

2010 ENGINE

Engine Mechanical - 3.9L - Repair Instructions - On Vehicle - Lucerne

INTAKE MANIFOLD COVER REPLACEMENT

REMOVAL PROCEDURE

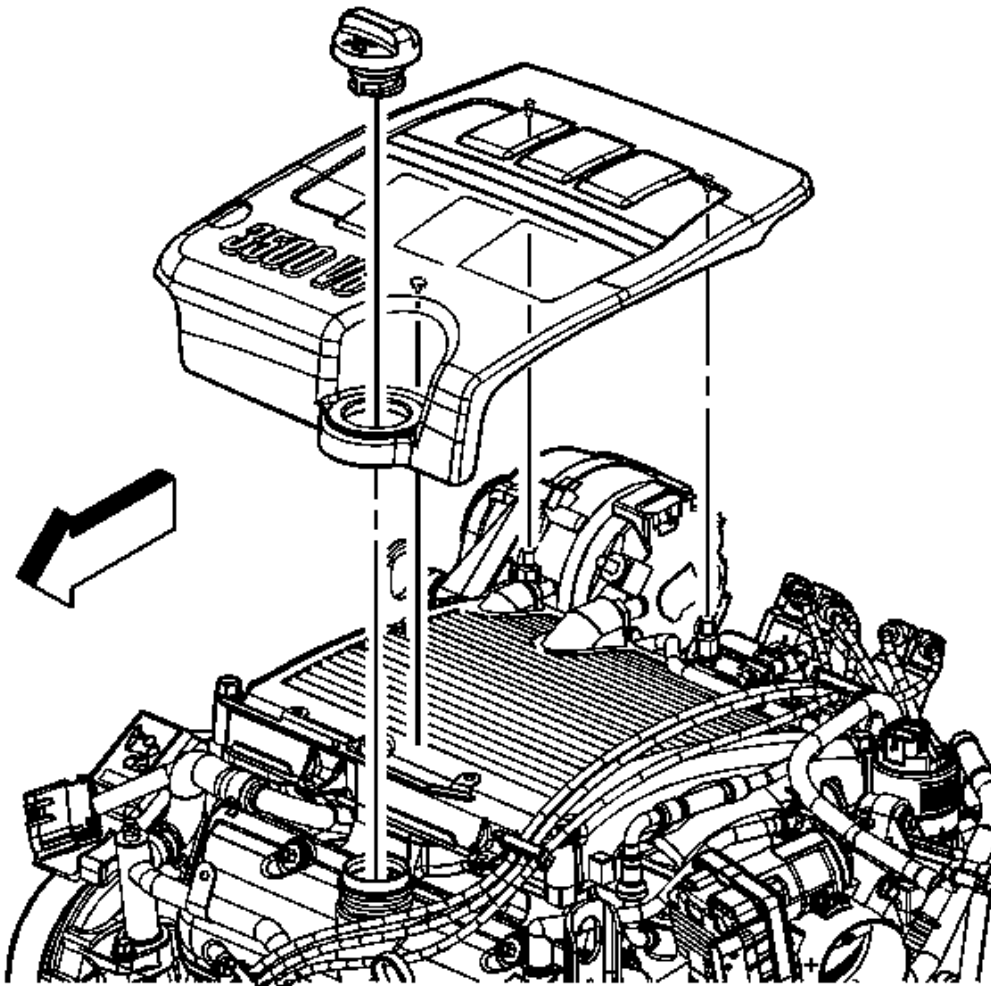


Fig. 1: Intake Manifold Cover & Oil Fill Cap
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine oil fill cap.

2. Pull up on the cover in order to disengage the cover from the studs.

INSTALLATION PROCEDURE

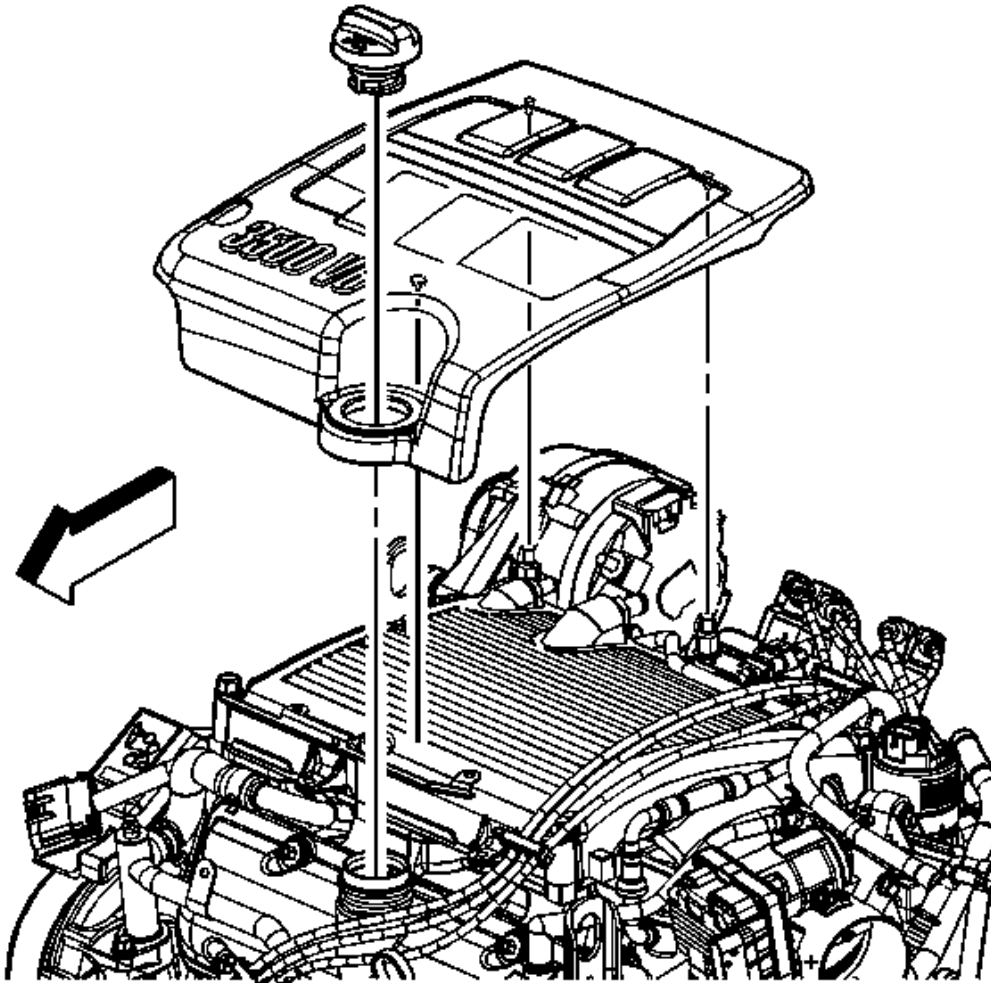


Fig. 2: Intake Manifold Cover & Oil Fill Cap
Courtesy of GENERAL MOTORS CORP.

1. Align the cover to the studs on the engine, push down on the cover above the studs in order to engage the cover to the studs.
2. Install the engine oil fill cap.

DRIVE BELT REPLACEMENT

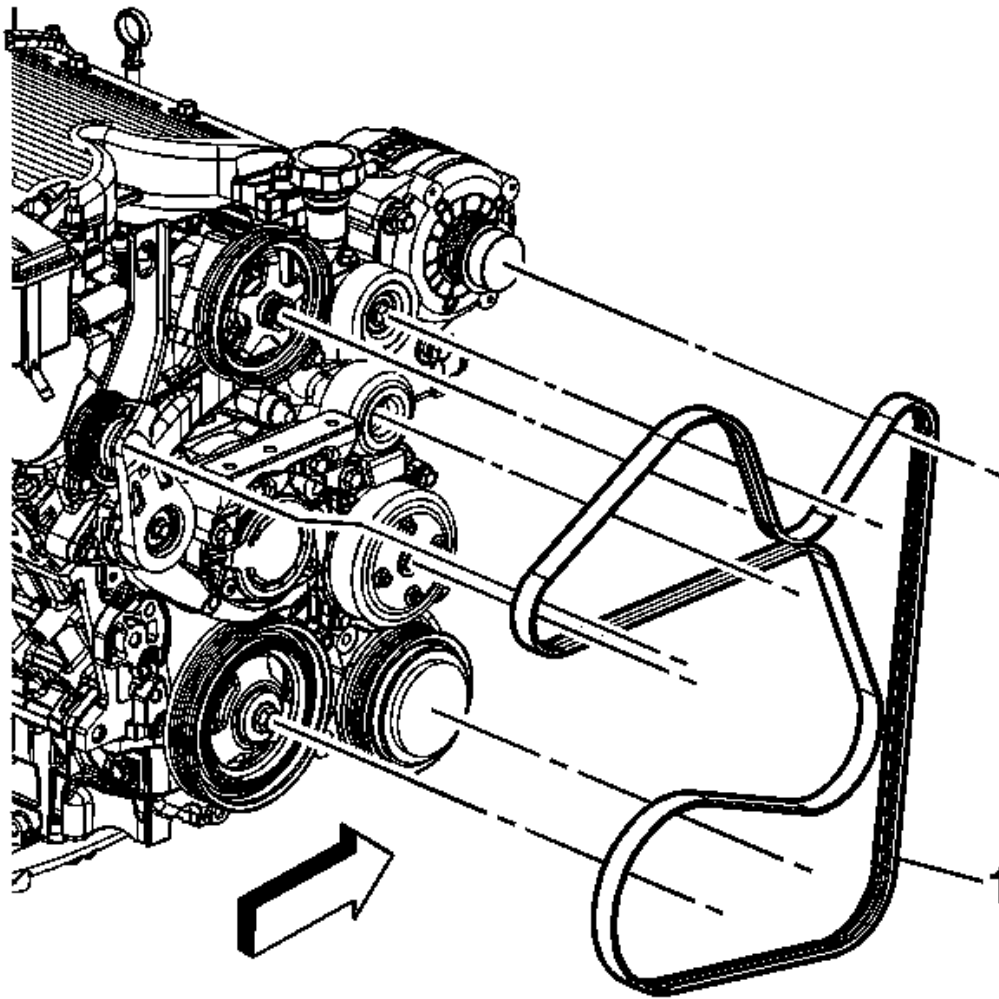
REMOVAL PROCEDURE

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

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Rotate the drive belt tensioner clockwise in order to release the tensioner spring tension.
3. Remove the drive belt from around the tensioner pulley.
4. Release the drive belt tensioner.
5. Remove the drive belt (1) from around all the other pulleys.

INSTALLATION PROCEDURE

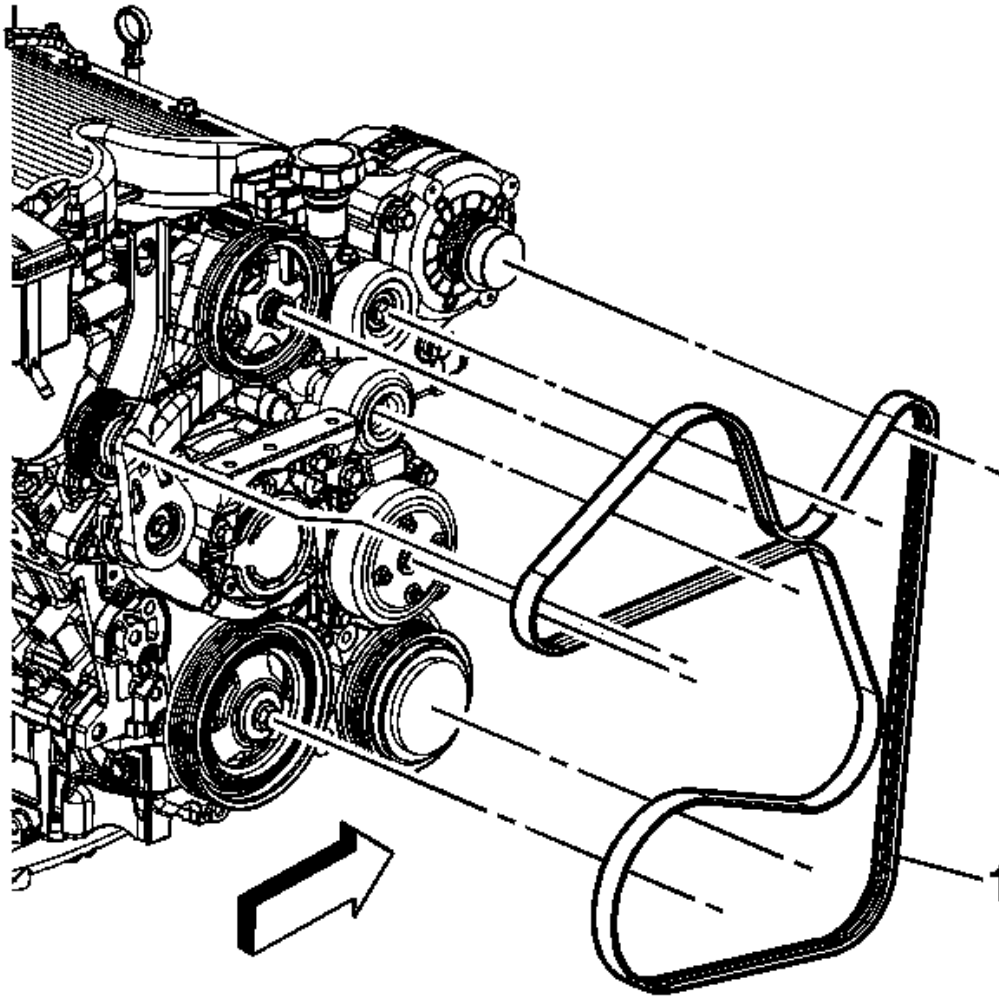


Fig. 4: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt (1) around the pulleys except for the tensioner pulley.
2. Rotate the drive belt tensioner clockwise in order to release the tensioner spring tension.
3. Install the drive belt around the tensioner pulley.
4. Release the drive belt tensioner.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

DRIVE BELT IDLER PULLEY REPLACEMENT

REMOVAL PROCEDURE

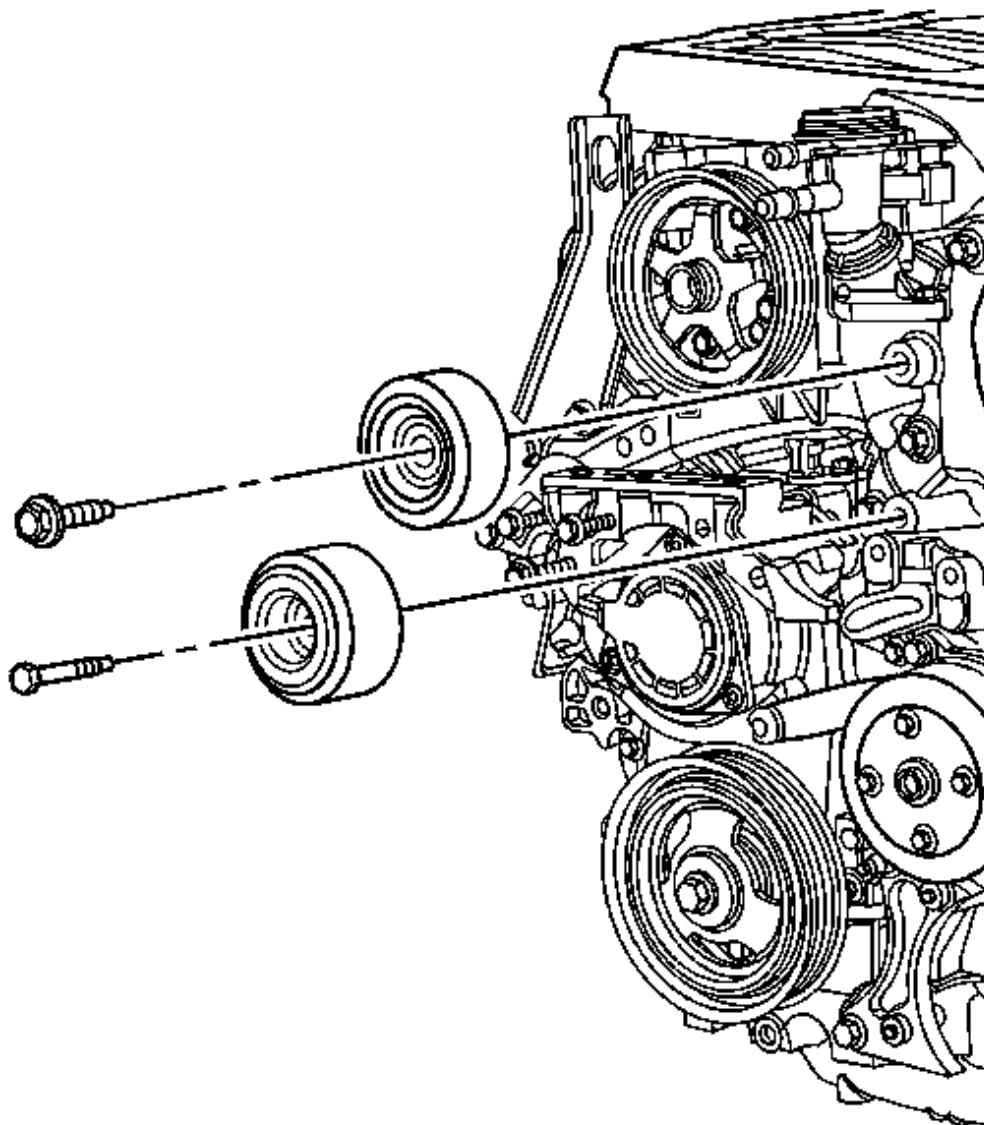


Fig. 5: Drive Belt Idler Pulleys & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Loosen the required drive belt idler pulley bolt.

2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the drive belt idler pulley.

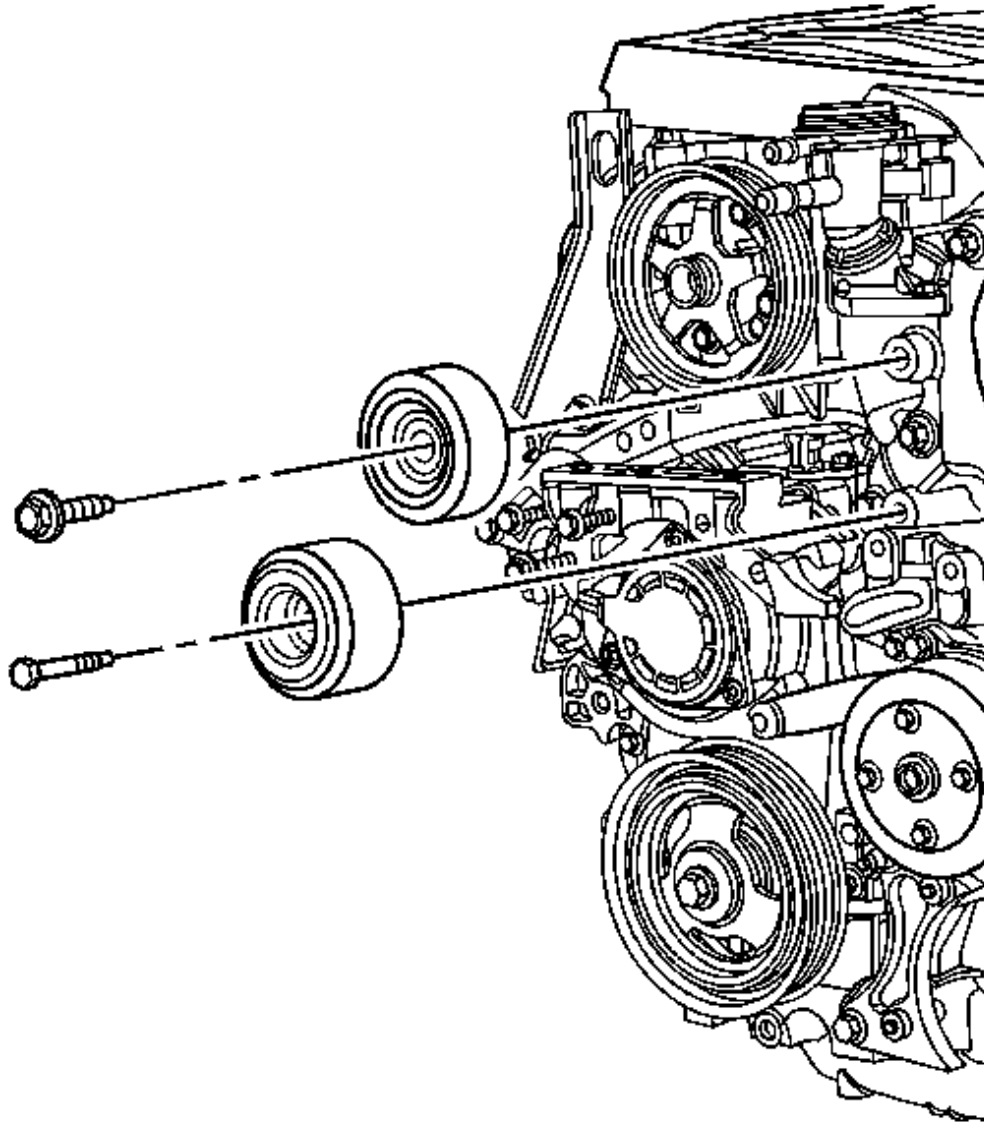
INSTALLATION PROCEDURE

Fig. 6: Drive Belt Idler Pulleys & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.
2. Install the drive belt. Refer to **Drive Belt Replacement**.

CAUTION: Refer to **Fastener Caution** .

3. Tighten the required drive belt idler pulley bolt.

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

DRIVE BELT TENSIONER REPLACEMENT

REMOVAL PROCEDURE

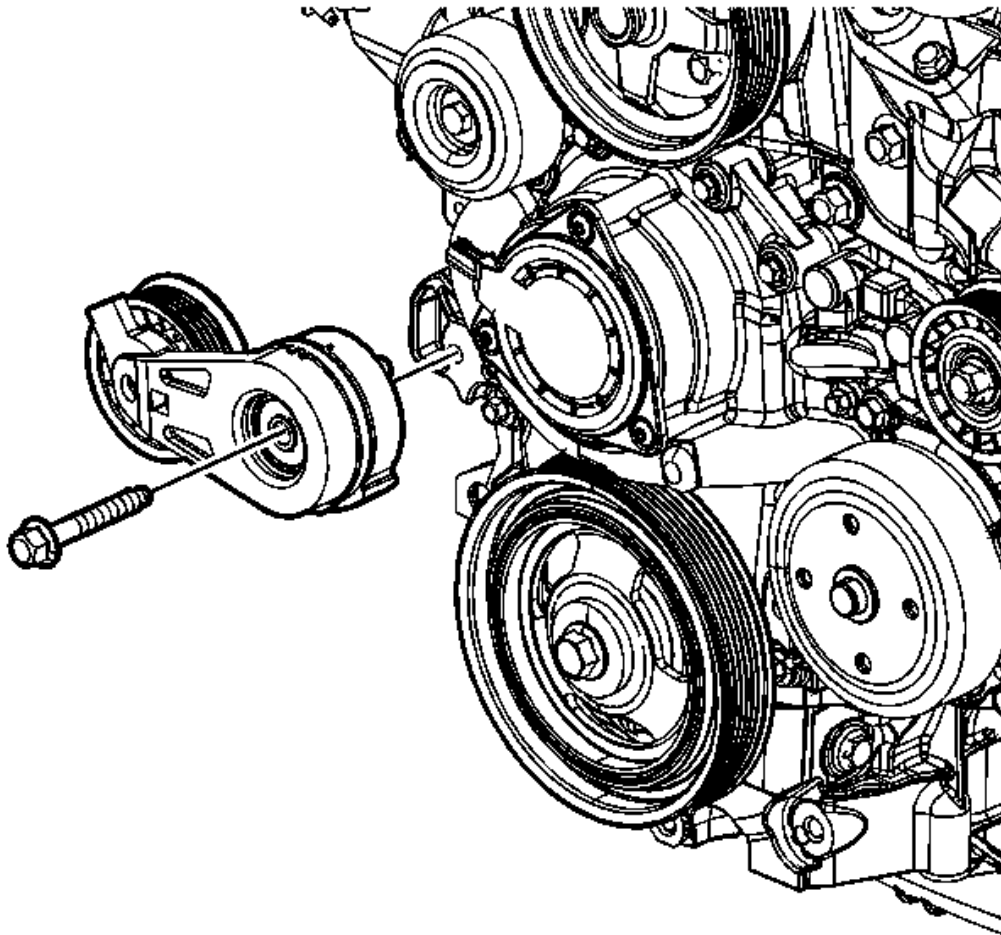


Fig. 7: Drive Belt Tensioner & Bolt
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

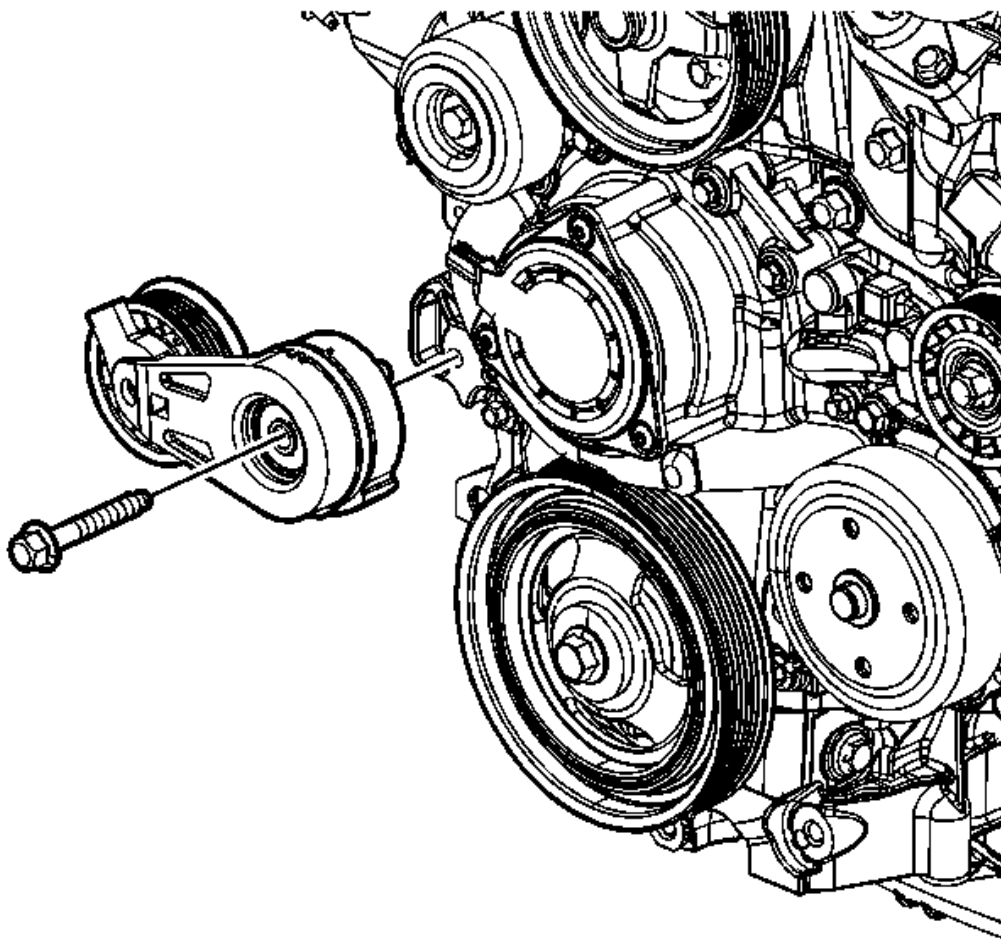


Fig. 8: Drive Belt Tensioner & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner.

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.

ENGINE SUPPORT FIXTURE

Special Tools

- **J 28467-B** Engine Support Fixture. See Special Tools .
- **J 36462** Engine Support Adapter Leg. See Special Tools .
- **J 36857** Engine Lift Bracket

1. Raise the hood.
2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .
3. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.

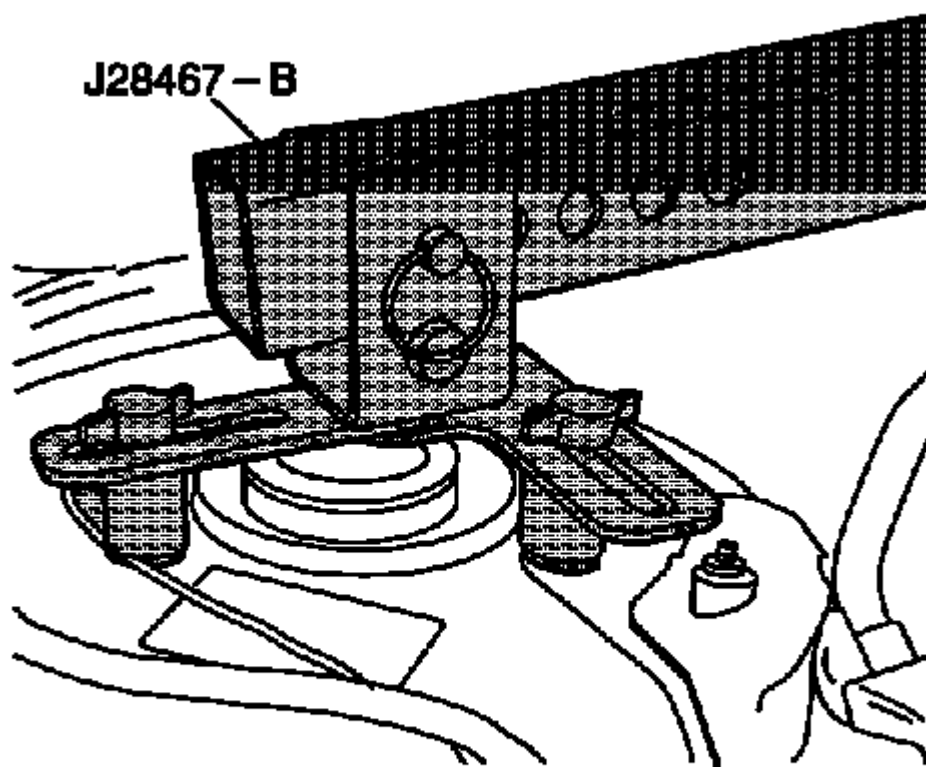


Fig. 9: Thread Support Nuts On Strut Attaching Studs
Courtesy of GENERAL MOTORS CORP.

4. Install the thread support nuts J 28467-33A onto the strut attaching studs.
5. Install the strut tower support assemblies J 28467-5A over the thread support nuts J 28467-33A.
6. Install the T-bolts J 28467-5 with 5/16 inch washers through the strut tower support assemblies J 28467-

- 5A into the thread support nuts J 28467-33A. Hand tighten the bolts.
7. Install the 2 cross bracket assemblies J 28467-1A over the strut tower tube J 28467-3.
8. Install the strut tower tube J 28467-3 into the strut tower support assemblies J 28467-5A.
9. Install the 1/2 inch x 2.5 inch quick release pin J 28467-10 through the strut tower support assemblies J 28467-5A and the strut tower tube J 28467-3 on one side only.

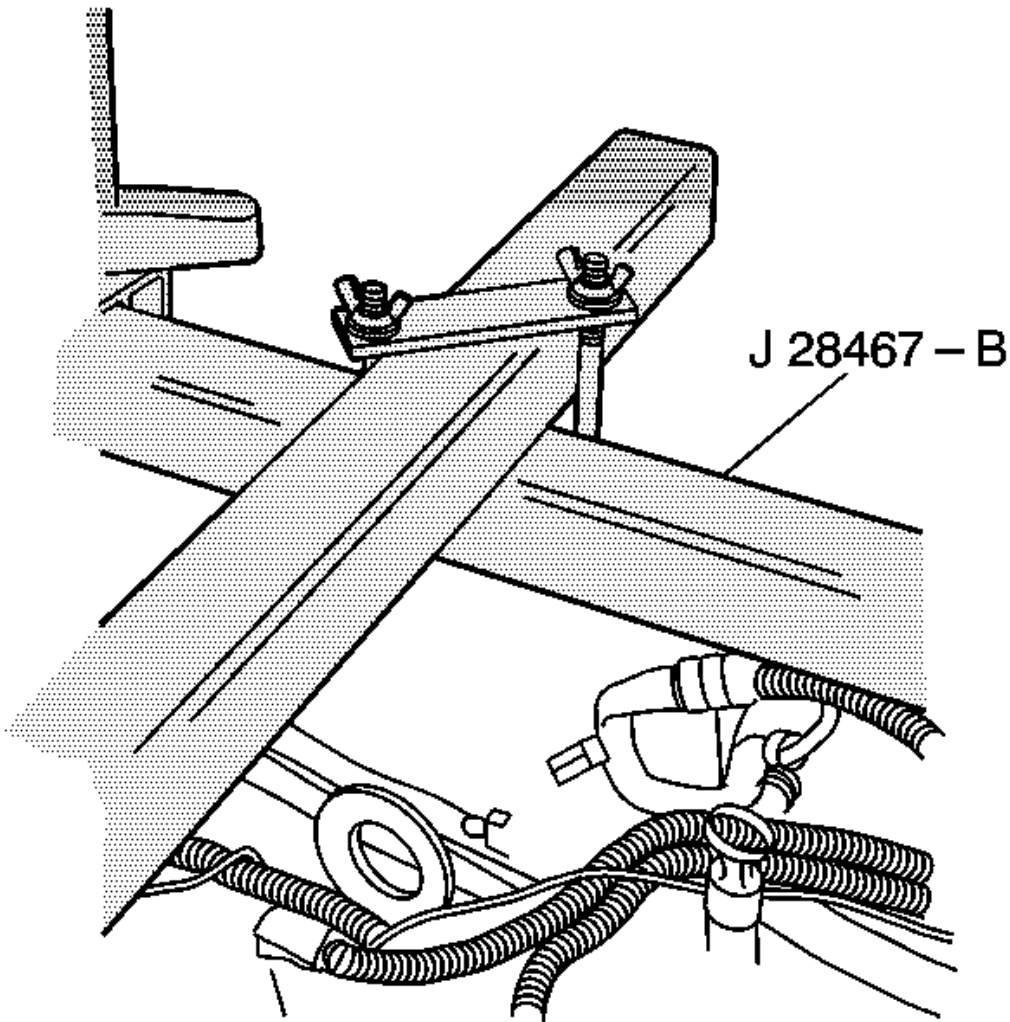


Fig. 10: Radiator Shelf Tube

Courtesy of GENERAL MOTORS CORP.

10. Install the radiator shelf tube J 28467-2A through the driver side cross bracket assembly J 28467-1A on the top of the strut tower tube J 28467-B.

11. Place the rubber padded foot of the front support assembly J 28467-4A on the vehicle radiator shelf. The foot position used in the front support assembly J 28467-4A depends on the vehicle application.
12. Install the 7/16 inch x 2.0 inch quick release pin J 28467-9 through the hole in the front support assembly J 28467-4A in order to level the radiator shelf tube J 28467-2A. The hole used in the front support assembly J 28467-4A depends on the vehicle application.
13. Install the lift hook J 28467-7A through the lift hook bracket J 28467-6A.
14. Install the 1/2 inch lift hook washer and lift hook wing nut J 28467-34 onto the lift hook J 28467-7A.
15. Install the assembled lift hook bracket J 28467-6A over the radiator shelf tube J 28467-2A.
16. Adjust the radiator shelf tube J 28467-2A and the assemblage lift hook bracket J 28467-6A in order to align the hook with the left (front), rear of engine, lift hook bracket part of the left engine mount strut bracket.
17. Hand tighten the driver side cross bracket assembly J 28467-1A wing nuts.
18. Install the second radiator shelf tube J 28467-2A through the passenger side cross bracket assembly (J 28467-1A) on the top of the strut tower tube J 28467-3.
19. Place the rubber padded foot of the front support assembly J 28467-4A on the vehicle radiator shelf. The foot position used in the front support assembly J 28467-4A depends on the vehicle application.
20. Install the 7/16 inch x 2.0 inch quick release pin J 28467-9 through the hole in the front support assembly J 28467-4A in order to level the radiator shelf tube J 28467-2A. The hole used in the front support assembly J 28467-4A depends on the vehicle application.
21. Install the lift hook J 28467-7A through the lift hook bracket J 28467-6A.
22. Install the 1/2 inch lift hook washer and lift hook wing nut J 28467-34 onto the lift hook J 28467-7A.
23. Install the assemblage lift hook bracket J 28467-6A over the radiator shelf tube J 28467-2A.
24. Adjust the radiator shelf tube J 28467-2A and the assemblage lift hook bracket J 28467-6A in order to align the hook with the right rear and front of engine.

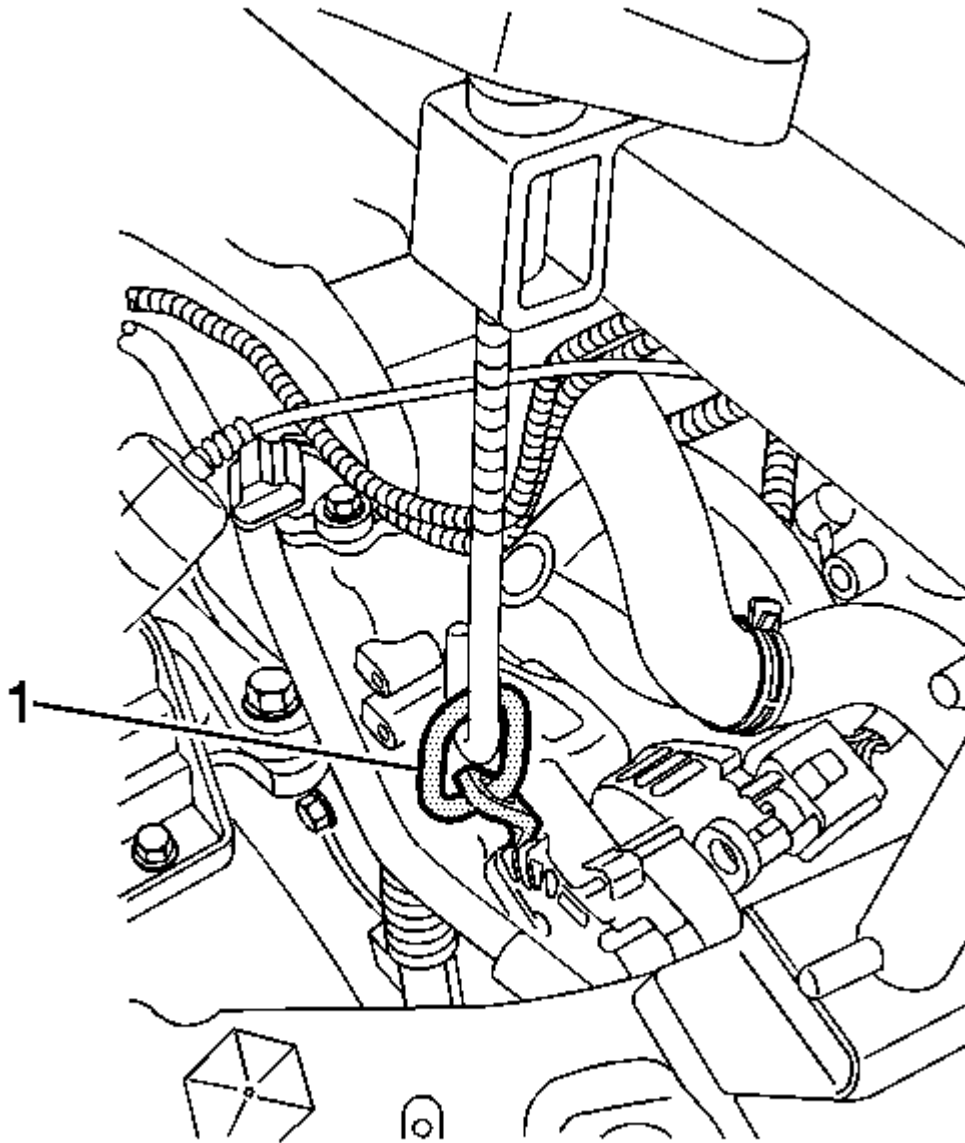


Fig. 11: Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

25. Install the J 36857 lift hook bracket (1).
26. Hand tighten the passenger side cross bracket assembly J 28467-1A wing nuts.
27. Hand tighten the lift hook wing nuts J 28467-34 securely in order to remove all slack from the engine support fixture assembly.

ENGINE MOUNT INSPECTION

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

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

ENGINE MOUNT STRUT REPLACEMENT

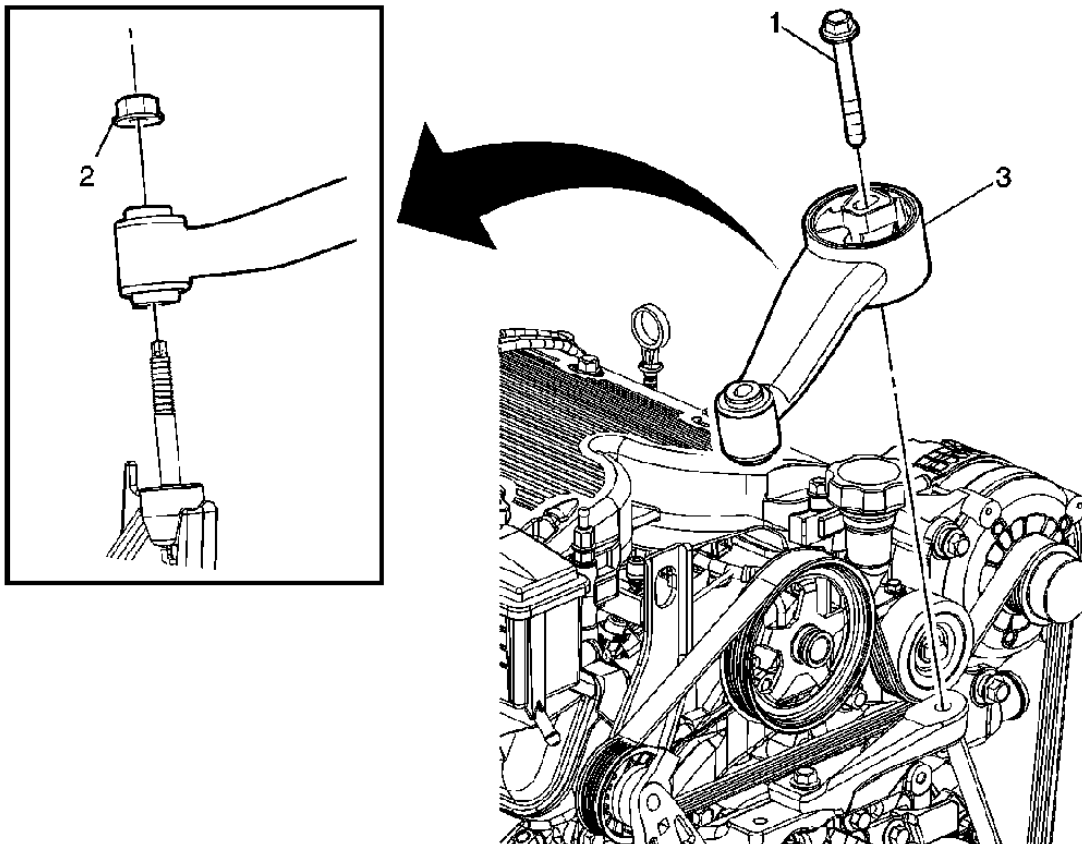


Fig. 12: Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Support the engine before removing the engine mount.	
1	Engine Mount Strut Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten: 70 N.m (52 lb ft)
2	Engine Mount Strut Fastener Tighten: 70 N.m (52 lb ft)
3	Engine Mount Strut Procedure: Transfer components as necessary.

ENGINE MOUNT STRUT BRACKET REPLACEMENT (ENGINE SIDE)

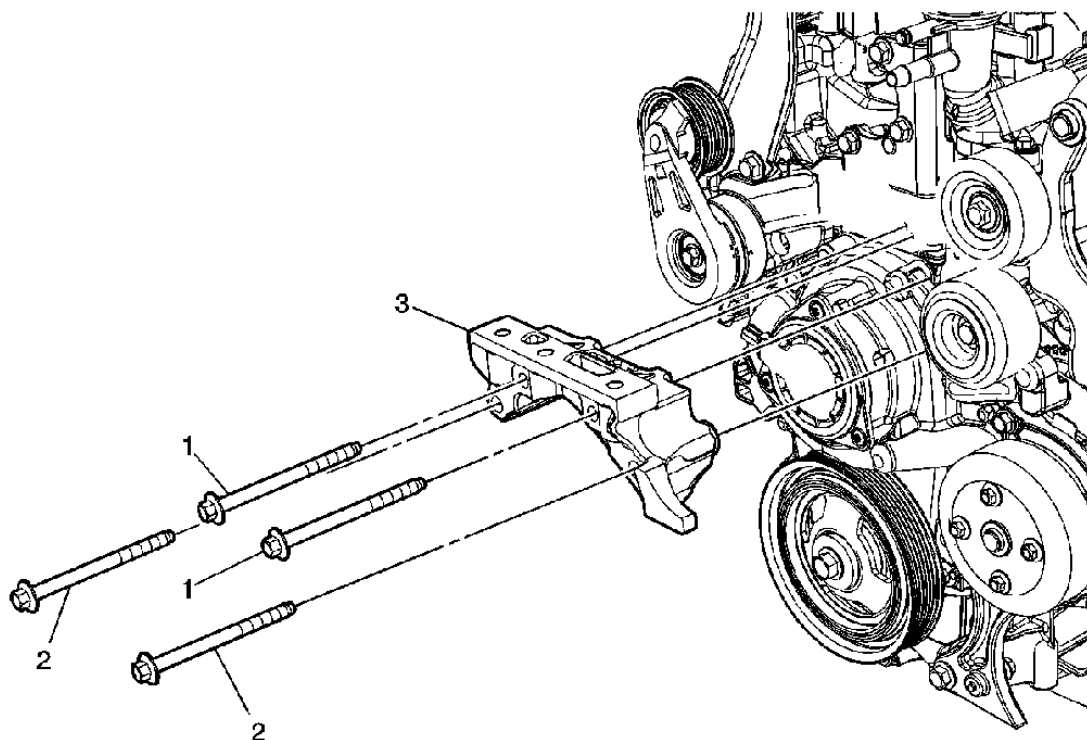


Fig. 13: Engine Mount Strut Bracket (Engine Side)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure:	

Remove the engine mount strut engine side bracket. Refer to **Engine Mount Strut Replacement**.

1	Engine Mount Strut Engine Side Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten: 58 N.m (43 lb ft)
2	Engine Mount Strut Engine Side Bracket Fastener (Qty: 2) Tighten: 15 N.m (11 lb ft) plus 45 degrees
3	Engine Mount Strut Engine Side Bracket Procedure: Transfer components as necessary.

ENGINE MOUNT STRUT BRACKET REPLACEMENT (STRUT SIDE)

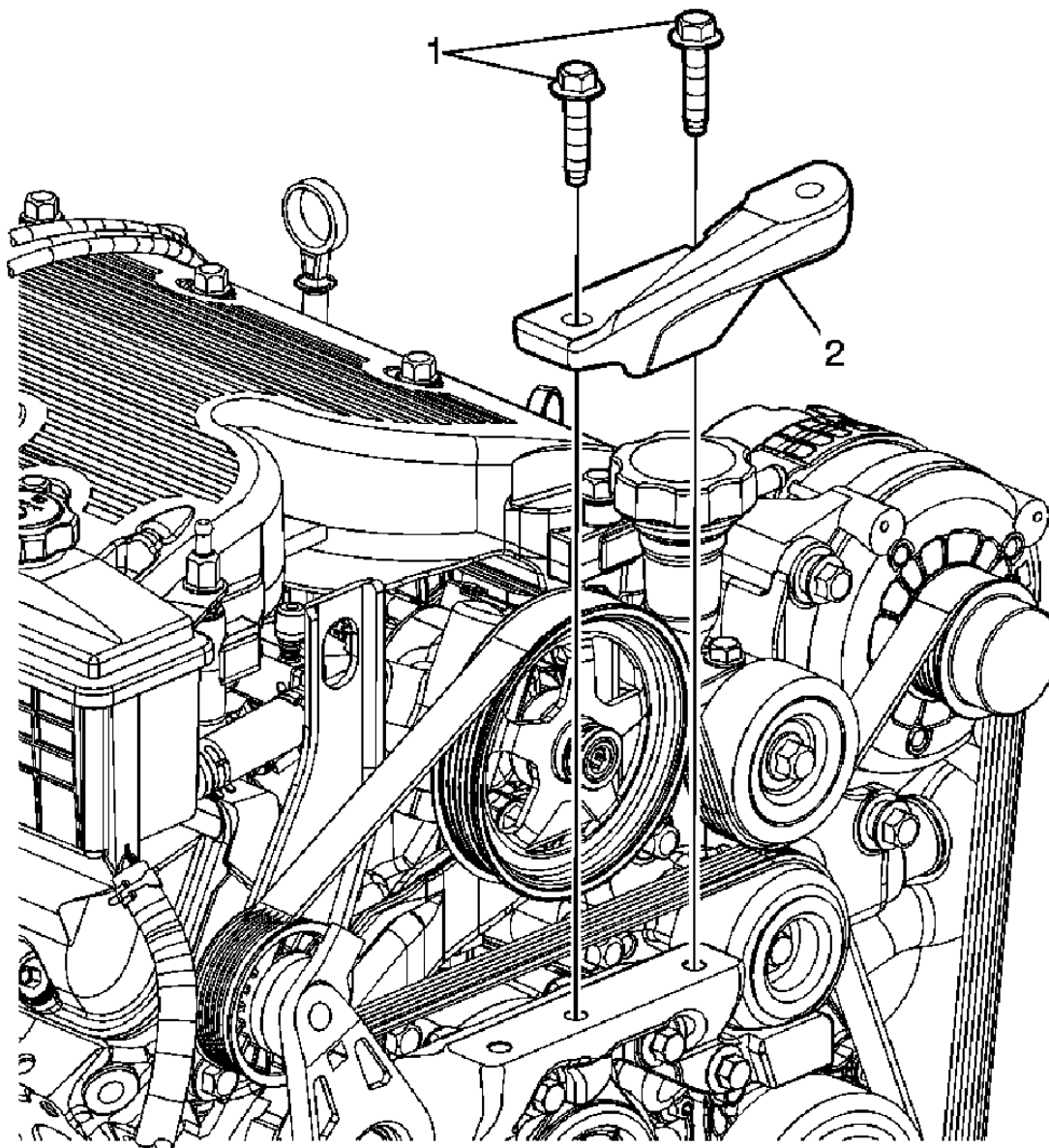


Fig. 14: Engine Mount Strut Bracket (Strut Side)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine strut. Refer to <u>Engine Mount Strut Replacement</u> .	
1	Engine Mount Strut Engine Side Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

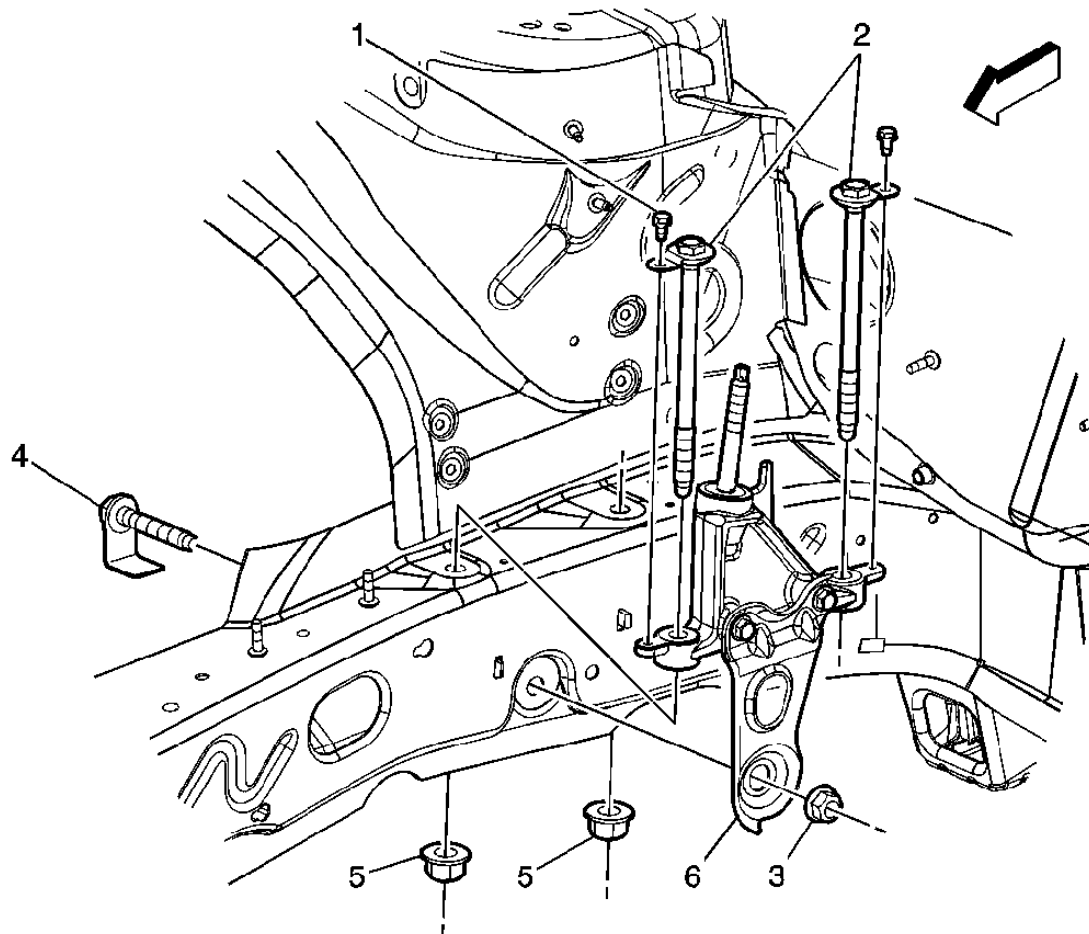
Tighten: 50 N.m (37 lb ft)

2

Engine Mount Strut Engine Side Bracket

Procedure:

Transfer components as necessary.

ENGINE MOUNT STRUT BRACKET REPLACEMENT (BODY SIDE)**Fig. 15: Engine Mount Strut Bracket (Body Side)**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine strut. Refer to Engine Mount Strut Replacement	
1	Engine Mount Strut Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

2010 Buick Lucerne CX

2010 ENGINE Engine Mechanical - 3.9L - Repair Instructions - On Vehicle - Lucerne

	Tighten: 9 N.m (80 lb in)
2	Engine Mount Strut Bracket Fastener (Qty: 2) Tighten: 70 N.m (52 lb ft)
3	Engine Mount Strut Bracket Fastener Tighten: 70 N.m (52 lb ft)
4	Engine Mount Strut Bracket Bolt Procedure: Ensure the bolt is locked in place
5	Engine Mount Strut Bracket Fastener (Qty: 2) Tighten: 70 N.m (52 lb ft)
6	Engine Mount Strut Bracket Procedure: Transfer components as necessary.

ENGINE FRONT MOUNT REPLACEMENT

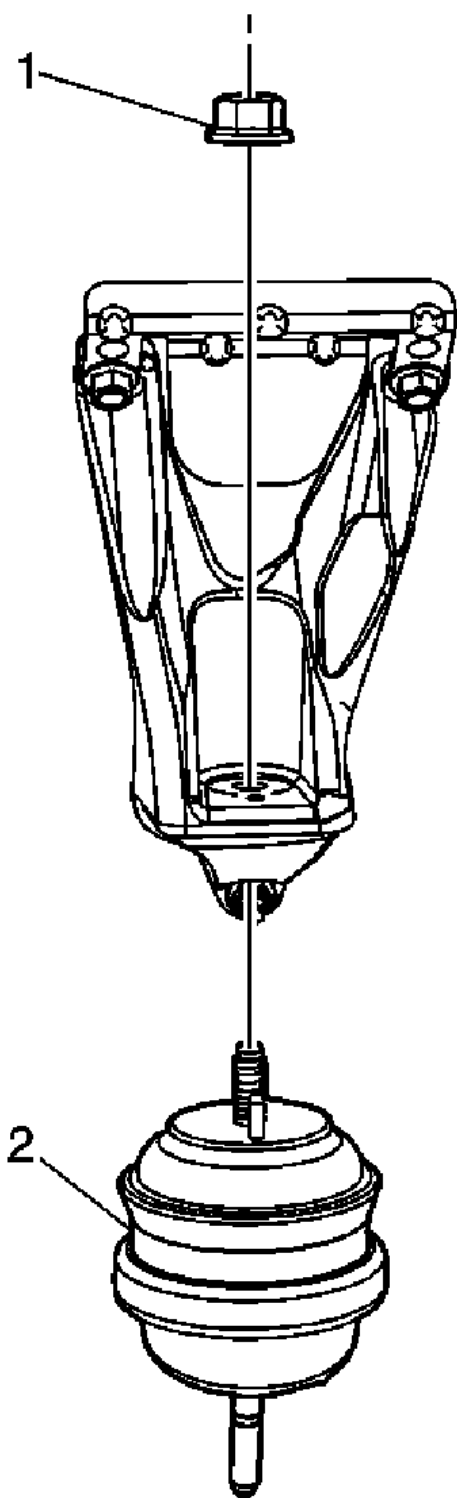


Fig. 16: Engine Front Mount
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:

Remove the engine front mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 80 N.m (59 lb ft)
2	Engine Mount Procedure: Transfer components as necessary.

ENGINE REAR MOUNT REPLACEMENT

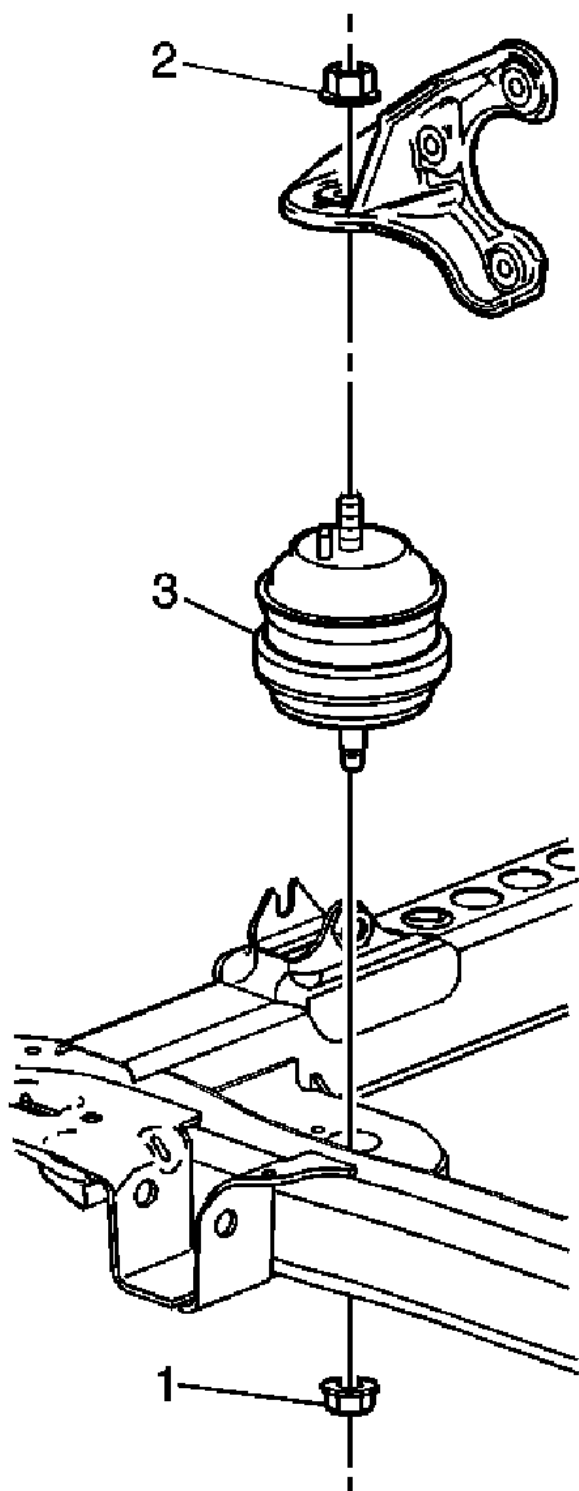


Fig. 17: Engine Rear Mount

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:Remove the front frame. Refer to **Drivetrain and Front Suspension Frame Replacement (3.9L)**.

1	Engine Rear Mount Upper Fastener CAUTION: Refer to Fastener Caution . Tighten: 80 N.m (59 lb ft)
2	Engine Rear Mount Lower Fastener Tighten: 80 N.m (59 lb ft)
3	Engine Rear Mount Procedure: Transfer parts as needed.

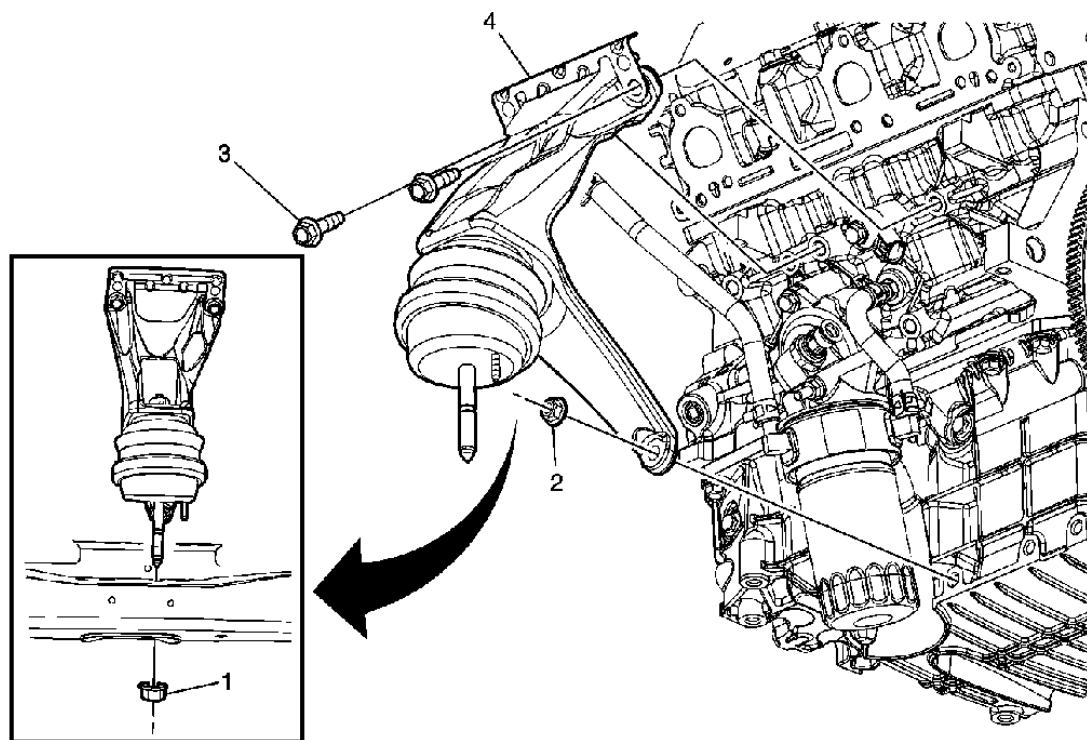
ENGINE FRONT MOUNT BRACKET REPLACEMENT

Fig. 18: Engine Front Mount Bracket
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	

1. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
2. Remove the front frame. Refer to **Drivetrain and Front Suspension Frame Replacement (3.9L)** .

1	Engine Front Mount Bracket Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten: 80 N.m (59 lb ft)
2	Engine Front Mount Bracket Fastener Tighten: 50 N.m (37 lb ft)
3	Engine Front Mount Bracket Fastener (Qty: 2) Tighten: 50 N.m (37 lb ft)
4	Engine Front Mount Bracket Procedure: Transfer components as necessary.

ENGINE REAR MOUNT BRACKET REPLACEMENT

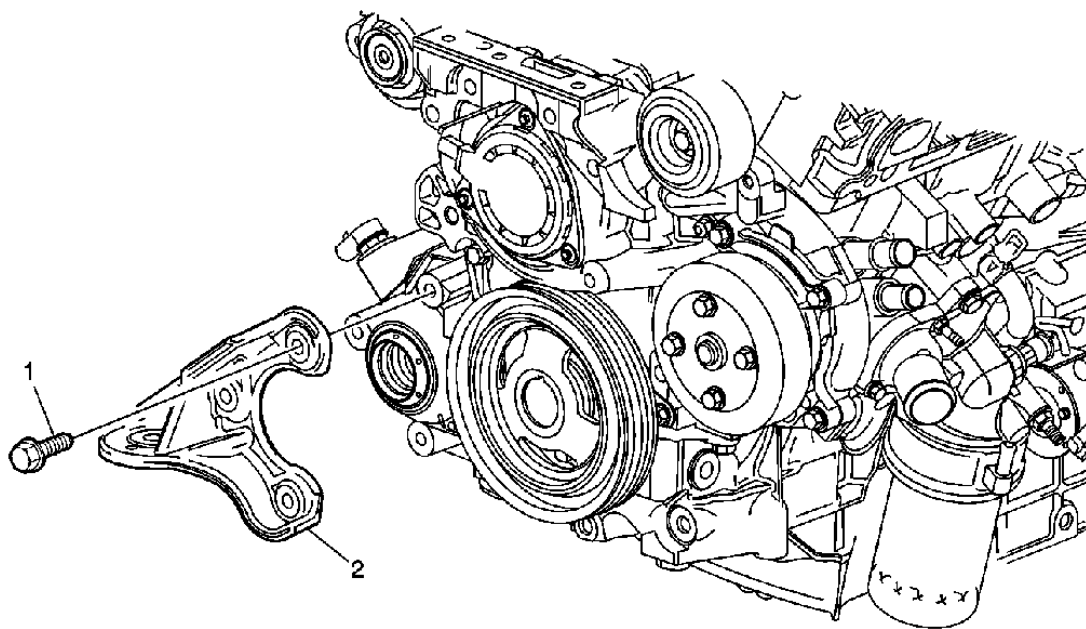


Fig. 19: Engine Rear Mount Bracket
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure:	

Remove the engine mount. Refer to **Engine Rear Mount Replacement**.

1	Engine Rear Mount Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 50 N.m (37 lb ft)
2	Engine Rear Mount Bracket Procedure 1. Position any lines as needed. 2. Transfer parts as needed.

OIL FILTER ADAPTER AND BYPASS VALVE ASSEMBLY REPLACEMENT

REMOVAL PROCEDURE

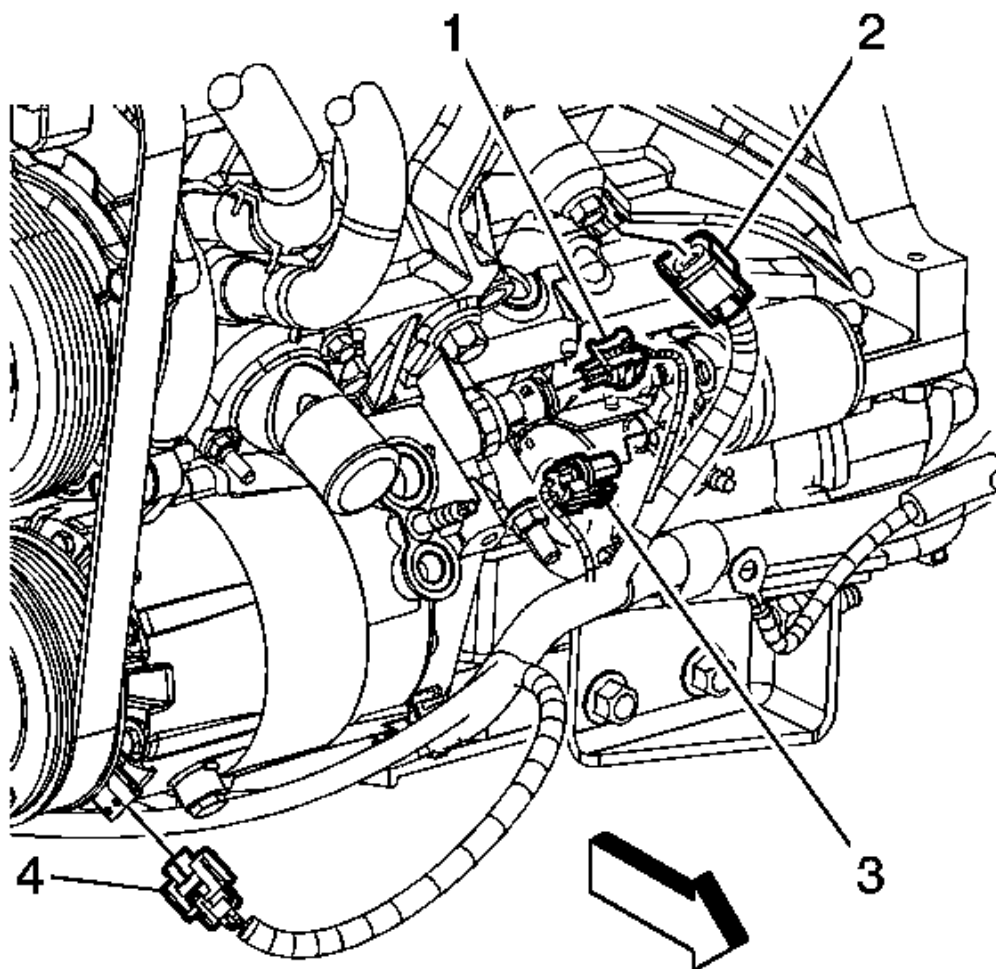


Fig. 20: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the oil pressure sensor electrical connector (1).

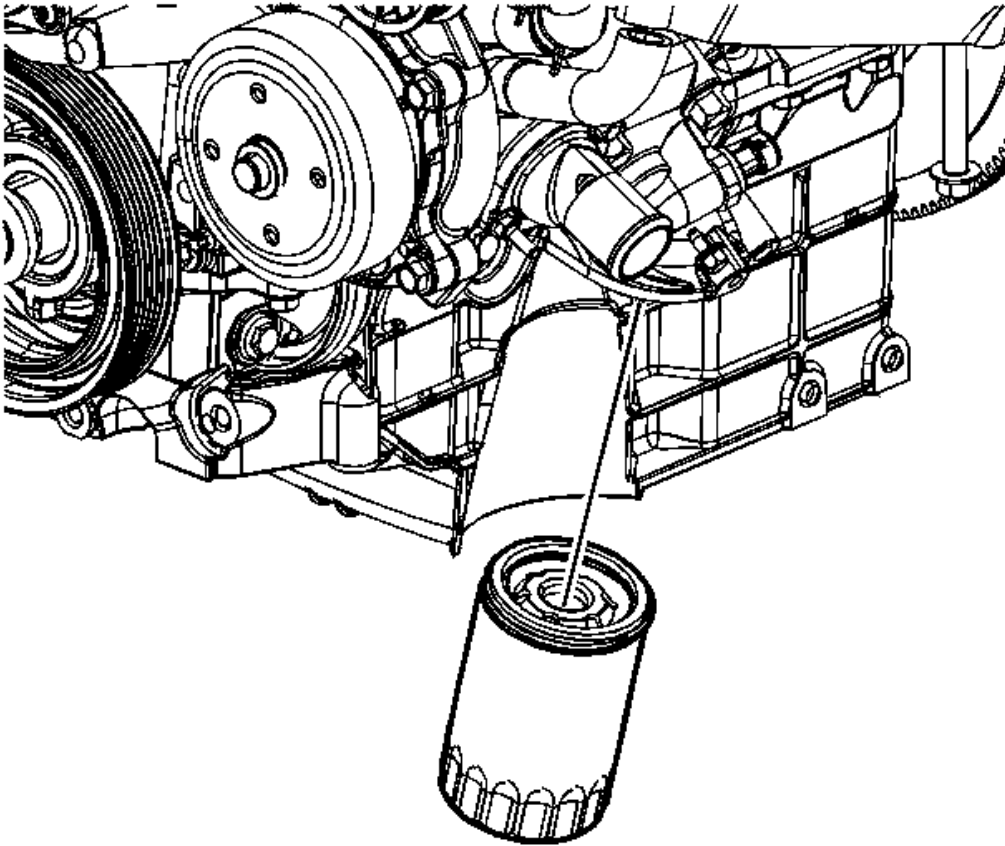


Fig. 21: Oil Filter

Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter.

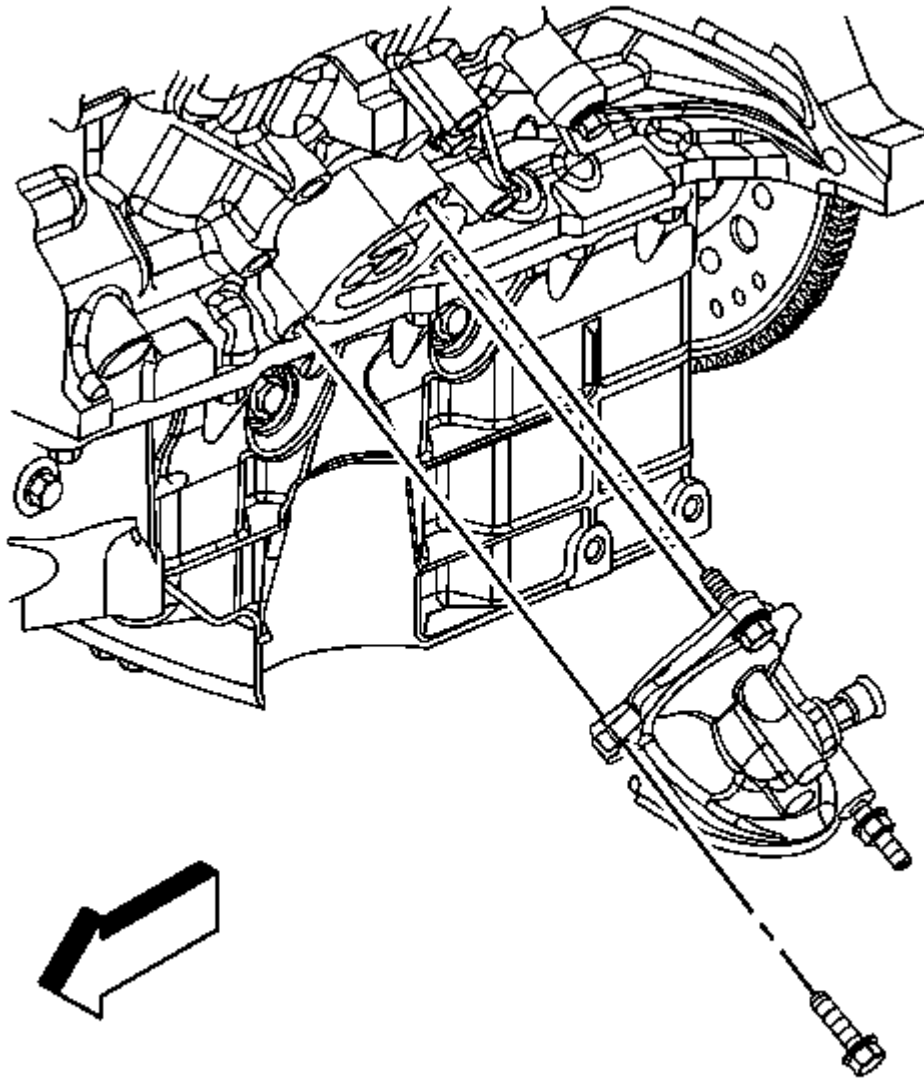


Fig. 22: Oil Filter Adapter Bolts & Stud
Courtesy of GENERAL MOTORS CORP.

4. Remove A/C compressor bolt and nut and reposition.
5. Remove engine mount bracket.
6. Remove oil cooler if equipped.
7. Remove the oil filter adapter bolts and stud.
8. Remove the oil filter adapter and gasket.

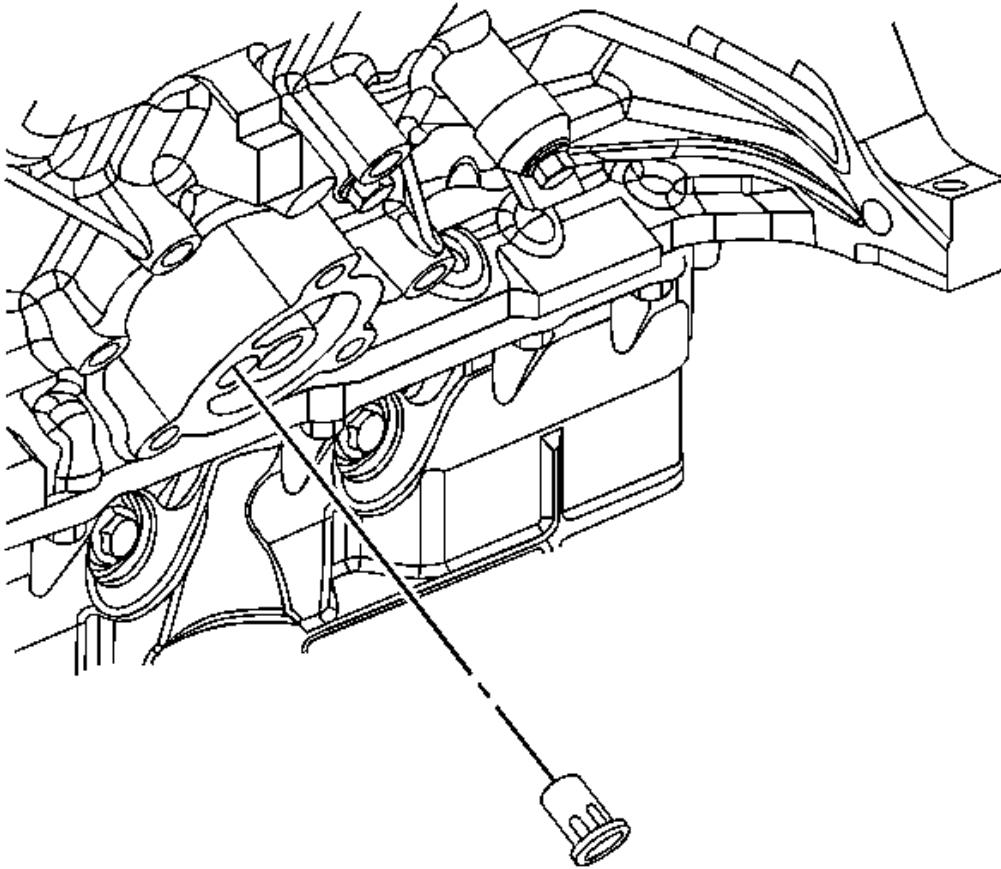


Fig. 23: Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

9. Insert a flat-bladed tool into the oil filter bypass hole and remove the oil filter bypass valve.

INSTALLATION PROCEDURE

CAUTION: Maximum gasket performance is achieved when using new fasteners, which contain a thread-locking patch. If the fasteners are not replaced, a thread locking chemical must be applied to the fastener threads. Failure to replace the fasteners or apply a thread-locking chemical MAY reduce gasket sealing capability.

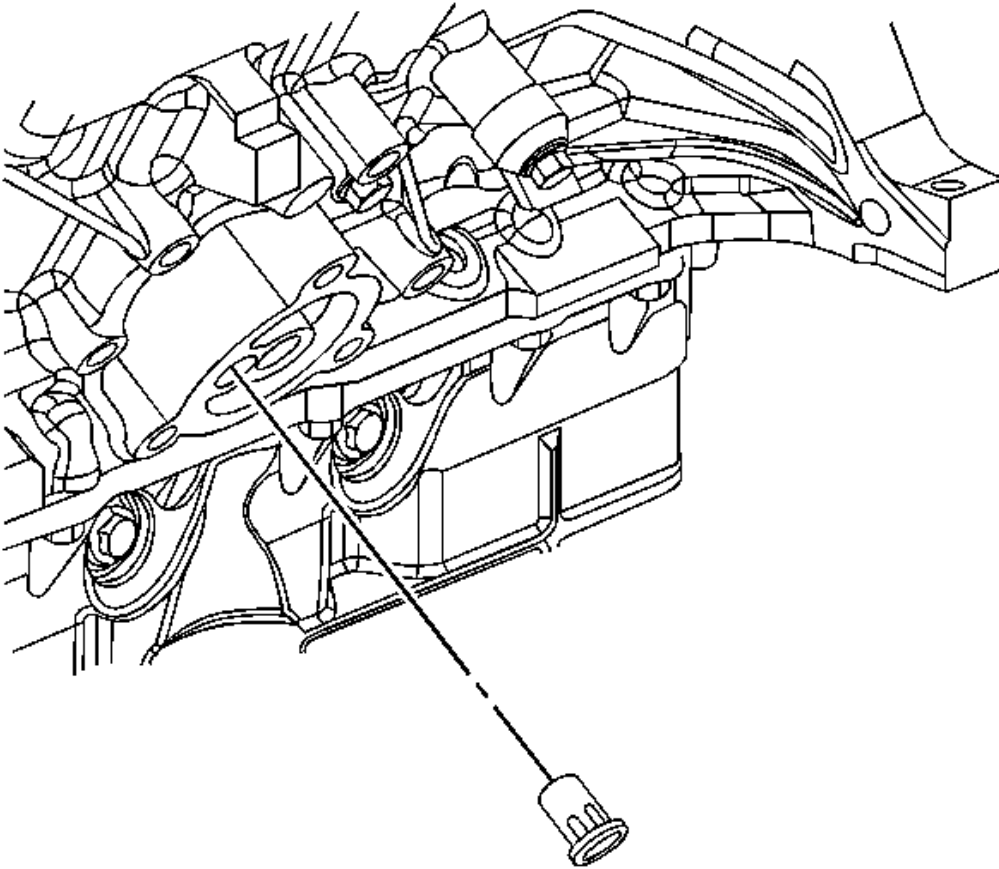


Fig. 24: Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter bypass valve. Seat the valve fully below the bypass valve hole chamfer.

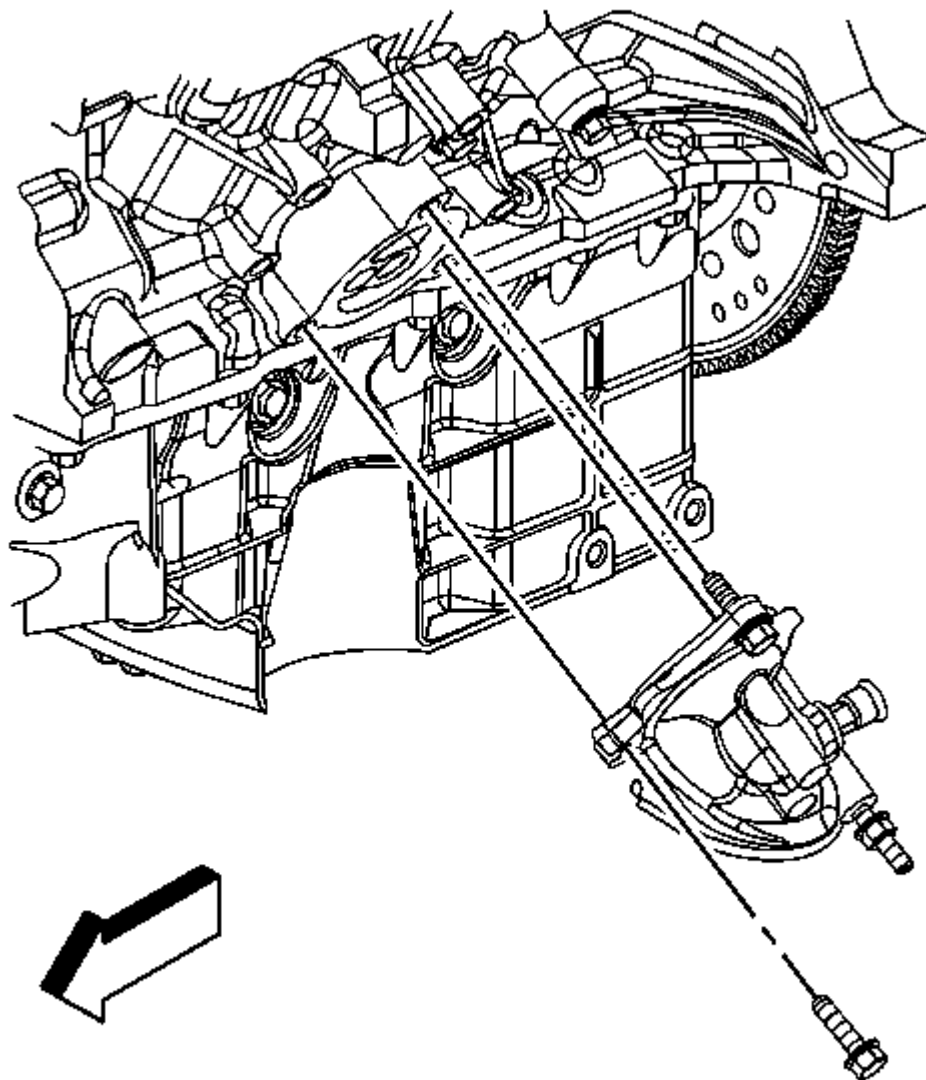


Fig. 25: Oil Filter Adapter Bolts & Stud
Courtesy of GENERAL MOTORS CORP.

2. Position the oil filter adapter and gasket to the engine.
3. Apply threadlock to the bolt/stud threads, if required. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

4. Install the oil filter adapter bolts and stud.

Tighten: Tighten the bolts and stud to 25 N.m (18 lb ft).

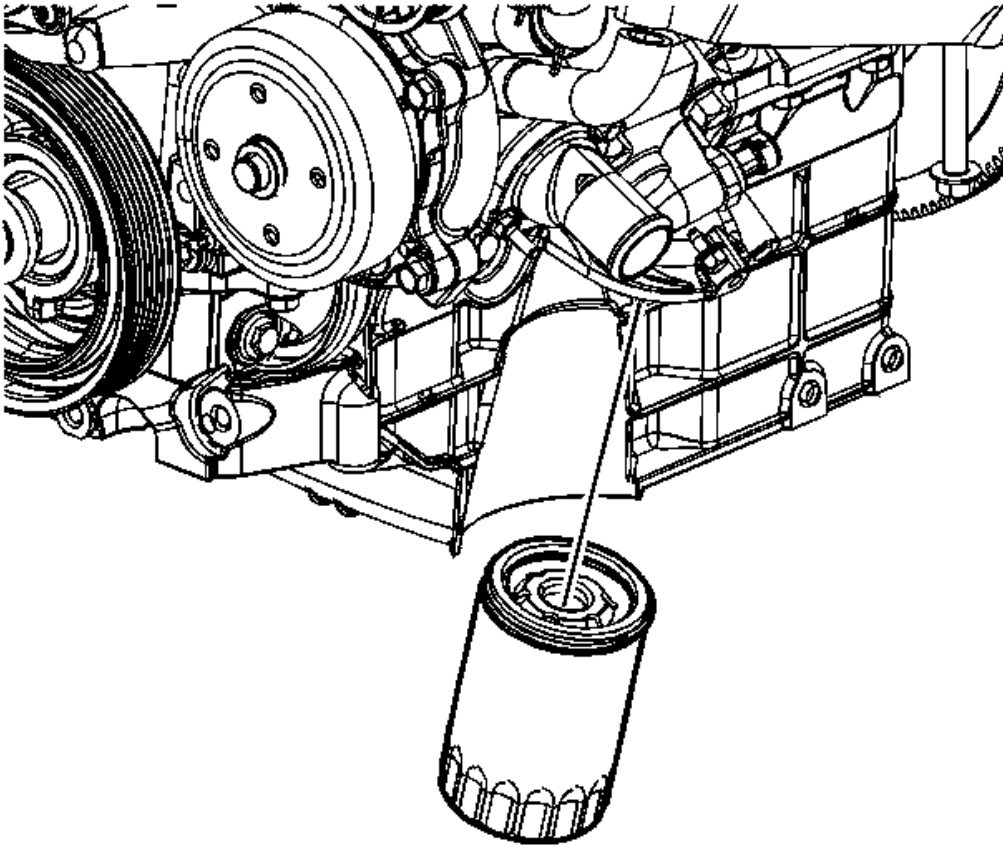


Fig. 26: Oil Filter

Courtesy of GENERAL MOTORS CORP.

5. Install the oil filter.

Tighten: Tighten the filter to 30 N.m (22 lb ft).

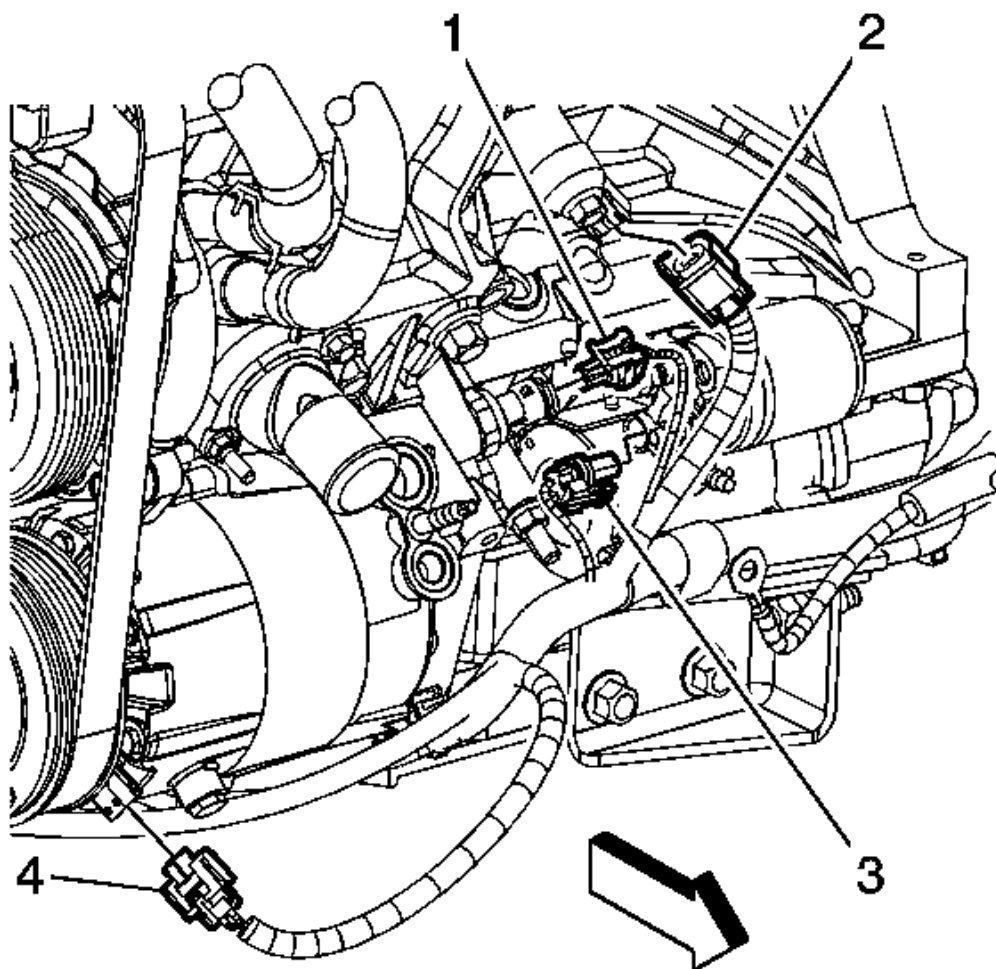


Fig. 27: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

6. Disconnect the oil pressure sensor electrical connector (1).
7. Lower the vehicle.
8. Check and fill the crankcase, if necessary.

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

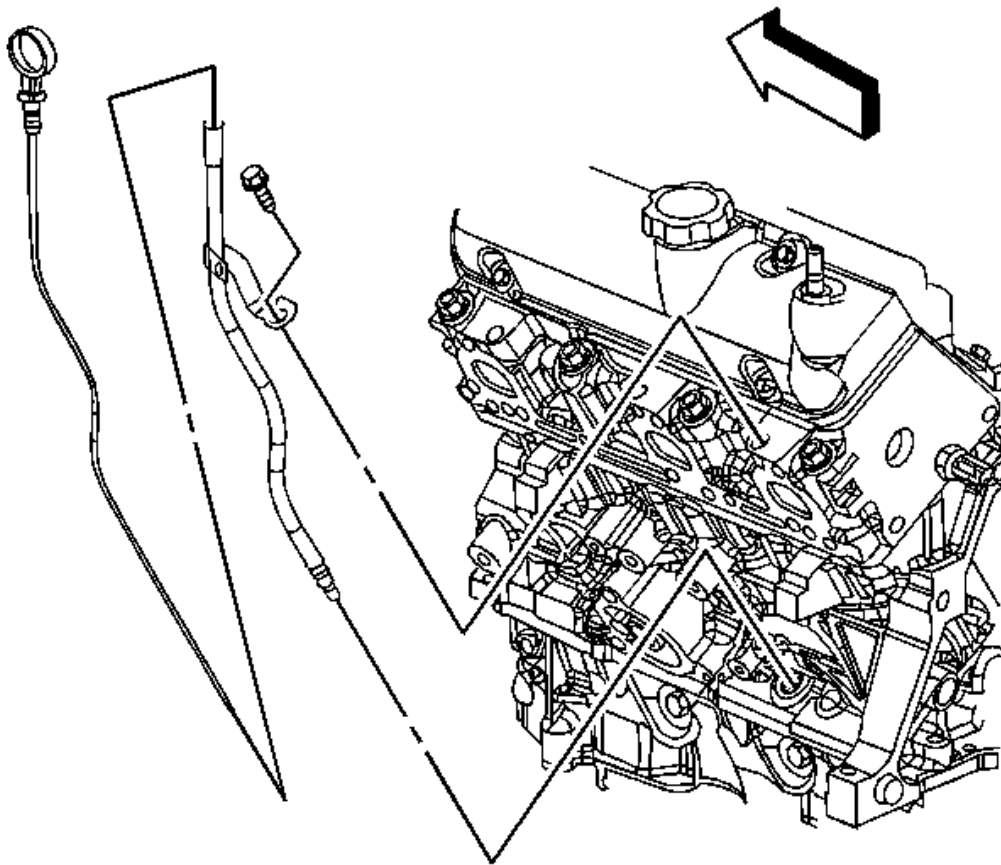


Fig. 28: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the oil level indicator tube bracket bolt.
3. Remove the oil level indicator tube.
4. Inspect the oil level indicator tube O-ring seal, for damage, replace as necessary.

INSTALLATION PROCEDURE

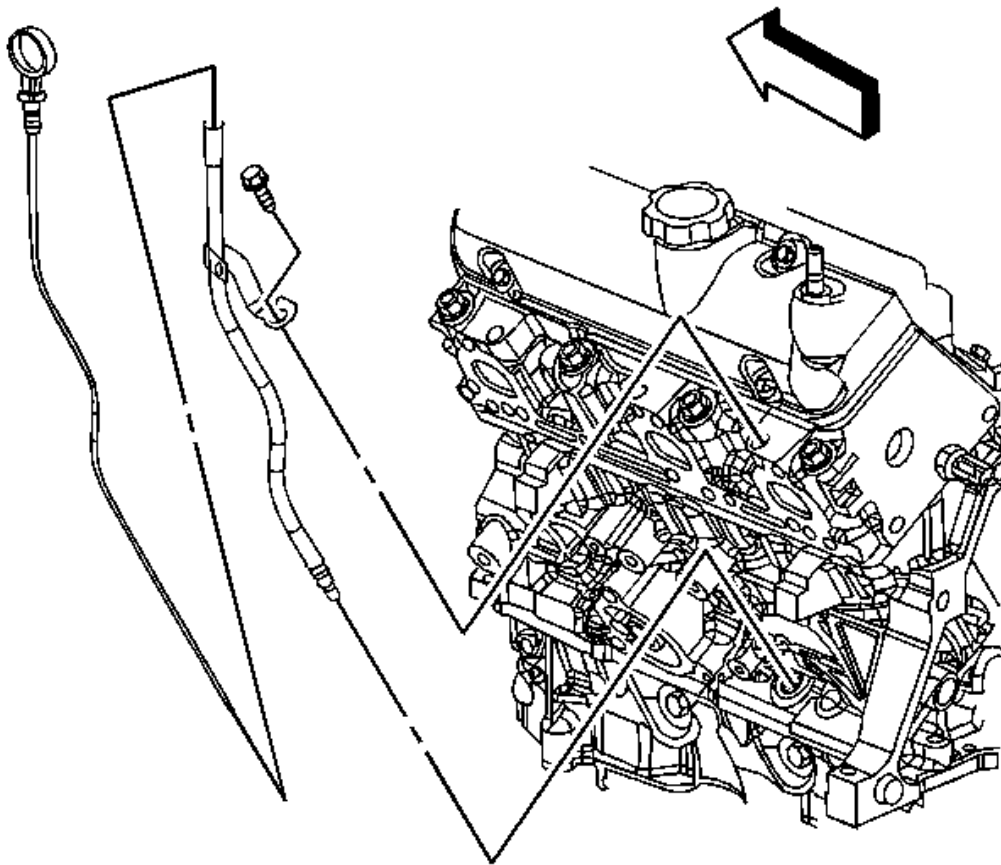


Fig. 29: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil level indicator tube O-ring seal with clean engine oil.
2. Install the oil level indicator tube into the engine block.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bracket bolt.

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

4. Install the oil level indicator.

UPPER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

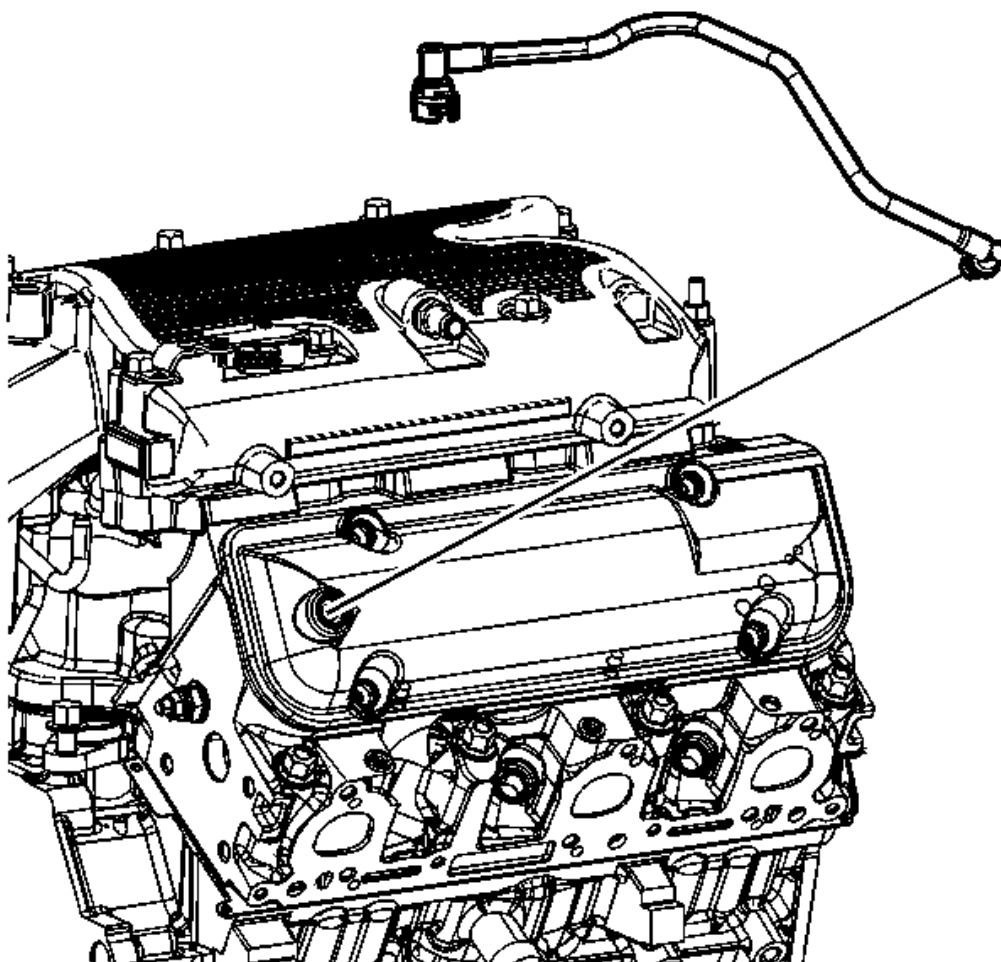


Fig. 30: Fresh Air Tube

Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)**.
4. Remove the positive crankcase ventilation (PCV) fresh air tube. Refer to **Plastic Collar Quick Connect**.

Fitting Service .

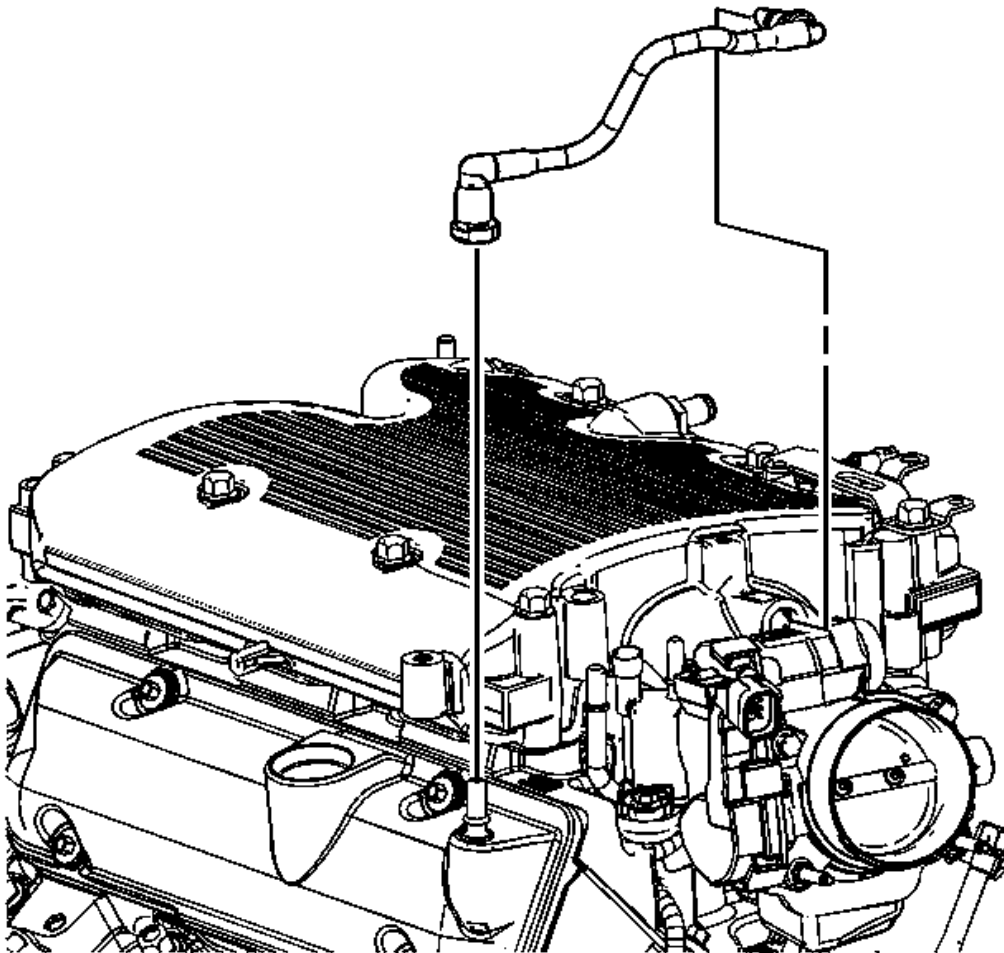


Fig. 31: Foul Air Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS CORP.

5. Remove the PCV foul air tube. Refer to **Plastic Collar Quick Connect Fitting Service .**

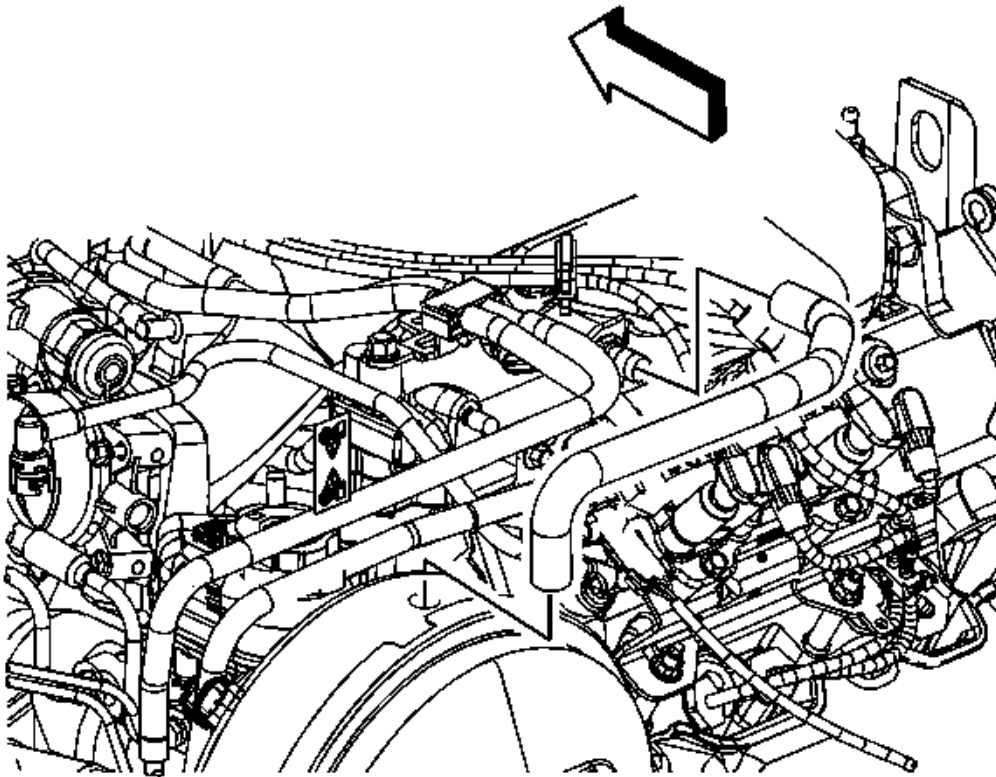


Fig. 32: Brake Booster Vacuum Hose & Intake Manifold Fitting
Courtesy of GENERAL MOTORS CORP.

6. Remove the brake booster vacuum hose from the intake manifold fitting.

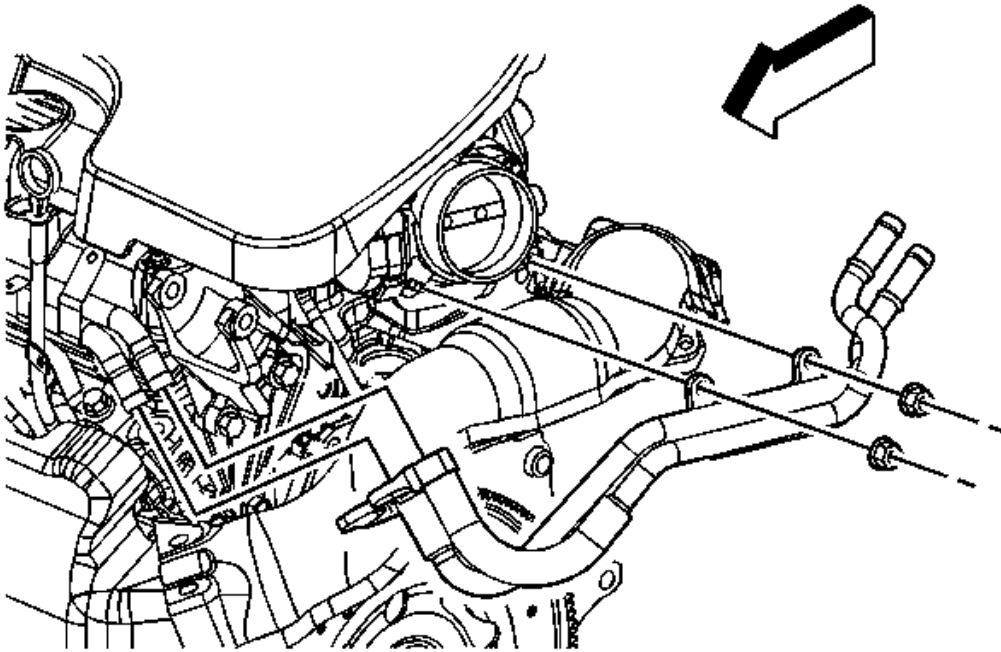


Fig. 33: Heater Inlet & Outlet Hoses/Pipes
Courtesy of GENERAL MOTORS CORP.

7. Reposition the heater inlet and outlet hose/pipe clamps at the engine pipes.
8. Remove the heater inlet and outlet hose/pipe clamp nuts from the throttle body studs.
9. Remove the heater inlet and outlet hoses/pipes from the engine pipes and the throttle body studs.
10. Reposition the hoses/pipes out of the way.

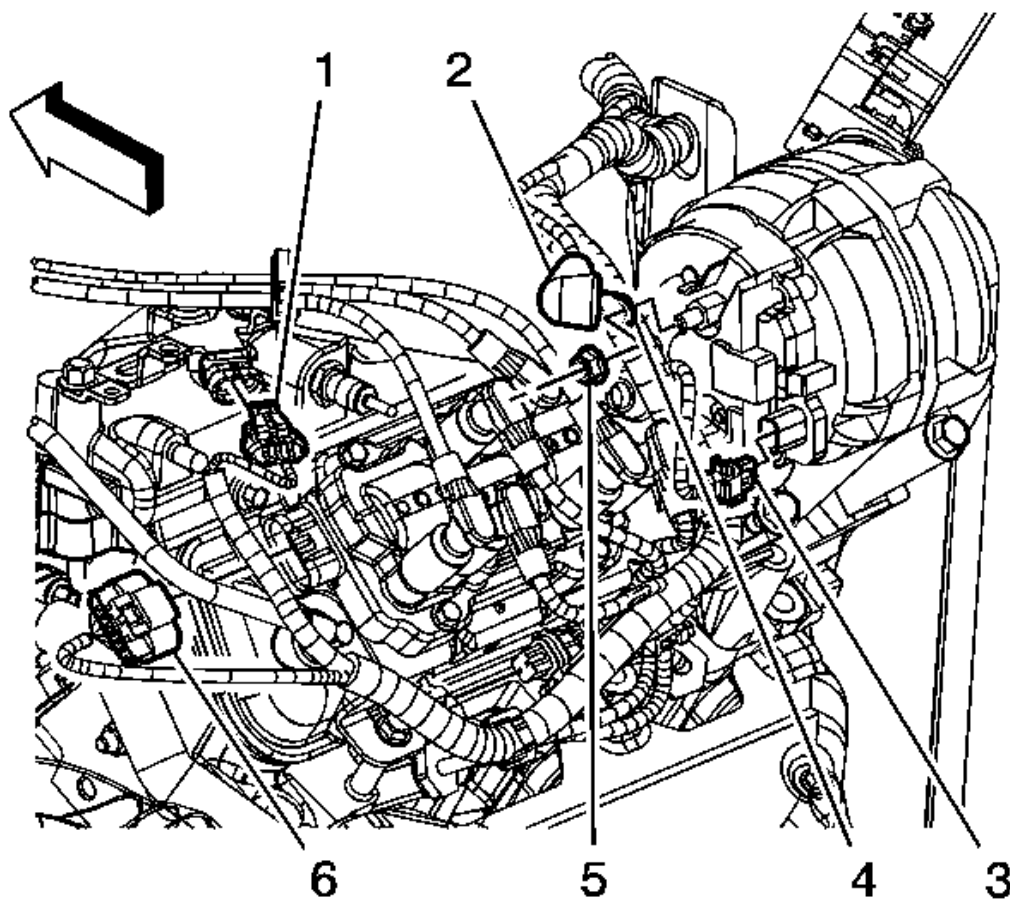


Fig. 34: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

11. Remove the fuel line and evaporative emission (EVAP) line clip from the manifold absolute pressure (MAP) sensor bracket.
12. Disconnect the MAP sensor electrical connector (1).

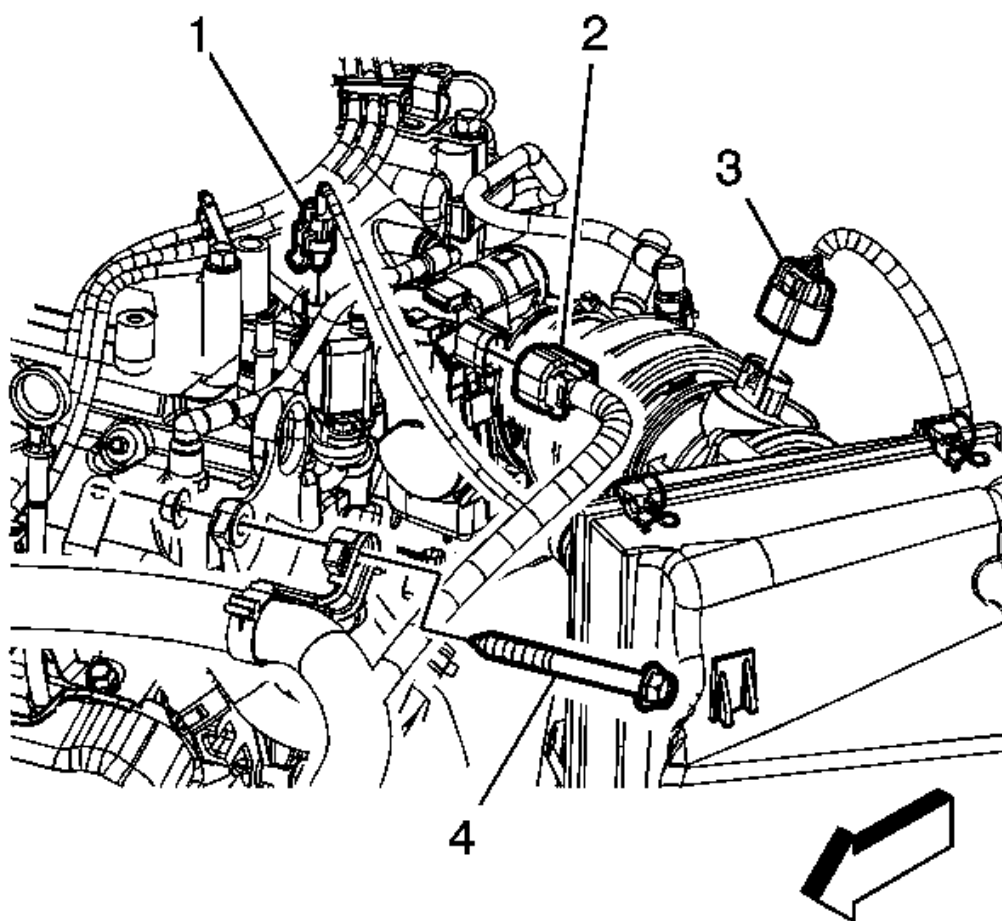


Fig. 35: EVAP Canister Purge Solenoid & Electronic Throttle Control Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the EVAP canister purge solenoid electrical connector (1).
14. Disconnect the chassis EVAP line quick connect fitting from the purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.
15. Disconnect the electronic throttle control (ETC) electrical connector (2).

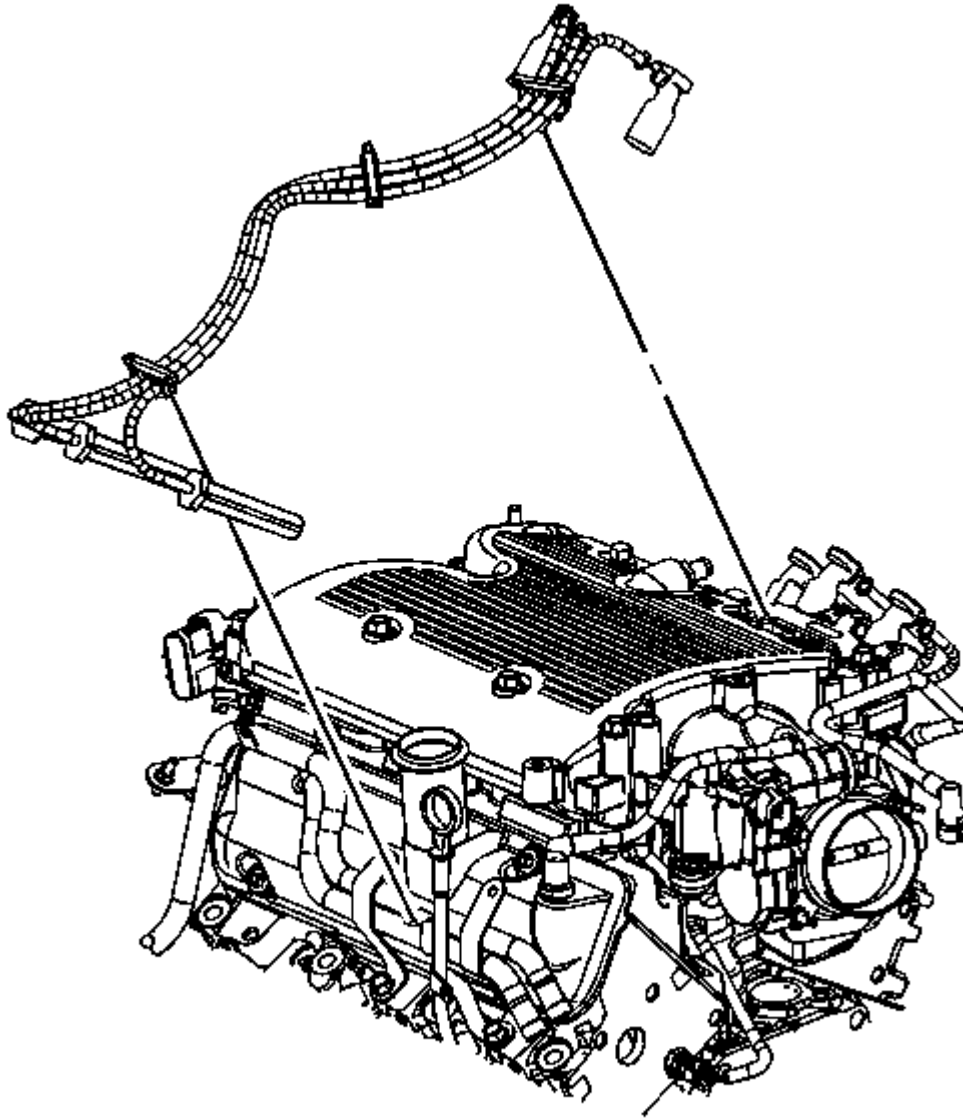


Fig. 36: Left Side Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

16. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
17. Disconnect the left side spark plug wires from the spark plugs.
18. Disconnect the left side spark plug wires from the ignition coil.
19. Disengage the spark plug wire retainer clips from the intake manifold bracket and the heater inlet/outlet

hose/pipe bracket.

20. Remove the left side spark plug wires.

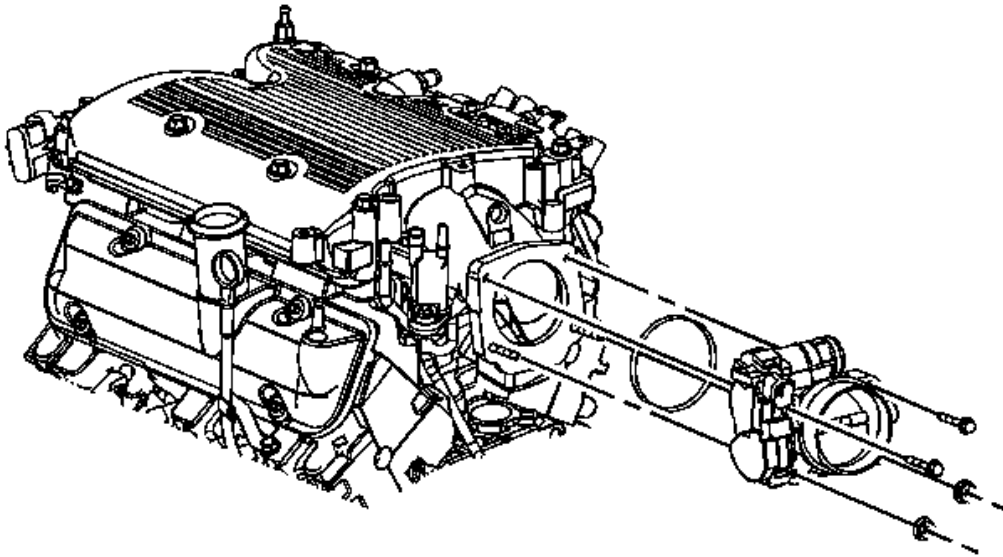


Fig. 37: Throttle Body, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

21. Remove the throttle body bolts and nuts.
22. Remove the throttle body and gasket.
23. If installing a replacement manifold, remove the throttle body-to-manifold studs.

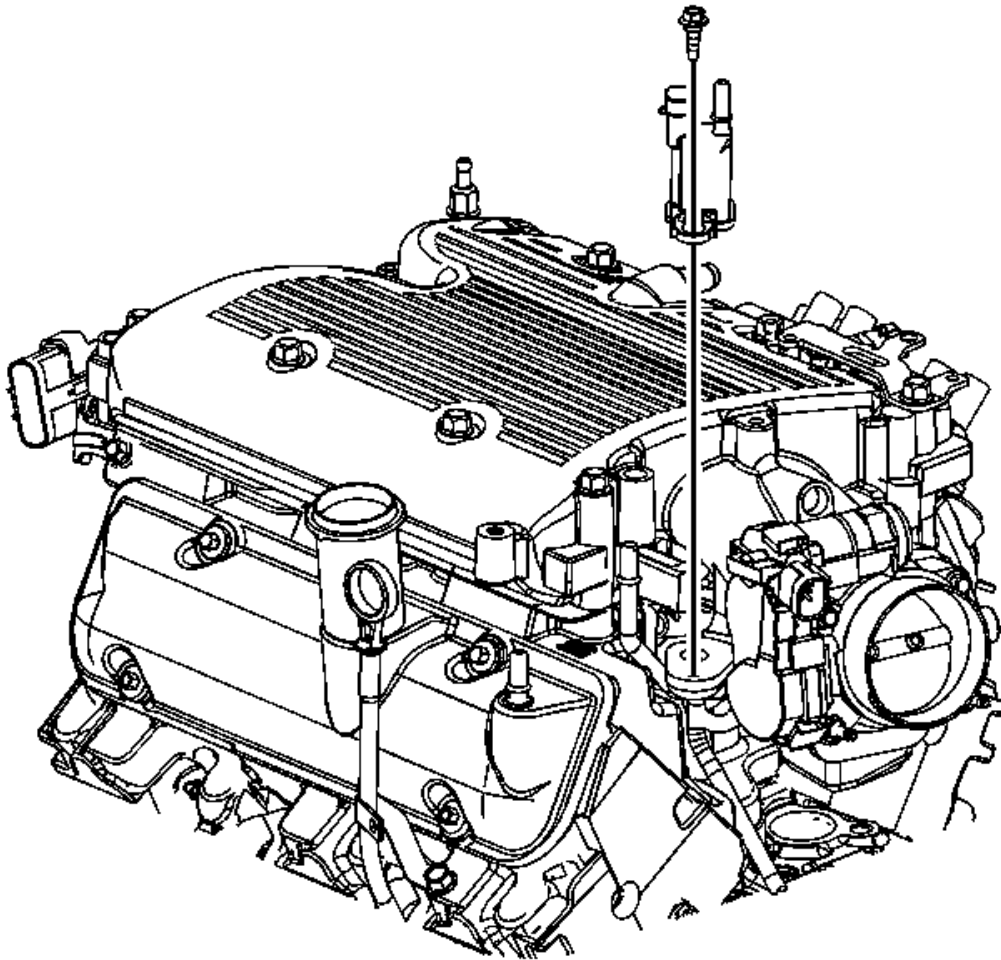


Fig. 38: EVAP Canister Purge Valve
Courtesy of GENERAL MOTORS CORP.

24. Remove the EVAP canister purge solenoid valve bolt.
25. Remove the EVAP canister purge solenoid valve.

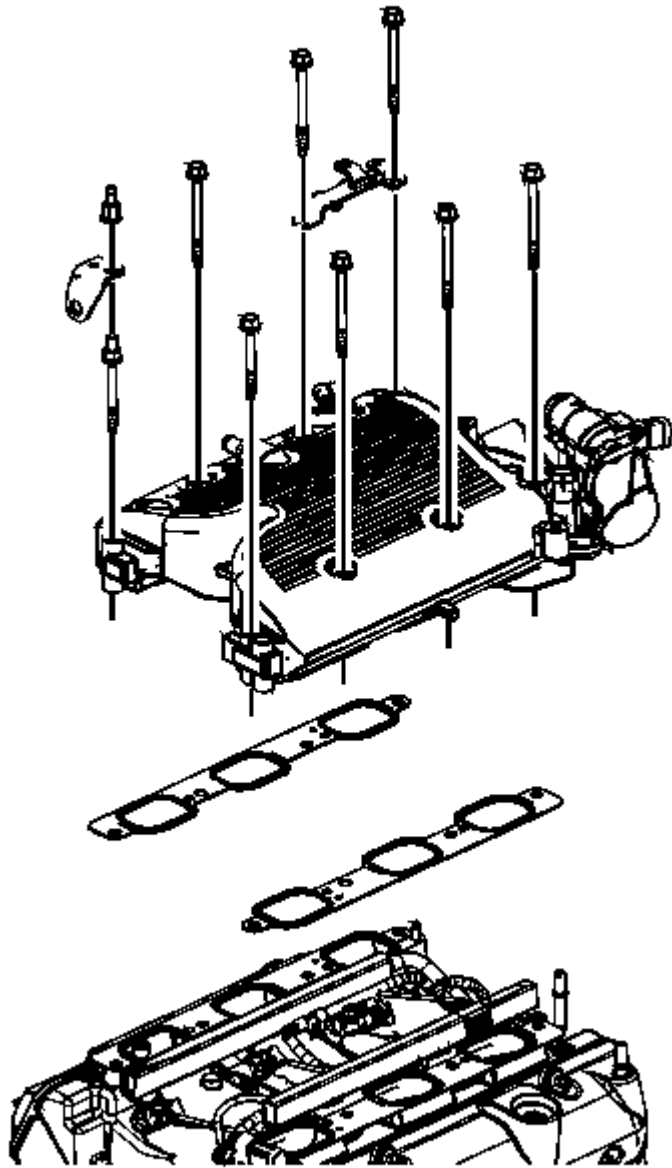


Fig. 39: Upper Intake Manifold, Bolts & Gaskets
Courtesy of GENERAL MOTORS CORP.

26. Remove the ignition coil bracket to intake manifold bolts.
27. Loosen power steering reservoir to intake manifold bolt and reposition.
28. Remove generator to intake manifold bracket bolt.

29. Remove the intake manifold cover ball stud nut from the intake manifold stud.
30. Remove the upper intake manifold bolts and stud.
31. Separate and remove the upper intake manifold from the lower intake manifold.
32. Remove the upper to lower intake manifold gaskets.
33. Clean the upper intake to lower intake gasket mating surfaces.

INSTALLATION PROCEDURE

1. Install the upper intake manifold onto the lower intake manifold.
2. Apply threadlock to the upper intake manifold bolts/stud threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

3. Install the upper intake manifold bolts and stud and tighten the bolts to 25 N.m (18 lb ft).
4. Install the intake manifold cover ball stud nut to the intake manifold stud and tighten the nut to 5 N.m (44 lb in).
5. Install the ignition coil bracket to intake manifold bolts and tighten the bolts to 25 N.m (18 lb ft).

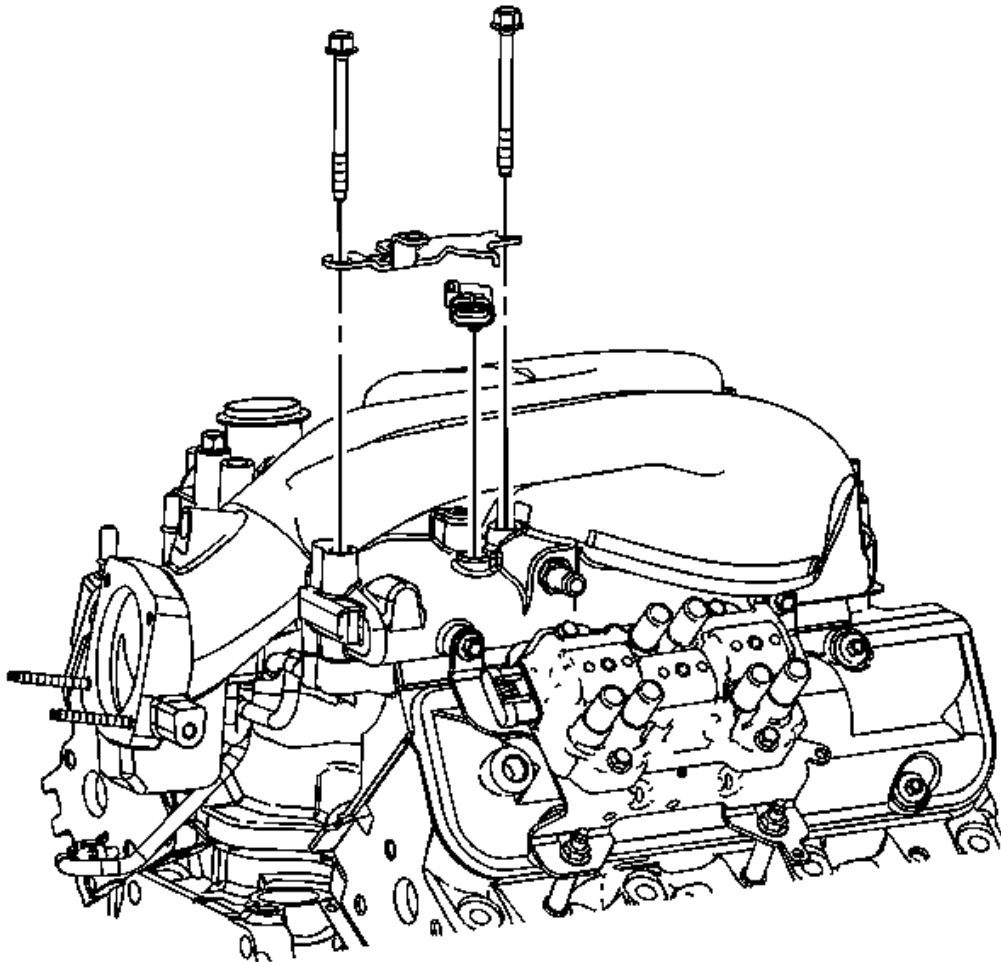


Fig. 40: MAP Sensor Bracket/Upper Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the MAP sensor and bracket.
7. Install the MAP sensor bracket/upper intake manifold bolts and tighten to 25 N.m (18 lb ft).

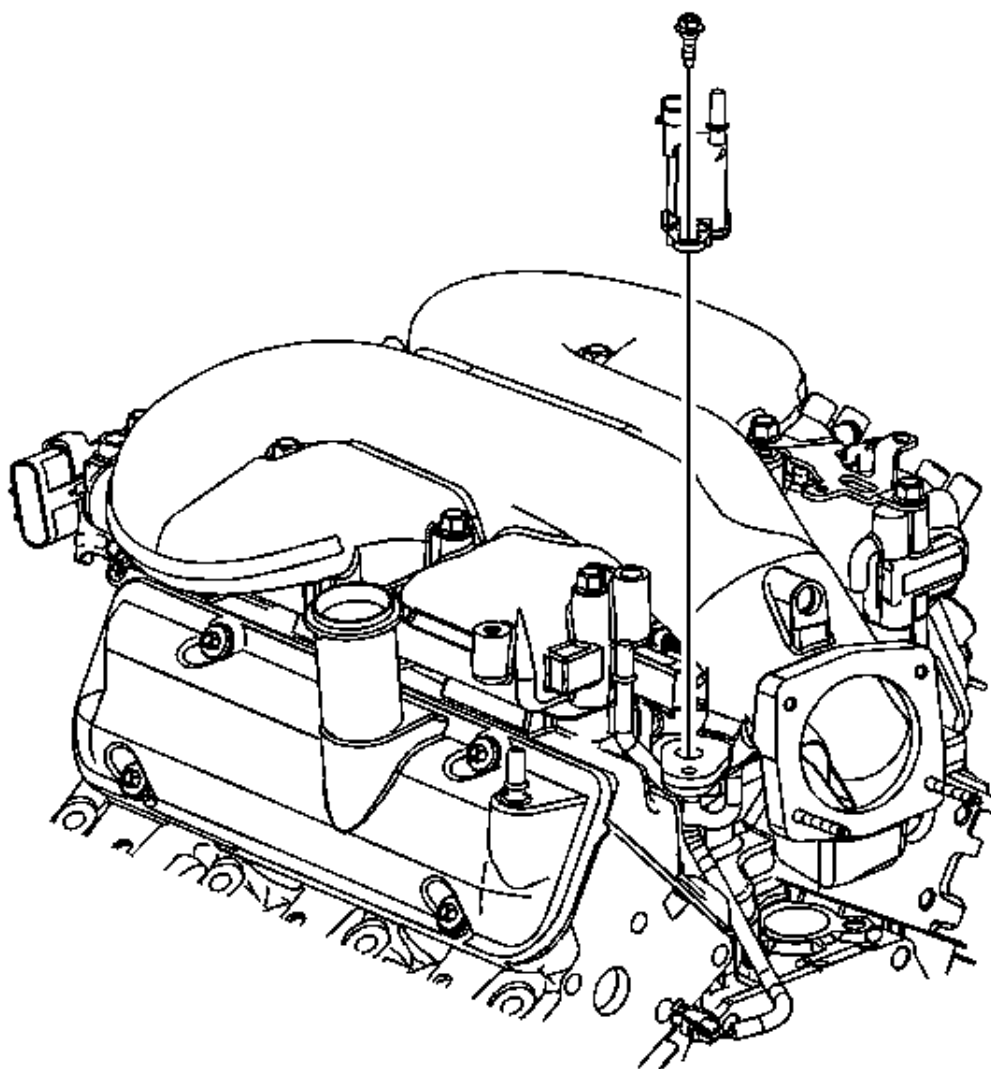


Fig. 41: EVAP Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

8. Install the EVAP canister purge solenoid valve.
9. Install the EVAP canister purge solenoid valve bolt and tighten to 16 N.m (12 lb ft).

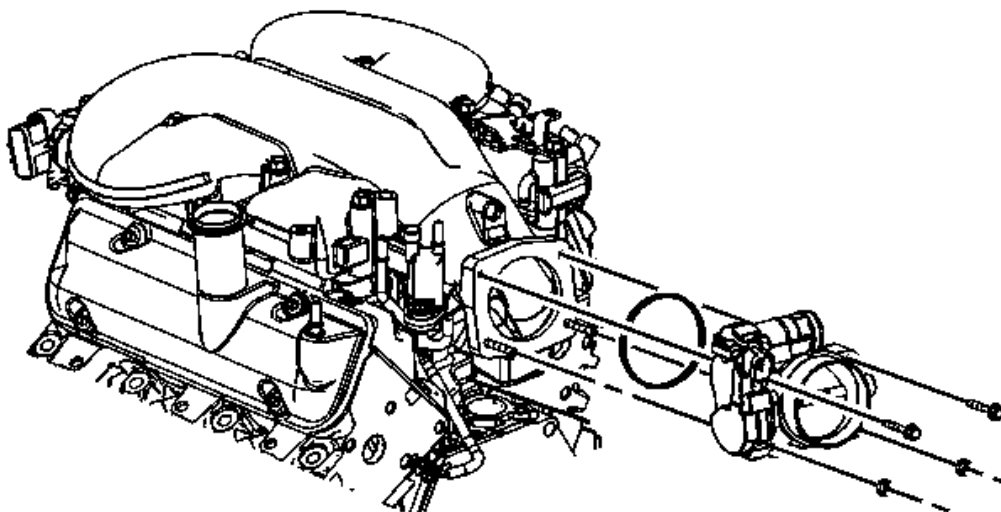


Fig. 42: Throttle Body, Bolts, Nuts & Gasket

Courtesy of GENERAL MOTORS CORP.

10. Inspect the throttle body seal for damage. Replace as necessary.
11. Apply threadlock to the throttle body bolts/studs threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
12. Position the throttle body gasket and throttle body to the intake.
13. Install the throttle body studs, if required and tighten to 6 N.m (53 lb in).
14. Install the throttle body bolts and nuts and tighten to 10 N.m (89 lb in).

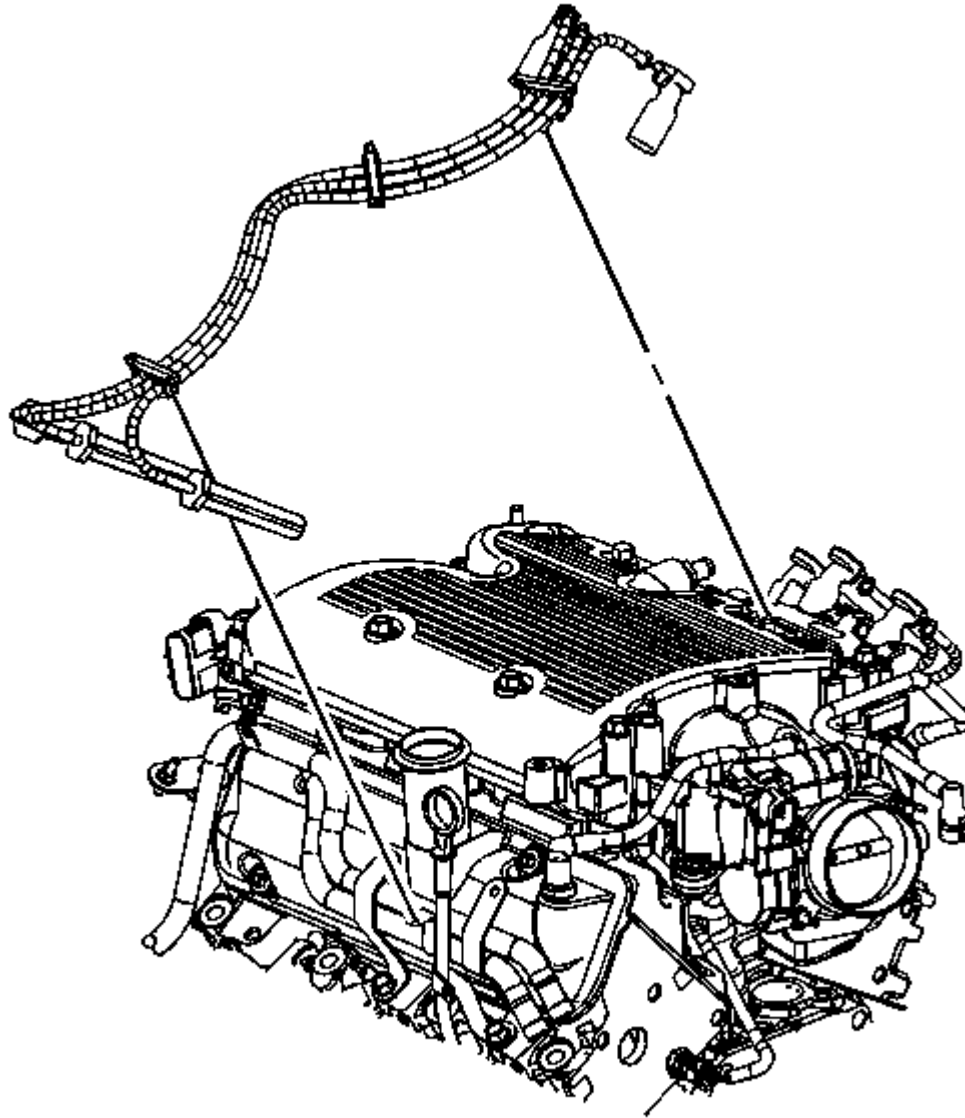


Fig. 43: Left Side Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

15. Install the left side spark plug wires.
16. Engage the spark plug wire retainer clips to the intake manifold bracket and the heater inlet/outlet hose/pipe bracket.
17. Connect the left side spark plug wires to the ignition coil.

18. Connect the left side spark plug wires to the spark plugs.
19. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .

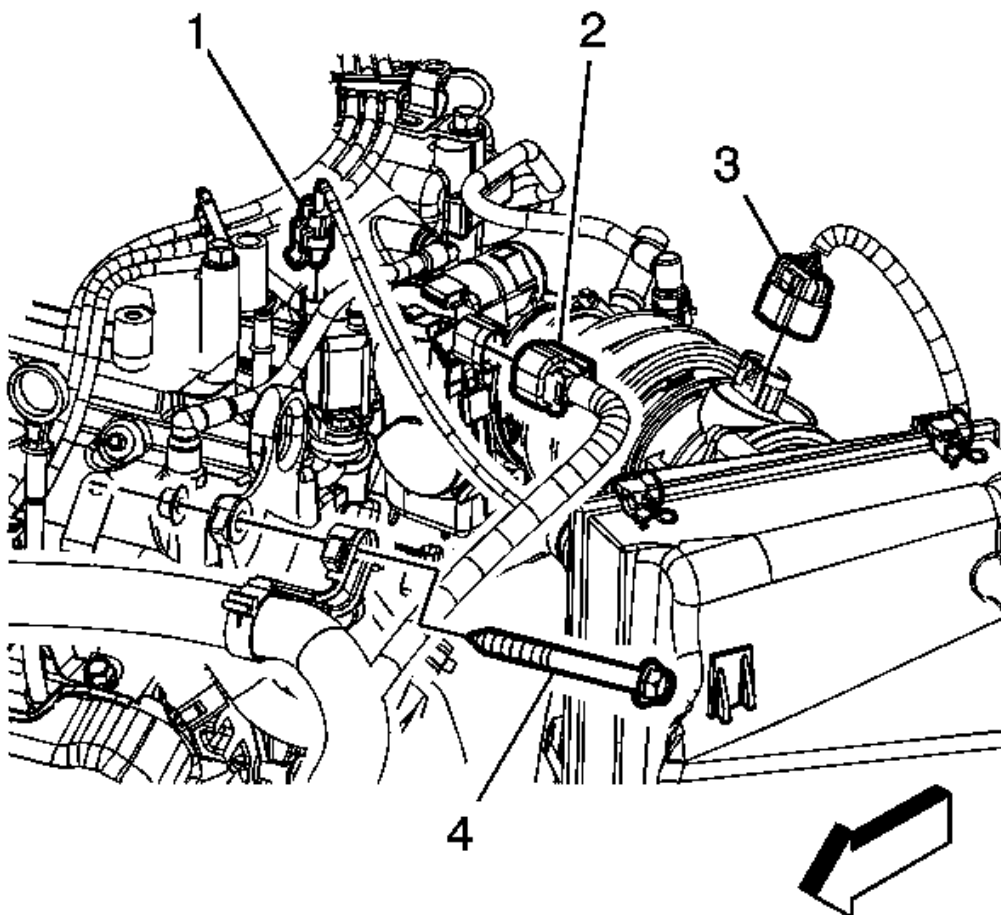


Fig. 44: EVAP Canister Purge Solenoid & Electronic Throttle Control Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

20. Connect the EVAP canister purge solenoid electrical connector (1).
21. Connect the chassis EVAP line quick connect fitting to the purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#) .
22. Connect the ETC electrical connector (2).

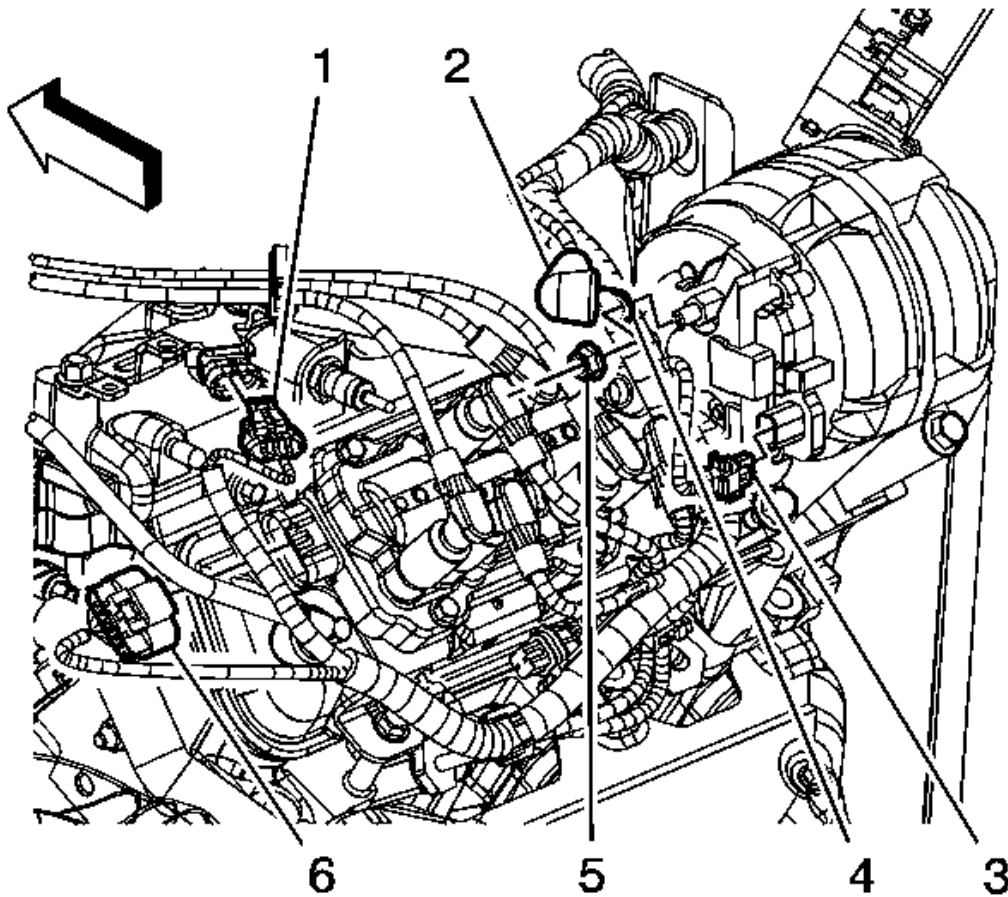


Fig. 45: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

23. Connect the MAP sensor electrical connector (1).
24. Install the fuel feed and EVAP line clip to the MAP sensor bracket.

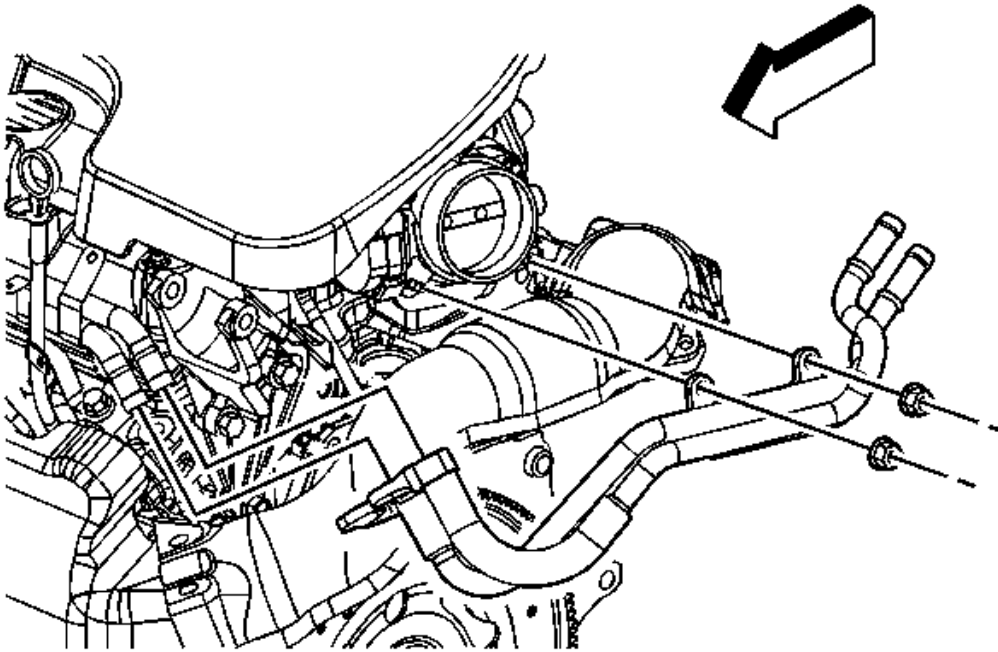


Fig. 46: Heater Inlet & Outlet Hoses/Pipes
Courtesy of GENERAL MOTORS CORP.

25. Position the hoses/pipes.
26. Install the heater inlet and outlet hoses/pipes to the engine pipes and the throttle body studs.
27. Install the heater inlet and outlet hose/pipe clamp nuts to the throttle body studs and tighten the nuts to 10 N.m (89 lb in).
28. Position the heater inlet and outlet hose/pipe clamps at the engine pipes.

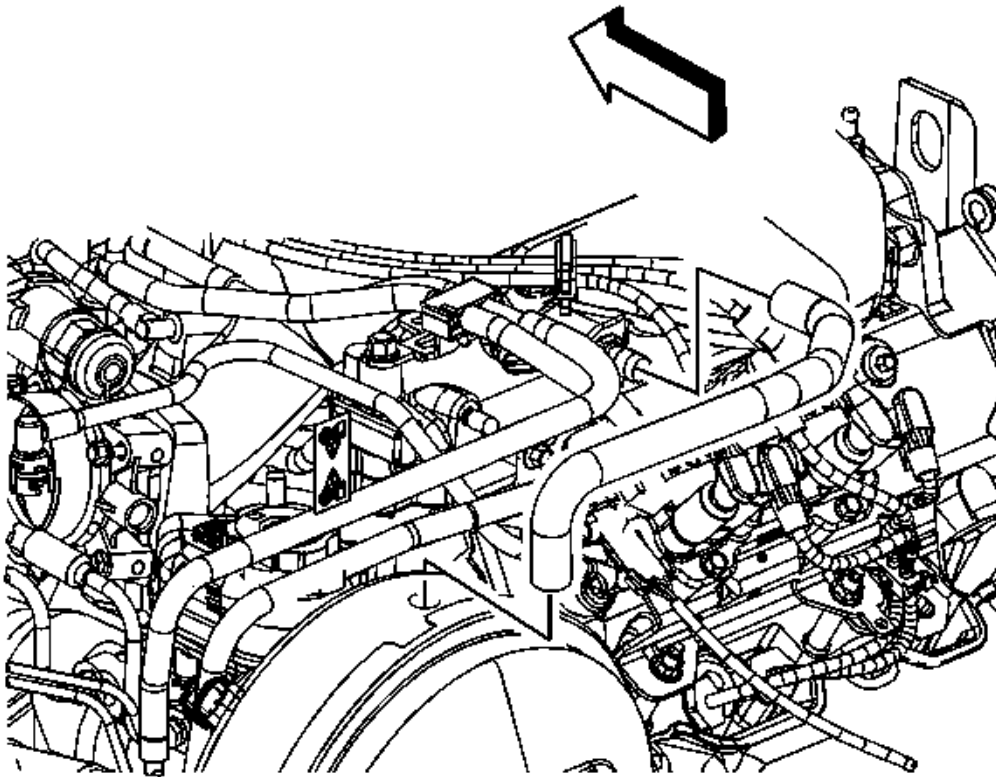


Fig. 47: Brake Booster Vacuum Hose & Intake Manifold Fitting
Courtesy of GENERAL MOTORS CORP.

29. Install the brake booster vacuum hose to the intake manifold.

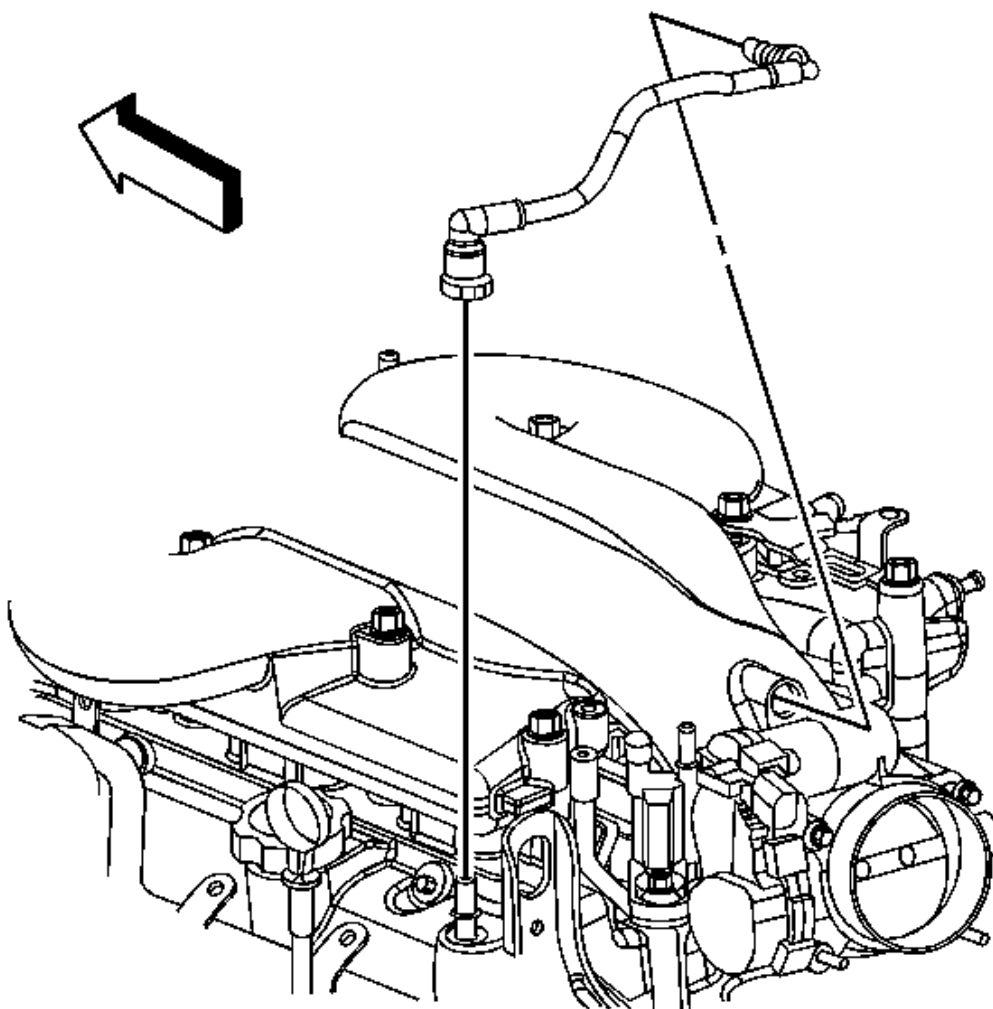


Fig. 48: Positive Crankcase Ventilation (PCV) Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

30. Install the PCV foul air tube. Refer to Plastic Collar Quick Connect Fitting Service .

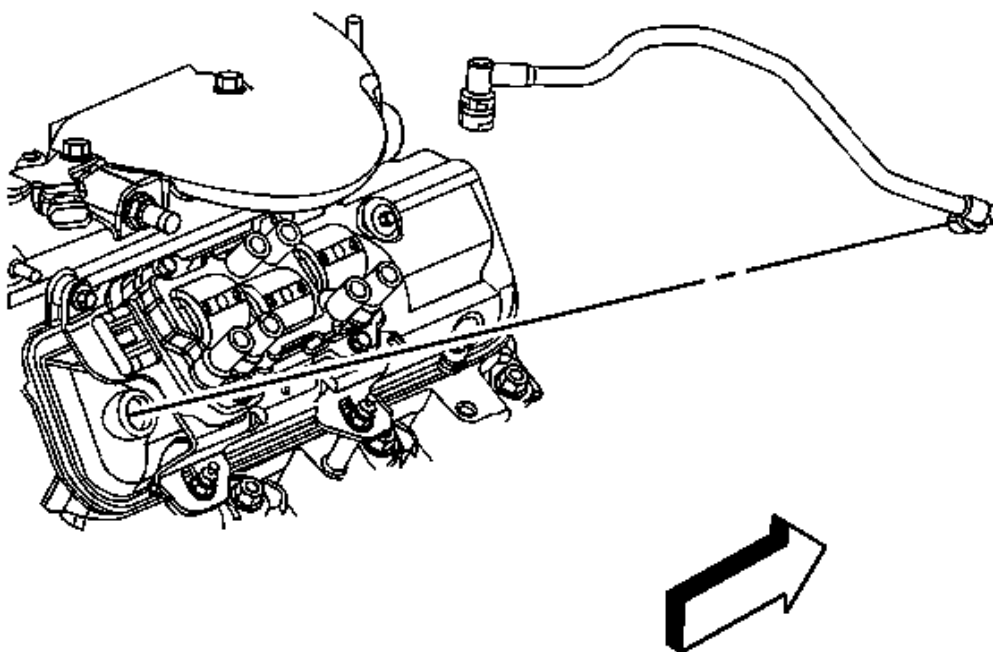


Fig. 49: Positive Crankcase Ventilation (PCV) Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

31. Install the PCV fresh air tube. Refer to Plastic Collar Quick Connect Fitting Service .
32. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac-N-Fill) .
33. Install the intake manifold cover. Refer to Intake Manifold Cover Replacement.
34. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

LOWER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

NOTE: This engine uses a sequential multiport fuel injection system. Injector wiring harness connectors must be connected to their appropriate fuel injector or exhaust emissions and engine performance may be seriously affected.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

2. Remove the upper intake manifold. Refer to Upper Intake Manifold Replacement.
3. Remove the left valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side.
4. Remove the right valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Right Side.
5. Disconnect the fuel feed line from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service.

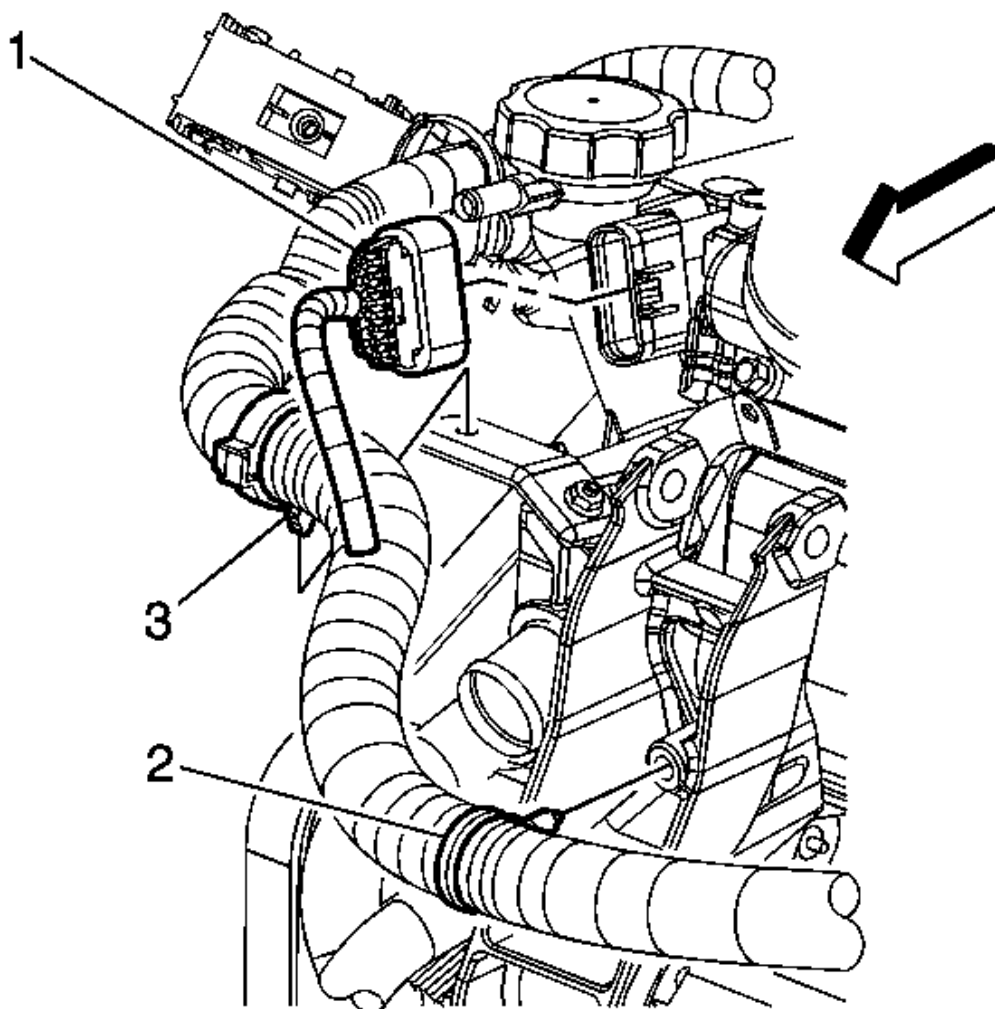


Fig. 50: Fuel Injector Inline Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect fuel injector inline connector (1).

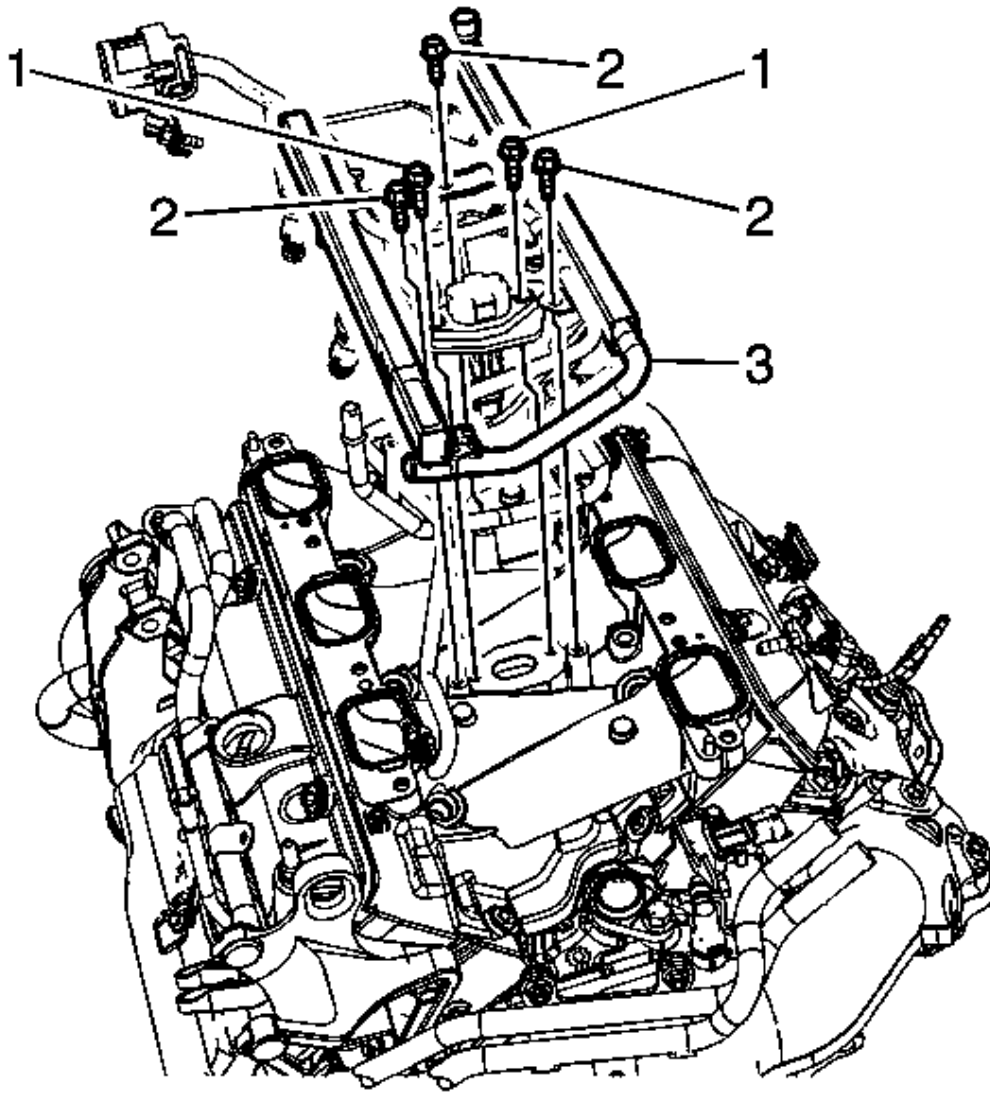


Fig. 51: Fuel Rail Components

Courtesy of GENERAL MOTORS CORP.

7. Remove the fuel injector harness connector bracket retainer from the intake manifold.
8. Disconnect the engine coolant temperature (ECT) electrical connector.
9. Disconnect the camshaft position (CMP) sensor electrical connector.
10. Remove two lifter oil manifold assembly (LOMA) electrical connector bolts (1) from the lower intake manifold if equipped..

11. Remove the fuel injector rail bolts (2).
12. Remove power steering pump. Refer to **Power Steering Pump Replacement (LZ9/LGD)**
13. Remove the fuel rail (3) and LOMA.

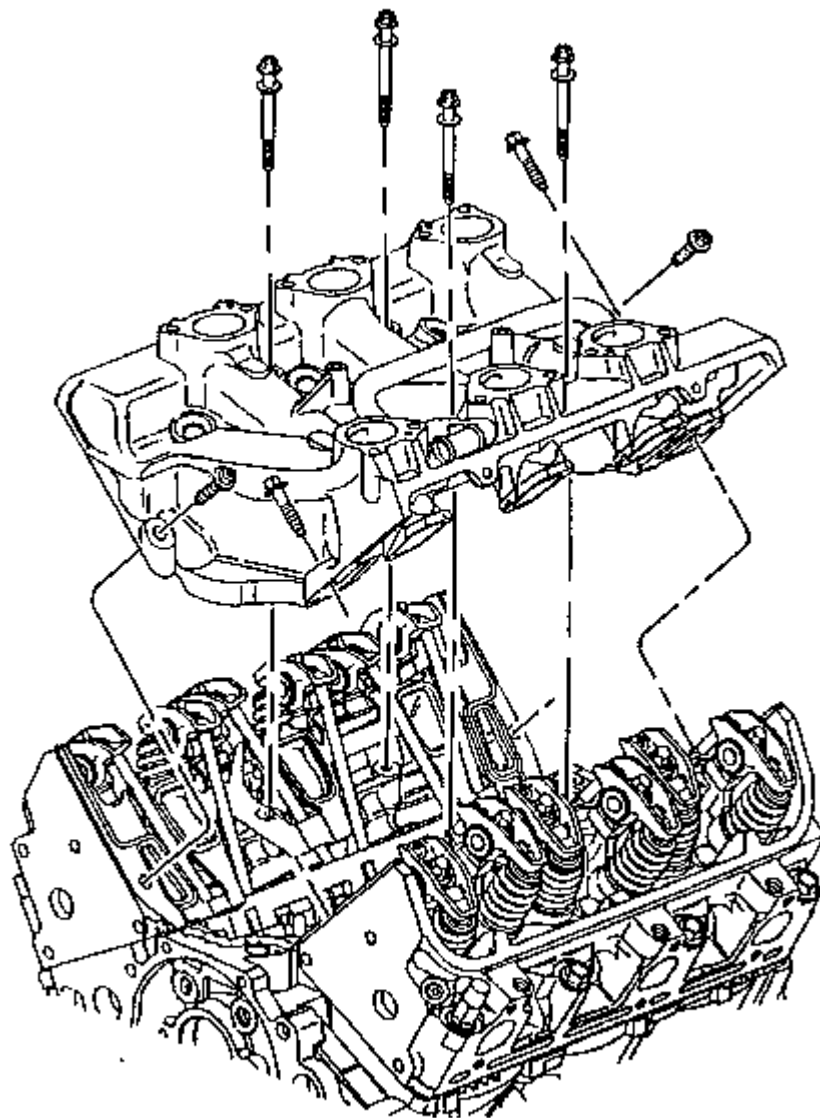


Fig. 52: Lower Intake Manifold & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the lower intake manifold bolts.
15. Remove the lower intake manifold.

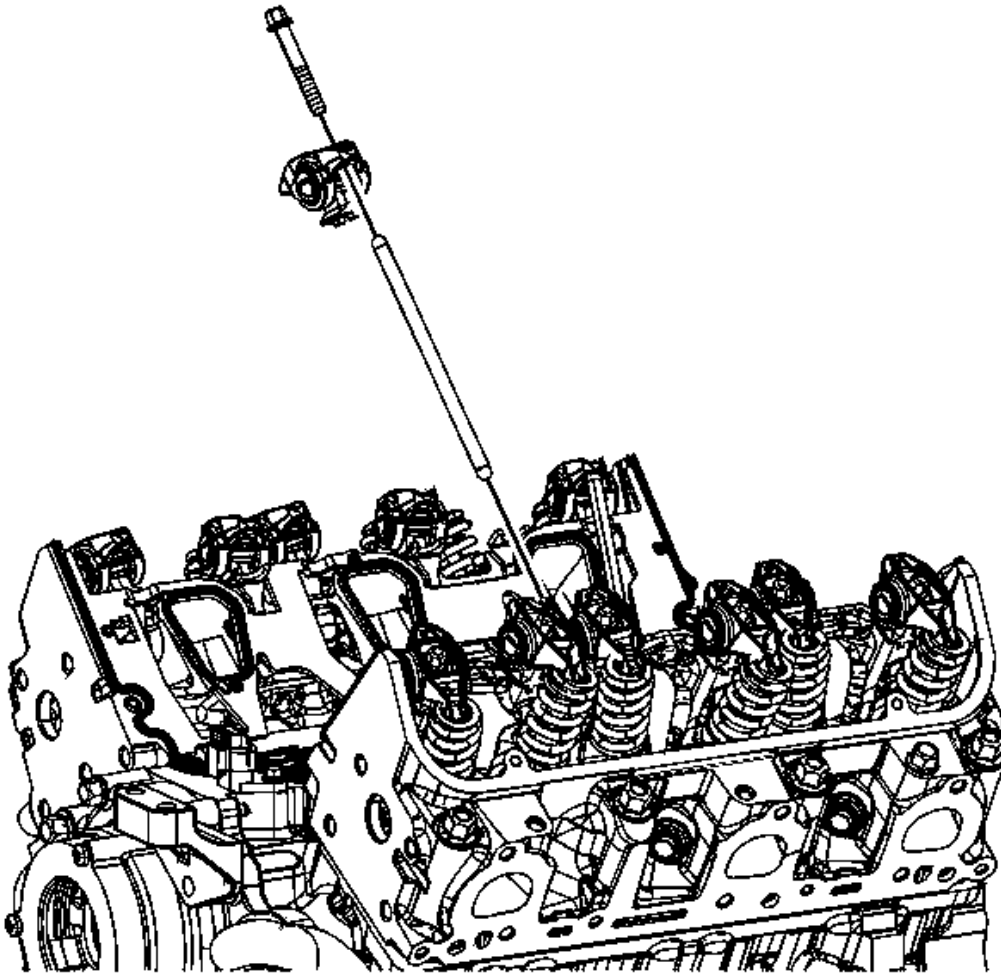


Fig. 53: Valve Rocker Arm, Bolt & Push Rod
Courtesy of GENERAL MOTORS CORP.

16. Loosen the valve rocker arm bolts.

NOTE: Place the valve train components in a rack in order to ensure that the components are installed in the same location from which they were removed.

17. Remove the valve rocker arms.
18. Remove the push rods.
 - The intake push rods measure 147.51 mm (5.81 in).
 - The exhaust push rods measure 154.87 mm (6.1 in).

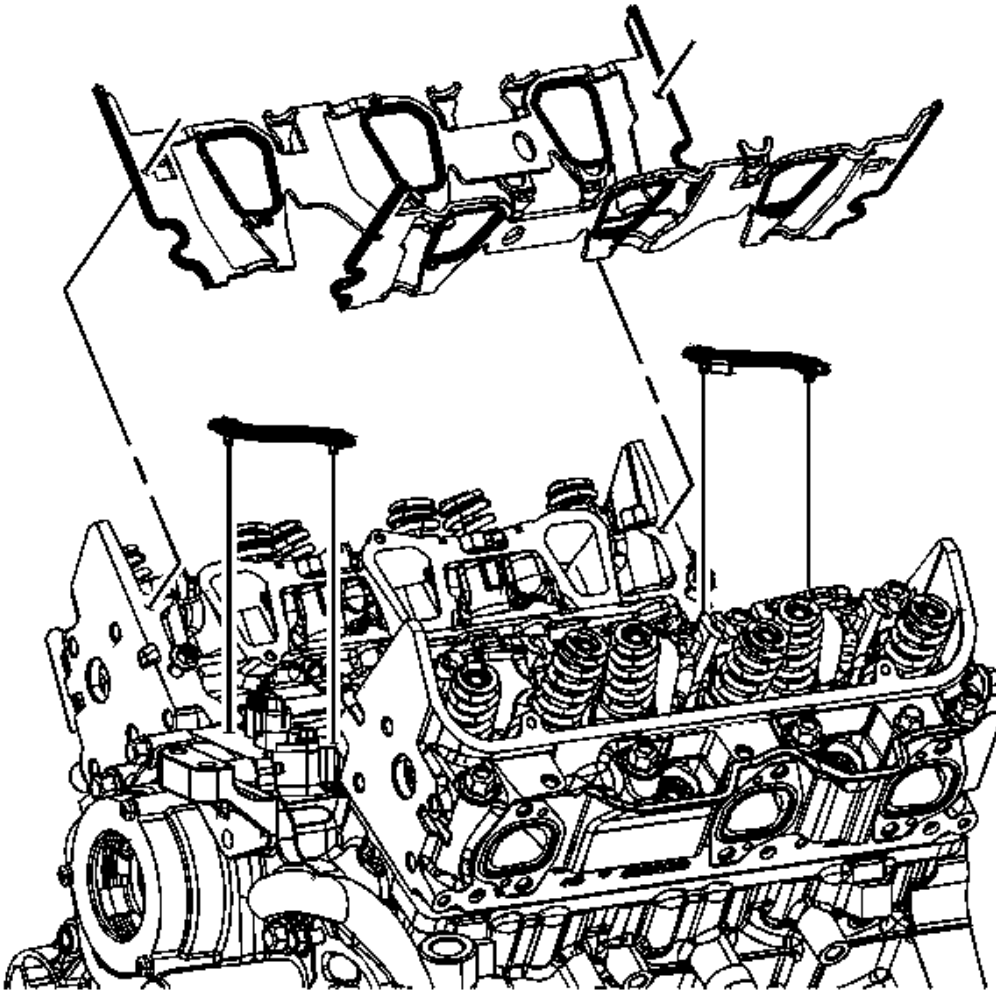


Fig. 54: Intake Manifold Gaskets & Seals
Courtesy of GENERAL MOTORS CORP.

19. Remove the lower intake manifold gaskets and seals.
20. Clean the lower intake manifold gasket and seal surfaces on the cylinder heads and the engine block.
21. Clean the gasket and seal surfaces on the lower intake manifold with degreaser.

22. Remove all the loose room temperature vulcanizing (RTV) sealer.

INSTALLATION PROCEDURE

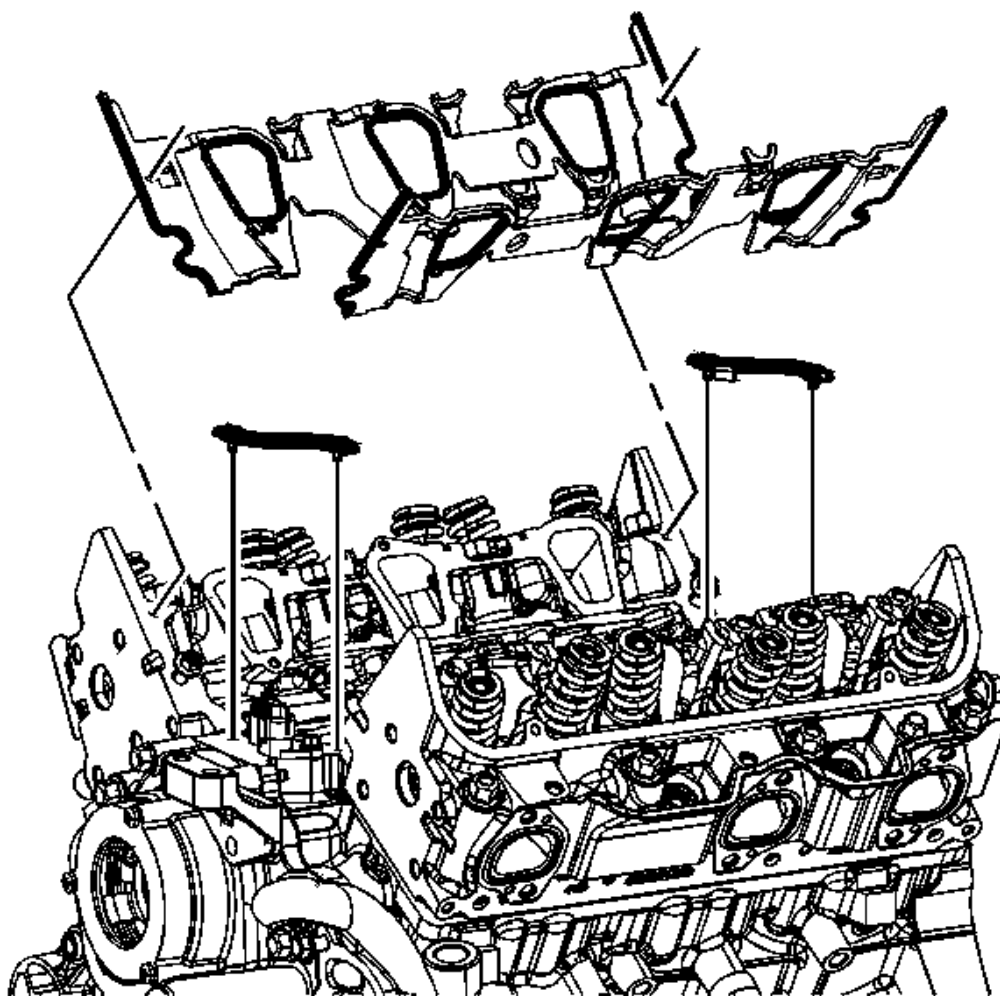


Fig. 55: Intake Manifold Gaskets & Seals
Courtesy of GENERAL MOTORS CORP.

NOTE:

- All gasket mating surfaces need to be free of oil and foreign material. Use cleaner to clean the surfaces. Refer to Adhesives, Fluids, Lubricants, and Sealers .
- RTV sealer is NOT to be placed under the lower intake manifold

gaskets.

1. Install the lower intake manifold gaskets and seals.

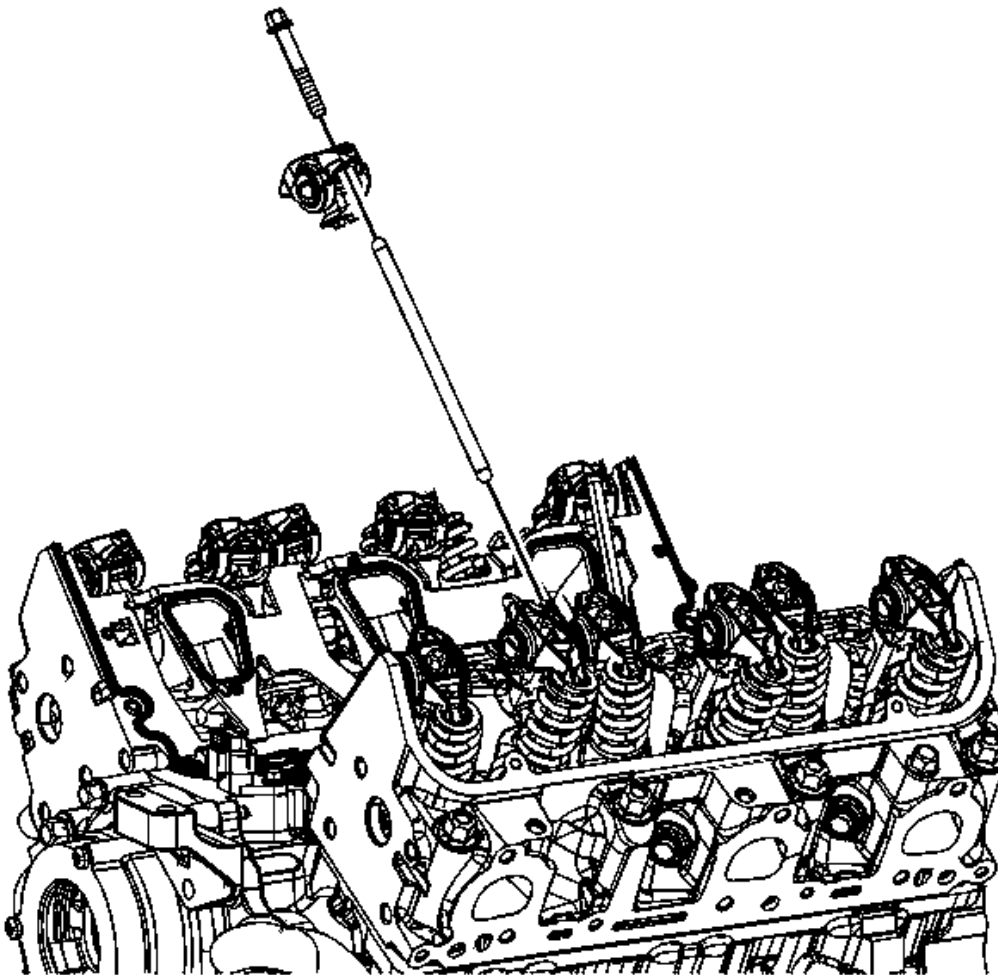


Fig. 56: Valve Rocker Arm, Bolt & Push Rod
Courtesy of GENERAL MOTORS CORP.

2. Coat the ends of the push rods using prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

NOTE: The intake valve push rods measure 147.51 mm (5.81 in) and the exhaust valve push rods measure 154.87 mm (6.10 in).

3. Install the push rods in their original location.

4. Coat the rocker arm friction surfaces using prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

NOTE: Shims (P/N 88894006) may be required under the valve rocker arm pedestals if reconditioning has been performed on the cylinder head or its components.

CAUTION: Refer to **Fastener Caution** .

5. Install the valve rocker arms in their original positions.
6. Install the valve rocker arm bolts.

Tighten: Tighten the bolts to 34 N.m (25 lb ft).

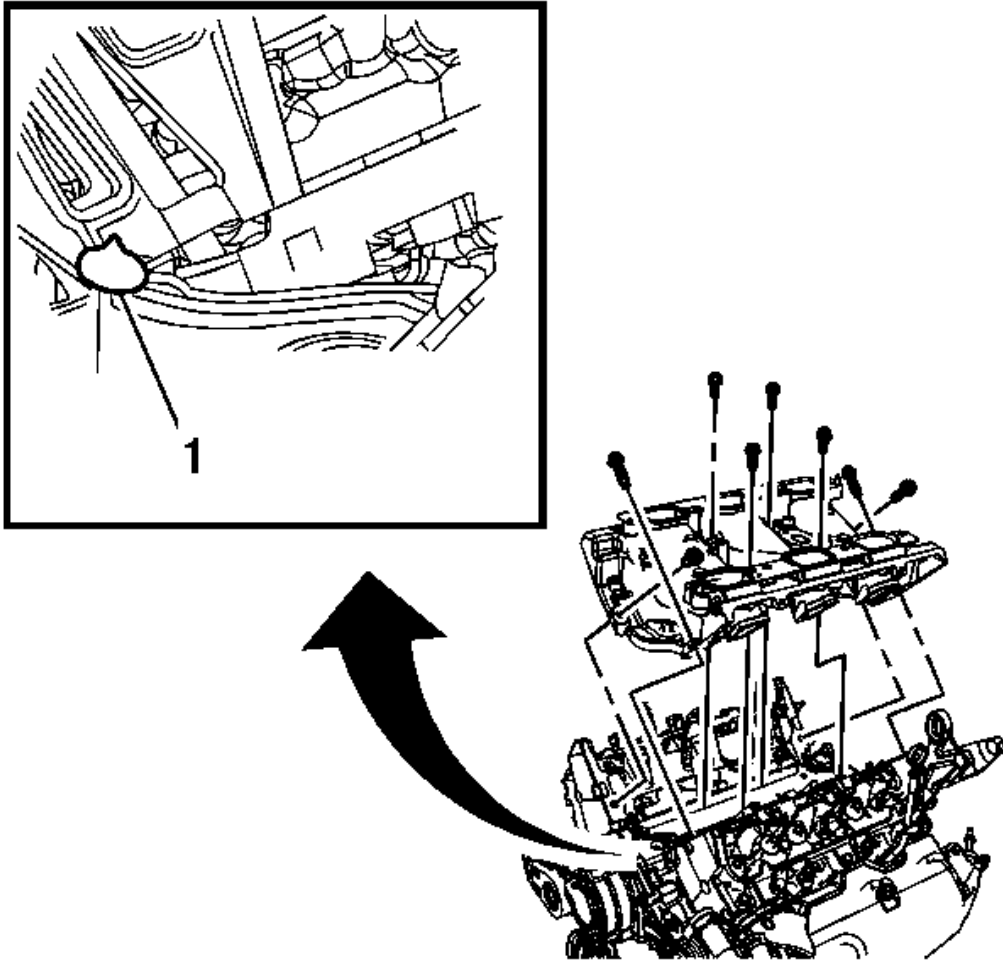


Fig. 57: Applying RTV Sealer
 Courtesy of GENERAL MOTORS CORP.

7. With the NEW gaskets and seals in place, apply a small drop, 8-10 mm (0.031-0.39 in) of RTV sealer to the 4 corners of the intake manifold to engine block joints (1). Refer to Adhesives, Fluids, Lubricants, and Sealers .

NOTE: **The LOMA connector must be disconnected from the lower intake manifold before installing the lower intake manifold.**

8. Install the lower intake manifold.

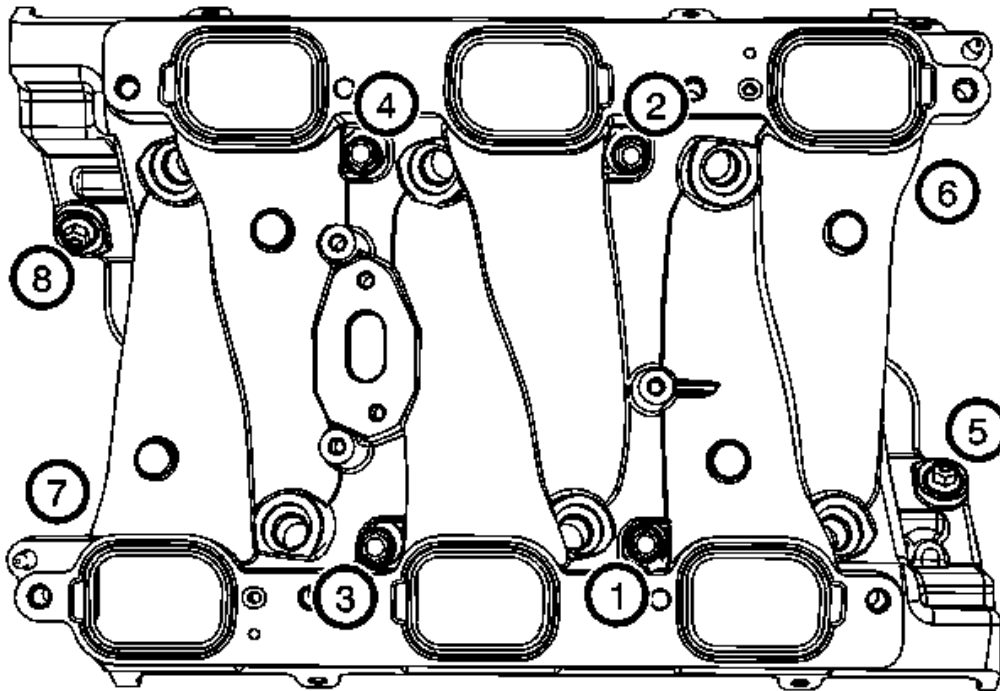


Fig. 58: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Maximum gasket performance is achieved when using new fasteners, which contain a thread-locking patch. If the fasteners are not replaced, a thread locking chemical must be applied to the fastener threads. Failure to replace the fasteners or apply a thread-locking chemical MAY reduce gasket sealing capability.

CAUTION: Failure to tighten vertical bolts before the diagonal bolts may cause an oil leak.

9. Apply sealer to the lower intake manifold bolt threads. Refer to Adhesives, Fluids, Lubricants, and Sealers.
10. Install the lower intake manifold bolts.
11. Tighten the lower intake manifold bolts in the sequence shown.
 1. Tighten the lower intake manifold bolts (1, 2, 3, 4, 5, 8, 6, 7, 8) in sequence to 7 N.m (62 lb in)
 2. Tighten the center lower intake manifold bolts (1, 2, 3, 4) in sequence to 16 N.m (12 lb ft).
 3. Tighten the visible corner lower intake manifold bolts (5, 8) to 25 N.m (18 lb ft).

4. Tighten the hidden corner lower intake manifold bolts (6, 7) to 25 N.m (18 lb ft).

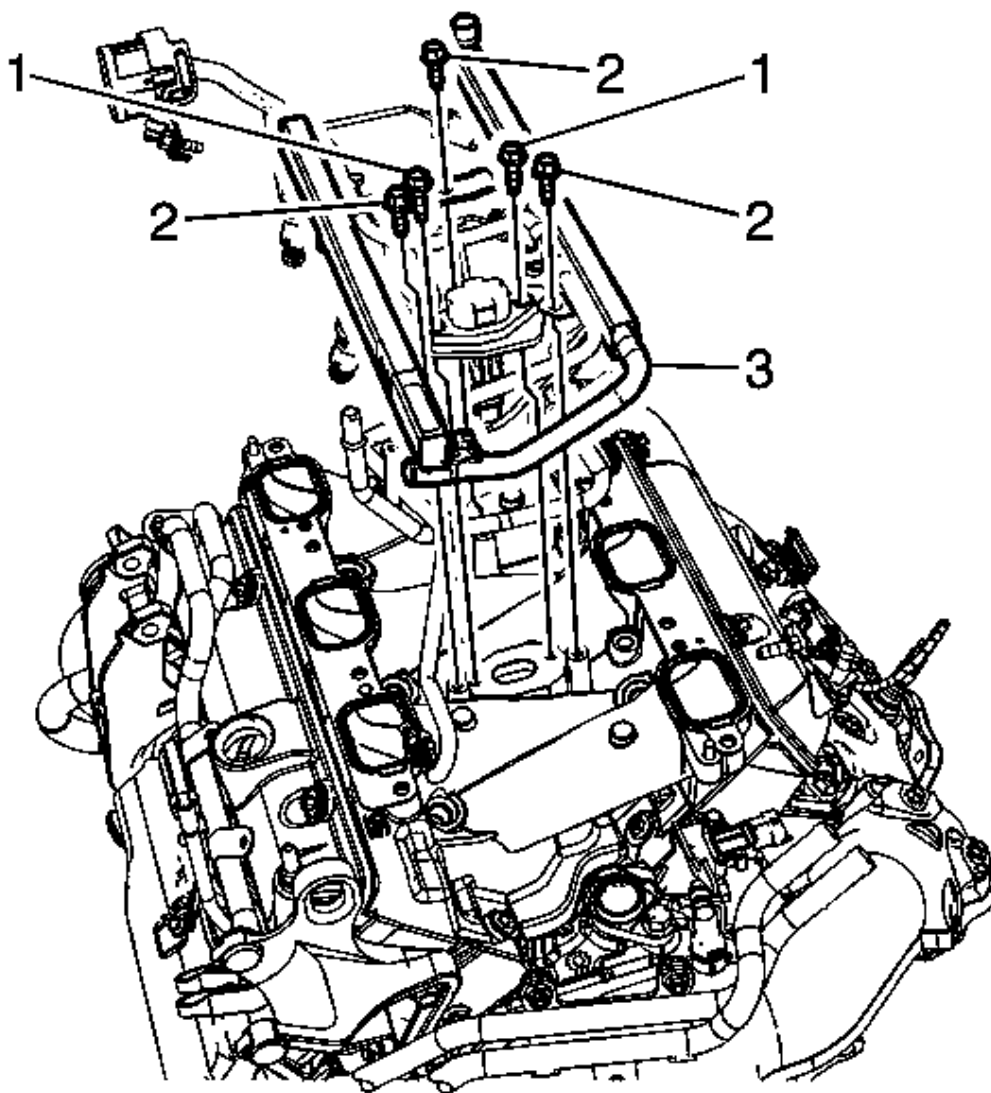


Fig. 59: Fuel Rail Components
Courtesy of GENERAL MOTORS CORP.

12. Inspect the fuel rail, fuel injectors, and fuel injector O-rings for damage and replace as necessary.
13. Lubricate the fuel injector O-rings using engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
14. Install the injector nozzles into the lower intake manifold injector bores.

15. Install the LOMA then press on the injector rail (3) using the palms of both hands until the injector are fully seated.
16. Install the fuel injector rail bolts (2).

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

17. Connect the CMP sensor electrical connector.
18. Connect the ECT electrical connector.
19. Position the fuel injector harness connector bracket to the intake manifold.
20. Install the fuel injector harness connector bracket bolt.

Tighten: Tighten the bolt to 8 N.m (71 lb in).

21. Install two LOMA electrical connector bolts (1) to the lower intake manifold.

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

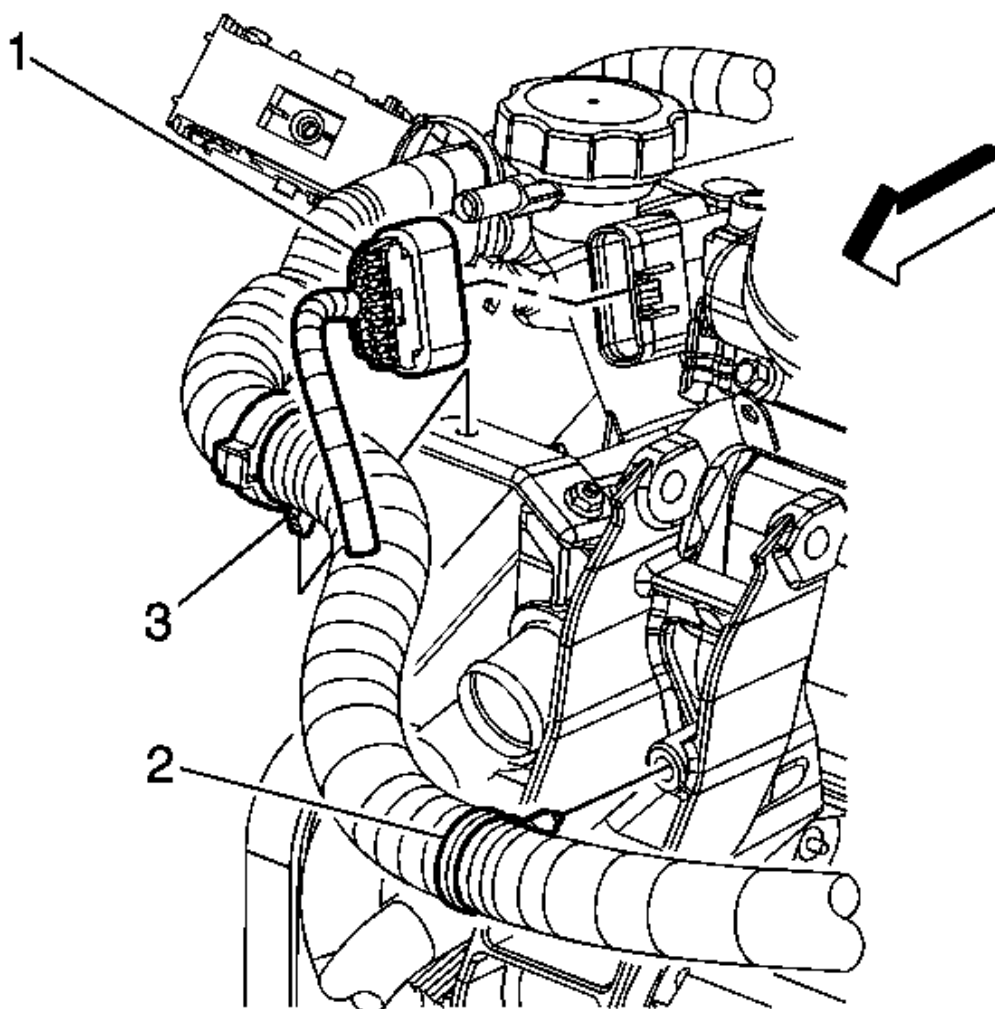


Fig. 60: Fuel Injector Inline Connector
Courtesy of GENERAL MOTORS CORP.

22. Connect fuel injector inline connector (1).
23. Connect the fuel feed line to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
24. Install the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Right Side**.
25. Install the left valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side**.
26. Install the upper intake manifold. Refer to **Upper Intake Manifold Replacement**.
27. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

REMOVAL PROCEDURE

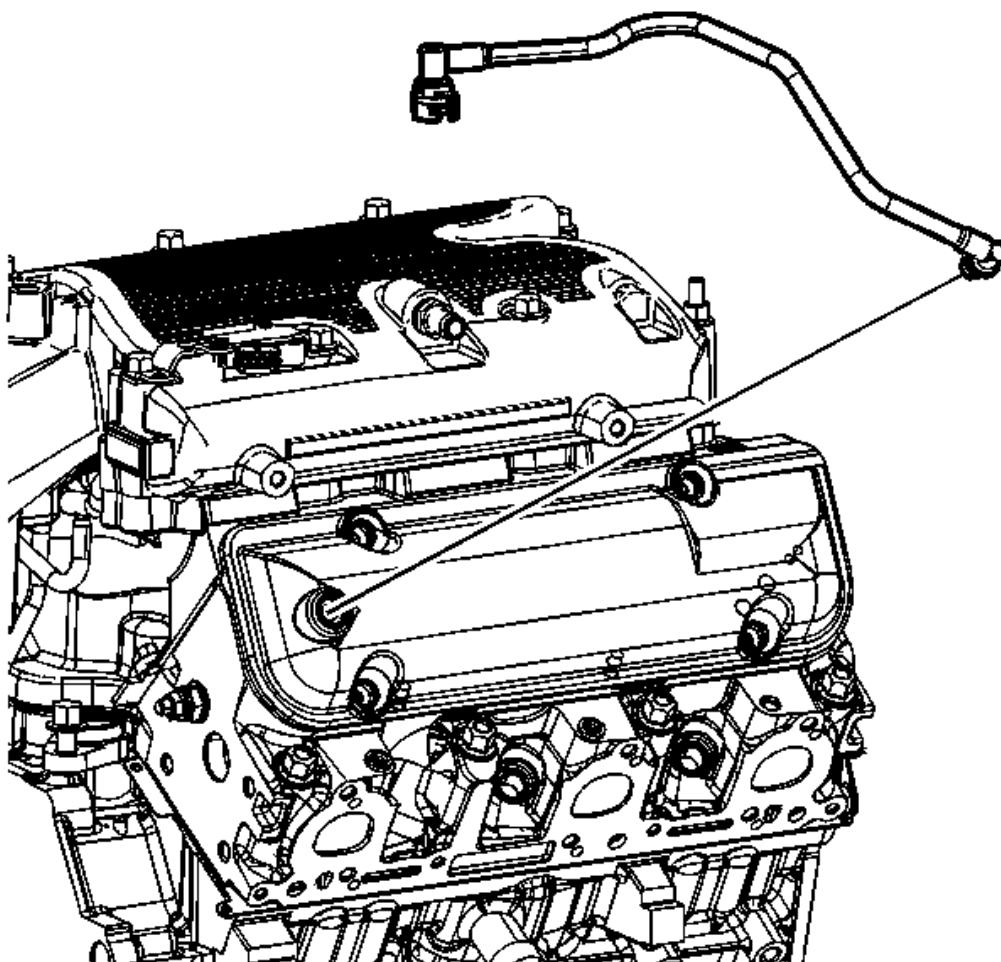


Fig. 61: Fresh Air Tube

Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Disconnect the positive crankcase ventilation (PCV) fresh air tube from the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the PCV fresh air tube from the rocker arm cover.
4. Remove the PCV fresh air tube from the vehicle.

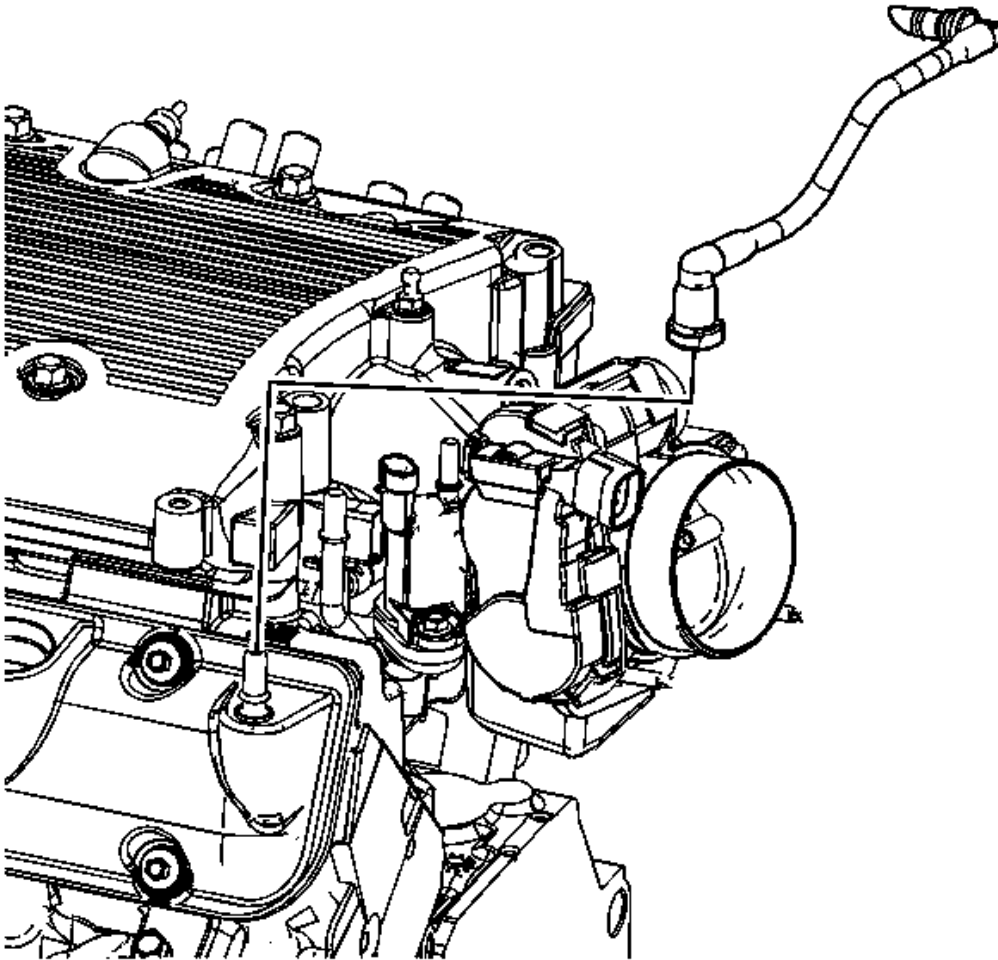


Fig. 62: Positive Crankcase Ventilation Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the PCV foul air tube from the PCV valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
6. Remove the PCV foul air tube from the intake manifold.
7. Remove the PCV foul air tube from the vehicle.

INSTALLATION PROCEDURE

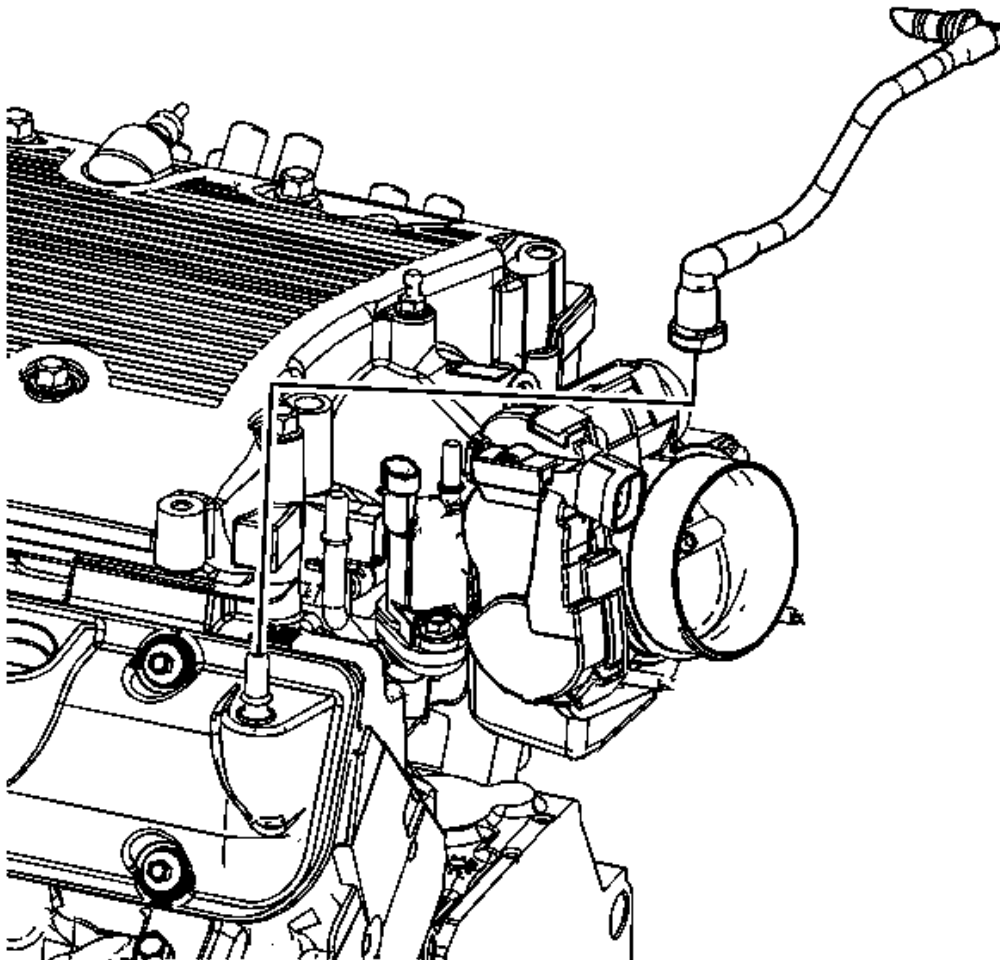


Fig. 63: Positive Crankcase Ventilation Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV foul air tube to the vehicle.
2. Install the PCV foul air tube to the intake manifold.
3. Connect the PCV foul air tube to the PCV valve. Refer to **Plastic Collar Quick Connect Fitting Service** .

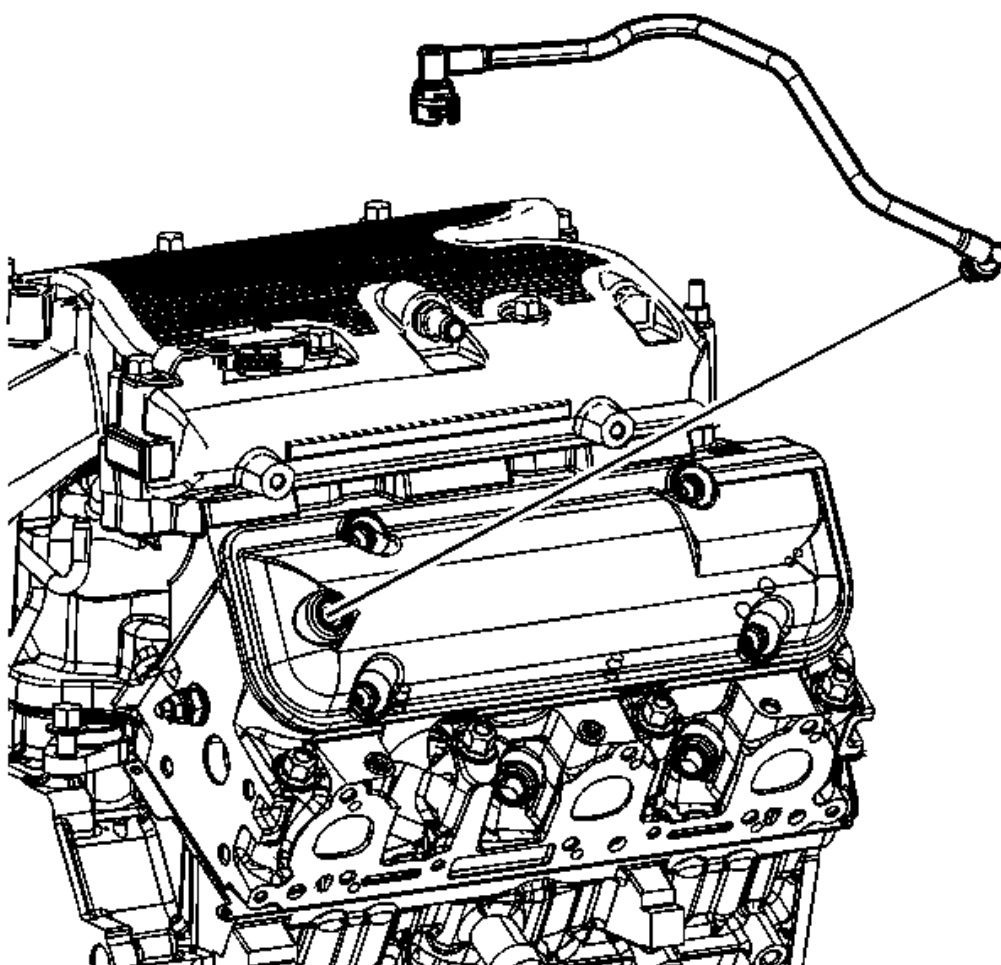


Fig. 64: Fresh Air Tube

Courtesy of GENERAL MOTORS CORP.

4. Install the PCV fresh air tube to the vehicle.
5. Install the PCV fresh air tube to the rocker arm cover.
6. Connect the PCV fresh air tube to the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

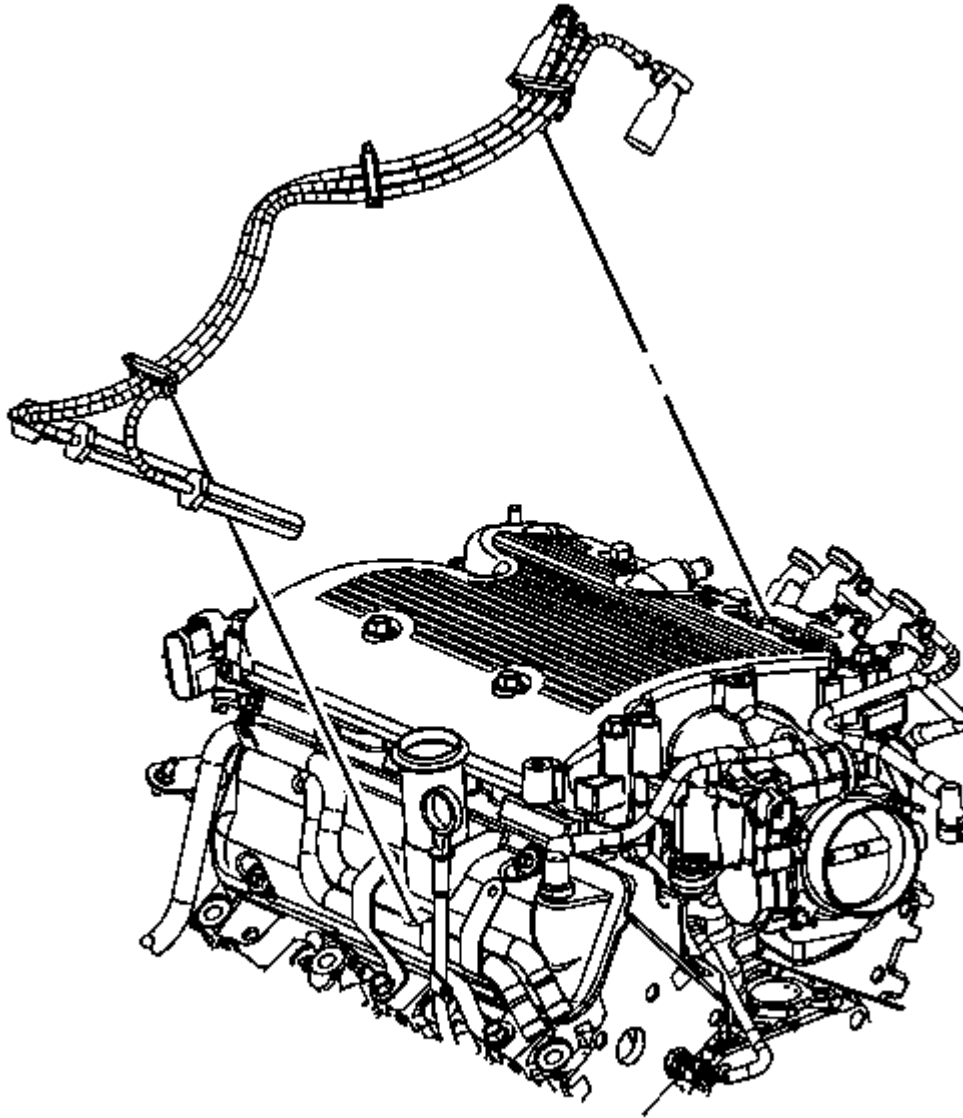


Fig. 65: Left Side Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
3. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

4. Disconnect the left spark plug wires from the spark plugs.
5. Remove the spark plug wire harness clip from the heater inlet and outlet front pipe bracket.
6. Reposition the spark plug harness.

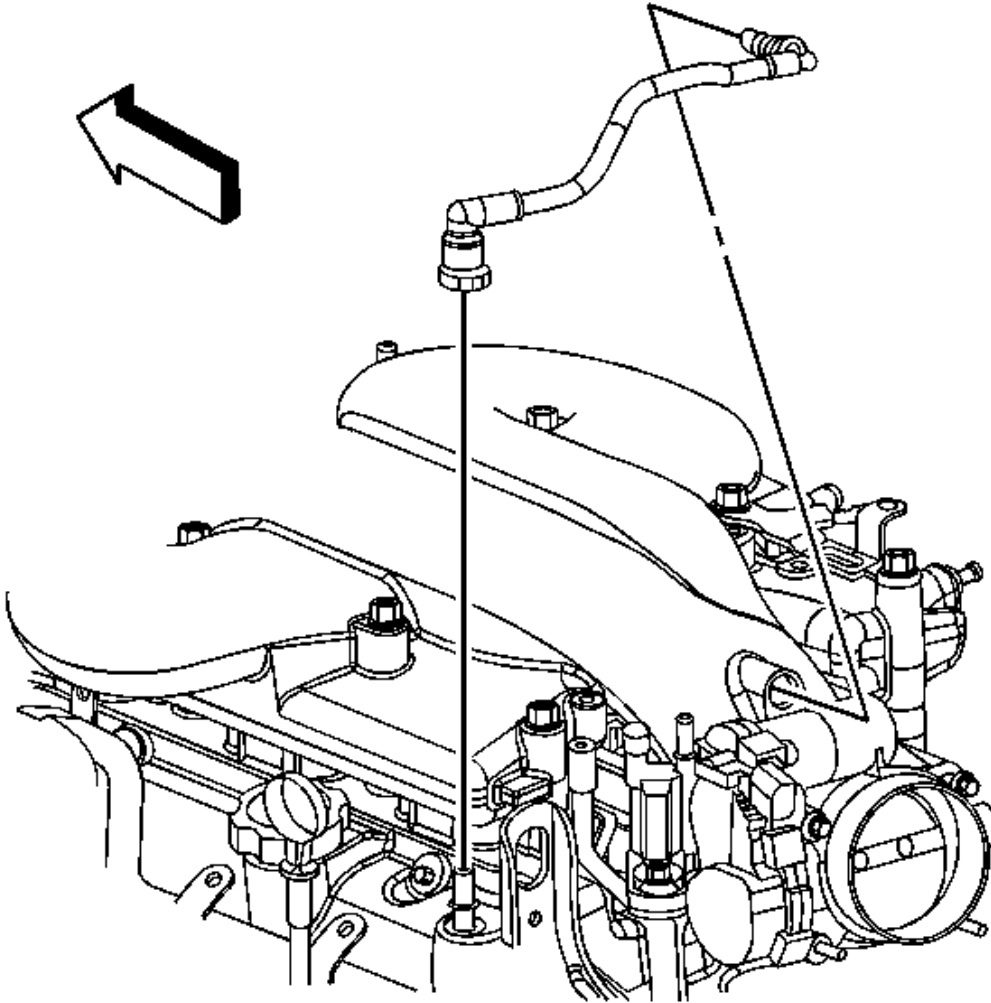


Fig. 66: Positive Crankcase Ventilation (PCV) Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

7. Remove the positive crankcase ventilation (PCV) foul air tube. Refer to **Plastic Collar Quick Connect Fitting Service** .

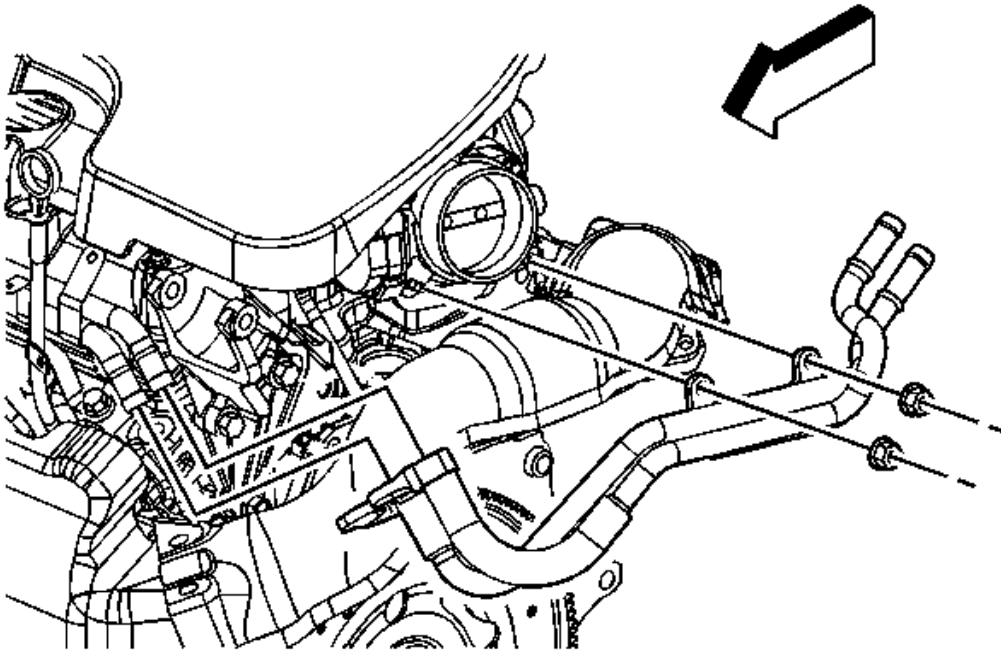


Fig. 67: Heater Inlet & Outlet Hoses/Pipes

Courtesy of GENERAL MOTORS CORP.

8. Reposition the heater inlet and outlet hose/pipe clamps at the engine inlet and outer pipes.
9. Remove the heater inlet and outlet hose/pipe clip nuts at the throttle body.
10. Remove the heater inlet and outer hoses/pipes from the engine inlet and outlet pipes.
11. Remove the clips from the throttle body studs. Reposition the hose/pipe assembly.

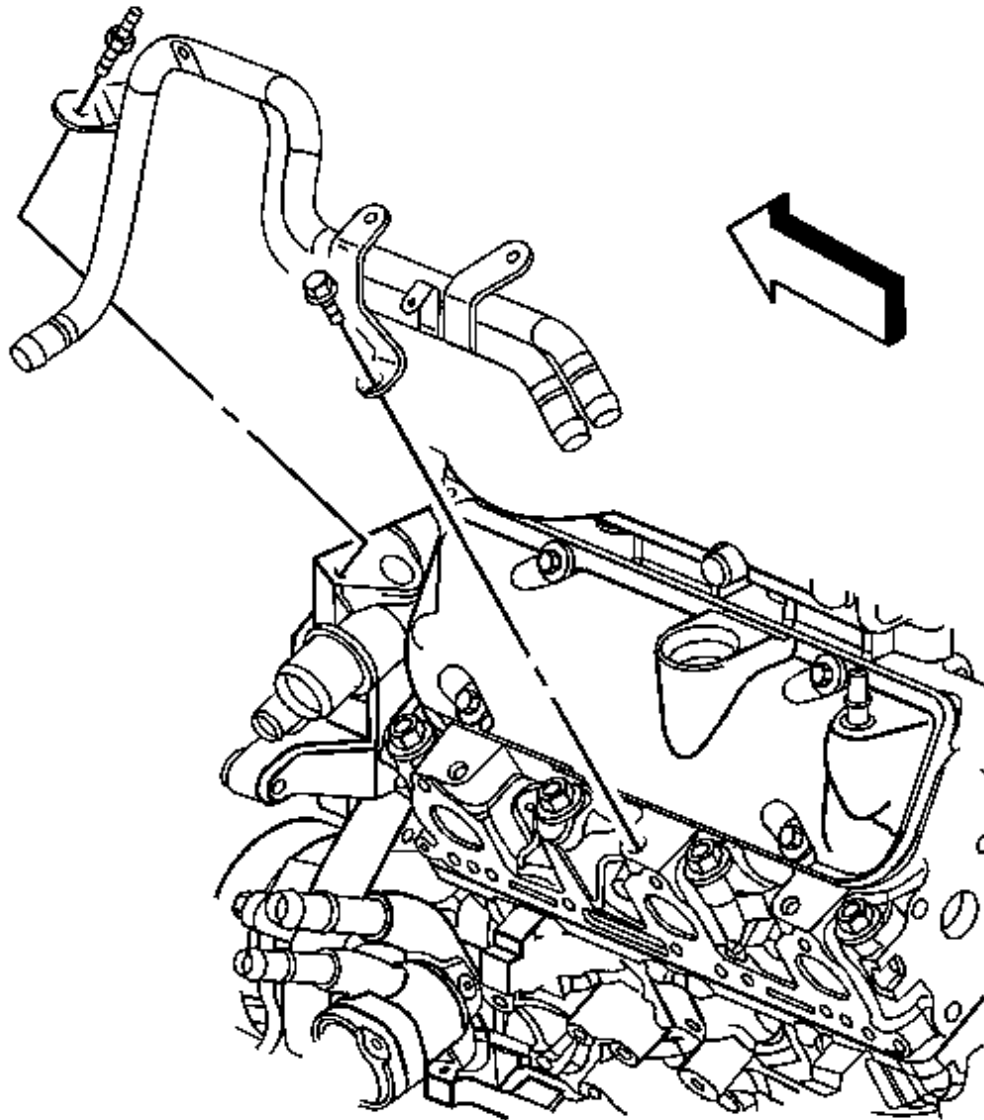


Fig. 68: Heater Inlet & Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

12. Remove the front heater outlet hose from the outlet heater pipe.
13. Remove the heater inlet and outlet pipe bolt and stud.
14. Remove the heater inlet and outlet pipe from the vehicle.

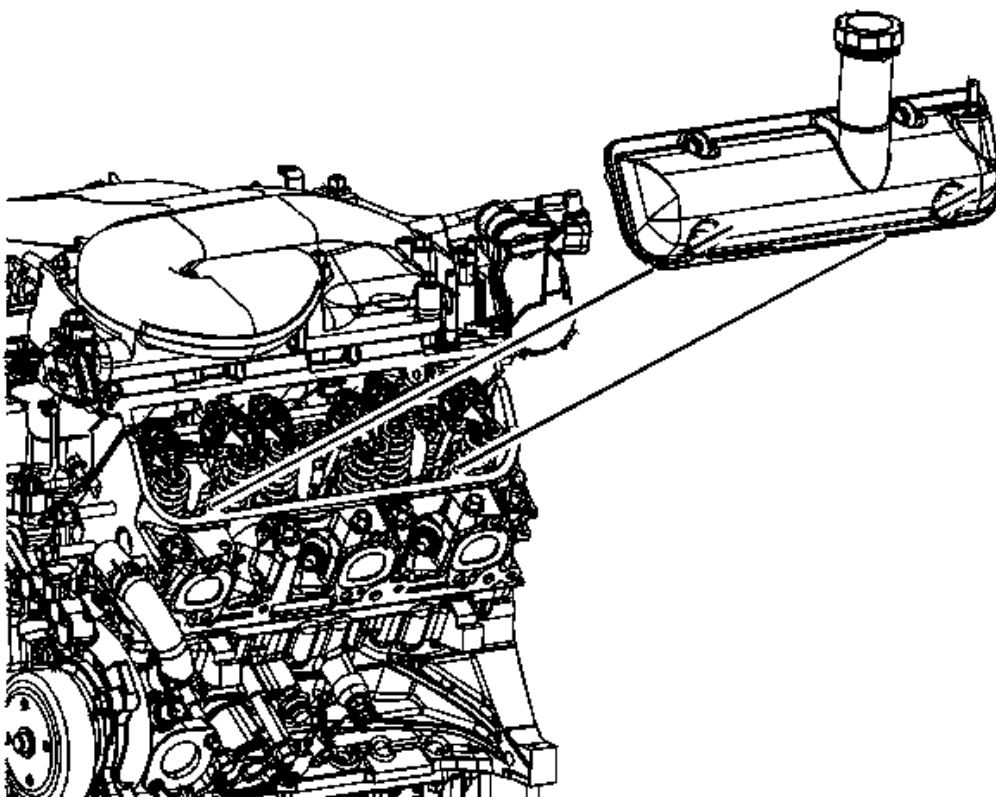


Fig. 69: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

15. Loosen the valve rocker arm cover bolts.

NOTE: When removing the valve rocker arm cover, ensure the gasket stays in place attached to the cylinder head.

16. Remove the valve rocker arm cover. If necessary, bump the end of the cover with the palm of your hand or a soft rubber mallet if the cover adheres to the cylinder head.
17. Cut the RTV in the channel where the intake, cylinder head and valve rocker arm cover meet with a suitable tool.
18. Remove the valve cover gasket.
19. Clean the sealing surface on the cylinder head with degreaser.

INSTALLATION PROCEDURE

NOTE: All gasket mating surfaces need to be free of oil and foreign material. Use cleaner to clean the surfaces. Refer to Adhesives, Fluids, Lubricants, and Sealers for the 3.9L engine.

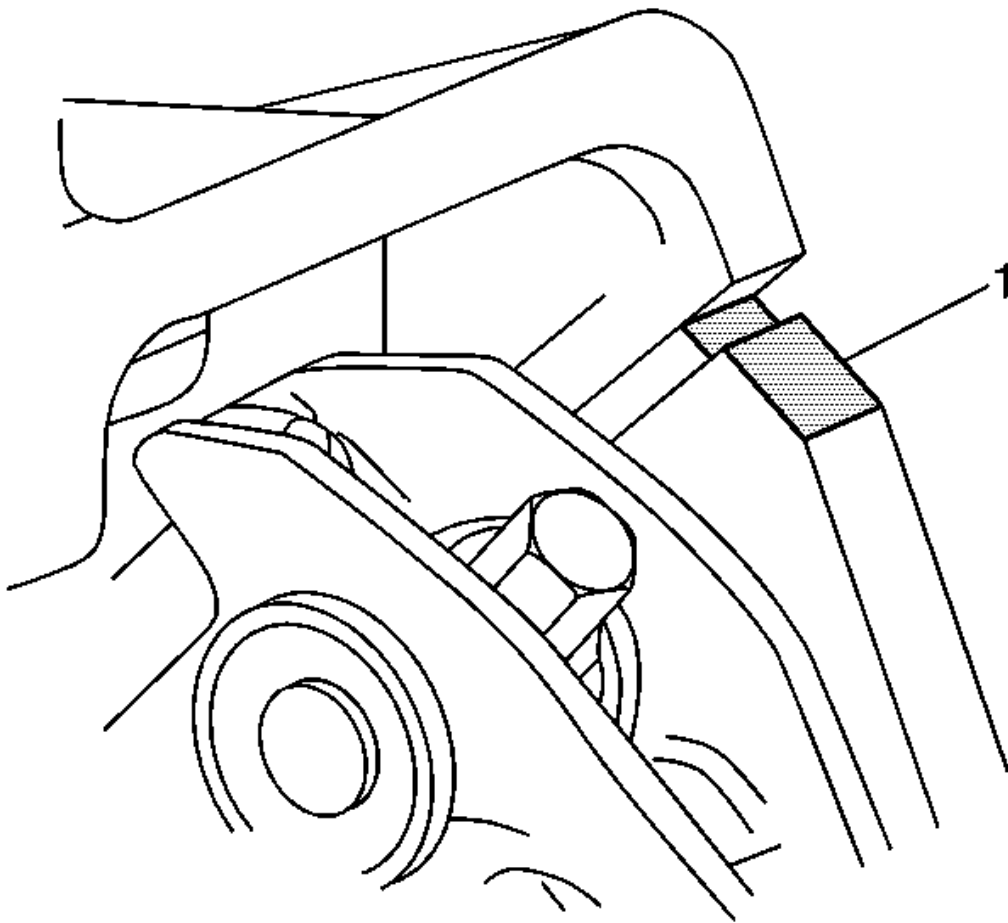


Fig. 70: Cylinder Head To Lower Intake Manifold Joint
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve rocker arm cover gasket into the groove in the valve rocker arm cover. Ensure that the gasket is properly seated in the groove of the valve rocker arm cover.
2. Apply sealant at the cylinder head to the surfaces where the cylinder head and intake manifold meet (1). Refer to Adhesives, Fluids, Lubricants, and Sealers for the 3.9L engine.

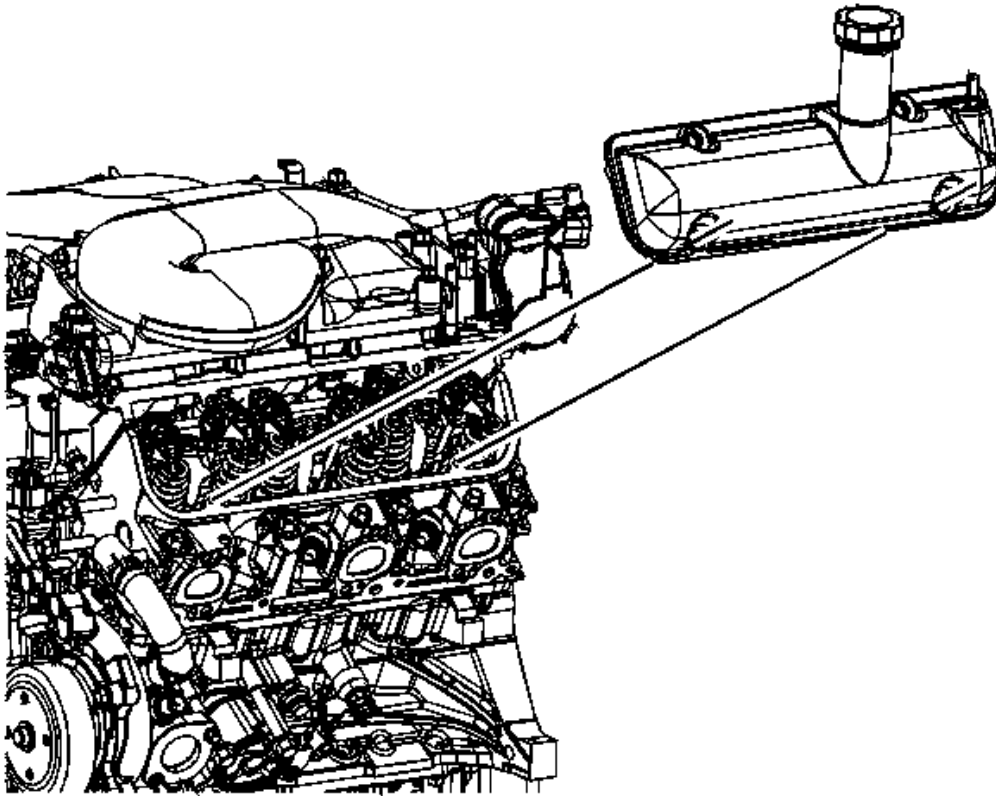


Fig. 71: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm cover.

NOTE: Use an alternating criss-cross pattern when tightening the valve rocker cover bolts. Failure to do so may result in oil leakage from the valve cover due to improper seating of the gasket.

4. Install the valve rocker arm cover bolts. Refer to Valve Rocker Arm Cover Installation - Left Side .

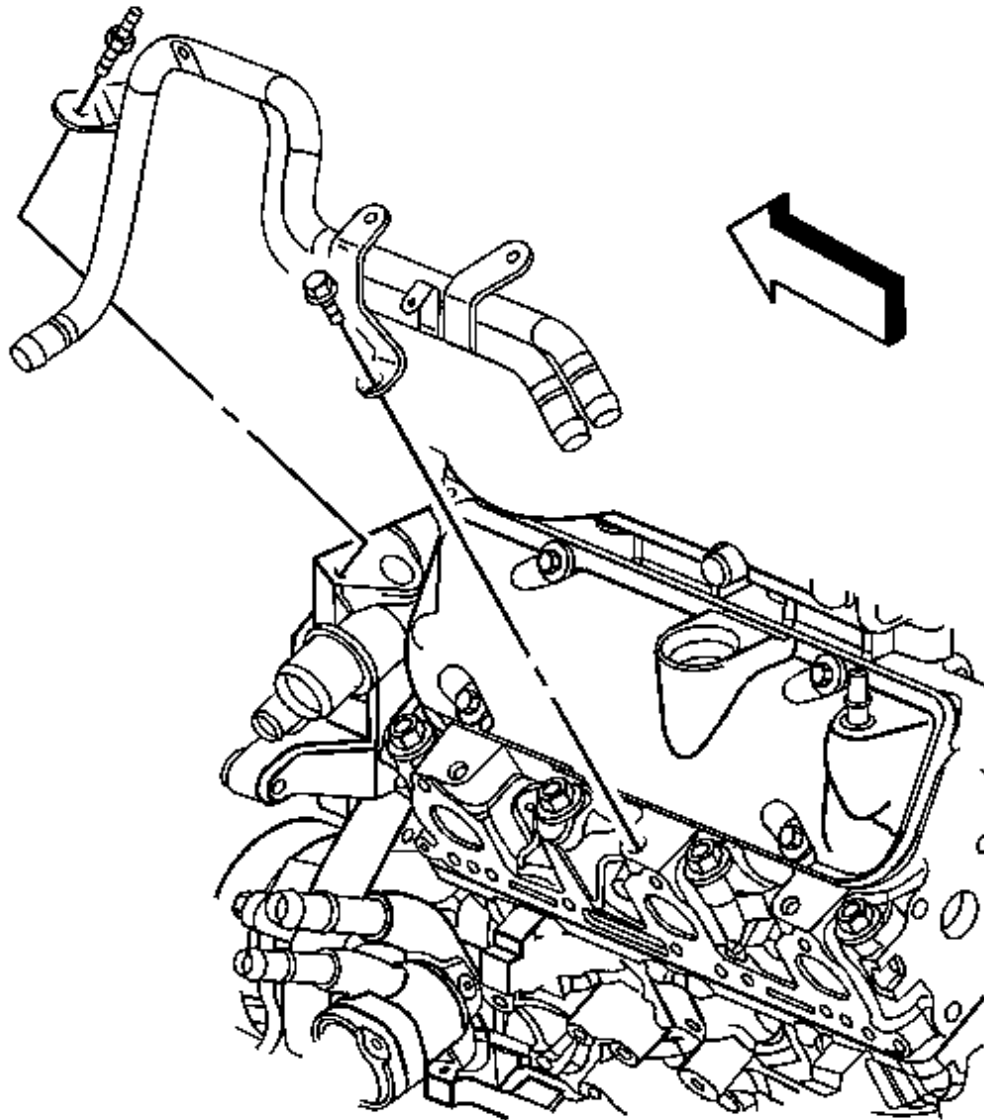


Fig. 72: Heater Inlet & Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

5. Install the heater inlet and outlet pipe to the vehicle.

CAUTION: Refer to Fastener Caution .

6. Install the heater inlet and outlet pipe bolt and stud.
 - Tighten the bolt to 25 N.m (18 lb ft).
 - Tighten the stud to 10 N.m (89 lb in).
7. Install the front heater outlet hose to the outlet heater pipe.

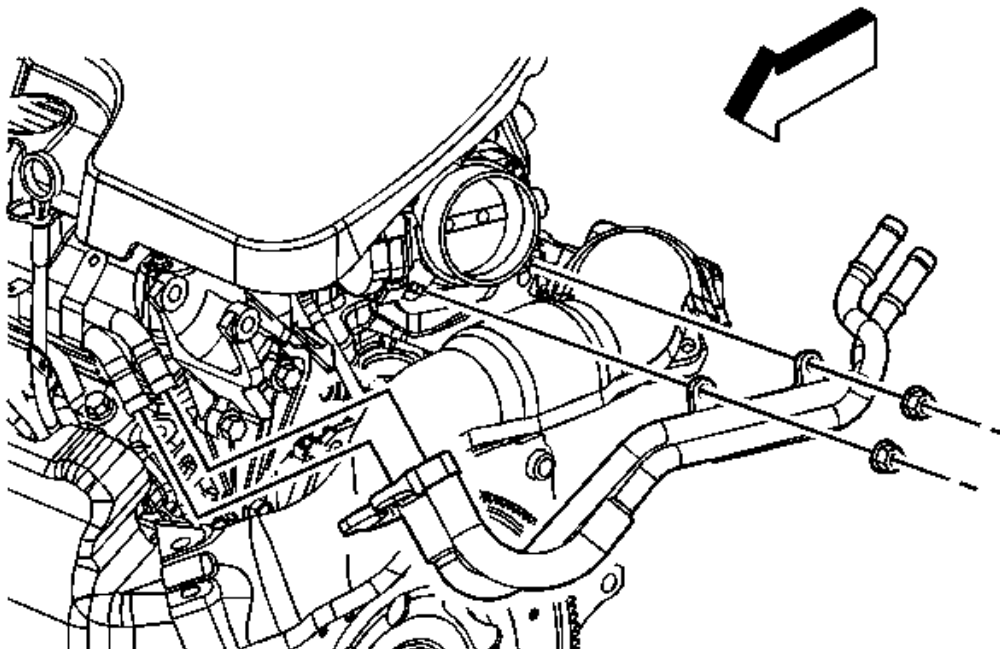


Fig. 73: Heater Inlet & Outlet Hoses/Pipes
Courtesy of GENERAL MOTORS CORP.

8. Position the hose/pipe assembly. Install the clips to the throttle body studs.
9. Install the heater inlet and outer hoses/pipes to the engine inlet and outlet pipes.
10. Install the heater inlet and outlet hose/pipe clip nuts at the throttle body and tighten the nuts to 10 N.m (89 lb in).
11. Position the heater inlet and outlet hose/pipe clamps at the engine inlet and outer pipes.

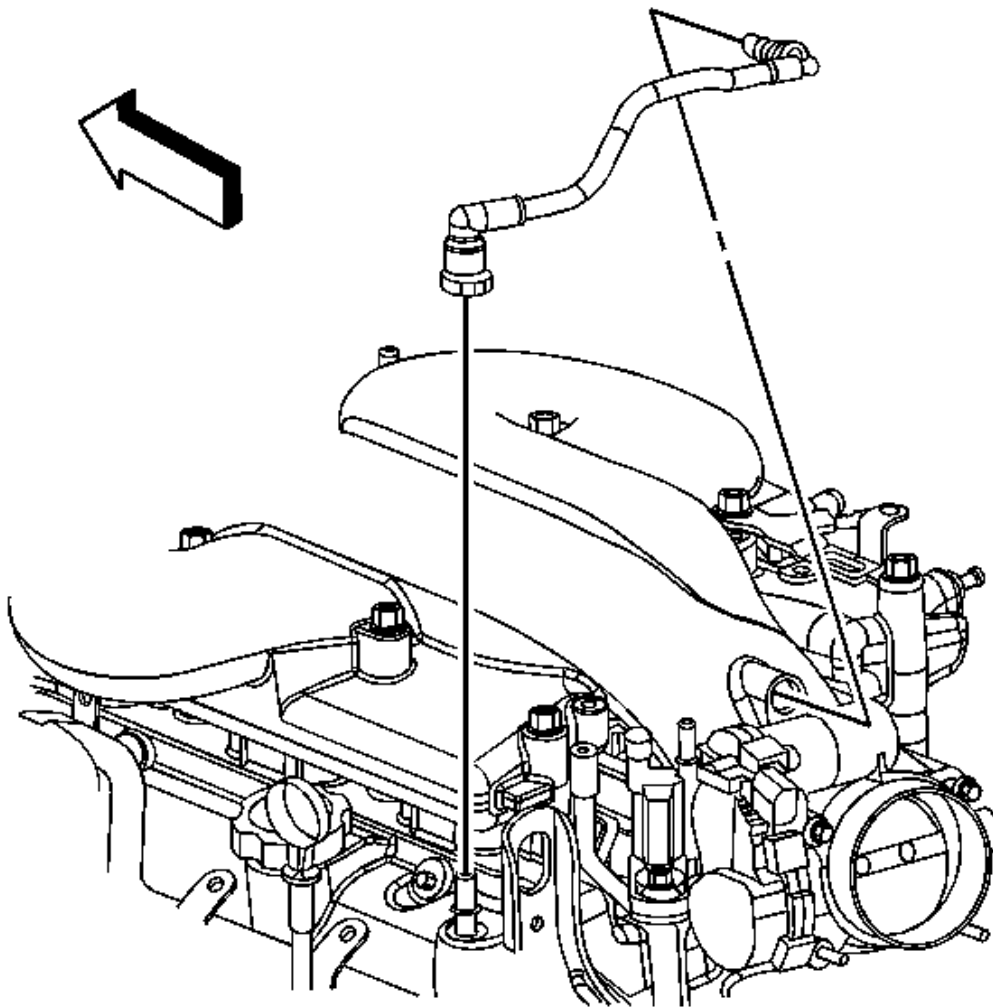


Fig. 74: Positive Crankcase Ventilation (PCV) Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

12. Install the PCV foul air tube. Refer to **Plastic Collar Quick Connect Fitting Service** .

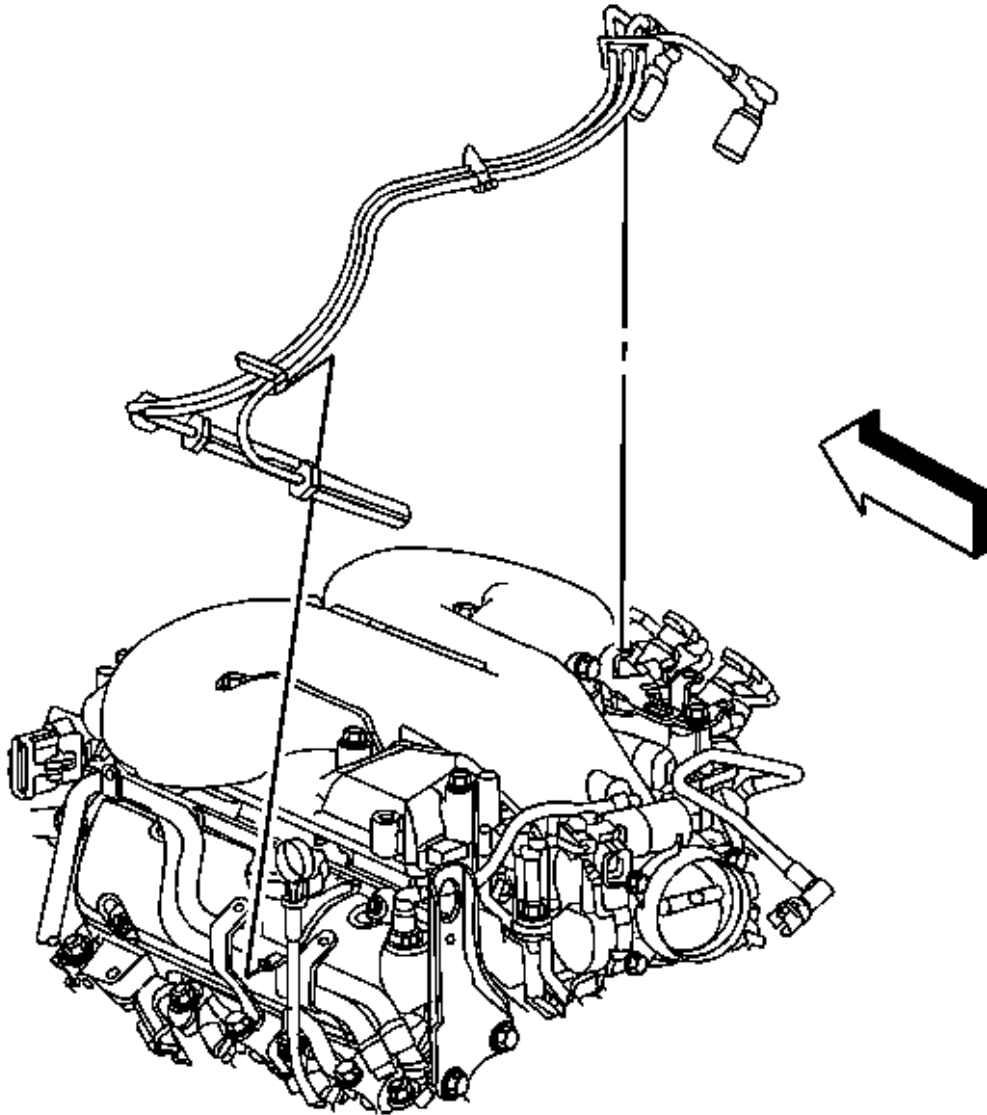


Fig. 75: Left Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

13. Position the spark plug harness.
14. Install the spark plug wire harness clip to the heater inlet and outlet front pipe bracket.
15. Connect the left spark plug wires to the spark plugs.
16. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

17. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
18. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)**.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

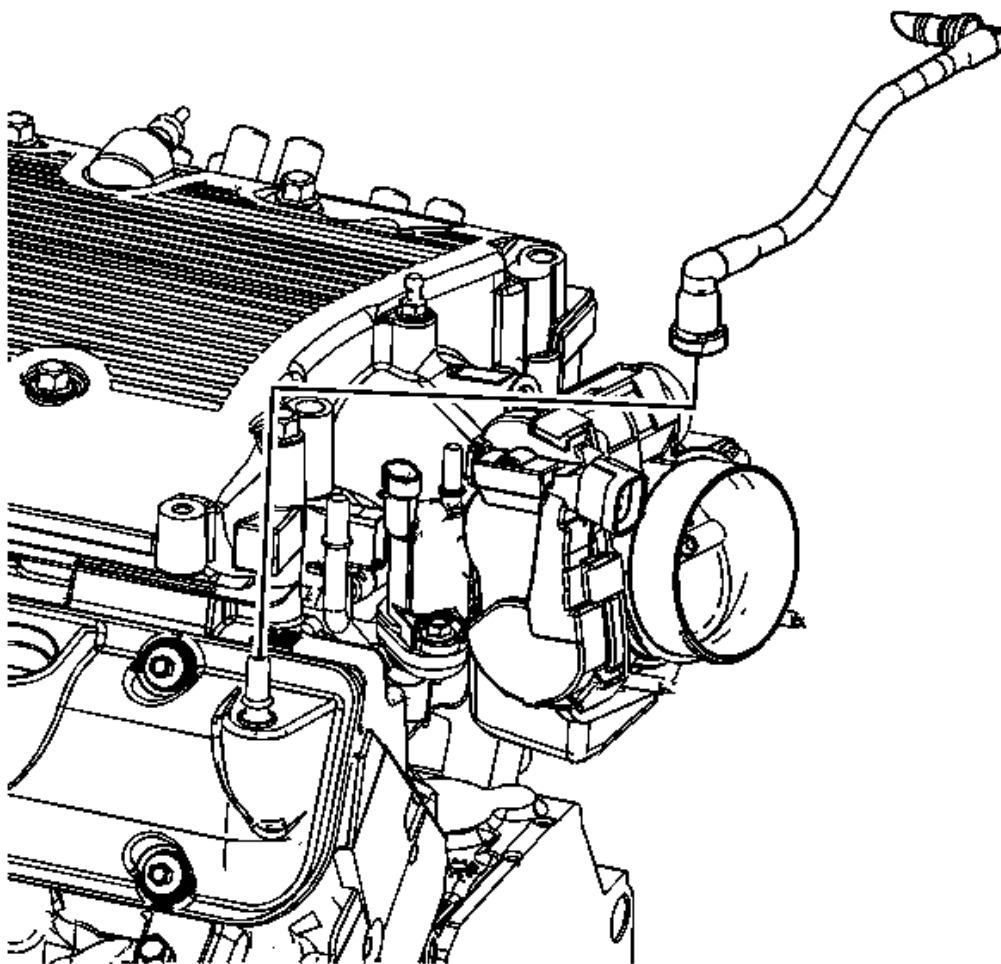


Fig. 76: Positive Crankcase Ventilation Foul Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove power steering reservoir. refer to **Power Steering Fluid Reservoir Replacement (LZ9/LGD)**.
2. Disconnect the positive crankcase ventilation (PCV) fresh air tube from the air cleaner outlet duct. Refer

to **Plastic Collar Quick Connect Fitting Service**.

3. Remove the PCV fresh air tube from the right side valve rocker arm cover.

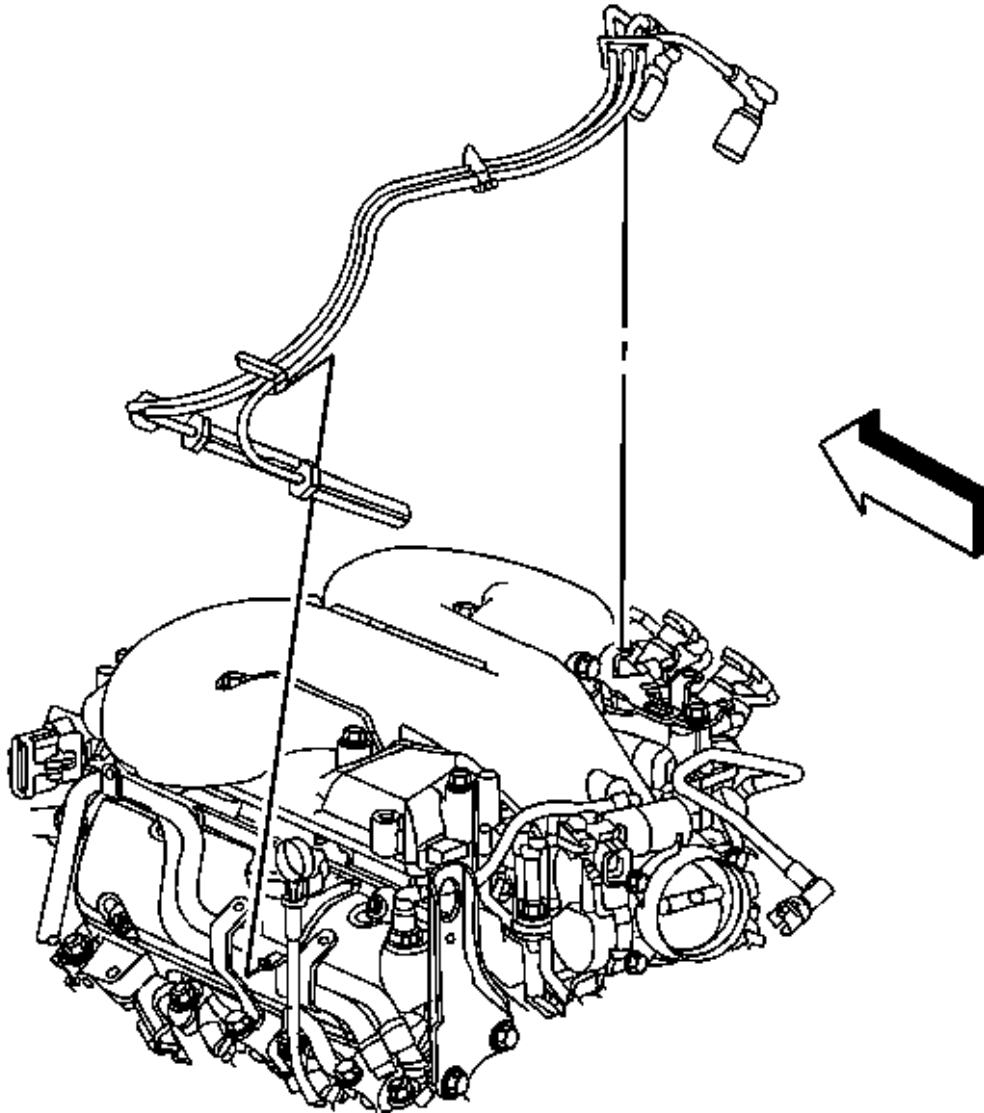


Fig. 77: Left Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the left side spark plug wires from the ignition coil.

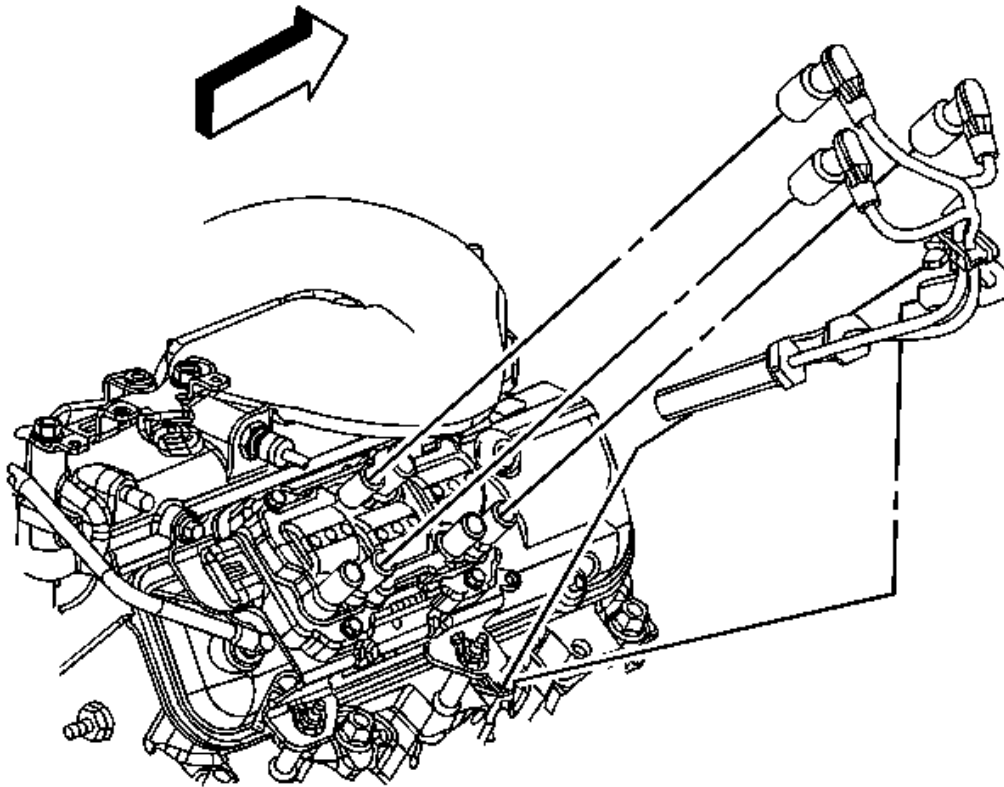


Fig. 78: Right Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the right side spark plug wires from the spark plugs.
6. Disconnect the right side spark plug wires from the ignition coil.
7. Remove the right side spark plug harness clip from the ignition coil bracket.
8. Remove the spark plug harness.

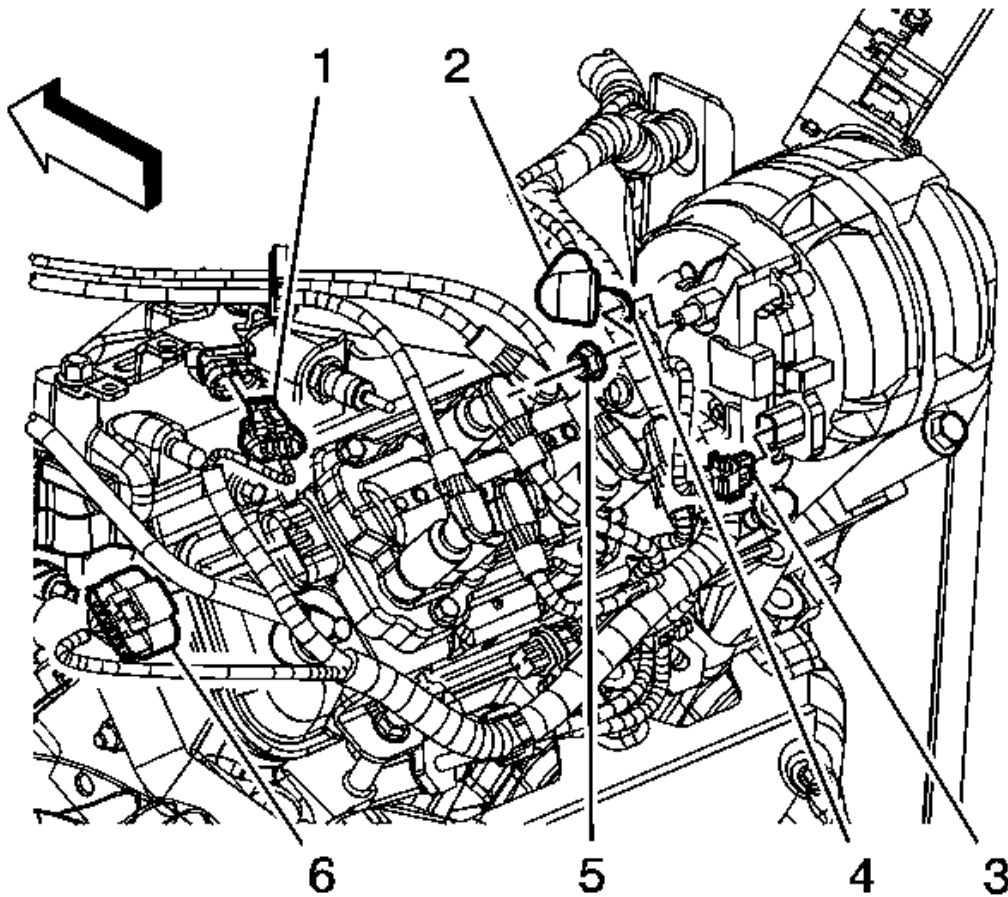


Fig. 79: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

9. Disconnect the manifold absolute pressure (MAP) sensor electrical connector (1).
10. Disconnect the ignition coil electrical connector (6).
11. Remove the engine harness clip from the ignition coil bracket.

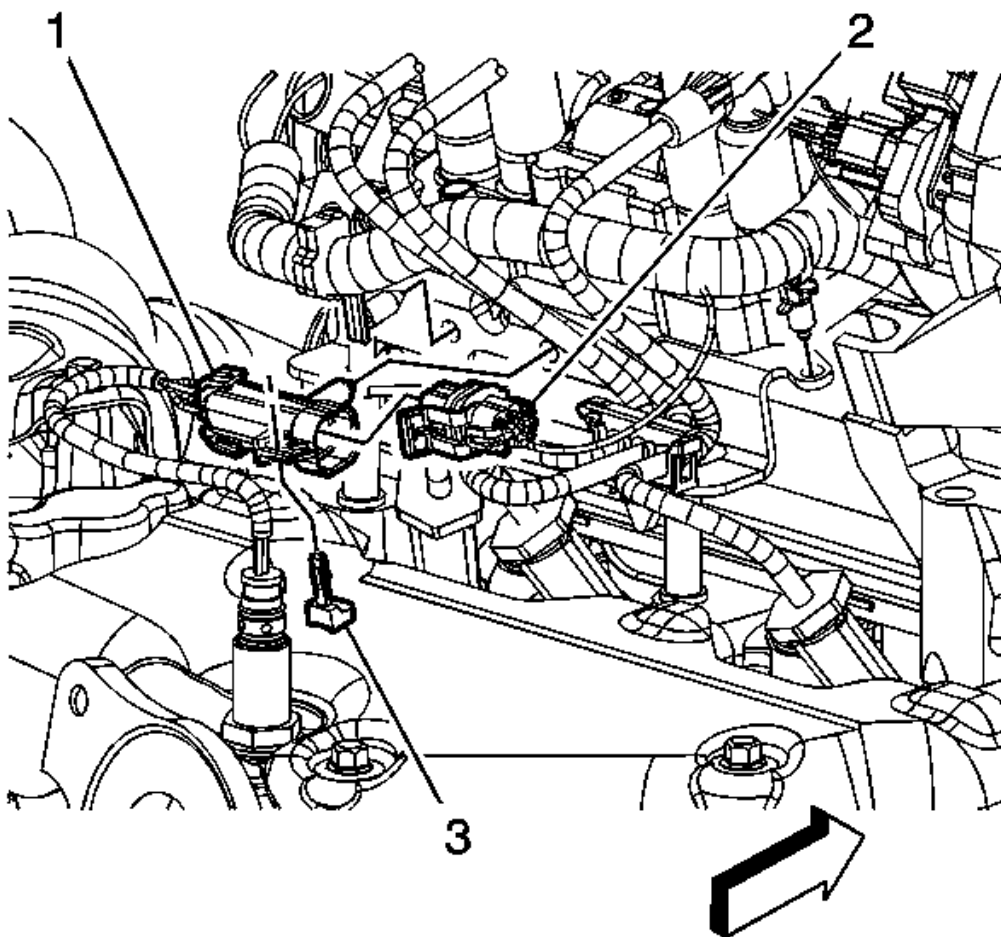


Fig. 80: HO2S Electrical Connector Clip & Ignition Coil Bracket
Courtesy of GENERAL MOTORS CORP.

12. Remove the heated oxygen sensor (HO2S) electrical connector clip (1) from the ignition coil bracket.

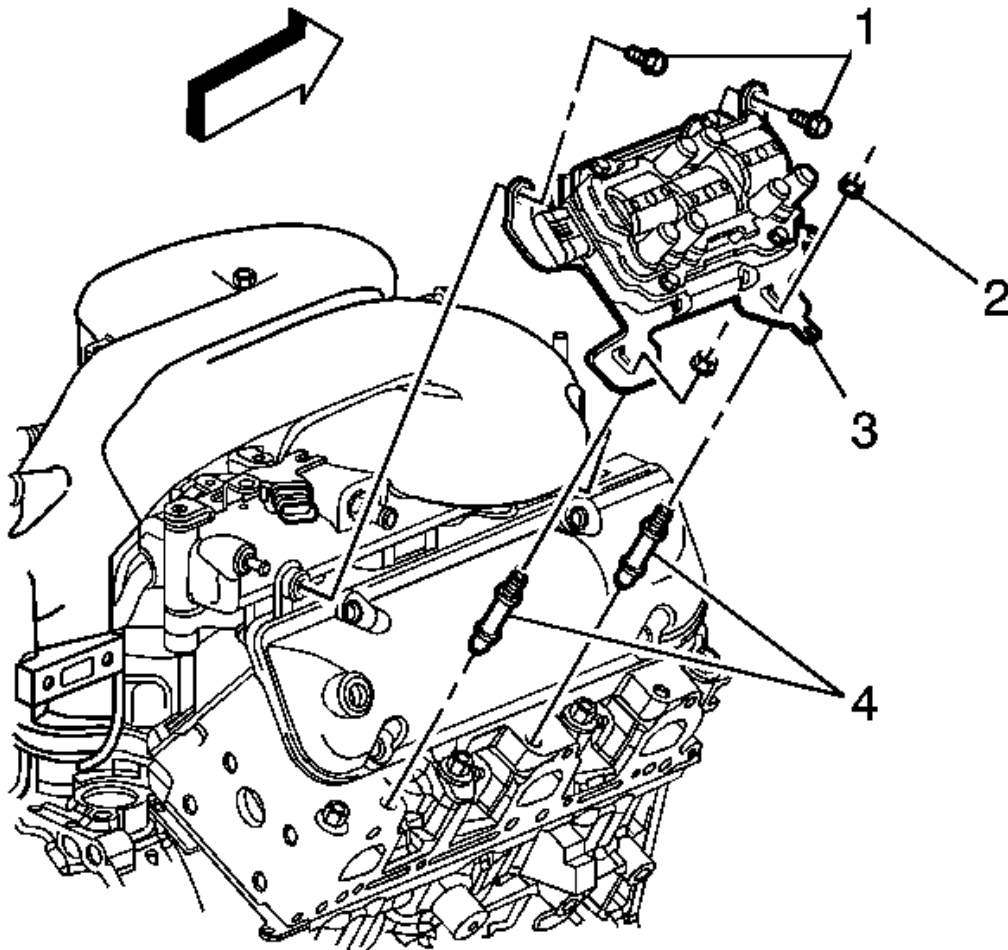


Fig. 81: Ignition Coil, Bracket Bolts & Nuts
 Courtesy of GENERAL MOTORS CORP.

13. Remove the ignition coil bracket nuts (2).
14. Remove the ignition coil bracket bolts (1).
15. Remove the ignition coil.

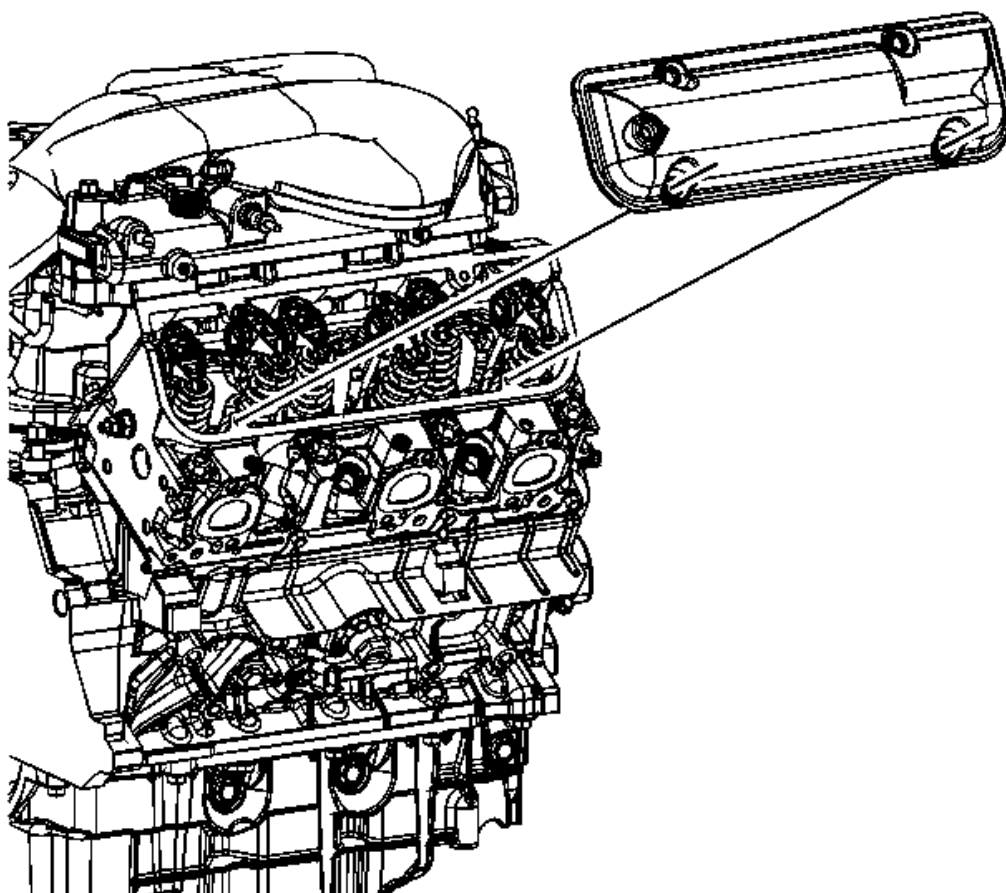


Fig. 82: Right Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

16. Loosen the valve rocker arm cover bolts.

NOTE: When removing the valve rocker arm cover, ensure the gasket stays in place attached to the cylinder head.

17. Remove the valve rocker arm cover. Bump the end of the cover with the palm of your hand or a soft rubber mallet if the cover adheres to the cylinder head.
18. Cut the room temperature vulcanizing (RTV) sealer in the channel where the intake, cylinder head and valve rocker arm cover meet with a suitable tool.
19. Remove the valve cover gasket.
20. Clean the sealing surface on the cylinder head with degreaser.

INSTALLATION PROCEDURE

NOTE: All gasket mating surfaces need to be free of oil and foreign material. Use cleaner to clean the surfaces. Refer to Adhesives, Fluids, Lubricants, and Sealers for the 3.9L engine.

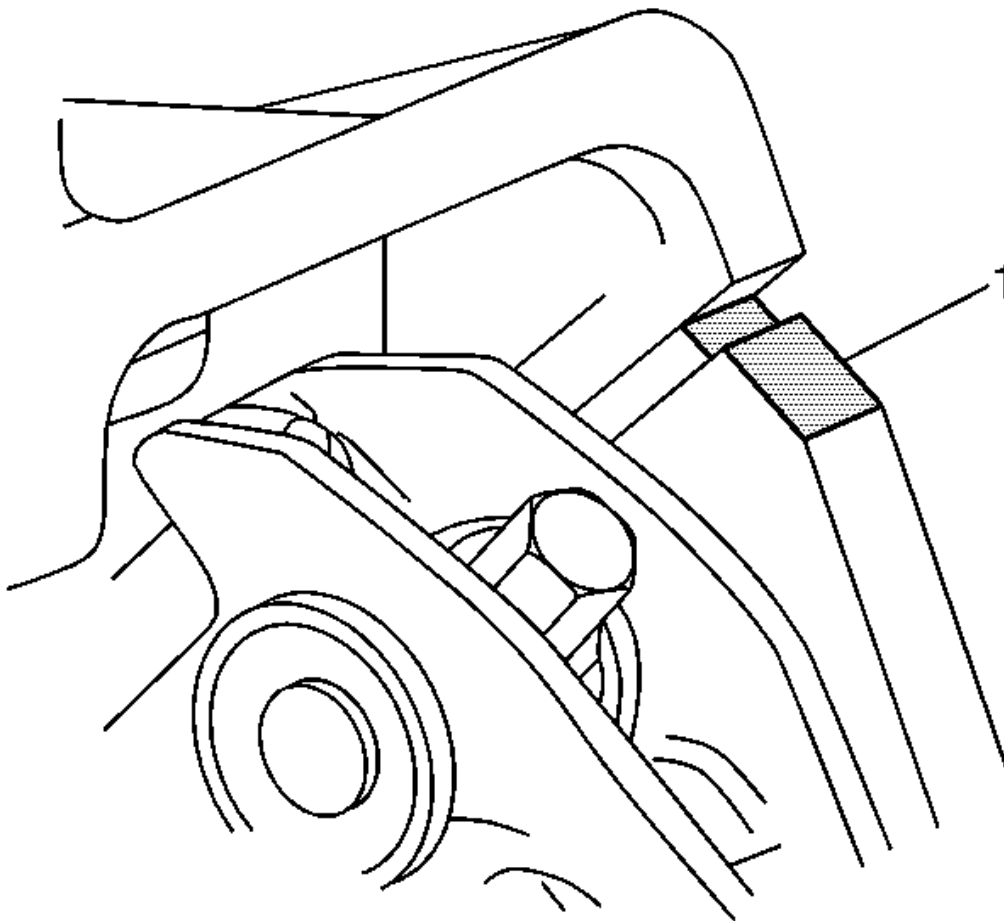


Fig. 83: Cylinder Head To Lower Intake Manifold Joint
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve rocker arm cover gasket into the groove in the valve rocker arm cover. Ensure that the gasket is properly seated in the groove of the valve rocker arm cover.
2. Apply sealant at the cylinder head to the surfaces where the cylinder head and intake manifold meet (1). Refer to Adhesives, Fluids, Lubricants, and Sealers for the 3.9L engine.

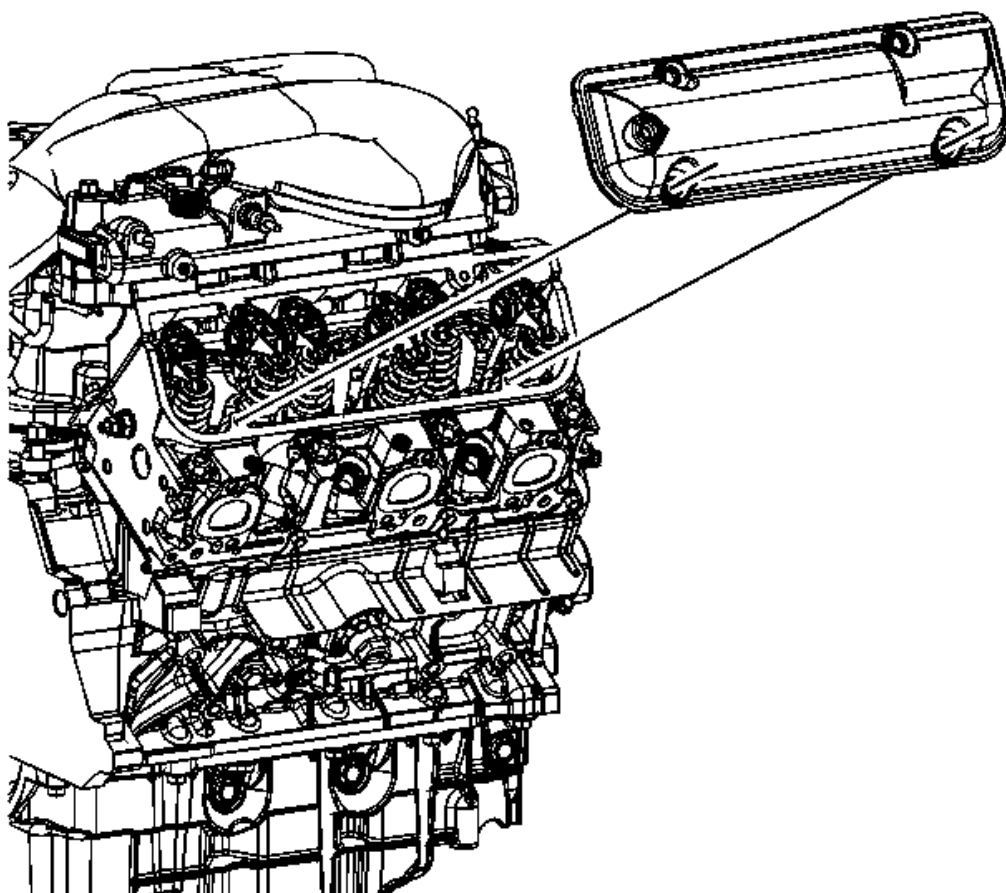


Fig. 84: Right Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Install a new gasket to the valve rocker arm cover. Ensure that the gasket is properly seated in the groove of the valve rocker arm cover.
4. Install the right valve rocker arm cover.

NOTE: Use an alternating criss-cross pattern when tightening the valve rocker cover bolts. Failure to do so may result in oil leakage from the valve cover due to improper seating of the gasket.

5. Install the valve rocker arm cover bolts. Refer to Valve Rocker Arm Cover Installation - Right Side .

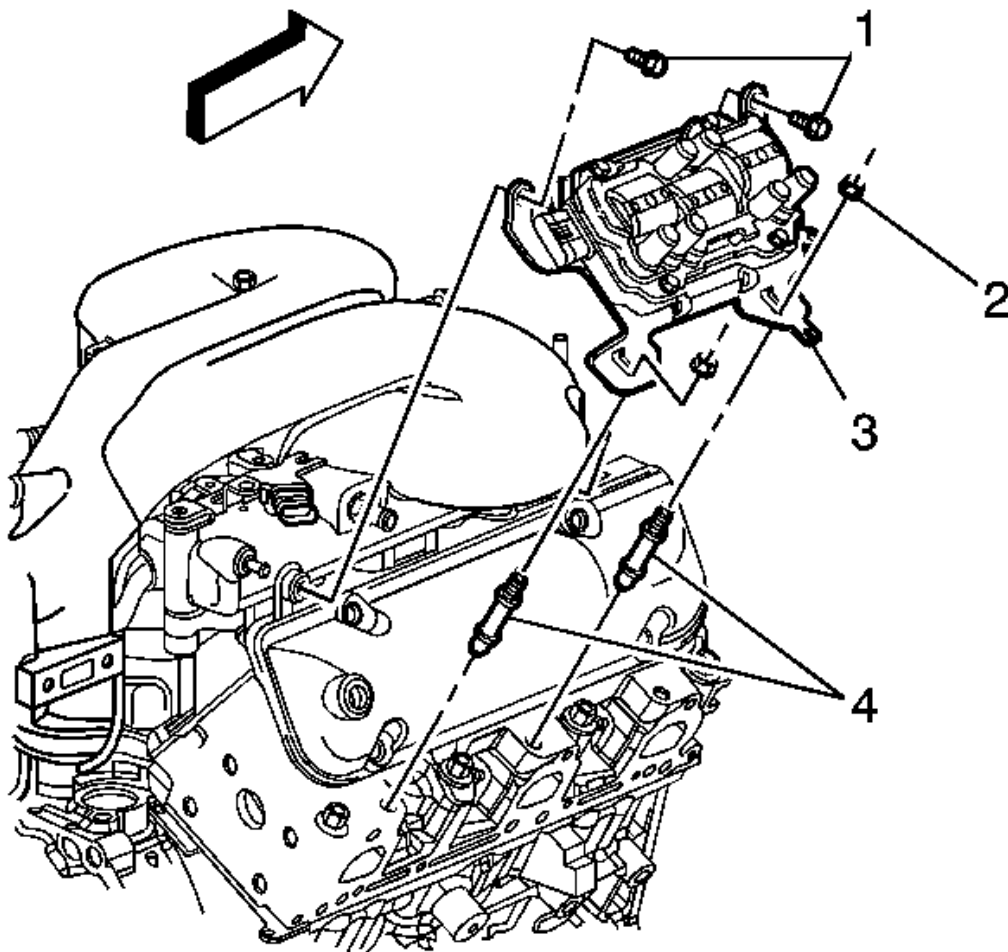


Fig. 85: Ignition Coil, Bracket Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

6. Install the ignition coil.
7. Install the ignition coil bracket bolts (1).

CAUTION: Refer to Fastener Caution .

8. Install the ignition coil bracket nuts (2).

Tighten: Tighten the bolts/nuts to 25 N.m (18 lb ft).

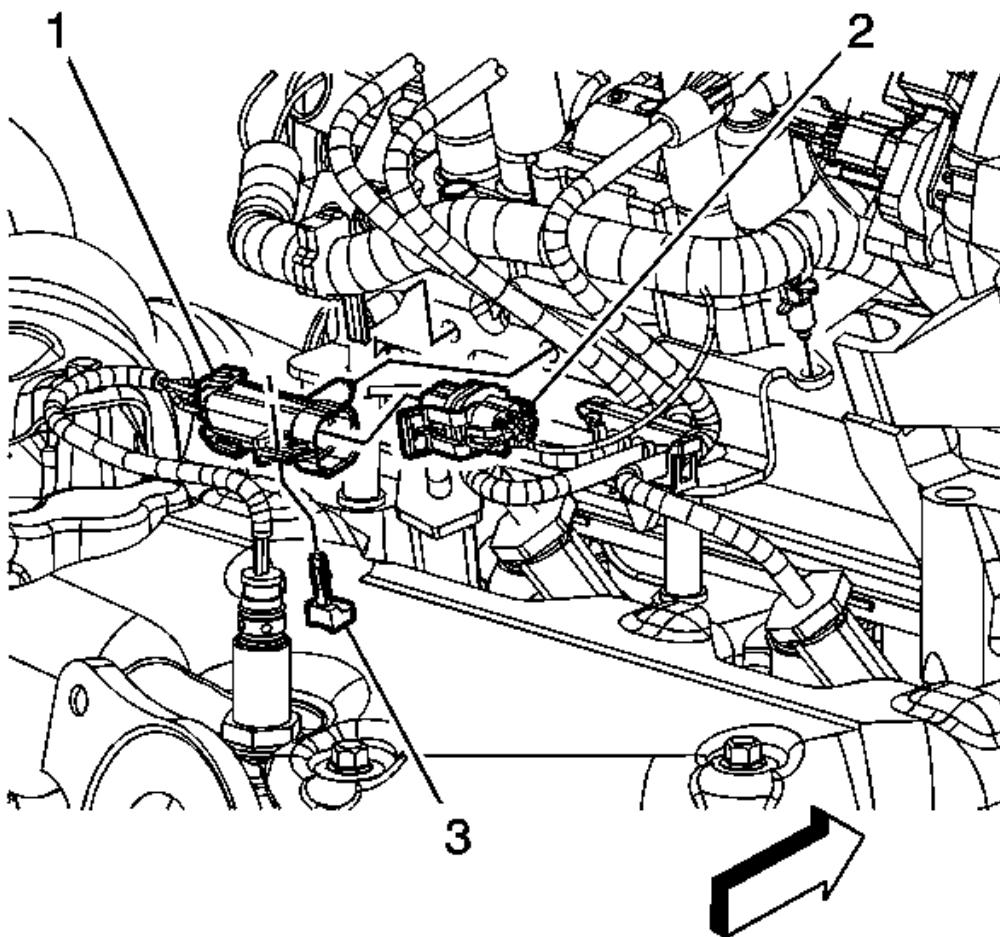


Fig. 86: HO2S Electrical Connector Clip & Ignition Coil Bracket
Courtesy of GENERAL MOTORS CORP.

9. Install the HO2S electrical connector clip (1) to the ignition coil bracket.

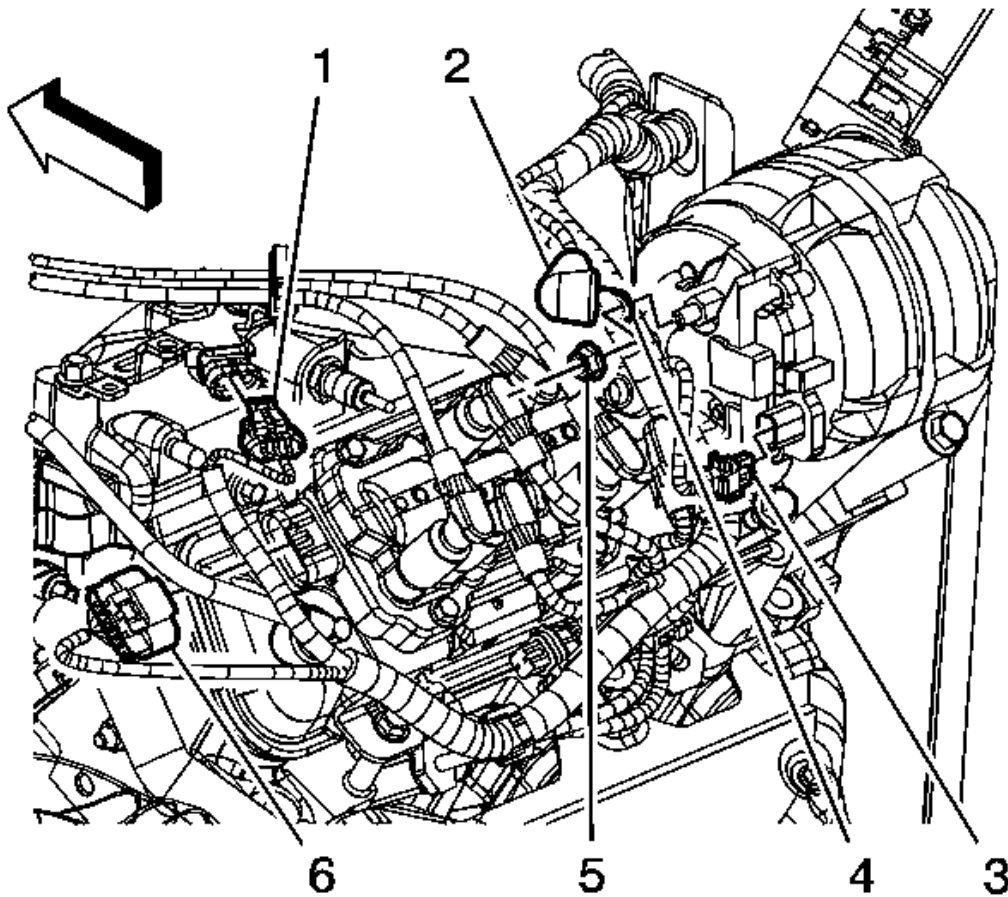


Fig. 87: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

10. Install the engine harness clip to the ignition coil bracket.
11. Connect the ignition coil electrical connector (6).
12. Connect the MAP sensor electrical connector (1).

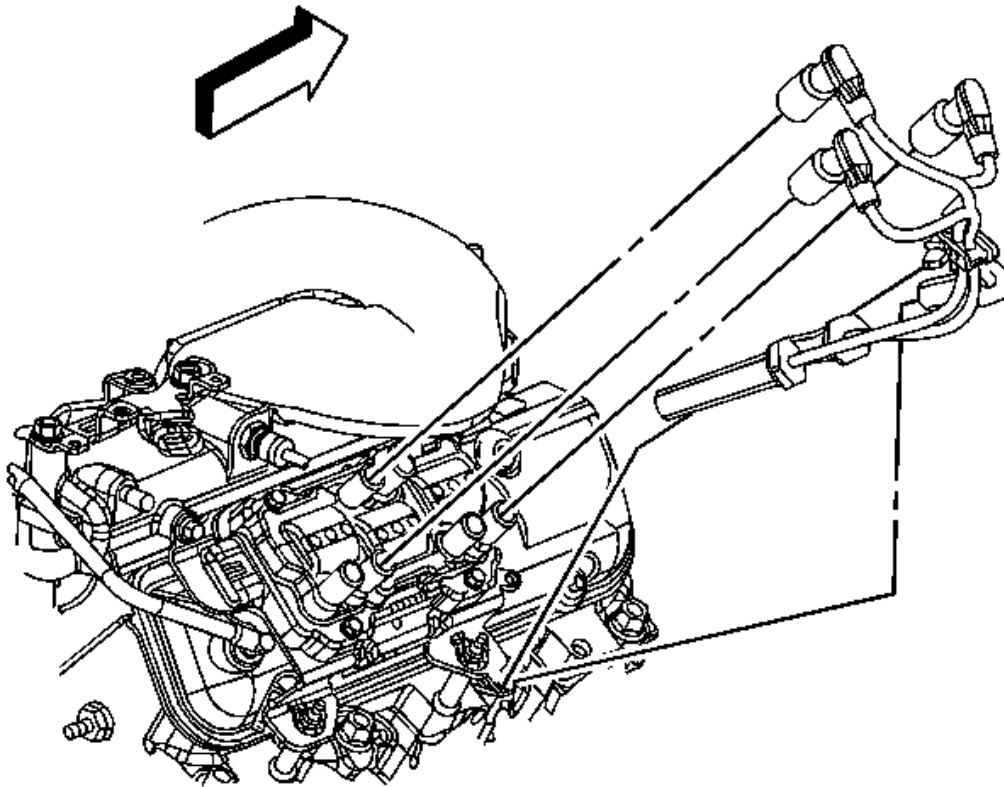


Fig. 88: Right Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

13. Install the spark plug harness.
14. Connect the right side spark plug wires to the spark plugs.
15. Connect the right side spark plug wires to the ignition coil.
16. Install the right side spark plug harness clip to the ignition coil bracket.

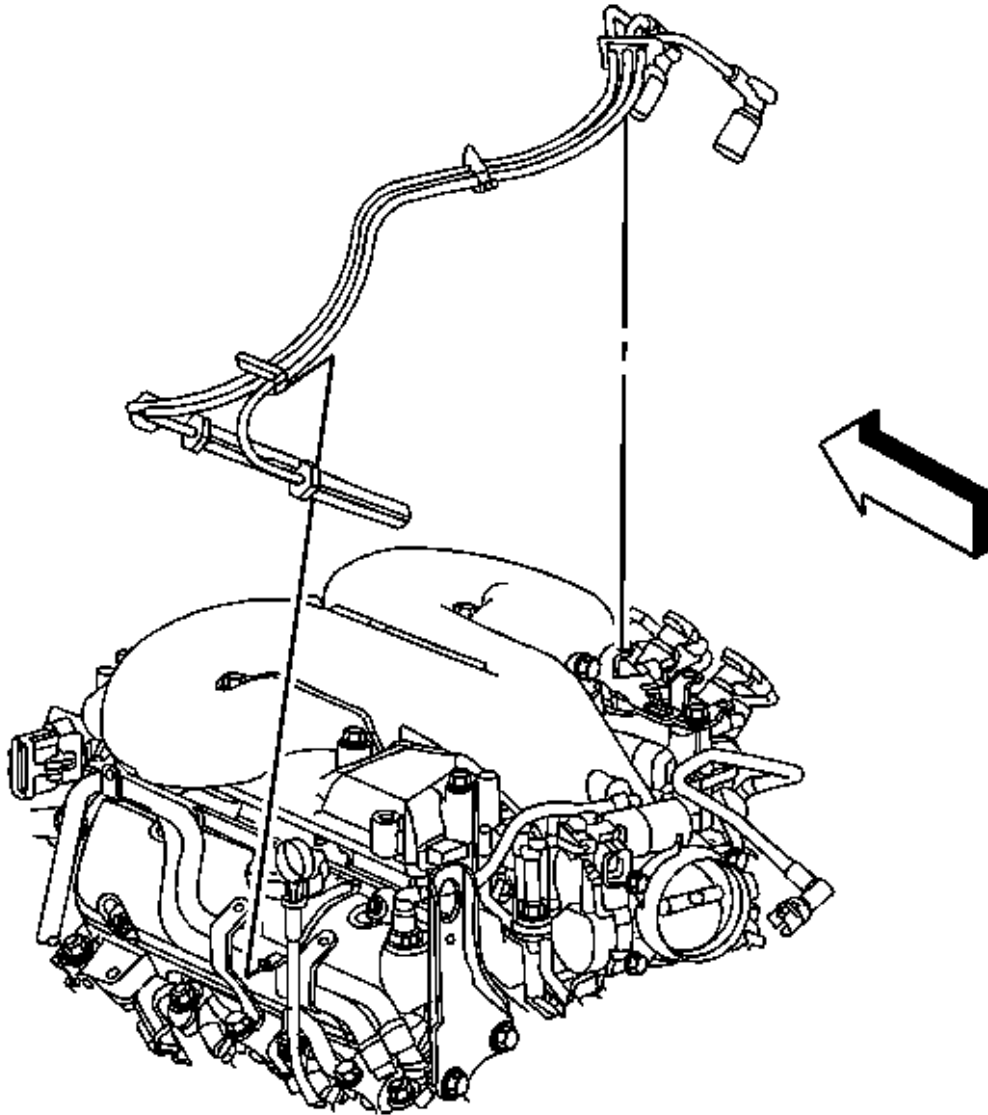


Fig. 89: Left Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

17. Connect the left side spark plug wires to the ignition coil.

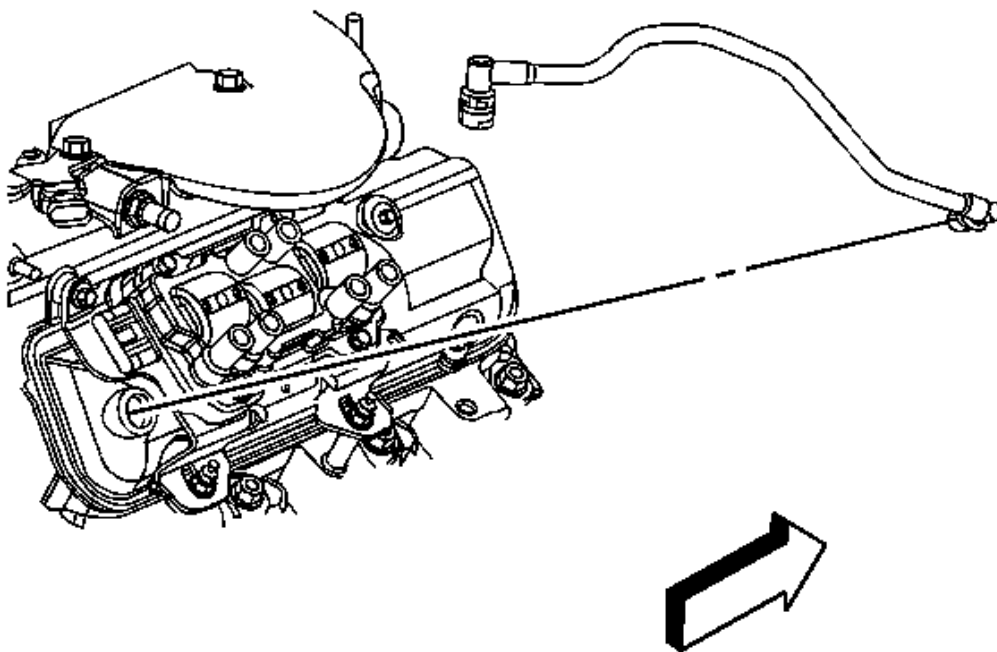


Fig. 90: Positive Crankcase Ventilation (PCV) Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

18. Install the PCV fresh air tube to the right side valve rocker arm cover.
19. Connect the PCV fresh air tube to the air cleaner outlet duct. Refer to **Plastic Collar Quick Connect Fitting Service**.
20. Install the generator. Refer to **Generator Replacement (V6)**.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

REMOVAL PROCEDURE

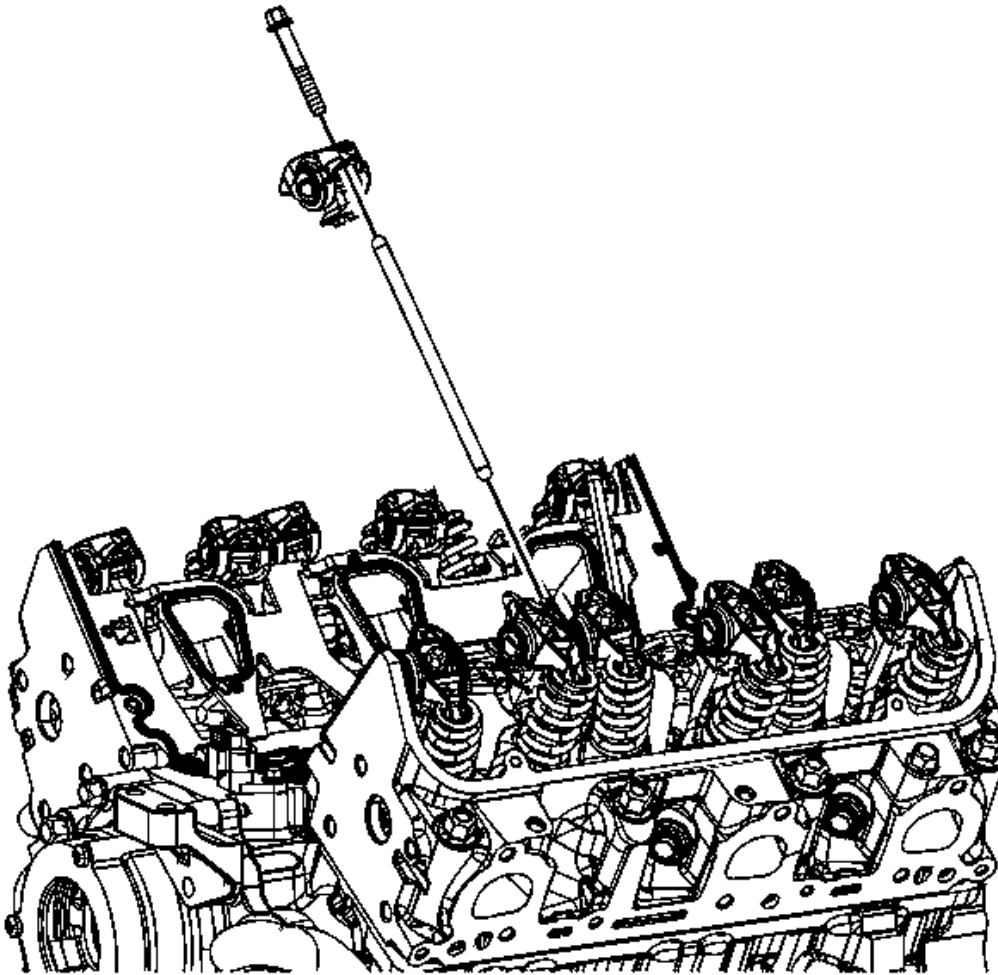


Fig. 91: Valve Rocker Arm, Bolt & Push Rod
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the valve train components in a rack in order to ensure that the components are installed in the same location from which they were removed.

1. Remove the valve rocker arm covers. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.
2. Loosen the valve rocker arm bolts.
3. Remove the rocker arms.
4. Remove the pushrods.

- The intake push rods measure 147.51 mm (5.81 in).
- The exhaust push rods measure 154.87 mm (6.1 in).

INSTALLATION PROCEDURE

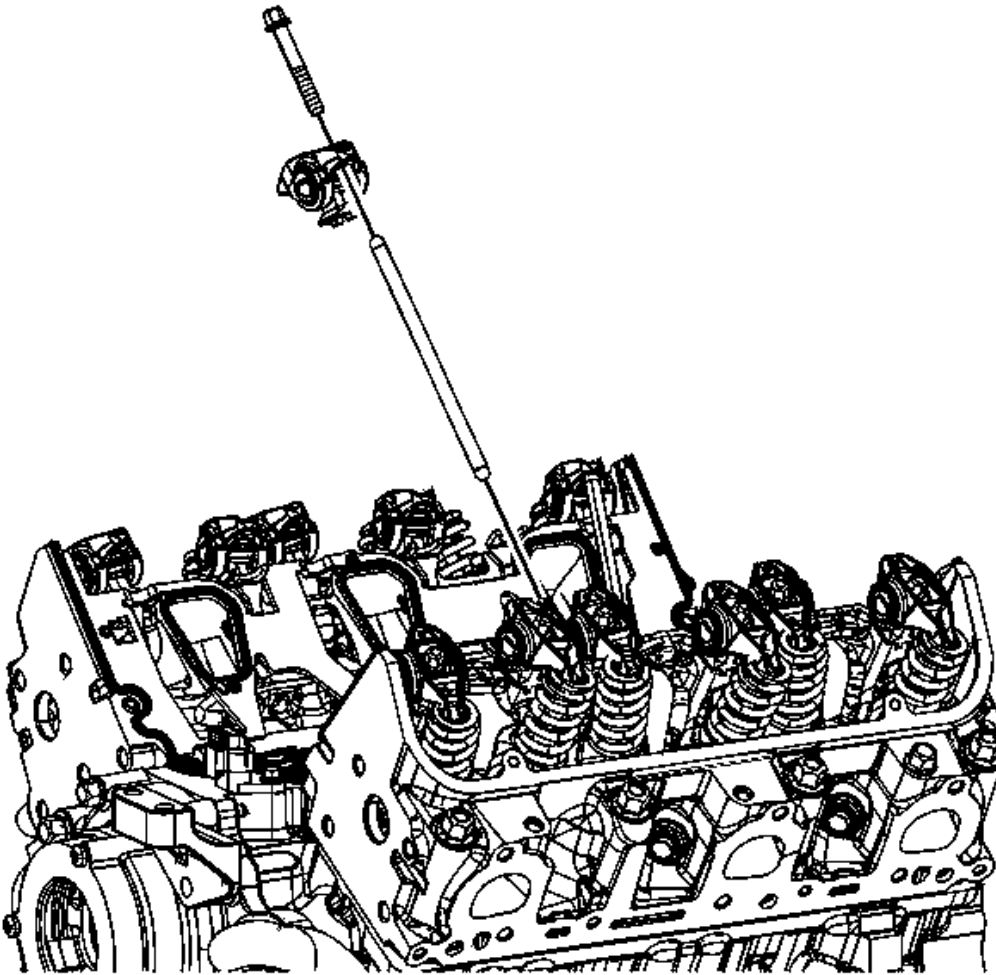


Fig. 92: Valve Rocker Arm, Bolt & Push Rod
Courtesy of GENERAL MOTORS CORP.

1. Coat the ends of the pushrods using prelude. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the pushrods.
 - The intake push rods measure 147.51 mm (5.81 in).
 - The exhaust push rods measure 154.87 mm (6.1 in).

3. Ensure that the pushrods seat in the lifter bore.
4. Coat the rocker arm friction surfaces using prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

NOTE: Shims (88894006) may be required under the valve rocker arm pedestals if reconditioning has been performed on the cylinder head or its components.

5. Install the rocker arms.
6. Install the rocker arm bolts. Refer to **Valve Rocker Arm and Push Rod Installation** .
7. Install the valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Tools Required

- **EN-47823** Valve Spring Compressor Adapter. See **Special Tools** .
- **J 22794** Spark Plug Port Adapter. See **Special Tools** .
- **J 5892-D** Valve Spring Compressor. See **Special Tools** .

REMOVAL PROCEDURE

- IMPORTANT:**
- Before removing the valve locks, rotate the engine so that the piston in the cylinder you are working on is at top dead center (TDC). This will eliminate the possibility of the valve accidentally falling inside the cylinder.
 - Loosen the spark plug, and clean any dirt and/or debris from the spark plug recess area before removing.

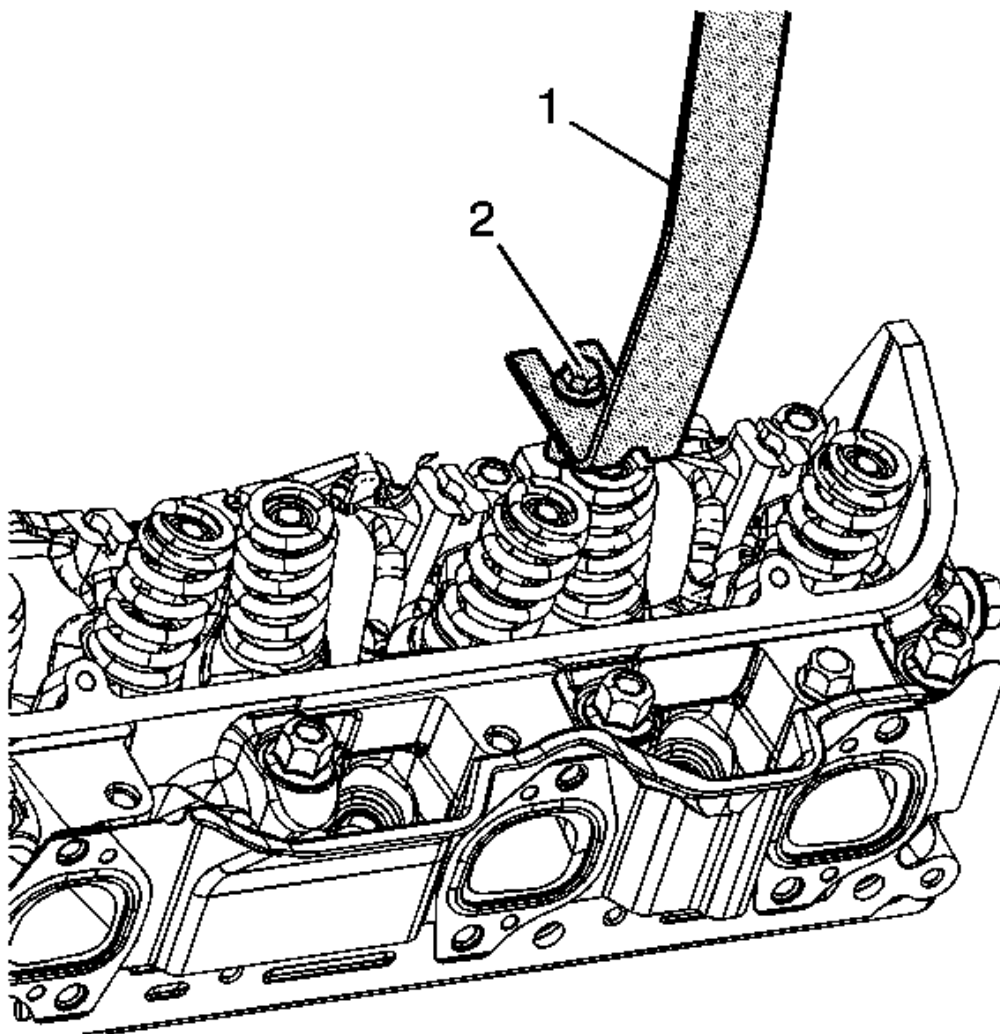


Fig. 93: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug. Refer to **Spark Plug Replacement**.
2. Remove the rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Install the **J 22794** into the spark plug port. See **Special Tools**. Apply compressed air in order to hold the valve in place.
4. Using caution so as not to damage the valve spring or valve spring dampener, compress the valve spring using the **J 5892-D** (1) and the **EN-47823** (2). See **Special Tools**.

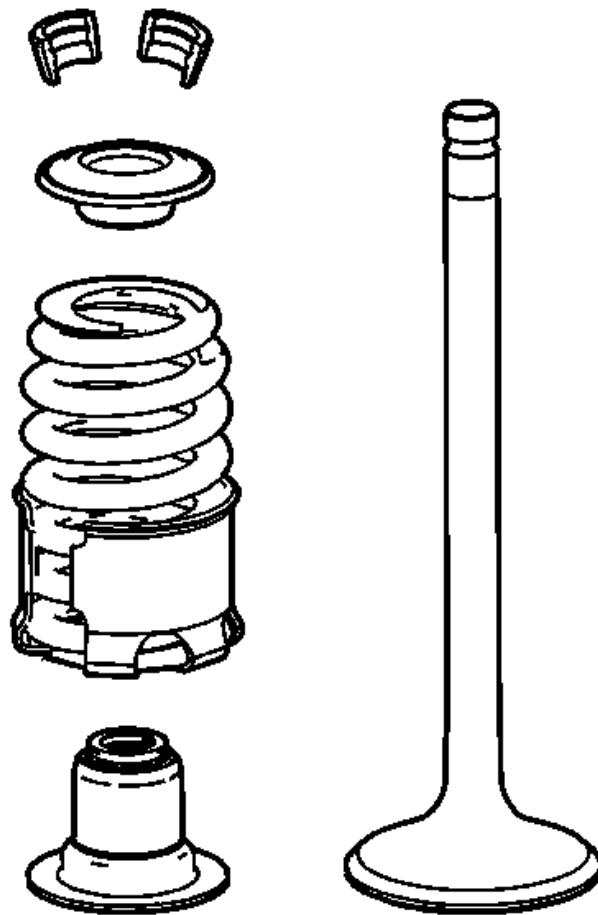


Fig. 94: Valve Components
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve spring cap keys.
6. Remove the valve cap.
7. Remove the valve spring assembly.
8. Remove the valve stem oil seal.

INSTALLATION PROCEDURE

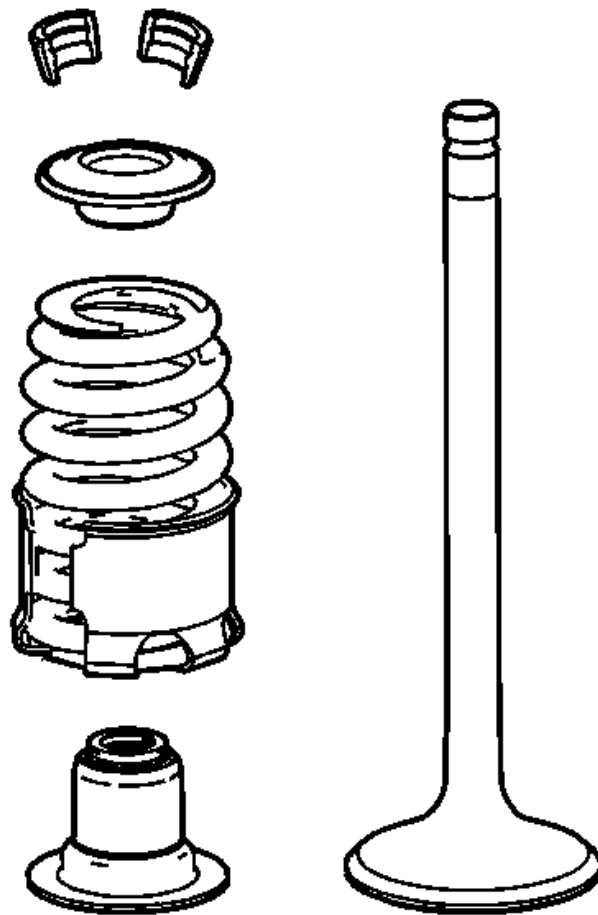


Fig. 95: Valve Components
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve stem with clean engine oil.
2. Install the valve stem oil seal, ensuring the proper seals (intake - black seal and exhaust - brown seal) are installed.
3. Install the valve spring.
4. Install the valve cap.

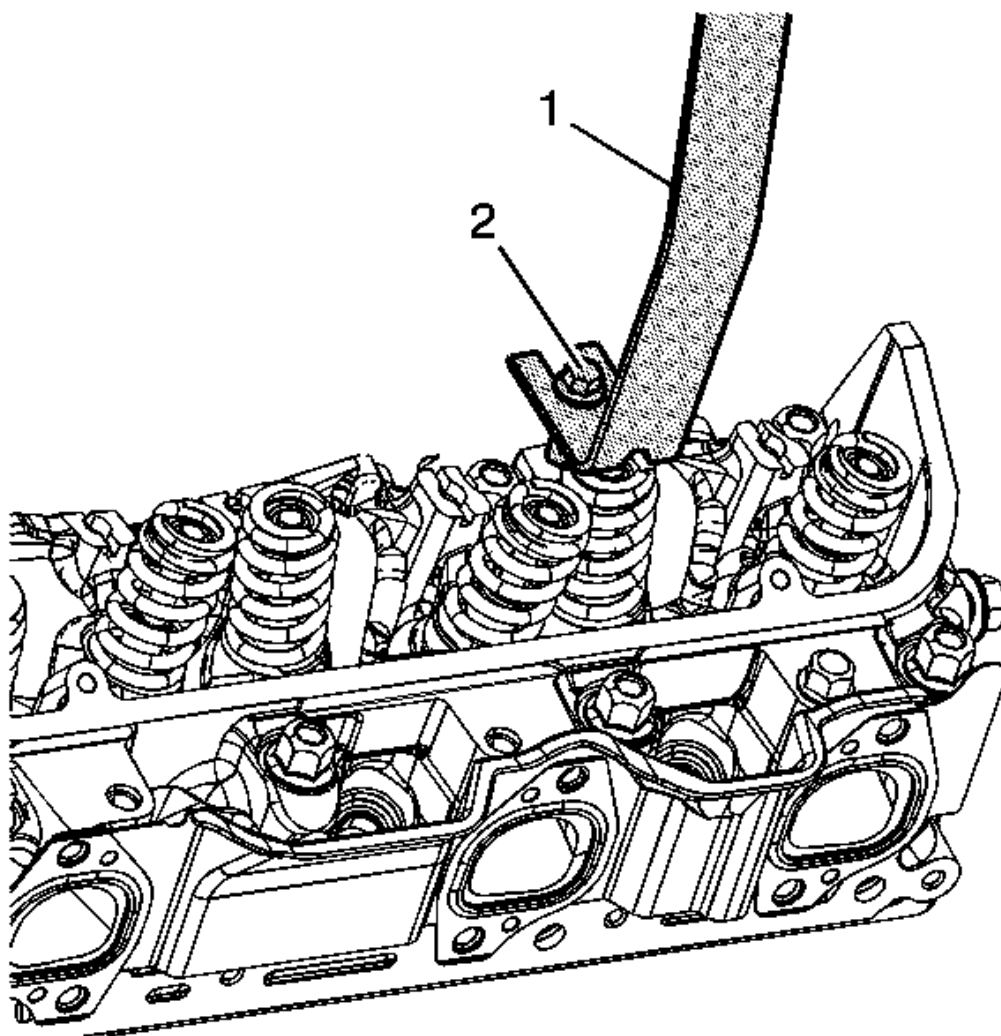


Fig. 96: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

5. Using caution so as not to damage the valve spring or valve spring dampener, compress the valve spring using the **J 5892-D** (1) and the **EN-47823** (2). See **Special Tools** .
6. Install the valve cap keys. If necessary, use grease in order to hold the valve cap keys in place.
7. Ensure the valve cap keys are seated.
8. Remove the compressed air and remove the **J 22794** from the spark plug port. See **Special Tools** .
9. Install the rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.
10. Install the spark plug. Refer to **Spark Plug Replacement** .

VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

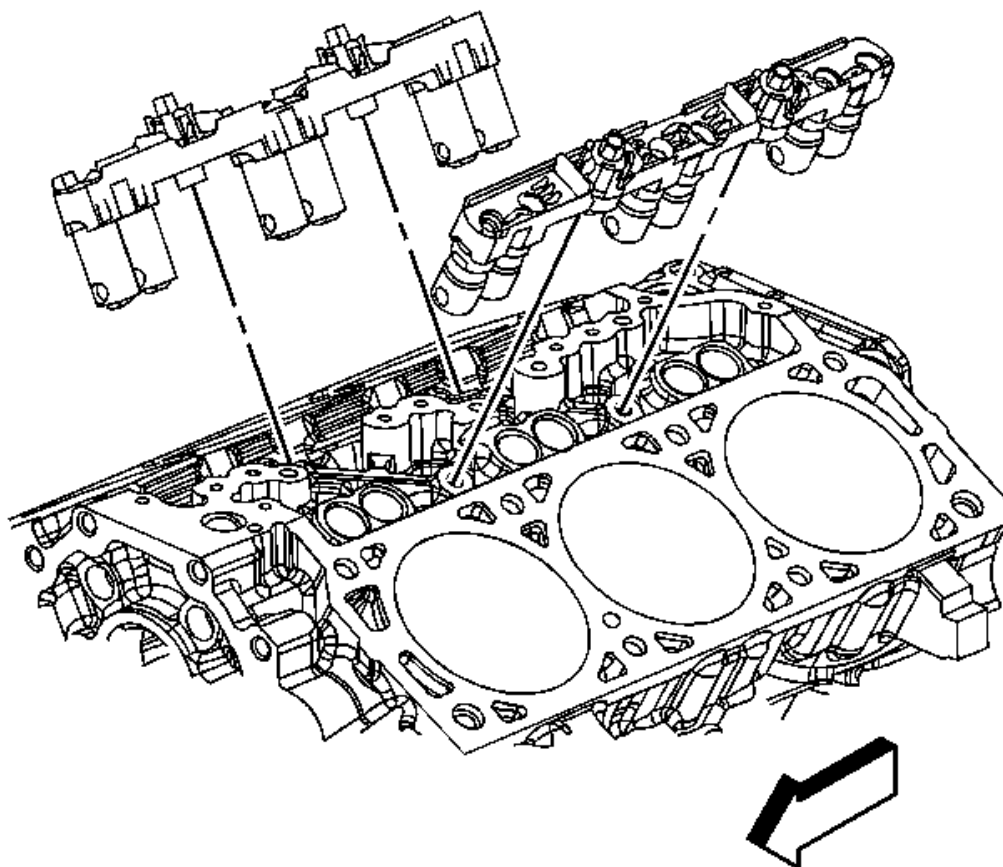


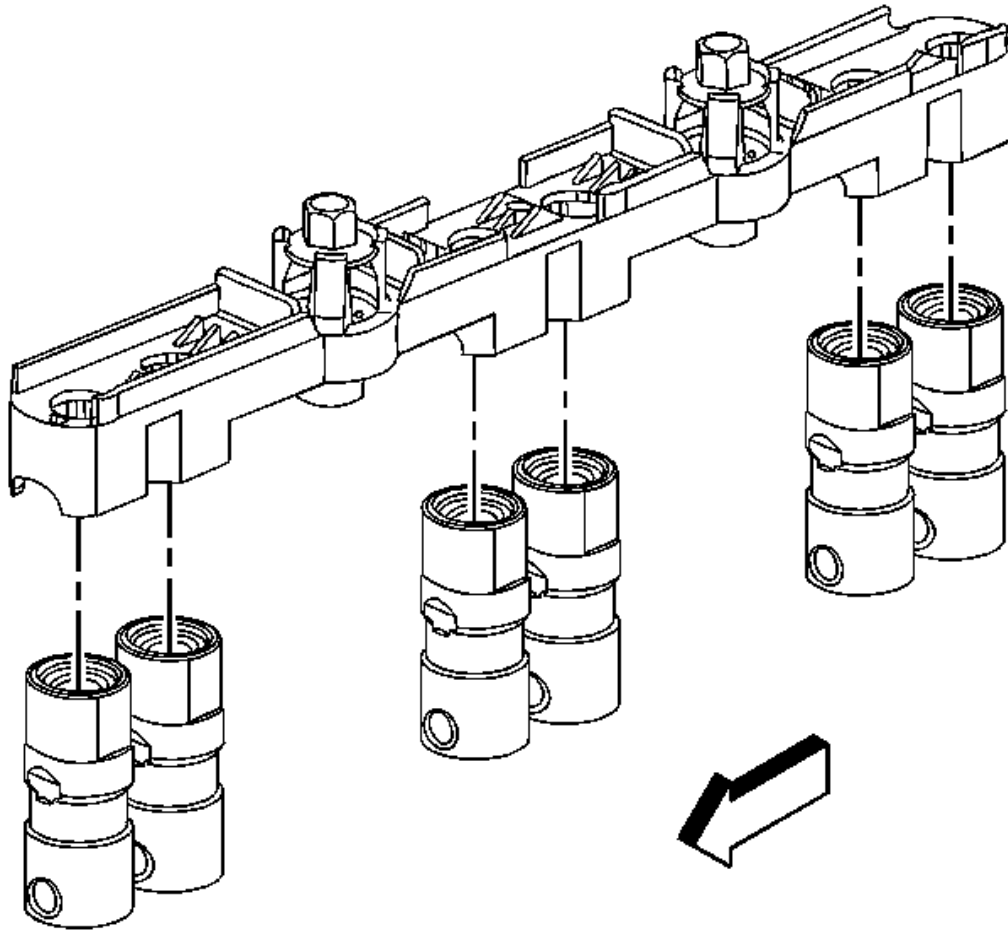
Fig. 97: Valve Lifter Guides

Courtesy of GENERAL MOTORS CORP.

1. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
2. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

NOTE: The valve lifter guide bolts are not removable.

3. Loosen the valve lifter guide bolts.
4. Remove the valve lifter guides.

**Fig. 98: Valve Lifters**

Courtesy of GENERAL MOTORS CORP.

5. Remove the valve lifters from the valve lifter guides.
6. Clean all gasket surfaces with degreaser.

INSTALLATION PROCEDURE

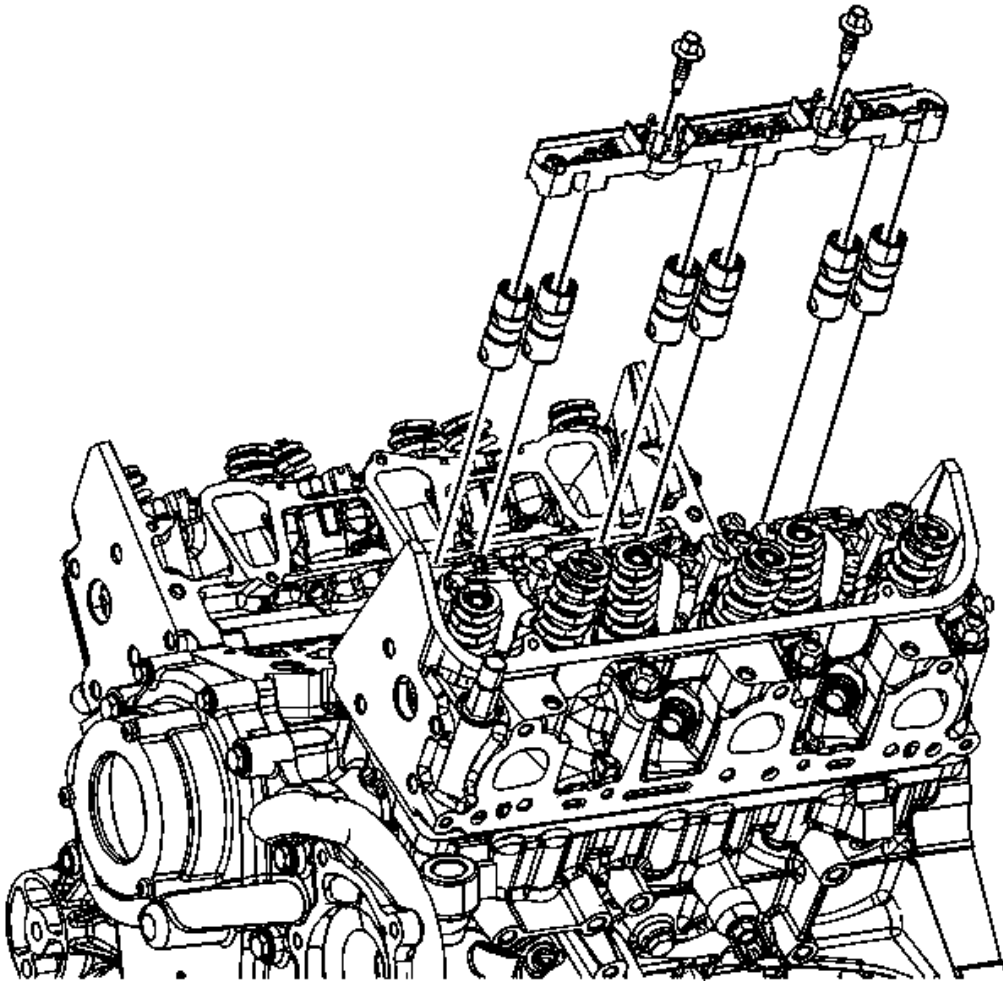


Fig. 99: Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

1. Coat the valve lifters using prelube. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Install the valve lifters to the cylinder bores.
3. Apply threadlock to the valve lifter guide bolt threads. Refer to Adhesives, Fluids, Lubricants, and Sealers .
4. Install the valve lifter guides.

CAUTION: Refer to Fastener Caution .

5. Tighten the valve lifter guide bolts.

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

6. Install the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
7. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN 46359** Puller End Protector. See **Special Tools** .
- **J 29113** Balancer and Crank Sprocket Installer. See **Special Tools** .
- **J 37096** Flywheel Holder. See **Special Tools** .
- **J 41816** Harmonic Balancer Remover. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

CAUTION: The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the crankshaft balancer.

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
5. Install adjustable jack stands under the frame.
6. Loosen the left side frame bolts and remove the right side frame bolts.
7. Using the jack stands, lower the right side of the frame in order to access the crankshaft balancer.
8. Remove the torque converter covers.
9. Install the **J 37096** to the flywheel in order to prevent flywheel rotation. See **Special Tools** .

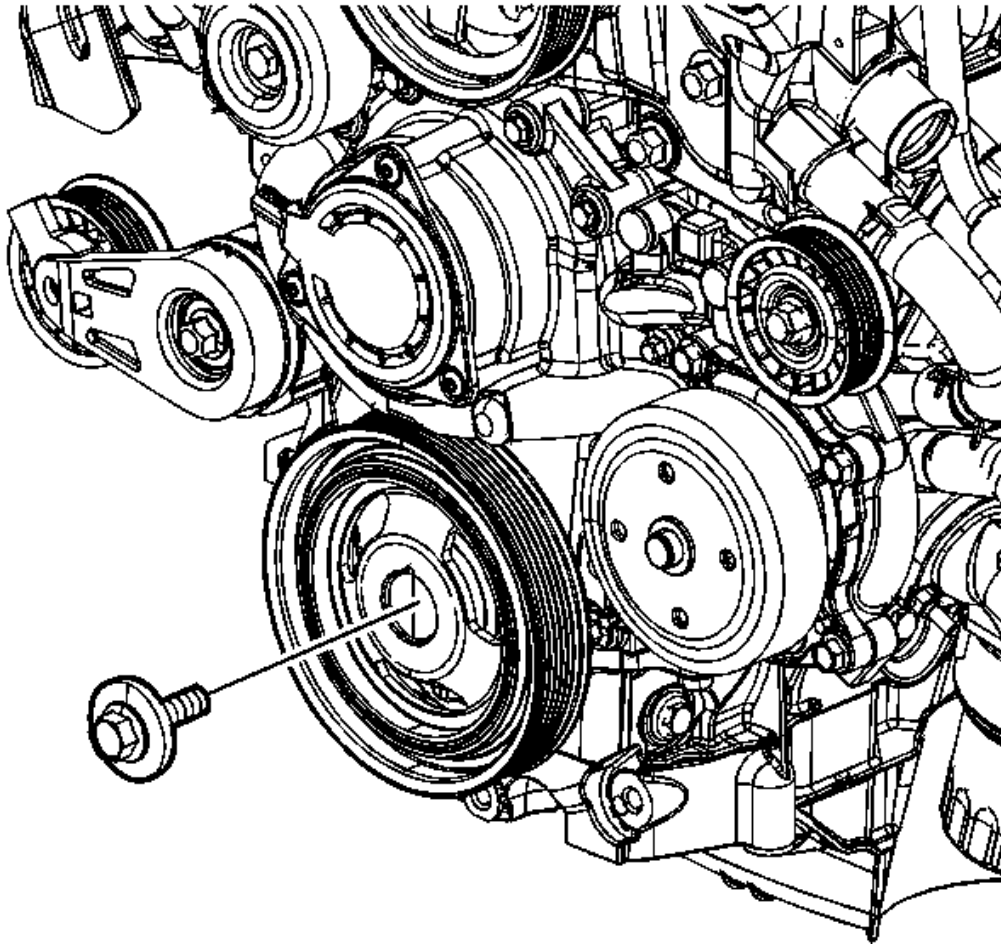


Fig. 100: Crankshaft Balancer Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

10. Remove the crankshaft balancer bolt and the washer.

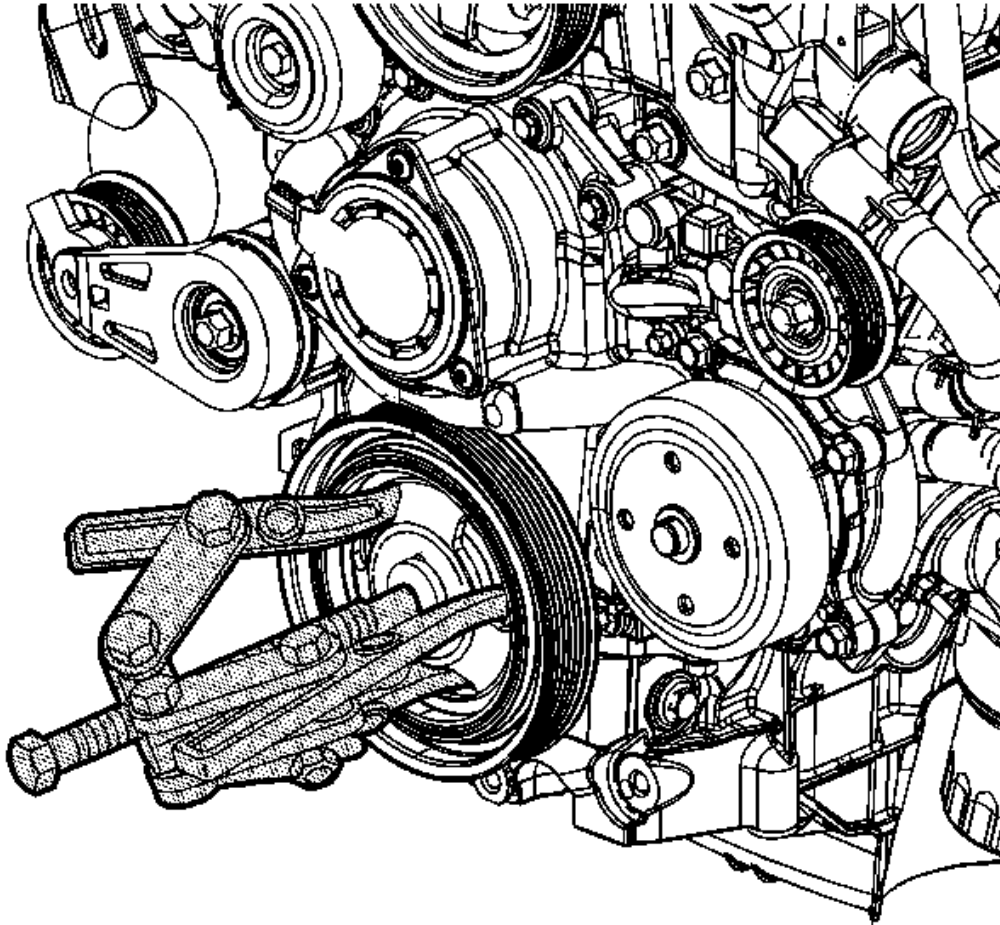


Fig. 101: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do NOT use a power-assisted tool with the special tool in order to remove or install this component. You cannot properly control the alignment of this component using a power-assisted tool, and this can damage the component.

11. Remove the crankshaft balancer using the J 41816 and EN 46359 . See Special Tools .

INSTALLATION PROCEDURE

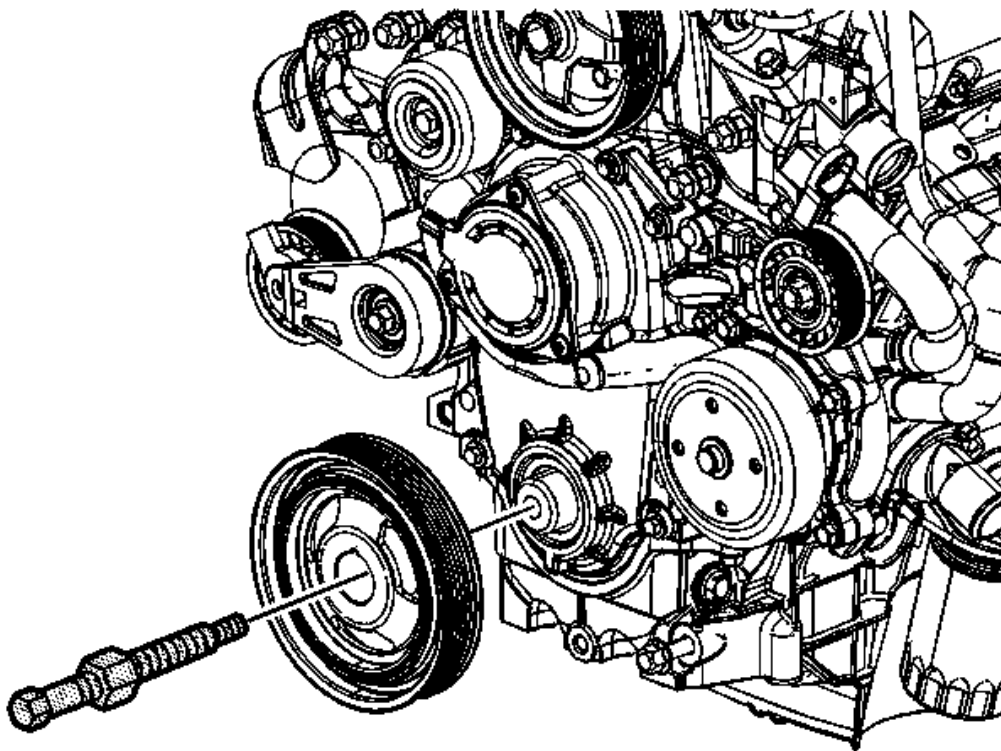


Fig. 102: Installing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Apply sealer to the keyway of the crankshaft balancer. Refer to Adhesives, Fluids, Lubricants, and Sealers .
2. Place the crankshaft balancer into position over the key in the crankshaft.

CAUTION: Do NOT use a power-assisted tool with the special tool in order to remove or install this component. You cannot properly control the alignment of this component using a power-assisted tool, and this can damage the component.

3. Thread the **J 29113** into the crankshaft. See Special Tools .
4. Rotate the hex nut on the **J 29113** in order to install the crankshaft balancer onto the crankshaft. See Special Tools .
5. Remove the **J 29113** from the crankshaft. See Special Tools .

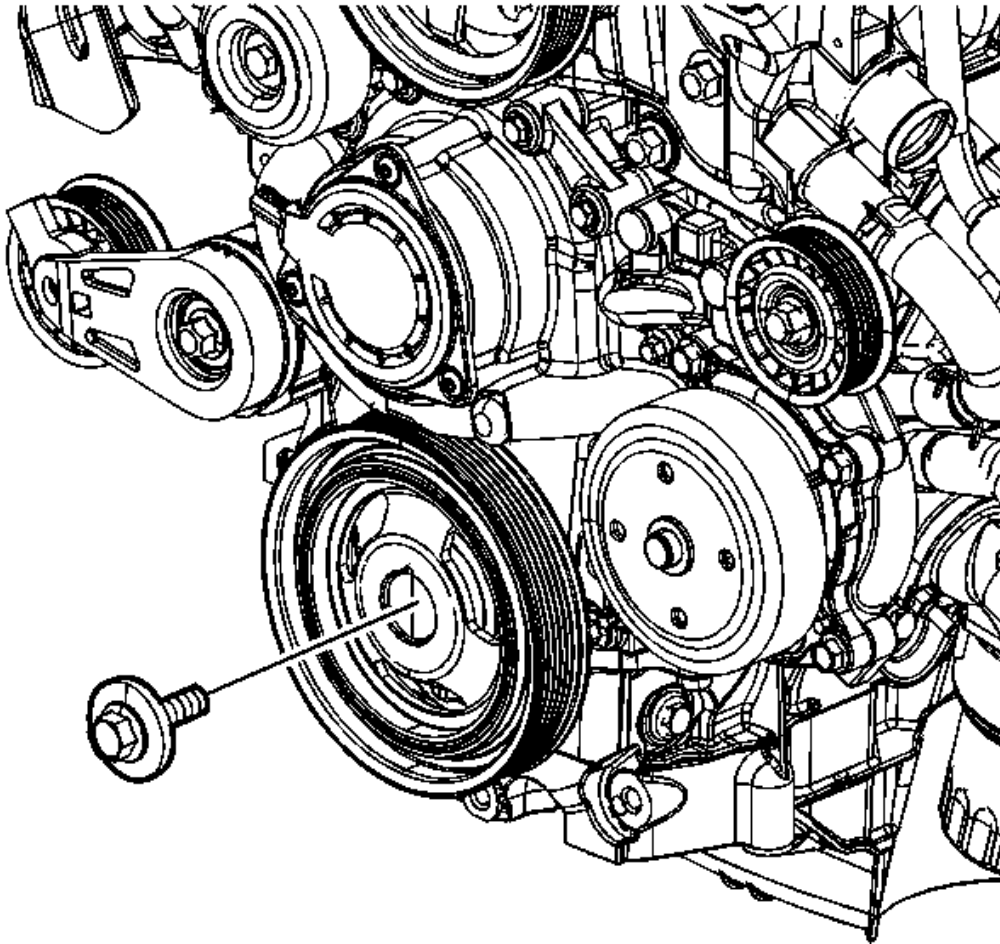


Fig. 103: Crankshaft Balancer Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

6. Install the crankshaft balancer washer and the bolt.

CAUTION: Refer to Fastener Caution .

7. Install the used crankshaft balancer bolt and tighten to 125 N.m (92 lb ft).
8. Remove the used crankshaft balancer bolt.
9. Install the NEW crankshaft balancer bolt.
 1. Tighten the crankshaft balancer bolt a first pass to 125 N.m (92 lb ft).

2. Tighten the crankshaft balancer bolt a final pass to 130 degrees using the **J 45059** .
10. Remove the **J 45059** from the flywheel.
11. Install the torque converter covers.
12. Raise the frame into the original position.
13. Install and tighten the right and left side frame bolts to 100 N.m (74 lb ft) plus an additional 90 degrees using the **J 45059** .
14. Install the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
15. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
16. Lower the vehicle.
17. Install the drive belt. Refer to **Drive Belt Replacement**.

OIL PAN REPLACEMENT

Special Tools

J 39505 Torque Wrench Adapter

REMOVAL PROCEDURE

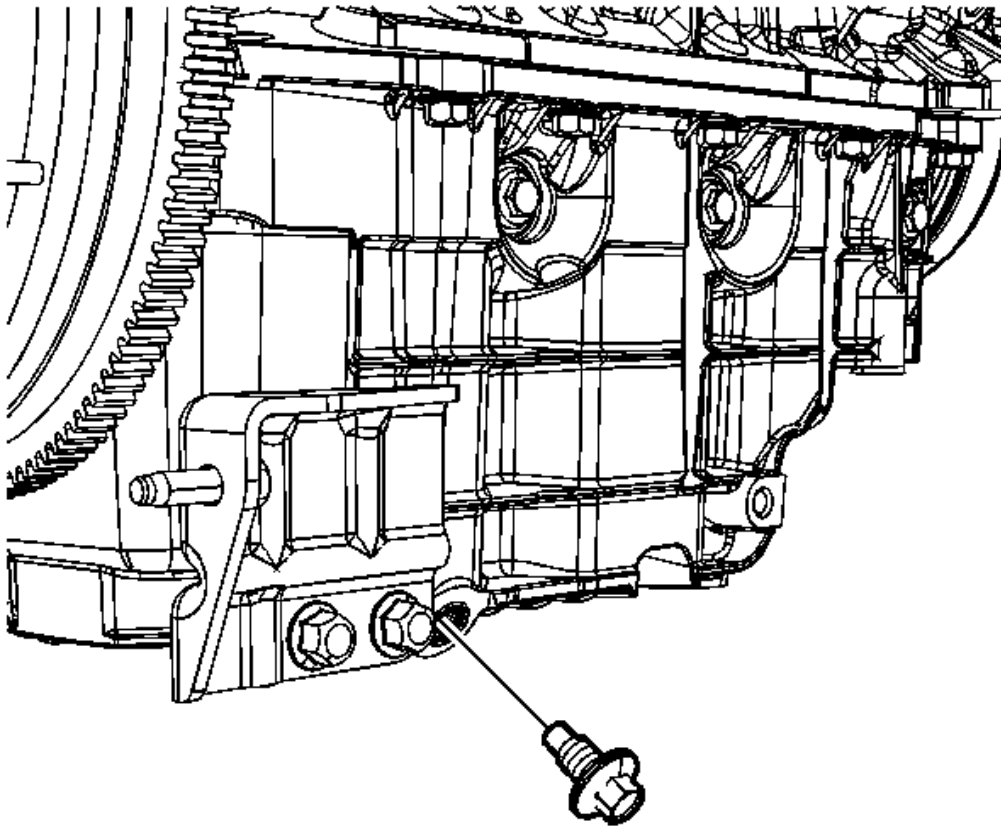


Fig. 104: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine mount struts. Refer to **Engine Mount Strut Replacement**.
3. Install the engine support fixture. Refer to **Engine Support Fixture**.
4. Remove the catalytic converter.
5. Remove the oil pan drain plug.
6. Drain the crankcase.
7. Reinstall the oil pan drain plug.
8. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
9. Remove the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
10. Remove the accessory drive belt. Refer to **Drive Belt Replacement**.

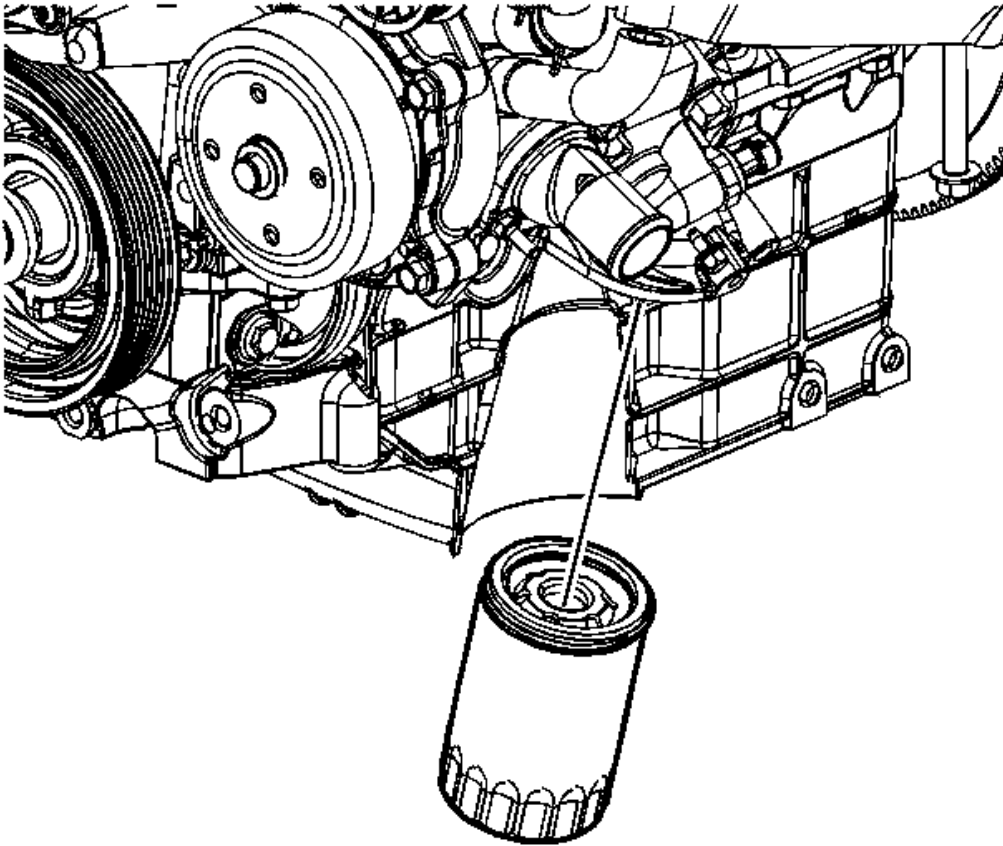


Fig. 105: Oil Filter

Courtesy of GENERAL MOTORS CORP.

11. Remove the oil filter adapter. Refer to **Oil Filter Adapter and Bypass Valve Assembly Replacement**.
12. Remove the starter. Refer to **Starter Replacement (V6)**.

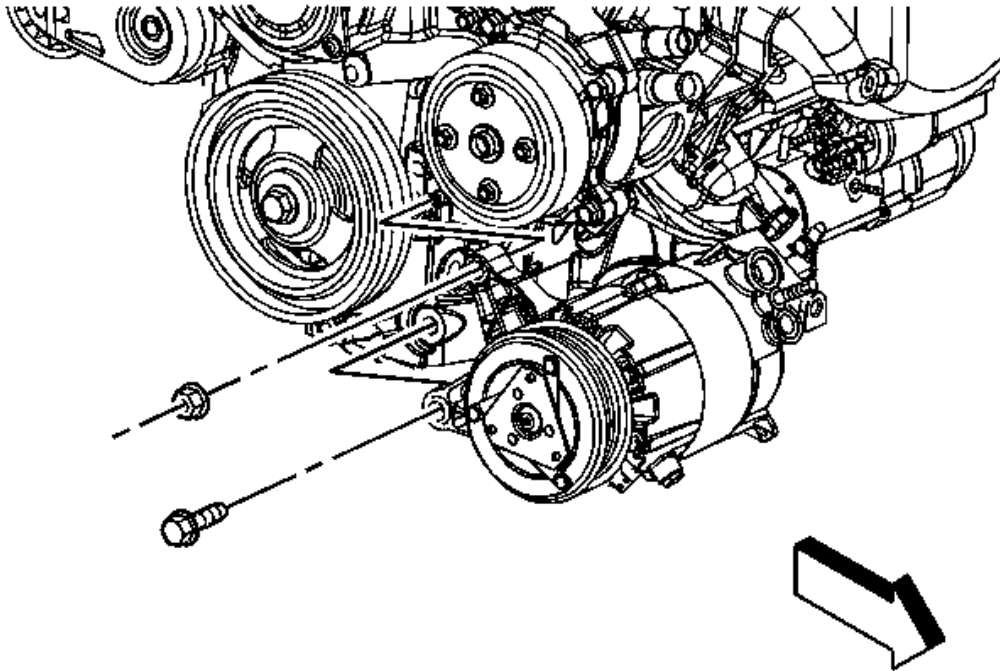


Fig. 106: Air Conditioning Compressor Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

13. Remove the air conditioning (A/C) compressor nut and bolt.

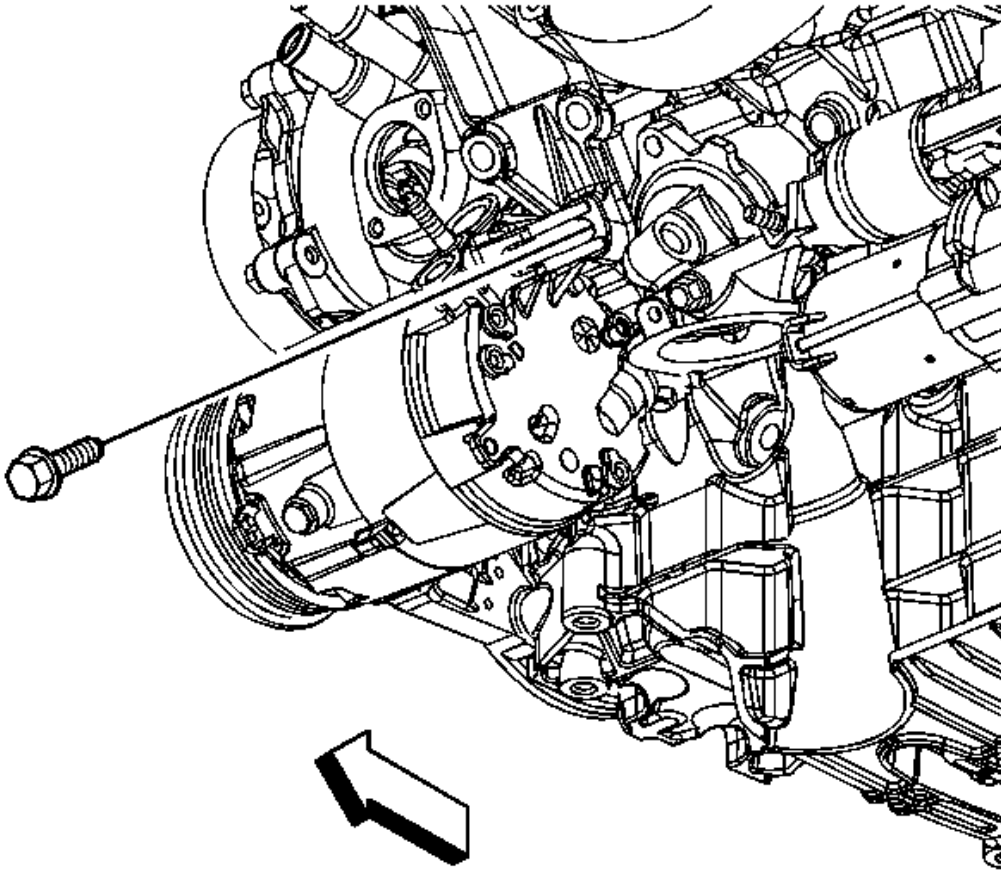


Fig. 107: A/C Compressor Rear Bolt
Courtesy of GENERAL MOTORS CORP.

14. Remove the A/C compressor rear bolt and position the compressor aside.

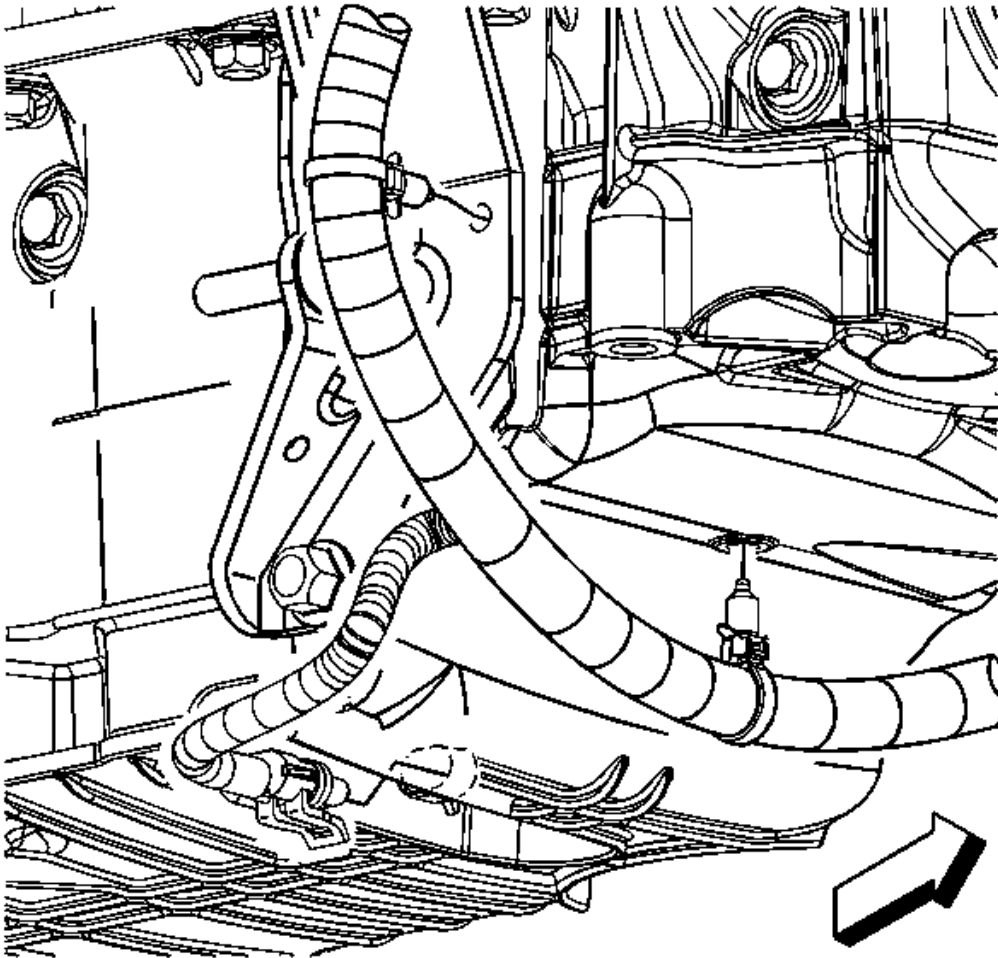


Fig. 108: Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the oil level sensor electrical connector.
16. Remove the engine harness clips from the oil pan and the transaxle brace.

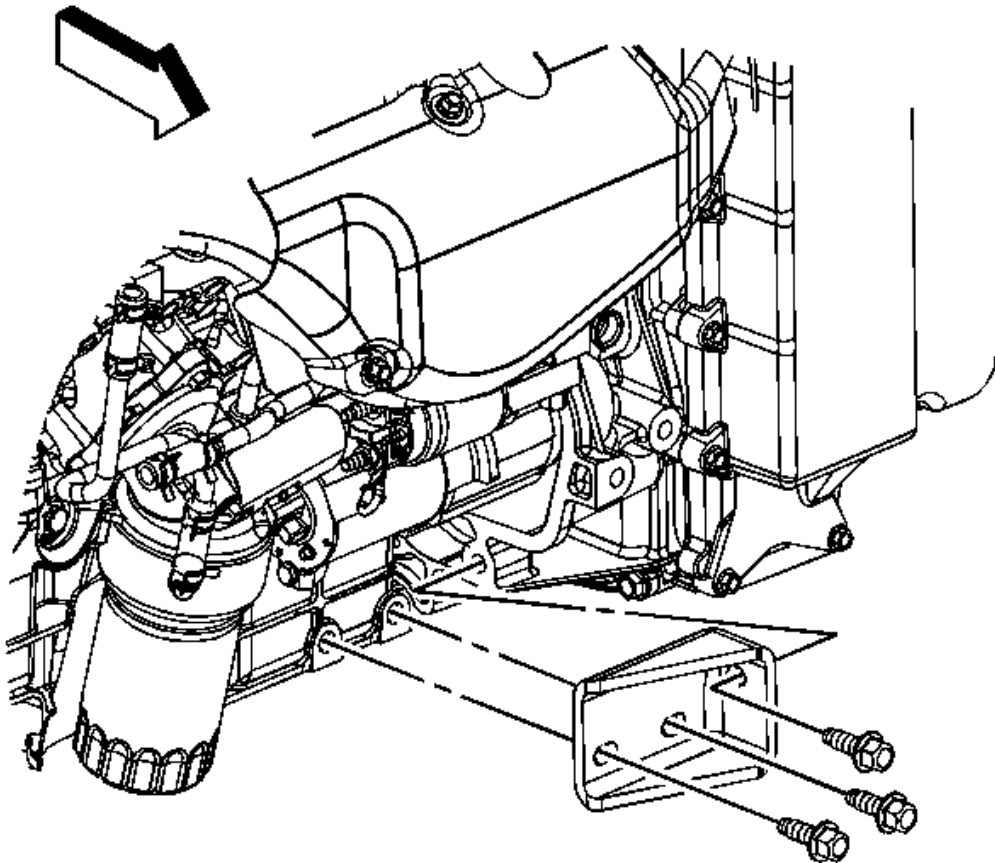


Fig. 109: Front Transaxle Brace & Engine Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the front transaxle brace to engine bolts and the brace.
18. Loosen the transaxle mount lower nuts. Refer to **Transmission Mount Replacement - Left Side** .

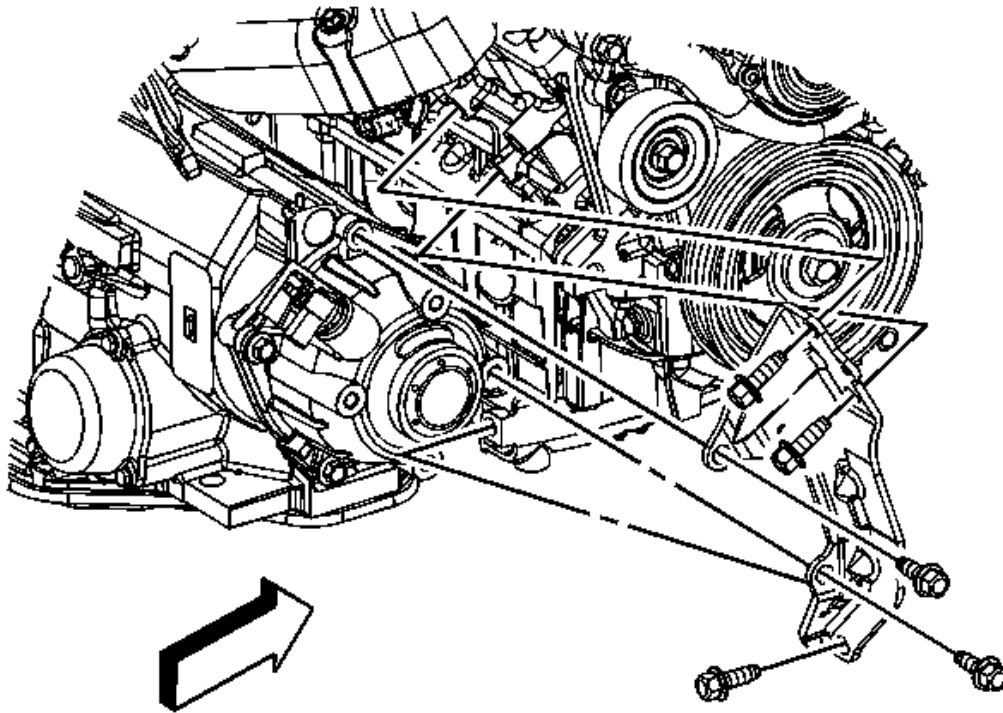


Fig. 110: Rear Transaxle Brace To Engine/Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

19. Remove the rear transaxle brace to engine/oil pan bolts.
20. Lower the vehicle.
21. Using the engine support fixture, raise the engine.
22. Raise the engine.

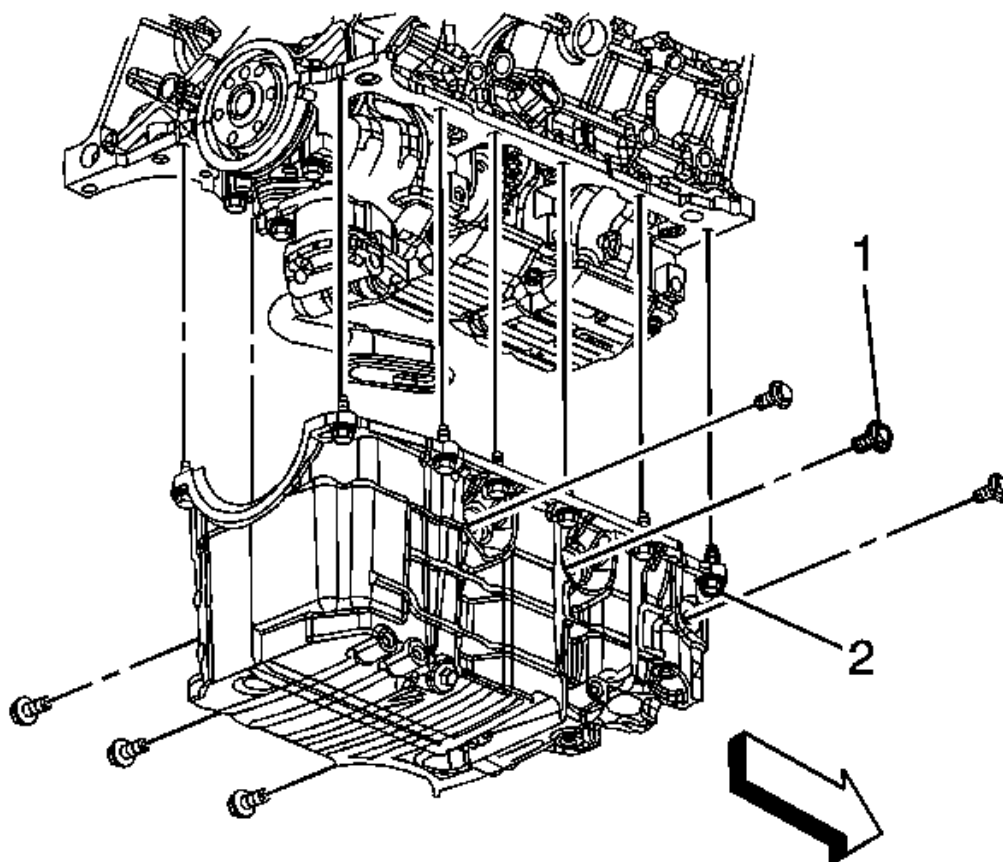


Fig. 111: Oil Pan & Bolts

Courtesy of GENERAL MOTORS CORP.

23. Using the **J 39505** , remove the right side oil pan side bolts.
24. Remove the left side oil pan side bolts (1).
25. Remove the oil pan bolts (2).
26. Remove the oil pan.
27. Remove the oil pan gasket.
28. Clean the following items:
 - The oil pan flanges
 - The oil pan rail
 - The front cover
 - The rear main bearing cap
 - The threaded holes

INSTALLATION PROCEDURE

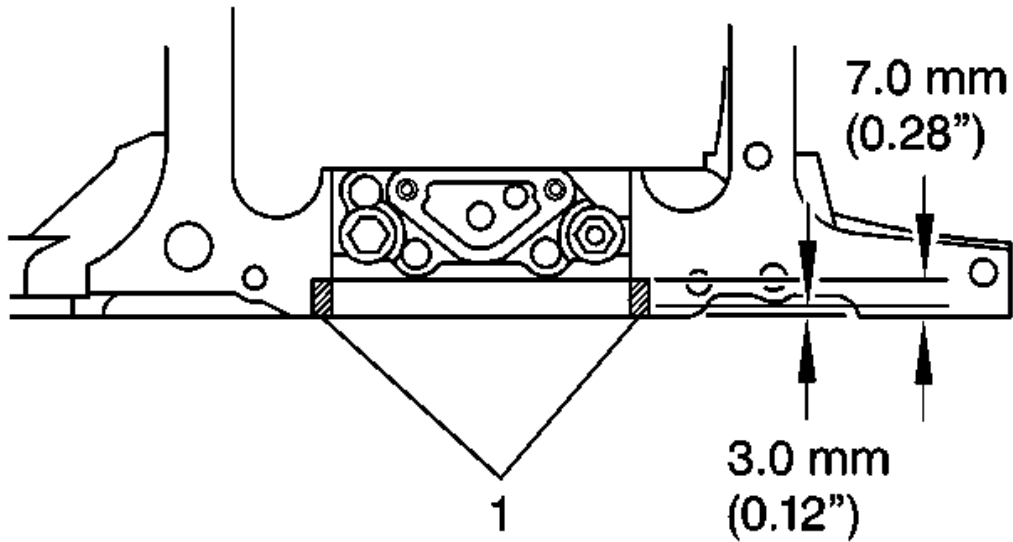


Fig. 112: Proper Sealer Application
Courtesy of GENERAL MOTORS CORP.

1. Apply sealer to both sides of the crankshaft rear main bearing cap (1) and the front cover/block mating area. Press the sealer into the gap using a putty knife. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

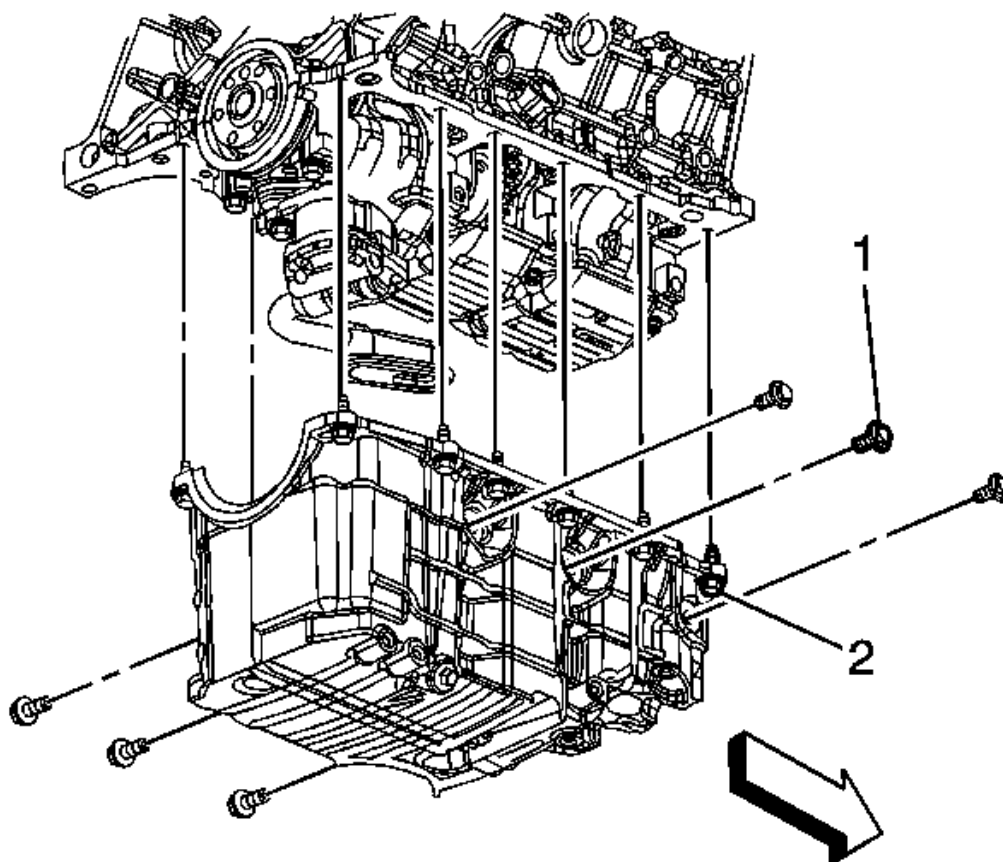


Fig. 113: Oil Pan & Bolts

Courtesy of GENERAL MOTORS CORP.

2. Install a NEW oil pan gasket.
3. Position the oil pan to the engine.

CAUTION: Refer to Fastener Caution .

4. Install the oil pan bolts (2) and tighten to 25 N.m (18 lb ft).
5. Install the left side oil pan side bolts (1).
6. Using the **J 39505** , install the right side oil pan side bolts and tighten to 50 N.m (37 lb ft) + 50 degrees.
7. Install the engine mount bracket bolts and tighten to 50 N.m (37 lb ft).

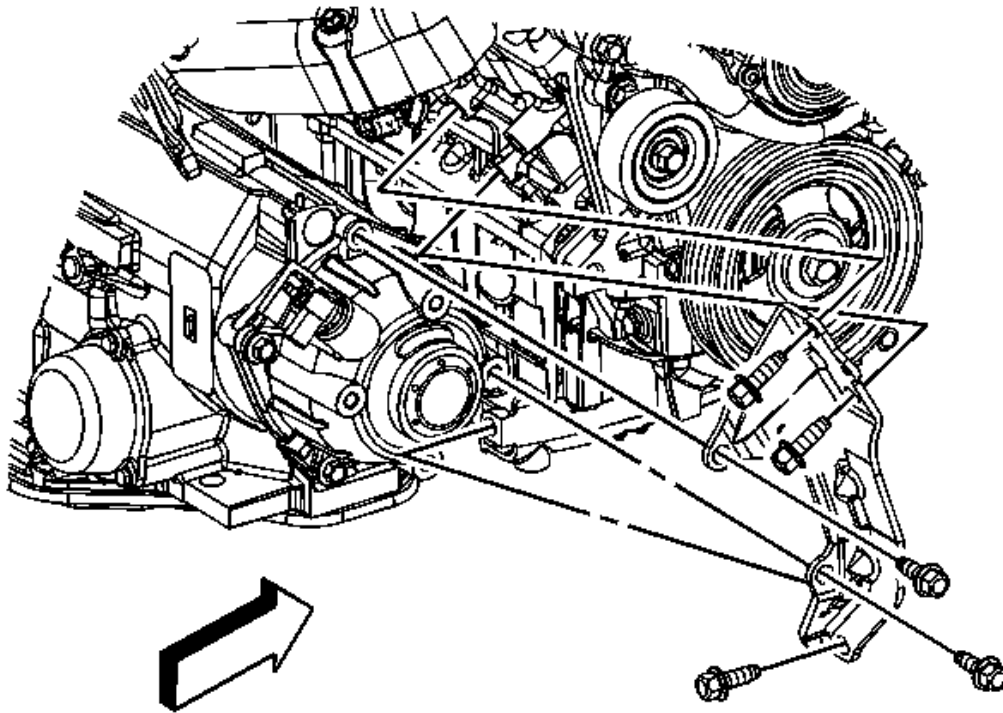


Fig. 114: Rear Transaxle Brace To Engine/Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

8. Lower the vehicle.
9. Using the engine support fixture, lower the engine.
10. Raise the vehicle.
11. Install the rear transaxle brace to engine/oil pan bolts and tighten to 63 N.m (46 lb ft).

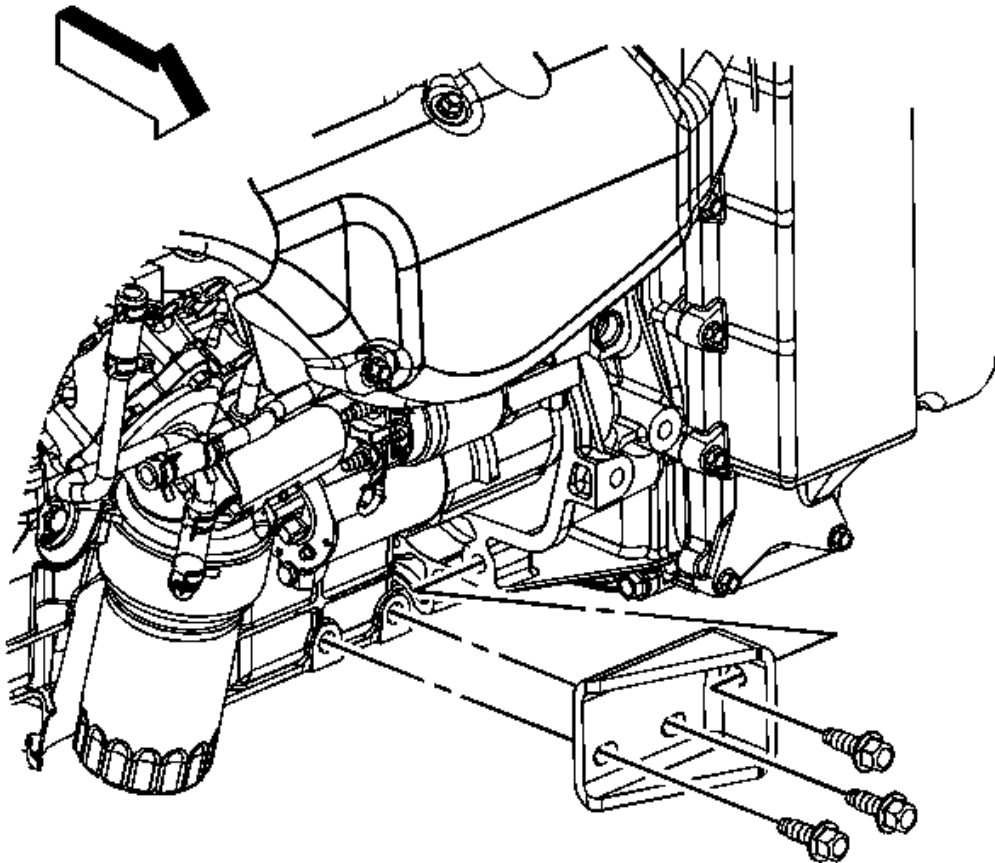


Fig. 115: Front Transaxle Brace & Engine Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the front transaxle brace and the brace to engine bolts and tighten to 63 N.m (46 lb ft).

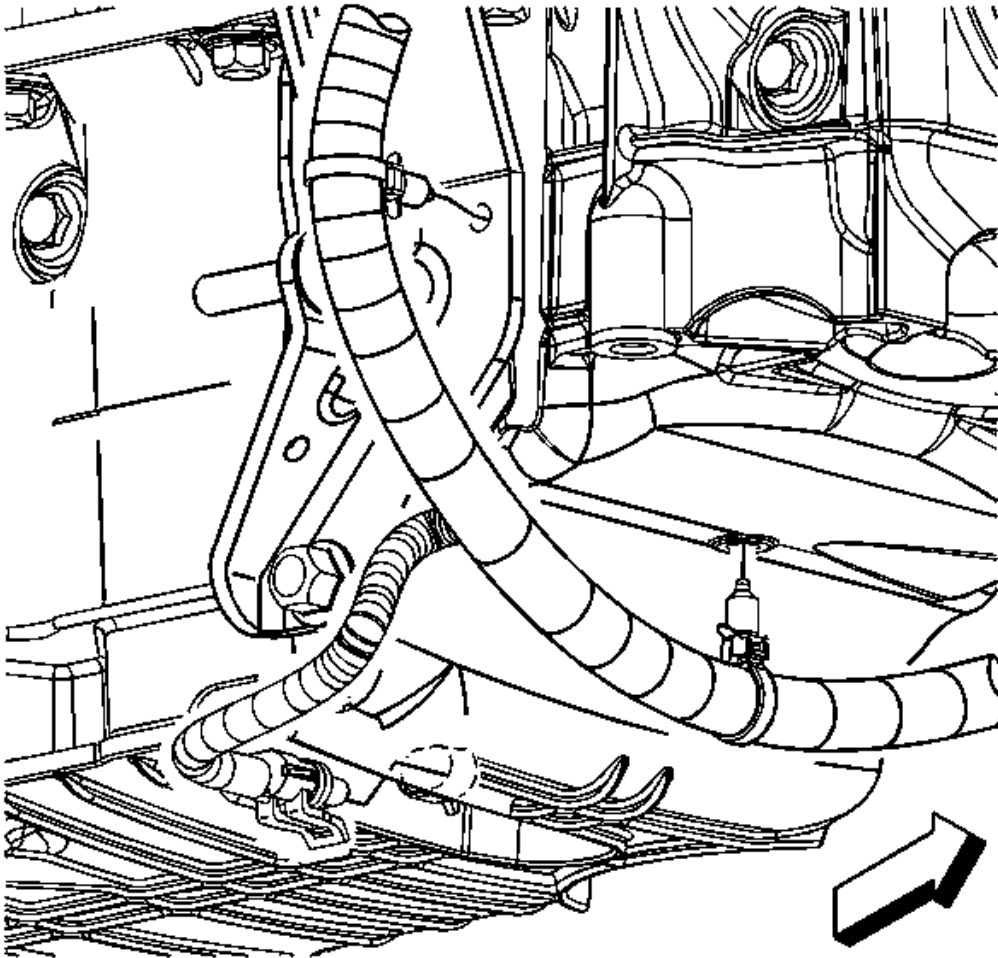


Fig. 116: Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Connect the oil level sensor electrical connector.
14. Install the engine harness clips to the oil pan and the transaxle brace.
15. Tighten the transaxle mount lower nuts. Refer to **Transmission Mount Replacement - Left Side** .

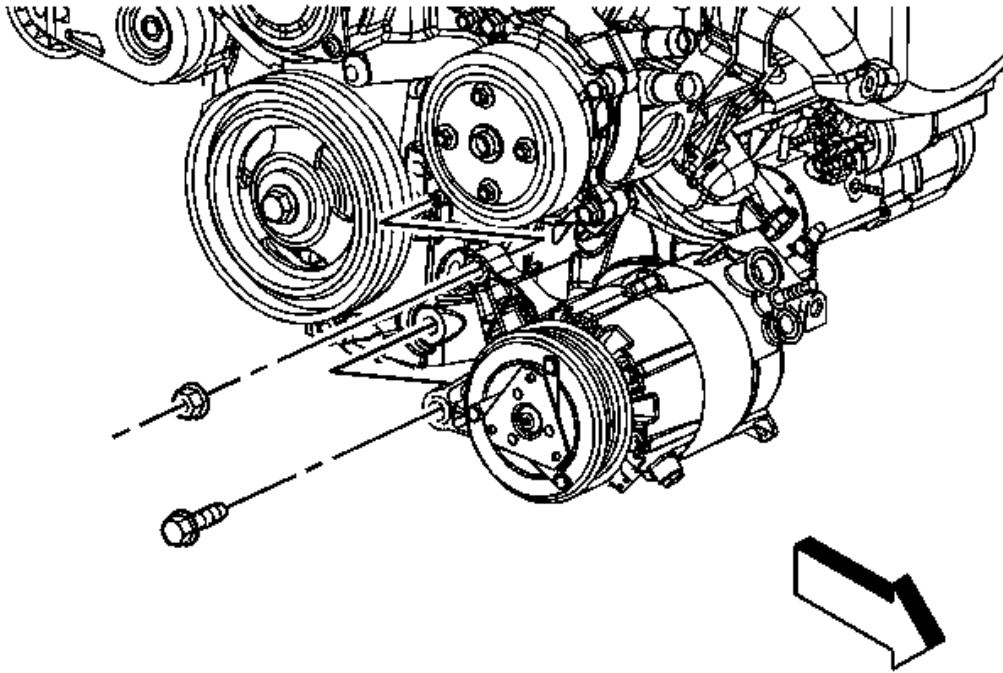


Fig. 117: Air Conditioning Compressor Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

16. Position the A/C compressor, and install the A/C compressor nut and bolt and tighten to 50 N.m (37 lb ft).

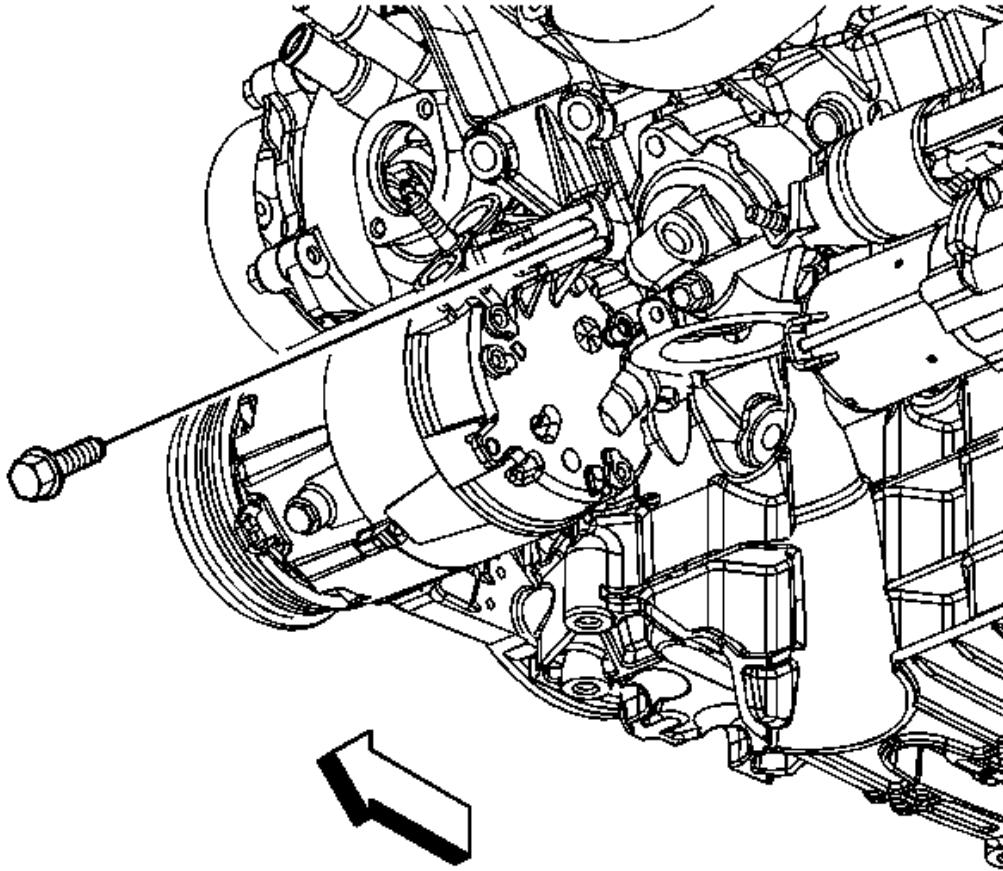


Fig. 118: A/C Compressor Rear Bolt
Courtesy of GENERAL MOTORS CORP.

17. Install the A/C compressor rear bolt and tighten to 50 N.m (37 lb ft).

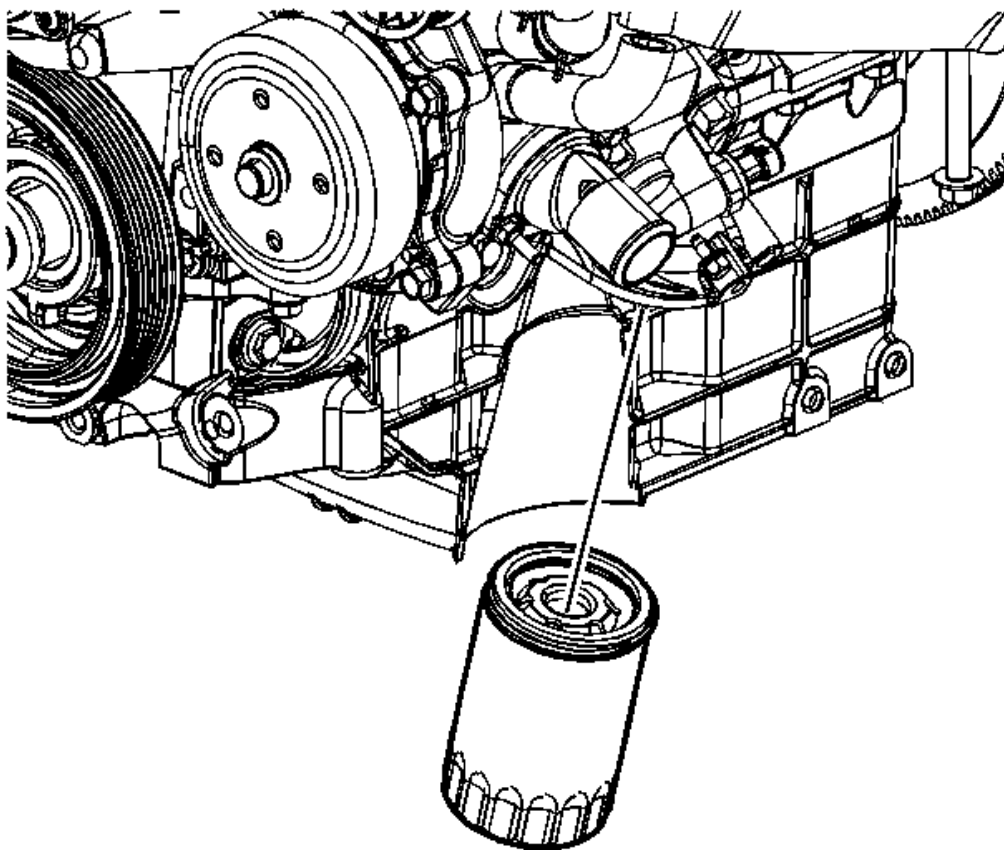


Fig. 119: Oil Filter

Courtesy of GENERAL MOTORS CORP.

18. Install the starter. Refer to **Starter Replacement (V6)** .
19. Install the oil filter adapter. Refer to **Oil Filter Adapter and Bypass Valve Assembly Replacement** .
20. Install the accessory drive belt. Refer to **Drive Belt Replacement** .
21. Install the front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
22. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
23. Install the catalytic converter.
24. Lower the vehicle.
25. Remove the engine support fixture.
26. Install the engine mount struts. Refer to **Engine Mount Strut Replacement** .
27. Fill the crankcase with new engine oil.
28. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

REMOVAL PROCEDURE

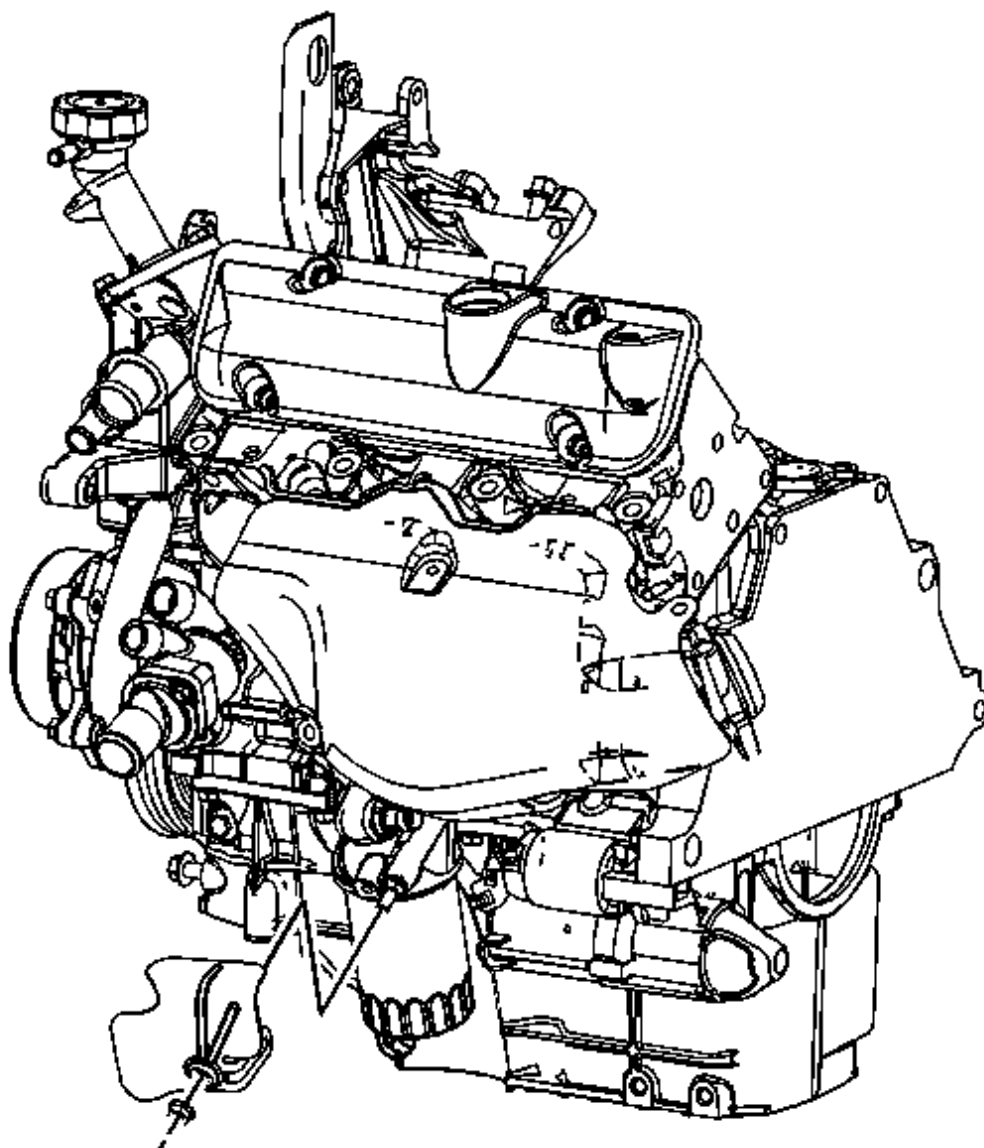


Fig. 120: Oil Pressure Sensor Heat Shield & Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pressure sensor heat shield nut and shield.

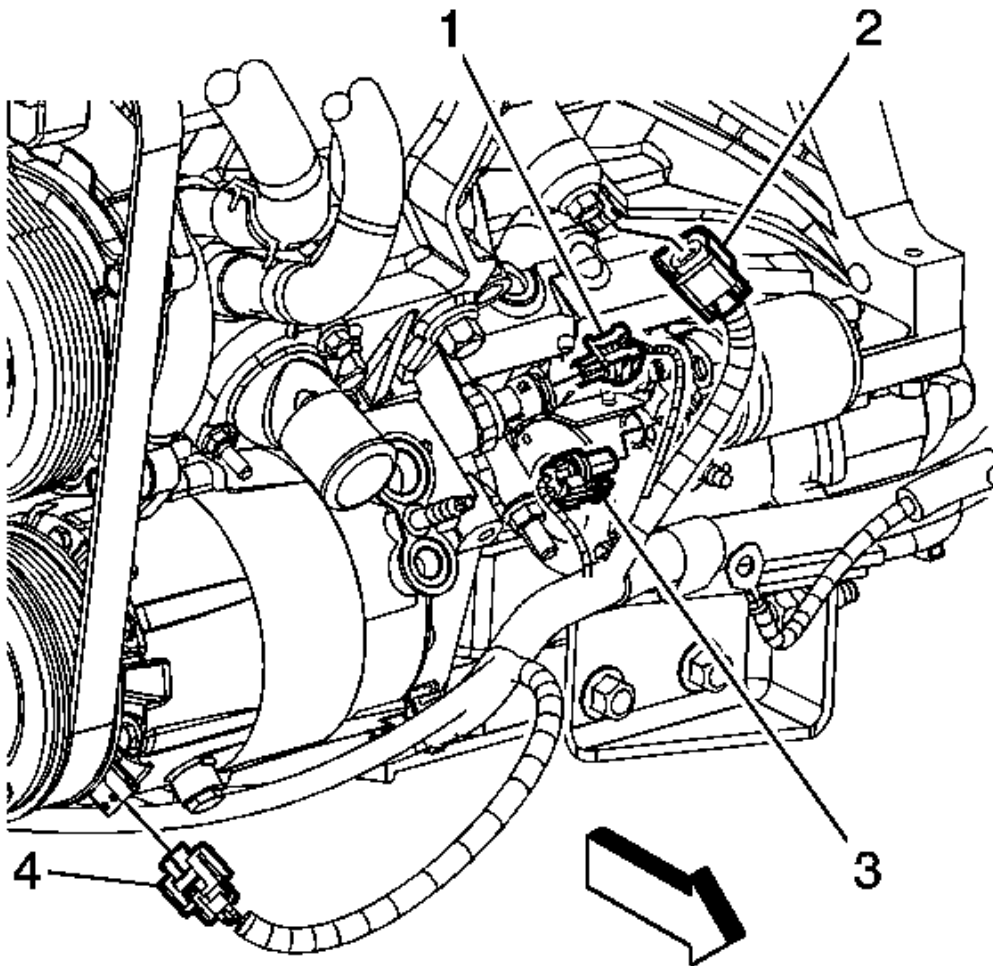


Fig. 121: Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the engine oil pressure sensor electrical connector (1).

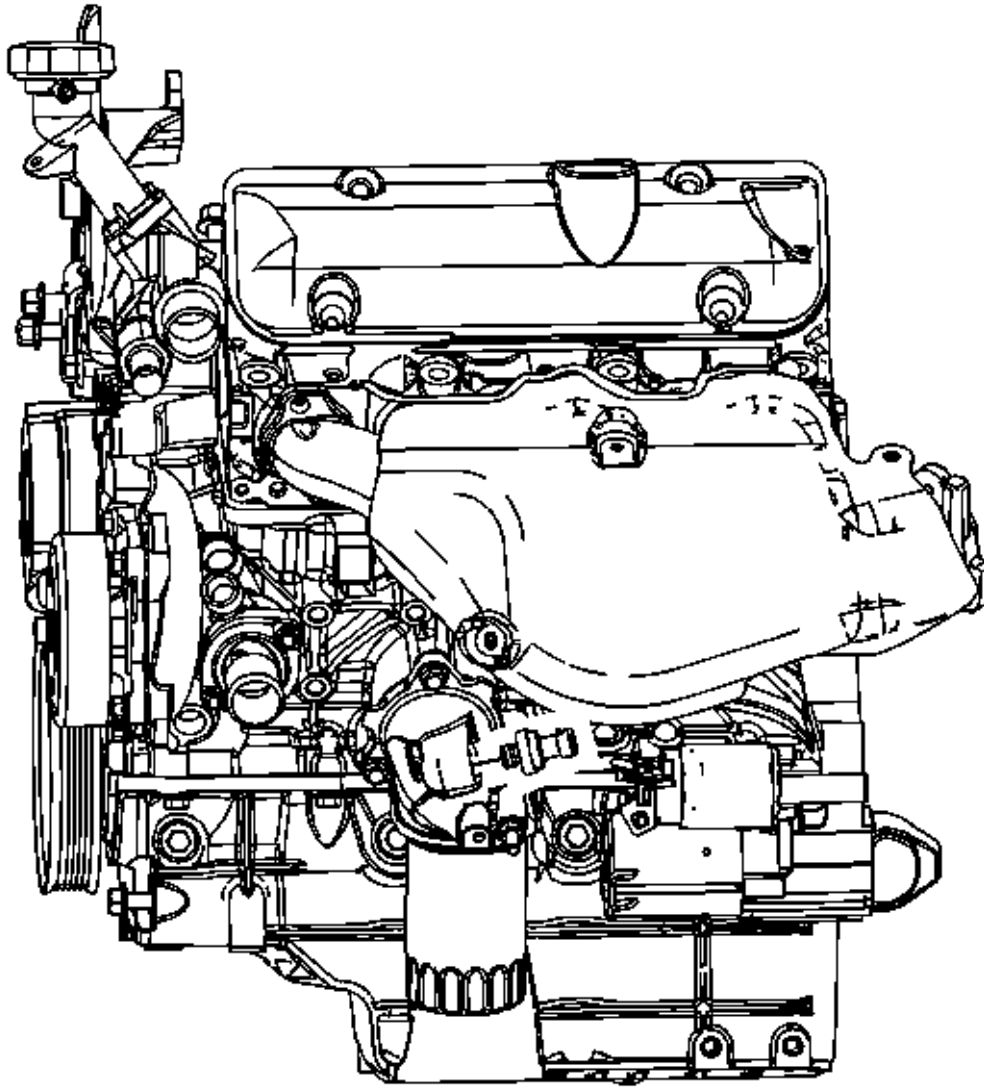


Fig. 122: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil pressure sensor.

INSTALLATION PROCEDURE

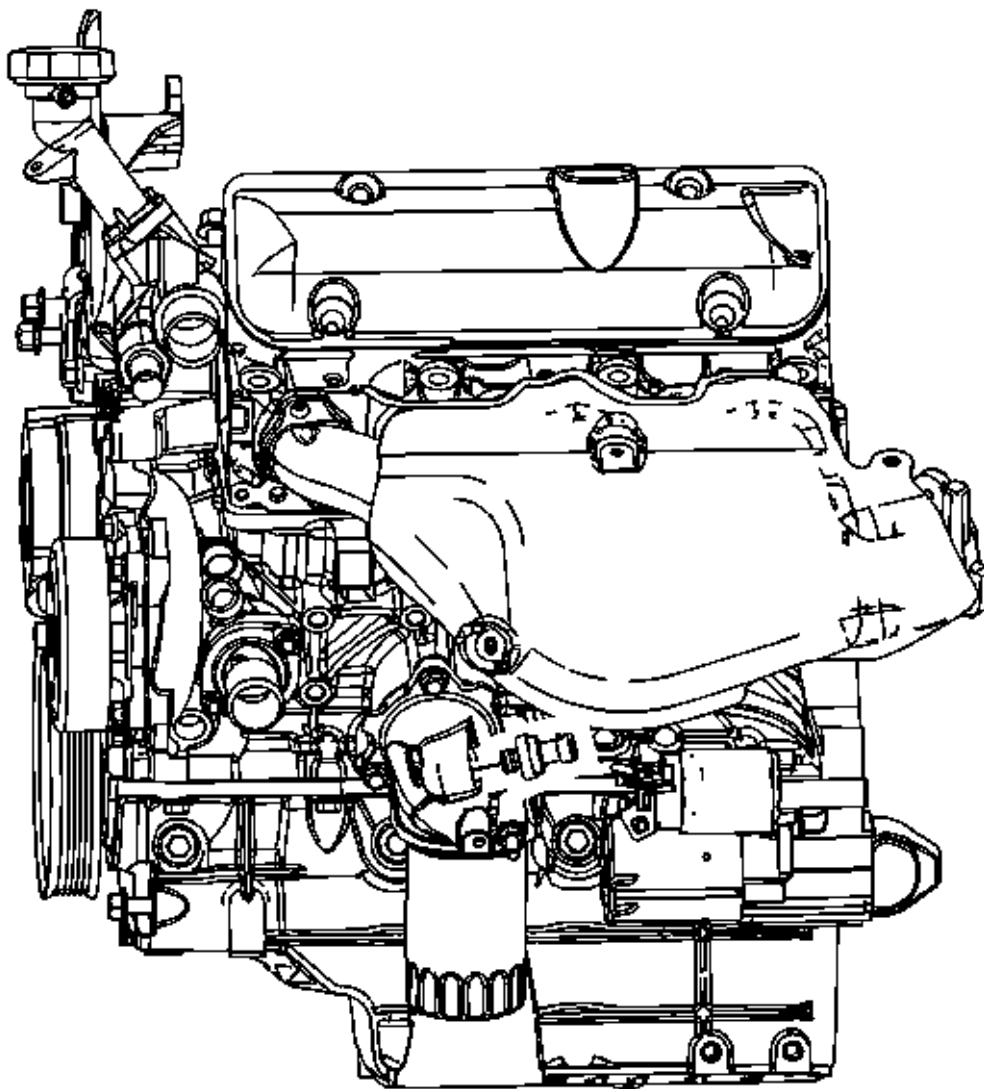


Fig. 123: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil pressure sensor.

Tighten: Tighten the sensor to 16 N.m (12 lb ft).

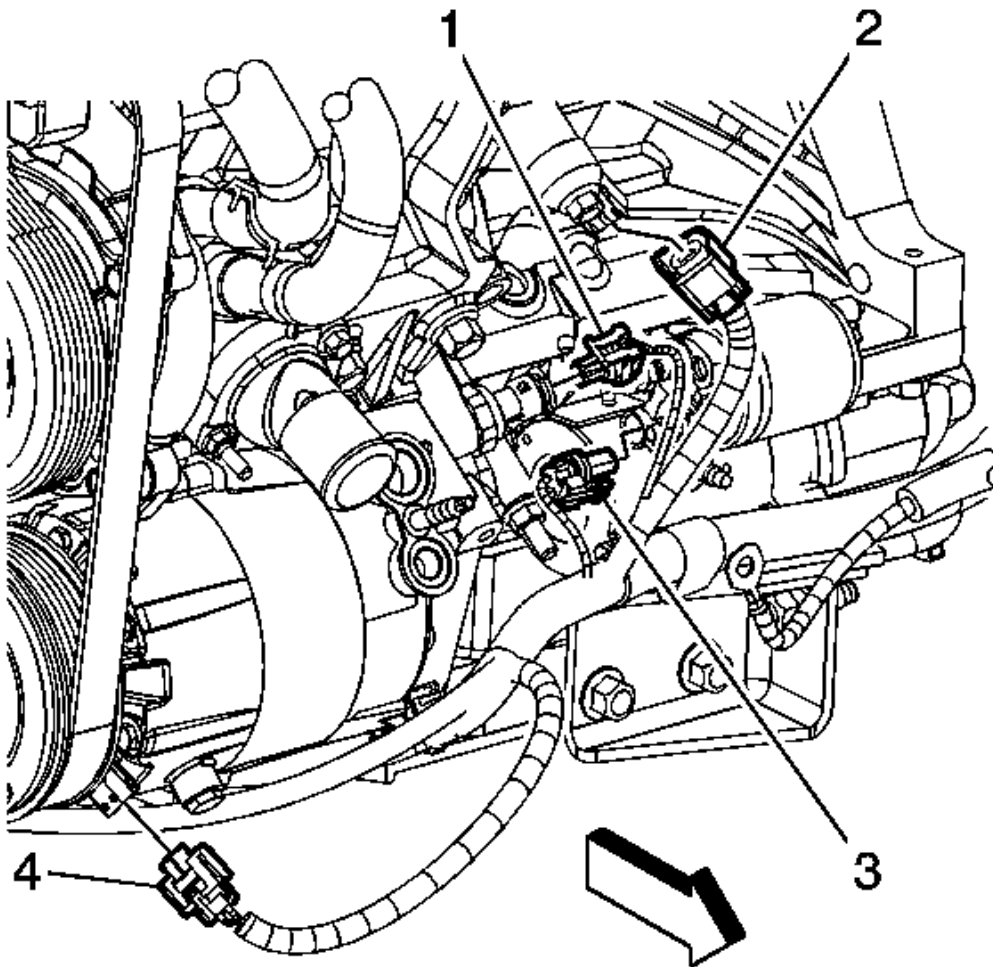


Fig. 124: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

2. Connect the engine oil pressure sensor electrical connector (1).

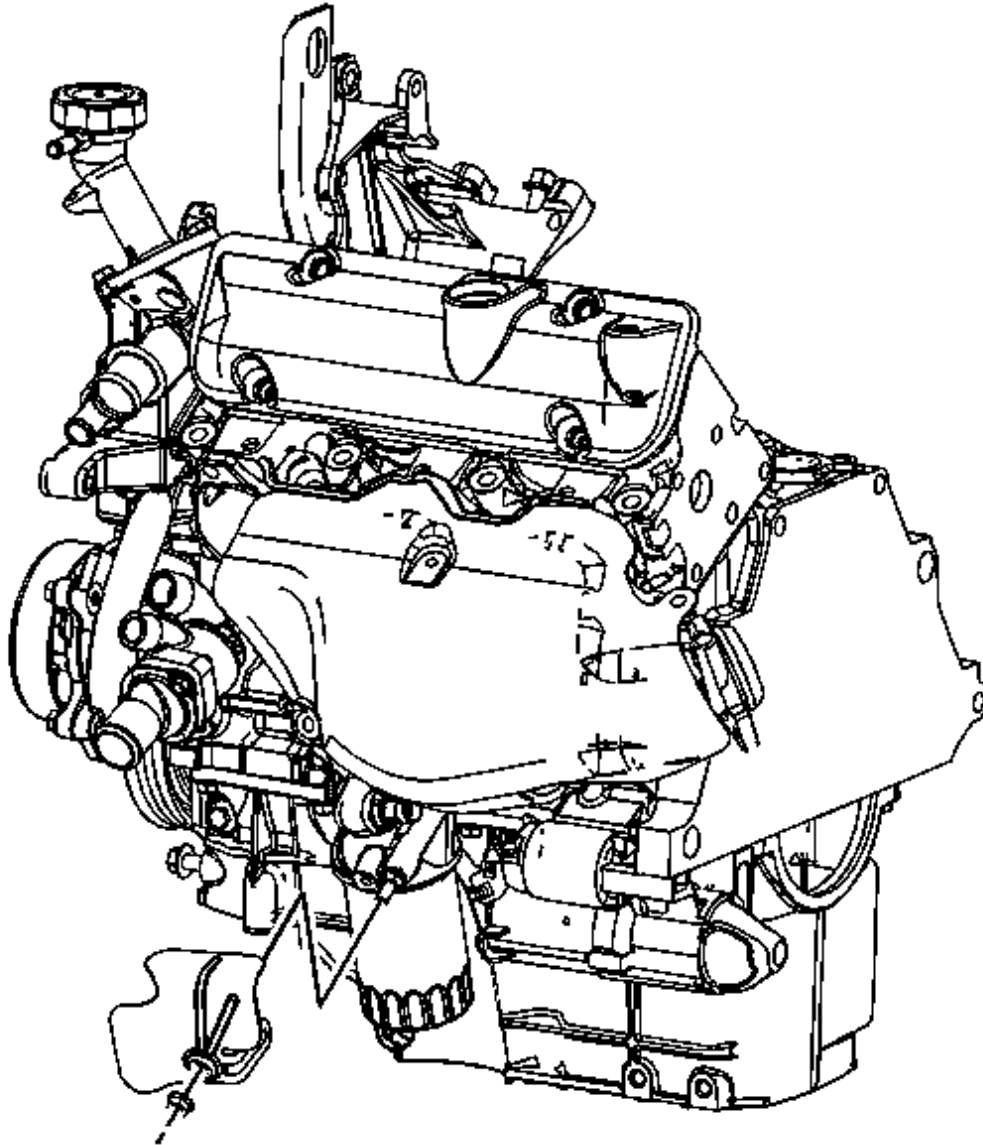


Fig. 125: Oil Pressure Sensor Heat Shield & Nut
Courtesy of GENERAL MOTORS CORP.

3. Install the oil pressure sensor heat shield and nut.

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

OIL PUMP REPLACEMENT

REMOVAL PROCEDURE

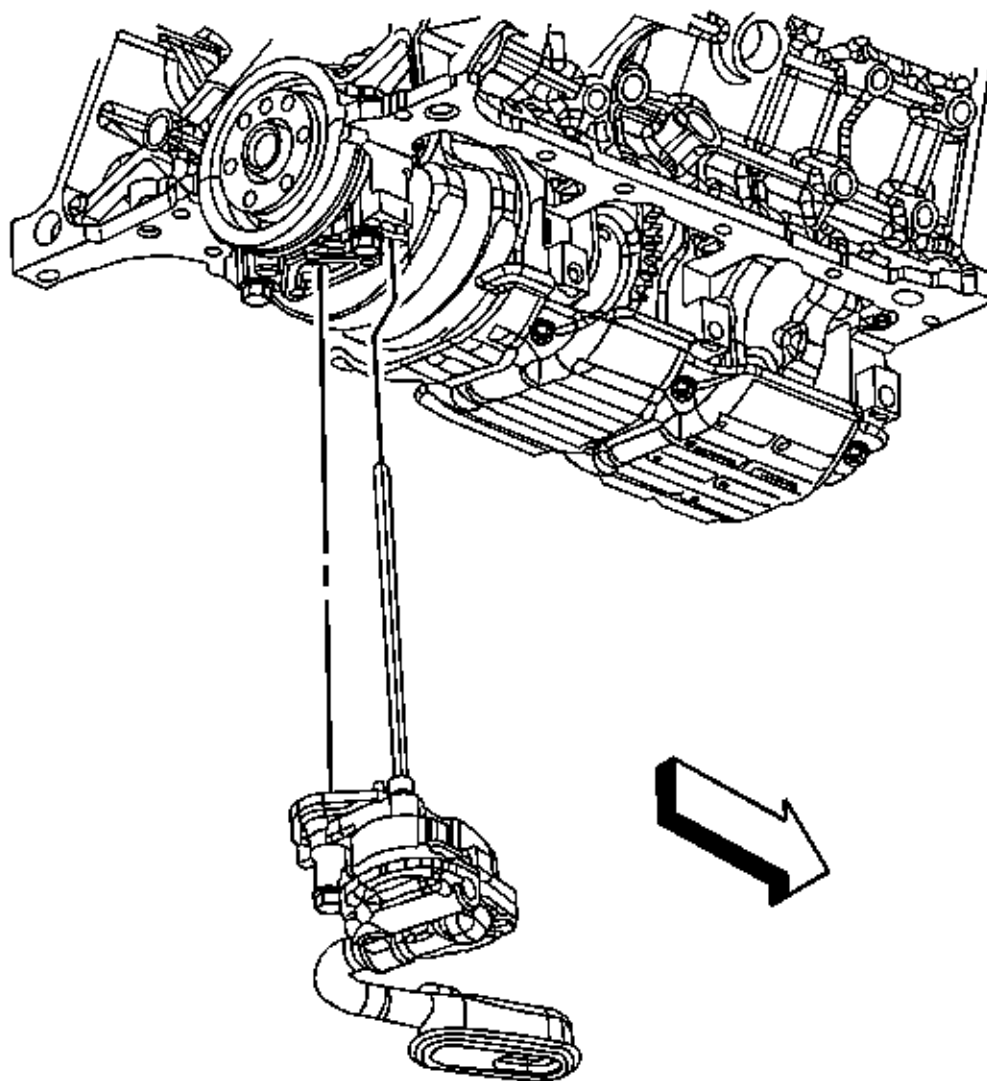


Fig. 126: Oil Pump & Oil Pump Drive Shaft
Courtesy of GENERAL MOTORS CORP.

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

3. Remove the oil pump and the oil pump drive shaft.

INSTALLATION PROCEDURE

NOTE: Rotate the oil pump drive shaft as necessary in order to obtain the engagement with the oil pump drive unit.

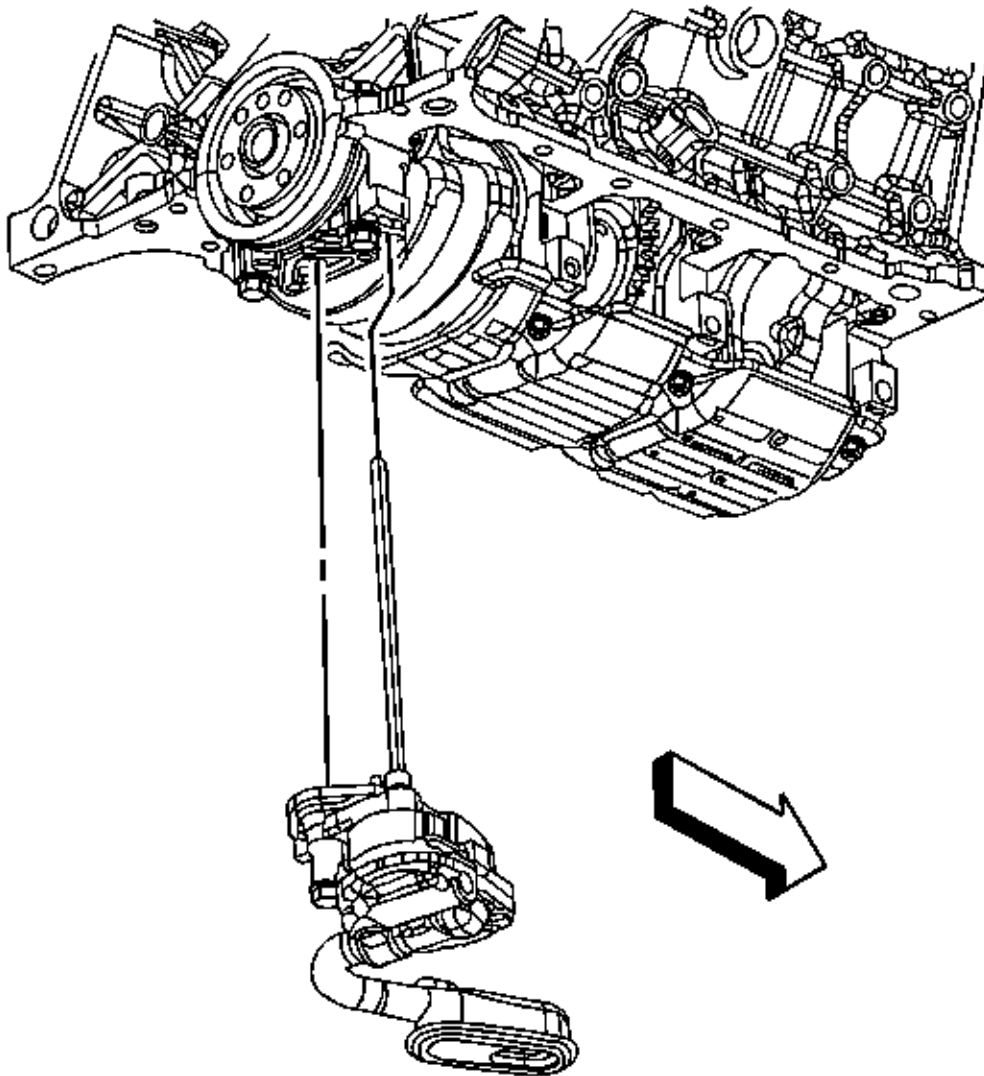


Fig. 127: Oil Pump & Oil Pump Drive Shaft
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil pump drive shaft and the oil pump.
2. Install the oil pump bolt.

Tighten: Tighten the bolt to 41 N.m (30 lb ft).

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

OIL PUMP DRIVE REPLACEMENT**REMOVAL PROCEDURE**

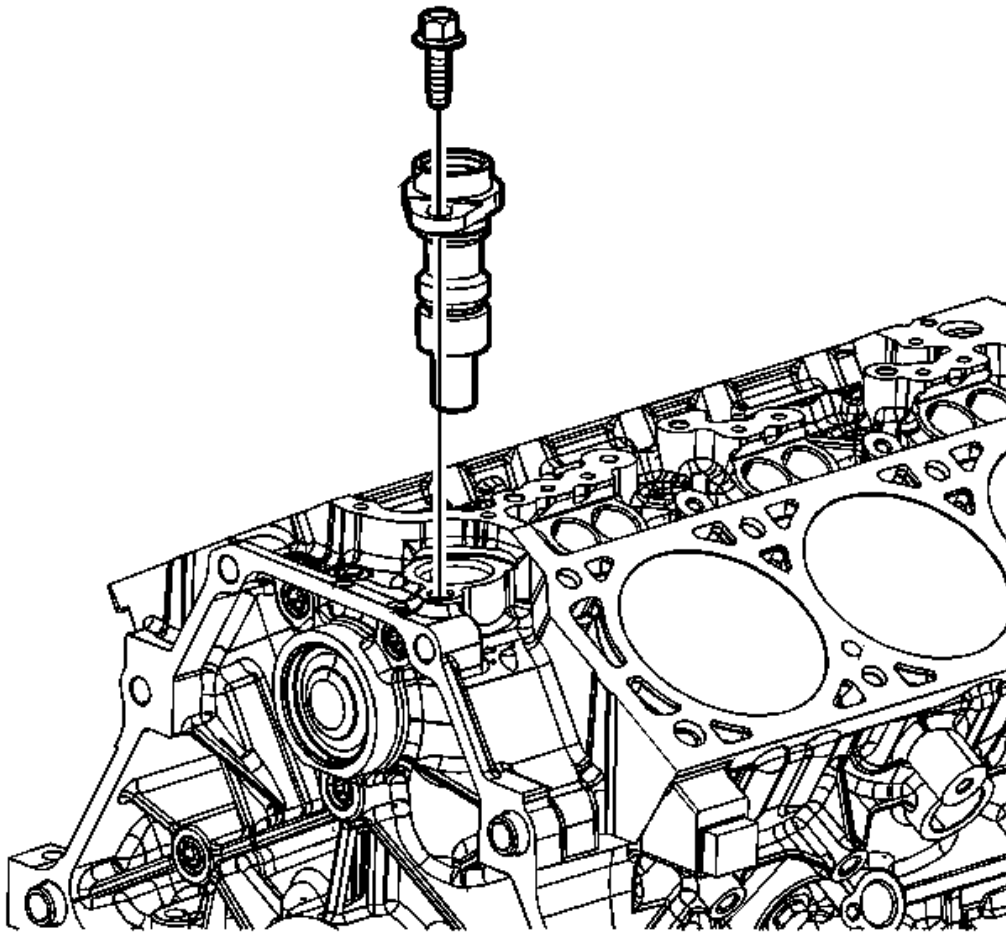


Fig. 128: Oil Pump Drive

Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the oil pump drive bolt.
3. Remove the oil pump drive.
4. Remove the oil pump drive seal.

INSTALLATION PROCEDURE

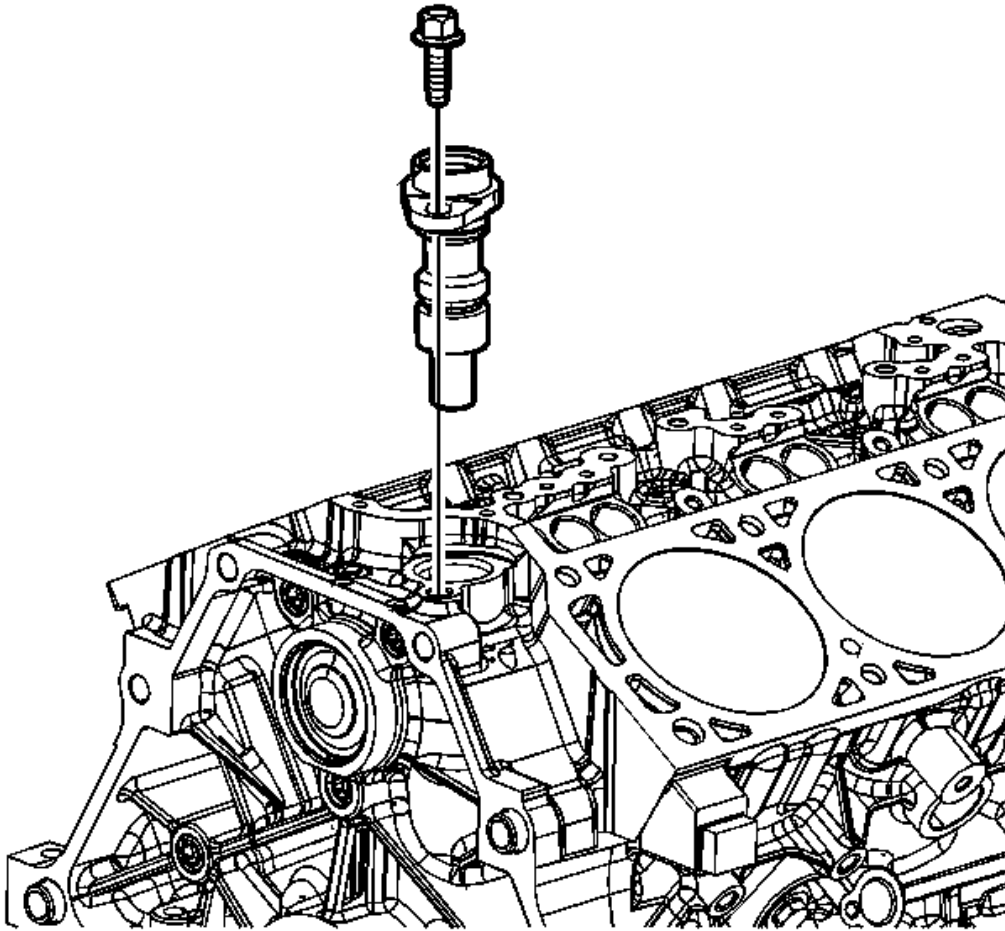


Fig. 129: Oil Pump Drive
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump drive seal. Coat the seal or bore in the engine block with clean engine oil.
2. Apply prelube to the oil pump drive gear. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Install the oil pump drive.

CAUTION: Refer to **Fastener Caution** .

4. Install the oil pump drive bolt.

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

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

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-48869 Front Crankshaft Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

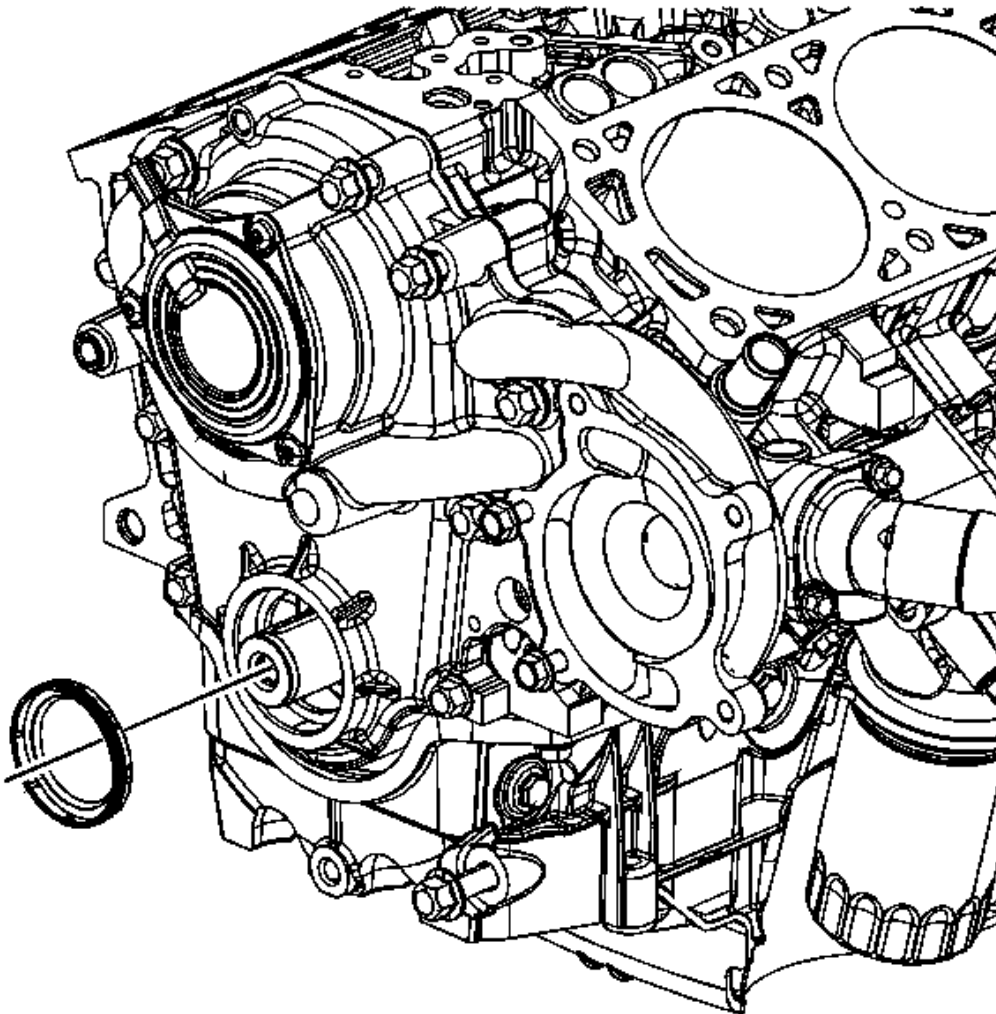


Fig. 130: Crankshaft Front Oil Seal

Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Pry out the crankshaft front oil seal using a suitable tool. Use care not to damage the engine front cover or the crankshaft.

INSTALLATION PROCEDURE

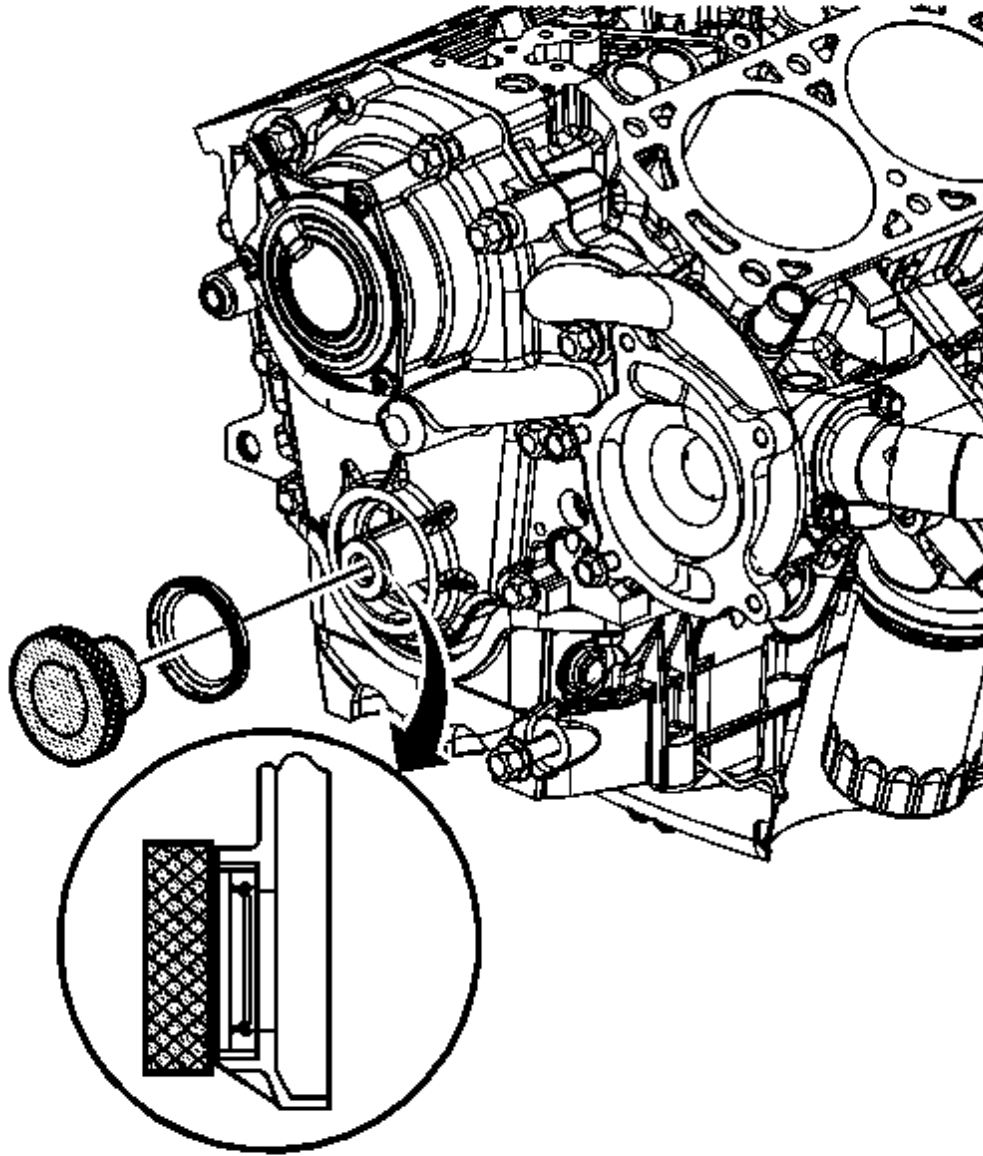


Fig. 131: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the NEW oil seal with clean engine oil.
2. Align the **EN-48869** and the crankshaft front oil seal with the engine front cover and crankshaft. See **Special Tools** .
3. Install the crankshaft front oil seal using **EN-48869** and a suitable tool. See **Special Tools** .

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

CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

REMOVAL PROCEDURE

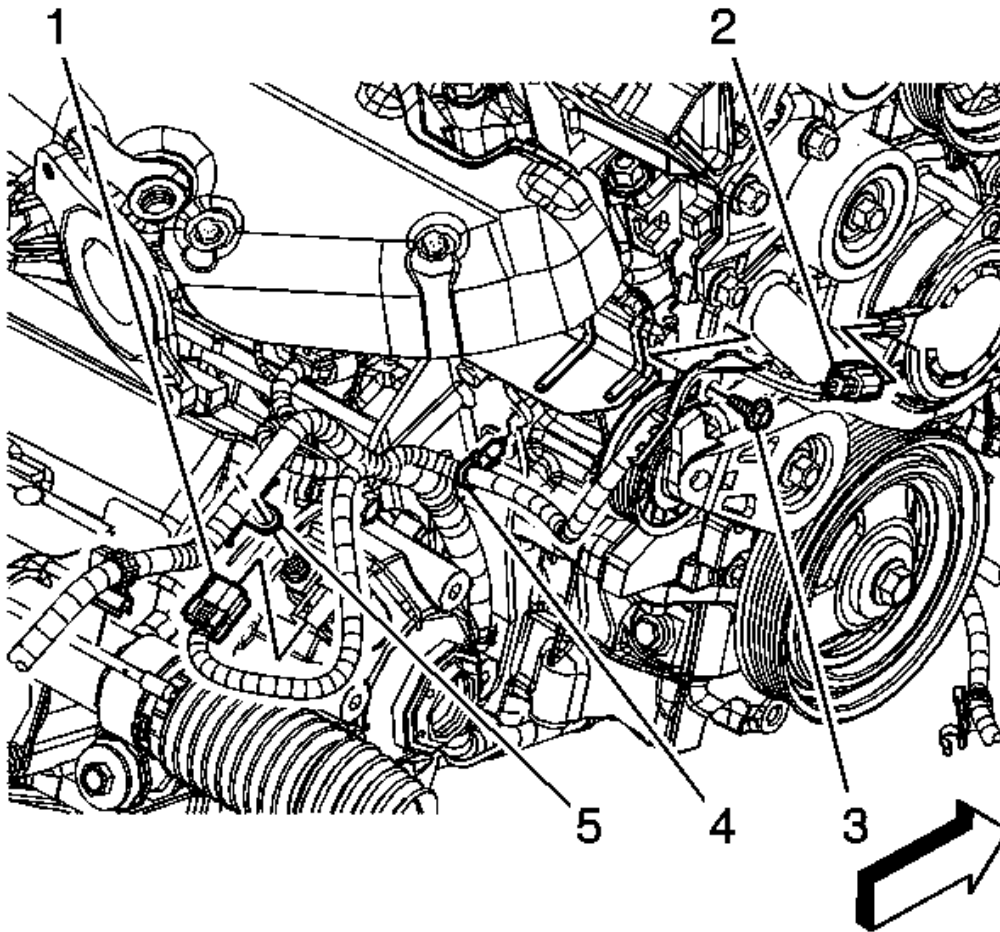


Fig. 132: Camshaft Position Actuator Magnet Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.
2. Disconnect the camshaft position actuator magnet electrical connector (2).

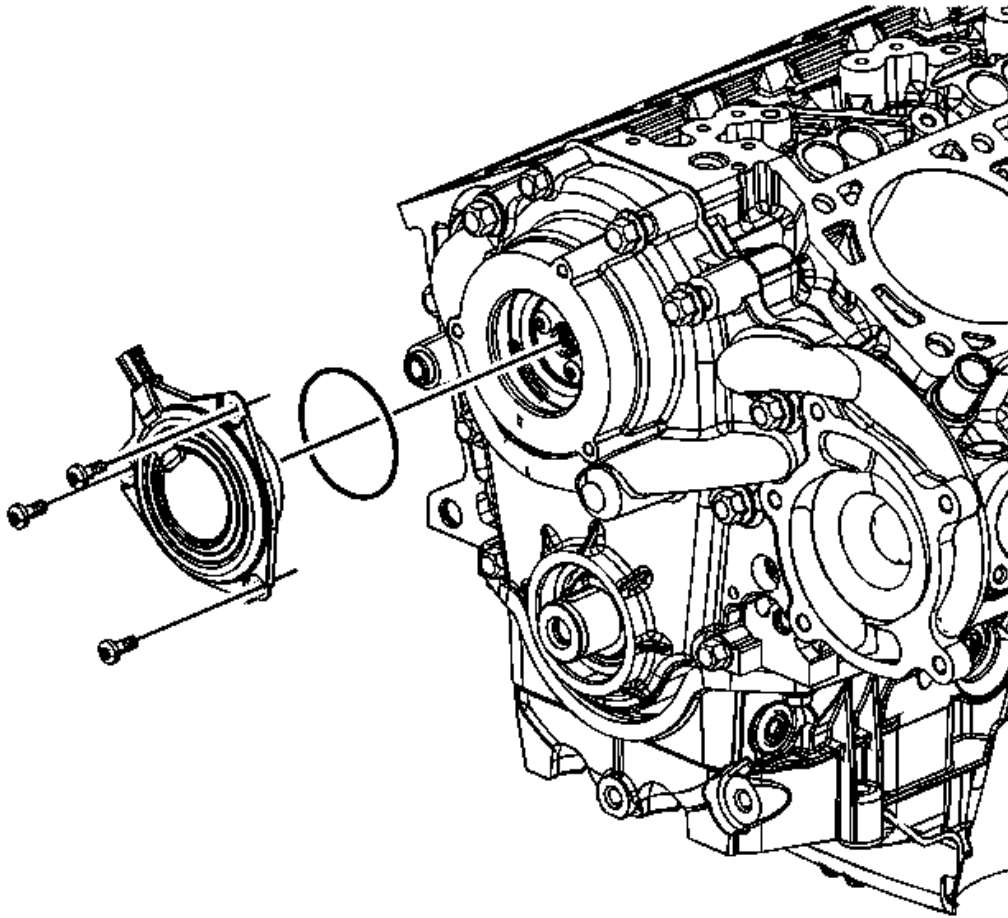


Fig. 133: Camshaft Position Actuator Magnet, Bolts & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position actuator magnet bolts.
4. Remove the camshaft position actuator magnet and O-ring seal.

INSTALLATION PROCEDURE

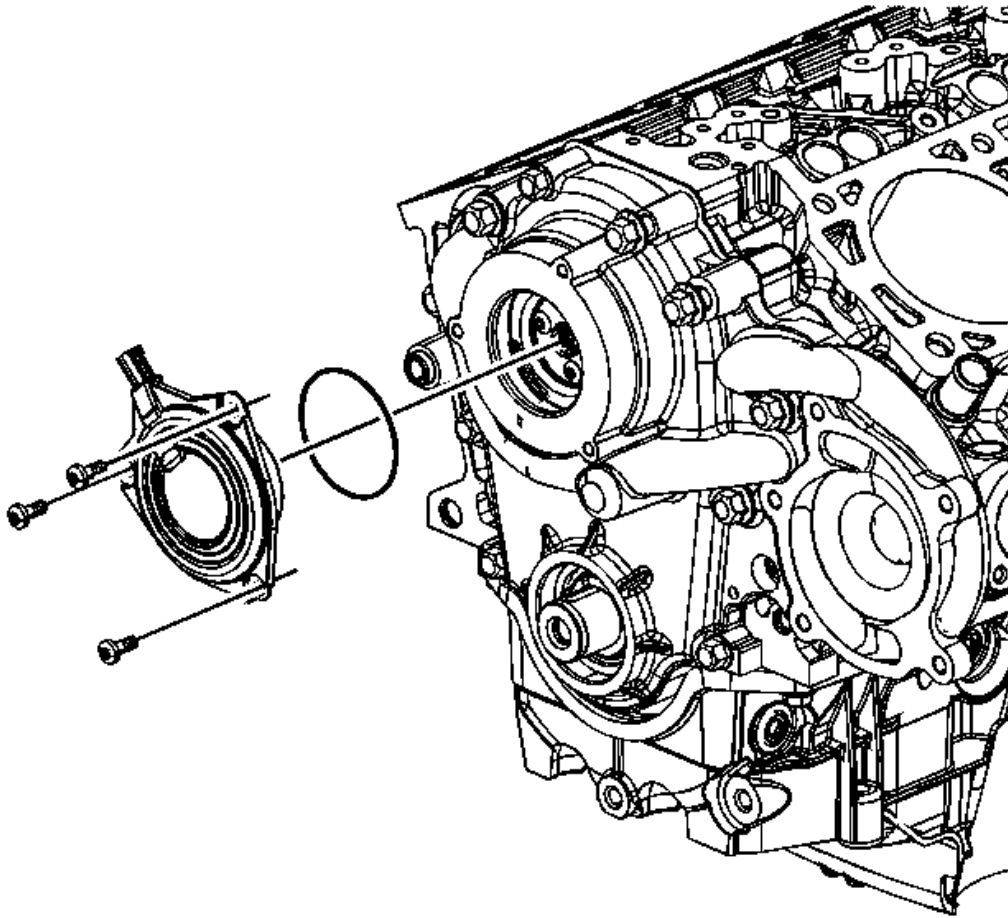


Fig. 134: Camshaft Position Actuator Magnet, Bolts & O-Ring Seal
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the camshaft position actuator magnet O-ring seal and magnet.
2. Install the camshaft position actuator magnet bolts.

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

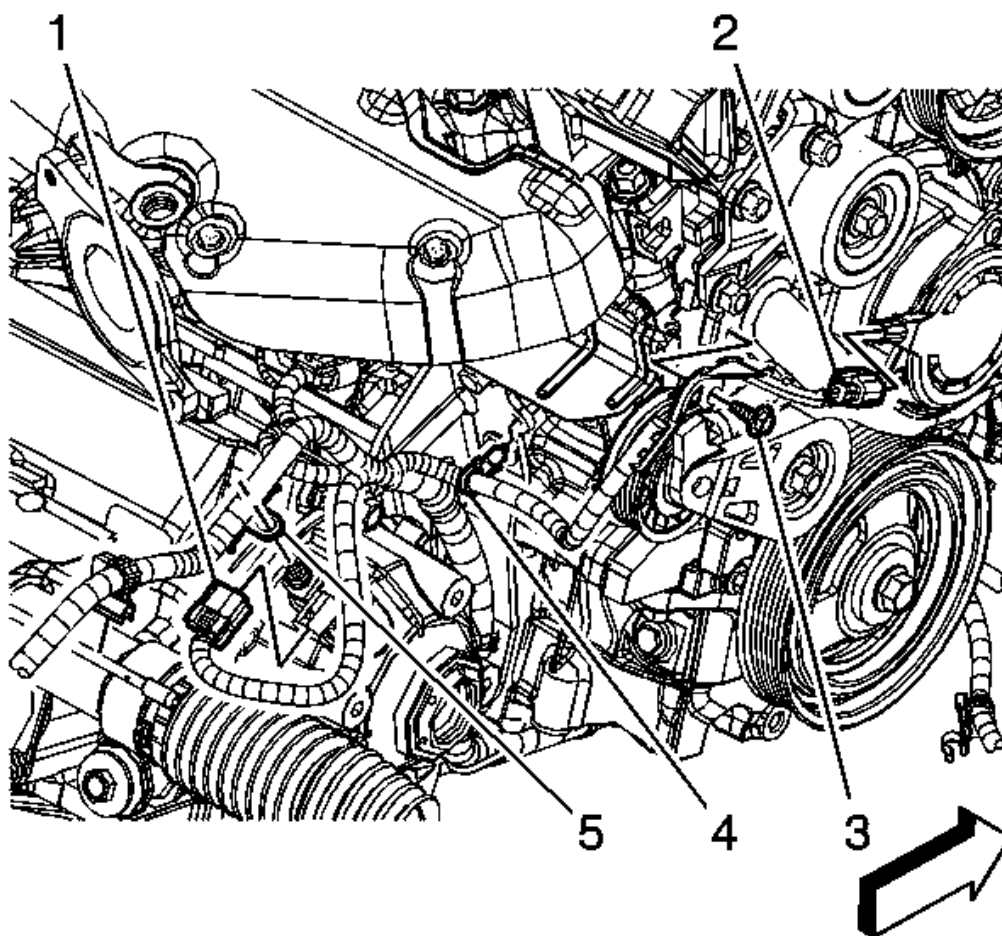


Fig. 135: Camshaft Position Actuator Magnet Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the camshaft position actuator magnet electrical connector (2)
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

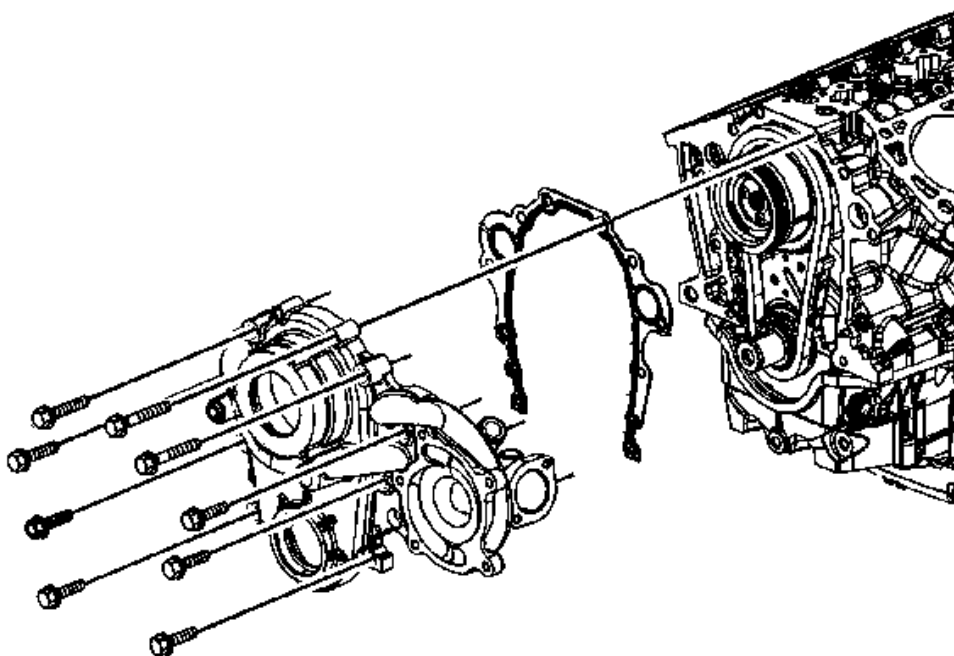


Fig. 136: Engine Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
3. Remove the oil pan. Refer to **Oil Pan Replacement**.
4. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the crankshaft position actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.
6. Remove the thermostat housing. Refer to **Engine Coolant Thermostat Replacement (LZ9 or LGD)** .
7. Remove the water pump. Refer to **Water Pump Replacement (LZ9 or LGD)** .
8. Remove the engine front cover bolts.
9. Remove coolant hose from front cover
10. Remove the engine front cover.

11. Remove the engine front cover gasket.

INSTALLATION PROCEDURE

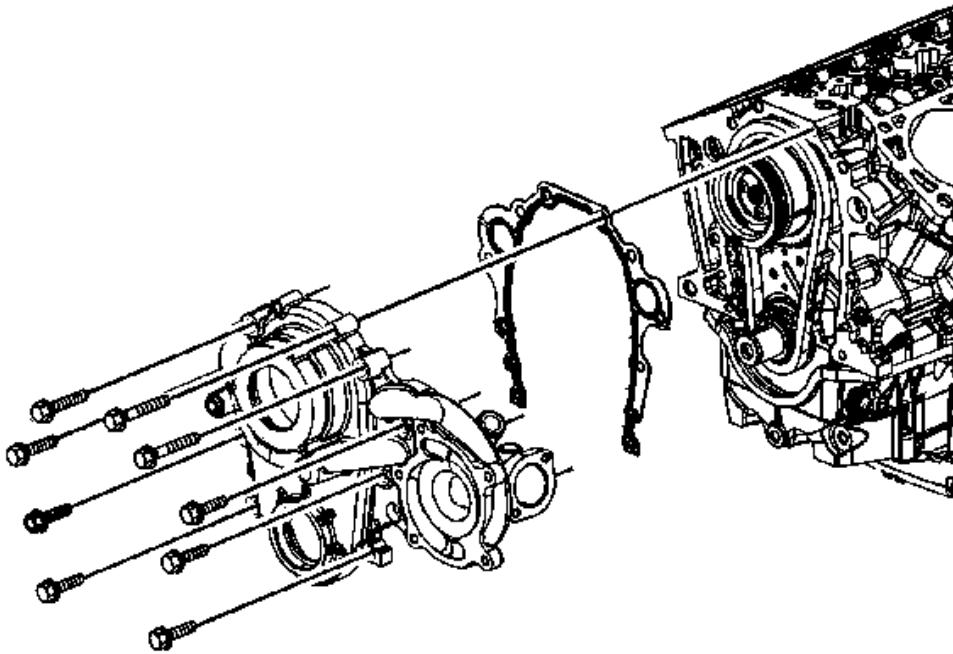


Fig. 137: Engine Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the engine front cover gasket.
2. Install the engine front cover.

CAUTION: Refer to Fastener Caution .

3. Install the engine front cover bolts and tighten to 25 N.m (18 lb ft).
4. Install the water pump. Refer to **Water Pump Replacement (LZ9 or LGD)** .

5. Install the thermostat housing. Refer to **Engine Coolant Thermostat Replacement (LZ9 or LGD)** .
6. Install the crankshaft position actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Install the oil pan. Refer to **Oil Pan Replacement**.
9. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .

CAMSHAFT TIMING CHAIN AND SPROCKET REPLACEMENT

Special Tools

EN-47719 Tensioner Compressor. See **Special Tools** .

REMOVAL PROCEDURE

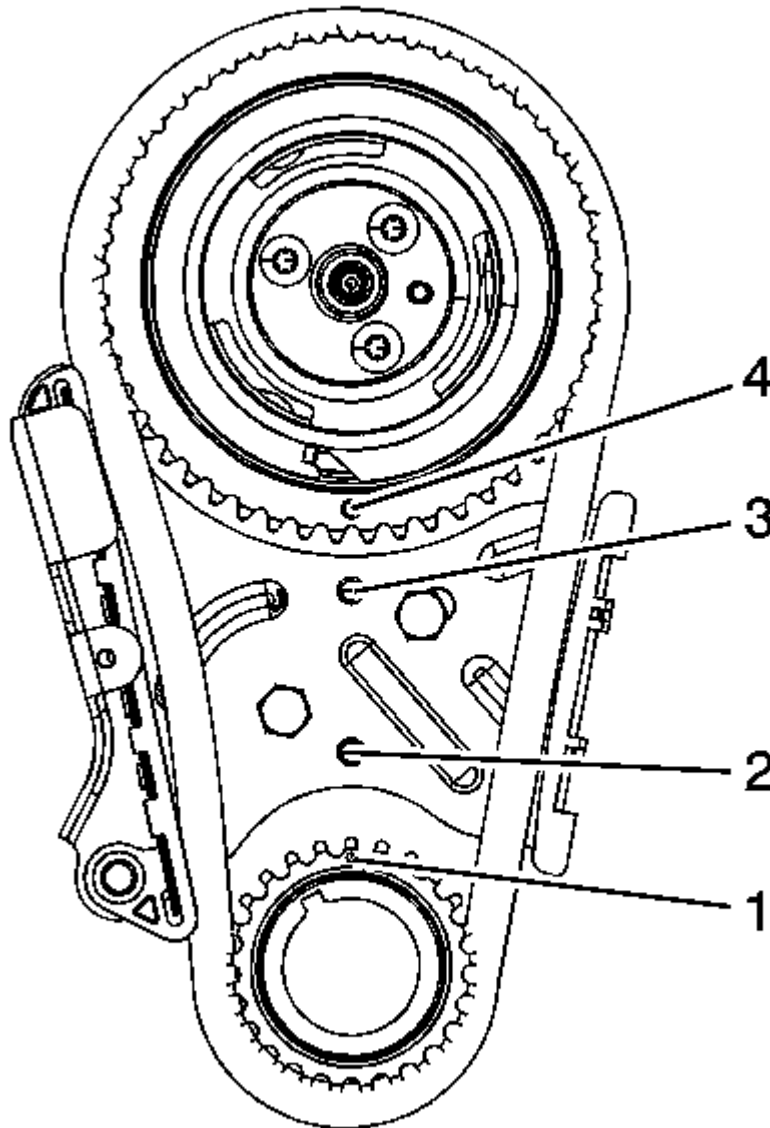


Fig. 138: Timing Marks & Chain Tensioners
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Align the crankshaft timing mark (1) to the timing mark on the bottom of the timing chain tensioner (2).
3. Align the timing mark on the camshaft gear (3) with the timing mark on top of the timing chain tensioner (4).

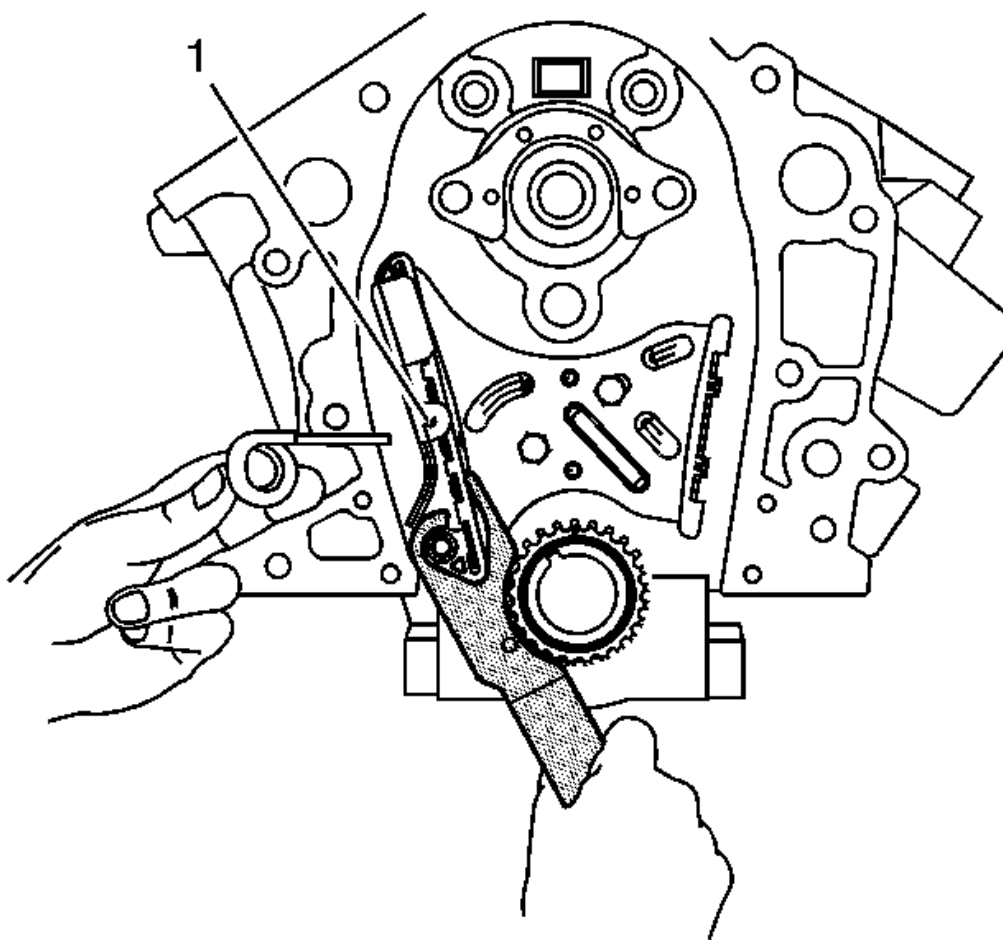


Fig. 139: Collapsing Tensioner & Placing Retaining Pin
Courtesy of GENERAL MOTORS CORP.

4. Using the **EN-47719** , collapse the tensioner and place the tensioner retaining pin into the retaining hole (1). See **Special Tools** .

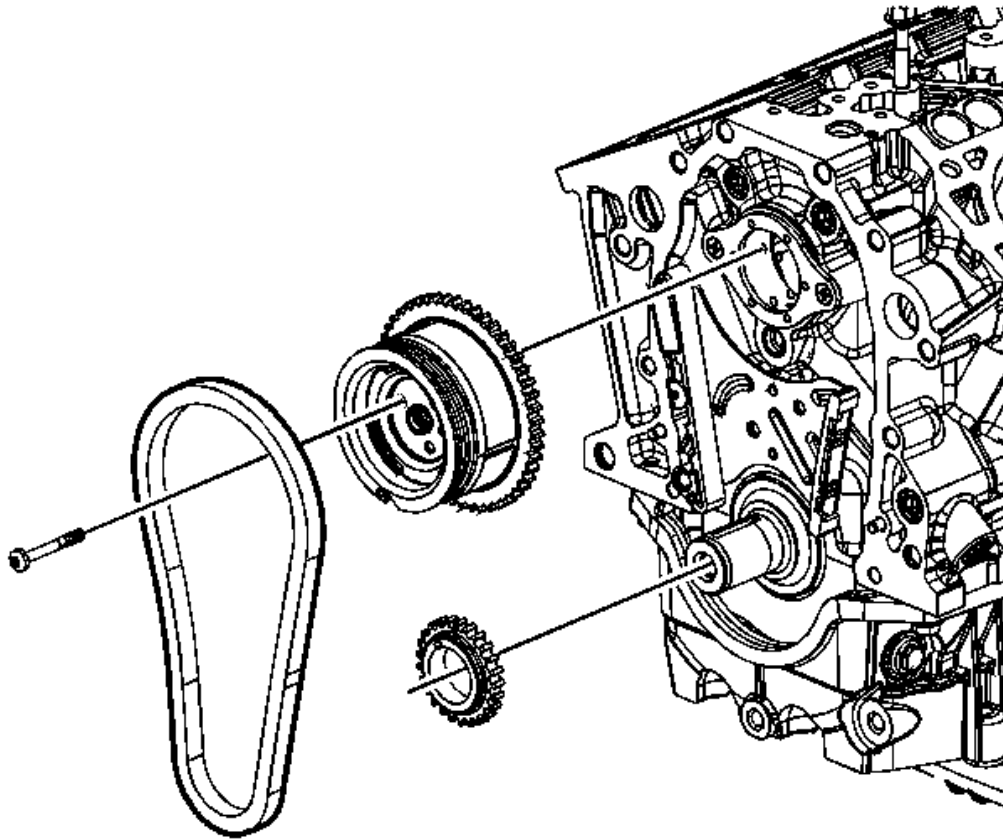


Fig. 140: Timing Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket/actuator bolts.
6. Remove the timing chain, camshaft sprocket/actuator, and crankshaft sprockets.

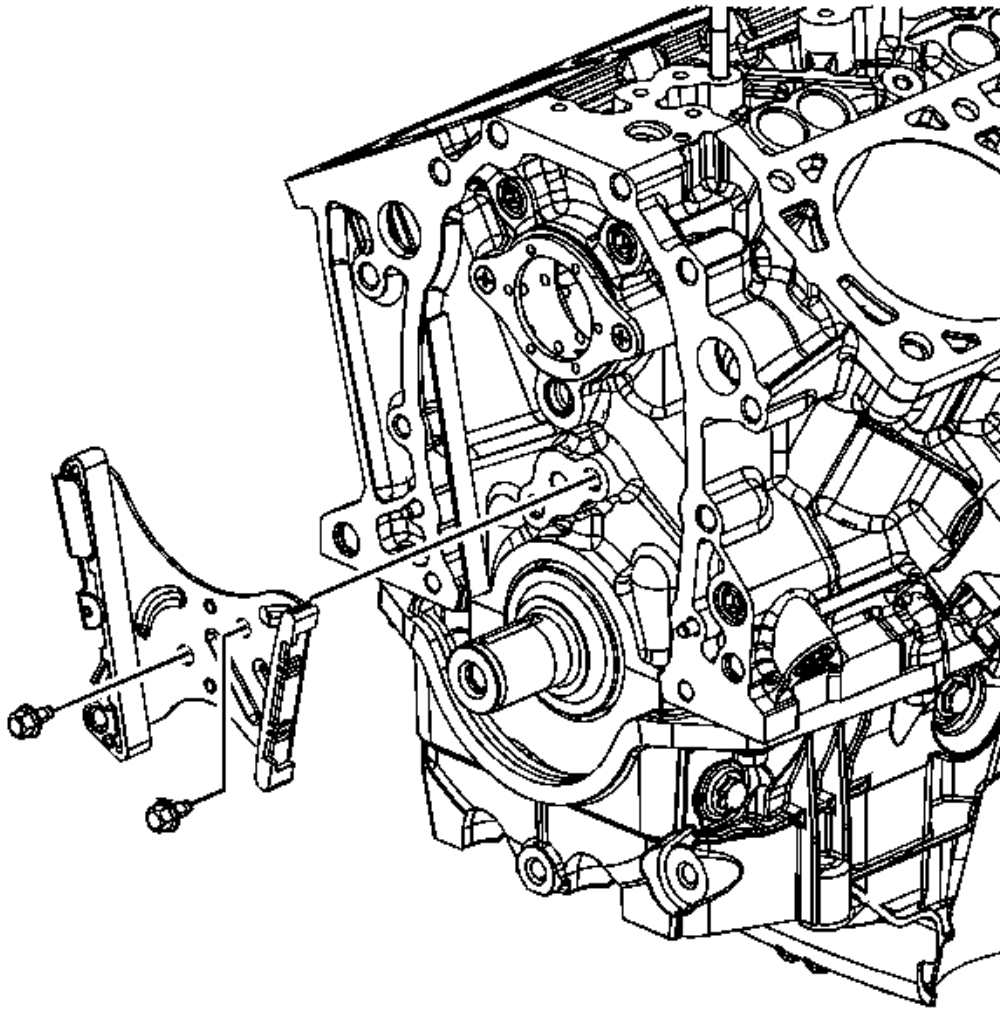


Fig. 141: Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the timing chain tensioner bolts.
8. Remove the timing chain tensioner.

INSTALLATION PROCEDURE

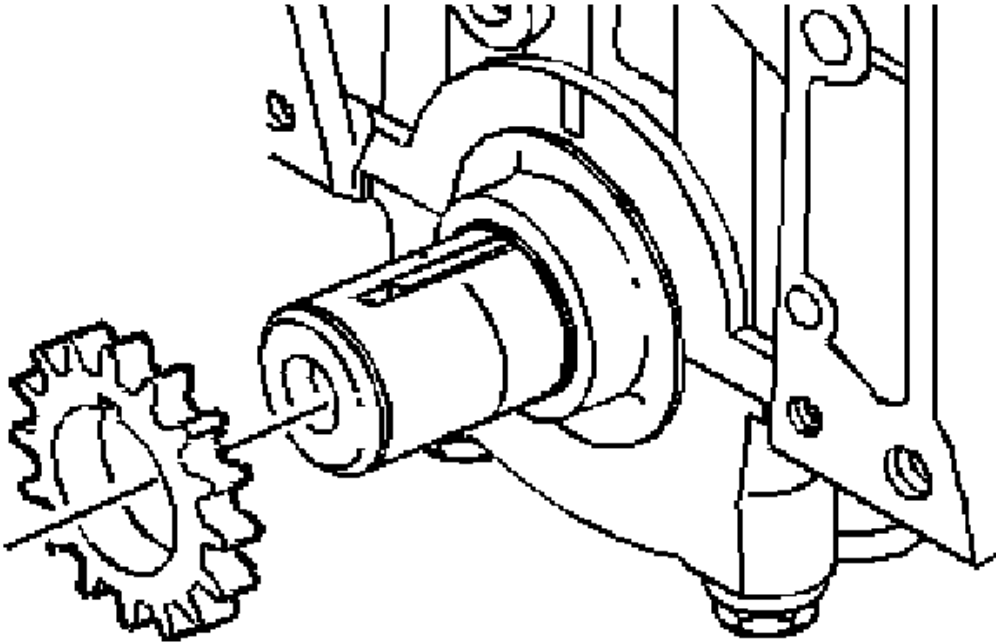


Fig. 142: Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft sprocket.
2. Apply prelube to the crankshaft sprocket thrust surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

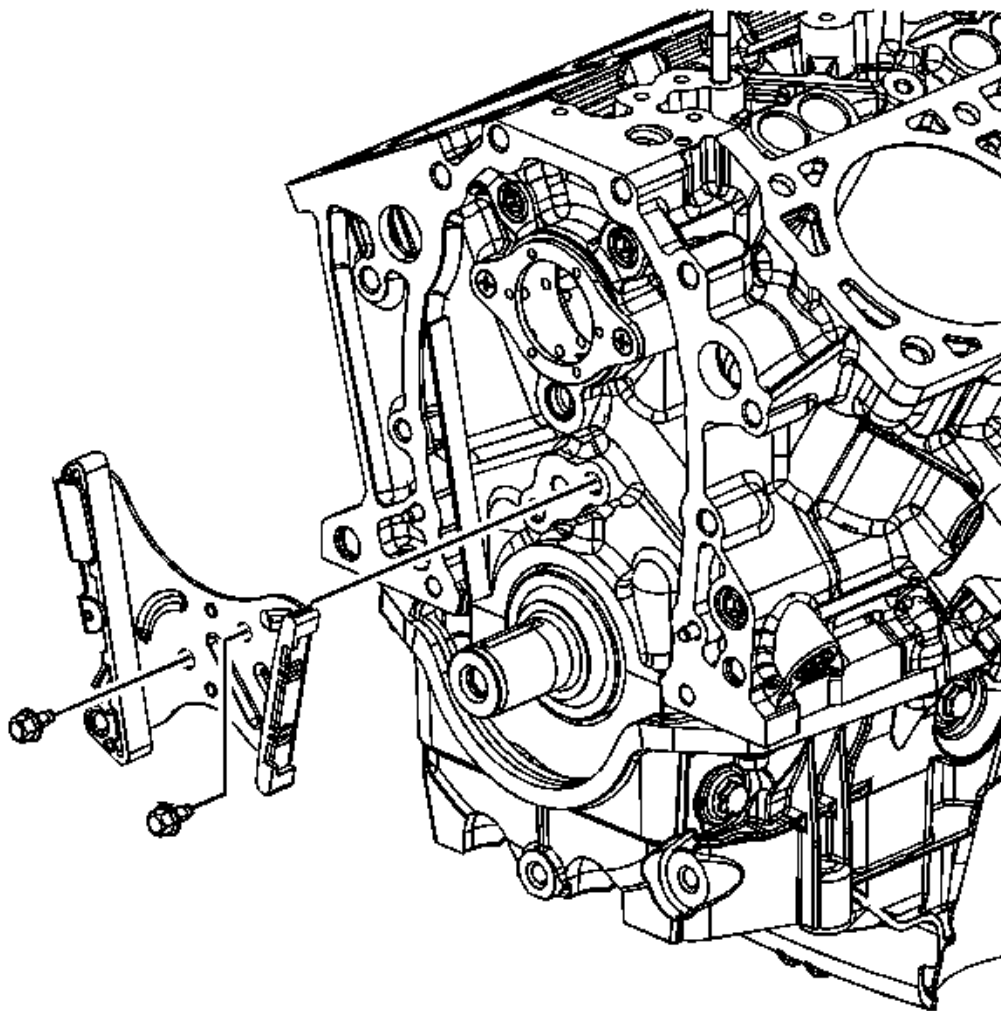


Fig. 143: Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the timing chain tensioner.
4. Install the timing chain tensioner bolts and tighten to 21 N.m (15 lb ft).

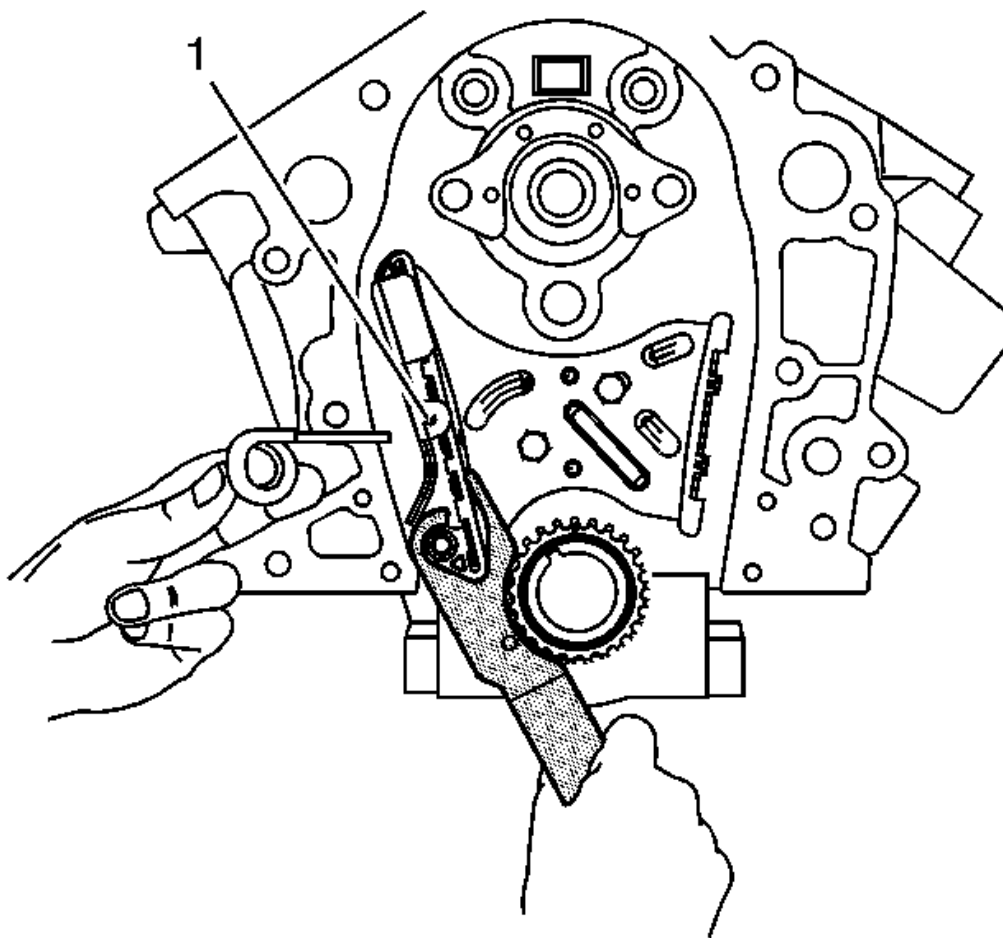


Fig. 144: Collapsing Tensioner & Placing Retaining Pin
Courtesy of GENERAL MOTORS CORP.

5. Using the **EN-47719** , fully collapse the tensioner, and place the tensioner retaining pin into the retaining hole (1). See **Special Tools** .

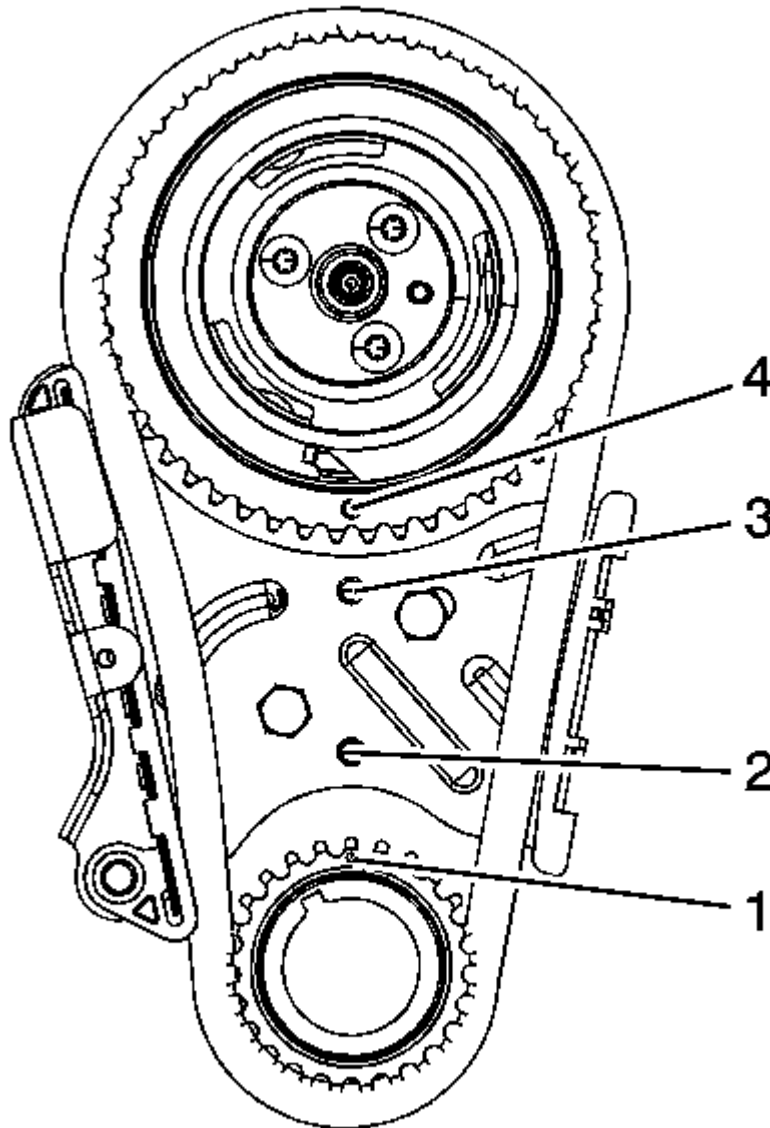


Fig. 145: Timing Marks & Chain Tensioners
Courtesy of GENERAL MOTORS CORP.

NOTE: Always install a NEW camshaft position actuator filter (located in the camshaft pilot nose) anytime the camshaft position actuator is removed or installed. Refer to Camshaft and Bearings Cleaning and Inspection for filter changing instructions.

6. Align the crankshaft timing mark (1) to the timing mark on the bottom of the timing chain tensioner (2).
7. Hold the camshaft sprocket with the timing chain hanging down and install the timing chain to the crankshaft gear.
8. Align the timing mark on the camshaft gear (3) with the timing mark on top of the timing chain tensioner (4).

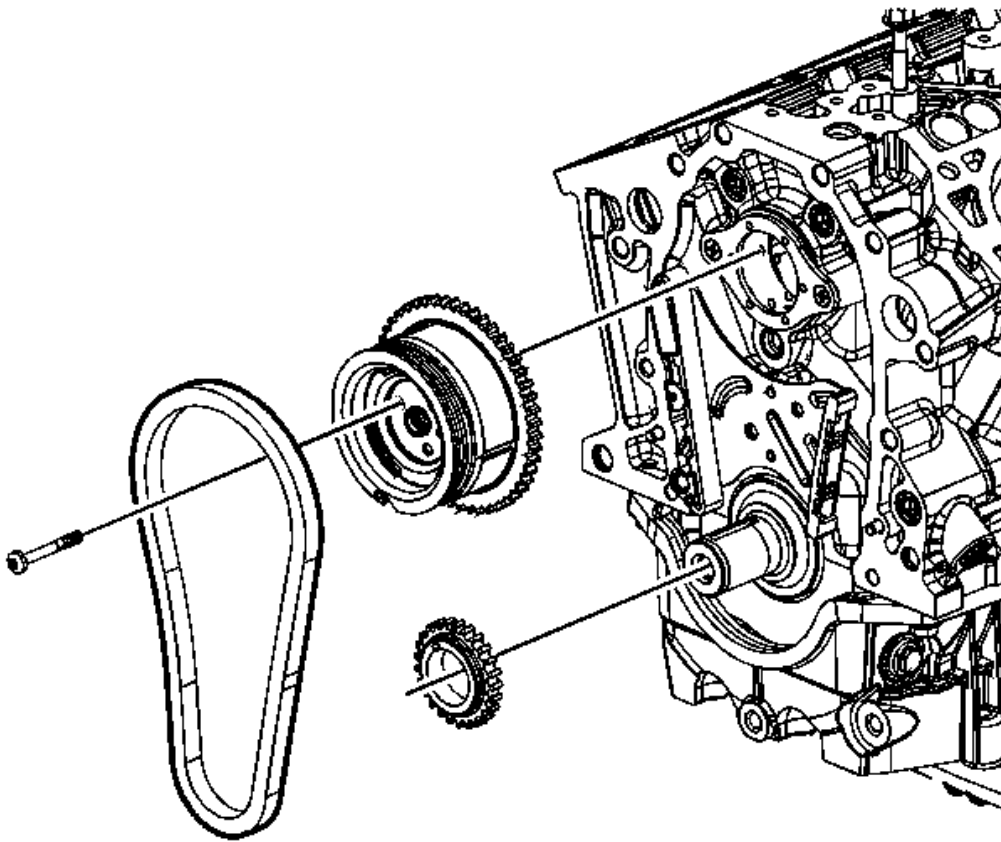


Fig. 146: Timing Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

9. Align the dowel in the camshaft sprocket with the dowel hole in the camshaft.

NOTE: DO NOT use any type of threadlocking compound on the camshaft position actuator mounting bolts. Usage of a threadlocking compound on the threads could lead to contamination of the camshaft position actuator, possibly resulting in potential damage to the actuator.

10. Draw the camshaft sprocket onto the camshaft using the mounting bolts and tighten the bolts to 16 N.m (12 lb ft).
11. Coat the crankshaft and camshaft sprockets with clean engine oil.
12. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

J 45059 Angle Meter

REMOVAL PROCEDURE

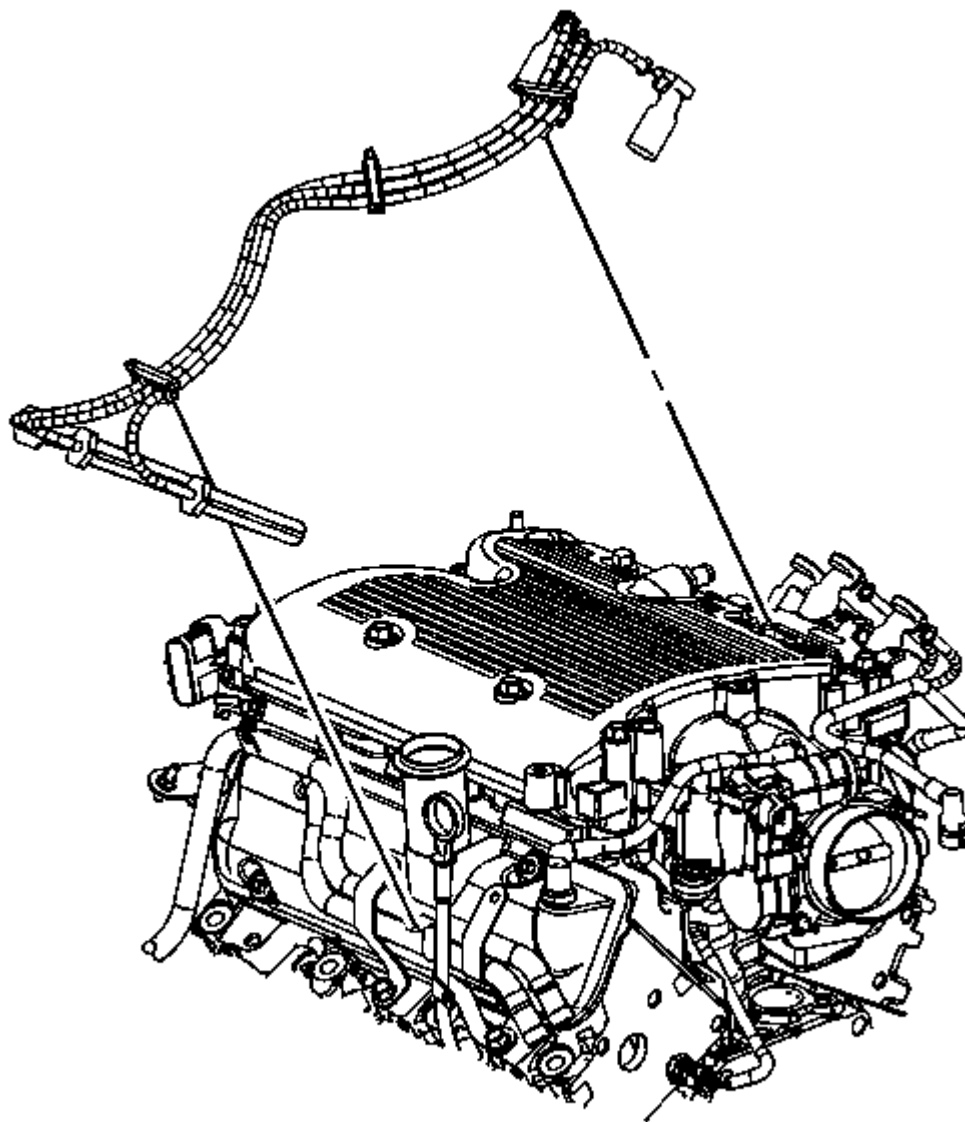


Fig. 147: Left Side Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
2. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
3. Lower the vehicle.

4. Remove the generator. **Generator Replacement (V6)**
5. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
6. Remove the valve rocker arms and the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
7. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LZ9 or LGD)** .
8. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.
9. Disconnect the left spark plug wires from the spark plugs.
10. Remove the spark plug wire clips from the brackets.
11. Disconnect and remove the left spark plug wires from the ignition coil.

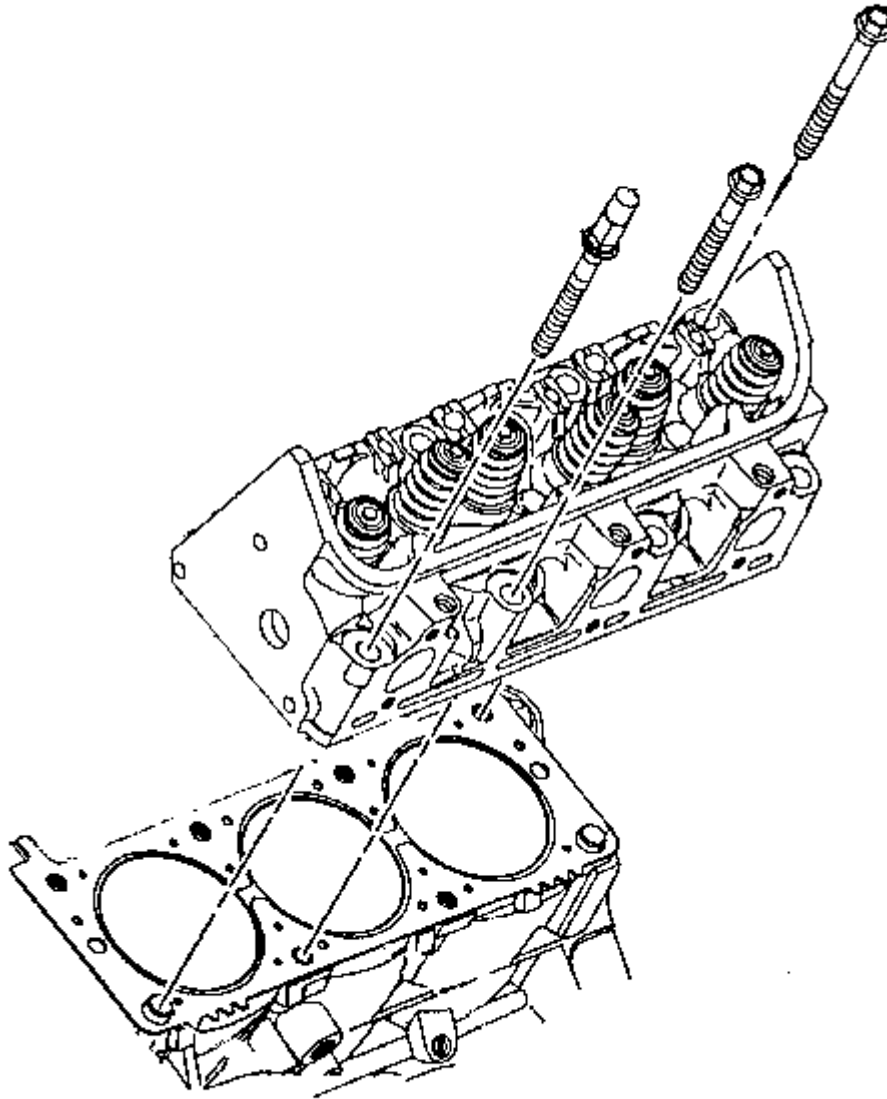


Fig. 148: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the left spark plugs. Refer to **Spark Plug Replacement** .
13. Remove and discard the cylinder head bolts.
14. Remove the cylinder head.

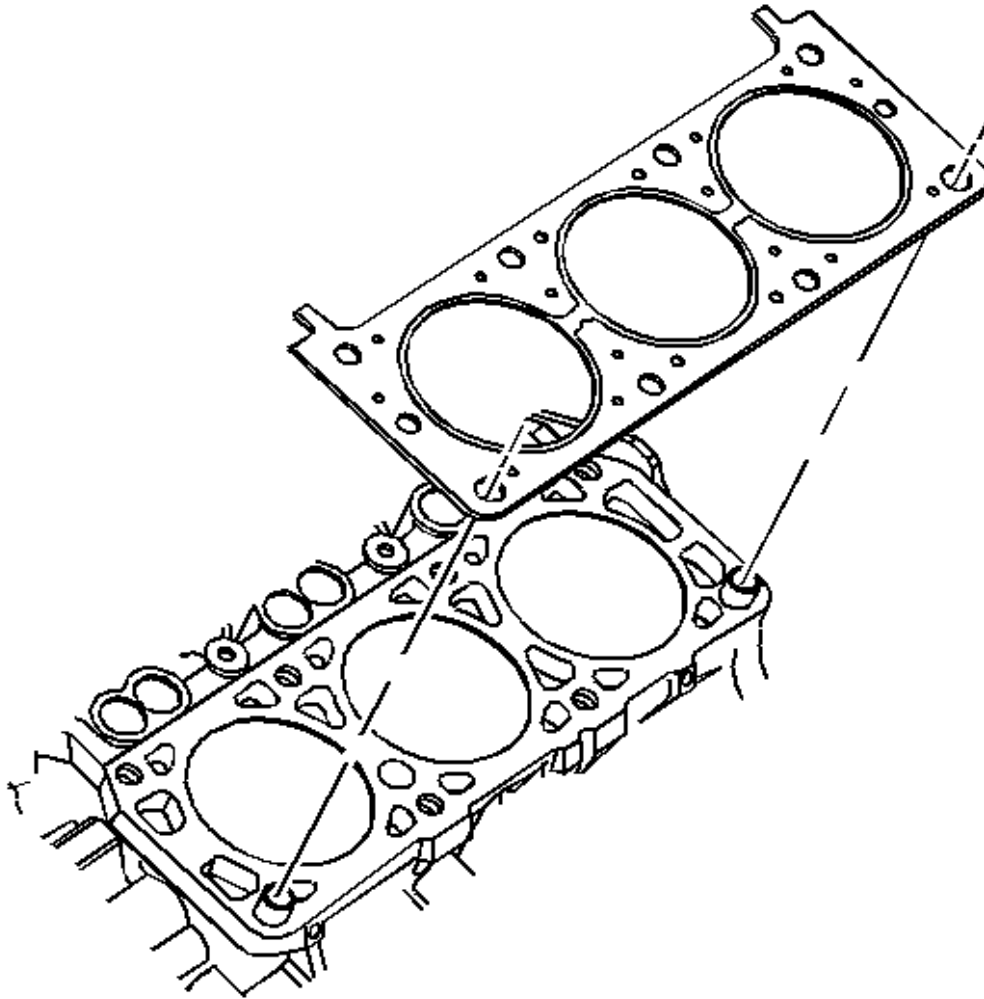


Fig. 149: Cylinder Head Gasket & Alignment Pins
Courtesy of GENERAL MOTORS CORP.

15. Remove and discard the cylinder head gasket.
16. Remove the cylinder head locator dowel pins, if necessary.

INSTALLATION PROCEDURE

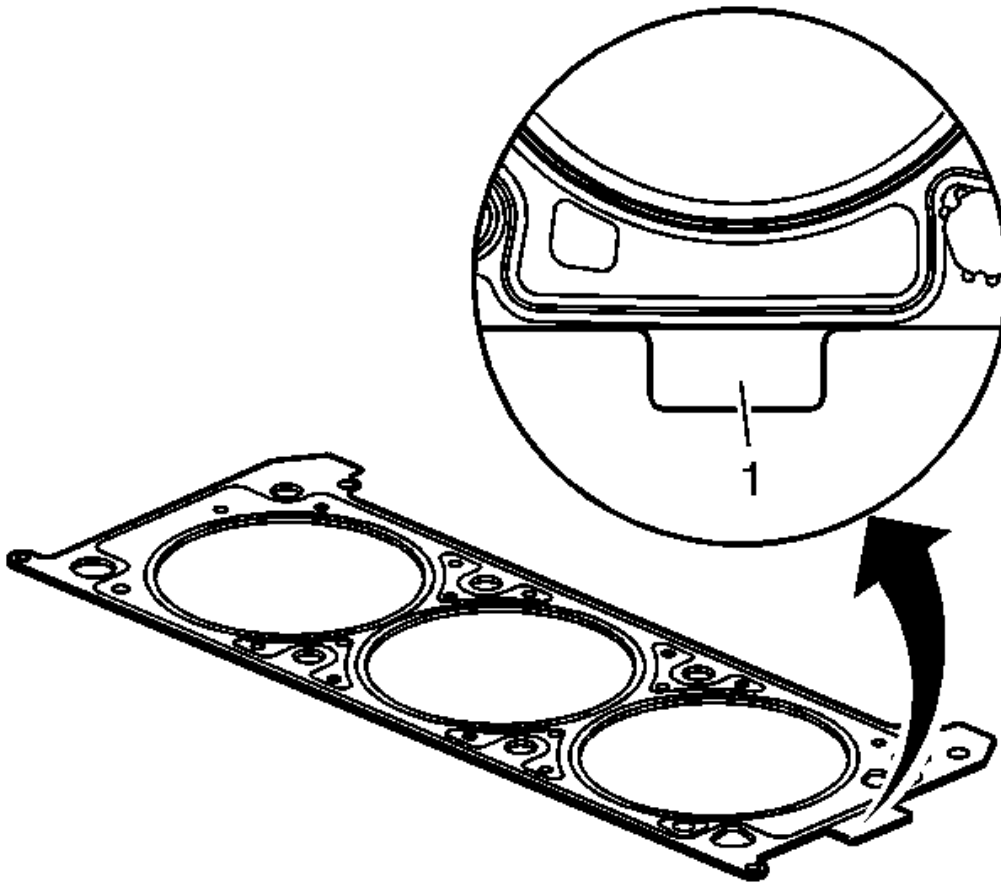


Fig. 150: Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS CORP.

CAUTION: Head gaskets are specific for right hand and left hand applications, and also must be installed with the correct side facing up. Note the markings (1) on the head gaskets for proper installation. Failure to do so may lead to engine damage.

1. Install the cylinder head locator dowel pins, if necessary.
2. Inspect the cylinder head locator dowel pins for proper installation.

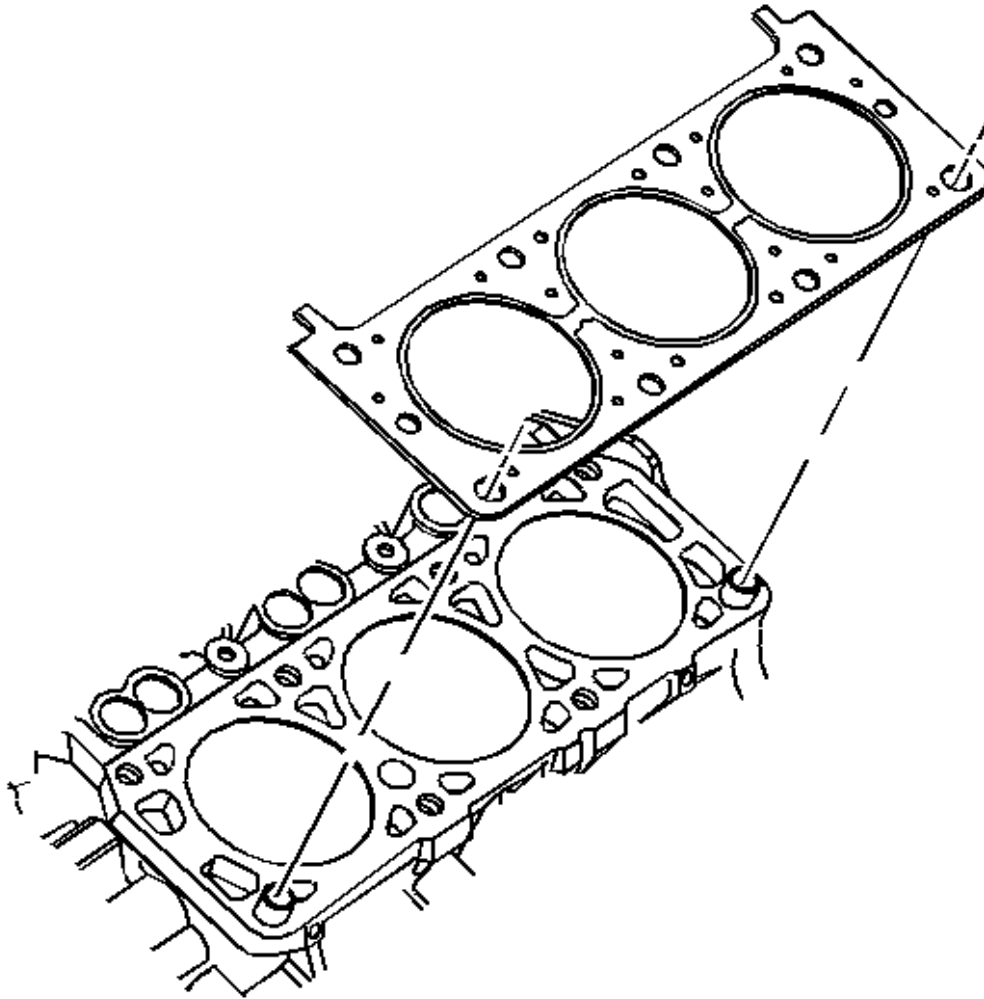


Fig. 151: Cylinder Head Gasket & Alignment Pins
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW cylinder head gasket.

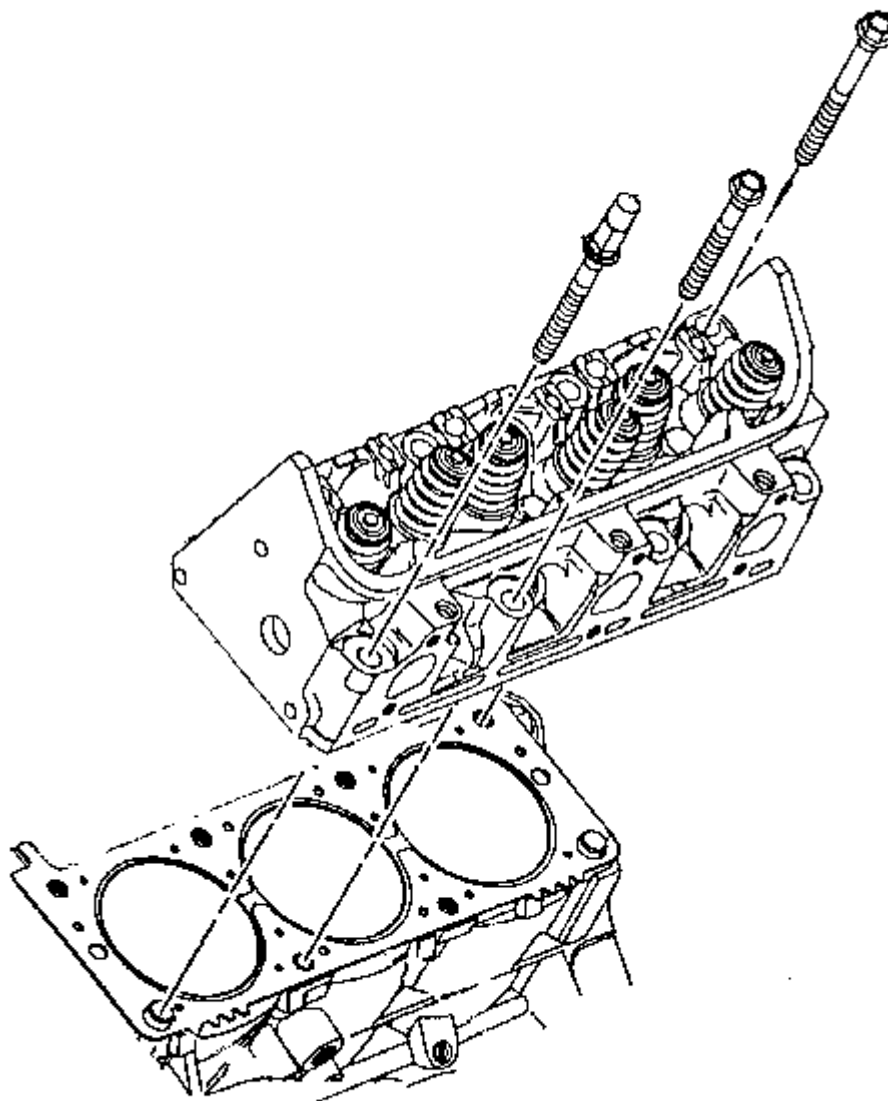


Fig. 152: Cylinder Head & Bolts

Courtesy of GENERAL MOTORS CORP.

CAUTION: This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.

4. Install the cylinder head onto the locator pins and the engine.
5. Install NEW cylinder head bolts finger tight.

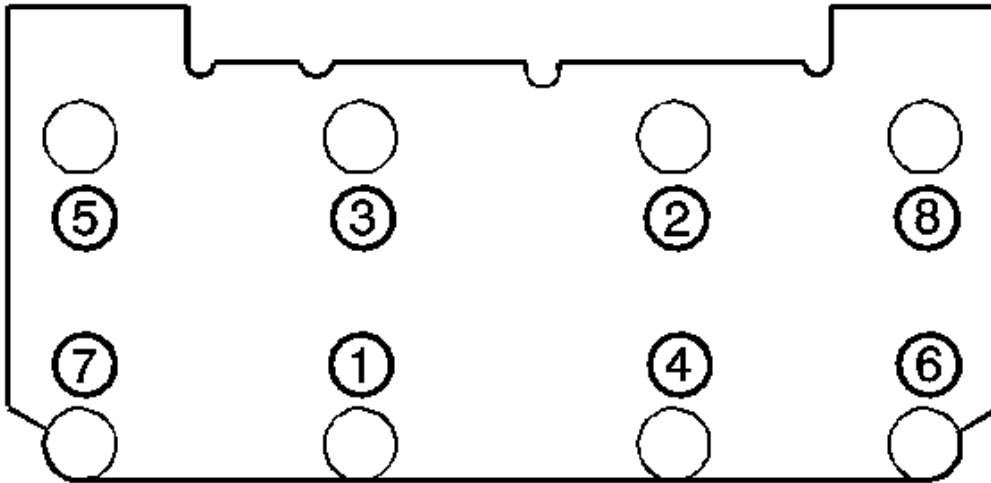


Fig. 153: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the cylinder head bolts.
 - Tighten the cylinder head bolts a first pass in sequence to 60 N.m (44 lb ft).
 - Tighten the cylinder head bolts a final pass in sequence to 140 degrees using the **J 45059** .
7. Install the left spark plugs. Refer to Spark Plug Replacement .

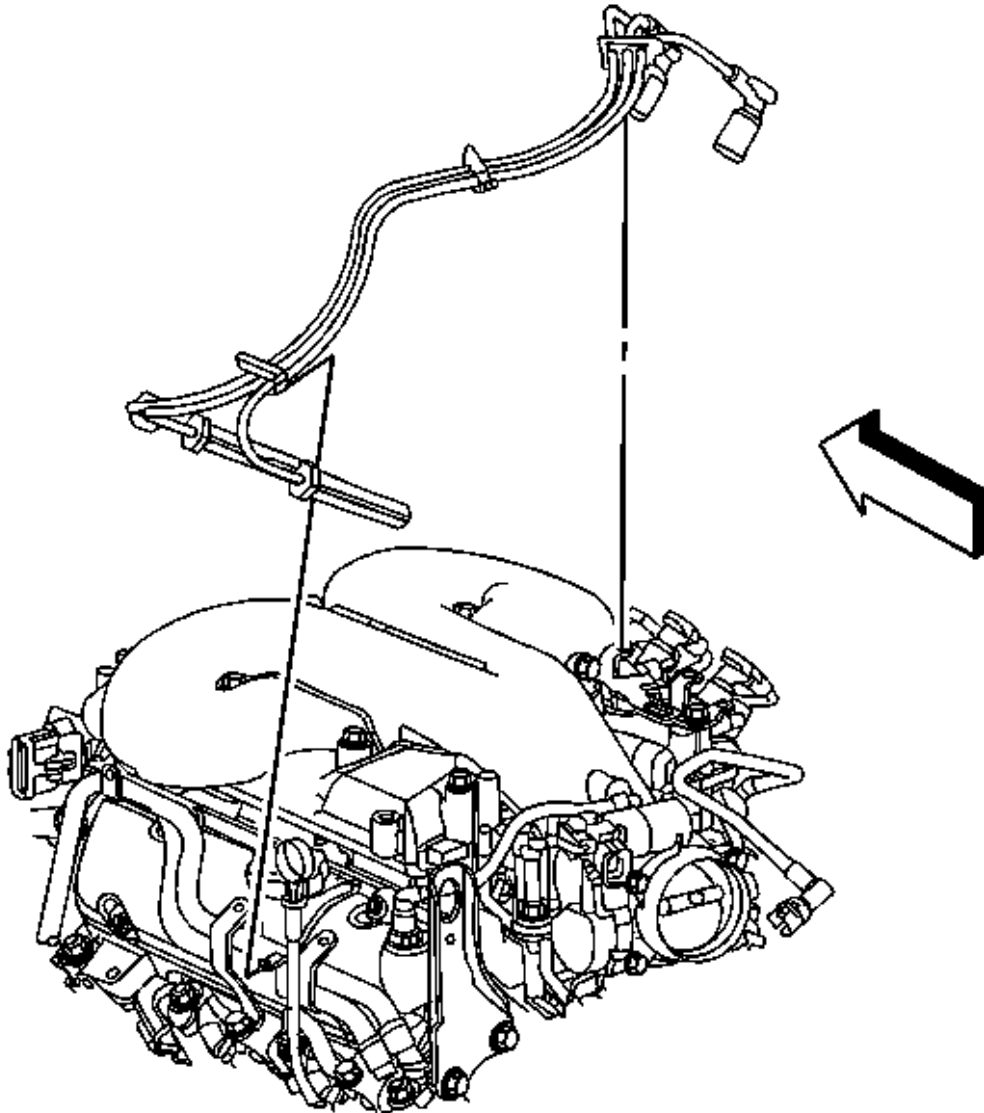


Fig. 154: Left Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

8. Install and connect the left spark plug wires to the ignition coil.
9. Install the spark plug wire clips to the brackets.
10. Connect the left spark plug wires to the spark plugs.
11. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

12. Install the exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side (LZ9 or LGD) .
13. Install the valve rocker arms and the pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
14. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.
15. Fill the engine with oil. Refer to Engine Oil and Oil Filter Replacement.
16. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac-N-Fill) .
17. Inspect for leaks.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

J 45059 Angle Meter

REMOVAL PROCEDURE

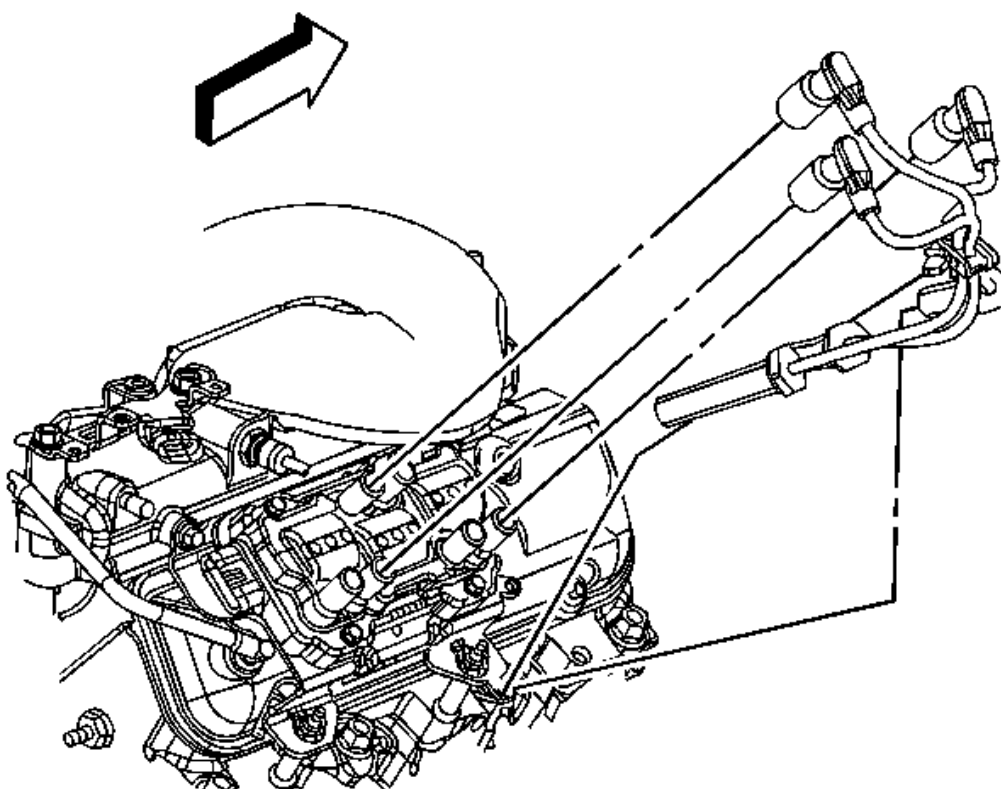


Fig. 155: Right Spark Plug Wires**Courtesy of GENERAL MOTORS CORP.**

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
2. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
3. Lower the vehicle.
4. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
5. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LZ9 or LGD)** .
7. Disconnect the right spark plug wires from the spark plugs.
8. Remove the spark plug wire clip from the bracket.
9. Disconnect and remove the right spark plug wires from the ignition coil.
10. Remove the right spark plugs. Refer to **Spark Plug Replacement** .
11. Remove the Power Steering Fluid Reservoir. Refer to **Power Steering Fluid Reservoir Replacement (LZ9/LGD)** .
12. Remove Drive Belt Tensioner. Refer **Drive Belt Tensioner Replacement**

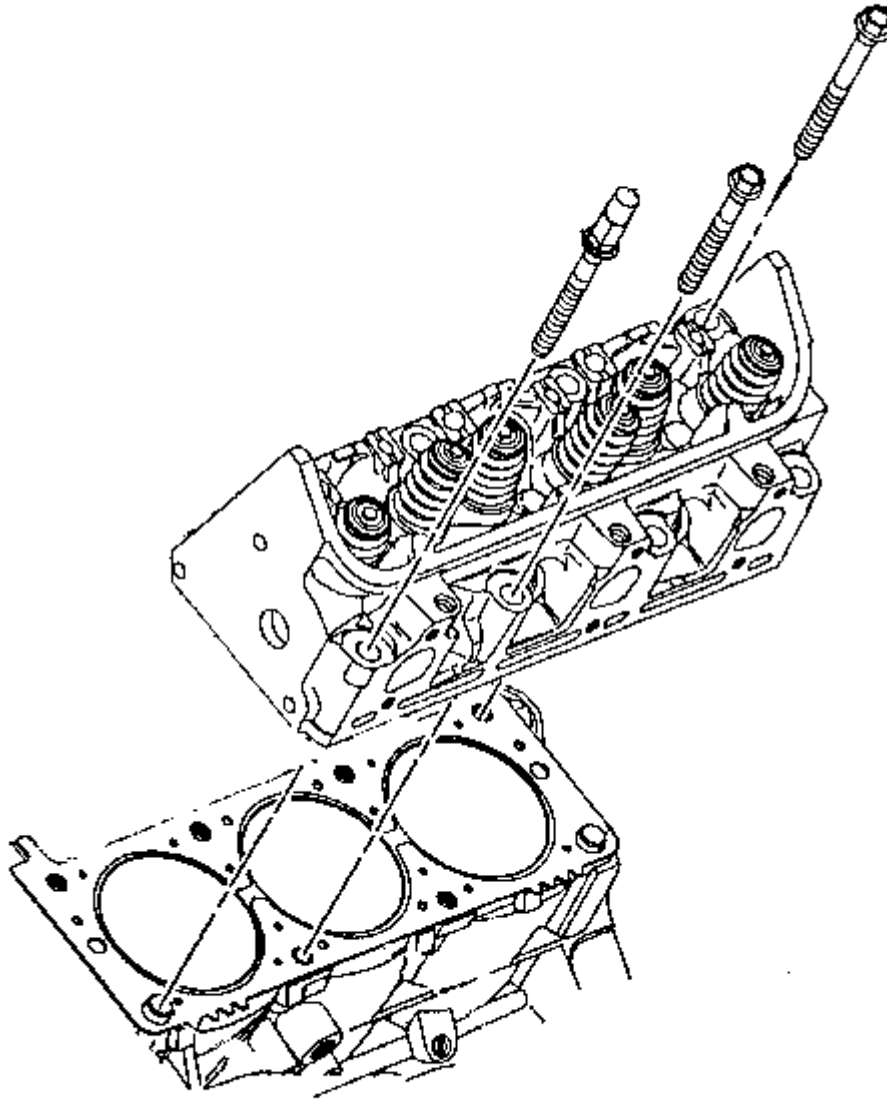


Fig. 156: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove and discard the cylinder head bolts.
14. Remove the cylinder head.

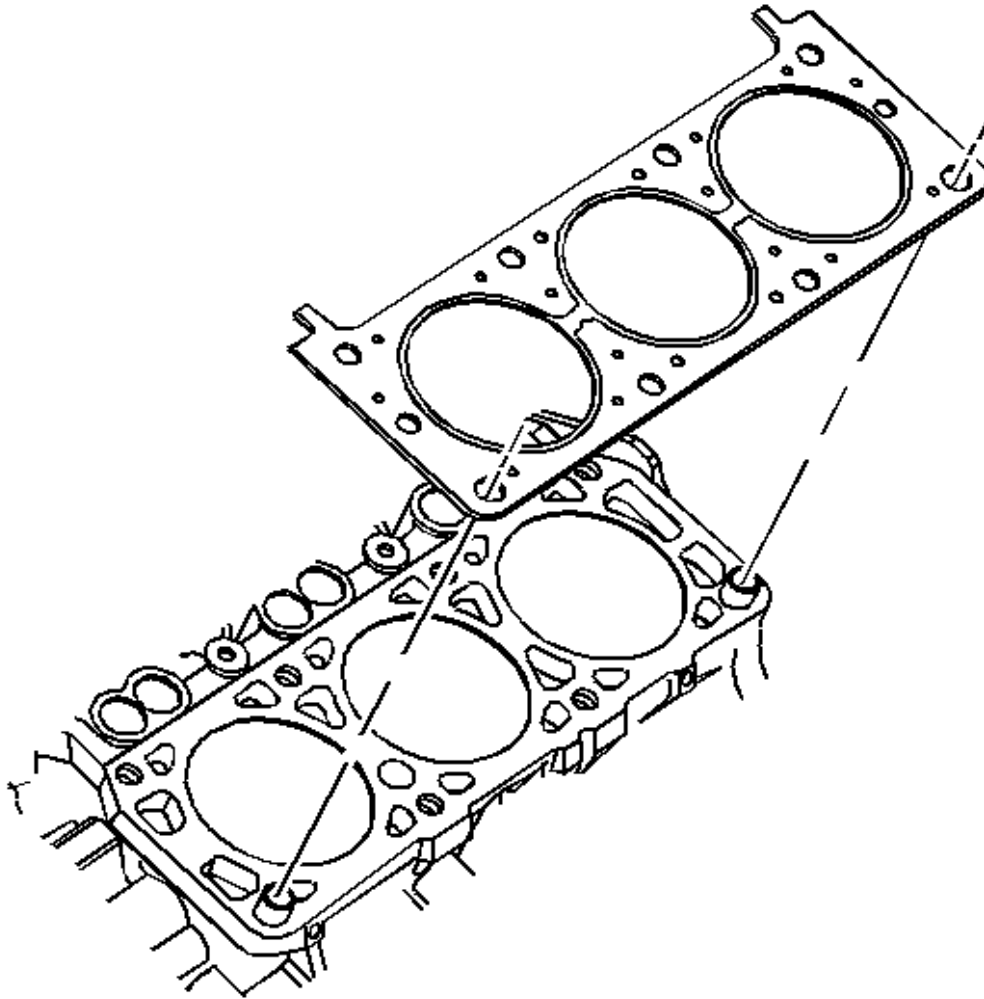


Fig. 157: Cylinder Head Gasket & Alignment Pins
Courtesy of GENERAL MOTORS CORP.

15. Remove and discard the cylinder head gasket.
16. Remove the cylinder head locator dowel pins, if necessary.

INSTALLATION PROCEDURE

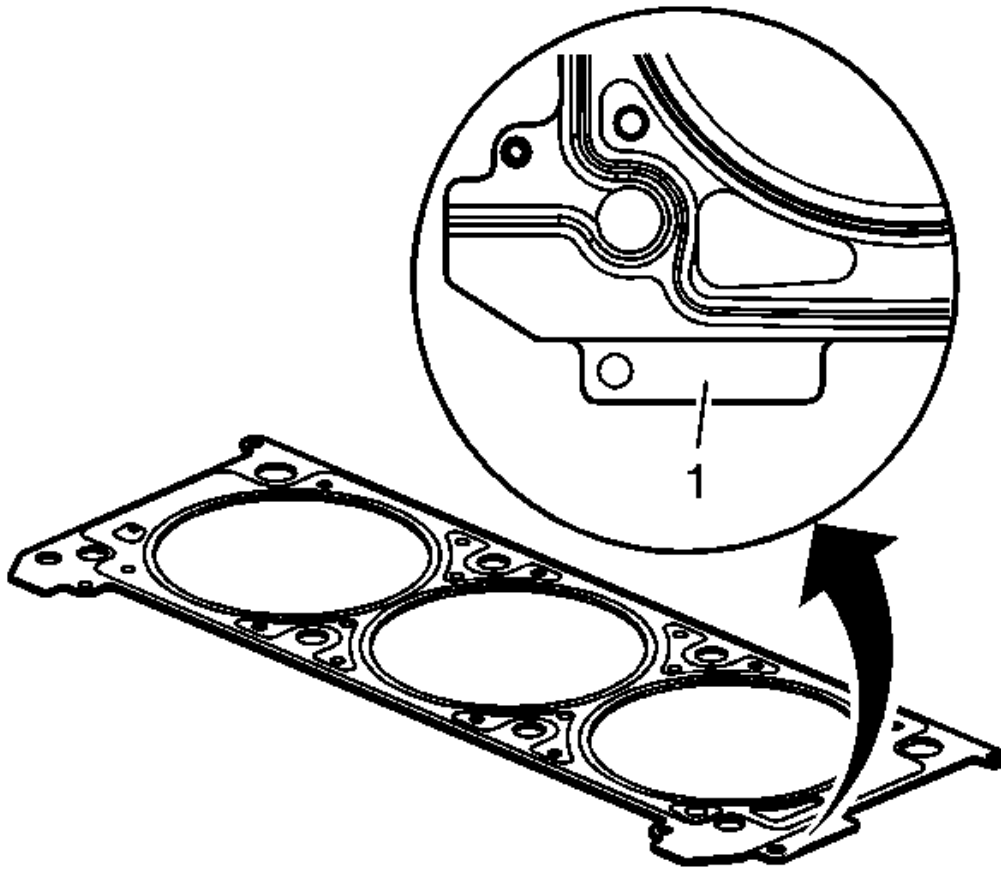


Fig. 158: Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS CORP.

CAUTION: Head gaskets are specific for right hand and left hand applications, and also must be installed with the correct side facing up. Note the markings (1) on the head gaskets for proper installation. Failure to do so may lead to engine damage.

1. Install the cylinder head locator dowel pins, if necessary.
2. Inspect the cylinder head locator dowel pins for proper installation.

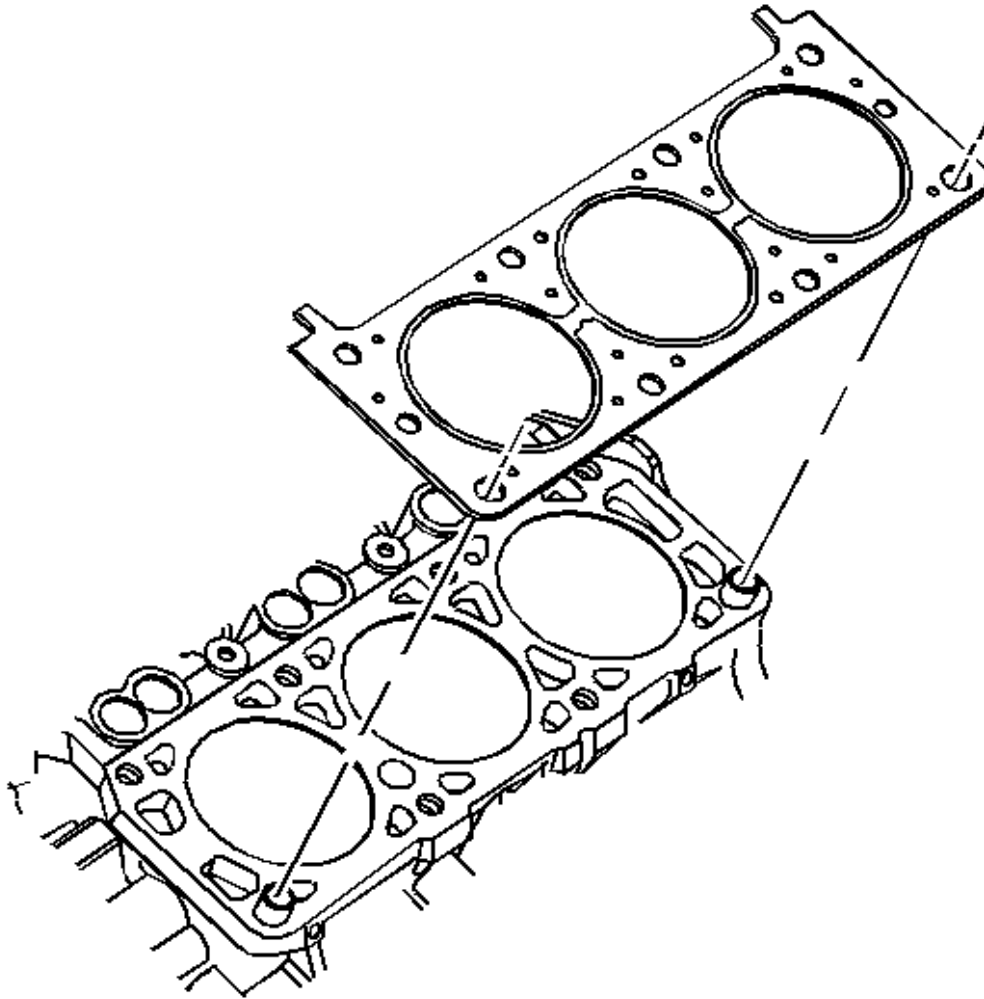


Fig. 159: Cylinder Head Gasket & Alignment Pins
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW cylinder head gasket.

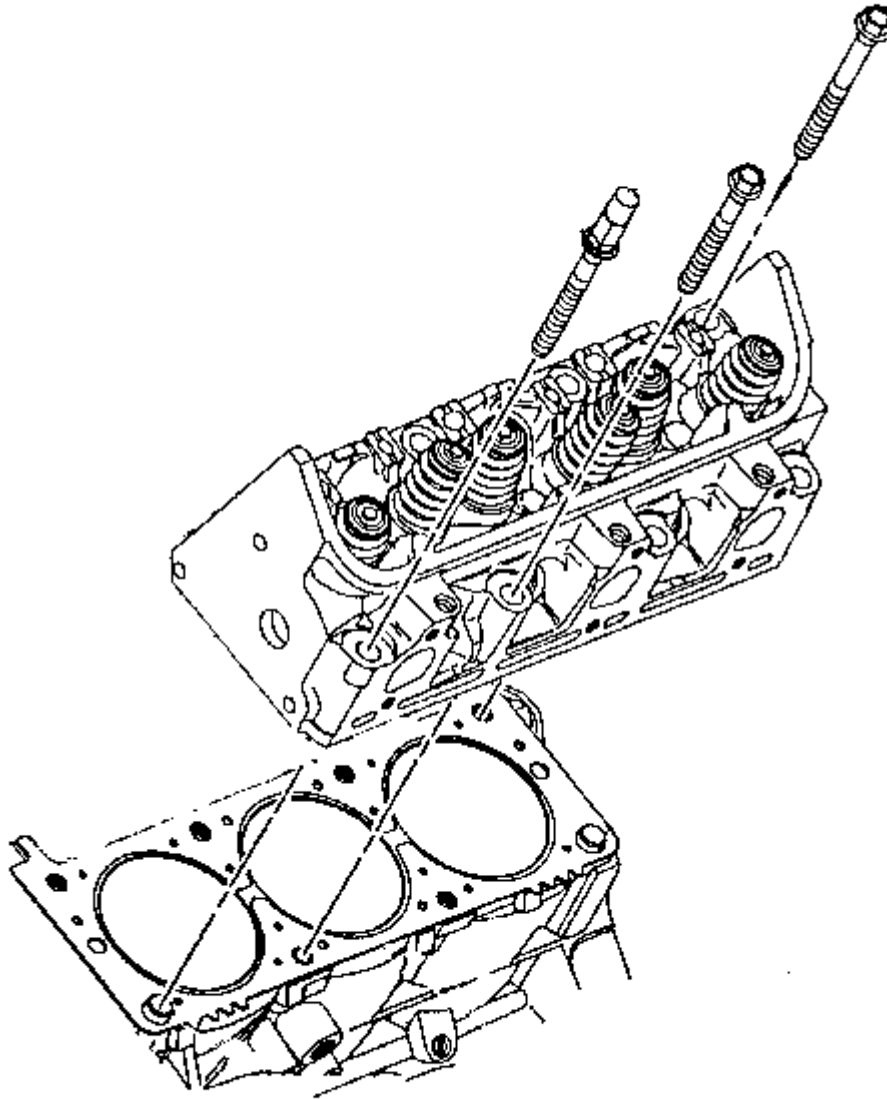


Fig. 160: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.

4. Install the cylinder head onto the locator pins and the engine.
5. Install NEW cylinder head bolts finger tight.

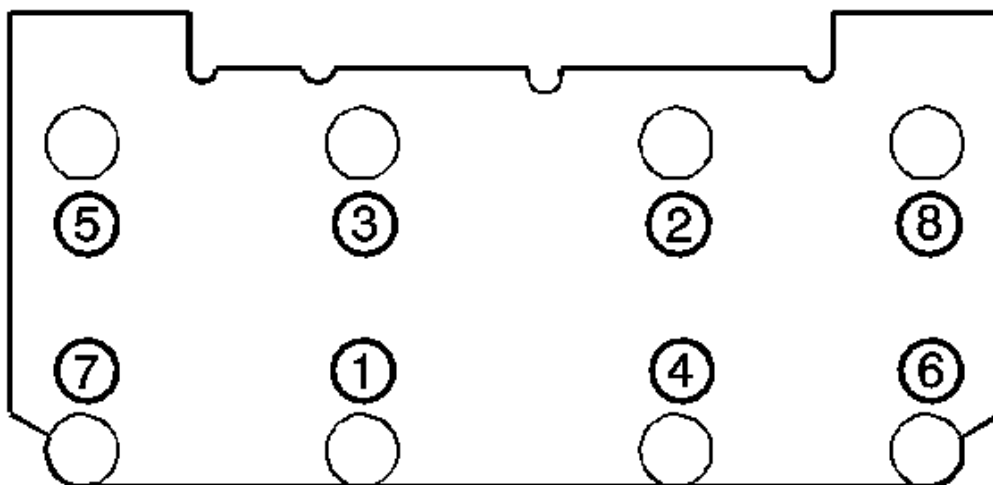


Fig. 161: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the cylinder head bolts.
 1. Tighten the cylinder head bolts a first pass in sequence to 60 N.m (44 lb ft).
 2. Tighten the cylinder head bolts a final pass in sequence to 140 degrees using the **J 45059** .
7. Install the generator. Refer to **Generator Replacement (V6)** .
8. Install the right spark plugs. Refer to **Spark Plug Replacement** .

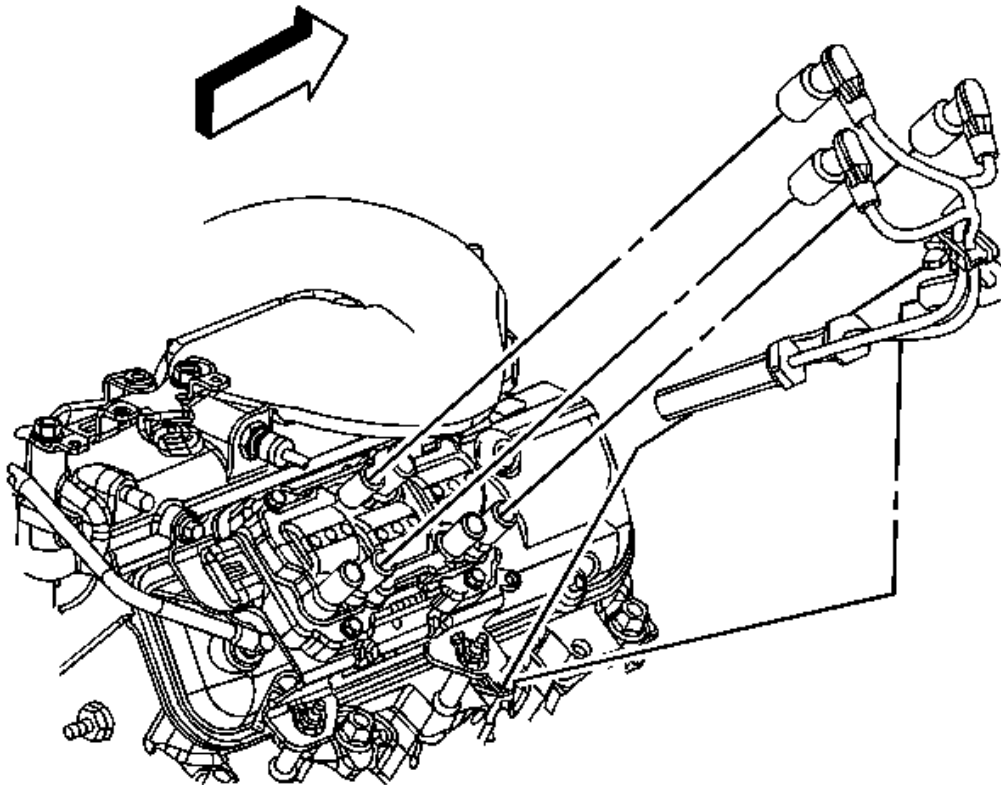


Fig. 162: Right Spark Plug Wires
Courtesy of GENERAL MOTORS CORP.

9. Install and connect the right spark plug wires to the ignition coil.
10. Install the spark plug wire clip to the bracket.
11. Connect the right spark plug wires to the spark plugs.
12. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LZ9 or LGD)** .
13. Install the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
14. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
15. Fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
17. Inspect for leaks.

ENGINE FLYWHEEL REPLACEMENT

Special Tools

J 37096 Flywheel Holder. See **Special Tools** .

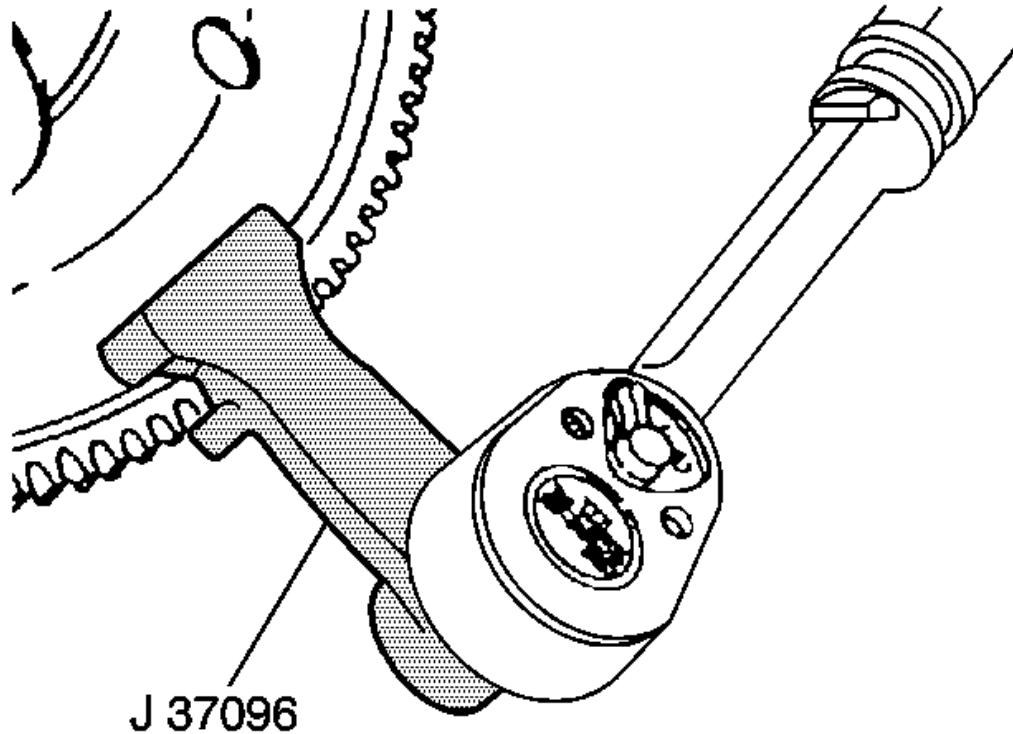
REMOVAL PROCEDURE

Fig. 163: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transaxle, if equipped. Refer to **Transmission Replacement** .
2. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools** .

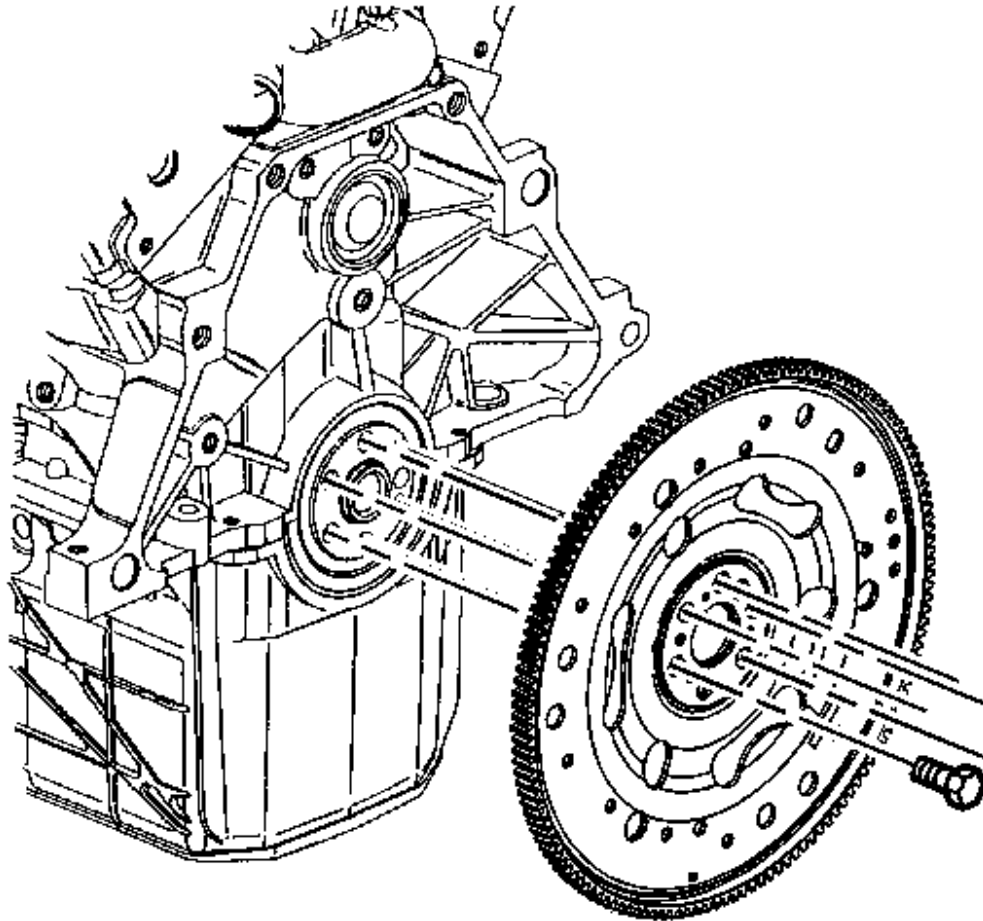


Fig. 164: Flywheel

Courtesy of GENERAL MOTORS CORP.

3. Loosen the flywheel bolts.
4. Remove 5 of the 6 flywheel bolts leaving one bolt at the top of the crankshaft.
5. Grip the flywheel and remove the remaining bolt. Do not drop the flywheel when removing the final bolt.
6. Remove the engine flywheel.
7. Clean the engine flywheel bolt threads and bolt holes.

INSTALLATION PROCEDURE

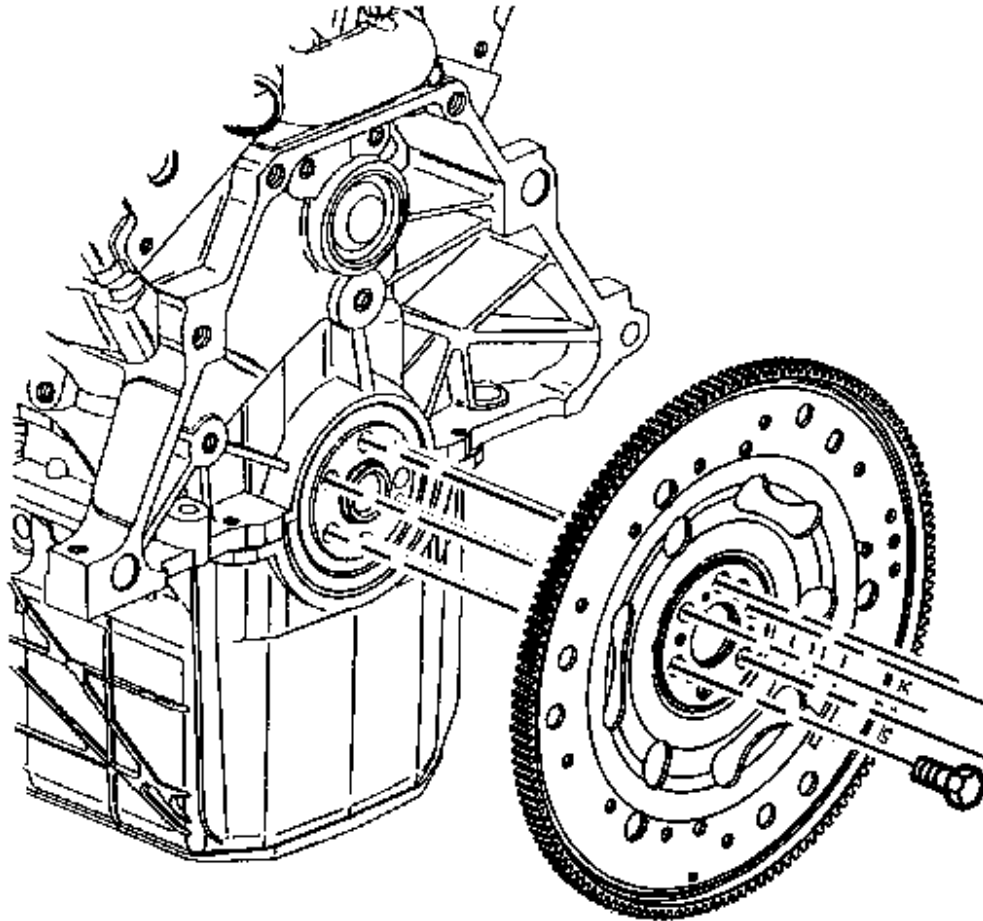


Fig. 165: Flywheel

Courtesy of GENERAL MOTORS CORP.

1. Position the flywheel to the crankshaft.
2. Install the flywheel bolts finger tight.
3. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools** .

CAUTION: Refer to **Fastener Caution** .

4. Tighten the engine flywheel bolts.

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

5. Install the automatic transaxle, if equipped. Refer to [Transmission Replacement](#) .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

REMOVAL PROCEDURE

1. Remove the flywheel. Refer to [Engine Flywheel Replacement](#).
2. Remove the crankshaft rear oil seal. Refer to [Crankshaft Rear Oil Seal Removal](#) .

INSTALLATION PROCEDURE

1. Install the rear main seal. Refer to [Crankshaft Rear Oil Seal Installation](#) .
2. Install the engine flywheel. Refer to [Engine Flywheel Replacement](#).

CAMSHAFT REAR BEARING HOLE PLUG REPLACEMENT

REMOVAL PROCEDURE

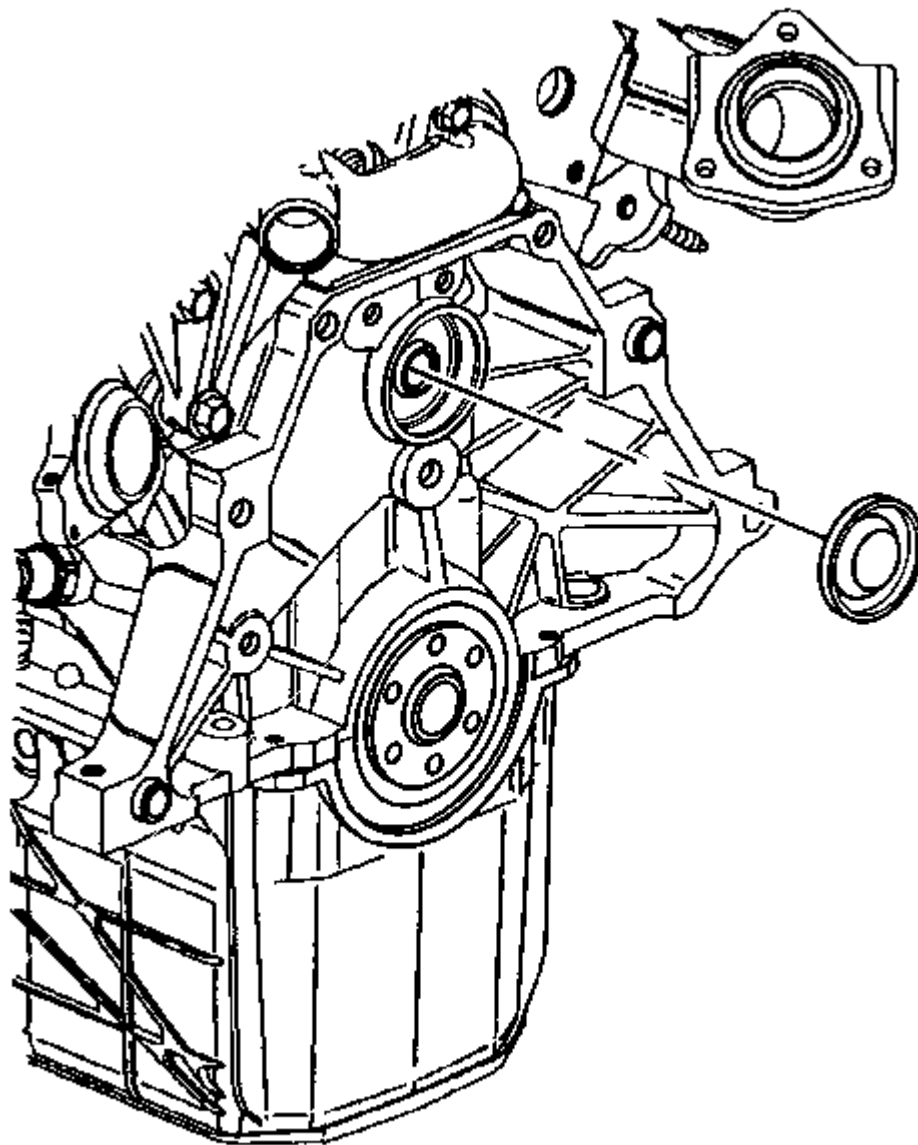


Fig. 166: Camshaft Rear Bearing Hole Plug
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
2. Remove the camshaft rear bearing hole plug.

INSTALLATION PROCEDURE

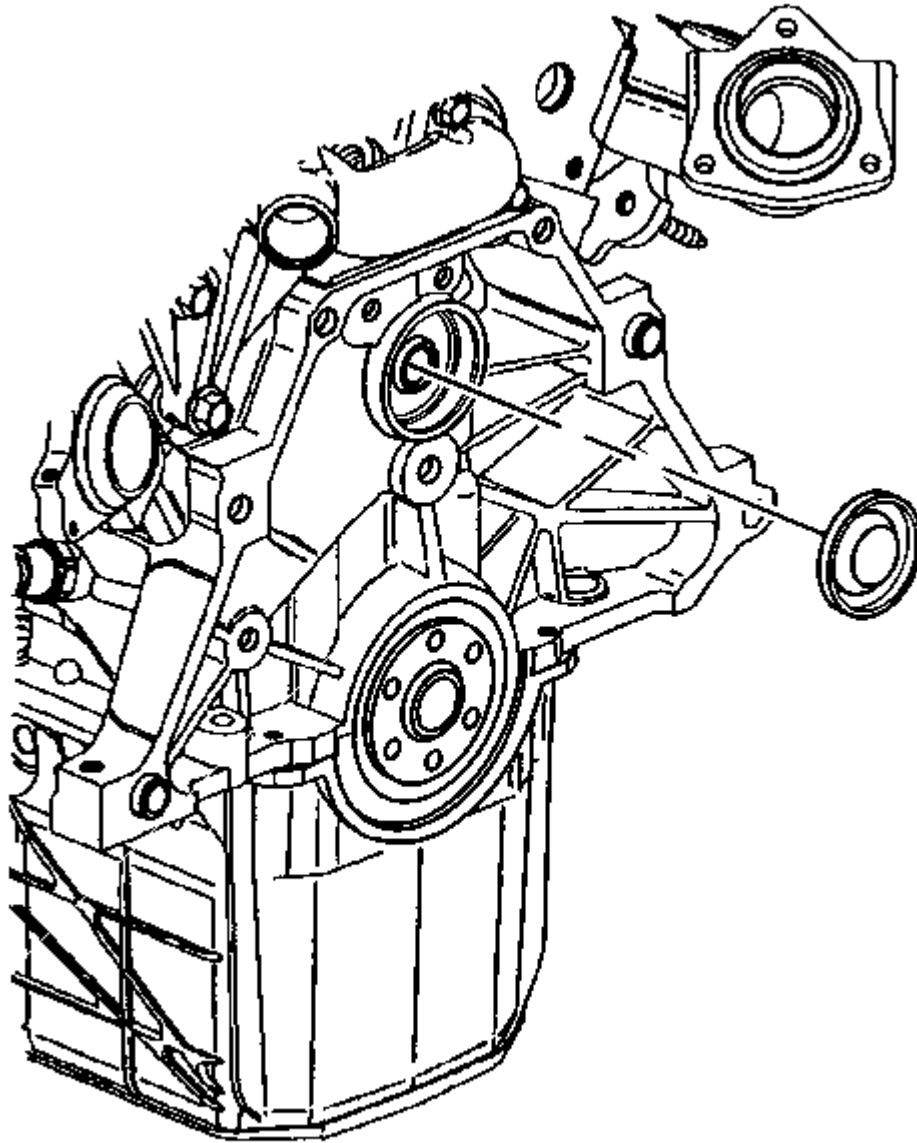


Fig. 167: Camshaft Rear Bearing Hole Plug
Courtesy of GENERAL MOTORS CORP.

1. Coat the camshaft rear bearing hole plug with sealer. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the camshaft rear bearing hole plug.

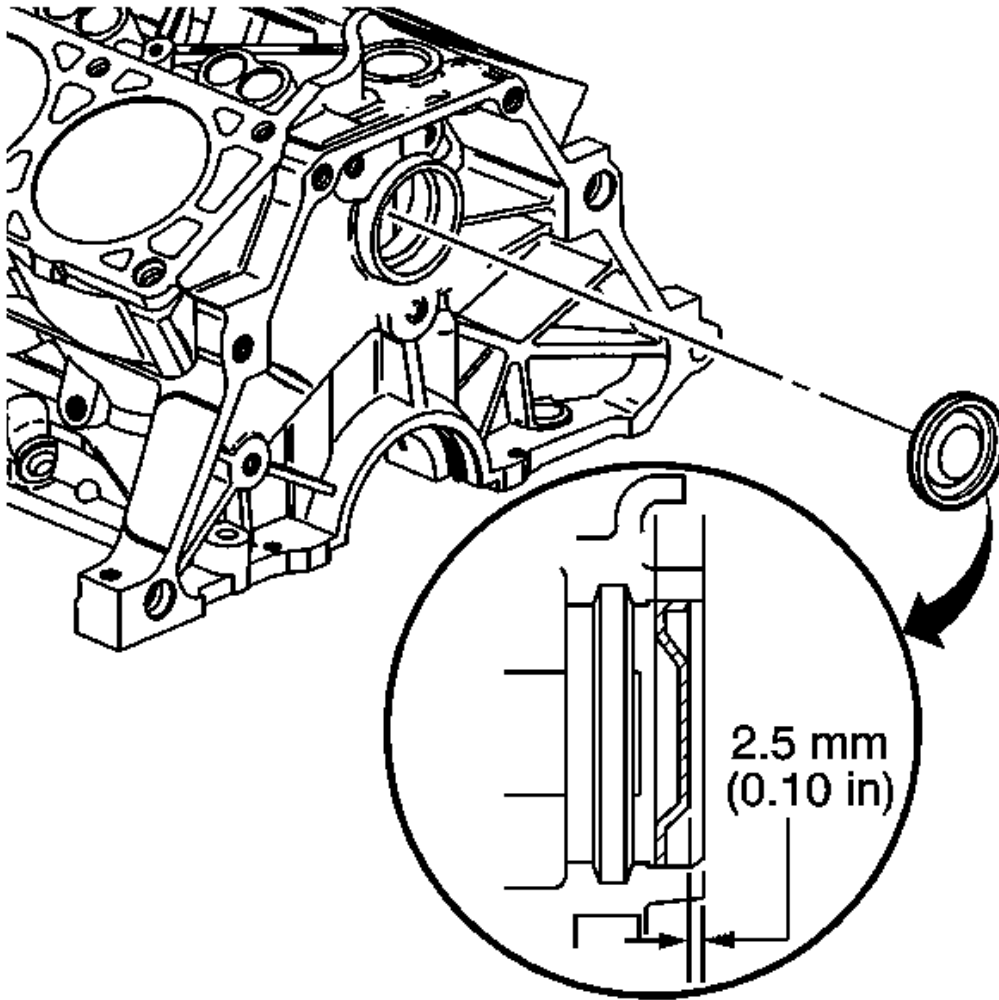


Fig. 168: Identifying Camshaft Rear Bearing Hole Plug Installation Depth
Courtesy of GENERAL MOTORS CORP.

3. Ensure that the camshaft rear bearing plug is installed to specifications.
4. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REPLACEMENT

REMOVAL PROCEDURE

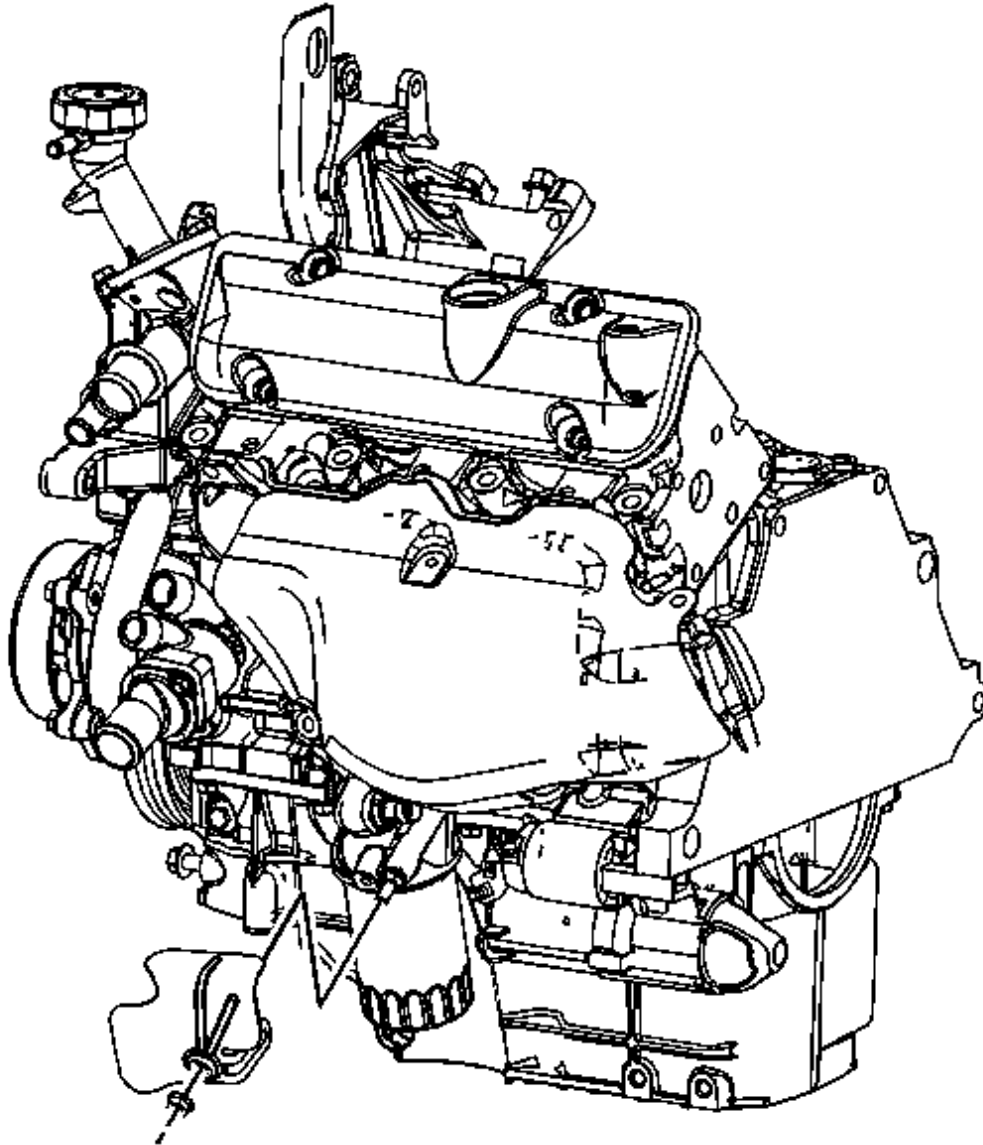


Fig. 169: Oil Pressure Sensor Heat Shield & Nut
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the hood. Refer to **Hood Replacement** .
3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

4. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .
5. Remove the engine mount struts. Refer to [Engine Mount Strut Replacement](#).
6. Remove the drive belt. Refer to [Drive Belt Replacement](#).
7. Drain the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#) .
8. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
9. Remove the oil pressure sensor heat shield nuts and shield.

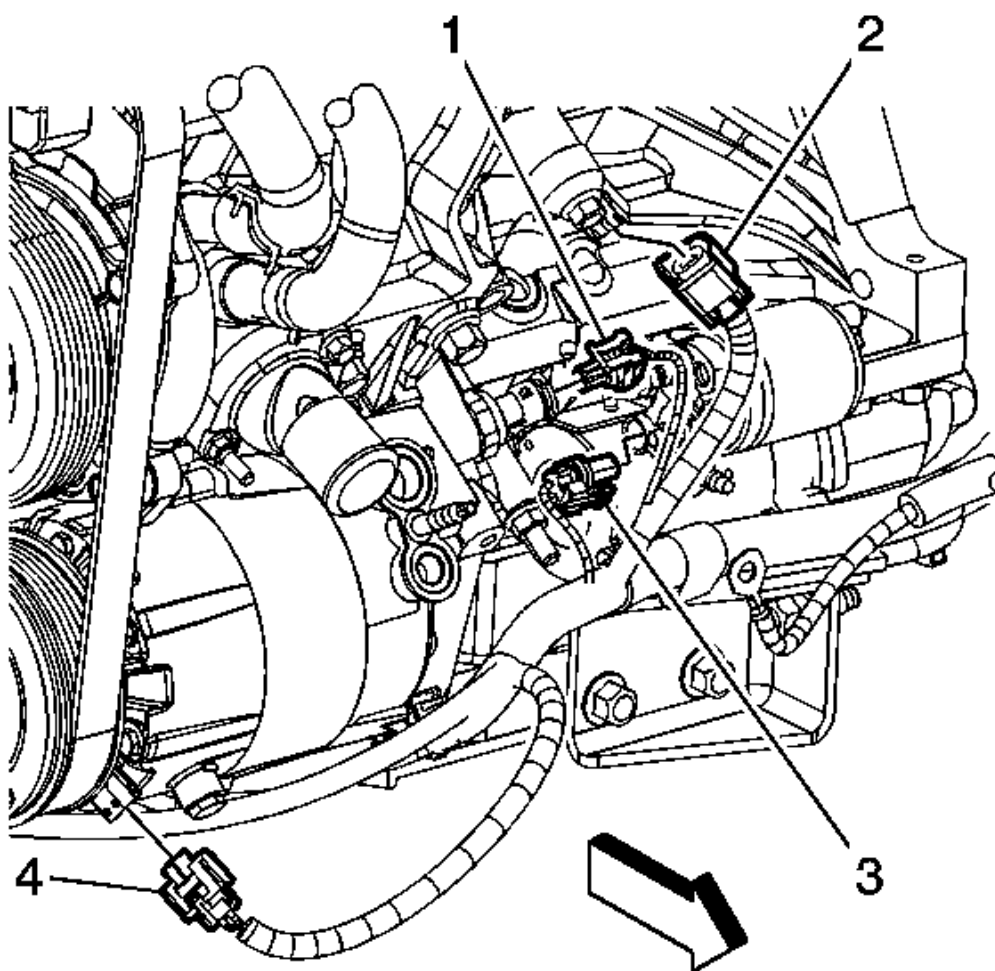


Fig. 170: Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the oil pressure sensor electrical connector (1).

11. Disconnect the knock sensor electrical connector (2).
12. Disconnect the starter motor electrical connector (3).
13. Disconnect the air conditioning (A/C) compressor electrical connector (4).

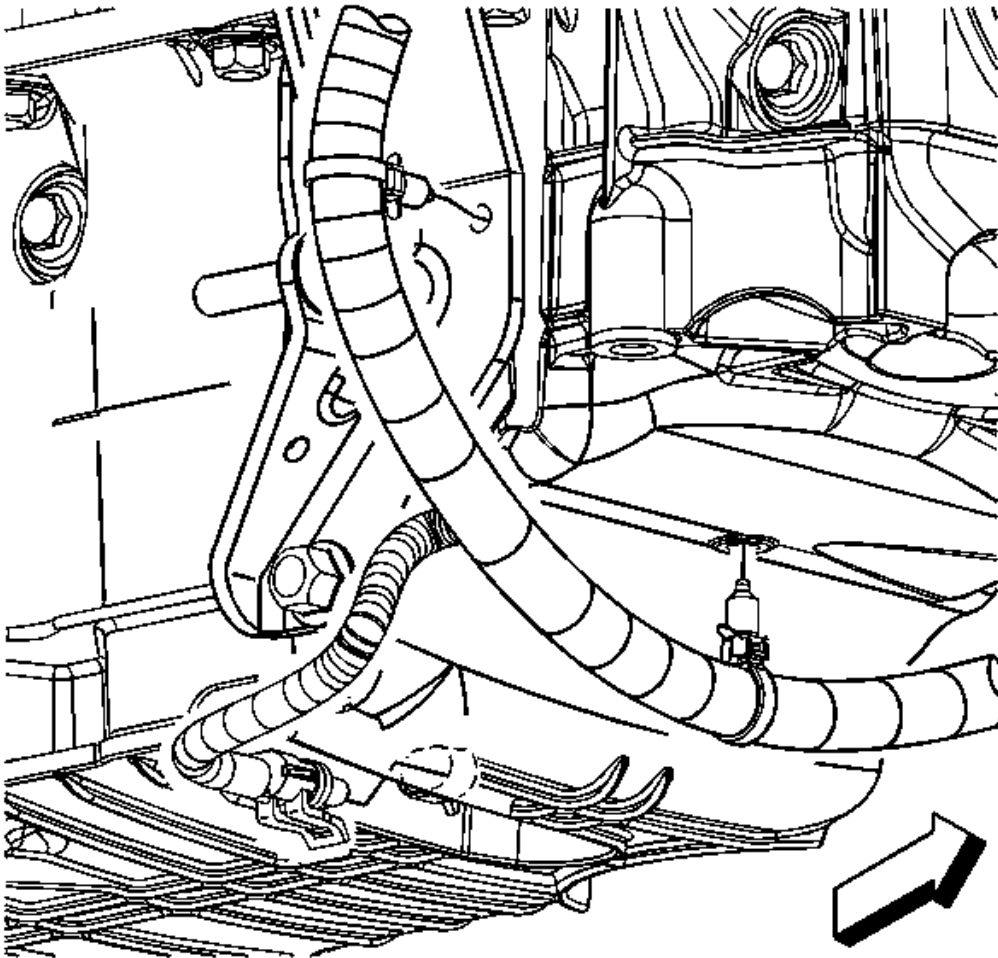


Fig. 171: Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the oil level sensor electrical connector.
15. Remove the engine harness clips from the transaxle brace and the oil pan.
16. Lower the vehicle.

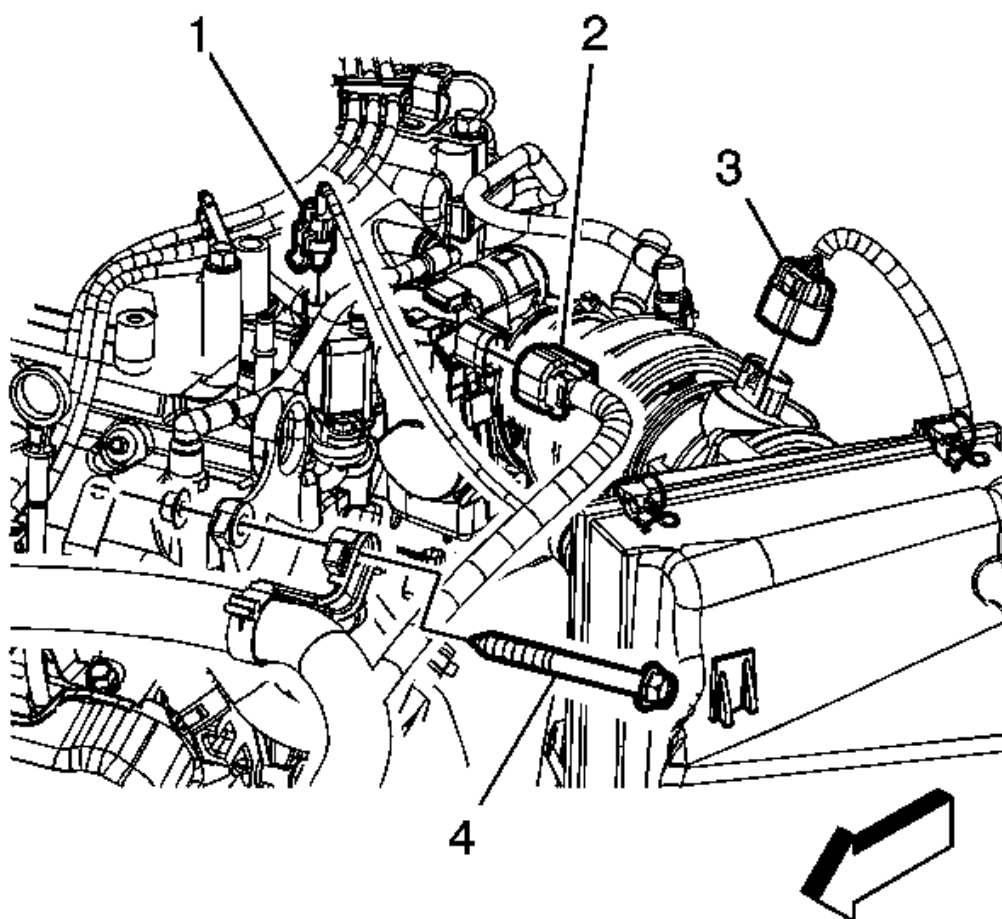


Fig. 172: EVAP Canister Purge Solenoid & Electronic Throttle Control Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the evaporative emission (EVAP) canister purge solenoid electrical connector (1).
18. Disconnect the electronic throttle control (ETC) electrical connector (2).

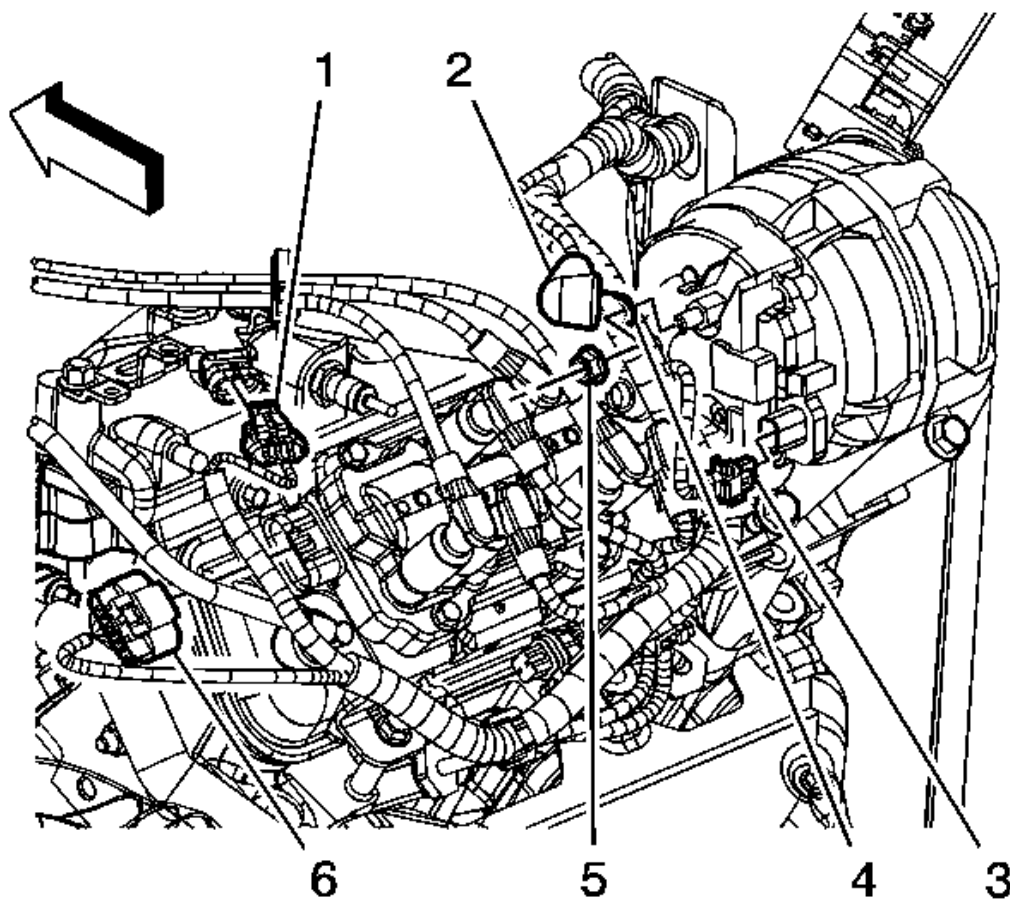


Fig. 173: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

19. Disconnect the manifold absolute pressure (MAP) sensor electrical connector (1).
20. Reposition the generator terminal boot (2).
21. Remove the generator terminal nut (5).
22. Remove the generator terminal (4) from the stud.
23. Disconnect the generator electrical connector (3).
24. Disconnect the ignition coil electrical connector (6).

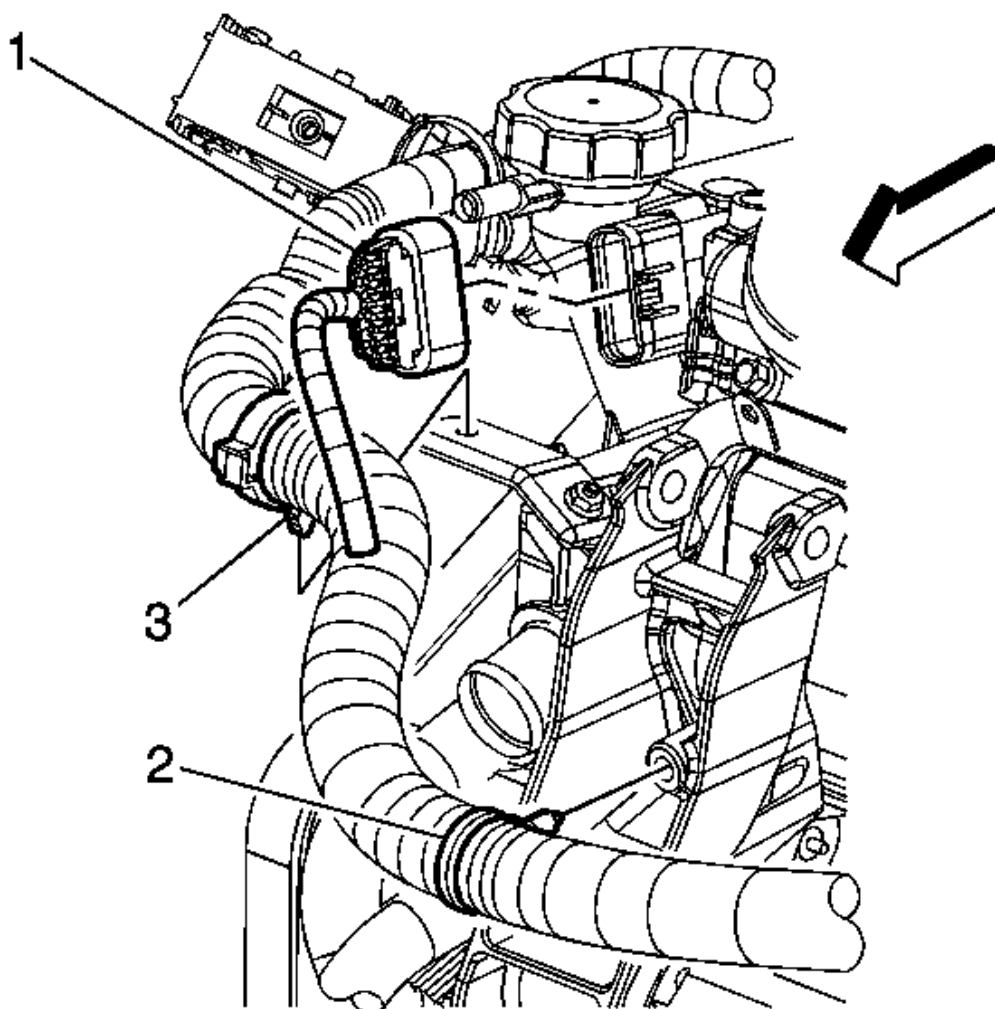


Fig. 174: Fuel Injector Inline Connector
 Courtesy of GENERAL MOTORS CORP.

25. Disconnect the fuel injector inline (1) electrical connector.
26. Remove the engine harness clips (2, 3) from the brackets.

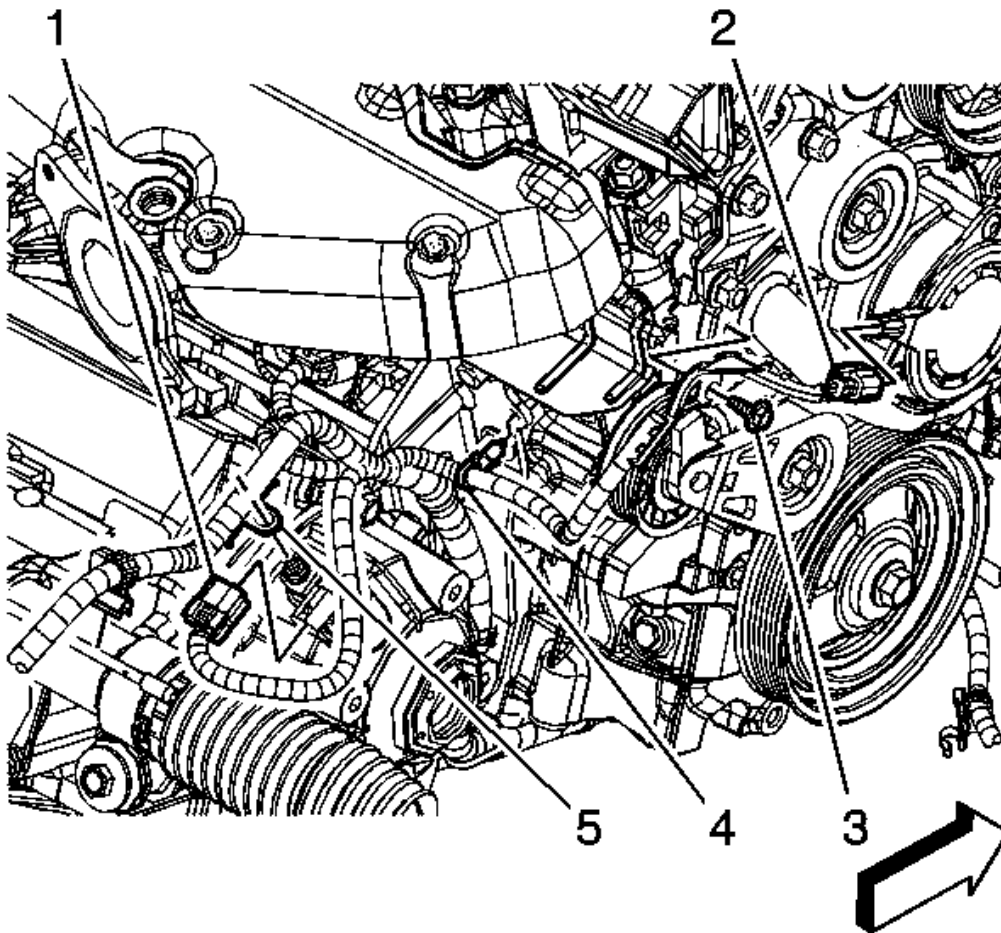


Fig. 175: Camshaft Position Actuator Magnet Electrical Connector
Courtesy of GENERAL MOTORS CORP.

27. Disconnect the camshaft phasor sensor electrical connector (2).
28. Remove the engine harness clip bolt (3).
29. Remove the engine harness clip (4) from the transaxle bracket.

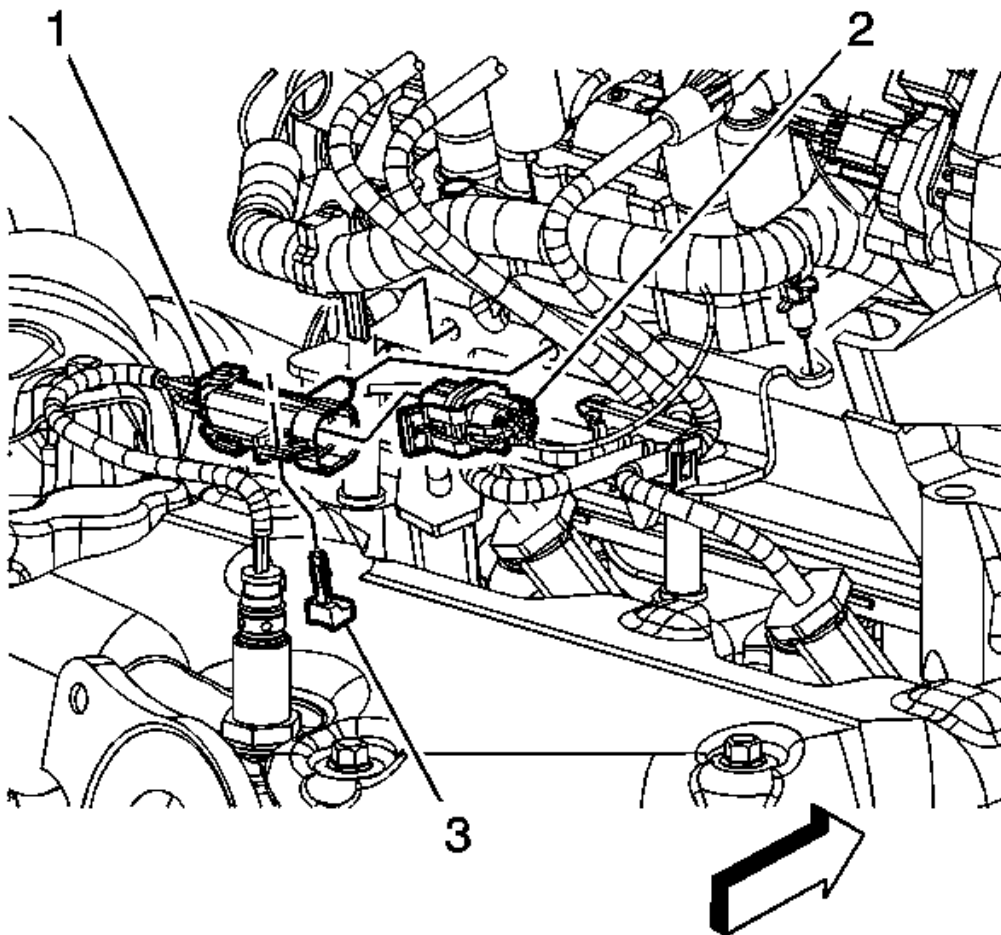


Fig. 176: HO2S Electrical Connector Clip & Ignition Coil Bracket
Courtesy of GENERAL MOTORS CORP.

30. Remove the connector position assurance (CPA) retainer (3).
31. Disconnect the rear upper heated oxygen sensor (HO2S) electrical connector (2).

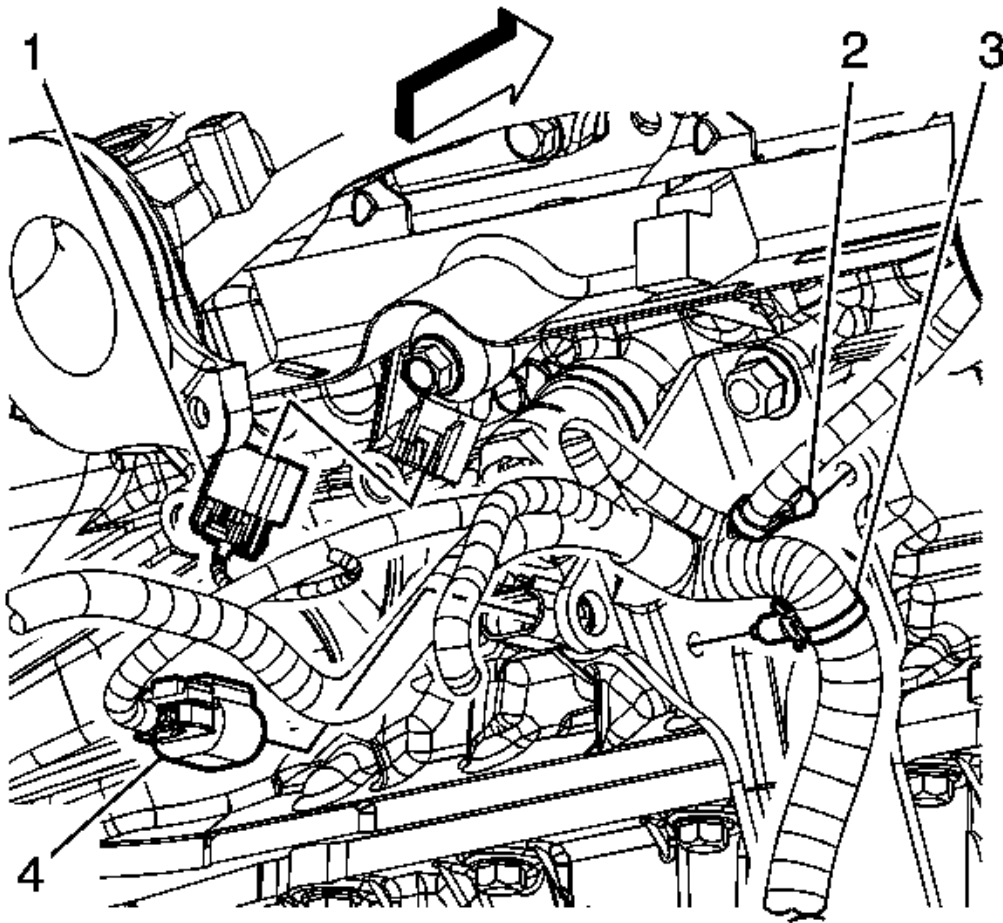


Fig. 177: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

32. Disconnect the knock sensor electrical connector (1).
33. Disconnect the crankshaft position (CKP) sensor electrical connector (4).
34. Remove the engine harness clips (2, 3) from the transaxle brace.

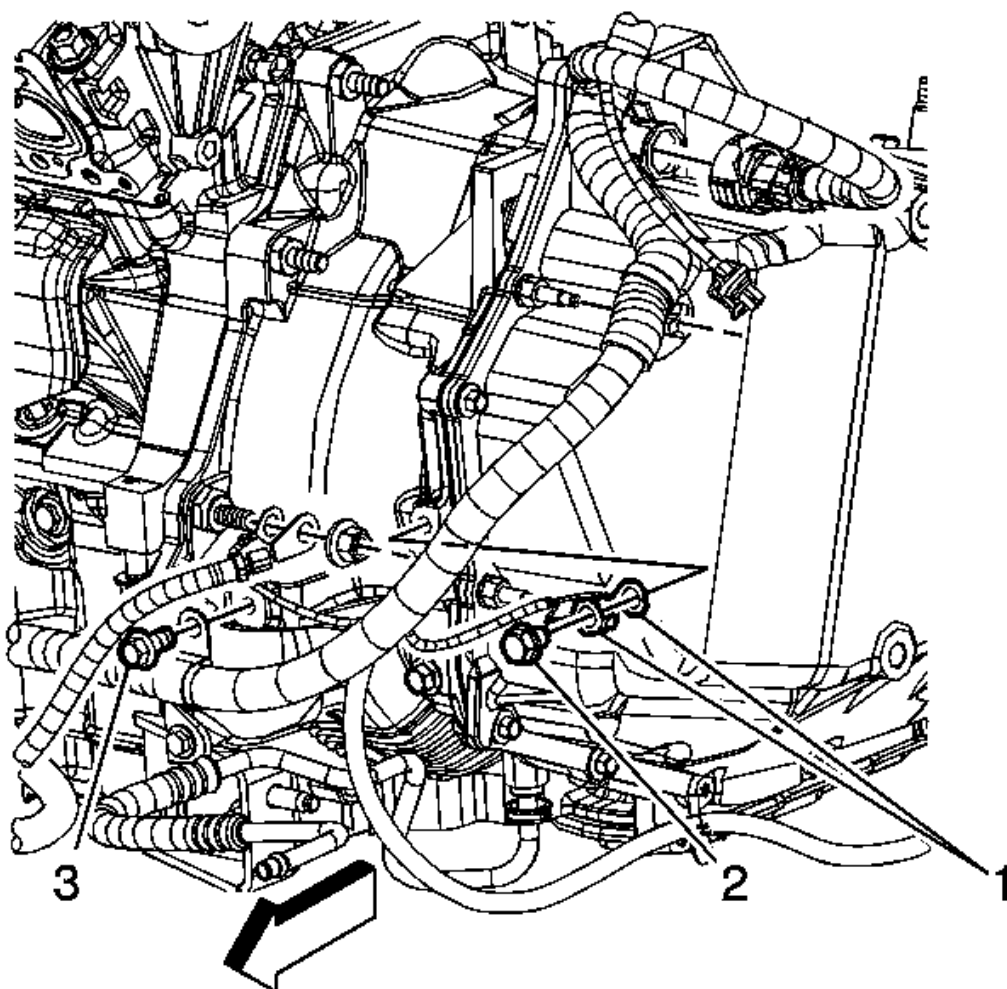


Fig. 178: Engine Harness Bolts & Terminals
Courtesy of GENERAL MOTORS CORP.

35. Remove the engine harness ground bolt (2).
36. Remove the engine harness ground terminals (1) from the transmission.
37. Remove the engine harness clip bolt (3) from the transmission.
38. Reposition all branches of the engine harness out of the way.
39. Remove the catalytic converter.

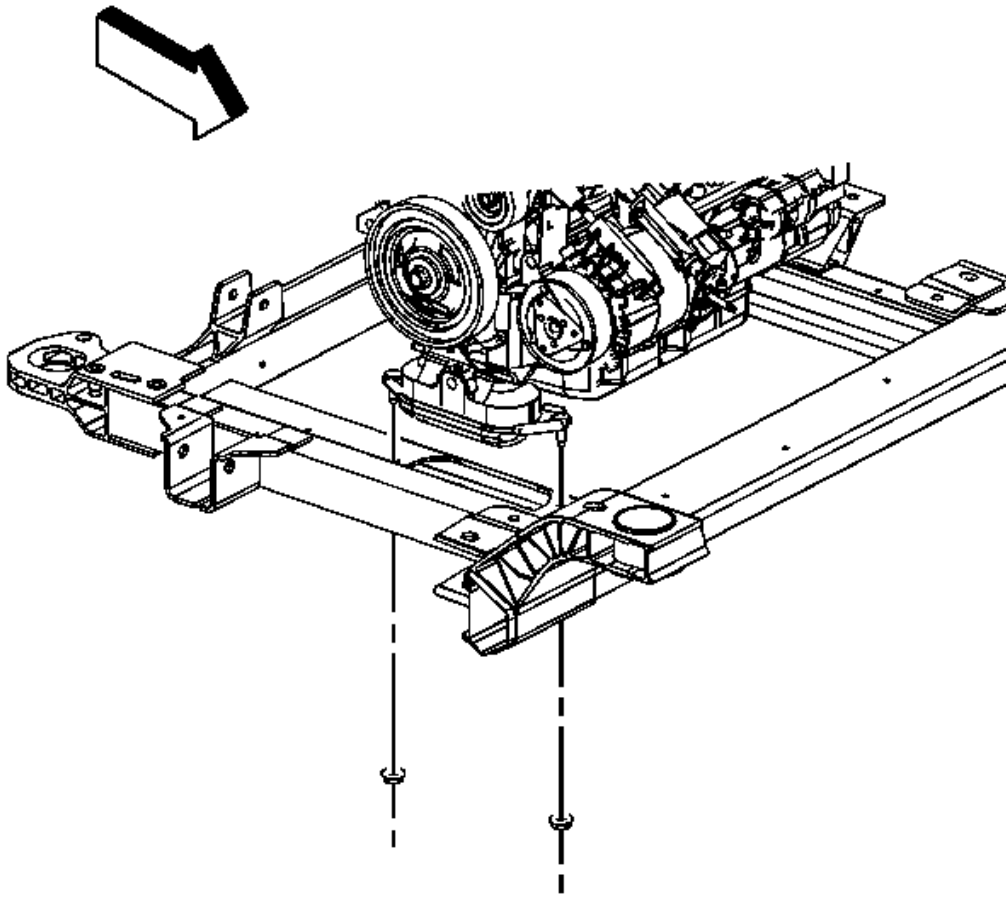


Fig. 179: Engine Mount Lower Nuts
Courtesy of GENERAL MOTORS CORP.

40. Remove the engine mount lower nuts.

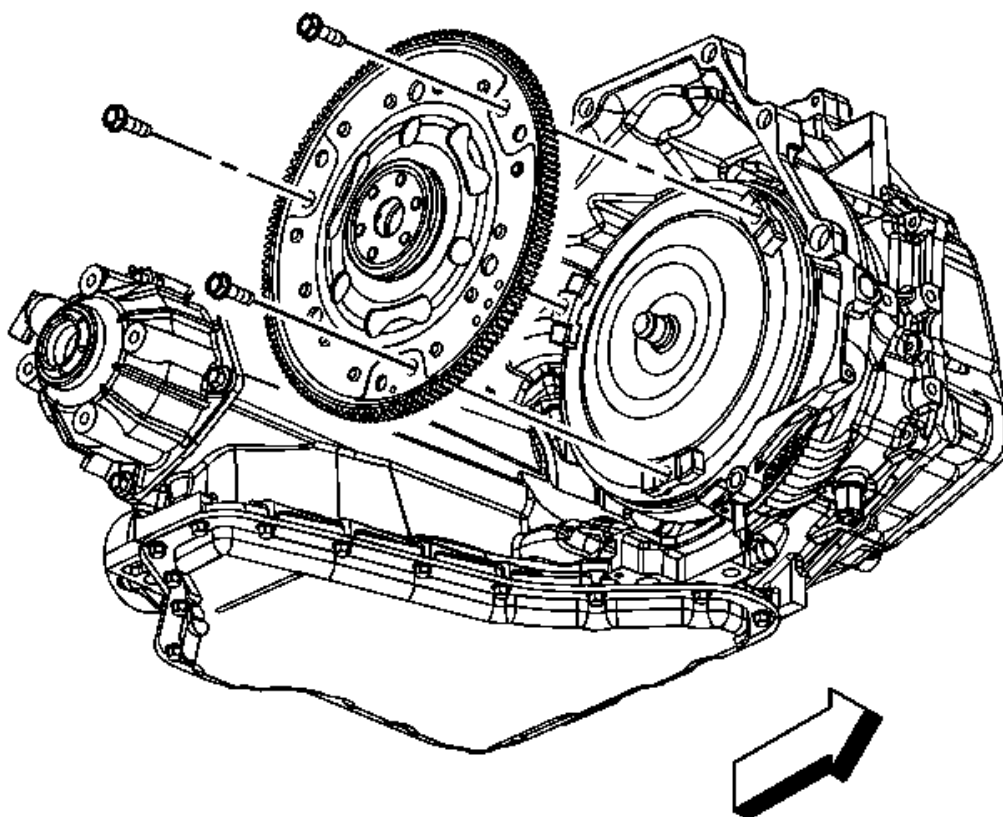


Fig. 180: Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

41. Remove the torque converter cover. Refer to **Torque Converter Cover Replacement** .
42. Remove the starter motor. Refer to **Starter Replacement (V6)** .
43. Remove the torque converter bolts.

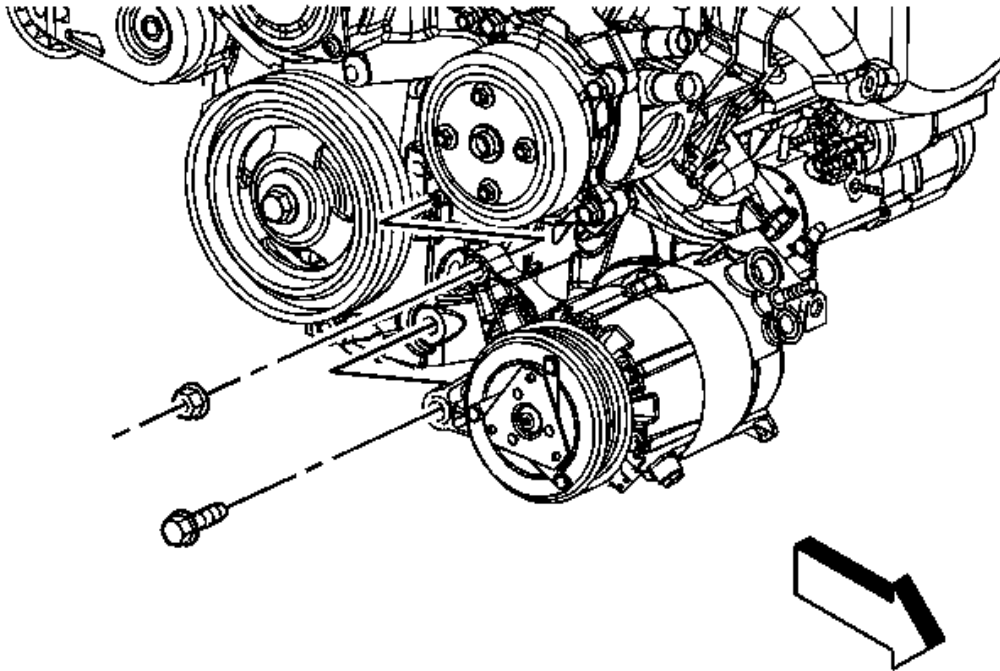


Fig. 181: Air Conditioning Compressor Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

44. Remove the A/C compressor front bolt and nut.

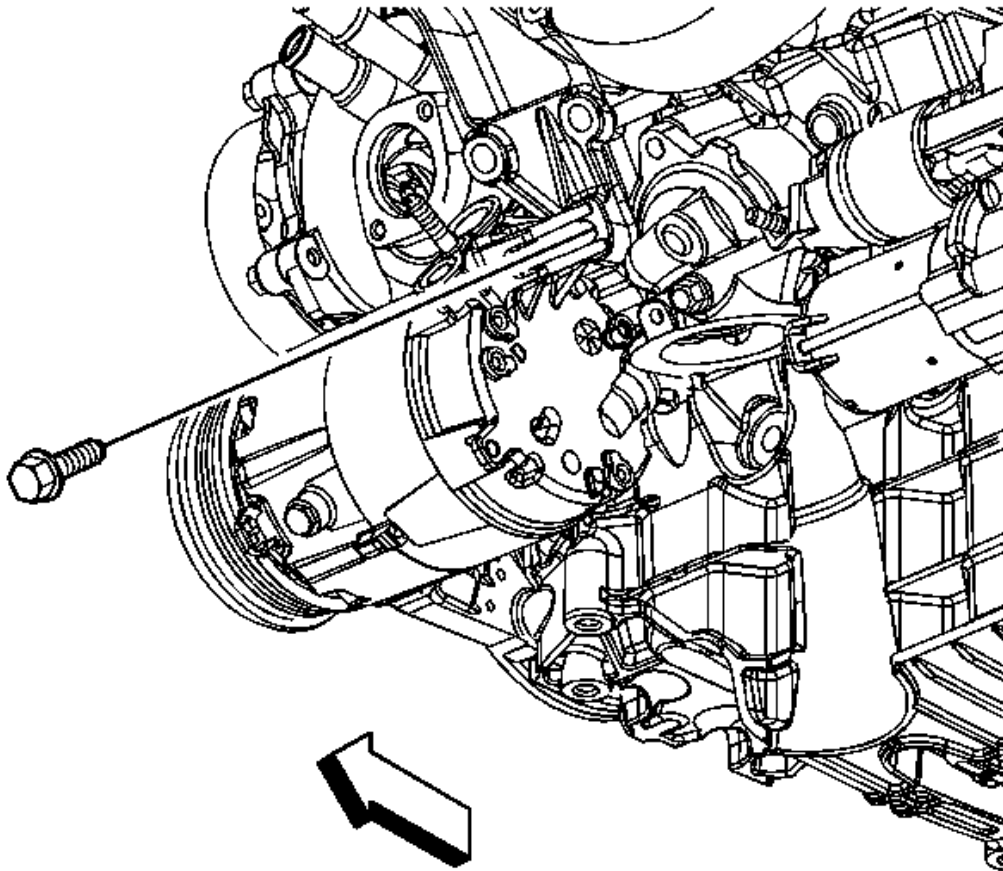


Fig. 182: A/C Compressor Rear Bolt
Courtesy of GENERAL MOTORS CORP.

45. Remove the A/C compressor rear bolt and reposition the compressor off to the side. DO NOT discharge the A/C system.

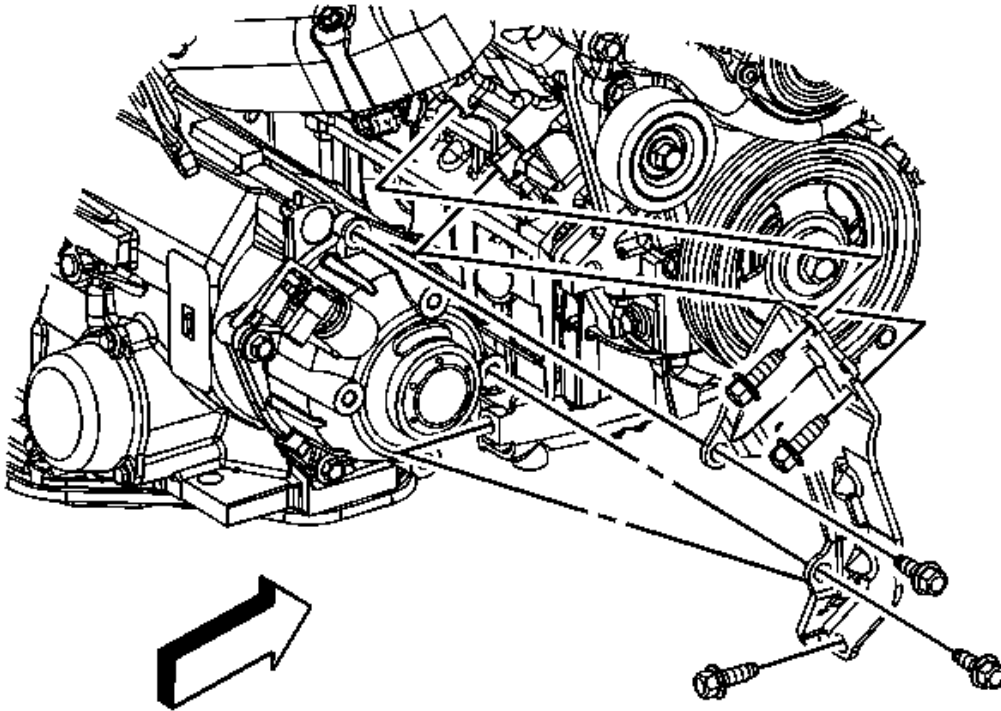


Fig. 183: Rear Transaxle Brace To Engine/Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

46. Remove the transaxle brace to transaxle bolts.
47. Remove the transaxle brace to engine bolts.
48. Remove the transaxle brace.

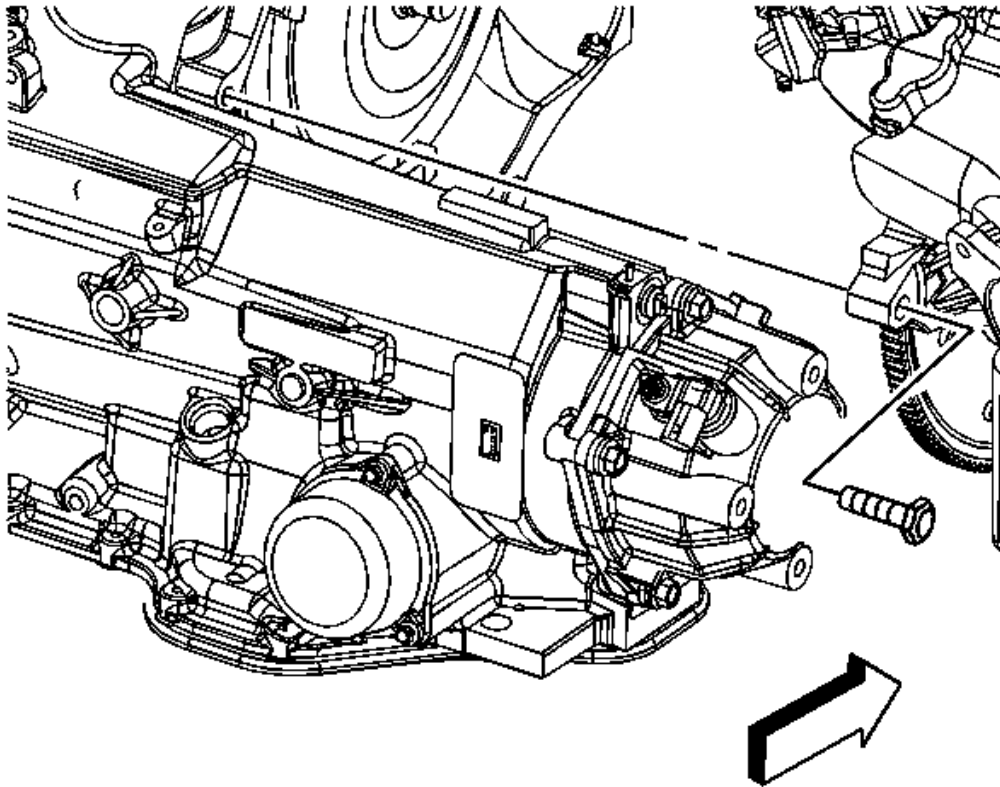


Fig. 184: Transaxle-To-Engine Lower Rear Bolt
Courtesy of GENERAL MOTORS CORP.

49. Remove the transaxle-to-engine lower rear bolt.

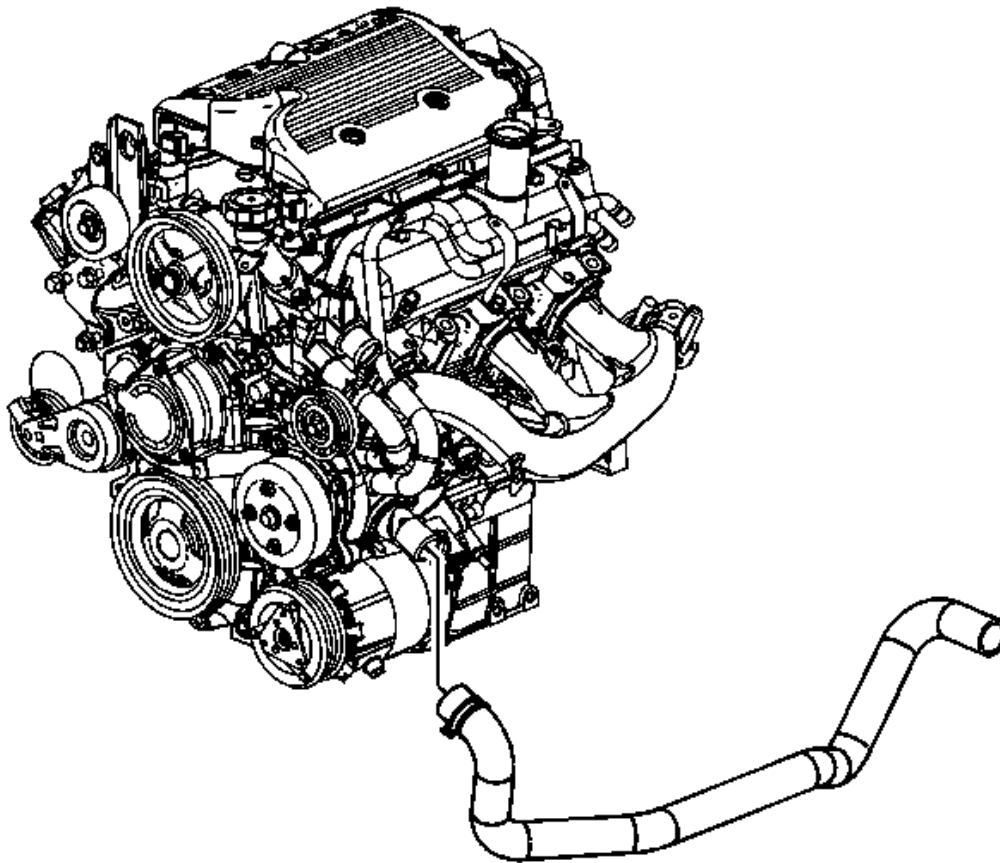


Fig. 185: Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

50. Reposition the radiator outlet hose clamp at the thermostat housing.
51. Remove the radiator outlet hose from the thermostat housing.
52. Lower the vehicle and support the transaxle.

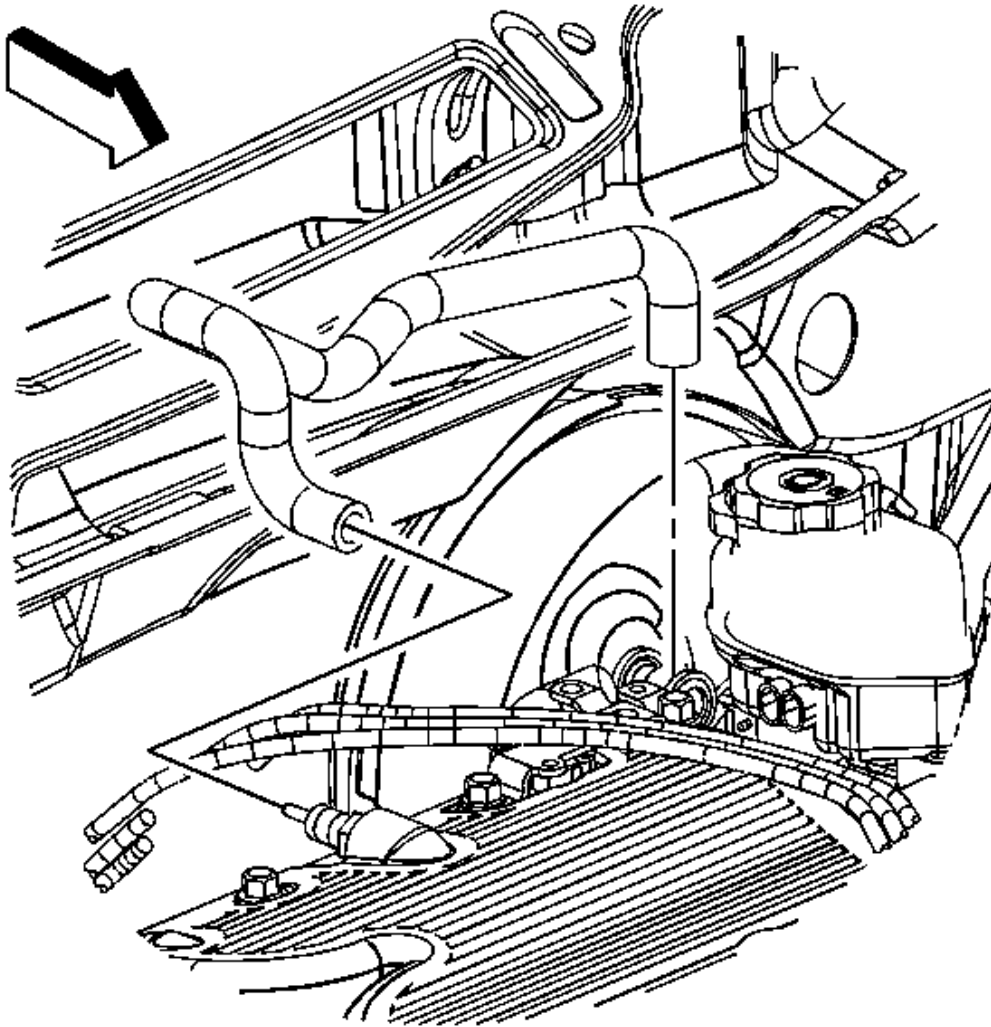


Fig. 186: Brake Booster Vacuum Hose & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

53. Remove the brake booster vacuum hose from the intake manifold.

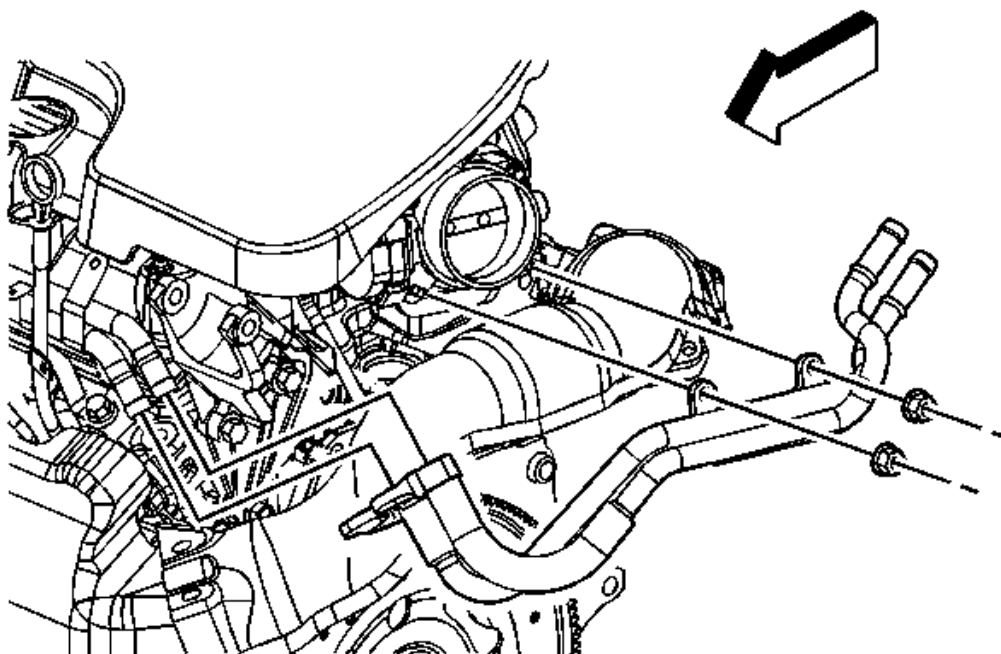


Fig. 187: Heater Inlet & Outlet Hoses/Pipes
Courtesy of GENERAL MOTORS CORP.

54. Reposition the heater inlet and outlet hose clamps at the engine.
55. Remove the heater inlet and outlet hoses from the engine pipes.
56. Remove the exhaust crossover pipe. Refer to **Exhaust Crossover Pipe Replacement** .
57. Disconnect the fuel feed line from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
58. Disconnect the EVAP purge line from the canister purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

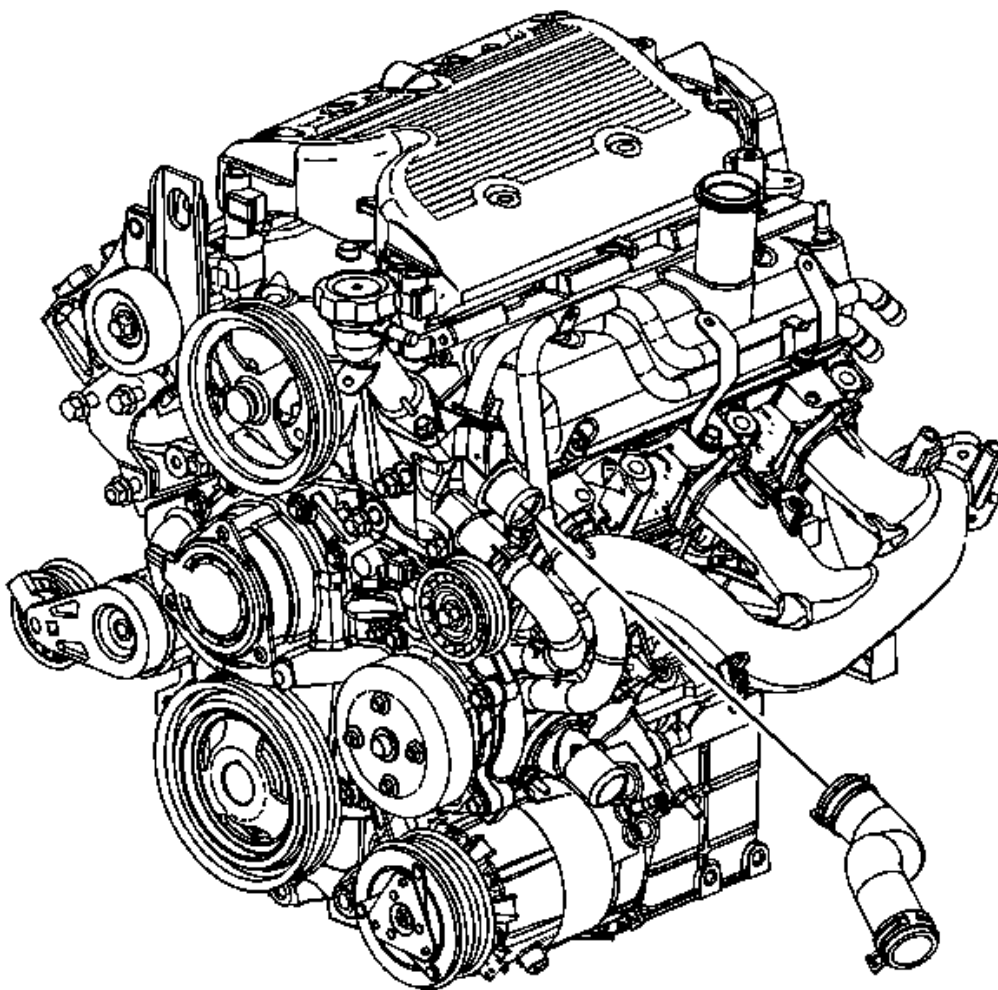


Fig. 188: Radiator Inlet Hose

Courtesy of GENERAL MOTORS CORP.

59. Reposition the radiator inlet hose clamp at the engine.
60. Remove the radiator inlet hose from the engine.

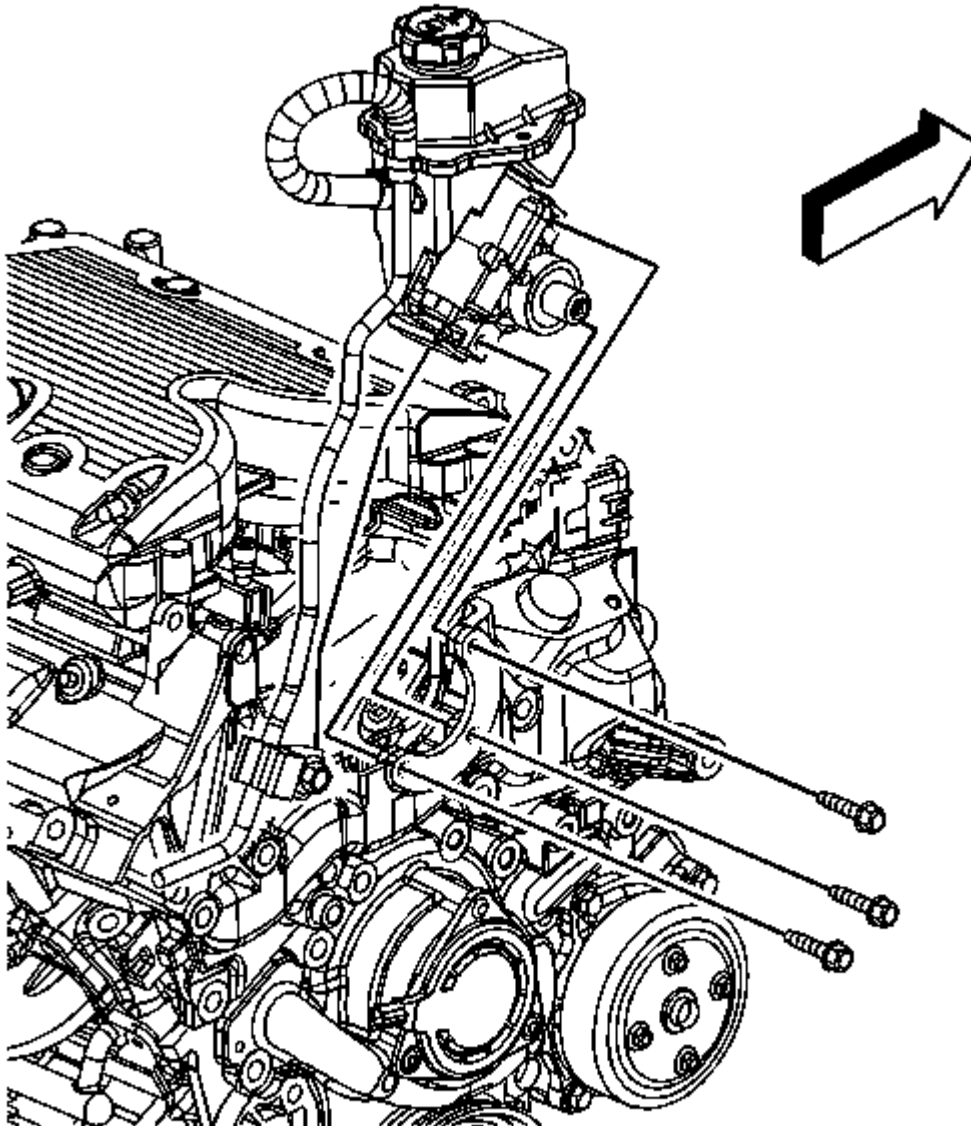


Fig. 189: Power Steering Pump & Bolts
 Courtesy of GENERAL MOTORS CORP.

61. Remove the power steering pump bolts and reposition. Refer to **Power Steering Pump Replacement (LZ9/LGD)**.
62. Install a engine lifting device to the engine.

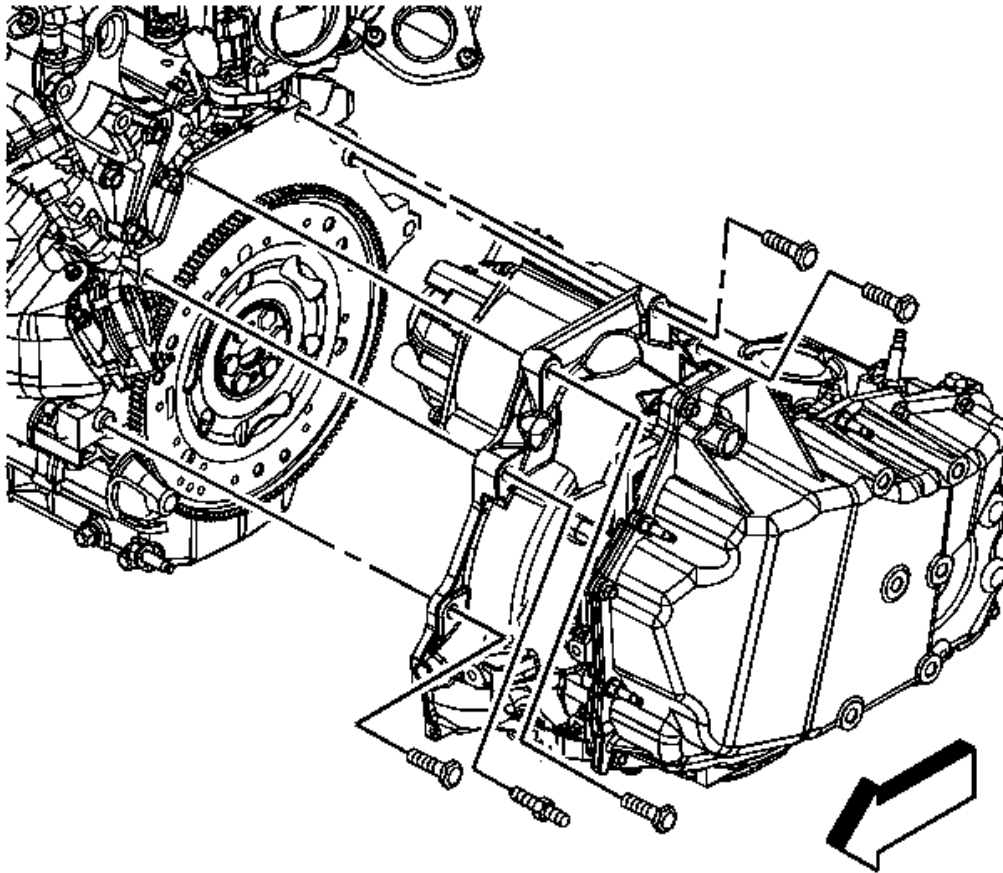


Fig. 190: Transaxle-To-Engine Bolts/Studs
Courtesy of GENERAL MOTORS CORP.

63. Remove the transaxle-to-engine bolts/studs.
64. Remove the engine from the vehicle.
65. Remove the flywheel. Refer to **Engine Flywheel Removal (Automatic Transmission)** or **Engine Flywheel Removal (Manual Transmission)** .
66. Install the engine to a engine stand.

INSTALLATION PROCEDURE

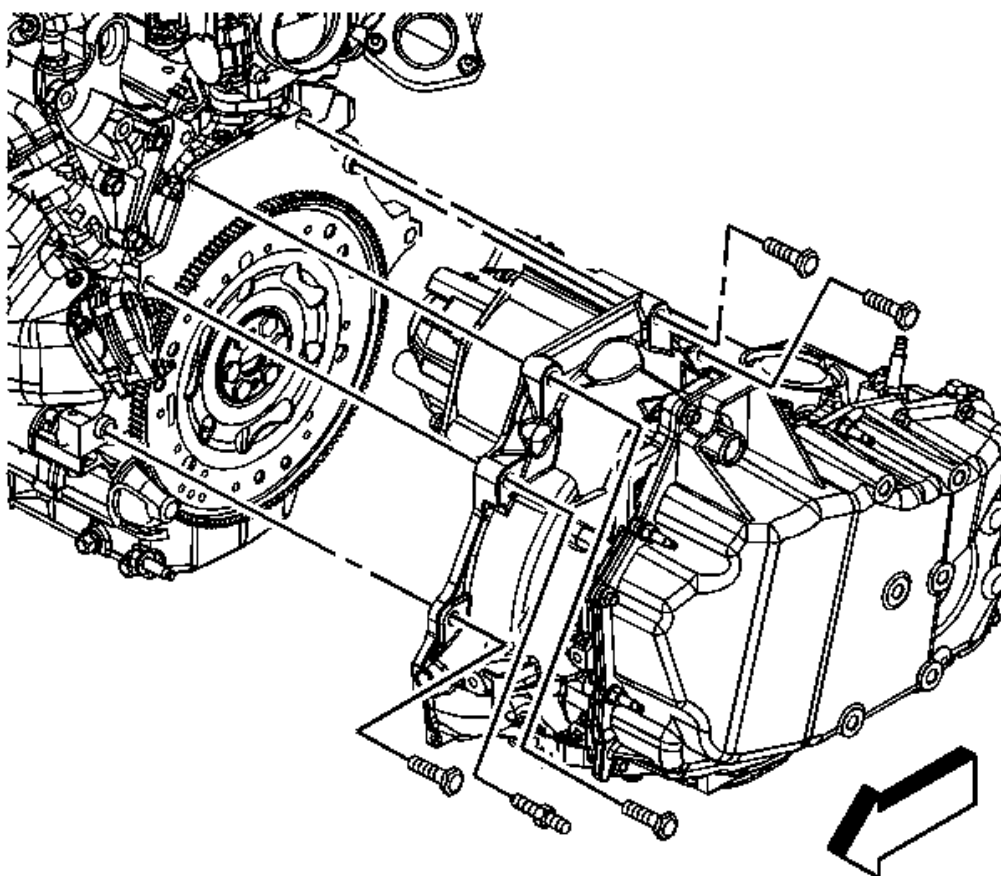


Fig. 191: Transaxle-To-Engine Bolts/Studs
Courtesy of GENERAL MOTORS CORP.

1. Install a engine lifting devise to the engine.
2. Remove the engine from the engine stand.
3. Install the flywheel. Refer to **Engine Flywheel Installation (Automatic Transmission)** or **Engine Flywheel Installation (Manual Transmission)** .
4. Install the engine to the vehicle.

CAUTION: Refer to **Fastener Caution** .

5. Install the transaxle-to-engine bolts/studs.

Tighten: Tighten the bolts/stud to 75 N.m (55 lb ft).

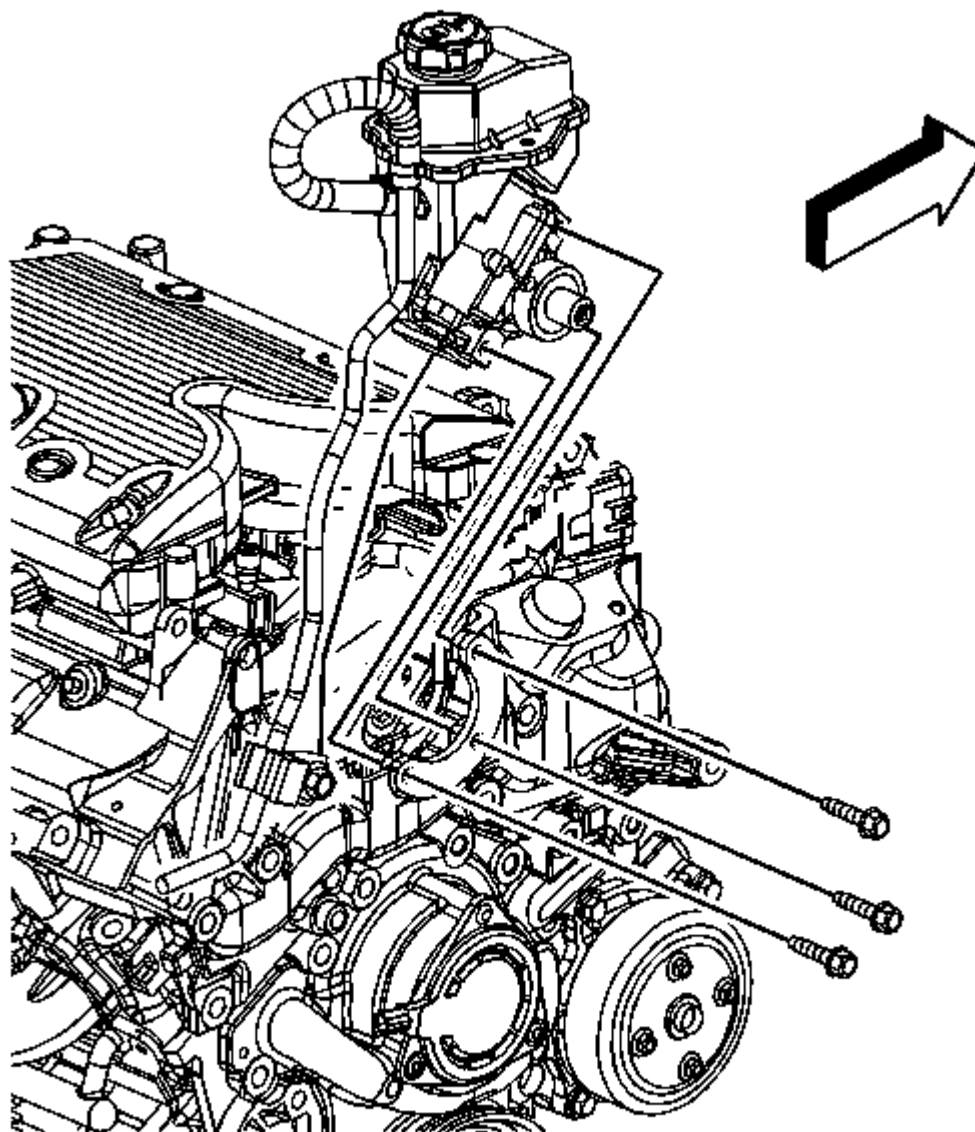


Fig. 192: Power Steering Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine lifting device from the engine.
7. Position and install the power steering pump bolts. Refer to **Power Steering Pump Replacement (LZ9/LGD)**.

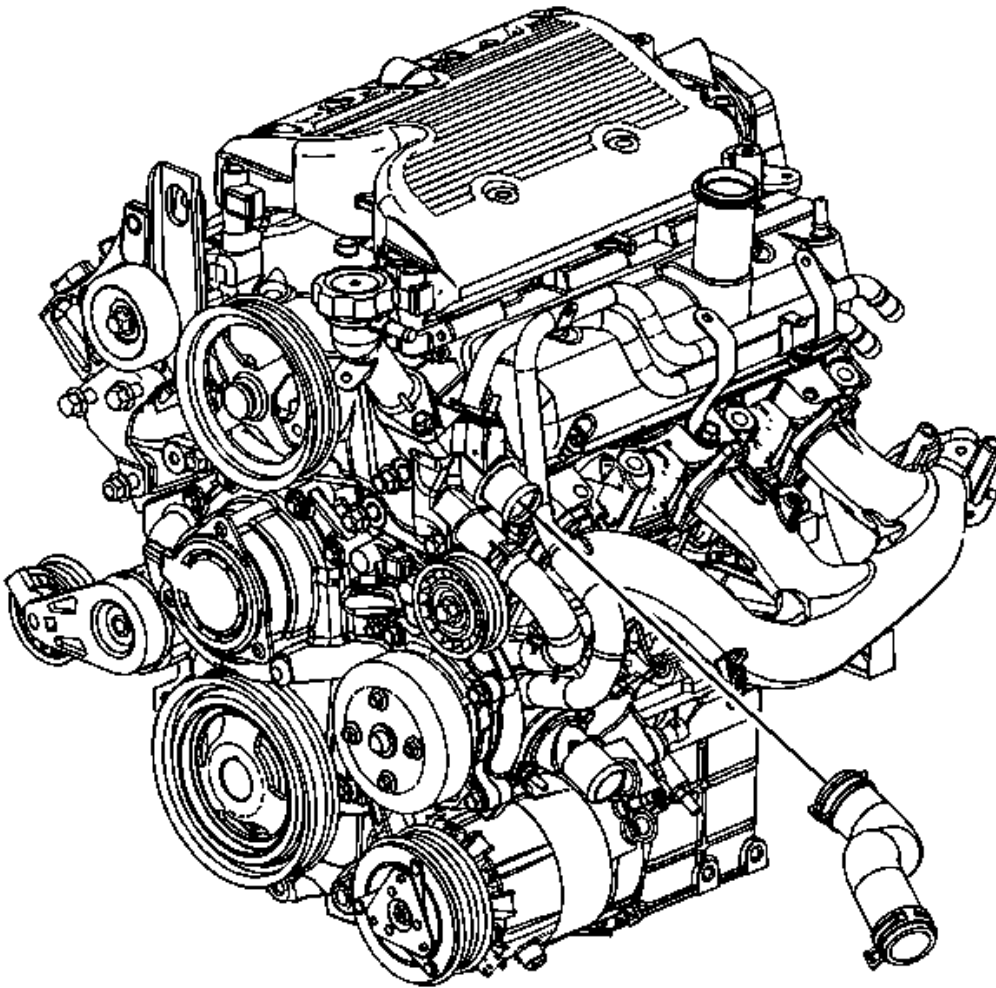


Fig. 193: Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

8. Install the radiator inlet hose to the engine.
9. Position the radiator inlet hose clamp at the engine.

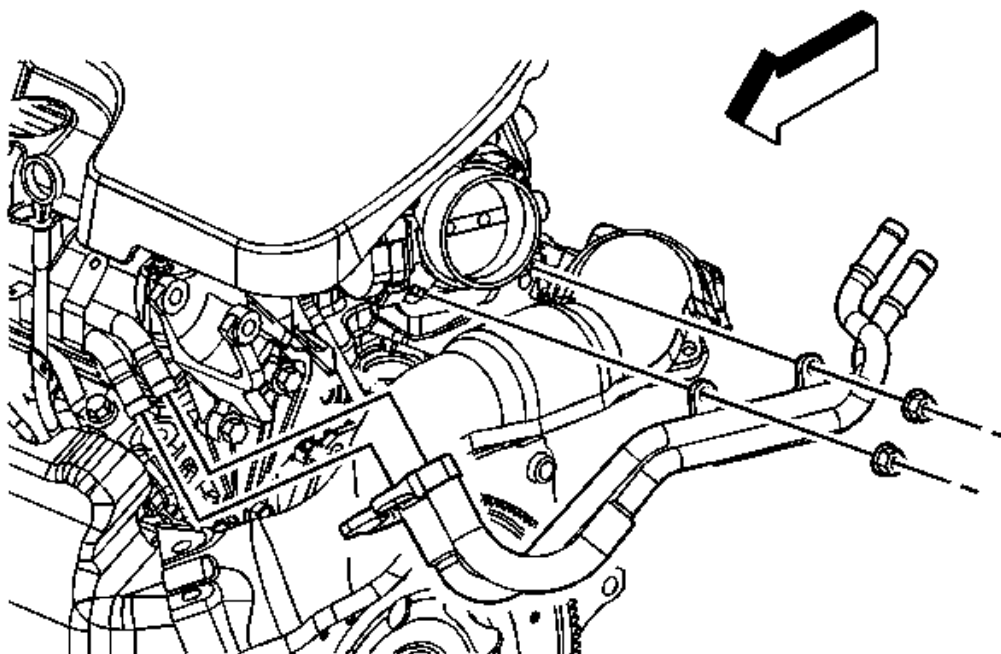


Fig. 194: Heater Inlet & Outlet Hoses/Pipes
Courtesy of GENERAL MOTORS CORP.

10. Connect the EVAP purge line to the canister purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Connect the fuel feed line to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
12. Install the exhaust crossover pipe. Refer to **Exhaust Crossover Pipe Replacement** .
13. Install the heater inlet and outlet hoses to the engine pipes.
14. Position the heater inlet and outlet hose clamps at the engine.

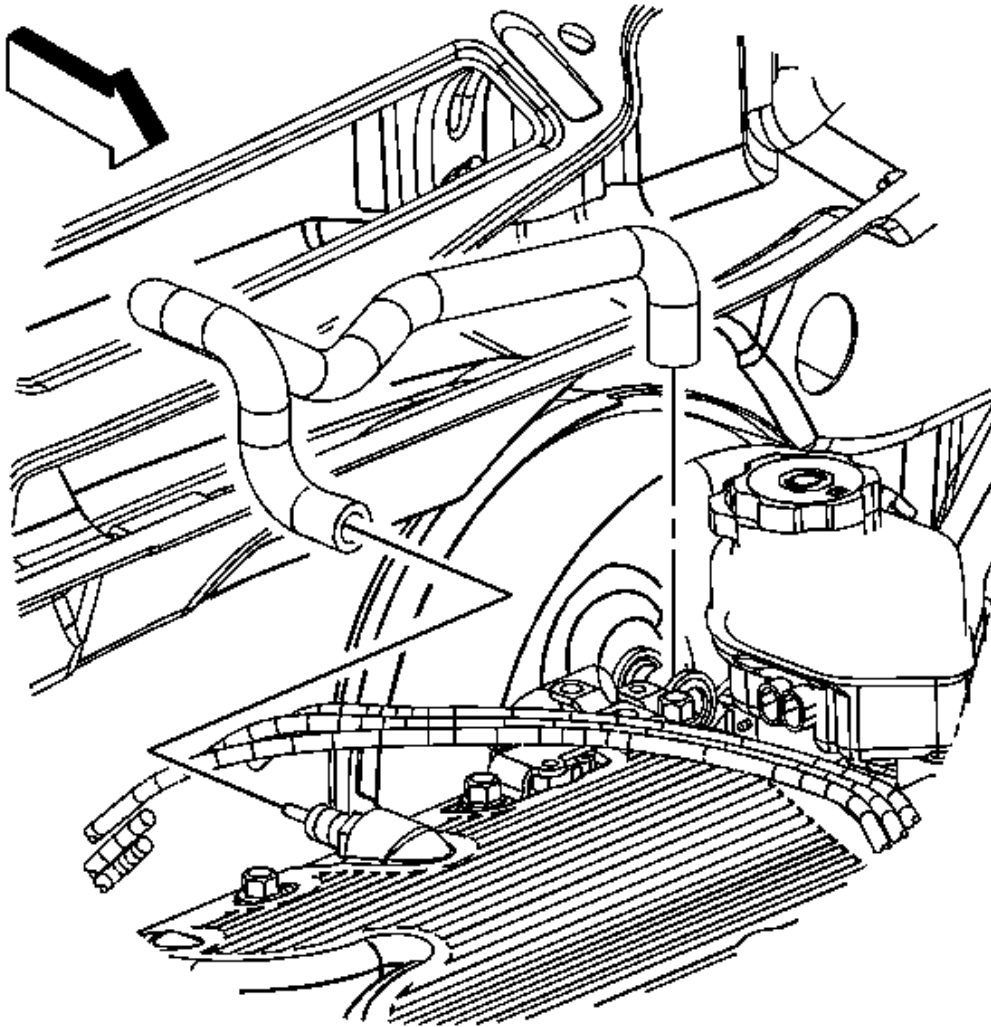


Fig. 195: Brake Booster Vacuum Hose & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

15. Install the brake booster vacuum hose to the intake manifold.

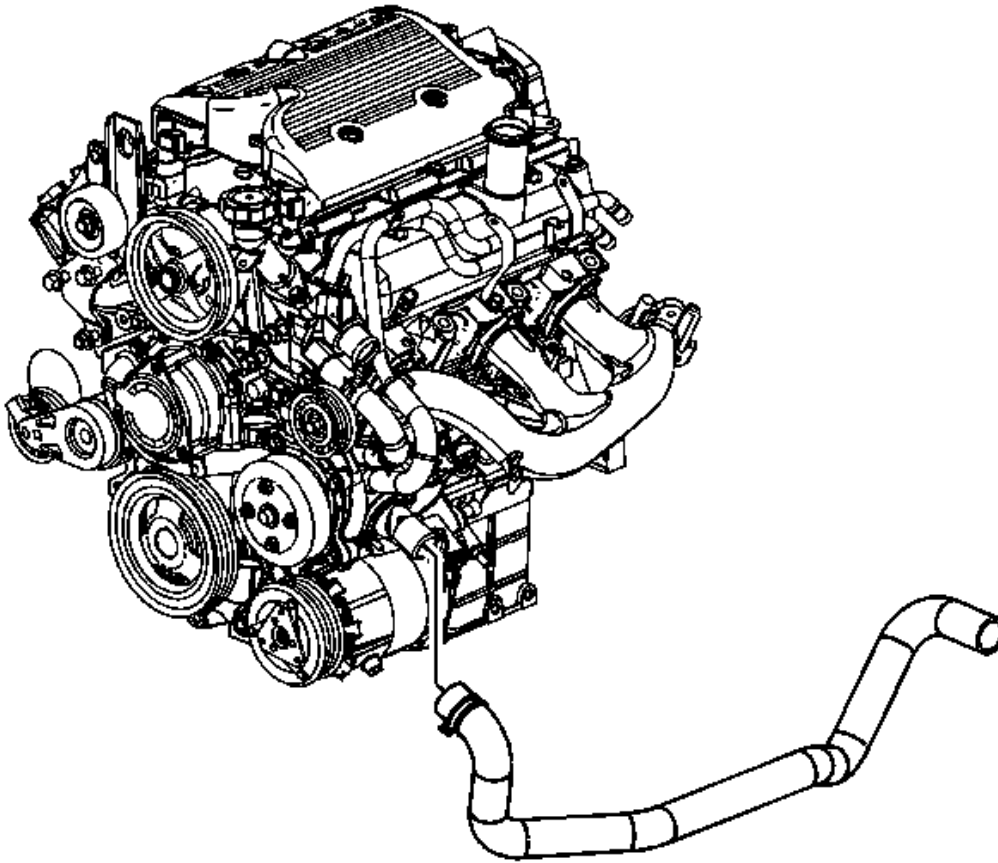


Fig. 196: Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

16. Install the radiator outlet hose to the thermostat housing.
17. Position the radiator outlet hose clamp at the thermostat housing.
18. Raise and support the vehicle.

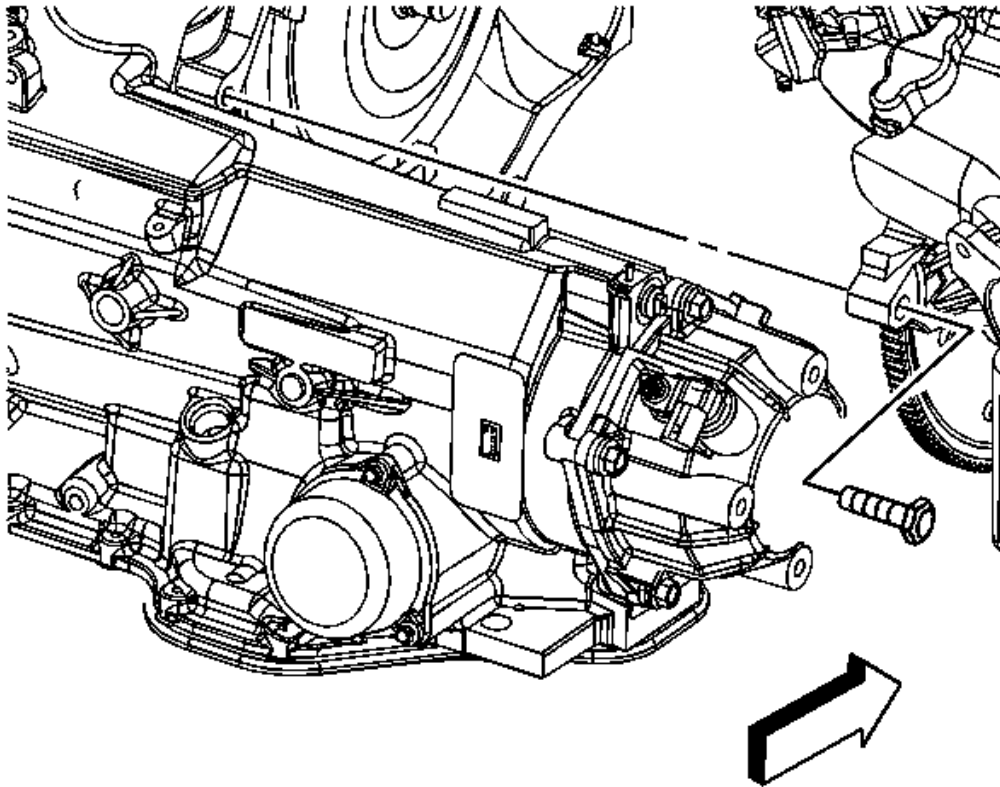


Fig. 197: Transaxle-To-Engine Lower Rear Bolt
Courtesy of GENERAL MOTORS CORP.

19. Install the transaxle-to-engine lower rear bolt.

Tighten: Tighten the bolt to 75 N.m (55 lb ft).

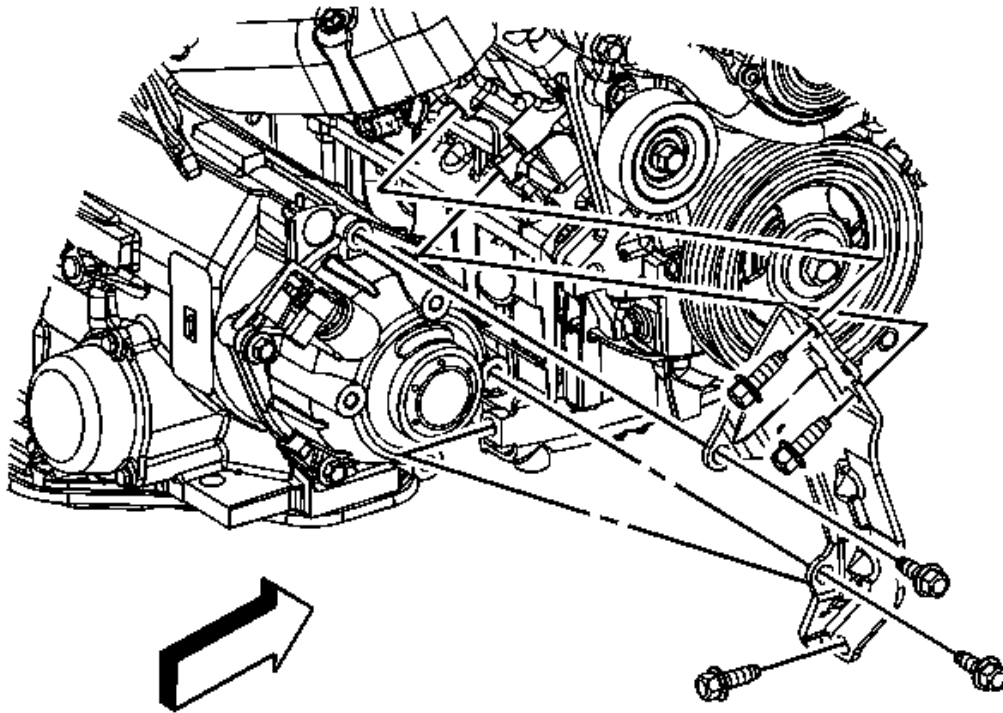


Fig. 198: Rear Transaxle Brace To Engine/Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

20. Install the transaxle brace.
21. Install the transaxle brace to engine bolts.
22. Install the transaxle brace to transaxle bolts.

Tighten: Tighten the bolts to 63 N.m (46 lb ft).

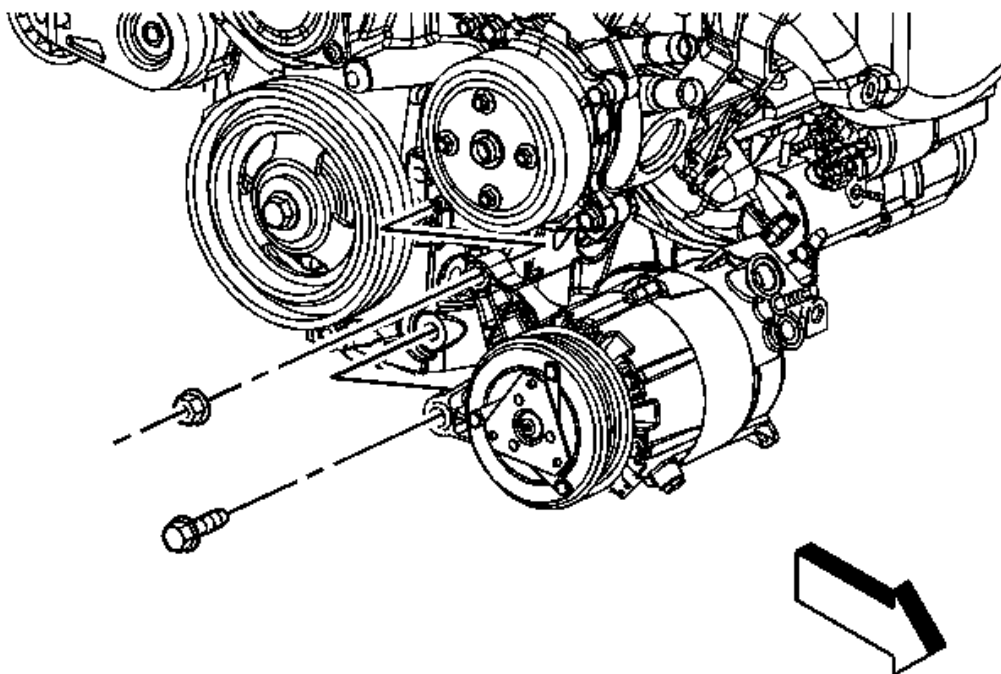


Fig. 199: Air Conditioning Compressor Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

23. Position the A/C compressor and install the compressor front bolt and nut.

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

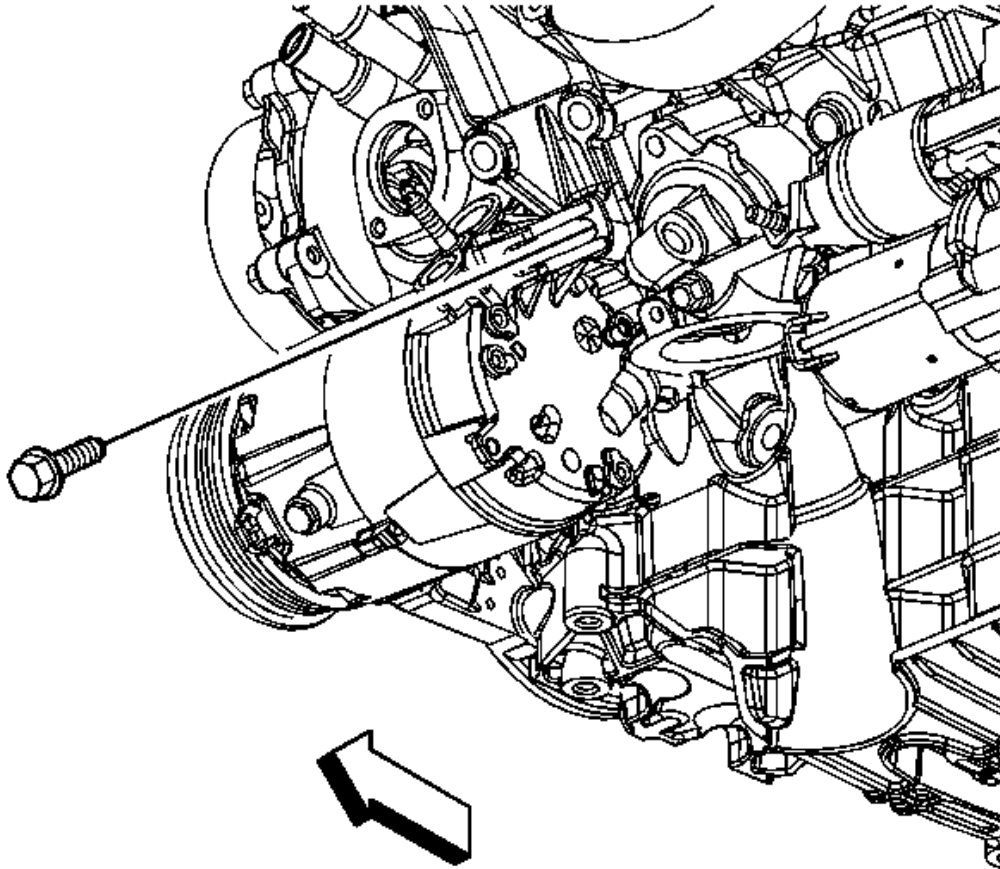


Fig. 200: A/C Compressor Rear Bolt
Courtesy of GENERAL MOTORS CORP.

24. Install the A/C compressor rear bolt.

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

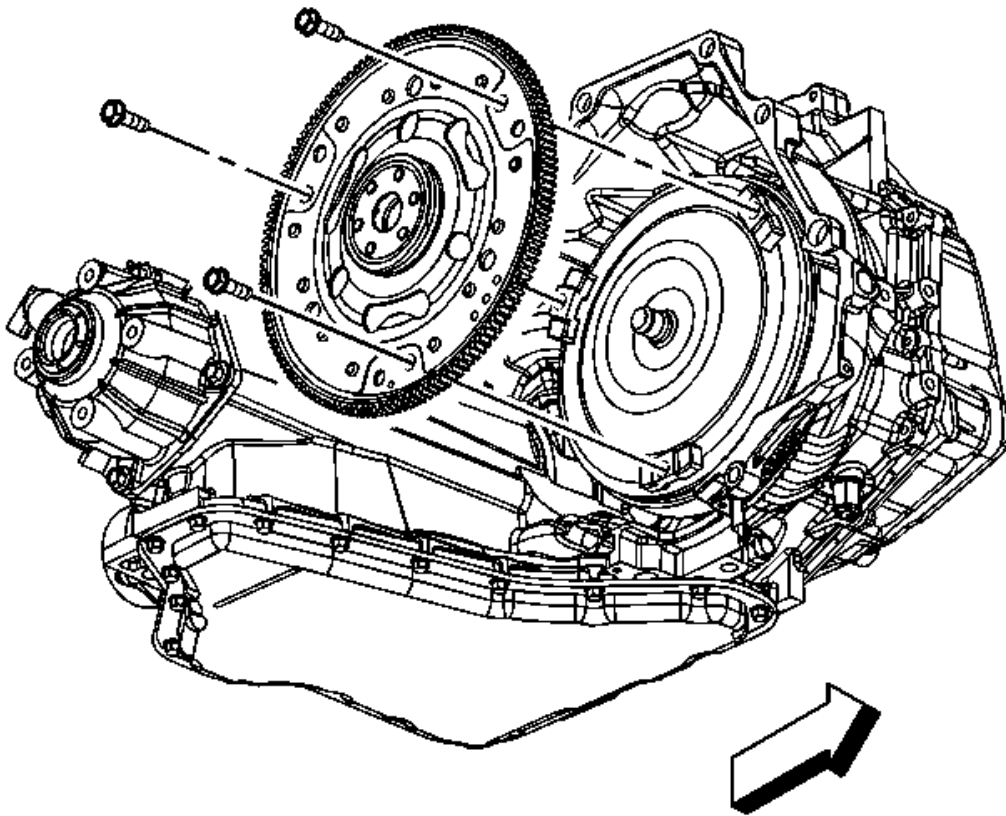


Fig. 201: Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the torque converter bolts.

Tighten: Tighten the bolts to 63 N.m (46 lb ft).

26. Install the starter motor. Refer to **Starter Replacement (V6)** .
27. Install the torque converter cover. Refer to **Torque Converter Cover Replacement** .

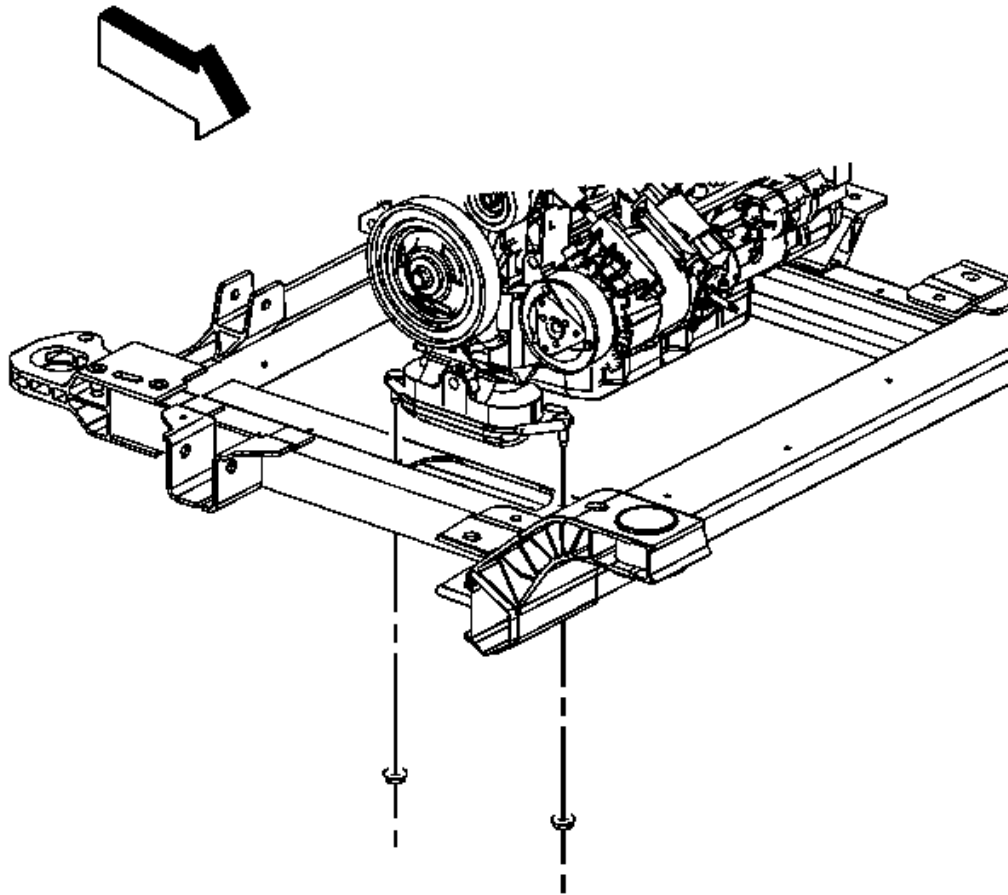


Fig. 202: Engine Mount Lower Nuts
 Courtesy of GENERAL MOTORS CORP.

28. Install the engine mount lower nuts.

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

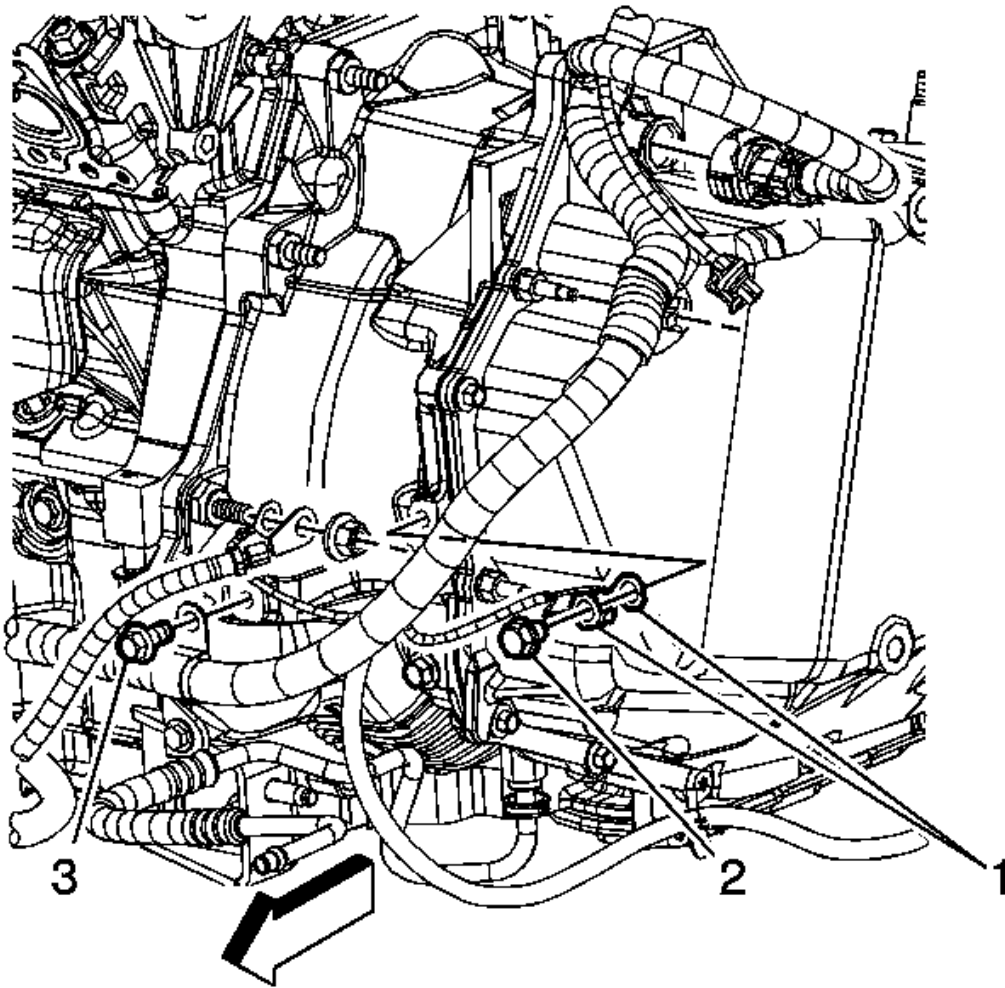


Fig. 203: Engine Harness Bolts & Terminals
Courtesy of GENERAL MOTORS CORP.

29. Install the catalytic converter.
30. Position the engine harness over the engine.
31. Position the engine harness ground terminals (1) to the transmission.
32. Install the engine harness ground bolt (2).

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

33. Install the engine harness clip bolt (3) to the transmission.

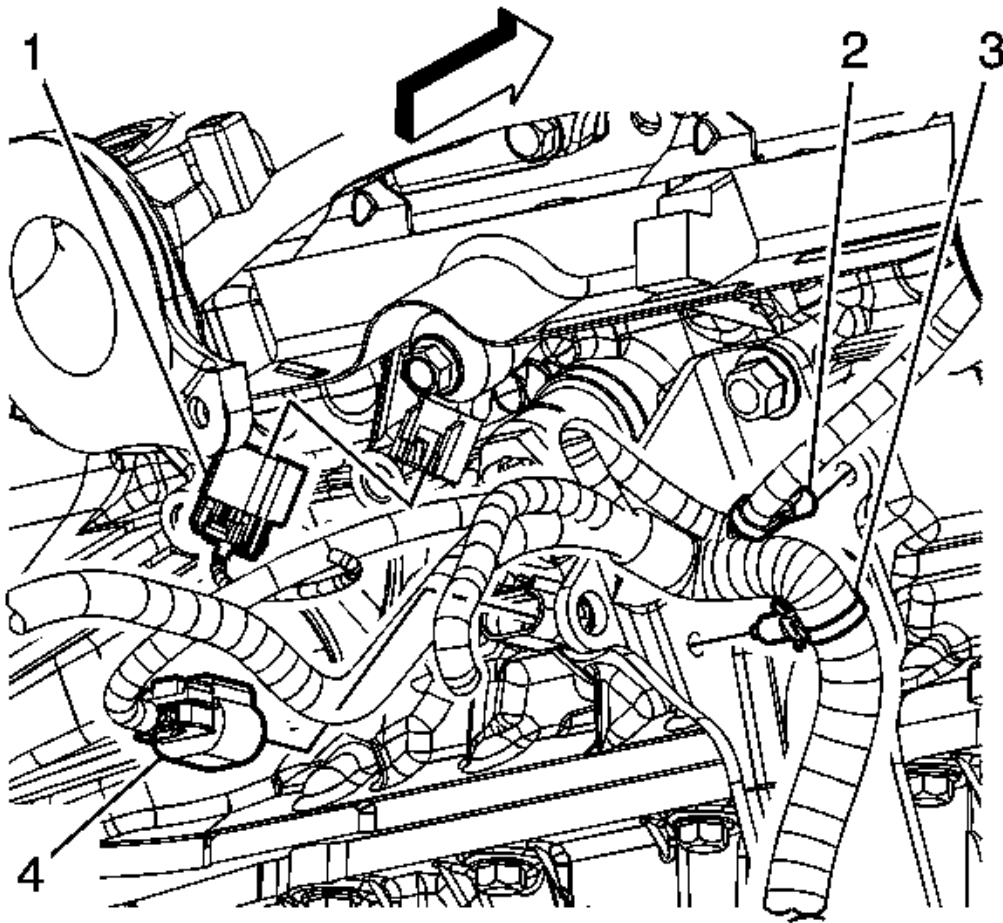


Fig. 204: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

34. Connect the CKP sensor electrical connector (4).
35. Connect the knock sensor electrical connector (1).
36. Install the engine harness clips (2, 3) to the transaxle brace.
37. Lower the vehicle.

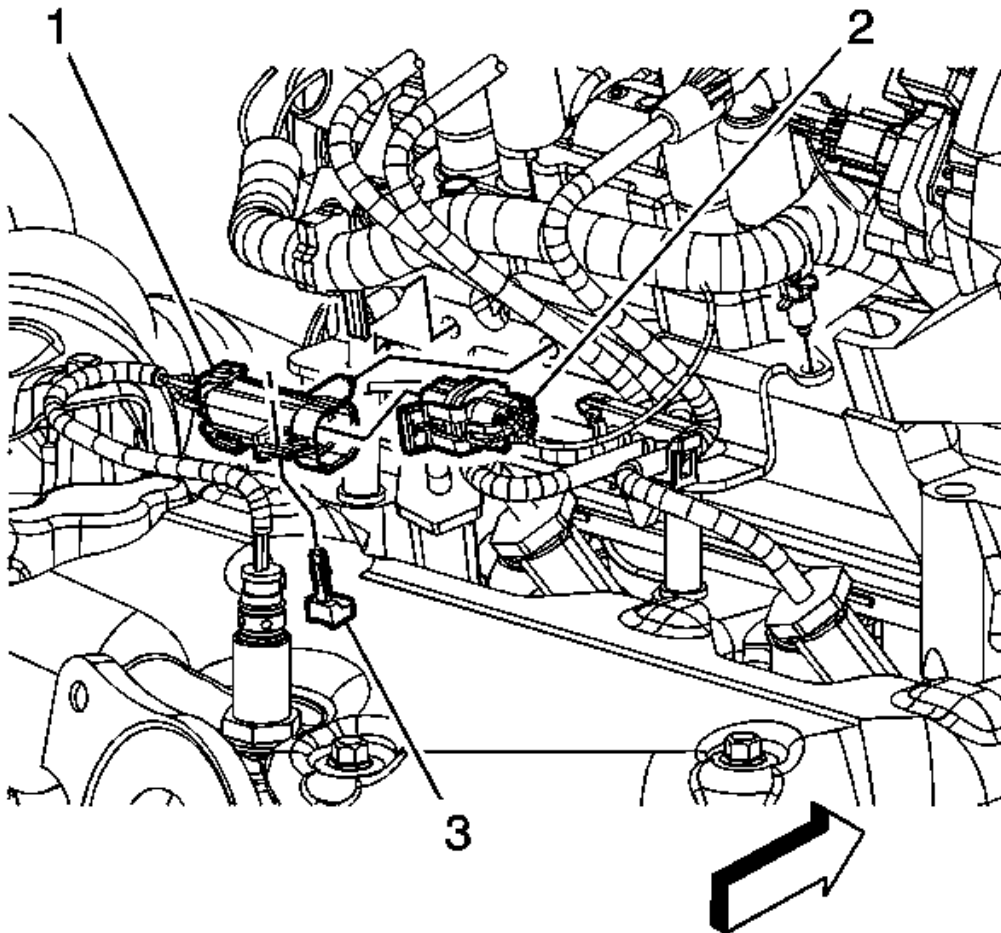


Fig. 205: HO2S Electrical Connector Clip & Ignition Coil Bracket
Courtesy of GENERAL MOTORS CORP.

38. Connect the rear upper HO2S electrical connector (2).
39. Install the CPA retainer (3).

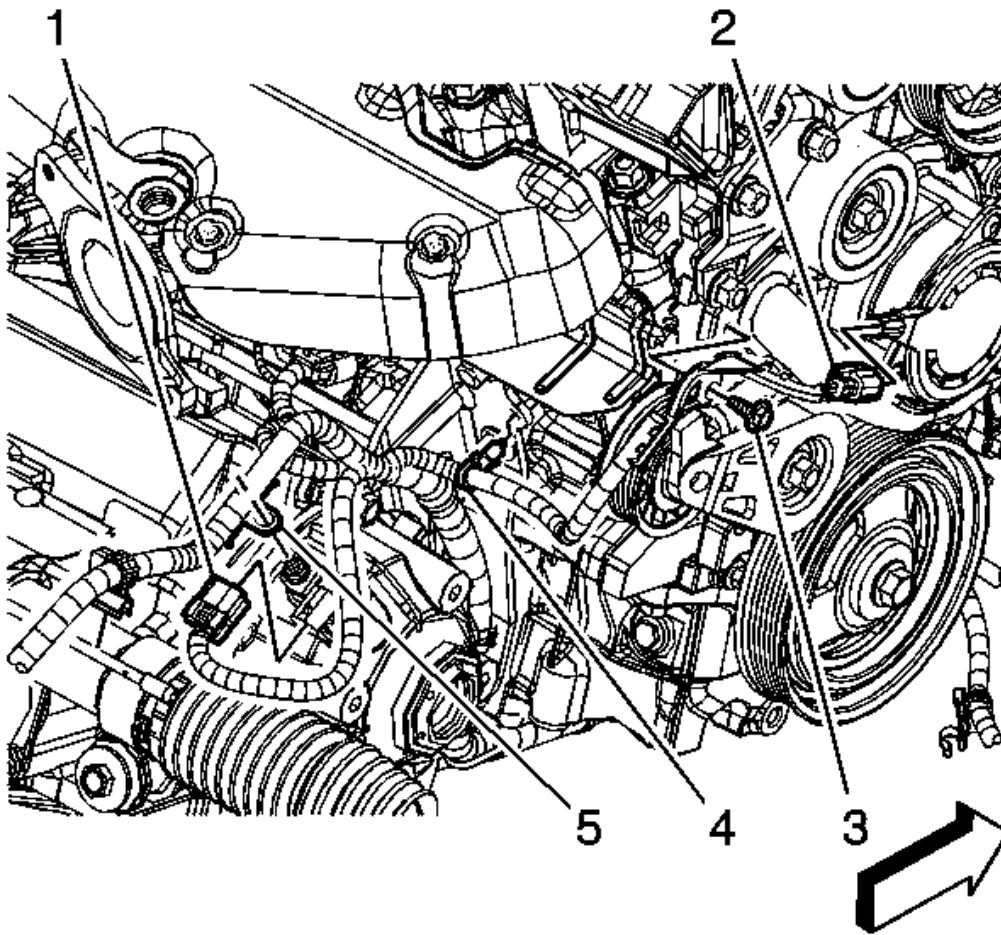


Fig. 206: Camshaft Position Actuator Magnet Electrical Connector
Courtesy of GENERAL MOTORS CORP.

40. Install the engine harness clip (4) to the transaxle bracket.
41. Install the engine harness clip bolt (3).

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

42. Connect the camshaft phasor sensor electrical connector (2).

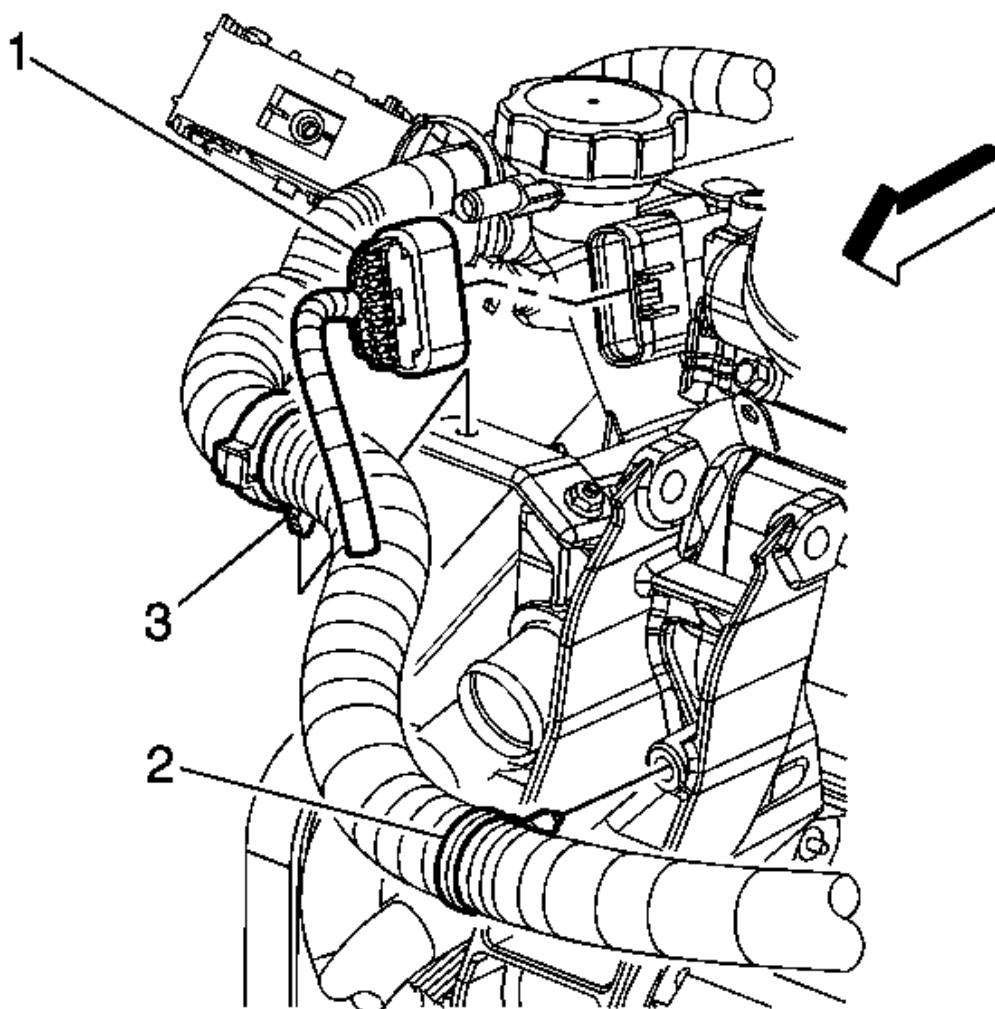


Fig. 207: Fuel Injector Inline Connector
 Courtesy of GENERAL MOTORS CORP.

43. Connect the fuel injector inline (1) electrical connector.
44. Install the engine harness clips (2, 3) to the brackets.

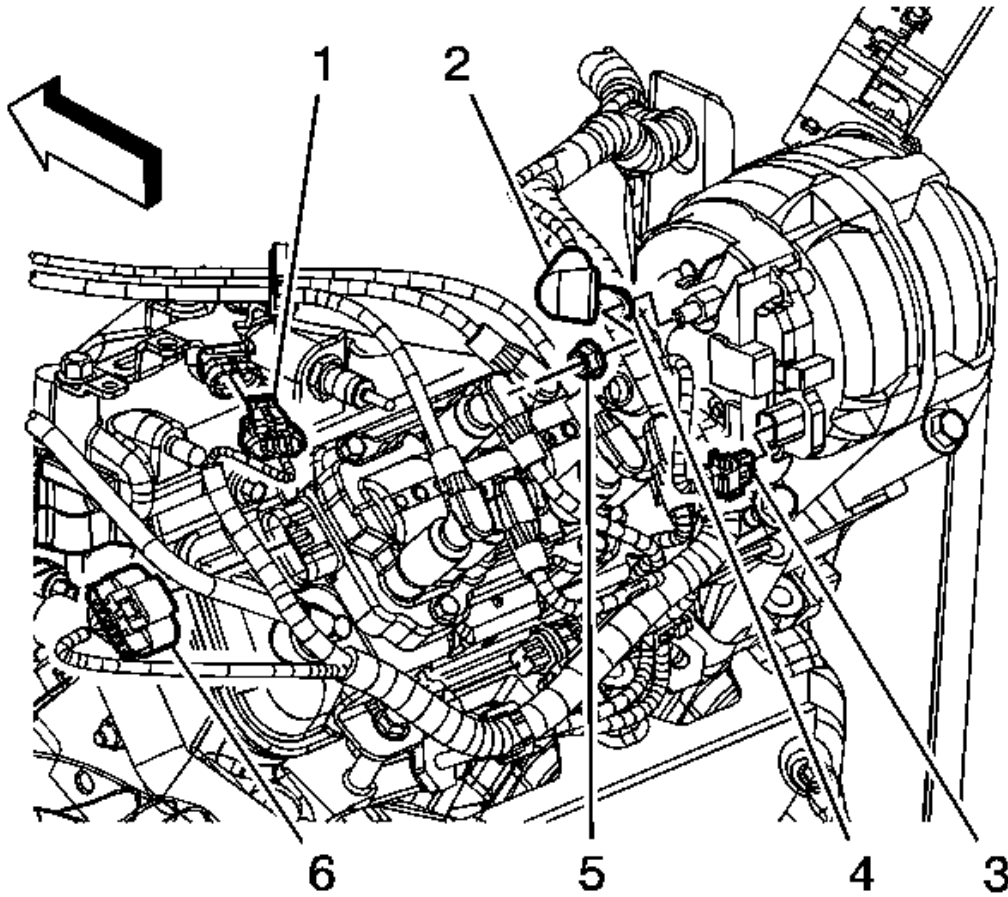


Fig. 208: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

45. Connect the ignition coil electrical connector (6).
46. Connect the generator electrical connector (3).
47. Install the generator terminal (4).
48. Install the generator terminal nut (5).

Tighten: Tighten the nut to 30 N.m (22 lb ft).

49. Position the generator terminal boot (2).
50. Connect the MAP sensor electrical connector (1).

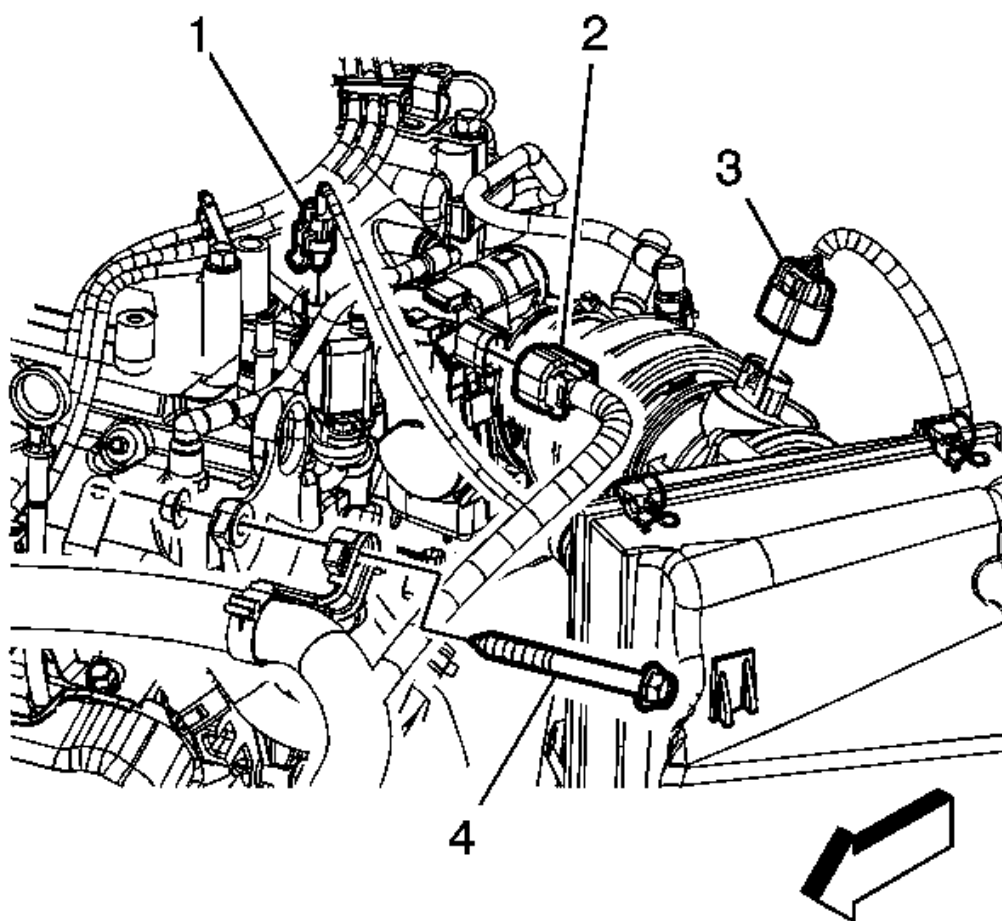


Fig. 209: EVAP Canister Purge Solenoid & Electronic Throttle Control Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

51. Connect the ETC (2) electrical connector.
52. Connect the EVAP canister purge solenoid (1) electrical connector.

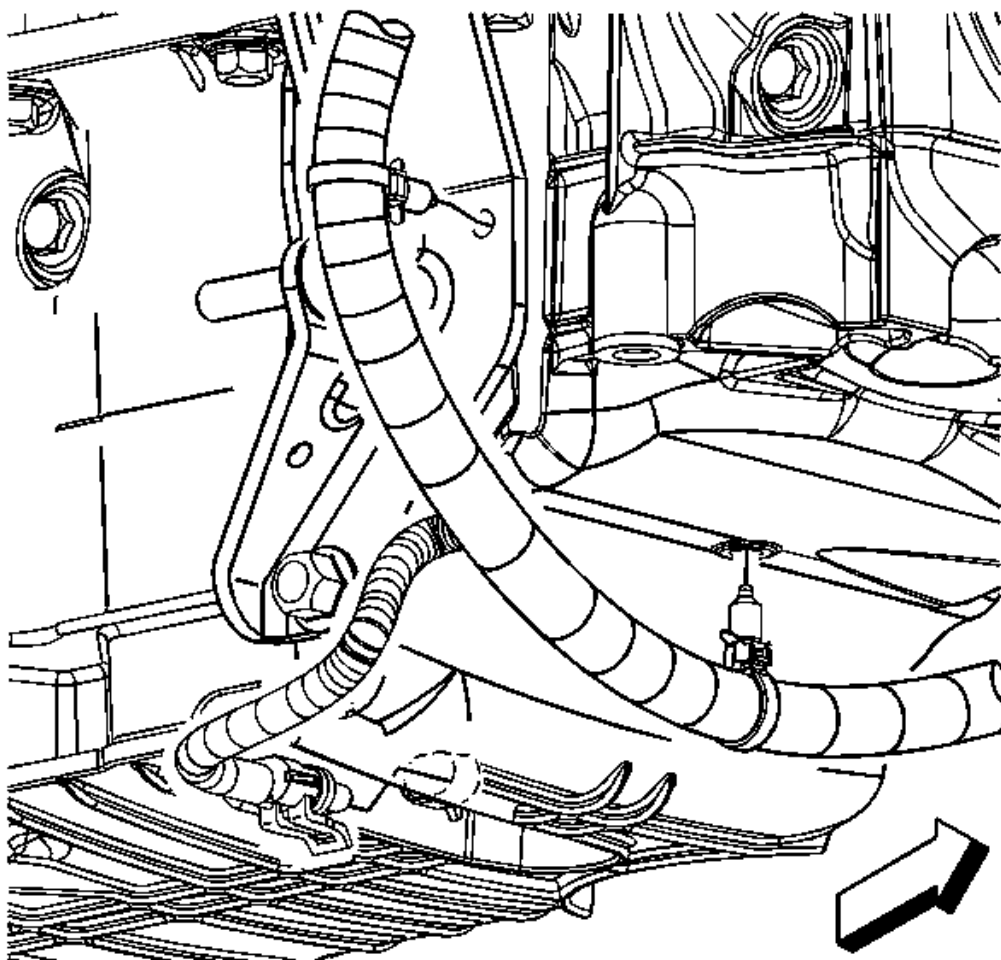


Fig. 210: Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

53. Raise the vehicle.
54. Connect the oil level sensor electrical connector.
55. Install the engine harness clips to the transaxle brace and the oil pan.

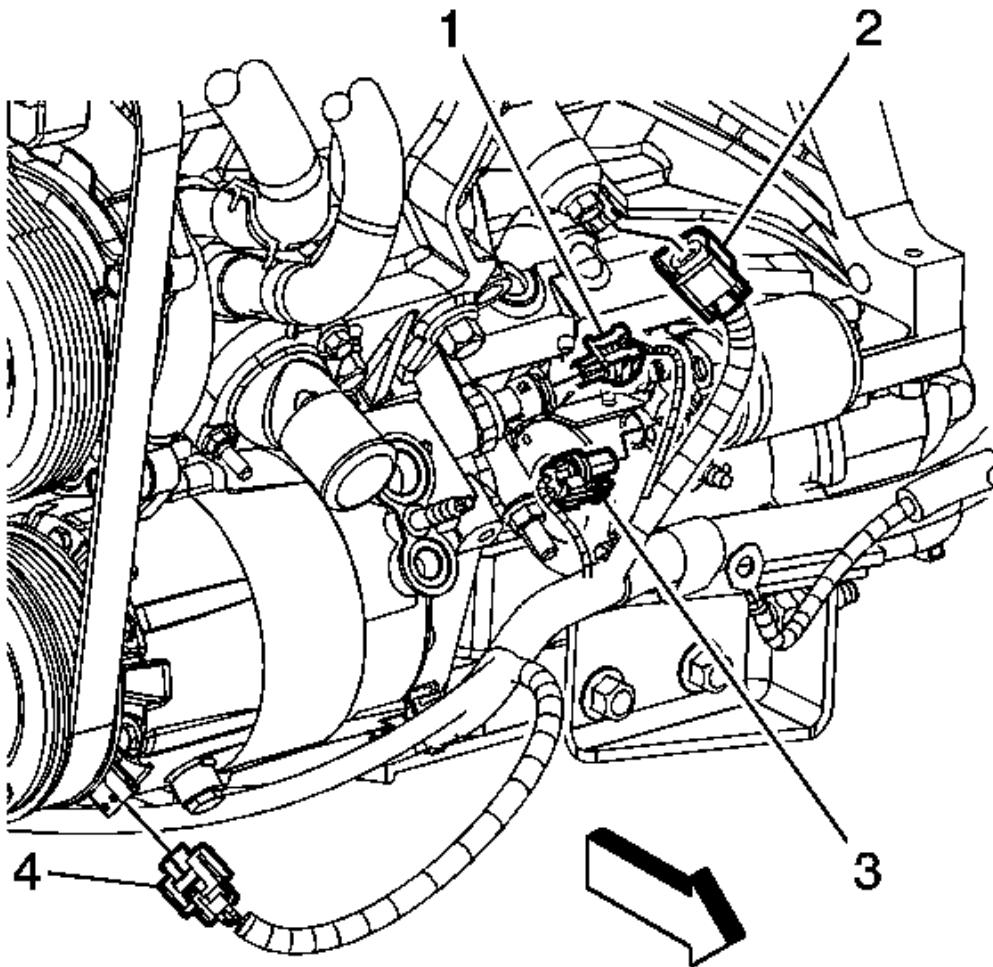


Fig. 211: Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

56. Connect the A/C compressor electrical connector (4).
57. Connect the starter motor electrical connector (3)
58. Connect the knock sensor (2) electrical connector.
59. Connect the oil pressure sensor (1) electrical connector.

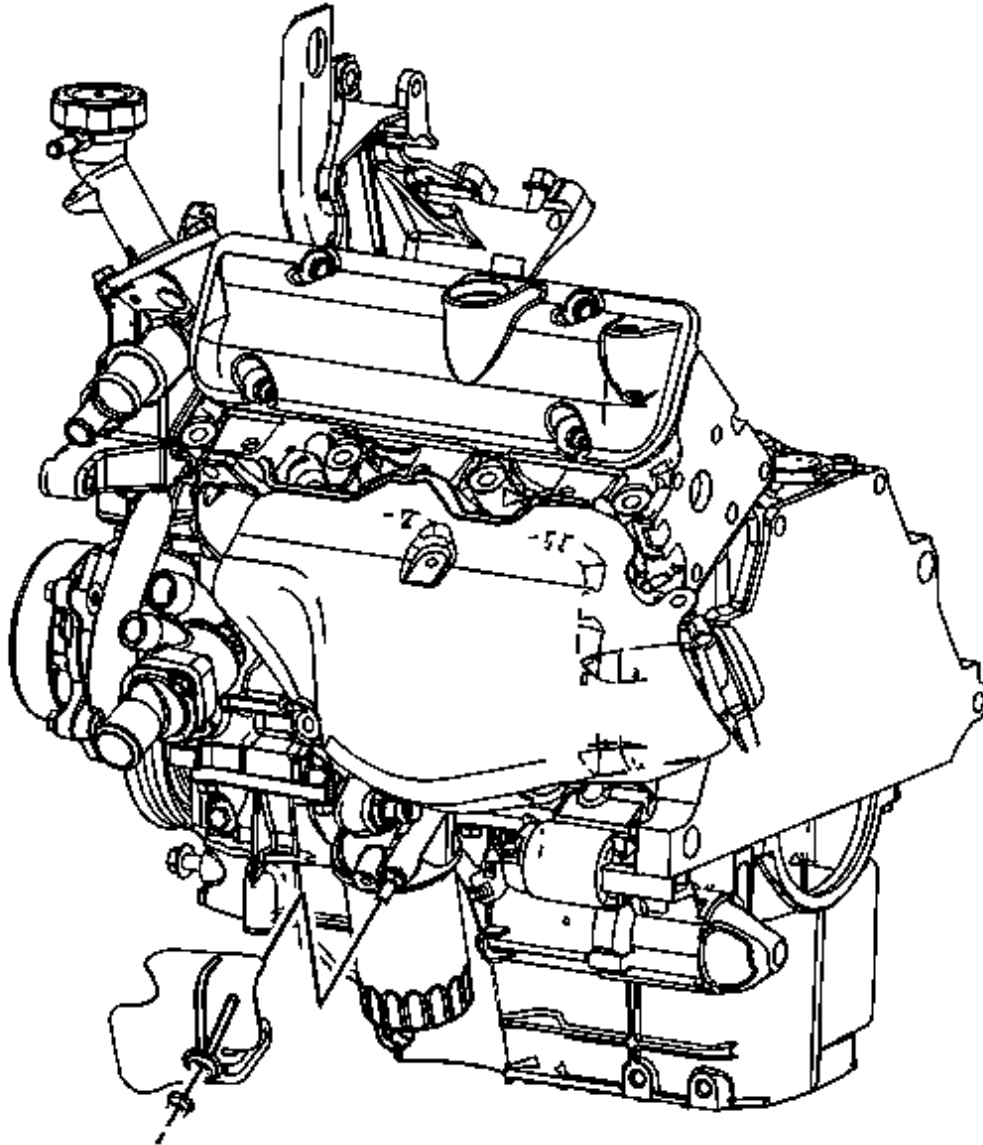


Fig. 212: Oil Pressure Sensor Heat Shield & Nut
Courtesy of GENERAL MOTORS CORP.

60. Install the oil pressure sensor heat shield and nuts.

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

61. Lower the vehicle.
62. Install the engine mount struts. Refer to [Engine Mount Strut Replacement](#).
63. Install the drive belt. Refer to [Drive Belt Replacement](#).
64. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).
65. Install the hood. Refer to [Hood Replacement](#).
66. Fill the engine with oil. Refer to [Engine Oil and Oil Filter Replacement](#).
67. Fill the cooling system. Refer to [Cooling System Draining and Filling \(Static Fill\)](#) or [Cooling System Draining and Filling \(Vac-N-Fill\)](#).
68. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
69. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

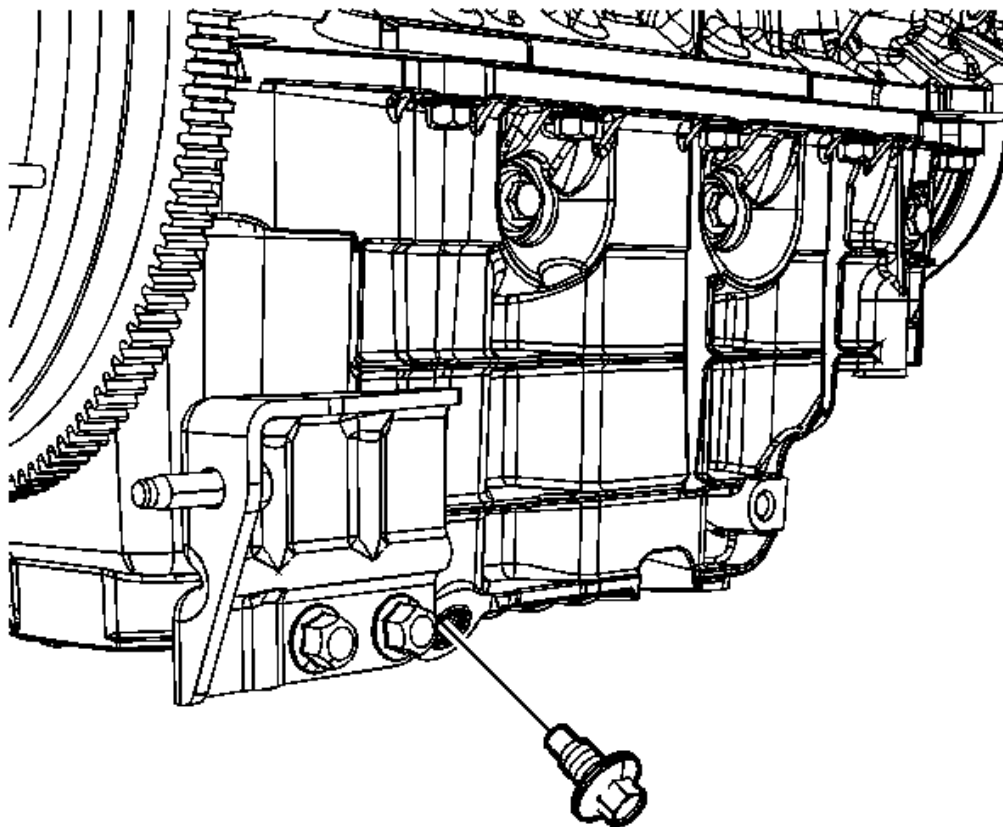
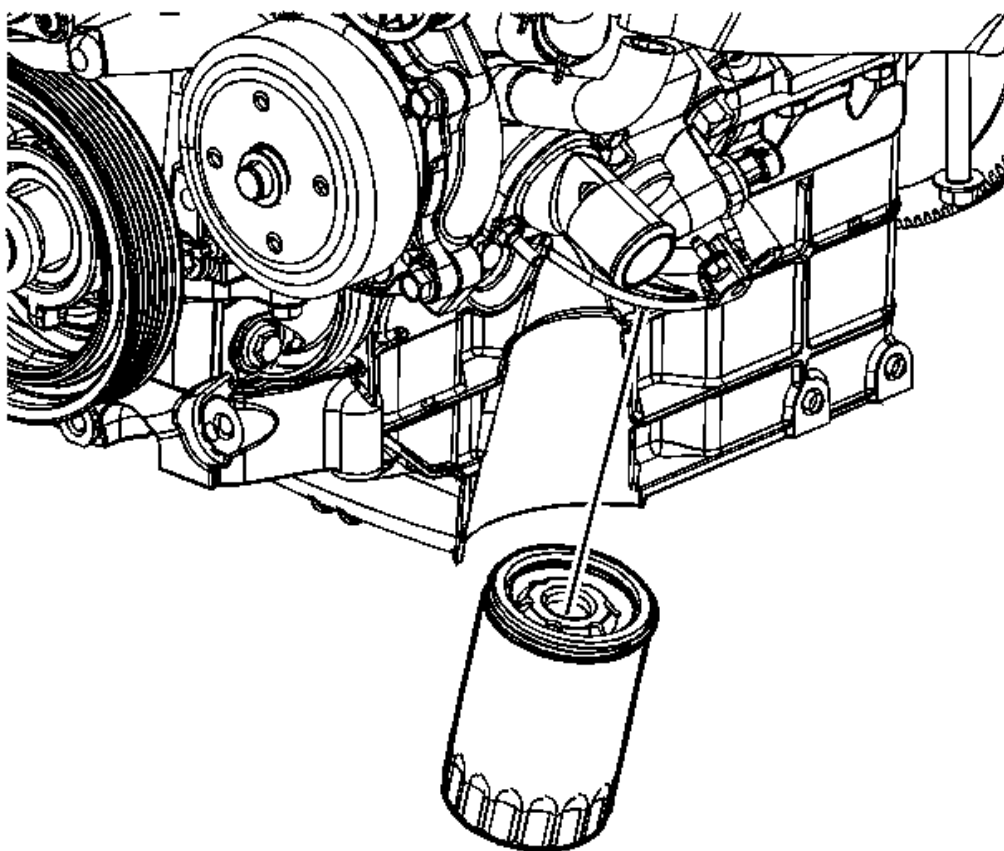


Fig. 213: Oil Pan Drain Plug**Courtesy of GENERAL MOTORS CORP.**

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

**Fig. 214: Oil Filter****Courtesy of GENERAL MOTORS CORP.**

4. Remove the oil filter.

INSTALLATION PROCEDURE

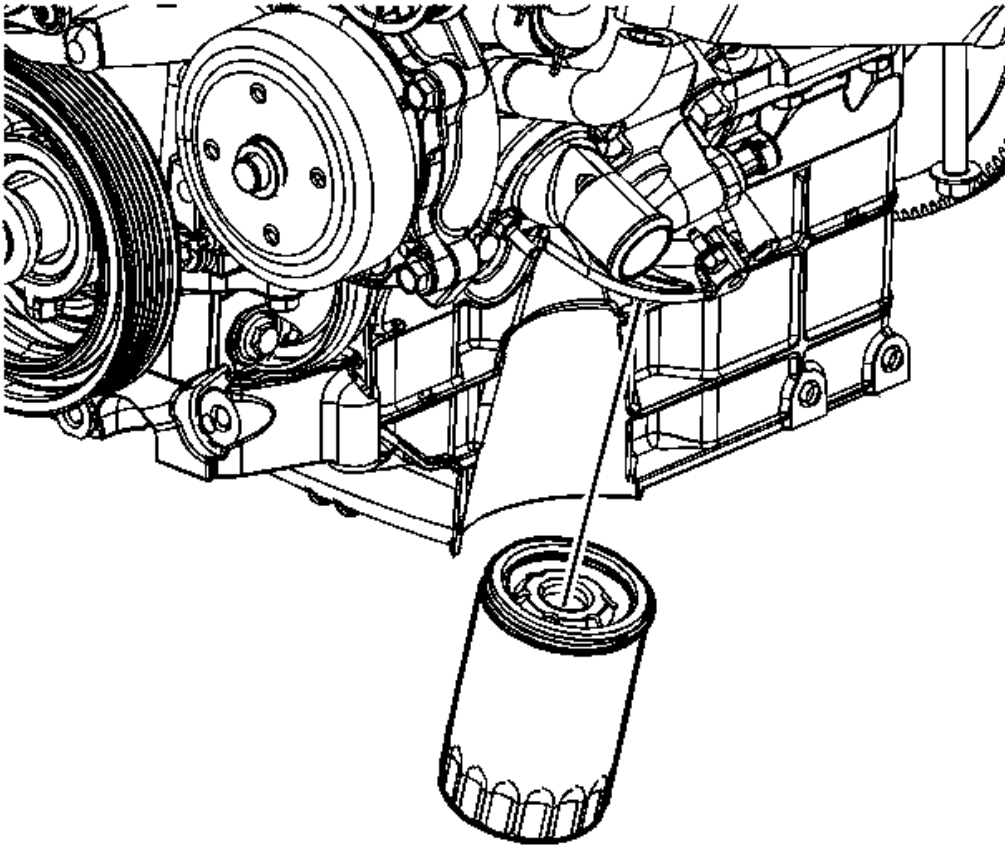


Fig. 215: Oil Filter

Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter.

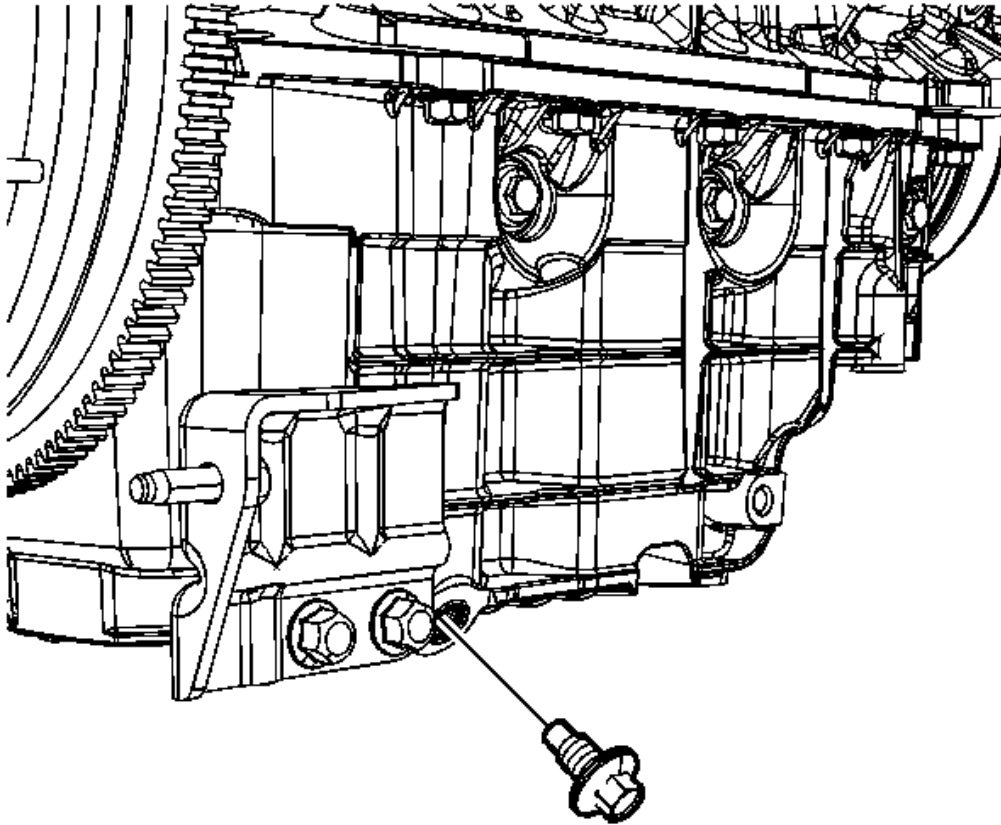


Fig. 216: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the oil pan drain bolt.

Tighten: Tighten the bolt to 26 N.m (19 lb ft).

3. Lower the vehicle.
4. Fill the engine with oil to the appropriate level.
5. Start engine and inspect for leaks.