

2004 ENGINE

Engine Mechanical - 1.4L DOHC - Repair Instructions - On Vehicle - Optra

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

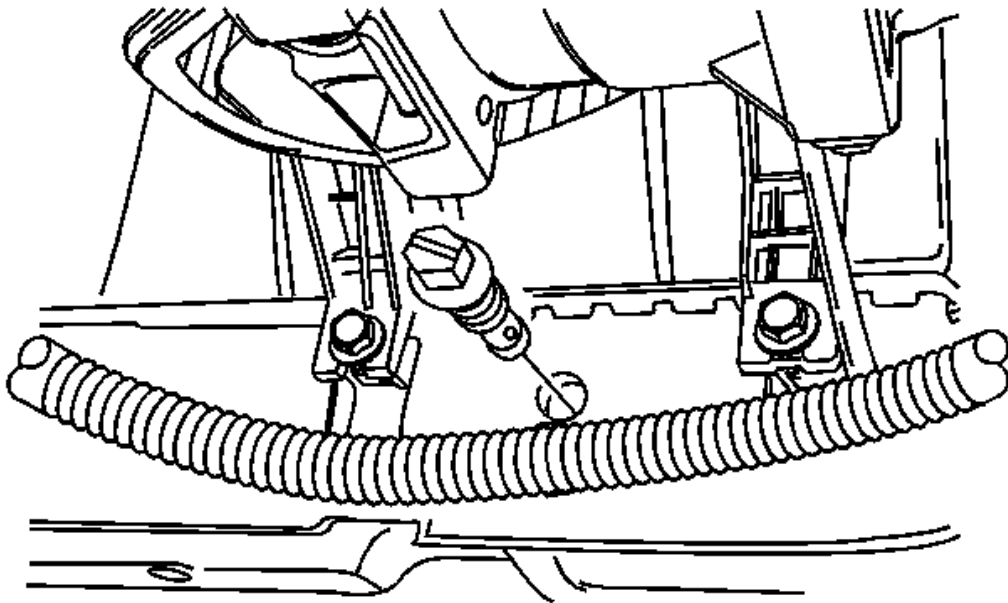


Fig. 1: Identifying Fuel Pump Fuse
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.

CAUTION: Refer to Battery Disconnect Caution .

3. Disconnect the negative battery cable.
4. Disconnect the engine control module (ECM) ground terminal from the intake manifold.

CAUTION: Refer to Safety Glasses Caution .

5. Drain the engine coolant. Refer to Cooling System Draining and Filling (Gasoline Engines) .

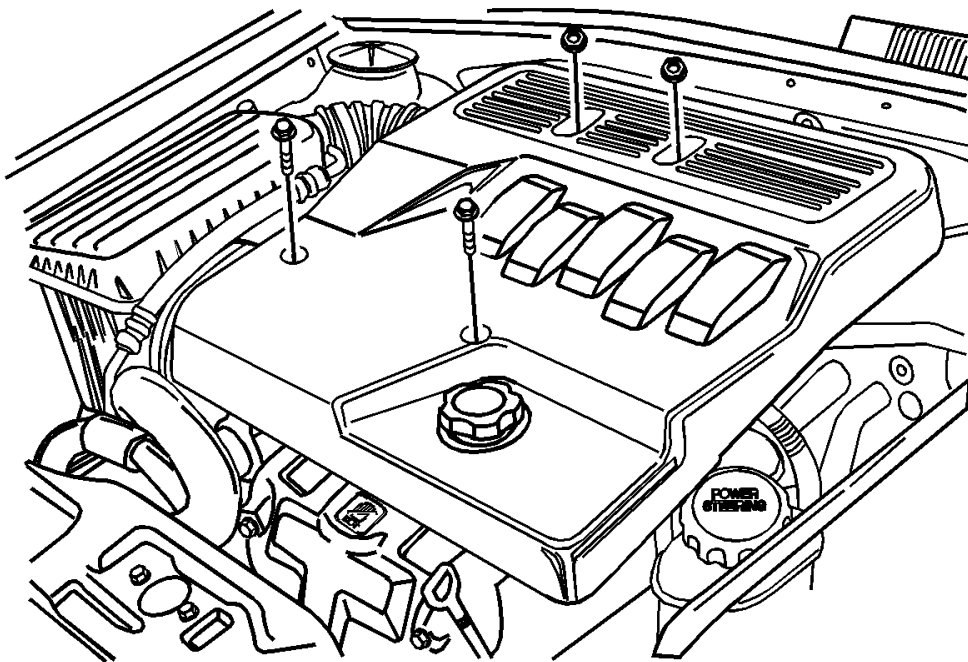


Fig. 2: View Of Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine cover and throttle body. Refer to Throttle Body Assembly Replacement .

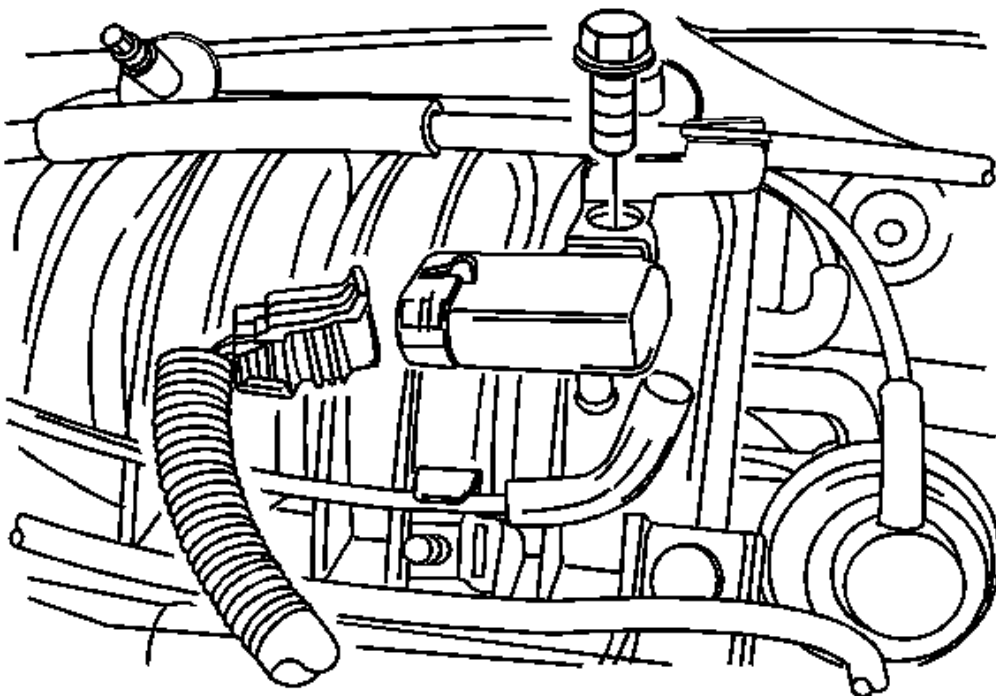


Fig. 3: View Of Intake Manifold Pressure Sensor Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the intake manifold pressure sensor connector, attaching bolt, and vacuum hose.

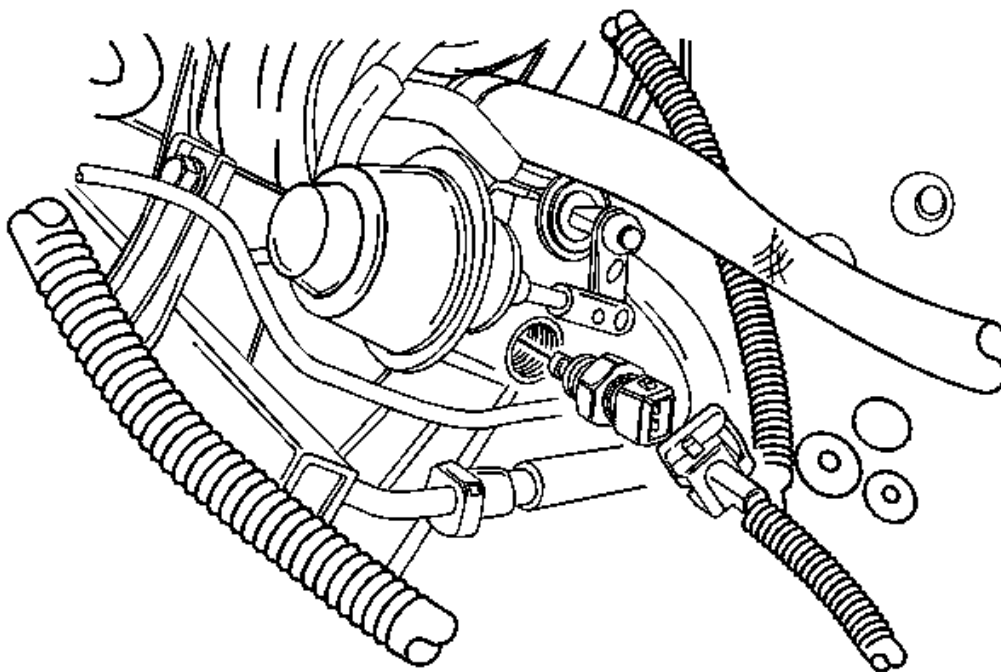


Fig. 4: View Of IAT Sensor And Connector
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the intake air temperature (IAT) sensor connector and remove the IAT sensor.

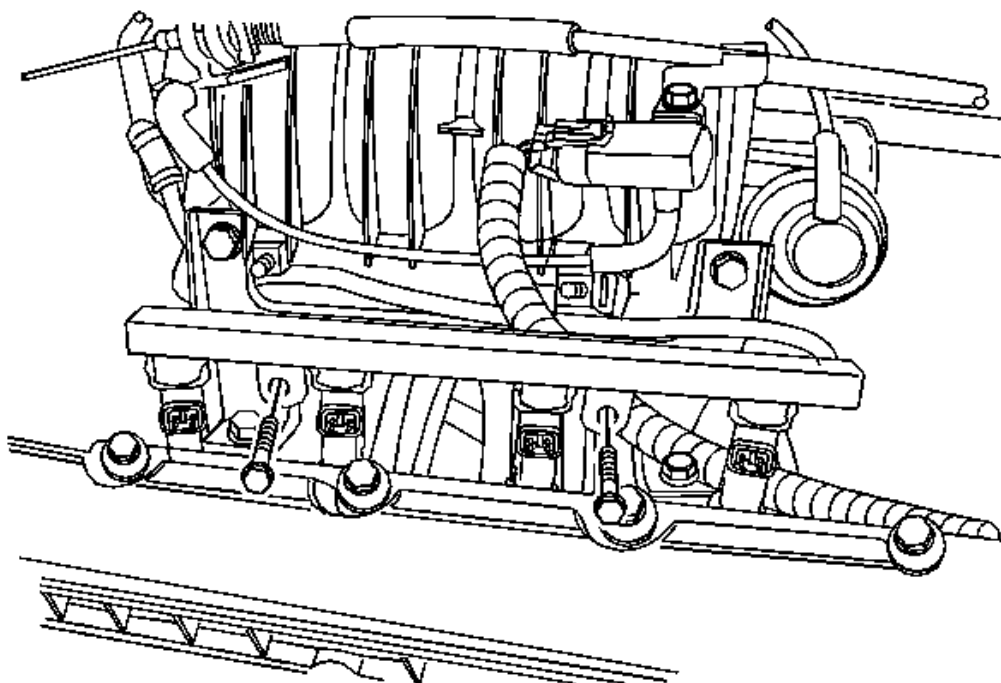


Fig. 5: View Of Fuel Rail And Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the intake manifold upper bracket
10. Remove the fuel rail bolts and the fuel rail.

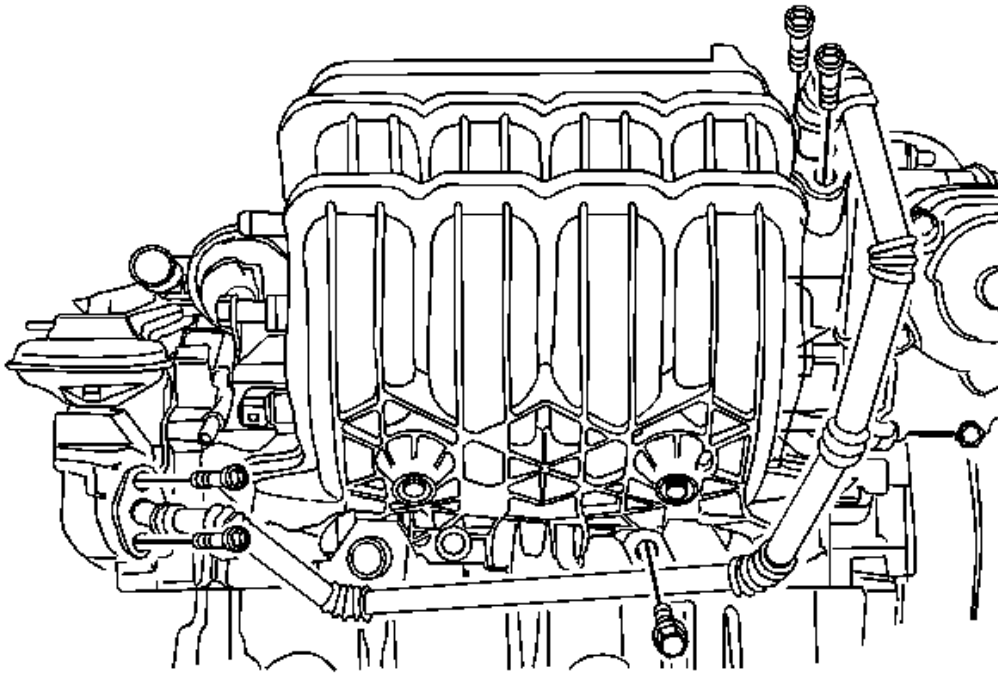


Fig. 6: Identifying EGR Pipe
Courtesy of GENERAL MOTORS CORP.

11. Remove the all the vacuum hoses from the intake manifold including the positive crankcase ventilation (PCV) hose and brake booster vacuum hose.
12. Remove the exhaust gas recirculation (EGR) pipe.

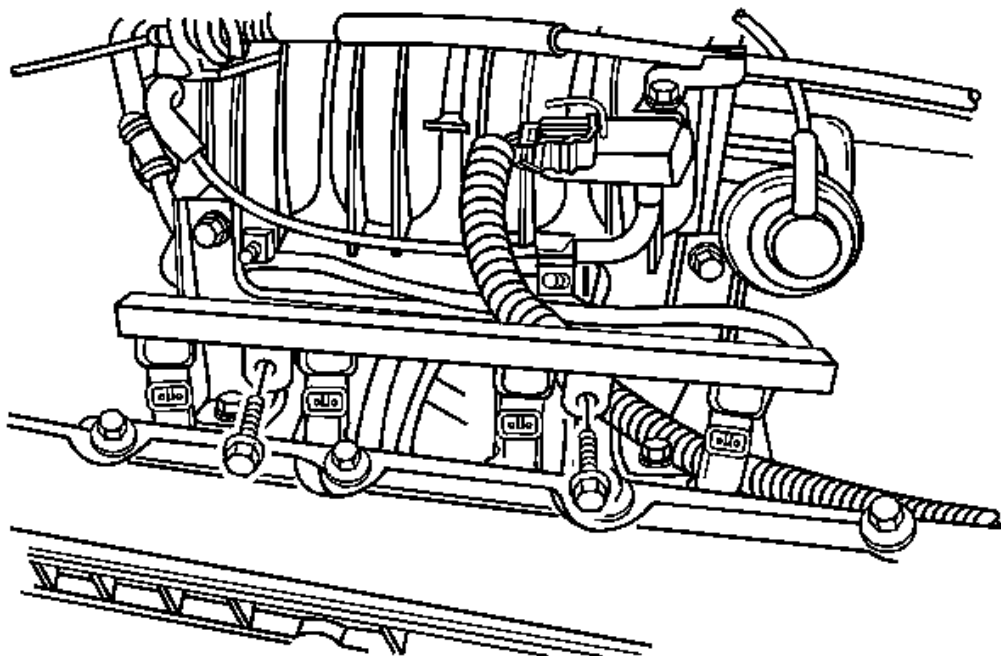


Fig. 7: View Of Fuel Rail And Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the intake manifold upper bracket bolts.
14. Remove the intake manifold upper bracket.
15. Remove the fuel rail bolts.
16. Remove the fuel rail.

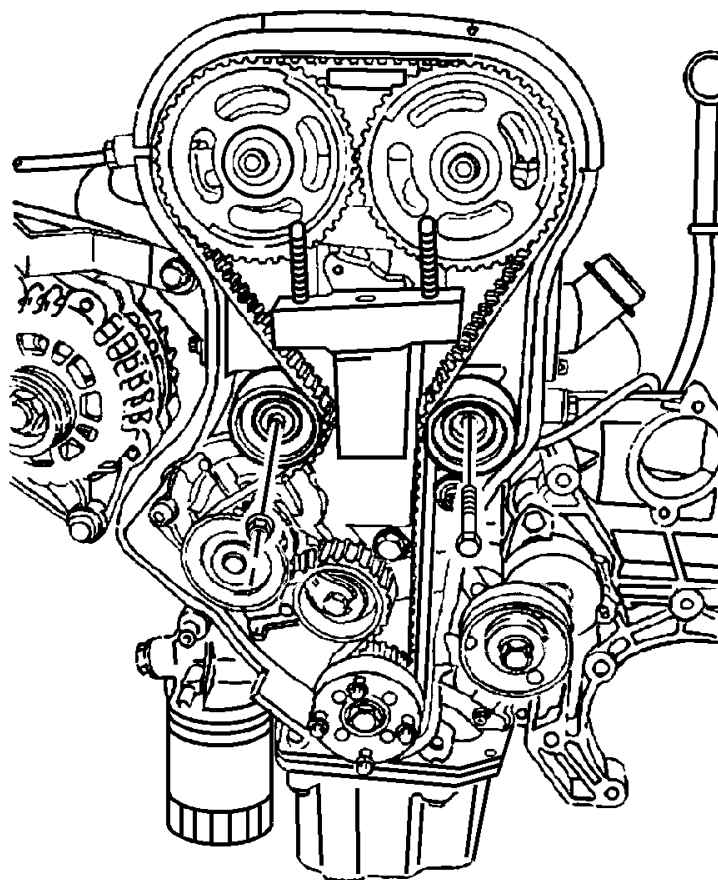


Fig. 8: View Of Timing Belt Idler Pulleys And Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the alternator.
18. Remove the intake manifold support bracket.

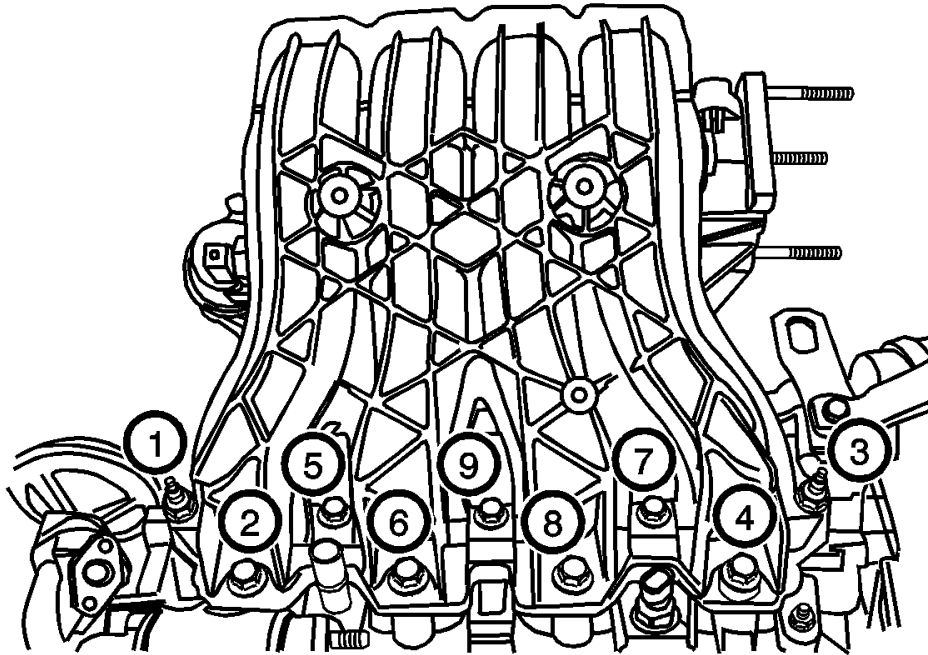


Fig. 9: Identifying Intake Manifold Retaining Nuts And Bolts Sequence
Courtesy of GENERAL MOTORS CORP.

19. Remove the intake manifold retaining bolts/nuts in the sequence shown.
20. Remove the intake manifold and gasket.
21. Clean the sealing surfaces of the intake manifold and the cylinder head.

INSTALLATION PROCEDURE

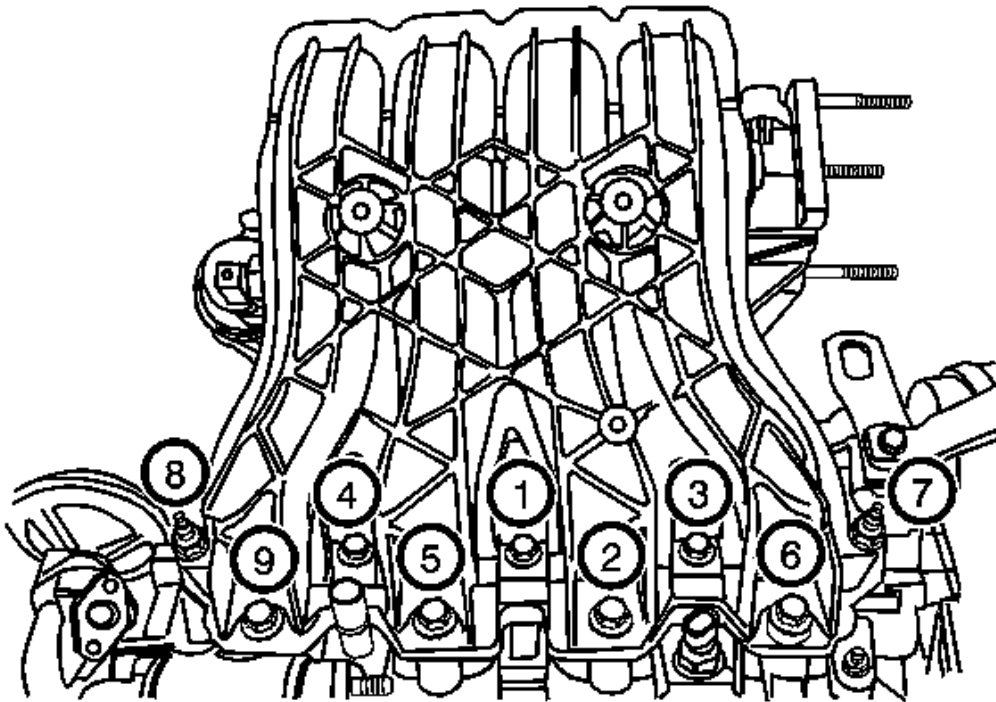


Fig. 10: Identifying Intake Manifold Retaining Nuts And Bolts Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the fuel rail.

Tighten: Tighten the fuel rail bolts to **25 N.m (18 lb ft)** .

2. Install the new intake manifold gasket and intake manifold.

Tighten: Tighten the intake manifold bolts and nuts to **25 N.m (18 lb ft)** .

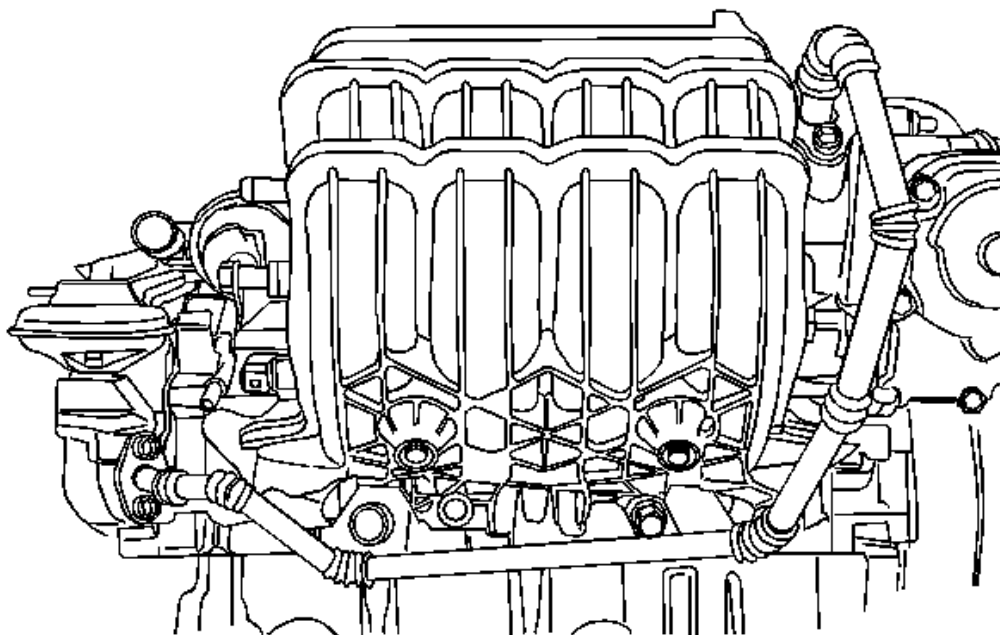


Fig. 11: Identifying EGR Pipe
Courtesy of GENERAL MOTORS CORP.

3. Install the EGR pipe.

Tighten: Tighten the EGR pipe bolts to **10 N.m (89 lb ft)** .

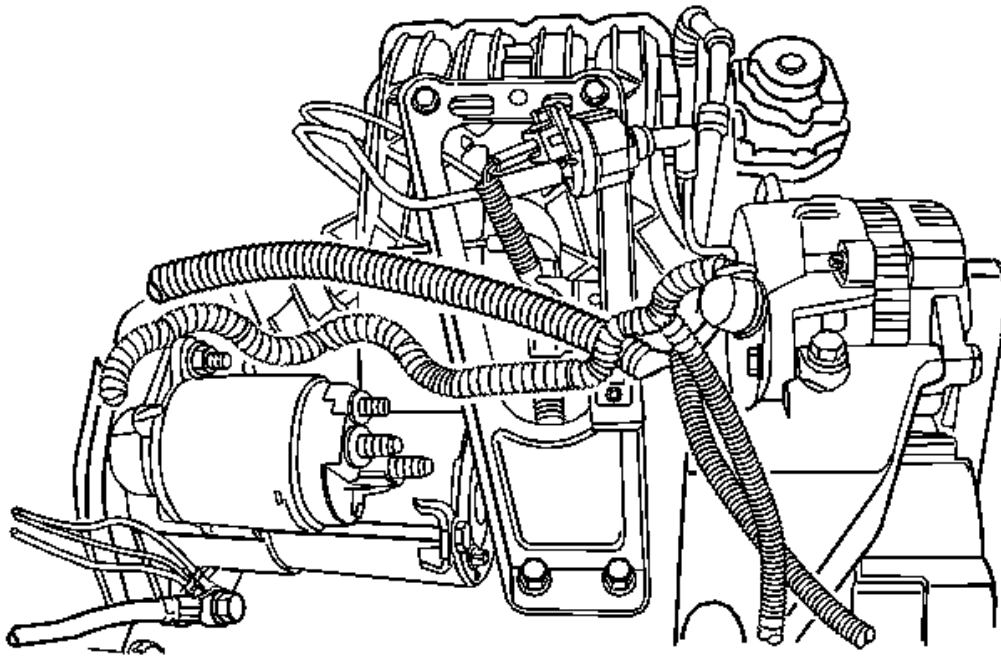


Fig. 12: View Of Intake Manifold Support Bracket And Alternator
Courtesy of GENERAL MOTORS CORP.

4. Install the intake manifold support bracket.

Tighten:

- Tighten the intake manifold support bracket upper bolts to **25 N.m (18 lb ft)** .
- Tighten the lower bolts to **45 N.m (33 lb ft)** .

5. Install the alternator.

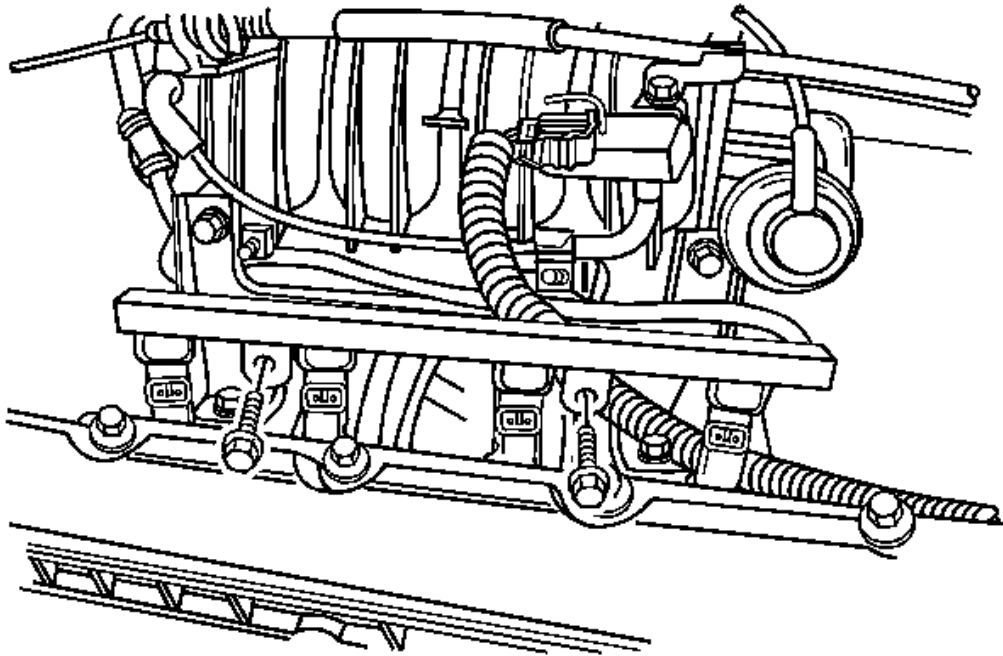


Fig. 13: View Of Fuel Rail And Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel rail.
7. Install the fuel rail bolts.

Tighten: Tighten the fuel rail bolts to **25 N.m (18 lb ft)** .

8. Install the intake manifold upper bracket.
9. Install the intake manifold upper bracket bolts.

Tighten: Tighten the intake manifold upper bracket bolts to **25 N.m (18 lb ft)** .

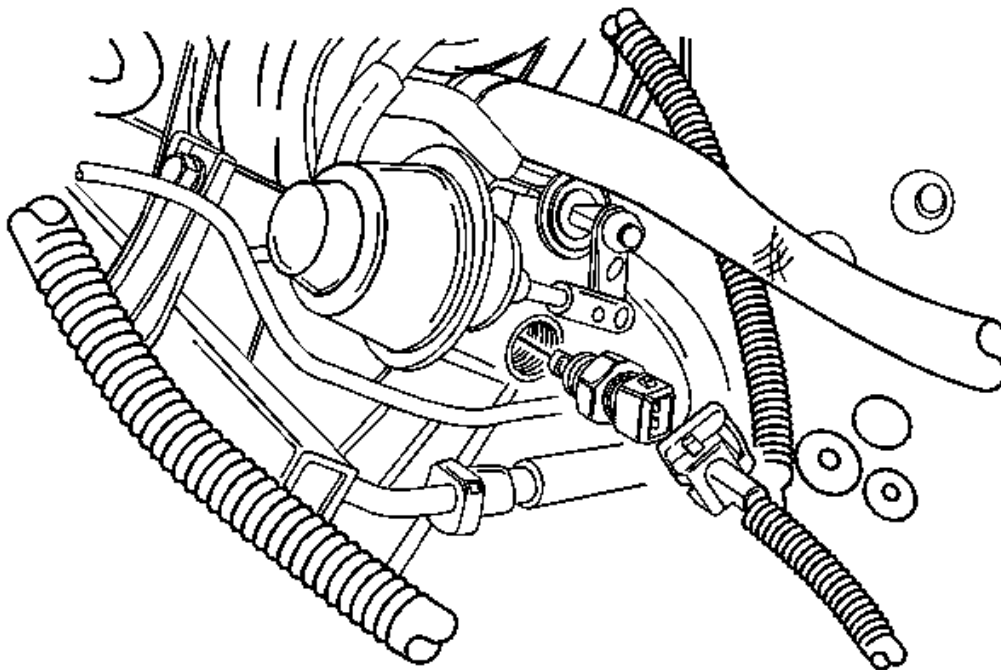


Fig. 14: View Of IAT Sensor And Connector
Courtesy of GENERAL MOTORS CORP.

10. Install the IAT and connect the IAT sensor connector.

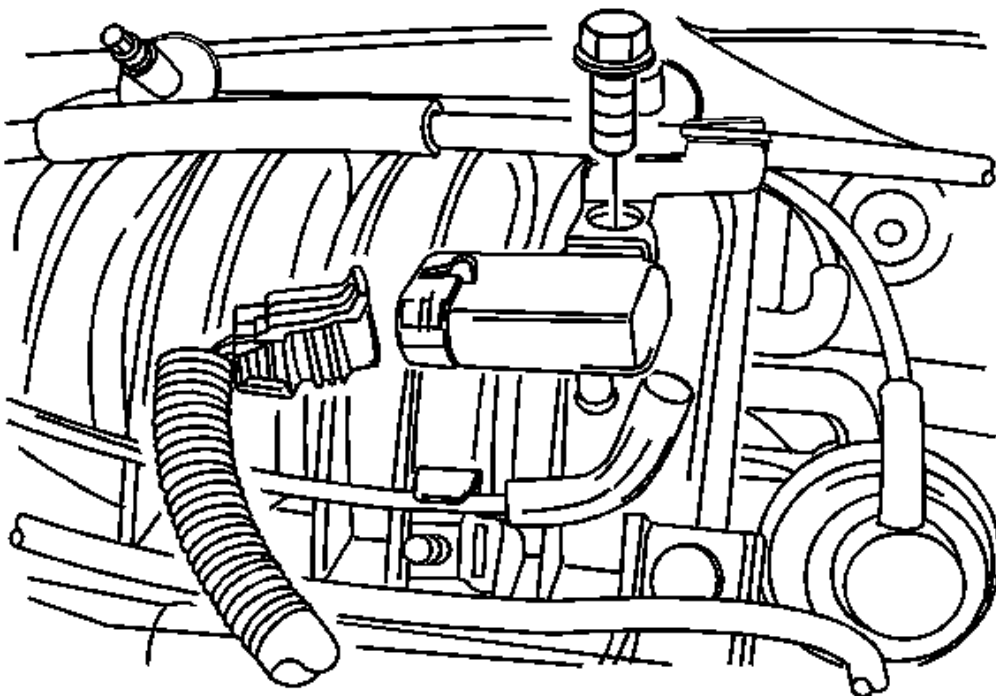


Fig. 15: View Of Intake Manifold Pressure Sensor Connector
Courtesy of GENERAL MOTORS CORP.

11. Install the intake manifold pressure sensor and vacuum hose.

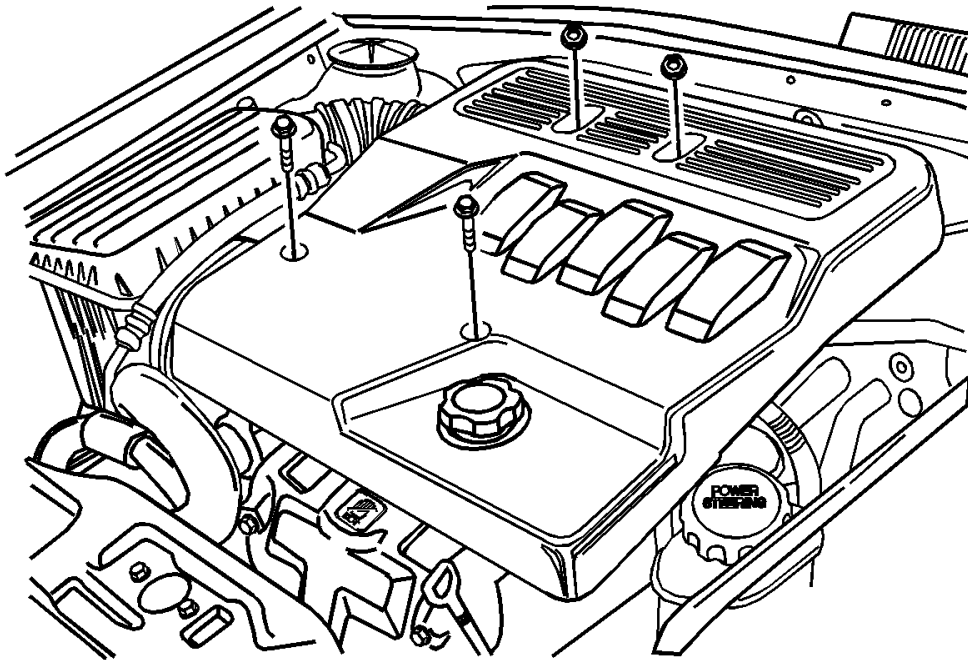


Fig. 16: View Of Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the throttle body and engine cover. Refer to **Throttle Body Assembly Replacement**
13. Refill the engine cooling system. Refer to **Cooling System Draining and Filling (Gasoline Engines)** .
14. Install the fuel pump fuse and connect the negative battery cable.

TIMING BELT REPLACEMENT

TOOLS REQUIRED

- **J 42492-A** (KM-421-A) Timing Belt Adjuster. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .
- **KM-470-B** Angular Torque Gauge. See **Special Tools** .

REMOVAL PROCEDURE

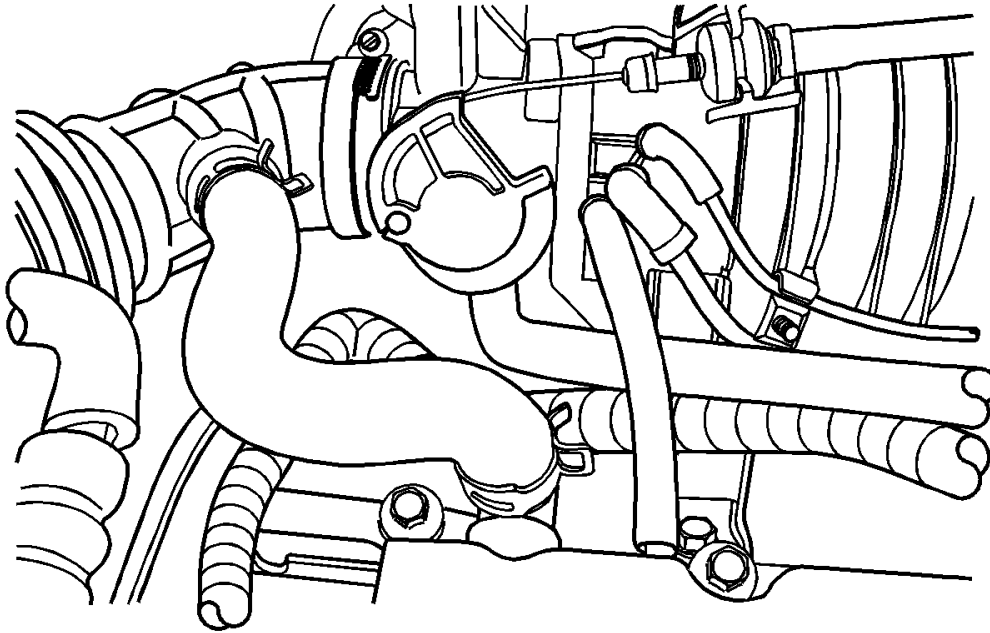


Fig. 17: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Disconnect the intake air temperature (IAT) sensor connector.
3. Disconnect the air intake tube from the throttle body.
4. Disconnect the breather tube from the valve cover.

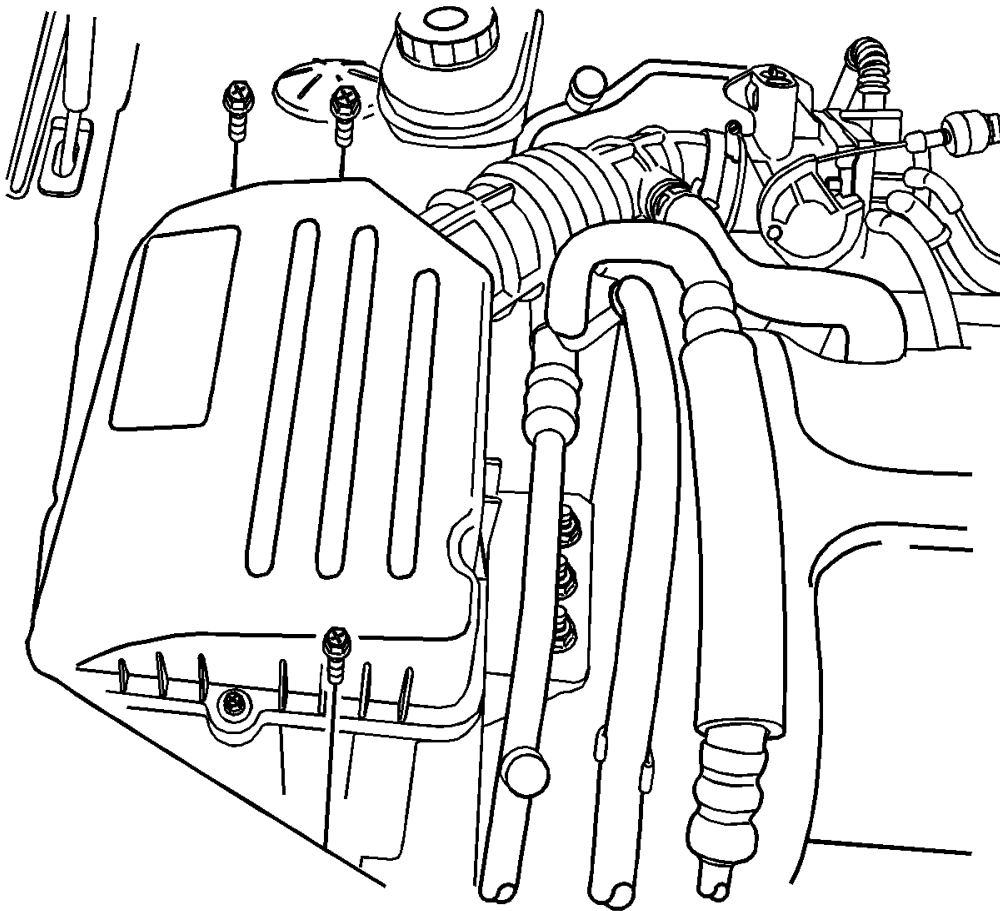


Fig. 18: View Of Air Filter Housing And Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the air filter housing bolts.
6. Remove the air filter housing.
7. Remove the right front wheel. Refer to **Tire and Wheel Removal and Installation** .
8. Remove the right front splash shield.

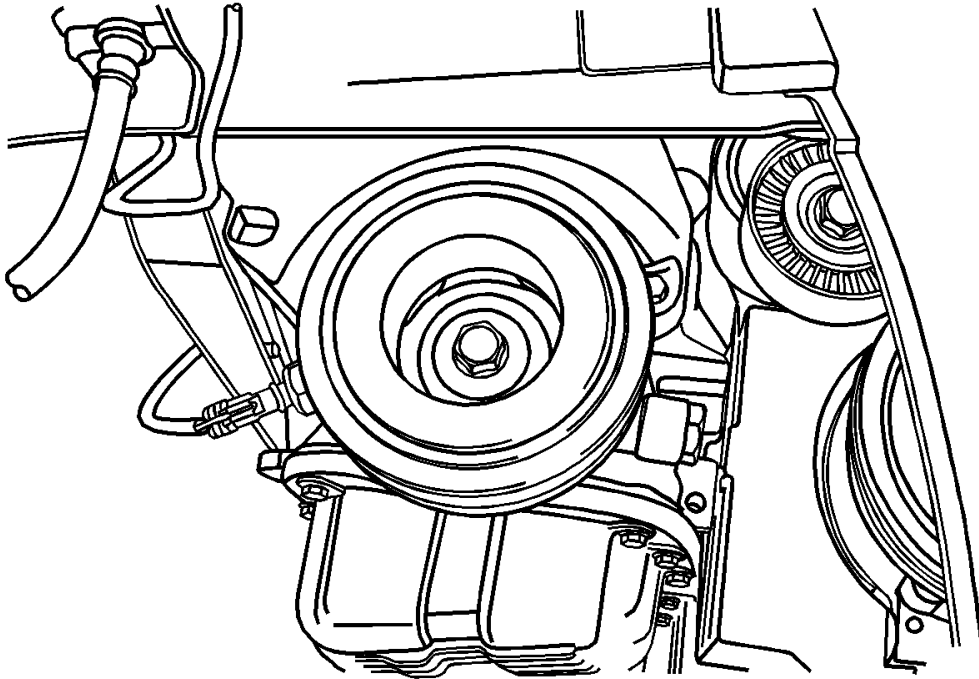


Fig. 19: View Of Crankshaft Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the accessory drive belt.
10. Remove the crankshaft pulley bolt.
11. Remove the crankshaft pulley.

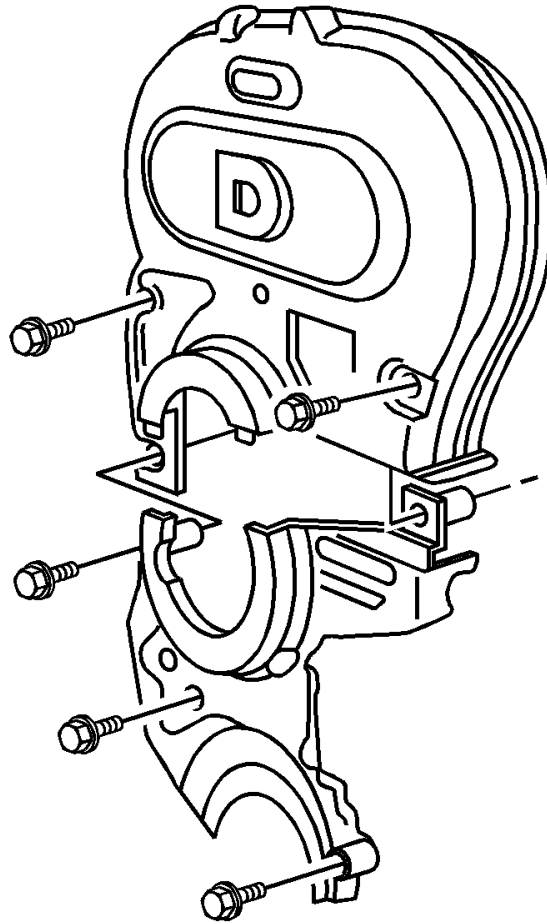


Fig. 20: View Of Upper Front Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the upper front timing belt cover bolts.
13. Remove the upper front timing belt cover.
14. Remove the lower front timing belt cover bolts.
15. Remove the lower front timing belt cover.
16. Remove the power steering pump mounting bolts, if equipped.
17. Install the crankshaft pulley bolt.

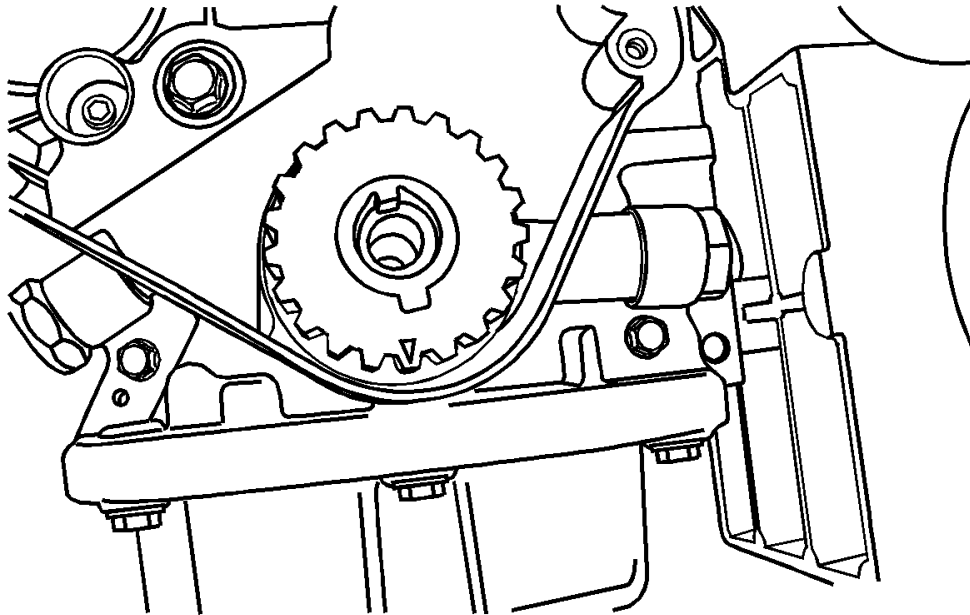


Fig. 21: View Of Crankshaft Gear And Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

18. Using the crankshaft pulley bolt, rotate the crankshaft clockwise until the timing mark on the crankshaft gear is aligned with the notch at the bottom of the rear timing belt cover.

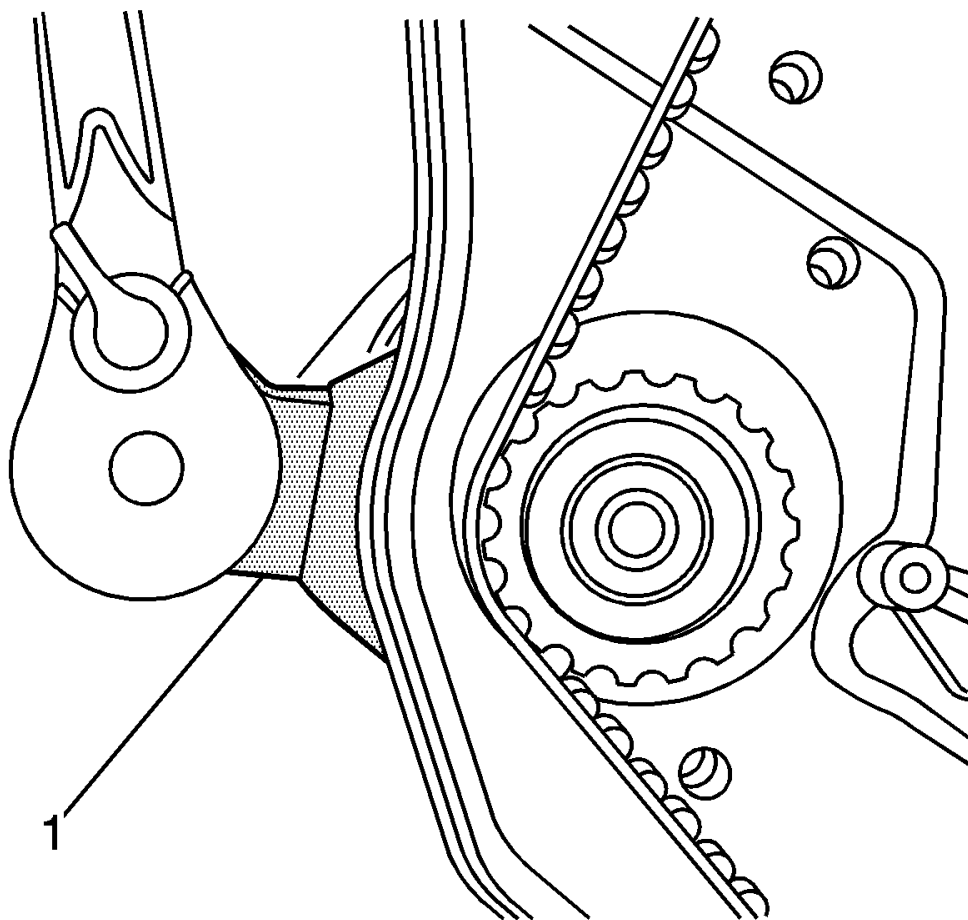


Fig. 22: View Of J42492-A And Coolant Pump
Courtesy of GENERAL MOTORS CORP.

19. Slightly loosen the coolant pump retaining bolts.
20. Using the **J 42492-A** (1), rotate the coolant pump counterclockwise to release the tension on the timing belt. See **Special Tools** .

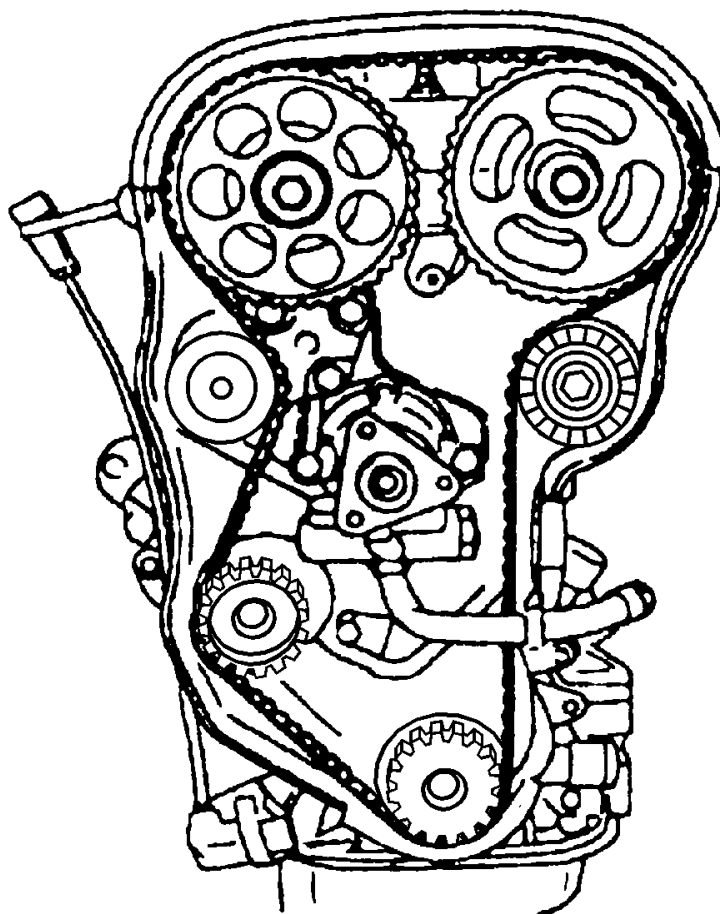


Fig. 23: View Of Timing Belt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove the timing belt behind the power steering pump.

21. Remove the timing belt.

INSTALLATION PROCEDURE

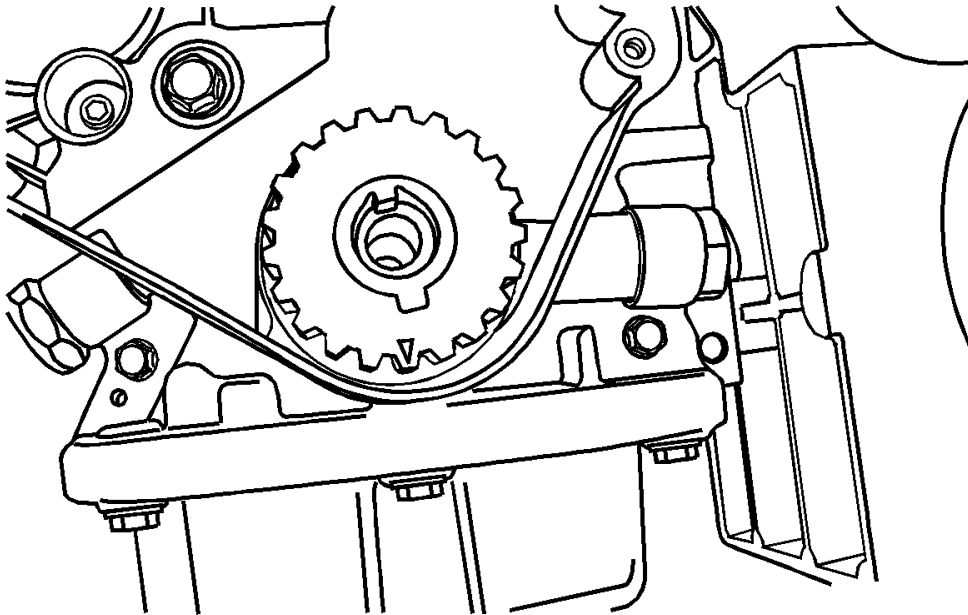


Fig. 24: View Of Crankshaft Gear And Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

1. Align the timing mark on the crankshaft gear to the notch on the bottom of the rear timing belt cover.

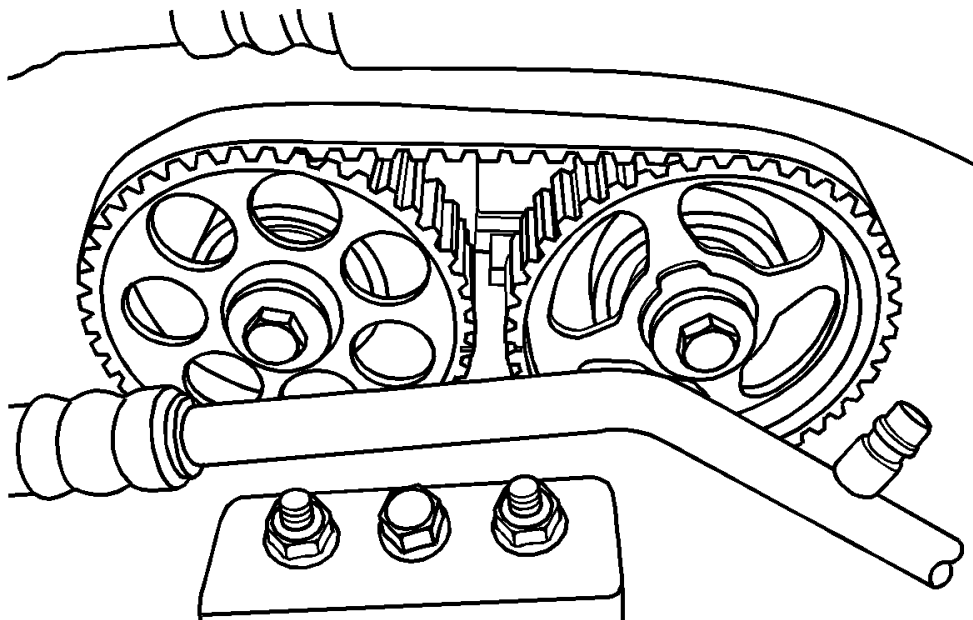


Fig. 25: View Of Camshaft Gears
Courtesy of GENERAL MOTORS CORP.

2. Align the timing marks on the camshaft gears.
3. Install the timing belt.

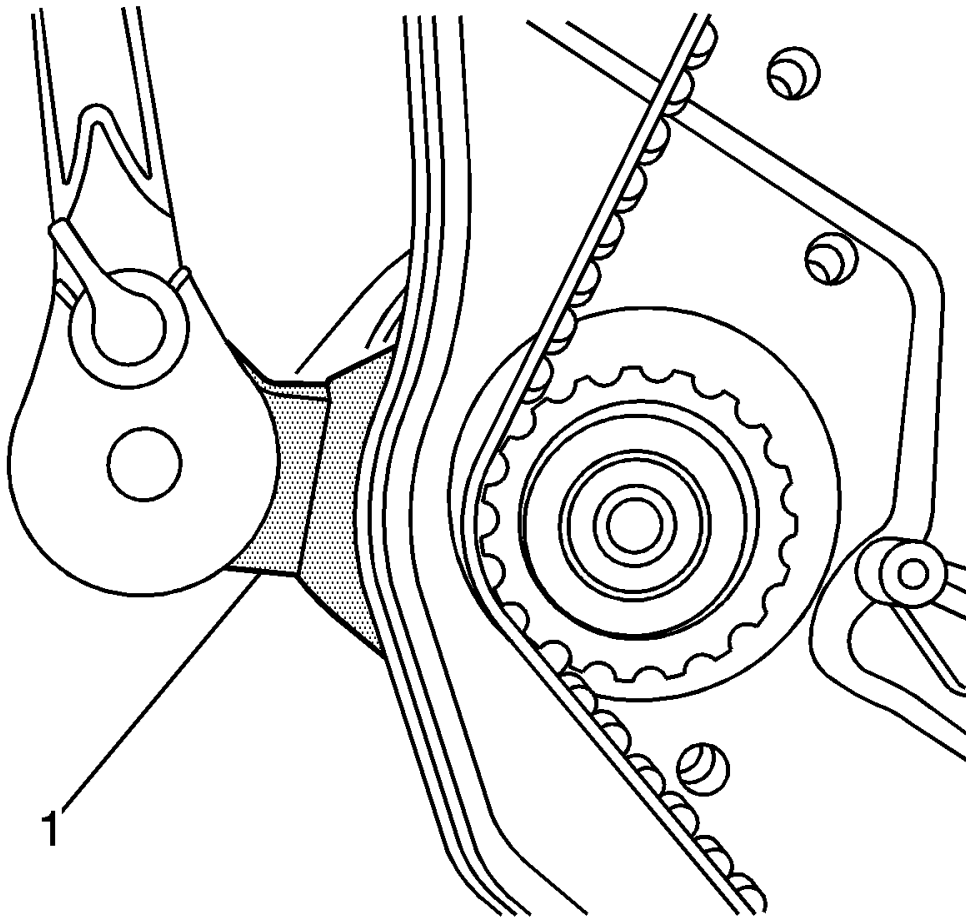


Fig. 26: View Of J42492-A And Coolant Pump
Courtesy of GENERAL MOTORS CORP.

4. Rotate the coolant pump clockwise using the J 42492-A (1). See **Special Tools** .

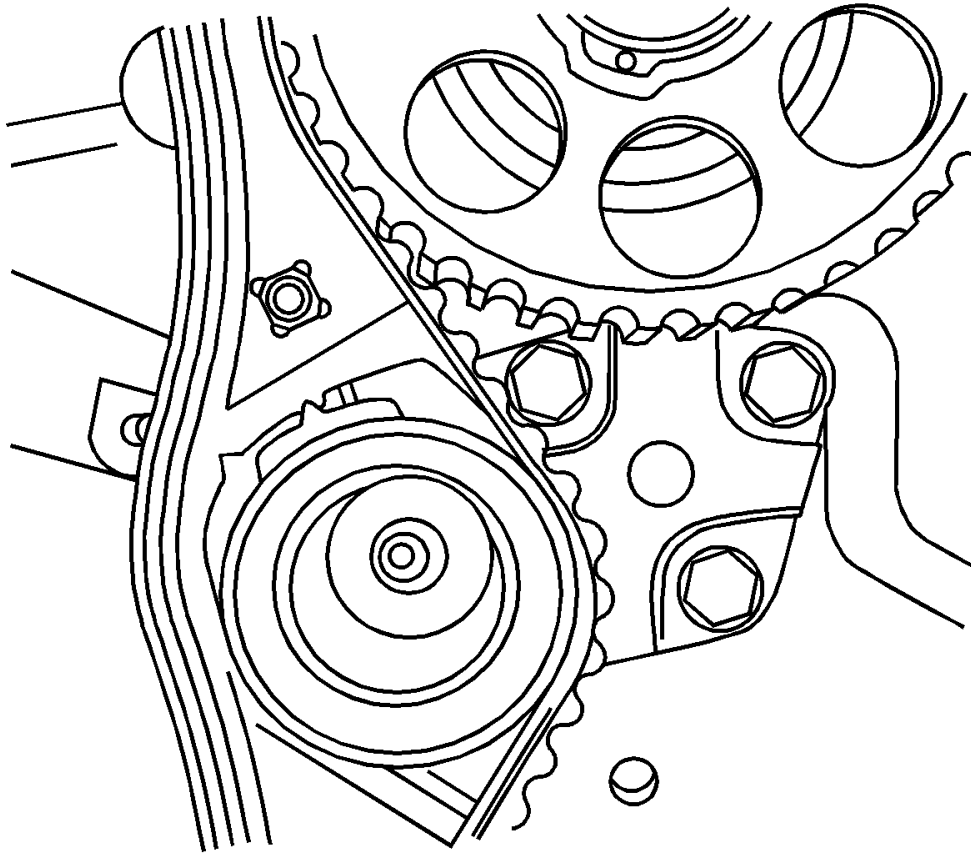


Fig. 27: View Of Timing Belt Automatic Tensioner Pointer Aligned With Bracket Notch
Courtesy of GENERAL MOTORS CORP.

5. Rotate the coolant pump clockwise until the adjust arm pointer of the timing belt automatic tensioner is aligned to the notch in the timing belt automatic tensioner bracket.

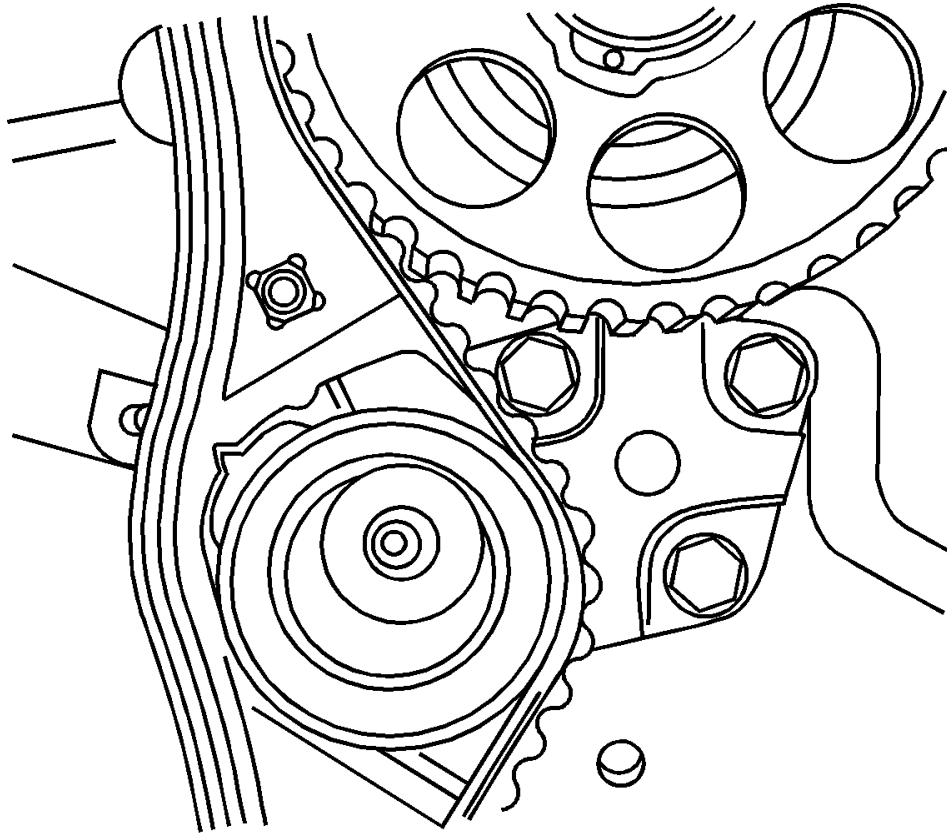


Fig. 28: View Of Timing Belt Automatic Tensioner Pointer Aligned With Bracket Pointer
Courtesy of GENERAL MOTORS CORP.

6. Tighten the coolant pump retaining bolts.
7. Rotate the crankshaft 2 full turns clockwise using the crankshaft pulley bolt.
8. Loosen the coolant pump retaining bolts.
9. Rotate the coolant pump until the adjust arm pointer of the timing belt automatic tensioner is aligned with the pointer on the timing belt automatic tensioner bracket.

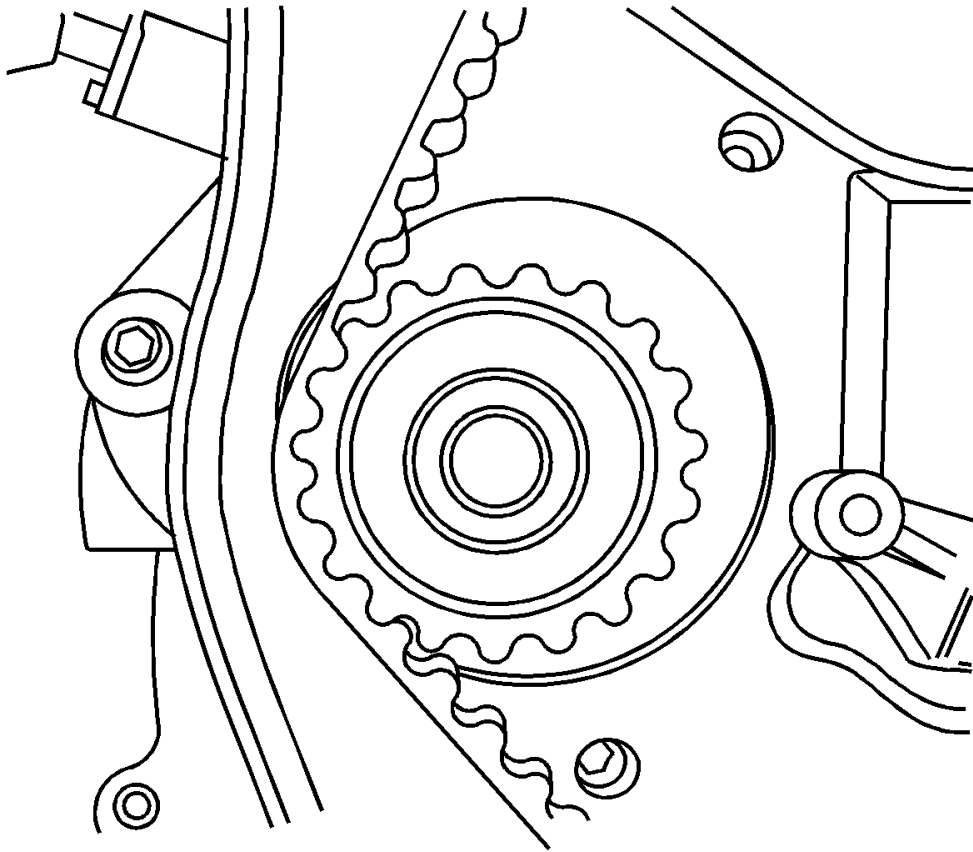


Fig. 29: View Of Coolant Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

10. Tighten the coolant pump retaining bolts.

Tighten: Tighten the coolant pump retaining bolts to **10 N.m (89 lb in)** .

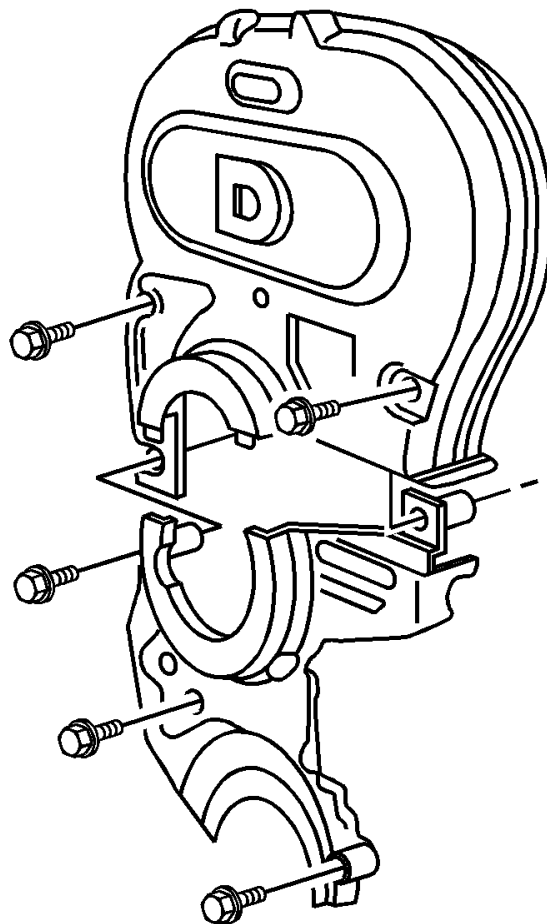


Fig. 30: View Of Upper Front Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft pulley bolt.
12. Install the upper and lower front timing belt cover.
13. Install the upper and lower front timing belt cover bolts.

Tighten: Tighten the upper and lower front timing belt cover bolts to **10 N.m (89 lb in)** .

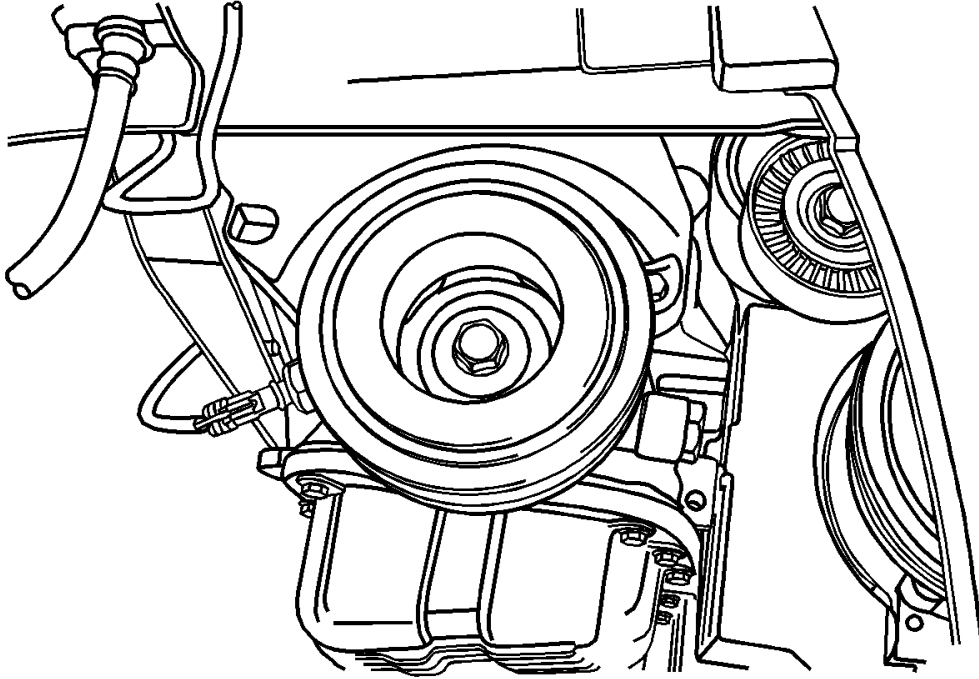


Fig. 31: View Of Crankshaft Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the crankshaft pulley.
15. Install the crankshaft pulley bolt.

Tighten: Tighten the crankshaft pulley bolt to **95 N.m (70 lb ft)** using a torque wrench. Using the **J 45059** or the **KM-470-B** , tighten the crankshaft pulley bolt 30 degrees plus 15 degrees.

16. Install the accessory drive belt, if equipped.
17. Install the right front splash shield.
18. Install the right front wheel. Refer to **Tire and Wheel Removal and Installation** .

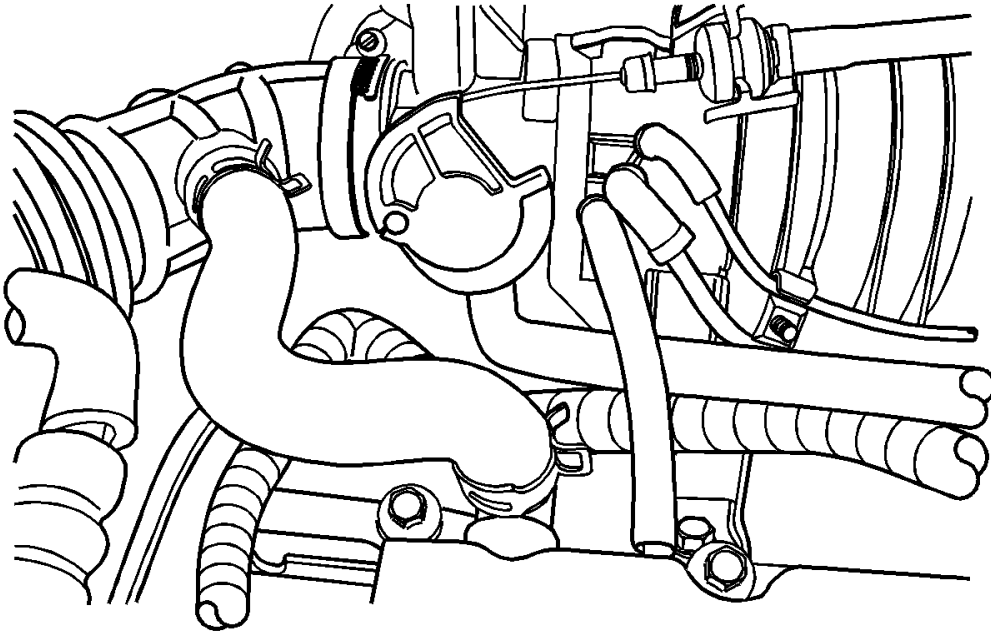


Fig. 32: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

19. Install the air filter housing.
20. Install the air filter housing bolts.

Tighten: Tighten the air filter housing bolts to **8 N.m (71 lb in)** .

21. Connect the air intake tube to the throttle body.
22. Connect the breather tube to the throttle body.
23. Connect the IAT sensor connector.
24. Connect the negative battery cable.

TIMING BELT COVER REPLACEMENT

REMOVAL PROCEDURE

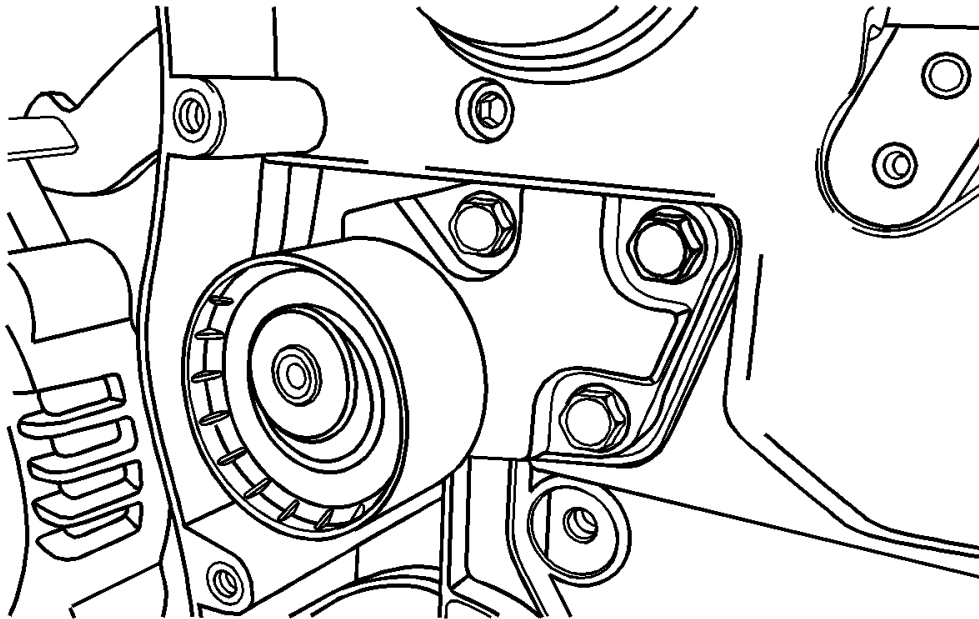


Fig. 33: View Of Timing Belt Tensioner And Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the timing belt and the timing belt cover. Refer to **Timing Belt Replacement**.
2. Remove the camshaft gears. Refer to **Camshaft Gear Replacement**.
3. Remove the crankshaft gear.
4. Remove the timing belt automatic tensioner bolts.
5. Remove the timing belt automatic tensioner.

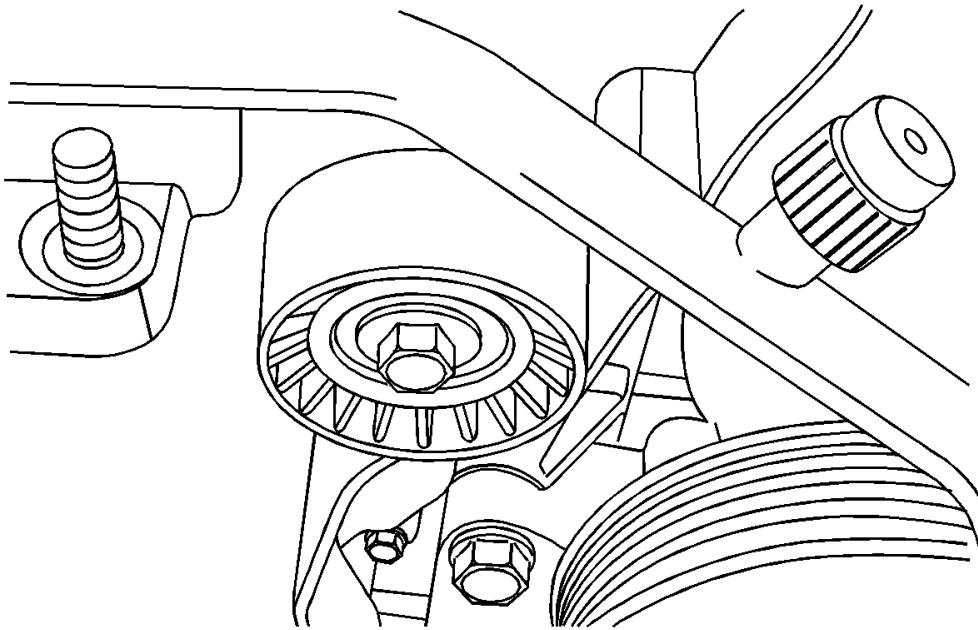


Fig. 34: View Of Timing Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the timing belt idler pulley bolt.
7. Remove the timing belt idler pulley.

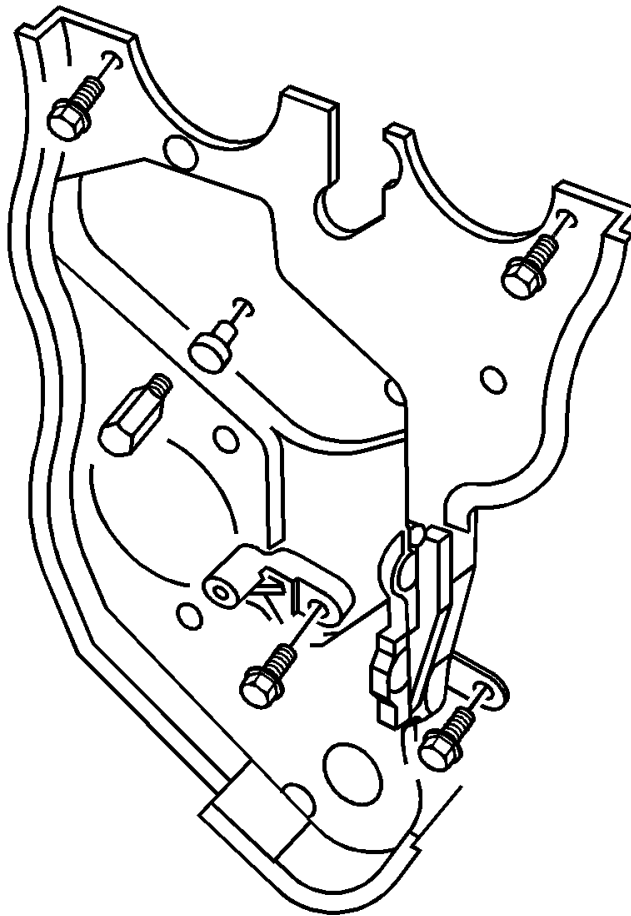


Fig. 35: View Of Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the rear timing belt cover bolts.
9. Remove the rear timing belt cover.

INSTALLATION PROCEDURE

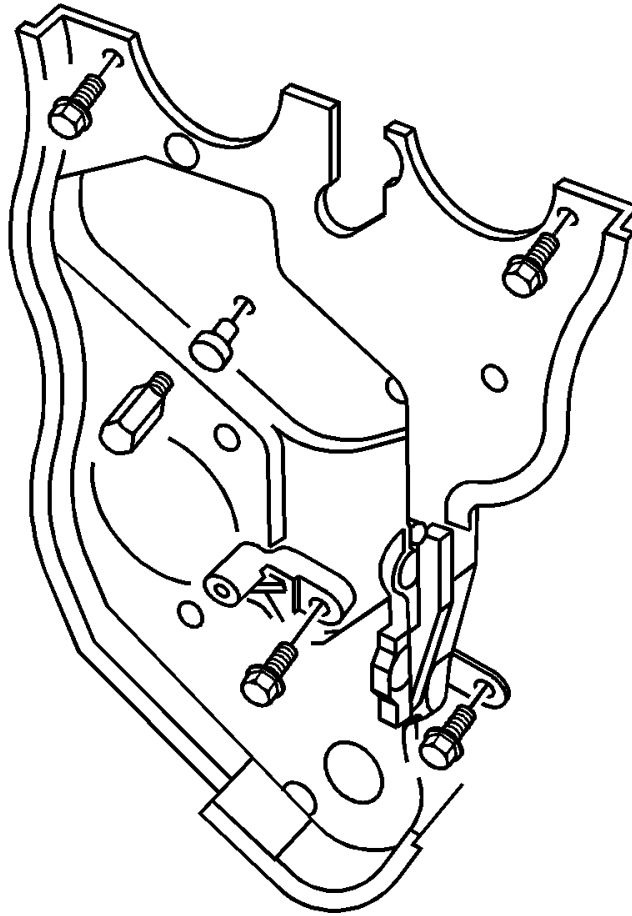


Fig. 36: View Of Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the rear timing belt cover.

NOTE: Refer to **Fastener Notice** .

2. Install the rear timing belt cover bolts.

Tighten: Tighten the rear timing belt cover bolts to **10 N.m (89 lb in)** .

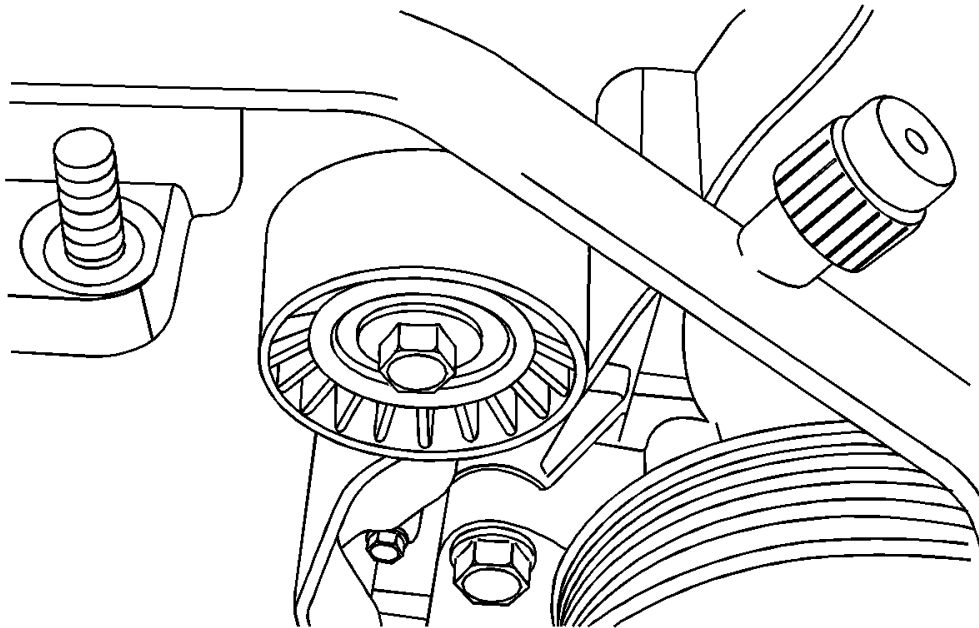


Fig. 37: View Of Timing Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the timing belt idler pulley.
4. Install the timing belt idler pulley bolt.

Tighten: Tighten the timing belt idler pulley bolt to **40 N.m (30 lb ft)** .

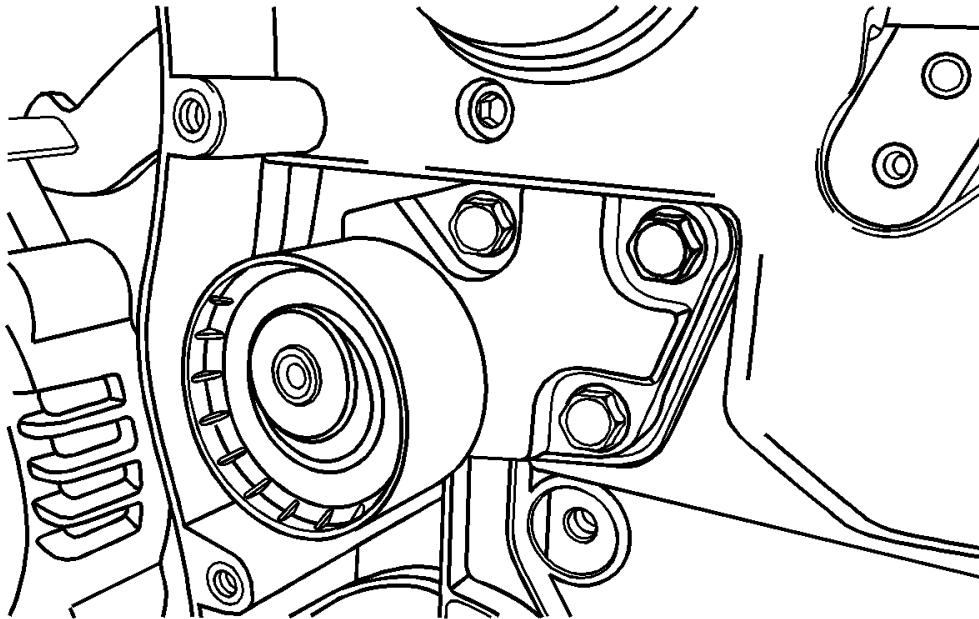


Fig. 38: View Of Timing Belt Tensioner And Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the timing belt automatic tensioner.
6. Install the timing belt automatic tensioner bolts.

Tighten: Tighten the timing belt automatic tensioner bolts to **25 N.m (18 lb ft)** .

7. Install the crankshaft gear.
8. Install the camshaft gears. Refer to **Camshaft Gear Replacement**.
9. Install the timing belt and timing belt cover. Refer to **Timing Belt Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT

REMOVAL PROCEDURE

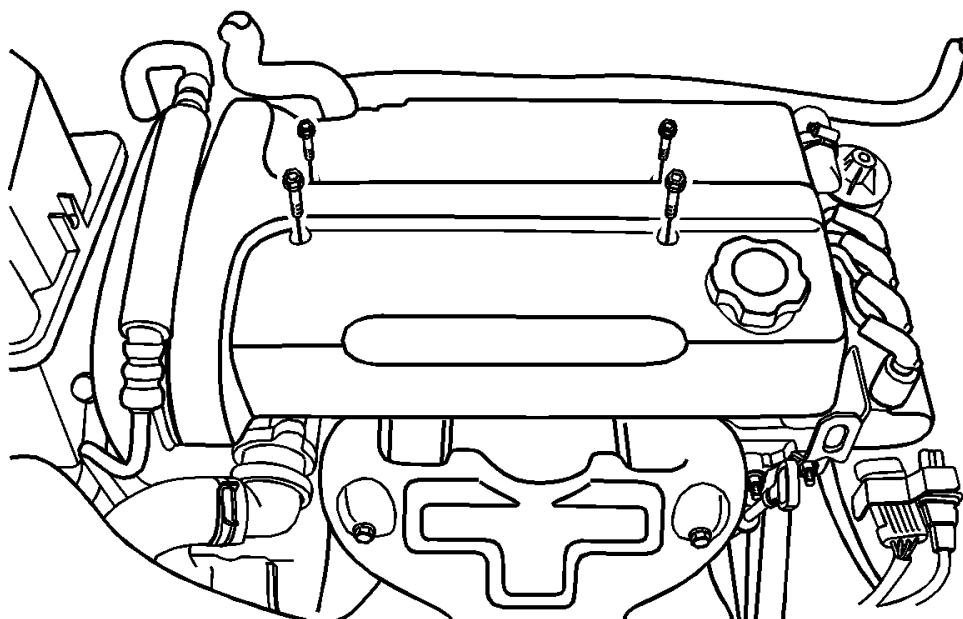


Fig. 39: Identifying Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Remove the spark plug cover bolts and cover.

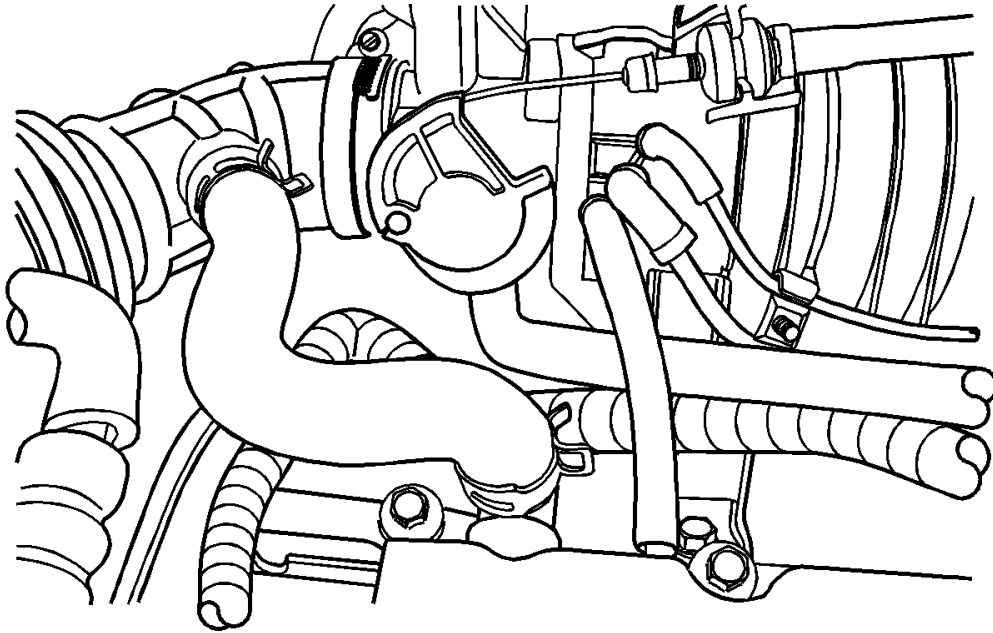


Fig. 40: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the breather tube from the valve cover.

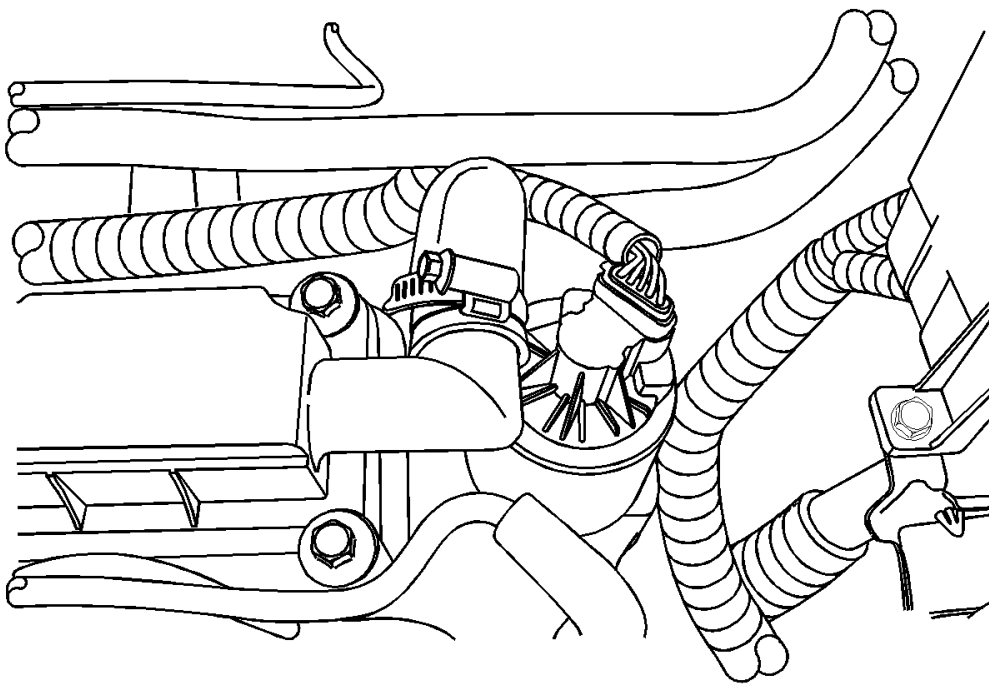


Fig. 41: View Of Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the crankcase ventilation tube from the valve cover.

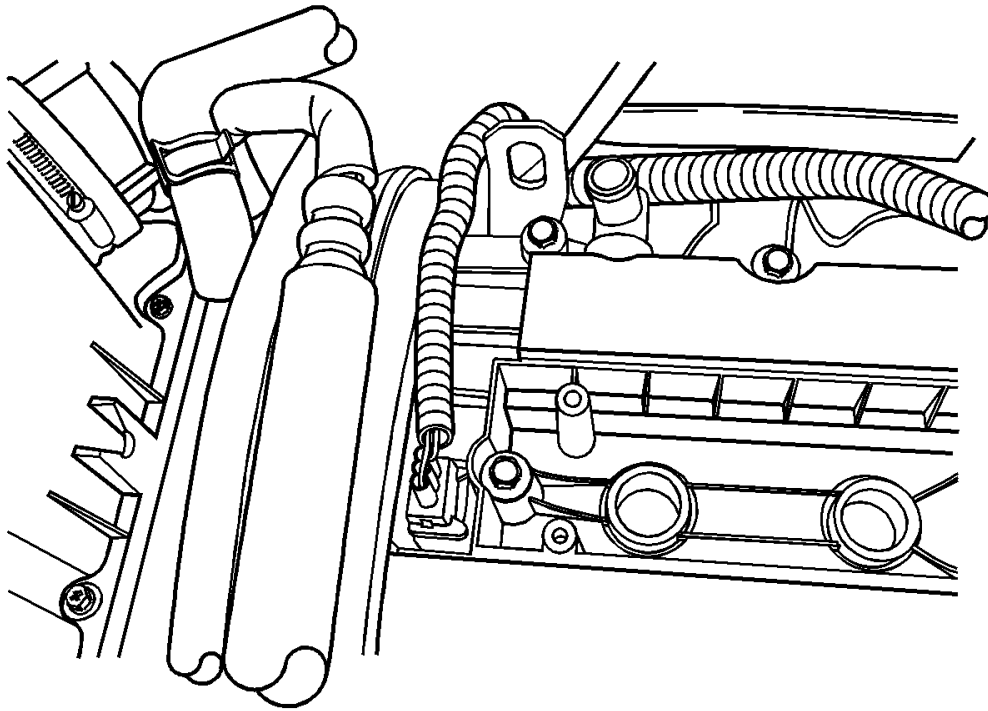


Fig. 42: View Of Camshaft Position (CMP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the camshaft position (CMP) sensor connector.

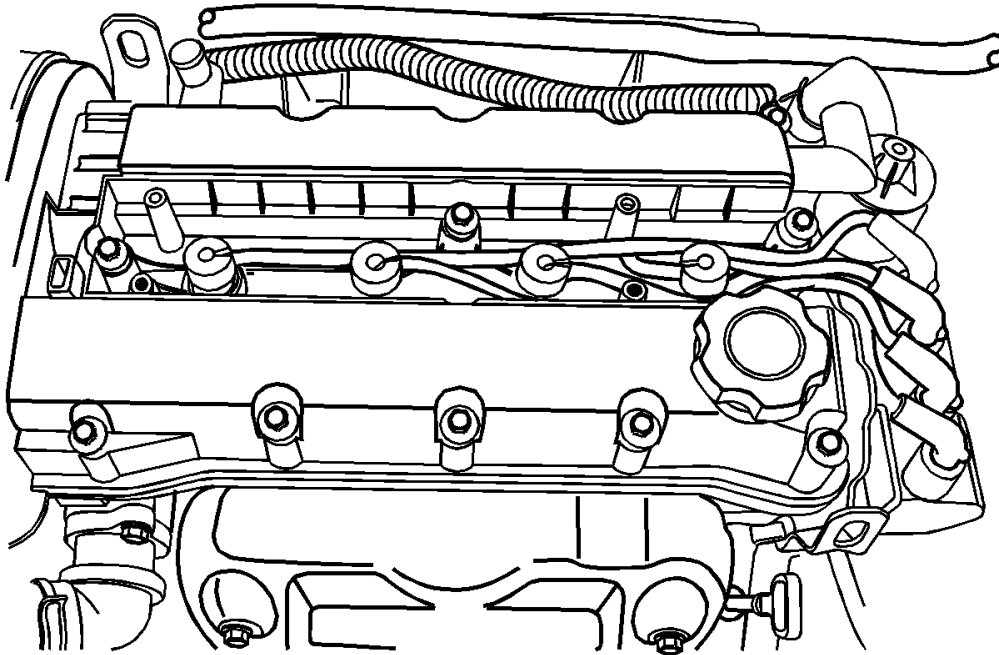


Fig. 43: View Of Ignition Wires And Spark Plugs
Courtesy of GENERAL MOTORS CORP.

6. Disconnect all of the necessary vacuum lines.
7. Disconnect the ignition wires from the spark plugs.

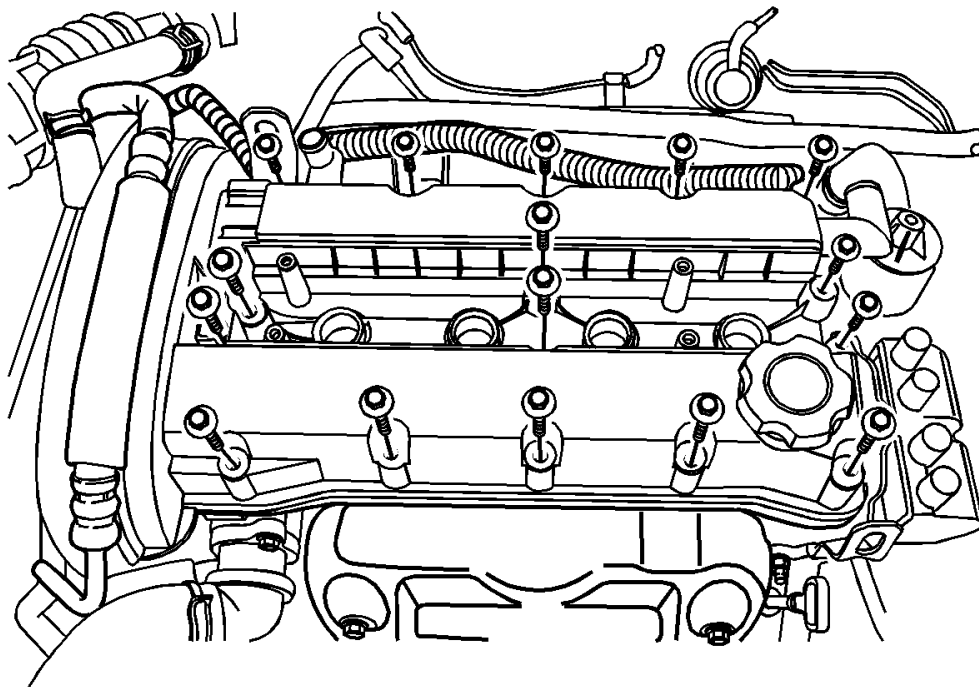


Fig. 44: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve cover bolts.
9. Remove the valve cover.

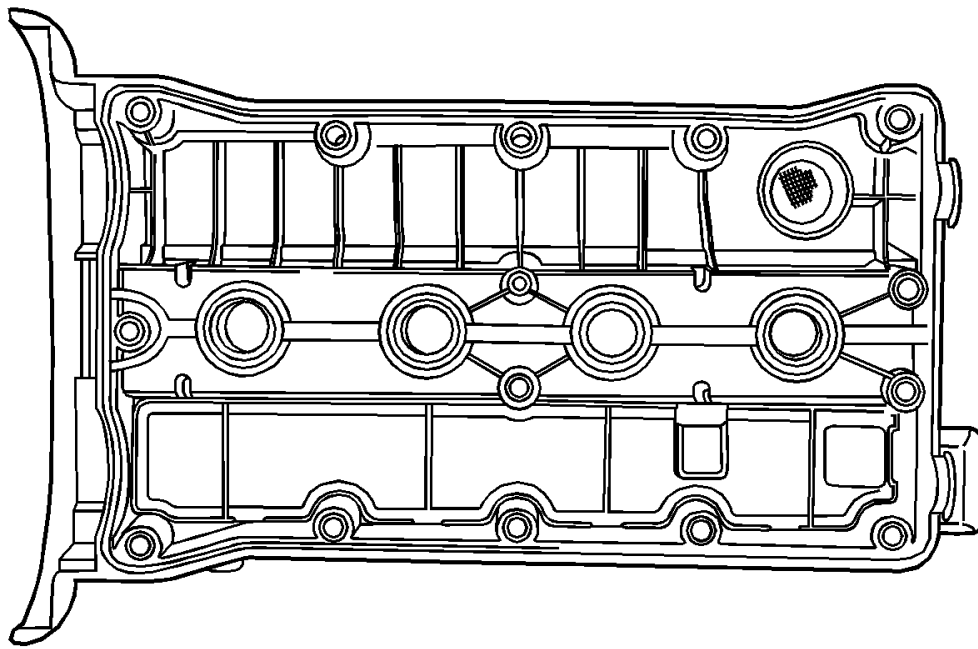


Fig. 45: View Of Valve Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve cover gasket from the valve cover.

INSTALLATION PROCEDURE

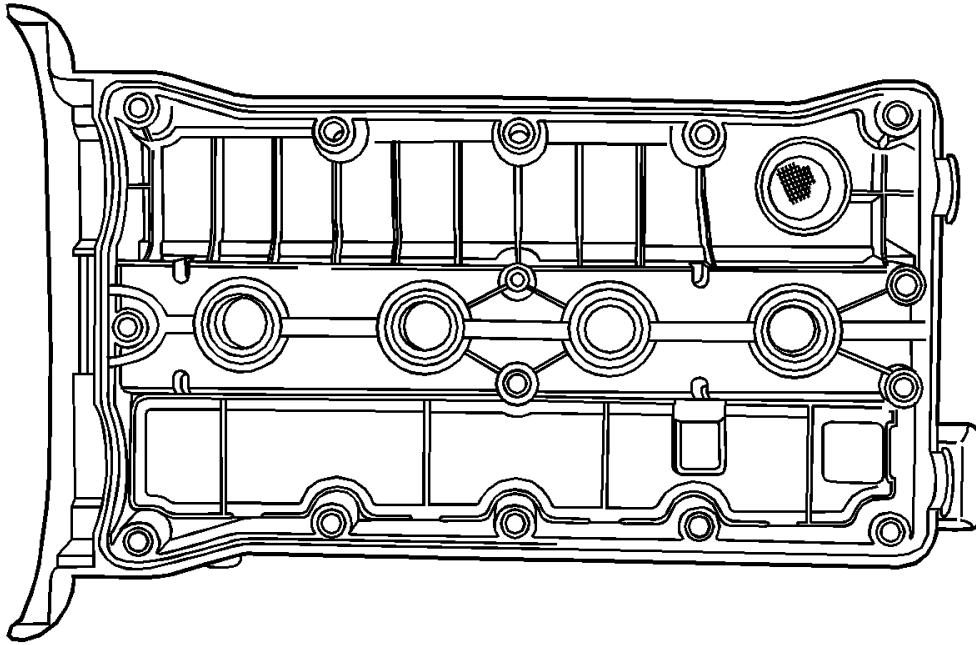


Fig. 46: View Of Valve Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover to cylinder head seal.
2. Install the new valve cover gasket to the valve cover.

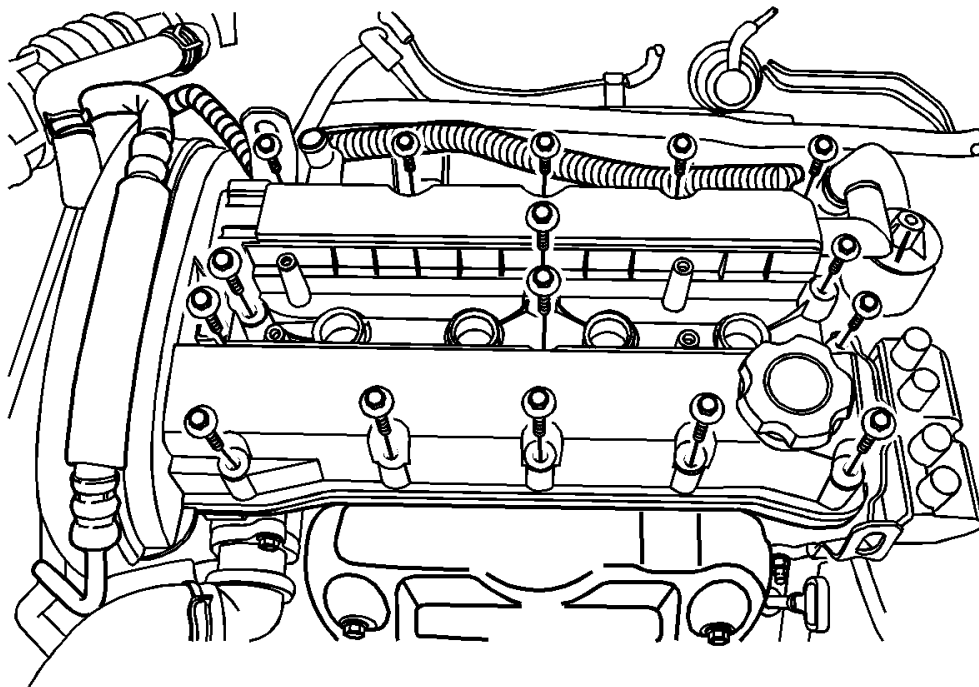


Fig. 47: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the valve cover.

NOTE: Refer to Fastener Notice .

4. Install the valve cover bolts.

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

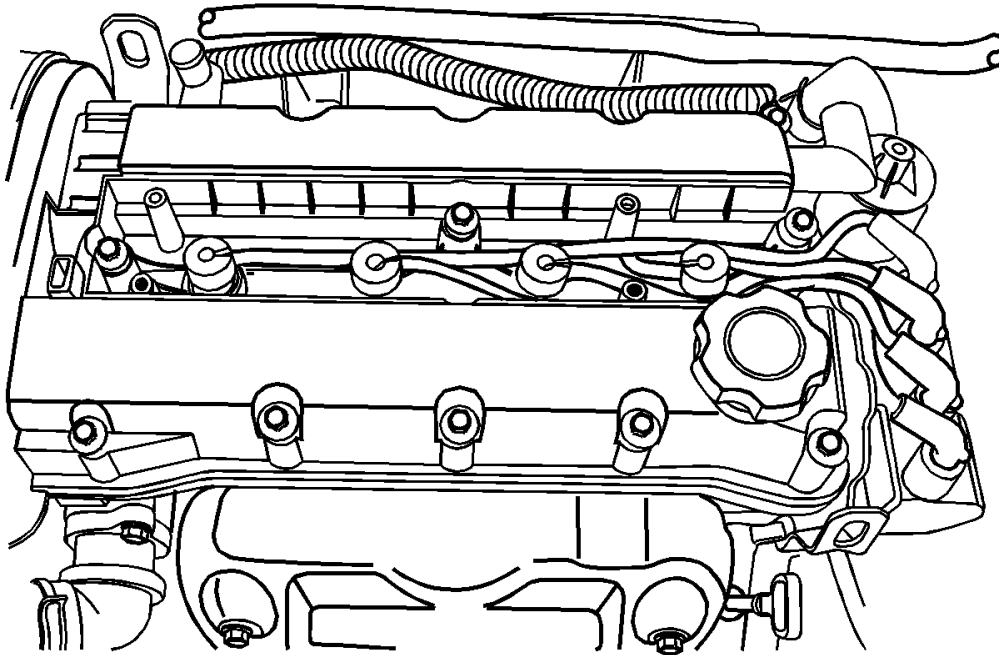


Fig. 48: View Of Ignition Wires And Spark Plugs
Courtesy of GENERAL MOTORS CORP.

5. Connect the ignition wires from the spark plugs.
6. Connect all of the necessary vacuum lines.

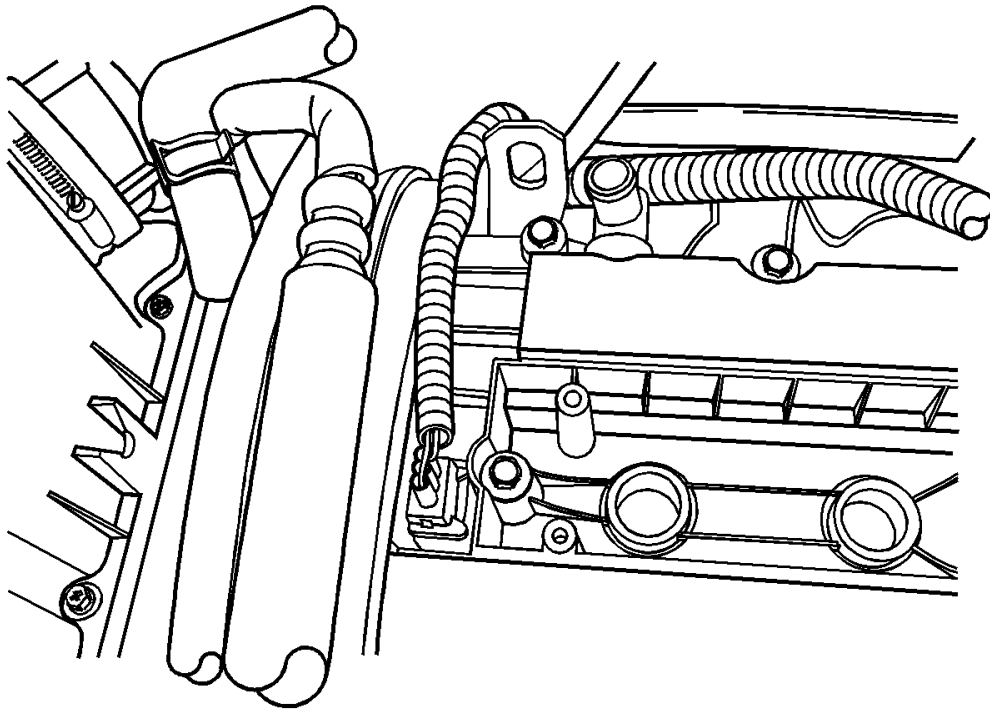


Fig. 49: View Of Camshaft Position (CMP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

7. Connect the CMP sensor connector.

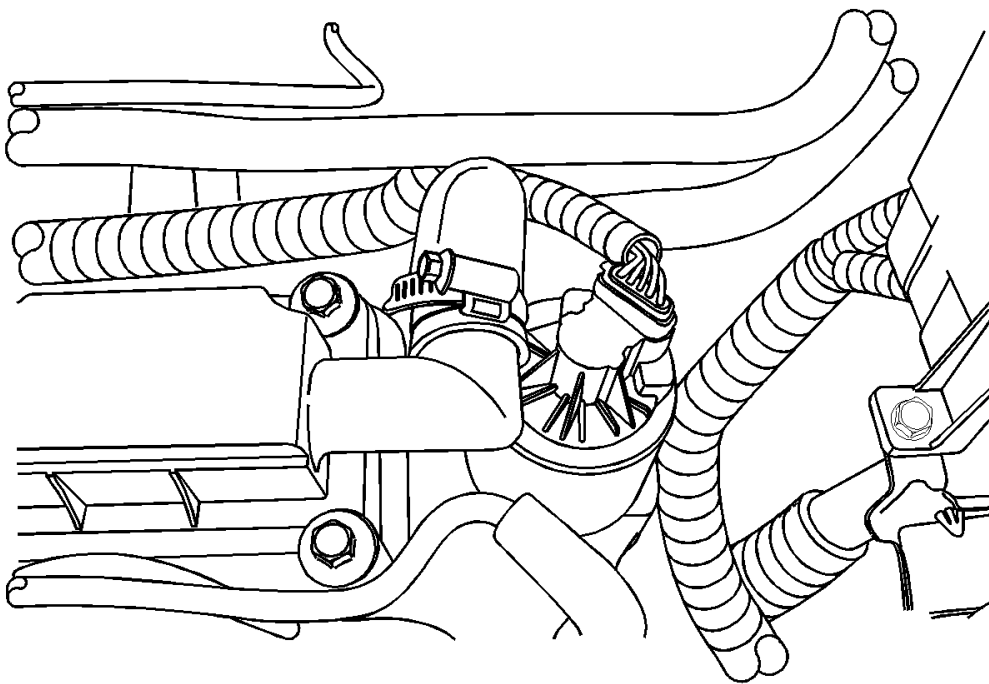


Fig. 50: View Of Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS CORP.

8. Connect the crankcase ventilation tube from the valve cover.

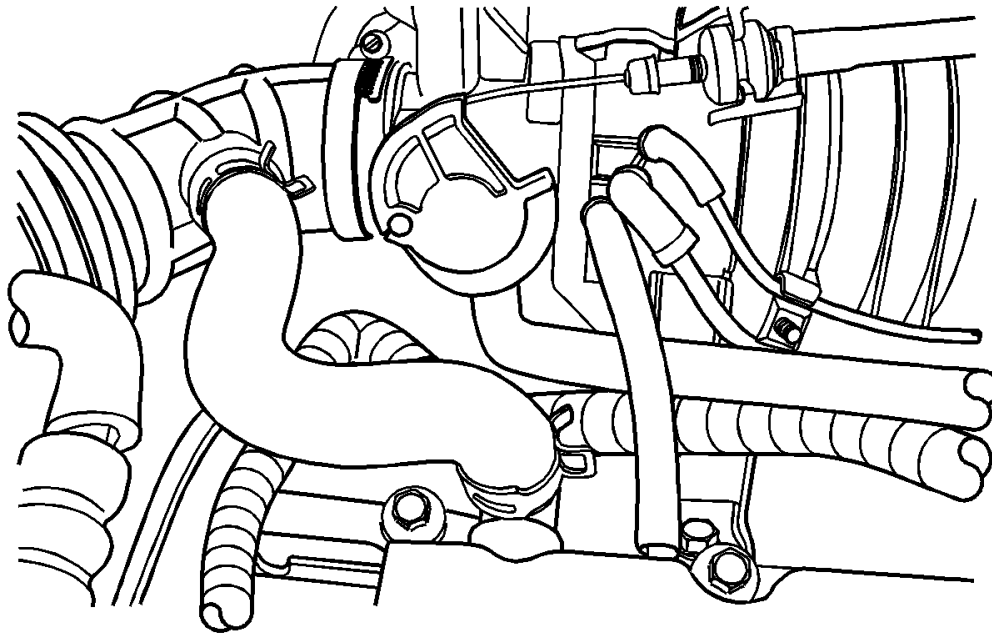


Fig. 51: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

9. Connect the breather tube from the valve cover.

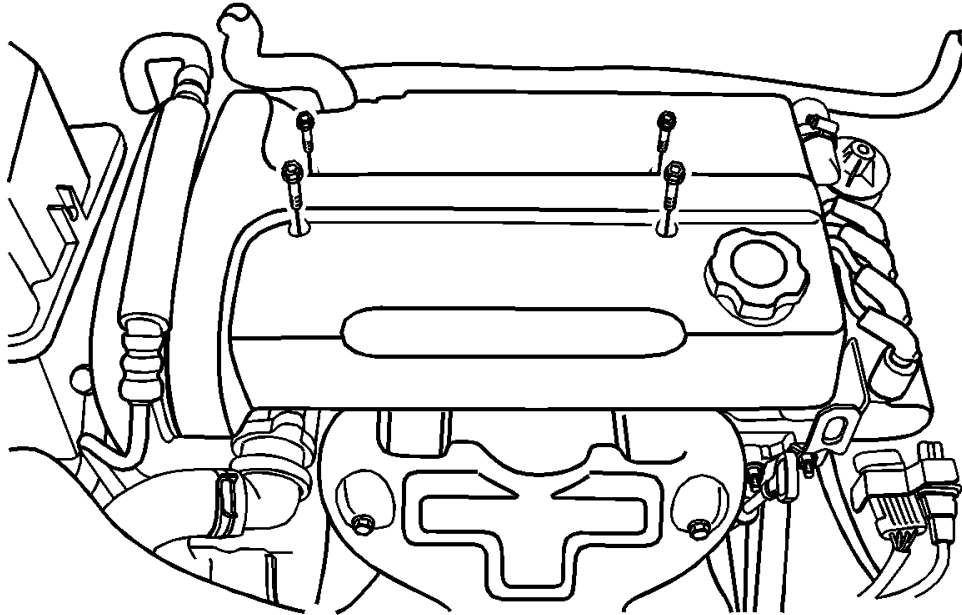


Fig. 52: Identifying Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

10. Install the spark plug cover.
11. Install the spark plug cover bolts.

Tighten: Tighten the spark plug cover bolts to **3 N.m (27 lb in)** .

12. Connect the negative battery cable.

CYLINDER HEAD REPLACEMENT

TOOLS REQUIRED

- **J 42492-A (KM-421-A)** Timing Belt Adjuster. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .
- **KM-470-B** Angular Torque Gauge. See **Special Tools** .

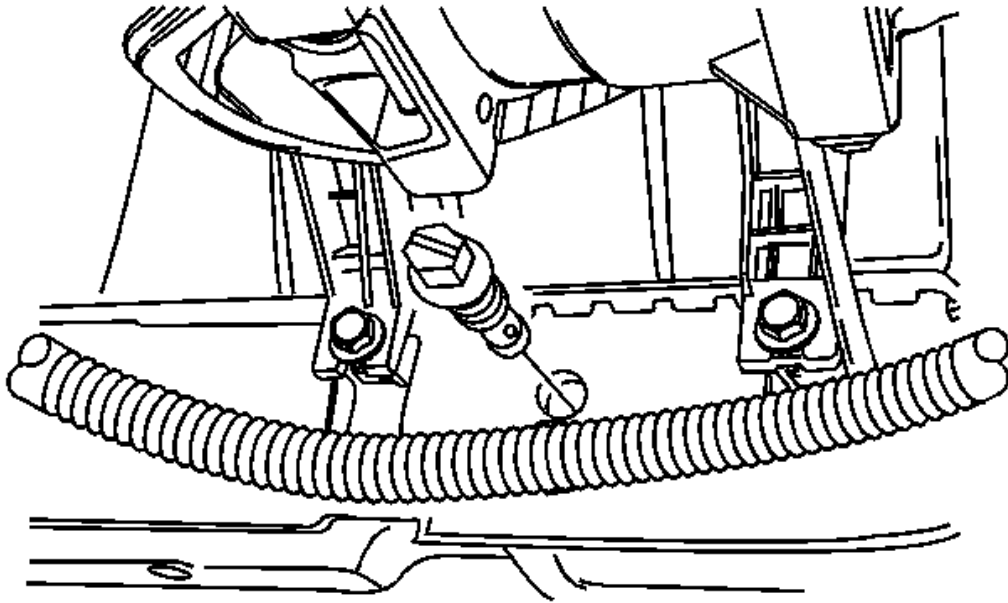
REMOVAL PROCEDURE

Fig. 53: Identifying Fuel Pump Fuse
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.

CAUTION: Refer to Battery Disconnect Caution .

3. Disconnect the negative battery cable.
4. Disconnect the engine control module (ECM) ground terminal from the intake manifold.
5. Drain the engine coolant. Refer to Cooling System Draining and Filling (Gasoline Engines) .

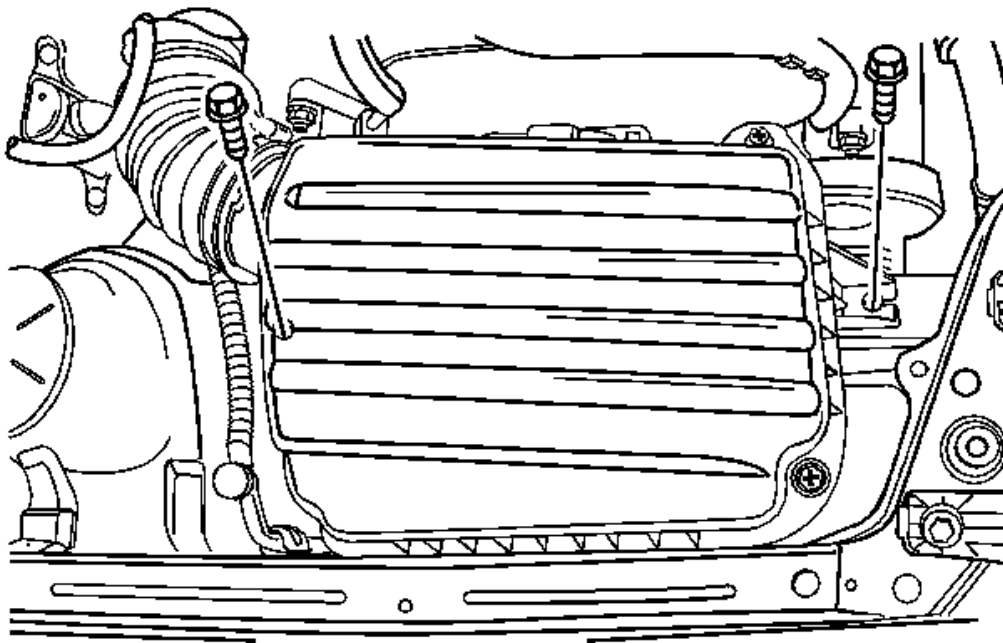


Fig. 54: View Of Air Cleaner Housing And Bolts
Courtesy of GENERAL MOTORS CORP.

6. Drain the engine oil.
7. Remove the air cleaner housing.

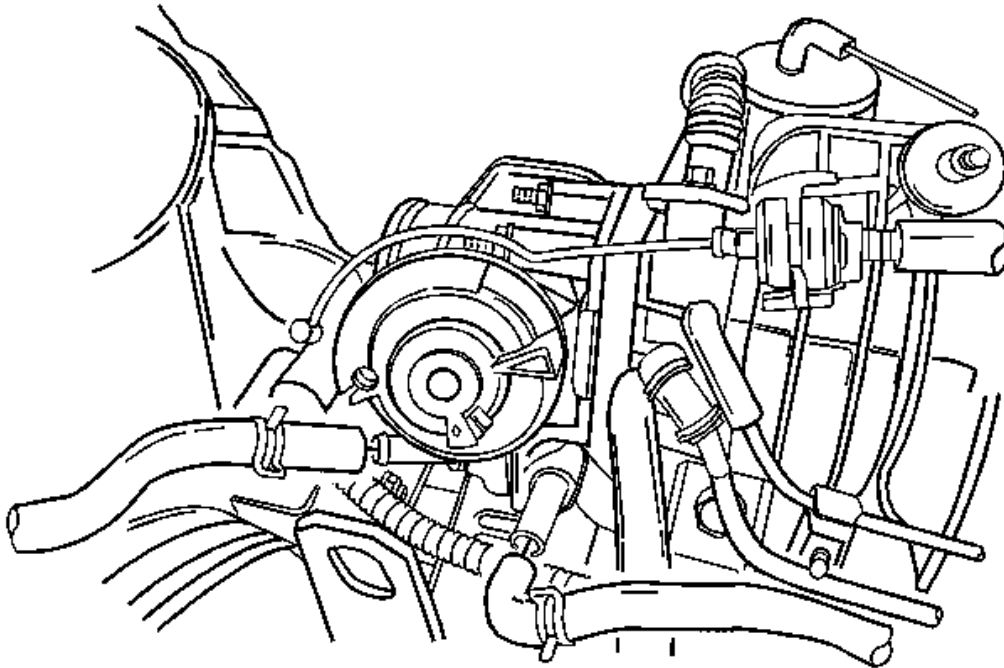


Fig. 55: Identifying Throttle Cable And Coolant Hoses
Courtesy of GENERAL MOTORS CORP.

8. Remove the throttle cable and inlet/outlet coolant hoses.

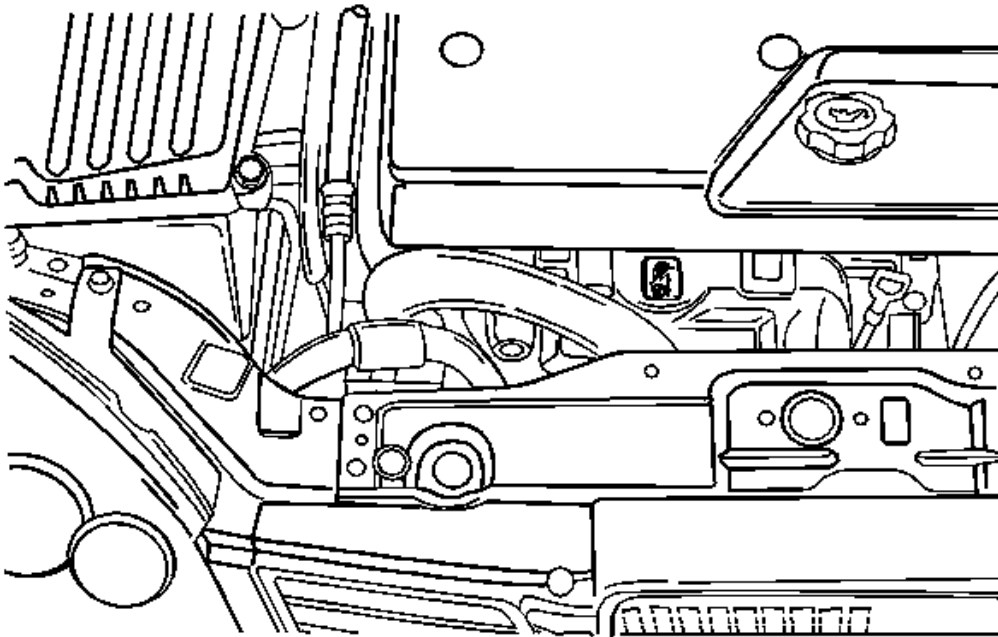


Fig. 56: Identifying Upper Thermostat Hose
Courtesy of GENERAL MOTORS CORP.

9. Remove the thermostat upper hose.

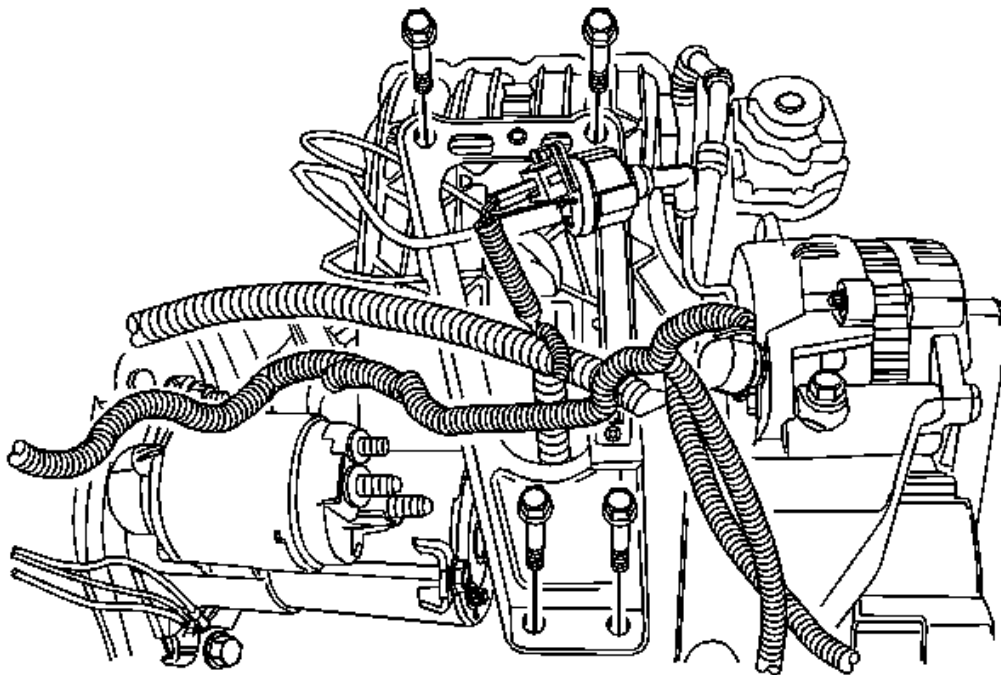


Fig. 57: Identifying Intake Manifold Support Bracket
Courtesy of GENERAL MOTORS CORP.

10. Remove the intake manifold pressure sensor, intake air temperature (IAT) sensor, and coolant temperature sensor.
11. Remove the intake manifold support bracket.

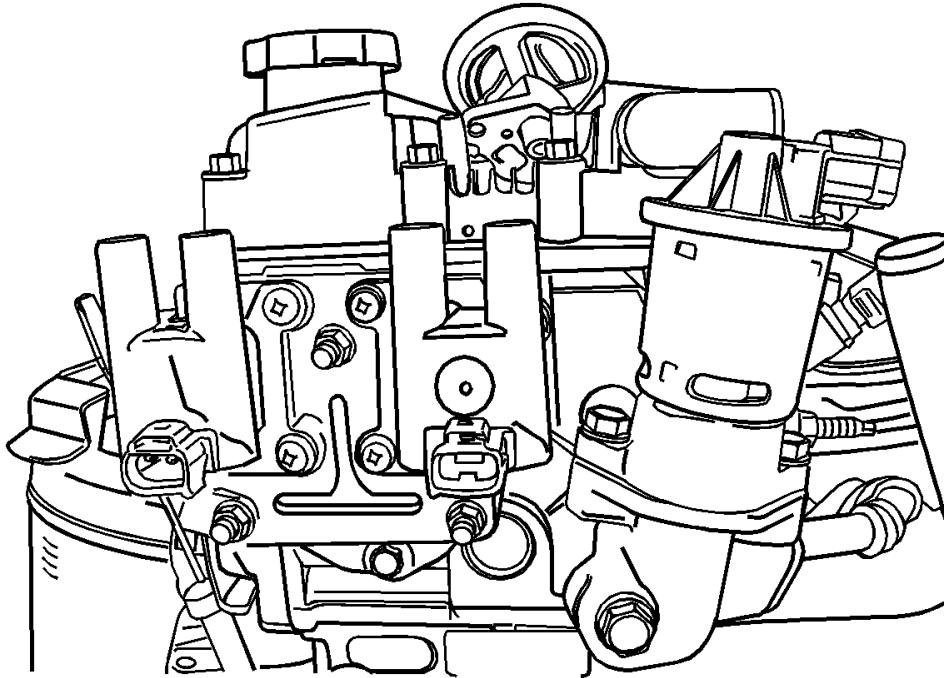


Fig. 58: View Of EGR Valve
Courtesy of GENERAL MOTORS CORP.

12. Remove the all the vacuum hoses from the intake manifold including the brake booster vacuum hose.
13. Remove the ignition cables from the spark plugs.
14. Remove the direct ignition coil and the bracket from the cylinder head.

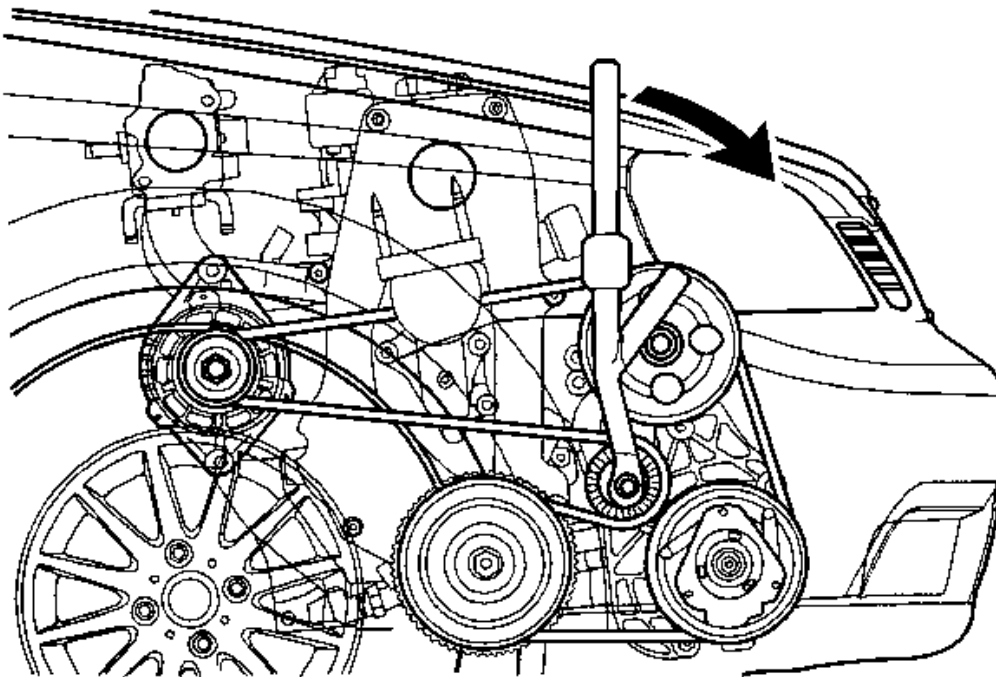


Fig. 59: Identifying Serpentine Accessory Drive Belt
Courtesy of GENERAL MOTORS CORP.

15. Remove the serpentine accessory drive belt. Refer to **Power Steering Pump Belt Replacement** .
16. Remove the front passenger side tire. Refer to **Tire and Wheel Removal and Installation** .
17. Remove the front wheel housing shield.

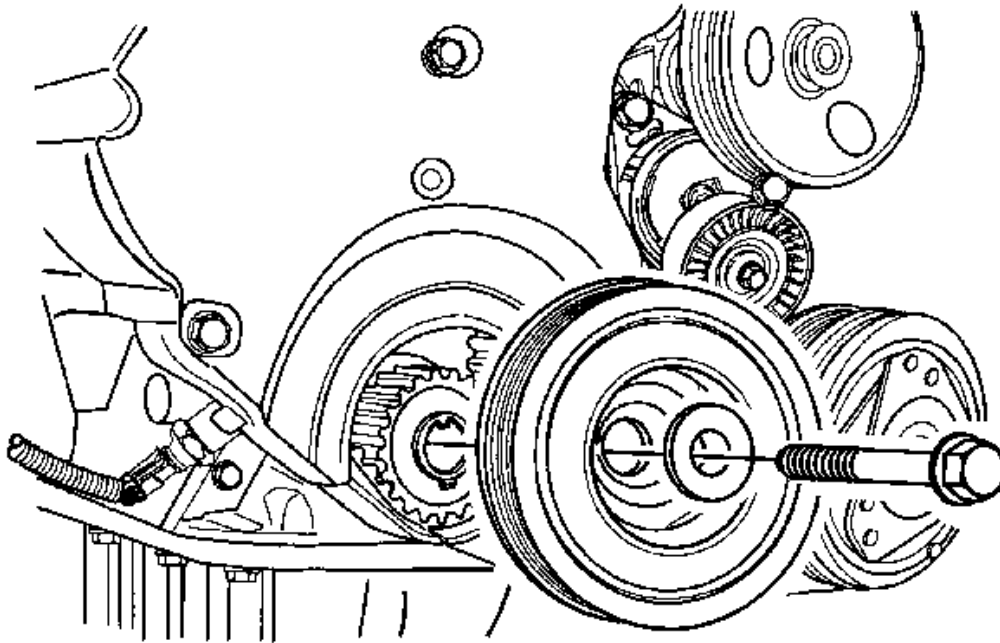


Fig. 60: Identifying Crankshaft Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

18. Remove the upper front timing belt cover bolts.
19. Remove the upper front timing belt cover.
20. Align the camshaft gear timing marks.
21. Remove the crankshaft pulley.
22. Remove the lower front timing belt cover bolts and cover.

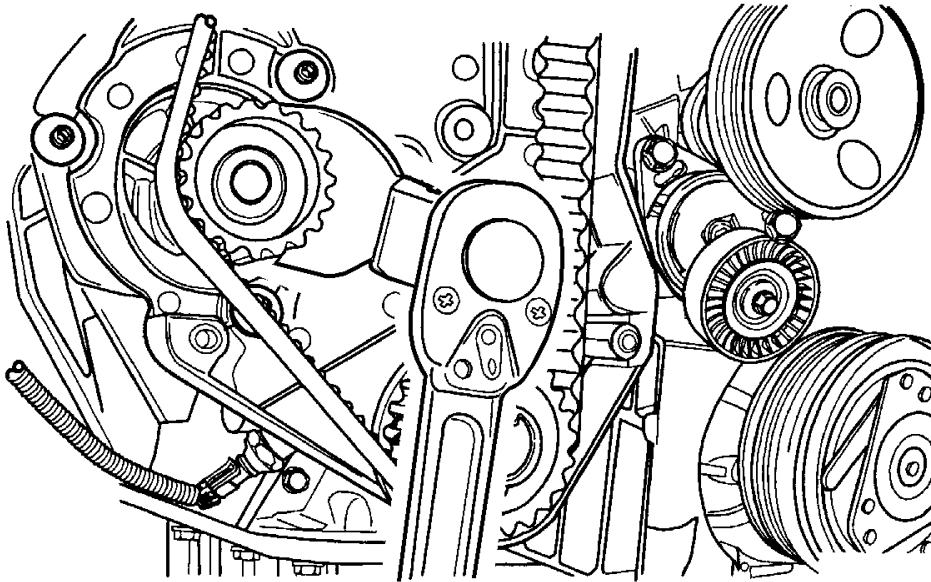


Fig. 61: Removing Timing Belt Tension Using J 42492-A
Courtesy of GENERAL MOTORS CORP.

23. Slightly loosen the water pump retaining bolts.
24. Rotate the water pump counterclockwise using **J 42492-A** to relieve the timing belt tension. See **Special Tools**.
25. Remove the timing belt. Refer to **Timing Belt Replacement**.

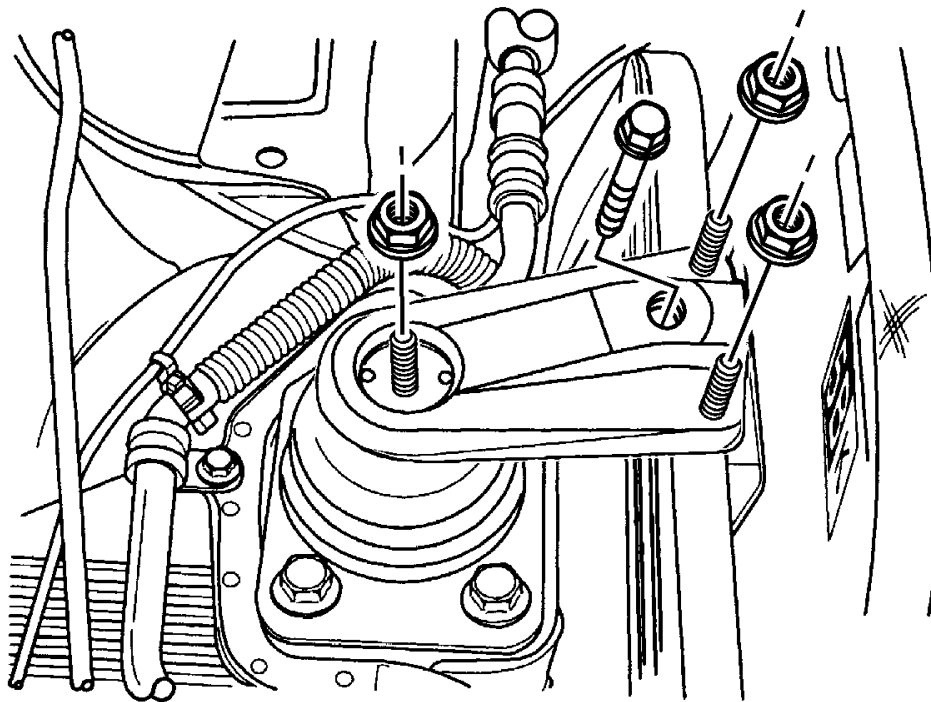


Fig. 62: View Of Engine Mount Bracket And Retainers
Courtesy of GENERAL MOTORS CORP.

26. Remove the engine mounting bracket. Refer to **Engine Mount Replacement**.
27. Remove the camshaft cover. Refer to **Valve Rocker Arm Cover Replacement**.

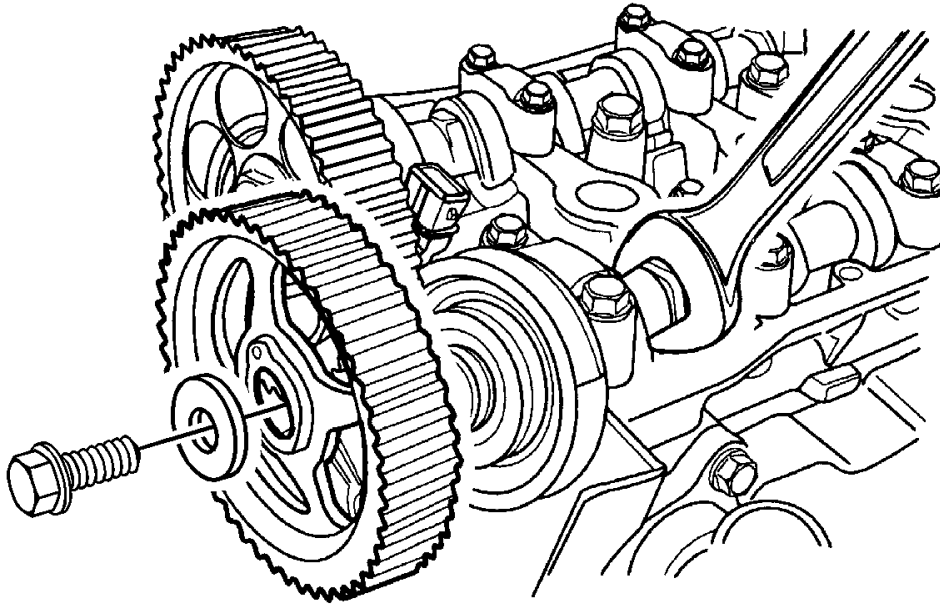


Fig. 63: Holding Camshaft To Tighten/Loosen Sprocket
Courtesy of GENERAL MOTORS CORP.

28. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt and gear.

IMPORTANT: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

29. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt and gear.

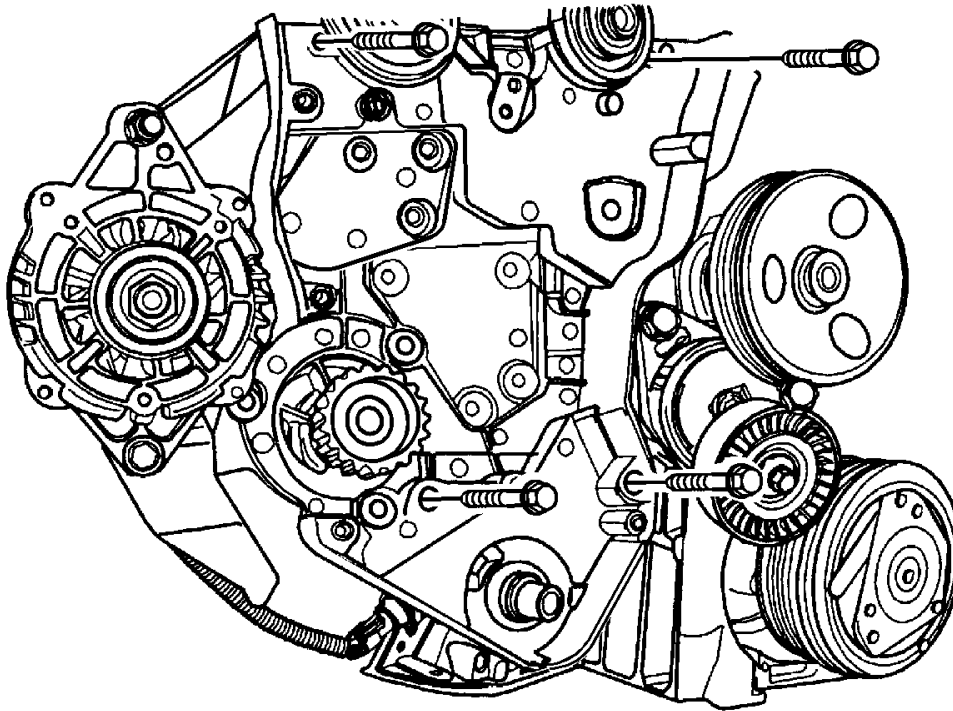


Fig. 64: View Of Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

30. Remove the timing belt automatic tensioner.
31. Remove the timing belt idler pulley.
32. Remove the right engine mount. Refer to **Engine Mount Replacement**.
33. Remove the rear timing belt cover.

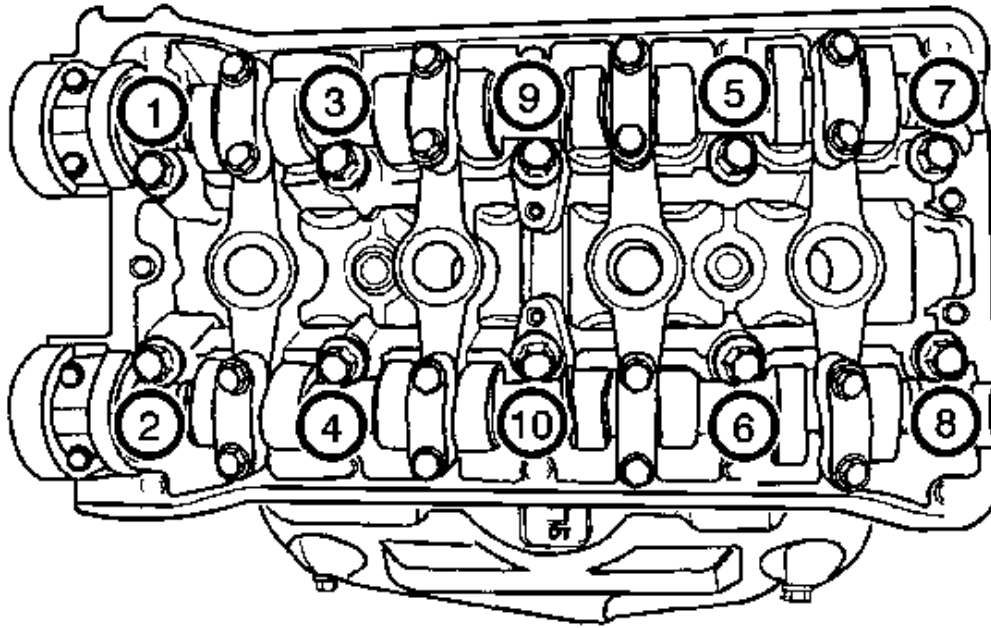


Fig. 65: View Of Cylinder Head Bolts And Sequence
Courtesy of GENERAL MOTORS CORP.

34. Remove the intake and exhaust manifold. Refer to Intake Manifold Replacement and Exhaust Manifold Replacement.
35. Remove the cylinder head bolts gradually in the sequence shown and remove the cylinder head.

NOTE: Use extreme care when removing the cylinder head to prevent any engine oil, dirt, or coolant from entering the engine. Damage to the engine could result.

36. Remove the cylinder head gasket.
37. Clean the gasket surfaces on the cylinder head and the engine block. Refer to Cylinder Head Cleaning and Inspection (Off Vehicle).

INSTALLATION PROCEDURE

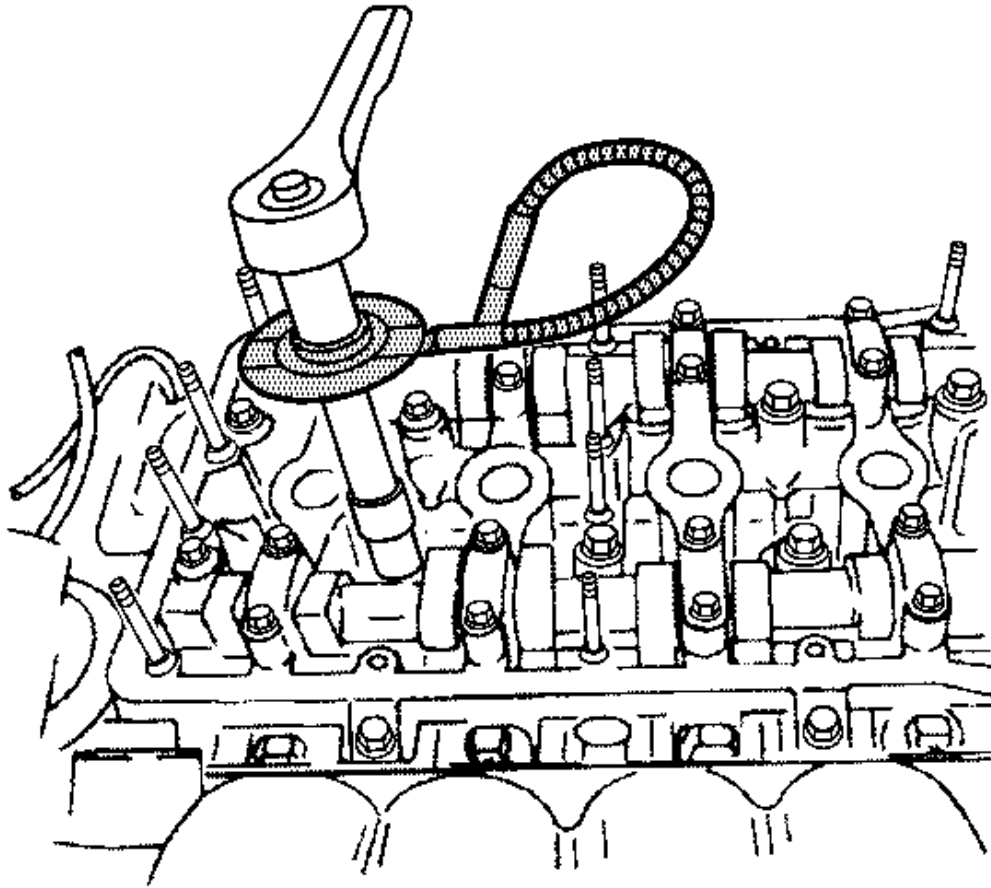


Fig. 66: View Of Cylinder Head Bolt Installation
Courtesy of GENERAL MOTORS CORP.

1. Install the new cylinder head gasket.
2. Install the intake/exhaust manifold to the cylinder head. Refer to **Intake Manifold Replacement** and **Exhaust Manifold Replacement**.

NOTE: Refer to **Fastener Notice** .

3. Install the cylinder head bolts gradually in the reverse of removal sequence using **J 45059** or **KM-470-B** . See **Special Tools** .

Tighten: Tighten the cylinder head bolts to **25 N.m (18 lb ft)** and retighten the cylinder head bolts 70 degrees plus 70 degrees plus 50 degrees.

4. Install the right engine mount. Refer to **Engine Mount Replacement**.

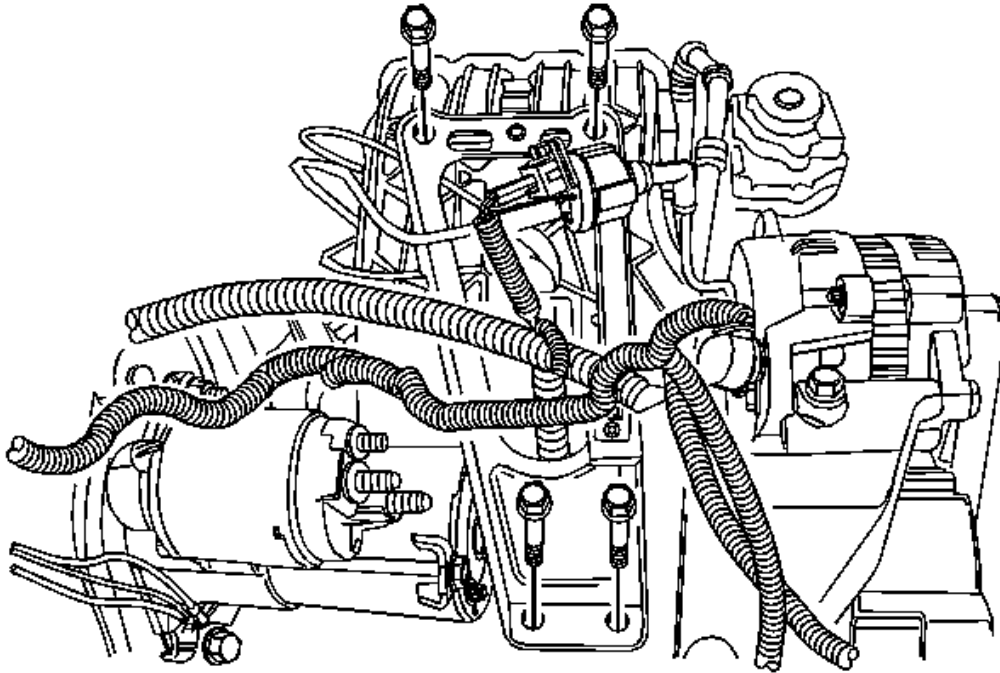


Fig. 67: Identifying Intake Manifold Support Bracket
Courtesy of GENERAL MOTORS CORP.

5. Connect the throttle cable at the throttle body and the intake manifold.
6. Install the intake manifold support bracket upper bolts to the intake manifold.

Tighten: Tighten the intake manifold support bracket upper bolts to the intake manifold to **25 N.m (18 lb ft)**.

7. Connect the surge tank coolant hose at the throttle body.
8. Connect the heater inlet hose to the cylinder head.

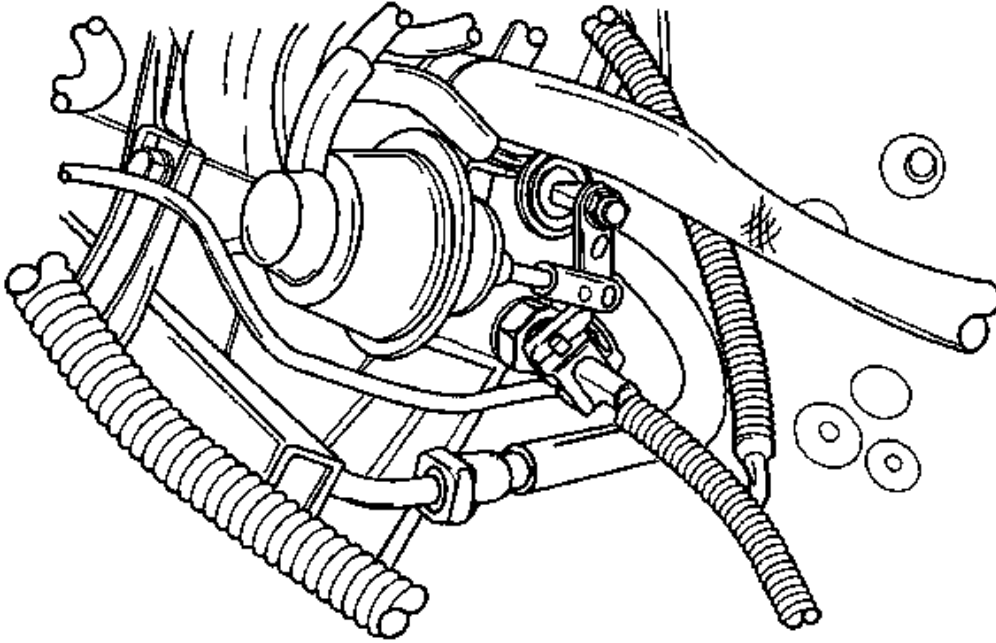


Fig. 68: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

9. Install the generator upper retaining bolt.

Tighten: Tighten the generator upper retaining bolt to **20 N.m (15 lb ft)** .

10. Connect the fuel feed line at the fuel rail.
11. Connect all the disconnected vacuum hoses and the brake booster vacuum hose at the intake manifold.

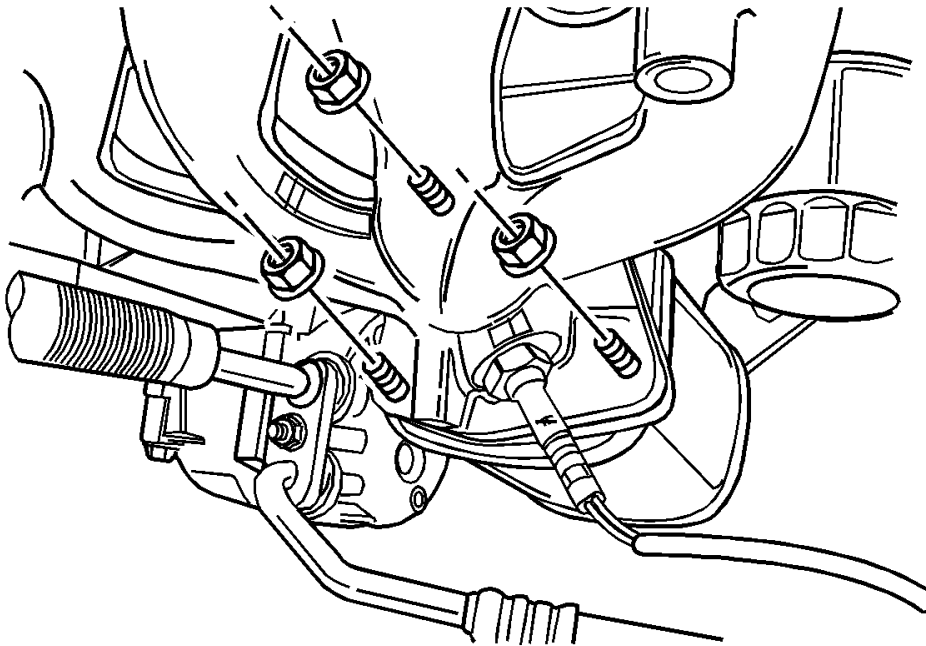


Fig. 69: View Of Exhaust Manifold Flange And Nuts
Courtesy of GENERAL MOTORS CORP.

12. Install the catalytic converter retaining nuts at the exhaust manifold flange.

Tighten: Tighten the catalytic converter to exhaust manifold flange nuts to **40 N.m (30 lb ft)** .

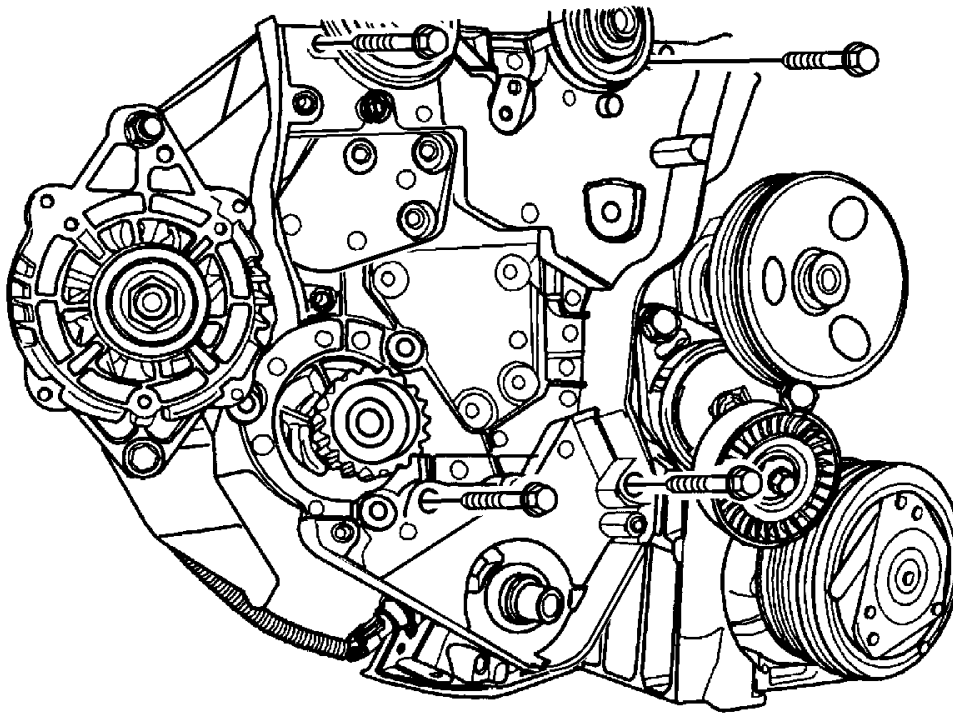


Fig. 70: View Of Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

13. Install the rear timing belt cover.
14. Install the rear timing belt cover bolts.

Tighten: Tighten the rear timing belt cover bolts to **10 N.m (89 lb in)** .

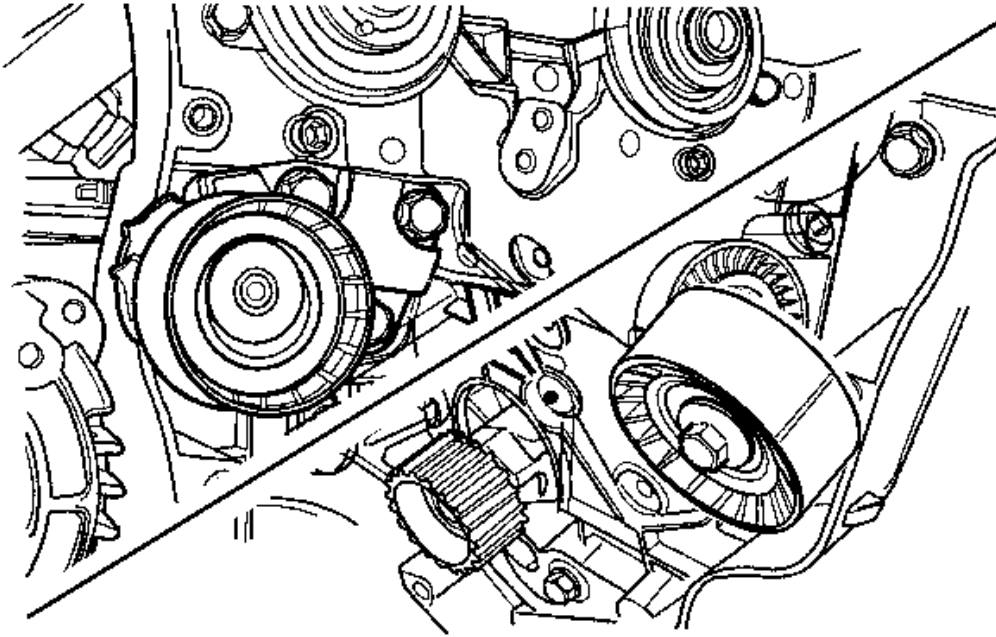


Fig. 71: View Of Automatic Tensioner And Idler Pulley
Courtesy of GENERAL MOTORS CORP.

15. Install the timing belt automatic tensioner.

Tighten: Tighten the timing belt automatic tensioner bolts to **25 N.m (18 lb ft)** .

16. Install the timing belt idler pulley.

Tighten: Tighten the timing belt idler pulley bolt to **25 N.m (18 lb ft)** .

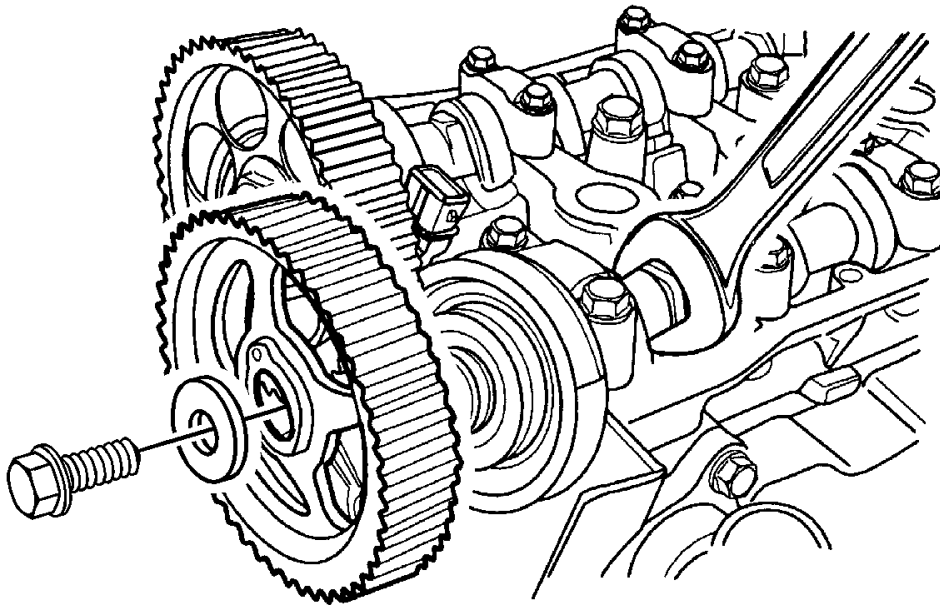


Fig. 72: Holding Camshaft To Tighten/Loosen Sprocket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

17. Install the intake and exhaust camshaft gear.

Tighten: Tighten the intake and exhaust camshaft gear bolts to **67.5 N.m (49 lb ft)** .

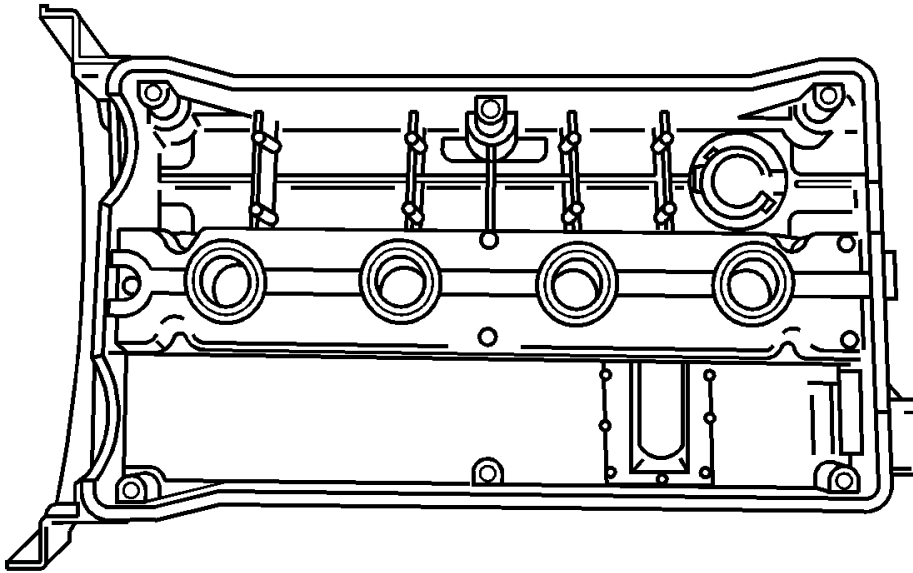


Fig. 73: View OF DIS Coil Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

18. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear camshaft cover-to-cylinder head seal.
19. Install the camshaft cover and the gasket. Refer to **Valve Rocker Arm Cover Replacement**.

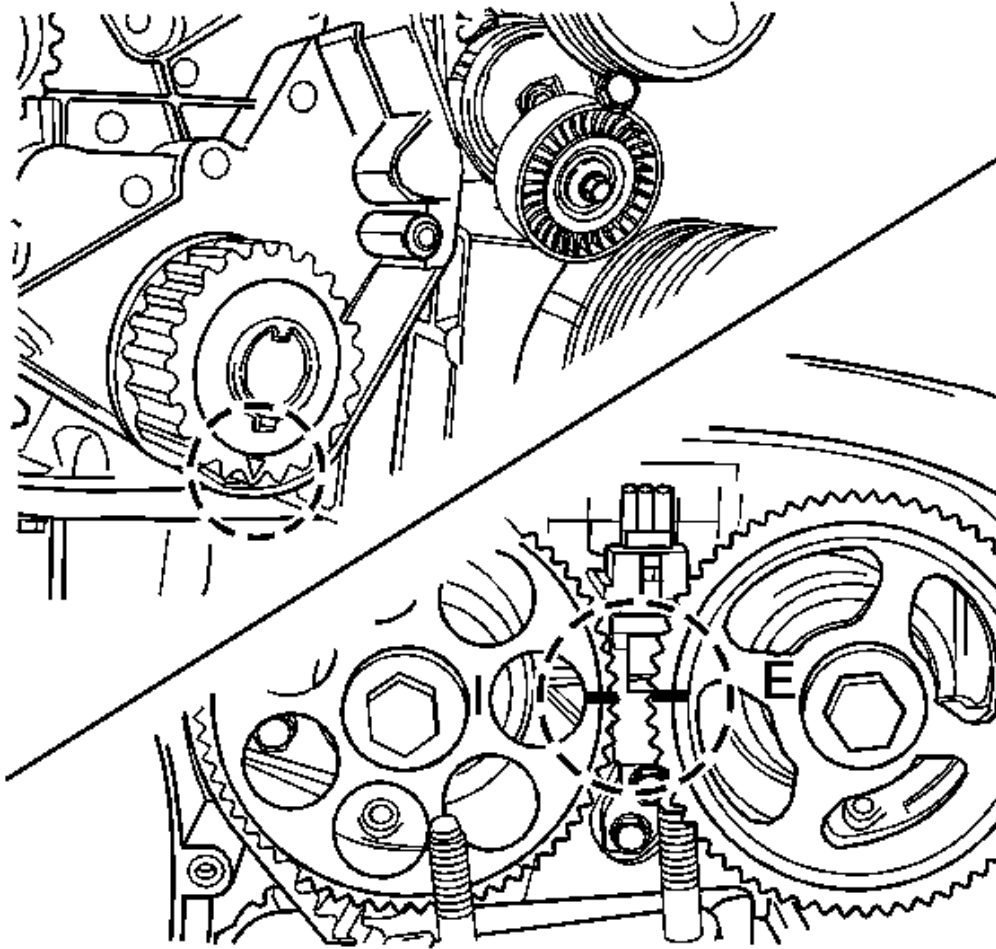


Fig. 74: Locating Gear Marks
Courtesy of GENERAL MOTORS CORP.

20. Connect the ignition wires to the spark plugs.
21. Install the oil filler cap.
22. Connect the engine ventilation hose to the camshaft cover.
23. Align the timing marks on the camshaft gears.
24. Align the mark on the crank shaft gear with the notch at the bottom of the rear timing belt cover.

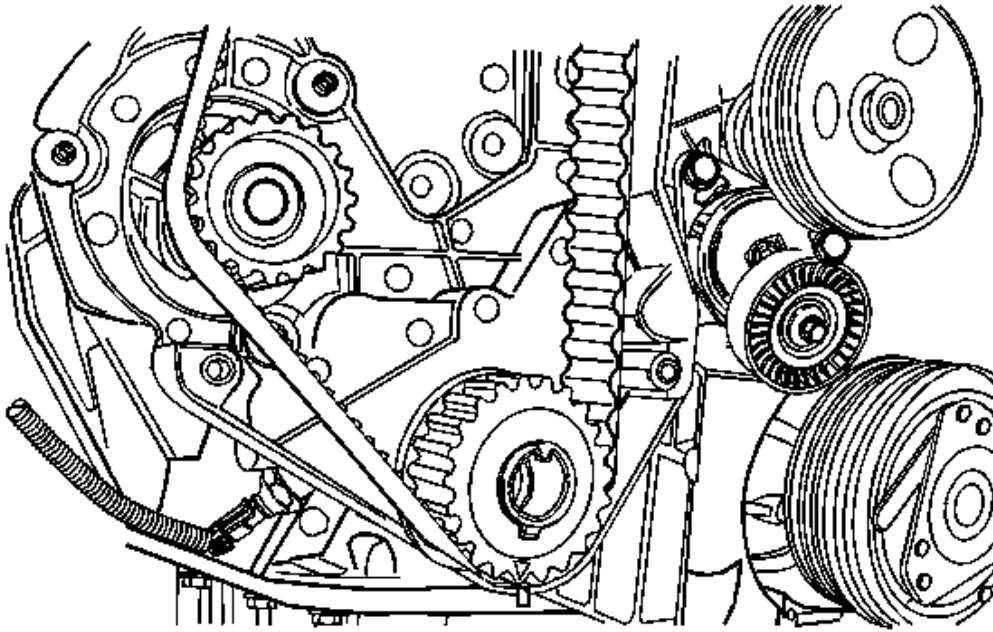


Fig. 75: View Of Timing Belt
Courtesy of GENERAL MOTORS CORP.

25. Install the timing belt.
26. Rotate the water pump clockwise using the **J 42492-A** to apply tension to the timing belt. See **Special Tools** .

Tighten: Tighten the water pump retaining bolts to **10 N.m (89 lb in)** .

27. Check and adjust the timing belt tension. Refer to **Engine Mount Replacement**.

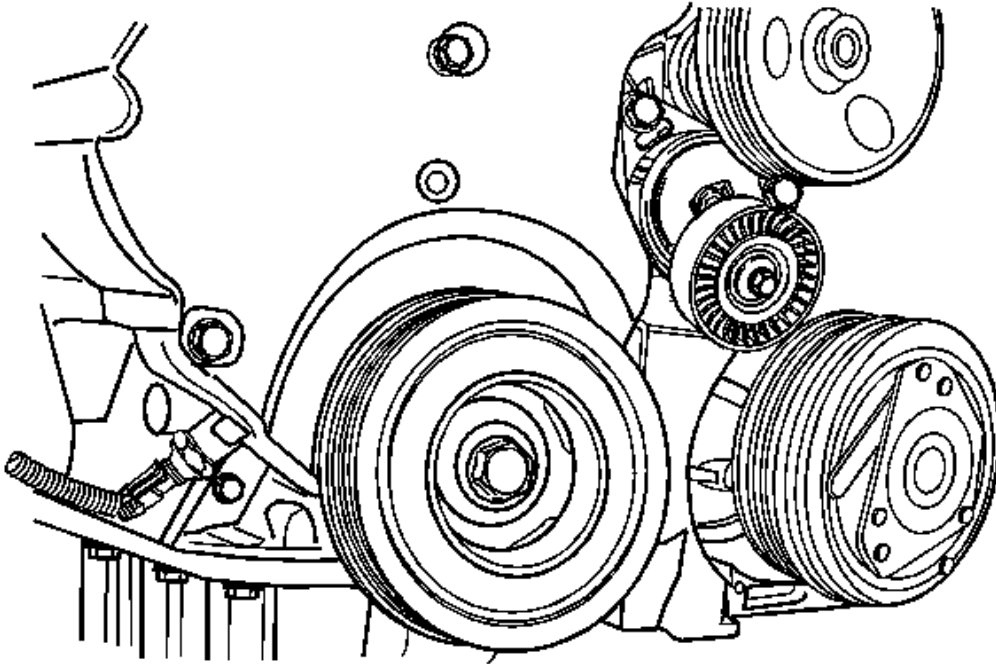


Fig. 76: View Of Crankshaft Pulley
Courtesy of GENERAL MOTORS CORP.

28. Install the upper and lower front timing belt covers.

Tighten: Tighten the upper and lower front timing belt cover bolts to **10 N.m (89 lb in)** .

29. Install the crankshaft pulley bolt.

Tighten: Tighten the crank shaft pulley bolt to **95 N.m (70 lb ft)** and retighten 30 degrees plus 15 degrees.

30. Install the serpentine accessory drive belt. Refer to **Power Steering Pump Belt Replacement** .
31. Connect the upper radiator hose to the thermostat housing.
32. Install the front wheel and splash shield. Refer to **Tire and Wheel Removal and Installation** .

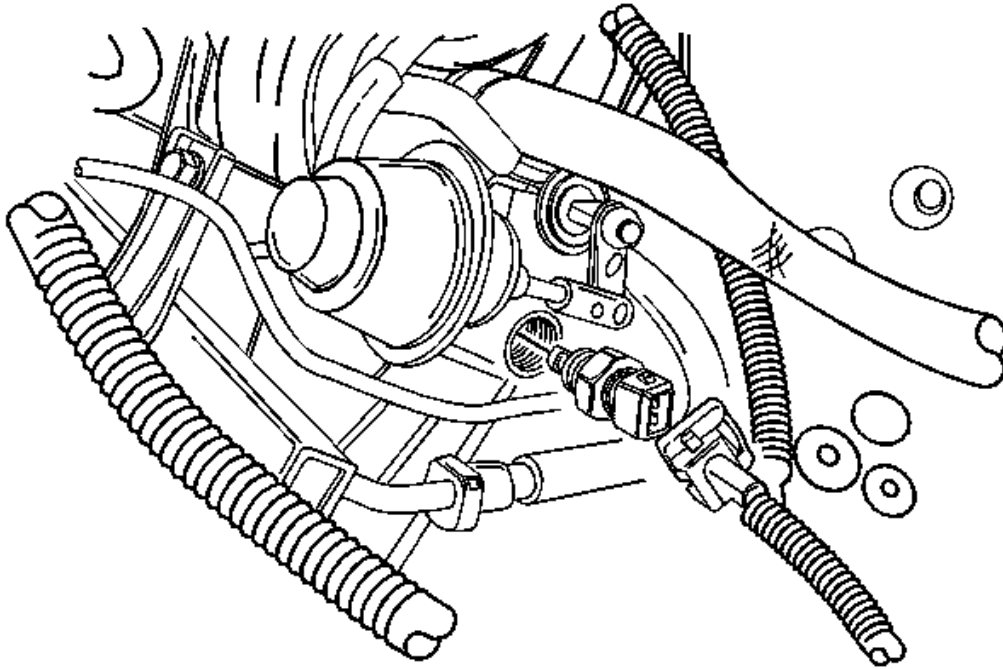


Fig. 77: View Of IAT Sensor And Connector
Courtesy of GENERAL MOTORS CORP.

33. Install the air cleaner housing.

Tighten: Tighten the air cleaner housing bolts to **10 N.m (89 lb in)** .

34. Connect the breather tube to the camshaft cover.
35. Install the crankshaft pulley bolt.
36. Connect the IAT sensor connector.
37. Connect the intake manifold pressure sensor, IAT sensor, and coolant temperature sensor connector.

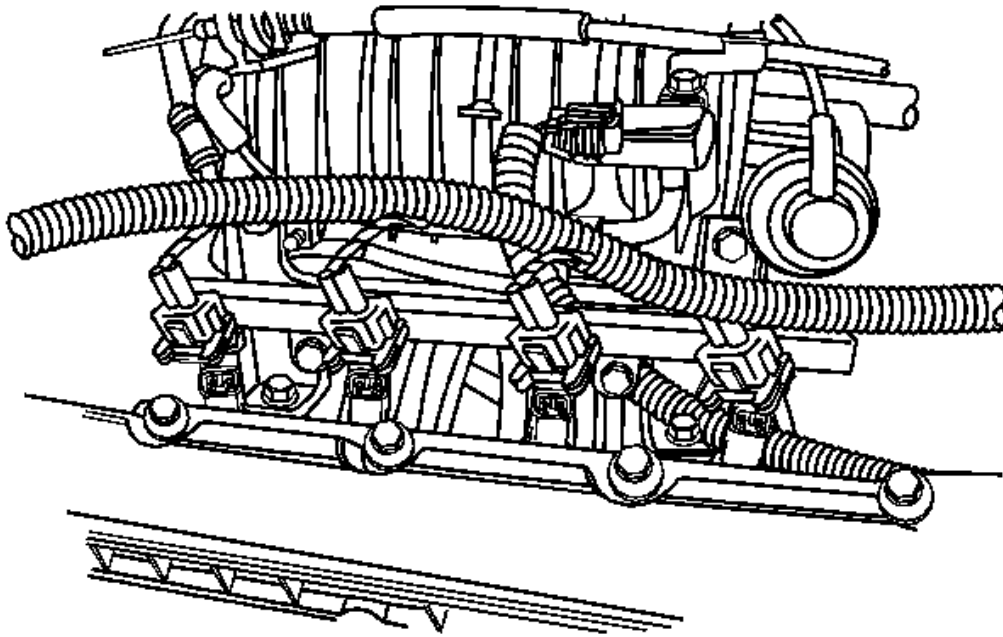


Fig. 78: View Of Direct Ignition Coil
Courtesy of GENERAL MOTORS CORP.

38. Connect the direct ignition coil connector.
39. Connect the fuel injector harness connectors.
40. Connect the oxygen sensor connector and the ECM ground terminal at the intake manifold.
41. Install the fuel pump fuse.
42. Connect the negative battery ground cable.
43. Refill the engine cooling system. Refer to **Cooling System Draining and Filling (Gasoline Engines)** .

OIL PAN REPLACEMENT

REMOVAL PROCEDURE

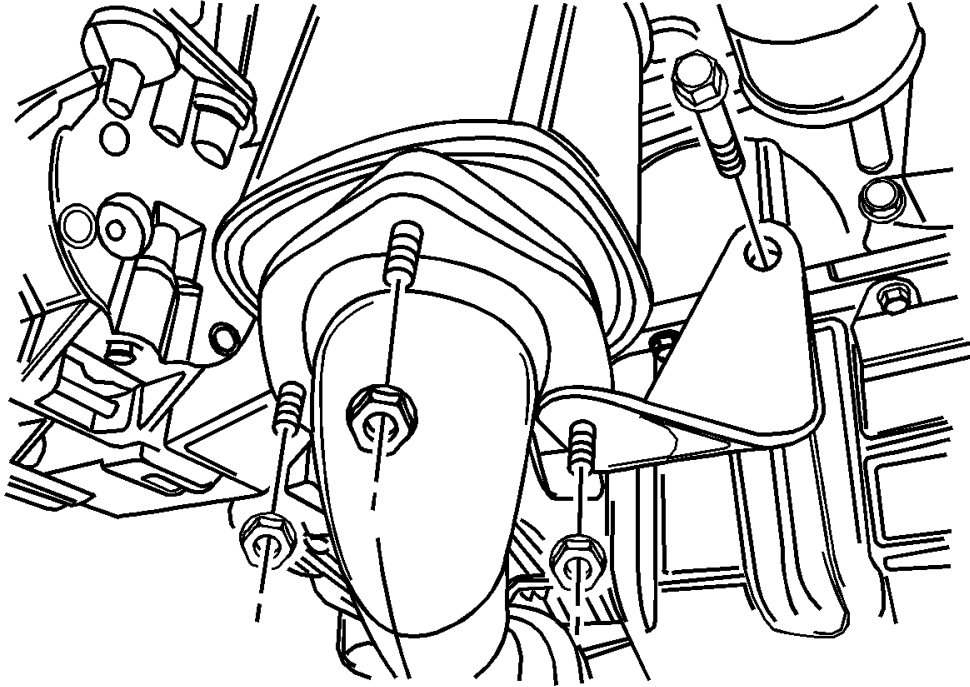


Fig. 79: View Of Exhaust Pipe Catalytic Converter Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.

CAUTION: Refer to Safety Glasses Caution .

2. Drain the engine oil from the engine crankcase.
3. Remove the catalytic converter retaining nuts from the exhaust pipe.

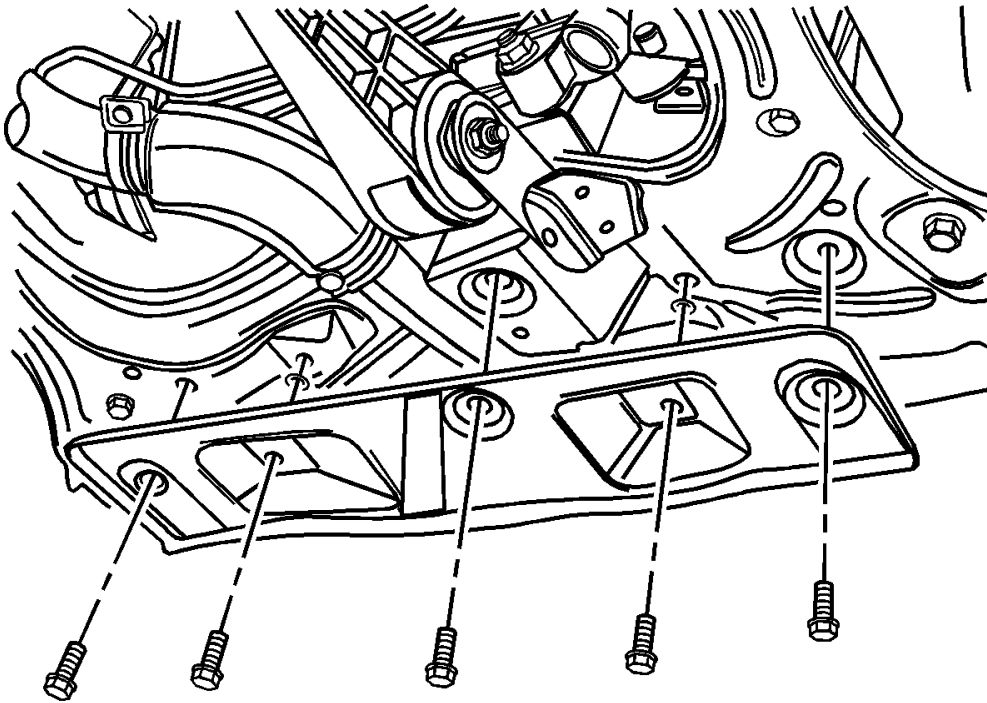


Fig. 80: View Of Lower Crossmember Bracket
Courtesy of GENERAL MOTORS CORP.

4. Remove the lower crossmember bracket.
5. Remove the exhaust connecting pipe.

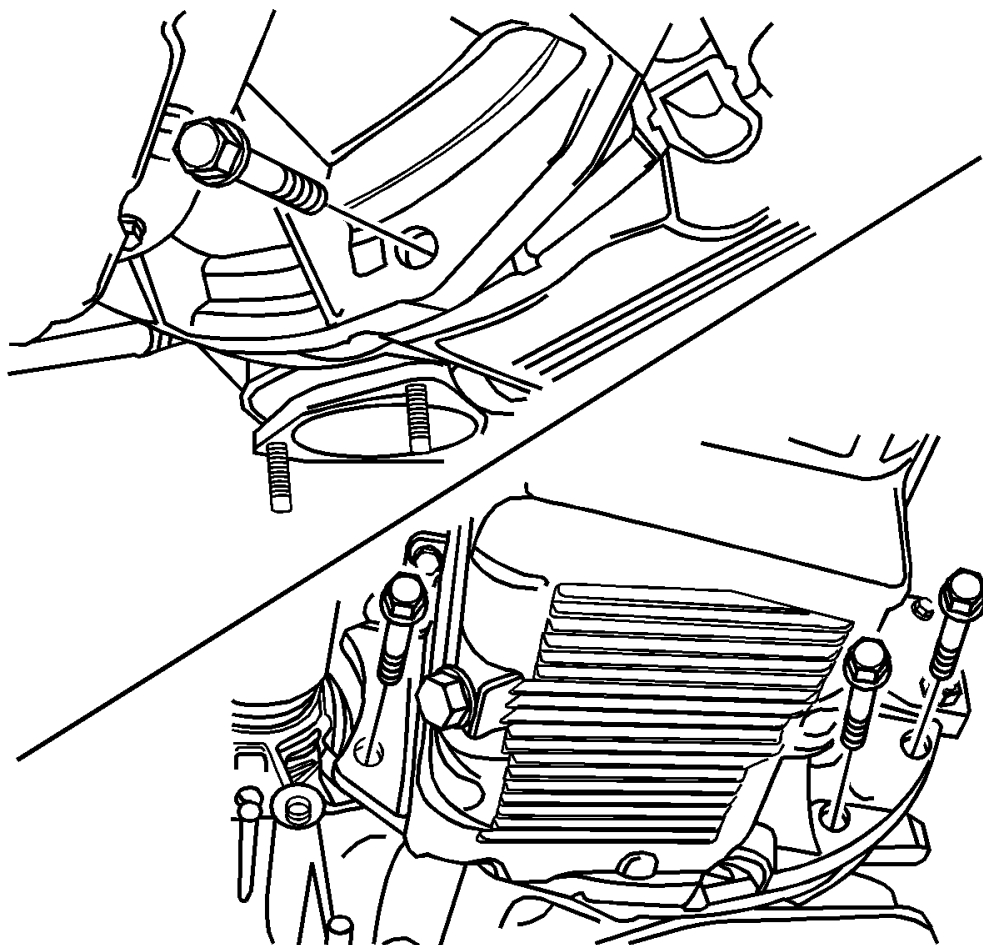


Fig. 81: View Of Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pan bolts to the transaxle case.

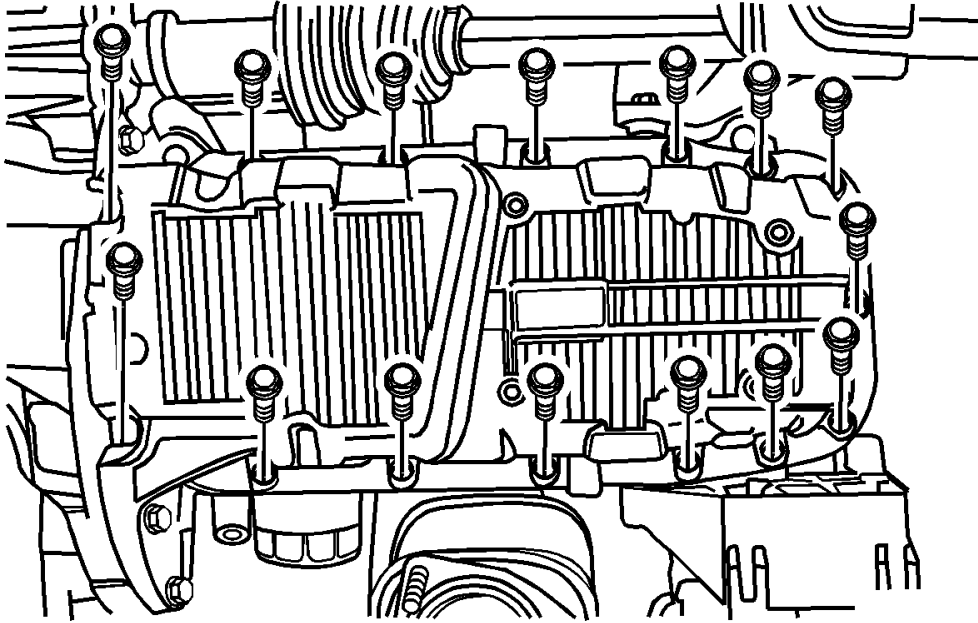


Fig. 82: View Of Oil Pan And Engine Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pan retaining bolts to the engine block.
8. Remove the oil pan from the engine block.
9. Clean the gasket surfaces on the oil pan and the engine block. Refer to **Oil Pan Cleaning and Inspection** .

INSTALLATION PROCEDURE

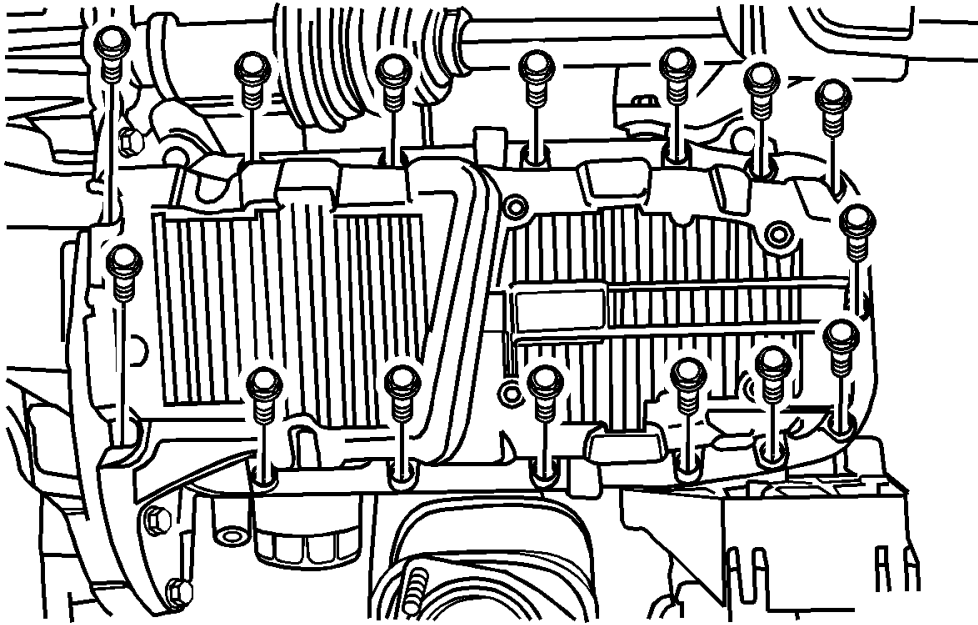


Fig. 83: View Of Oil Pan And Engine Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Coat the new oil pan gasket with sealant.

IMPORTANT: Install the oil pan within 5 minutes after applying the liquid gasket to the oil pan.

2. Install the oil pan to the engine block.

NOTE: Refer to Fastener Notice .

3. Install the oil pan retaining bolts.

Tighten: Tighten the oil pan retaining bolts to **10 N.m (89 lb in)** .

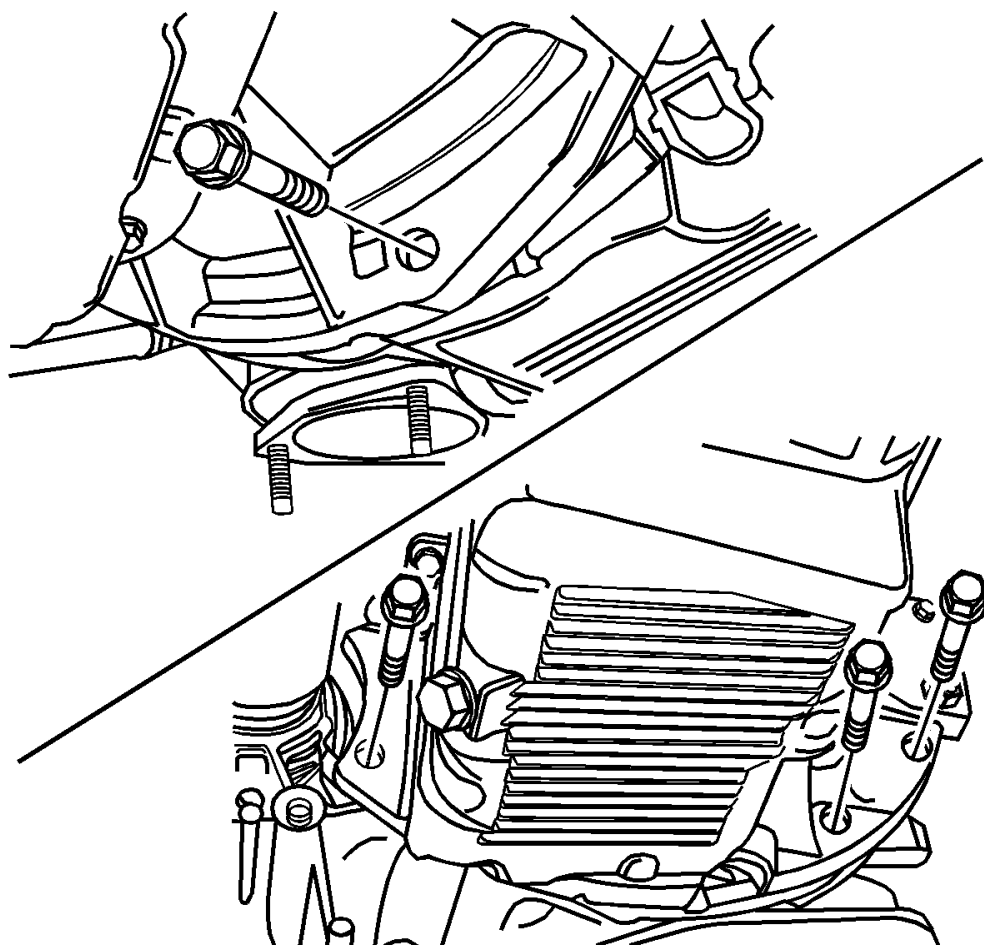


Fig. 84: View Of Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan bolts to the transaxle case.

Tighten: Tighten the oil pan bolts to the transaxle case bolts to **31 N.m (23 lb ft)** .

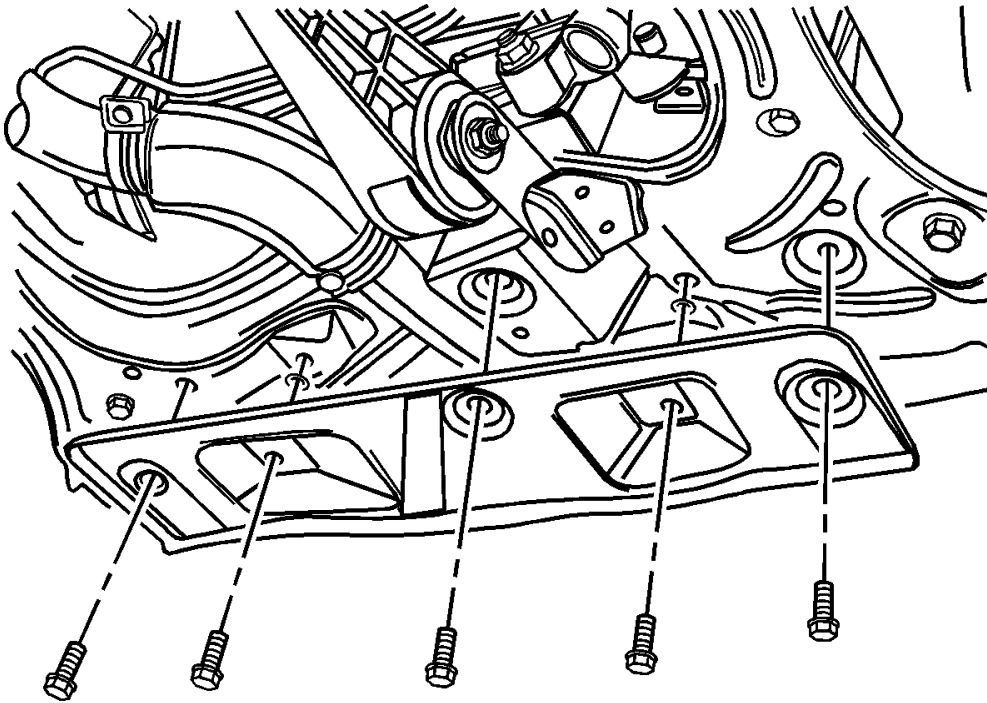


Fig. 85: View Of Lower Crossmember Bracket
Courtesy of GENERAL MOTORS CORP.

5. Install the exhaust connecting pipe.
6. Install the catalytic converter retaining nuts to the exhaust pipe.

Tighten: Tighten the catalytic converter to exhaust pipe retaining nuts to **40 N.m (30 lb ft)** .

7. Install the lower crossmember bracket.
8. Connect the negative battery cable.
9. Discard the used oil pan drain plug washer and replace it with a new one.
10. Install the oil pan drain plug.

Tighten: Tighten the oil pan drain plug to **55 N.m (40 lb ft)** .

11. Refill the engine crankcase with engine oil.

OIL PUMP REPLACEMENT

REMOVAL PROCEDURE

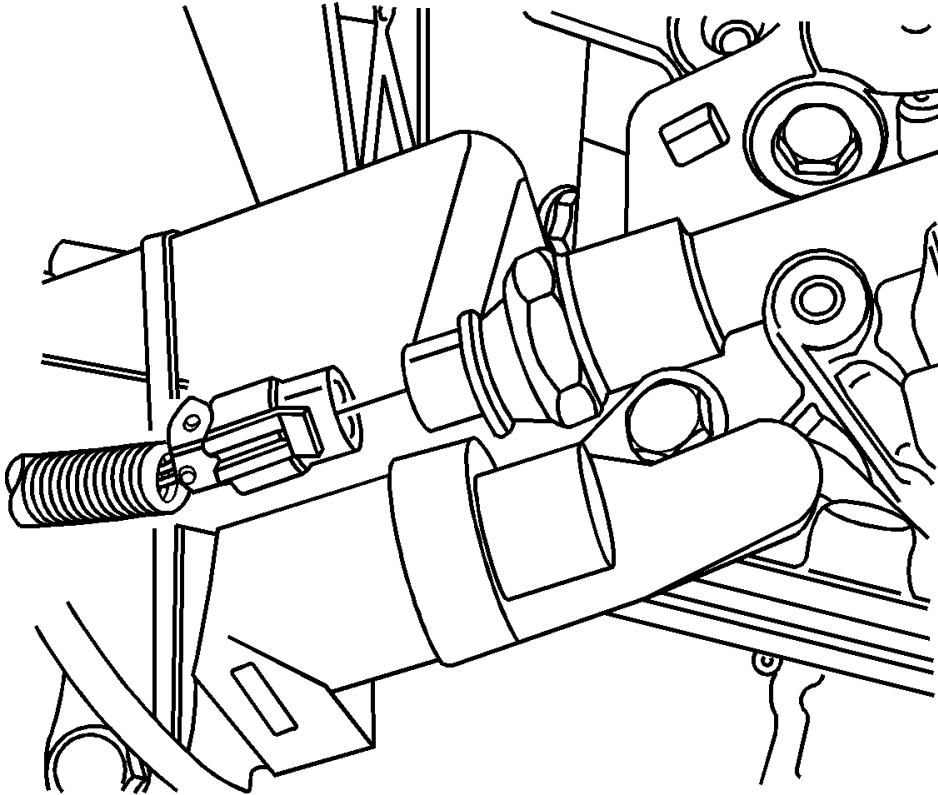


Fig. 86: View Of Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to Timing Belt Replacement.
3. Remove the rear timing belt cover. Refer to Timing Belt Cover Replacement.
4. Disconnect the oil pressure switch connector.

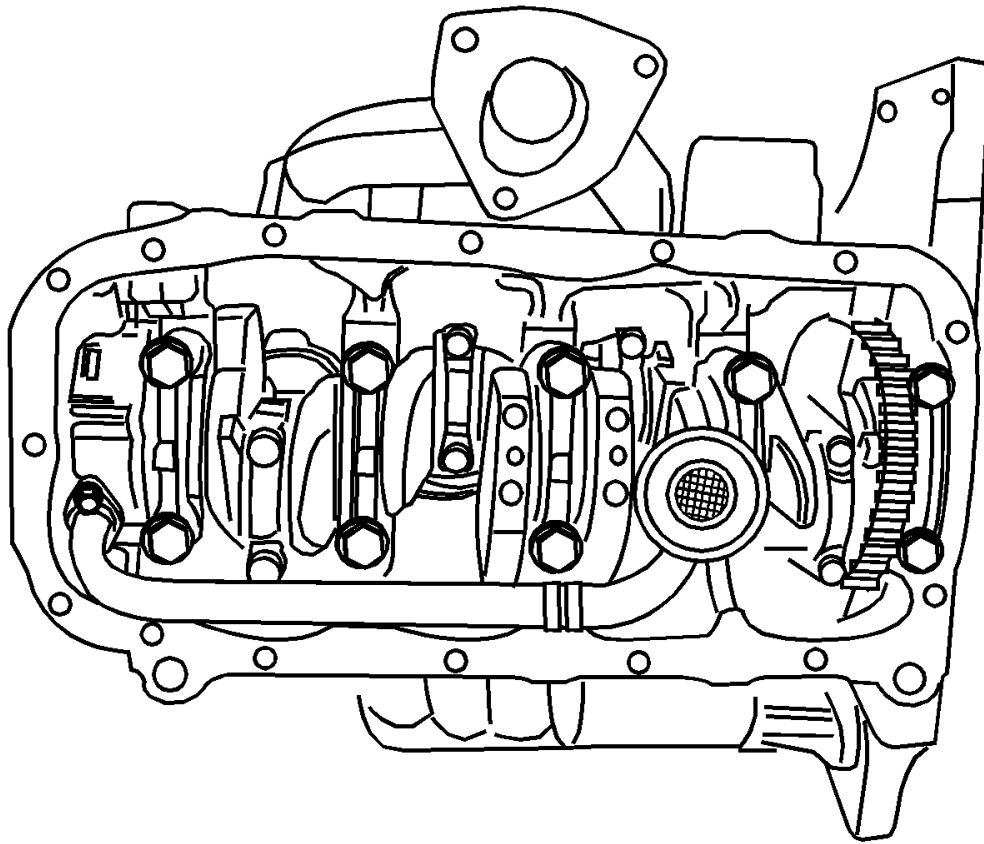


Fig. 87: View Of Oil Pump/Pickup Tube And Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft position (CKP) sensor bolt.
6. Remove the CKP sensor.
7. Remove the oil pan. Refer to **Oil Pan Replacement**.
8. Remove the oil pump pickup tube and the support bracket bolts.
9. Remove the oil pump pickup tube.

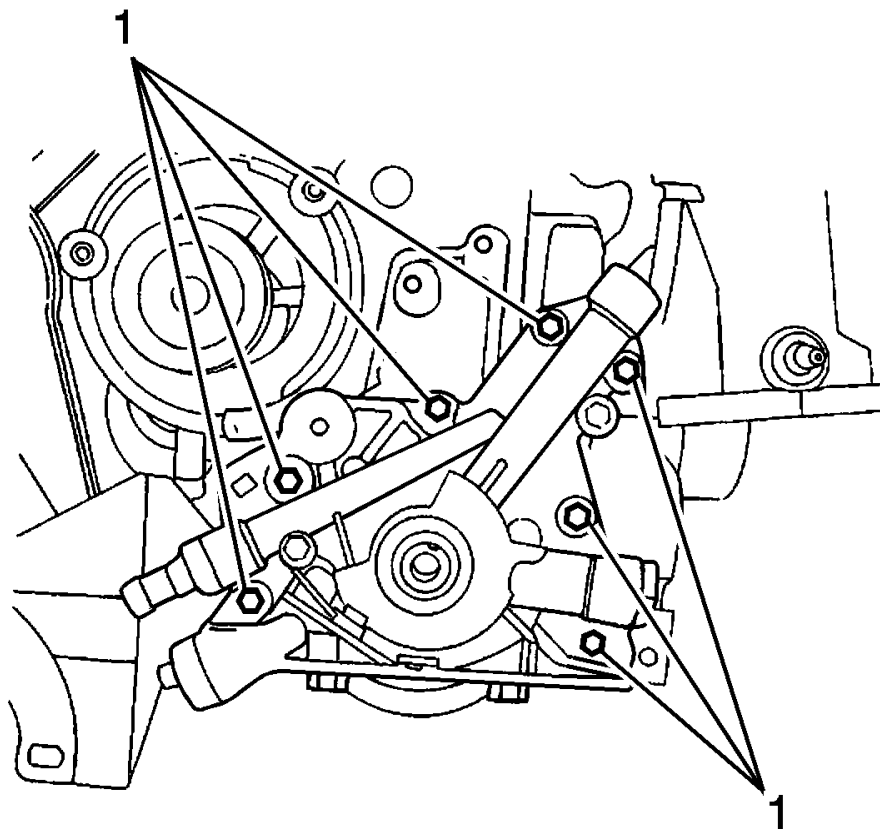


Fig. 88: Identifying Oil Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the oil pump retaining bolts (1).

CAUTION: Refer to Safety Glasses Caution .

11. Carefully separate the oil pump and the gasket from the engine block and the oil pan.
12. Remove the oil pump.

INSTALLATION PROCEDURE

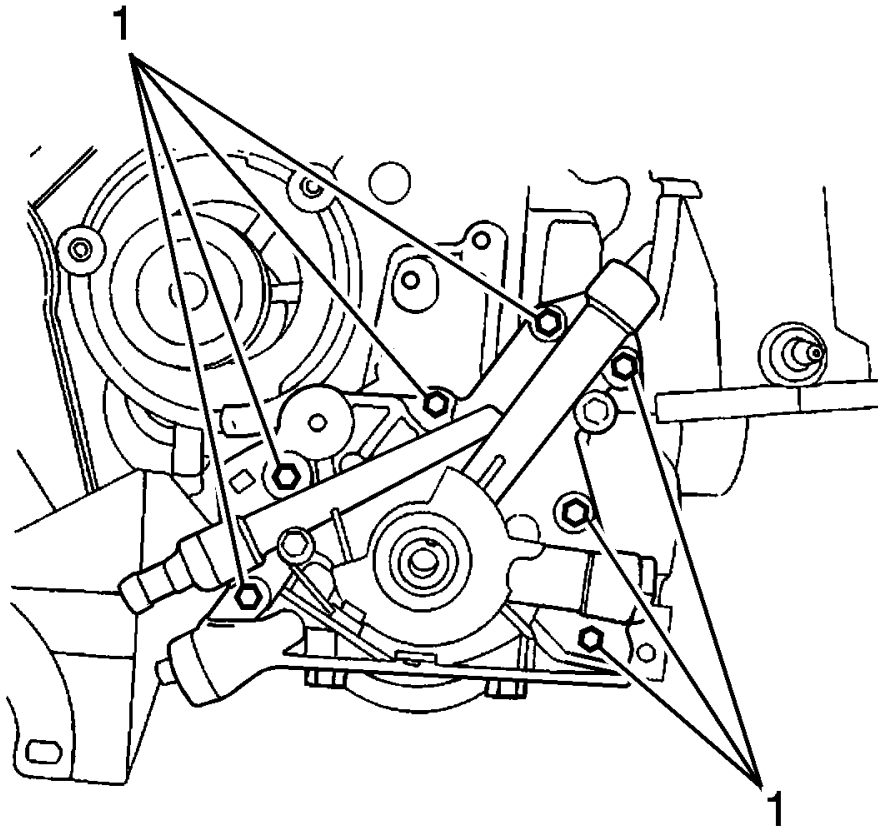


Fig. 89: Identifying Oil Pump Retaining Bolts
 Courtesy of GENERAL MOTORS CORP.

1. Apply a bead of room temperature vulcanizing (RTV) sealer to the oil pump gasket.
2. Install a new oil pump gasket to the oil pump.
3. Coat the threads of the oil pump bolts with LOCTITE® 242.

NOTE: Refer to Fastener Notice .

4. Install the oil pump to the engine block with the bolts (1).

Tighten: Tighten the oil pump retaining bolts to **10 N.m (89 lb in)** .

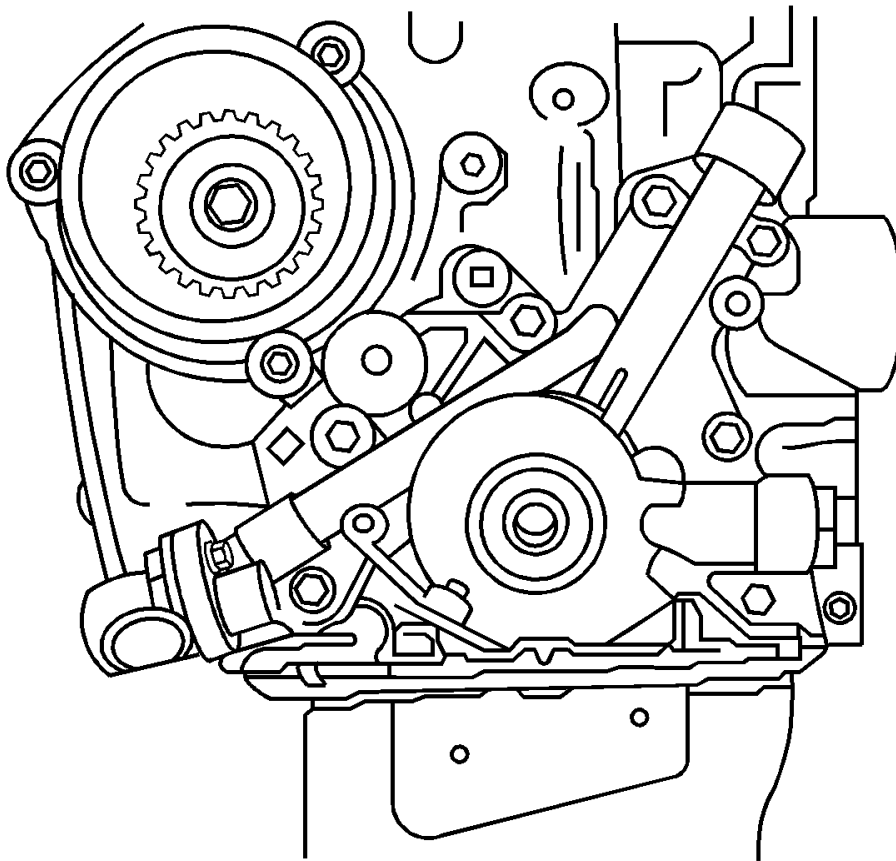


Fig. 90: View Of Oil Pump And Crankshaft Seal
Courtesy of GENERAL MOTORS CORP.

5. Install a new oil pump to the crankshaft shaft seal.
6. Coat the lip of the seal with a thin coat of grease.

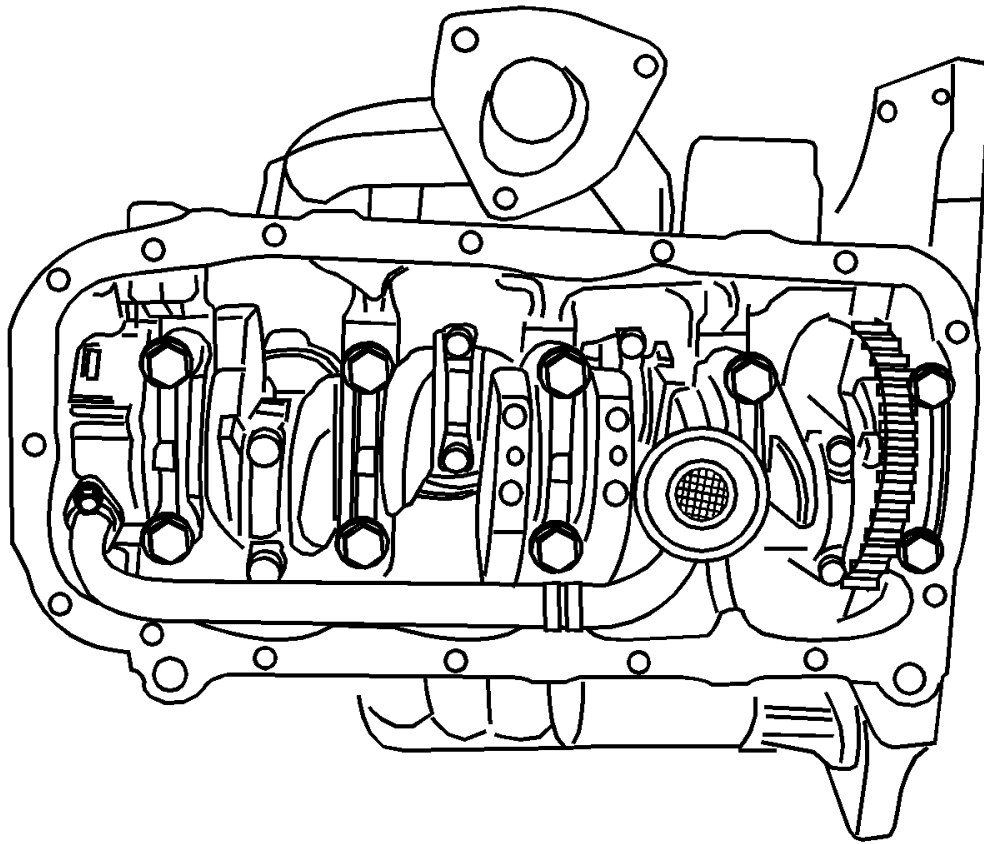


Fig. 91: View Of Oil Pump/Pickup Tube And Bolts
Courtesy of GENERAL MOTORS CORP.

7. Coat the threads of the oil pump pickup tube and the support bracket bolts with LOCTITE® 242.
8. Install the oil pump pickup tube and the bolts.

Tighten: Tighten the oil pump pickup tube and the support bracket bolts to **10 N.m (89 lb in)** .

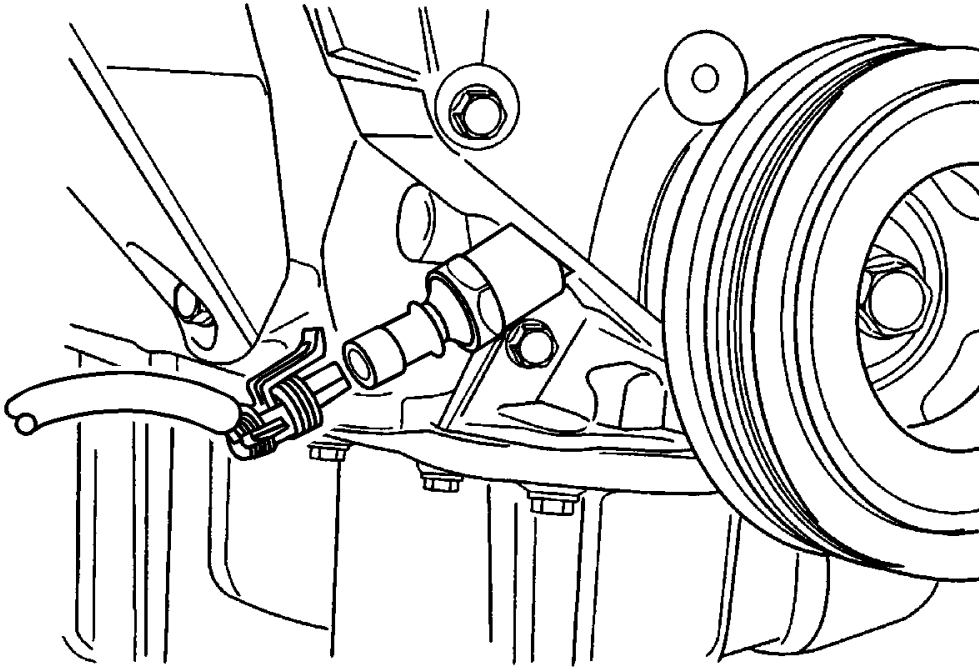


Fig. 92: Identifying Oil Pressure Switch Connector
Courtesy of GENERAL MOTORS CORP.

9. Install the oil pan. Refer to **Oil Pan Replacement**.
10. Install the CKP sensor and the bolt.

Tighten: Tighten the CKP sensor retaining bolt to **10 N.m (89 lb in)** .

11. Connect the oil pressure switch connector.
12. Install the rear timing belt cover. Refer to **Timing Belt Cover Replacement**.
13. Install the timing belt. Refer to **Timing Belt Replacement**.
14. Connect the negative battery cable.

ENGINE MOUNT REPLACEMENT

TOOLS REQUIRED

J 28467-B (DW-117) Universal Engine Support Fixture. See **Special Tools** .

REMOVAL PROCEDURE

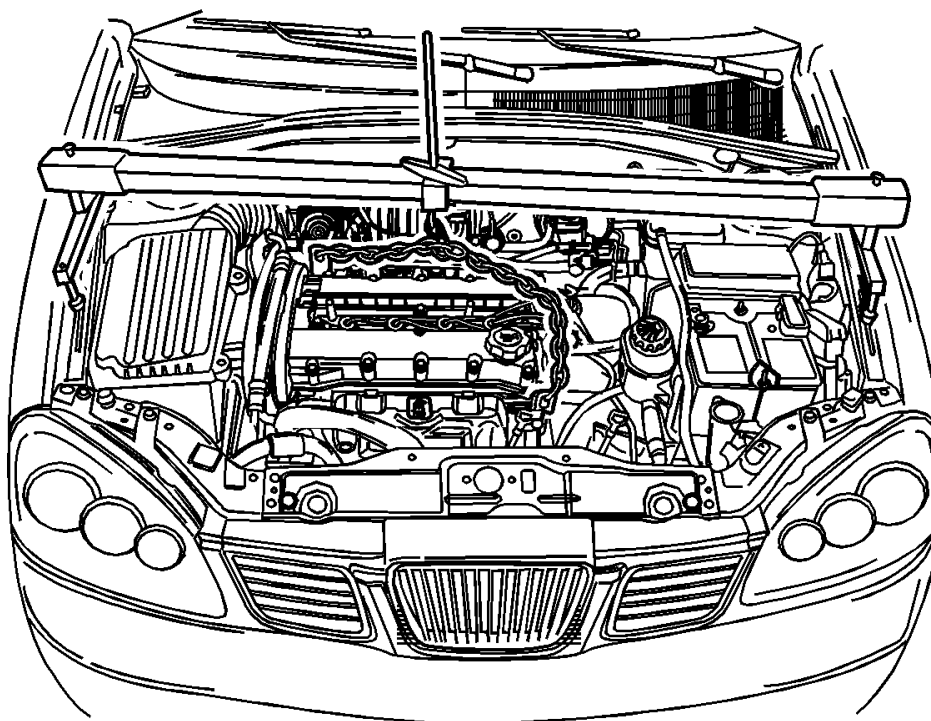


Fig. 93: View Of Engine Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Support the engine assembly using the **J 28467-B** . See Special Tools .

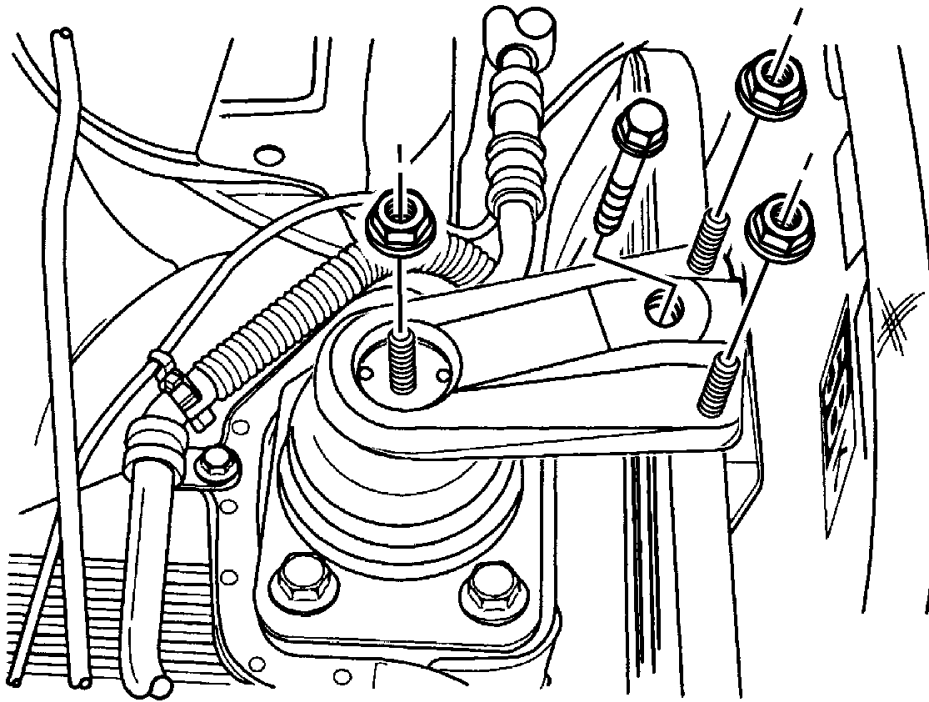


Fig. 94: View Of Engine Mount Bracket And Retainers
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount bracket attaching bolts/nuts.
4. Remove the front timing belt cover. Refer to **Timing Belt Cover Replacement**.

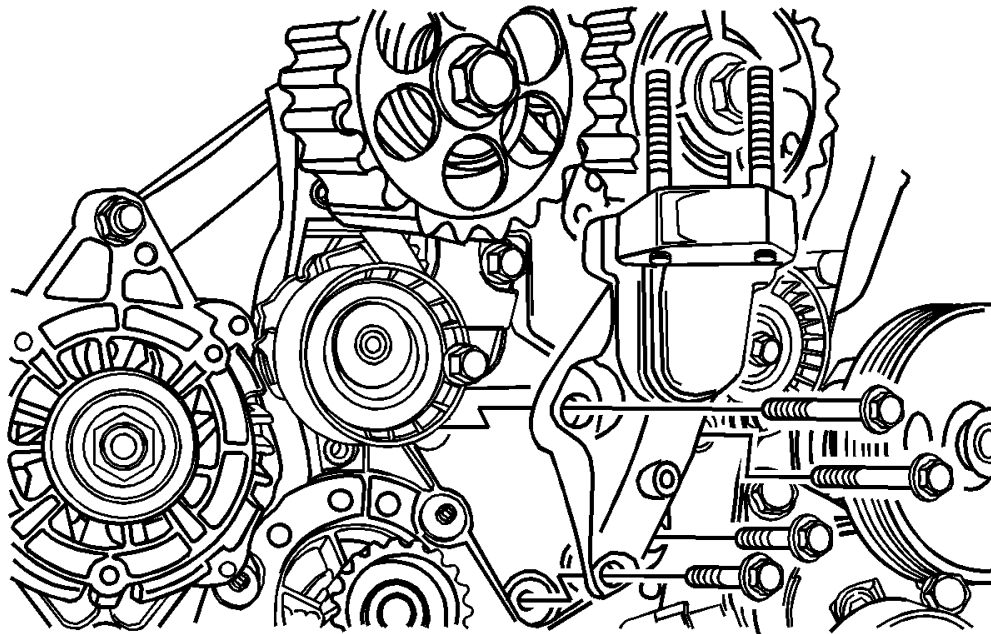


Fig. 95: View Of Engine Mount Attaching Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount attaching bolts/nuts.
6. Remove the engine mount.

INSTALLATION PROCEDURE

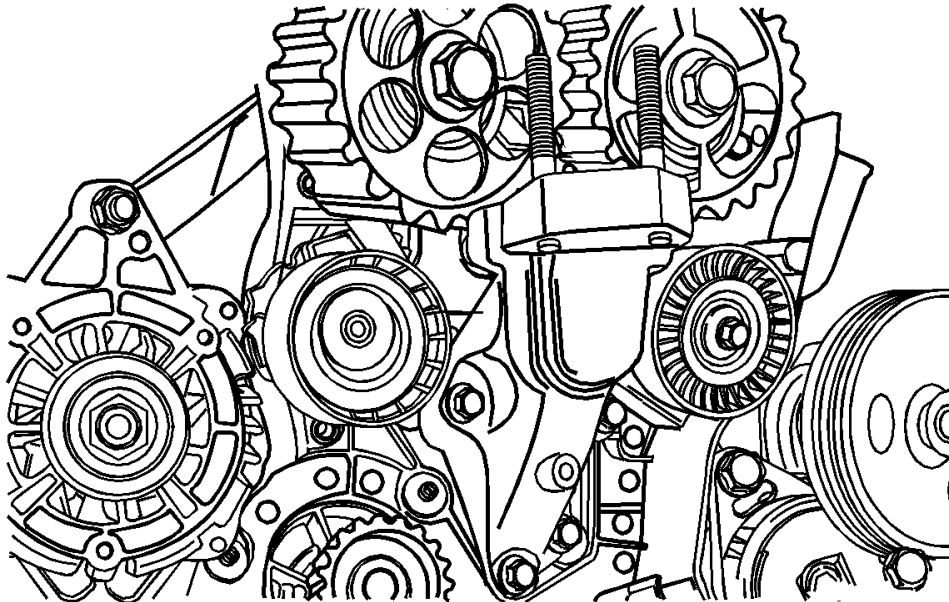


Fig. 96: View Of Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount.

NOTE: Refer to Fastener Notice .

2. Install the engine mount retaining bolts.

Tighten: Tighten the engine mount attaching bolts to **30 N.m (22 lb ft)** .

3. Install the front timing belt cover. Refer to Timing Belt Cover Replacement.

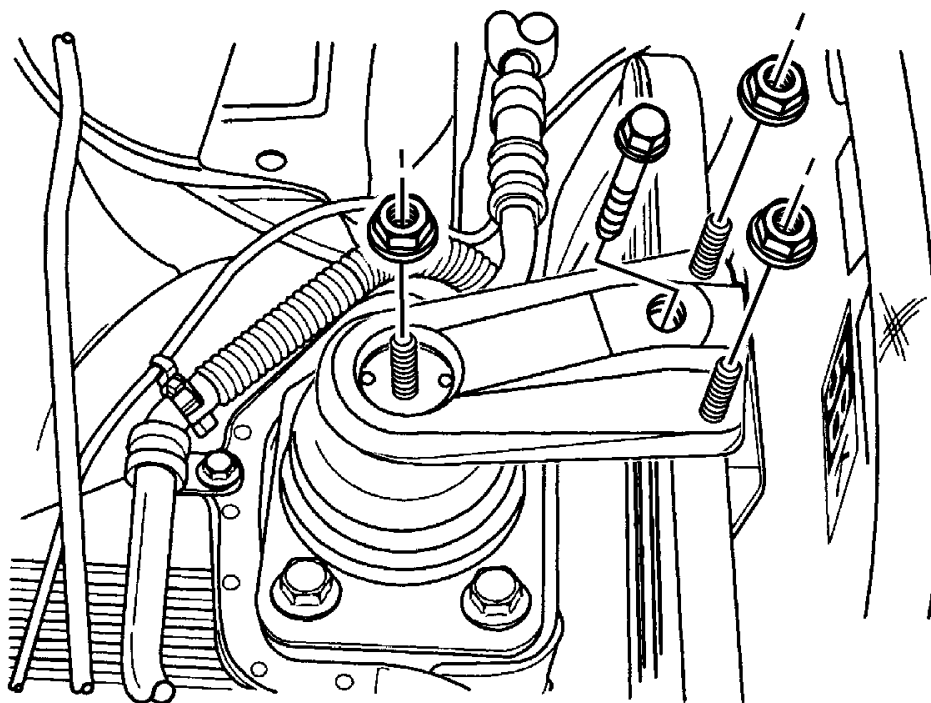


Fig. 97: View Of Engine Mount Bracket And Retainers
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount bracket attaching bolts/nuts.

Tighten: Tighten the engine mount bracket attaching bolts/nuts to **55 N.m (41 lb ft)** .

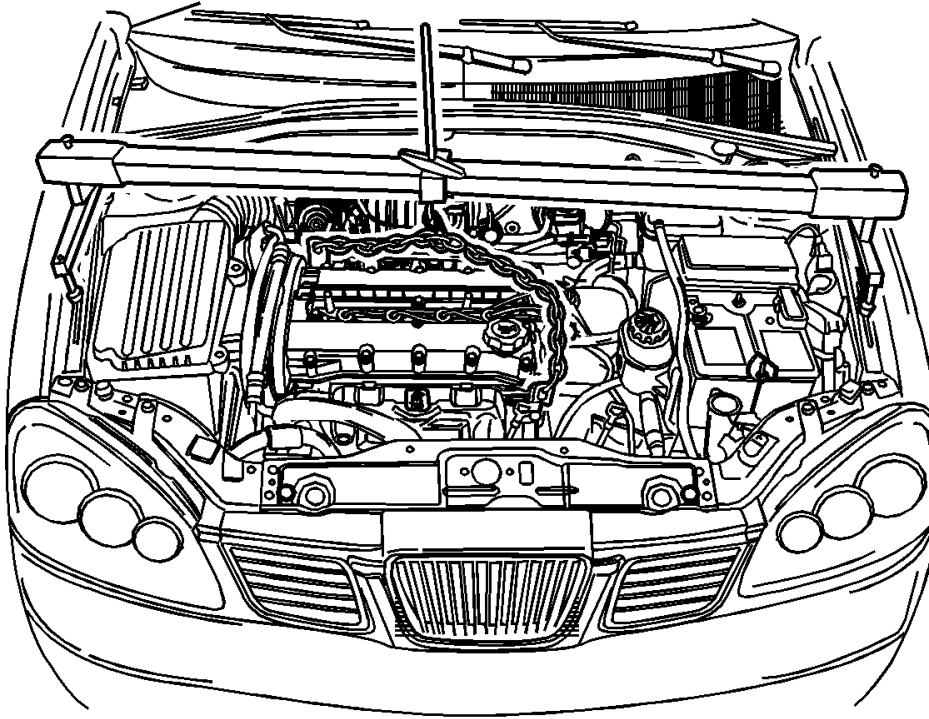


Fig. 98: View Of Engine Assembly
Courtesy of GENERAL MOTORS CORP.

5. Remove the **J 28467-B** . See Special Tools .
6. Connect the negative battery cable.

ENGINE REPLACEMENT

TOOLS REQUIRED

J 45059 Angle Meter. See Special Tools .

KM-470-B Angular Torque Gauge. See Special Tools .

REMOVAL PROCEDURE

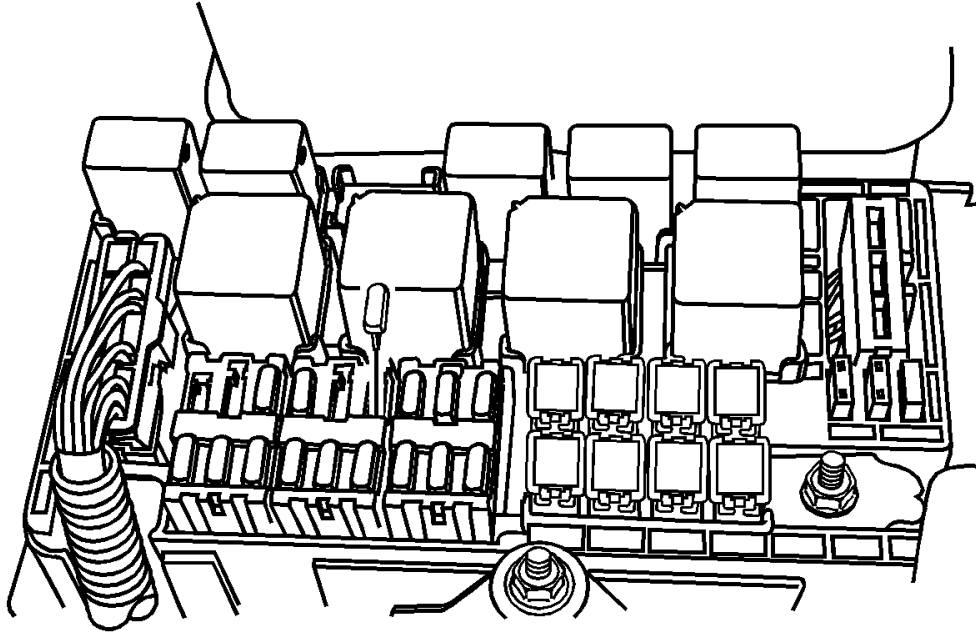


Fig. 99: View Of Fuel Pump Fuse
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: On vehicles equipped with a manual transaxle, the manual transaxle must be removed before the engine is removed.

1. Remove the fuel pump fuse.
2. Start the engine. Crank the engine for 10 seconds after it stalls to rid the fuel system of fuel pressure.
3. Remove the hood. Refer to **Hood Replacement** .

CAUTION: Refer to **Safety Glasses Caution** .

4. Drain the engine oil.

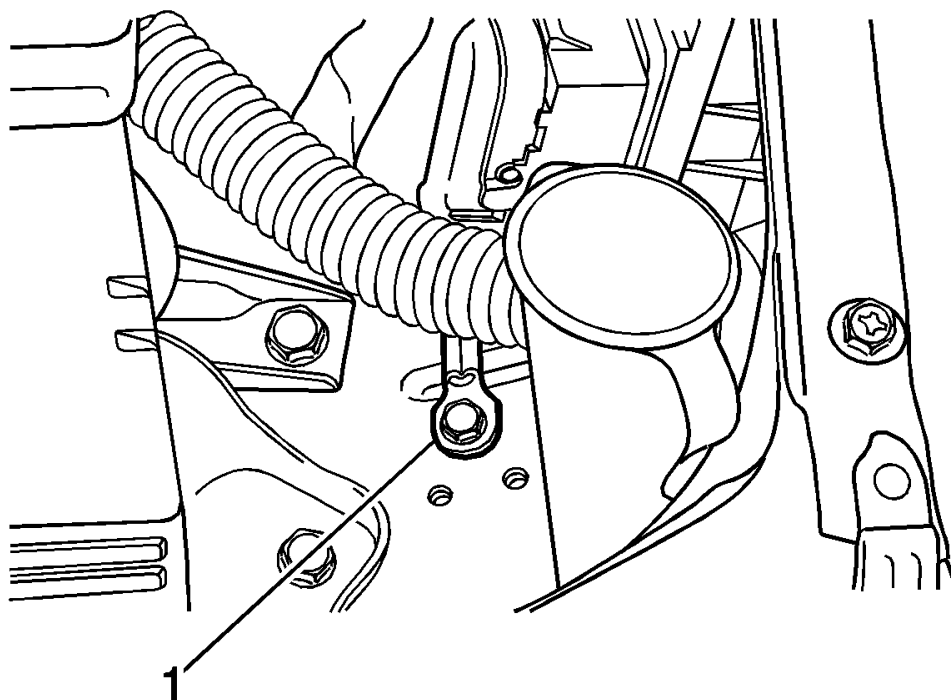


Fig. 100: View Of Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

5. Disconnect the negative battery cable.
6. Disconnect and separate the positive battery cable.
7. Disconnect the negative battery cable (1) from the vehicle frame.

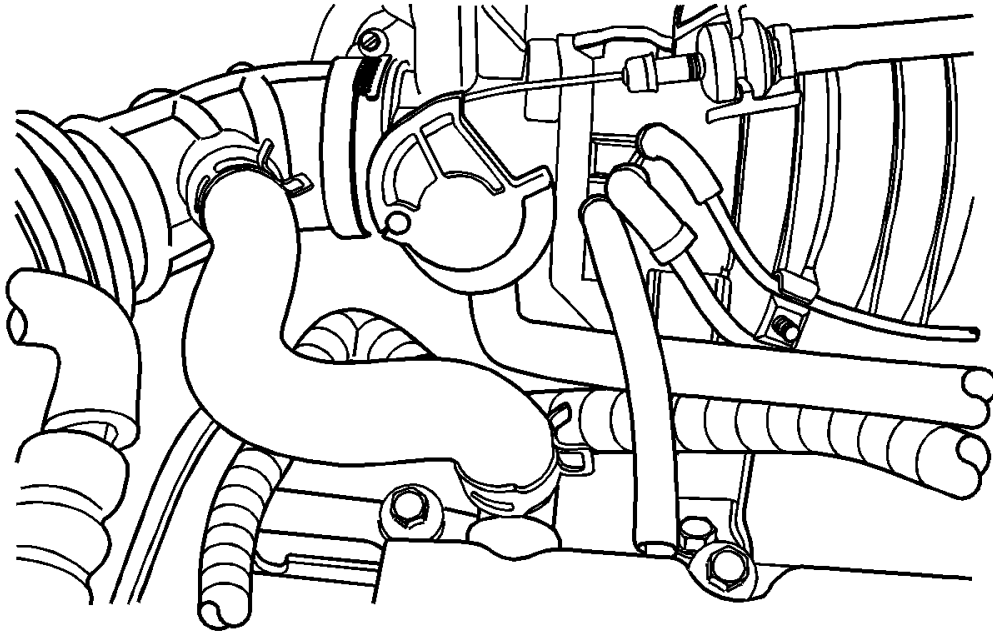


Fig. 101: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

8. Discharge the air conditioning (A/C) system, if equipped. Refer to **Refrigerant Recovery and Recharging** .
9. Disconnect the intake air temperature (IAT) sensor connector.
10. Remove the air intake tube from the throttle body and air filter housing.
11. Disconnect the breather tubes from the valve cover.
12. Remove the right front wheel. Refer to **Tire and Wheel Removal and Installation** .
13. Remove the right front splash shield.
14. Remove the accessory drive belt, if equipped.
15. Remove the alternator adjusting bolt.

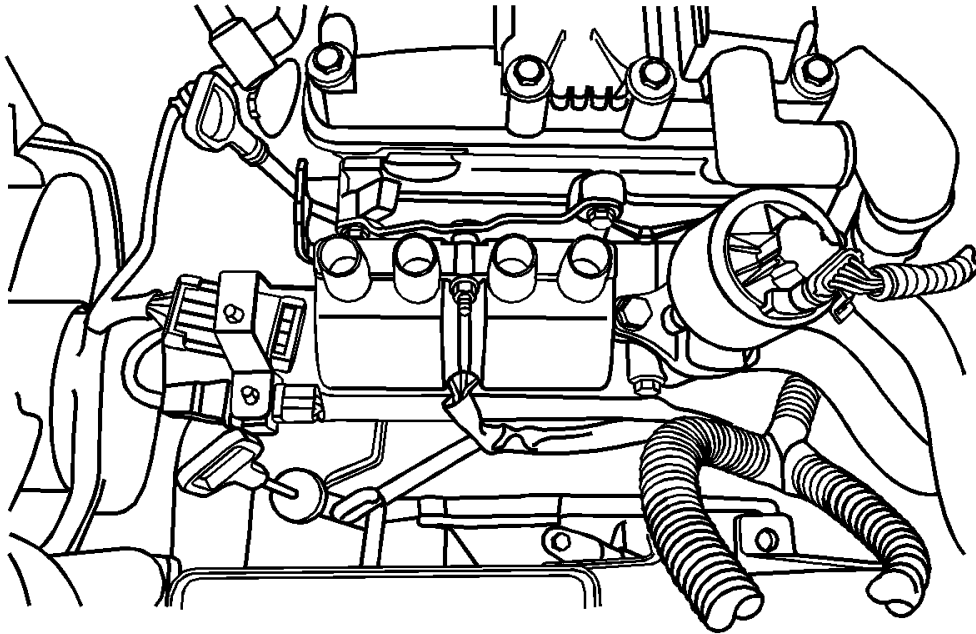


Fig. 102: Locating EGR Valve
Courtesy of GENERAL MOTORS CORP.

16. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Gasoline Engines)** .
17. Remove the cooling system radiator and the engine cooling fans. Refer to **Radiator Replacement (Gasoline Engines)** .
18. Disconnect the upper radiator hose from the thermostat housing.
19. Disconnect the power steering return hose from the power steering pump, if equipped.
20. Disconnect the power steering pressure hose from the power steering pump, if equipped. Refer to **Power Steering Pump Hoses and Pipes Replacement** .
21. Disconnect the electrical connector at the electronic ignition (EI) system ignition coil and the powertrain control module (PCM)/engine control module (ECM) ground terminal at the intake manifold and at the starter motor.

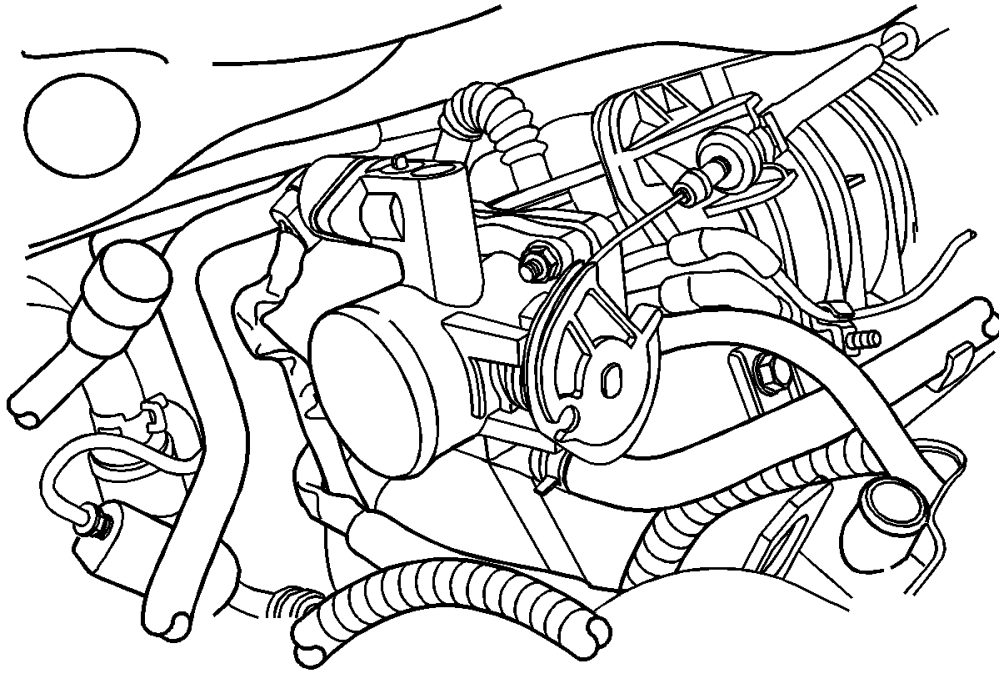


Fig. 103: View Of Throttle Body And Throttle Cable
Courtesy of GENERAL MOTORS CORP.

22. Disconnect the oxygen sensor connector.
23. Disconnect the fuel injector harness connectors.
24. Disconnect the idle air control (IAC) valve connector.
25. Disconnect the throttle position (TP) sensor connector.
26. Disconnect the engine coolant temperature (ECT) sensor connector.
27. Disconnect the alternator voltage regulator connector.
28. Remove the engine cover bolts.
29. Remove the engine cover.
30. Disconnect the camshaft position (CMP) sensor.

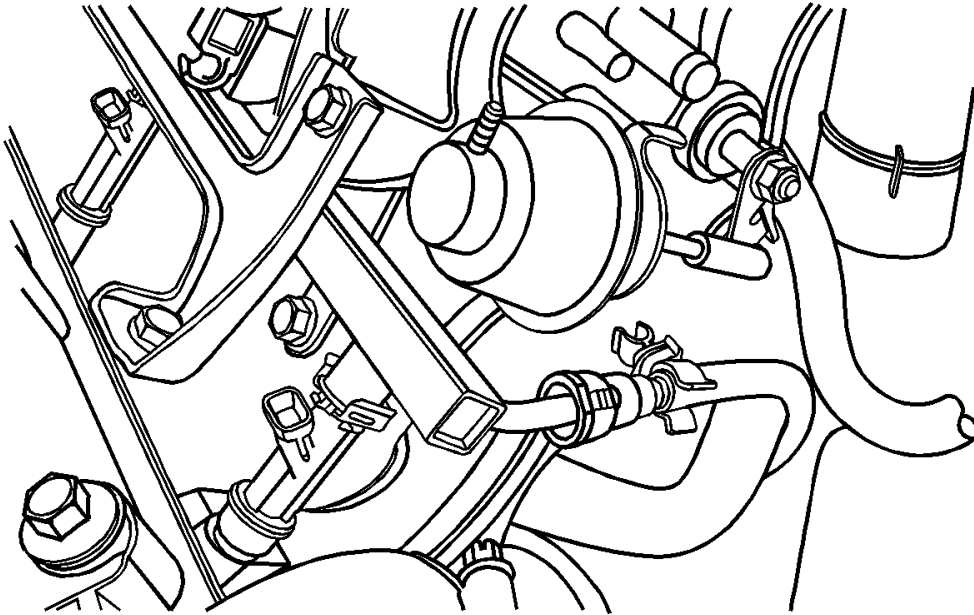


Fig. 104: View Of Fuel Feed Line At Fuel Rail
Courtesy of GENERAL MOTORS CORP.

31. Disconnect all of the necessary vacuum lines including the brake booster vacuum hose.
32. Disconnect the fuel feed line at the fuel rail.

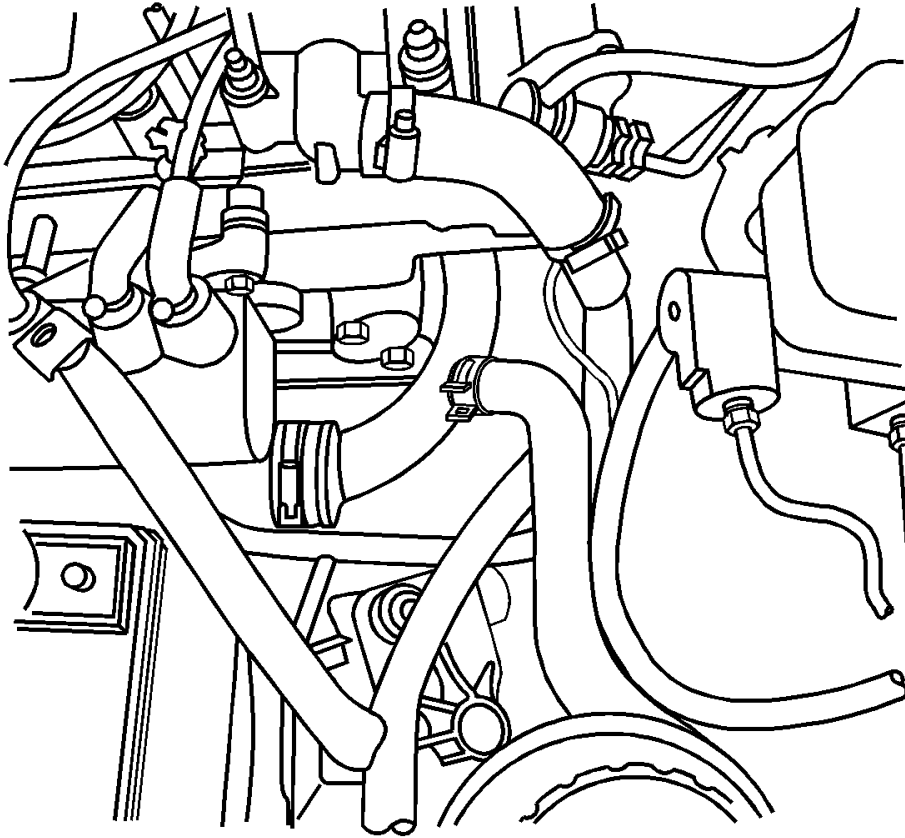


Fig. 105: View Of Surge Tank, Heater And Radiator Hoses
Courtesy of GENERAL MOTORS CORP.

33. Disconnect the throttle cable from the throttle body and the intake manifold bracket.
34. Disconnect the surge tank coolant hose at the throttle body.
35. Disconnect the heater outlet hose at the coolant pipe.
36. Disconnect the heater inlet hose from the cylinder head.
37. Disconnect the surge tank coolant hose from the coolant pipe.
38. Disconnect the lower radiator hose from the coolant pipe.

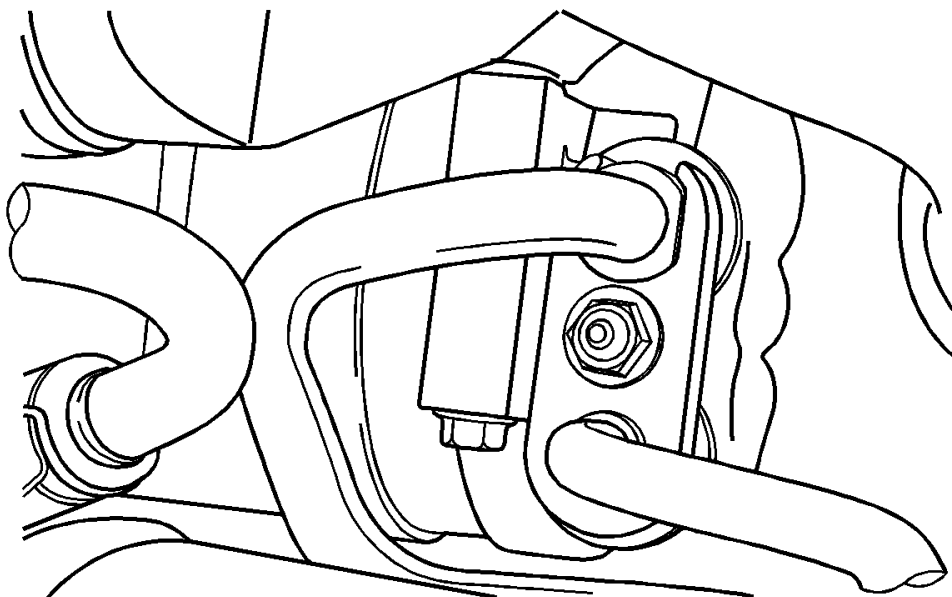


Fig. 106: View Of A/C Evaporator Pipes
Courtesy of GENERAL MOTORS CORP.

39. Disconnect the starter solenoid S terminal wire.
40. Remove the A/C compressor hose assembly retaining bolt.
41. Disconnect the A/C compressor hose assembly from the compressor.
42. Disconnect the electrical connector at the A/C compressor coil.
43. Remove the power steering hose from the power steering pump.

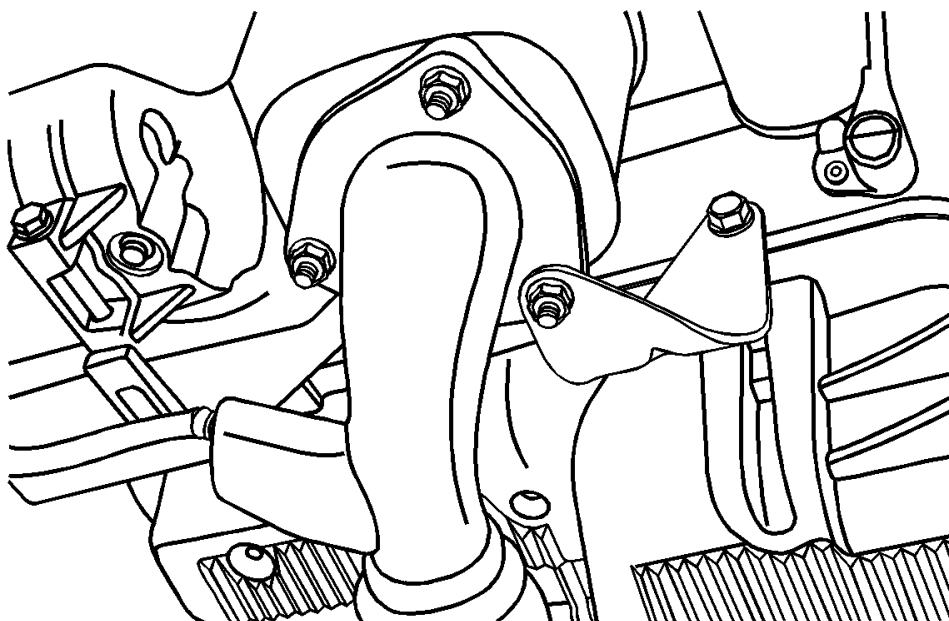


Fig. 107: View Of Catalytic Converter Lower Flange Nuts
Courtesy of GENERAL MOTORS CORP.

44. Remove the catalytic converter lower flange nuts from the exhaust manifold studs and the bolts at the bracket.

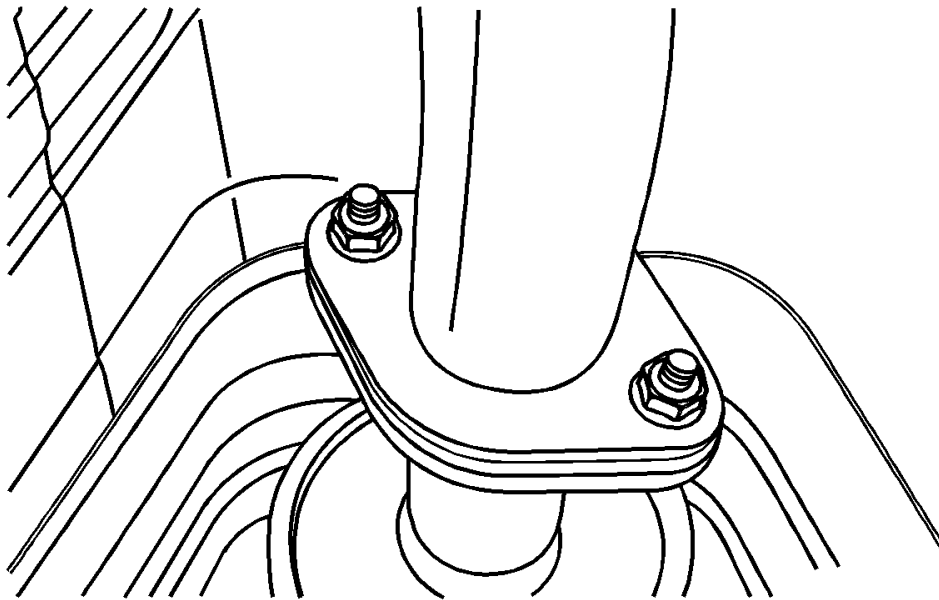


Fig. 108: View Of Muffler Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

45. Remove the nuts that secure the front muffler pipe.
46. Remove the front exhaust pipe as a unit.

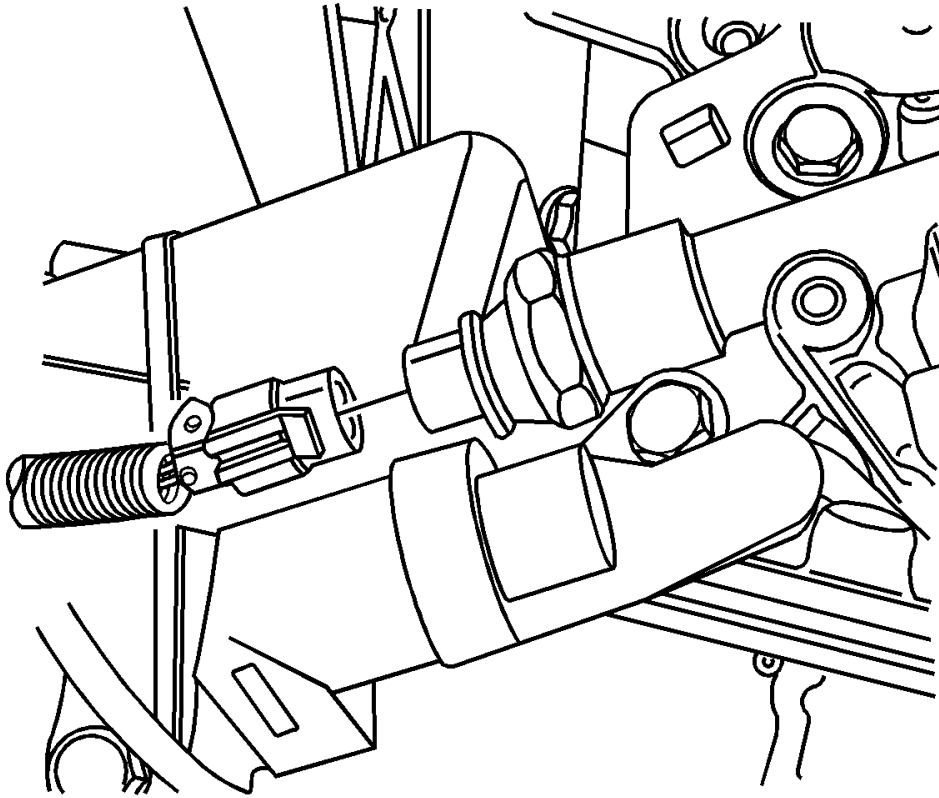


Fig. 109: View Of Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

47. Remove the crankshaft pulley bolt.
48. Remove the crankshaft pulley.
49. Disconnect the vacuum lines at the evaporative emission (EVAP) canister purge solenoid.
50. Disconnect the electrical connector at the EVAP charcoal canister purge solenoid.
51. Disconnect the electrical connector at the oil pressure switch.
52. Disconnect the crankshaft position (CKP) sensor and the knock sensor connectors.
53. Remove the CKP sensor retaining bolt.
54. Remove the CKP sensor.

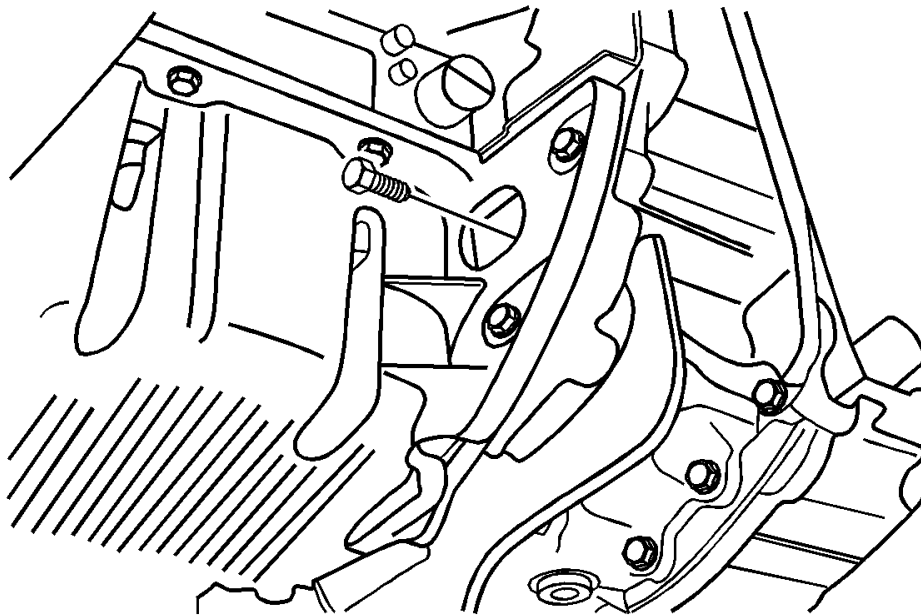


Fig. 110: View Of Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

55. Install the engine lifting device.
56. Remove the service hole cover.
57. Remove the torque converter bolts. Refer to **Transmission Replacement** .

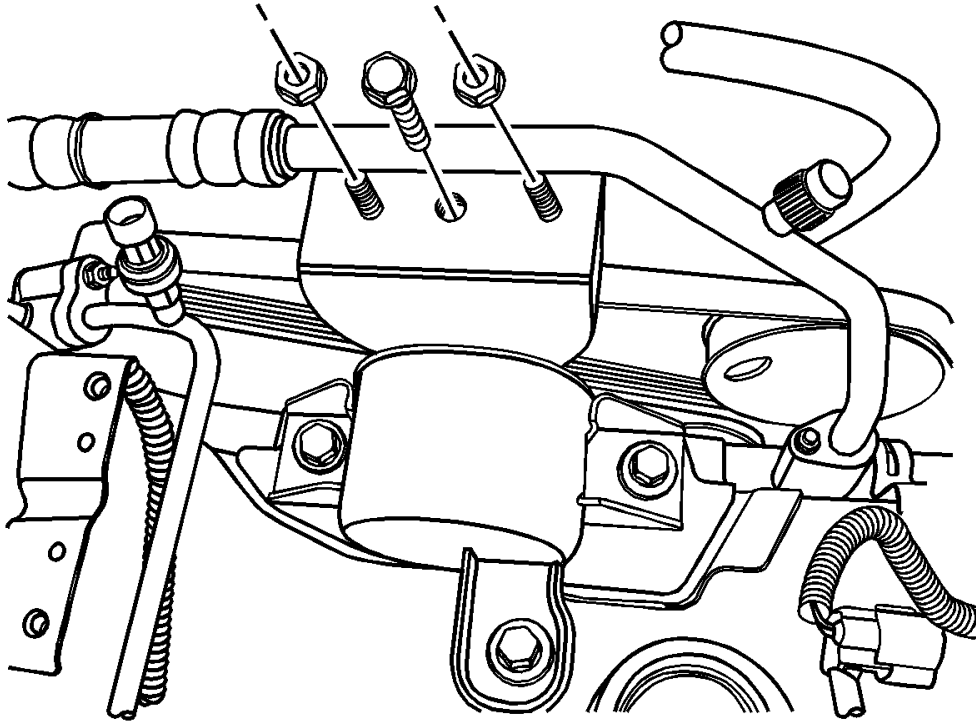


Fig. 111: View Of Crossmember, Nuts, And Bolts
Courtesy of GENERAL MOTORS CORP.

58. Remove the power steering hoses and pipes. Refer to **Power Steering Pump Hoses and Pipes Replacement** .
59. Remove the cross member by removing the nuts and the bolts to underbody.
60. Disconnect the right engine mount bracket from the engine mount by removing the retaining bolts.
61. Remove the right engine mount bracket from the engine block.
62. Separate the engine block from the transaxle.
63. Remove the engine.

INSTALLATION PROCEDURE

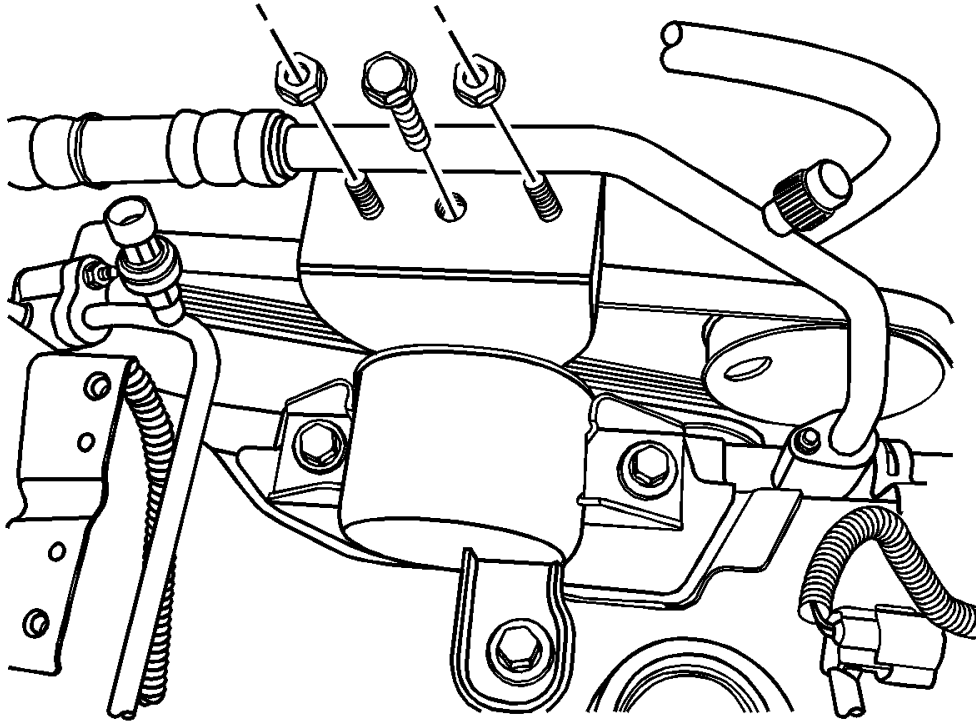


Fig. 112: View Of Crossmember, Nuts, And Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine into the engine compartment.
2. Install the right engine mount bracket to the engine block.

NOTE: Refer to Fastener Notice .

3. Install the right engine mount bracket retaining bolts.

Tighten: Tighten the engine mount bracket retaining bolts to **60 N.m (44 lb ft)** .

4. Connect the right engine mount bracket to the engine mount by installing the 2 retaining bolts.

Tighten: Tighten the engine mount-to-engine mount bracket retaining bolts to **60 N.m (44 lb ft)** .

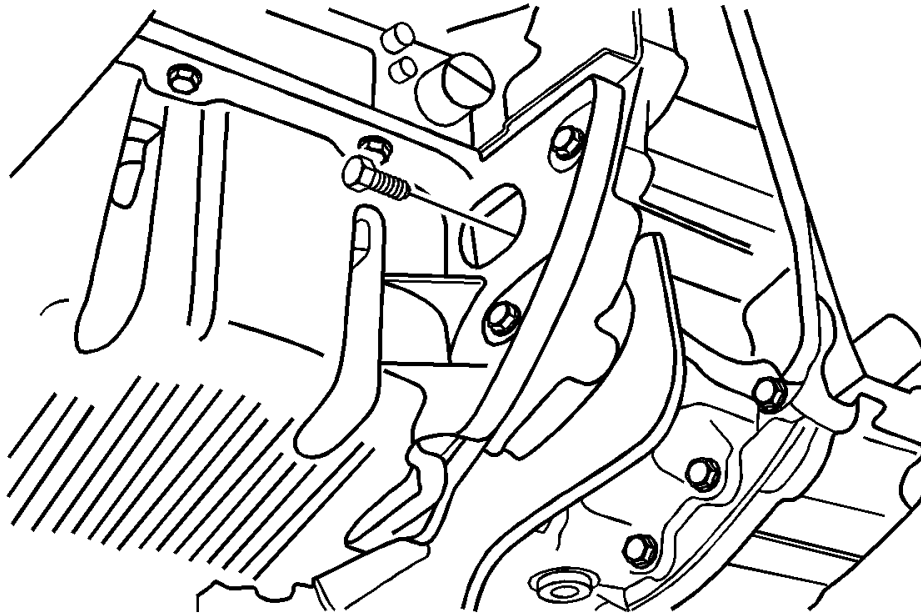


Fig. 113: View Of Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the floor jack used for support of the transaxle.
6. Remove the engine lifting device.
7. Install the transaxle torque converter bolts on vehicles equipped with an automatic transaxle.

Tighten: Tighten the transaxle torque converter bolts to **65 N.m (48 lb ft)** .

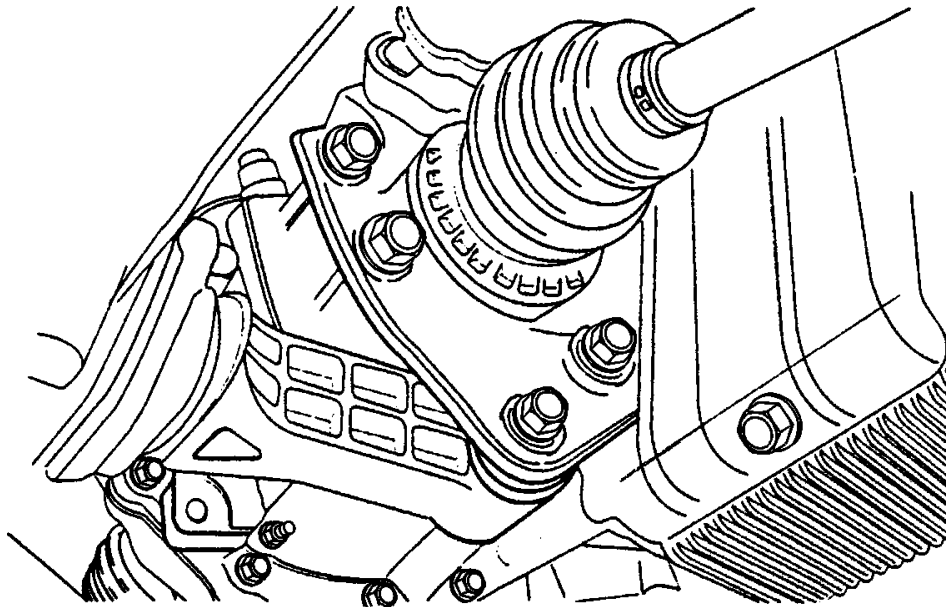


Fig. 114: Installing Damping Block Connection Nut And Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the rear mounting bracket bolts and the bracket.

Tighten: Tighten the rear mounting bracket bolts to **60 N.m (44 lb ft)** .

9. Install the damping block connection nut and bolt.

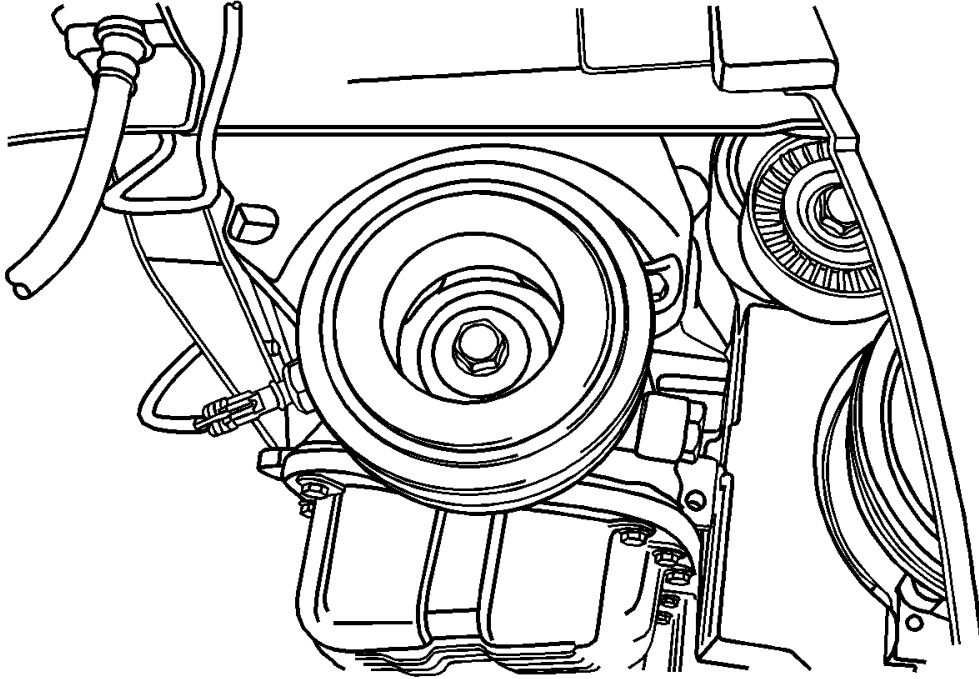


Fig. 115: View Of Crankshaft Pulley And Bolt
Courtesy of GENERAL MOTORS CORP.

10. Connect the vacuum lines at the EVAP charcoal canister purge solenoid.
11. Connect the electrical connector to the EVAP canister purge solenoid.
12. Connect the oil pressure switch connector.
13. Install the crankshaft pulley.
14. Install the crankshaft pulley bolt.

Tighten: Tighten the crankshaft pulley bolt to **95 N.m (70 lb ft)** using a torque wrench. Using the **J 45059** or **KM-470-B**, tighten the crankshaft pulley bolt 30 degrees plus 15 degrees.

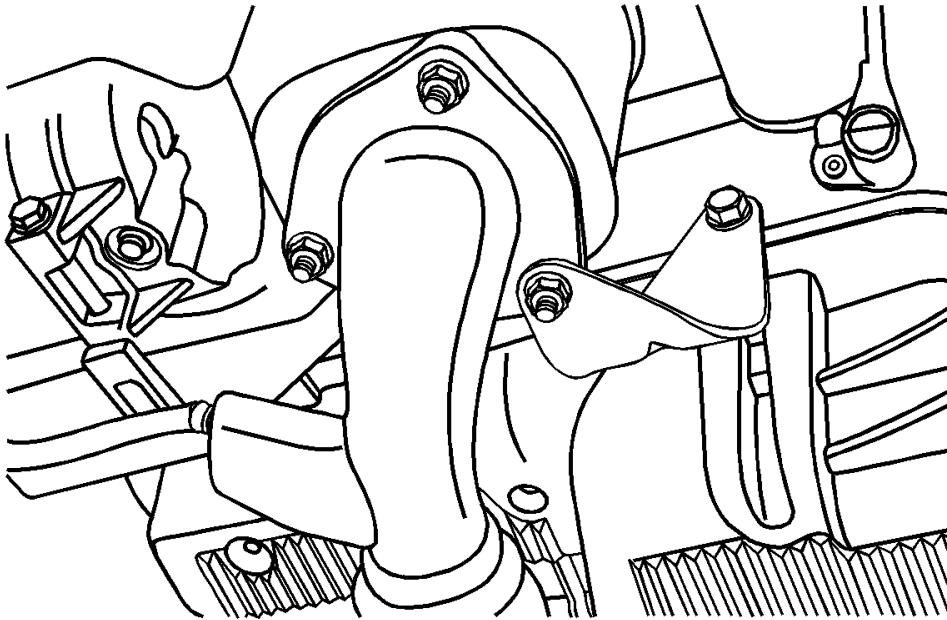


Fig. 116: View Of Catalytic Converter Lower Flange Nuts
Courtesy of GENERAL MOTORS CORP.

15. Install the CKP sensor and the CKP sensor retaining bolt.

Tighten: Tighten the crankshaft position sensor retaining bolt to **10 N.m (89 lb in)** .

16. Connect the CKP sensor and the knock sensor connectors.
17. Install the catalytic converter and the exhaust pipe as a unit.

Tighten:

- Tighten the catalytic converter-to-exhaust manifold nuts and the bolts at the bracket to **40 N.m (30 lb ft)** .
- Tighten the front muffler nuts to **30 N.m (22 lb ft)** .

18. Connect the power steering pressure hose, if equipped.

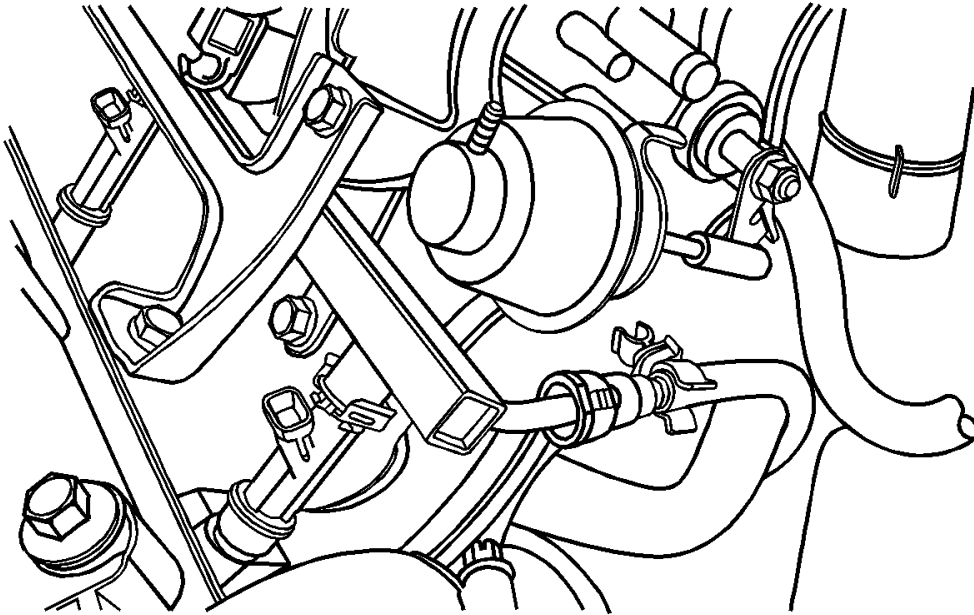


Fig. 117: View Of Fuel Feed Line At Fuel Rail
 Courtesy of GENERAL MOTORS CORP.

19. Connect the A/C compressor coil connector, if equipped.
20. Connect the ECT sensor connector.
21. Install the alternator adjusting bolt.
22. Install the accessory drive belt, if equipped.
23. Connect the A/C compressor hose assembly and the A/C compressor hose assembly retaining bolt, if equipped.

Tighten: Tighten the A/C compressor hose assembly retaining bolt to **33 N.m (24 lb ft)** .

24. Install the right front splash shield.
25. Install the right front wheel. Refer to **Tire and Wheel Removal and Installation** .
26. Connect the fuel feed line to the fuel rail.

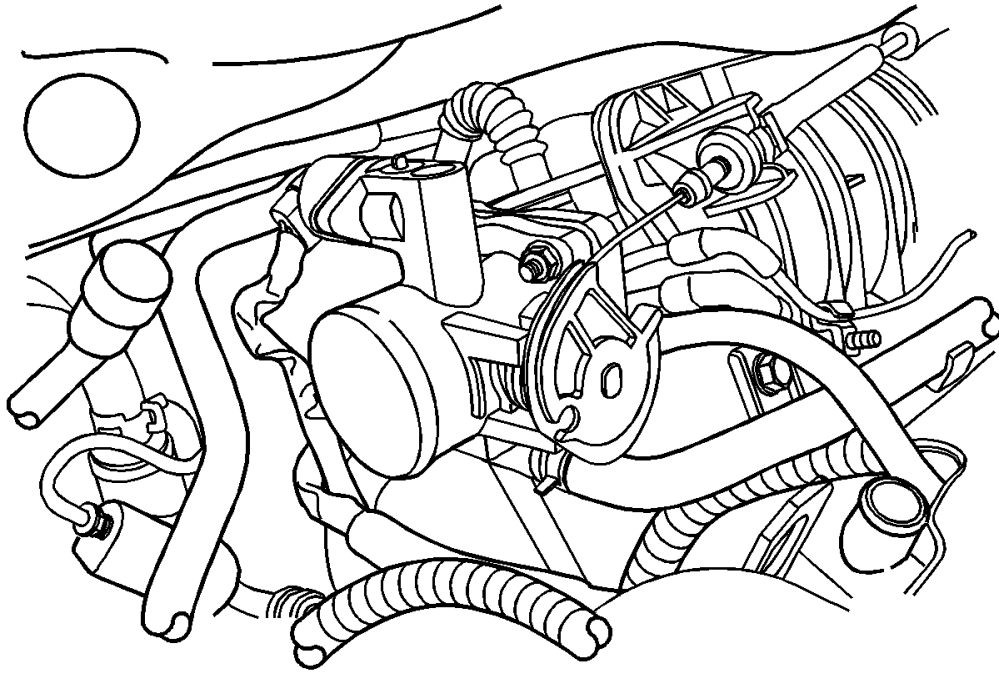


Fig. 118: View Of Throttle Body And Throttle Cable
Courtesy of GENERAL MOTORS CORP.

27. Connect all of the necessary vacuum lines including the brake booster vacuum hose.
28. Connect the oxygen sensor connector.
29. Connect the starter solenoid S terminal wire.
30. Connect the alternator voltage regulator connector.
31. Connect the TP sensor connector.
32. Connect the IAC valve connector.
33. Connect the CMP sensor.
34. Install the engine cover.
35. Install the engine cover bolts.

Tighten: Tighten the engine cover bolts to **3 N.m (27 lb in)** .

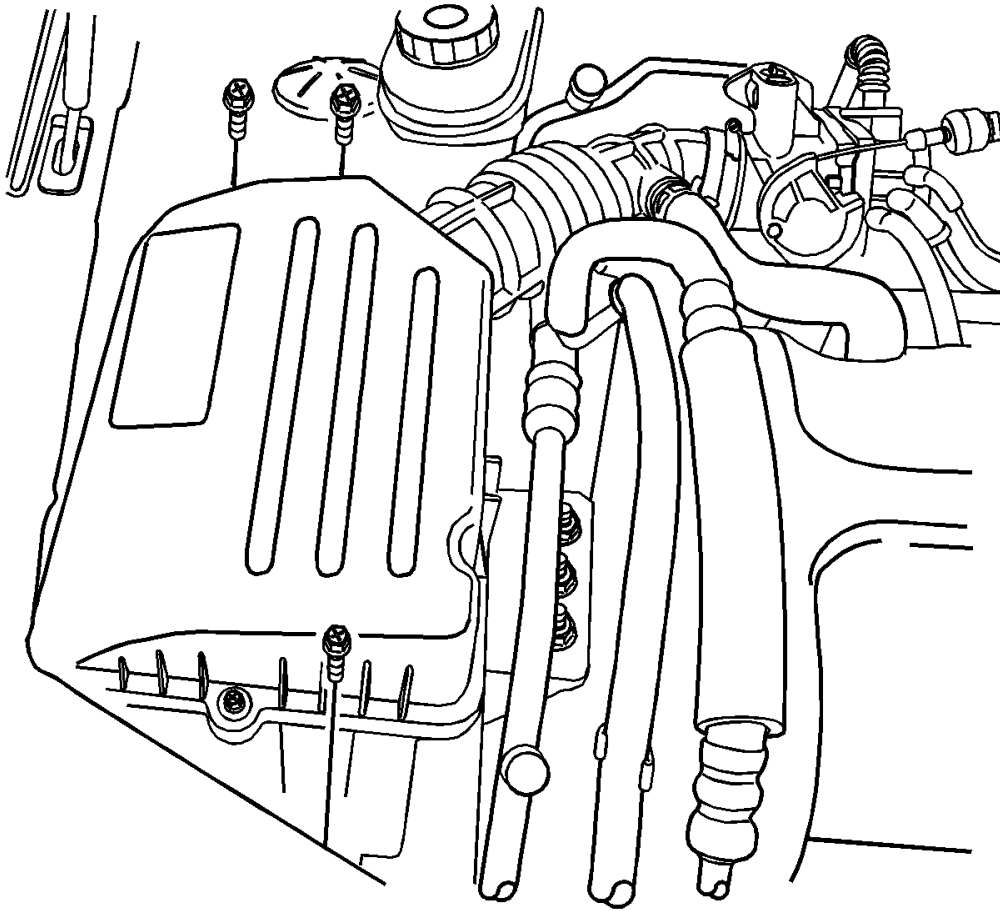


Fig. 119: View Of Air Filter Housing And Bolts
Courtesy of GENERAL MOTORS CORP.

36. Connect the fuel injector harness connectors.
37. Connect the electrical connector at the EI system ignition coil and the PCM/ECM ground terminal at the intake manifold and the starter motor.
38. Install the air intake tube between the throttle body and the air filter housing.
39. Connect the breather tubes to the valve cover.
40. Connect the IAT sensor connector.
41. Install the cooling system radiator and the engine cooling fans. Refer to **Radiator Replacement (Gasoline Engines)** .

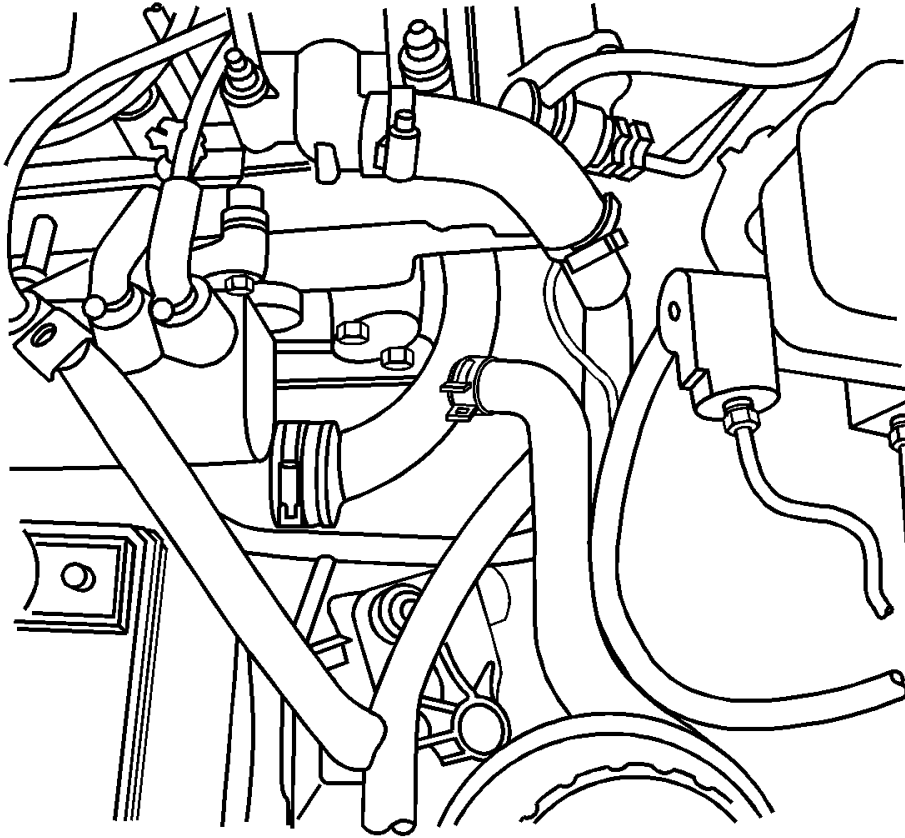


Fig. 120: View Of Surge Tank, Heater And Radiator Hoses
Courtesy of GENERAL MOTORS CORP.

42. Connect the lower radiator hose to the coolant pipe.
43. Connect the upper radiator hose to the thermostat housing.
44. Connect the heater inlet hose to the cylinder head.
45. Connect the heater outlet hose to the coolant pipe.
46. Connect the coolant surge tank hose to the coolant pipe.
47. Connect the surge tank coolant hose to the throttle body.
48. Connect the throttle cable to the throttle body and the intake manifold bracket.
49. Install the fuel pump fuse.
50. Connect the negative battery cable to the vehicle frame.
51. Connect the negative battery cable.
52. Connect and assemble the positive battery cable.
53. Refill the engine crankcase with engine oil.
54. Refill the engine coolant system. Refer to **Cooling System Draining and Filling (Gasoline Engines)** .

55. Bleed the power steering system, if equipped. Refer to **Power Steering System Bleeding** .
56. Refill the A/C refrigerant system, if equipped. Refer to **Refrigerant Recovery and Recharging** .
57. Install the hood. Refer to **Hood Replacement** .

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

1. Raise and properly support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position an appropriate drain pan under the engine.
3. Remove the oil pan drain plug bolt.
4. Remove the oil filter.

INSTALLATION PROCEDURE

NOTE: Refer to **Fastener Notice** .

1. Install the oil filter.

Tighten: Tighten the oil filter to **14 N.m (10 lb ft)** .

2. Discard the used oil pan drain plug washer and replace with a new oil pan drain plug washer.
3. Install the oil pan drain plug bolt.

Tighten: Tighten the oil pan drain plug bolt to **35 N.m (26 lb ft)** .

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

EXHAUST MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

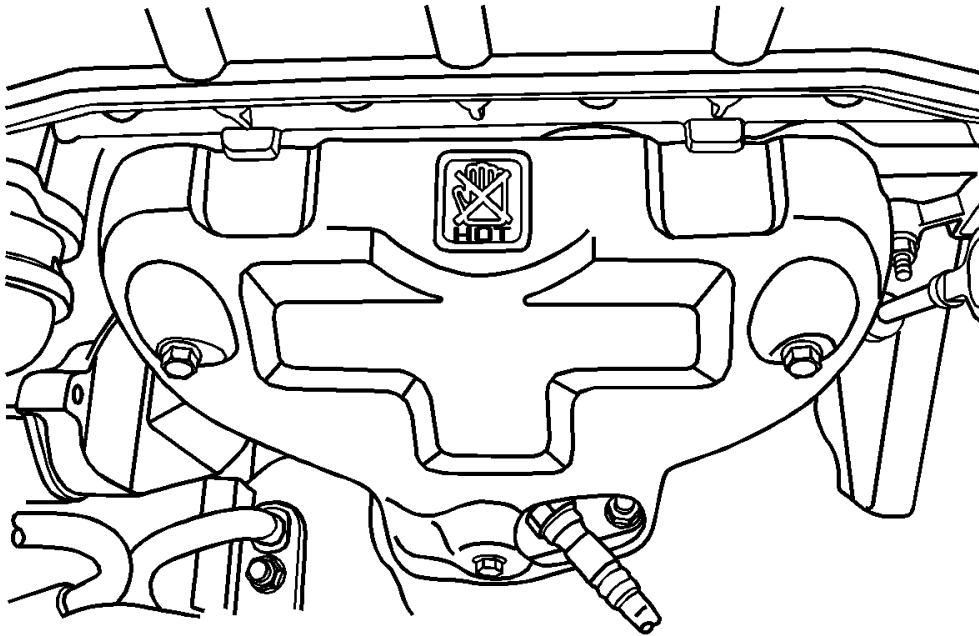


Fig. 121: View Of Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Disconnect the pre-converter oxygen sensor connector.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.

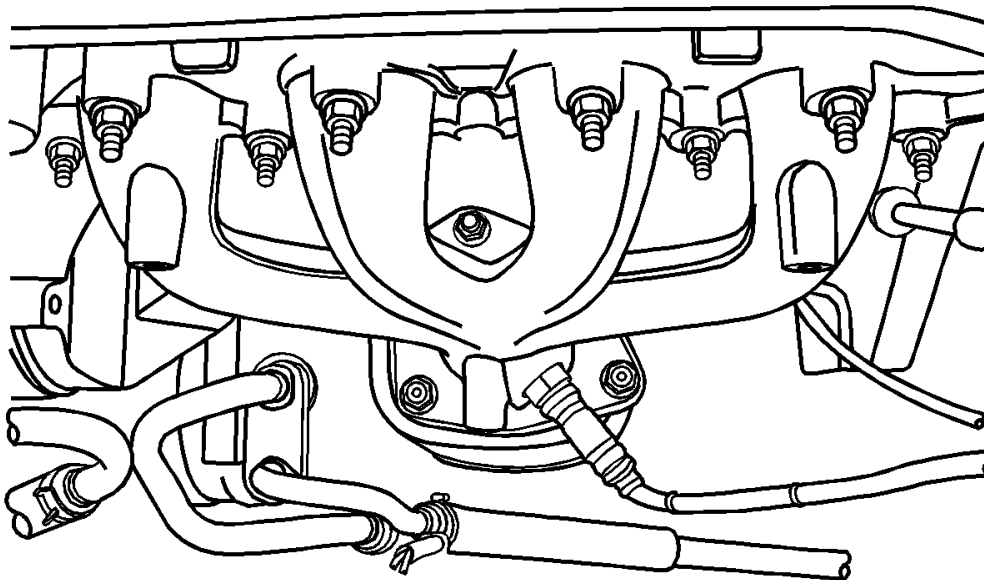


Fig. 122: View Of Catalytic Converter Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the auxiliary catalytic converter nuts from the exhaust manifold.

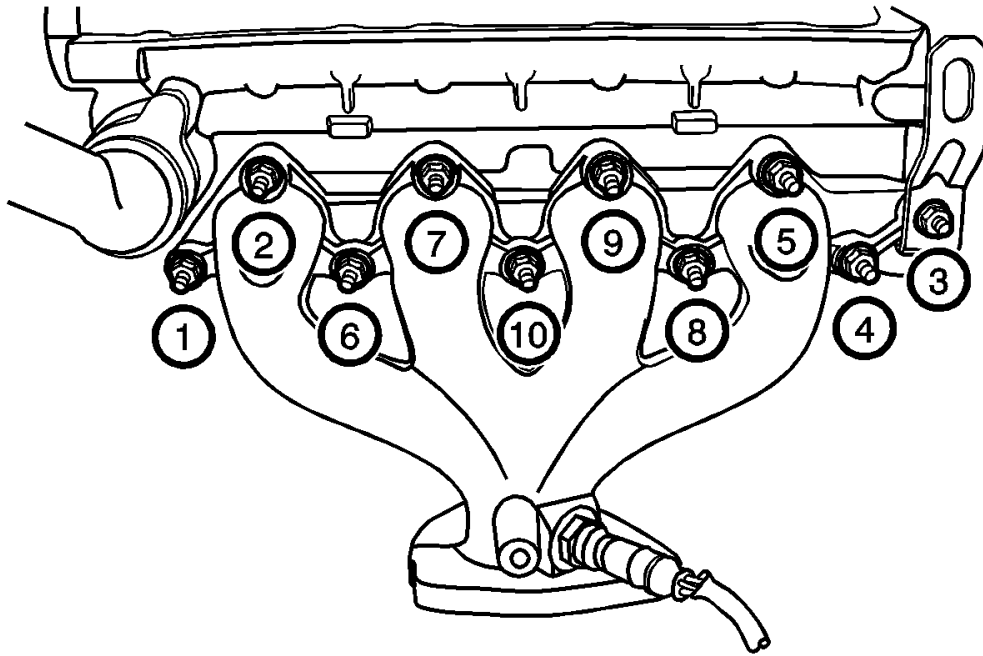


Fig. 123: View Of Exhaust Manifold Retaining Nut Removal Sequence
 Courtesy of GENERAL MOTORS CORP.

6. Remove the exhaust manifold retaining nuts in the sequence shown.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket.

CAUTION: Refer to Safety Glasses Caution .

9. Clean the sealing surfaces of the exhaust manifold and the cylinder head.

INSTALLATION PROCEDURE

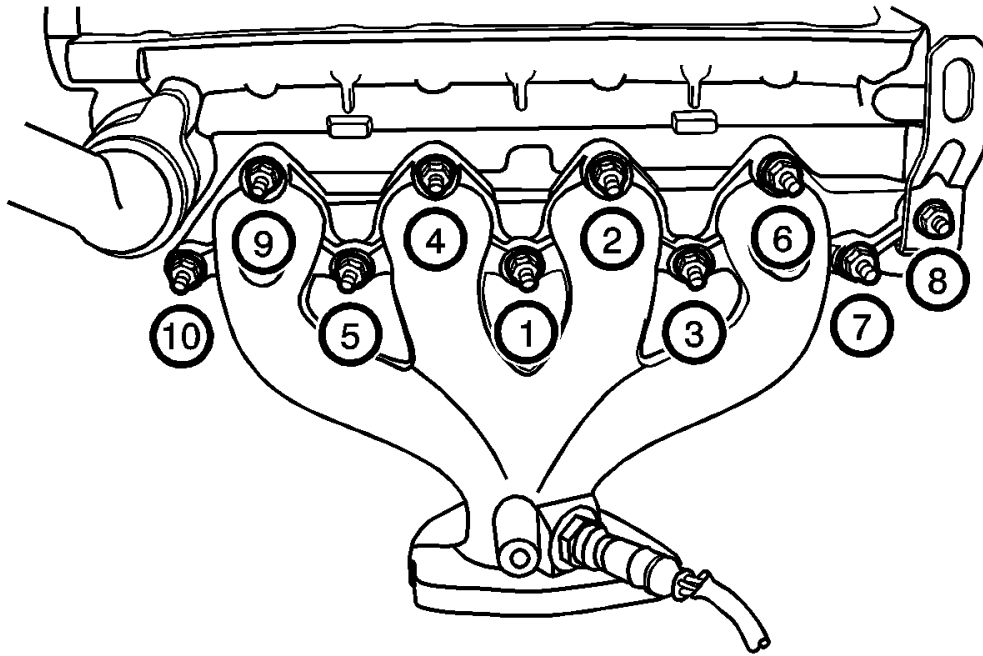


Fig. 124: View Of Exhaust Manifold Retaining Nut Installation Sequence
Courtesy of GENERAL MOTORS CORP.

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.

NOTE: Refer to Fastener Notice .

3. Install the exhaust manifold retaining nuts and tighten them in the sequence shown.

Tighten: Tighten the exhaust manifold retaining nuts **25 N.m (18 lb ft)** .

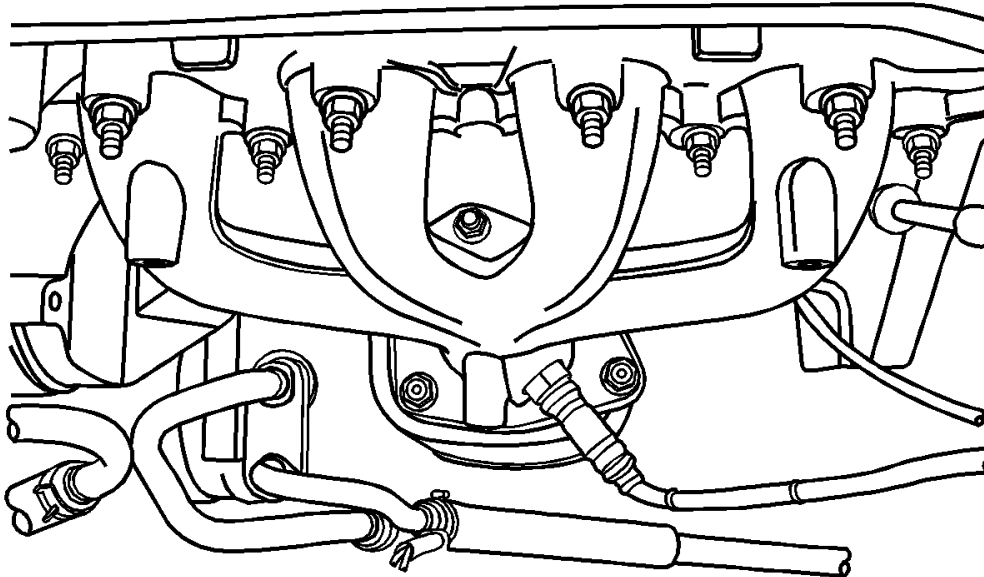


Fig. 125: View Of Catalytic Converter Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the auxiliary catalytic converter nuts to the exhaust manifold.

Tighten: Tighten the auxiliary catalytic converter-to-exhaust manifold nuts to **40 N.m (30 lb ft)** .

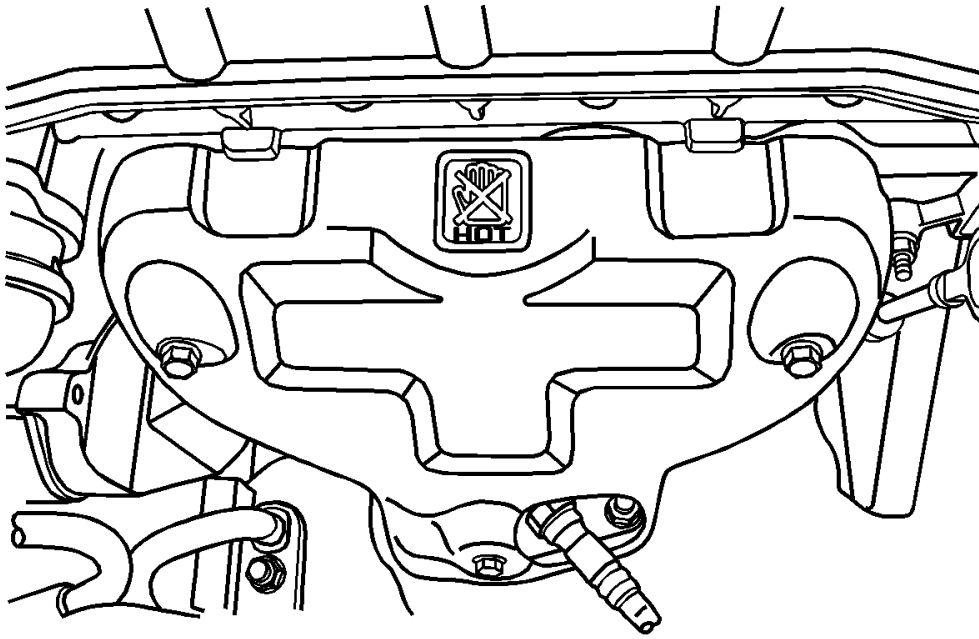


Fig. 126: View Of Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

5. Install the exhaust manifold heat shield.
6. Install the exhaust manifold heat shield bolts.

Tighten: Tighten the exhaust manifold heat shield bolts to **15 N.m (11 lb ft)** .

7. Connect the pre-converter oxygen sensor connector.
8. Connect the negative battery cable.

CRANKSHAFT REPLACEMENT

TOOLS REQUIRED

- **OTC 1726 (KM-412)** Engine Overhaul Stand.
- **J 42492-A (KM-421-A)** Timing Belt Adjuster. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .

- **KM-470-B** Angular Torque Gauge. See Special Tools .
- **J-36792** Crankshaft Rear Oil Seal Installer. See Special Tools .
- **KM-635** Crankshaft Rear Oil Seal Installer. See Special Tools .

REMOVAL PROCEDURE

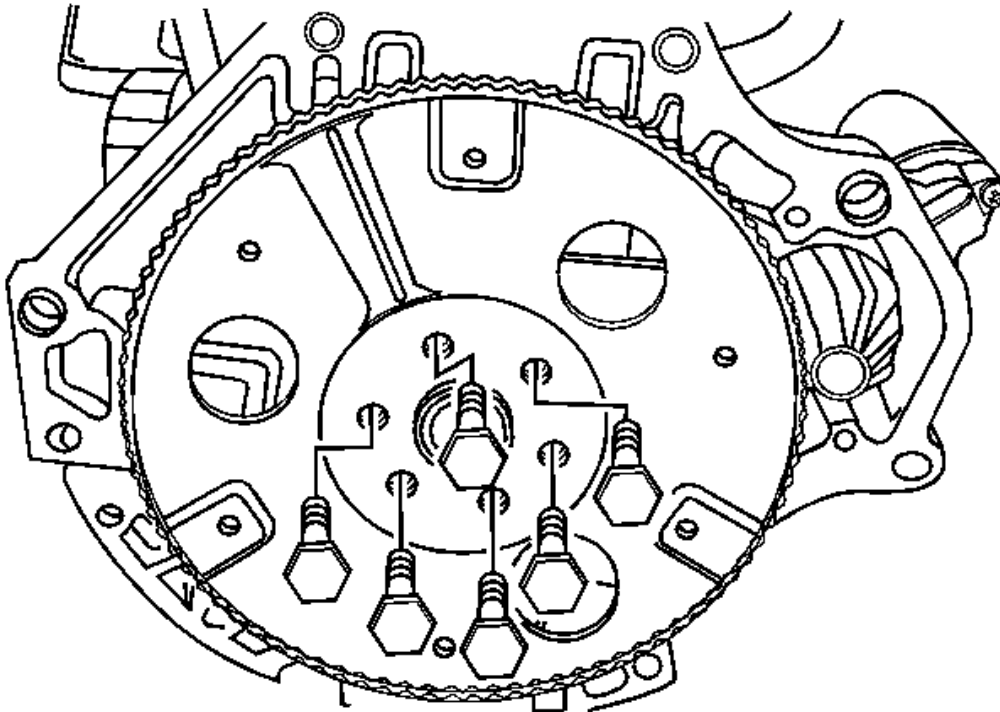


Fig. 127: View Of Flex Plate And Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

1. Remove the engine. Refer to Engine Replacement.
2. Remove the flywheel or flexible plate bolts.
3. Remove the flywheel or the flexible plate.

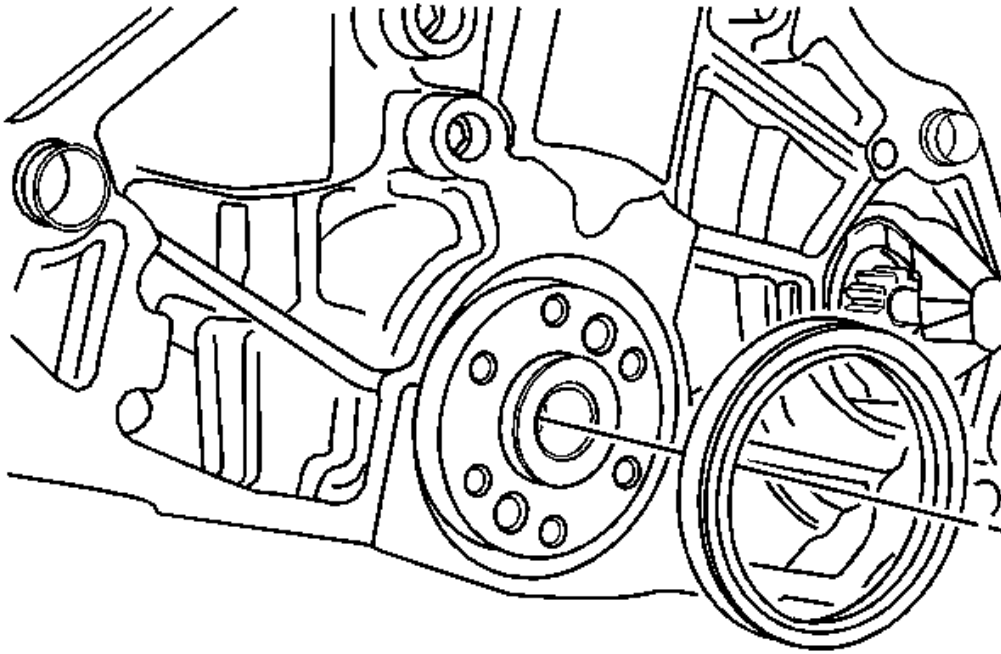


Fig. 128: View Of Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft rear oil seal.
5. Mount the engine assembly on the **OTC 1726** .

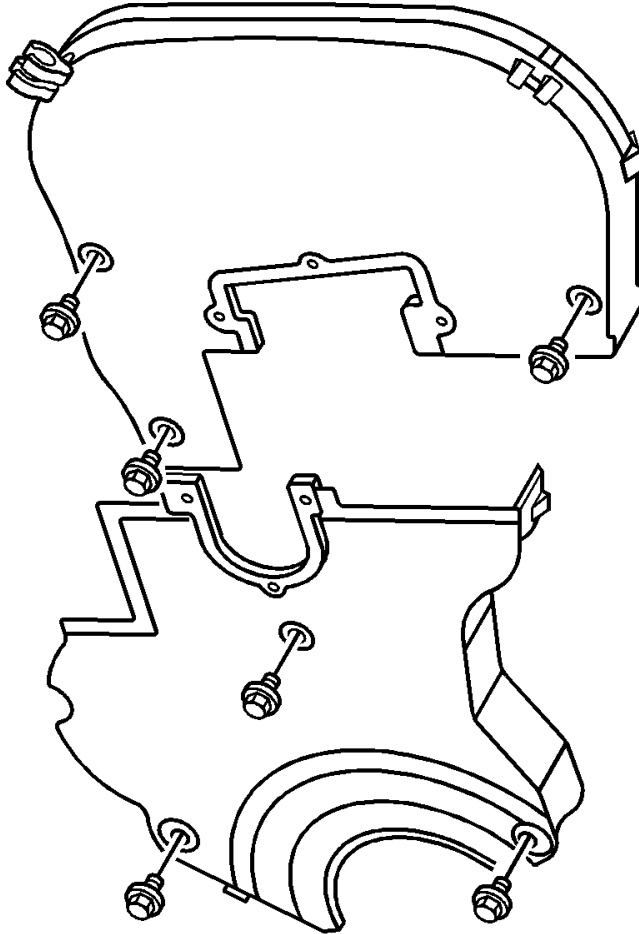


Fig. 129: View Of Upper And Lower Front Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the upper and the lower front timing belt cover bolts.
7. Remove the upper and the lower front timing belt cover.

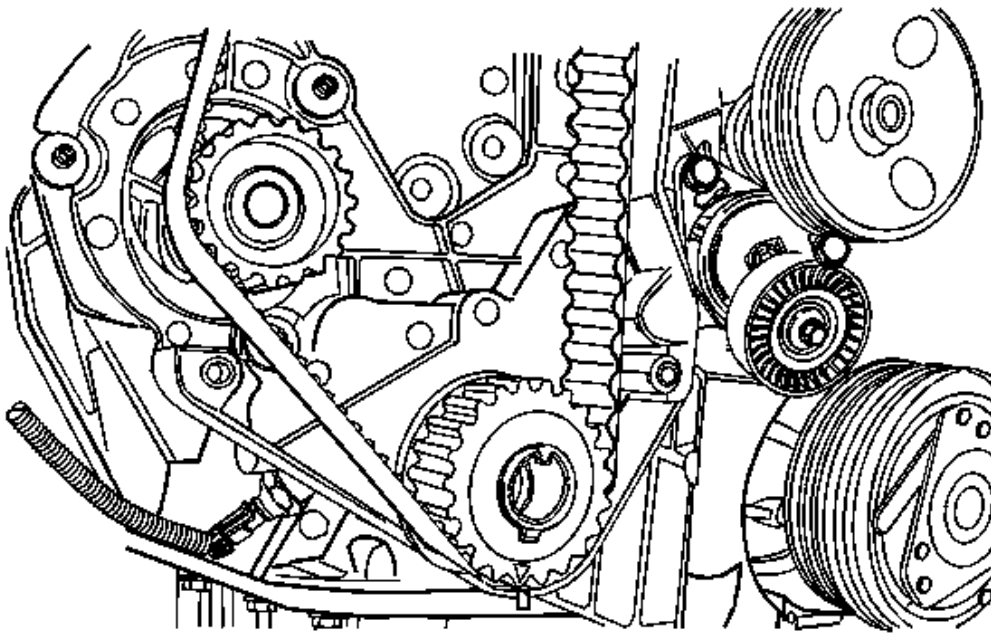


Fig. 130: View Of Timing Belt
Courtesy of GENERAL MOTORS CORP.

8. Slightly loosen the water pump retaining bolts.

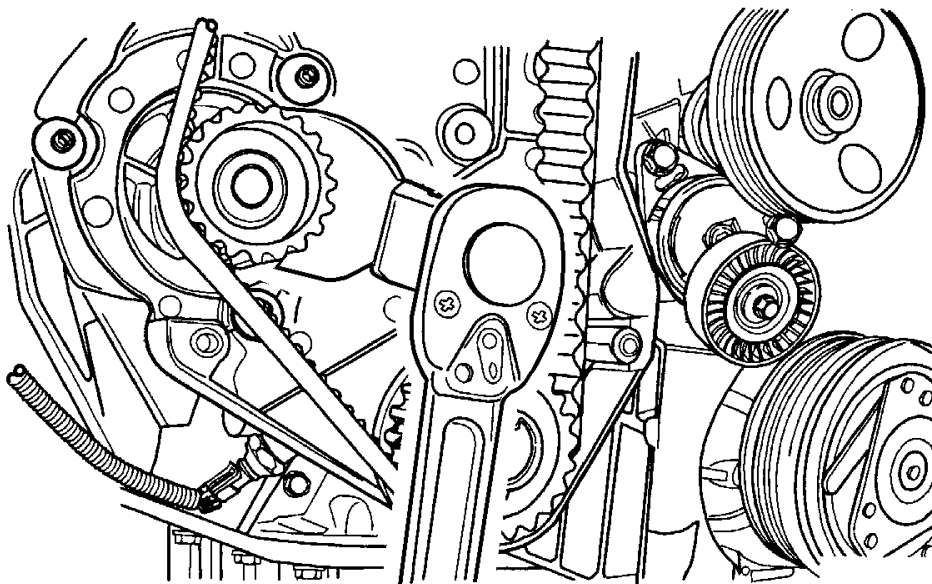


Fig. 131: Removing Timing Belt Tension Using J 42492-A
Courtesy of GENERAL MOTORS CORP.

9. Rotate the water pump using the **J 42492-A** to remove the tension from the timing belt. See **Special Tools**.
10. Remove the spark plug cover bolts.

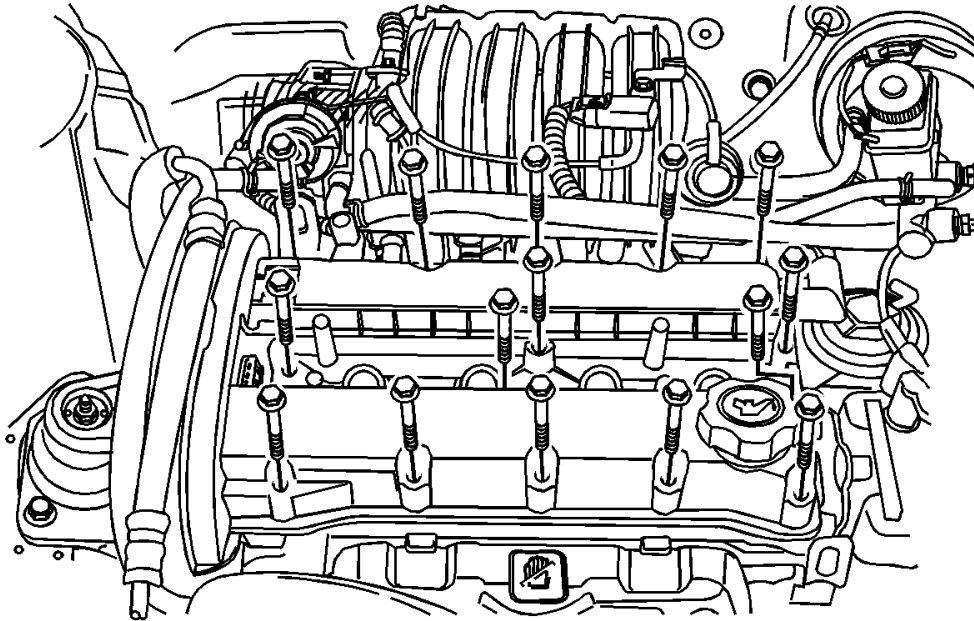


Fig. 132: Identifying Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the engine ventilation hoses from the camshaft cover.
12. Disconnect the oil filler cap.
13. Remove the spark plug cover bolts.
14. Remove the spark plug cover.
15. Remove the spark plug cover.
16. Remove the camshaft cover nuts.
17. Remove the camshaft cover washers.
18. Remove the camshaft cover and the camshaft cover gasket.

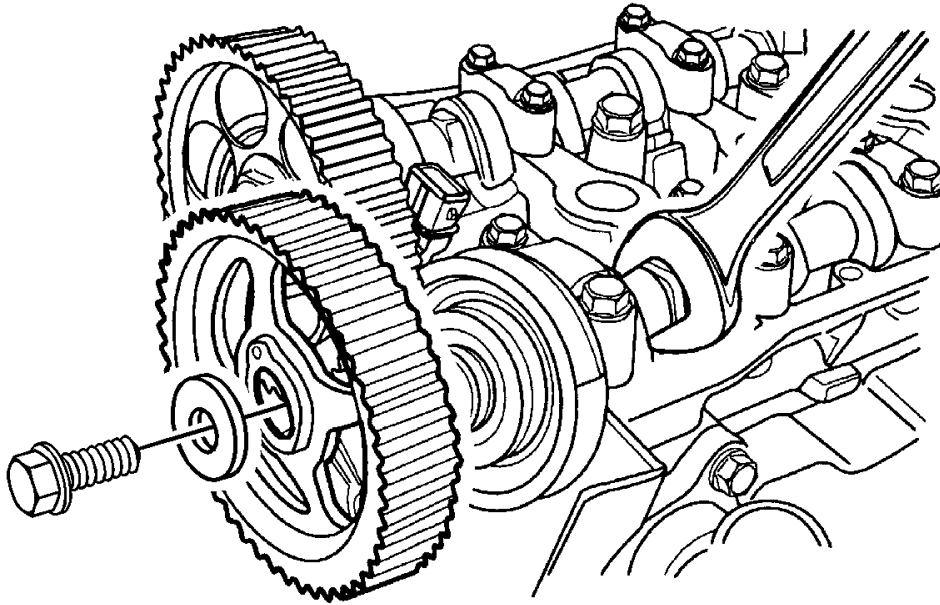


Fig. 133: Holding Camshaft To Tighten/Loosen Sprocket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

19. While holding the intake camshaft firmly in place, remove the intake camshaft bolt.
20. Remove the intake camshaft gear.
21. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft bolt.
22. Remove the exhaust camshaft gear.

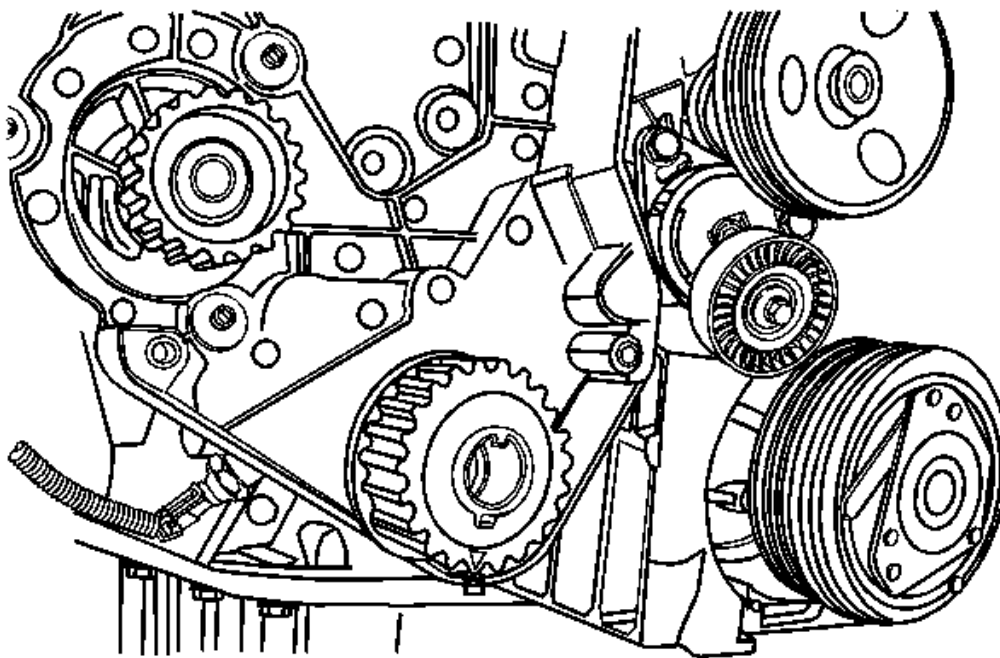


Fig. 134: View Of Camshaft Gear
Courtesy of GENERAL MOTORS CORP.

23. Remove the timing belt automatic tensioner bolts.
24. Remove the timing belt automatic tensioner.
25. Remove the timing belt idler pulley bolt.
26. Remove the timing belt idler pulley.

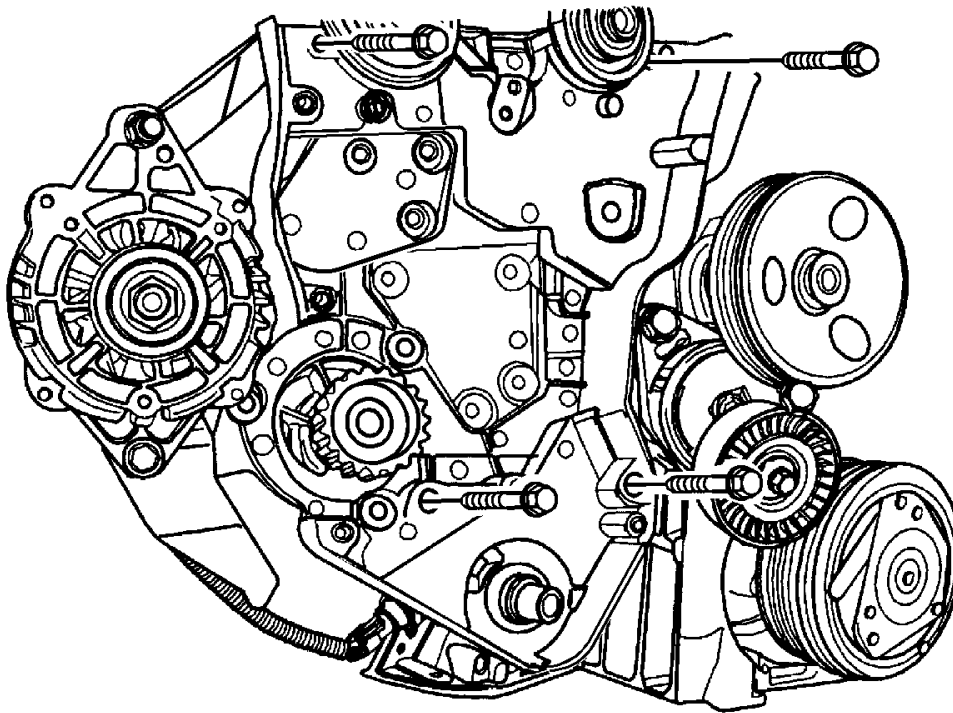


Fig. 135: View Of Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

27. Remove the crankshaft timing belt gear.
28. Remove the rear timing belt cover bolts.
29. Remove the rear timing belt cover.

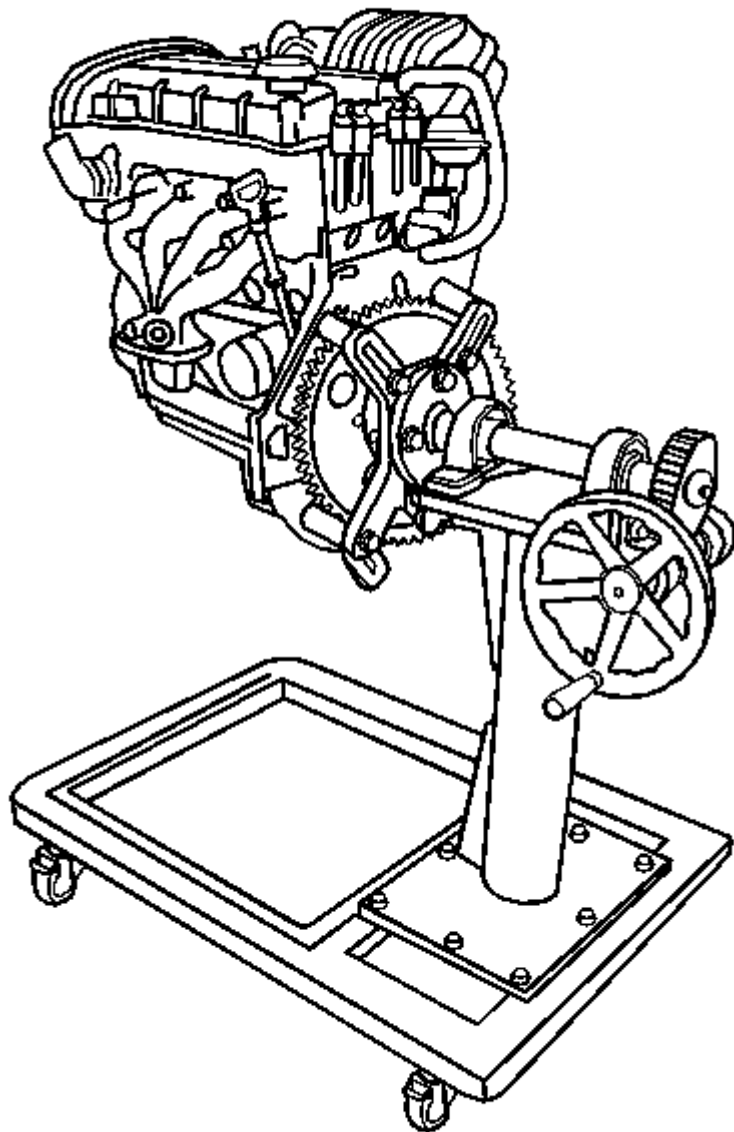


Fig. 136: View Of Engine On Overhaul Stand
Courtesy of GENERAL MOTORS CORP.

30. Rotate the engine on the engine overhaul stand **OTC 1726** .

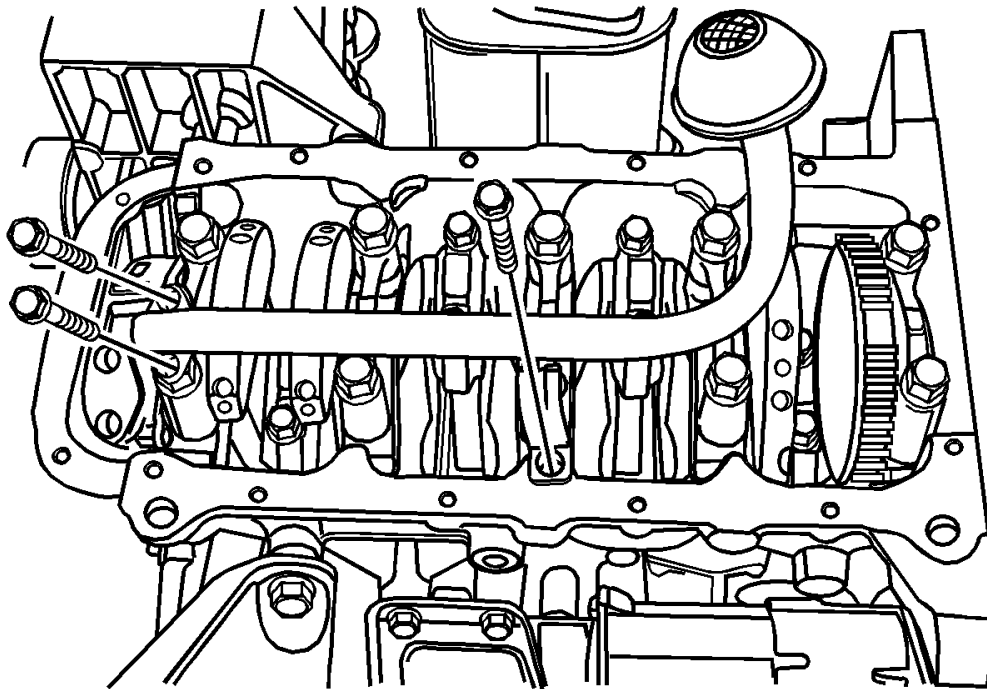


Fig. 137: View Of Oil Pan, Oil Pickup Tube And Bolts
Courtesy of GENERAL MOTORS CORP.

31. Remove the oil pan retaining bolts.
32. Remove the oil pan.
33. Remove the oil suction pipe bolts.
34. Remove the oil suction pipe.

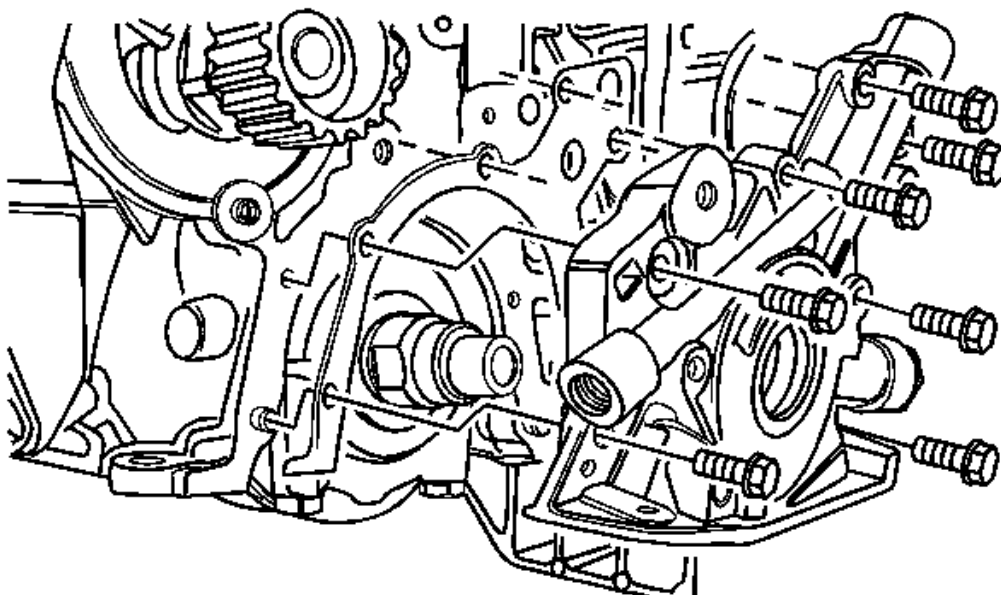


Fig. 138: Identifying Oil Pump And Bolts
Courtesy of GENERAL MOTORS CORP.

35. Remove the oil pump retaining bolts.
36. Remove the oil pump.

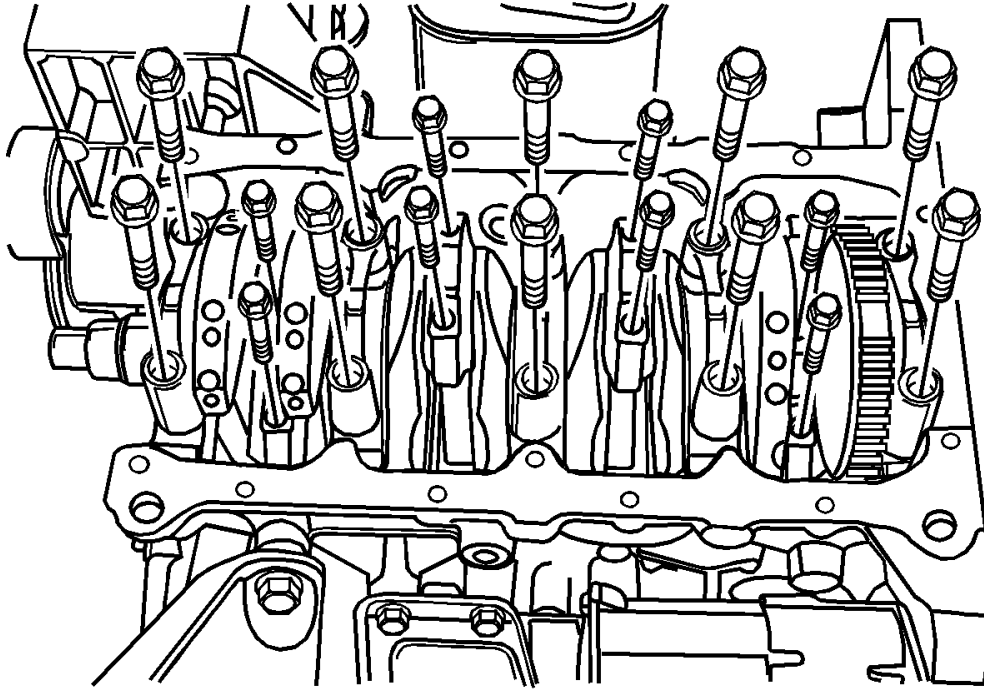


Fig. 139: View Of Connecting Rod Bearing Cap Rod Bolts
Courtesy of GENERAL MOTORS CORP.

37. Mark the order of the connecting rod bearing caps.
38. Remove the connecting rod bearing cap bolts for all of the pistons.
39. Remove the connecting rod bearing caps and the lower connecting rod bearings.
40. Remove the upper connecting rod bearings.
41. Mark the order of the crankshaft bearing caps.
42. Remove the crankshaft bearing cap bolts.
43. Remove the crankshaft bearing caps and the lower crankshaft bearings.
44. Remove the crankshaft.
45. Remove the upper crankshaft bearings.

CAUTION: Refer to Safety Glasses Caution .

46. Clean the parts, as needed.

INSTALLATION PROCEDURE

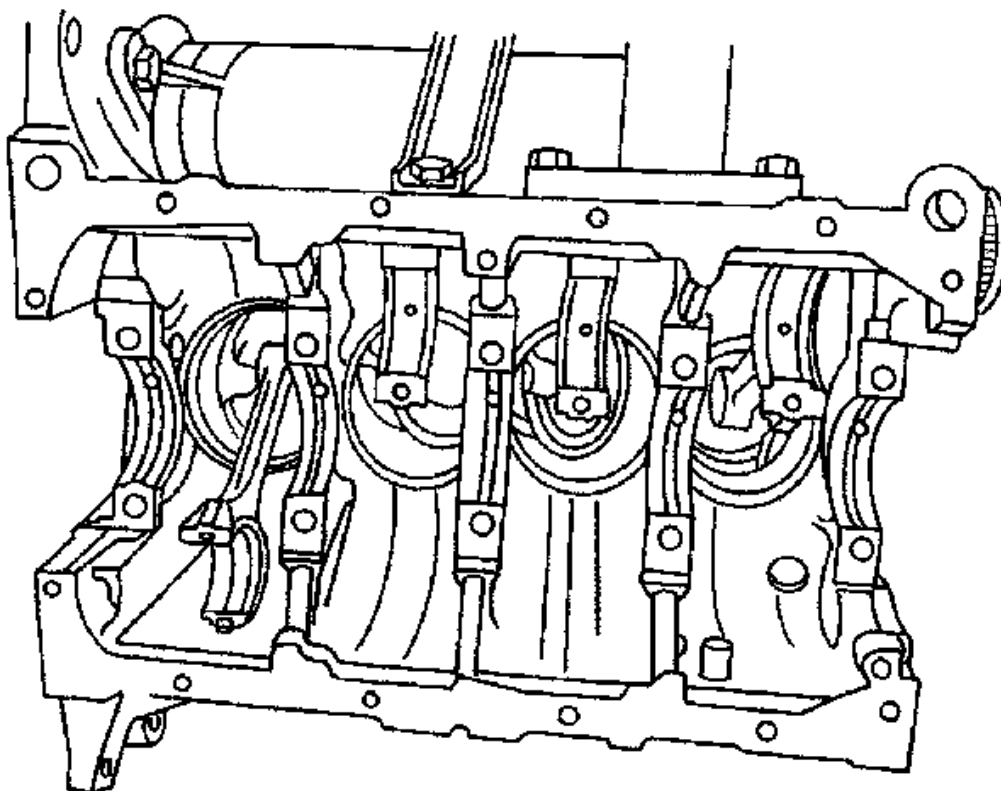


Fig. 140: Identifying Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS CORP.

1. Coat the crankshaft bearings with the engine oil.
2. Install the upper crankshaft bearings in the engine block.

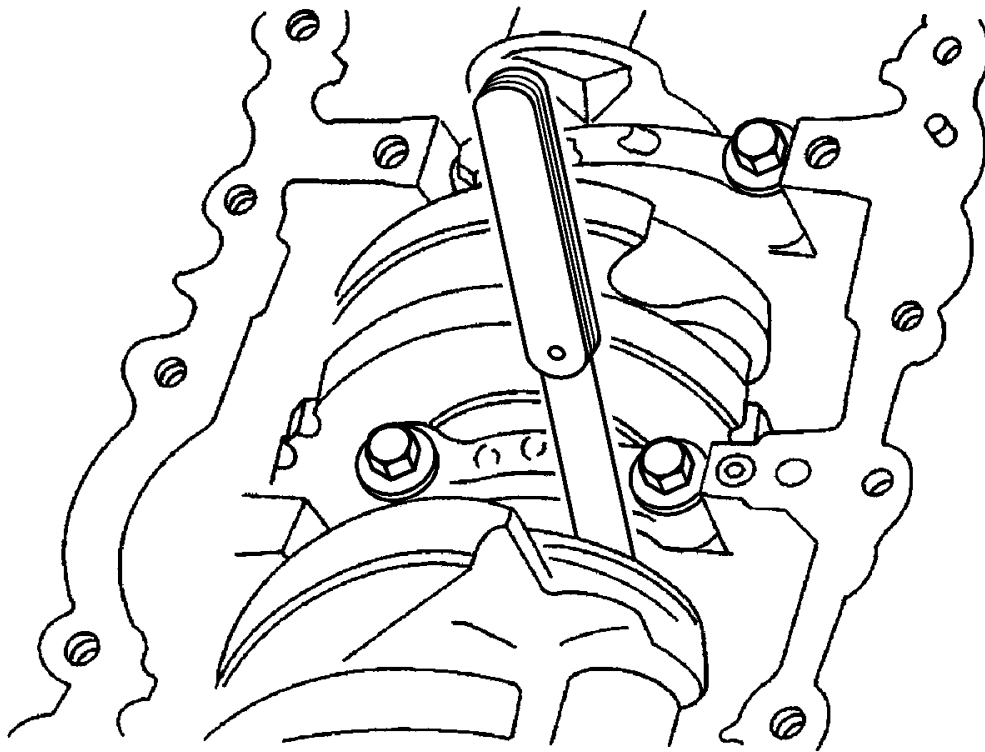


Fig. 141: Inspecting Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft.
4. Install the lower crankshaft bearings in the bearing caps.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to **Engine Mechanical Specifications** .

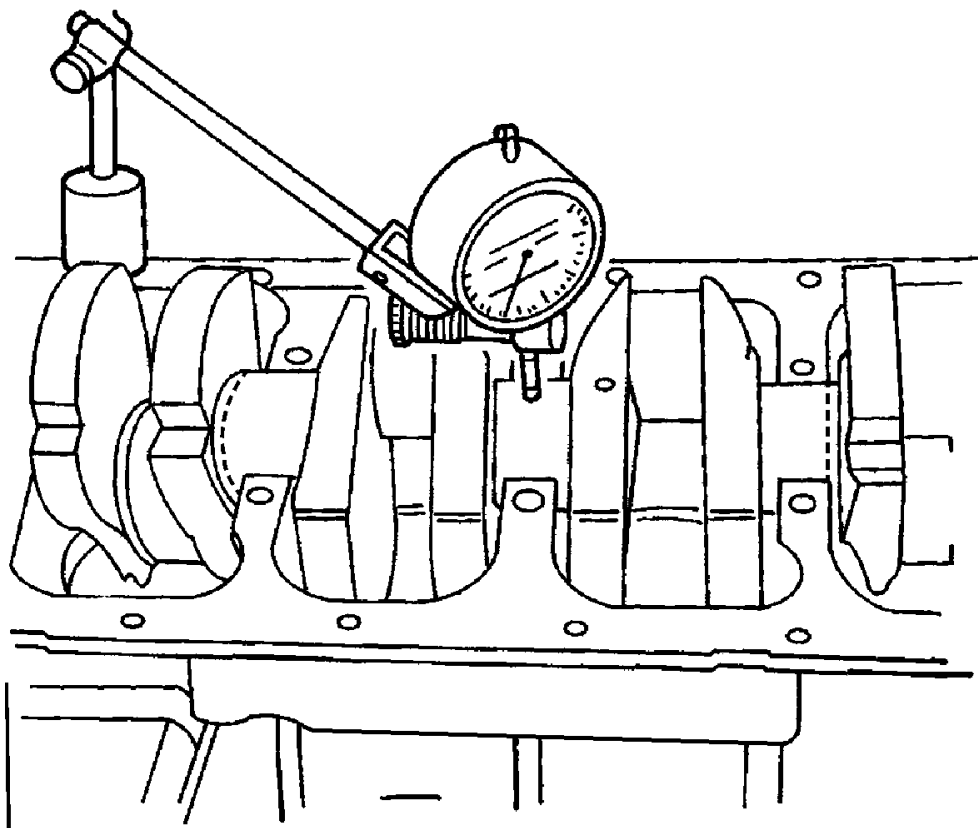


Fig. 142: Checking Middle Crankshaft Journal For Out-Of-Round Runout
Courtesy of GENERAL MOTORS CORP.

7. With the crankshaft mounted on the front and the rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to **Engine Mechanical Specifications** .

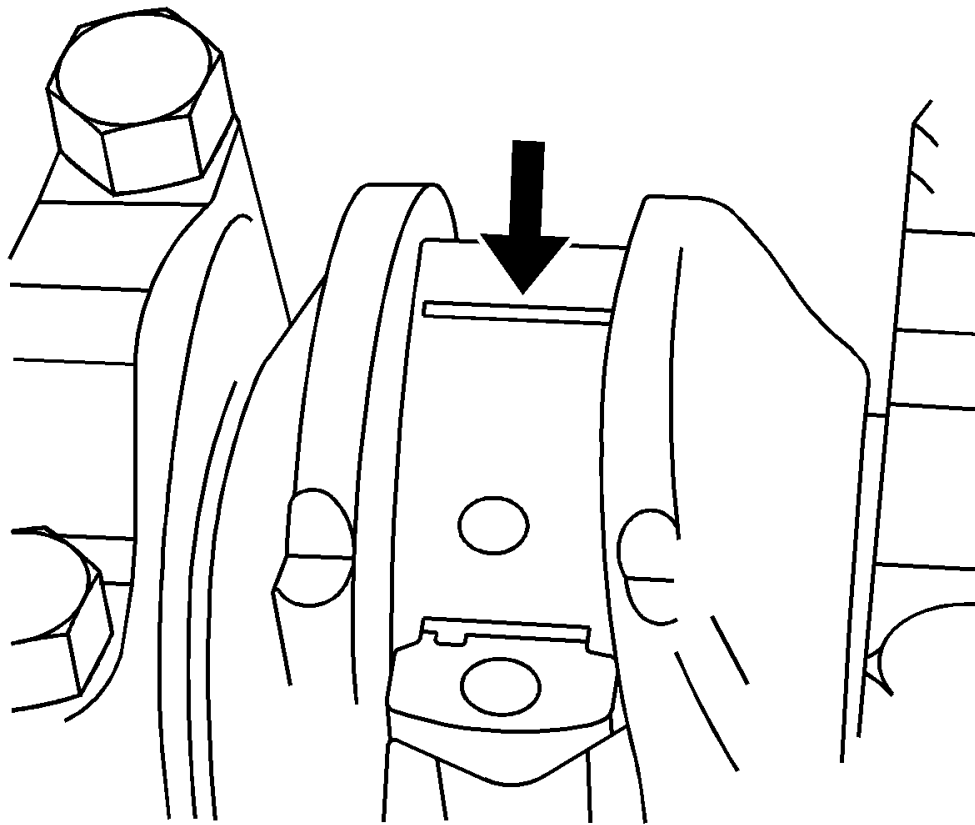


Fig. 143: View Of Plastic Gauging Thread On Bearing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gaging thread does not tear when the crankshaft bearing caps are removed.

8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gaging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings

NOTE: Refer to Fastener Notice .

10. Install the crankshaft bearing caps and the bolts.

Tighten: Tighten the crankshaft bearing cap bolts to **50 N.m (37 lb ft)** plus 45 degrees plus 15 degrees.

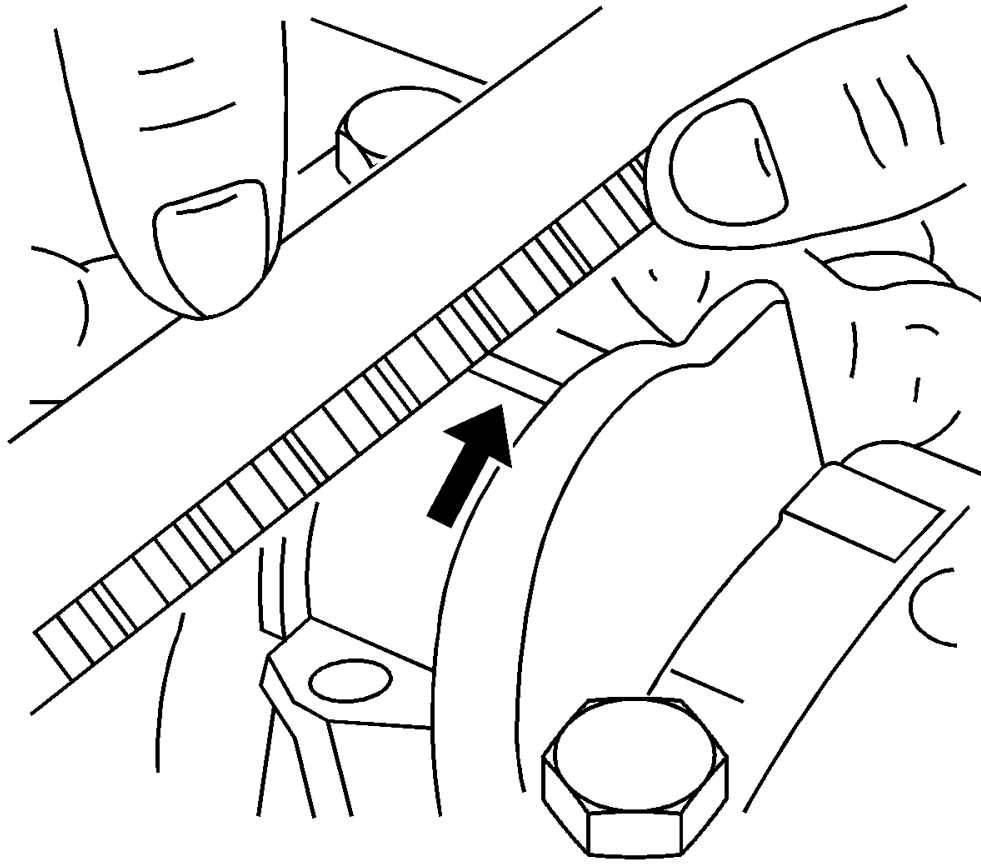


Fig. 144: Measuring Plastic Gaging
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft bearing cap bolts and the caps.
12. Measure the width of the flattened plastic thread of the plastic gaging using the scale printed on the plastic gaging package. Plastic gaging is available for different tolerance ranges.
13. Inspect the bearing clearance for permissible tolerance ranges. Refer to **Engine Mechanical Specifications** .

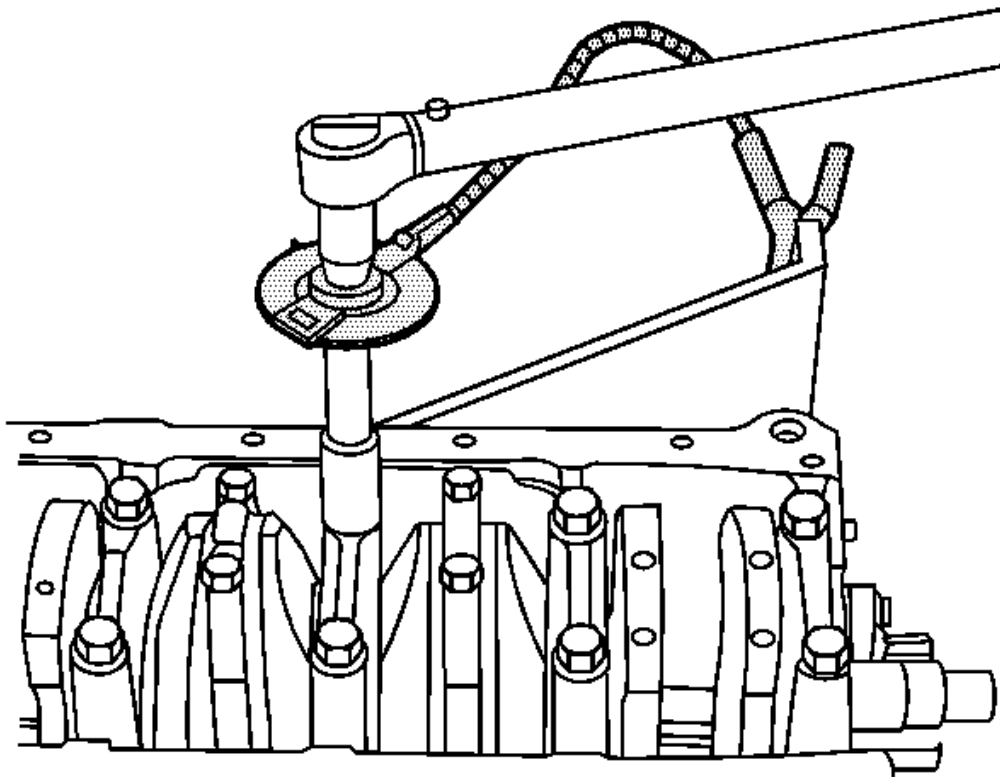


Fig. 145: View Of J 45059 And KM-470-B
Courtesy of GENERAL MOTORS CORP.

14. Apply a bead of adhesive sealing compound to the grooves of the crankshaft bearing caps.
15. Install the crankshaft bearing caps to the engine block.
16. Tighten the crankshaft bearing caps using new bolts using the **J 45059** or the **KM-470-B** . See **Special Tools** .

Tighten: Tighten the crankshaft bearing cap bolts to **50 N.m (37 lb ft)** using a torque wrench. Tighten the crankshaft bearing 45 degrees plus 15 degrees.

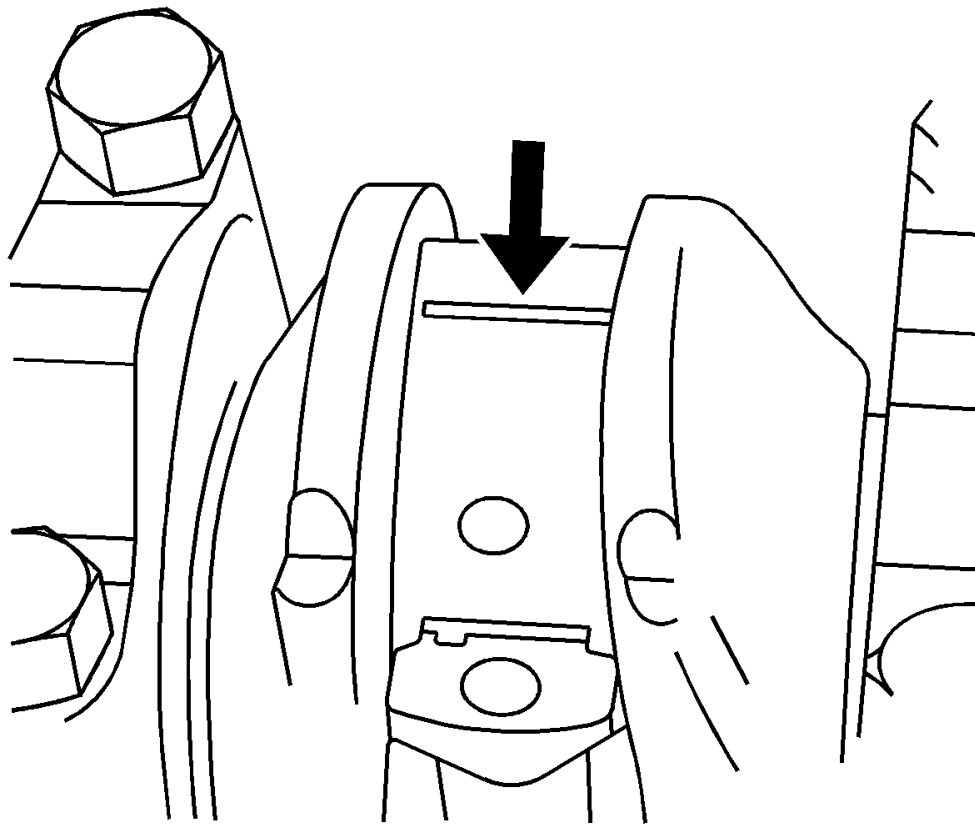


Fig. 146: View Of Plastic Gauging Thread On Bearing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gaging thread does not tear when the connecting rod bearing caps are removed.

17. Inspect all of the connecting rod bearing clearances using a commercially available plastic gaging (ductile plastic threads).
18. Cut the plastic gaging threads to the length of the connecting rod bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.
19. Install the connecting rod bearing caps using the **J 45059** or the **KM-470-B** . See **Special Tools** .

Tighten: Tighten the connecting rod bearing cap bolts to **25 N.m (18 lb ft)** using a torque wrench. Tighten the connecting rod bearing cap bolts 30 degrees plus 15 degrees.

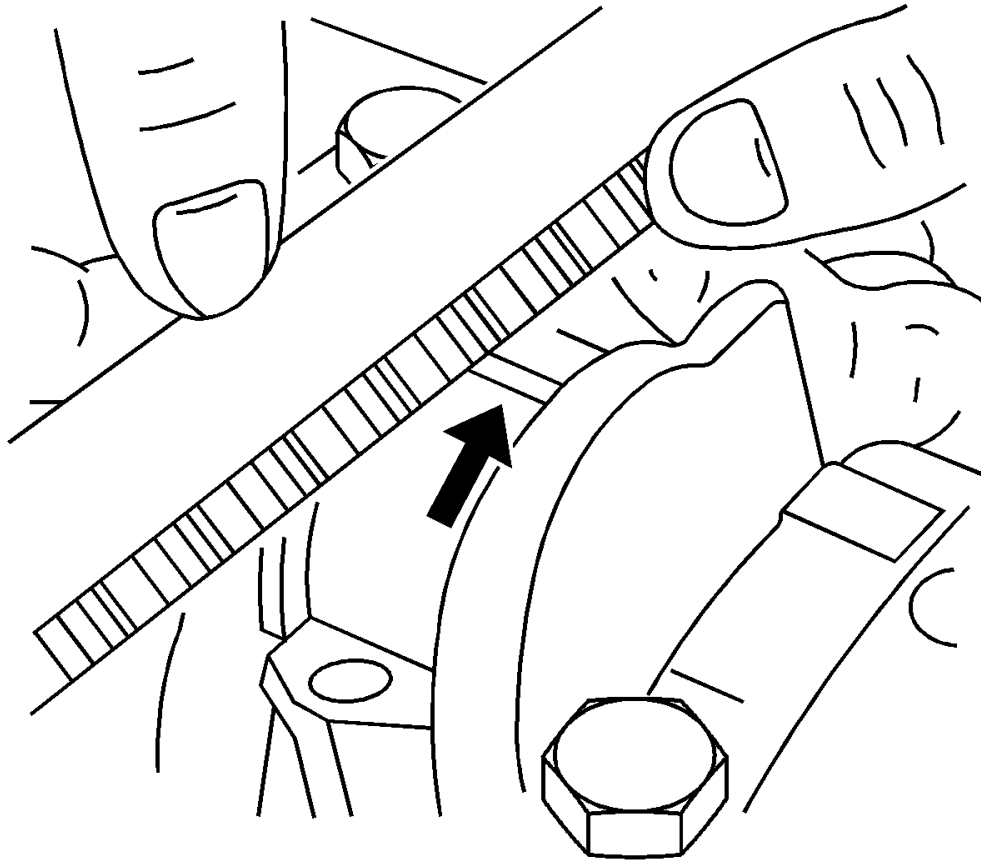


Fig. 147: Measuring Plastic Gaging
Courtesy of GENERAL MOTORS CORP.

20. Remove the connecting rod bearing caps.
21. Measure the width of the flattened plastic thread of the plastic gaging using the scale printed on the plastic gaging package. Plastic gaging is available for different tolerance ranges.
22. Inspect the bearing clearance for permissible tolerance ranges. Refer to **Engine Mechanical Specifications** .

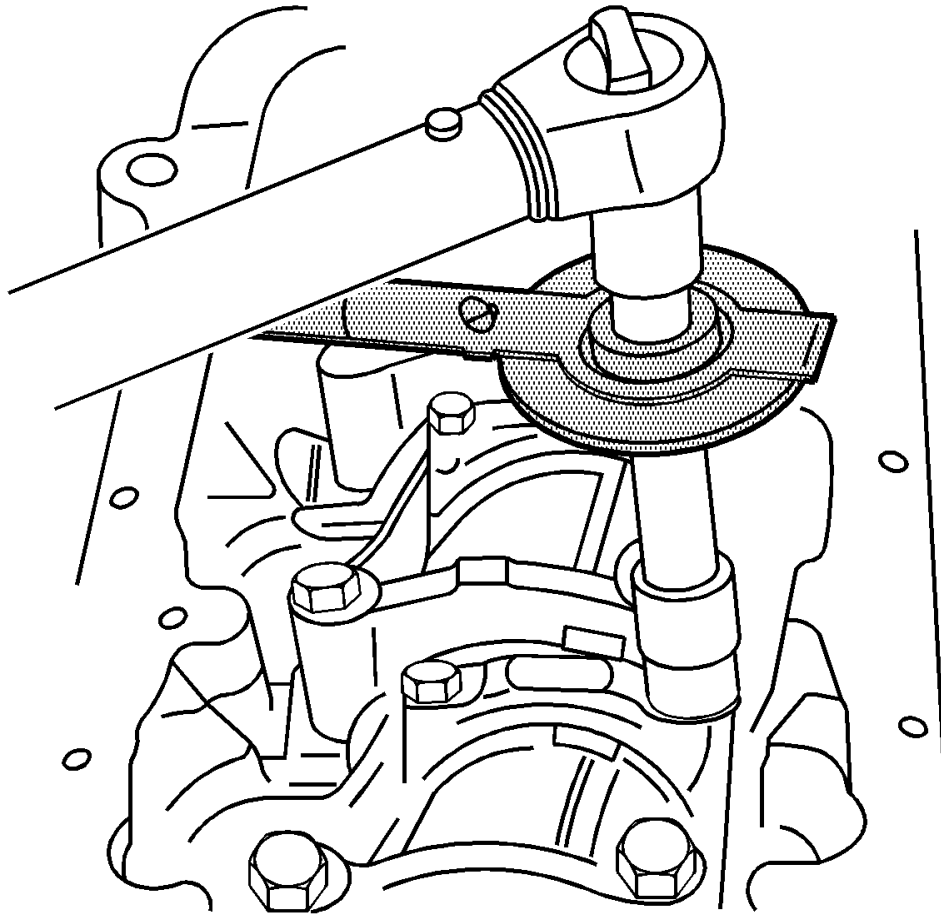


Fig. 148: Identifying J 45059 And KM-470-B
Courtesy of GENERAL MOTORS CORP.

23. Install the connecting rod bearing caps to the connecting rods.
24. Tighten the connecting rod bearing caps using new bolts using the **J 45059** or the **KM-470-B** . See **Special Tools** .

Tighten: Tighten the connecting rod bearing cap bolts to **25 N.m (18 lb ft)** using a torque wrench. Tighten the connecting rod cap bolts 30 degrees plus 15 degrees.

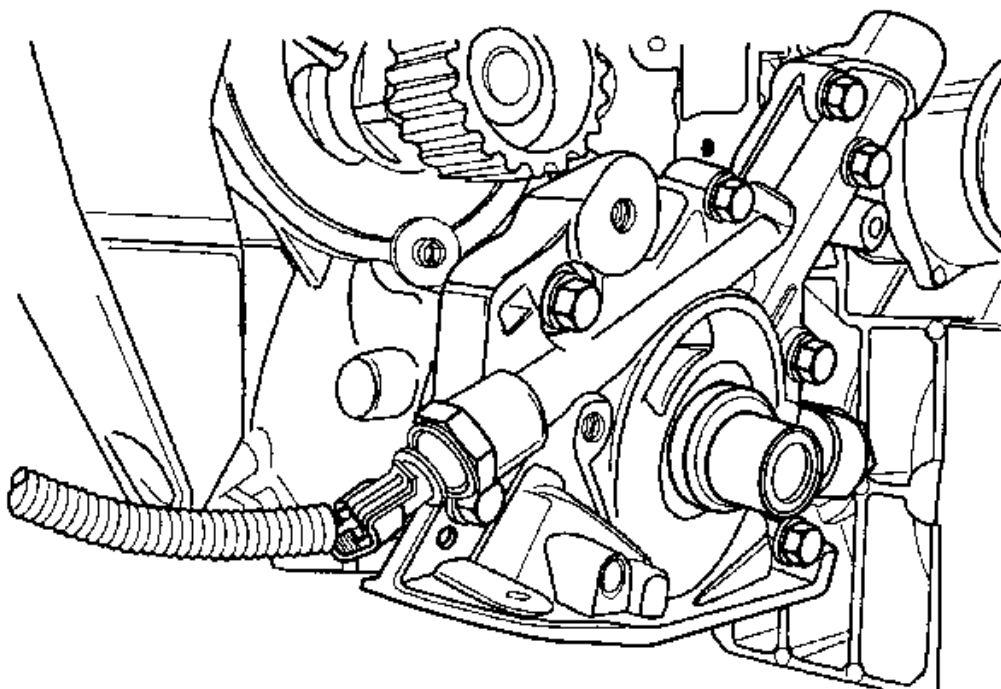


Fig. 149: View Of Oil Pump And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the oil pump.
26. Install the oil pump retaining bolts.

Tighten: Tighten the oil pump retaining bolts to **10 N.m (89 lb in)** .

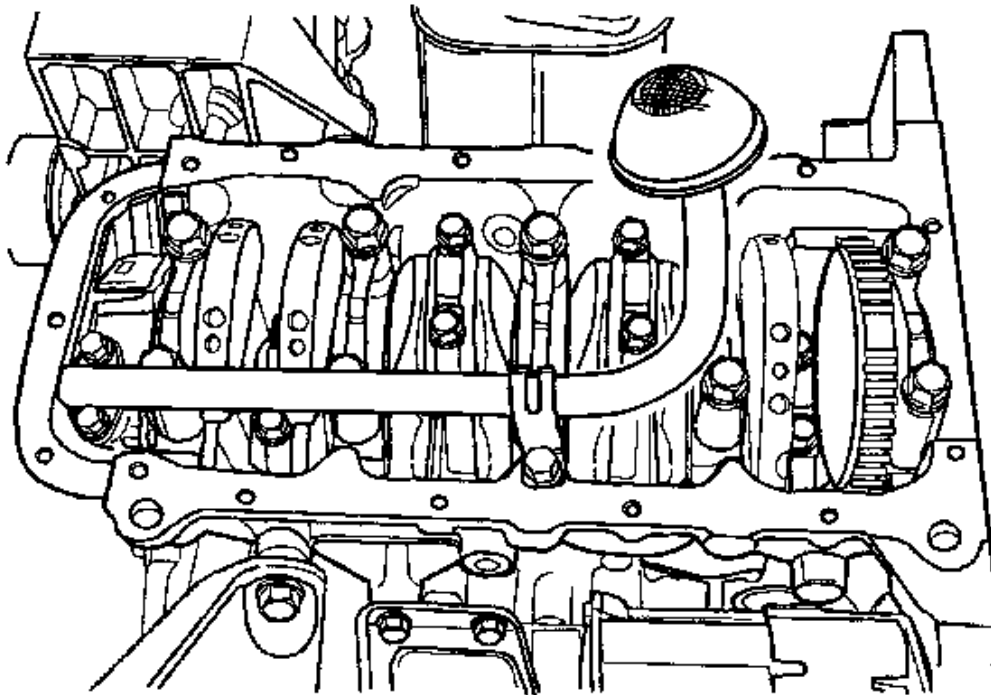


Fig. 150: Identifying Oil Suction Pipe And Bolts
Courtesy of GENERAL MOTORS CORP.

27. Install the oil suction pipe.
28. Install the oil suction pipe bolts.

Tighten: Tighten the oil suction pipe bolts to **10 N.m (89 lb in)** .

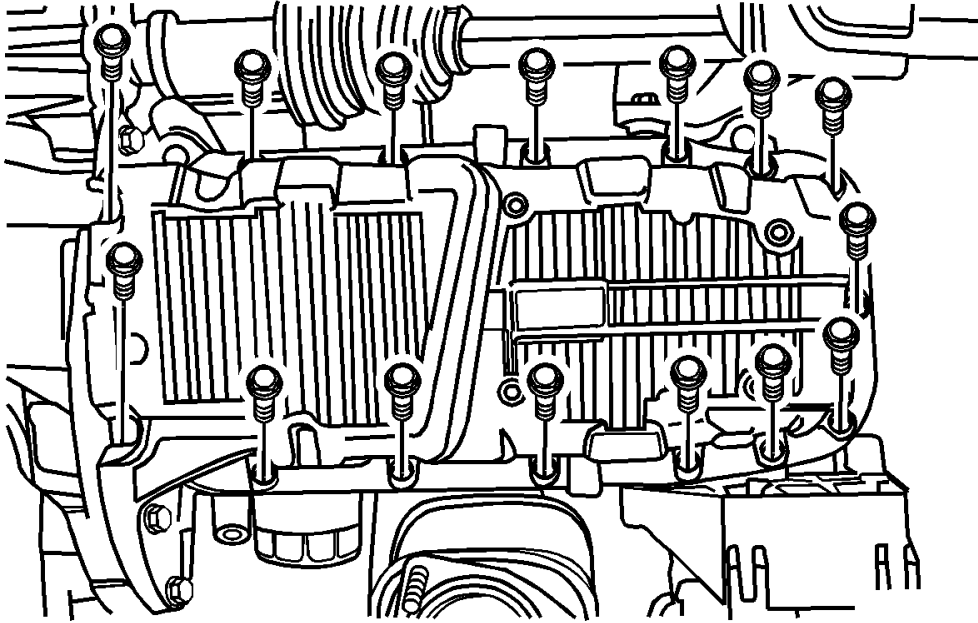


Fig. 151: View Of Oil Pan And Engine Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

29. Coat the new oil pan gasket with sealant.
30. Install the oil pan gasket to the oil pan.
31. Install the oil pan.
32. Install the oil pan retaining bolts.

Tighten: Tighten the oil pane retaining bolts to **10 N.m (89 lb in)** .

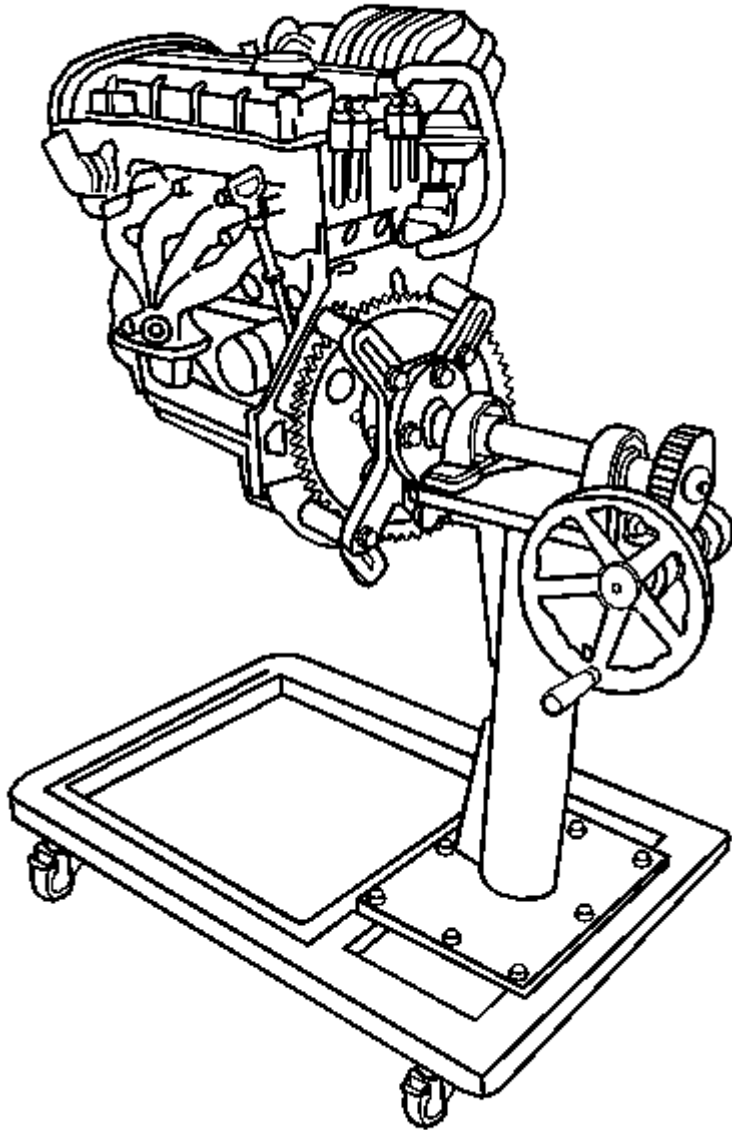


Fig. 152: View Of Engine On Overhaul Stand
Courtesy of GENERAL MOTORS CORP.

33. Rotate the engine on the engine overhaul stand **OTC 1726** .

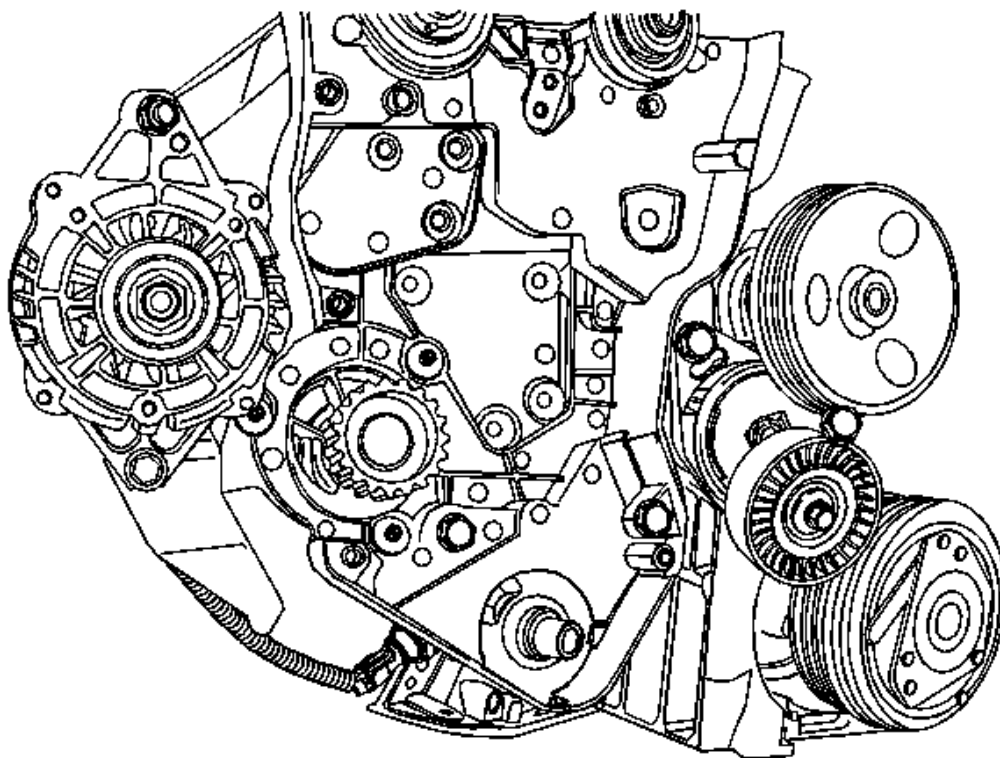


Fig. 153: View Of Rear Timing Belt Cover
Courtesy of GENERAL MOTORS CORP.

34. Install the rear timing belt cover.
35. Install the rear timing belt cover bolts.

Tighten: Tighten the rear timing belt cover bolts to **10 N.m (89 lb in)** .

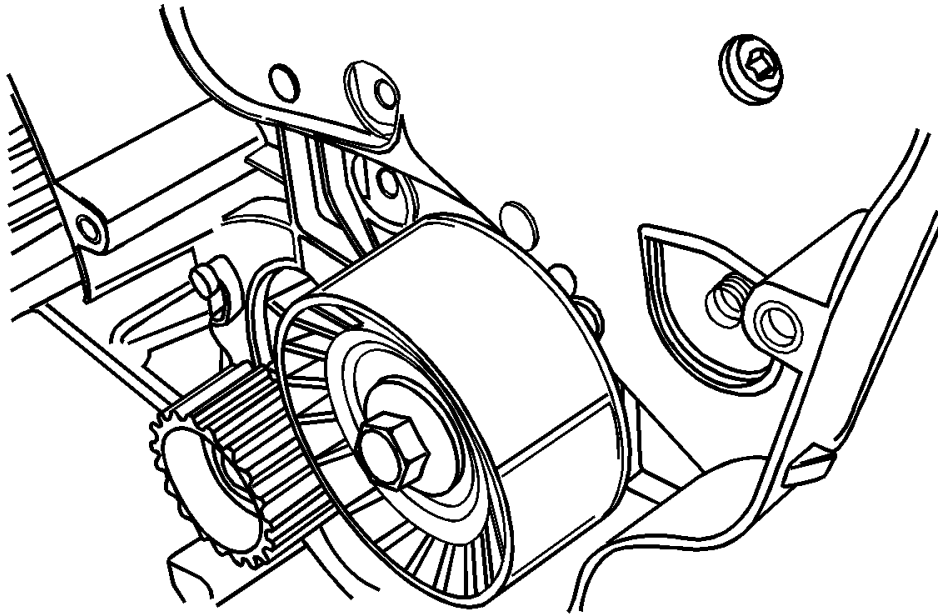


Fig. 154: View Of Timing Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

36. Install the crankshaft timing belt gear.
37. Install the timing belt automatic tensioner.
38. Install the timing belt automatic tensioner bolts.

Tighten: Tighten the timing belt automatic tensioner bolts to **25 N.m (18 lb ft)** .

39. Install the timing belt idler pulley.
40. Install the timing belt idler pulley bolt.

Tighten: Tighten the timing belt idler pulley bolt to **40 N.m (30 lb ft)** .

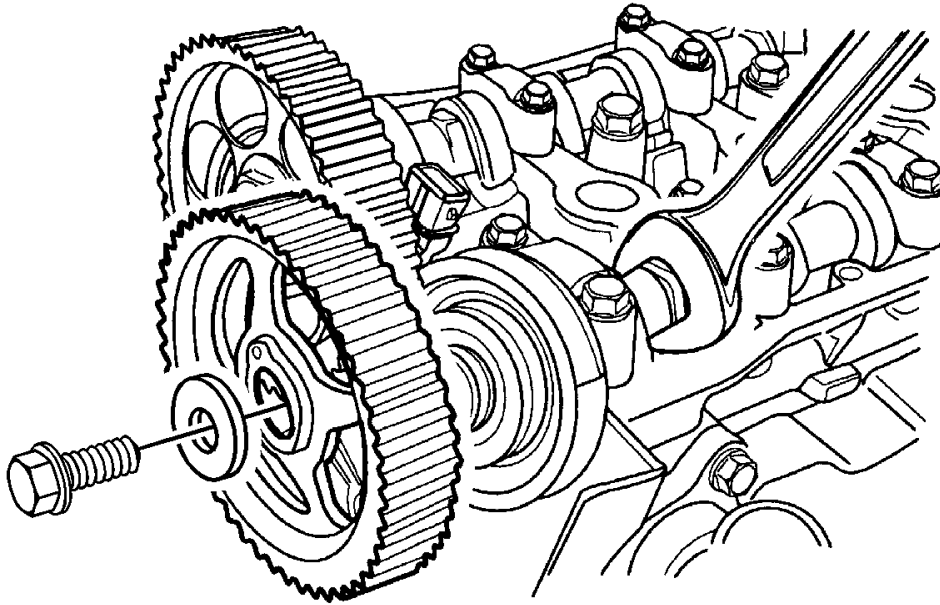


Fig. 155: Holding Camshaft To Tighten/Loosen Sprocket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

41. Install the intake camshaft gear.
42. Install the intake camshaft gear bolt while holding the intake camshaft firmly in place.

Tighten: Tighten the intake camshaft gear bolt to **67.5 N.m (49 lb ft)** .

43. Install the exhaust camshaft gear
44. Install the exhaust camshaft gear bolt while holding the exhaust camshaft firmly in place.

Tighten: Tighten the exhaust camshaft gear bolt to **67.5 N.m (49 lb ft)** .

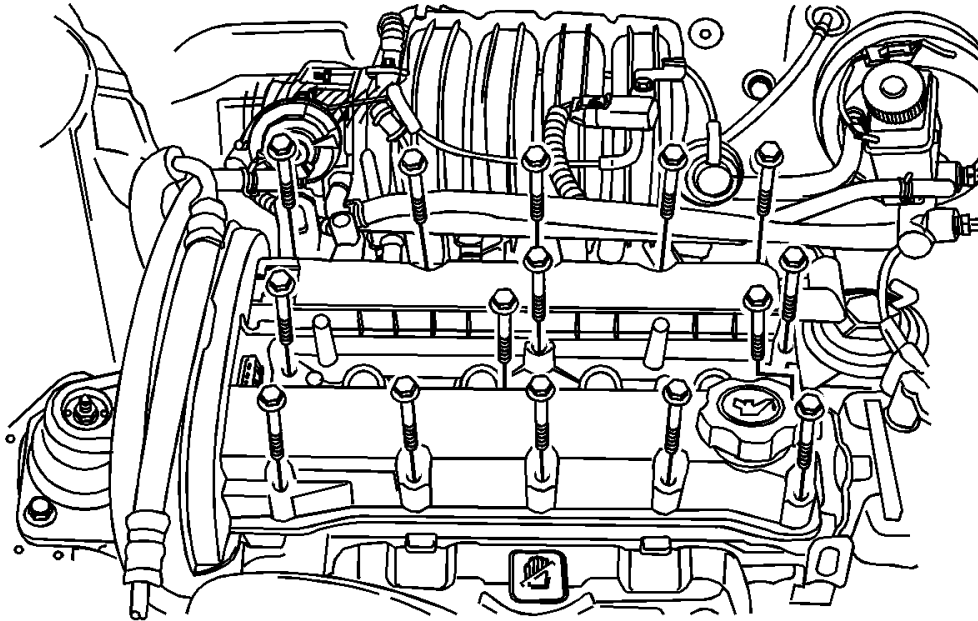


Fig. 156: Identifying Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

45. Install the timing belt. Refer to **Timing Belt Replacement**.
46. Adjust the timing belt tension. Refer to **Timing Belt Inspection**.
47. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear camshaft cover-to-cylinder head seal.
48. Install the camshaft cover and the camshaft cover gasket.
49. Install the camshaft cover washers.
50. Install the camshaft cover nuts.

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

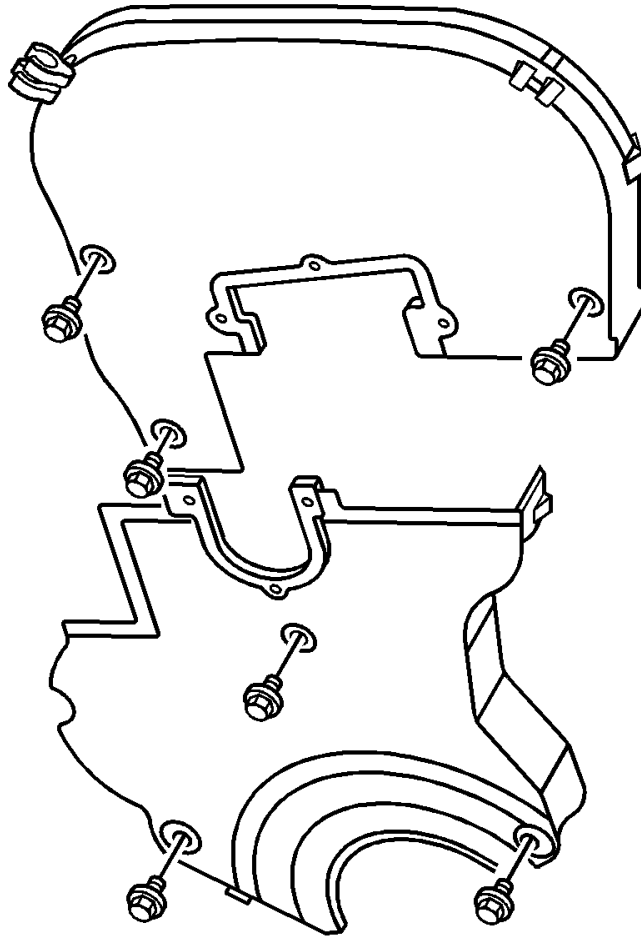


Fig. 157: View Of Upper And Lower Front Timing Belt Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

51. Connect the ignition wires to the spark plugs
52. Connect the oil filler cap.
53. Connect the engine ventilation hose to the camshaft cover.
54. Install the upper and the lower front timing belt covers.
55. Install the upper and the lower front timing belt cover bolts.

Tighten: Tighten the upper and the lower front timing belt cover bolts to **10 N.m (89 lb in)** .

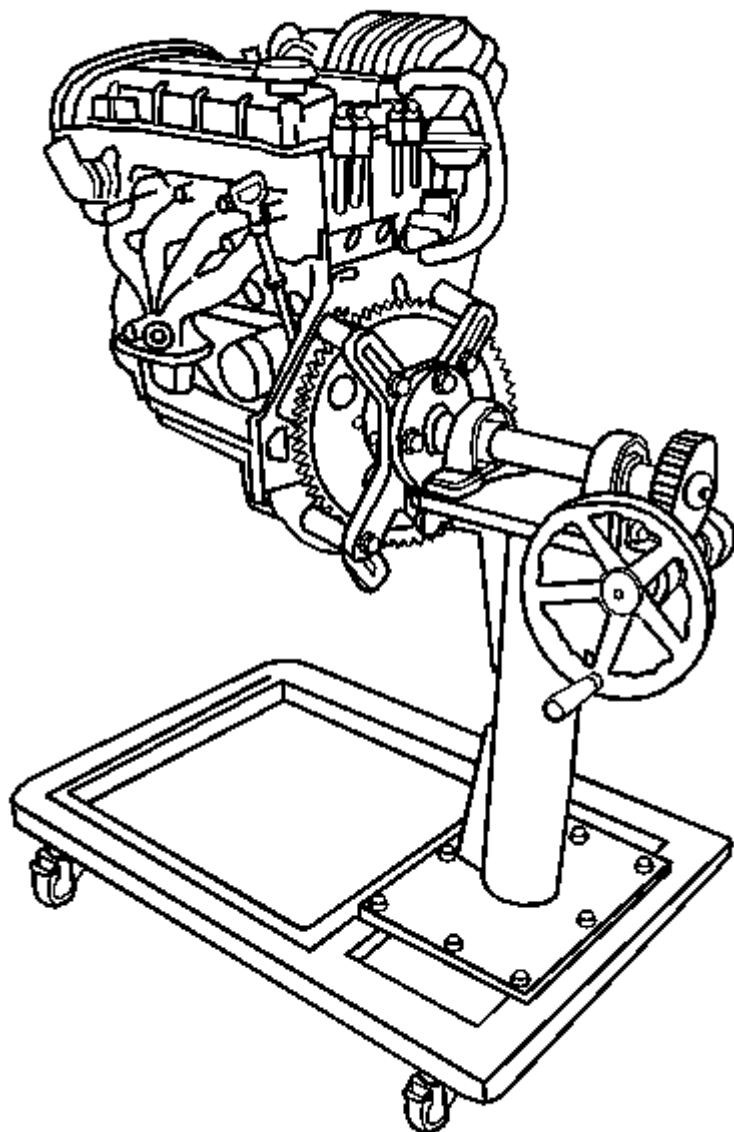


Fig. 158: View Of Engine On Overhaul Stand
Courtesy of GENERAL MOTORS CORP.

56. Install the engine lifting device.
57. Remove the engine from the engine overhaul stand **OTC 1726** .

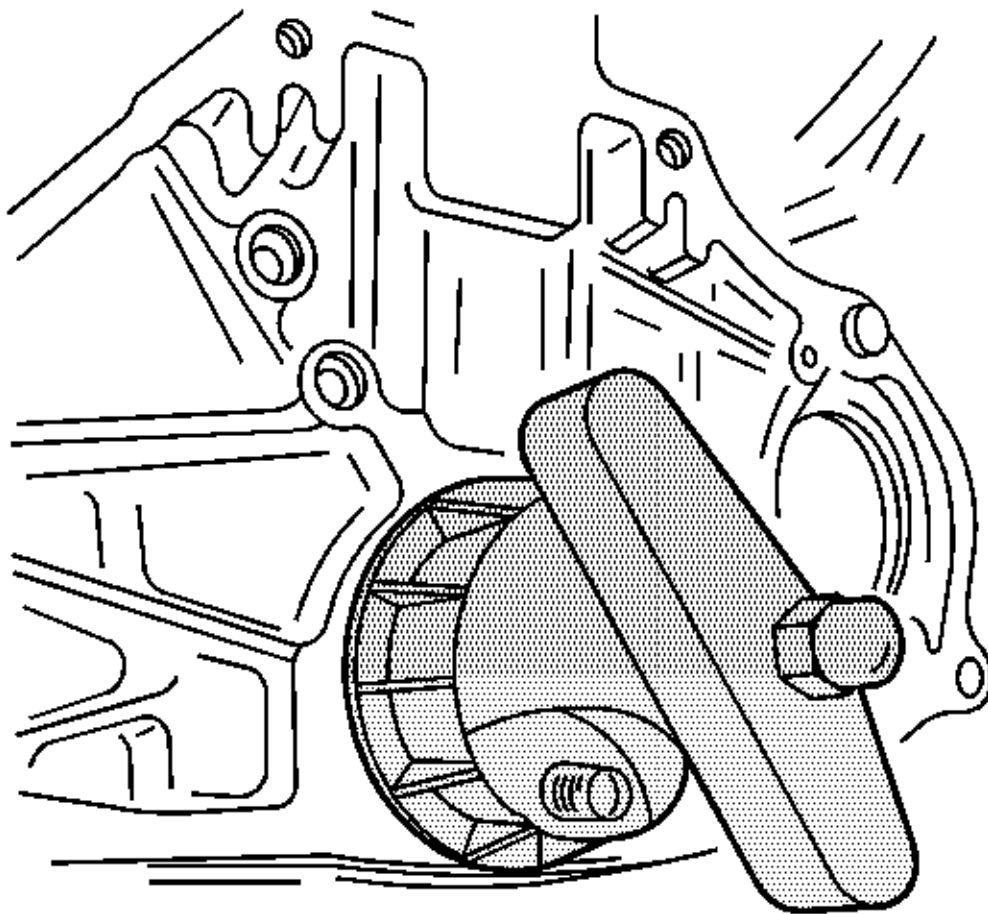


Fig. 159: View Of J 36972

Courtesy of GENERAL MOTORS CORP.

58. Install a new crankshaft rear oil seal using the **J-36792** or the **KM-635** . See **Special Tools** .

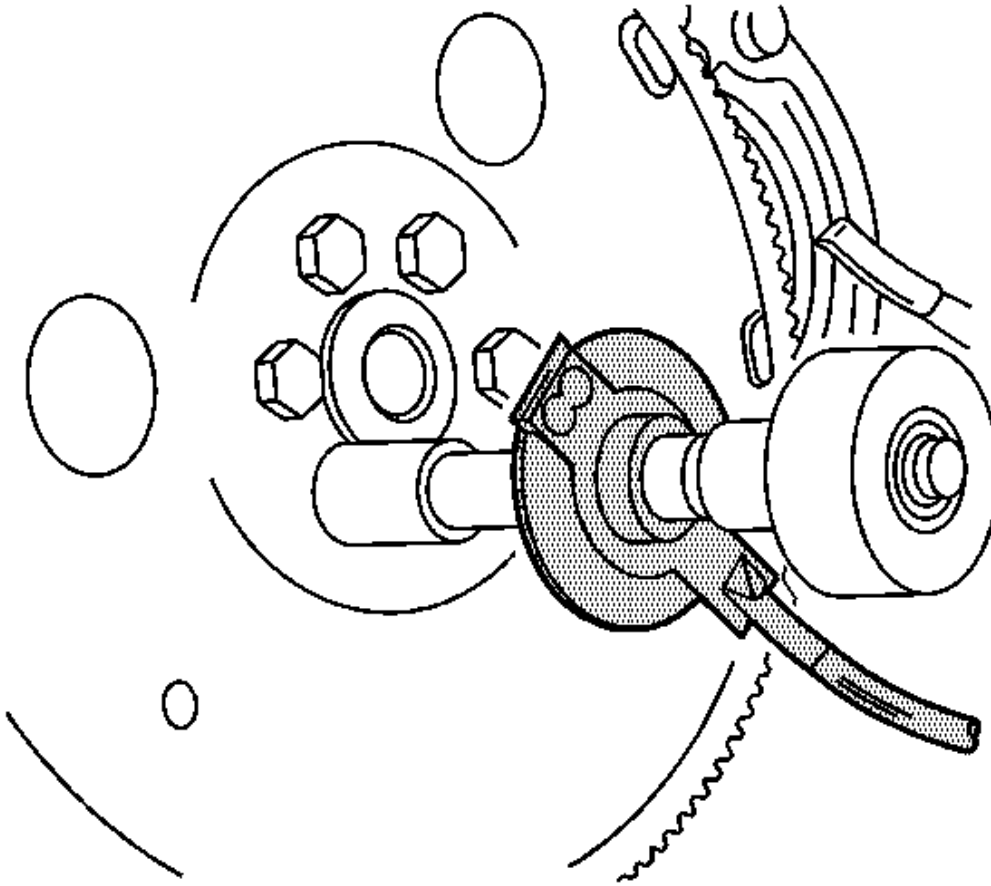


Fig. 160: View Of J 45059

Courtesy of GENERAL MOTORS CORP.

59. Install the flywheel or the flexible plate.
60. Install the flywheel or the flexible plate bolts using the **J 45059** or the **KM-470-B** . See **Special Tools** .

Tighten: Tighten the flywheel bolts to **35 N.m (25 lb ft)** . Tighten the flywheel bolts another 30 degrees plus 15 degrees. If the vehicle is equipped with an automatic transaxle, tighten the flexible plate bolts to **45 N.m (33 lb ft)** .

61. Install the engine. Refer to **Engine Replacement**.

PISTON, CONNECTING ROD, AND BEARING REPLACEMENT

TOOLS REQUIRED

- **J 24086-B** (KM-427) Piston Pin Remover/Installer. See **Special Tools** .
- **KM-470-B** Angular Torque Gauge. See **Special Tools** .
- **J 45059** Angle Meter. See **Special Tools** .

REMOVAL PROCEDURE

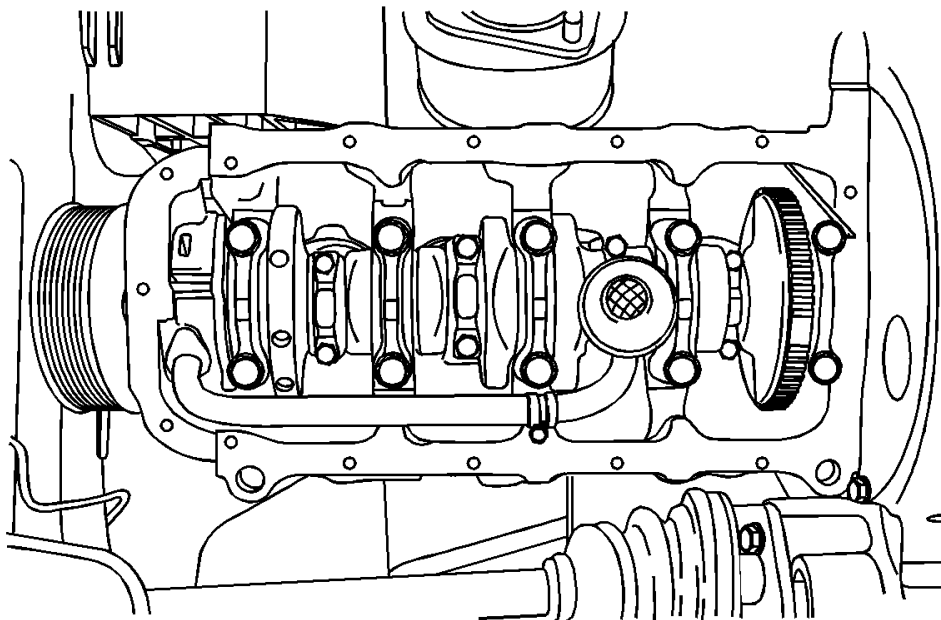


Fig. 161: View Of Oil Pump/Pickup Tube And Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to **Safety Glasses Caution** .

1. Remove the cylinder head with the intake manifold and exhaust manifold attached. Refer to **Cylinder Head Replacement**.
2. Remove the oil pan. Refer to **Oil Pan Replacement**.
3. Remove the oil pump/pickup tube bolts.
4. Remove the oil pump/pickup tube.

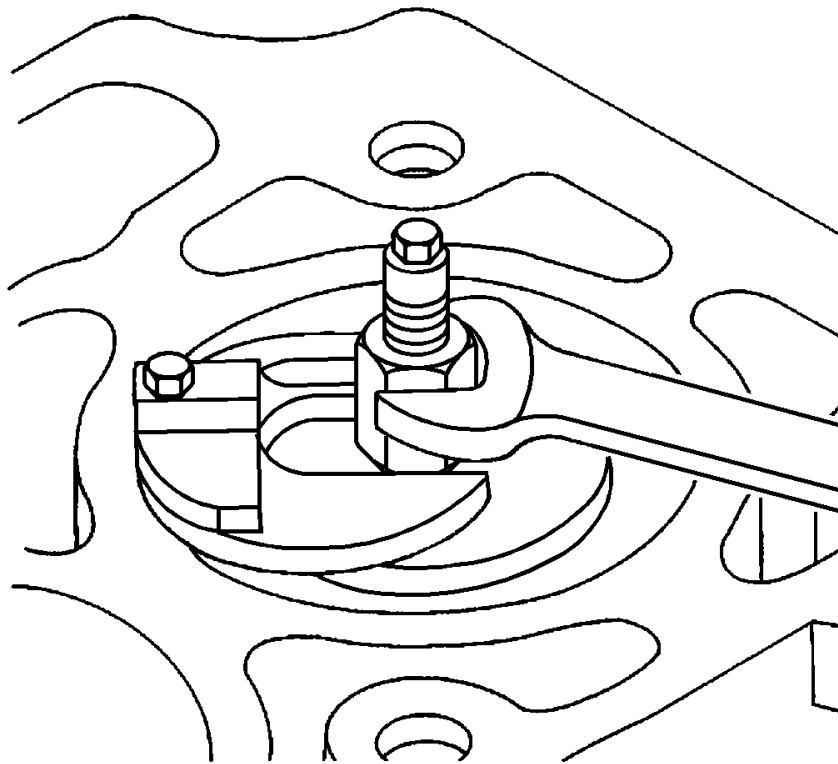


Fig. 162: View Of Connecting Rod Cap Bolts
Courtesy of GENERAL MOTORS CORP.

5. Move the piston to the bottom of the piston stroke.
6. Mark the connecting rod cap.
7. Remove the connecting rod cap bolts.
8. Remove the connecting rod cap and lower connecting rod bearing.
9. Remove the upper piston connecting rod bearing.
10. Ridge ream the cylinder wall.

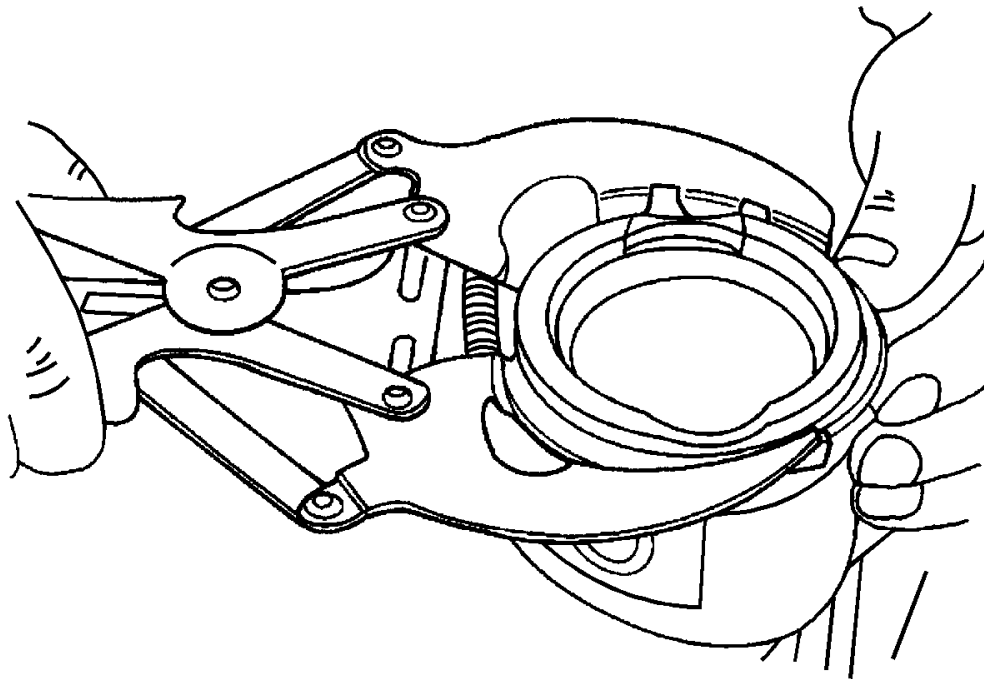


Fig. 163: View Of Piston Rings And Expander
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

11. Remove the piston.
12. Use a piston ring expander tool to expand the piston rings.
13. Remove the piston rings.

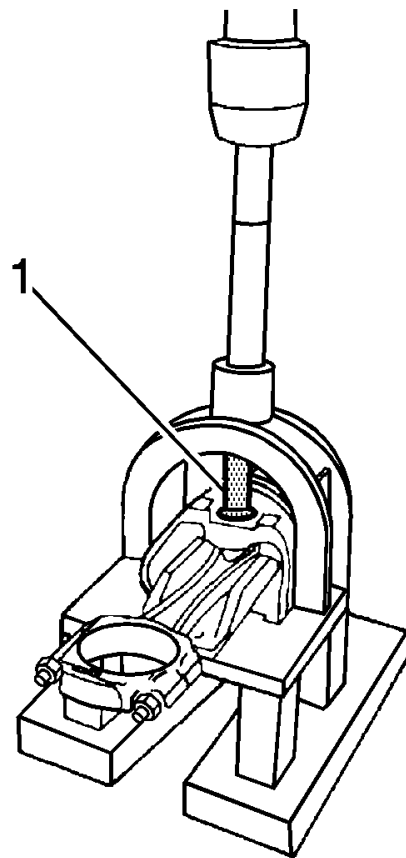


Fig. 164: View Of Piston Pin And Installation/Removal Tool J 24086-B
Courtesy of GENERAL MOTORS CORP.

14. Remove the piston pin from the piston and connecting rod assembly using the **J 24086-B (1)**. See **Special Tools**.
15. Separate the piston from the connecting rod.

INSTALLATION PROCEDURE

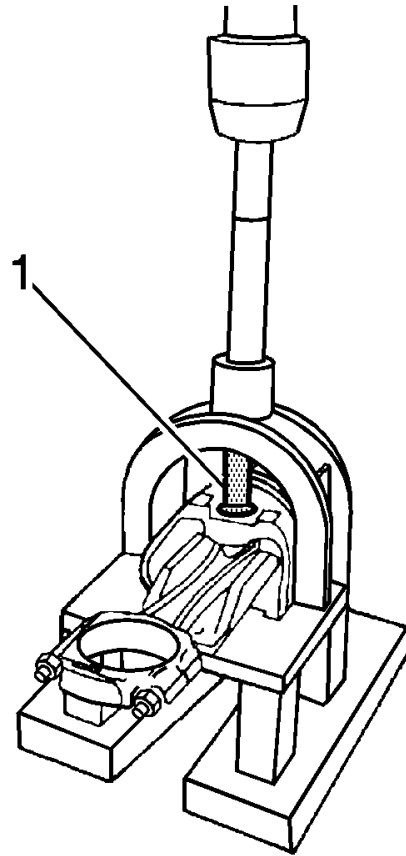


Fig. 165: View Of Piston Pin And Installation/Removal Tool J 24086-B
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Avoid contact with moving parts and hot surfaces while working around a running engine in order to prevent physical injury.

1. Align the notch on the piston and connecting rod so that the proper sides will be facing the front of the engine.
2. Install the piston pin guide through the piston and the connecting rod.
3. Coat the piston pin with clean oil.
4. Install the piston pin into the opposite side of the piston.
5. Install the piston pin into the piston and connecting rod assembly using the **J 24086-B (1)**. See **Special Tools**.
6. Select a set of new piston rings.
7. Measure the piston ring gap using a feeler gauge. Refer to **Engine Mechanical Specifications**.
8. Increase the piston ring gap by carefully filing off excess material if the piston ring gap is below specifications.

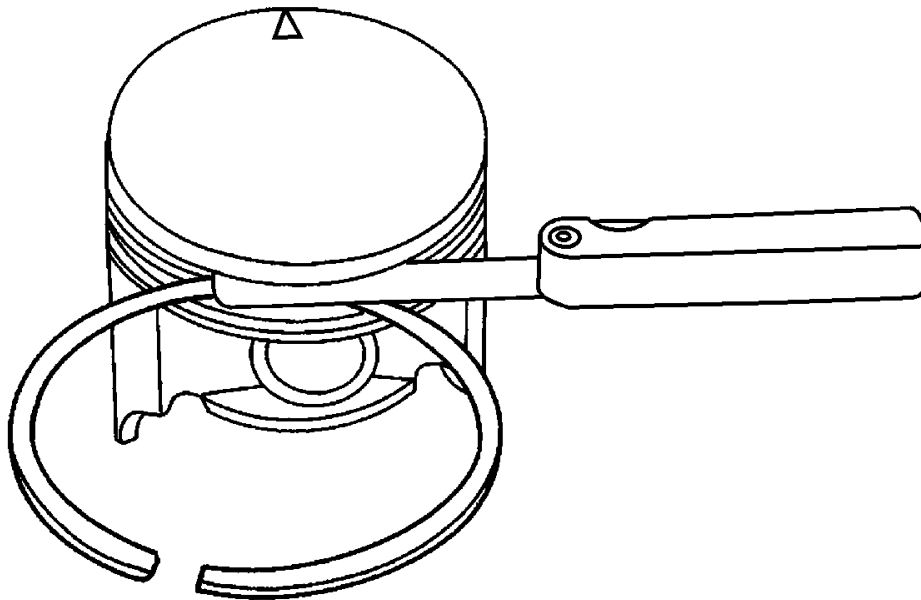


Fig. 166: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

9. Measure the piston ring side clearance using a feeler gauge. Refer to **Engine Mechanical Specifications** .
10. If the piston ring is too thick, try another piston ring.
11. If no piston ring can be found that fits to specifications, the piston ring may be ground to size with emery paper placed on a sheet of glass.

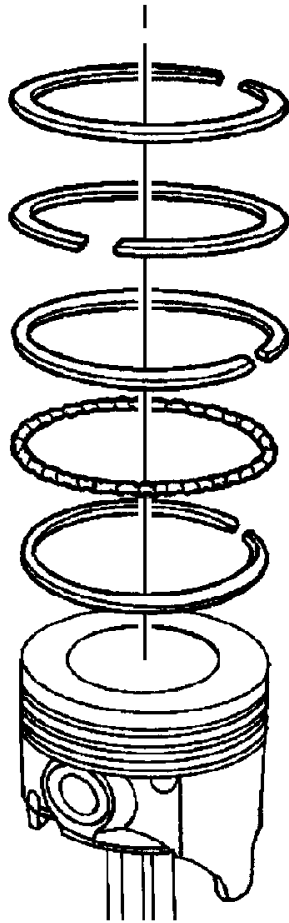


Fig. 167: View Of Piston Rings, 2nd Compression Ring, And Top Compression Ring
Courtesy of GENERAL MOTORS CORP.

12. Install a piston oil ring, the expander, then the 2nd piston oil ring to the bottom ring groove of the piston.
13. Install the 2nd compression ring to the middle ring groove of the piston.
14. Install the top compression ring to the top ring groove of the piston.

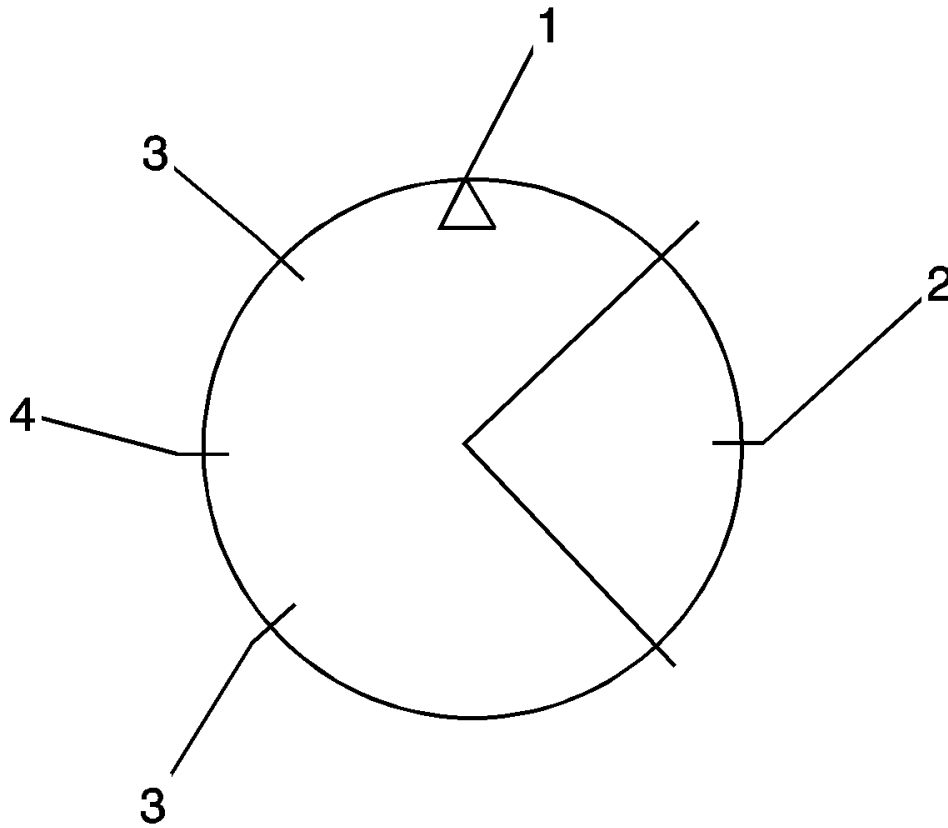


Fig. 168: View Of Piston Oil Rings, Rail Gaps, And 2nd Compression Ring
Courtesy of GENERAL MOTORS CORP.

NOTE: Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

15. Use a piston ring expander to install the piston rings. Do not expand the piston rings beyond the expansion necessary for installation.
16. Stagger the piston oil rings (2), the oil ring rail gaps (3), the 2nd compression ring (4), and the top compression ring in relation to the notch on the top of the piston (1).

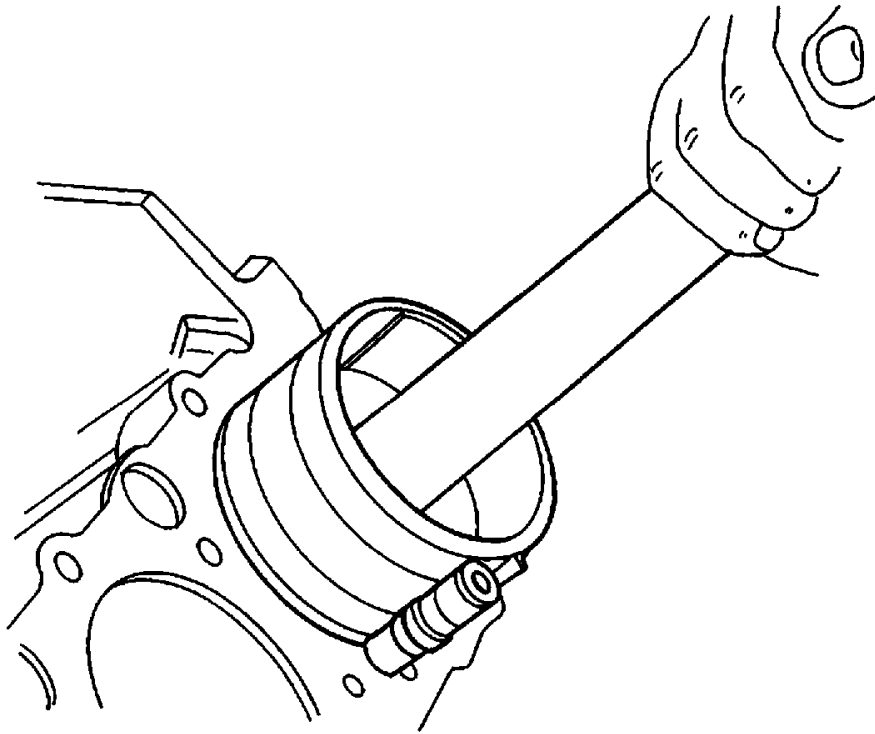


Fig. 169: Installing Piston

Courtesy of GENERAL MOTORS CORP.

17. Lubricate the cylinder wall and the piston rings with clean engine oil.
18. Install the piston using a ring compressor and a wood handle. Guide the lower connecting rod end to prevent damaging the crankshaft journal.
19. Install the connecting rod cap and bearings. Refer to **Crankshaft and Bearing Cleaning and Inspection** .

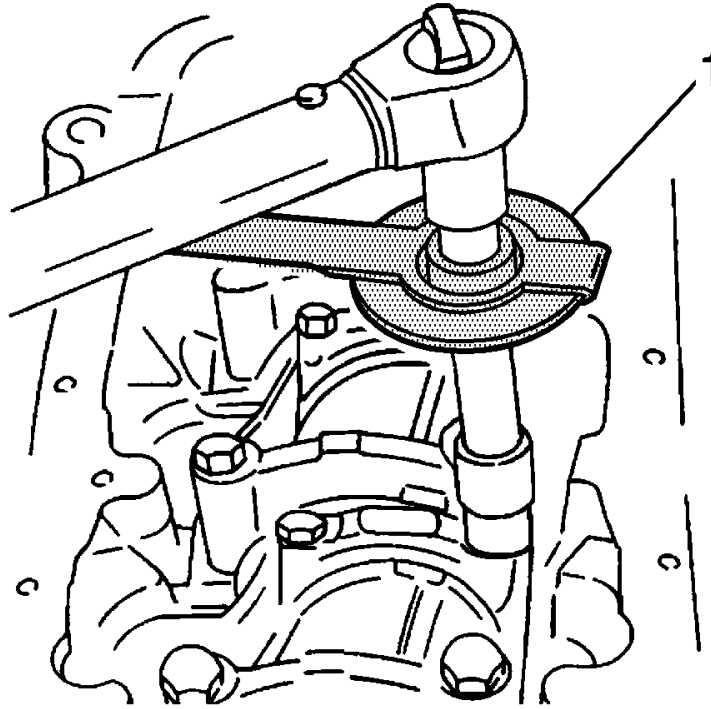


Fig. 170: View Of KM-470-B And Torque Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

20. Install the connecting rod cap bearing bolts.

Tighten: Tighten the connecting rod bearing cap bolts to **25 N.m (18 lb ft)** . Using the **J 45059** or **KM-470-B (1)**, tighten one turn of 30 degrees plus.

21. Install the oil pump/pickup tube.
22. Install the oil pump/pickup tube bolts.

Tighten: Tighten the oil pump/pickup tube and support bracket bolts to **10 N.m (89 lb in)** .

23. Install the oil pan. Refer to Oil Pan Replacement.
24. Install the cylinder head with the intake manifold and the exhaust manifold attached. Refer to Cylinder Head Replacement.

CAMSHAFT GEAR REPLACEMENT

REMOVAL PROCEDURE

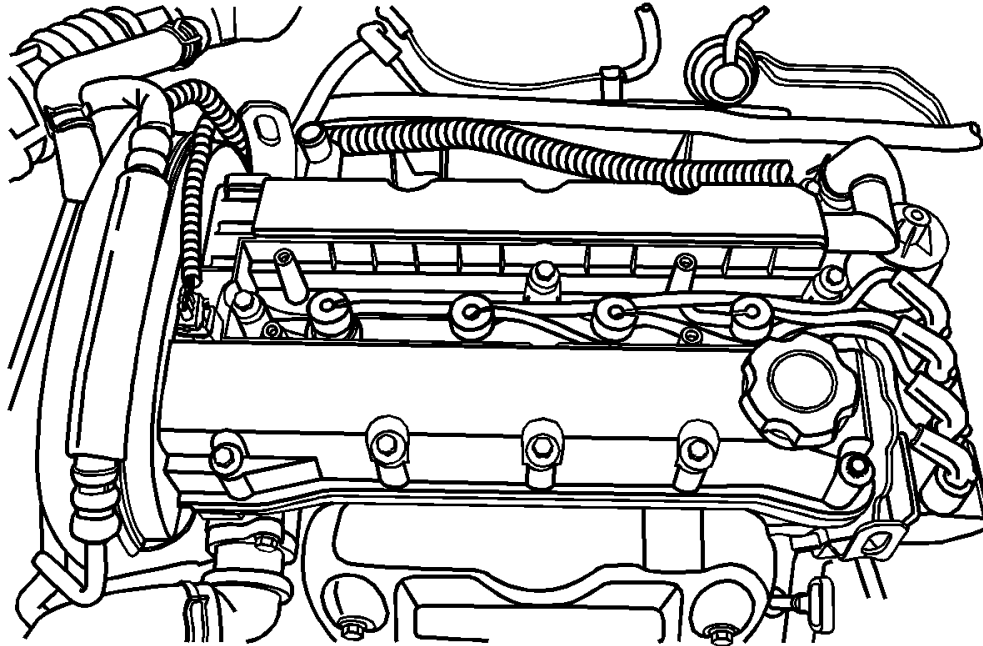


Fig. 171: View Of Ignition Wires And Spark Plugs
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Battery Disconnect Caution .

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to Timing Belt Replacement.
3. Remove the spark plug cover bolts.
4. Remove the spark plug cover.
5. Disconnect the ignition wires from the spark plugs.
6. Disconnect the crankcase ventilation tubes from the valve cover.

7. Disconnect the camshaft position (CMP) sensor.

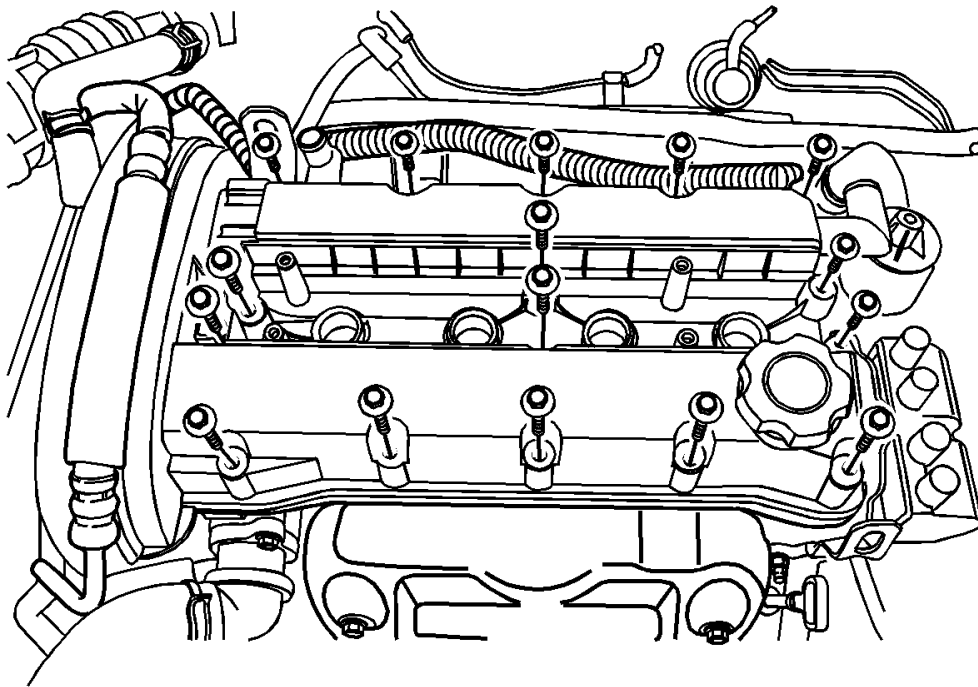


Fig. 172: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve cover nuts.
9. Remove the valve cover washers.
10. Remove the valve cover and the valve cover gasket.

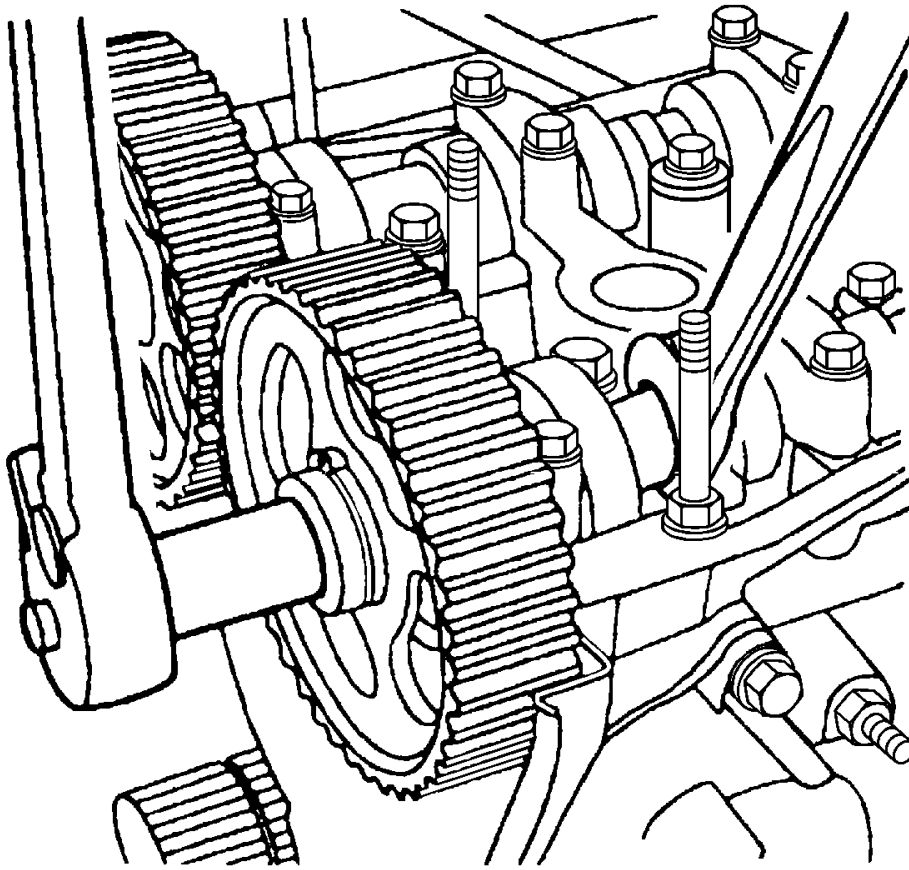


Fig. 173: View Of Intake And Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Use extreme care when installing the camshaft not to nick, scratch, or damage the camshaft lobes or bearing surfaces.

11. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
12. Remove the intake camshaft gear.
13. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
14. Remove the exhaust camshaft gear.

INSTALLATION PROCEDURE

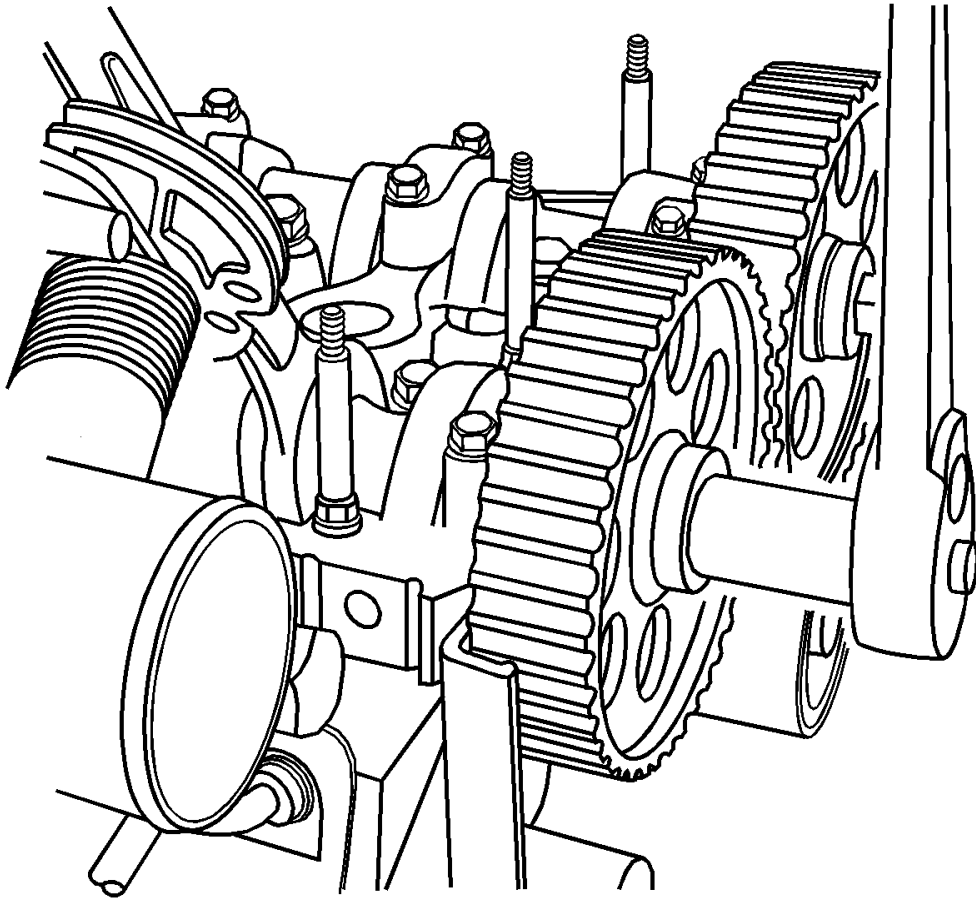


Fig. 174: View Of Intake And Exhaust Camshaft Gears
Courtesy of GENERAL MOTORS CORP.

NOTE: Use extreme care when installing the camshaft not to nick, scratch, or damage the camshaft lobes or bearing surfaces.

1. Install the intake camshaft gear.

NOTE: Refer to Fastener Notice .

2. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten: Tighten the intake camshaft gear bolt to **67.5 N.m (49 lb ft)** .

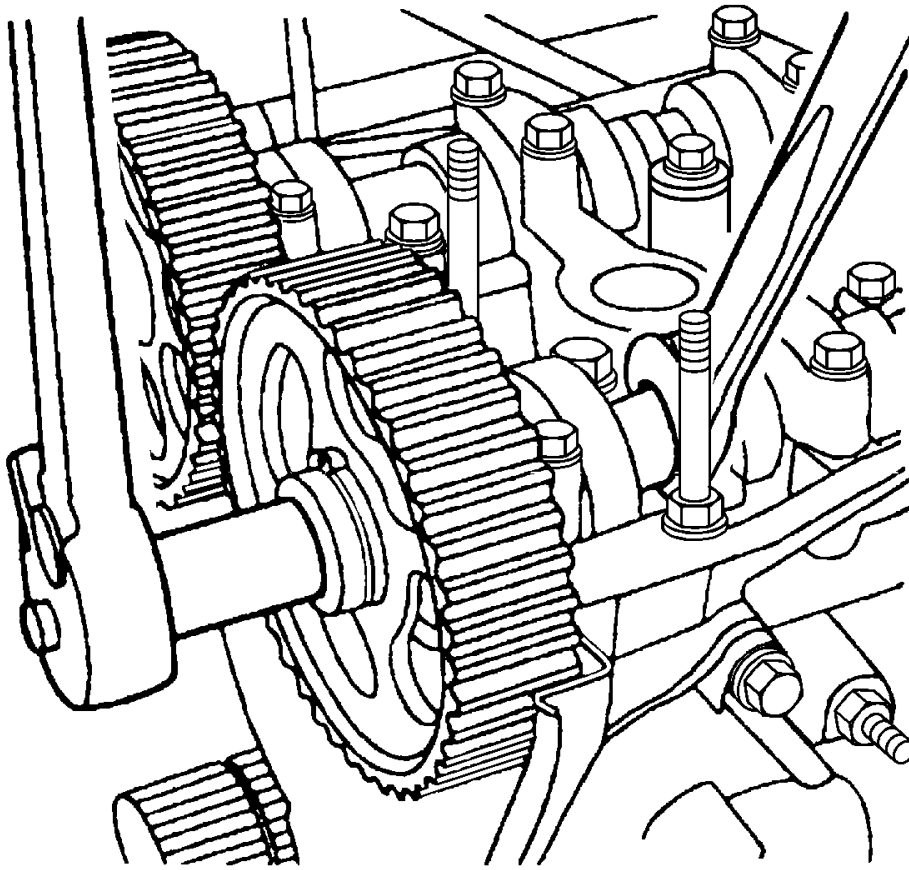


Fig. 175: View Of Intake And Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

3. Install the exhaust camshaft gear.
4. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten: Tighten the exhaust camshaft gear bolt to **67.5 N.m (49 lb ft)** .

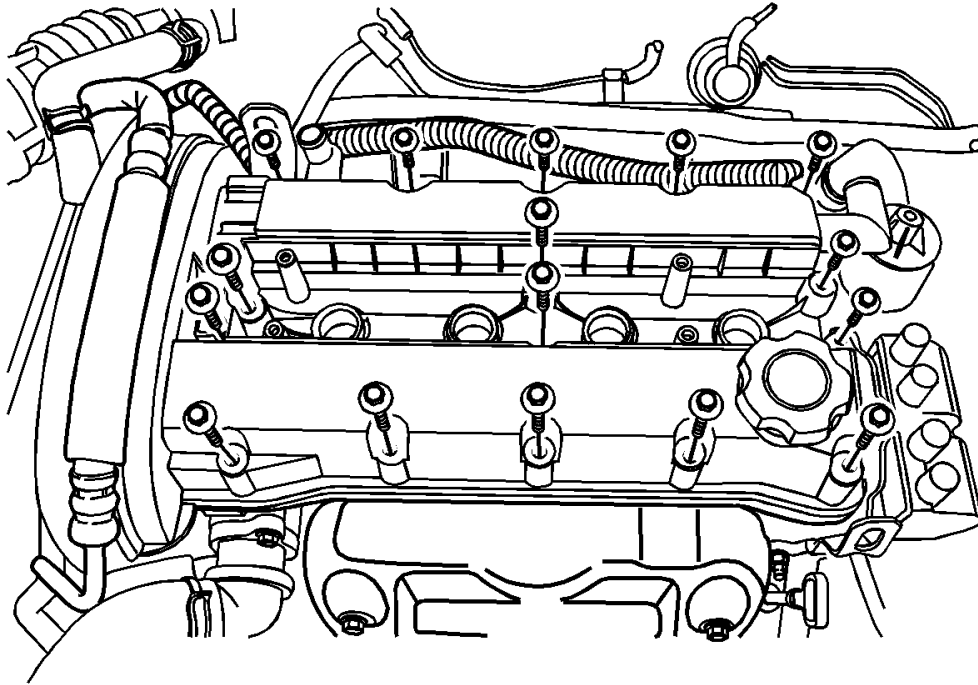


Fig. 176: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

5. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover-to-cylinder head seal.
6. Install the valve cover and the valve cover gasket.
7. Install the valve cover washers.
8. Install the valve cover nuts.

Tighten: Tighten the valve cover nuts to **9 N.m (80 lb in)** .

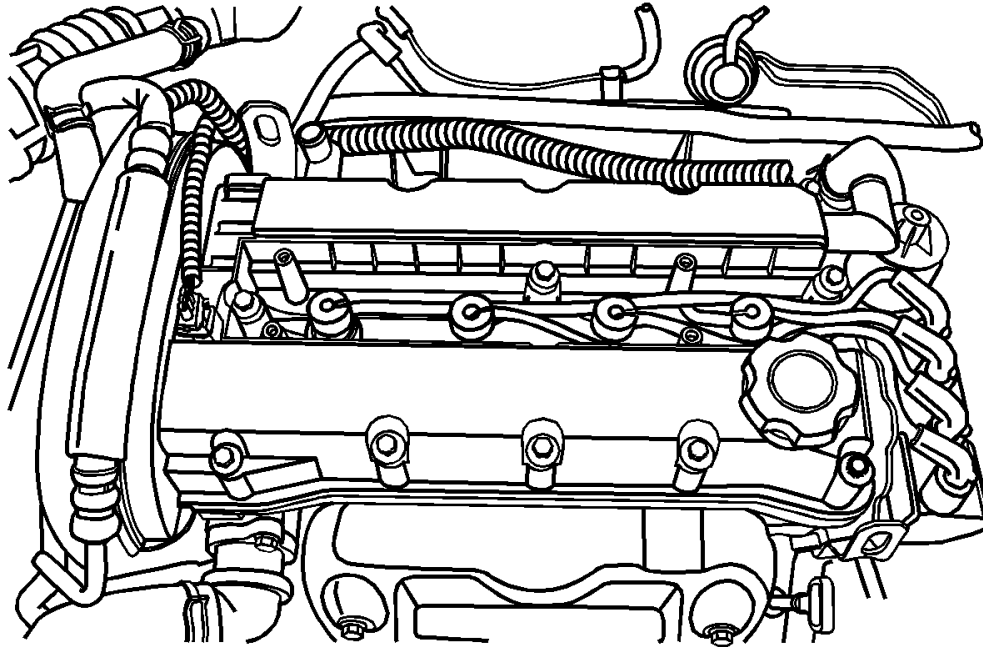


Fig. 177: View Of Ignition Wires And Spark Plugs
Courtesy of GENERAL MOTORS CORP.

9. Connect the crankcase ventilation tubes to the valve cover.
10. Connect the ignition wires to the spark plugs.
11. Install the spark plug cover.
12. Install the spark plug cover bolts.

Tighten: Tighten the spark plug cover bolts to **3 N.m (27 lb in)** .

13. Install the timing belt. Refer to **Timing Belt Replacement**.
14. Connect the CMP.
15. Connect the negative battery cable.

CAMSHAFT REPLACEMENT

REMOVAL PROCEDURE

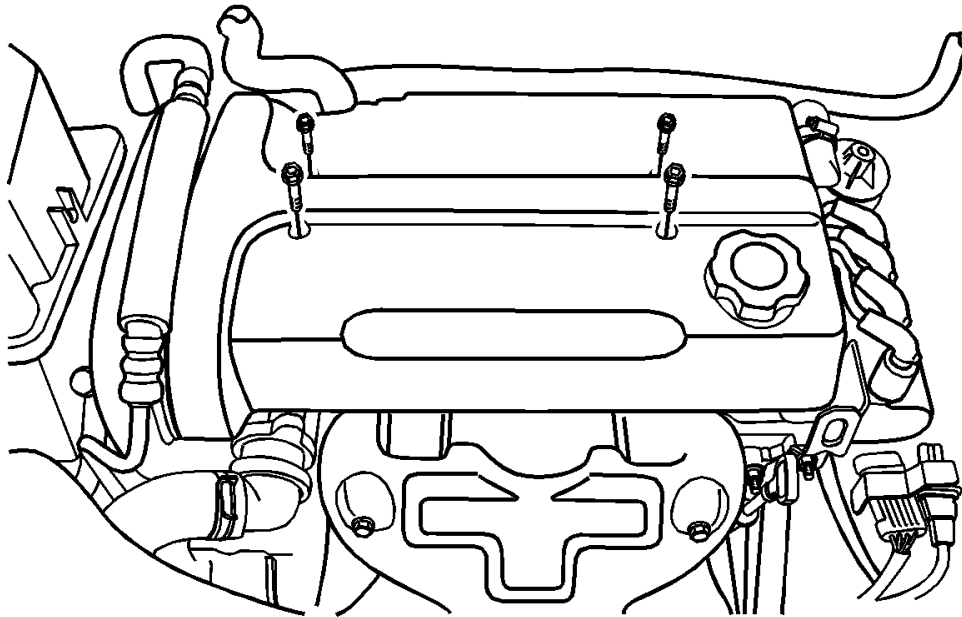


Fig. 178: Identifying Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the timing belt. Refer to **Timing Belt Replacement**.
2. Remove the spark plug cover bolts.
3. Remove the spark plug cover.

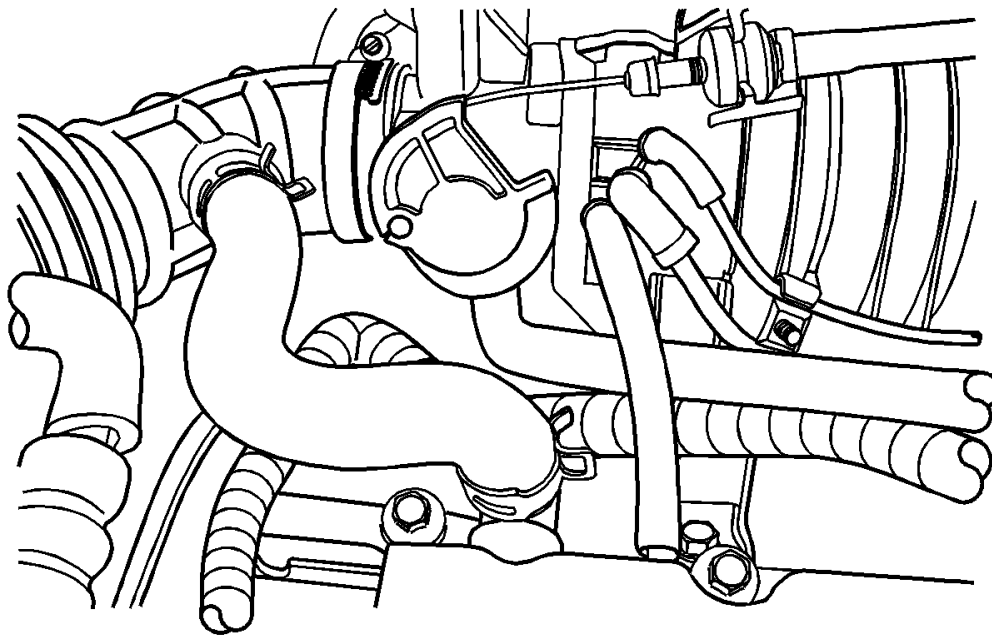


Fig. 179: View Of Throttle Cable And Breather Tube
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the breather tube from the valve cover.
5. Disconnect the crankcase ventilation tube from the valve cover.

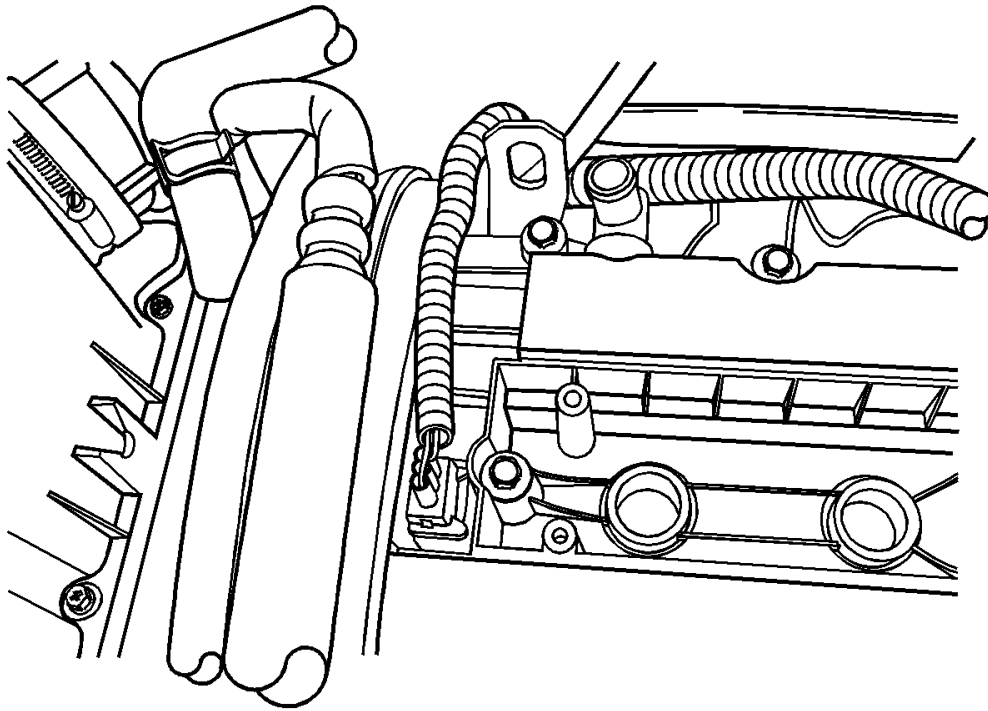


Fig. 180: View Of Camshaft Position (CMP) Sensor Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the camshaft position (CMP) sensor connector.

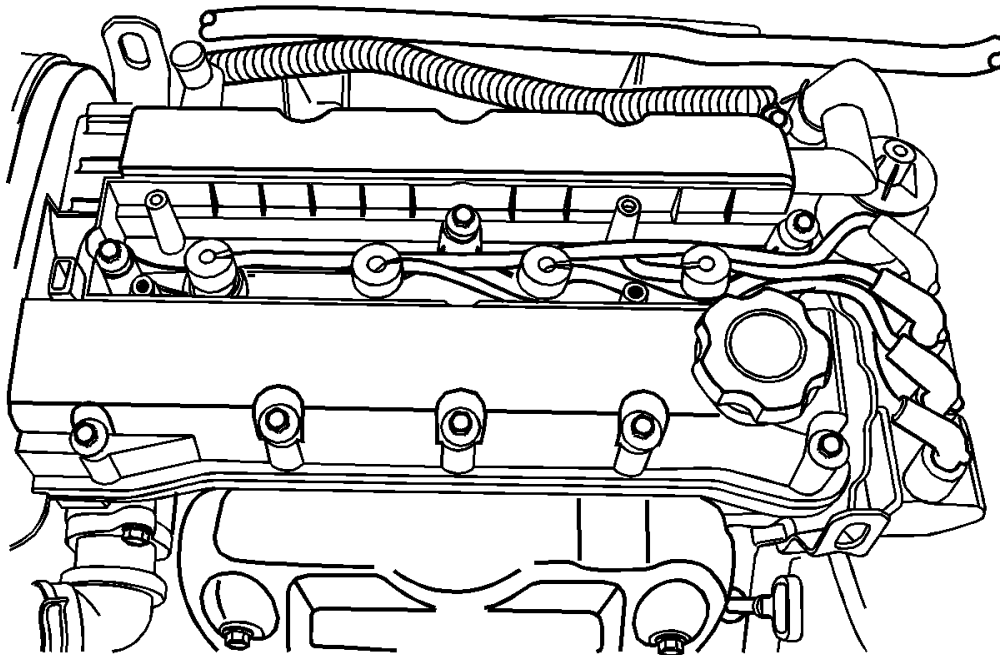


Fig. 181: View Of Ignition Wires And Spark Plugs
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the ignition wires from the spark plugs.

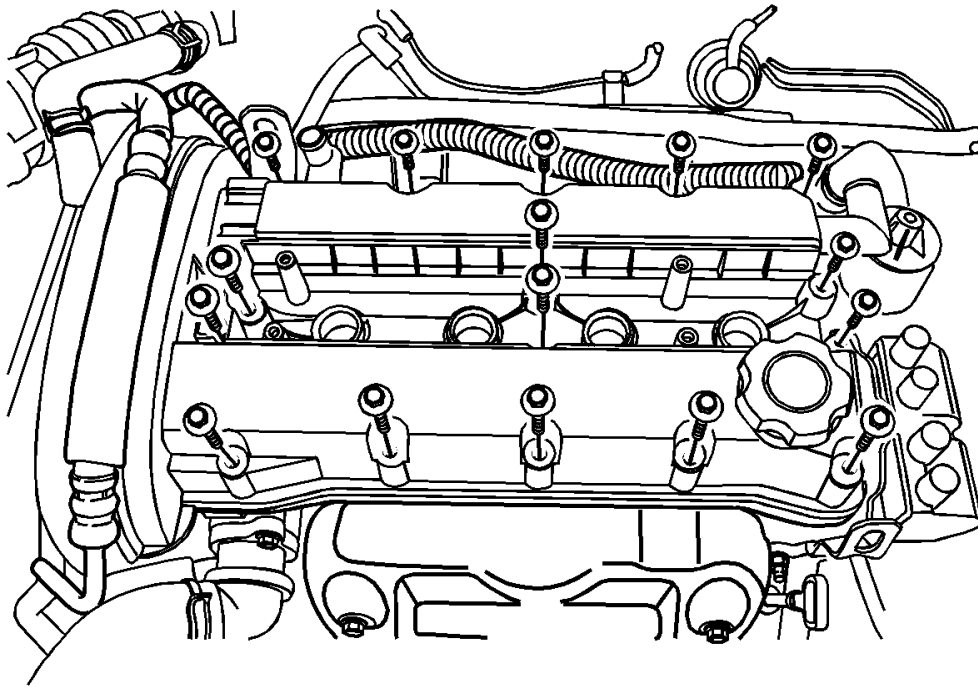


Fig. 182: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve cover bolts.
9. Remove the valve cover and gasket.

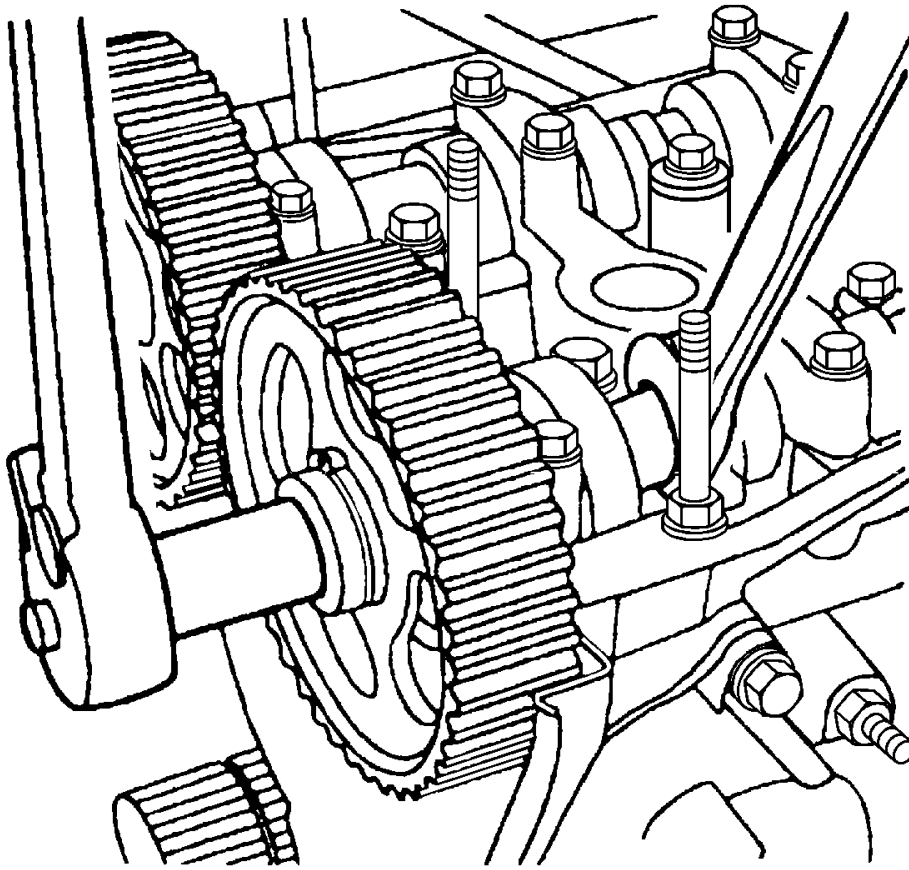


Fig. 183: View Of Intake And Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Use extreme care when removing the camshaft not to nick, scratch, or damage the camshaft lobes or bearing surfaces.

10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.

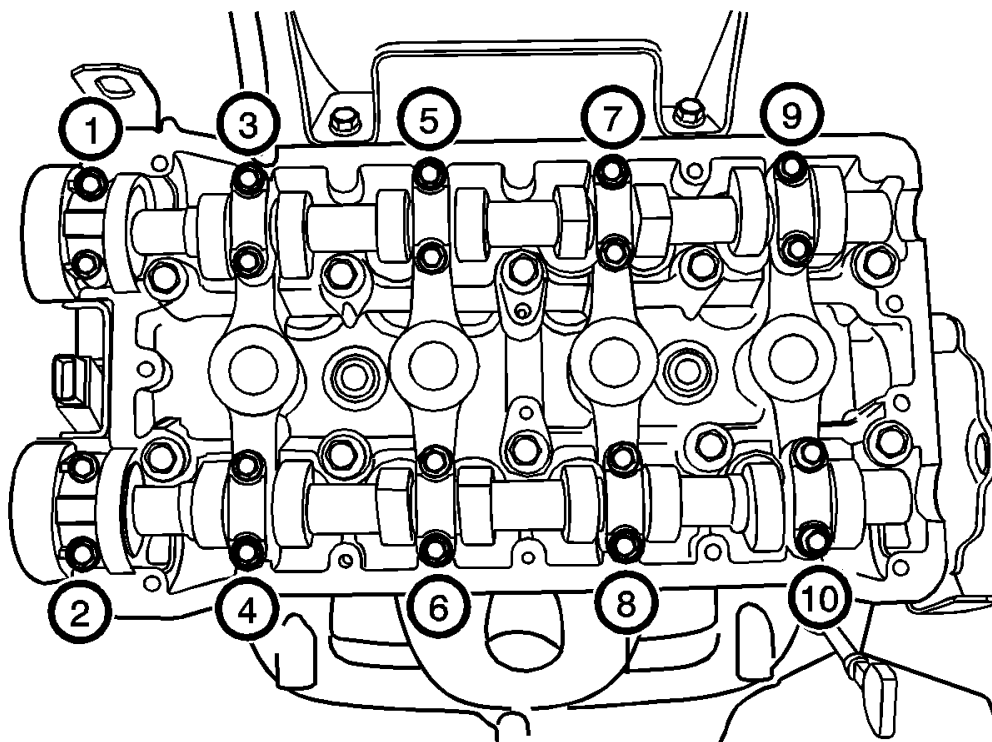


Fig. 184: View Of Camshaft Caps And Bolts Sequence
Courtesy of GENERAL MOTORS CORP.

14. Remove the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

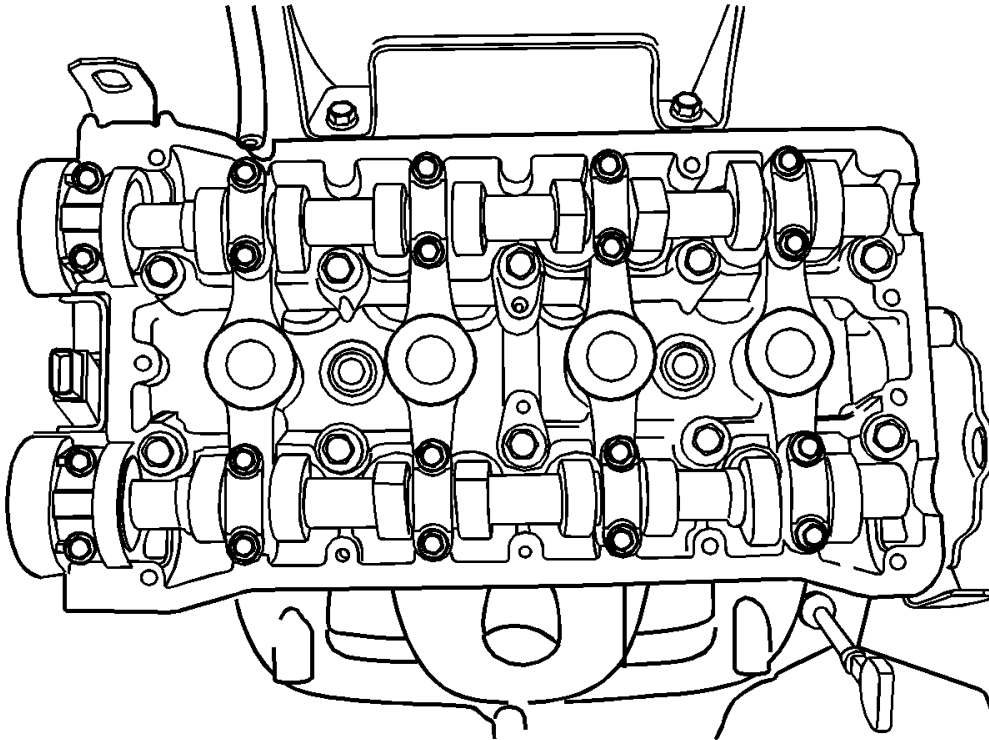


Fig. 185: View Of Intake And Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

15. Remove the intake camshaft caps. Maintain the correct positions for installation.
16. Remove the intake camshaft.
17. Remove the exhaust camshaft caps. Maintaining the correct positions for installation.
18. Remove the exhaust camshaft.

INSTALLATION PROCEDURE

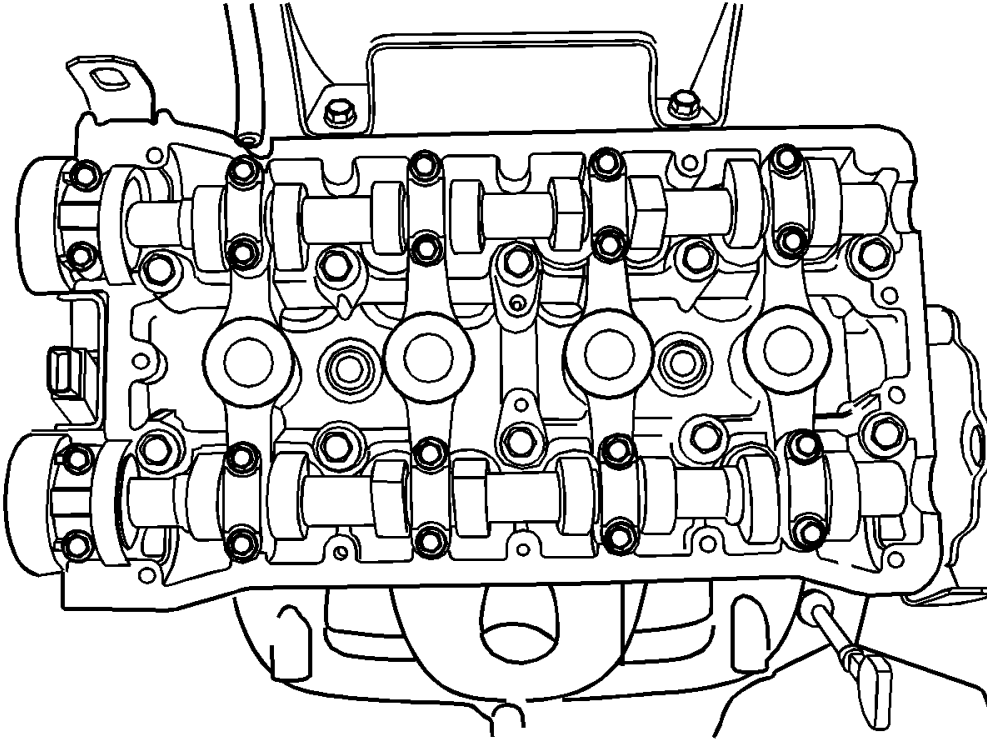


Fig. 186: View Of Intake And Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

NOTE: Use extreme care when installing the camshaft not to nick, scratch, or damage the camshaft lobes or bearing surfaces.

1. Lubricate the camshaft journals and the camshaft caps with engine oil.
2. Install the intake camshaft.
3. Install the intake camshaft caps in their original positions.
4. Install the intake camshaft cap bolts.
5. Install the exhaust camshaft.
6. Install the exhaust camshaft caps in their original positions.

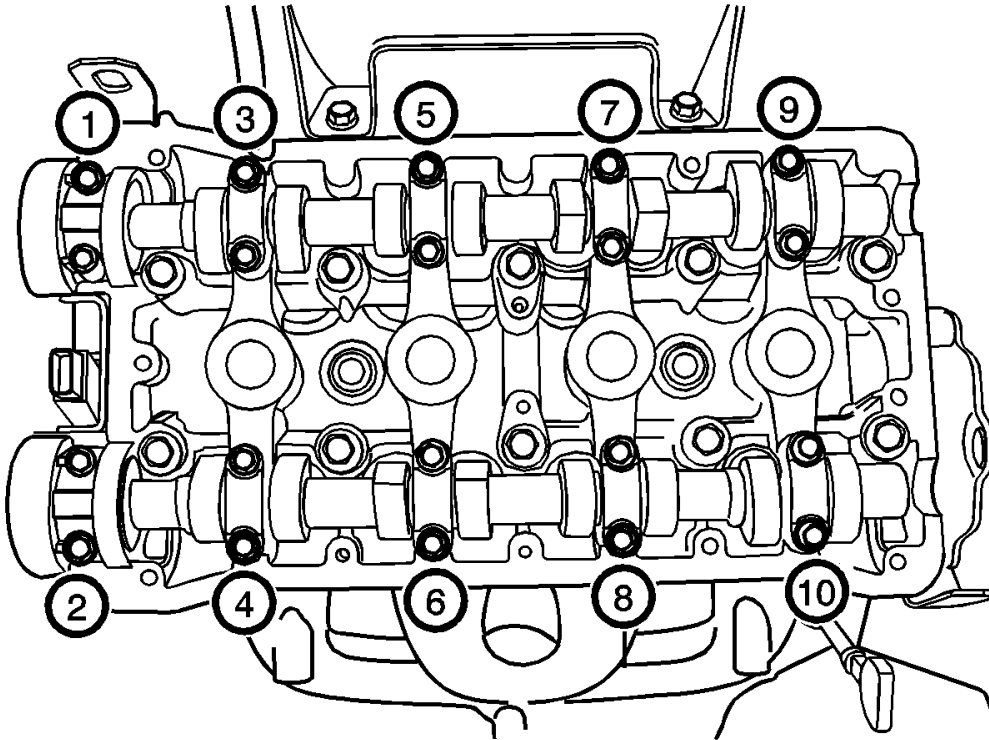


Fig. 187: View Of Camshaft Caps And Bolts Sequence
 Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust camshaft cap bolts.

NOTE: Refer to Fastener Notice .

8. Tighten the camshaft cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten: Tighten the camshaft cap bolts to **16 N.m (12 lb ft)** .

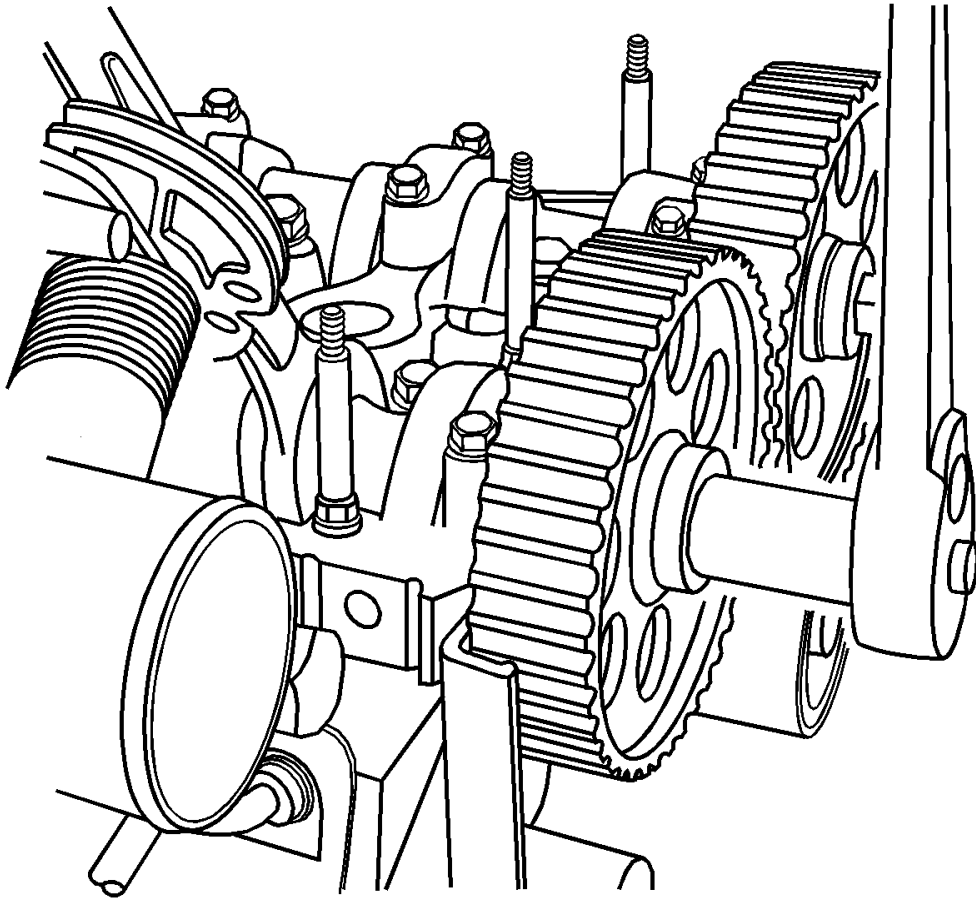


Fig. 188: View Of Intake And Exhaust Camshaft Gears
Courtesy of GENERAL MOTORS CORP.

9. Measure the intake camshaft end play and the exhaust camshaft end play. Refer to **Engine Mechanical Specifications** .
10. Install the intake camshaft gear.
11. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten: Tighten the intake camshaft gear bolt to **67.5 N.m (49 lb ft)** .

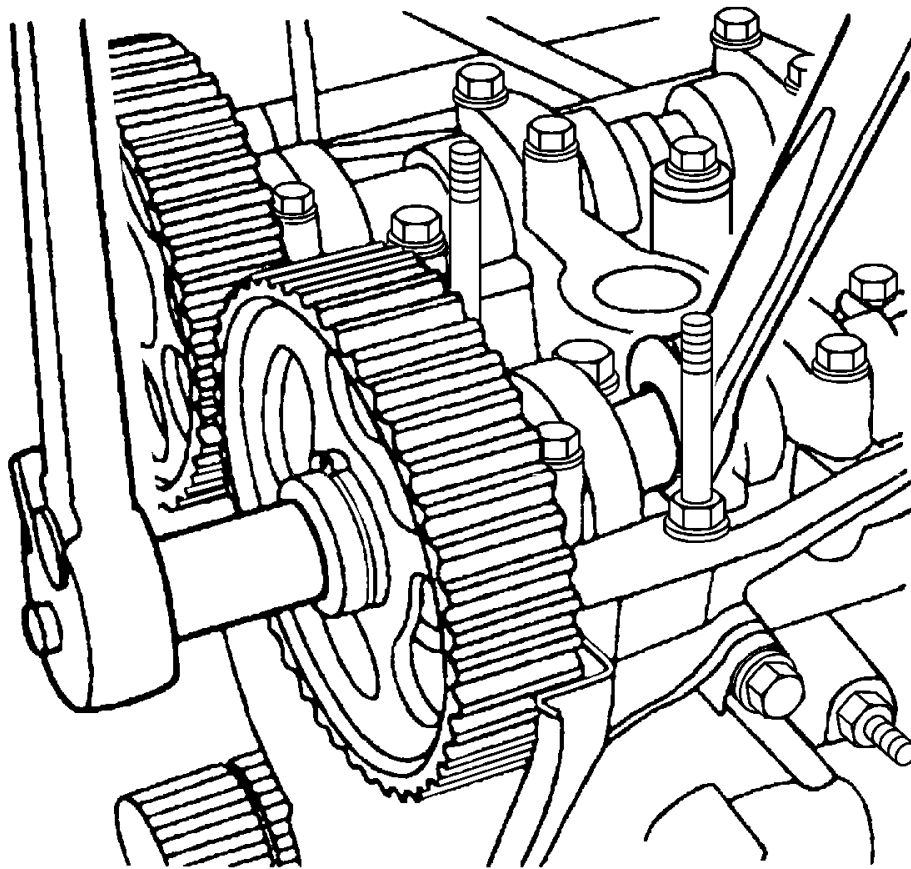


Fig. 189: View Of Intake And Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

12. Install the exhaust camshaft gear.
13. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten: Tighten the exhaust camshaft gear bolt to **67.5 N.m (49 lb ft)** .

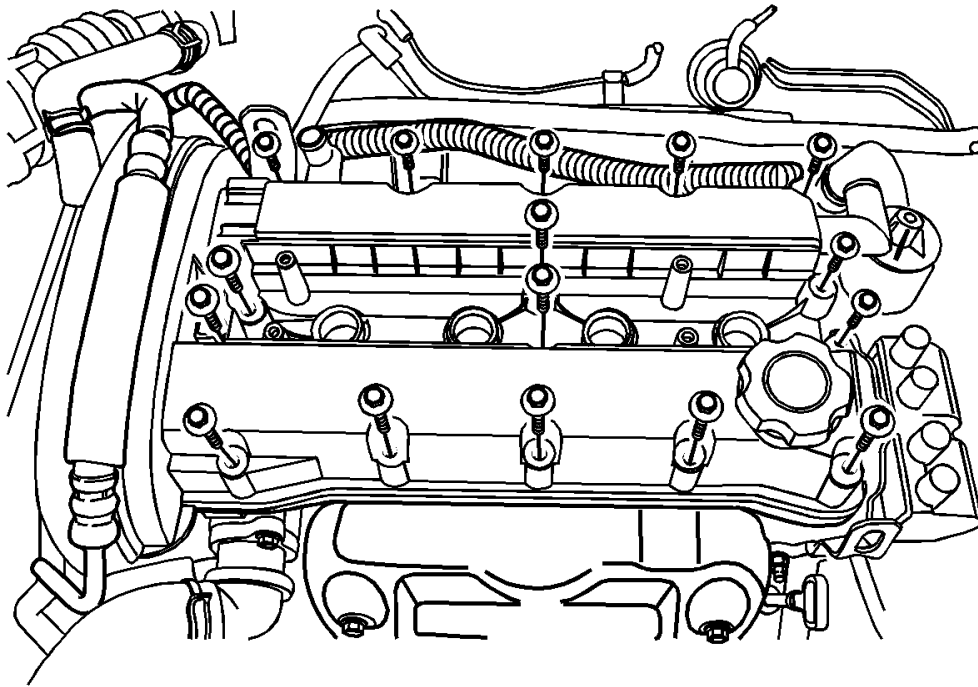


Fig. 190: View Of Valve Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

14. Install the valve cover and the valve cover gasket.
15. Install the valve cover washers.
16. Install the valve cover nuts.

Tighten: Tighten the valve cover nuts to **9 N.m (80 lb in)** .

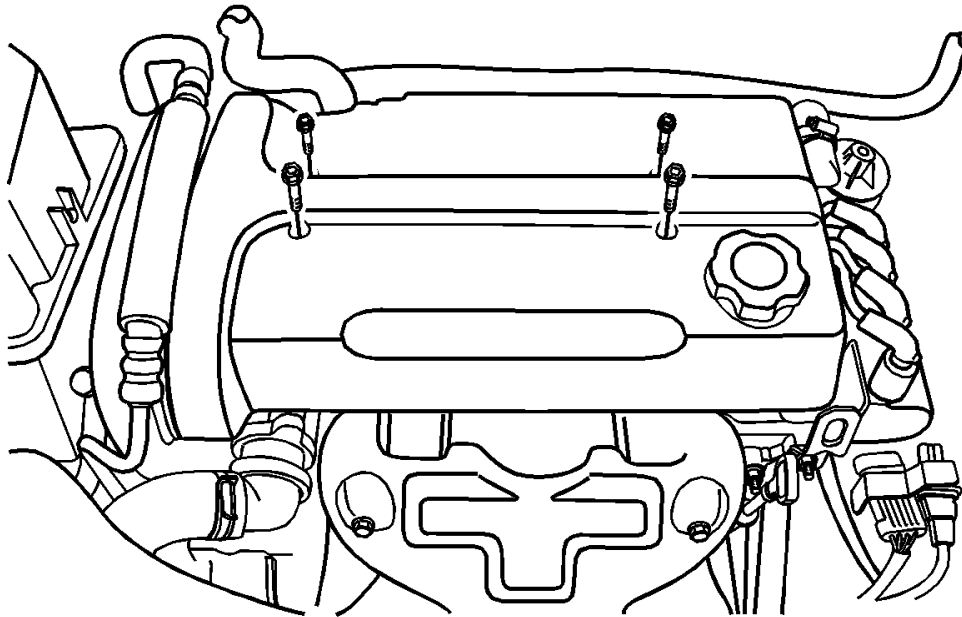


Fig. 191: Identifying Engine Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

17. Connect the ignition wires to the spark plugs.
18. Connect the CMP sensor.
19. Install the spark plug cover.
20. Install the spark plug cover bolts.

Tighten: Tighten the spark plug cover bolts to **3 N.m (27 lb in)** .

21. Install the oil filler cap.
22. Connect the vacuum line.
23. Connect the air breather tube to the valve cover.
24. Install the timing belt. Refer to **Timing Belt Replacement**.