

2010 ENGINE

Engine Mechanical - 2.0L - Repair Instructions - On Vehicle - Solstice & Sky

INTAKE MANIFOLD COVER REPLACEMENT

REMOVAL PROCEDURE

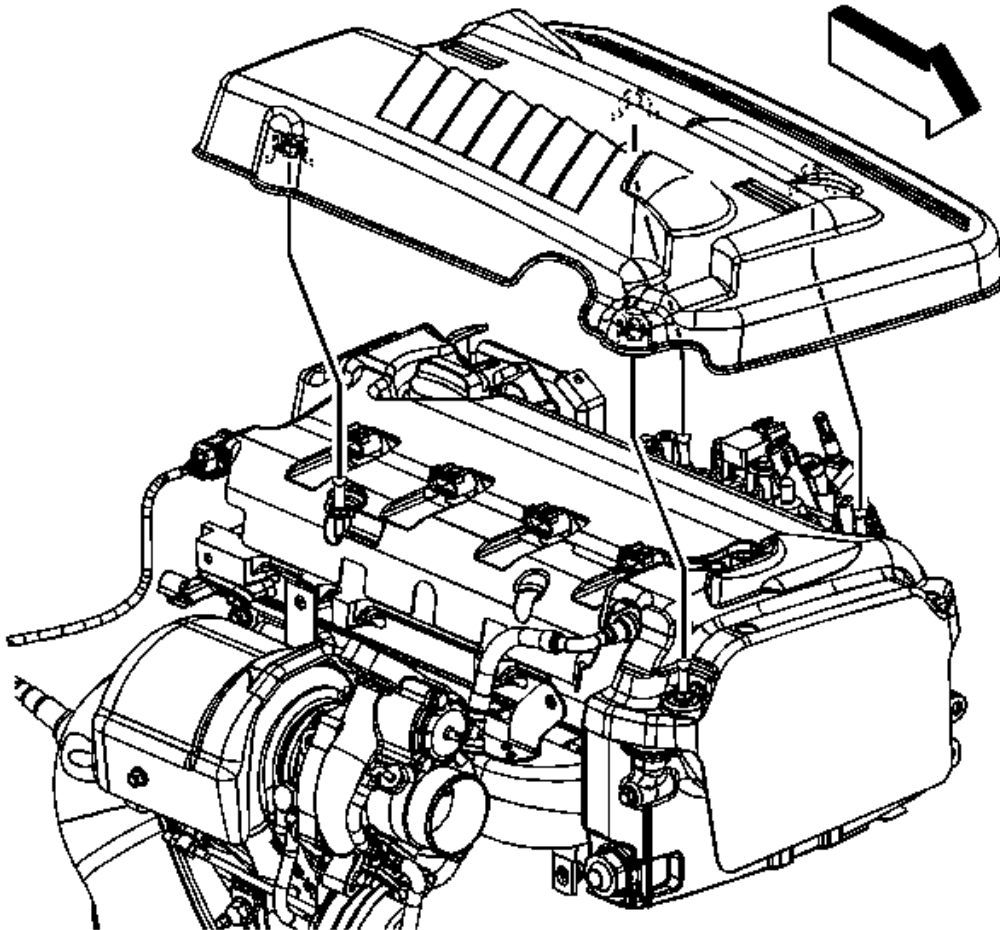


Fig. 1: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

1. Grasp the intake manifold cover in the middle of the right side and pull up in order to disengage the cover from the studs.
2. Grasp the intake manifold cover in the middle of the left side and pull up in order to disengage the cover

from the studs.

3. Disconnect the ignition coils and remove electrical harness from stud.
4. Disconnect the cam phaser electrical connector.
5. Remove the intake manifold cover.

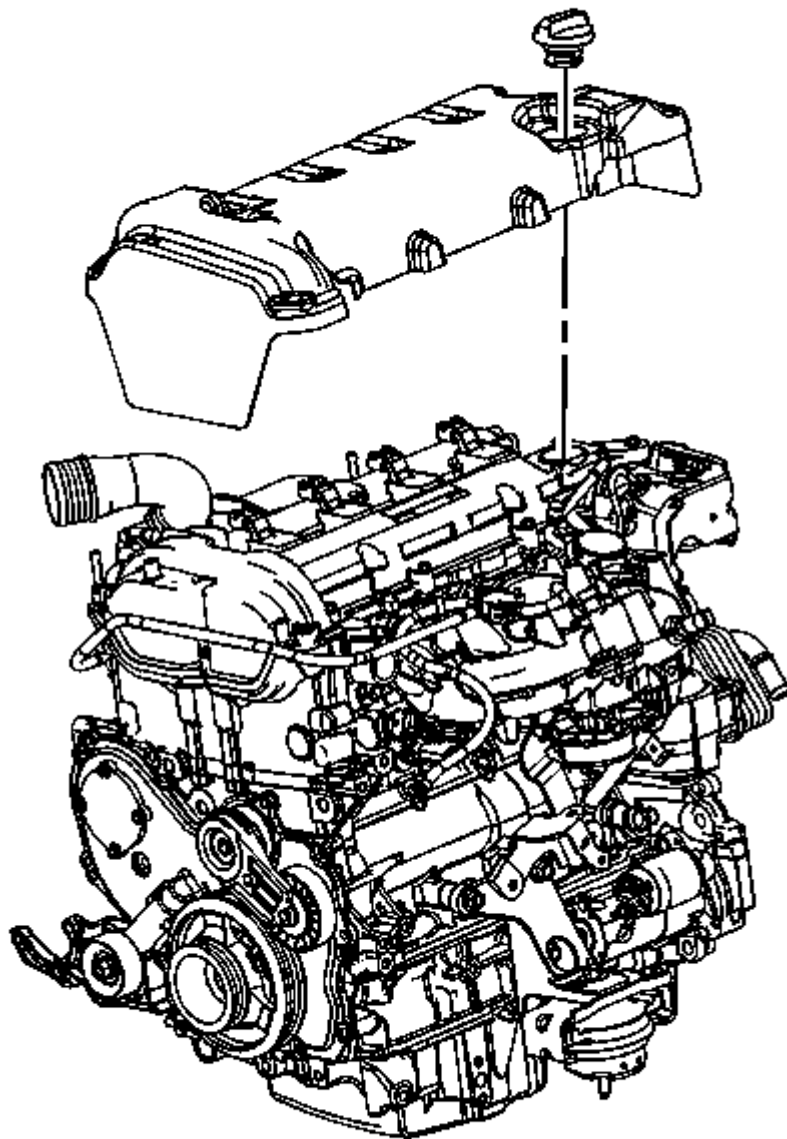


Fig. 2: View Of Oil Fill Cap & Insulator
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil fill cap.
7. Remove the insulator.
8. Reinstall the oil fill cap.

INSTALLATION PROCEDURE

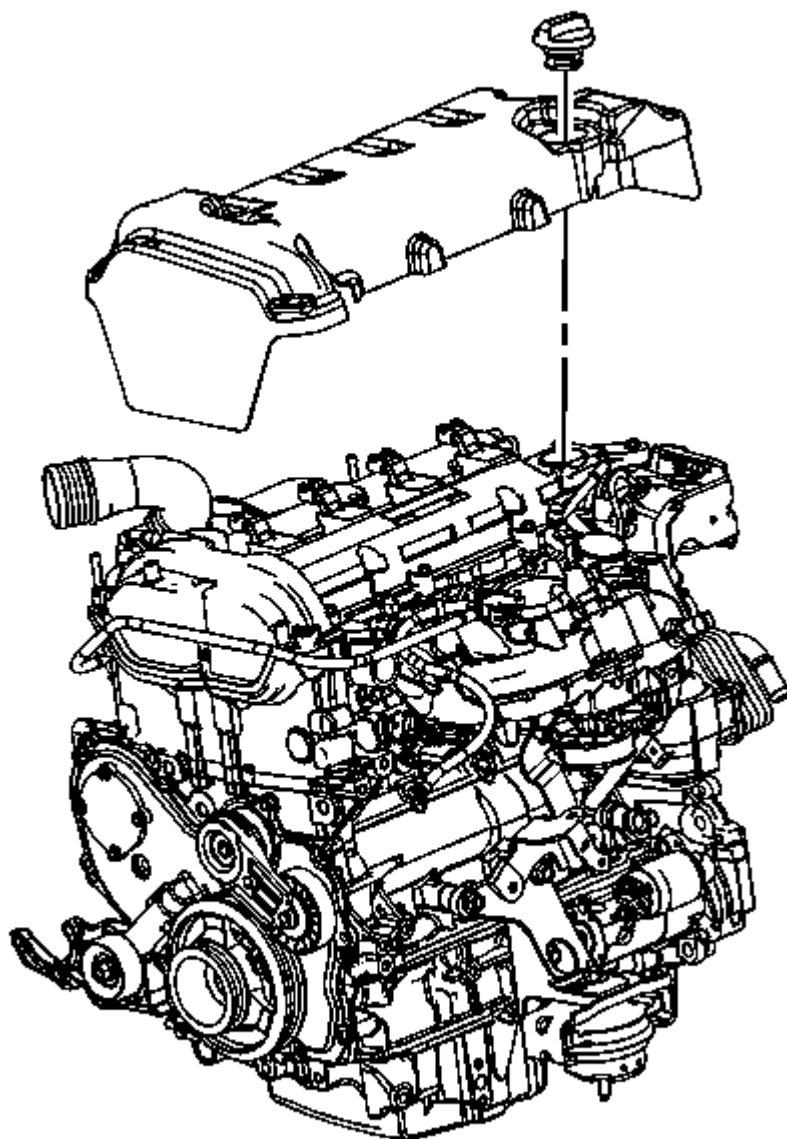


Fig. 3: View Of Oil Fill Cap & Insulator

Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill cap.
2. Install the insulator.
3. Reinstall the oil fill cap.
4. Connect the cam phaser electrical connector.
5. Connect the ignition coils and install the electrical harness to the stud.

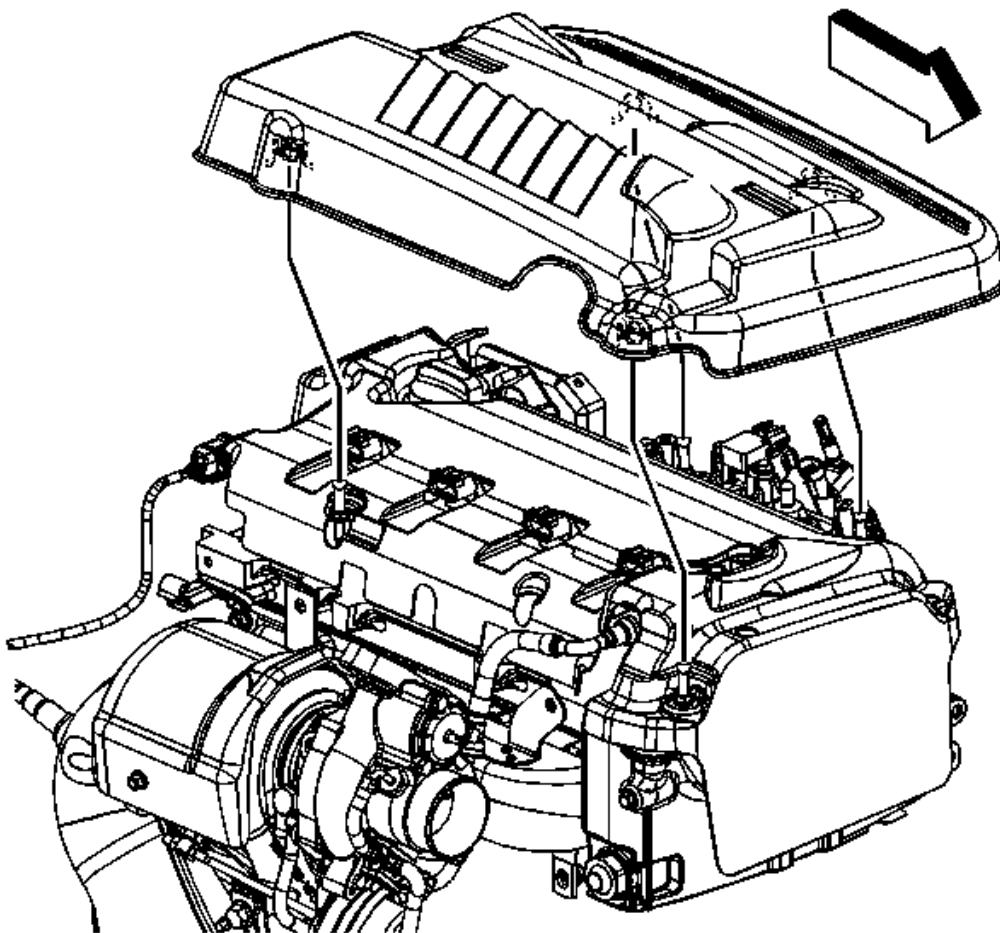


Fig. 4: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

6. Place the intake manifold cover onto the engine over the studs.
7. Push down on the intake manifold cover directly over the left side studs in order to engage the cover to

the studs.

8. Push down on the intake manifold cover directly over the right side studs in order to engage the cover to the studs.

DRIVE BELT REPLACEMENT

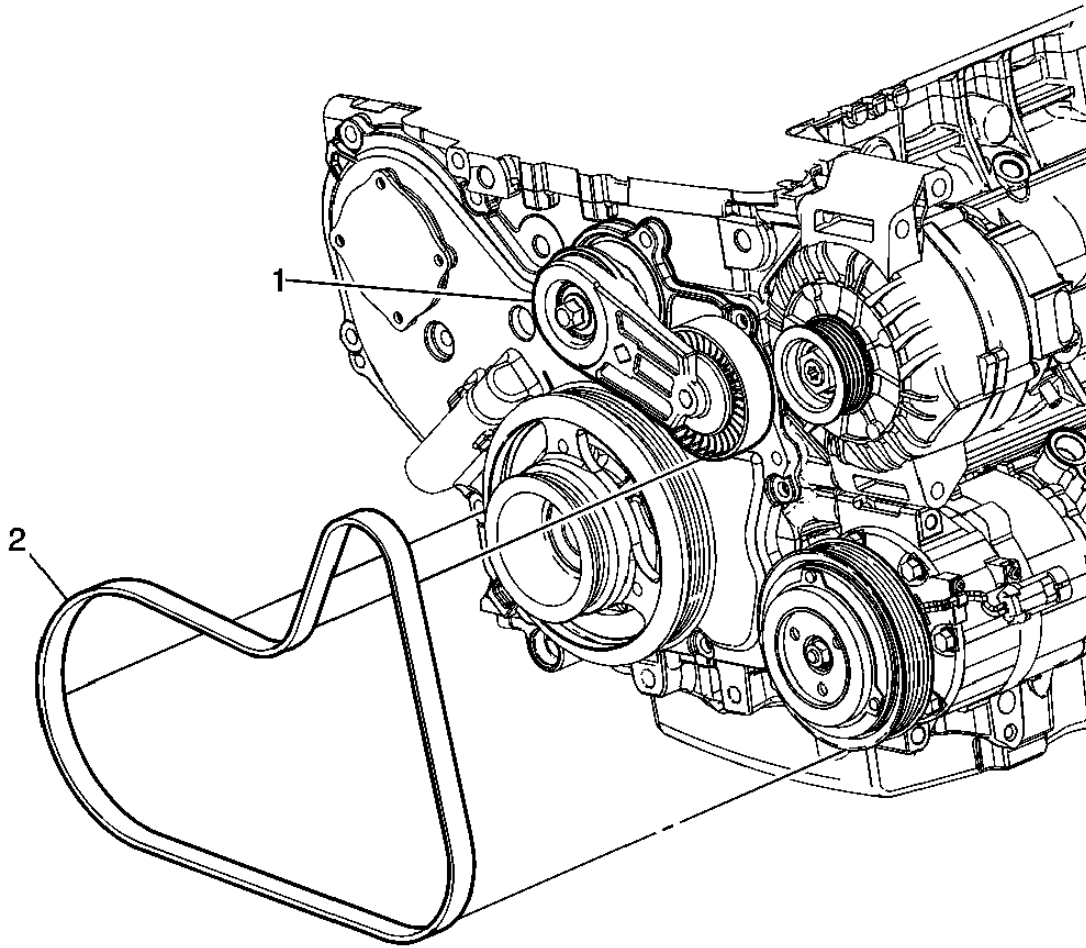


Fig. 5: Identifying Drive Belt (With A/C)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
2. Remove the power steering pump drive belt. Refer to <u>Power Steering Pump Belt Replacement</u> .	
3. Lower the vehicle.	
1	Drive Belt Tensioner
	Drive Belt

2

Procedure:

Transfer parts as needed.

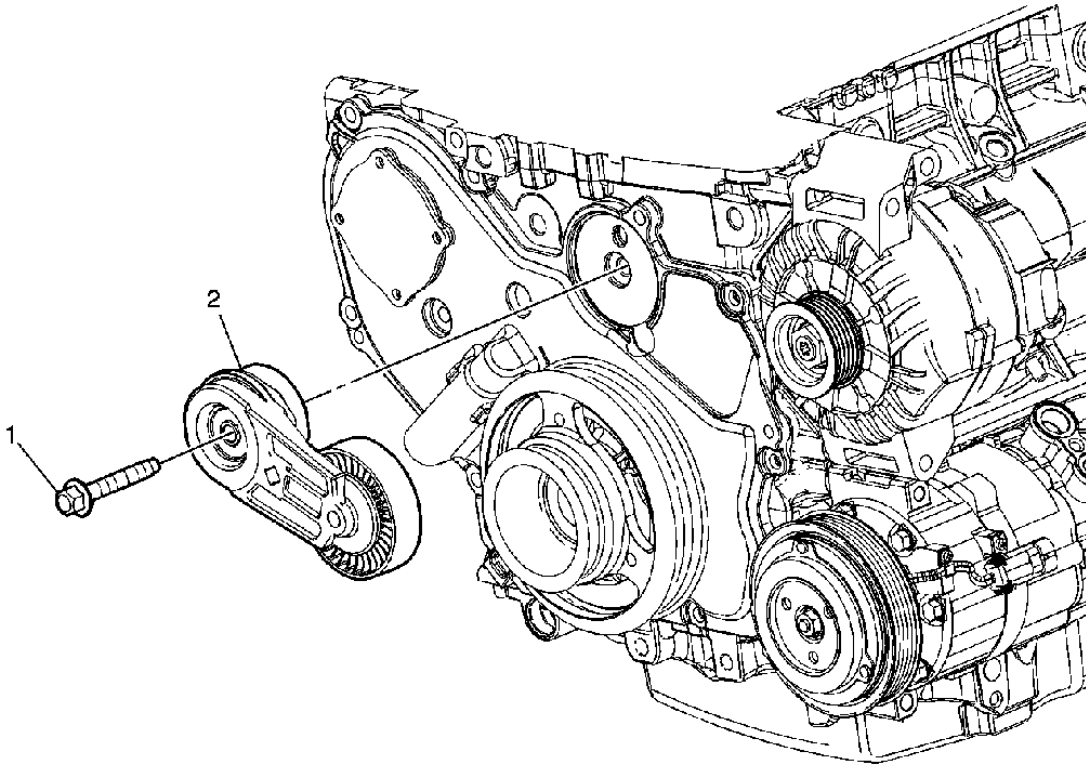
DRIVE BELT TENSIONER REPLACEMENT

Fig. 6: Identifying Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive Belt Tensioner Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 45 N.m (33 lb ft)
2	Drive Belt Tensioner

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT**REMOVAL PROCEDURE**

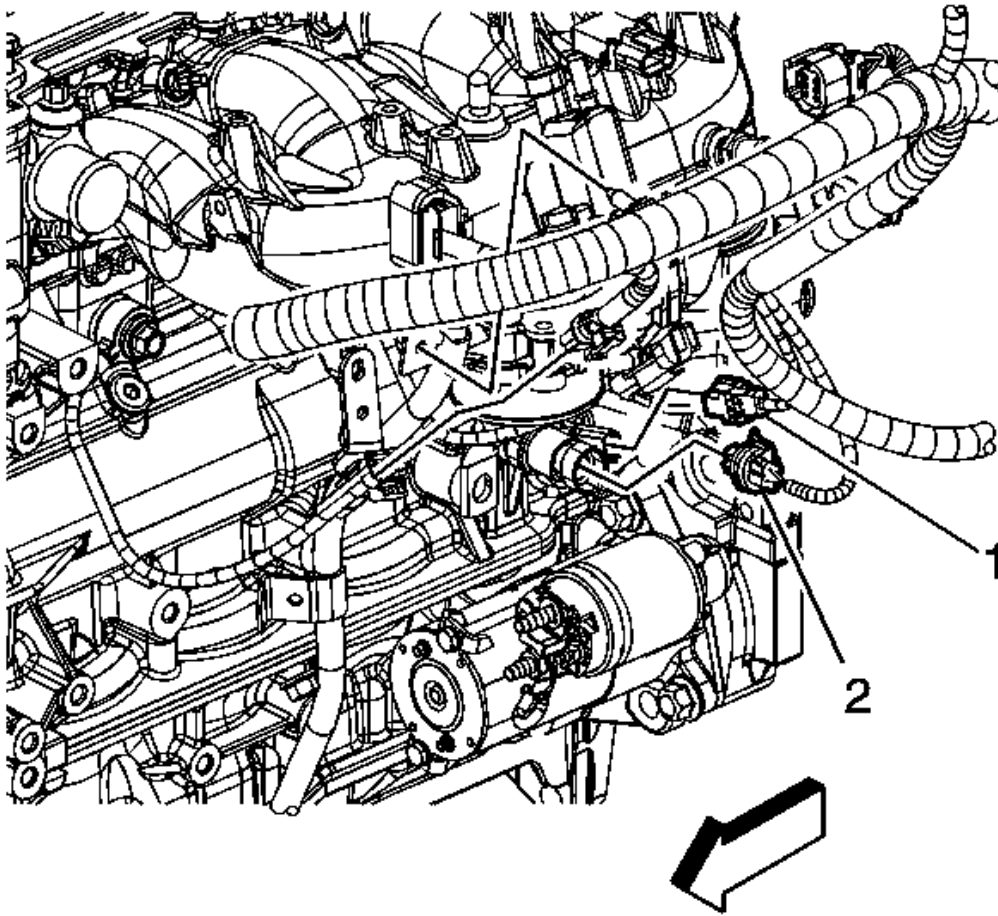


Fig. 7: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

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

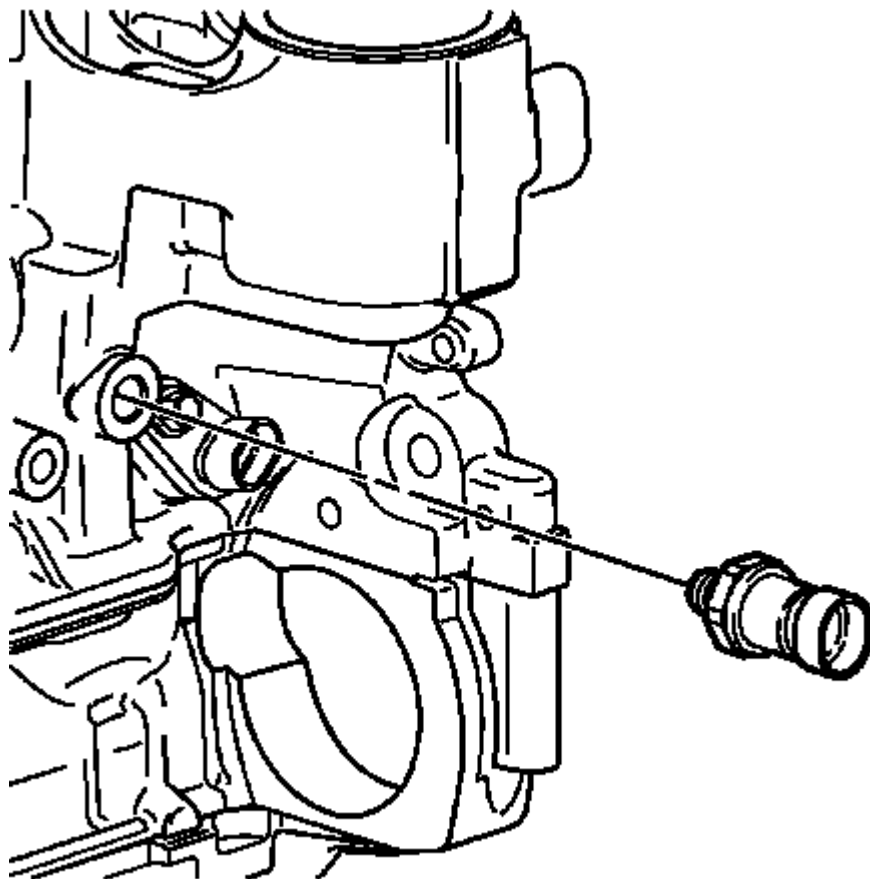


Fig. 8: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil pressure sensor.

INSTALLATION PROCEDURE

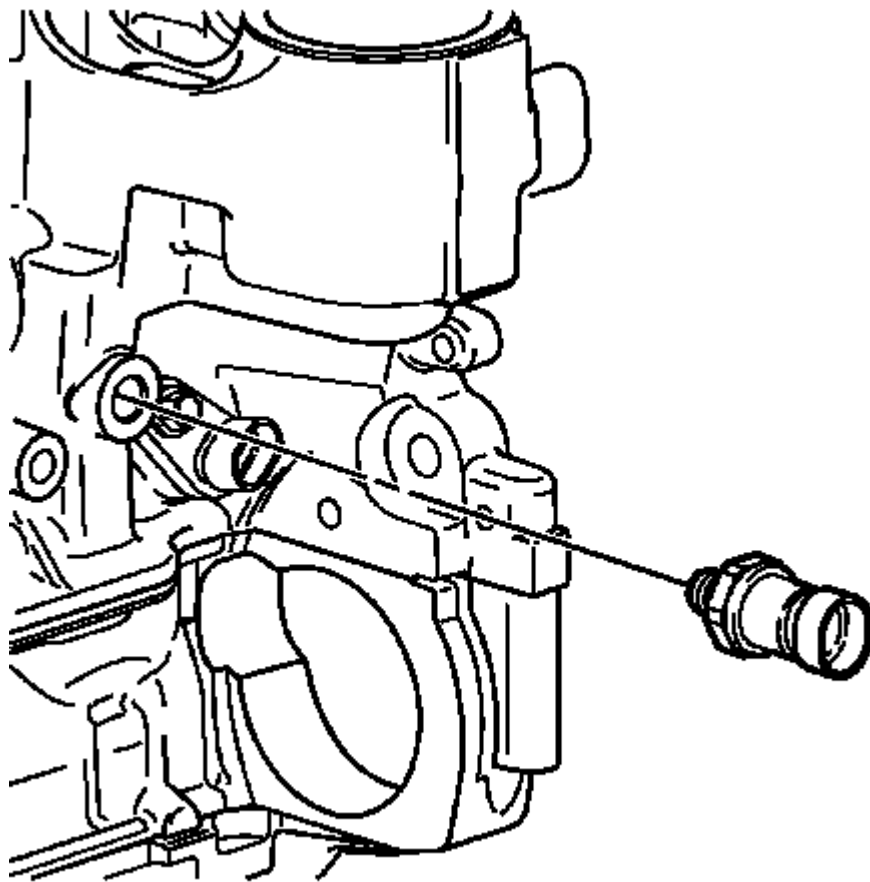


Fig. 9: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil pressure sensor and tighten to 22 N.m (16 lb ft).

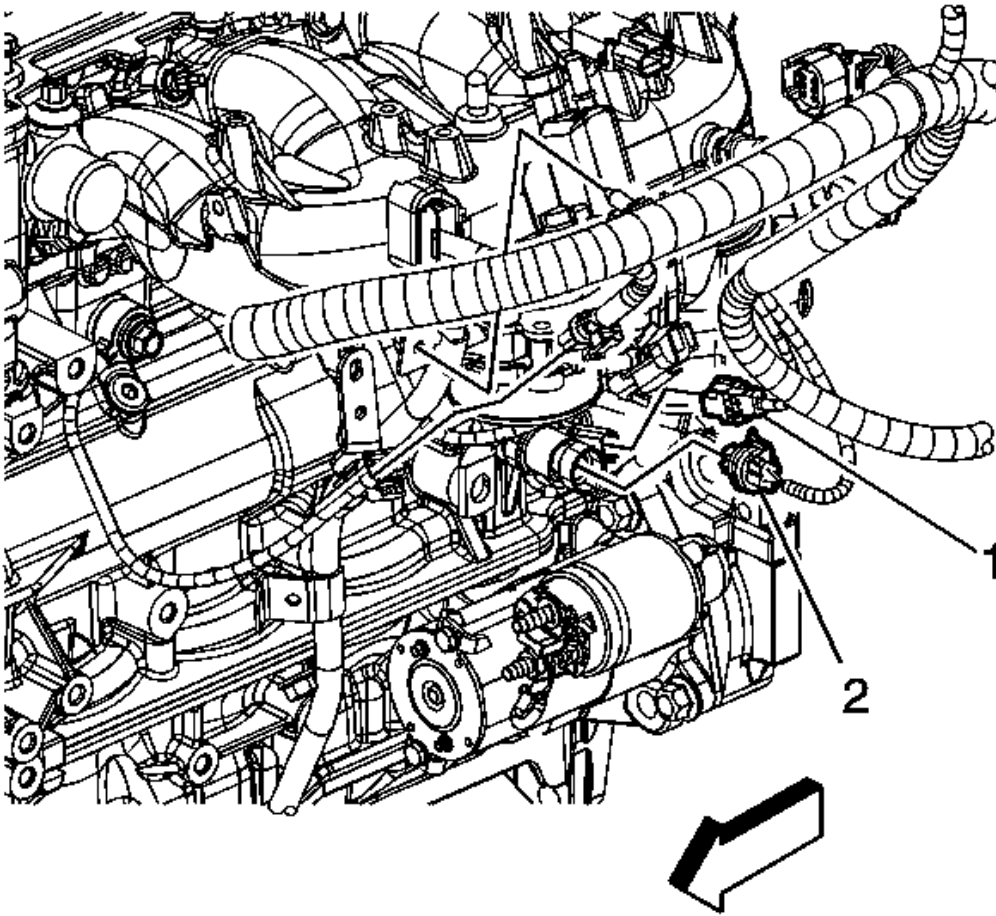


Fig. 10: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Connect the engine wiring harness electrical connector (2) to the engine oil pressure sensor.
3. Lower the vehicle.

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 a engine hoist to the lift brackets and raise the engine slightly putting pressure on the engine mounts.
2. Observe the engine mount while slightly lifting the engine. Lifting 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 is leaking fluid, if applicable.
4. For engine mount replacement, refer to **Engine Mount Replacement - Left Side** and/or **Engine Mount Replacement - Right Side**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

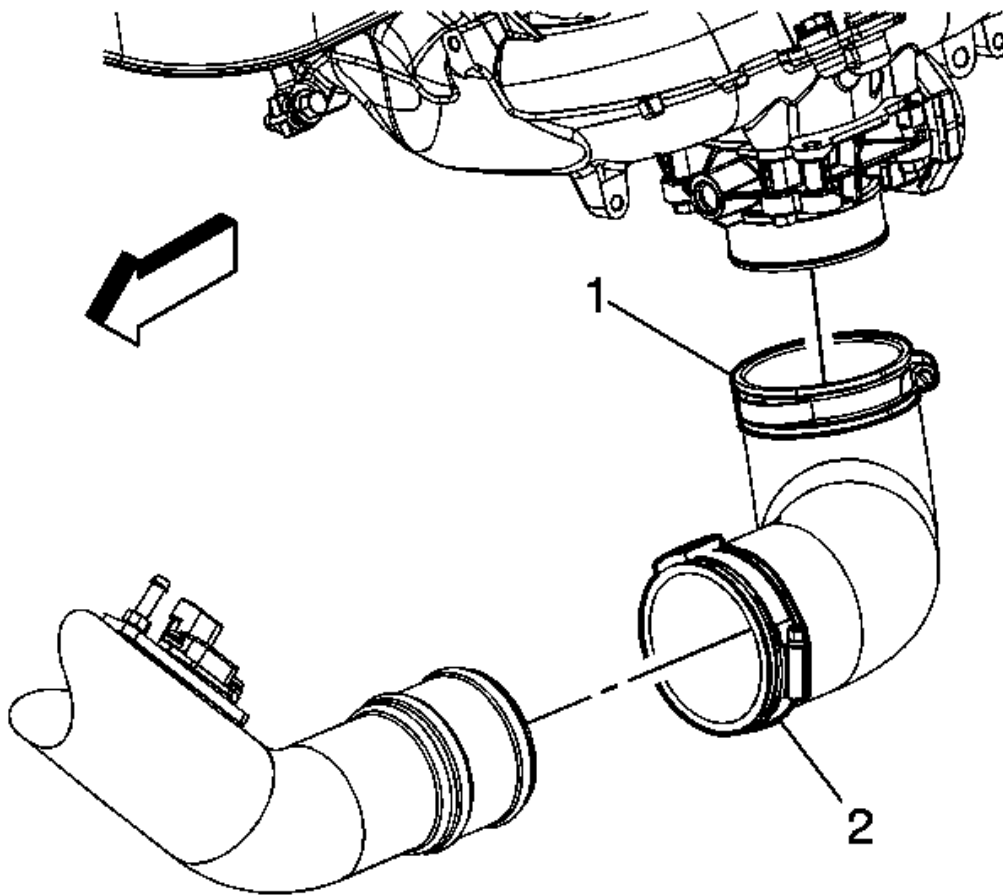


Fig. 11: View Of Charge Air Cooler Hose & Clamp

Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Loosen the charge air cooler (CAC) outlet hose clamp (2) at the CAC outlet pipe.
3. Loosen the CAC outlet hose clamp (1) at the throttle body.
4. Remove the CAC outlet hose from the CAC outlet pipe and throttle body.

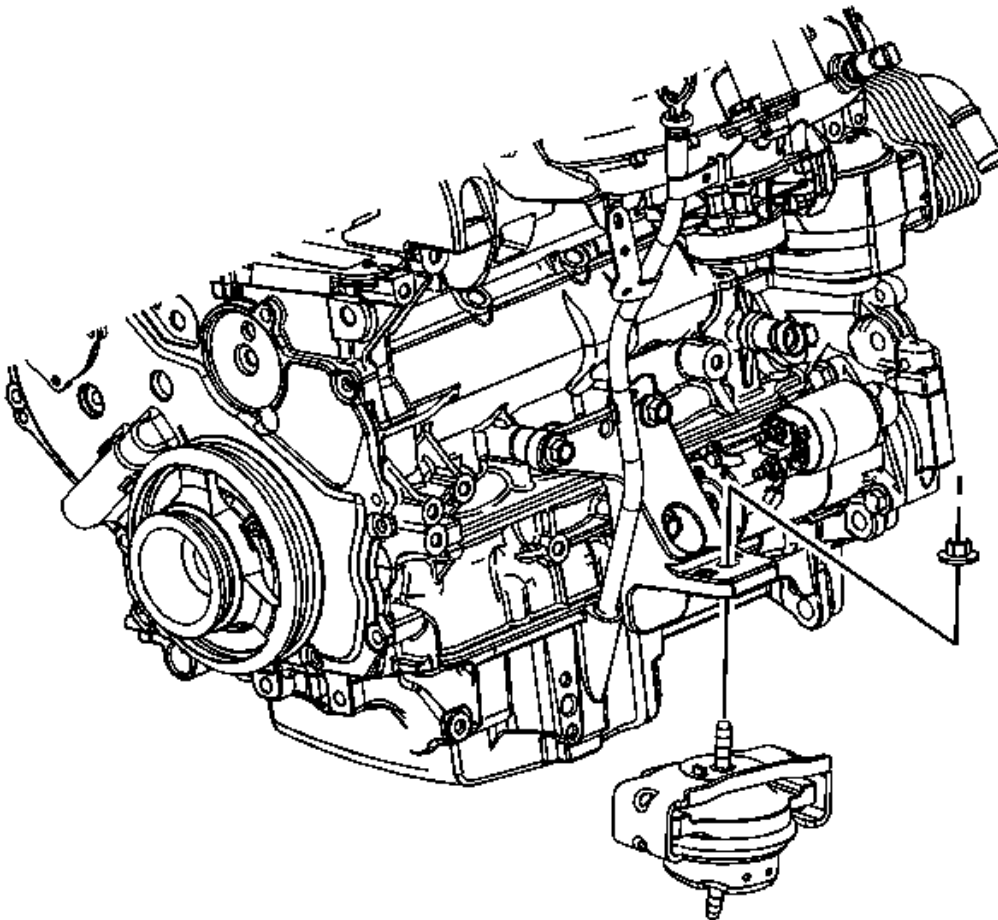


Fig. 12: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the left engine mount upper nut.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.

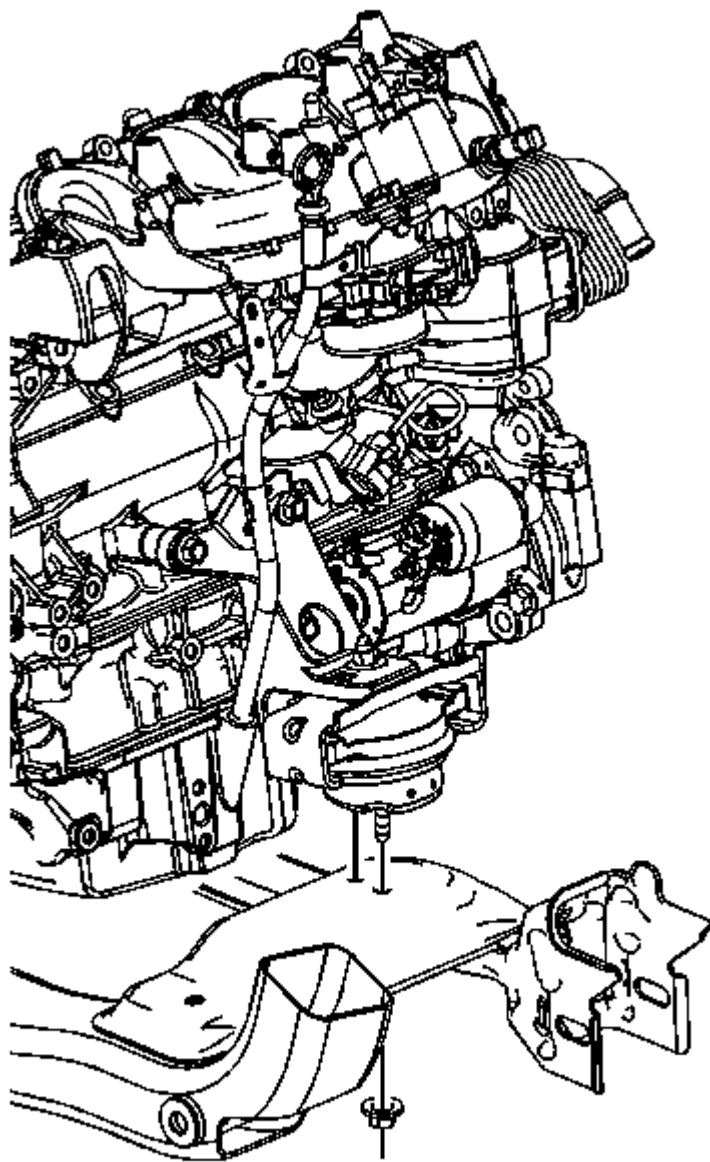


Fig. 13: View Of Driver Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the left engine mount lower nut.

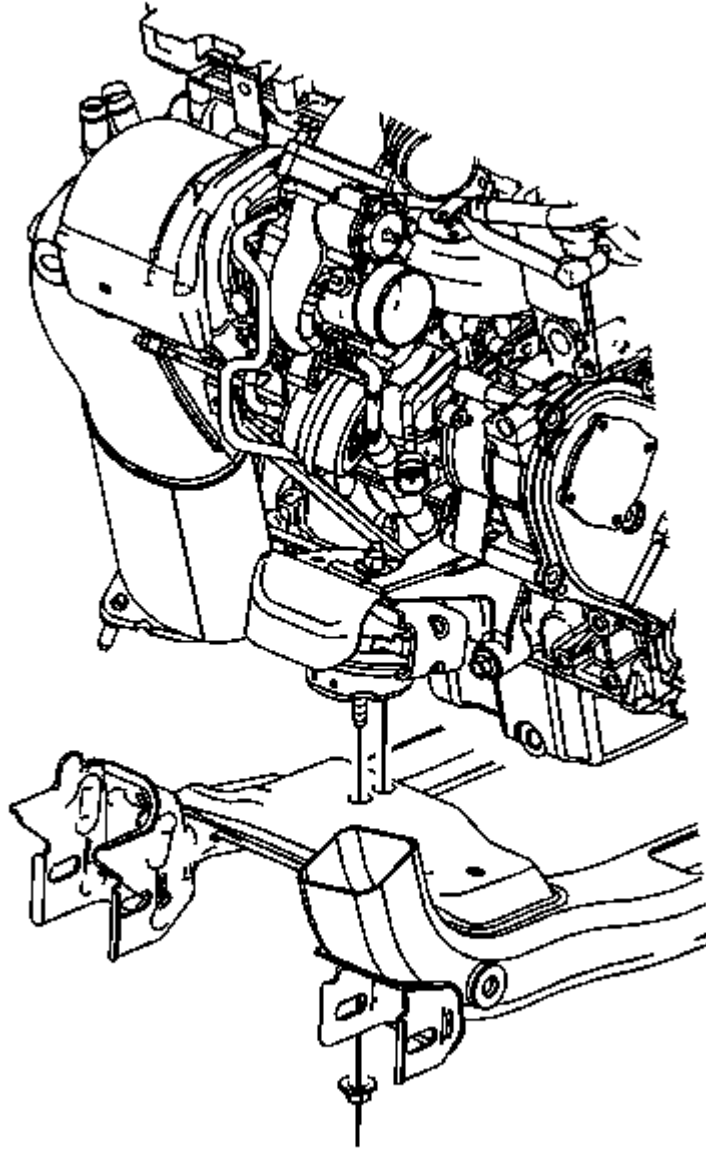


Fig. 14: View Of Passenger Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

8. Remove the right engine mount lower nut.
9. Position an adjustable jack below the oil pan. Place a block of wood between the oil pan and the jack.
10. Raise the engine using the adjustable jack until the engine mount can be removed.

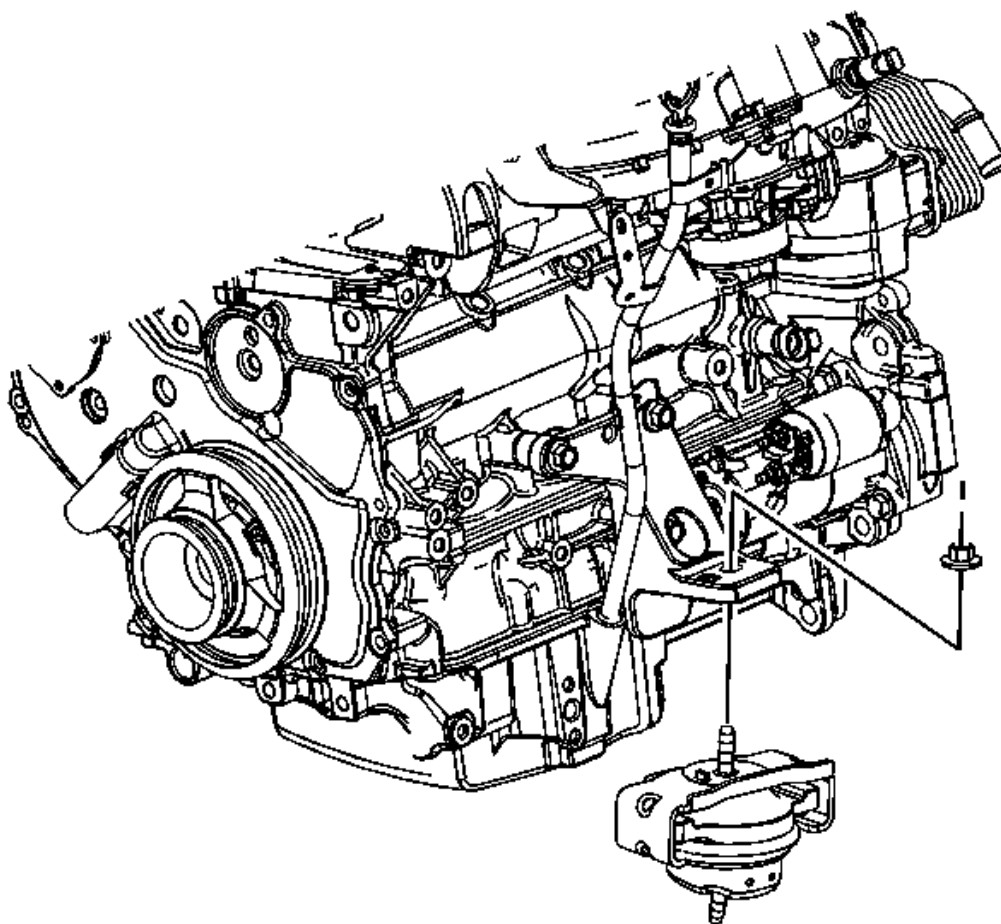


Fig. 15: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

11. Remove the left engine mount.

INSTALLATION PROCEDURE

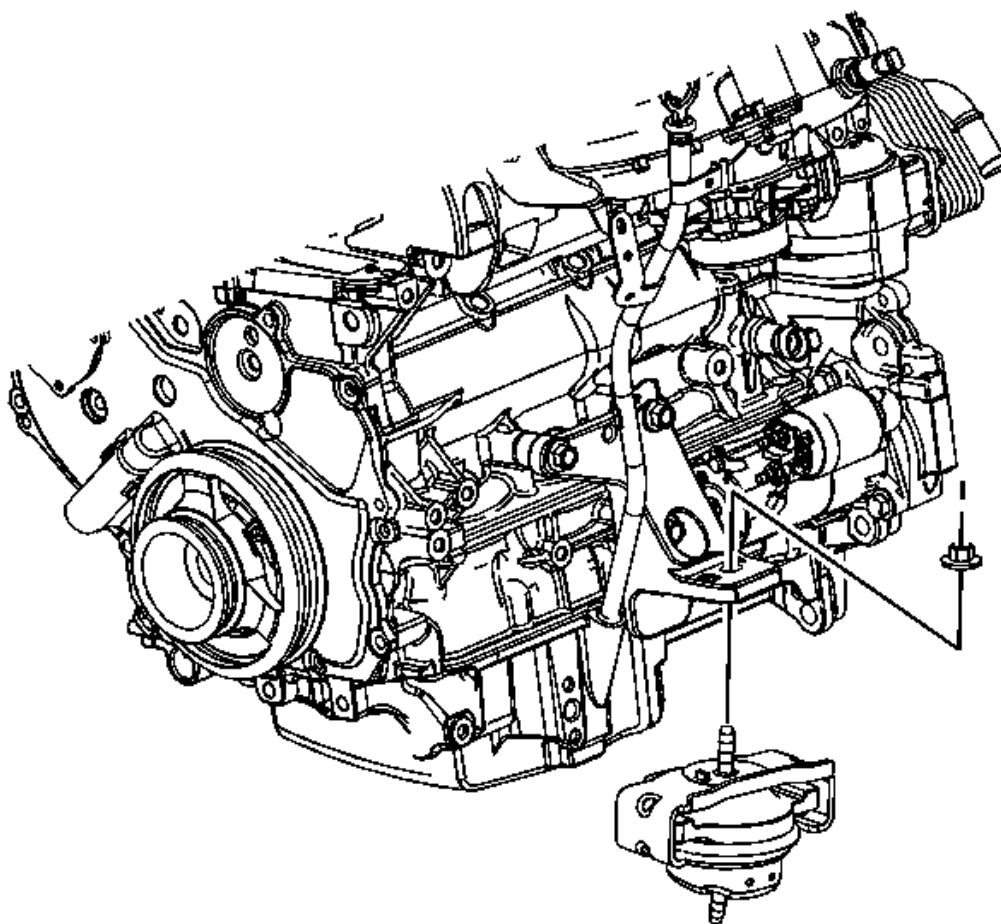


Fig. 16: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the left engine mount.
2. Lower the engine using the adjustable jack until the engine is resting on the mount.
3. Remove the adjustable jack from below the oil pan.

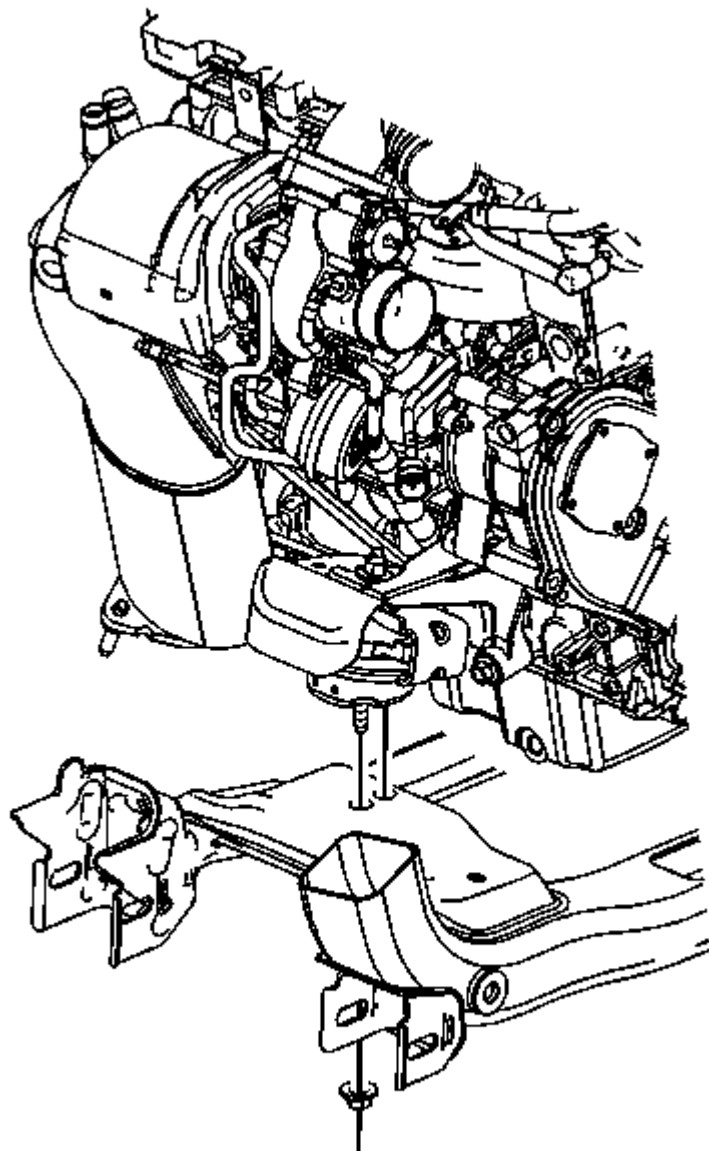


Fig. 17: View Of Passenger Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the right engine mount lower nut and tighten to 55 N.m (41 lb ft).

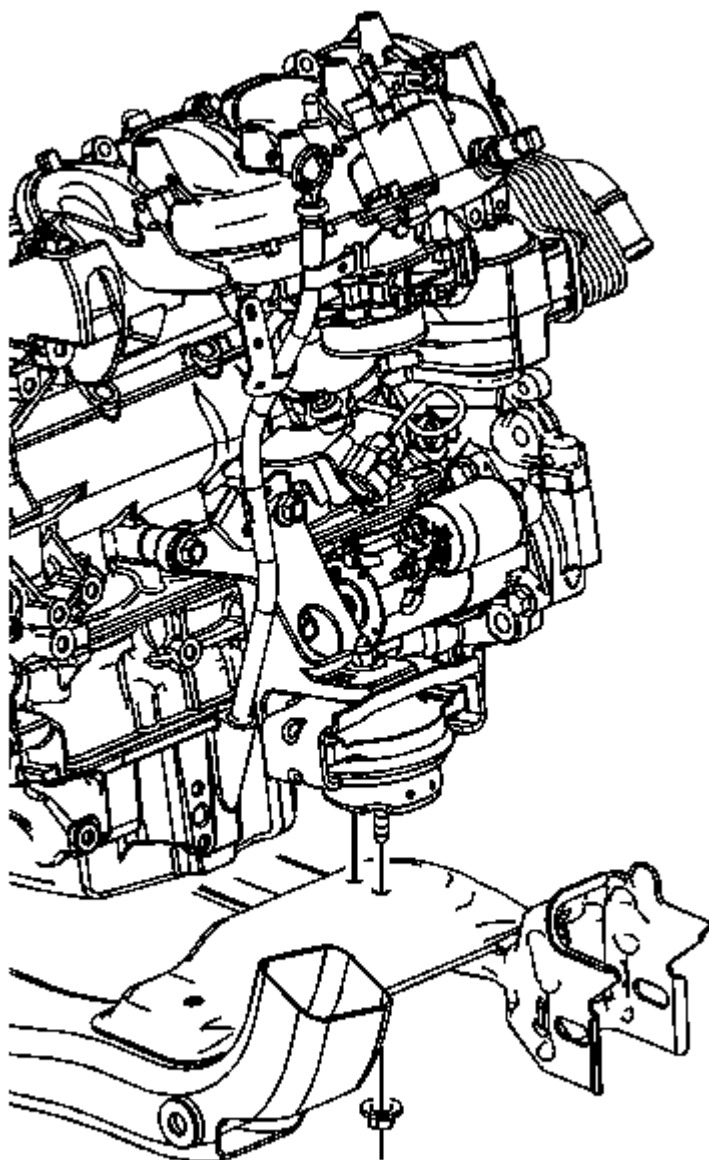


Fig. 18: View Of Driver Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

5. Install the left engine mount lower nut and tighten to 55 N.m (41 lb ft).

6. Lower the vehicle.

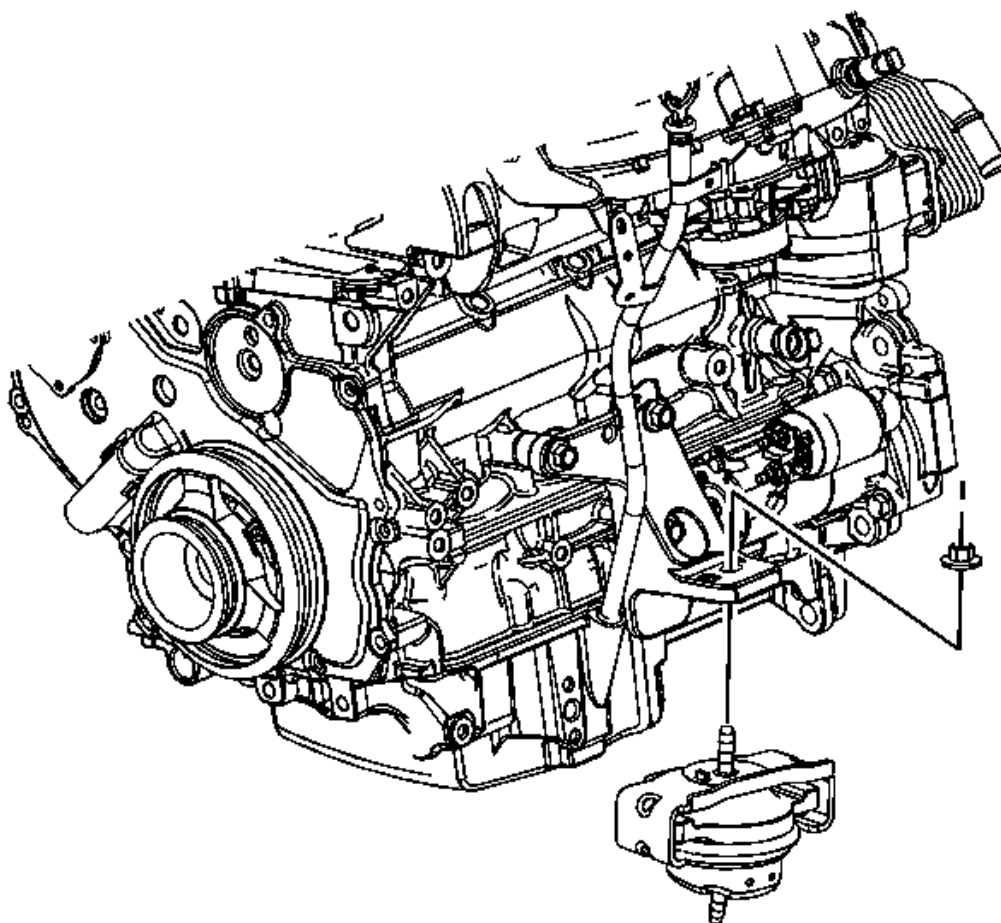


Fig. 19: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

7. Install the left engine mount upper nut and tighten to 55 N.m (41 lb ft).

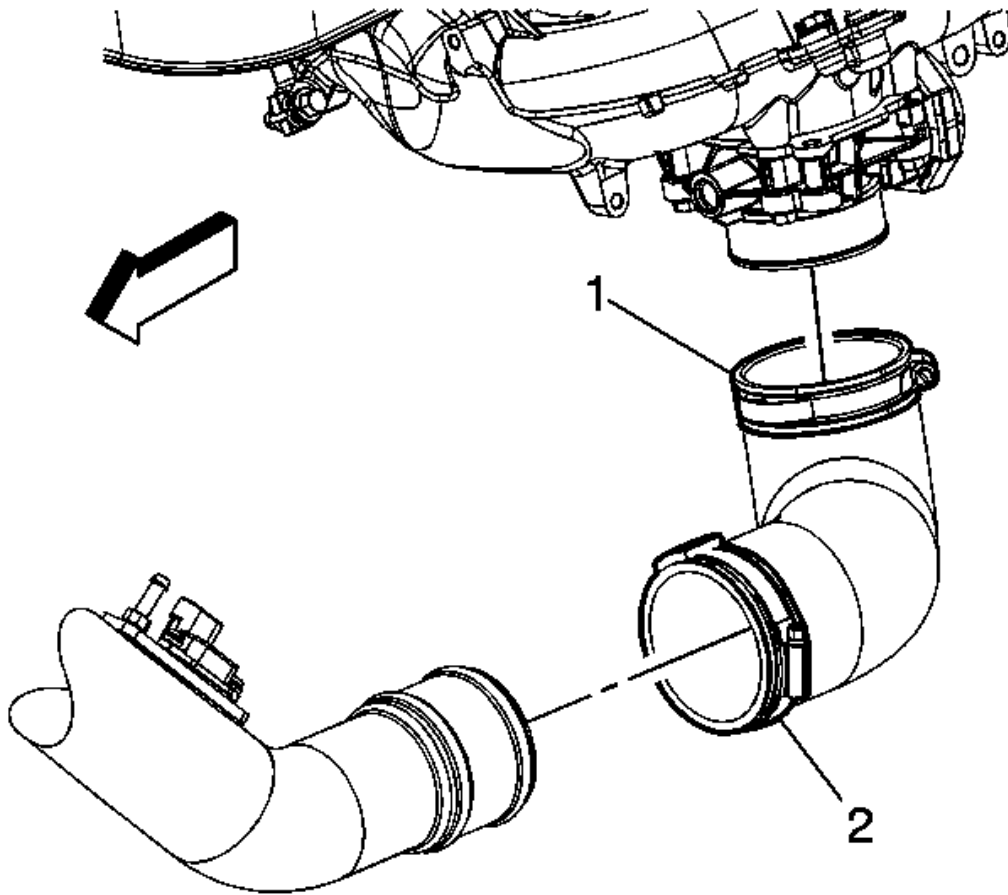


Fig. 20: View Of Charge Air Cooler Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

8. Install the CAC outlet hose to the CAC outlet pipe and throttle body.
9. Tighten the CAC outlet hose clamp (1) at the throttle body.
10. Tighten the CAC outlet hose clamp (2) at the CAC outlet pipe.

Tighten the clamps to 5 N.m (44 lb in).

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

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

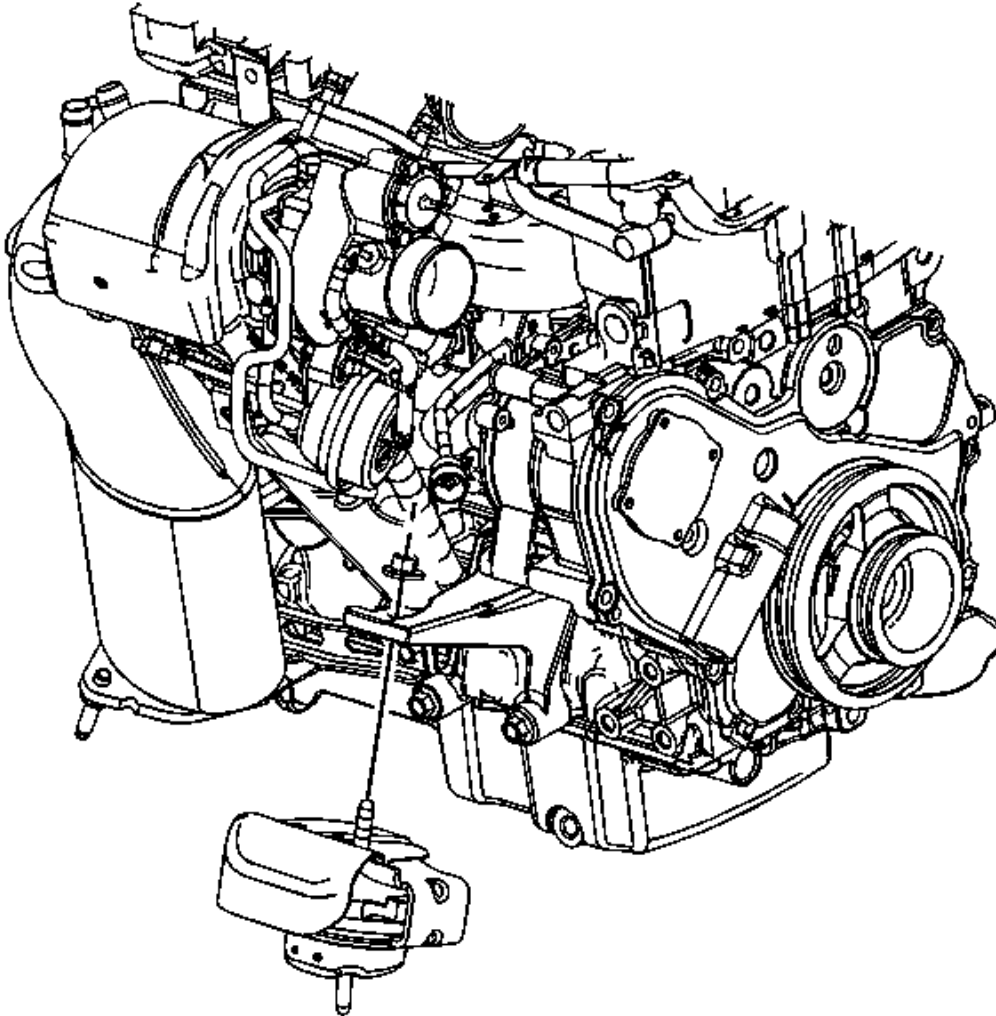


Fig. 21: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation**.
3. Remove the right engine mount upper nut.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.

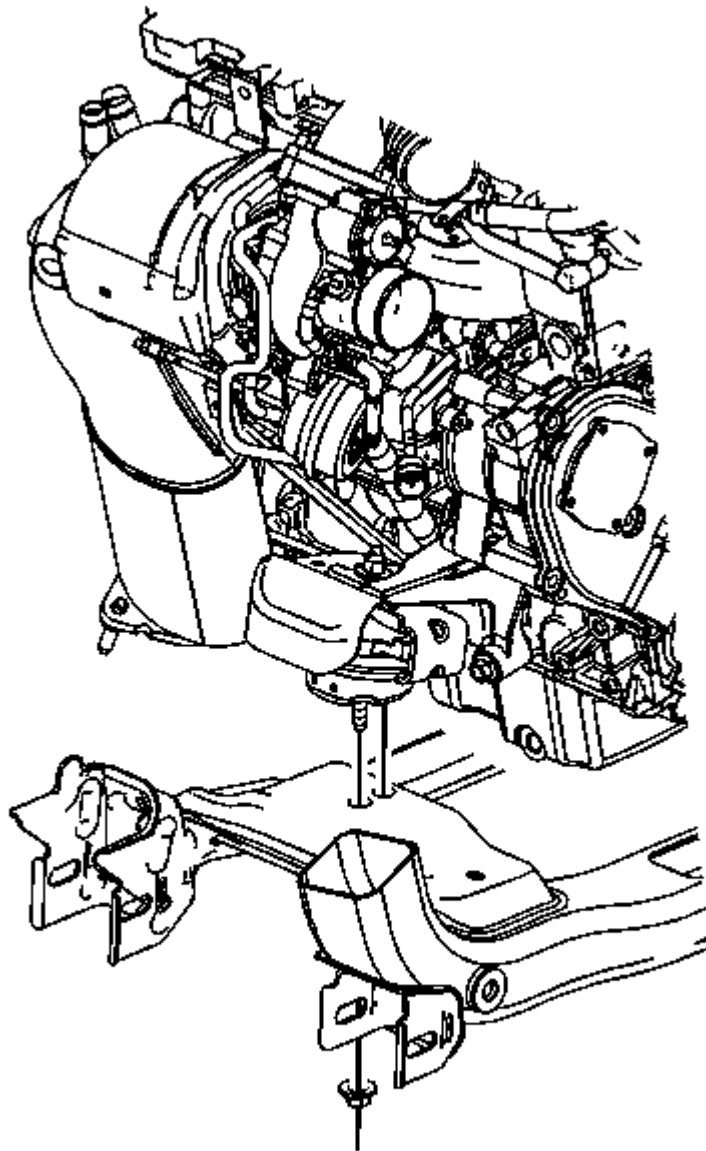


Fig. 22: View Of Passenger Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

5. Remove the right engine mount lower nut.

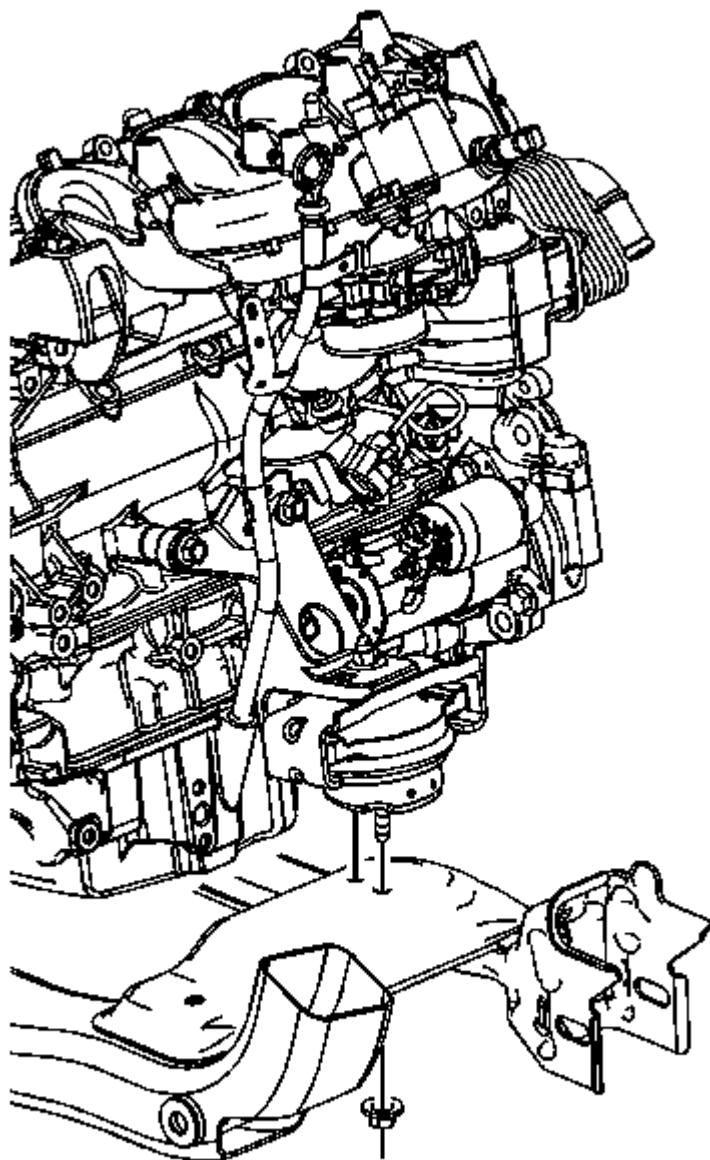


Fig. 23: View Of Driver Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the left engine mount lower nut.

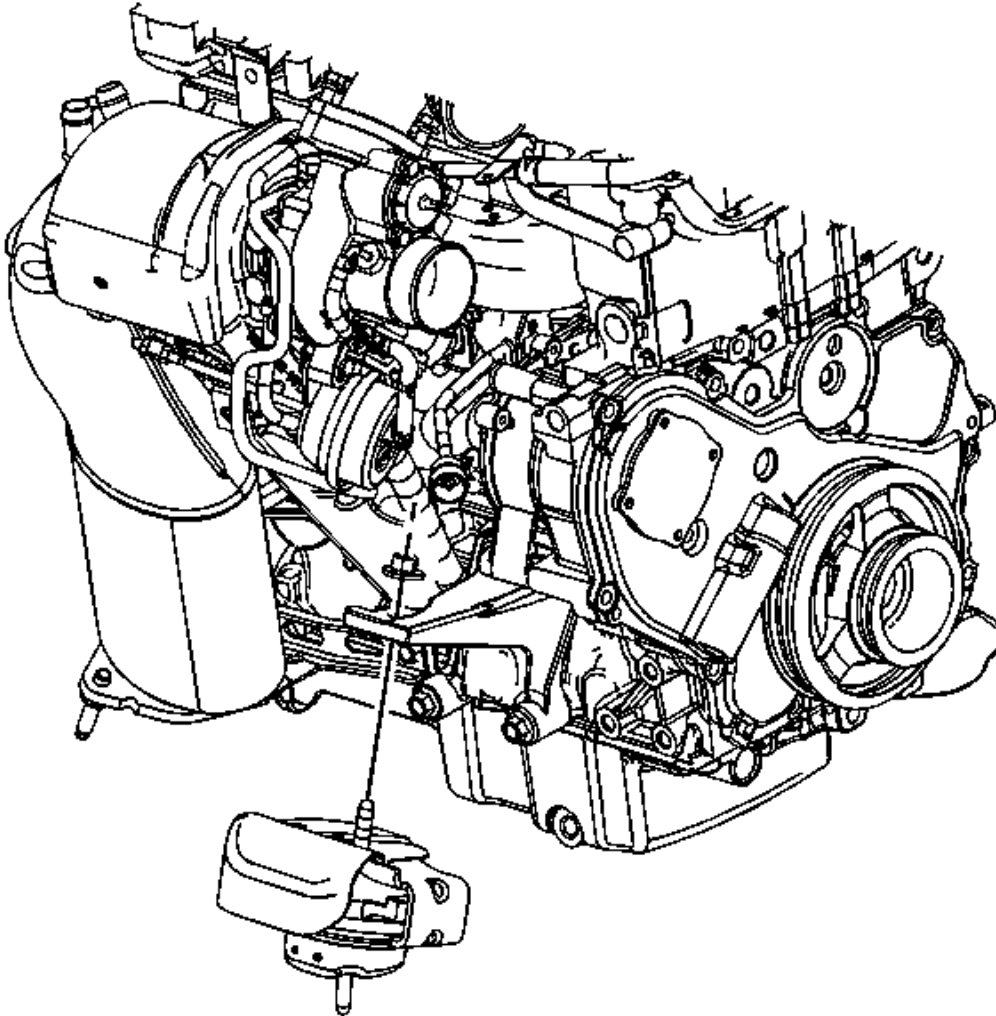


Fig. 24: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

7. Remove the right brake hose bracket bolt.
8. Remove the right brake line clip at the crossmember.
9. Position an adjustable jack below the oil pan. Place a block of wood between the oil pan and the jack.
10. Raise the engine using the adjustable jack until the engine mount can be removed.
11. Remove the right engine mount.

INSTALLATION PROCEDURE

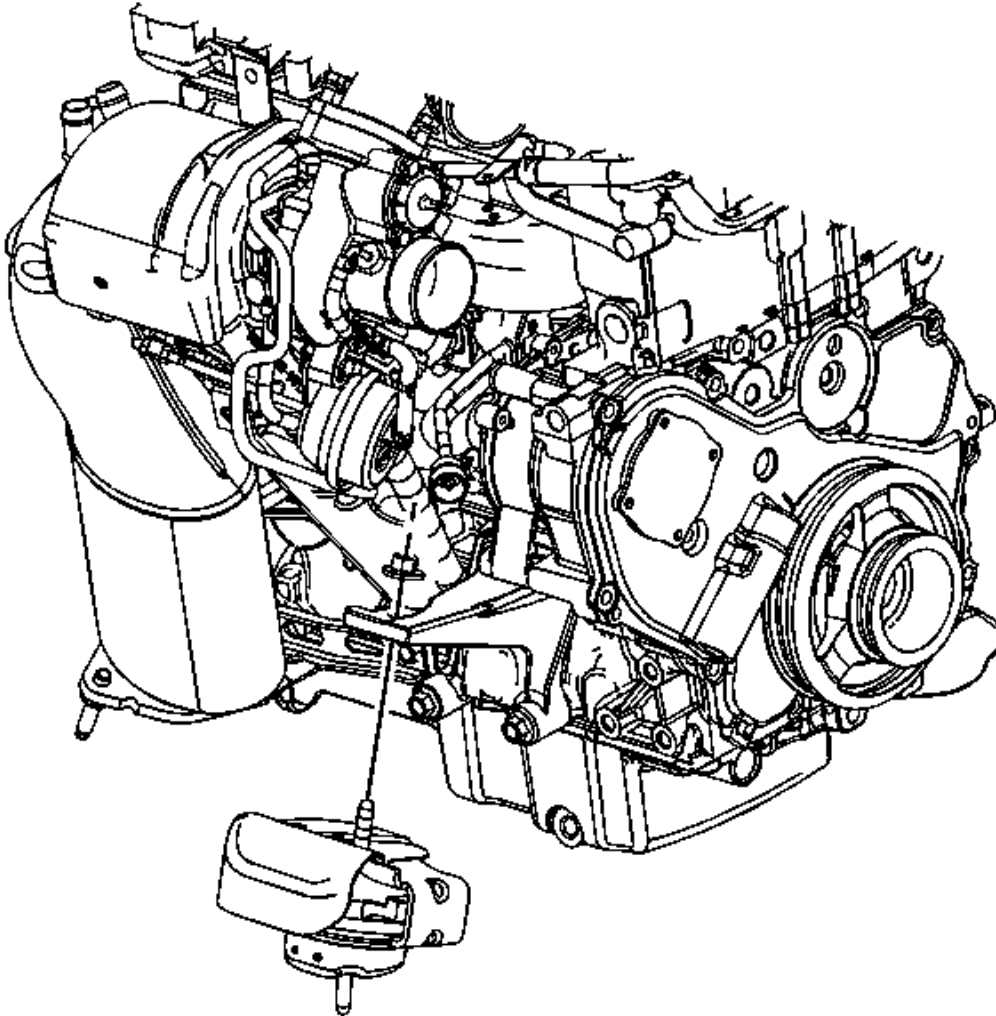


Fig. 25: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the right engine mount.
2. Lower the engine using the adjustable jack until the engine is resting on the mount.
3. Remove the adjustable jack from below the oil pan.
4. Install the right brake line clip at the crossmember.

CAUTION: Refer to Fastener Caution .

5. Install the right brake hose bracket bolt and tighten to 10 N.m (89 lb in).

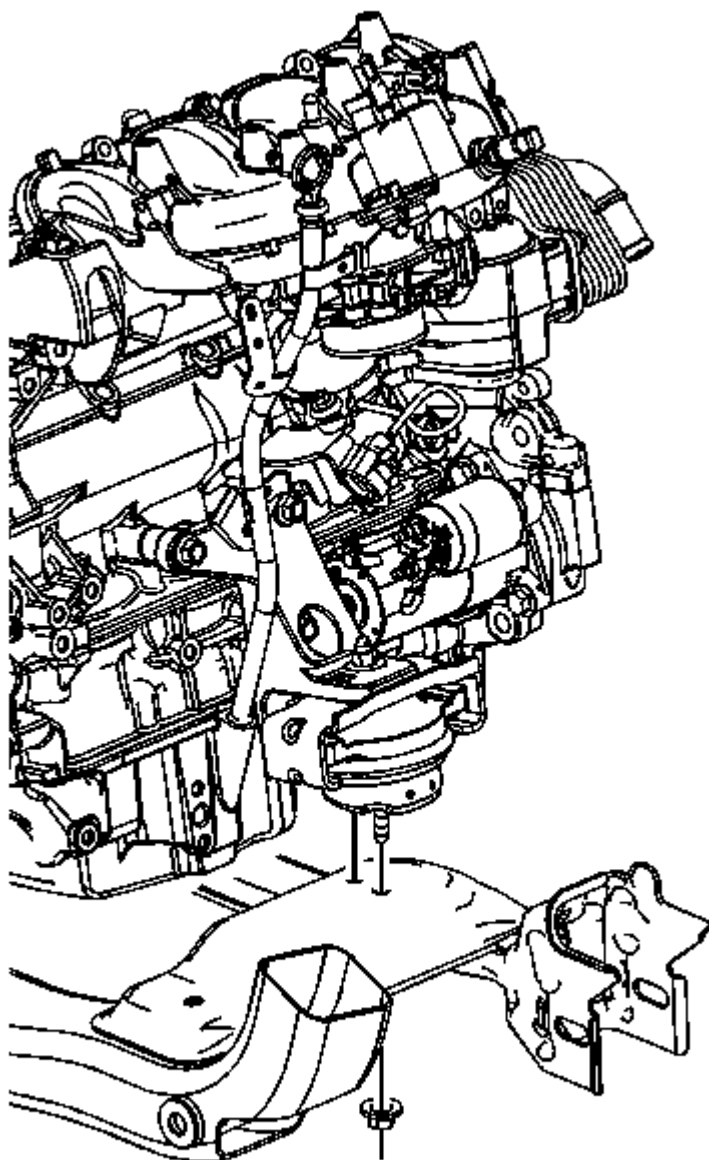


Fig. 26: View Of Driver Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

6. Install the left engine mount lower nut and tighten to 55 N.m (41 lb ft).

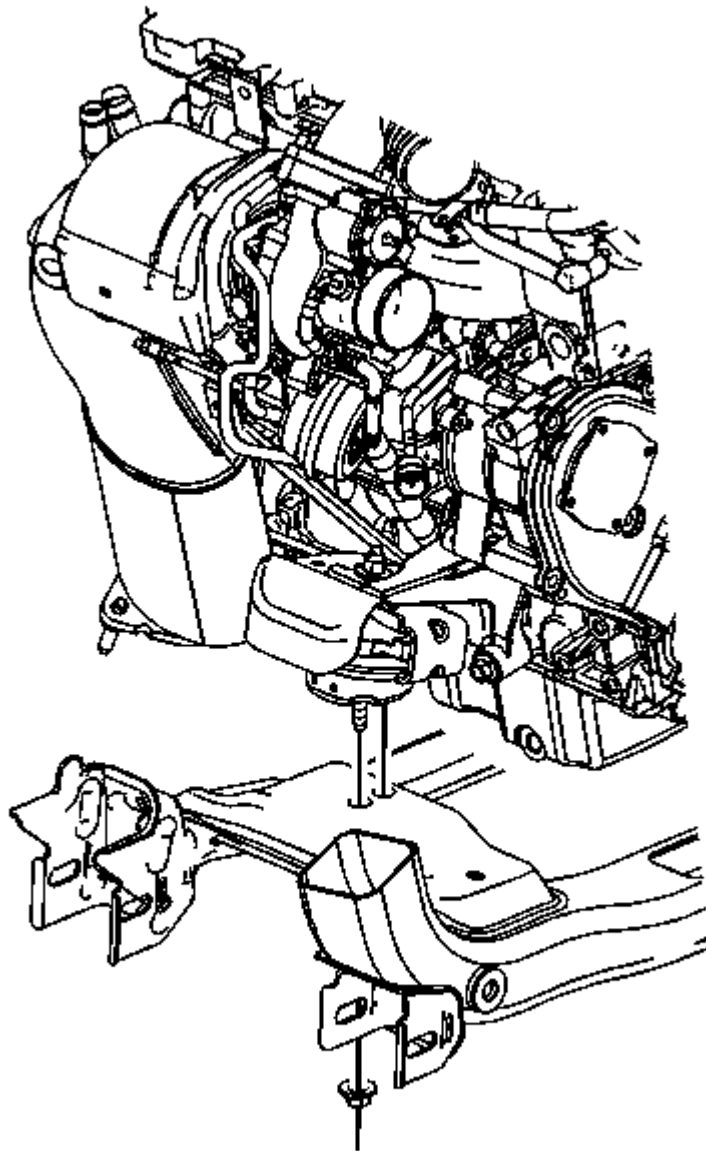


Fig. 27: View Of Passenger Side Engine Mount-To-Frame Lower Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the right engine mount lower nut and tighten to 55 N.m (41 lb ft).
8. Lower the vehicle.

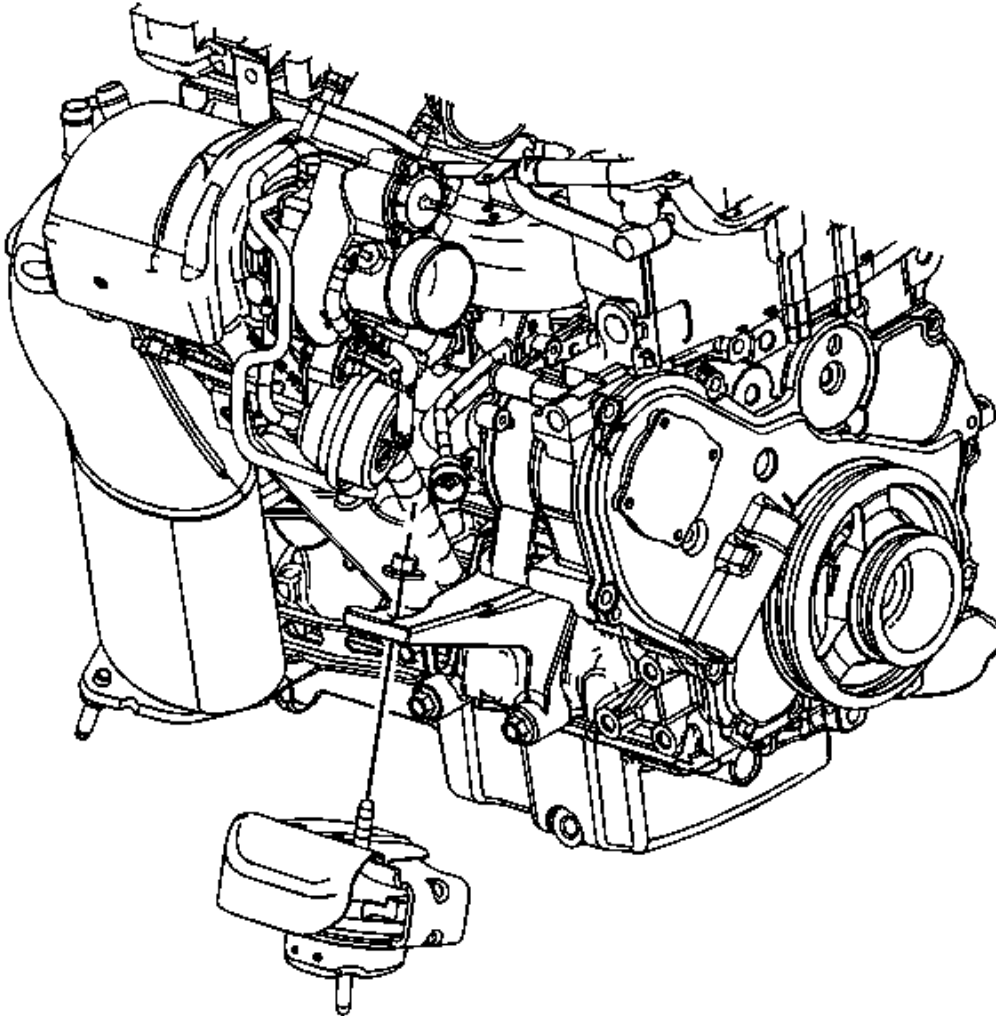


Fig. 28: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

9. Install the right engine mount upper nut and tighten to 55 N.m (41 lb ft).
10. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
11. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

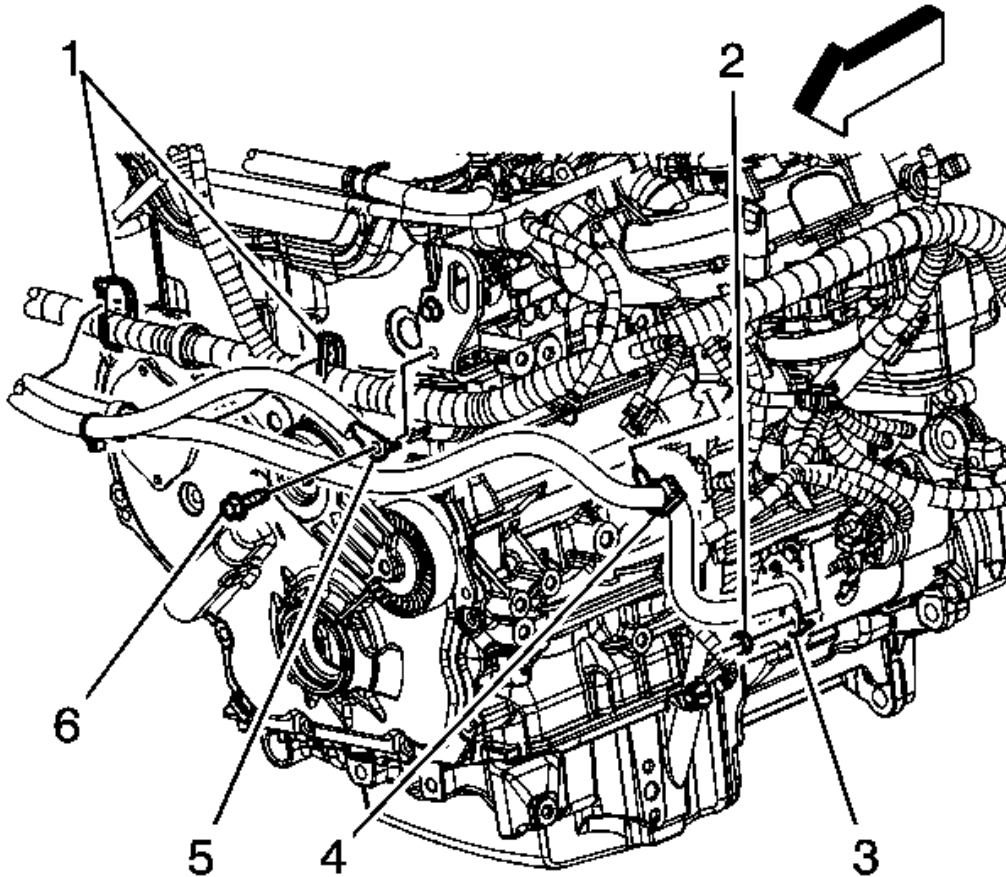


Fig. 29: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the left engine mount. Refer to **Engine Mount Replacement - Left Side**.
4. Remove the positive battery cable starter solenoid nut (2) from the starter.
5. Remove the positive battery cable terminal (3) from the starter.

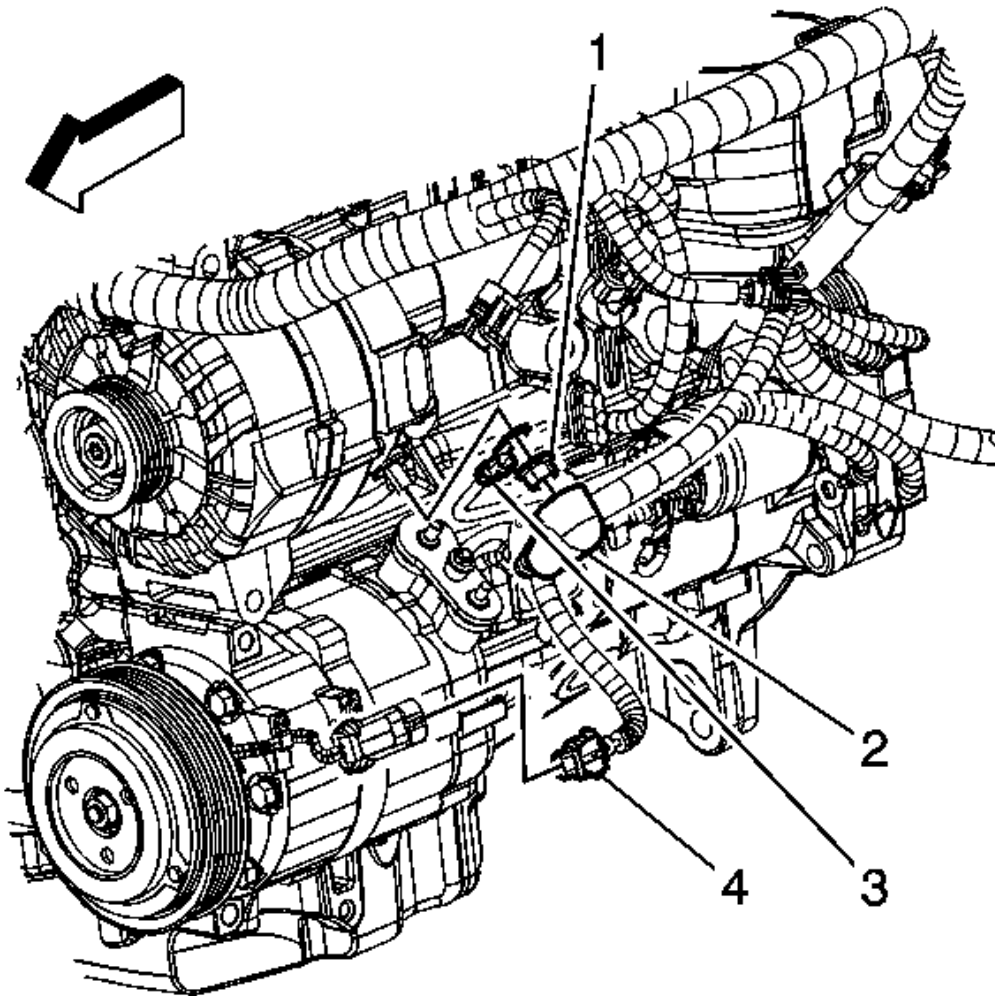


Fig. 30: Identifying Generator

Courtesy of GENERAL MOTORS CORP.

6. Reposition the engine wiring harness boot (2) at the generator stud.
7. Remove the engine wiring harness nut (1) from the generator.
8. Remove the engine wiring harness terminal (3) from the generator.

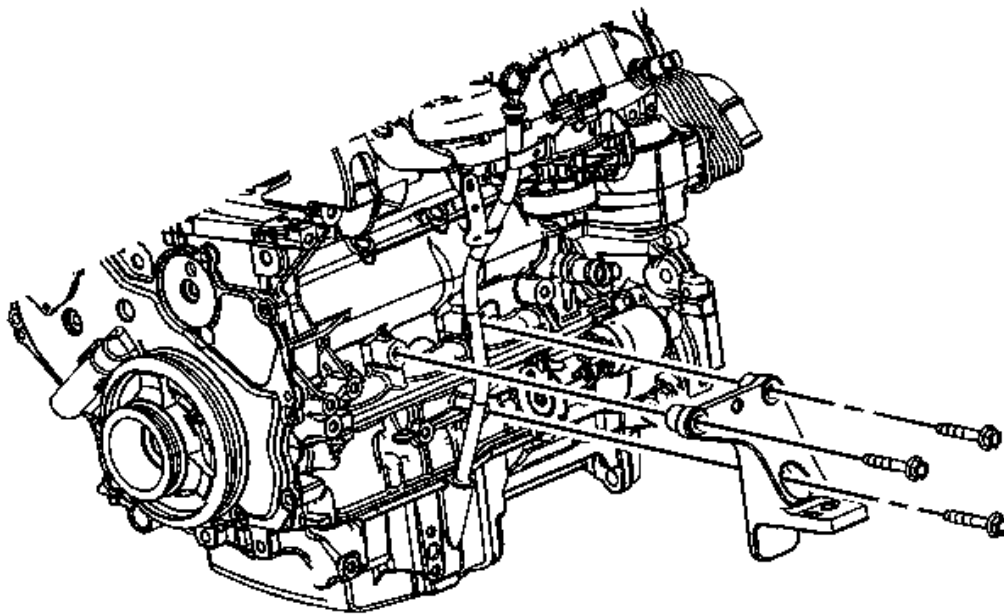


Fig. 31: View Of Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine mount bracket bolts and bracket.

INSTALLATION PROCEDURE

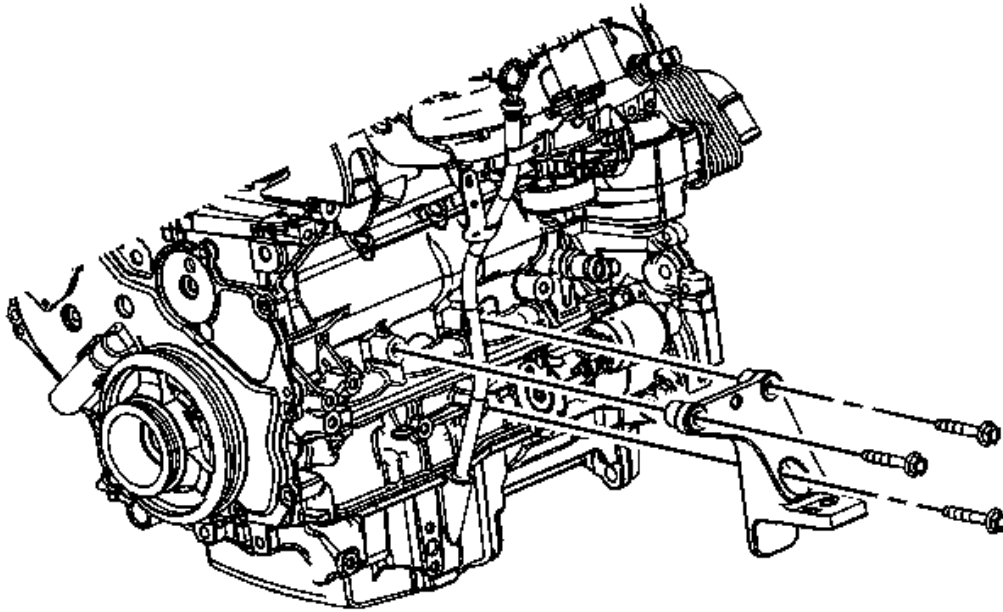


Fig. 32: View Of Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket to the engine block.
2. Install the engine mount bracket bolts until snug.

CAUTION: Refer to Fastener Caution .

3. Tighten the engine mount bracket bolts in the following sequence.
 1. Lower
 2. Upper front
 3. Upper Rear

Tighten: Tighten the bolts to 55 N.m (41 lb ft).

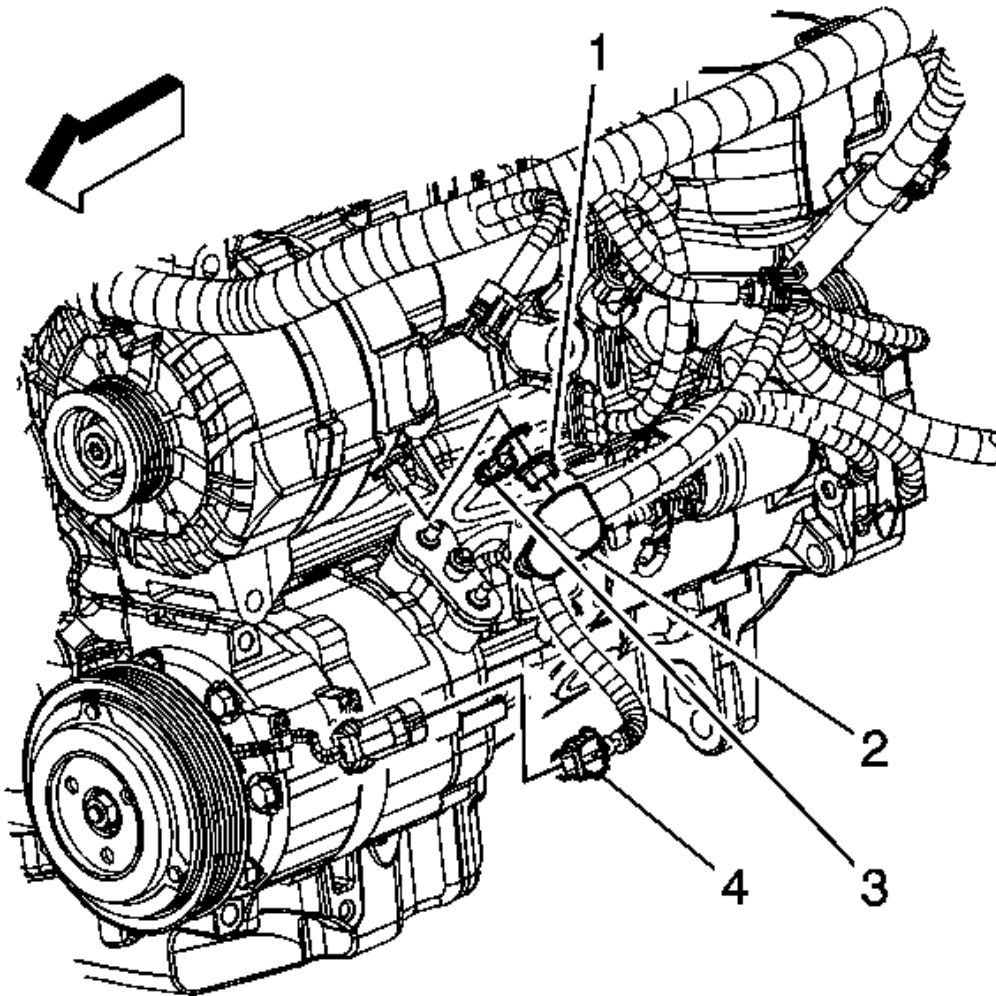


Fig. 33: Identifying Generator

Courtesy of GENERAL MOTORS CORP.

4. Install the engine wiring harness terminal (3) to the generator.
5. Install the engine wiring harness nut (1) to the generator.

Tighten: Tighten the nut to 20 N.m (15 lb ft).

6. Position the engine wiring harness boot (2).

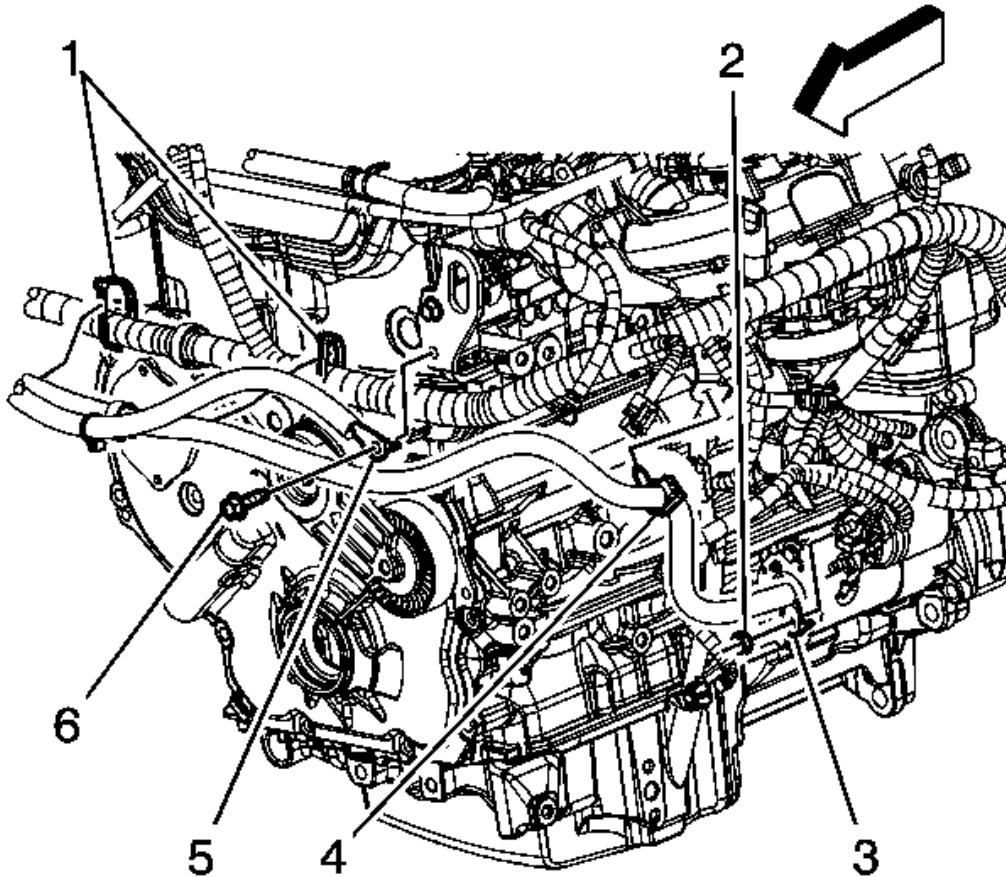


Fig. 34: Identifying Negative Battery Cables & Cable Components
 Courtesy of GENERAL MOTORS CORP.

7. Install the positive battery cable terminal (3) to the starter.
8. Install the positive battery cable starter solenoid nut (2) to the starter.

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

9. Install the left engine mount. Refer to **Engine Mount Replacement - Left Side**.
10. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation**.
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

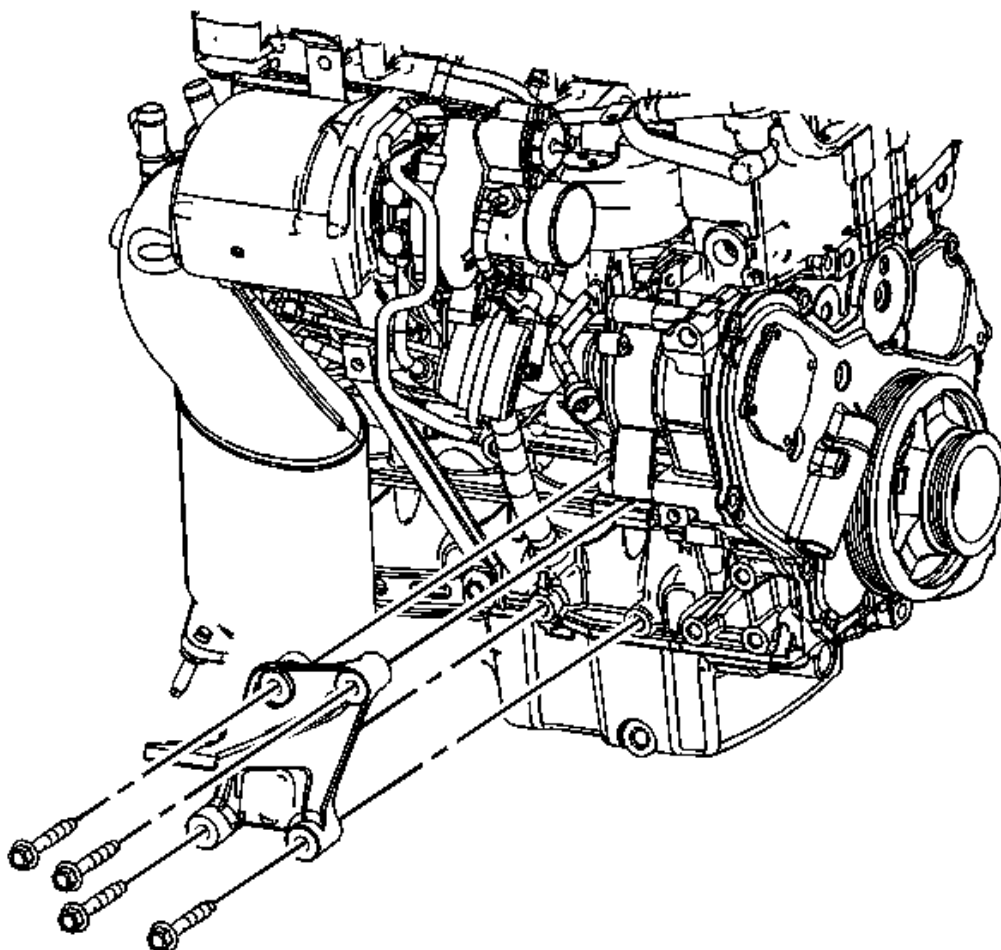


Fig. 35: View Of Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the right engine mount. Refer to **Engine Mount Replacement - Right Side.**
2. Remove the engine mount bracket bolts and bracket.

INSTALLATION PROCEDURE

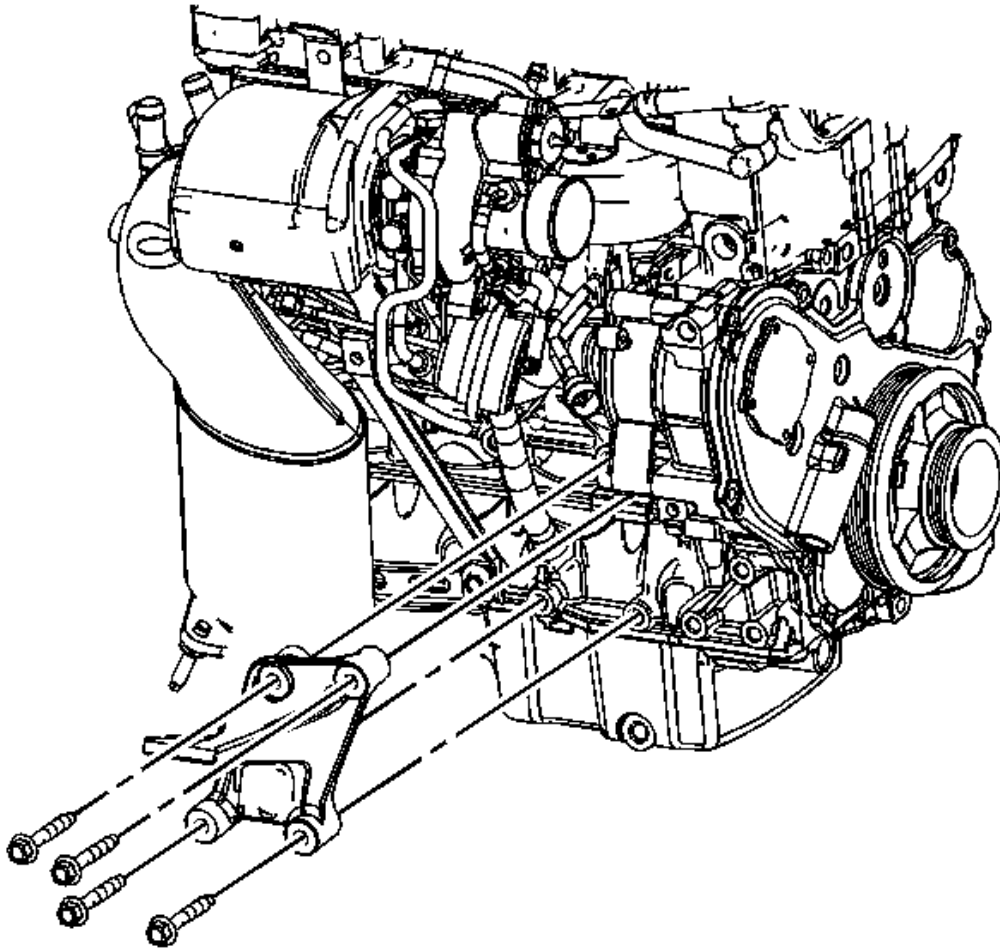


Fig. 36: View Of Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the right engine mount bracket to the engine block.
2. Install the engine mount bracket bolts until snug.

CAUTION: Refer to Fastener Caution .

3. Tighten the right engine mount bracket bolts in the following sequence, to 55 N.m (41 lb ft).
 1. Lower rear
 2. Upper front

3. Lower front
4. Upper rear
4. Install the right engine mount. Refer to Engine Mount Replacement - Right Side.

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

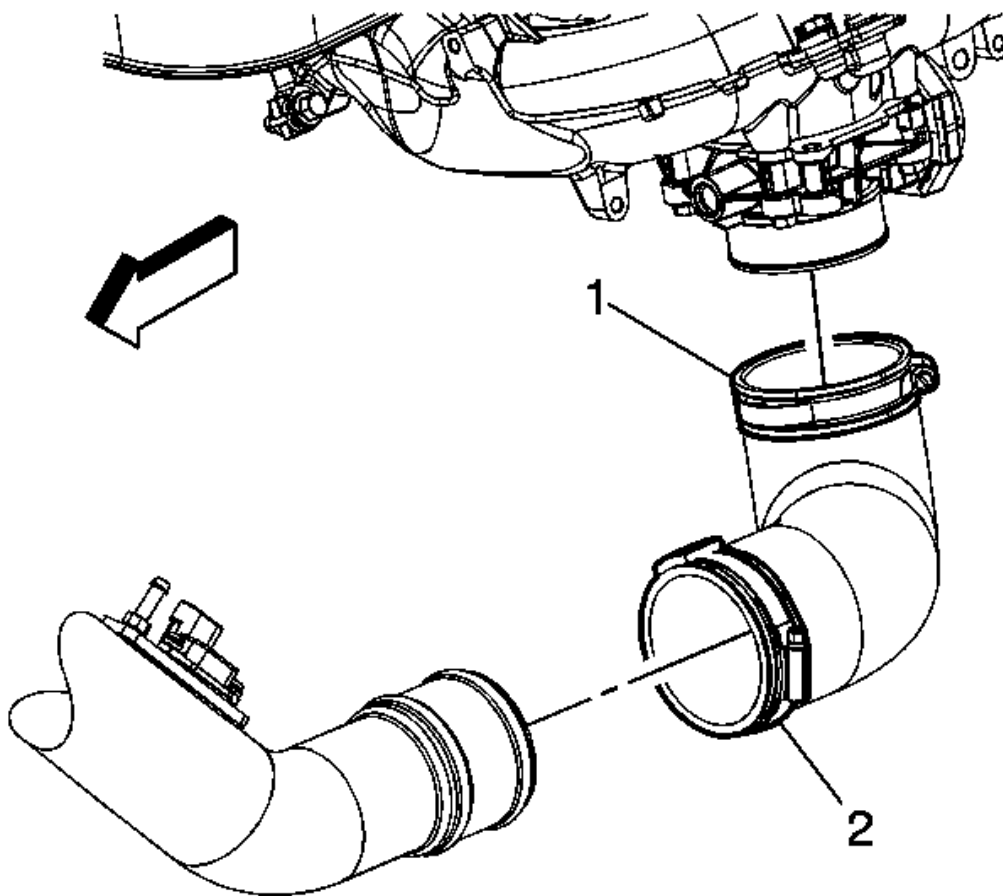


Fig. 37: View Of Charge Air Cooler Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

1. Loosen the charge air cooler (CAC) outlet hose clamp (2) at the CAC outlet pipe.
2. Loosen the CAC outlet hose clamp (1) at the throttle body.
3. Remove the CAC outlet hose from the CAC outlet pipe and throttle body.

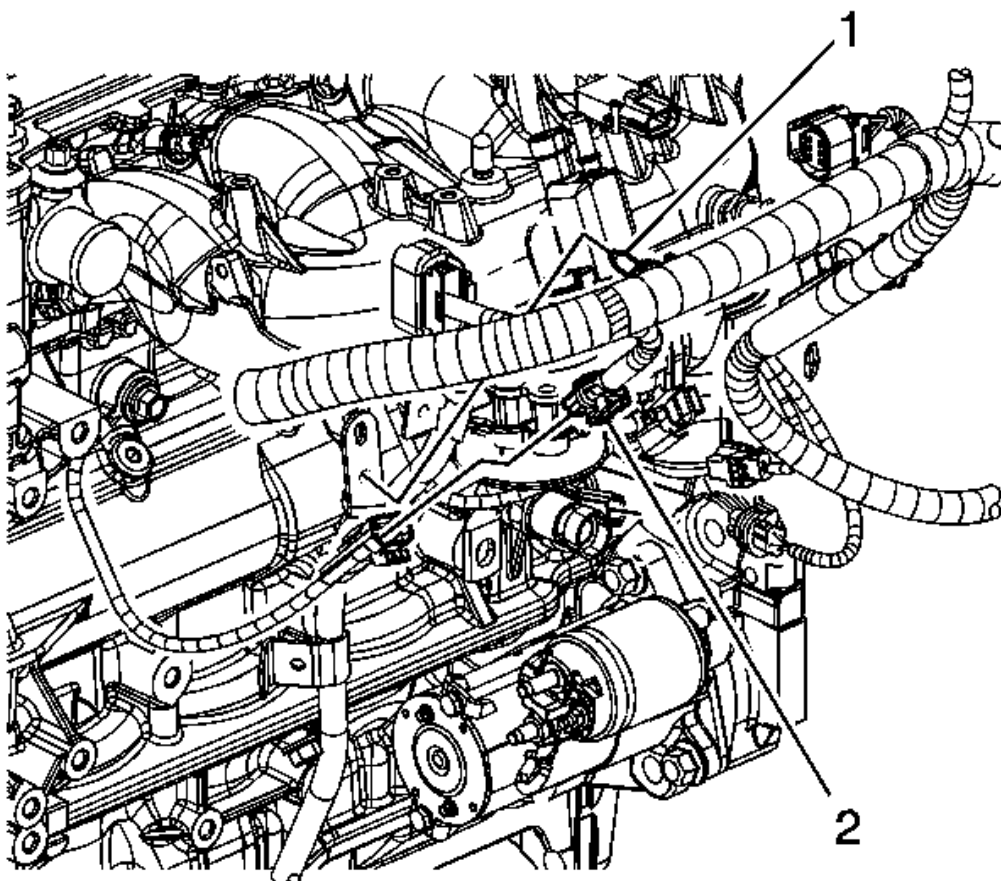


Fig. 38: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine wiring harness clip (1) from the oil level indicator tube bracket.

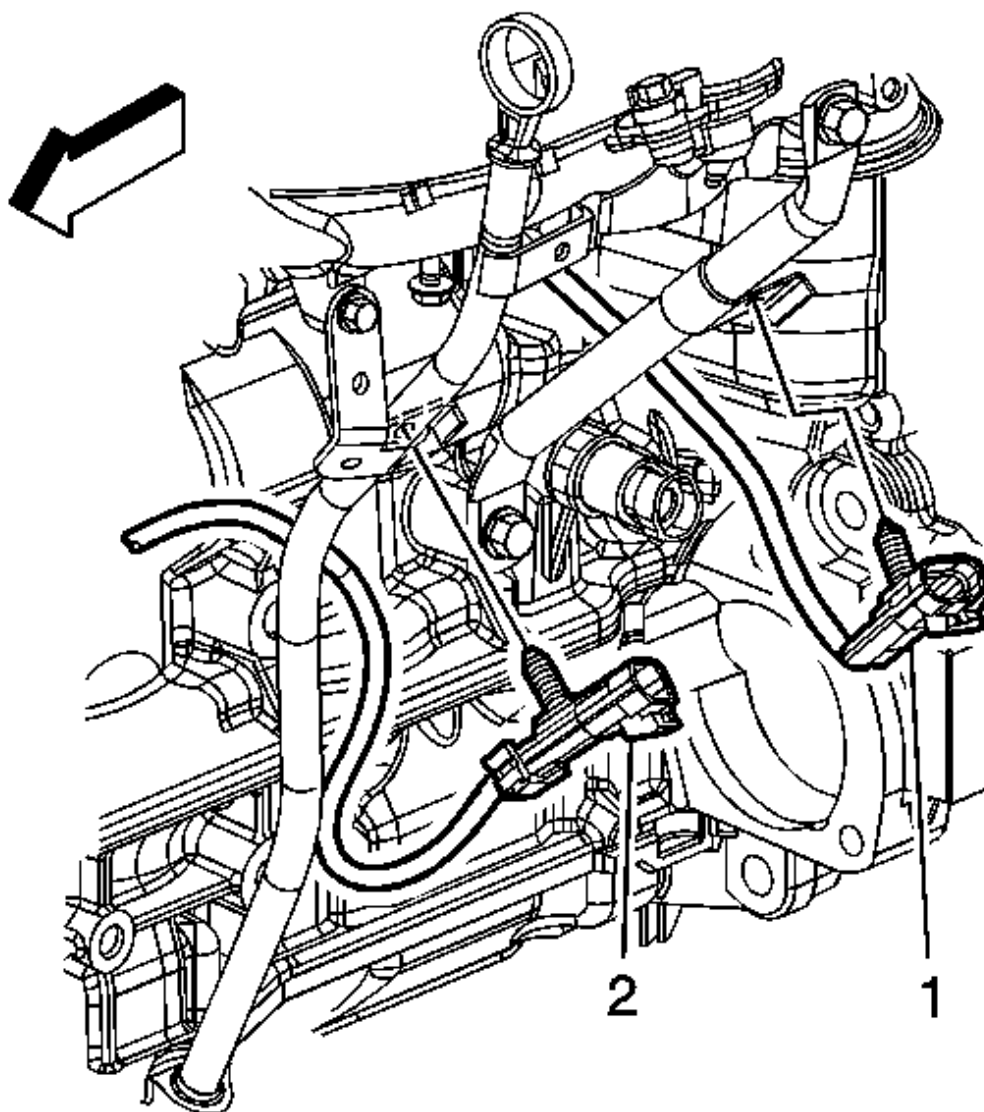


Fig. 39: Identifying Front & Rear Knock Sensor Clips
Courtesy of GENERAL MOTORS CORP.

5. Remove the number 1 knock sensor (2) clip from the oil level indicator tube bracket.

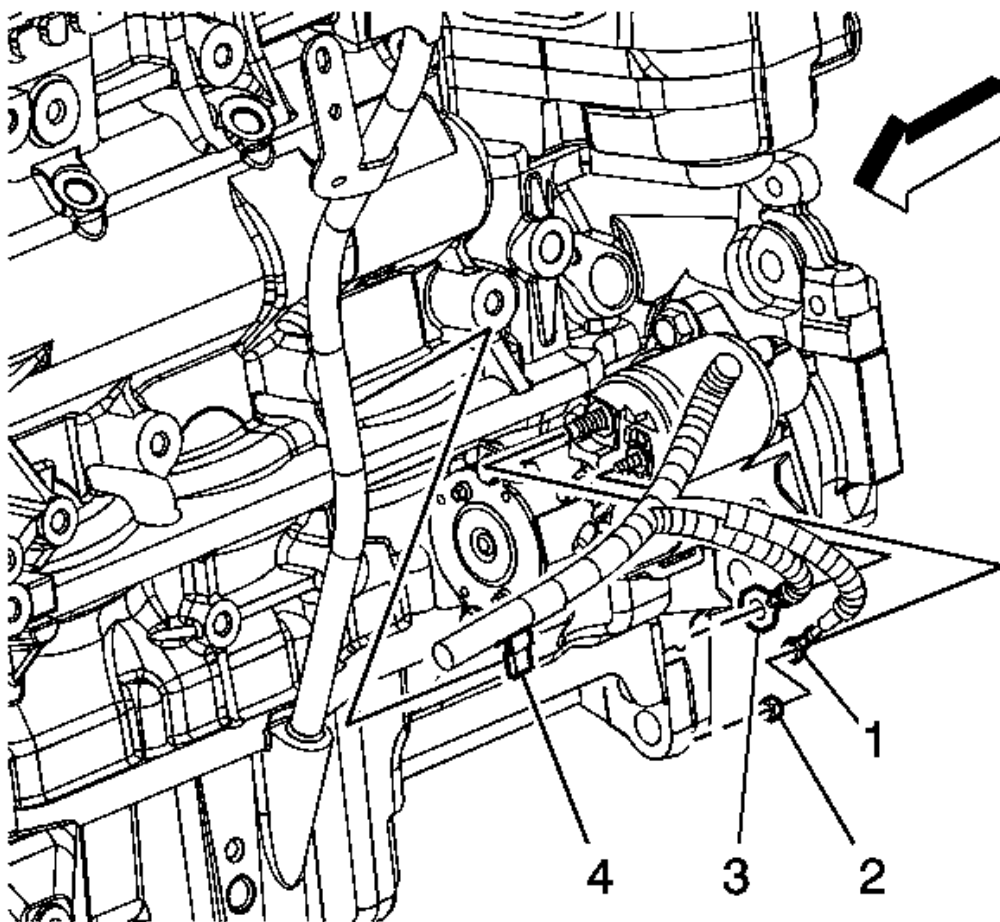


Fig. 40: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine wiring harness clip (4) from the oil level indicator tube bracket.

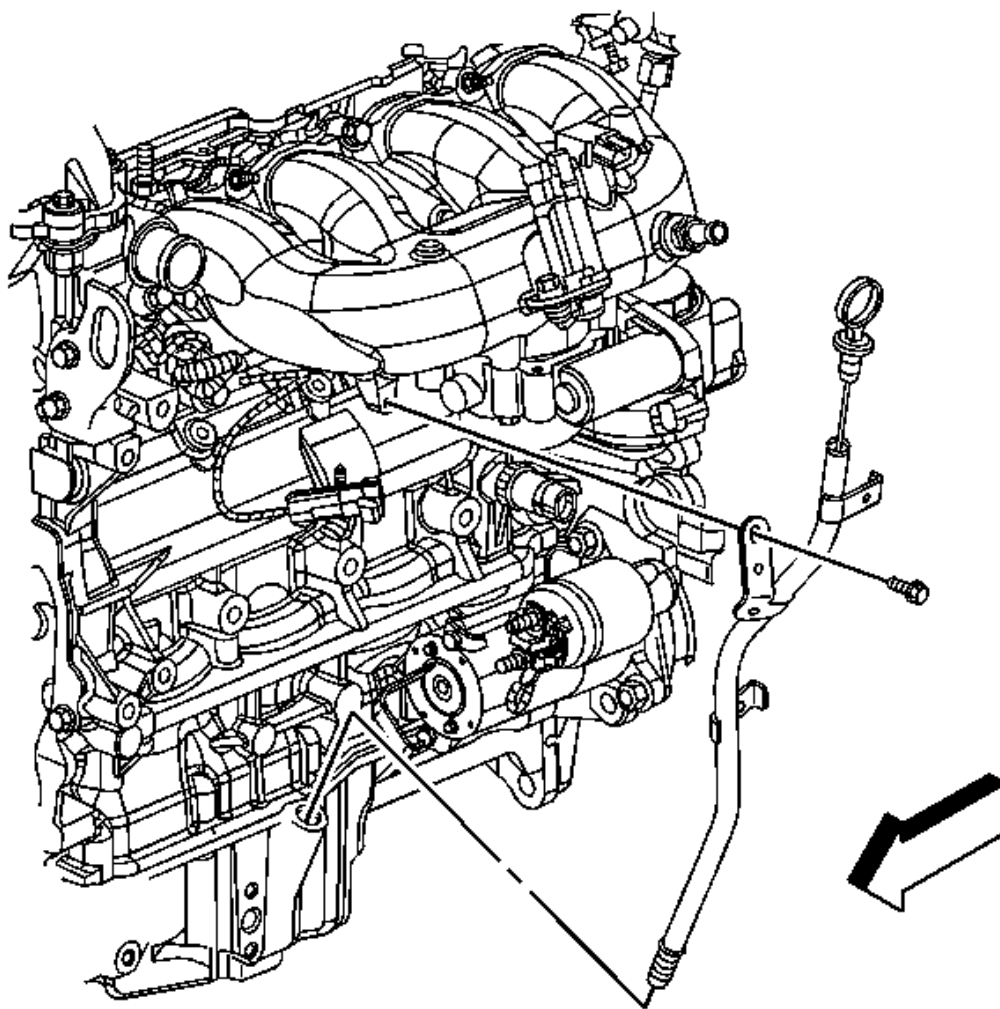


Fig. 41: View Of Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil level indicator tube bolt.
8. Remove the oil level indicator tube and indicator.

INSTALLATION PROCEDURE

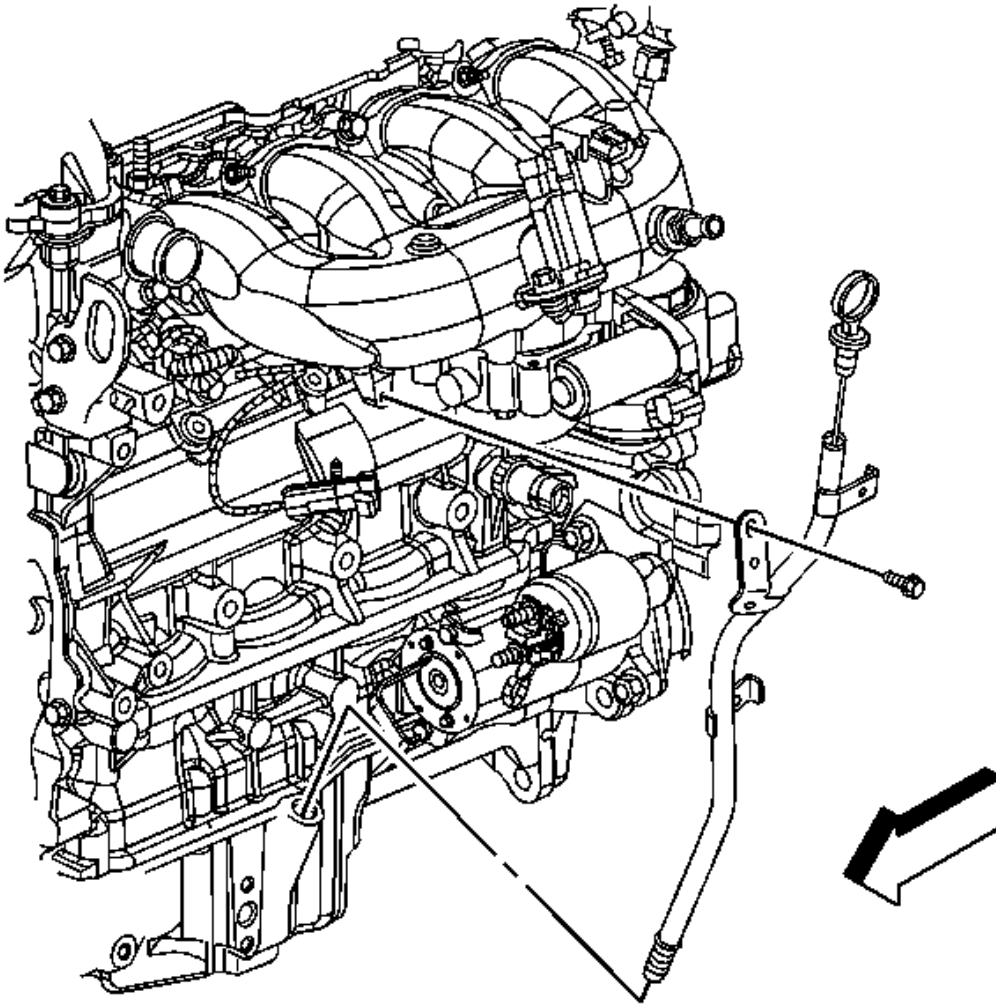


Fig. 42: View Of Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil level indicator tube O-ring seal with lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the oil level indicator tube to the engine block.

CAUTION: Refer to **Fastener Caution** .

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

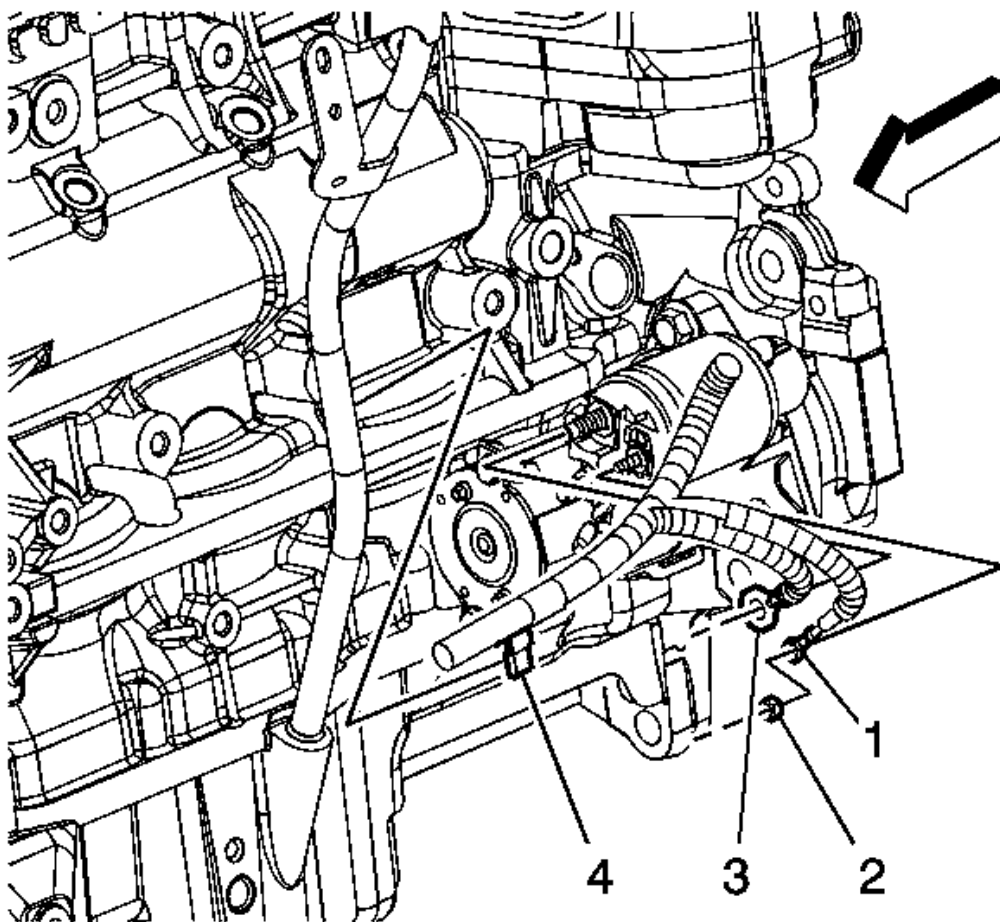


Fig. 43: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

4. Install the engine wiring harness clip (4) to the oil level indicator tube bracket.

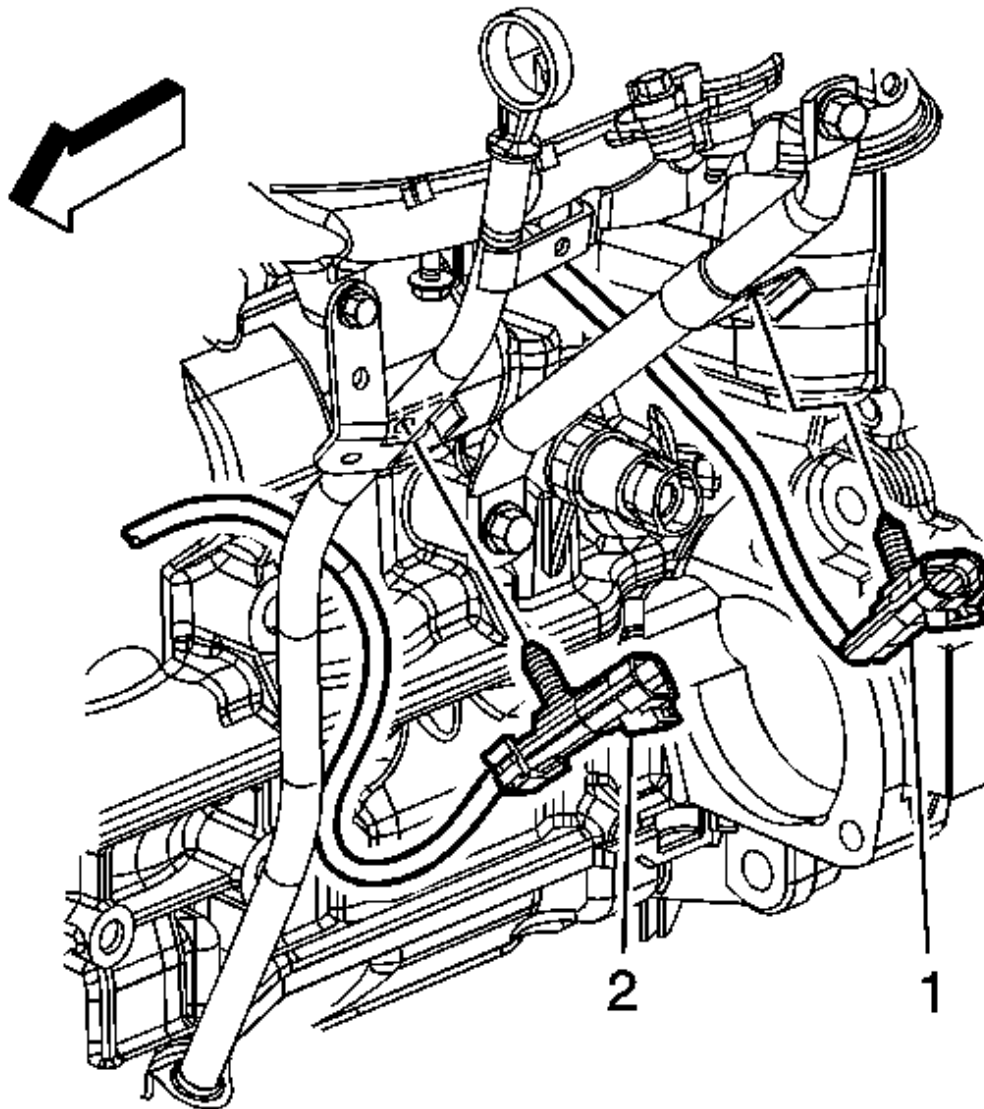


Fig. 44: Identifying Front & Rear Knock Sensor Clips
Courtesy of GENERAL MOTORS CORP.

5. Install the number 1 knock sensor (2) clip to the oil level indicator tube bracket.

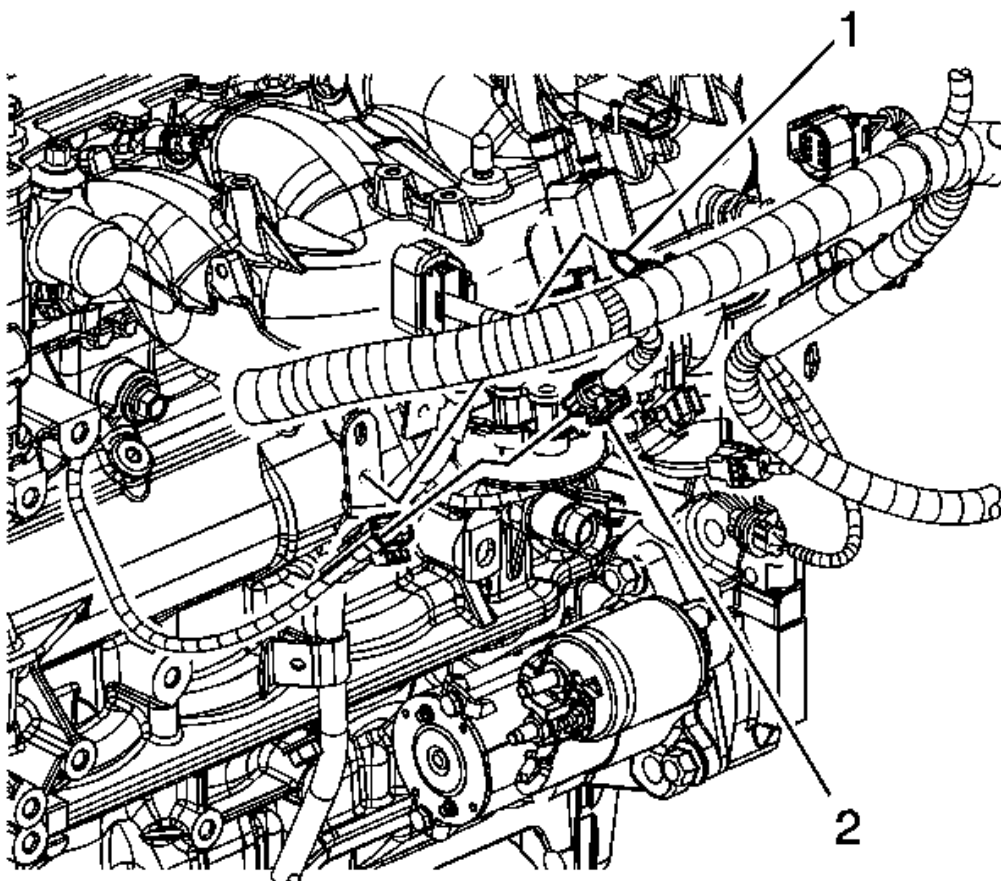


Fig. 45: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

6. Install the engine wiring harness clip (1) to the oil level indicator tube bracket.

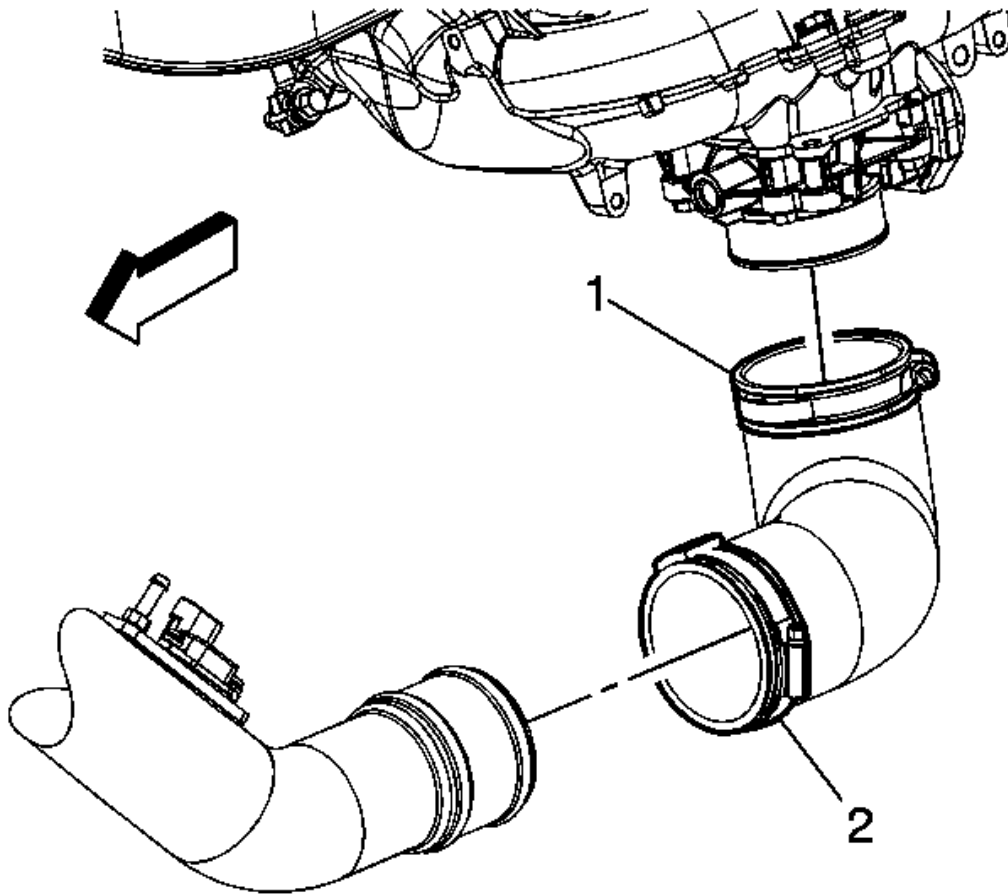


Fig. 46: View Of Charge Air Cooler Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

7. Install the CAC outlet hose to the CAC outlet pipe and throttle body.
8. Tighten the CAC outlet hose clamp (1) at the throttle body.
9. Tighten the CAC outlet hose clamp (2) at the CAC outlet pipe.

Tighten the clamps to 5 N.m (44 lb in).

TURBOCHARGER REPLACEMENT

REMOVAL PROCEDURE

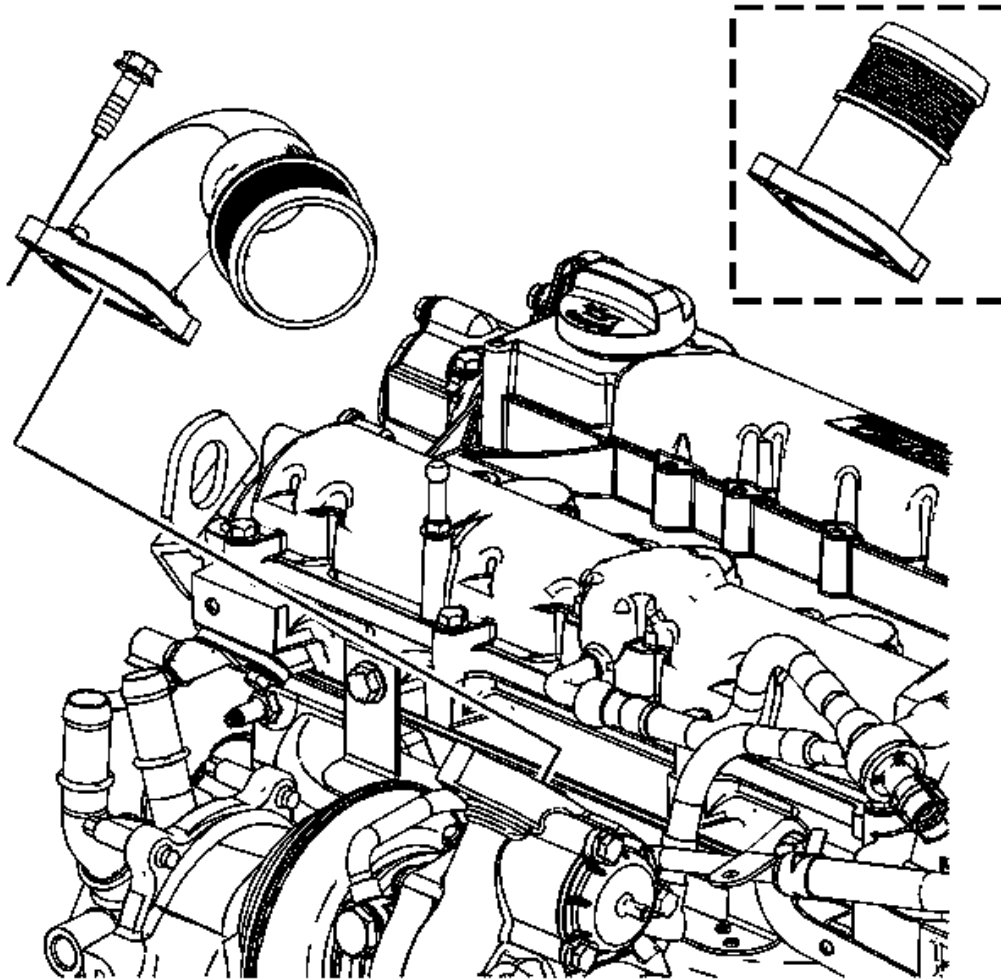


Fig. 47: Identifying Charge Air Cooler Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE-47716) or Cooling System Draining and Filling (Static Fill-LNF)
2. Remove the charge air cooler inlet pipe. Refer to Charge Air Cooler Inlet Pipe Replacement
3. Remove the charge air cooler pipe bolts at the turbocharger.
4. Remove the charge air cooler pipe from the turbocharger.

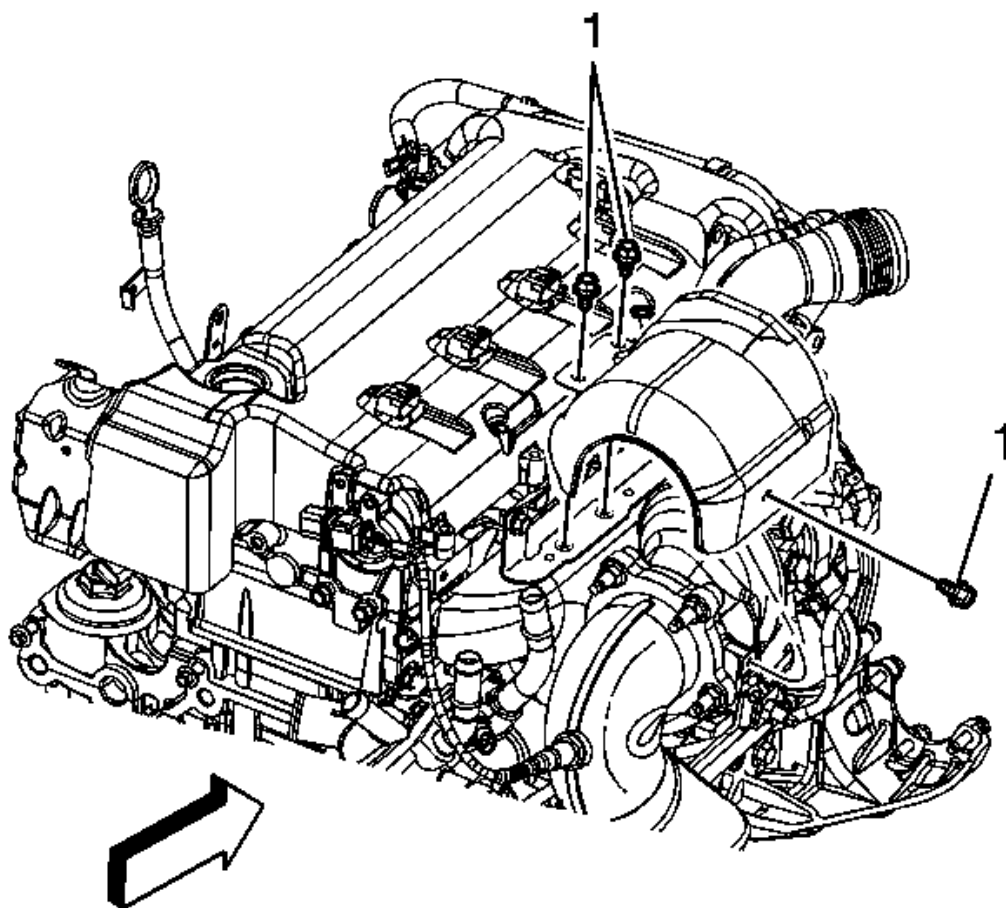


Fig. 48: Identifying Turbocharger Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the turbocharger heat shield bolts (1) and shield.
6. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LNF)**

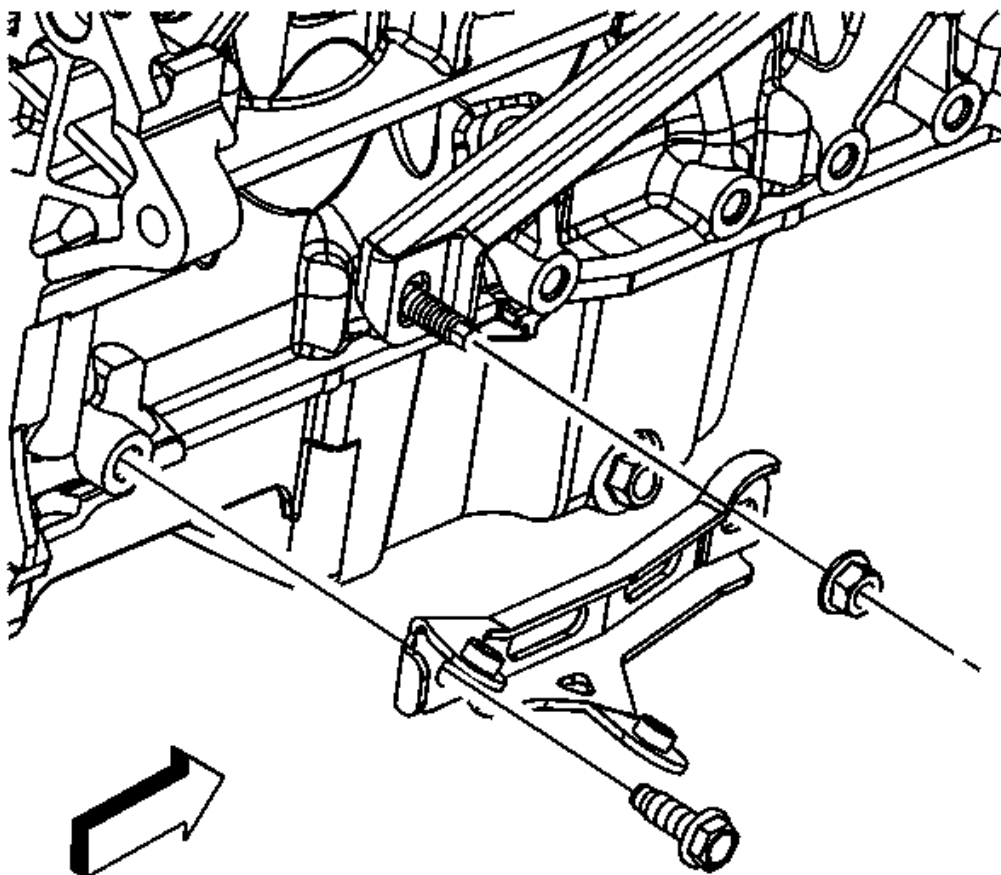


Fig. 49: View Of Catalytic Converter Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the catalytic converter bracket bolt, nut, and bracket.
8. Lower the vehicle.

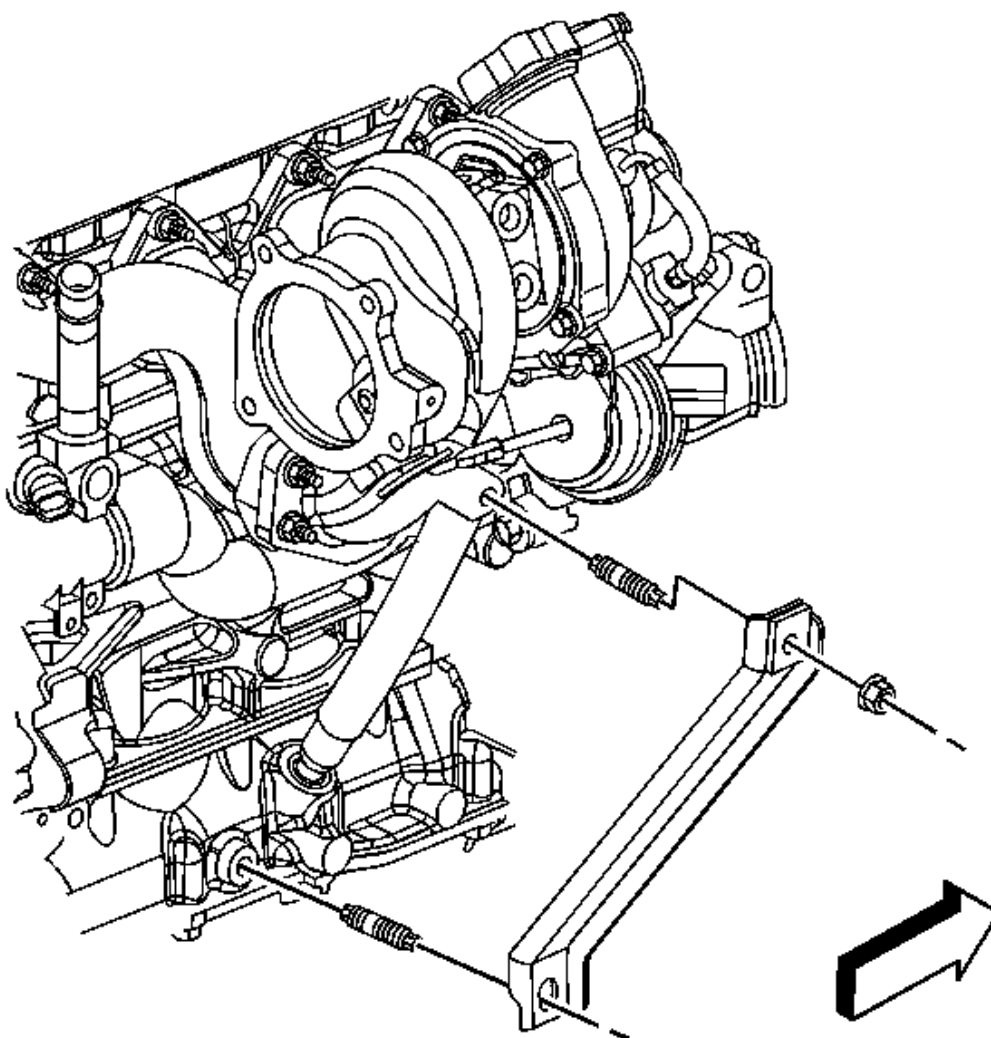


Fig. 50: View Of Turbocharger Brace
Courtesy of GENERAL MOTORS CORP.

9. Remove the turbocharger brace nut and brace.

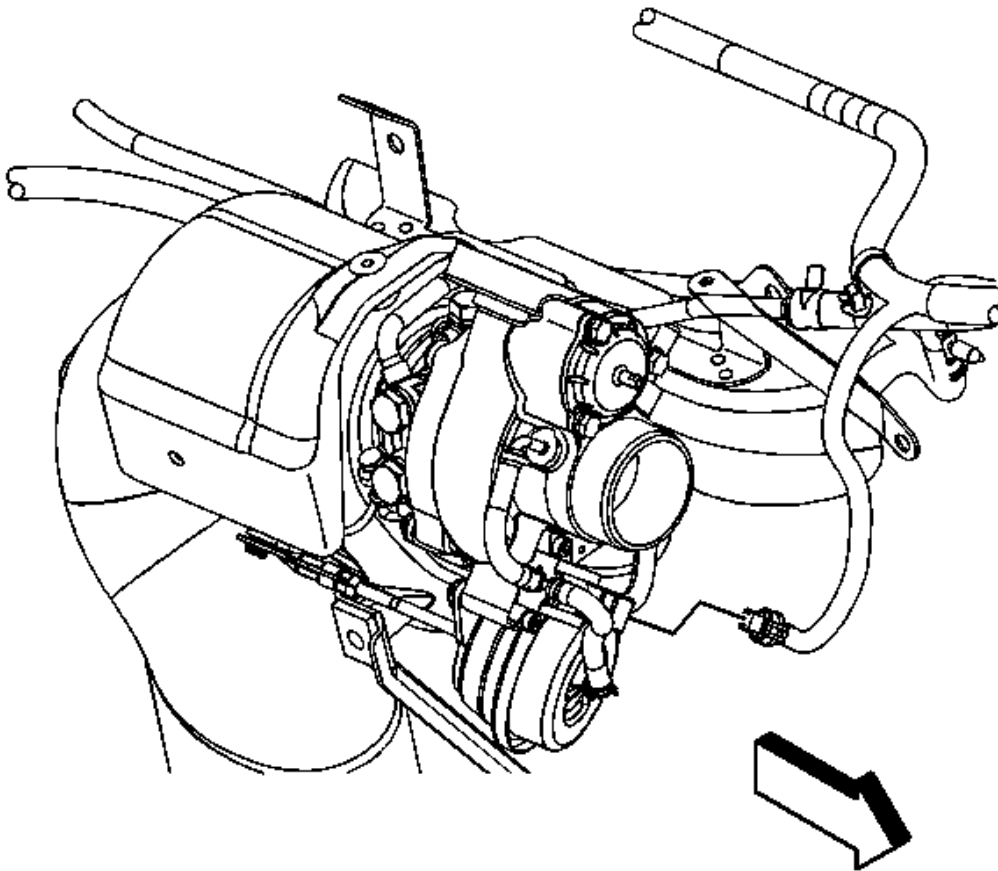


Fig. 51: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the engine wiring harness electrical connector from the turbocharger wastegate solenoid valve.

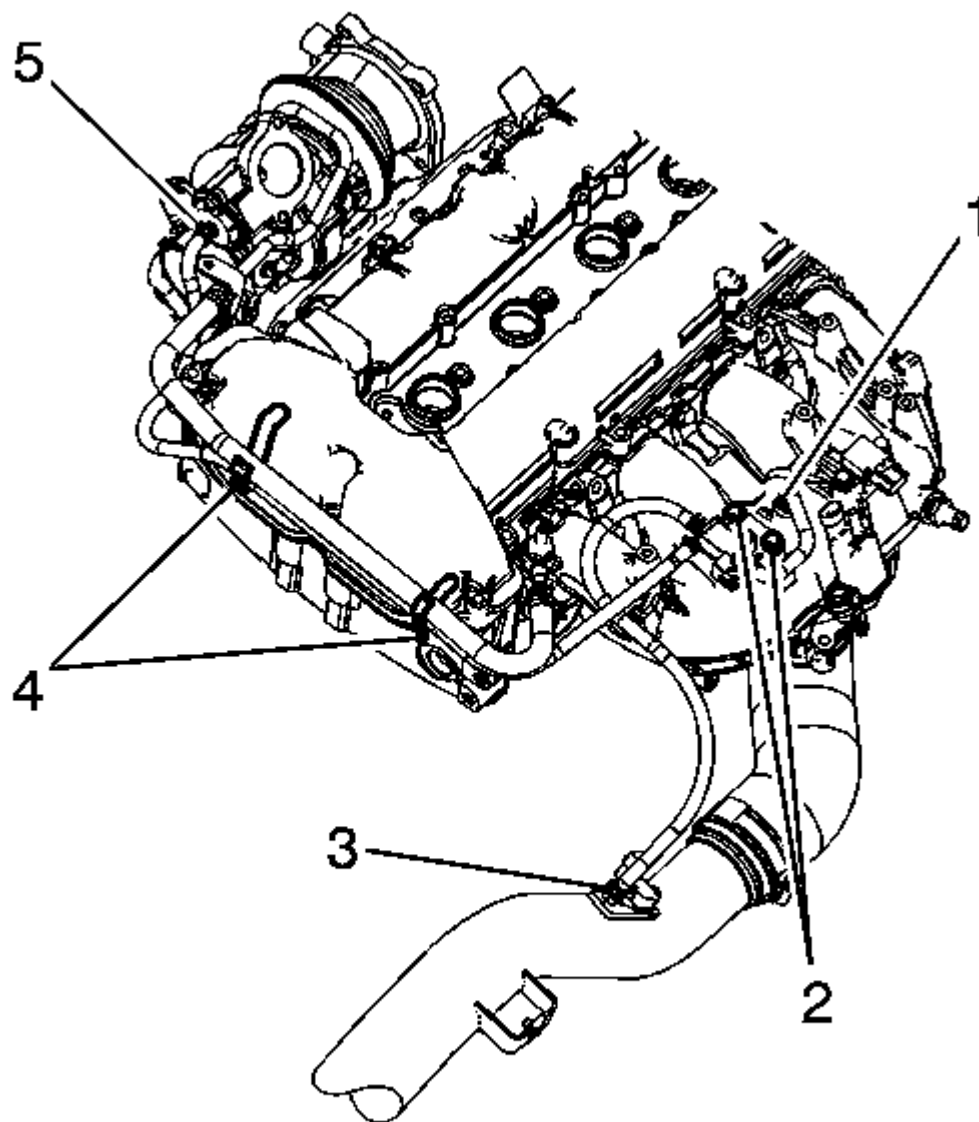


Fig. 52: Identifying Charge Air Bypass Solenoid Components
Courtesy of GENERAL MOTORS CORP.

11. Reposition the vacuum hose clamp (5) at the turbocharger.
12. Remove the vacuum hose from the turbocharger.

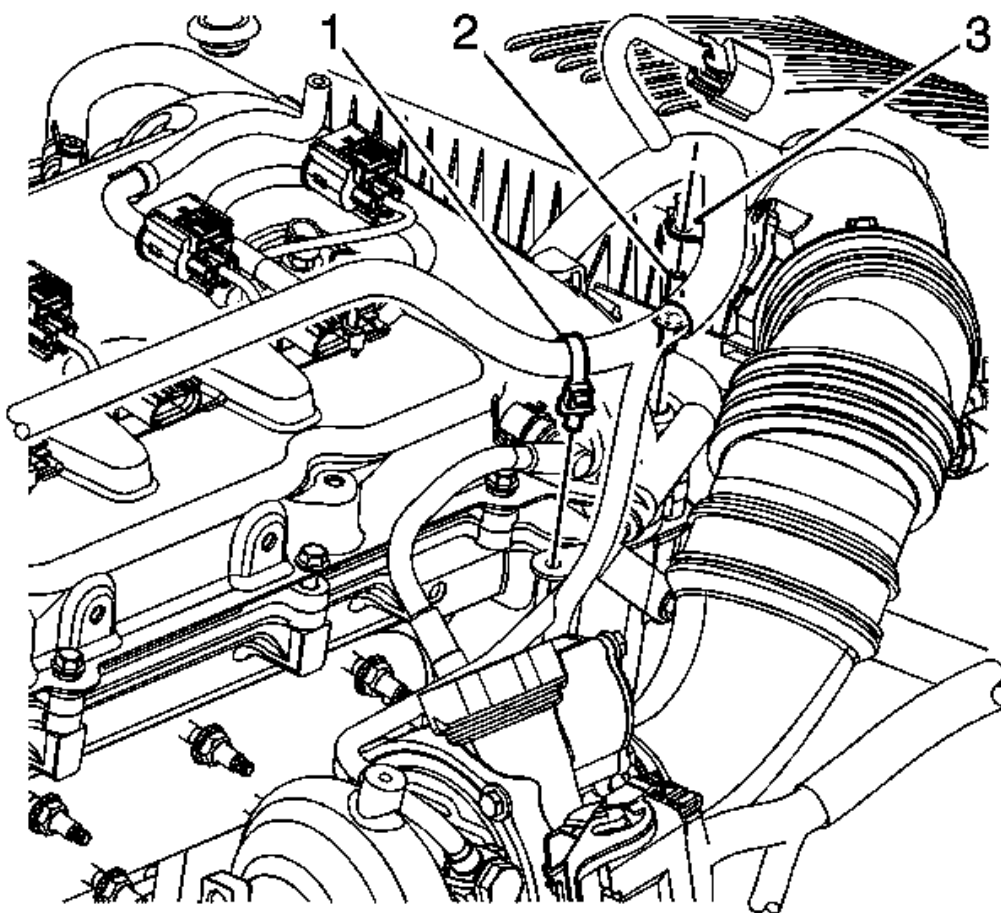


Fig. 53: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

13. Remove the engine wiring harness clip (1) from the turbocharger coolant feed pipe.

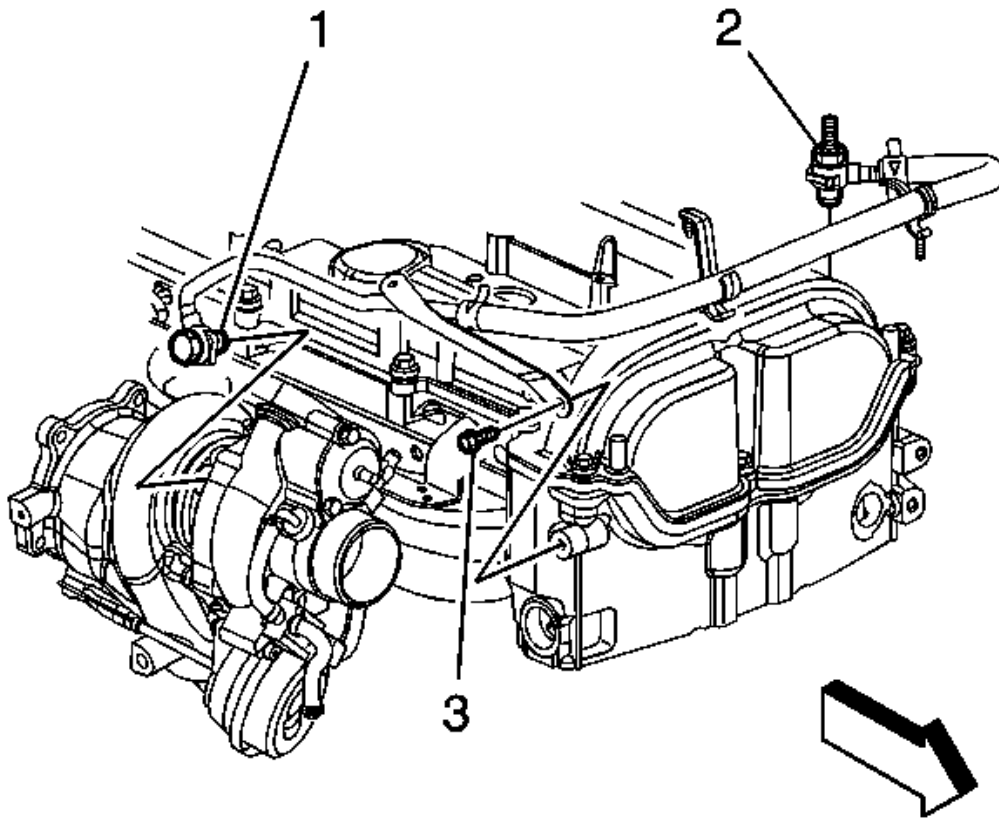


Fig. 54: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the turbocharger coolant feed pipe bolt (1) at the turbocharger.
15. Remove and discard the turbocharger coolant feed pipe gasket.
16. Remove the turbocharger coolant feed pipe bolt (3) from the cylinder head.
17. Reposition the turbocharger coolant feed pipe out of the way.

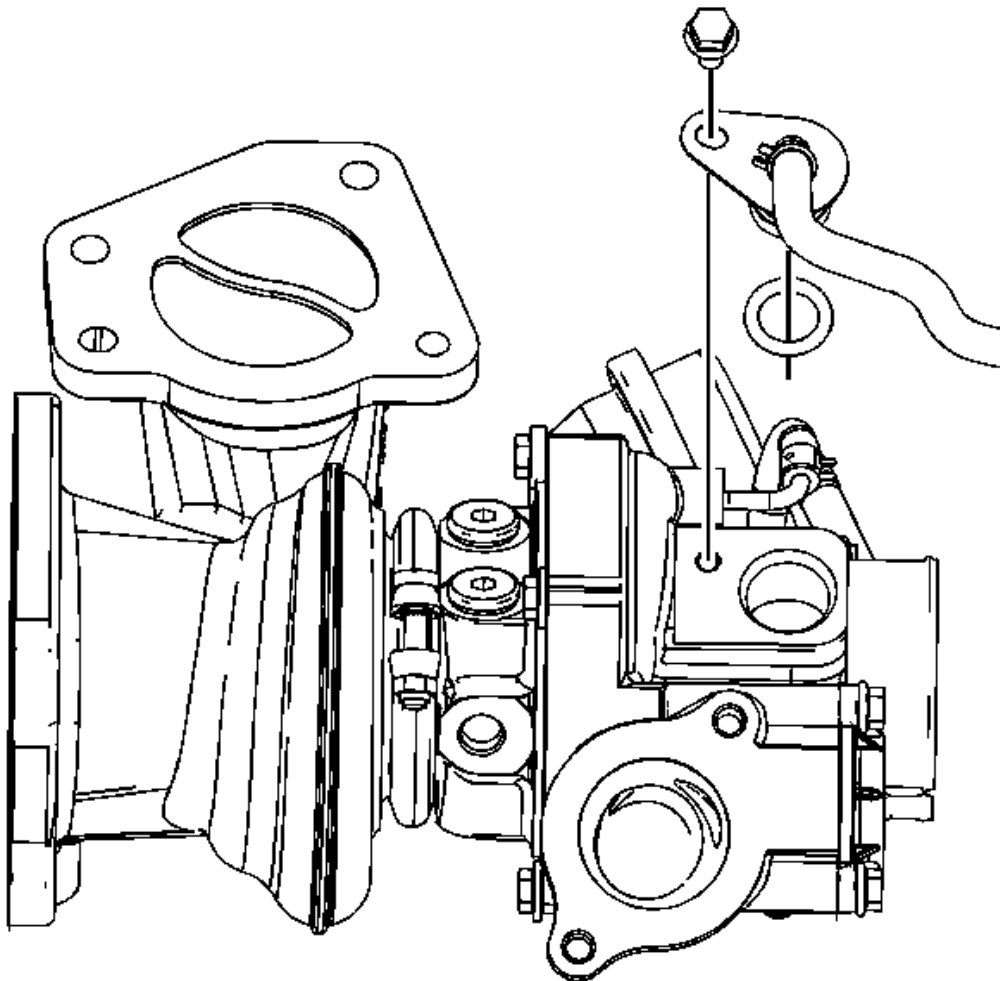


Fig. 55: View Of PCV Fitting, Bolt & Pipe
 Courtesy of GENERAL MOTORS CORP.

18. Remove the positive crankcase ventilation (PCV) fitting bolt from the turbocharger. Reposition the PCV pipe (with fitting) out of the way.

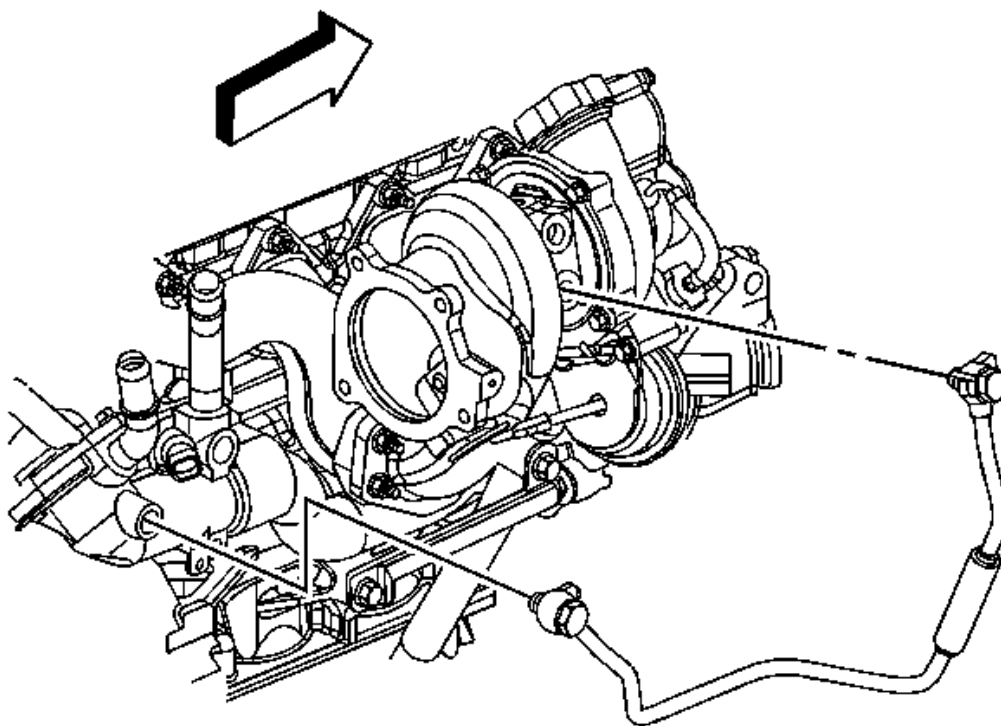


Fig. 56: View Of Turbocharger Coolant Return Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

19. Remove the turbocharger coolant return pipe bolts and pipe.
20. Remove and discard the turbocharger coolant return pipe gaskets.

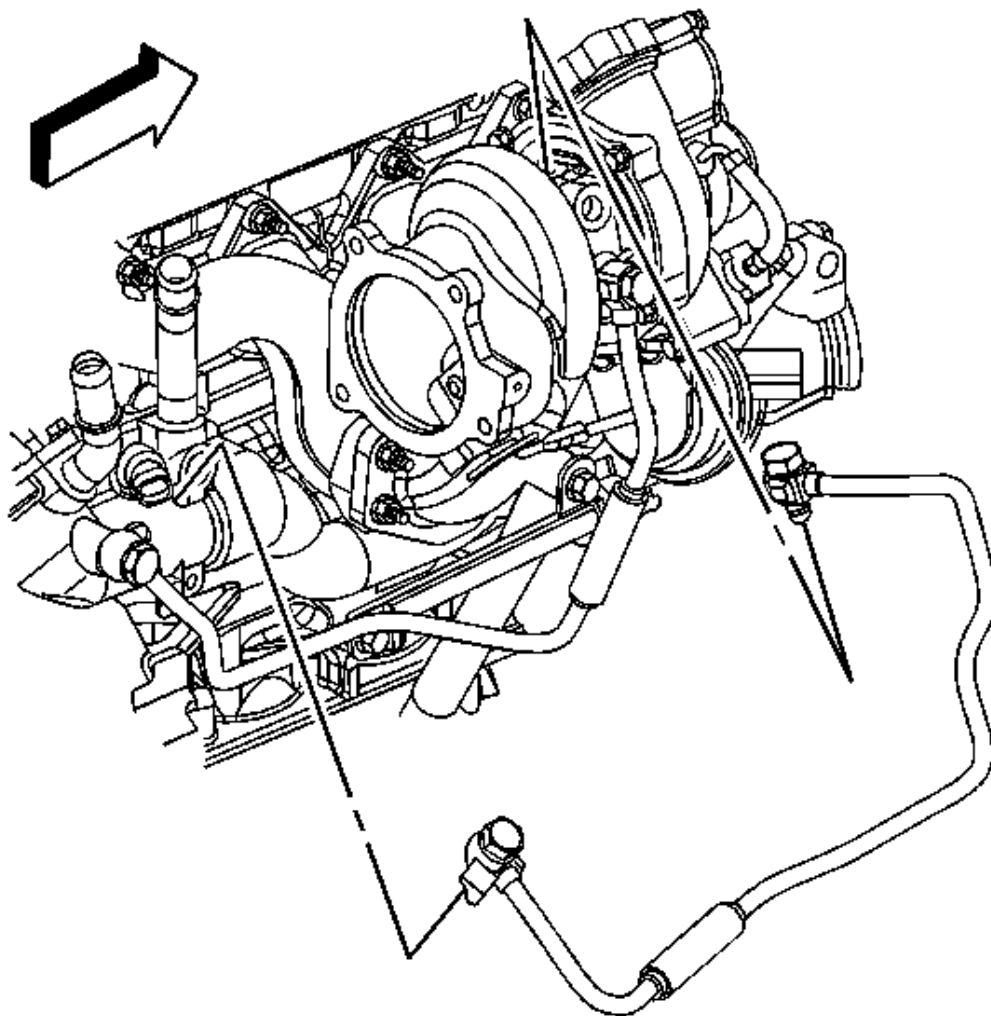


Fig. 57: View Of Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS CORP.

21. Remove the turbocharger oil feed pipe bolts and pipe.
22. Remove and discard the turbocharger oil feed pipe gaskets.

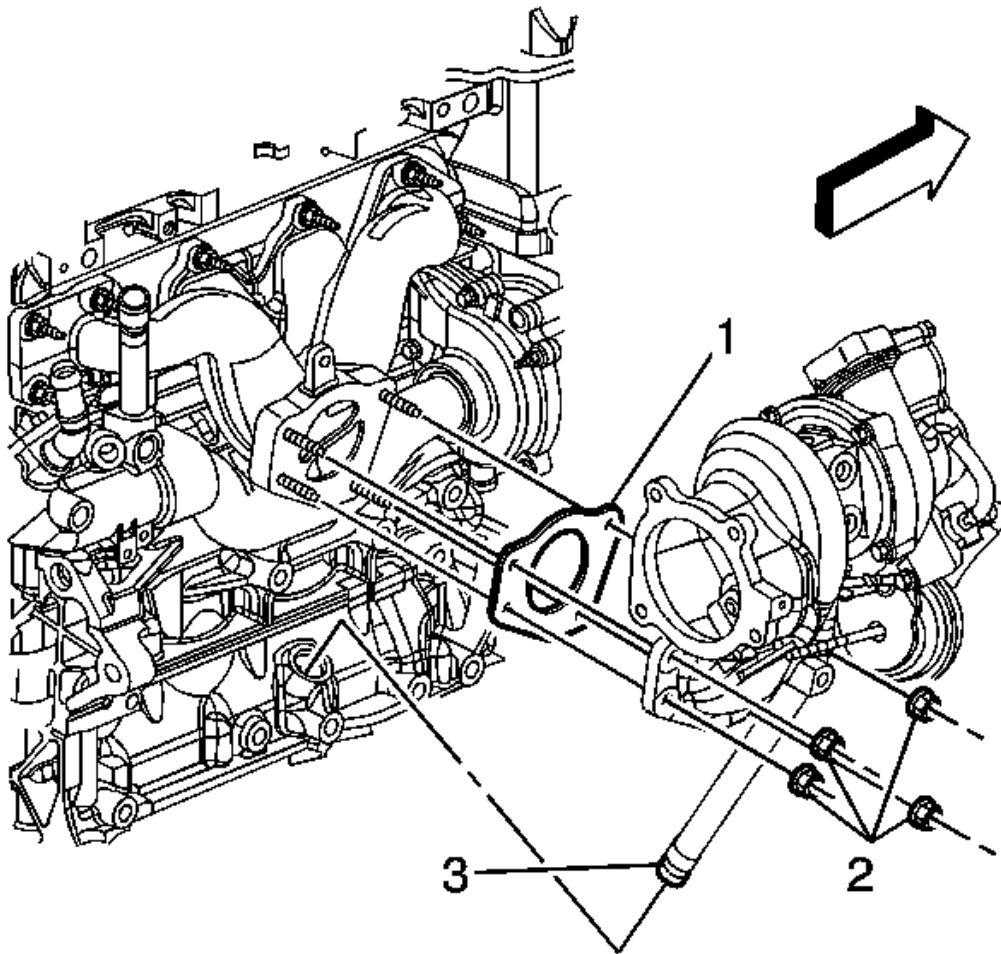


Fig. 58: Identifying Turbocharger Components
Courtesy of GENERAL MOTORS CORP.

23. Remove the turbocharger nuts (2).
24. Remove the turbocharger from the exhaust manifold studs while also removing the turbocharger oil return hose from the engine block.
25. Clean and inspect turbocharger. Refer to **Turbocharger Cleaning and Inspection**
26. Remove and discard the turbocharger gasket (1) and oil return hose O-ring seal (3).

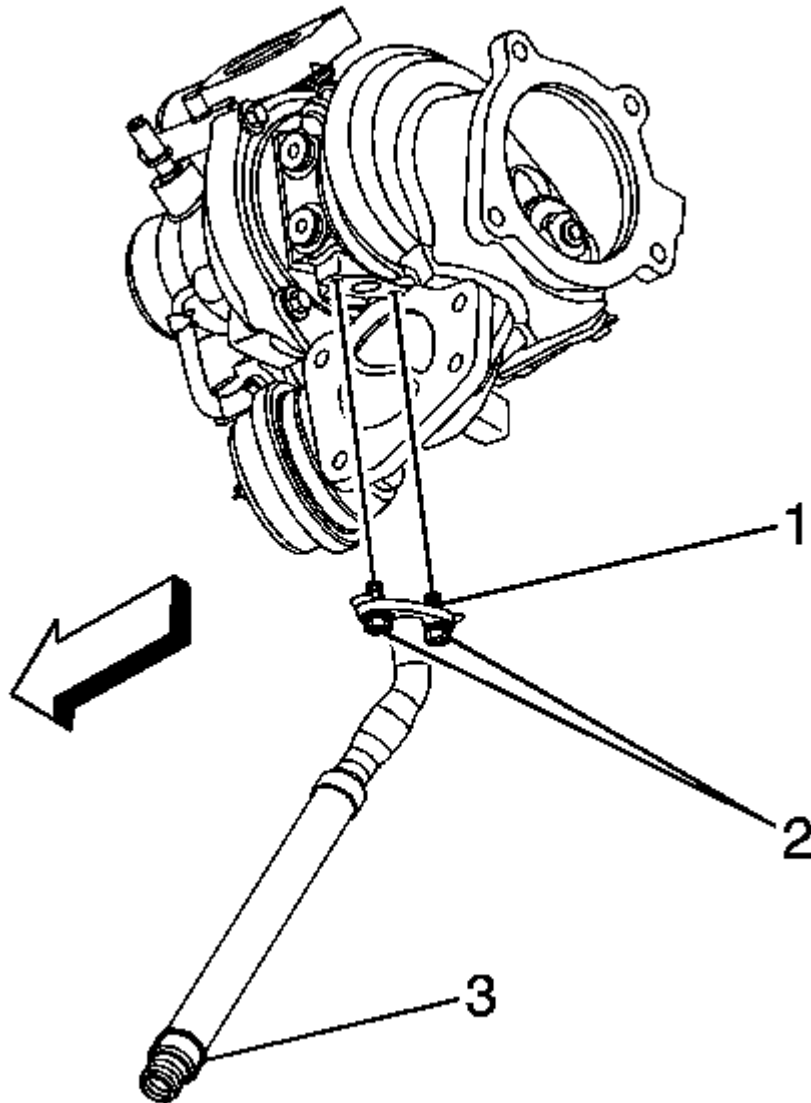


Fig. 59: Identifying Turbocharger Oil Return Hose
Courtesy of GENERAL MOTORS CORP.

27. If replacing the turbocharger, perform the following steps otherwise proceed to the step 7 in the Installation Procedure.
28. Remove the turbocharger oil return hose bolts (2) and hose from the turbocharger.
29. Remove and discard the turbocharger oil return hose gasket (1).

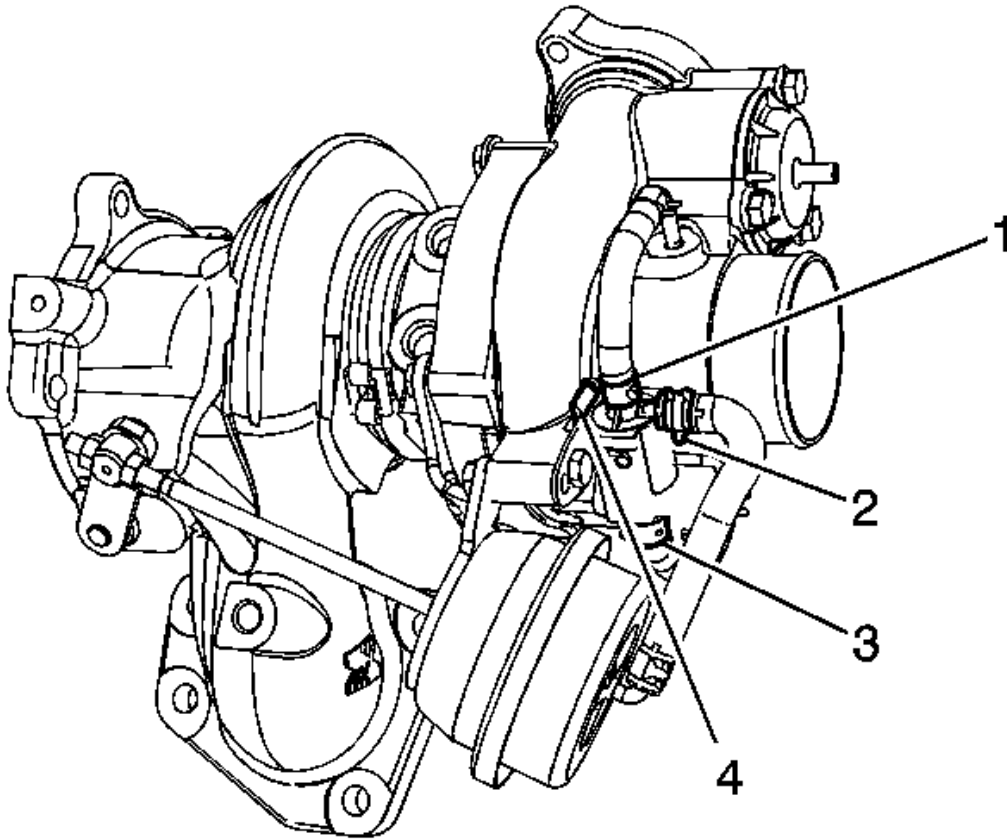


Fig. 60: Identifying Turbocharger Wastegate Solenoid Valve Components
Courtesy of GENERAL MOTORS CORP.

30. Reposition the vacuum hose clamps (1, 2, and 3) at the turbocharger wastegate solenoid valve.
31. Remove the vacuum hoses from the turbocharger wastegate solenoid valve.
32. Gently push back the turbocharger wastegate solenoid valve retainer (4) and remove the turbocharger wastegate solenoid valve from the bracket.

INSTALLATION PROCEDURE

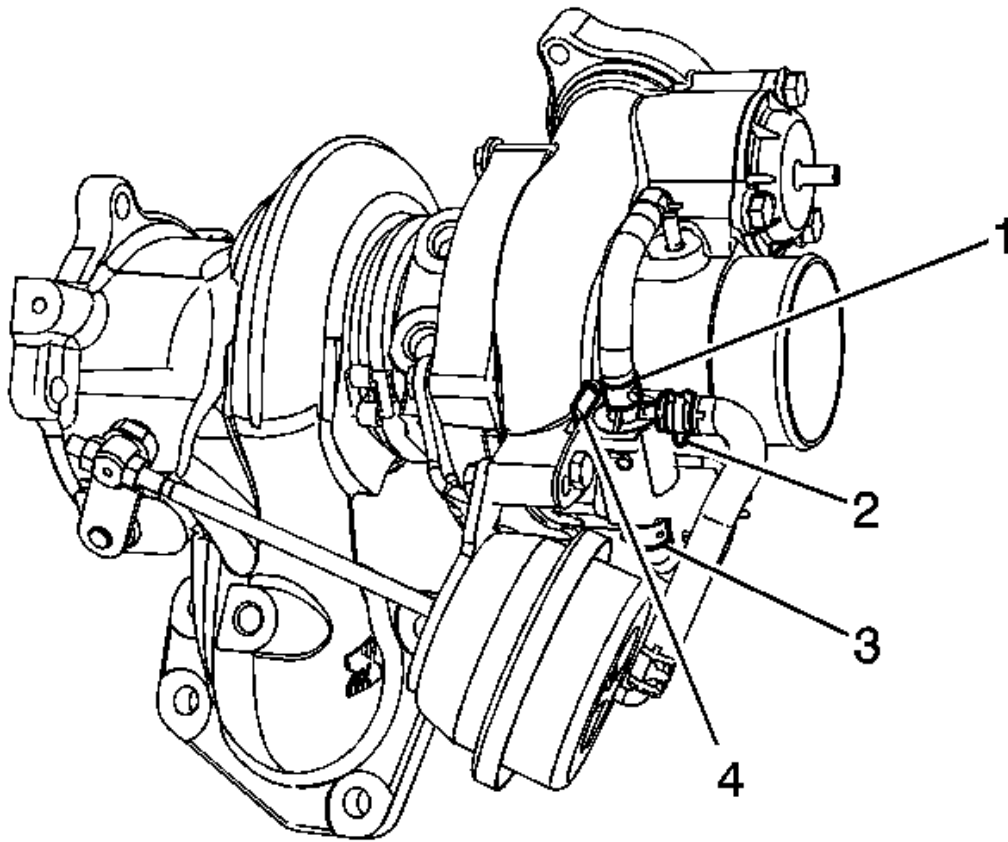


Fig. 61: Identifying Turbocharger Wastegate Solenoid Valve Components
 Courtesy of GENERAL MOTORS CORP.

1. If replacing the turbocharger, perform the following steps otherwise proceed to step 7.
2. Install the turbocharger wastegate solenoid valve to the bracket until the retainer (4) clips into place.
3. Install the vacuum hoses to the turbocharger wastegate solenoid valve.
4. Position the vacuum hose clamps (1, 2, and 3) at the turbocharger wastegate solenoid valve.

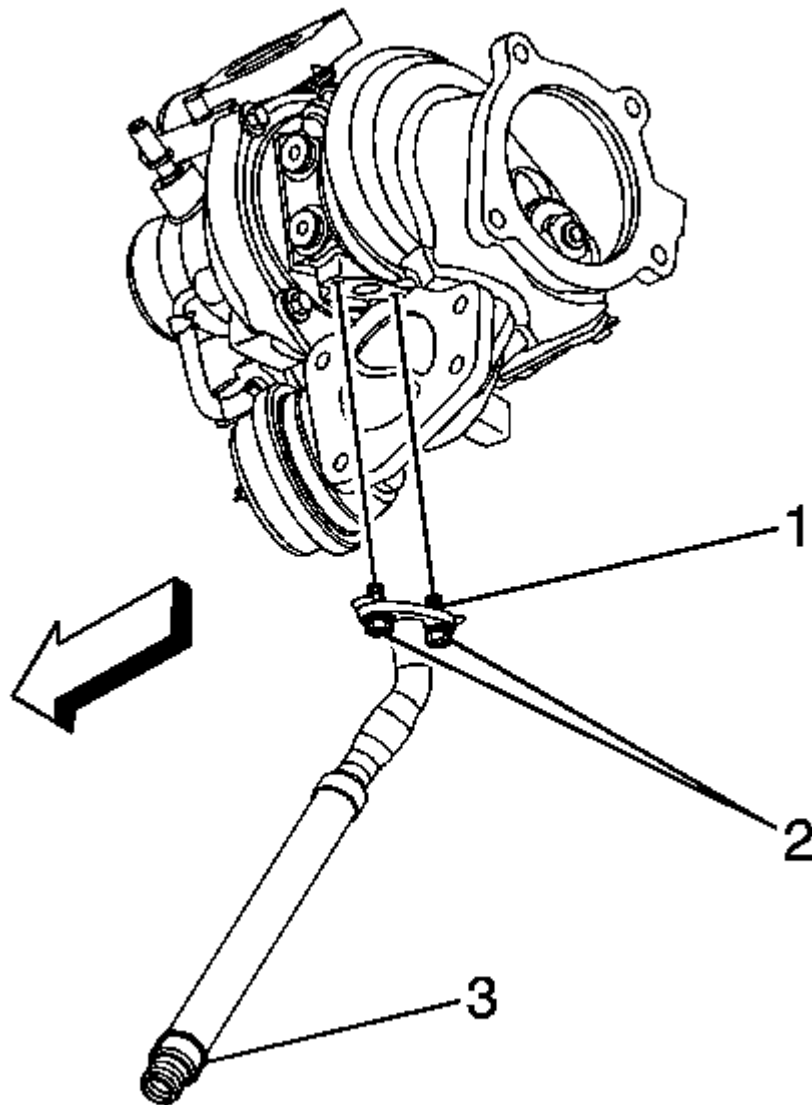


Fig. 62: Identifying Turbocharger Oil Return Hose
 Courtesy of GENERAL MOTORS CORP.

5. Position a NEW turbocharger oil return hose gasket (1) on the turbocharger oil return hose.

CAUTION: Refer to Fastener Caution

6. Install the turbocharger oil return hose and bolts (2) and tighten to 10 N.m (89 lb in).

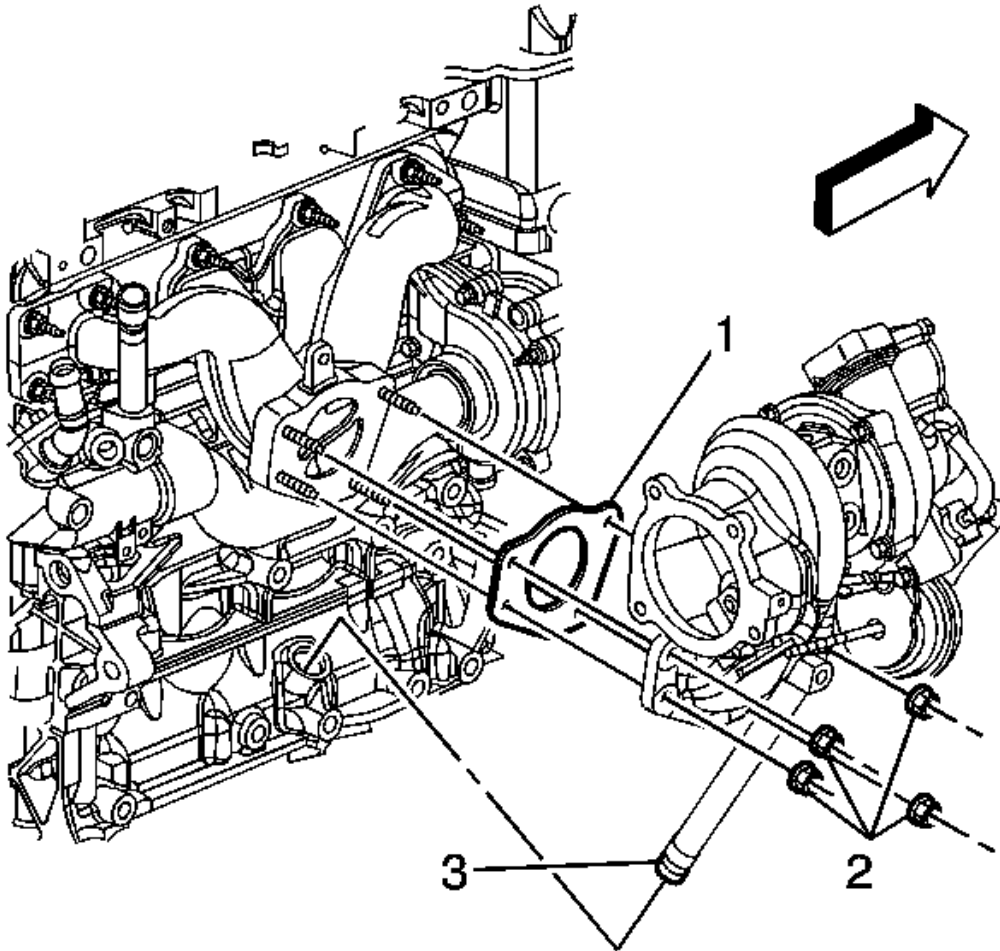


Fig. 63: Identifying Turbocharger Components
Courtesy of GENERAL MOTORS CORP.

7. Install a NEW turbocharger gasket (1) onto the exhaust manifold studs.
8. Lubricate and install a NEW turbocharger oil return hose O-ring seal (3).
9. Install the turbocharger oil return hose to the engine block while also installing the turbocharger to the exhaust manifold studs.
10. Install the turbocharger nuts (2) and tighten to 35 N.m (26 lb ft).

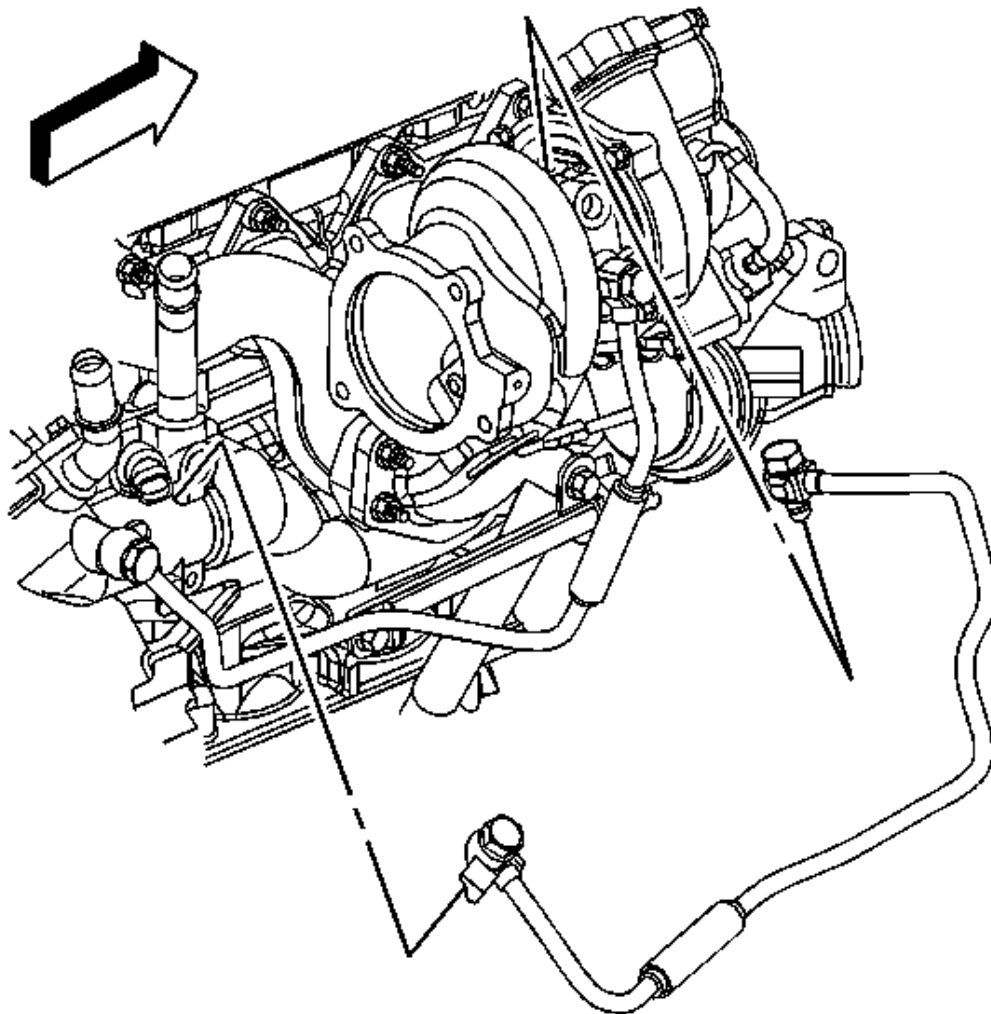


Fig. 64: View Of Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS CORP.

11. Install NEW gaskets onto the turbocharger oil feed pipe fittings.
12. Install the turbocharger oil feed pipe and bolts and tighten to 32 N.m (24 lb ft).

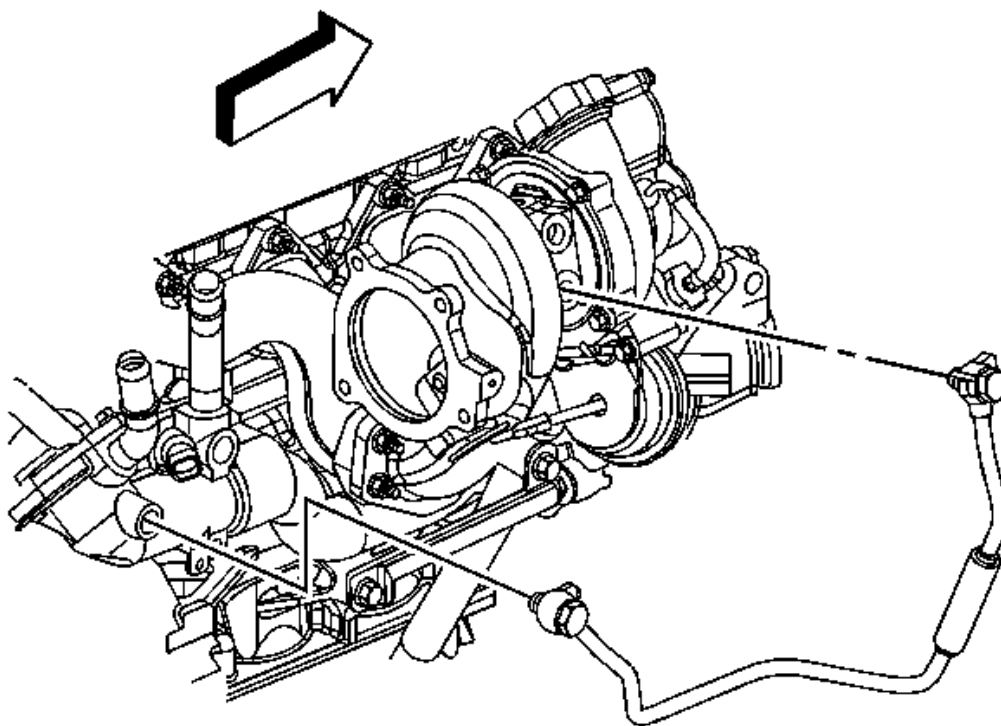


Fig. 65: View Of Turbocharger Coolant Return Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install NEW gaskets onto the turbocharger coolant return pipe fittings.
14. Install the turbocharger coolant return pipe and bolts and tighten to 35 N.m (26 lb ft).

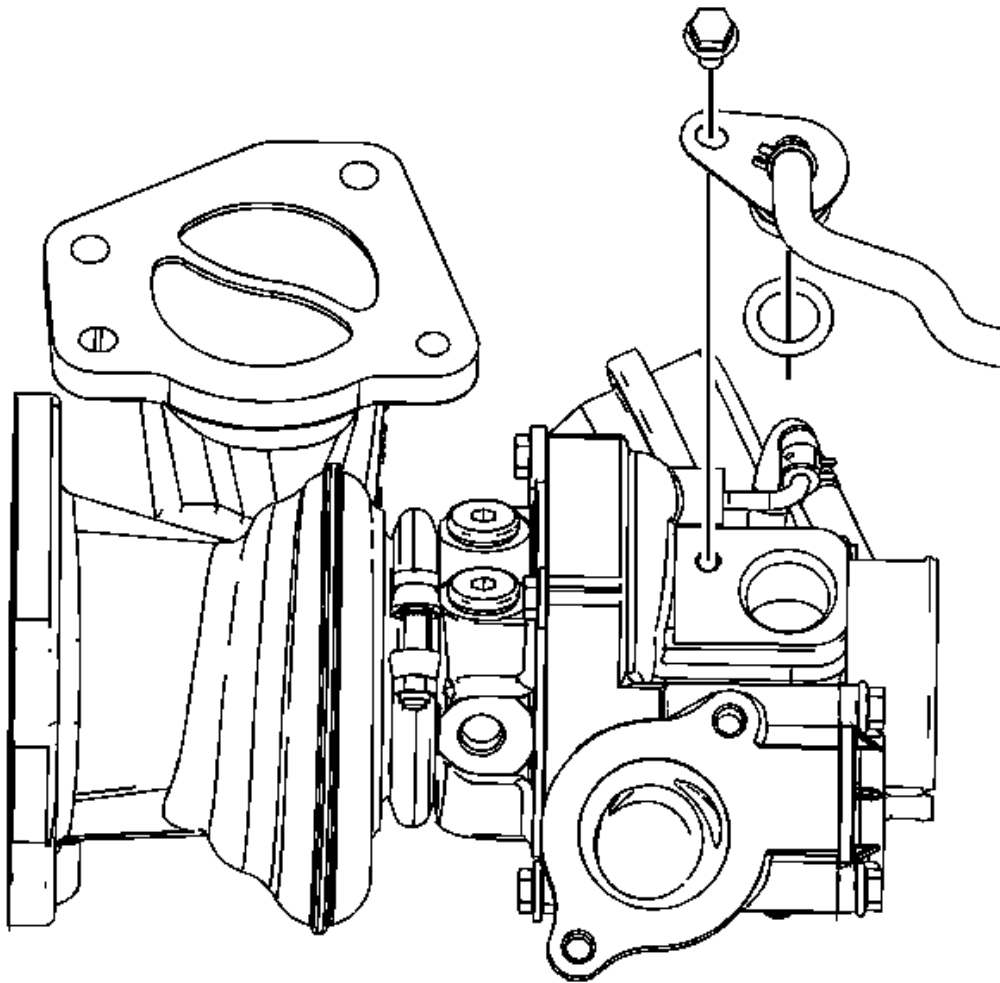


Fig. 66: View Of PCV Fitting, Bolt & Pipe
Courtesy of GENERAL MOTORS CORP.

15. Install a NEW O-ring seal to the PCV fitting.
16. Position the PCV pipe (with fitting) and install the PCV fitting bolt to the turbocharger and tighten to 10 N.m (89 lb in).

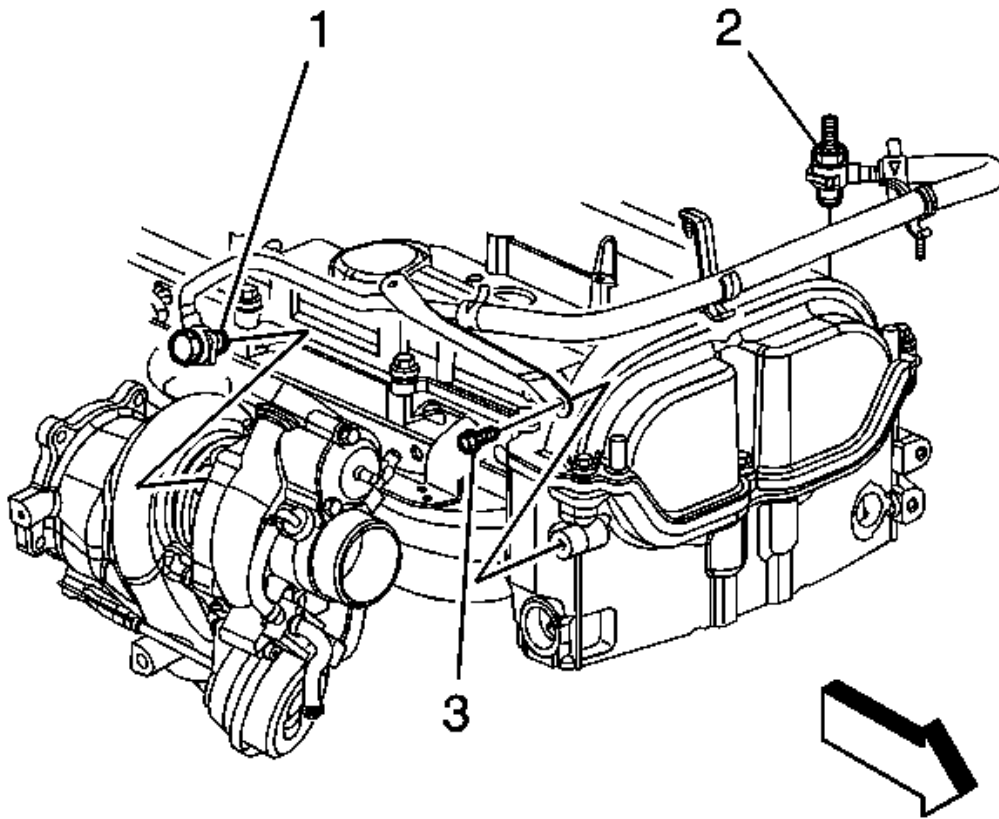


Fig. 67: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Position the turbocharger coolant feed pipe to the turbocharger.
18. Install NEW gaskets onto the turbocharger coolant feed pipe fitting.
19. Install the turbocharger coolant feed pipe bolt (1) at the turbocharger and tighten to 35 N.m (26 lb ft).
20. Install the turbocharger coolant feed pipe bolt (3) to the cylinder head and tighten to 10 N.m (89 lb in).

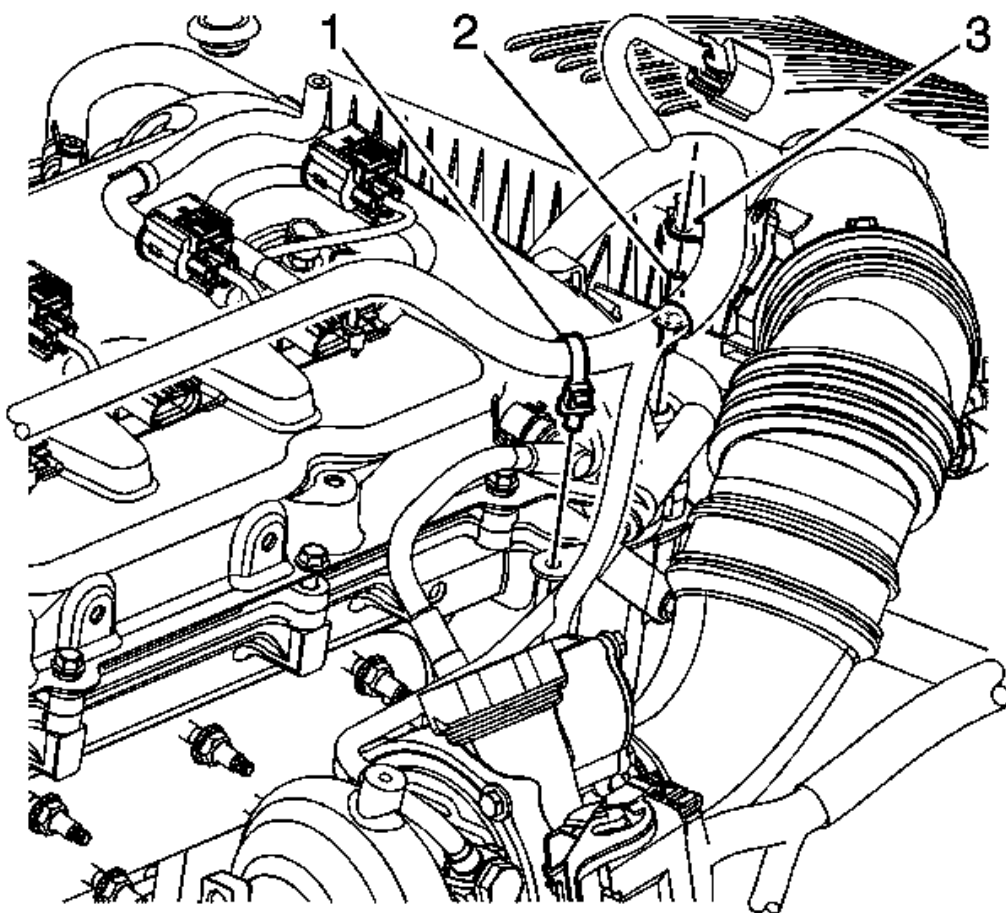


Fig. 68: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

21. Install the engine wiring harness clip (1) to the turbocharger coolant feed pipe.

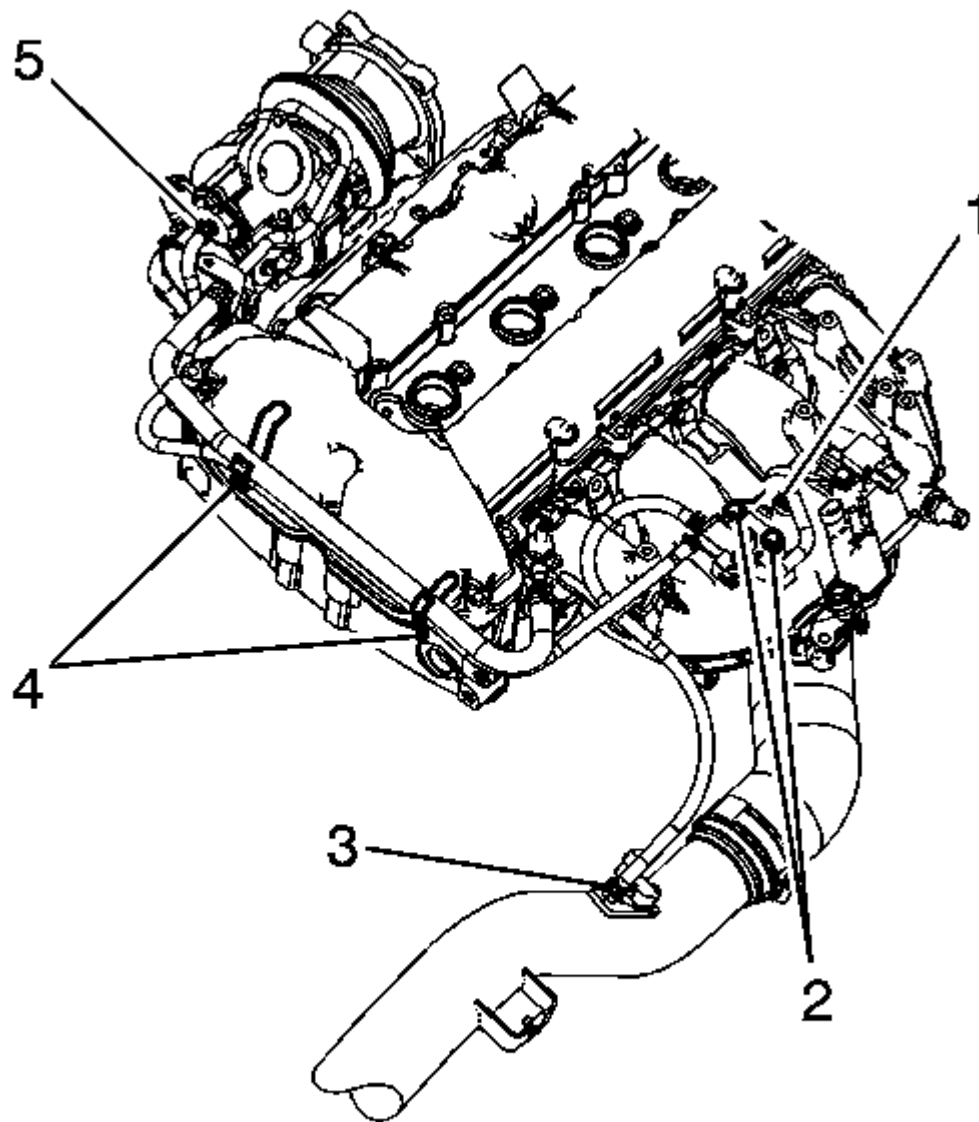


Fig. 69: Identifying Charge Air Bypass Solenoid Components
Courtesy of GENERAL MOTORS CORP.

22. Install the vacuum hose to the turbocharger.
23. Position the vacuum hose clamp (5) at the turbocharger.

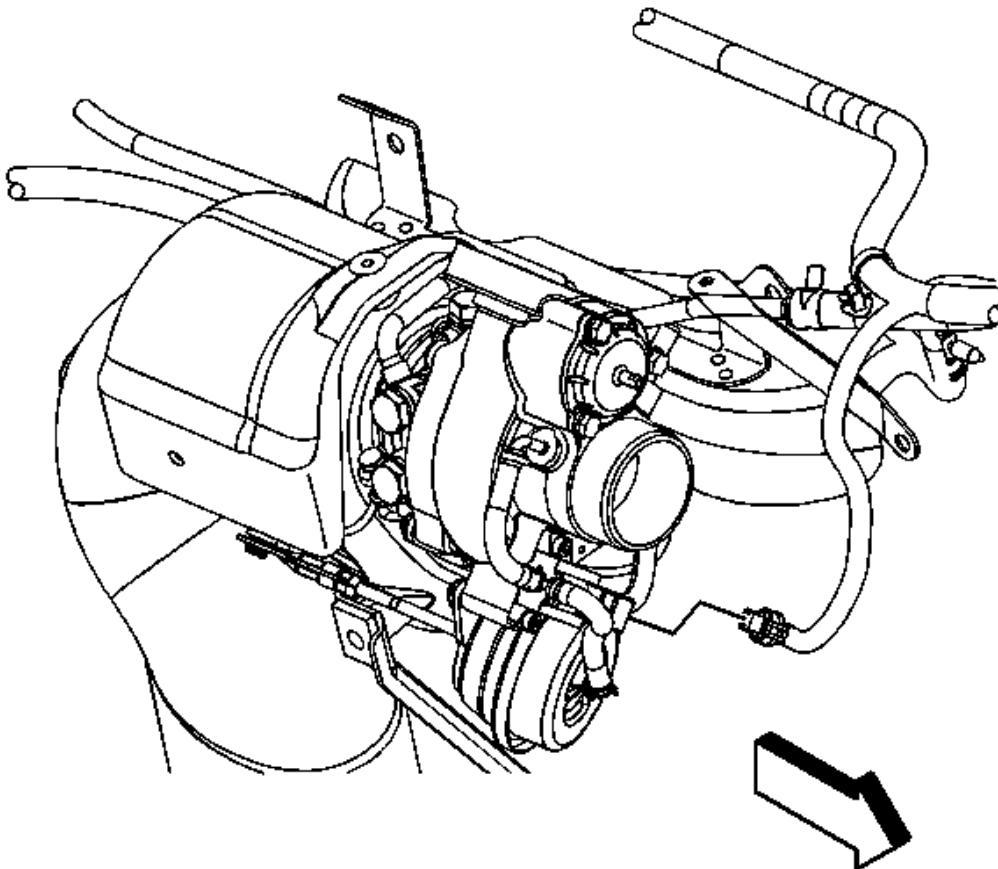


Fig. 70: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

24. Connect the engine wiring harness electrical connector to the turbocharger wastegate solenoid valve.

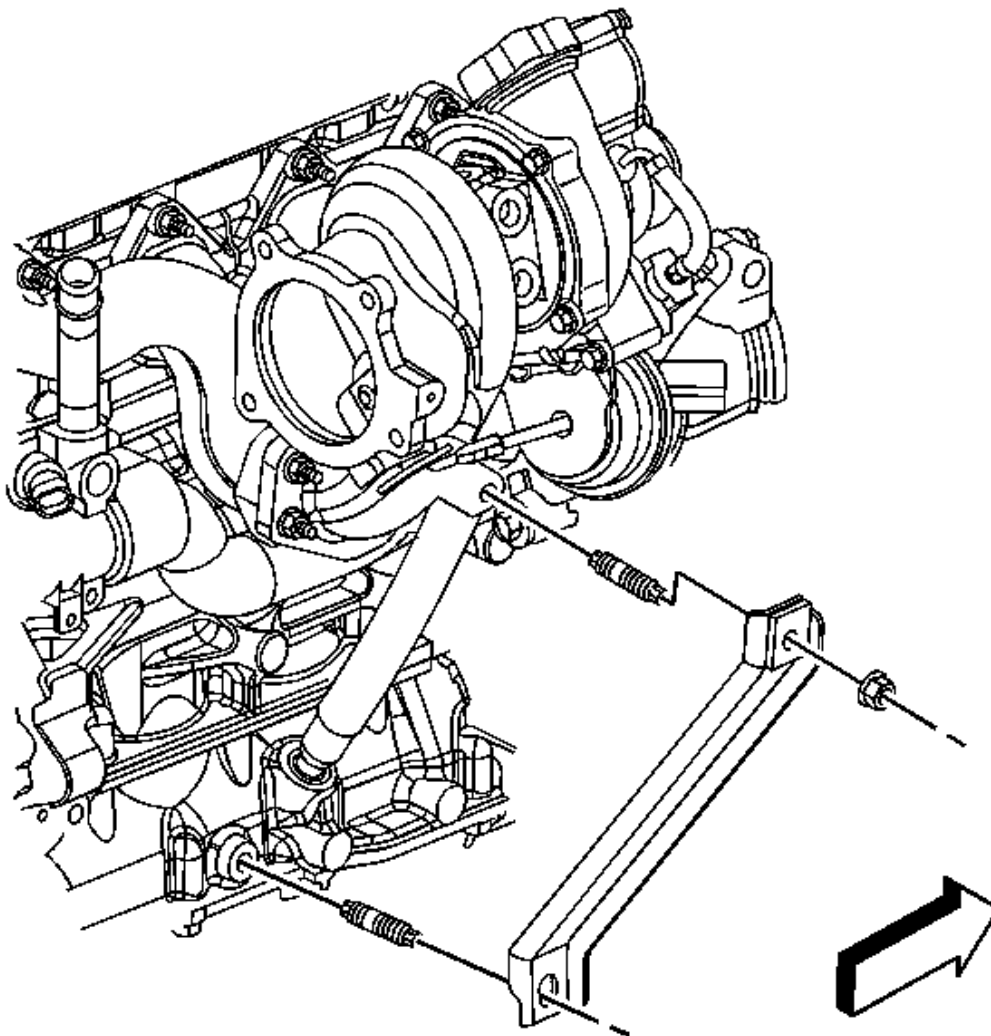


Fig. 71: View Of Turbocharger Brace
Courtesy of GENERAL MOTORS CORP.

25. Install the turbocharger brace bolt and nut and tighten to 58 N.m (43 lb ft).

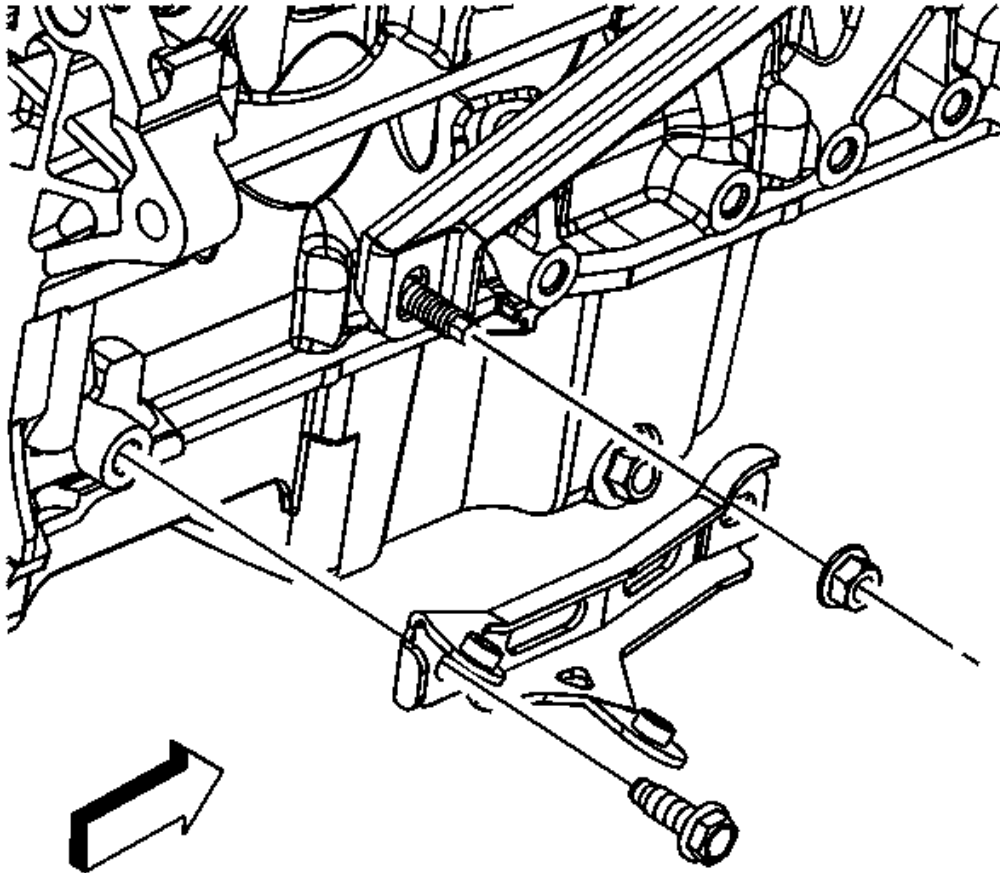


Fig. 72: View Of Catalytic Converter Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

26. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle**
27. Position the catalytic converter bracket to the engine.
28. Install the catalytic converter bracket bolt, and nut until snug.
29. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LNF)**
30. Tighten the catalytic converter bracket bolt and nut and tighten to 58 N.m (43 lb ft).

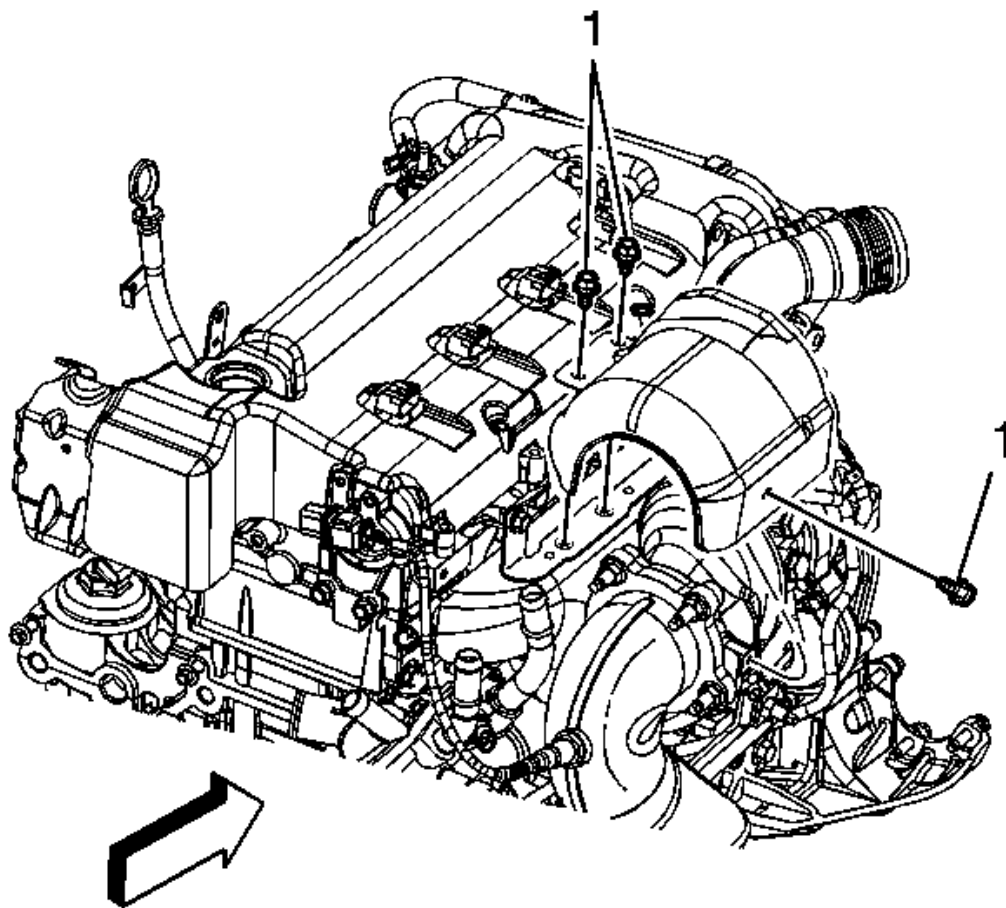


Fig. 73: Identifying Turbocharger Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

31. Lower the vehicle.
32. Install the turbocharger heat shield and bolts (1) and tighten to 10 N.m (89 lb in).

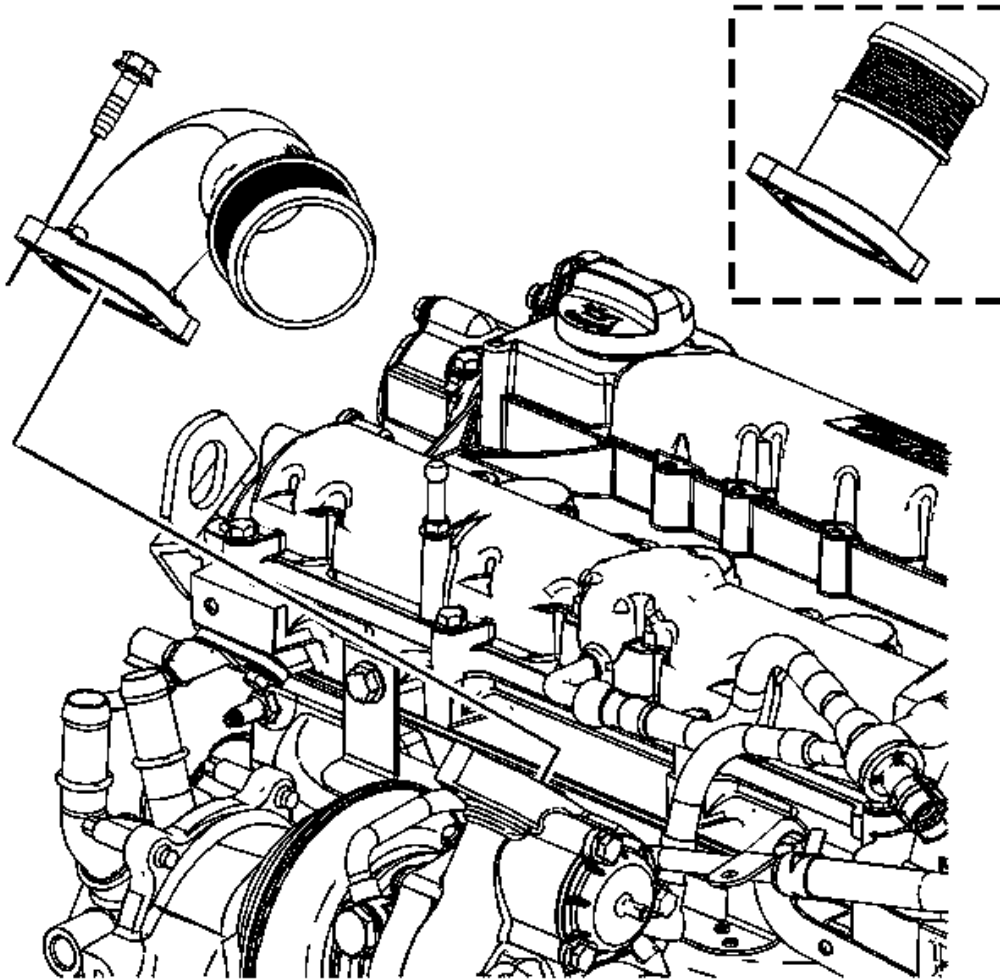


Fig. 74: Identifying Charge Air Cooler Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

33. Install the charge air cooler pipe and gasket to the turbocharger.
34. Install the charge air cooler pipe bolts at the turbocharger and tighten to 22 N.m (16 lb ft).
35. Install the charge air cooler inlet pipe. Refer to **Charge Air Cooler Inlet Pipe Replacement**
36. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE-47716)** or **Cooling System Draining and Filling (Static Fill-LNF)**

TURBOCHARGER OIL FEED PIPE REPLACEMENT

REMOVAL PROCEDURE

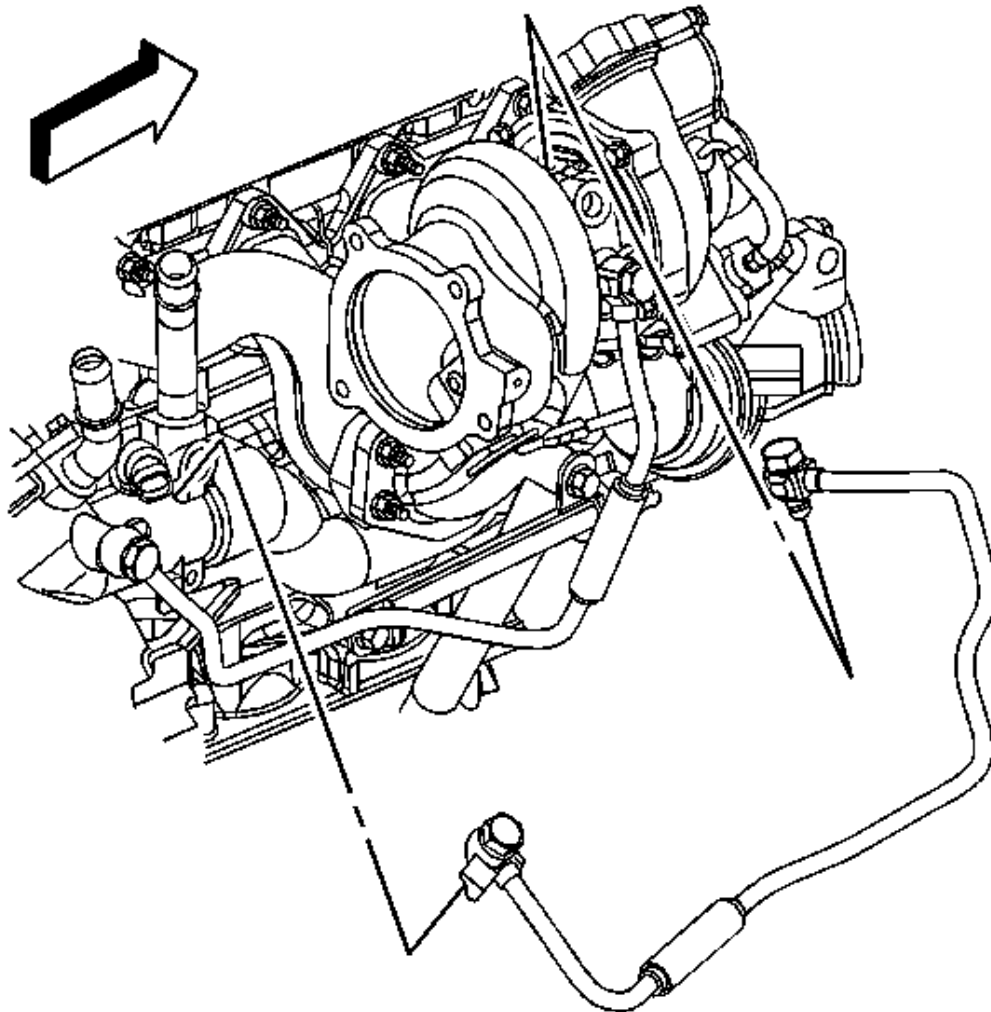


Fig. 75: View Of Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (LNF)** .
2. Remove the turbocharger oil feed pipe bolts and pipe.
3. Remove and discard the turbocharger oil feed pipe gaskets.

INSTALLATION PROCEDURE

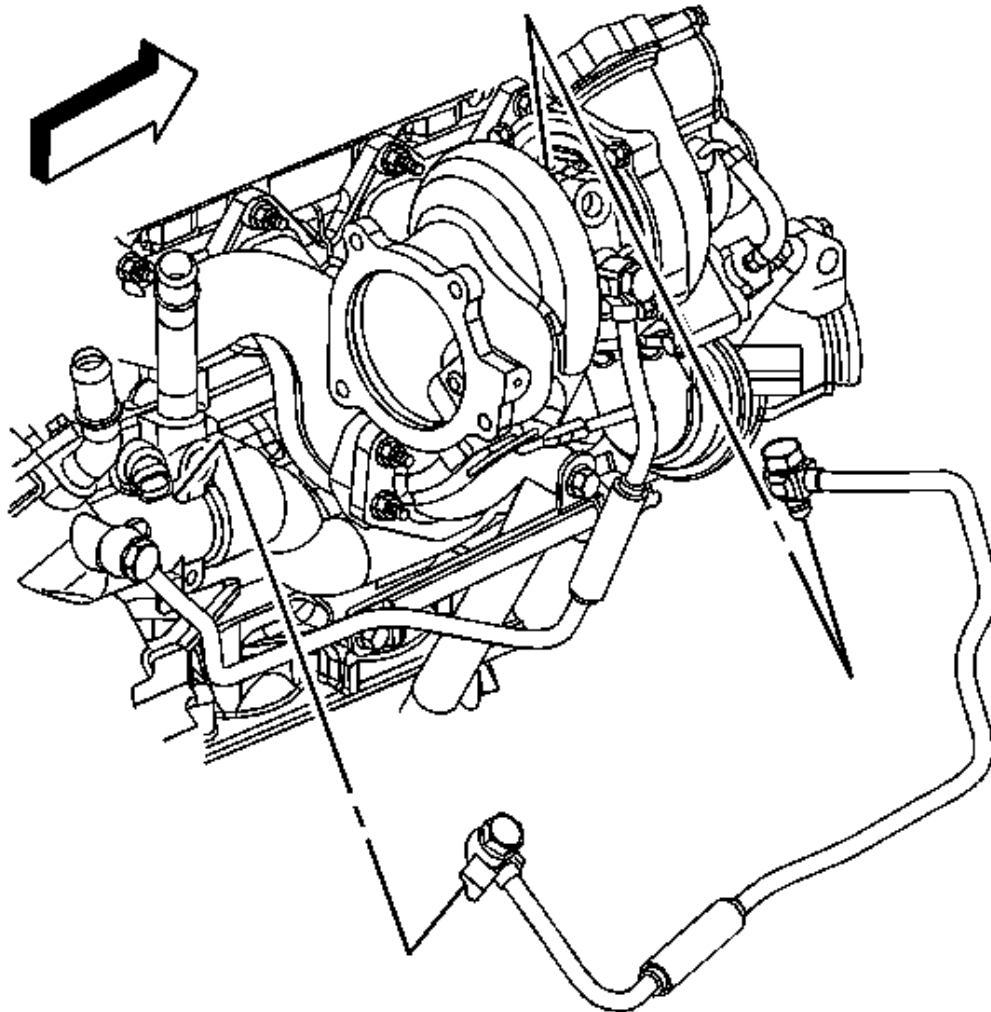


Fig. 76: View Of Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS CORP.

1. Install NEW gaskets onto the turbocharger oil feed pipe fittings.

CAUTION: Refer to Fastener Caution .

2. Install the turbocharger oil feed pipe and bolts.

Tighten the bolts to 20 N.m (15 lb ft).

3. Install the catalytic converter. Refer to Catalytic Converter Replacement (LNF) .

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

REMOVAL PROCEDURE

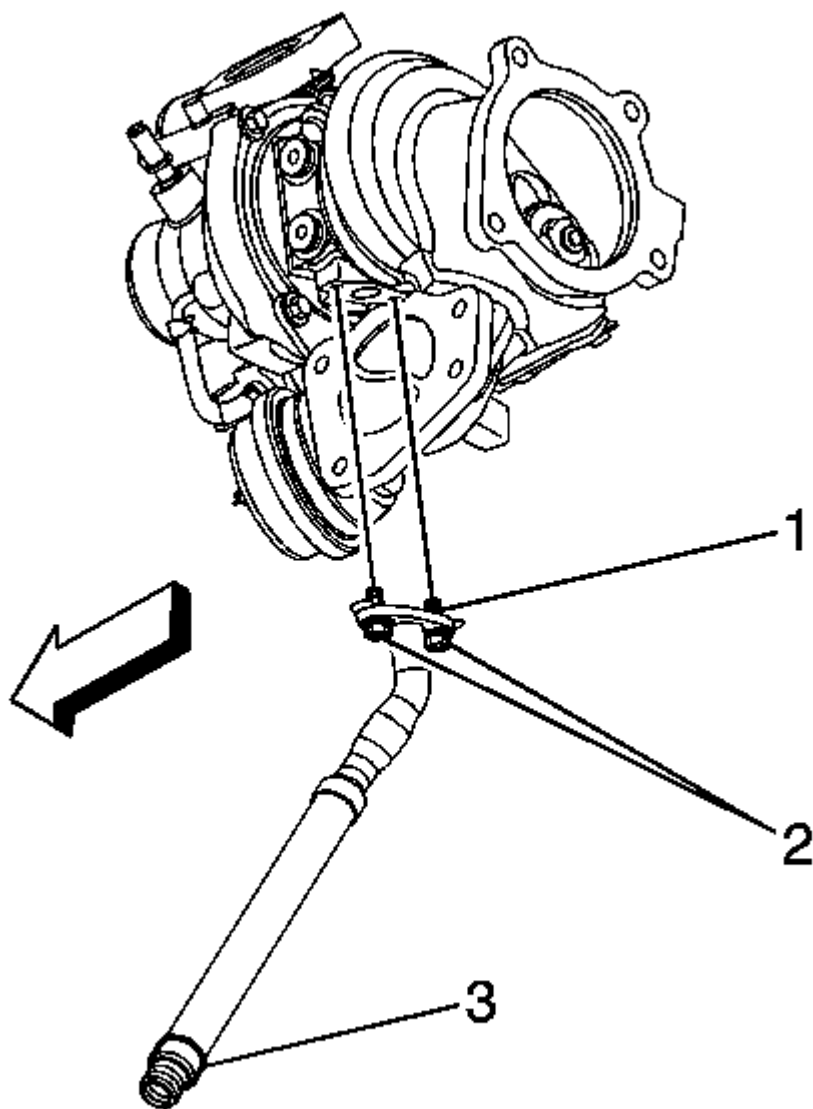


Fig. 77: Identifying Turbocharger Oil Return Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the turbocharger. Refer to **Turbocharger Replacement**.
2. Remove the turbocharger oil return hose bolts (2) and hose from the turbocharger.
3. Remove and discard the turbocharger oil return hose gasket (1).

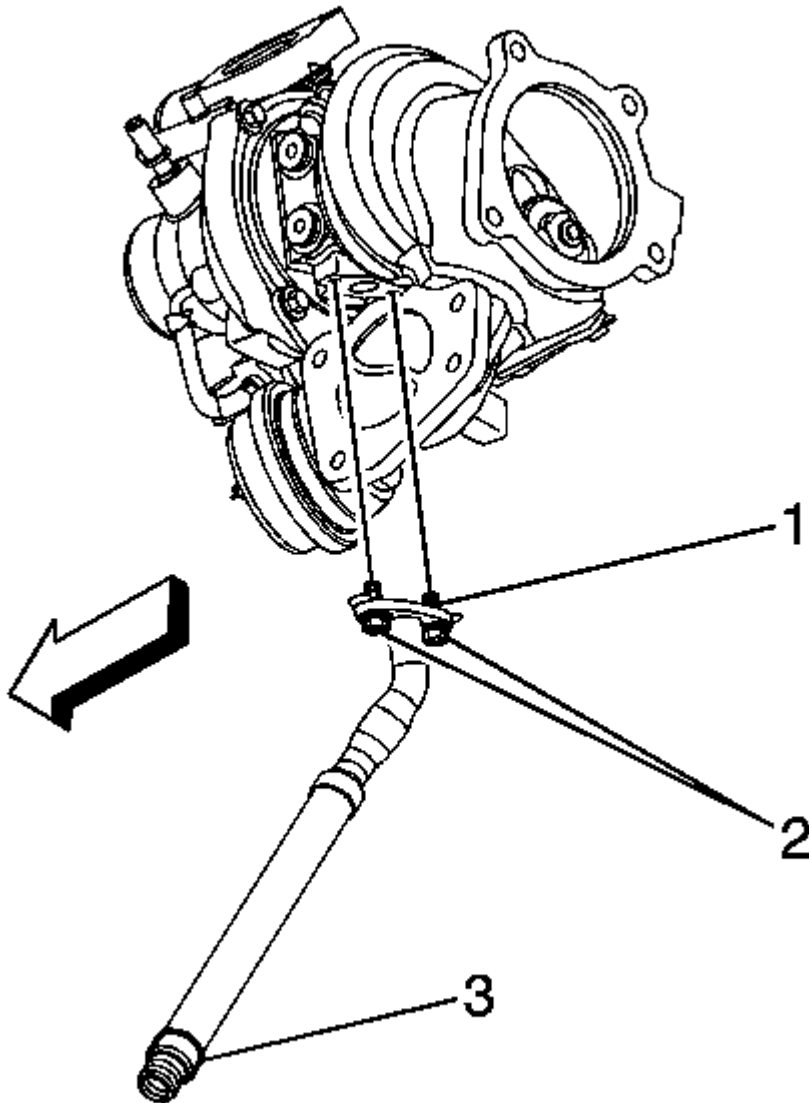
INSTALLATION PROCEDURE

Fig. 78: Identifying Turbocharger Oil Return Hose
Courtesy of GENERAL MOTORS CORP.

1. Lubricate and install a NEW turbocharger oil return hose O-ring seal (3).
2. Position a NEW turbocharger oil return hose gasket (1) on the turbocharger oil return hose.

CAUTION: Refer to Fastener Caution .

3. Install the turbocharger oil return hose and bolts (2).

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

4. Install the turbocharger. Refer to Turbocharger Replacement.

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

CAUTION: Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.

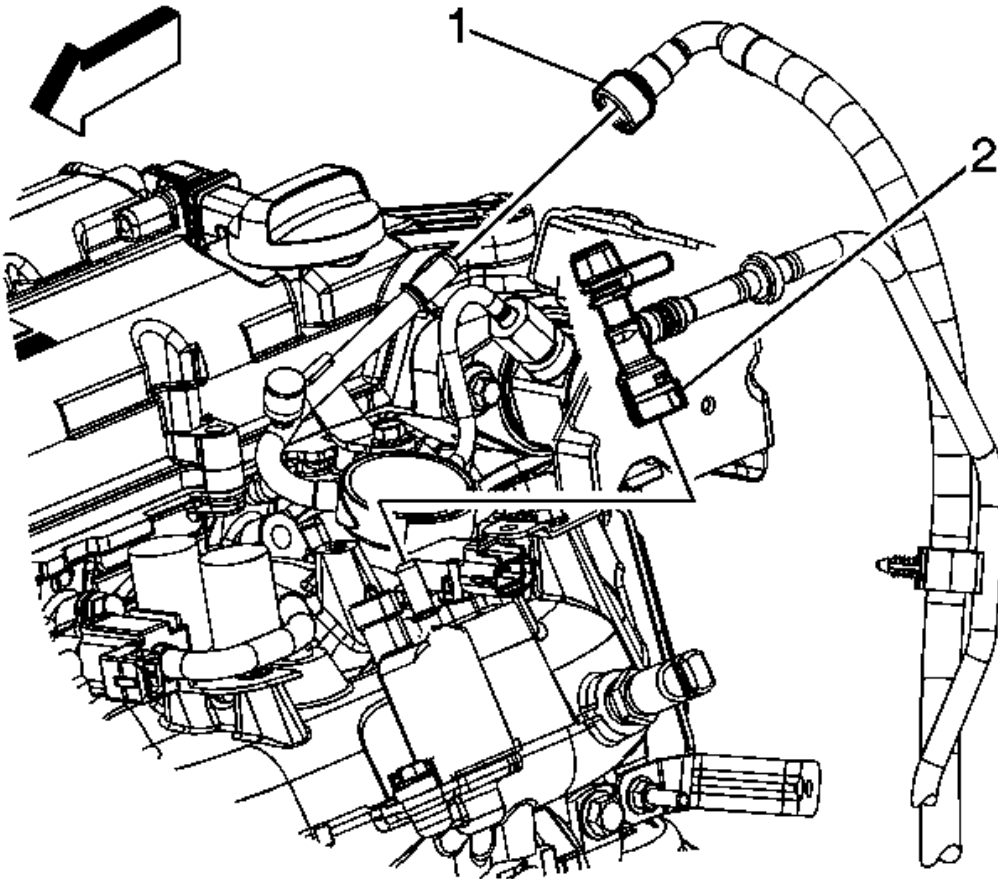


Fig. 79: Identifying EVAP & Fuel Feed Pipes
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#) .
2. Remove the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).
3. Disconnect the fuel feed line quick connect fitting (1) from the fuel rail. Refer to [Metal Collar Quick Connect Fitting Service](#) .
4. Disconnect the evaporative emission (EVAP) line quick connect fitting (2) from the EVAP purge solenoid. Refer to [Plastic Collar Quick Connect Fitting Service](#) .

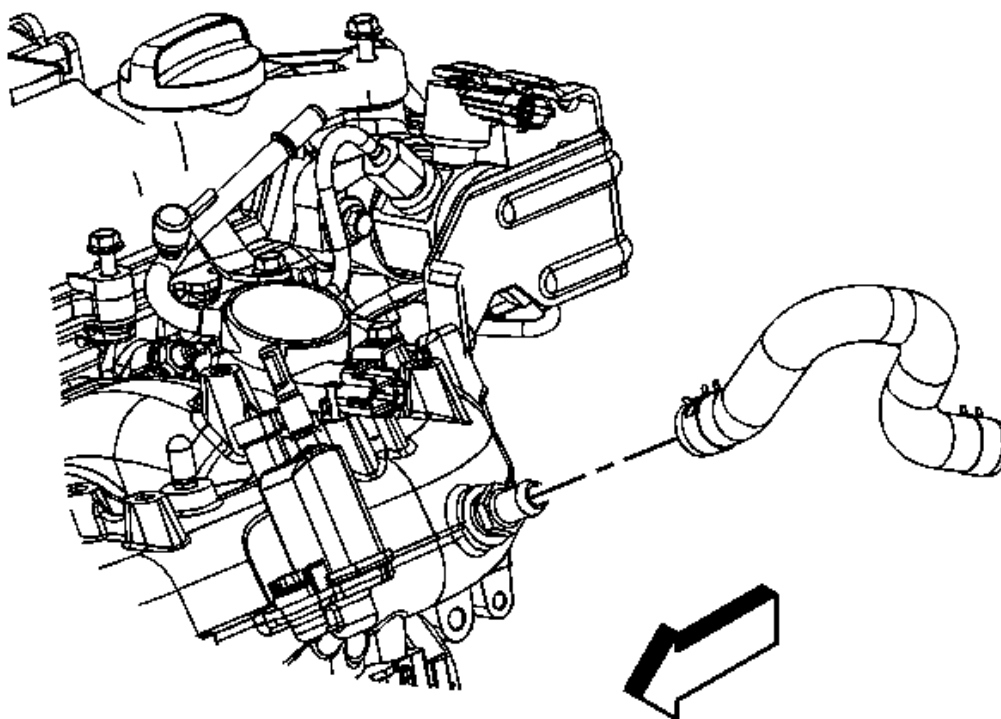


Fig. 80: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

5. Reposition the brake booster vacuum hose clamp at the intake manifold.
6. Remove the brake booster hose from the intake manifold.

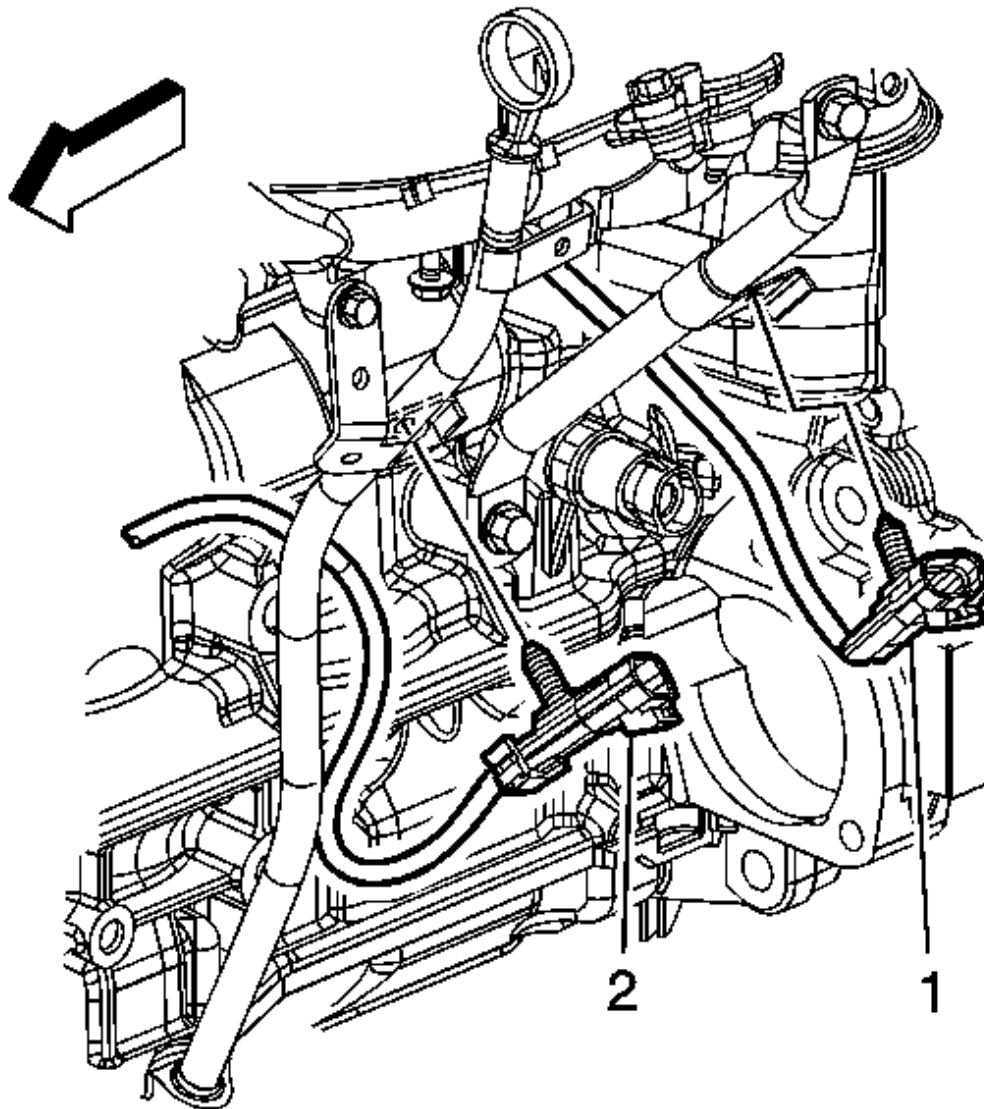


Fig. 81: Identifying Front & Rear Knock Sensor Clips
Courtesy of GENERAL MOTORS CORP.

7. Remove the knock sensor electrical connector (1) clip from the intake manifold brace.
8. Remove the knock sensor electrical connector (2) clip from the oil level indicator tube bracket.

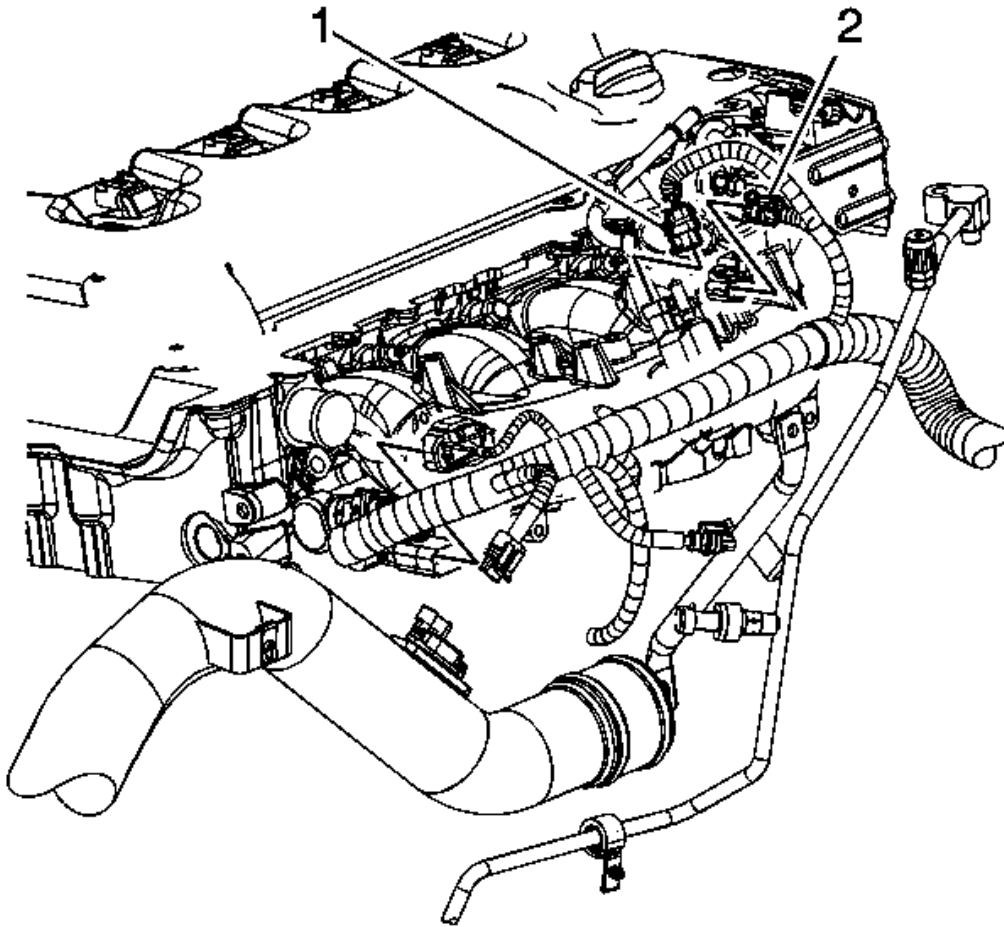


Fig. 82: Identifying MAP Sensor Connector
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the engine wiring harness electrical connector (1) from the EVAP canister purge solenoid.
10. Disconnect the engine wiring harness electrical connector (2) from the manifold absolute pressure (MAP) sensor.
11. Disconnect the engine wiring harness electrical connector from the charge air bypass valve solenoid.

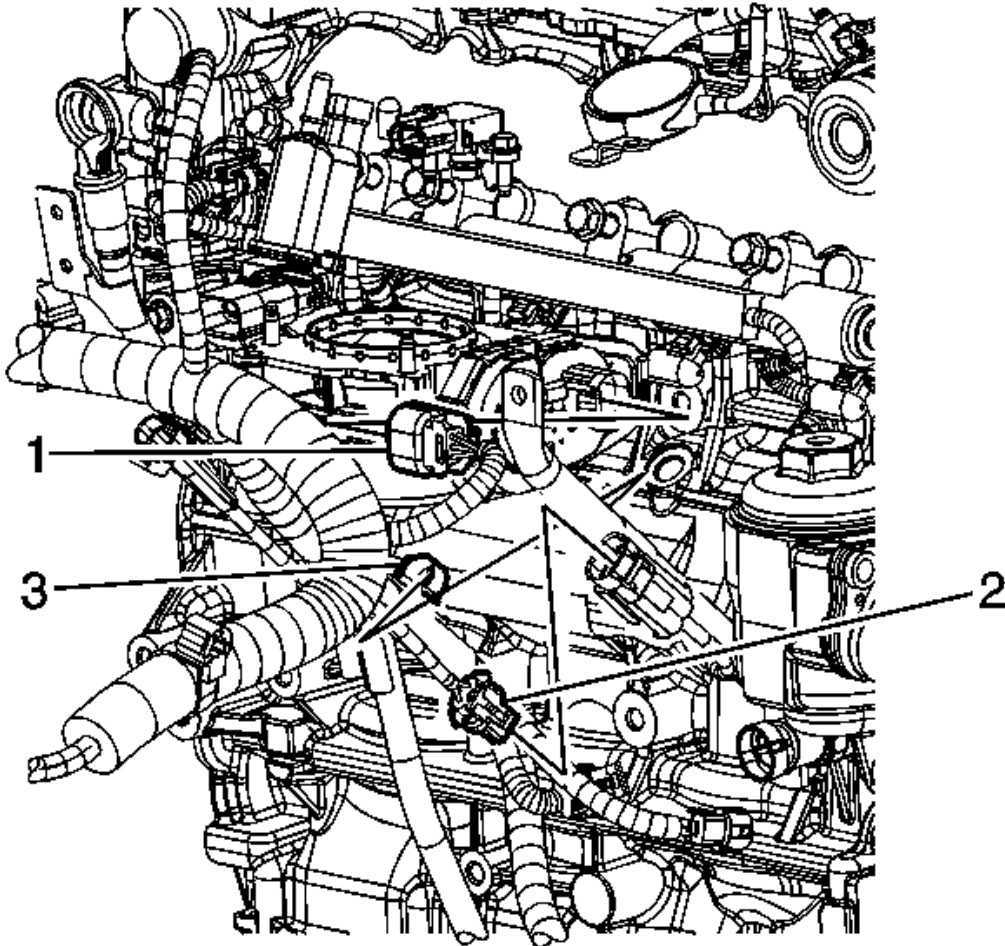


Fig. 83: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the engine wiring harness electrical connector (1) from the throttle actuator control (TAC) module.
13. Remove the engine wiring harness clip (3) from the intake manifold brace.

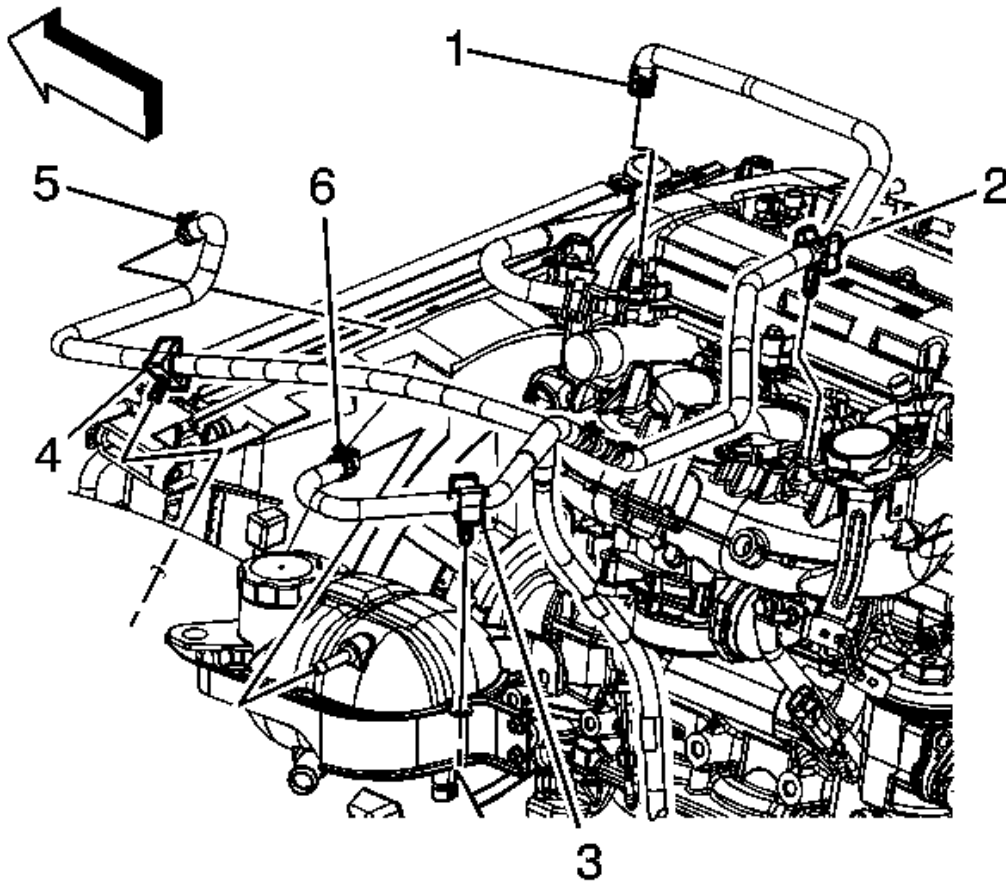


Fig. 84: Identifying Surge Tank Hose Components
 Courtesy of GENERAL MOTORS CORP.

14. Reposition the surge tank air bleed hose clamp at the engine (1).
15. Remove the surge tank air bleed hose from the engine.
16. Remove the surge tank air bleed hose clip (2) from the surge tank bracket.
17. Reposition the surge tank air bleed hose out of the way.

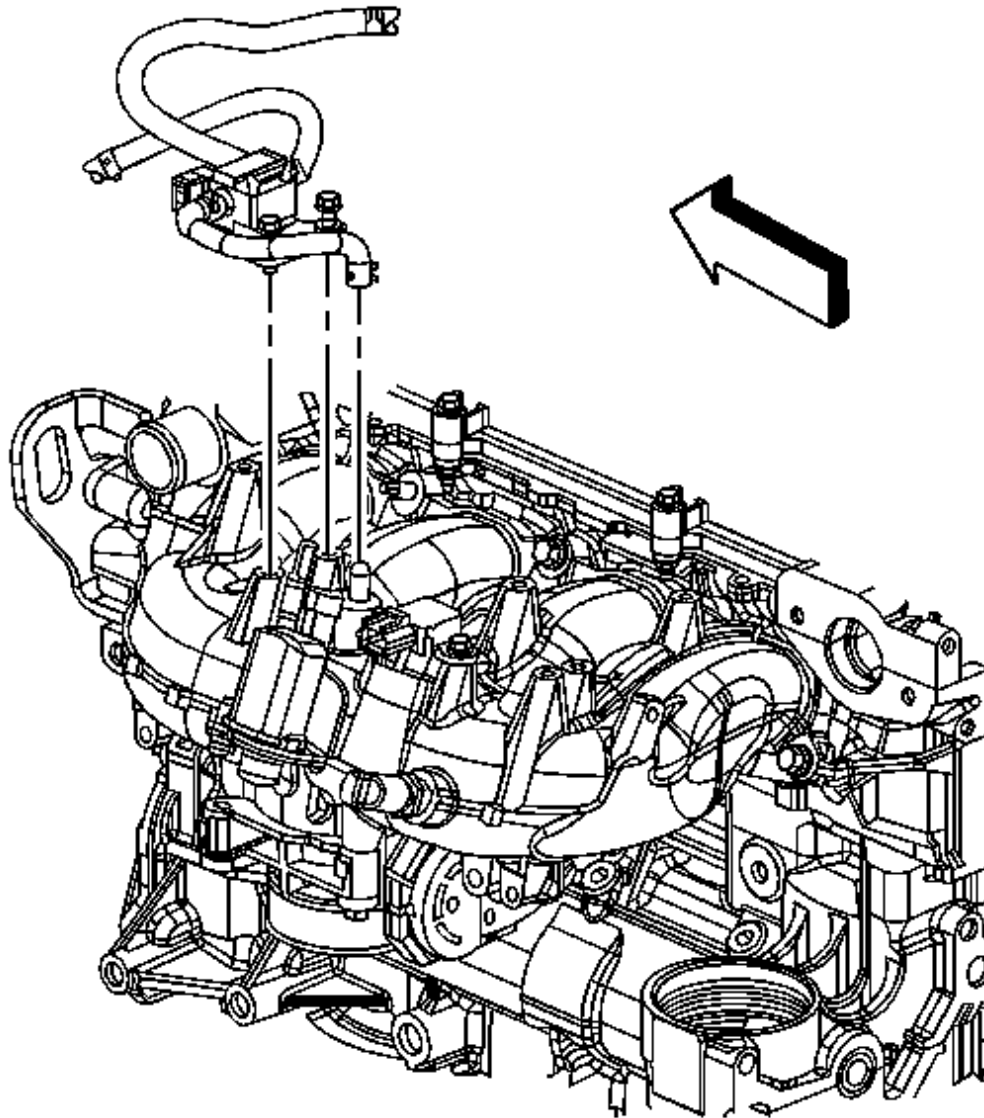


Fig. 85: Identifying Charge Air Bypass Valve Solenoid Assembly
Courtesy of GENERAL MOTORS CORP.

18. Reposition the charge air bypass valve vacuum hose clamp at the intake manifold.
19. Remove the charge air bypass valve vacuum hose from the intake manifold.
20. Remove the charge air bypass valve solenoid bolts.
21. Reposition the charge air bypass valve solenoid assembly out of the way.

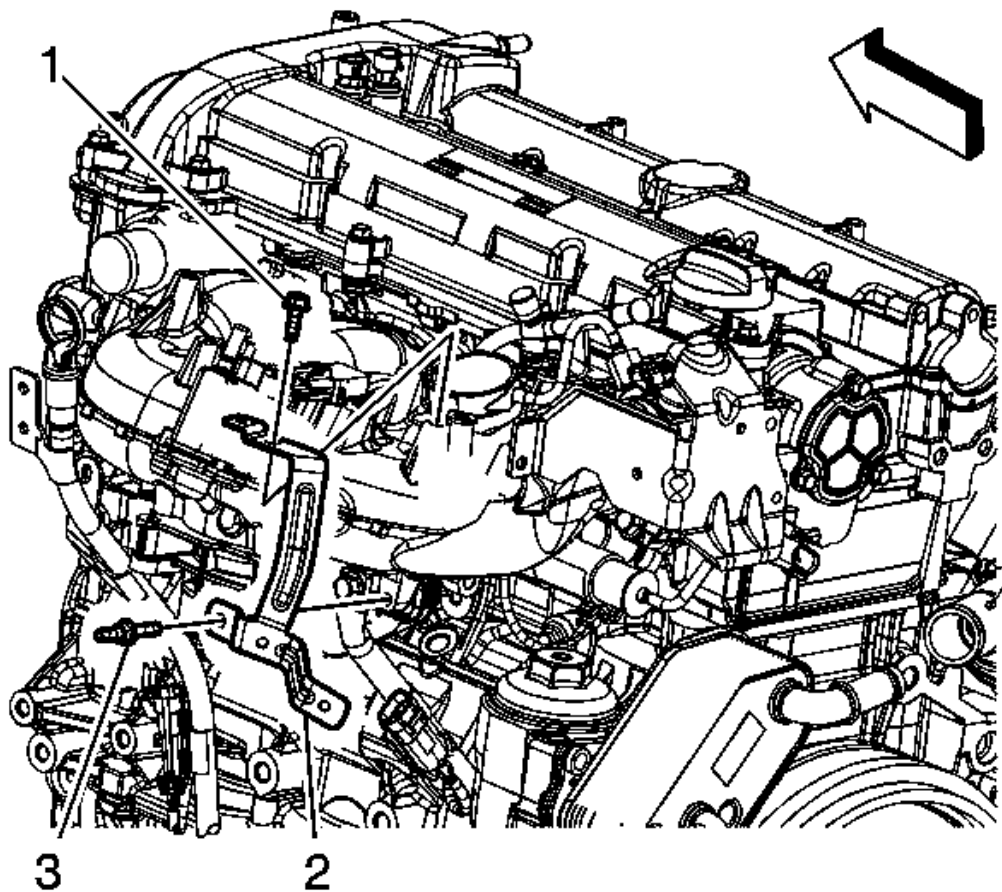


Fig. 86: Identifying Surge Tank Bracket
Courtesy of GENERAL MOTORS CORP.

22. Remove the surge tank bracket bolt (1) and stud (2).
23. Remove the surge tank bracket (3).
24. Remove the surge tank hose retainer and hose from the surge tank bracket.

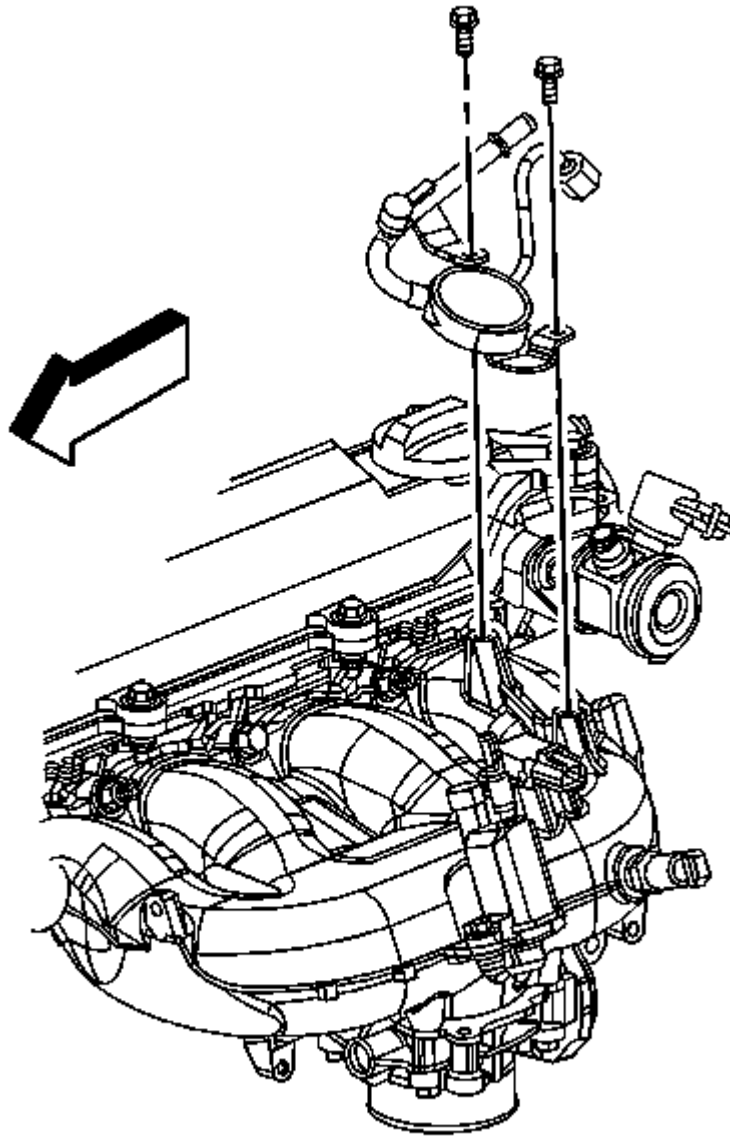


Fig. 87: Identifying Fuel Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

25. Disconnect the metal quick connect fitting from the fuel feed pip. Refer to **Metal Collar Quick Connect Fitting Service** .
26. Disconnect the fuel feed pipe fitting from the fuel pump.
27. Remove the fuel feed pipe bolts.

28. Remove the fuel feed pipe.
29. Inspect the fuel feed pipe nut for damaged threads.
30. Inspect the fuel feed pipe sealing bail for damage or debris.
31. Replace the fuel feed pipe if any damage is found.

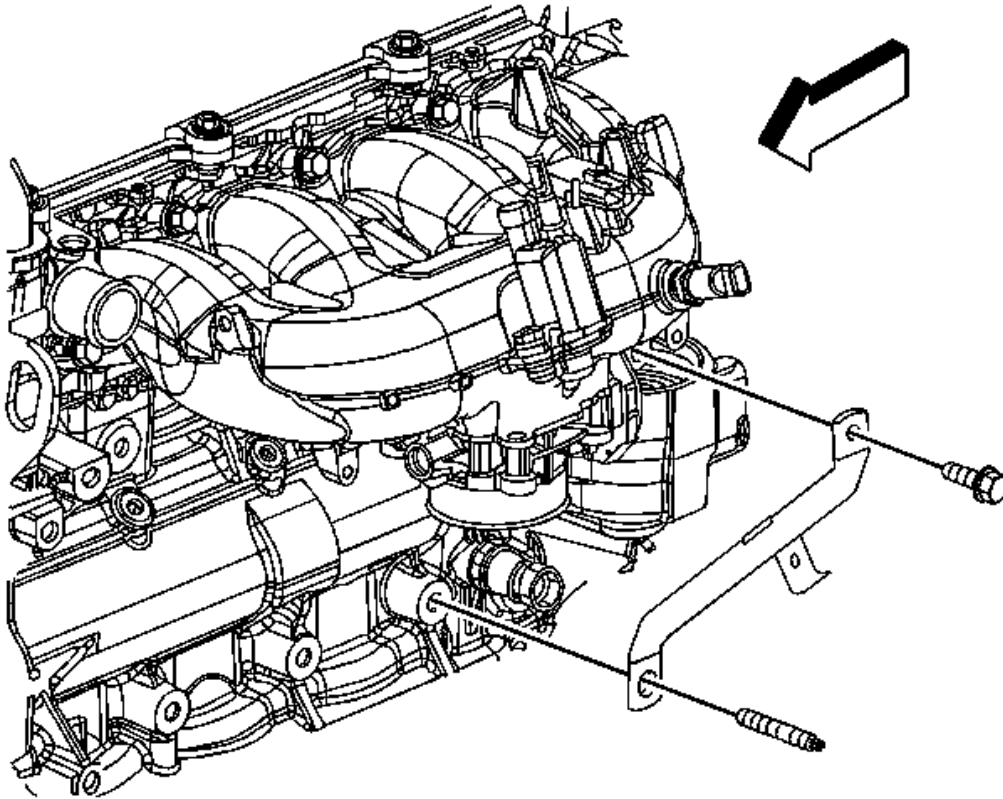


Fig. 88: View Of Intake Manifold Brace
Courtesy of GENERAL MOTORS CORP.

32. Remove the intake manifold brace bolt.
33. Remove the intake manifold brace.

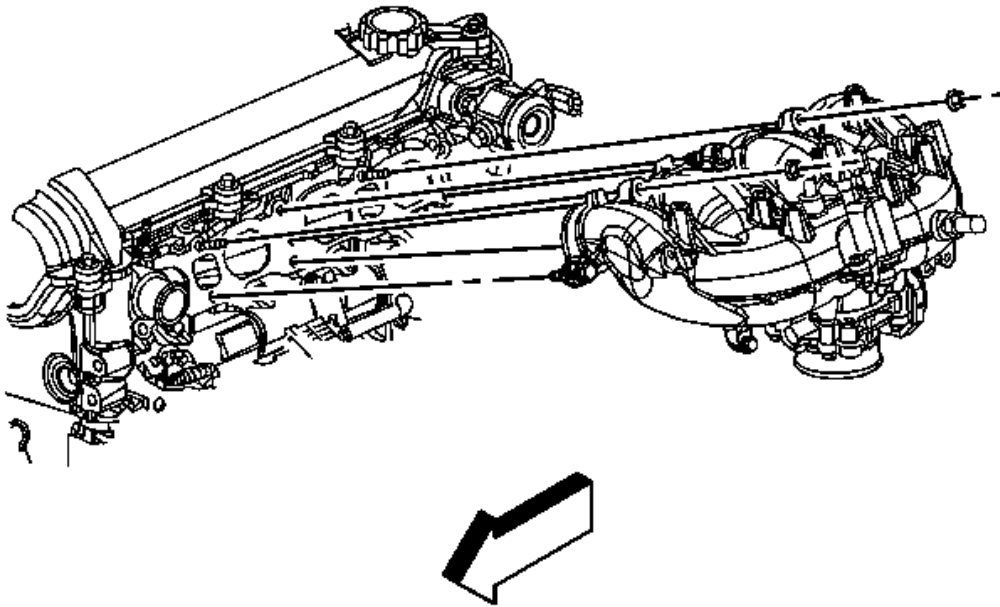


Fig. 89: View Of Intake Manifold
Courtesy of GENERAL MOTORS CORP.

34. Remove the intake manifold bolts and nuts.
35. Remove the intake manifold and place on a clean work surface.

NOTE: **The intake manifold gasket is reusable. Only replace the gasket if damage has occurred.**

36. Remove the intake manifold gasket, if necessary.

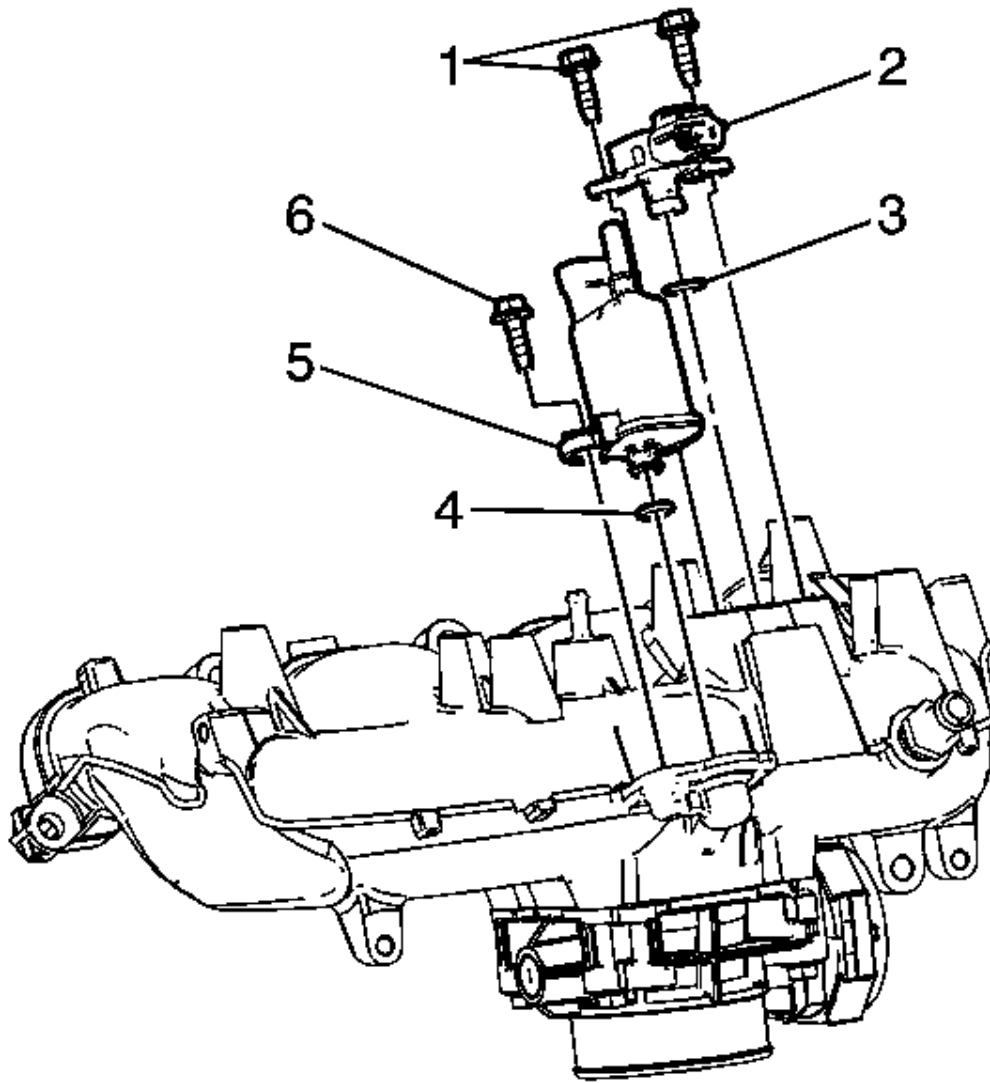


Fig. 90: View Of EVAP Canister Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

37. If replacing the intake manifold perform the following steps, otherwise proceed to step 11 in the installation procedure.
38. Remove the MAP sensor bolts (1).
39. Remove the MAP sensor (2), ensure that the O-ring seal (3) is still attached on the sensor, if not remove the O-ring seal from the intake manifold.
40. Remove the EVAP purge solenoid bolt (6).

41. Remove the EVAP purge solenoid (5), ensure that the O-ring seal (4) is still attached on the sensor, if not remove the O-ring seal from the intake manifold.

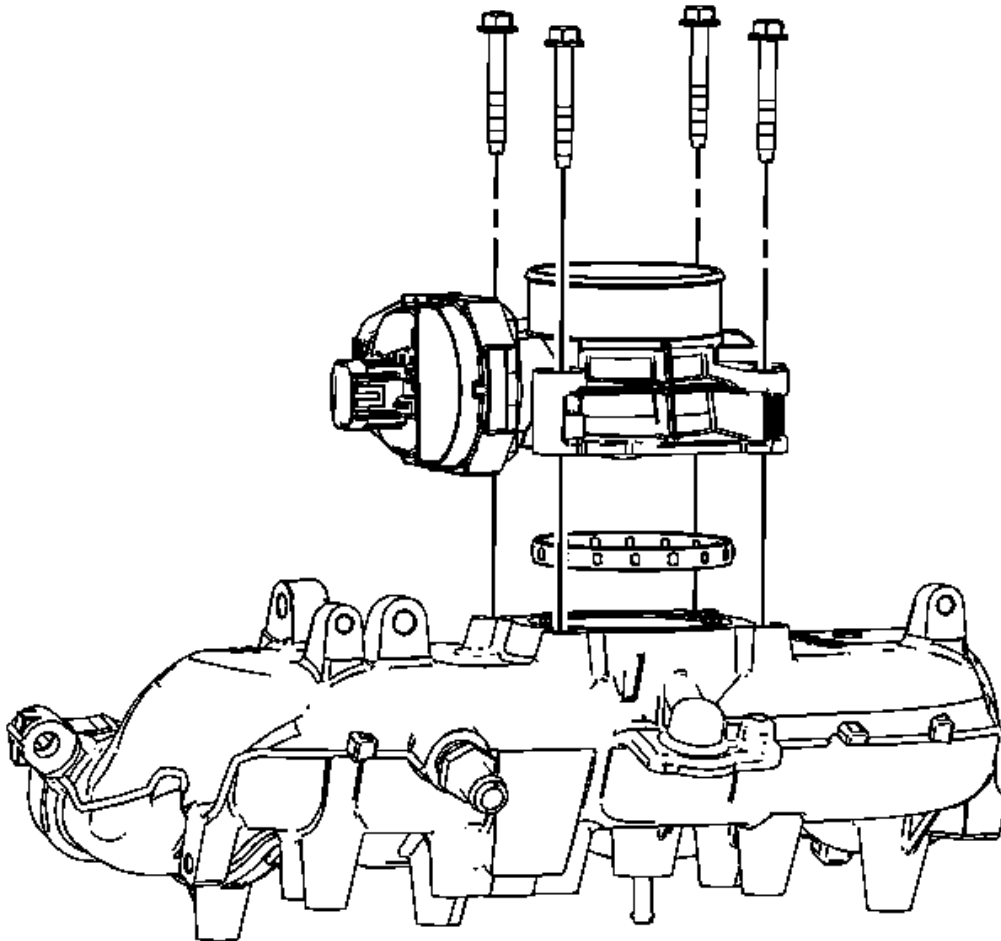


Fig. 91: View Of Throttle Body
Courtesy of GENERAL MOTORS CORP.

42. Turn the intake manifold up side down.
43. Remove the throttle body bolts.
44. Remove the throttle body and seal.

INSTALLATION PROCEDURE

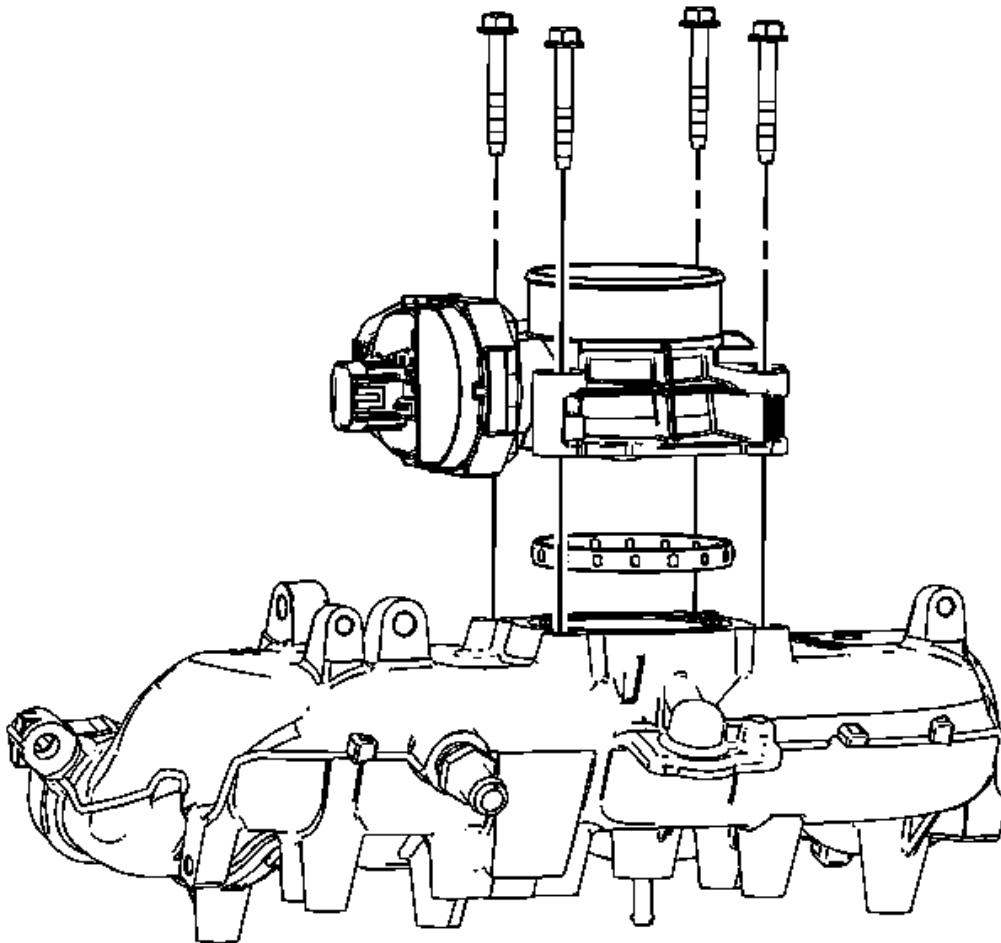


Fig. 92: View Of Throttle Body

Courtesy of GENERAL MOTORS CORP.

1. If replacing the intake manifold perform the following steps, otherwise proceed to step 11.
2. Inspect the throttle body seal and replace if necessary.
3. Install the throttle body seal and position the throttle body.

CAUTION: Refer to Fastener Caution .

4. Install the throttle body bolts.

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

5. Turn the intake manifold right side up.

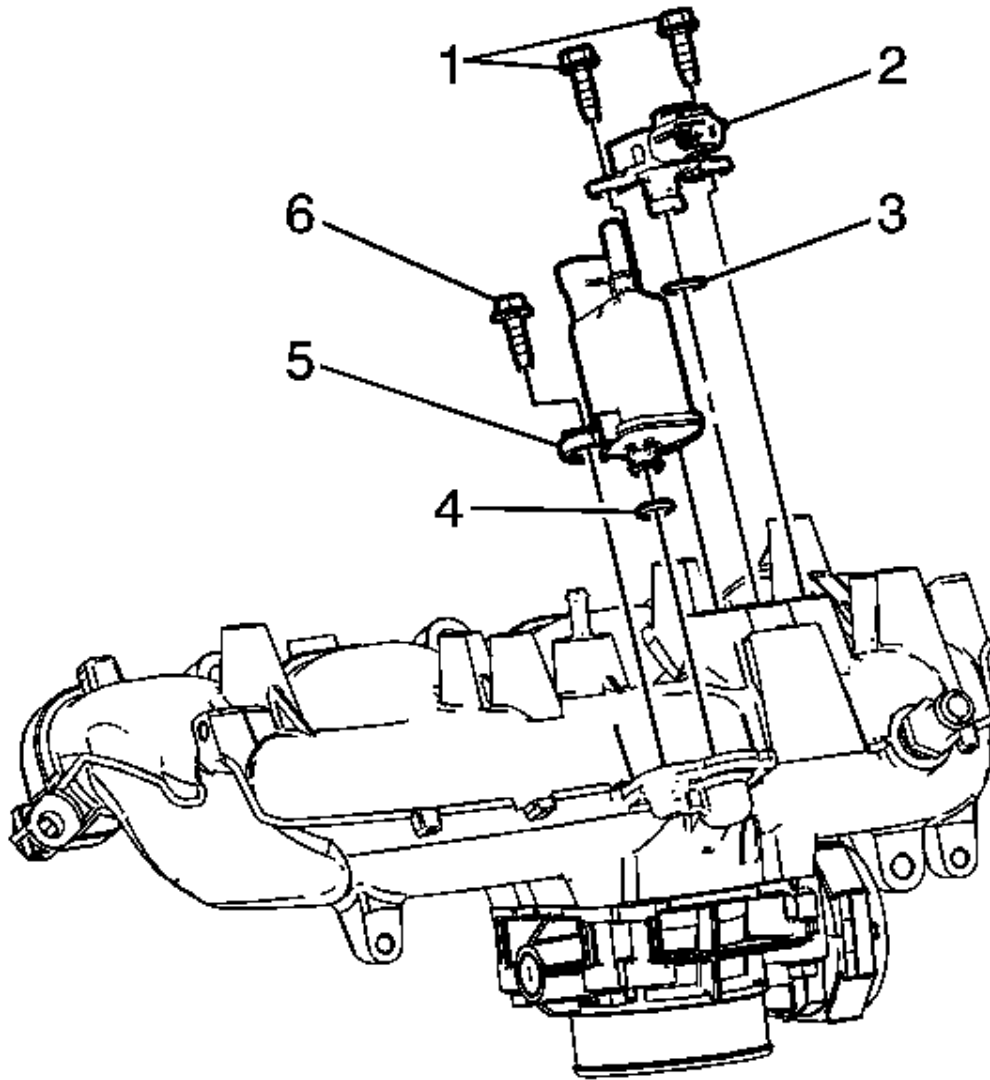


Fig. 93: View Of EVAP Canister Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

6. Inspect the EVAP purge solenoid and MAP sensor O-ring seals, replace if necessary.
7. Ensure that the EVAP purge solenoid O-ring seal (4) is installed on the EVAP purge solenoid (5).
8. Install the EVAP purge solenoid (5) and bolt (6).

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

9. Ensure that the MAP sensor O-ring seal (3) is installed on the MAP sensor (2).
10. Install the MAP sensor (2) and bolts (1).

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

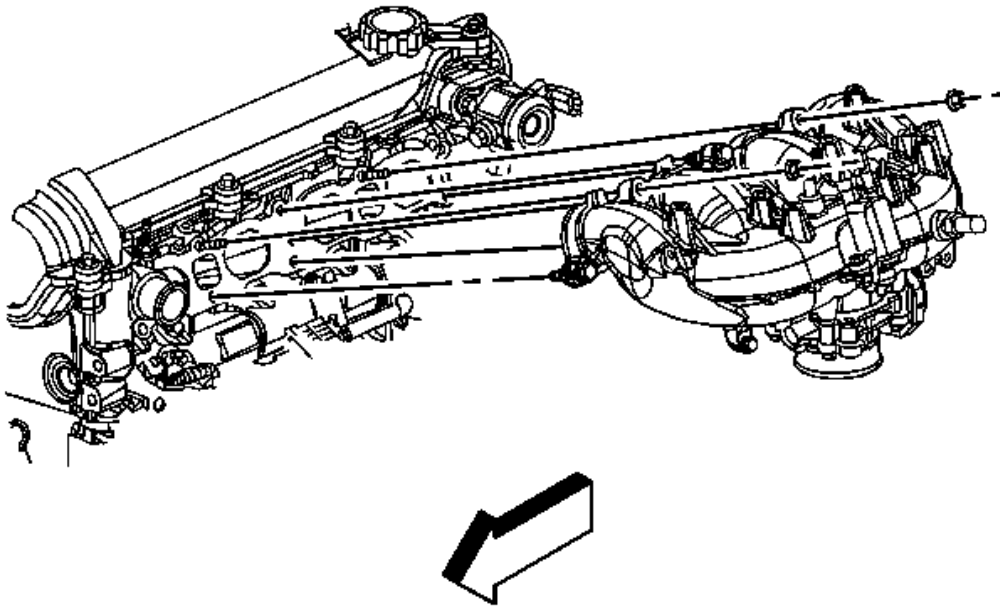


Fig. 94: View Of Intake Manifold
 Courtesy of GENERAL MOTORS CORP.

11. Install the intake manifold gasket, if necessary.
12. Install the intake manifold to the studs.
13. Install the intake manifold bolts and nuts.

Tighten: Tighten the bolts/nuts to 22 N.m (16 lb ft).

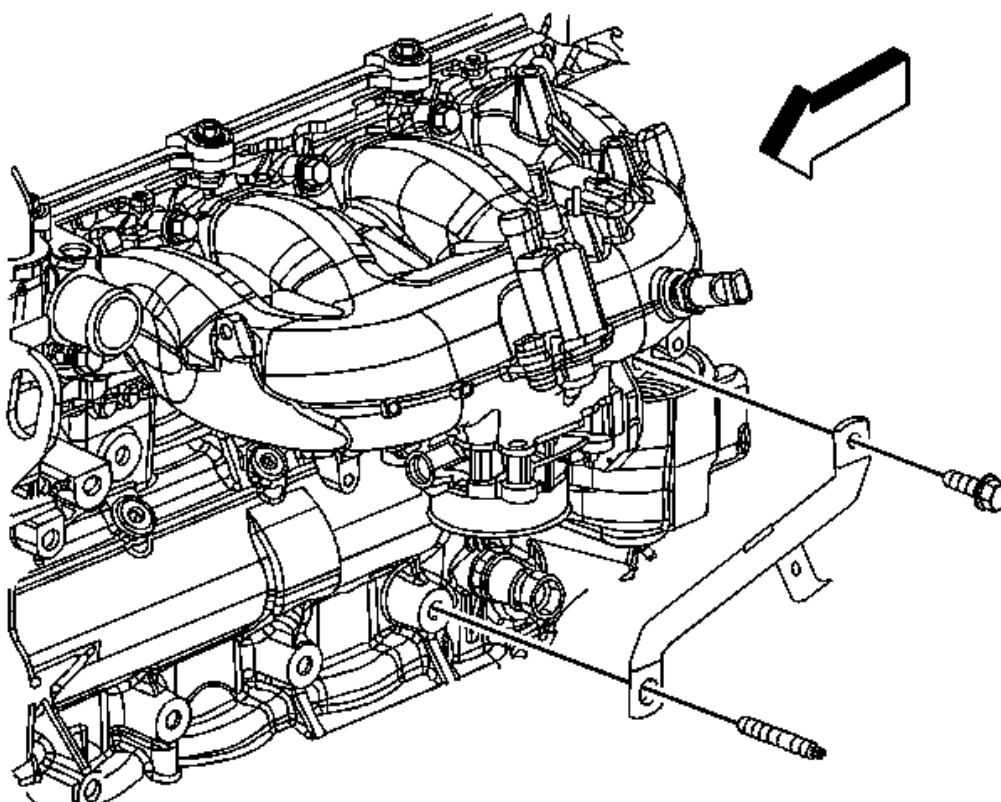


Fig. 95: View Of Intake Manifold Brace
Courtesy of GENERAL MOTORS CORP.

14. Install the intake manifold brace.
15. Loosely install the intake manifold brace bolt.
16. Tighten the intake manifold brace bolt.

Tighten: Tighten the bolt to 22 N.m (16 lb ft).

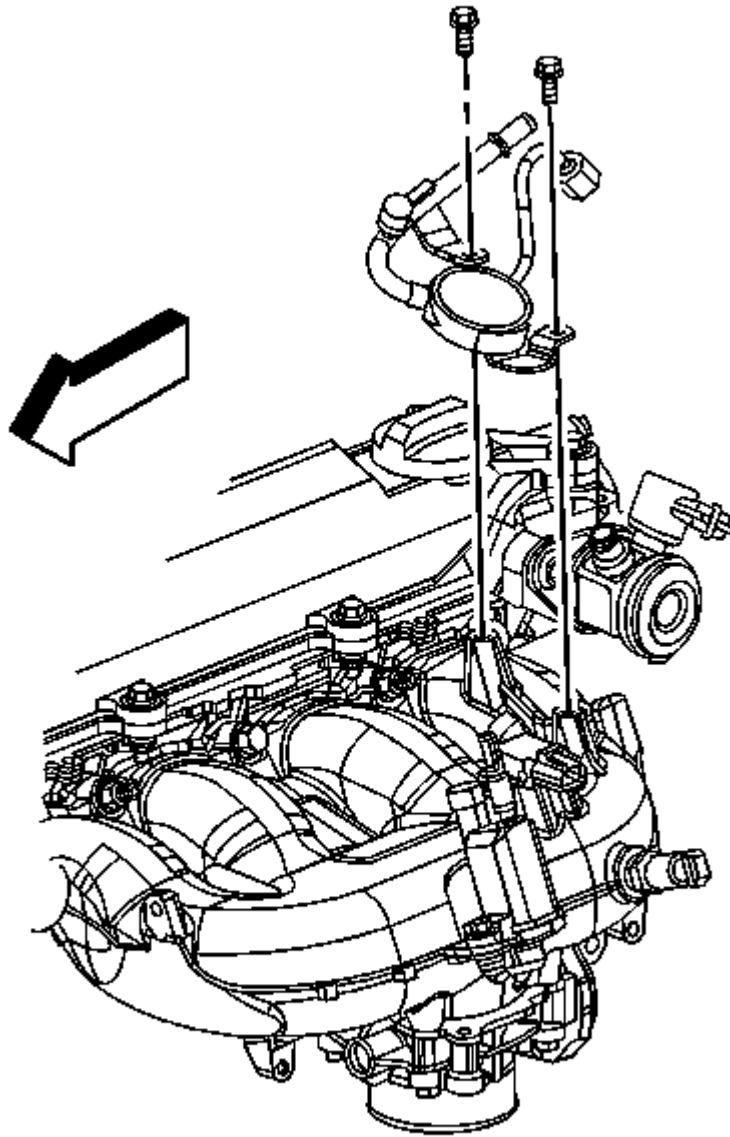


Fig. 96: Identifying Fuel Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Lubricate the high pressure fuel pump fuel feed pipe connection threads with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended lubricant.
18. Place the fuel feed pipe on top of the intake manifold.
19. Connect the fuel feed pipe fitting to the high pressure fuel pump.

20. Install the fuel feed pipe bolts.

Tighten:

- Tighten the bolts to 10 N.m (89 lb in).
- Tighten the fitting to 30 N.m (22 lb ft).

21. Connect the metal quick connect fitting to the fuel feed pip. Refer to **Metal Collar Quick Connect Fitting Service** .

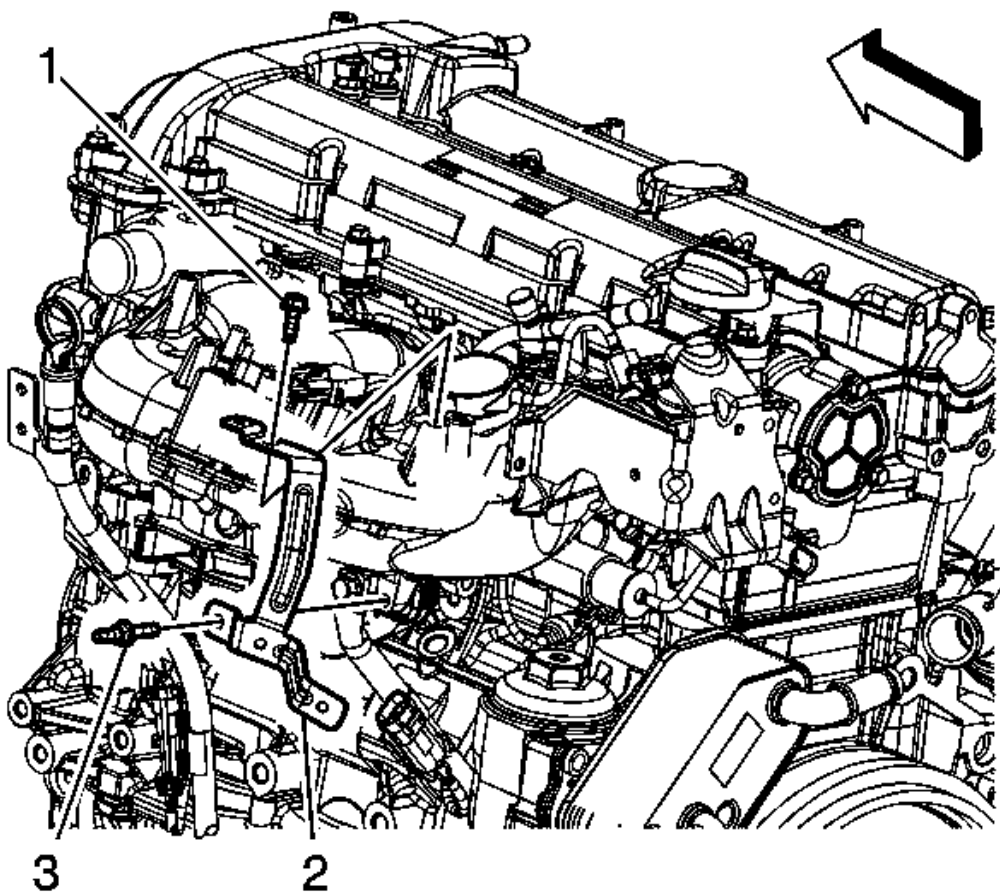


Fig. 97: Identifying Surge Tank Bracket
Courtesy of GENERAL MOTORS CORP.

22. Position the surge tank bracket (3) to the intake manifold.

23. Install the surge tank bracket bolt (1) and stud (2).

Tighten: Tighten the bolt/stud to 9 N.m (80 lb in).

24. Install the surge tank hose retainer and hose to the surge tank bracket.

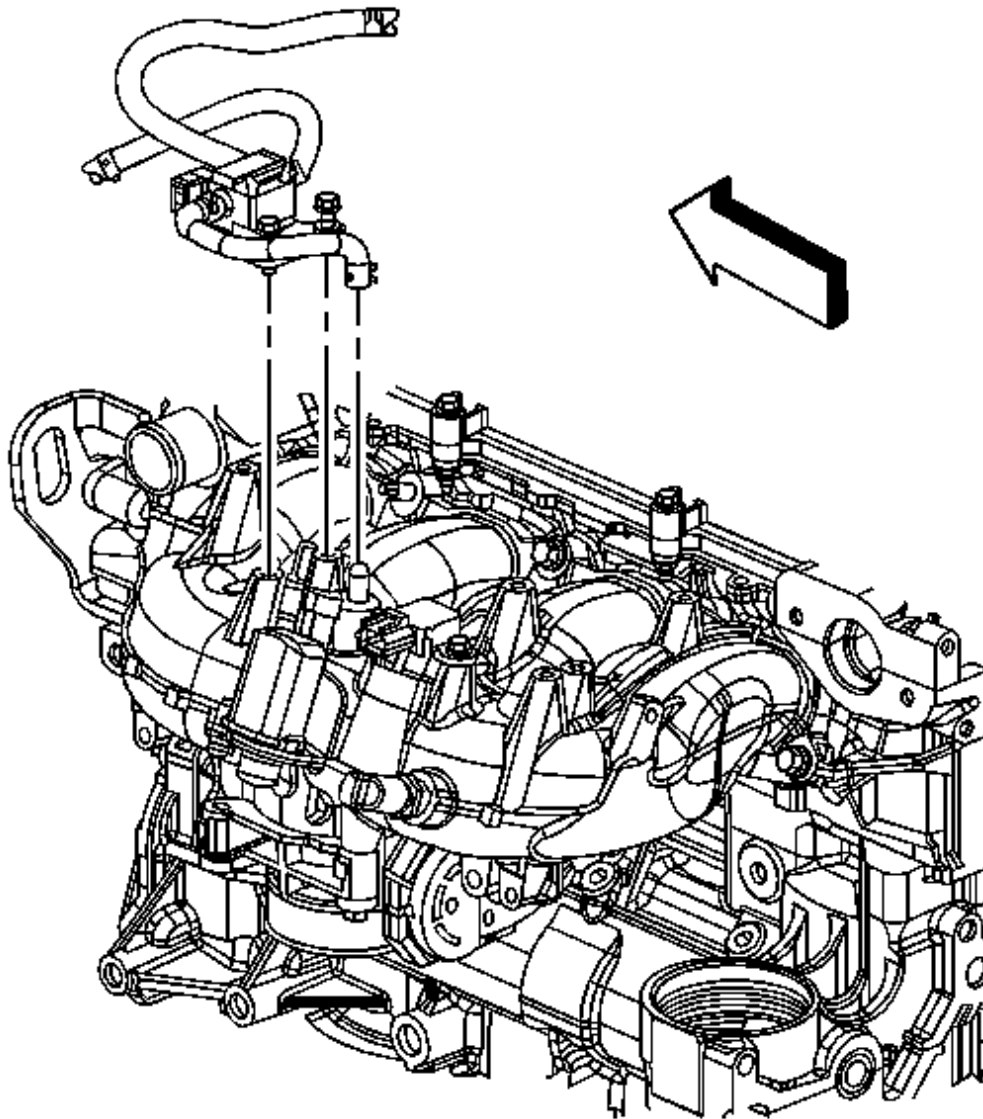


Fig. 98: Identifying Charge Air Bypass Valve Solenoid Assembly
Courtesy of GENERAL MOTORS CORP.

25. Position the charge air bypass valve solenoid assembly to the intake manifold.

26. Install the charge air bypass valve solenoid bolts.

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

27. Install the charge air bypass valve vacuum hose to the intake manifold.

28. Position the charge air bypass valve vacuum hose clamp at the intake manifold.

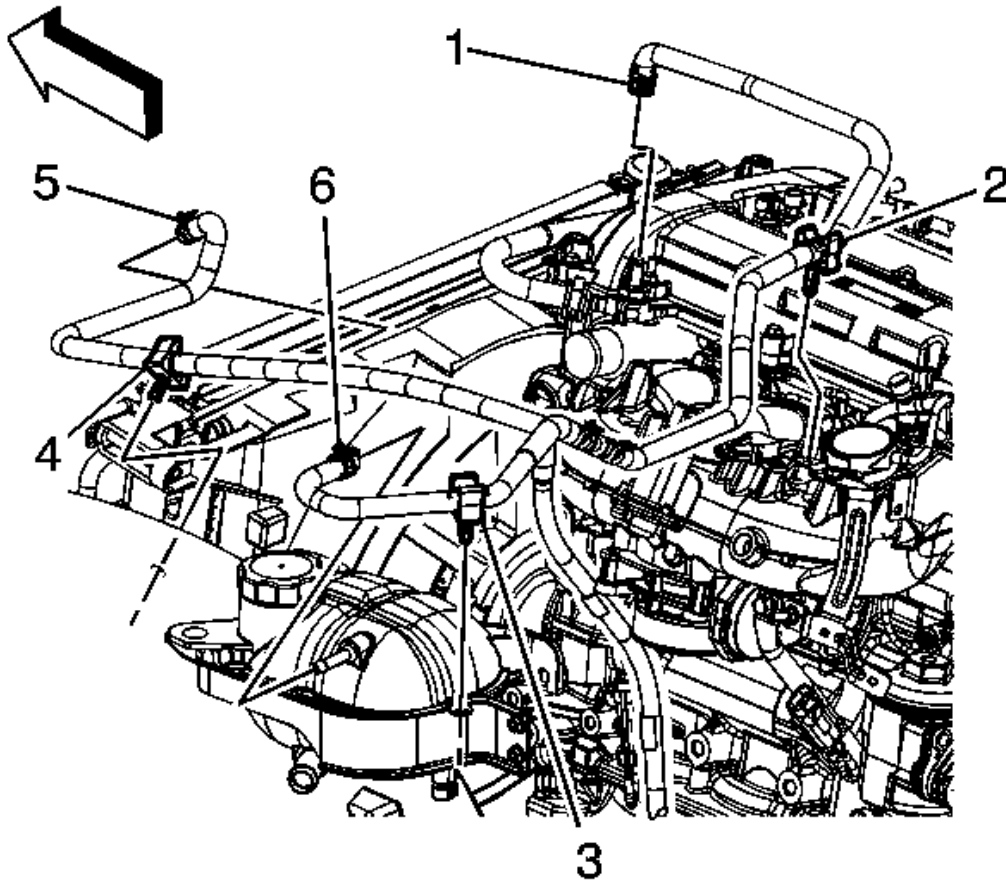


Fig. 99: Identifying Surge Tank Hose Components
Courtesy of GENERAL MOTORS CORP.

29. Position the surge tank air bleed hose to the engine.

30. Install the surge tank air bleed hose to the engine.

31. Position the surge tank air bleed hose clamp at the engine (1).

32. Install the surge tank air bleed hose clip (2) to the surge tank bracket.

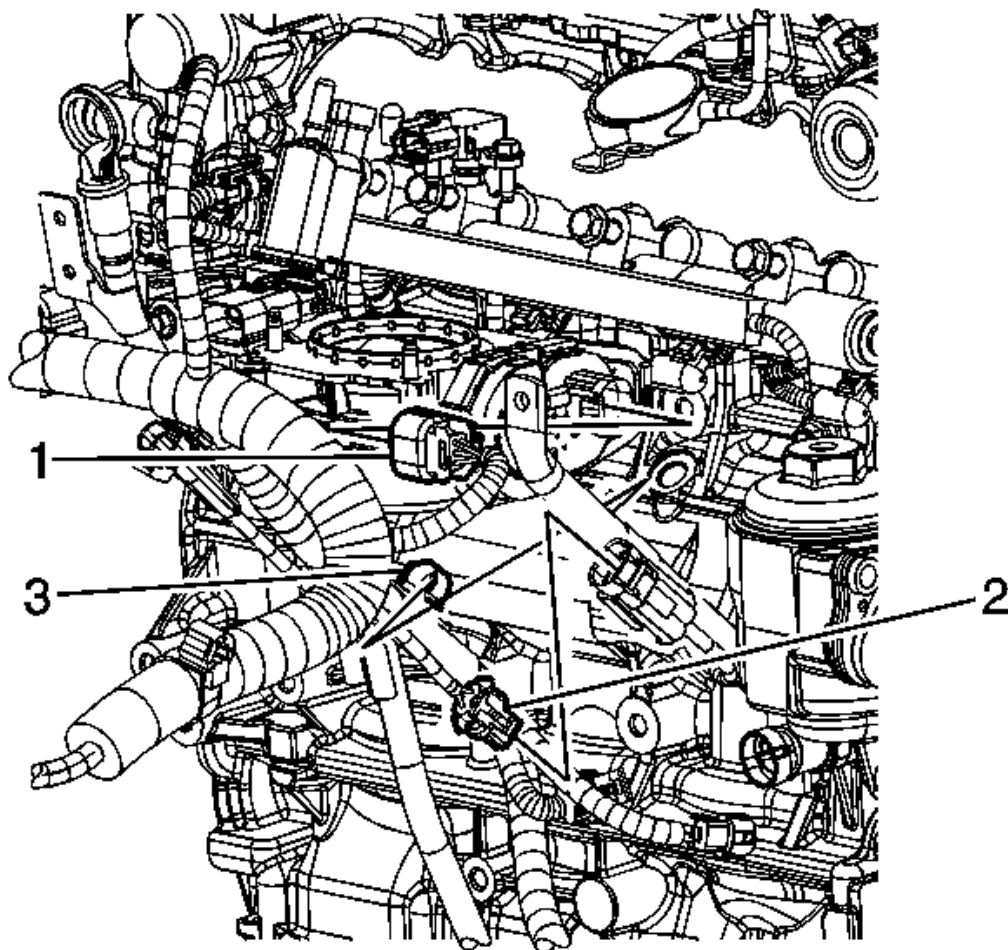


Fig. 100: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

33. Connect the engine wiring harness electrical connector (1) to the TAC module.
34. Install the engine wiring harness clip (3) to the intake manifold brace.

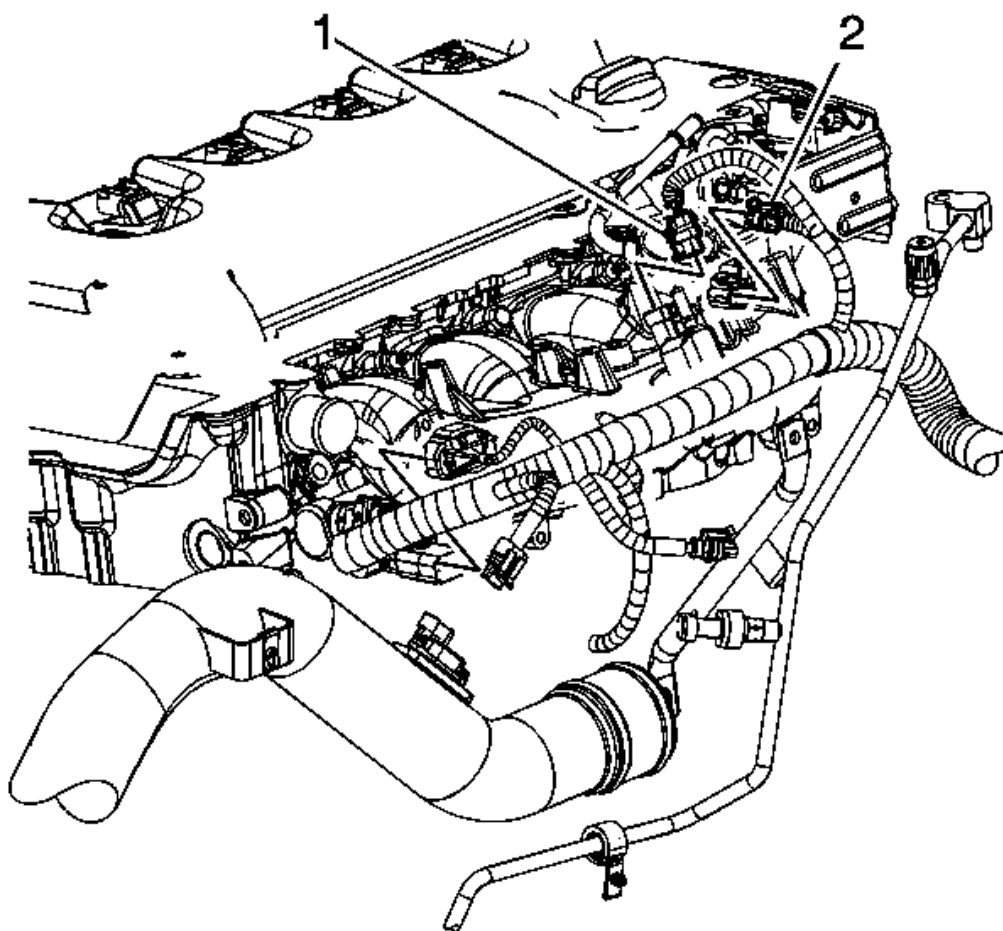


Fig. 101: Identifying MAP Sensor Connector
Courtesy of GENERAL MOTORS CORP.

35. Connect the engine wiring harness electrical connector to the charge air bypass valve solenoid.
36. Connect the engine wiring harness electrical connector (2) to the MAP sensor.
37. Connect the engine wiring harness electrical connector (1) to the EVAP canister purge solenoid.

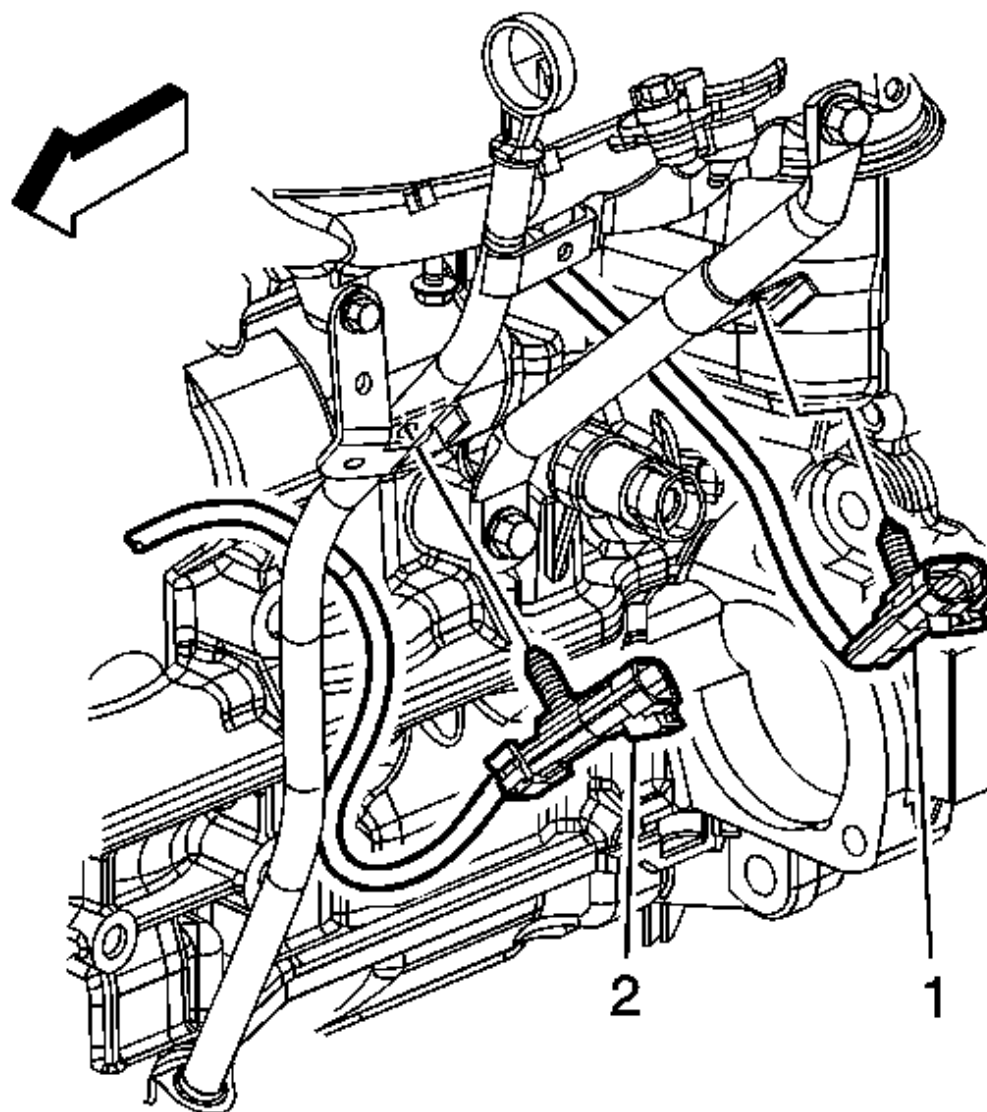


Fig. 102: Identifying Front & Rear Knock Sensor Clips
Courtesy of GENERAL MOTORS CORP.

38. Install the knock sensor electrical connector (1) clip to the intake manifold brace.
39. Install the knock sensor electrical connector (2) clip to the oil level indicator tube bracket.

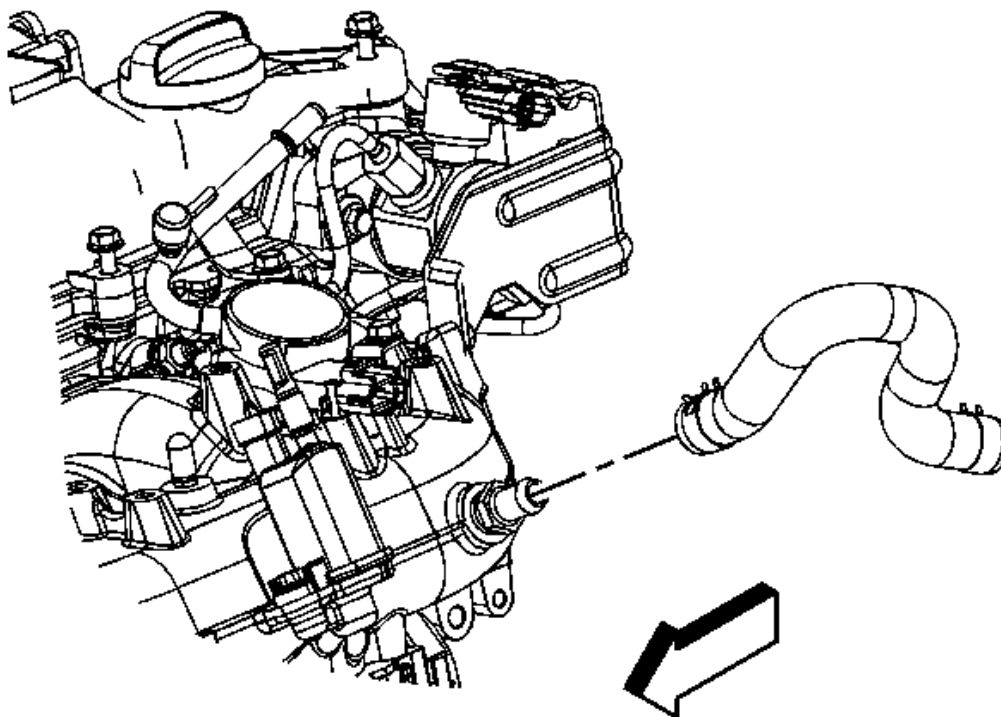


Fig. 103: View Of Brake Booster Vacuum Hose

Courtesy of GENERAL MOTORS CORP.

40. Install the brake booster hose to the intake manifold.
41. Position the brake booster vacuum hose clamp at the intake manifold.

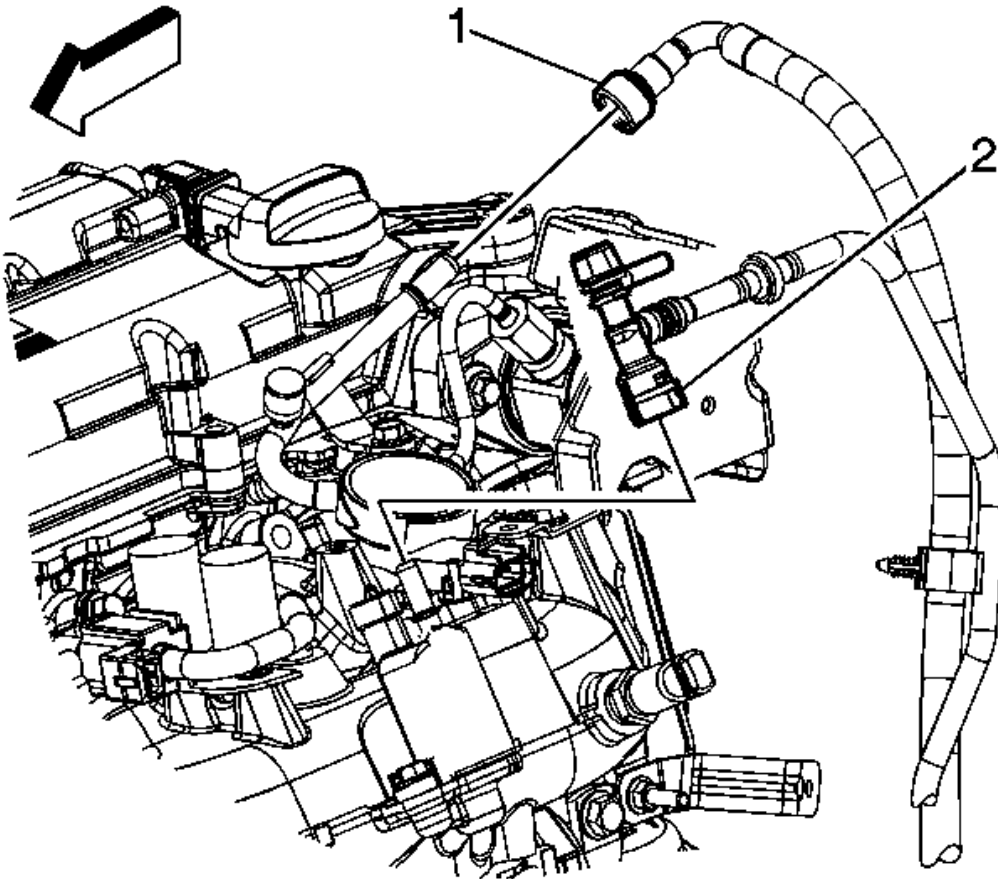


Fig. 104: Identifying EVAP & Fuel Feed Pipes
Courtesy of GENERAL MOTORS CORP.

42. Connect the EVAP line quick connect fitting (2) to the EVAP purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .
43. Connect the fuel feed line quick connect fitting (1) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
44. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.
45. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

CRANKSHAFT BALANCER REPLACEMENT

SPECIAL TOOLS

- J 43653 Flywheel Holding Tool

- **J 45059** Angle Meter

REMOVAL PROCEDURE

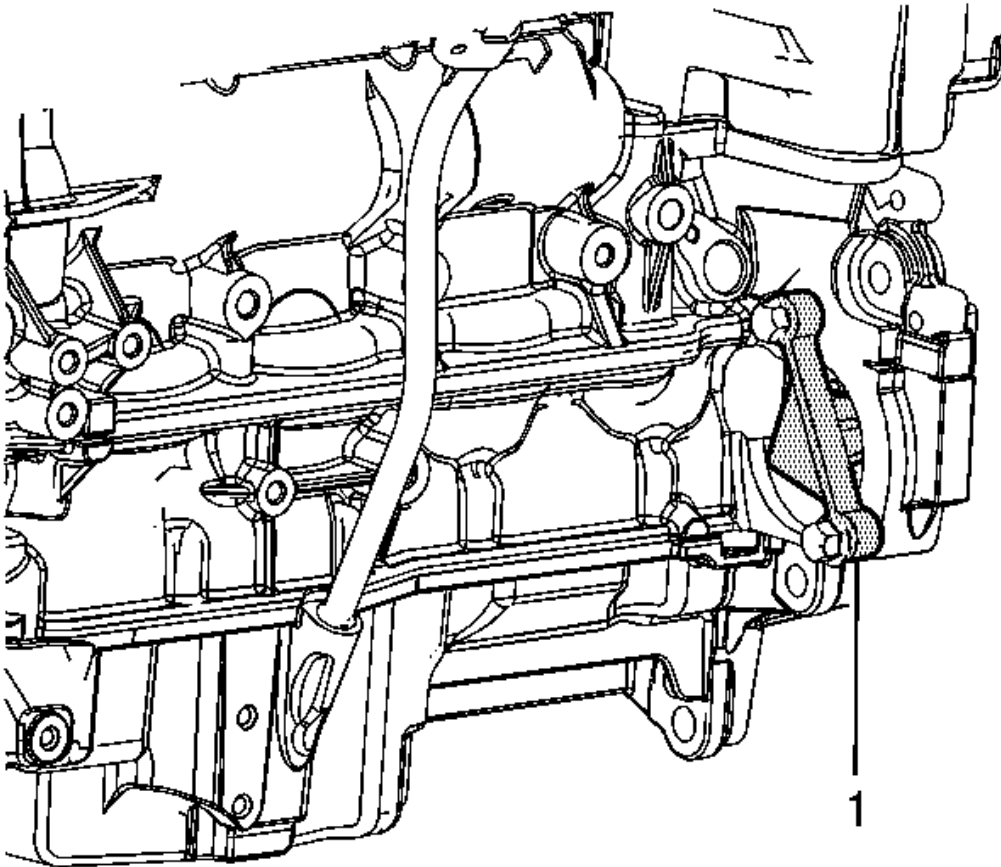


Fig. 105: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine drive belt. Refer to **Drive Belt Replacement (With A/C)** or **Drive Belt Replacement (Without A/C)** .
2. Remove the starter motor. Refer to **Starter Replacement** .
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Install the **J 43653** (1) to the engine block, in order to hold the flywheel.

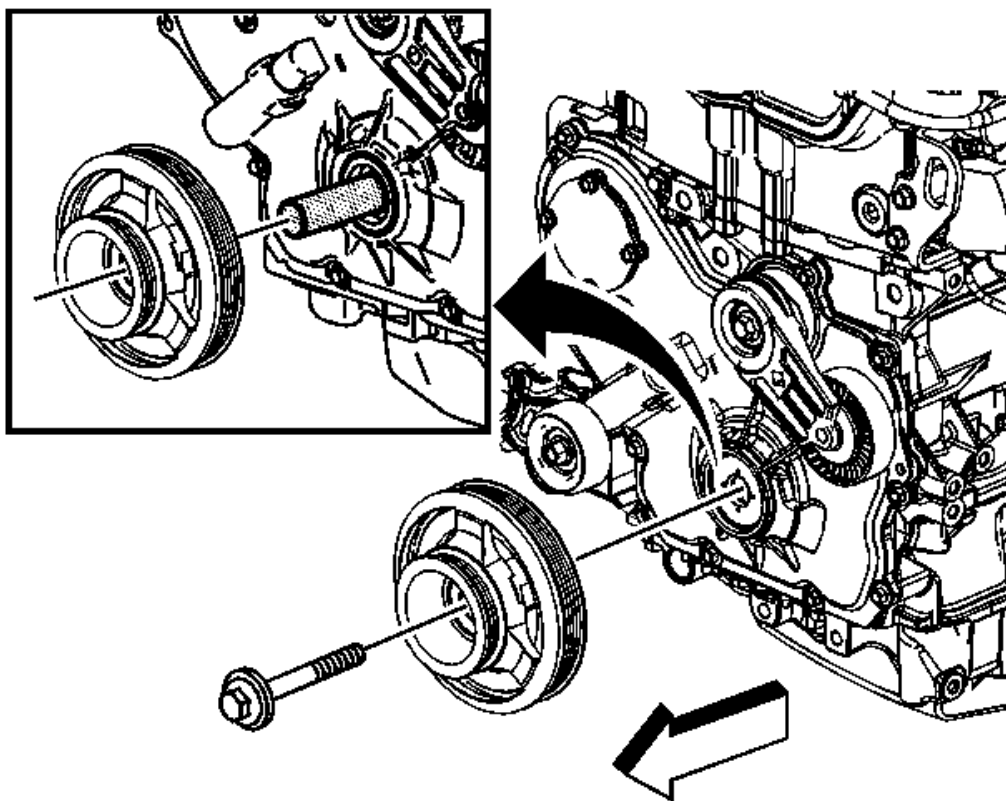


Fig. 106: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft balancer bolt. Discard the bolt.
6. Remove the balancer using a universal removal tool.

INSTALLATION PROCEDURE

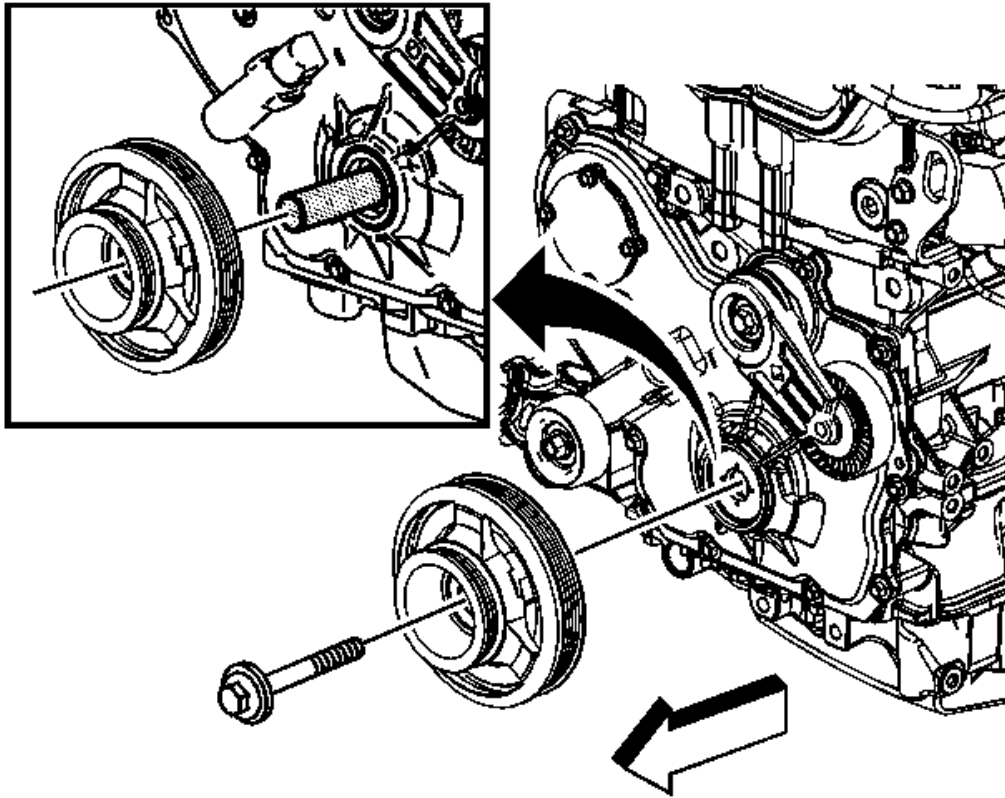


Fig. 107: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Ensure both components are aligned correctly or serious engine damage will occur.

1. Install the crankshaft balancer onto the crankshaft indexing keyway. Use care to properly align the keyway and the flats on the balancer with the oil pump drive.
2. Install the crankshaft balancer using a universal balancer installer.

CAUTION: Refer to Fastener Caution .

NOTE: Always install a NEW crankshaft balancer bolt and washer.

3. Install a NEW crankshaft balancer bolt. Prevent the crankshaft from rotating when tightening the bolt.

Tighten: Tighten the bolt to 100 N.m (74 lb ft) plus an additional 125 degrees using the **J 45059** .

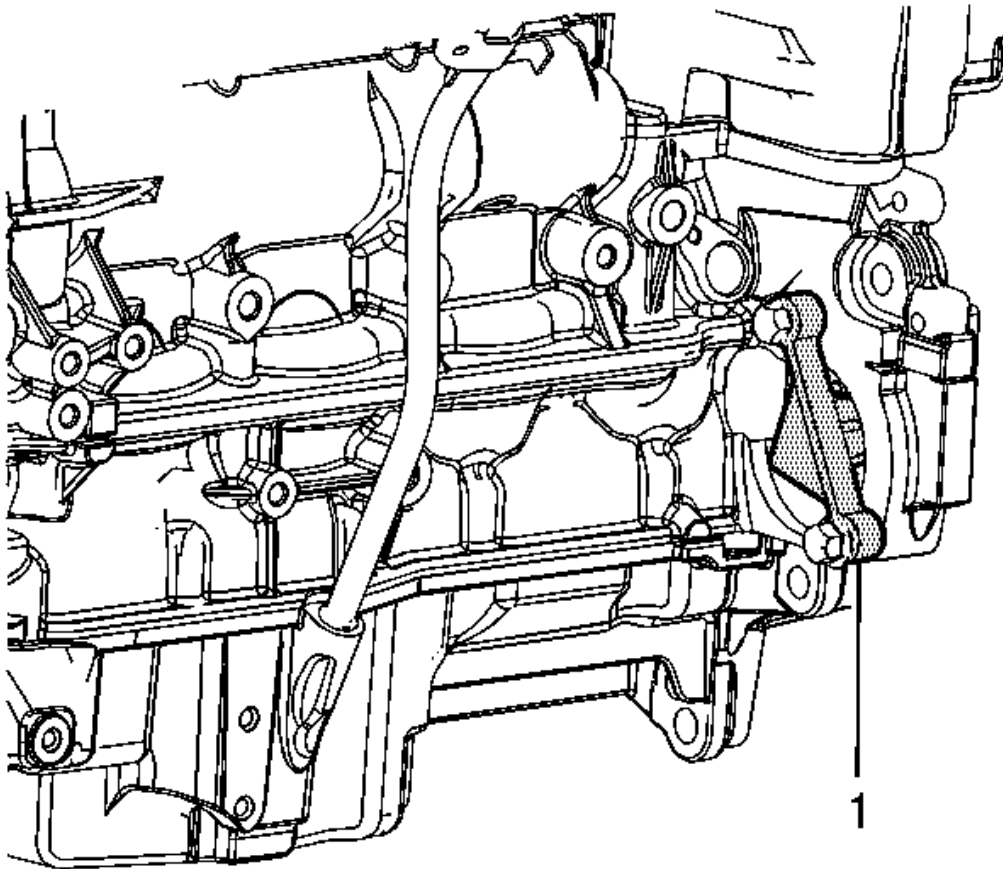


Fig. 108: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

4. Remove the **J 43653** (1) from the engine block.
5. Lower the vehicle.
6. Install the starter motor. Refer to **Starter Replacement** .
7. Install the engine drive belt. Refer to **Drive Belt Replacement (With A/C)** or **Drive Belt Replacement (Without A/C)** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

TOOLS REQUIRED

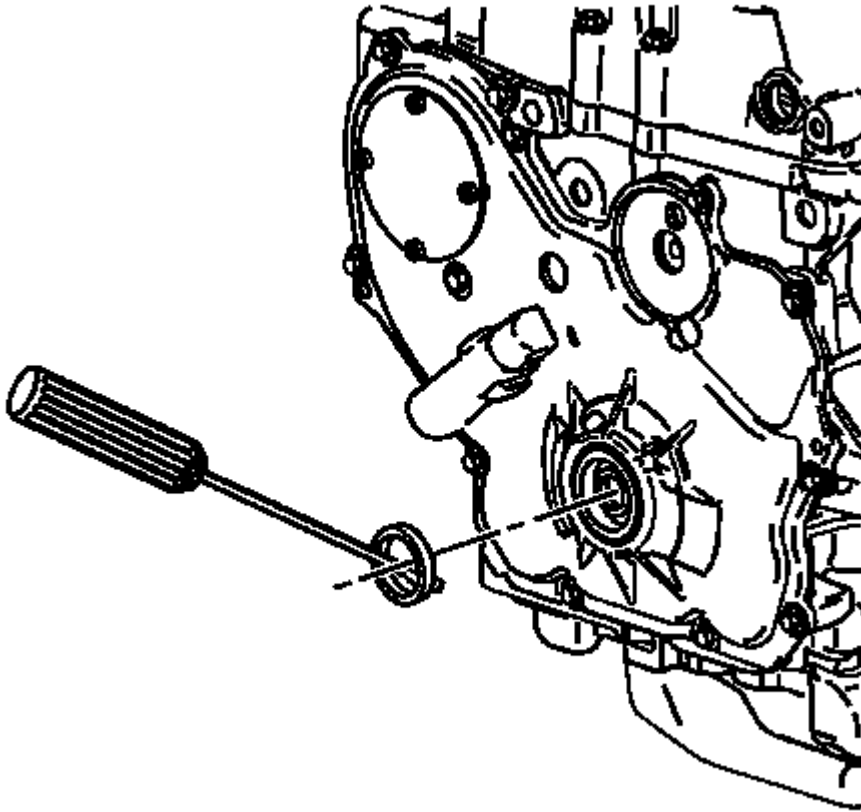
J 35268-A Camshaft/Front Main Seal Installer**REMOVAL PROCEDURE**

Fig. 109: View Of Crankshaft Front Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Using a flat-bladed tool, remove the oil seal from the front cover.

INSTALLATION PROCEDURE

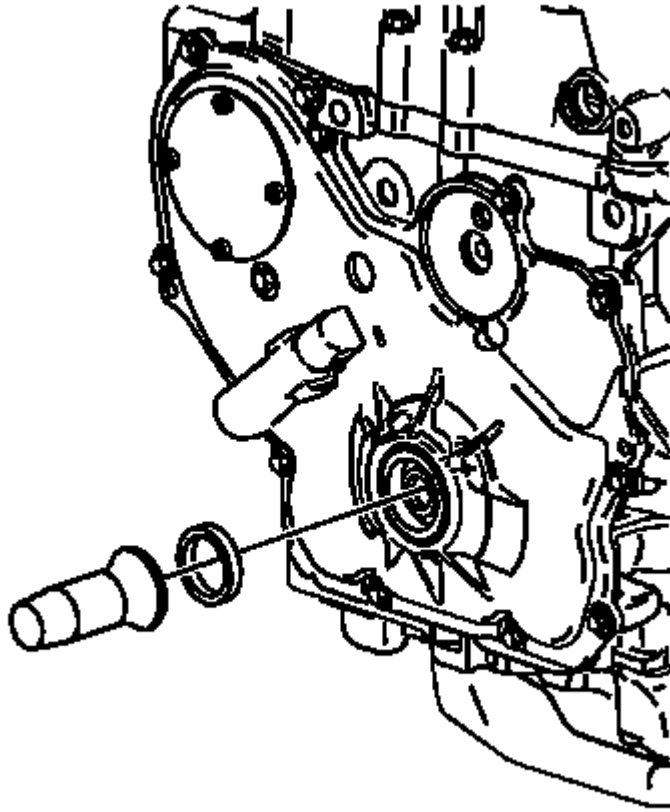


Fig. 110: Identifying Crankshaft Front Oil Seal & Special Tool J 35268-A
Courtesy of GENERAL MOTORS CORP.

1. Use the **J 35268-A** in order to install the oil seal to the front cover.
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

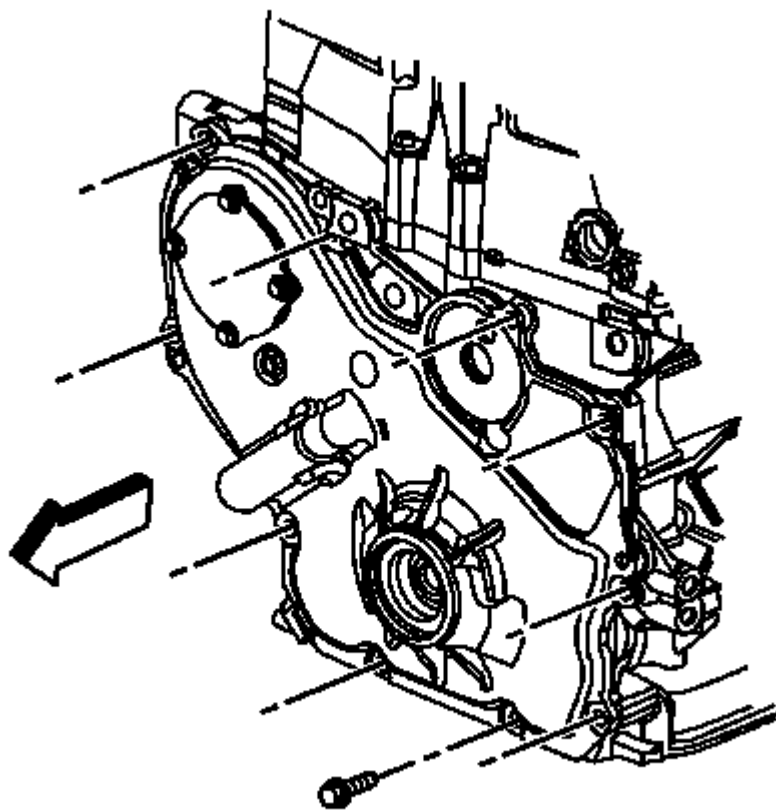


Fig. 111: Identifying Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the hood. Refer to **Hood Replacement** .
2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** .
3. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement** .
4. Remove the engine front cover bolts.

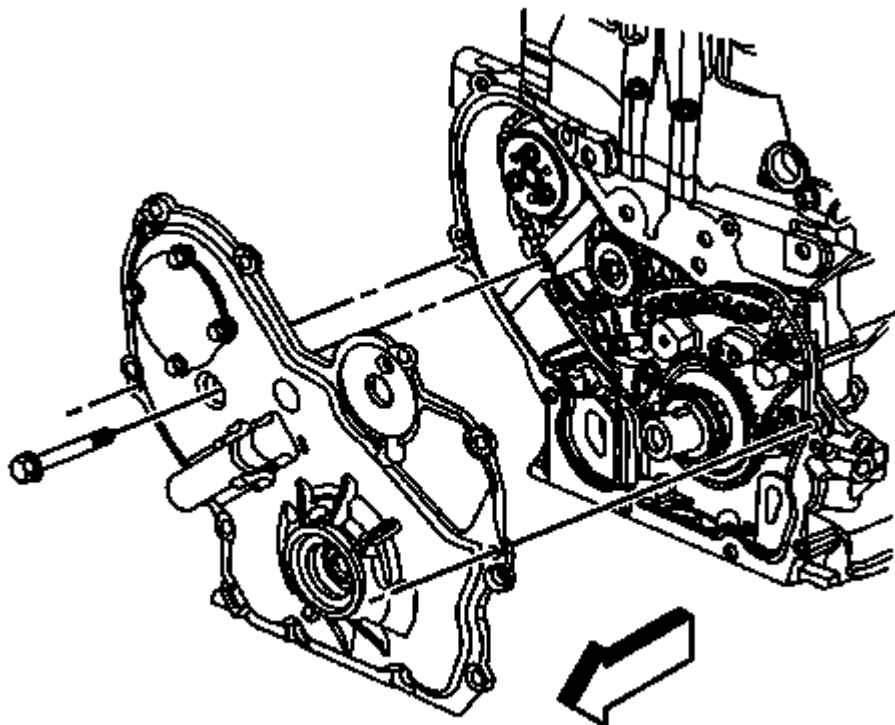


Fig. 112: Identifying Engine Front Cover & Water Pump Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine front cover to water pump bolt.

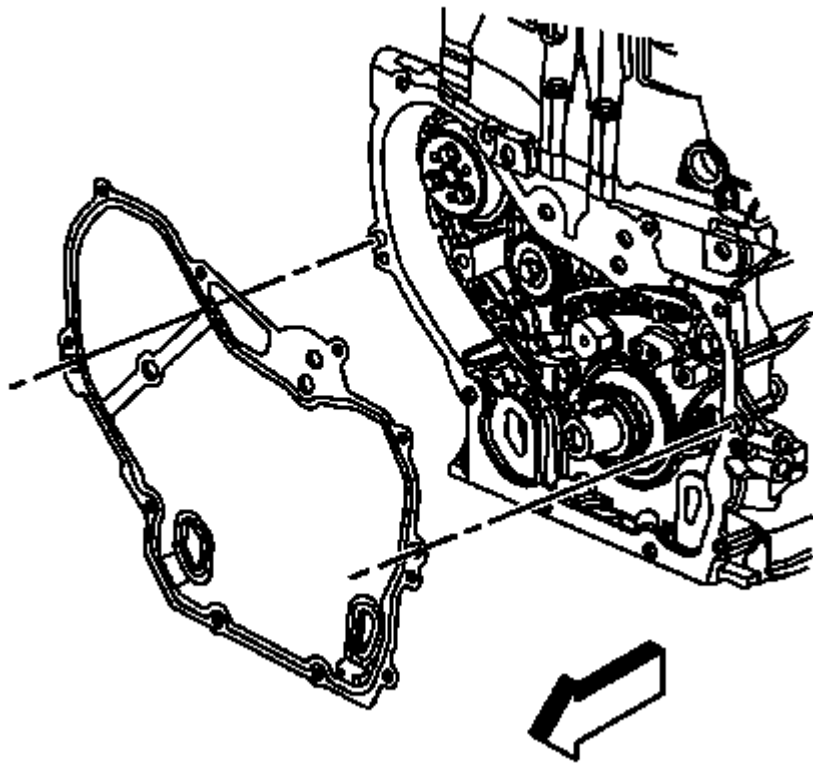


Fig. 113: Identifying Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the engine front cover gasket.
7. Remove the crankshaft front cover oil seal with an appropriate tool.
8. Remove and discard the friction washer.

INSTALLATION PROCEDURE

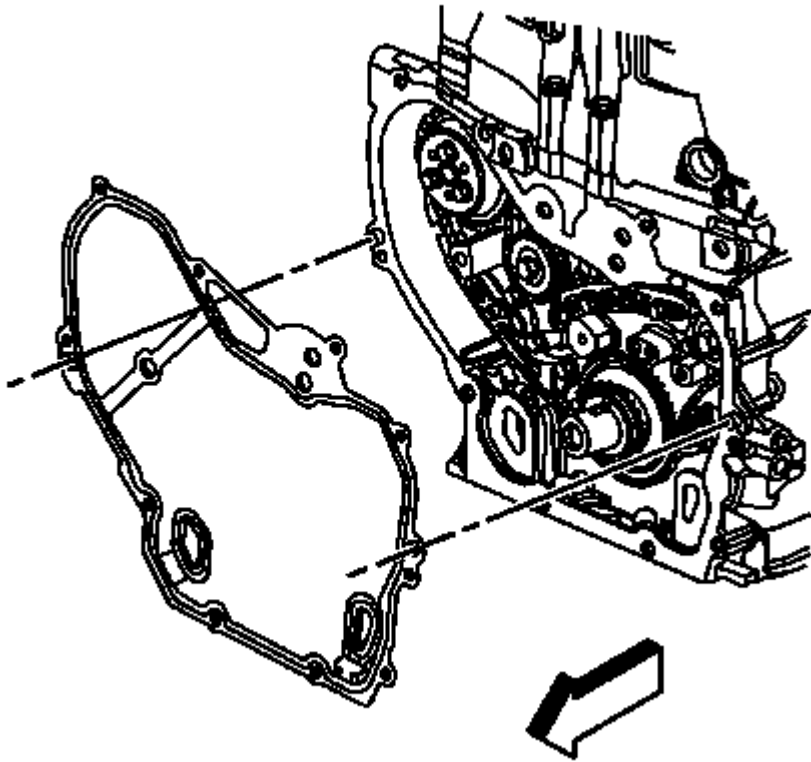


Fig. 114: Identifying Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW crankshaft front oil seal. Refer to [Crankshaft Front Oil Seal Installation](#) .
2. Install a NEW friction washer.
3. Position and install a NEW engine front cover gasket to the dowel pins.

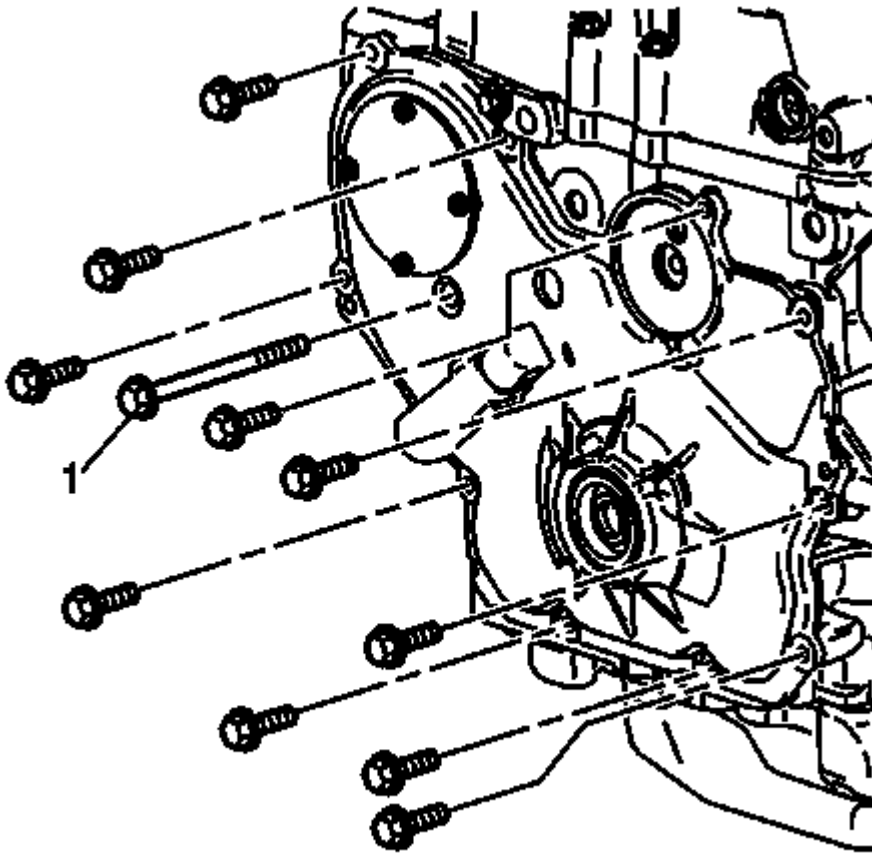


Fig. 115: Identifying Engine Front Cover Bolts & Long Water Pump Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the engine front cover bolts.

CAUTION: Refer to Fastener Caution .

NOTE: The center bolt (1) should be tightened last.

5. Install the long water pump bolt (1).

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

6. Install the crankshaft balancer. Refer to Crankshaft Balancer Replacement .
7. Install the drive belt tensioner. Refer to Drive Belt Tensioner Replacement .
8. Install the hood. Refer to Hood Replacement .

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

SPECIAL TOOLS

- **J 45027** Tensioner Tool. See Special Tools .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

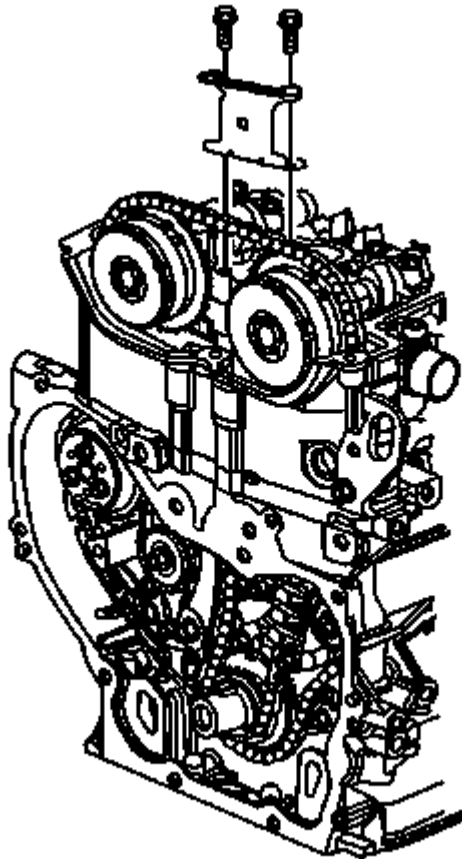


Fig. 116: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

1. Remove the hood. Refer to Hood Replacement .
2. Remove the #1 cylinder spark plug. Refer to Spark Plug Replacement .
3. Rotate the crankshaft in the engine rotational direction clockwise, until the #1 piston is at top dead center (TDC) on the exhaust stroke.
4. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
5. Remove the engine front cover. Refer to Engine Front Cover Replacement.
6. Remove the upper timing chain guide bolts and guide.

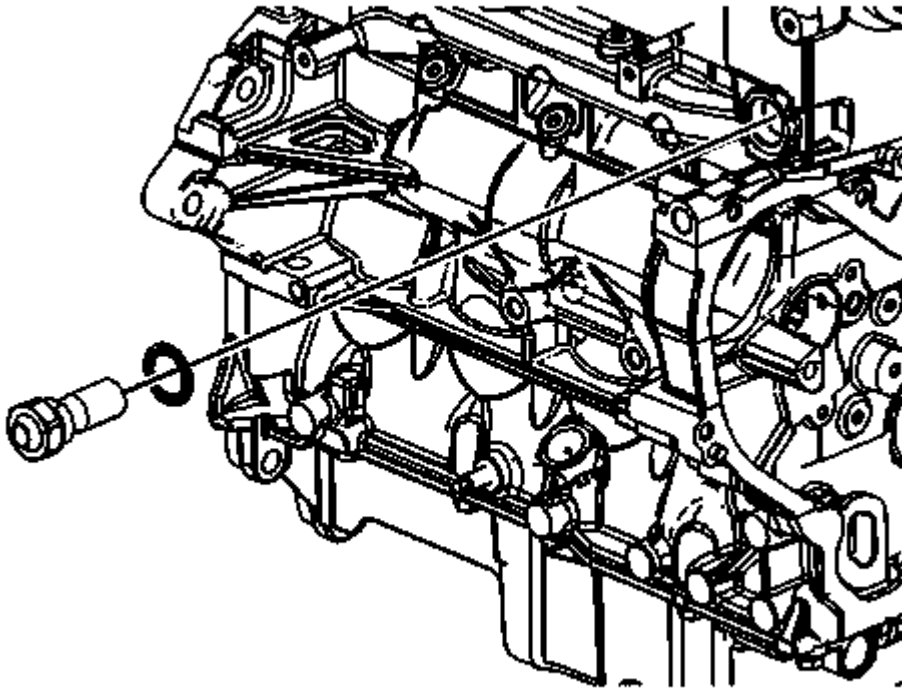


Fig. 117: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: The timing chain tensioner must be removed to unload chain tension before the timing chain is removed. If it is not, the timing chain will become cocked and it will be difficult to remove.

7. Remove the timing chain tensioner.

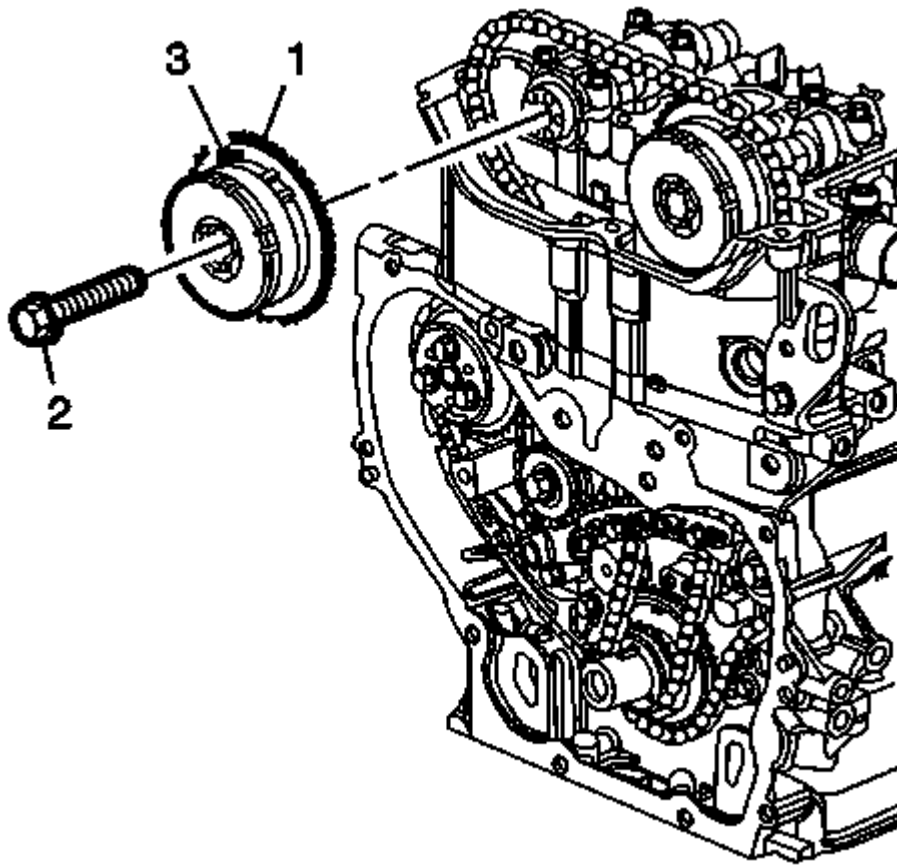


Fig. 118: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

8. Install a 24 mm wrench on the hex on the exhaust camshaft in order to hold the camshaft.
9. Remove and discard the exhaust camshaft actuator bolt (2).
10. Remove the exhaust camshaft actuator (1, 3) from the camshaft and timing chain.

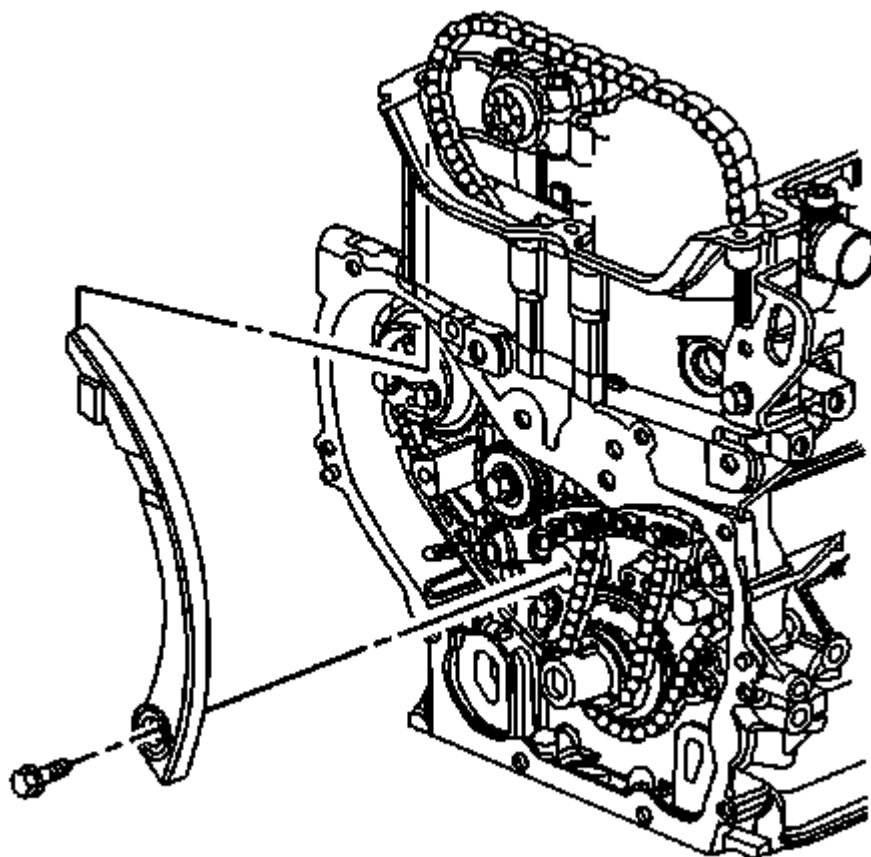


Fig. 119: Identifying Timing Chain Tensioner Guide
Courtesy of GENERAL MOTORS CORP.

11. Remove the timing chain tensioner guide bolt and guide.

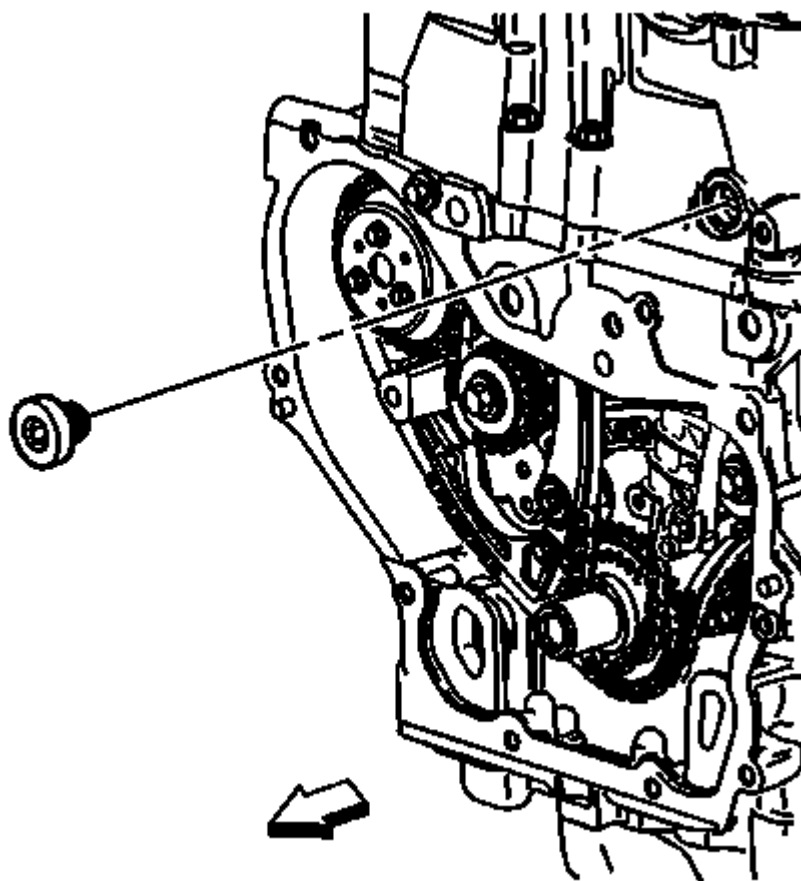


Fig. 120: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

12. Remove the fixed timing chain guide access plug.

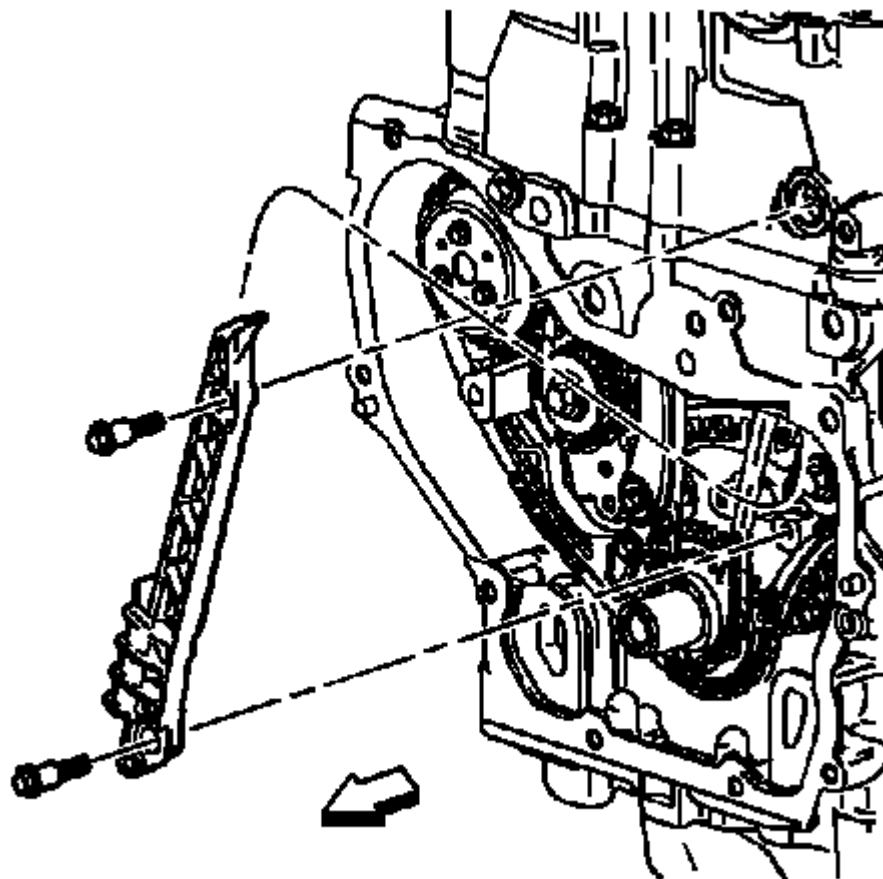


Fig. 121: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

13. Remove the fixed timing chain guide bolts and guide.

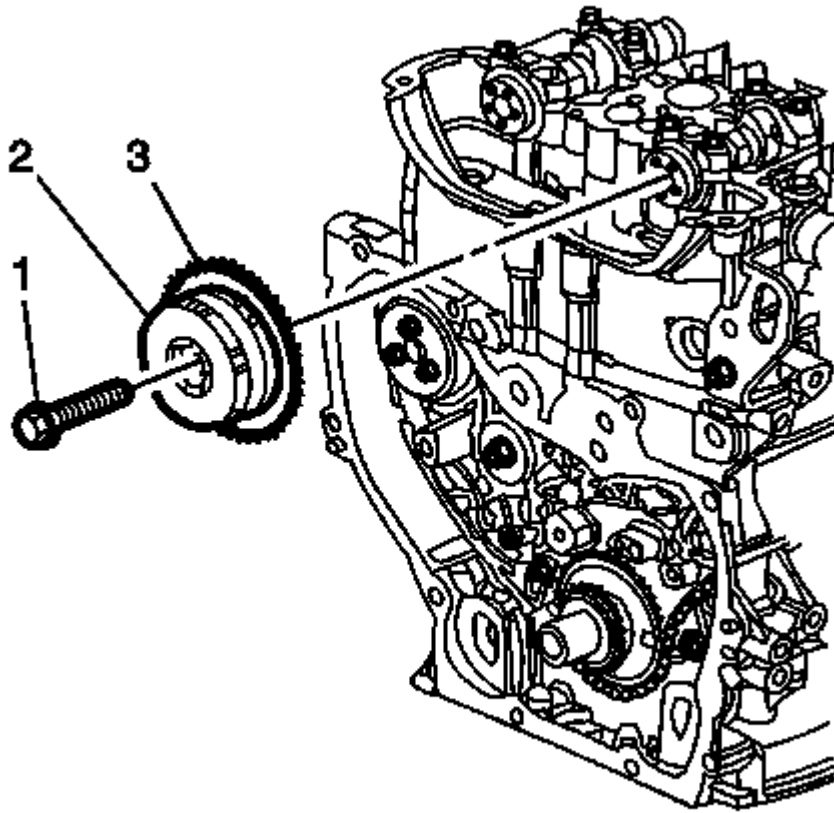


Fig. 122: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

14. Install a 24 mm wrench on the hex on the intake camshaft in order to hold the camshaft.
15. Remove and discard the intake camshaft actuator bolt (2).
16. Remove the intake camshaft actuator (3), and the timing chain through the top of the cylinder head.

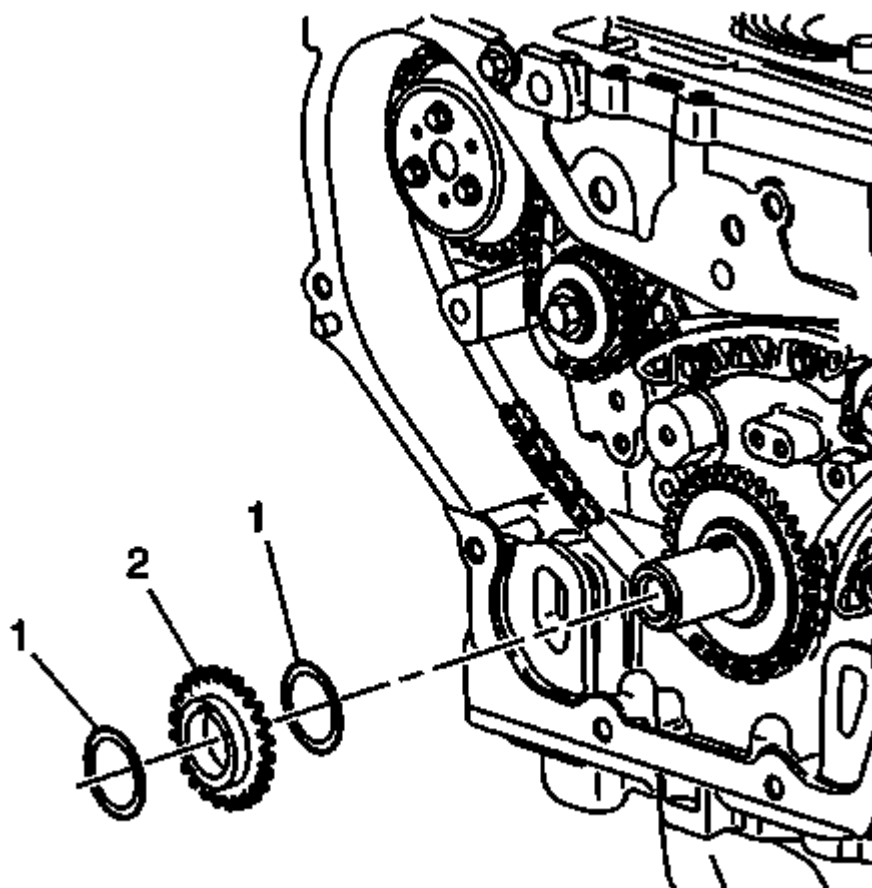


Fig. 123: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

17. Remove the friction washers (1).
18. Remove the crankshaft sprocket (2).

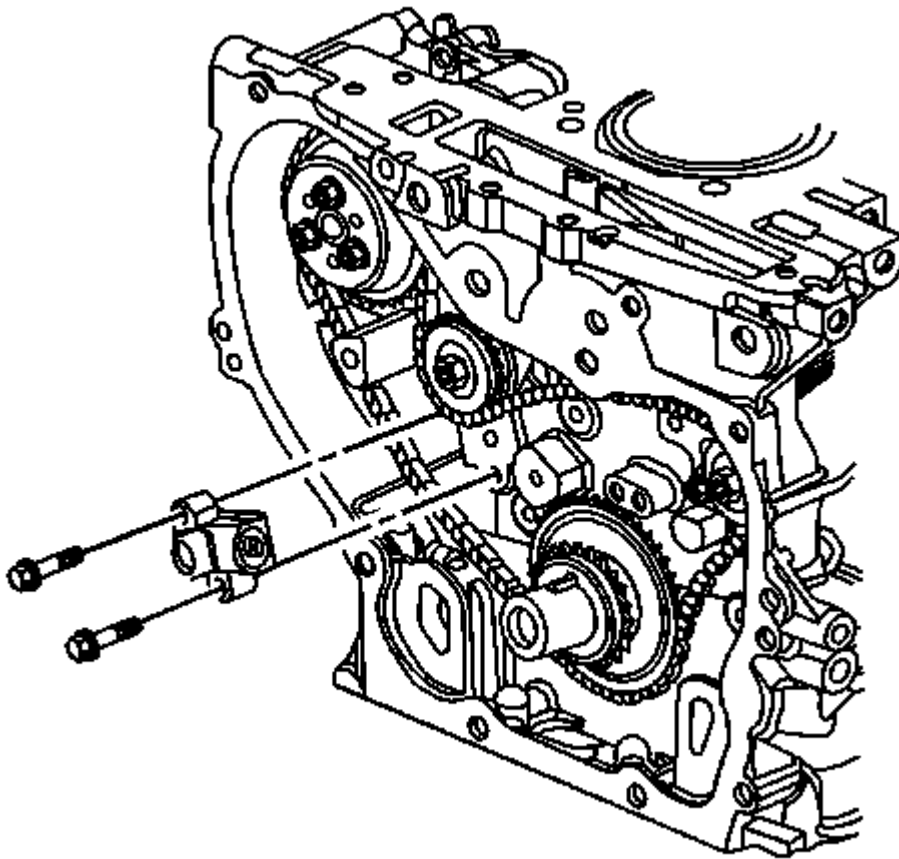


Fig. 124: Identifying Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

19. If replacing the balance shaft timing chain and sprocket, perform the following steps, if not proceed to step 10 in the installation procedure.
20. Remove the balance shaft drive chain tensioner bolts and tensioner.

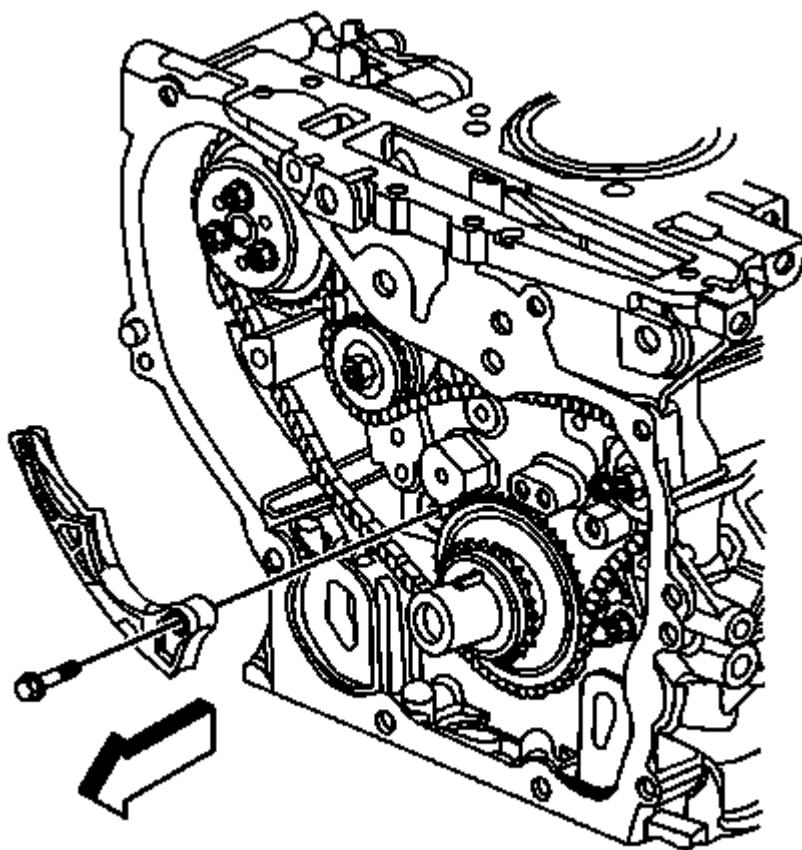


Fig. 125: Identifying Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

21. Remove the adjustable balance shaft chain guide bolt and guide.

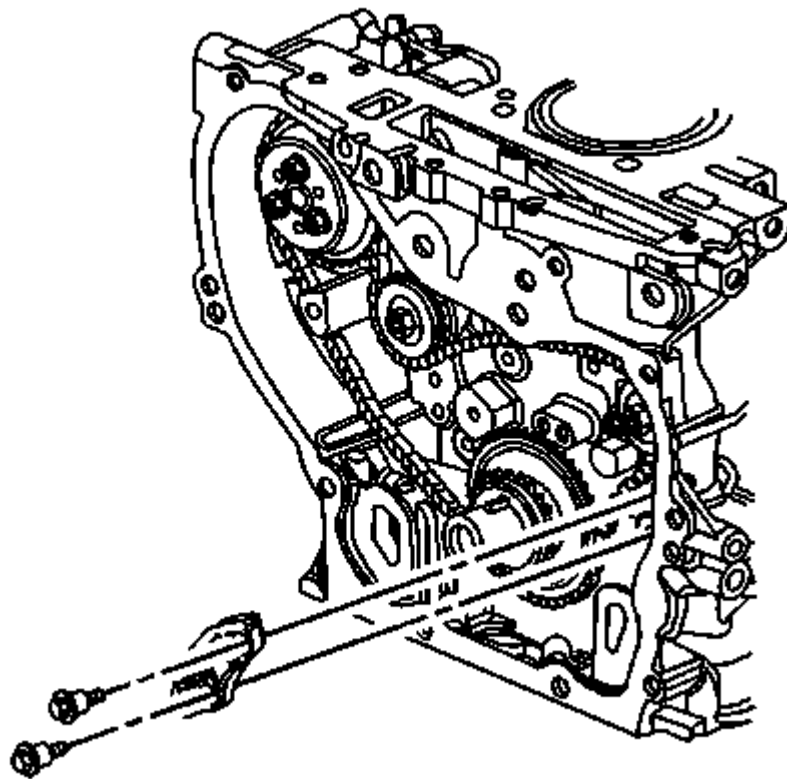


Fig. 126: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

22. Remove the small balance shaft drive chain guide bolts and guide.

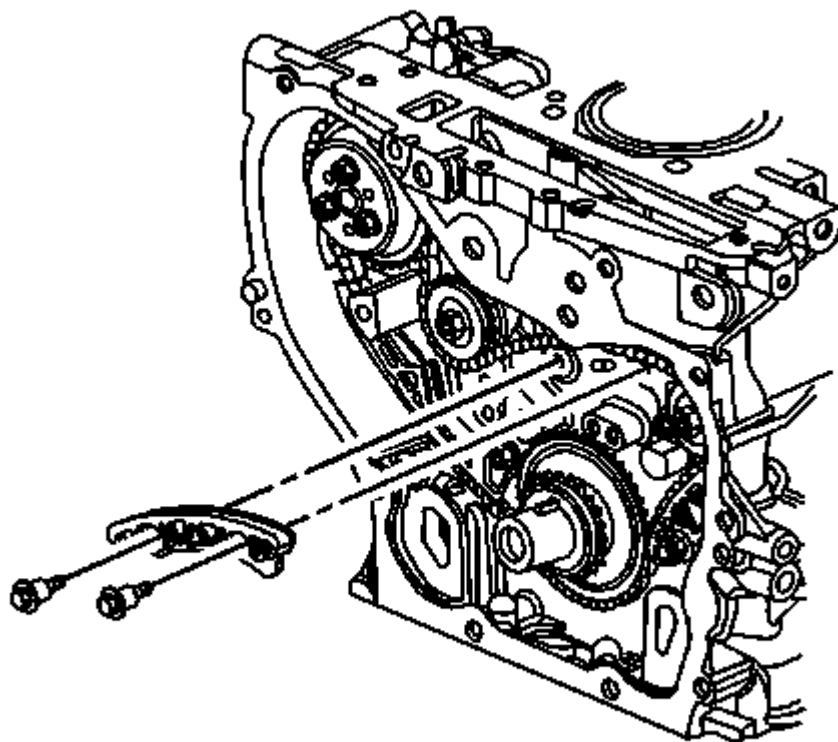


Fig. 127: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

23. Remove the upper balance shaft drive chain guide bolts and guide.

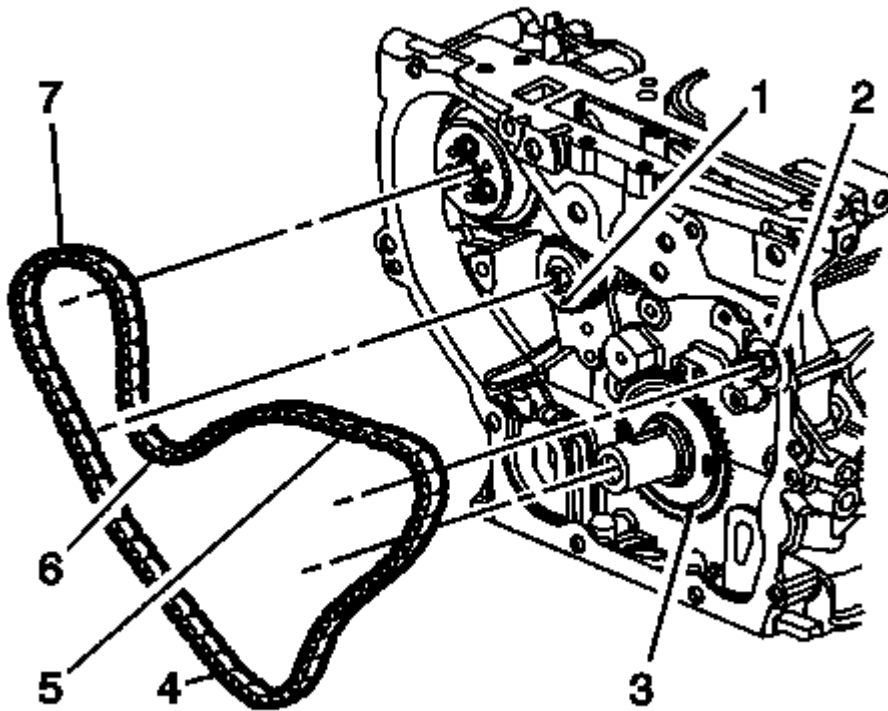


Fig. 128: Identifying Balance Shaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

NOTE: It may ease removal of the balance shaft drive chain to get all the slack in the chain between the crankshaft and water pump sprockets.

24. Remove the balance shaft drive chain (7).
25. Remove the balance shaft drive sprocket.

INSTALLATION PROCEDURE

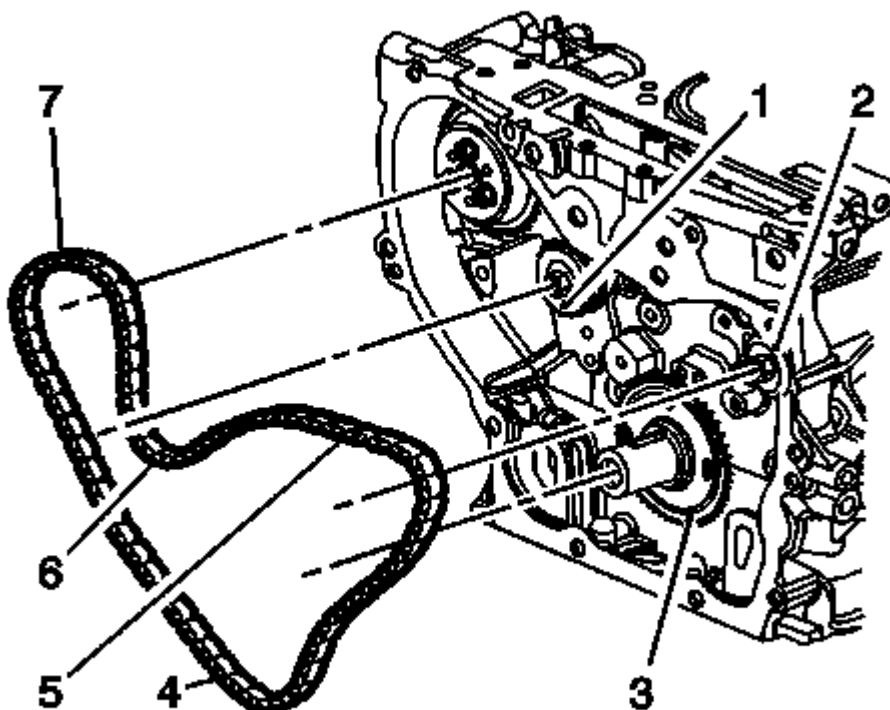


Fig. 129: Identifying Balance Shaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. If replacing the balance shaft timing chain, perform the following steps, if not proceed to step 10.
2. Install the balance shaft drive sprocket.

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.

3. Install the balance shaft drive chain (1) with the colored link lined up with the marks on the balance shaft sprockets and the balance shaft drive sprocket. There are three colored links on the chain. Two are chrome and one is copper. Use the following steps in order to line up the links with the sprockets.
 1. Place the copper link (5) so that it lines up with the timing mark (2) on the intake side balance shaft sprocket.
 2. Working clockwise around the chain, place the chrome link (4) in line with the timing mark (3) on the balance shaft drive sprocket. (approximately 6 o'clock position on the sprocket).
 3. Place the chain (7) on the water pump drive sprocket. The alignment is not critical.
 4. Align the last chrome link (6) with the timing mark (1) on the exhaust side balance shaft drive sprocket.

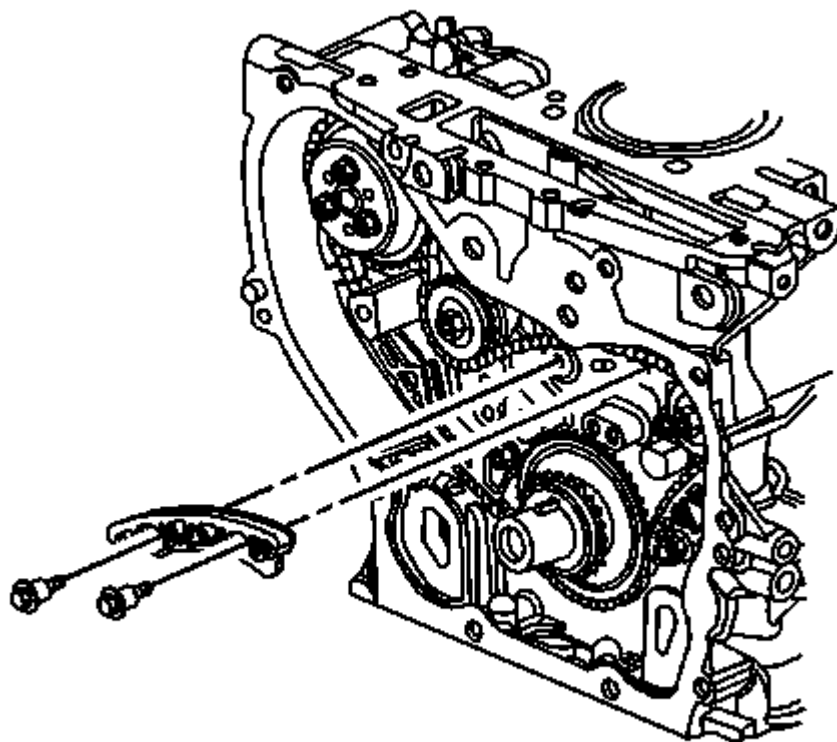


Fig. 130: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the upper balance shaft drive chain guide and bolts and tighten to 15 N.m (11 lb ft).

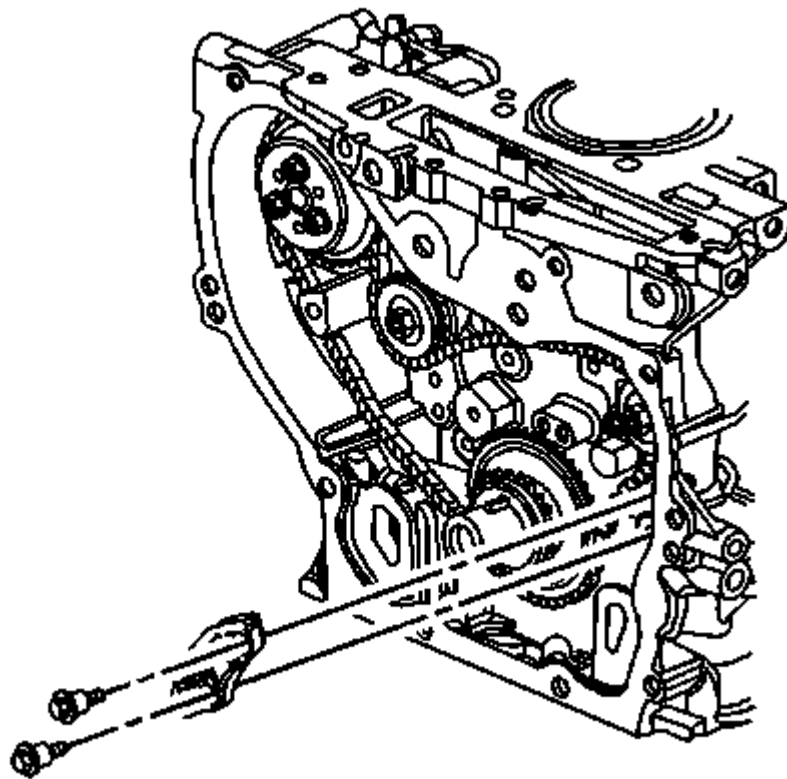


Fig. 131: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

5. Install the small balance shaft drive chain guide and bolts and tighten to 15 N.m (11 lb ft).

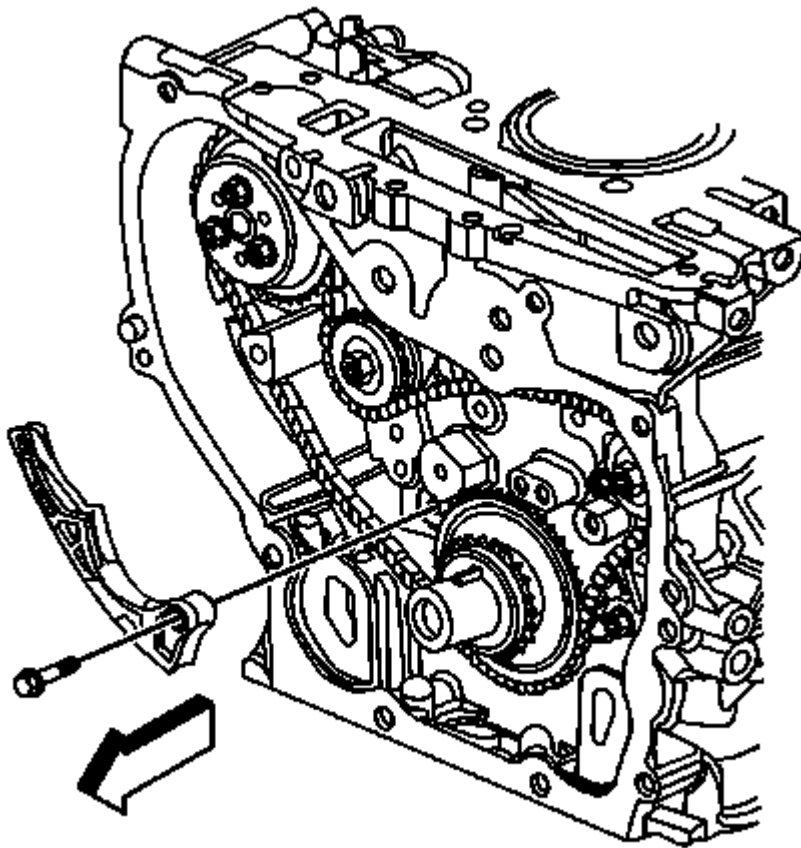


Fig. 132: Identifying Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

6. Install the adjustable balance shaft chain guide and bolt and tighten to 10 N.m (89 lb in).

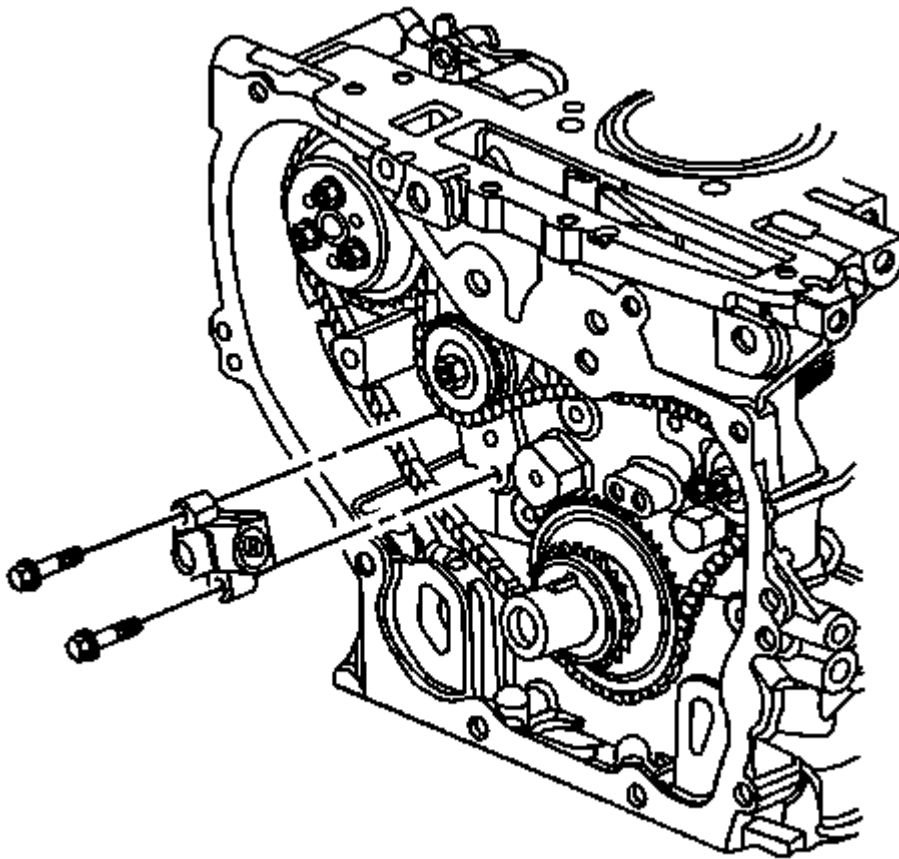


Fig. 133: Identifying Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Reset the timing chain tensioner by performing the following steps:
 1. Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 2. Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hose in the tensioner plunger.
8. Install the balance shaft drive chain tensioner and bolts and tighten to 10 N.m (89 lb in).
9. Remove the paper clip from the balance shaft drive chain tensioner.

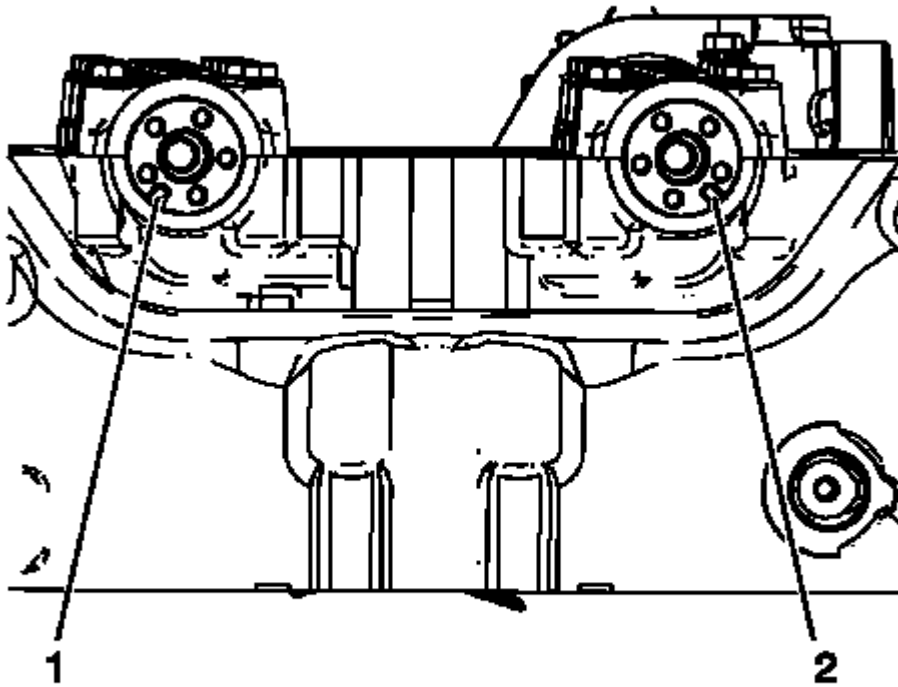


Fig. 134: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS CORP.

10. Ensure the intake camshaft notch is in the 5 o'clock position (2) and the exhaust camshaft notch is in the 7 o'clock position (1). The number 1 piston should be at top dead center (TDC), crankshaft key at 12 o'clock.

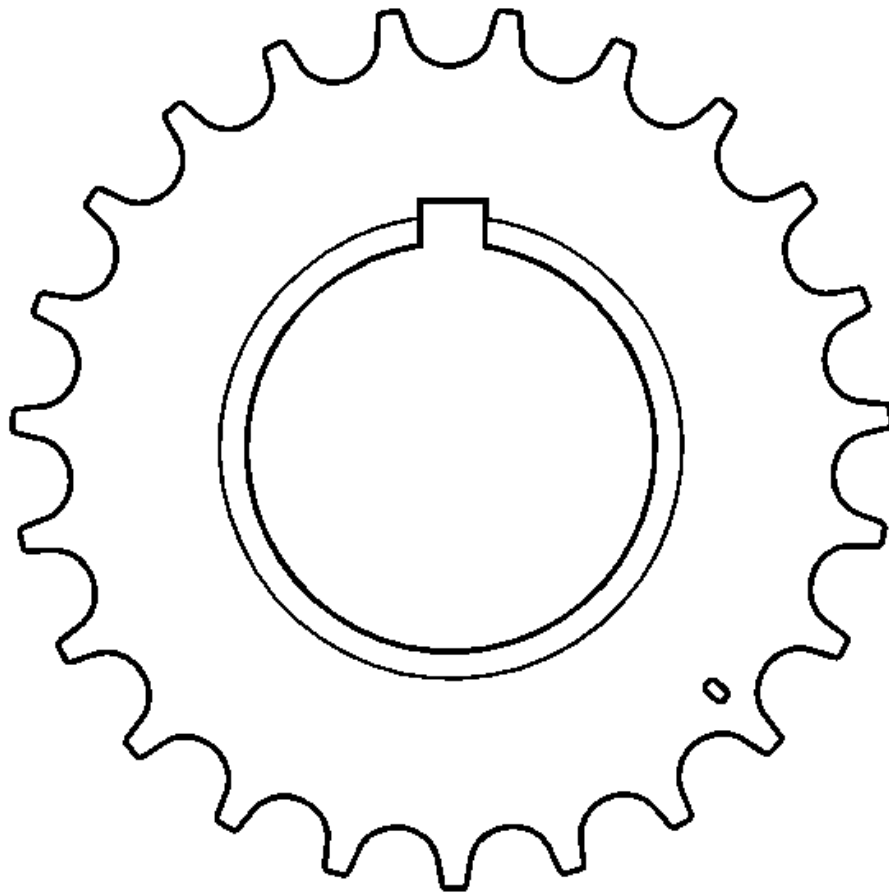


Fig. 135: View Of Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

11. Install the Friction Washer if equipped.
12. Install the timing chain drive sprocket to the crankshaft with the timing mark in the 5 o'clock position and the front of the sprocket facing out

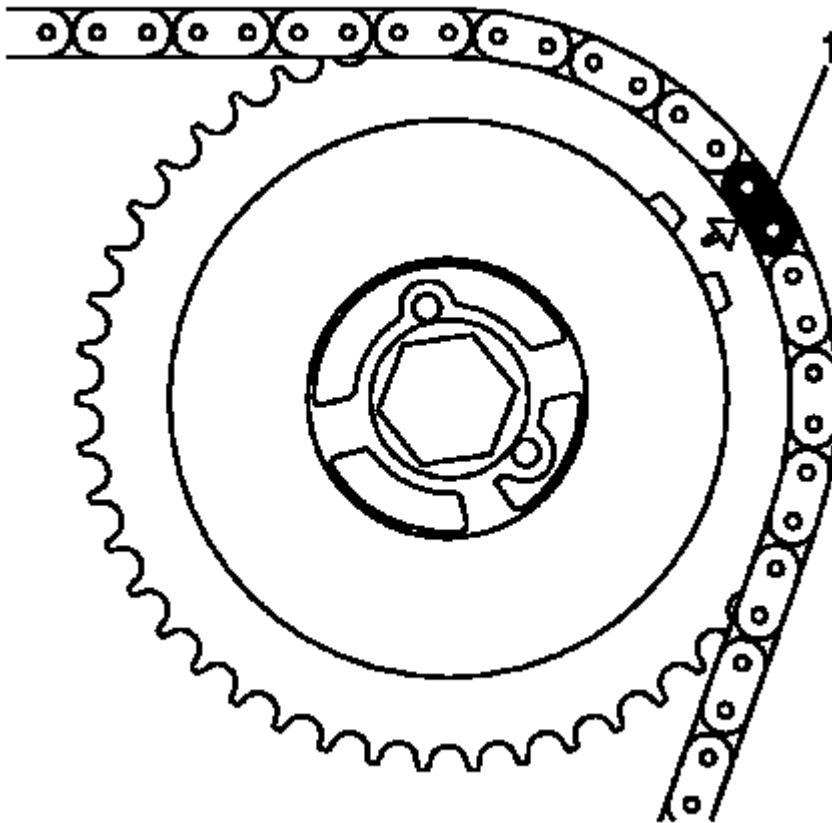


Fig. 136: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE:

- There are 3 colored links on the timing chain. Two links are of matching color, and 1 link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.
- Always use new actuator bolts.

13. Assemble the intake camshaft actuator into the timing chain with the timing mark lined up with the uniquely colored link (1).

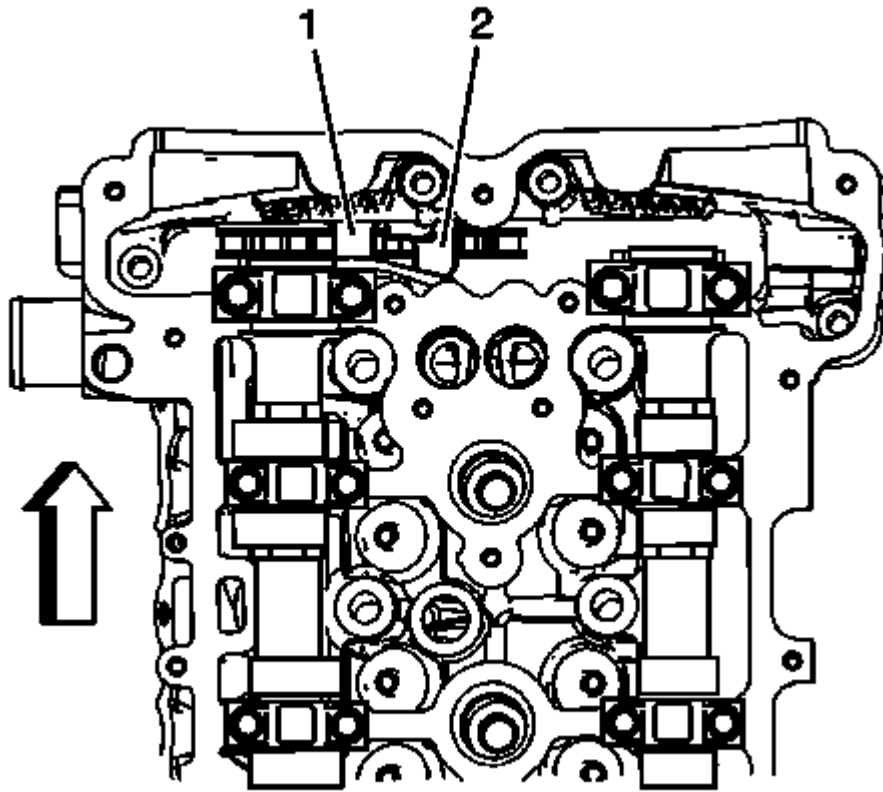


Fig. 137: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS CORP.

14. Lower the timing chain through the opening in the cylinder head. Use care to ensure that the chain goes around both sides of the cylinder block bosses (1, 2).
15. Install the intake camshaft actuator onto the intake camshaft while aligning the dowel pin into the camshaft slot.
16. Hand tighten the new intake camshaft actuator bolt.

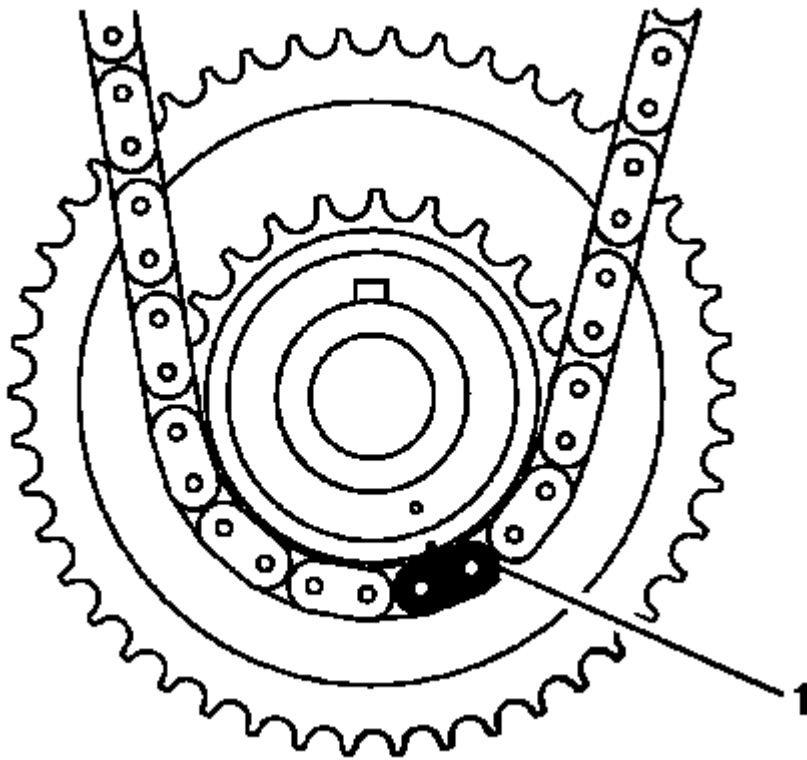


Fig. 138: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

17. Route the timing chain around the crankshaft sprocket and line up the first matching colored link with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.
18. Install the Friction Washer if equipped,

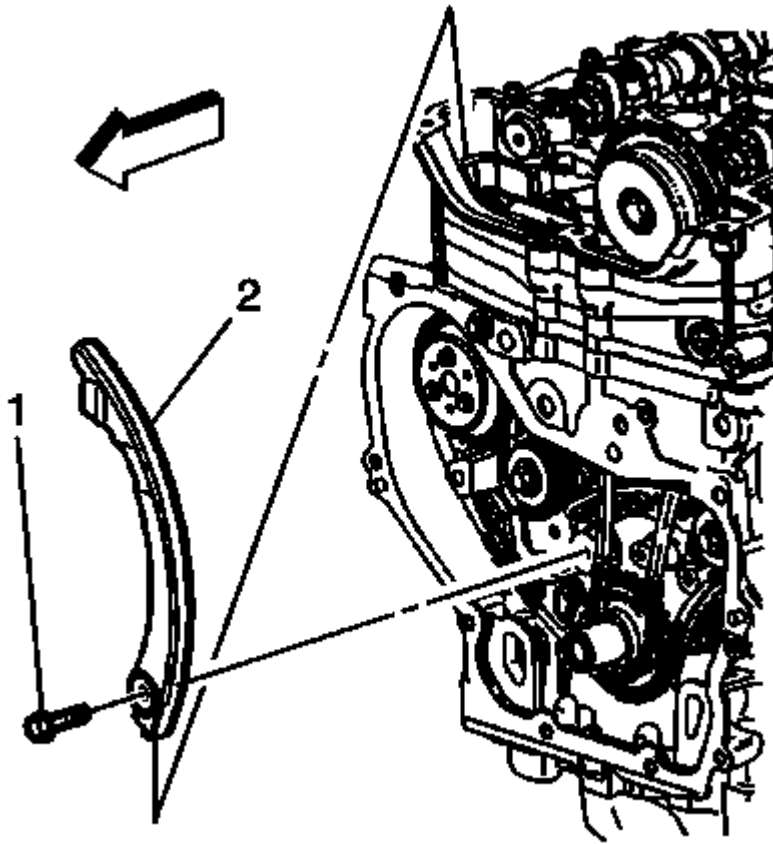


Fig. 139: Identifying Adjustable Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

19. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.
20. Install the adjustable timing chain guide down through the opening in the cylinder head and install the adjustable timing chain bolt. Tighten the bolt to 10 N.m (89 lb in).

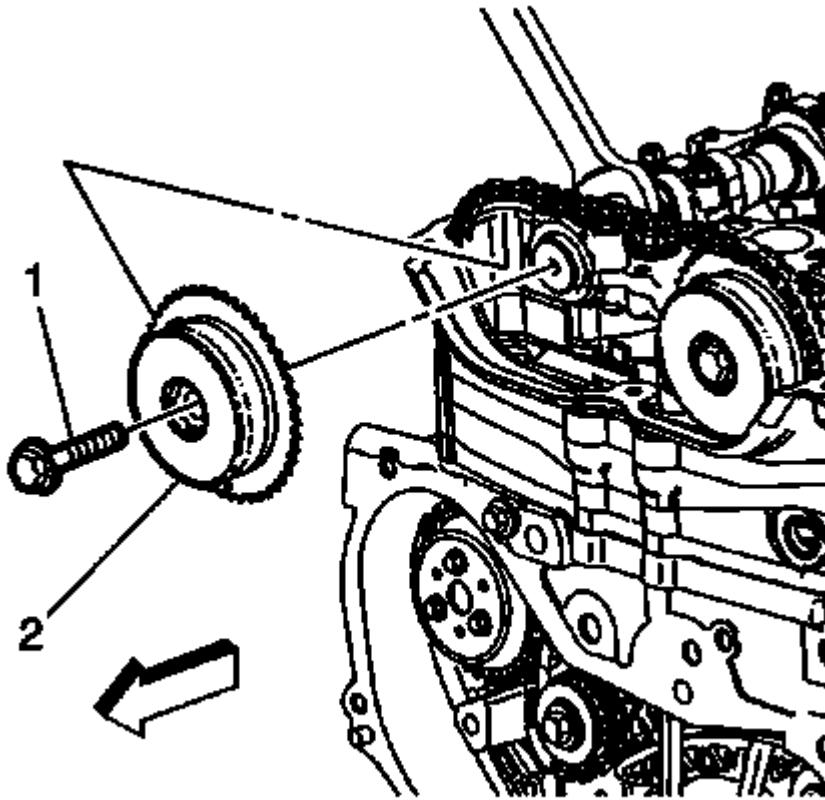


Fig. 140: View Of Exhaust Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

NOTE: Always install NEW actuator bolts.

21. Install the exhaust camshaft actuator into the timing chain with the timing mark lined up with the second matching colored link.

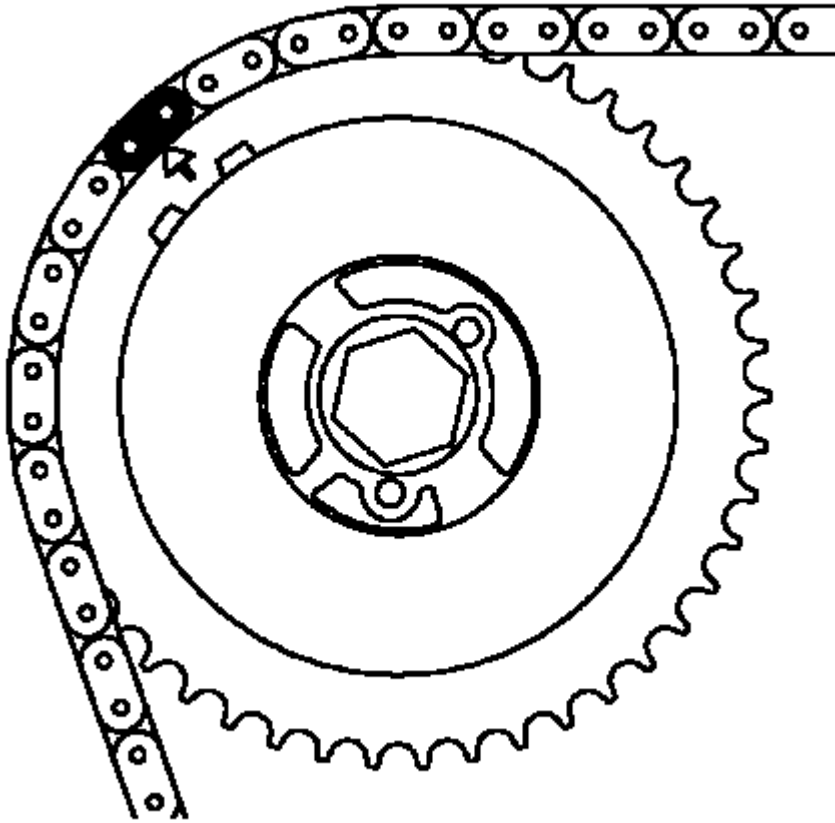


Fig. 141: Aligning Timing Mark On Actuator With Last Pink Colored Link
Courtesy of GENERAL MOTORS CORP.

22. Install the exhaust camshaft actuator onto the exhaust camshaft, aligning the dowel pin into the camshaft slot.
23. Using a 23 mm open end wrench, rotate the exhaust camshaft approximately 45 degrees until the dowel pin in the camshaft actuator goes into the camshaft slot.

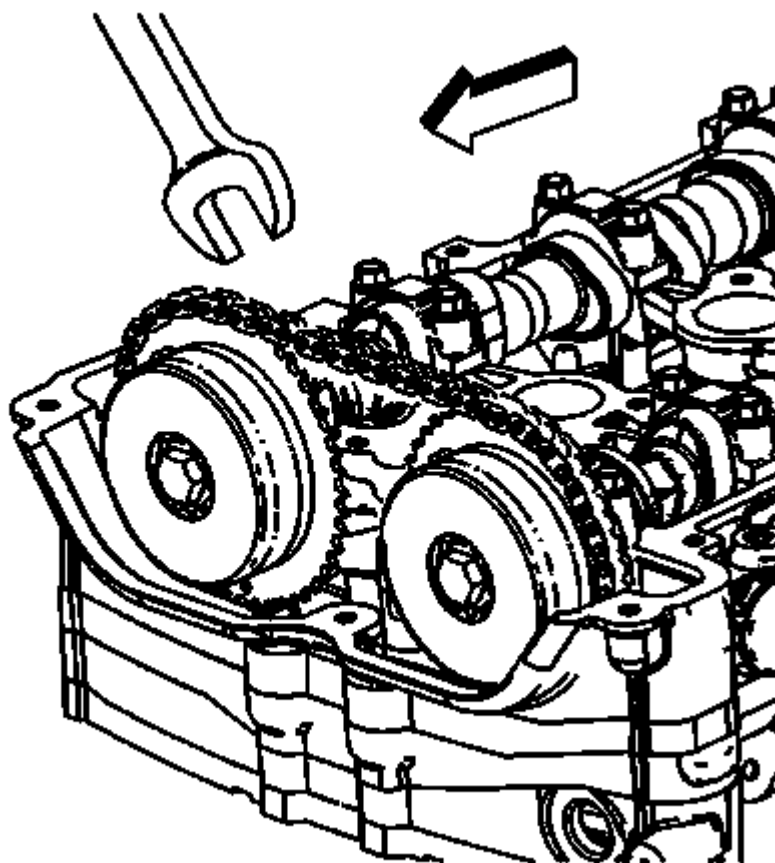


Fig. 142: Identifying Cam Actuator, Camshaft & Chain
Courtesy of GENERAL MOTORS CORP.

24. When the actuator seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.

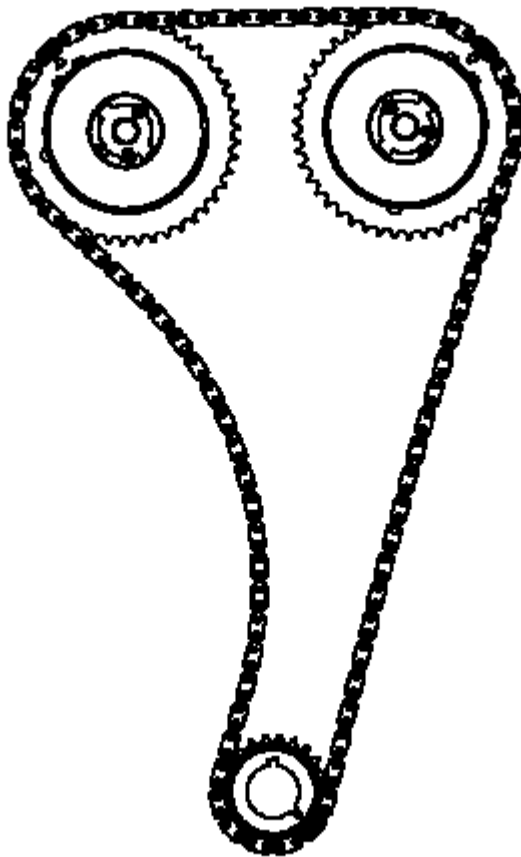


Fig. 143: Identifying Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

25. Verify that all of the colored links and the appropriate timing marks are still aligned. If they are not aligned, repeat the portion of the procedure necessary to align the timing marks.

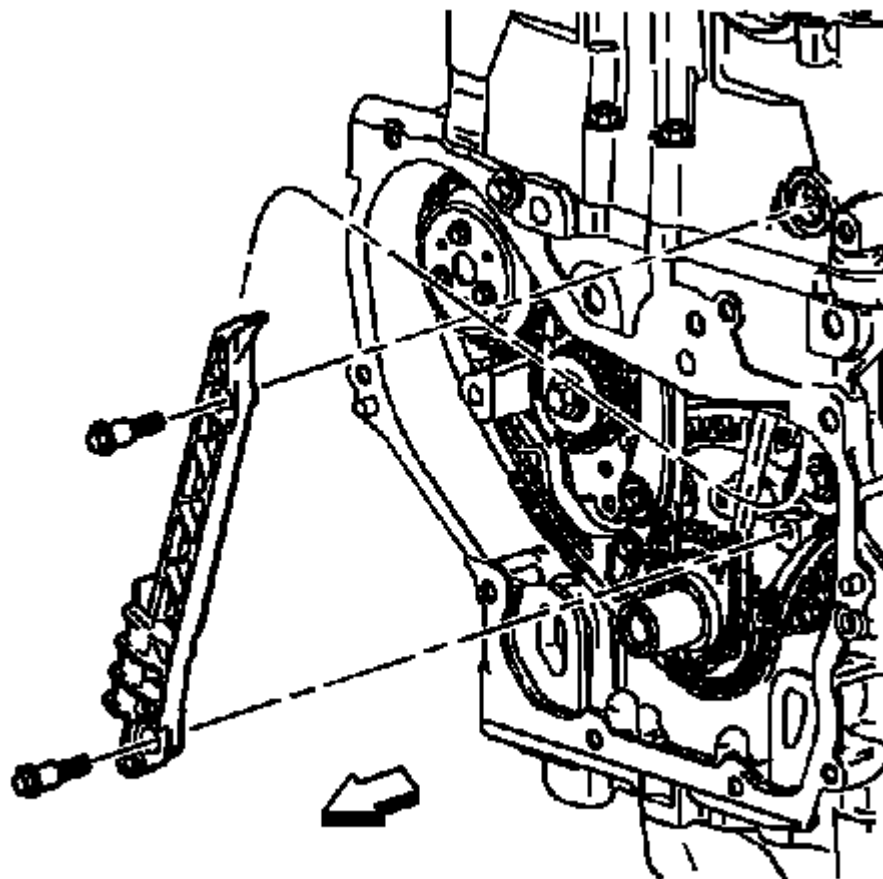


Fig. 144: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

26. Install the fixed timing chain guide and bolts and tighten to 12 N.m (106 lb in).

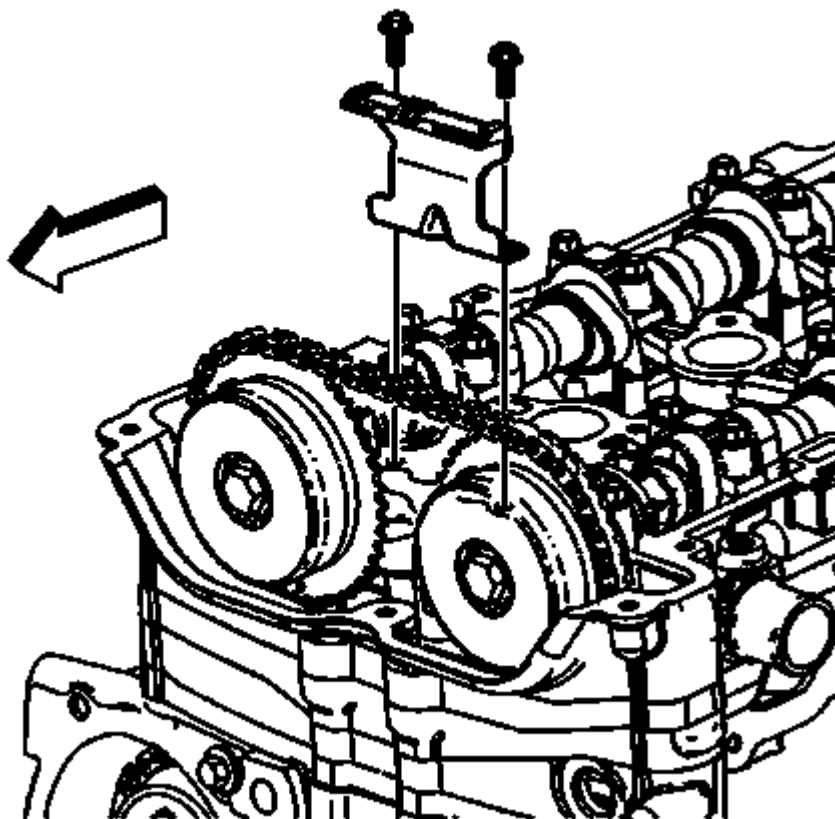


Fig. 145: View Of Upper Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

27. Install the upper timing chain guide and bolts and tighten to 10 N.m (89 lb in).

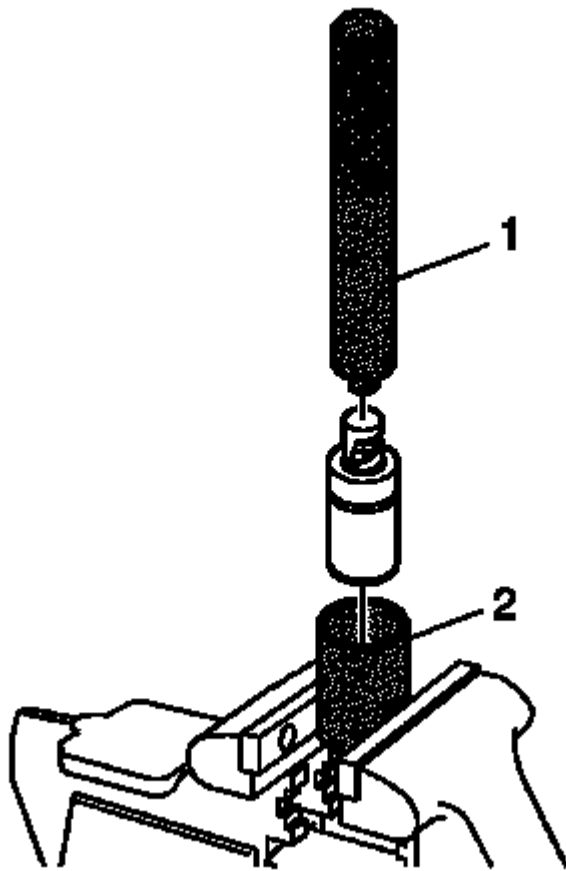


Fig. 146: View Of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

28. Reset the timing chain tensioner by performing the following steps:
1. Remove the snap ring.
 2. Remove the piston assembly from the body of the timing chain tensioner.
 3. Install the J 45027-2 (2) into a vise.
 4. Install the notch end of the piston assembly into the J 45027-2 (2).
 5. Using the J 45027-1 (1), turn the ratchet cylinder into the piston.
 6. Reinstall the piston assembly into the body of the tensioner.
 7. Install the snap ring.

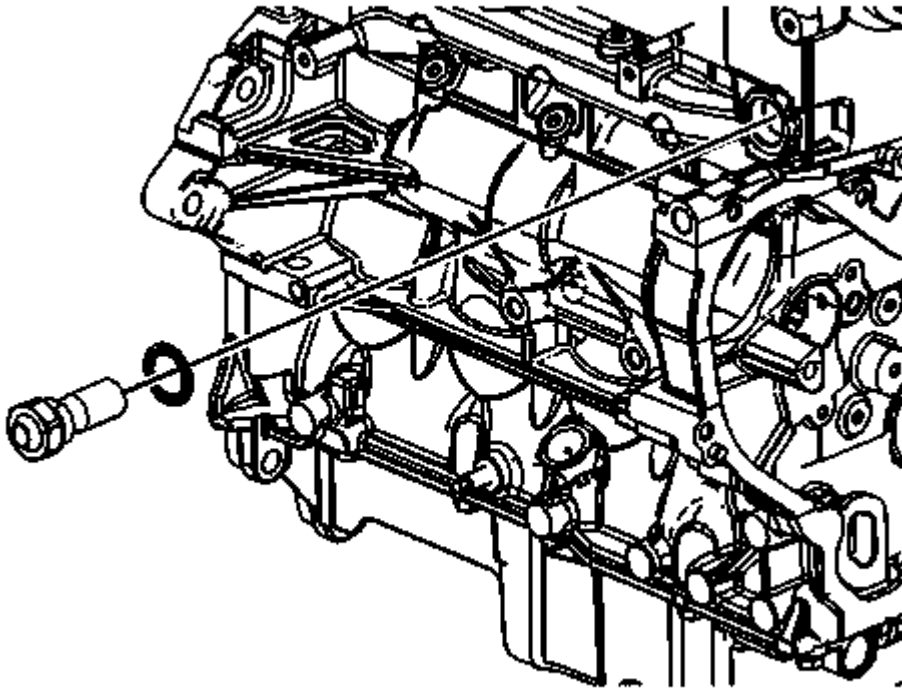


Fig. 147: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

29. Inspect the timing chain tensioner seal for damage. If damaged, replace the seal.
30. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

NOTE: **Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.**

31. Install the timing chain tensioner assembly.

Tighten the timing chain tensioner to 75 N.m (55 lb ft).

32. The timing chain tensioner is released by compressing it 2 mm (0.079 in), which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

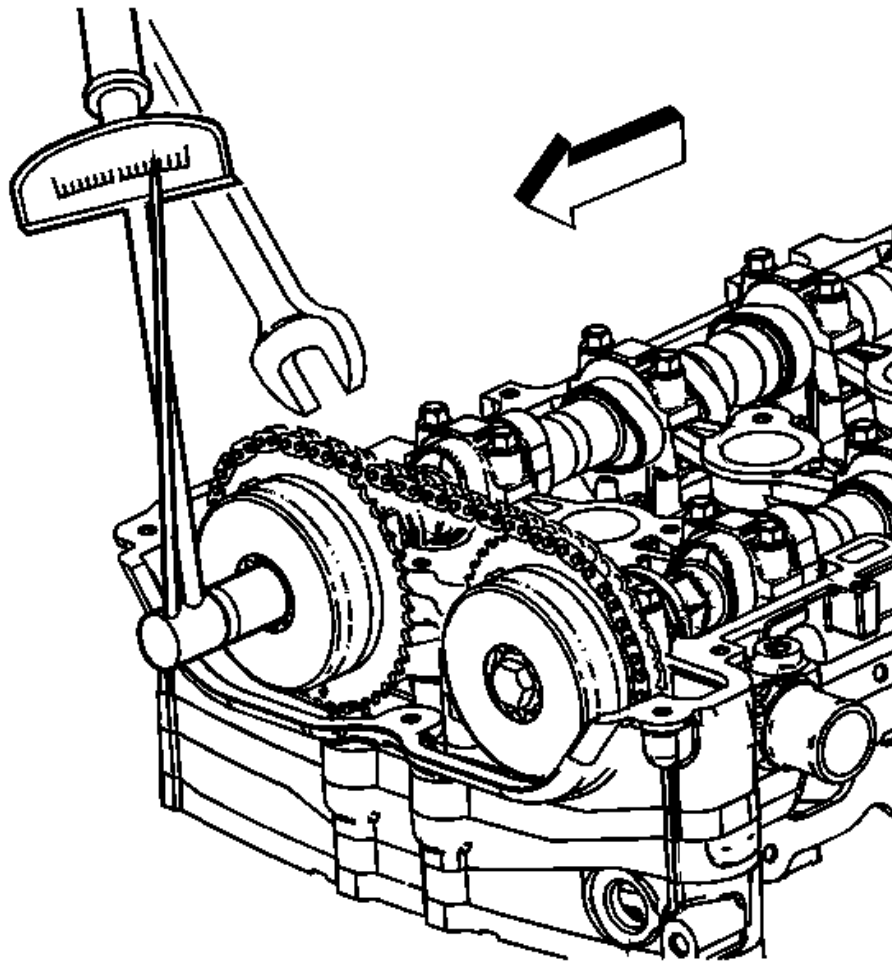


Fig. 148: View Of Tightening Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

33. Using a 23 mm wrench, engage the hex on the intake camshaft, and using a torque wrench, tighten the camshaft actuator bolt to 30 N.m (22 lb ft) plus 100 degrees using the **J 45059**.
34. Using a 23 mm wrench, engage the hex on the exhaust camshaft, and using a torque wrench, tighten the camshaft actuator bolt to 30 N.m (22 lb ft) plus 100 degrees using the **J 45059**.

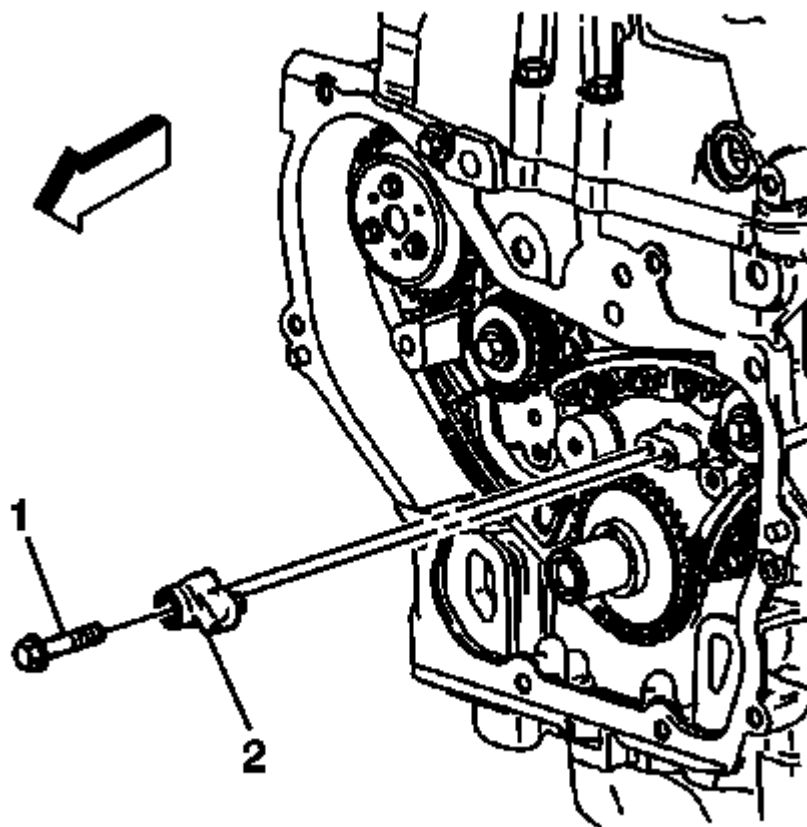


Fig. 149: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS CORP.

35. Install the timing chain oiling nozzle.

Tighten the timing chain oiling nozzle bolt to 10 N.m (89 lb in).

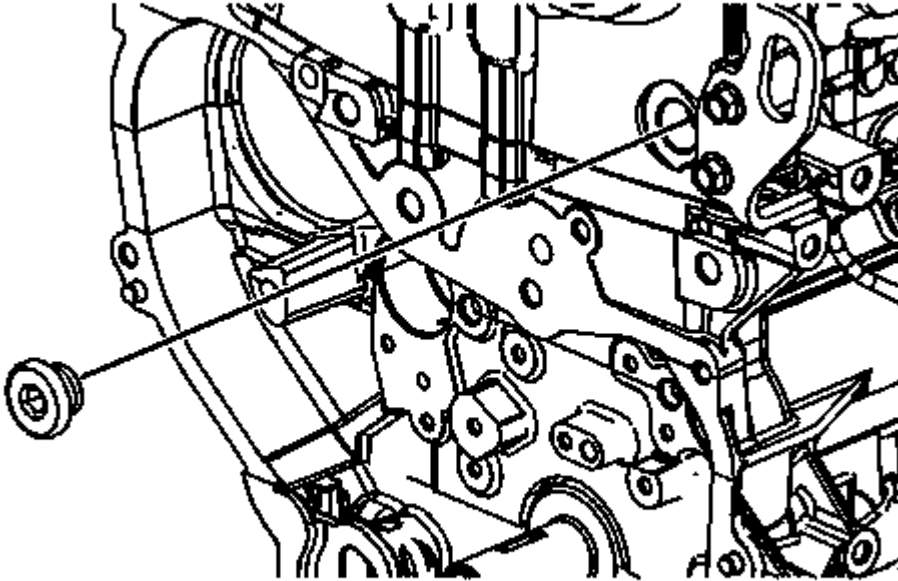


Fig. 150: View Of Timing Chain Guide Bolt Access Hole & Plug
Courtesy of GENERAL MOTORS CORP.

36. Apply sealer to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.
37. Install the timing chain guide bolt access hole plug and tighten to 90 N.m (66 lb ft).
38. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
39. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
40. Install the #1 cylinder spark plug. Refer to **Spark Plug Replacement**.
41. Install the hood. Refer to **Hood Replacement**.

BALANCE SHAFT REPLACEMENT - RIGHT SIDE

SPECIAL TOOLS

J 43650 Balance Shaft Bearing Remover and Installer. See **Special Tools**.

REMOVAL PROCEDURE

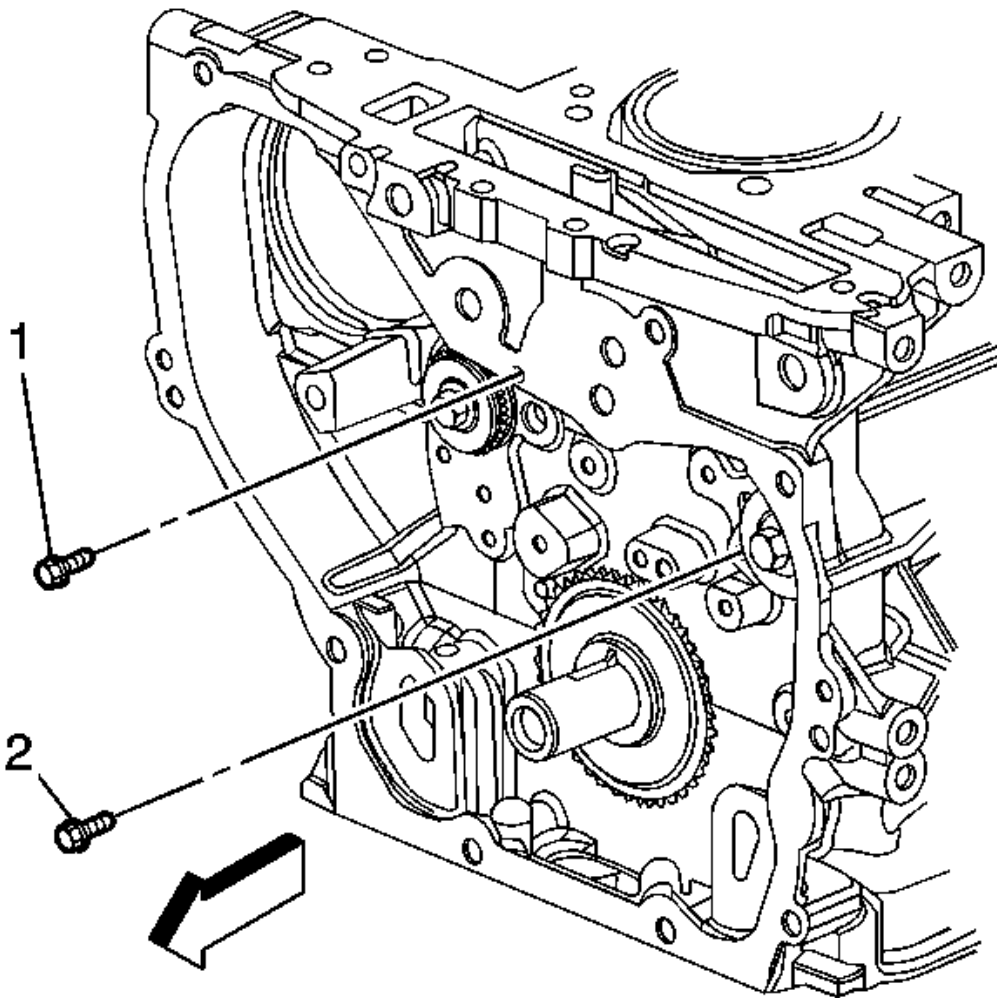


Fig. 151: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the radiator. Refer to **Radiator Replacement** .
2. Remove the condenser. Refer to **Air Conditioning Condenser Replacement** .
3. Remove the timing chain, sprocket and tensioner. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

NOTE: **DO NOT** remove the bolt holding the sprocket.

4. Remove the right intake balance shaft bolt (1).

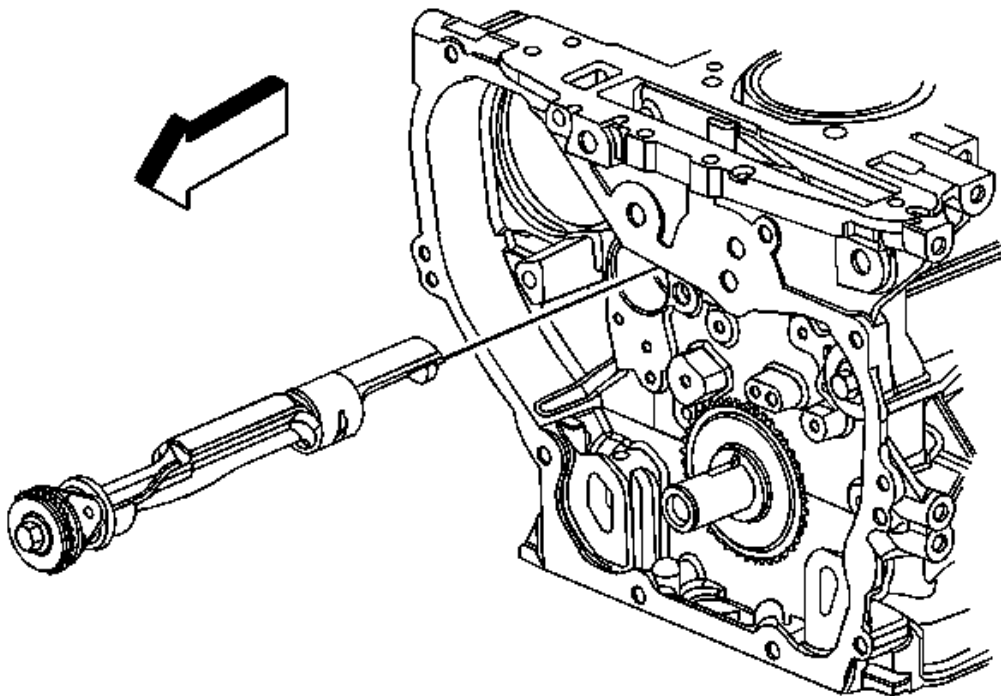


Fig. 152: View Of Right Intake Balance Shaft
Courtesy of GENERAL MOTORS CORP.

5. Remove the right intake balance shaft.

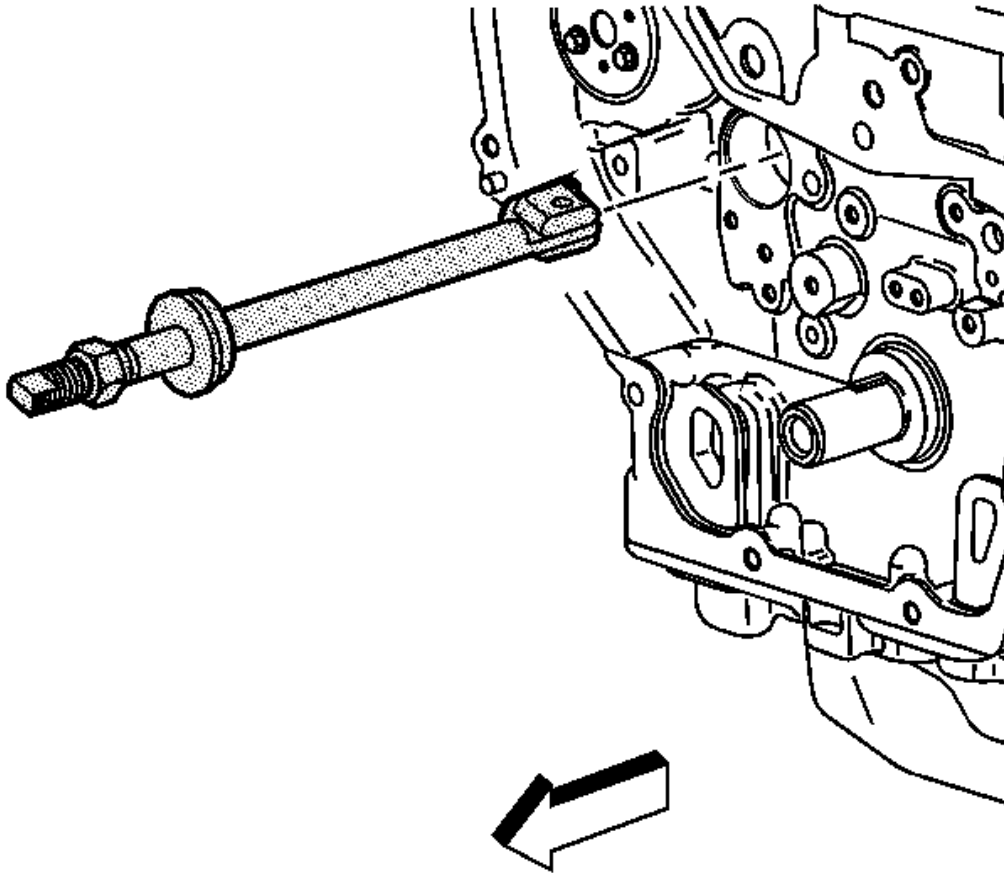


Fig. 153: View Of Balance Shaft Bearing Remover & Installer
Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper centering of the tool is required on the balance shaft bushing. If the tool is not properly centered then damage to the bearing bore and block will occur.

6. Install the **J 43650** into the balance shaft hole. See **Special Tools** . Insert the tool with the foot parallel to the shaft.

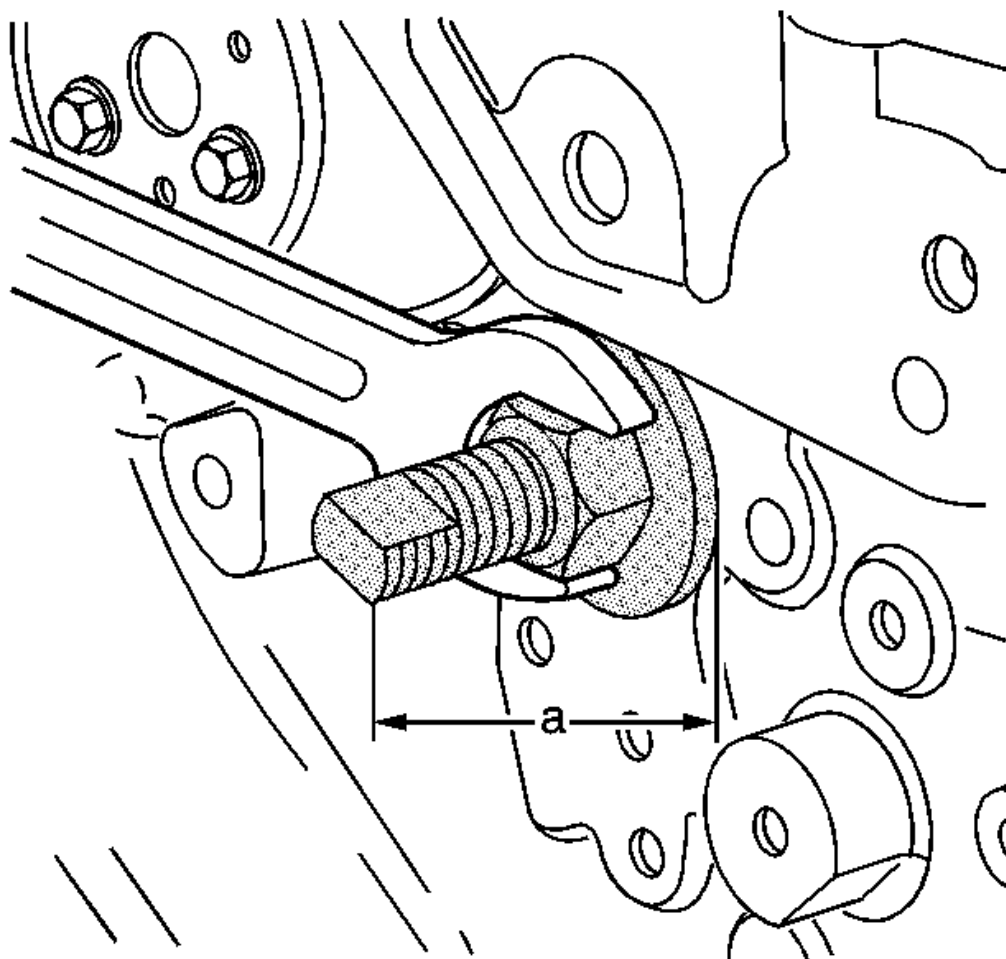


Fig. 154: View of Correct Angle of Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

7. When the **J 43650** is inserted in the block, turn the **J 43650** so that the foot becomes perpendicular to the shaft. See **Special Tools** .
8. Center the foot of the **J 43650** on the balance shaft bushing. See **Special Tools** .
9. Once the **J 43650** is centered on the balance shaft bushing, then insert the centering guide into the front balance shaft bore and tighten the nut with an appropriate wrench. See **Special Tools** .

When the **J 43650** is properly installed, before removing the bushing, the end of the tool should be 116 mm (4.6 in) (a) from the block face.

If the **J 43650** is less than approximately 114 mm (4.5 in) (a), recheck the tool alignment.

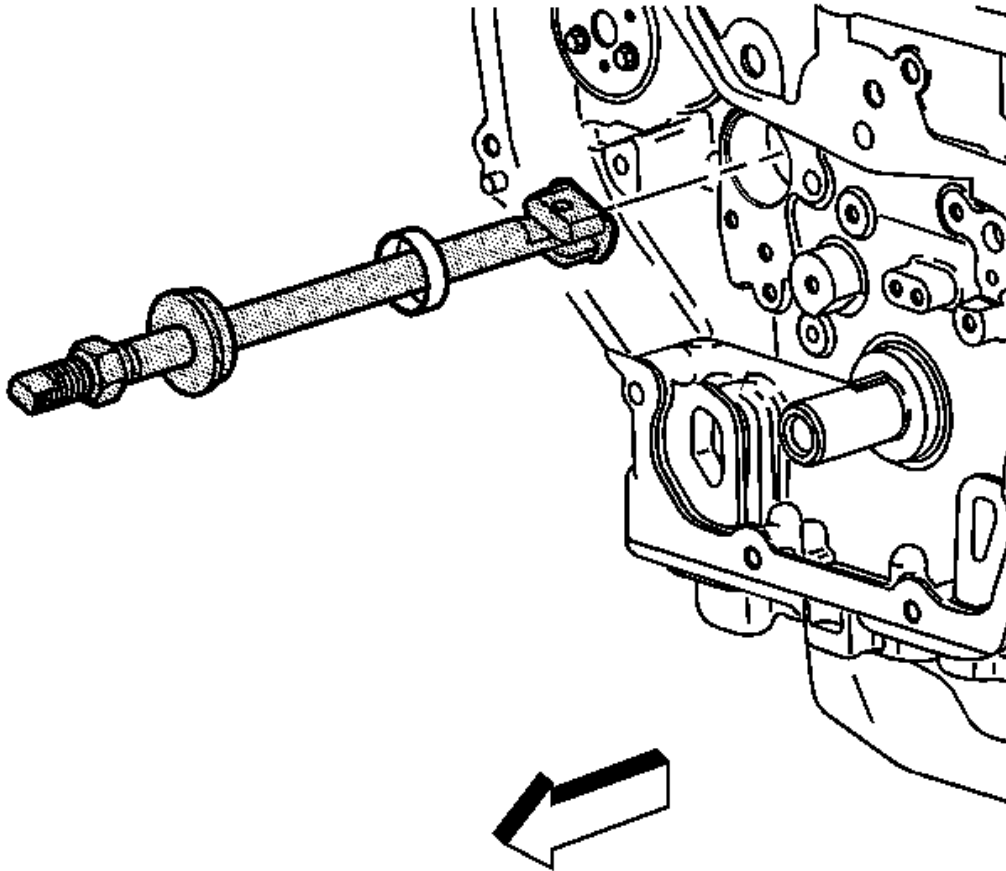


Fig. 155: Using Special Tool J 43650 To Remove Balance Shaft Bushing
 Courtesy of GENERAL MOTORS CORP.

10. Tighten the nut on the **J 43650** until the tension releases. See **Special Tools** . When the tension releases, remove the **J 43650** and the balance shaft bushing.

INSTALLATION PROCEDURE

NOTE: Service the balance shaft as an assembly. **DO NOT** disassemble or assemble the balance shaft.

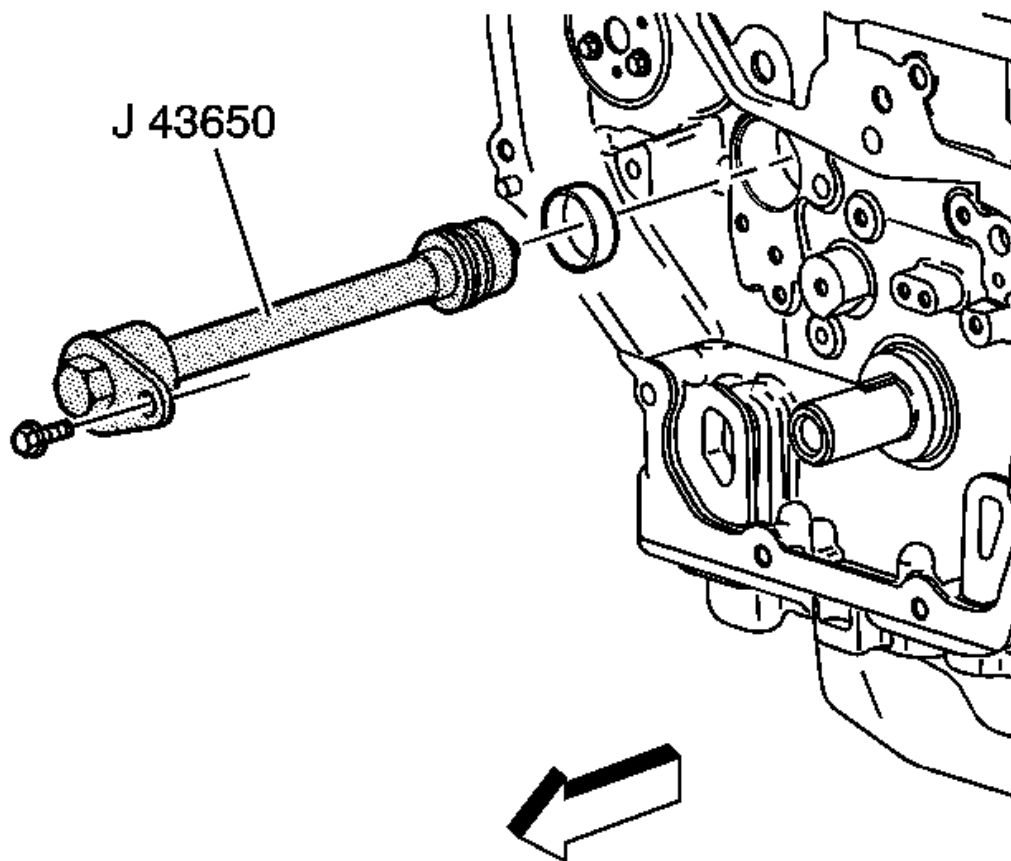


Fig. 156: View of Balance Shaft & Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

1. Install the balance shaft bushing using the **J 43650** . See **Special Tools** .

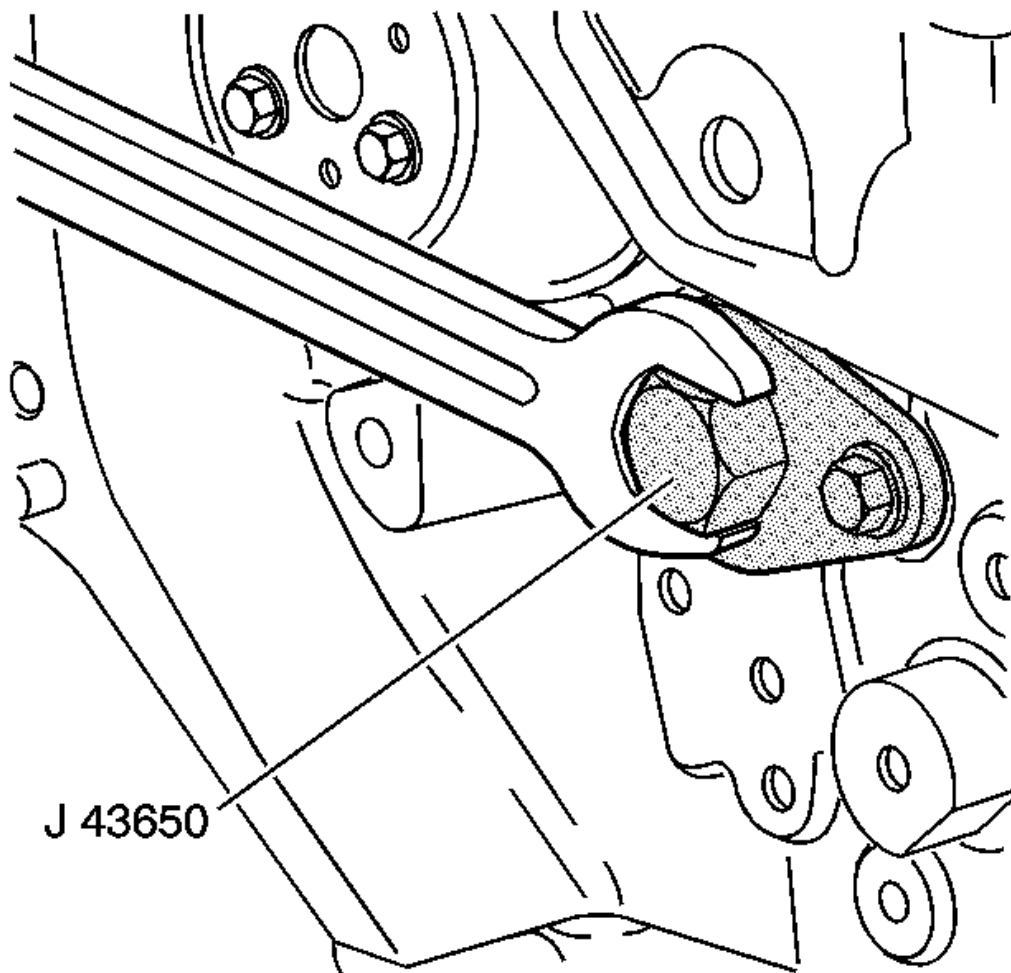


Fig. 157: Seating Balance Shaft Bushing Into Bore
Courtesy of GENERAL MOTORS CORP.

2. Seat the balance shaft bushing into the bore using the **J 43650** and a wrench. See **Special Tools**.
3. When the **J 43650** is fully seated in the engine block, remove it with a wrench.

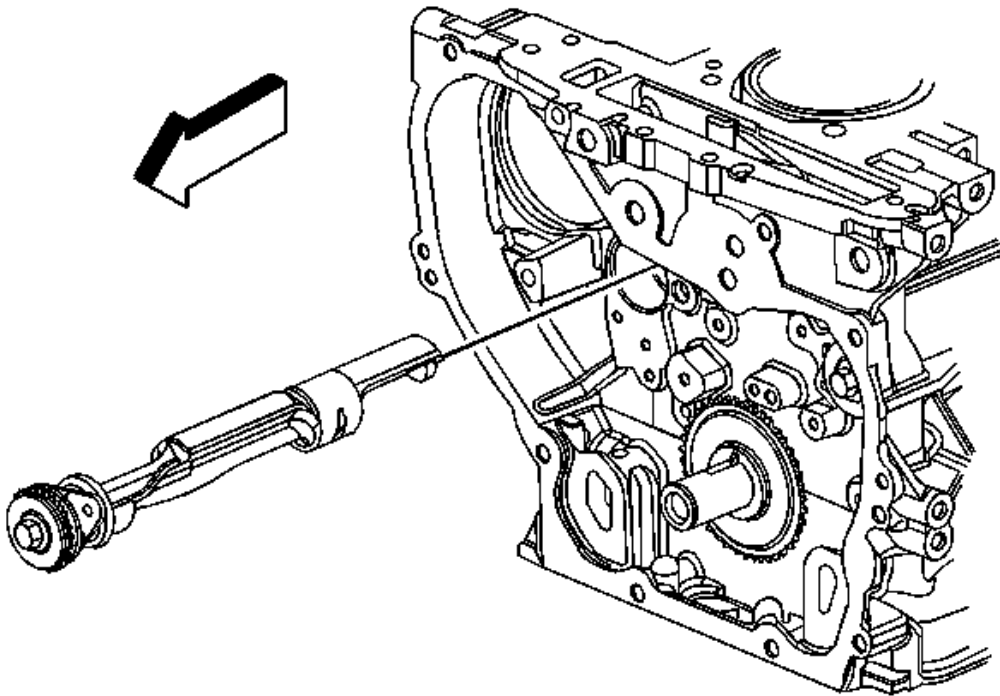


Fig. 158: View Of Right Intake Balance Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.**

4. Install the balance shaft to the engine using the following steps:
 1. Place the number one cylinder at top dead center (TDC).
 2. Lubricate the balance shaft lobes with engine oil.
 3. Install the right intake balance shaft.

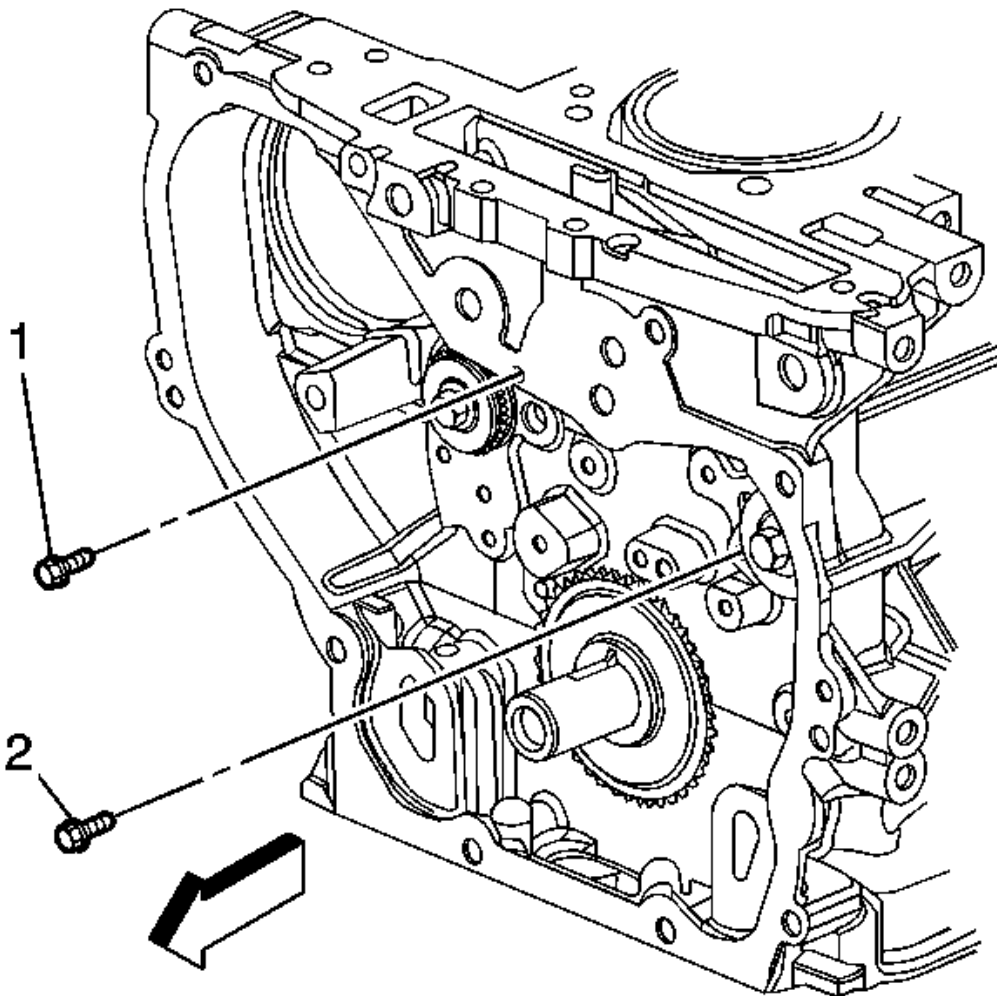


Fig. 159: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Install the right intake balance shaft bolt (1) and tighten to 10 N.m (89 lb in).
6. Install the timing chain, sprocket and tensioner. Refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.
7. Install the condenser. Refer to Air Conditioning Condenser Replacement .
8. Install the radiator. Refer to Radiator Replacement .

BALANCE SHAFT REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

J 43650 Balance Shaft Bearing Remover and Installer. See Special Tools .

REMOVAL PROCEDURE

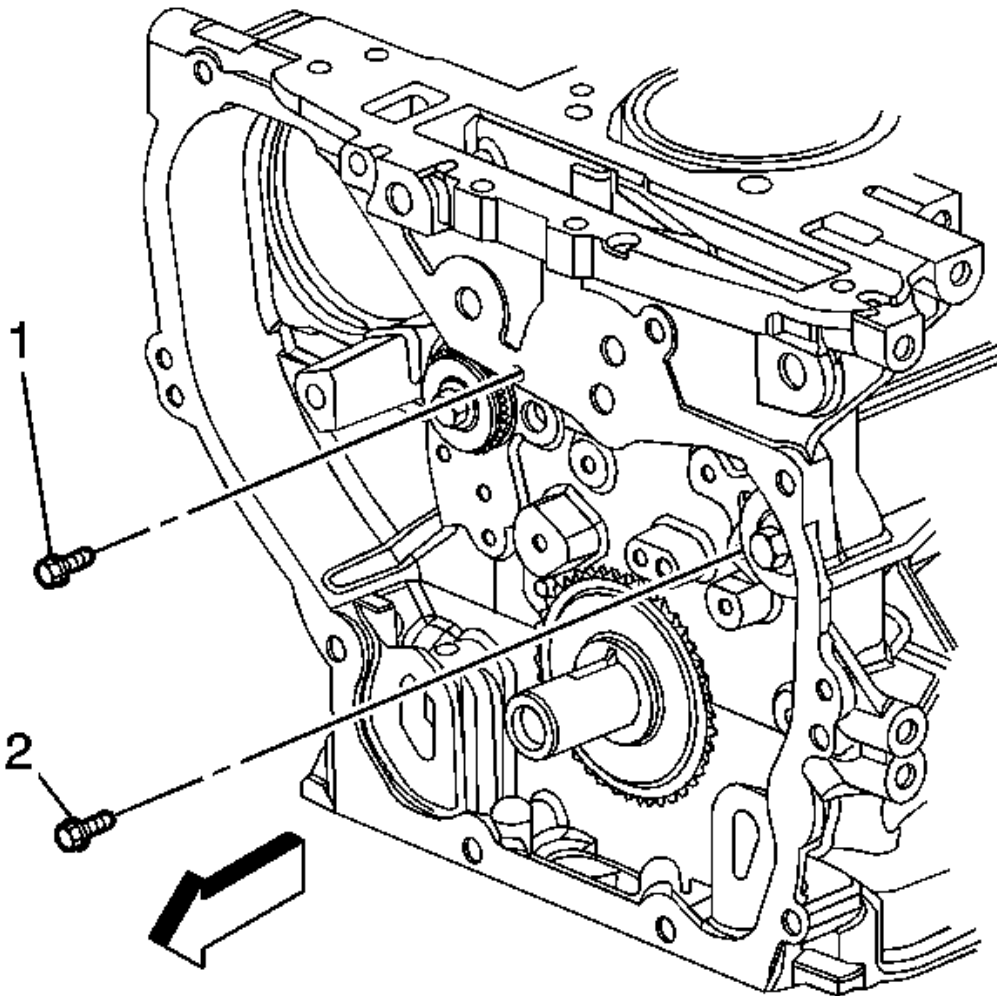


Fig. 160: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the radiator. Refer to Radiator Replacement .

2. Remove the condenser. Refer to [Air Conditioning Condenser Replacement](#) .
3. Remove the timing chain, sprocket and tensioner. Refer to [Camshaft Timing Chain, Sprocket, and Tensioner Replacement](#).

NOTE: **DO NOT** remove the bolt holding the sprocket.

4. Remove the left exhaust balance shaft bolt (2).

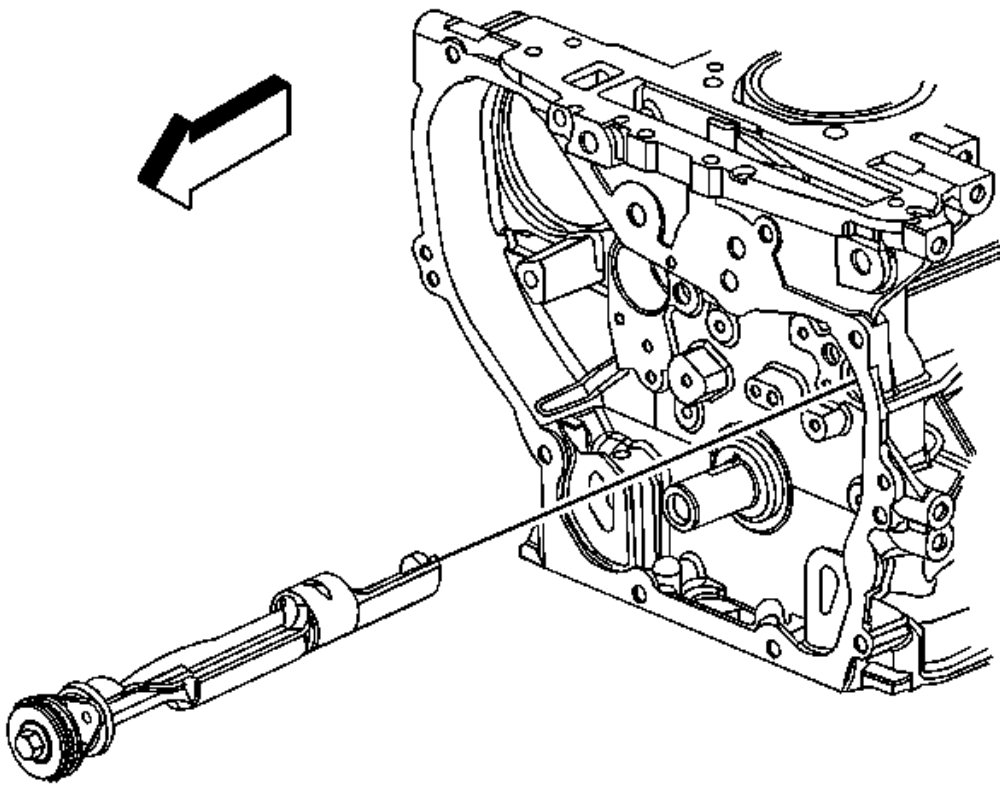


Fig. 161: View Of Left (Exhaust) Balance Shaft
Courtesy of GENERAL MOTORS CORP.

5. Remove the left exhaust balance shaft.

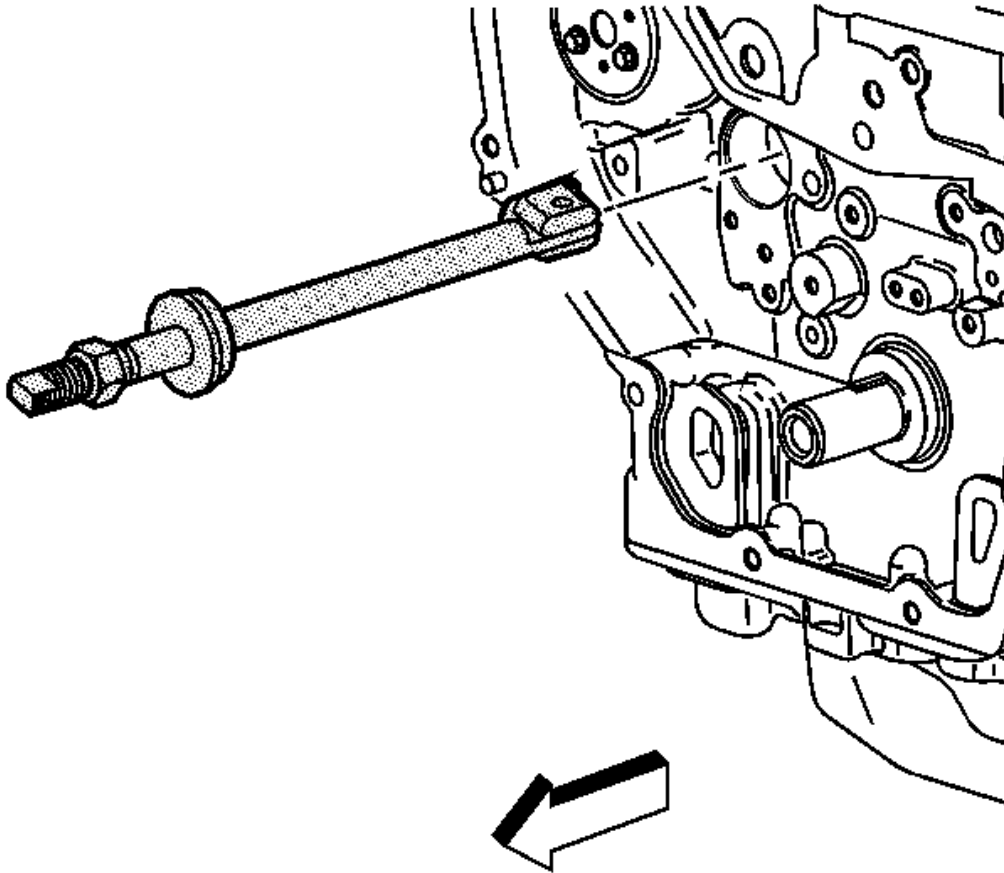


Fig. 162: View Of Balance Shaft Bearing Remover & Installer
Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper centering of the tool is required on the balance shaft bushing. If the tool is not properly centered then damage to the bearing bore and block will occur.

6. Install the **J 43650** into the balance shaft hole. See **Special Tools** . Insert the tool with the foot parallel to the shaft, (right side shown, left side similar).

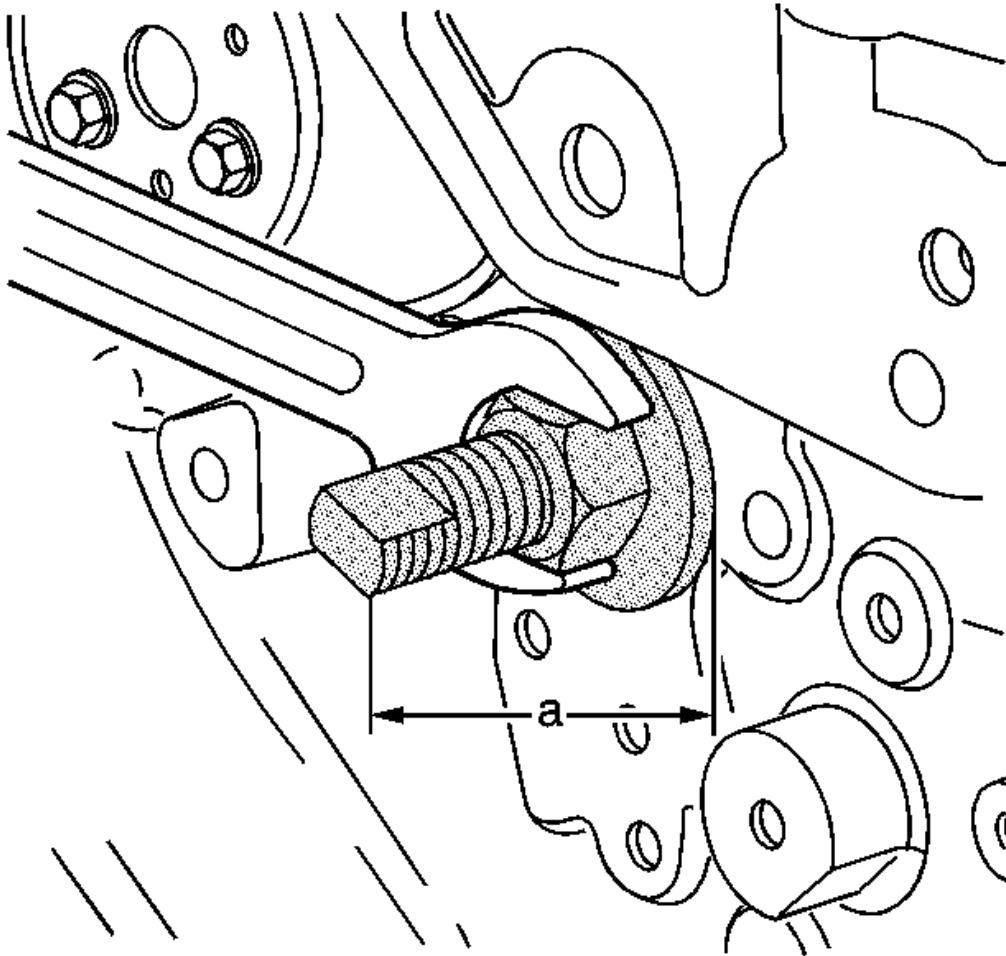


Fig. 163: View of Correct Angle of Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

7. When the **J 43650** is inserted in the block, turn the **J 43650** so that the foot becomes perpendicular to the shaft.
8. Center the foot of the **J 43650** on the balance shaft bushing.
9. Once the **J 43650** is centered on the balance shaft bushing, then insert the centering guide into the front balance shaft bore and tighten the nut with an appropriate wrench. See **Special Tools** .

When the **J 43650** is properly installed, before removing the bushing, the end of the tool should be 116 mm (4.6 in) (a) from the block face.

If the **J 43650** is less than approximately 114 mm (4.5 in) (a), recheck the tool alignment.

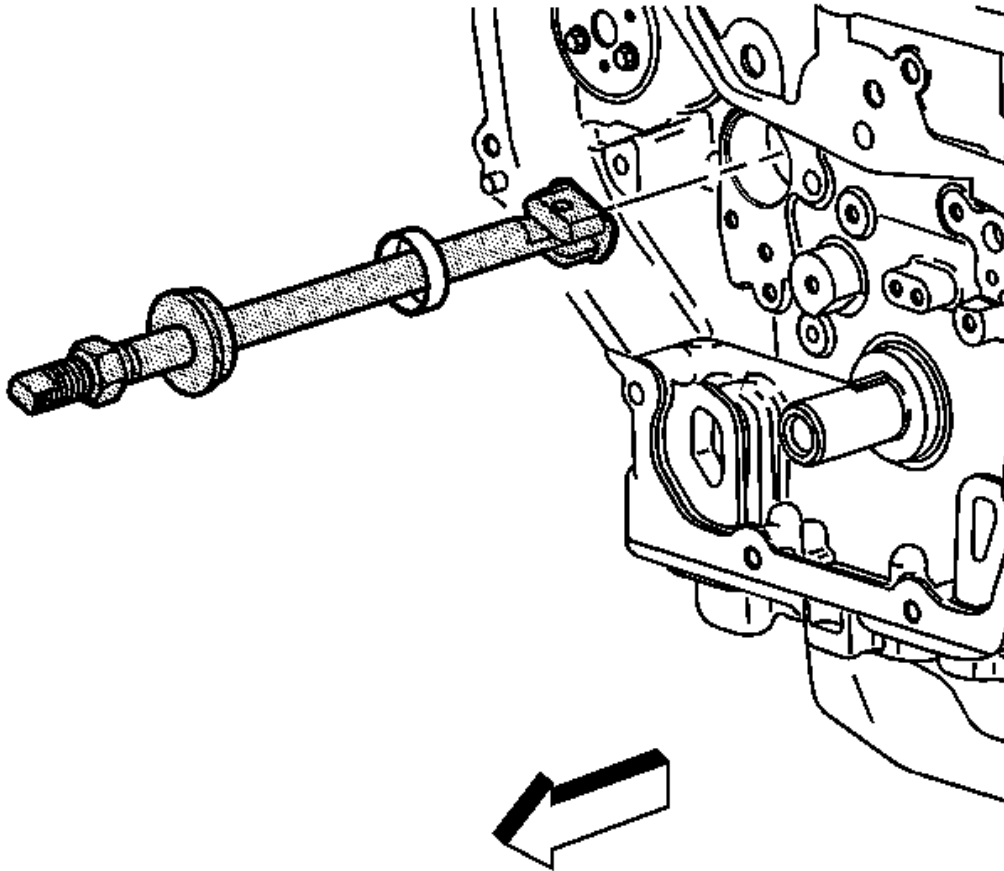


Fig. 164: Using Special Tool J 43650 To Remove Balance Shaft Bushing
Courtesy of GENERAL MOTORS CORP.

10. Tighten the nut on the **J 43650** until the tension releases. See **Special Tools** . When the tension releases, remove the **J 43650** and the balance shaft bushing, (right side shown, left side similar).

INSTALLATION PROCEDURE

NOTE: Service the balance shaft as an assembly. **DO NOT** disassemble or assemble the balance shaft.

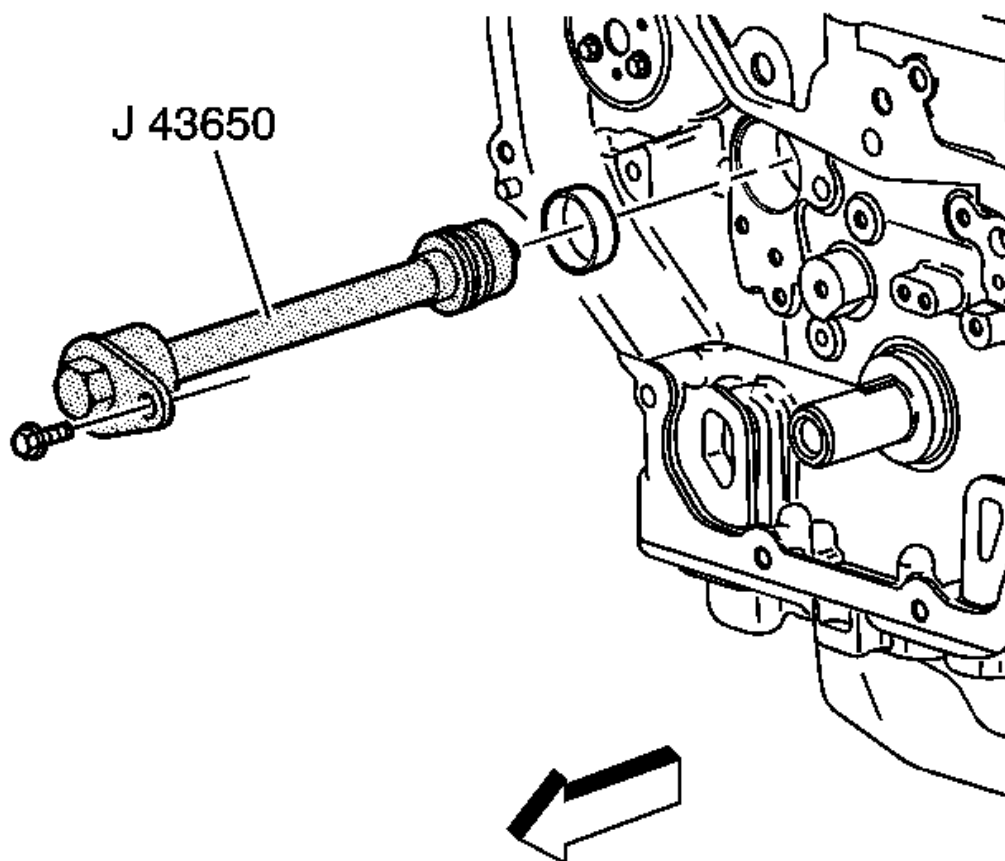


Fig. 165: View of Balance Shaft & Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

1. Install the balance shaft bushing using the **J 43650** , (right side shown, left side similar). See **Special Tools** .

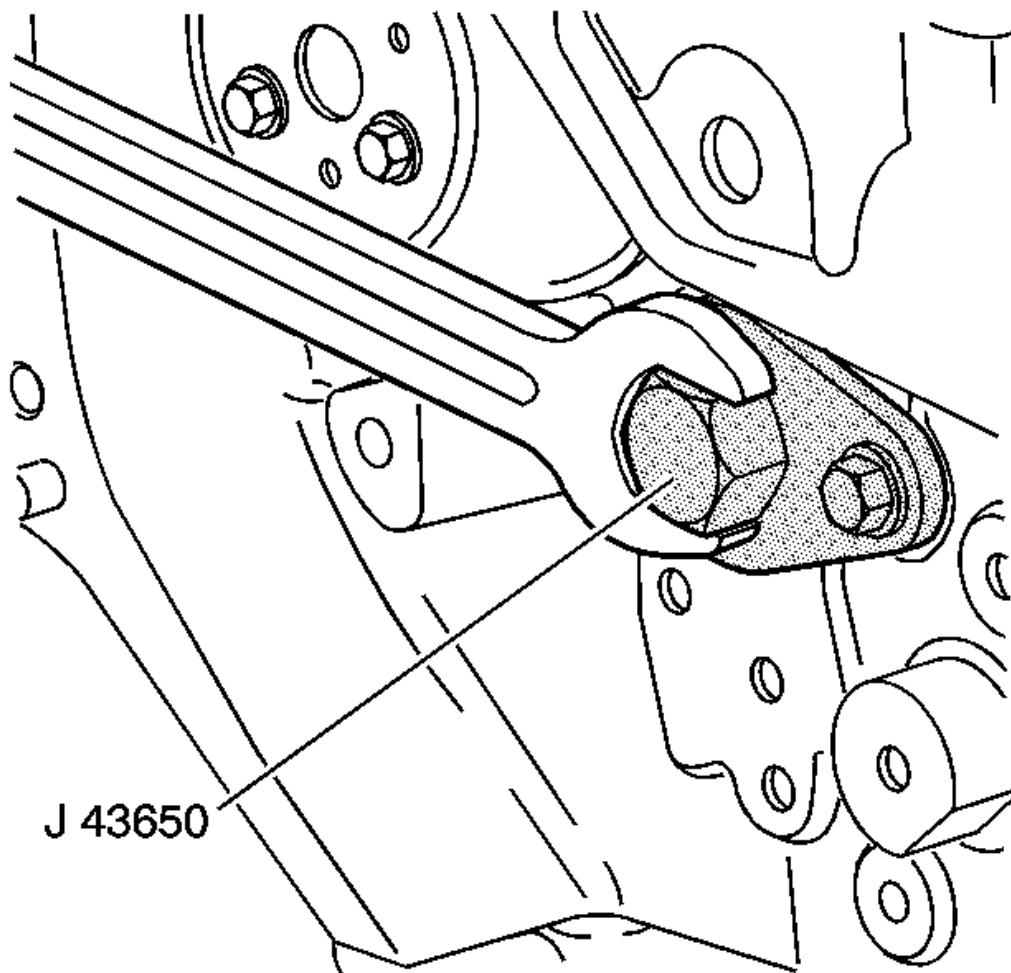


Fig. 166: Seating Balance Shaft Bushing Into Bore
Courtesy of GENERAL MOTORS CORP.

2. Seat the balance shaft bushing into the bore using the **J 43650** and a wrench.
3. When the **J 43650** is fully seated in the engine block, remove it with a wrench.

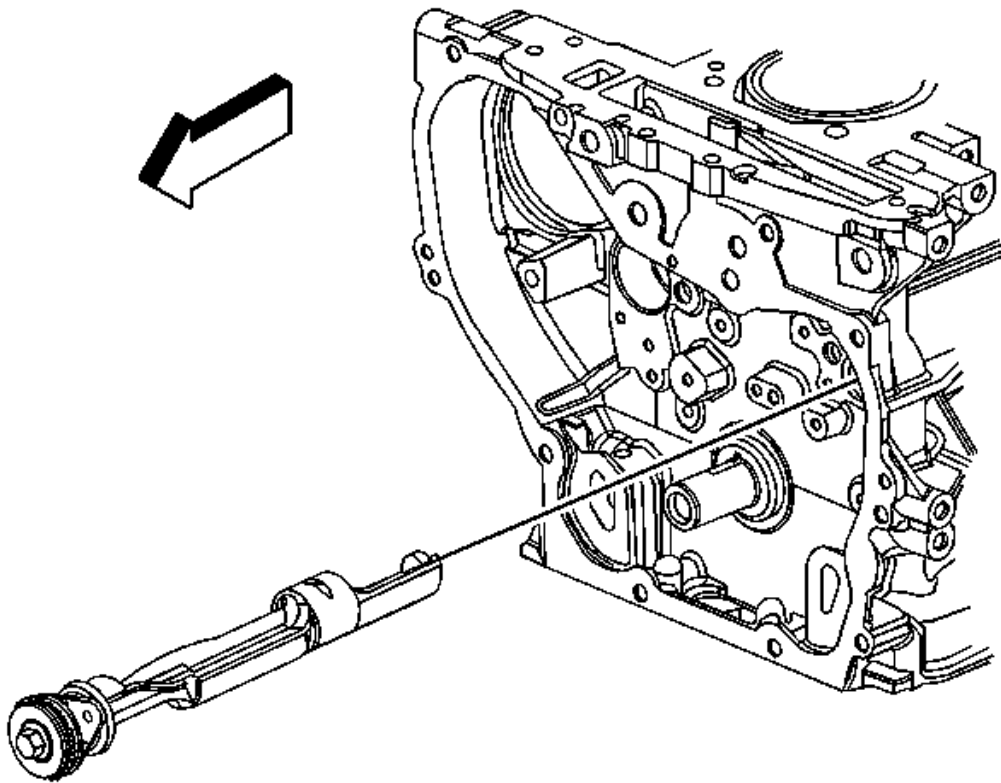


Fig. 167: View Of Left (Exhaust) Balance Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.

4. Install the balance shaft to the engine using the following steps:
 1. Place the number one cylinder at top dead center (TDC).
 2. Lubricate the balance shaft lobes with engine oil.
 3. Install the left exhaust balance shaft.

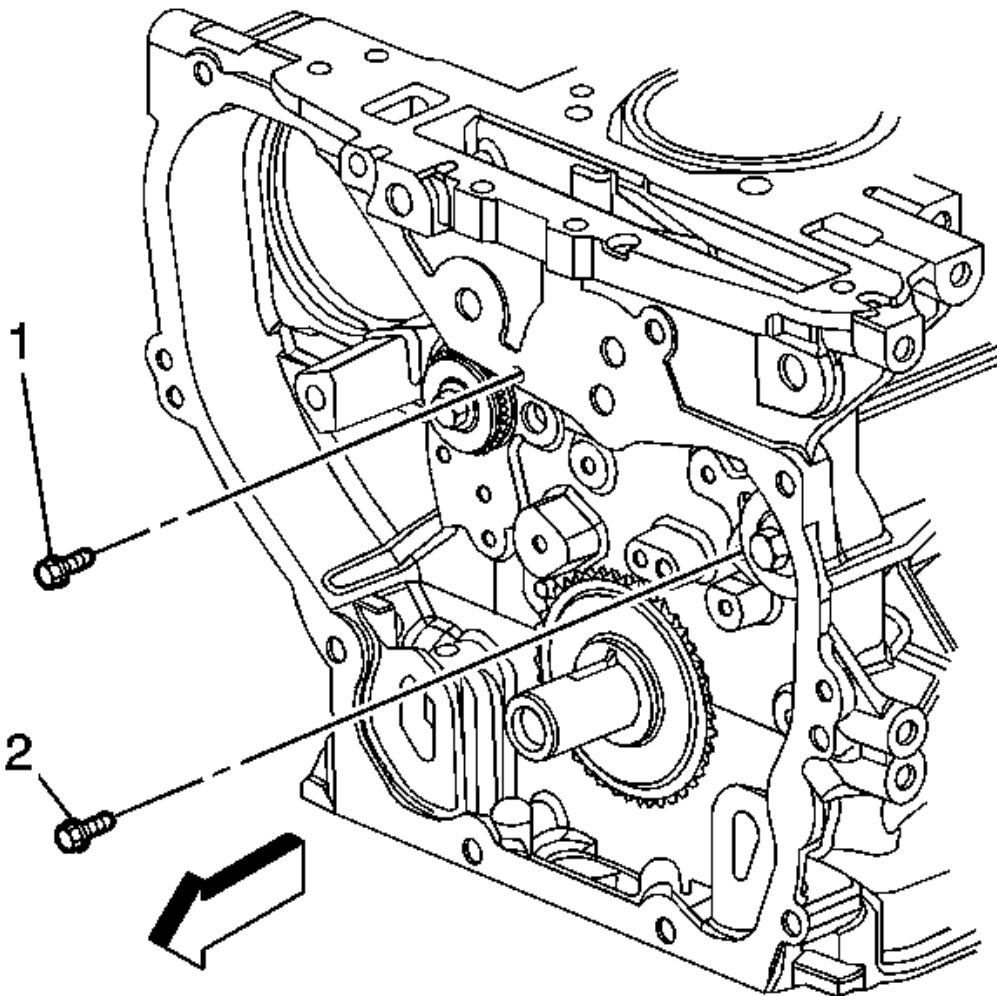


Fig. 168: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Install the left exhaust balance shaft bolt (2) and tighten to 10 N.m (89 lb in).
6. Install the timing chain, sprocket and tensioner. Refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.
7. Install the condenser. Refer to Air Conditioning Condenser Replacement .
8. Install the radiator. Refer to Radiator Replacement .

CAMSHAFT COVER REPLACEMENT

REMOVAL PROCEDURE

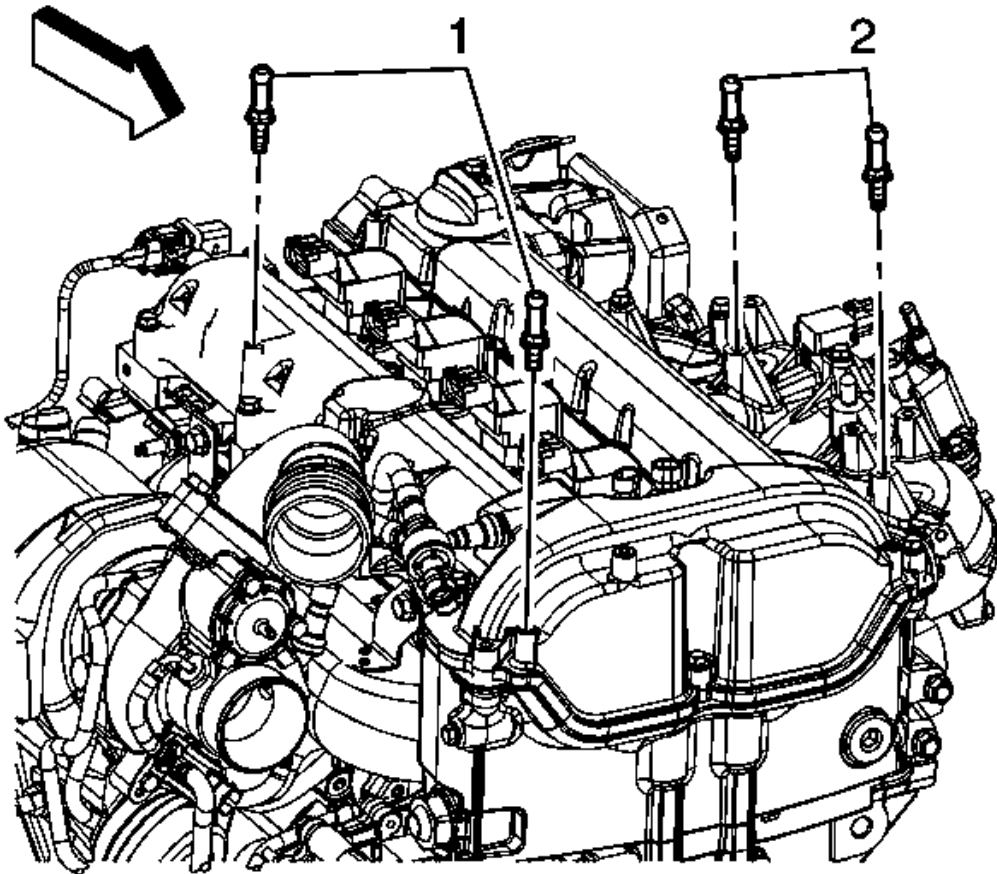


Fig. 169: Identifying Intake Manifold Cover Studs
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the intake manifold cover studs (1).

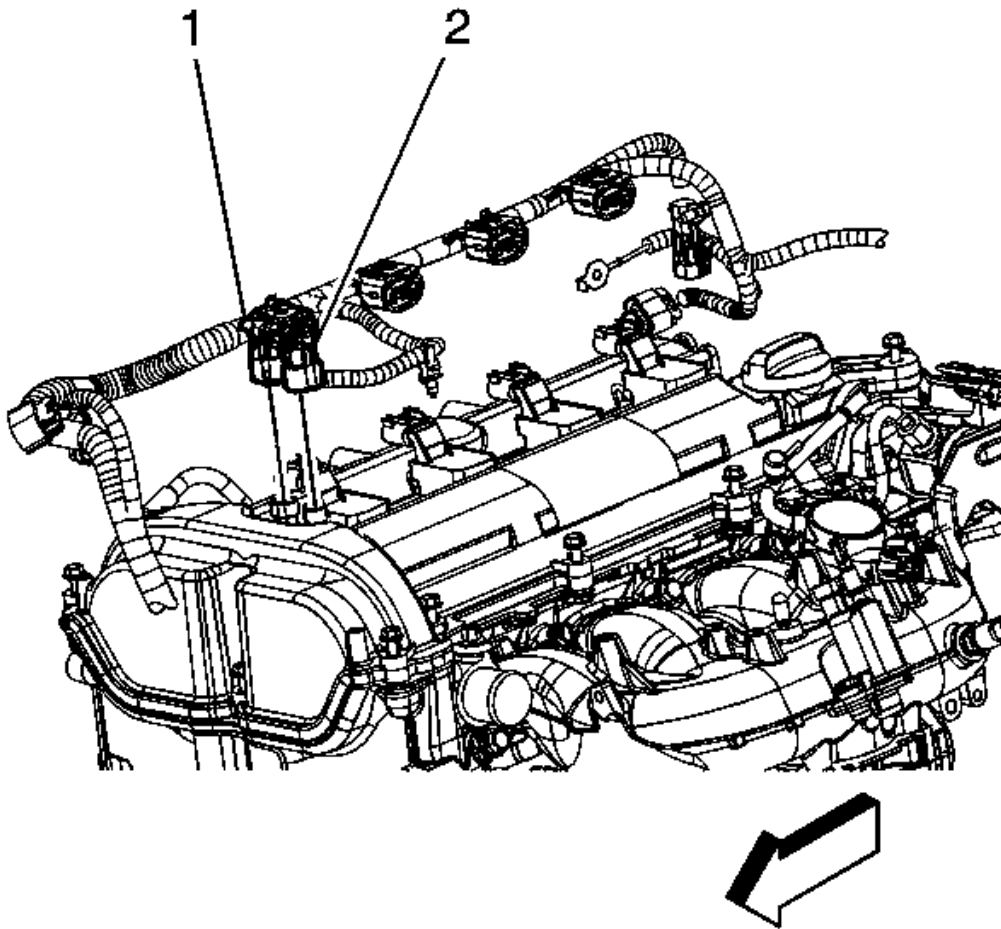


Fig. 170: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

3. Remove the air cleaner outlet. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Disconnect the engine wiring harness intake (2) and exhaust (1) electrical connectors from the camshaft position actuator solenoid valves.

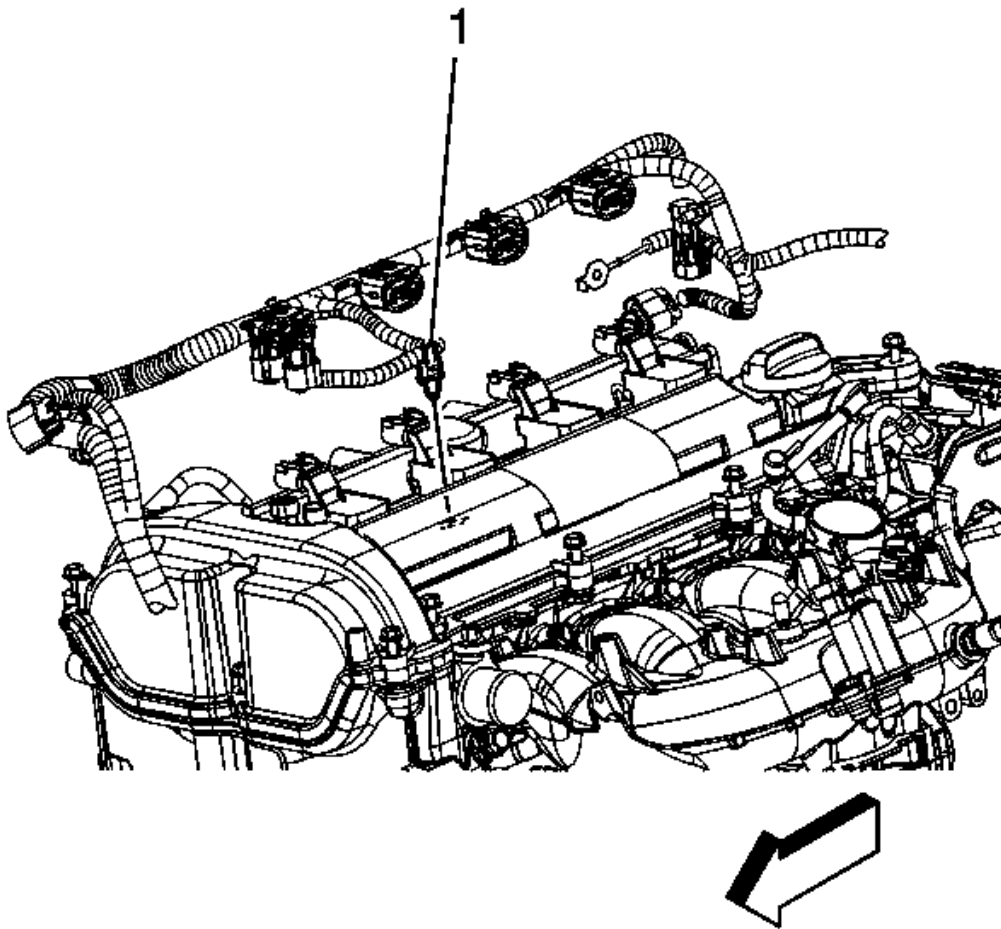


Fig. 171: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine wiring harness clip (1) from the camshaft cover.

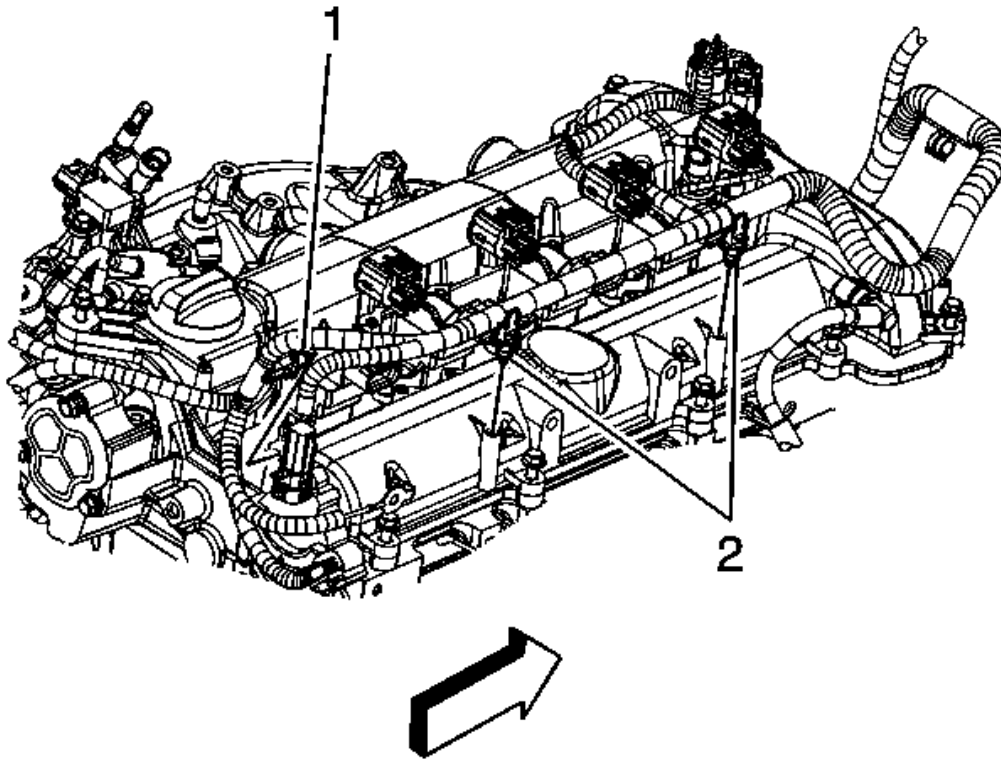


Fig. 172: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine wiring harness clips (1, 2) from the camshaft cover.
7. Disconnect the engine wiring harness electrical connector from the evaporative emission (EVAP) canister purge solenoid valve.
8. Remove the ignition coils. Refer to **Ignition Coil Replacement** .

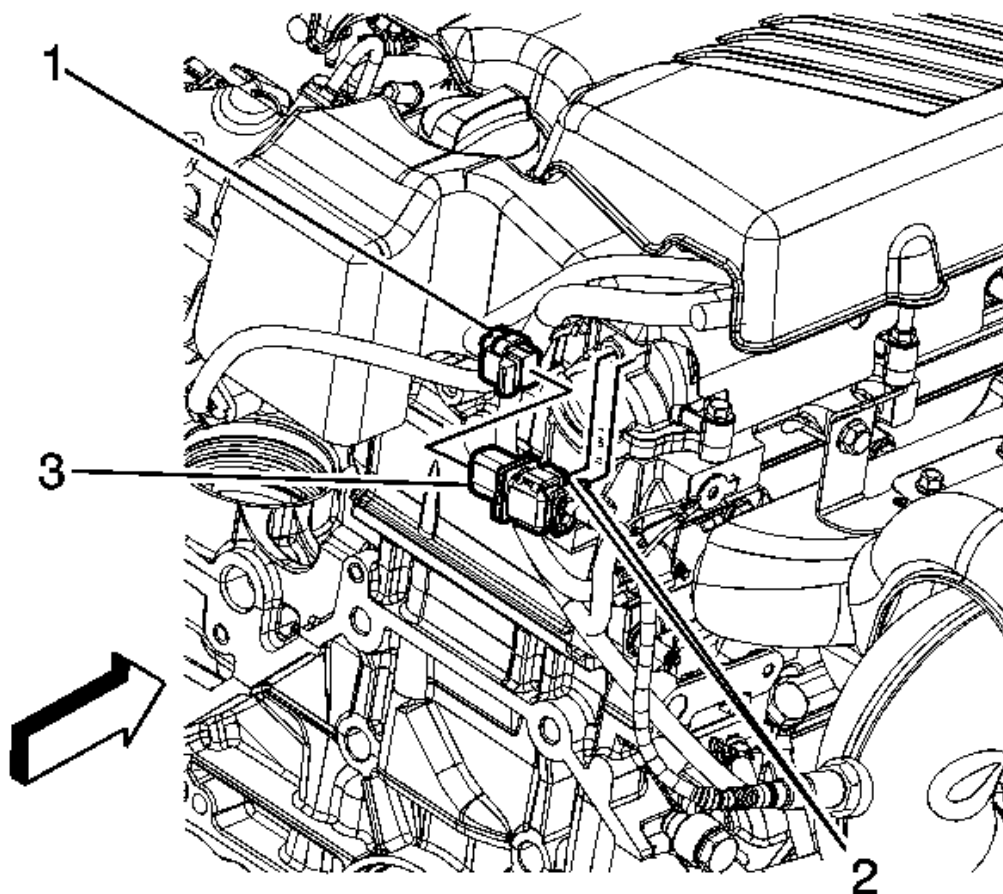


Fig. 173: Identifying CPA Retainer & HO2S Connector & Clip
Courtesy of GENERAL MOTORS CORP.

9. Remove the heated oxygen sensor (HO2S) electrical connector clip (2) from the camshaft cover.

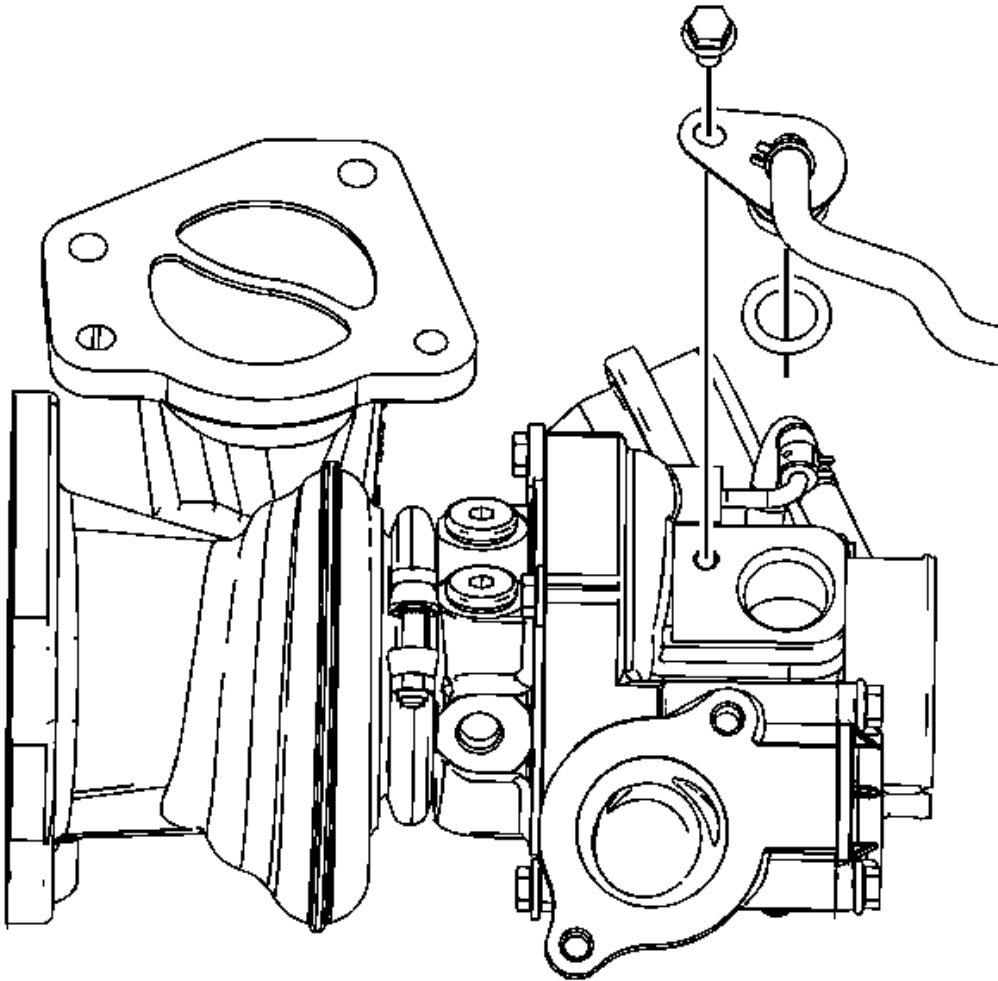


Fig. 174: View Of PCV Fitting, Bolt & Pipe
Courtesy of GENERAL MOTORS CORP.

10. Remove the positive crankcase ventilation (PCV) fitting bolt from the turbocharger. Reposition the PCV pipe (with fitting) out of the way.
11. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
12. Remove the electrical harness attached at the rear of the camshaft cover.

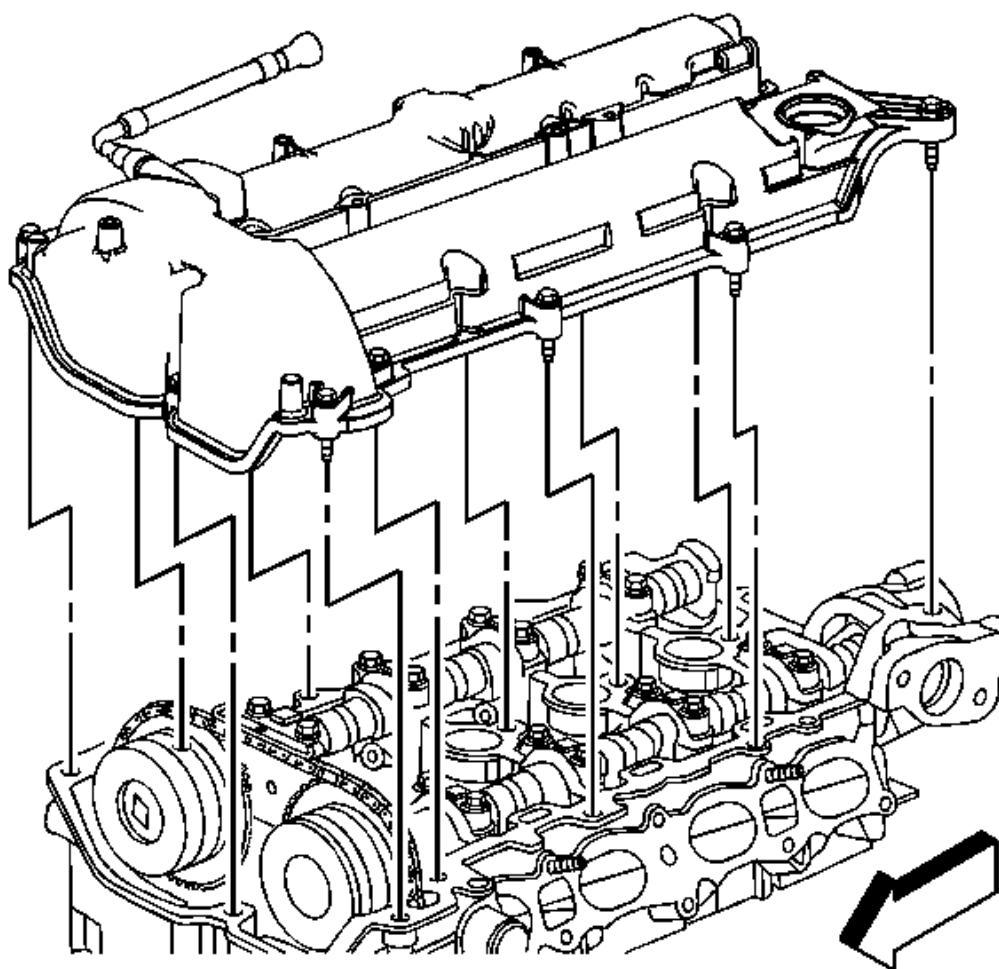


Fig. 175: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: The PCV hose should NOT be disconnected from the camshaft cover as damage to the hose connection will result.

13. Remove the camshaft cover bolts.
14. Remove the camshaft cover.

INSTALLATION PROCEDURE

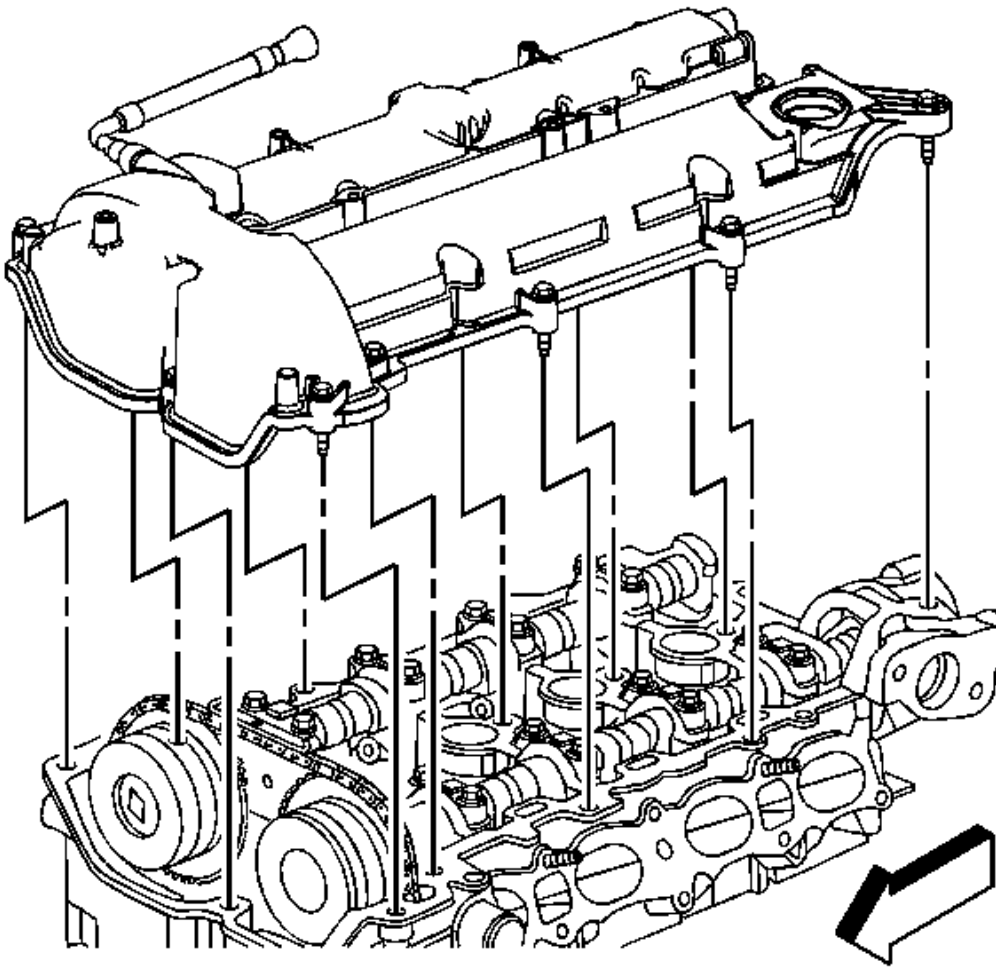


Fig. 176: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the camshaft cover and bolts and tighten to 10 N.m (89 lb in).
2. Attach the electrical harness at the rear of the camshaft cover.
3. Install the air inlet grille panel. Refer to Air Inlet Grille Panel Replacement (SKY) or Air Inlet Grille Panel Replacement (Solstice) .

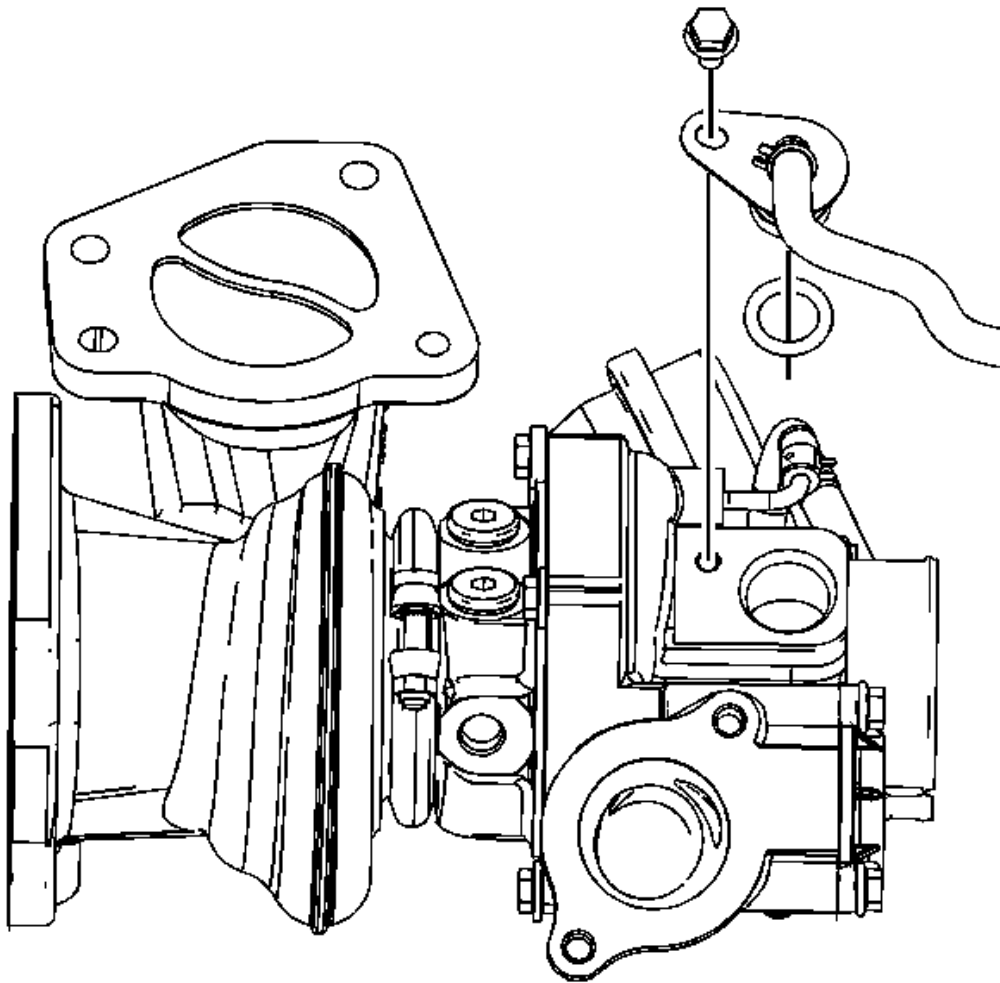


Fig. 177: View Of PCV Fitting, Bolt & Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install a NEW O-ring seal to the PCV fitting.
5. Position the PCV pipe (with fitting), install the PCV fitting bolt to the turbocharger and tighten to 10 N.m (89 lb in).

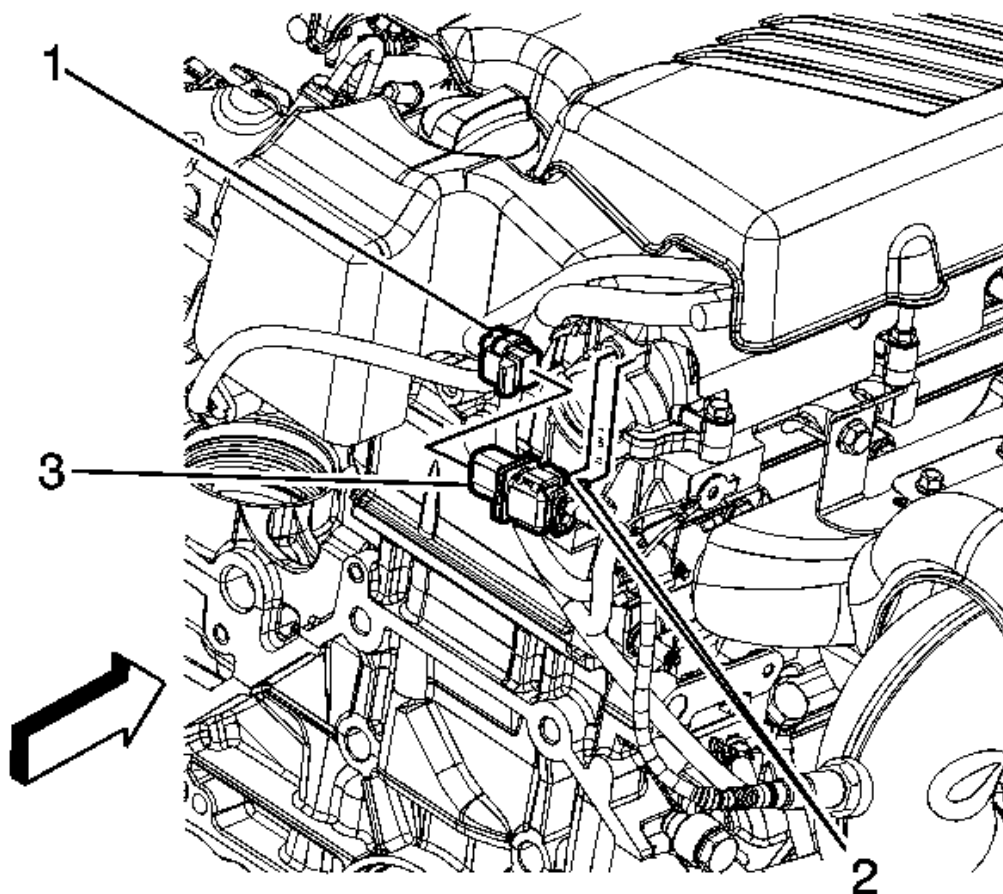


Fig. 178: Identifying CPA Retainer & HO2S Connector & Clip
Courtesy of GENERAL MOTORS CORP.

6. Install the HO2S electrical connector clip (2) to the camshaft cover.

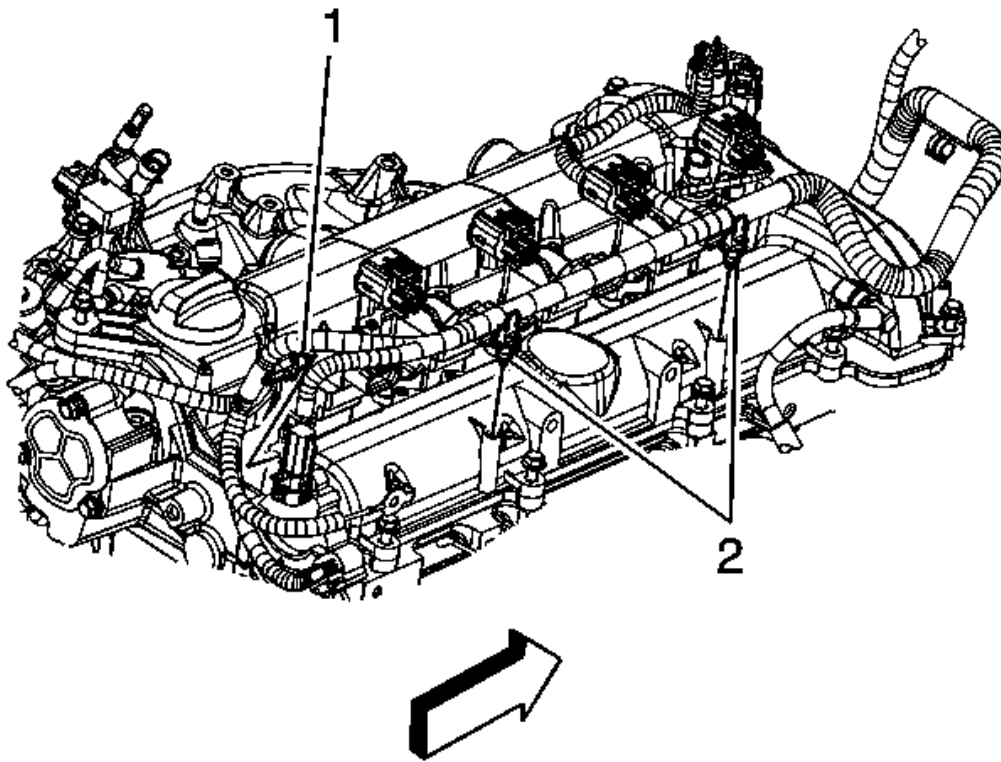


Fig. 179: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

7. Install the ignition coils. Refer to **Ignition Coil Replacement** .
8. Disconnect the engine wiring harness electrical connector from the evaporative emission (EVAP) canister purge solenoid valve.
9. Install the engine harness clips (1, 2) to the camshaft cover.

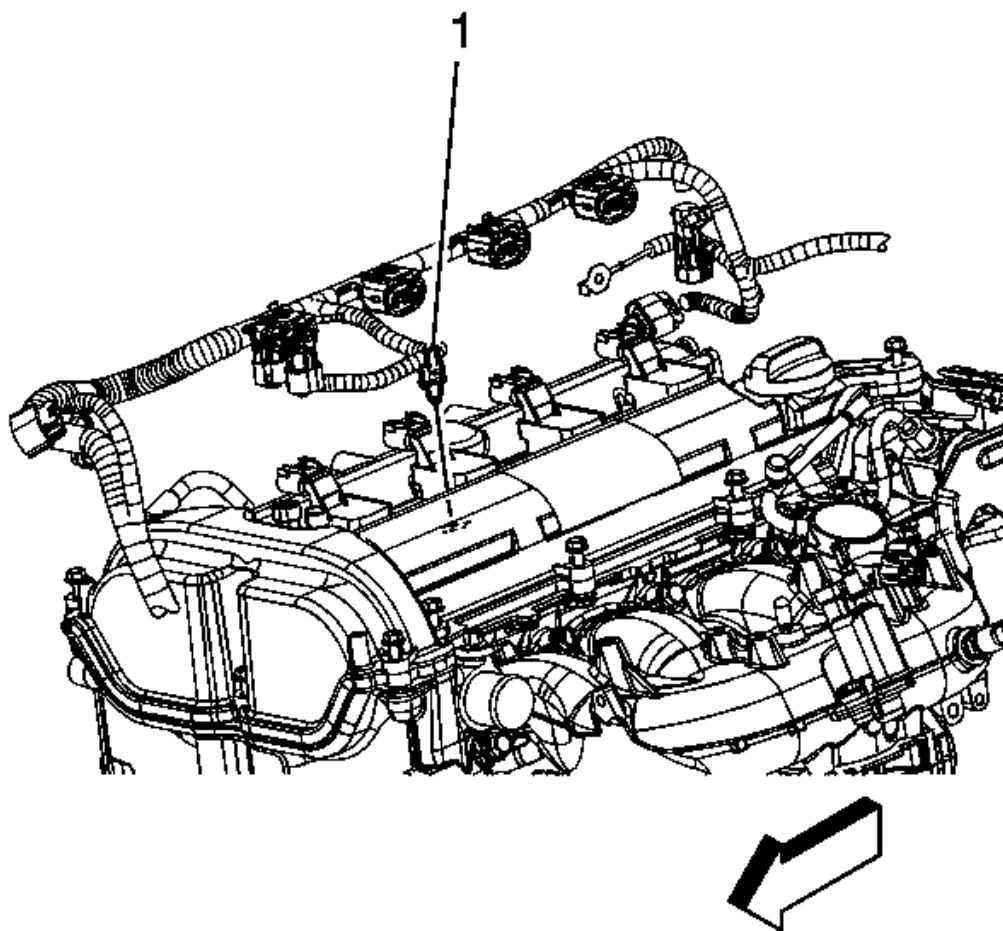


Fig. 180: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

10. Install the engine wiring harness clip (1) to the camshaft cover.

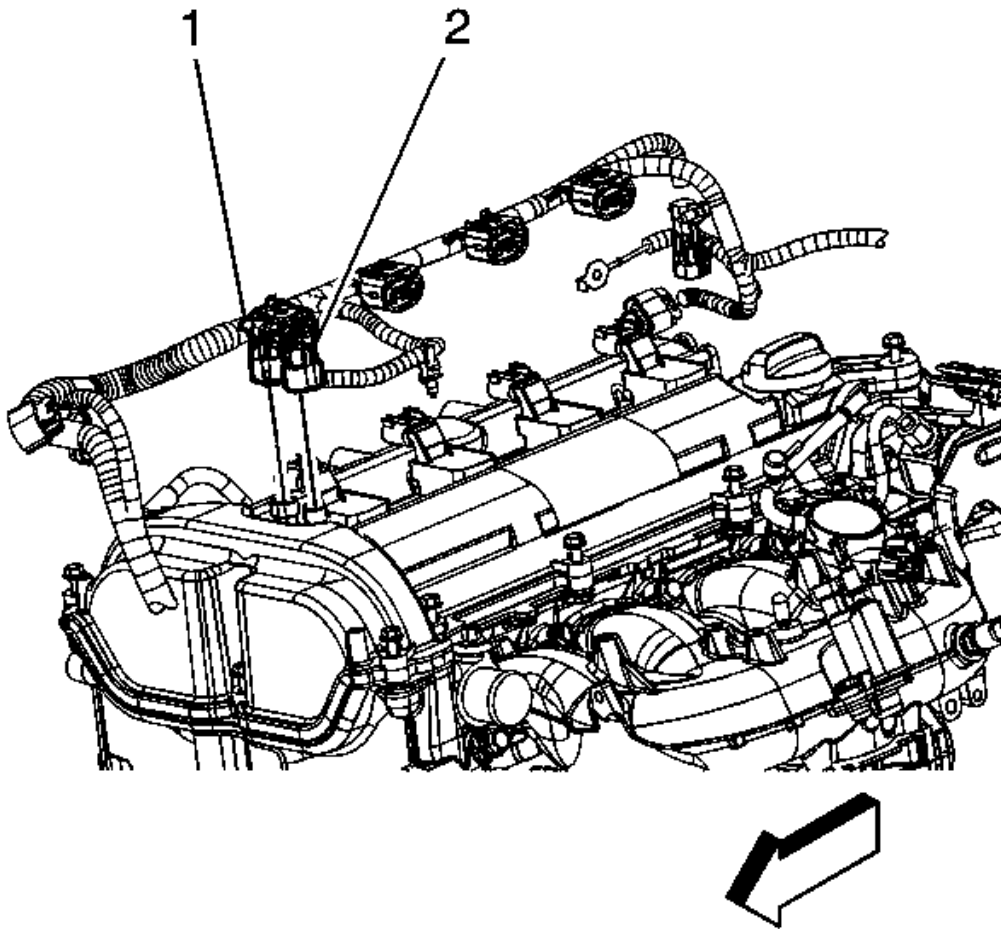


Fig. 181: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

11. Connect the engine wiring harness intake (2) and exhaust (1) electrical connectors to the camshaft position actuator solenoid valves.
12. Install the air cleaner outlet. Refer to **Air Cleaner Outlet Duct Replacement** .

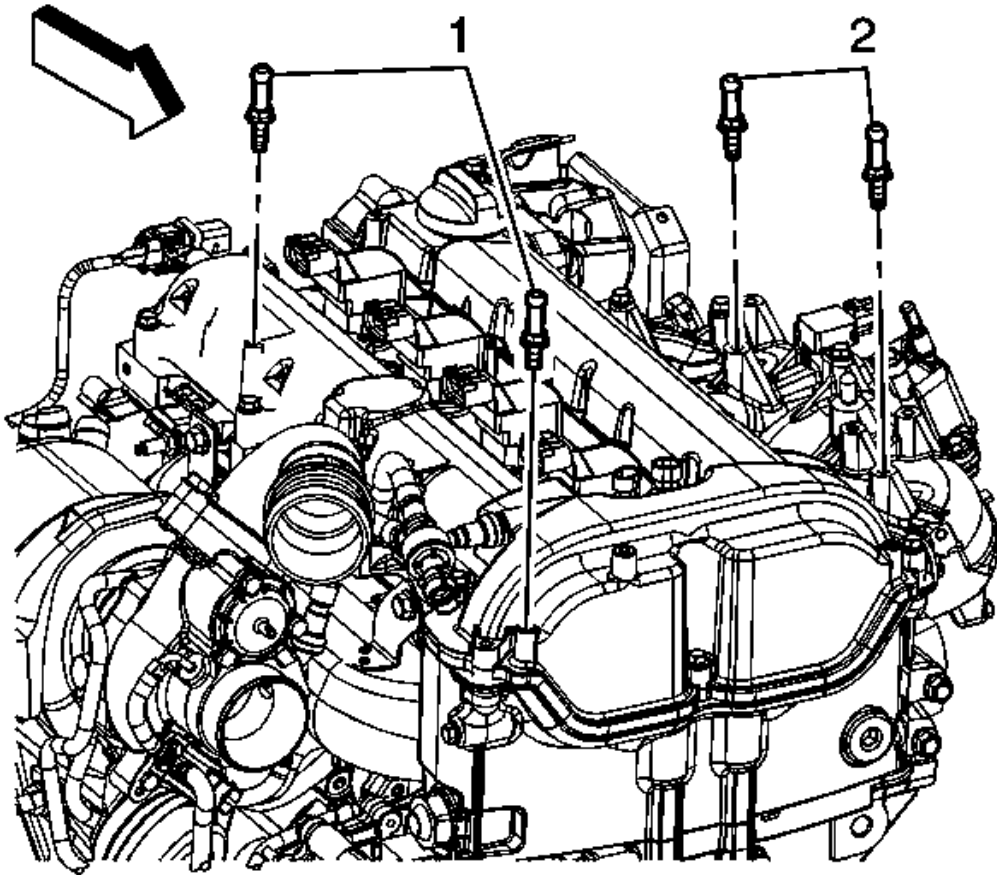


Fig. 182: Identifying Intake Manifold Cover Studs
Courtesy of GENERAL MOTORS CORP.

13. Install the intake manifold cover studs (1) and tighten to 9 N.m (80 lb in).
14. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

TIMING CHAIN TENSIONER REPLACEMENT

SPECIAL TOOLS

J 45027 Tensioner Tool. See **Special Tools** .

REMOVAL PROCEDURE

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

Connection .

2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.

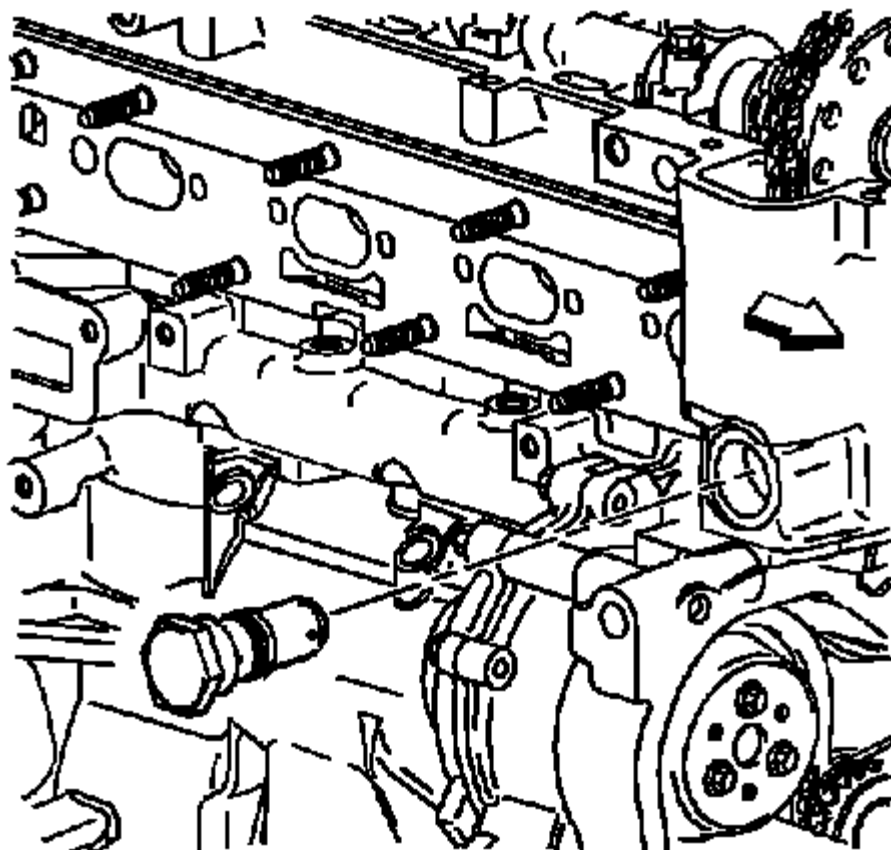


Fig. 183: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Remove the timing chain tensioner.
4. Remove the seal from the tensioner.

INSTALLATION PROCEDURE

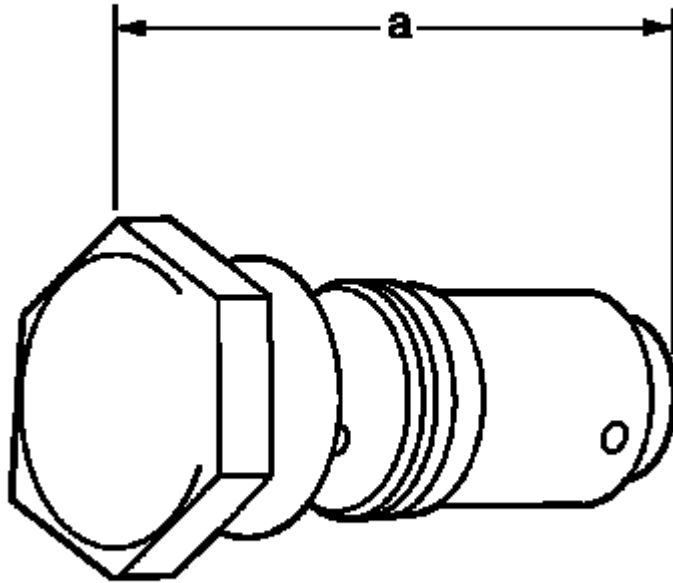


Fig. 184: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

1. Inspect the timing chain tensioner. If the timing chain tensioner, O-ring seal, or washer is damaged, replace the timing chain tensioner or O-ring seal as applicable.
2. Measure the timing chain tensioner assembly from end to end. If the timing chain tensioner is to be replaced, a new tensioner should be supplied in the fully compressed non-active state. A tensioner in the compressed state will measure 72 mm (2.83 in) (a) from end to end. A tensioner in the active state will measure 85 mm (3.35 in) (a) from end to end.

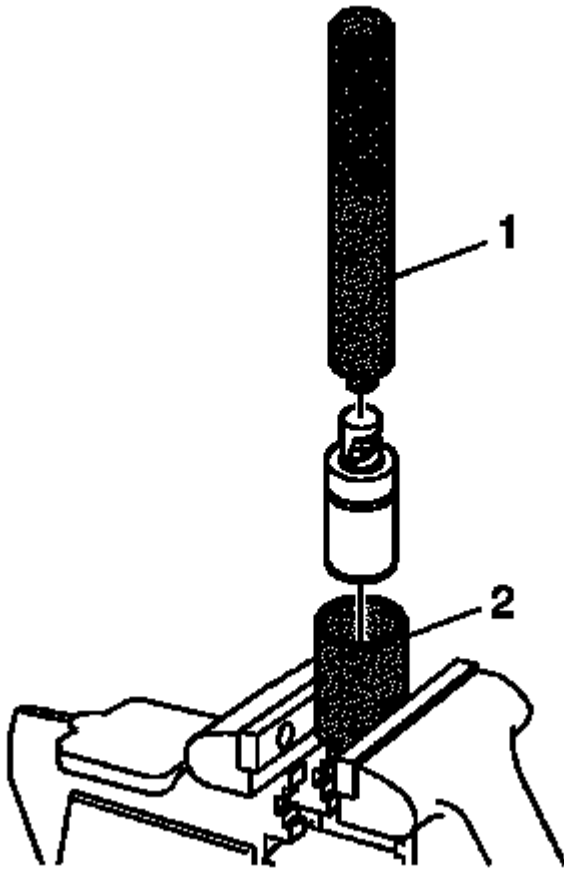


Fig. 185: View Of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

3. If the timing chain tensioner is not in the compressed state, perform the following steps:
 1. Remove the piston assembly from the body of the timing chain tensioner by pulling it out.
 2. Install the J 45027-2 (2) into a vise.
 3. Install the notch end of the piston assembly into the J 45027-2 (2).
 4. Using the J 45027-1 (1), turn the ratchet cylinder into the piston.

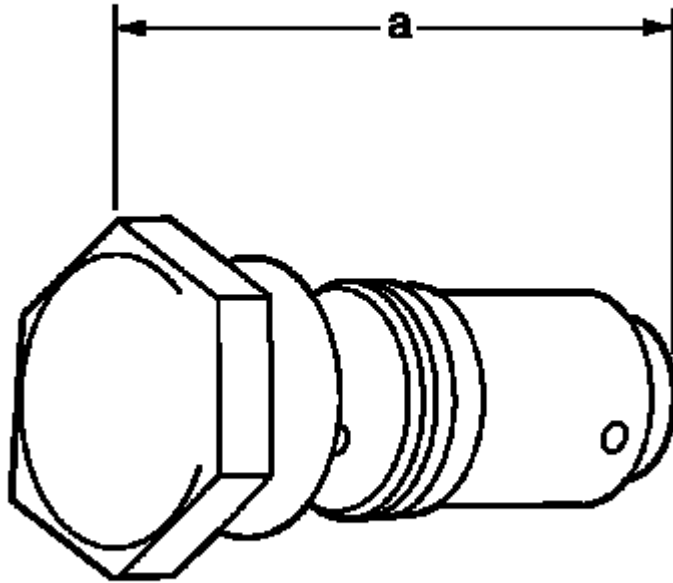


Fig. 186: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

4. Inspect the bore of the tensioner body for dirt, debris, and damage. If any damage appears, replace the tensioner. Clean dirt or debris out with a lint-free cloth.
5. Install the compressed piston assembly back into the timing chain tensioner body until it stops at the bottom of the bore. Do not compress the piston assembly against the bottom of the bore. If the piston assembly is compressed against the bottom of the bore, it will activate the tensioner, which will then need to be reset again.
6. At this point the tensioner should measure approximately 72 mm (2.83 in) (a) from end to end. If the tensioner does not read 72 mm (2.83 in) (a) from end to end, repeat steps 3-5.

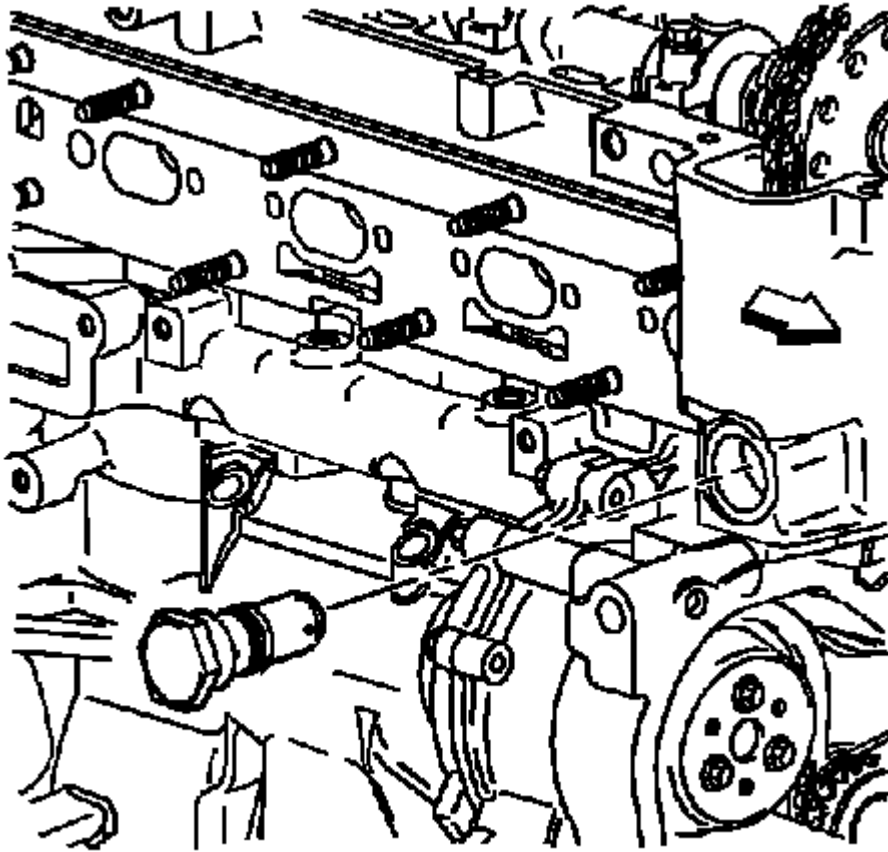


Fig. 187: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Inspect to ensure all dirt and debris is removed from the timing chain tensioner threaded hole in the cylinder head.

CAUTION: Refer to Fastener Caution .

NOTE: Ensure the timing chain tensioner seal is centered throughout the torque procedure to eliminate the possibility of an oil leak.

8. Install the timing chain tensioner assembly.

Tighten the timing chain tensioner to 75 N.m (55 lb ft).

9. The timing chain tensioner is released by compressing the tensioner 2 mm (0.079 in) which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.

10. Install the camshaft cover. Refer to Camshaft Cover Replacement.
11. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection.

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

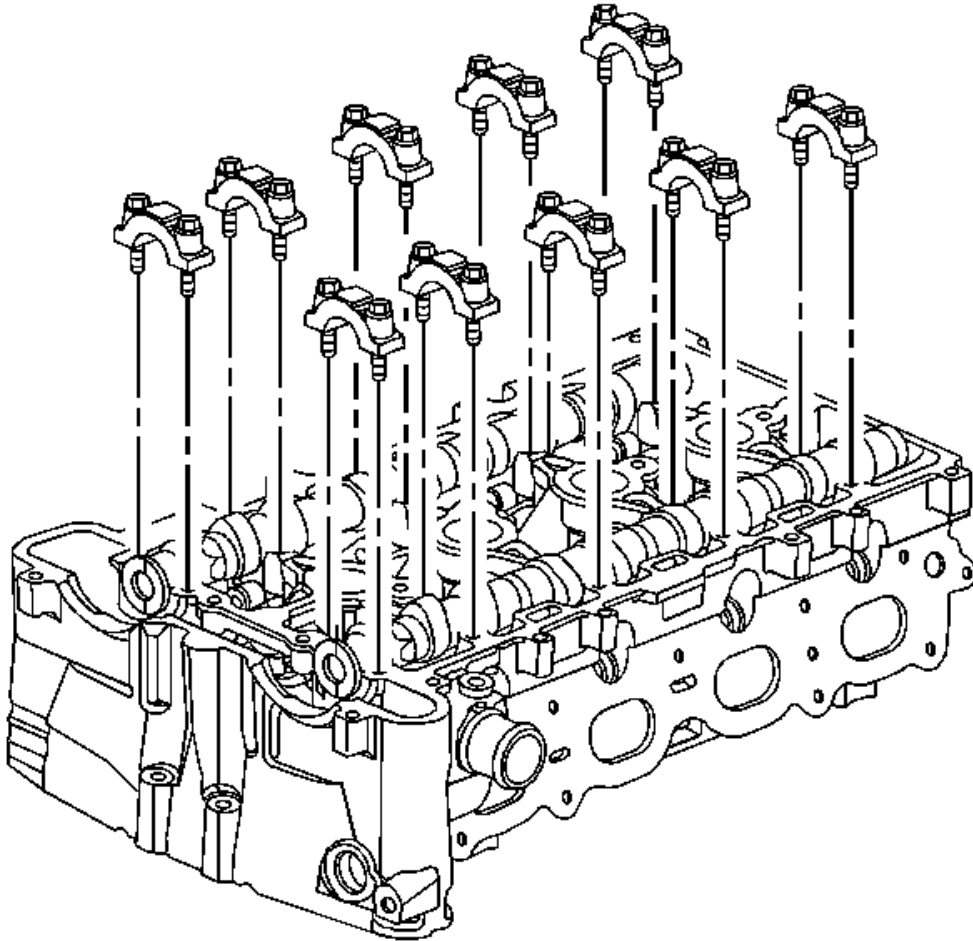


Fig. 188: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft position intake actuator. Refer to Camshaft Position Intake Actuator Replacement.

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

2. Mark the bearing caps to ensure they are installed in the original position.
3. Remove the bearing cap bolts.

4. Remove the bearing caps.

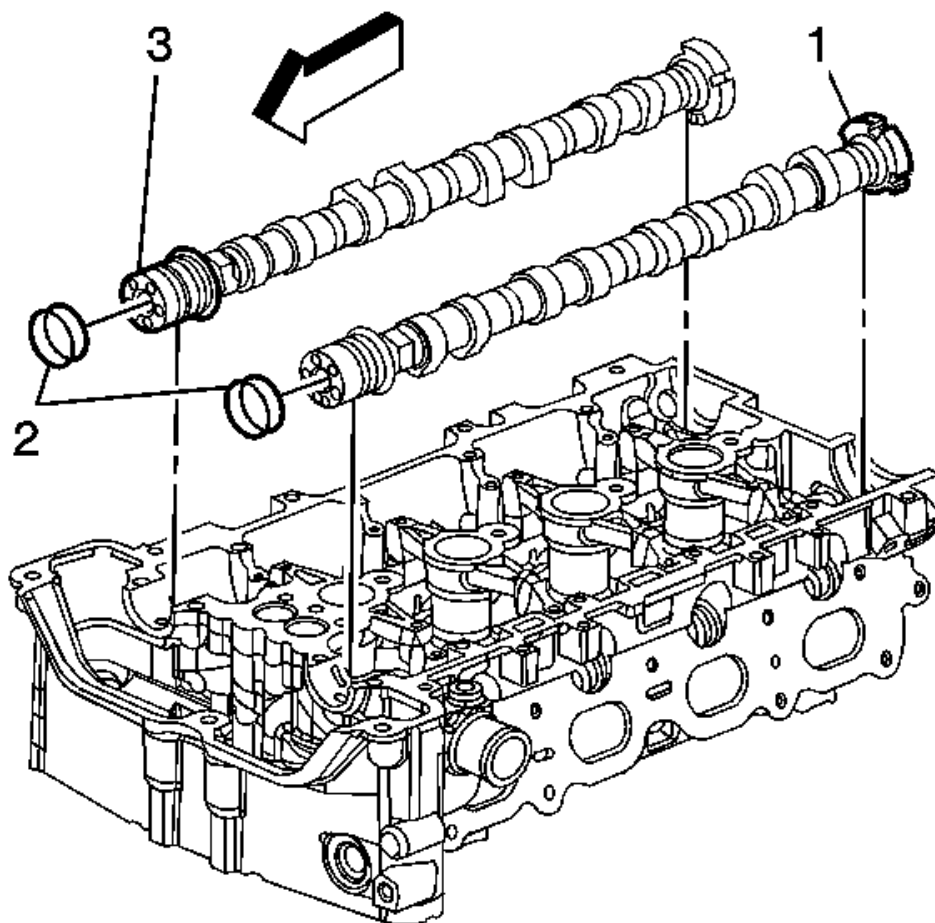


Fig. 189: Identifying Intake/Exhaust Camshaft
 Courtesy of GENERAL MOTORS CORP.

5. Remove the intake camshaft (1).

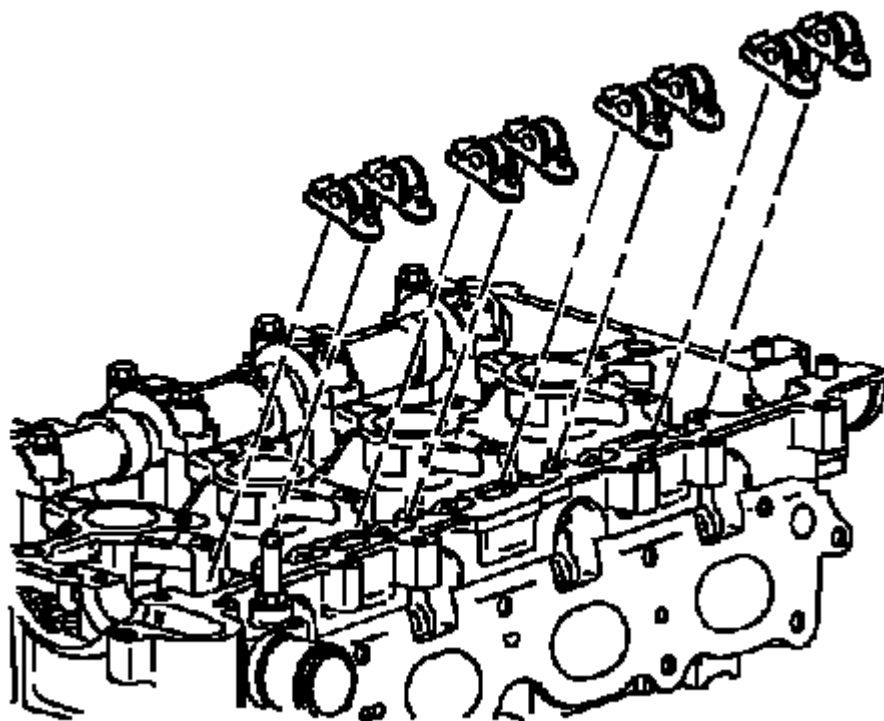


Fig. 190: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Keep all of the roller followers and hydraulic adjusters in order so that they can be reinstalled in their respective locations.

6. Remove the camshaft roller followers.

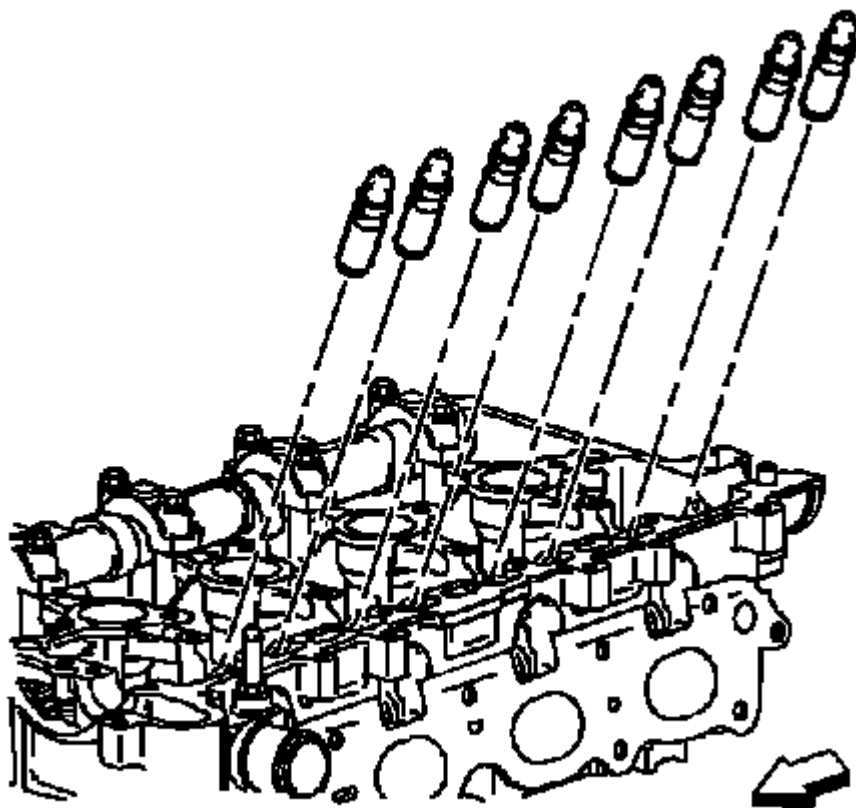


Fig. 191: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

7. Remove the hydraulic element lash adjusters.

INSTALLATION PROCEDURE

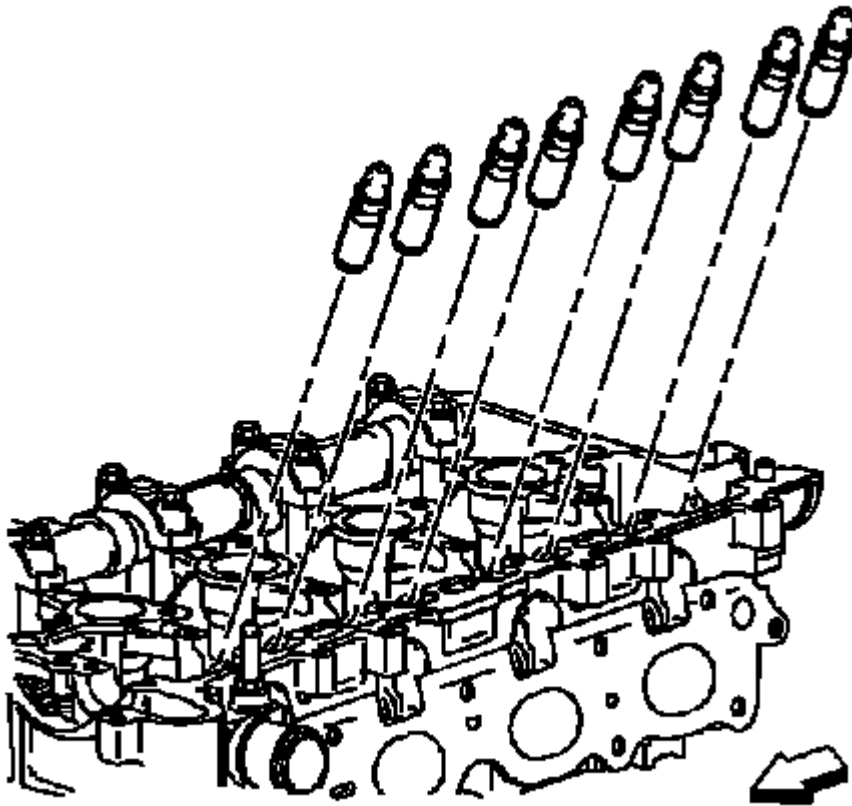


Fig. 192: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic element lash adjusters into their bores in the cylinder head. Install the camshaft caps and hand start the camshaft cap bolts.
2. Install the camshaft caps.

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cap bolts in increments of 3 turns until they are seated. Tighten the camshaft caps to 10 N.m (89 lb in).

NOTE:

- It is critical during installation to ensure the bearing rear cap and cylinder head alignment is correct and the mating surfaces are flush.
 - Ensure that all sealing material has been removed from the components, and the sealing surfaces are clean and free of contamination prior to applying the sealer.
 - Install and align the rear cap within 20 minutes of applying the sealer.

- Apply the sealer to all locations centrally locating the bead on the rail.
4. Apply a 3.5 mm bead of sealer to the cylinder head at the number 6 intake camshaft rear cap mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.
 5. Install the number 6 intake camshaft rear cap.
 1. Tighten the cap bolts evenly to 5 N.m (44 lb in).
 2. Tighten the cap bolts evenly a final pass to 10 N.m (89 lb in).

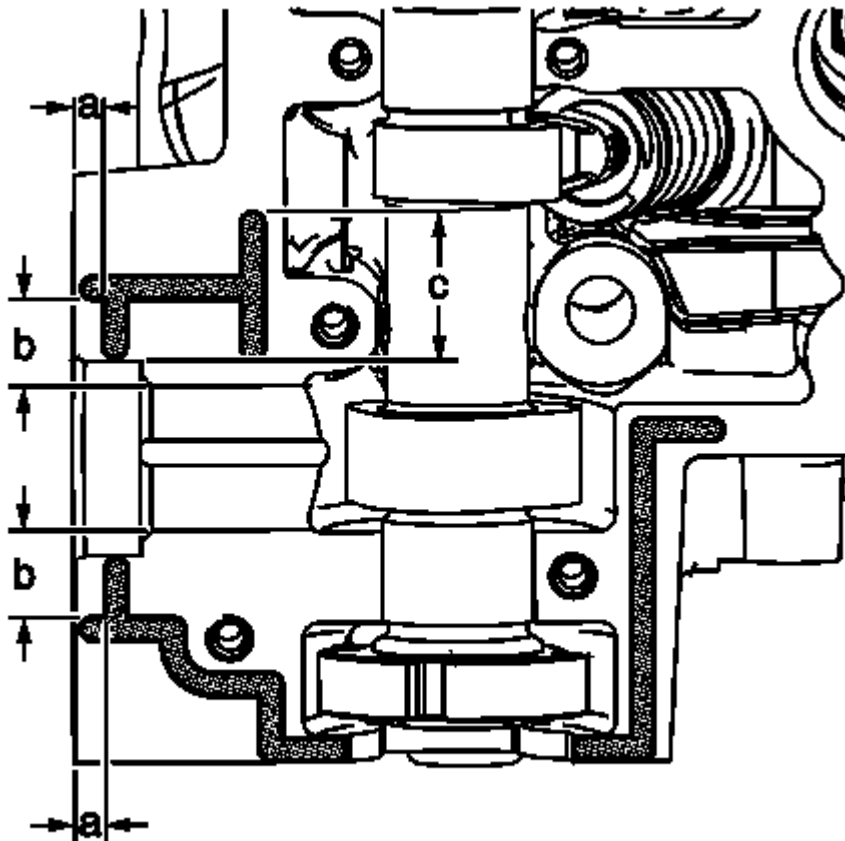


Fig. 193: Locating Sealer Application Areas
Courtesy of GENERAL MOTORS CORP.

NOTE:

- It is critical during installation to ensure the bearing rear cap and cylinder head alignment is correct and the mating surfaces are flush.
 - Ensure that all sealing material has been removed from the components, and the sealing surfaces are clean and free of contamination prior to applying the sealer.
 - Install and align the rear cap within 20 minutes of applying the sealer.

- Apply the sealer to all locations centrally locating the bead on the rail.
 - Run bead to 5.0 mm, dimension a, as shown.
 - Where the cap ends on the perimeter rail, extend bead approximately 4.0 mm beyond edge of cap.
 - Run bead, dimension c, 32 mm from the edge of the cylinder head as shown.
 - Run beads, dimension b, 20 mm from edge of cylinder head as shown.
- 6. Apply a 2.5 mm bead of sealer to the cylinder head at the number 6 intake camshaft rear cap mating surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
- 7. Install the number 6 intake camshaft rear cap.
 1. Tighten the cap bolts evenly to 5 N.m (44 lb in).
 2. Tighten the cap bolts evenly to 10 N.m (89 lb in).
 3. Back the cap bolts out 120 degrees.
 4. Tighten the cap bolts evenly a final pass to 10 N.m (89 lb in).

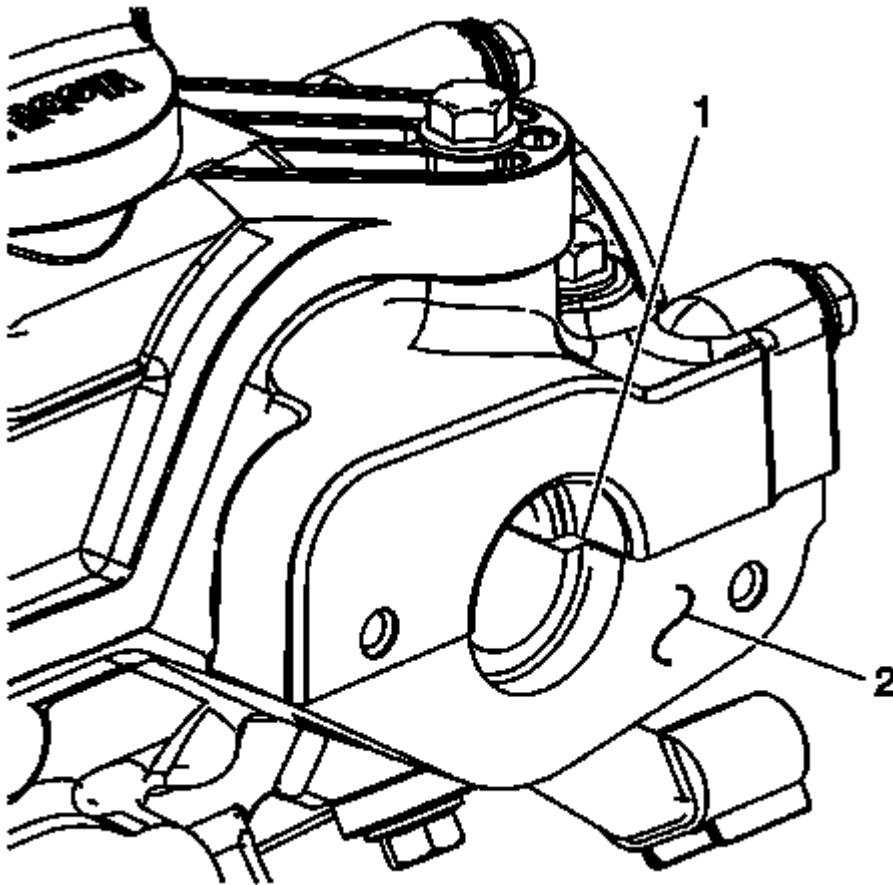


Fig. 194: Identifying Fuel Pump Roller Lifter Orifice

Courtesy of GENERAL MOTORS CORP.

8. Remove all excess sealing material from the fuel pump roller lifter orifice (1), and ensure the orifice is free of debris.
9. Remove all excess sealing material from the sealing surfaces.

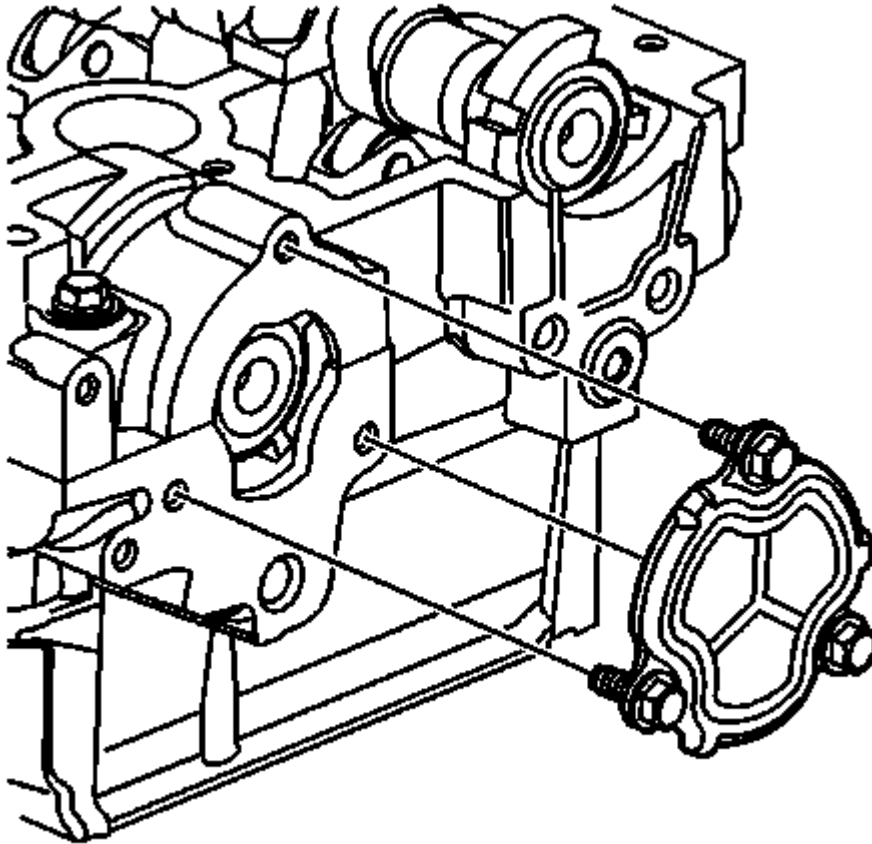


Fig. 195: View Of Cylinder Head Opening Plate
Courtesy of GENERAL MOTORS CORP.

10. Install the rear cylinder head opening plate and bolts and tighten to 10 N.m (89 lb in).
11. Install the camshaft position intake actuator. Refer to **Camshaft Position Intake Actuator Replacement**.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

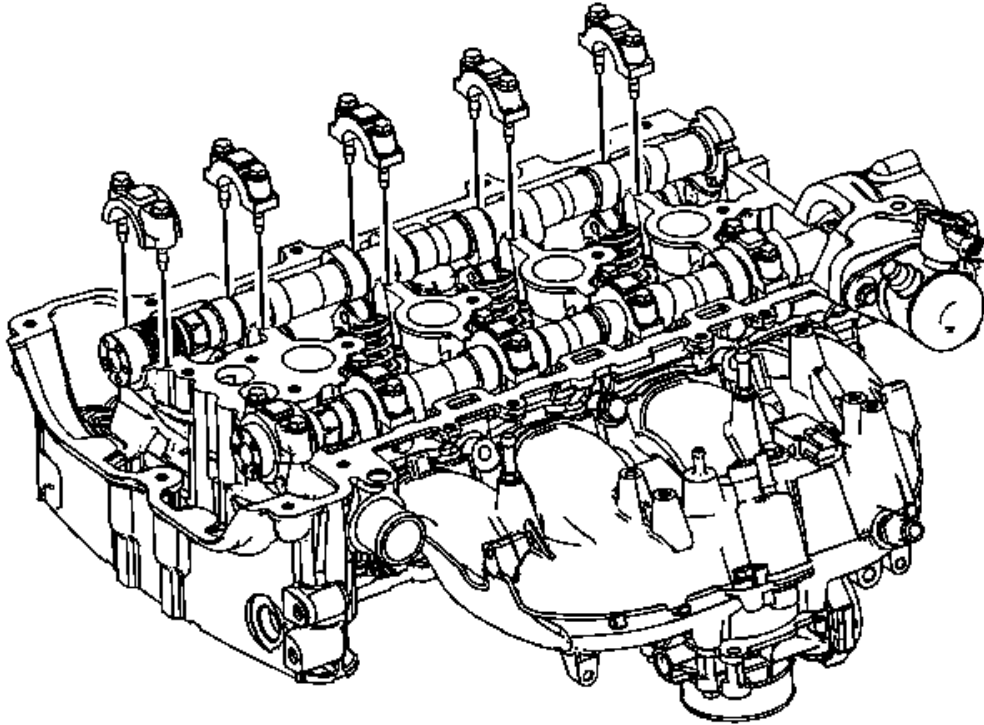


Fig. 196: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft position exhaust actuator. Refer to **Camshaft Position Exhaust Actuator Replacement**.

NOTE: Remove each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.

2. Mark the camshaft bearing caps to ensure they are installed in the same position.
3. Remove the camshaft bearing cap bolts and cap.

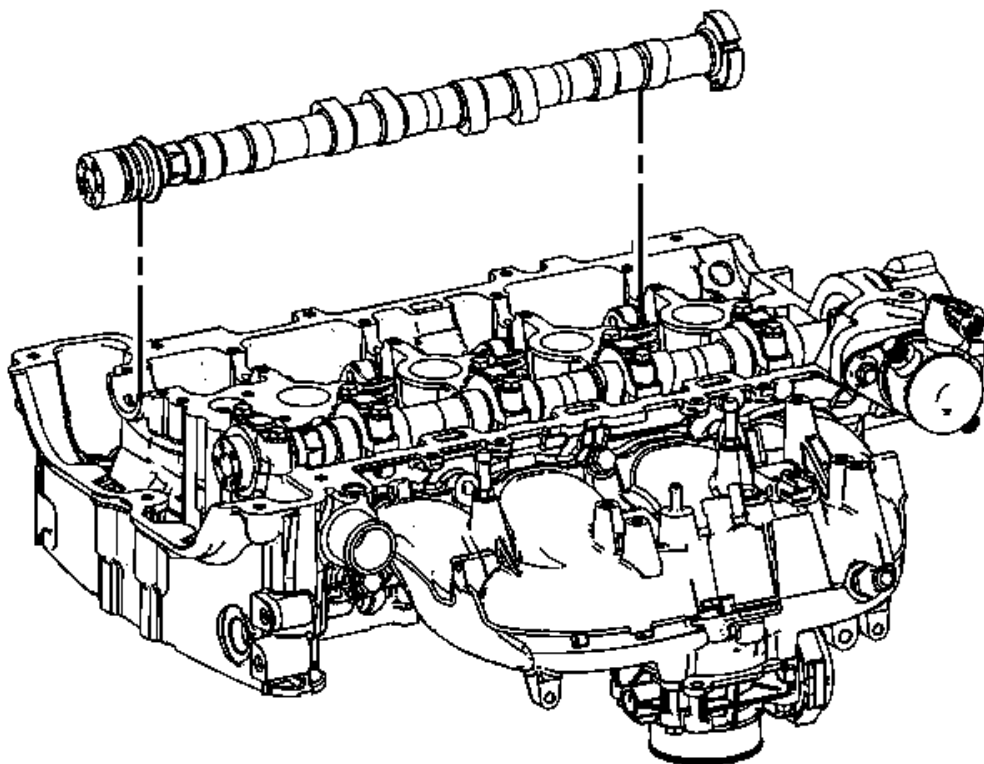


Fig. 197: Identifying Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust camshaft.

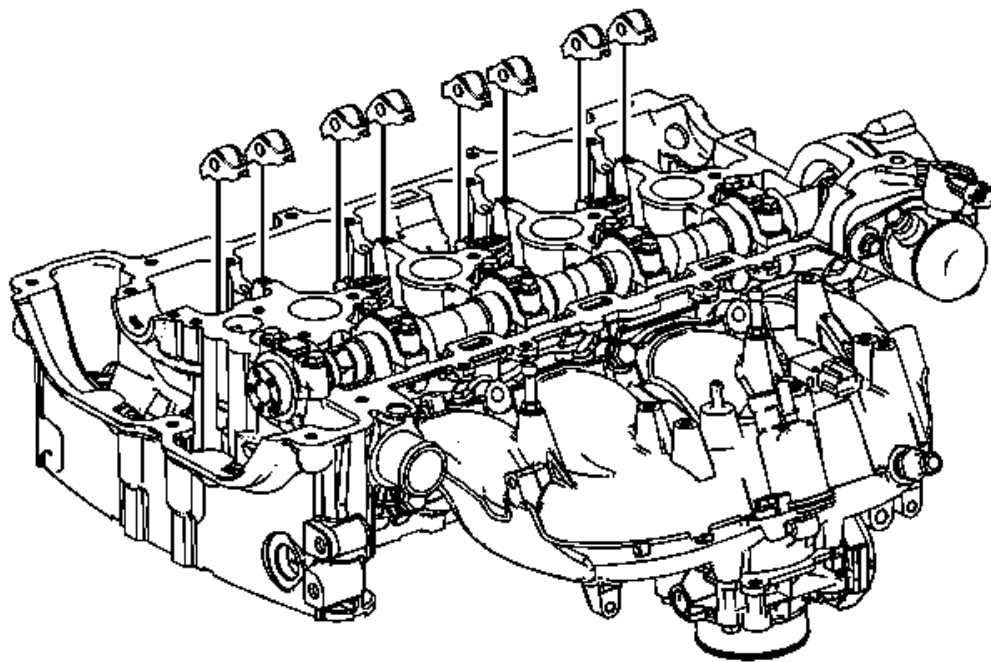


Fig. 198: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

NOTE: Keep all of the rocker arms and hydraulic valve lash adjusters in order so that they can be reinstalled in their respective locations.

5. Remove the valve rocker arms.

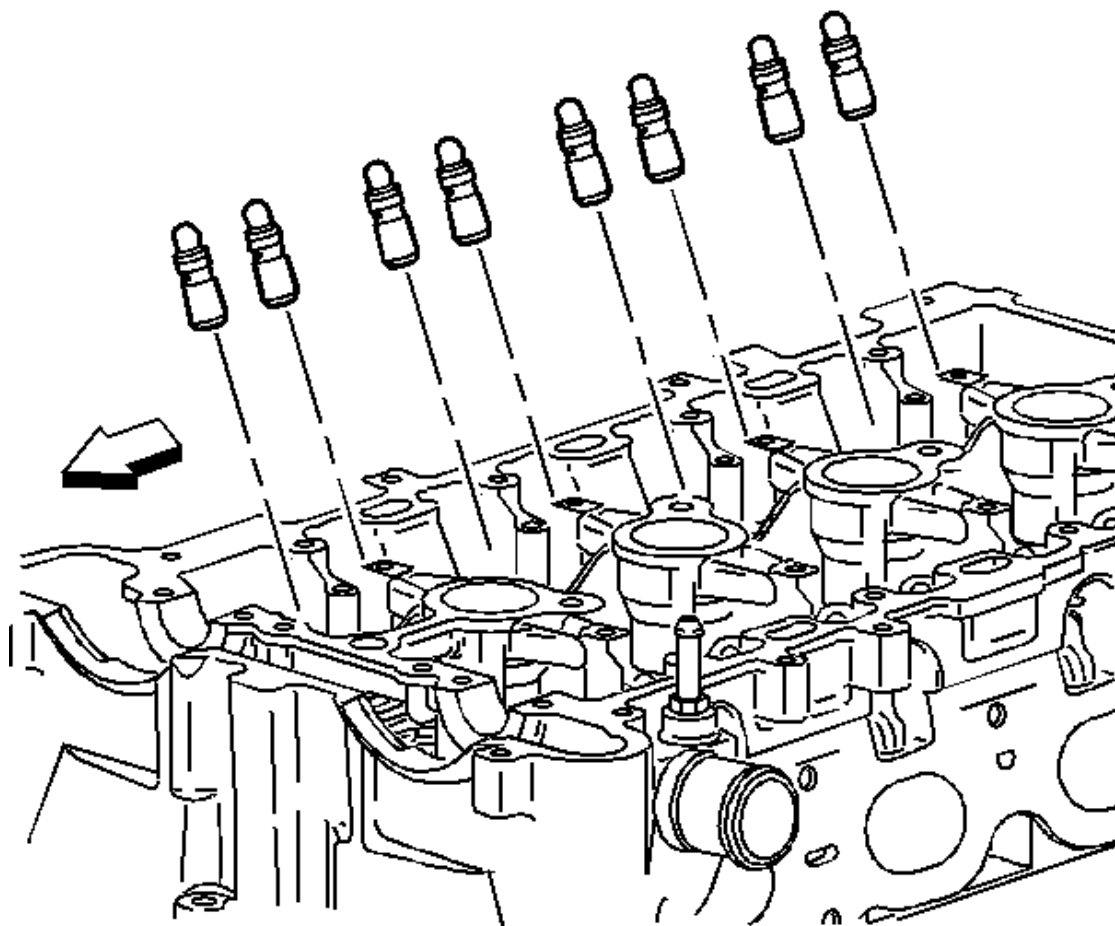


Fig. 199: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

6. Remove the hydraulic valve lash adjusters.

INSTALLATION PROCEDURE

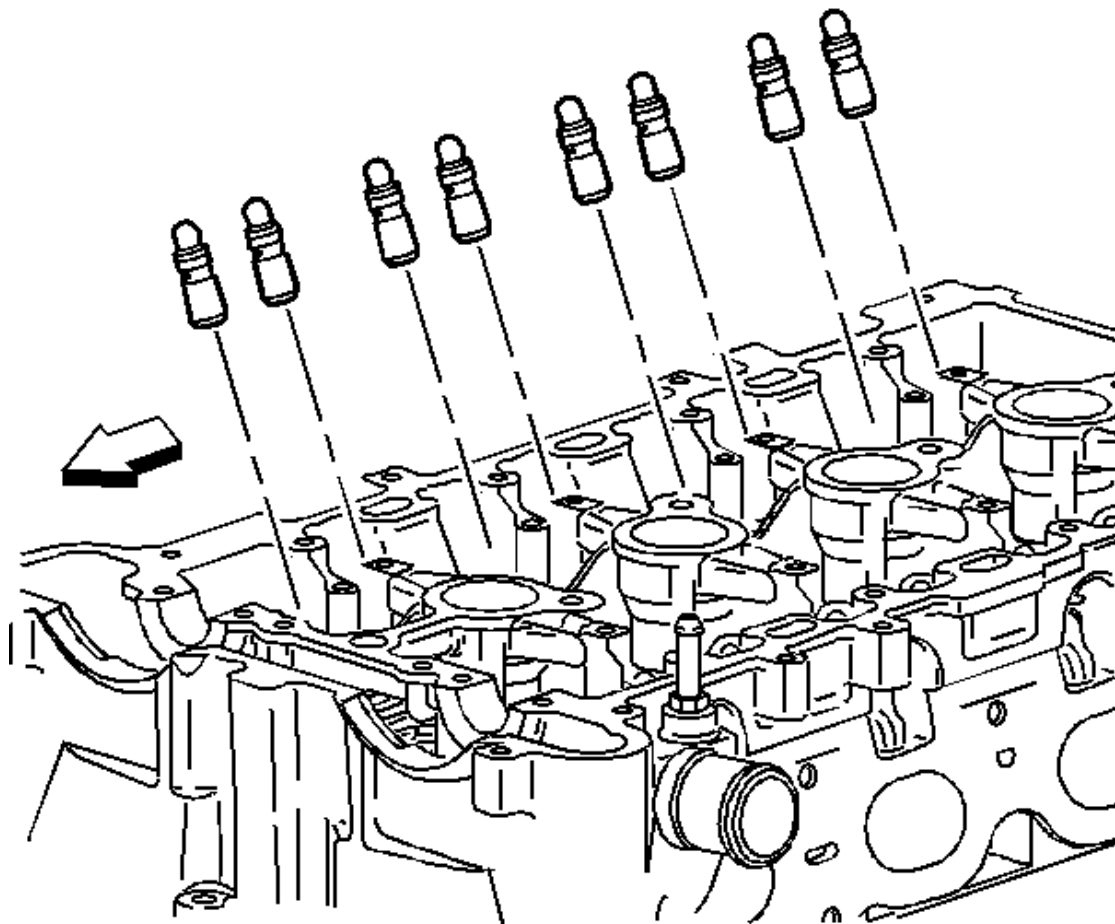


Fig. 200: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic valve lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic valve lash adjusters. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

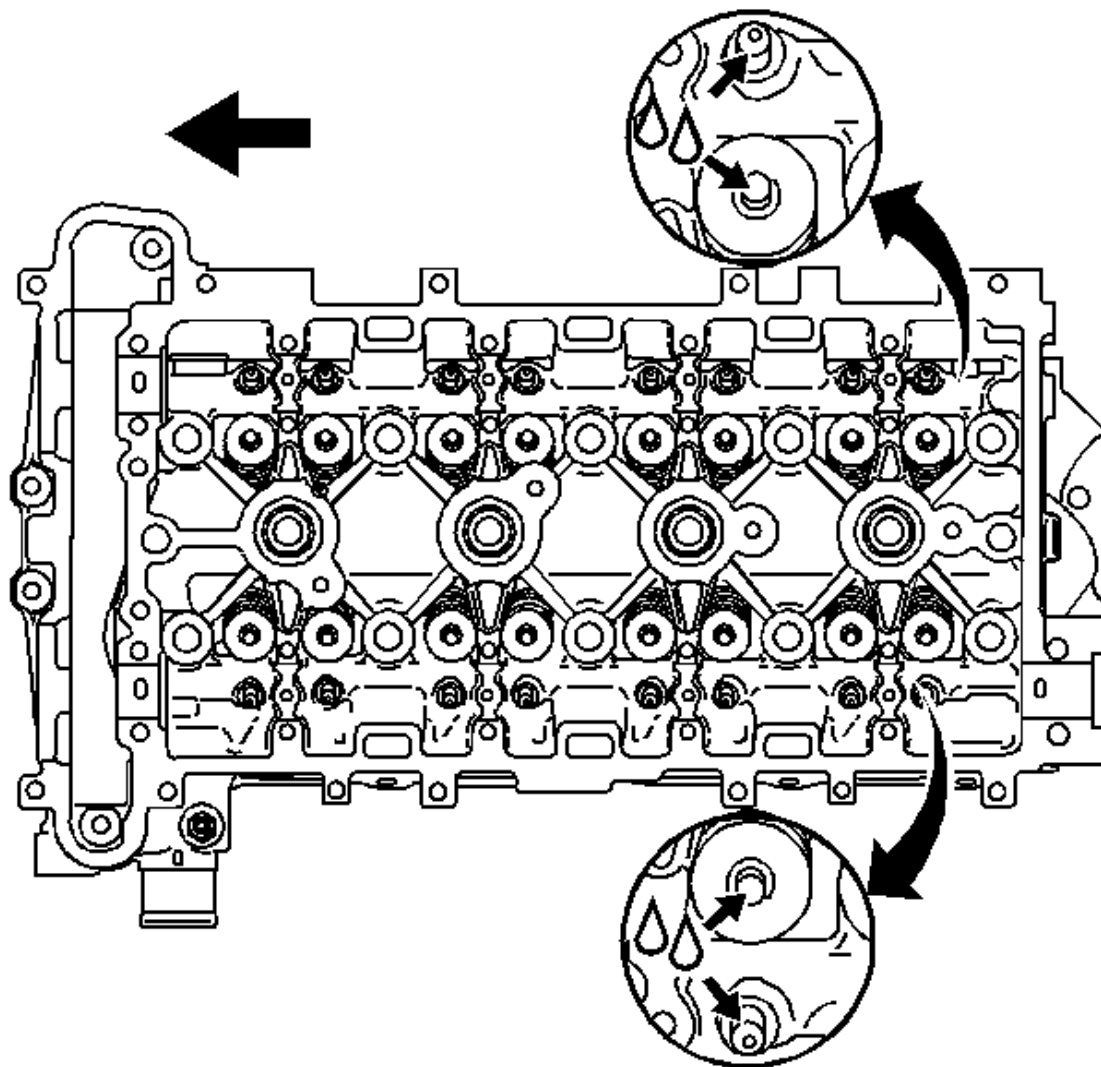


Fig. 201: Lubricating Valve Tips
Courtesy of GENERAL MOTORS CORP.

3. Lubricate the valve tips. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) .

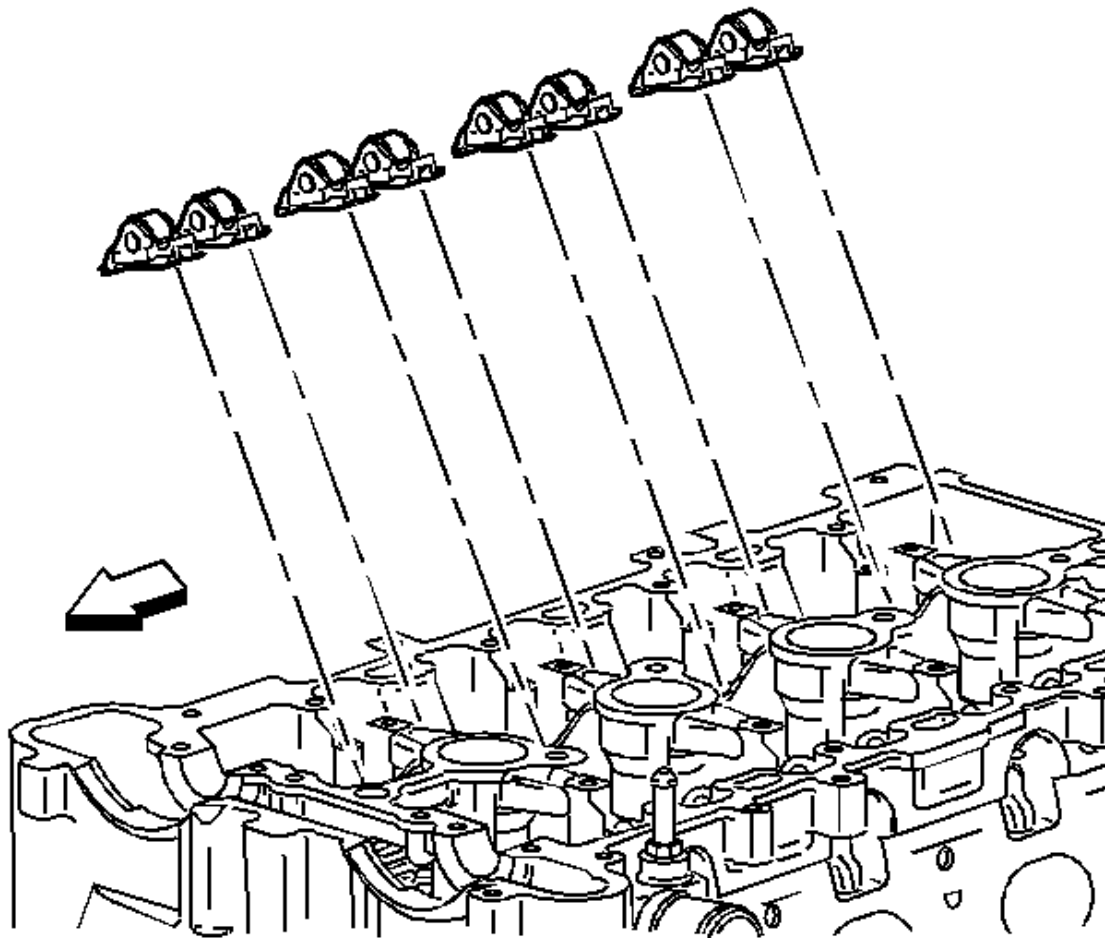


Fig. 202: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Used rocker arms **MUST** be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms **MUST** also be replaced.

4. Position the rocker arms on the tip of the valve stem and on the valve lash adjuster. Lubricate the rocker arms. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

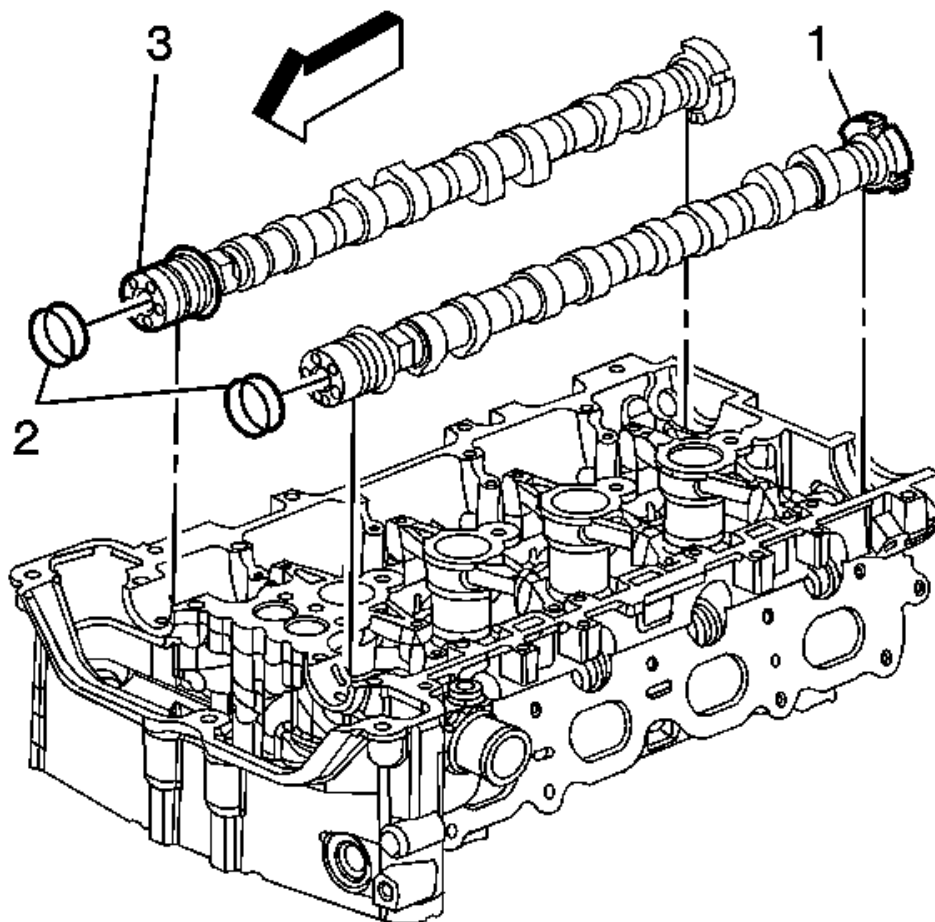


Fig. 203: Identifying Intake/Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

5. Install the exhaust camshaft. Lubricate the camshaft. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

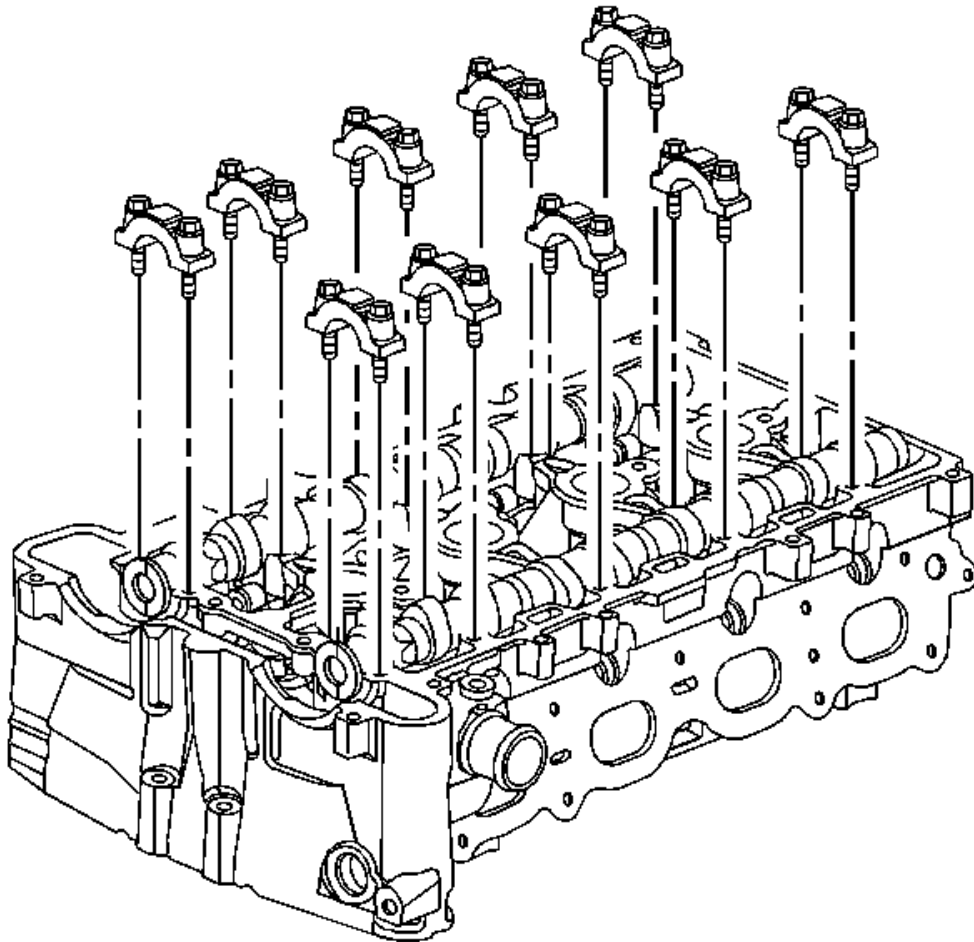


Fig. 204: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

NOTE: The caps should be installed on the cylinder head in sequence as shown on top of the bearing caps.

6. Position the camshaft bearing caps. Install the bearing cap bolts hand tight.

CAUTION: Refer to Fastener Caution .

7. Tighten the bearing cap bolts in increments of 3 turns until they are seated.

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

8. Install the camshaft position exhaust actuator. Refer to Camshaft Position Exhaust Actuator Replacement.

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

SPECIAL TOOLS

- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the spark plugs. Refer to **Spark Plug Replacement**

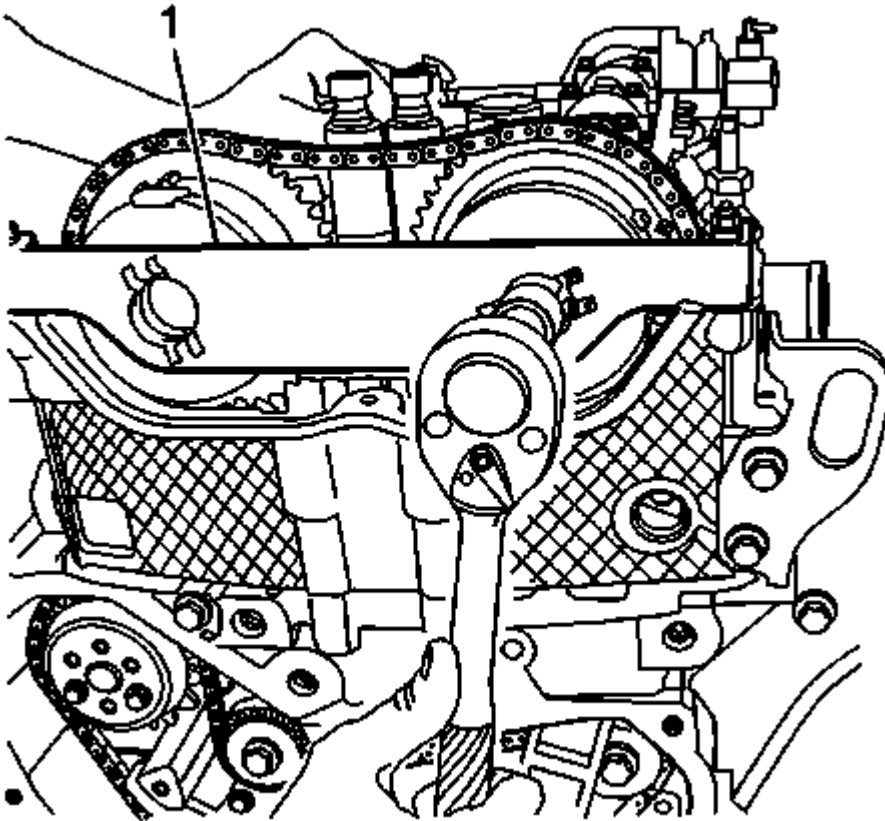


Fig. 205: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the camshaft actuator retainer **EN-48953** (1).

CAUTION: Refer to **Fastener Caution** .

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but DO NOT remove the intake camshaft actuator bolt.
6. Remove the camshaft actuator locking tool, **EN-48953** (1).
7. Clean the timing chain and gears with solvent.

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

8. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

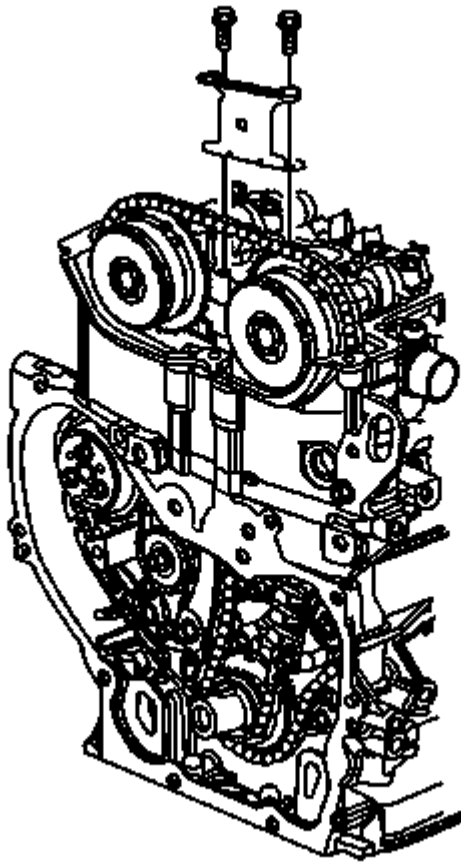


Fig. 206: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

9. Remove the upper timing chain guide bolts and guide.

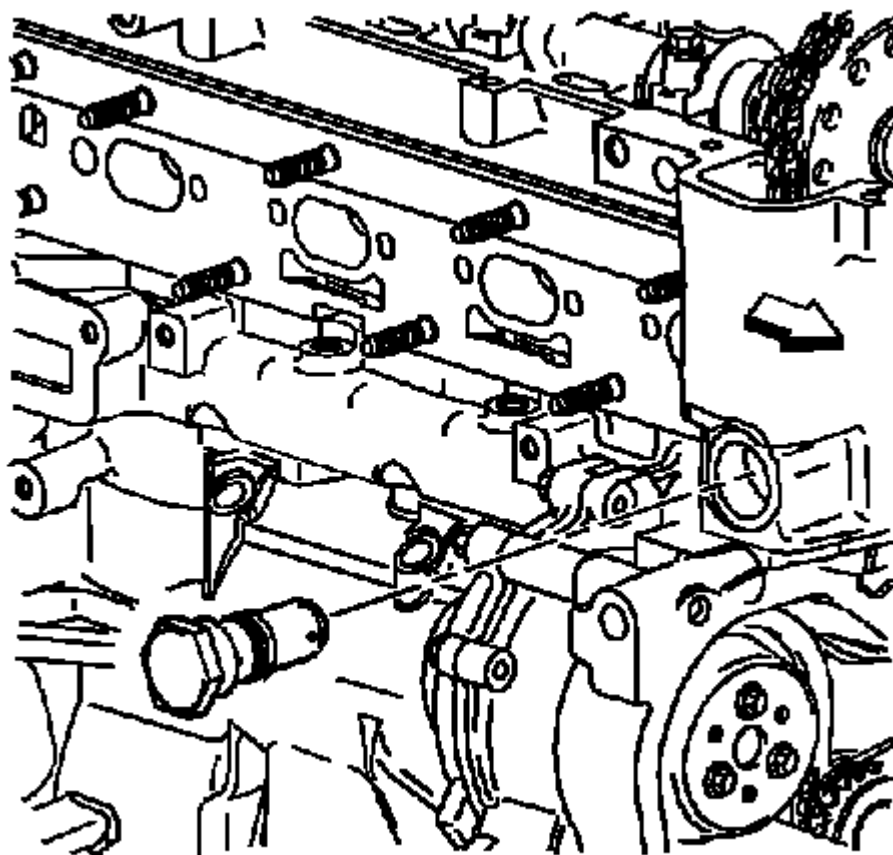


Fig. 207: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

10. Remove the timing chain tensioner.

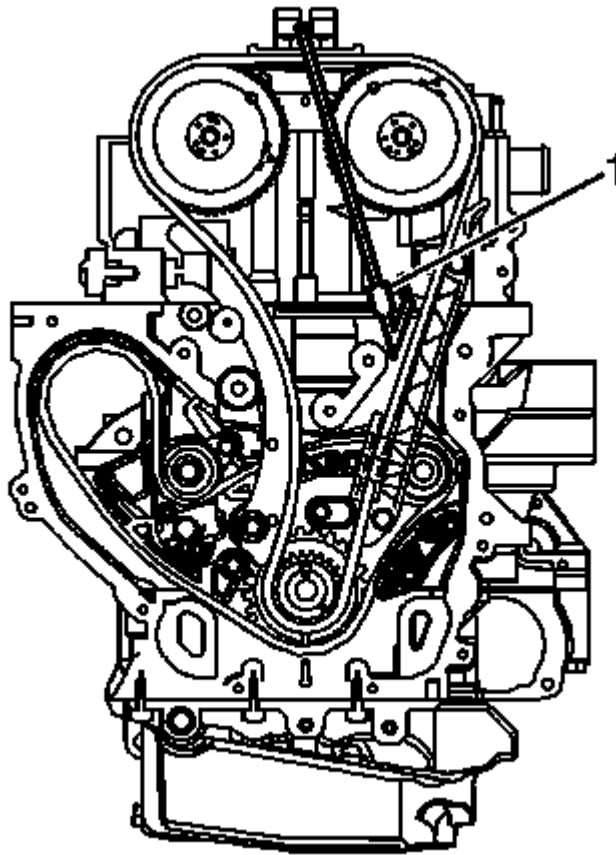


Fig. 208: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- The intake camshaft actuator should not rotate during the removal or installation.
- Ensure the tips of the are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

11. Install the timing chain retention tool **EN-48749** (1) to the intake side of the timing chain.

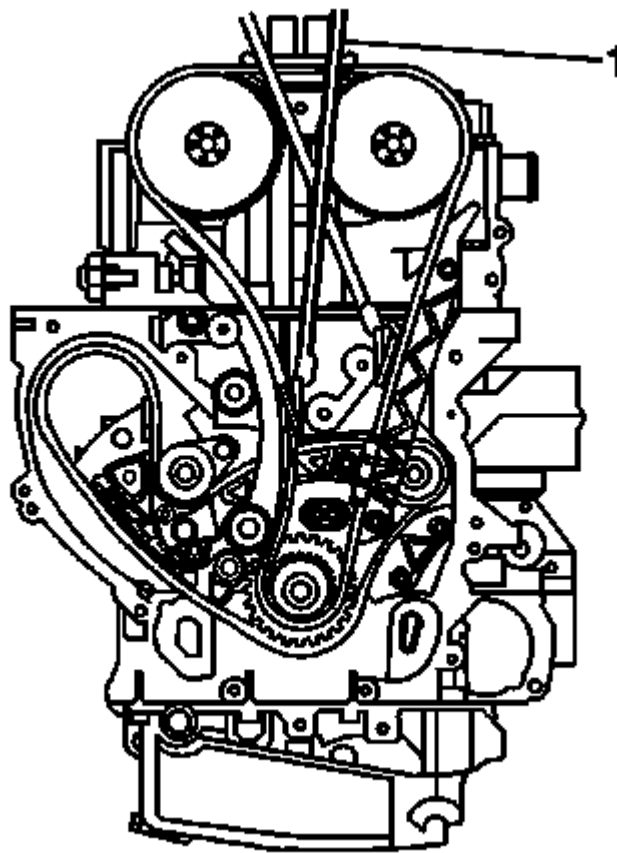


Fig. 209: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the timing chain retention tool EN-48749 (1) to the exhaust side of the timing chain.

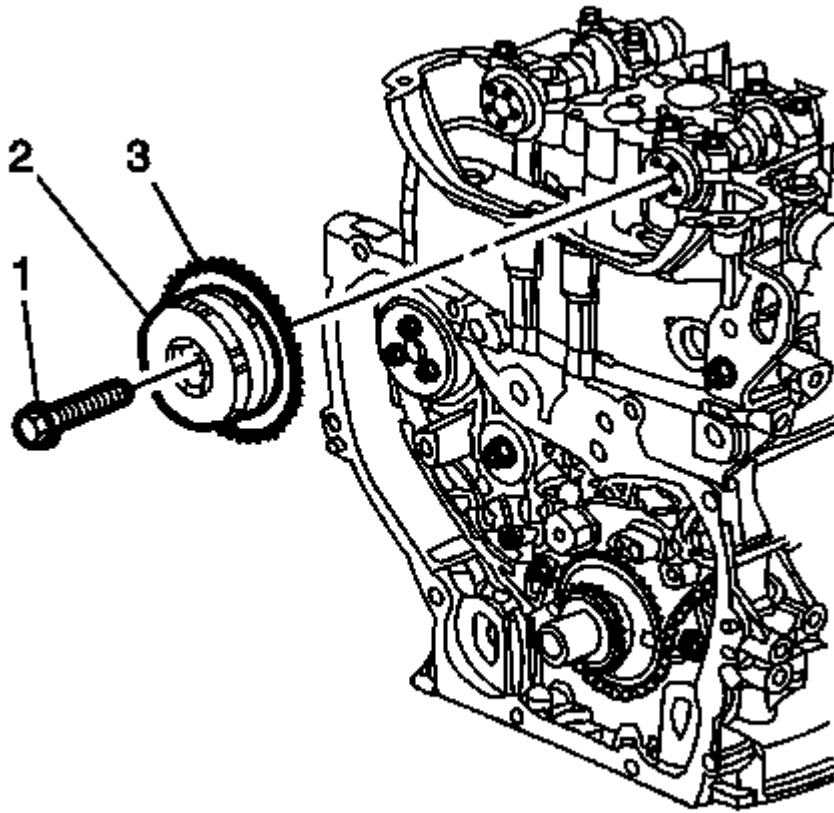


Fig. 210: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

13. Remove and discard the intake camshaft actuator bolt (2).
14. Rotate the exhaust camshaft clockwise slightly to take the tension off of the timing chain on the intake actuator.
15. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

INSTALLATION PROCEDURE

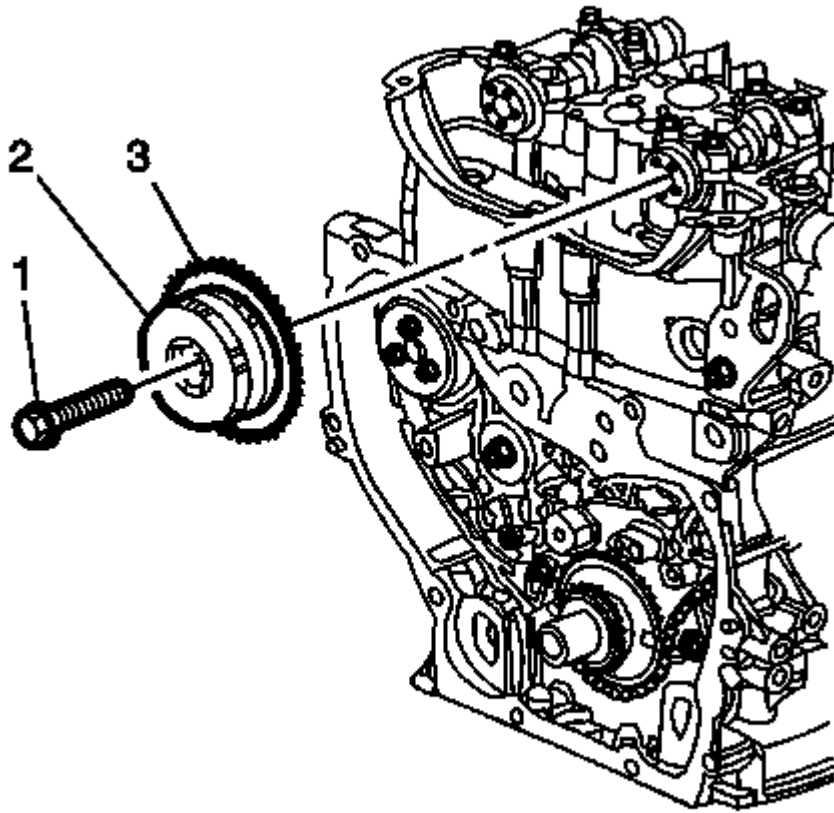


Fig. 211: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.

1. Install the timing chain onto the intake camshaft actuator.
2. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft rotating the exhaust camshaft clockwise, if required.
3. Install a NEW intake camshaft actuator bolt (2) until snug.

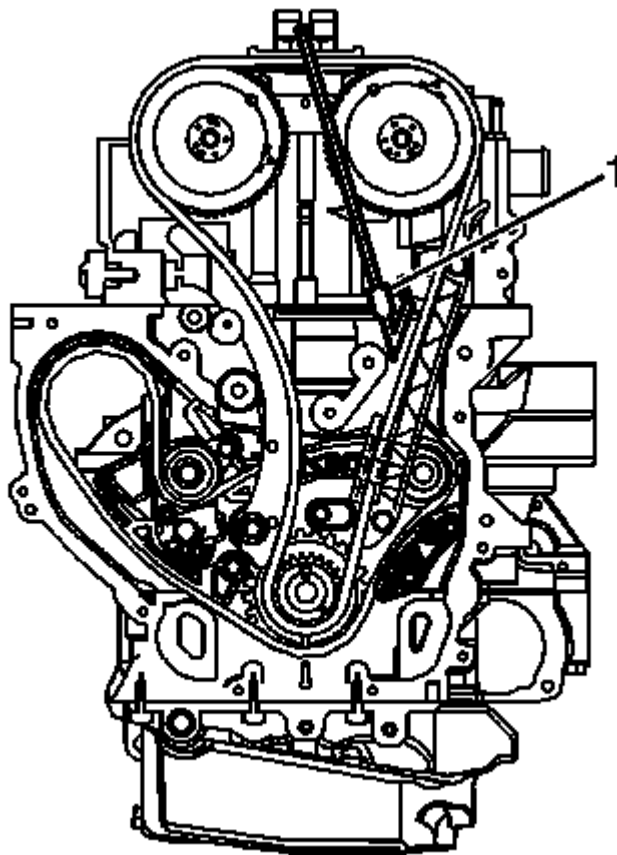


Fig. 212: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

4. Remove the timing chain retention tool (1) from the intake side of the timing chain.

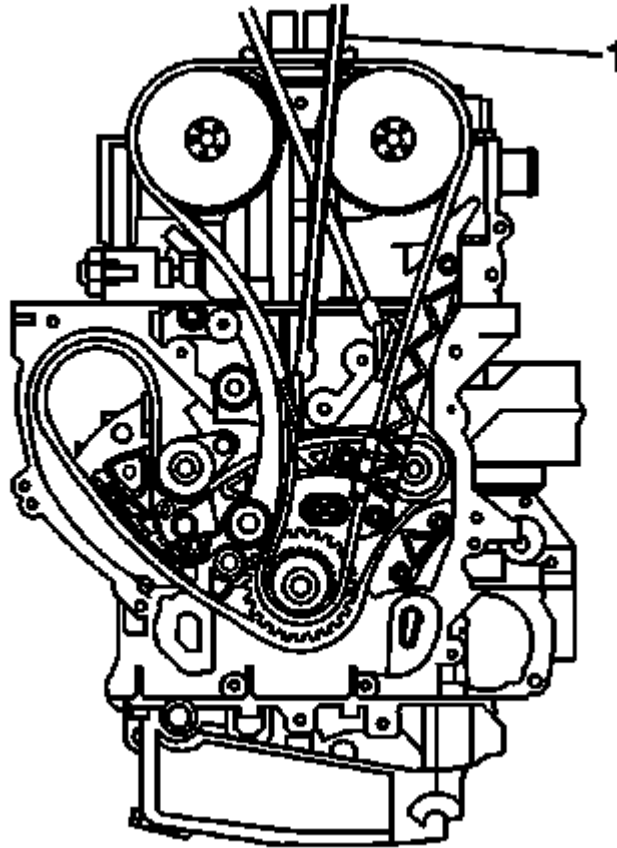


Fig. 213: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark previously on the intake camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

5. Remove the timing chain retention tool (1) from the exhaust side of the timing chain.
6. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

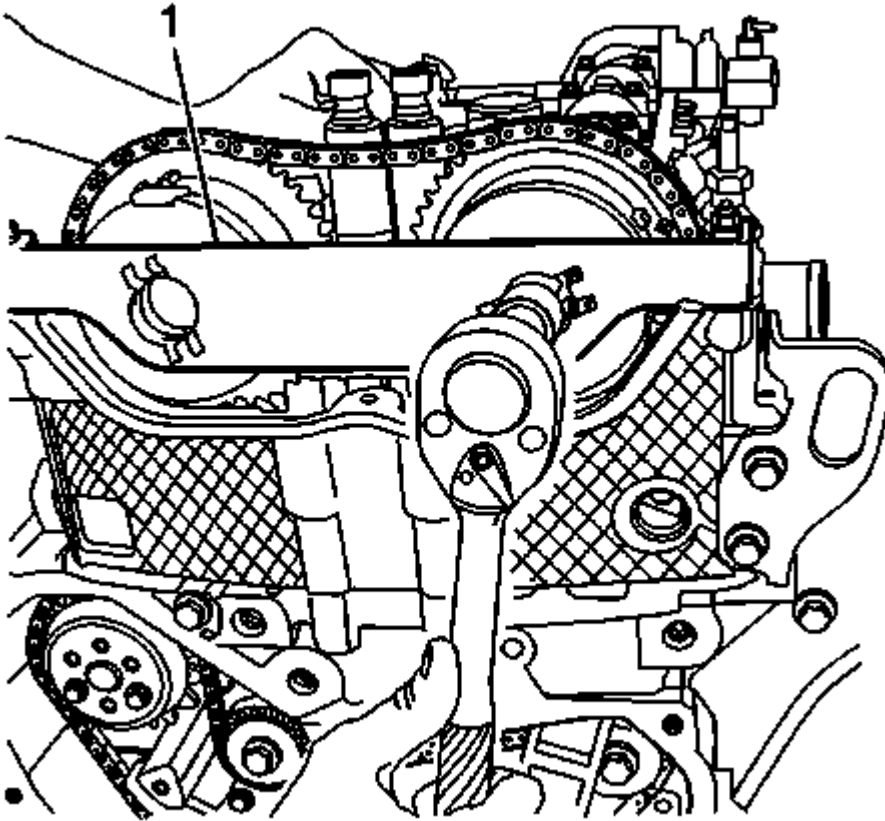


Fig. 214: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft actuator retainer (1) **EN-48953**: Camshaft Actuator Locking Tool.
8. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
9. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **J 45059**.

NOTE: You must have the **EN-48953** installed to perform this procedure.

10. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).
11. Remove the camshaft actuator retainer **EN-48953** (1).

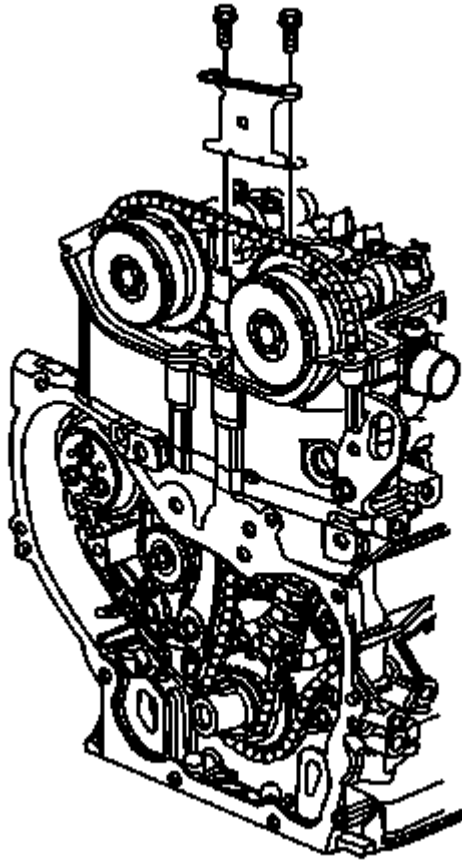


Fig. 215: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

12. Install the upper timing chain guide and bolts and tighten to 10 N.m (89 lb in).
13. Install the spark plugs. Refer to **Spark Plug Replacement**
14. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

SPECIAL TOOLS

- **EN-48749** Timing Chain Retention Tool Kit
- **EN-48953** Camshaft Actuator Locking Tool
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the spark plugs. Refer to **Spark Plug Replacement**

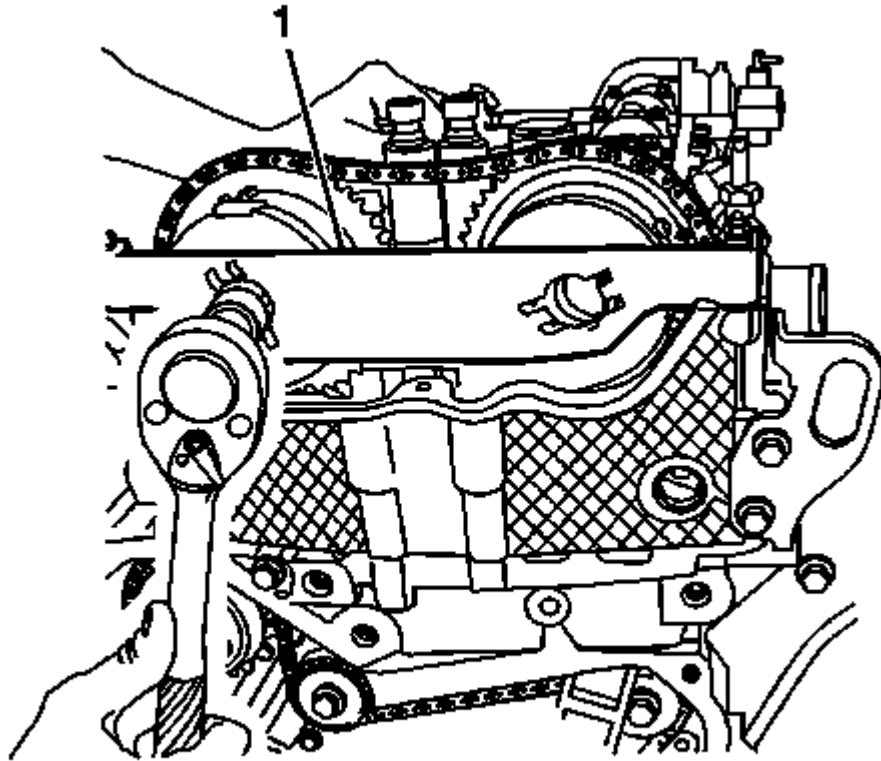


Fig. 216: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the camshaft actuator retainer **EN-48953** (1).

CAUTION: Refer to Fastener Caution .

4. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).
5. Loosen, but do not remove the exhaust camshaft actuator bolt.
6. Clean the timing chain and gears with solvent.

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

7. Mark the intake and exhaust camshaft actuators and the respective locations on the timing chain.

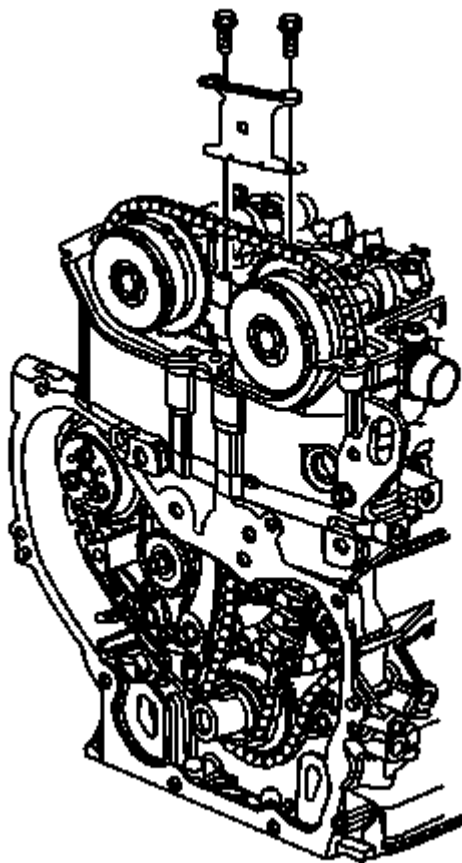


Fig. 217: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

8. Remove the upper timing chain guide bolts and guide.

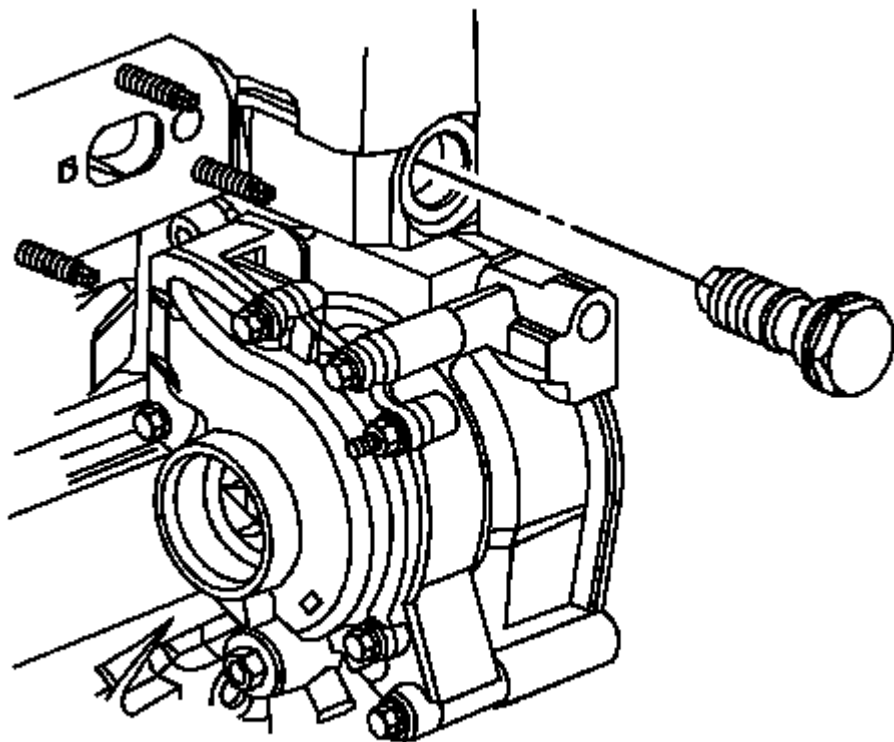


Fig. 218: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

9. Remove the timing chain tensioner.

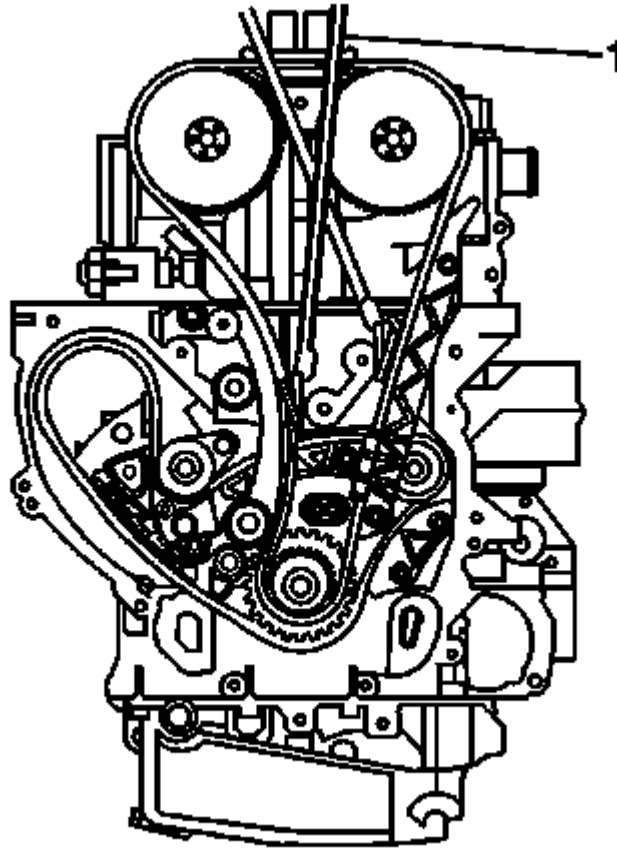


Fig. 219: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- The camshaft actuators should not rotate during the removal or installation.
- Ensure the tips of the EN-48749 are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

10. Install the timing chain retention tool **EN-48749** (1) to the exhaust side of the timing chain.

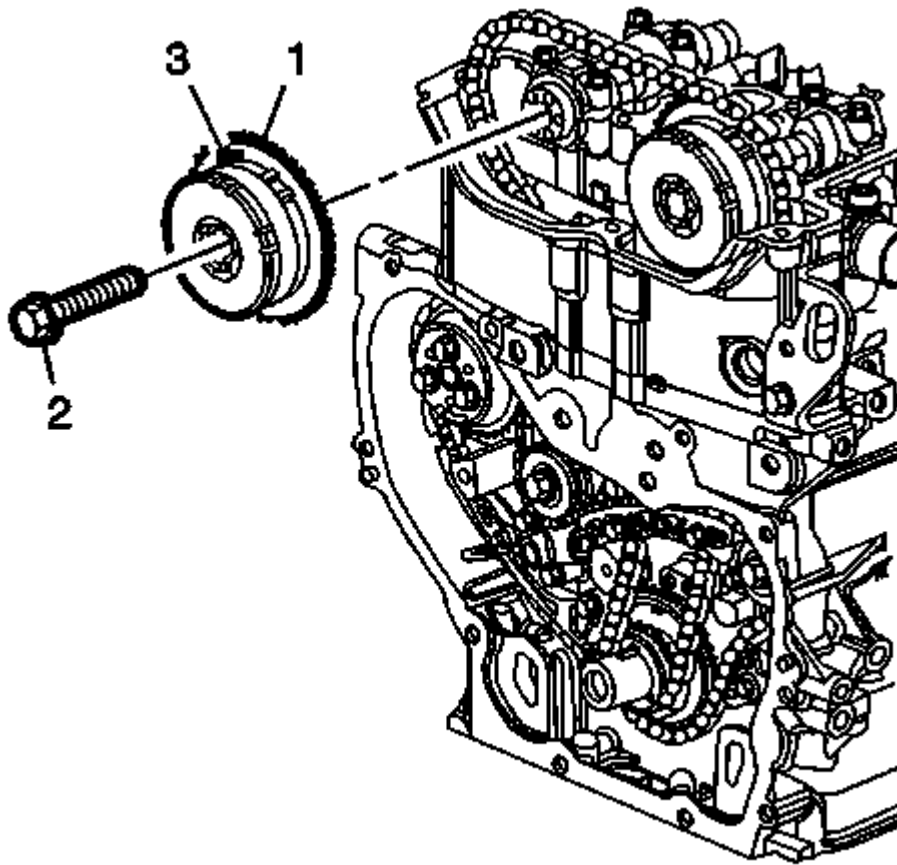


Fig. 220: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

11. Remove and discard the exhaust camshaft actuator bolt (2).
12. Remove the exhaust camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

INSTALLATION PROCEDURE

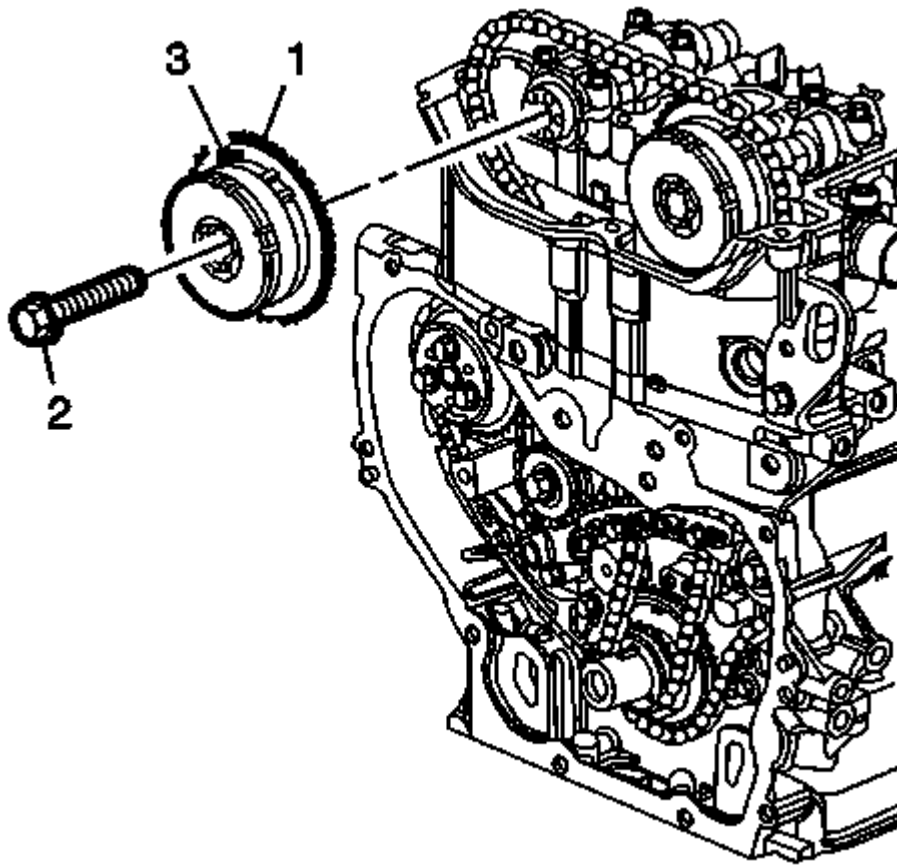


Fig. 221: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain.
- The exhaust camshaft may need to be rotated clockwise to fully set the camshaft actuator.

1. Install the timing chain onto the exhaust camshaft actuator.
2. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
3. Install a NEW exhaust camshaft actuator bolt (2) until snug.

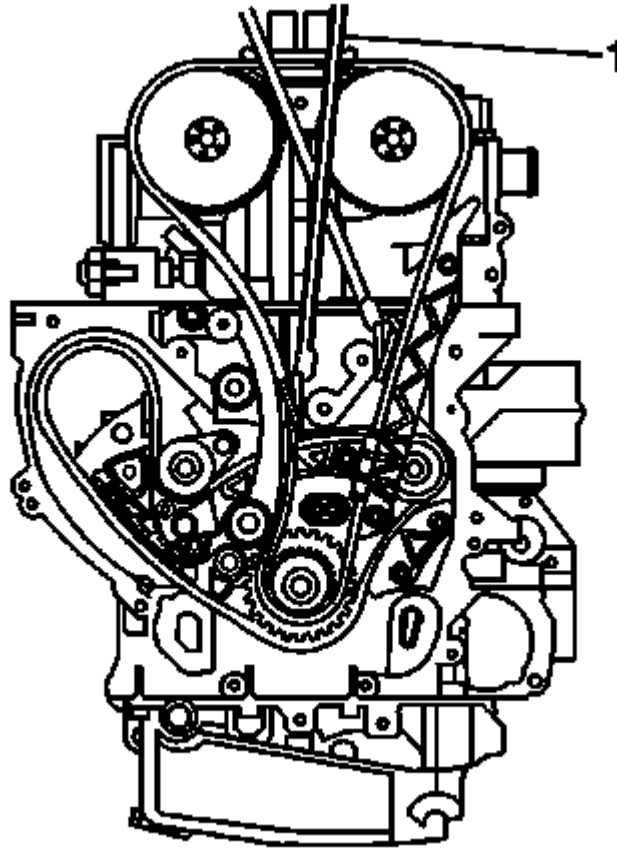


Fig. 222: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark previously on the exhaust camshaft actuator is still aligned properly with the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

4. Remove the timing chain retention tool EN-48749 (1) from the exhaust side of the timing chain.
5. Reset and install the timing chain tensioner. Refer to Timing Chain Tensioner Replacement.

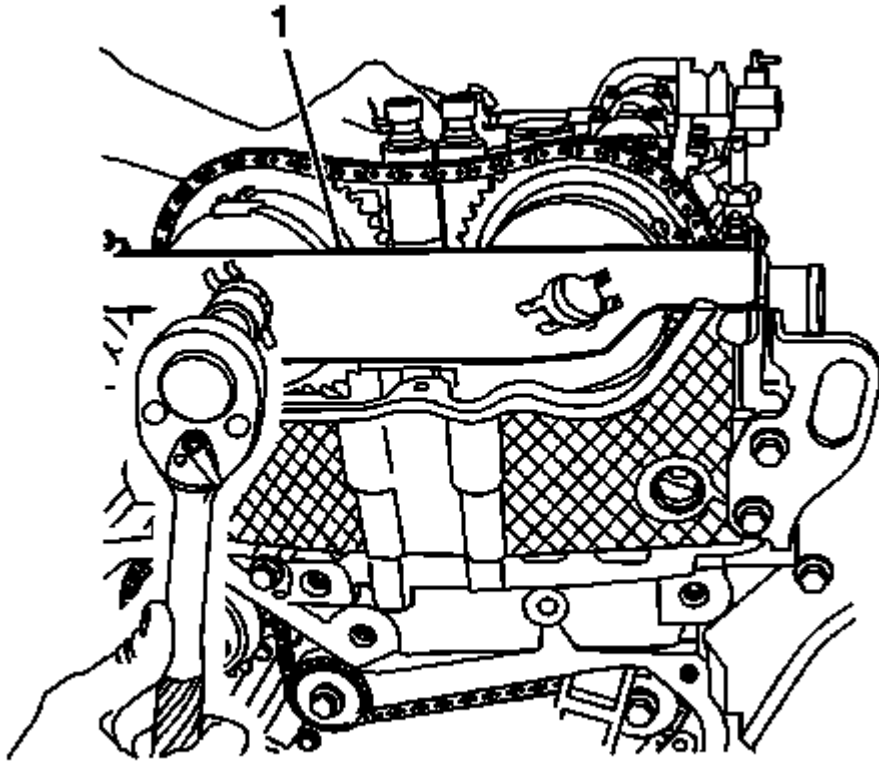


Fig. 223: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

6. Install the intake camshaft actuator retainer (1).
7. Install the camshaft actuator retainer bolts and tighten 10 N.m (89 lb in).
8. Tighten the NEW camshaft actuator bolt to 30 N.m (22 lb ft) plus an additional 100 degrees using the **J 45059**.

NOTE: You must have the **EN-48953** installed to perform this procedure.

9. To release the tensioner apply a counterclockwise rotational torque to the crankshaft balancer bolt of 45 N.m (33 lb ft).

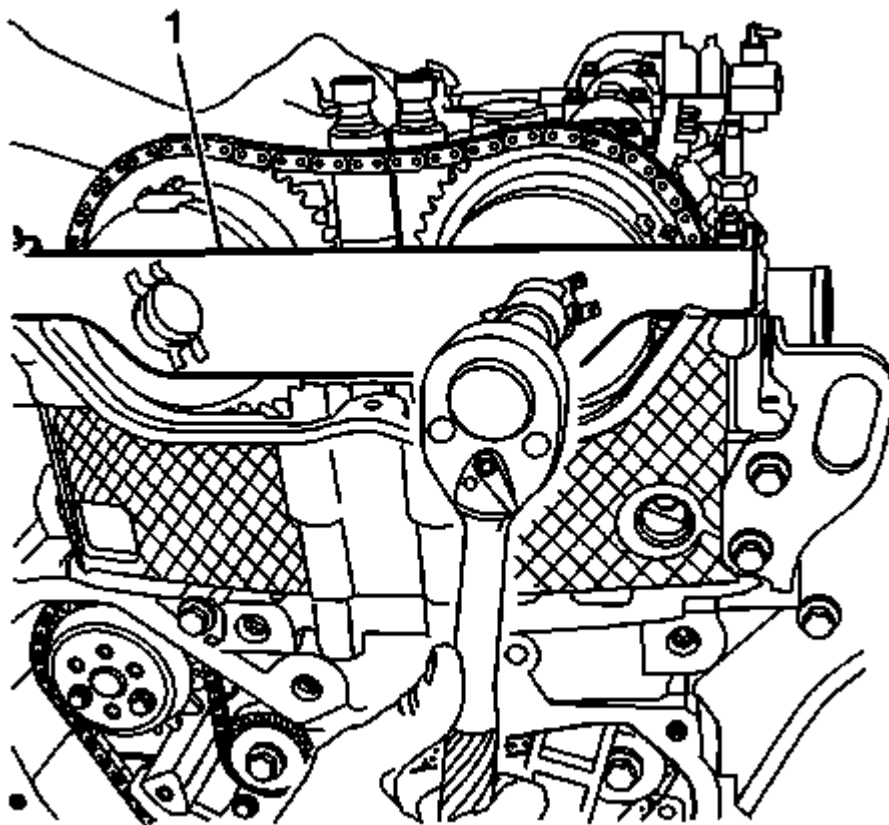


Fig. 224: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft actuator retainer **EN-48953** (1).

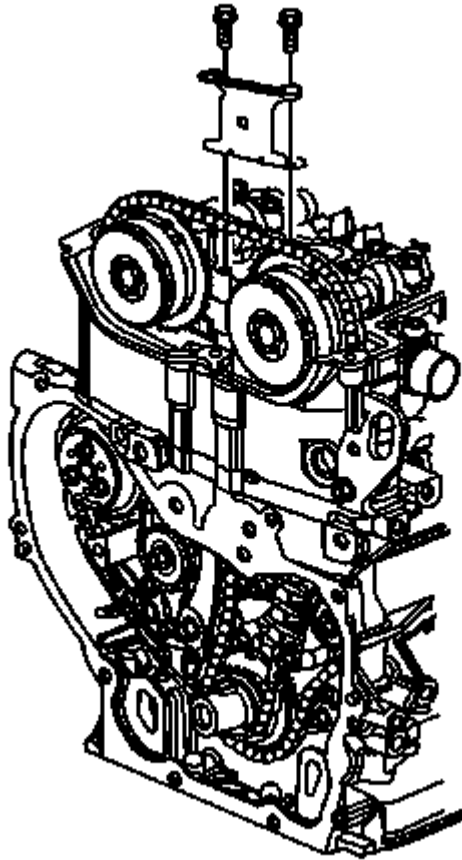


Fig. 225: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

11. Install the upper timing chain guide and bolts and tighten to 10 N.m (89 lb in).
12. Install the camshaft cover. Refer to Camshaft Cover Replacement.
13. Install the spark plugs. Refer to Spark Plug Replacement

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **J 43649** Valve Spring Compressor. See Special Tools .
- **J 36017** Valve Guide Seal Remover.
- **J 43653** Flywheel Holding Tool
- **J 43655** Sprocket Holding Tool

REMOVAL PROCEDURE

IMPORTANT: Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause

damage to J 43655 .

1. If equipped with a manual transmission leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped with an automatic transmission, remove the starter. Refer to **Starter Replacement** .
3. Install **J 43653** .

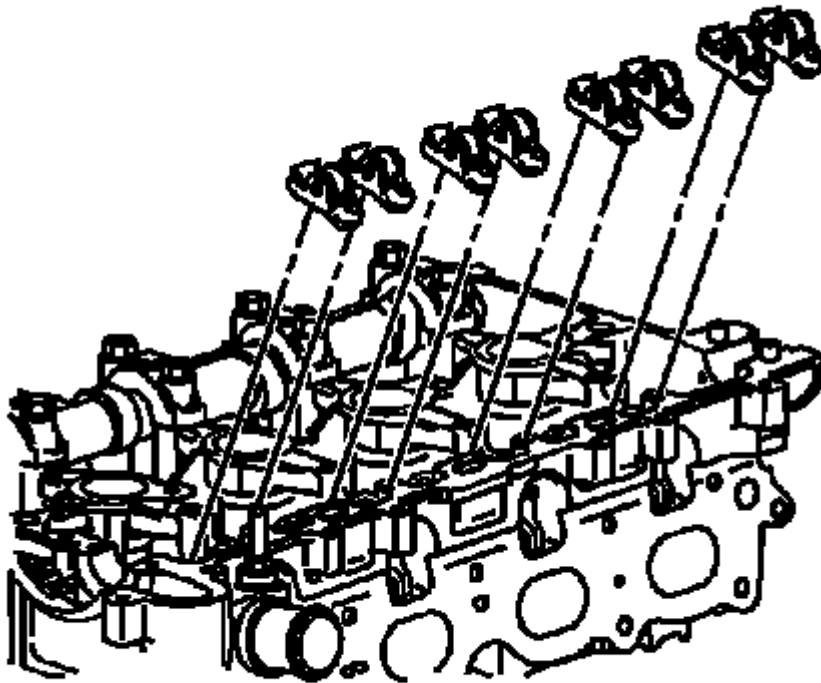


Fig. 226: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement** or **Exhaust Camshaft and Valve Lifter Replacement**.
5. Remove the camshaft roller followers.

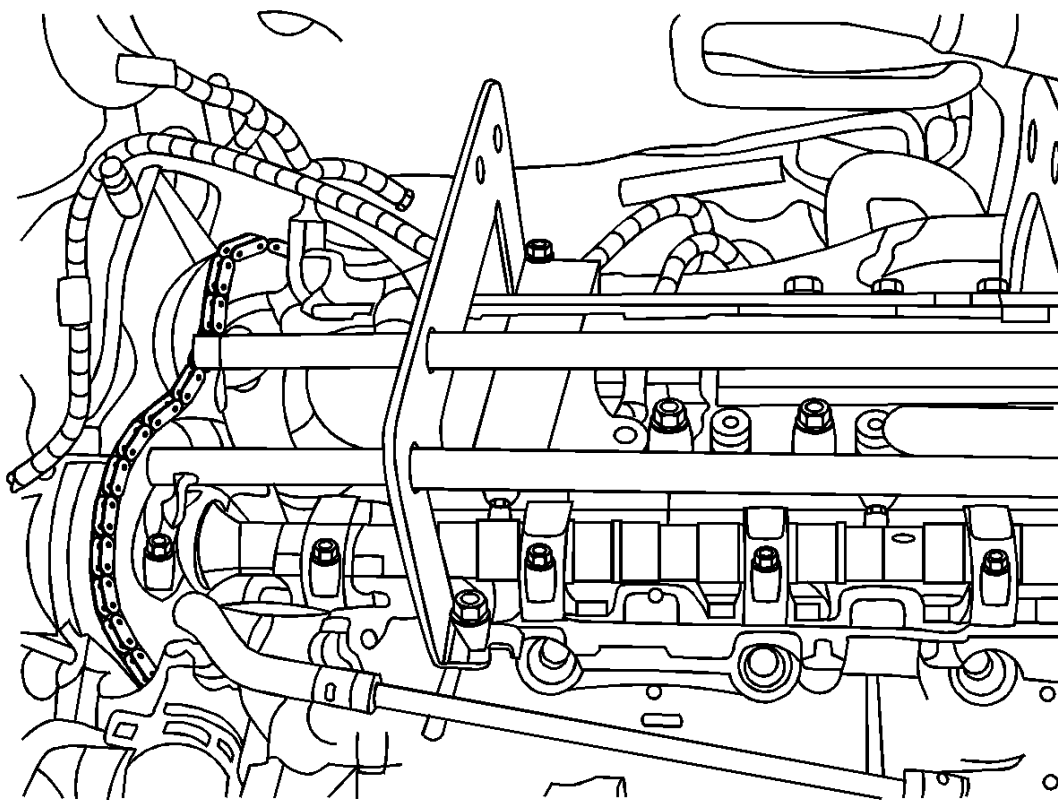


Fig. 227: View Of J 43649 Valve Spring Compressor (Second Camshaft Cover Bolt Hole)
Courtesy of GENERAL MOTORS CORP.

6. Install the front section of the **J 43649** to the second camshaft cover bolt hole. See **Special Tools** .

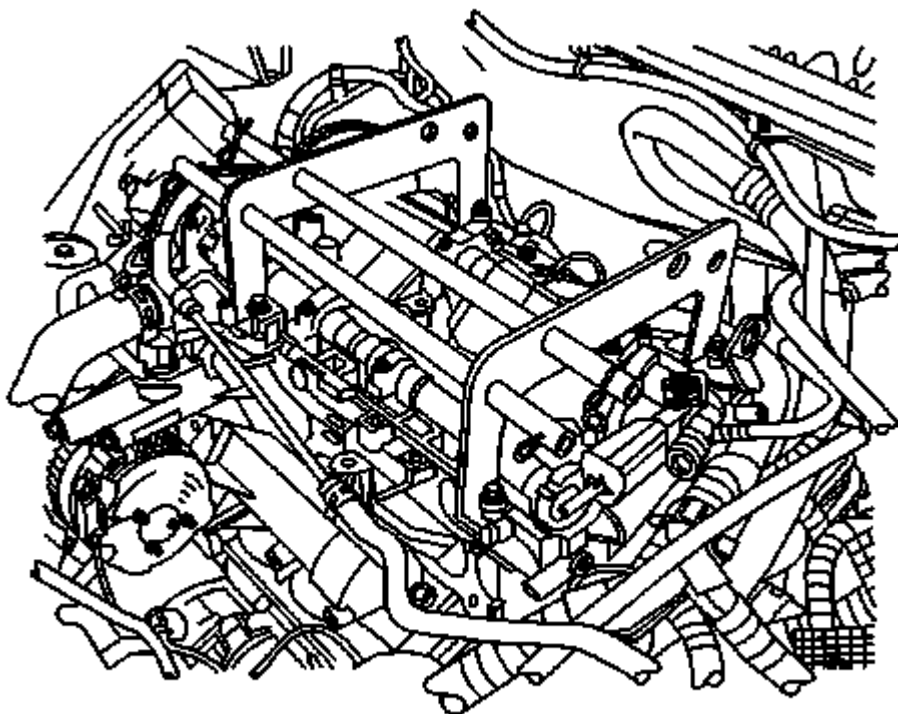


Fig. 228: View Of J 43649 Valve Spring Compressor (Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

7. Install the remaining parts of the **J 43649** to the cylinder head. See **Special Tools** .
8. Remove the spark plugs. Refer to **Spark Plug Replacement** .

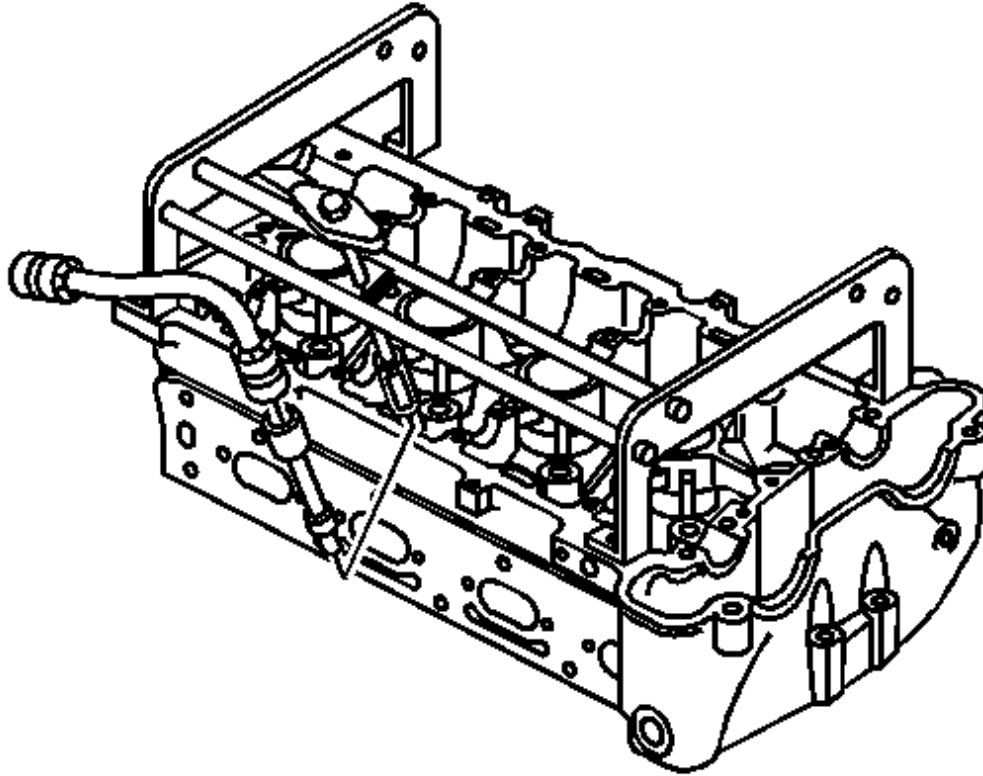


Fig. 229: View Of Air Hose Adaptor
Courtesy of GENERAL MOTORS CORP.

9. Install an air hose adapter into the spark plug hole.
10. Attach an air hose to the adapter
11. Using the compressed air, pressurize the cylinder to 690 kPa (100 psi).
12. Compress the valve spring using the **J 43649** . See **Special Tools** .

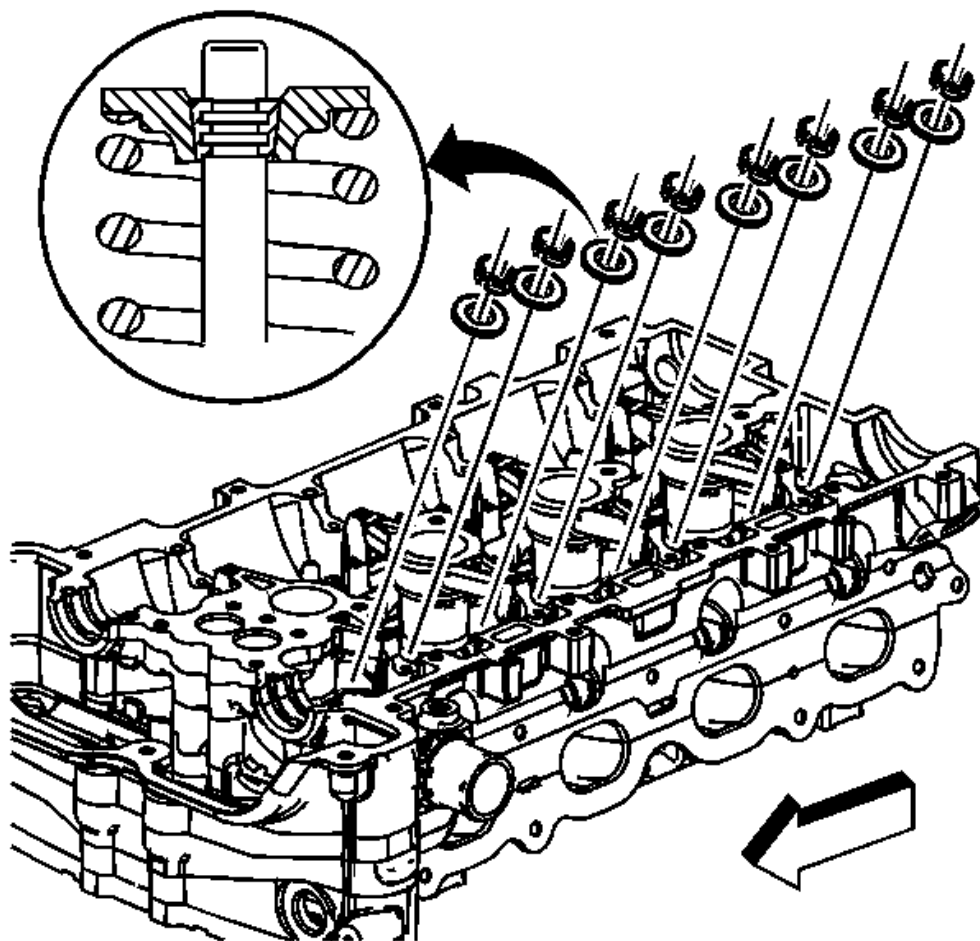


Fig. 230: Identifying Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

13. Remove the valve spring keepers.
14. Remove the valve spring retainer.

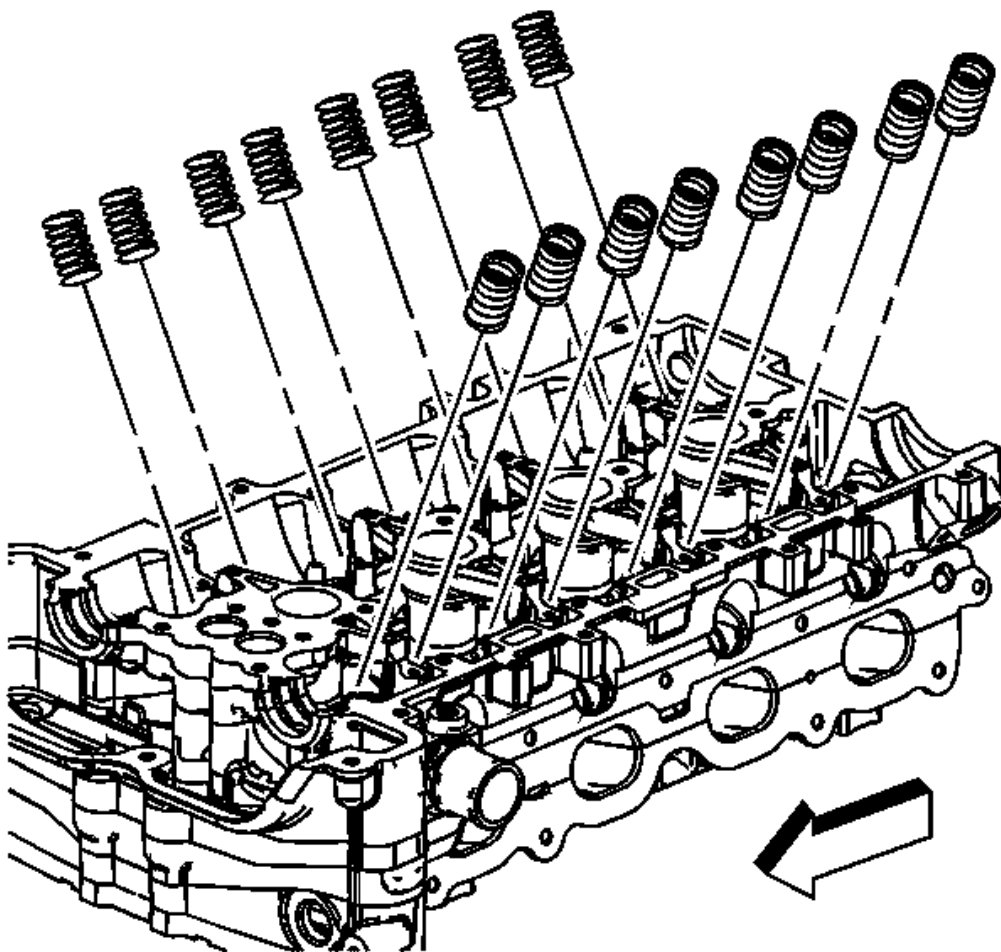


Fig. 231: Identifying Valve Springs
Courtesy of GENERAL MOTORS CORP.

15. Remove the valve spring.

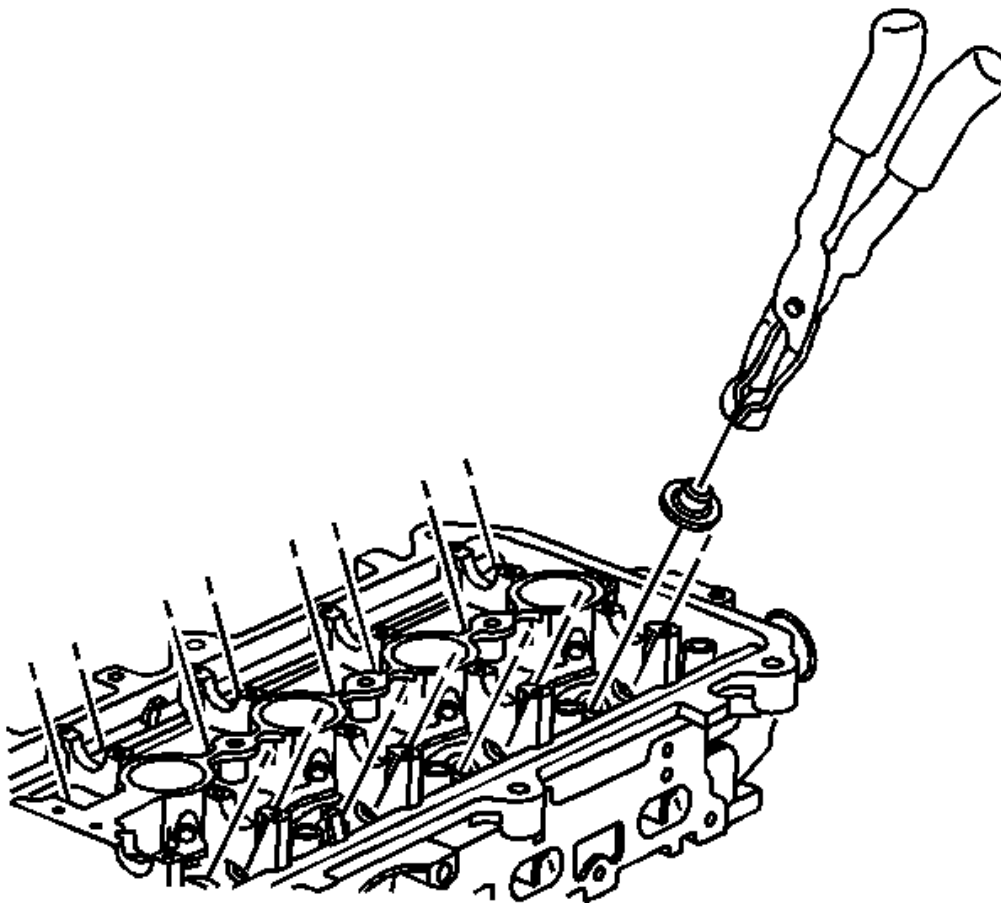


Fig. 232: View Of Special Tool J 36017 & Valve Seal
Courtesy of GENERAL MOTORS CORP.

16. Using the **J 36017** remove the valve seal. See **Special Tools** .

INSTALLATION PROCEDURE

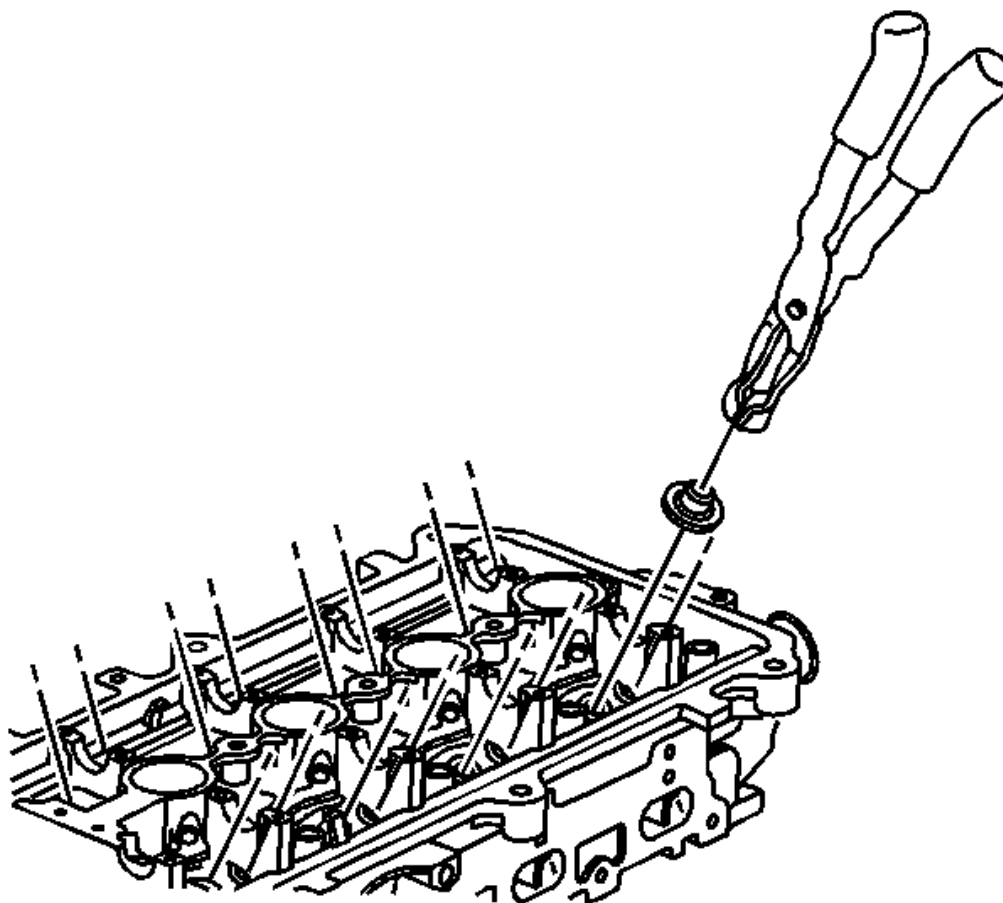


Fig. 233: View Of Special Tool J 36017 & Valve Seal
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 36017** install the NEW valve seal. See **Special Tools** . Fully seat the seal onto the valve guide.

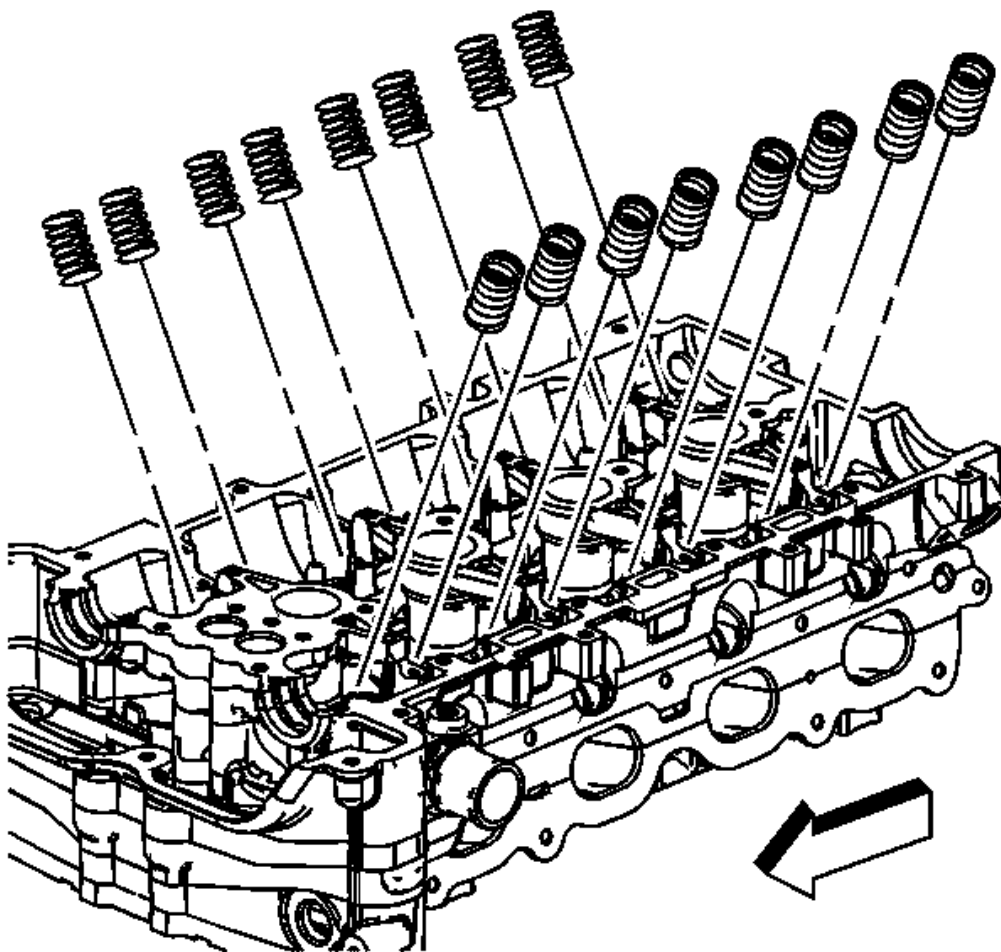


Fig. 234: Identifying Valve Springs
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.

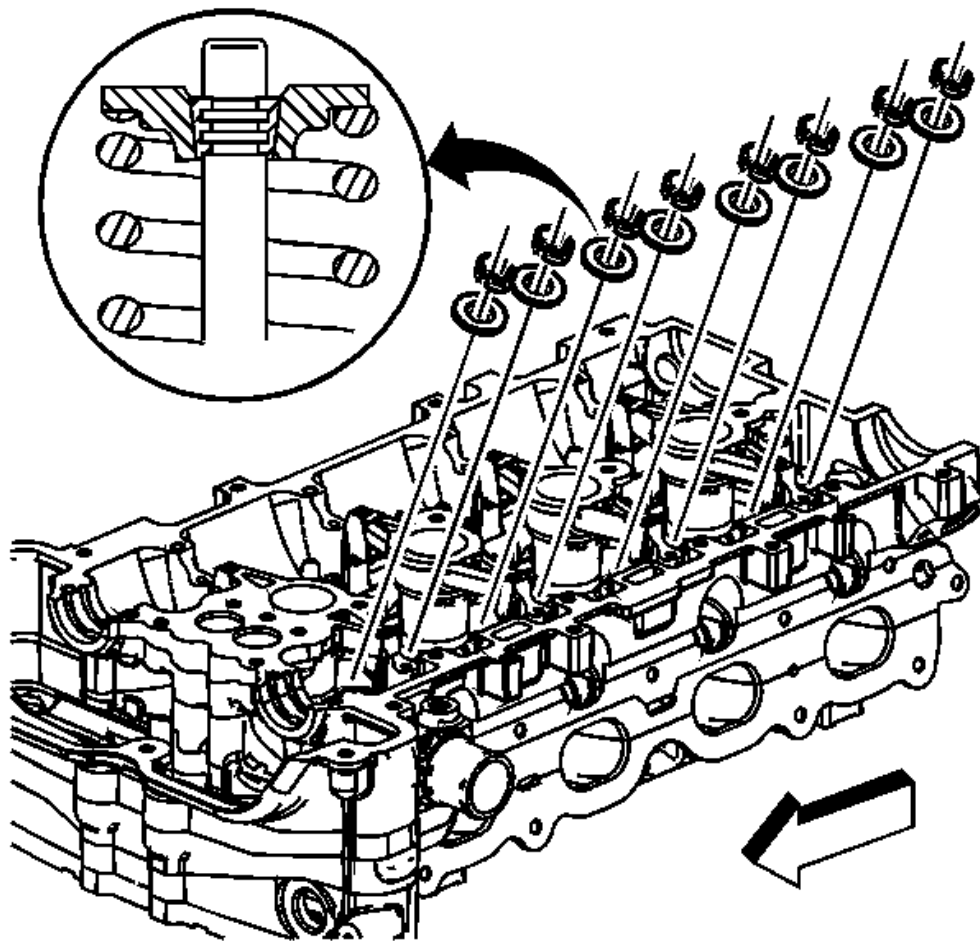


Fig. 235: Identifying Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

3. Install the valve spring retainer.
4. Compress the valve spring using the **J 43649** . See **Special Tools** .
5. Install the valve spring keepers.

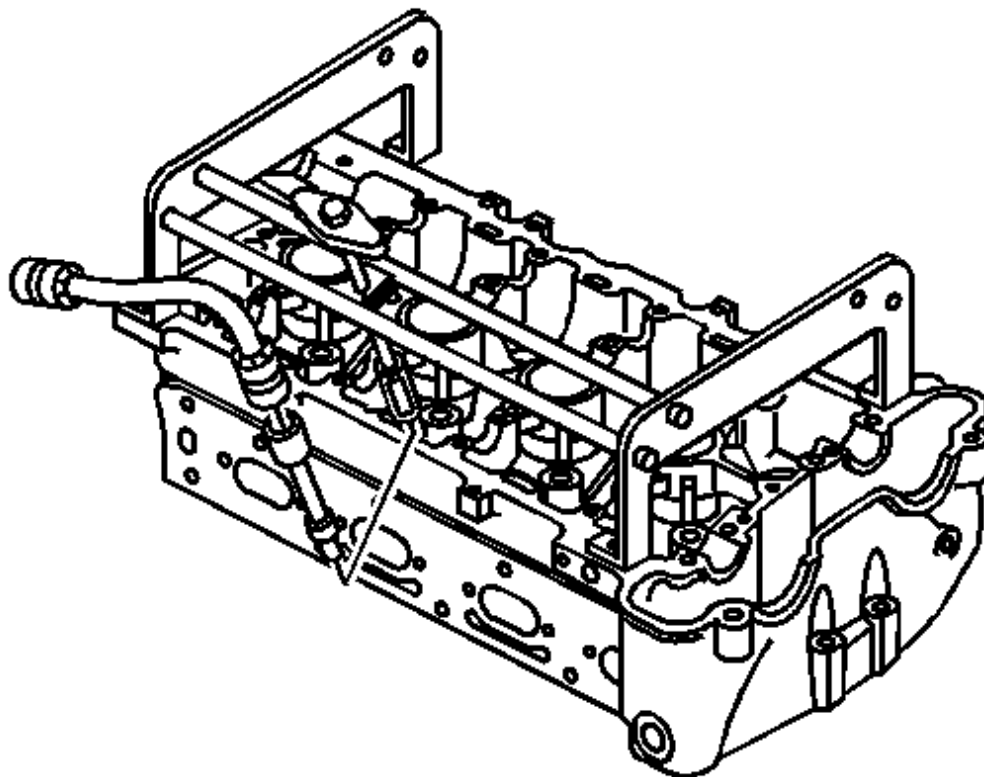


Fig. 236: View Of Air Hose Adaptor
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the air hose from the adaptor.
7. Remove the air hose adaptor from the spark plug hole.

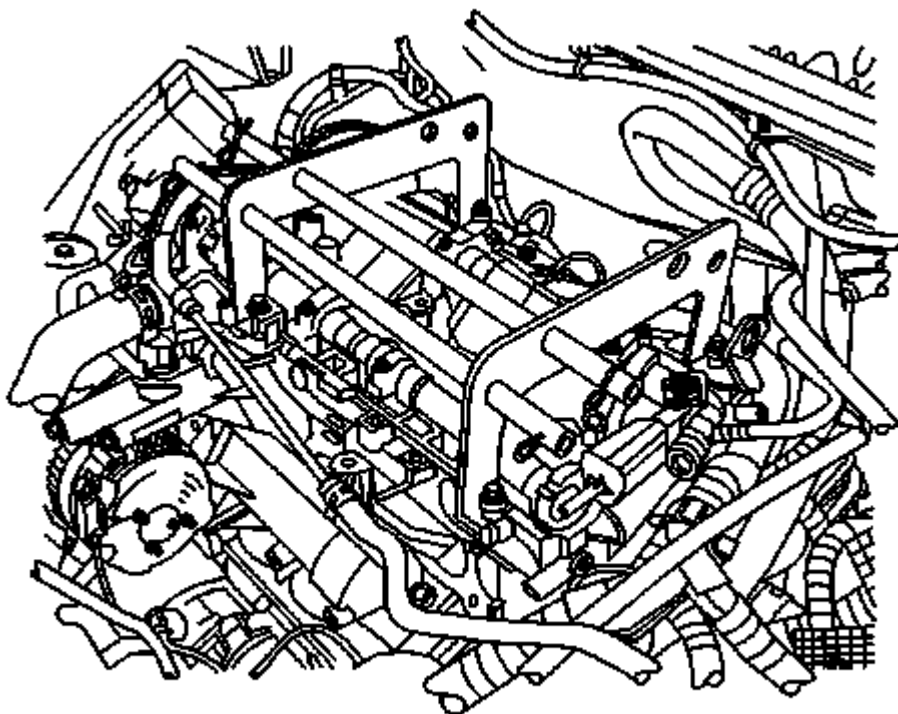


Fig. 237: View Of J 43649 Valve Spring Compressor (Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

8. Remove the **J 43649** from the cylinder head. See Special Tools .
9. Install the spark plugs. Refer to Spark Plug Replacement .

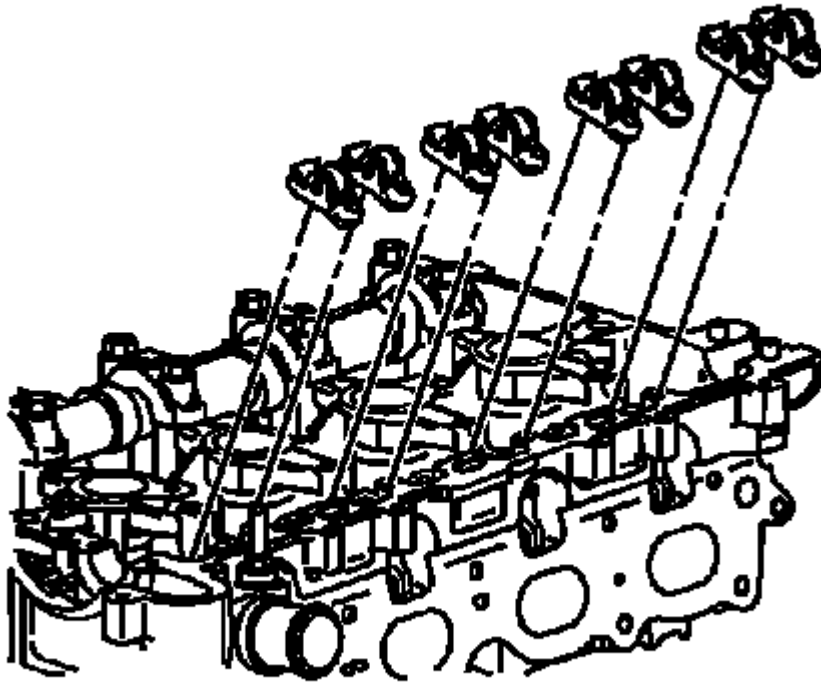


Fig. 238: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

10. Install the camshaft roller followers.
11. Install the camshaft. Refer to Intake Camshaft and Valve Lifter Replacement or Exhaust Camshaft and Valve Lifter Replacement.
12. If used, remove the J 43653 .
13. If removed, install the starter. Refer to Starter Replacement .

CYLINDER HEAD REPLACEMENT

SPECIAL TOOLS

- J 38185 Hose Clamp Pliers
- J 45059 Angle Meter
- EN-48953 Camshaft Actuator Locking Tool
- EN 46101 Spark Plug Tube Seal Guide

REMOVAL PROCEDURE

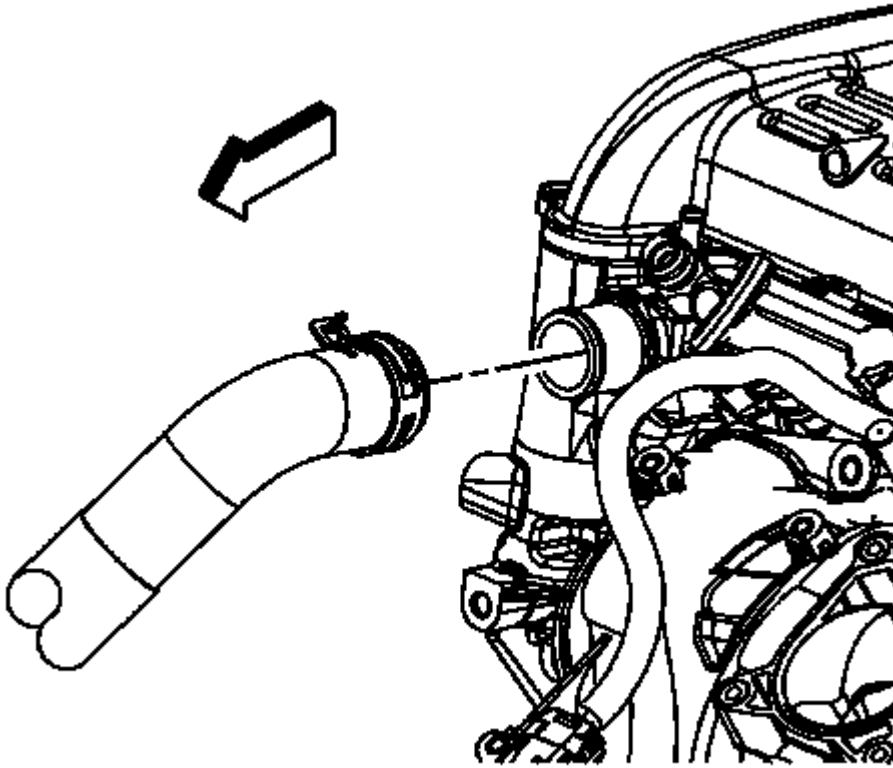


Fig. 239: View Of Radiator Inlet Hose To Engine
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE-47716) or Cooling System Draining and Filling (Static Fill-LNF) .
2. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LNF) .
3. Remove the intake manifold. Refer to Intake Manifold Replacement.
4. Reposition the radiator surge tank air bleed hose clamp.
5. Remove the radiator surge tank air bleed hose from the cylinder head.
6. Reposition the radiator inlet hose clamp using the **J 38185** .
7. Remove the radiator inlet hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
10. Remove the camshaft cover. Refer to Camshaft Cover Replacement.

NOTE: If the intake camshaft actuator is moving independently of the camshaft, this means the camshaft is not locked to the actuator. Rotate the camshaft counter-clockwise while the holding tool is installed and this will lock the camshaft to the actuator.

11. Rotate the crankshaft clockwise to install the camshaft actuator retaining tool **EN-48953**: EGR Cooler Pressure Tester Adapter Set.

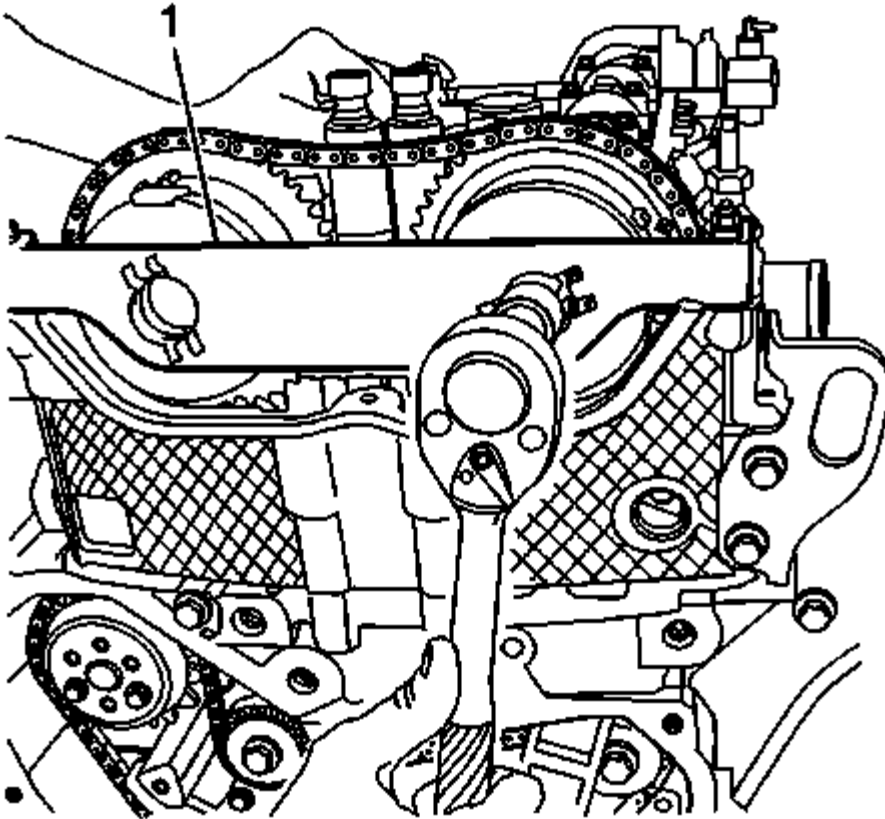


Fig. 240: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the **EN-48953** (1).

CAUTION: Refer to Fastener Caution .

13. Install the camshaft actuator retainer bolts and tighten to 10 N.m (89 lb in).

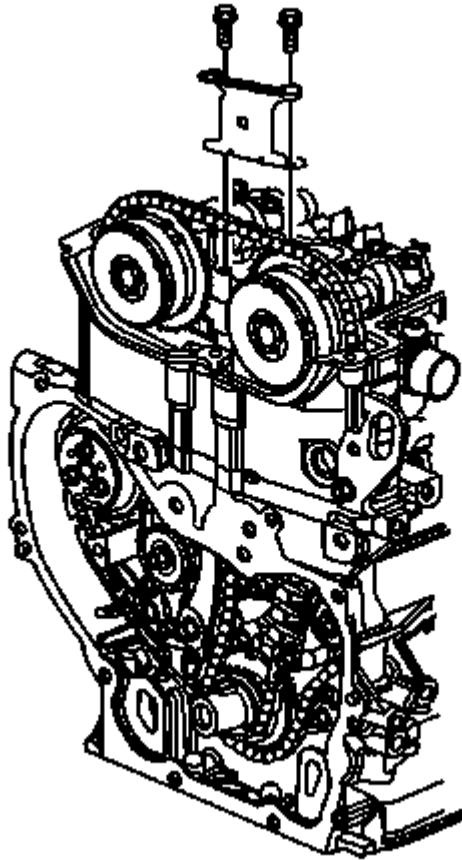


Fig. 241: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

14. Remove the upper timing chain guide bolts and guide.
15. Clean the timing chain and gears with solvent.

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

16. Mark the timing gear sprockets and the timing chain. It is recommended that the paint marks are located in the 12 o'clock position.
17. Loosen, but do not remove the intake and exhaust camshaft actuator bolts.
18. Remove the camshaft actuator locking tool, **EN-48953** .

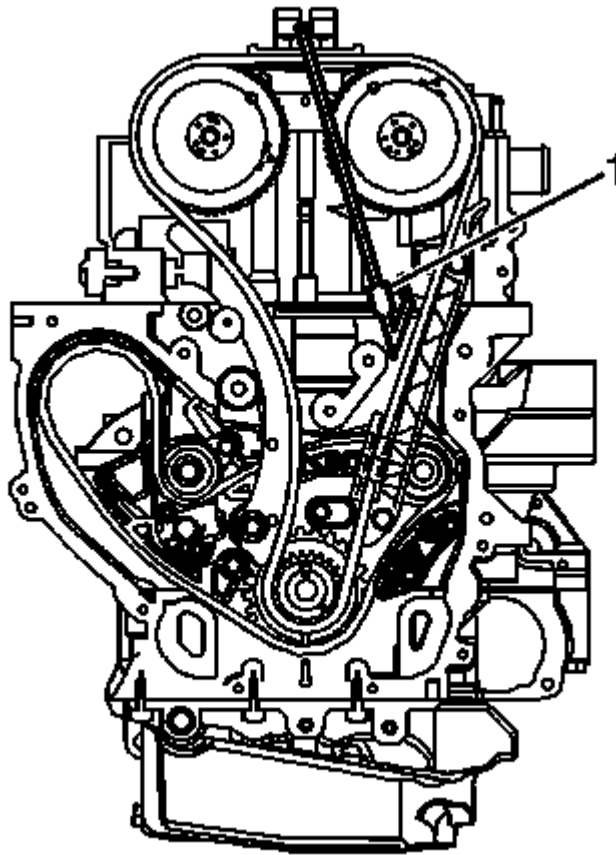


Fig. 242: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the tips of the EN-48749 are fully engaged into the timing chain. The retention tool rod can be used on the back side of the chain to ensure the teeth from the retention tool are engaged.

19. Install the timing chain retention tool EN-48749 (1) to the intake side of the timing chain.

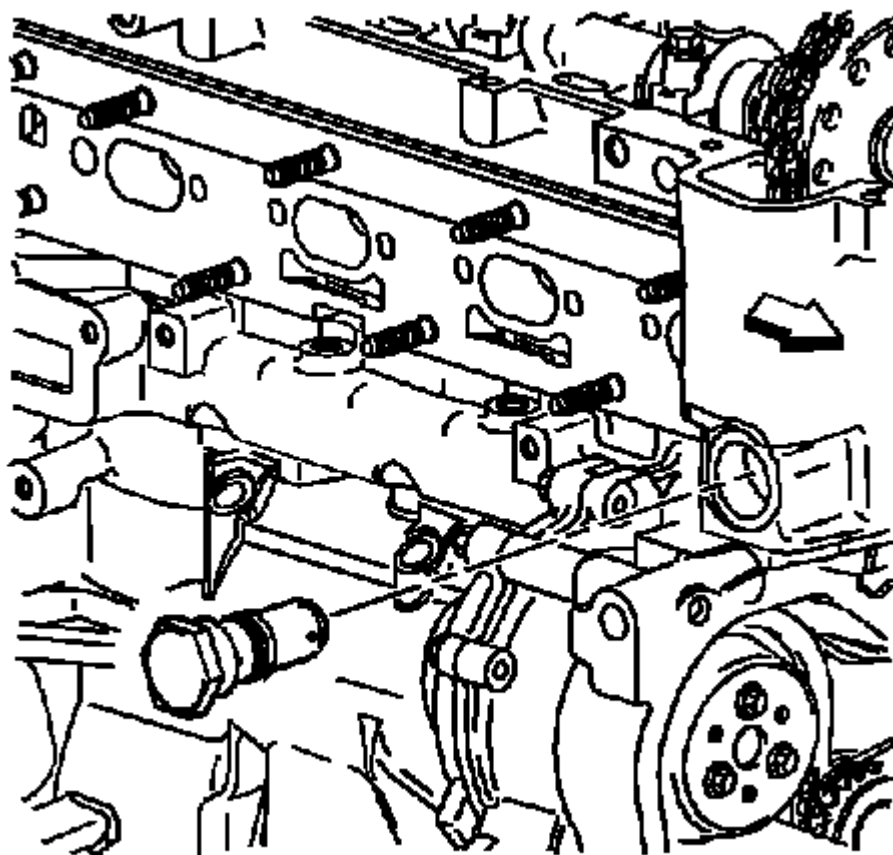


Fig. 243: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

20. Remove the timing chain tensioner.

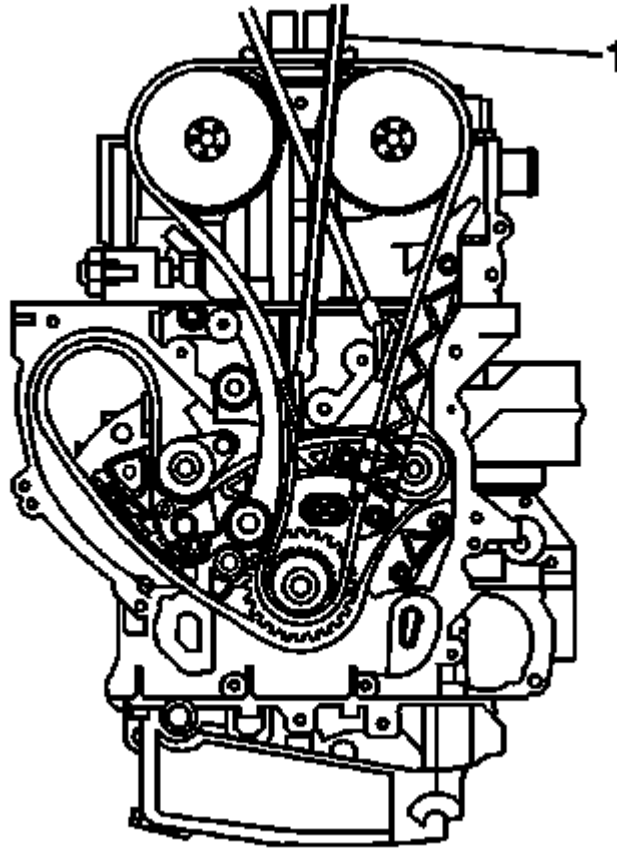


Fig. 244: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: The Intake camshaft and actuator should not rotate during the removal or installation.

21. Install the timing chain retention tool **EN-48749** (1) to the exhaust side of the timing chain.

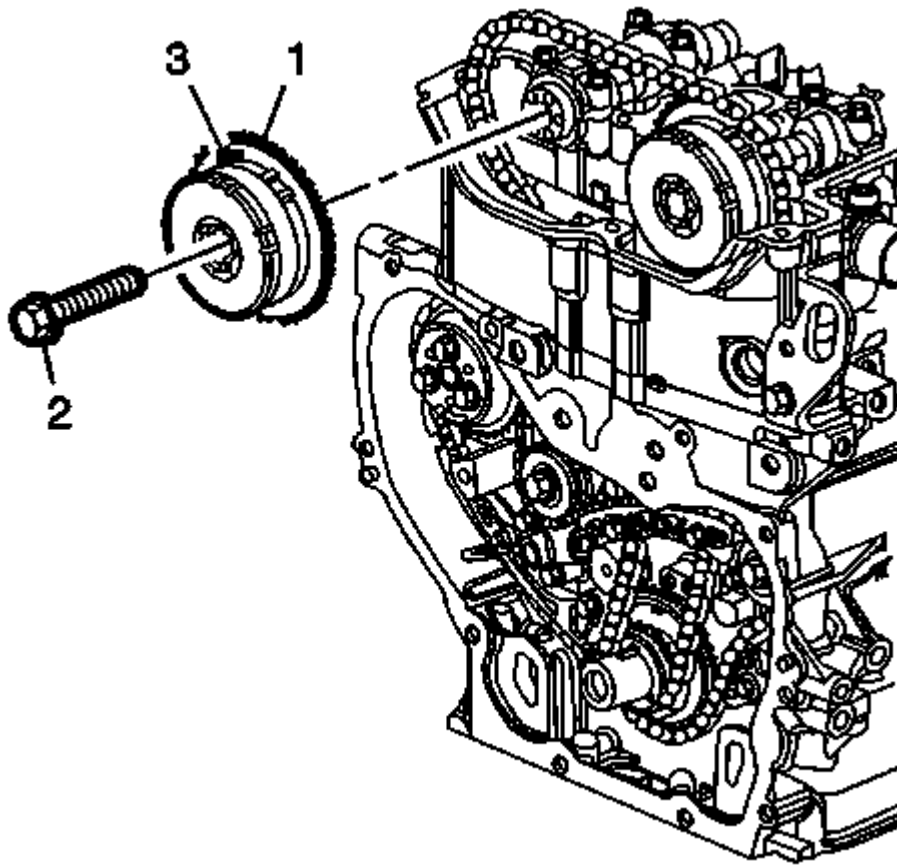


Fig. 245: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

22. Remove and discard the exhaust camshaft actuator bolt (2).
23. Remove the exhaust cam actuator (3) from the exhaust camshaft while also removing the actuator from the chain.

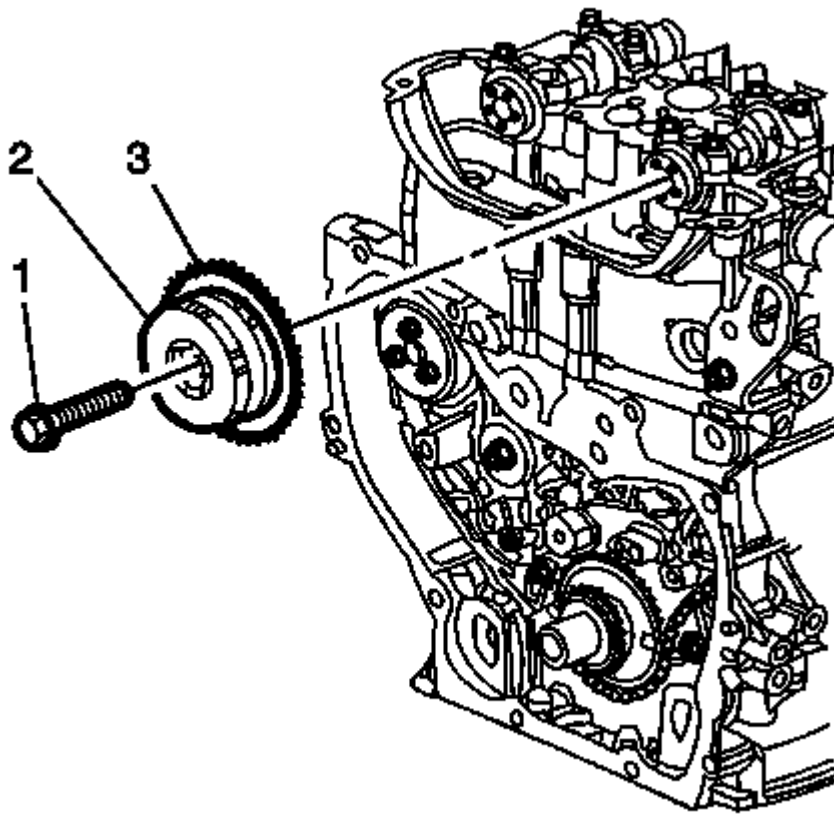


Fig. 246: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

24. Remove and discard the intake camshaft actuator bolt (2).
25. Remove the intake camshaft actuator (3) from the camshaft while also removing the actuator from the timing chain.

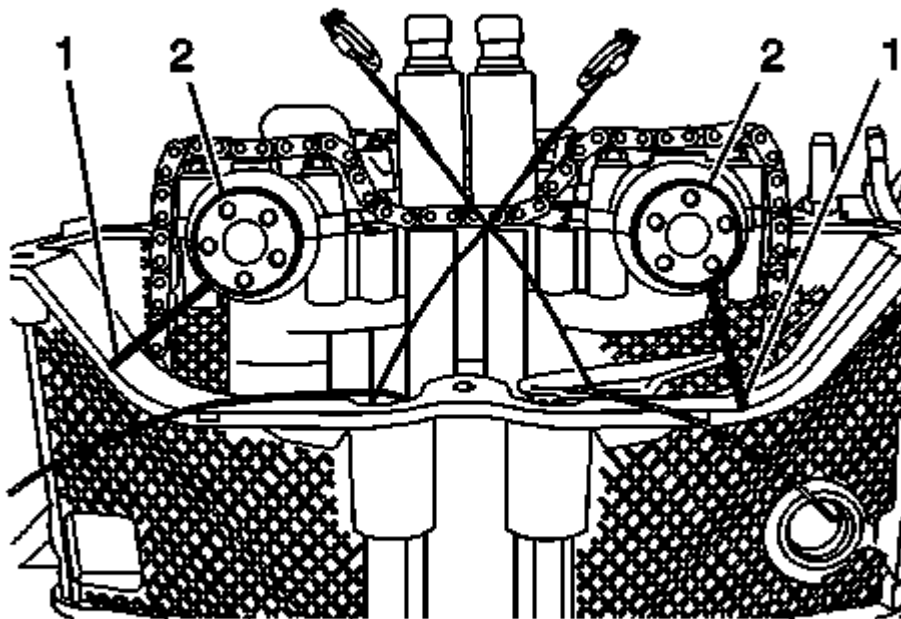


Fig. 247: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

26. Mark the cylinder head (1) in relationship to the camshaft actuator notch is on the camshaft (2).

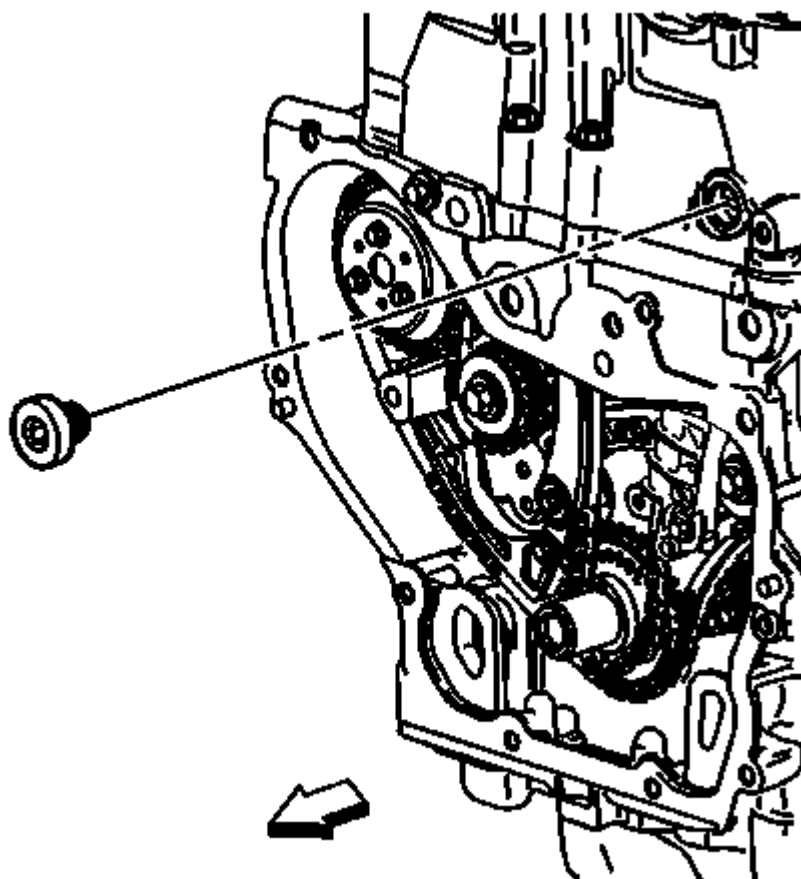


Fig. 248: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

27. Remove the fixed timing chain guide access plug.
28. Remove the upper fixed timing chain guide bolt.

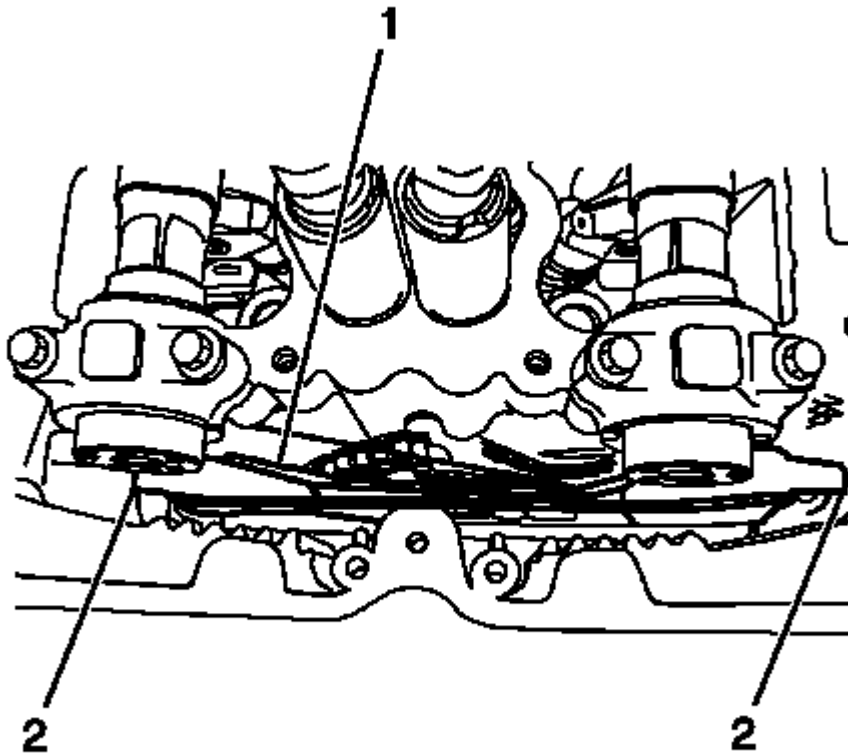


Fig. 249: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

NOTE: The threaded rod from the timing chain retention tool can be used to help feed the rubber band around the chain guides.

29. Install a rubber band (1) around the top of the upper timing chain guides (2) in order to pull the guides together.

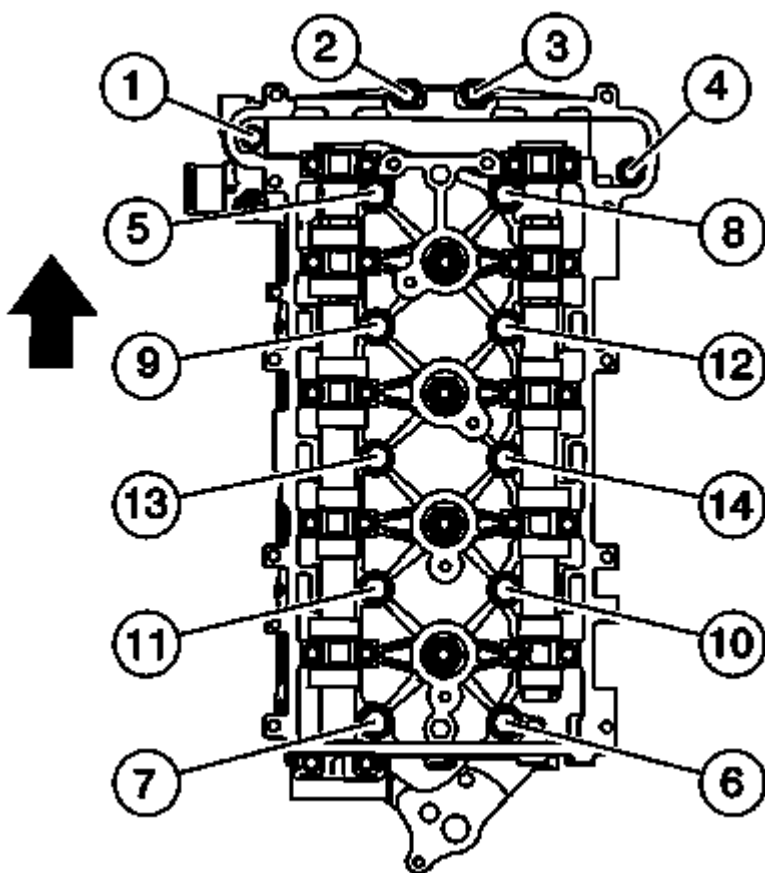


Fig. 250: Identifying Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

30. Remove the cylinder head bolts in the sequence shown. Discard the bolts.

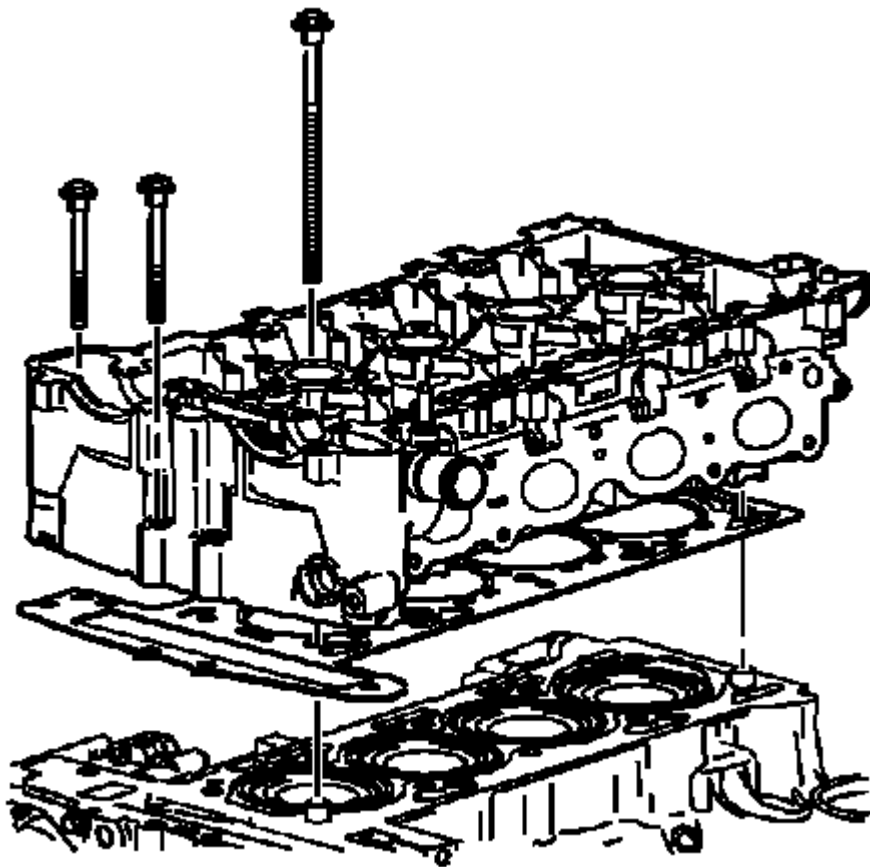


Fig. 251: View Of Cylinder Head And Gasket
Courtesy of GENERAL MOTORS CORP.

31. Remove the cylinder head.
32. Remove the cylinder head gasket.
33. Clean all of the gasket surfaces.
34. Use the following steps when cleaning the cylinder head and cylinder block surfaces:
 - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge either surface.

NOTE: **DO NOT use any other method or technique to clean these gasket surfaces.**

- Use a NEW razor blade on the cylinder head and a NEW blade on the cylinder block.

NOTE: **Be careful not to gouge or scratch the gasket surfaces. DO NOT gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in**

by the NEW gasket.

- Hold the razor blade as parallel to the gasket surface as possible.

35. Clean the old sealer/lube and any dirt from around the bolt holes.

NOTE: DO NOT use a tap to clean the cylinder head bolt holes.

36. Clean the bolts holes with a nylon bristle brush.

37. When cleaning the cylinder head bolt holes use suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.

38. If replacing the cylinder head, transfer all parts as necessary.

INSTALLATION PROCEDURE

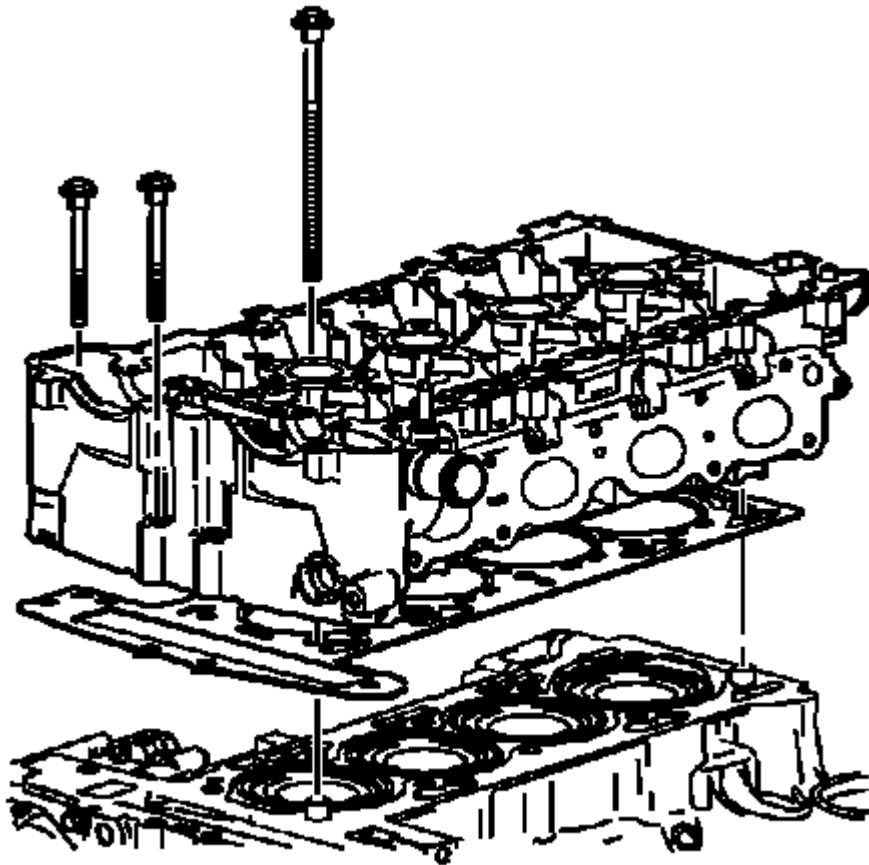


Fig. 252: View Of Cylinder Head And Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use any sealing material.

1. Install the cylinder head gasket.

2. Install the cylinder head.
3. Install NEW cylinder head bolts.

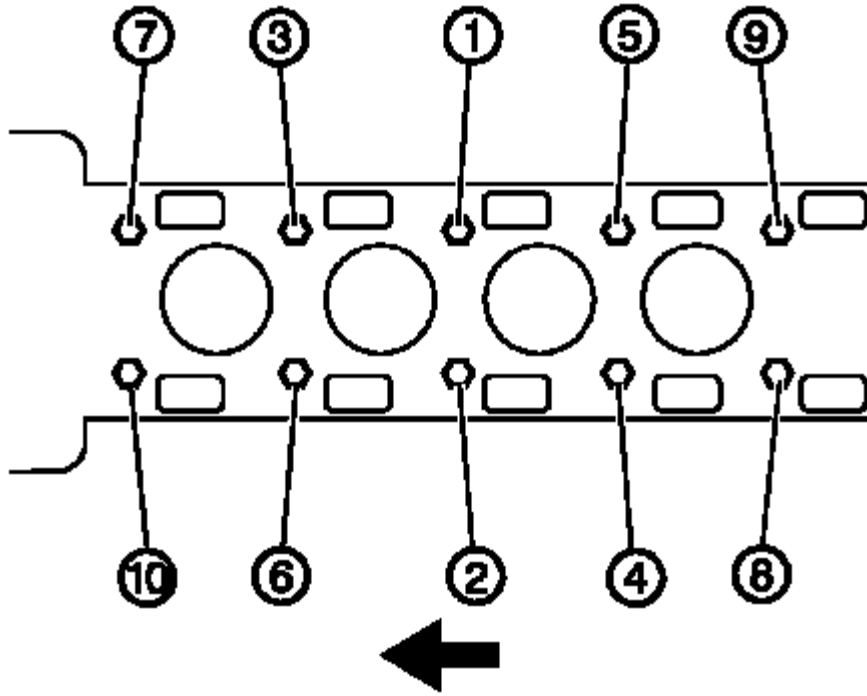


Fig. 253: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install and tighten the cylinder head bolts in the sequence shown. Tighten the bolts to 30 N.m (22 lb ft) plus an additional 155 degrees using the **J 45059** .

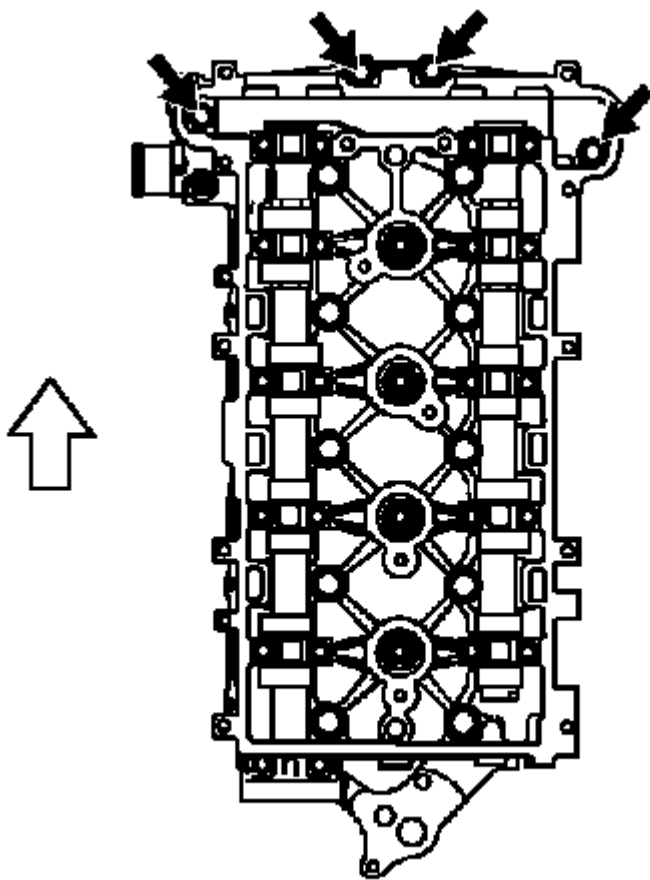


Fig. 254: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the NEW front cylinder head bolts and tighten to 35 N.m (26 lb ft).

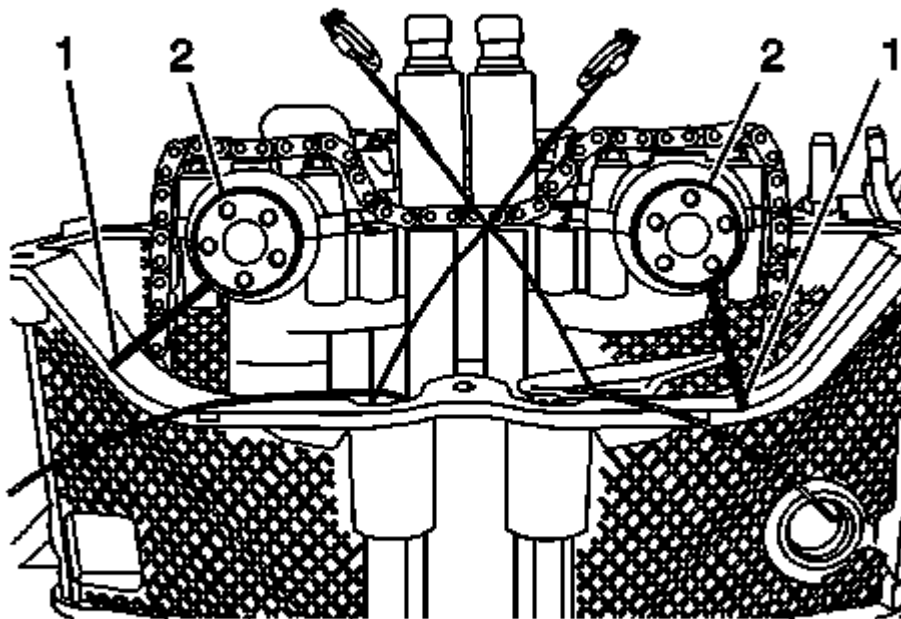


Fig. 255: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

6. Ensure the cylinder head (1) and the camshaft (2) are correctly aligned.

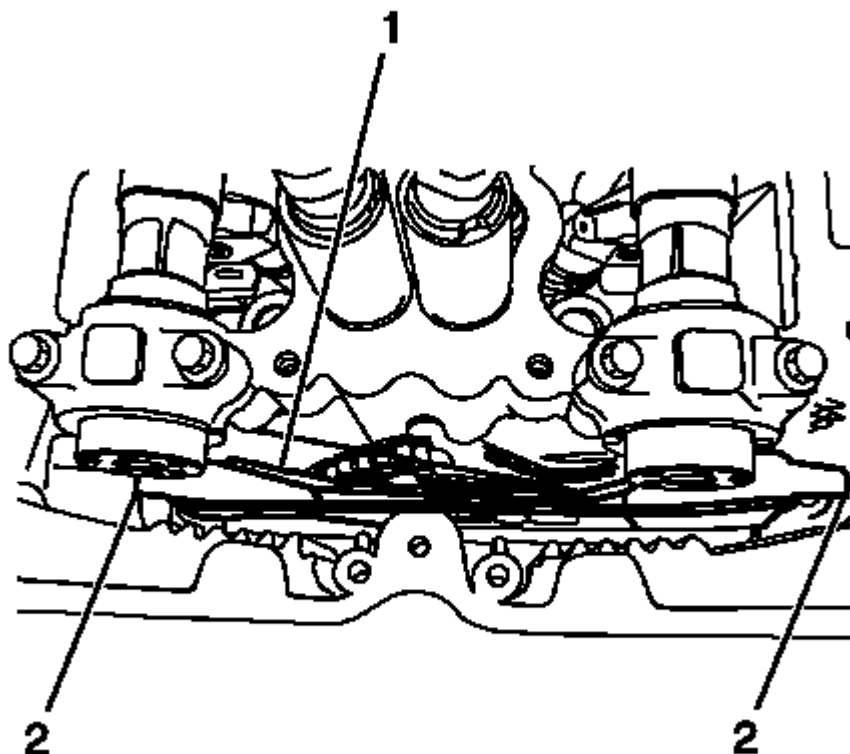


Fig. 256: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

7. Remove the rubber band (1) from around the top of the upper timing chain guides (2).
8. Install the fixed guide bolt into the cylinder head and tighten to 12 N.m (106 lb in)

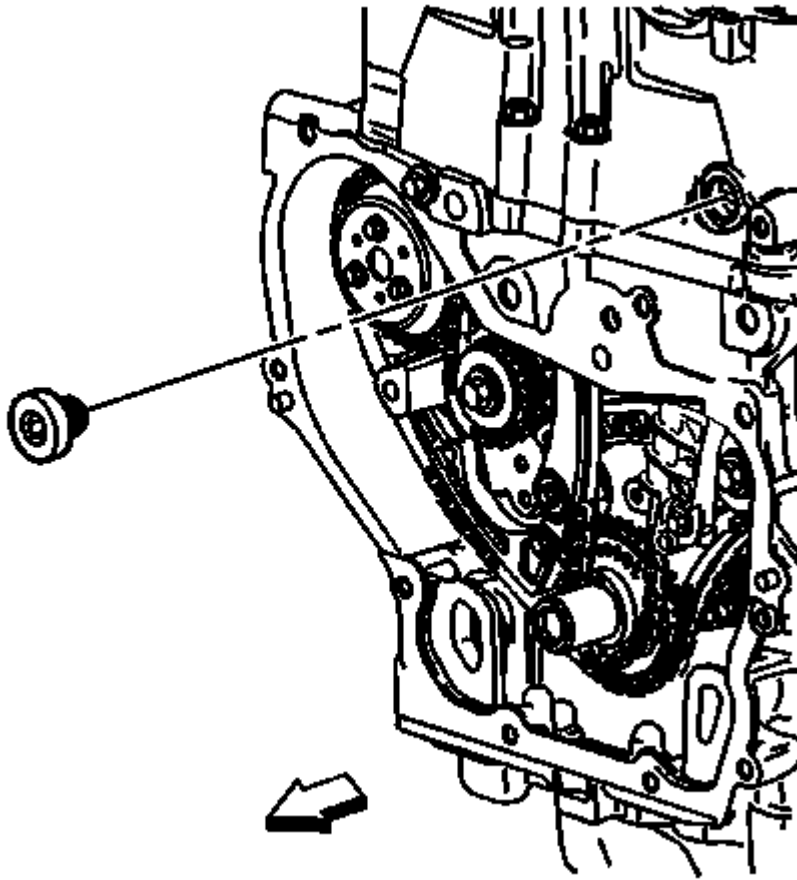


Fig. 257: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

9. Apply sealant compound to thread and install the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
10. Install the fixed timing chain guide access plug and tighten to 90 N.m (59 lb ft).

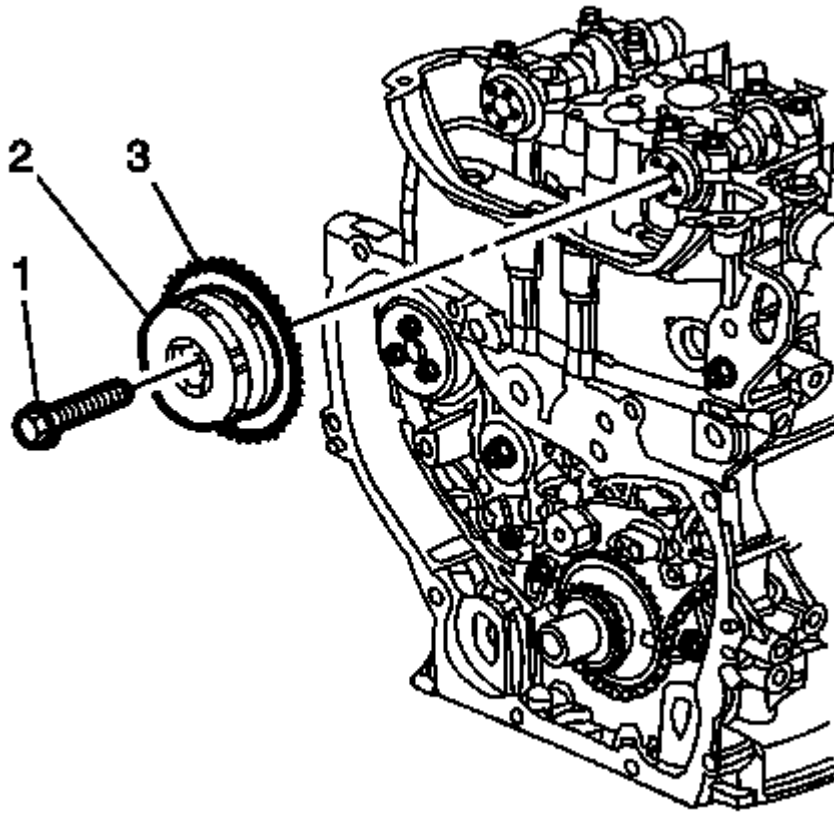


Fig. 258: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the intake camshaft actuator is still aligned properly with the mark on the timing chain. If the mark made previously on the intake camshaft actuator is not aligned properly, refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

11. Install the timing chain onto the intake camshaft actuator.
12. Align the intake camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
13. Install a NEW intake camshaft actuator bolt (2) until snug.

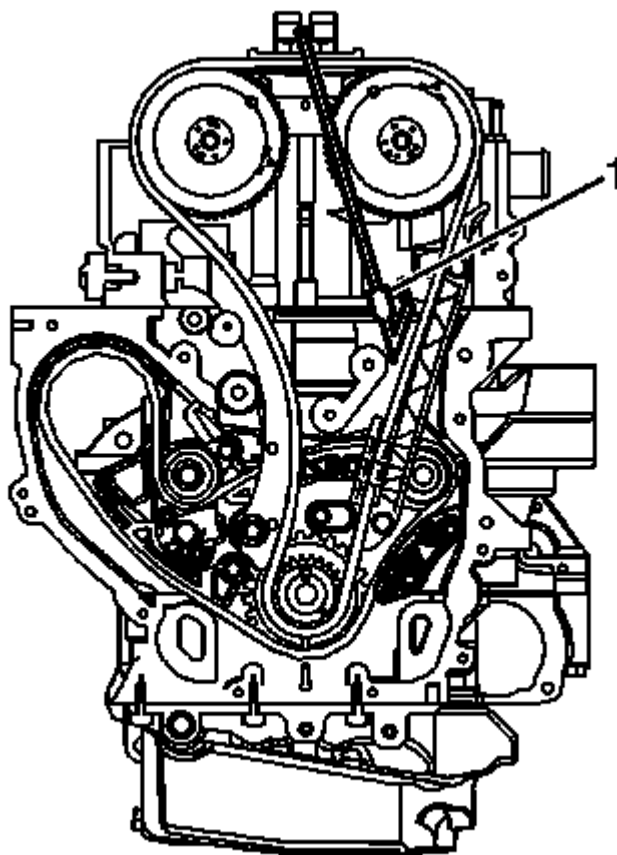


Fig. 259: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

14. Remove the timing chain retention tool EN-48749 (1) from the intake side of the timing chain.

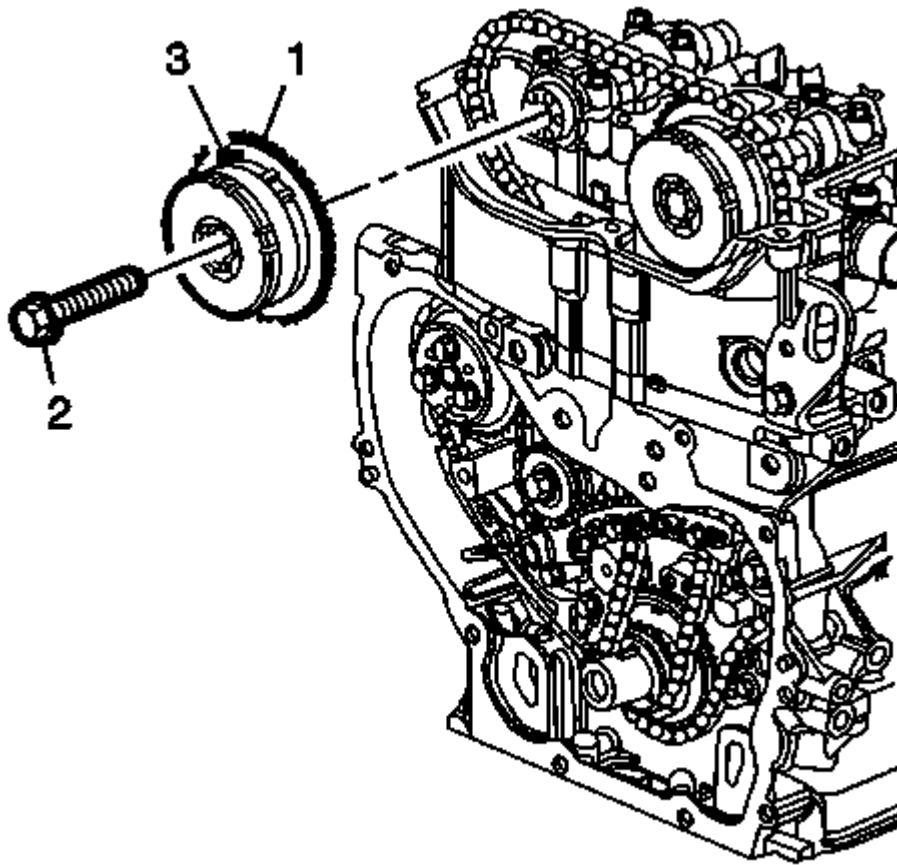


Fig. 260: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the alignment mark made previously on the exhaust camshaft actuator is still aligned properly with the mark on the timing chain. The exhaust cam may have to be rotated clockwise to install the exhaust actuator.

15. Install the timing chain onto the exhaust camshaft actuator.
16. Align the exhaust camshaft actuator alignment mark made previously with the timing chain mark and install the actuator onto the camshaft.
17. Install a NEW exhaust camshaft actuator bolt (2) until snug.
18. Remove the timing chain retention tool **EN-48749** (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the chain tensioner will put excess tension on the chain, limiting the chains life.

19. Reset and install the timing chain tensioner. Refer to **Timing Chain Tensioner Replacement**.

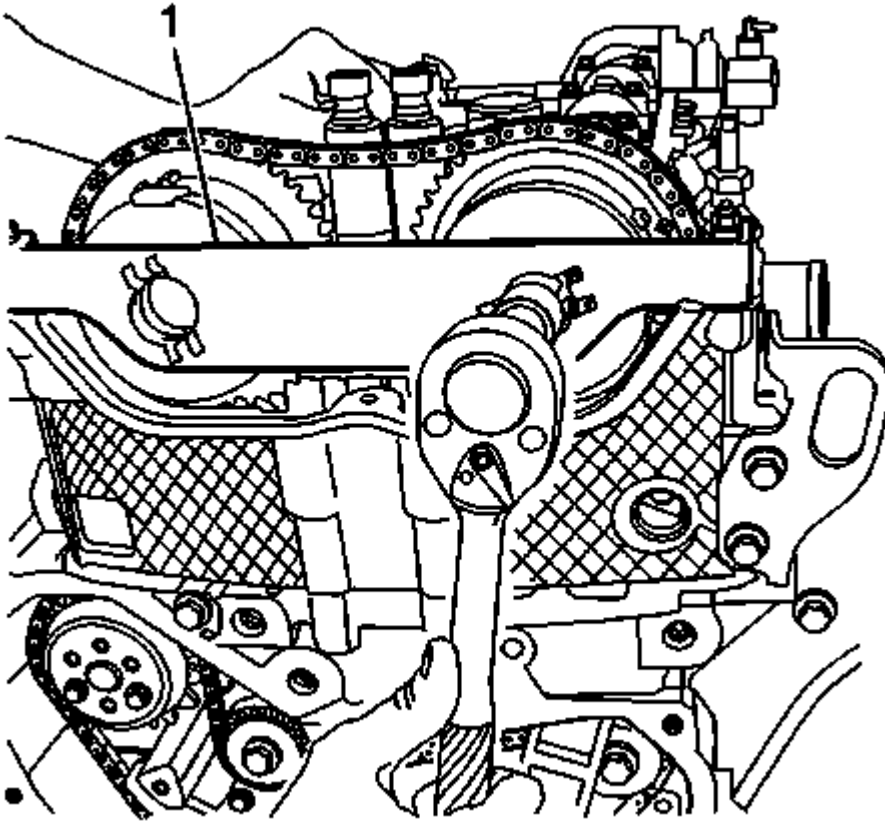


Fig. 261: View of Loosening/Tightening Camshaft Actuator Retainer Bolts
 Courtesy of GENERAL MOTORS CORP.

20. Install the **EN-48953** (1) to the actuators.
21. Install the camshaft actuator locking tool bolts and tighten to 10 N.m (89 lb in).
22. Tighten the NEW camshaft actuator bolt and tighten to 30 N.m (22 lb ft), plus an additional 100 degrees using the **J 45059**.
23. Release the tensioner by applying a counterclockwise rotational torque of 45 N.m (33 lb ft) to the harmonic balancer bolt.
24. Remove the camshaft actuator locking tool, **EN-48953**.

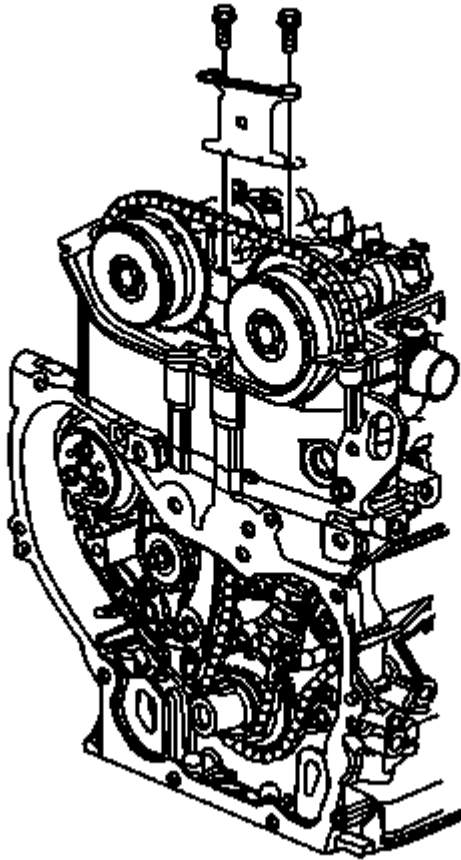


Fig. 262: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

25. Install the upper timing chain guide bolts and guide and tighten to 10 N.m (89 lb in).
26. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
27. Install the spark plugs. Refer to **Spark Plug Replacement**.

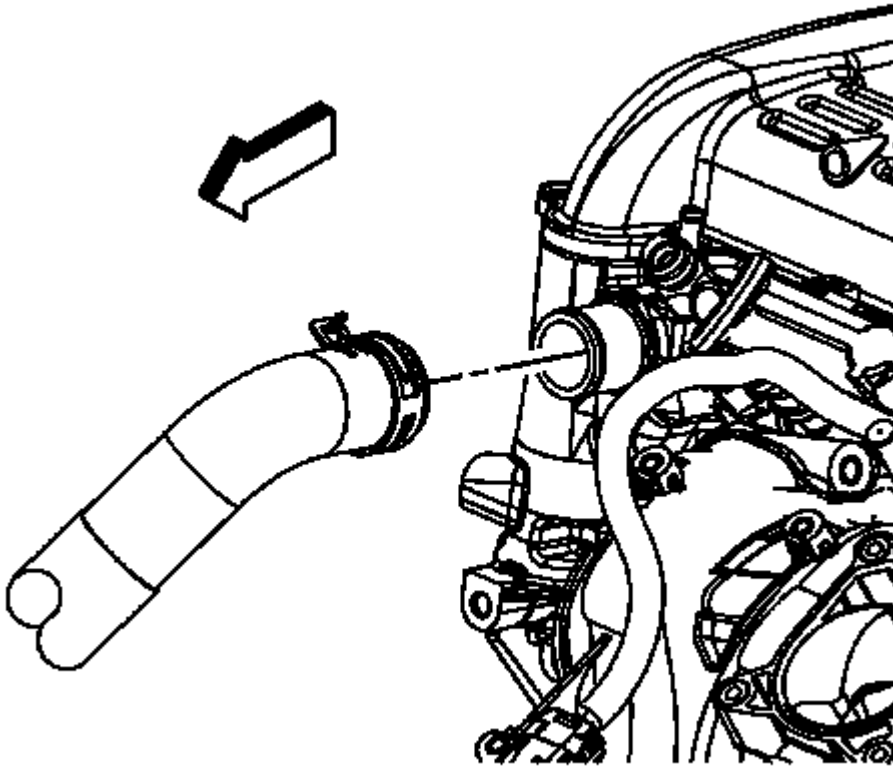


Fig. 263: View Of Radiator Inlet Hose To Engine
Courtesy of GENERAL MOTORS CORP.

28. Connect all electrical connectors as necessary.
29. Install the radiator inlet hose to the cylinder head.
30. Position the radiator inlet hose clamp using the **J 38185**.
31. Install the radiator surge tank air bleed hose to the cylinder head.
32. Position the radiator surge tank air bleed hose clamp.
33. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LNF)**.
34. Install the intake manifold. Refer to **Intake Manifold Replacement**.
35. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE-47716)** or **Cooling System Draining and Filling (Static Fill-LNF)**.

ENGINE OIL COOLER REPLACEMENT

REMOVAL PROCEDURE

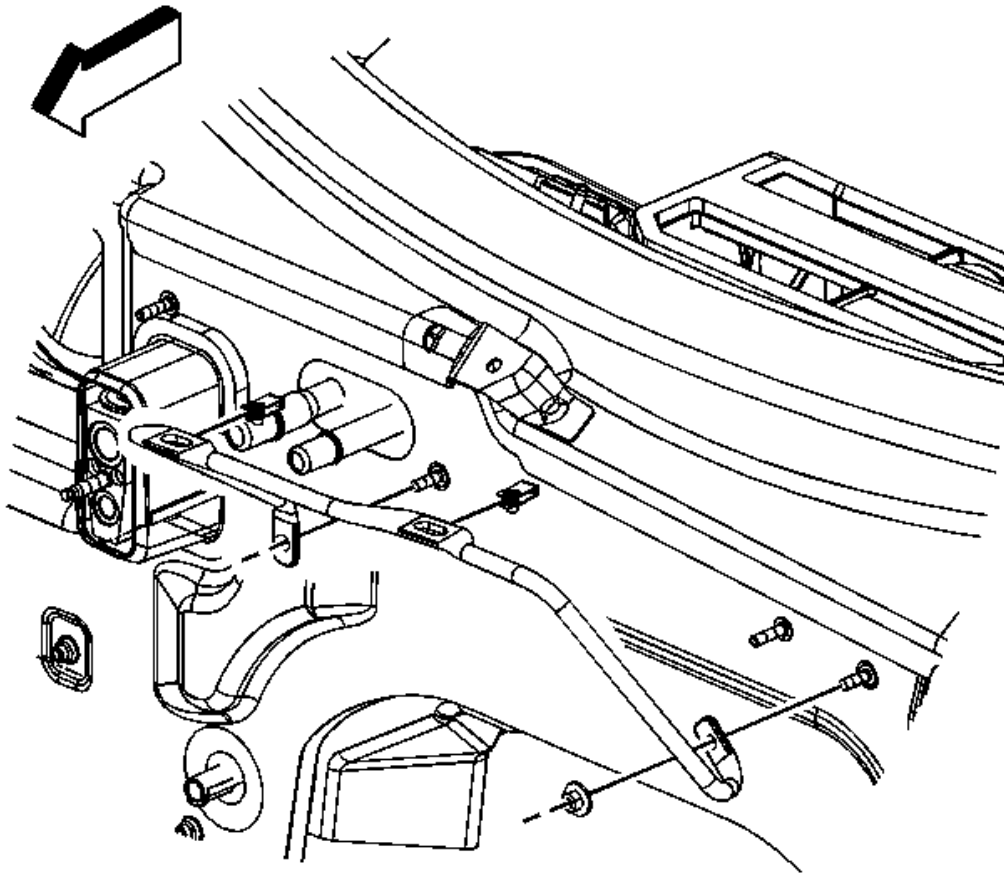


Fig. 264: View Of Intake CMP Sensor & Air Inlet Screen Support
 Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE-47716)** or **Cooling System Draining and Filling (Static Fill-LNF)** .
2. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
3. Remove the intake camshaft position (CMP) sensor.
4. Remove the air inlet screen support nuts and support.

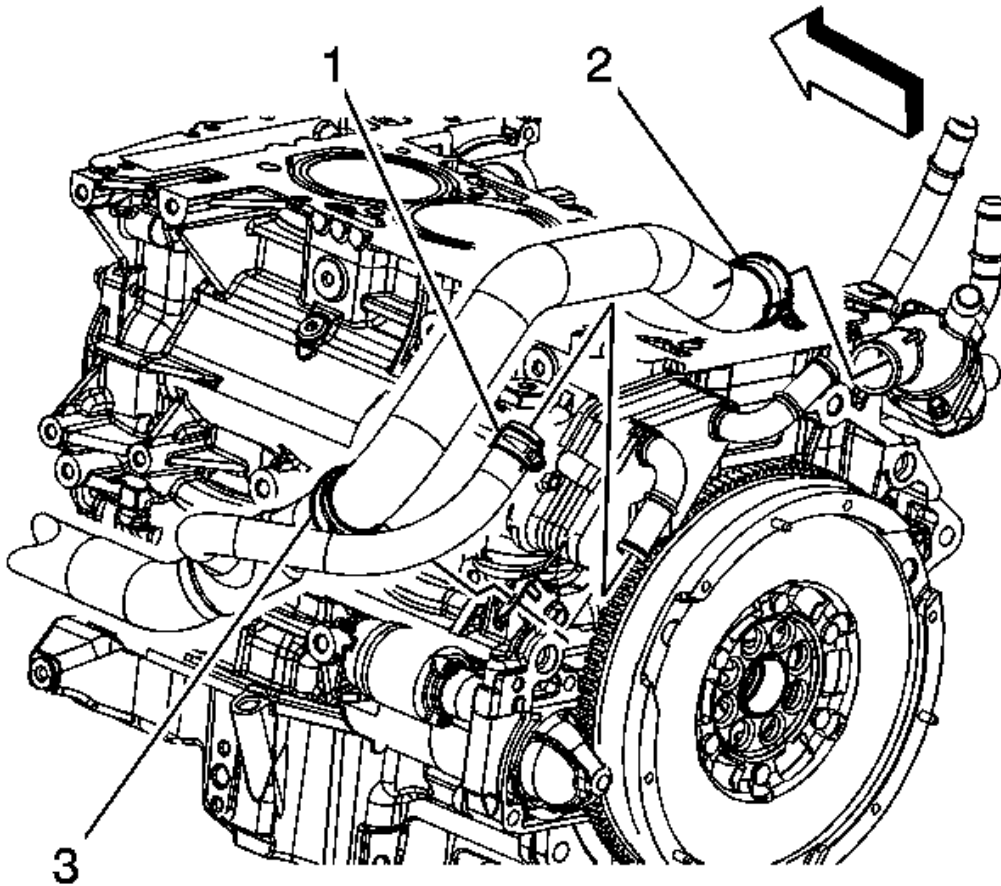


Fig. 265: Identifying Radiator Outlet Hose Components
 Courtesy of GENERAL MOTORS CORP.

5. Reposition the radiator outlet hose clamp (2) at the thermostat housing.
6. Remove the radiator outlet hose from the thermostat housing for access and removal of the oil cooler.
7. Reposition the radiator outlet hose clamp (1) at the oil cooler.
8. Remove the radiator outlet hose from the oil cooler.
9. Remove the radiator outlet hose clip (3) from the bracket.

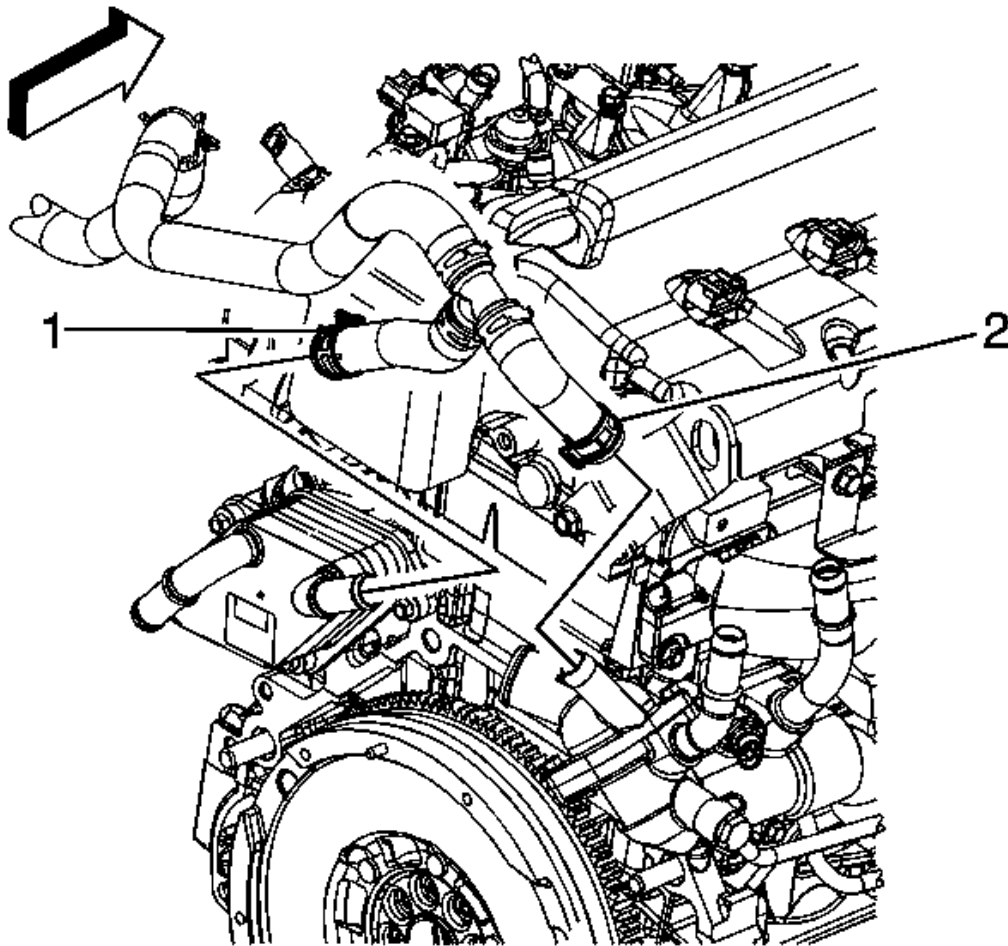


Fig. 266: Identifying Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

10. Reposition the surge tank outlet hose clamp (1) at the oil cooler.
11. Remove the surge tank outlet hose from the oil cooler.

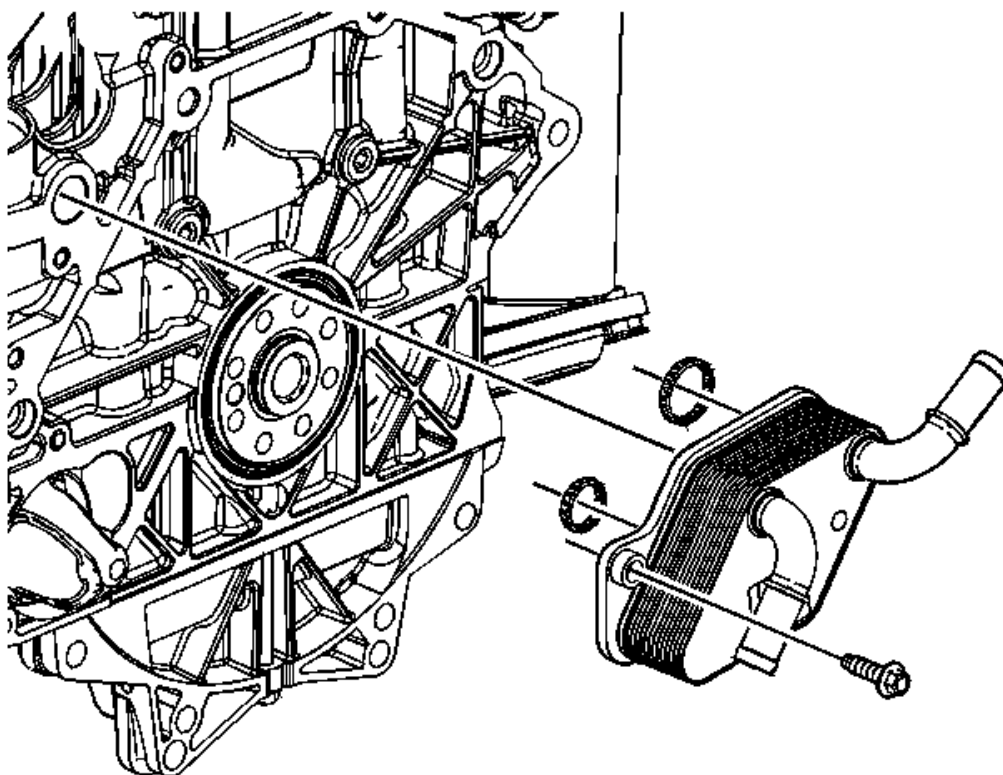


Fig. 267: View Of Engine Oil Cooler
Courtesy of GENERAL MOTORS CORP.

12. Remove the oil cooler bolts.
13. Remove the oil cooler.

INSTALLATION PROCEDURE

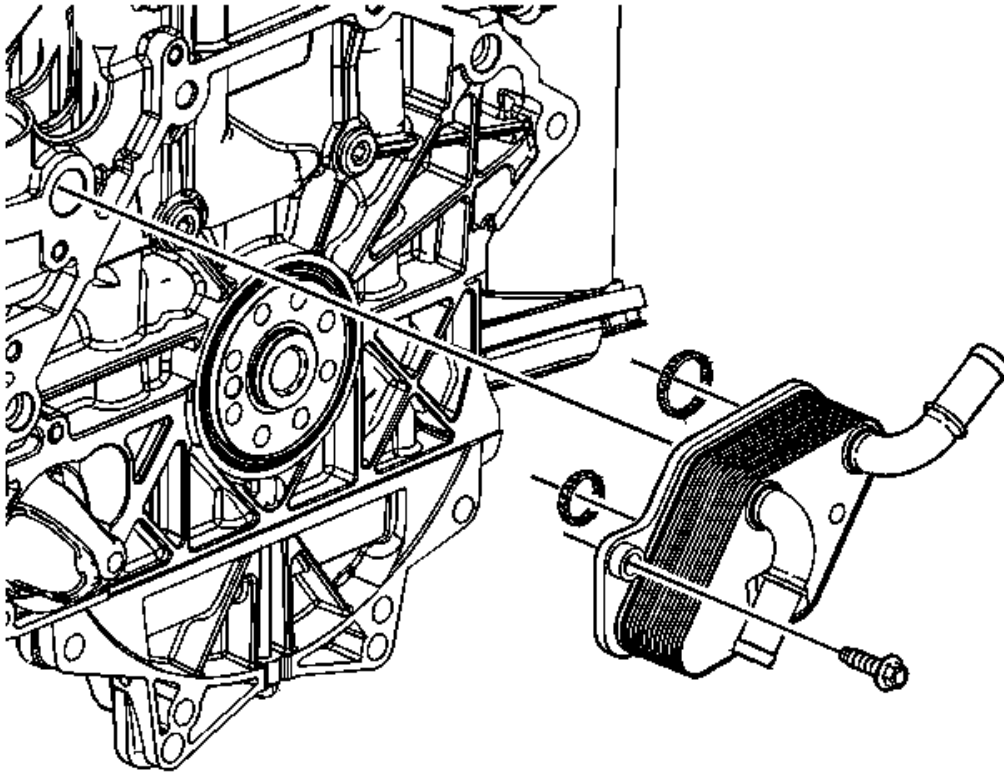


Fig. 268: View Of Engine Oil Cooler
Courtesy of GENERAL MOTORS CORP.

1. Position the oil cooler to the engine block.

CAUTION: Refer to Fastener Caution .

2. Install the oil cooler bolts and tighten to 22 N.m (16 lb ft).

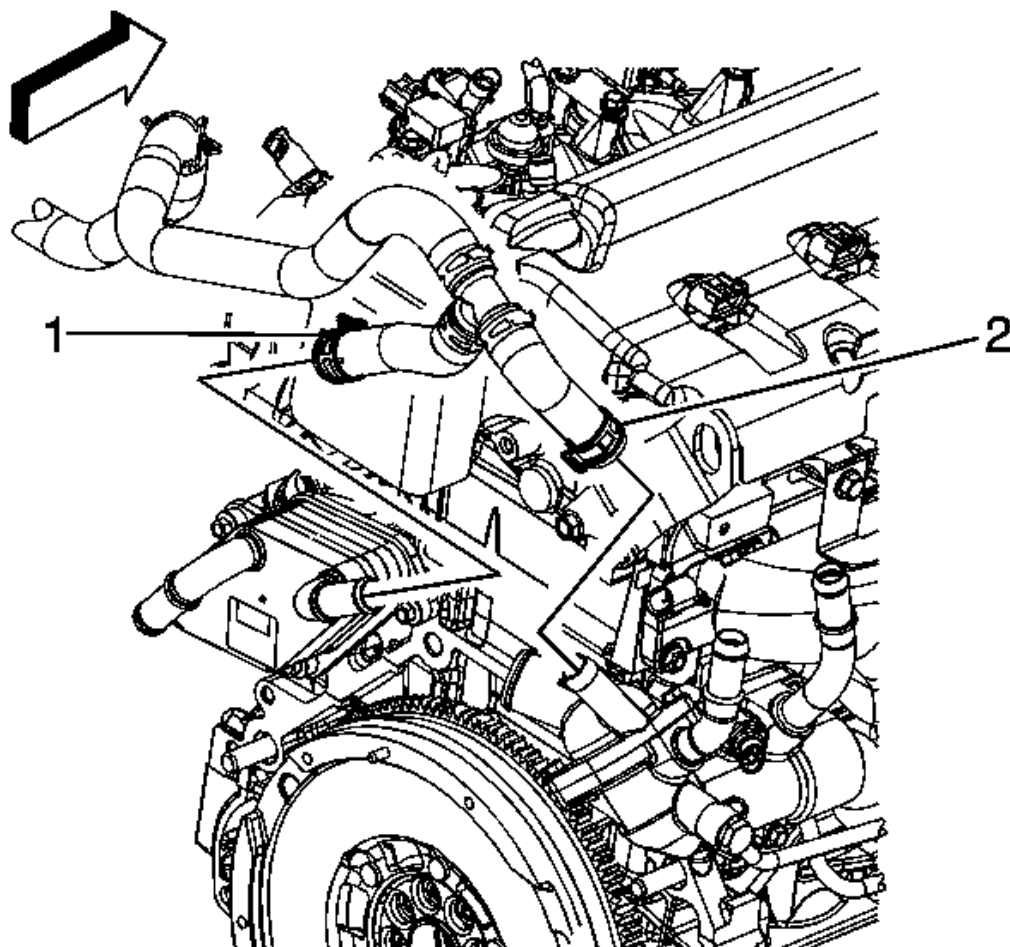


Fig. 269: Identifying Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

3. Install the surge tank outlet hose to the oil cooler.
4. Position the surge tank outlet hose clamp (1) at the oil cooler.

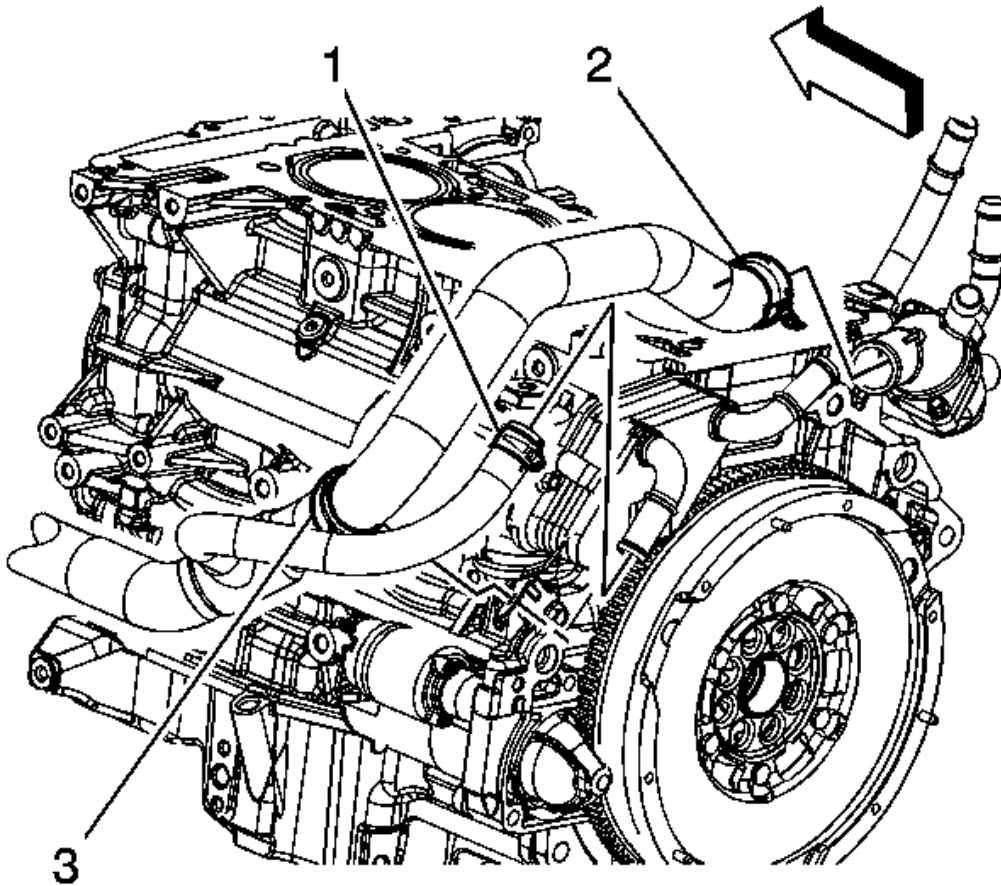


Fig. 270: Identifying Radiator Outlet Hose Components
Courtesy of GENERAL MOTORS CORP.

5. Install the radiator outlet hose to the oil cooler.
6. Install the radiator outlet hose to the thermostat housing.
7. Position the radiator outlet hose clamp (2) at the thermostat housing.
8. Position the radiator outlet hose clamp (1) at the oil cooler.
9. Install the radiator outlet hose clip (3) to the bracket.

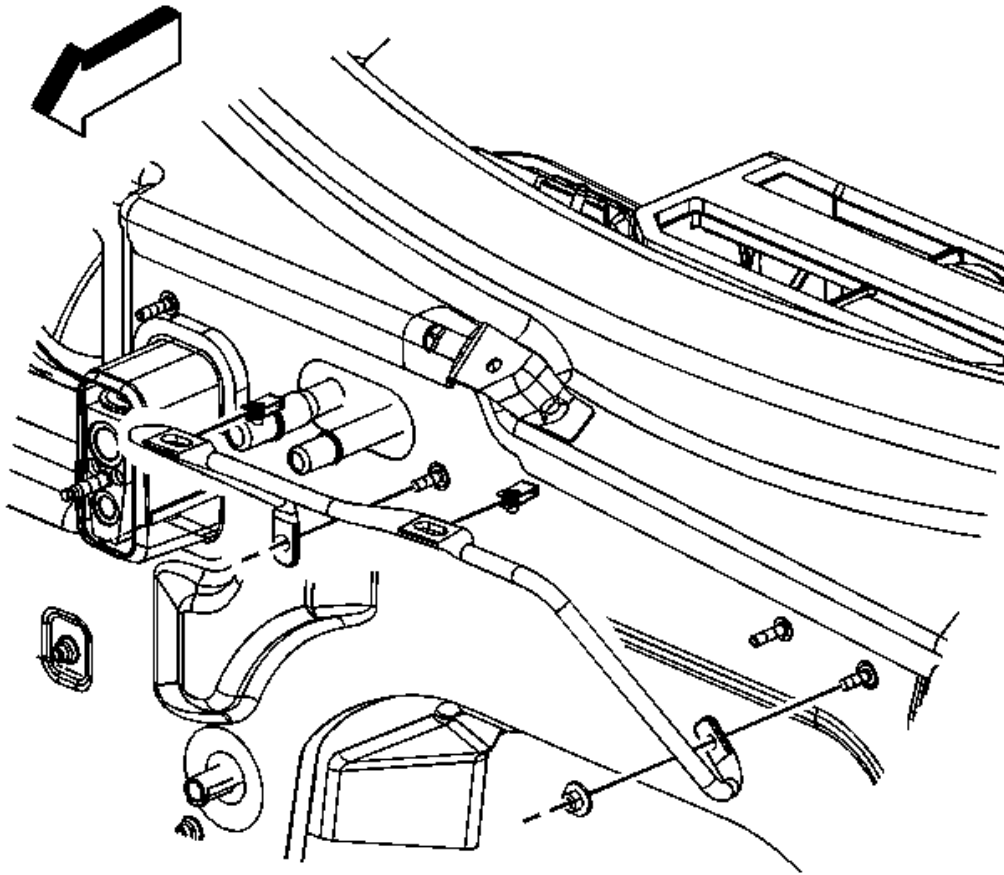


Fig. 271: View Of Intake CMP Sensor & Air Inlet Screen Support
Courtesy of GENERAL MOTORS CORP.

10. Install the air inlet screen support and nuts and tighten to 10 N.m (89 lb in).
11. Install the intake CMP sensor.
12. Install the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement \(SKY\)](#) or [Air Inlet Grille Panel Replacement \(Solstice\)](#) .
13. Fill the cooling system. Refer to [Cooling System Draining and Filling \(GE-47716\)](#) or [Cooling System Draining and Filling \(Static Fill-LNF\)](#) .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 42067 Rear Main Seal Installer. See [Special Tools](#) .

REMOVAL PROCEDURE

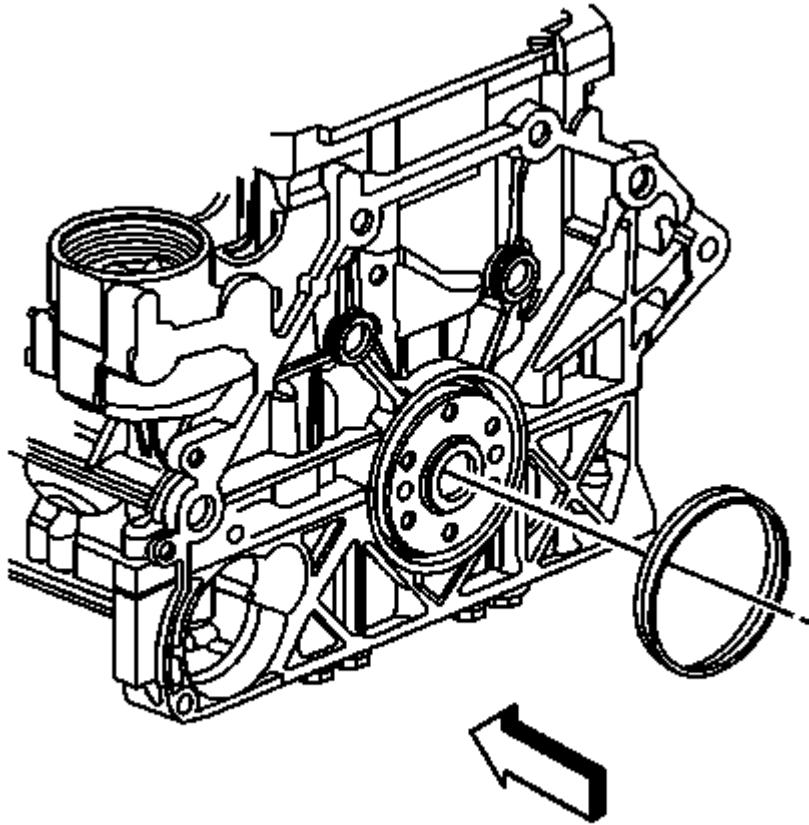


Fig. 272: Identifying Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel. Refer to **Engine Replacement (w/Manual Transmission)** or **Engine Replacement (w/Automatic Transmission)**.

IMPORTANT: Do not damage the outside diameter of the crankshaft or chamber with any tool.

2. Pry out the crankshaft rear oil seal using a flat-bladed tool.

INSTALLATION PROCEDURE

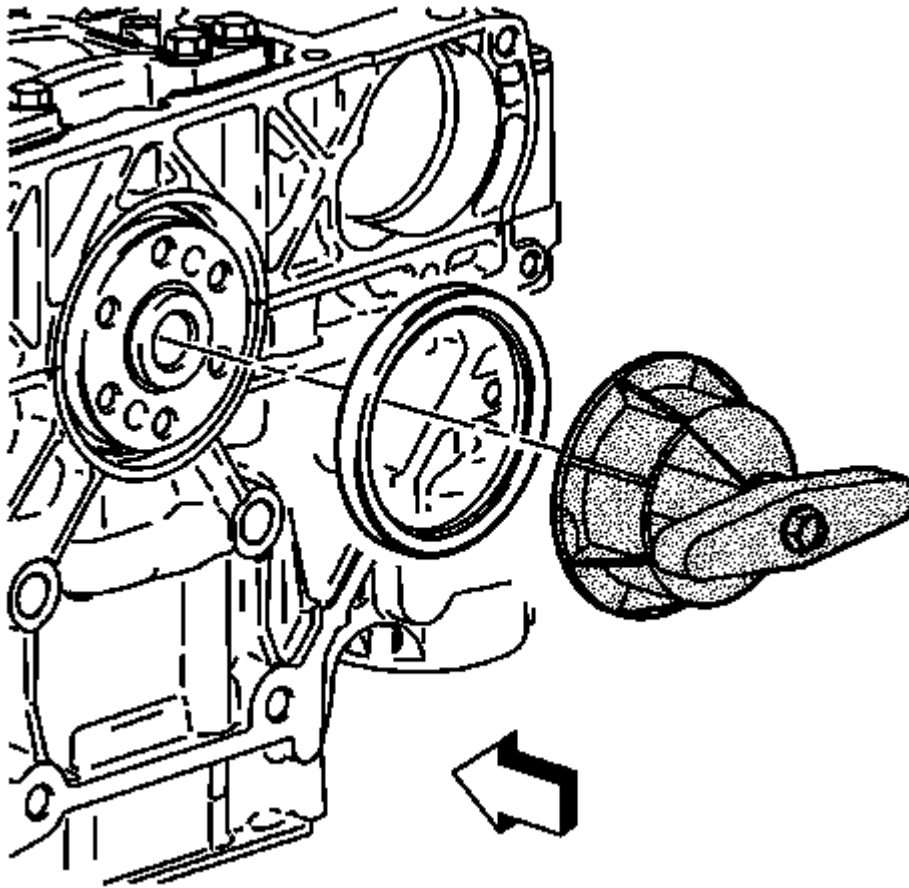


Fig. 273: View Of Crankshaft Rear Oil Seal & Special Tool J 42067
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 42067** , install a NEW crankshaft rear oil seal. See **Special Tools** .
2. Install the flywheel. Refer to **Engine Replacement (w/Manual Transmission)** or **Engine Replacement (w/Automatic Transmission)**.

ENGINE FLYWHEEL REPLACEMENT

SPECIAL TOOLS

- **J 43653** Flywheel Holding Tool
- **J 45059** Angle Meter

REMOVAL PROCEDURE

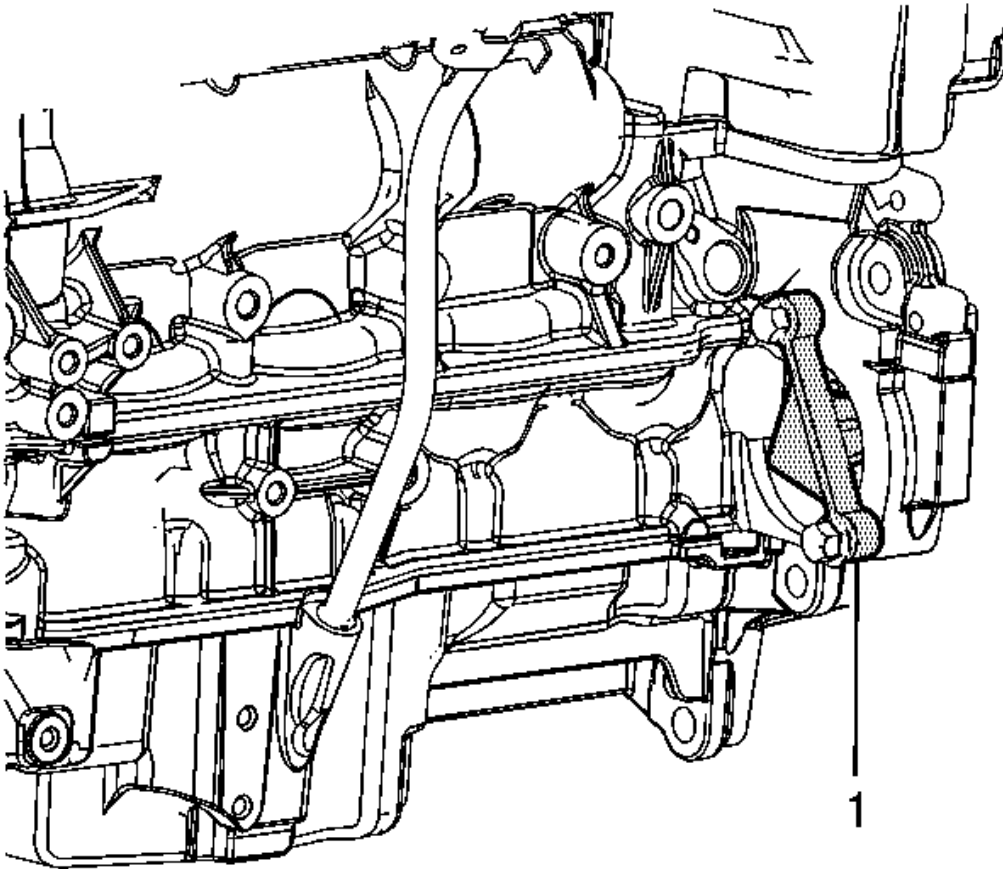


Fig. 274: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission, if equipped. Refer to **Transmission Replacement** .
2. Remove the starter, if equipped with a manual transmission. Refer to **Starter Replacement** .
3. Remove the clutch, if equipped. Refer to **Clutch Pressure and Driven Plate Replacement** .
4. Install the **J 43653** (1) to the engine block in order to hold the flywheel.

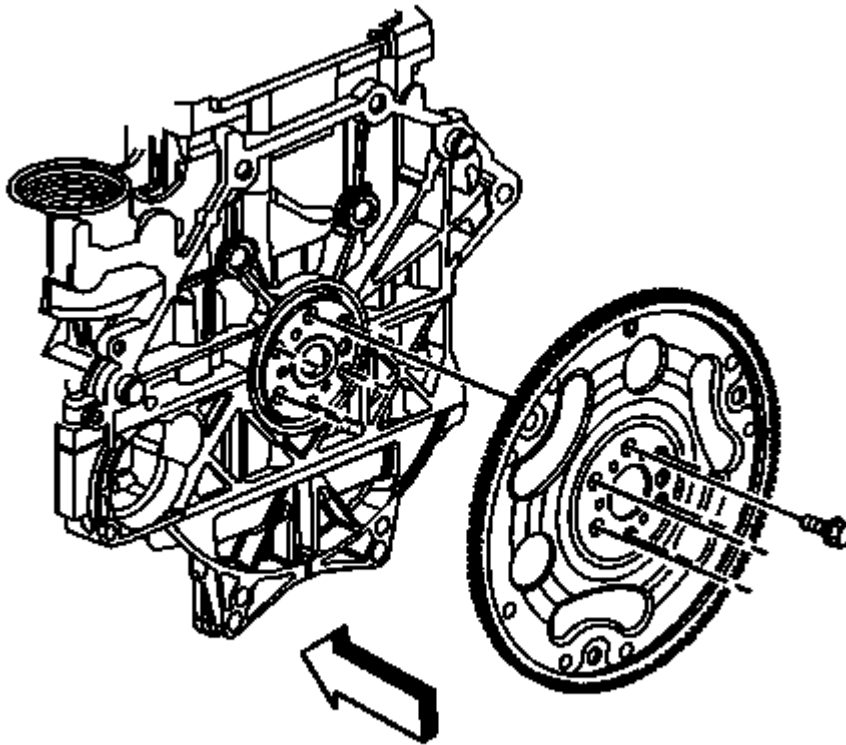


Fig. 275: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

NOTE: It may be necessary to remove the chamfer (bevel) from the edge of an 18 mm socket in order to get full engagement on the thin-headed flywheel bolts.

5. Remove the flywheel bolts, if equipped with a automatic transmission.

NOTE: Do not orientate the flywheel to the crankshaft. It is balanced separately from the engine.

6. Remove the flywheel.
7. Clean the thread adhesive from the flywheel bolt holes. Use a nylon bristle brush to clean the holes in the crankshaft.

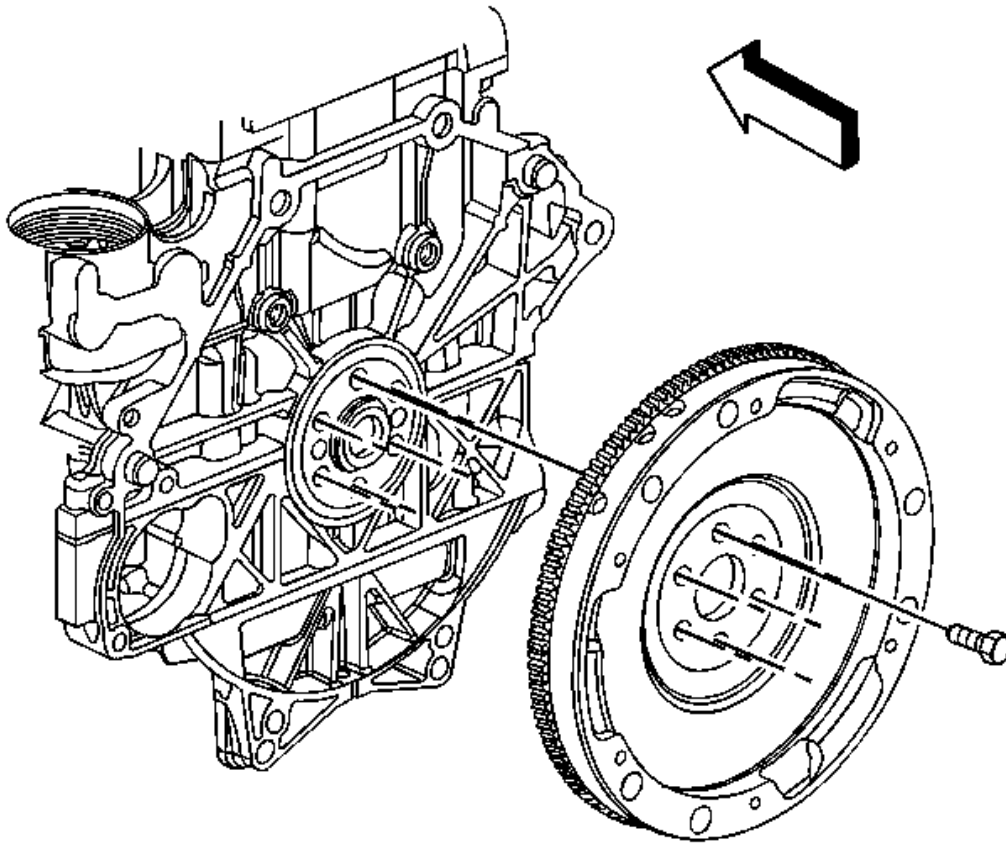


Fig. 276: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

8. Remove the flywheel bolts, if equipped with a manual transmission.
9. Remove the flywheel.
10. Clean the thread adhesive from the flywheel bolt holes. Use a nylon bristle brush to clean the holes in the crankshaft.

INSTALLATION PROCEDURE

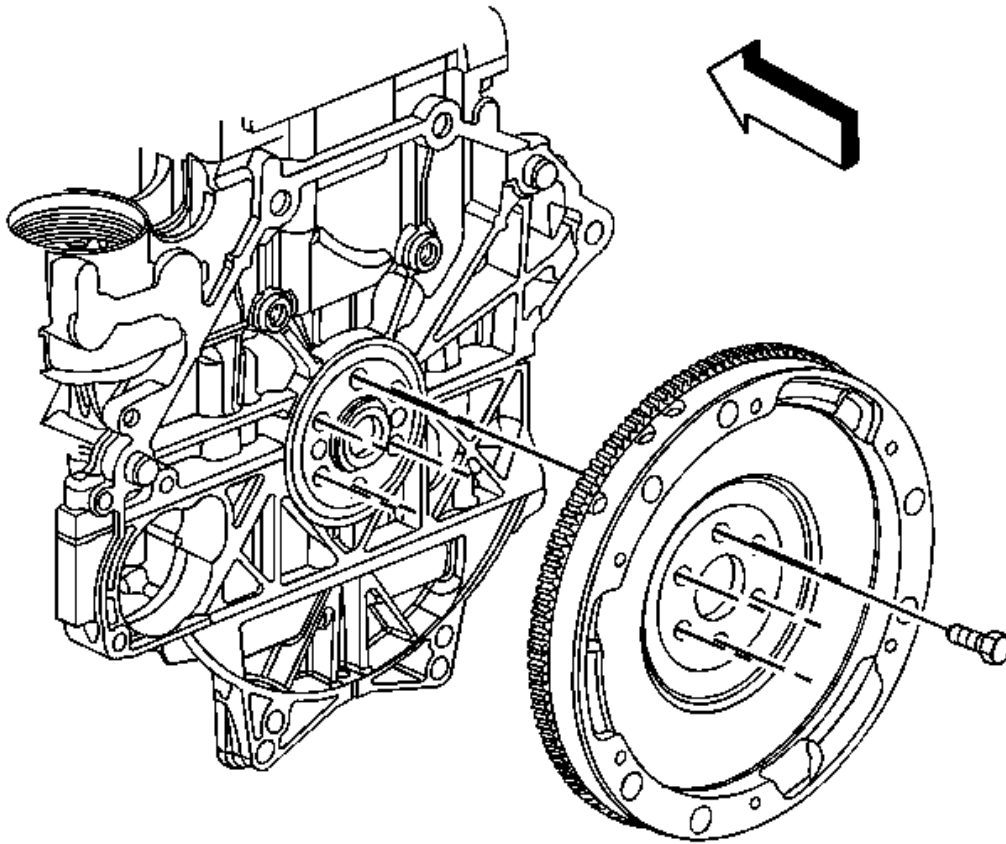


Fig. 277: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the flywheel, if equipped with a manual transmission.
2. Install the flywheel bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft) plus an additional 25 degrees using the **J 45059** .

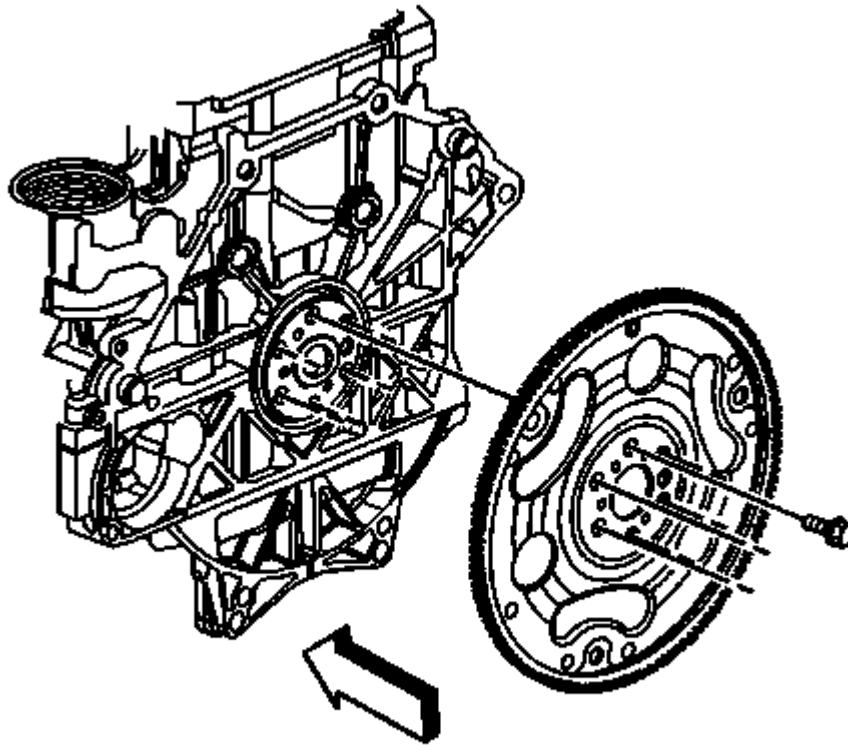


Fig. 278: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

3. Install the flywheel if equipped with an automatic transmission.
4. Install the flywheel bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft) plus an additional 25 degrees using the **J 45059** .

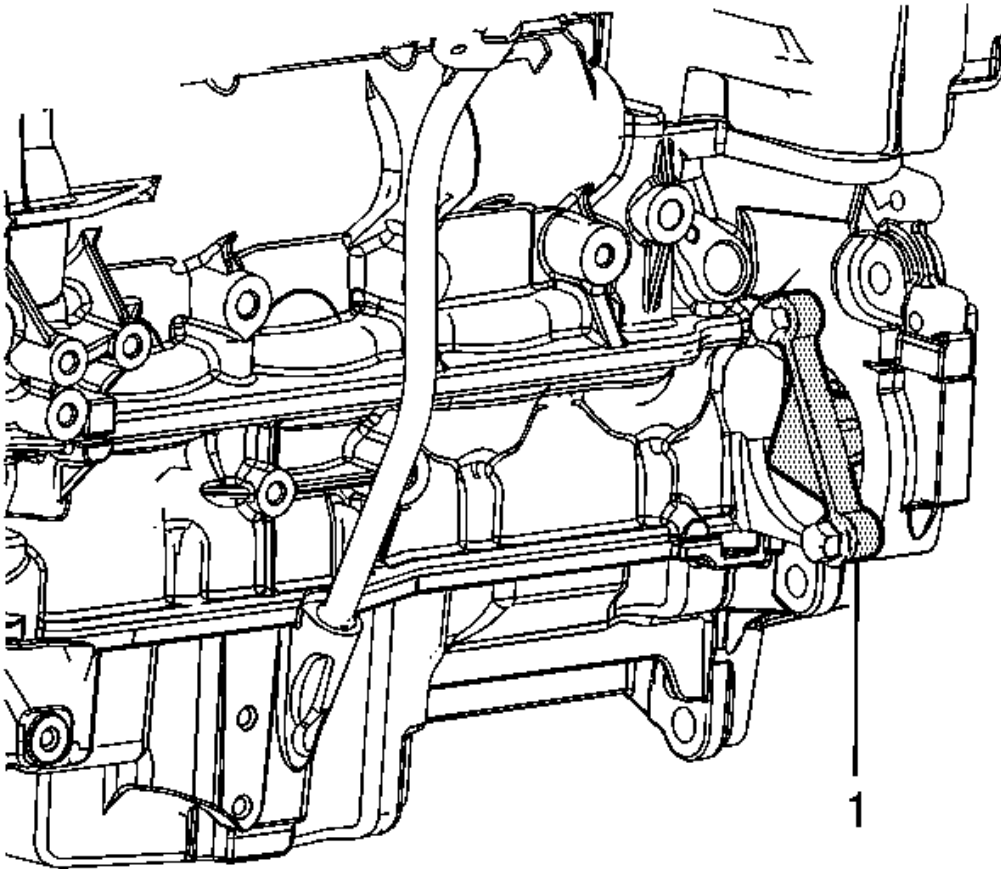


Fig. 279: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

5. Remove the **J 43653** (1) from the engine block.
6. Install the clutch, if equipped. Refer to **Clutch Pressure and Driven Plate Replacement**.
7. Install the starter, if equipped with a manual transmission. Refer to **Starter Replacement**.
8. Install the automatic transmission, if equipped. Refer to **Transmission Replacement**.

ENGINE REPLACEMENT (W/MANUAL TRANSMISSION)

SPECIAL TOOLS

J 45059 Angle Meter

REMOVAL PROCEDURE

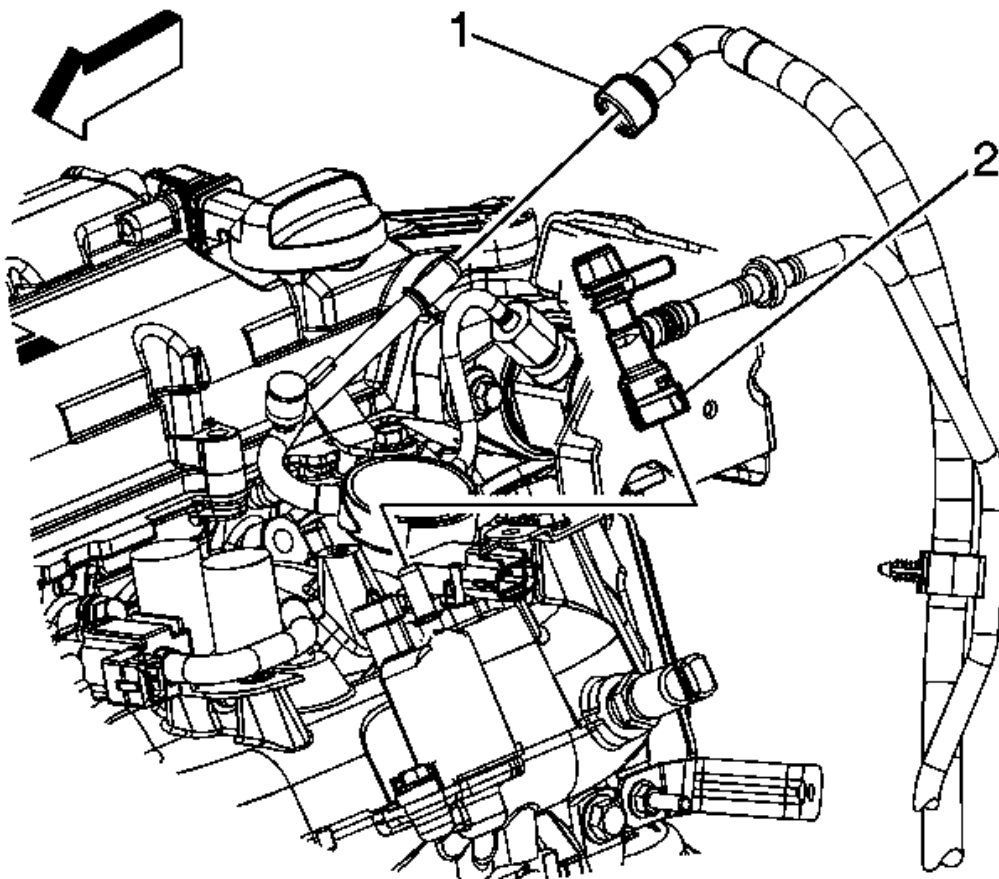


Fig. 280: Identifying EVAP & Fuel Feed Pipes
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the hood. Refer to **Hood Replacement** .
3. Recover the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
4. Remove the drive belt. Refer to **Drive Belt Replacement**.
5. Remove the radiator. Refer to **Radiator Replacement** .
6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Low Pressure without Special Tool)** or **Fuel Pressure Relief (Low Pressure with CH 48027)** or **Fuel Pressure Relief (Low Pressure Side with CH 48027-100)** or **Fuel Pressure Relief (High Pressure Side)** .
7. Disconnect the evaporative emission (EVAP) canister purge solenoid tube from the valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .

8. Disconnect the fuel feed pipe (1) from the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .
9. Remove the charge air cooler inlet and outlet pipes. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .
10. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
11. Remove the transmission. Refer to **Transmission Replacement (With ZOK)** .
12. After the transmission is removed, reinstall the bolt from the differential case bracket assembly to body, in order to remove the support from under the rear drive module.

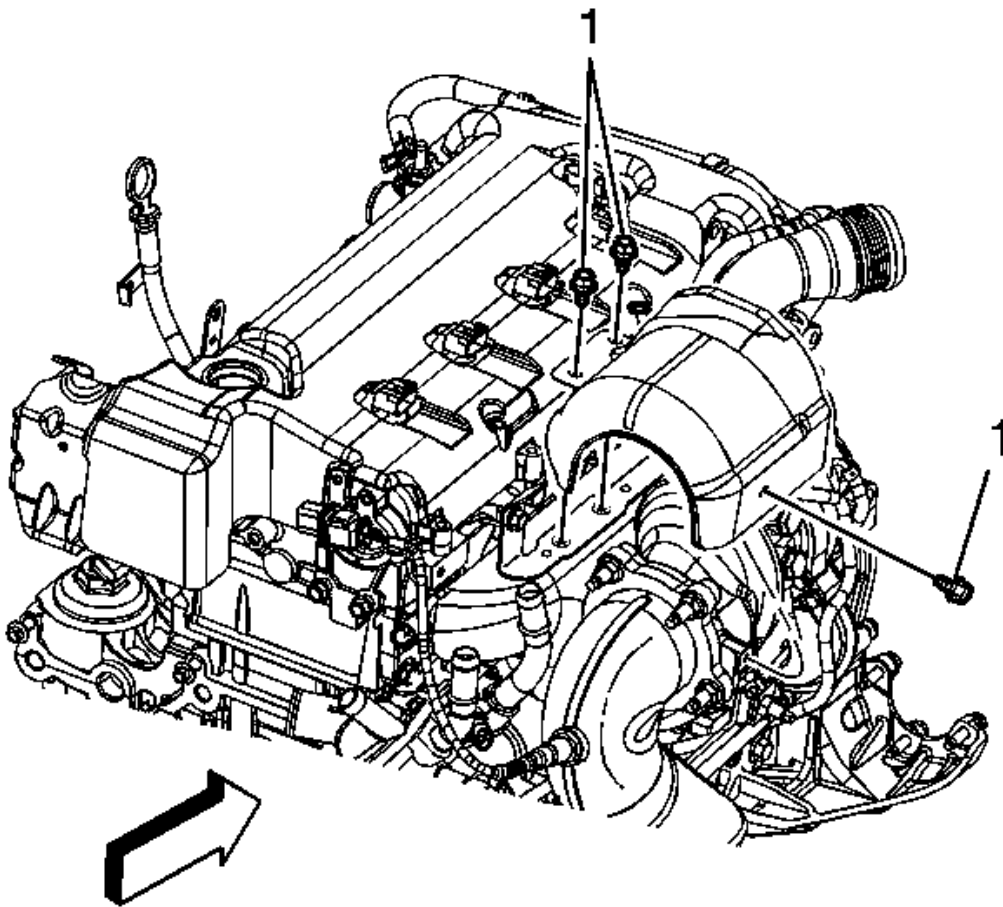


Fig. 281: Identifying Turbocharger Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the turbocharger heat shield bolts (1) and shield.

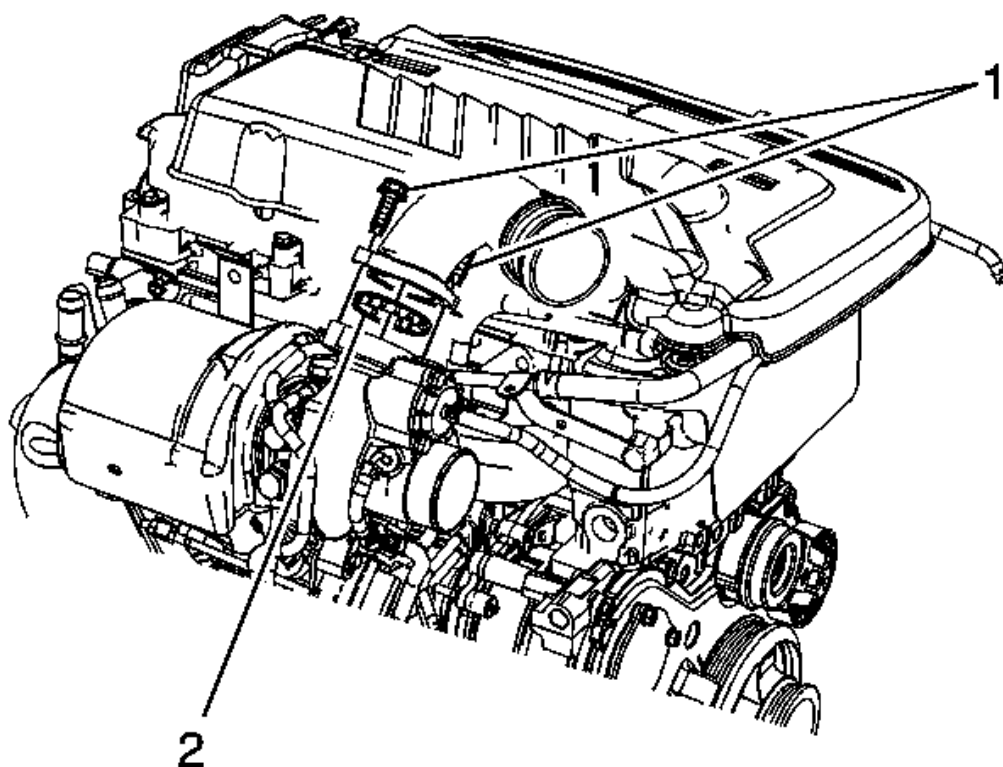


Fig. 282: Identifying Charge Air Cooler Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

14. Remove the charge air cooler pipe to turbocharger bolts (1).
15. Remove the charge air cooler pipe and gasket (2) from the turbocharger.
16. Cap or plug the turbocharger opening.

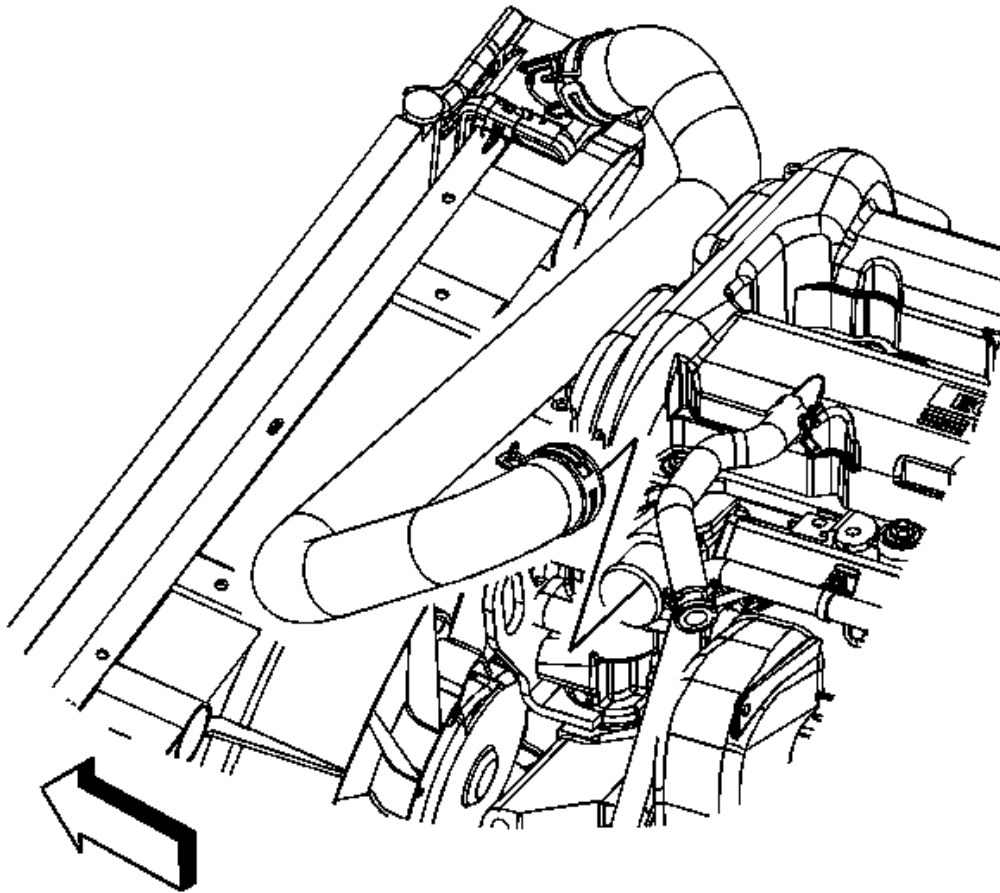


Fig. 283: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

17. Reposition the radiator inlet hose clamp at the engine.
18. Remove the radiator inlet hose from the engine.
19. Reposition the radiator inlet hose out of the way.

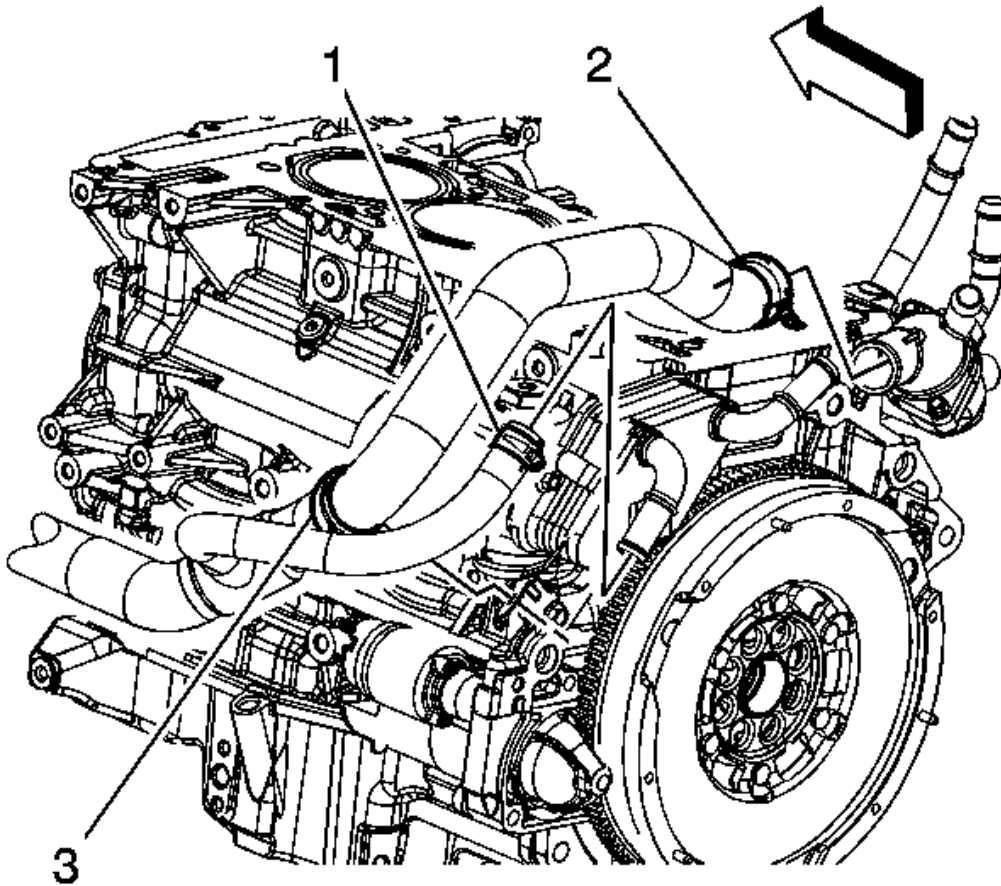


Fig. 284: Identifying Radiator Outlet Hose Components
 Courtesy of GENERAL MOTORS CORP.

20. Reposition the radiator outlet hose clamp (2) at the thermostat housing.
21. Reposition the radiator outlet hose clamp (1) at the oil cooler.
22. Remove the radiator outlet hose from the thermostat housing and oil cooler.
23. Remove the radiator outlet hose clip (3) from the bracket.
24. Reposition the radiator outlet hose out of the way.

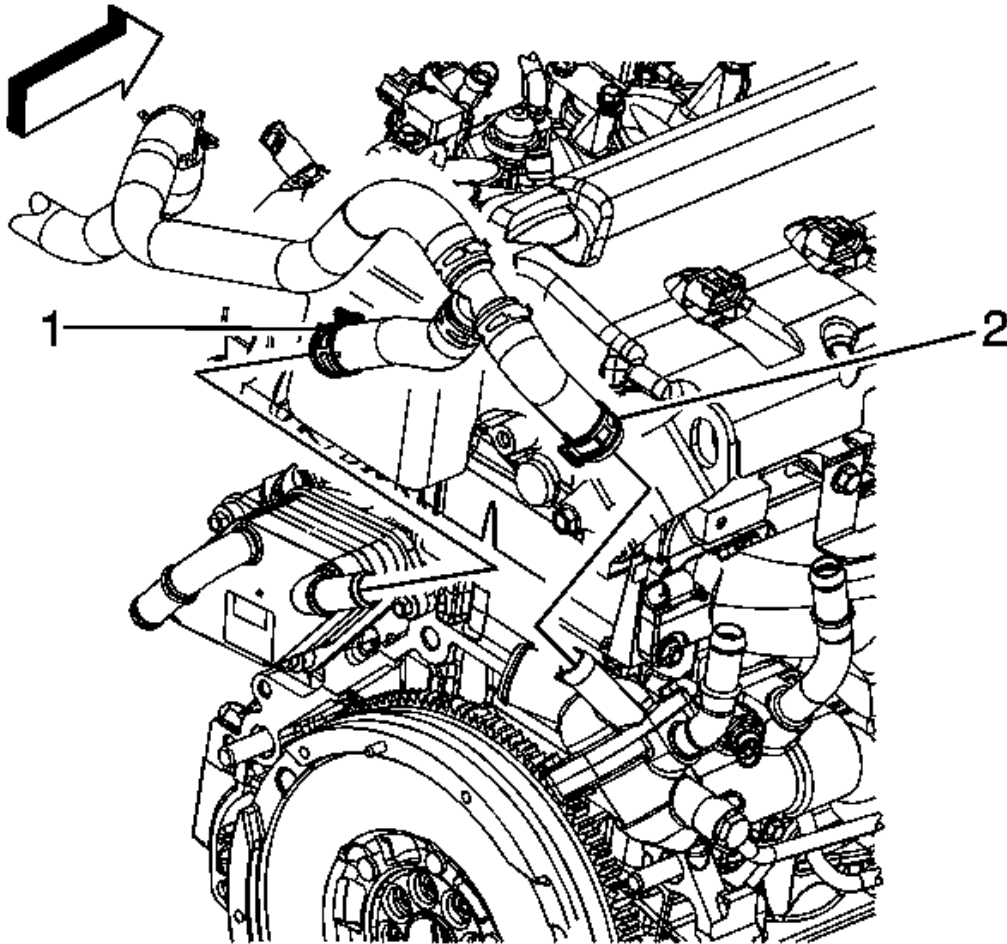


Fig. 285: Identifying Surge Tank Outlet Hose
 Courtesy of GENERAL MOTORS CORP.

25. Reposition the surge tank outlet hose clamp (2) at the thermostat housing.
26. Reposition the surge tank outlet hose clamp (1) at the oil cooler.
27. Remove the surge tank outlet hose from the thermostat housing and oil cooler.

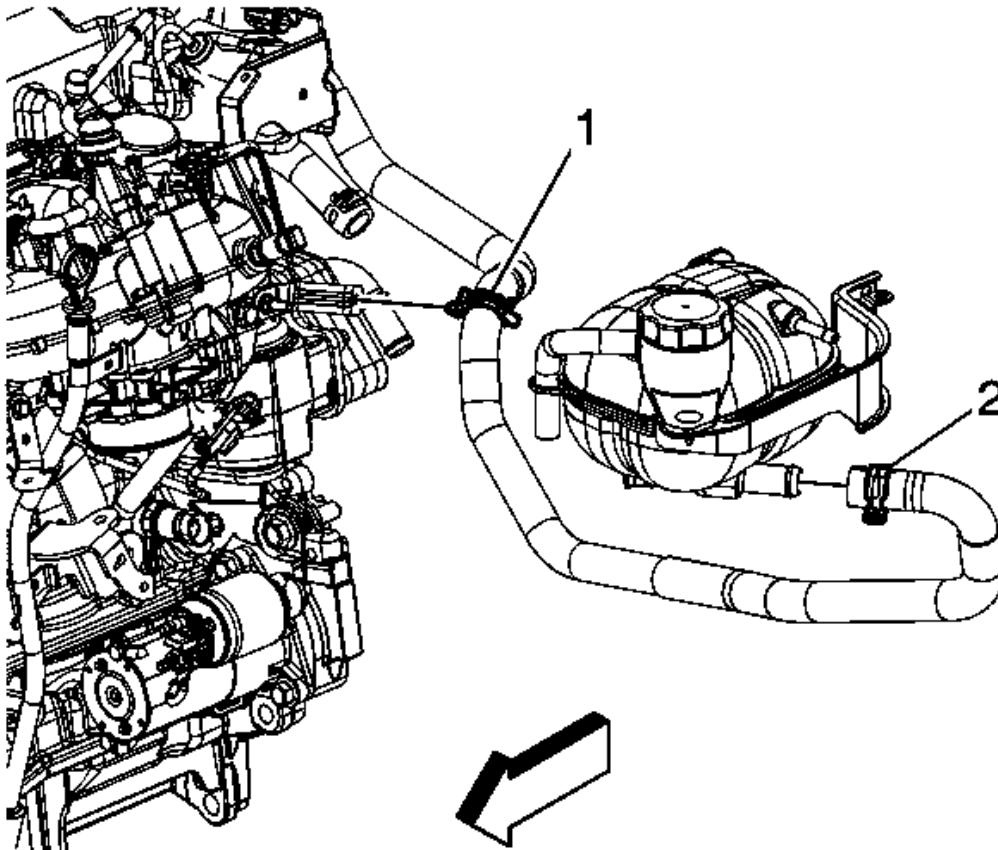


Fig. 286: Identifying Surge Tank Outlet Hose Clamp (At Surge Tank)
Courtesy of GENERAL MOTORS CORP.

28. Reposition the surge tank outlet hose clamp (2) at the surge tank.
29. Remove the surge tank outlet hose from the surge tank.
30. Remove the surge tank clip (1) from the oil level indicator tube bracket.
31. Remove the surge tank outlet hose from the vehicle.

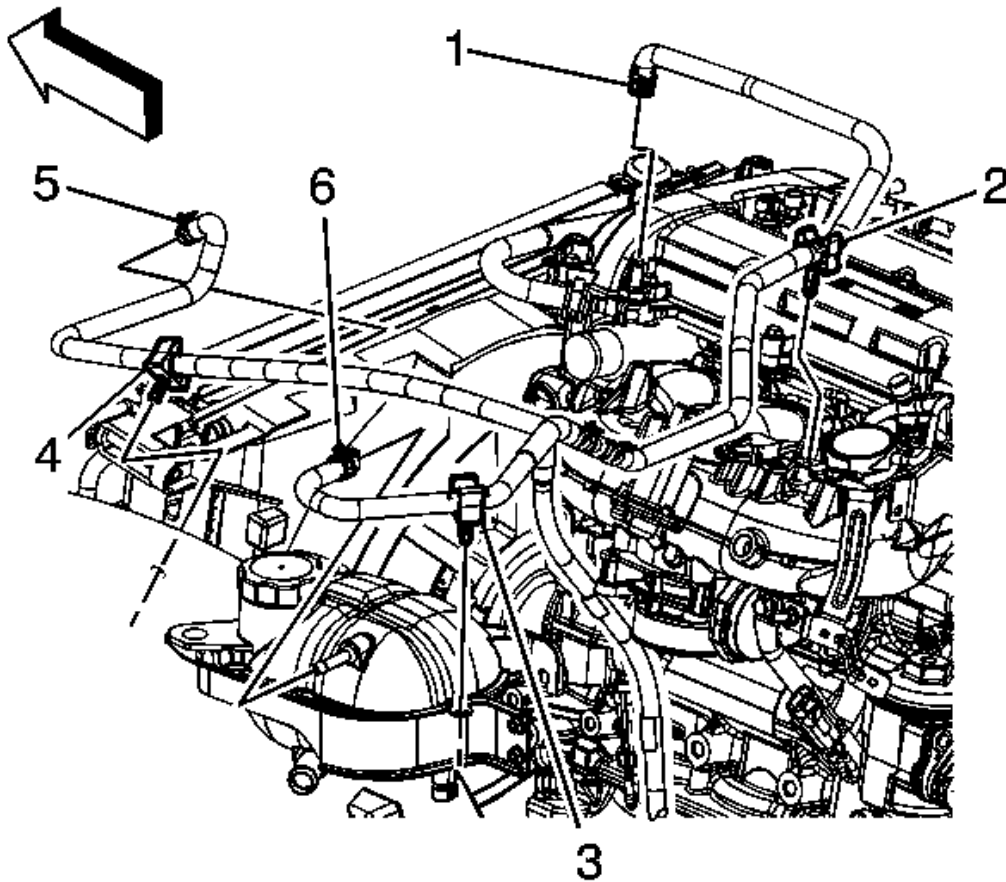


Fig. 287: Identifying Surge Tank Hose Components
Courtesy of GENERAL MOTORS CORP.

32. Reposition the surge tank air bleed hose clamp (1) at the engine.
33. Remove the surge tank air bleed hose cli (3) from the surge tank bracket.
34. Remove the surge tank air bleed hose from the engine.
35. Reposition the air bleed hose out of the way.

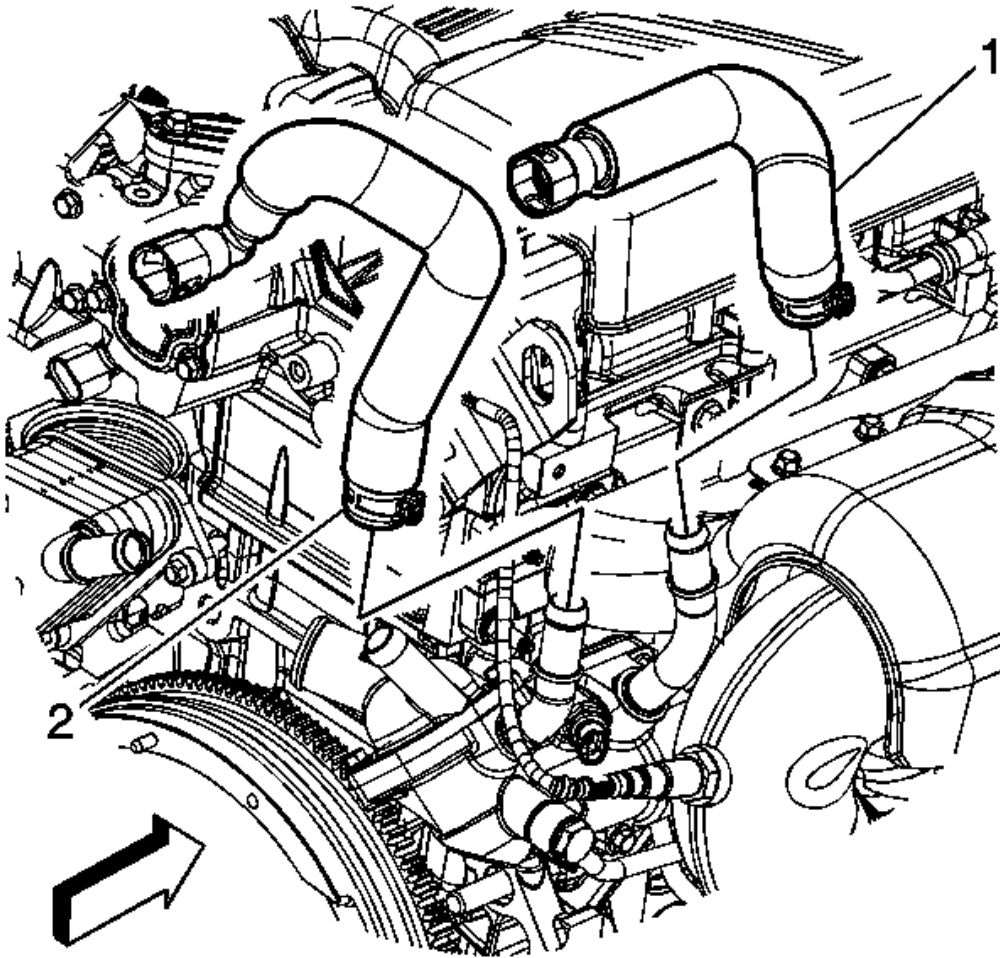


Fig. 288: Identifying Heater Inlet & Outlet Hoses & Clamps
 Courtesy of GENERAL MOTORS CORP.

36. Reposition the heater inlet and outlet hose clamps at the thermostat housing.
37. Remove the heater inlet (1) and outlet (2) hoses from the thermostat housing.
38. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
39. Drain the engine oil.

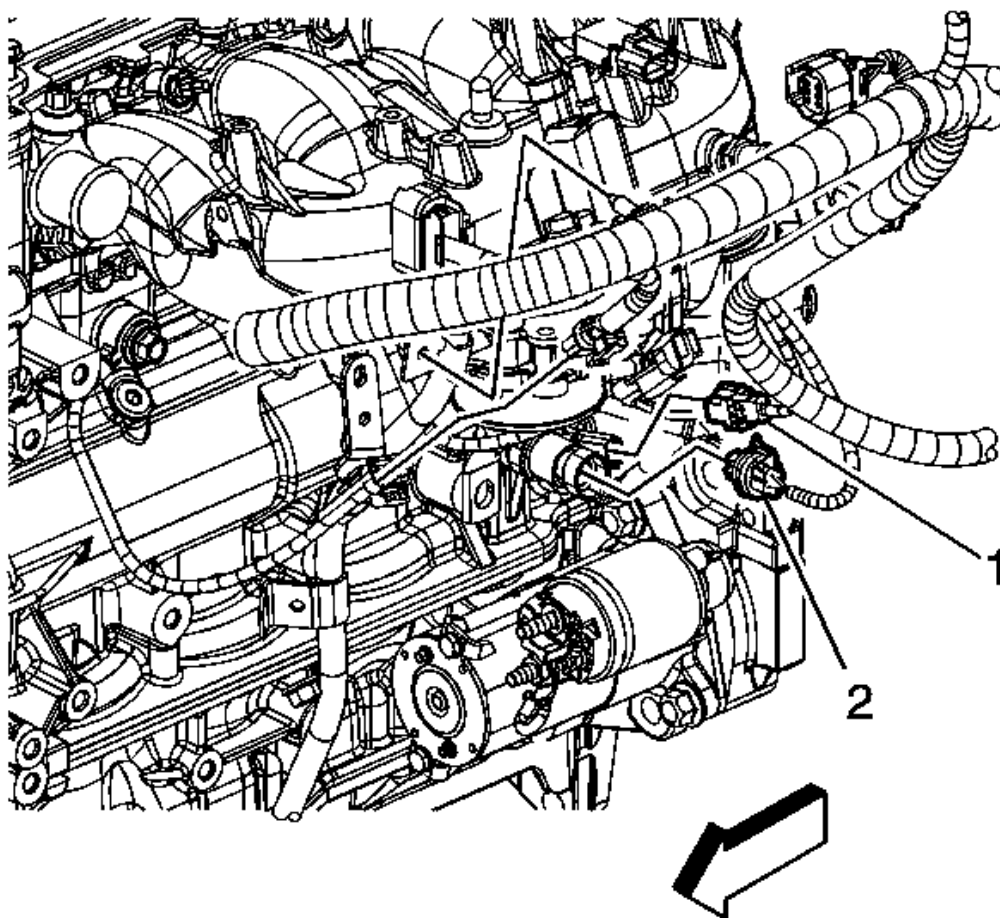


Fig. 289: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

40. Disconnect the engine wiring harness electrical connector (1) from the crankshaft position (CKP) sensor.
41. Disconnect the engine wiring harness electrical connector (2) from the oil pressure sensor.

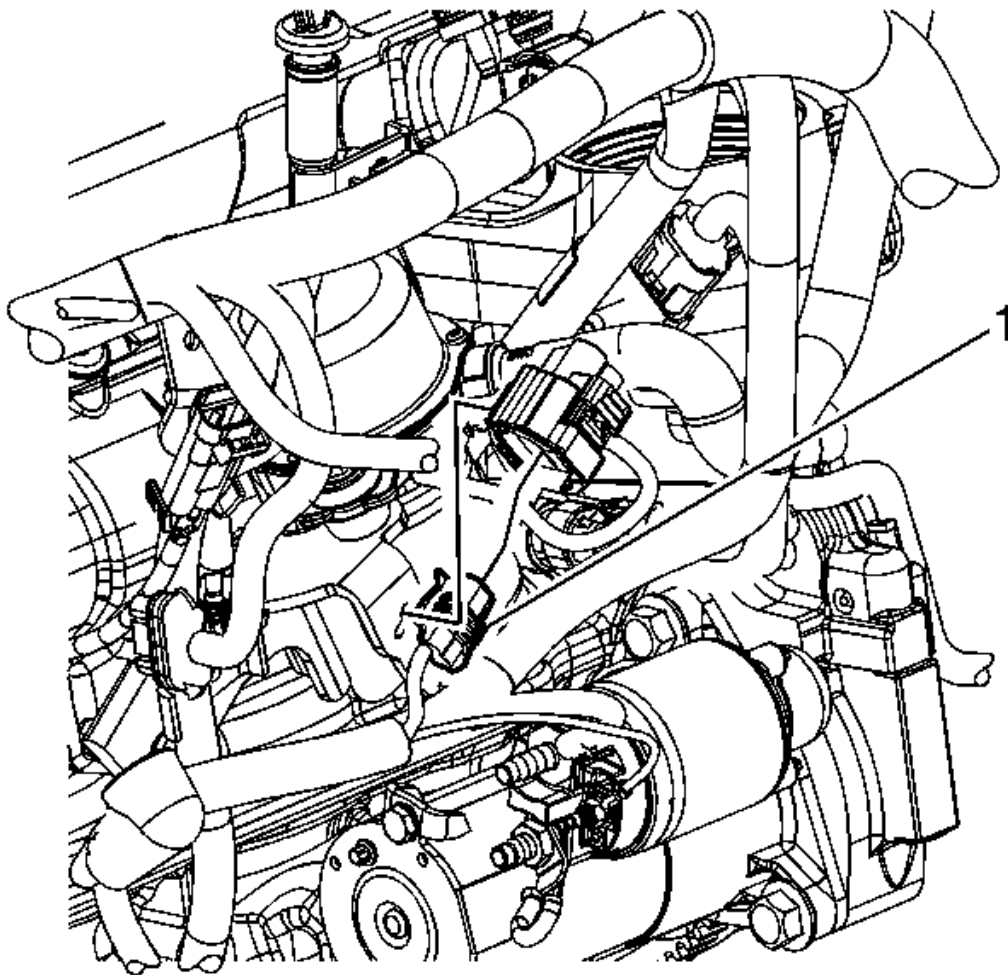


Fig. 290: Identifying Brake Booster Auxiliary Pump Connector
Courtesy of GENERAL MOTORS CORP.

42. Disconnect the engine wiring harness electrical connector (1) from the brake booster vacuum pump.

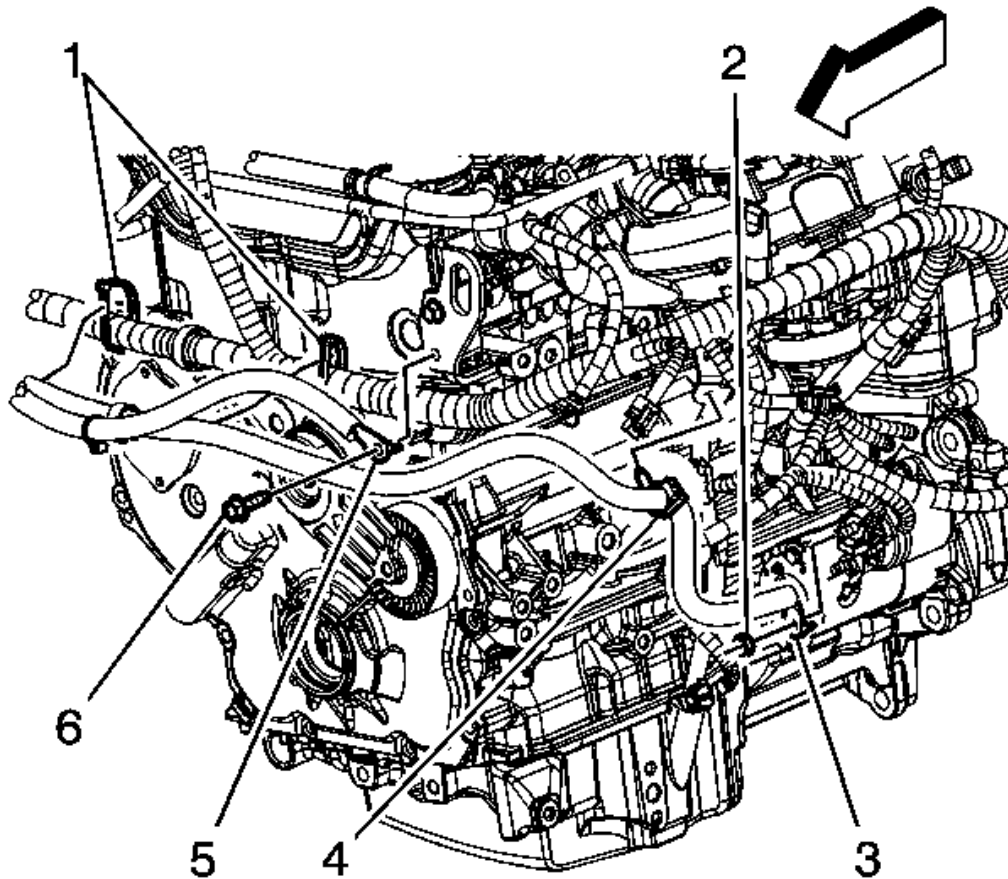


Fig. 291: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

43. Remove the positive battery cable lead nut (2) at the starter.
44. Remove the positive battery cable lead (3) from the starter.
45. Remove the engine wiring harness clip (4) from the oil level indicator tube bracket.

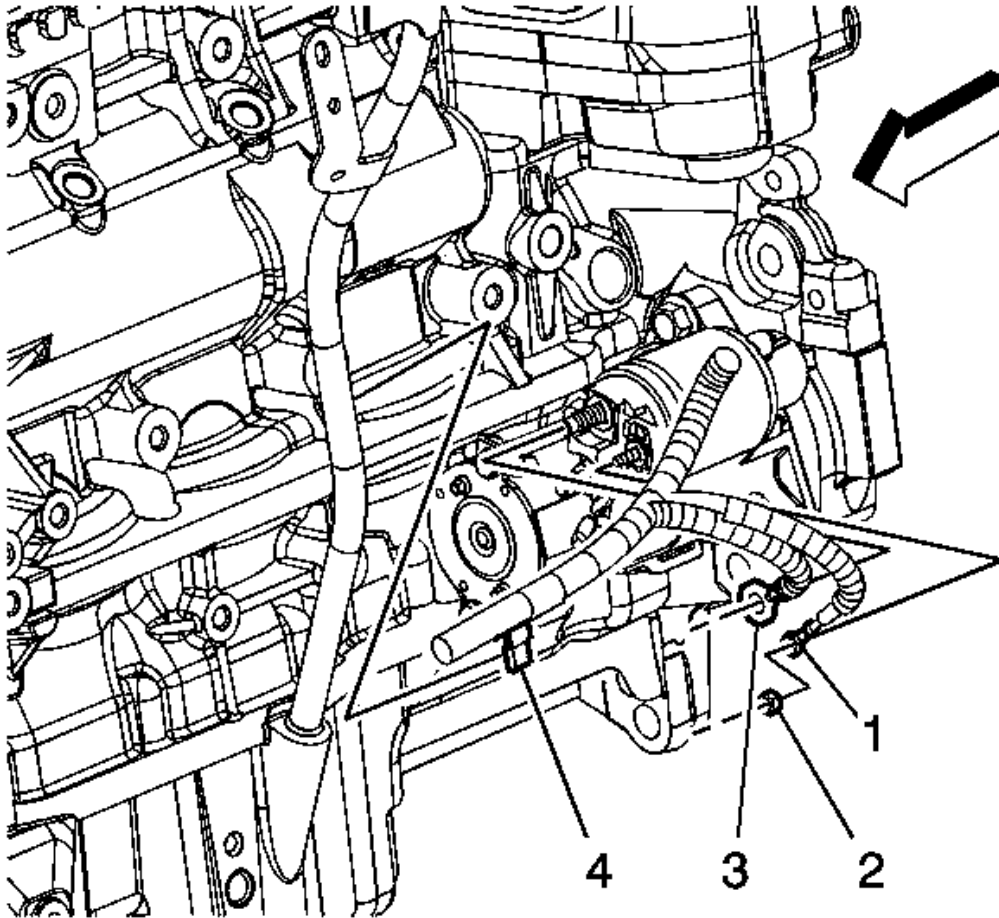


Fig. 292: Identifying Engine Wiring Harness Clips
 Courtesy of GENERAL MOTORS CORP.

46. Remove the engine wiring harness terminal (3) from the starter.
47. Remove the engine wiring harness terminal nut (2) from the starter.
48. Remove the engine wiring harness terminal (1) from the starter.
49. Remove the engine wiring harness clip (4) from the oil level indicator tube.
50. Lower the vehicle.

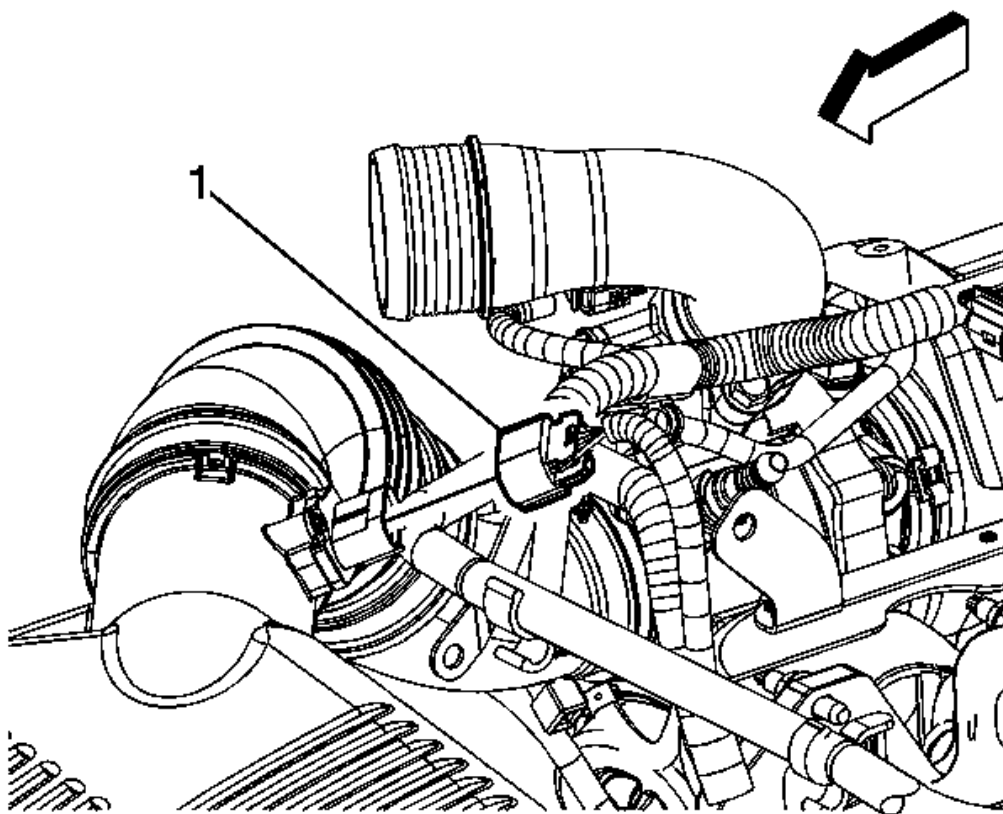


Fig. 293: Identifying MAF Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

51. Disconnect the engine wiring harness electrical connector (1) from the mass air flow (MAF) sensor.

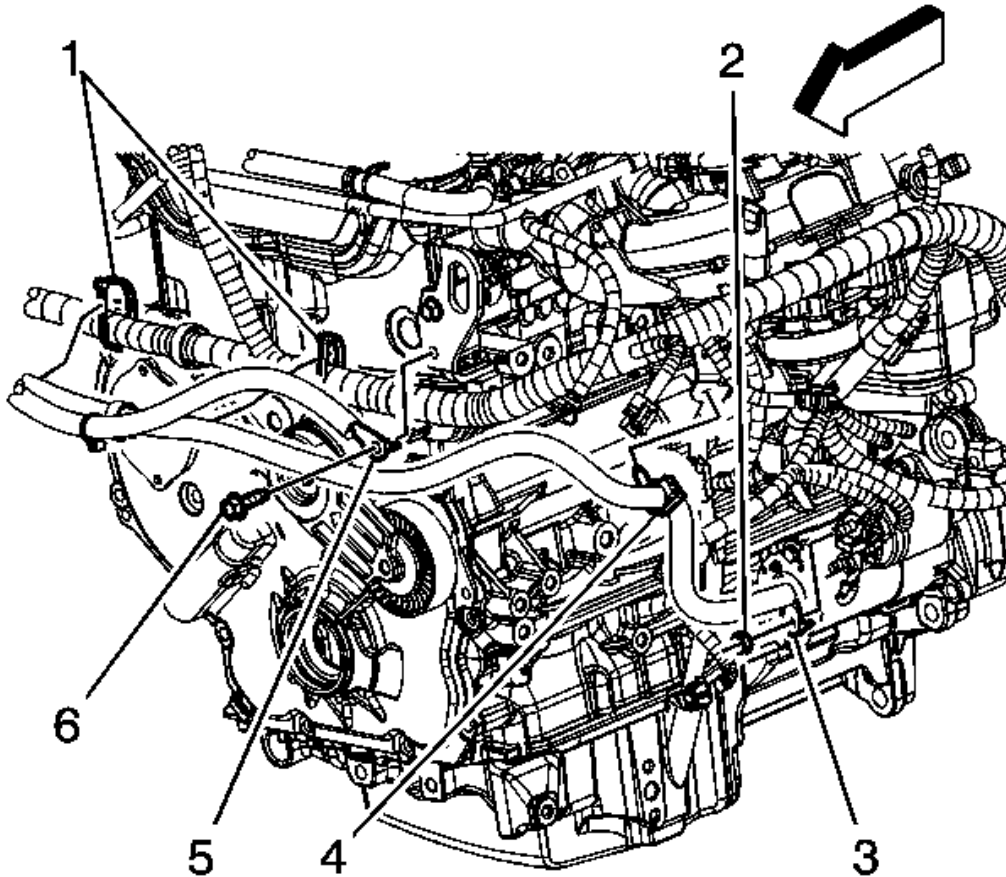


Fig. 294: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

52. Cut the engine harness tie straps (1).
53. Remove the negative battery cable ground bolt (6) from the front engine lift bracket.
54. Remove the negative battery cable ground terminal (5) from the engine lift bracket.
55. Reposition the negative/positive battery cable out of the way.

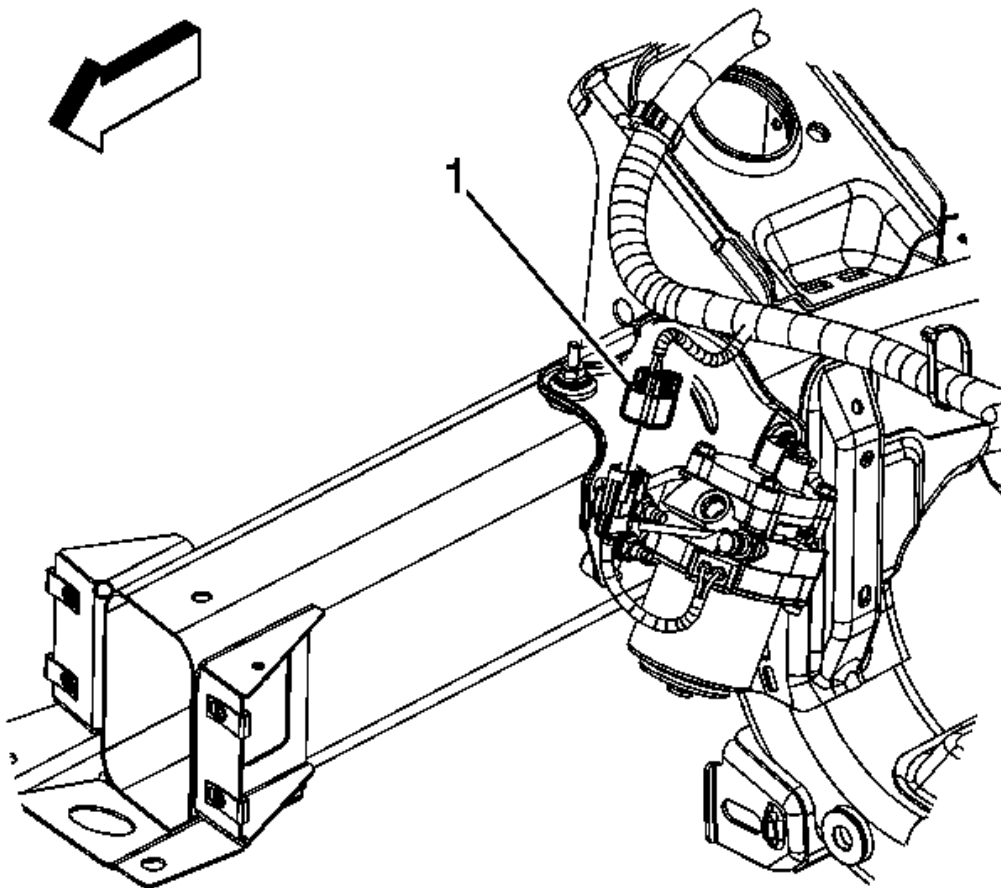


Fig. 295: Locating Transmission Oil Cooler Pump Electrical Connector
Courtesy of GENERAL MOTORS CORP.

56. Disconnect the engine wiring harness electrical connector (1) from the transmission oil cooler pump.

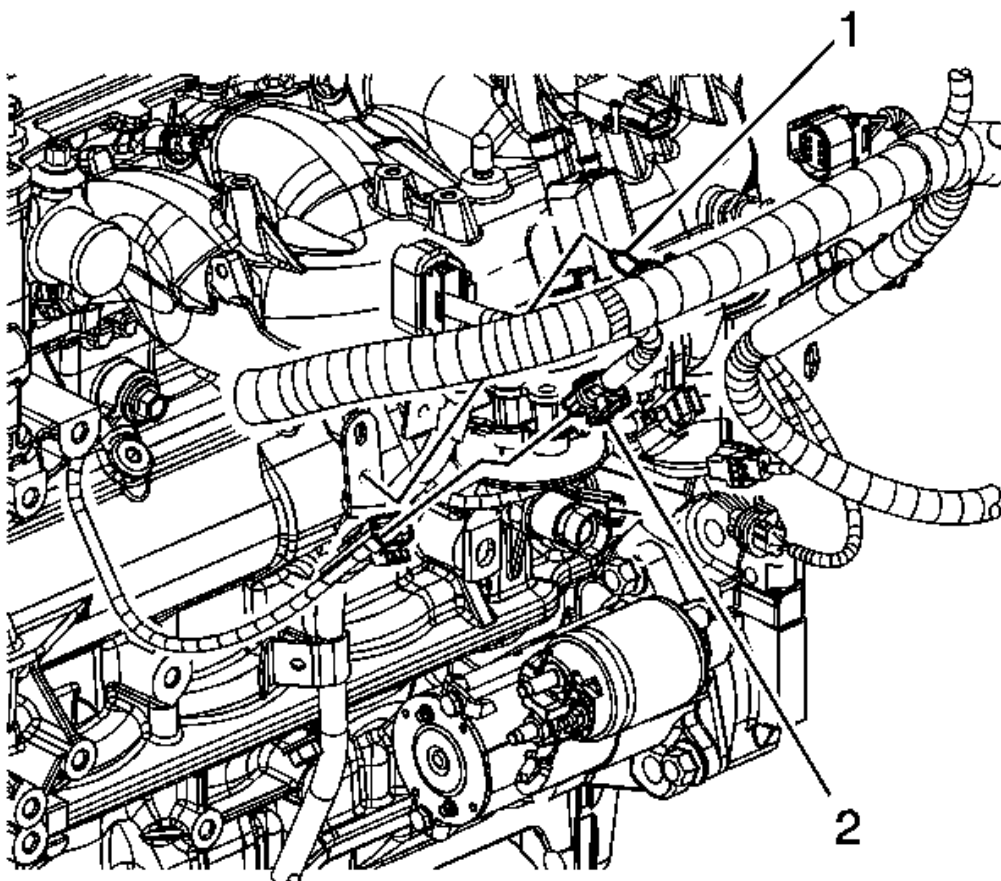


Fig. 296: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

57. Disconnect the engine wiring harness electrical connector (2) from the knock sensor.
58. Remove the engine wiring harness clip (1) from the oil level indicator tube bracket.

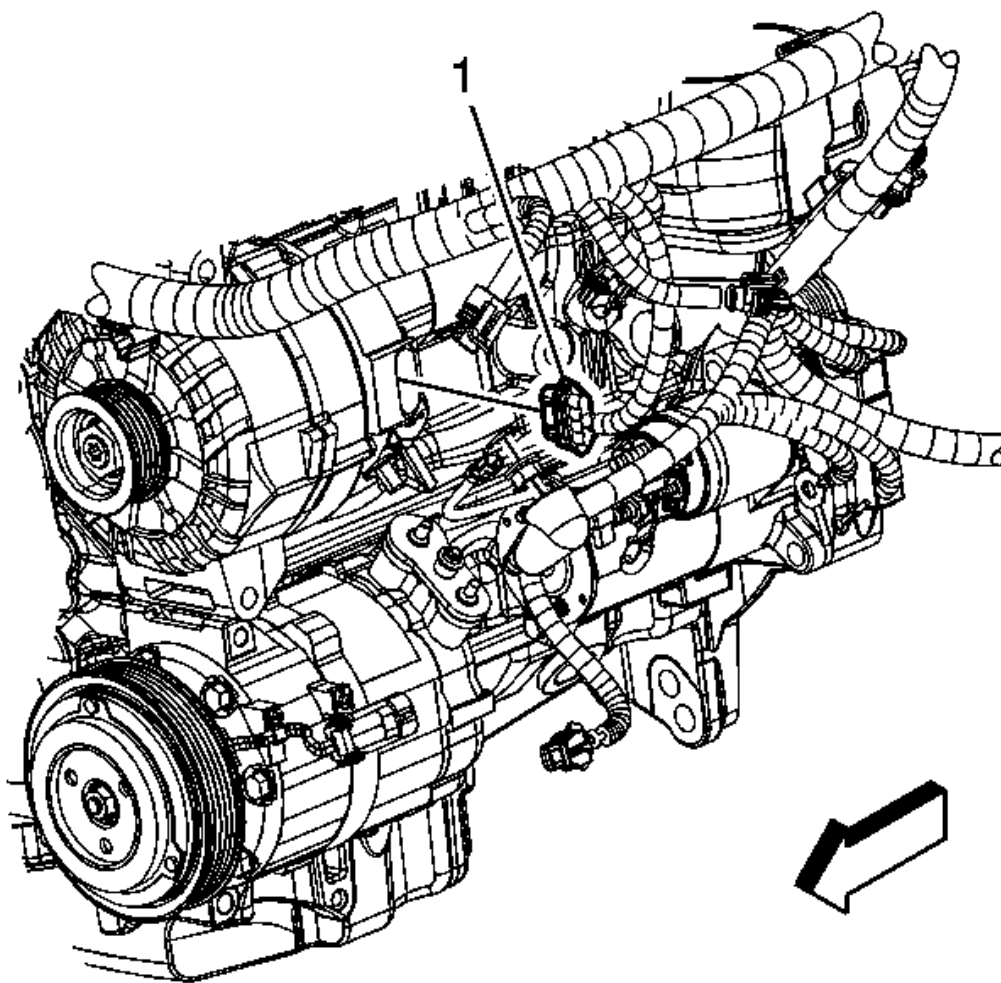


Fig. 297: Identifying Generator Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

59. Disconnect the engine wiring harness electrical connector (1) from the generator.

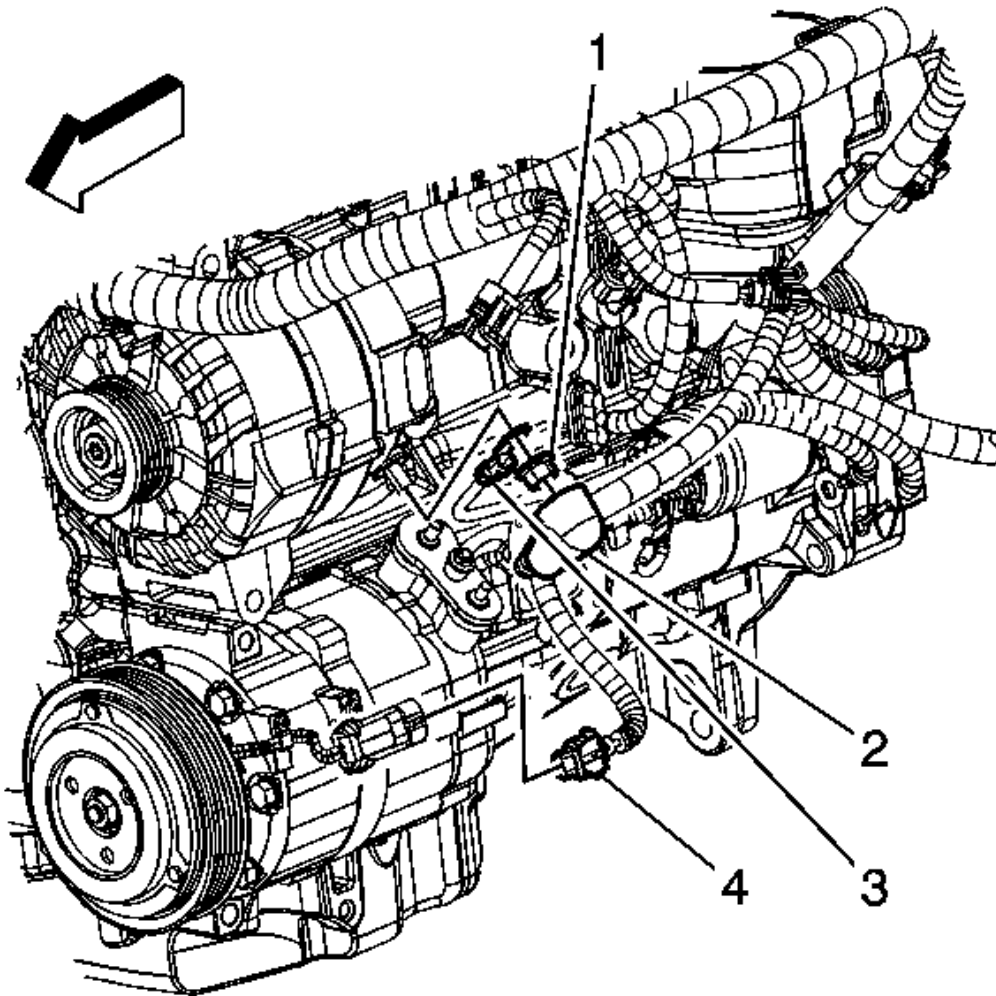


Fig. 298: Identifying Generator
Courtesy of GENERAL MOTORS CORP.

60. Reposition the positive battery cable terminal boot (2).
61. Remove the generator terminal nut (1).
62. Remove the positive battery cable terminal (3) from the generator.
63. Disconnect the engine wiring harness electrical connector (4) from the A/C compressor.

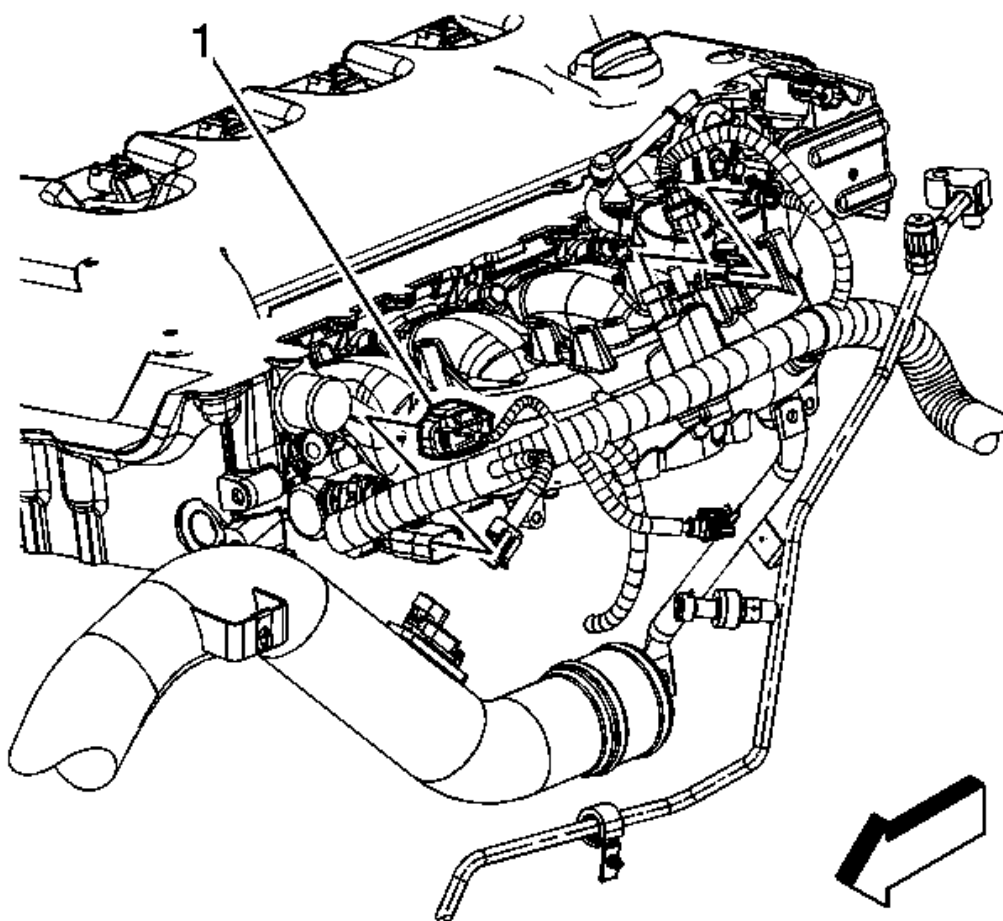


Fig. 299: View Of Engine Wiring Harness Connector & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

64. Disconnect the engine wiring harness electrical connector (1) from the fuel injector jumper electrical connector.

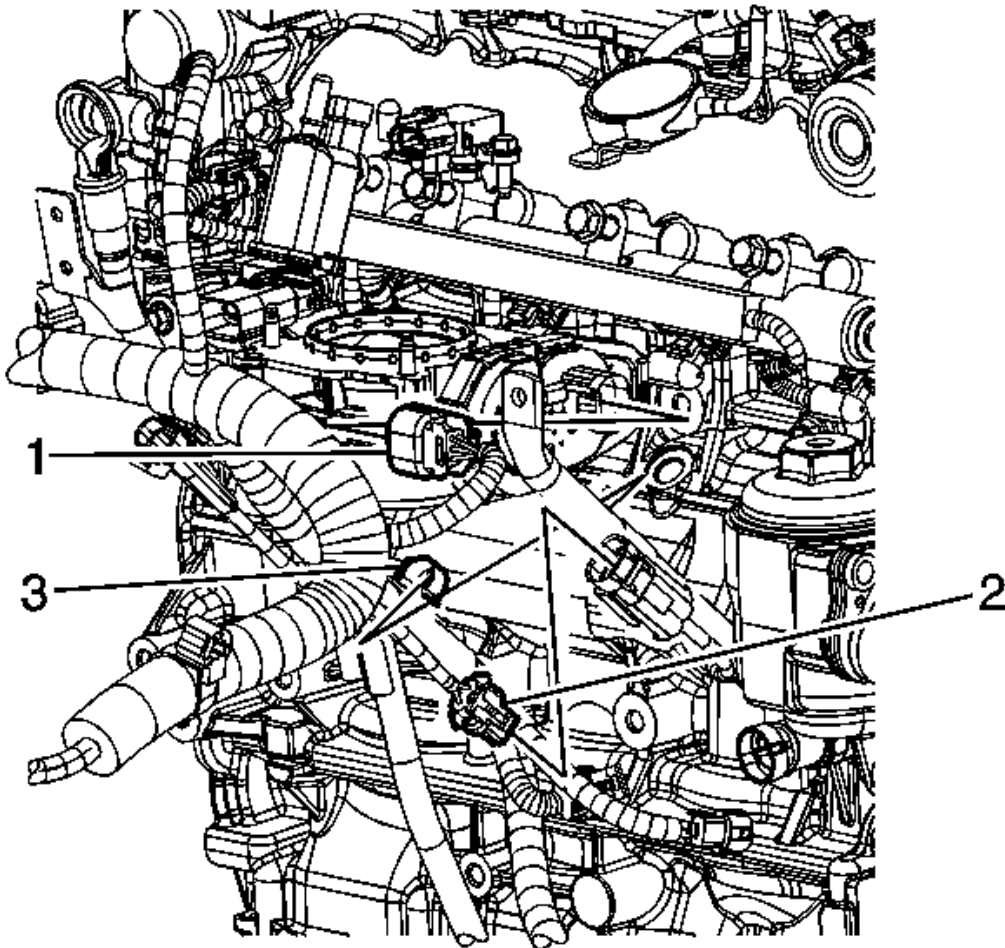


Fig. 300: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

65. Disconnect the engine wiring harness electrical connector (1) from the throttle actuator.
66. Disconnect the engine wiring harness electrical connector (2) from the knock sensor.
67. Remove the engine wiring harness clip (3) from the intake manifold brace.

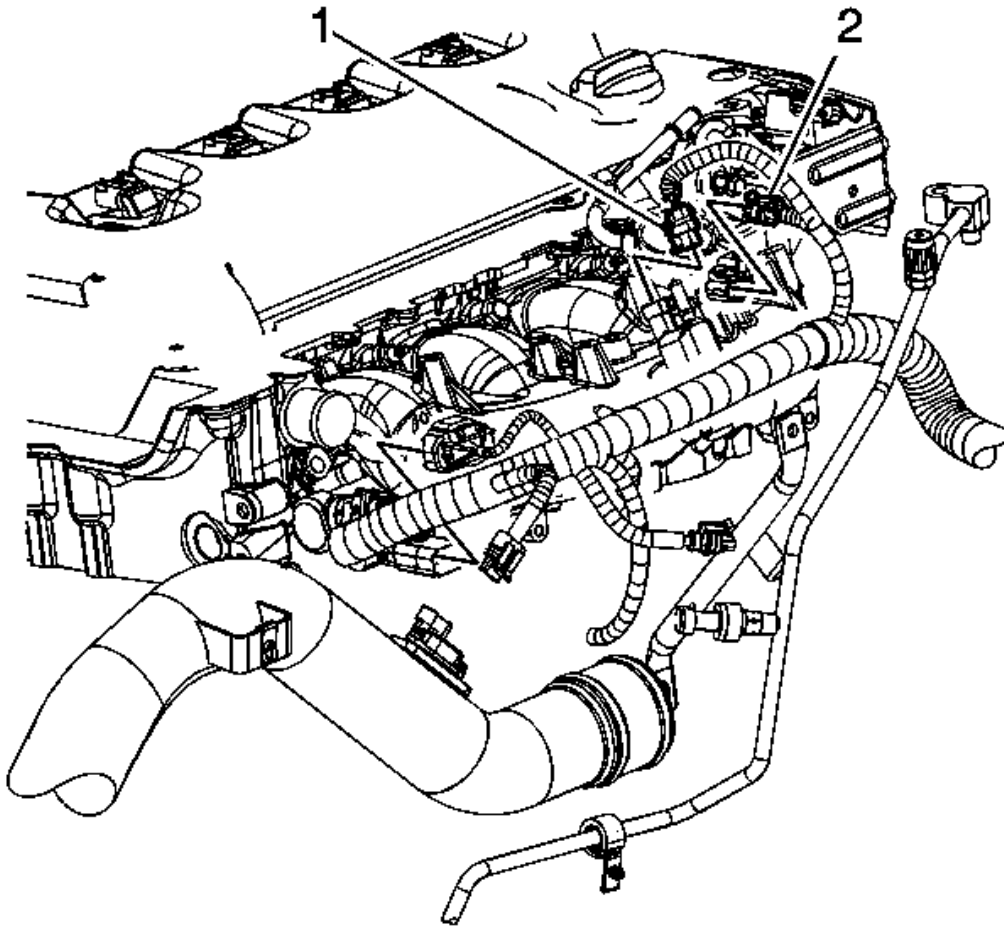


Fig. 301: Identifying MAP Sensor Connector
Courtesy of GENERAL MOTORS CORP.

68. Disconnect the engine wiring harness electrical connector (1) from the EVAP canister purge solenoid valve.
69. Disconnect the engine wiring harness electrical connector (2) from the manifold absolute pressure (MAP) sensor.

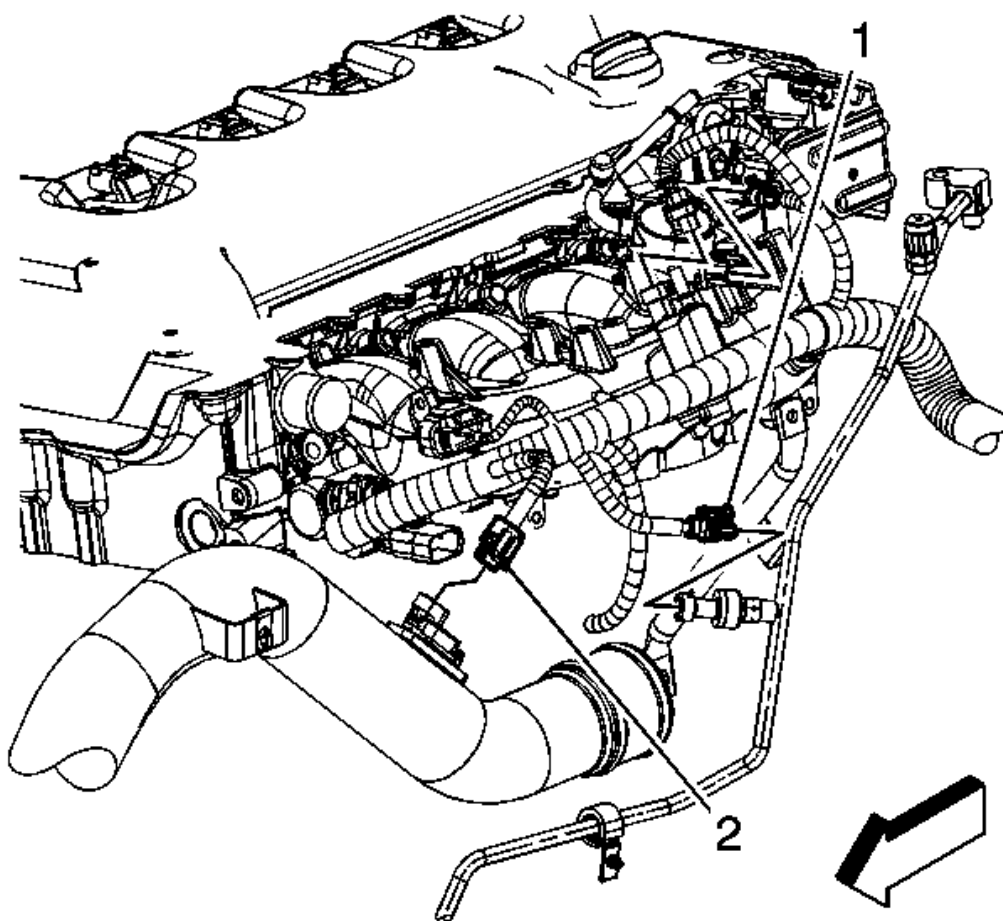


Fig. 302: View Of Intake Air Pressure & Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

70. Disconnect the engine wiring harness electrical connector (1) from the A/C refrigerant pressure sensor.

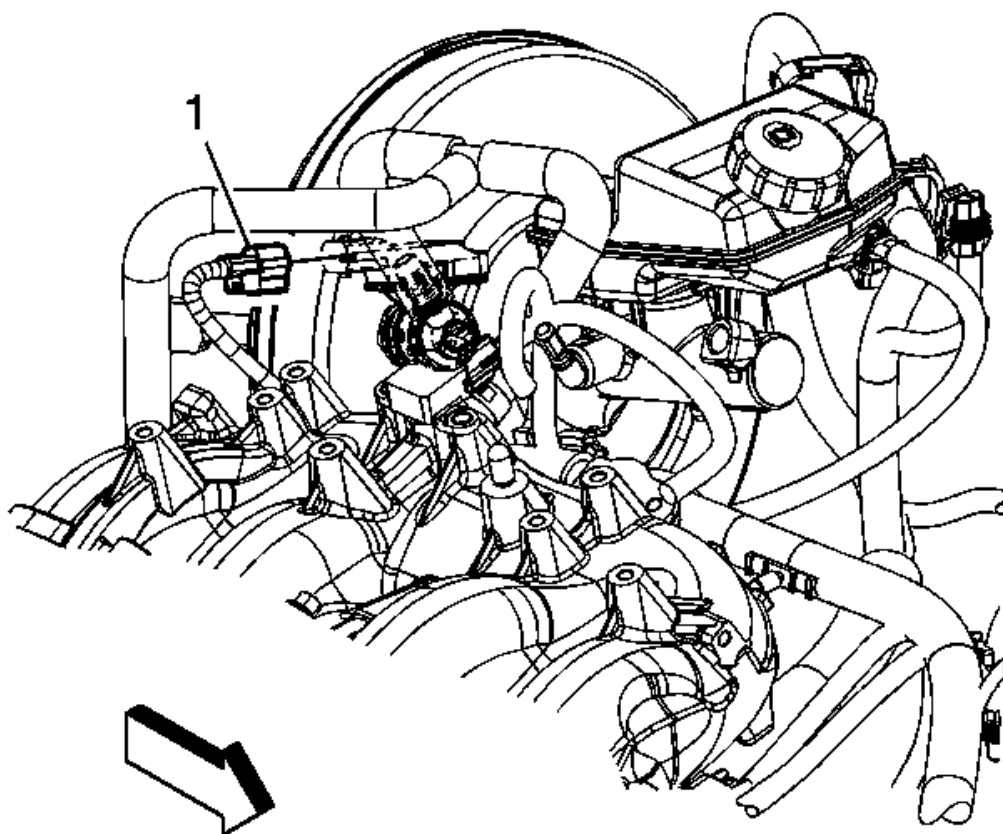


Fig. 303: Identifying Brake Booster Vacuum Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

71. Disconnect the engine wiring harness electrical connector (1) from the brake booster vacuum sensor.

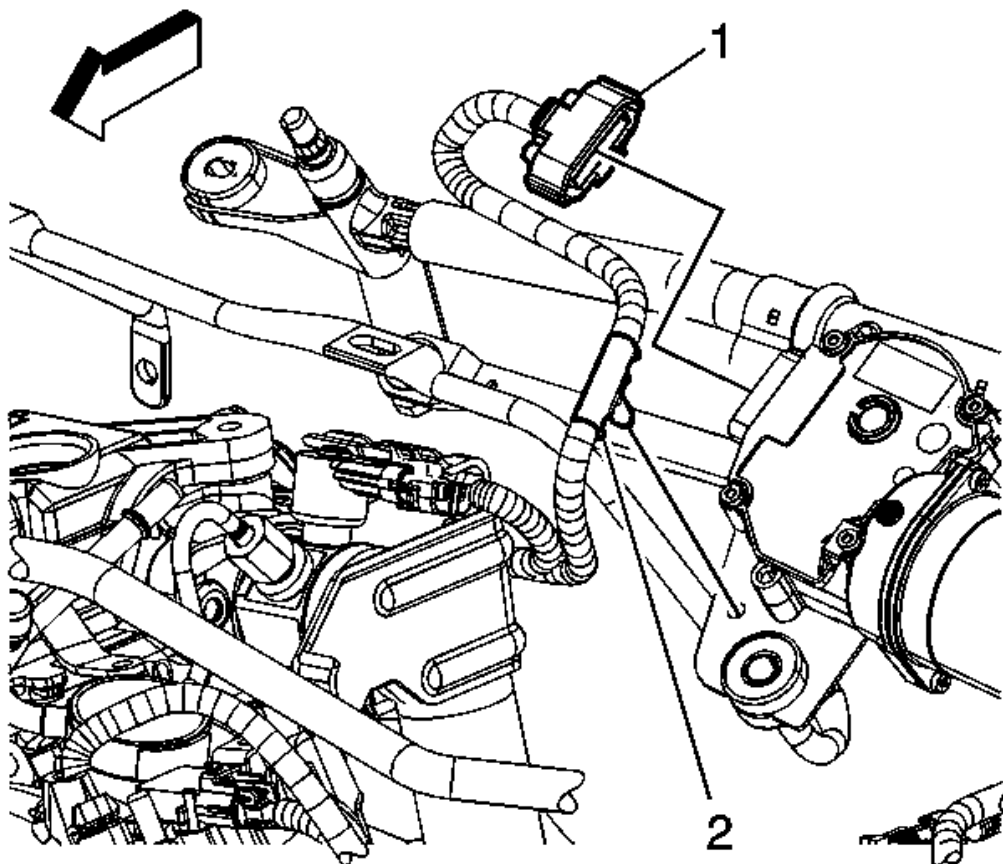


Fig. 304: Locating Windshield Wiper Motor Electrical Connector & Harness Clip
Courtesy of GENERAL MOTORS CORP.

72. Disconnect the engine wiring harness electrical connector (1) from the windshield wiper motor.
73. Remove the engine harness clip (2) from the wiper motor hole.

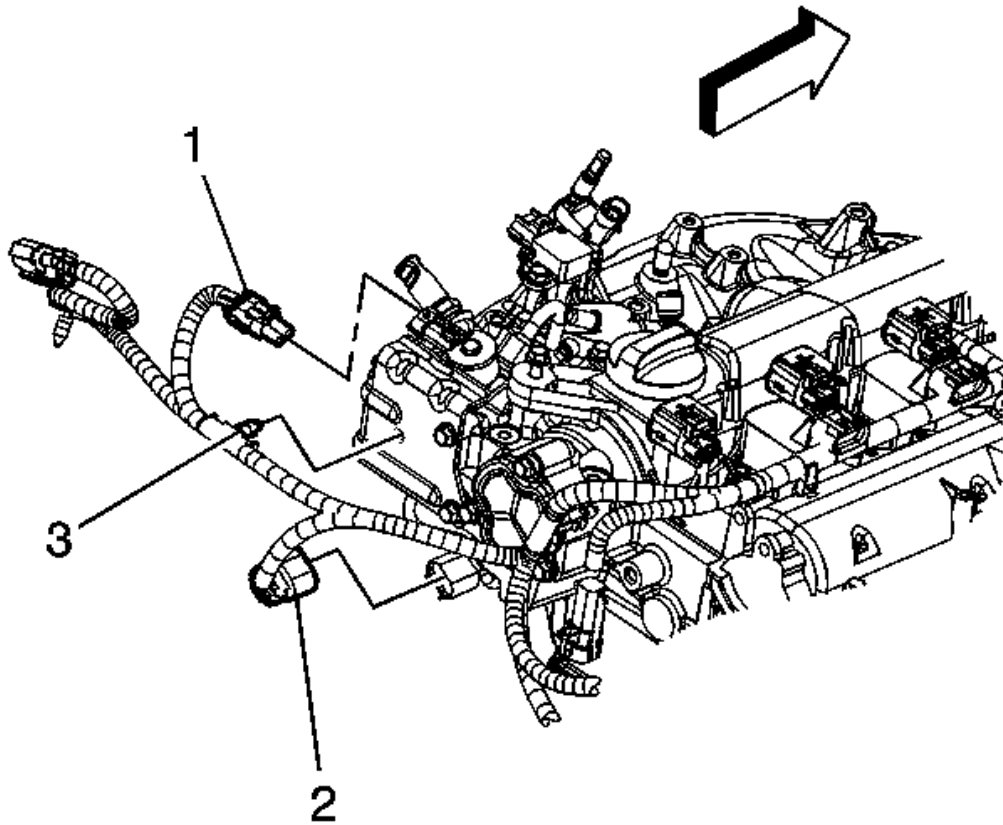


Fig. 305: Identifying High Pressure Fuel Pump Connector & Clip
Courtesy of GENERAL MOTORS CORP.

74. Disconnect the engine wiring harness electrical connector (2) from the intake camshaft position (CMP) sensor.
75. Disconnect the engine wiring harness electrical connector (1) from the high pressure fuel pump.
76. Remove the engine wiring harness clip (3) from the high pressure fuel pump bracket.

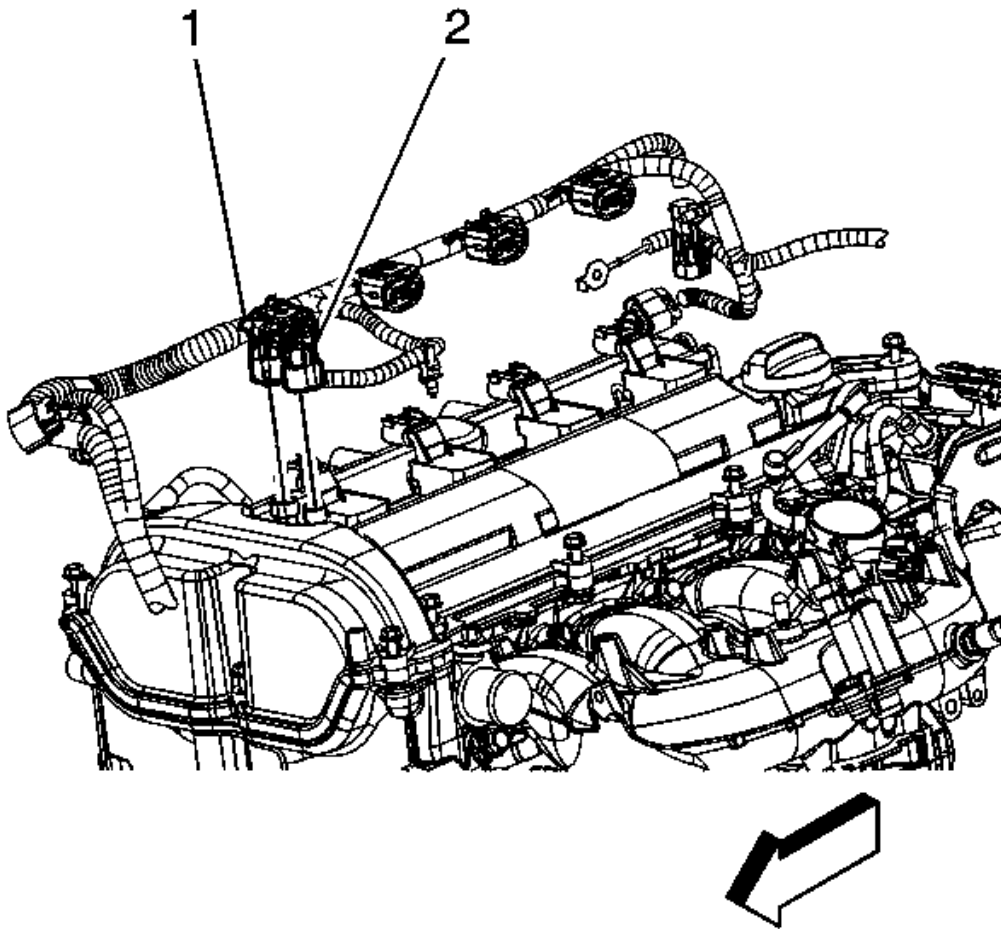


Fig. 306: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

77. Disconnect the engine wiring harness electrical connector (2) from the intake CMP actuator.
78. Disconnect the engine wiring harness electrical connector (1) from the exhaust CMP actuator.

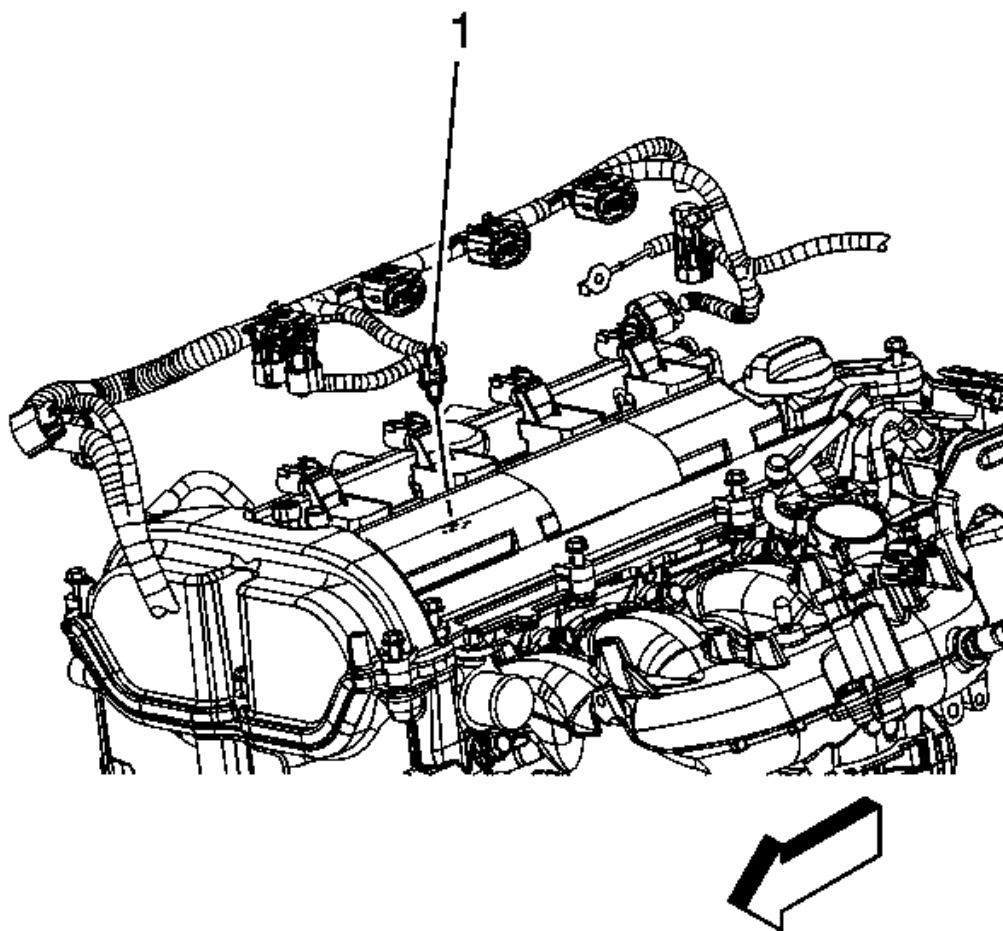


Fig. 307: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

79. Remove the engine harness clip (1) from the camshaft cover.

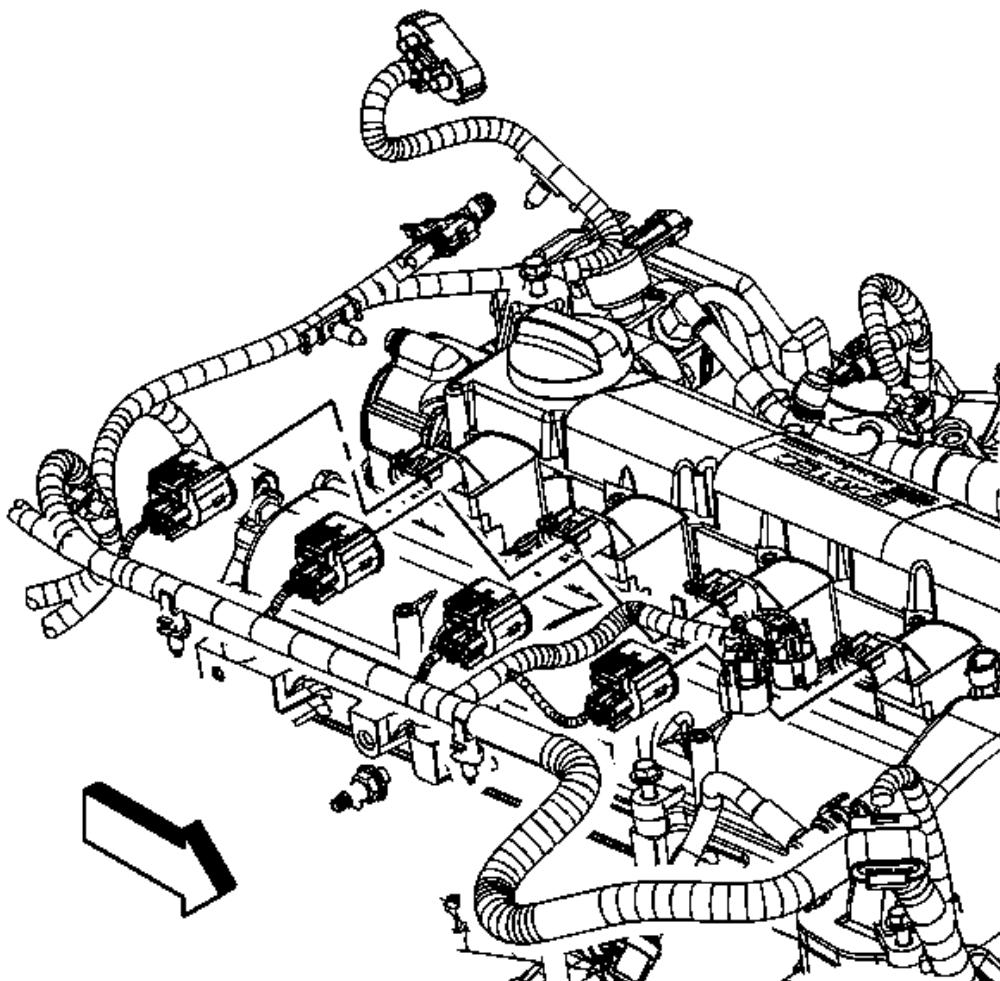


Fig. 308: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

80. Disconnect the engine wiring harness electrical connectors from the ignition coils.

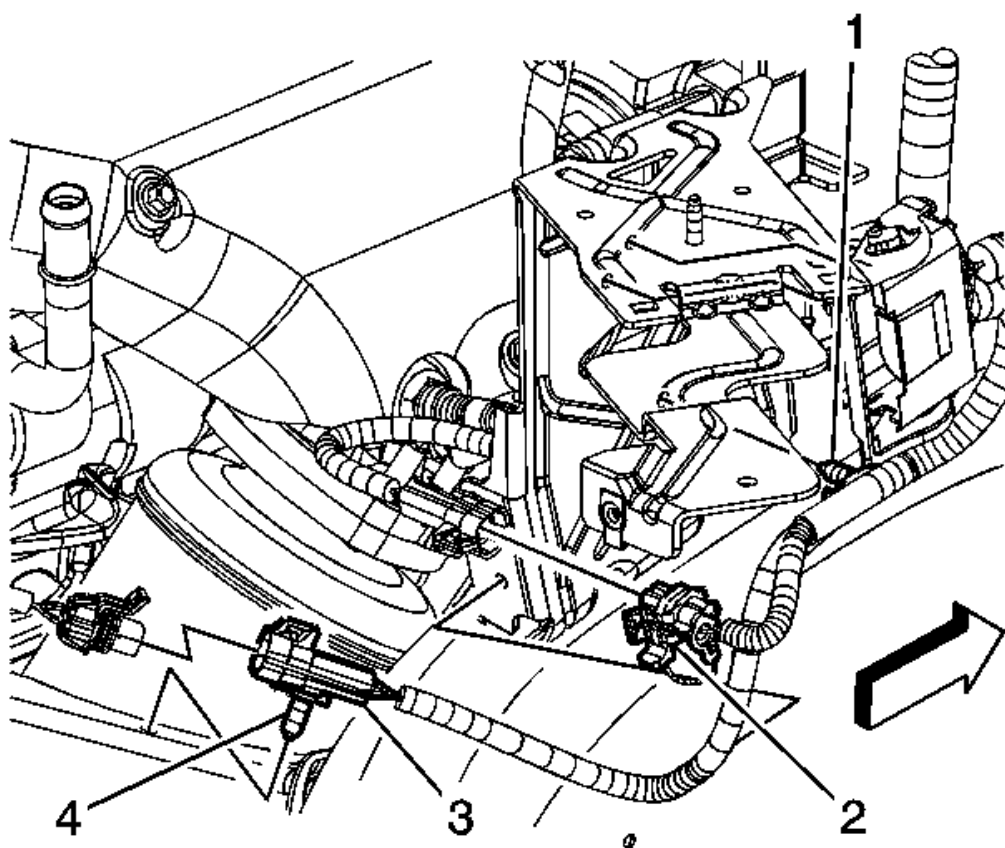


Fig. 309: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

81. Disconnect the engine wiring harness electrical connector (1) from the heated oxygen sensor (HO2S) (3).

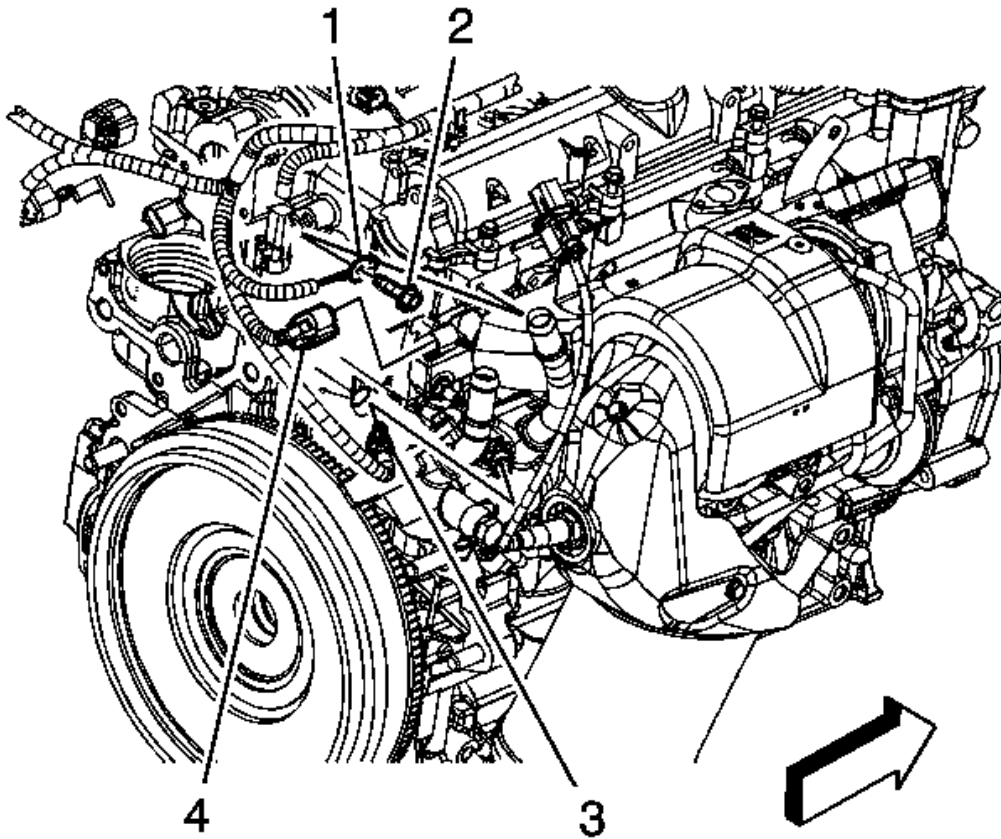


Fig. 310: Identifying ECT Sensor Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

82. Disconnect the engine wiring harness electrical connector (4) from the exhaust CMP sensor.
83. Remove the engine harness ground terminal bolt (2) and reposition the engine harness ground terminal (1).
84. Disconnect the engine wiring harness electrical connector (3) from the engine coolant temperature (ECT) sensor.

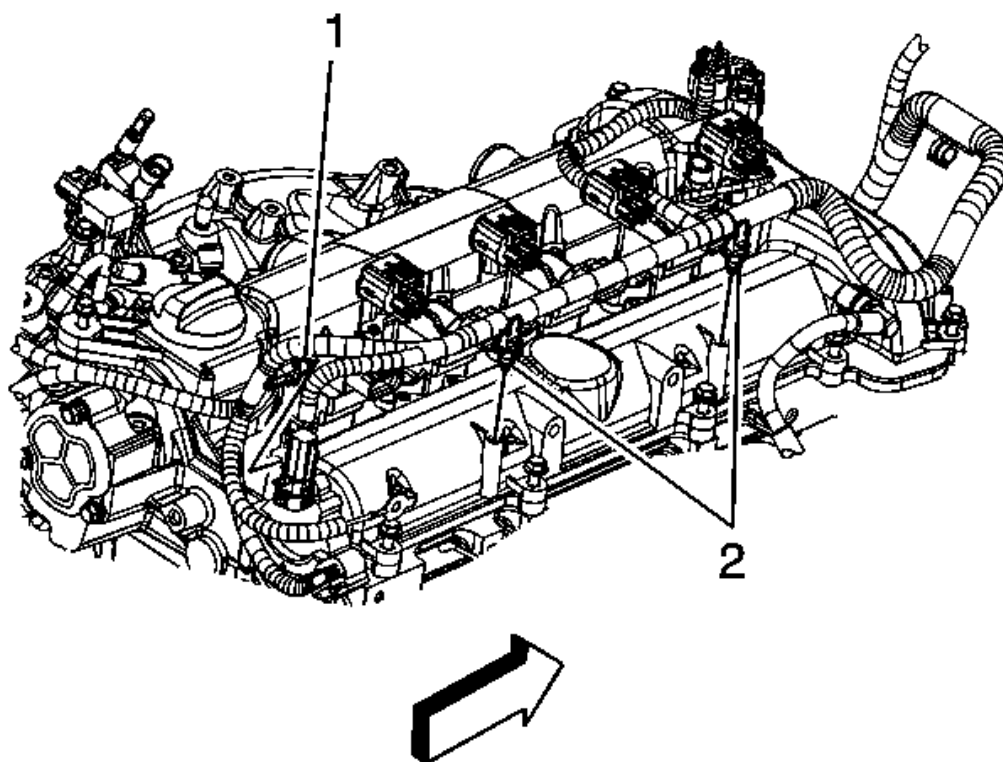


Fig. 311: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

- 85. Disconnect the engine harness clips (2) from the camshaft cover.
- 86. Disconnect the engine harness clip (1) from the camshaft cover.

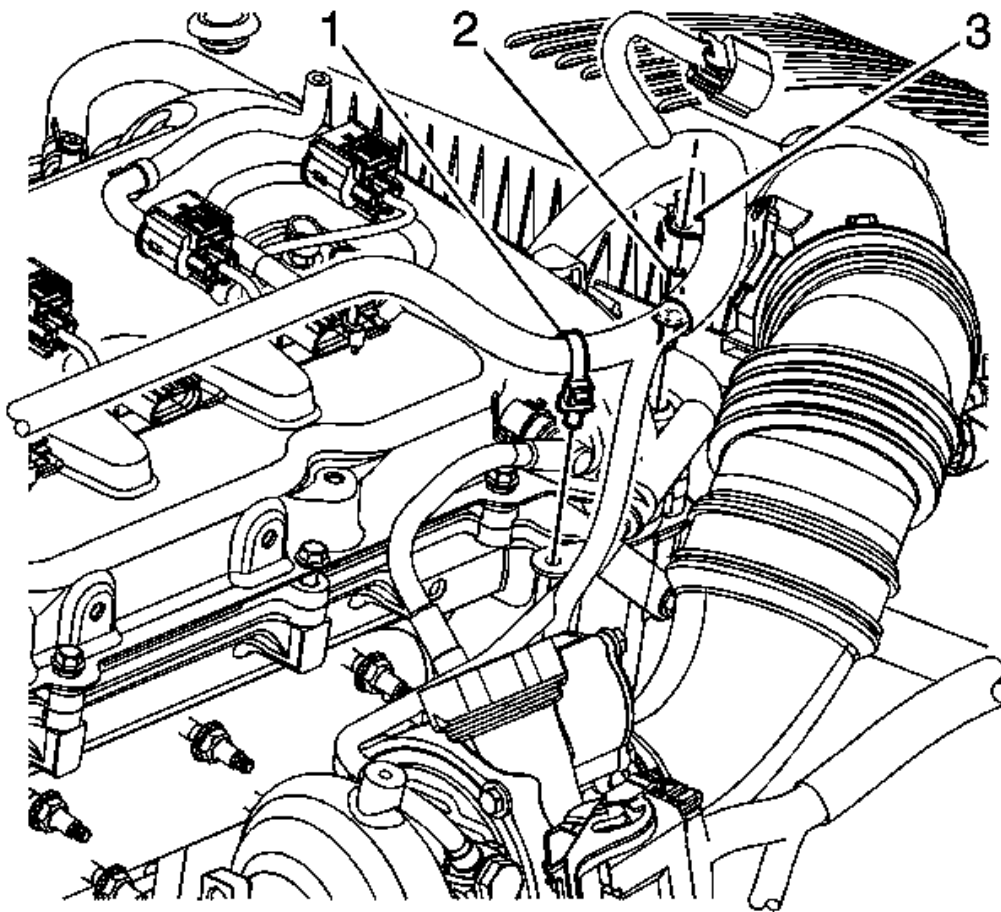


Fig. 312: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

87. Remove the engine wiring harness clip (3) from the turbocharger coolant feed pipe stud (2).
88. Remove the engine wiring harness clip (1) from the turbocharger coolant feed pipe tab.

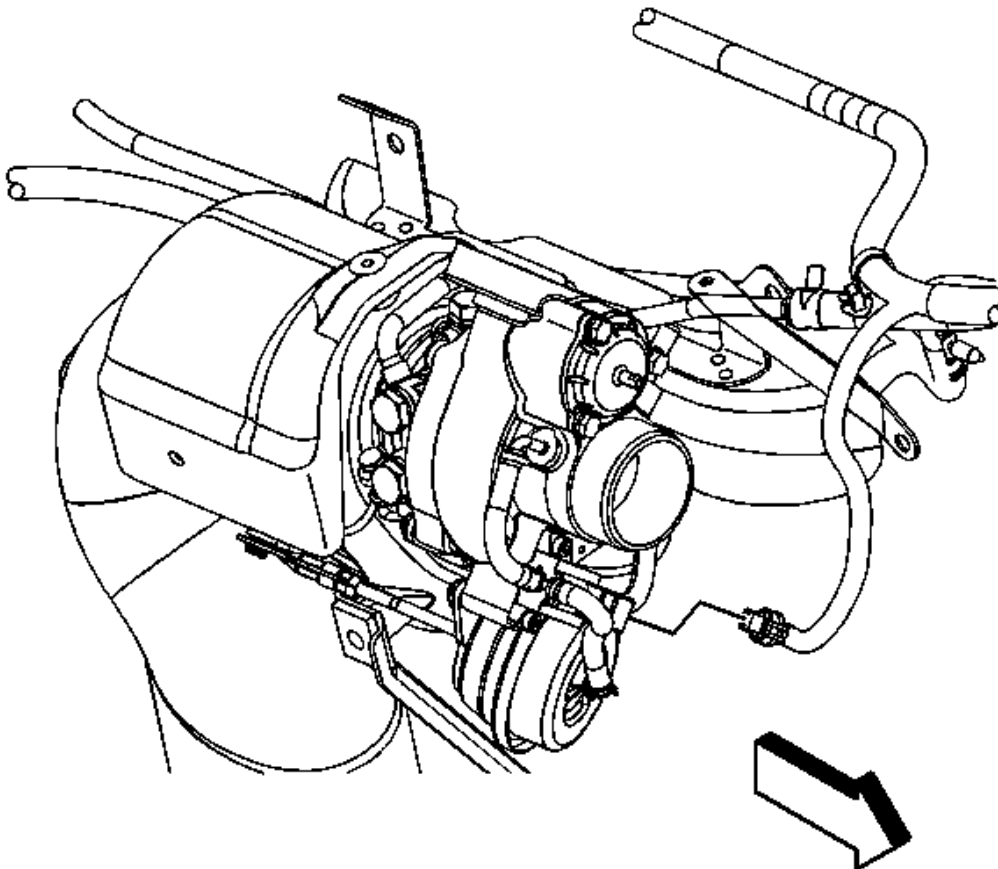


Fig. 313: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

89. Disconnect the engine wiring harness electrical connector from the boost sensor.

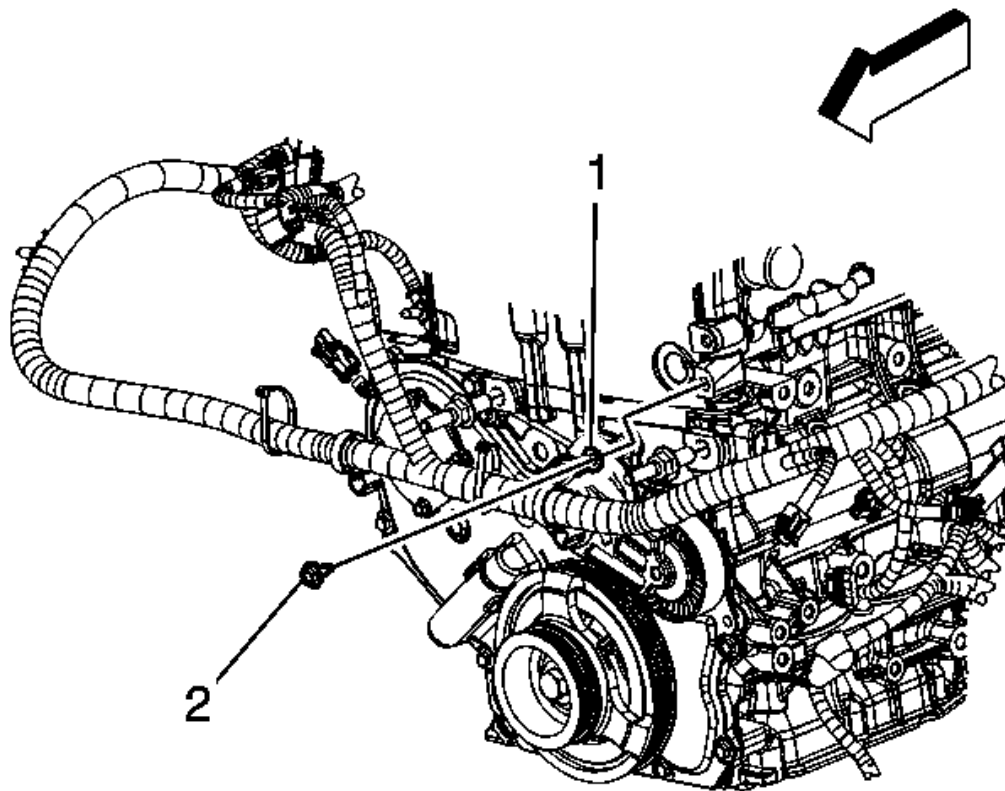


Fig. 314: Identifying Engine Wiring Harness Ground Terminal
Courtesy of GENERAL MOTORS CORP.

90. Remove the engine wiring harness ground bolt (2) from the cylinder head.
91. Remove the engine wiring harness ground terminal (1) from the cylinder head.

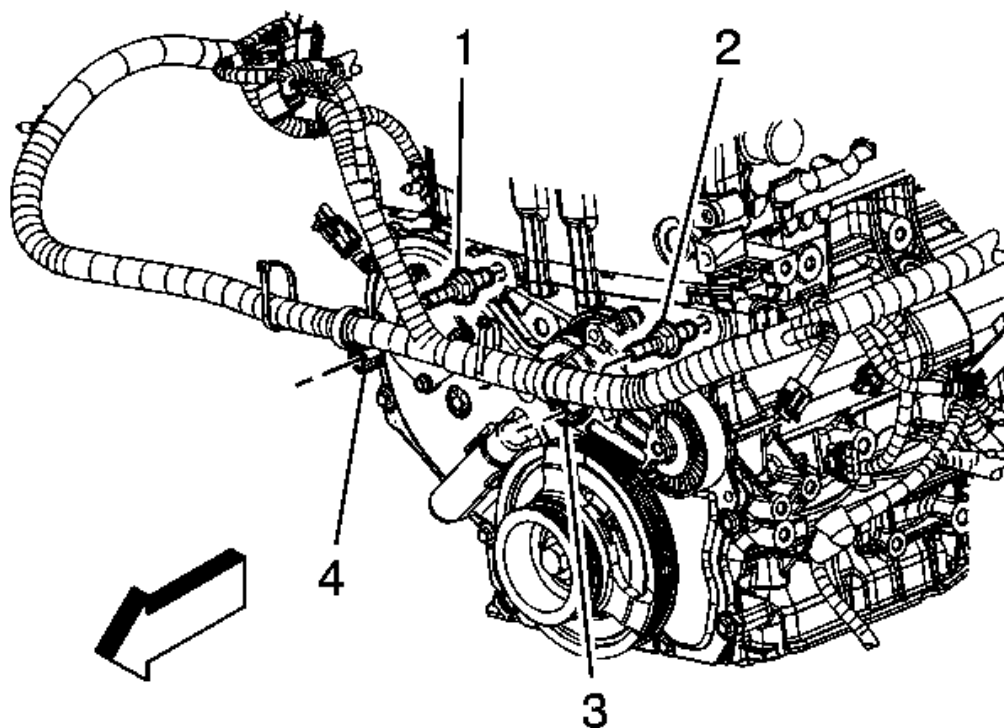


Fig. 315: Identifying Engine Harness Clips
Courtesy of GENERAL MOTORS CORP.

92. Remove the engine harness clips (3, 4) from the front studs.
93. Gather all branches of the engine harness and lay off to the side.

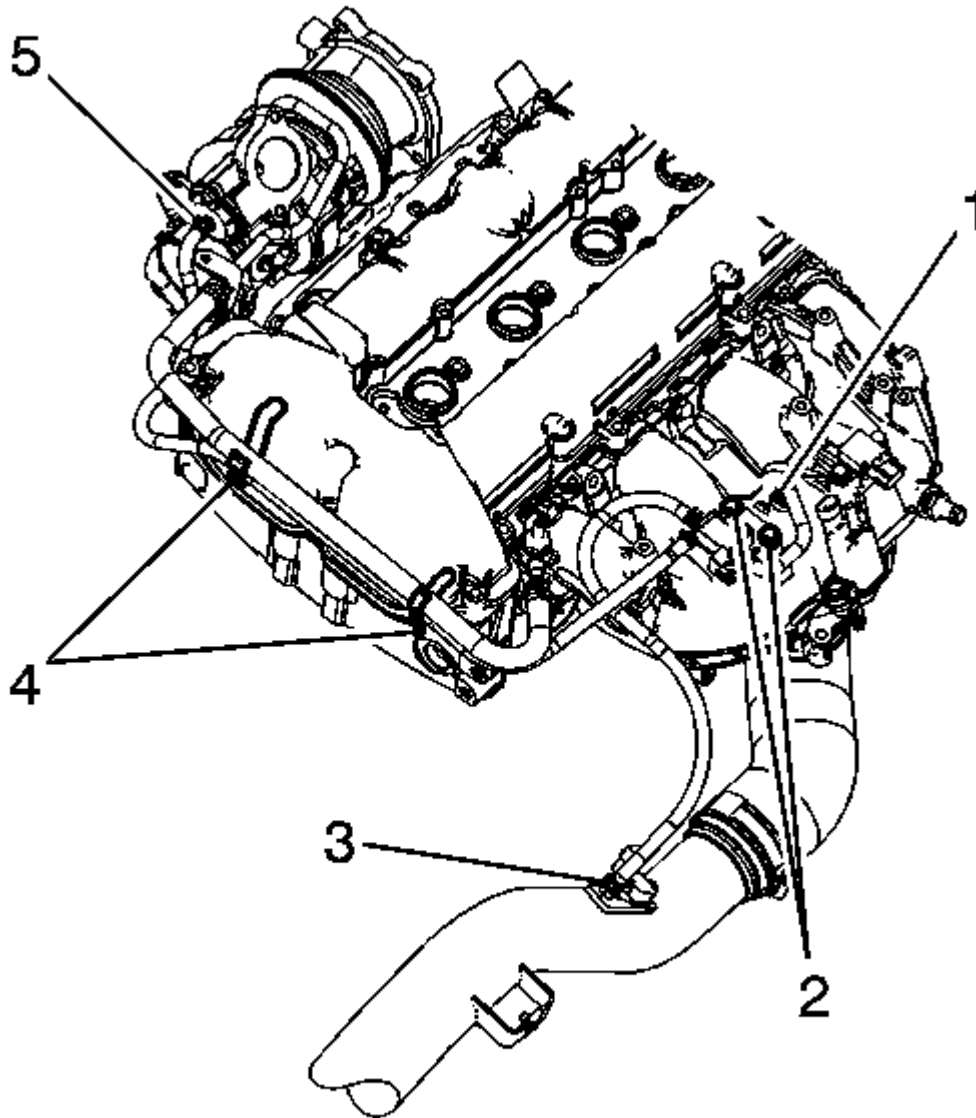


Fig. 316: Identifying Charge Air Bypass Solenoid Components
Courtesy of GENERAL MOTORS CORP.

- 94. Reposition the vacuum hose clamp (5) at the turbocharger.
- 95. Remove the vacuum hose from the turbocharger.
- 96. Remove the vacuum hose from the turbocharger coolant feed pipe clips (4).
- 97. Reposition the vacuum hose out of the way.

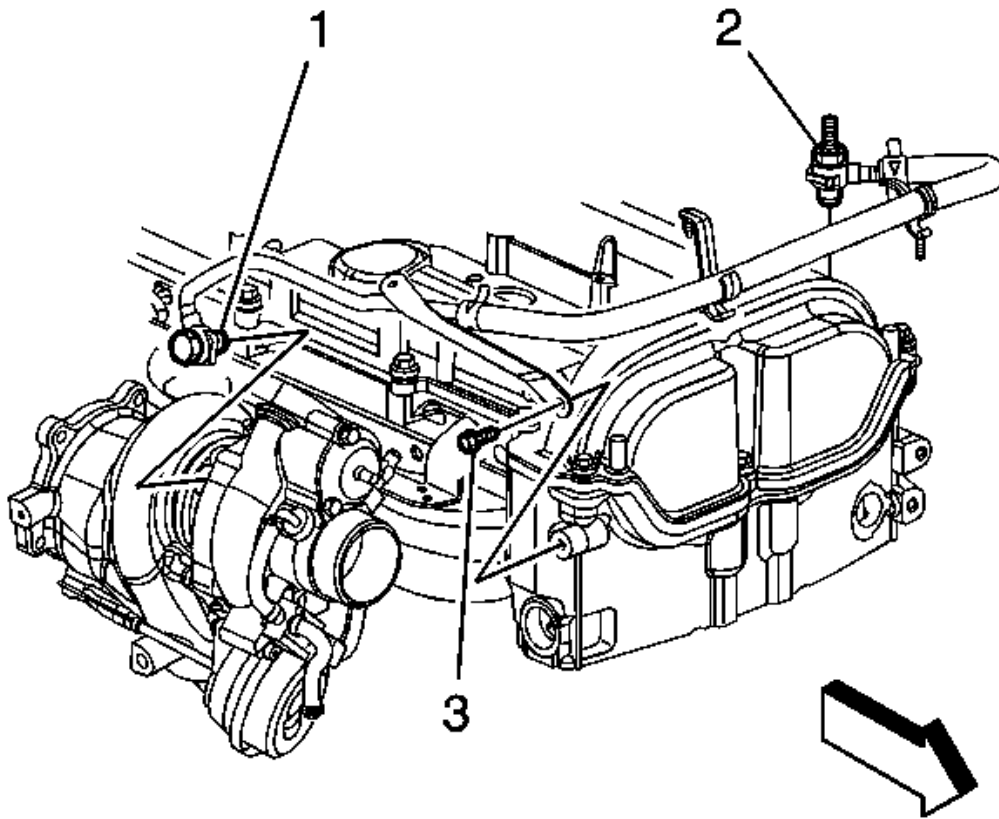


Fig. 317: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

98. Remove the turbocharger coolant feed pipe bolt (1) at the turbocharger.
99. Remove the turbocharger coolant feed pipe fitting (2) from the cylinder head.
100. Remove the turbocharger coolant feed pipe bracket bolt from the cylinder head.
101. Remove the turbocharger coolant feed pipe bracket from the vehicle.

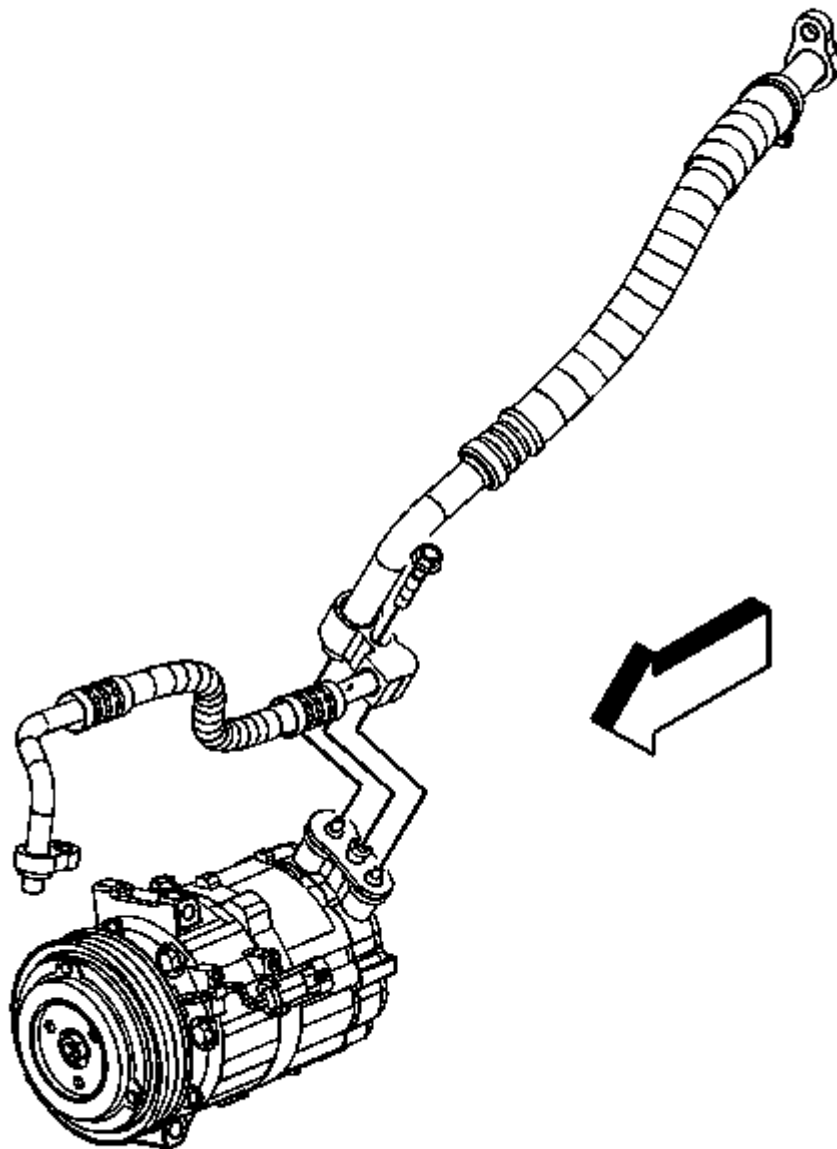


Fig. 318: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

102. Remove the A/C compressor line bolt and reposition the line off to the side.
103. Raise and support the vehicle.

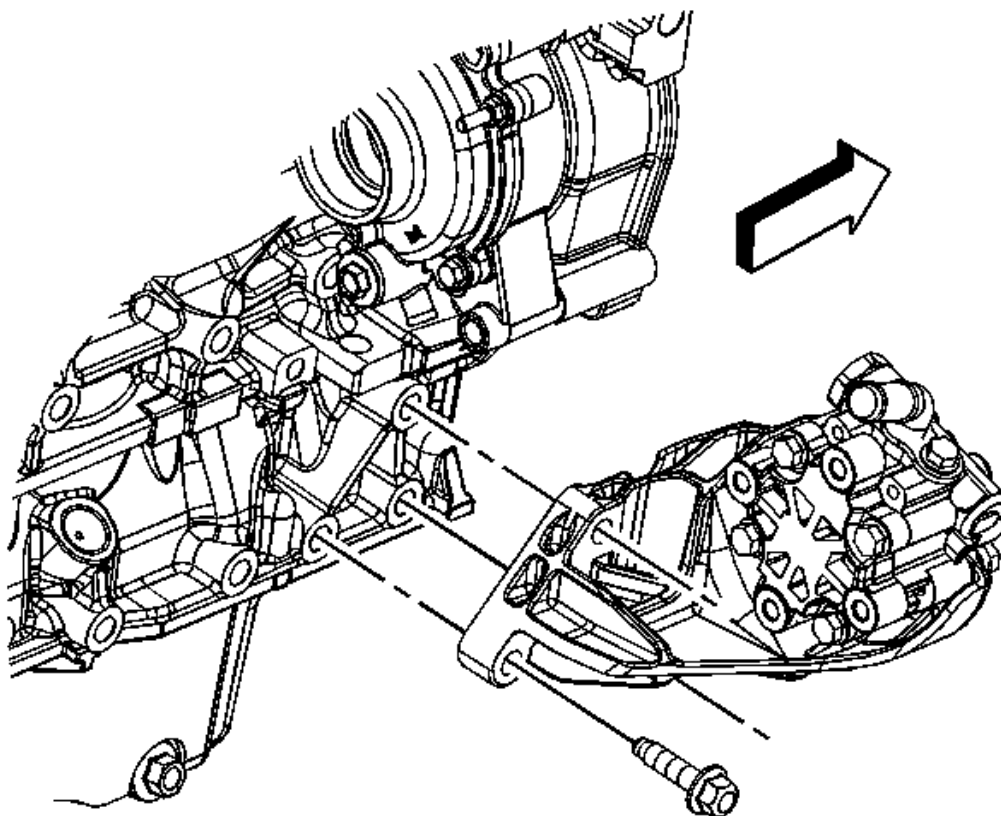


Fig. 319: View Of Power Steering Pump & Bracket
Courtesy of GENERAL MOTORS CORP.

104. Remove the power steering pump bracket bolts and reposition the pump and bracket off to the side.
105. Lower the vehicle.

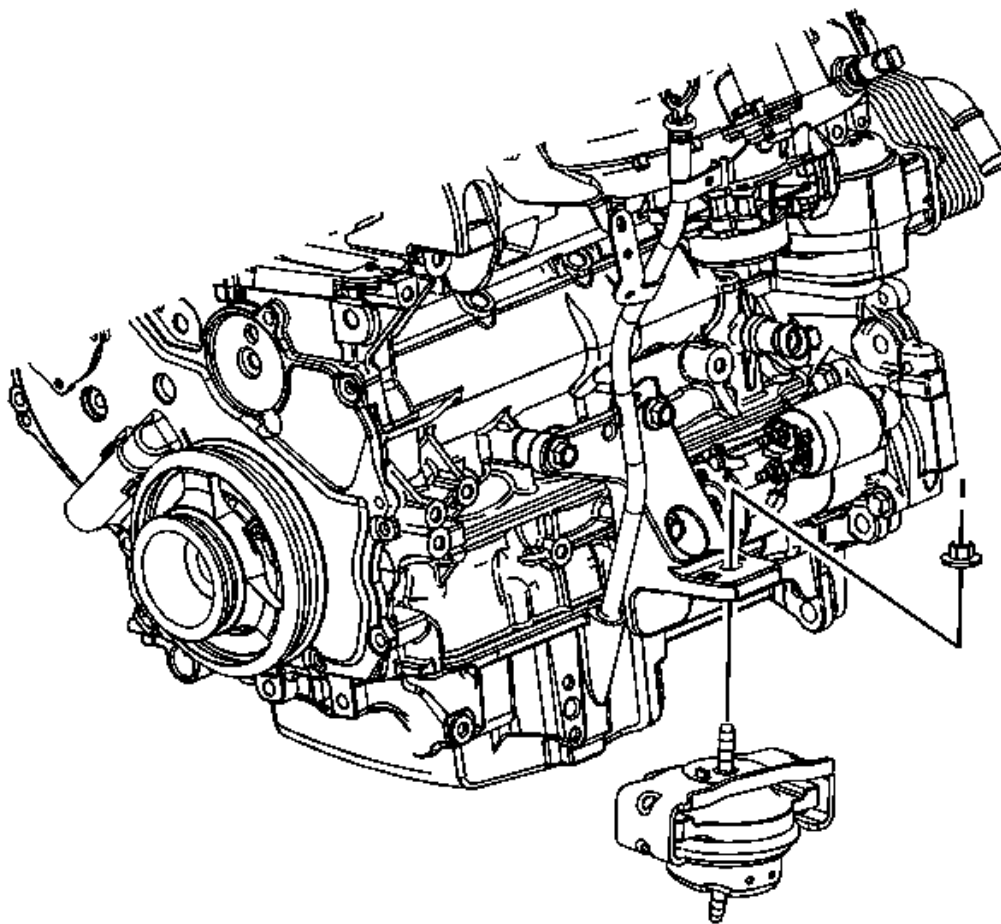


Fig. 320: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

106. Remove the left engine mount upper nut.

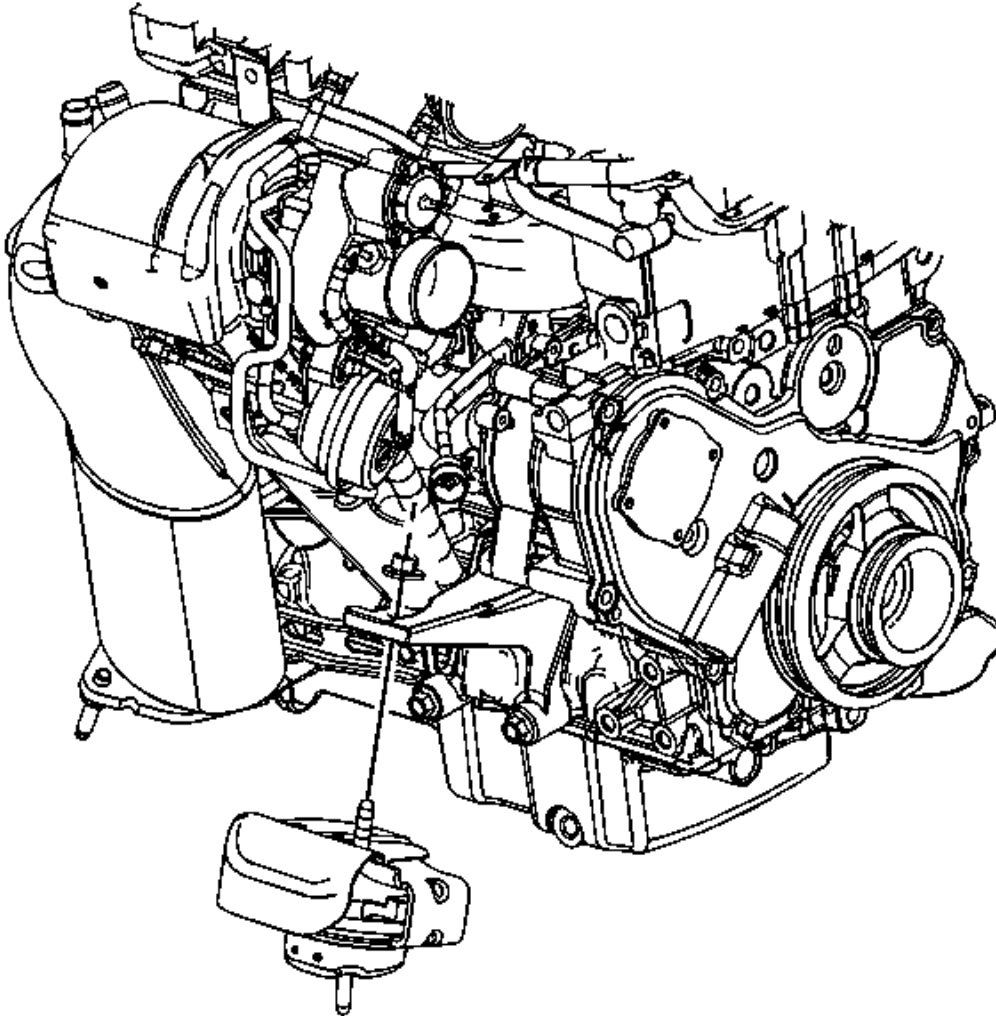


Fig. 321: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

107. Remove the right engine mount upper nut.
108. If not present, install a service part engine lift bracket.
109. Install a suitable engine lifting device to the engine.
110. Remove the engine from the vehicle.
111. Remove the clutch pressure plate and disc. Refer to **Clutch Pressure and Driven Plate Replacement** .

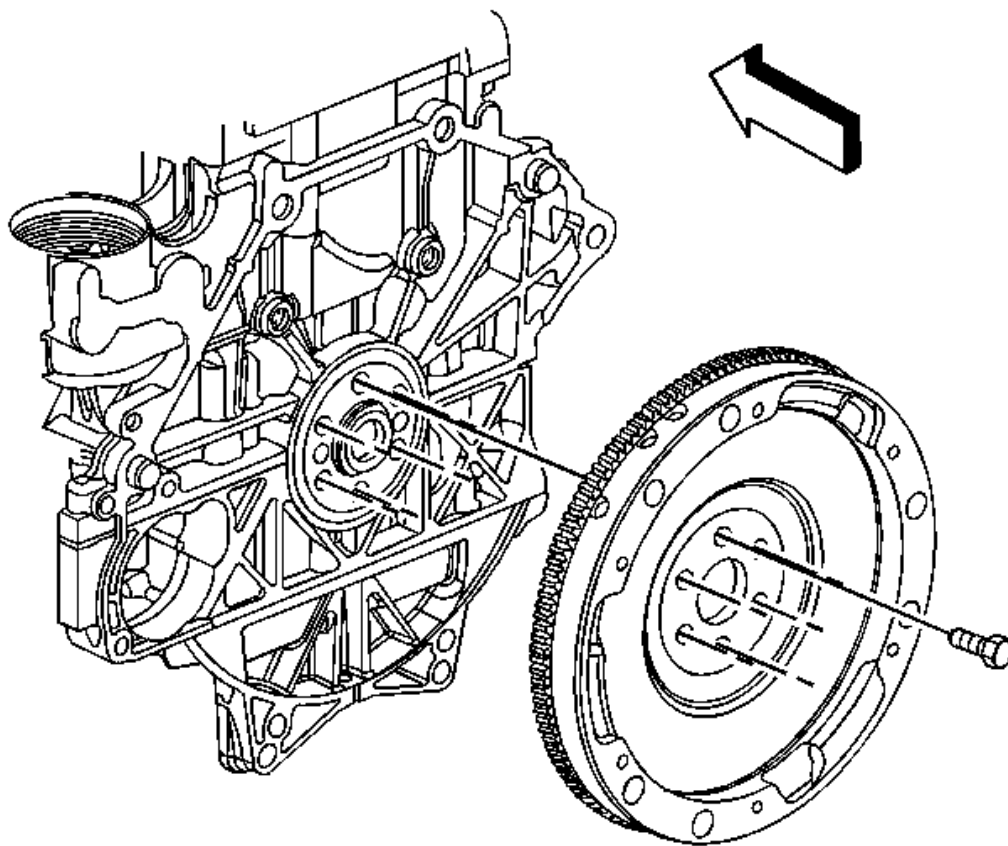


Fig. 322: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

112. Remove the flywheel bolts and flywheel.
113. Install the engine to an engine stand.

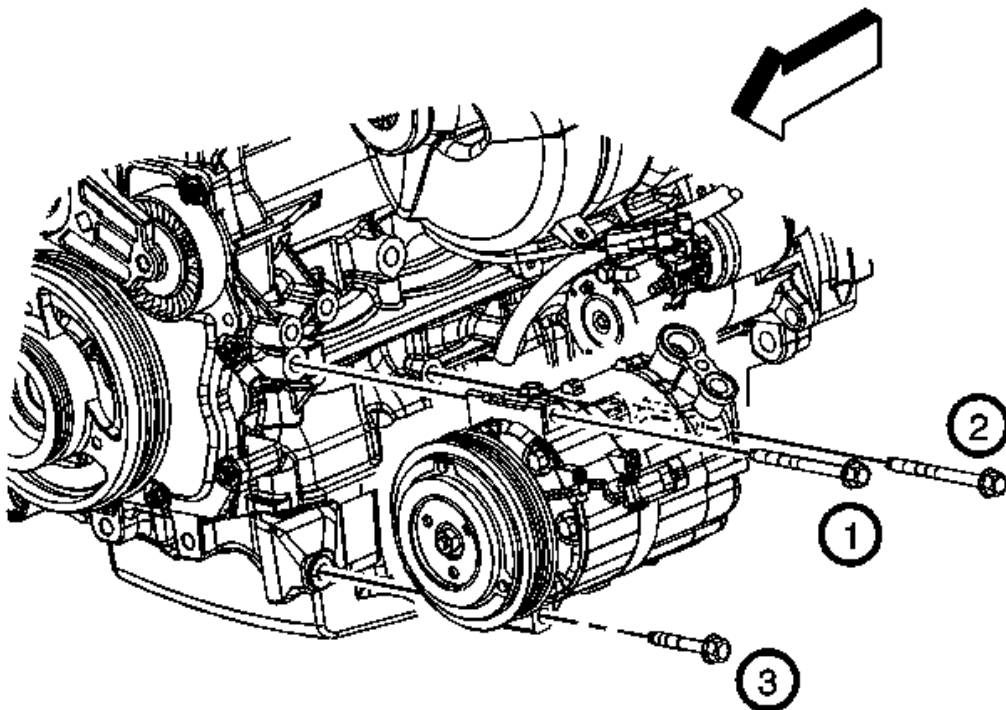


Fig. 323: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

114. Remove the A/C compressor bolts and compressor.

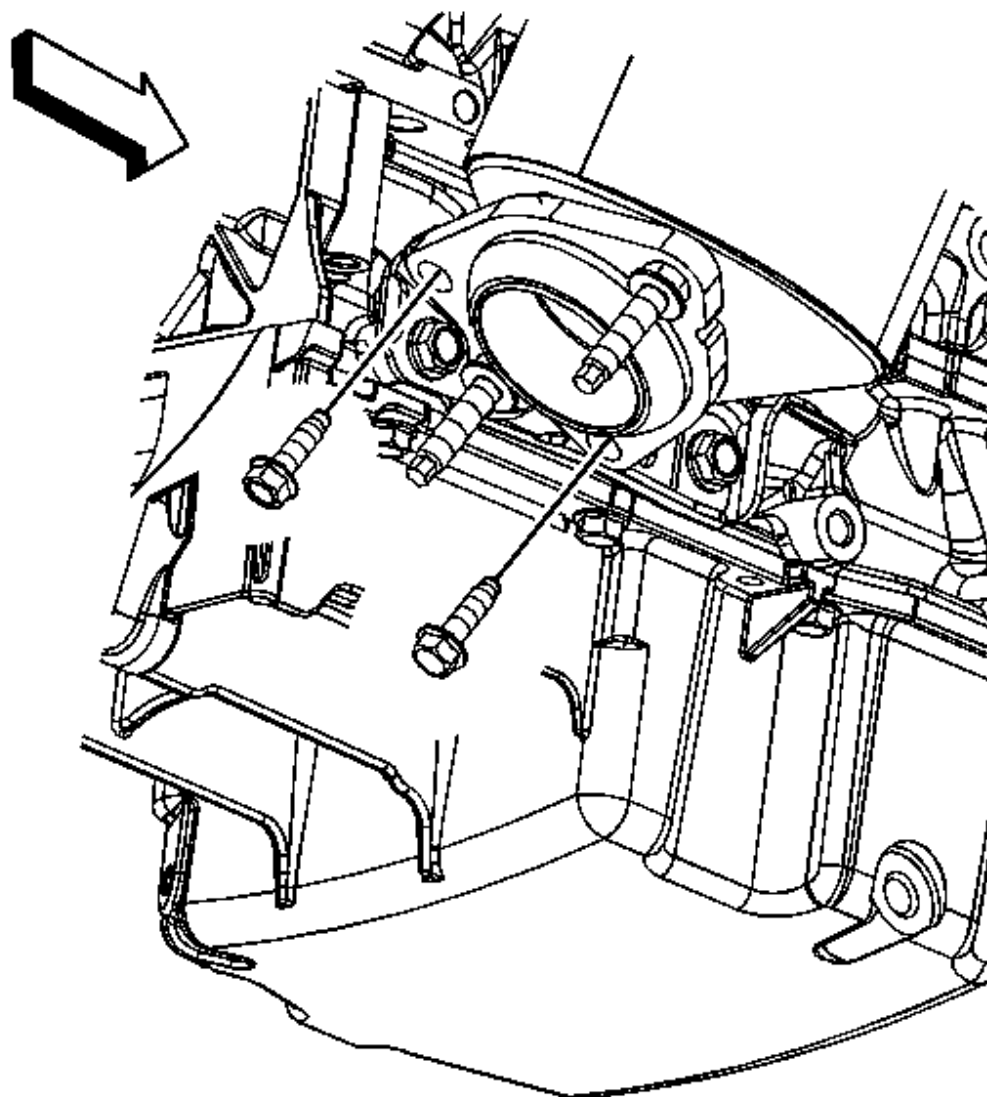


Fig. 324: View Of Catalytic Converter-To-Catalytic Converter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

115. Remove the catalytic converter to bracket bolts.

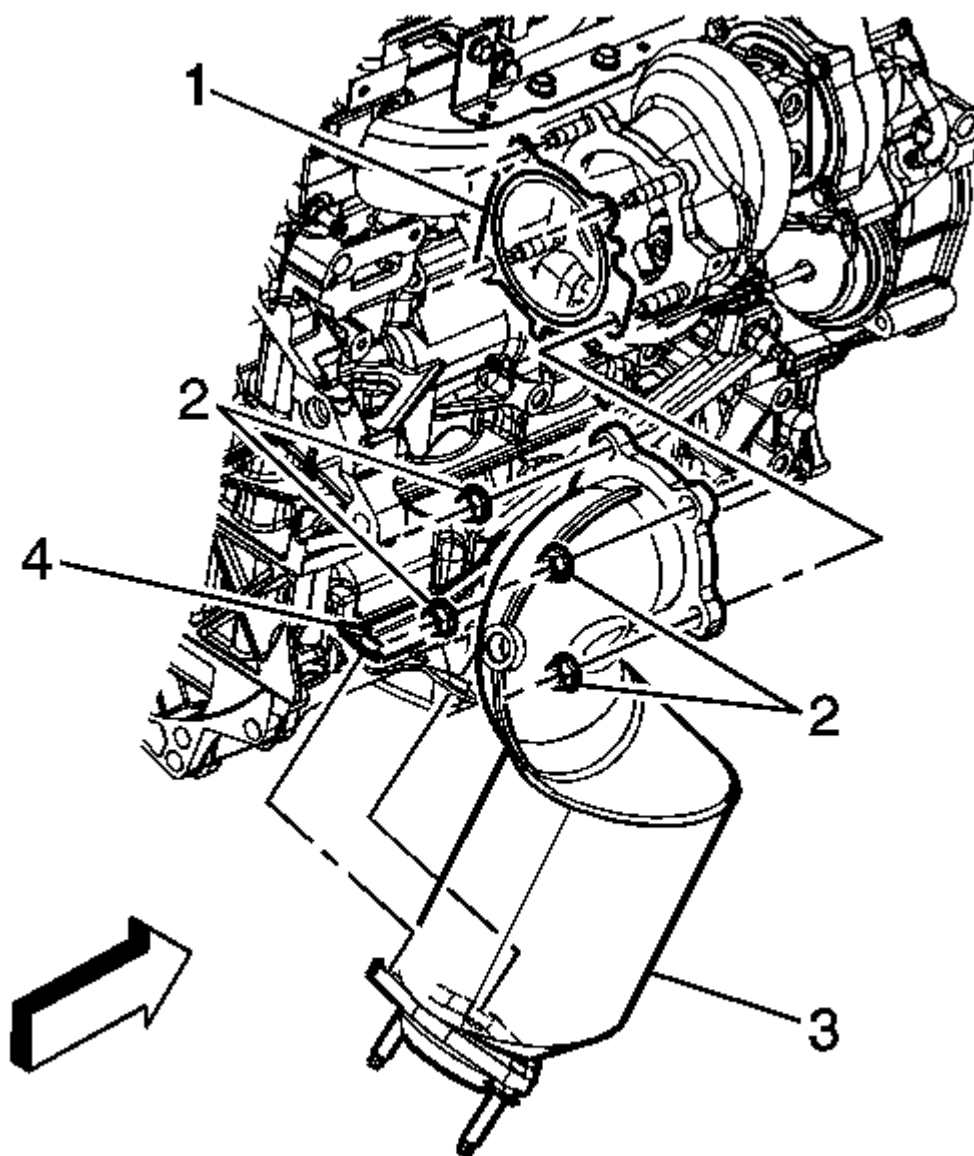


Fig. 325: Identifying Catalytic Converter & Turbocharger
Courtesy of GENERAL MOTORS CORP.

116. Remove the catalytic converter nuts (2).
117. Remove the catalytic converter (3) and gasket (1) from the turbocharger and bracket (4).

INSTALLATION PROCEDURE

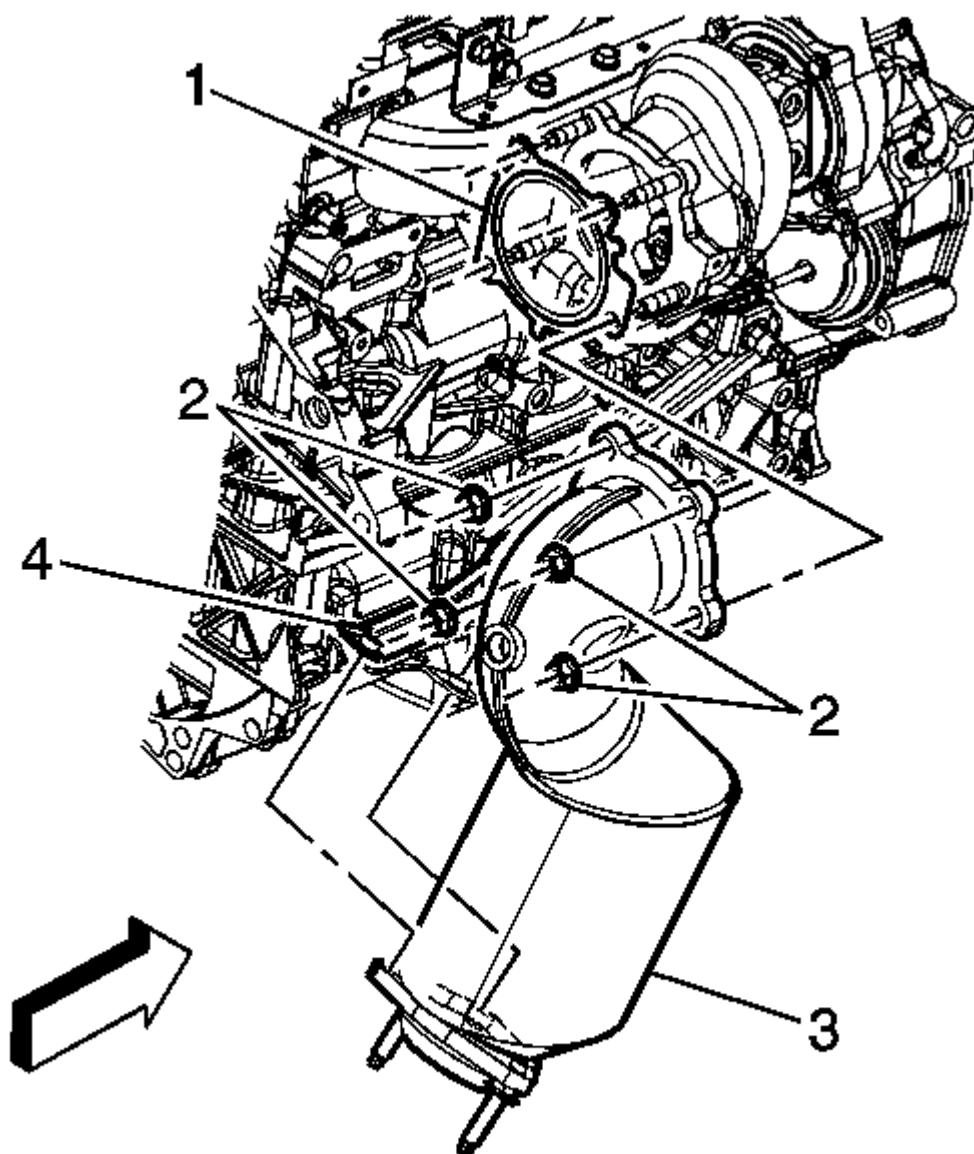


Fig. 326: Identifying Catalytic Converter & Turbocharger
Courtesy of GENERAL MOTORS CORP.

1. Install the catalytic converter (3) and gasket (1) to the turbocharger and bracket (4).

CAUTION: Refer to Fastener Caution .

2. Install the catalytic converter nuts (2).

Tighten: Tighten the nuts to 59 N.m (43 lb ft).

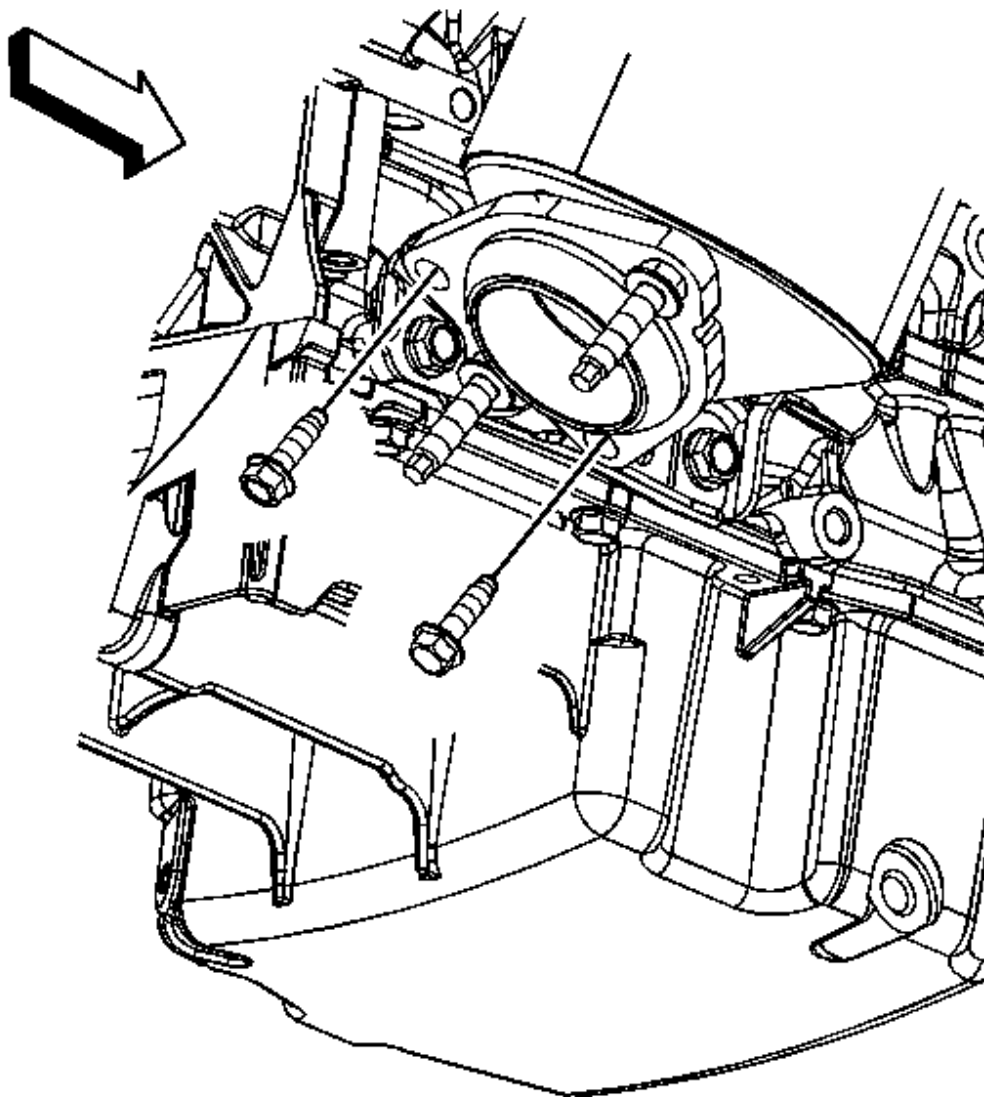


Fig. 327: View Of Catalytic Converter-To-Catalytic Converter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the catalytic converter to bracket bolts.

Tighten: Tighten the bolts to 22 N.m (16 lb ft).

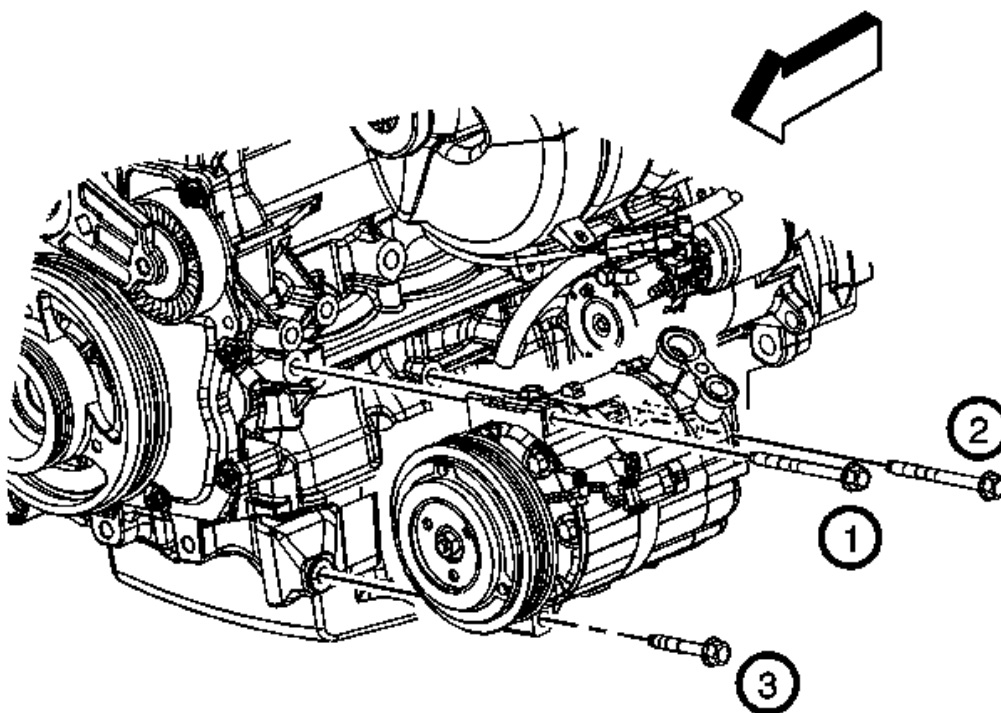


Fig. 328: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the A/C compressor and bolts.

Tighten: Tighten the bolts in the sequence shown to 22 N.m (16 lb ft).

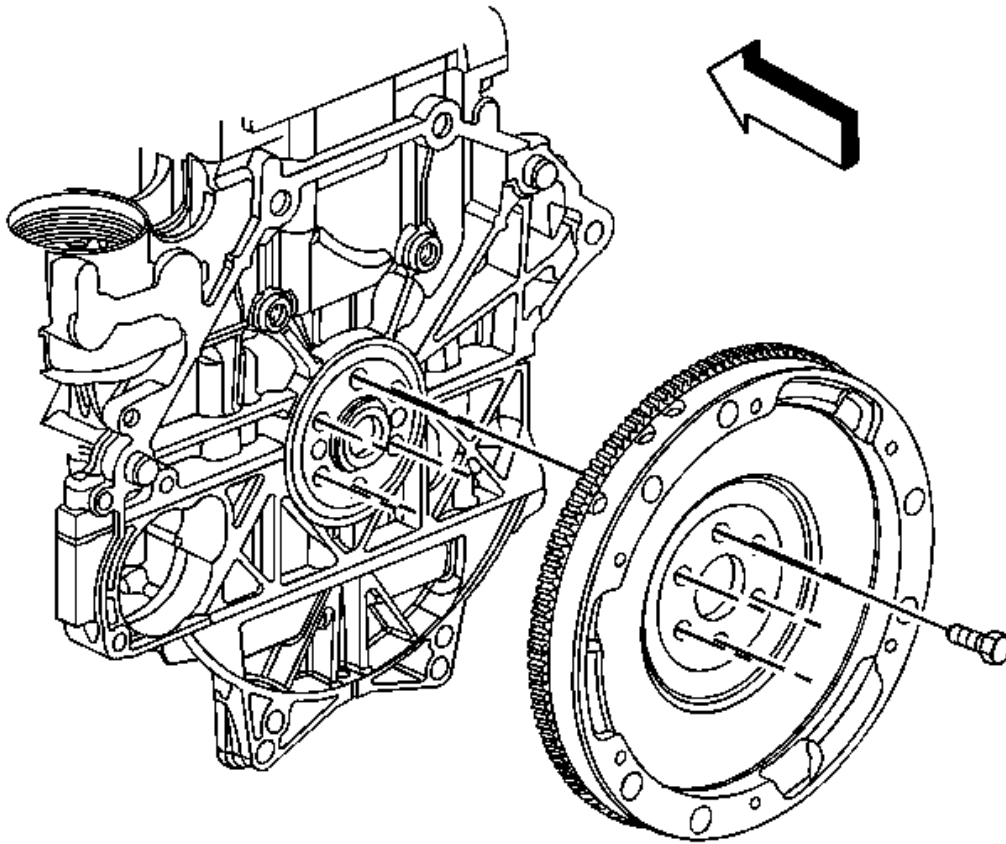


Fig. 329: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

5. Install a suitable engine lifting device to the engine.
6. Remove the engine from the stand.
7. Using a nylon bristle brush clean the thread adhesive from the flywheel bolt holes, if necessary.
8. Install the flywheel and bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft) plus an additional 25 degrees using the **J 45059** .

9. Install the clutch pressure plate and disc. Refer to **Clutch Pressure and Driven Plate Replacement** .

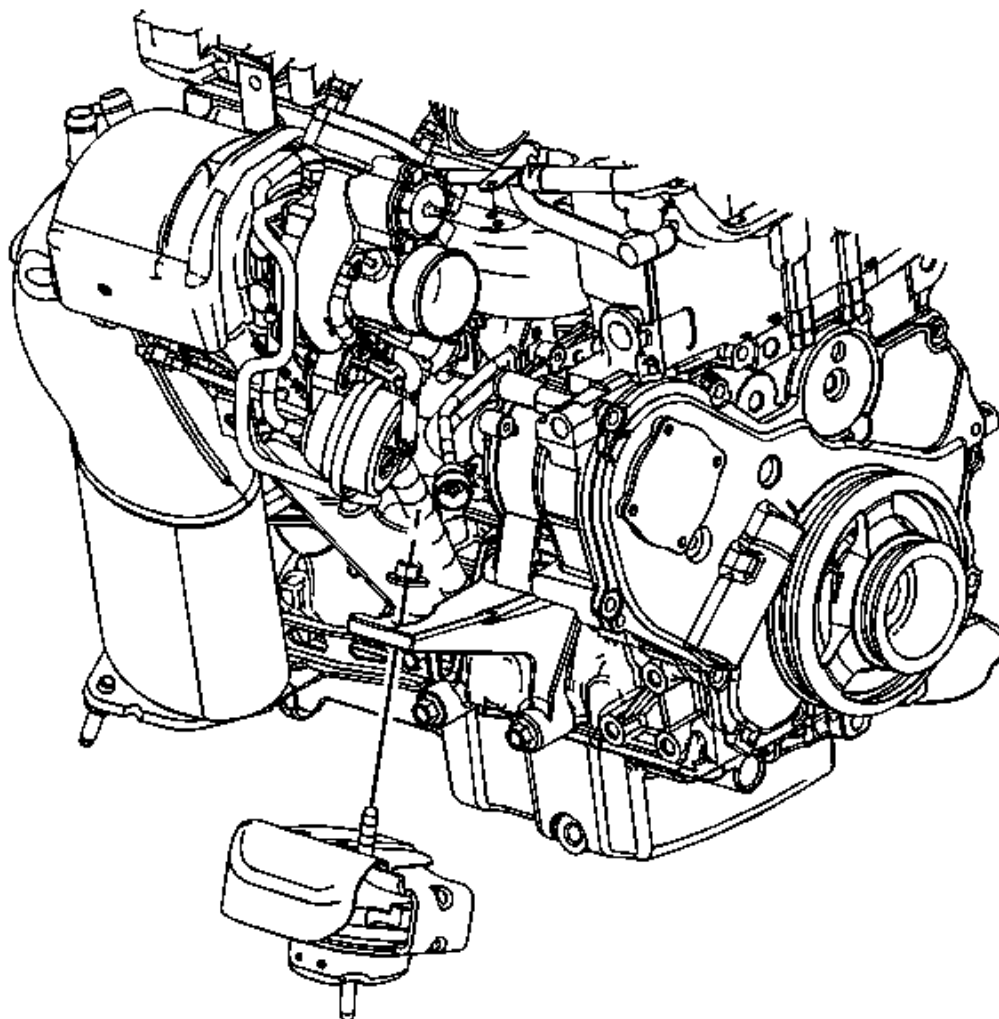


Fig. 330: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

10. Install the engine to the vehicle.
11. Install the right engine mount upper nut.

Tighten: Tighten the nut to 55 N.m (41 lb ft).

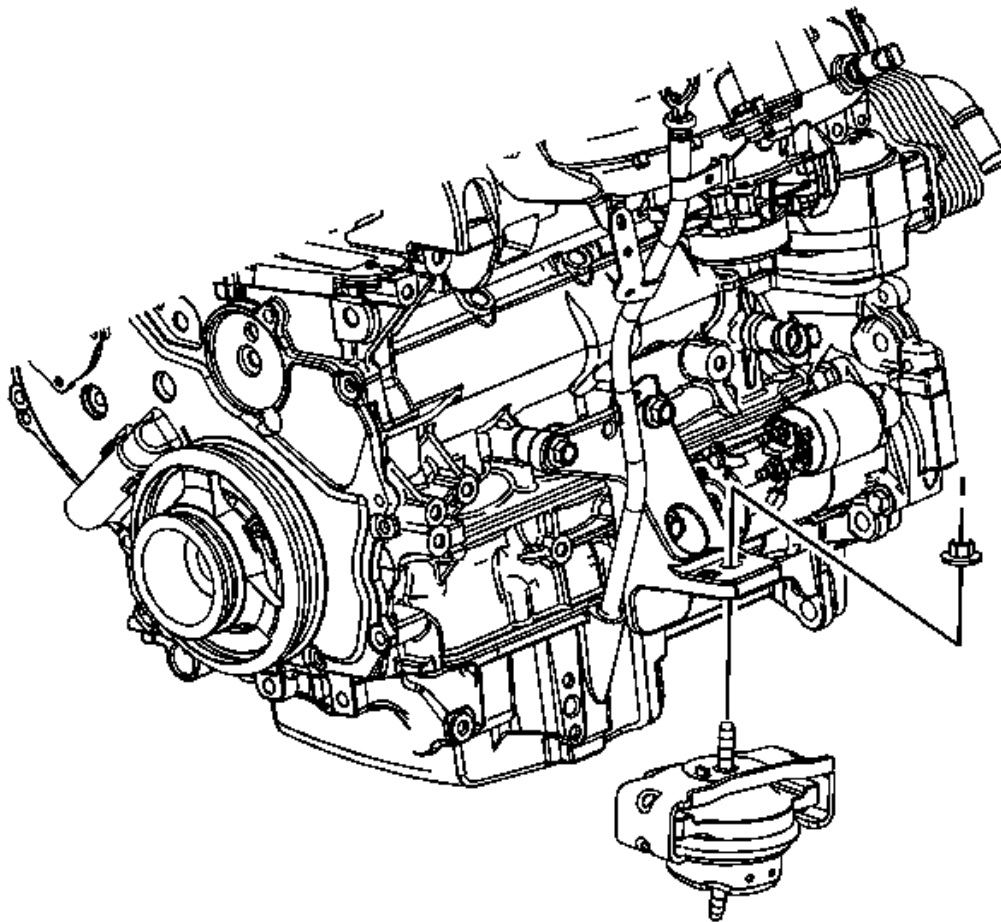


Fig. 331: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

12. Install the left engine mount upper nut.

Tighten: Tighten the nut to 55 N.m (41 lb ft).

13. If installed, remove the engine lift bracket from the engine.
14. Raise and support the vehicle.

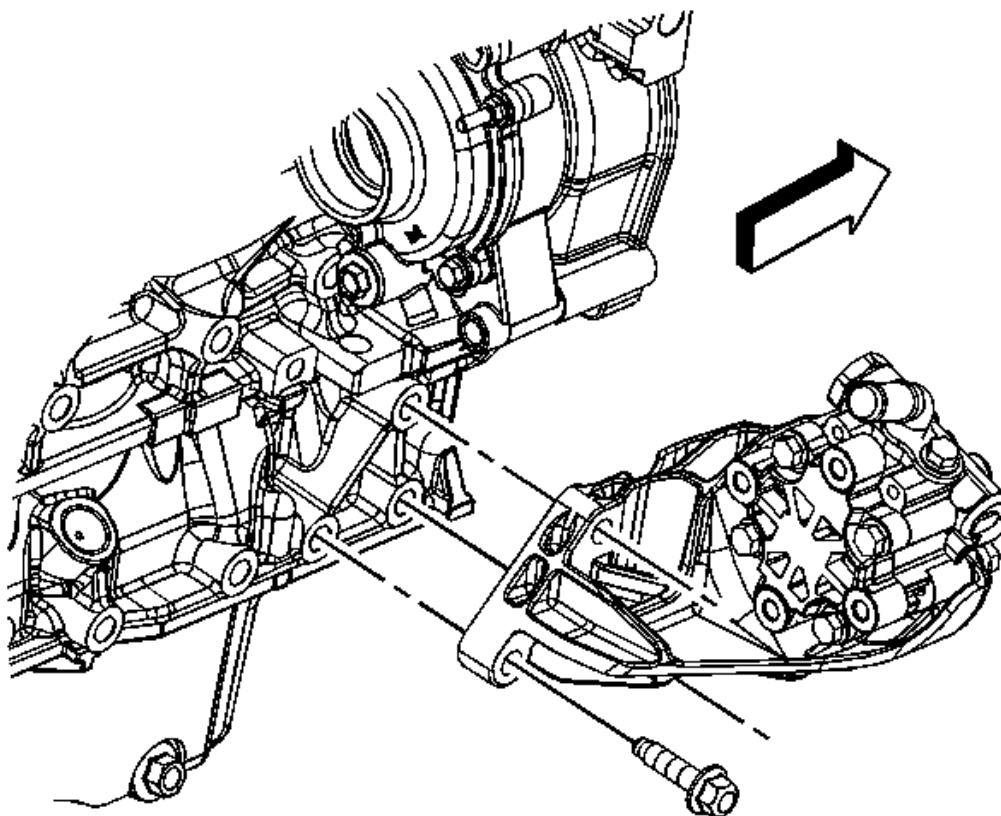


Fig. 332: View Of Power Steering Pump & Bracket
Courtesy of GENERAL MOTORS CORP.

15. Position the power steering pump bracket to the engine and install the bracket bolts.

Tighten: Tighten the bolts to 58 N.m (43 lb ft).

16. Lower the vehicle.

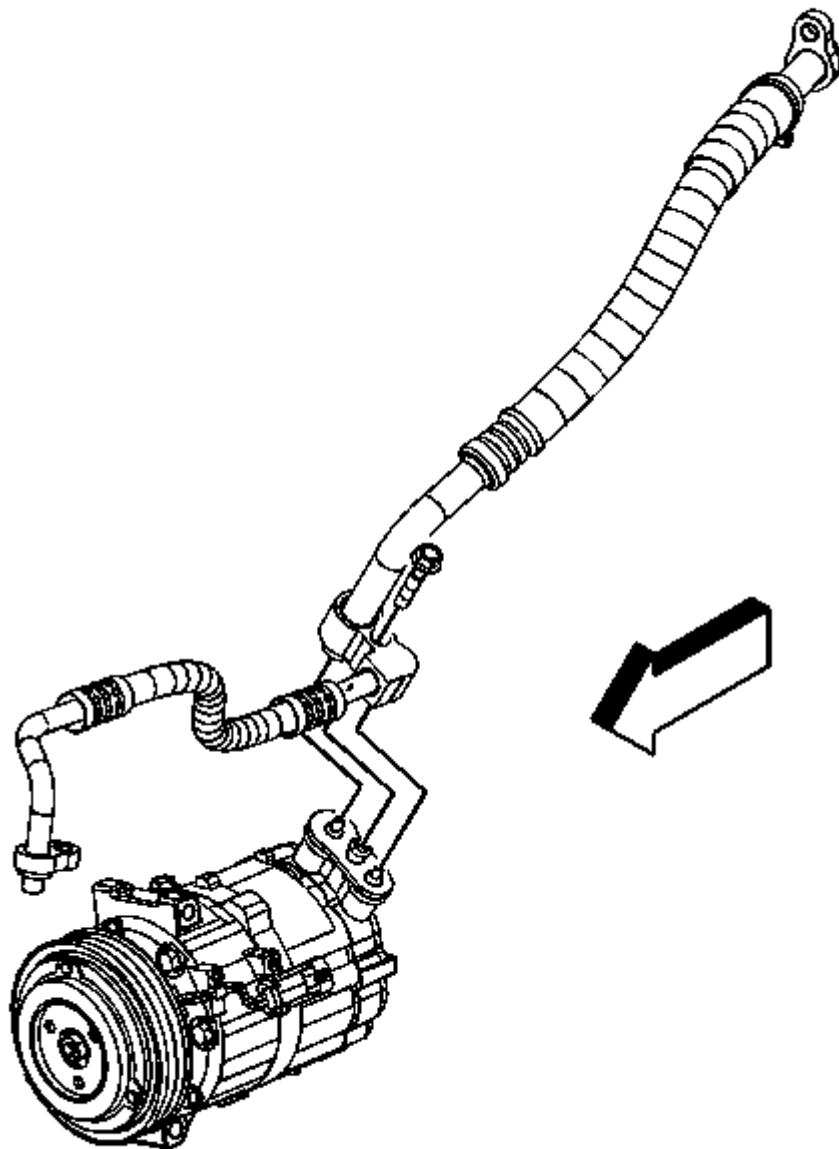


Fig. 333: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

17. Position the A/C compressor line and install the bolt.

Tighten: Tighten the bolts to 22 N.m (16 lb ft).

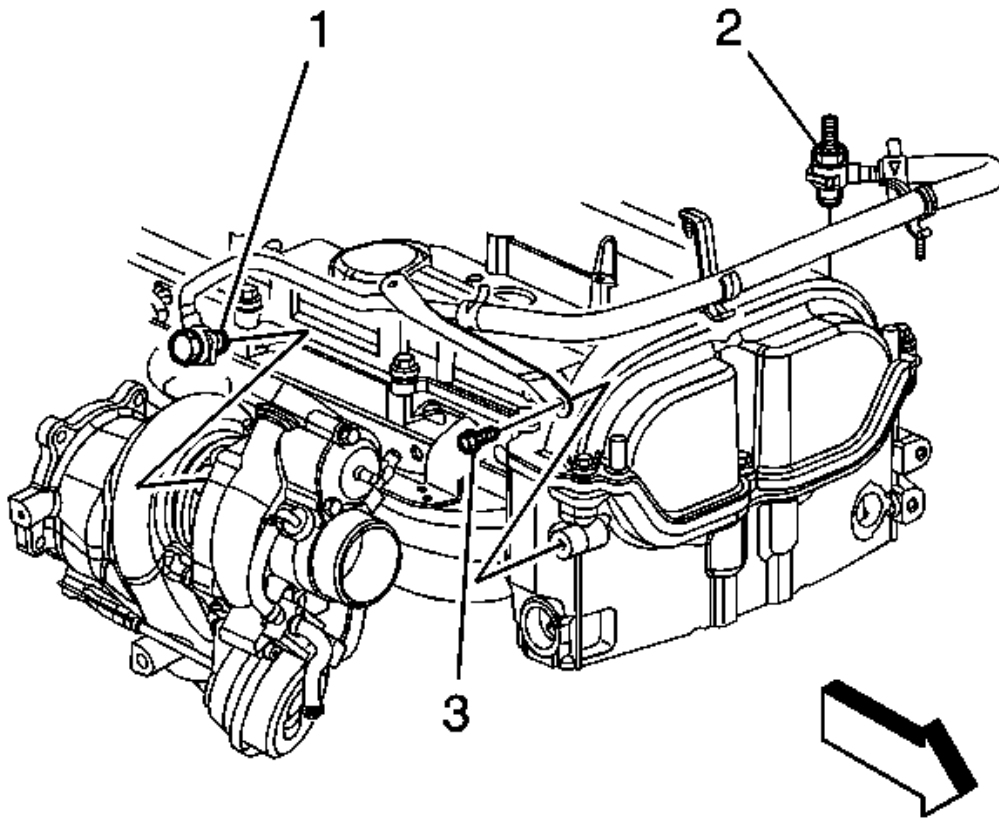


Fig. 334: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

18. Position the turbocharger coolant feed pipe to the vehicle.
19. Install the turbocharger coolant feed pipe bracket bolt (3) to the cylinder head.

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

20. Install the turbocharger coolant feed pipe fitting (2) to the cylinder head.

Tighten: Tighten the fitting to 35 N.m (26 lb ft).

21. Install the turbocharger coolant feed pipe bolt (1) at the turbocharger.

Tighten: Tighten the bolt to 35 N.m (26 lb ft).

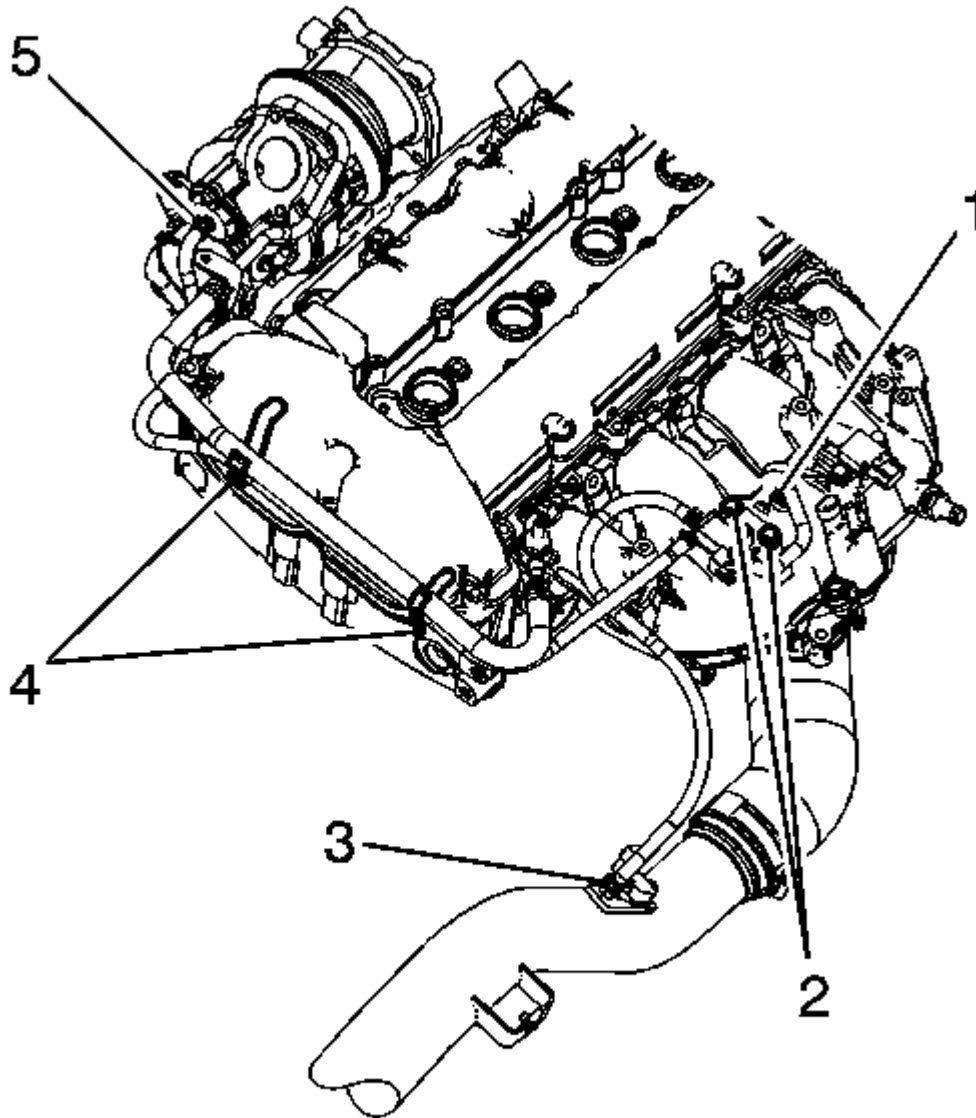


Fig. 335: Identifying Charge Air Bypass Solenoid Components
 Courtesy of GENERAL MOTORS CORP.

22. Position the vacuum hose to the turbocharger.
23. Install the vacuum hose to the turbocharger.
24. Position the vacuum hose clamp (5) at the turbocharger.
25. Install the vacuum hose to the turbocharger coolant feed pipe clips (4).

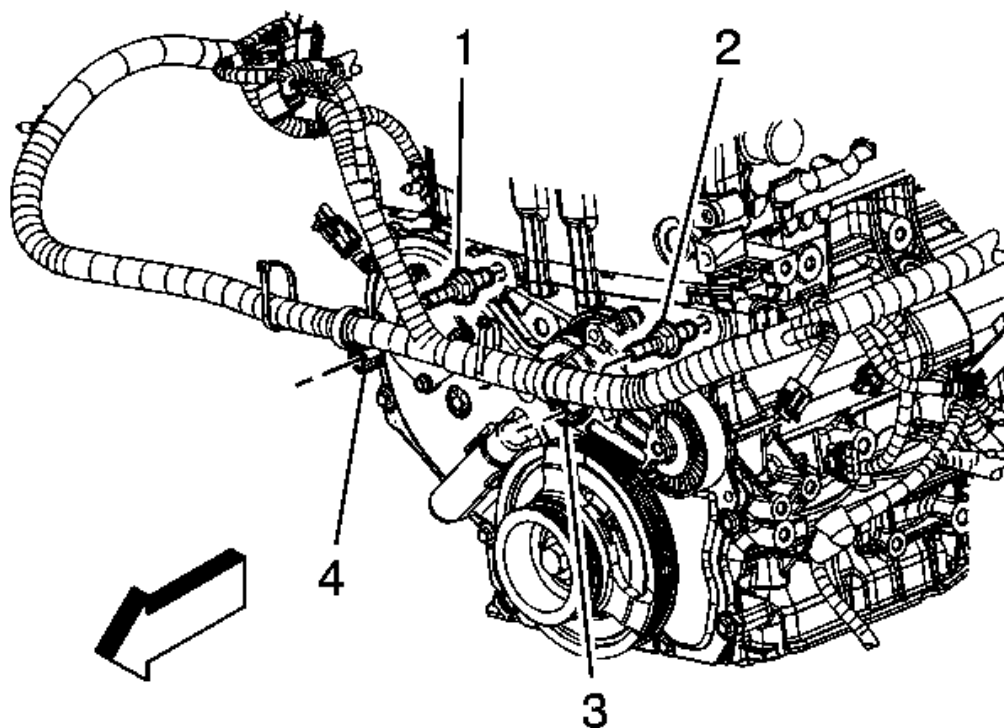


Fig. 336: Identifying Engine Harness Clips

Courtesy of GENERAL MOTORS CORP.

26. Position the branches of the engine harness to the engine.
27. Install the engine harness clips (3, 4) to the front studs.

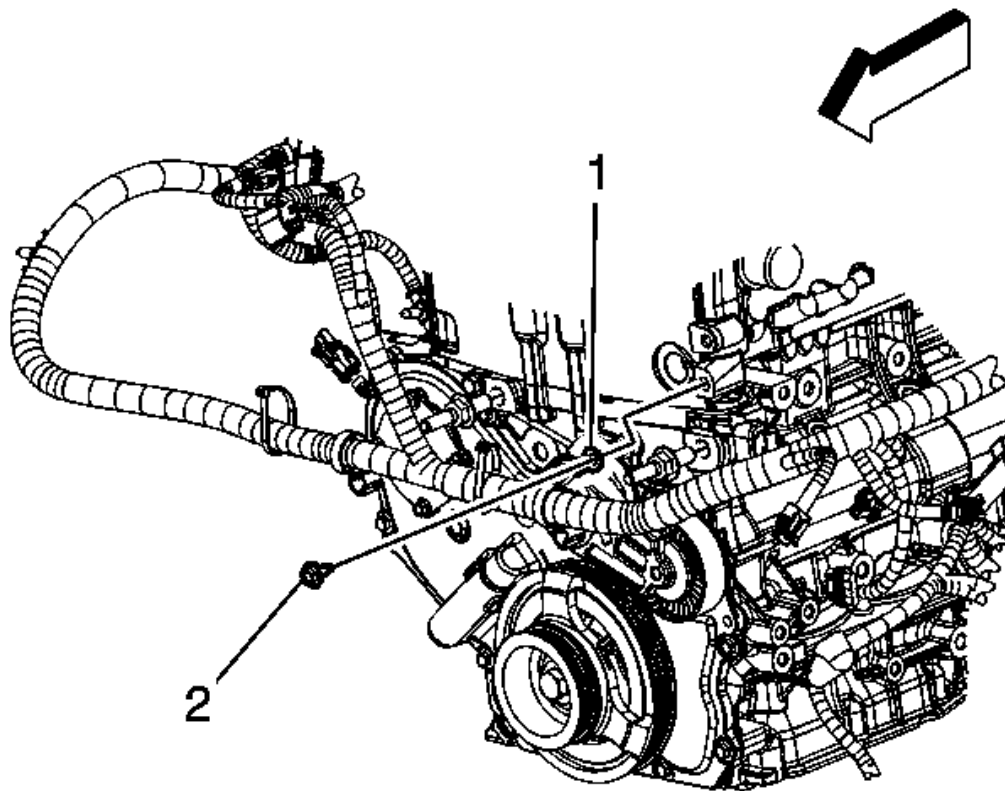


Fig. 337: Identifying Engine Wiring Harness Ground Terminal
Courtesy of GENERAL MOTORS CORP.

28. Install the engine wiring harness ground terminal (1) to the cylinder head.
29. Install the engine wiring harness ground bolt (2) to the cylinder head.

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

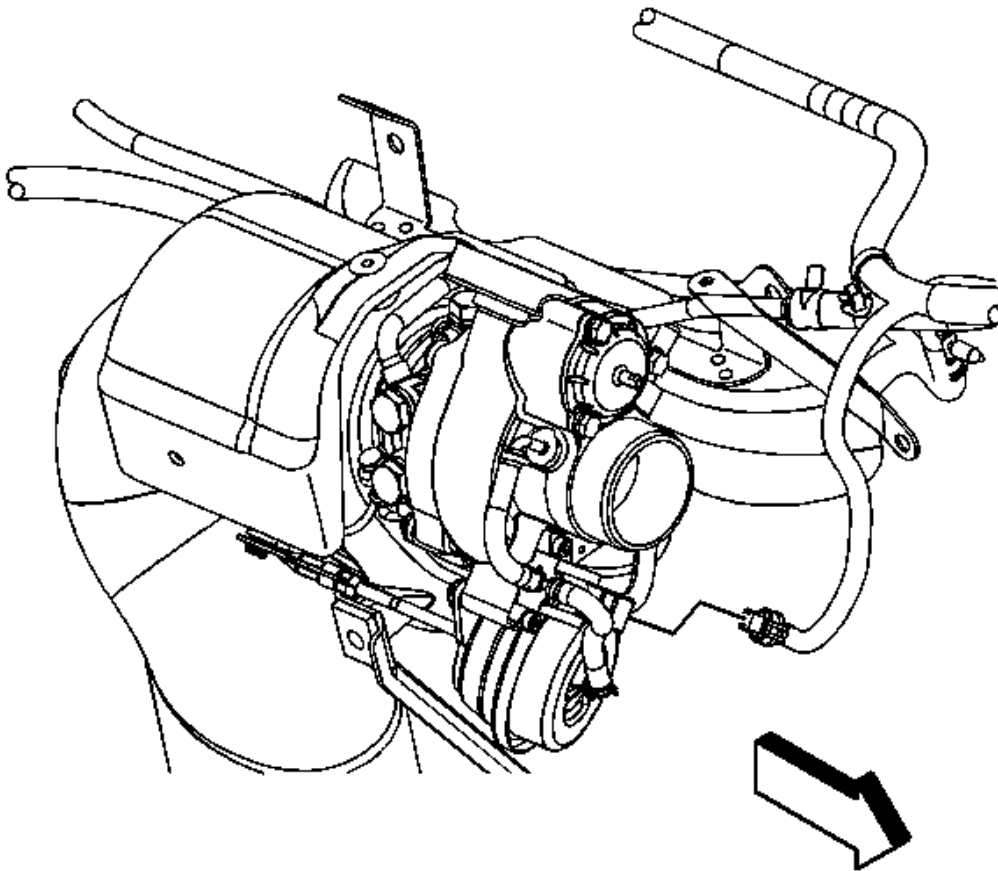


Fig. 338: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

30. Connect the engine wiring harness electrical connector to the boost sensor.

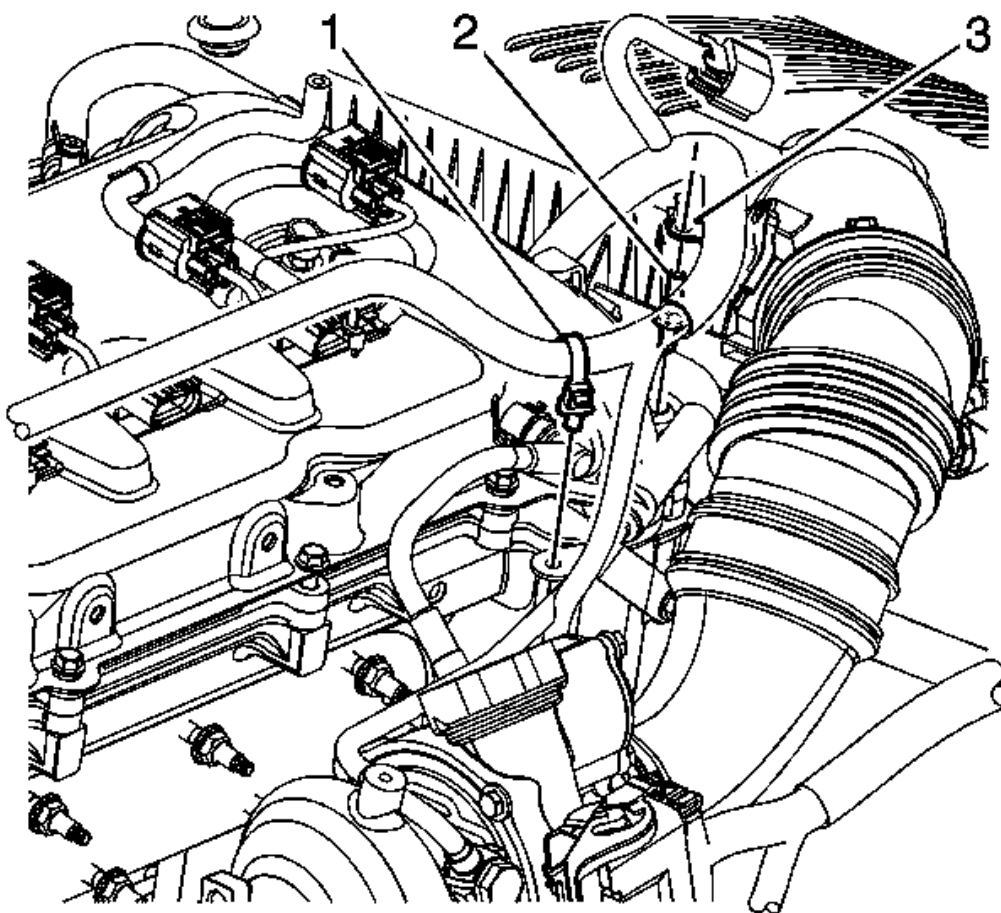


Fig. 339: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

31. Install the engine wiring harness clip (1) to the turbocharger coolant feed pipe tab.
32. Install the engine wiring harness clip (3) to the turbocharger coolant feed pipe stud (2).

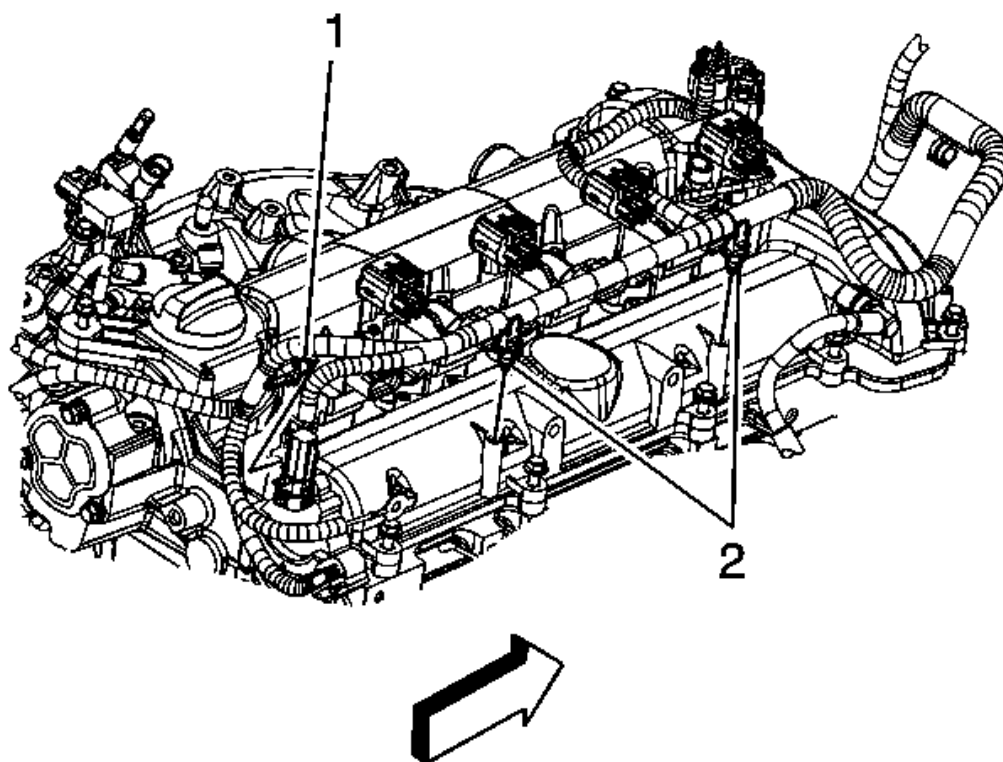


Fig. 340: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

33. Connect the engine harness clips (2) to the camshaft cover.
34. Connect the engine harness clip (1) to the camshaft cover.

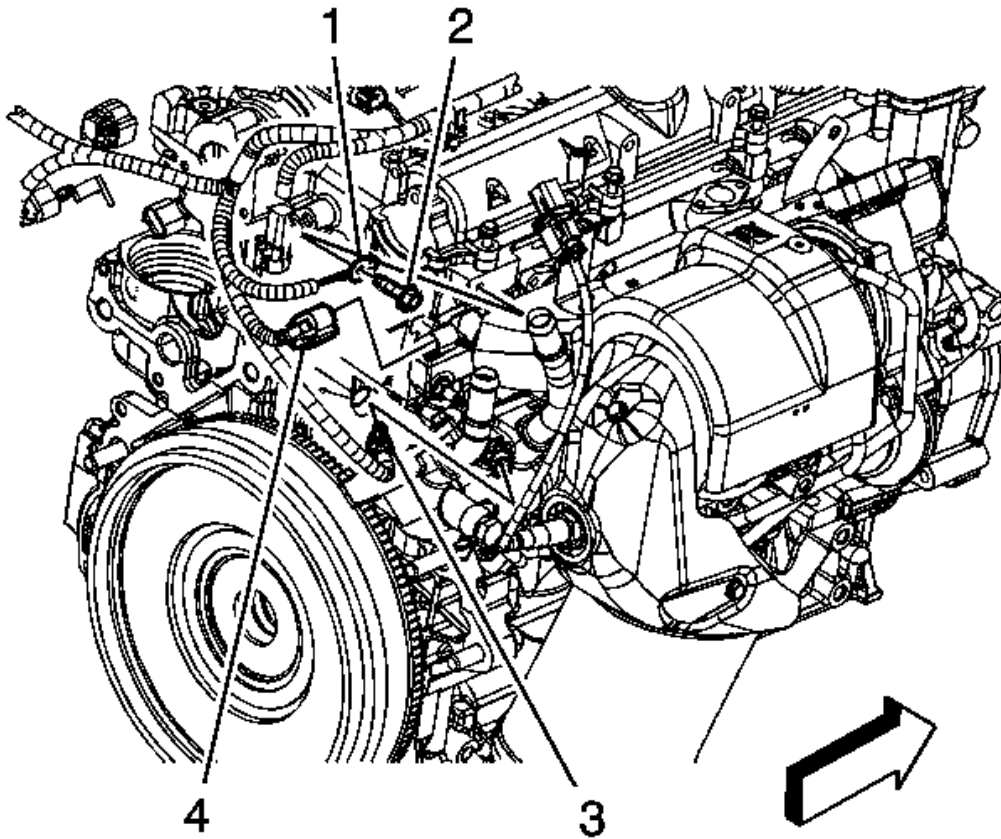


Fig. 341: Identifying ECT Sensor Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

35. Connect the engine wiring harness electrical connector (4) to the exhaust CMP sensor.
36. Connect the engine wiring harness electrical connector (3) to the ECT sensor.
37. Position the engine harness ground terminal (1) and install the engine harness ground terminal bolt (2).

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

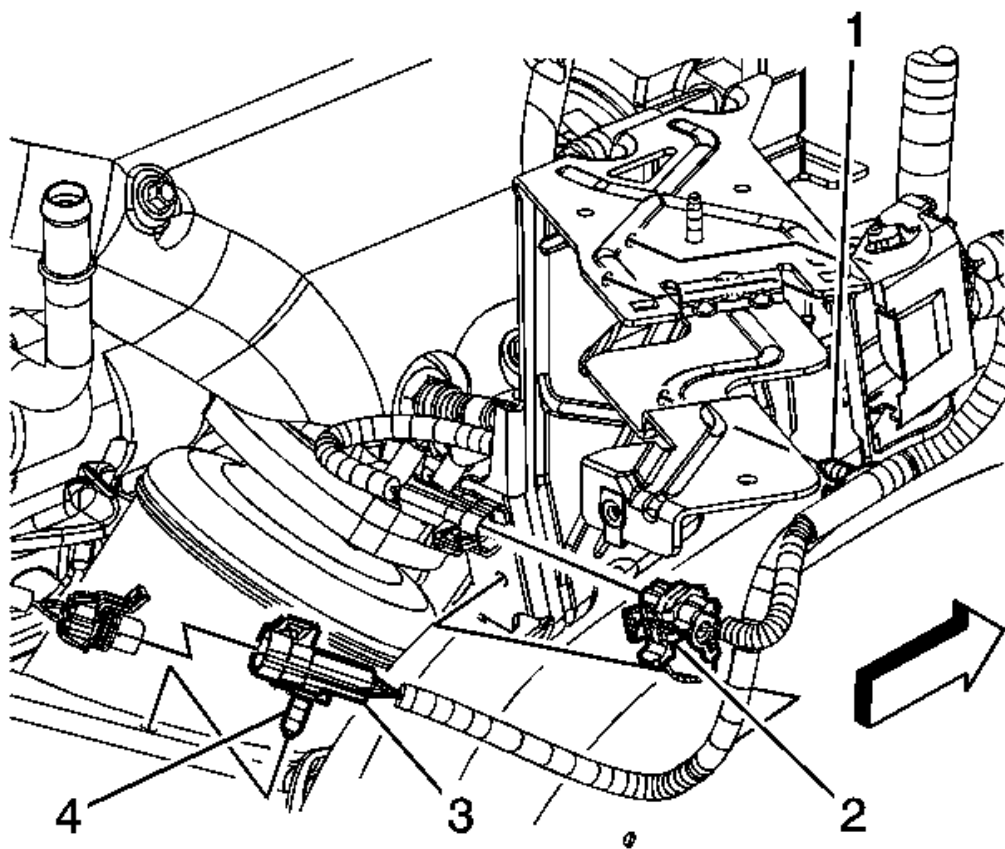


Fig. 342: Identifying CPA Retainer & HO2S Electrical Connector
 Courtesy of GENERAL MOTORS CORP.

38. Connect the engine wiring harness electrical connector (1) to the HO2S (3).

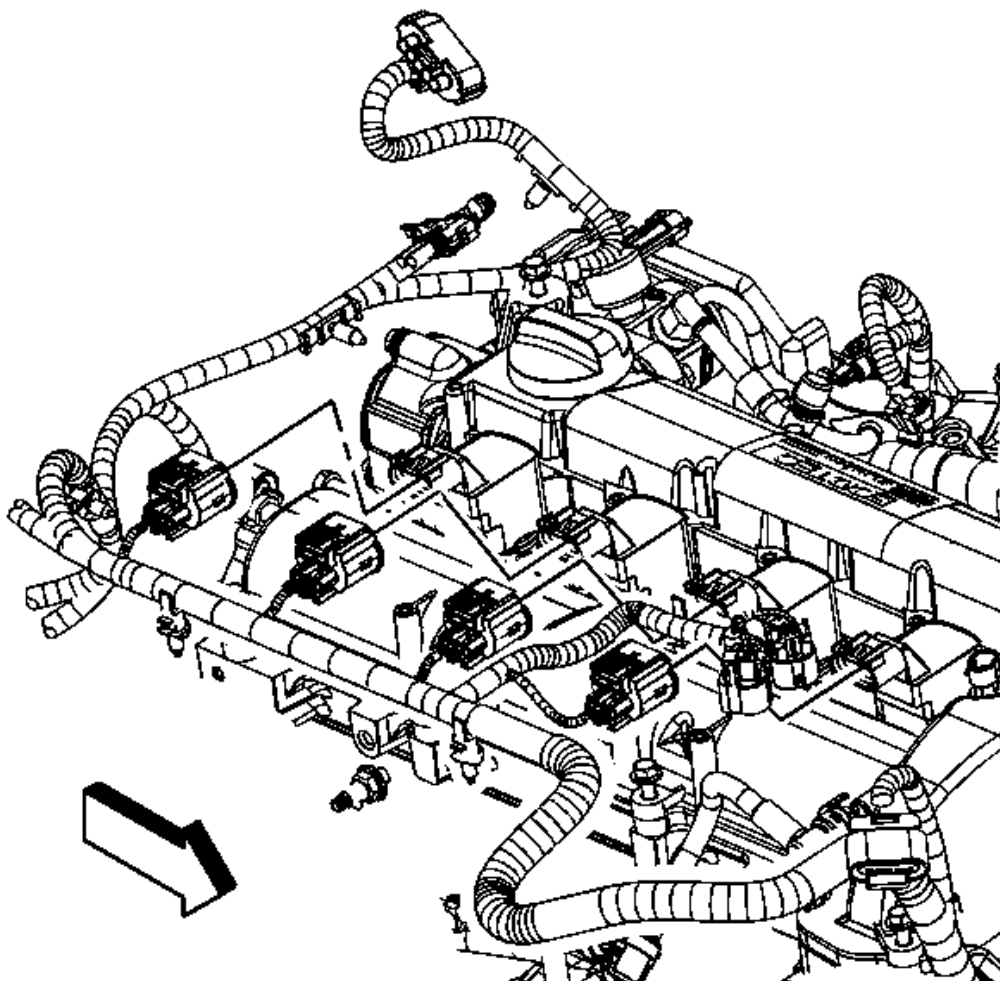


Fig. 343: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

39. Connect the engine wiring harness electrical connectors to the ignition coils.

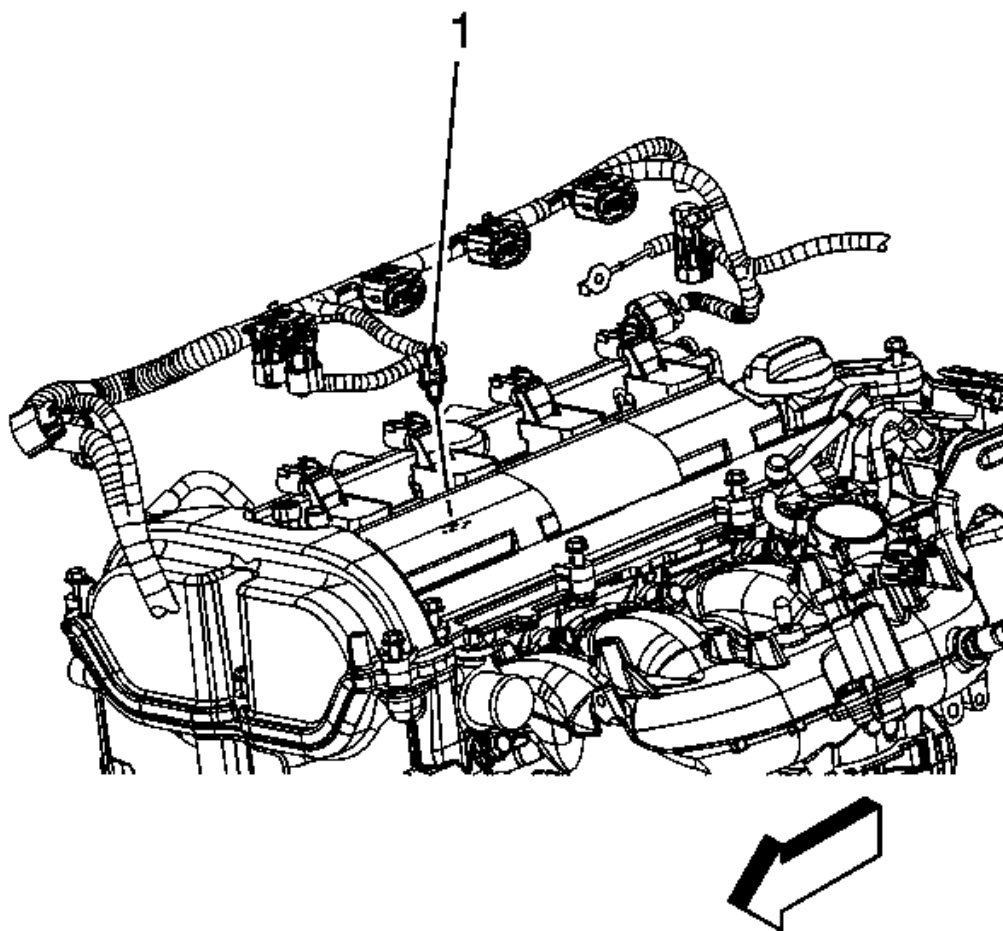


Fig. 344: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

40. Install the engine harness clip (1) to the camshaft cover.

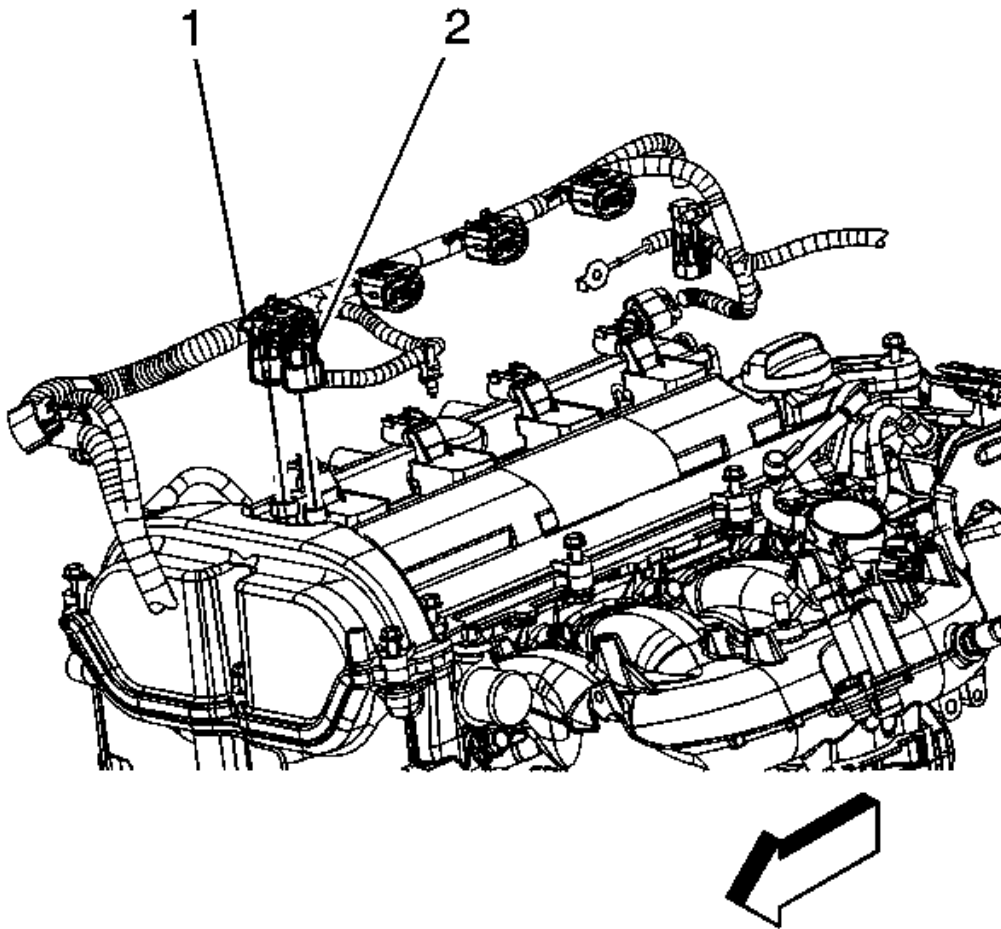


Fig. 345: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

41. Connect the engine wiring harness electrical connector (2) to the intake CMP actuator.
42. Connect the engine wiring harness electrical connector (1) to the exhaust CMP actuator.

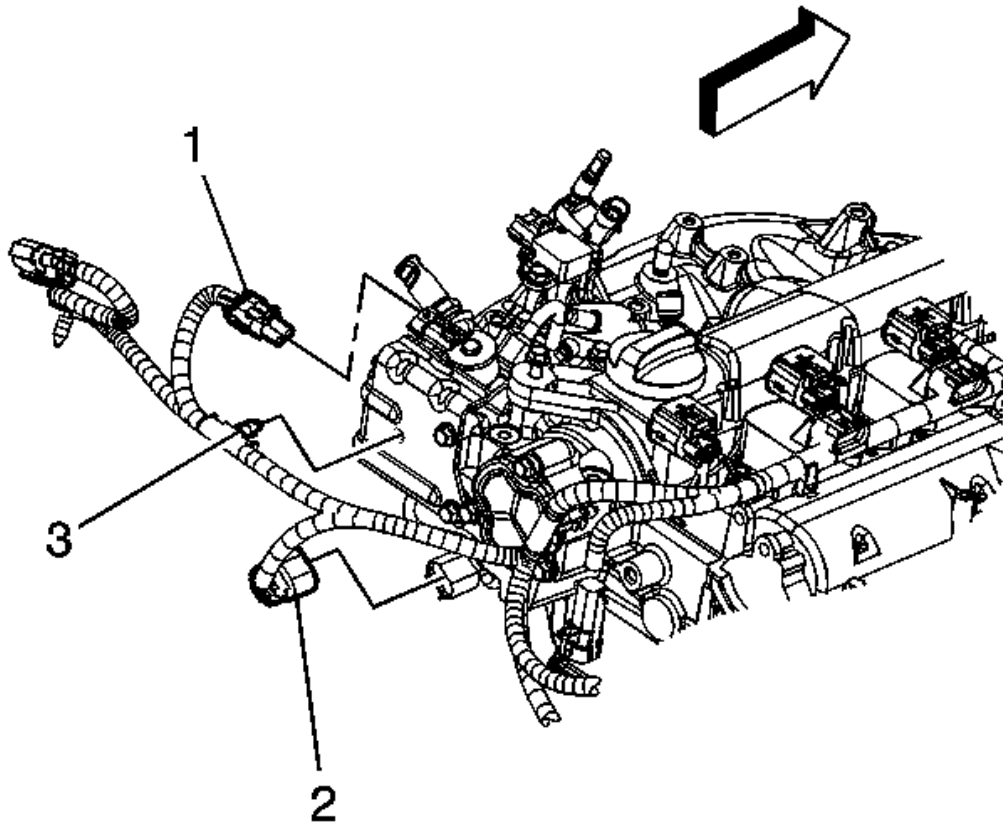


Fig. 346: Identifying High Pressure Fuel Pump Connector & Clip
Courtesy of GENERAL MOTORS CORP.

43. Connect the engine wiring harness electrical connector (2) to the intake CMP sensor.
44. Connect the engine wiring harness electrical connector (1) to the high pressure fuel pump.
45. Install the engine wiring harness clip (3) to the high pressure fuel pump bracket.

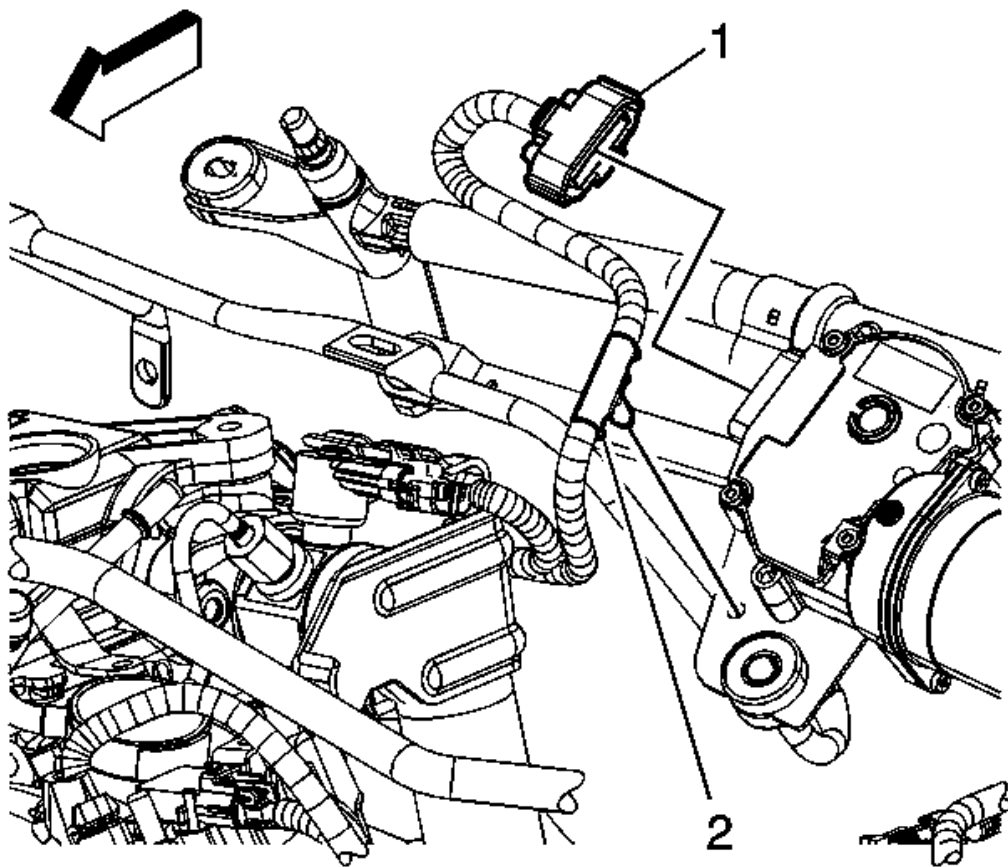


Fig. 347: Locating Windshield Wiper Motor Electrical Connector & Harness Clip
 Courtesy of GENERAL MOTORS CORP.

46. Connect the engine wiring harness electrical connector (1) to the windshield wiper motor.
47. Install the engine harness clip (2) to the wiper motor hole.

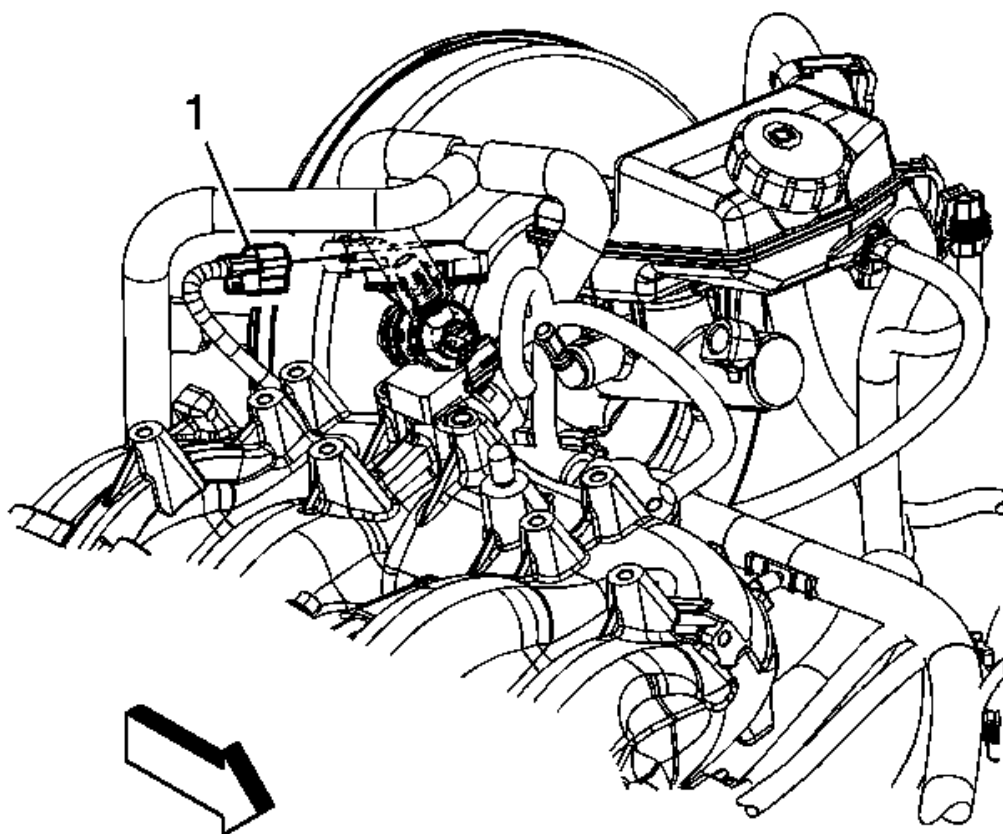


Fig. 348: Identifying Brake Booster Vacuum Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

48. Connect the engine wiring harness electrical connector (1) to the brake booster vacuum sensor.

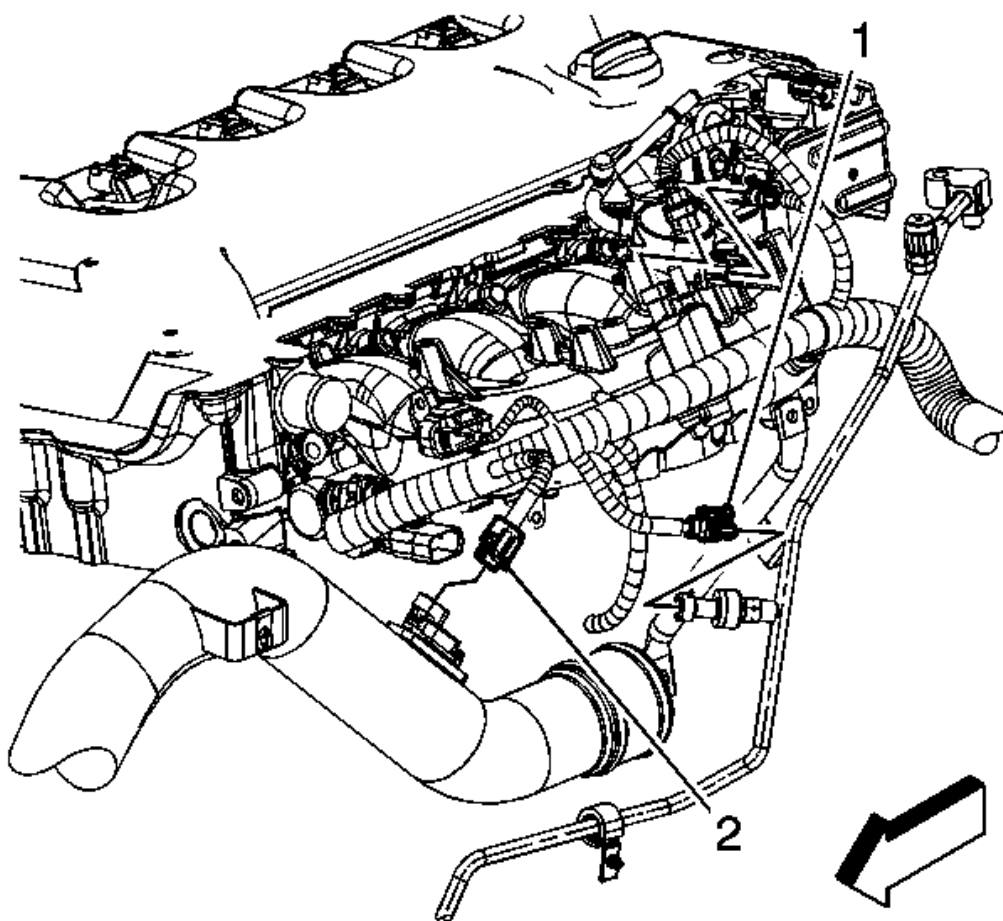


Fig. 349: View Of Intake Air Pressure & Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

49. Connect the engine wiring harness electrical connector (1) to the A/C refrigerant pressure sensor.

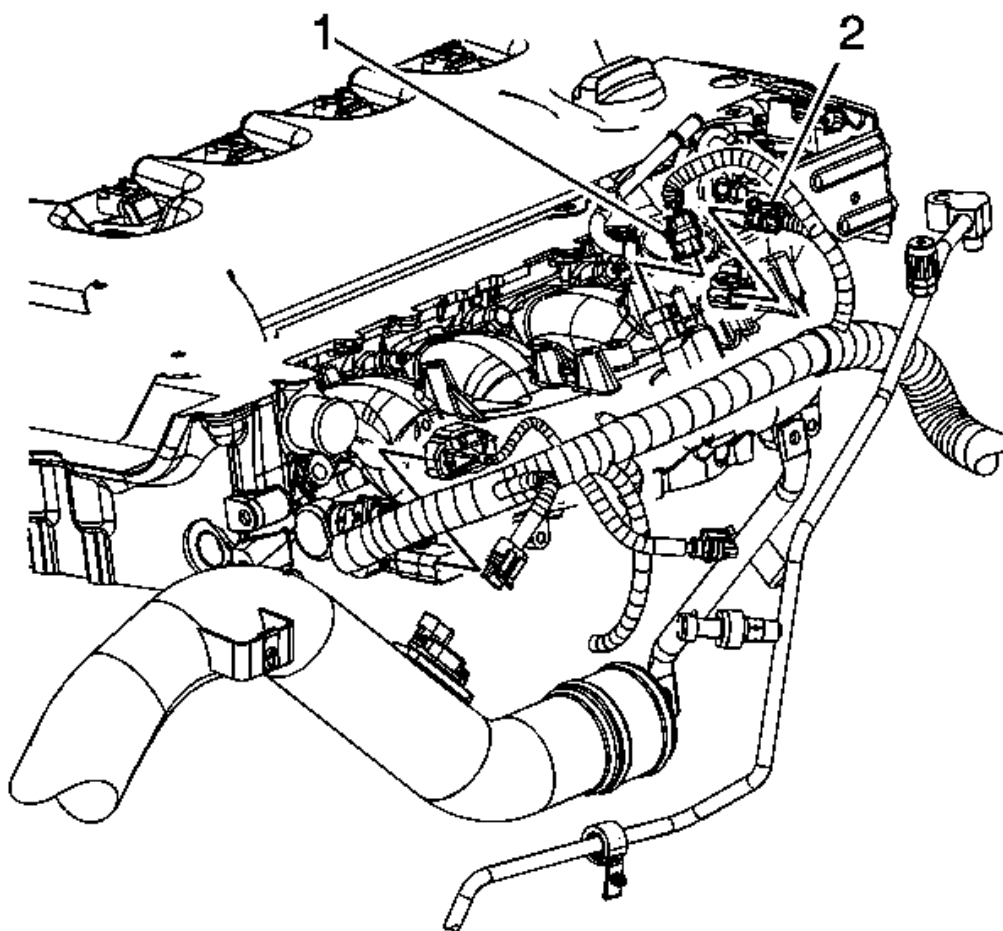


Fig. 350: Identifying MAP Sensor Connector
Courtesy of GENERAL MOTORS CORP.

50. Connect the engine wiring harness electrical connector (1) to the EVAP canister purge solenoid valve.
51. Connect the engine wiring harness electrical connector (2) to the MAP sensor.

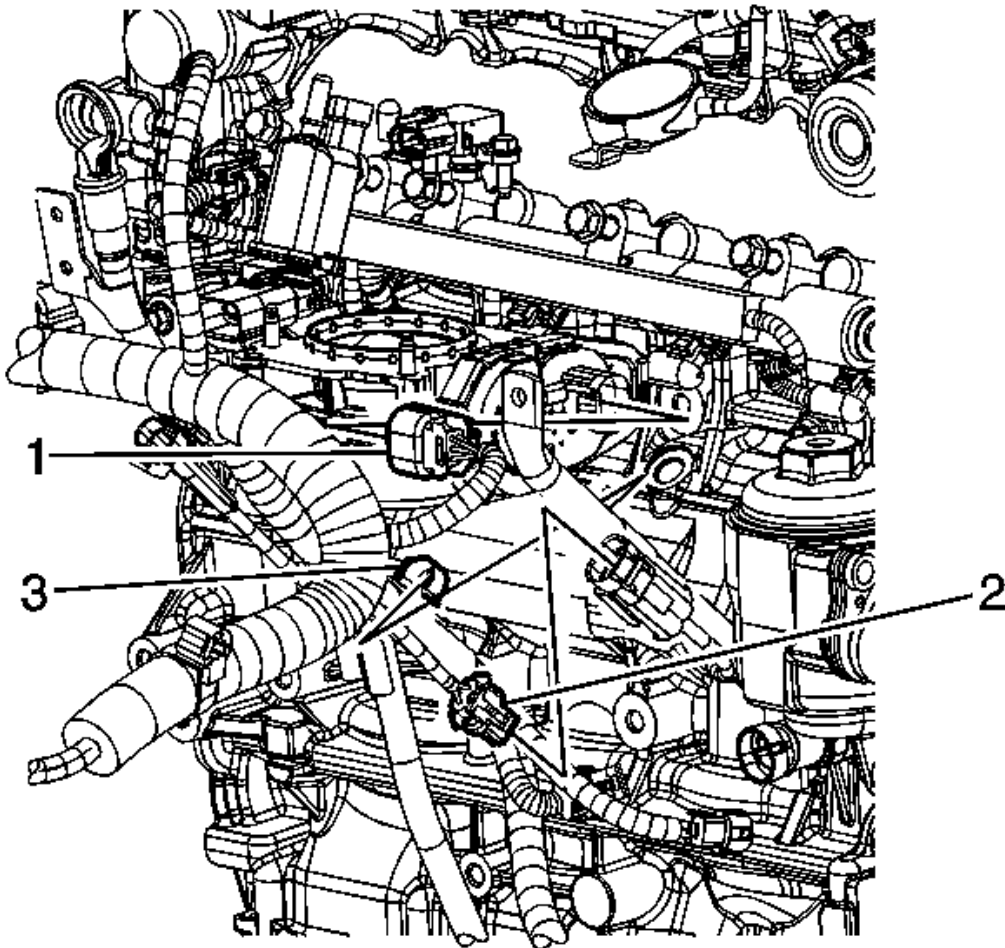


Fig. 351: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

52. Connect the engine wiring harness electrical connector (1) to the throttle actuator.
53. Connect the engine wiring harness electrical connector (2) to the knock sensor.
54. Install the engine wiring harness clip (3) to the intake manifold brace.

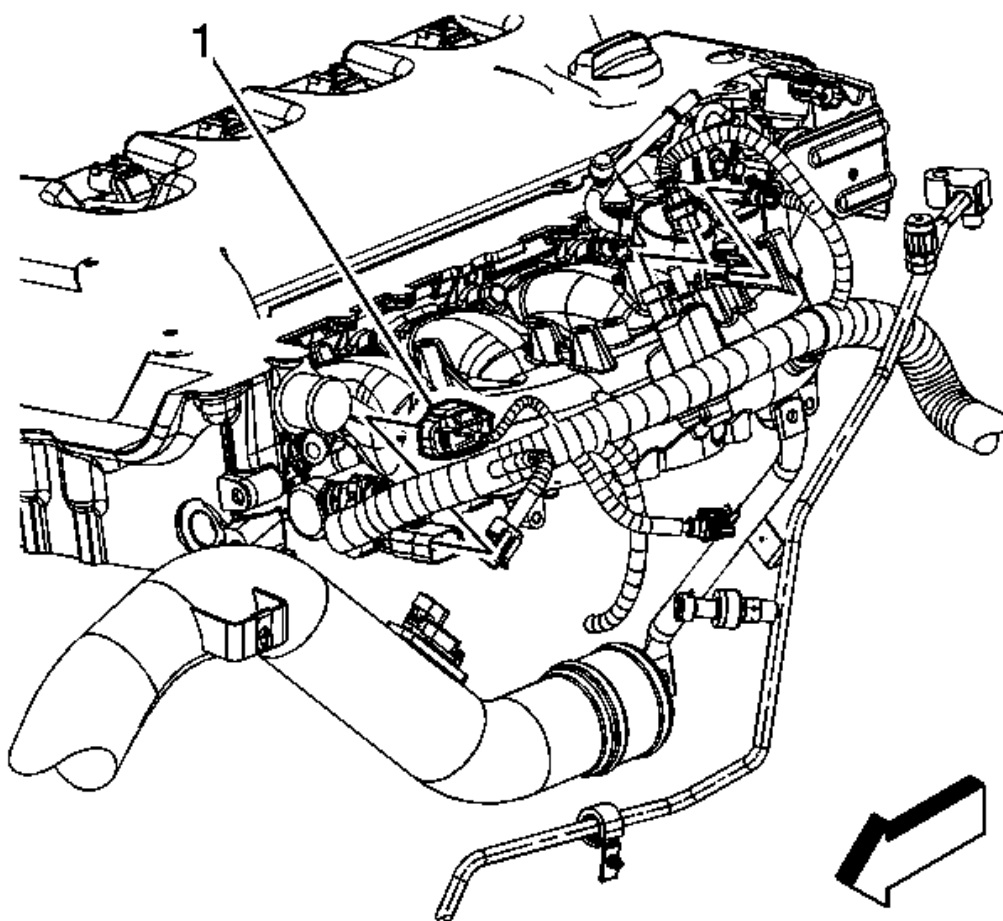


Fig. 352: View Of Engine Wiring Harness Connector & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

55. Connect the engine wiring harness electrical connector (1) to the fuel injector jumper electrical connector.

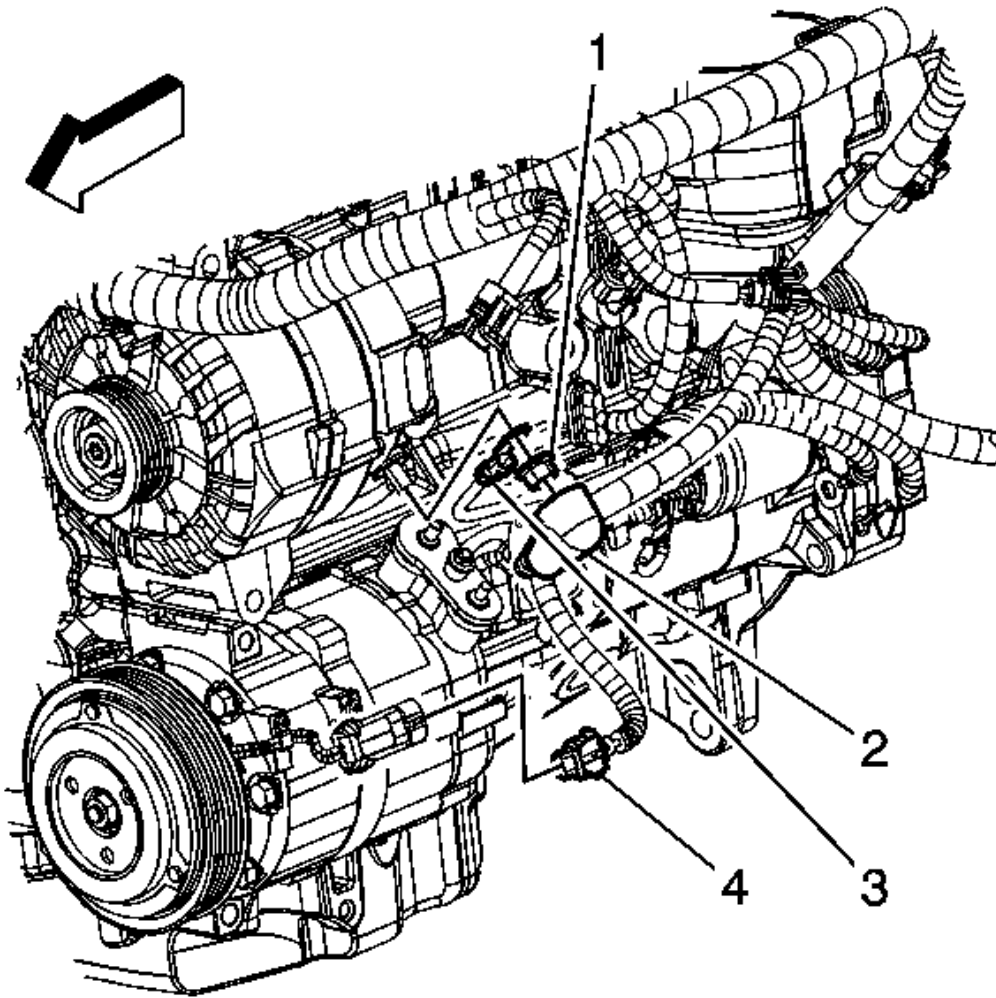


Fig. 353: Identifying Generator
Courtesy of GENERAL MOTORS CORP.

- 56. Install the positive battery cable terminal (3) to the generator.
- 57. Install the generator terminal nut (1).

Tighten: Tighten the nut to 20 N.m (15 lb ft).

- 58. Position the positive battery cable terminal boot (2).
- 59. Connect the engine wiring harness electrical connector (4) to the A/C compressor.

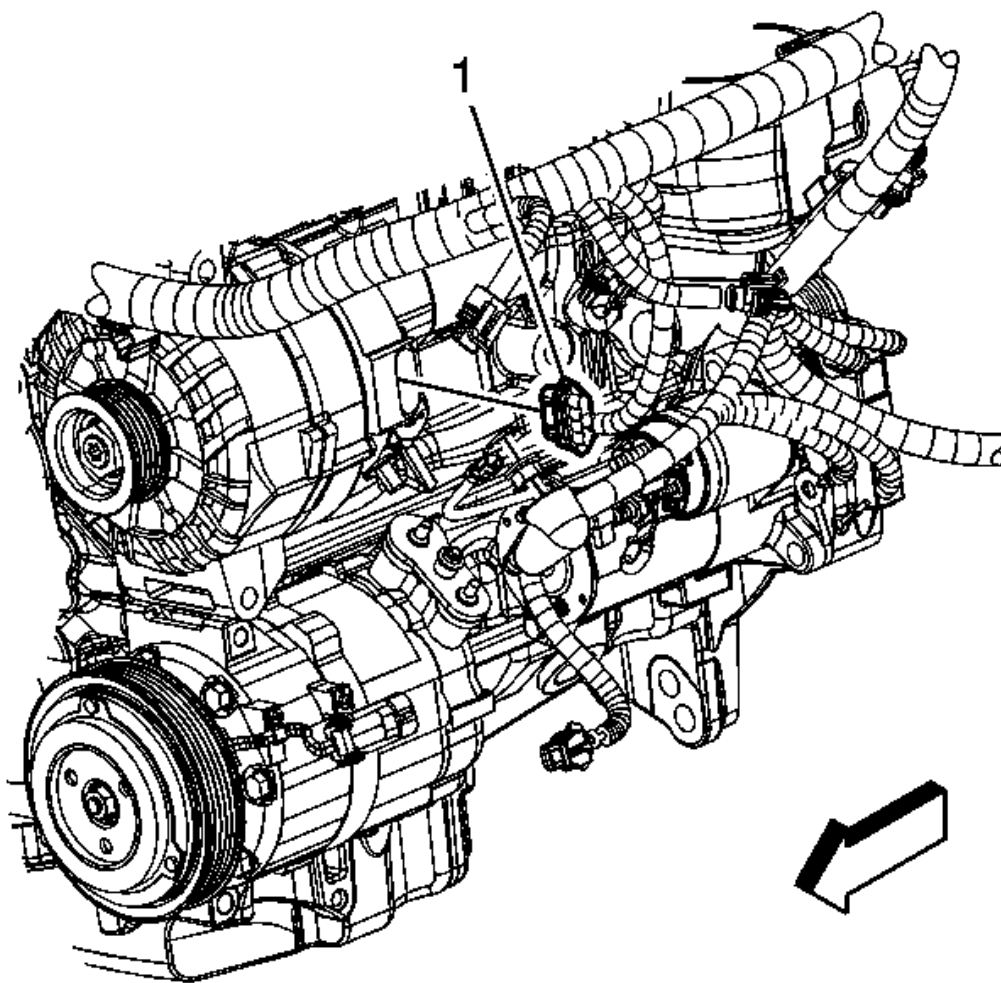


Fig. 354: Identifying Generator Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

60. Connect the engine wiring harness electrical connector (1) to the generator.

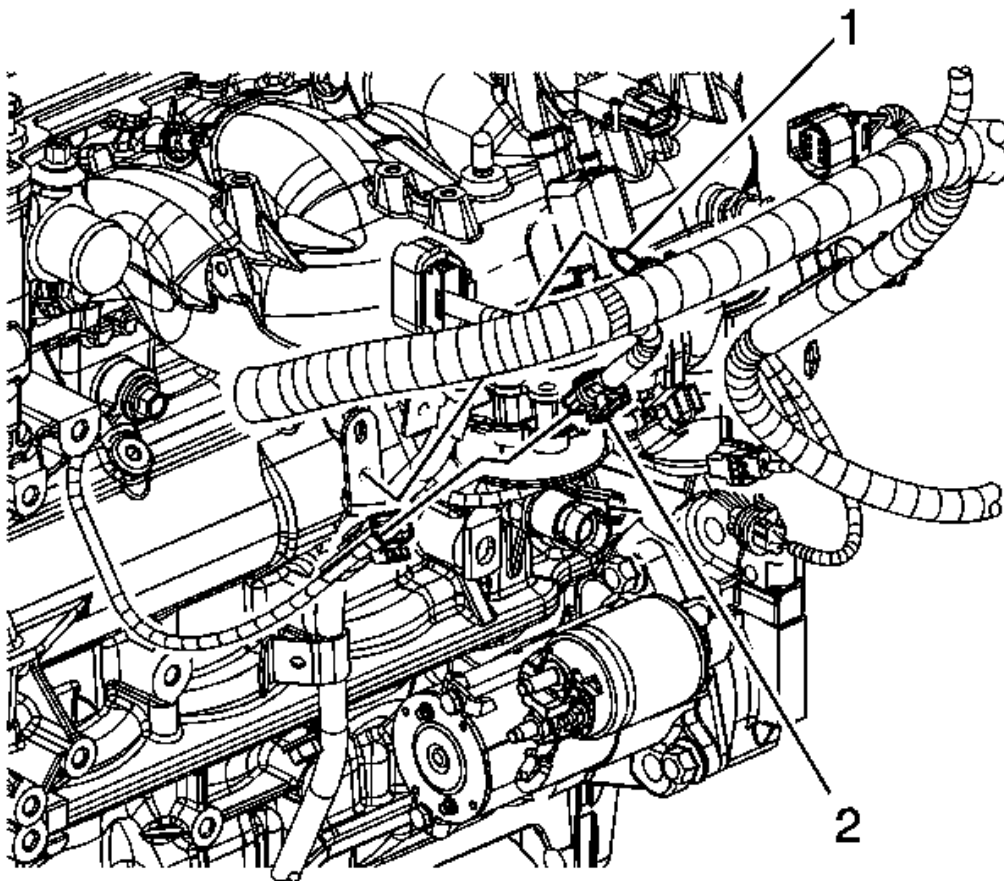


Fig. 355: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

61. Connect the engine wiring harness electrical connector (2) to the knock sensor.
62. Install the engine wiring harness clip (1) to the oil level indicator tube bracket.

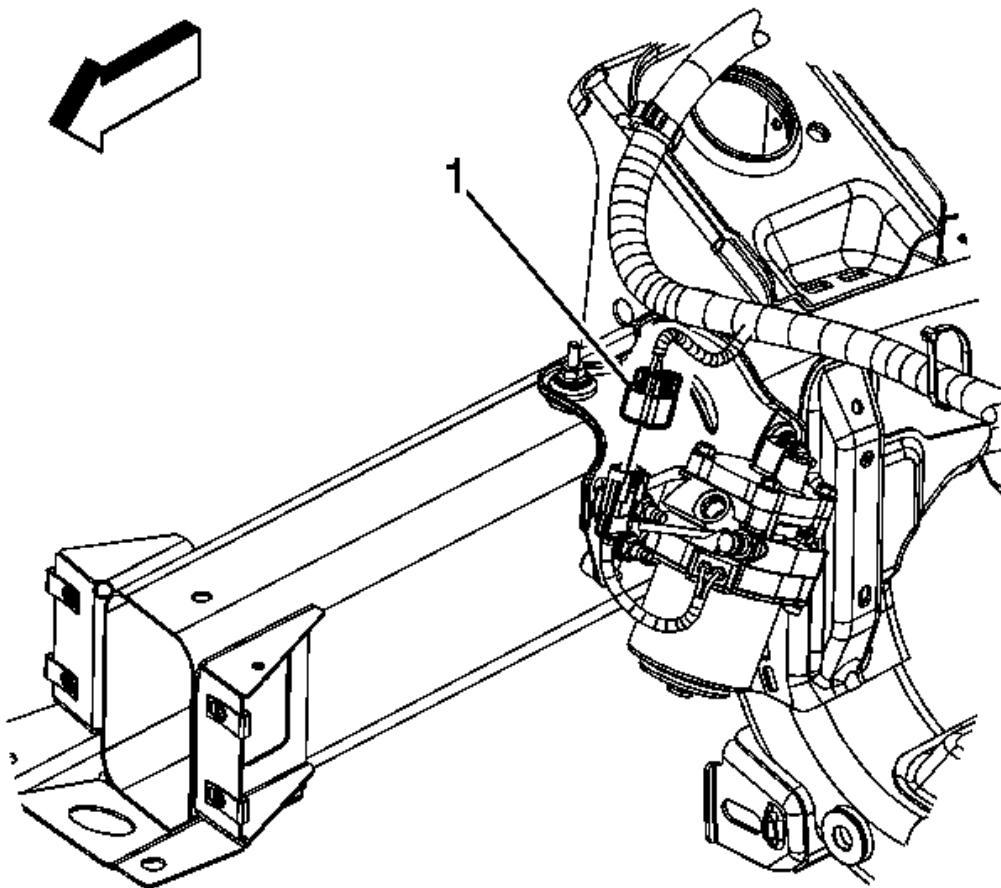


Fig. 356: Locating Transmission Oil Cooler Pump Electrical Connector
Courtesy of GENERAL MOTORS CORP.

63. Connect the engine wiring harness electrical connector (1) to the transmission oil cooler pump.

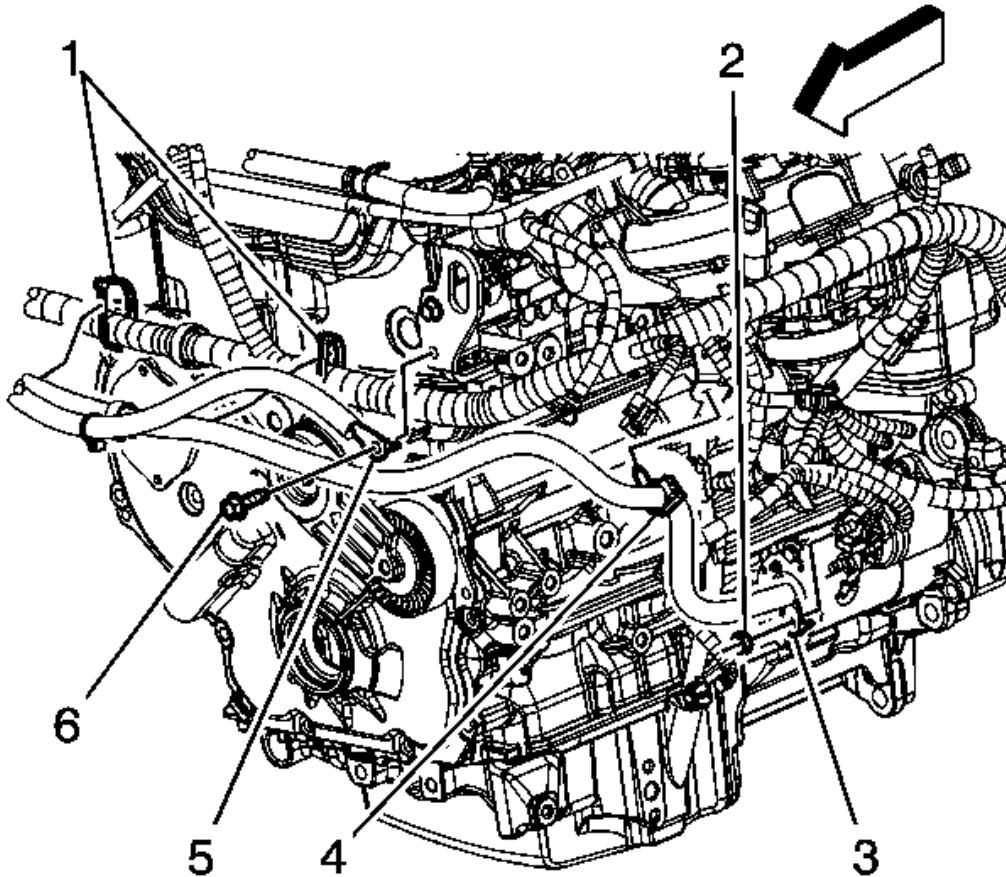


Fig. 357: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

64. Position the negative/positive battery cable to the engine.
65. Install the negative battery cable ground terminal (5) to the engine lift bracket.
66. Install the negative battery cable ground bolt (6) to the front engine lift bracket.

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

67. Install NEW tie straps (1) to the engine wiring harness.

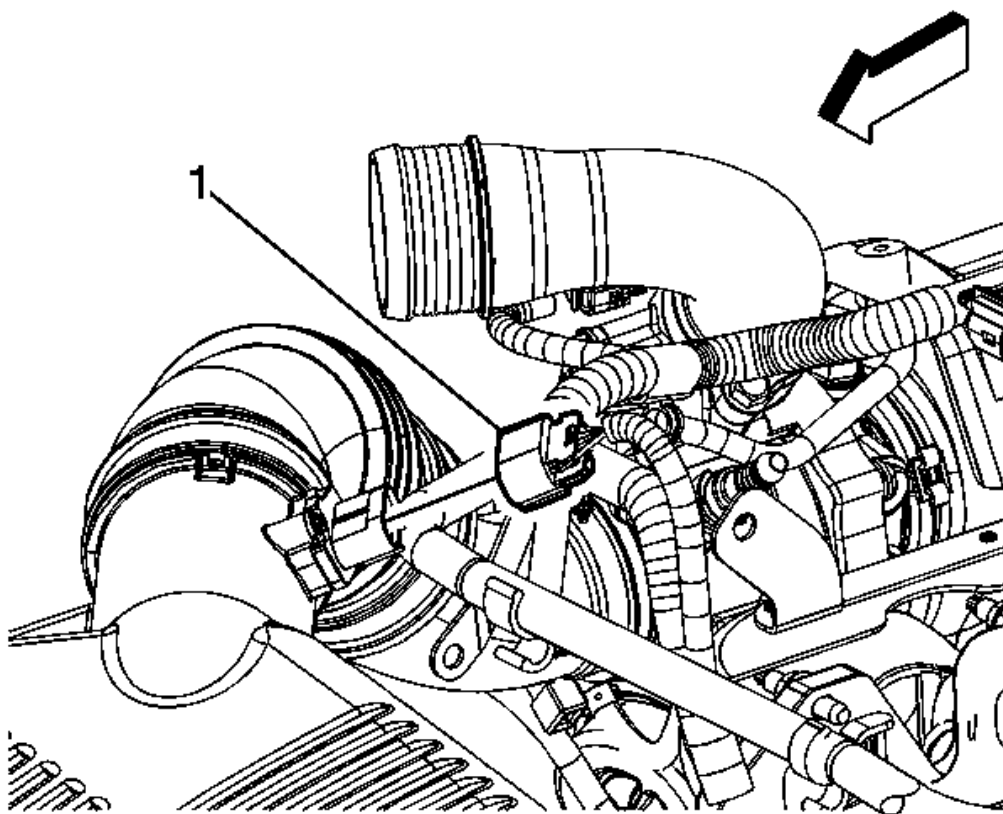


Fig. 358: Identifying MAF Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

68. Connect the engine wiring harness electrical connector (1) to the MAF sensor.
69. Raise the vehicle.

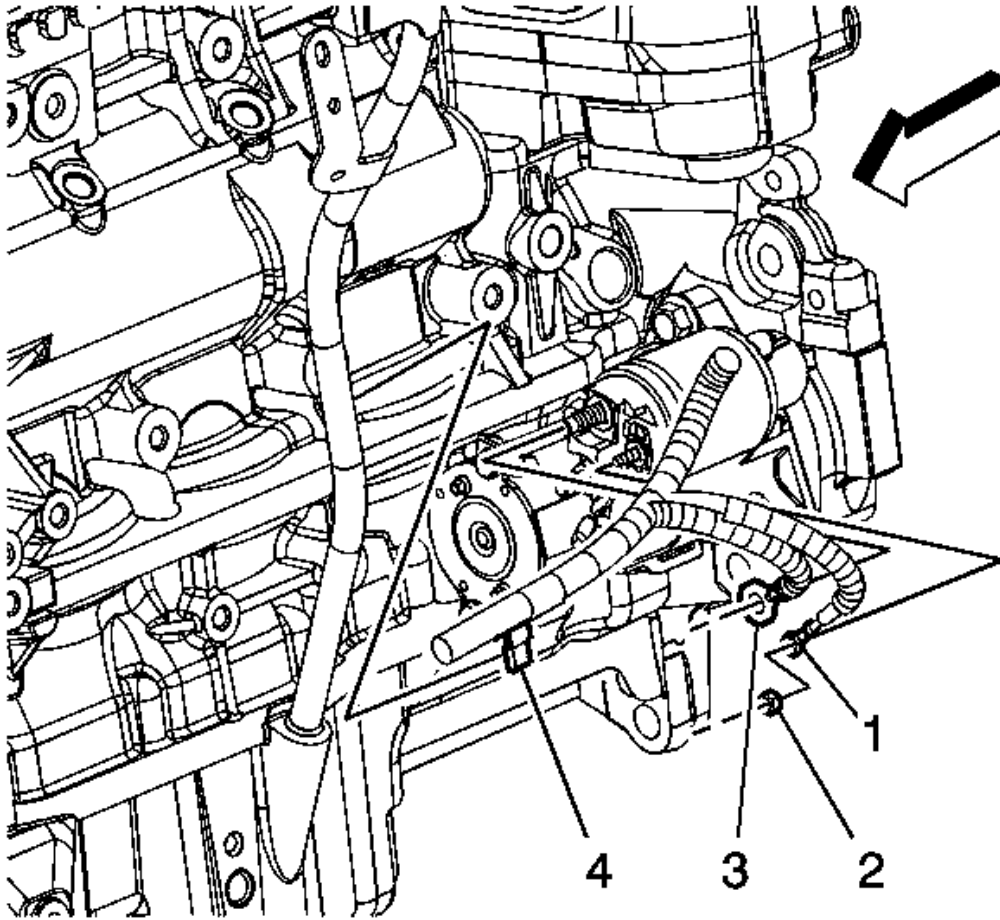


Fig. 359: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

- 70. Install the engine wiring harness terminal (3) to the starter.
- 71. Install the engine wiring harness terminal (1) to the starter.
- 72. Install the engine wiring harness terminal nut (2) to the starter.

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

- 73. Install the engine wiring harness clip (4) to the oil level indicator tube.

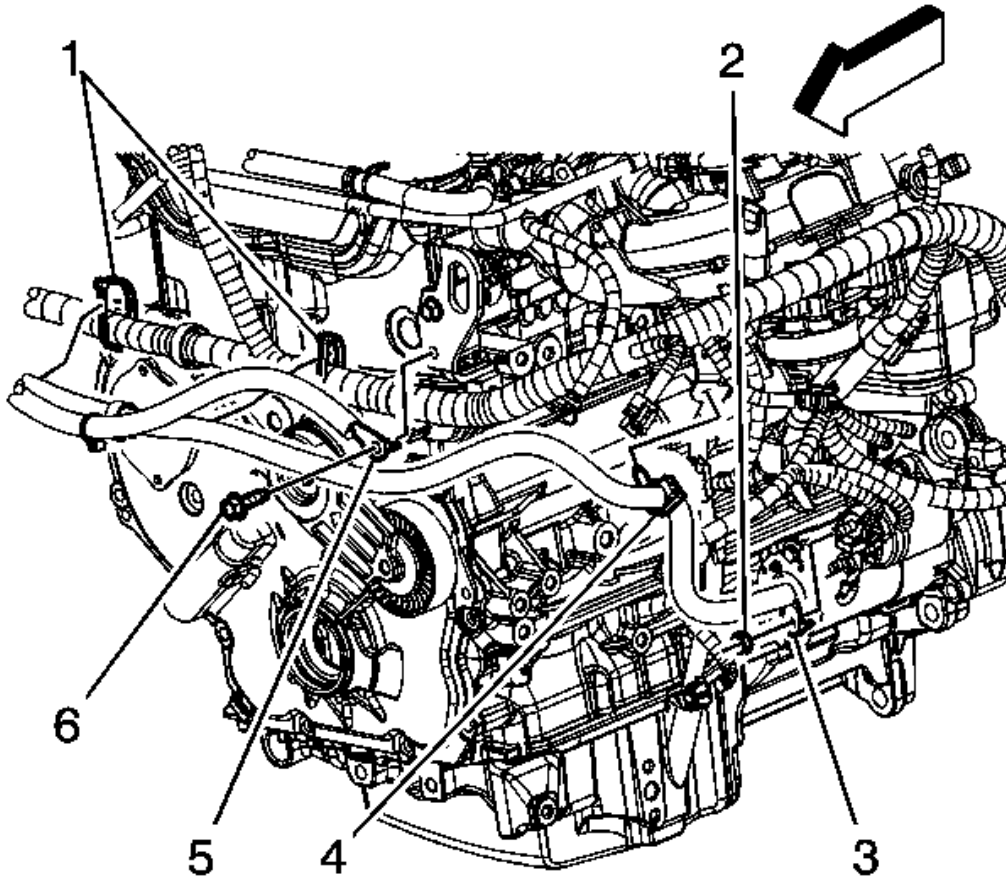


Fig. 360: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

- 74. Install the positive battery cable lead (3) to the starter.
- 75. Install the positive battery cable lead nut (2) at the starter.

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

- 76. Install the engine wiring harness clip (4) to the oil level indicator tube bracket.

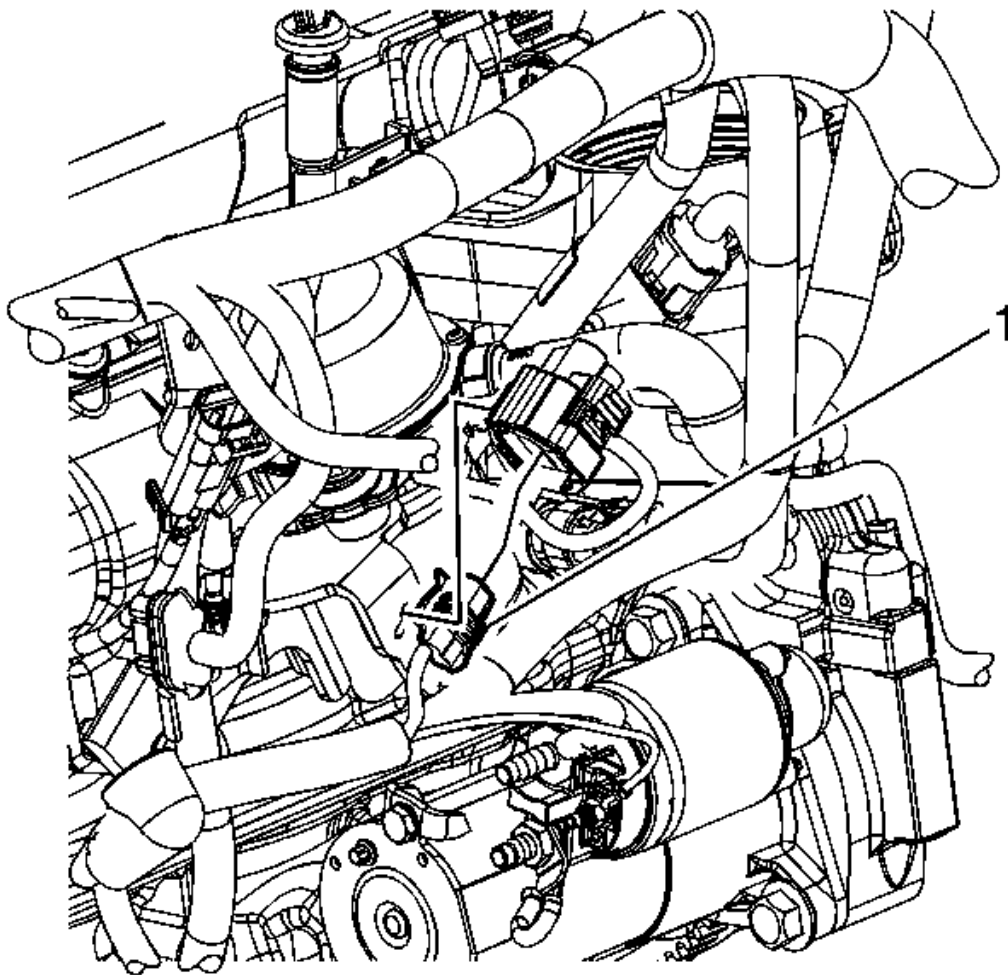


Fig. 361: Identifying Brake Booster Auxiliary Pump Connector
Courtesy of GENERAL MOTORS CORP.

77. Connect the engine wiring harness electrical connector (1) to the brake booster vacuum pump.

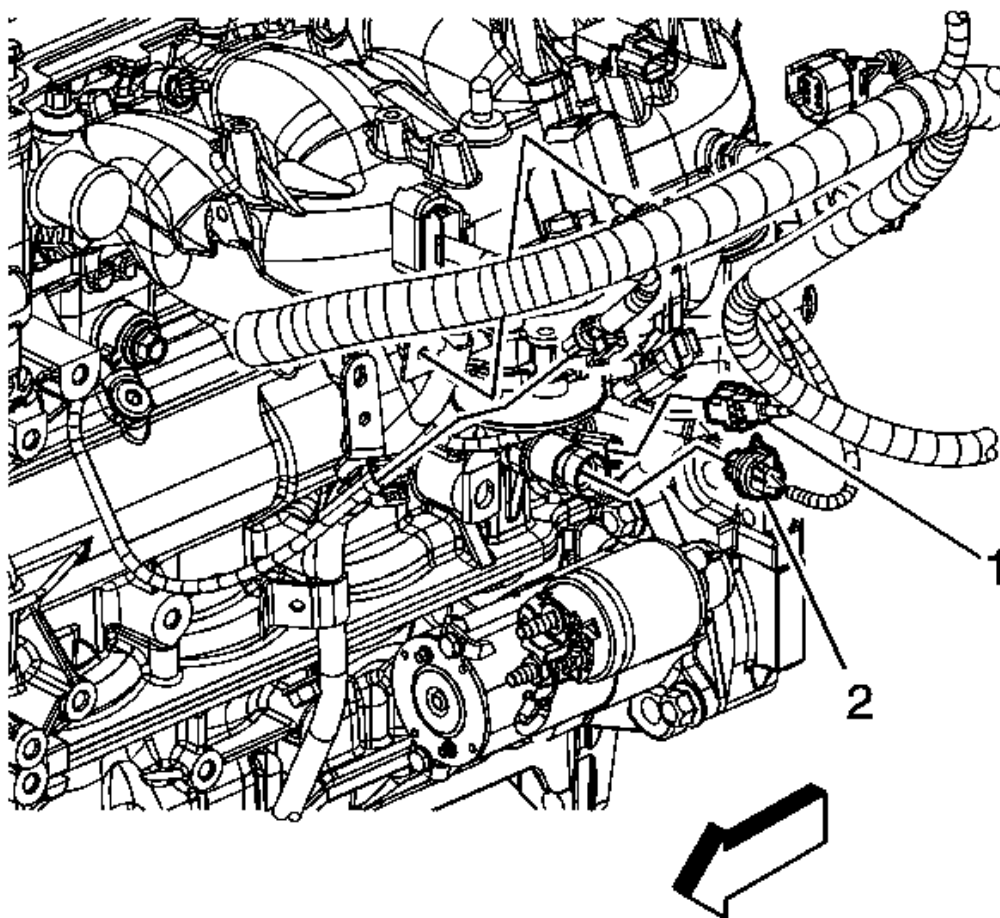


Fig. 362: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

78. Connect the engine wiring harness electrical connector (1) to the CKP sensor.
79. Connect the engine wiring harness electrical connector (2) to the oil pressure sensor.
80. Lower the vehicle.

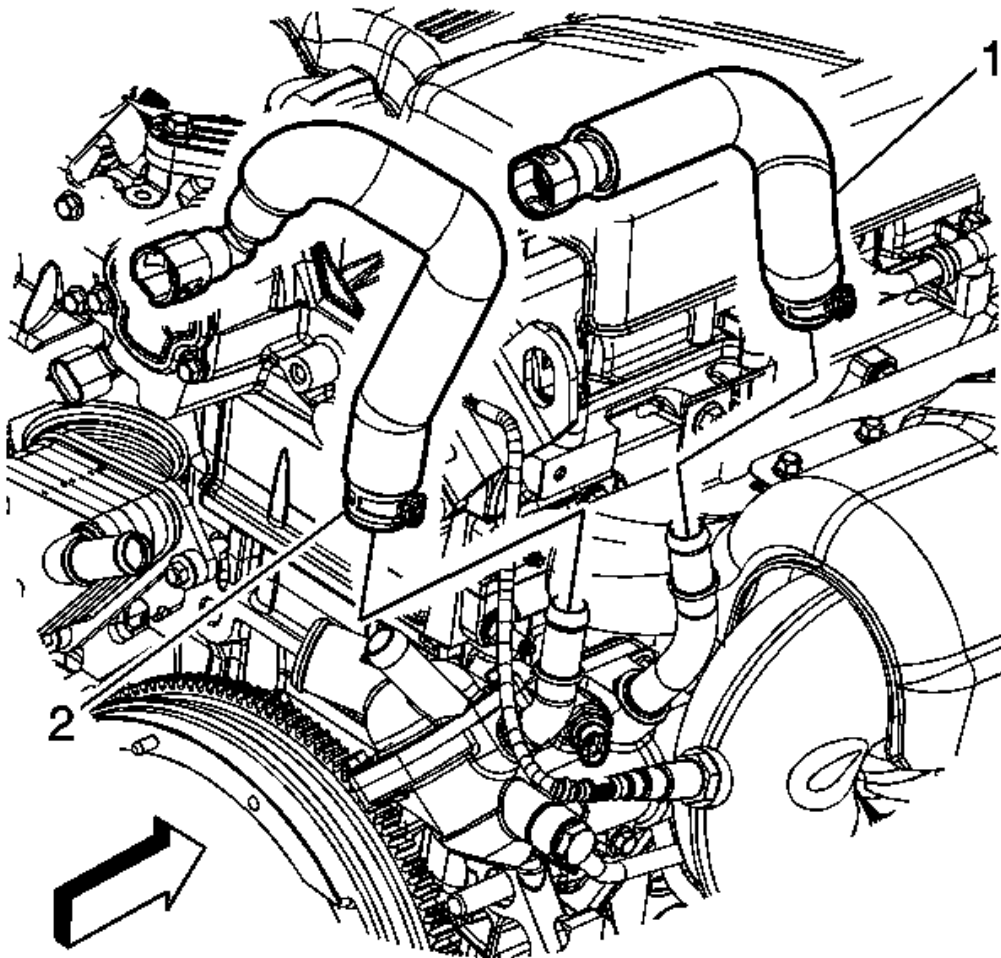


Fig. 363: Identifying Heater Inlet & Outlet Hoses & Clamps
Courtesy of GENERAL MOTORS CORP.

81. Install the heater inlet (1) and outlet (2) hoses to the thermostat housing.
82. Position the heater inlet and outlet hose clamps at the thermostat housing.

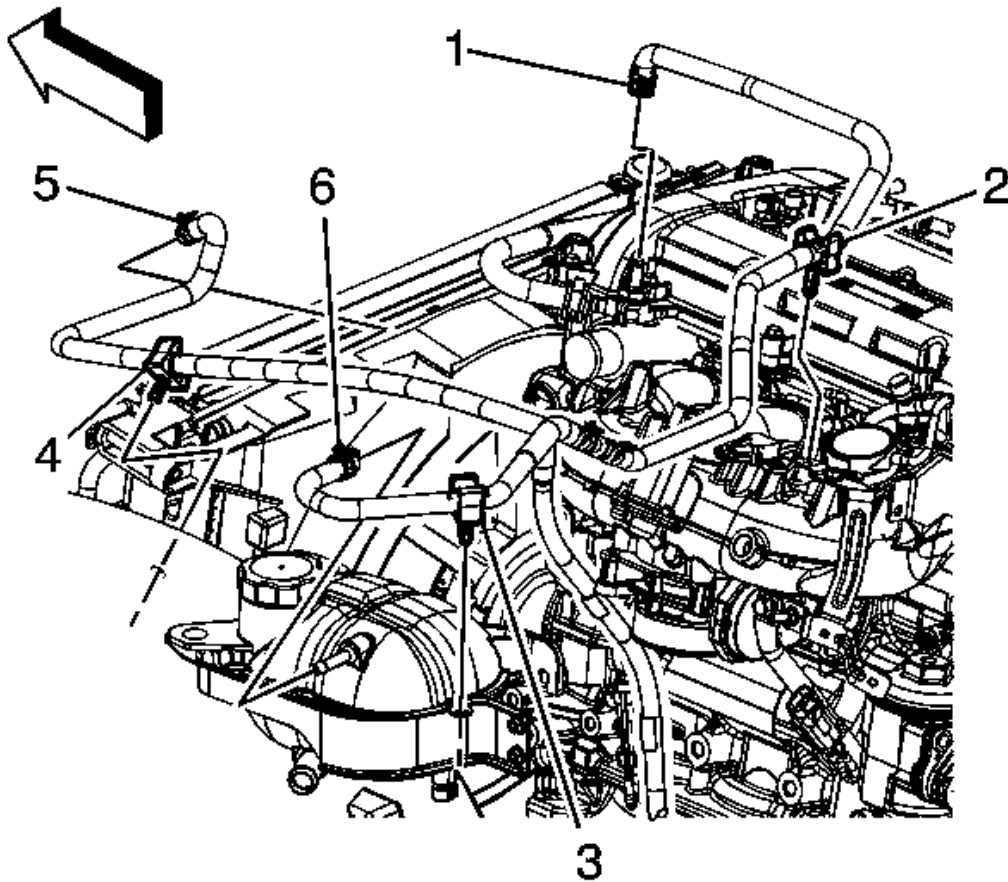


Fig. 364: Identifying Surge Tank Hose Components
Courtesy of GENERAL MOTORS CORP.

- 83. Position the air bleed hose to the engine.
- 84. Install the surge tank air bleed hose to the engine.
- 85. Install the surge tank air bleed hose clip (3) to the surge tank bracket.
- 86. Position the surge tank air bleed hose clamp (1) at the engine.

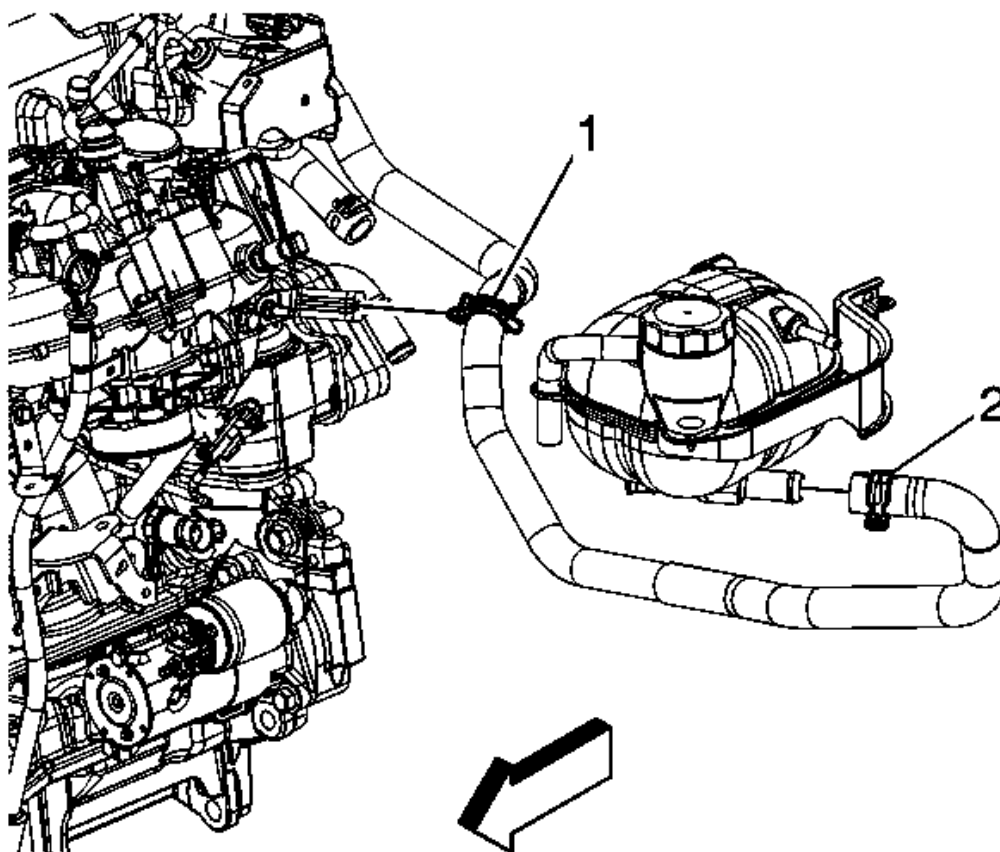


Fig. 365: Identifying Surge Tank Outlet Hose Clamp (At Surge Tank)
Courtesy of GENERAL MOTORS CORP.

87. Install the surge tank clip (1) to the oil level indicator tube bracket.
88. Position the surge tank outlet hose clamp (2) at the surge tank.

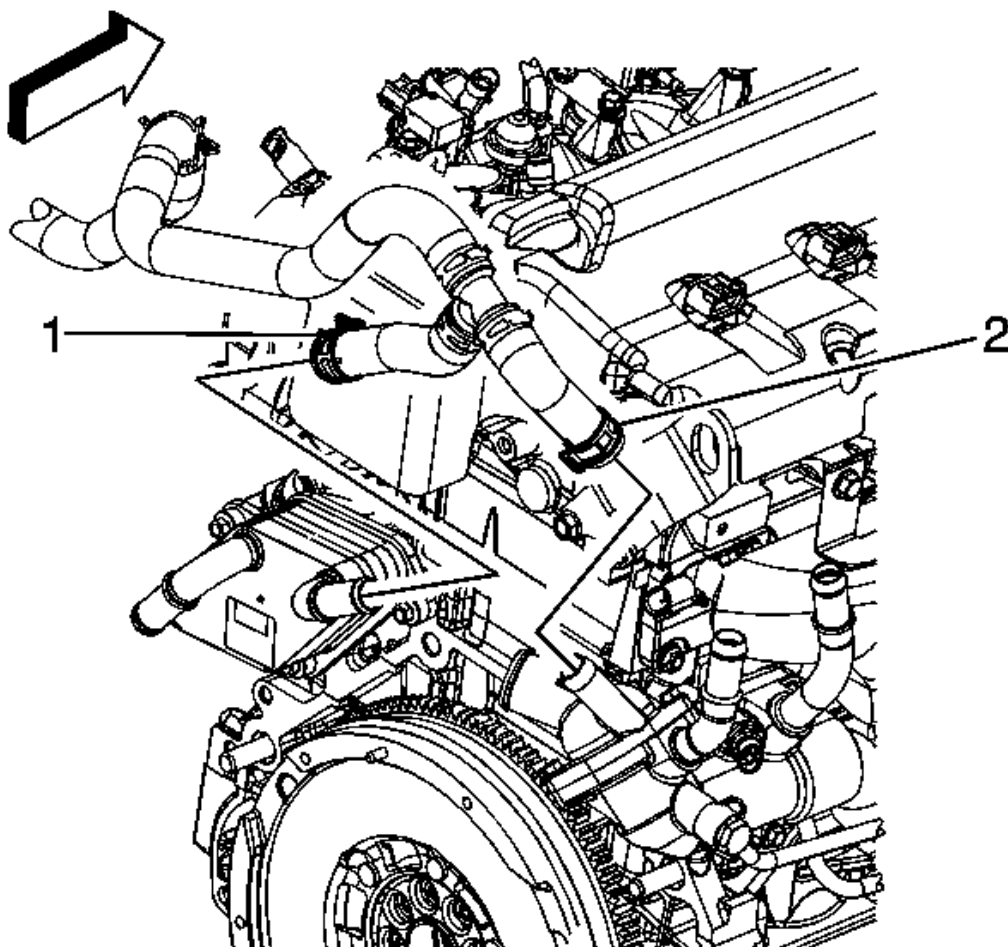


Fig. 366: Identifying Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

- 89. Install the surge tank outlet hose to the thermostat housing and oil cooler.
- 90. Position the surge tank outlet hose clamp (1) at the oil cooler.
- 91. Position the surge tank outlet hose clamp (2) at the thermostat housing.

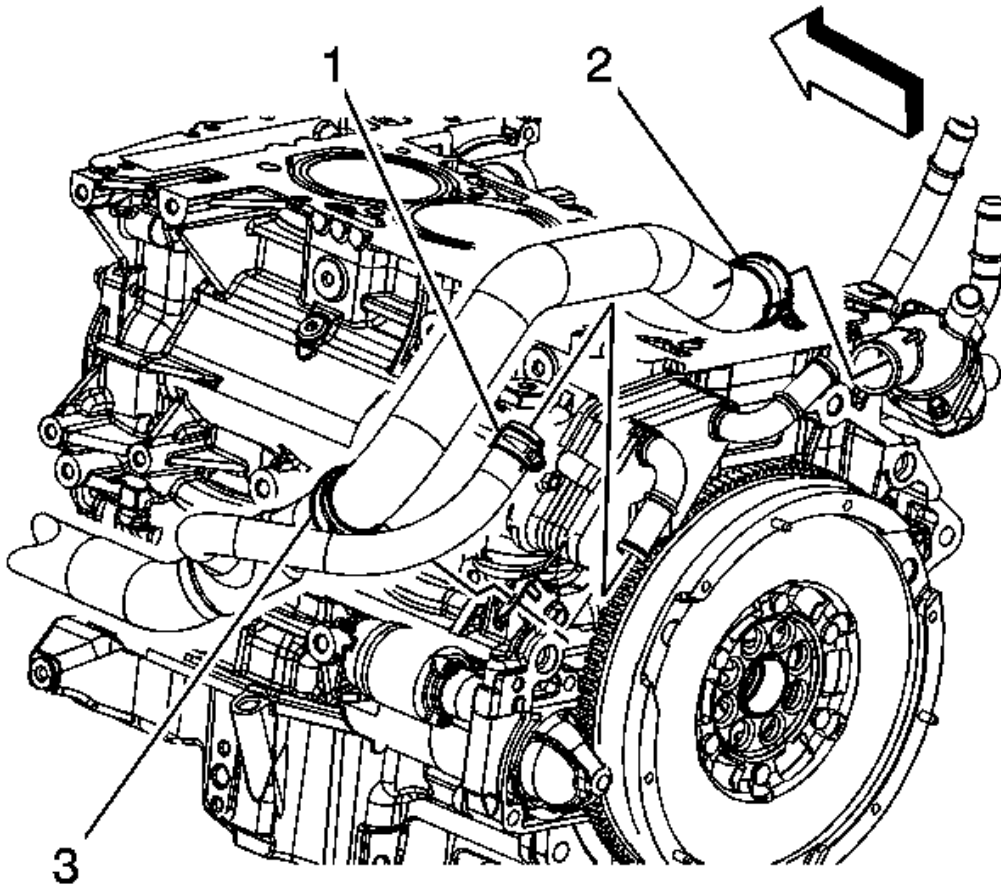


Fig. 367: Identifying Radiator Outlet Hose Components
 Courtesy of GENERAL MOTORS CORP.

92. Position the outlet hose to the engine.
93. Install the radiator outlet hose clip (3) to the bracket.
94. Install the radiator outlet hose to the thermostat housing and oil cooler.
95. Position the radiator outlet hose clamp (1) at the oil cooler.
96. Position the radiator outlet hose clamp (2) at the thermostat housing.

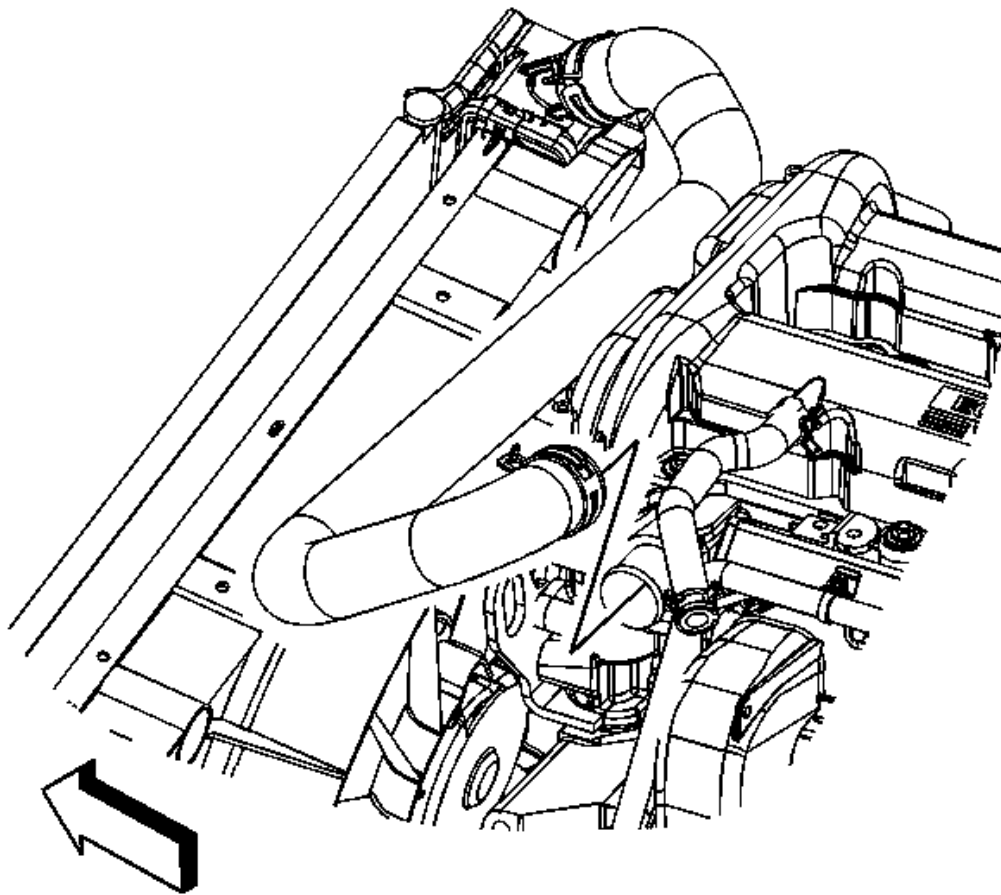


Fig. 368: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

97. Position the inlet hose to the engine.
98. Install the radiator inlet hose to the engine.
99. Position the radiator inlet hose clamp at the engine.

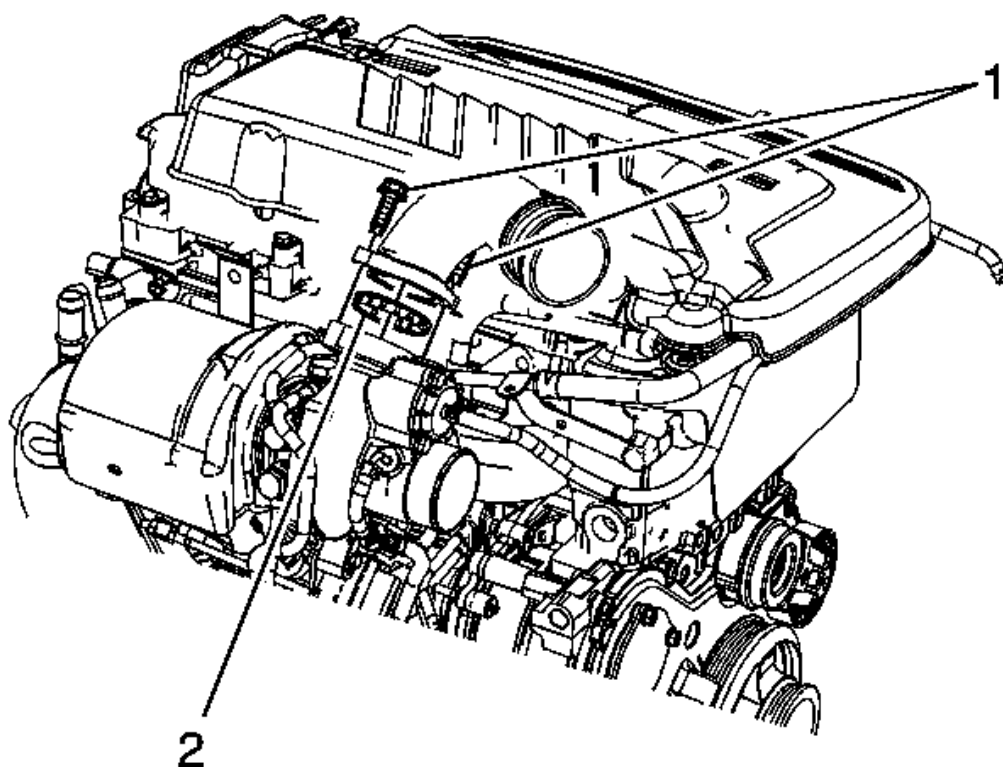


Fig. 369: Identifying Charge Air Cooler Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

100. Remove the cap or plug from the turbocharger opening.
101. Install the charge air cooler pipe to the turbocharger.
102. Install the charge air cooler pipe to turbocharger bolts (1).

Tighten: Tighten the bolts to 22 N.m (16 lb ft).

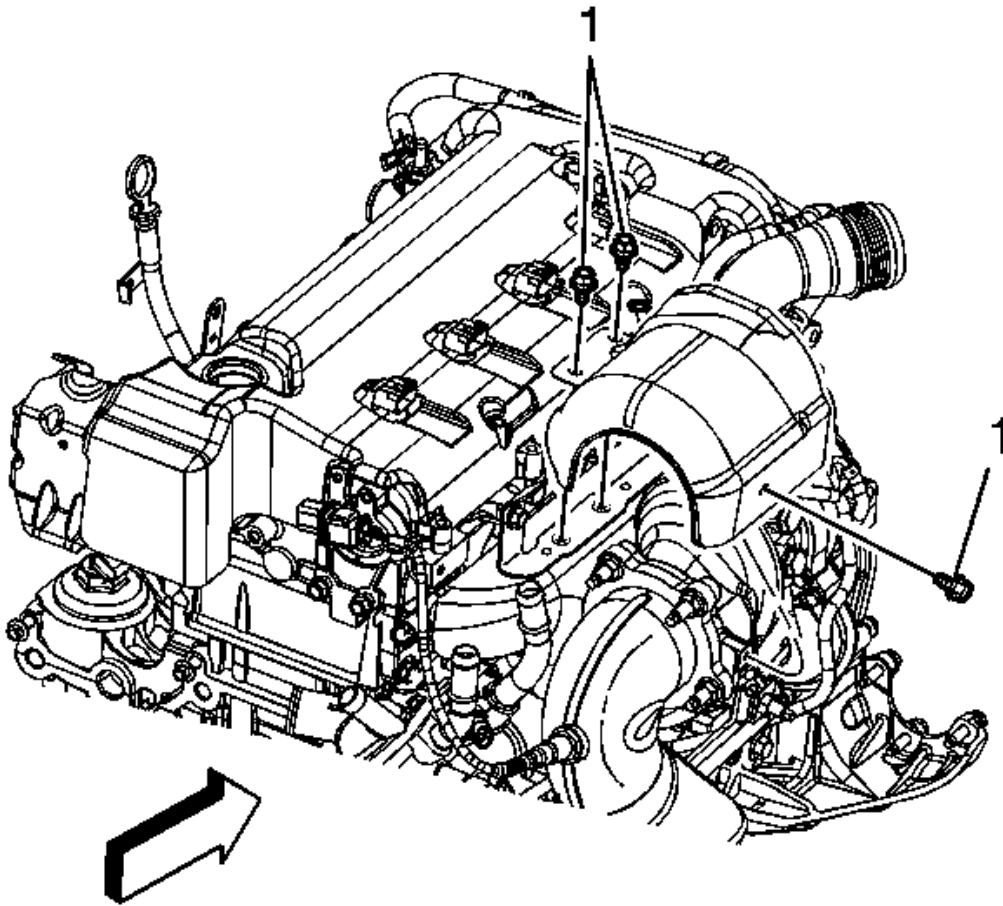


Fig. 370: Identifying Turbocharger Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

103. Install the turbocharger heat shield and bolts (1).

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

104. Install the transmission. Refer to **Transmission Replacement (With ZOK)** .
105. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
106. Install the charge air cooler inlet and outlet pipes. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .

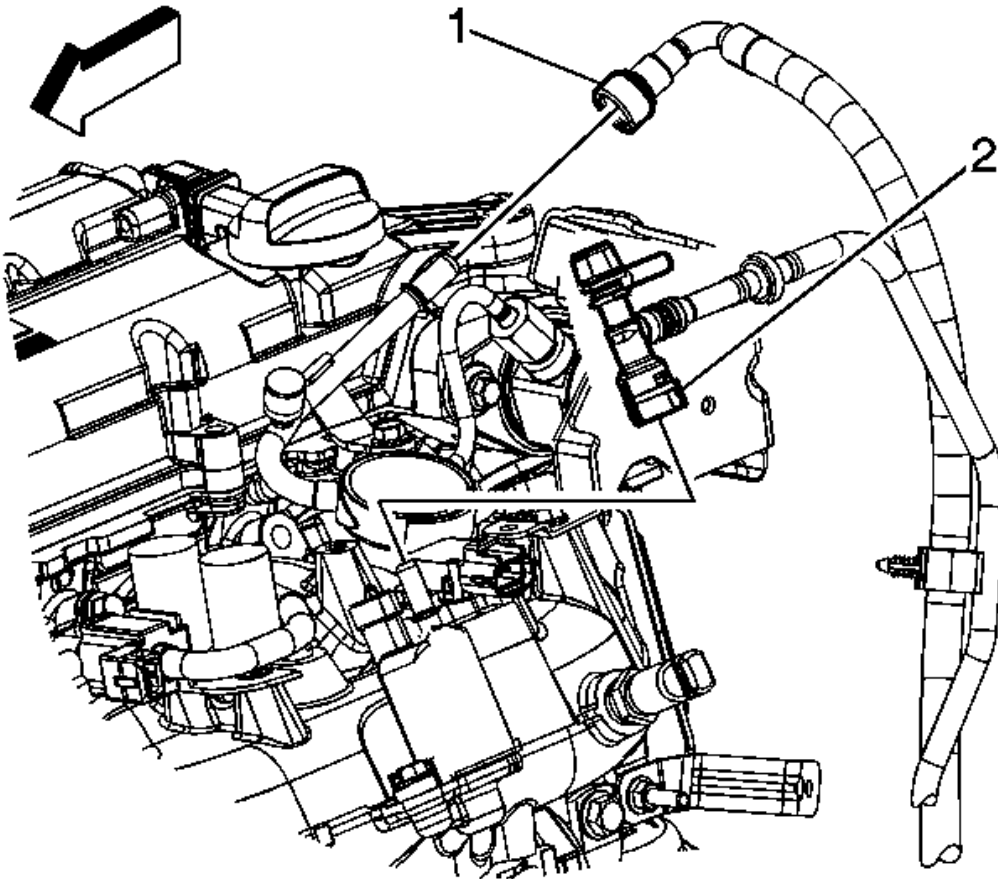


Fig. 371: Identifying EVAP & Fuel Feed Pipes
Courtesy of GENERAL MOTORS CORP.

107. Connect the fuel feed pipe (1) to the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .
108. Connect the EVAP canister purge solenoid tube to the valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
109. Install the radiator. Refer to **Radiator Replacement** .
110. Install the drive belt. Refer to **Drive Belt Replacement**.
111. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
112. Install the hood. Refer to **Hood Replacement** .
113. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
114. Fill the engine with oil.

ENGINE REPLACEMENT (W/AUTOMATIC TRANSMISSION)

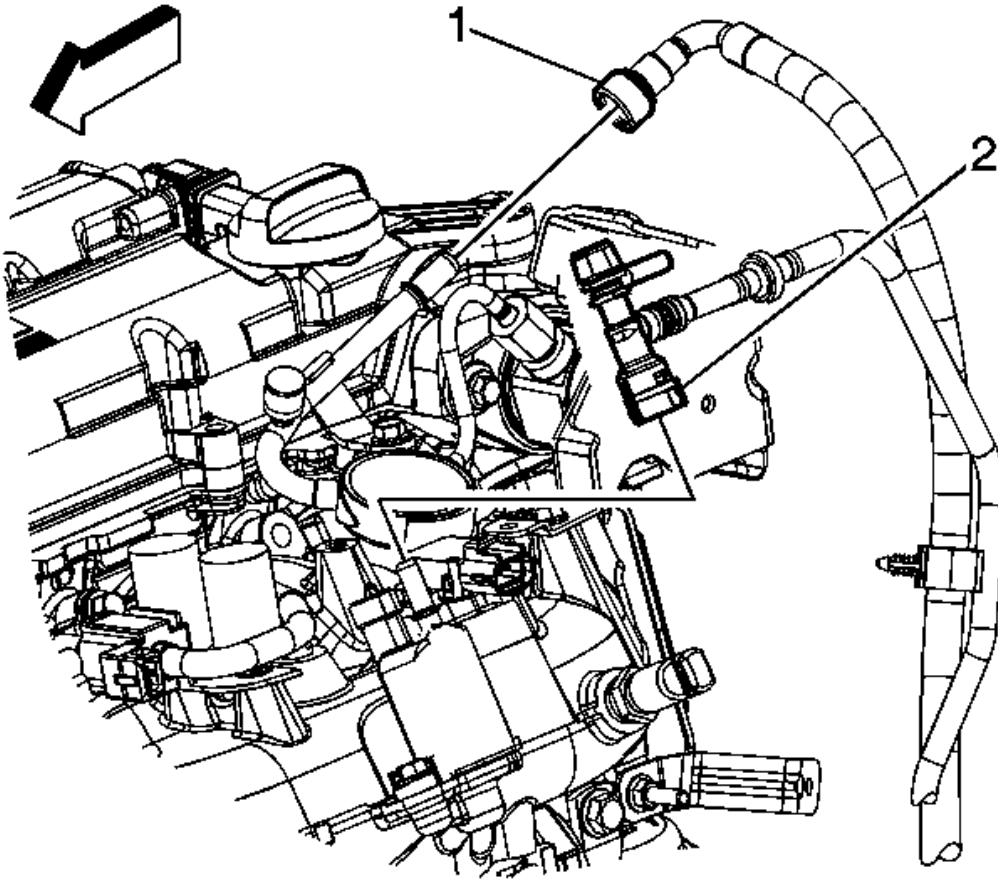
SPECIAL TOOLS**J 45059** Angle Meter**REMOVAL PROCEDURE**

Fig. 372: Identifying EVAP & Fuel Feed Pipes
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. Recover the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
4. Remove the drive belt. Refer to **Drive Belt Replacement**.
5. Remove the radiator. Refer to **Radiator Replacement** .

6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Low Pressure without Special Tool)** or **Fuel Pressure Relief (Low Pressure with CH 48027)** or **Fuel Pressure Relief (Low Pressure Side with CH 48027-100)** or **Fuel Pressure Relief (High Pressure Side)** .
7. Disconnect the evaporative emission (EVAP) canister purge solenoid tube from the valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Disconnect the fuel feed pipe (1) from the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .
9. Remove the charge air cooler inlet and outlet pipes. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .
10. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
11. Remove the starter. Refer to **Starter Replacement** .

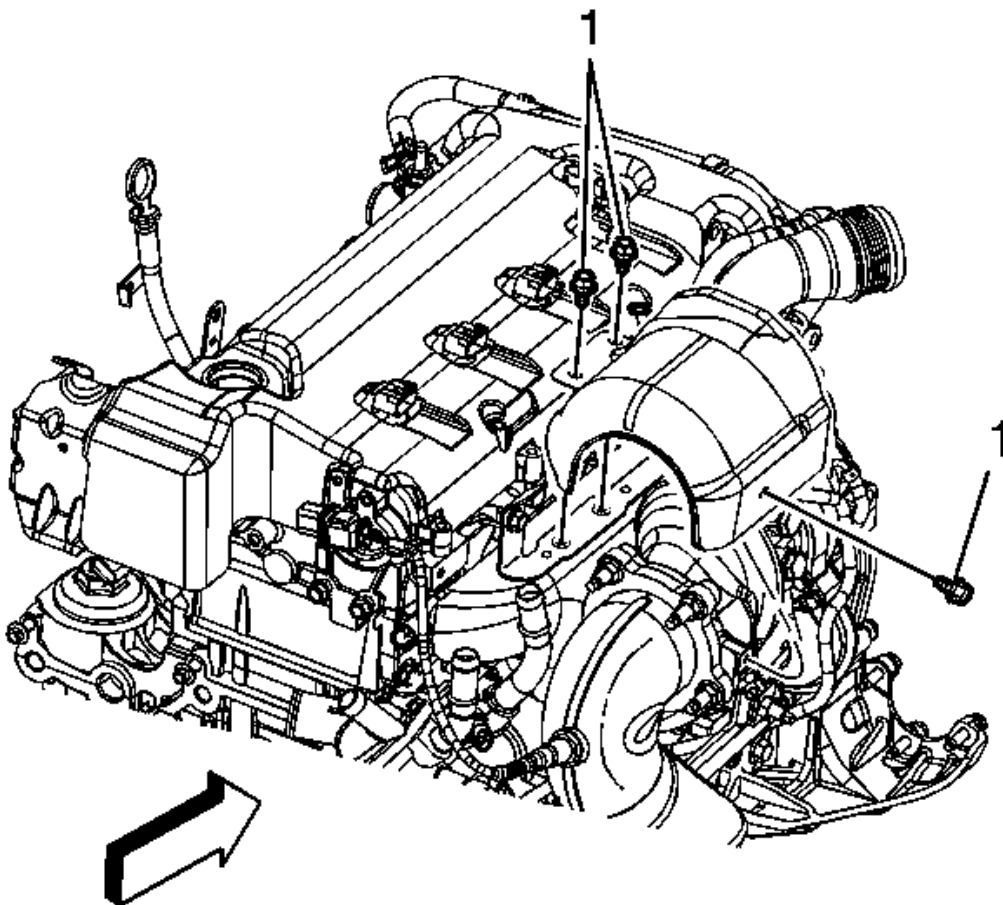


Fig. 373: Identifying Turbocharger Heat Shield & Bolts

Courtesy of GENERAL MOTORS CORP.

12. Remove the turbocharger heat shield bolts (1) and shield.

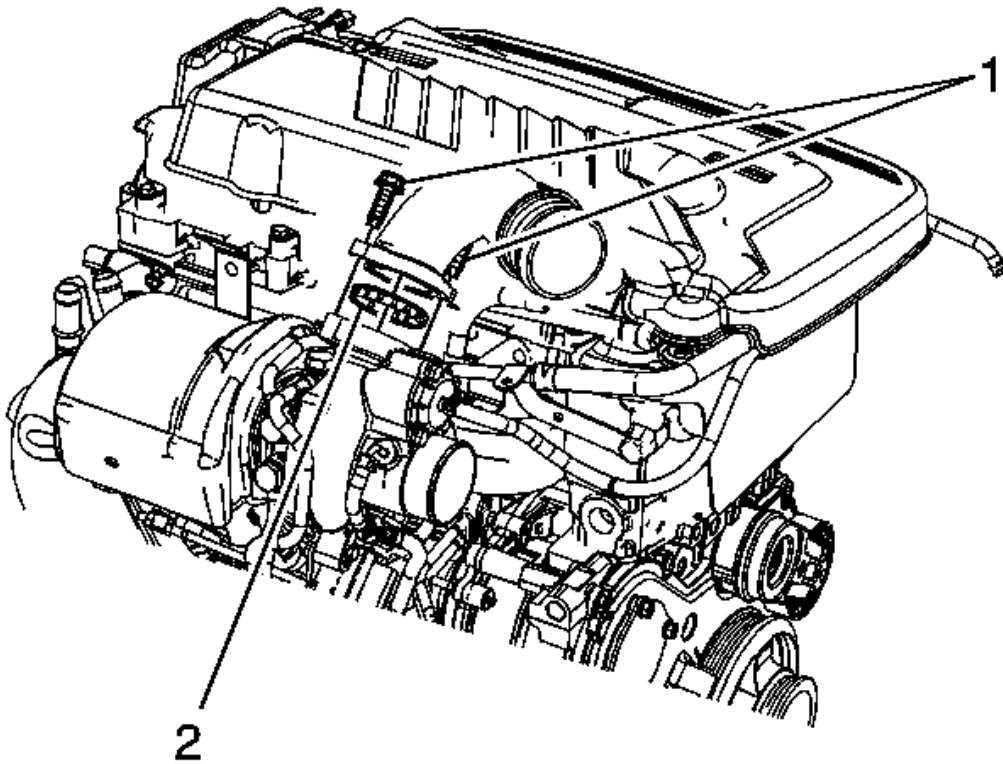


Fig. 374: Identifying Charge Air Cooler Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

13. Remove the charge air cooler pipe to turbocharger bolts (1).
14. Remove the charge air cooler pipe and gasket (2) from the turbocharger.
15. Cap or plug the turbocharger opening.

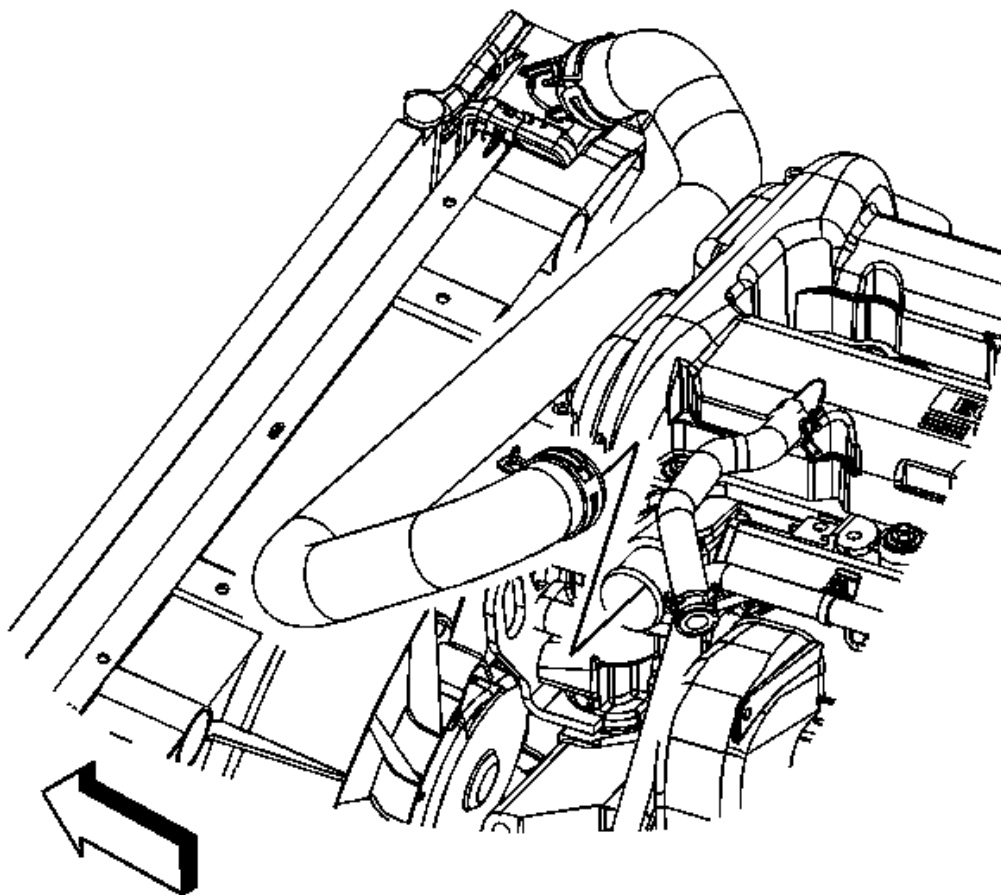


Fig. 375: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

16. Reposition the radiator inlet hose clamp at the engine.
17. Remove the radiator inlet hose from the engine.
18. Reposition the radiator inlet hose out of the way.

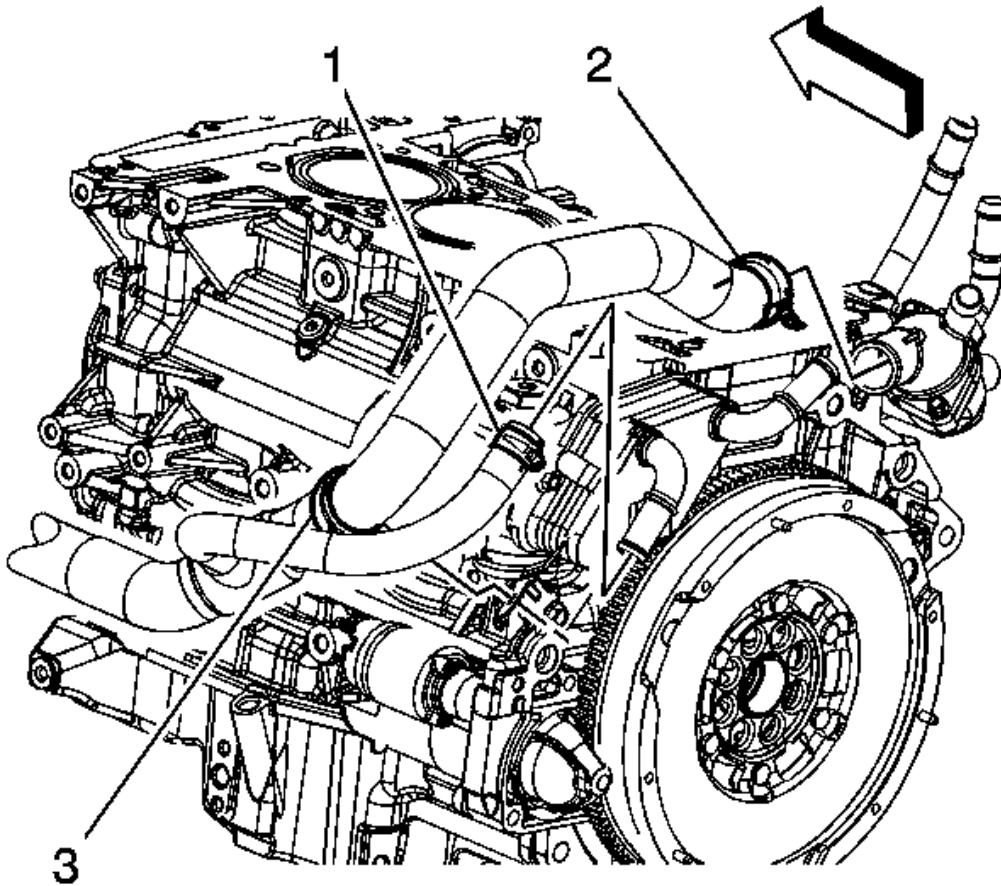


Fig. 376: Identifying Radiator Outlet Hose Components
 Courtesy of GENERAL MOTORS CORP.

19. Reposition the radiator outlet hose clamp (2) at the thermostat housing.
20. Reposition the radiator outlet hose clamp (1) at the oil cooler.
21. Remove the radiator outlet hose from the thermostat housing and oil cooler.
22. Remove the radiator outlet hose clip (3) from the bracket.
23. Reposition the radiator outlet hose out of the way.

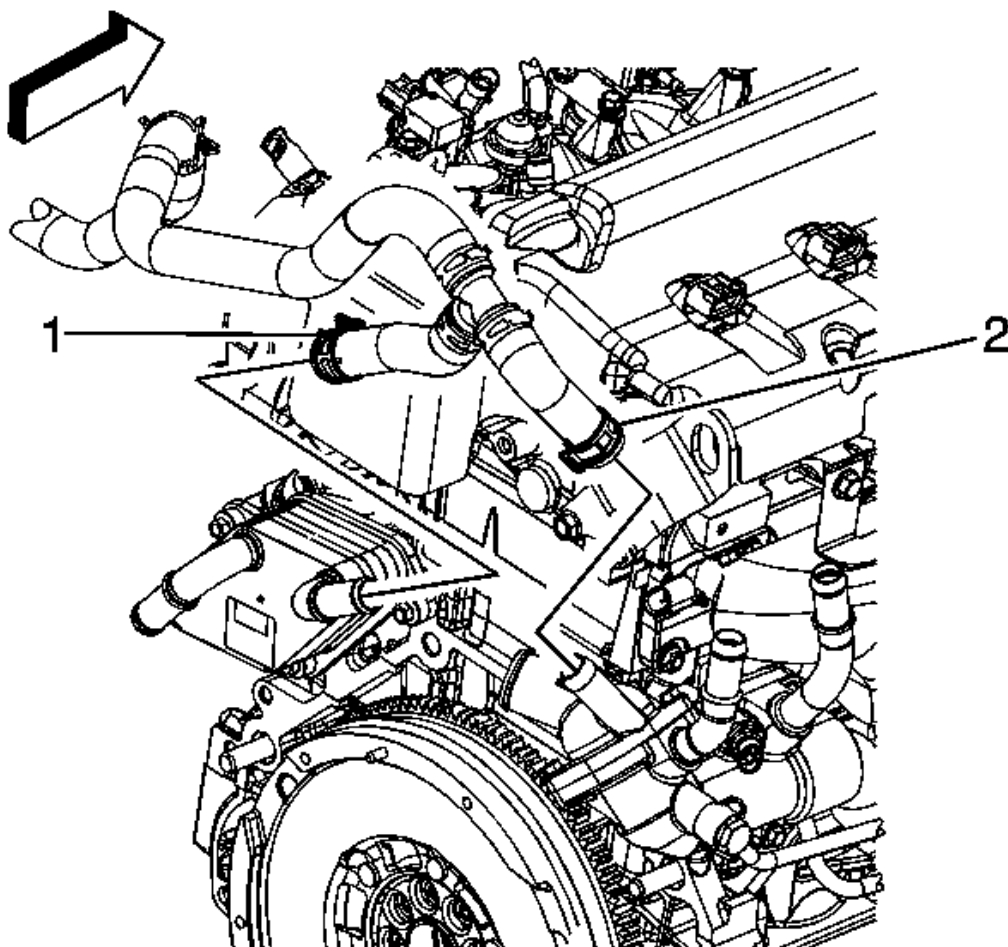


Fig. 377: Identifying Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

24. Reposition the surge tank outlet hose clamp (2) at the thermostat housing.
25. Reposition the surge tank outlet hose clamp (1) at the oil cooler.
26. Remove the surge tank outlet hose from the thermostat housing and oil cooler.

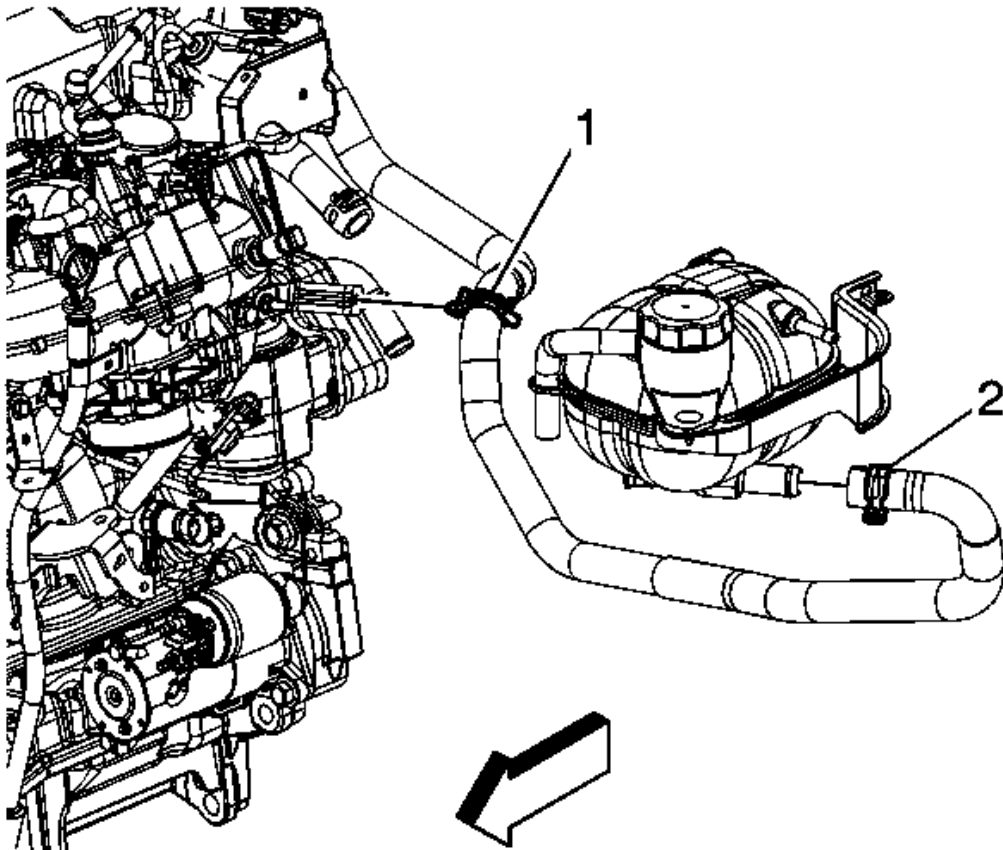


Fig. 378: Identifying Surge Tank Outlet Hose Clamp (At Surge Tank)
Courtesy of GENERAL MOTORS CORP.

27. Reposition the surge tank outlet hose clamp (2) at the surge tank.
28. Remove the surge tank outlet hose from the surge tank.
29. Remove the surge tank clip (1) from the oil level indicator tube bracket.
30. Remove the surge tank outlet hose from the vehicle.

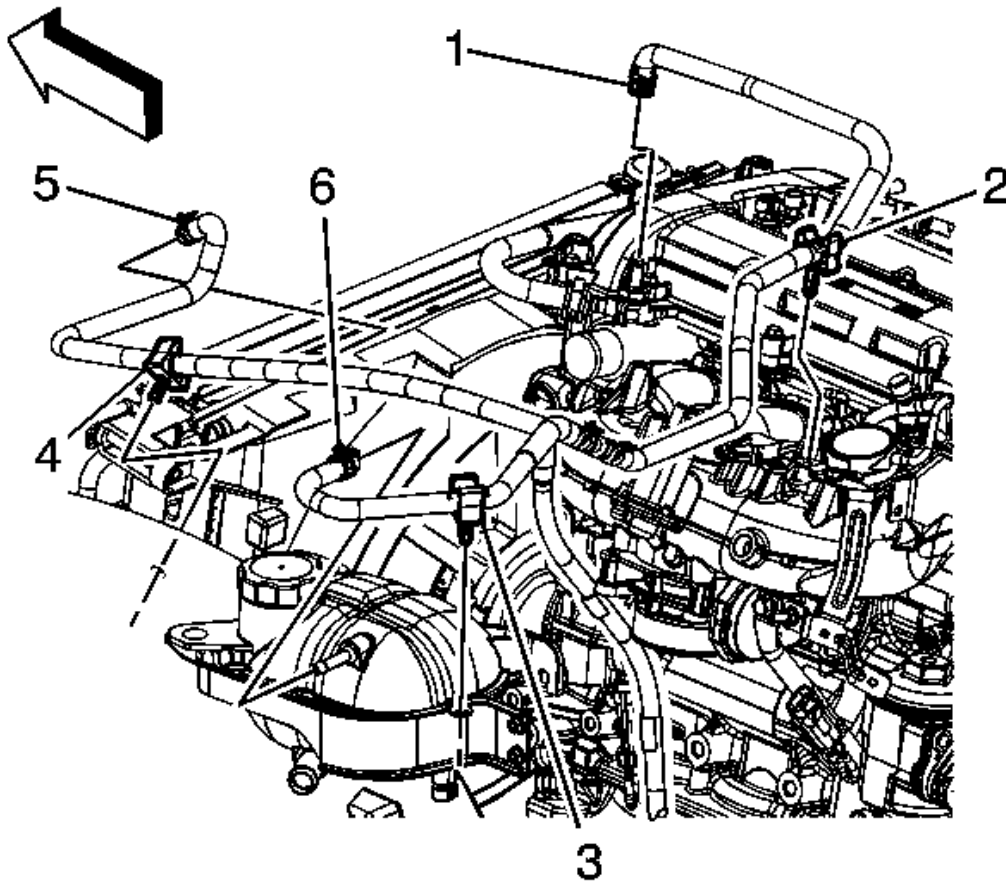


Fig. 379: Identifying Surge Tank Hose Components
Courtesy of GENERAL MOTORS CORP.

31. Reposition the surge tank air bleed hose clamp (1) at the engine.
32. Remove the surge tank air bleed hose clip (3) from the surge tank bracket.
33. Remove the surge tank air bleed hose from the engine.
34. Reposition the air bleed hose out of the way.

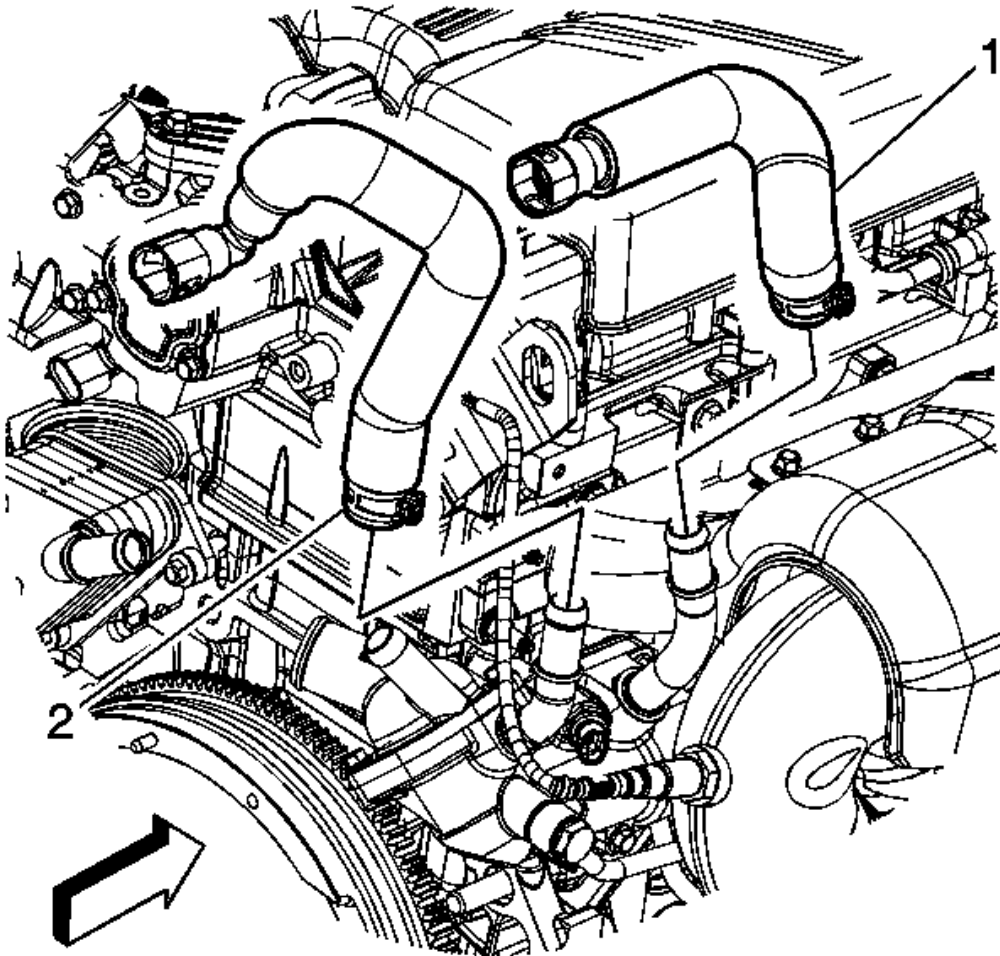


Fig. 380: Identifying Heater Inlet & Outlet Hoses & Clamps
Courtesy of GENERAL MOTORS CORP.

35. Reposition the heater inlet and outlet hose clamps at the thermostat housing.
36. Remove the heater inlet (1) and outlet (2) hoses from the thermostat housing.
37. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
38. Drain the engine oil.
39. Unbolt the catalytic converter from the exhaust pipe.

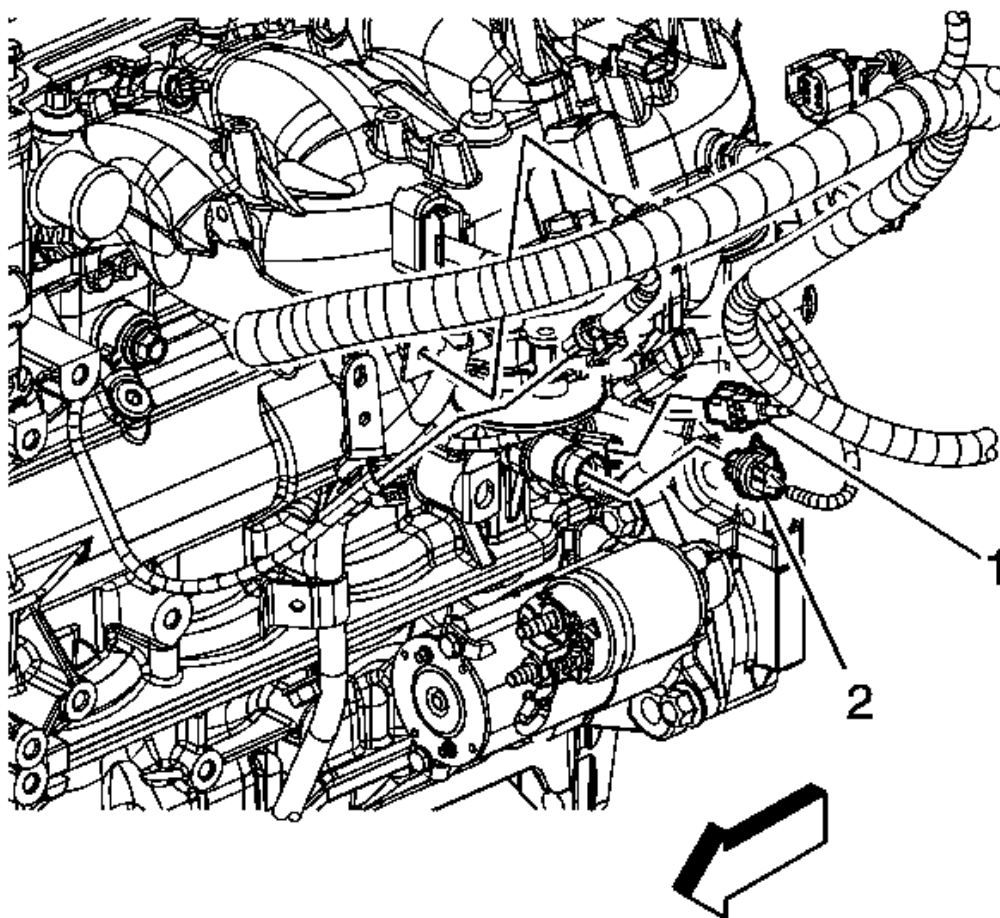


Fig. 381: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

40. Disconnect the engine wiring harness electrical connector (1) from the crankshaft position (CKP) sensor.
41. Disconnect the engine wiring harness electrical connector (2) from the oil pressure sensor.

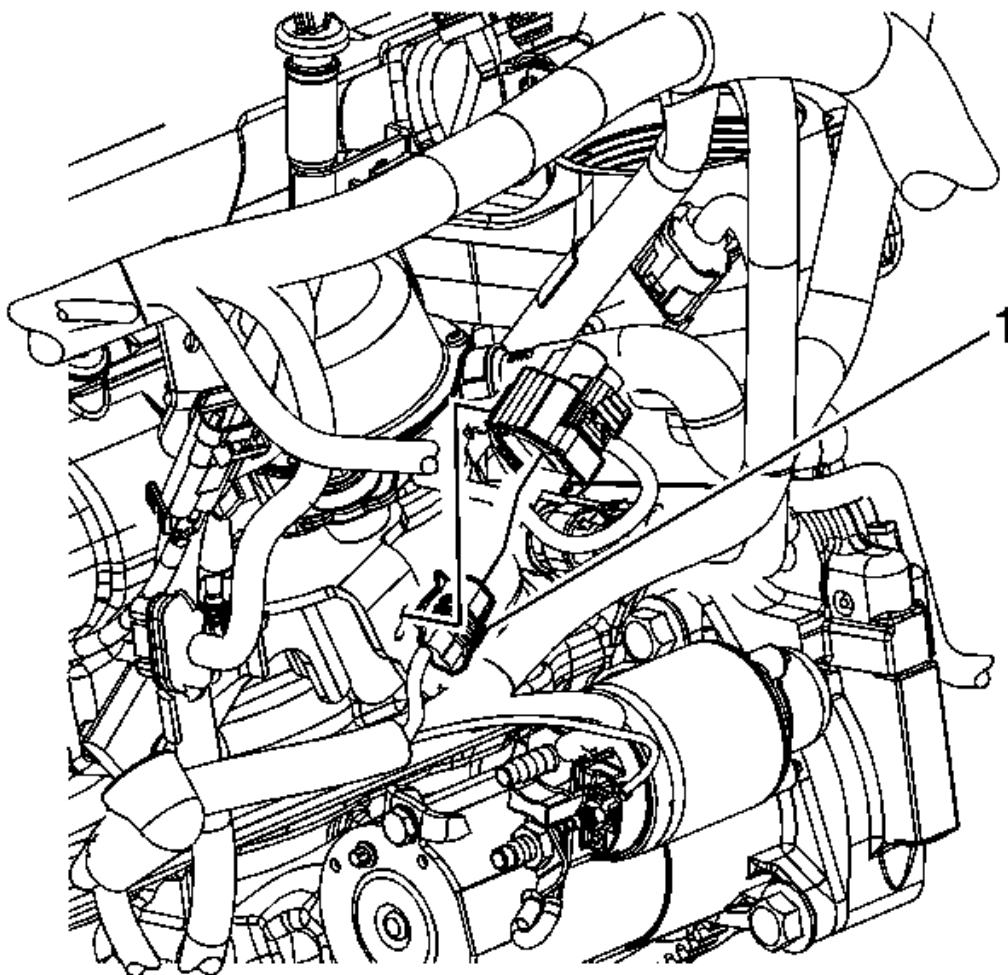


Fig. 382: Identifying Brake Booster Auxiliary Pump Connector
Courtesy of GENERAL MOTORS CORP.

42. Disconnect the engine wiring harness electrical connector (1) from the brake booster vacuum pump.
43. Lower the vehicle.

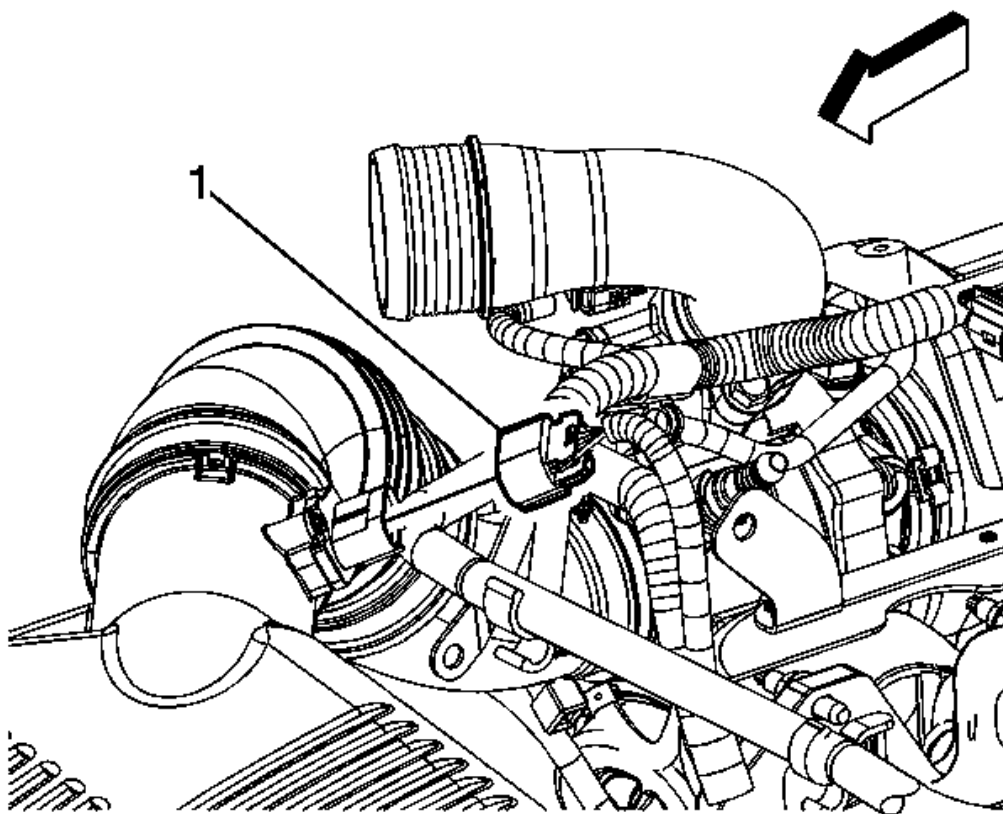


Fig. 383: Identifying MAF Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

44. Disconnect the engine wiring harness electrical connector (1) from the mass air flow (MAF) sensor.

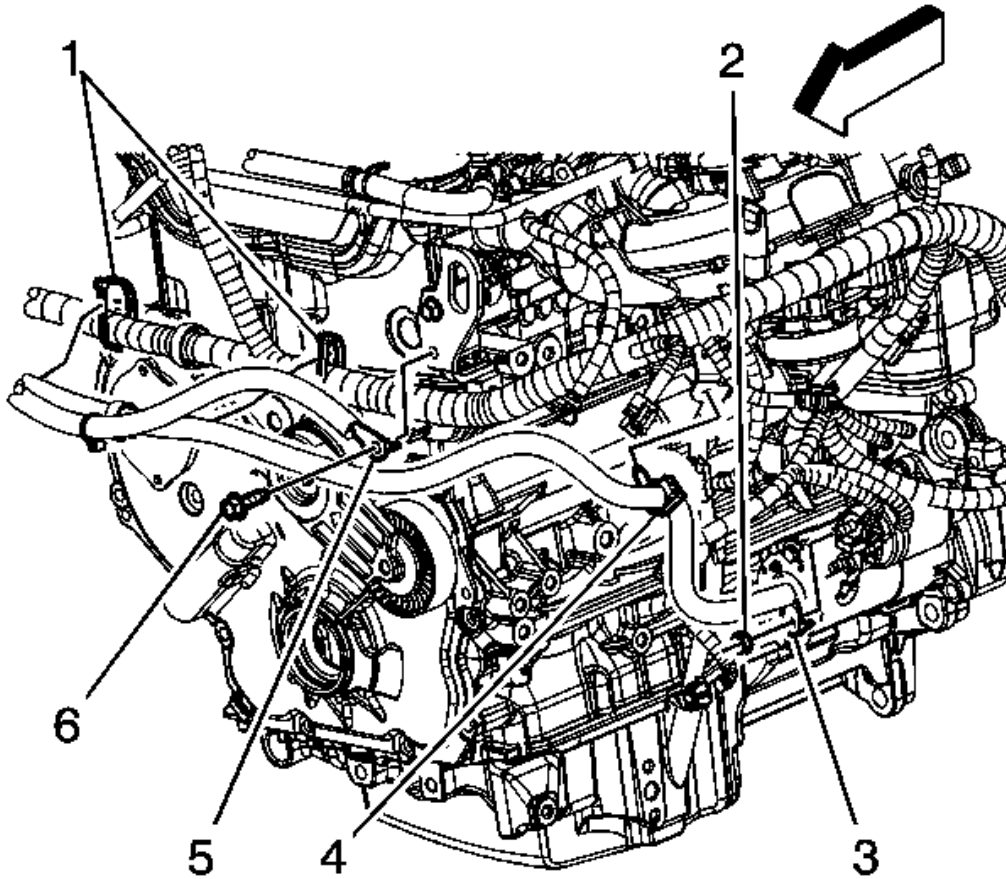


Fig. 384: Identifying Negative Battery Cables & Cable Components
Courtesy of GENERAL MOTORS CORP.

45. Cut the engine harness tie straps (1).
46. Remove the negative battery cable ground bolt (6) from the front engine lift bracket.
47. Remove the negative battery cable ground terminal (5) from the engine lift bracket.
48. Reposition the negative/positive battery cable out of the way.

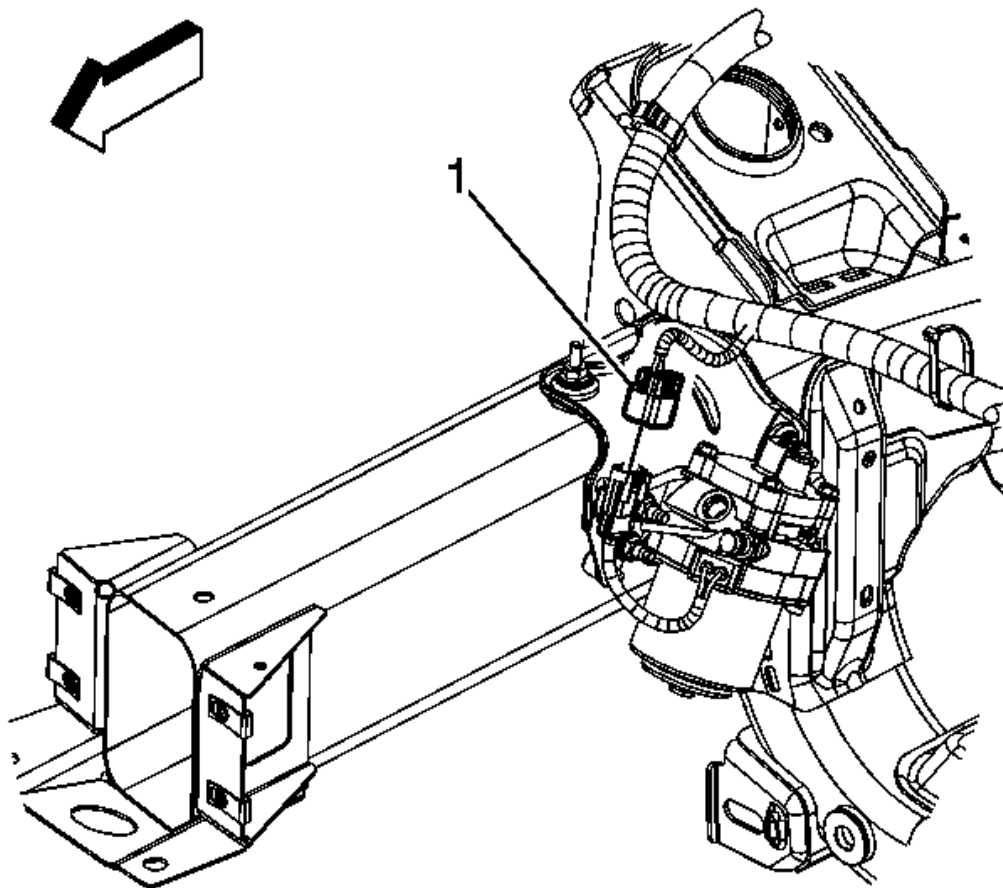


Fig. 385: Locating Transmission Oil Cooler Pump Electrical Connector
Courtesy of GENERAL MOTORS CORP.

49. Disconnect the engine wiring harness electrical connector (1) from the transmission oil cooler pump.

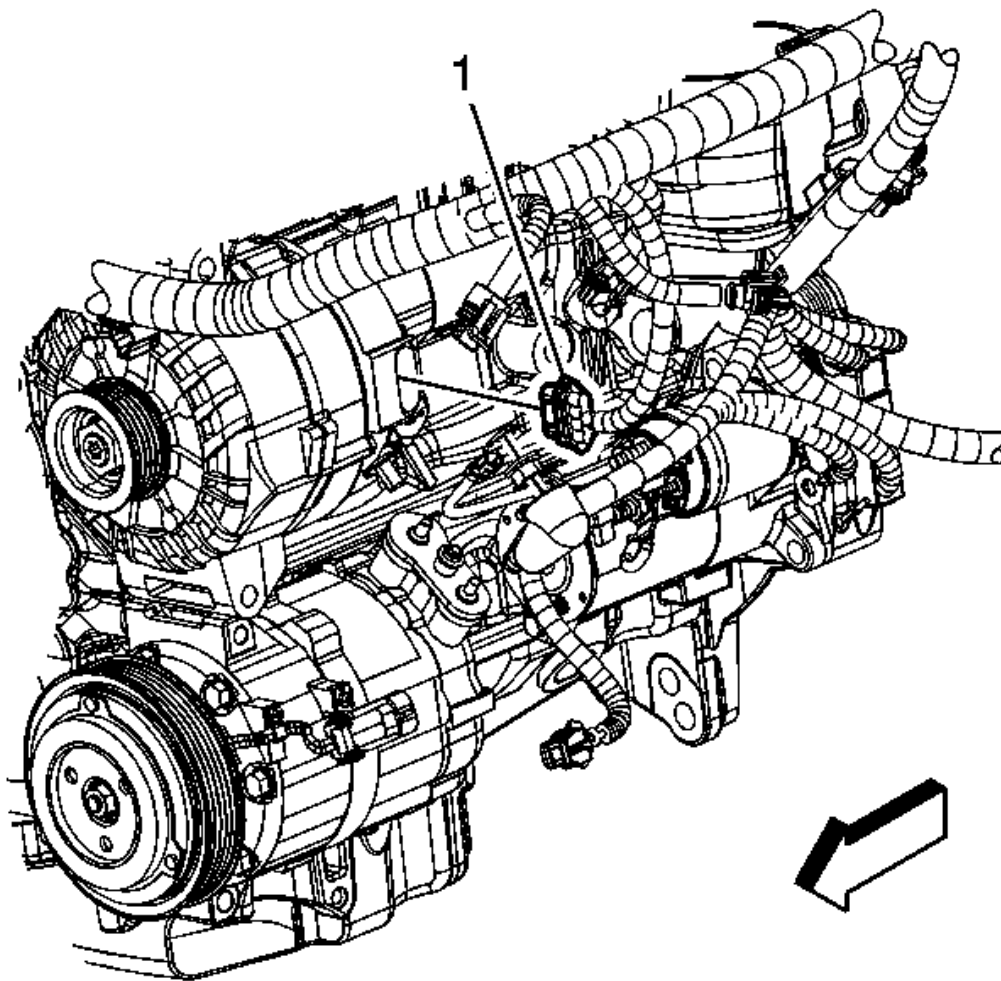


Fig. 386: Identifying Generator Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

50. Disconnect the engine wiring harness electrical connector (1) from the generator.

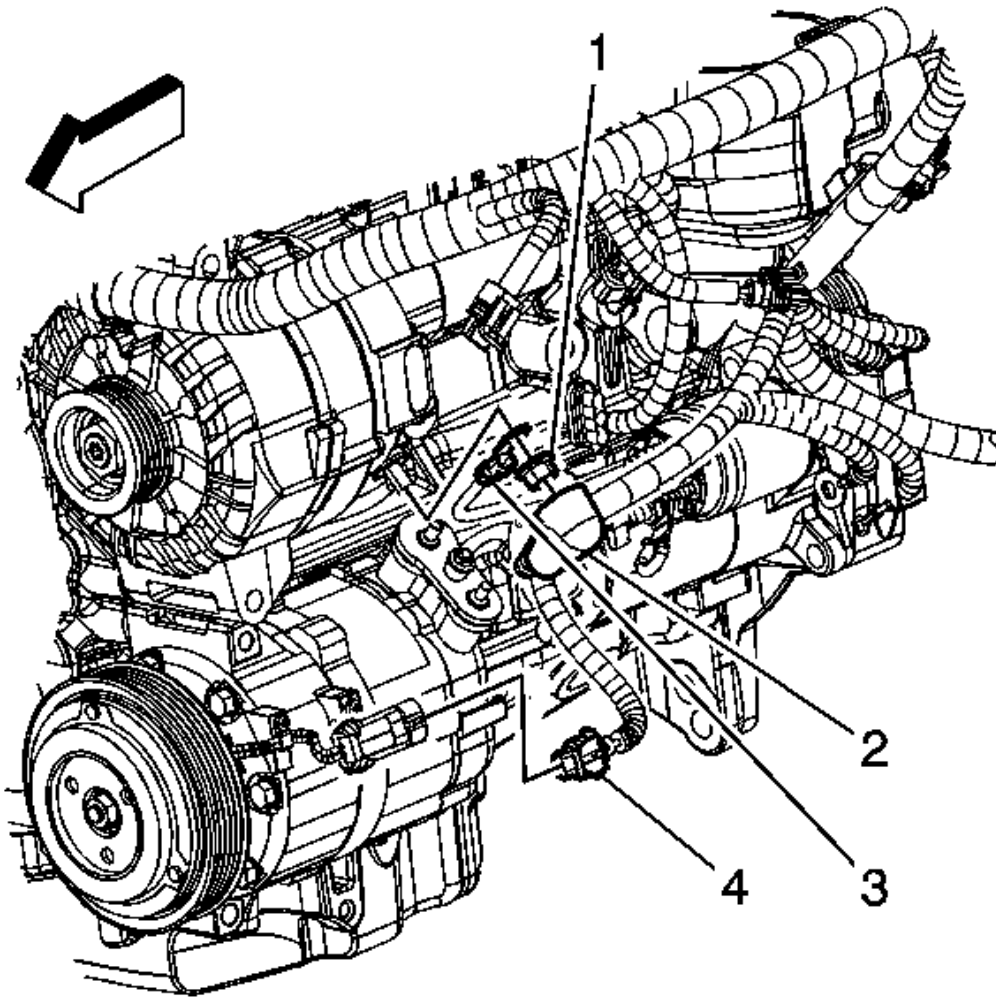


Fig. 387: Identifying Generator
Courtesy of GENERAL MOTORS CORP.

51. Reposition the positive battery cable terminal boot (2).
52. Remove the generator terminal nut (1).
53. Remove the positive battery cable terminal (3) from the generator.
54. Disconnect the engine wiring harness electrical connector (4) from the A/C compressor.

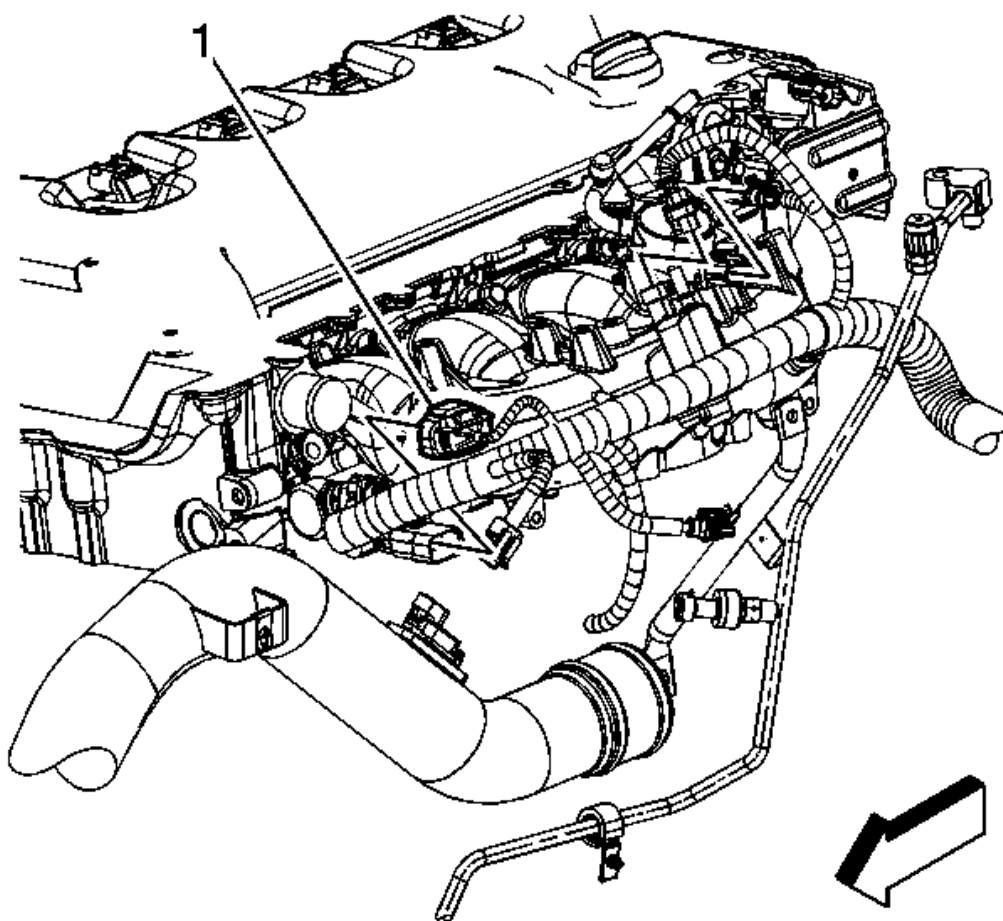


Fig. 388: View Of Engine Wiring Harness Connector & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

55. Disconnect the engine wiring harness electrical connector (1) from the fuel injector jumper electrical connector.

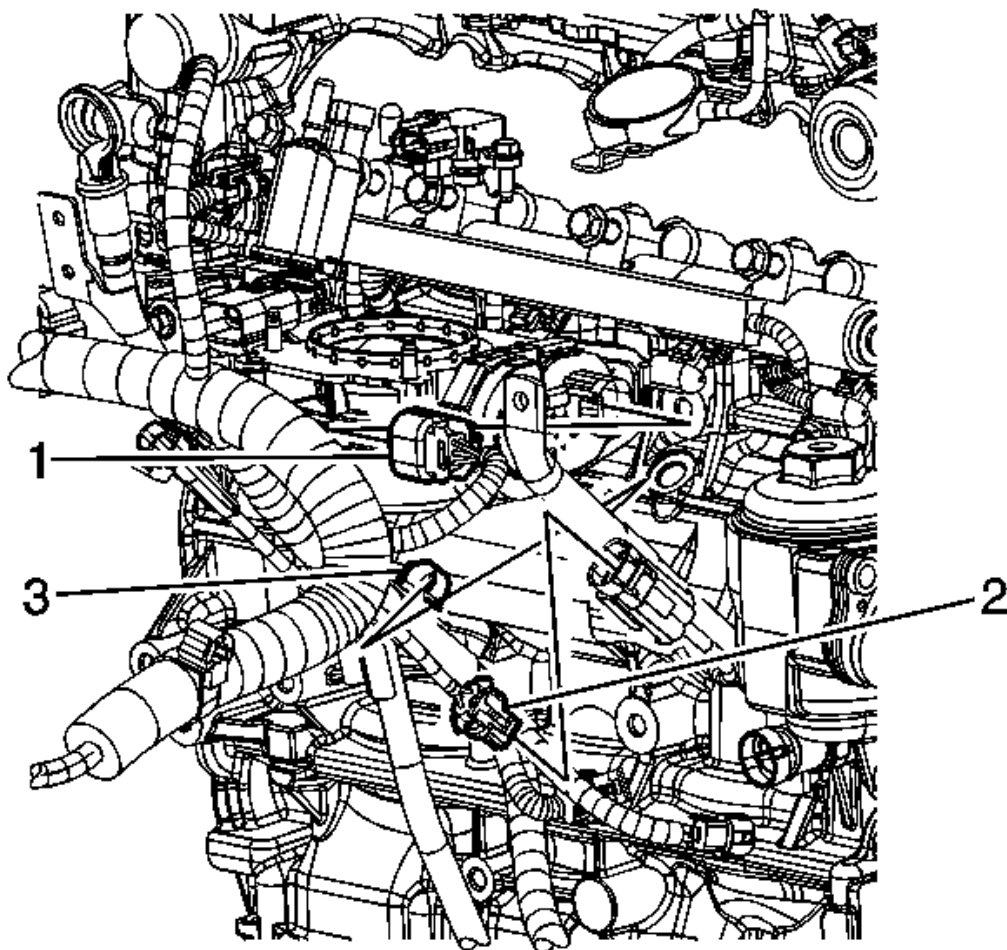


Fig. 389: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

56. Disconnect the engine wiring harness electrical connector (2) from the knock sensor.

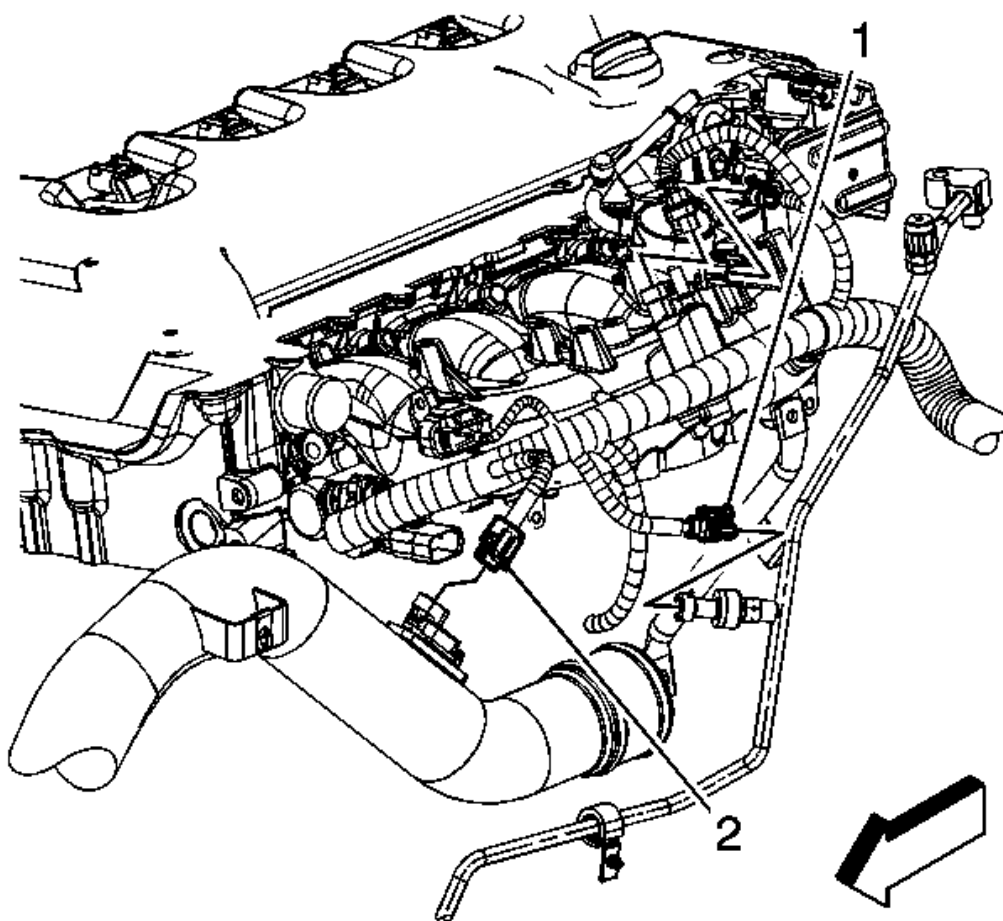


Fig. 390: View Of Intake Air Pressure & Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

57. Disconnect the engine wiring harness electrical connector (1) from the A/C refrigerant pressure sensor.

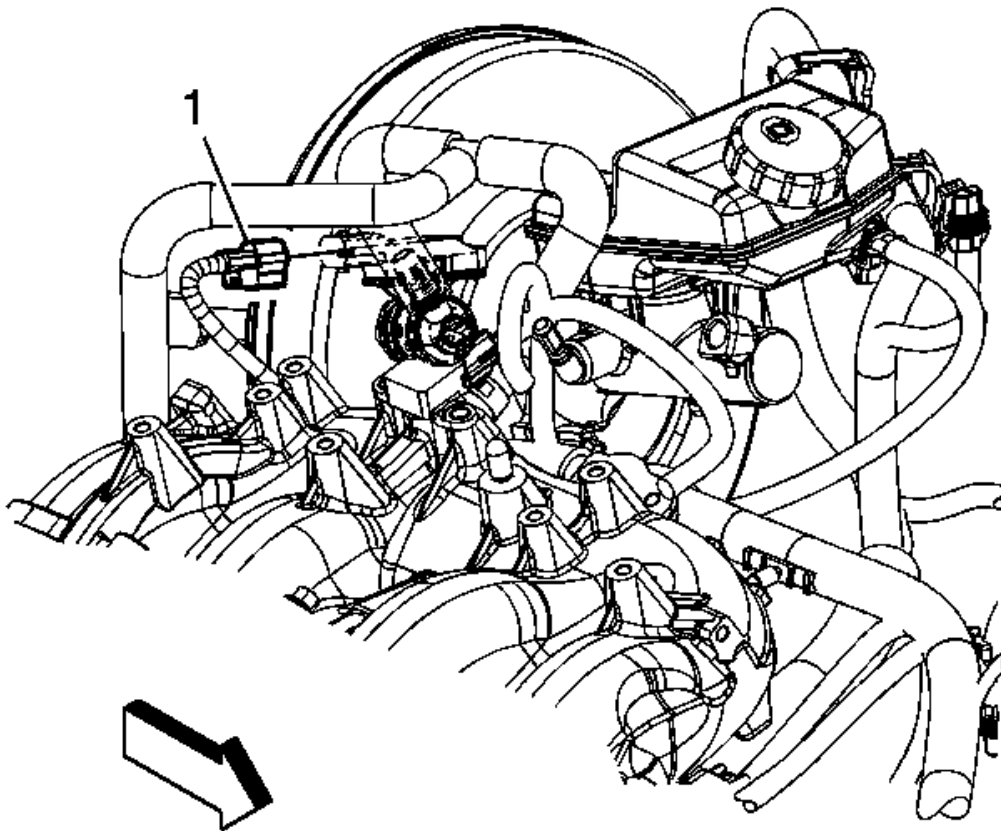


Fig. 391: Identifying Brake Booster Vacuum Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

58. Disconnect the engine wiring harness electrical connector (1) from the brake booster vacuum sensor.

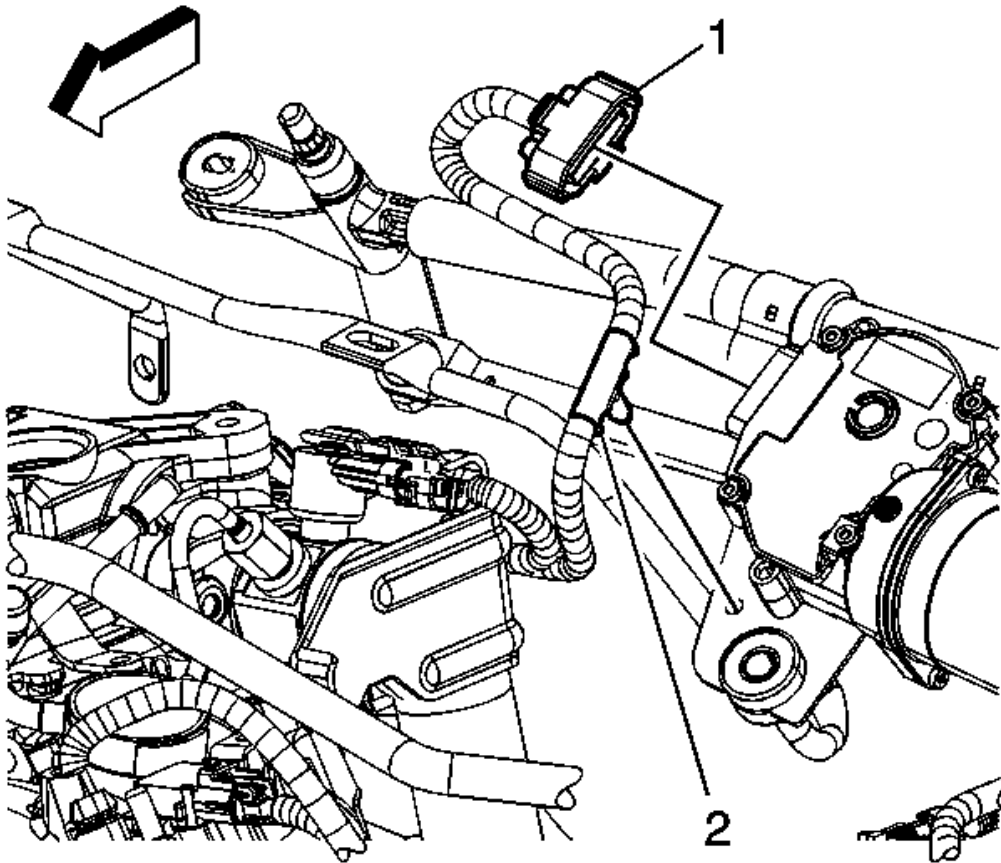


Fig. 392: Locating Windshield Wiper Motor Electrical Connector & Harness Clip
Courtesy of GENERAL MOTORS CORP.

59. Disconnect the engine wiring harness electrical connector (1) from the windshield wiper motor.
60. Remove the engine harness clip (2) from the wiper motor hole.

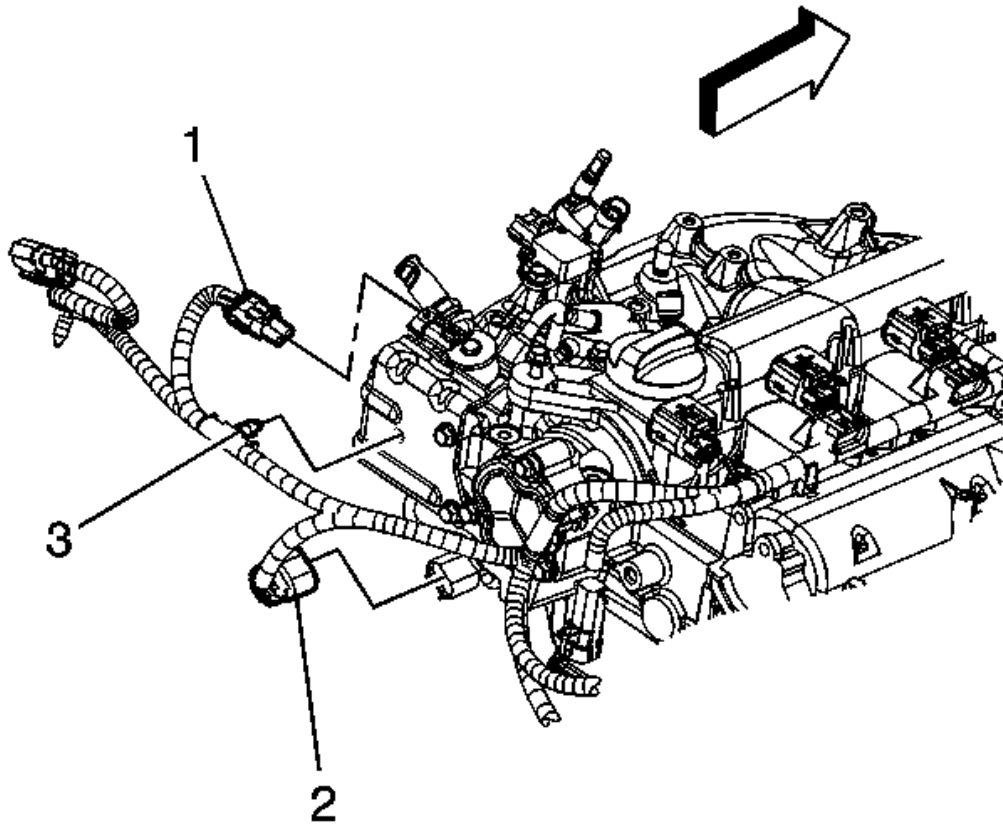


Fig. 393: Identifying High Pressure Fuel Pump Connector & Clip
 Courtesy of GENERAL MOTORS CORP.

61. Disconnect the engine wiring harness electrical connector (2) from the intake camshaft position (CMP) sensor.
62. Disconnect the engine wiring harness electrical connector (1) from the high pressure fuel pump.
63. Remove the engine wiring harness clip (3) from the high pressure fuel pump bracket.

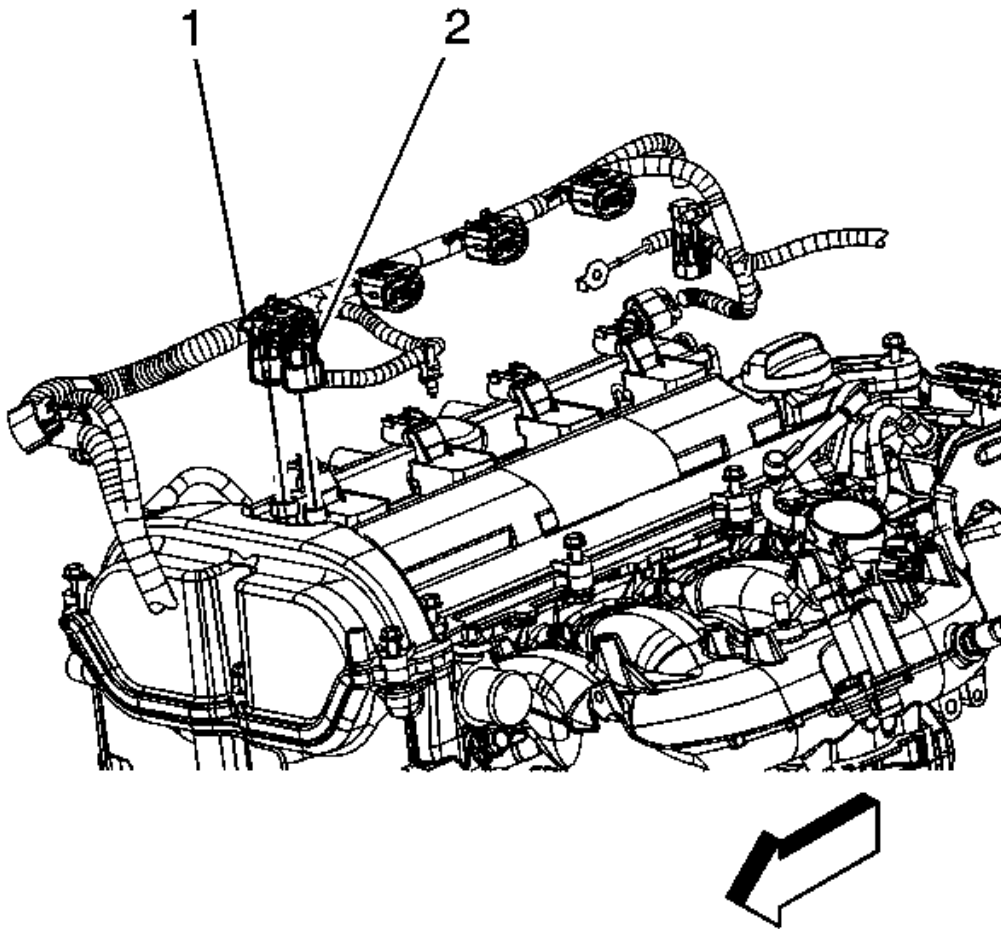


Fig. 394: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

64. Disconnect the engine wiring harness electrical connector (2) from the intake CMP actuator.
65. Disconnect the engine wiring harness electrical connector (1) from the exhaust CMP actuator.

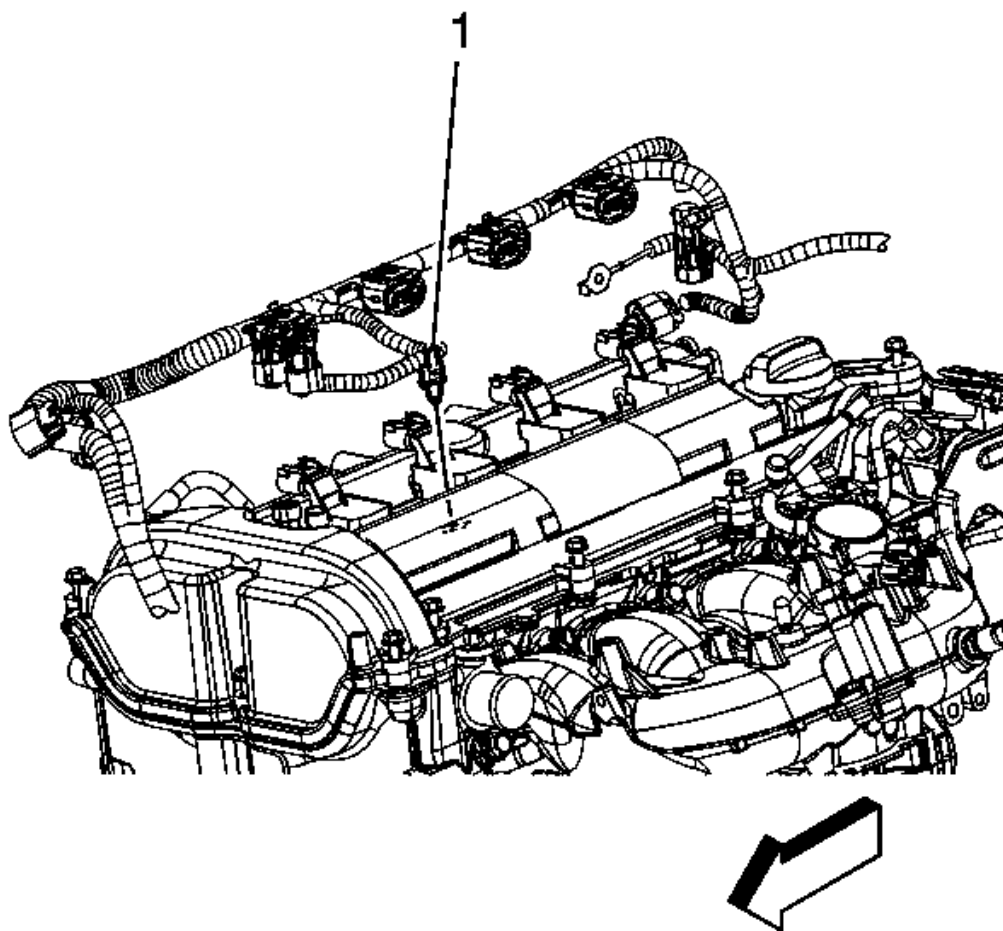


Fig. 395: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

66. Remove the engine harness clip (1) from the camshaft cover.

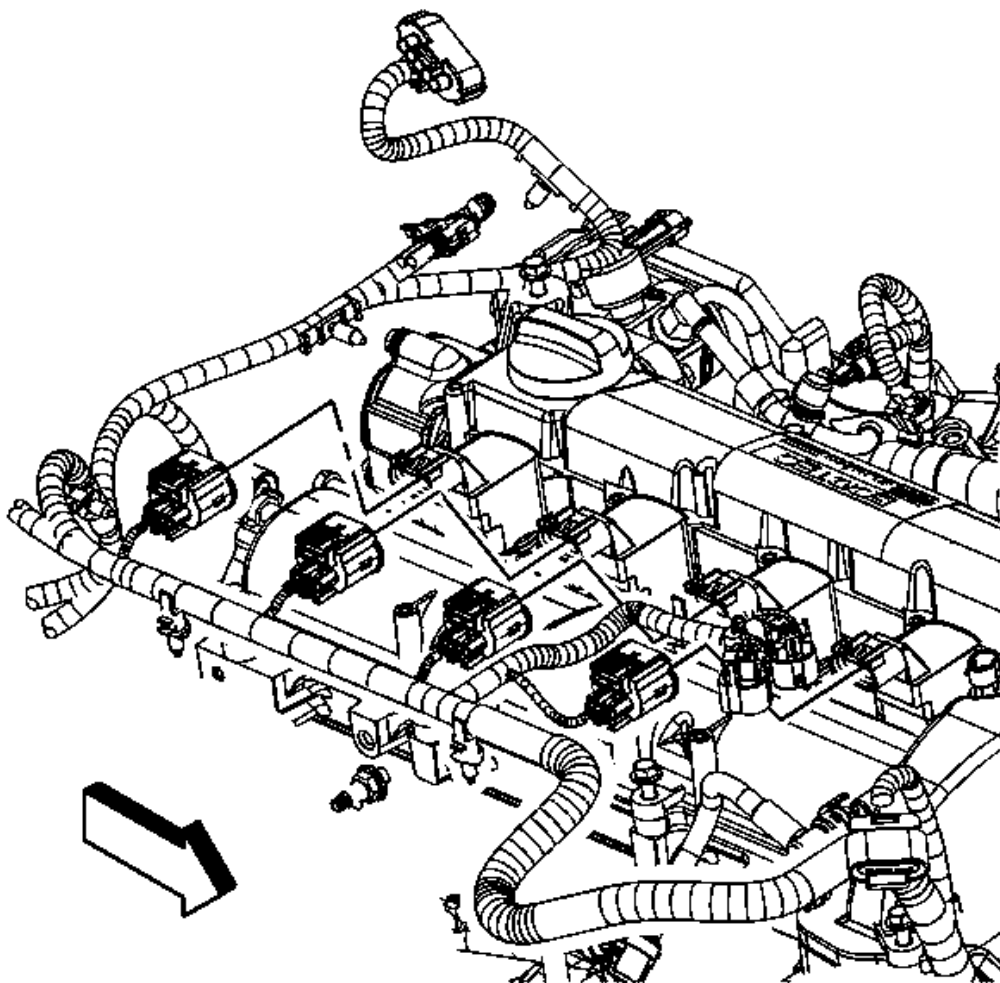


Fig. 396: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

67. Disconnect the engine wiring harness electrical connectors from the ignition coils.

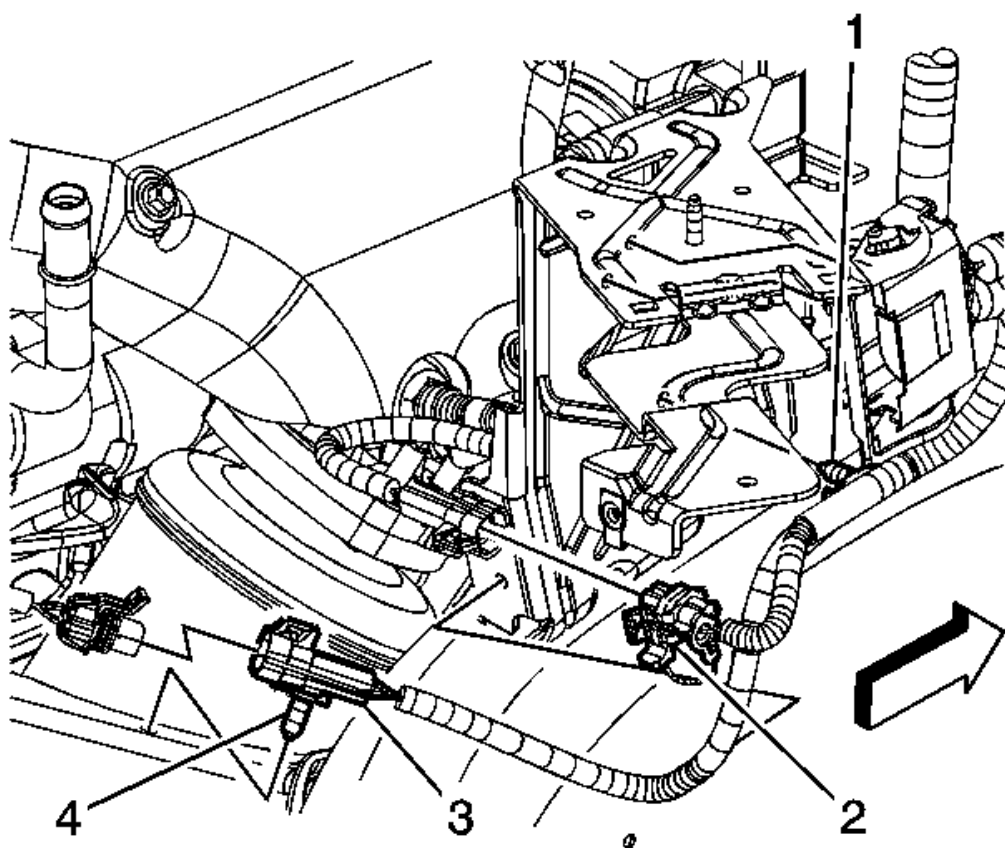


Fig. 397: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

68. Disconnect the engine wiring harness electrical connector (1) from the heated oxygen sensor (HO2S) (3).

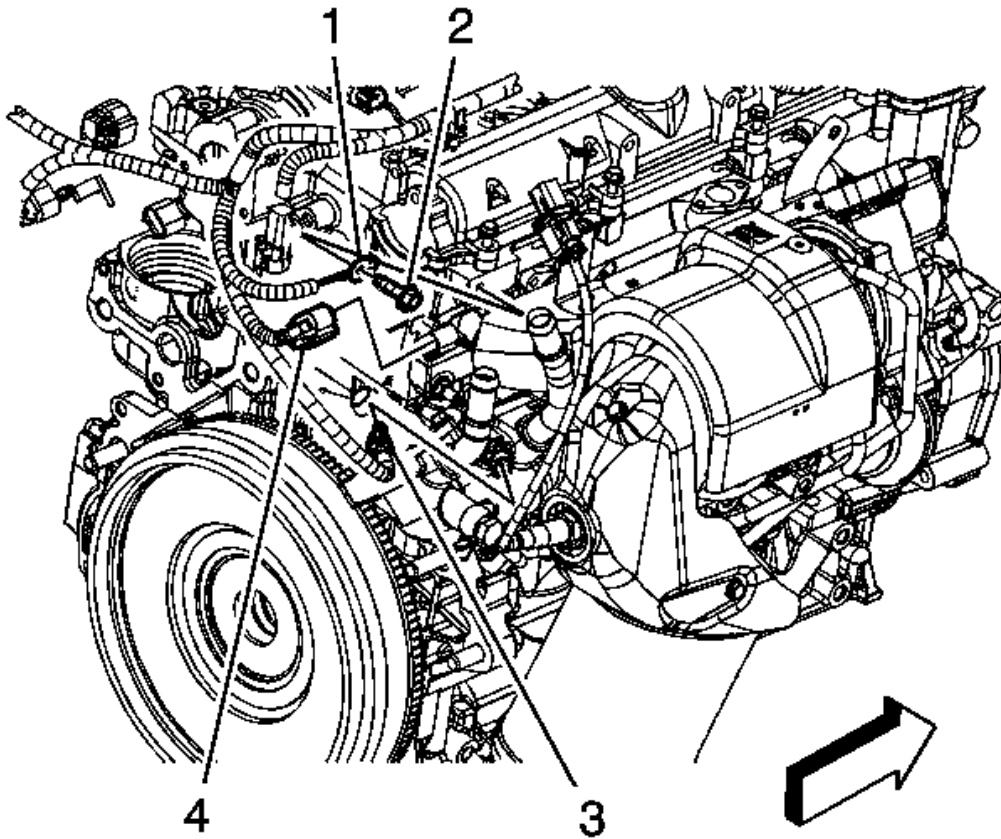


Fig. 398: Identifying ECT Sensor Engine Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

69. Disconnect the engine wiring harness electrical connector (4) from the exhaust CMP sensor.
70. Remove the engine harness ground terminal bolt (2) and reposition the engine harness ground terminal (1).
71. Disconnect the engine wiring harness electrical connector (3) from the engine coolant temperature (ECT) sensor.

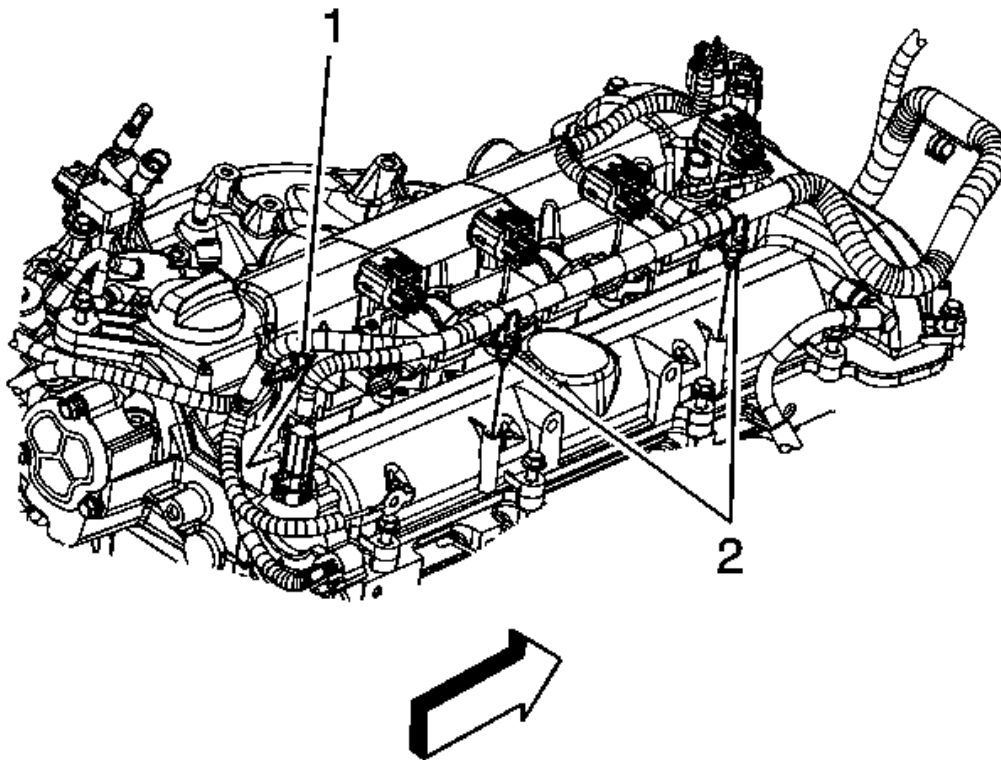


Fig. 399: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

- 72. Disconnect the engine harness clips (2) from the camshaft cover.
- 73. Disconnect the engine harness clip (1) from the camshaft cover.

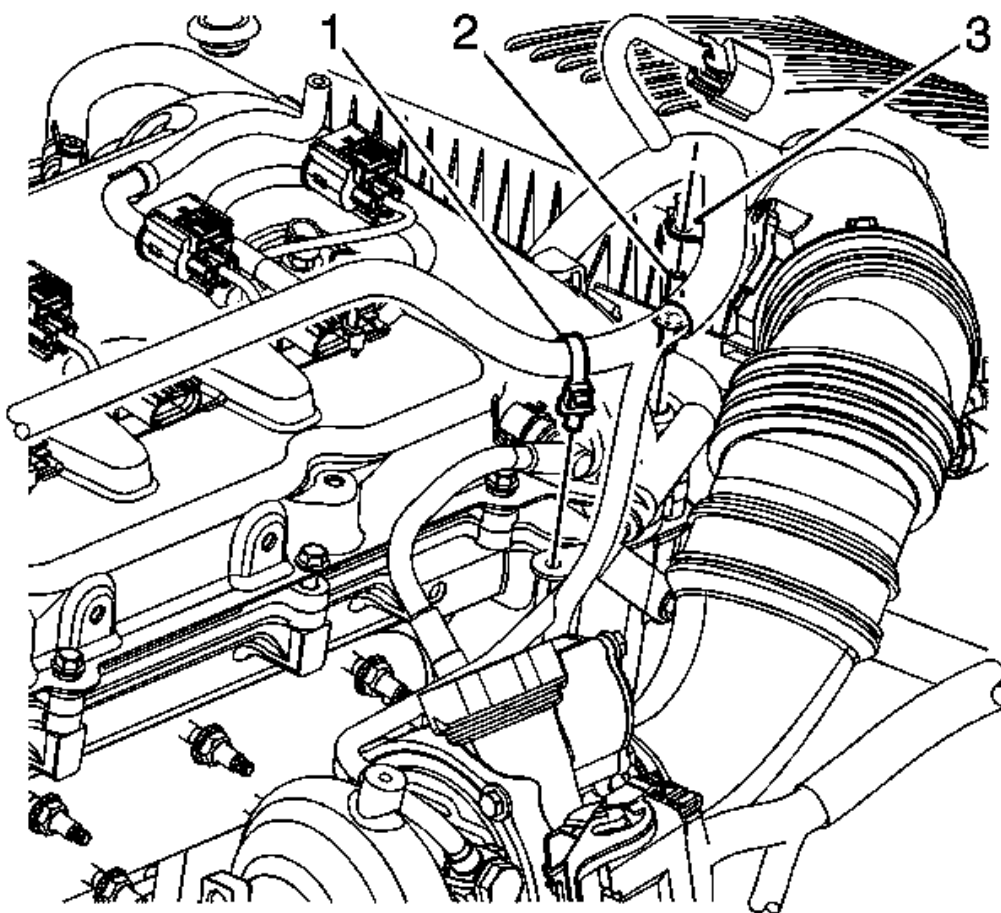


Fig. 400: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

74. Remove the engine wiring harness clip (3) from the turbocharger coolant feed pipe stud (2).
75. Remove the engine wiring harness clip (1) from the turbocharger coolant feed pipe tab.

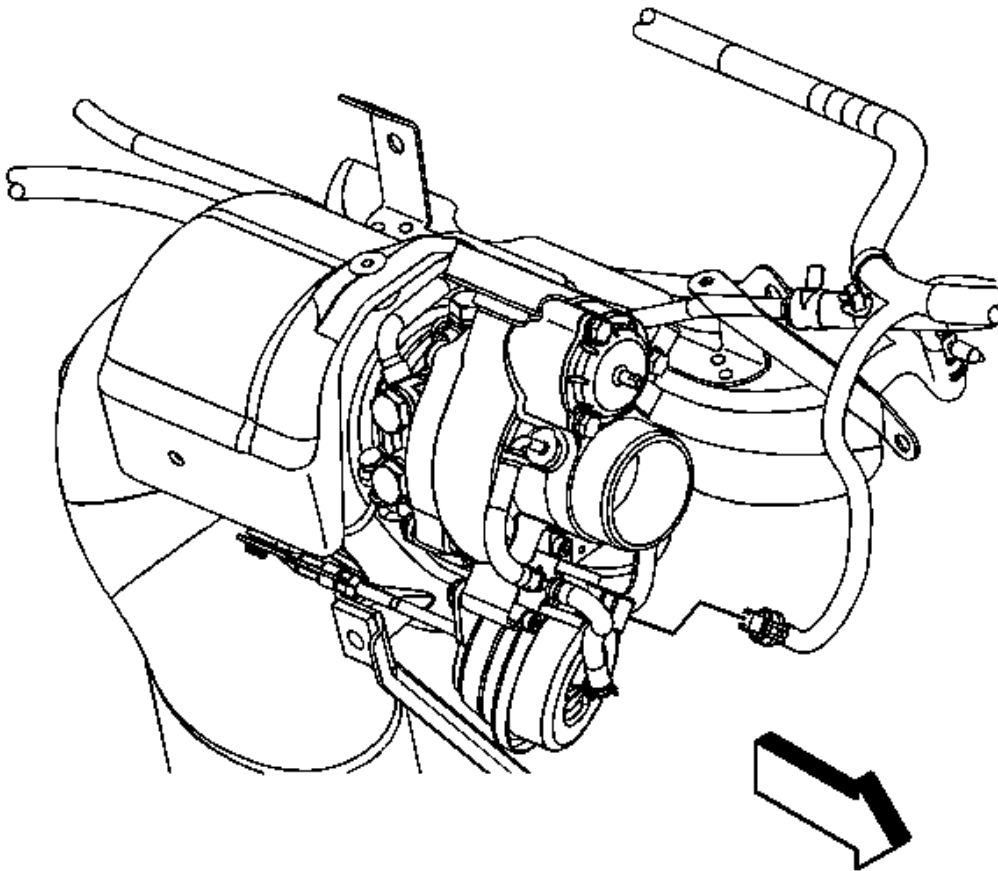


Fig. 401: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

76. Disconnect the engine wiring harness electrical connector from the boost sensor.

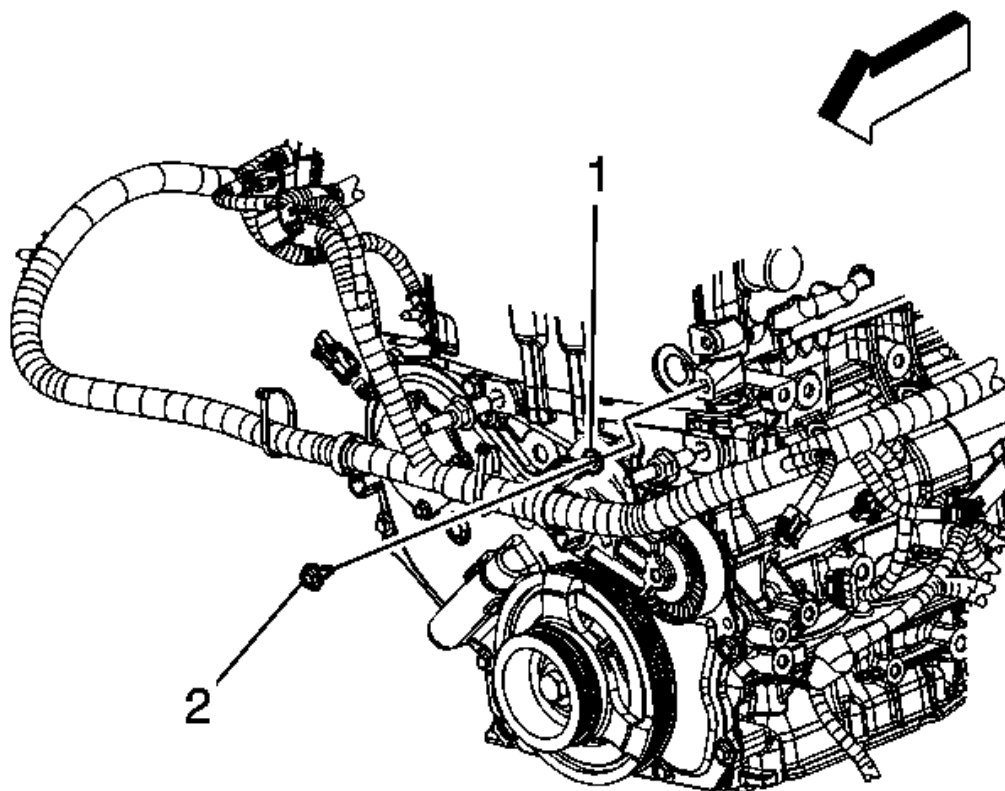


Fig. 402: Identifying Engine Wiring Harness Ground Terminal
Courtesy of GENERAL MOTORS CORP.

- 77. Remove the engine wiring harness ground bolt (2) from the cylinder head.
- 78. Remove the engine wiring harness ground terminal (1) from the cylinder head.

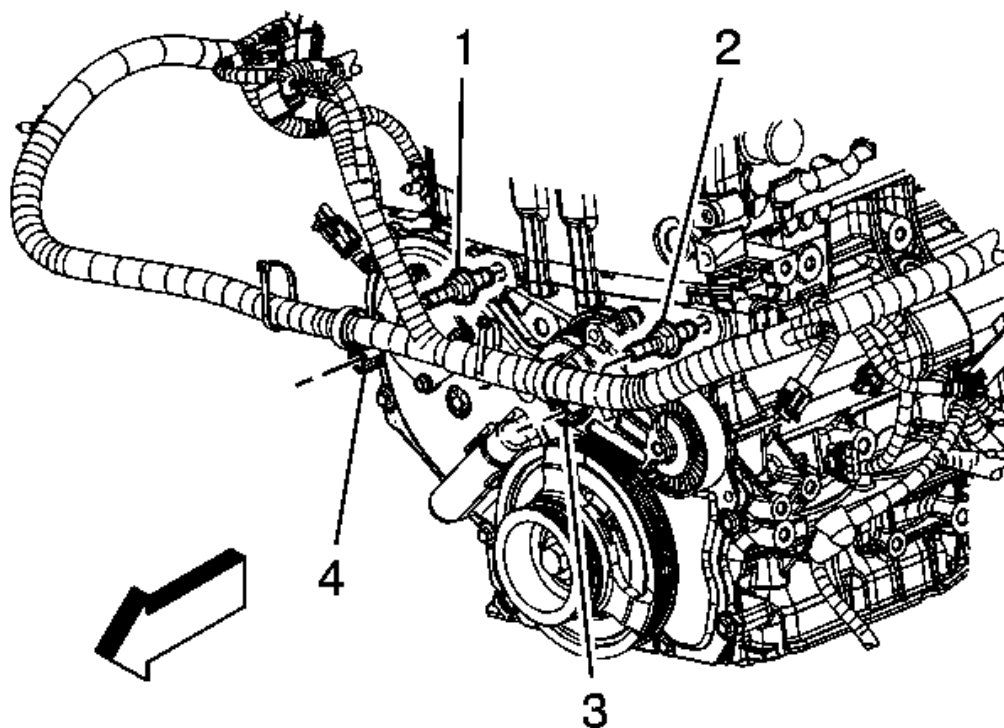


Fig. 403: Identifying Engine Harness Clips
Courtesy of GENERAL MOTORS CORP.

79. Remove the engine harness clips (3, 4) from the front studs.
80. Gather all branches of the engine harness and lay off to the side.

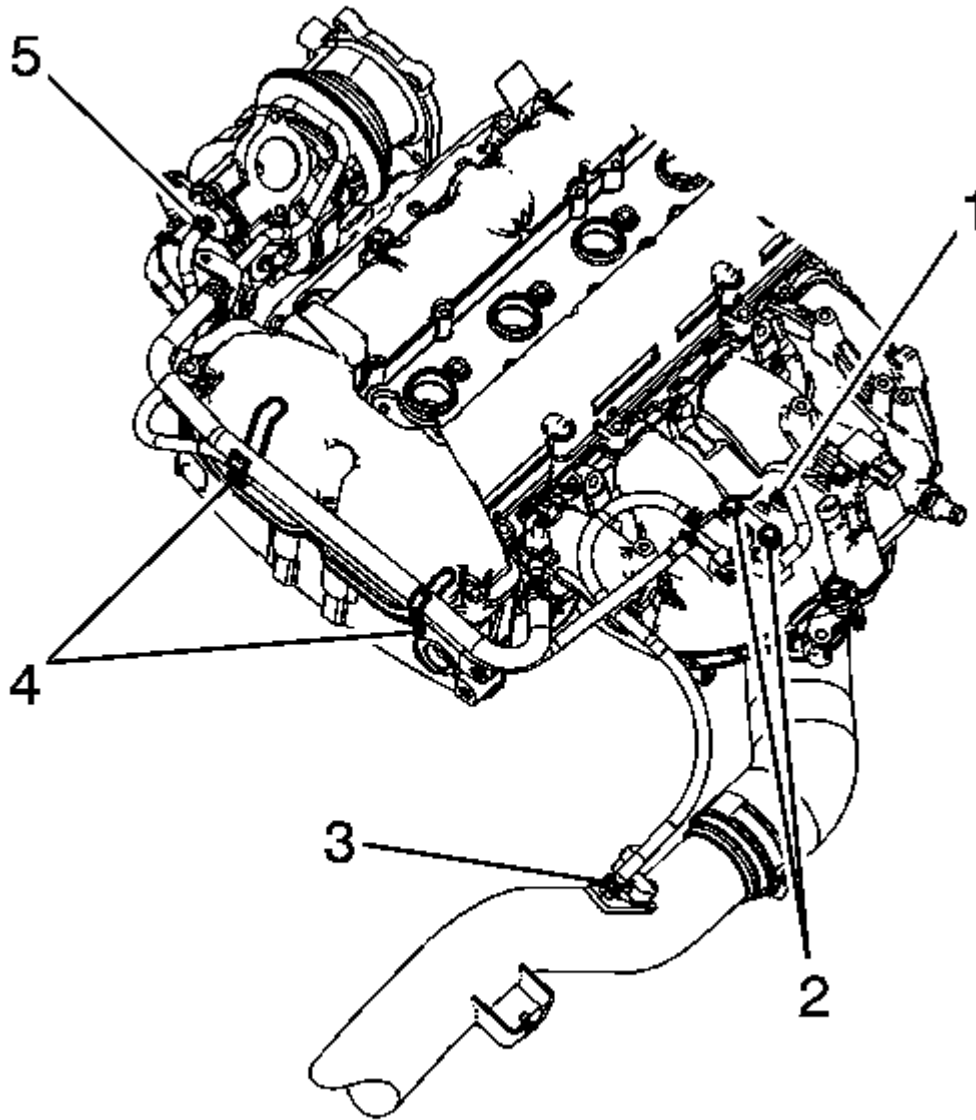


Fig. 404: Identifying Charge Air Bypass Solenoid Components
Courtesy of GENERAL MOTORS CORP.

81. Reposition the charge air bypass valve vacuum hose clamp (5) at the turbocharger.
82. Remove the vacuum hose from the turbocharger coolant feed pipe clips (4).
83. Remove the charge air bypass valve solenoid.

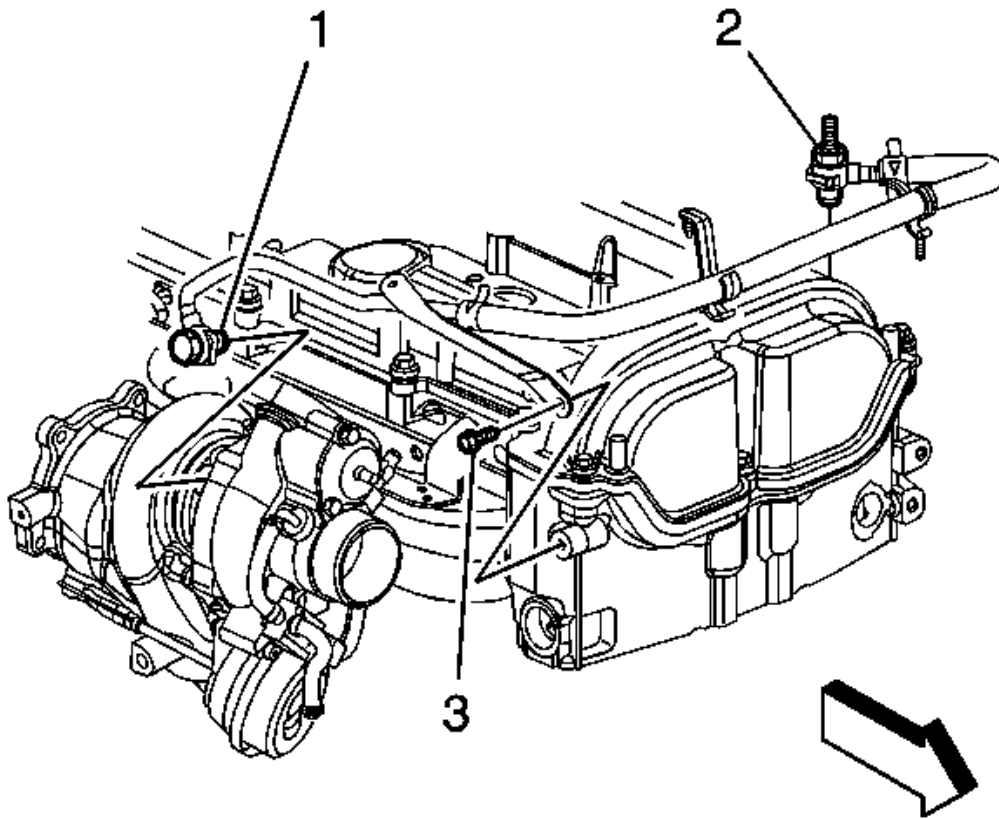


Fig. 405: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

84. Remove the turbocharger coolant feed pipe bolt (1) at the turbocharger.
85. Remove the turbocharger coolant feed pipe fitting (2) from the cylinder head.
86. Remove the turbocharger coolant feed pipe bracket bolt from the cylinder head.
87. Remove the turbocharger coolant feed pipe bracket from the vehicle.

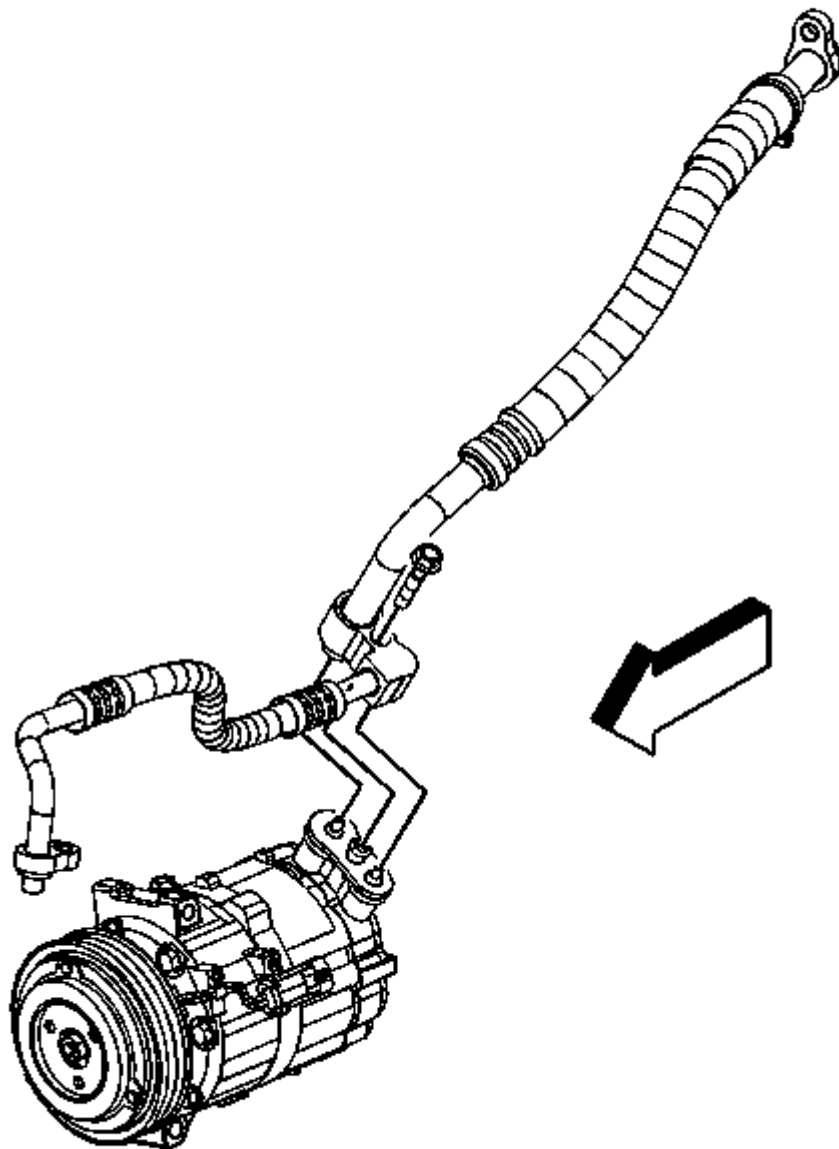


Fig. 406: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

88. Remove the A/C compressor line bolt and reposition the line off to the side.
89. Raise and support the vehicle.

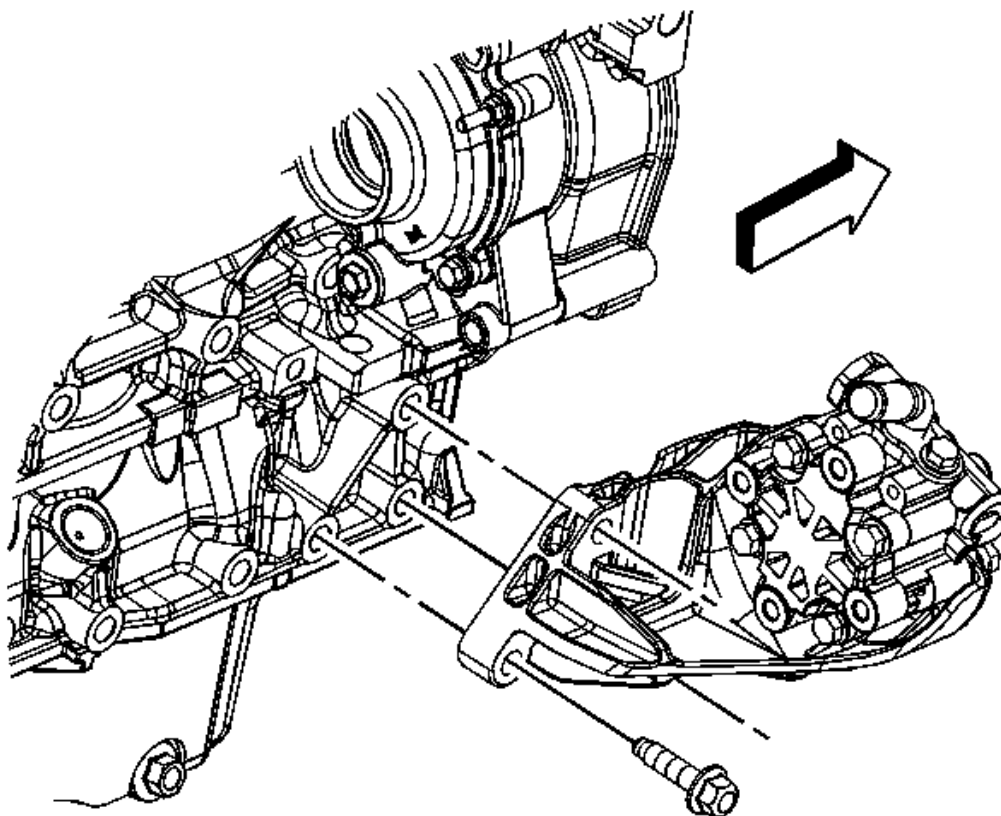


Fig. 407: View Of Power Steering Pump & Bracket
Courtesy of GENERAL MOTORS CORP.

90. Remove the power steering pump bracket bolts and reposition the pump and bracket off to the side.

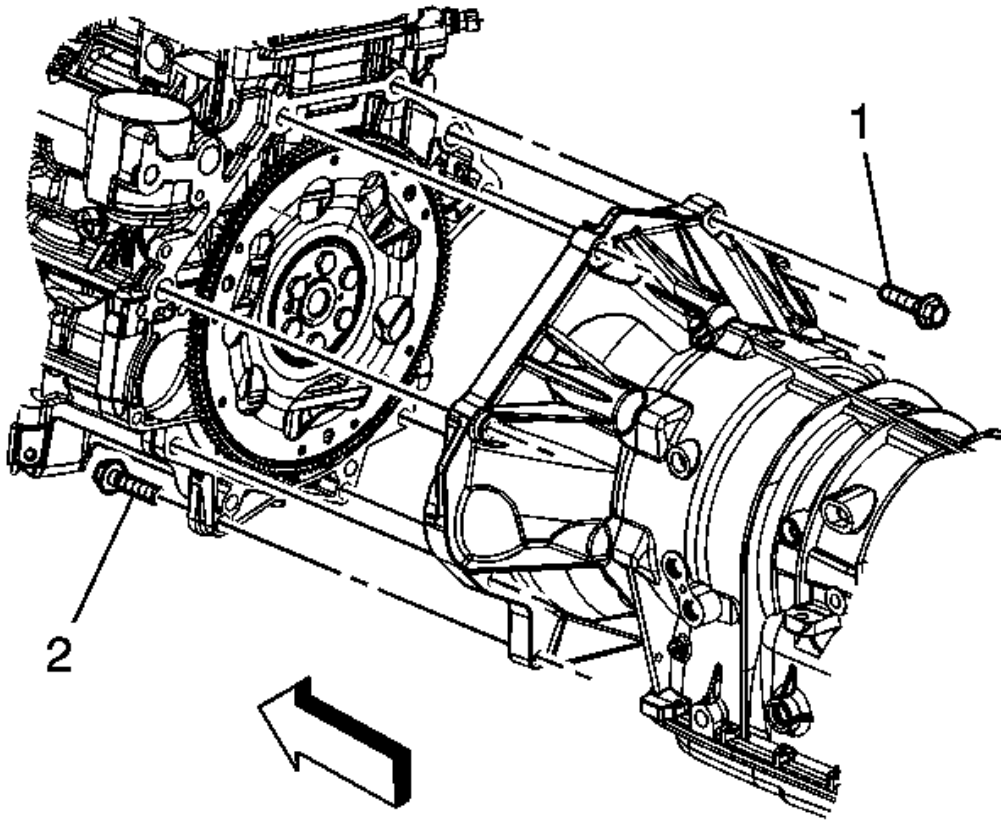


Fig. 408: Locating Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

91. Remove the torque converter to flywheel bolts.

NOTE: The top 2 bellhousing bolts install through the bellhousing into the engine block. The remaining 7 bolts install through the engine block into the bellhousing.

92. Remove the 4 lower bellhousing bolts (2).
93. Lower the vehicle.
94. Remove the remaining upper 5 bellhousing bolts (1).

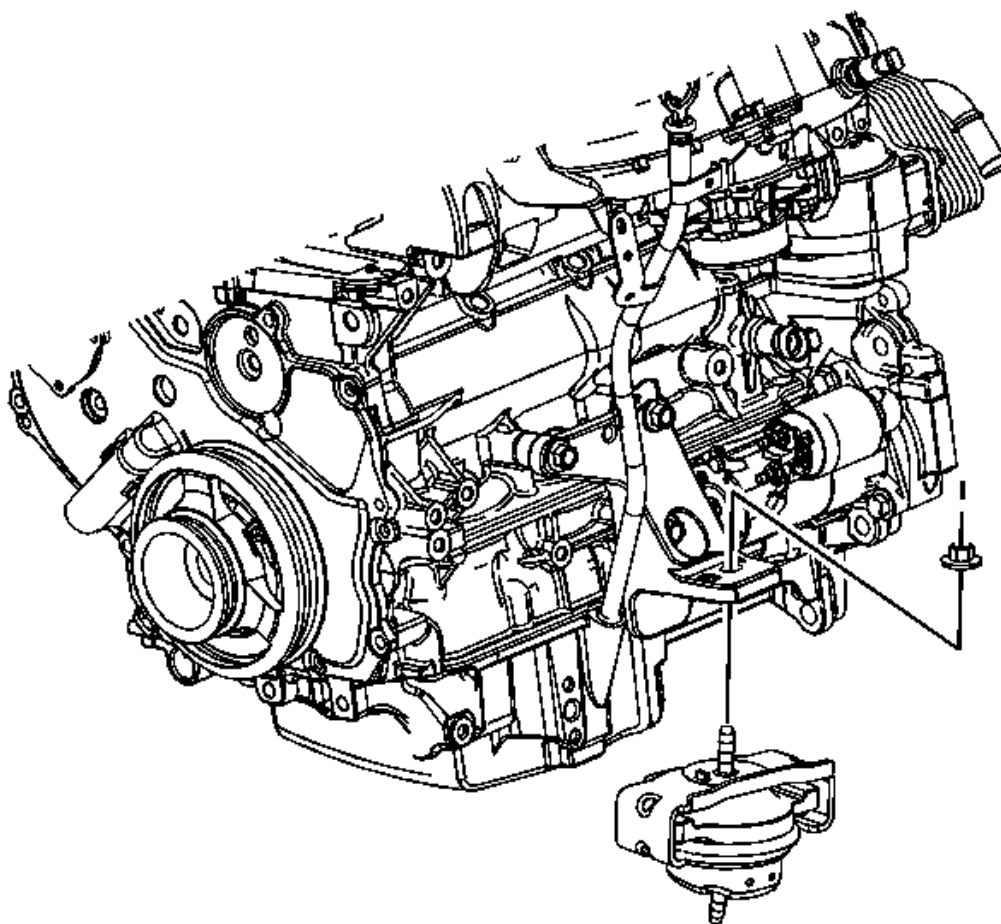


Fig. 409: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

95. Remove the left engine mount upper nut.

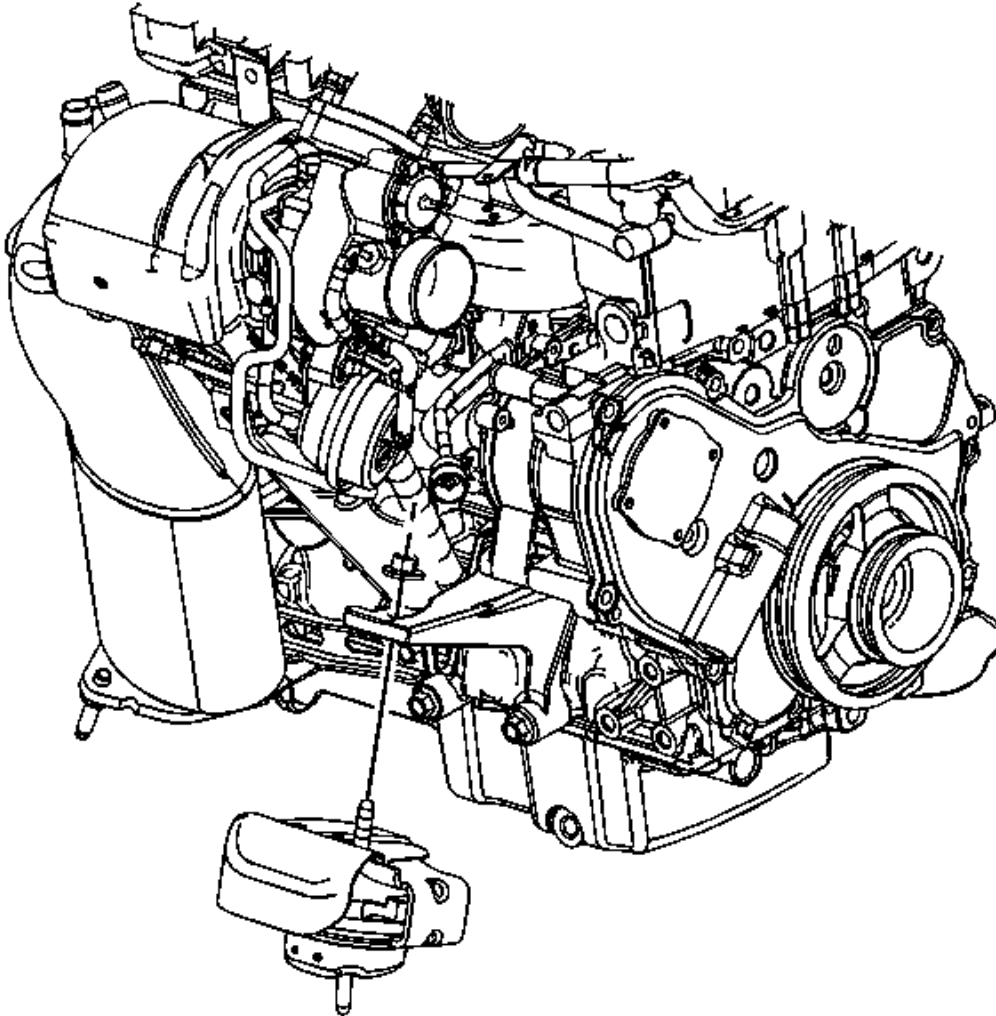


Fig. 410: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

96. Remove the right engine mount upper nut.
97. If not present, install a service part engine lift bracket.
98. Install a suitable engine lifting device to the engine.
99. Separate the engine from the transmission.
100. Remove the engine from the vehicle.

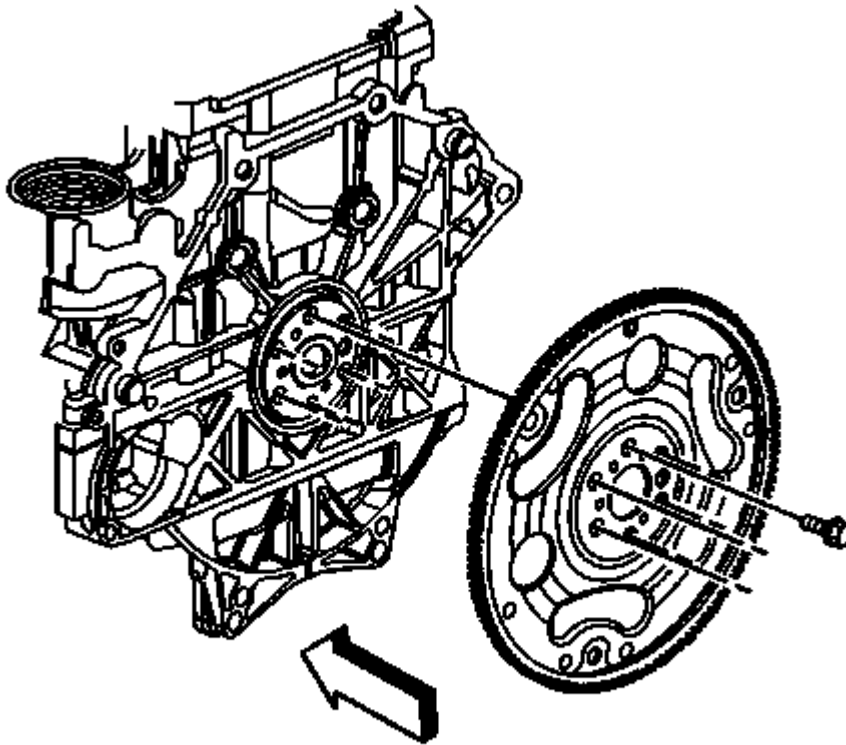


Fig. 411: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

NOTE: It may be necessary to remove the chamfer (bevel) from the edge of an 18 mm socket in order to get full engagement on the thin headed flywheel bolts.

101. Remove the flywheel bolts and flywheel.
102. Install the engine to an engine stand.

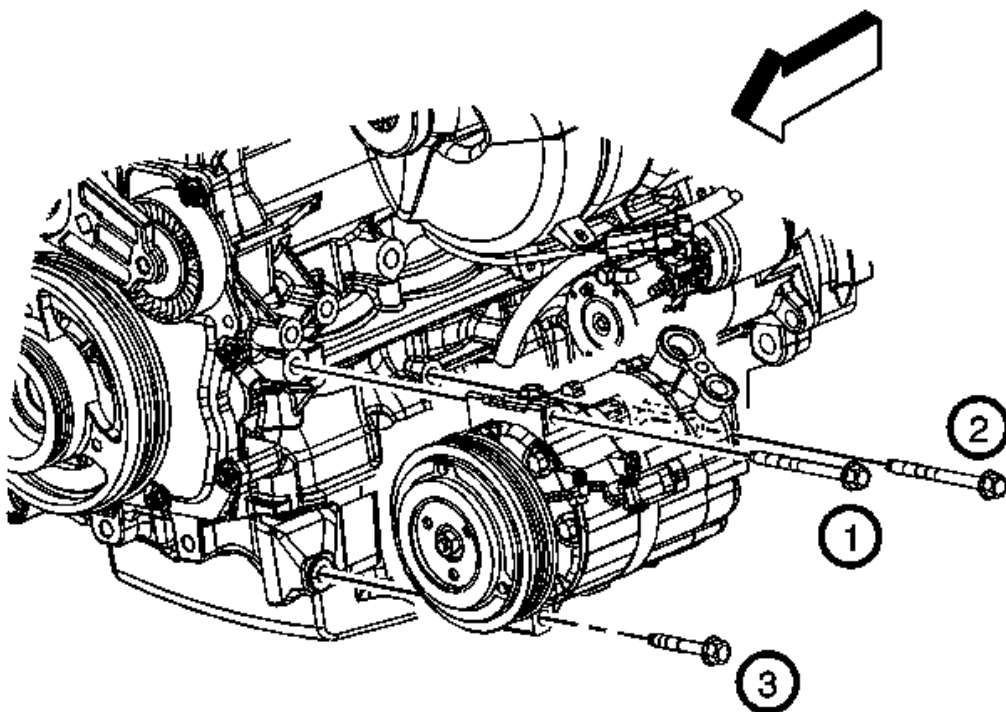


Fig. 412: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

103. Remove the A/C compressor bolts and compressor.

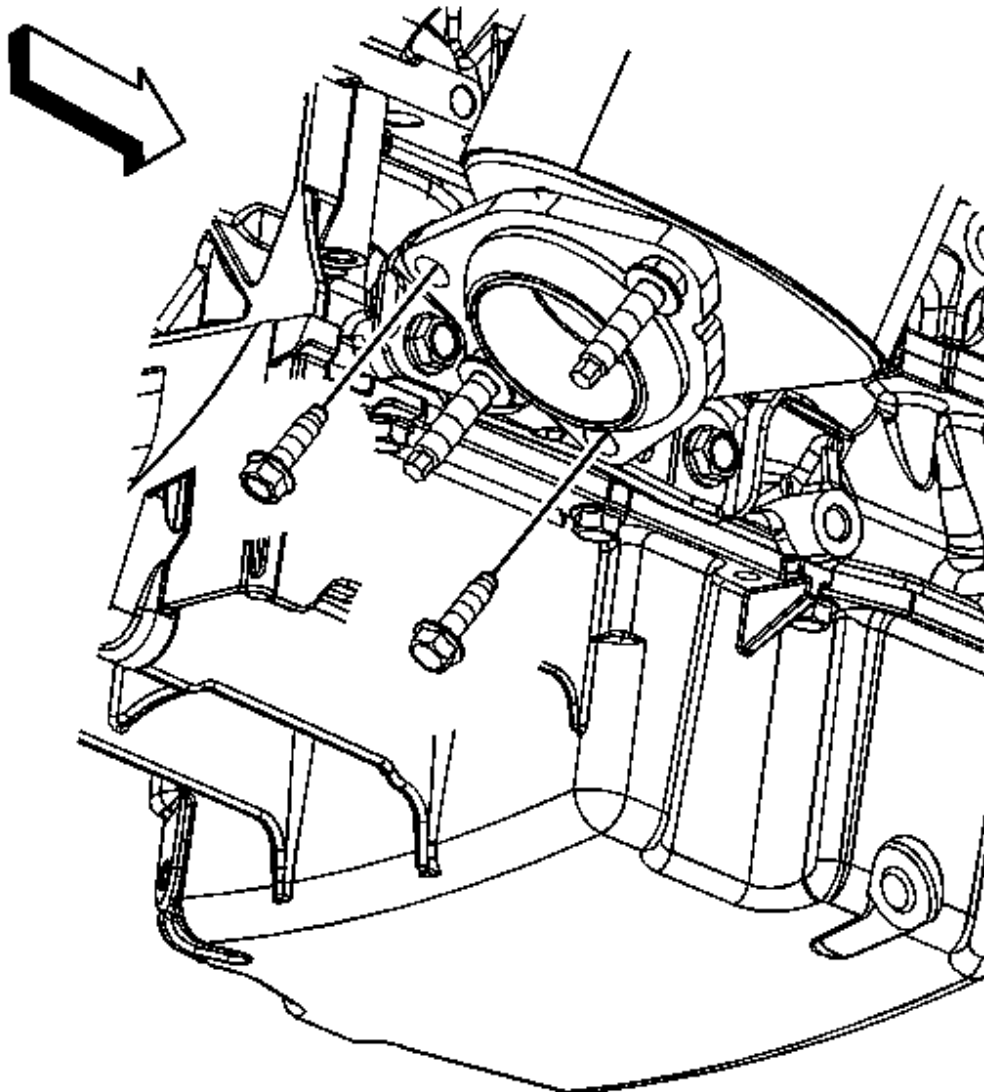


Fig. 413: View Of Catalytic Converter-To-Catalytic Converter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

104. Remove the catalytic converter to bracket bolts.

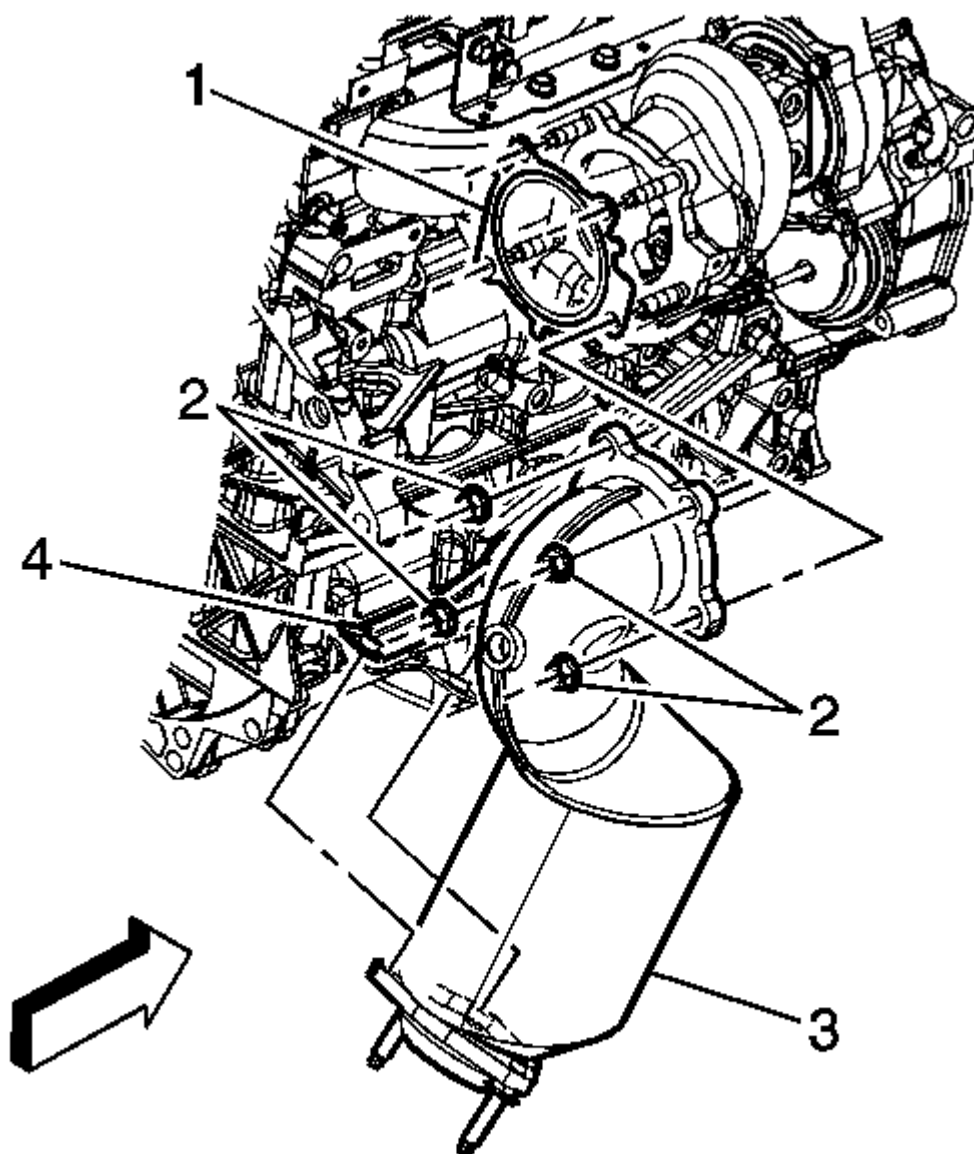


Fig. 414: Identifying Catalytic Converter & Turbocharger
Courtesy of GENERAL MOTORS CORP.

105. Remove the catalytic converter nuts (2).
106. Remove the catalytic converter (3) and gasket (1) from the turbocharger and bracket (4).

INSTALLATION PROCEDURE

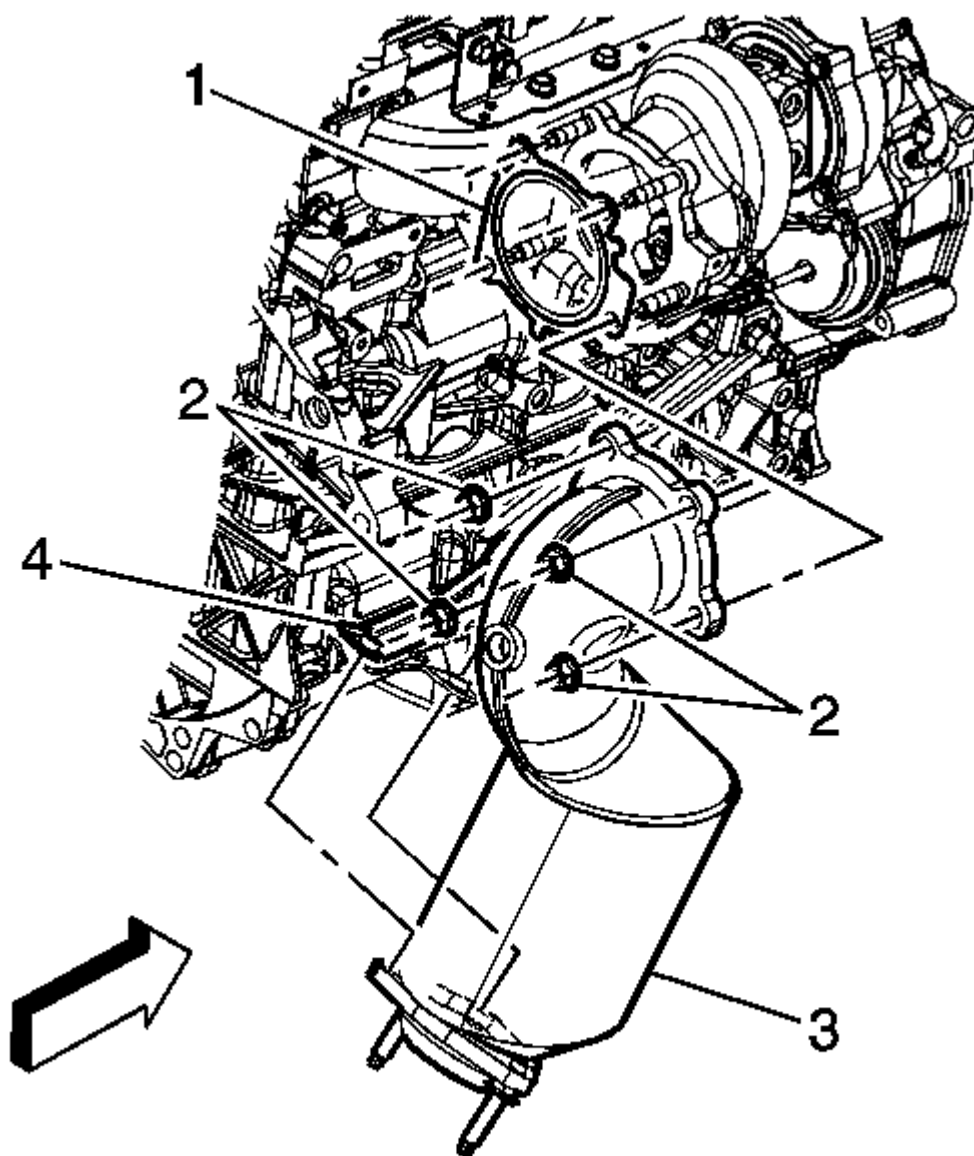


Fig. 415: Identifying Catalytic Converter & Turbocharger
Courtesy of GENERAL MOTORS CORP.

1. Install the catalytic converter (3) and gasket (1) to the turbocharger and bracket (4).

CAUTION: Refer to Fastener Caution .

2. Install the catalytic converter nuts (2) and tighten to 59 N.m (43 lb ft).

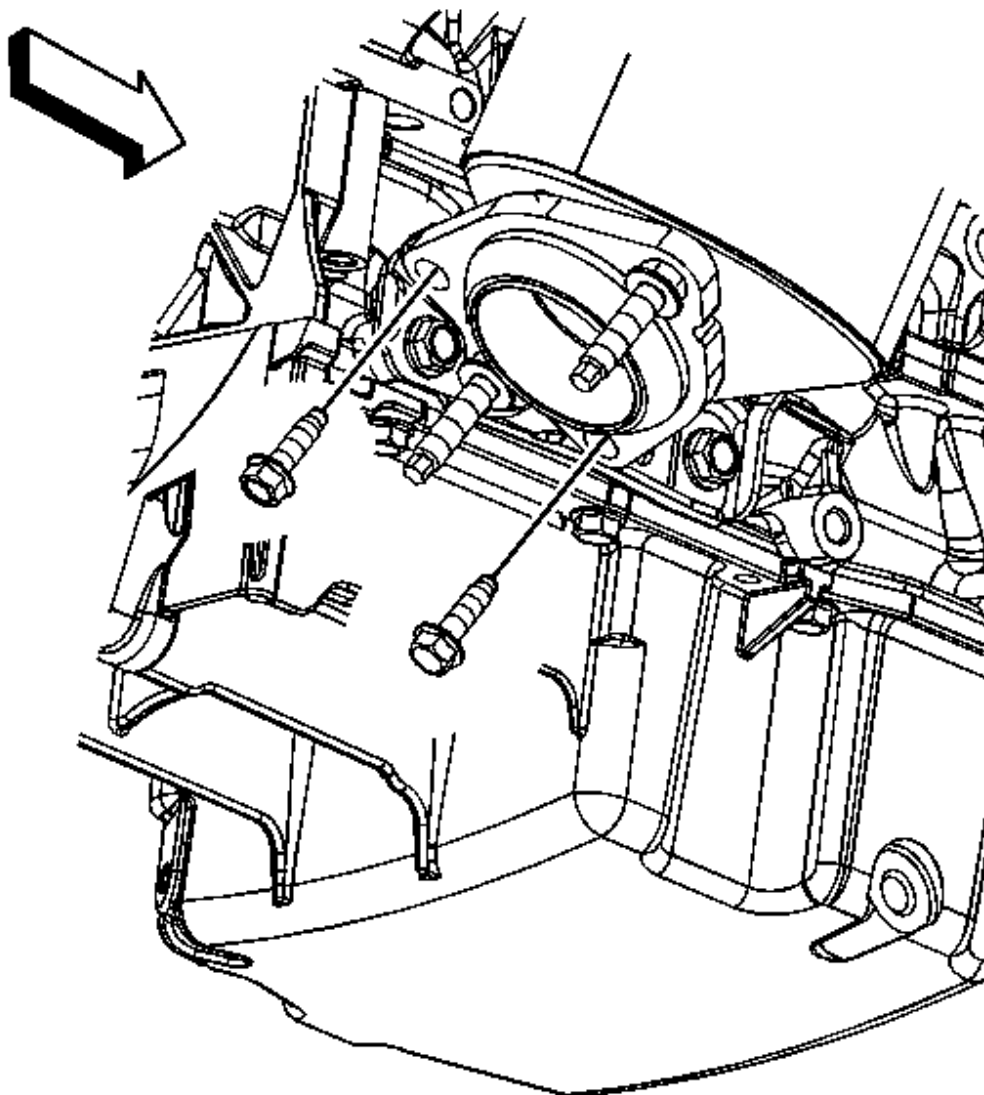


Fig. 416: View Of Catalytic Converter-To-Catalytic Converter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the catalytic converter to bracket bolts and tighten to 22 N.m (16 lb ft).

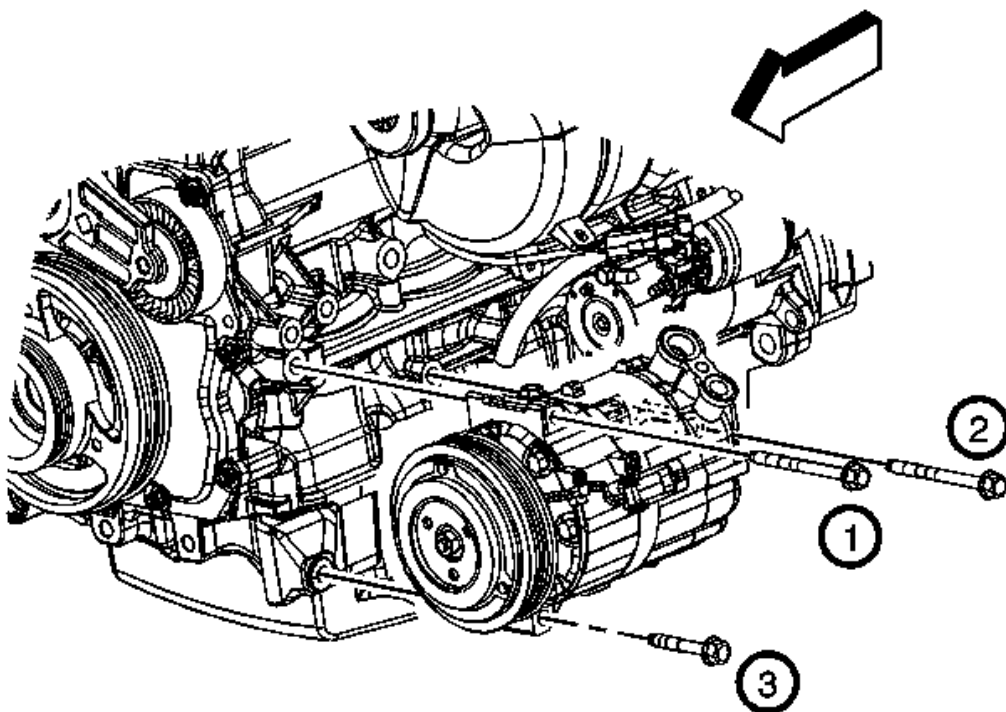


Fig. 417: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the A/C compressor and bolts. Tighten the bolts in the sequence shown to 22 N.m (16 lb ft).

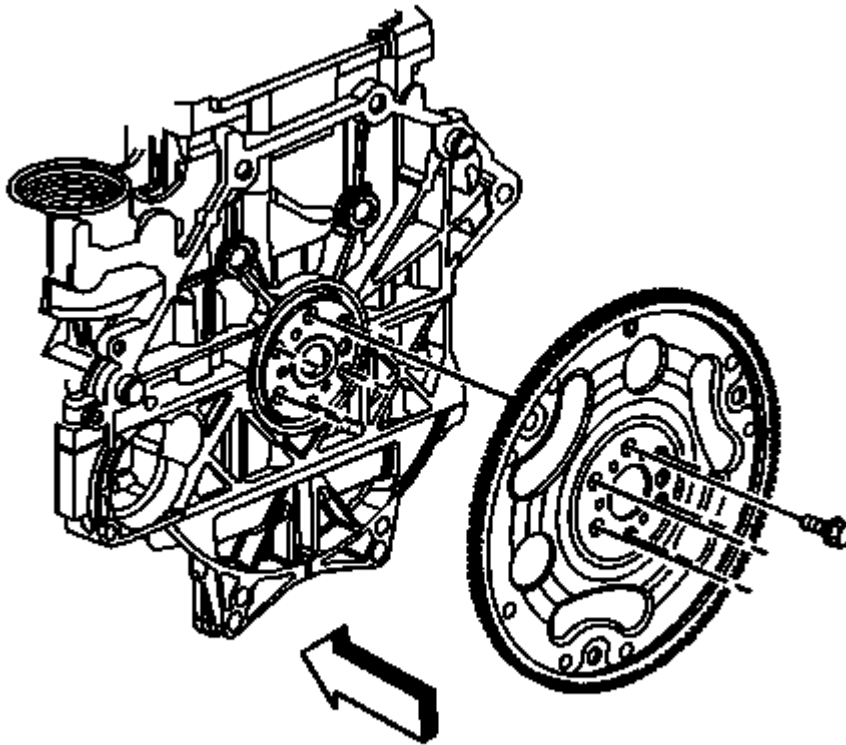


Fig. 418: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

5. Install a suitable engine lifting devise to the engine.
6. Remove the engine from the stand.
7. Using a nylon bristle brush clean the thread adhesive from the flywheel bolt holes, if necessary.
8. Install the flywheel and bolts. Tighten the bolts to 53 N.m (39 lb ft) plus an additional 25 degrees using the **J 45059** .

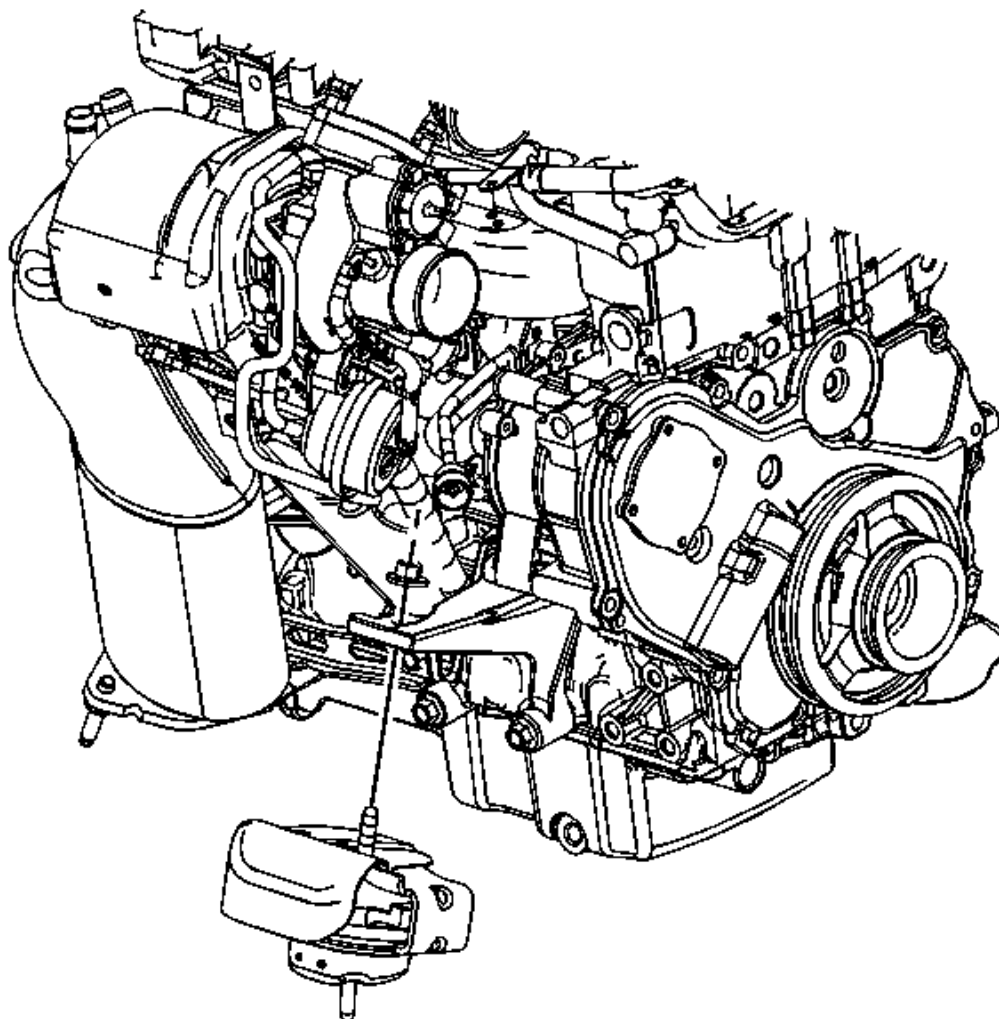


Fig. 419: View Of Right Engine Mount
Courtesy of GENERAL MOTORS CORP.

9. Install the engine to the vehicle.
10. Install the right engine mount upper nut and tighten to 55 N.m (41 lb ft).

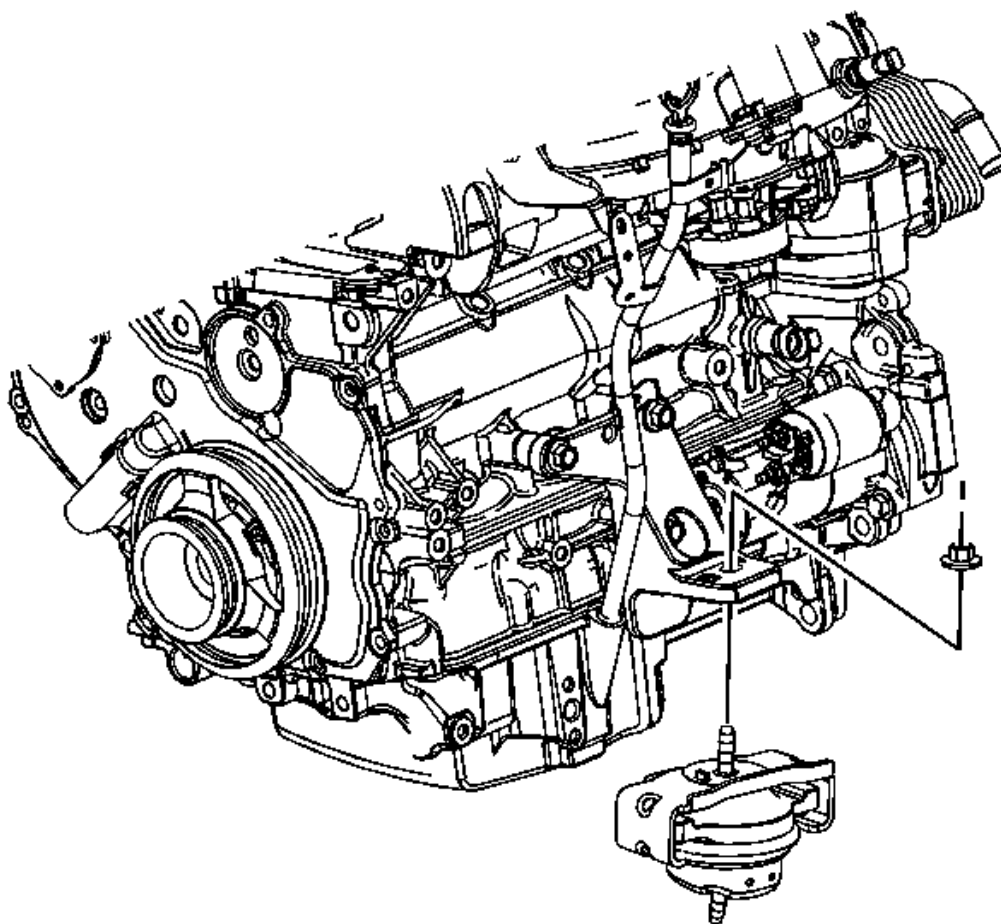


Fig. 420: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

11. Install the left engine mount upper nut and tighten to 55 N.m (41 lb ft).
12. If installed, remove the engine lift bracket from the engine.

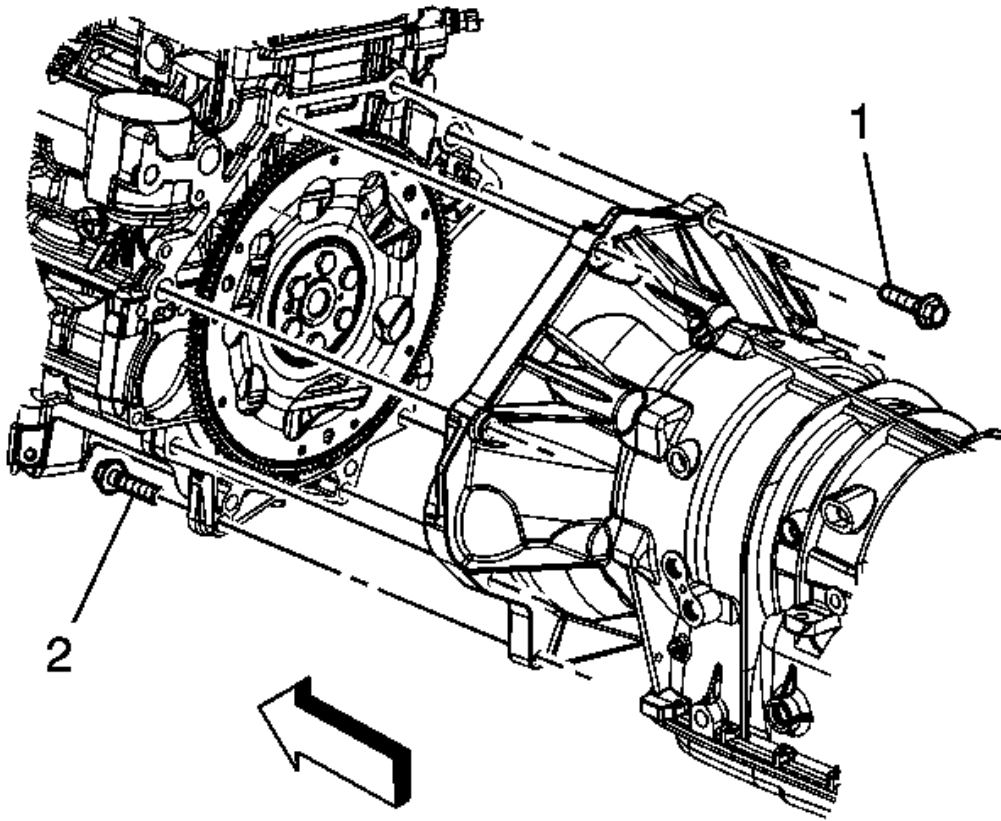


Fig. 421: Locating Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The top 2 bellhousing bolts install through the bellhousing into the engine block. The remaining 7 bolts install through the engine block into the bellhousing.

13. Install the upper 5 bellhousing bolts (1) and tighten to 50 N.m (37 lb ft).
14. Raise and support the vehicle.
15. Install the 4 lower bellhousing bolts (2) and tighten to 50 N.m (37 lb ft).
16. Install the torque converter to flywheel bolts and tighten to 63 N.m (46 lb ft).

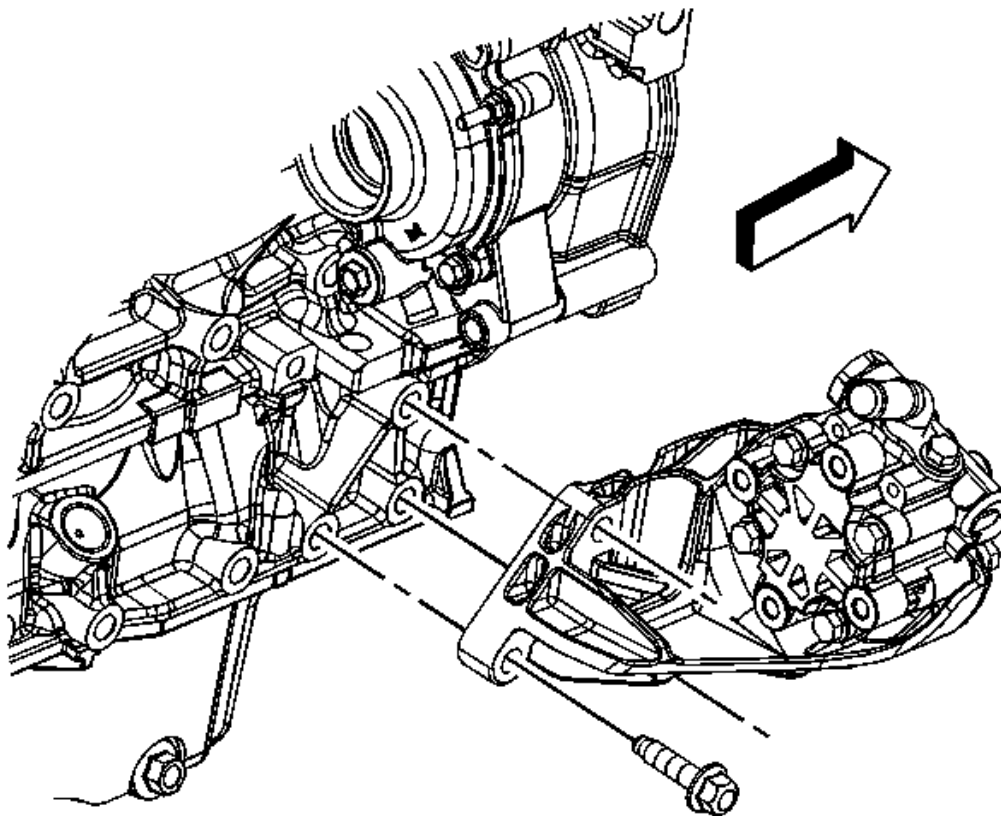


Fig. 422: View Of Power Steering Pump & Bracket
Courtesy of GENERAL MOTORS CORP.

17. Position the power steering pump bracket to the engine and install the bracket bolts and tighten to 58 N.m (43 lb ft).
18. Lower the vehicle.

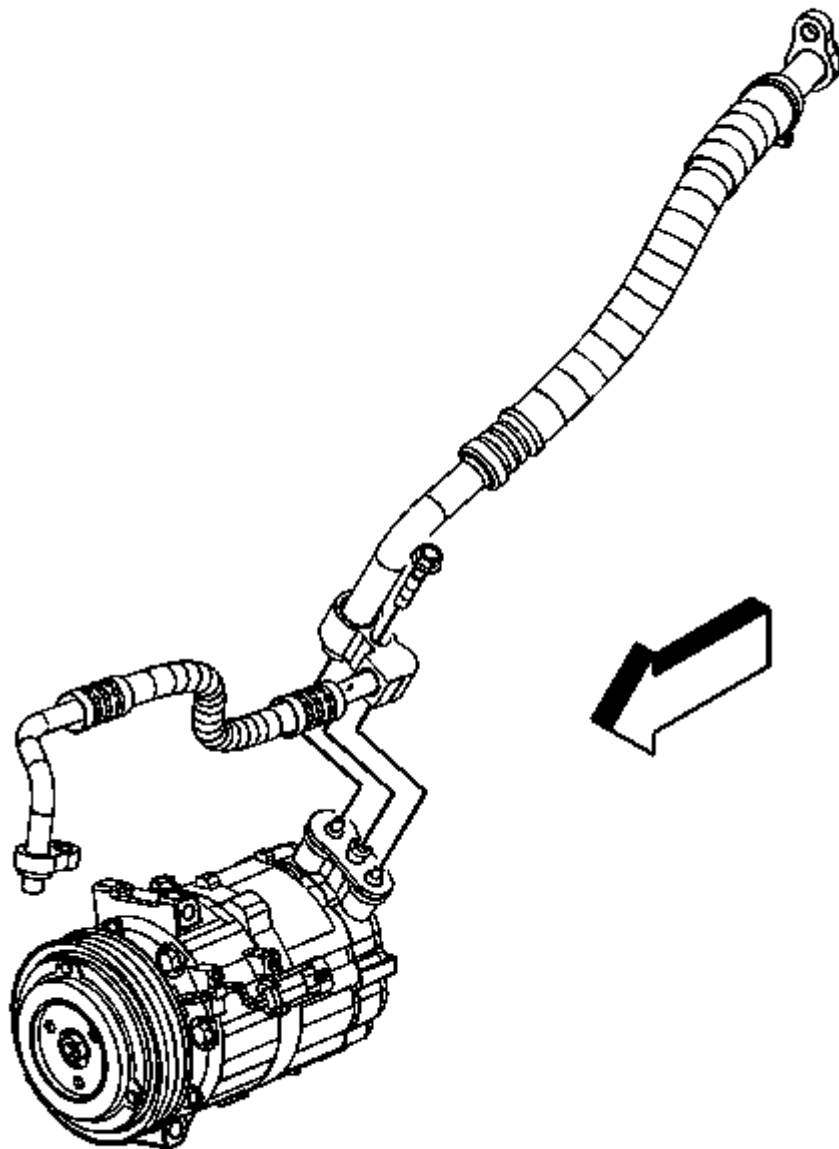


Fig. 423: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

19. Position the A/C compressor line and install the bolt and tighten to 22 N.m (16 lb ft).

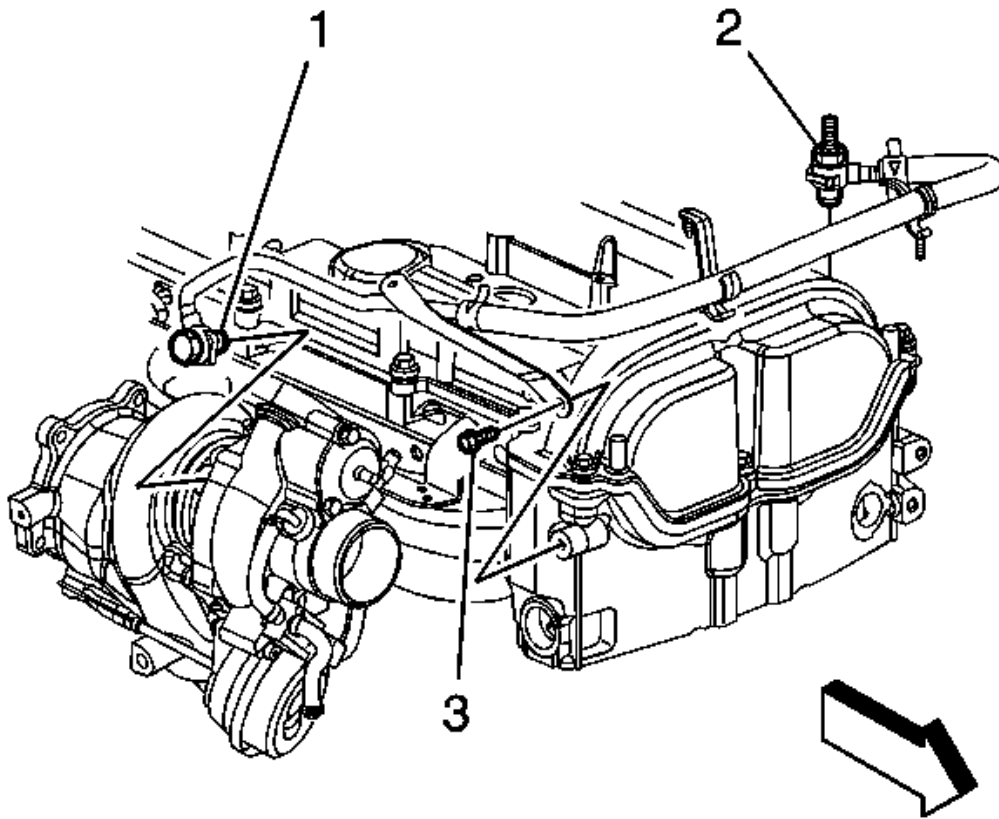


Fig. 424: Identifying Turbocharger Coolant Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

20. Position the turbocharger coolant feed pipe to the vehicle.
21. Install the turbocharger coolant feed pipe bracket bolt (3) to the cylinder head and tighten to 10 N.m (89 lb in).
22. Install the turbocharger coolant feed pipe fitting (2) to the cylinder head and tighten to 35 N.m (26 lb ft).
23. Install the turbocharger coolant feed pipe bolt (1) at the turbocharger and tighten to 35 N.m (26 lb ft).

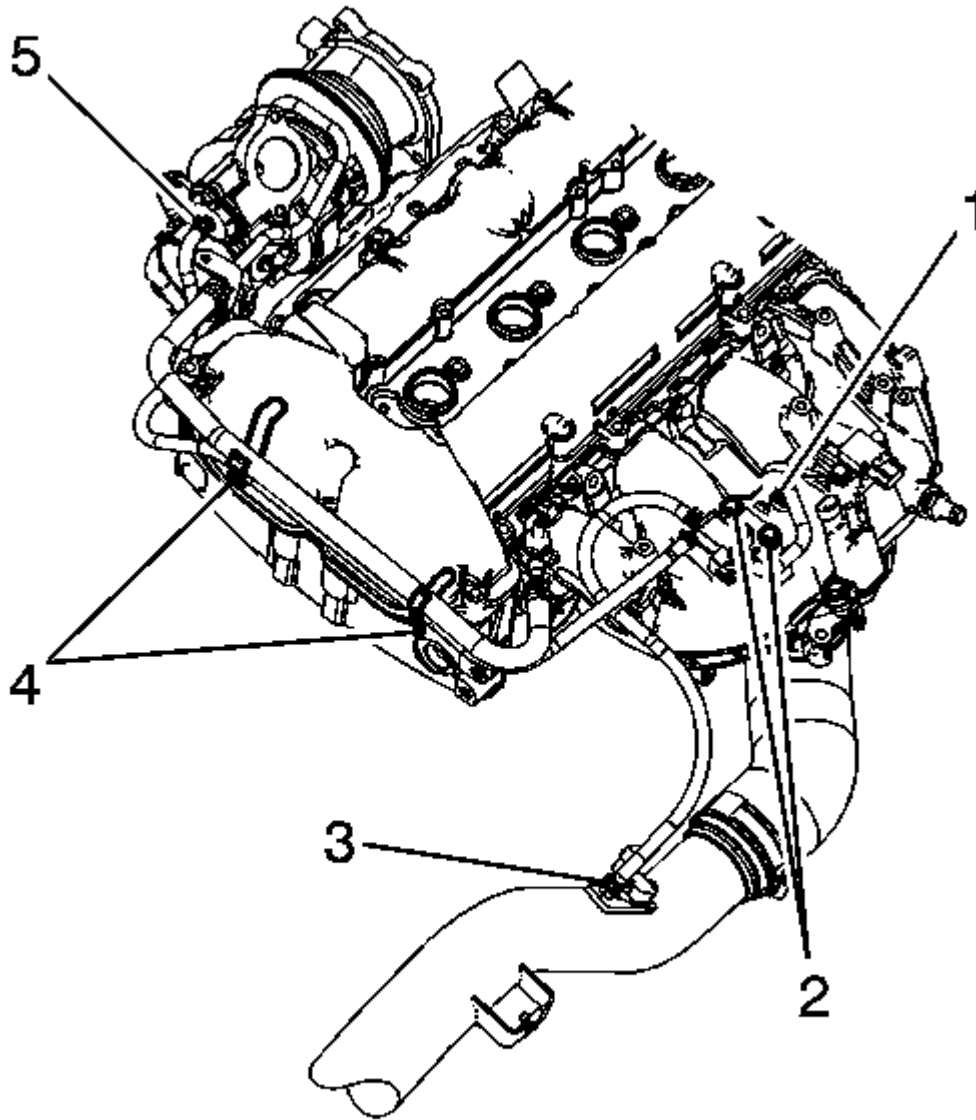


Fig. 425: Identifying Charge Air Bypass Solenoid Components
Courtesy of GENERAL MOTORS CORP.

24. Install the charge air bypass valve vacuum solenoid.
25. Install the charge air bypass valve vacuum hose to the turbocharger coolant feed pipe clips (4).
26. Position the charge air bypass valve vacuum hose clamp (5) at the turbocharger.
27. Place the charge air bypass valve solenoid out of the way.

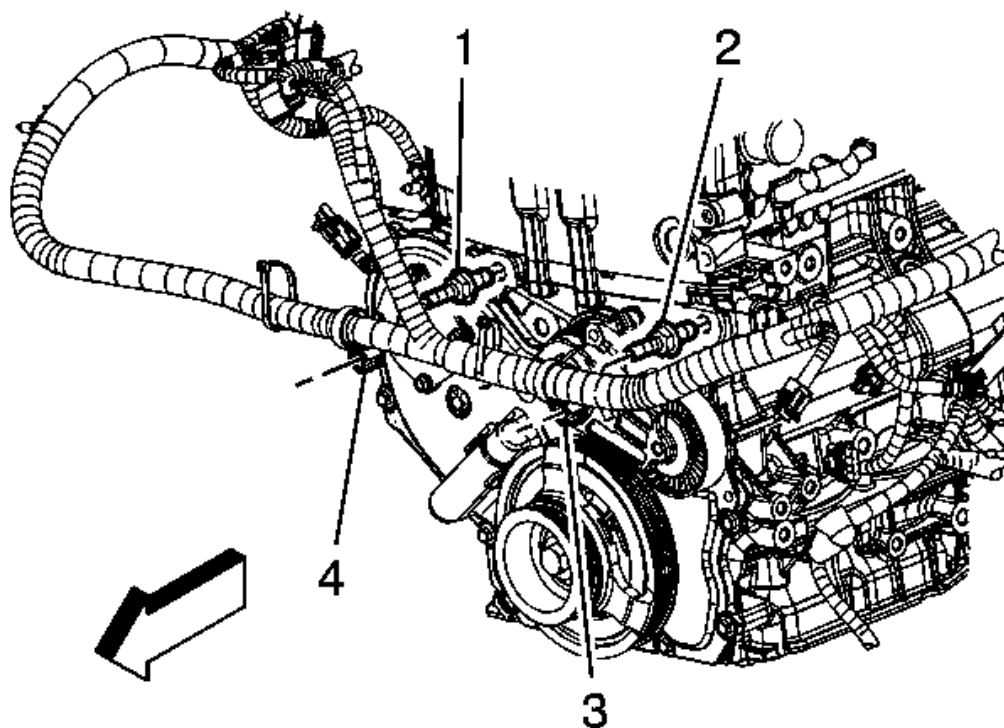


Fig. 426: Identifying Engine Harness Clips
Courtesy of GENERAL MOTORS CORP.

28. Position the branches of the engine harness to the engine.
29. Install the engine harness clips (3, 4) to the front studs.

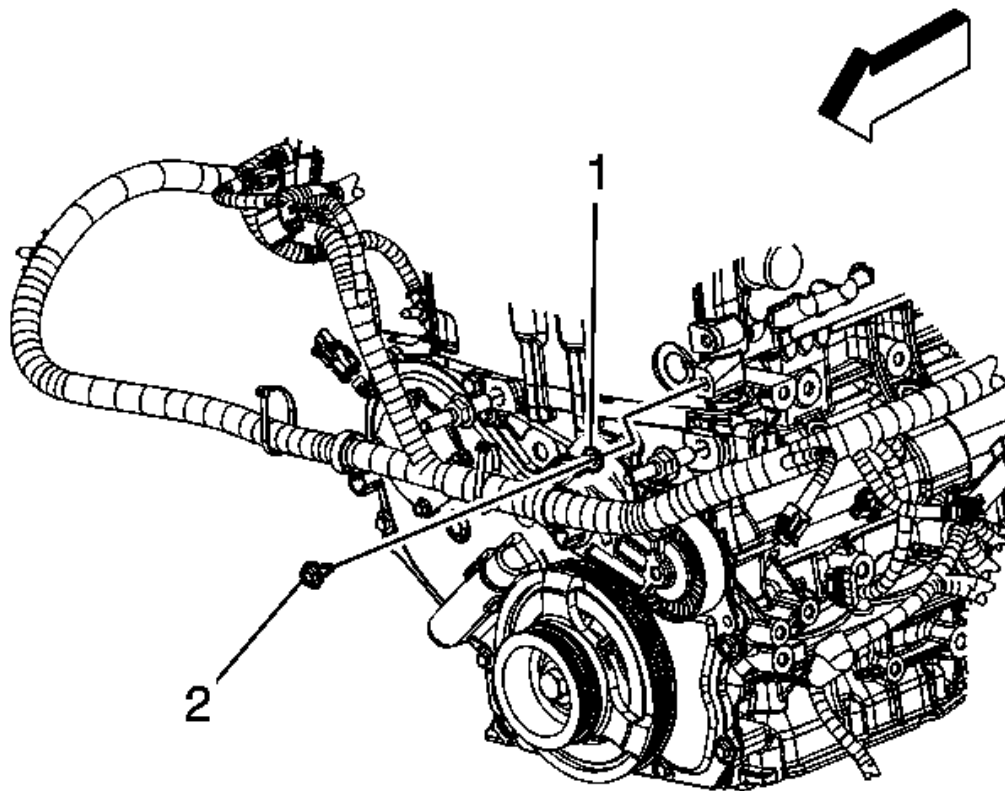


Fig. 427: Identifying Engine Wiring Harness Ground Terminal
Courtesy of GENERAL MOTORS CORP.

30. Install the engine wiring harness ground terminal (1) to the cylinder head.
31. Install the engine wiring harness ground bolt (2) to the cylinder head and tighten to 25 N.m (18 lb ft).

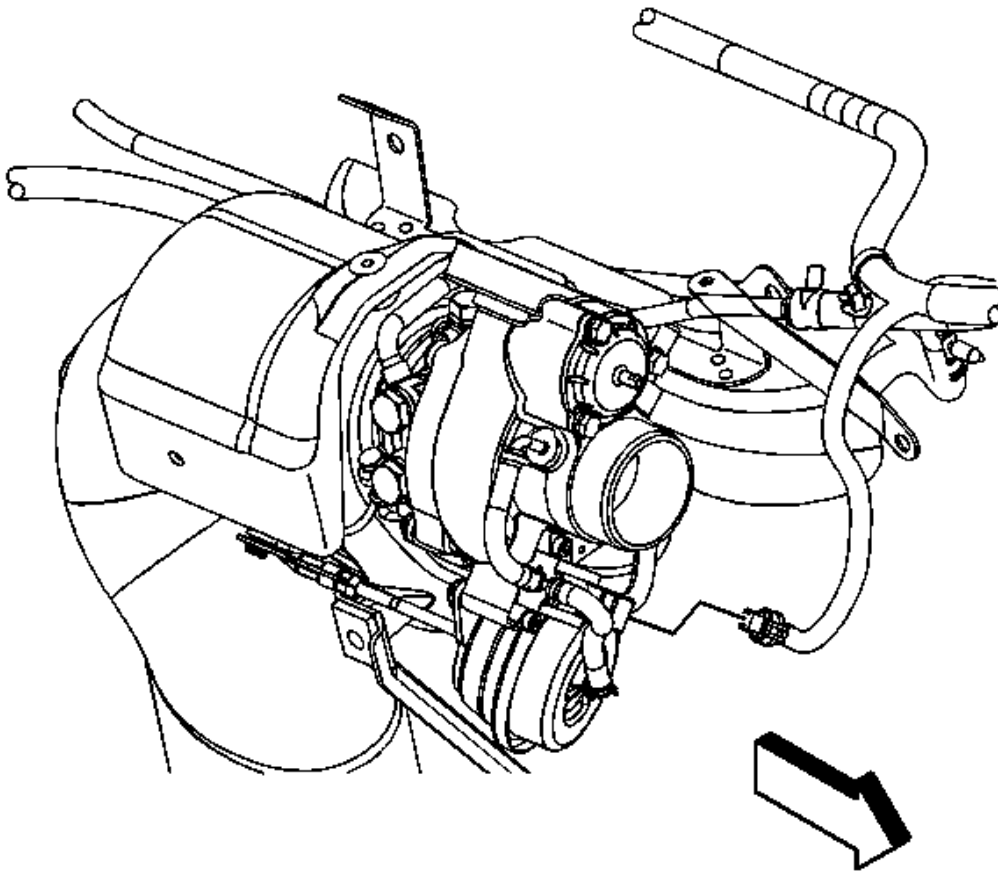


Fig. 428: Locating turbocharger wastegate solenoid valve Harness & Connector
Courtesy of GENERAL MOTORS CORP.

32. Connect the engine wiring harness electrical connector to the boost sensor.

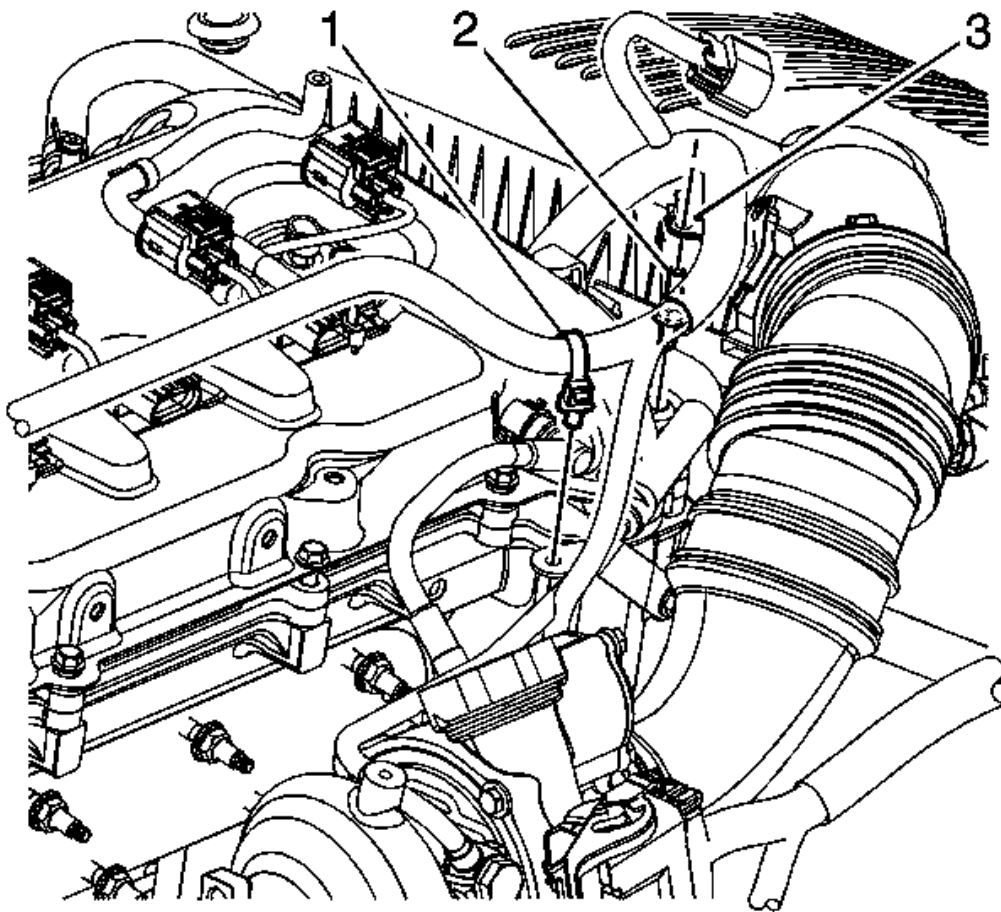


Fig. 429: View Of Turbocharger Coolant Feed Pipe Clips & Studs
Courtesy of GENERAL MOTORS CORP.

- 33. Install the engine wiring harness clip (1) to the turbocharger coolant feed pipe tab.
- 34. Install the engine wiring harness clip (3) to the turbocharger coolant feed pipe stud (2).

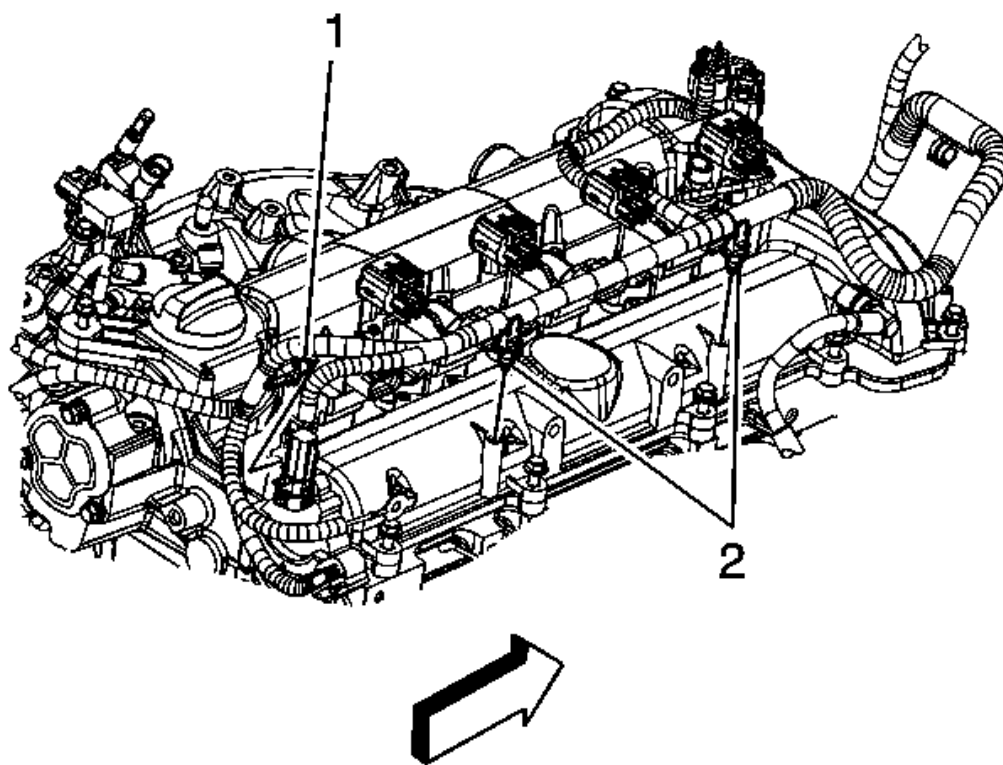


Fig. 430: Identifying Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

35. Connect the engine harness clips (2) to the camshaft cover.
36. Connect the engine harness clip (1) to the camshaft cover.

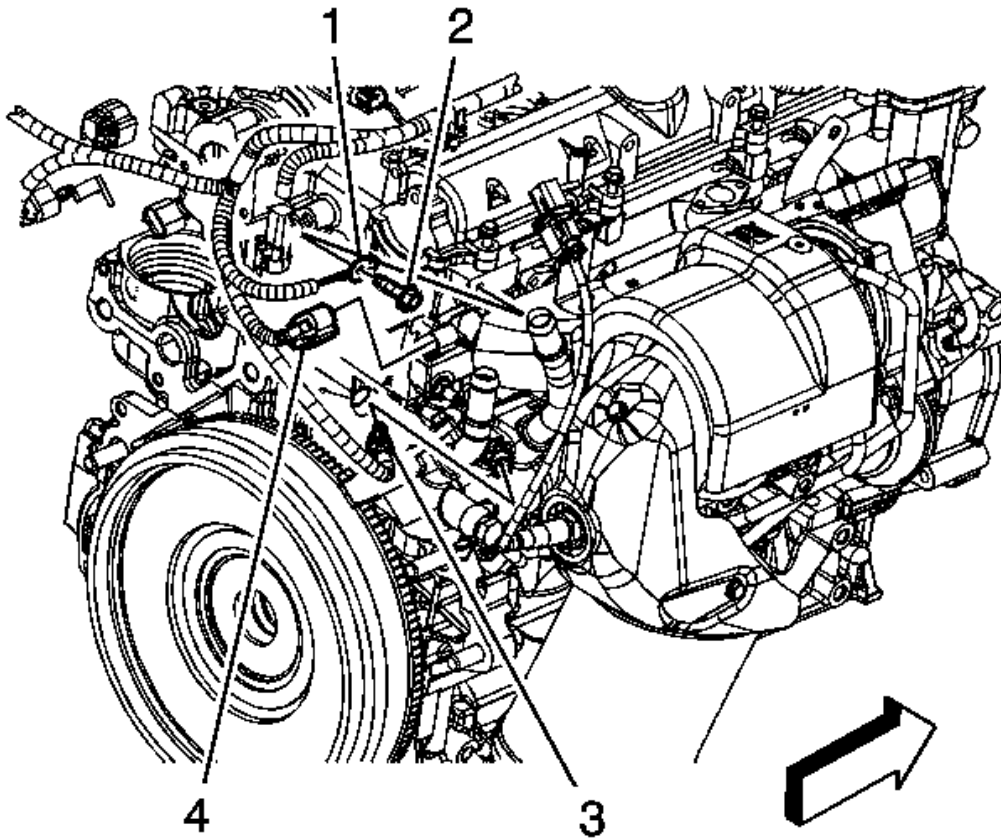


Fig. 431: Identifying ECT Sensor Engine Wiring Harness Electrical Connector
 Courtesy of GENERAL MOTORS CORP.

37. Connect the engine wiring harness electrical connector (4) to the exhaust CMP sensor.
38. Connect the engine wiring harness electrical connector (3) to the ECT sensor.
39. Position the engine harness ground terminal (1) and install the engine harness ground terminal bolt (2) and tighten to 25 N.m (18 lb ft).

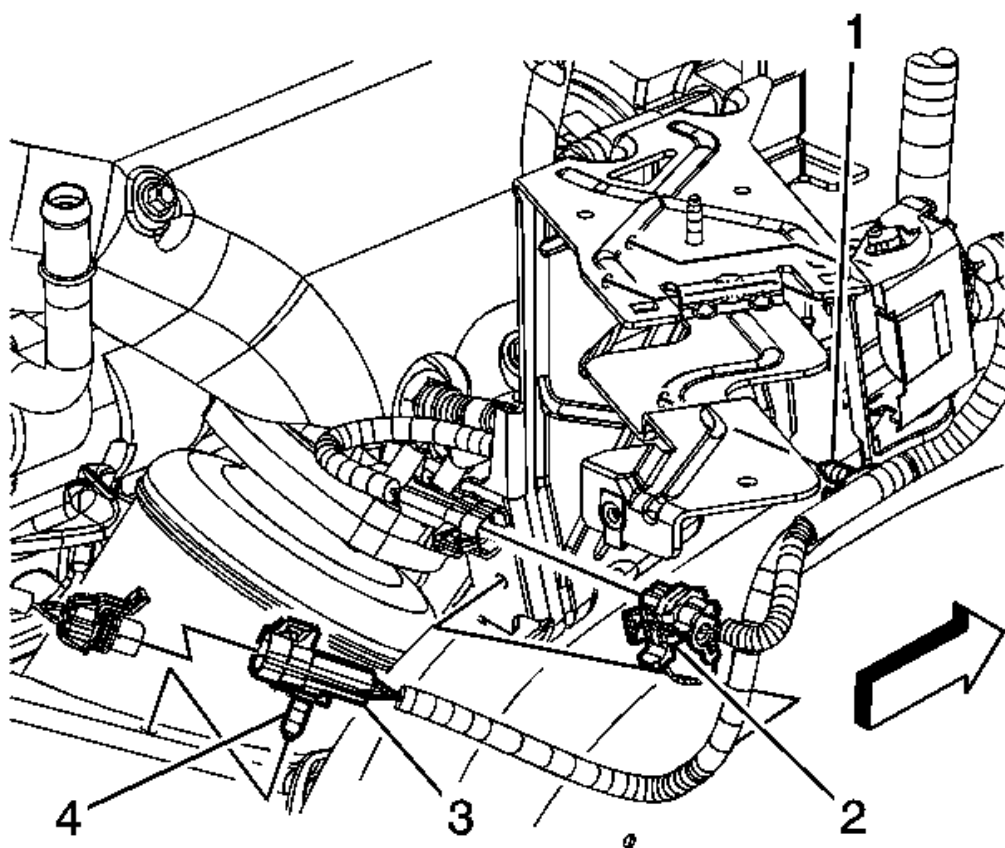


Fig. 432: Identifying CPA Retainer & HO2S Electrical Connector
 Courtesy of GENERAL MOTORS CORP.

40. Connect the engine wiring harness electrical connector (1) to the HO2S (3).

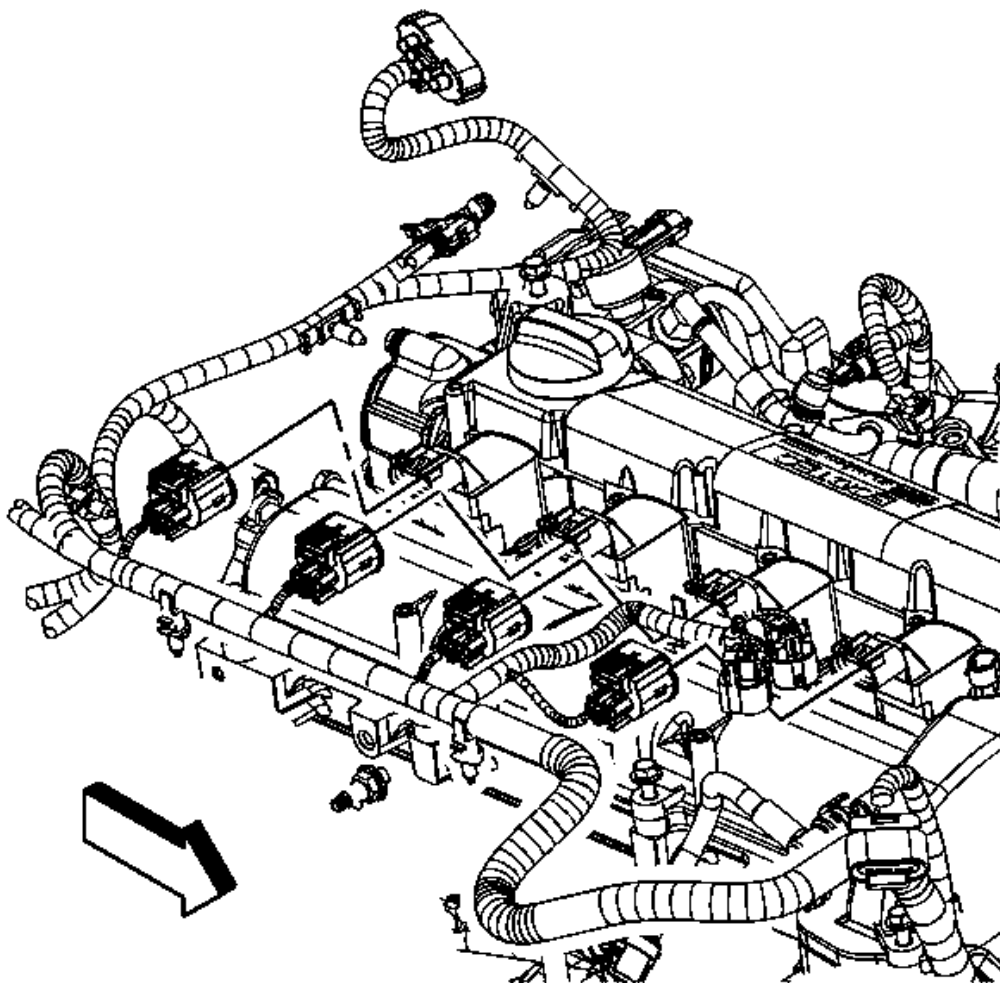


Fig. 433: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

41. Connect the engine wiring harness electrical connectors to the ignition coils.

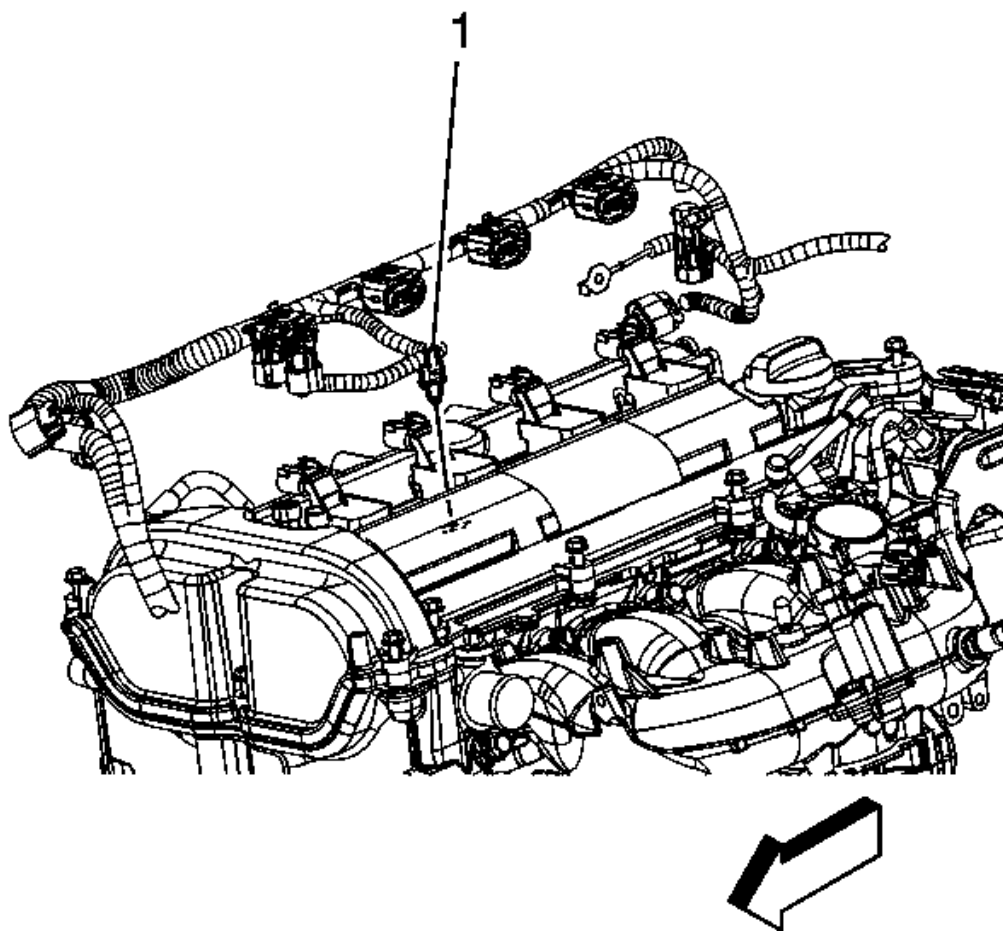


Fig. 434: Identifying Engine Wiring Harness Clip
Courtesy of GENERAL MOTORS CORP.

42. Install the engine harness clip (1) to the camshaft cover.

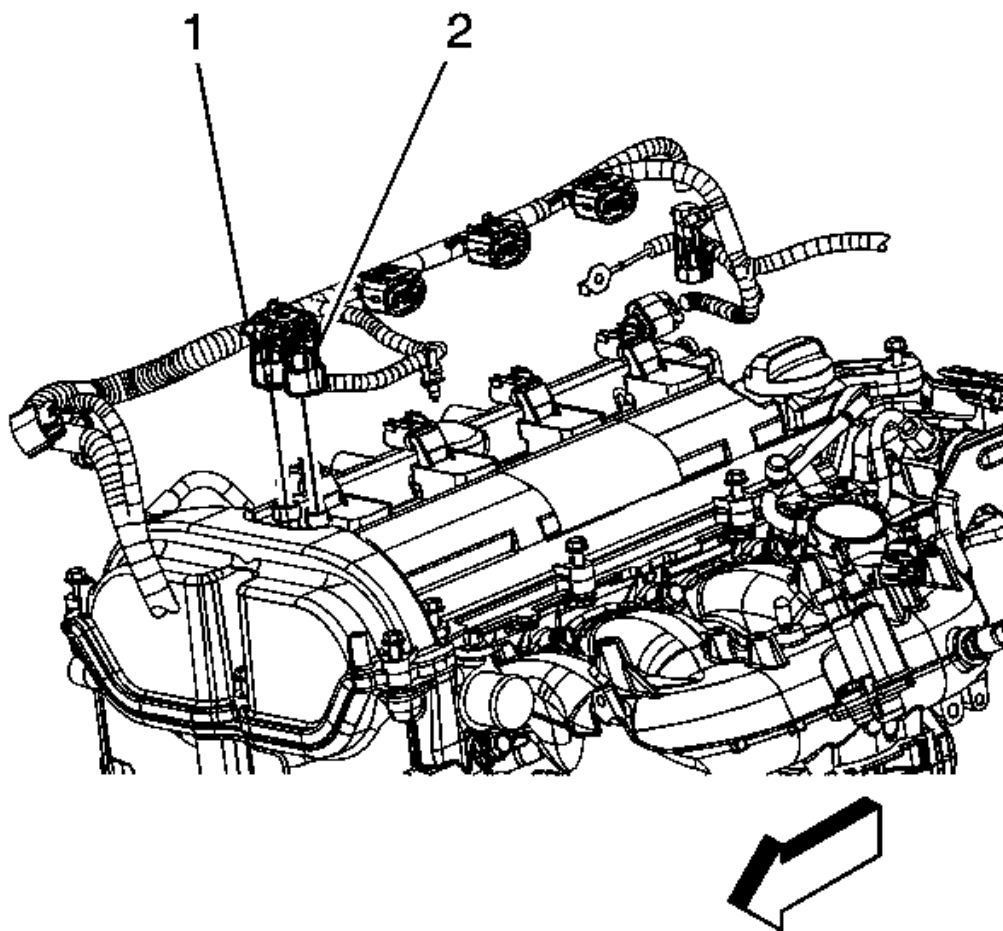


Fig. 435: Identifying Intake & Exhaust CMP Actuator Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

43. Connect the engine wiring harness electrical connector (2) to the intake CMP actuator.
44. Connect the engine wiring harness electrical connector (1) to the exhaust CMP actuator.

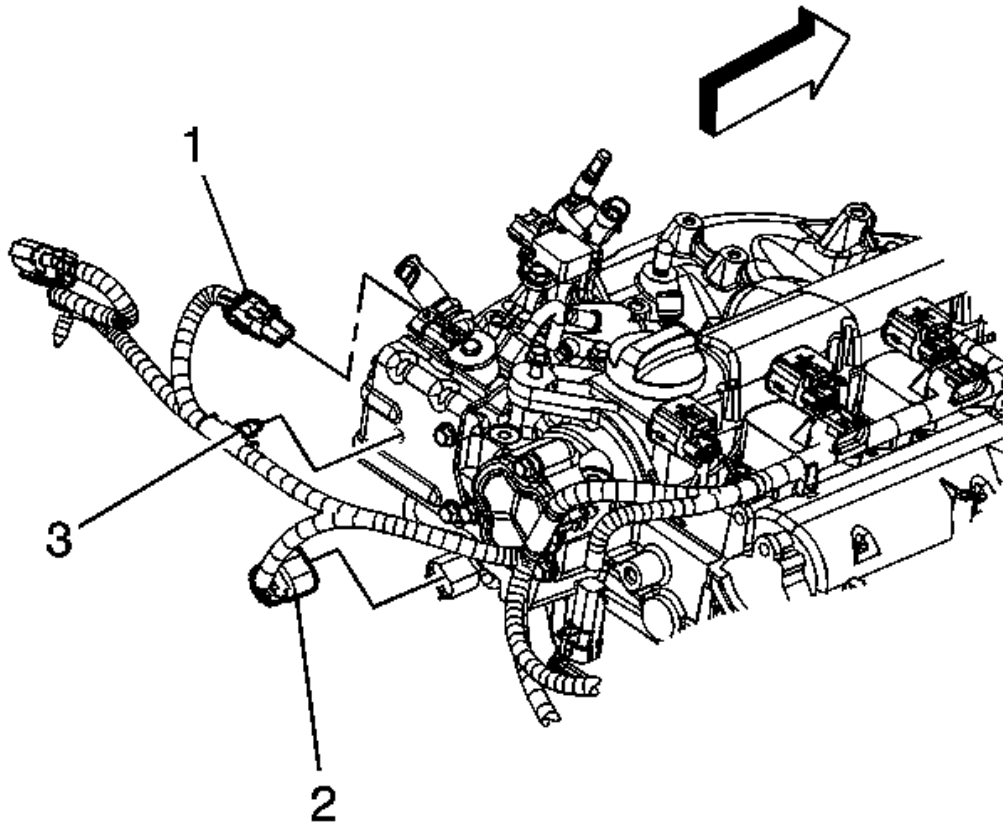


Fig. 436: Identifying High Pressure Fuel Pump Connector & Clip
Courtesy of GENERAL MOTORS CORP.

45. Connect the engine wiring harness electrical connector (2) to the intake CMP sensor.
46. Connect the engine wiring harness electrical connector (1) to the high pressure fuel pump.
47. Install the engine wiring harness clip (3) to the high pressure fuel pump bracket.

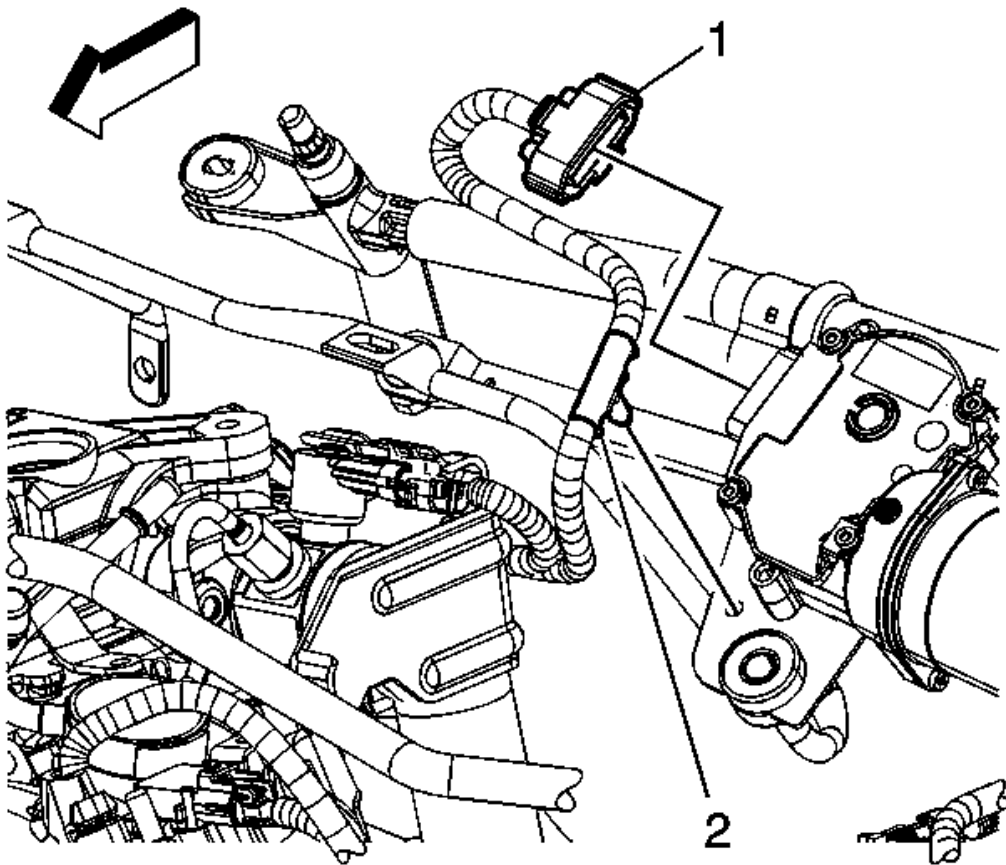


Fig. 437: Locating Windshield Wiper Motor Electrical Connector & Harness Clip
Courtesy of GENERAL MOTORS CORP.

48. Connect the engine wiring harness electrical connector (1) to the windshield wiper motor.
49. Install the engine harness clip (2) to the wiper motor hole.

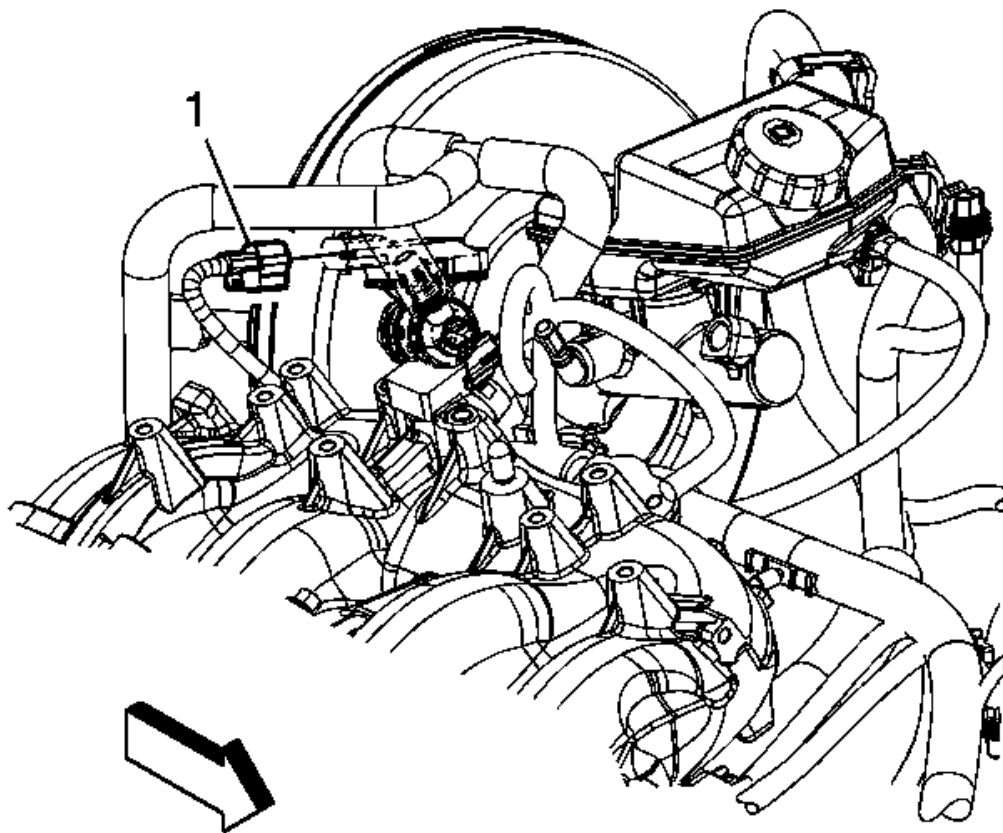


Fig. 438: Identifying Brake Booster Vacuum Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

50. Connect the engine wiring harness electrical connector (1) to the brake booster vacuum sensor.

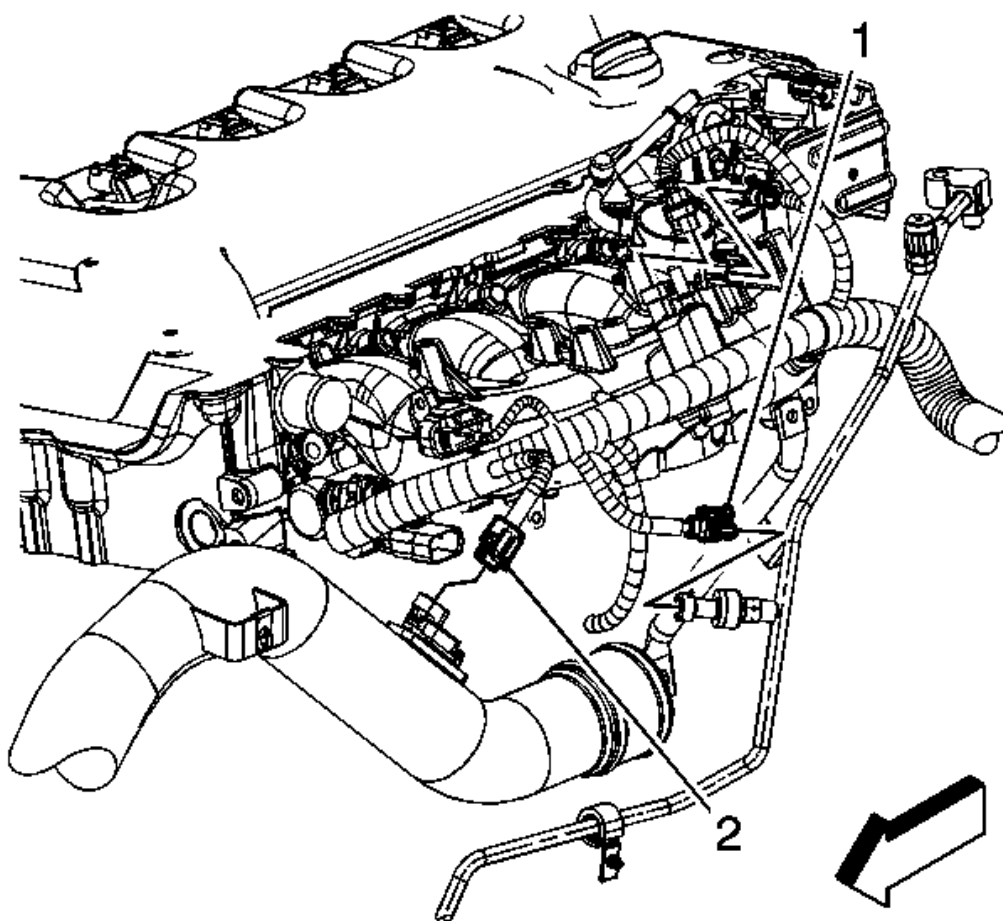


Fig. 439: View Of Intake Air Pressure & Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

51. Connect the engine wiring harness electrical connector (1) to the A/C refrigerant pressure sensor.

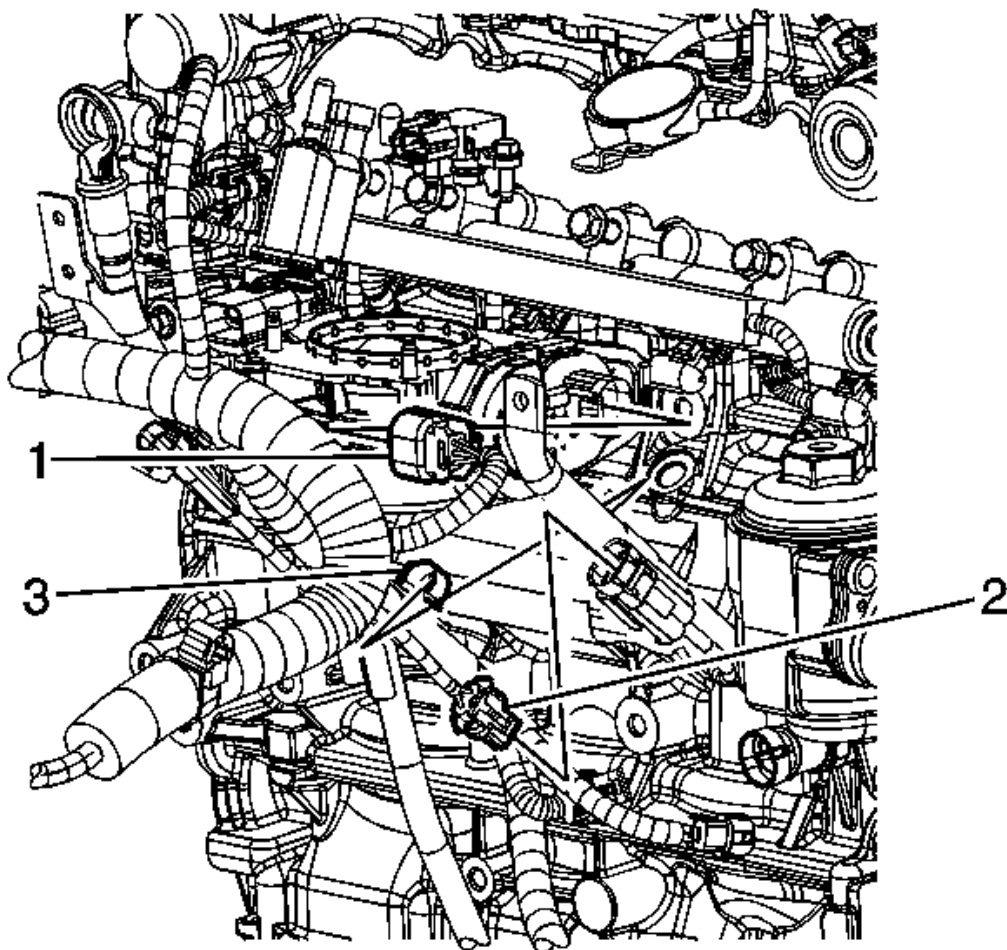


Fig. 440: Identifying Throttle Actuator & Knock Sensor Electrical Connectors & Harness Clip
Courtesy of GENERAL MOTORS CORP.

52. Connect the engine wiring harness electrical connector (2) to the knock sensor.

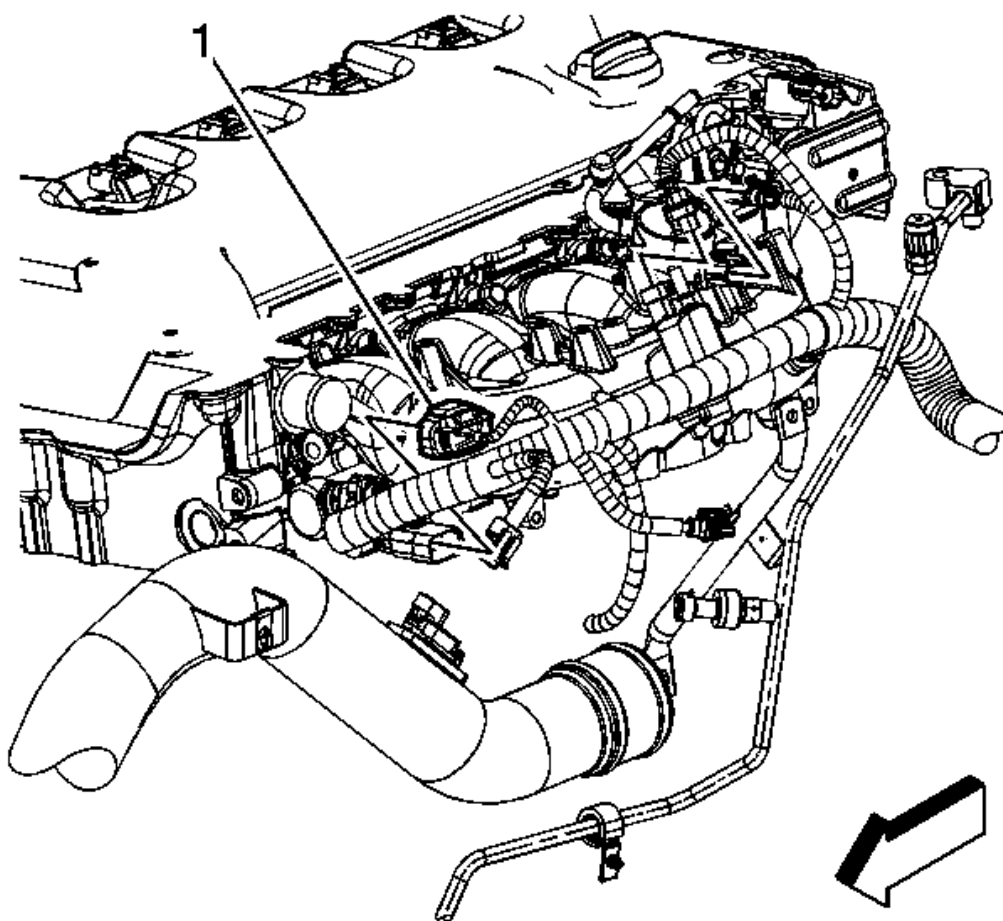


Fig. 441: View Of Engine Wiring Harness Connector & Fuel Injector Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

53. Connect the engine wiring harness electrical connector (1) to the fuel injector jumper electrical connector.

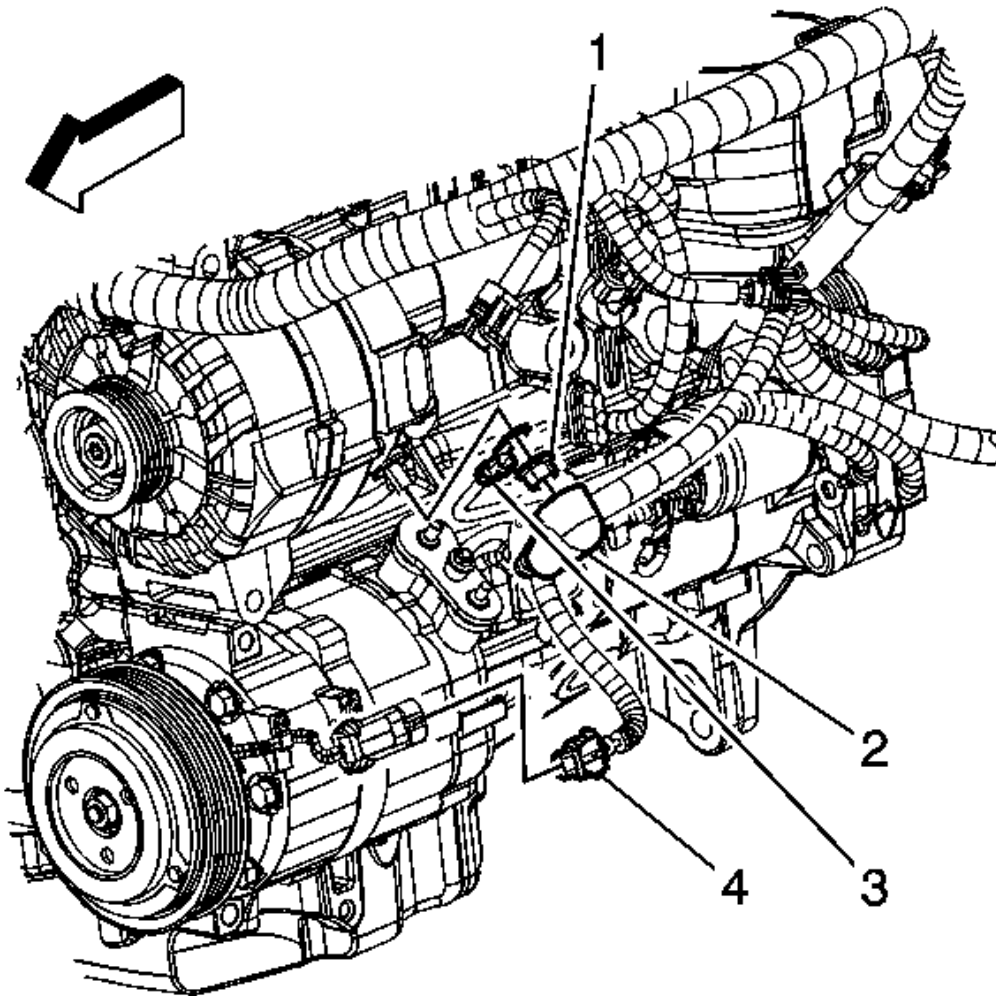


Fig. 442: Identifying Generator

Courtesy of GENERAL MOTORS CORP.

54. Install the positive battery cable terminal (3) to the generator.
55. Install the generator terminal nut (1) and tighten to 20 N.m (15 lb ft).
56. Position the positive battery cable terminal boot (2).
57. Connect the engine wiring harness electrical connector (4) to the A/C compressor.

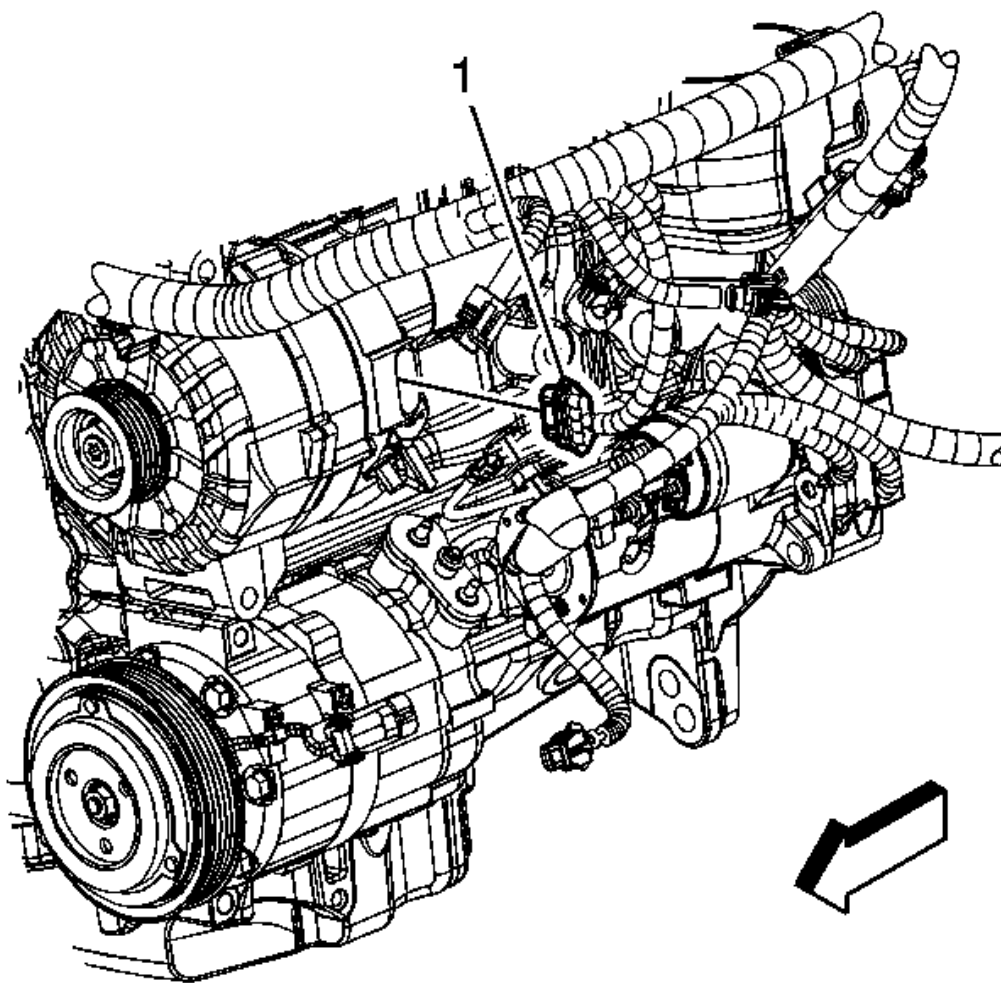


Fig. 443: Identifying Generator Wiring Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

58. Connect the engine wiring harness electrical connector (1) to the generator.

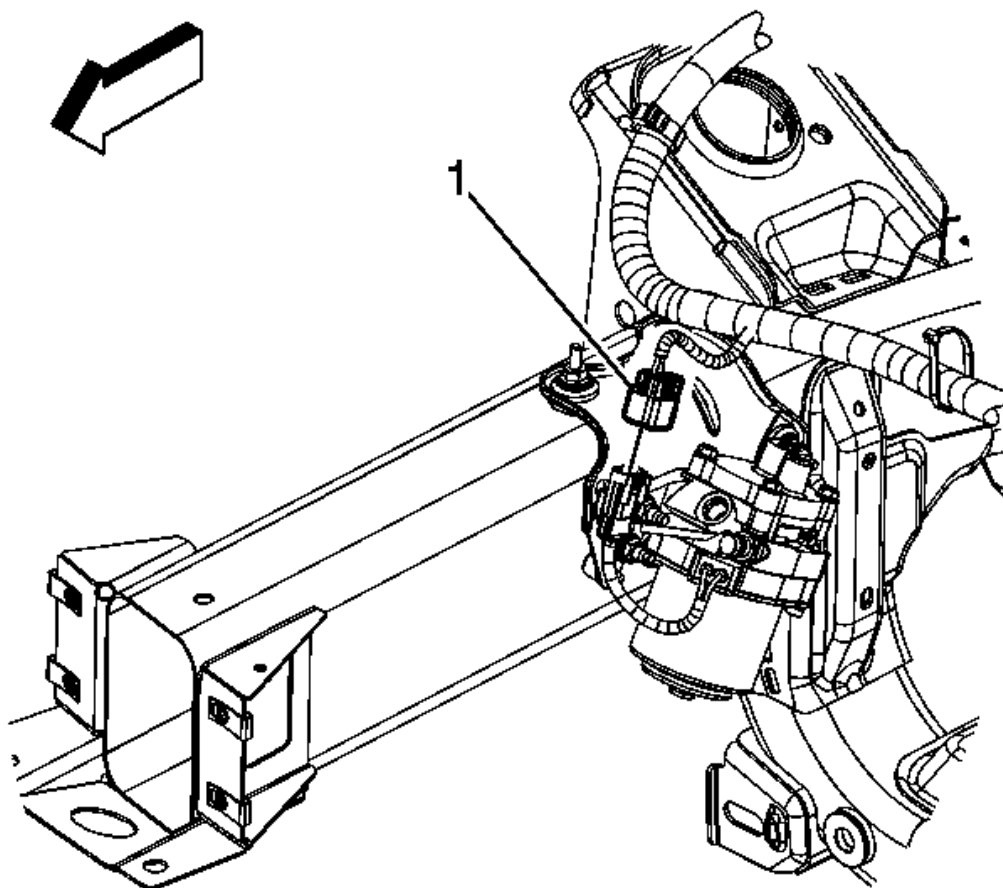


Fig. 444: Locating Transmission Oil Cooler Pump Electrical Connector
Courtesy of GENERAL MOTORS CORP.

59. Connect the engine wiring harness electrical connector (1) to the transmission oil cooler pump.

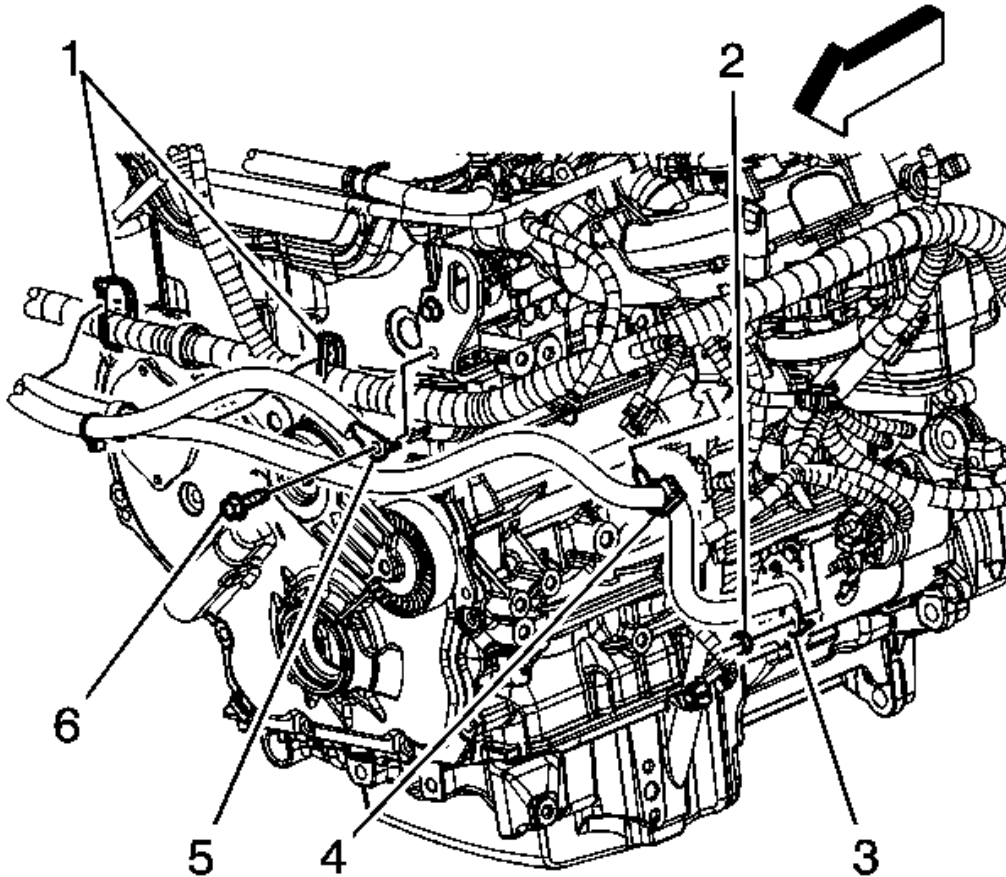


Fig. 445: Identifying Negative Battery Cables & Cable Components
 Courtesy of GENERAL MOTORS CORP.

60. Position the negative/positive battery cable to the engine.
61. Install the negative battery cable ground terminal (5) to the engine lift bracket.
62. Install the negative battery cable ground bolt (6) to the front engine lift bracket and tighten to 25 N.m (18 lb ft).
63. Install NEW tie straps (1) to the engine wiring harness.

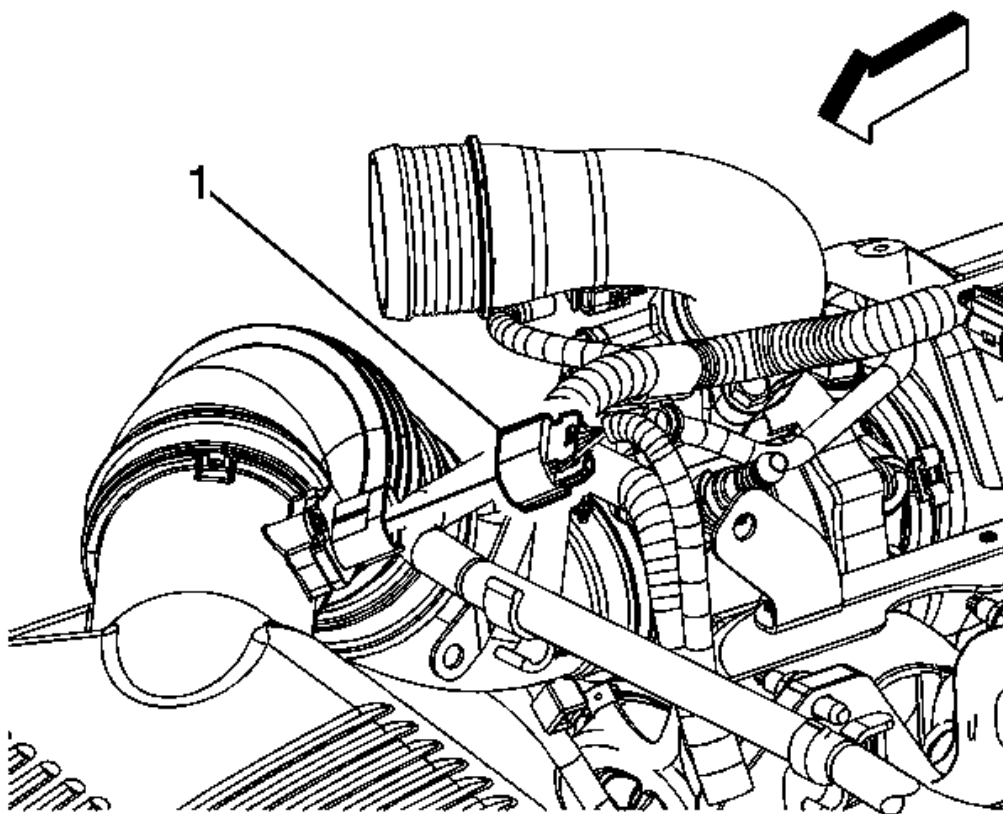


Fig. 446: Identifying MAF Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

64. Connect the engine wiring harness electrical connector (1) to the MAF sensor.
65. Raise the vehicle.

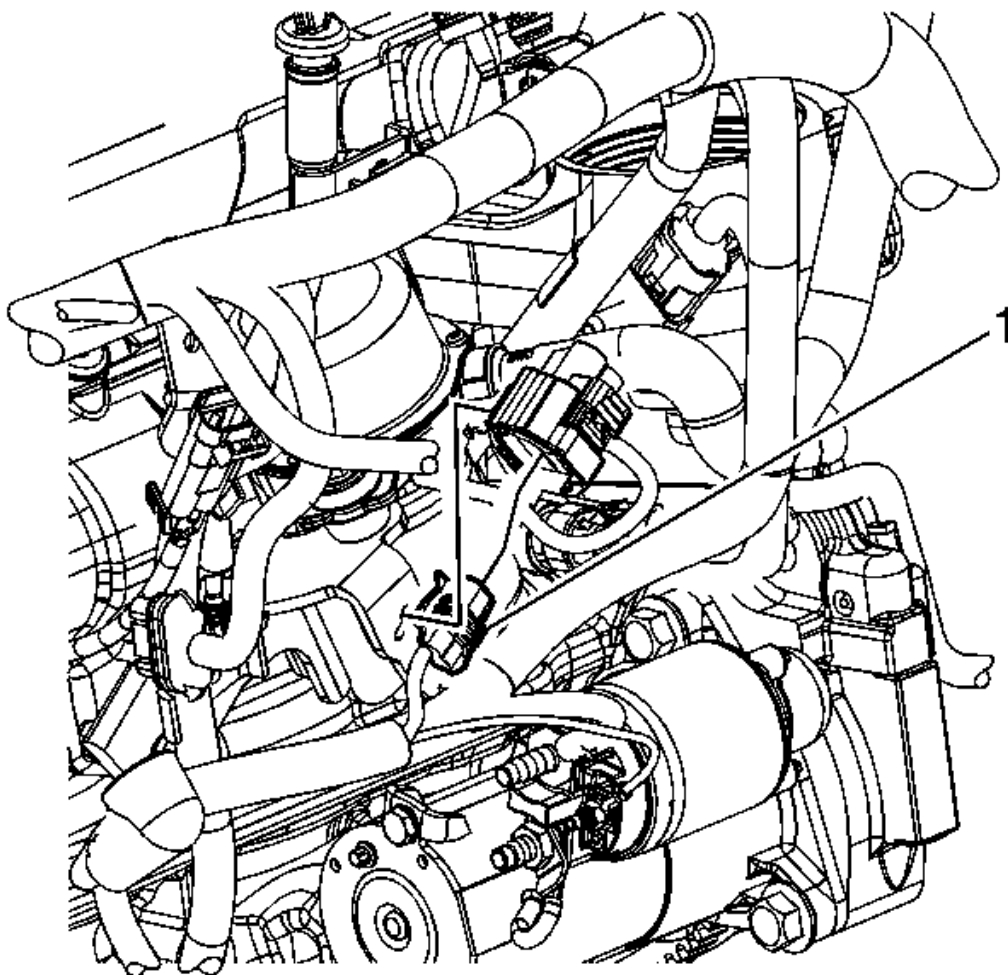


Fig. 447: Identifying Brake Booster Auxiliary Pump Connector
Courtesy of GENERAL MOTORS CORP.

66. Connect the engine wiring harness electrical connector (1) to the brake booster vacuum pump.
67. Bolt the catalytic converter to the exhaust pipe and tighten to 17 N.m (13 lb ft).

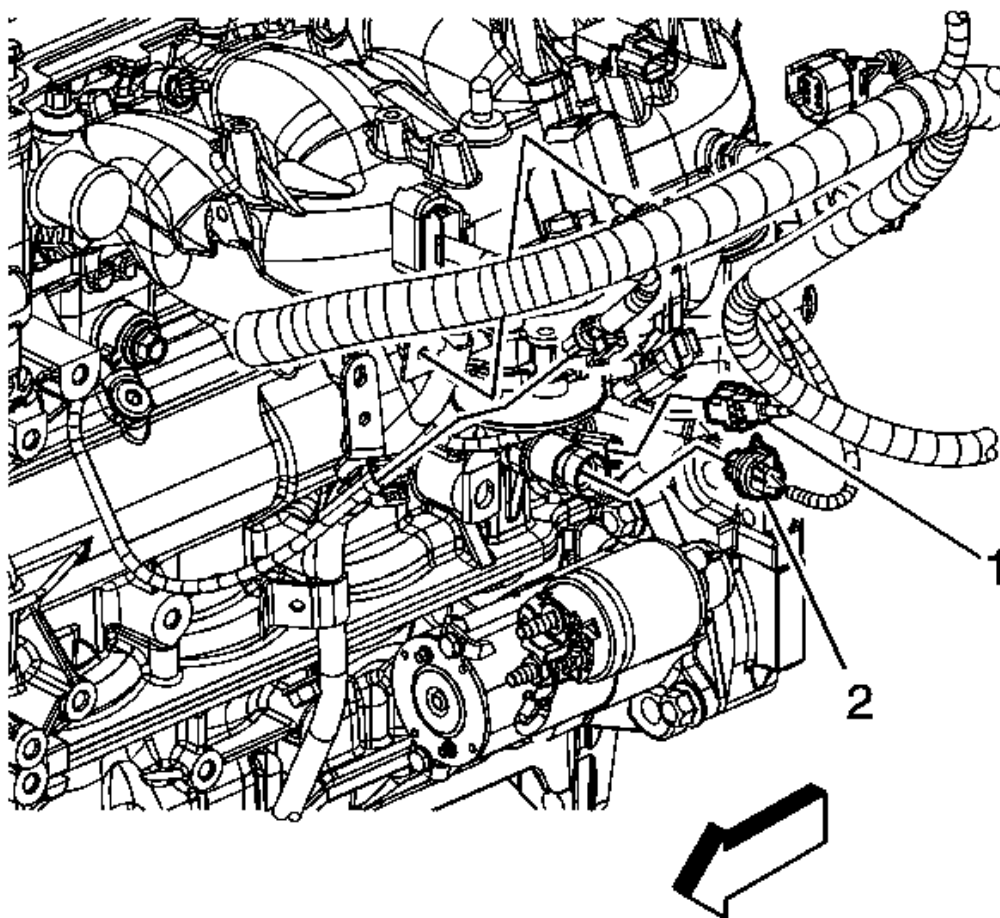


Fig. 448: Identifying Engine Oil Pressure & Crankshaft Position Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

68. Connect the engine wiring harness electrical connector (1) to the CKP sensor.
69. Connect the engine wiring harness electrical connector (2) to the oil pressure sensor.
70. Lower the vehicle.

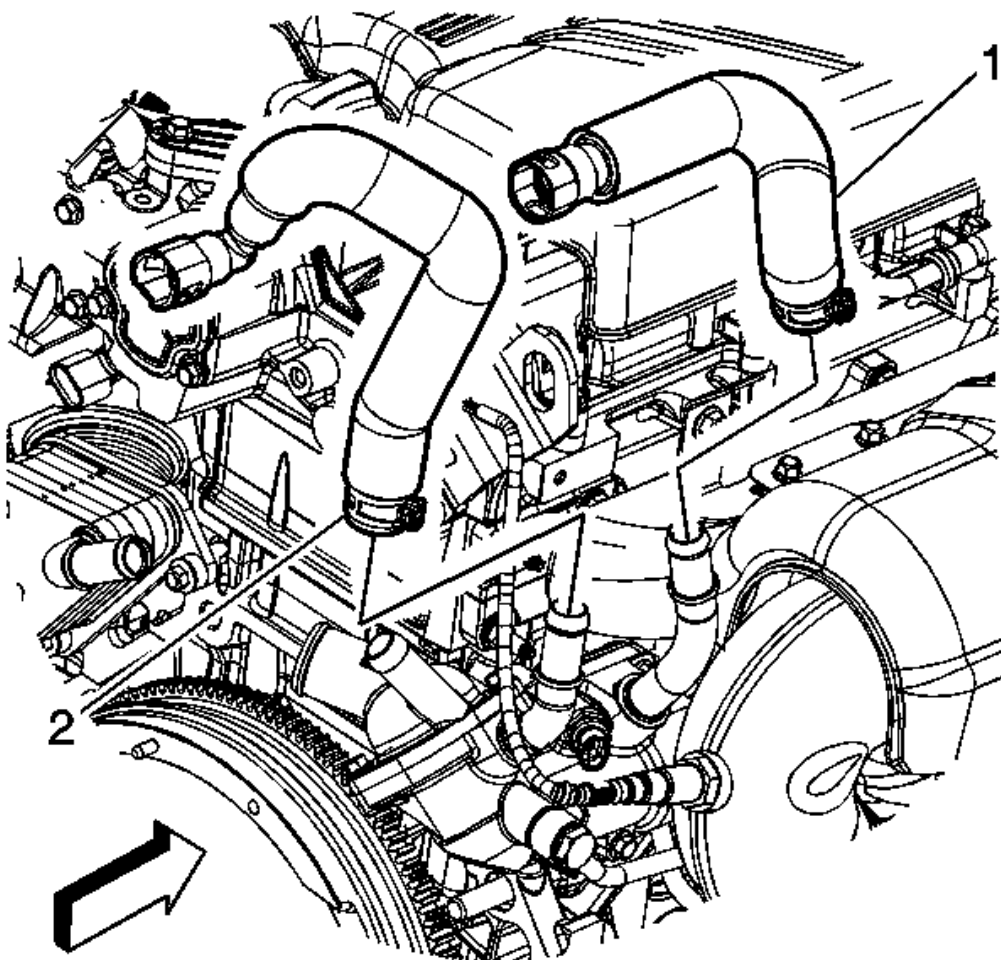


Fig. 449: Identifying Heater Inlet & Outlet Hoses & Clamps
Courtesy of GENERAL MOTORS CORP.

71. Install the heater inlet (1) and outlet (2) hoses to the thermostat housing.
72. Position the heater inlet and outlet hose clamps at the thermostat housing.

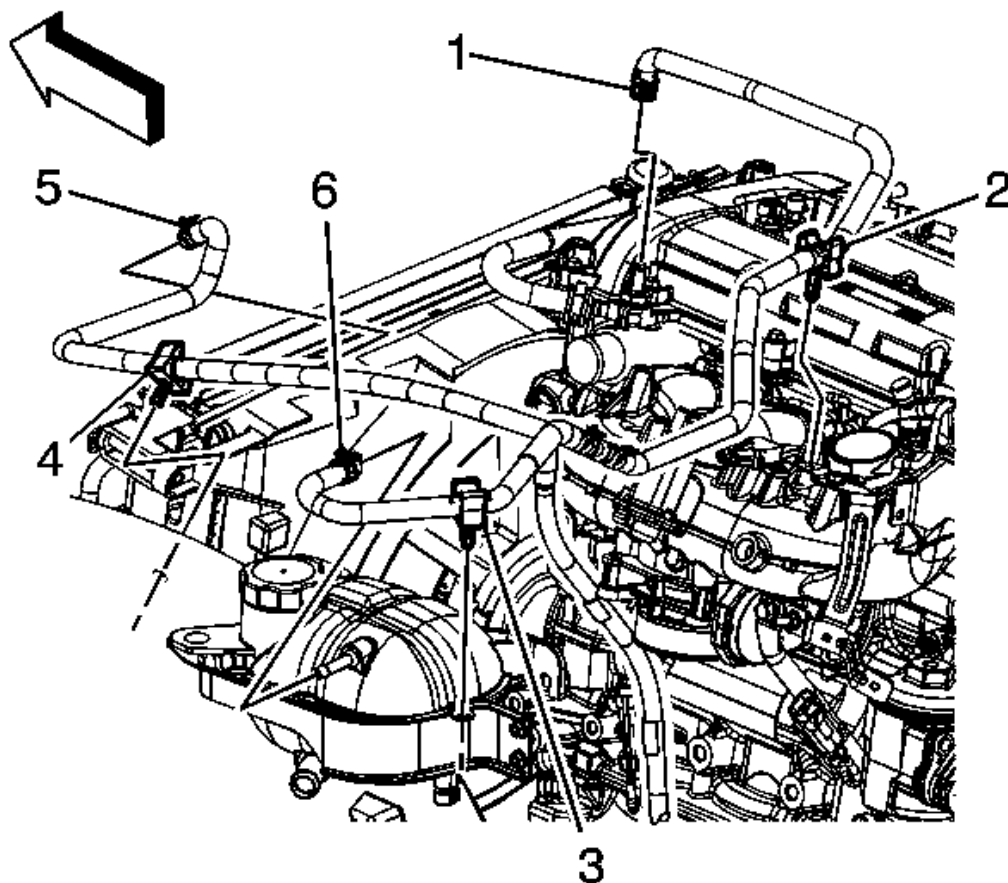


Fig. 450: Identifying Surge Tank Hose Components
Courtesy of GENERAL MOTORS CORP.

- 73. Position the air bleed hose to the engine.
- 74. Install the surge tank air bleed hose to the engine.
- 75. Install the surge tank air bleed hose clip (3) to the surge tank bracket.
- 76. Position the surge tank air bleed hose clamp (1) at the engine.

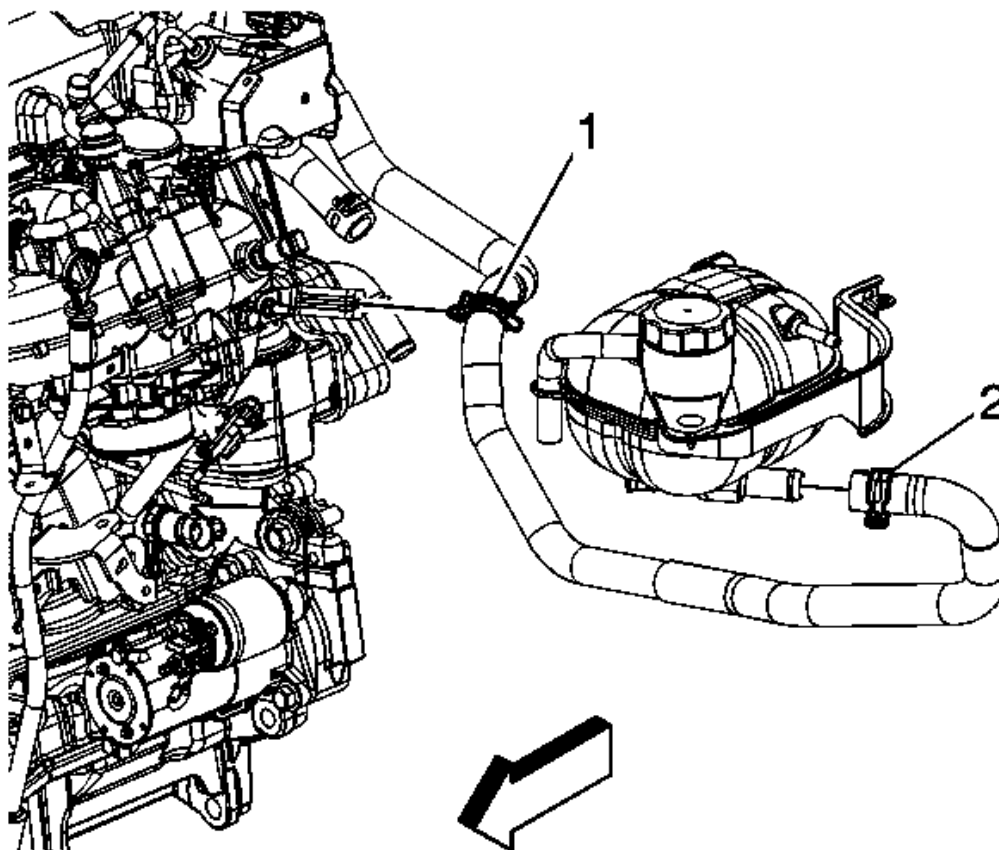


Fig. 451: Identifying Surge Tank Outlet Hose Clamp (At Surge Tank)
 Courtesy of GENERAL MOTORS CORP.

77. Install the surge tank clip (1) to the oil level indicator tube bracket.
78. Position the surge tank outlet hose clamp (2) at the surge tank.

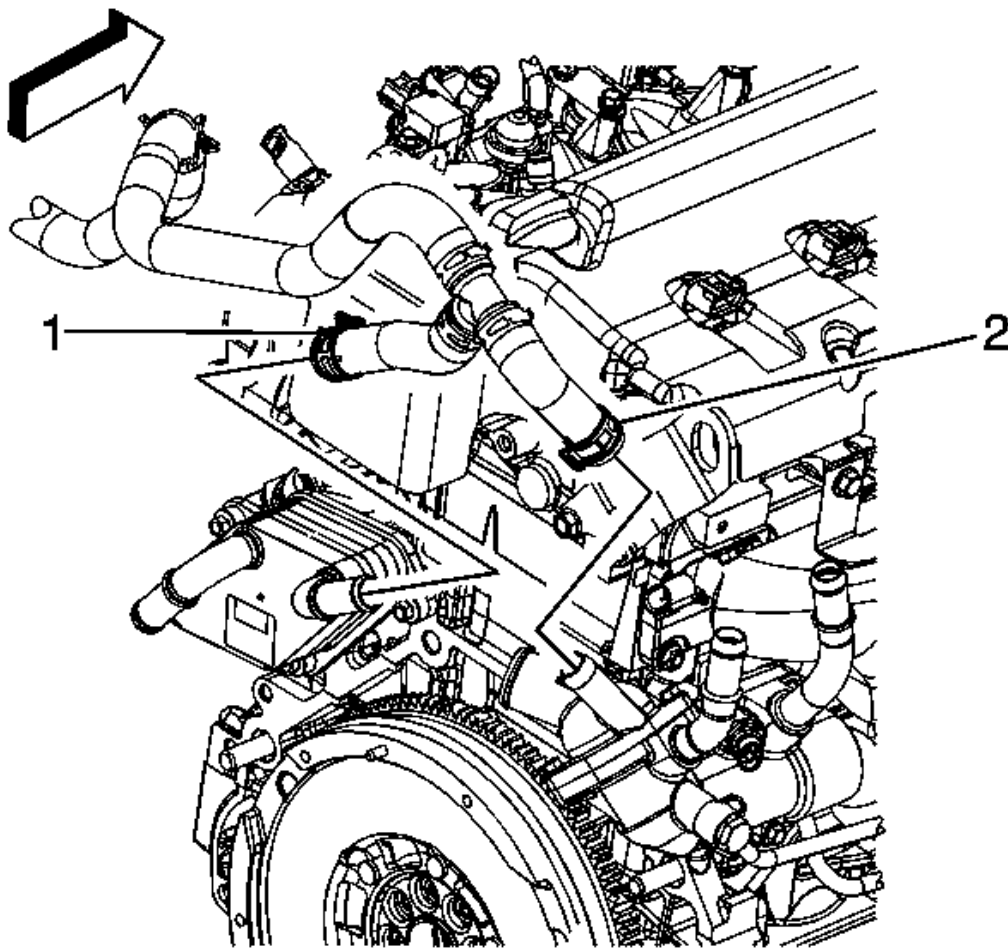


Fig. 452: Identifying Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

79. Install the surge tank outlet hose to the thermostat housing and oil cooler.
80. Position the surge tank outlet hose clamp (1) at the oil cooler.
81. Position the surge tank outlet hose clamp (2) at the thermostat housing.

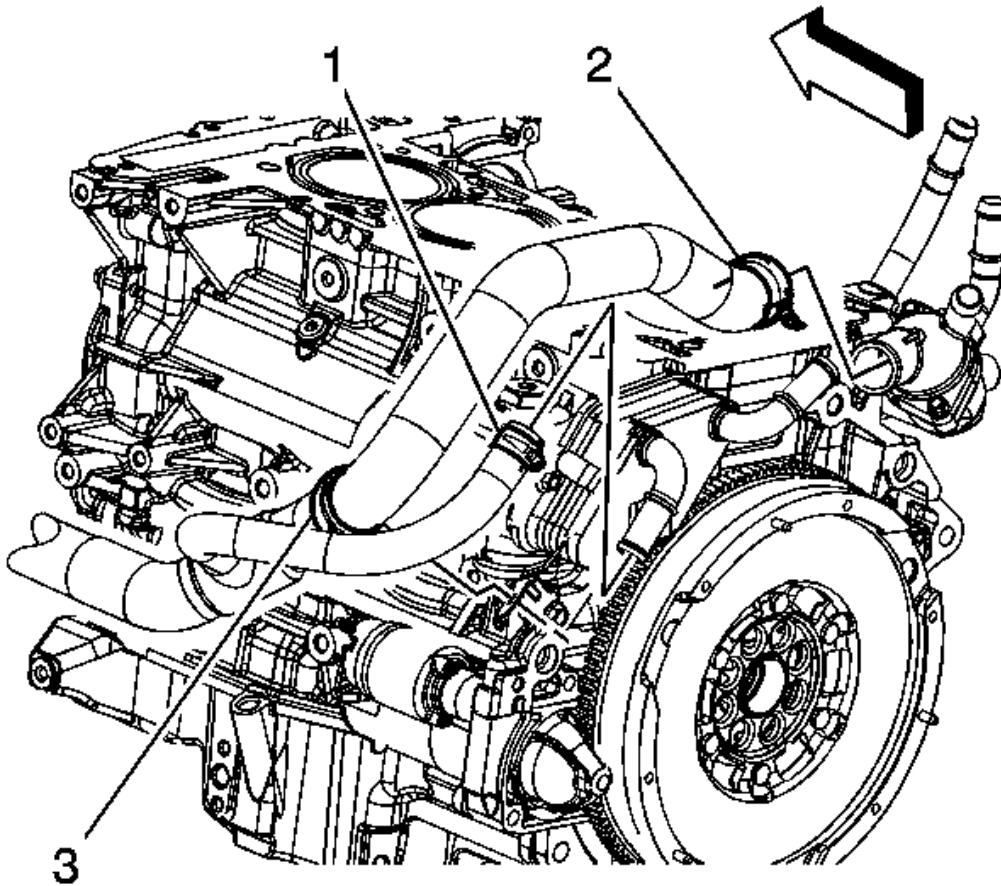


Fig. 453: Identifying Radiator Outlet Hose Components
 Courtesy of GENERAL MOTORS CORP.

82. Position the outlet hose to the engine.
83. Install the radiator outlet hose clip (3) to the bracket.
84. Install the radiator outlet hose to the thermostat housing and oil cooler.
85. Position the radiator outlet hose clamp (1) at the oil cooler.
86. Position the radiator outlet hose clamp (2) at the thermostat housing.

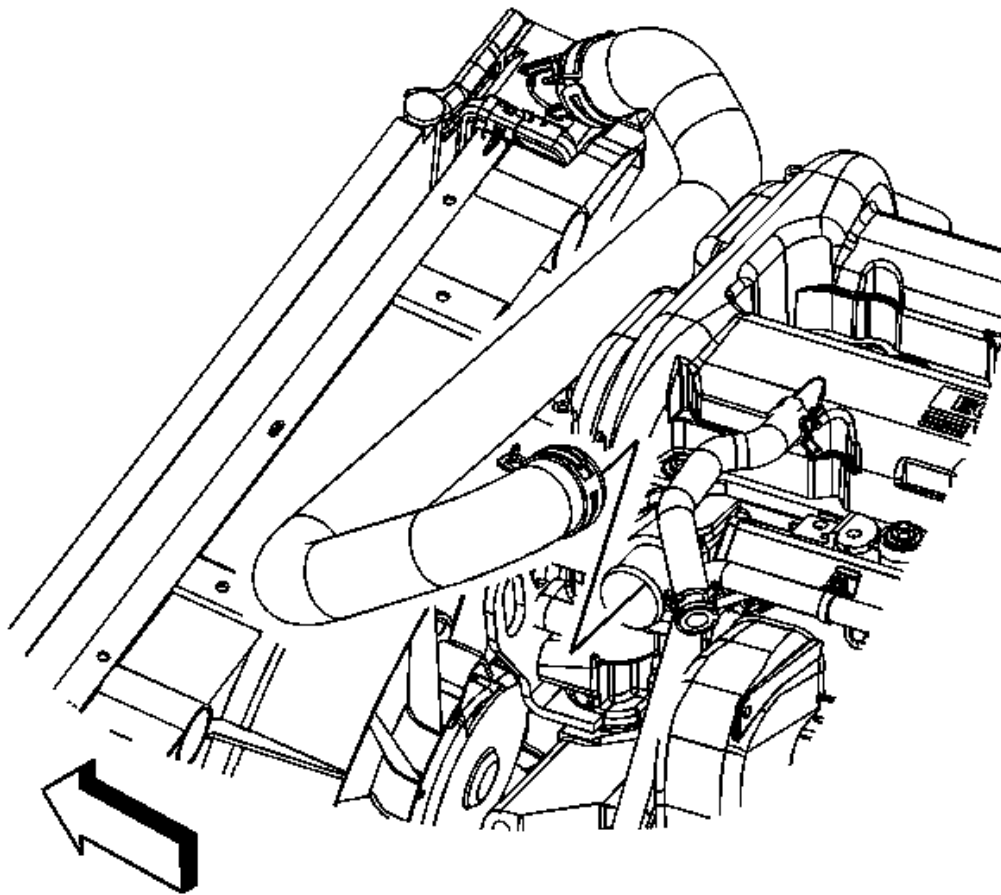


Fig. 454: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

87. Position the inlet hose to the engine.
88. Install the radiator inlet hose to the engine.
89. Position the radiator inlet hose clamp at the engine.

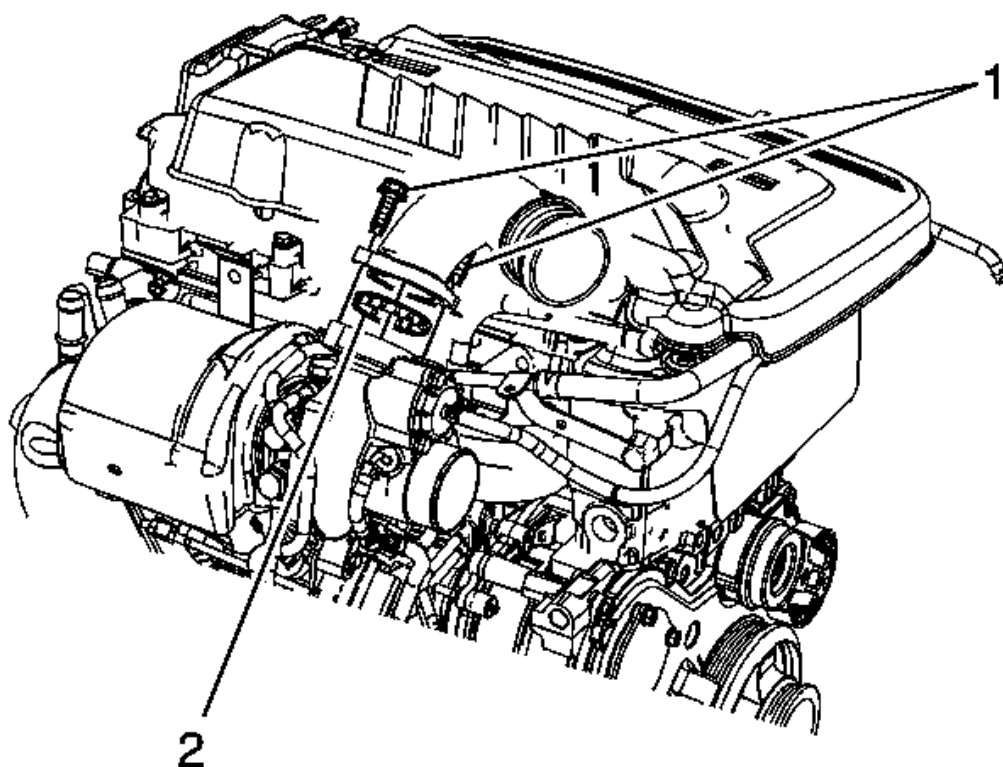


Fig. 455: Identifying Charge Air Cooler Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

90. Remove the cap or plug from the turbocharger opening.
91. Install the charge air cooler pipe to the turbocharger.
92. Install the charge air cooler pipe to turbocharger bolts (1) and tighten to 22 N.m (16 lb ft).

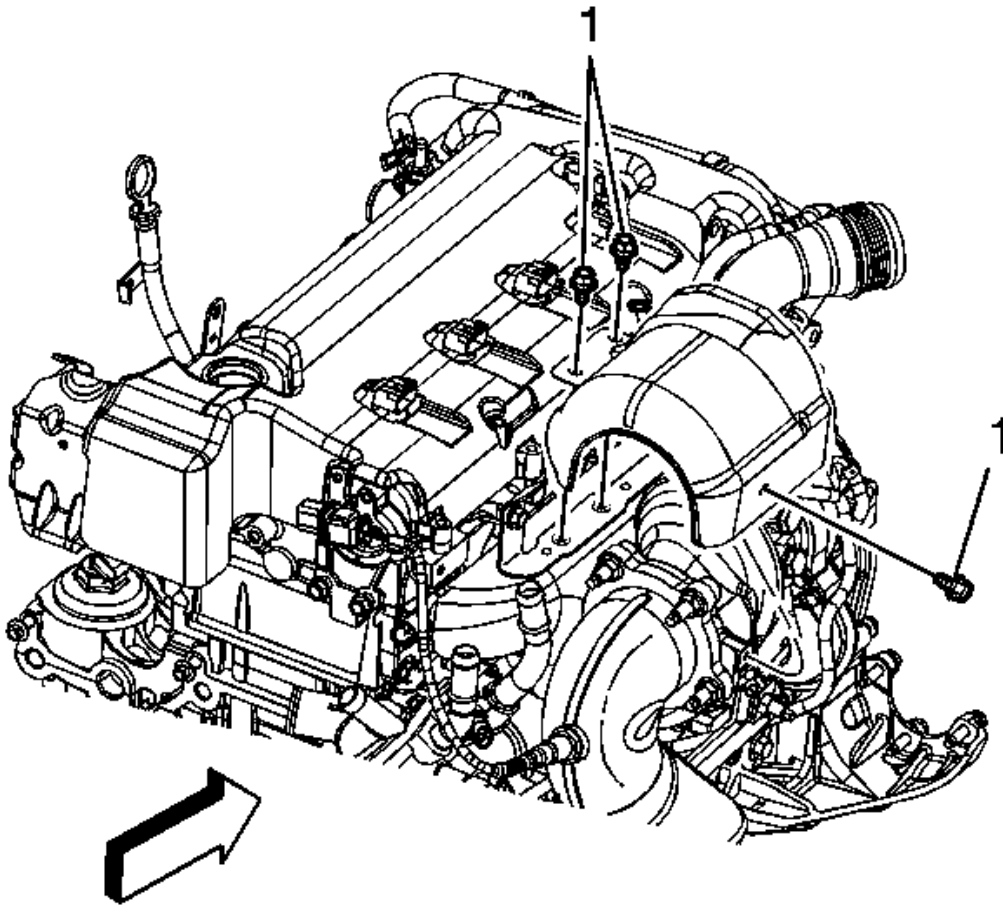


Fig. 456: Identifying Turbocharger Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

93. Install the turbocharger heat shield and bolts (1) and tighten to 10 N.m (89 lb in).
94. Install the starter. Refer to **Starter Replacement** .
95. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
96. Install the charge air cooler inlet and outlet pipes. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .

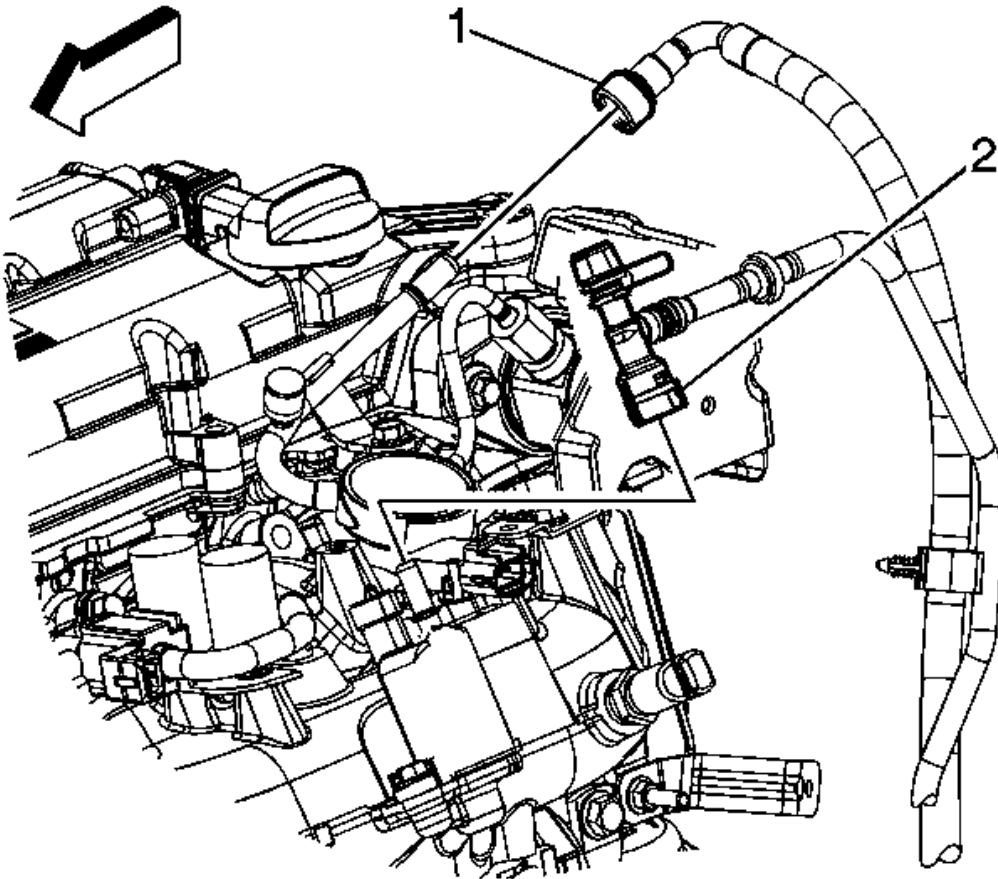


Fig. 457: Identifying EVAP & Fuel Feed Pipes
Courtesy of GENERAL MOTORS CORP.

97. Connect the fuel feed pipe (1) to the fuel line. Refer to **Metal Collar Quick Connect Fitting Service** .
98. Connect the EVAP canister purge solenoid tube to the valve (2). Refer to **Plastic Collar Quick Connect Fitting Service** .
99. Install the radiator. Refer to **Radiator Replacement** .
100. Install the drive belt. Refer to **Drive Belt Replacement**.
101. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
102. Install the hood. Refer to **Hood Replacement** .
103. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
104. Fill the engine with oil.

ENGINE OIL AND OIL FILTER REPLACEMENT

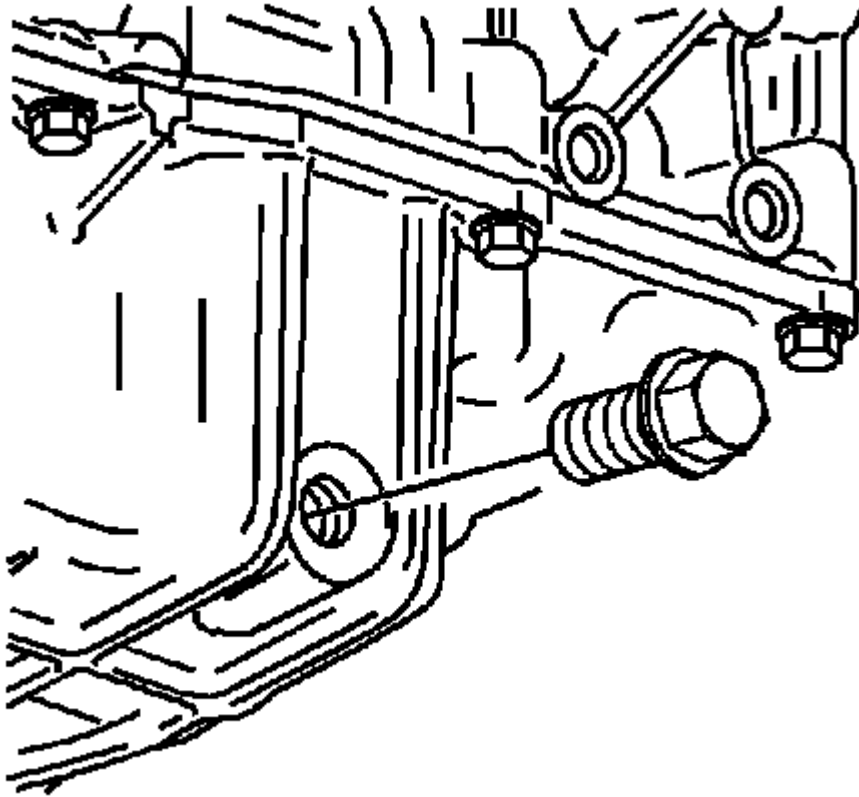
REMOVAL PROCEDURE

Fig. 458: View Of Oil Pan Drain Bolt
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

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

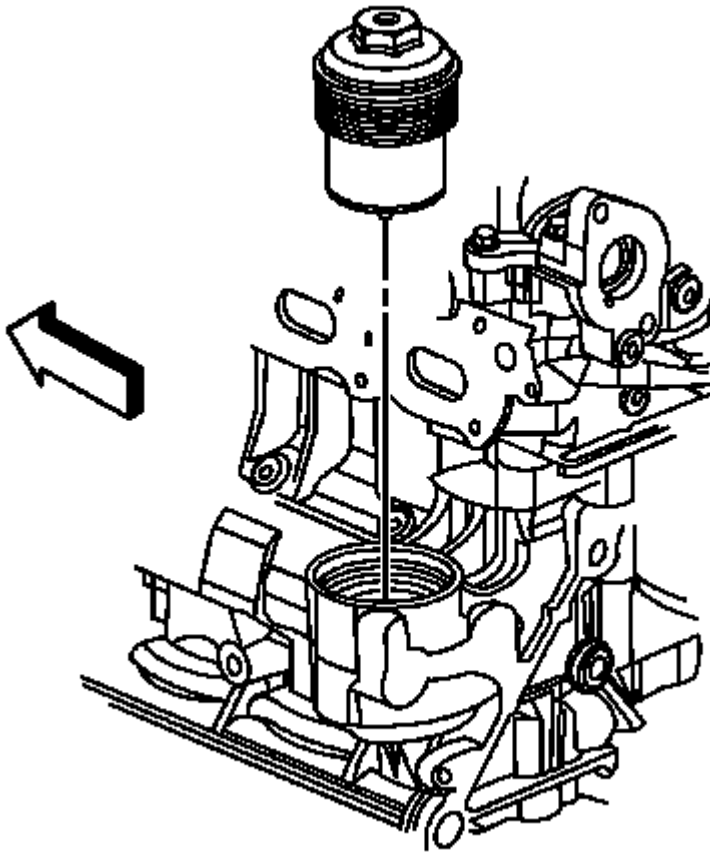


Fig. 459: Locating Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: **DO NOT** use an open end wrench on the hex on top of the oil filter cap.

6. Use a 32 mm (1 1/4 in) socket on the hex on top of the oil filter cap, or an oil filter wrench on the outside diameter of the oil filter cap.
7. Remove the oil filter cap and filter.

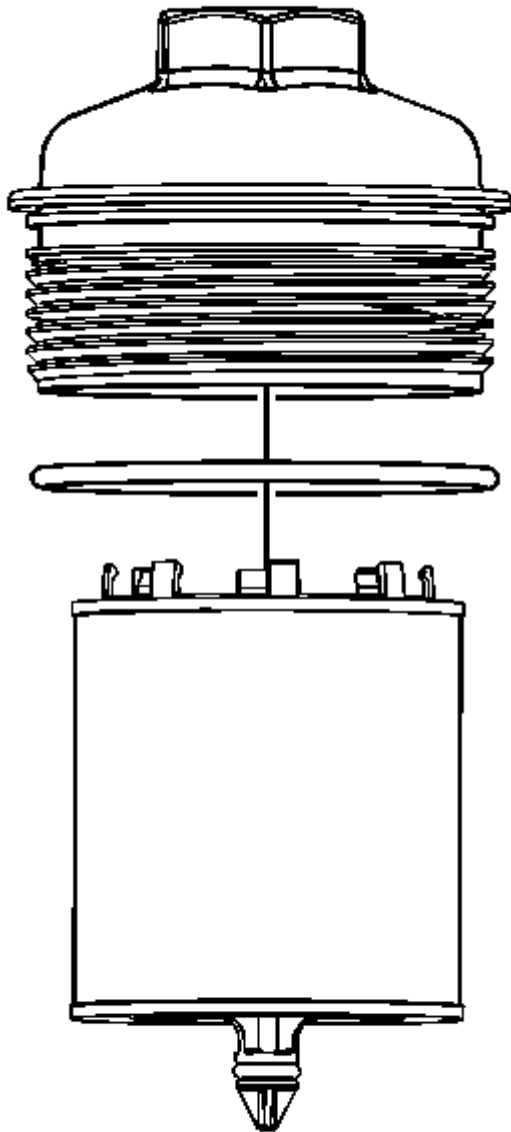


Fig. 460: View Of Oil Filter, Seal & Cap
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil filter from the oil filter cap.
9. Inspect the oil filter cap O-ring seal for damage, replace as necessary.

INSTALLATION PROCEDURE

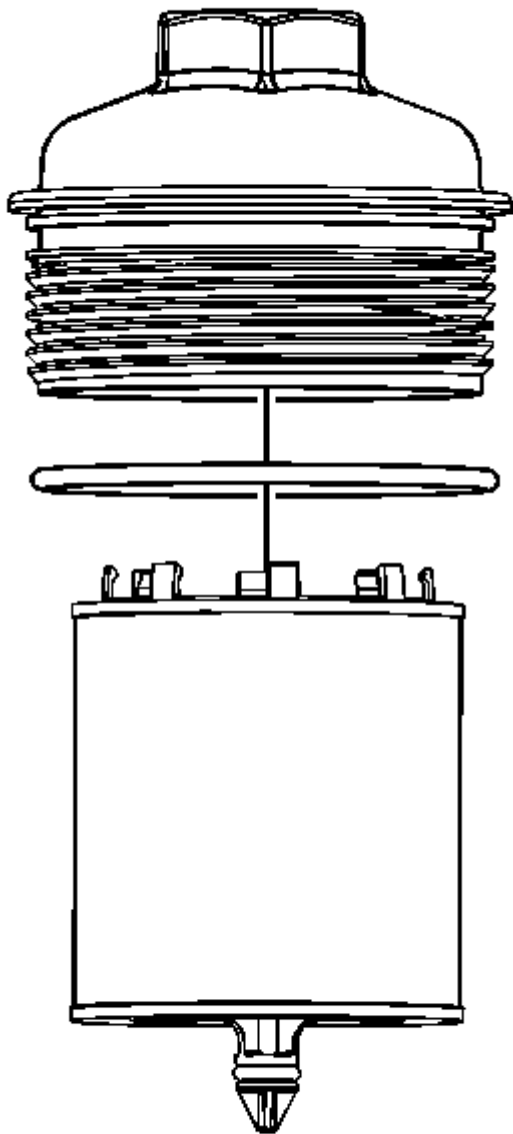


Fig. 461: View Of Oil Filter, Seal & Cap
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil filter to the oil filter cap.

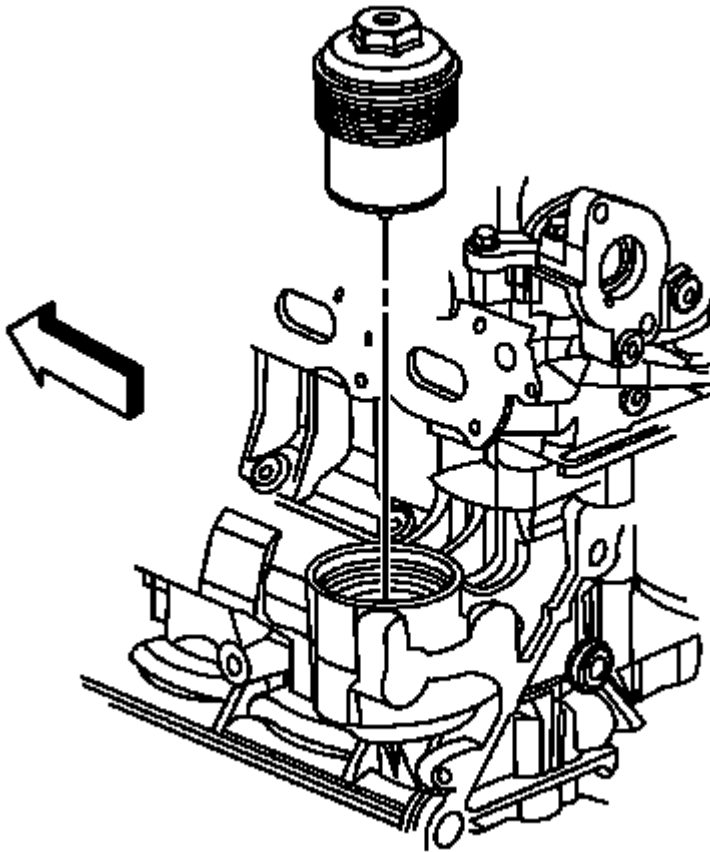


Fig. 462: Locating Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter cap and filter.

CAUTION: Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

NOTE: DO NOT use an open end wrench on the hex on top of the oil filter cap.

3. Use a 32 mm (1 1/4 in) socket on the hex on the top of the oil filter cap, or an oil filter wrench on the outside diameter of the oil filter cap.

Tighten the oil filter cap until fully seated. DO NOT exceed 25 N.m (18 lb ft).

4. Lower the vehicle.
5. Fill the engine with oil. Refer to **Fluid and Lubricant Recommendations (USA and Canada)**.