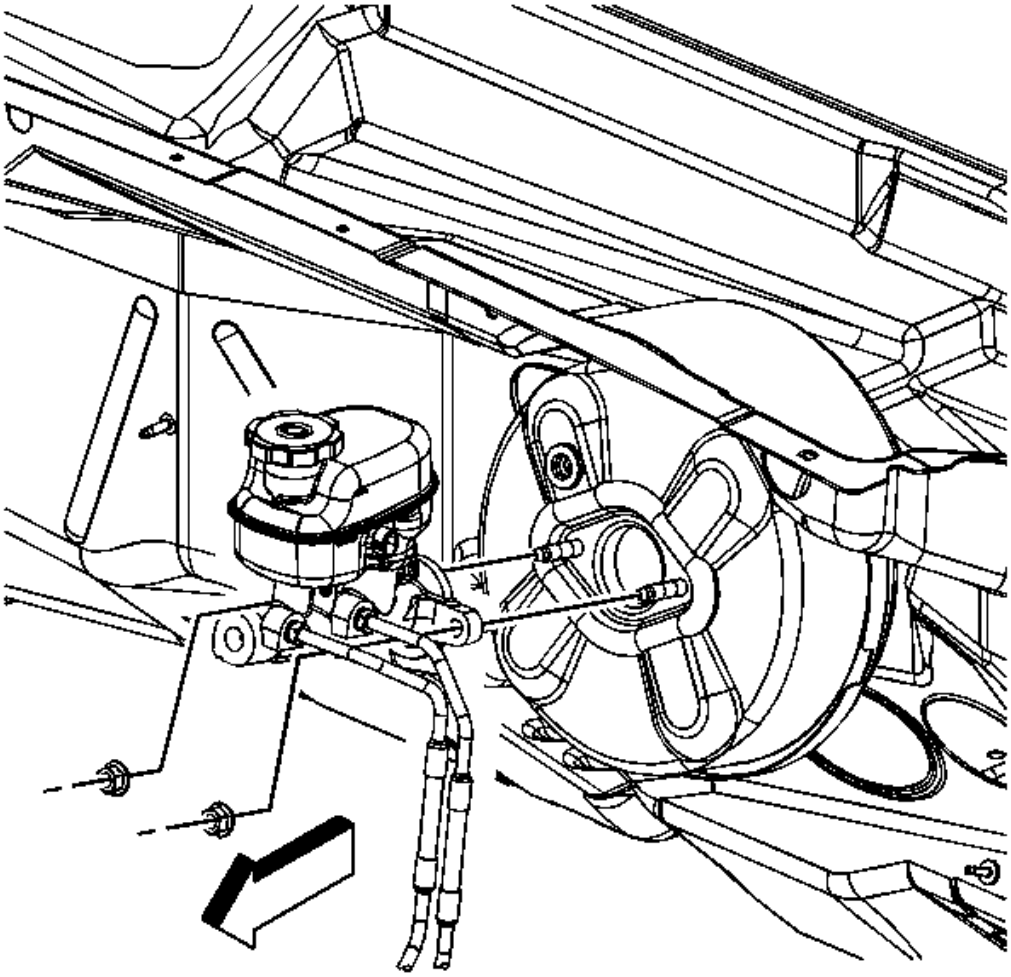


Fig. 523: View Of Master Cylinder & Brake Booster
Courtesy of GENERAL MOTORS COMPANY

124. Unsecure the master cylinder from the engine and position the master cylinder the brake booster.
125. Install the master cylinder nuts.

Tighten

Tighten the nuts to 30 N.m (22 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

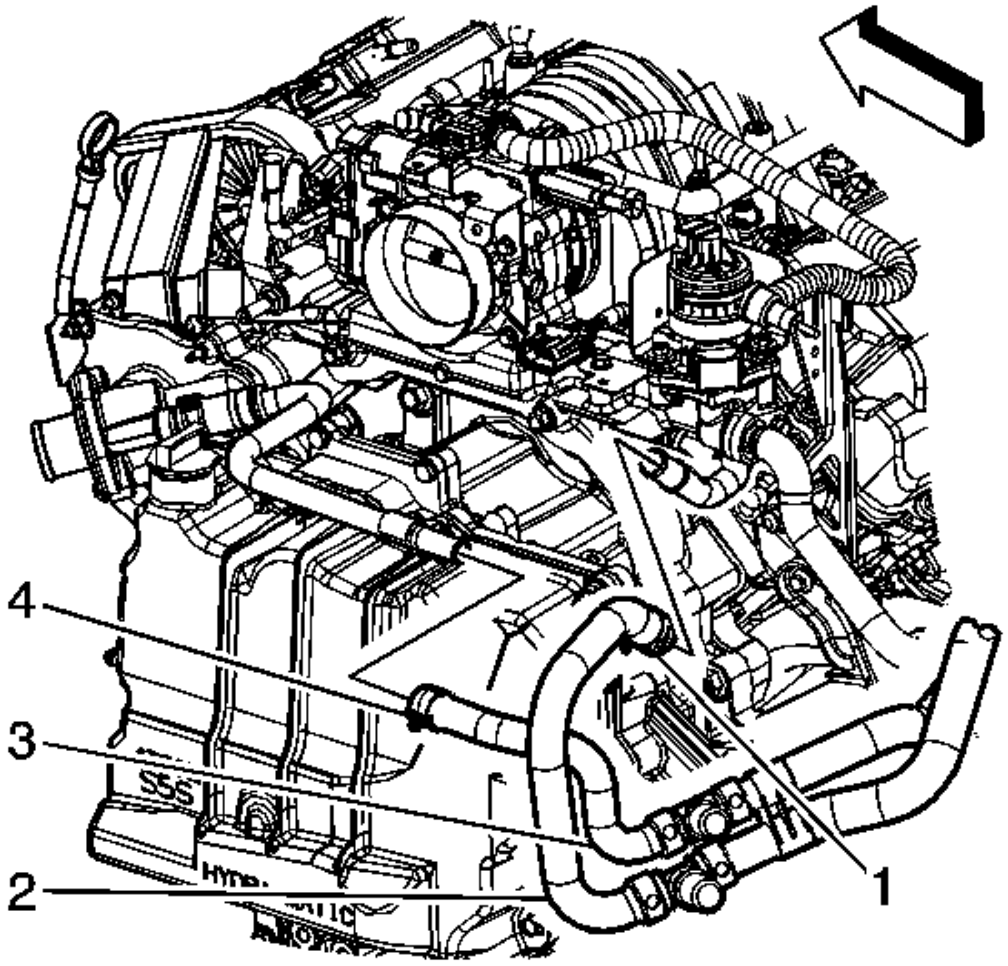


Fig. 524: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

126. Install the heater inlet (2) and outlet (3) hoses to the heater pipes.
127. Position the heater inlet (1) and outlet (2) hose clamps at the heater pipes.

 © 2011 Mitchell Repair Information Company, LLC.

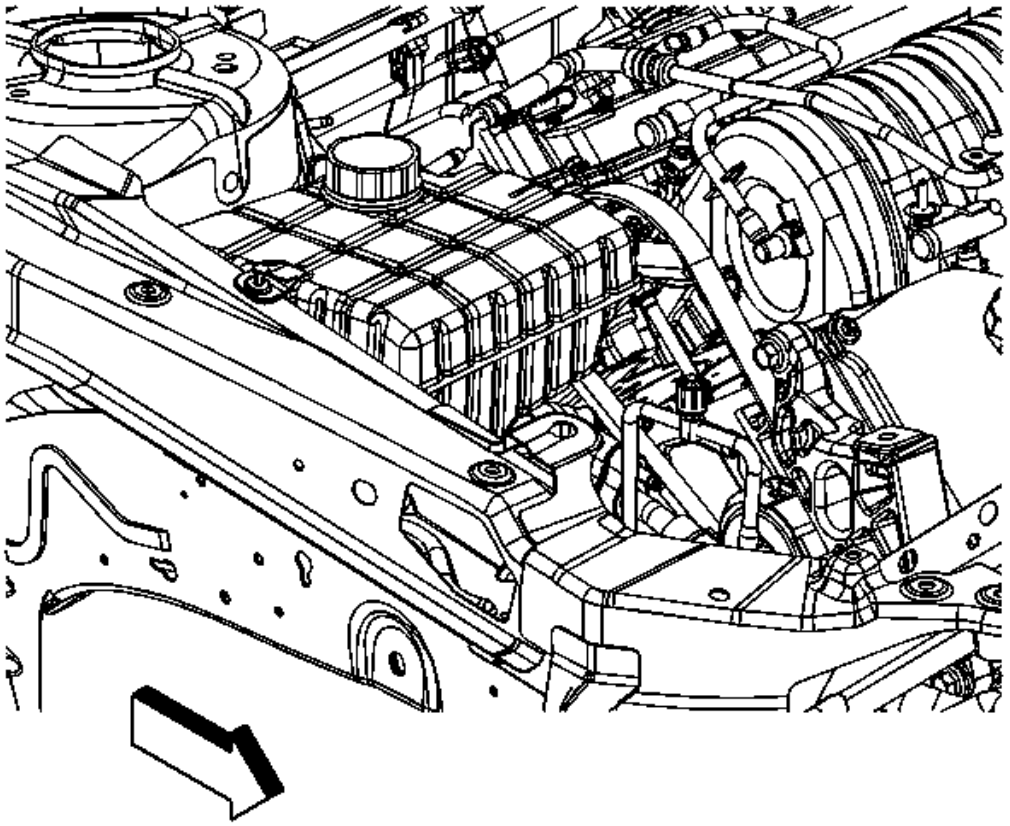


Fig. 525: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

128. Install the surge tank inlet hose to the surge tank.
129. Position the radiator surge tank inlet hose clamp at the surge tank.

 © 2011 Mitchell Repair Information Company, LLC.

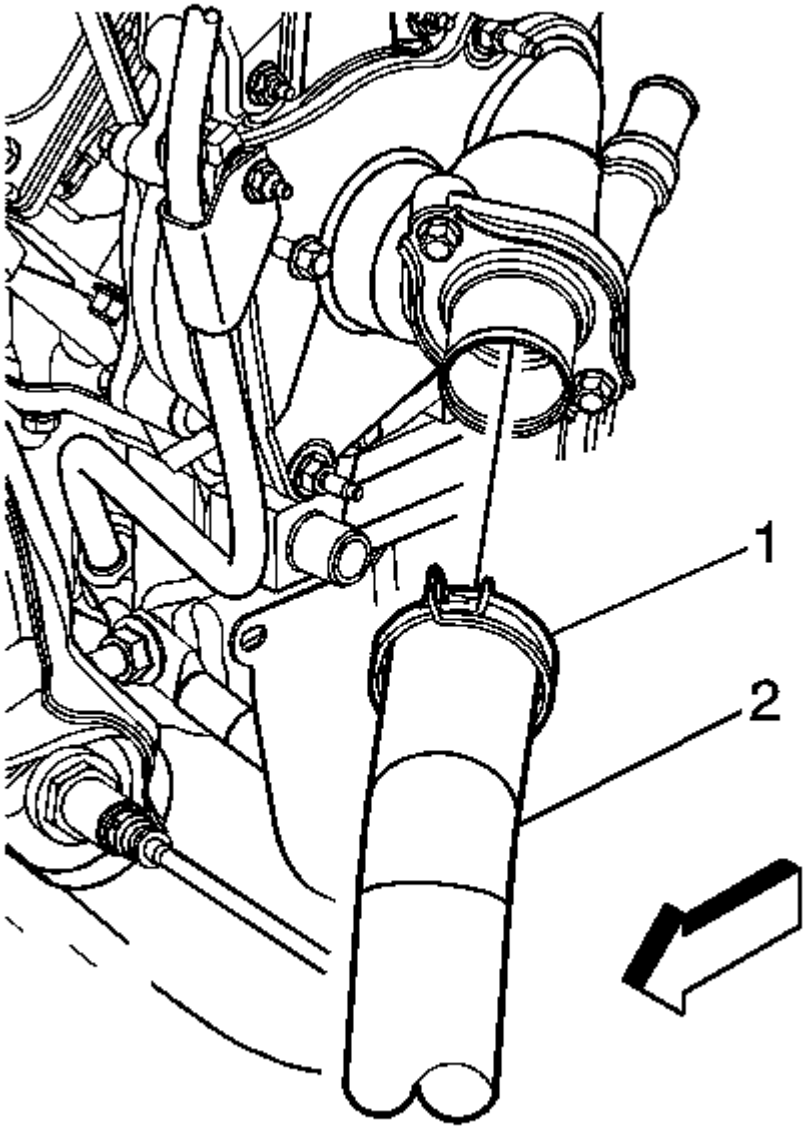


Fig. 526: View Of Radiator Outlet Hose At Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

130. Install the radiator outlet hose (2) to the thermostat housing.
131. Using the **J 38185** position the radiator outlet hose clamp (1).

 © 2011 Mitchell Repair Information Company, LLC.

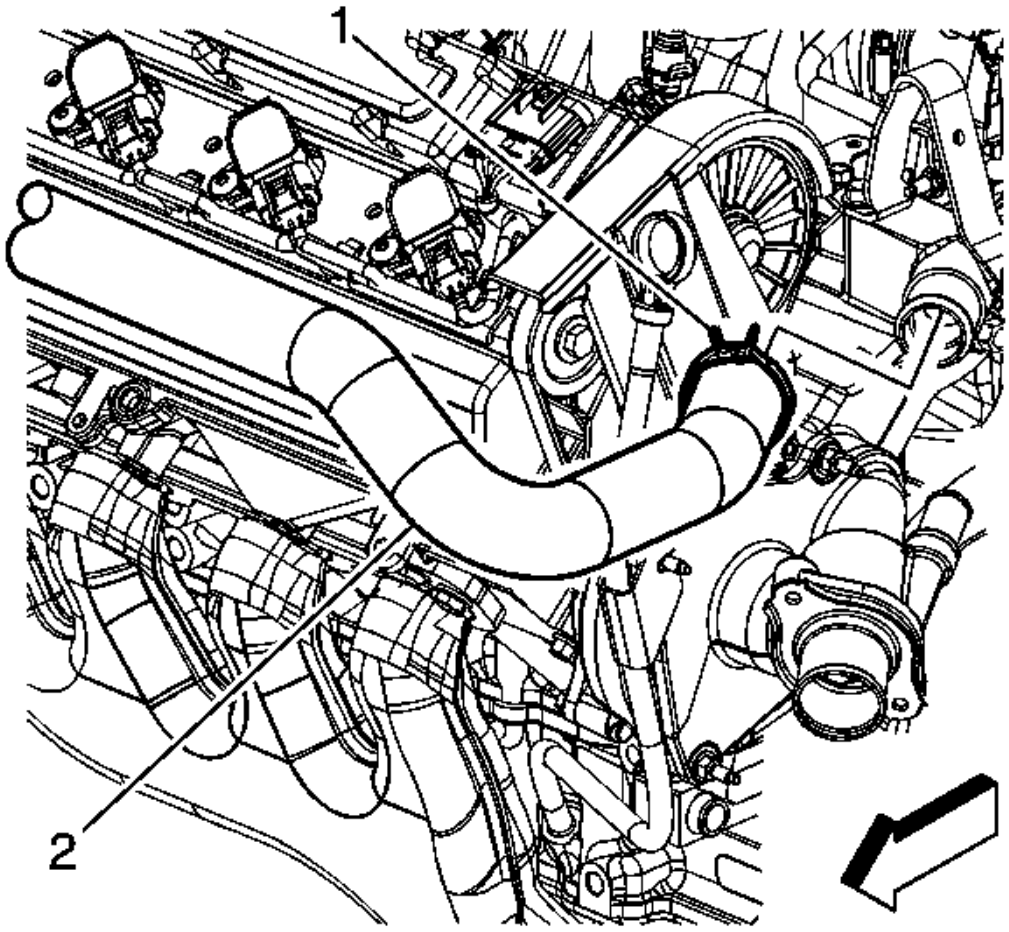


Fig. 527: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

132. Install the radiator inlet hose (2) to the water pump housing.
133. Using the **J 37097-A** position the radiator inlet hose clamp (1).

 © 2011 Mitchell Repair Information Company, LLC.

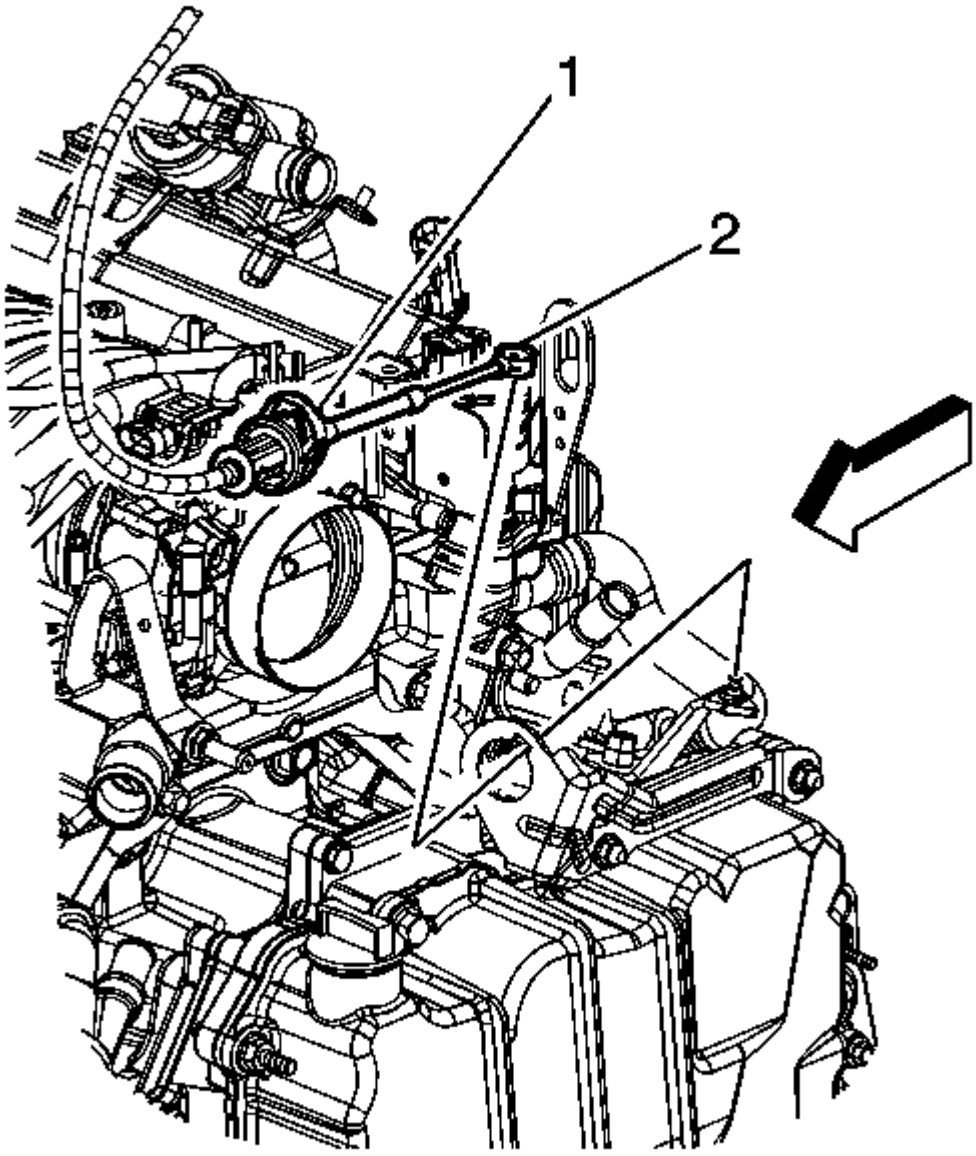


Fig. 528: View Of Transaxle Shift Cable
Courtesy of GENERAL MOTORS COMPANY

134. Install the transaxle shift cable to the bracket.
135. Connect the transaxle shift cable end (2) to the range selector lever (1).

 © 2011 Mitchell Repair Information Company, LLC.

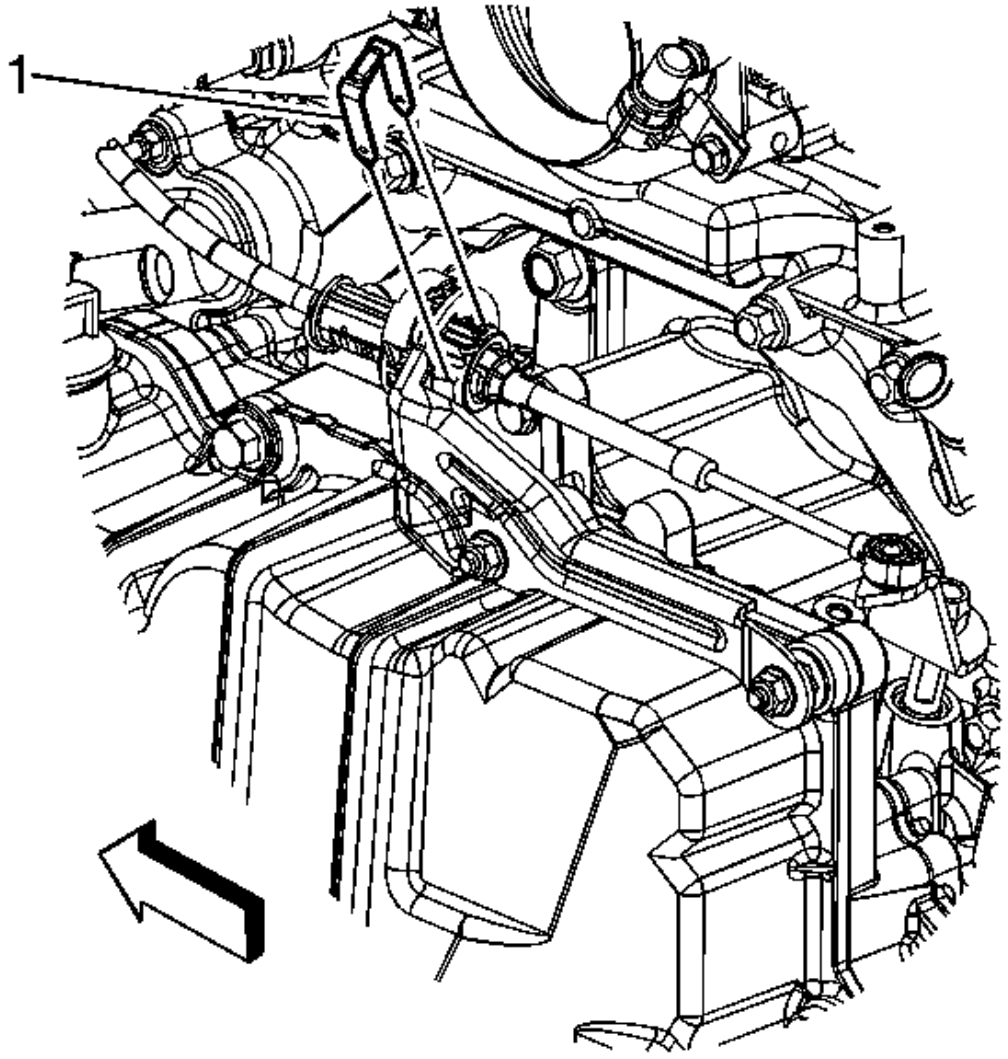


Fig. 529: Identifying Transaxle Shift Cable Retainer
Courtesy of GENERAL MOTORS COMPANY

136. Install the transaxle shift cable retainer (1).

 © 2011 Mitchell Repair Information Company, LLC.

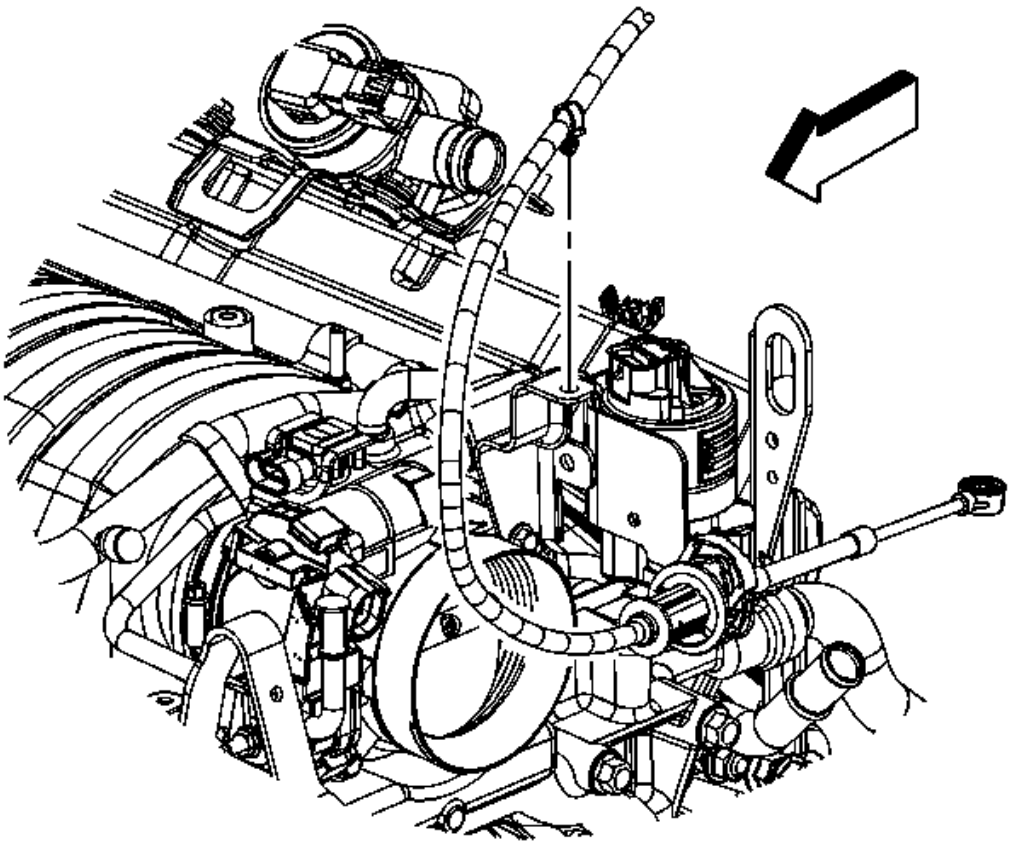


Fig. 530: Identifying Transaxle Shift Cable
Courtesy of GENERAL MOTORS COMPANY

137. Install the transaxle shift cable clip to the shift cable bracket.

 © 2011 Mitchell Repair Information Company, LLC.

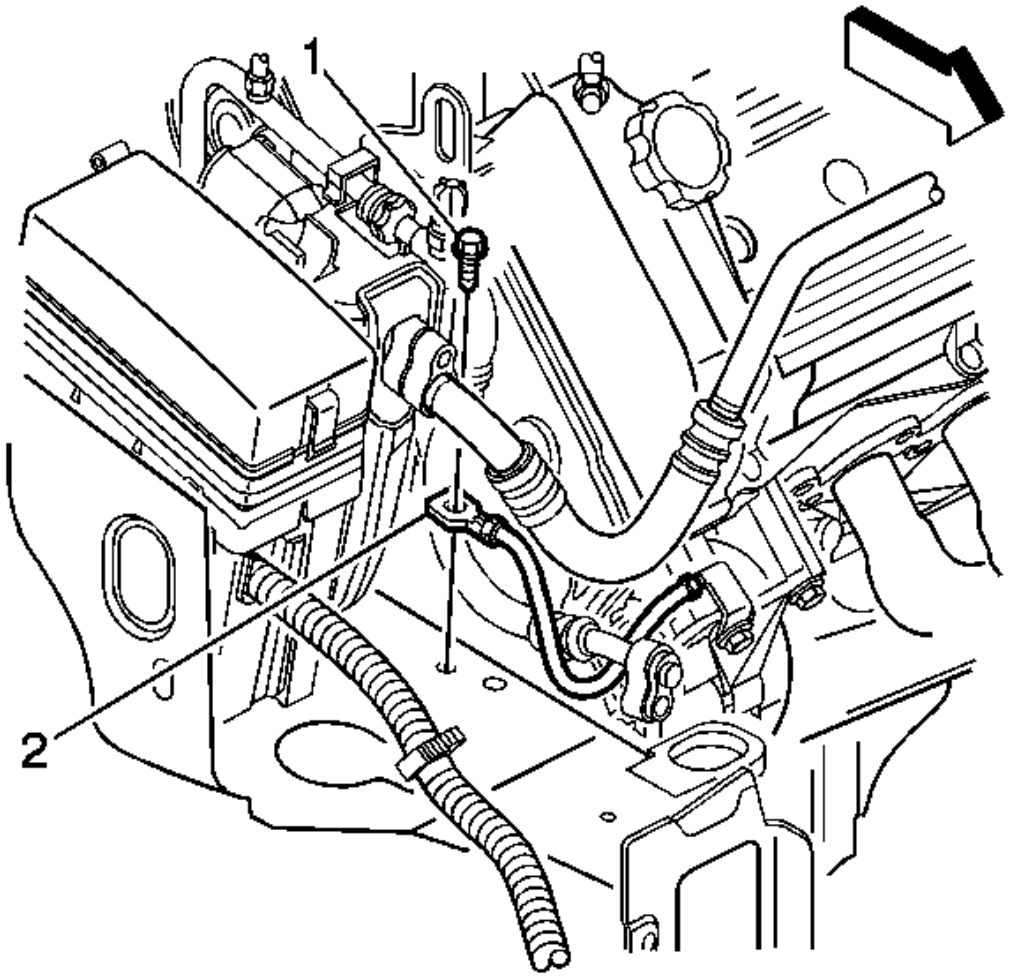


Fig. 531: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS COMPANY

138. Position the ground strap to the frame rail.
139. Install the engine ground strap bolt (1) to the right side frame rail.

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

 © 2011 Mitchell Repair Information Company, LLC.

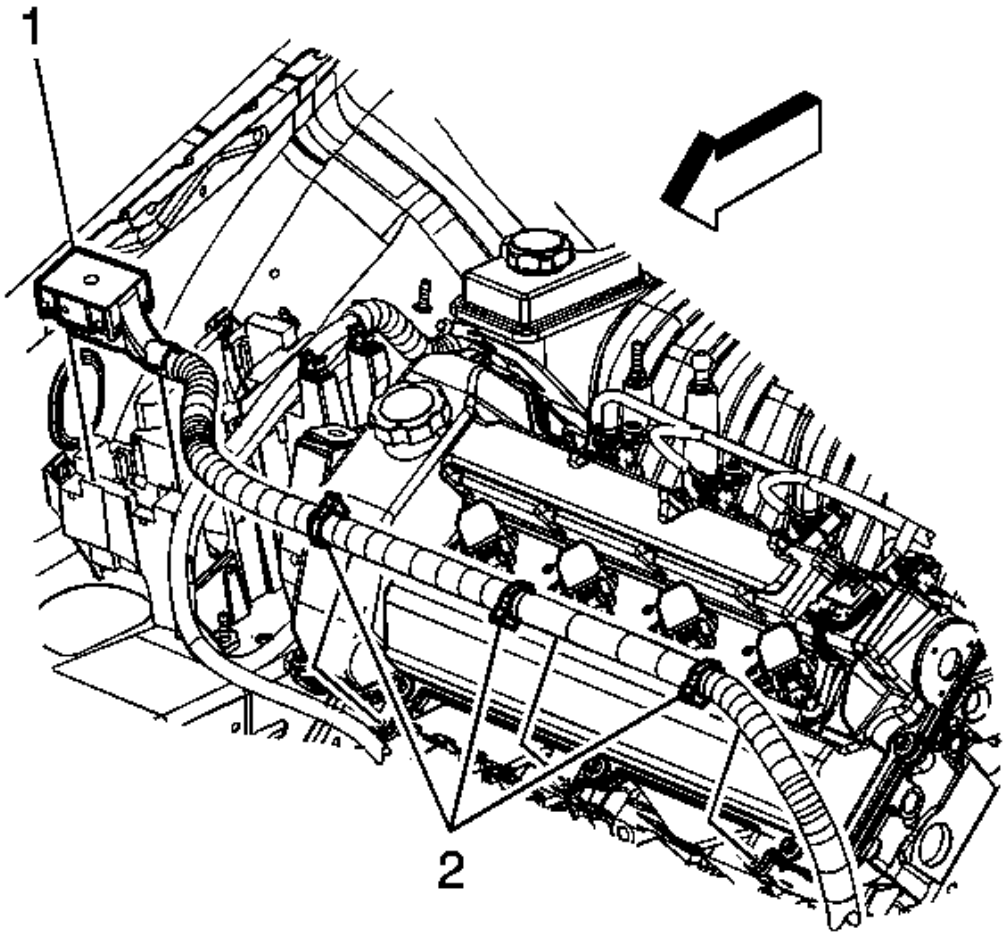


Fig. 532: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS COMPANY

140. Install the engine harness (1) to the BEC.

 © 2011 Mitchell Repair Information Company, LLC.

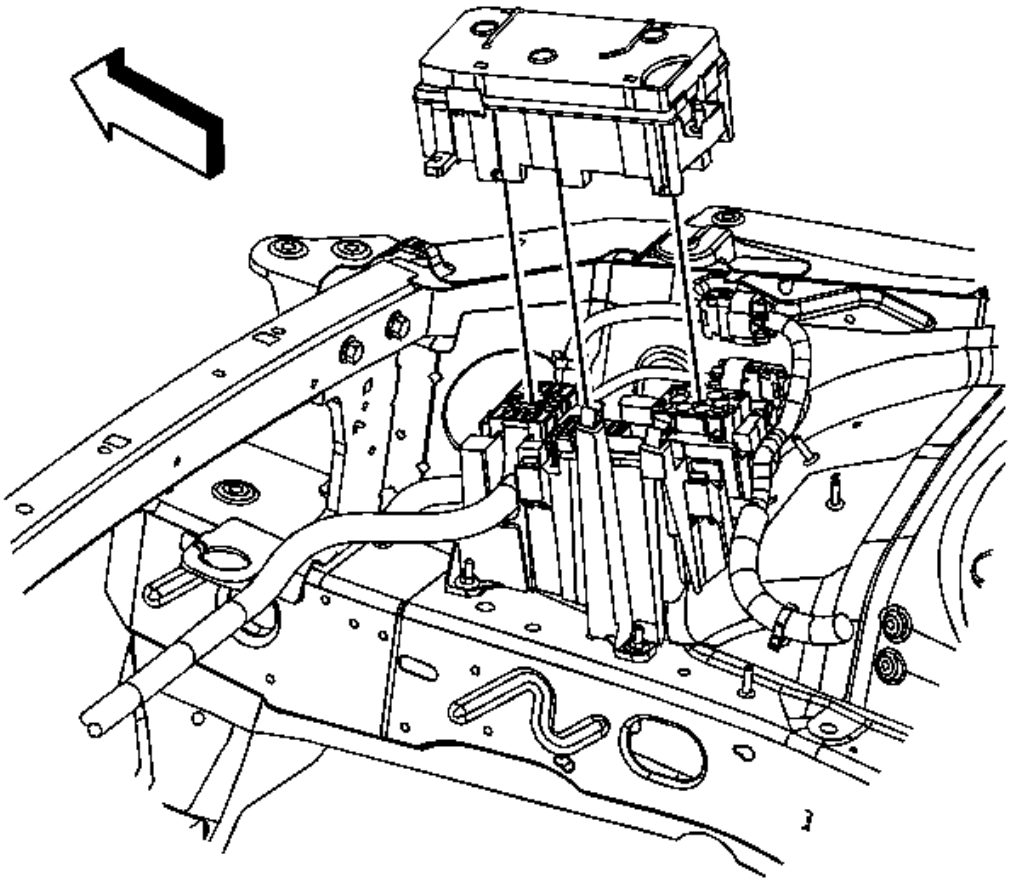


Fig. 533: Locating Junction Block
Courtesy of GENERAL MOTORS COMPANY

141. Install the junction block.
142. Install the junction block bolts.

Tighten

Tighten the bolts to 6.5 N.m (58 lb in).

 © 2011 Mitchell Repair Information Company, LLC.

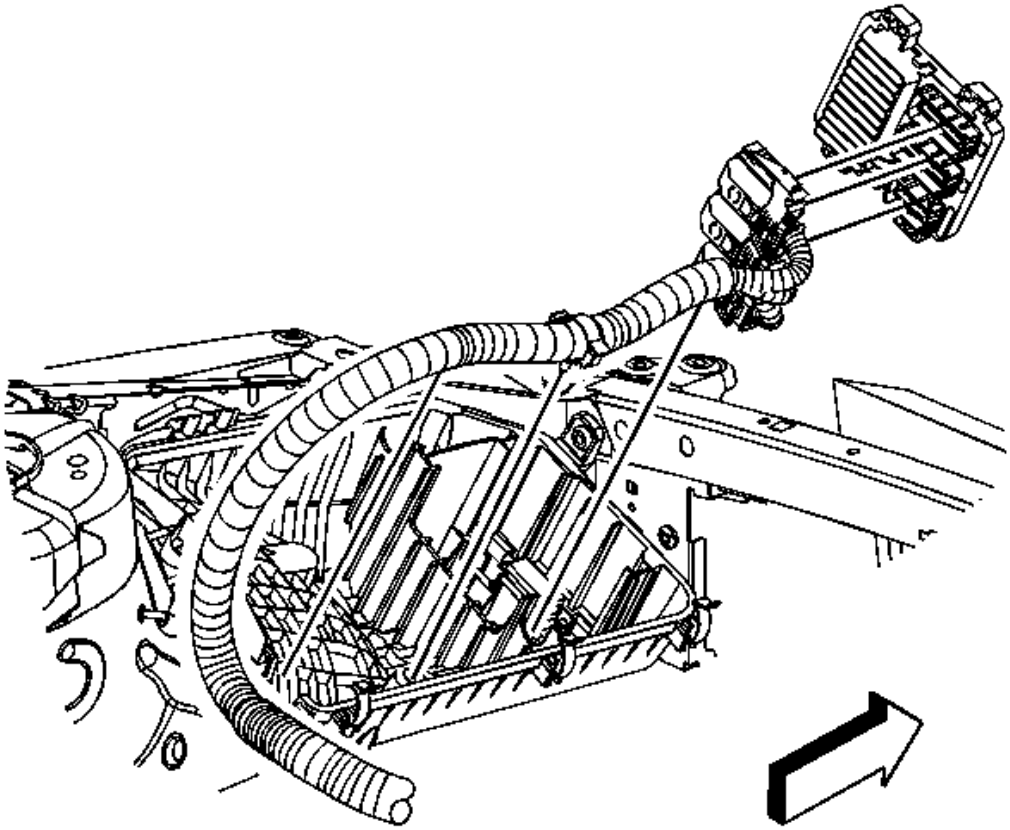


Fig. 534: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

143. Connect the engine harness electrical connectors to the ECM.
144. Engage the lever locks.

 © 2011 Mitchell Repair Information Company, LLC.

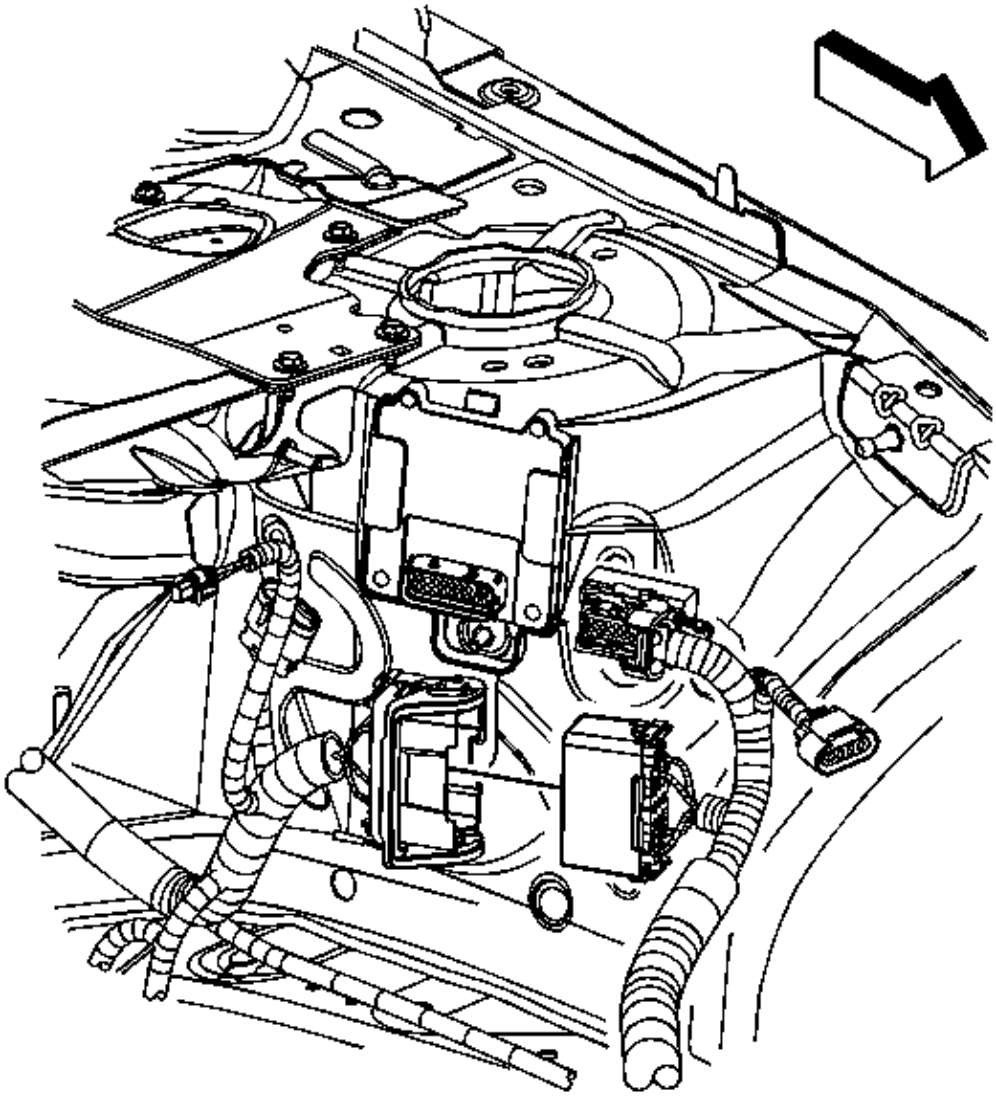


Fig. 535: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

145. Connect the engine harness electrical connector to the body harness electrical connector.
146. Engage the lever lock.

 © 2011 Mitchell Repair Information Company, LLC.

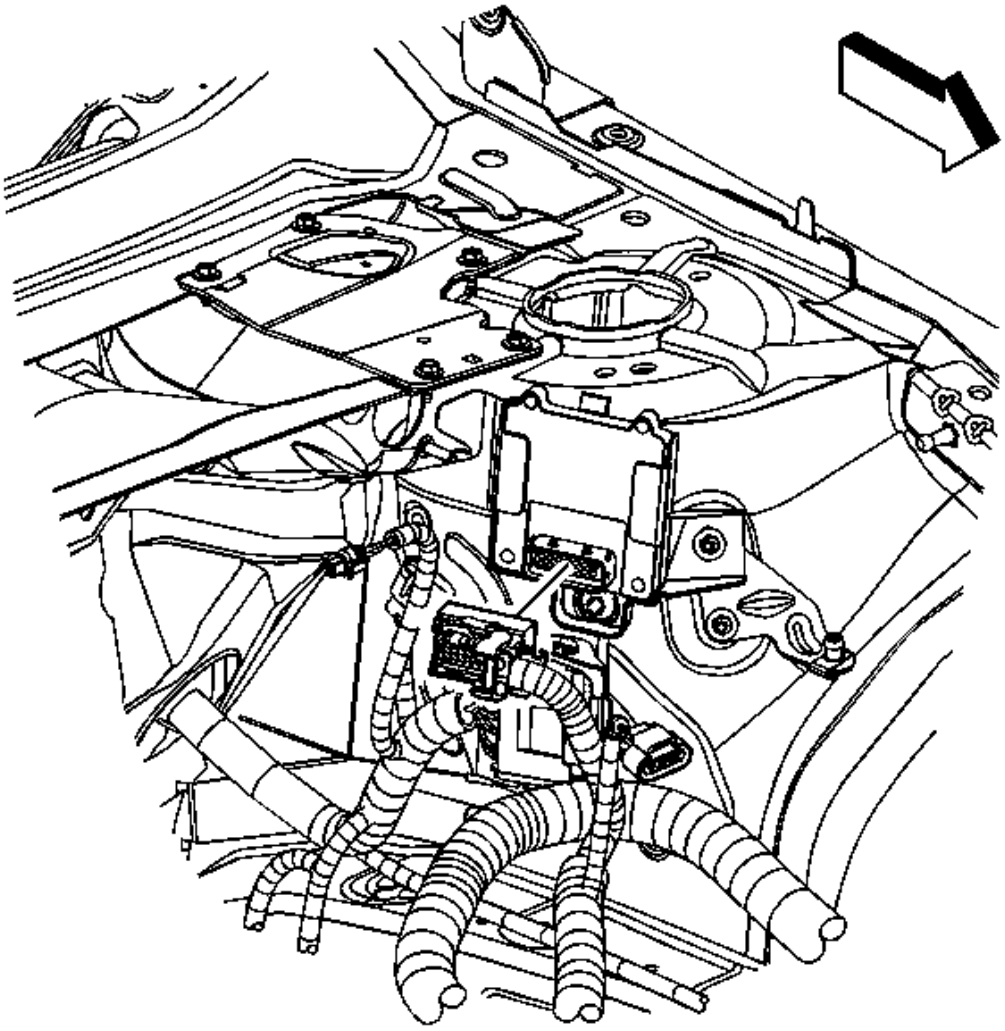


Fig. 536: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

147. Connect the engine harness electrical connector to the TCM.
148. Engage the lever lock.

 © 2011 Mitchell Repair Information Company, LLC.

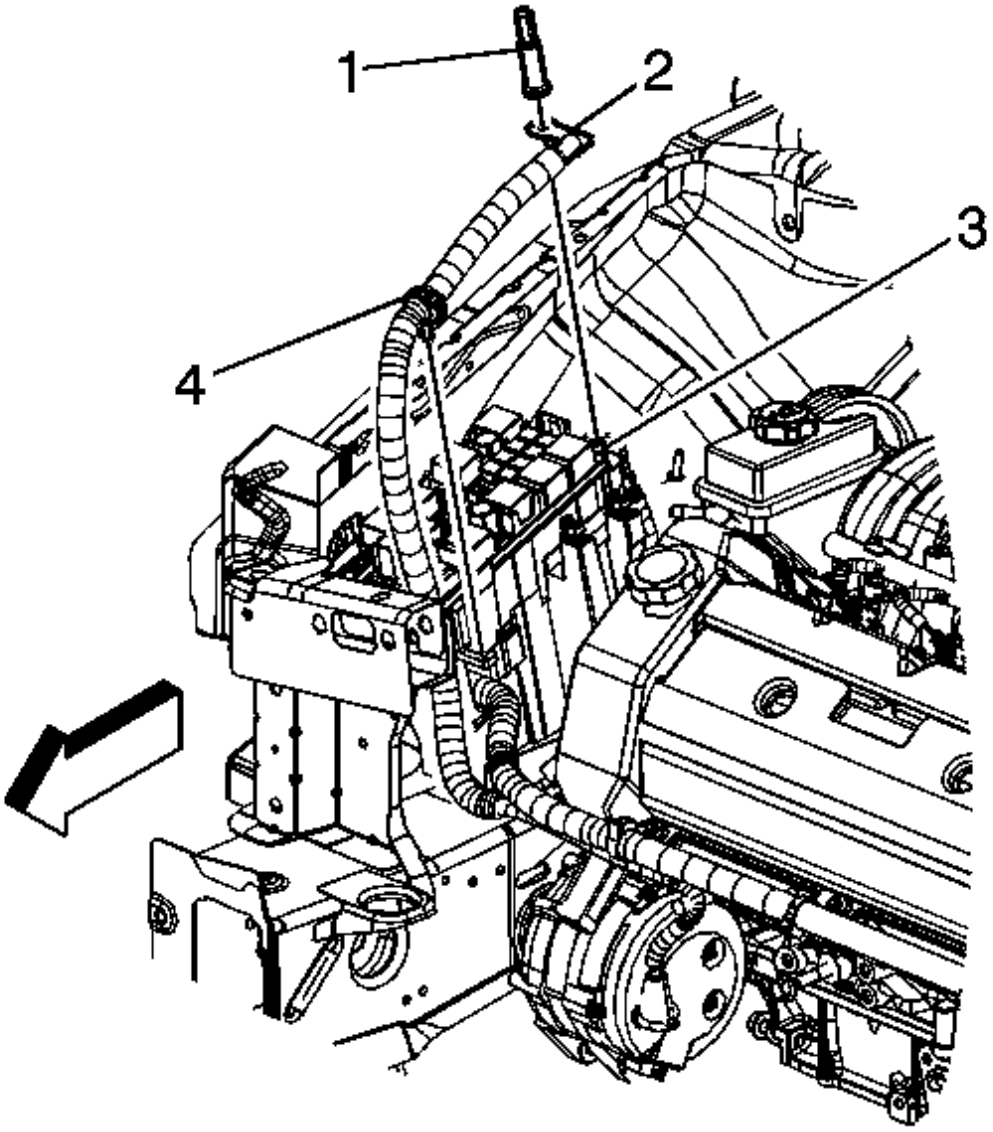


Fig. 537: Identifying Starter Solenoid Cable To Bussed Electrical Center (BEC)
Courtesy of GENERAL MOTORS COMPANY

149. Install the starter cable to the BEC terminal.
150. Install the starter cable clip (4) to the BEC.
151. Install the nut (1) securing the starter cable to the BEC.

 © 2011 Mitchell Repair Information Company, LLC.

Tighten

Tighten the nut to 15 N.m (11 lb ft).

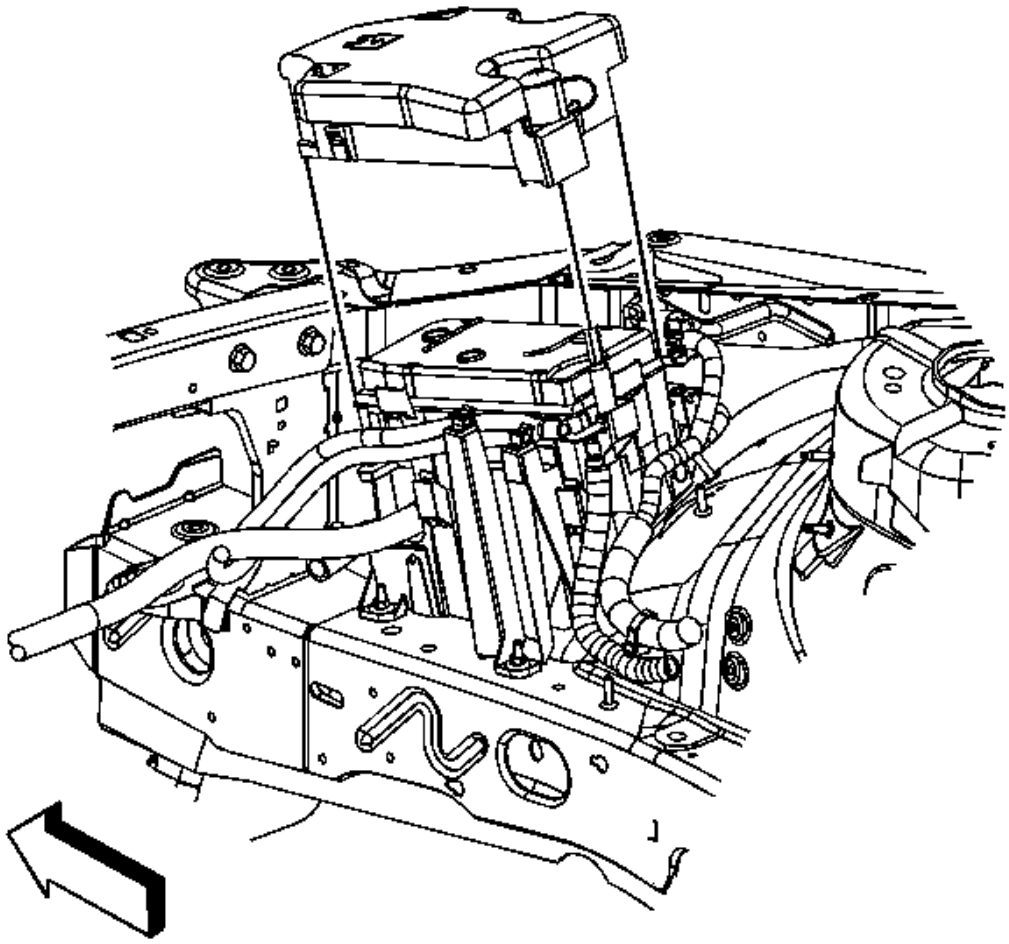


Fig. 538: View Of Junction Block Cover
Courtesy of GENERAL MOTORS COMPANY

152. Install the junction block cover.
153. Install the air cleaner. Refer to **Air Cleaner Assembly Replacement** .
154. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

 © 2011 Mitchell Repair Information Company, LLC.

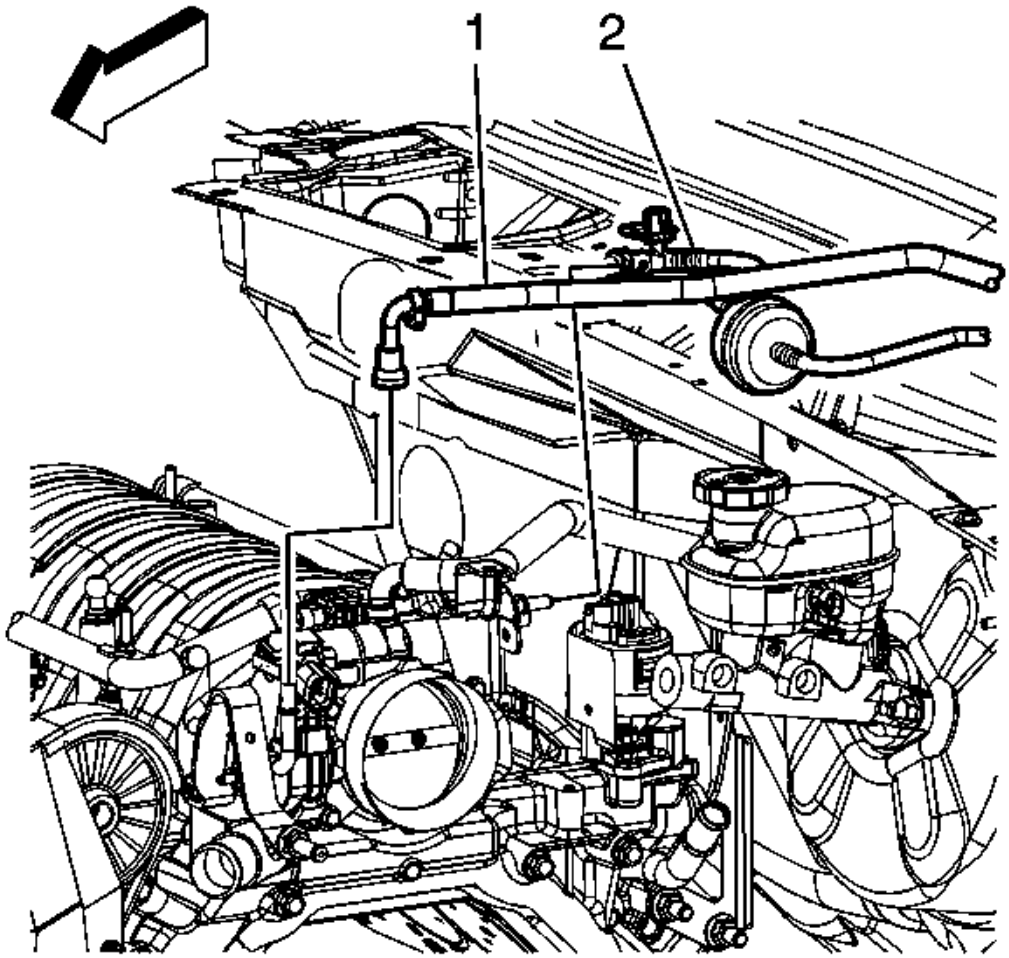


Fig. 539: Fuel Feed & EVAP Line
Courtesy of GENERAL MOTORS COMPANY

155. Connect the fuel feed and EVAP line quick-connect fittings (1, 2). Refer to **Metal Collar Quick Connect Fitting Service** , and **Plastic Collar Quick Connect Fitting Service** .

 © 2011 Mitchell Repair Information Company, LLC.

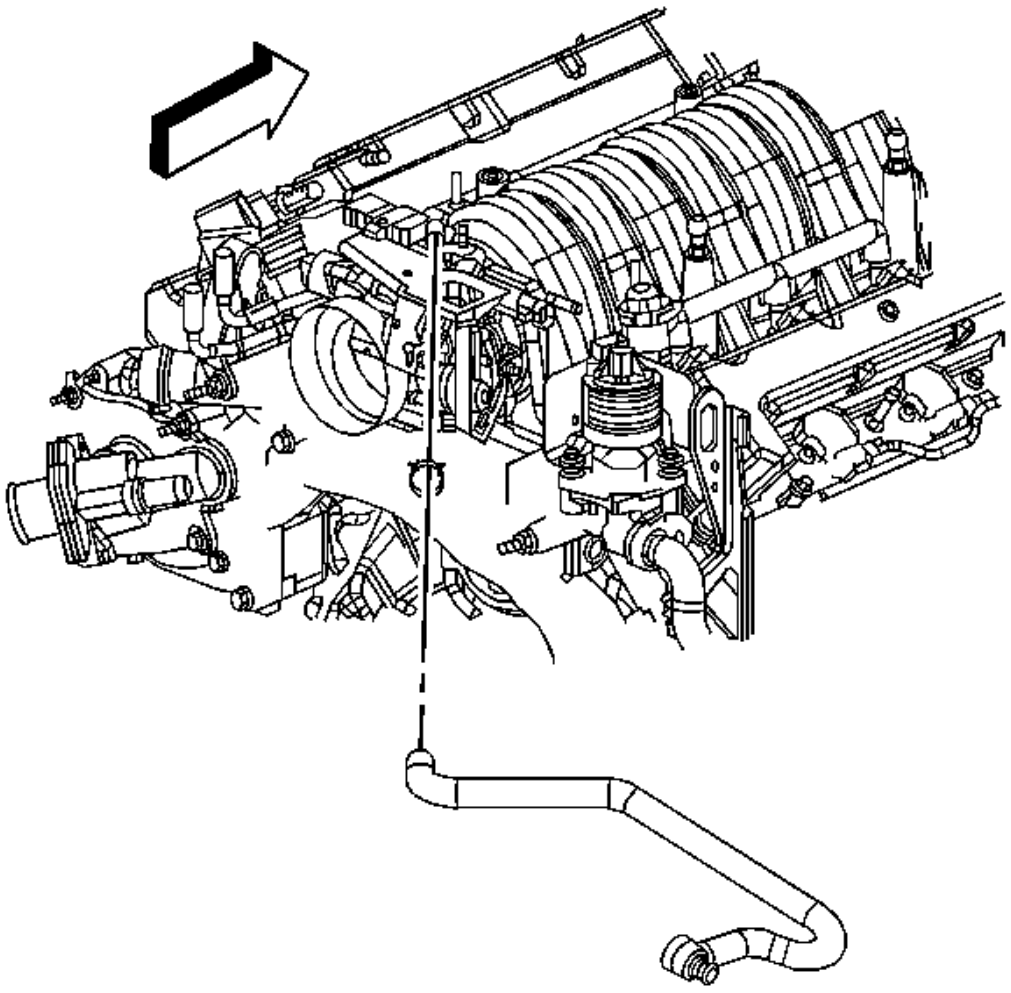


Fig. 540: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

156. Connect the brake booster vacuum hose to the vacuum connection.
157. Position the brake booster vacuum hose clamp at the engine port.
158. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
159. Fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
160. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** , **Cooling System Draining and Filling (Static Fill)** .
161. Bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** , **Hydraulic Brake System Bleeding (Pressure)** .

 © 2011 Mitchell Repair Information Company, LLC.

162. Recharge the A/C refrigerant system. Refer to **Refrigerant Recovery and Recharging** .
163. Bleed the power steering system. Refer to **Power Steering System Bleeding** .
164. Check the wheel alignment. Refer to **Wheel Alignment Measurement** .
165. Pre-lube the engine. Refer to **Engine Prelubing** .
166. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
167. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any parts are binding.
168. Start the engine and listen for abnormal conditions.
169. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
170. Run the engine at approximately 1000 RPM until the engine reaches normal operating temperature.
171. While the engine continues to idle raise and support the vehicle.
172. Inspect for oil, coolant and exhaust leaks while the engine is idling.
173. Lower the vehicle.
174. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .
175. Perform a final inspection for the proper engine oil and coolant levels.
176. Road test the vehicle.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position the oil drain pan under the engine oil drain plug.

 © 2011 Mitchell Repair Information Company, LLC.

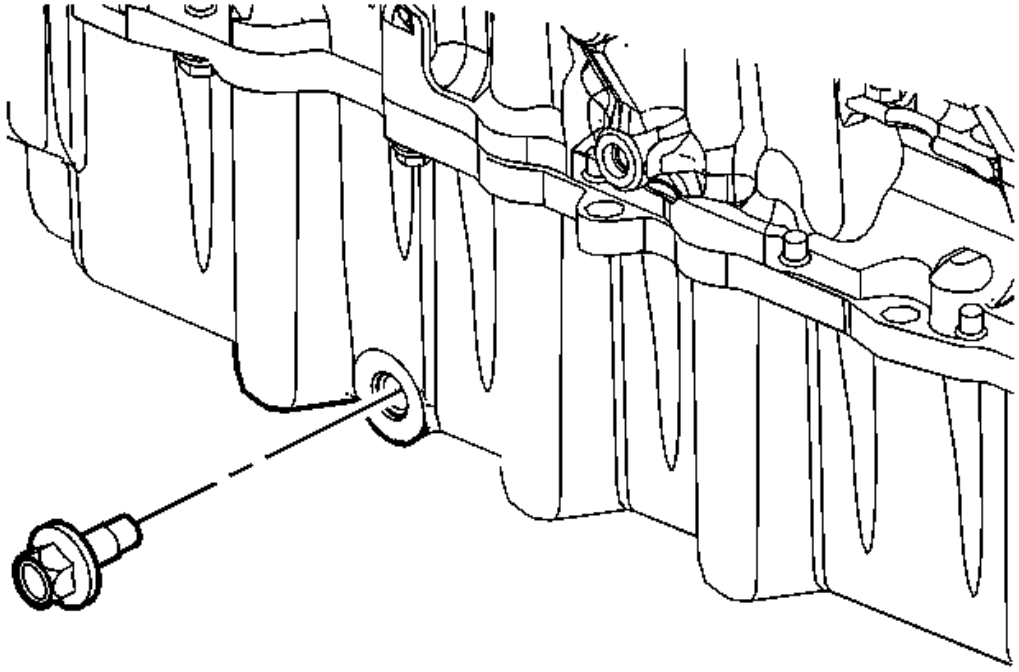


Fig. 541: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil drain plug.
4. Clean and inspect the engine oil drain plug, replace if necessary.
5. Clean and inspect the engine oil drain plug sealing surface on the oil pan, repair or replace oil pan if necessary.

 © 2011 Mitchell Repair Information Company, LLC.

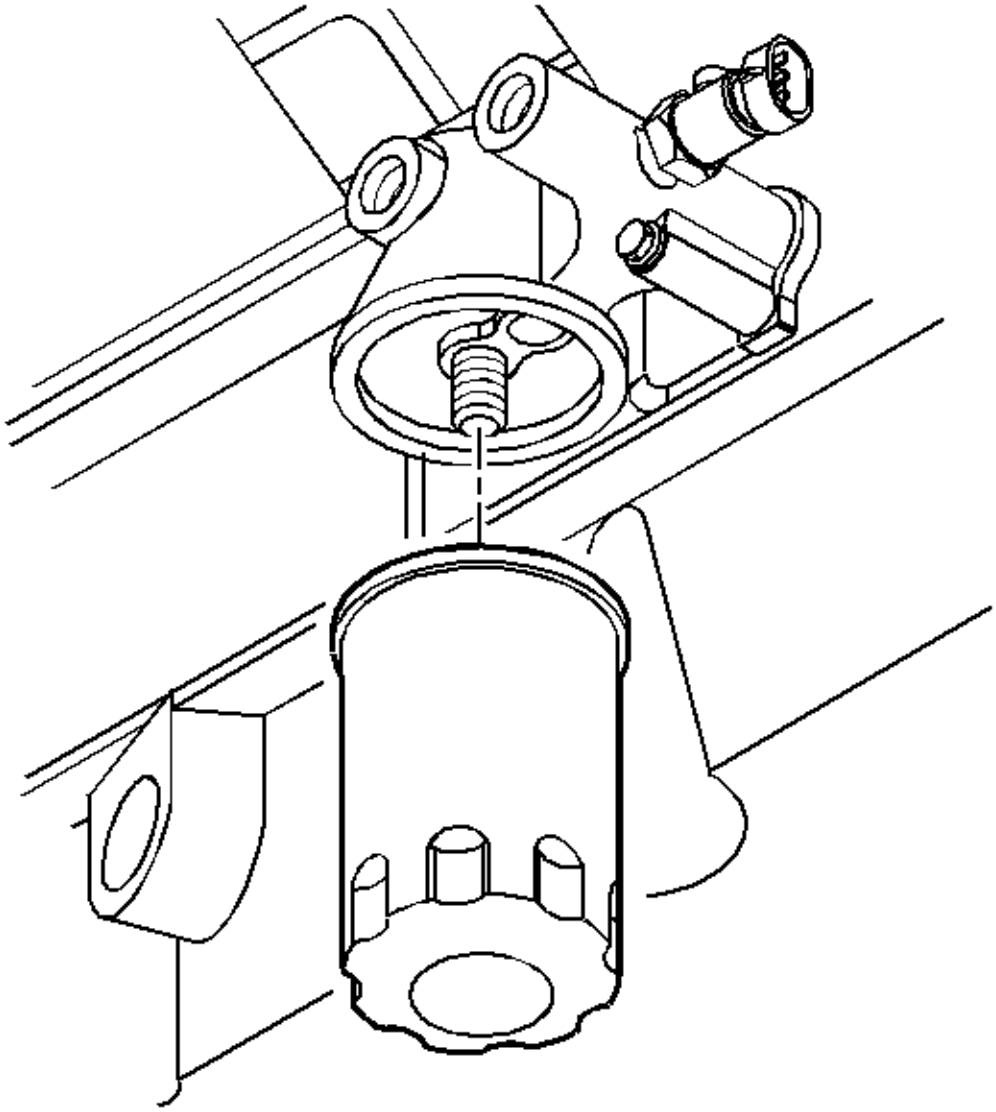


Fig. 542: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil filter.
7. Clean and inspect the oil filter sealing area on the oil filter adapter, repair or replace if necessary.

Installation Procedure

1. Fill the oil filter with oil.

 © 2011 Mitchell Repair Information Company, LLC.

2. Lightly oil the replacement oil filter gasket with clean oil.

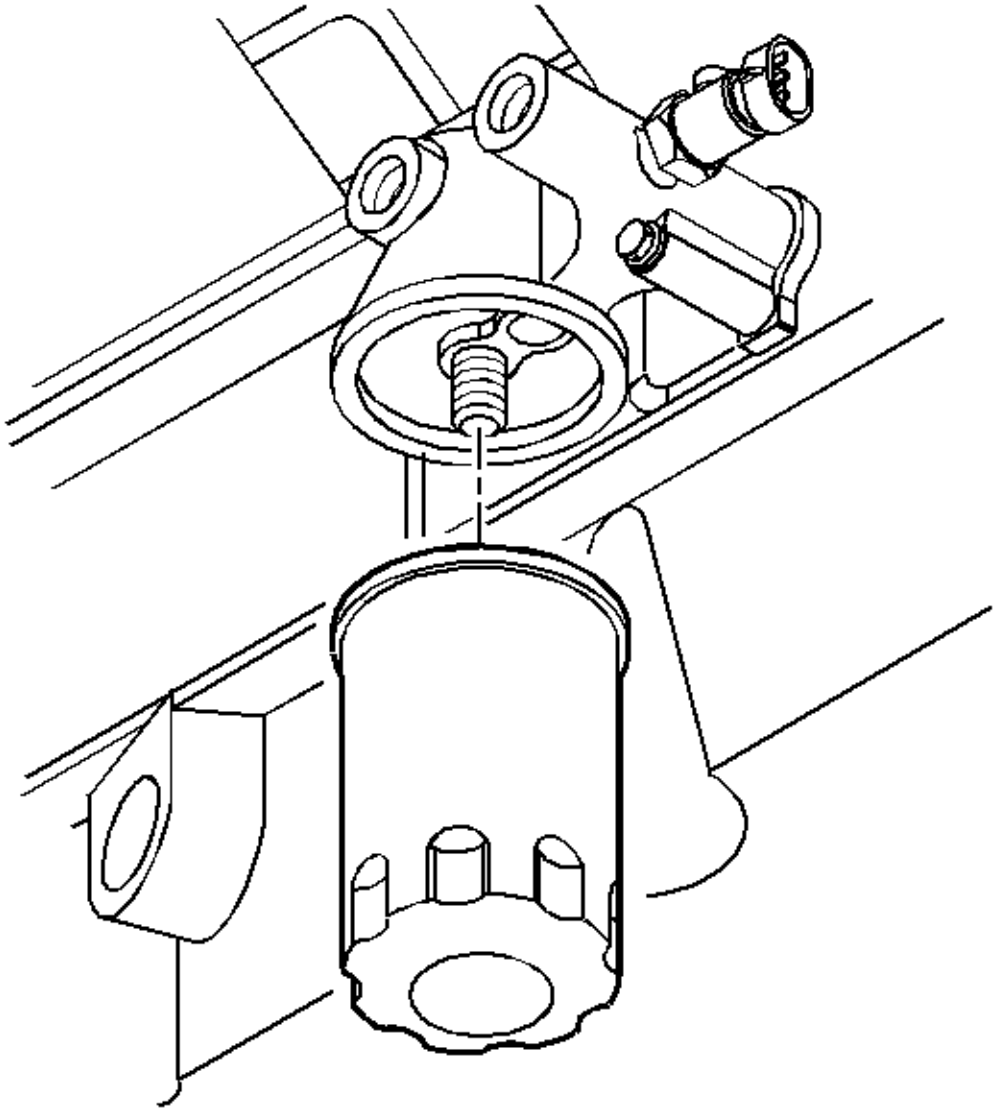


Fig. 543: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

 © 2011 Mitchell Repair Information Company, LLC.

3. Install the new oil filter.

   Tighten

   Tighten the new oil filter to 3/4 to 1 full turn, after the oil filter gasket contacts the oil filter mounting surface.

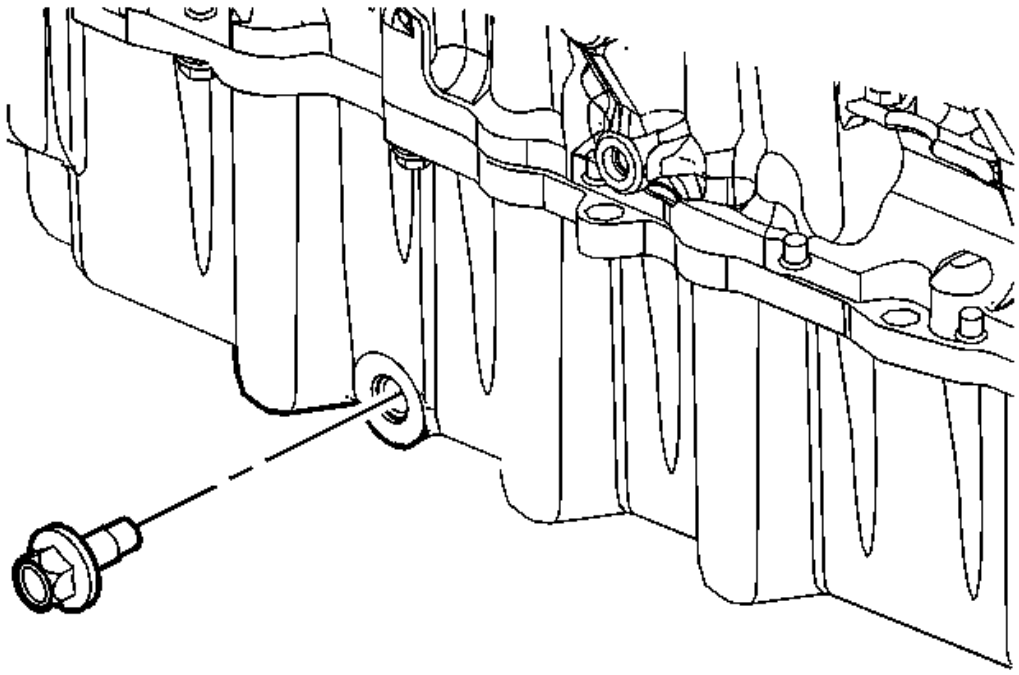


Fig. 544: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine oil drain plug.

   Tighten

   Tighten the engine oil drain plug to 20 N.m (15 lb ft).

5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** , and **Fluid and Lubricant Recommendations** .
7. Inspect for oil leaks after engine start up.

 © 2011 Mitchell Repair Information Company, LLC.