

2010 ENGINE**Engine Mechanical - 4.3L - Repair Instructions - On Vehicle - Express & Savana****DRIVE BELT REPLACEMENT****REMOVAL PROCEDURE**

1. Remove the coolant air cleaner outlet resonator duct. Refer to [Air Cleaner Outlet Resonator Replacement](#) .

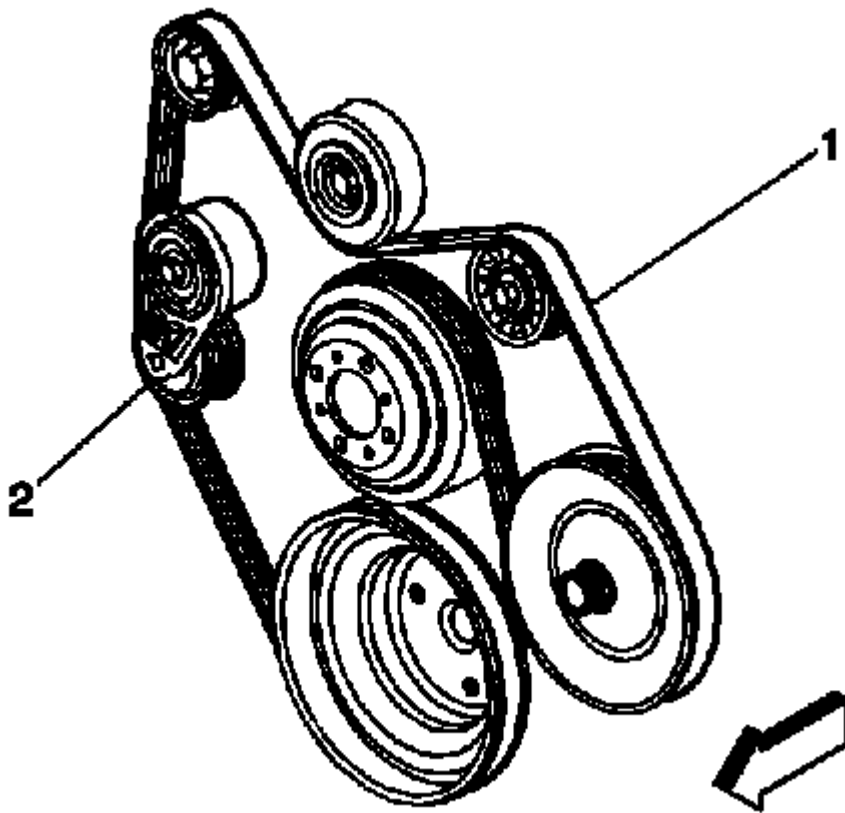


Fig. 1: Drive Belt Routing And Tensioner (W/O A/C
Courtesy of GENERAL MOTORS CORP.

2. Install a 3/8 inch drive breaker bar to the drive belt tensioner arm.
3. Rotate the drive belt tensioner (2) counterclockwise in order to relieve tension on the belt.
4. If equipped without air conditioning (A/C), remove the belt (1) from the pulleys and the drive belt tensioner.

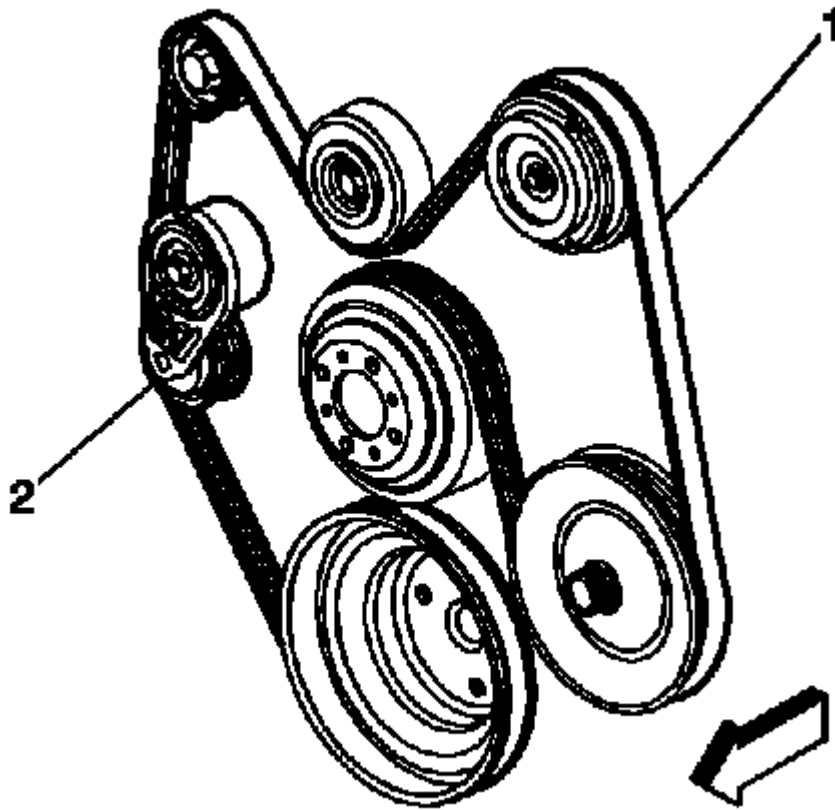


Fig. 2: Drive Belt Routing & Tensioner (W/ A/C)
Courtesy of GENERAL MOTORS CORP.

5. If equipped with A/C, remove the belt (1) from the pulleys and the drive belt tensioner.
6. Slowly release the tension on the drive belt tensioner (2).
7. Remove the breaker bar from the drive belt tensioner.
8. Clean and inspect the belt surfaces of all the pulleys.

INSTALLATION PROCEDURE

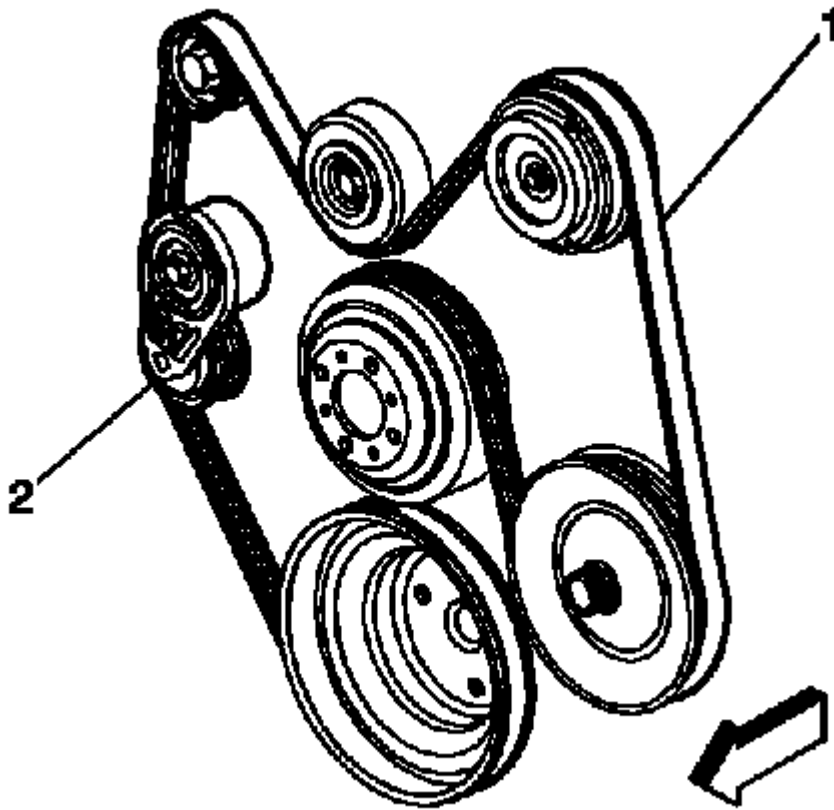


Fig. 3: Drive Belt Routing & Tensioner (W/ A/C)
Courtesy of GENERAL MOTORS CORP.

1. Route the belt (1) around all the pulleys except the flat idler pulley.
2. Install a 3/8 inch drive breaker bar to the drive belt tensioner arm.
3. Rotate the belt tensioner (2) counterclockwise in order to relieve the tension on the tensioner.
4. If equipped with A/C, install the belt under the flat idler pulley.

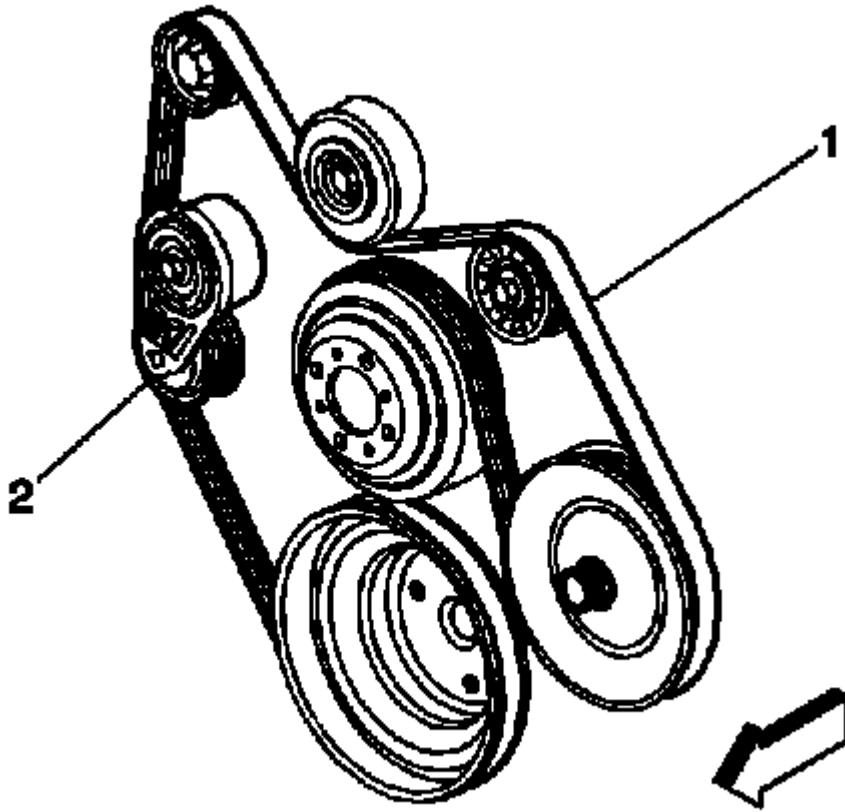


Fig. 4: Drive Belt Routing And Tensioner (W/O A/C
Courtesy of GENERAL MOTORS CORP.

5. If equipped without A/C, install the belt (1) to the pulleys and the drive belt tensioner.
6. Slowly release the tension on the belt tensioner (2).
7. Remove the breaker bar from the drive belt tensioner.
8. Inspect the drive belt for proper installation and alignment.
9. Install the coolant air cleaner outlet resonator duct. Refer to **Air Cleaner Outlet Resonator Replacement** .

DRIVE BELT TENSIONER REPLACEMENT

REMOVAL PROCEDURE

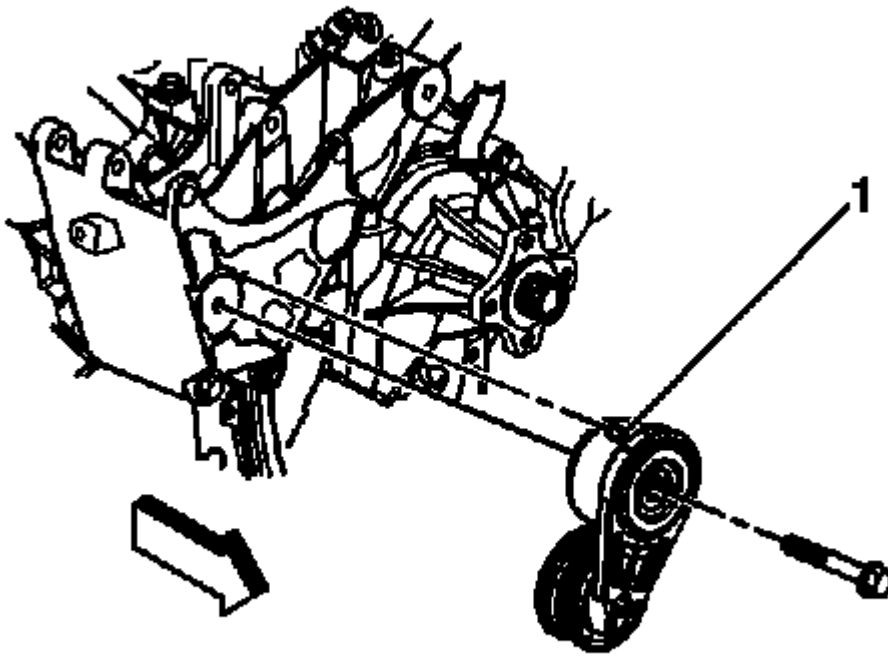


Fig. 5: View Of Drive Belt Tensioner Locating Pin
Courtesy of GENERAL MOTORS CORP.

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

Ensure that there is a locating pin (1) on the tensioner.

INSTALLATION PROCEDURE

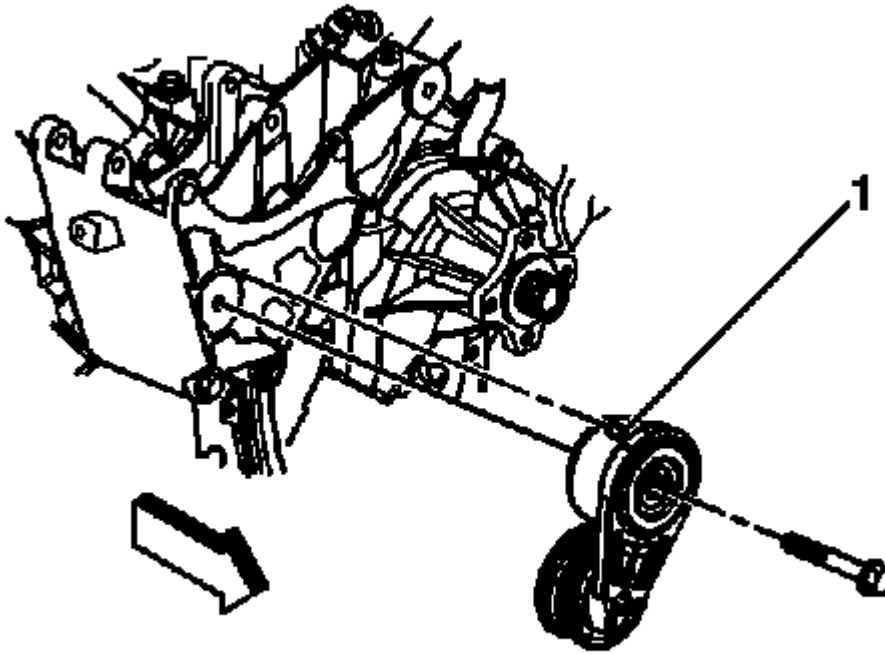


Fig. 6: View Of Drive Belt Tensioner Locating Pin
Courtesy of GENERAL MOTORS CORP.

1. Install the belt tensioner. Position the locating pin (1) on the tensioner into the hole in the generator bracket.

CAUTION: Refer to Fastener Caution .

2. Install the belt tensioner bolt and tighten to 50 N.m (37 lb ft).
3. Install the drive belt. Refer to Drive Belt Replacement.

DRIVE BELT IDLER PULLEY REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

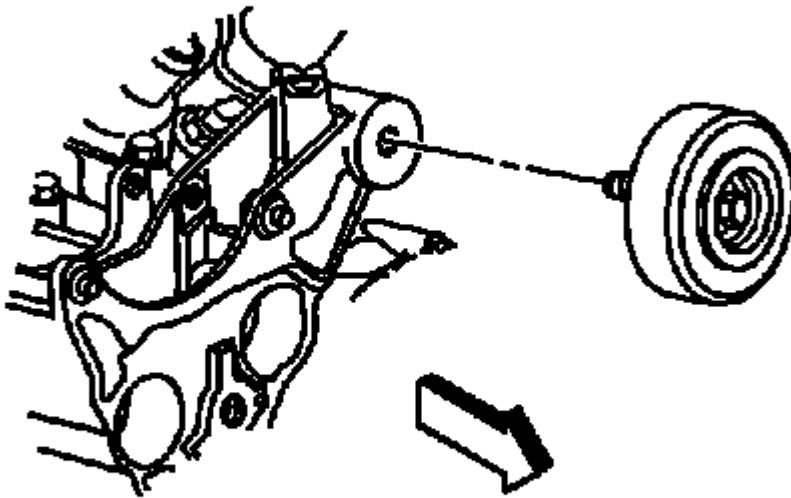


Fig. 7: View Of Right Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

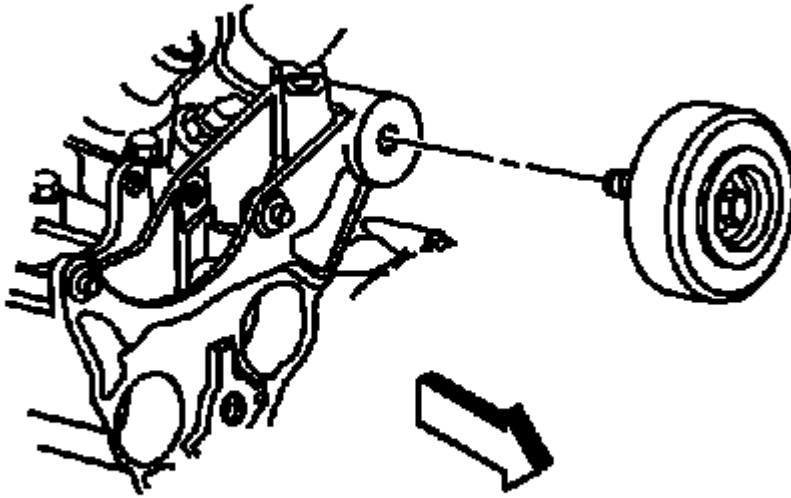


Fig. 8: View Of Right Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Install the idler pulley.
2. Install the idler pulley bolt until snug.
3. Install the drive belt. Refer to **Drive Belt Replacement**.

CAUTION: Refer to **Fastener Caution** .

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

DRIVE BELT IDLER PULLEY REPLACEMENT - WITHOUT AIR CONDITIONING

REMOVAL PROCEDURE

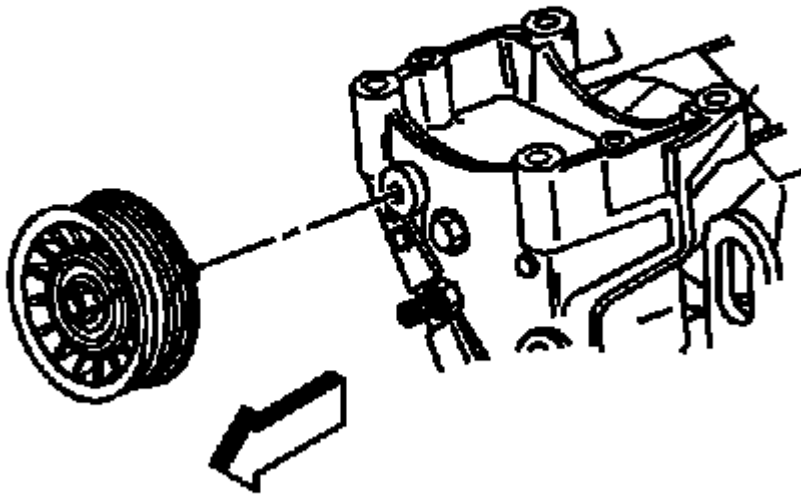


Fig. 9: View Of Drive Belt Idler Pulley (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

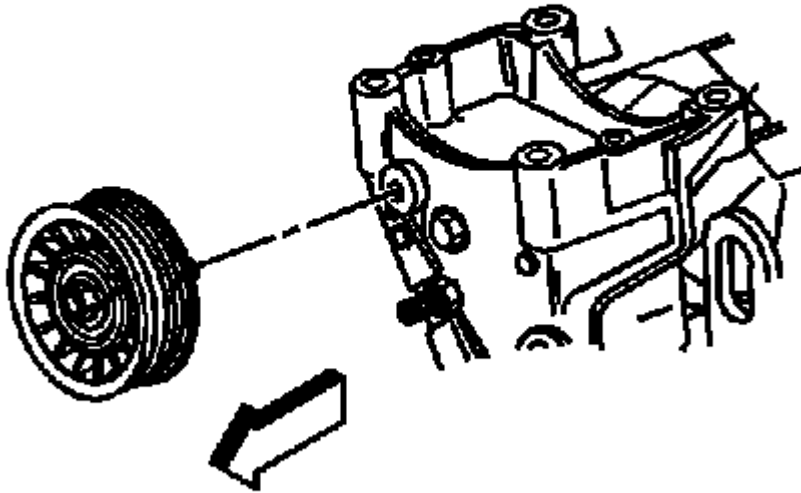


Fig. 10: View Of Drive Belt Idler Pulley (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Install the idler pulley.
2. Install the idler pulley bolt until snug.
3. Install the drive belt. Refer to **Drive Belt Replacement**.

CAUTION: Refer to Fastener Caution .

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

ENGINE MOUNT INSPECTION

CAUTION: Refer to Engine Mounting Caution .

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Inspect for loose or missing bolts at the following locations:

- Engine mount bracket to engine
 - Engine mount frame bracket to frame
 - Engine mount to engine mount bracket
 - Engine mount to engine mount frame bracket
3. Replace missing or loose bolts.

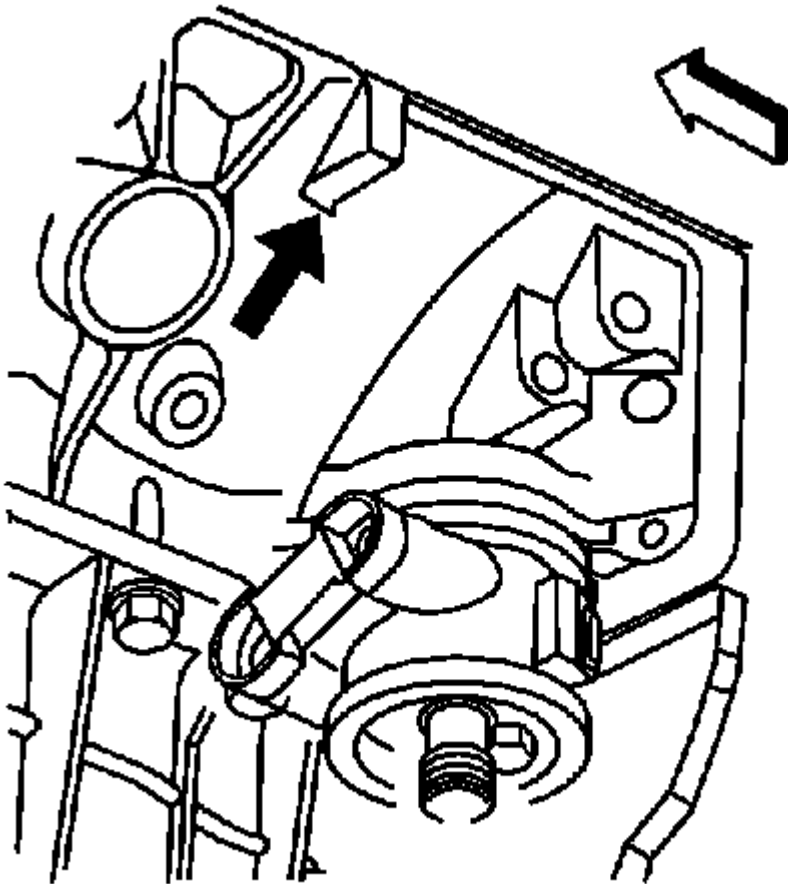


Fig. 11: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Lifting Caution .

4. In order to access the square tab on the right side of the engine remove the starter. Refer to **Starter Replacement (V6)** .
5. Using a jack on the square tab at the rear of the engine block (left side shown) raise the engine in order to complete the following tasks:
- Remove weight from the engine mount.
 - Place a slight tension on the rubber cushion.

- Observe the engine mount while raising the engine.
6. Replace the engine mount if the following conditions exist:
 - Heat check cracks cover the hard rubber surface.
 - The rubber cushion is separated from the metal plate of the engine mount.
 - There is a split through the rubber cushion.
 7. Install the starter, if removed. Refer to **Starter Replacement (V6)** .

ENGINE MOUNT REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

CAUTION: Refer to **Engine Mounting Caution** .

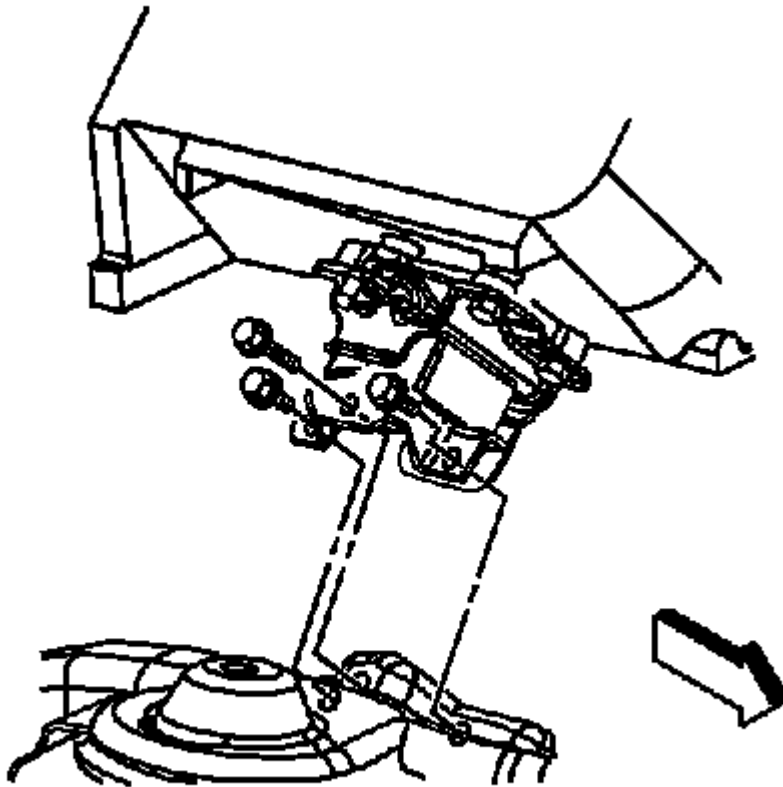


Fig. 12: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. From under the hood, remove the engine mount to engine mount bracket bolts.

2. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .

CAUTION: Refer to Engine Lifting Caution .

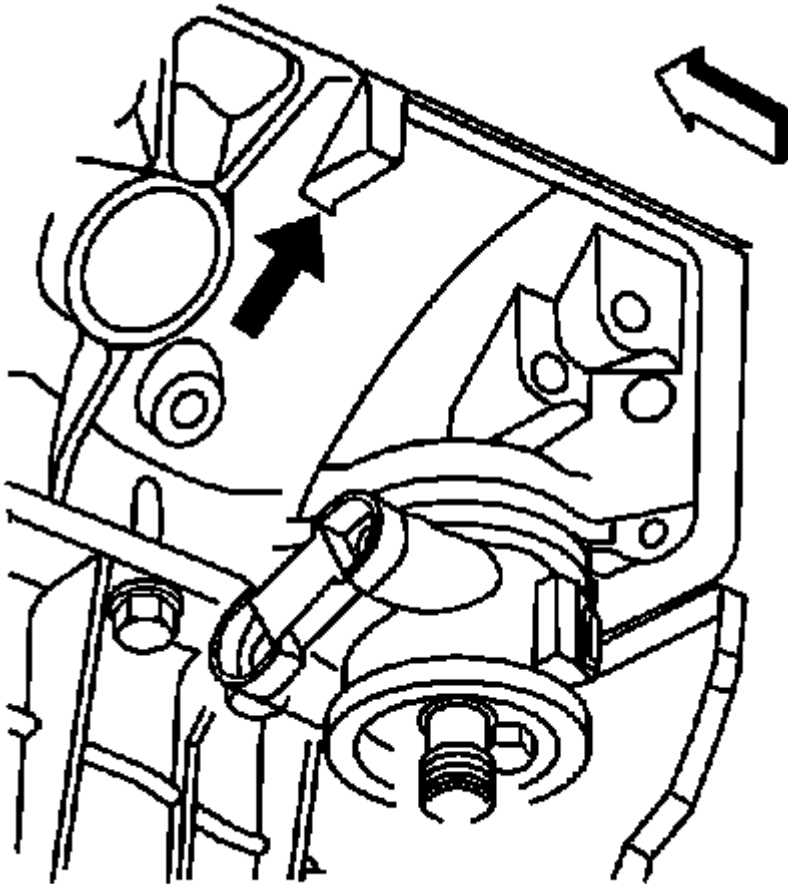


Fig. 13: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

3. Using an adjustable jack on the square tab at the rear of the engine block, raise the engine.

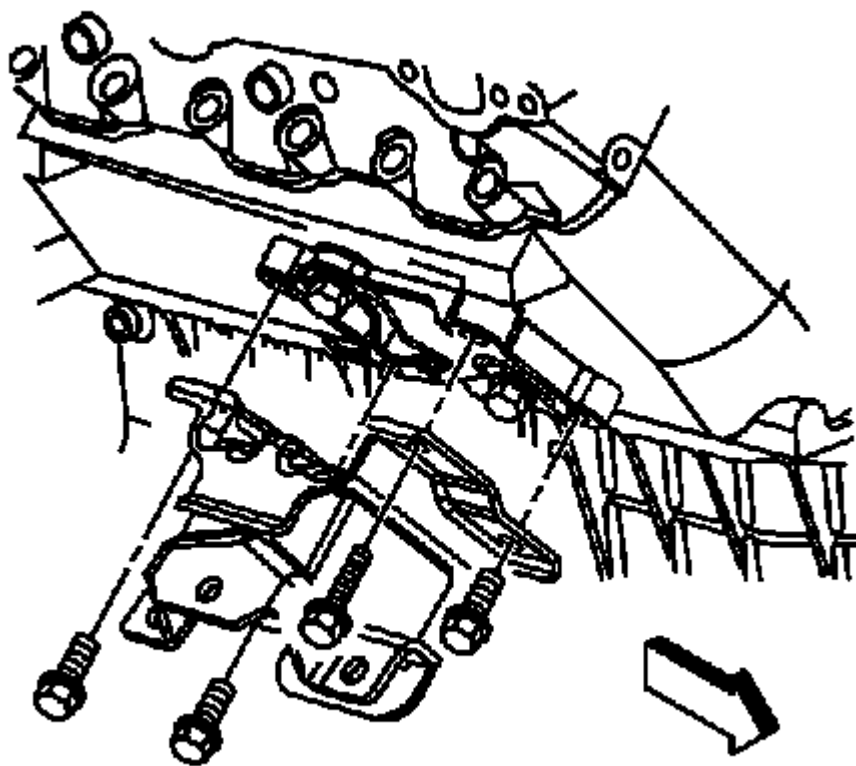


Fig. 14: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount bolts.
5. Remove the engine mount.

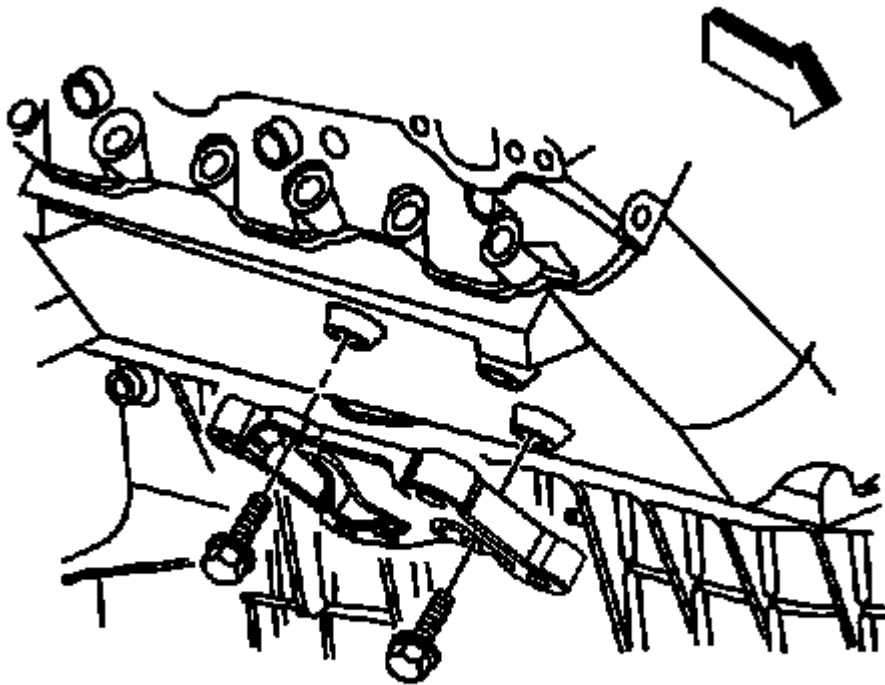


Fig. 15: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

6. If equipped and necessary, remove the engine mount side bracket bolts and bracket.

INSTALLATION PROCEDURE

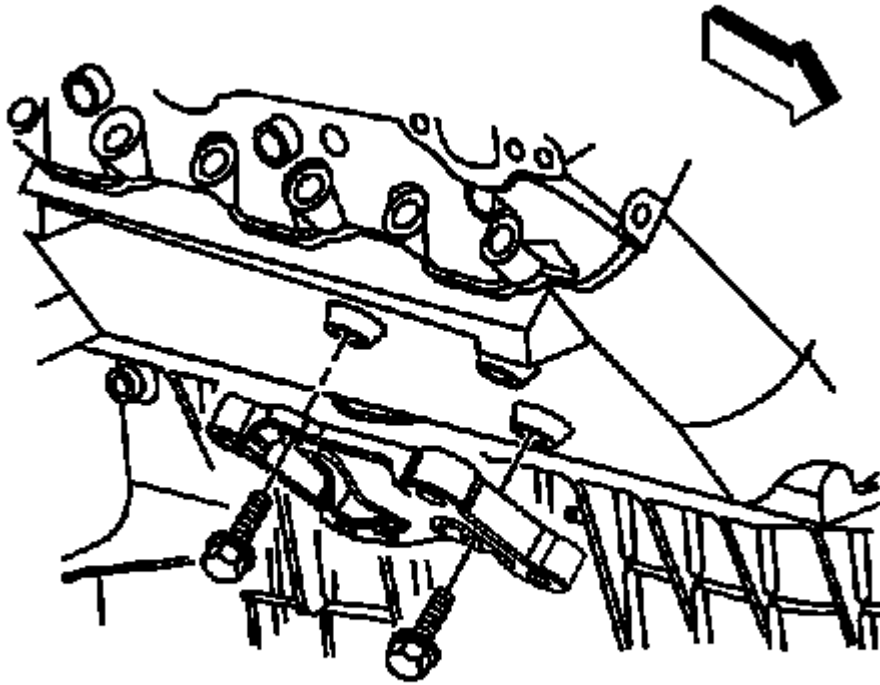


Fig. 16: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount side bracket to the engine, if removed and equipped.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount side bracket bolts and tighten to 50 N.m (37 lb ft).

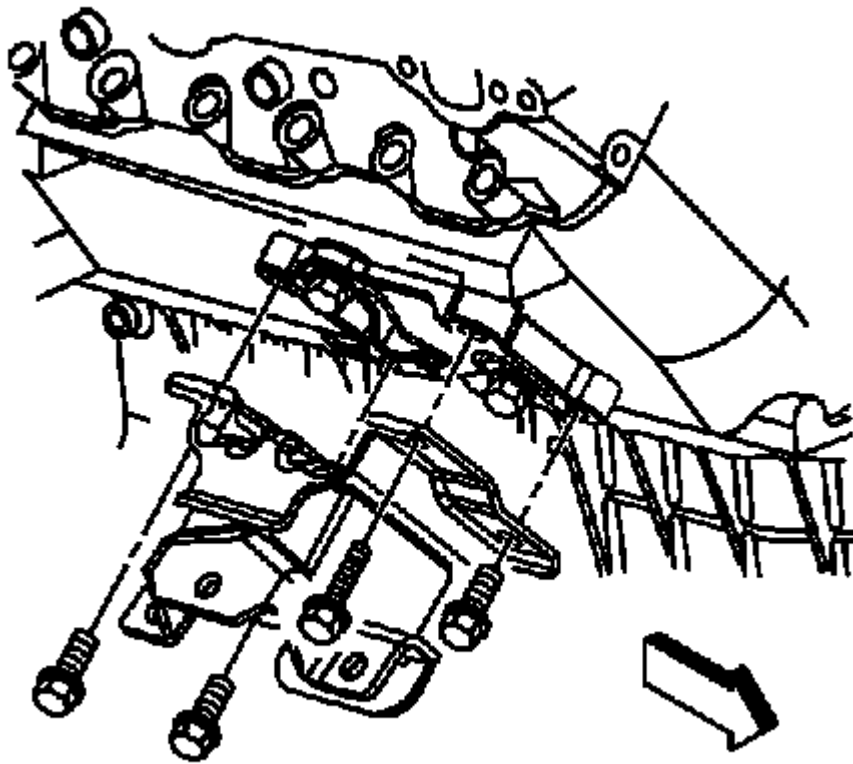


Fig. 17: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount.
4. Install the engine mount bolts and tighten to 50 N.m (37 lb ft).
5. Lower the engine.
6. Lower the vehicle.

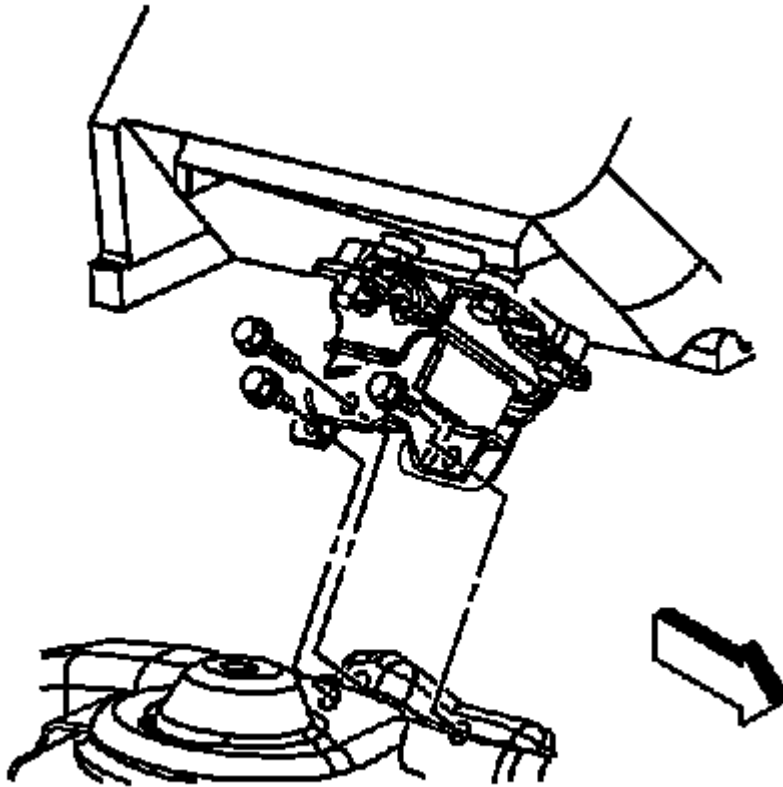


Fig. 18: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the engine mount to engine mount bracket bolts and tighten to 65 N.m (48 lb ft).

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

CAUTION: Refer to Engine Mounting Caution .

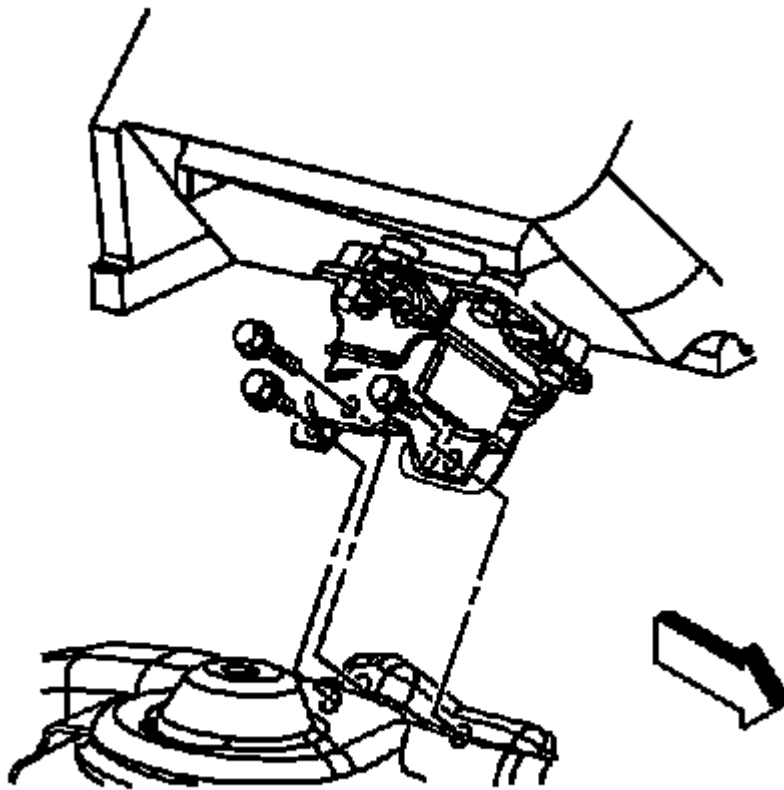


Fig. 19: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. From under the hood, remove the engine mount to engine mount bracket bolts.
2. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

CAUTION: Refer to **Engine Lifting Caution** .

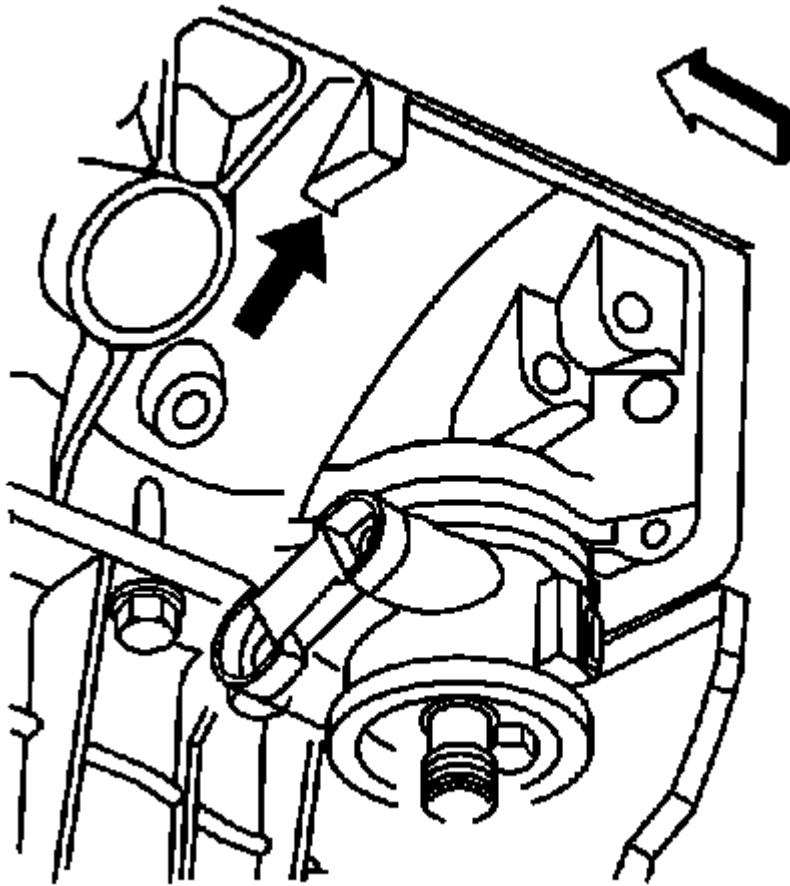


Fig. 20: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

3. Using an adjustable jack on the square tab (left side shown) at the rear of the engine block, raise the engine. In order to access the square tab, remove the starter. Refer to **Starter Replacement (V6)** .

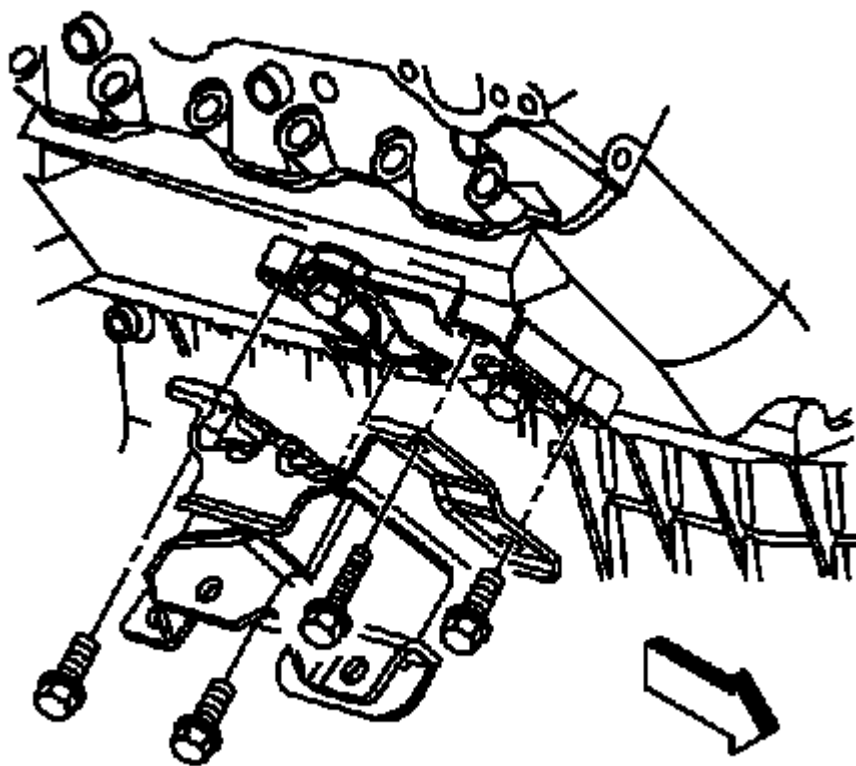


Fig. 21: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount bolts.
5. Remove the engine mount.

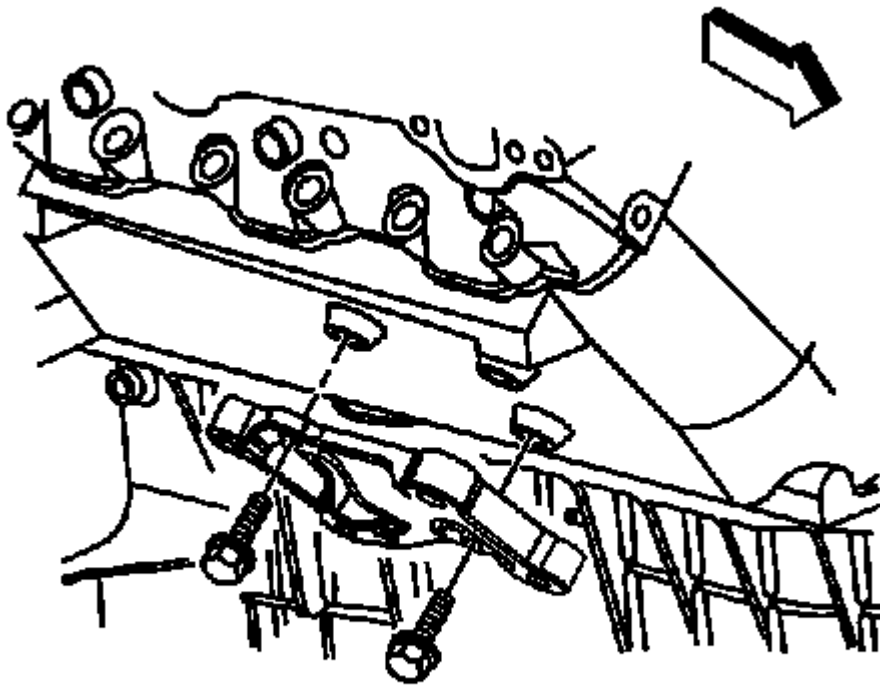


Fig. 22: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

6. If necessary, remove the engine mount side bracket bolts and bracket.

INSTALLATION PROCEDURE

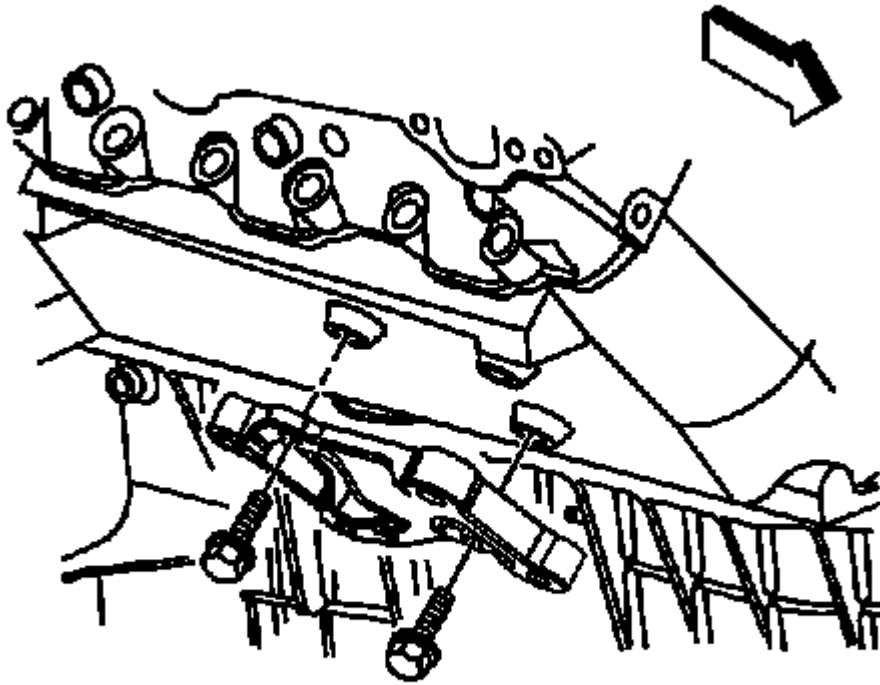


Fig. 23: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount side bracket to the engine, if removed.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount side bracket bolts and tighten to 50 N.m (37 lb ft).

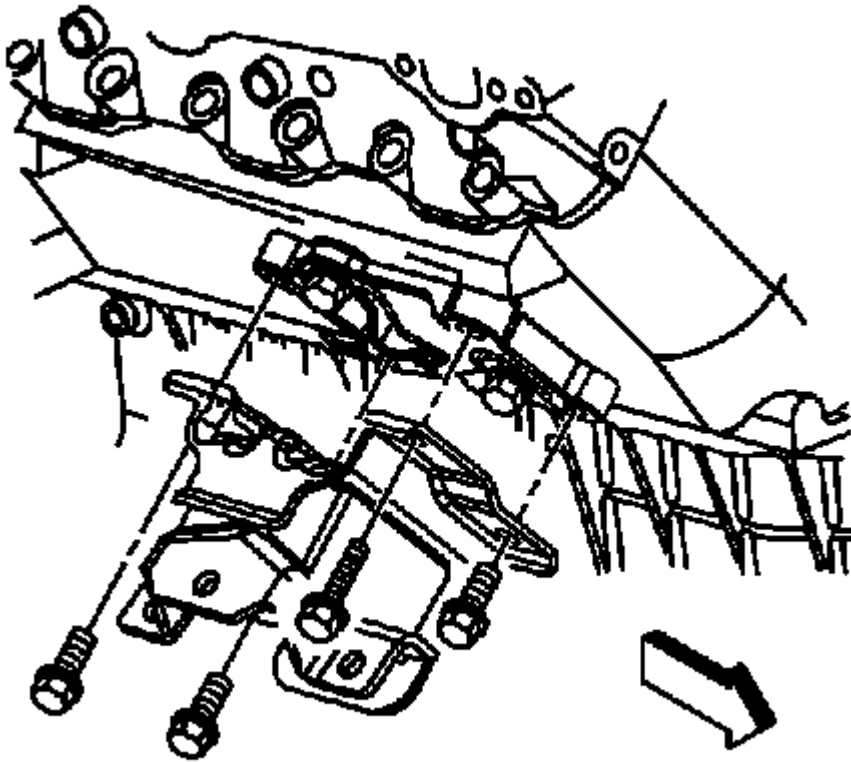


Fig. 24: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount.
4. Install the engine mount bolts and tighten to 50 N.m (37 lb ft).
5. Lower the engine.
6. Install the starter. Refer to **Starter Replacement (V6)** .
7. Lower the vehicle.

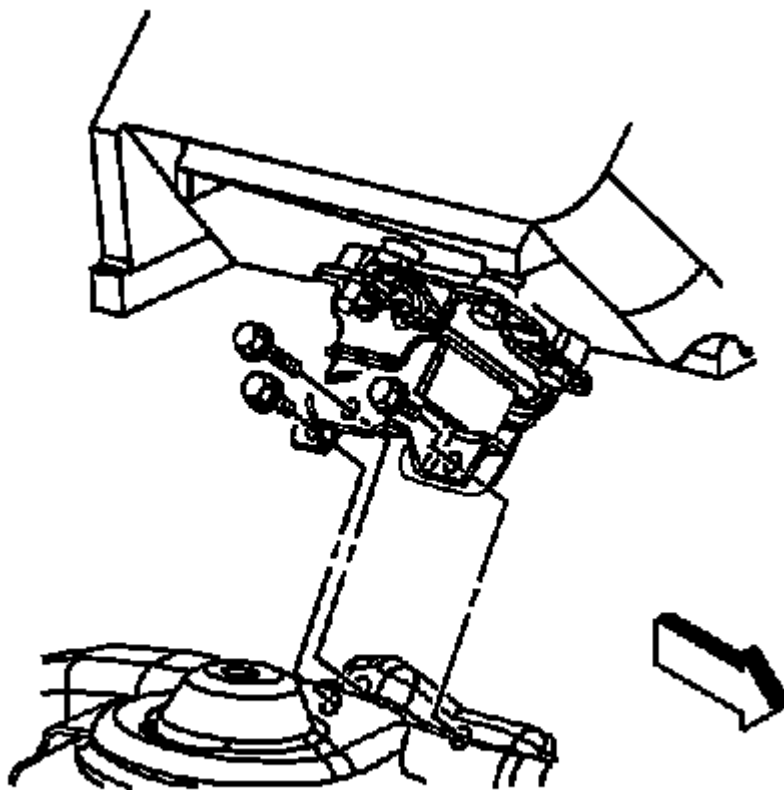


Fig. 25: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the engine mount to engine mount bracket bolts and tighten to 65 N.m (48 lb ft).

ENGINE MOUNT ADAPTER REPLACEMENT

REMOVAL PROCEDURE

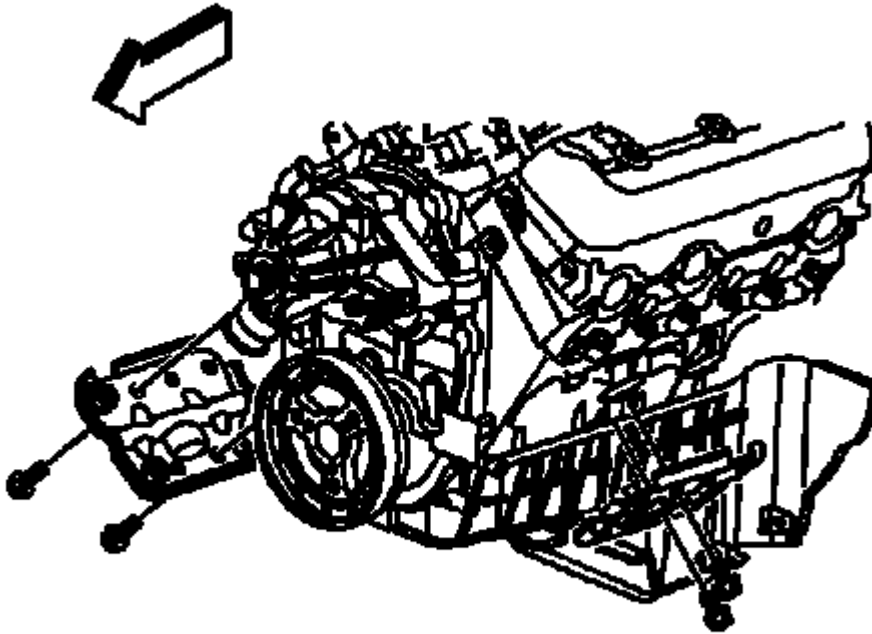


Fig. 26: Identifying Engine Mount Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Remove the engine mount. Refer to Engine Mount Replacement - Left Side or Engine Mount Replacement - Right Side.
3. Remove the engine mount adapter mounting bolts.
4. Remove the engine mount adapter.

INSTALLATION PROCEDURE

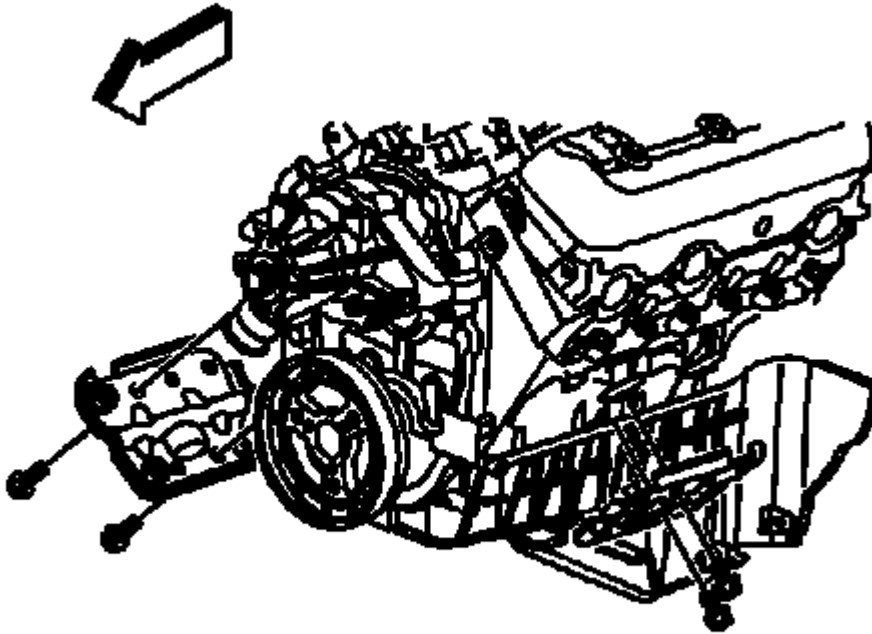


Fig. 27: Identifying Engine Mount Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount adapter.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount adapter mounting bolts and tighten to 50 N.m (37 lb ft).
3. Install the engine mount. Refer to Engine Mount Replacement - Left Side or Engine Mount Replacement - Right Side.
4. Lower the vehicle.

OIL FILLER TUBE REPLACEMENT

REMOVAL PROCEDURE

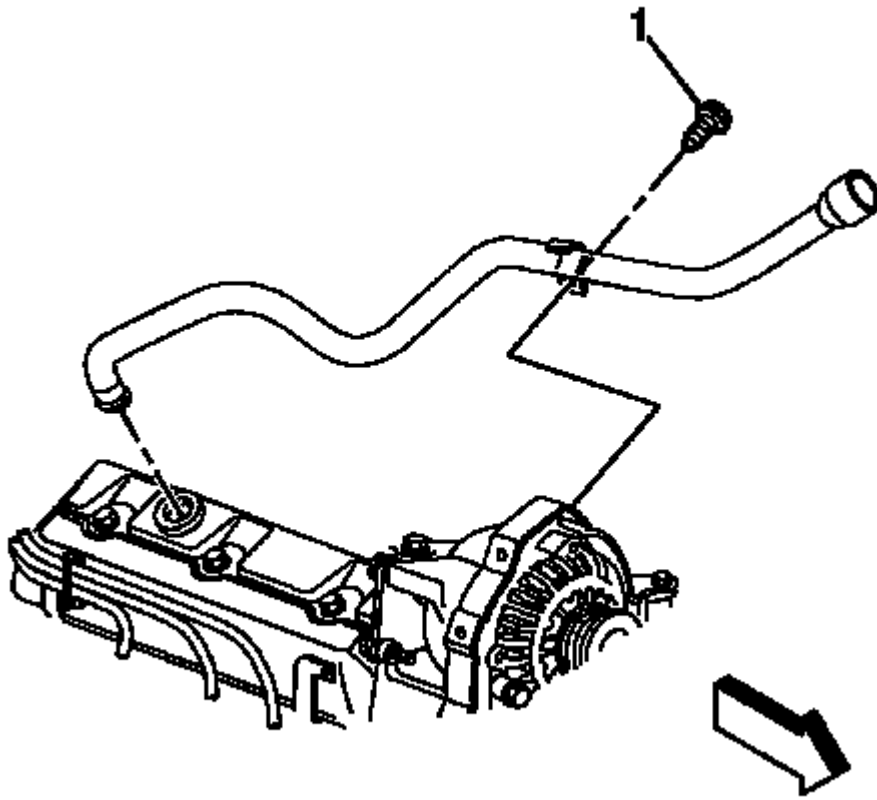


Fig. 28: View Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the oil fill tube bolt (1).
3. Remove the oil fill tube.

INSTALLATION PROCEDURE

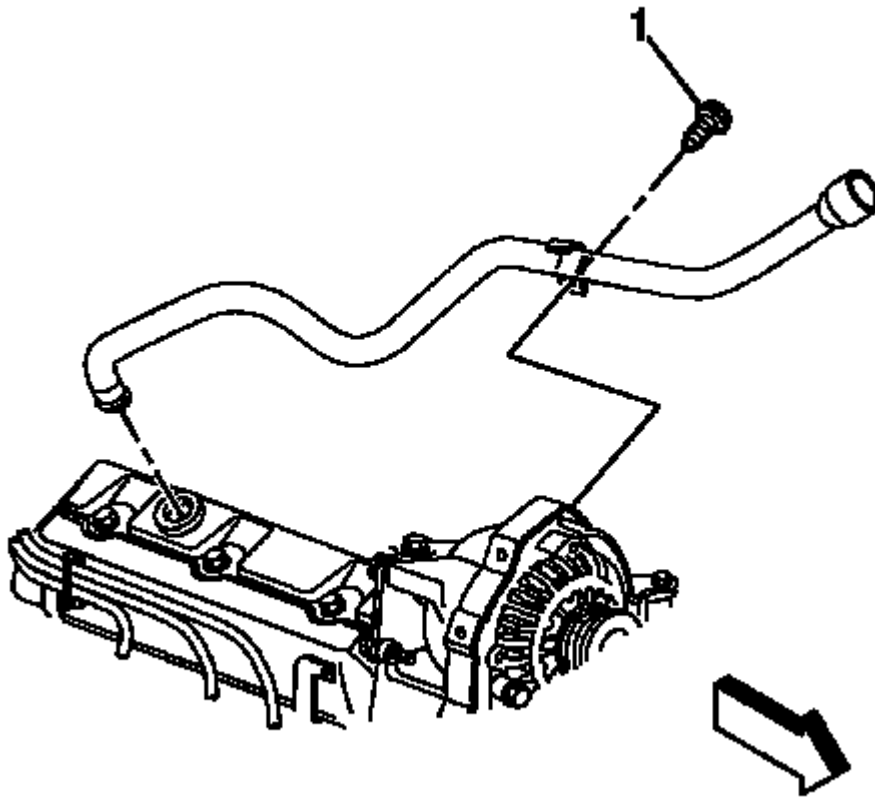


Fig. 29: View Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the oil fill tube.

CAUTION: Refer to Fastener Caution .

2. Install the oil fill tube bolt (1) and tighten to 21 N.m (15 lb ft).
3. Install the engine cover. Refer to Engine Cover Replacement .

UPPER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .
3. Remove the fuel pipes/hoses. Refer to Fuel Line Replacement - Engine .
4. Disconnect the air conditioning (A/C) compressor clutch, if equipped.

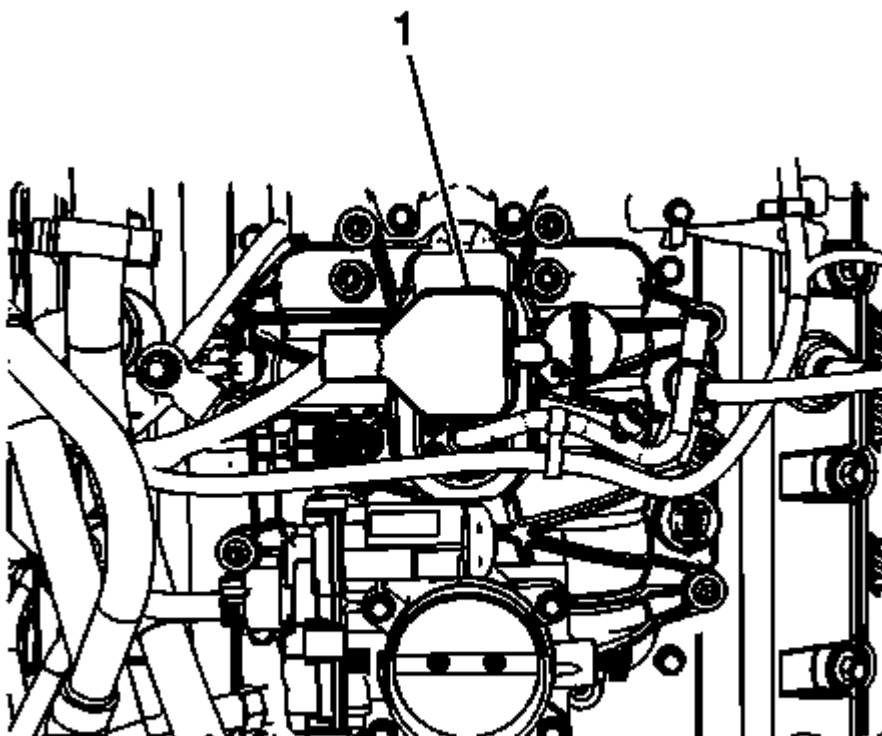


Fig. 30: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the control port injector module (1).

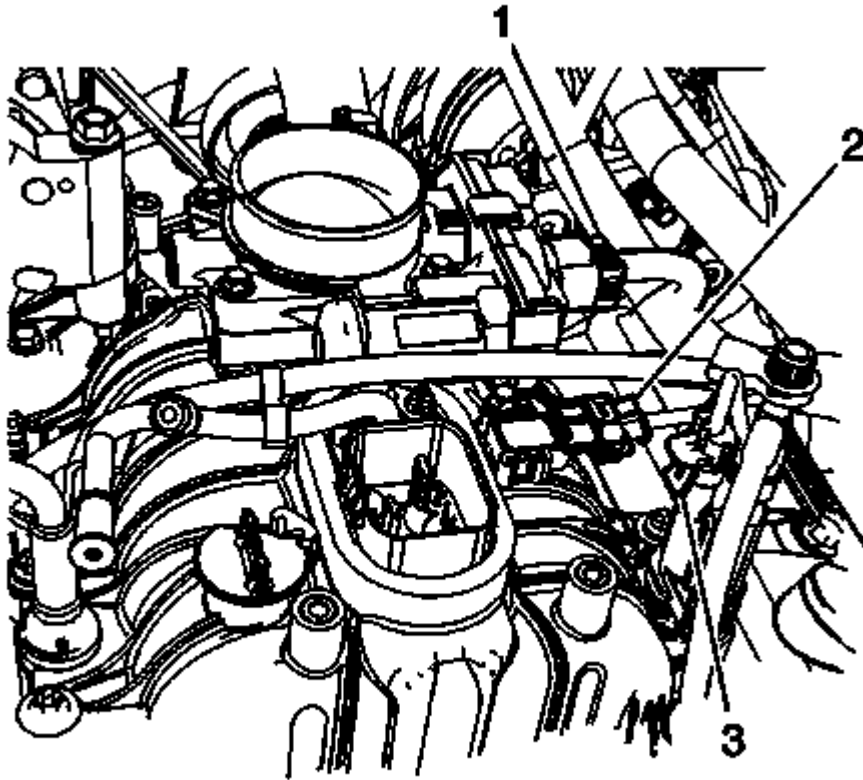


Fig. 31: View Of Throttle Body Actuator, Manifold Absolute Pressure (MAP) Sensor & Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the following electrical connectors:
- The throttle body actuator (1)
 - The manifold absolute pressure (MAP) sensor (2)
 - The evaporative emission (EVAP) canister purge solenoid valve (3)

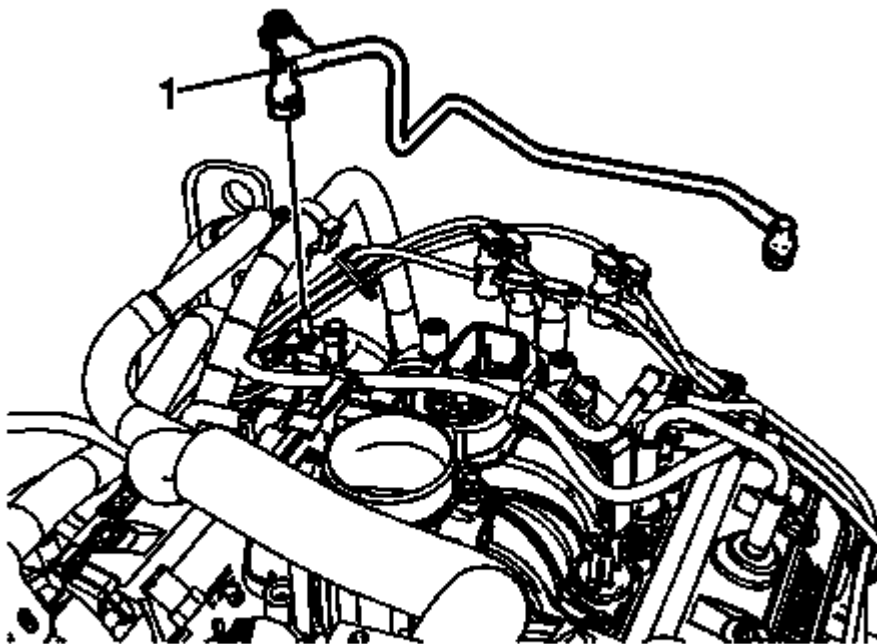


Fig. 32: View Of Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

7. Disconnect EVAP canister purge solenoid valve tube quick connect fitting (1) from the EVAP purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Reposition the tube out of the way.

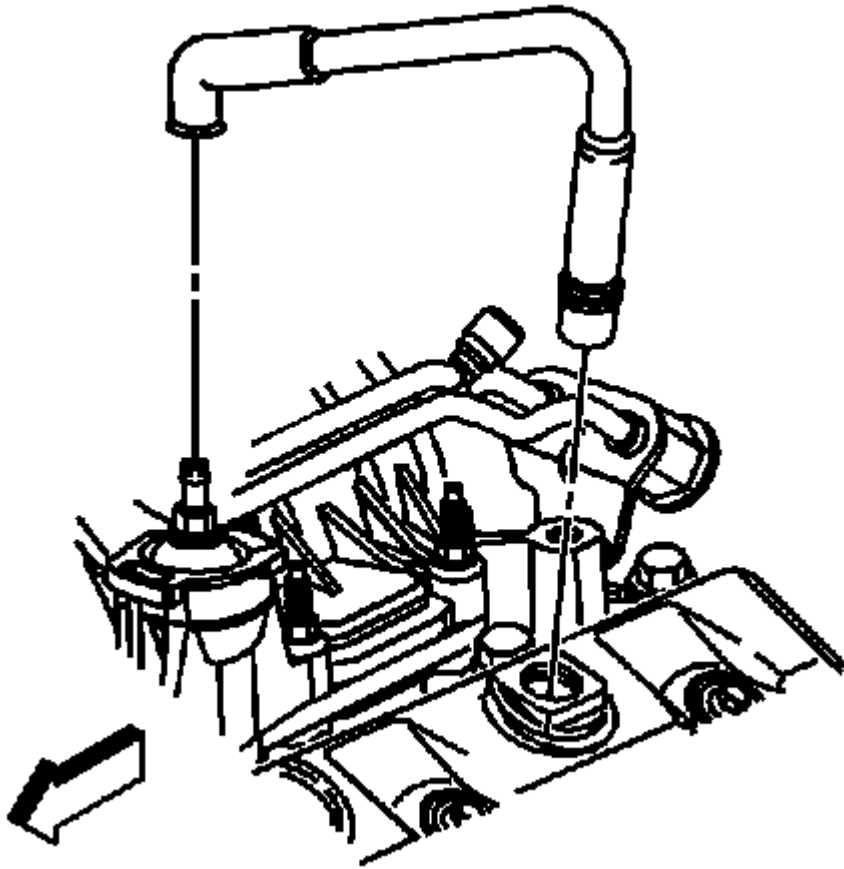


Fig. 33: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the positive crankcase ventilation (PCV) valve hose from the valve and rocker cover.
10. Reposition the engine wiring harness aside.
11. Disconnect the power brake booster vacuum hose from the vacuum fitting.

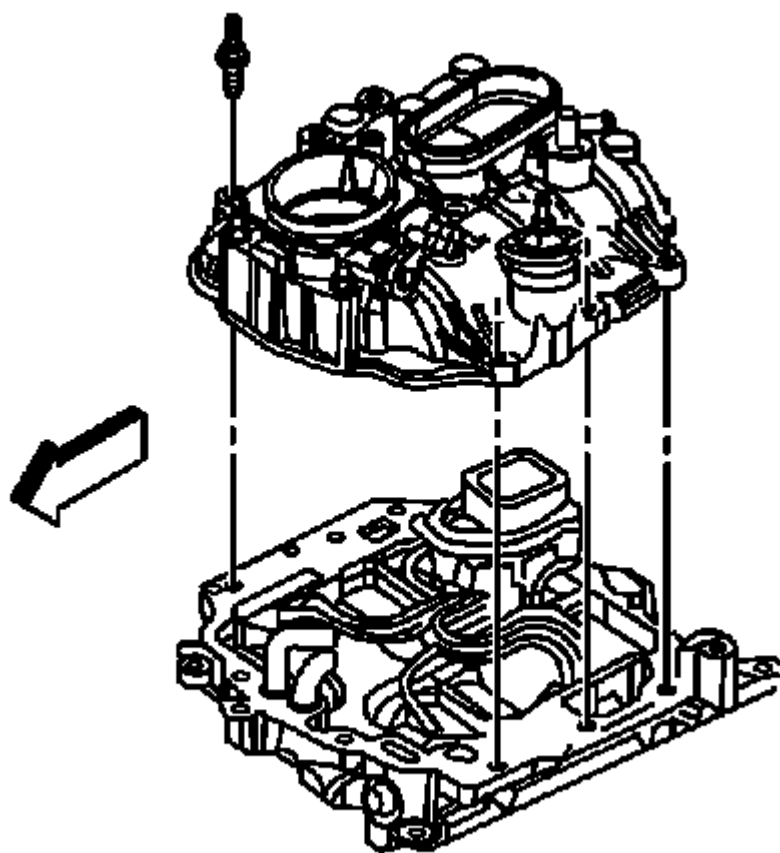


Fig. 34: Identifying Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

12. Remove the intake manifold - upper studs.
13. Remove the front 2 throttle body studs.
14. Remove the intake manifold - upper.

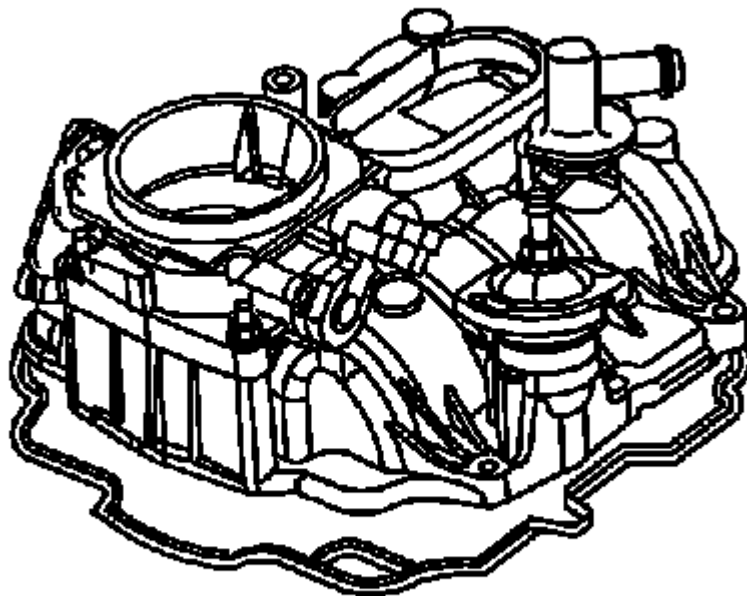


Fig. 35: View Of Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

15. Remove and discard the intake manifold - upper gasket.

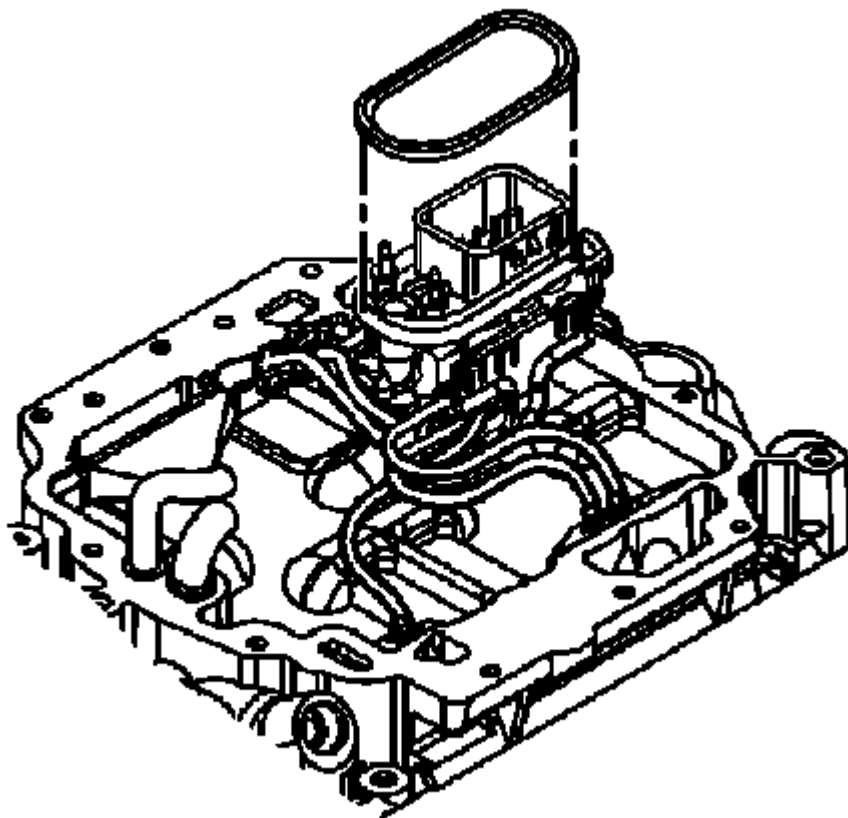


Fig. 36: Identifying Fuel Meter Body O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

16. Remove and discard the O-ring seal from the fuel meter body.

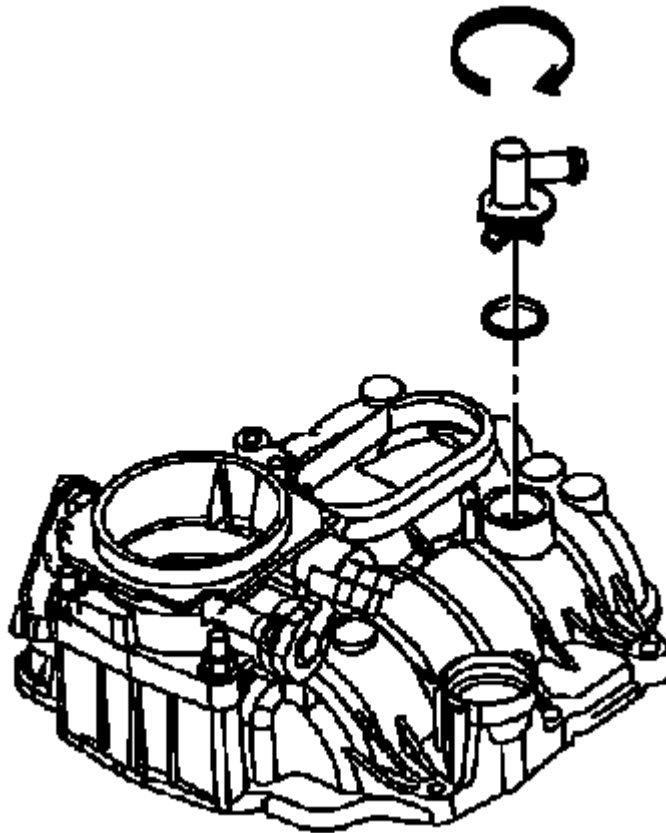


Fig. 37: View Of Power Brake Booster Vacuum O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

17. If required, remove the power brake booster vacuum fitting.
18. Remove and discard the O-ring seal.

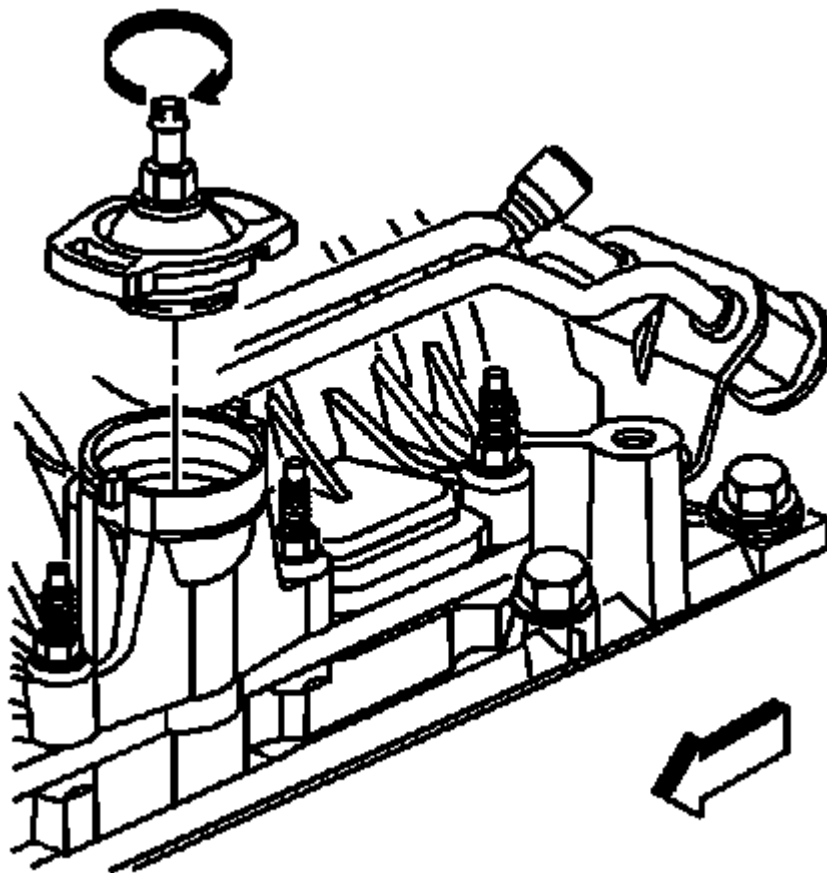


Fig. 38: Identifying PCV Valve Cover
Courtesy of GENERAL MOTORS CORP.

19. If required, remove the PCV valve cover.
20. Remove and discard the O-ring seal.

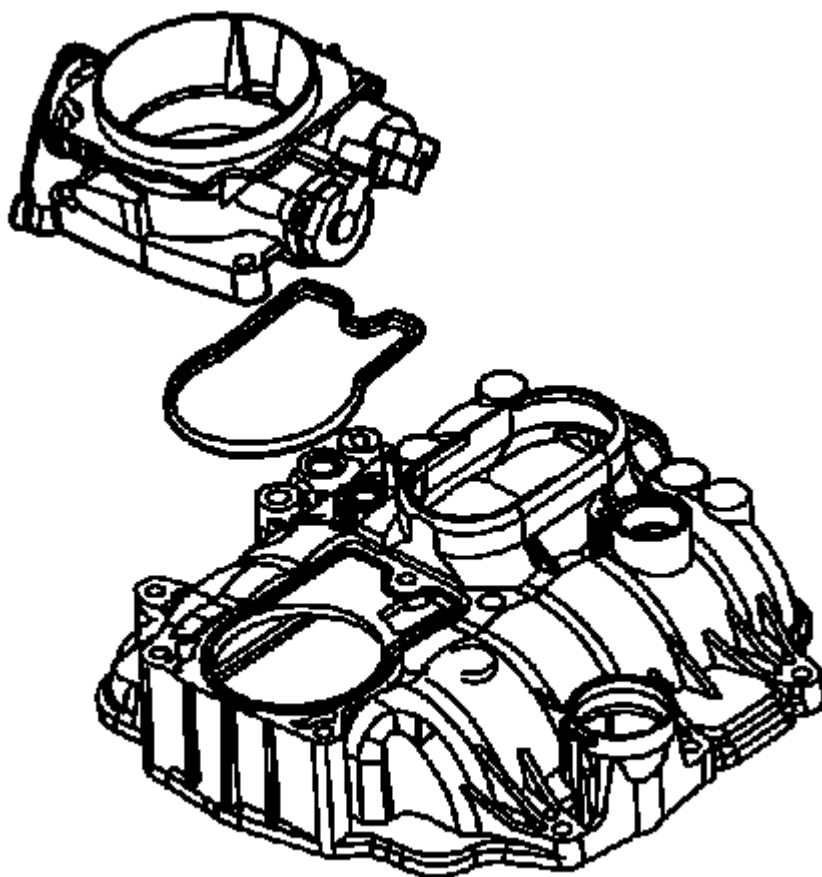


Fig. 39: View Of Throttle Body & Gasket
Courtesy of GENERAL MOTORS CORP.

21. If required, remove the rear throttle body stud.
22. Remove the throttle body.
23. Remove and discard the throttle body gasket.

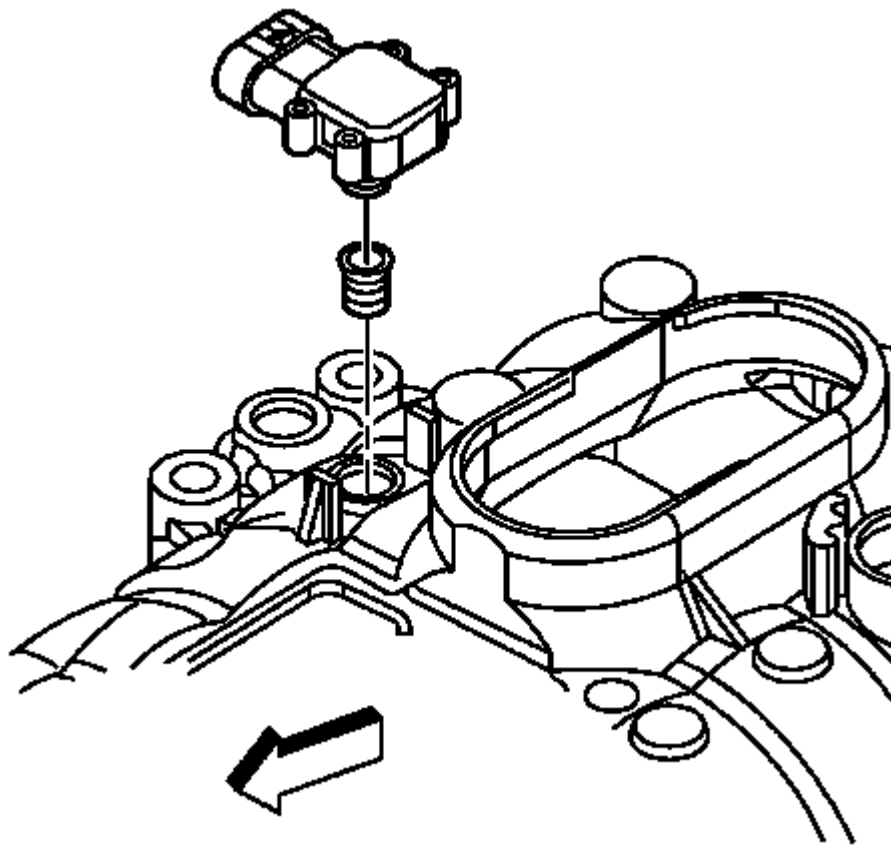


Fig. 40: Identifying MAP Sensor
Courtesy of GENERAL MOTORS CORP.

24. If required, remove the MAP sensor.
25. Remove and discard the MAP sensor seal.

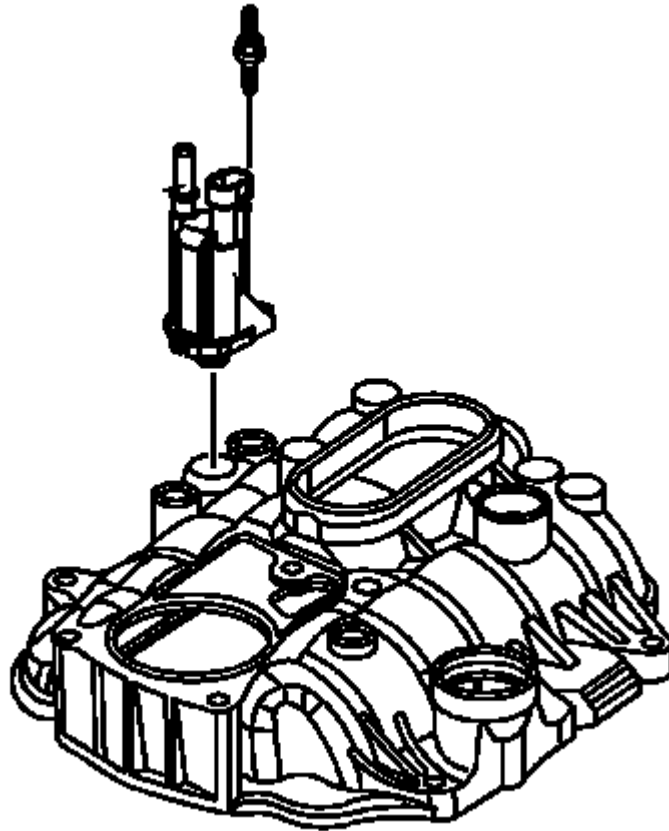


Fig. 41: Identifying Purge Solenoid & Nut
Courtesy of GENERAL MOTORS CORP.

26. If required, remove the EVAP canister purge solenoid valve studs.
27. Remove the purge solenoid valve.
28. Clean and inspect the intake manifold - upper, if necessary. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

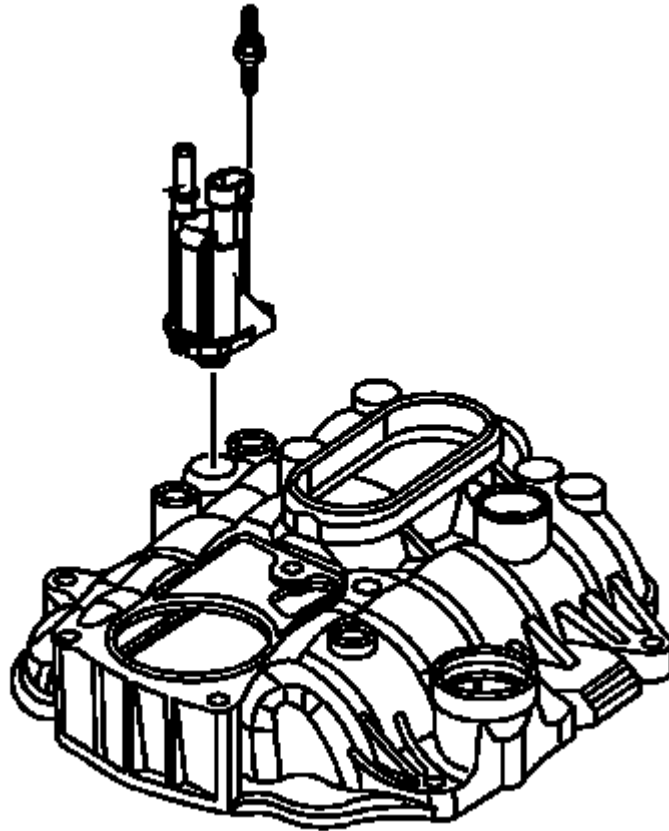


Fig. 42: Identifying Purge Solenoid & Nut
Courtesy of GENERAL MOTORS CORP.

1. If required, install the purge solenoid valve.

CAUTION: Refer to Fastener Caution .

2. Install the EVAP canister purge solenoid valve studs. If reusing the old studs, apply threadlock to the threads. Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number. Tighten the studs to 10 N.m (89 lb in).

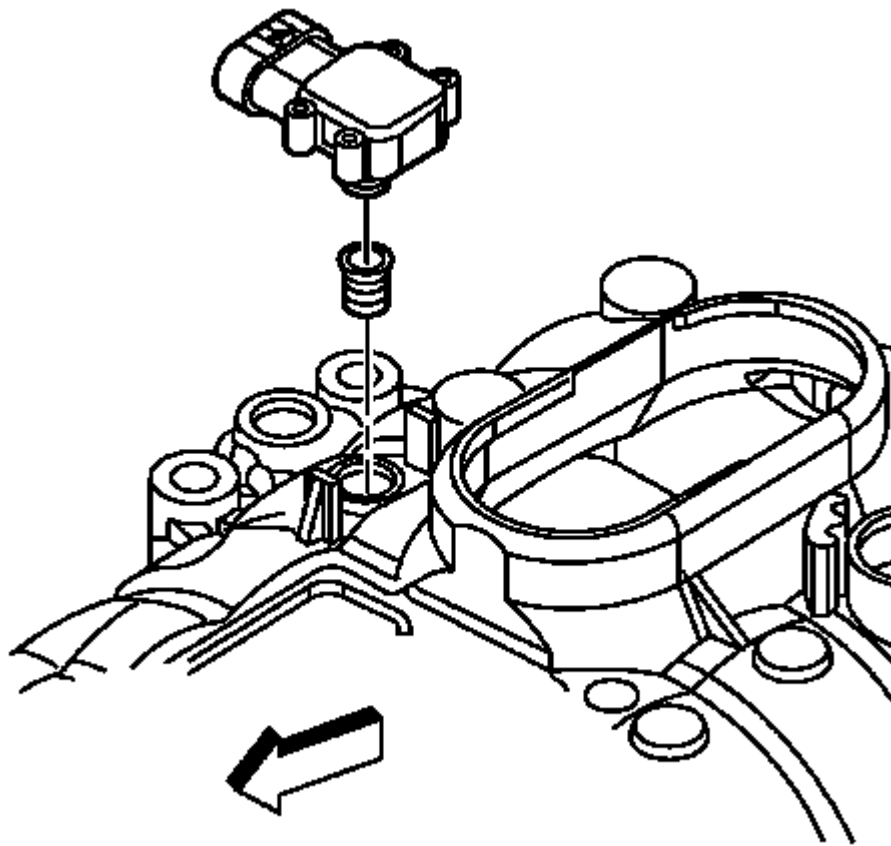


Fig. 43: Identifying MAP Sensor
Courtesy of GENERAL MOTORS CORP.

3. If required, install a NEW MAP sensor seal. Apply a small drop of clean engine oil to the seal.
4. Install the MAP sensor.

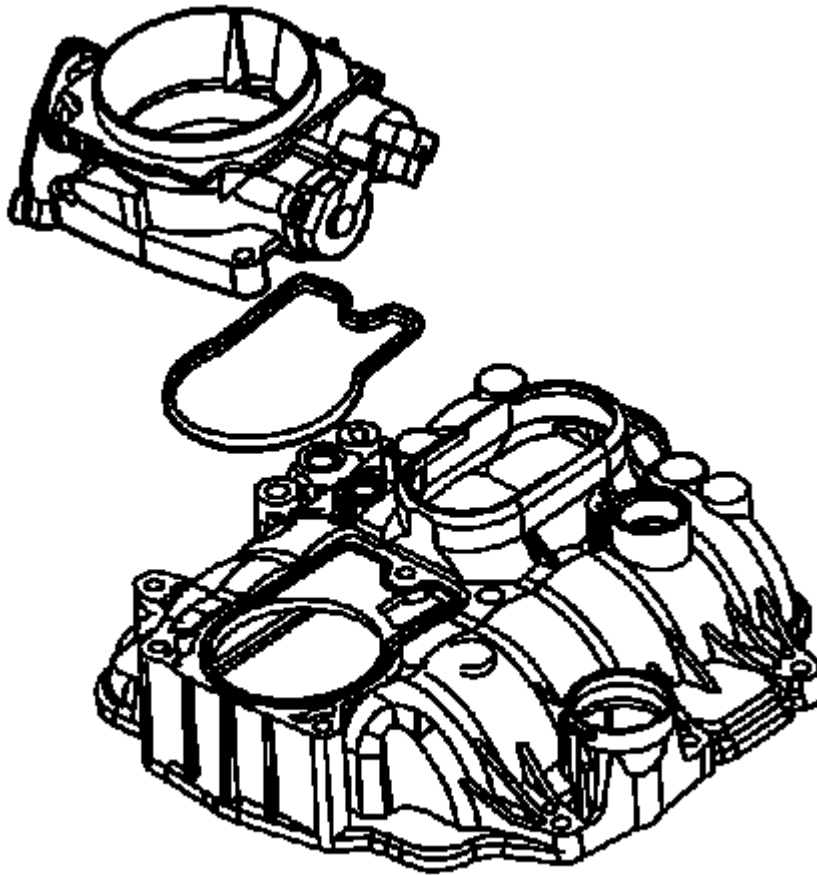


Fig. 44: View Of Throttle Body & Gasket
Courtesy of GENERAL MOTORS CORP.

5. If required, install a NEW throttle body gasket.
6. Install the throttle body.
7. Install the rear throttle body stud. If reusing the old stud, apply threadlock to the threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Tighten the stud to 9 N.m (80 lb in).

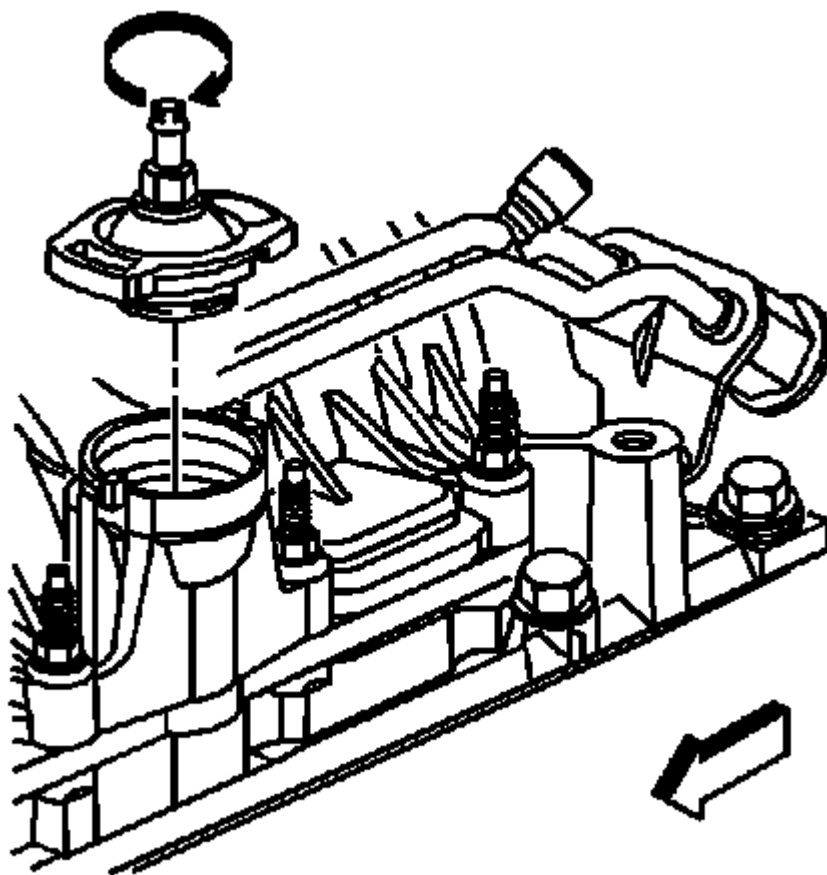


Fig. 45: Identifying PCV Valve Cover
Courtesy of GENERAL MOTORS CORP.

8. If required, install a NEW O-ring seal to the PCV cover. Apply clean engine oil to the seal.
9. Install the PCV valve cover.

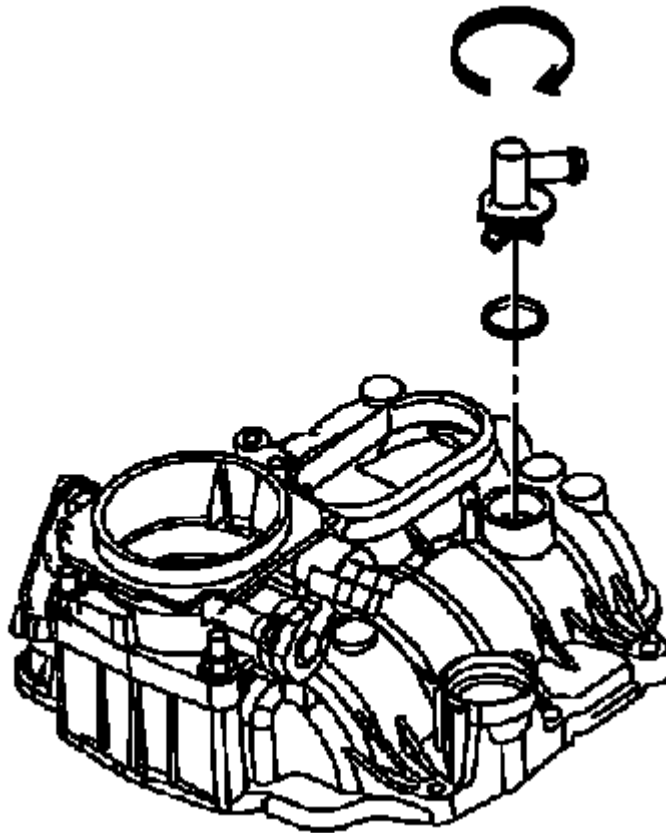


Fig. 46: View Of Power Brake Booster Vacuum O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

10. If required, install a NEW O-ring seal. Apply clean engine oil to the seal.
11. Install the power brake booster vacuum fitting.

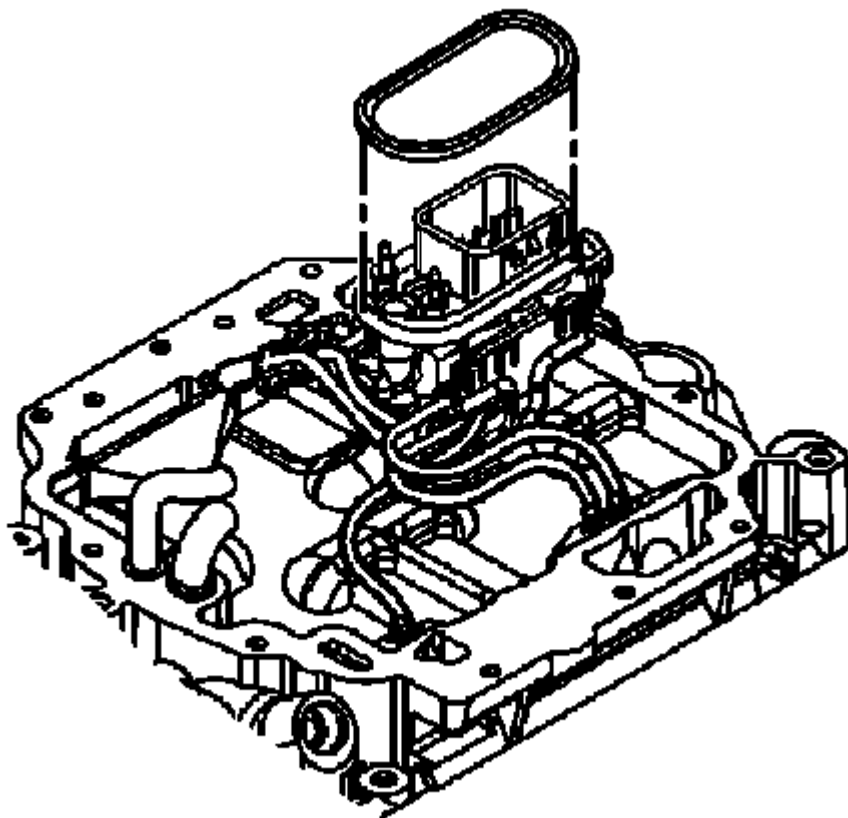


Fig. 47: Identifying Fuel Meter Body O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW O-ring seal to the fuel meter body.

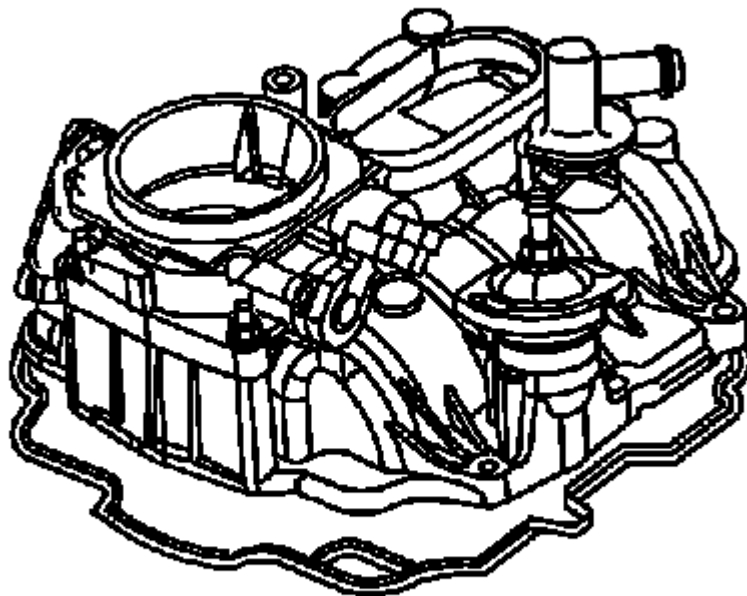


Fig. 48: View Of Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

13. Install a NEW upper intake manifold gasket.

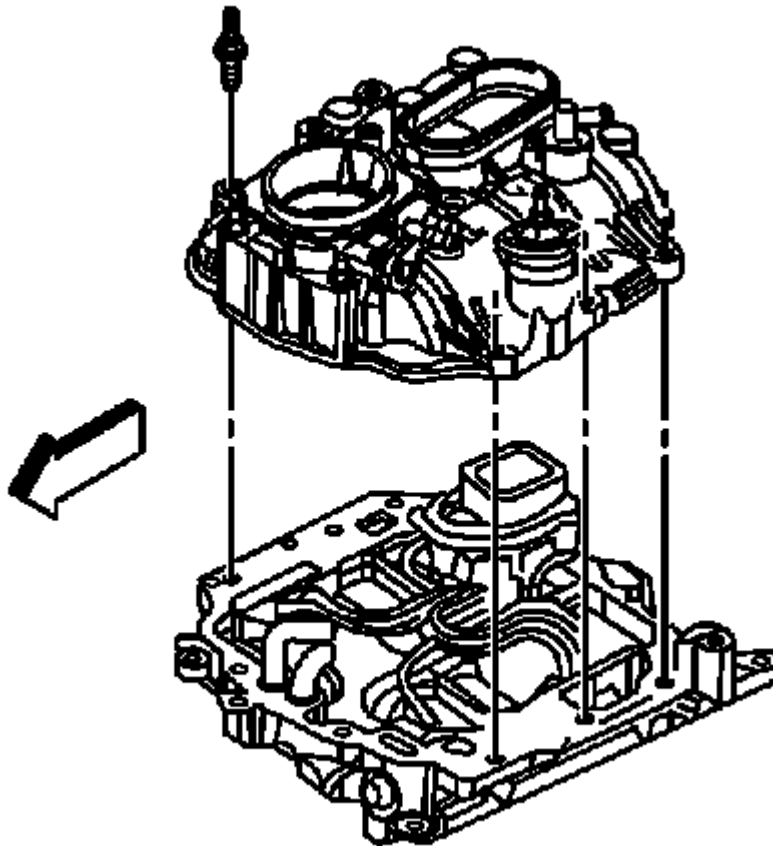


Fig. 49: Identifying Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

14. Install the intake manifold - upper.
15. If reusing the old throttle body/intake manifold studs, apply threadlock to the threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
16. Install the front two throttle body studs.
17. Install the intake manifold - upper studs and tighten to 9 N.m (80 lb in).
18. Connect the power brake booster vacuum hose to the vacuum fitting.

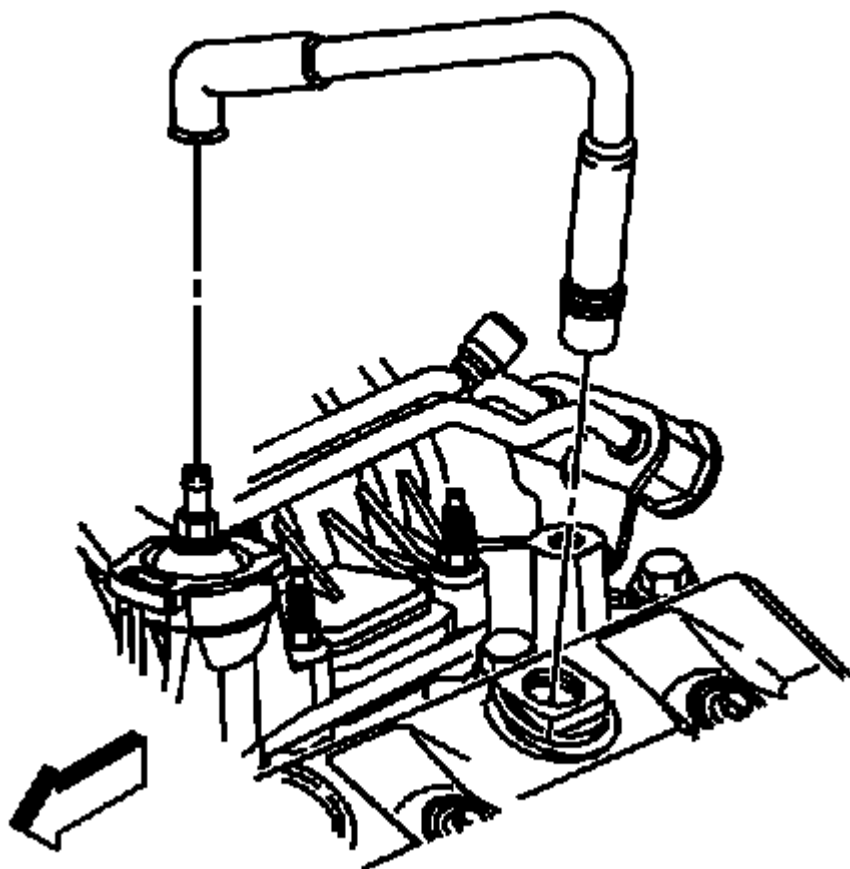


Fig. 50: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

19. Position the engine wiring harness.
20. Install the PCV valve hose to the valve cover and rocker cover.

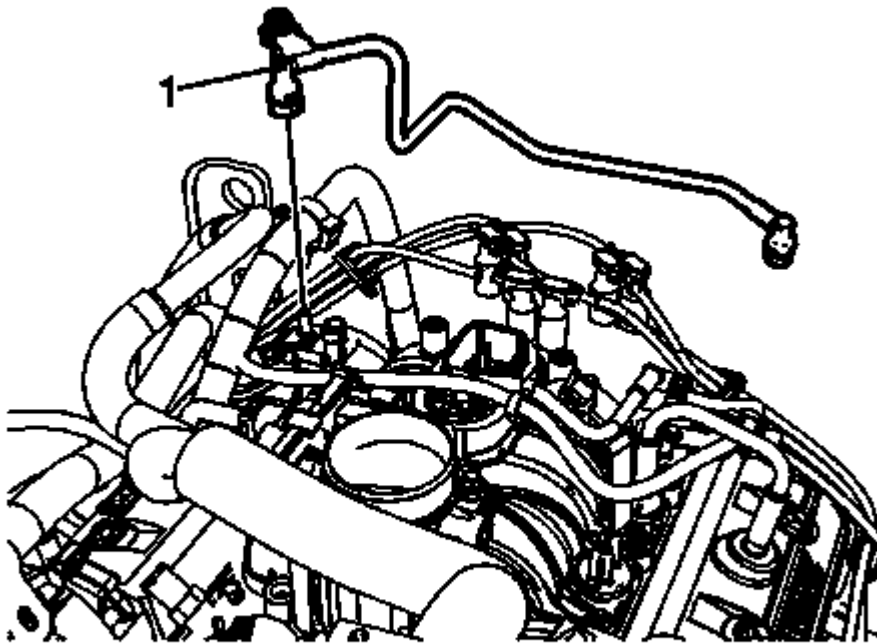


Fig. 51: View Of Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

21. Position the EVAP canister purge solenoid tube, and connect the tube quick connect fitting (1) to the EVAP purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .

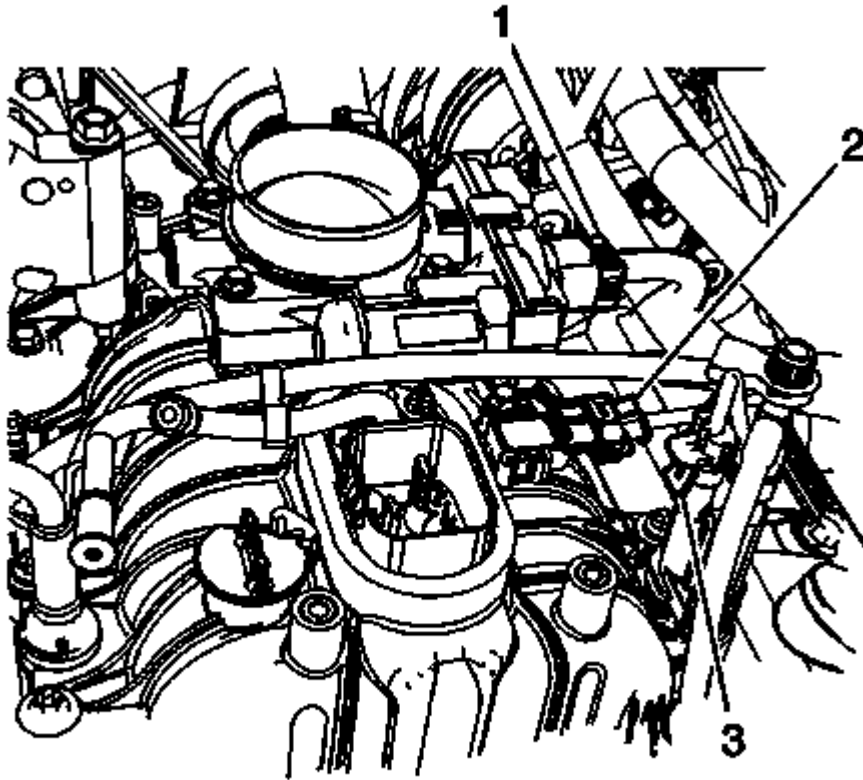


Fig. 52: View Of Throttle Body Actuator, Manifold Absolute Pressure (MAP) Sensor & Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

22. Connect the following electrical connectors:
- The EVAP canister purge solenoid valve (3)
 - The MAP sensor (2)
 - The throttle body actuator (1)

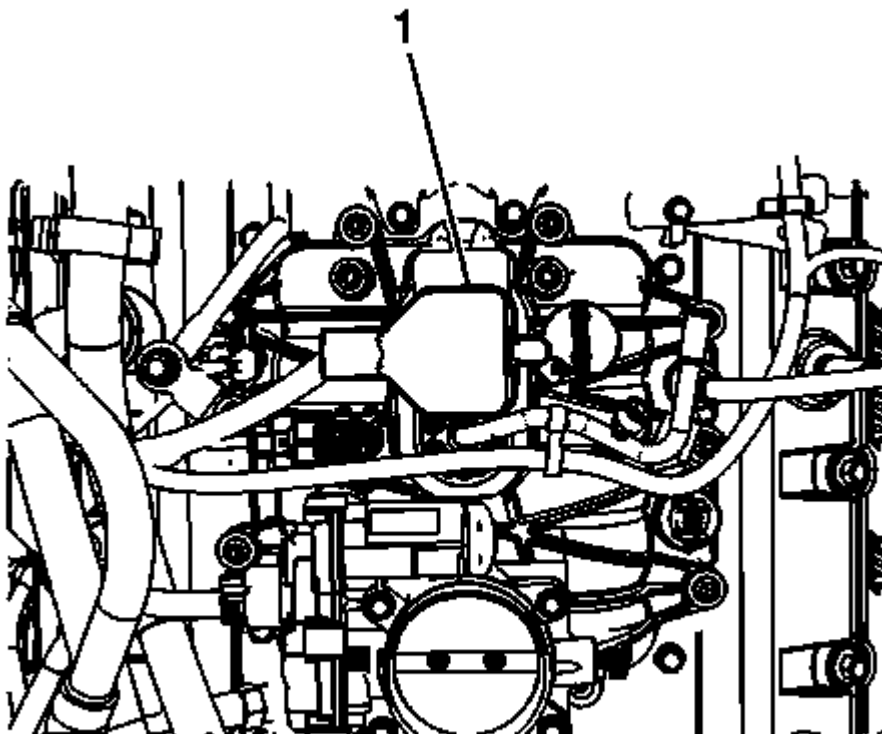


Fig. 53: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

23. Connect the control port injector module (1).
24. Connect the A/C compressor clutch, if equipped.
25. Install the fuel pipes/hoses. Refer to **Fuel Line Replacement - Engine** .
26. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
27. Install the engine cover. Refer to **Engine Cover Replacement** .

LOWER INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

NOTE:

- The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.
- It is not necessary to remove the upper intake manifold in order to remove the lower intake manifold.
- Do not allow dirt or debris to enter the fuel system. Ensure that the ends of

the fuel system are properly sealed.

- Do not disassemble the central sequential fuel injection (SFI) unit, unless service is required.

1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .
3. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac N Fill) .
4. Remove the fuel pipes/hoses. Refer to Fuel Line Replacement - Engine .
5. Remove the ignition coil assembly. Refer to Ignition Coil Replacement .
6. Remove the evaporative emission (EVAP) canister tube. Refer to Evaporative Emission Line Replacement - Engine .

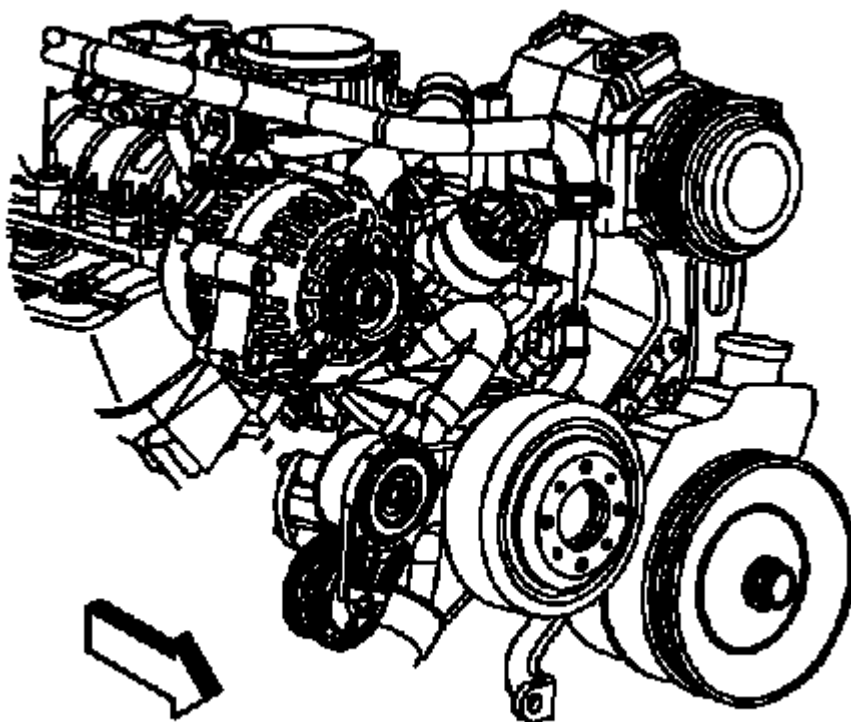


Fig. 54: Identifying Intake Manifold Hose
Courtesy of GENERAL MOTORS CORP.

7. Open the heater outlet hose clamp and remove the hose from the intake manifold.

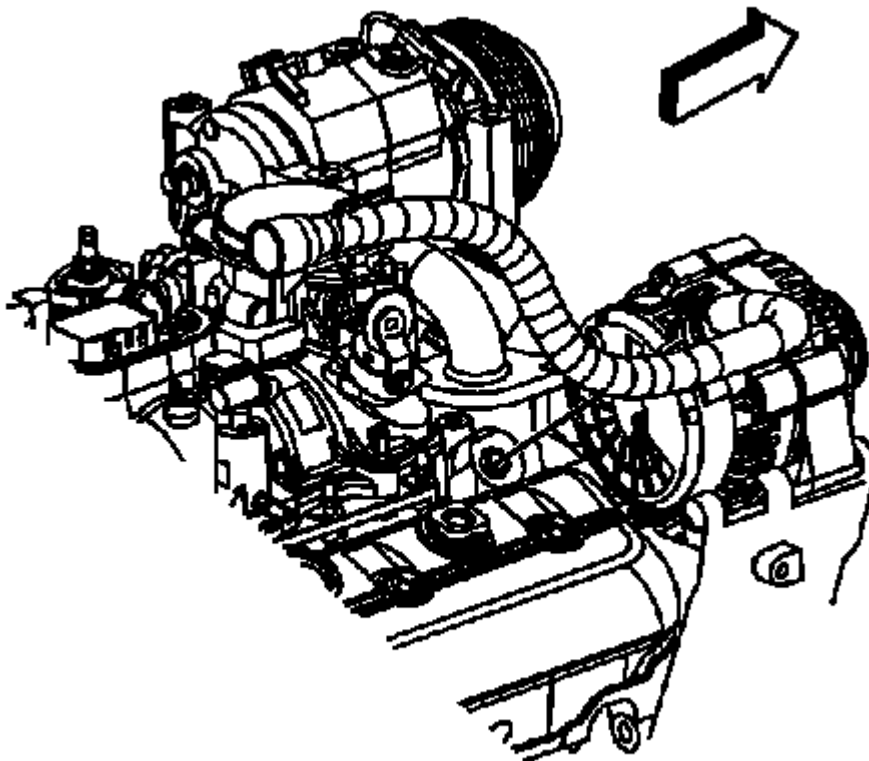


Fig. 55: Identifying Heater Inlet Hose & Water Pump
Courtesy of GENERAL MOTORS CORP.

8. Open the heater inlet hose clamp and remove the hose from the water pump.
9. Reposition the heater inlet and outlet hoses.

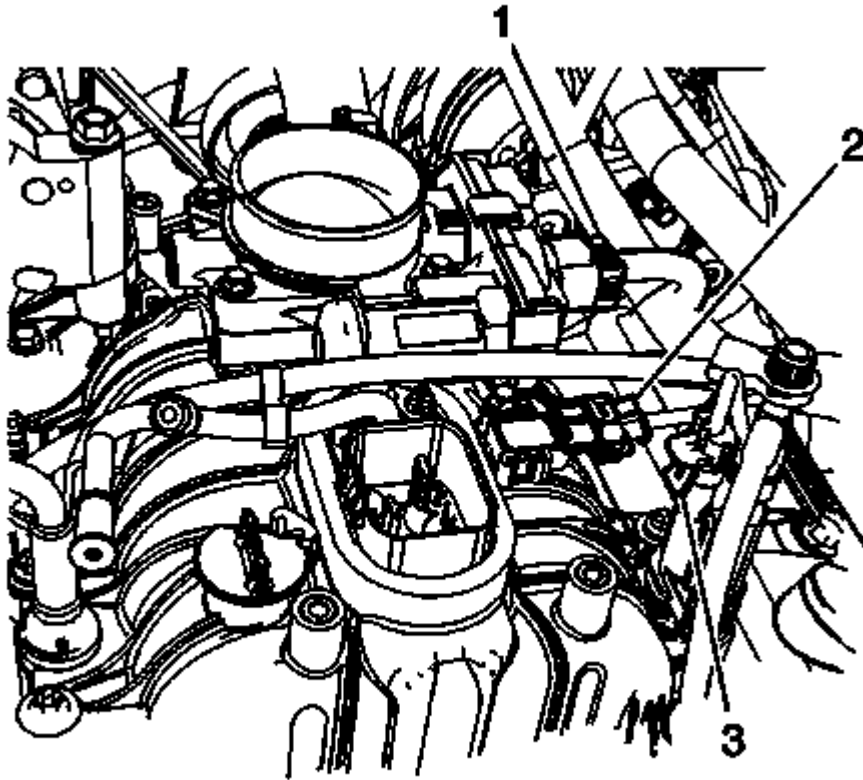


Fig. 56: View Of Throttle Body Actuator, Manifold Absolute Pressure (MAP) Sensor & Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the following electrical connectors:
 - The throttle body actuator (1)
 - The manifold absolute pressure (MAP) sensor (2)
 - The evaporative emission (EVAP) canister purge solenoid valve (3)
11. Disconnect the A/C pressure switch, if equipped.

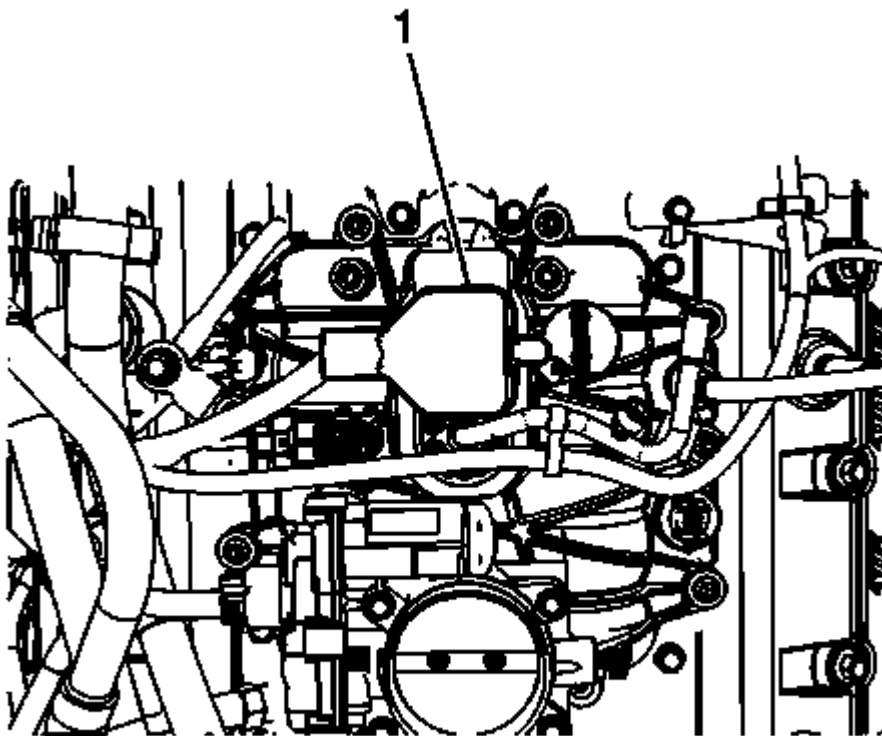


Fig. 57: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the control port injector module (1).

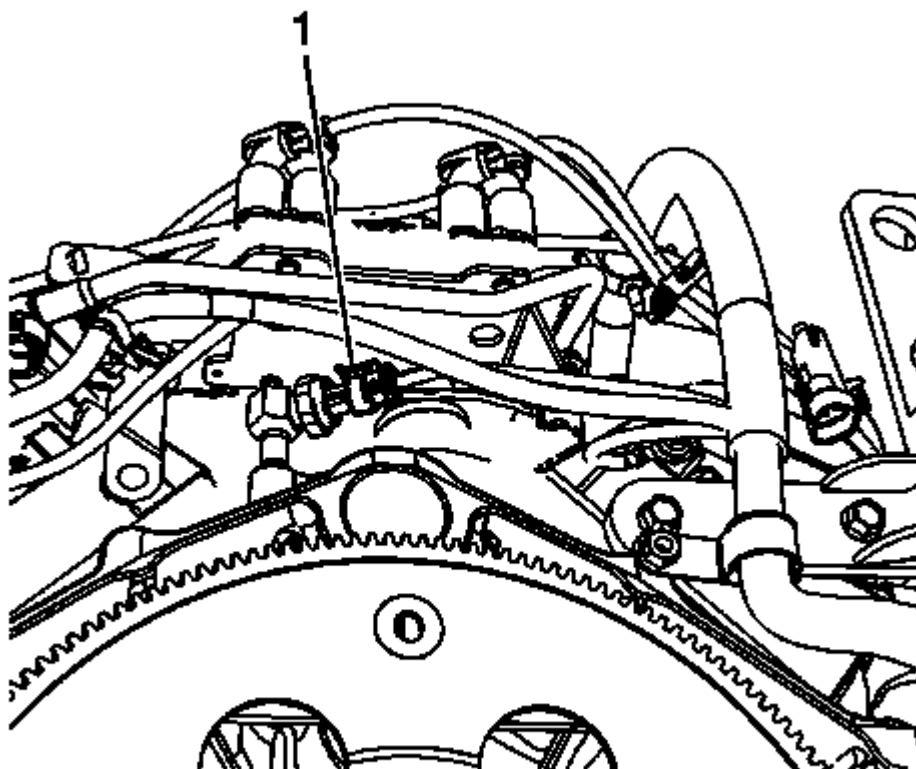


Fig. 58: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

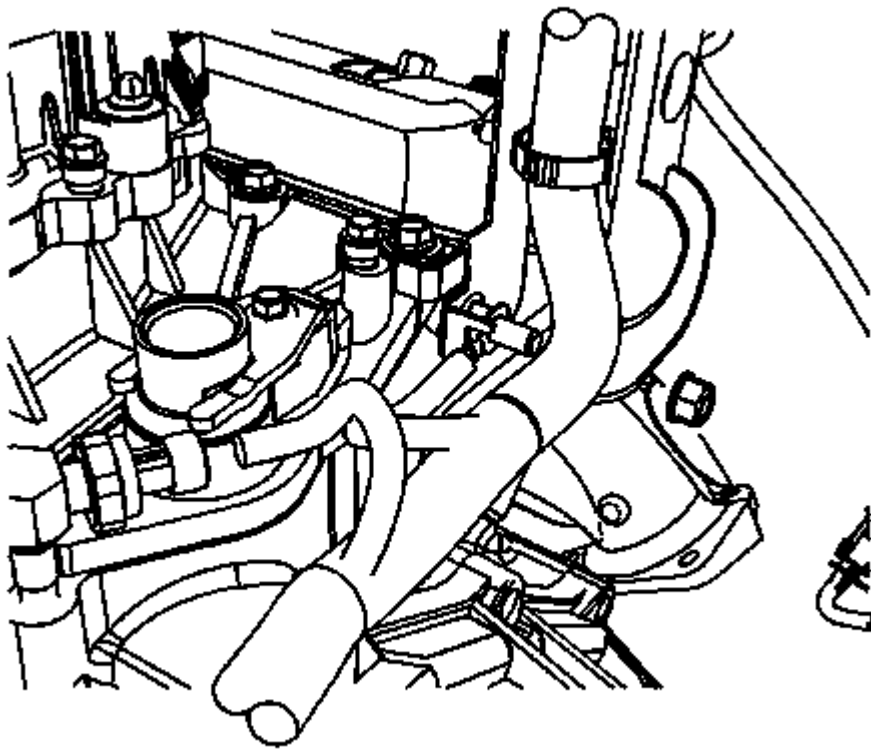


Fig. 59: View Of Engine Wiring Harness Ground Nut & Ground Wire
Courtesy of GENERAL MOTORS CORP.

14. Remove the engine wiring harness ground nut and ground wire (1) from the rear of the right cylinder head.

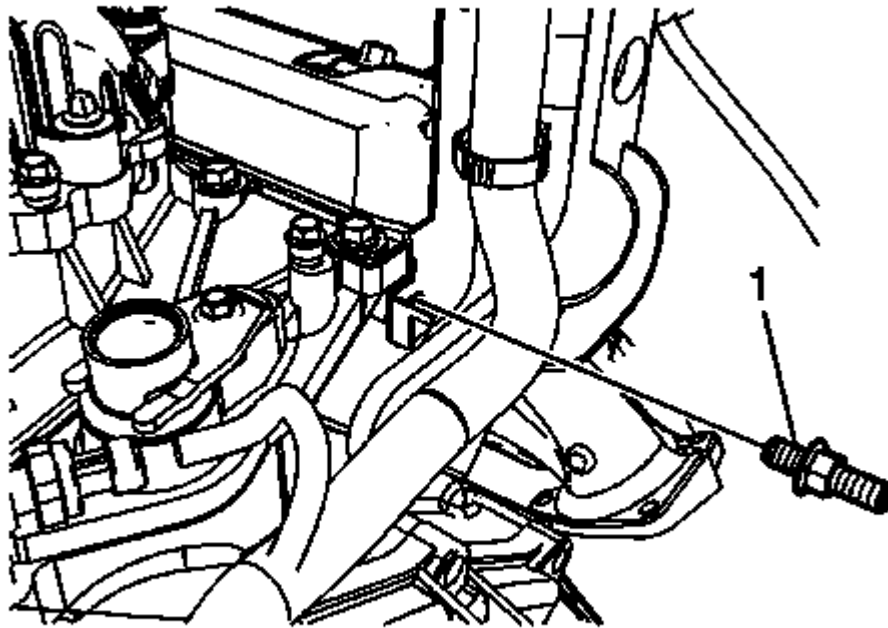


Fig. 60: Locating Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

15. Remove the stud (1) holding the engine wiring harness bracket.
16. Reposition the engine wiring harness with the bracket aside.

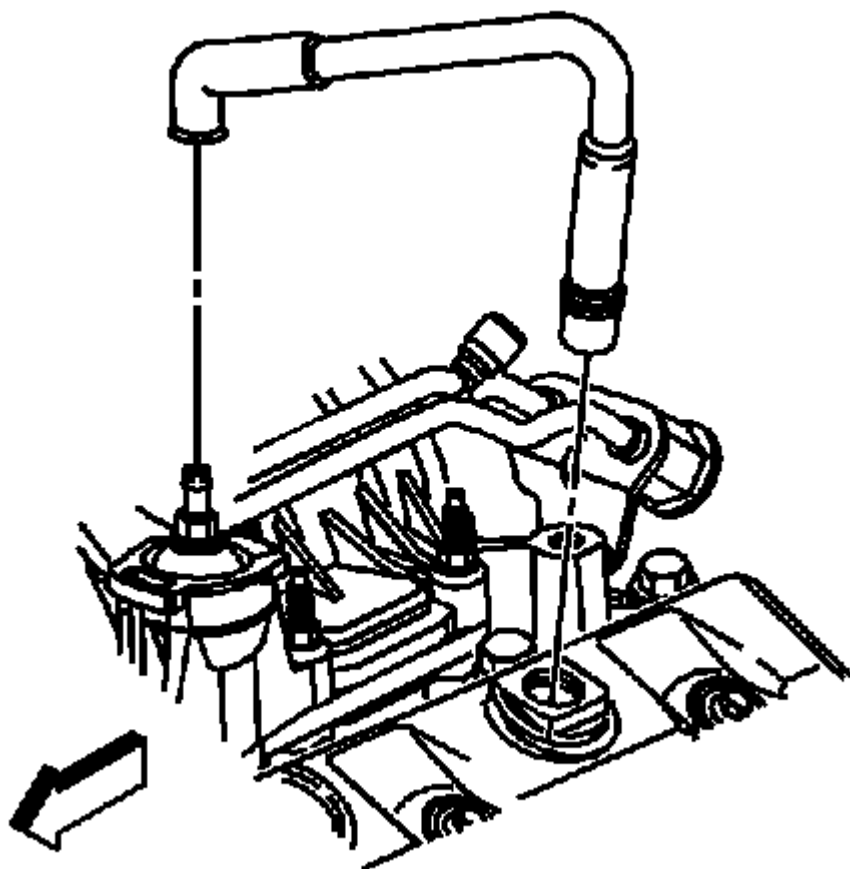


Fig. 61: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

17. Remove the positive crankcase ventilation (PCV) valve hose from the valve cover and rocker cover.
18. Disconnect the power brake booster vacuum hose from the vacuum fitting.

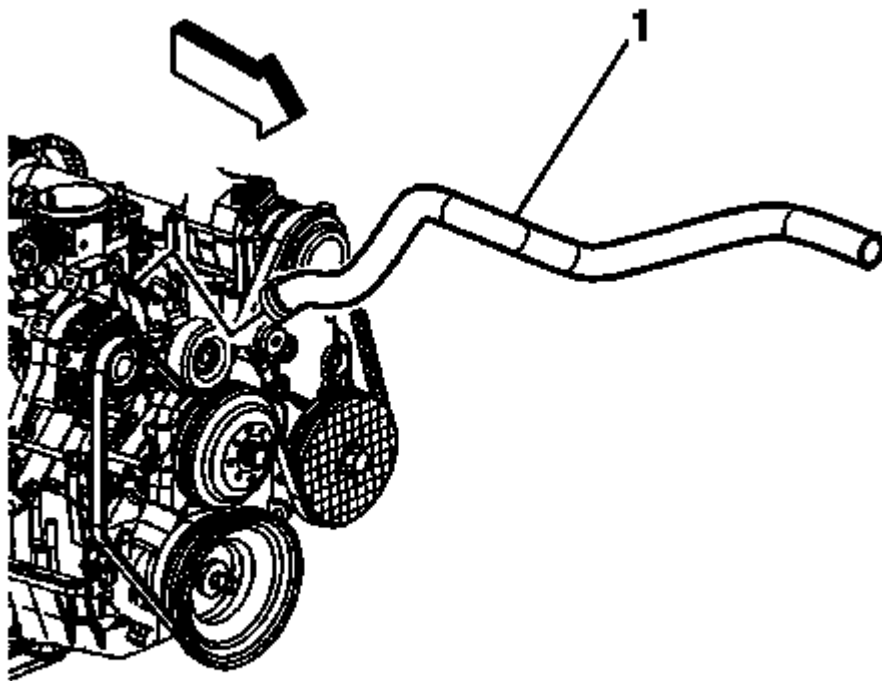


Fig. 62: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

19. Reposition the radiator inlet hose clamps.
20. Remove the radiator inlet hose (1) from the thermostat housing.

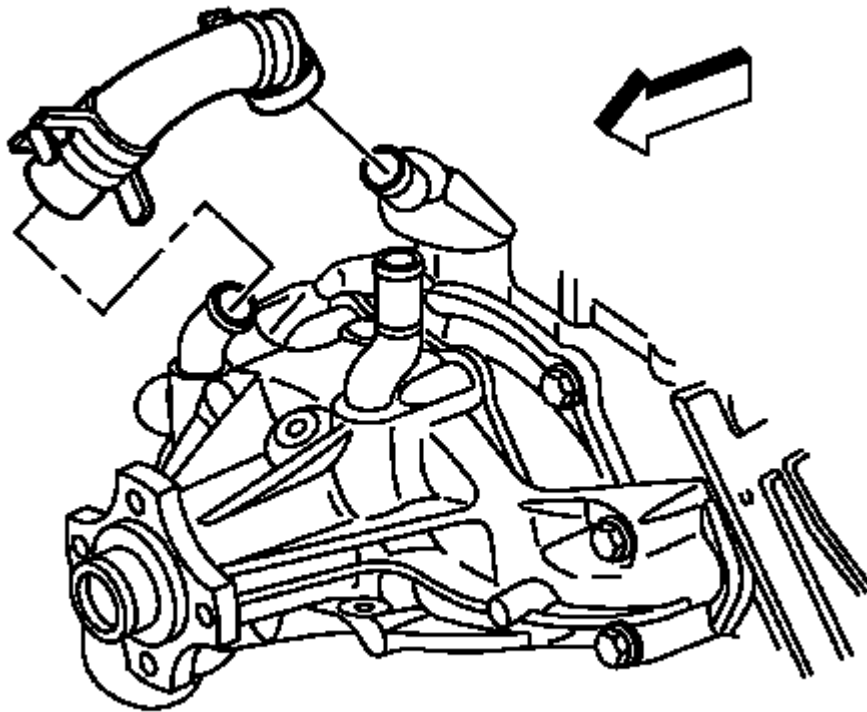


Fig. 63: View Of Water Pump Inlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

21. Reposition the water pump inlet hose clamps.
22. Remove the water pump inlet hose.

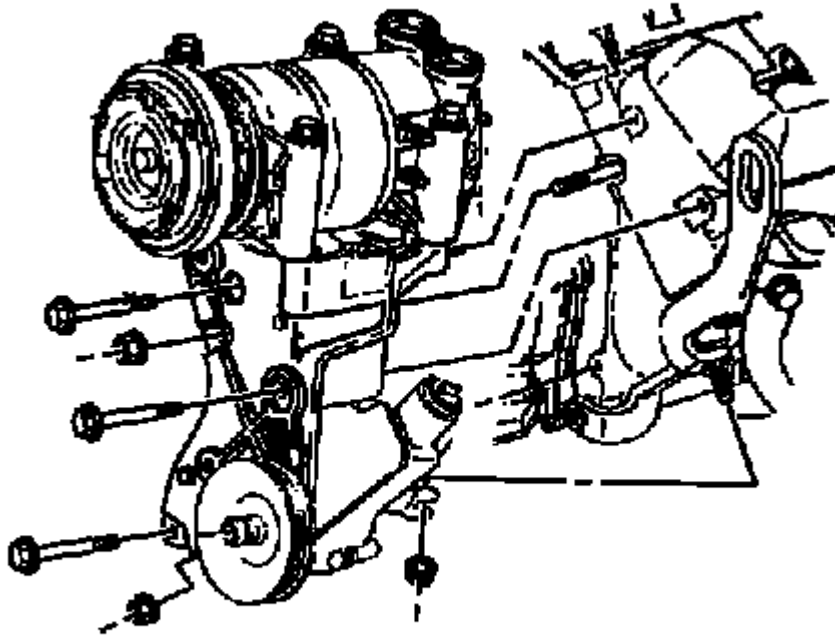


Fig. 64: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

23. In order to remove the front intake manifold bolt, perform the following:
 1. Remove the drive belt. Refer to **Drive Belt Replacement**.
 2. Loosen the power steering (P/S) pump rear bracket nut.
 3. Remove the P/S pump rear bracket front nut.
 4. Remove the bolts and the nut for the P/S pump bracket.
 5. Leave the A/C compressor, if equipped, and the P/S pump on the bracket.
 6. Slide the P/S pump bracket forward to access the front intake manifold bolt.

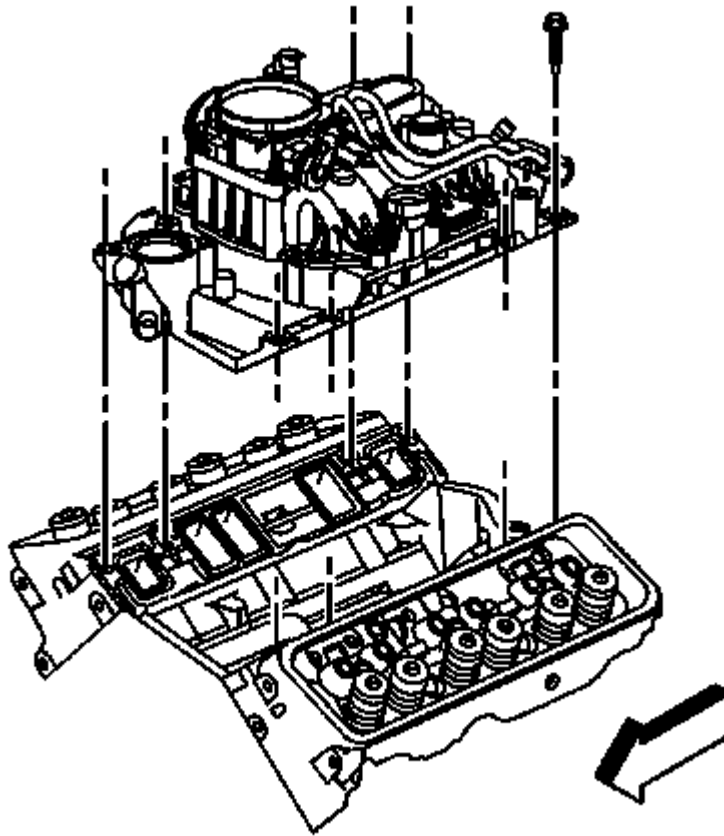


Fig. 65: Identifying Intake Manifold
Courtesy of GENERAL MOTORS CORP.

24. Remove the intake manifold - lower bolts.
25. Remove the intake manifold.
26. Remove and discard the intake manifold gaskets.
27. Clean and inspect the intake manifold - lower, if necessary. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

CAUTION: Apply the proper amount of the sealant when assembling this component. Excessive use of the sealant can prohibit the component from sealing properly. A component that is not sealed properly can leak leading to extensive engine damage.

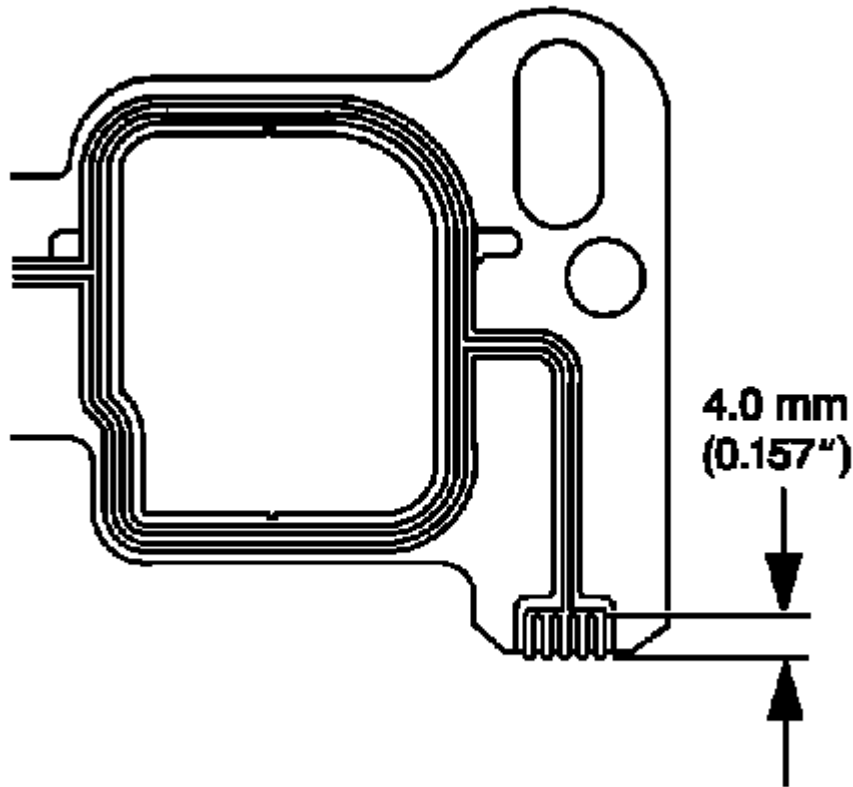


Fig. 66: Identifying Proper Amount Of Adhesive
Courtesy of GENERAL MOTORS CORP.

NOTE: The intake manifold gasket must be installed while the adhesive is still wet to the touch.

1. Apply a 4.0 mm (0.157 in) patch of adhesive to the cylinder head side of the intake manifold gasket at each end. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Install the intake manifold gasket onto the cylinder head. Use the gasket locating pins in order to properly seat the gasket.

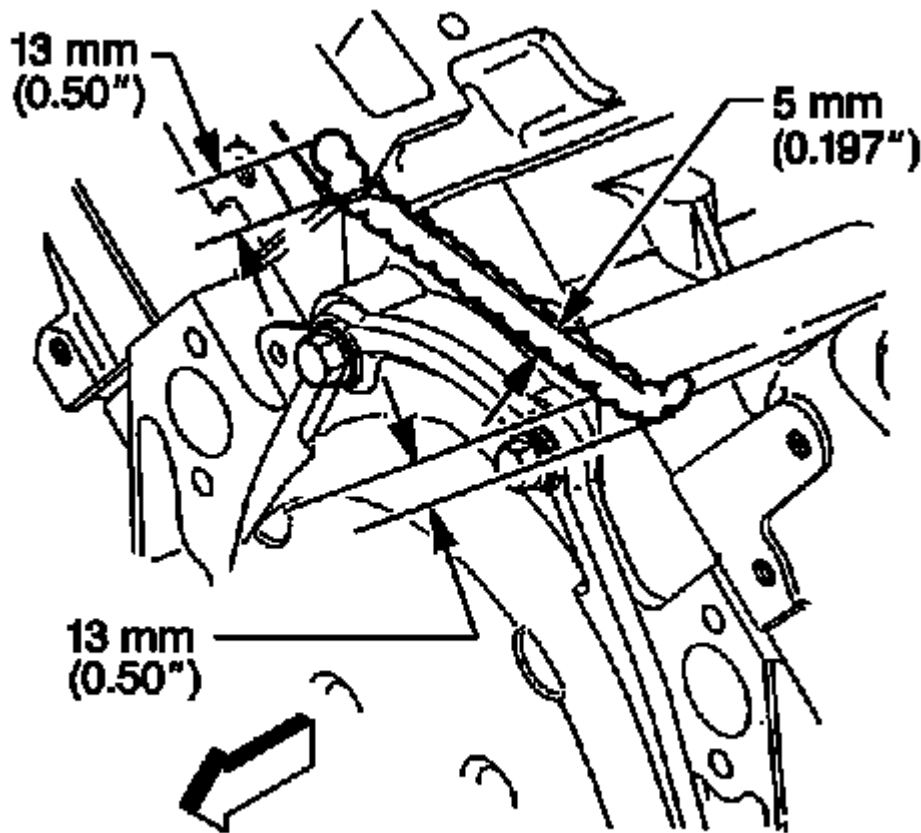


Fig. 67: Applying Adhesive To Front Top Of Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: The intake manifold must be installed and the fasteners tightened while the adhesive is still wet to the touch.

3. Apply a 5 mm (0.197 in) bead of adhesive to the front top of the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
4. Extend the adhesive bead 13 mm (0.50 in) up onto each intake manifold gasket.

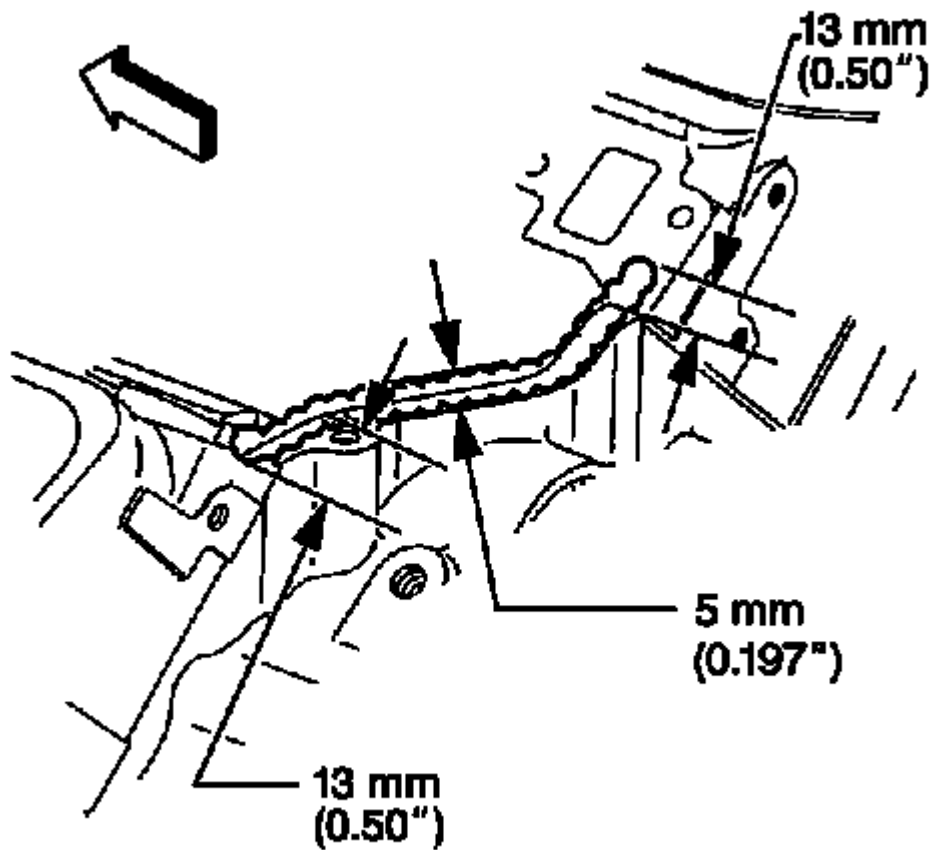


Fig. 68: Applying Adhesive To Rear Top Of Engine Block
Courtesy of GENERAL MOTORS CORP.

5. Apply a 5 mm (0.197 in) bead of adhesive to the rear top of the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Extend the adhesive bead 13 mm (0.50 in) up onto each intake manifold gasket.

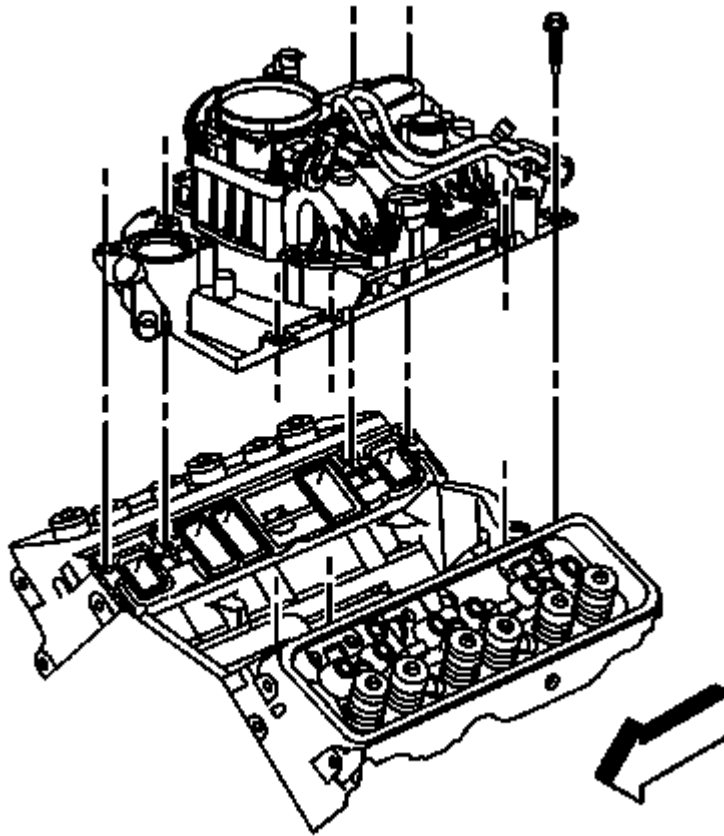


Fig. 69: Identifying Intake Manifold
Courtesy of GENERAL MOTORS CORP.

7. Install the intake manifold.
8. If reusing the old fasteners, apply threadlock to the threads of the intake manifold - lower bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
9. Install the intake manifold - lower bolts.

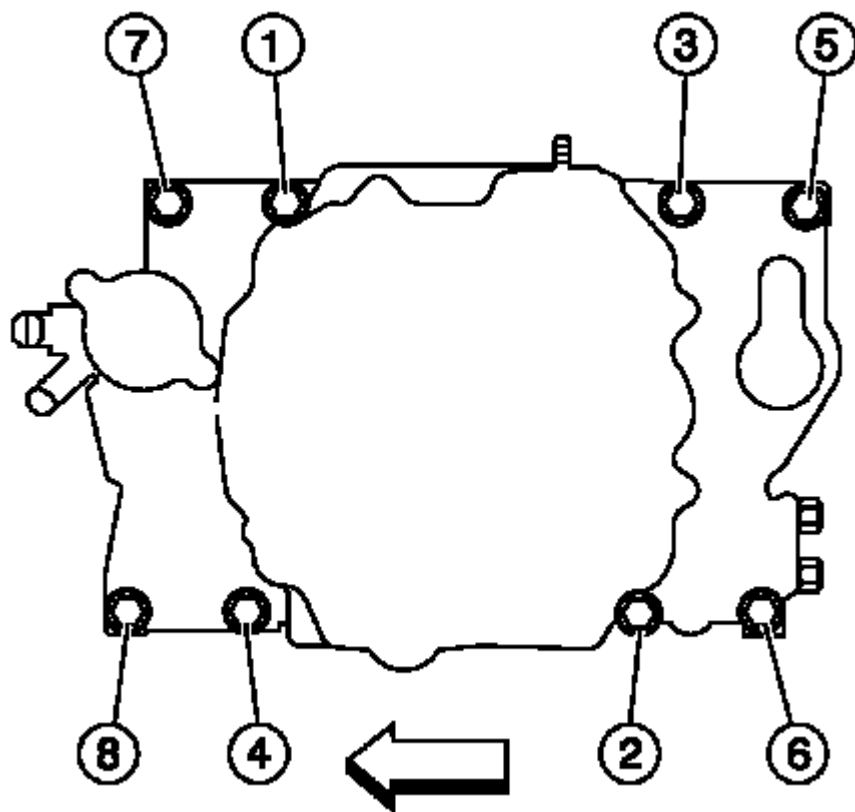


Fig. 70: Identifying Lower Intake Manifold Fastener Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper lower intake manifold fastener tightening sequence and torque is critical. Always follow the tightening sequence, and torque the intake manifold bolts using the 3 step method. Failing to do so may distort the crankshaft bearing bore alignment and cause damage to the crankshaft bearings.

CAUTION: Refer to Fastener Caution .

10. Tighten the intake manifold - lower bolts in the sequence shown.
 1. Tighten the bolts a first pass to 3 N.m (27 lb in).
 2. Tighten the bolts a second pass to 12 N.m (106 lb in).
 3. Tighten the bolts a final pass to 15 N.m (11 lb ft).

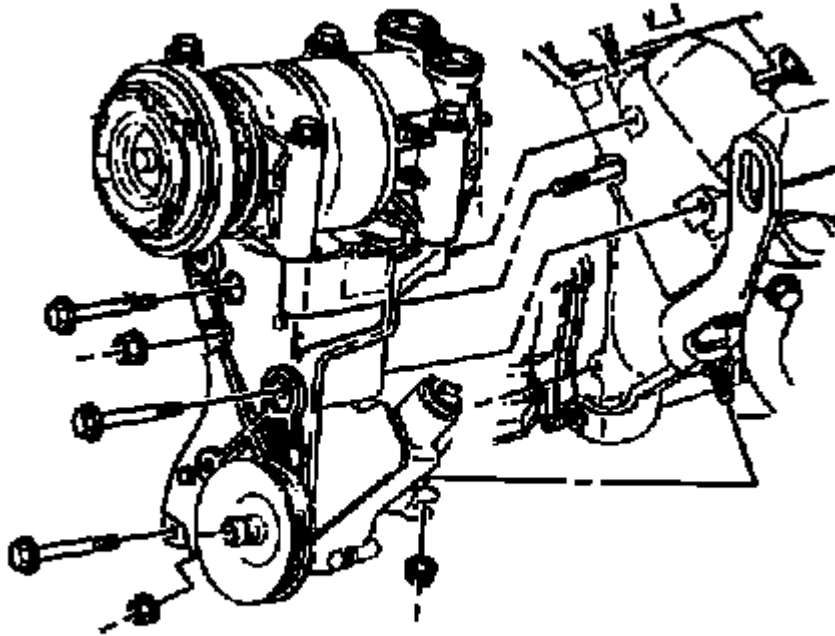


Fig. 71: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

11. Slide the P/S pump bracket rearward.
12. Install the bolts and the nut for the P/S pump bracket.
13. Install the P/S pump rear bracket front nut.
14. Tighten the P/S pump rear bracket nuts and bolts to 41 N.m (30 lb ft).
15. Install the drive belt. Refer to **Drive Belt Replacement**.

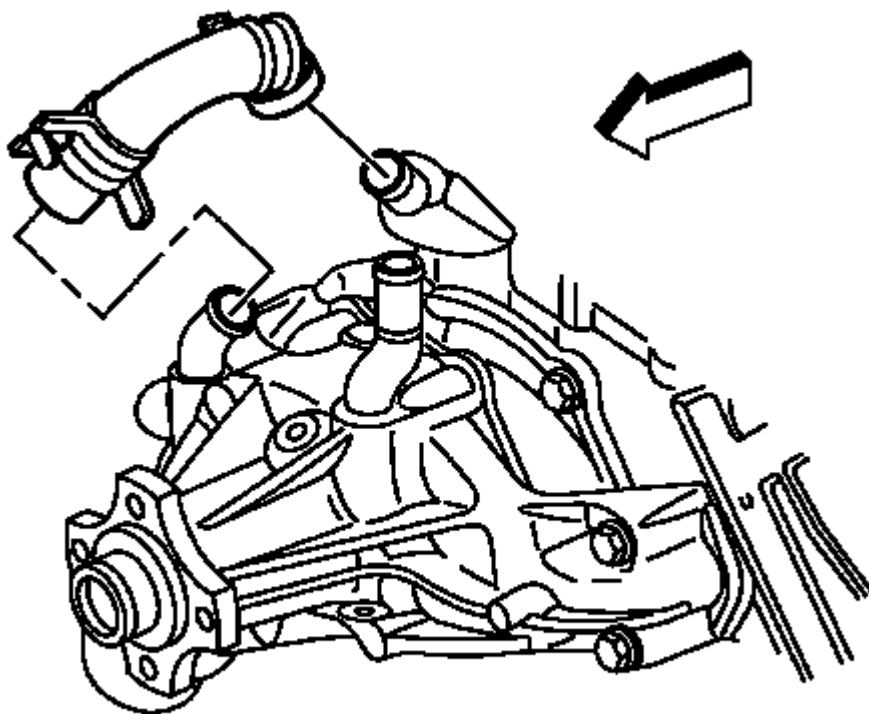


Fig. 72: View Of Water Pump Inlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

16. Install the water pump inlet hose.
17. Position the water pump inlet hose clamps.

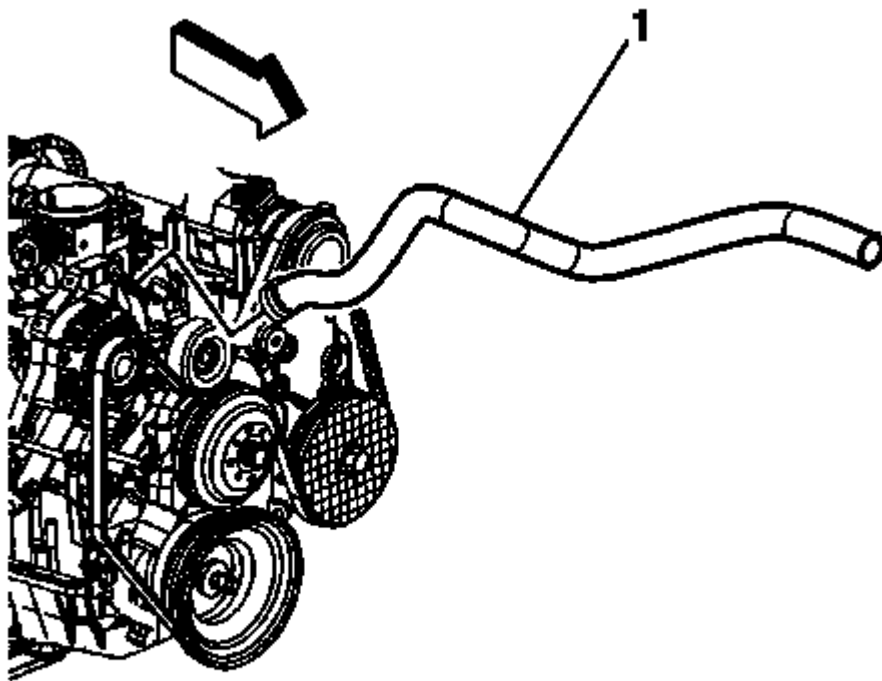


Fig. 73: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

18. Install the radiator inlet hose (1) to the thermostat housing.
19. Position the radiator inlet hose clamps.
20. Connect the power brake booster vacuum hose to the vacuum fitting.

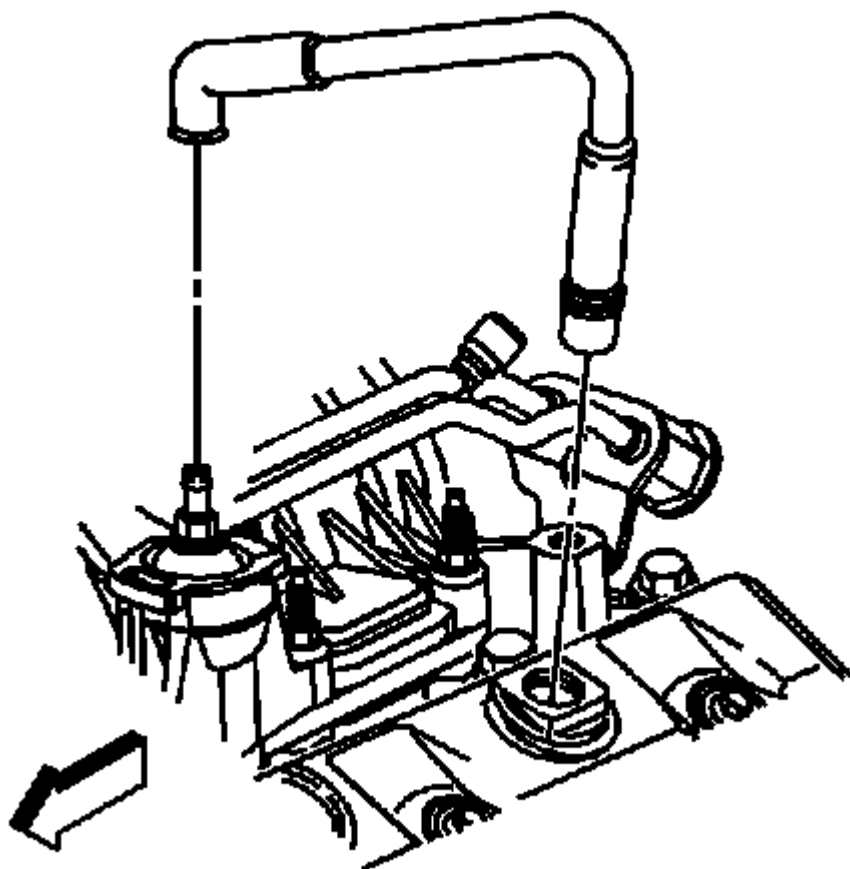


Fig. 74: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

21. Install the PCV valve hose to the valve cover and rocker cover.

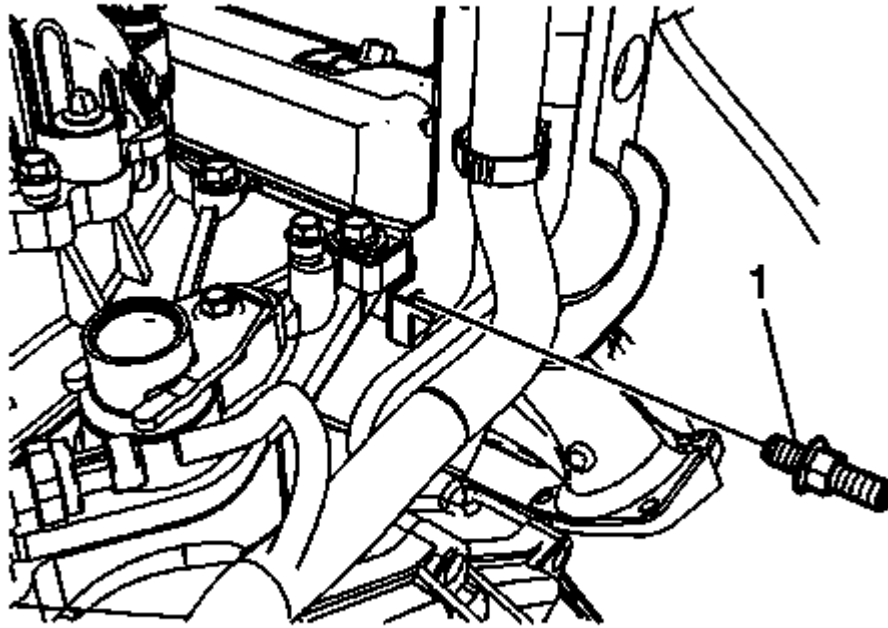


Fig. 75: Locating Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

22. Position the engine wiring harness and bracket.
23. Install the engine wiring harness bracket stud (1) and tighten to 25 N.m (18 lb ft).
24. Install the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve and tighten to 9 N.m (80 lb in).

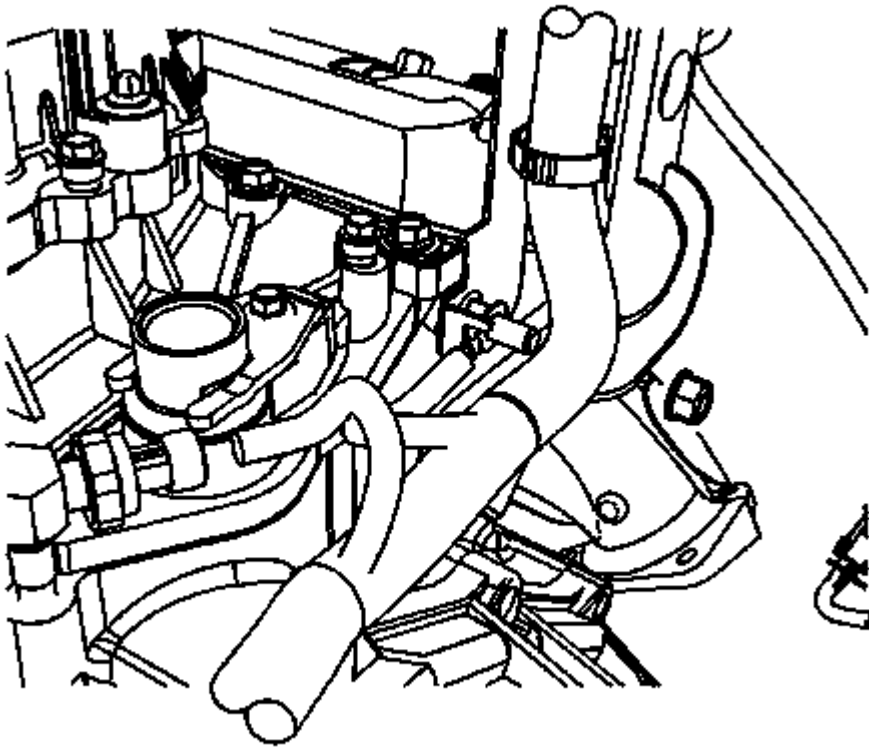


Fig. 76: View Of Engine Wiring Harness Ground Nut & Ground Wire
Courtesy of GENERAL MOTORS CORP.

25. Install the engine wiring harness ground nut and ground wire (1) to the rear of the right cylinder head and tighten to 16 N.m (12 lb ft).
26. Install the EVAP canister tube. Refer to **Evaporative Emission Line Replacement - Engine** .

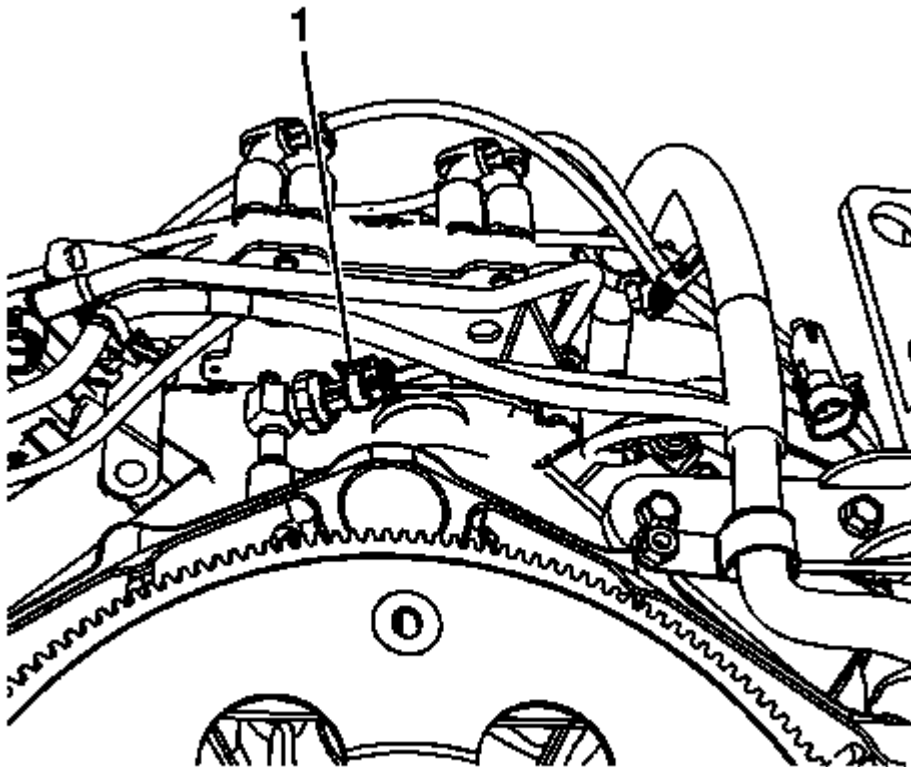


Fig. 77: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

27. Connect the oil pressure sensor electrical connector (1).

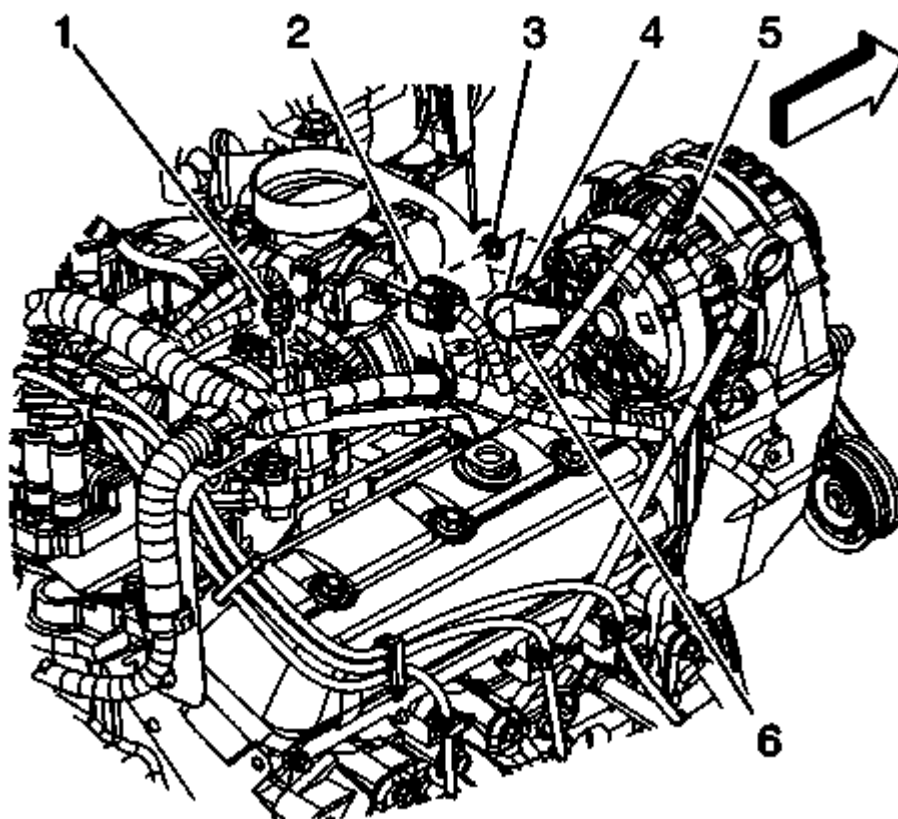


Fig. 78: View Of Engine Wiring Harness & Components
Courtesy of GENERAL MOTORS CORP.

28. Connect the following electrical connectors:
- The EVAP canister purge solenoid valve (1)
 - The MAP sensor

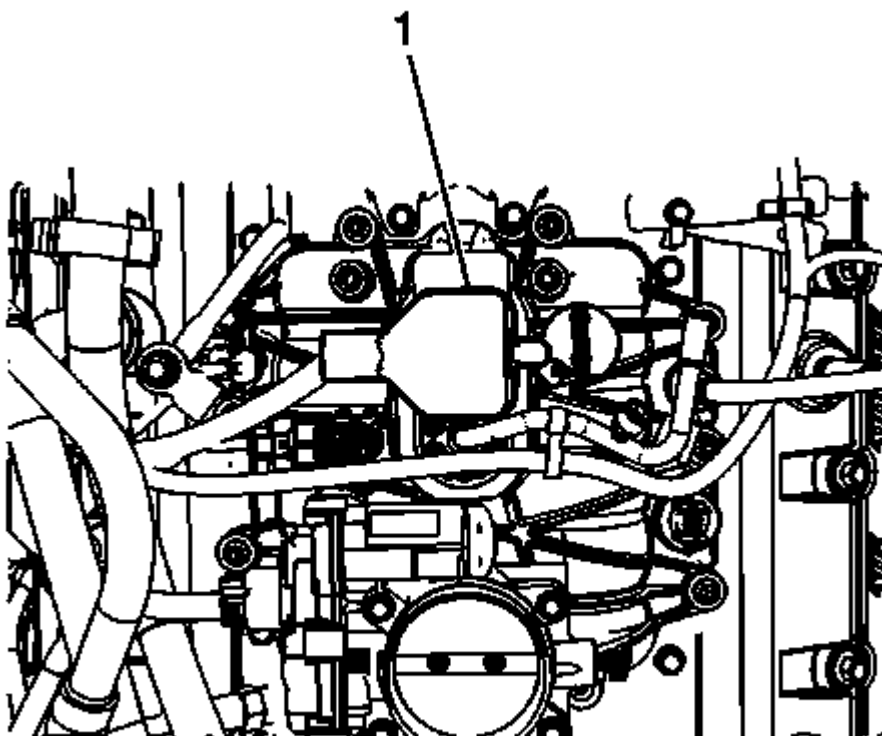


Fig. 79: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

29. Connect the control port injector module (1).

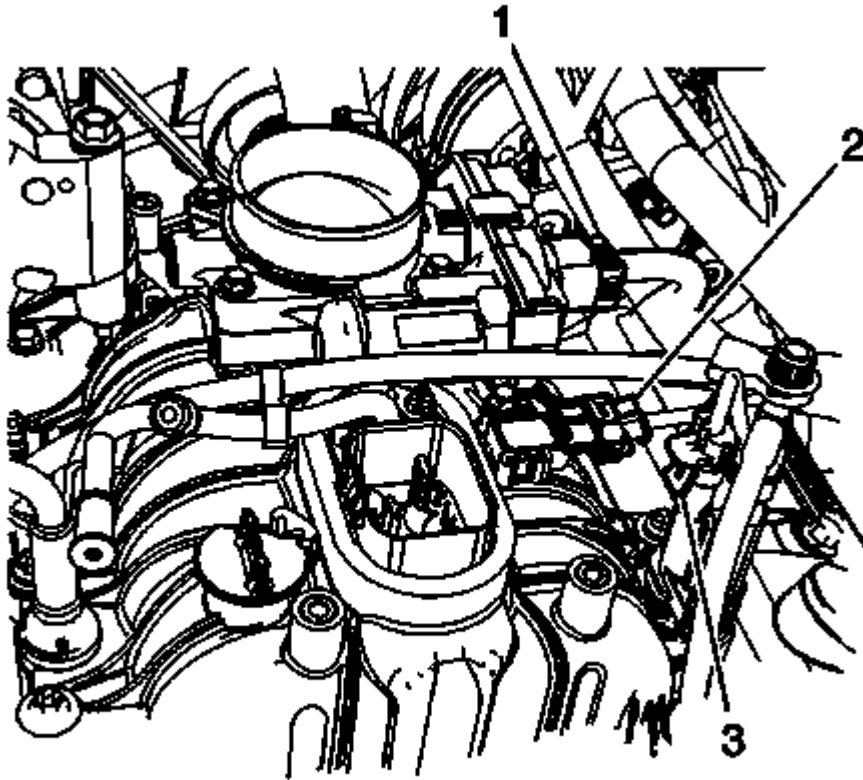


Fig. 80: View Of Throttle Body Actuator, Manifold Absolute Pressure (MAP) Sensor & Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

30. Connect A/C compressor clutch, if equipped.
31. Connect the following electrical connectors:
 - The EVAP canister purge solenoid valve (3)
 - The MAP sensor (2)
 - The throttle body actuator (1)

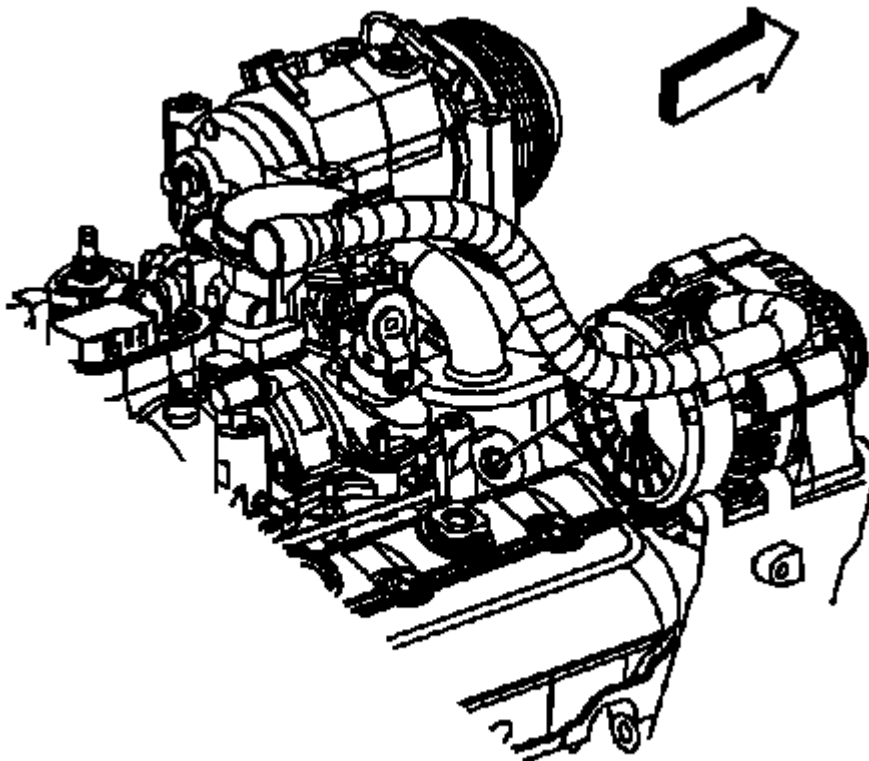


Fig. 81: Identifying Heater Inlet Hose & Water Pump
Courtesy of GENERAL MOTORS CORP.

32. Position the heater inlet and outlet hoses.
33. Open the heater inlet hose clamp and install the hose to the water pump.

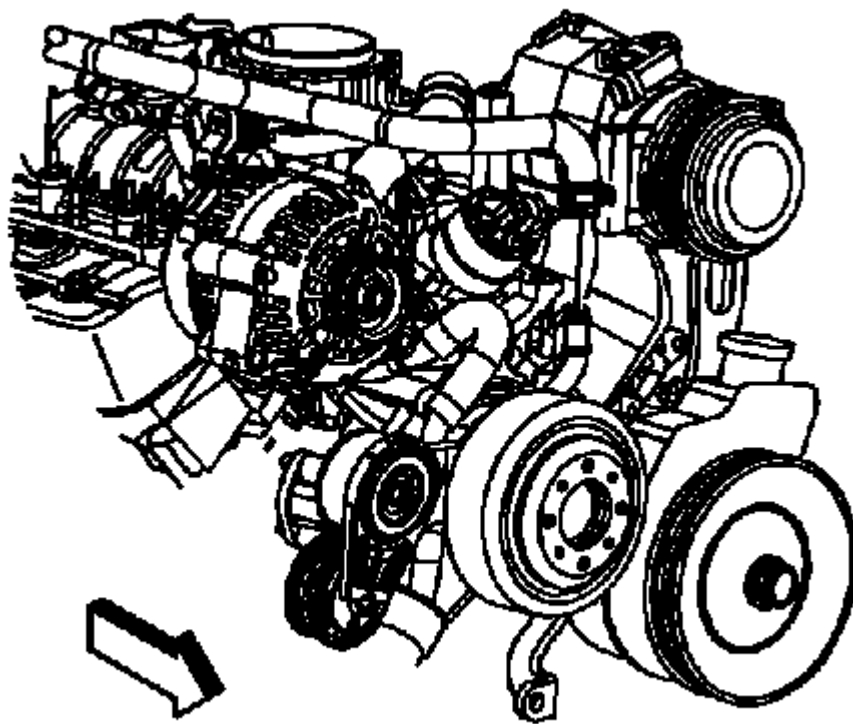


Fig. 82: Identifying Intake Manifold Hose
Courtesy of GENERAL MOTORS CORP.

34. Open the heater outlet hose clamp and install the hose to the intake manifold.
35. Install the fuel pipes/hoses. Refer to **Fuel Line Replacement - Engine** .
36. Install the ignition coil assembly. Refer to **Ignition Coil Replacement** .
37. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)** .
38. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
39. Install the engine cover. Refer to **Engine Cover Replacement** .

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

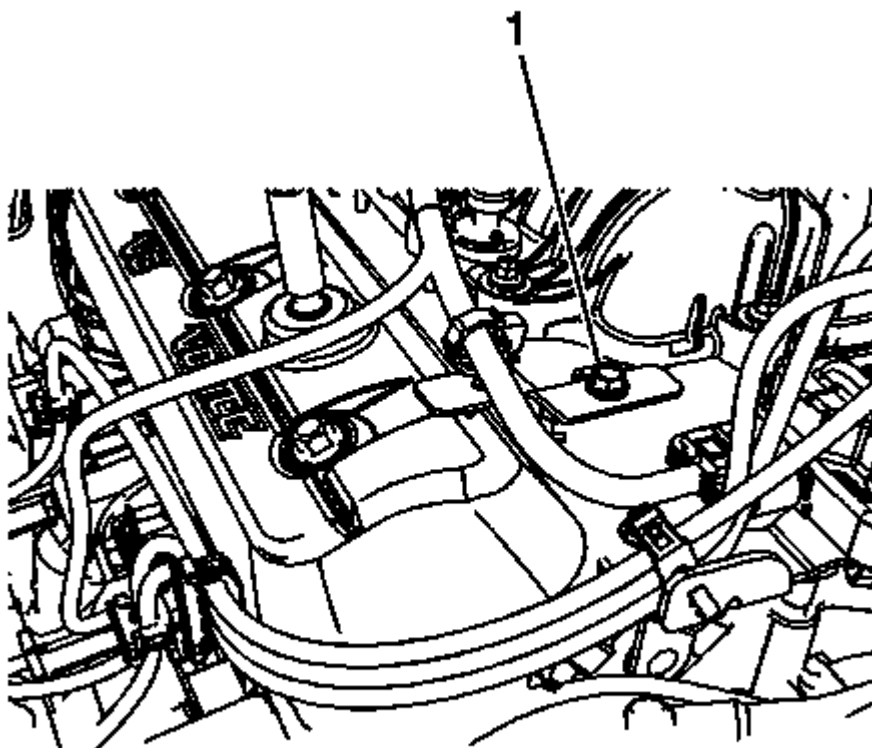


Fig. 83: View Coil Wiring Harness Bracket Nut
Courtesy of GENERAL MOTORS CORP.

2. Remove the coil wiring harness bracket nut (1).
3. Remove the coil wiring harness bracket and set aside.

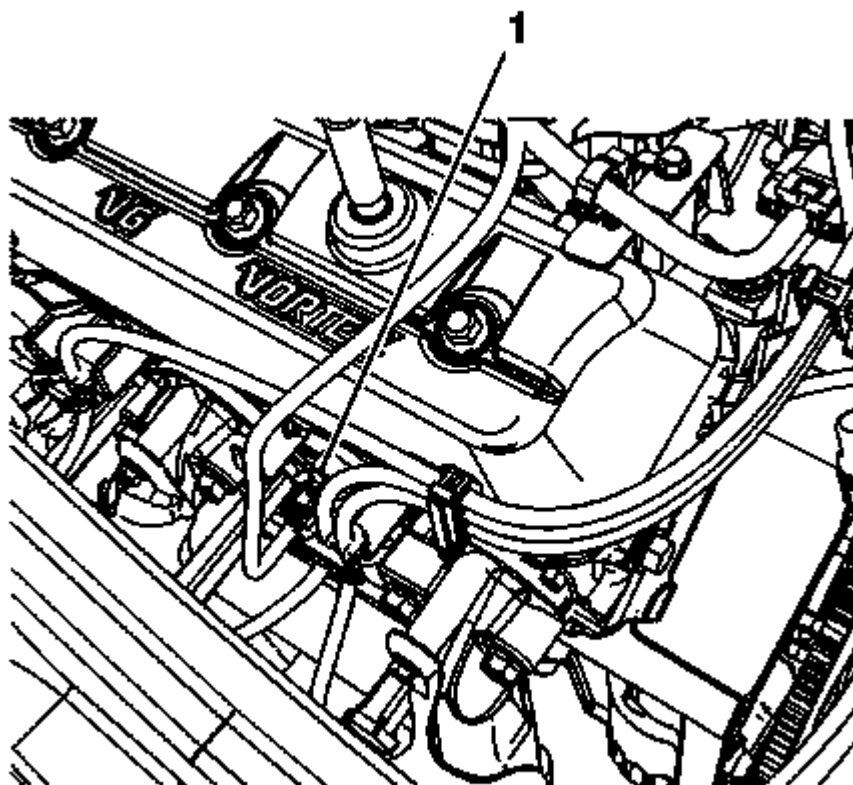


Fig. 84: View Of Engine Coolant Temperature (ECT) Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the engine coolant temperature (ECT) sensor electrical connector (1).
5. Disconnect the power brake booster vacuum hose from the vacuum fitting.

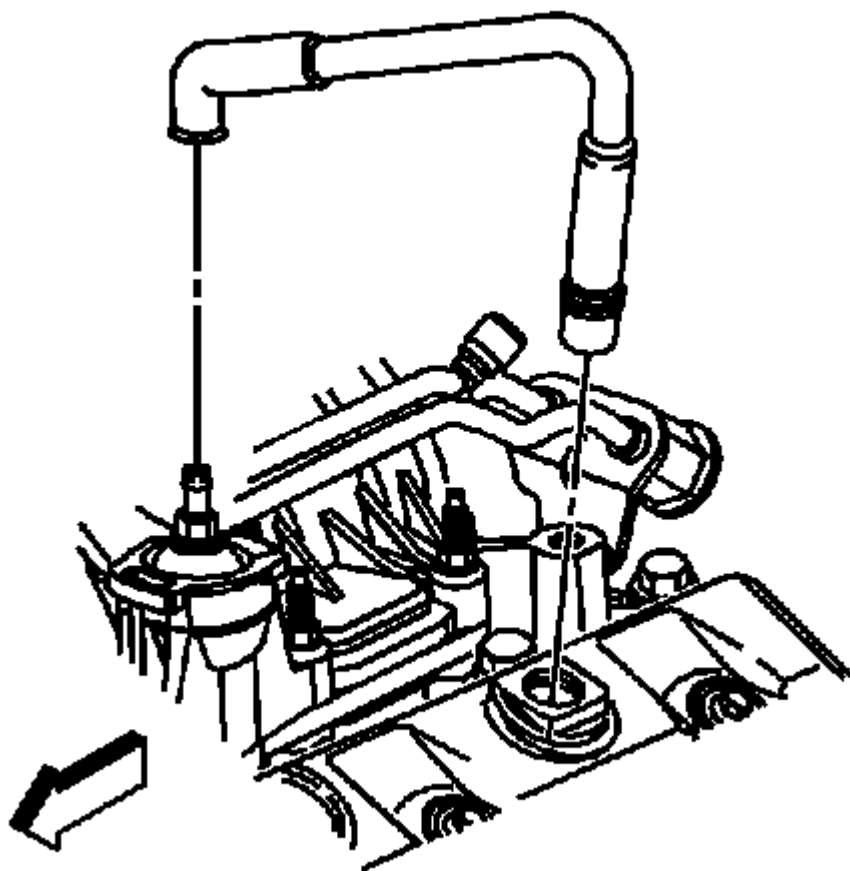


Fig. 85: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

6. Remove the positive crankcase ventilation (PCV) valve hose from the valve cover and rocker cover.

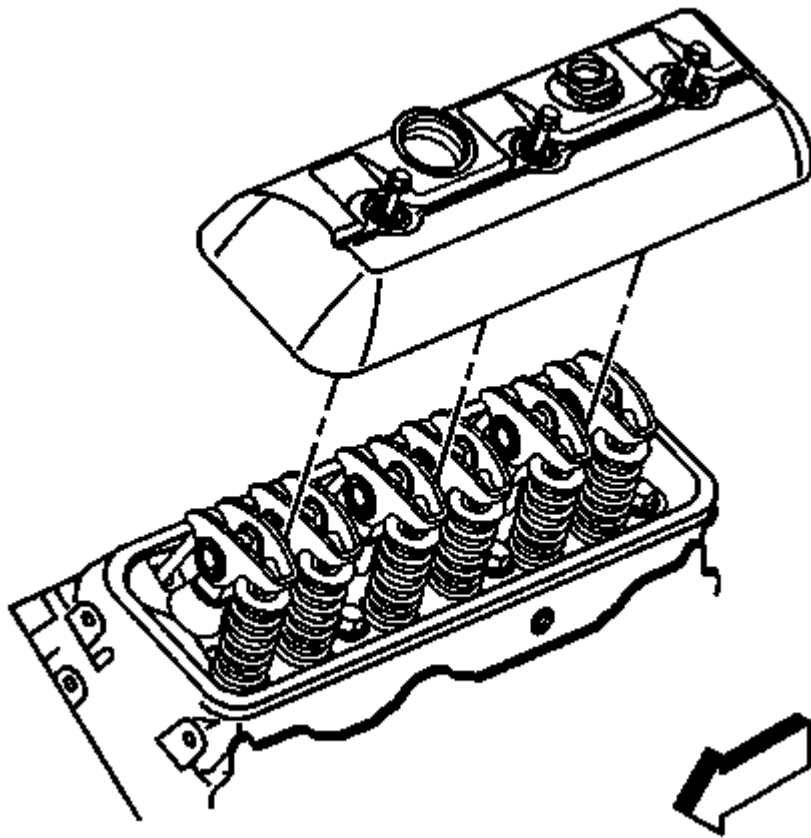


Fig. 86: Identifying Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

7. Remove the rocker arm cover bolts.
8. Remove and discard the rocker arm cover bolt grommets, if necessary.
9. Remove the rocker arm cover.

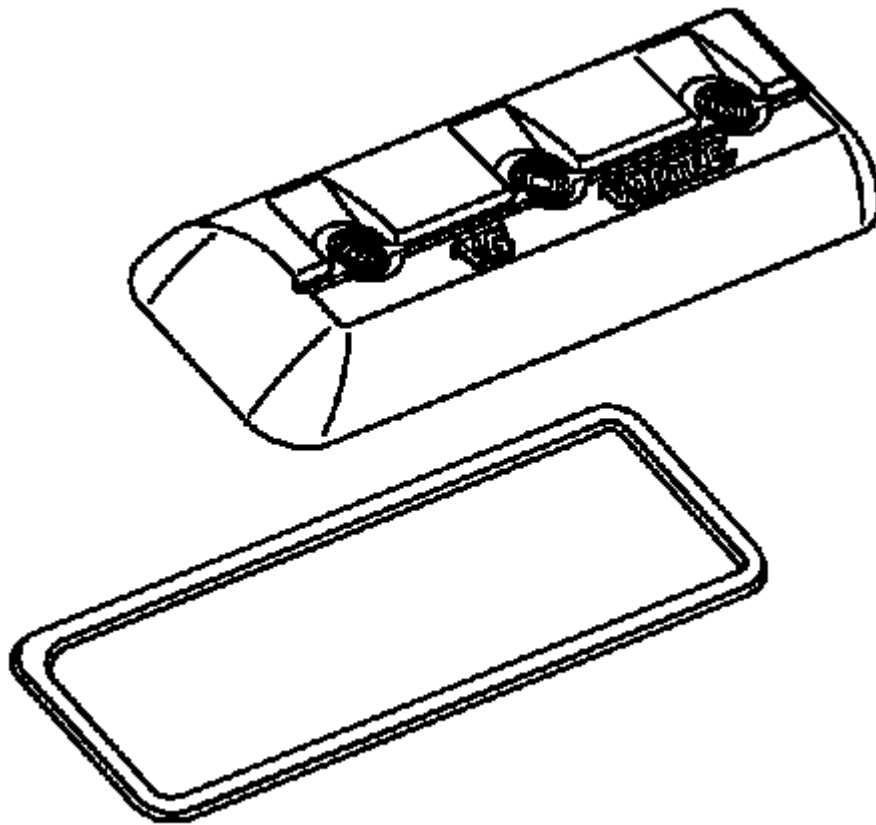


Fig. 87: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

10. Remove and discard the rocker arm cover gasket.
11. Clean and inspect the rocker arm cover, if necessary. Refer to **Valve Rocker Arm Cover Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: **Do not reuse the rocker cover gasket or the rocker arm cover bolt grommets.**

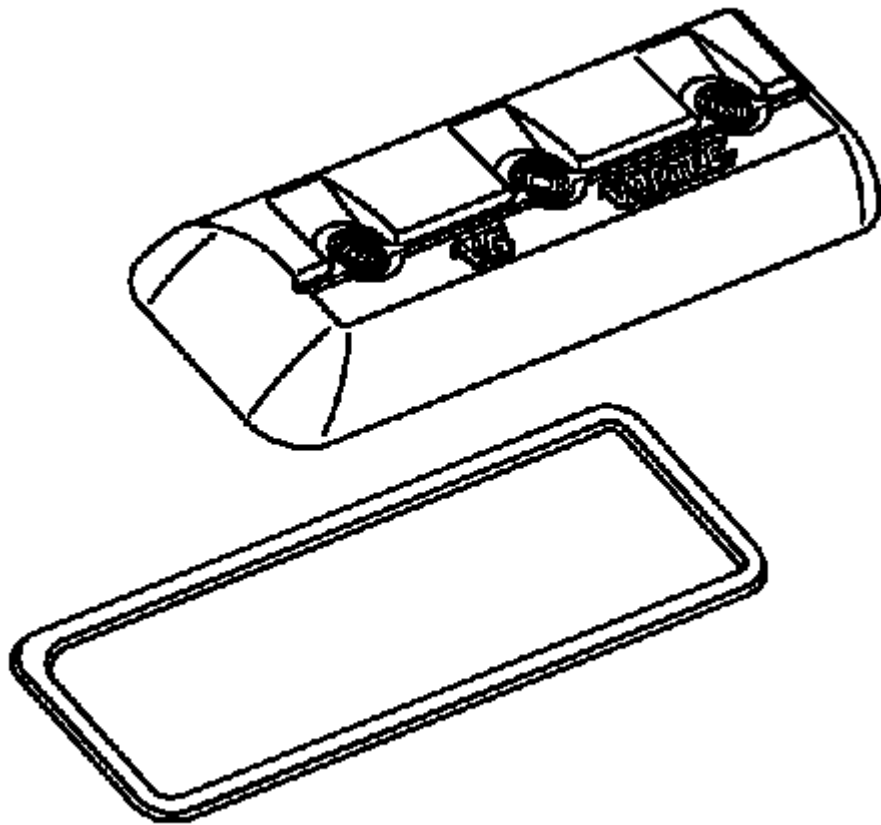


Fig. 88: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW rocker arm cover gasket to the cover.
2. Install NEW rocker arm cover bolt grommets to the cover, if necessary.

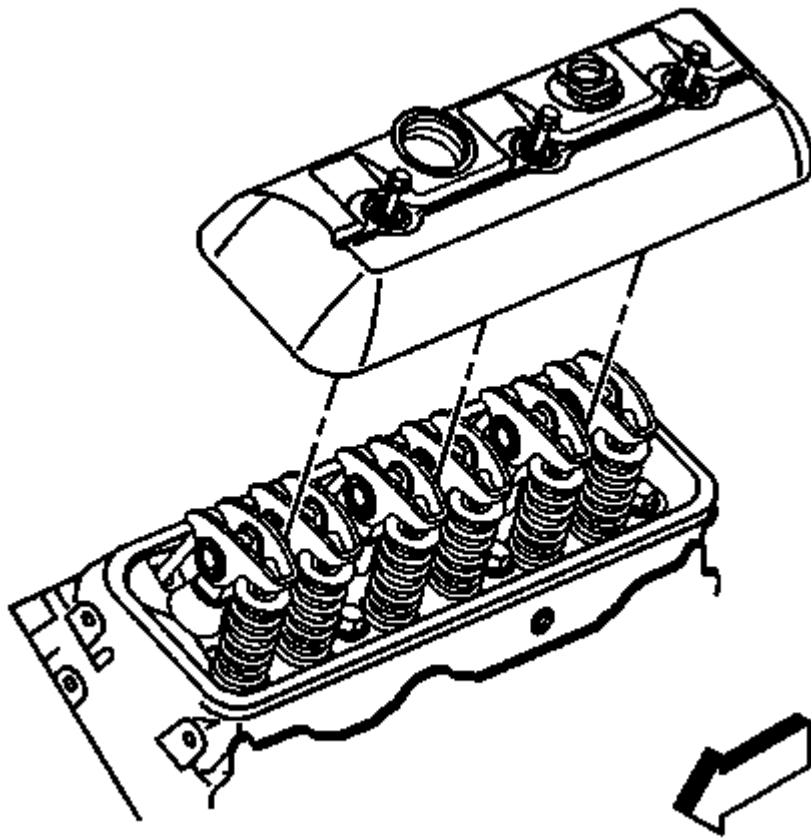


Fig. 89: Identifying Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the rocker arm cover.

CAUTION: Refer to Fastener Caution .

4. Install the rocker arm cover bolts and tighten to 12 N.m (106 lb in).

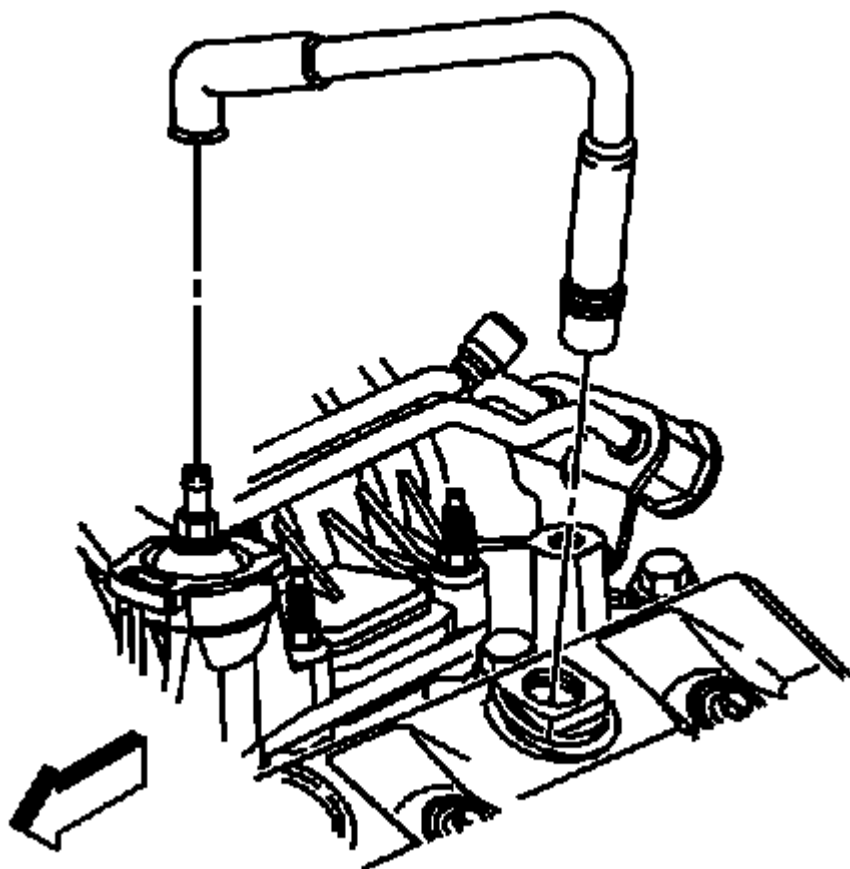


Fig. 90: Locating PCV Valve Hose At Valve & Rocker Cover
Courtesy of GENERAL MOTORS CORP.

5. Install the PCV valve hose to the valve cover and rocker cover.

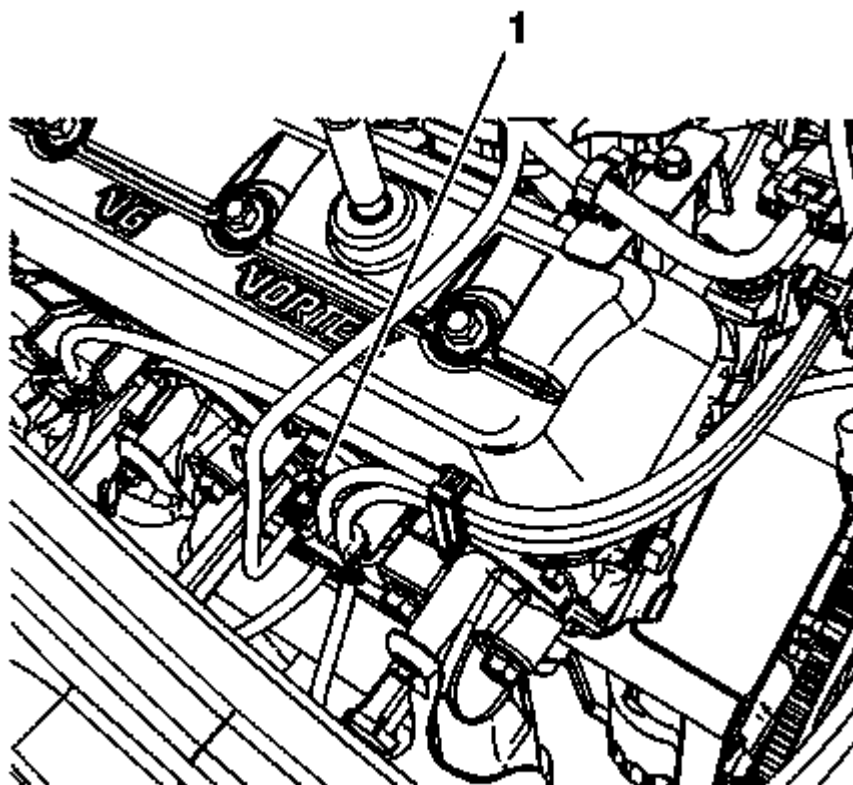


Fig. 91: View Of Engine Coolant Temperature (ECT) Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the power brake booster vacuum hose to the vacuum fitting.
7. Connect the ECT sensor electrical connector (1).

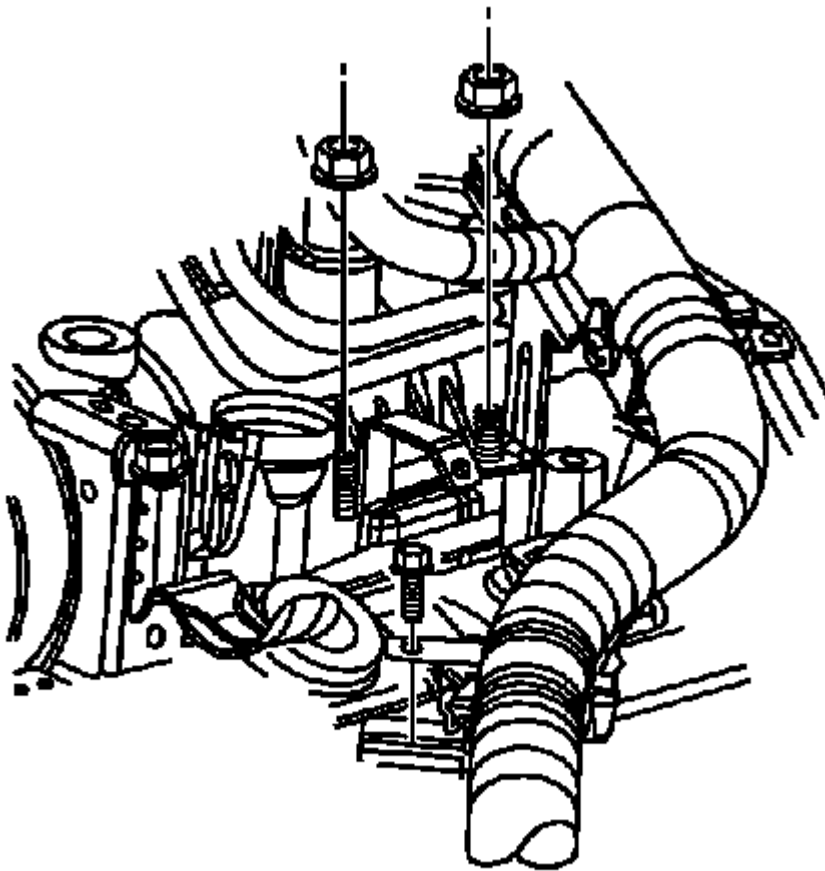


Fig. 92: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

8. Install the coil wiring harness bracket.
9. Install the coil wiring harness bracket nut and tighten to 9 N.m (80 lb in).
10. Install the engine cover. Refer to **Engine Cover Replacement** .

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the oil filler tube.

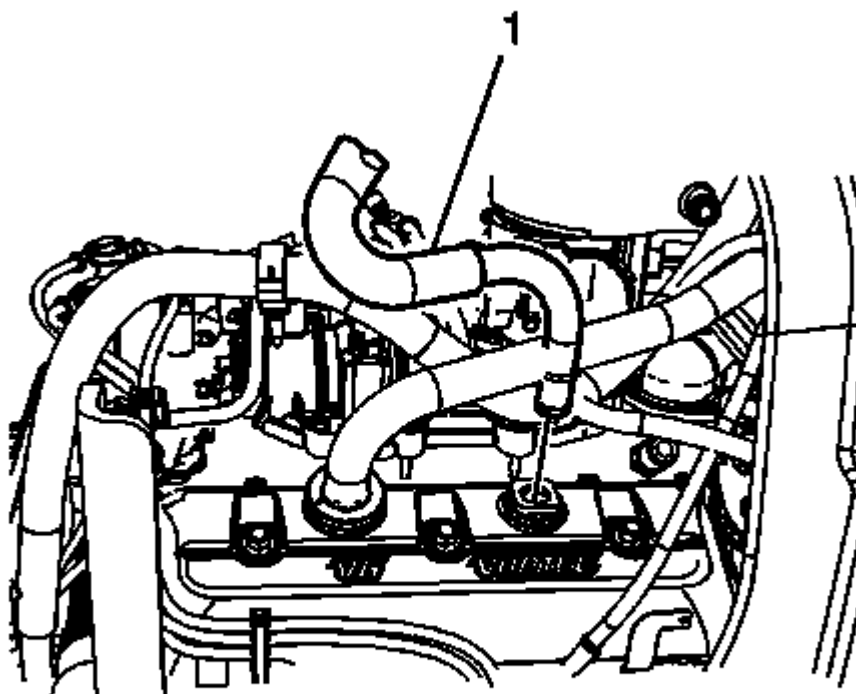


Fig. 93: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

3. Remove the positive crankcase ventilation (PCV) hose (1).

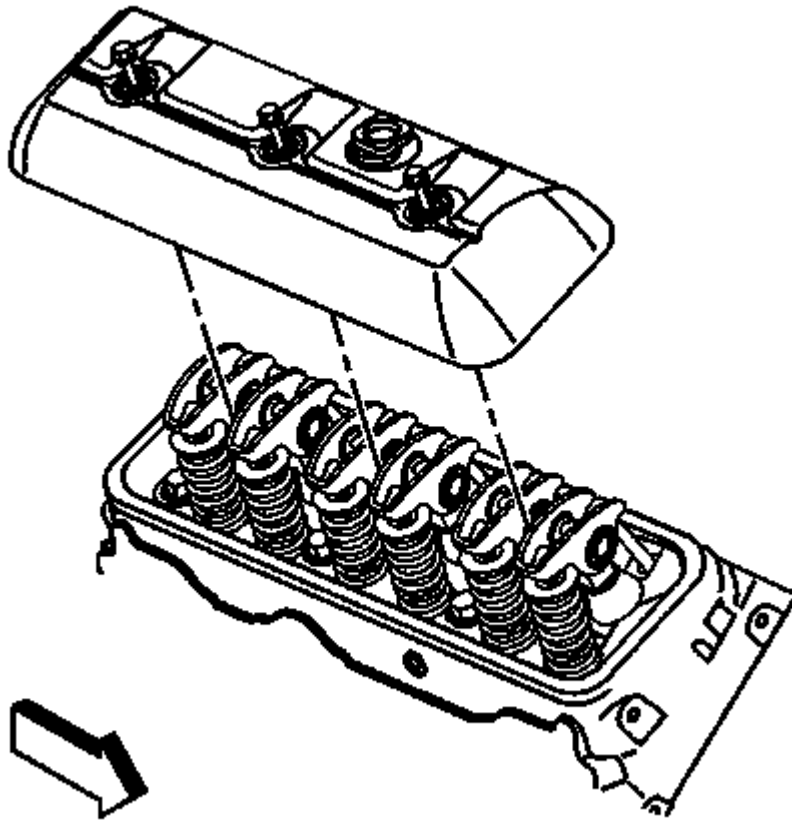


Fig. 94: View Of Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the rocker arm cover bolts.
5. Remove and discard the rocker arm cover bolt grommets, if necessary.
6. Remove the rocker arm cover.

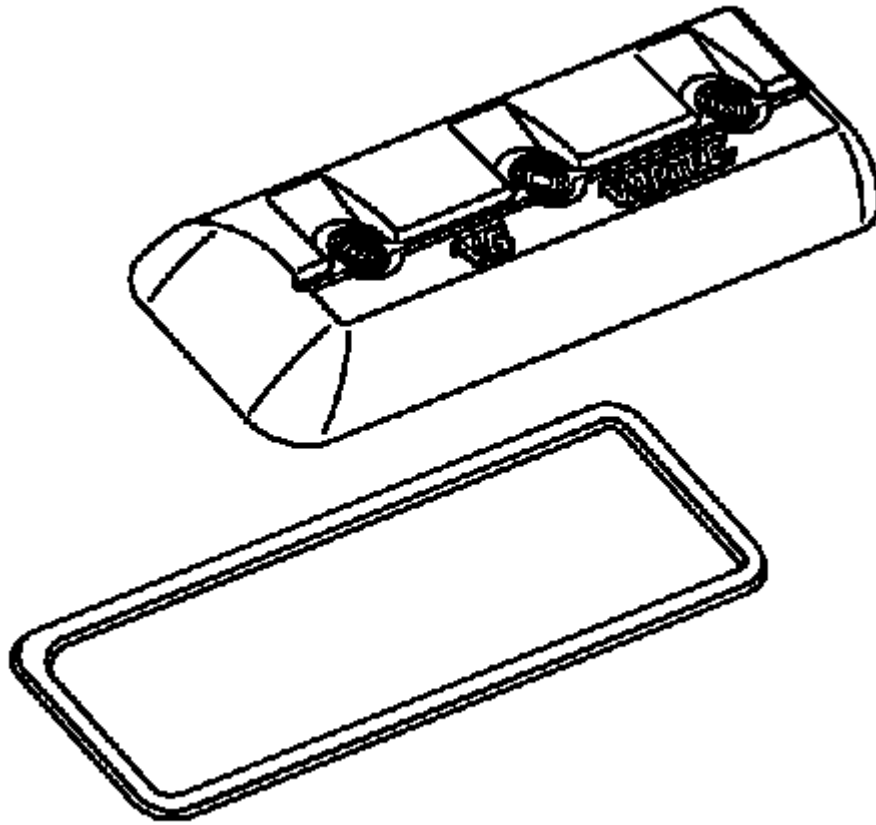


Fig. 95: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard the rocker arm cover gasket.
8. Clean and inspect the rocker arm cover, if necessary. Refer to **Valve Rocker Arm Cover Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: Do not reuse the cover gasket or the valve rocker arm cover bolt grommets.

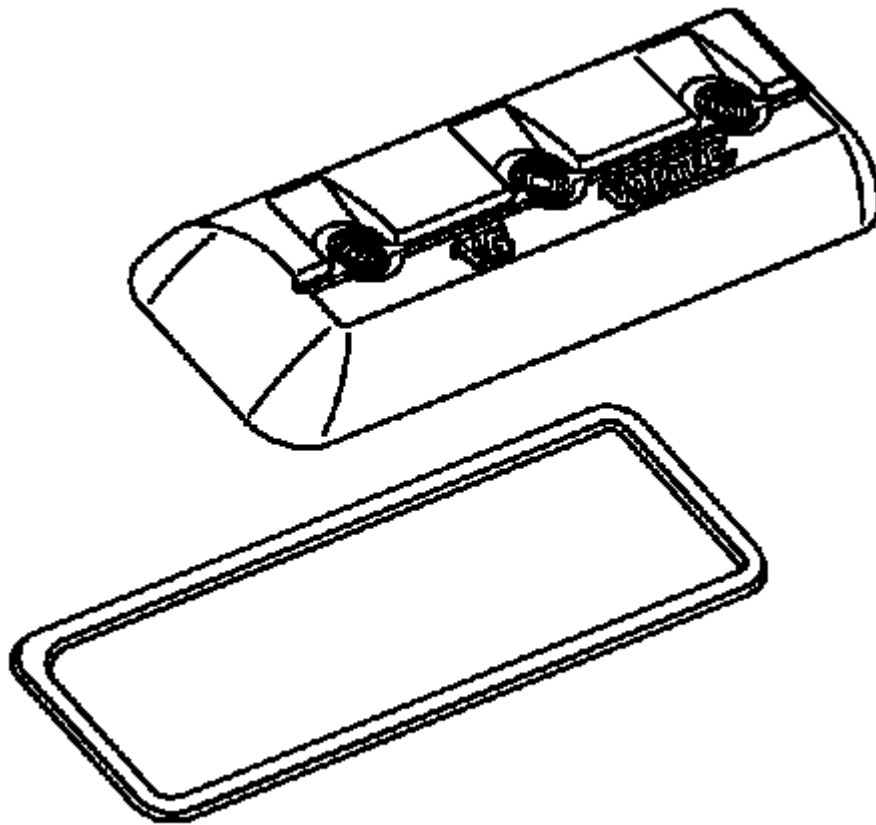


Fig. 96: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW rocker arm cover gasket.
2. Install NEW rocker arm cover bolt grommets, if necessary.

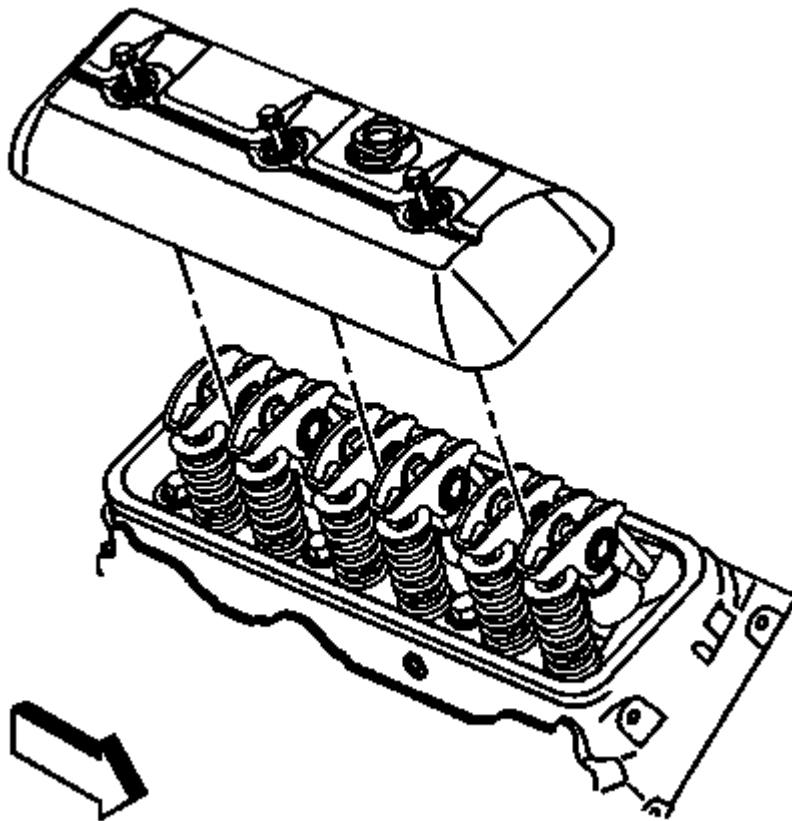


Fig. 97: View Of Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the rocker arm cover.
4. Install the rocker arm cover bolts and tighten to 12 N.m (106 lb in).

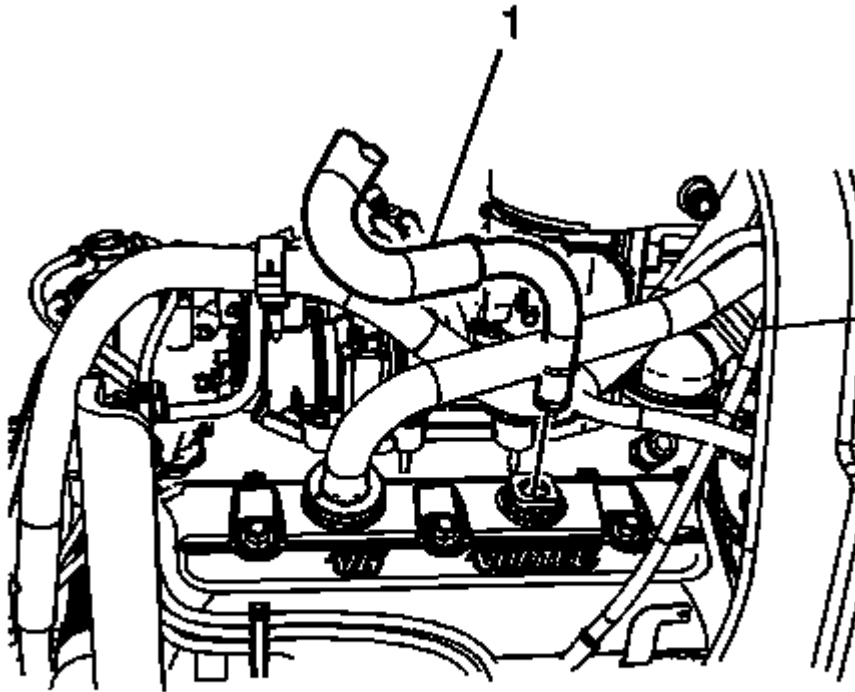


Fig. 98: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

5. Install the PCV hose (1).
6. Install the oil filler tube.
7. Install the engine cover. Refer to Engine Cover Replacement .

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

REMOVAL PROCEDURE

NOTE: Mark, sort, and organize all the components for assembly.

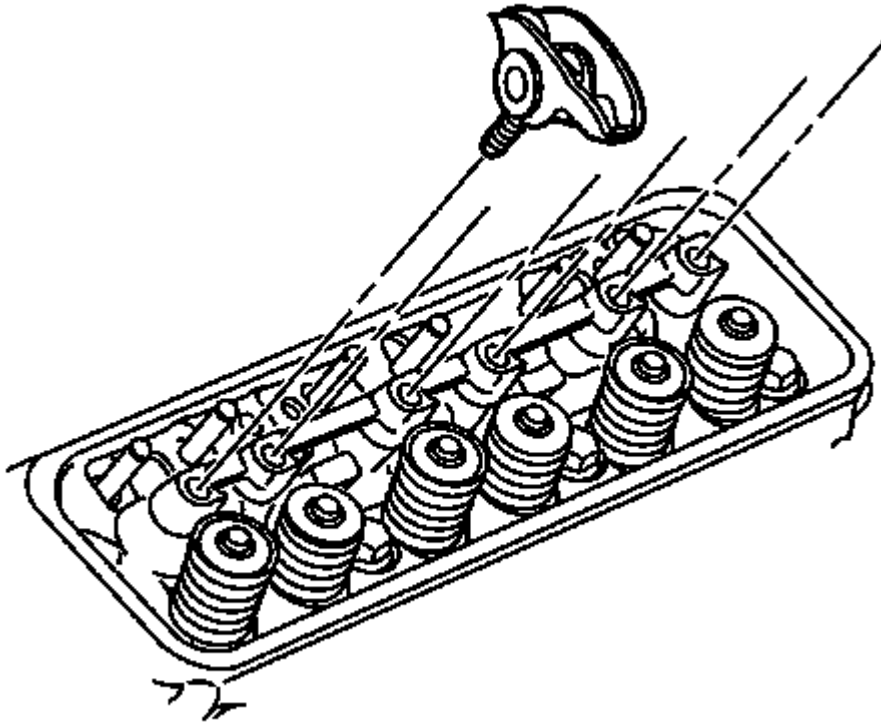


Fig. 99: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

1. Remove the rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Left Side](#) or [Valve Rocker Arm Cover Replacement - Right Side](#).
2. Remove the rocker arms.

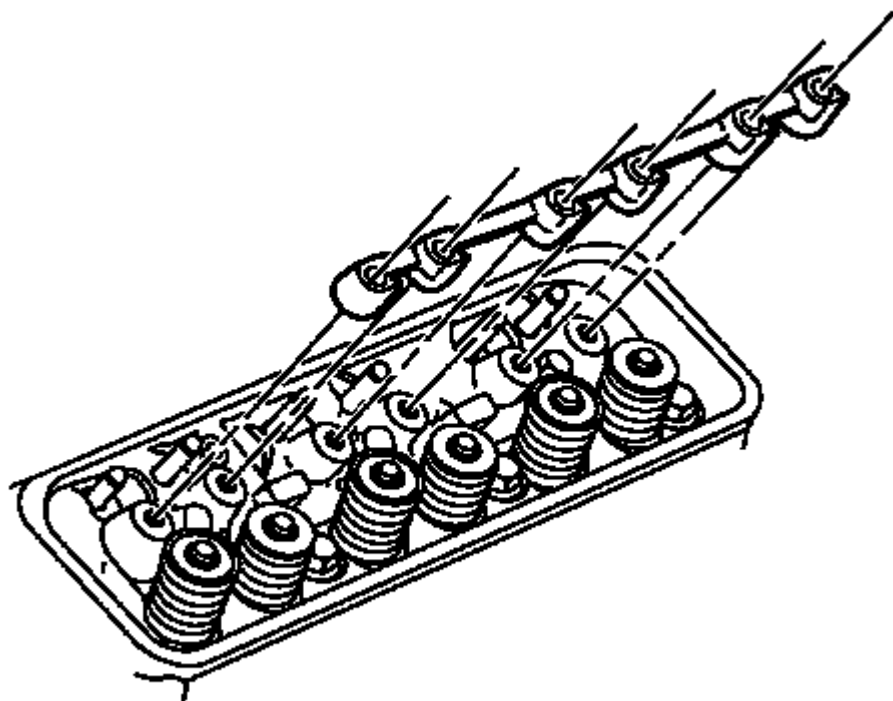


Fig. 100: Identifying Valve Rocker Arm Supports
Courtesy of GENERAL MOTORS CORP.

3. Remove the rocker arm supports.

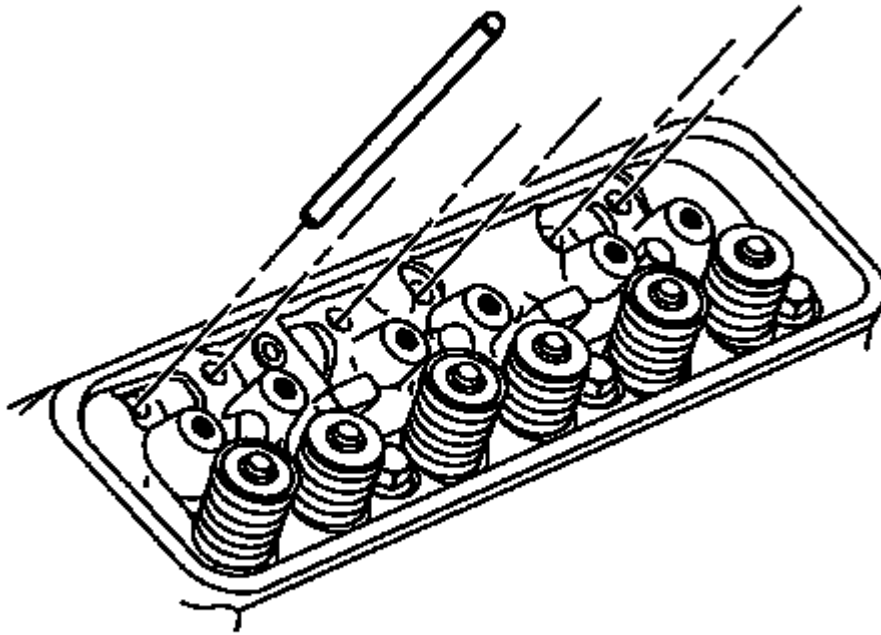


Fig. 101: View Of Valve Pushrods
Courtesy of GENERAL MOTORS CORP.

4. Remove the pushrods.
5. Clean and inspect the rocker arms and/or pushrods, if necessary. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: Be sure to keep parts in order. Parts must be reinstalled into the original location and position.

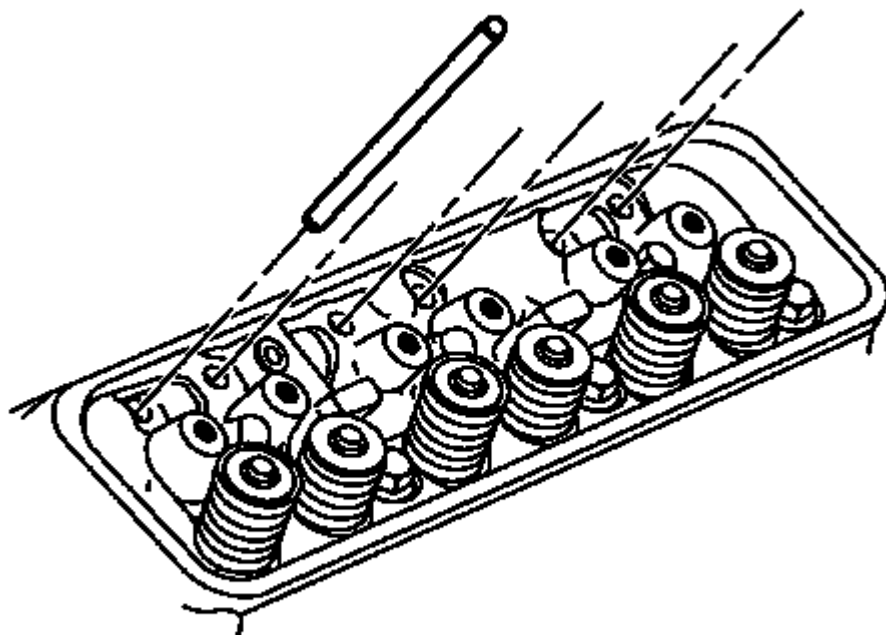


Fig. 102: View Of Valve Pushrods
Courtesy of GENERAL MOTORS CORP.

1. Install the pushrods.

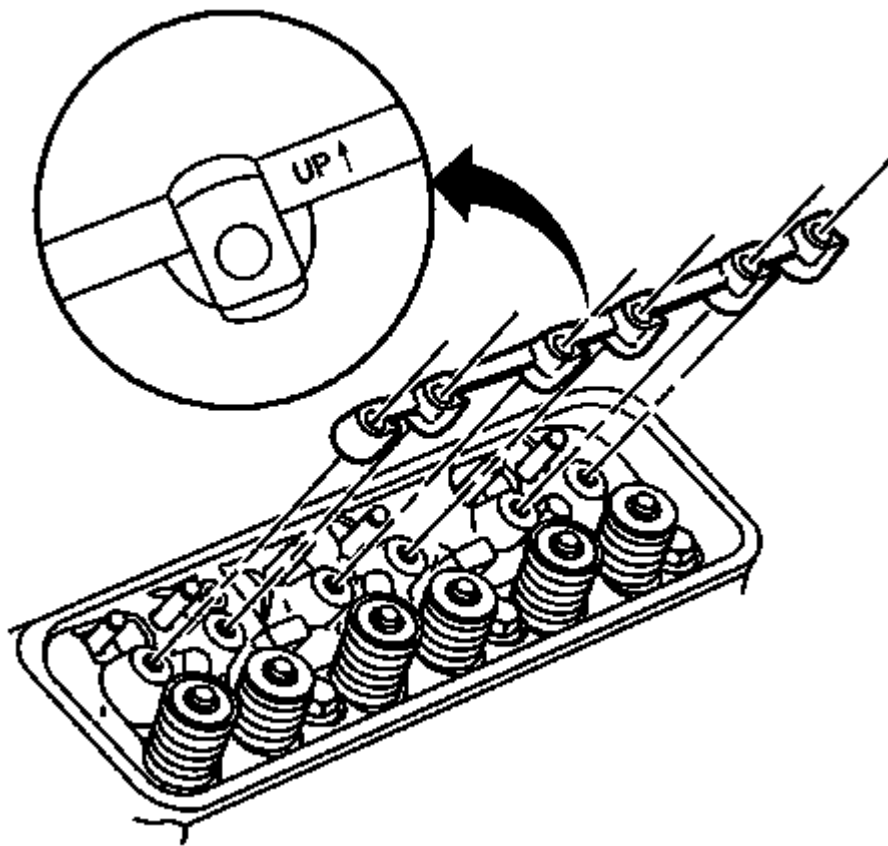


Fig. 103: View Of Valve Rocker Arm Supports
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure that the arrow on the rocker arm support is in the up position.

2. Install the rocker arm supports.

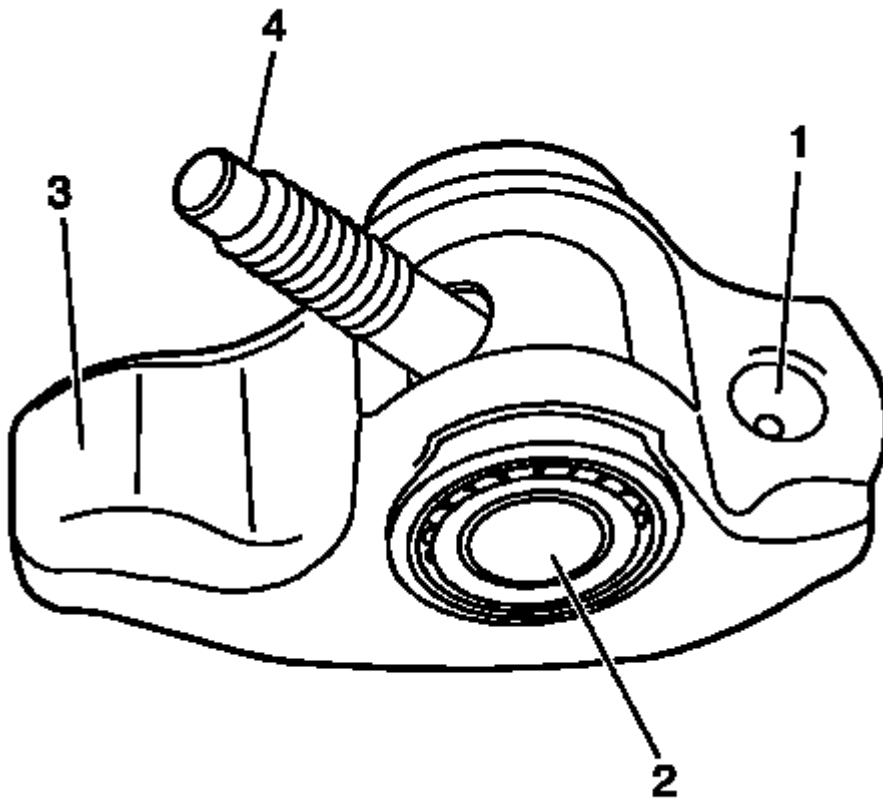


Fig. 104: View Of Valve Pushrod Socket, Roller Pivot & Valve Stem Tip
Courtesy of GENERAL MOTORS CORP.

3. Apply lubricant to the following rocker arm contact surfaces:
- Pushrod socket (1)
 - Roller pivot (2)
 - Valve stem tip (3)

Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

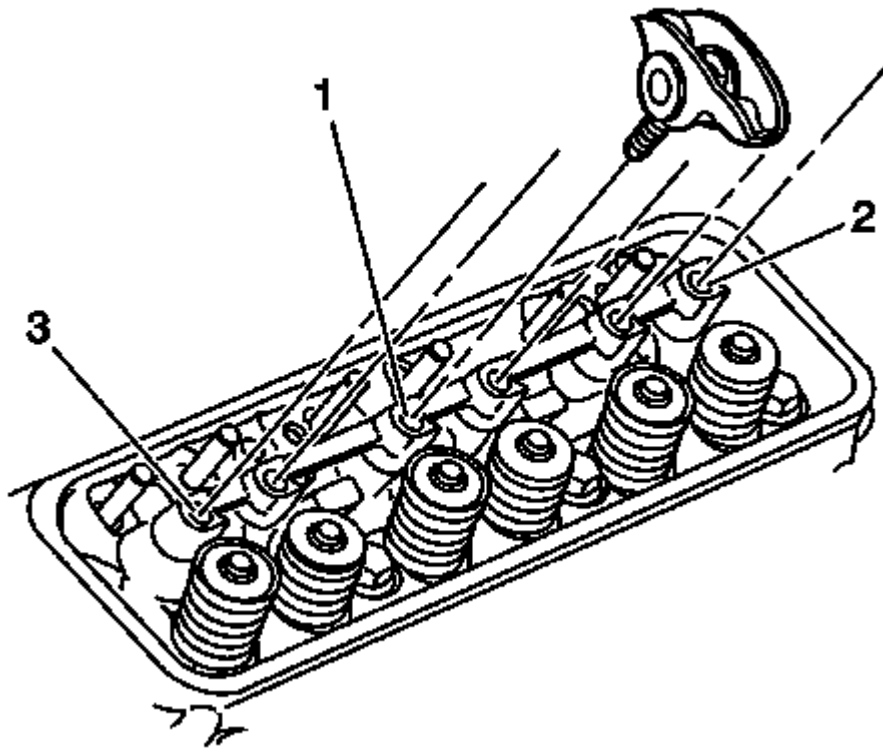


Fig. 105: View Of Valve Rocker Arm Bolt Locations
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the rocker arms as follows:
 1. Finger start the bolt at location (1)
 2. Finger start the bolt at location (2)
 3. Finger start the bolt at location (3)
 4. Finger start the remaining rocker arm bolts

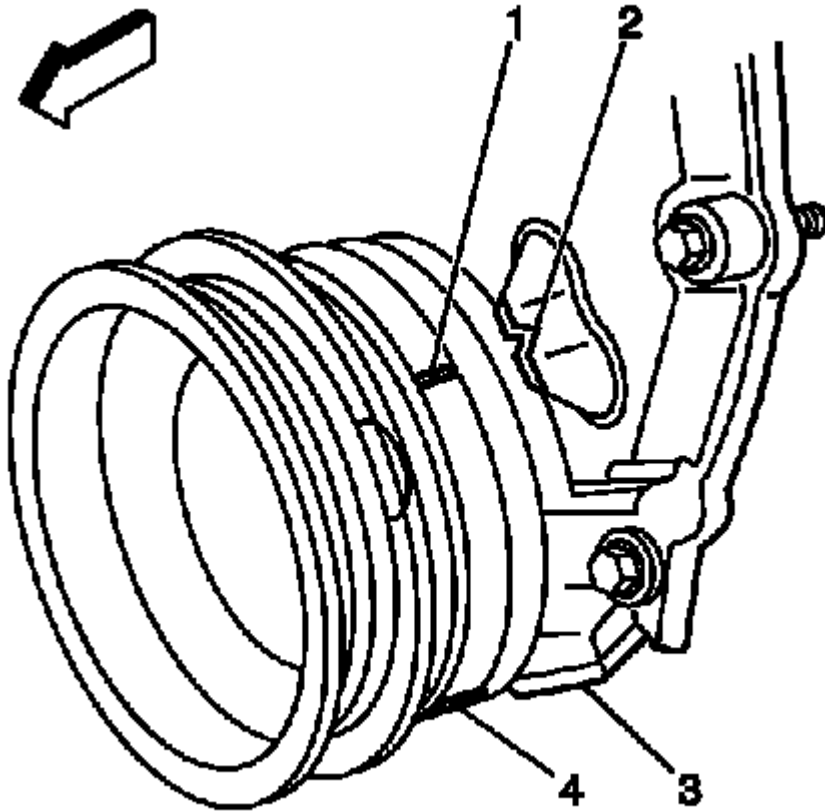


Fig. 106: View Of Crankshaft Balancer Alignment Mark & Engine Front Cover Alignment Tab
Courtesy of GENERAL MOTORS CORP.

5. Rotate the crankshaft balancer to position the crankshaft balancer alignment mark (1) 57-63 degrees clockwise or counterclockwise from the engine front cover alignment tab (2).

NOTE: Once the rocker arms are installed and properly torqued, no additional valve lash adjustment is required.

6. Tighten the rocker arm bolts to 30 N.m (22 lb ft).
7. Install the rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **J 22794** Spark Plug Port Adapter. See Special Tools .
- **J 38606** Valve Spring Compressor. See Special Tools .

- **J 5892-D** Valve Spring Compressor. See Special Tools .
- **J 42073** Valve Stem Oil Seal Installer. See Special Tools .

REMOVAL PROCEDURE

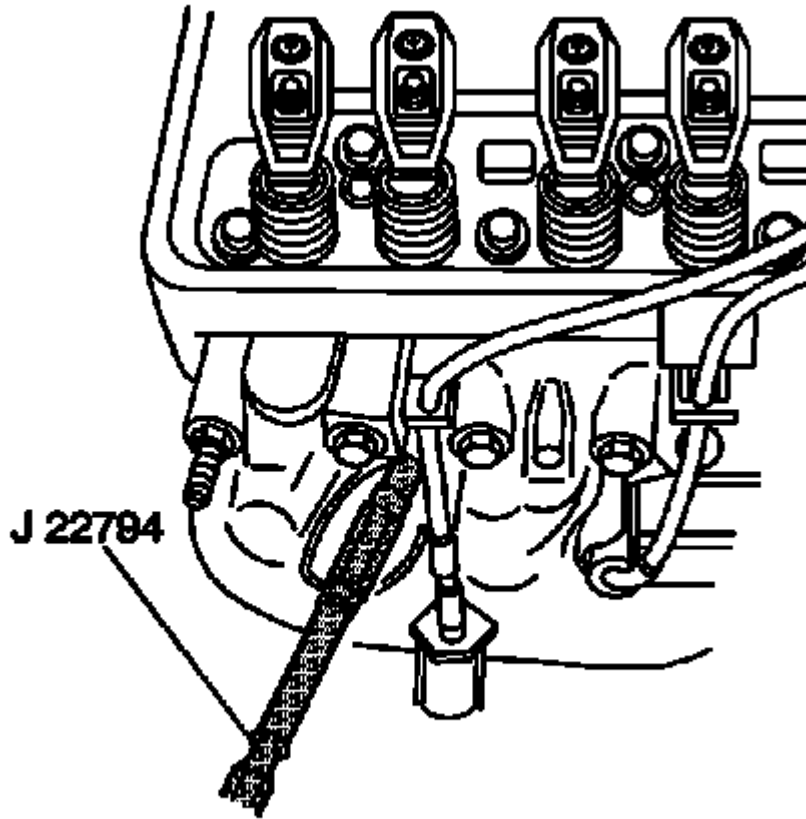


Fig. 107: View Of Special Tool J 22794 Installed Into Spark Plug Hole
Courtesy of GENERAL MOTORS CORP.

1. Remove the required valve rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement.
2. Remove the required spark plugs. Refer to Spark Plug Replacement .
3. Install the **J 22794** into the spark plug hole. See Special Tools .
4. Connect a shop air supply hose and apply compressed air in order to hold the valves in place.

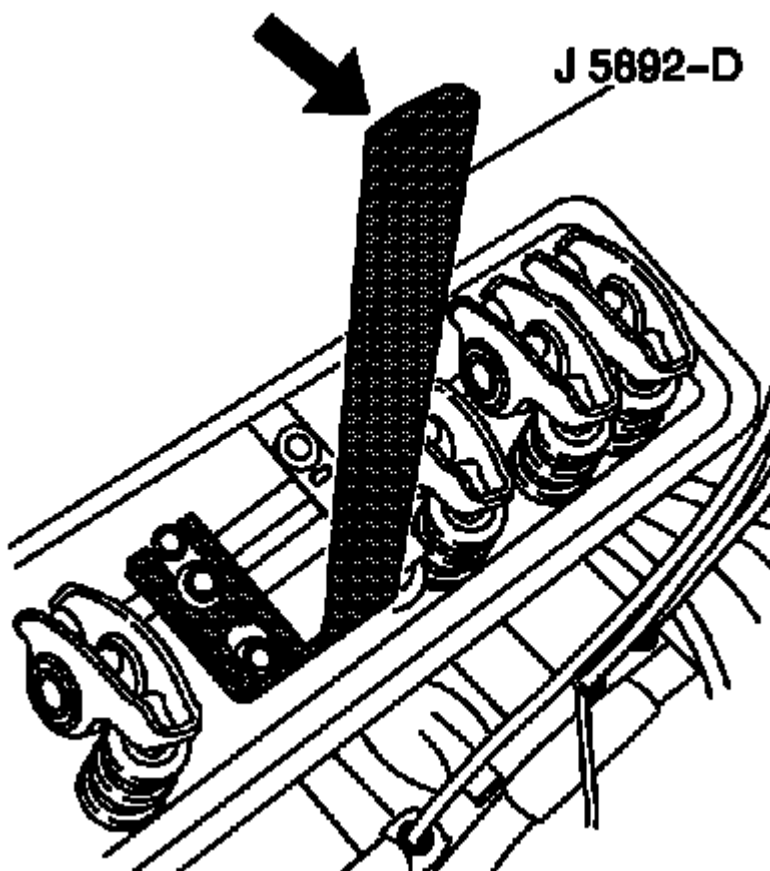


Fig. 108: View Of Special Tool J 5892--D, Valve Rocker Arm Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

5. Install a flat washer onto the removed rocker arm bolt.
6. Install the bolt and rocker arm for the valve spring requiring removal.

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

7. Using **J 5892-D** compress the valve spring. See Special Tools .
 1. Hook the slotted end of **J 5892-D** under the washer on the rocker arm bolt. See Special Tools .
 2. Apply steady pressure on the valve spring cap until the valve keys are accessible.

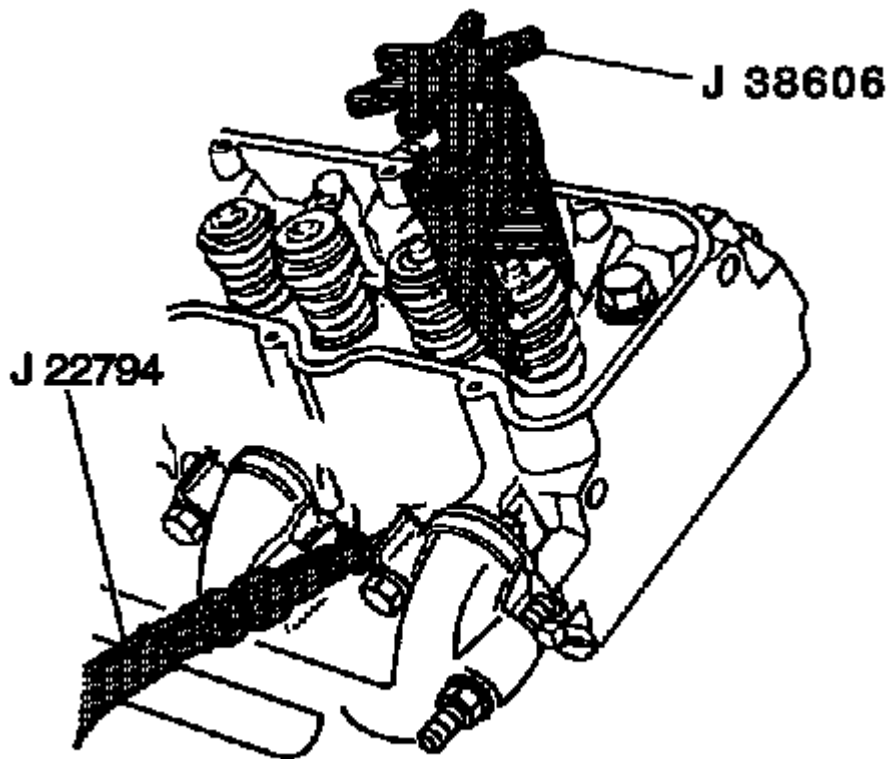


Fig. 109: View Of Special Tools J 38606 & J 5892-D Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

CAUTION: Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratch.

8. Use **J 38606** when **J 5892-D** will not fit. See Special Tools .

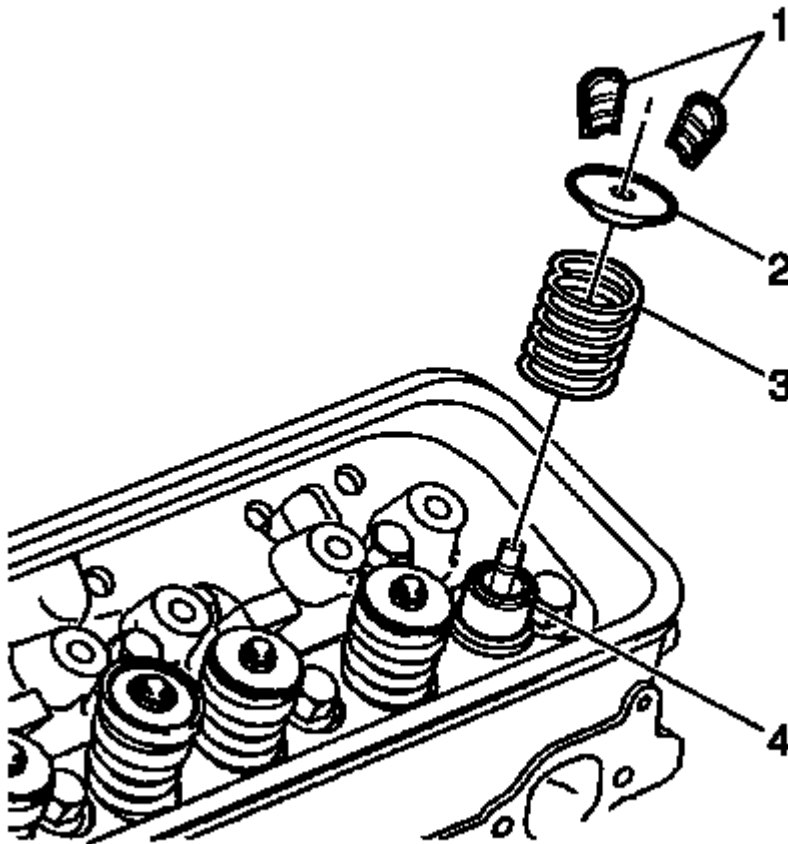


Fig. 110: Identifying Valve Components
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keys (1).
10. Carefully release the valve spring tension.
11. Remove the **J 5892-D** or the **J 38606** . See **Special Tools** .
12. Remove the valve spring cap (2) and valve spring (3).
13. Remove the valve stem oil seal (4).

INSTALLATION PROCEDURE

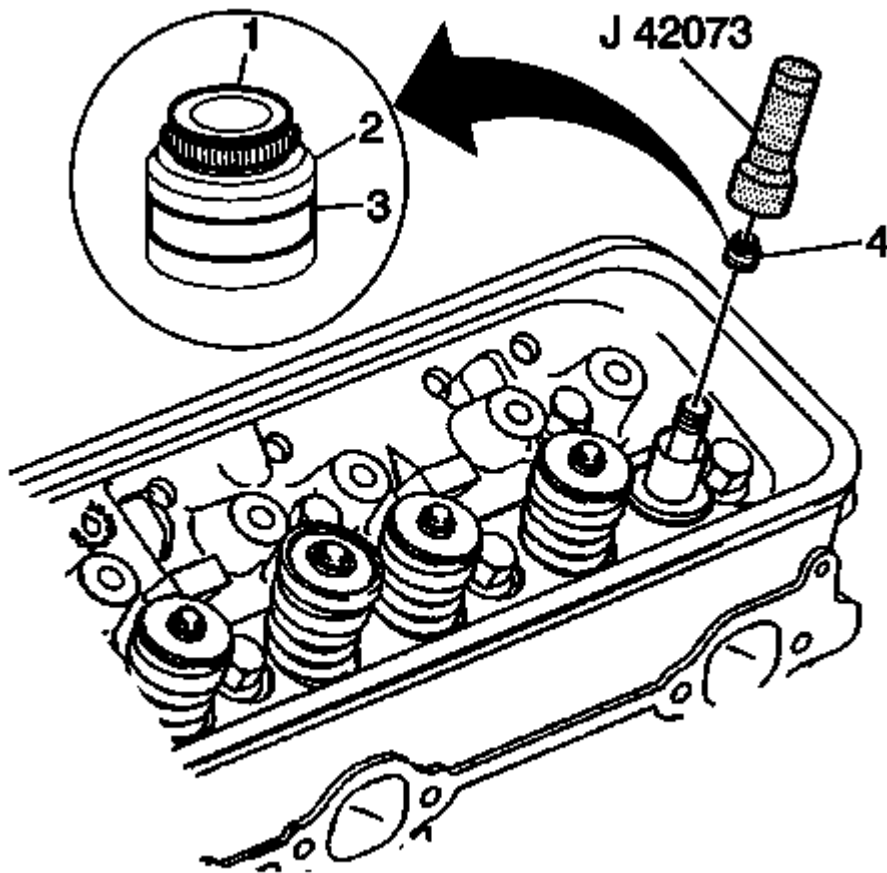


Fig. 111: Identifying Intake & Exhaust Valve Oil Stem Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: The exhaust valve oil stem seal has the letters EX (1) molded into the top of the seal. The exhaust valve oil stem seal material is brown in color (2) with a white stripe (3) painted onto the outside diameter of the seal, or the material may be red in color (2) with no paint stripe. The intake valve oil seal is black in color.

1. Assemble the valve into the proper valve guide.
2. Select the proper valve stem oil seal for the specific valve guide.
3. Lubricate the valve stem oil seal and the outside diameter of the valve guide with clean engine oil.
4. Assemble the valve stem oil seal onto the valve stem.

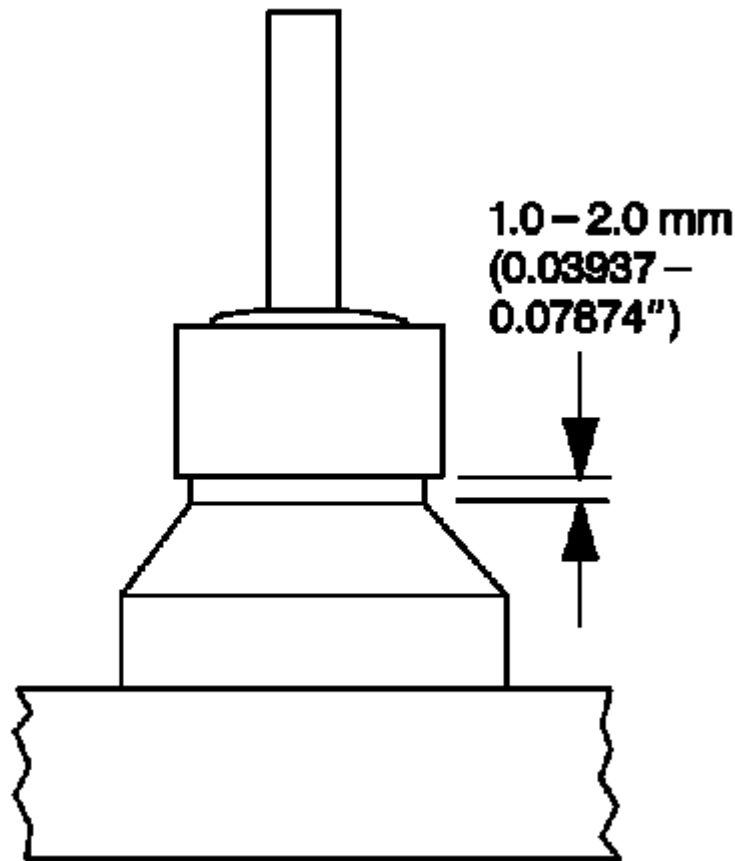


Fig. 112: Identifying Gap Between Bottom Edge Of Valve Stem Oil Seal & Valve Guide
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 42073** , install the valve stem oil seal onto the valve guide. See **Special Tools** .
 1. Tap the valve stem oil seal onto the valve guide until the **J 42073** bottoms against the valve spring seat. See **Special Tools** .
 2. Inspect the valve stem oil seal. The valve stem oil seal should not be bottomed against the valve guide.

There should be a 1-2 mm (0.03937-0.07874 in) gap between the bottom edge of the valve stem oil seal and the valve guide.

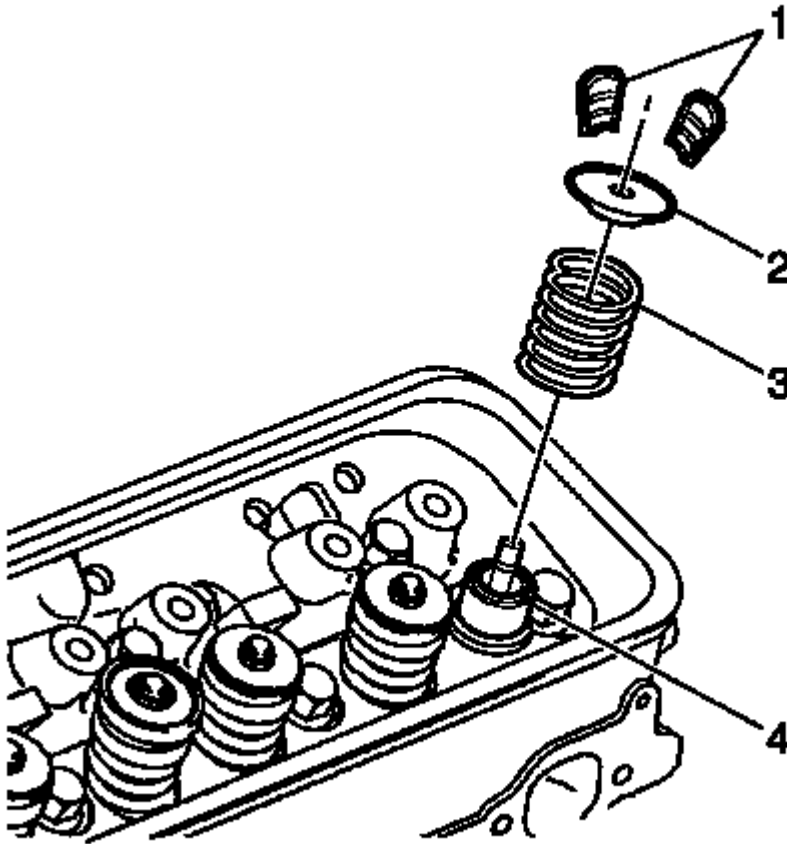


Fig. 113: Identifying Valve Components
Courtesy of GENERAL MOTORS CORP.

6. Install the valve spring (3).
7. Install the valve spring cap (2) onto the valve spring (3), over the valve stem.

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

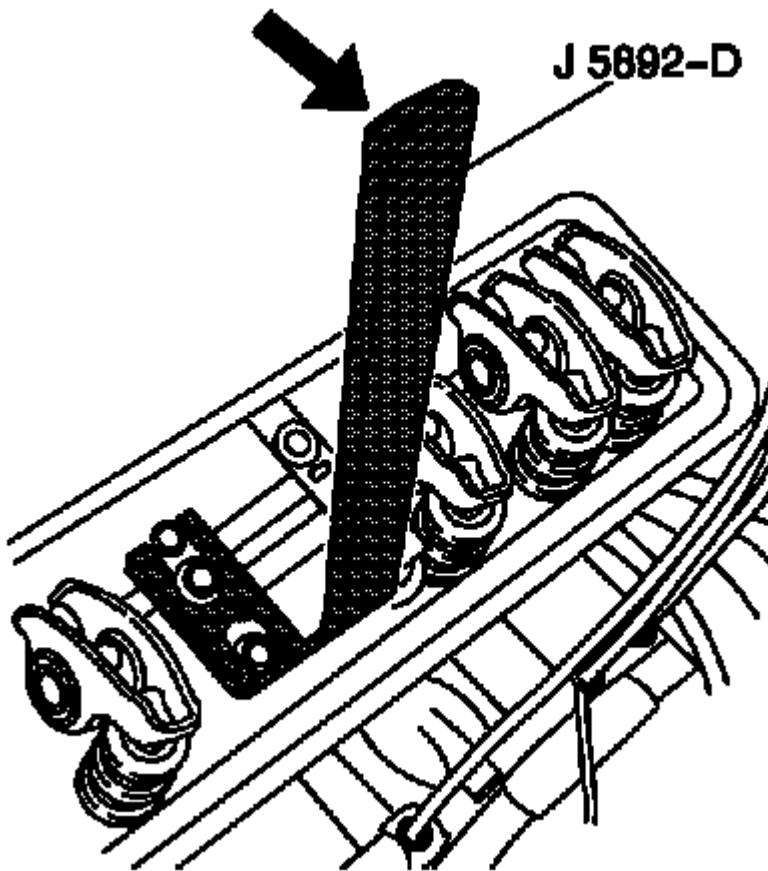


Fig. 114: View Of Special Tool J 5892--D, Valve Rocker Arm Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

8. Use the **J 5892-D** in order to compress the valve spring. See **Special Tools** .

Hook the slotted end of **J 5892-D** under the washer on the valve rocker arm bolt. See **Special Tools** .

9. Apply steady pressure on the valve spring cap until the valve keys are accessible.

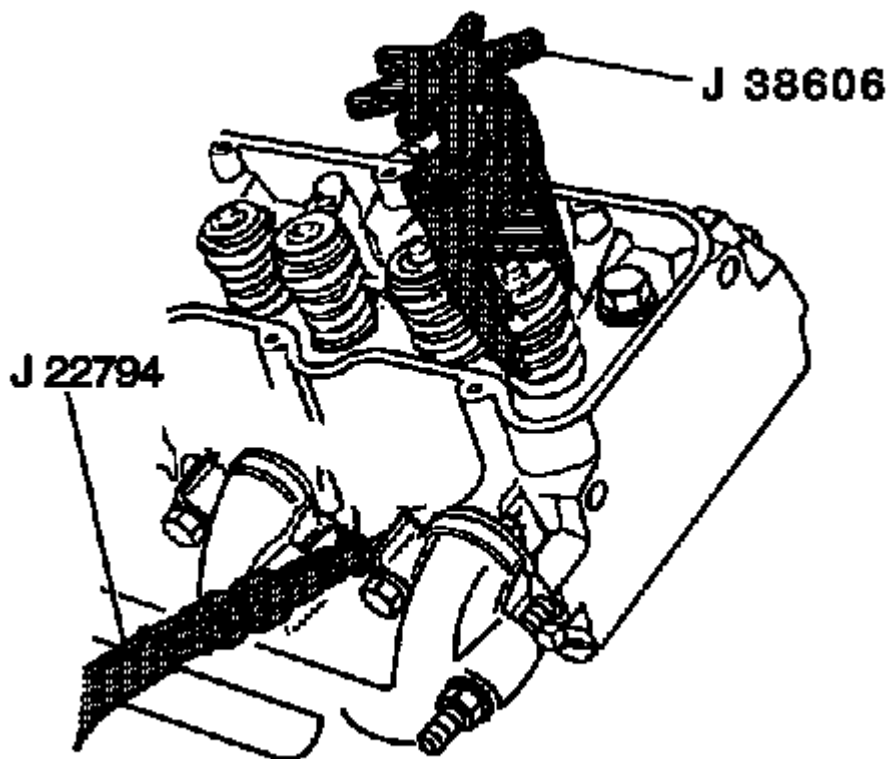


Fig. 115: View Of Special Tools J 38606 & J 5892-D Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

CAUTION: Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratch.

10. Use the **J 38606** if the clearance does not permit use of the **J 5892-D** . See Special Tools .
11. Install the valve stem O-ring seal.
12. Install the valve stem keys.

Use grease in order to hold the valve stem keys in place.

13. Carefully release the valve spring pressure, making sure the valve stem keys stay in place.

CAUTION: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

14. Remove the **J 5892-D** or the **J 38606** . See Special Tools .

1. Look to ensure that the valve stem keys seat properly in the upper groove of the valve stem.
2. Tap the end of the valve stem with a plastic faced hammer in order to seat the valve stem keys, if necessary.

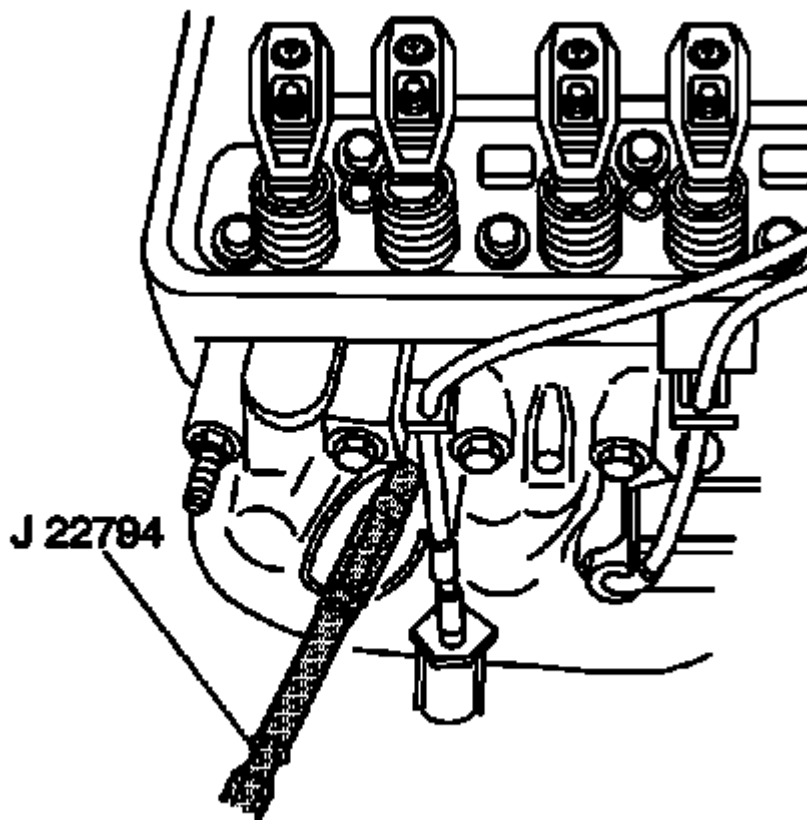


Fig. 116: View Of Special Tool J 22794 Installed Into Spark Plug Hole
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 22794** . See Special Tools .
16. Install the spark plugs. Refer to Spark Plug Replacement .
17. Install the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement.

VALVE LIFTER REPLACEMENT

SPECIAL TOOLS

J 3049-A Valve Lifter Remover. See Special Tools .

REMOVAL PROCEDURE

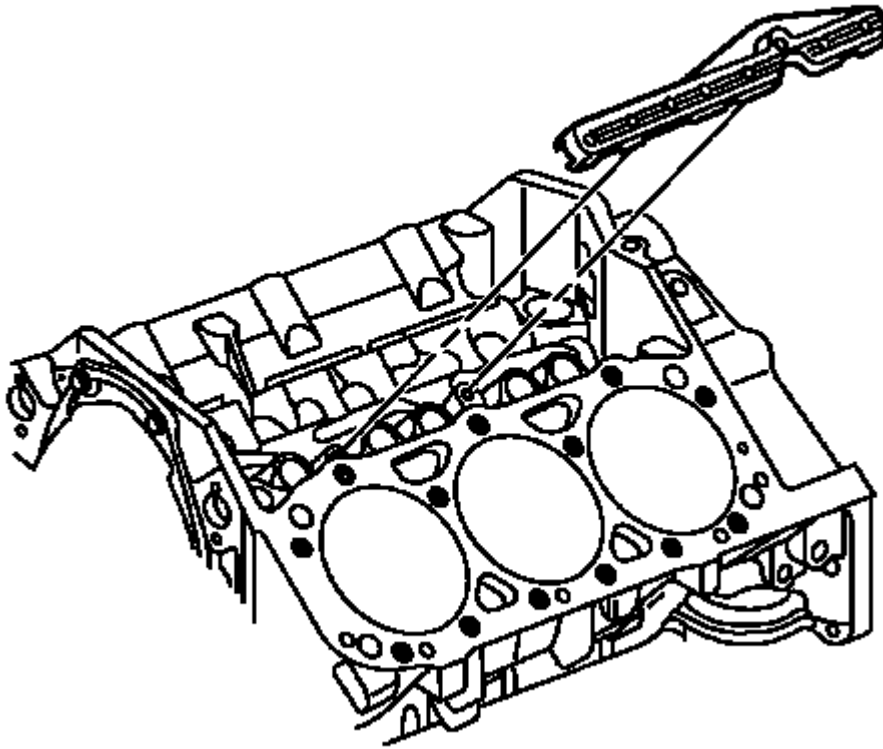


Fig. 117: View Of Valve Lifter Pushrod Guides
Courtesy of GENERAL MOTORS CORP.

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

NOTE: Place the components in a rack so that the components can be installed to their original location.

3. Remove the bolts and lifter pushrod guide.

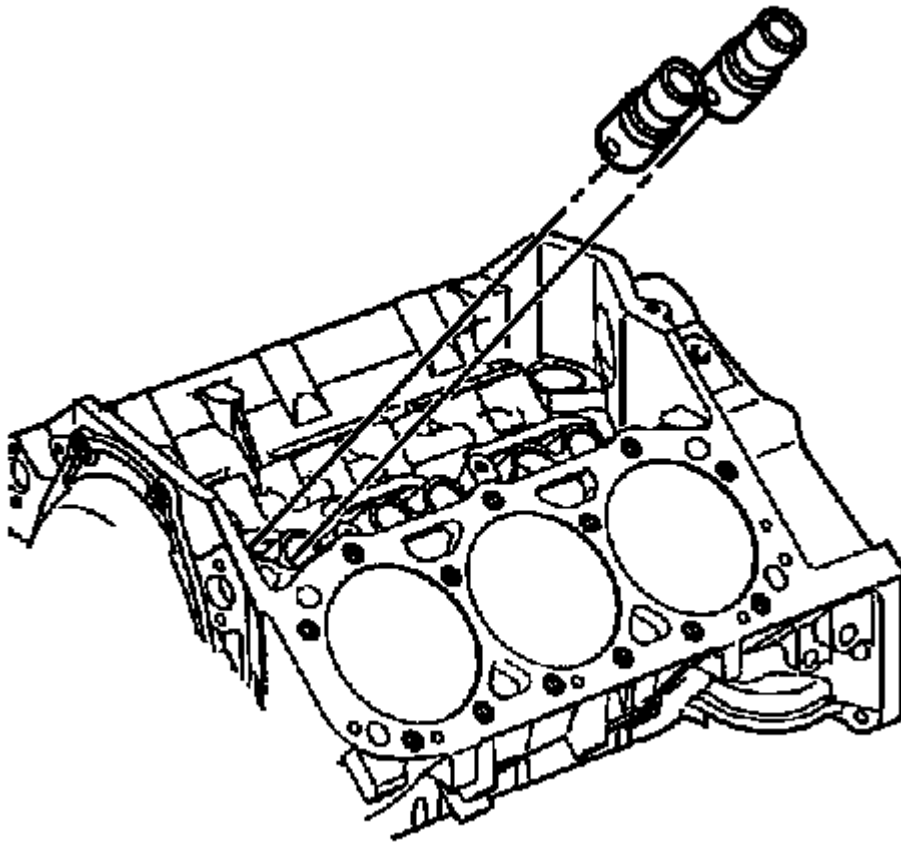


Fig. 118: View Of Valve Lifters
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the valve lifters in the rack in the upright position in order to maintain the oil inside the valve lifters.

4. Remove the lifters.

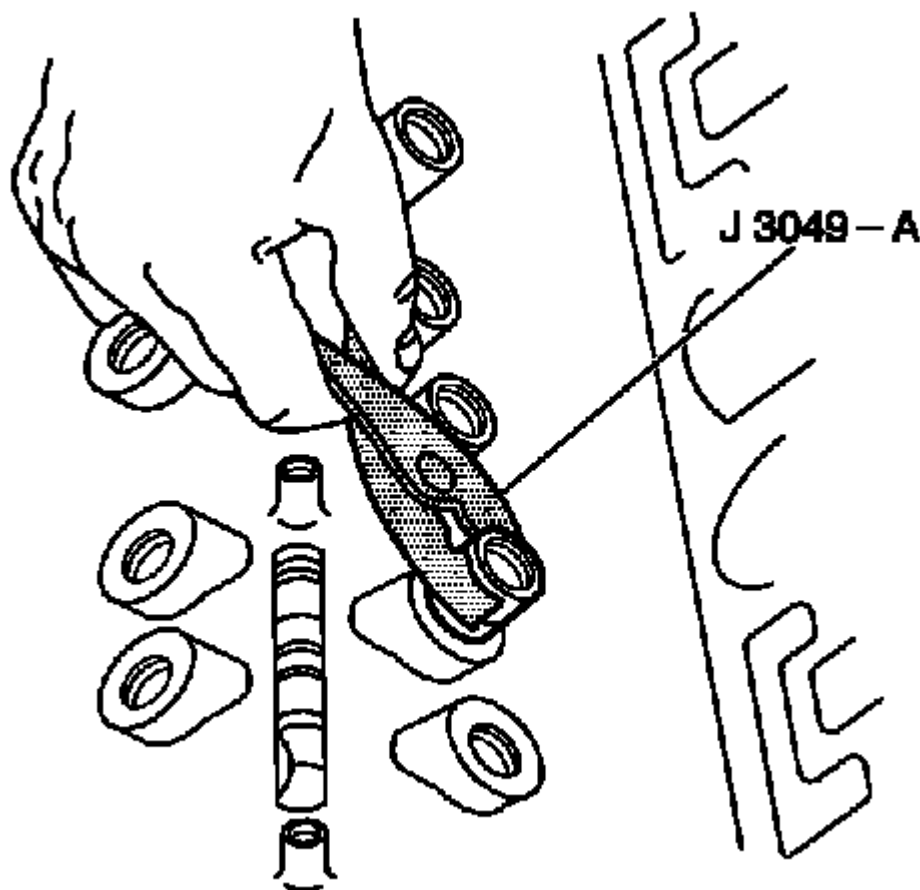


Fig. 119: View Of Using Special Tool J 3049-A To Remove Sticking Valve Lifters
 Courtesy of GENERAL MOTORS CORP.

NOTE: Some valve lifters may be stuck in the valve lifter bores because of gum or varnish deposits and may require the use of J 3049-A for removal. See Special Tools .

5. Use the **J 3049-A** in order to remove the stuck valve lifters. See Special Tools .
6. Use a cleaning solvent and a shop towel to clean any varnish from the valve lifter bores.
7. Inspect the lifter bores for excessive wear or scoring. Replace the engine block if there is excessive wear or deep scoring.
8. Inspect the camshaft for wear or damage. If the wear is questionable remove the camshaft and inspect. Refer to Camshaft and Bearings Cleaning and Inspection .
9. Clean and inspect the lifters, if necessary. Refer to Valve Lifter and Guide Cleaning and Inspection .

INSTALLATION PROCEDURE

NOTE: It is normal for **NEW** lifters to make a slight ticking noise when the engine is first started. Increasing the engine RPM slightly to raise oil pressure should

stop the noise.

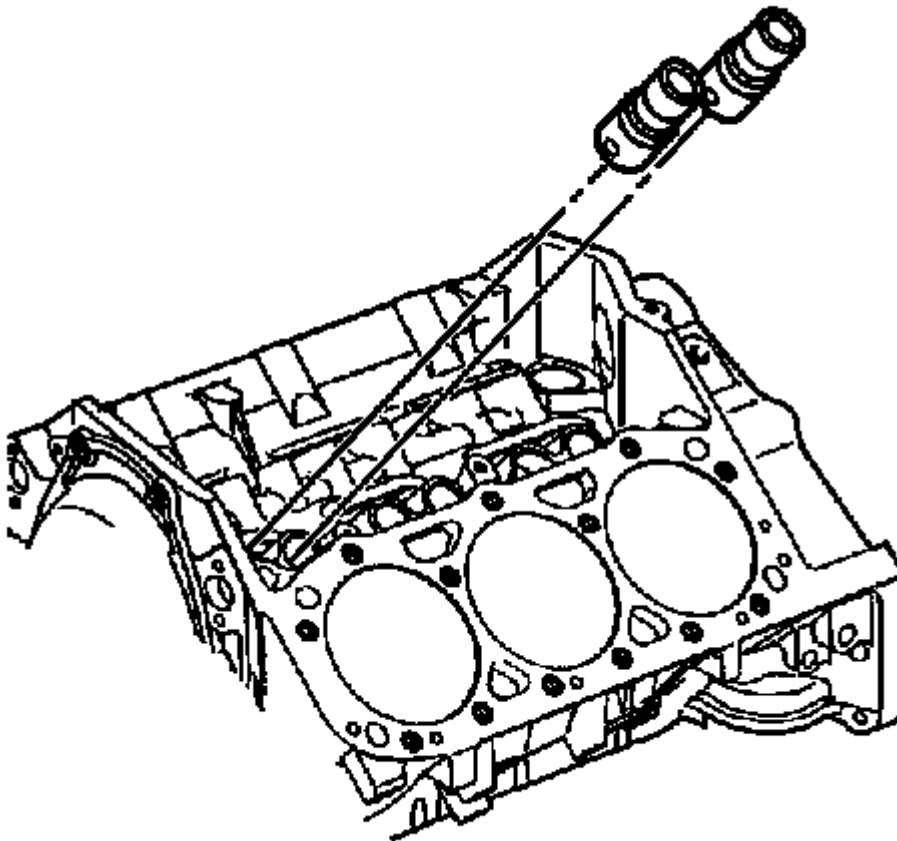


Fig. 120: View Of Valve Lifters

Courtesy of GENERAL MOTORS CORP.

1. Apply lubricant to the lifter rollers. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.

NOTE: If reusing the lifters, install the lifters to their original positions.

2. Install the lifters.

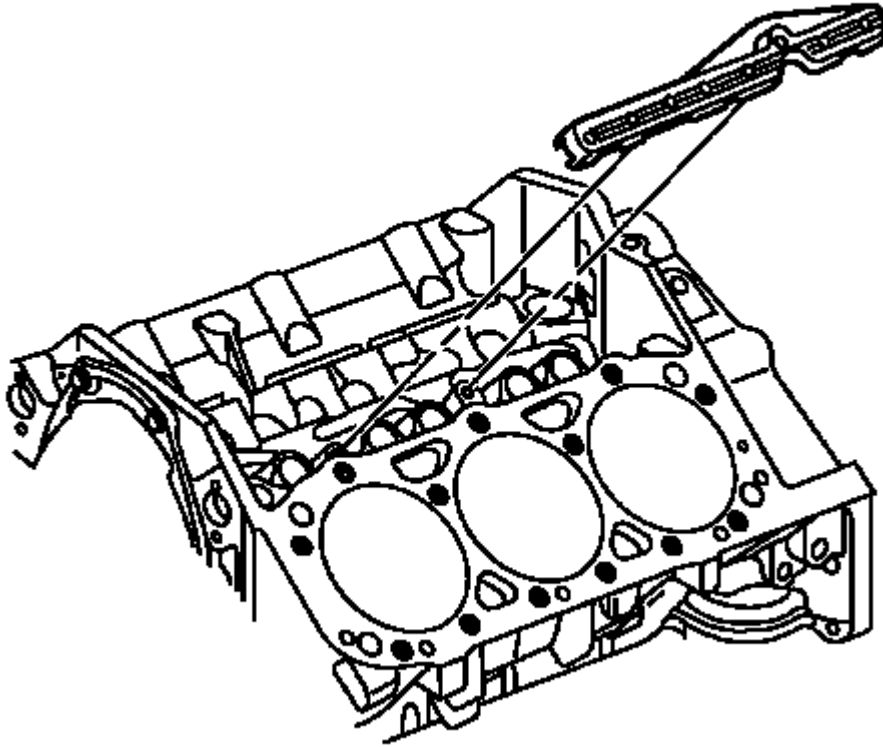


Fig. 121: View Of Valve Lifter Pushrod Guides
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the lifter pushrod guides and tighten the bolts to 16 N.m (12 lb ft).
4. Install the pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
5. Install the intake manifold. Refer to Lower Intake Manifold Replacement.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

J 45059 Angle Meter

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to Engine Cover Replacement .
2. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac N Fill) .

3. Remove the drive belt. Refer to [Drive Belt Replacement](#).
4. Remove the lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement \(4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L\)](#).
5. Remove the lower intake manifold. Refer to [Lower Intake Manifold Replacement](#).
6. Remove the left exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side \(4.3L\)](#).
7. Remove the left side pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).

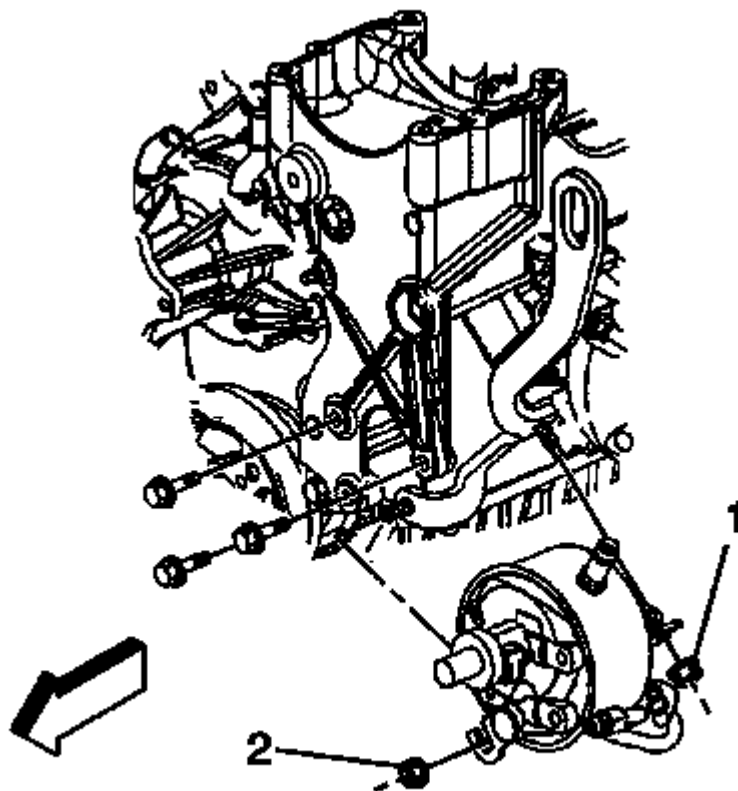


Fig. 122: View Of Power Steering (P/S) Pump Rear Bracket Nut And P/S Pump Rear Bracket Front Nut
Courtesy of GENERAL MOTORS CORP.

8. Loosen the power steering (P/S) pump rear bracket nut (1).
9. Remove the P/S pump rear bracket front nut (2).

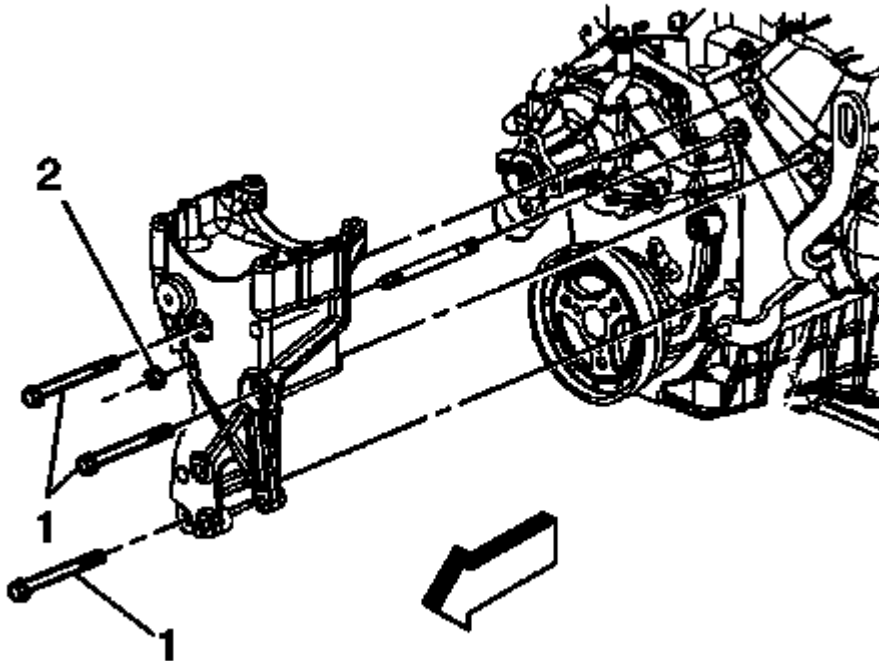


Fig. 123: View Of P/S Pump Rear Bracket Front Nut
Courtesy of GENERAL MOTORS CORP.

10. Remove the bolts (1) and nut (2) for the P/S pump bracket.
11. Leave the air conditioning (A/C) compressor, if equipped, and the P/S pump on the bracket.
12. Slide the P/S pump bracket off of the stud and set aside.

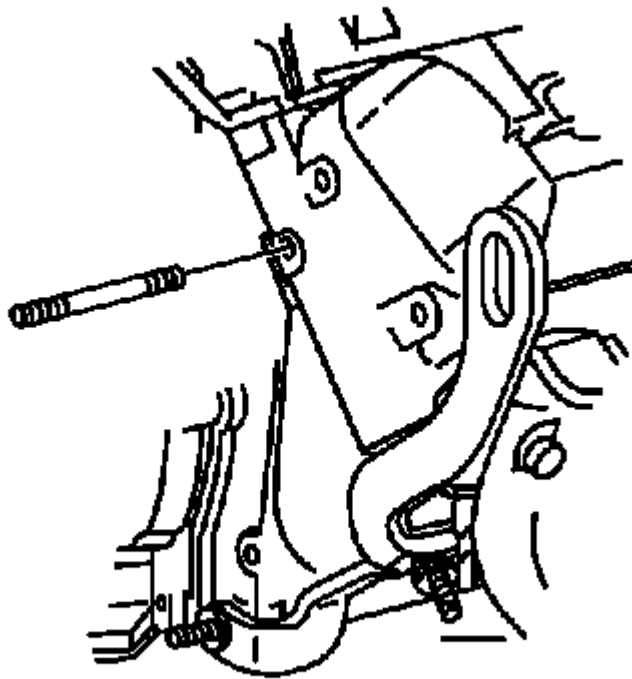


Fig. 124: View Of Power Steering Pump Bracket Stud
Courtesy of GENERAL MOTORS CORP.

13. Remove the P/S pump bracket stud.

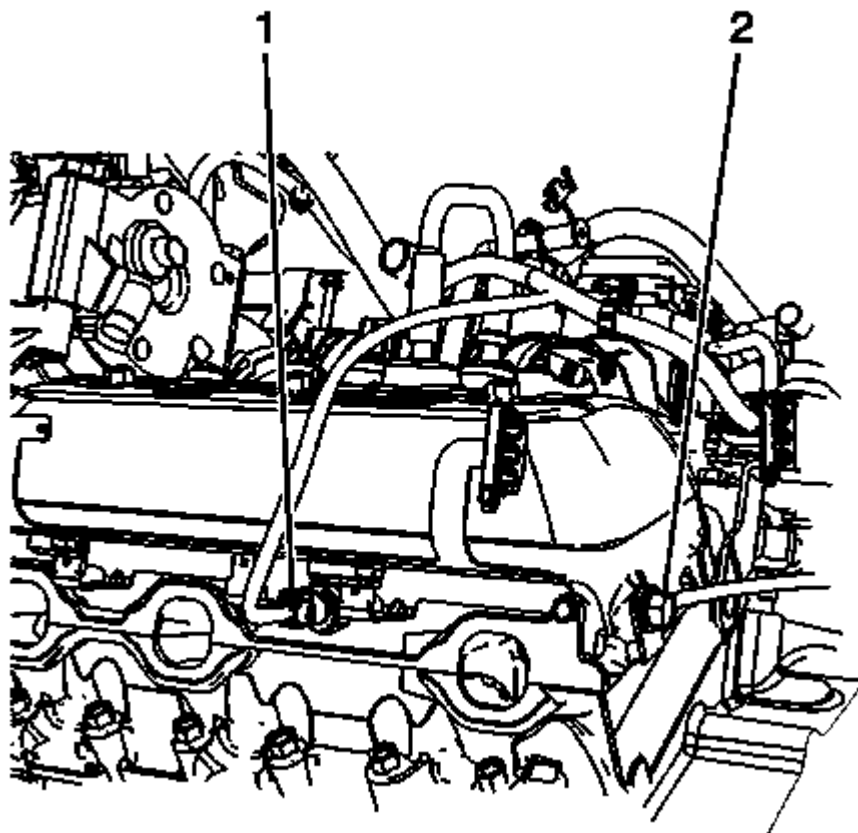


Fig. 125: View Of Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the engine coolant temperature (ECT) sensor electrical connector (1).
15. Remove the harness ground bolt (2).

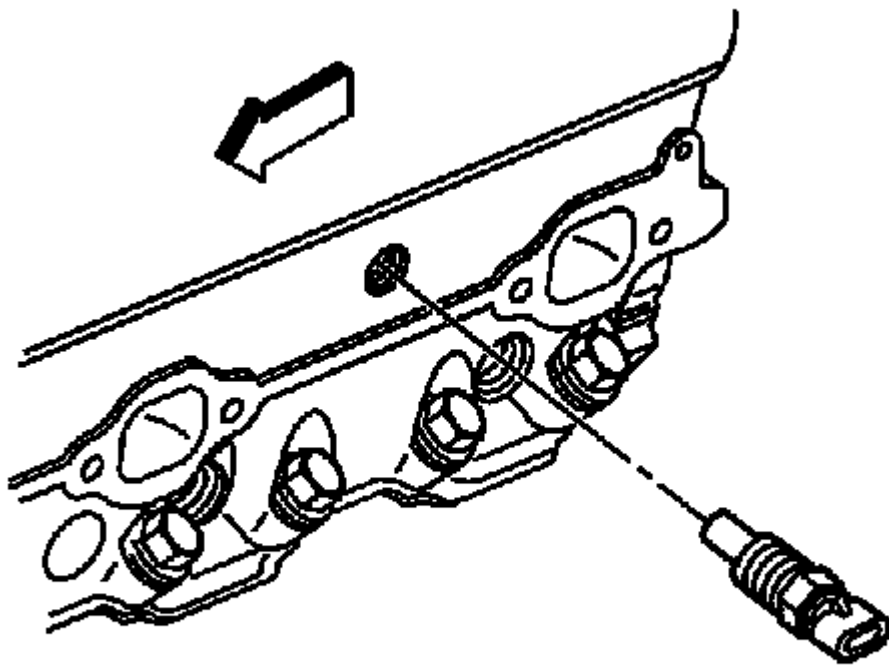


Fig. 126: View Of Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

16. Remove the engine coolant temperature (ECT) sensor.

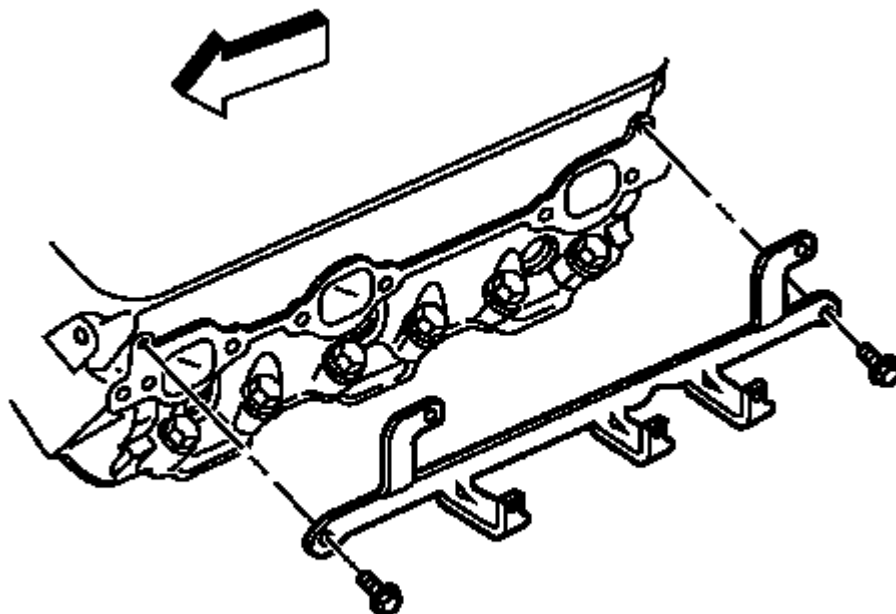


Fig. 127: Locating Spark Plug Wire Support
Courtesy of GENERAL MOTORS CORP.

17. Remove the spark plug wire support bolts and support.

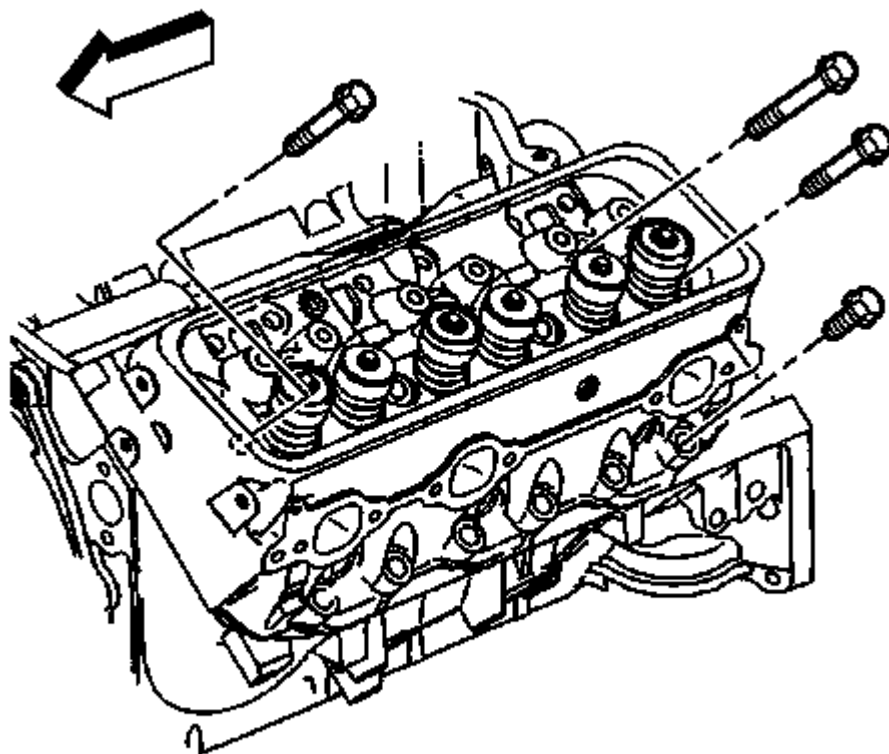


Fig. 128: Locating Cylinder Head Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

18. Remove and discard the cylinder head bolts.

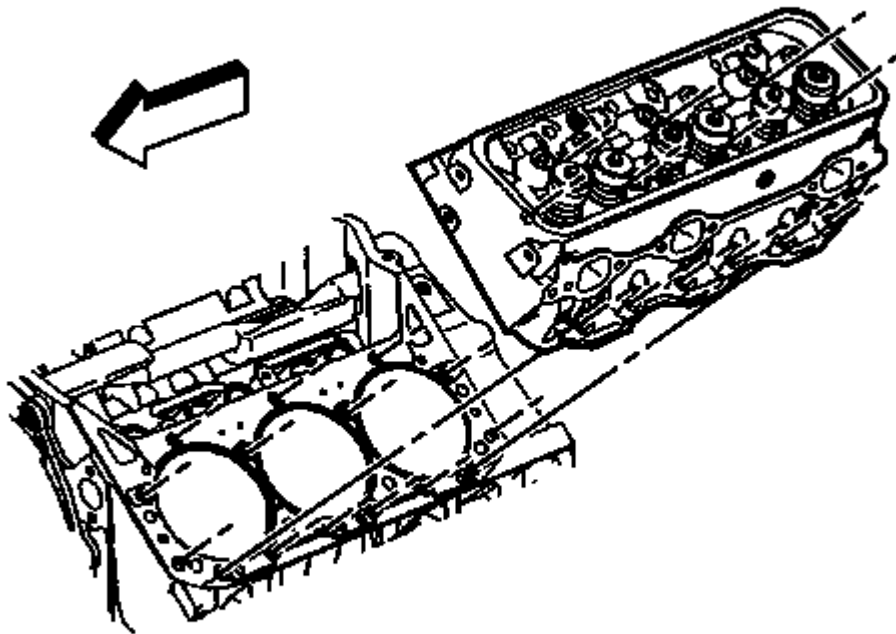


Fig. 129: View of Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

19. Remove the cylinder head.

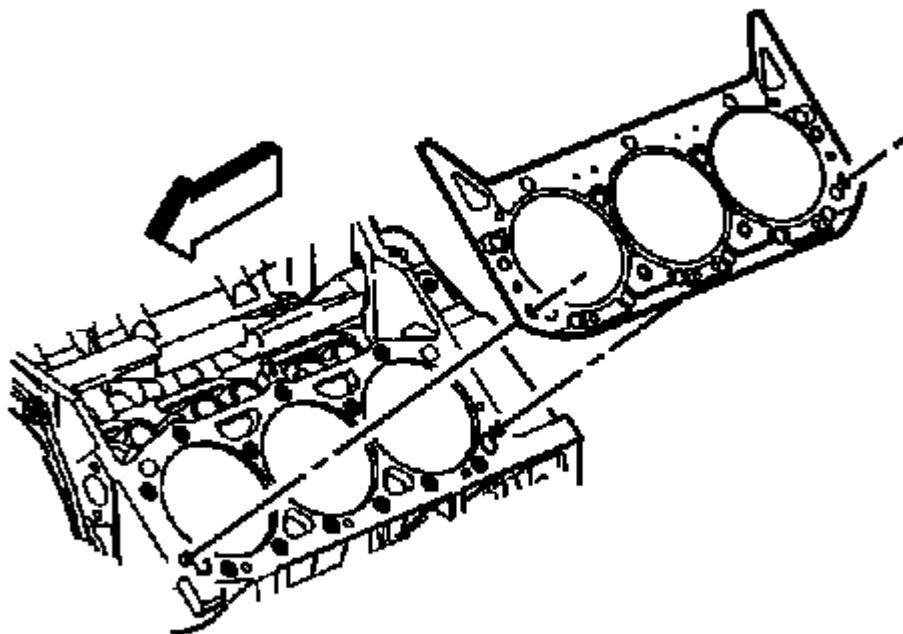


Fig. 130: View Of Cylinder Head Gasket And Alignment Pins - Left
Courtesy of GENERAL MOTORS CORP.

20. Remove and discard the cylinder head gasket.

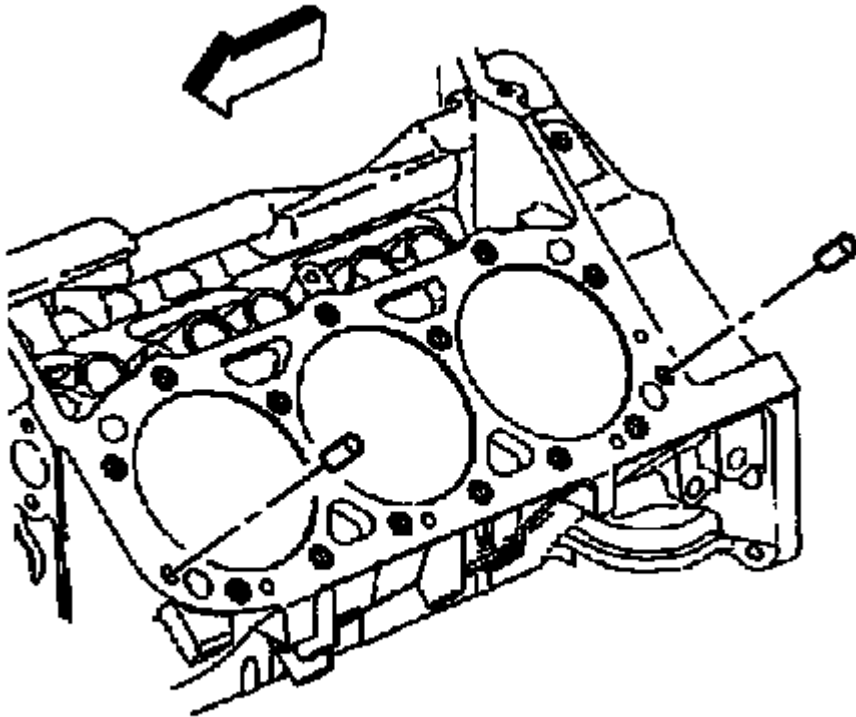


Fig. 131: View Of Cylinder Head Locator Pins
Courtesy of GENERAL MOTORS CORP.

21. Remove the cylinder head locator pins, if necessary.
22. Clean and inspect the cylinder head, if necessary. Refer to **Cylinder Head Cleaning and Inspection** .
23. Disassemble the cylinder head, if necessary. Refer to **Cylinder Head Disassemble** .

INSTALLATION PROCEDURE

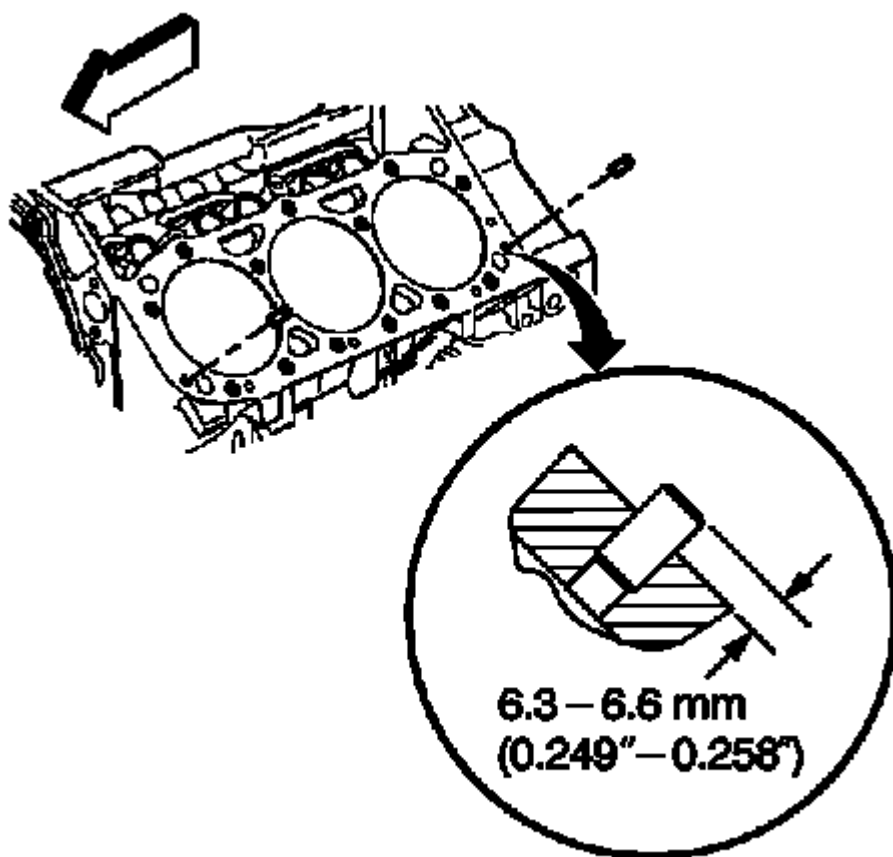


Fig. 132: Identifying Cylinder Head Locator Pins
Courtesy of GENERAL MOTORS CORP.

1. Assemble the cylinder head, if necessary. Refer to Cylinder Head Assemble .
2. Install the cylinder head locator pins, if necessary.

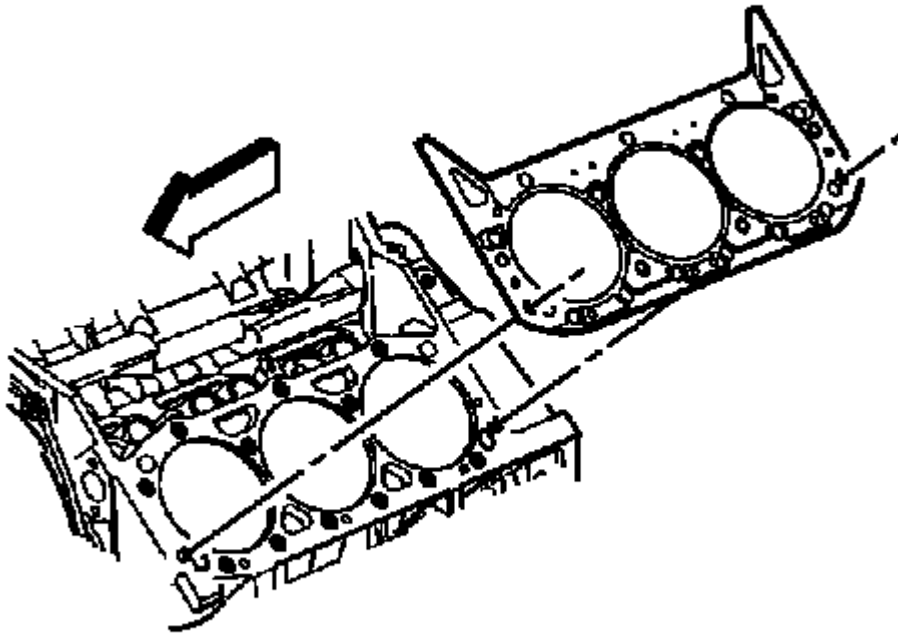


Fig. 133: View Of Cylinder Head Gasket And Alignment Pins - Left
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use any type of sealer on the cylinder head gasket.

3. Install a NEW cylinder head gasket.

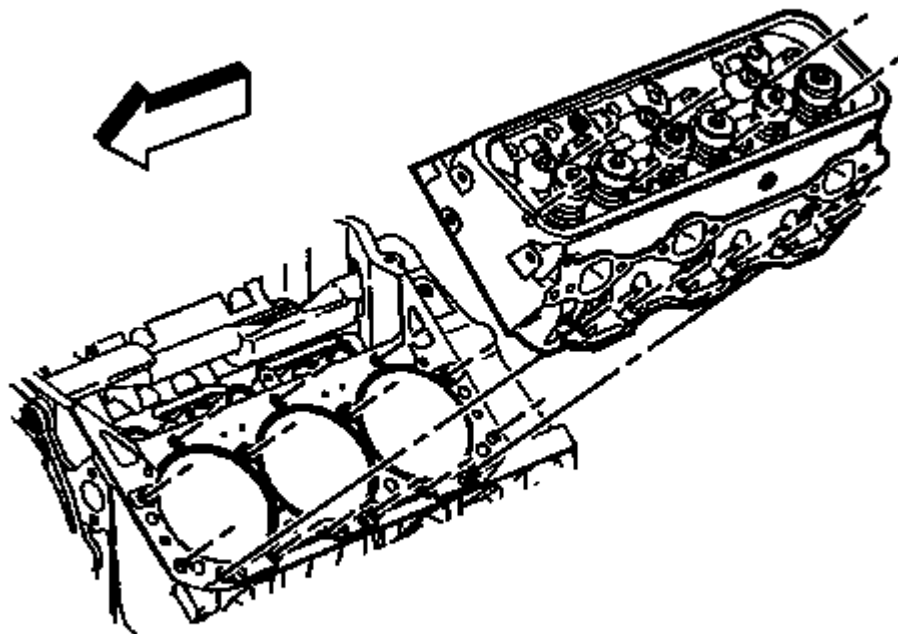


Fig. 134: View of Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder head.

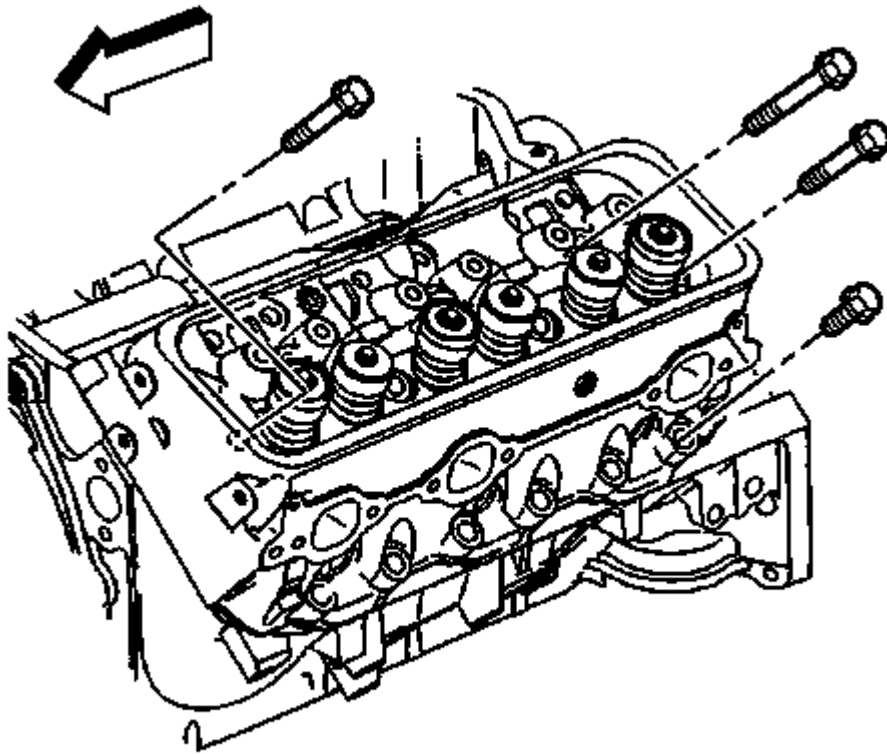


Fig. 135: Locating Cylinder Head Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

5. Apply sealant to the threads of the NEW cylinder head bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**
6. Install the cylinder head bolts finger tight.

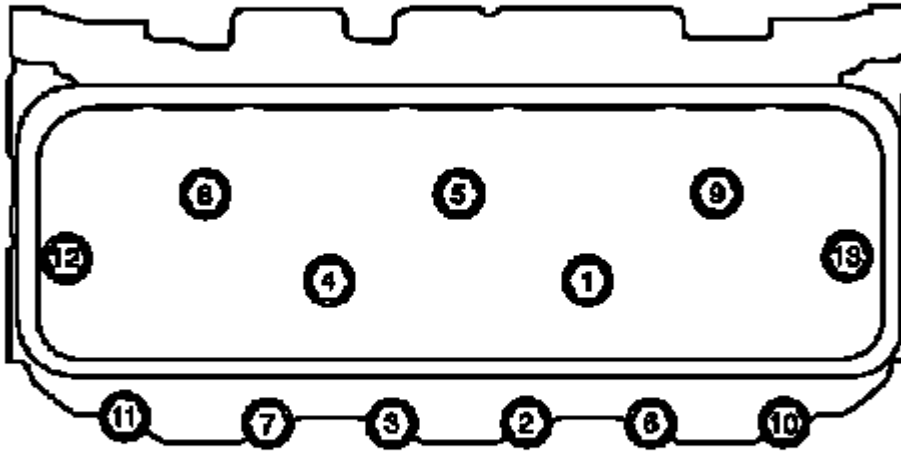


Fig. 136: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Tighten the cylinder head bolts using the sequence shown.
 1. Tighten the bolts a first pass to 30 N.m (22 lb ft).
 2. Tighten the long bolts (1, 4, 5, 8, 9) a final pass to 75 degrees using **J 45059**
 3. Tighten the medium bolts (12, 13) a final pass to 65 degrees using **J 45059**
 4. Tighten the short bolts (2, 3, 6, 7, 10, 11) a final pass to 55 degrees using **J 45059**

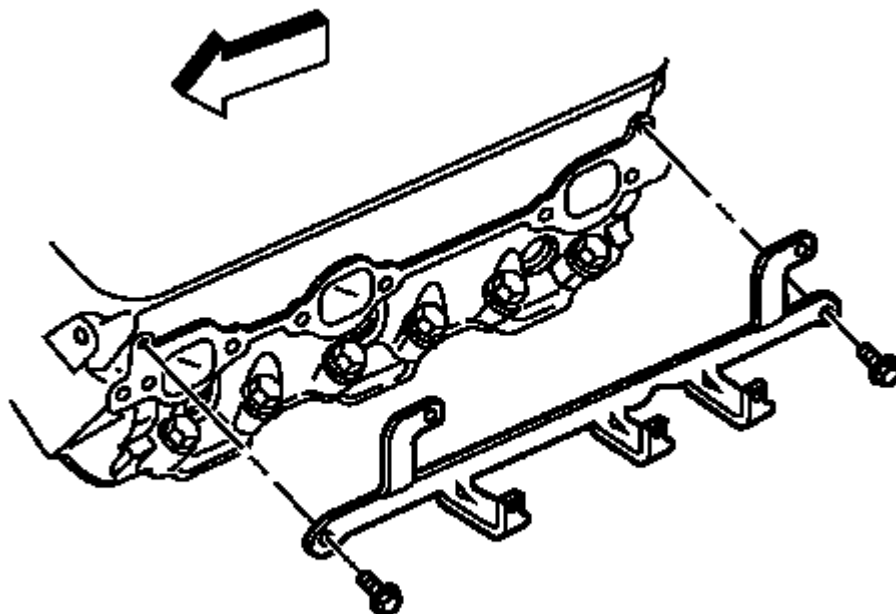


Fig. 137: Locating Spark Plug Wire Support
Courtesy of GENERAL MOTORS CORP.

8. Install the spark plug wire support and bolts and tighten to 12 N.m (106 lb in).

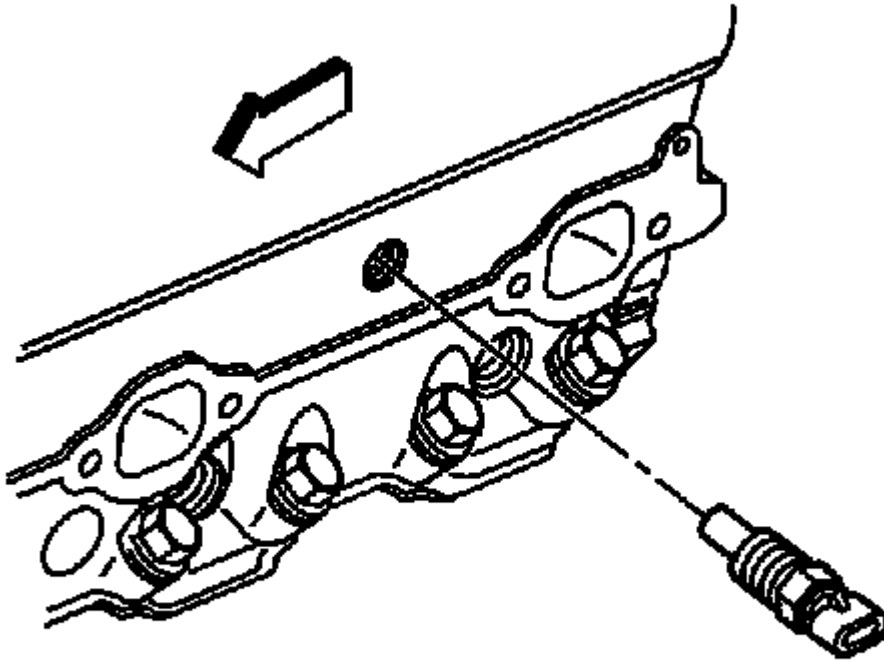


Fig. 138: View Of Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

9. Install the ECT sensor. If reusing the old sensor, apply sealant to the threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Tighten the sensor to 20 N.m (15 lb ft).

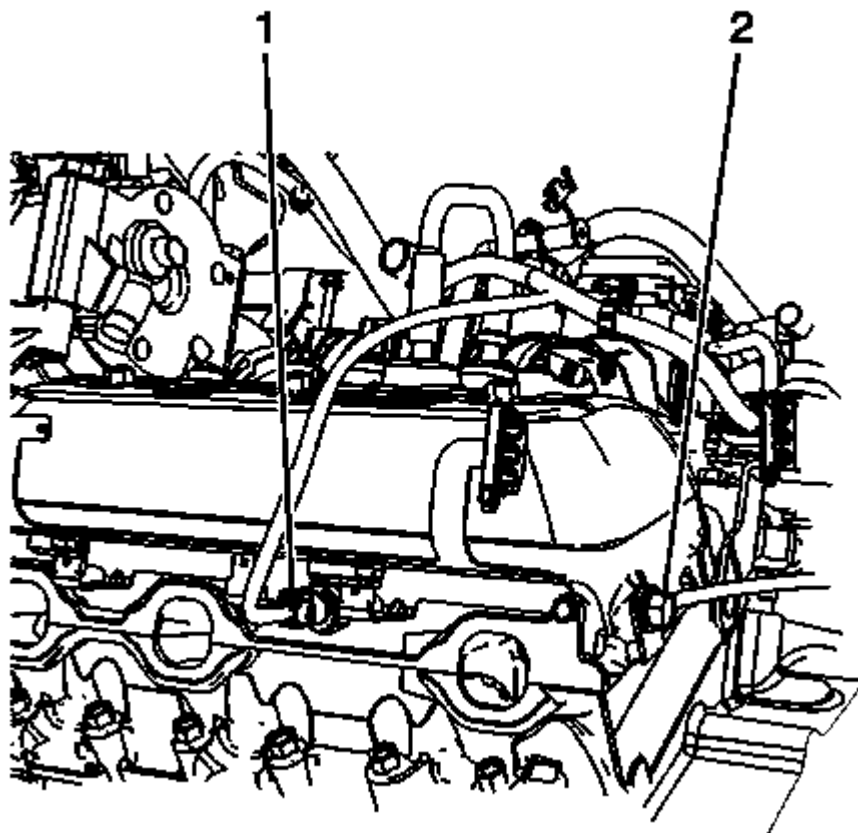


Fig. 139: View Of Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the harness ground bolt (2) and tighten to 16 N.m (12 lb ft).
11. Connect the engine coolant temperature (ECT) sensor electrical connector (1).

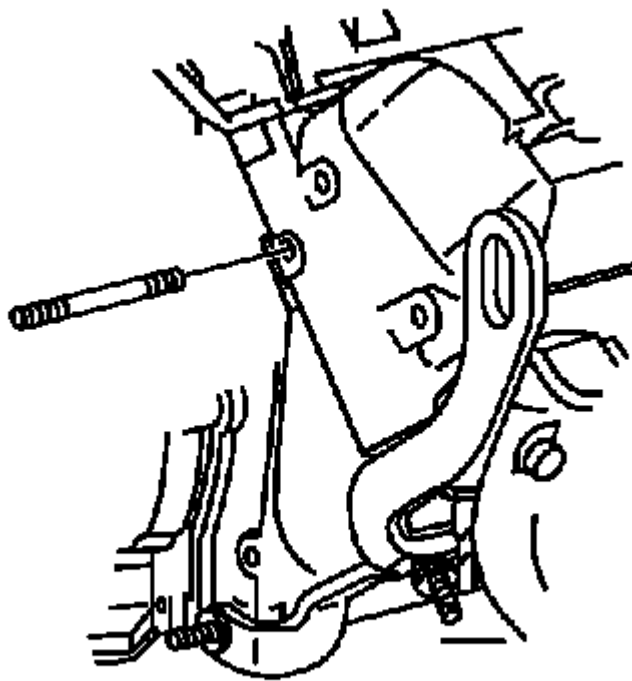


Fig. 140: View Of Power Steering Pump Bracket Stud
Courtesy of GENERAL MOTORS CORP.

12. Install the P/S pump bracket stud and tighten to 20 N.m (15 lb ft).

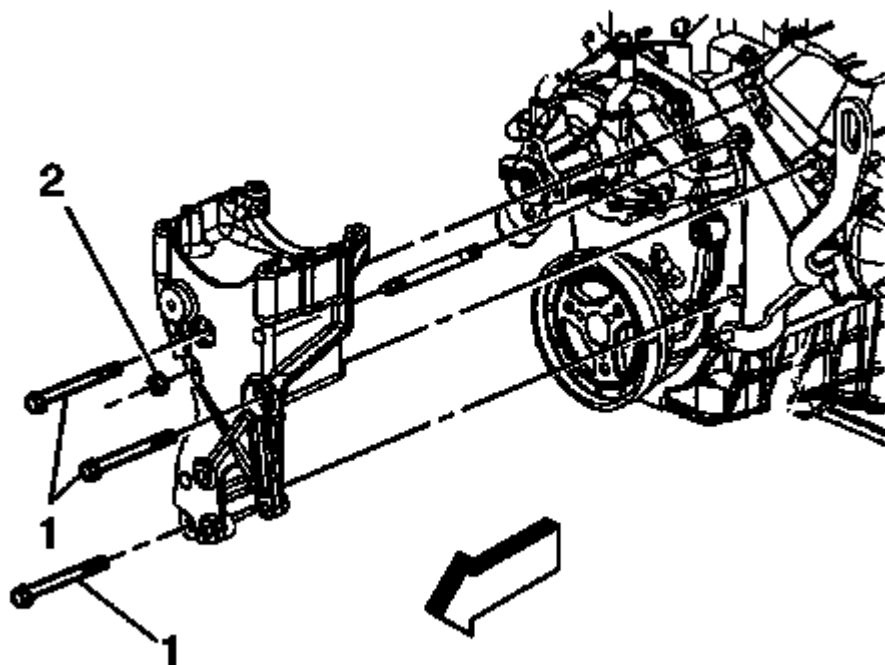


Fig. 141: View Of P/S Pump Rear Bracket Front Nut
Courtesy of GENERAL MOTORS CORP.

13. Slide the P/S pump bracket rearward.
14. Install the bolts and nut (2) for the P/S pump bracket.

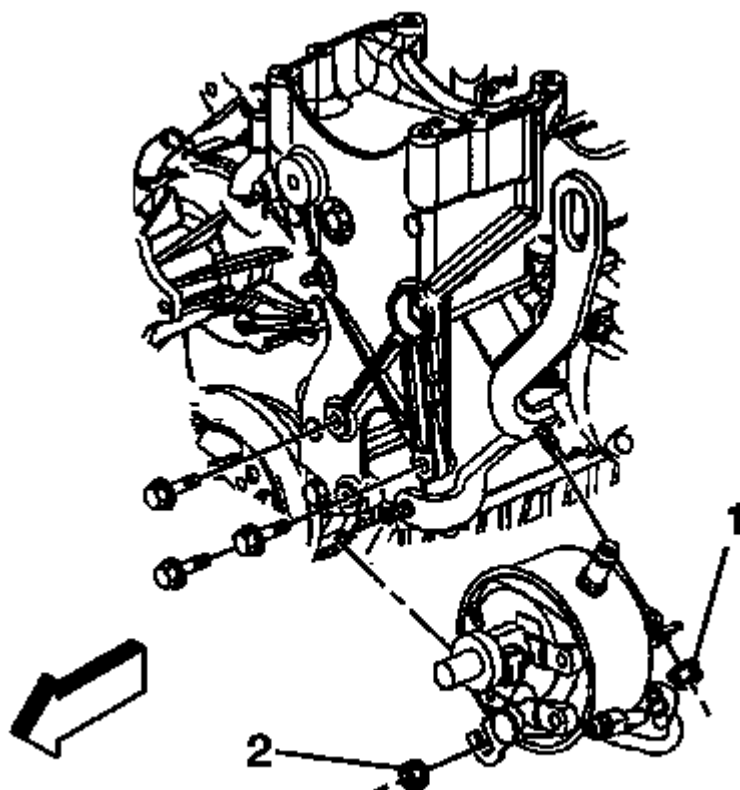


Fig. 142: View Of Power Steering (P/S) Pump Rear Bracket Nut And P/S Pump Rear Bracket Front Nut

Courtesy of GENERAL MOTORS CORP.

15. Install the P/S pump rear bracket front nut (2).
16. Tighten the P/S pump rear bracket nut (1) to 41 N.m (30 lb ft).
17. Install the left side pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
18. Install the left exhaust manifold. Refer to Exhaust Manifold Replacement - Left Side (4.3L).
19. Install the lower intake manifold. Refer to Lower Intake Manifold Replacement.
20. Install the lower fan shroud. Refer to Engine Coolant Fan Lower Shroud Replacement (4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L).
21. Install the drive belt. Refer to Drive Belt Replacement.
22. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill) or Cooling System Draining and Filling (Vac N Fill).
23. Install the engine cover. Refer to Engine Cover Replacement.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

SPECIAL TOOLS

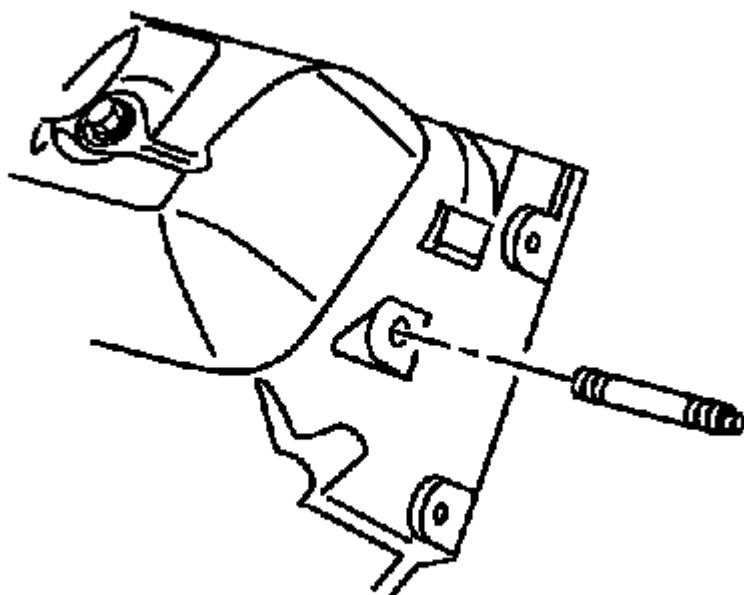
J 45059 Angle Meter**REMOVAL PROCEDURE**

Fig. 143: View Of Generator Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)** .
3. Remove the oil filler tube.
4. Remove the generator bracket. Refer to **Generator Bracket Replacement (V6)** .
5. Remove the intake manifold. Refer to **Lower Intake Manifold Replacement**.
6. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.3L)** .
7. Remove the right pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
8. Remove the generator bracket stud from the cylinder head.

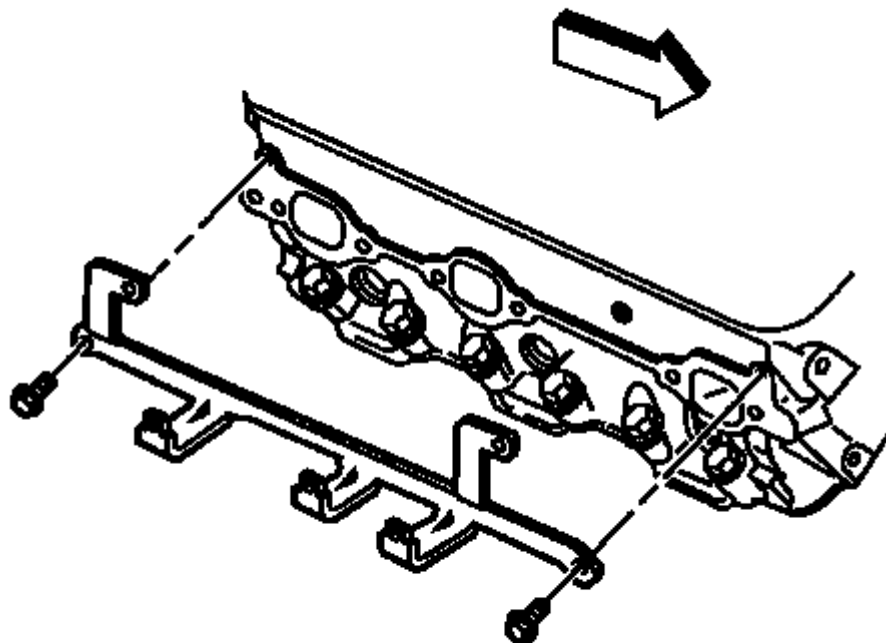


Fig. 144: View Of Spark Plug Wire Support Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

9. Remove the spark plug wire support bolts and support.

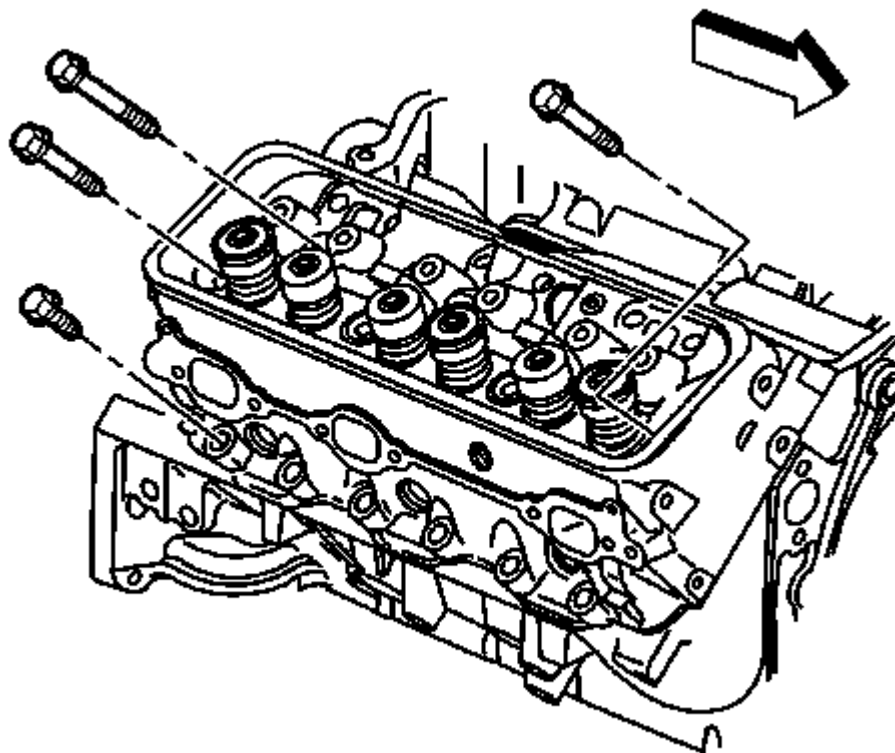


Fig. 145: Locating Cylinder Head Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

10. Remove and discard the cylinder head bolts.

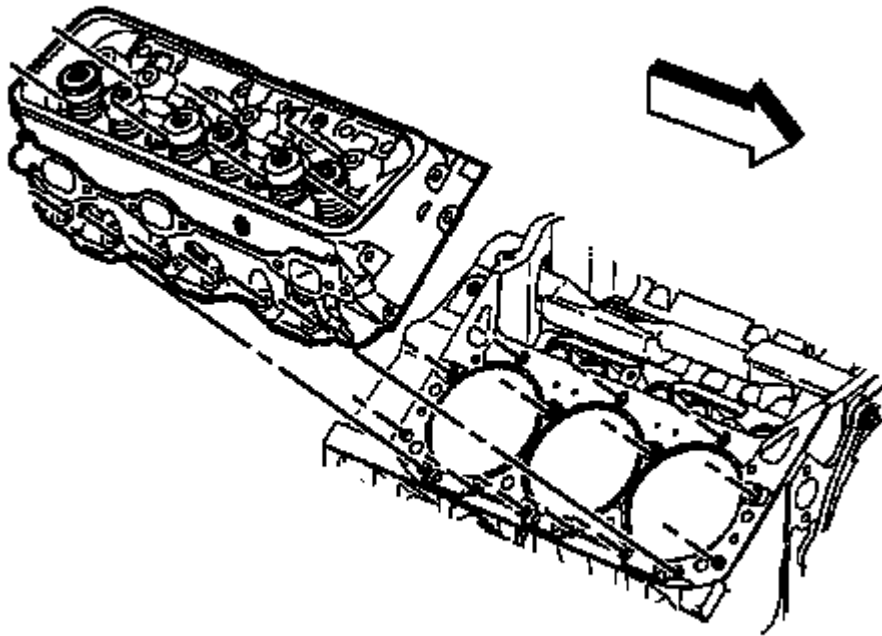


Fig. 146: View Of Cylinder Head (Right)
Courtesy of GENERAL MOTORS CORP.

11. Remove the cylinder head.

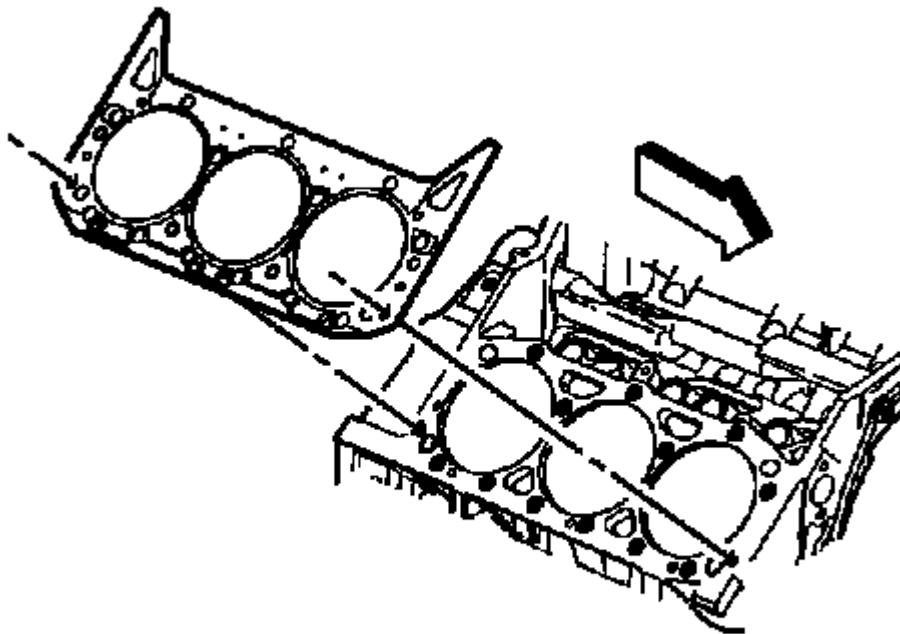


Fig. 147: View Of Cylinder Head Gasket & Alignment Pins - Right
Courtesy of GENERAL MOTORS CORP.

12. Remove and discard the cylinder head gasket.

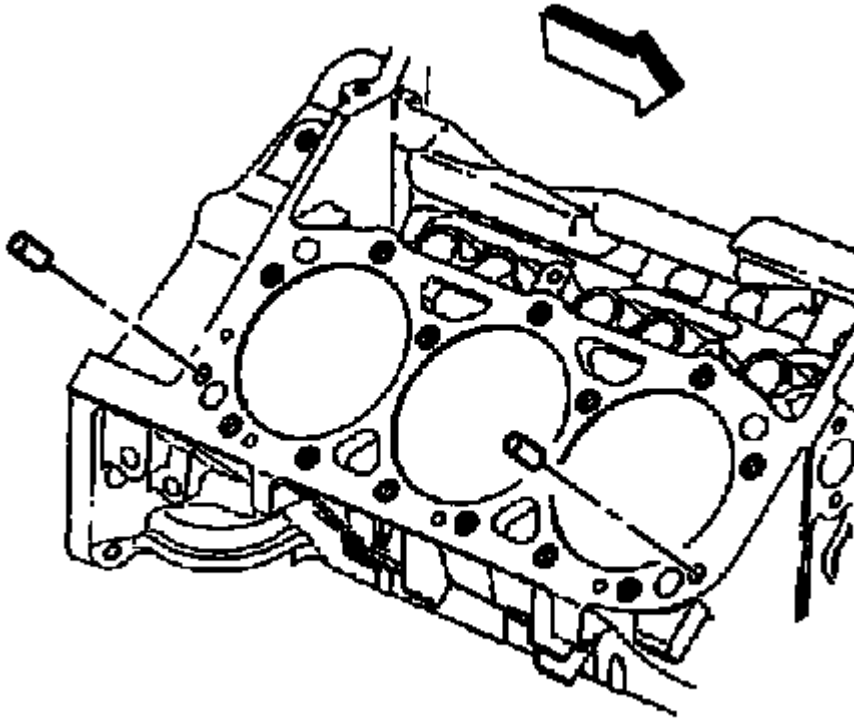


Fig. 148: View Of Cylinder Head Locator Pins - Right
Courtesy of GENERAL MOTORS CORP.

13. Remove the cylinder head locator pins, if necessary.
14. Clean and inspect the cylinder head, if necessary. Refer to Cylinder Head Cleaning and Inspection .
15. Disassemble the cylinder head, if necessary. Refer to Cylinder Head Disassemble .

INSTALLATION PROCEDURE

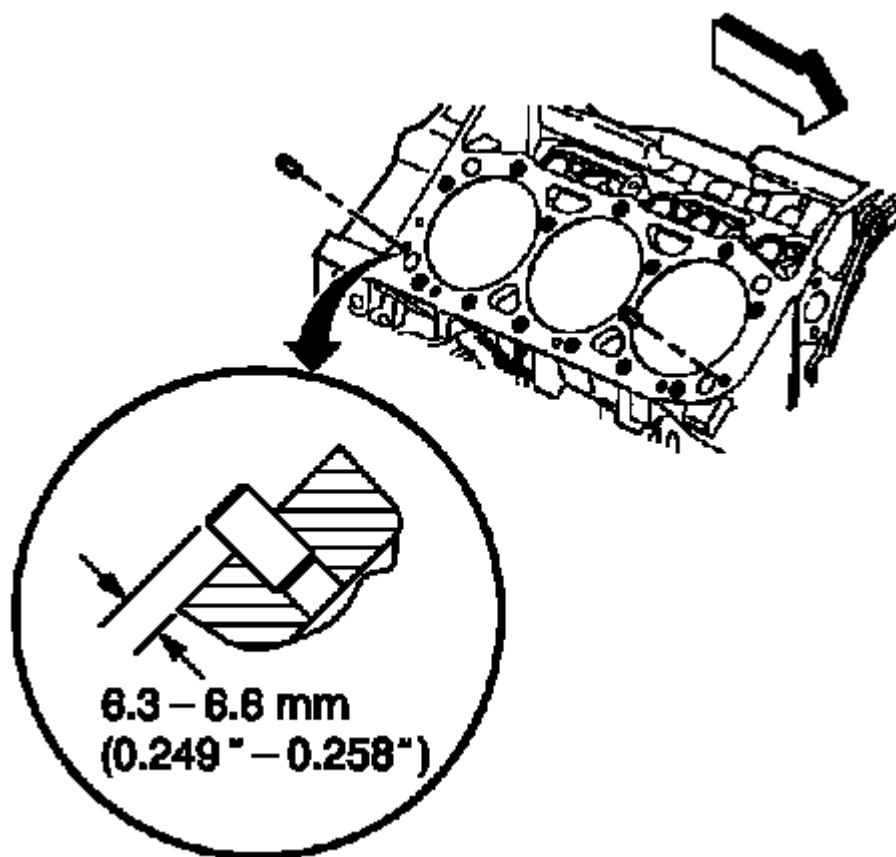


Fig. 149: Identifying Dowel Pins
Courtesy of GENERAL MOTORS CORP.

1. Assemble the cylinder head, if necessary. Refer to Cylinder Head Assemble .
2. Install the cylinder head locator pins, if necessary.

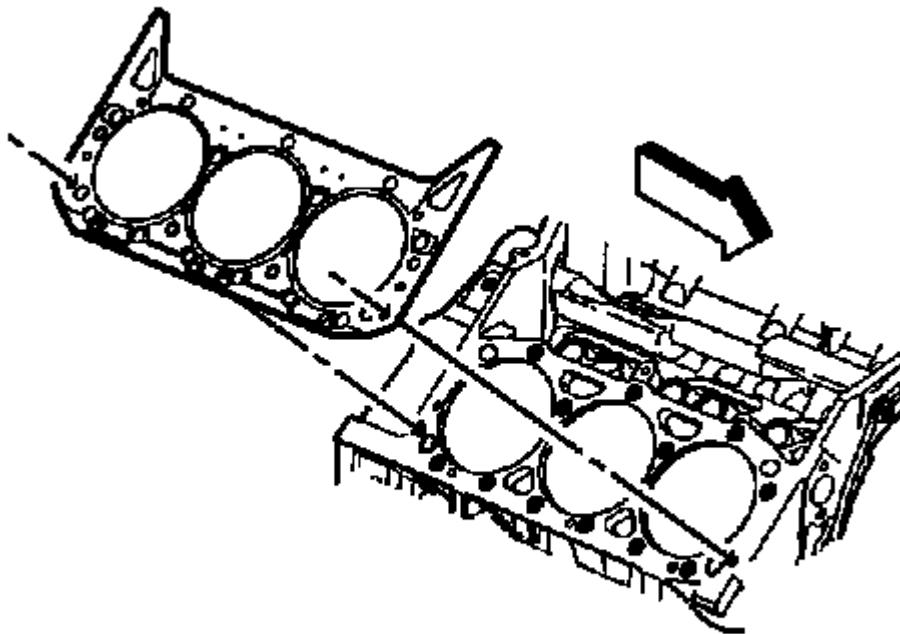


Fig. 150: View Of Cylinder Head Gasket & Alignment Pins - Right
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use any type of sealer on the cylinder head gasket.

3. Install a NEW cylinder head gasket.

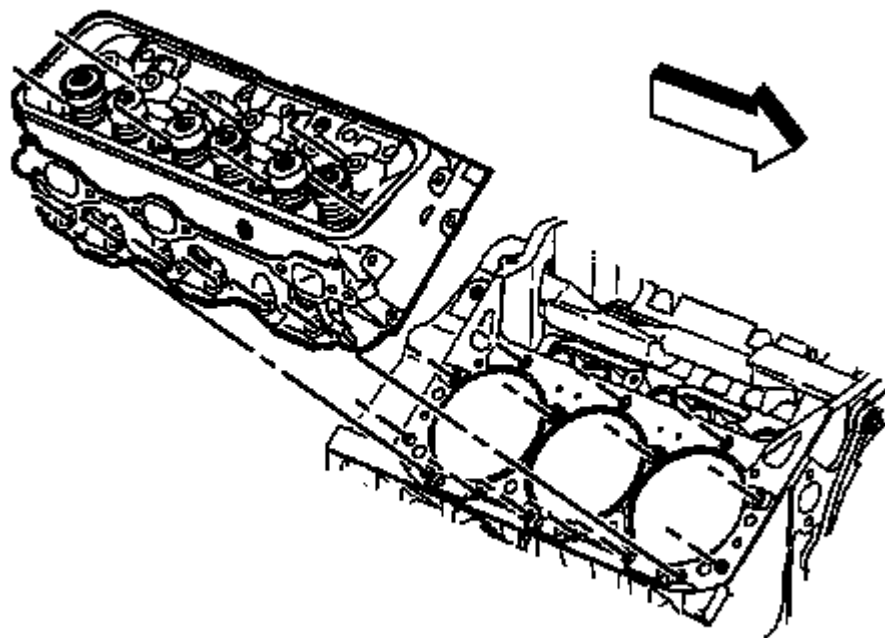


Fig. 151: View Of Cylinder Head (Right)
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder head.

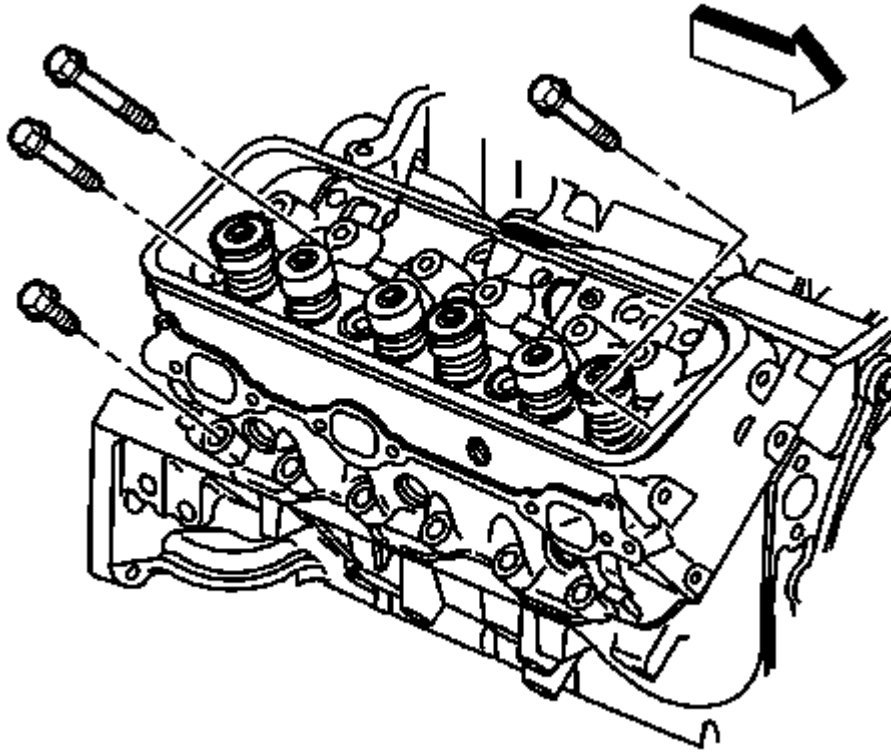


Fig. 152: Locating Cylinder Head Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

5. Apply sealant to the threads of the **NEW** cylinder head bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Install the cylinder head bolts finger tight.

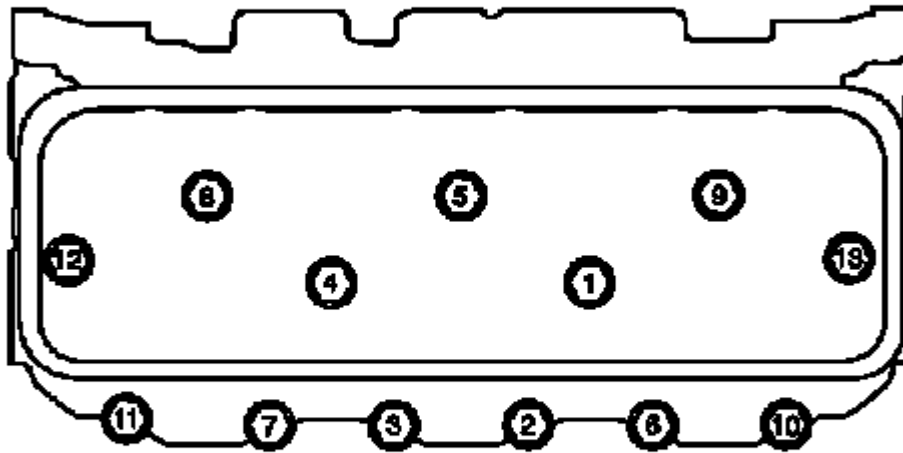


Fig. 153: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Tighten the cylinder head bolts using the sequence shown.
 - Tighten the bolts a first pass to 30 N.m (22 lb ft).
 - Tighten the long bolts (1, 4, 5, 8, 9) a final pass to 75 degrees using **J 45059**
 - Tighten the medium bolts (12, 13) a final pass to 65 degrees using **J 45059**
 - Tighten the short bolts (2, 3, 6, 7, 10, 11) a final pass to 55 degrees using **J 45059**

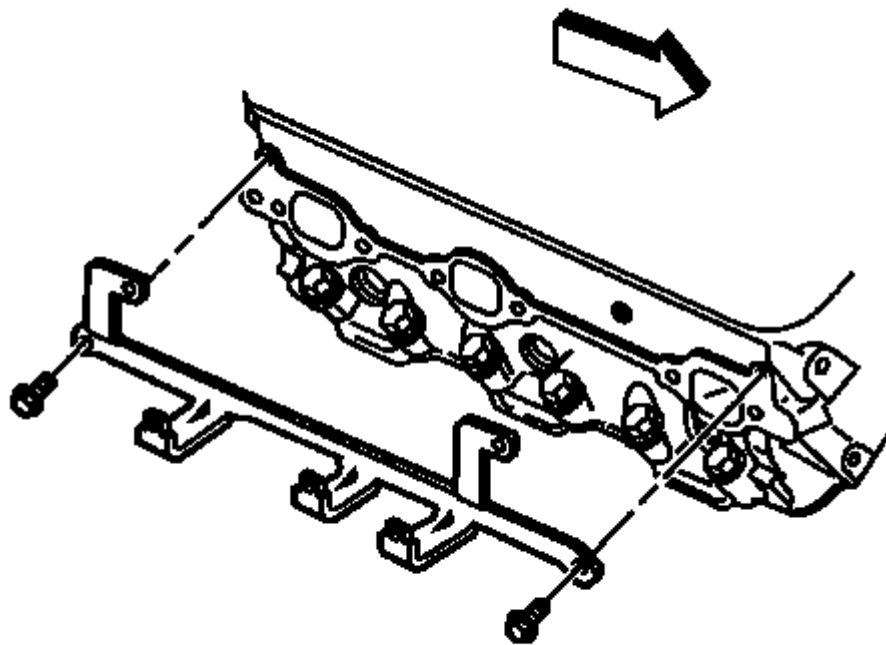


Fig. 154: View Of Spark Plug Wire Support Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

8. Install the spark plug wire support and bolts and tighten to 12 N.m (106 lb in).

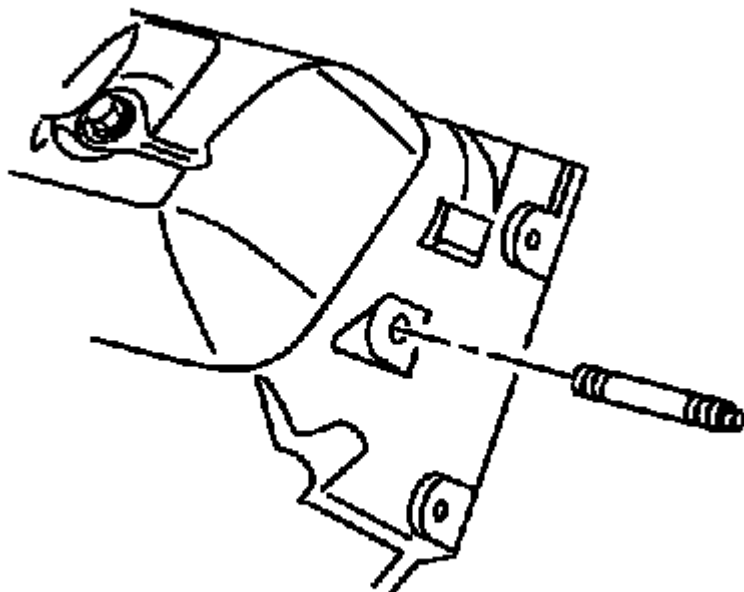


Fig. 155: View Of Generator Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

9. Install the generator bracket stud and tighten to 20 N.m (15 lb ft).
10. Install the right pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.3L)**.
12. Install the intake manifold. Refer to **Lower Intake Manifold Replacement**.
13. Install the generator bracket. Refer to **Generator Bracket Replacement (V6)**.
14. Install the oil filler tube.
15. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)**.
16. Install the engine cover. Refer to **Engine Cover Replacement**.

CRANKSHAFT BALANCER REPLACEMENT

SPECIAL TOOLS

J 23523-F Crankshaft Balancer Remover and Installer. See **Special Tools**.

REMOVAL PROCEDURE

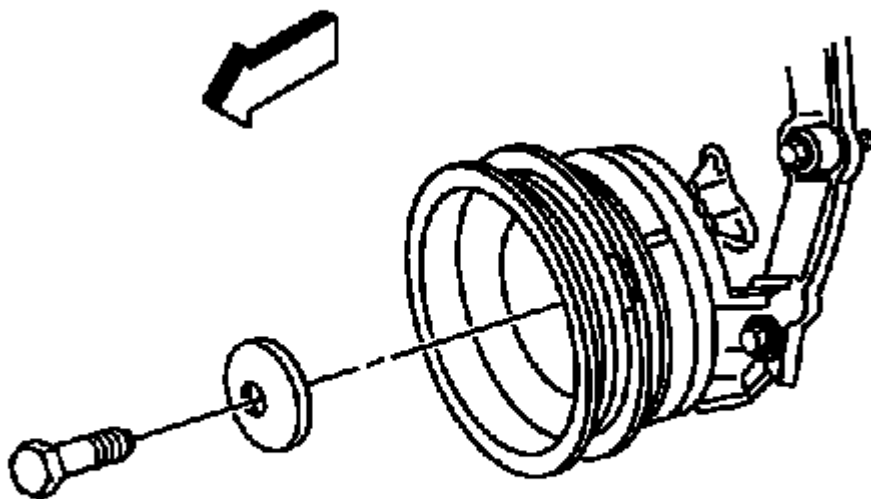


Fig. 156: View Of Crankshaft Balancer Washer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to [Drive Belt Replacement](#).
2. Remove the cooling fan. Refer to [Fan Replacement](#).

CAUTION: To prevent damage to the end of the crankshaft when using a crankshaft balancer removal tool install a bolt in the crankshaft. Use a shorter bolt with the same threads as the crankshaft balancer bolt. This bolt will allow a place for the tool to push against. The shorter bolt is to keep from going past the threads in the crankshaft and damaging the crankshaft threads.

3. Remove the crankshaft balancer bolt and washer.

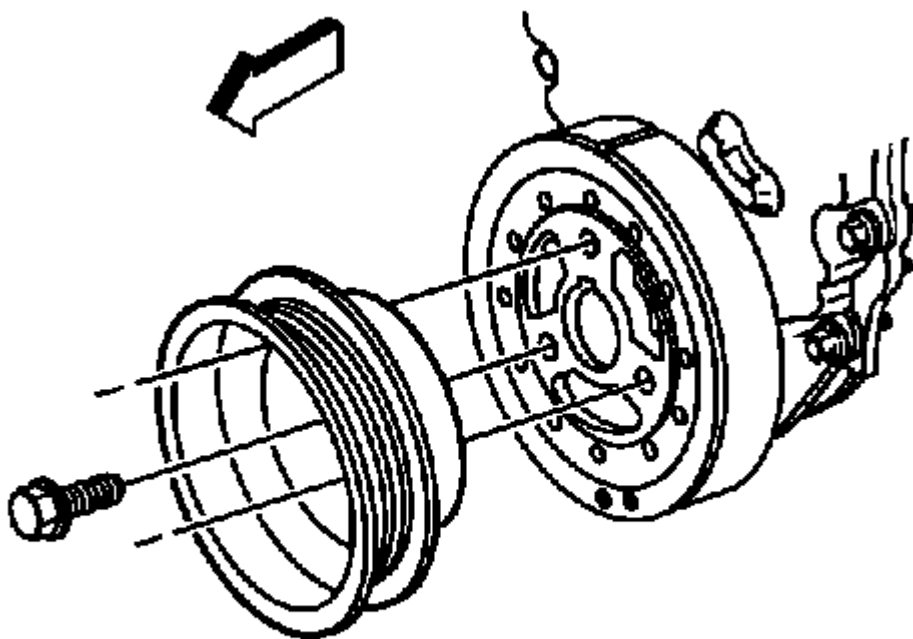


Fig. 157: View Of Crankshaft Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft pulley bolts and pulley.

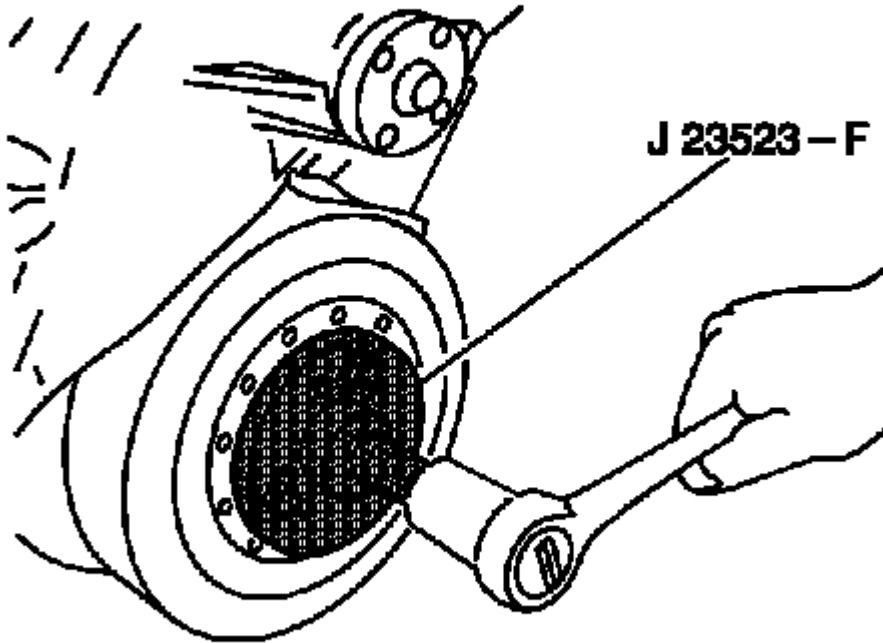


Fig. 158: Identifying Special Tool J 23523-F
Courtesy of GENERAL MOTORS CORP.

5. Using **J 23523-F** , remove the crankshaft balancer. See **Special Tools** .

CAUTION: Refer to **Fastener Caution** .

1. Install the **J 23523-F** plate and bolts onto the crankshaft balancer and tighten the bolts to 25 N.m (18 lb ft).
 2. Install the **J 23523-F** forcing screw into the plate. See **Special Tools** .
 3. Rotate the **J 23523-F** forcing screw clockwise in order to remove the crankshaft balancer. See **Special Tools** .
6. Remove the **J 23523-F** from the crankshaft balancer. See **Special Tools** .

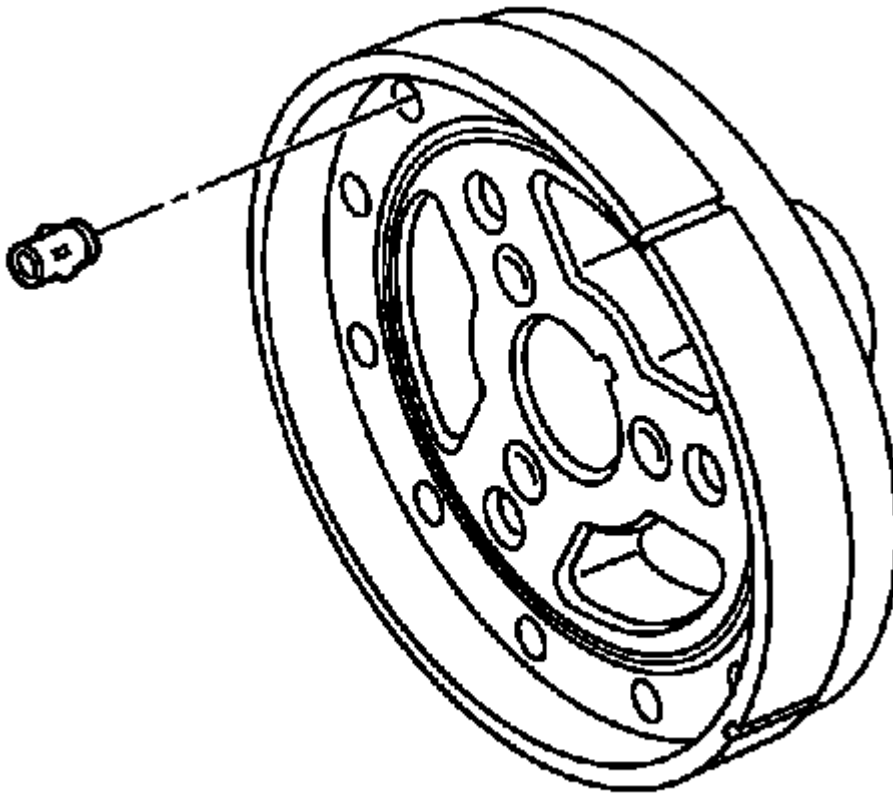


Fig. 159: View Of Crankshaft Balancer Weights
Courtesy of GENERAL MOTORS CORP.

7. Note the position and length of any crankshaft balancer weights, if necessary.
8. Clean and inspect the crankshaft balancer, if necessary. Refer to **Crankshaft Balancer Cleaning and Inspection** .

INSTALLATION PROCEDURE

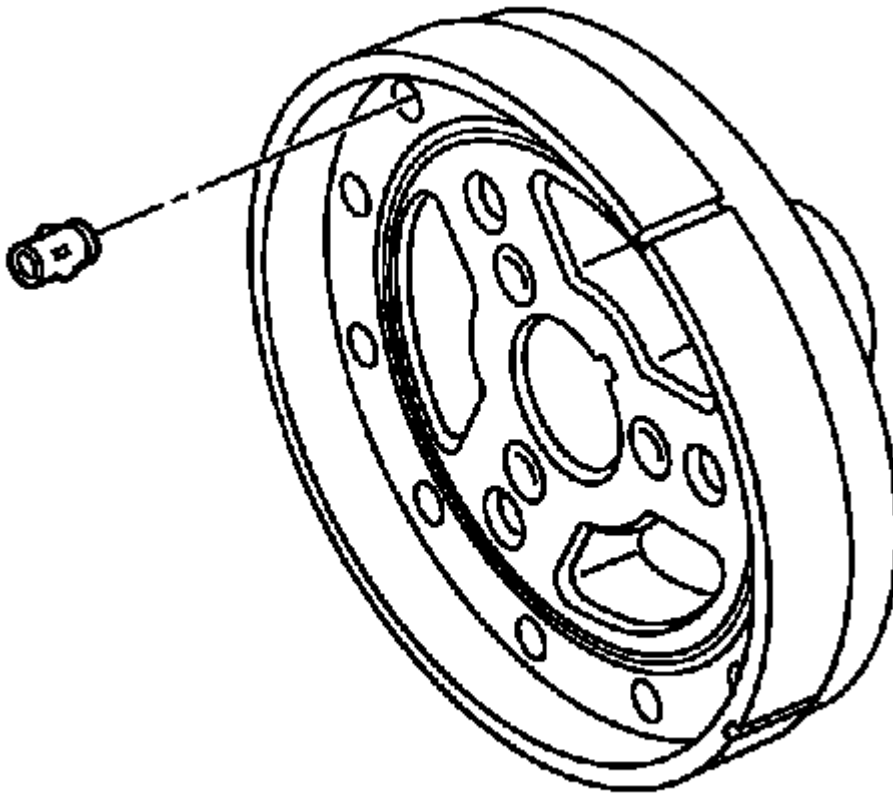


Fig. 160: View Of Crankshaft Balancer Weights
Courtesy of GENERAL MOTORS CORP.

NOTE: **The length and location of the weight(s) must be the same as the original.**

1. Apply a small amount of grease to the crankshaft front cover seal sealing surface if reusing the seal.
2. Ensure that the crankshaft balancer weight(s) is installed in the proper location, if necessary.

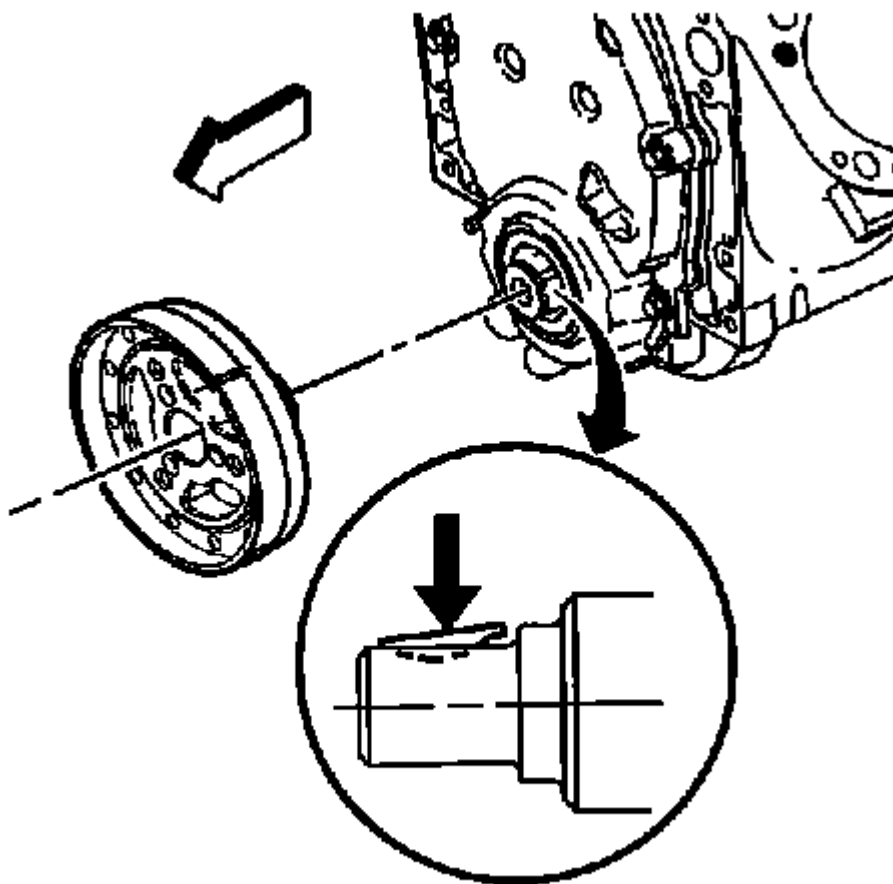


Fig. 161: Identifying Crankshaft Balancer & Key
Courtesy of GENERAL MOTORS CORP.

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

3. Apply a small amount of adhesive into the crankshaft balancer keyway in order to seal the crankshaft balancer keyway and crankshaft joint. Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number.
4. Align the keyway of the crankshaft balancer with the crankshaft balancer key.
5. Install the crankshaft balancer onto the end of the crankshaft.

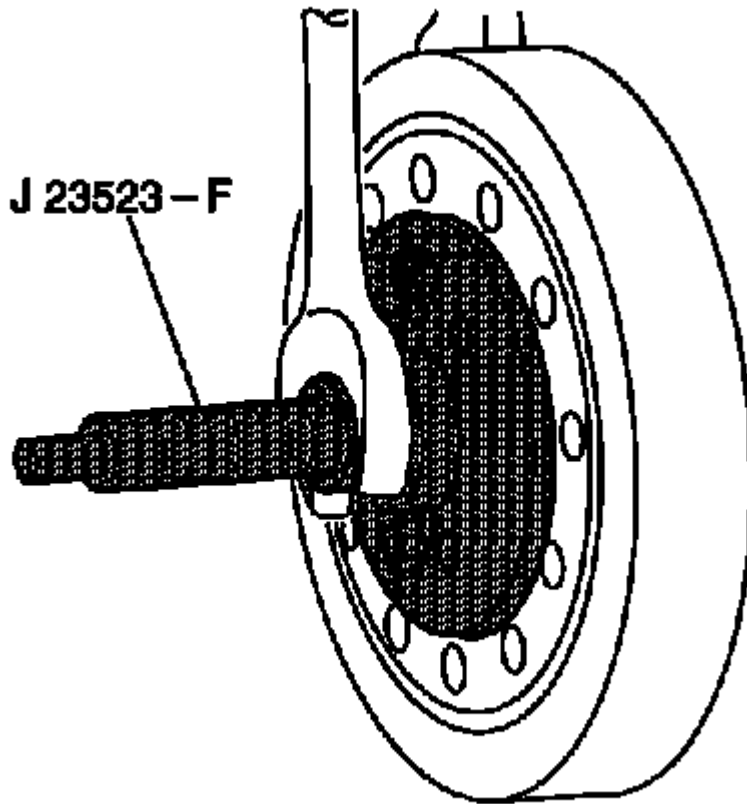


Fig. 162: Pressing Crankshaft Balancer Onto Crankshaft Using Special Tool J 23523-F
Courtesy of GENERAL MOTORS CORP.

6. Using **J 23523-F** , press the crankshaft balancer onto the crankshaft. See **Special Tools** .
 1. Install the **J 23523-F** plate and bolts onto the front of the crankshaft balancer and tighten the bolts to 25 N.m (18 lb ft).
 2. Install the **J 23523-F** forcing screw into the end for the crankshaft. See **Special Tools** .
 3. Install the **J 23523-F** bearing, the washer, and the nut onto the forcing screw. See **Special Tools** .
 4. Rotate the **J 23523-F** nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reductor ring. See **Special Tools** .
7. Remove the **J 23523-F** . See **Special Tools** .

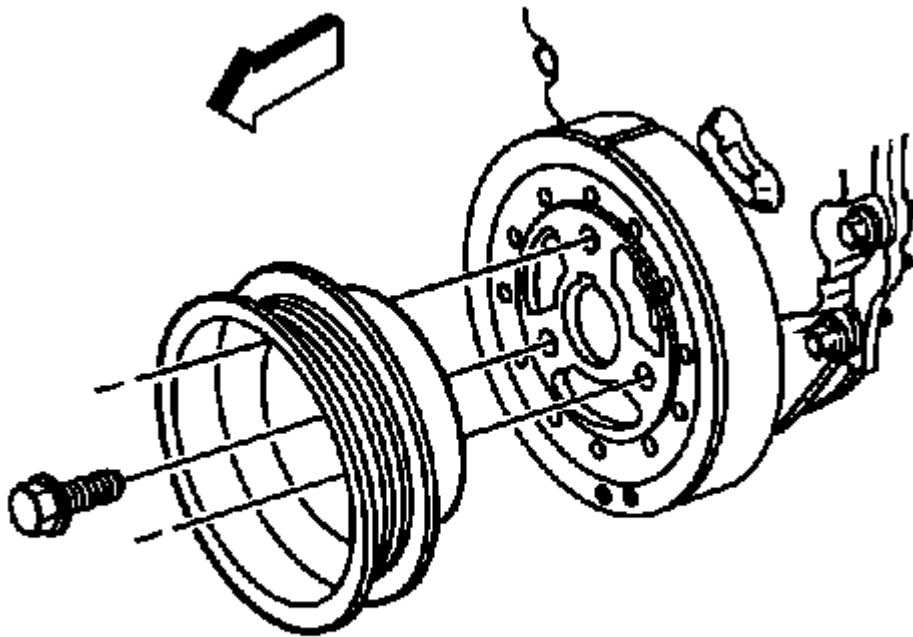


Fig. 163: View Of Crankshaft Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the crankshaft pulley and bolts. Finger tighten all bolts until snug in order to fully seat the pulley.
9. Tighten the bolts to 58 N.m (43 lb ft).

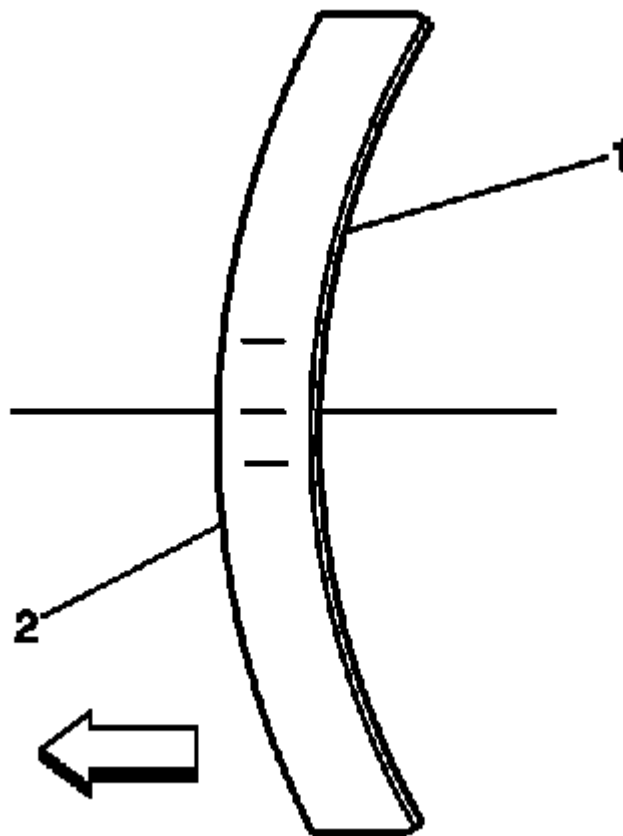


Fig. 164: Identifying Crankshaft Balancer Washer Crown
Courtesy of GENERAL MOTORS CORP.

10. Ensure that the crown of the crankshaft balancer washer (2) is faced away from the engine.

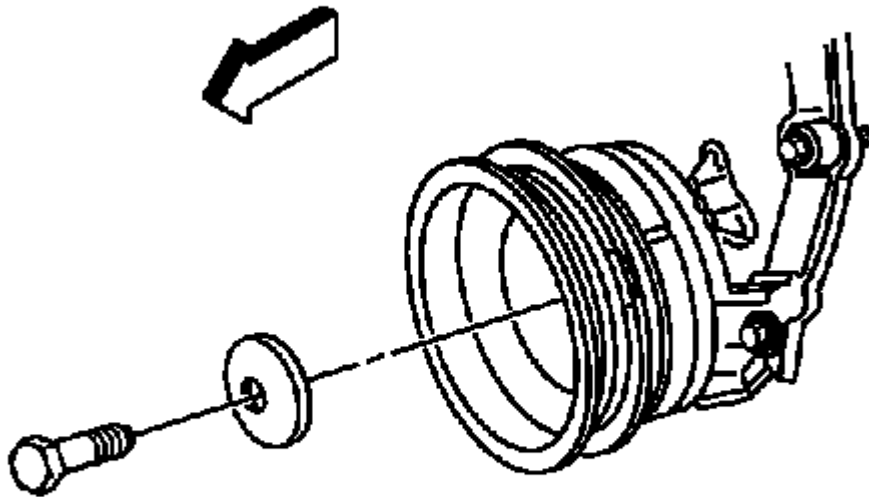


Fig. 165: View Of Crankshaft Balancer Washer & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Install the crankshaft balancer washer and bolt and tighten to 95 N.m (70 lb ft).
12. Install the cooling fan. Refer to **Fan Replacement** .
13. Install the drive belt. Refer to **Drive Belt Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 35468 Cover Aligner and Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

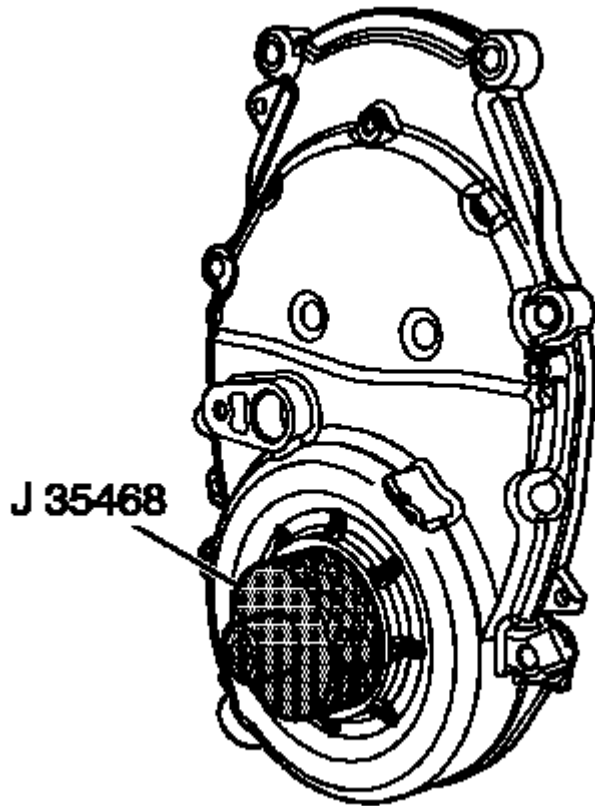


Fig. 166: Identifying Front Seal Cover Aligner and Seal Installer
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Inspect the engine front cover seal bore area for damage.
3. Use a suitable seal puller, remove the crankshaft front oil seal.

INSTALLATION PROCEDURE

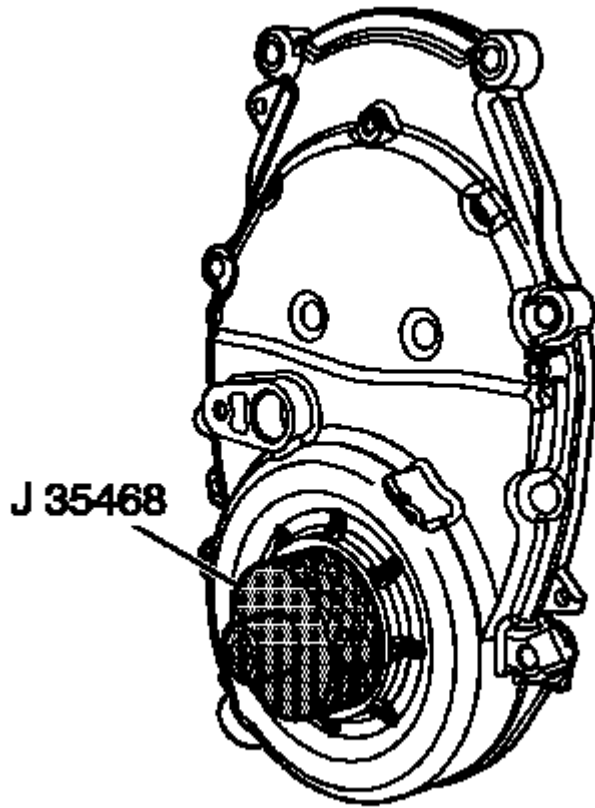


Fig. 167: Identifying Front Seal Cover Aligner and Seal Installer
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the exterior of the NEW seal with clean engine oil.
2. Using **J 35468** and a hammer, install the crankshaft front oil seal. See **Special Tools** .
3. Ensure the crankshaft front oil seal is flush and square to the engine front cover.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

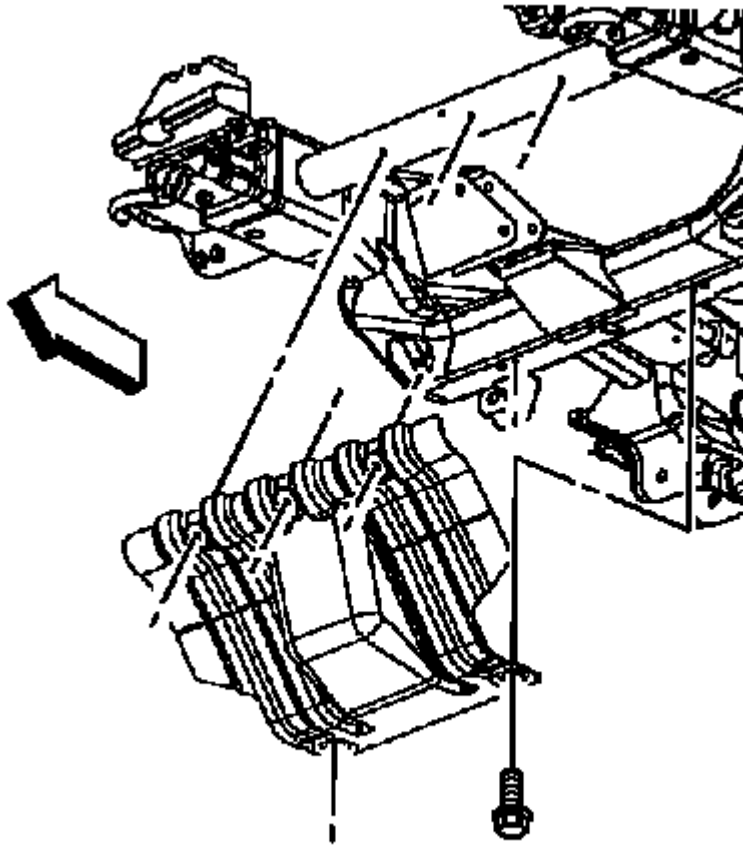


Fig. 168: View Of Engine Protection Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (V6)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the oil pan. Refer to **Oil Pan Replacement**.
4. Remove the engine shield bolts and shield.

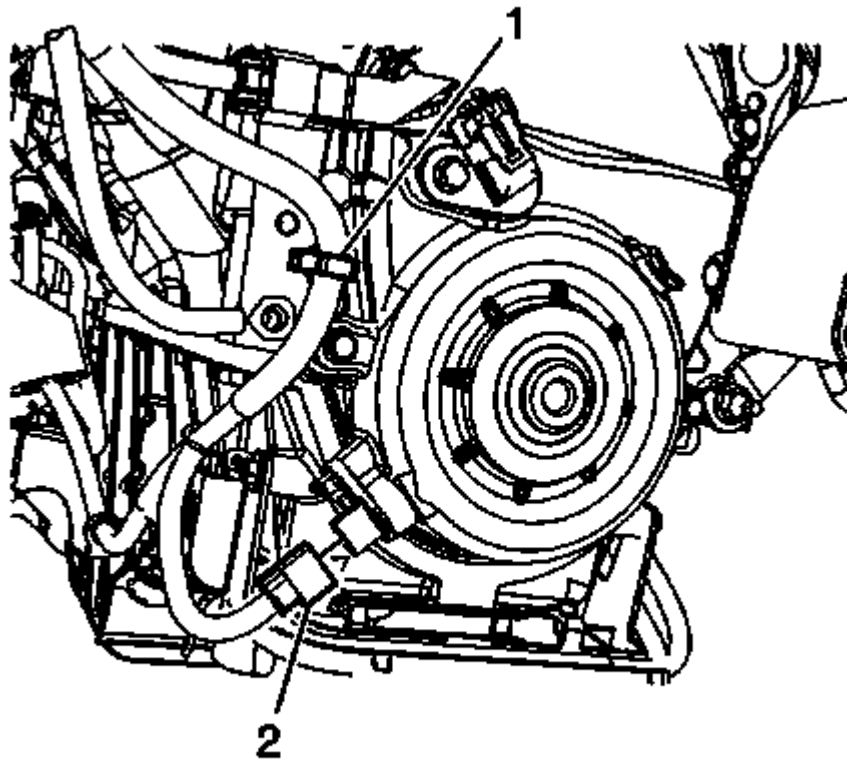


Fig. 169: Identifying Crankshaft Position (CKP) Sensor Electrical Connector & Clip
Courtesy of GENERAL MOTORS CORP.

5. Remove engine wire harness clip (1) from front cover.
6. Disconnect the crankshaft position (CKP) sensor electrical connector (2).

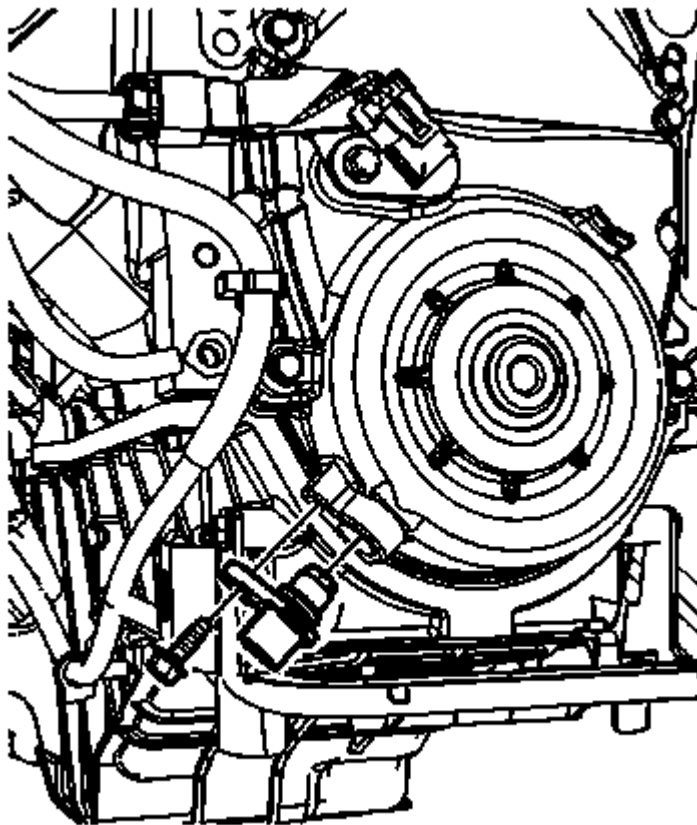


Fig. 170: Identifying CKP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS CORP.

7. Remove the CKP sensor bolt and sensor.

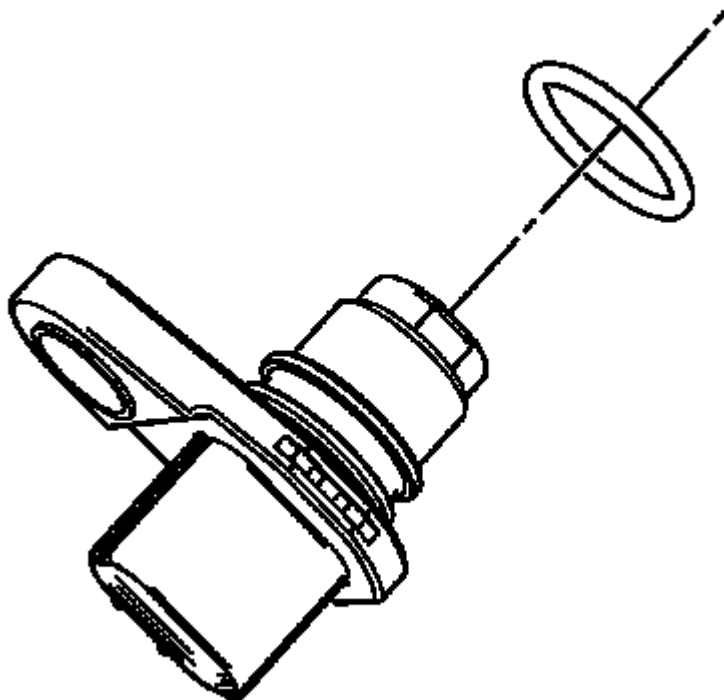


Fig. 171: Identifying CKP Sensor & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the CKP sensor O-ring seal.

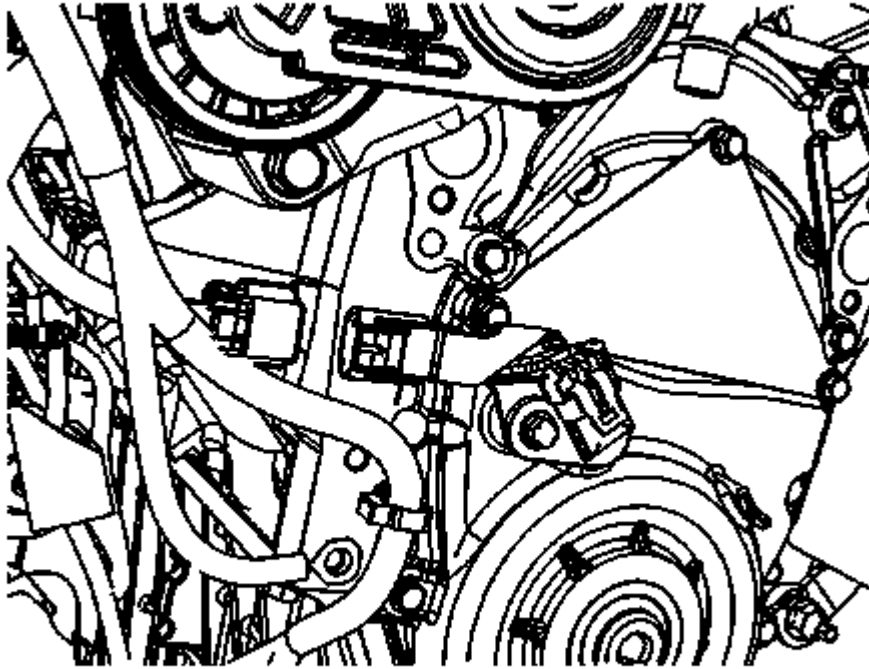


Fig. 172: Identifying Camshaft Position (CMP) Sensor Wiring Harness Jumper
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the engine wiring harness electrical connector from the camshaft position (CMP) sensor wiring harness jumper.

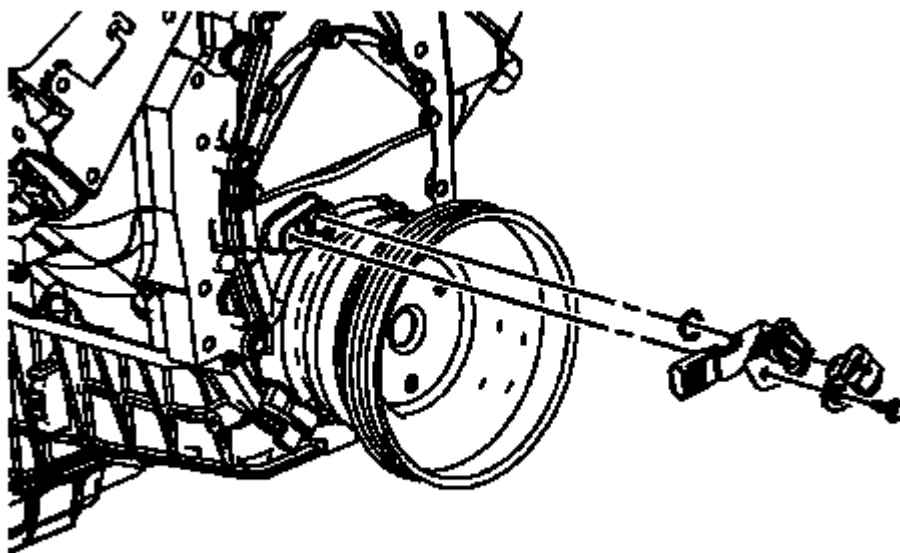


Fig. 173: View Of CMP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the CMP sensor bolt.
11. Remove the CMP sensor and wiring harness jumper from the engine front cover.
12. Disconnect the CMP sensor wiring harness jumper from the CMP sensor.
13. Remove the CMP sensor from the wiring harness jumper.

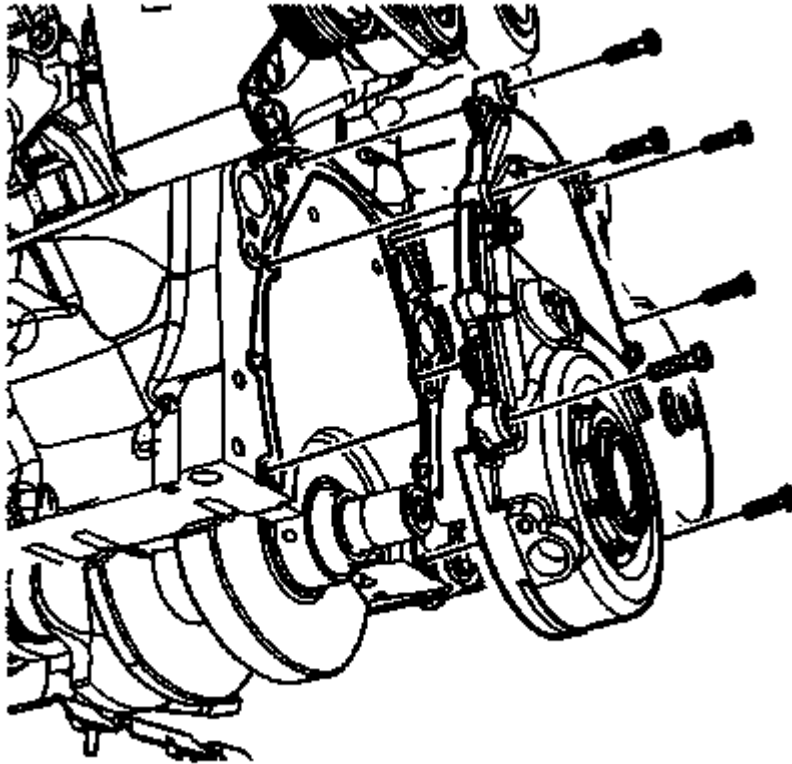


Fig. 174: View Of Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the front cover bolts.

NOTE: After the composite front cover is removed do not reinstall the front cover.
Always install a NEW front cover.

15. Remove and discard the front cover.
16. Clean all sealing surfaces.

INSTALLATION PROCEDURE

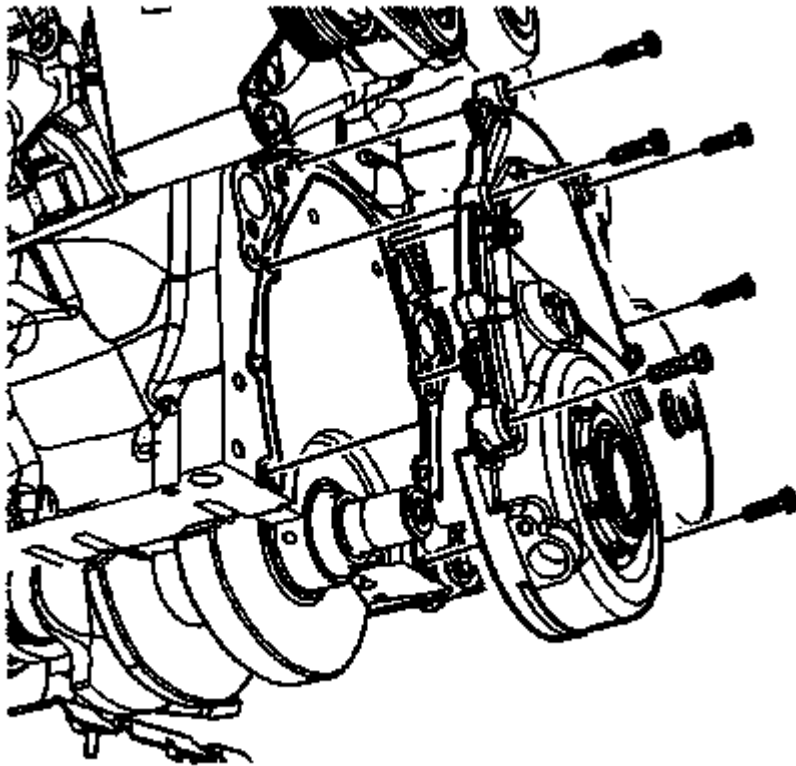


Fig. 175: View Of Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install a NEW front cover.
2. Install the front cover bolts and tighten to 12 N.m (106 lb in).

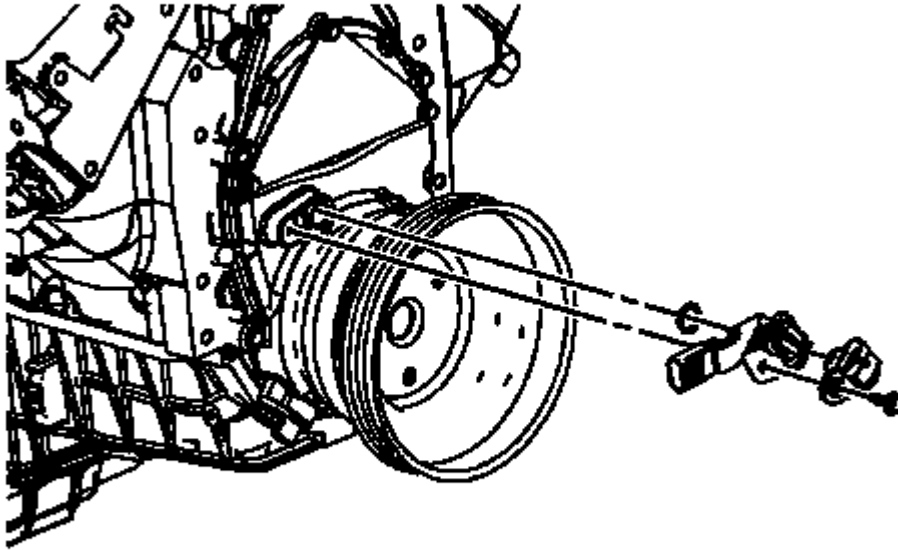


Fig. 176: View Of CMP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not reuse the original O-ring seal.

3. If reinstalling the old CMP sensor, install a NEW O-ring seal onto the sensor.
4. Install the CMP sensor to the wiring harness jumper.
5. Connect the CMP sensor wiring harness jumper to the CMP sensor.
6. Lubricate the O-ring seal with clean engine oil.
7. Install the CMP sensor and wiring harness jumper to the engine front cover.
8. Install the CMP sensor bolt and tighten to 10 N.m (89 lb in).

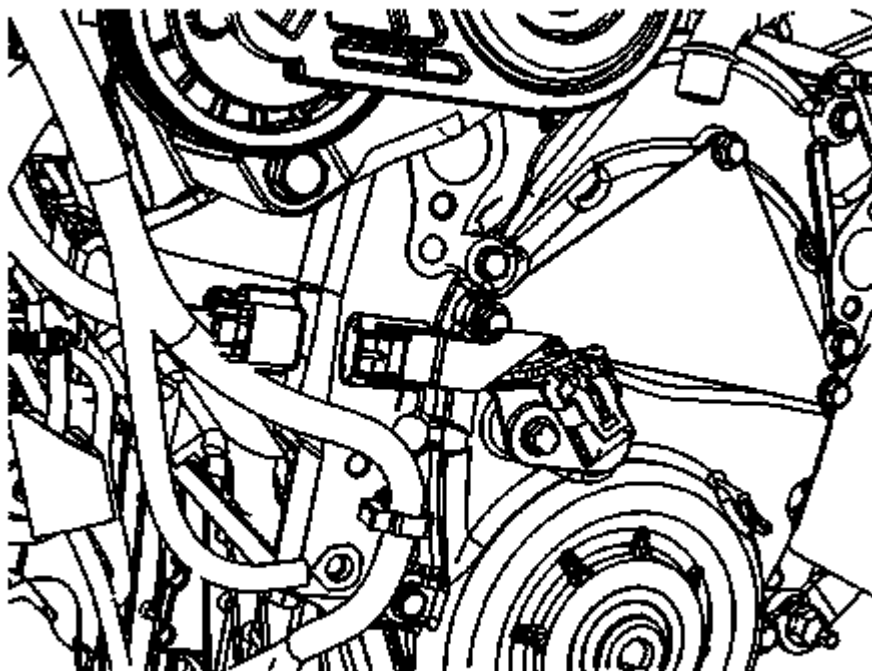


Fig. 177: Identifying Camshaft Position (CMP) Sensor Wiring Harness Jumper
Courtesy of GENERAL MOTORS CORP.

9. Connect the engine wiring harness electrical connector from the CMP sensor wiring harness jumper.

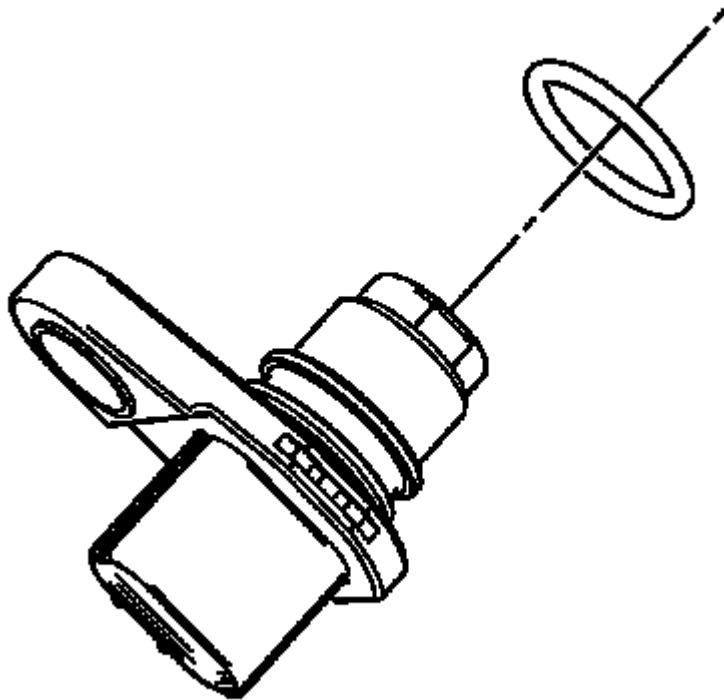


Fig. 178: Identifying CKP Sensor & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: **DO NOT reuse the original CKP sensor O-ring seal.**

10. Lubricate a NEW CKP sensor O-ring seal with clean engine oil.
11. Install the NEW O-ring seal onto the CKP sensor.

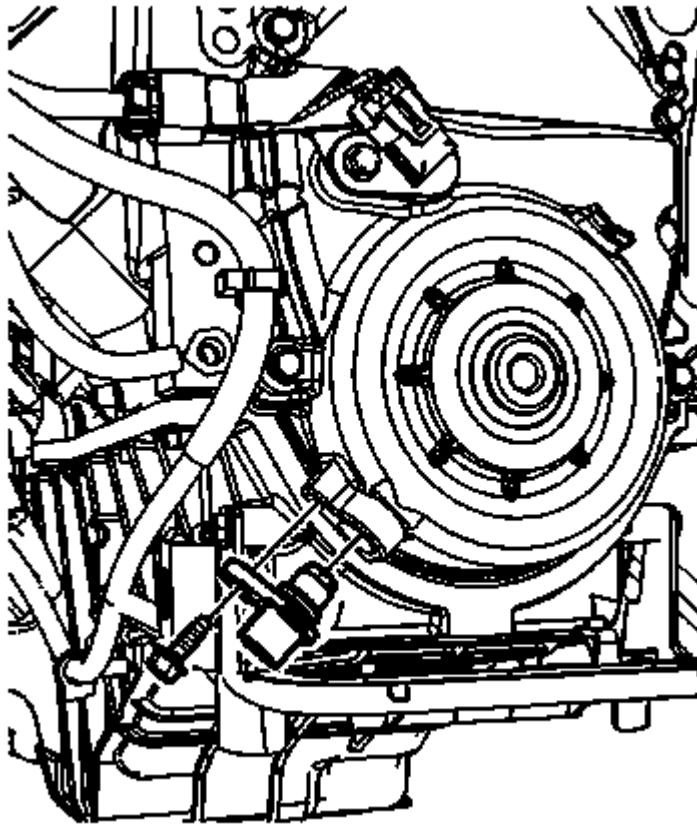


Fig. 179: Identifying CKP Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing the CKP sensor, make sure the sensor is fully seated before tightening the bolt. A poorly seated sensor may perform erratically and may set false DTCs.

12. Install the CKP sensor and bolt and tighten to 8 N.m (71 lb in).

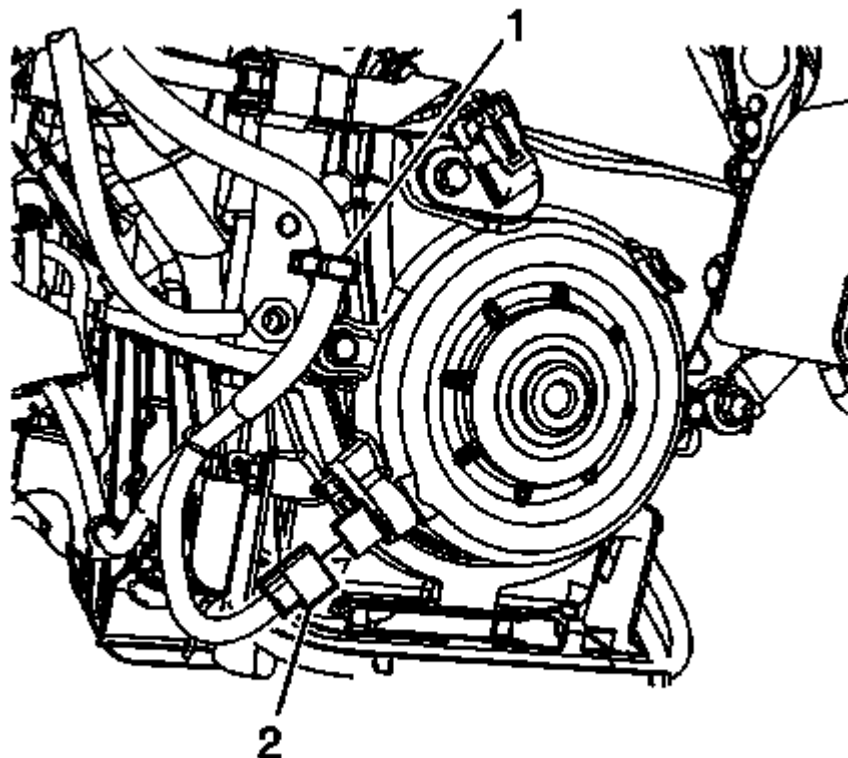


Fig. 180: Identifying Crankshaft Position (CKP) Sensor Electrical Connector & Clip
Courtesy of GENERAL MOTORS CORP.

13. Connect the CKP sensor electrical connector (2).
14. Install the engine wire harness clip (1) to front cover.
15. Install the oil pan. Refer to **Oil Pan Replacement**.
16. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
17. Install the water pump. Refer to **Water Pump Replacement (V6)**.

CRANKSHAFT POSITION SENSOR RELUCTOR RING REPLACEMENT

SPECIAL TOOLS

J 5590 Rear Pinion Bearing Race Installer. See **Special Tools**.

REMOVAL PROCEDURE

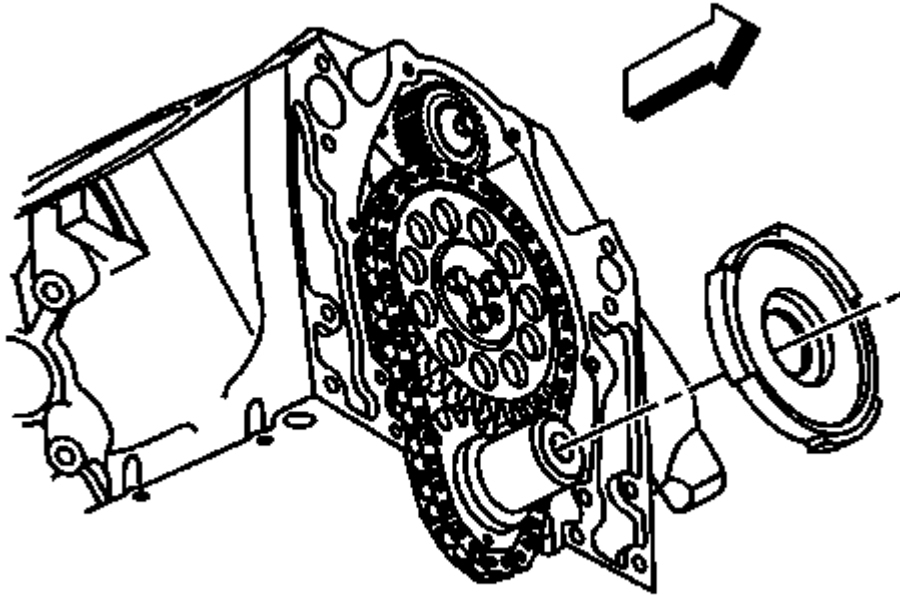


Fig. 181: Identifying CKP Sensor Reluctor Ring
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the crankshaft position (CKP) sensor reluctor ring.

INSTALLATION PROCEDURE

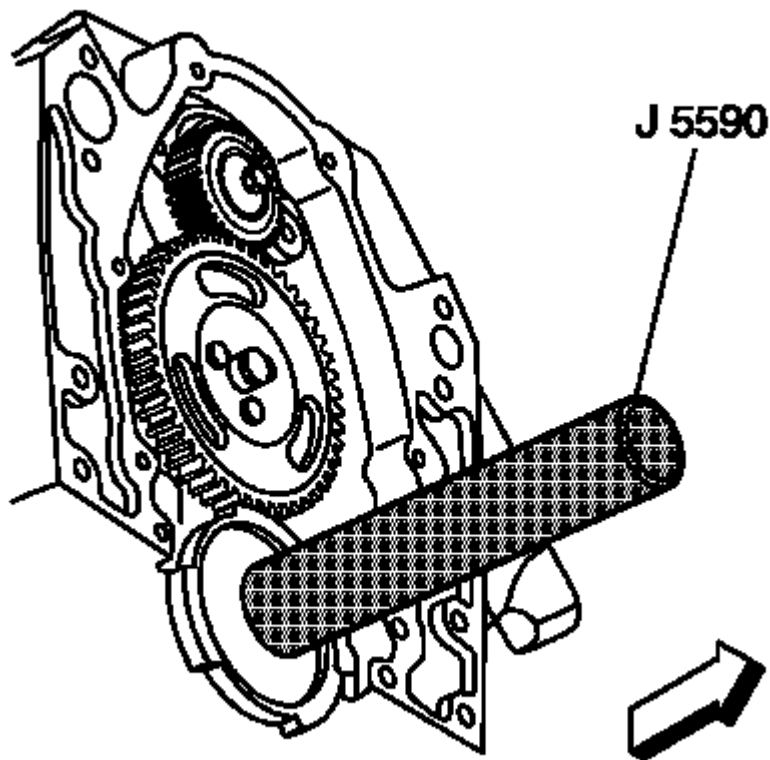


Fig. 182: View Of CKP Sensor Ring
Courtesy of GENERAL MOTORS CORP.

CAUTION: Failure to properly align the crankshaft position sensor reluctor ring may result in component damage and effect OBD II system performance.

NOTE: The reluctor ring is shaped like a dish. The dish must face the engine front cover. Failure to do so will damage the front cover and the reluctor ring.

1. Install the CKP sensor reluctor ring.
 1. Align the keyway on the CKP sensor reluctor ring with the key in the crankshaft.
 2. Using **J 5590** , push the CKP sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket. See **Special Tools** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

SPECIAL TOOLS

- **J 5590** Bearing and Seal Driver. See Special Tools .
- **J 5825-A** Crankshaft Gear Remover. See Special Tools .

REMOVAL PROCEDURE

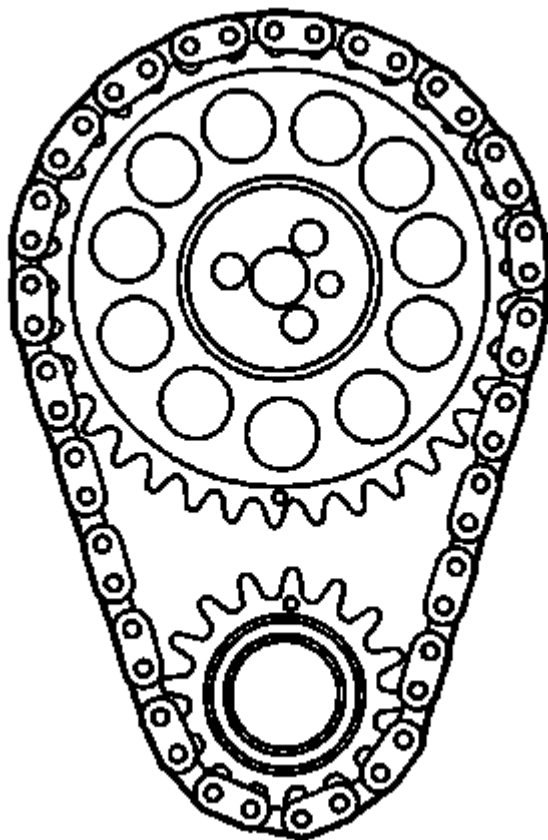


Fig. 183: View Of Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft position (CKP) sensor reluctor ring. Refer to Crankshaft Position Sensor Reluctor Ring Replacement.
2. Install a 7/16-20 x 1 inch bolt into the end of the crankshaft.

CAUTION: Align the timing marks before removing the timing chain. If it is necessary to turn either the camshaft or the crankshaft with the timing chain removed, loosen or remove the valve rocker arms. Turning either the crankshaft or camshaft with the timing chain removed may cause the pistons to contact the valves, resulting in damage.

3. Rotate the crankshaft until:
 - The timing marks on both sprockets line up.

- The number 4 cylinder is at top dead center (TDC) of the compression stroke.

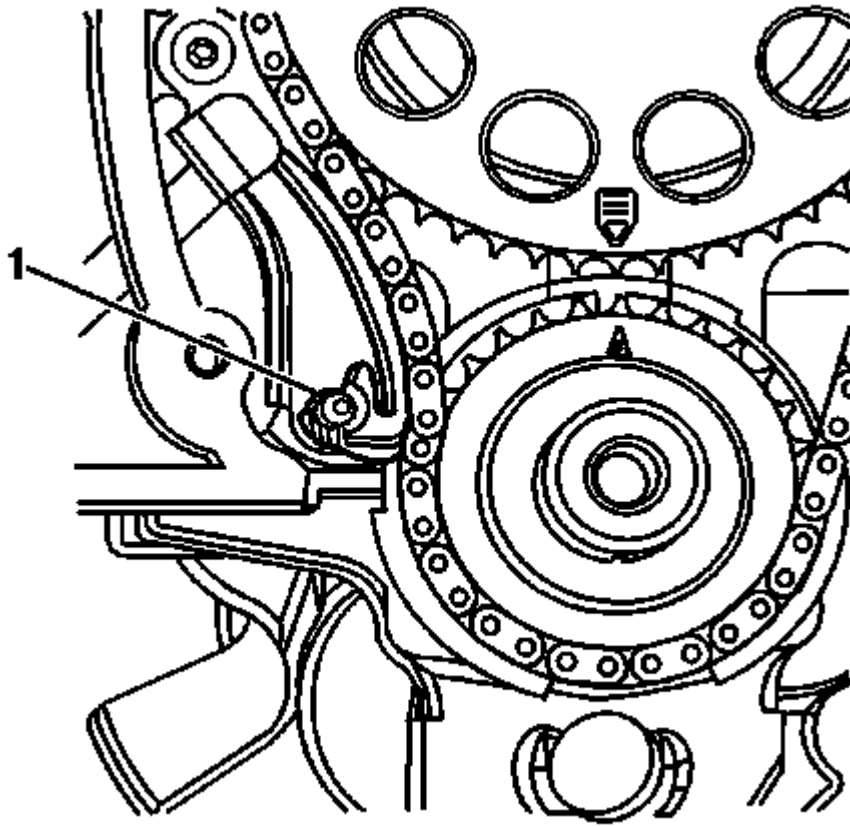


Fig. 184: View Of Timing Chain Tensioner Shoe & Pin
Courtesy of GENERAL MOTORS CORP.

4. Unsnap the timing chain tensioner shoe from the pin (1).

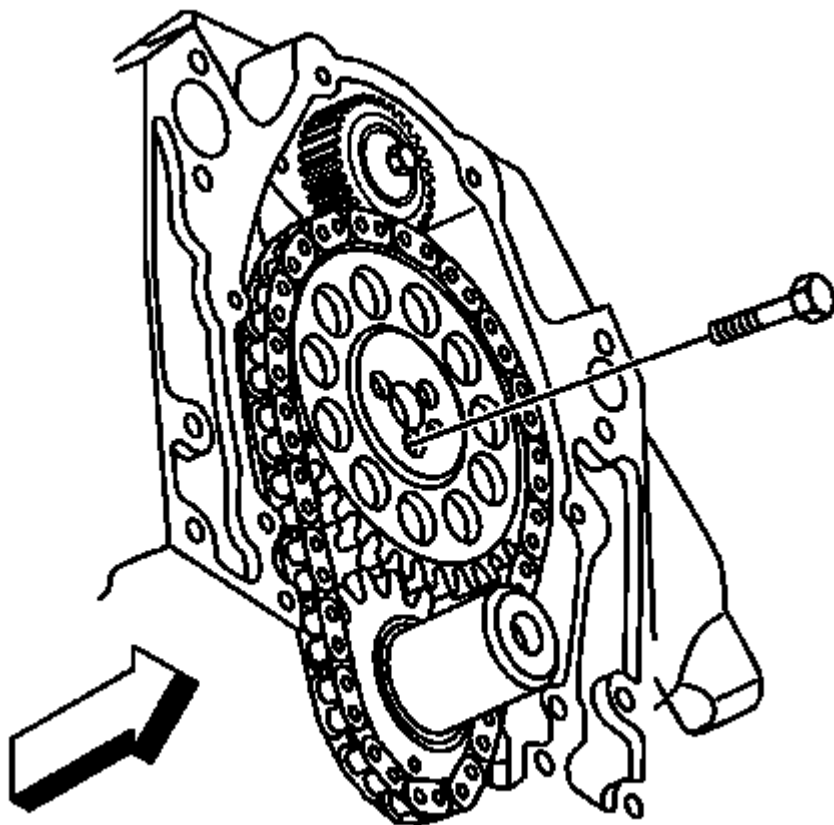


Fig. 185: Identifying Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket bolts.

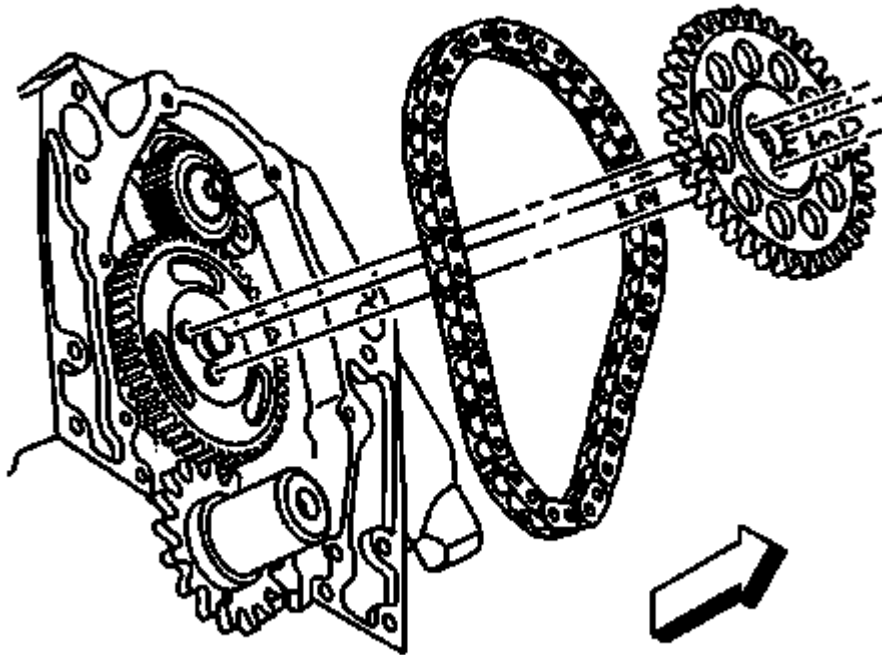


Fig. 186: View Of Camshaft Sprocket & Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft sprocket and the camshaft timing chain.

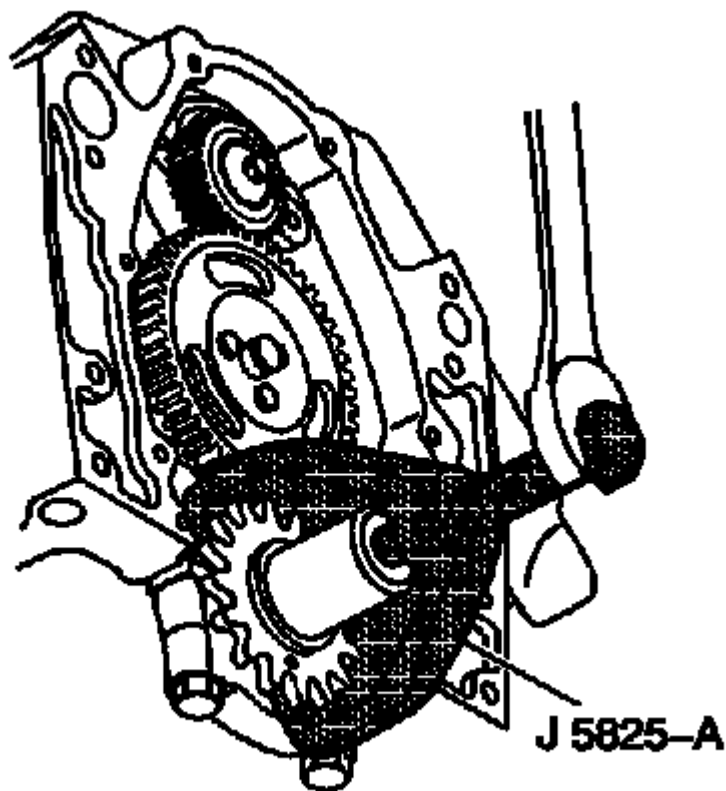


Fig. 187: Removing Crankshaft Sprocket Using J 5825-A
Courtesy of GENERAL MOTORS CORP.

7. Using **J 5825-A** and an open end wrench, remove the crankshaft sprocket. See **Special Tools** .

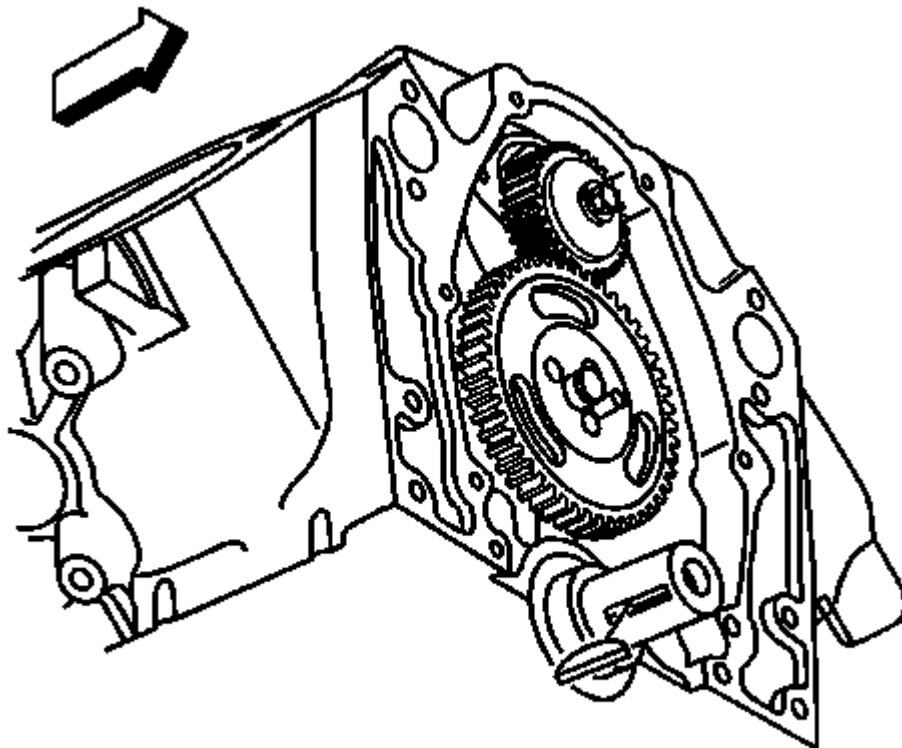


Fig. 188: Identifying Crankshaft Balancer Key
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft balancer key.

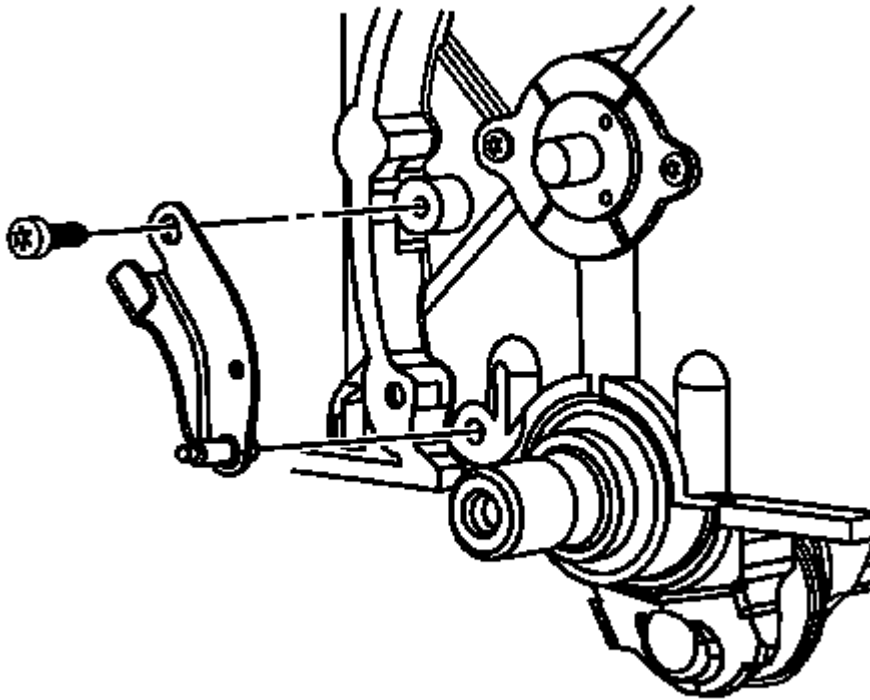


Fig. 189: View Of Timing Chain Tensioner Bracket
Courtesy of GENERAL MOTORS CORP.

9. If necessary, remove the timing chain tensioner bracket bolt and bracket.
10. Clean and inspect the timing chain and sprockets, if necessary. Refer to **Camshaft Timing Chain and Sprocket Cleaning and Inspection** .

INSTALLATION PROCEDURE

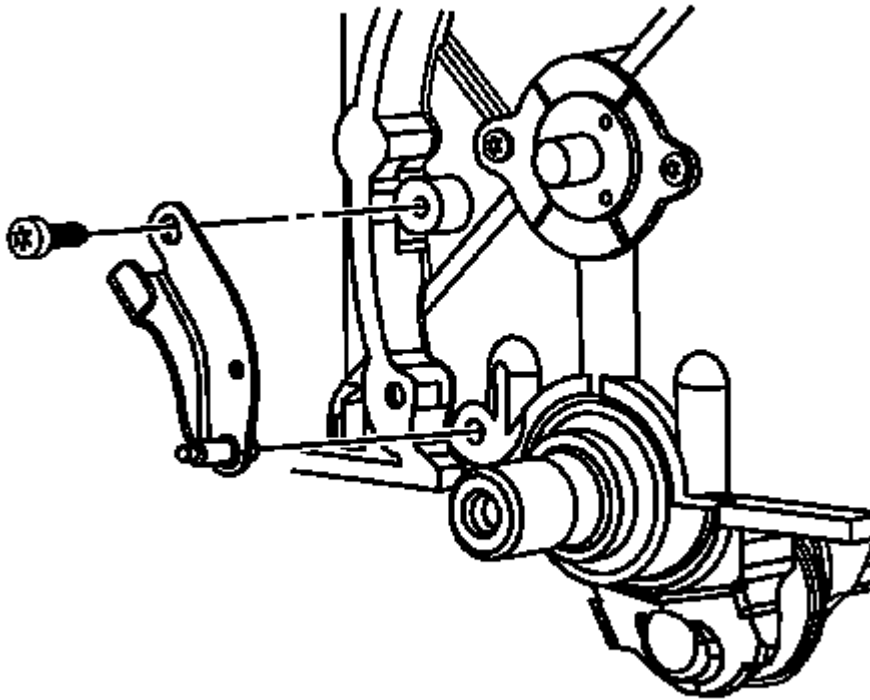


Fig. 190: View Of Timing Chain Tensioner Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. If necessary, install the timing chain tensioner bracket and bolt and tighten the bolt to 12 N.m (106 lb in).

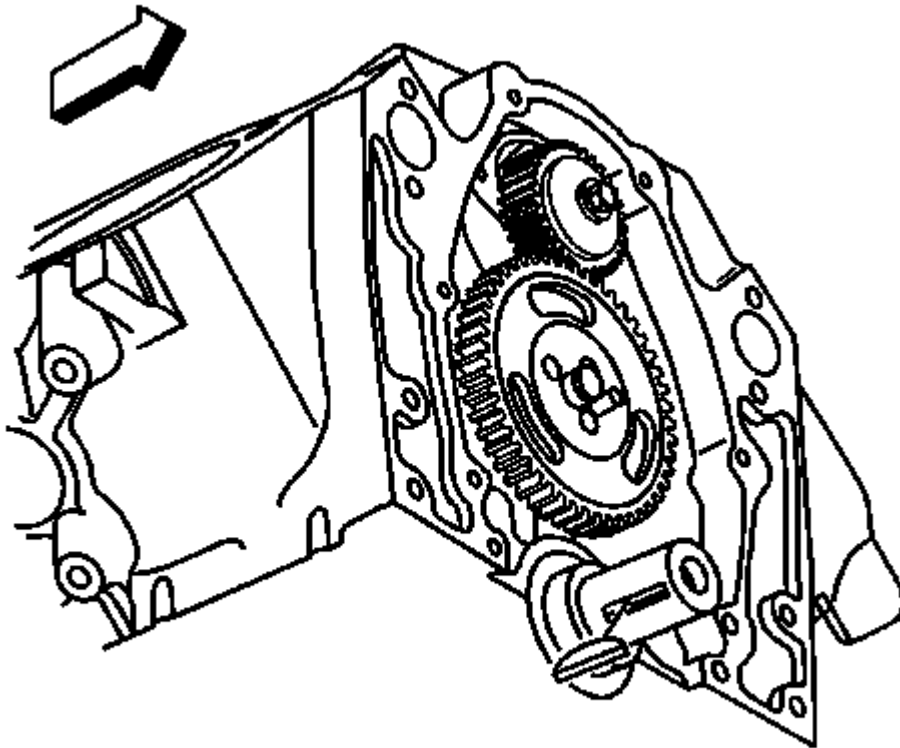


Fig. 191: Identifying Crankshaft Balancer Key
Courtesy of GENERAL MOTORS CORP.

2. Install the key into the crankshaft keyway.

The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.

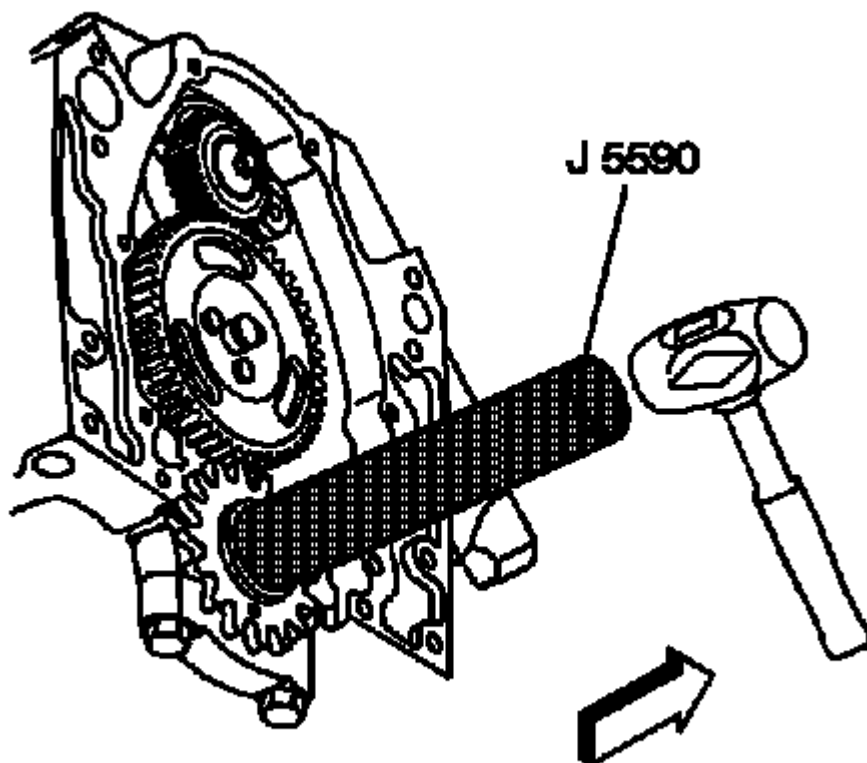


Fig. 192: View Of Crankshaft Sprocket & Special Tool J 5590
Courtesy of GENERAL MOTORS CORP.

3. Align the keyway of the crankshaft sprocket with the crankshaft balancer key.
4. Using **J 5590** , install the crankshaft sprocket. See **Special Tools** .

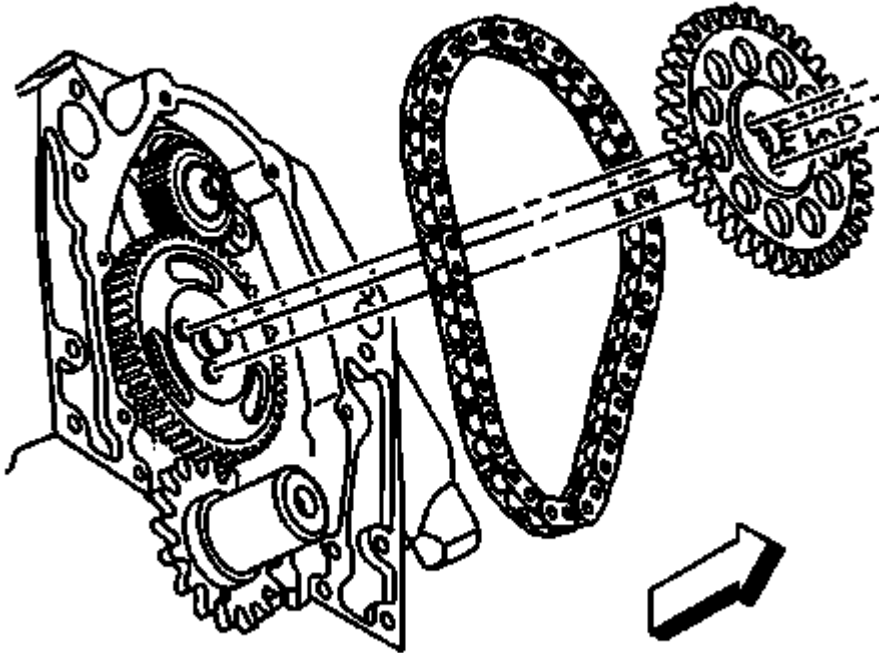


Fig. 193: View Of Camshaft Sprocket & Camshaft Timing Chain
 Courtesy of GENERAL MOTORS CORP.

NOTE: Install the camshaft sprocket with the alignment mark at the 6 o'clock position.

5. Install the camshaft sprocket and the camshaft timing chain. Wrap the timing chain around the crankshaft sprocket and position to the driver side of the engine.

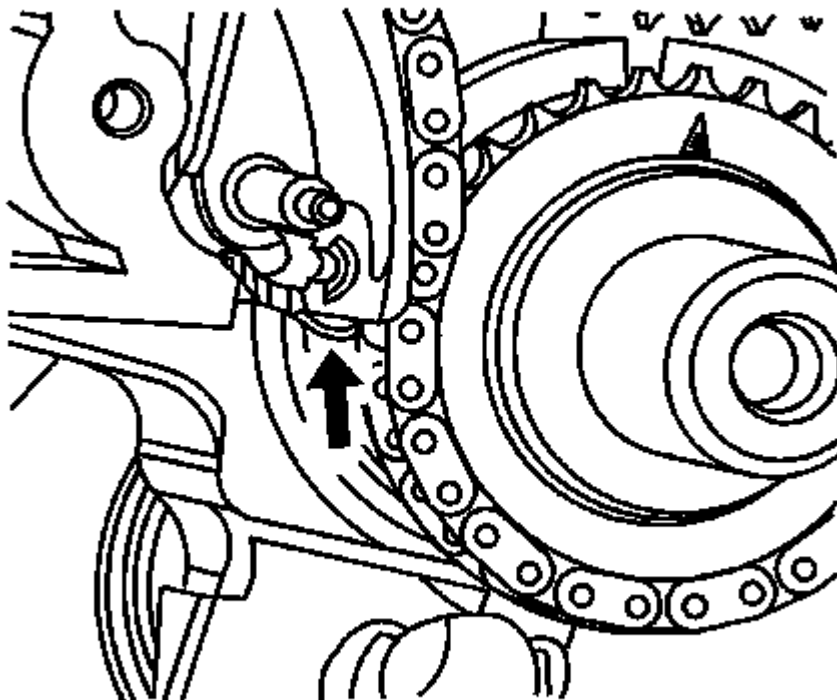


Fig. 194: Illustrating Proper Timing Chain Tensioner Shoe Position Under Tab
Courtesy of GENERAL MOTORS CORP.

6. Install the timing chain tensioner shoe onto the bracket and position the top of the shoe under the tab at the top of the bracket.

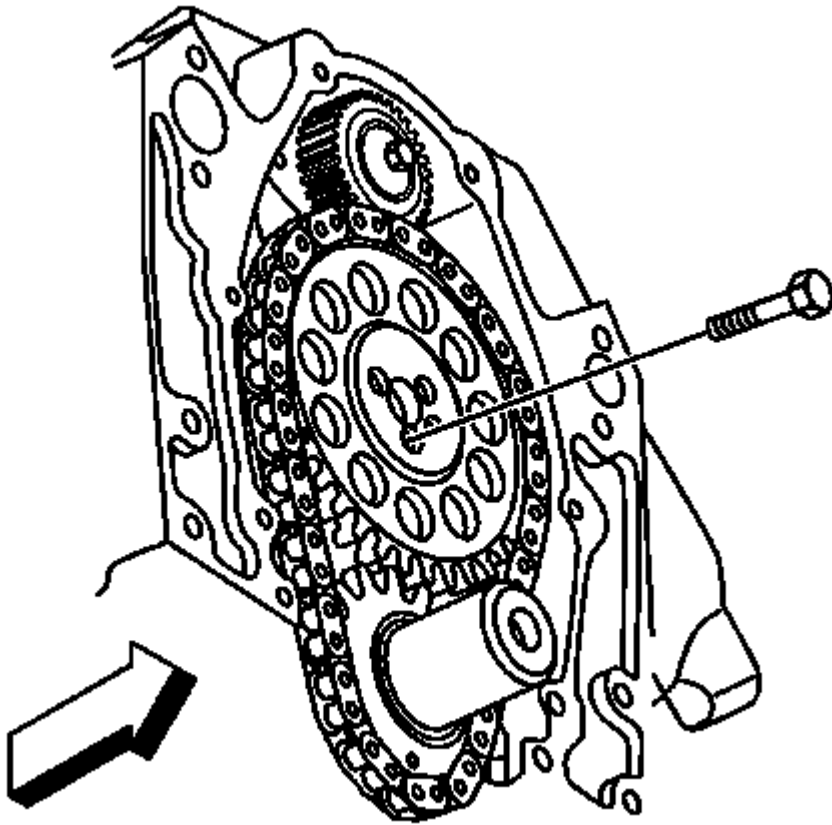


Fig. 195: Identifying Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use a hammer to install the camshaft sprocket onto the camshaft. To do so may dislodge the expansion cup plug.

7. Insert the camshaft timing chain sprocket into the timing chain and position so when the camshaft timing chain sprocket is installed on the camshaft, the camshaft timing marks will line up.
8. Install the camshaft sprocket bolts and tighten to 25 N.m (18 lb ft).

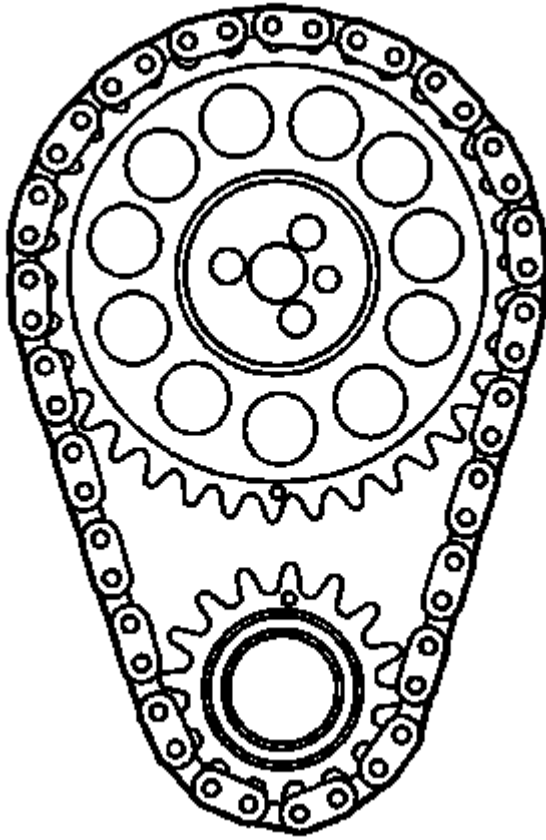


Fig. 196: View Of Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

9. Ensure that the crankshaft sprocket is aligned at the 12 o'clock position and camshaft sprocket is aligned at the 6 o'clock position.
10. Remove the bolt that was installed in the end of the crankshaft.
11. Install the CKP sensor reluctor ring. Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**.

BALANCE SHAFT REPLACEMENT

SPECIAL TOOLS

- **J 8092** Driver Handle
- **J 36996** Balance Shaft Installer. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

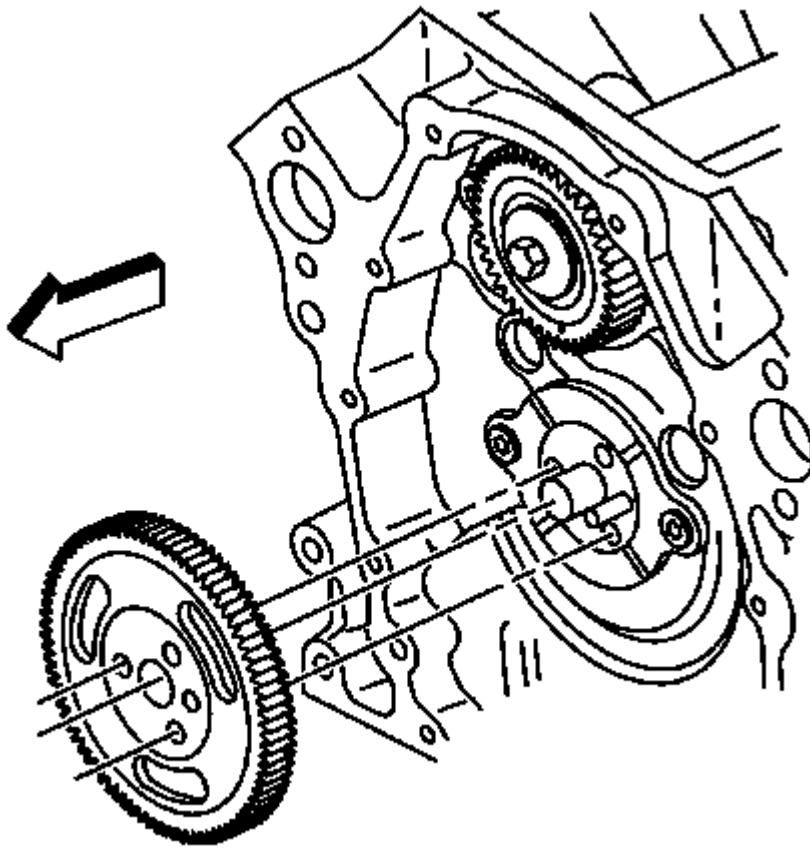


Fig. 197: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

1. Remove the lifter pushrod guide. Refer to **Valve Lifter Replacement**.
2. Remove the timing chain and camshaft sprocket. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.
3. Remove the balance shaft drive gear.

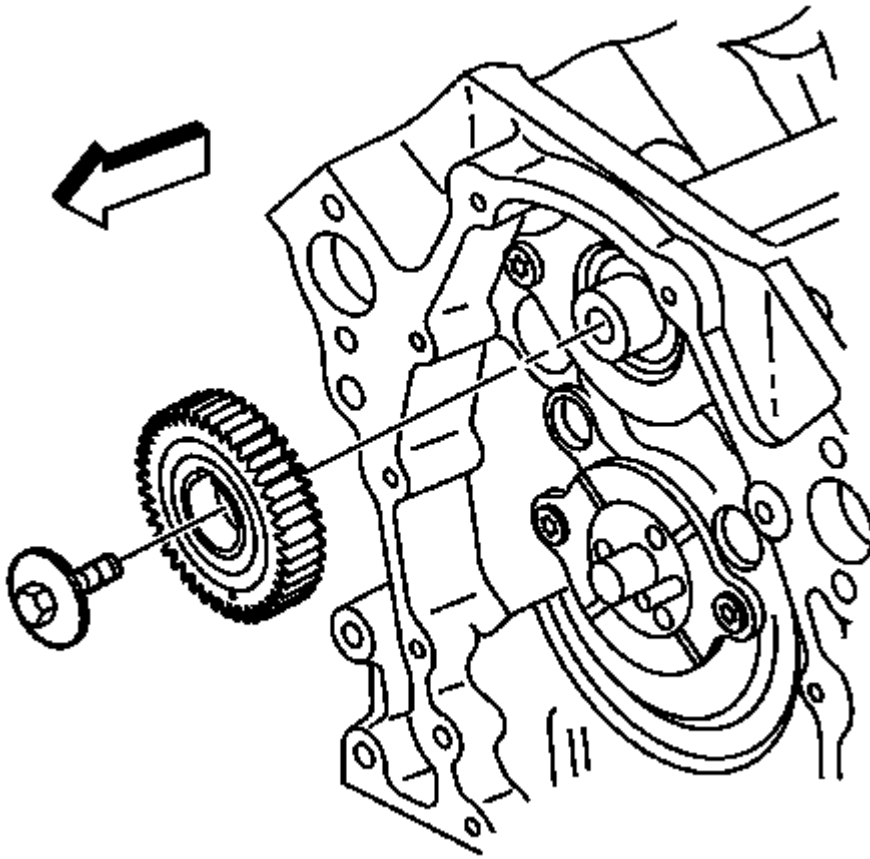


Fig. 198: Locating Balance Shaft Driven Gear
Courtesy of GENERAL MOTORS CORP.

4. Remove the balance shaft driven gear bolt.
 1. Use a wrench in order to secure the balance shaft.

Place the wrench onto the balance shaft near to the balance shaft front bearing.

2. Remove the balance shaft bolt.
 3. Remove the wrench from the balance shaft.
5. Remove the balance shaft driven gear.

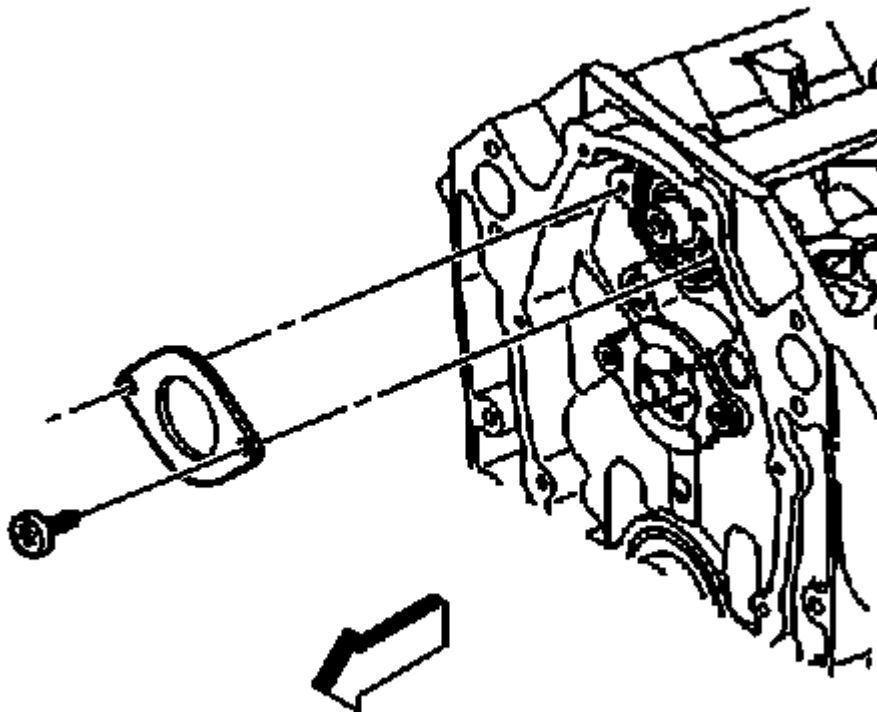


Fig. 199: View of Balance Shaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the balance shaft retainer bolts and retainer.

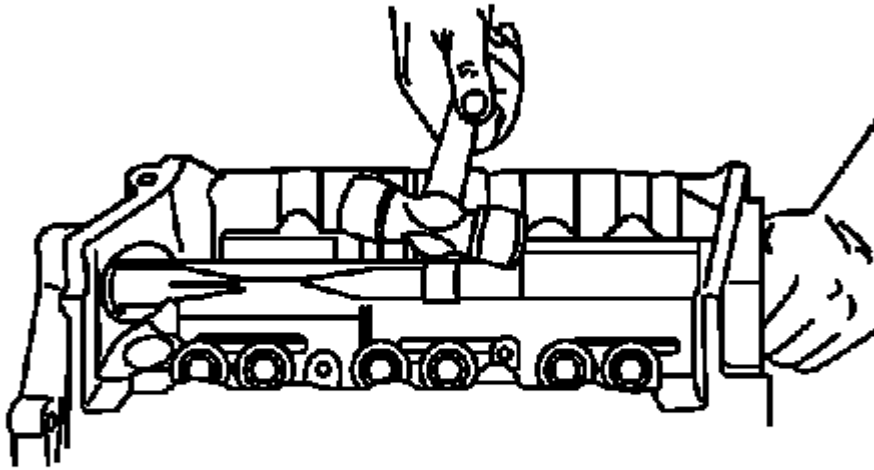


Fig. 200: Identifying Balance Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: The balance shaft and the balance shaft front bearing are serviced only as a package. Do not remove the balance shaft front bearing from the balance shaft.

7. Use a soft-faced hammer in order to remove the balance shaft from the engine block.
8. Clean and inspect the balance shaft, if necessary. Refer to **Balance Shaft Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: The balance shaft drive and balance shaft driven gears are serviced as a set. The set includes the balance shaft driven gear bolt.

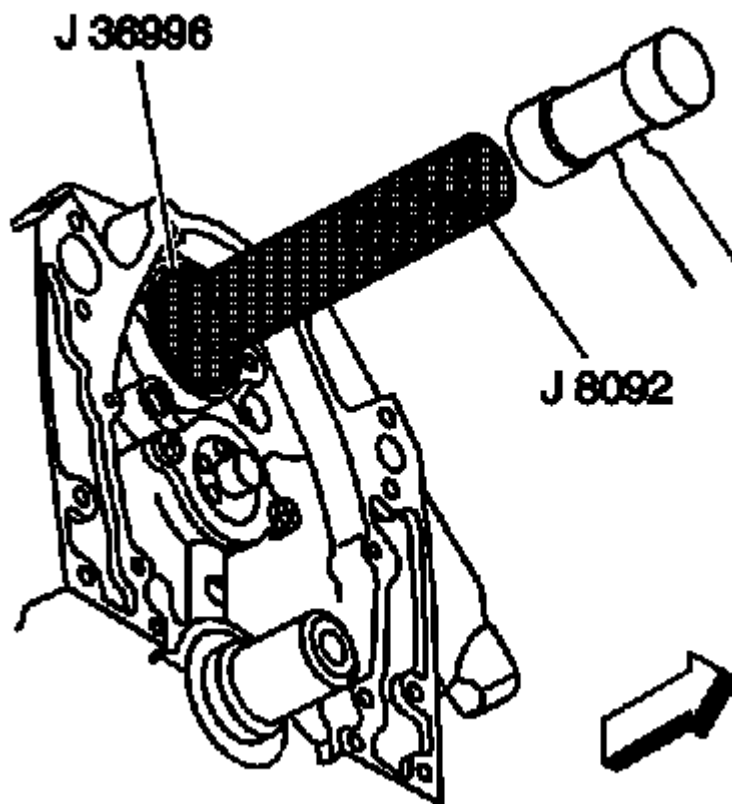


Fig. 201: View Of Balance Shaft & Special Tool J 36996
Courtesy of GENERAL MOTORS CORP.

1. Apply clean engine oil to the balance shaft front bearing.
2. Using **J 36996** and **J 8092** , install the balance shaft. See **Special Tools** .

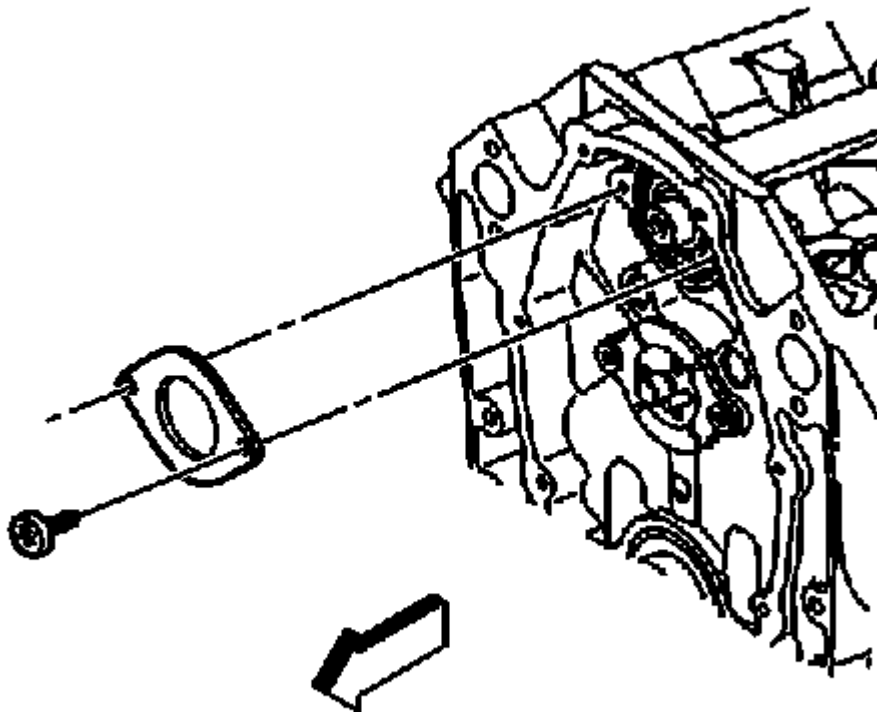


Fig. 202: View of Balance Shaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the balance shaft retainer and bolts and tighten to 12 N.m (106 lb in).

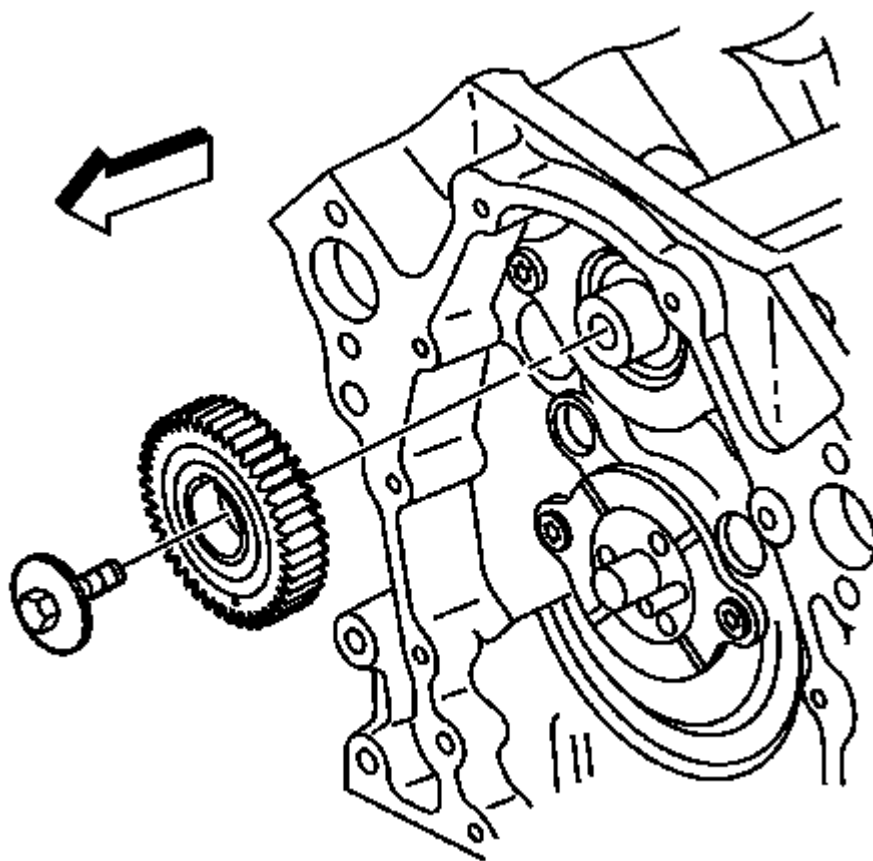


Fig. 203: Locating Balance Shaft Driven Gear
Courtesy of GENERAL MOTORS CORP.

4. Install the balance shaft driven gear.
5. If reusing the fastener, apply threadlocker to the threads of the balance shaft driven gear bolt. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Install the balance shaft driven gear bolt.
 1. Use a wrench to secure the balance shaft.

Place the wrench onto the balance shaft near to the balance shaft front bearing.

2. Install the balance shaft driven gear bolt.
 1. Tighten the bolt a first pass to 20 N.m (15 lb ft).
 2. Tighten the bolt a final pass an additional 35 degrees using **J 45059**
7. Remove the wrench from the balance shaft.
8. Rotate the balance shaft by hand in order to ensure that there is clearance between the balance shaft and the valve lifter pushrod guide. If the balance shaft does not rotate freely, check to ensure that the retaining ring on the balance shaft front bearing is seated on the case.

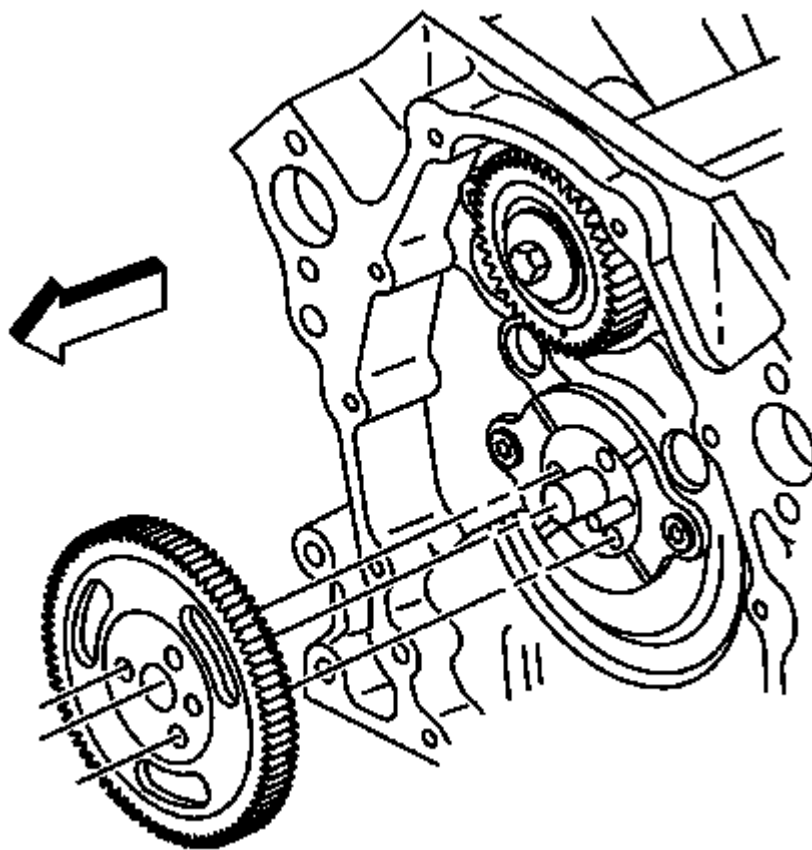


Fig. 204: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

9. Install the balance shaft drive gear. DO NOT install the camshaft sprocket bolts at this time.

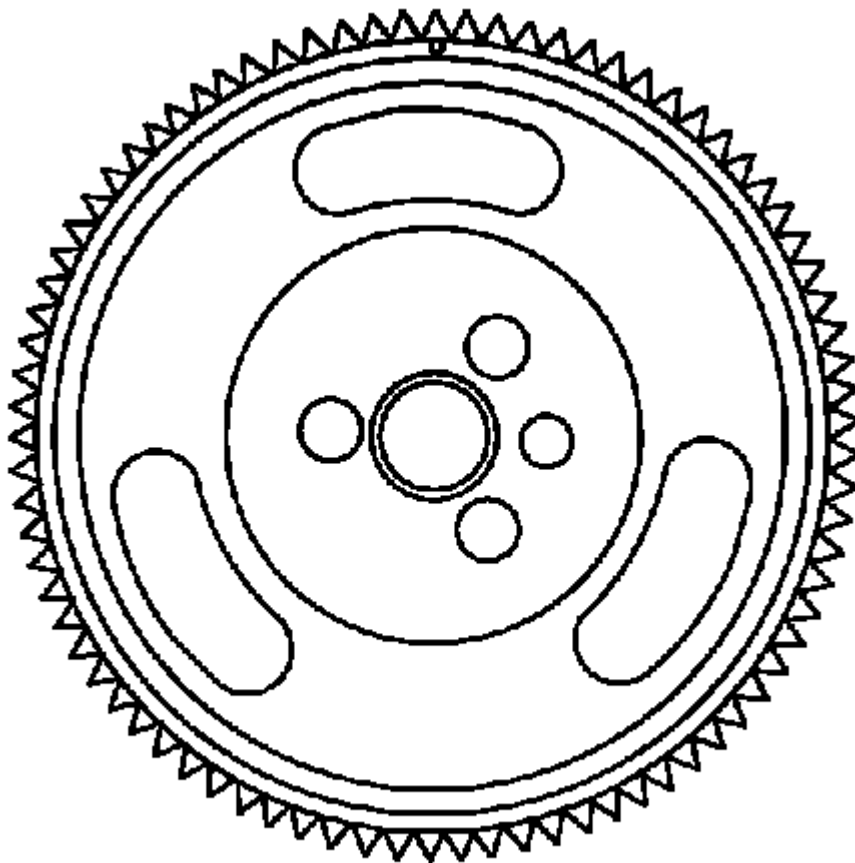


Fig. 205: Identifying Balance Shaft Drive Gear Camshaft Timing Mark
Courtesy of GENERAL MOTORS CORP.

10. Rotate the camshaft so that the timing mark on the balance shaft drive gear is in the 12 o'clock position.

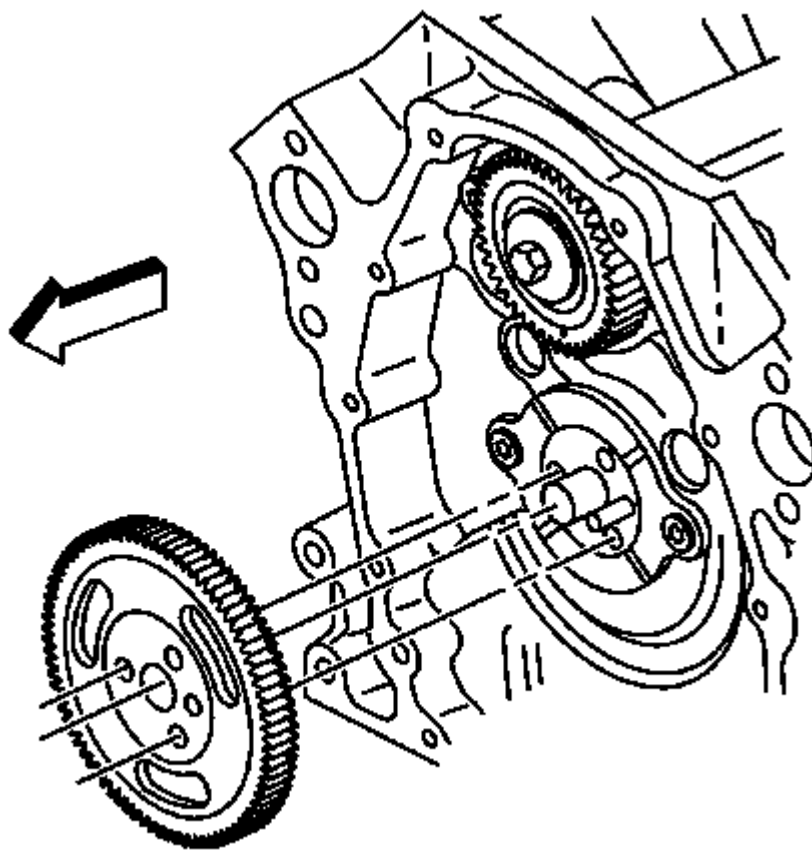


Fig. 206: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

11. Remove the balance shaft drive gear.

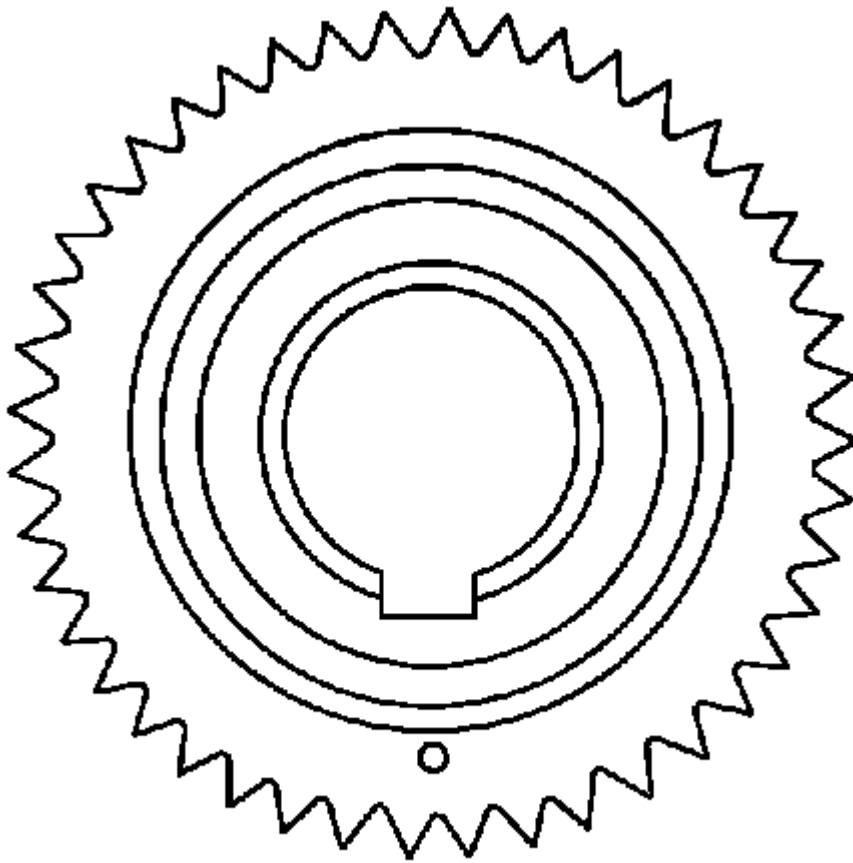


Fig. 207: View Of Balance Shaft Driven Gear & Timing Mark
Courtesy of GENERAL MOTORS CORP.

12. Rotate the balance shaft so that the timing mark on the balance shaft driven gear is in the 6 o'clock position.

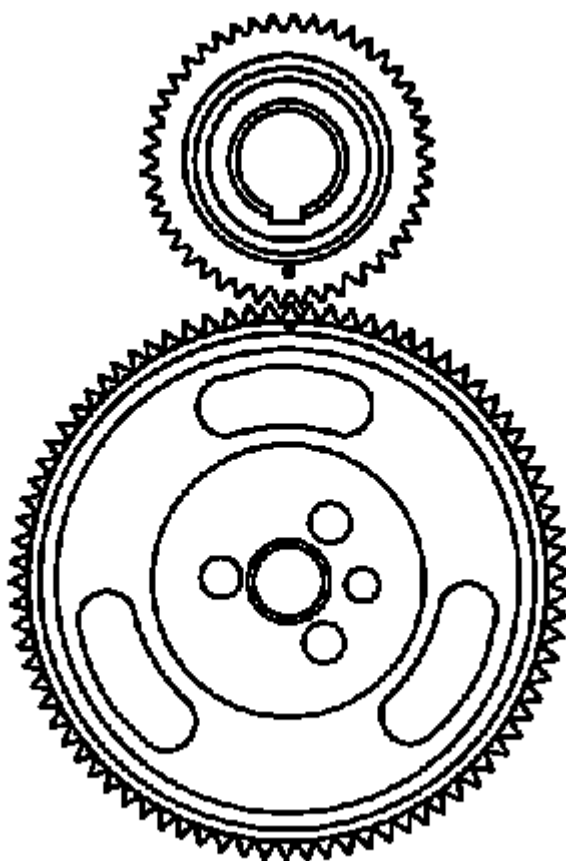


Fig. 208: View Of Balance Shaft Drive Gear & Balance Shaft Driven Gear Timing Marks Aligned
Courtesy of GENERAL MOTORS CORP.

13. Position the balance shaft drive gear onto the engine camshaft.
14. Look to ensure that the balance shaft drive gear and the balance shaft driven gear timing marks are aligned.
15. Install the timing chain and the camshaft sprocket. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.
16. Install the valve lifter pushrod guide. Refer to **Valve Lifter Replacement**.

BALANCER SHAFT FRONT BEARING AND REAR BEARING REPLACEMENT

TOOLS REQUIRED

- **J 26941** Bushing and Bearing Remover. See **Special Tools** .
- **J 38834** Balance Shaft Service Kit. See **Special Tools** .

REMOVAL PROCEDURE

IMPORTANT: The balance shaft and the front bearing are serviced only as a package. Do not remove the bearing from the balance shaft.

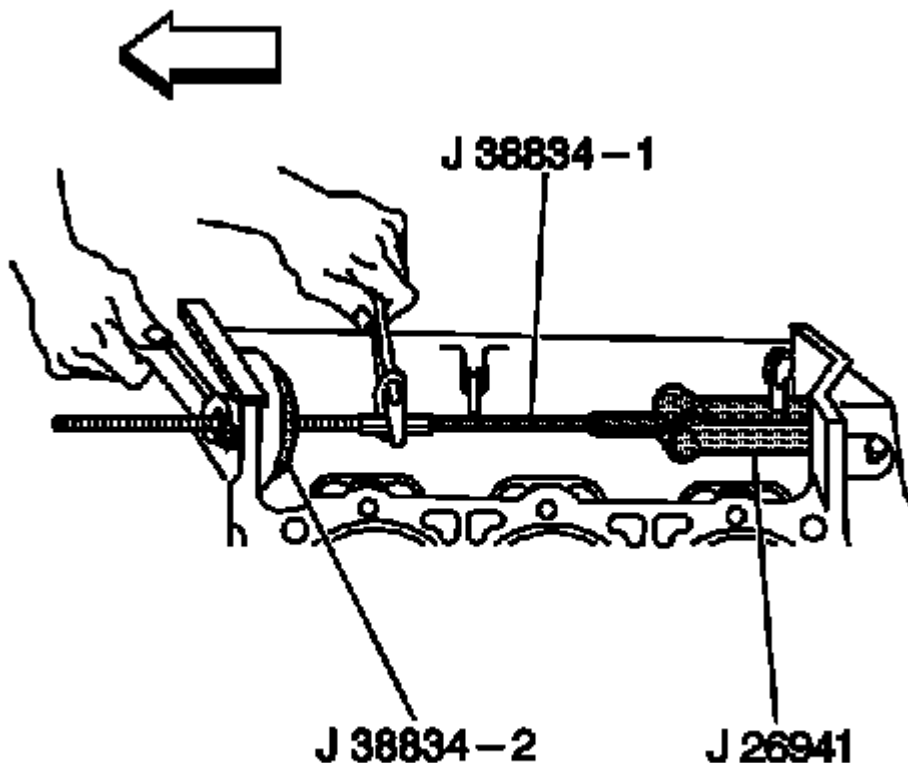


Fig. 209: View Of Balance Shaft Rear Bearing
Courtesy of GENERAL MOTORS CORP.

1. Remove the balance shaft. Refer to **Balance Shaft Replacement**.
2. Using **J 26941** and the **J 38834** , remove the balance shaft rear bearing. See **Special Tools** .
 1. Install the **J 26941** legs behind the balance shaft rear bearing and secure. See **Special Tools** .
 2. Install the **J 38834-1** with the short threaded end through the balance shaft bore in the front of the engine block.
 3. Install **J 38834-1** into the **J 26941** . See **Special Tools** .
 4. Slide the **J 38834-2** onto the **J 38834-1** and into the balance shaft bore of the engine block.
 5. Install the **J 38834** bearing, washer, and nut onto the **J 38834-1**. See **Special Tools** .
 6. Using a wrench, secure the **J 38834-1**, and then rotate the **J 38834** nut clockwise until the balance shaft rear bearing is removed from the engine block. See **Special Tools** .
 7. Remove the **J 26941** from the balance shaft rear bearing. See **Special Tools** .
3. Discard the balance shaft rear bearing.

INSTALLATION PROCEDURE

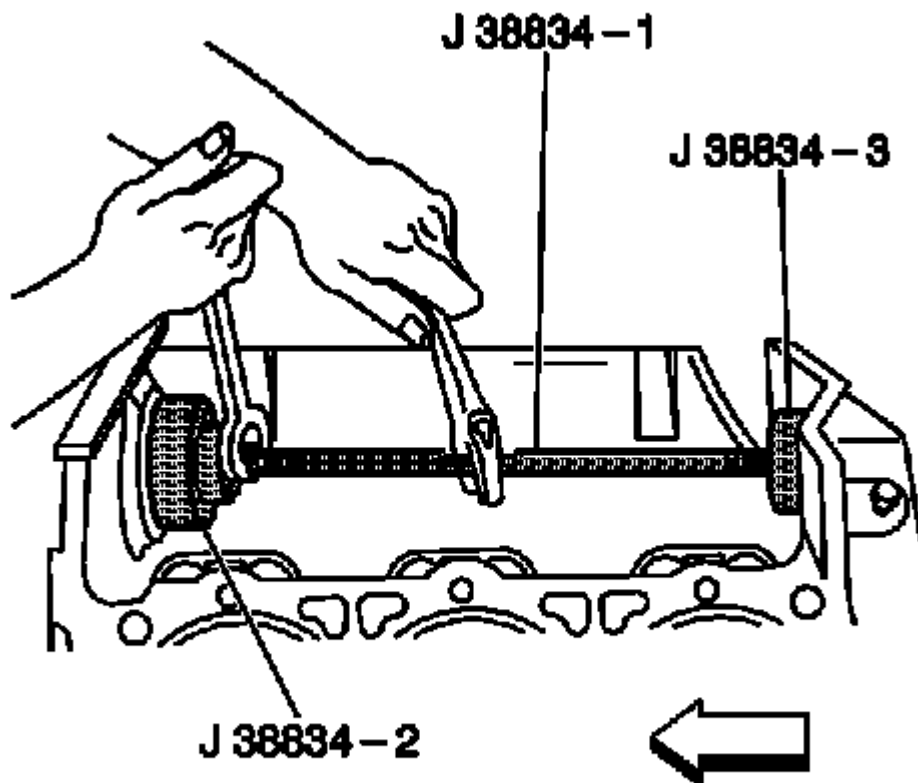


Fig. 210: Identifying Special Tool J 38834 Components
Courtesy of GENERAL MOTORS CORP.

1. Using **J 38834** , install the balance shaft rear bearing. See **Special Tools** .
 1. Install the J 38834-3 onto the short threaded end of the J 38834-1.
 2. Install the **J 38834** nut, the washer, and the bearing on the long threaded end of the J 38834-1. See **Special Tools** .
 3. Install the J 38834-2 onto the J 38834-1 so that the smaller diameter of the J 38834-2 will be facing the front of the engine block.
 4. Install the J 38834-2 on the inside of the balance shaft front bearing bore.
 5. Lubricate the NEW balance shaft rear bearing with clean engine oil.
 6. Install the balance shaft rear bearing onto the J 38834-2.
 7. Align the balance shaft rear bearing for installation.
 8. Using a wrench, secure the J 38834-1 into place.
 9. Rotate the **J 38834** nut until the balance shaft rear bearing is properly and completely pushed into the balance shaft rear bearing bore. See **Special Tools** .

2. Remove the **J 38834** . See **Special Tools** .
3. Install the balance shaft. Refer to **Balance Shaft Replacement**.

CAMSHAFT REPLACEMENT

REMOVAL PROCEDURE

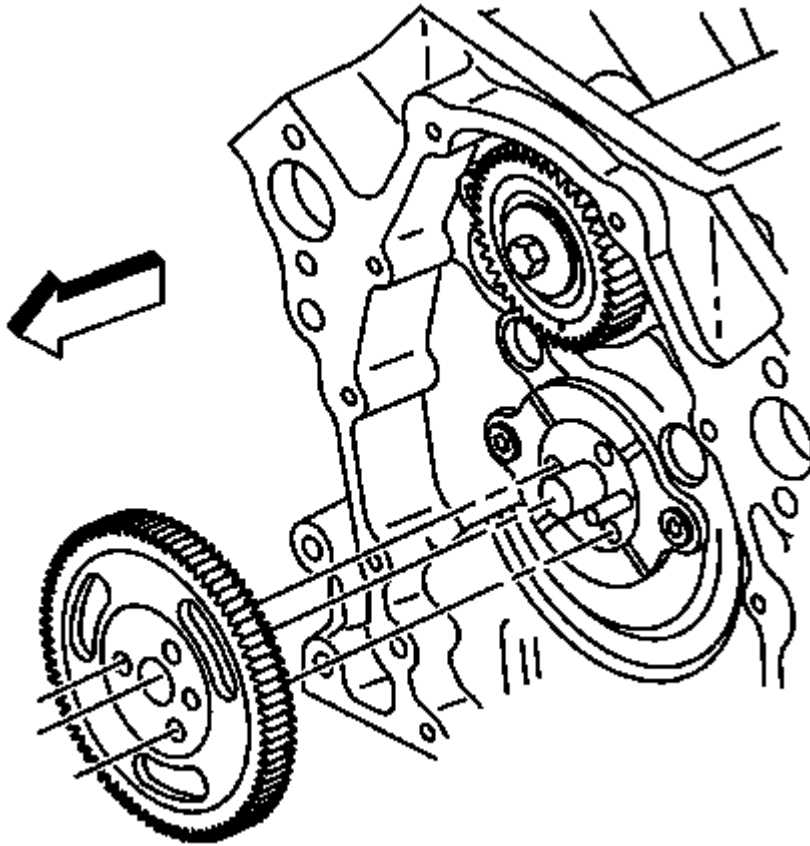


Fig. 211: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

1. Remove the lifters. Refer to **Valve Lifter Replacement**.
2. Remove the timing chain and the camshaft sprocket. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.
3. Remove the balance shaft drive gear.

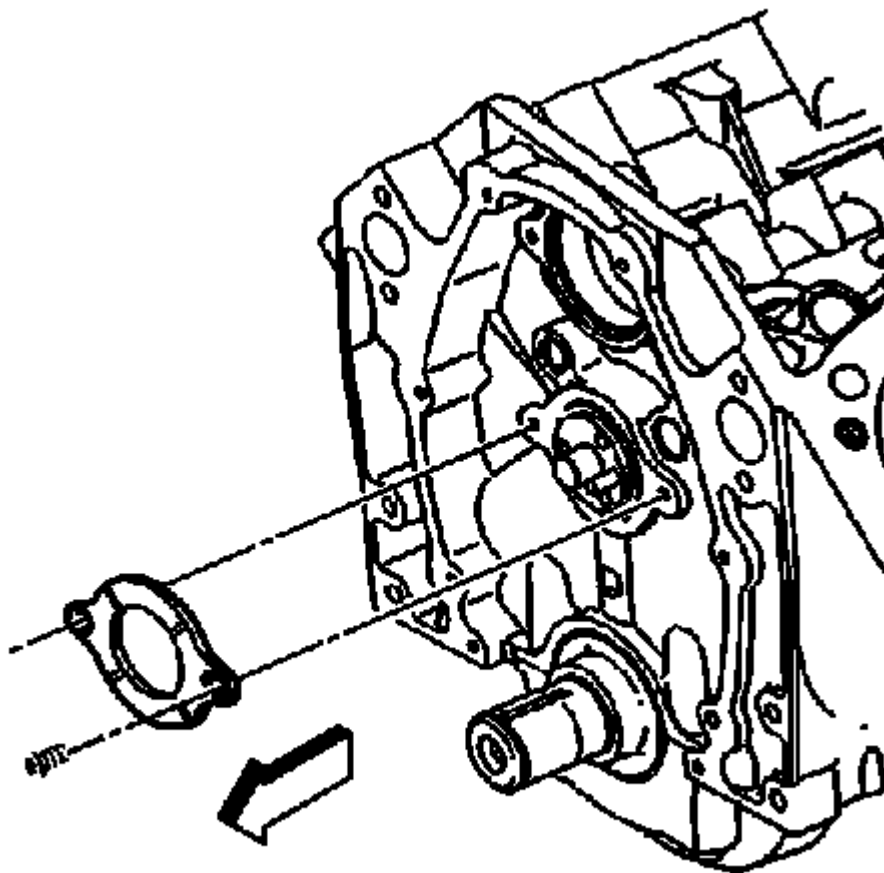


Fig. 212: View Of Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft retainer bolts and retainer.

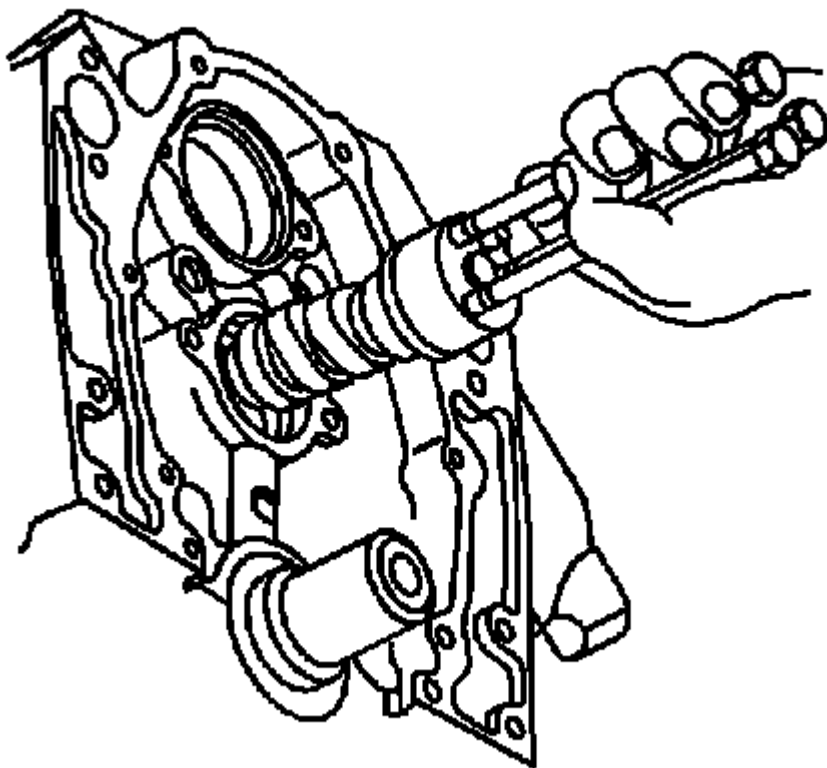


Fig. 213: Identifying Engine Camshaft Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

5. Remove the engine camshaft.
 1. Install the three 5/16-18 x 4.0 inch bolts into the engine camshaft front bolt holes.
 2. Using the bolts as a handle, carefully rotate and pull the engine camshaft out of the camshaft bearings.
 3. Remove the bolts from the front of the engine camshaft.
 4. Clean and inspect the camshaft and/or bearings, if necessary. Refer to **Camshaft and Bearings Cleaning and Inspection** .

INSTALLATION PROCEDURE

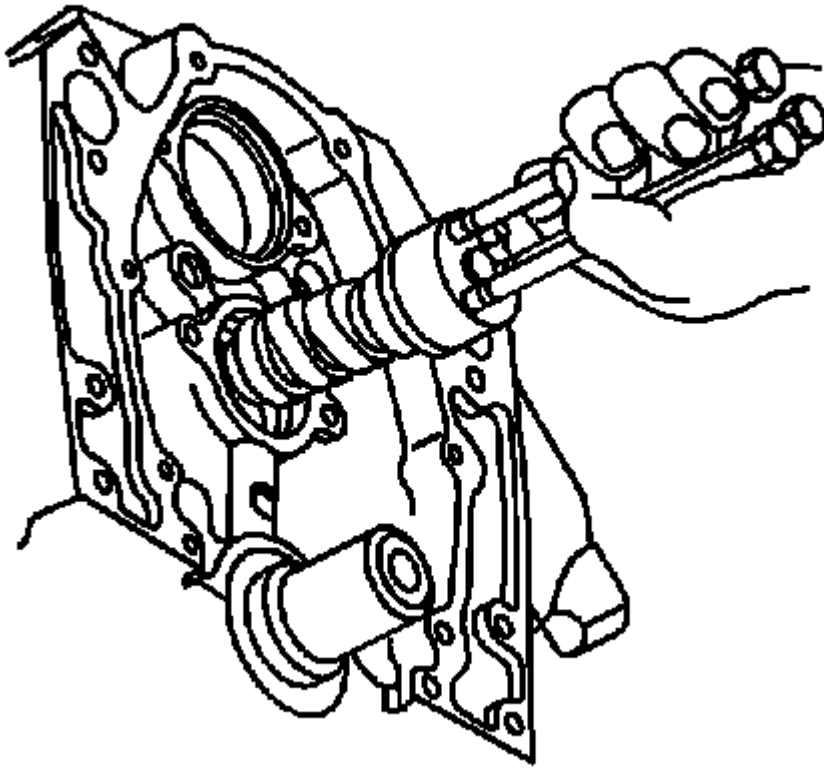


Fig. 214: Identifying Engine Camshaft Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Whenever a new camshaft is installed, perform the following:

- Change the engine oil and filter.
- Add engine oil supplement to the engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number.

1. Apply lubricant or engine oil supplement to the following components:

- The engine camshaft lobes
- The camshaft bearing journals
- The camshaft bearings

Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number.

2. Install three 5/16-18 x 4.0 inch bolts into the engine camshaft front bolt holes.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft

bearings.

3. Using the bolts as a handle, install the engine camshaft.
4. Remove the 3 bolts from the front of the engine camshaft.

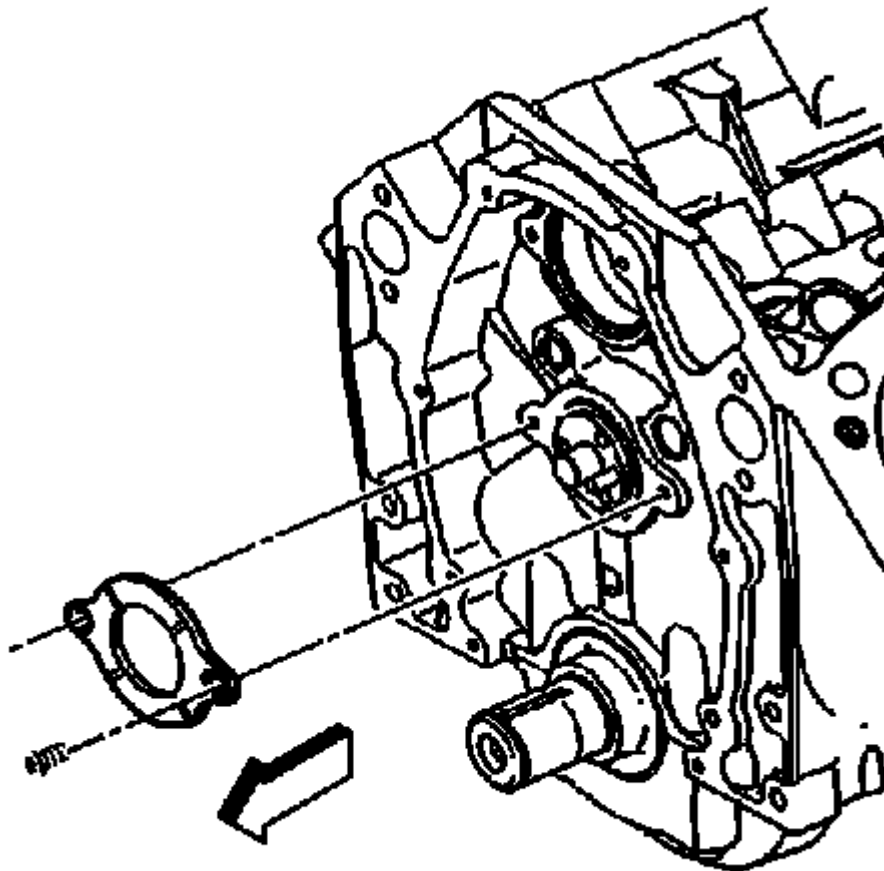


Fig. 215: View Of Camshaft Retainer & Bolts

Courtesy of GENERAL MOTORS CORP.

5. If reusing the fasteners, apply threadlocker to the threads of the camshaft retainer bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

6. Install the camshaft retainer and bolts and tighten to 12 N.m (106 lb in).
7. Install the balance shaft drive gear. Refer to **Balance Shaft Installation** , for alignment of the balance shaft drive gear and the driven gear.
8. Install the timing chain and camshaft sprocket. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Replacement**.

9. Install the lifters. Refer to Valve Lifter Replacement.

OIL FILTER ADAPTER REPLACEMENT (WITH ENGINE OIL COOLER)

REMOVAL PROCEDURE

1. Raise the vehicle. Refer to Lifting and Jacking the Vehicle.
2. Position a suitable container to catch the engine oil.
3. Remove the engine oil filter.
4. Disconnect the engine oil cooler hoses from the oil filter adapter. Refer to Engine Oil Cooler Hose/Pipe Replacement (LU3).

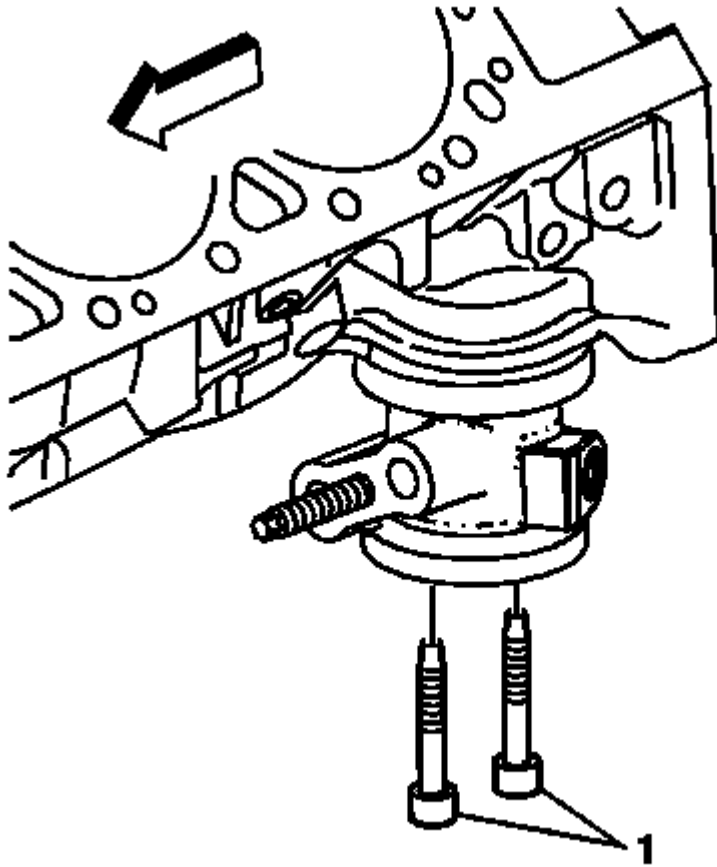


Fig. 216: Identifying Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil filter adapter bolts (1).

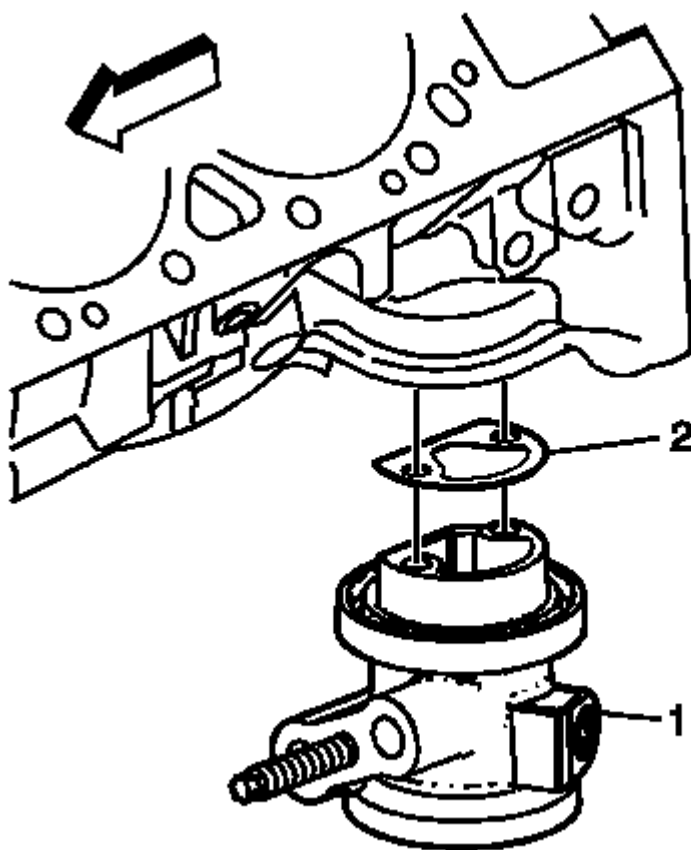


Fig. 217: Identifying Oil Filter Adapter And Oil Filter Adapter Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil filter adapter (1) and the oil filter adapter gasket (2).
7. Discard the oil filter adapter gasket.

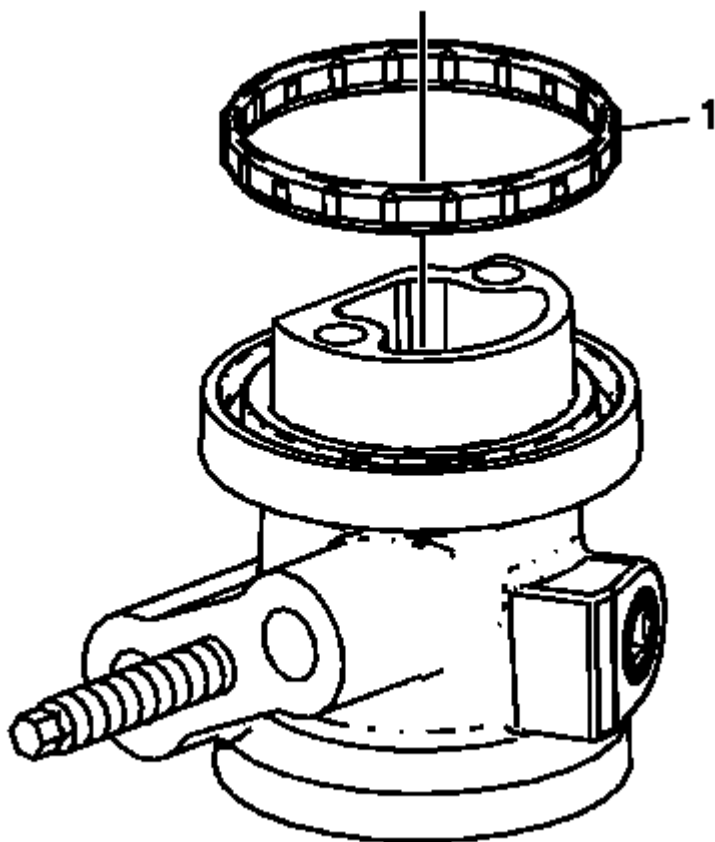


Fig. 218: Identifying Oil Filter Adapter Seal O-Ring
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the oil filter adapter seal, O-ring (1).

INSTALLATION PROCEDURE

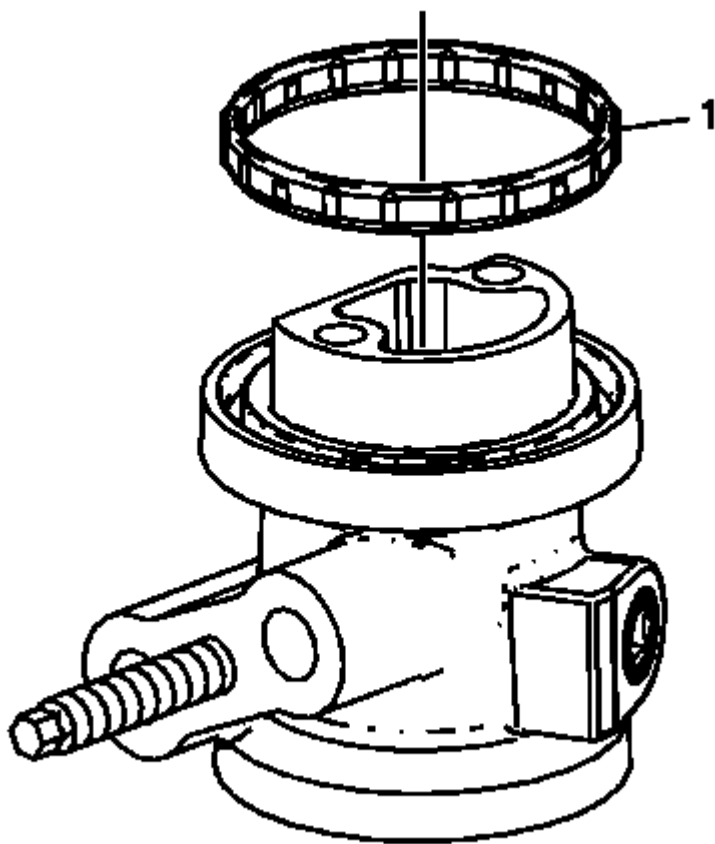


Fig. 219: Identifying Oil Filter Adapter Seal O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW oil filter adapter O-ring seal (1) into the groove in the oil filter adapter.

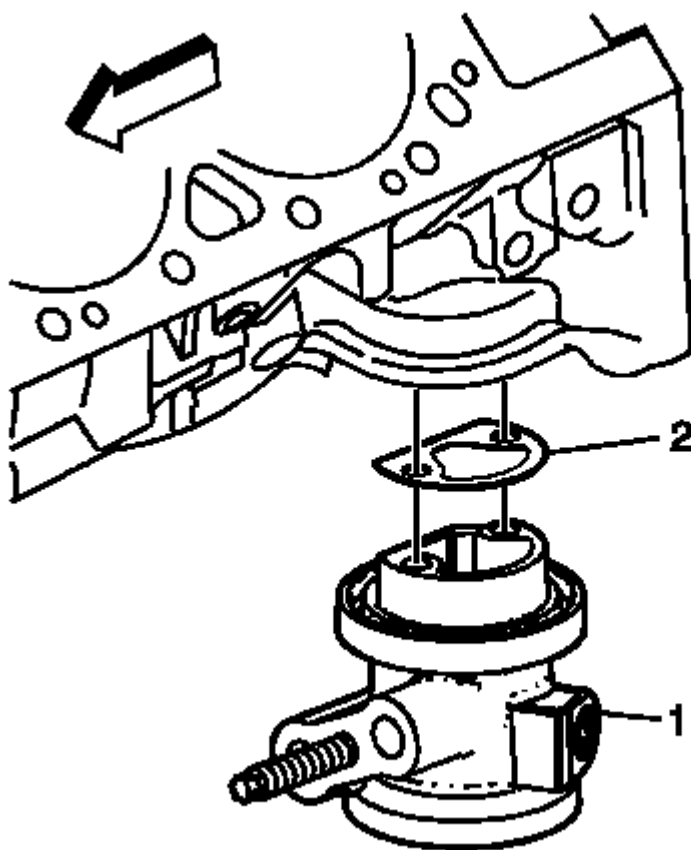


Fig. 220: Identifying Oil Filter Adapter And Oil Filter Adapter Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter adapter (1) and NEW oil filter adapter gasket (2).

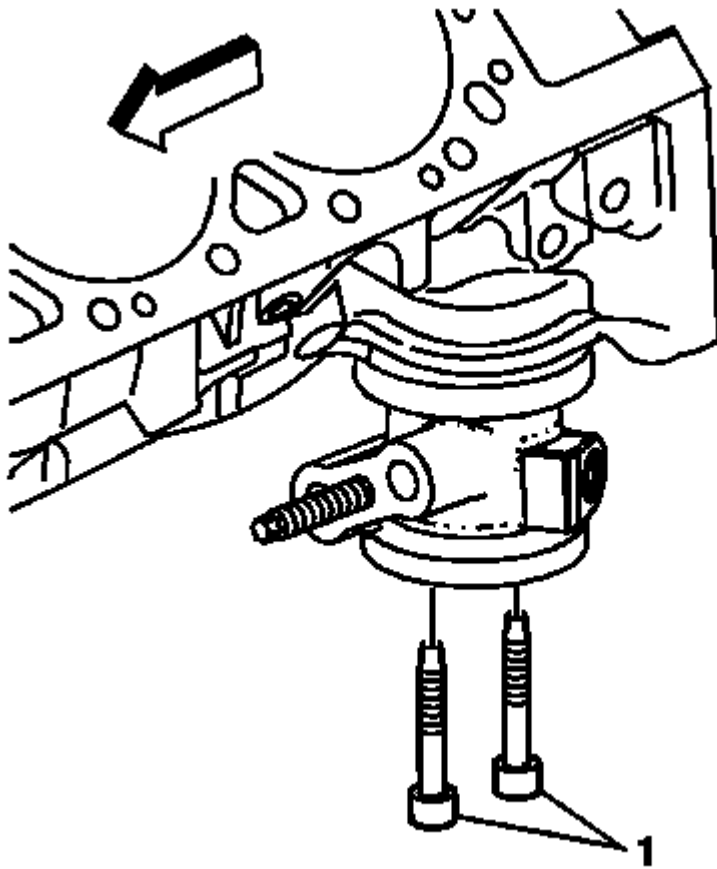


Fig. 221: Identifying Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the oil filter adapter bolts (1) and tighten to 21 N.m (15 lb ft).
4. Connect the engine oil cooler hoses to the oil filter adapter. Refer to Engine Oil Cooler Hose/Pipe Replacement (LU3) .
5. Install the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.
6. Lower the vehicle.
7. Operate the engine and check for leaks.
8. Inspect the engine oil level and fill to the proper level,

OIL FILTER ADAPTER REPLACEMENT (W/O ENGINE OIL COOLER)

REMOVAL PROCEDURE

1. Raise and suitably support the vehicle. Refer to Lifting and Jacking the Vehicle .

2. Position a suitable container under the vehicle.

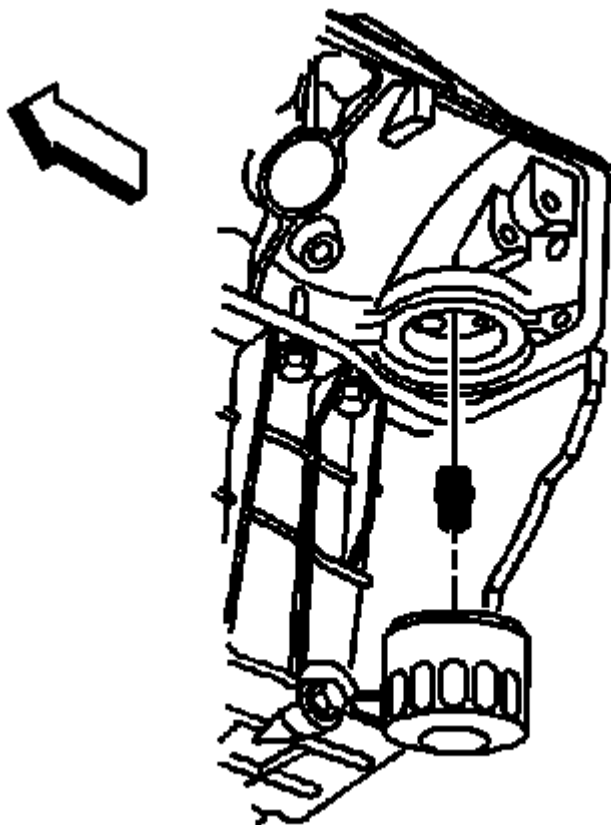


Fig. 222: Identifying Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter.
4. Remove the oil filter adapter.

INSTALLATION PROCEDURE

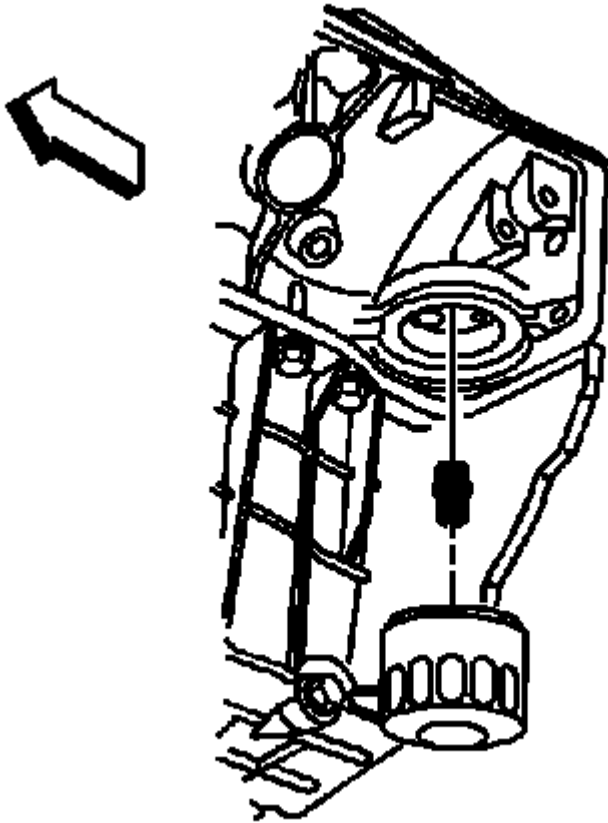


Fig. 223: Identifying Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil filter adapter and tighten to 55 N.m (41 lb ft).
2. Install the oil filter and tighten to 30 N.m (22 lb ft).
3. Lower the vehicle.
4. Start the engine and check for leaks.
5. Fill the engine with the proper quantity and quality of engine oil. Refer to Approximate Fluid Capacities .
6. Shut the engine OFF and check the oil level, add if needed.

OIL FILTER BYPASS VALVE REPLACEMENT

REMOVAL PROCEDURE

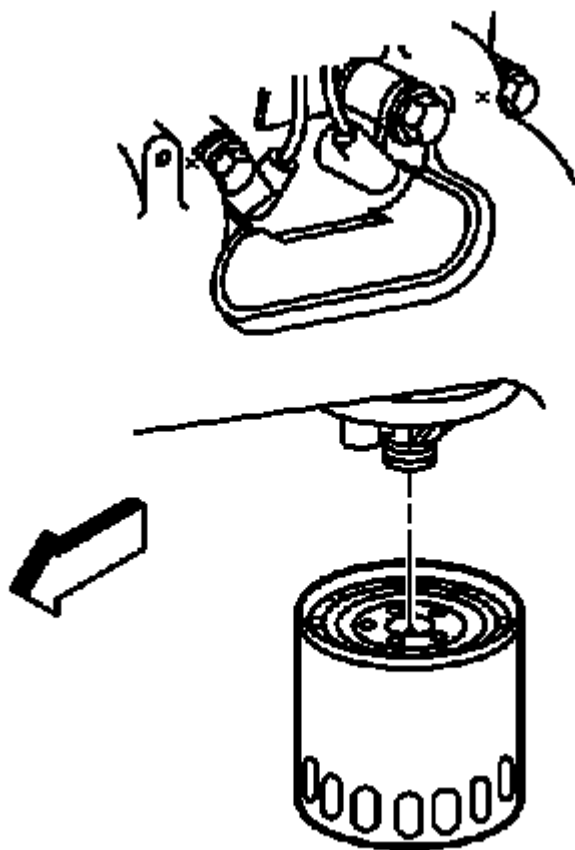


Fig. 224: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position a suitable container under the vehicle to catch the oil.
3. Remove the oil filter.

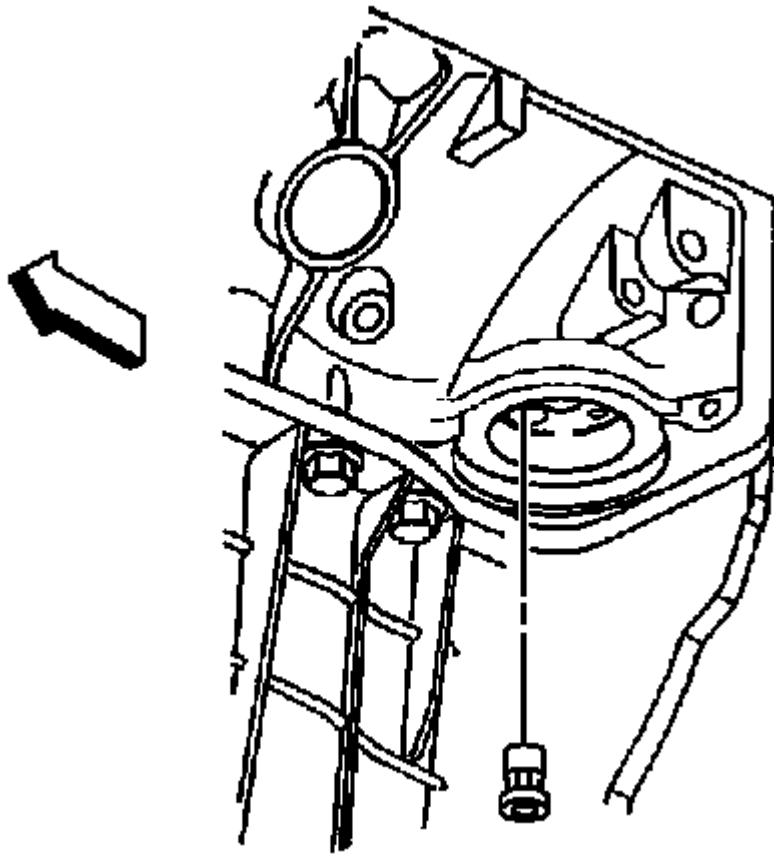


Fig. 225: View Of Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

4. Using a suitable prying tool, remove the oil filter bypass valve.
5. Clean and inspect the valve bore for damage.

INSTALLATION PROCEDURE

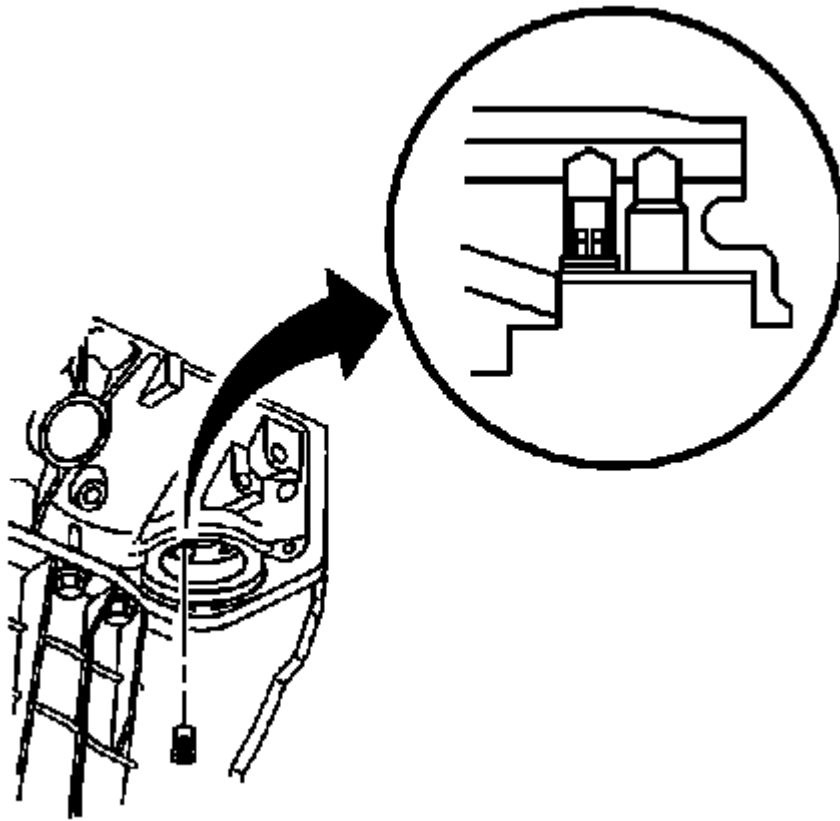


Fig. 226: Identifying Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil filter bypass valve using the following procedure:
 1. Use a brass drift that is the same diameter as the outside diameter of the oil filter bypass valve.
 2. Install the oil filter bypass valve into the oil gallery bore until slightly below flush with the surface of the engine block.
 3. Using a pointed punch, stake the engine block area around the oil filter bypass valve.

Stake in 3 locations 120 degrees apart.

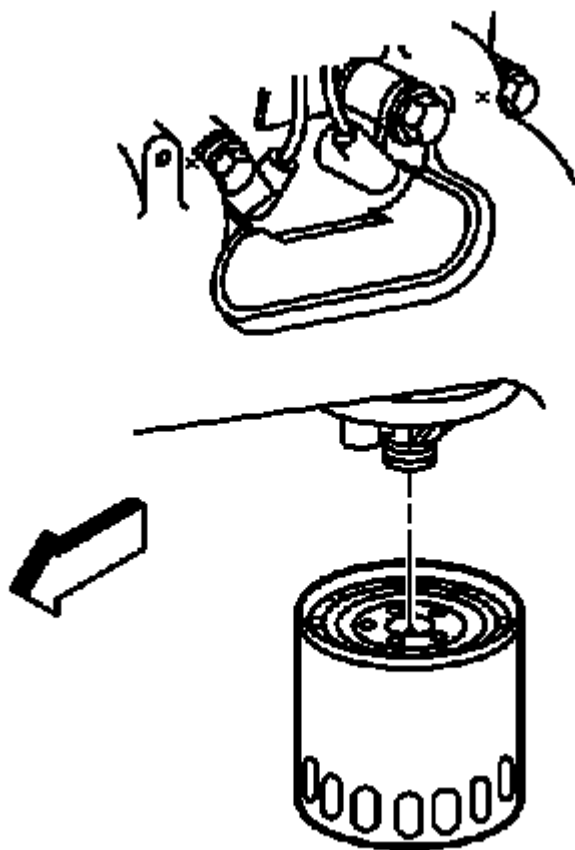


Fig. 227: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
3. Lower the vehicle.

OIL PAN REPLACEMENT

REMOVAL PROCEDURE

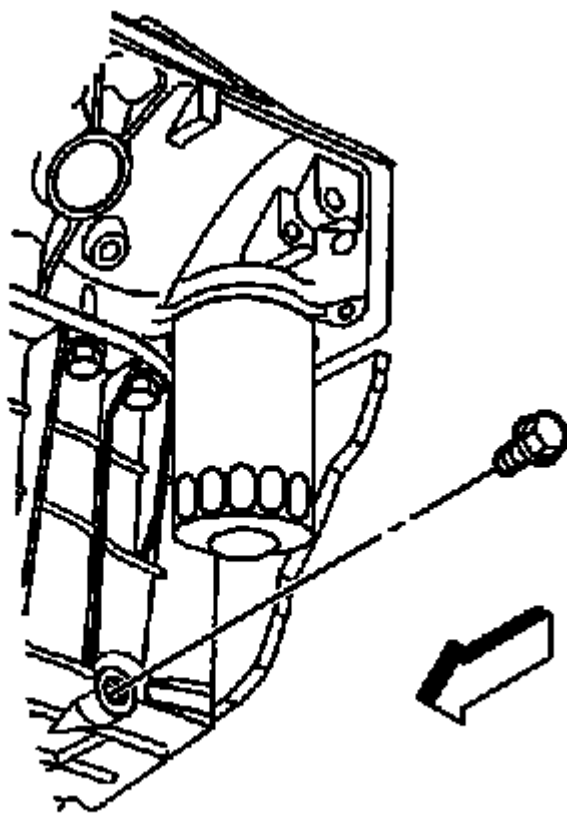


Fig. 228: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the drain plug and drain the oil into a suitable container.

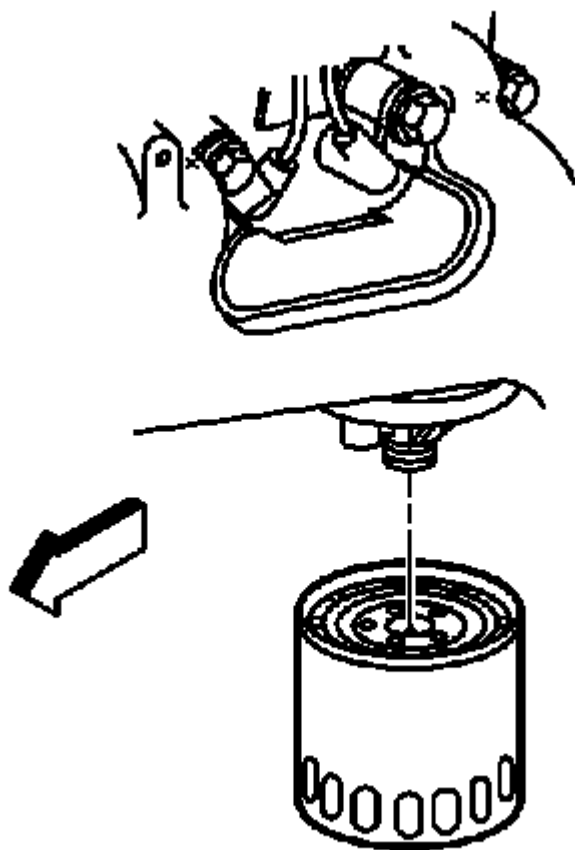


Fig. 229: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter.

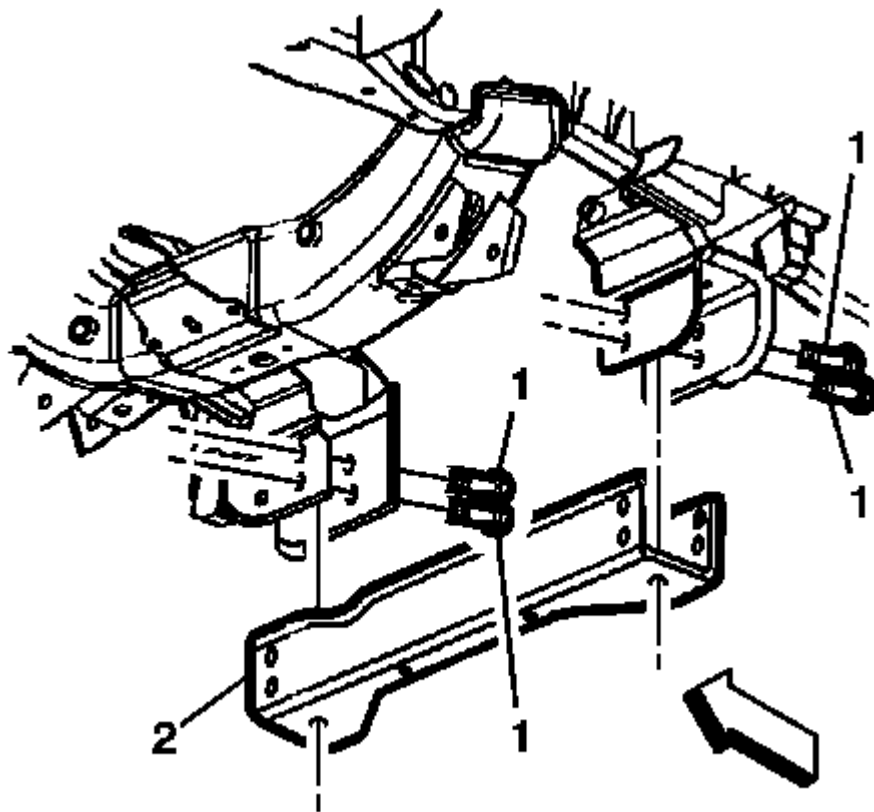


Fig. 230: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

4. Remove the crossmember bolts and bar.

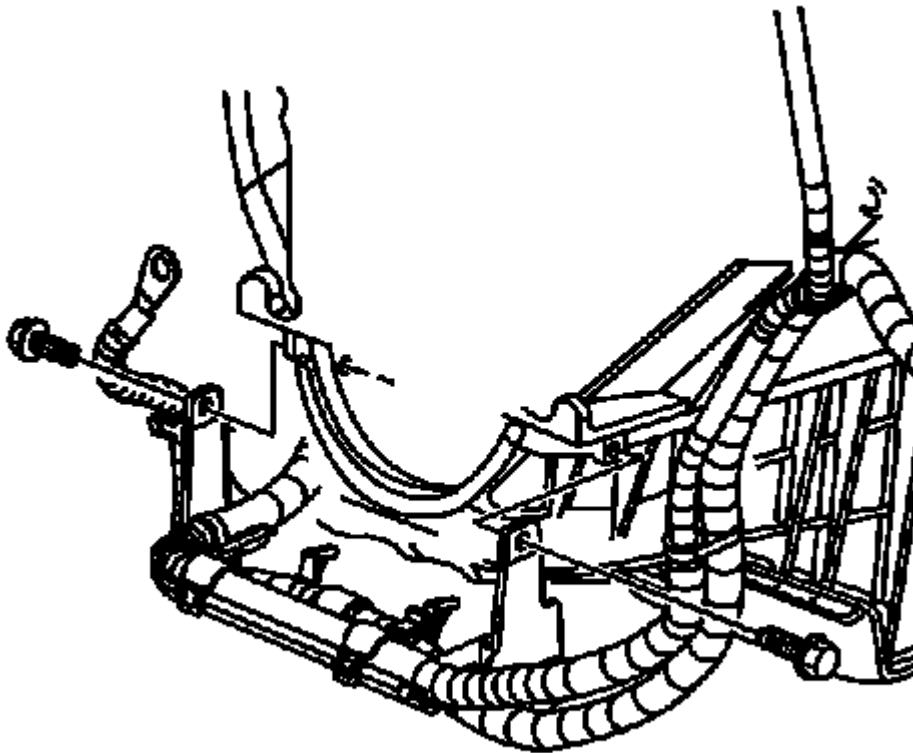


Fig. 231: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine harness bracket bolts.
6. Remove the starter. Refer to **Starter Replacement (V6)** .

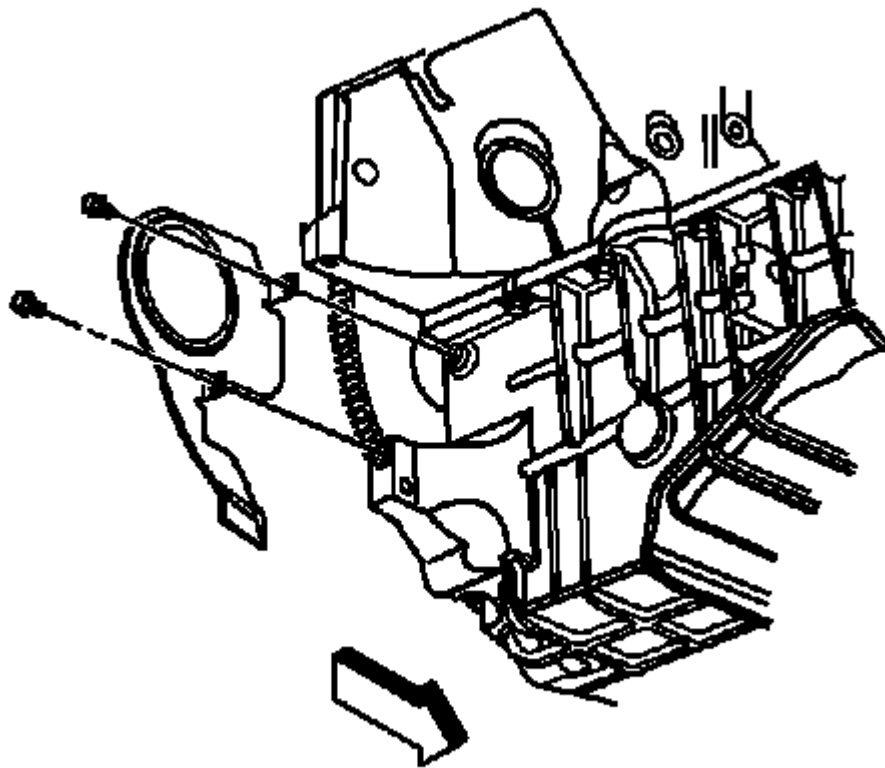


Fig. 232: View Of Transmission Cover
Courtesy of GENERAL MOTORS CORP.

7. Remove the transmission cover.

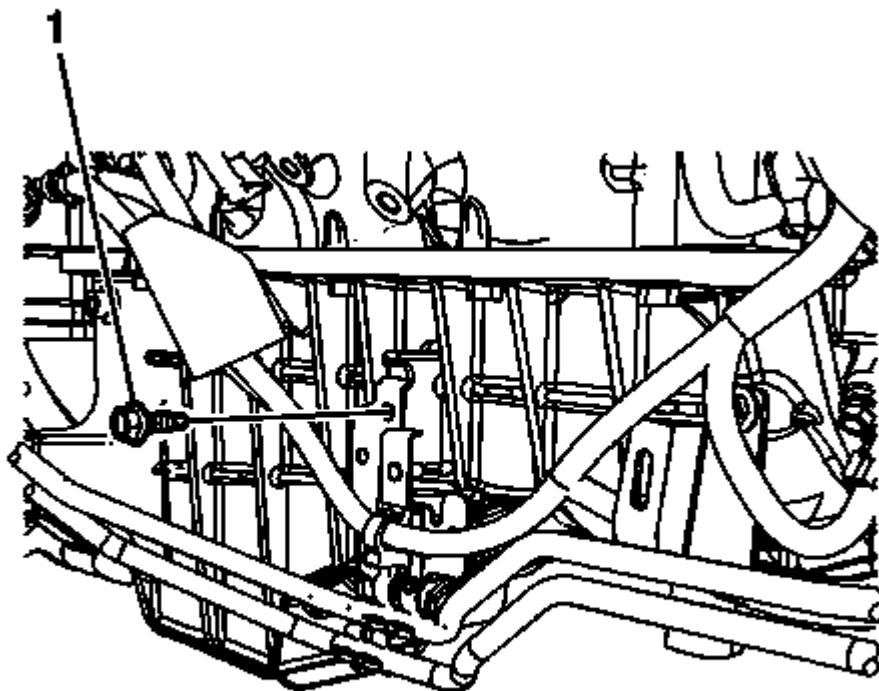


Fig. 233: View Of Transmission Tube Bracket
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine harness and transmission tube bracket (1).

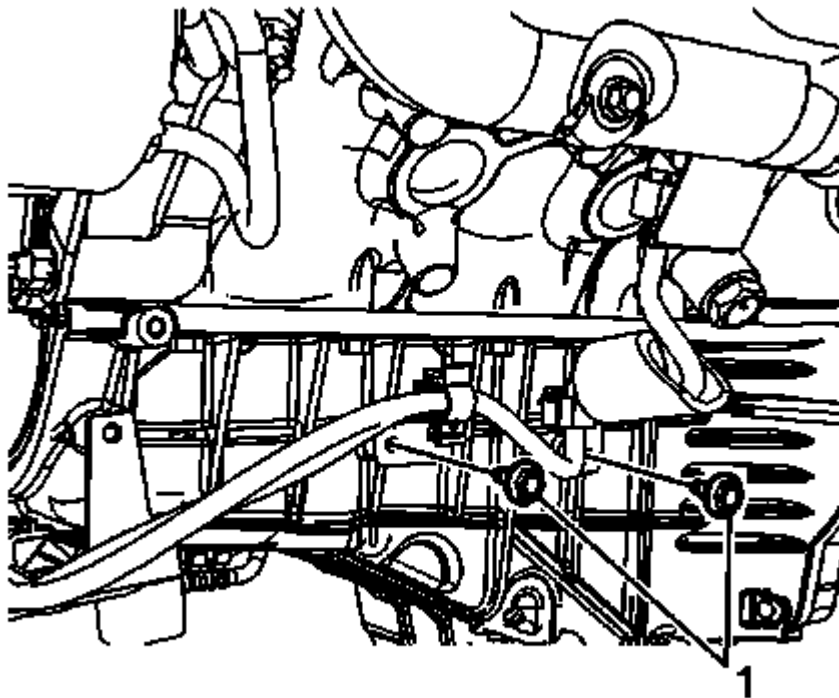


Fig. 234: Identifying Engine Wire Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove two engine wire harness bracket bolts (1).

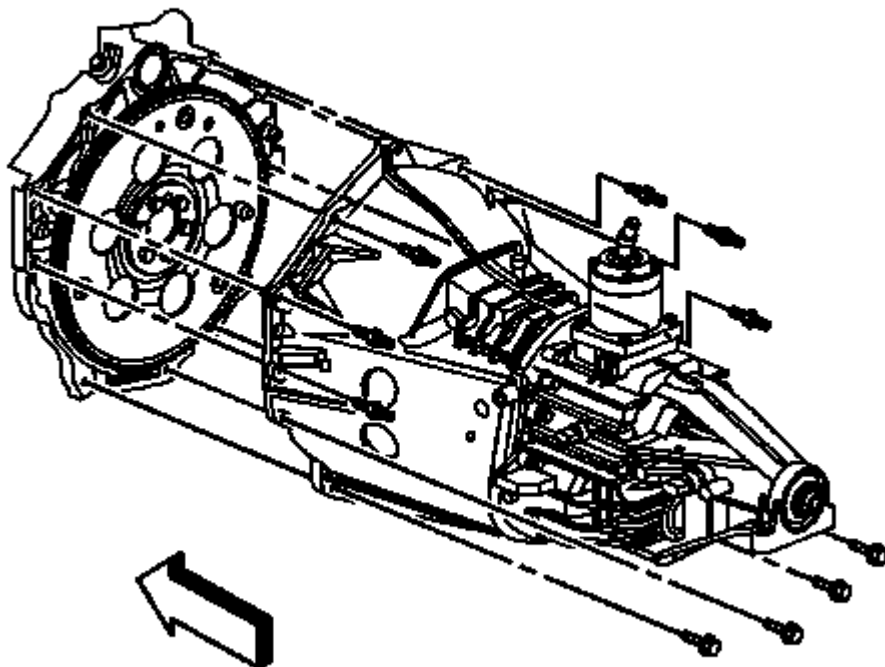


Fig. 235: Identifying Manual Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the manual transmission bolts, if equipped.

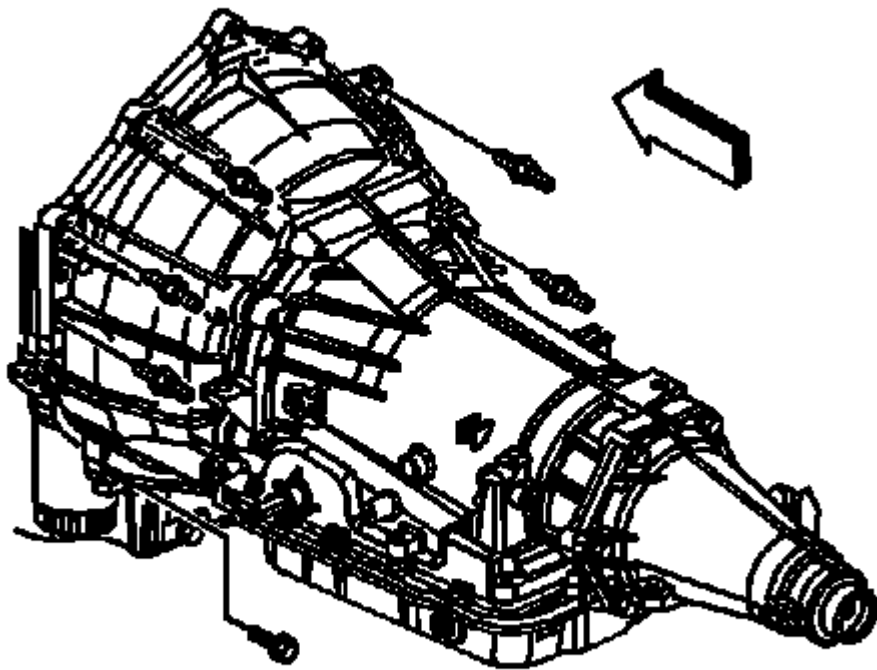


Fig. 236: Identifying Automatic Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the automatic transmission bolts, if equipped.

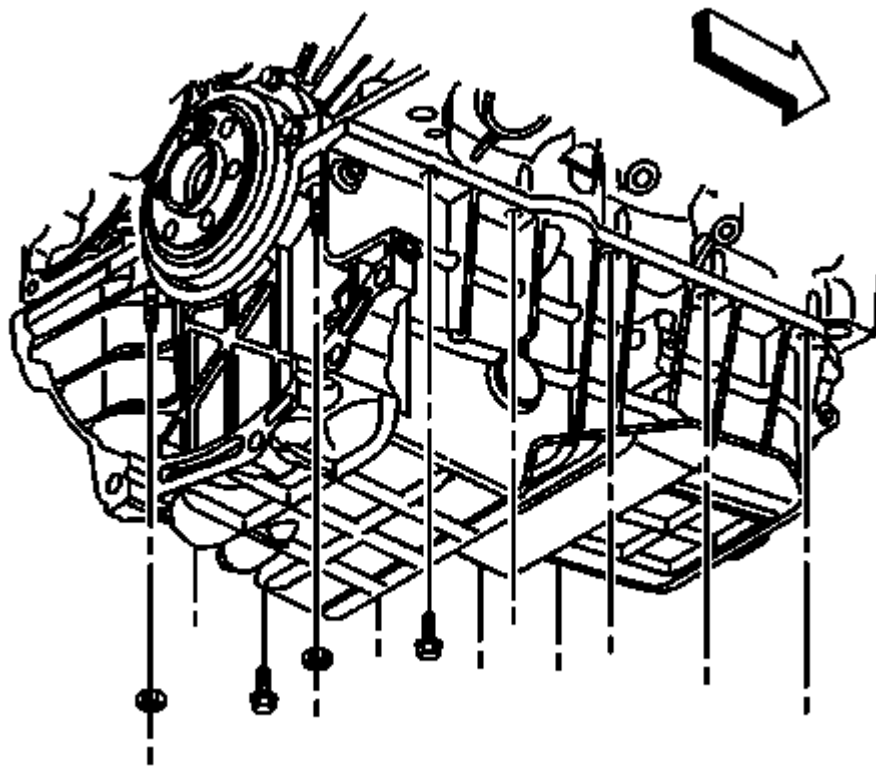


Fig. 237: Identifying Oil Pan Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

12. Remove the oil pan bolts and nuts.

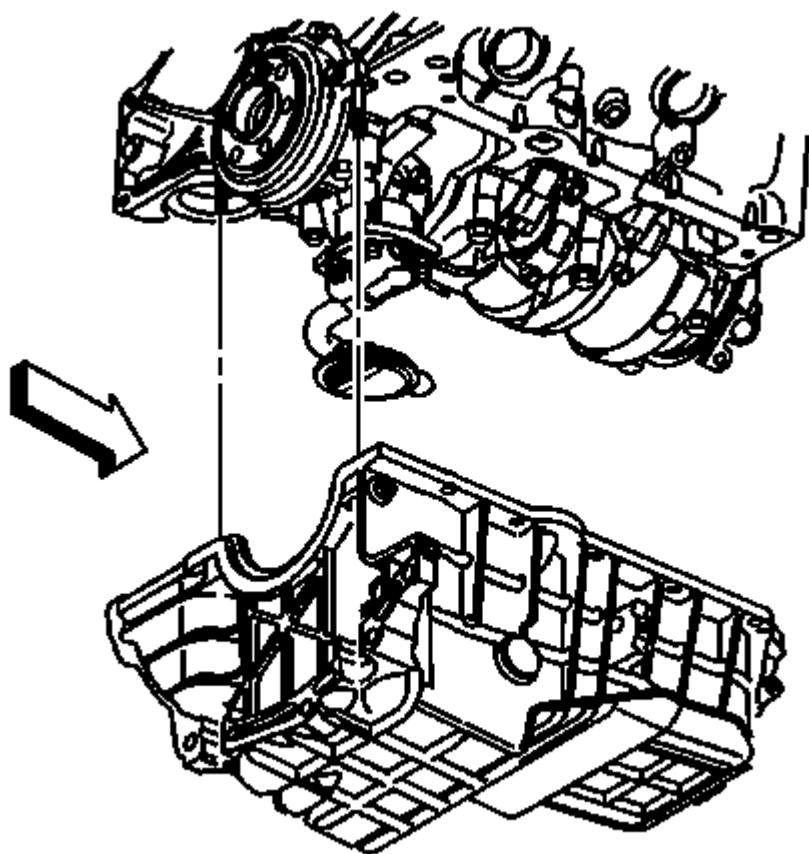


Fig. 238: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

13. Remove the oil pan.

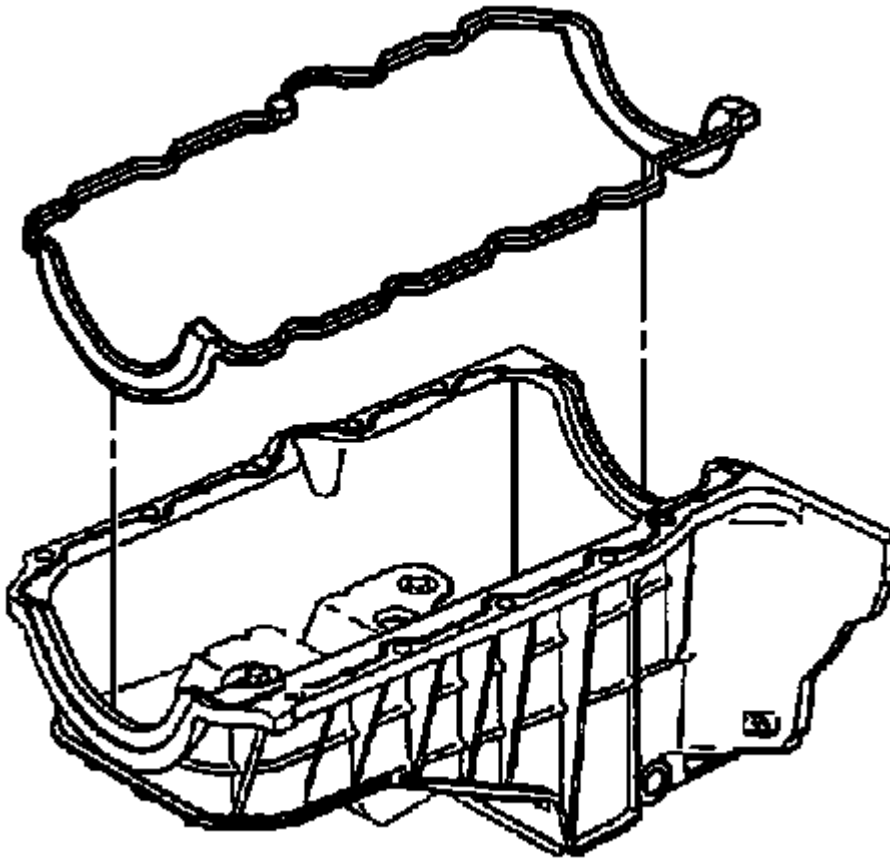


Fig. 239: View Of Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

14. Remove and discard the oil pan gasket.
15. Clean and inspect the oil pan, if necessary. Refer to Oil Pan Cleaning and Inspection .

INSTALLATION PROCEDURE

CAUTION: Any time the transmission and the engine oil pan are off of the engine at the same time, install the transmission before the oil pan. This is to allow for the proper oil pan alignment. Failure to achieve the correct oil pan alignment can result in transmission failure.

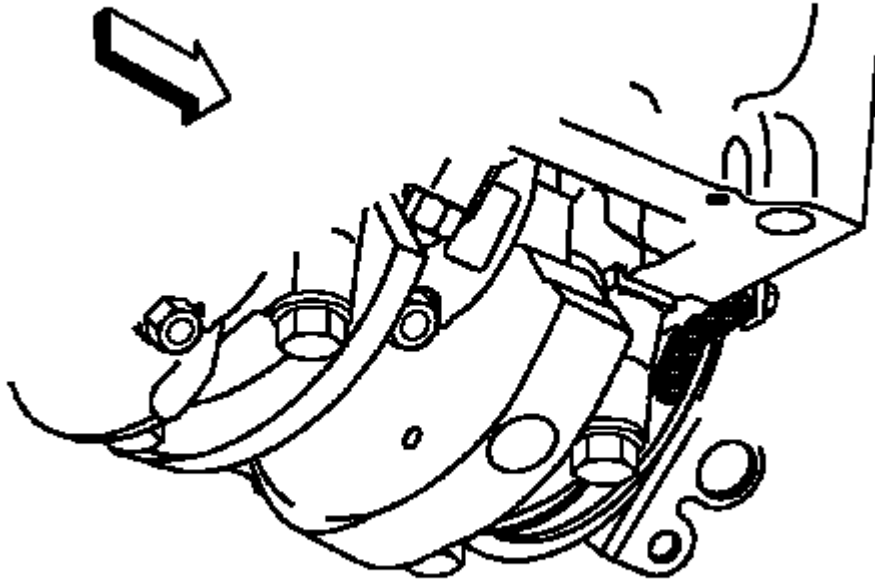


Fig. 240: Applying Adhesive To Sides Of Front Cover To Engine Block Junction At Oil Pan Sealing Surfaces

Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive to both the right and left sides of the front cover to engine block junction at the oil pan sealing surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

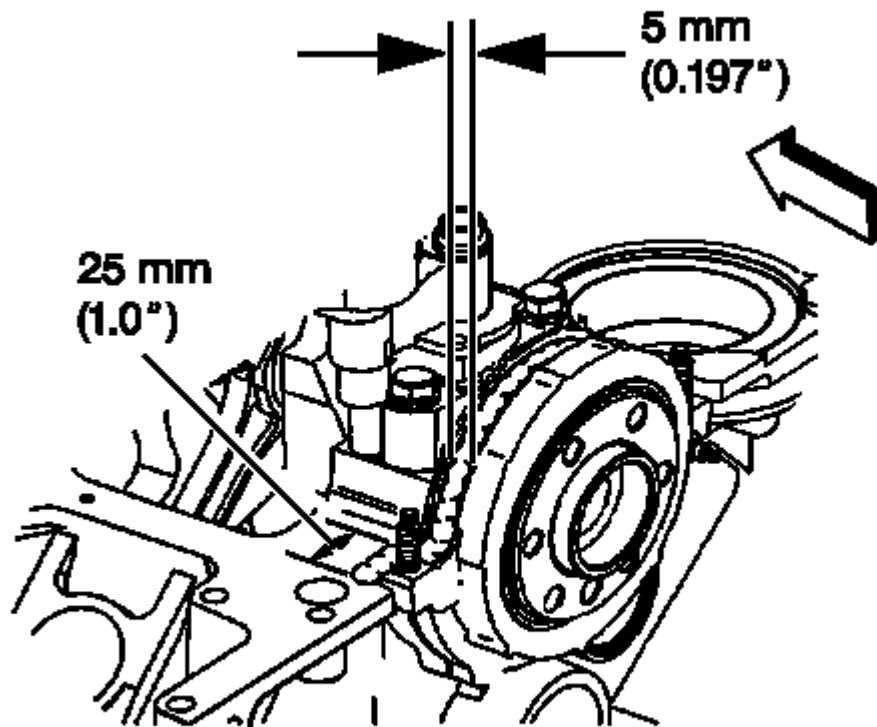


Fig. 241: Applying Adhesive To Entire Length Of Rear Oil Seal Housing To Engine Block Junction At Oil Pan Sealing Surfaces

Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive to the entire length of rear oil seal housing to engine block junction at the oil pan sealing surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

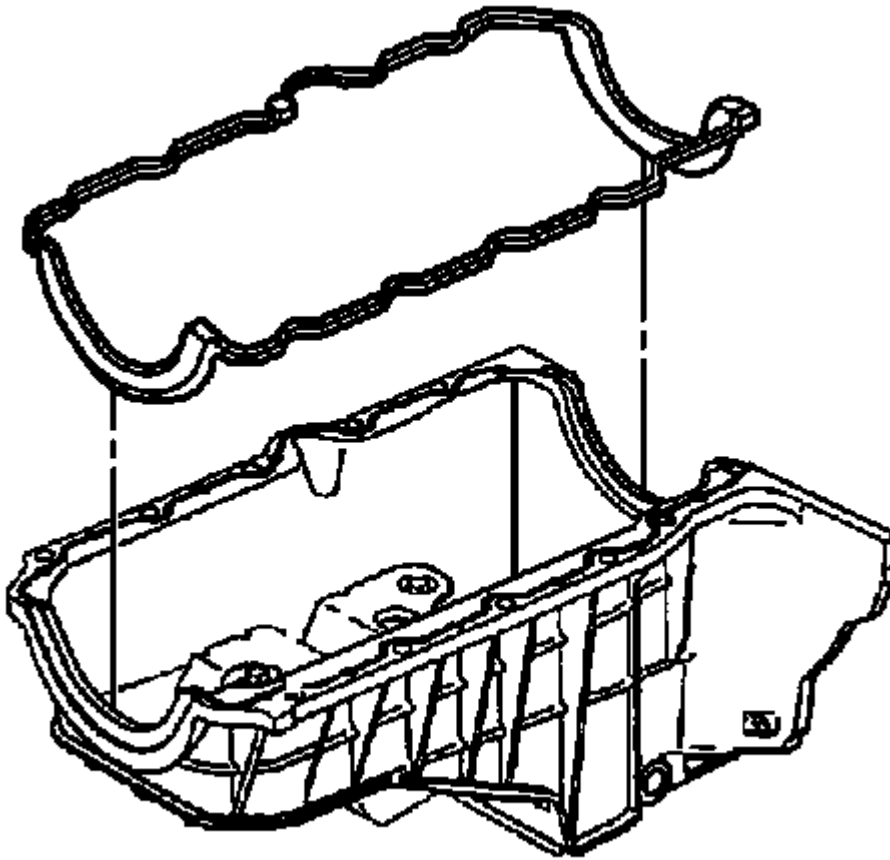


Fig. 242: View Of Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: Always install a NEW oil pan gasket.
The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

3. Install a NEW oil pan gasket into the groove in the oil pan.

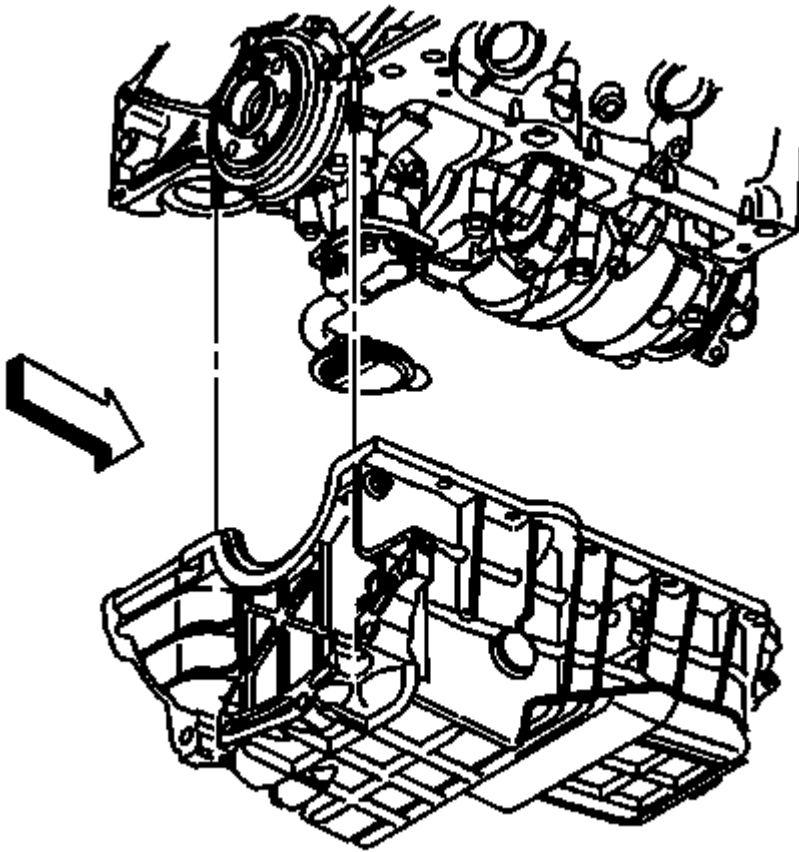


Fig. 243: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

NOTE: The oil pan alignment must always be flush or forward no more than 0.3 mm (0.011 in) from the rear face of the engine block.

4. Install the oil pan.

Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.

5. Slide the oil pan back against a suitable straight edge.

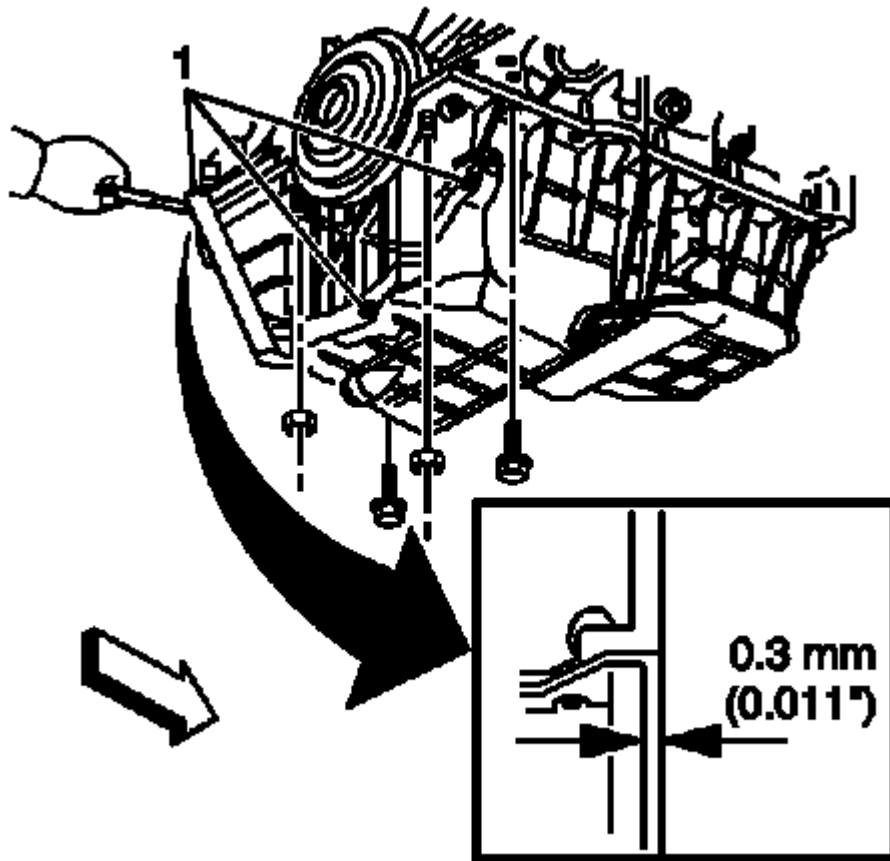


Fig. 244: Measuring Oil Pan-To-Transmission Housing Clearance
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan bolts and nuts until snug.
7. Measure the oil pan-to-transmission housing clearance using a feeler gauge and a straight edge.

Use the feeler gauge to check the clearance at the oil pan-to-transmission housing measurement points (1). If the clearance exceeds 0.3 mm (0.011 in) at any of the oil pan-to-transmission housing measurement points (1), then repeat the step until the oil pan-to-transmission housing clearance is within specifications. The oil pan must always be forward of the rear face of the engine block.

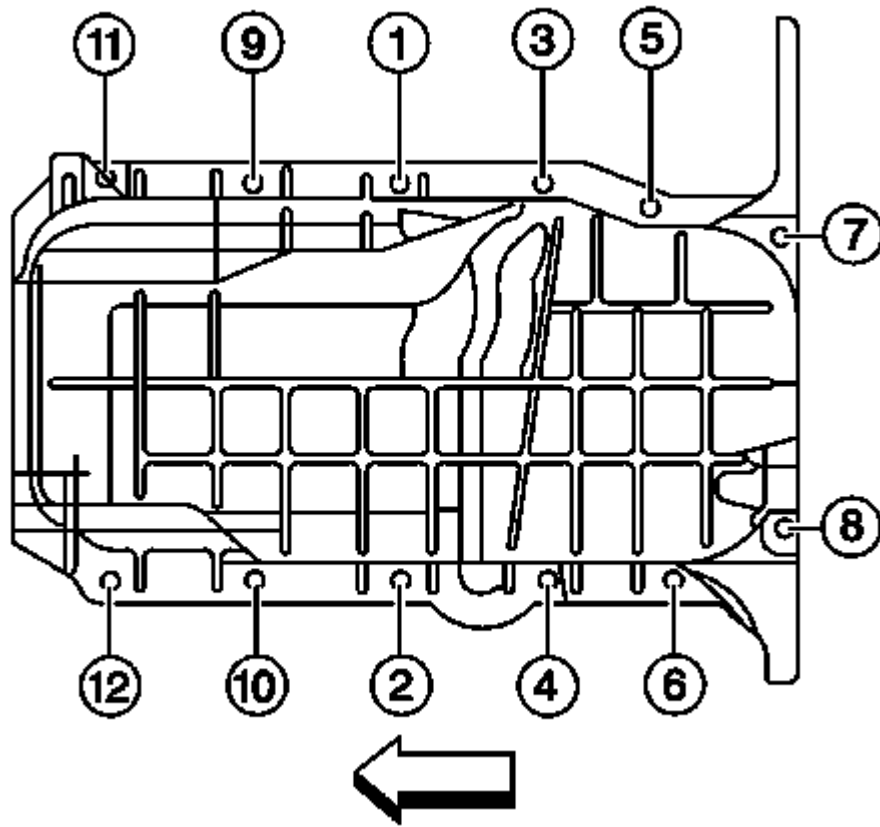


Fig. 245: Identifying Oil Pan Bolts & Nuts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the oil pan bolts and nuts in the sequence shown to 25 N.m (18 lb ft).
9. Measure the clearance at the oil pan-to-transmission housing measurement points in order to ensure proper alignment.

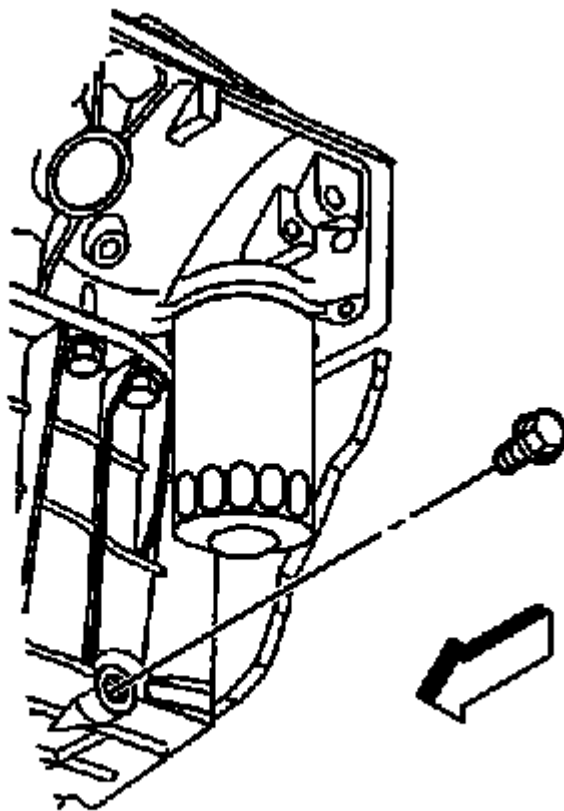


Fig. 246: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

10. Install a NEW drain plug O-ring seal onto the drain plug.
11. Install the drain plug and tighten to 25 N.m (18 lb ft).

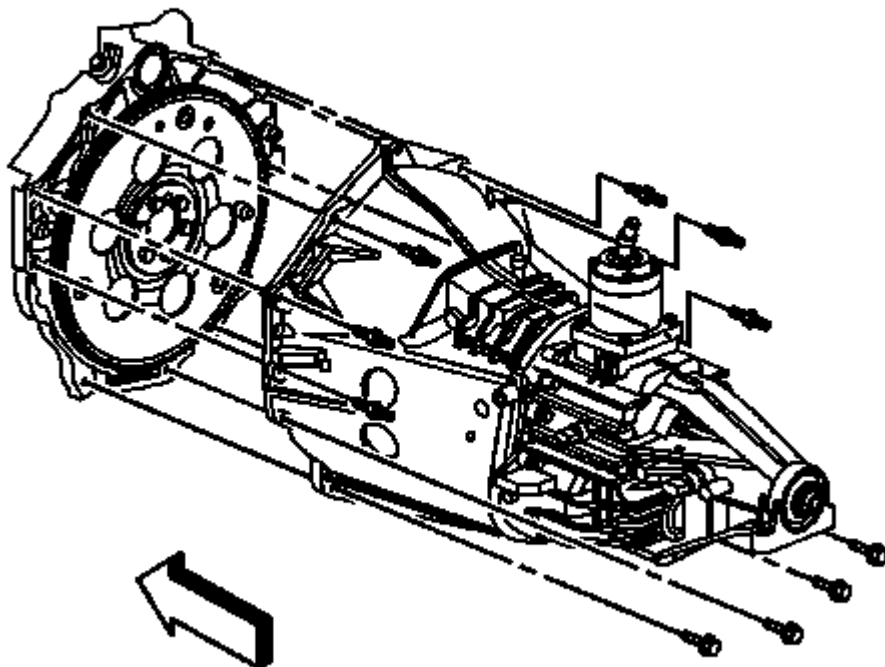


Fig. 247: Identifying Manual Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the transmission cover and tighten the bolts to 12 N.m (106 lb in).

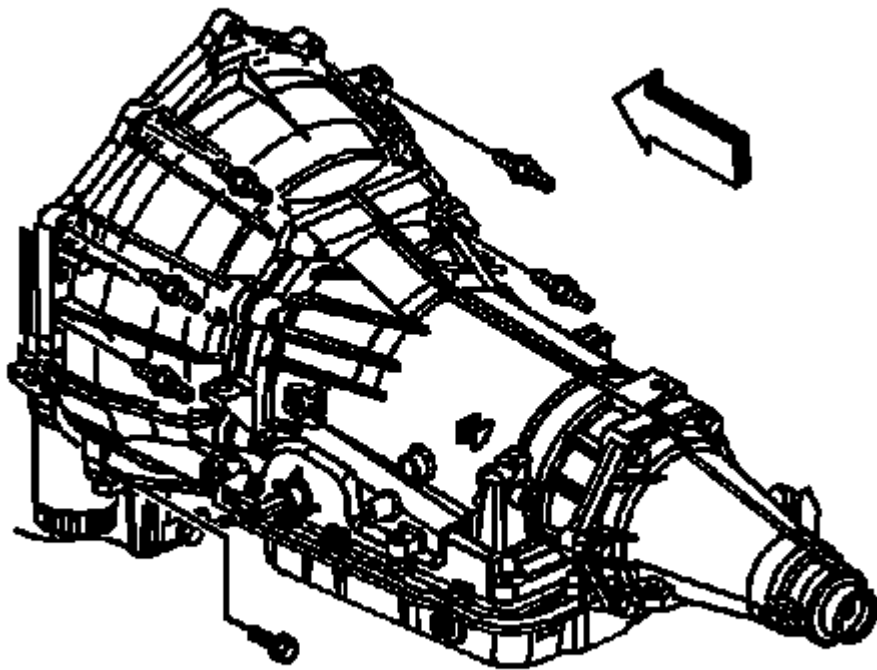


Fig. 248: Identifying Automatic Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the automatic transmission bolts, if equipped.

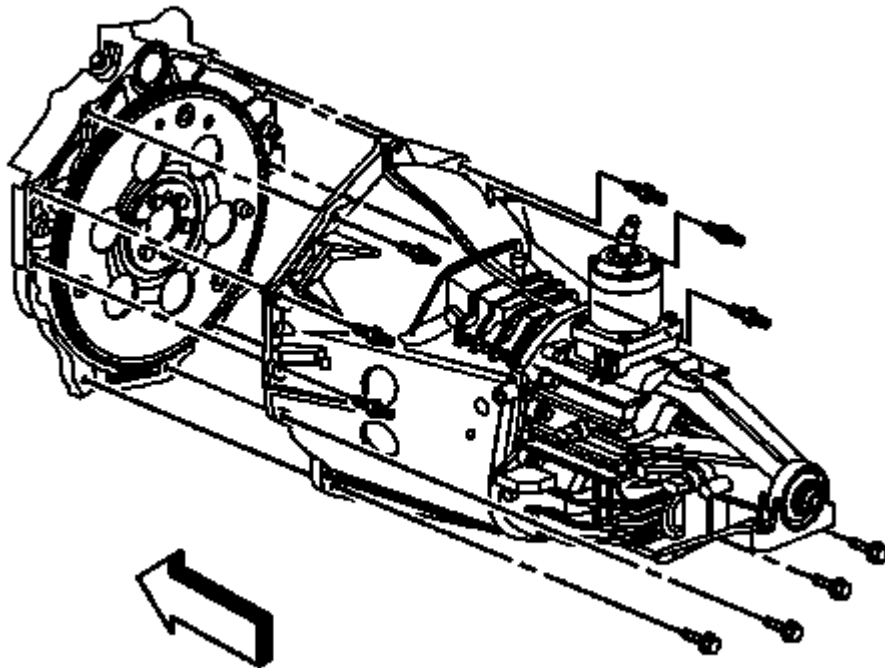


Fig. 249: Identifying Manual Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

14. Install the manual transmission bolts, if equipped and tighten to 50 N.m (37 lb ft).

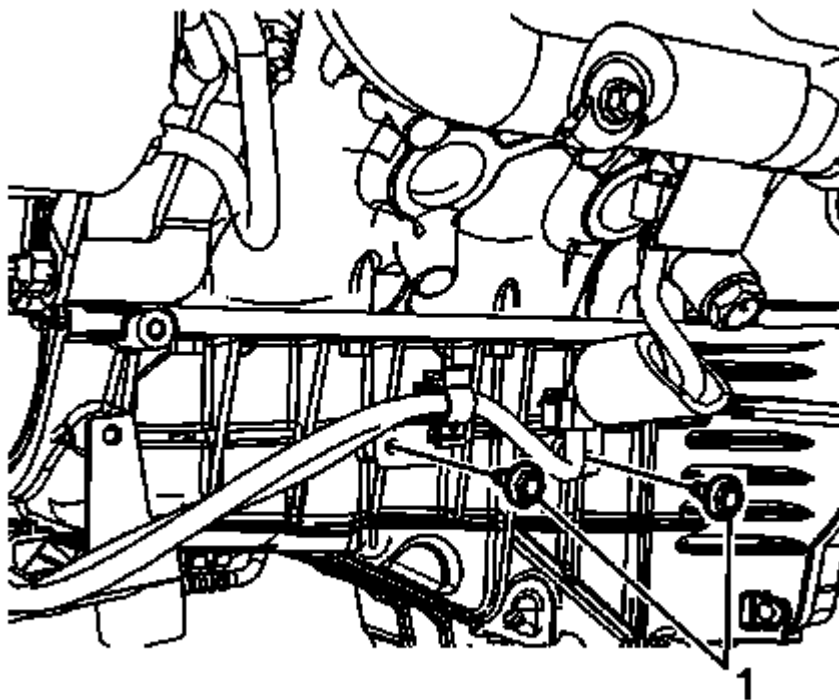


Fig. 250: Identifying Engine Wire Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

15. Install two engine wire harness bracket bolts (1).

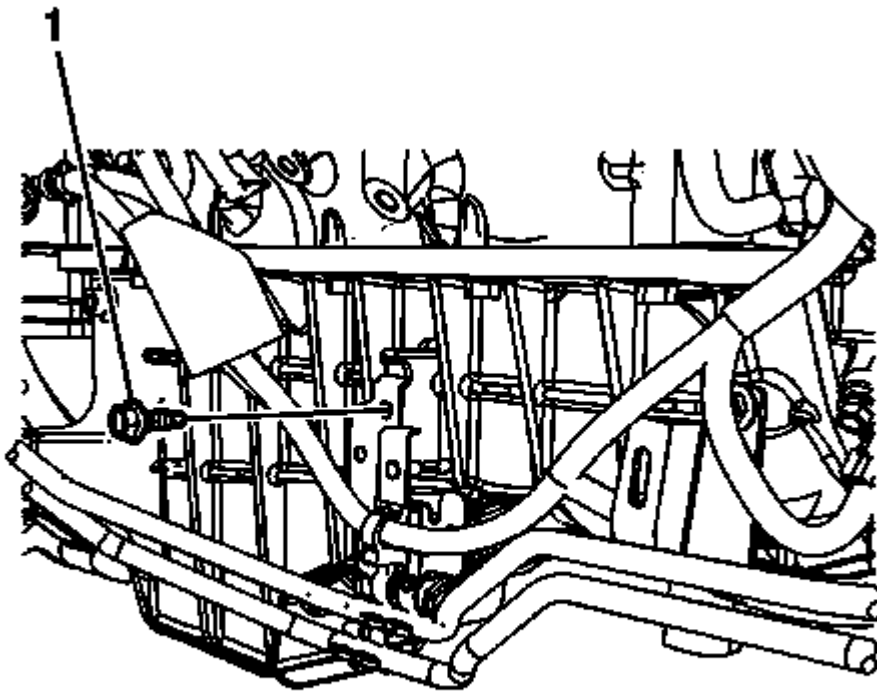


Fig. 251: View Of Transmission Tube Bracket
Courtesy of GENERAL MOTORS CORP.

16. Install the engine harness and transmission tube bracket bolt (1) and tighten to 9 N.m (80 lb in).

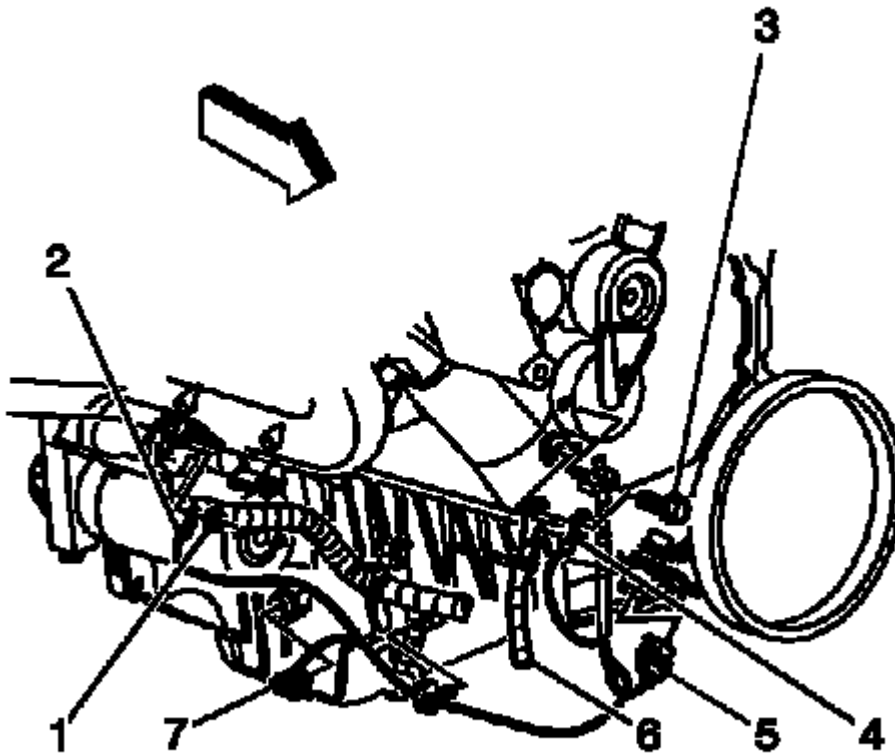


Fig. 252: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

17. Install the starter. Refer to **Starter Replacement (V6)** .
18. Connect the oil level sensor electrical connector (7).

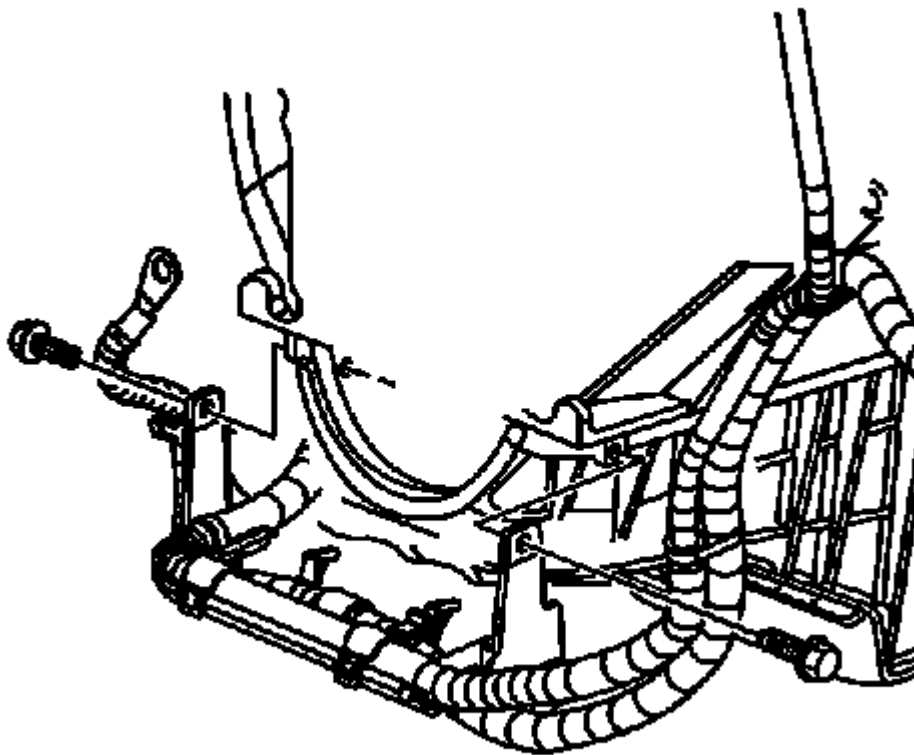


Fig. 253: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the engine harness bracket bolts and tighten to 12 N.m (106 lb in).

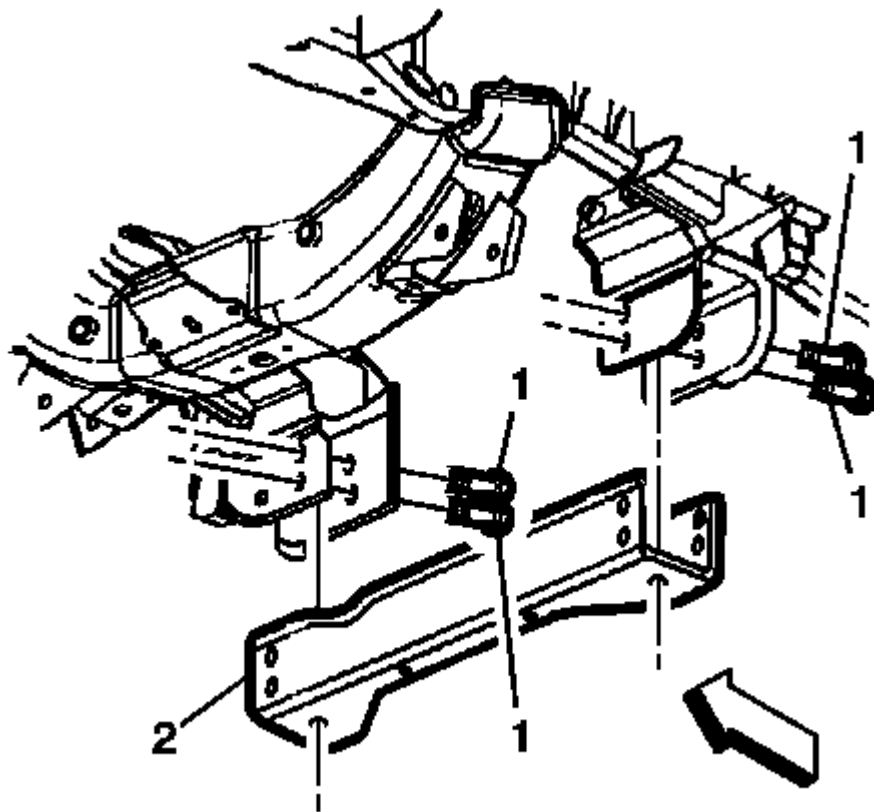


Fig. 254: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

20. Install the crossmember and bolts and tighten to 100 N.m (74 lb ft).

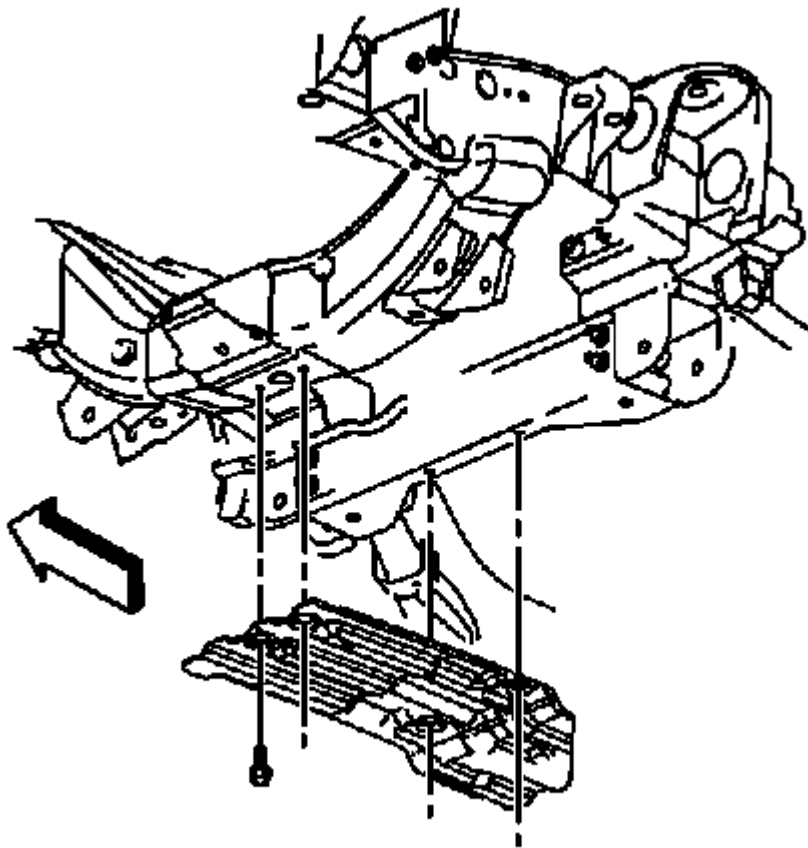


Fig. 255: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

21. If equipped, install the oil pan skid plate and bolts and tighten to 20 N.m (15 lb ft).

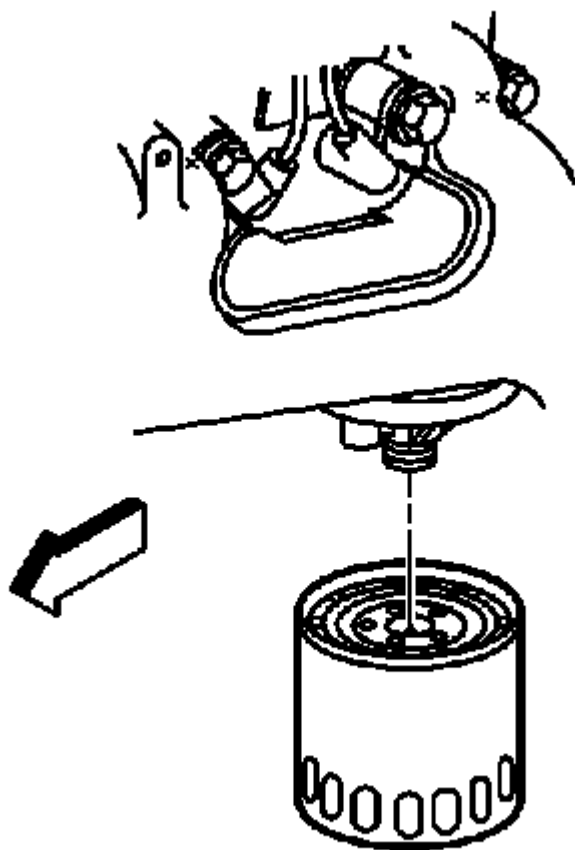


Fig. 256: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

22. Lubricate the oil filter gasket with clean engine oil.
23. Install the oil filter and tighten to 30 N.m (22 lb ft).
24. Lower the vehicle.
25. Fill the engine with the proper capacity and quality of engine oil. Refer to **Approximate Fluid Capacities** .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

SPECIAL TOOLS

J 41712 Oil Pressure Switch Socket. See **Special Tools** .

REMOVAL PROCEDURE

NOTE: Clean the area around the oil pressure sensor. Do not allow debris to enter the engine.

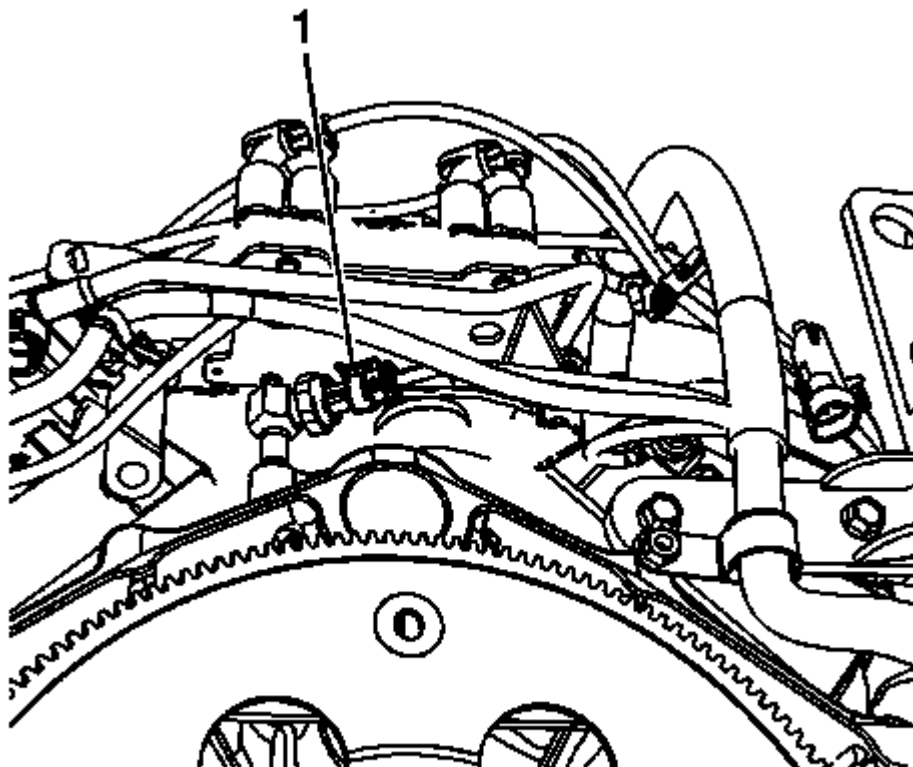


Fig. 257: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

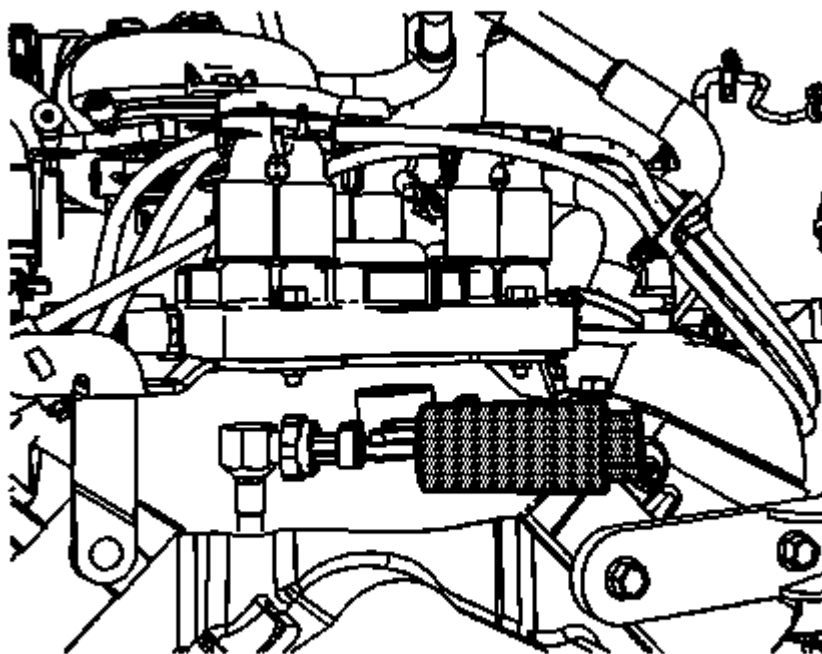


Fig. 258: Identifying Fuel Pump/Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

2. Using **J 41712** , remove the fuel pump/oil pressure sensor. See **Special Tools** .

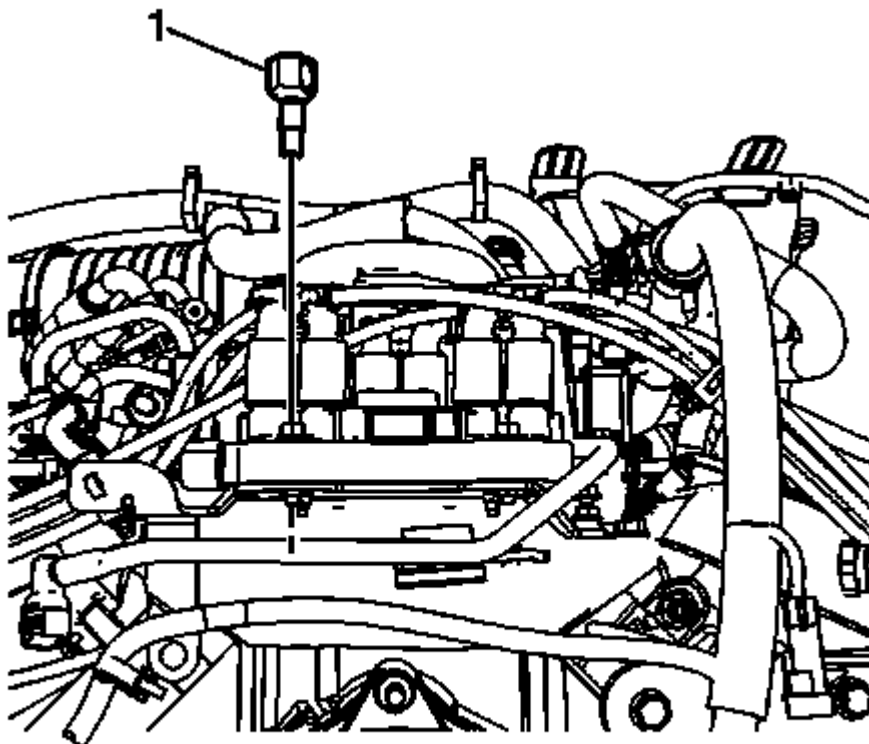


Fig. 259: Locating Oil Pressure Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

NOTE: Note the alignment of the engine oil pressure sensor fitting prior to removal.

3. Remove the oil pressure sensor fitting (1), if necessary.

INSTALLATION PROCEDURE

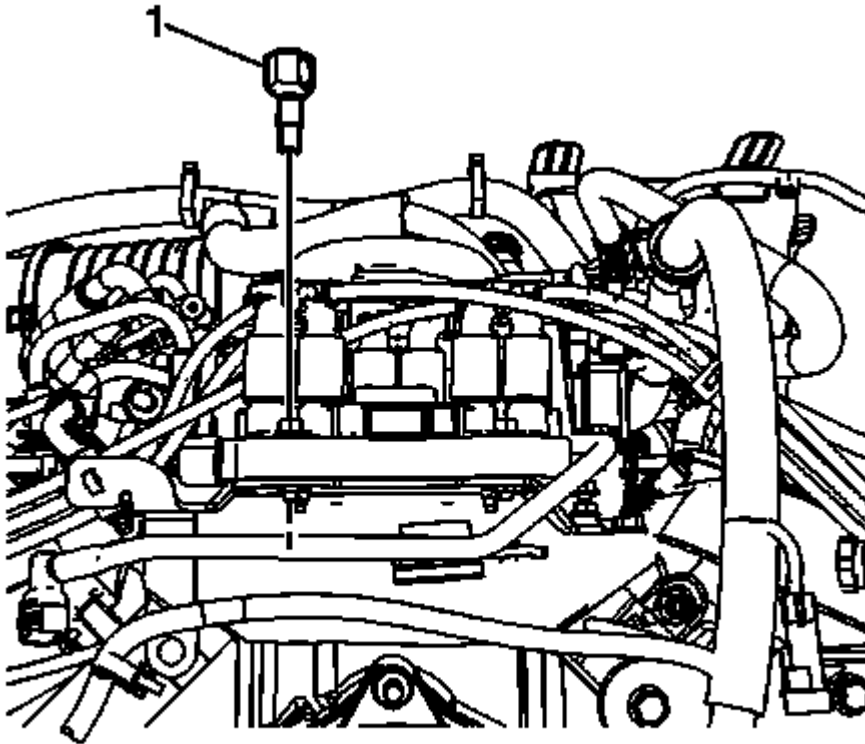


Fig. 260: Locating Oil Pressure Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

1. If installing the old oil pressure sensor fitting (1), apply sealant to the threads of the fitting. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Install the old oil pressure sensor fitting until snug, if necessary.

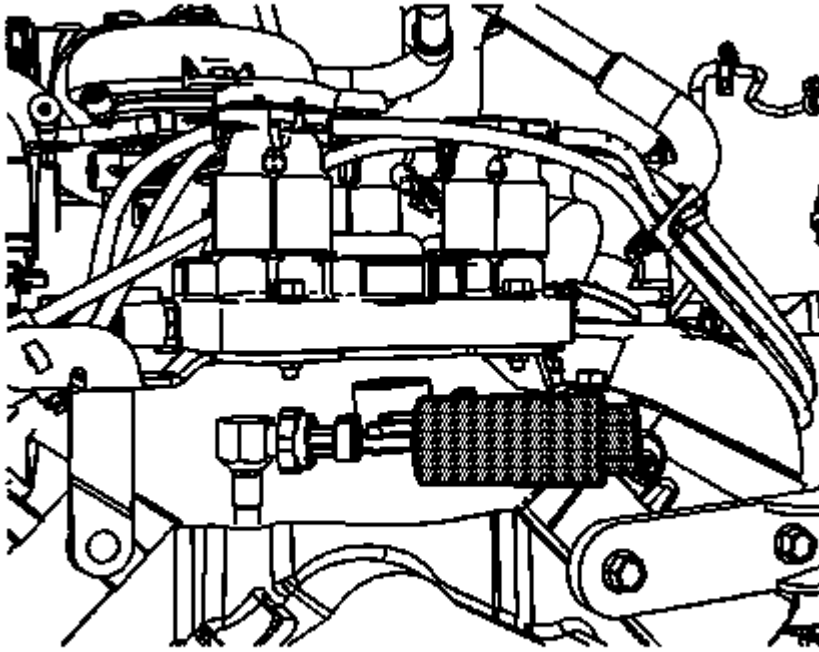


Fig. 261: Identifying Fuel Pump/Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Tighten the oil pressure sensor fitting.
 1. Tighten the fitting to 15 N.m (11 lb ft).
 2. Increase torque until the centerline of the fitting is 50 degrees from the centerline of the crankshaft.

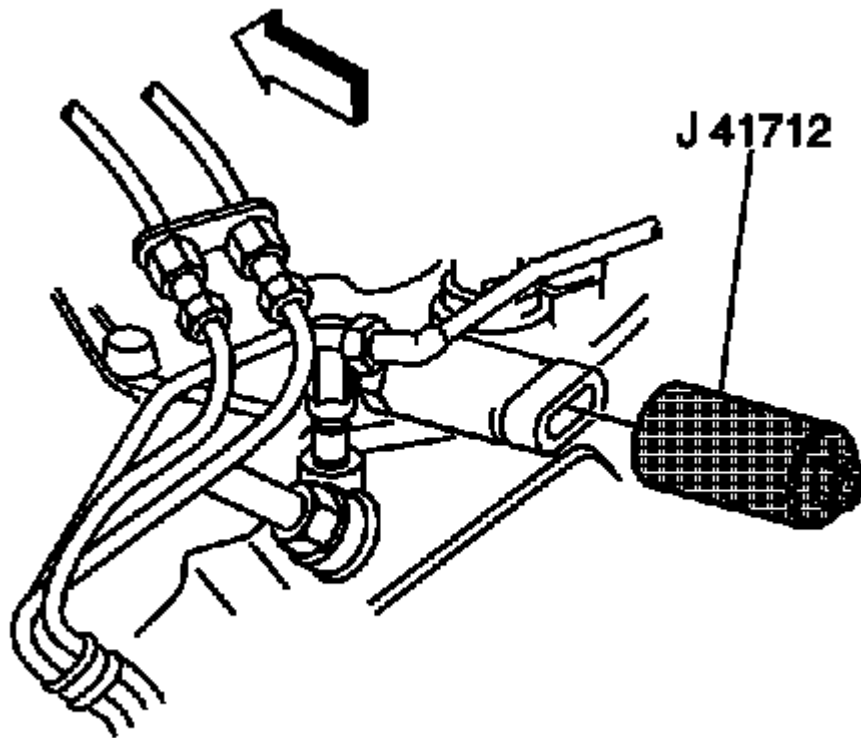


Fig. 262: View Of Special Tool J 41712
Courtesy of GENERAL MOTORS CORP.

4. If installing the old sensor, apply sealant to the threads of the sensor. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
5. Using **J 41712** , install the sensor and tighten to 30 N. See **Special Tools** .m (22 lb ft).

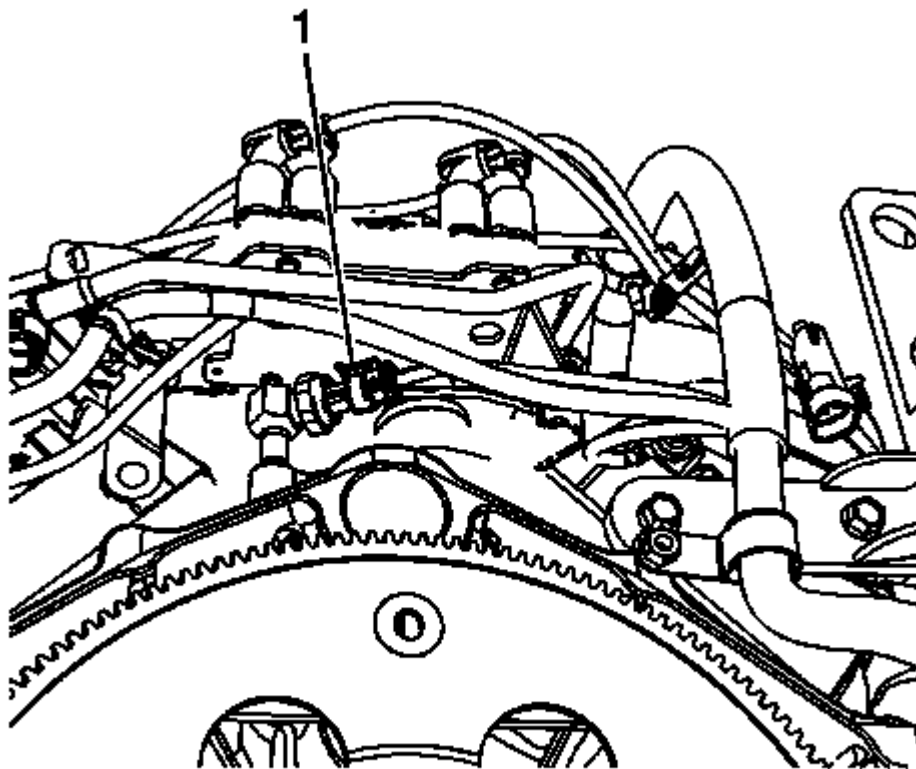


Fig. 263: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the oil pressure sensor electrical connector (1).
7. Check and adjust the engine oil level, if necessary.

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

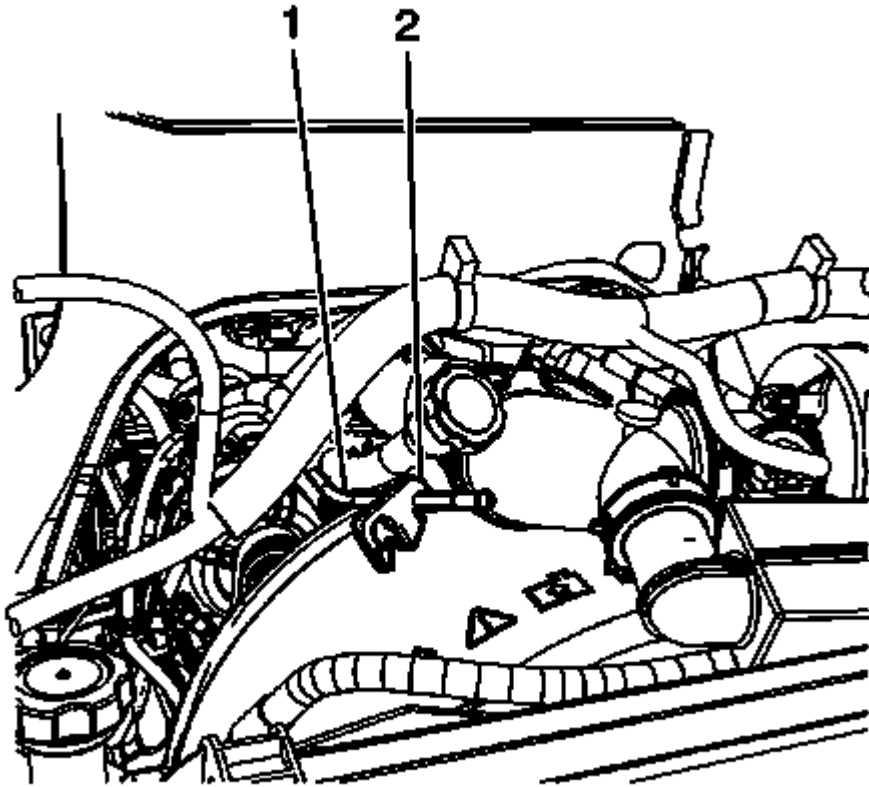


Fig. 264: View Of Oil Level Indicator Tube & Air Conditioning Line Retainer Clip
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the oil level indicator.
3. Remove the coolant reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
4. Remove the oil level indicator tube (1) from the air conditioning line retainer clip (2).

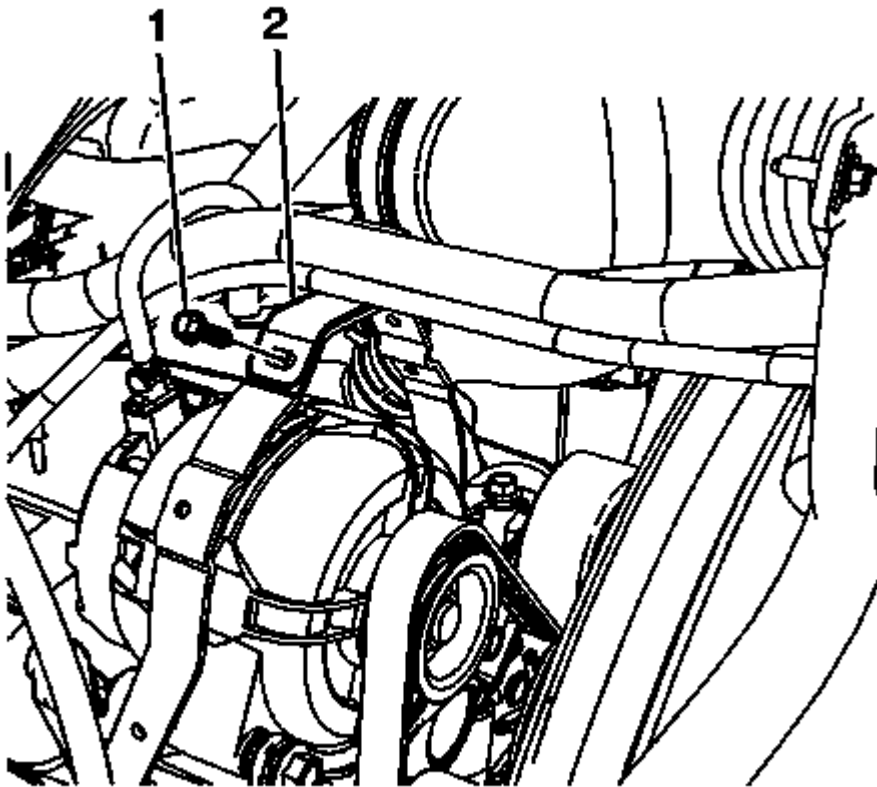


Fig. 265: Identifying Oil Level Indicator Tube Bolt & Bracket
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil level indicator tube bolt (1) from the oil indicator tube bracket (2).

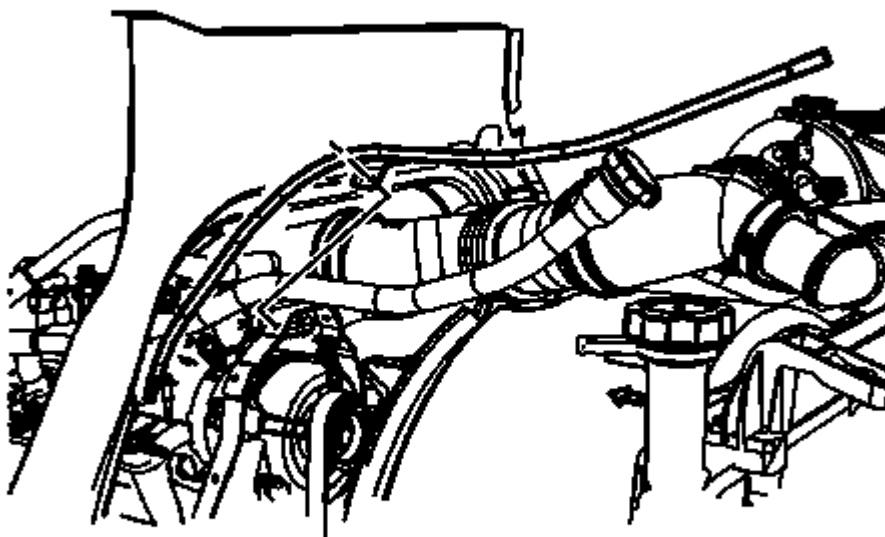


Fig. 266: Locating Oil Indicator Tube
Courtesy of GENERAL MOTORS CORP.

6. Remove the upper half of the oil indicator tube from the lower half of the oil indicator tube.

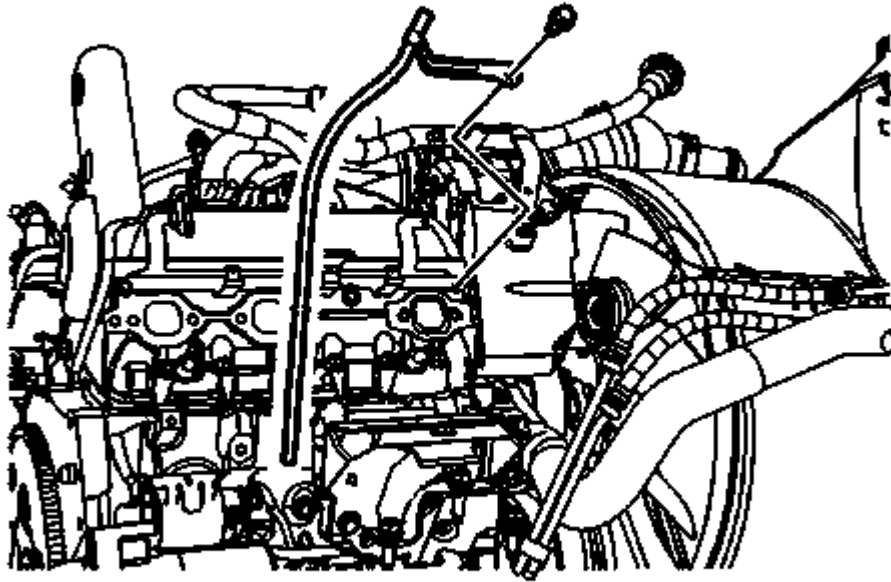


Fig. 267: Identifying Oil Level Indicator Tube Bolt & Tube
Courtesy of GENERAL MOTORS CORP.

7. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.3L)** .
8. Remove the oil level indicator tube bolt.
9. Remove the oil level indicator tube using a twisting motion.
10. Clean the old sealer from the indicator tube and engine block.

INSTALLATION PROCEDURE

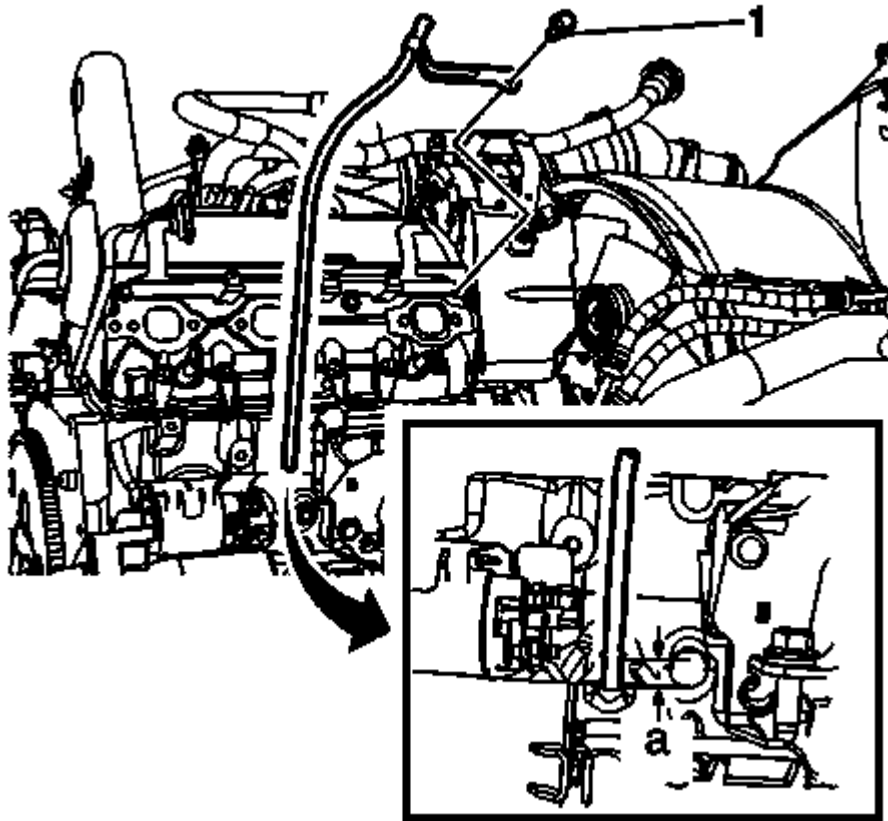


Fig. 268: Identifying Indicator Tube Bolt
Courtesy of GENERAL MOTORS CORP.

1. Apply sealant around the indicator tube 13 mm (0.5 in) below the tube bead. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Install the indicator tube. Rotate the oil level indicator tube into position.

CAUTION: Refer to **Fastener Caution** .

3. Install the indicator tube bolt (1) and tighten to 12 N.m (106 lb in).
4. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.3L)** .

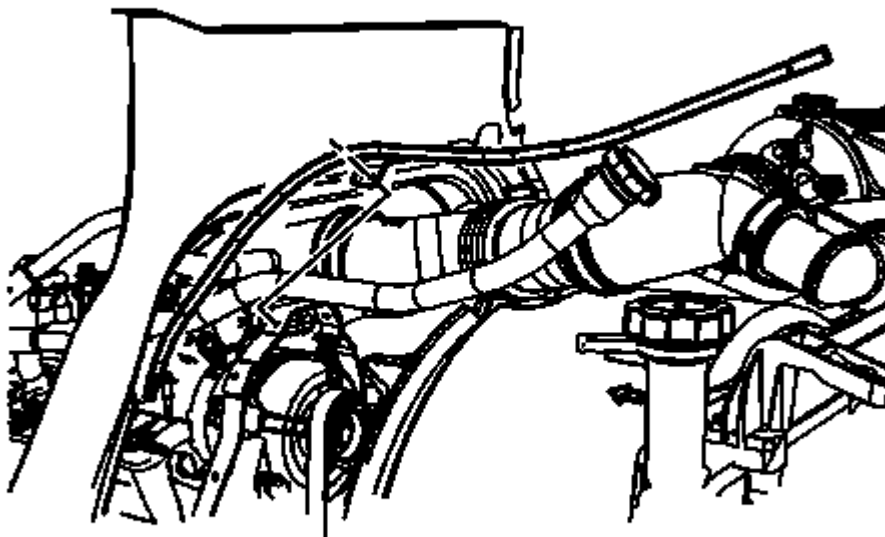


Fig. 269: Locating Oil Indicator Tube
Courtesy of GENERAL MOTORS CORP.

5. Install the upper half of the oil indicator tube into the lower half of the oil indicator tube.

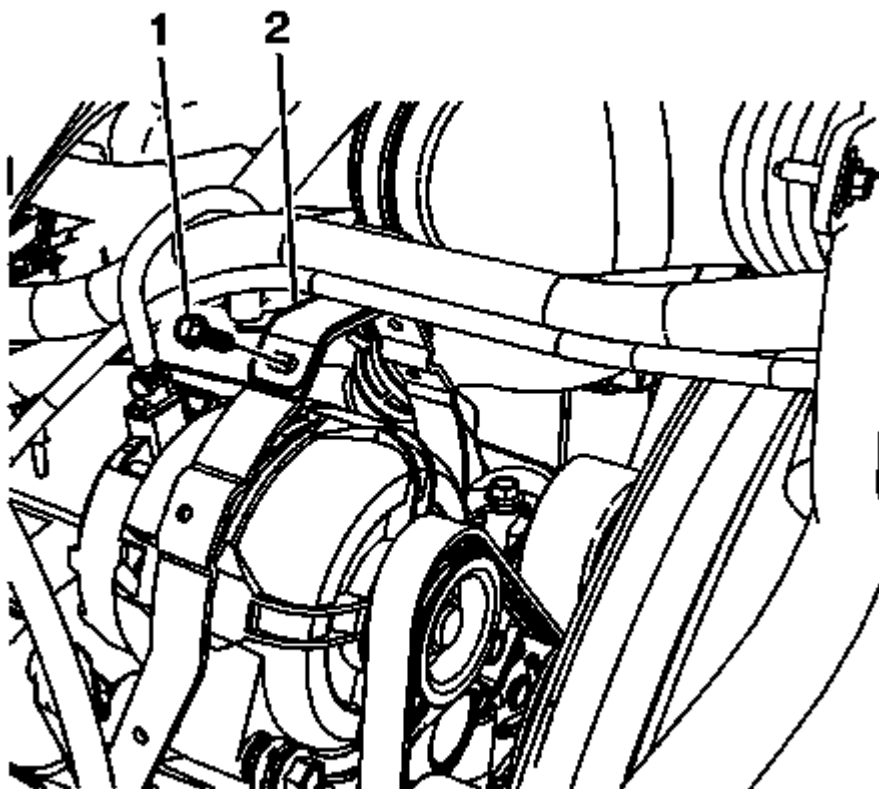


Fig. 270: Identifying Oil Level Indicator Tube Bolt & Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the oil level indicator tube bolt (1) to the oil indicator tube bracket (2).

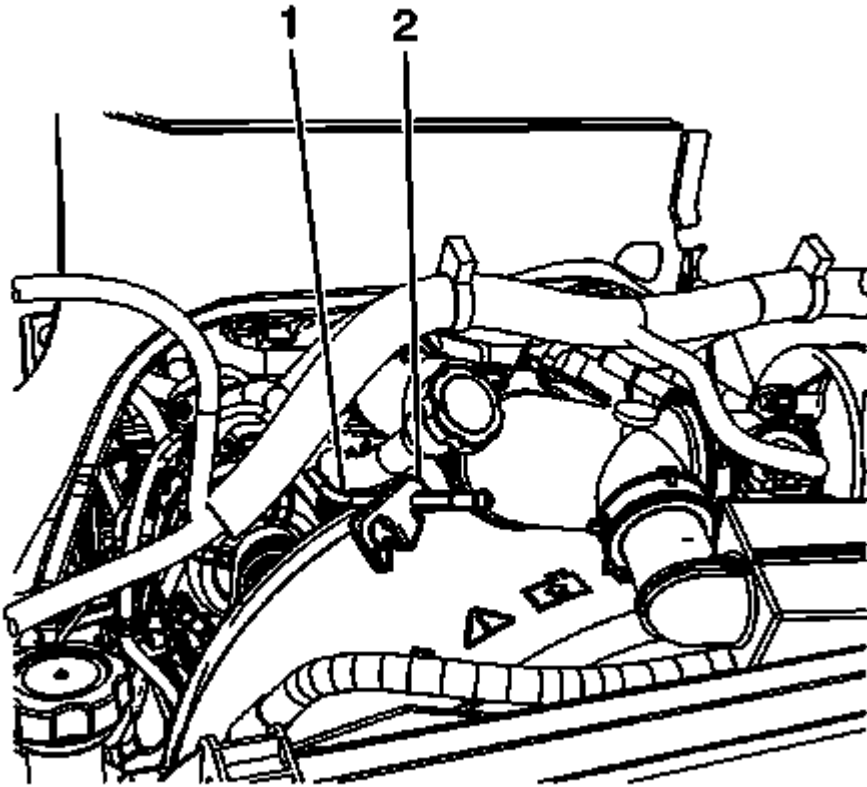


Fig. 271: View Of Oil Level Indicator Tube & Air Conditioning Line Retainer Clip
Courtesy of GENERAL MOTORS CORP.

7. Install the oil level indicator tube (1) to the air conditioning line retainer clip (2).
8. Install the oil level indicator.
9. Install the coolant reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
10. Install the engine cover. Refer to **Engine Cover Replacement** .

OIL PUMP REPLACEMENT

REMOVAL PROCEDURE

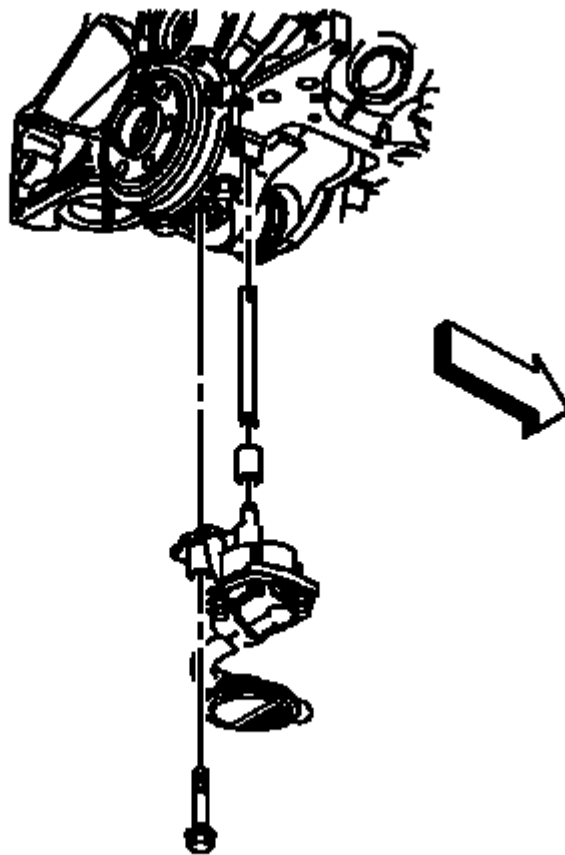


Fig. 272: View Of Oil Pump

Courtesy of GENERAL MOTORS CORP.

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

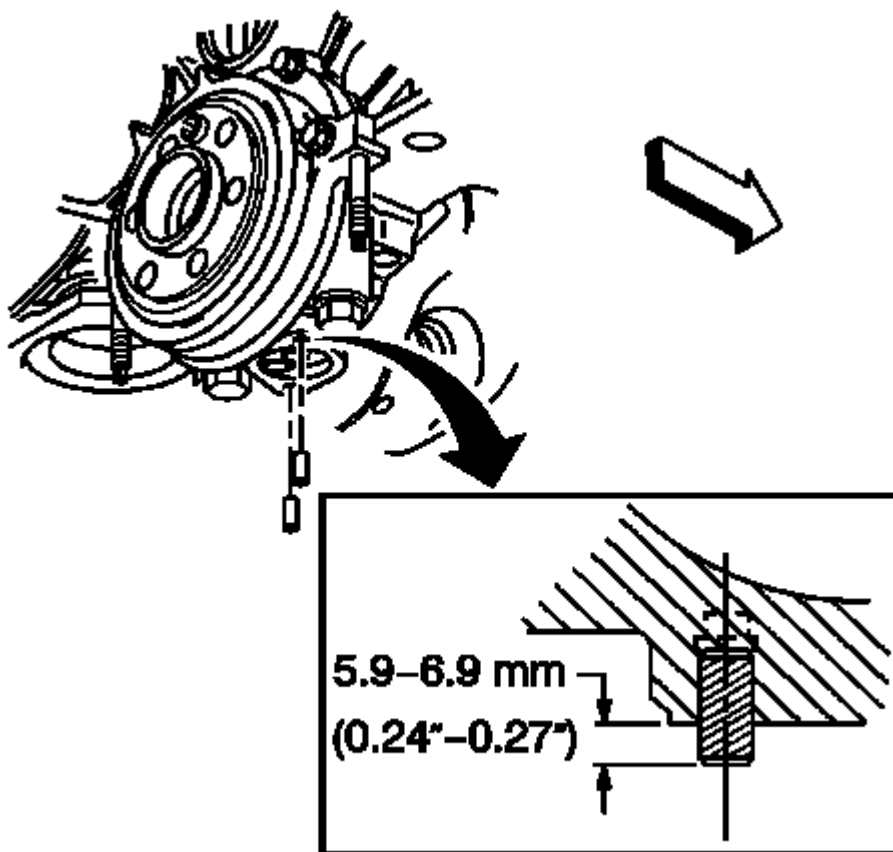


Fig. 273: View Of Oil Pump Locator Pins
Courtesy of GENERAL MOTORS CORP.

4. Inspect the oil pump locator pins for damage, and replace if required.
5. Clean and inspect the oil pump, if necessary.

INSTALLATION PROCEDURE

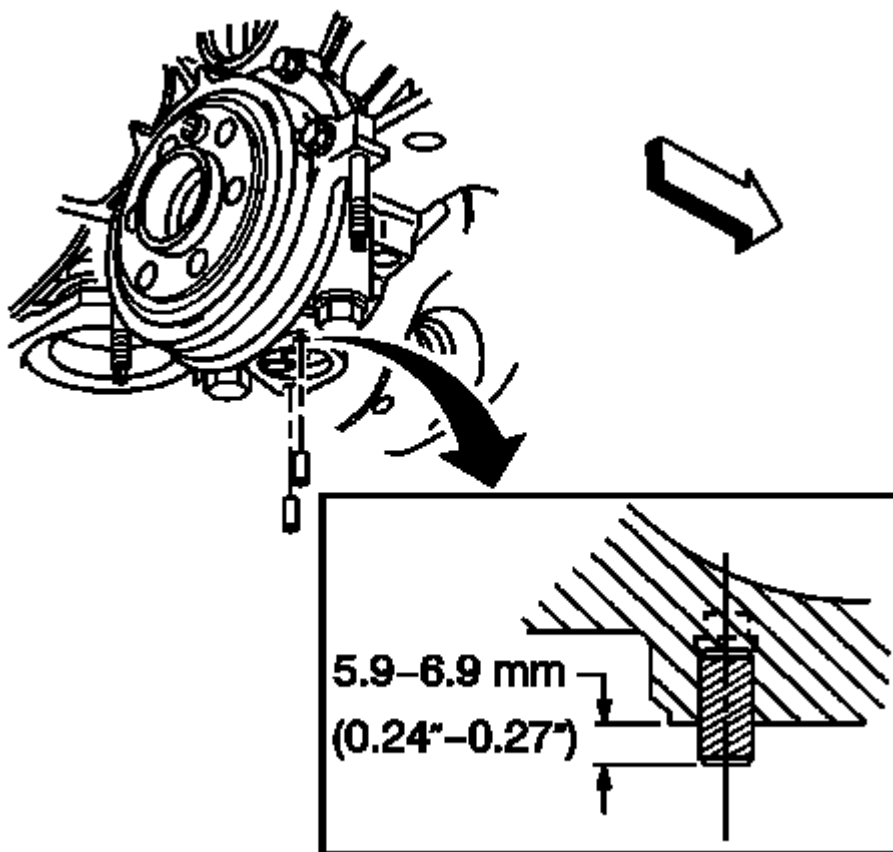


Fig. 274: View Of Oil Pump Locator Pins
Courtesy of GENERAL MOTORS CORP.

1. Inspect for properly installed oil pump locator pins.

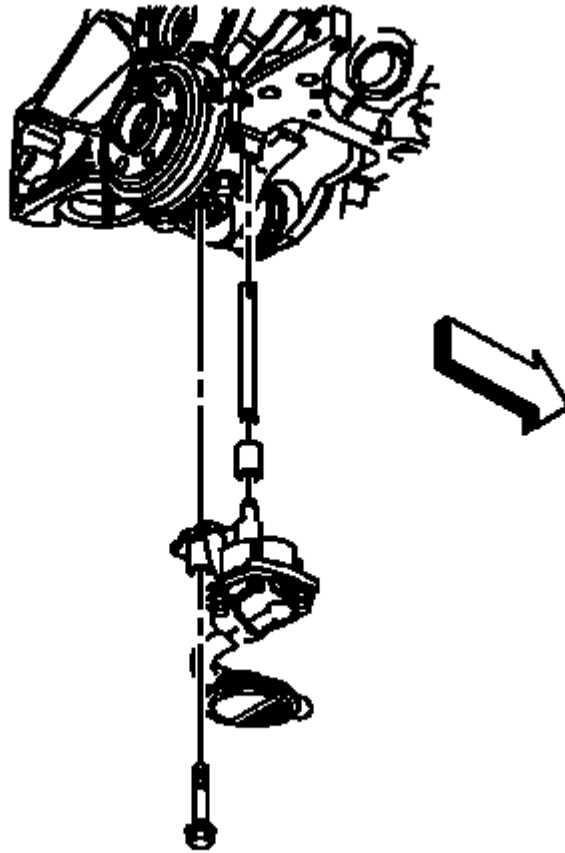


Fig. 275: View Of Oil Pump

Courtesy of GENERAL MOTORS CORP.

NOTE: Do not reuse the oil pump driveshaft retainer. During assembly, install a **NEW** oil pump driveshaft retainer.

2. Install the oil pump. Position the oil pump onto the locator pins.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolt and tighten to 90 N.m (66 lb ft).
4. Install the oil pan. Refer to Oil Pan Replacement.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 35621-B Rear Main Seal Installer. See Special Tools .

REMOVAL PROCEDURE

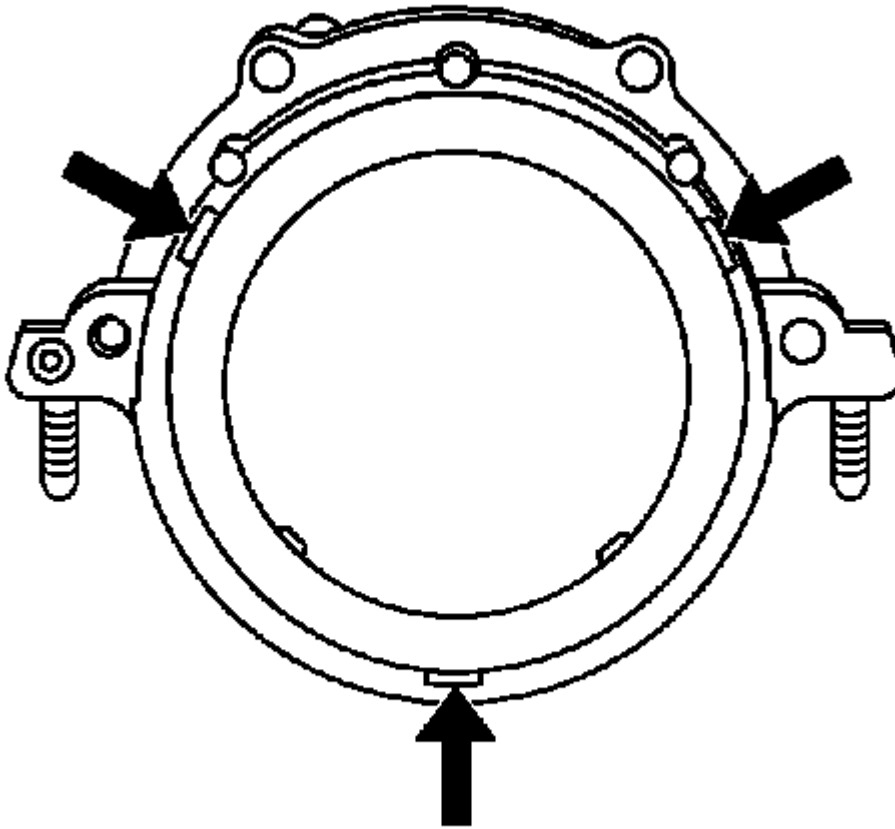


Fig. 276: Locating Crankshaft Rear Oil Seal Access Notches
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel. Refer to **Engine Flywheel Replacement**.
2. Insert a flat-tipped screwdriver into the access notches and carefully pry the seal from the housing.
3. Discard the seal.
4. Clean off any dirt or rust in the area.

INSTALLATION PROCEDURE

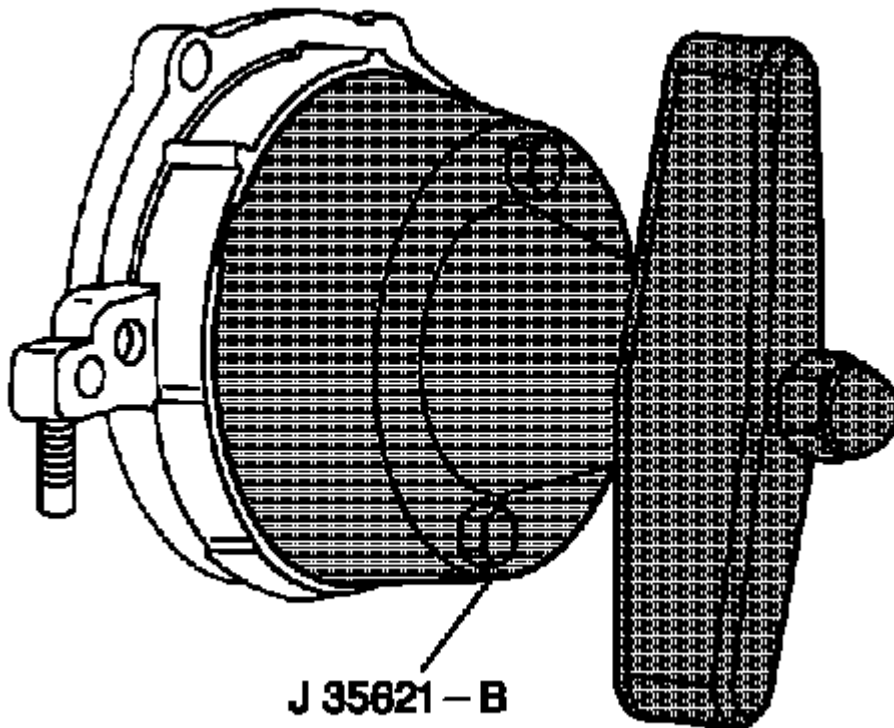


Fig. 277: View Of Crankshaft Rear Oil Seal Using Special Tool J 35621-B
Courtesy of GENERAL MOTORS CORP.

1. Apply 2 to 3 drops of clean engine oil to the bore of the housing.
2. Apply 2 to 3 drops of clean engine oil to the outside diameter of the engine flywheel pilot flange.
3. Apply 1 drop of clean engine oil to the outside diameter of the flywheel locator pin.
4. Apply 2 to 3 drops of clean engine oil to the crankshaft seal surface.

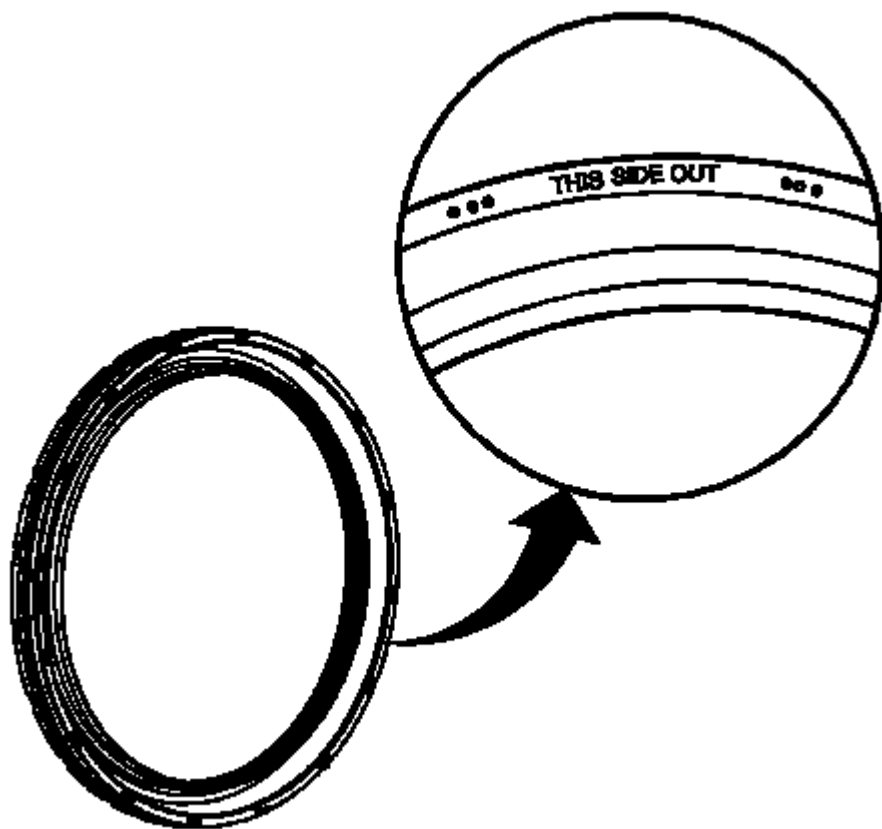


Fig. 278: Identifying Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Notice the direction of the rear oil seal. The new design seal is a reverse style as opposed to what has been used in the past. **THIS SIDE OUT** has been stamped into the seal as shown in the graphic.

5. Inspect the **J 35621-B** flange for imperfections that may damage the NEW seal. See Special Tools .

Minor imperfections may be removed with a fine grade emery cloth.

NOTE: **DO NOT** allow oil or any other lubricants to contact the seal lip surface of the seal.

6. Remove the sleeve from the seal.
7. Apply 2 to 3 drops of clean engine oil to the outside diameter of the seal.
8. Install the seal onto the **J 35621-B** . See Special Tools .
9. Install the **J 35621-B** onto the rear of the crankshaft and hand tighten the tool bolts until snug. See Special Tools .

CAUTION: Proper alignment of the crankshaft rear oil seal is critical. Install the crankshaft rear oil seal near to flush and square to the crankshaft rear oil seal housing. Failing to do so may cause the crankshaft rear oil seal or the crankshaft rear oil seal installation tool to fail.

10. Install the seal onto the crankshaft and into the housing:

1. Turn the **J 35621-B** wing nut clockwise until the seal is installed close to flush and square to the housing. See Special Tools .

Increased resistance will be felt when the seal has reached the bottom of the housing bore.

2. Turn the **J 35621-B** wing nut counterclockwise to release the **J 35621-B** from the seal. See Special Tools .

11. Remove the **J 35621-B** . See Special Tools .

12. Wipe off any excess engine oil with a clean rag.

13. Install the engine flywheel. Refer to Engine Flywheel Replacement.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

REMOVAL PROCEDURE

NOTE: Do not remove the crankshaft rear oil seal housing if only replacing the crankshaft rear oil seal.

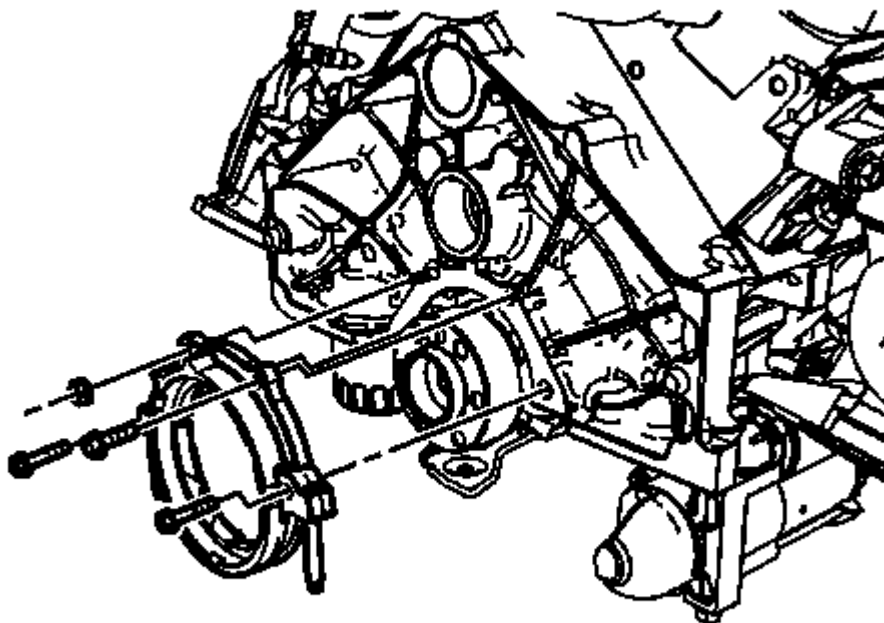


Fig. 279: View Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
3. Remove the housing bolts and nut.
4. Remove the housing.

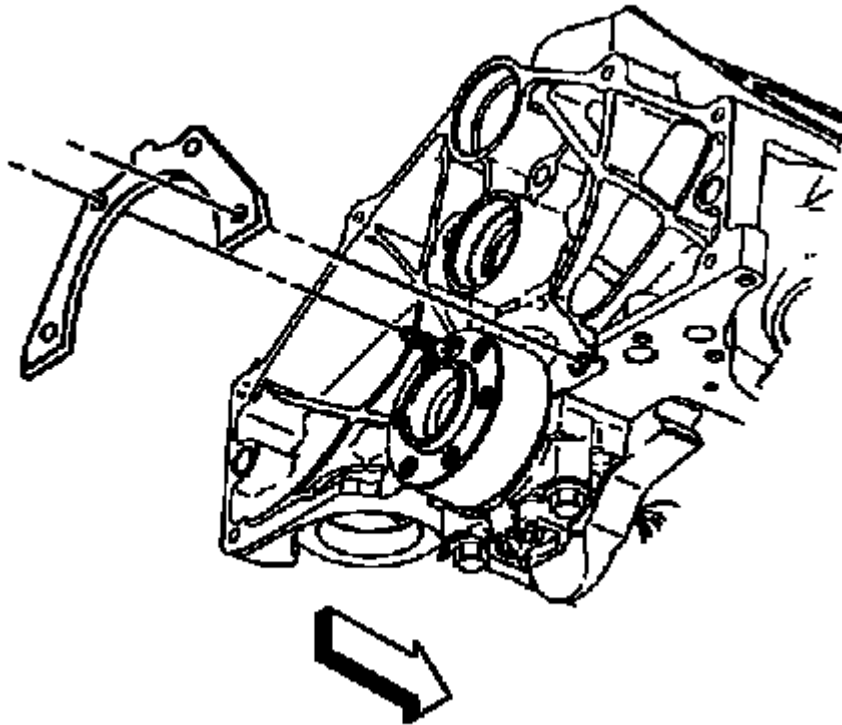


Fig. 280: Identifying Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the housing gasket.
6. Clean all the sealing surfaces.
7. Inspect and replace the housing for warping, cracks, wear, or damage.

INSTALLATION PROCEDURE

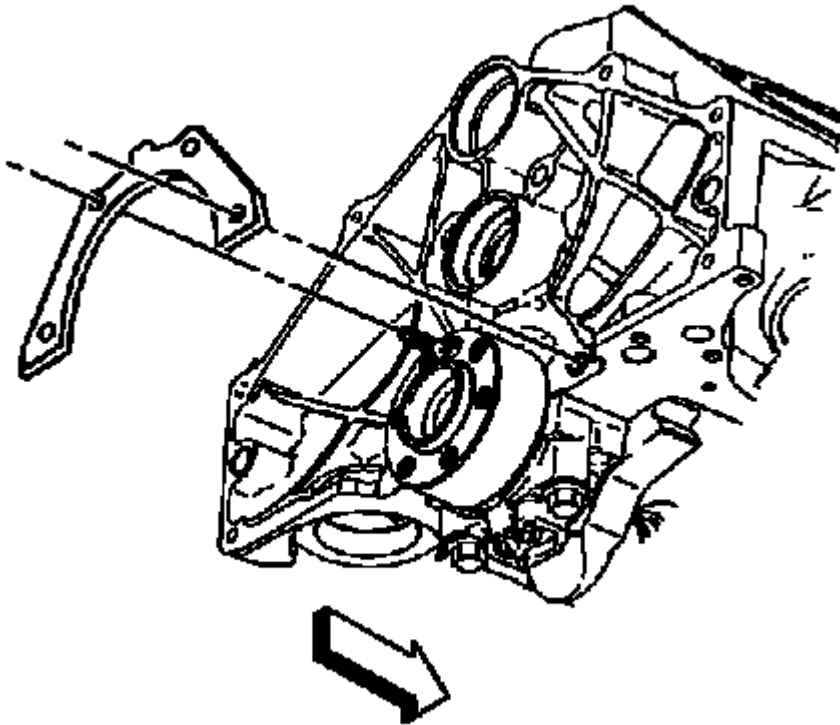


Fig. 281: Identifying Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing a NEW housing the seal will come with the housing. If reusing the housing and then installing a NEW seal follow the instructions for installing the housing and then refer to Crankshaft Rear Oil Seal Replacement to install the seal.

1. Install a NEW housing gasket.

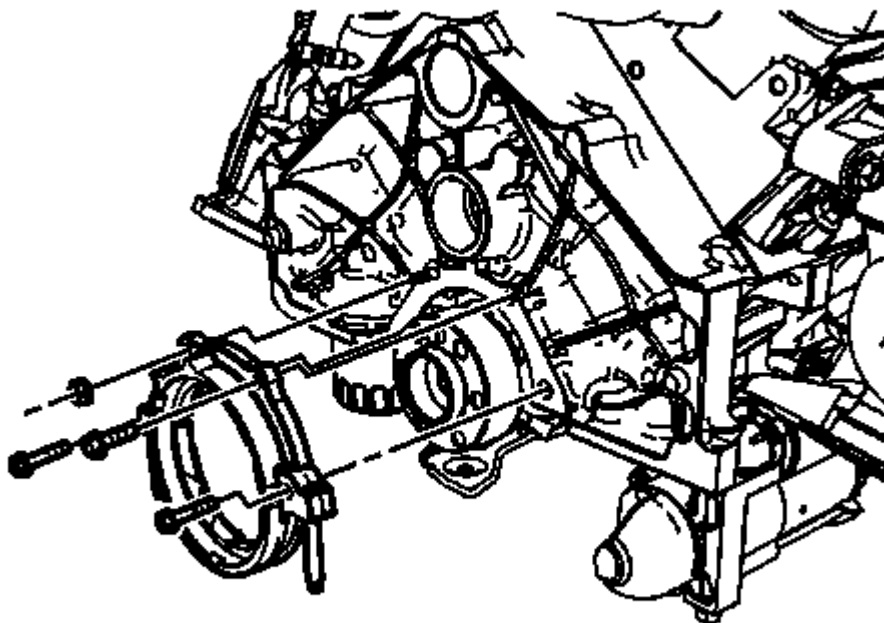


Fig. 282: View Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW housing with the seal using the following procedure.

NOTE: **Do not oil or grease the seal lip or the crankshaft seal area.**

1. Leave the sleeve in the seal and use the sleeve as a guide to ease installing the seal lip over the end of the crankshaft.
2. Push the housing fully onto the crankshaft until the housing is against the seal gasket and the engine.
3. Remove the sleeve.

CAUTION: Refer to Fastener Caution .

3. Install the crankshaft rear oil seal housing bolts and nut and tighten to 12 N.m (106 lb in).
4. Install the engine flywheel. Refer to Engine Flywheel Replacement.
5. Install the oil pan. Refer to Oil Pan Replacement.

ENGINE FLYWHEEL REPLACEMENT

REMOVAL PROCEDURE

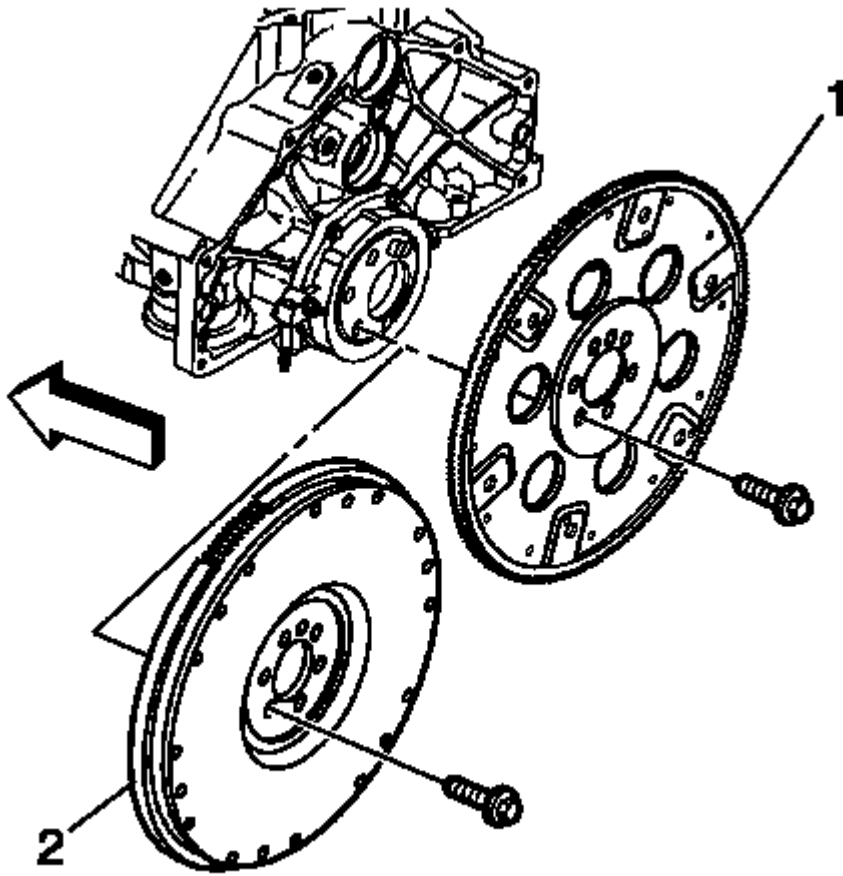


Fig. 283: View Of Flywheels

Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission. Refer to [Transmission Replacement](#) .
2. Remove the flywheel bolts.
3. Remove the flywheel (1 or 2).
4. Clean and inspect the flywheel, if necessary. Refer to [Engine Flywheel Cleaning and Inspection](#) .

INSTALLATION PROCEDURE

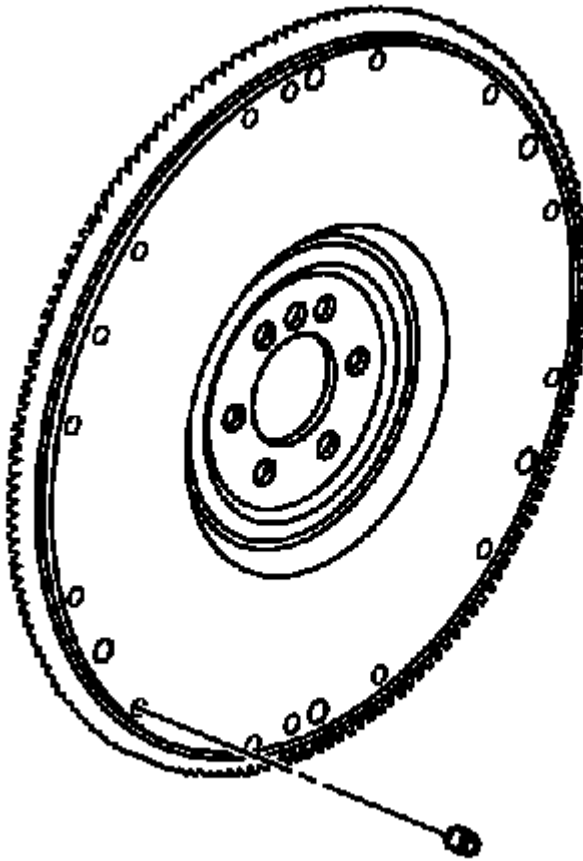


Fig. 284: Locating Flywheel Weights (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

NOTE: Flywheel weights of the same length must be installed into the NEW flywheel in the same location as the old weights were in the old flywheel.

1. Note the position of the old flywheel weights and install the NEW flywheel weights as required.

A properly installed flywheel weight will be flush or slightly below flush with the face of the flywheel.

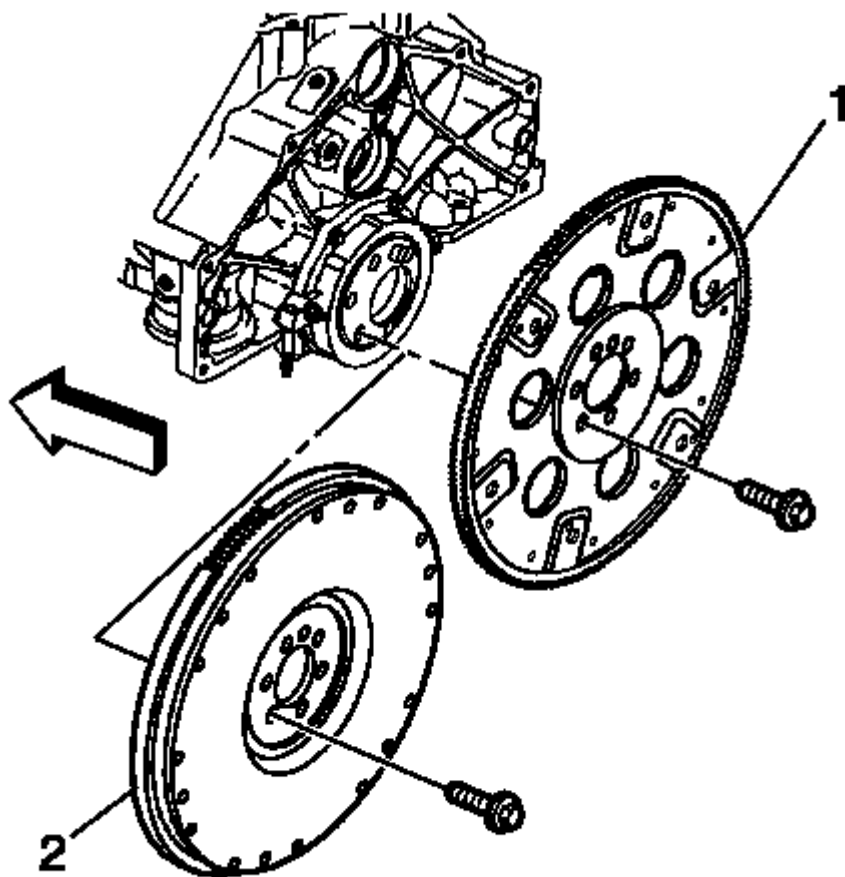


Fig. 285: View Of Flywheels

Courtesy of GENERAL MOTORS CORP.

2. Install the flywheel (1 or 2).

Align the flywheel locator hole to the flywheel locator pin.

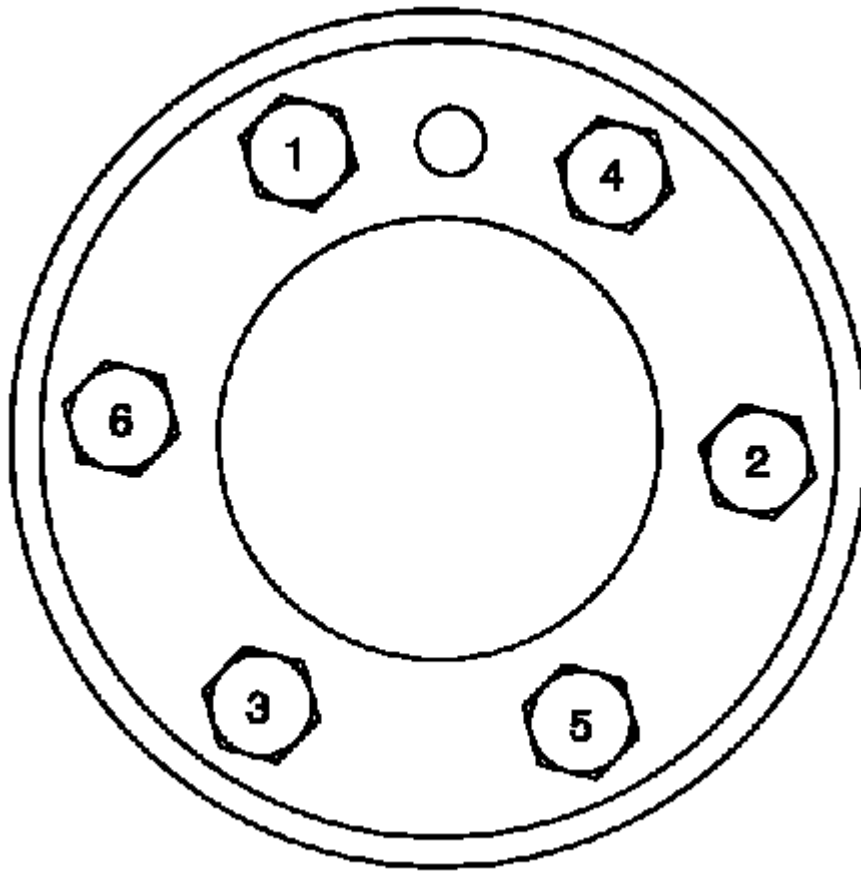


Fig. 286: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the flywheel bolts and tighten in the sequence shown to 100 N.m (74 lb ft).
4. Install the automatic transmission. Refer to Transmission Replacement .

ENGINE REPLACEMENT

SPECIAL TOOLS

J 41427 Engine Lift Brackets

REMOVAL PROCEDURE

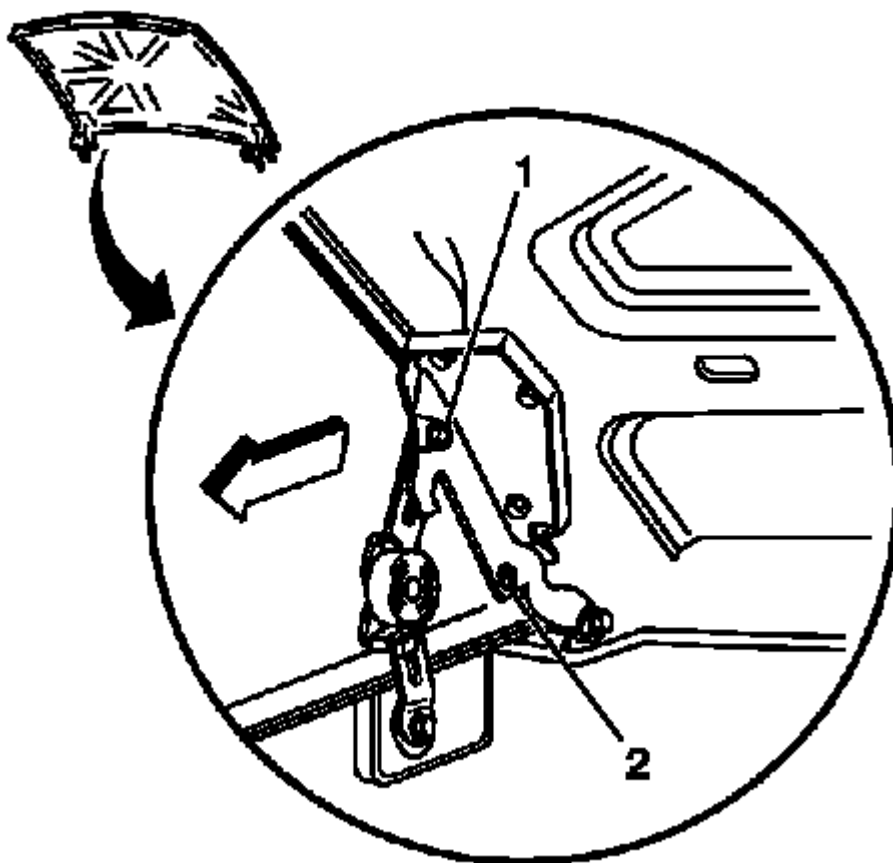


Fig. 287: Identifying Hood Hinge Normal And Service Position Bolt Holes
 Courtesy of GENERAL MOTORS CORP.

1. Raise the hood to the service position, perform the following:
 1. Remove the hood hinge bolts (1).
 2. Raise the hood until vertical.
 3. Install the hood hinge bolts until snug in the service position (2).
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the cooling layer. Refer to **Cooling Layer Removal** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)** .
5. Remove the fuel pipes/hoses. Refer to **Fuel Line Replacement - Engine** .
6. Remove the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L)** .
7. Remove the drive belt. Refer to **Drive Belt Replacement**.
8. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
9. Remove the starter. Refer to **Starter Replacement (V6)** .

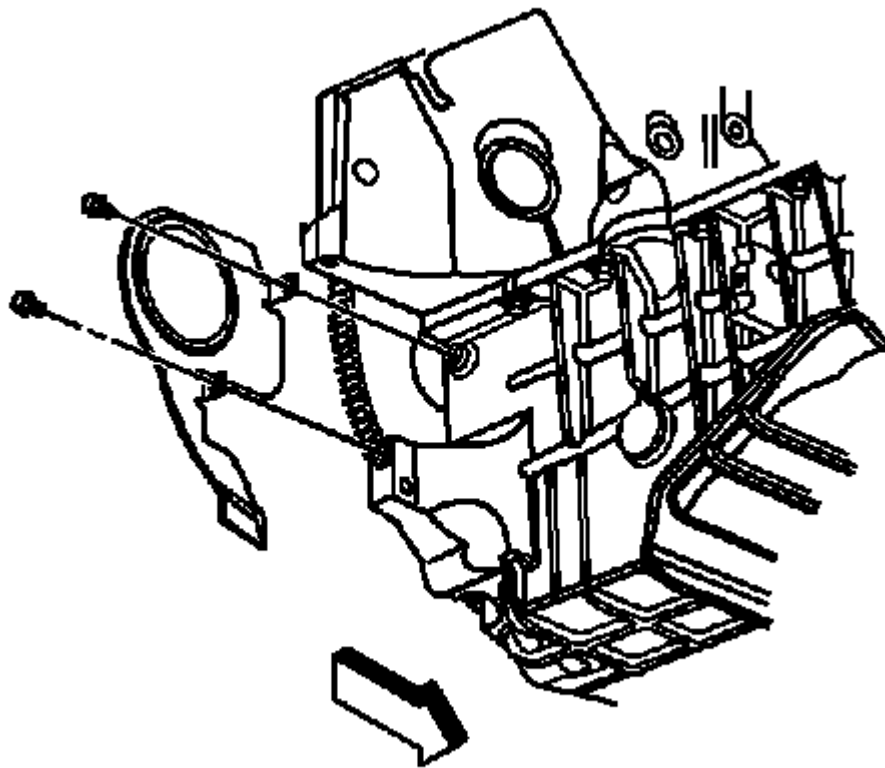


Fig. 288: View Of Transmission Cover
Courtesy of GENERAL MOTORS CORP.

10. Remove the transmission cover.

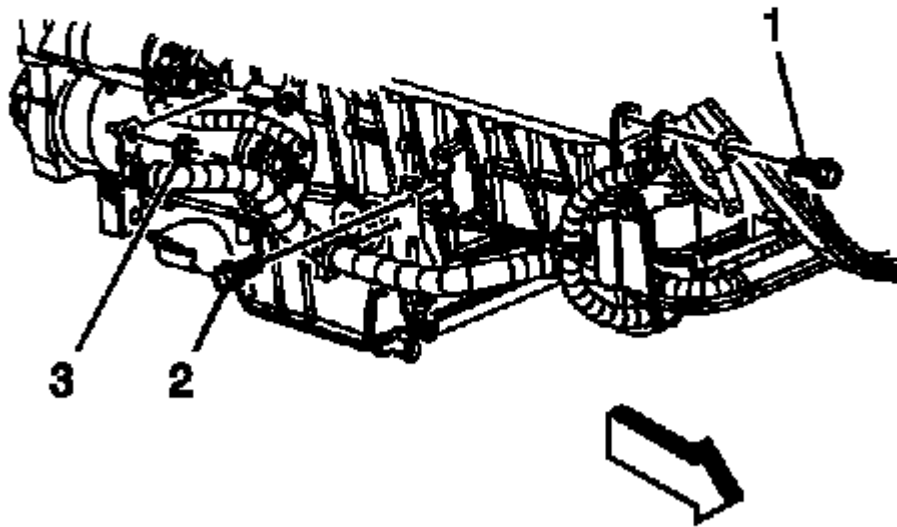


Fig. 289: View Of Engine Wiring Harness Ground/Negative Battery Cable Bolt (4.3L Engine)
Courtesy of GENERAL MOTORS CORP.

11. Remove the positive battery cable clip bolt (2).
12. Remove the catalytic converter. Refer to **Catalytic Converter Replacement (V6)** .

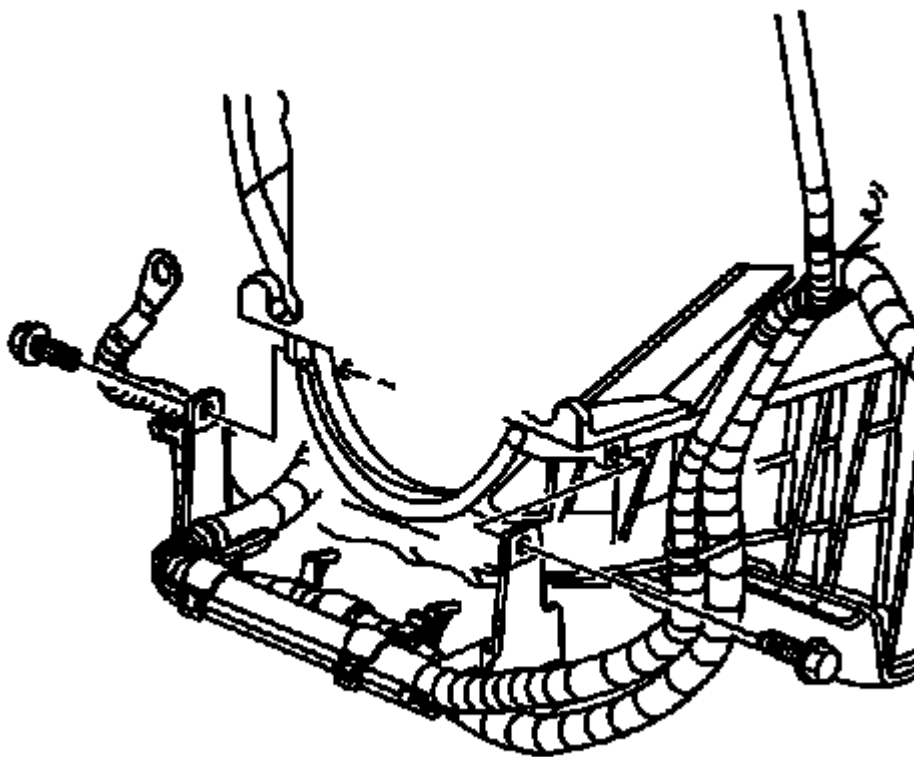


Fig. 290: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the battery cable bracket bolts.

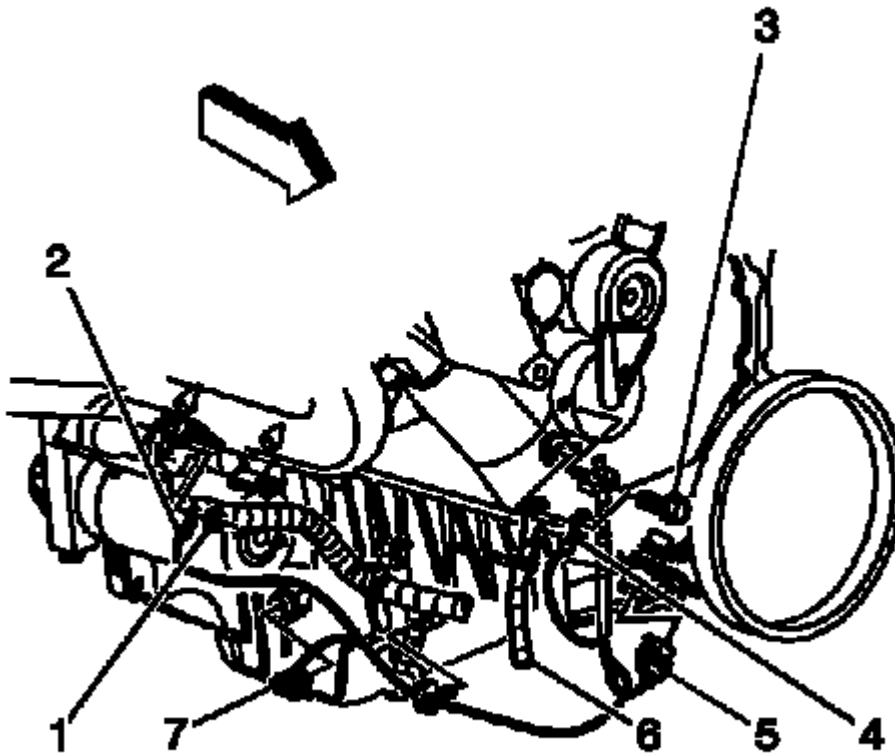


Fig. 291: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

14. Disconnect the crankshaft position (CKP) sensor electrical connector (5) and remove the harness from the retainer clip.
15. Remove the ground bolt (3) holding the negative battery cable (6) and ground cable (4) to the engine.

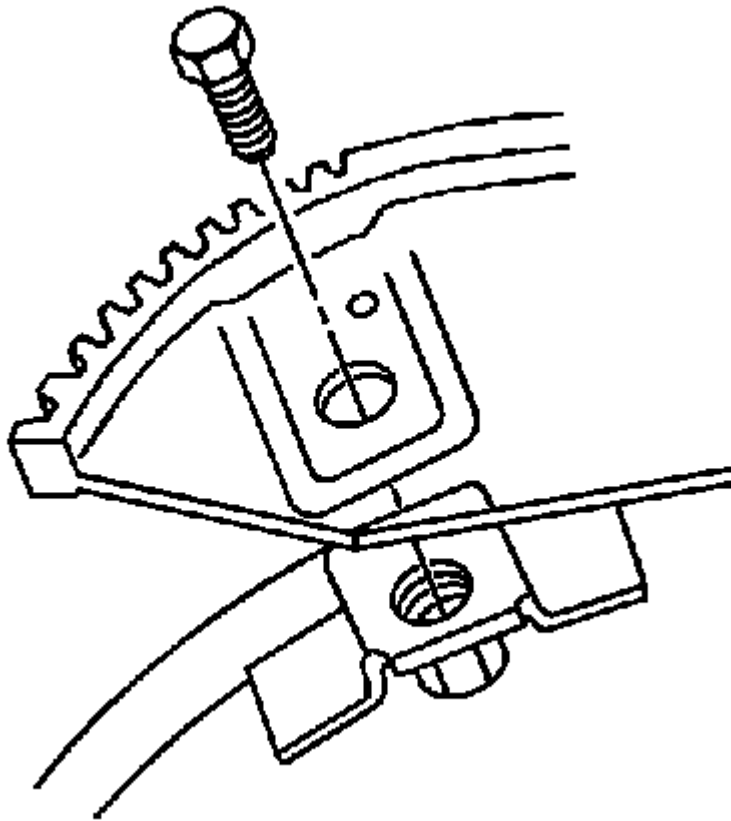


Fig. 292: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

16. If equipped, remove the torque converter bolts.
17. Remove the transmission bolts.
18. Lower the vehicle.

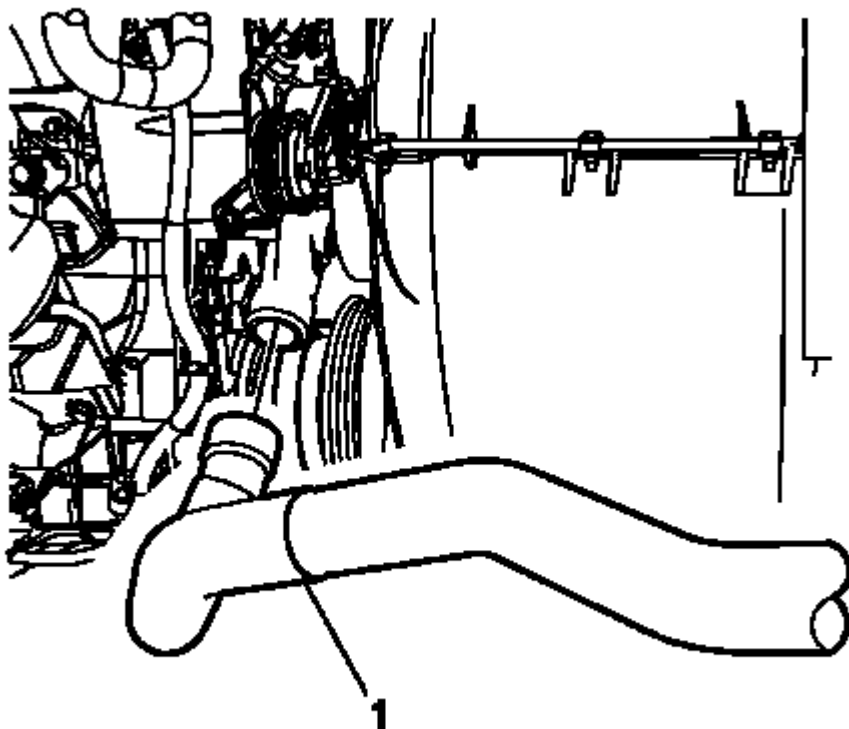


Fig. 293: Identifying Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

19. Reposition the radiator outlet hose clamps.
20. Remove the radiator outlet hose (1) from the water pump.

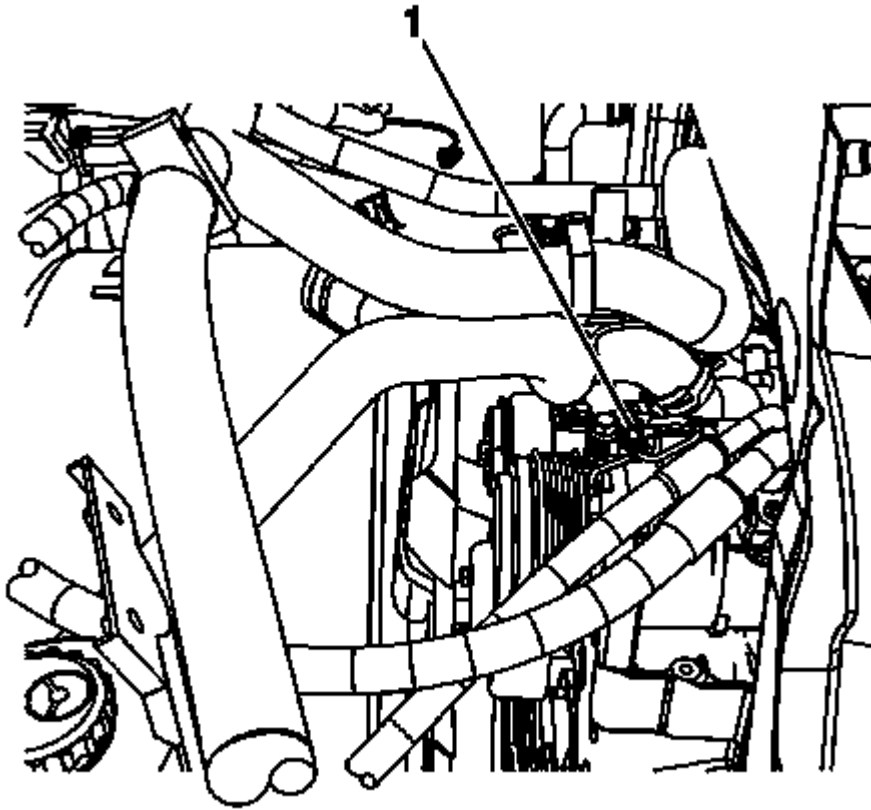


Fig. 294: Locating Air Conditioning (A/C) Compressor Clutch
Courtesy of GENERAL MOTORS CORP.

21. Disconnect the air conditioning (A/C) compressor clutch (1), if equipped
22. If equipped, remove the air conditioning (A/C) hoses. Refer to **Discharge Hose Replacement** and **Suction Hose Replacement** .
23. Remove the positive cable nut and cable from the generator.

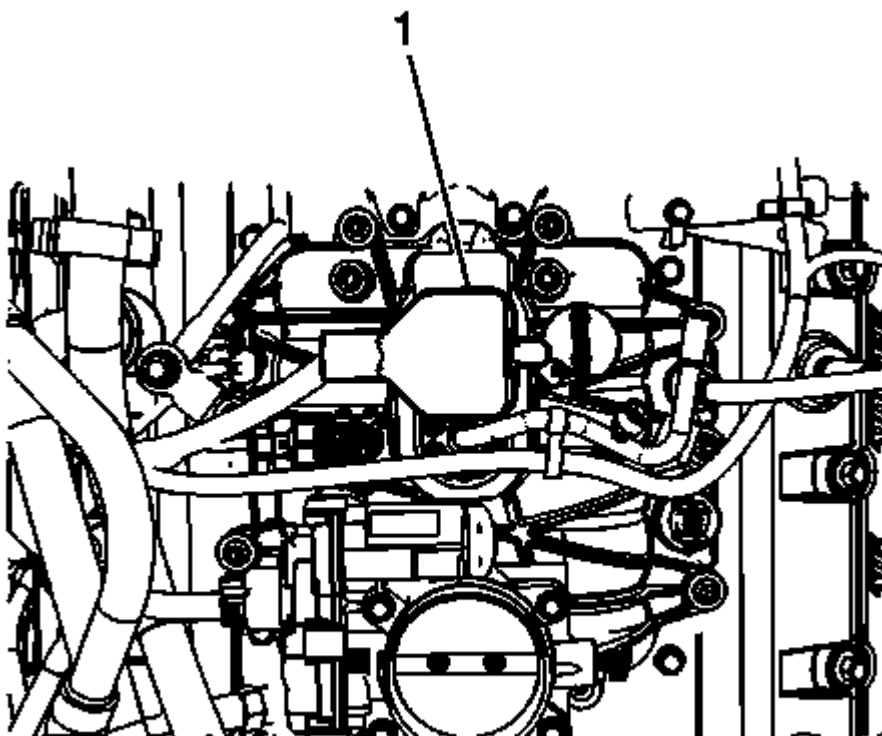


Fig. 295: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

24. Disconnect the control port injector module (1).

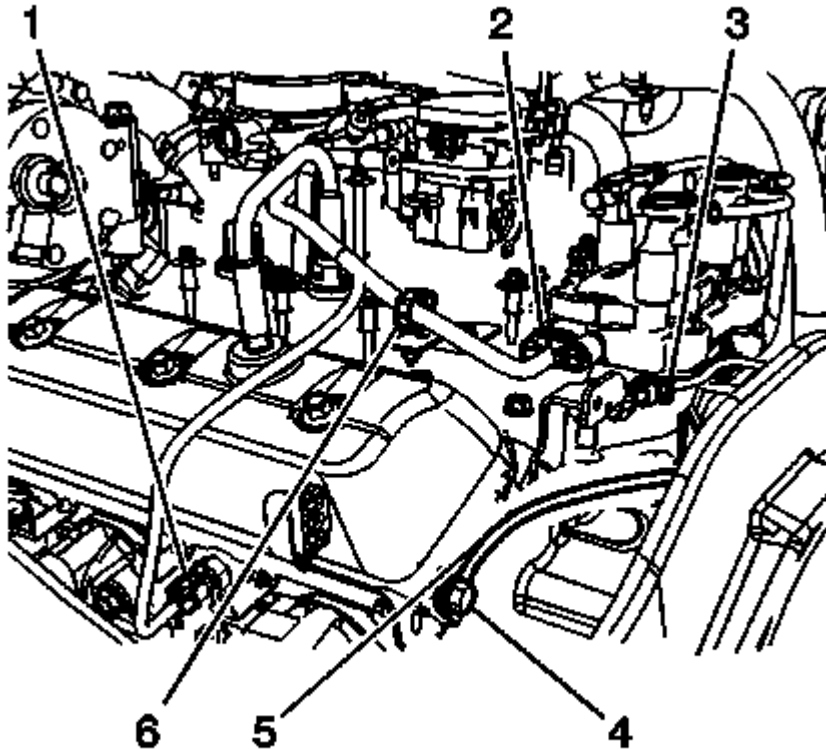


Fig. 296: Locating Engine Coolant Temperature Sensor, Ignition Coil & Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

25. Disconnect the following electrical connectors:
 - Engine coolant temperature sensor (1)
 - Ignition coil (2)
 - Oil pressure sensor (3)
26. Remove the harness ground bolt (4).
27. Reposition the harness ground (5).
28. Remove the ignition coil wiring harness clip (6) from the engine wiring bracket.
29. Unclip the ignition coil wiring harness from the fuel feed pipe.

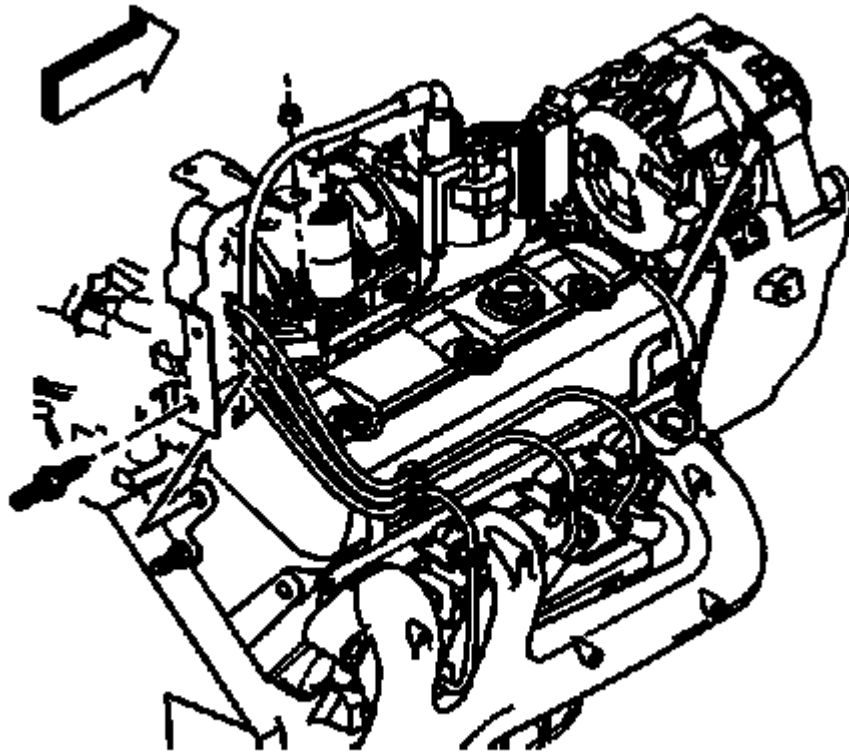


Fig. 297: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

30. Remove the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.
31. Remove the stud holding the engine wiring harness bracket.
32. Reposition the engine wiring harness with the bracket aside.
33. Remove the heater hoses. Refer to **Heater Inlet Hose Replacement (4.3L)** or **Heater Outlet Hose Replacement (4.3L)** .

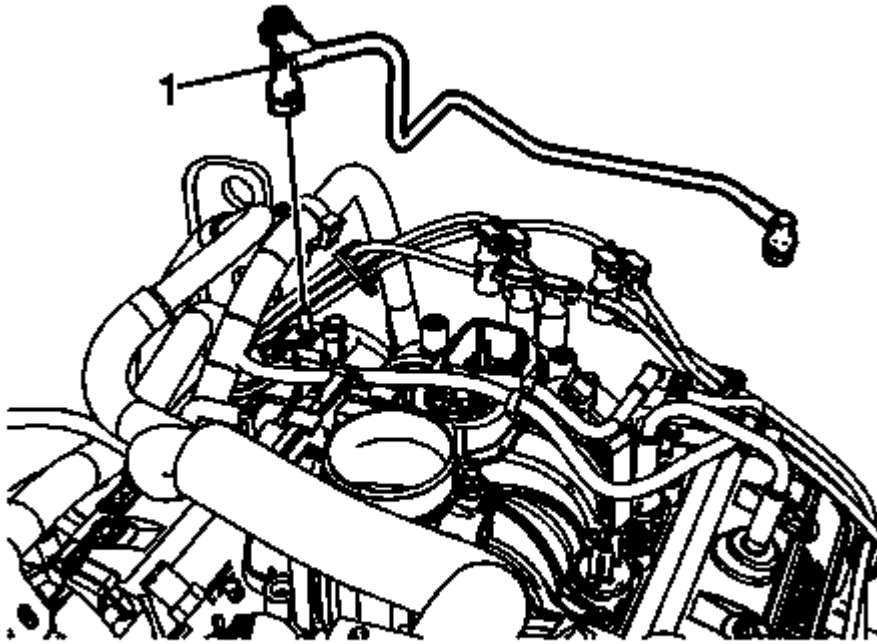


Fig. 298: View Of Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

34. Disconnect the EVAP canister harness (1) from the purge solenoid valve.
35. Disconnect the power brake booster vacuum hose from the vacuum fitting.
36. Remove the thermostat and water outlet. Refer to **Engine Coolant Thermostat Replacement (V6)** .
37. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

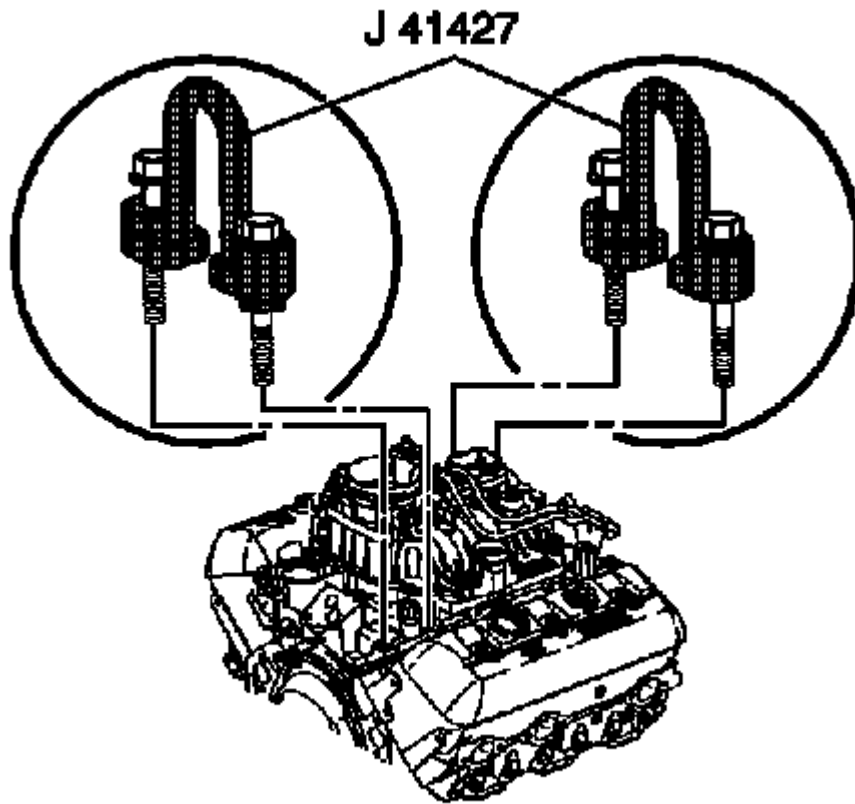


Fig. 299: View Of J 41427 & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

38. Remove the left front and right rear intake manifold lower bolts.
39. Install **J 41427** to the left front and right rear intake manifold bolts, using the following procedure:
 1. Install the **J 41427** marked RIGHT REAR.

CAUTION: Refer to Fastener Caution .

2. Install the lift bracket bolts and tighten to 15 N.m (11 lb ft).
 3. Install the **J 41427** marked LEFT FRONT with the arrow pointing to the front of the engine.
 4. Install the lift bracket bolts and tighten to 15 N.m (11 lb ft).
40. Install a suitable lifting devise to the engine lift brackets.

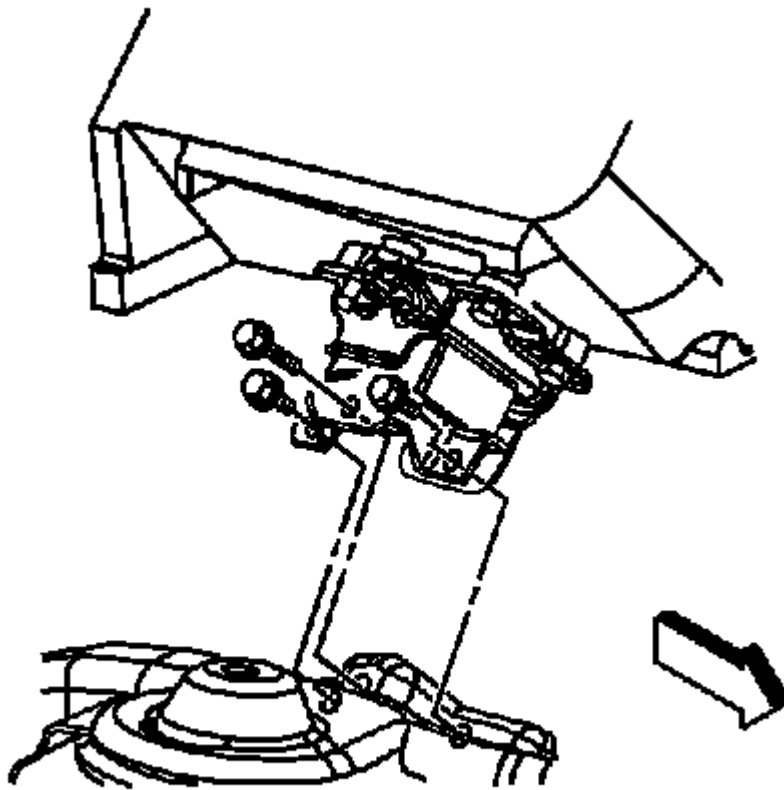


Fig. 300: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

41. Remove the engine mount to engine mount bracket nuts.
42. Support the transmission with a suitable floor jack.
43. Remove the engine.

INSTALLATION PROCEDURE

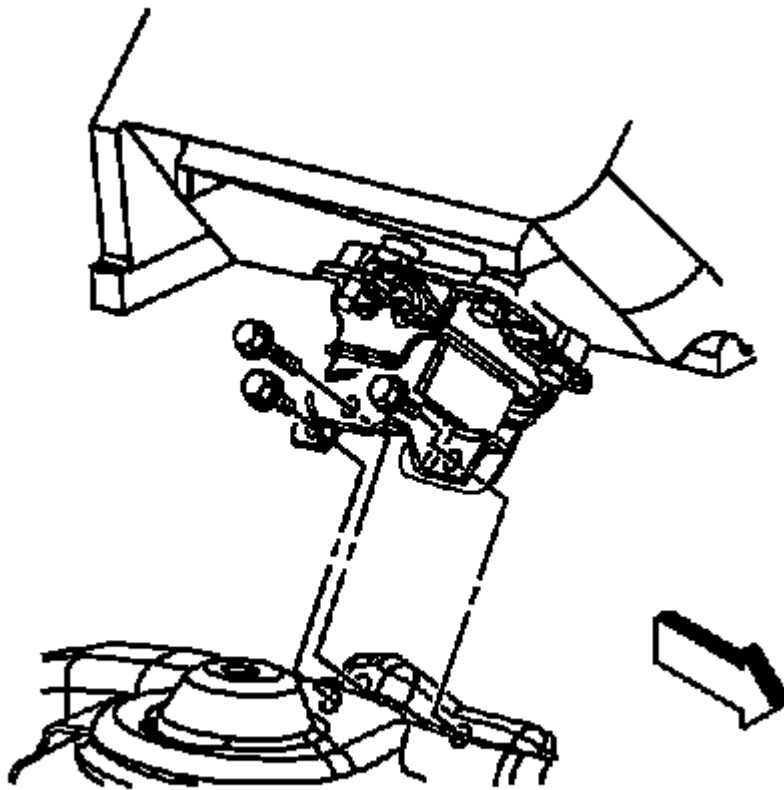


Fig. 301: Locating Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine.
2. Install the engine mount to engine mount bracket bolts and tighten to 65 N.m (48 lb ft).

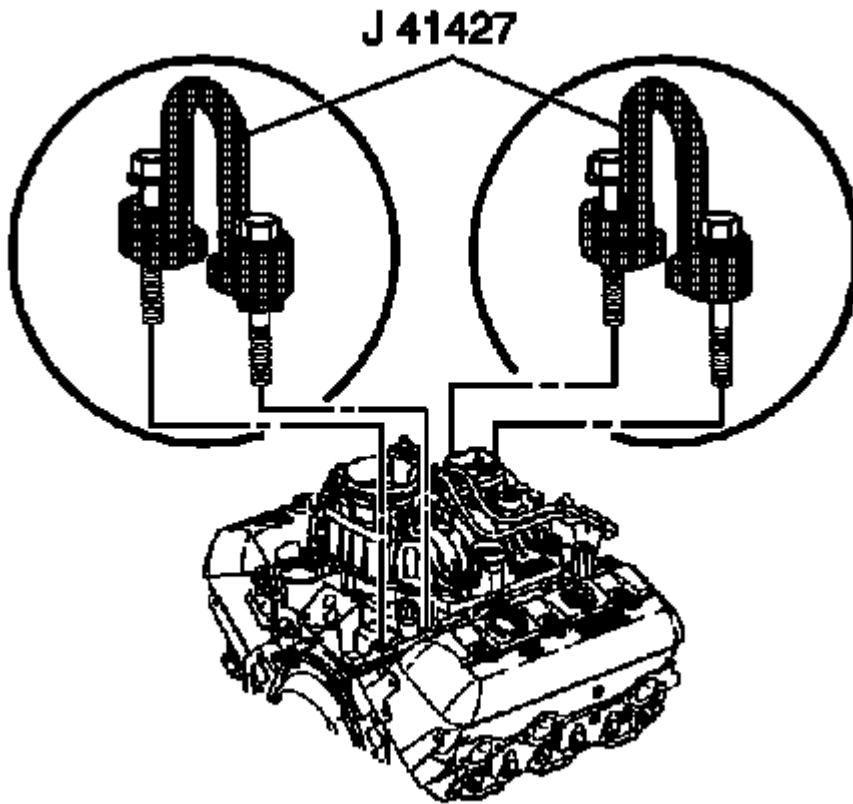


Fig. 302: View Of J 41427 & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

3. Remove the lifting device and the J 41427 .
4. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
5. Install one transmission bolt until snug.
6. Remove the support jack from under the transmission.
7. Install the thermostat and water outlet. Refer to **Engine Coolant Thermostat Replacement (V6)** .

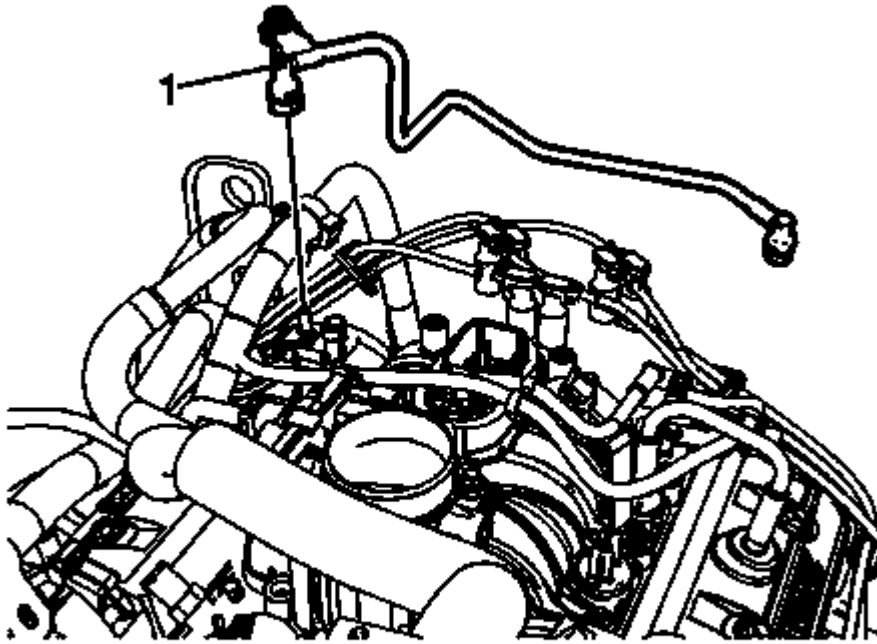


Fig. 303: View Of Tube Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

8. Connect the power brake booster vacuum hose to the vacuum fitting.
9. Connect the EVAP canister harness (1) to the purge solenoid valve.
10. Install the heater hoses. Refer to **Heater Inlet Hose Replacement (4.3L)** and **Heater Outlet Hose Replacement (4.3L)** .

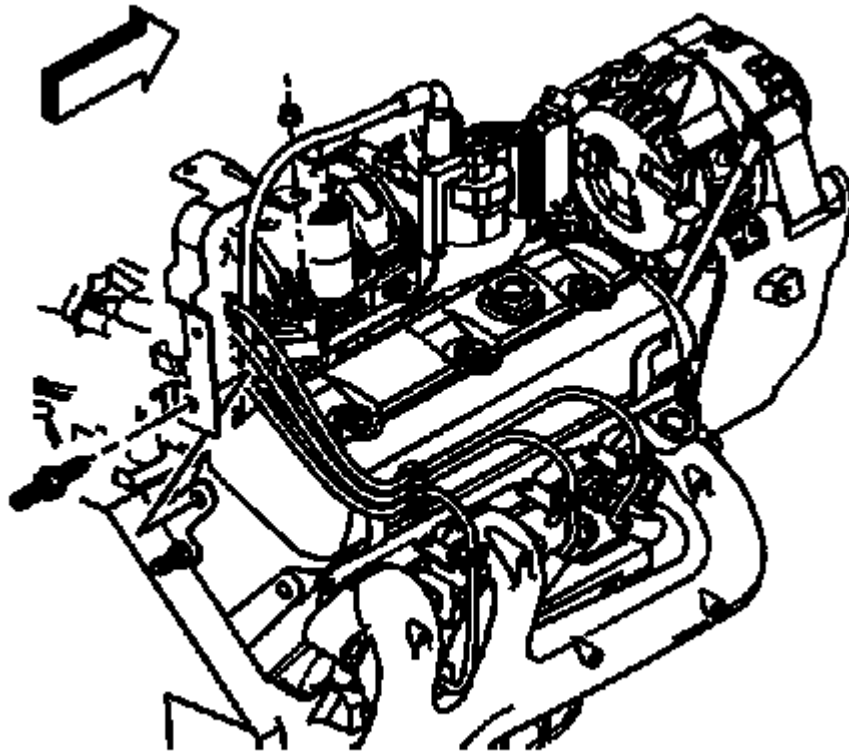


Fig. 304: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

11. Position the engine wiring harness.
12. Install the stud holding the engine wiring harness bracket.
13. Install the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve and tighten to 9 N.m (80 lb in).

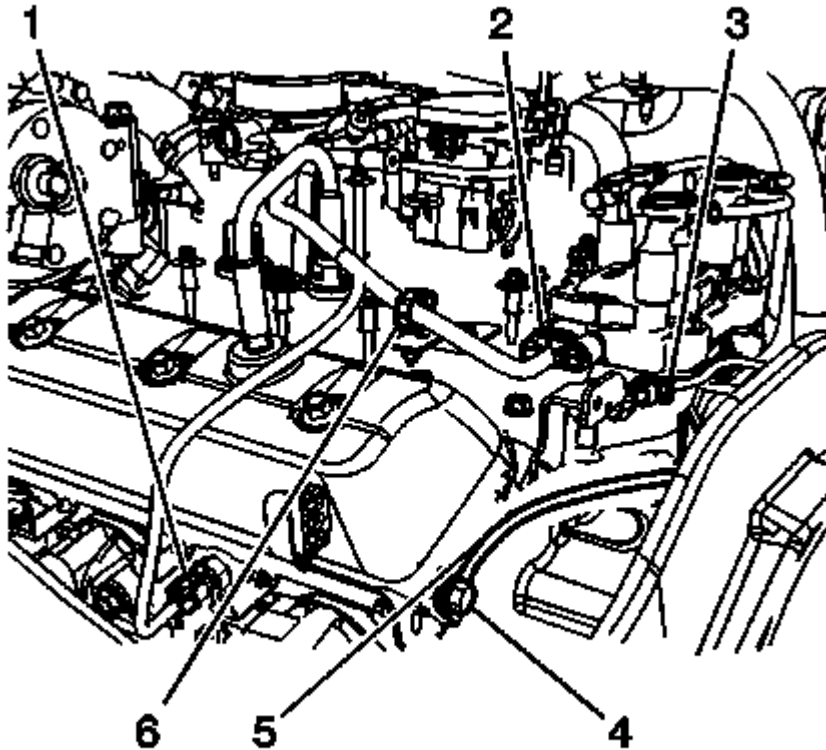


Fig. 305: Locating Engine Coolant Temperature Sensor, Ignition Coil & Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

14. Reposition the harness ground (5).
15. Install the harness ground bolt (4) and tighten to 16 N.m (12 lb ft).
16. Connect the following electrical connectors:
 - Oil pressure sensor (3)
 - Ignition coil (2)
 - Engine coolant temperature sensor (1)
17. Install the ignition coil harness retaining clip (6) into the engine wiring harness bracket.

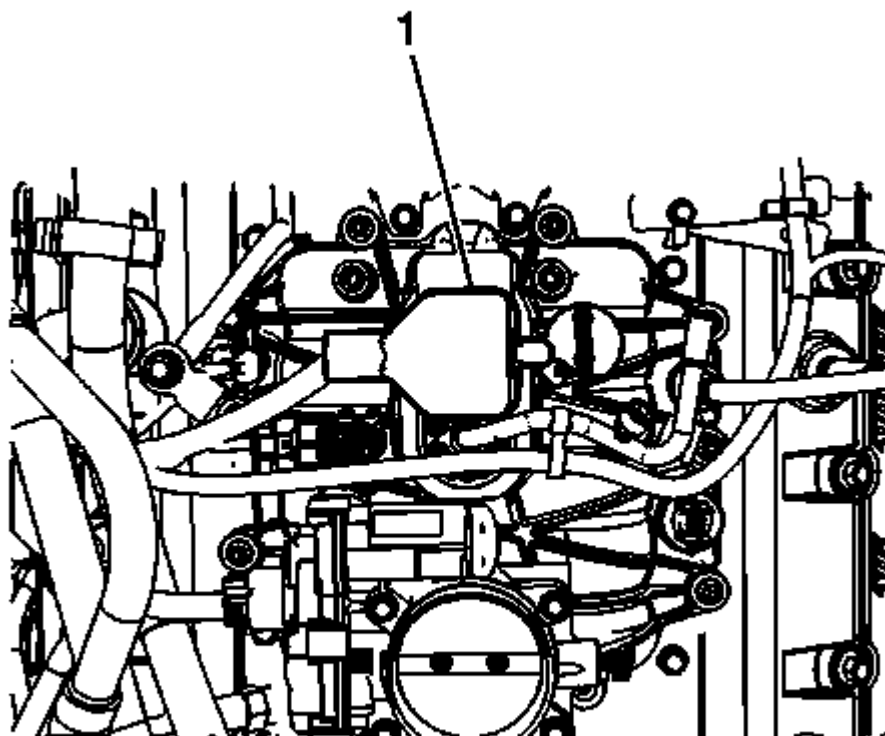


Fig. 306: View Of Control Port Injector Module
Courtesy of GENERAL MOTORS CORP.

18. Connect the control port injector module (1).

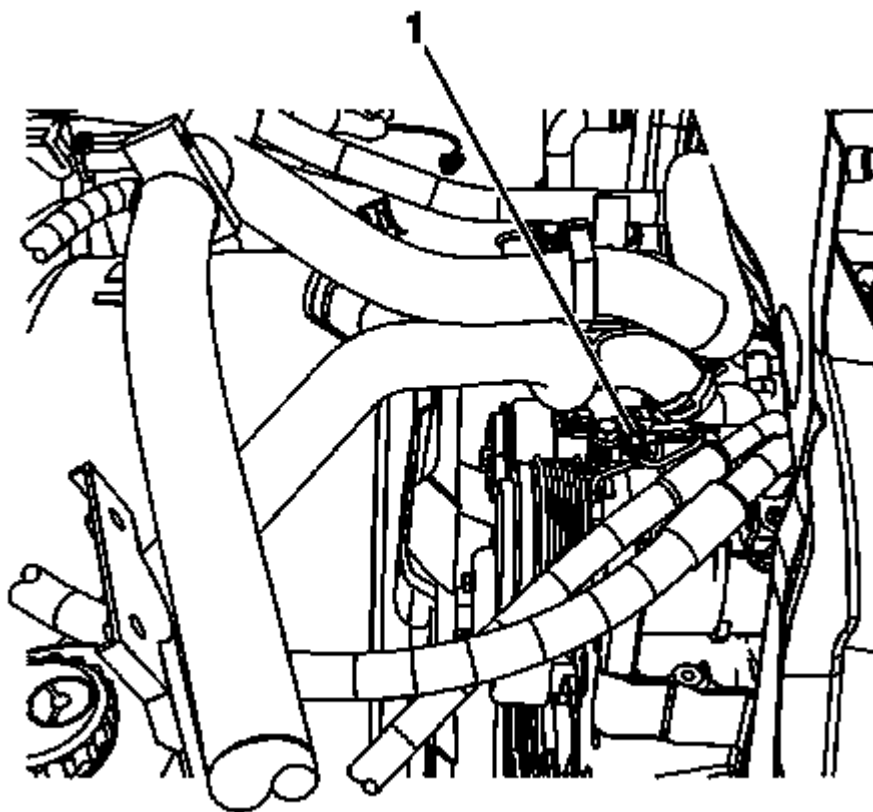


Fig. 307: Locating Air Conditioning (A/C) Compressor Clutch
Courtesy of GENERAL MOTORS CORP.

19. If equipped, install the A/C hoses. Refer to **Discharge Hose Replacement** and **Suction Hose Replacement**.
20. Connect the A/C compressor clutch (1), if equipped.

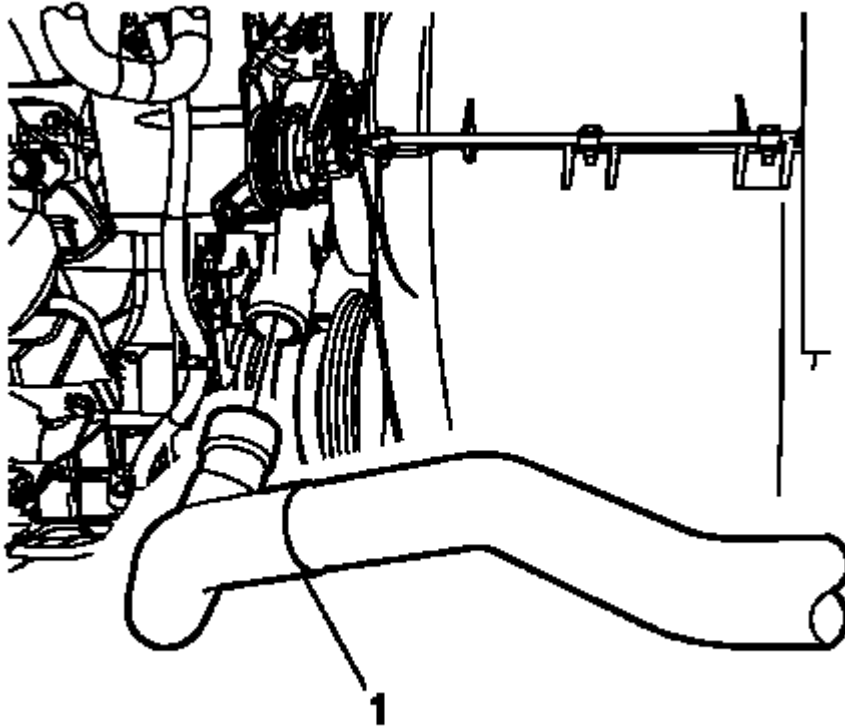


Fig. 308: Identifying Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

21. Install the radiator outlet hose (1) to the water pump.
22. Position the radiator outlet hose clamps.
23. Install the drive belt. Refer to **Drive Belt Replacement**.
24. Install the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L)** .
25. Install the fuel pipes/hoses. Refer to **Fuel Line Replacement - Engine** .

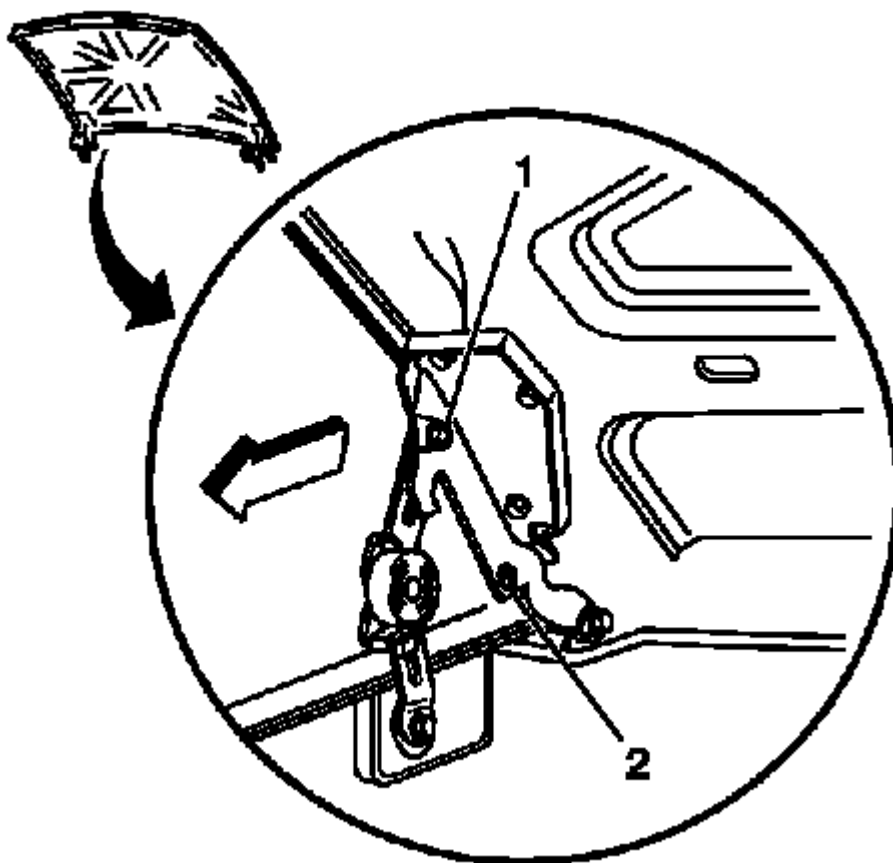


Fig. 309: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

26. Remove the hood hinge bolt from the service position (2).
27. Lower the hood to the normal position.
28. Install the hood hinge bolts and tighten to 25 N.m (18 lb ft).
29. Raise the vehicle.

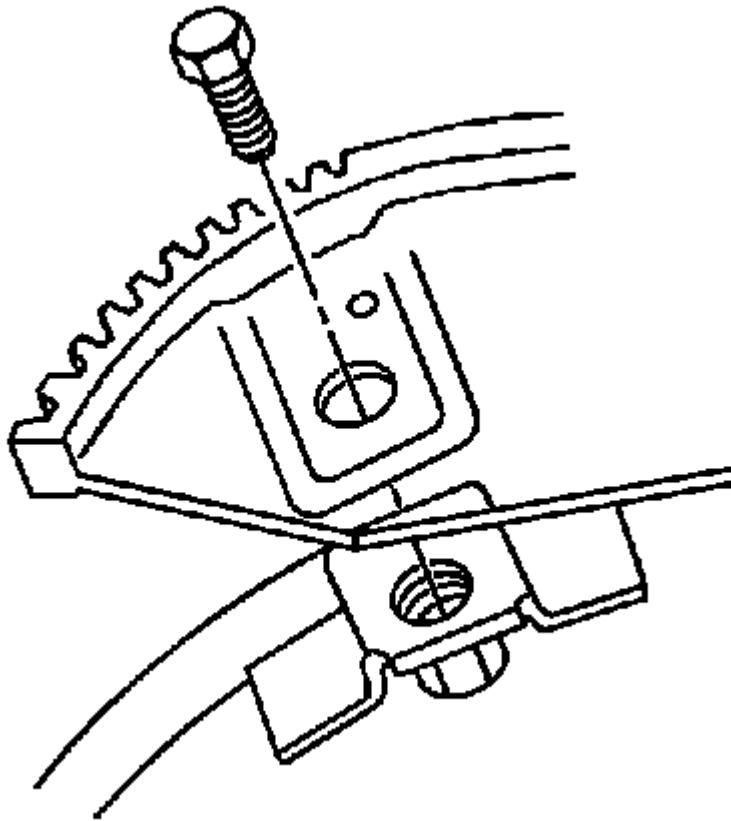


Fig. 310: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

30. Install the transmission bolts and tighten to 50 N.m (37 lb ft).
31. If equipped, install the torque converter bolts and tighten to 63 N.m (47 lb ft).

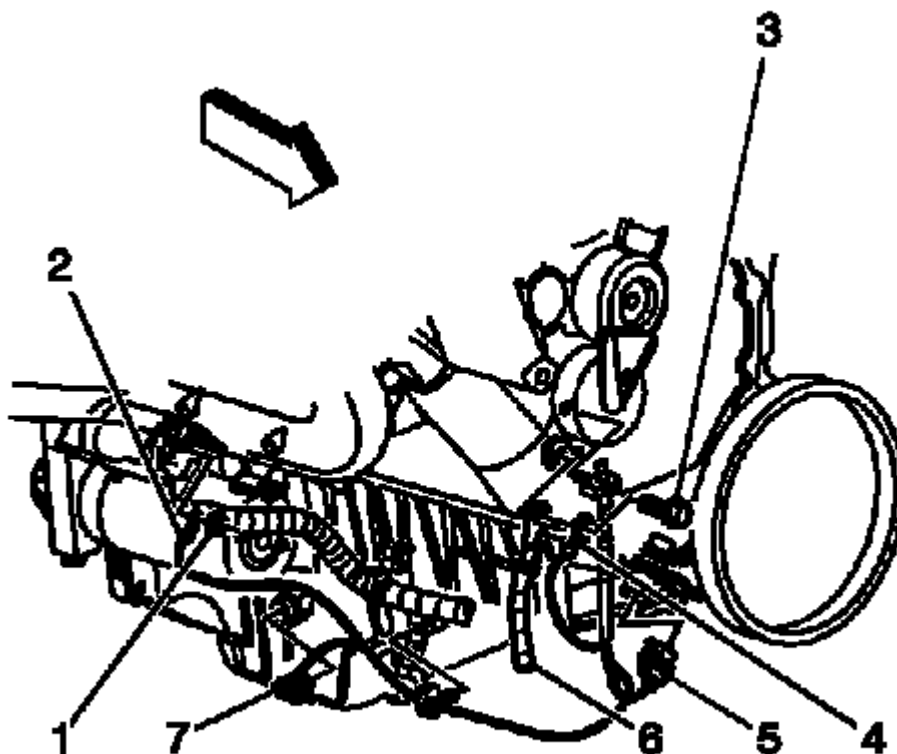


Fig. 311: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

32. Install the ground bolt (3) holding the negative battery cable (6) and ground cable (4) to the engine.
33. Connect the CKP sensor electrical connector (5) and install the harness to the retainer clip.

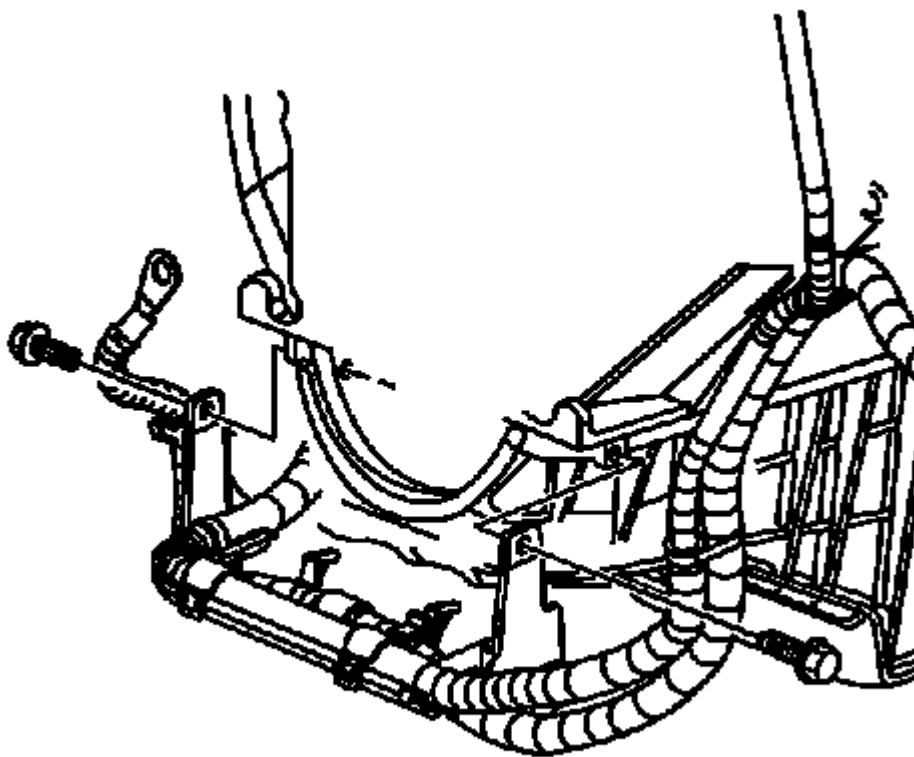


Fig. 312: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

34. Install the battery cable bracket bolts and tighten to 12 N.m (106 lb in).
35. Install the catalytic converter. Refer to **Catalytic Converter Replacement (V6)** .

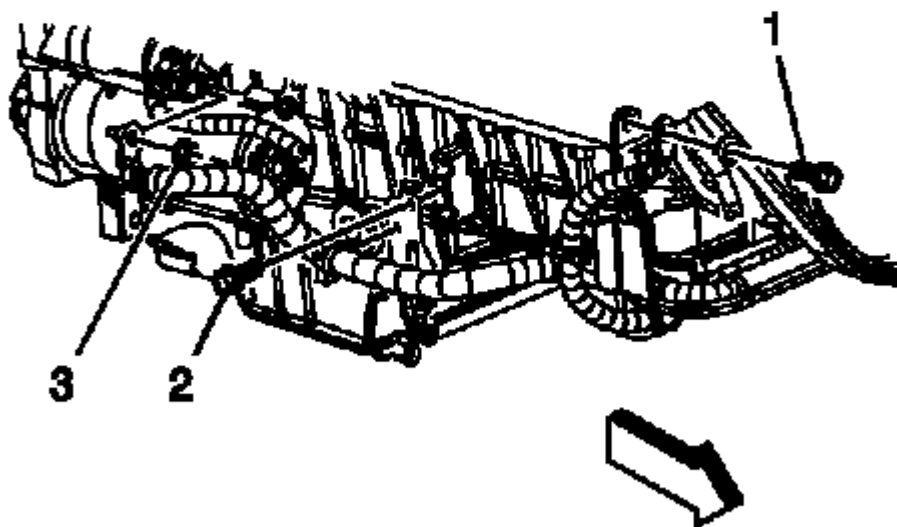


Fig. 313: View Of Engine Wiring Harness Ground/Negative Battery Cable Bolt (4.3L Engine)
Courtesy of GENERAL MOTORS CORP.

36. Install the positive battery cable clip bolt (2).

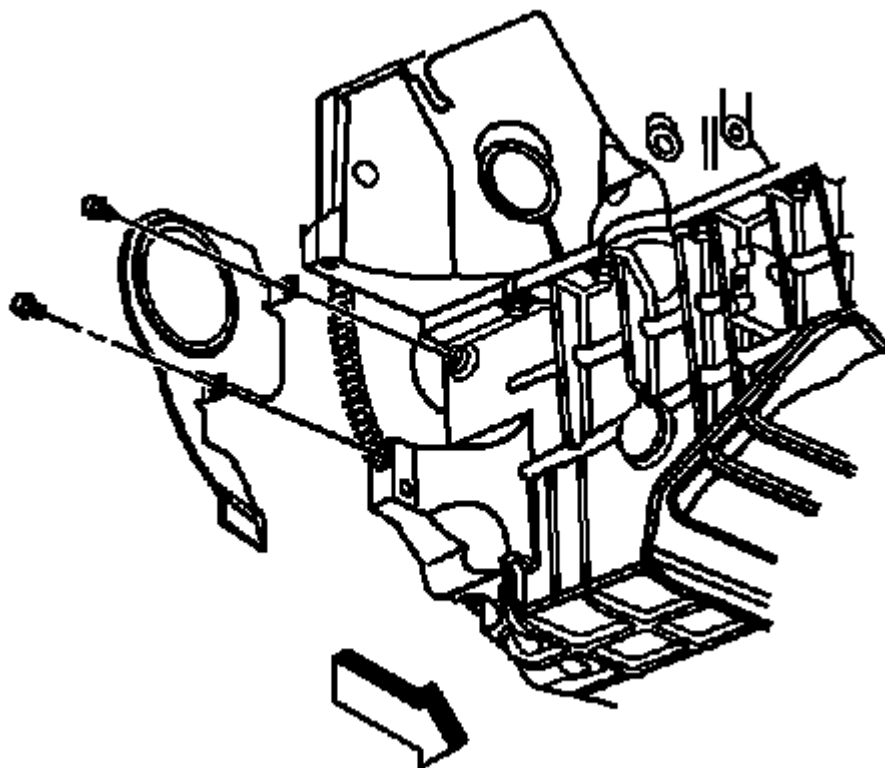


Fig. 314: View Of Transmission Cover
Courtesy of GENERAL MOTORS CORP.

37. Install the transmission cover and tighten the bolts to 12 N.m (106 lb in).
38. Install the starter. Refer to **Starter Replacement (V6)** .
39. Lower the vehicle.
40. Install the cooling layer. Refer to **Cooling Layer Installation** .
41. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
42. Perform the engine prelube procedure. Refer to **Engine Prelubing** .
43. Add engine oil supplement to the engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
44. Disable the ignition system.
45. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
46. Start the engine and listen for unusual noises.
47. Check the oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
48. If necessary, install an oil pressure gauge and measure the oil pressure.
49. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
50. Listen for sticking valve lifters, or other unusual noises.

51. Inspect for fuel, oil, and/or coolant leaks while the engine is running.
52. Perform a final inspection for the proper oil and coolant levels.
53. Close the hood.

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

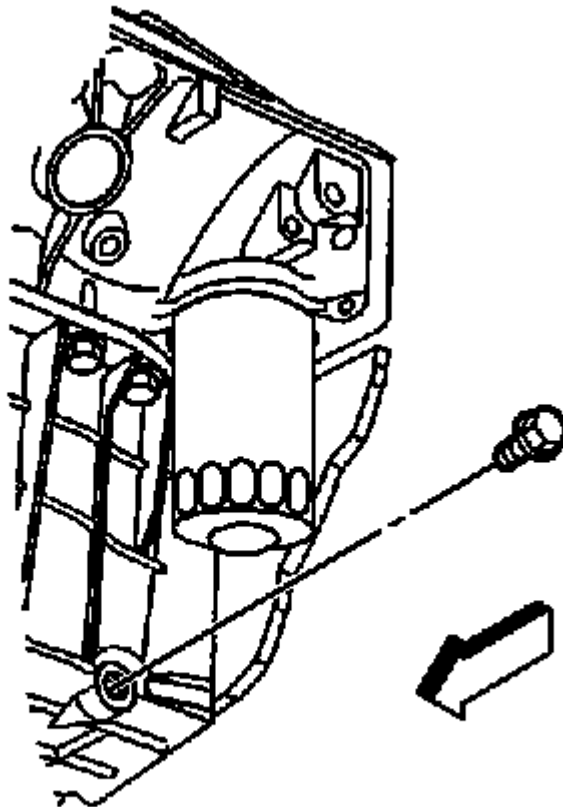


Fig. 315: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the drain plug and drain the engine oil in a suitable container.

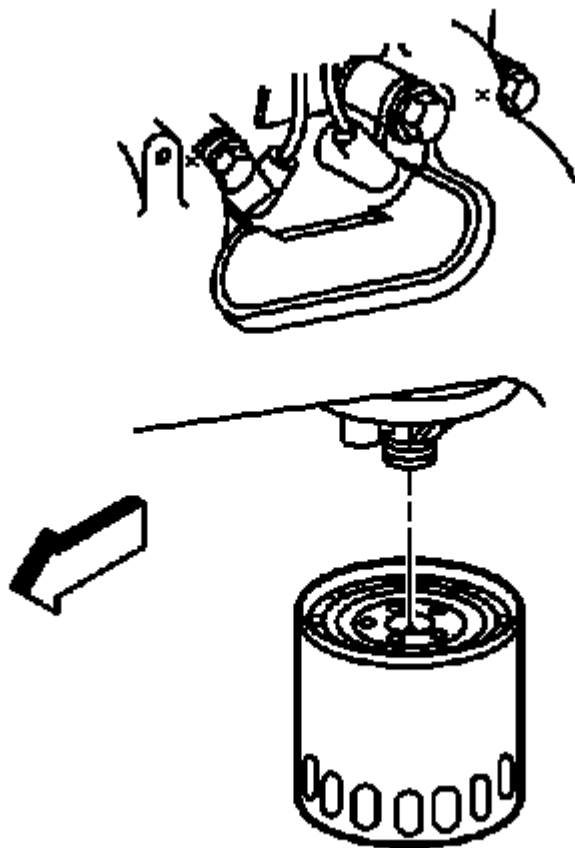


Fig. 316: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter.
4. Inspect to ensure the engine oil filter gasket is removed.

INSTALLATION PROCEDURE

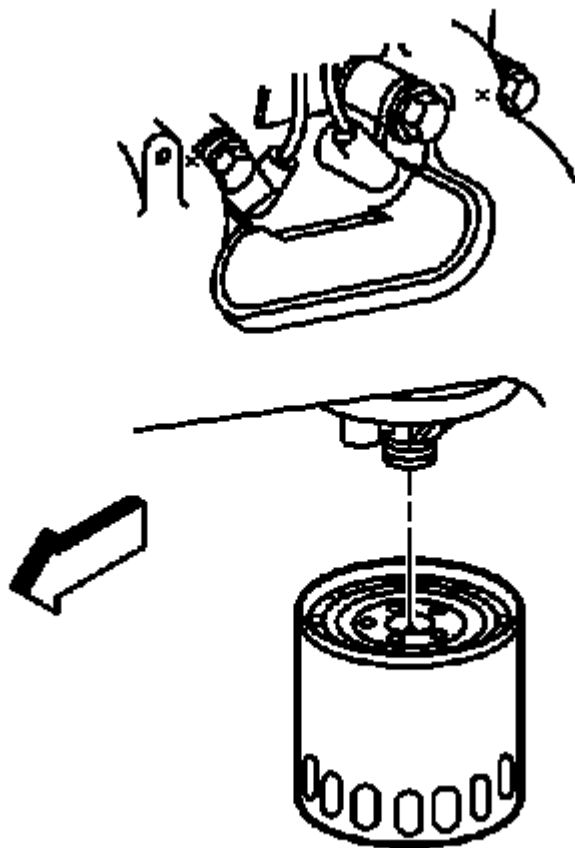


Fig. 317: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil filter gasket with clean engine oil.

CAUTION: Refer to Fastener Caution .

2. Install the oil filter and tighten to 30 N.m (22 lb ft).

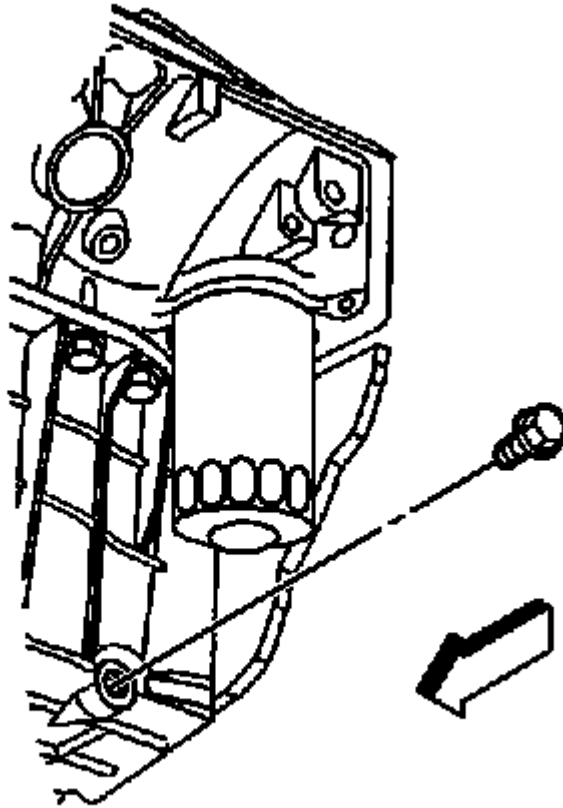


Fig. 318: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the drain plug and tighten to 25 N.m (18 lb ft).
4. Lower the vehicle.
5. Fill the engine with the proper capacity and quality of engine oil. Refer to **Approximate Fluid Capacities**.
6. Operate the engine, check for leaks, and oil pressure.