2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Repair Instructions - On Vehicle - Express & Savana

DRIVE BELT REPLACEMENT - ACCESSORY

REMOVAL PROCEDURE

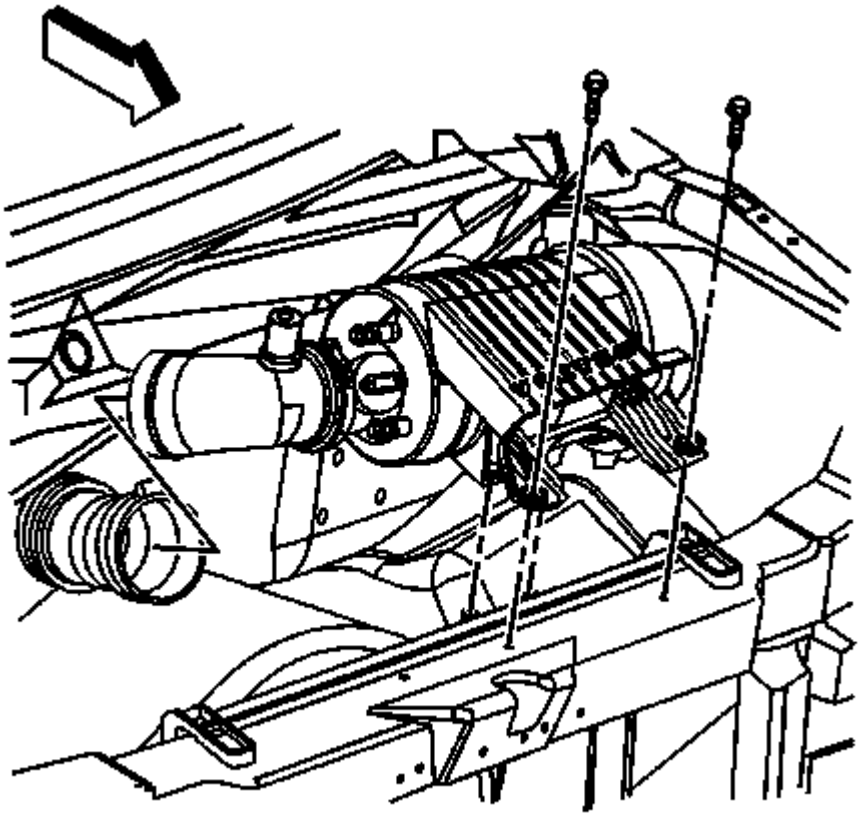

Fig. 1: Identifying Coolant Recovery Reservoir Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the retaining bolt for the coolant recovery reservoir and set the reservoir aside.

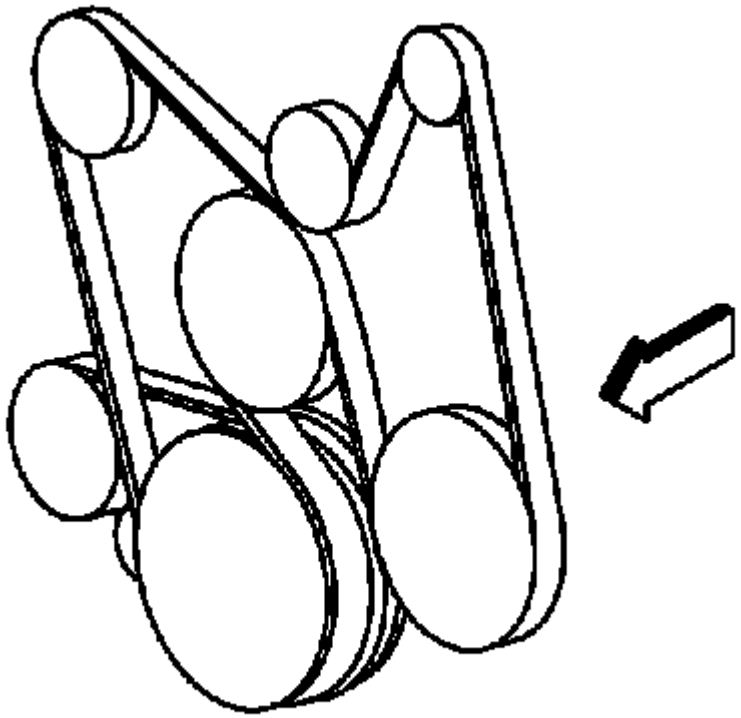

Fig. 2: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

3. Install a breaker bar with hex-head socket to the drive belt tensioner bolt.
4. Rotate the drive belt tensioner clockwise in order to relieve tension on the belt.
5. Remove the belt from the pulleys and the drive belt tensioner.
6. Slowly release the tension on the drive belt tensioner.
7. Remove the breaker bar and socket and from the drive belt tensioner bolt.
8. Clean and inspect the belt surfaces of all the pulleys.

INSTALLATION PROCEDURE

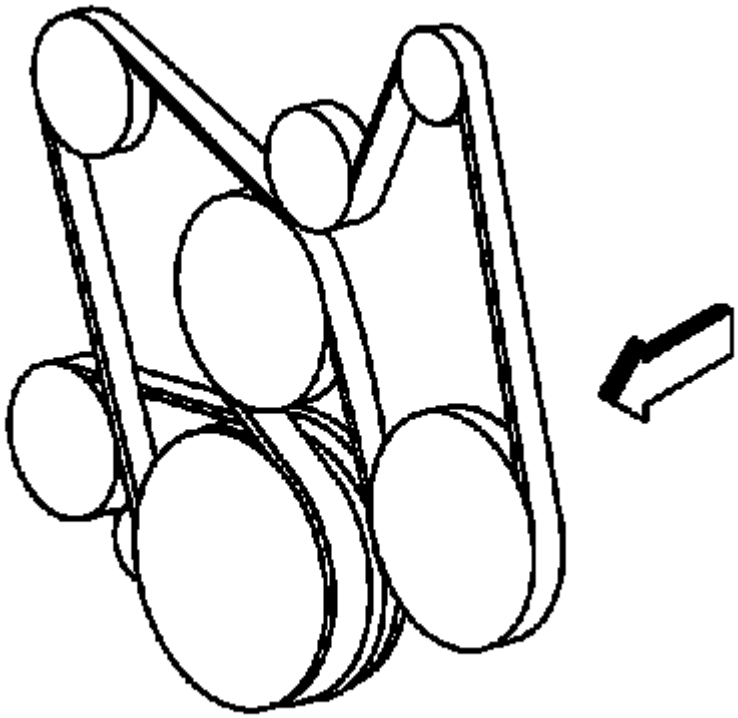

Fig. 3: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Route the drive belt around all the pulleys except the idler pulley.
2. Install the breaker bar with hex-head socket to the belt tensioner bolt.
3. Rotate the belt tensioner clockwise in order to relieve the tension on the tensioner.
4. Install the drive belt under the idler pulley.
5. Slowly release the tension on the belt tensioner.
6. Remove the breaker bar and socket from the belt tensioner bolt.
7. Inspect the drive belt for proper installation and alignment.

CAUTION: Refer to Fastener Caution .

8. Position the coolant recovery reservoir and install the retaining bolt and tighten to 11 N.m (97 lb in).
9. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT

REMOVAL PROCEDURE

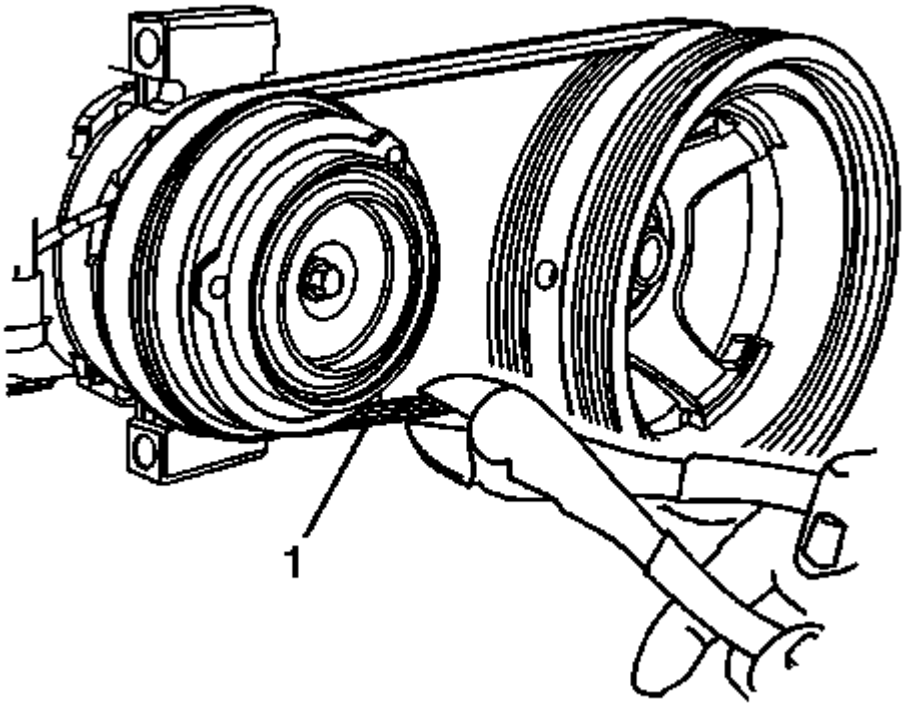

Fig. 4: Illustrating Air Conditioning Compressor Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory belt. Refer to **Drive Belt Replacement - Accessory**.
2. Remove the engine protection shield. Refer to **Engine Protection Shield Replacement** .
3. Cut the belt (1) from the air conditioning (A/C) and crankshaft pulleys.

INSTALLATION PROCEDURE

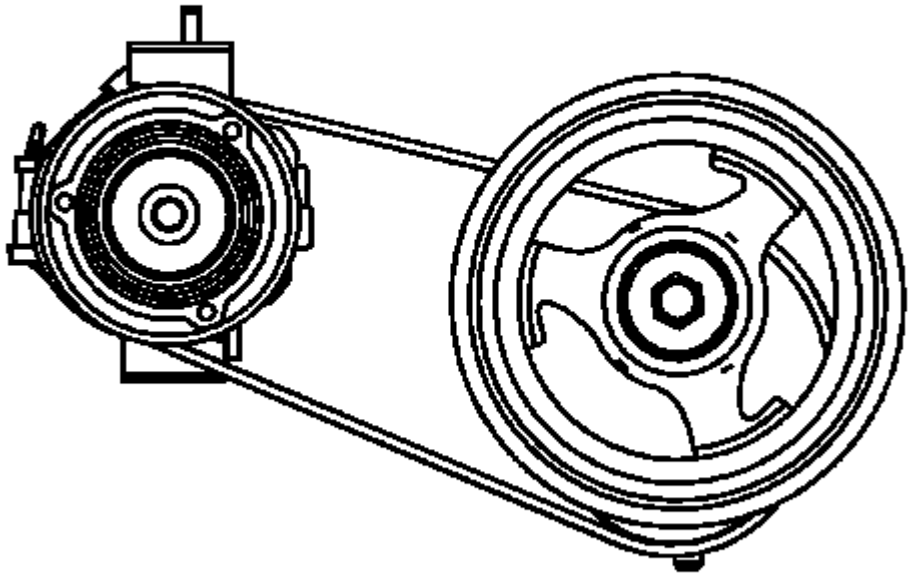

Fig. 5: Identifying Position Belt Behind Rear Face Of Balancer & Around A/C Pulley
Courtesy of GENERAL MOTORS CORP.

1. Position the belt behind the rear face of the balancer and around the A/C pulley.

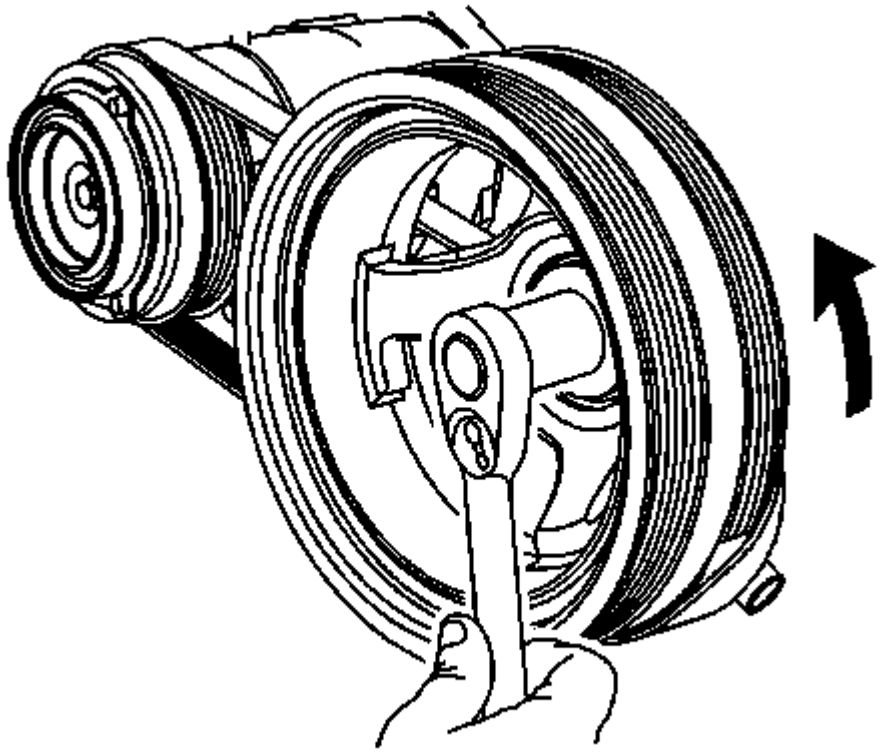

Fig. 6: View Of Belt Installation Tool & Balancer
Courtesy of GENERAL MOTORS CORP.

2. Install the belt installation tool onto the balancer.

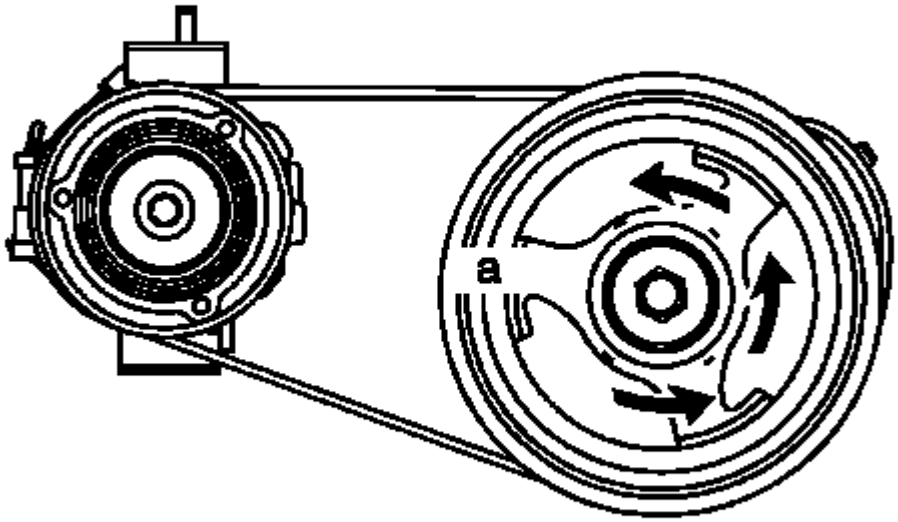

Fig. 7: Rotating Crankshaft Pulley In A Counterclockwise Direction 180 Degrees While Using Finger Pressure To Pull Belt Forward
Courtesy of GENERAL MOTORS CORP.

3. Slowly rotate the crankshaft pulley in a counterclockwise direction 180 degrees (a) while using finger pressure to pull the belt forward. Ensure the ribbed area of the belt remains facing forward and the belt aligns properly to the A/C pulley.

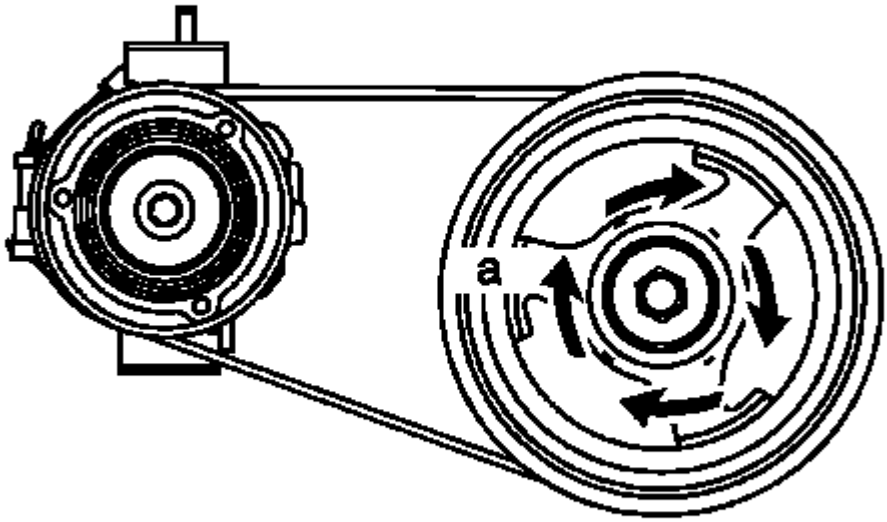

Fig. 8: Identifying Rotating Clockwise, Belt Installation Tool To Release Belt
Courtesy of GENERAL MOTORS CORP.

NOTE: As the balancer is rotated clockwise, the belt installation tool will release from the belt.

4. After installation of the belt, rotate the balancer clockwise 360 degrees (a).

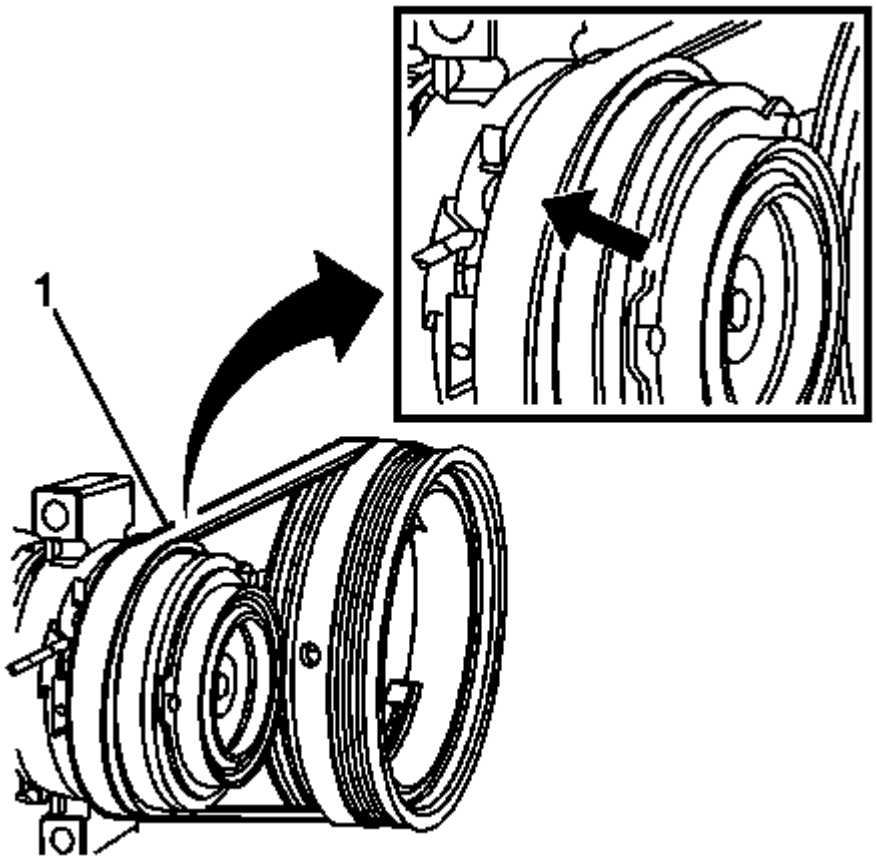

Fig. 9: Inspecting Drive Belt Alignment
Courtesy of GENERAL MOTORS CORP.

5. Inspect the drive belt (1) for proper installation and alignment.
6. Install the skid plate. Refer to **Engine Protection Shield Replacement** .
7. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

DRIVE BELT IDLER PULLEY REPLACEMENT

REMOVAL PROCEDURE

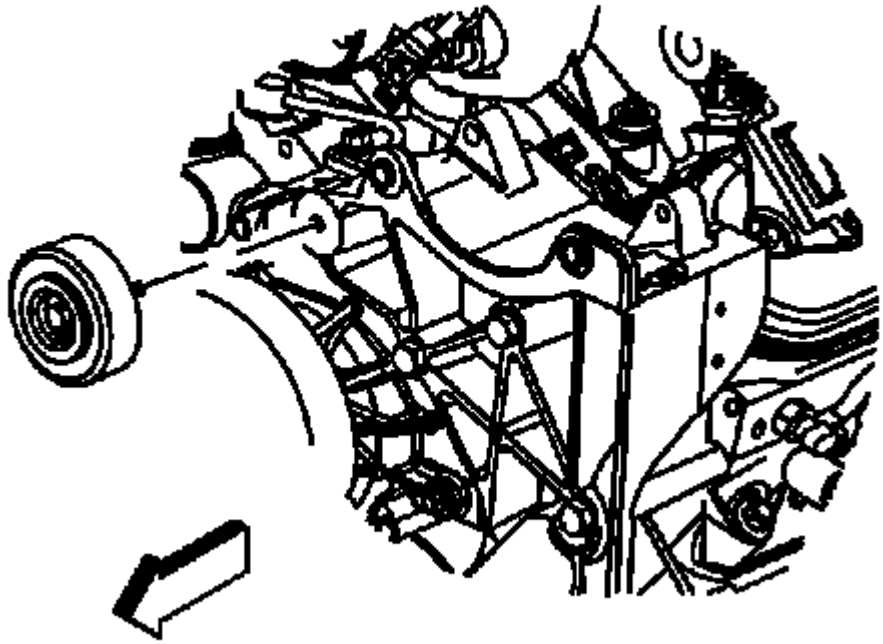

Fig. 10: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Remove the drive belt idler pulley and bolt.

INSTALLATION PROCEDURE

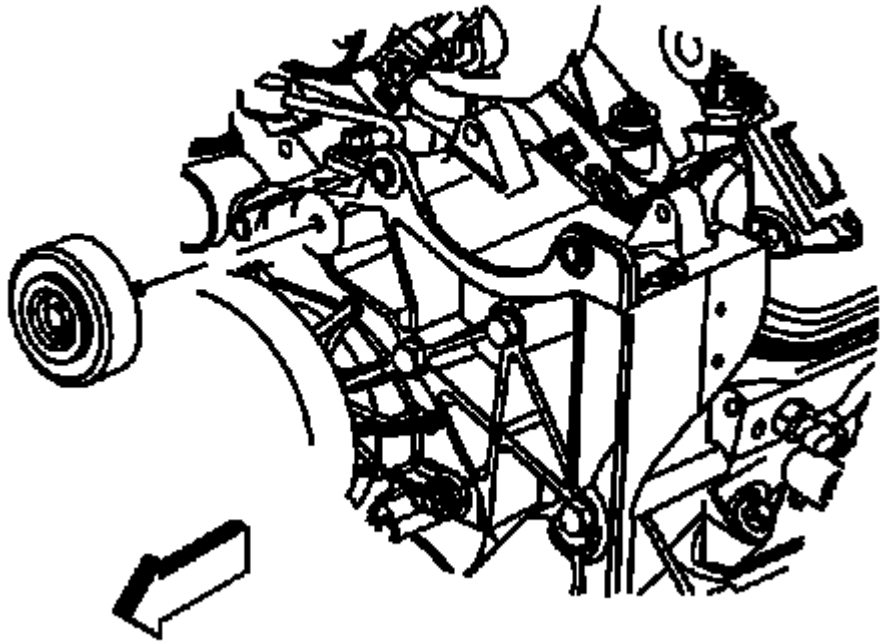

Fig. 11: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley and bolt to the generator bracket.

   Snug the bolt finger tight.

2. Install the drive belt. Refer to **Drive Belt Replacement - Accessory**.

   CAUTION: Refer to Fastener Caution .

3. Tighten the drive belt idler pulley bolt to 50 N.m (37 lb ft).

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

REMOVAL PROCEDURE

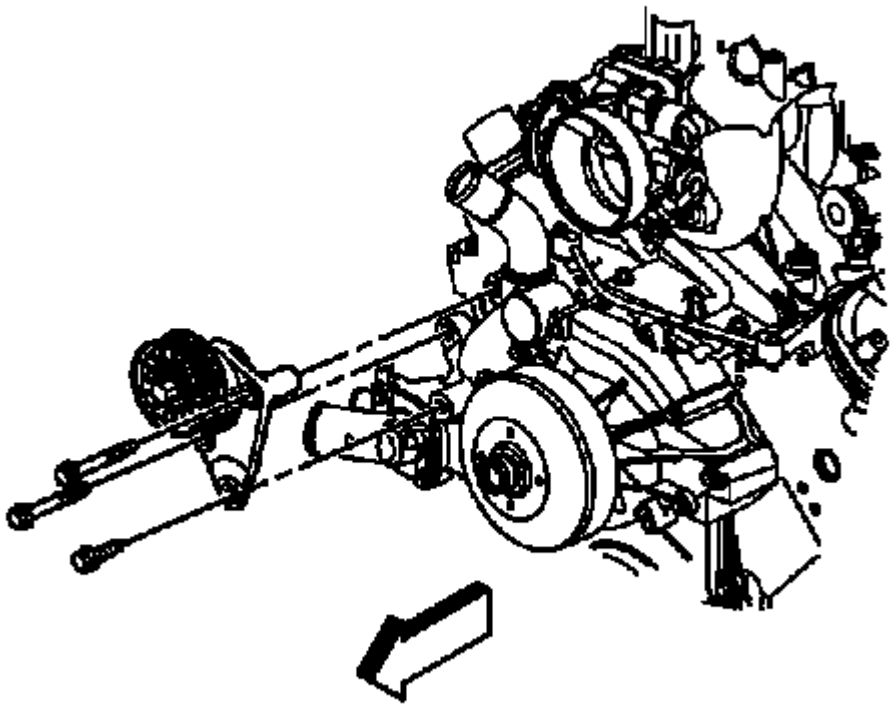

Fig. 12: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Remove the drive belt tensioner bolts.
3. Remove the drive belt tensioner.

INSTALLATION PROCEDURE

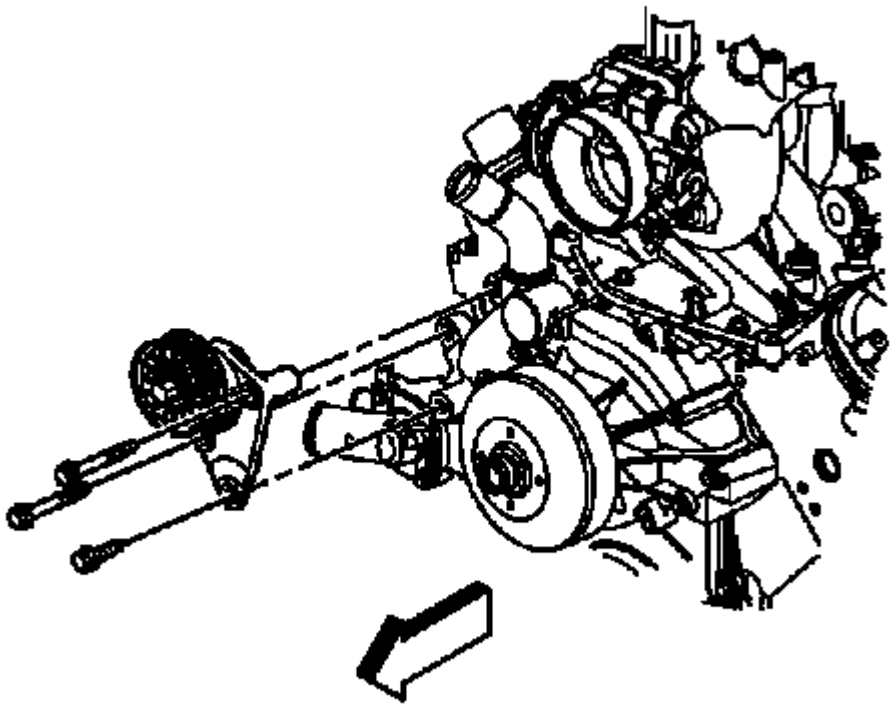

Fig. 13: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner.
2. Install the drive belt tensioner bolts.

CAUTION: Refer to Fastener Caution .

3. Tighten the drive belt tensioner bolts to 50 N.m (37 lb ft).
4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

ENGINE MOUNT INSPECTION

CAUTION: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the

small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

1. Measure the engine movement at the engine mount in order to check for damage to the rubber portions of the mount.
    1. Apply the park brake.
    2. Start the engine.
    3. Firmly apply and hold the primary brakes.
    4. Have an assistant stand to the side of the vehicle in order to observe for engine movement.
    5. Slightly load the engine shifting from drive to reverse a few times.
    6. If the engine moves more than 24 mm (0.945 in) from the at rest position, in either direction, check for loose engine mount bolts.
2. If the engine mount bolt torque is within specifications, check the condition of the engine mount.
3. Replace the engine mount if any of the following conditions exist:
    - Heat check cracks cover the rubber cushion surface.
    - The rubber cushion is separated from the metal plate of the mount.
    - There is a split through the rubber cushion.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

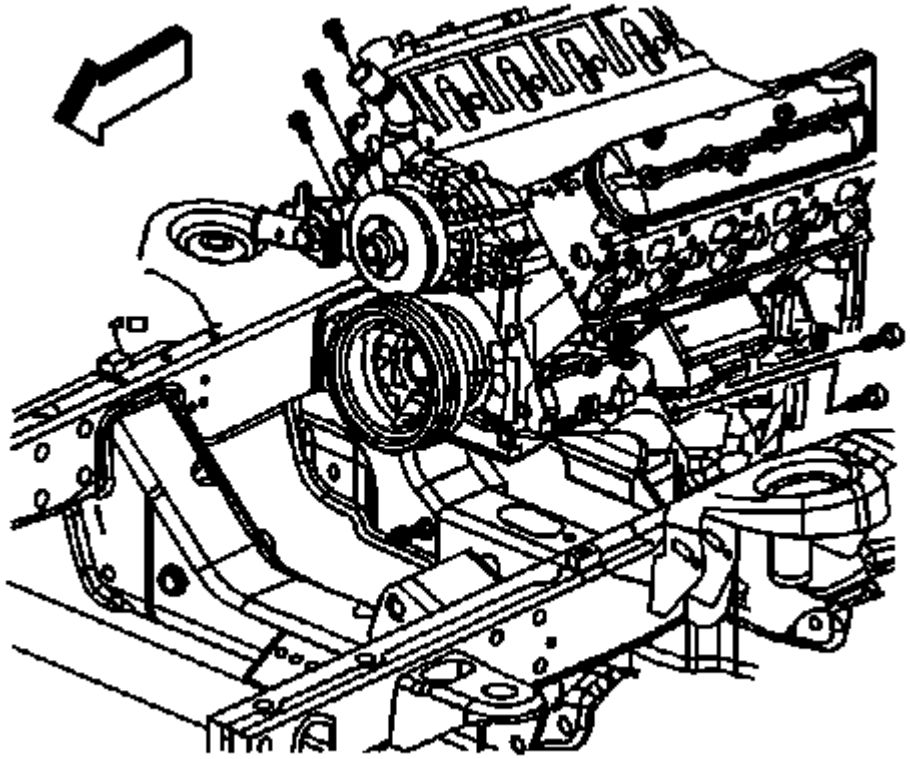

Fig. 14: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the front propeller shaft, 4WD vehicles only. Refer to **Front Propeller Shaft Replacement** .
4. Remove the engine mount to the frame mounting bolts through the wheel well.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft balancer. Jacking against the oil pan may cause it to crack or break.

NOTE: Raise the engine only enough to permit removal of the engine mount.

5. Raise and suitably support the engine using adjustable (screw type) jackstands.

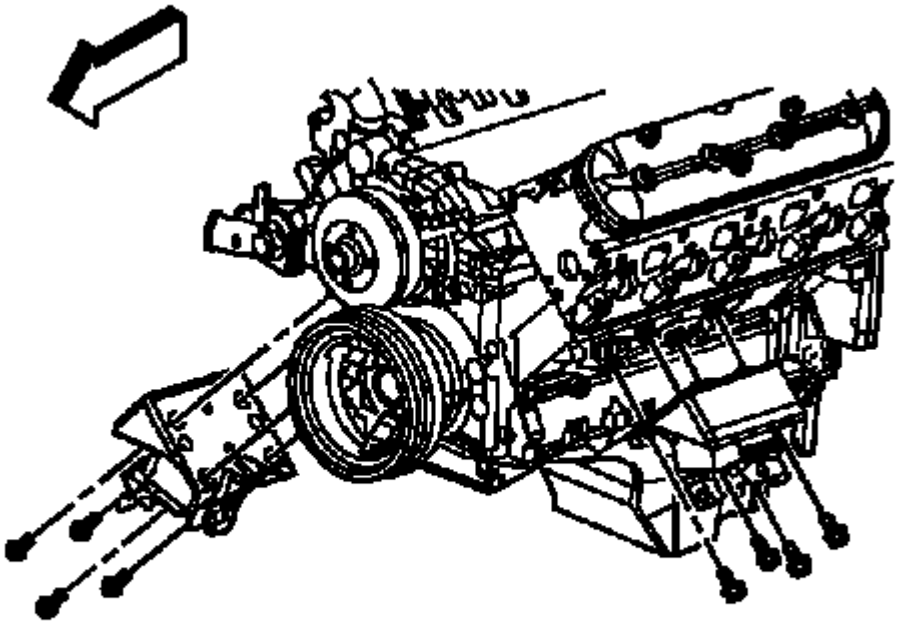

Fig. 15: Identifying Engine Mount To Engine Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the front engine mount to the engine mounting bolts through the wheel well.
7. Remove the rear engine mount to the engine mounting bolts from under the vehicle.
8. Remove the engine mount from the vehicle.

INSTALLATION PROCEDURE

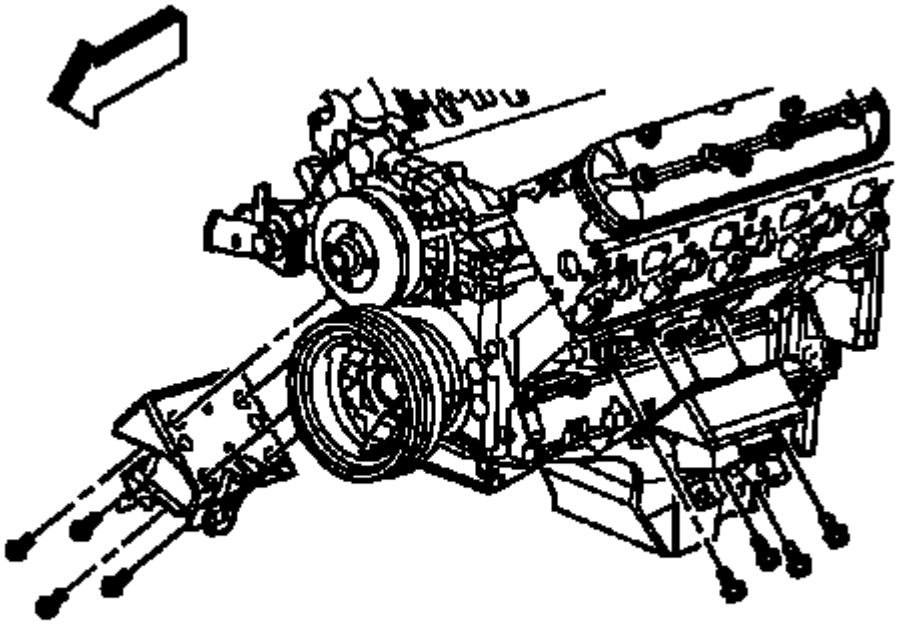

Fig. 16: Identifying Engine Mount To Engine Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the vehicle.
2. Install the rear engine mount to the engine mounting bolts from under the vehicle. Do not tighten at this time.

CAUTION: Refer to Fastener Caution .

3. Install the front engine mount to the engine mounting bolts through the wheel well and tighten to 50 N.m (37 lb ft).
4. Lower the engine.

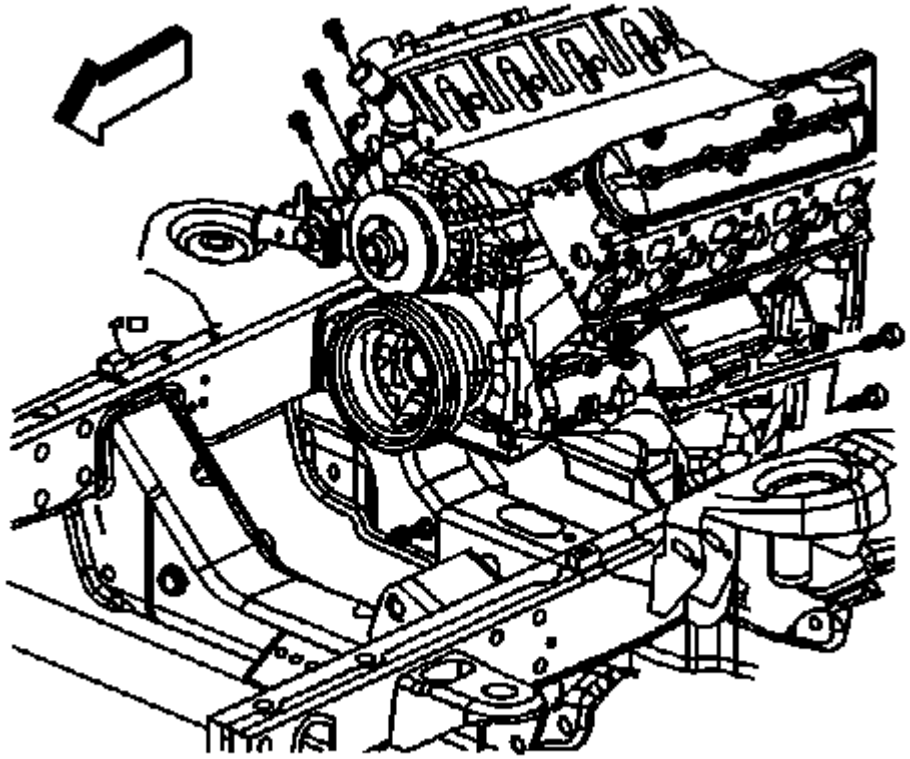

Fig. 17: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount to the frame mounting bolts through the wheel well and tighten to 60 N.m (44 lb ft).
6. Install the front propeller shaft, 4WD vehicles only. Refer to **Front Propeller Shaft Replacement** .
7. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

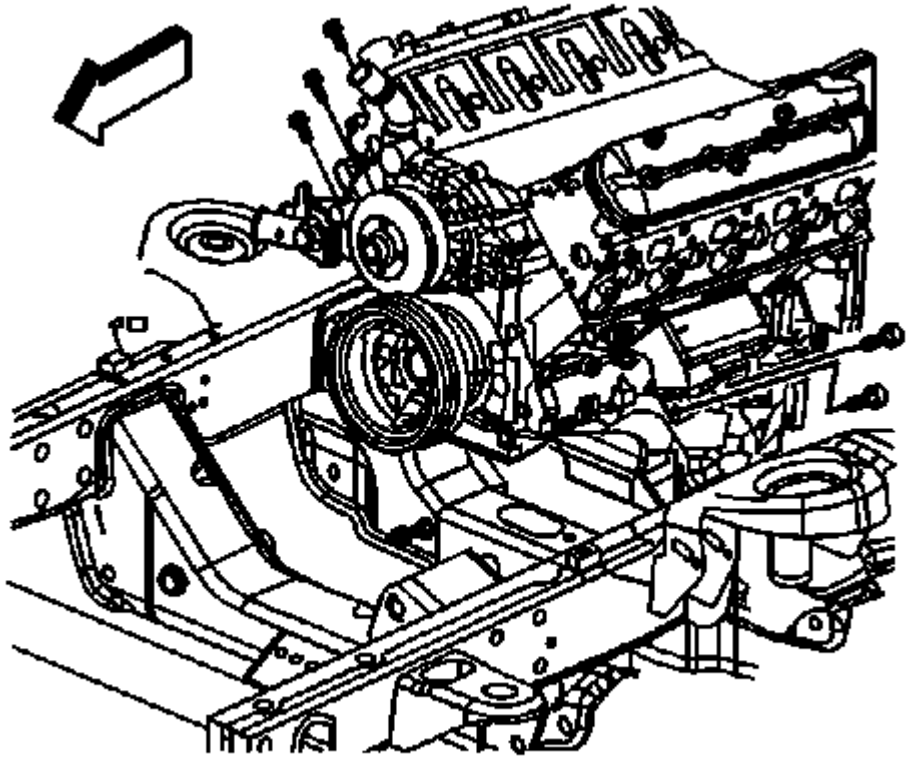

Fig. 18: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Mounting Caution .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the engine mount to engine mount bracket bolts.

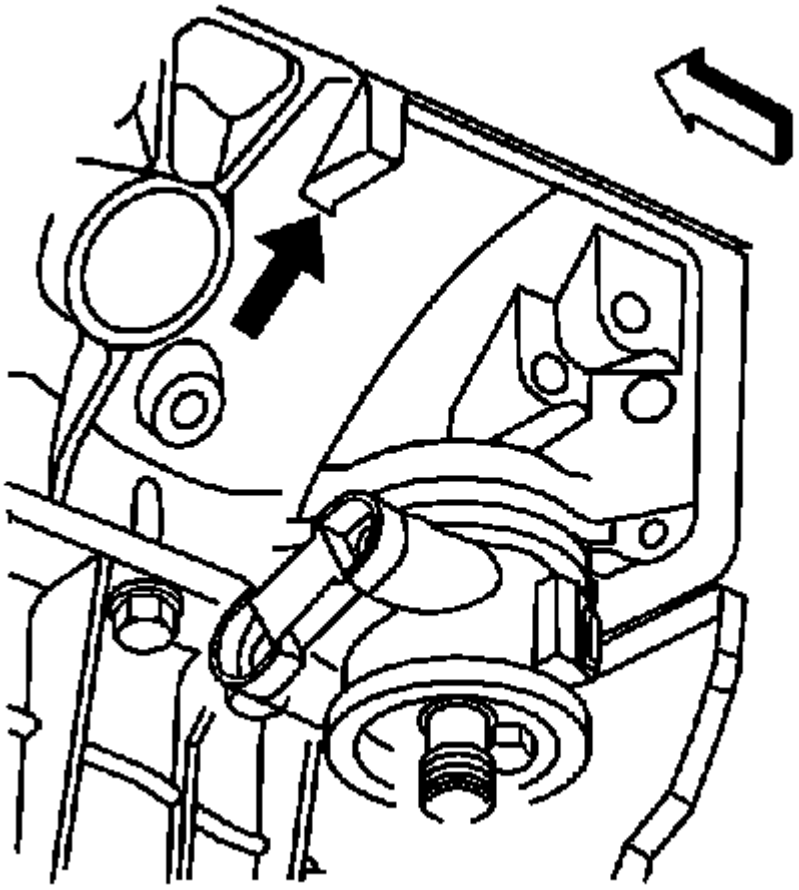

Fig. 19: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft balancer. Jacking against the oil pan may cause it to crack or break.

NOTE: Raise the engine only enough to permit removal of the engine mount bracket.

3. Using a jack on the square tab at the rear of the engine block and raise the engine, left side shown.

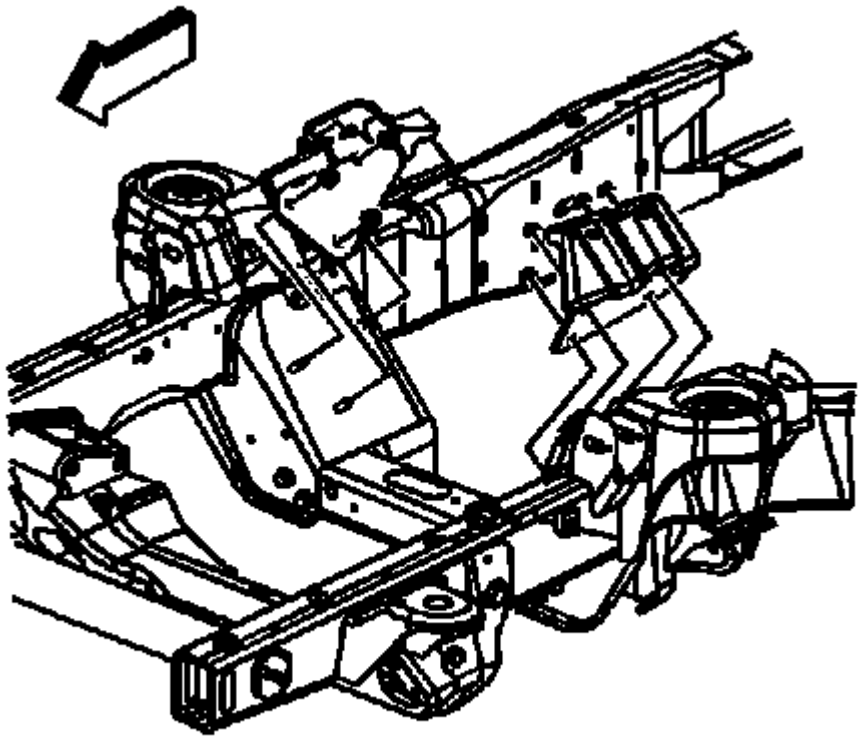

Fig. 20: Identifying Engine Mount Bracket Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount bracket mounting nuts
5. Remove the engine mount bracket from the vehicle.

INSTALLATION PROCEDURE

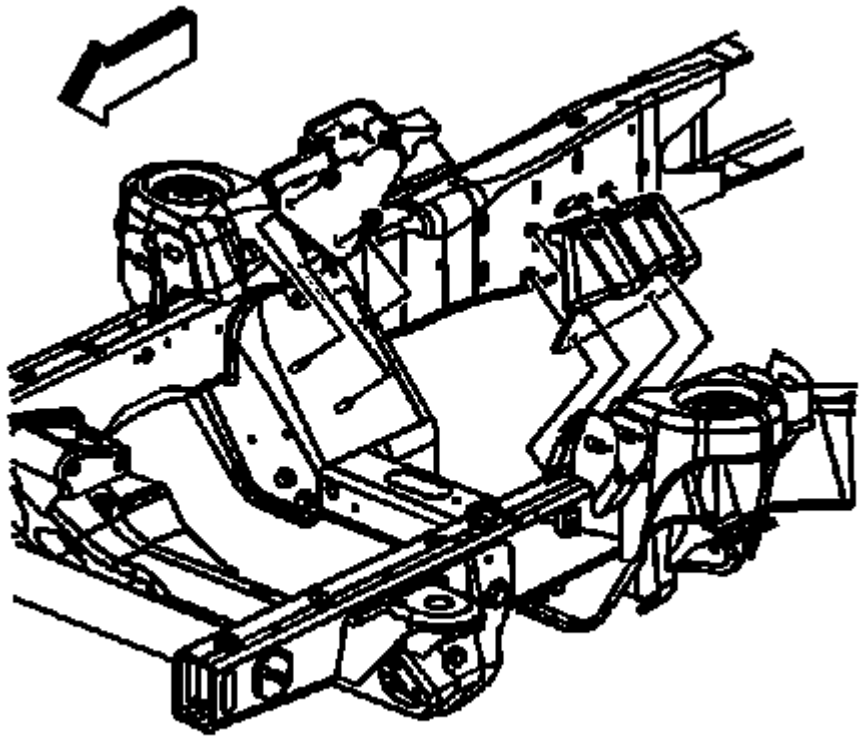

Fig. 21: Identifying Engine Mount Bracket Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount bracket retaining nuts and tighten to 45 N.m (33 lb ft).
3. Lower the engine.

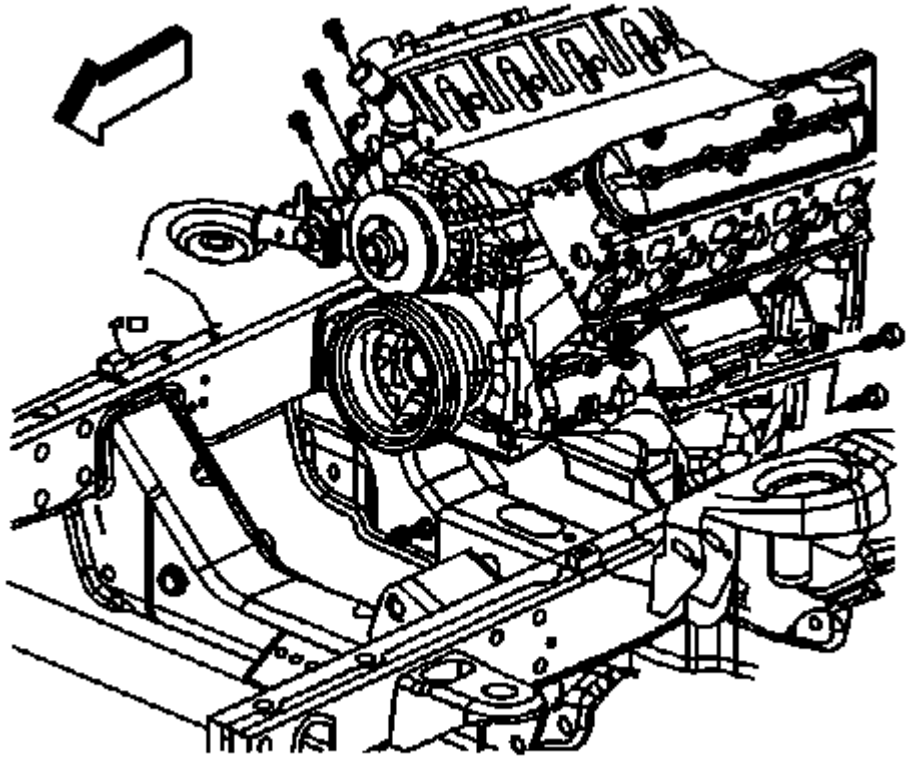

Fig. 22: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount to engine mount bracket bolts and tighten to 60 N.m (44 lb ft).
5. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

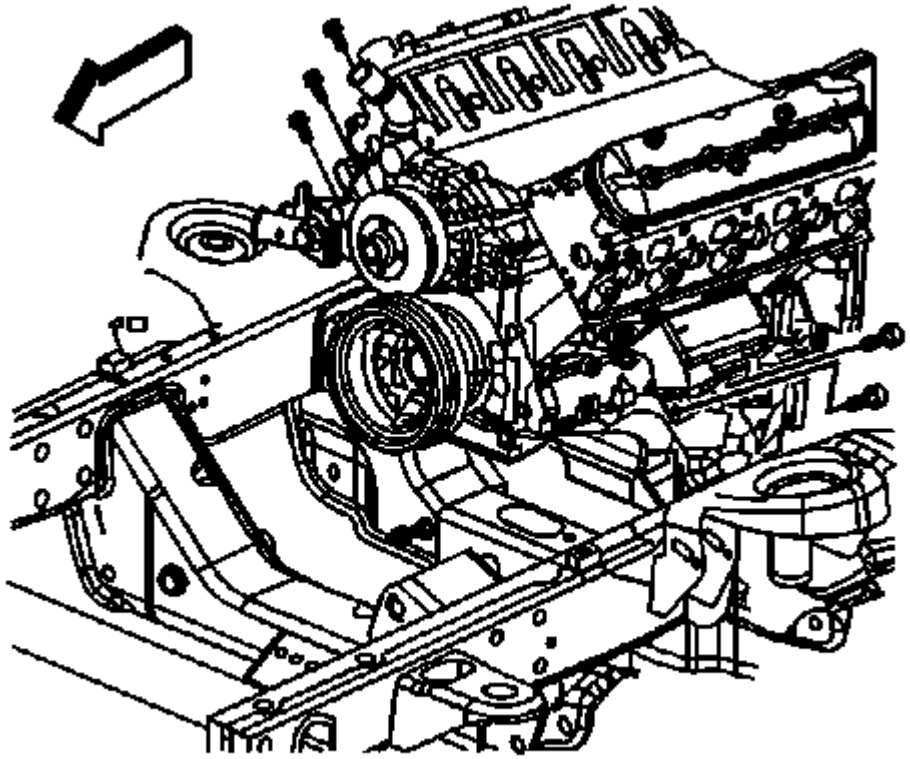

Fig. 23: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the starter. Refer to **Starter Replacement (V8)** .
3. Remove the right side exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.8L/5.3L/6.0L)** .
4. Remove the engine mount to the frame mounting bolts.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft balancer. Jacking against the oil pan may cause it to crack or break.

NOTE: Raise the engine only enough to permit removal of the engine mount.

5. Raise and suitably support the engine using adjustable (screw type) jackstands.

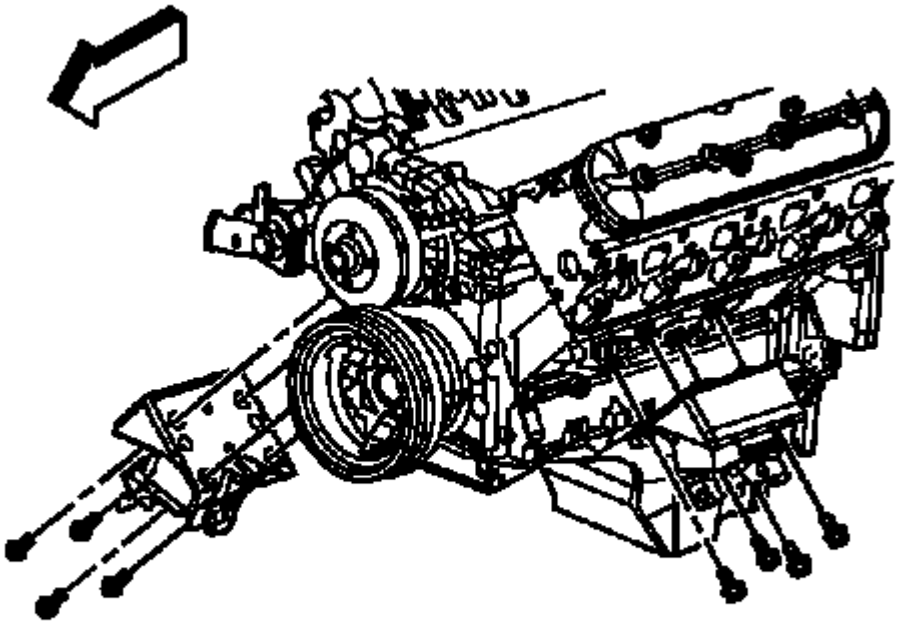

Fig. 24: Identifying Engine Mount To Engine Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine mount to the engine mounting bolts.
7. Remove the engine mount from the vehicle.

INSTALLATION PROCEDURE

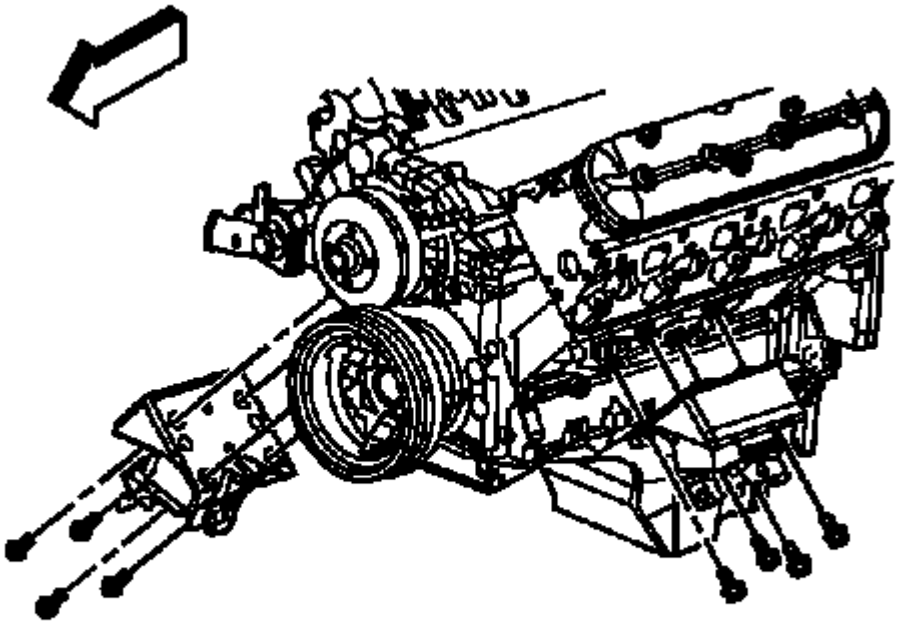

Fig. 25: Identifying Engine Mount To Engine Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount to the engine mounting bolts and tighten to 50 N.m (37 lb ft).
3. Lower the engine.

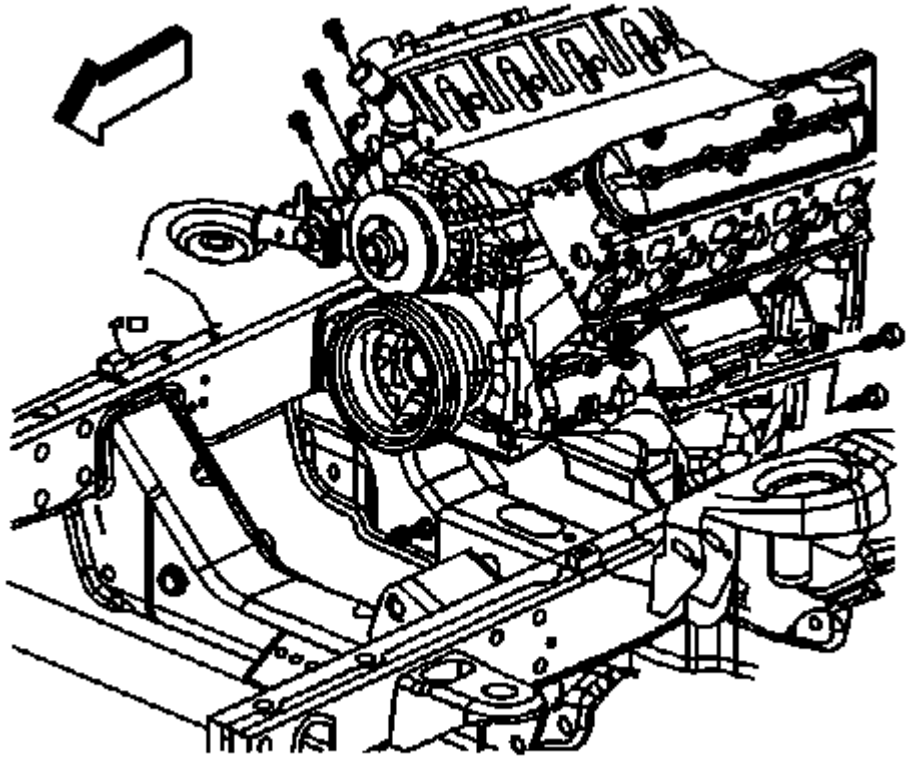

Fig. 26: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount to the frame mounting bolts and tighten to 60 N.m (44 lb ft).
5. Install the right side exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.8L/5.3L/6.0L)** .
6. Install the starter. Refer to **Starter Replacement (V8)** .
7. Lower the vehicle.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

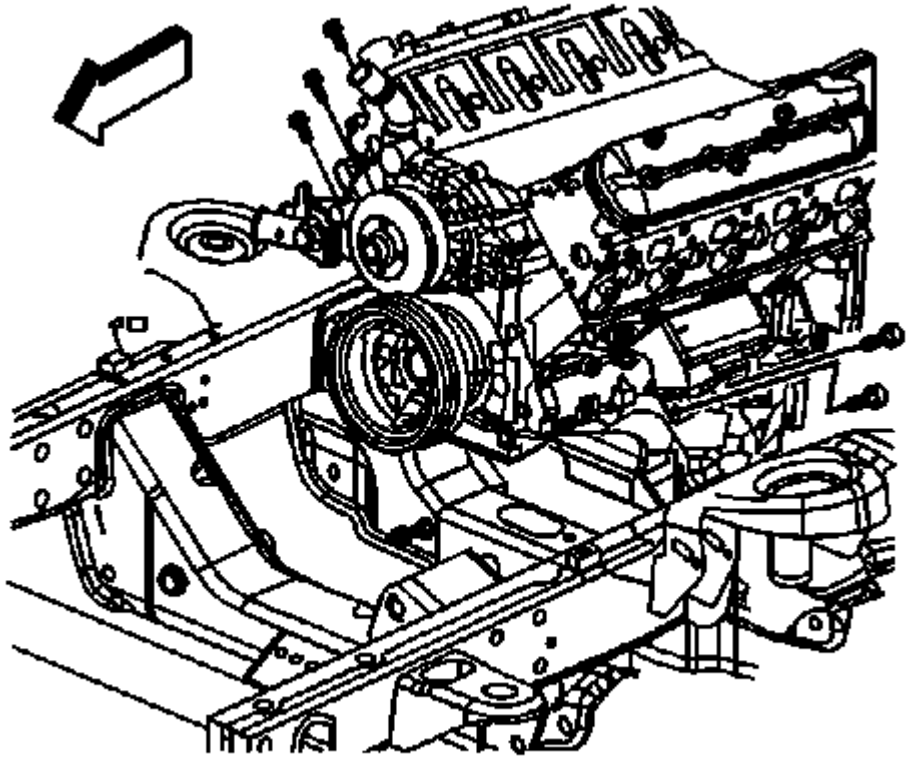

Fig. 27: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Mounting Caution .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the engine mount to engine mount bracket bolts.

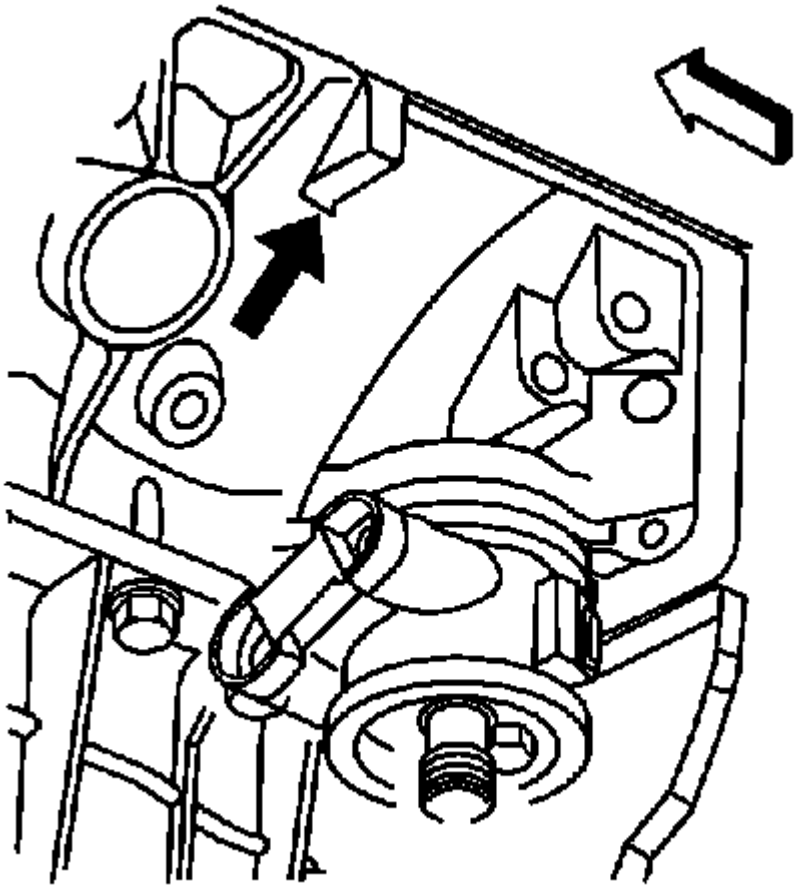

Fig. 28: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or crankshaft balancer. Jacking against the oil pan may cause it to crack or break.

NOTE: Raise the engine only enough to permit removal of the engine mount bracket.

3. Using a jack on the square tab at the rear of the engine block and raise the engine, left side shown.

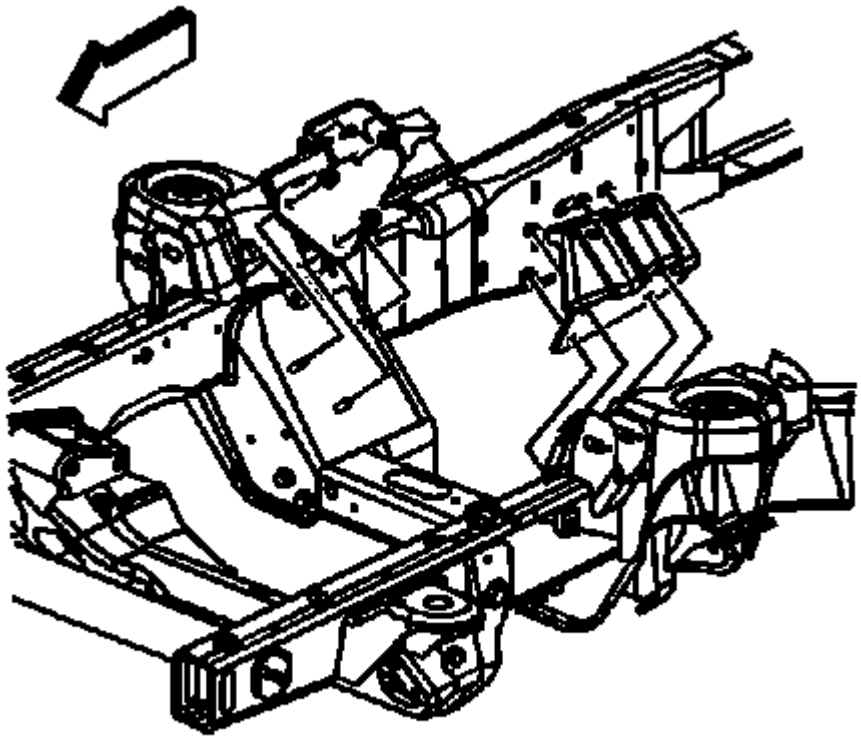

Fig. 29: Identifying Engine Mount Bracket Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount bracket mounting nuts.
5. Remove the engine mount bracket from the vehicle.

INSTALLATION PROCEDURE

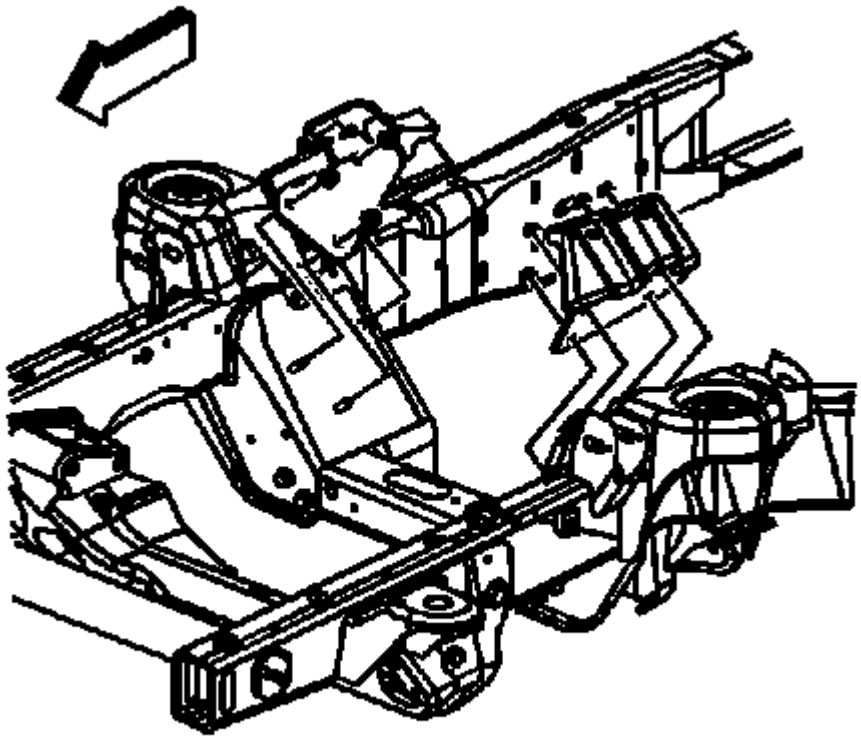

Fig. 30: Identifying Engine Mount Bracket Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount bracket retaining nuts and tighten to 45 N.m (33 lb ft).
3. Lower the engine.

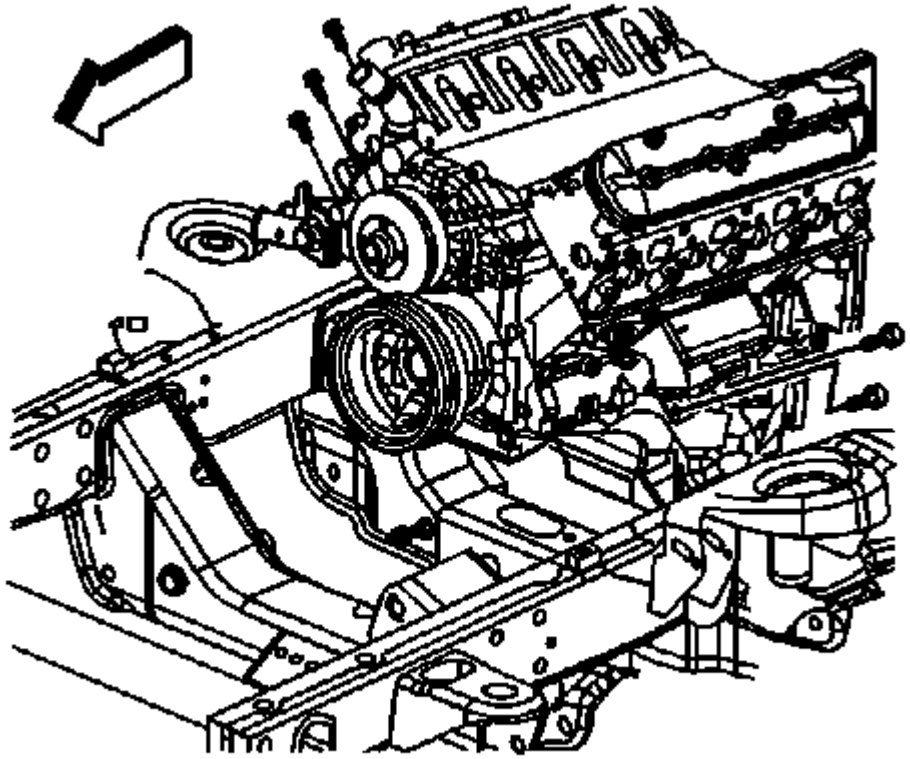

Fig. 31: Identifying Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount to the engine mount bracket bolts and tighten to 60 N.m (44 lb ft).
5. Lower the vehicle.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

REMOVAL PROCEDURE

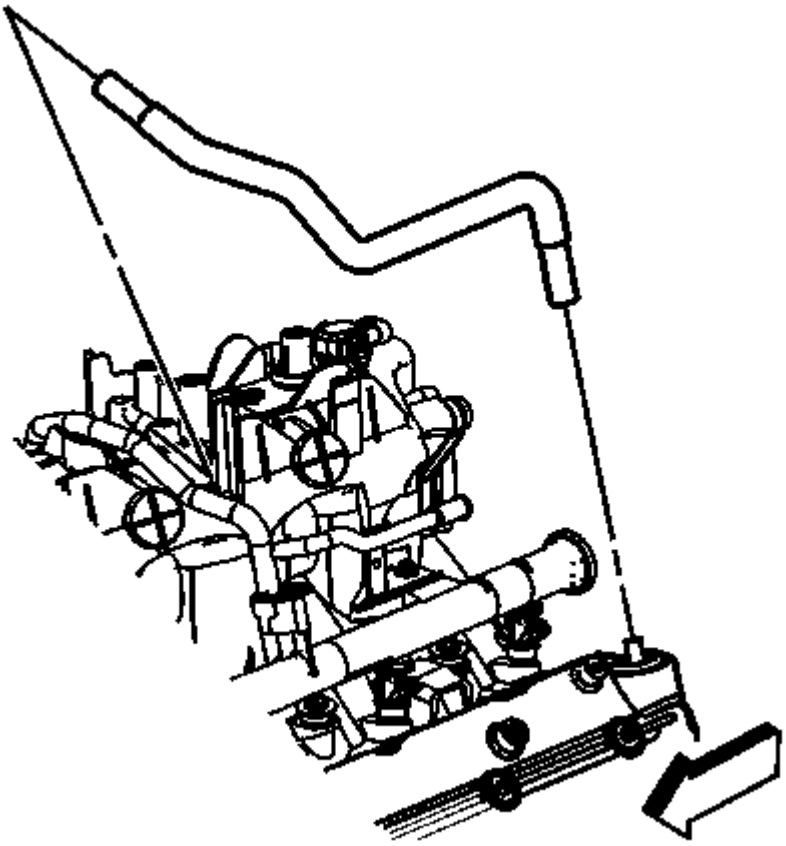

Fig. 32: View Of PCV Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the positive crankcase ventilation (PCV) tube from the intake manifold and valve rocker arm cover.

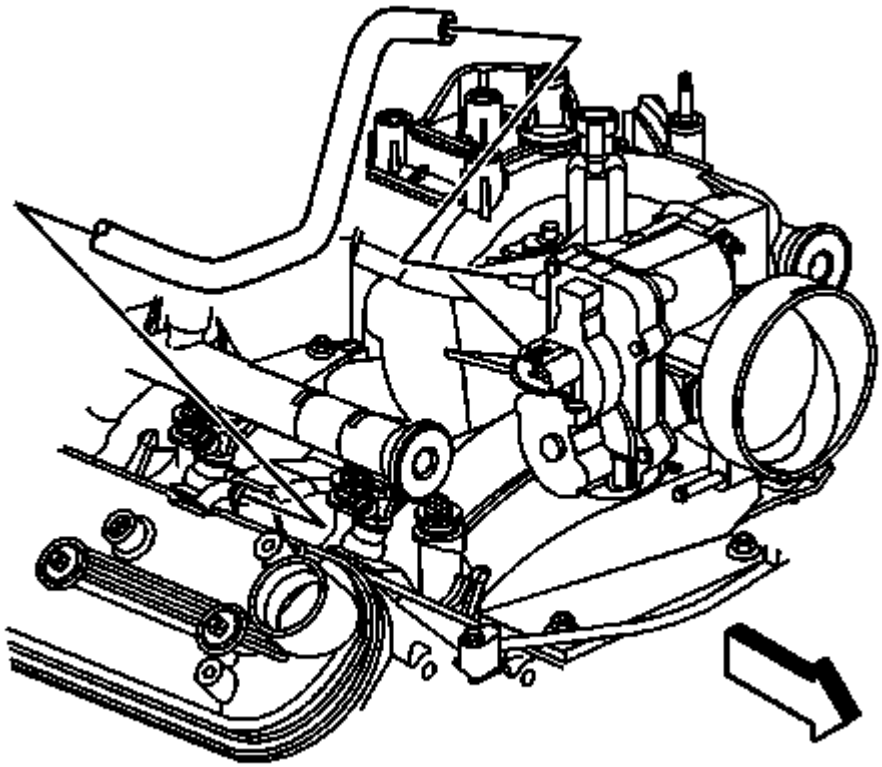

Fig. 33: View Of Throttle Body To Valve Rocker Arm Cover PCV Hose
Courtesy of GENERAL MOTORS CORP.

3. Remove the vent hose from the throttle body and the valve rocker arm cover.
4. Replace the hose/tube as necessary.

INSTALLATION PROCEDURE

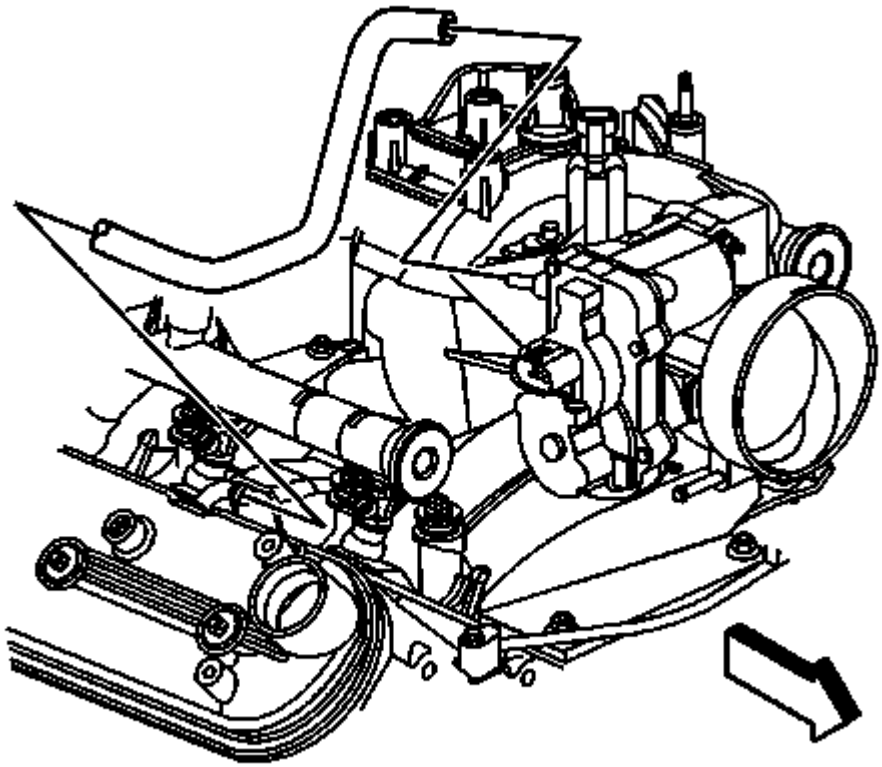

Fig. 34: View Of Throttle Body To Valve Rocker Arm Cover PCV Hose
Courtesy of GENERAL MOTORS CORP.

1. Install the vent hose to the throttle body and the valve rocker arm cover.

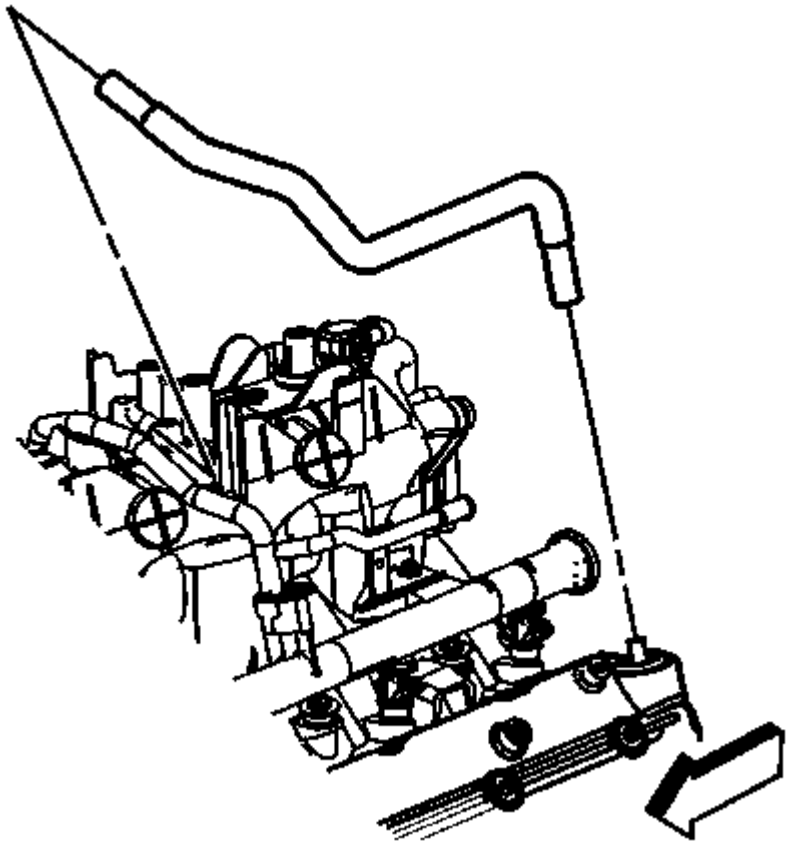

Fig. 35: View Of PCV Hose
Courtesy of GENERAL MOTORS CORP.

2. Install the PCV tube to the intake manifold and valve rocker arm cover.
3. Install the engine cover. Refer to **Engine Cover Replacement** .

OIL FILLER TUBE REPLACEMENT

REMOVAL PROCEDURE

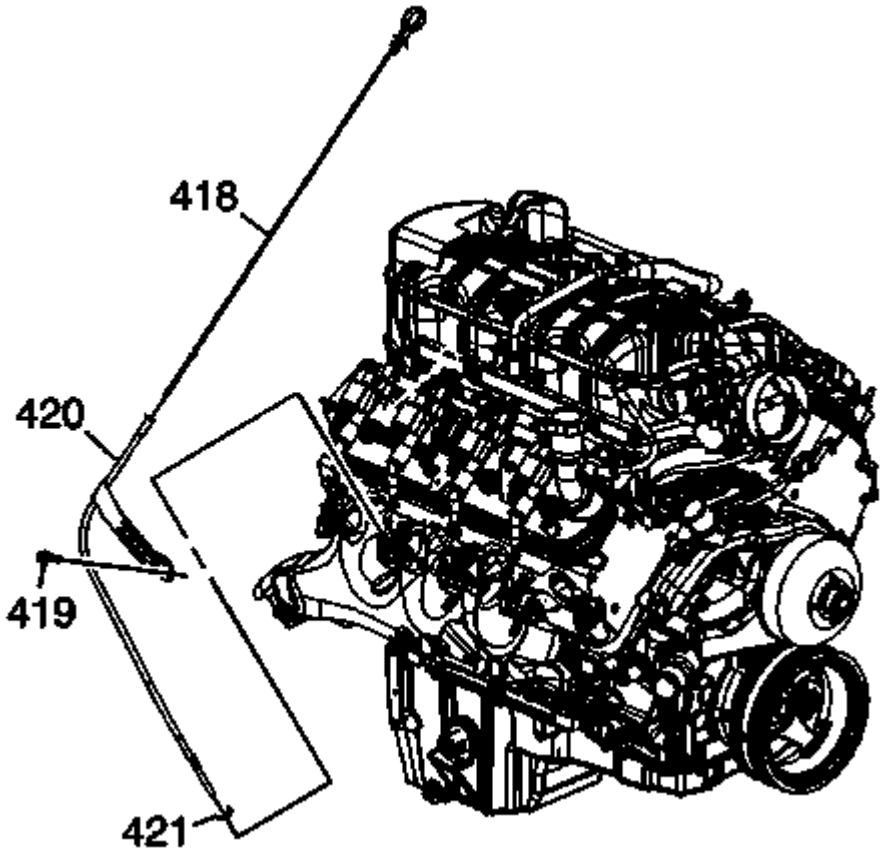

Fig. 36: View Of Oil Level Indicator, Tube Bolt, Indicator Tube & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the retaining bolt for the coolant recovery reservoir and set the reservoir aside.
3. Remove the oil level indicator (418).
4. Remove the oil level indicator tube bolt (419).
5. Remove the oil level indicator tube (420) from the engine block.

NOTE: The O-ring may be reused if not cut or damaged.

6. Inspect the O-ring seal for cuts or damage.
7. Remove the O-ring seal (421) from the tube, if required.

INSTALLATION PROCEDURE

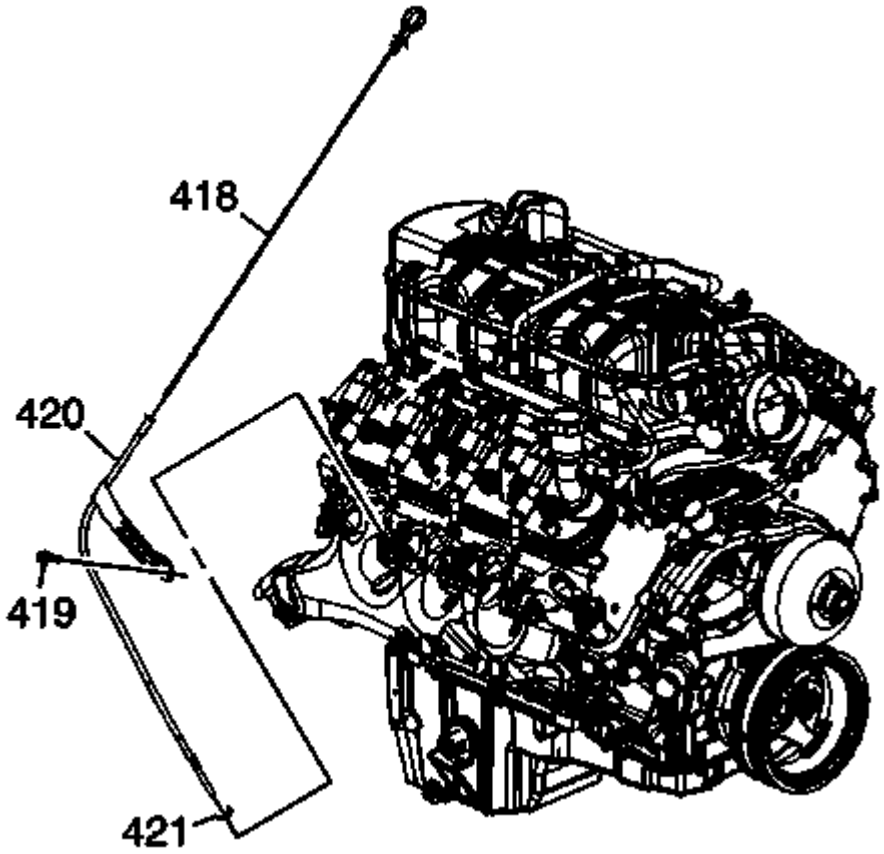

Fig. 37: View Of Oil Level Indicator, Tube Bolt, Indicator Tube & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seal (421) with clean engine oil.
2. Install a NEW O-ring seal onto the oil level indicator tube, if required.
3. Install the oil level indicator tube (420) between the exhaust manifold and engine block.
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Insert the oil level indicator tube into the block.

   The tube must be installed with the collar flush to the block.

6. Lower the vehicle.

CAUTION: Refer to Fastener Caution .

7. Install the oil level indicator tube bolt (419) and tighten to 25 N.m (18 lb ft).
8. Install the oil level indicator (418).
9. Position the coolant recovery reservoir and install the retaining bolt.

10. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

NOTE: The intake manifold, throttle body, fuel rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
2. Remove the fuel injectors. Refer to **Fuel Injector Replacement** .

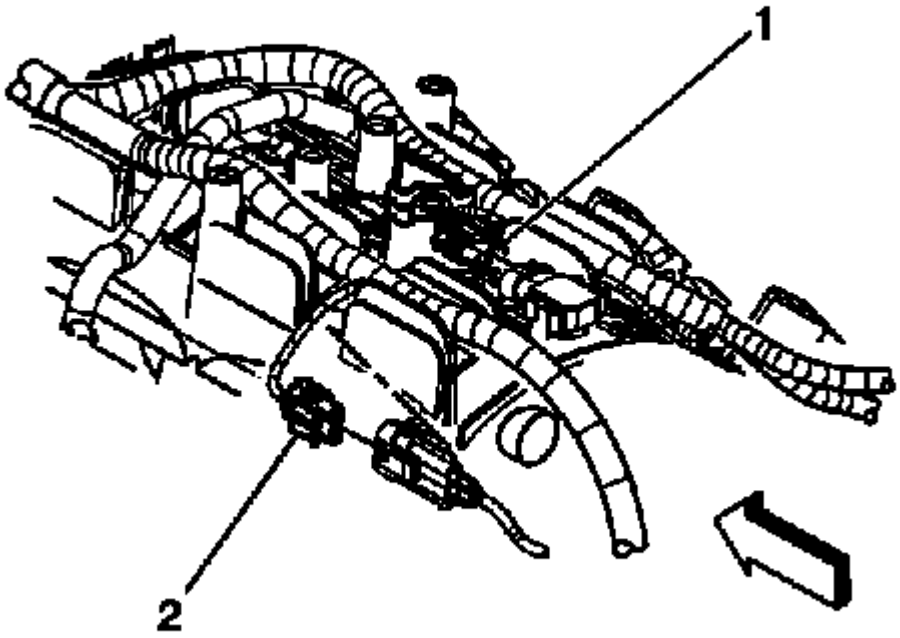

Fig. 38: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the following electrical connectors:
   - Manifold absolute pressure (MAP) sensor (1)
   - Knock sensor (2)
4. Remove the knock sensor harness electrical connector from the intake manifold.

5. Set the electrical harness aside.

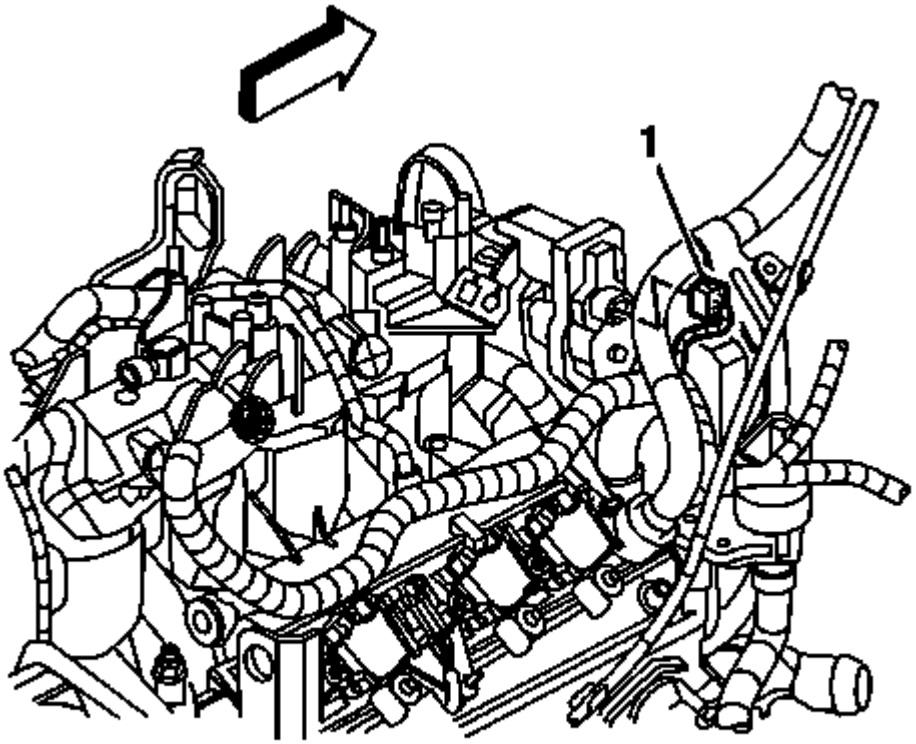

Fig. 39: View Of electronic temperature control (ETC) connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the electronic temperature control (ETC) connector.

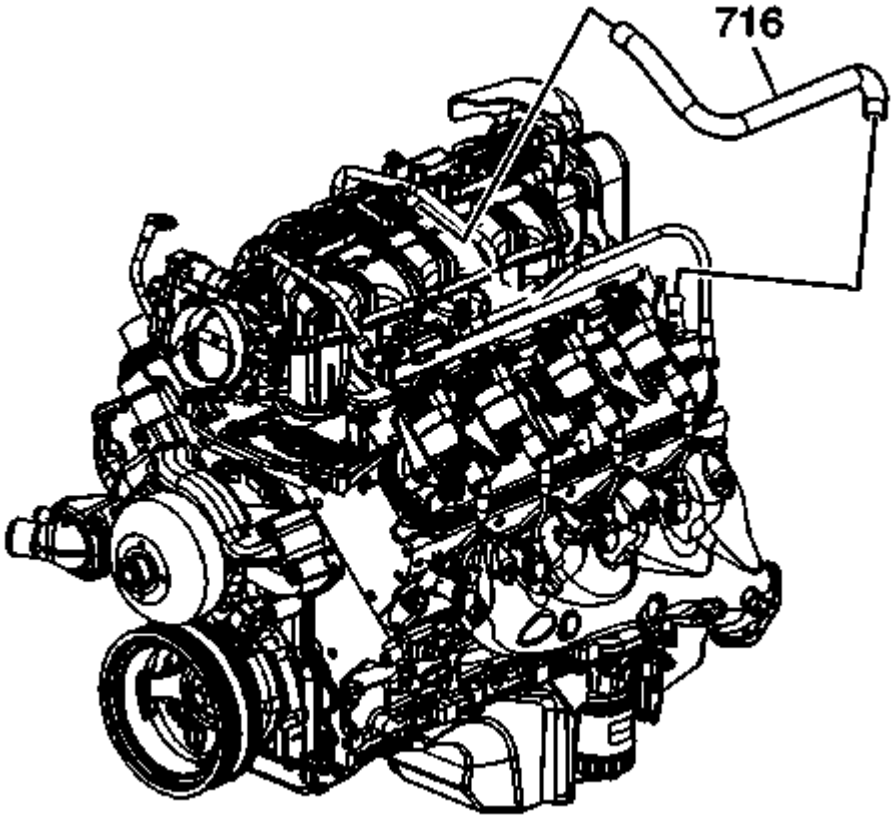

Fig. 40: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

7. Remove the positive crankcase ventilation (PCV) hose - dirty air (716).

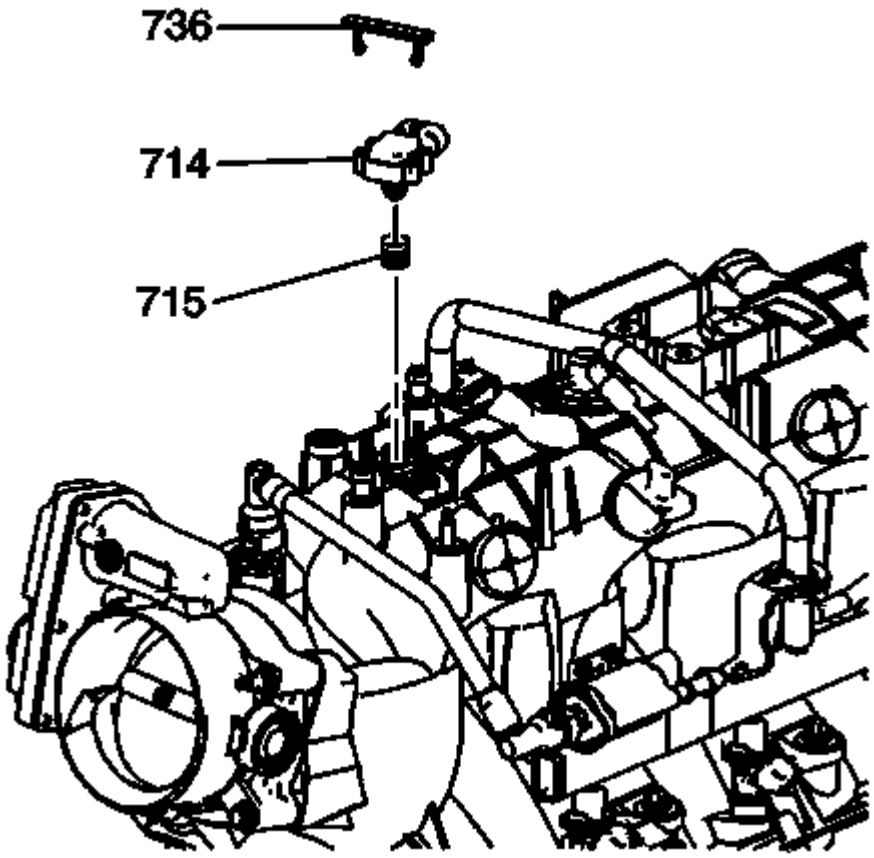

Fig. 41: Identifying MAP Sensor Components
Courtesy of GENERAL MOTORS CORP.

8. Remove the MAP sensor (714) and retainer (736) as required.
9. Remove the O-ring (715) from the sensor, as required.

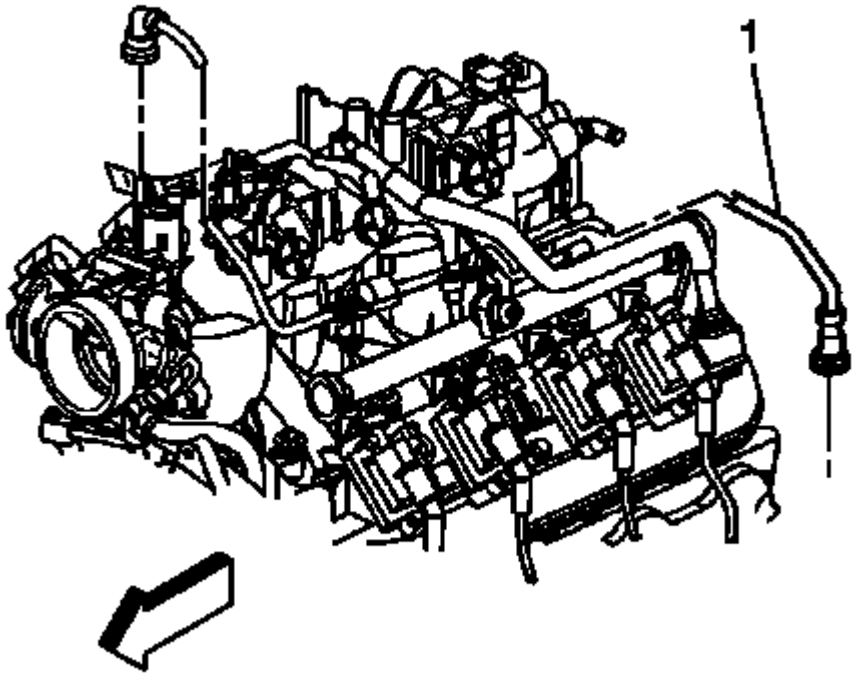

Fig. 42: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

10. Remove the evaporative emission (EVAP) purge solenoid vent tube by performing the following:
    1. Remove the EVAP tube end (2) from the solenoid (1).
    2. Squeeze the EVAP pipe quick connect fitting (3) retainer together.
    3. Remove the EVAP tube end (3) from the vapor pipe.

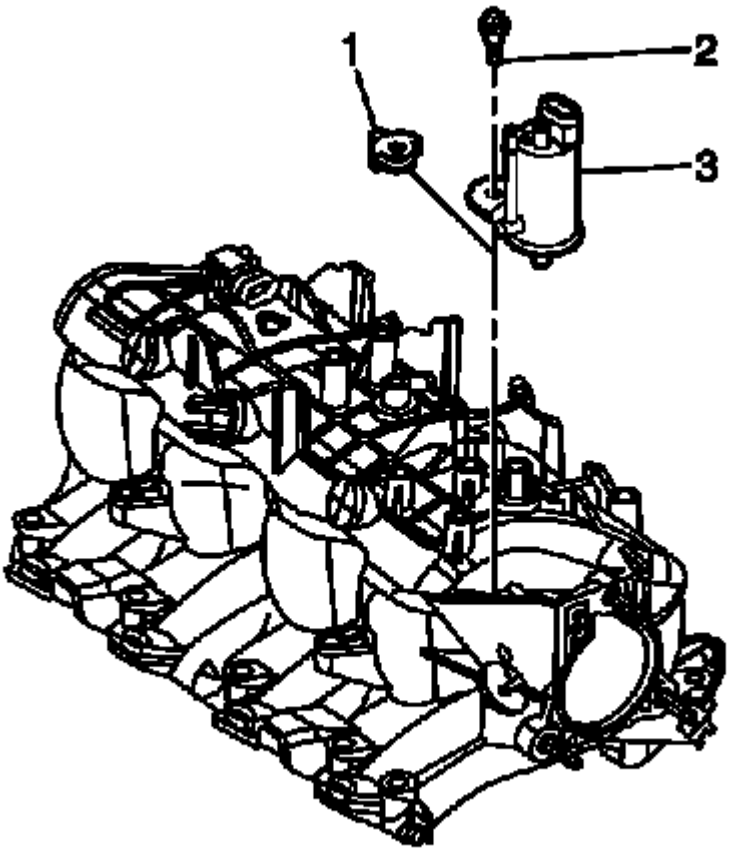

Fig. 43: View Of EVAP Purge Solenoid Bolt, Solenoid & Isolator
Courtesy of GENERAL MOTORS CORP.

11. Remove the EVAP purge solenoid bolt (2), solenoid (3), and isolator (1) from the intake manifold.

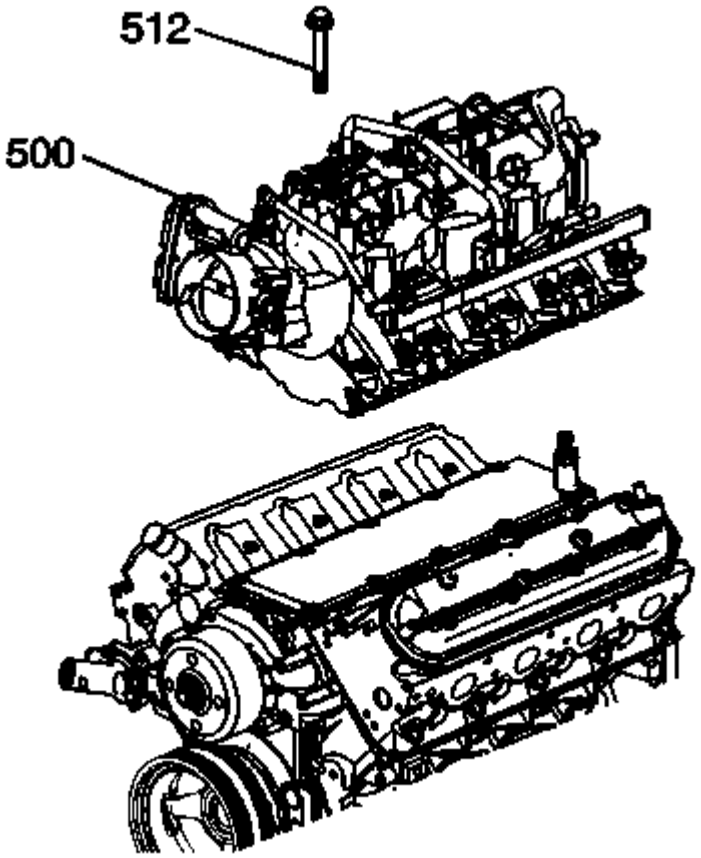

Fig. 44: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the intake manifold bolts (512).
13. Remove the intake manifold (500) with gaskets.

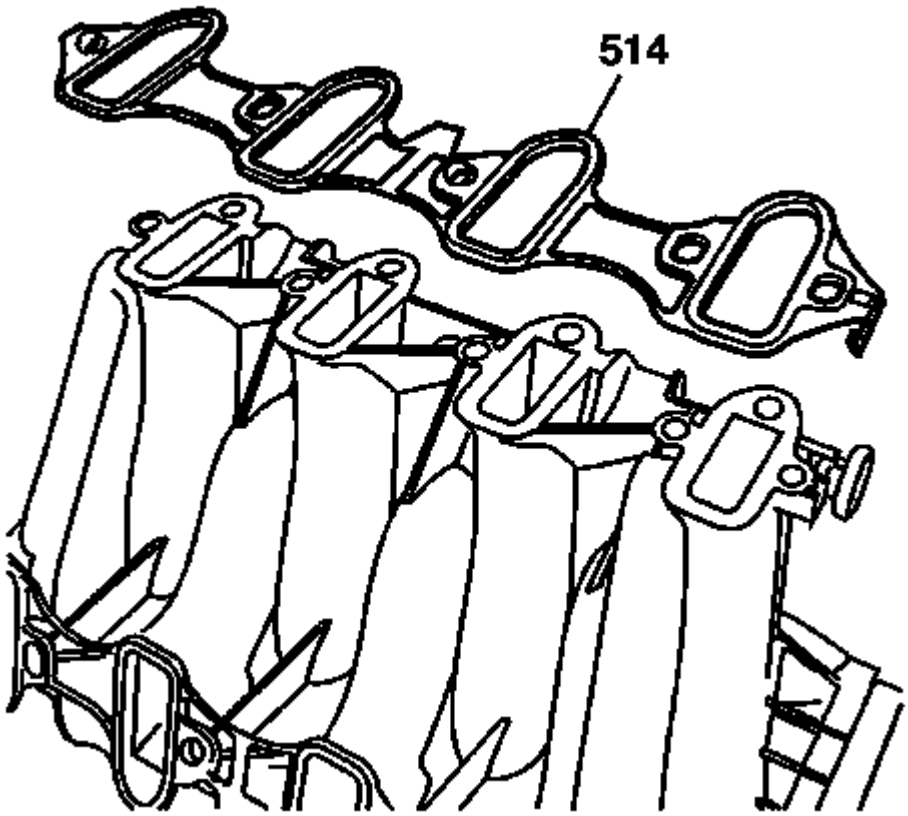

Fig. 45: View Of Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

14. Remove the intake manifold gaskets (514).
15. Discard the intake manifold gaskets.

INSTALLATION PROCEDURE

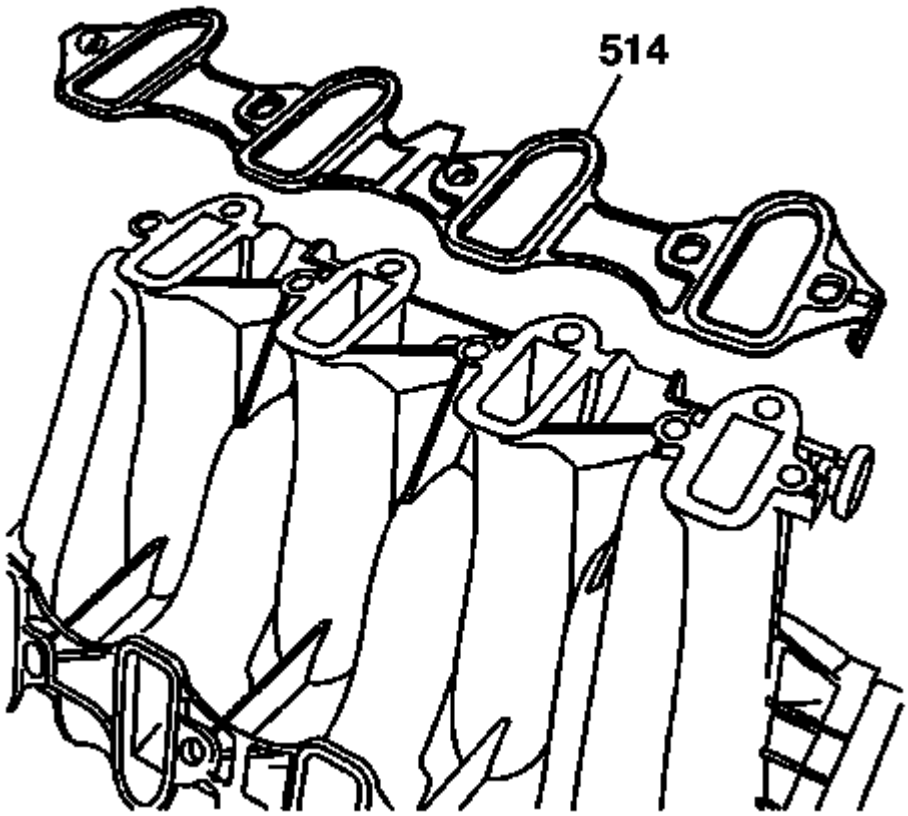

Fig. 46: View Of Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install NEW intake manifold gaskets (514) to the intake manifold.

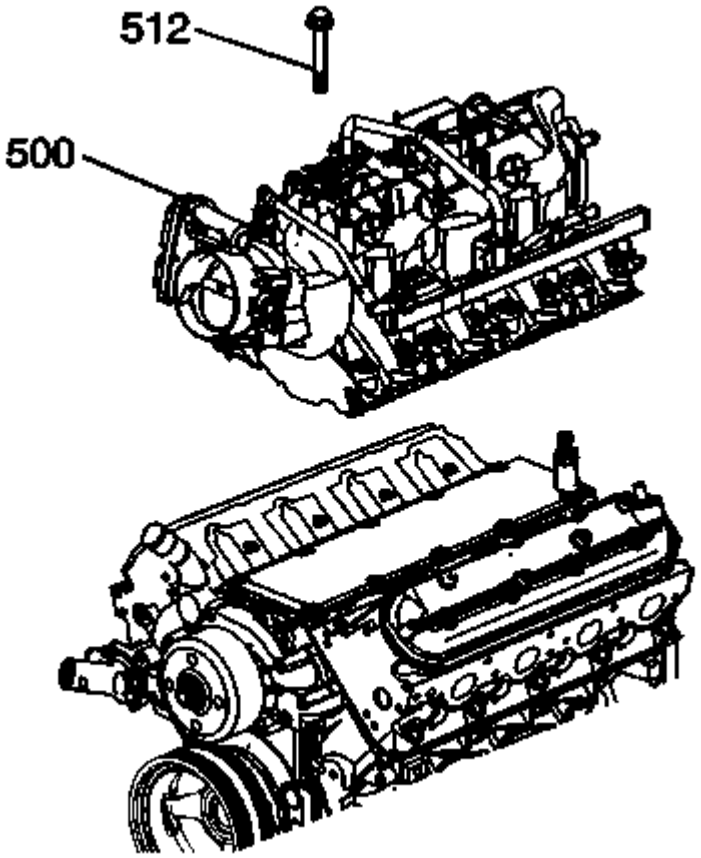

Fig. 47: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold (500).
3. Apply a 5 mm (0.20 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489) to the threads of the intake manifold bolts (512). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

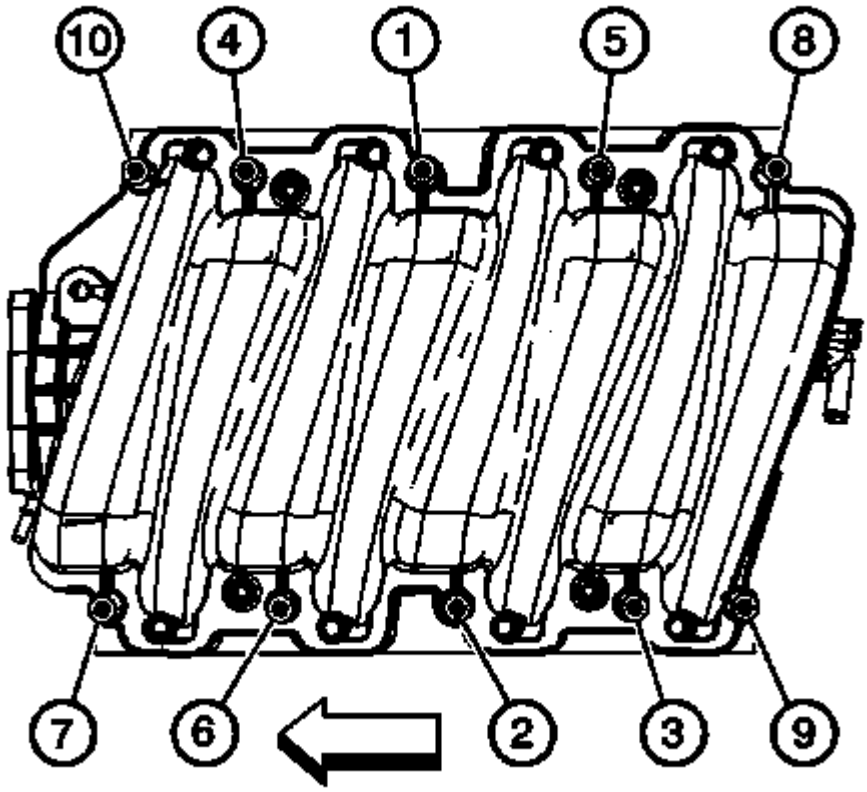

Fig. 48: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the intake manifold bolts.
    1. Tighten the intake manifold bolts a first pass in sequence to 5 N.m (44 lb in).
    2. Tighten the intake manifold bolts a final pass in sequence to 10 N.m (89 lb in).

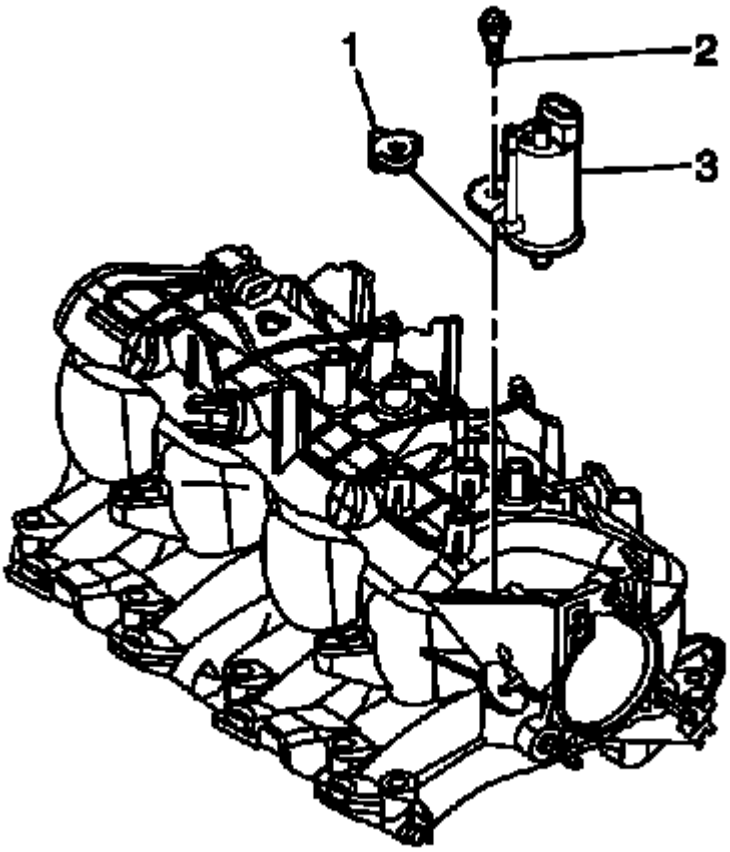

Fig. 49: View Of EVAP Purge Solenoid Bolt, Solenoid & Isolator
Courtesy of GENERAL MOTORS CORP.

5. Install the EVAP purge solenoid (3), isolator (1), and bolt (2) to the intake manifold. Tighten the EVAP purge solenoid bolt to 10 N.m (89 lb in).

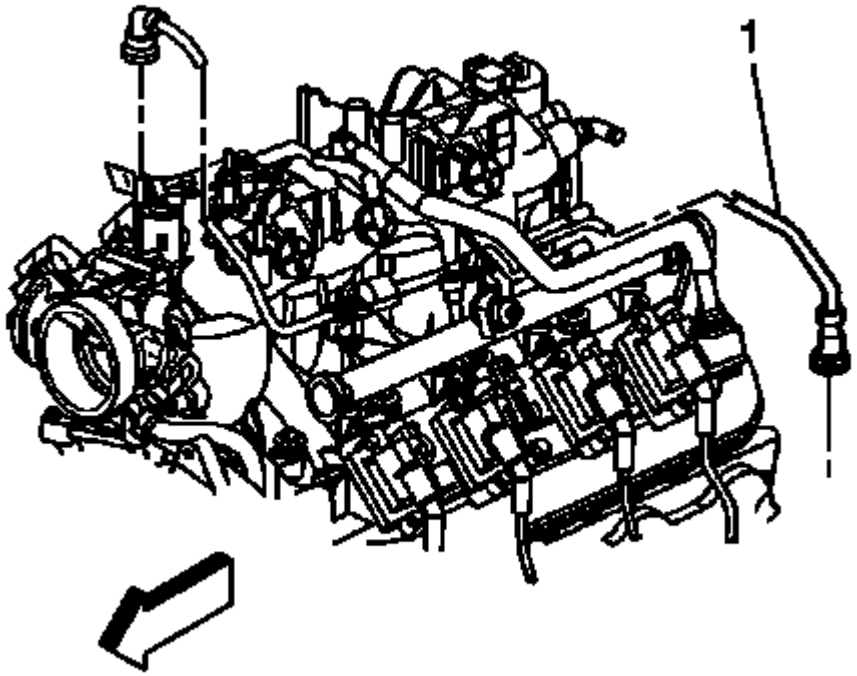

Fig. 50: View Of EVAP Purge Solenoid Vent Tube
Courtesy of GENERAL MOTORS CORP.

6. Install the EVAP purge solenoid vent tube to the solenoid (1) and vapor pipe.
7. Install the engine coolant air bleed clamp and hose to the throttle body, if applicable.

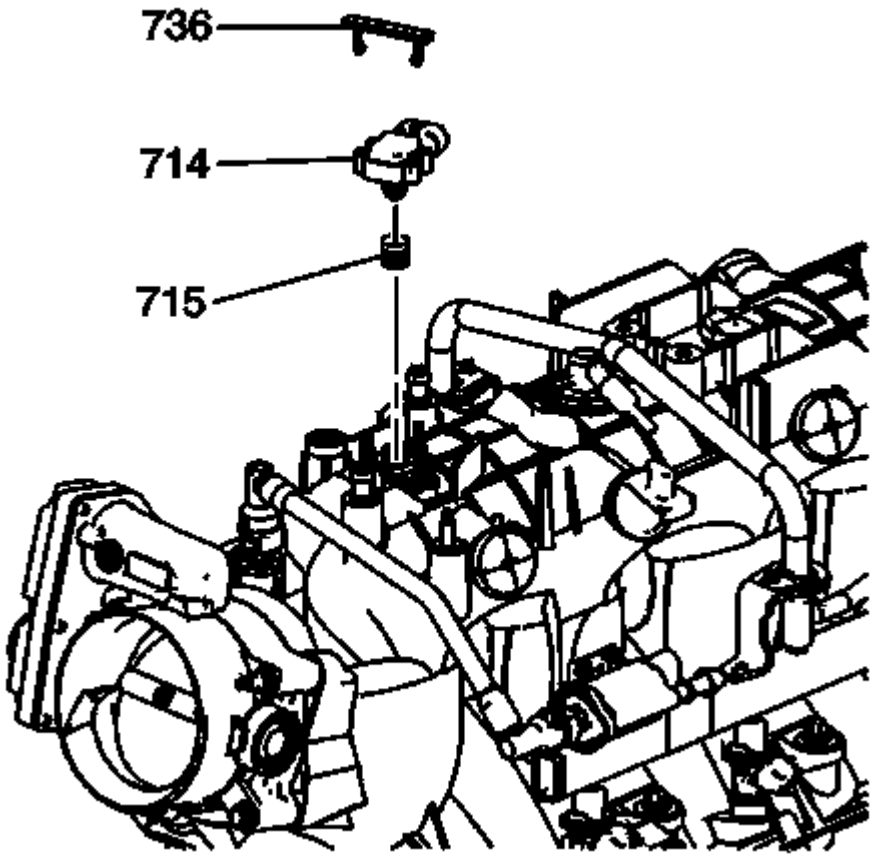

Fig. 51: Identifying MAP Sensor Components
Courtesy of GENERAL MOTORS CORP.

8. Lubricate the MAP sensor grommet (715) with clean engine oil.
9. Install the grommet onto the MAP sensor (714).
10. Install the MAP sensor (714) and the retainer (736).

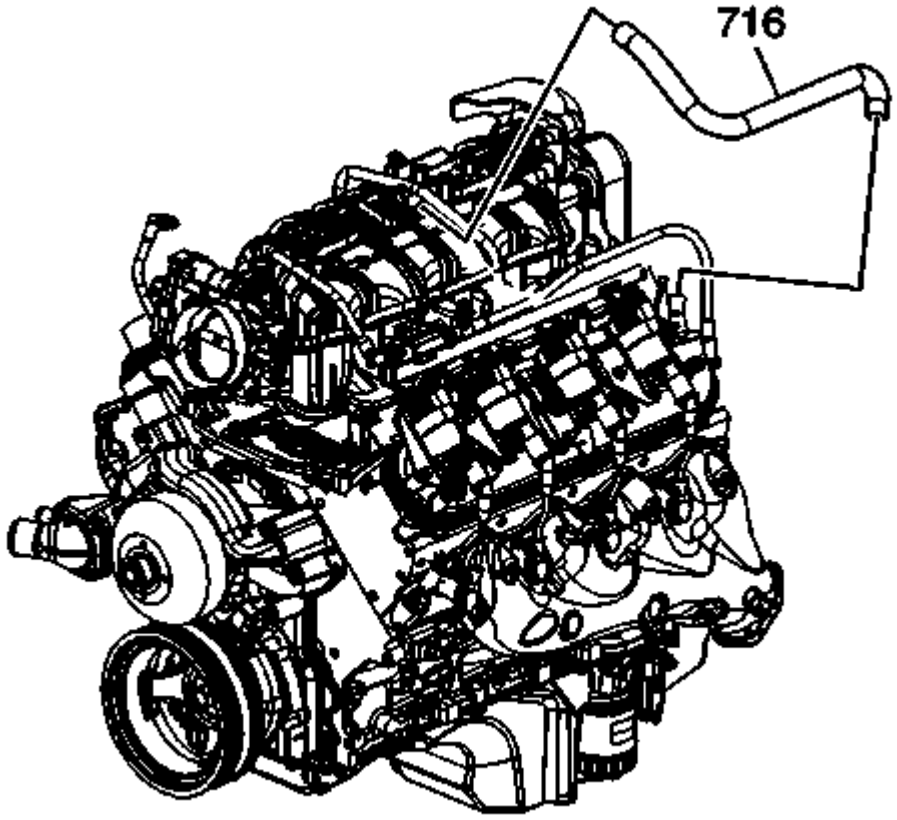

Fig. 52: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

11. Install the PCV hose - dirty air (716).

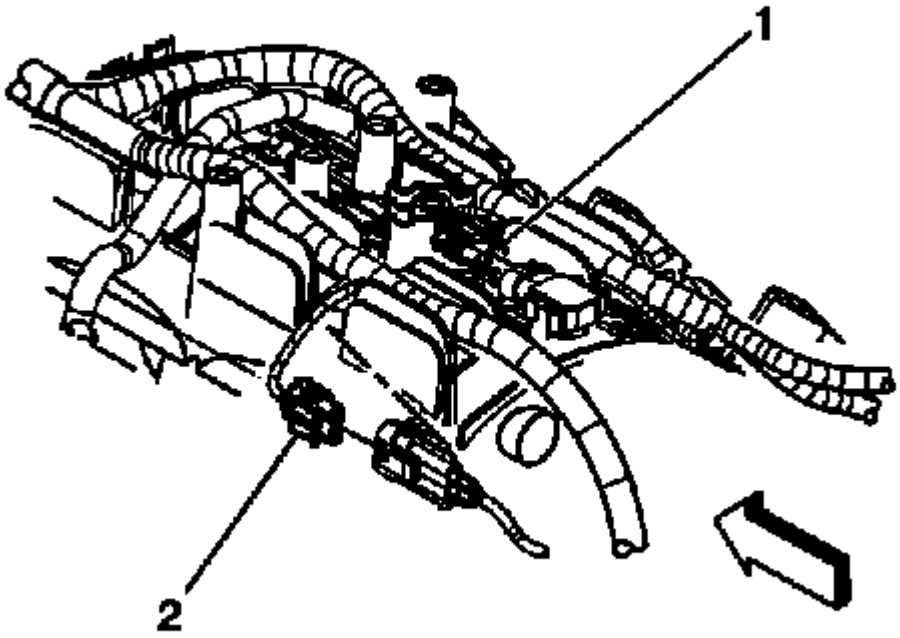

Fig. 53: View Of MAP Sensor & Knock Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

12. Connect the knock sensor harness electrical connector to the intake manifold.
13. Connect the following electrical connectors:
    - MAP sensor (1)
    - Knock sensor (2)
    - Exhaust gas recirculation (EGR) valve, if equipped
14. Install the fuel injectors. Refer to **Fuel Injector Replacement** .
15. Install the throttle body. Refer to **Throttle Body Assembly Replacement** .

ENGINE BLOCK VALLEY COVER REPLACEMENT

REMOVAL PROCEDURE

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.

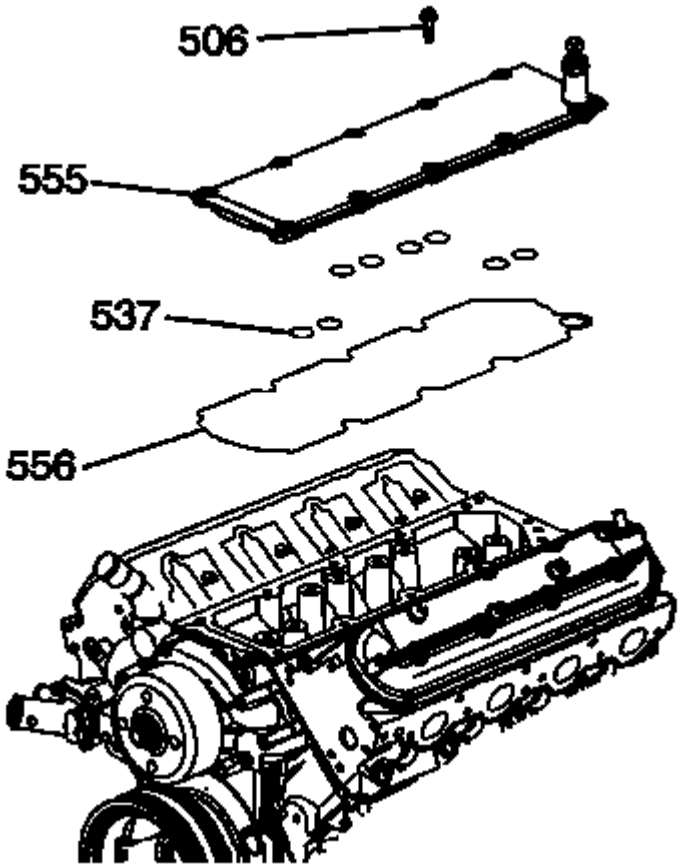

Fig. 54: Identifying Engine Valley Cover Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the valley cover bolts (506).
3. Remove the valley cover (555) and gasket (556).
4. Remove the O-ring seals (537) from the cover.

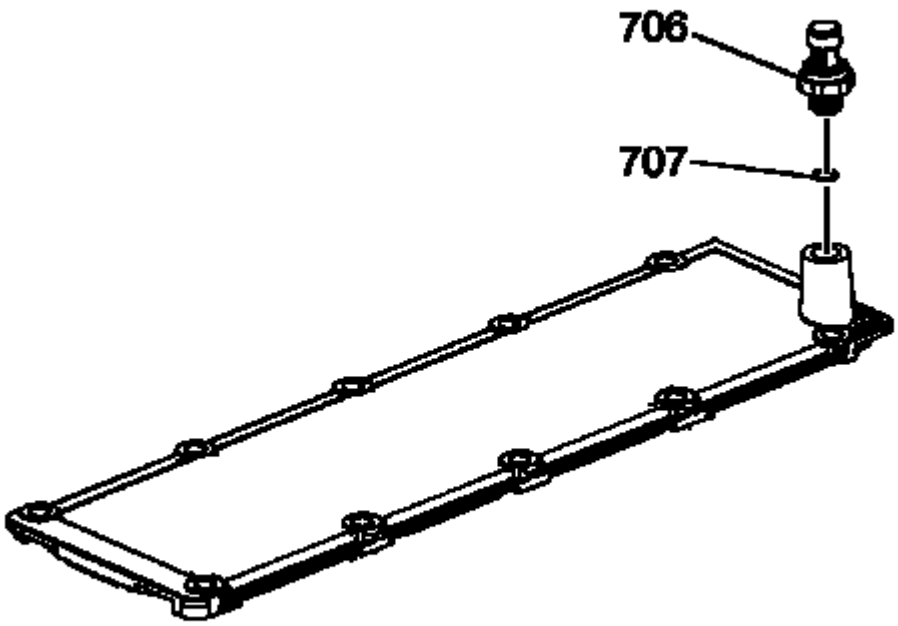

Fig. 55: Identifying Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pressure sensor (706) and washer (707) as required.
6. Clean and inspect the engine valley cover. Refer to **Engine Block Valley Cover Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: All gasket surfaces should be free of oil or other foreign material during assembly.

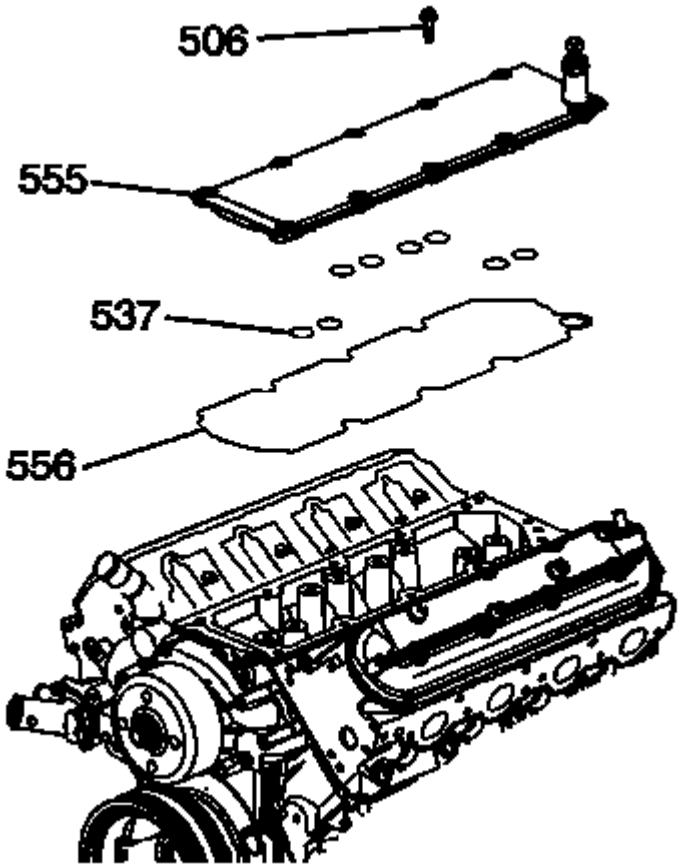

Fig. 56: Identifying Engine Valley Cover Components
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seals with clean engine oil.
2. Install the O-rings seals (537) to the cover (555).

CAUTION: Refer to Fastener Caution .

3. Install the cover (555), gasket (556), and bolts (506). Tighten the manifold bolts to 25 N.m (18 lb ft).

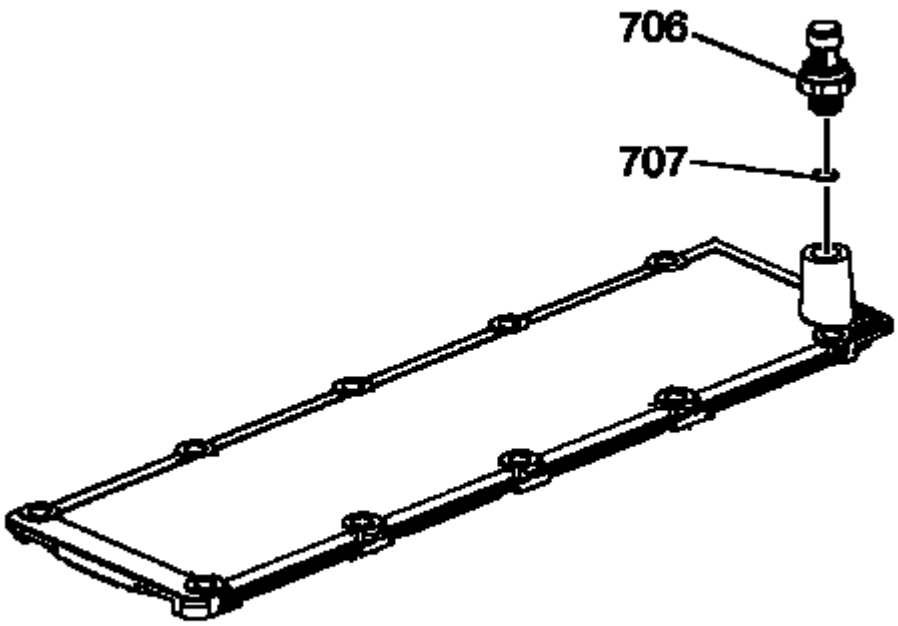

Fig. 57: Identifying Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707) and tighten to 35 N.m (26 lb ft).
6. Install the intake manifold. Refer to **Intake Manifold Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

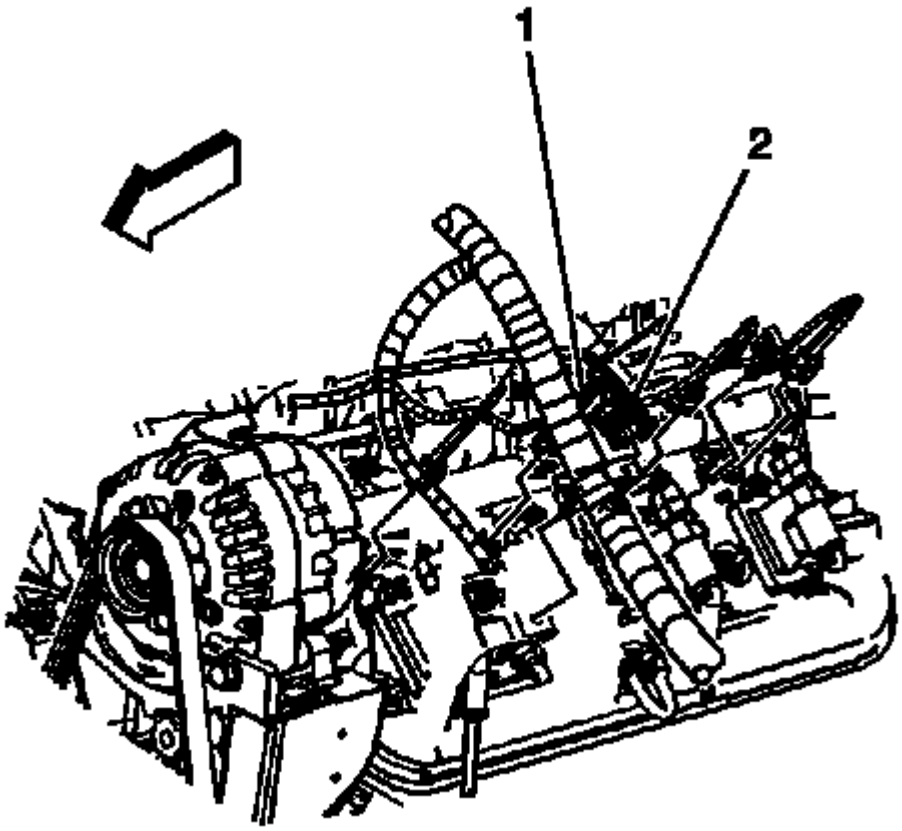

Fig. 58: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the connector position assurance (CPA) lock.
3. Disconnect the main electrical connector (2) to the ignition coil wire harness.
4. Remove the harness clips (1).
5. Reposition the engine harness, if necessary.
6. Remove the spark plug wires from the ignition coils:
   - Twist each plug wire 1/2 turn.
   - Pull only on the boot in order to remove the wire from the ignition coil.

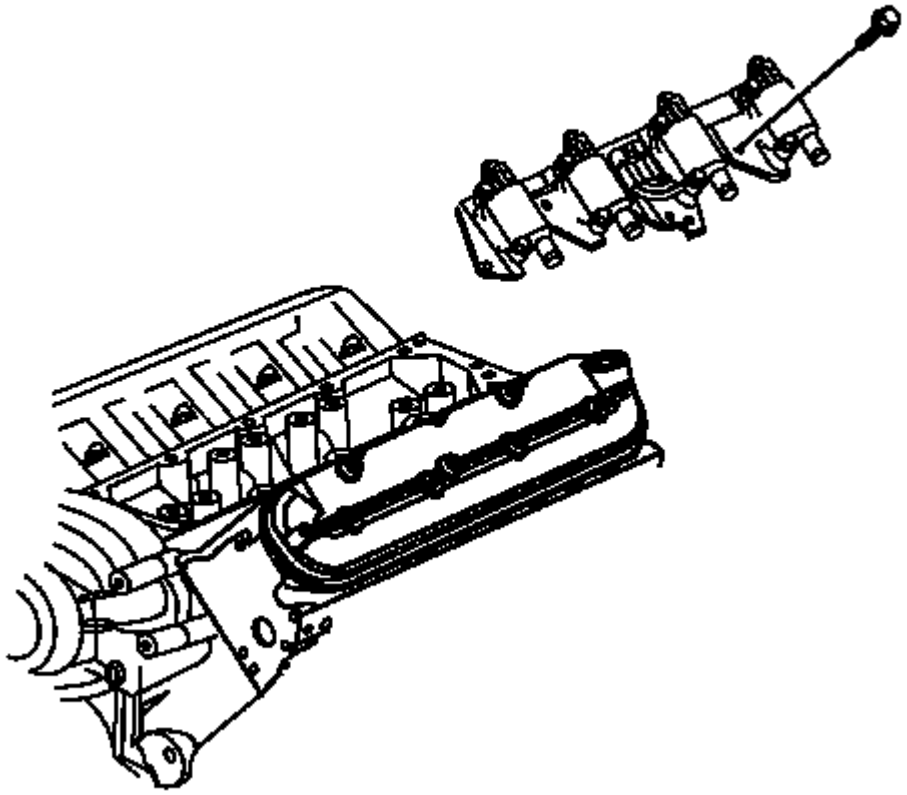

Fig. 59: Identifying ignition coil bracket studs
Courtesy of GENERAL MOTORS CORP.

7. Remove the ignition coil bracket studs from the rocker arm cover.
8. Remove the ignition coils and bracket from the rocker arm cover.

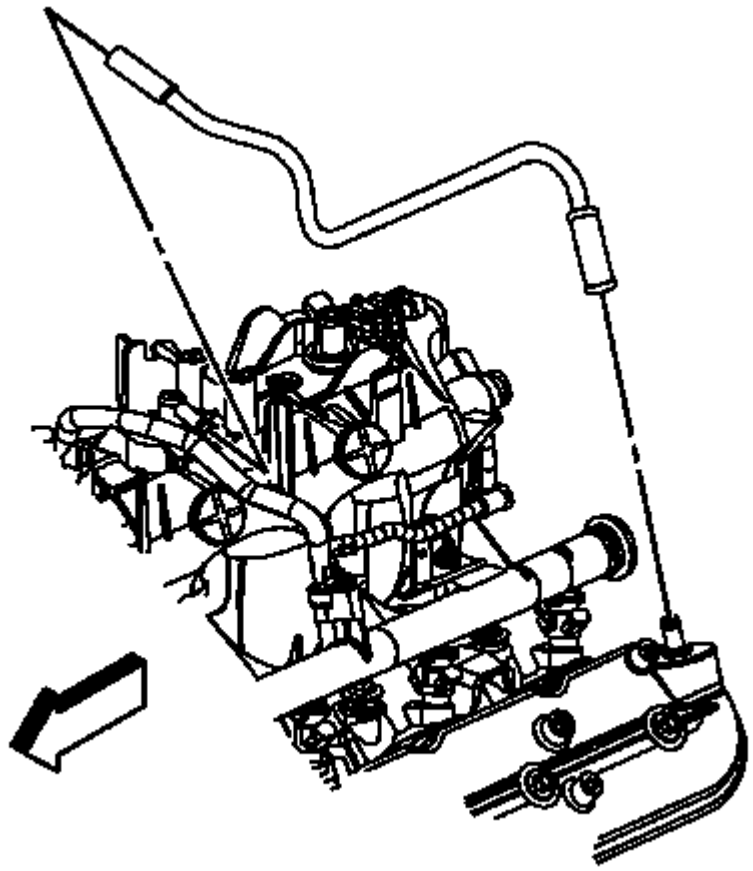

Fig. 60: Identifying positive crankcase ventilation (PCV) hose
Courtesy of GENERAL MOTORS CORP.

9. Remove the positive crankcase ventilation (PCV) hose from the rocker arm cover.

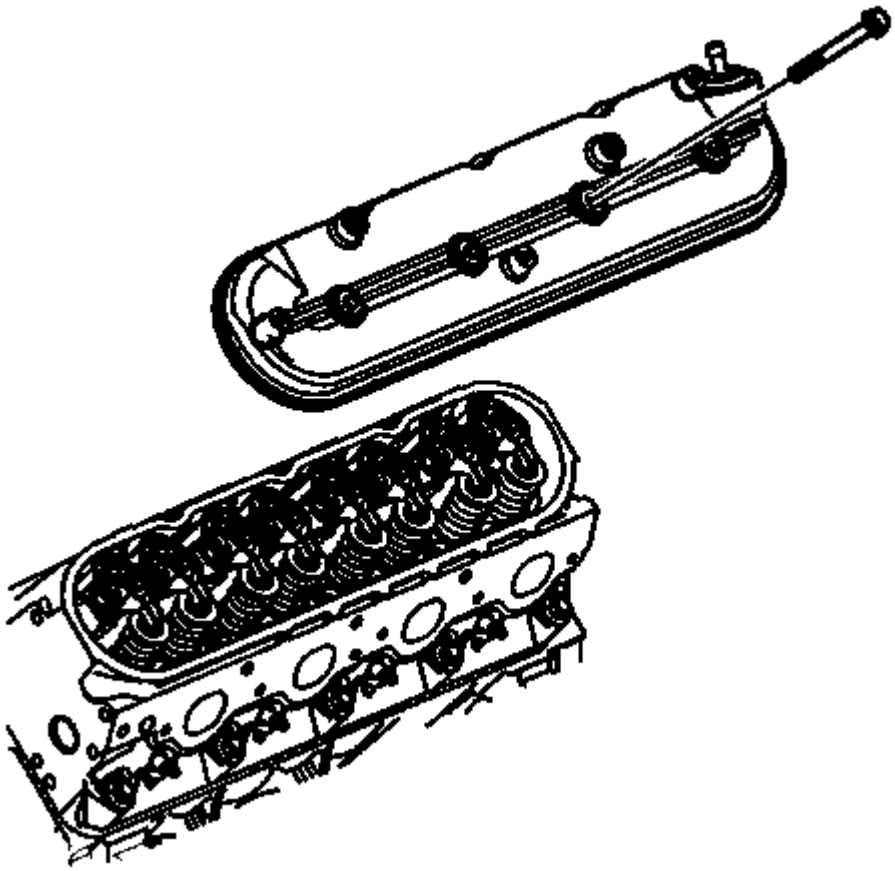

Fig. 61: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve rocker arm cover bolts.
11. Remove the valve rocker arm cover.

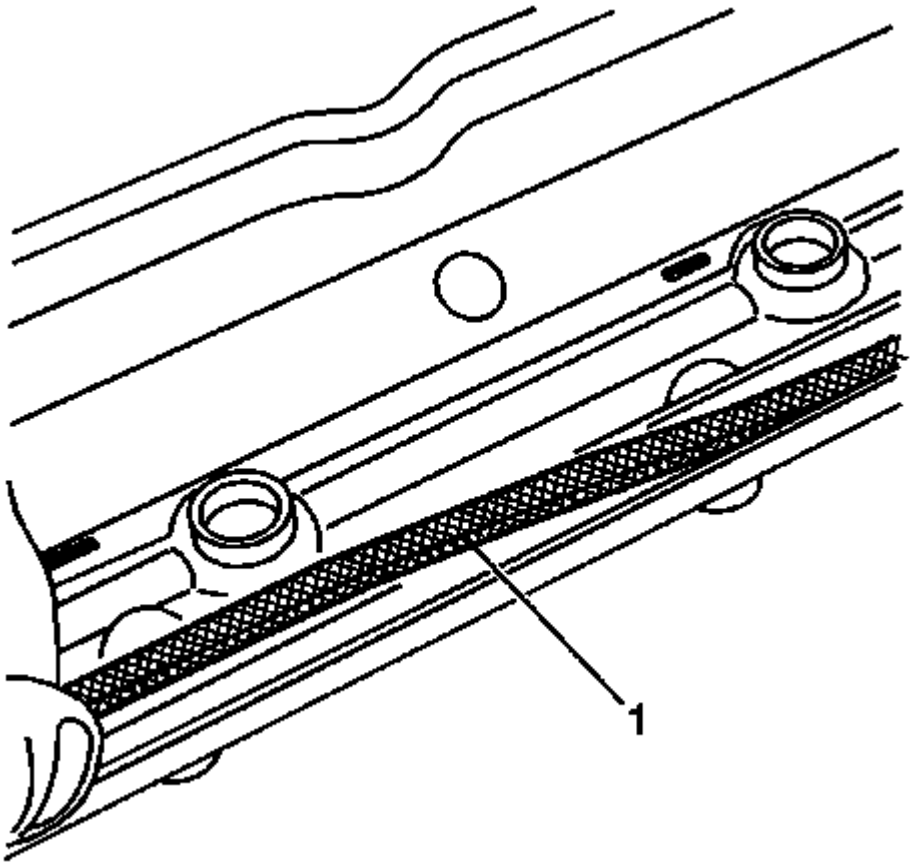

Fig. 62: View Of Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

12. Remove the gasket (1) from the rocker cover.
13. Discard the OLD gasket.

INSTALLATION PROCEDURE

NOTE:

- **All gasket surfaces should be free of oil an/or other foreign material during assembly.**
- **DO NOT reuse the valve rocker arm cover gasket.**
- **The valve rocker arm cover bolt grommets may be reused.**
- **If the PCV valve grommet has been removed from the rocker cover, install a NEW grommet during assembly.**

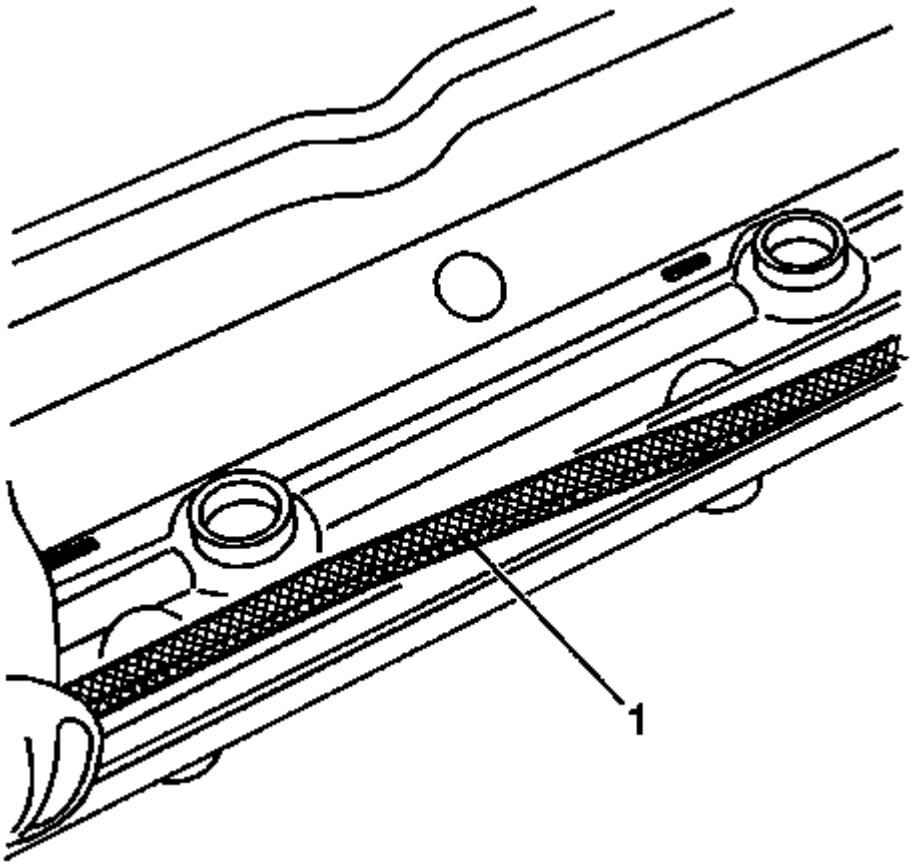

Fig. 63: View Of Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW rocker cover gasket (1) into the groove of the valve rocker arm cover.

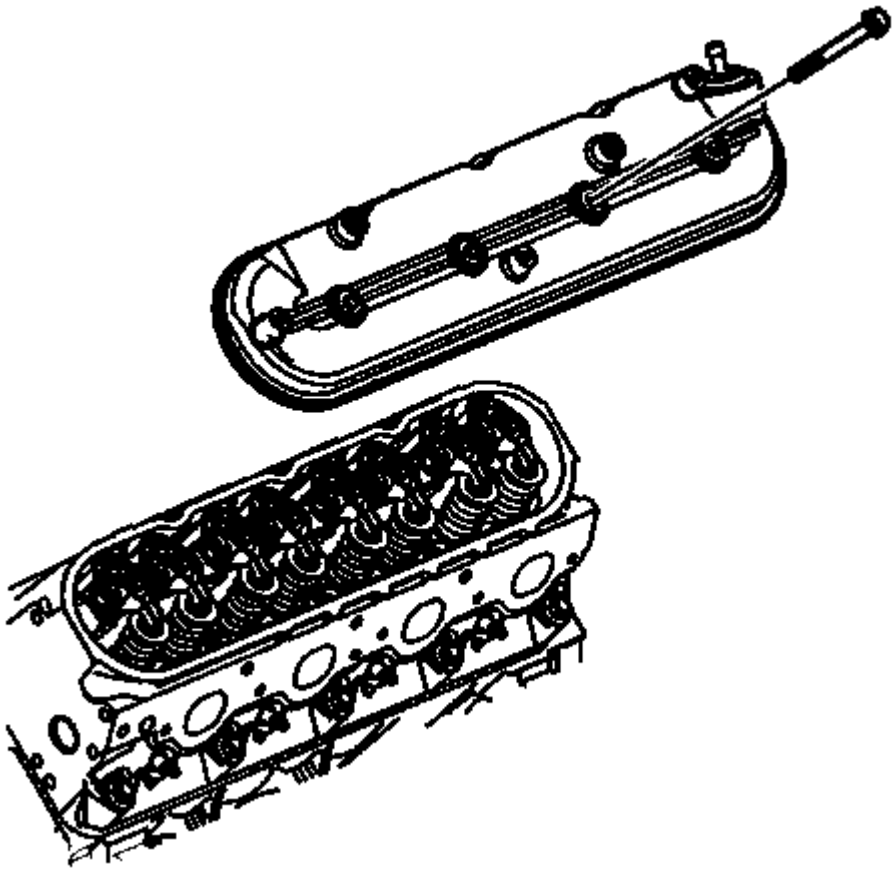

Fig. 64: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the valve rocker arm cover onto the cylinder head.
3. Install new rocker arm cover grommets, if necessary.

CAUTION: Refer to Fastener Caution .

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

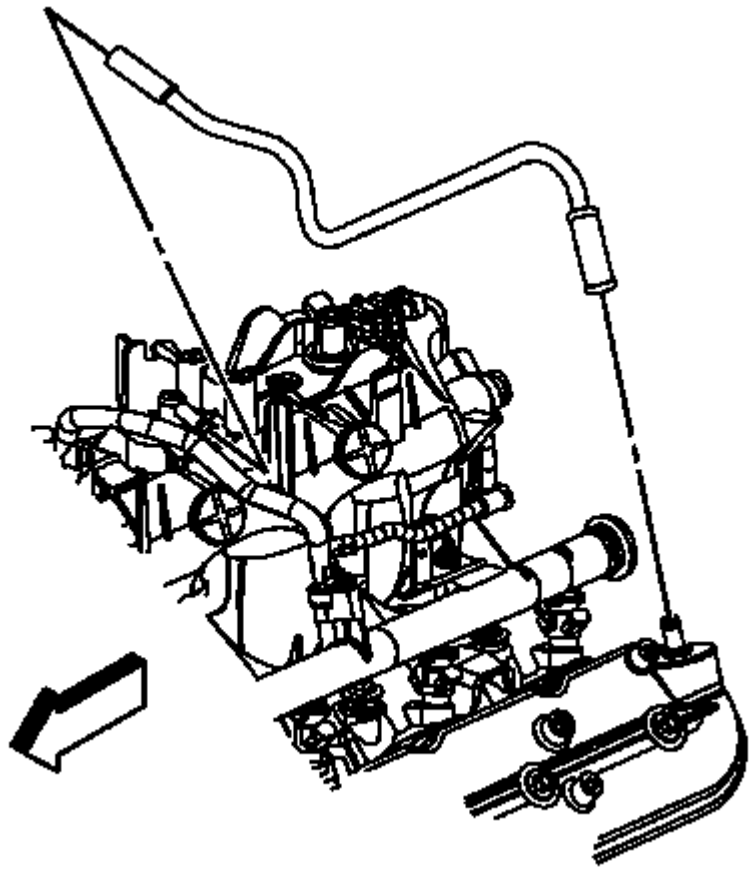

Fig. 65: Identifying positive crankcase ventilation (PCV) hose
Courtesy of GENERAL MOTORS CORP.

5. Install the PCV hose to the rocker arm cover.

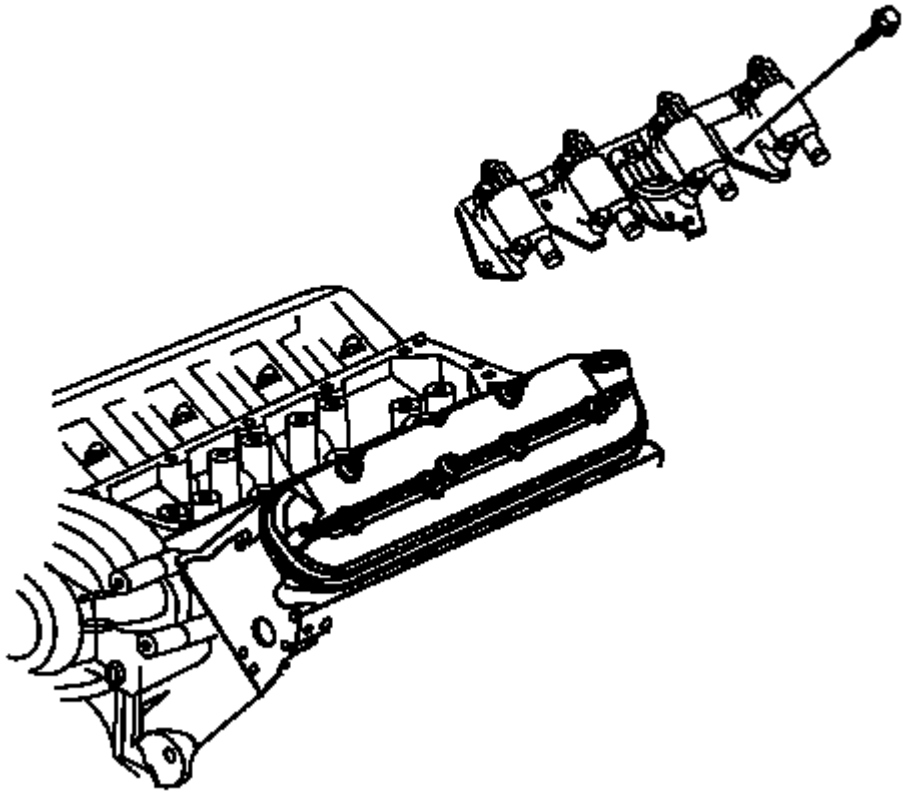

Fig. 66: Identifying ignition coil bracket studs
Courtesy of GENERAL MOTORS CORP.

6. Apply threadlock to the threads of the bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
7. Install the ignition coils and bracket to the rocker arm cover.
8. Install the ignition coil bracket studs to the rocker arm cover and tighten to 12 N.m (106 lb in).

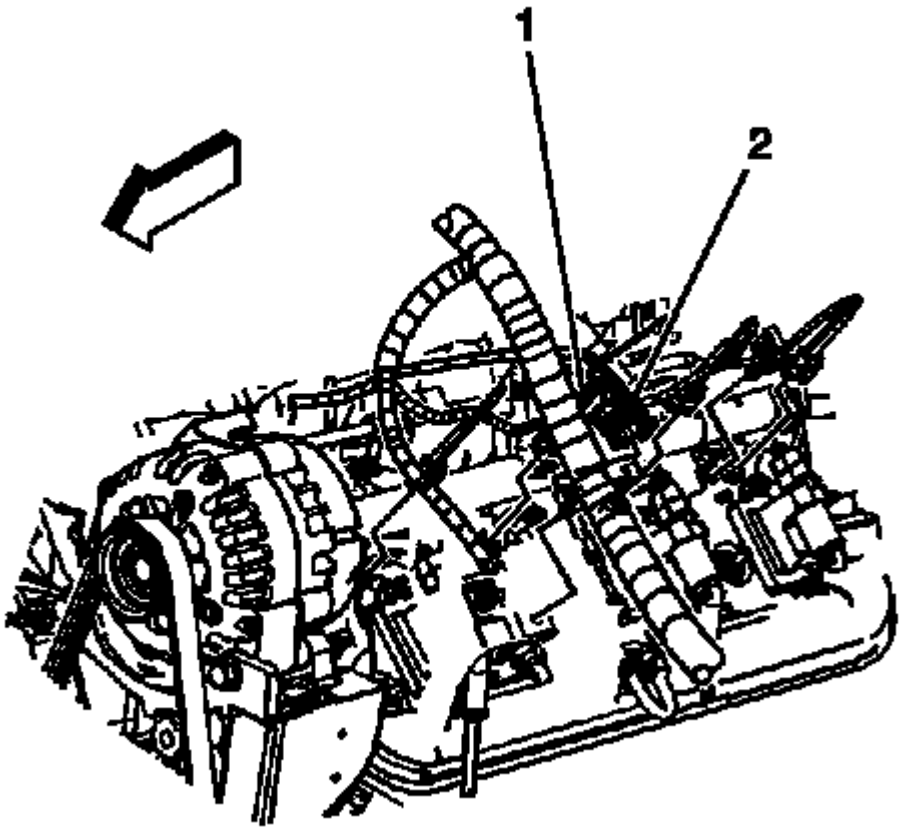

Fig. 67: View Of Main Ignition Coil Wire Harness Connector & Clips
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plug wires to the ignition coils.
10. Position the engine harness, if necessary.
11. Install the harness clips (1).
12. Connect the main electrical connector (2) to the ignition coil wire harness.
13. Install the CPA lock.
14. Install the engine cover. Refer to **Engine Cover Replacement** .

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

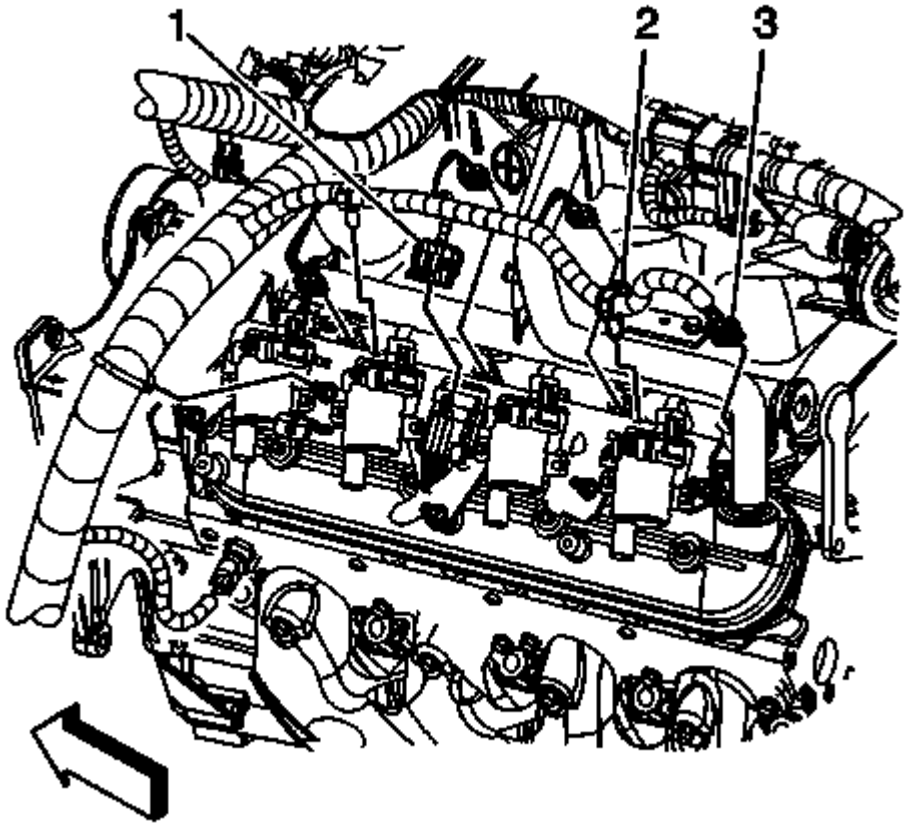

Fig. 68: Identifying main electrical connector
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the upper transmission fill tube. Refer to **Transmission Fluid Filler Tube and Seal Replacement** .
3. Remove the oil fill tube. Refer to **Oil Level Indicator Tube Replacement**.
4. Disconnect the main electrical connector (1) to the ignition coil wire harness.
5. Remove the harness clips (2).
6. Reposition the engine harness, if necessary.
7. Remove the spark plug wires from the ignition coils:
   - Twist each plug wire 1/2 turn.
   - Pull only on the boot in order to remove the wire from the ignition coil.

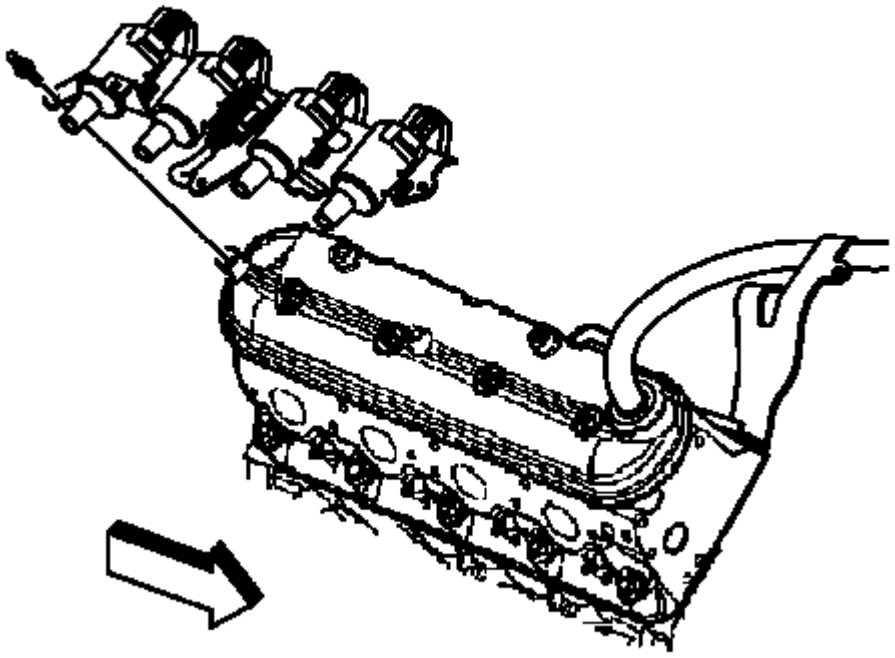

Fig. 69: View Of Right Cover Ignition Coil & Bracket Assembly, Bolts & Wire Harness
Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coil bracket studs from the rocker arm cover.
9. Remove the ignition coils and bracket from the rocker cover.

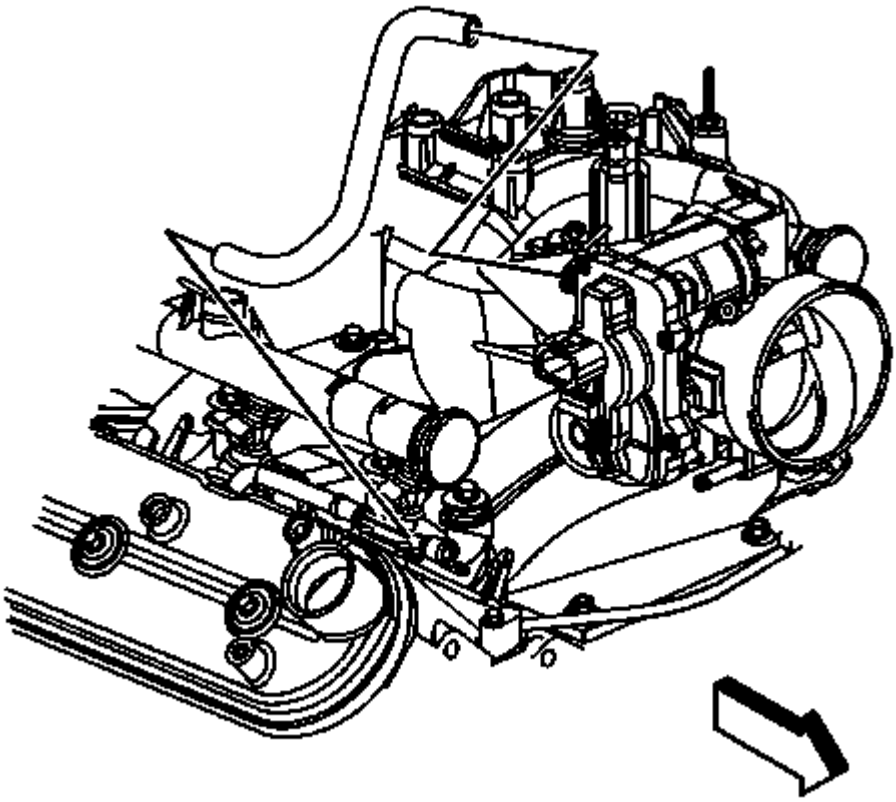

Fig. 70: Identifying vent hose
Courtesy of GENERAL MOTORS CORP.

10. Remove the vent hose from the valve rocker arm cover.

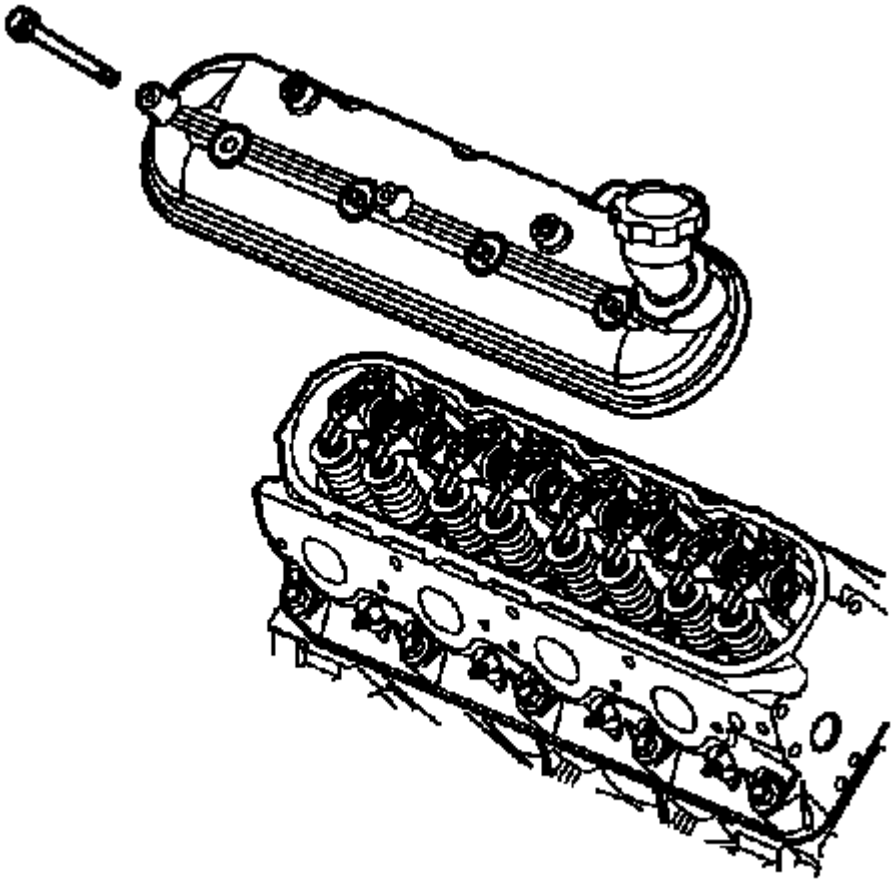

Fig. 71: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

11. Remove the valve rocker arm cover bolts.
12. Remove the valve rocker arm cover.

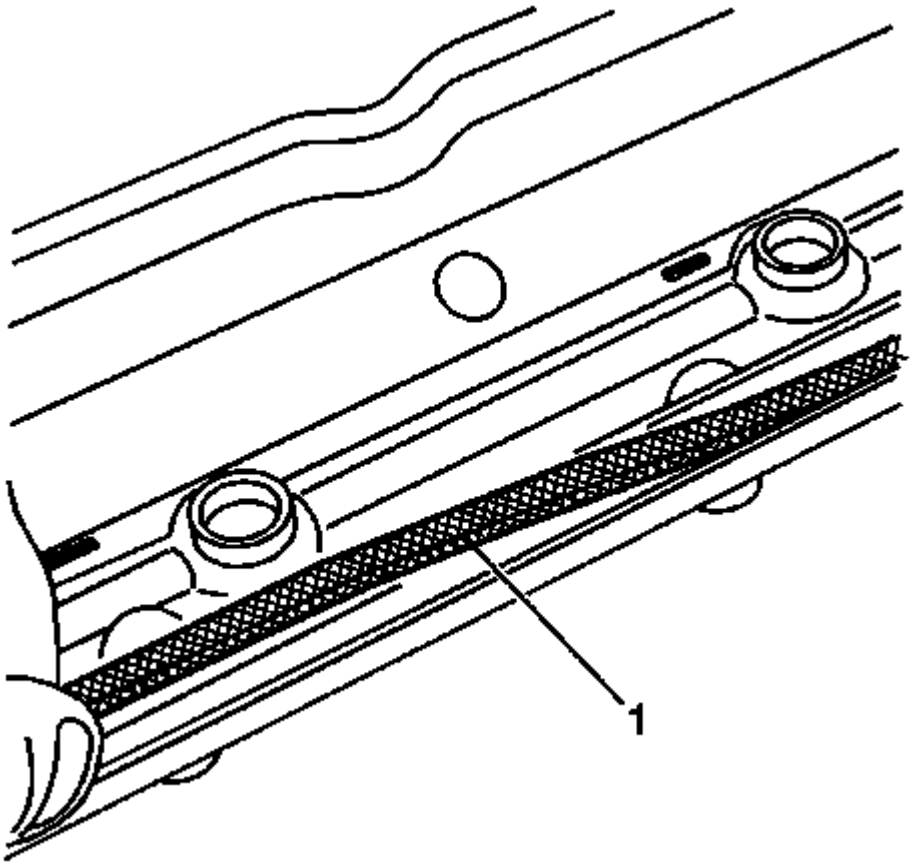

Fig. 72: View Of Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

13. Remove the gasket (1) from the rocker cover.
14. Discard the OLD gasket.

INSTALLATION PROCEDURE

NOTE:

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **DO NOT reuse the valve rocker arm cover gasket.**
- **The valve rocker arm cover bolt grommets may be reused.**

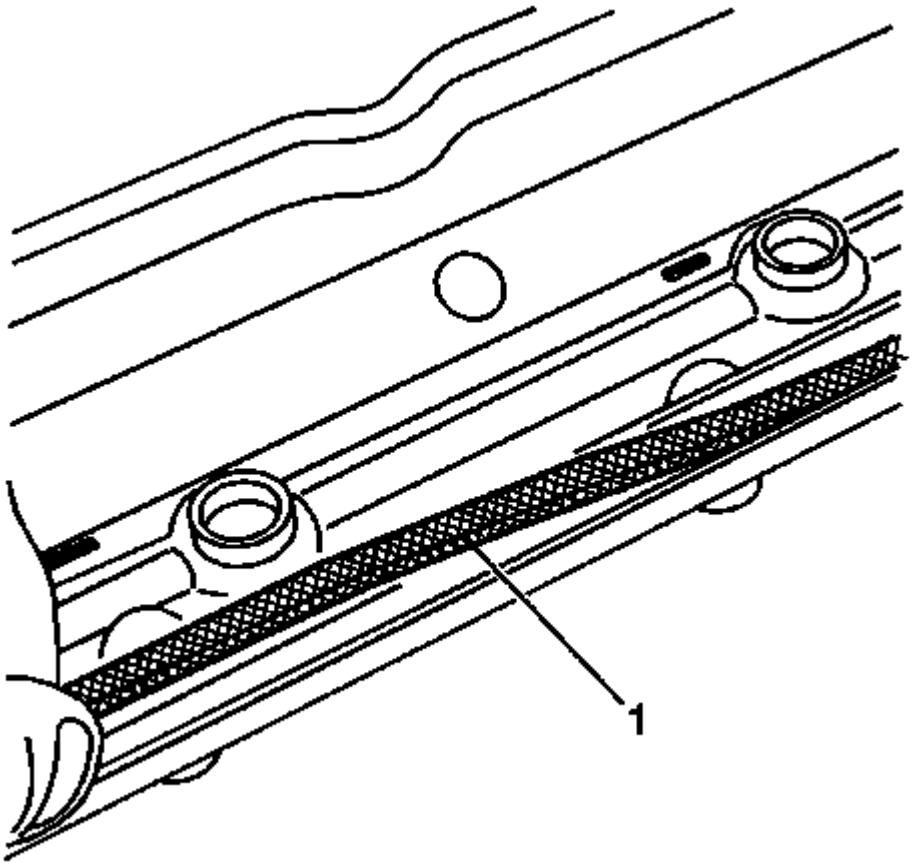

Fig. 73: View Of Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW rocker cover gasket (1) into the valve rocker arm cover.

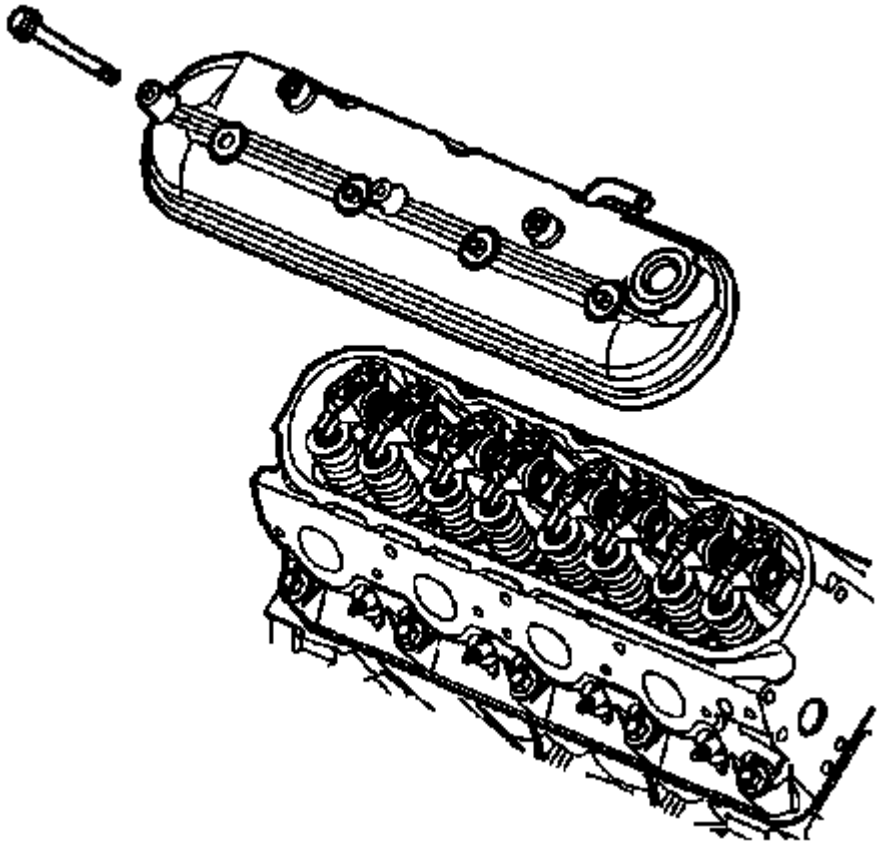

Fig. 74: Valve Rocker Arm Cover Onto Cylinder Head
Courtesy of GENERAL MOTORS CORP.

2. Install the valve rocker arm cover onto the cylinder head.
3. Install new rocker arm cover grommets, if necessary.

CAUTION: Refer to Fastener Caution .

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

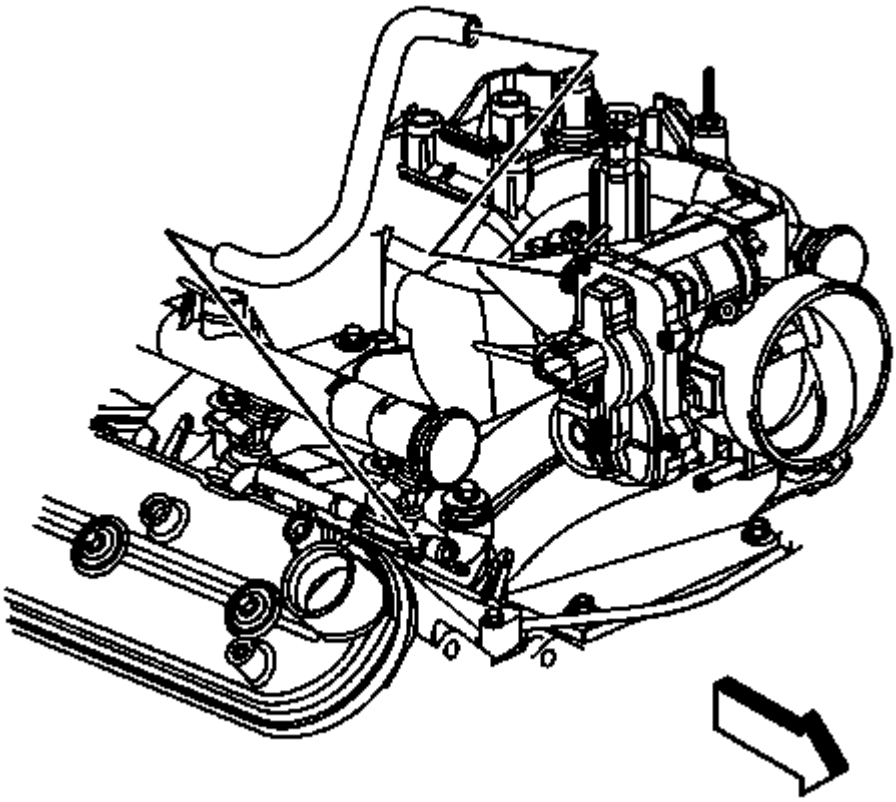

Fig. 75: Identifying vent hose
Courtesy of GENERAL MOTORS CORP.

5. Install the vent hose to the valve rocker arm cover.

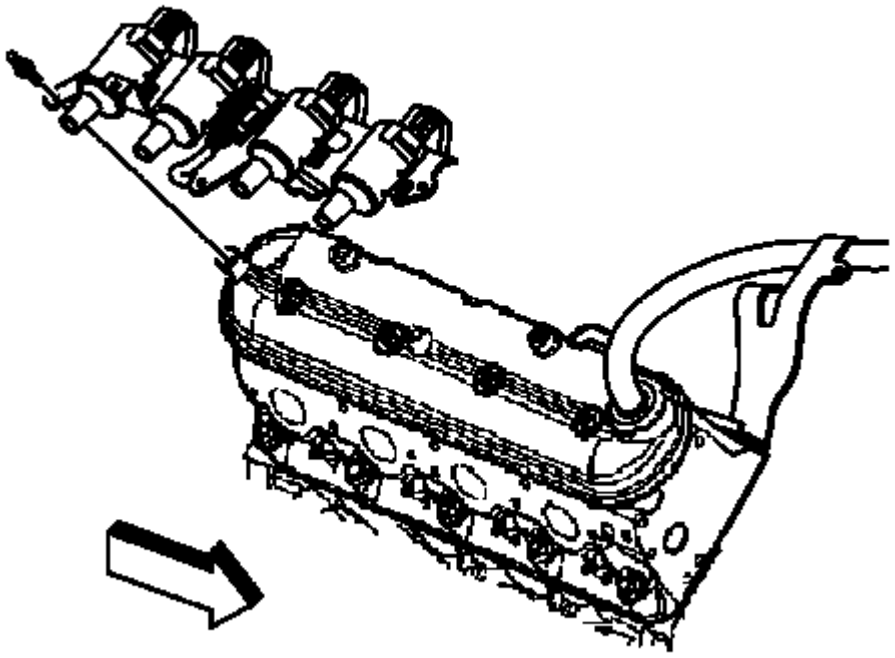

Fig. 76: View Of Right Cover Ignition Coil & Bracket Assembly, Bolts & Wire Harness
Courtesy of GENERAL MOTORS CORP.

6. Apply threadlock to the threads of the bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
7. Install the ignition coils and bracket to the rocker arm cover.
8. Install the ignition coil bracket studs to the rocker cover and tighten to 12 N.m (106 lb in).

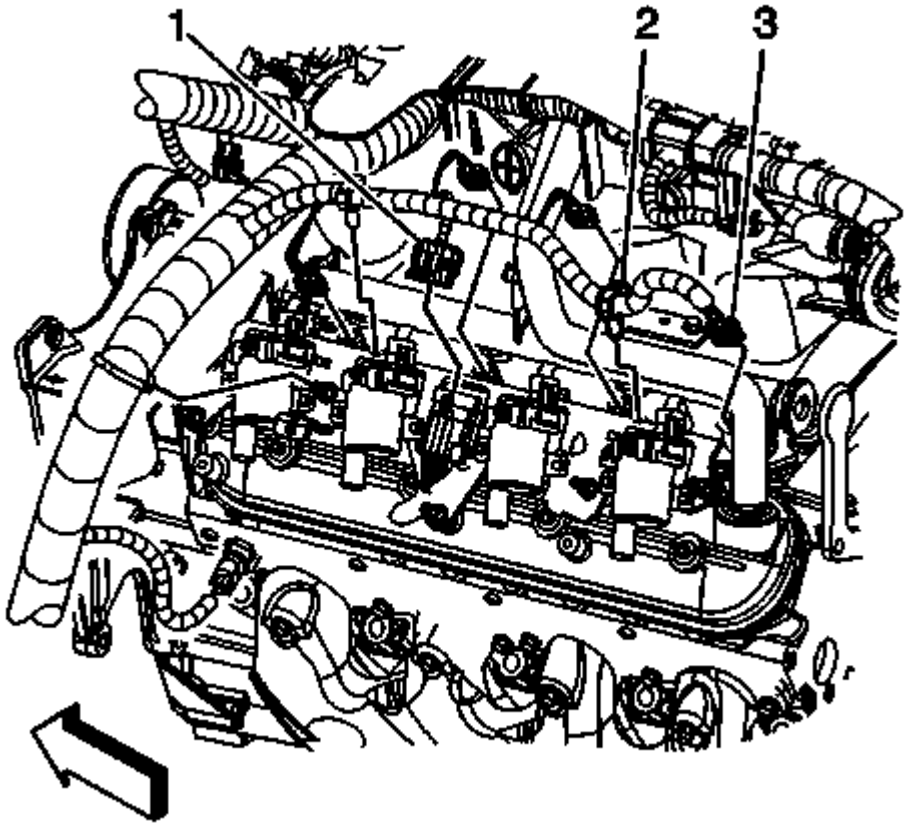

Fig. 77: Identifying main electrical connector
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plug wires to the ignition coils.
10. Position the engine harness, if necessary.
11. Install the harness clips (2).
12. Connect the main electrical connector (1) feeding the ignition coils.
13. Install the CPA lock.
14. Install the oil fill tube. Refer to **Oil Level Indicator Tube Replacement**.
15. Install the upper transmission fill tube. Refer to **Transmission Fluid Filler Tube and Seal Replacement** .
16. Install the engine cover. Refer to **Engine Cover Replacement** .

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

REMOVAL PROCEDURE

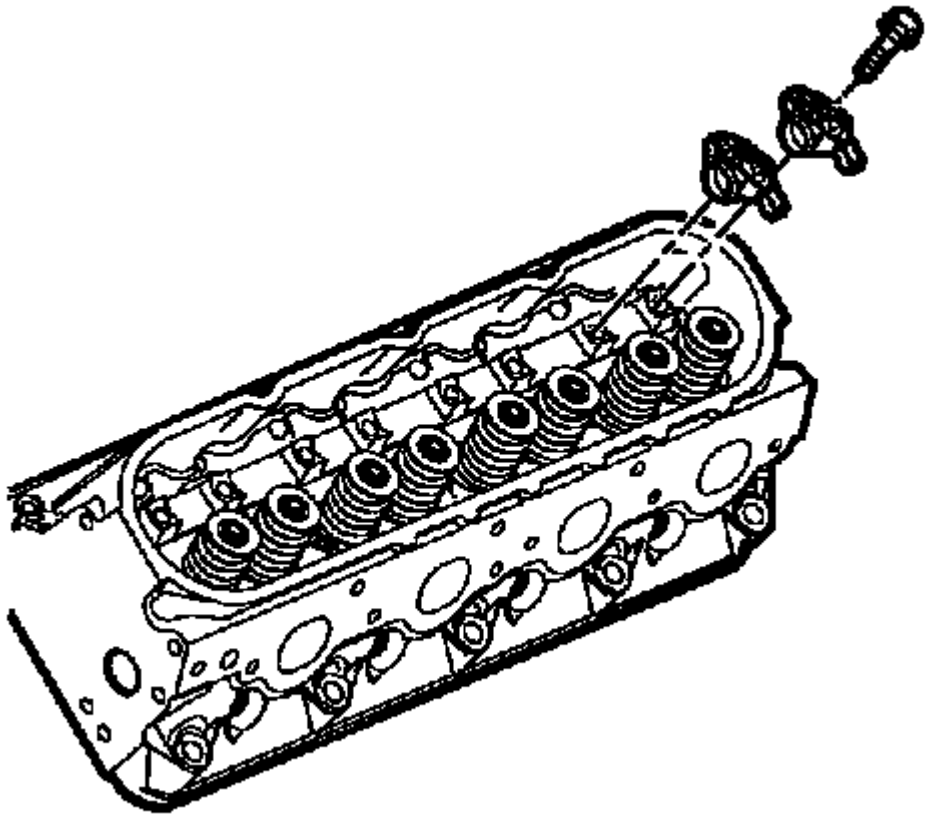

Fig. 78: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the valve rocker arms, pushrods, and pivot support, in a rack so that the can be installed in the same location from which they were removed.

1. Remove the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.
2. Remove the valve rocker arm bolts.
3. Remove the valve rocker arms.

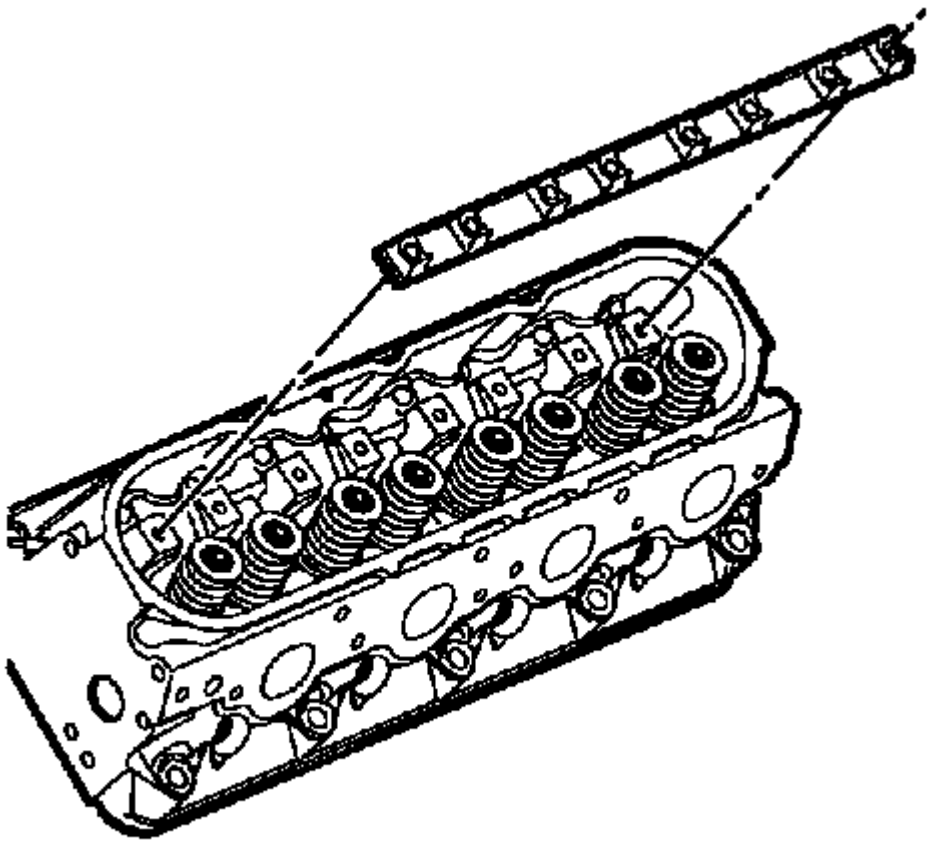

Fig. 79: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve rocker arm pivot support.

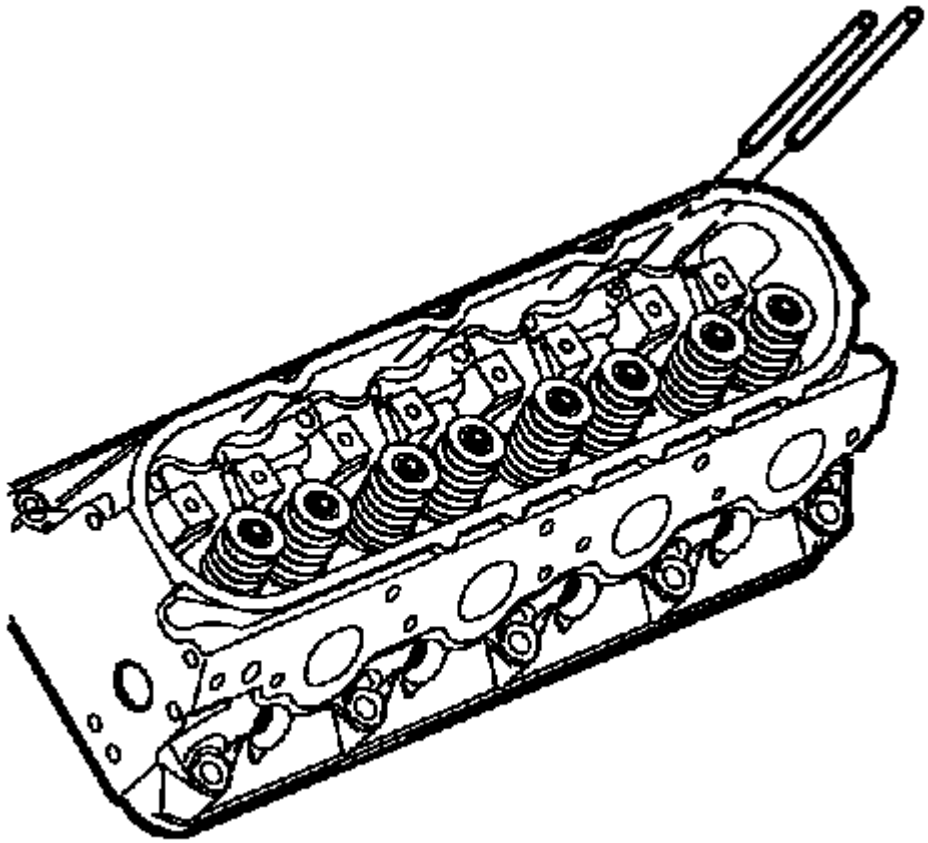

Fig. 80: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

5. Remove the pushrods.
6. Clean and inspect the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: When reusing the valve train components, always install the components to the original location and position.

Valve lash is net build, no valve adjustment is required.

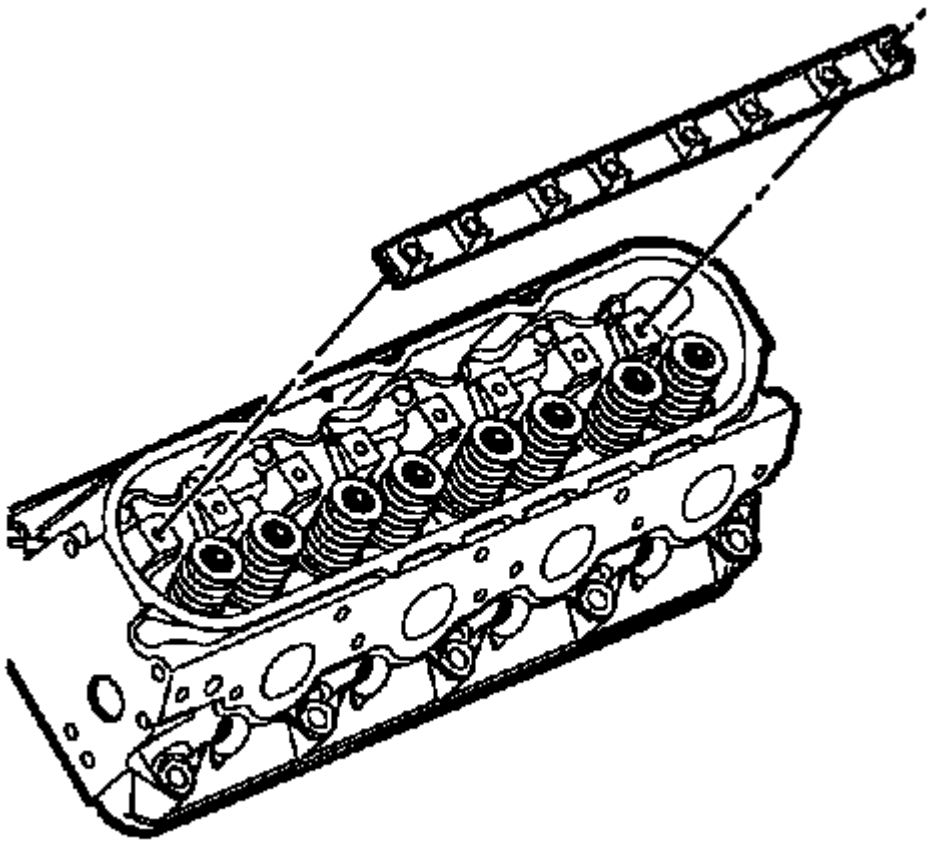

Fig. 81: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.

   Lubricate the flange or washer surface of the bolt that will contact the valve rocker arm.

3. Install the valve rocker arm pivot support.

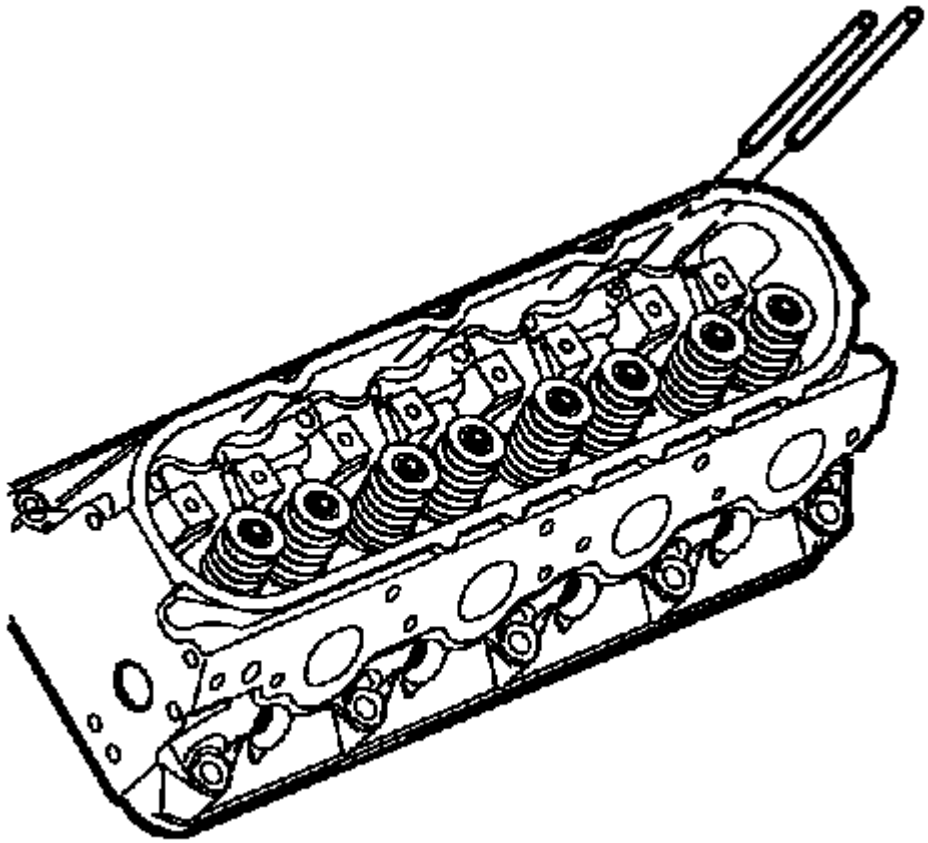

Fig. 82: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

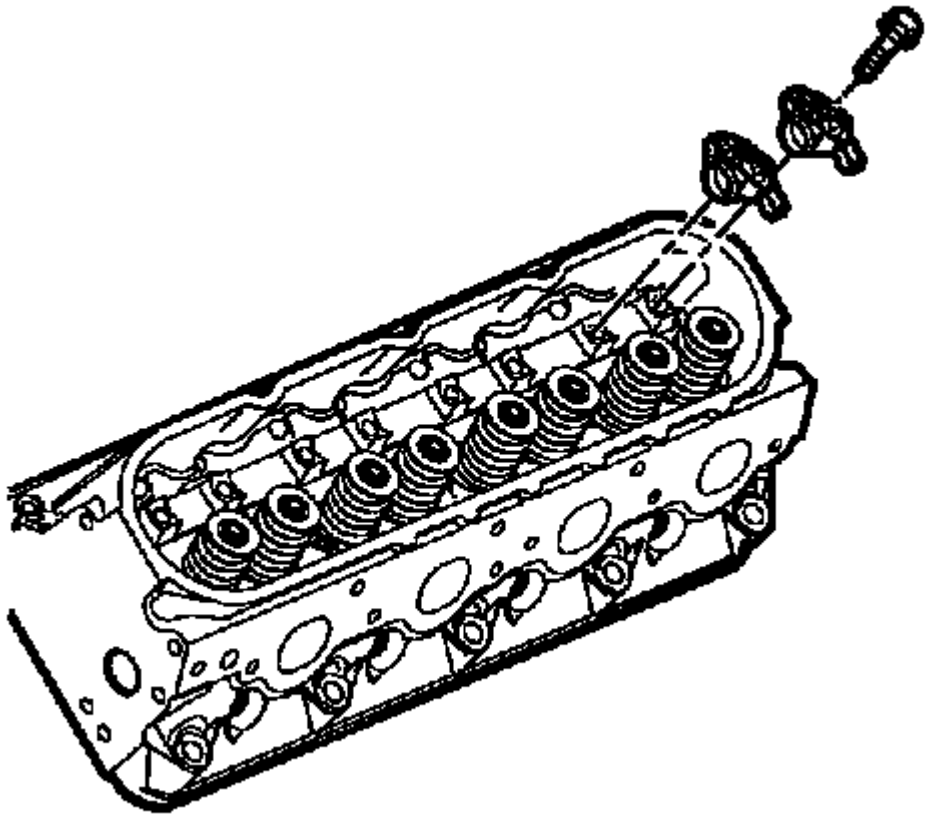

Fig. 83: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure that the pushrods seat properly to the ends of the rocker arms. DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

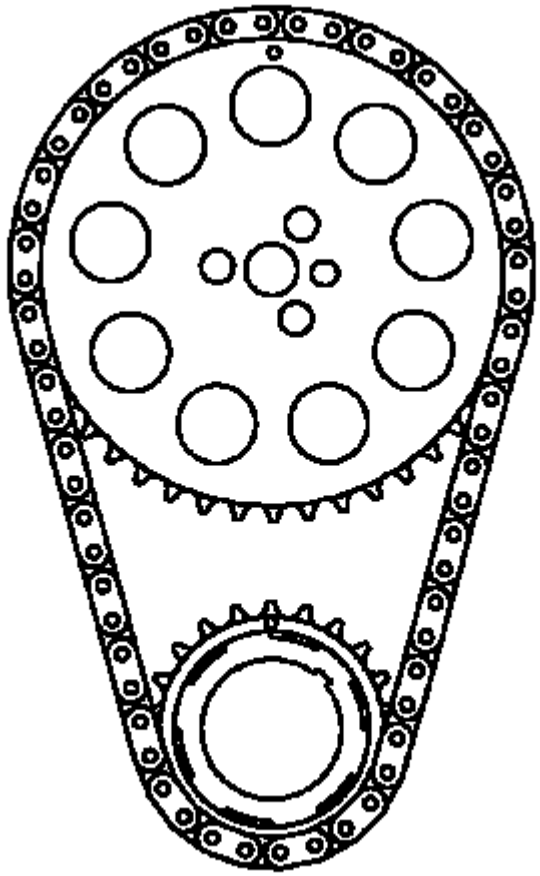

Fig. 84: View of Crankshaft/Camshaft In Position For Number 1 Piston At TDC
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Rotate the crankshaft until the number one piston is at top dead center (TDC) of the compression stroke.

   In this position, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5 and 7 are the left bank.

   Cylinder 2, 4, 6 and 8 are the right bank.

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:
   - Tighten the cylinders 1, 2, 7 and 8 exhaust valve rocker arm bolts to 30 N.m (22 lb ft).

- Tighten the cylinders 1, 3, 4 and 5 intake valve rocker arm bolts to 30 N.m (22 lb ft).

8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
   - Tighten the cylinders 3, 4, 5 and 6 exhaust valve rocker arm bolts to 30 N.m (22 lb ft).
   - Tighten the cylinders 2, 6, 7 and 8 intake valve rocker arm bolts to 30 N.m (22 lb ft).
10. Install the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **J 22794** Spark Plug Port Adapter
- **J 38606** Valve Spring Compressor
- **J 42078** Valve Stem Oil Seal Installer

REMOVAL PROCEDURE

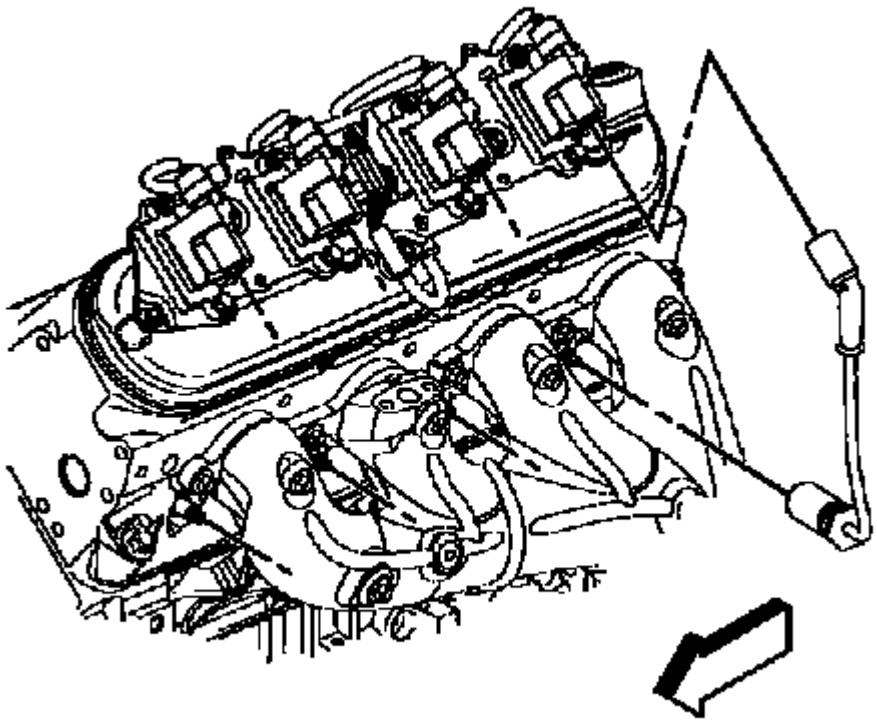

Fig. 85: View Of Spark Plug Wire & Boot
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.
2. Disconnect the spark plug wire at the spark plug.
   - Twist each plug wire boot 1/2 turn.
   - Pull only on the boot in order to remove the wire from the spark plug.

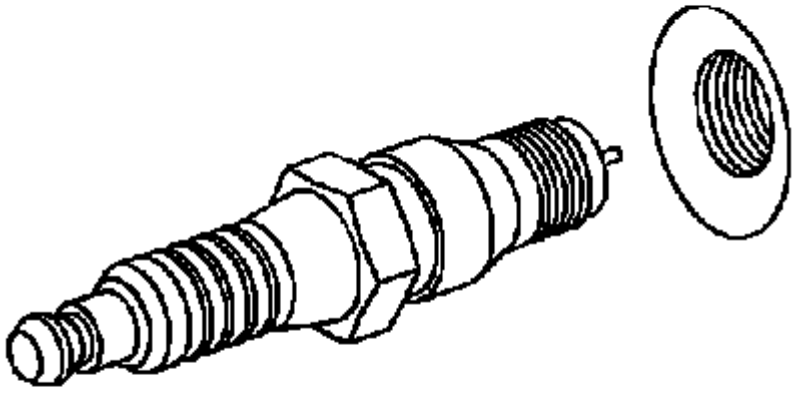

Fig. 86: View Of Spark Plug & Spark Plug Seat
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove the spark plugs from the cylinder head with the engine at room temperature.

3. Loosen the spark plug 1 or 2 turns.
4. Brush or air blast away any dirt or debris from around the spark plug.
5. Remove the spark plug.

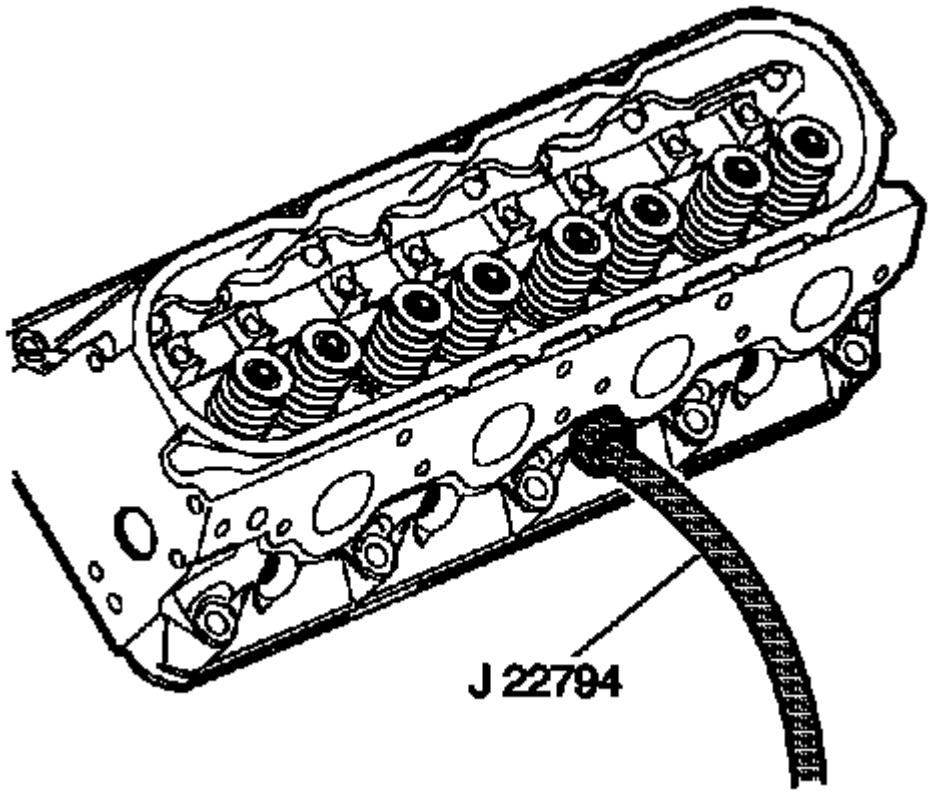

Fig. 87: Applying Compressed Air To J 22794
Courtesy of GENERAL MOTORS CORP.

6. Install **J 22794** into the spark plug hole.
7. Attach an air hose to **J 22794** .
8. Apply compressed air to **J 22794** in order to hold the valves in place.

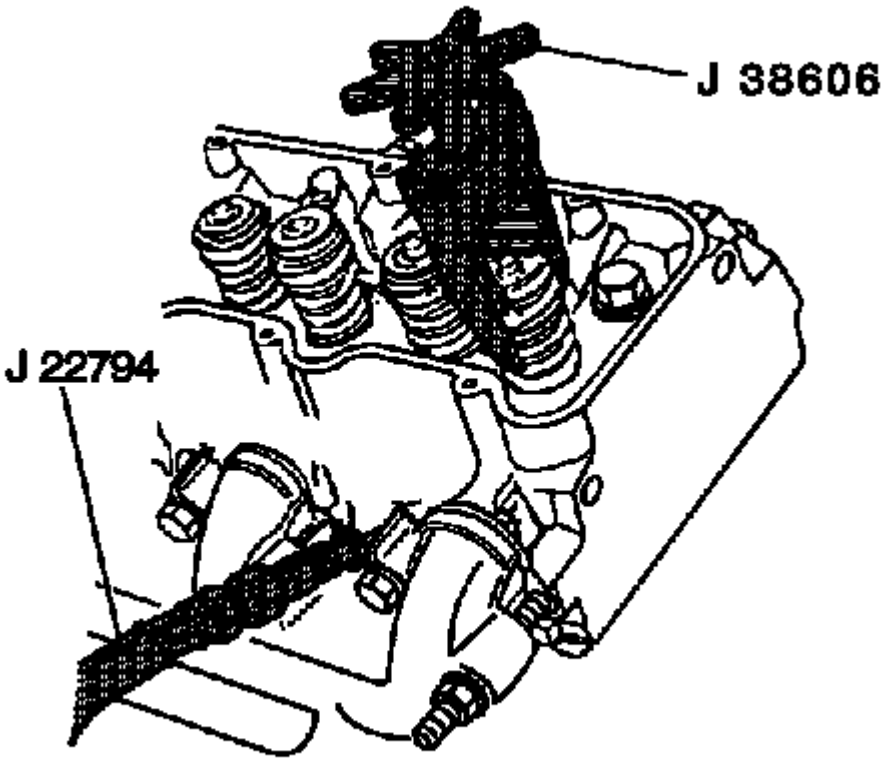

Fig. 88: View Of Special Tools J 38606 & J 5892-D Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

9. Use **J 38606** in order to compress the valve spring.

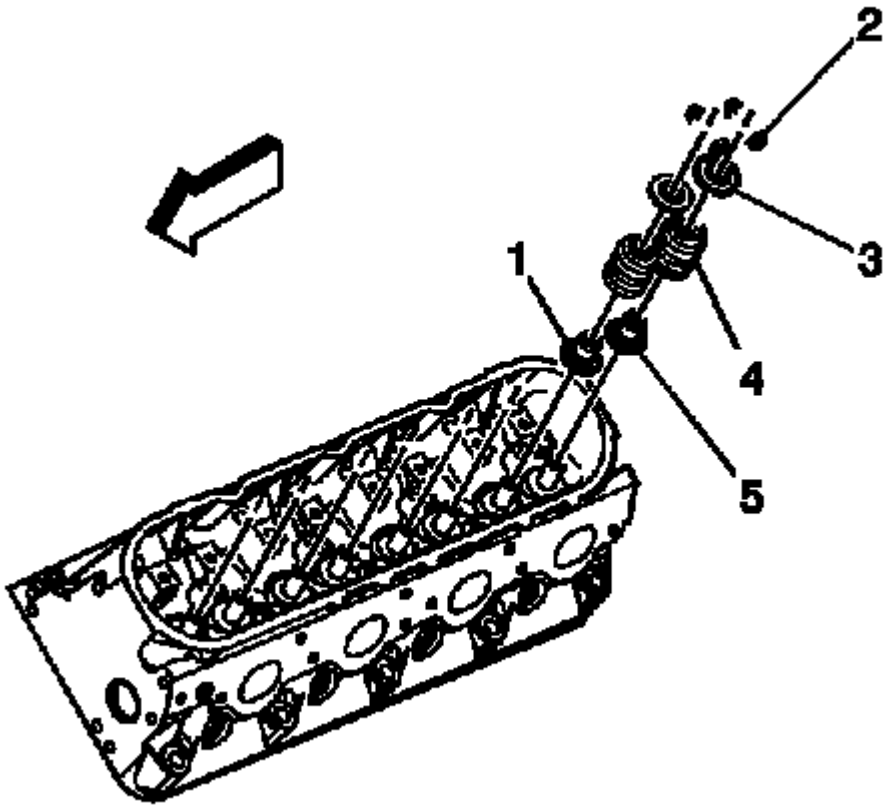

Fig. 89: View Of Valve Stem & Valve Spring Components
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve stem keys (2).
11. Carefully release the valve spring tension.
12. Remove the **J 38606** .
13. Remove the valve spring cap (3).
14. Remove the valve spring (4).
15. Remove the valve stem oil seal and shim (1, 5).

INSTALLATION PROCEDURE

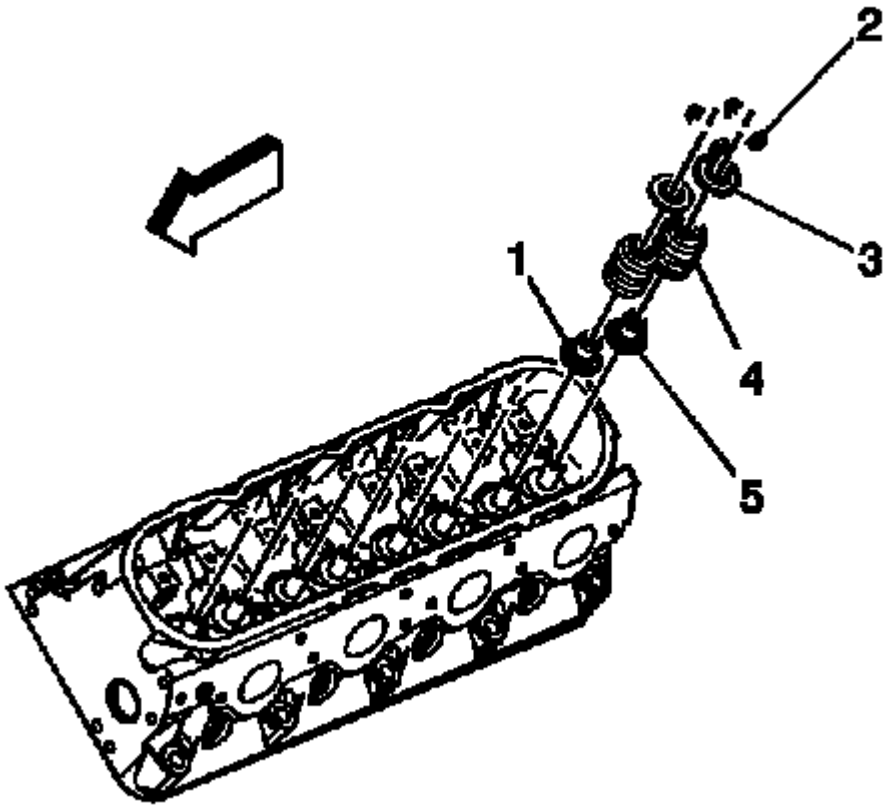

Fig. 90: View Of Valve Stem & Valve Spring Components
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring seat and/or shim area.
2. Lubricate the valve guide and valve stem oil seal with clean engine oil.
3. Install the valve stem oil seal and shim (1, 5).
4. Install the valve spring (4).
5. Install the valve spring cap (3).

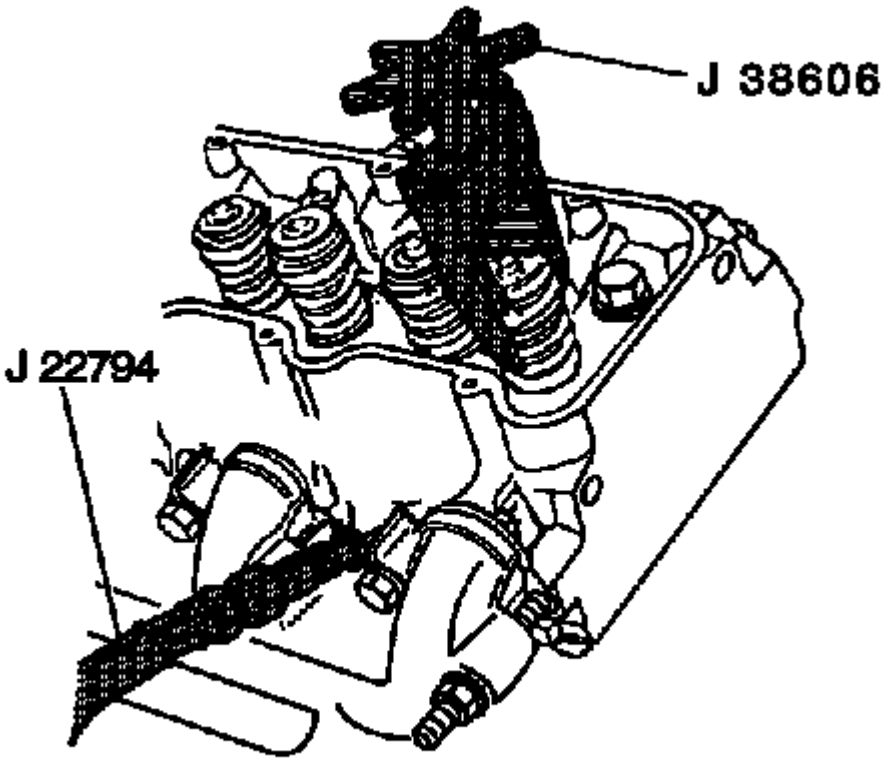

Fig. 91: View Of Special Tools J 38606 & J 5892-D Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

6. Compress the valve spring using the **J 38606** .
7. Install the valve keys:
    - Use grease in order to hold the valve keys in place.
    - Make sure the keys seat properly in the groove of the valve stem.
    - Carefully release the valve spring pressure, making sure the valve keys stay in place.
    - Remove the **J 38606** .
    - Tap the end of the valve stem with a plastic faced hammer to seat the keys (if necessary).

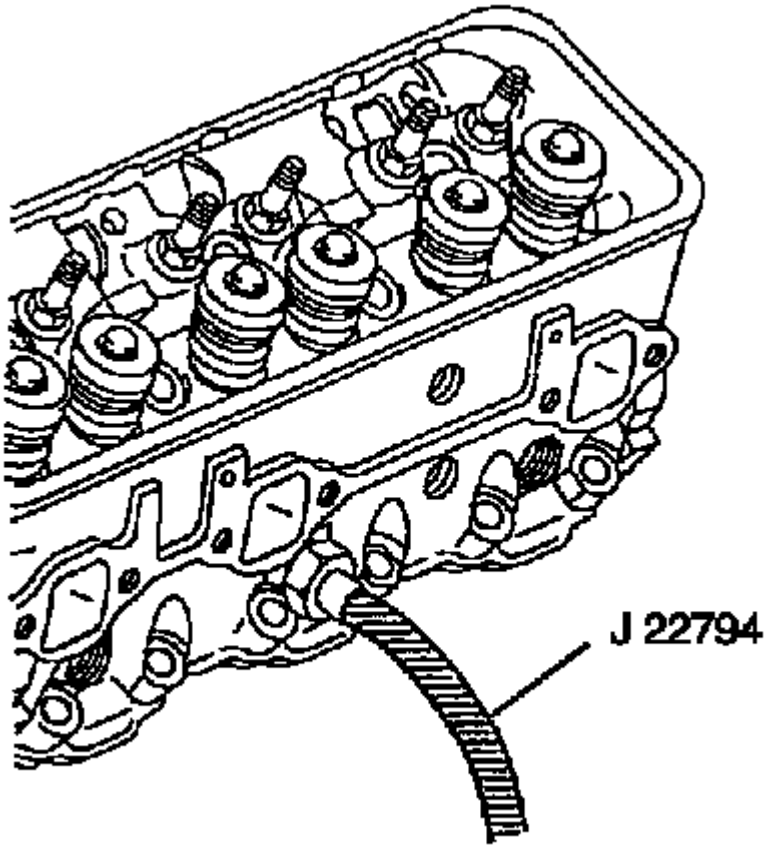

Fig. 92: View Of Special Tool J 22794 In Spark Plug Port
Courtesy of GENERAL MOTORS CORP.

8. Remove **J 22794** from the spark plug port.

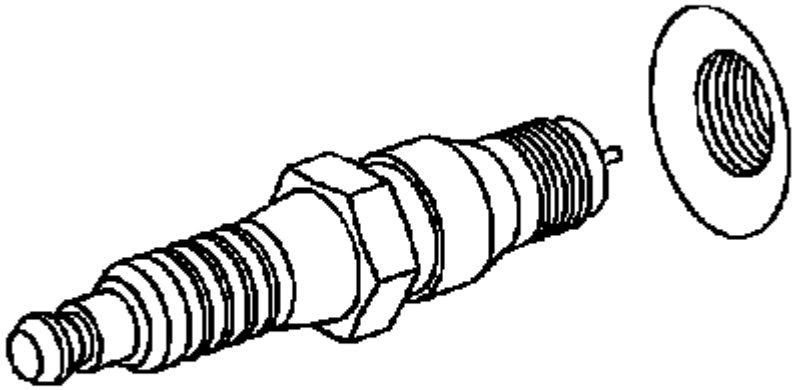

Fig. 93: View Of Spark Plug & Spark Plug Seat
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

9. Hand start the spark plug and tighten to 15 N.m (11 lb ft).
10. Install the spark plug wires at the ignition coil.
11. Install the spark plug wire to the spark plug.
12. Inspect the wires for proper installation:
    - Push sideways on each boot in order to check for proper installation.
    - Reinstall any loose boot.
13. Install the valve rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

2. Remove the retaining bolt for the coolant recovery reservoir and set the reservoir aside.

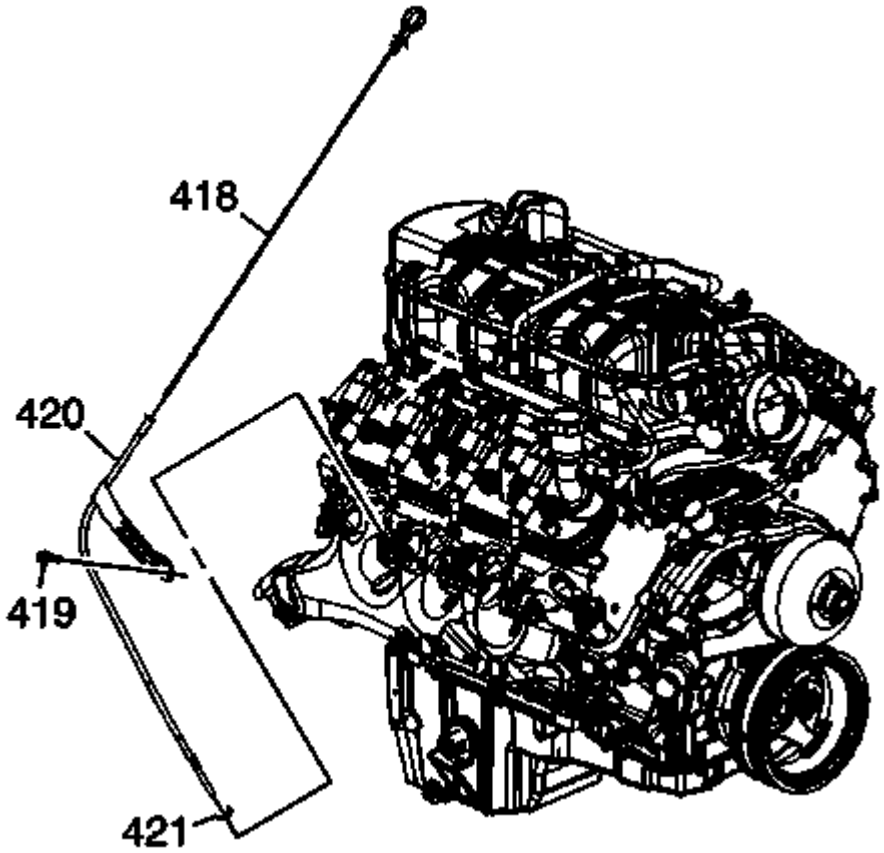

Fig. 94: View Of Oil Level Indicator, Tube Bolt, Indicator Tube & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil level indicator (418).
4. Remove the oil level indicator tube bolt (419).
5. Remove the oil level indicator tube (420) from the engine block.

NOTE: The O-ring may be reused if not cut or damaged.

6. Inspect the O-ring seal for cuts or damage.
7. Remove the O-ring seal (421) from the tube, if required.

INSTALLATION PROCEDURE

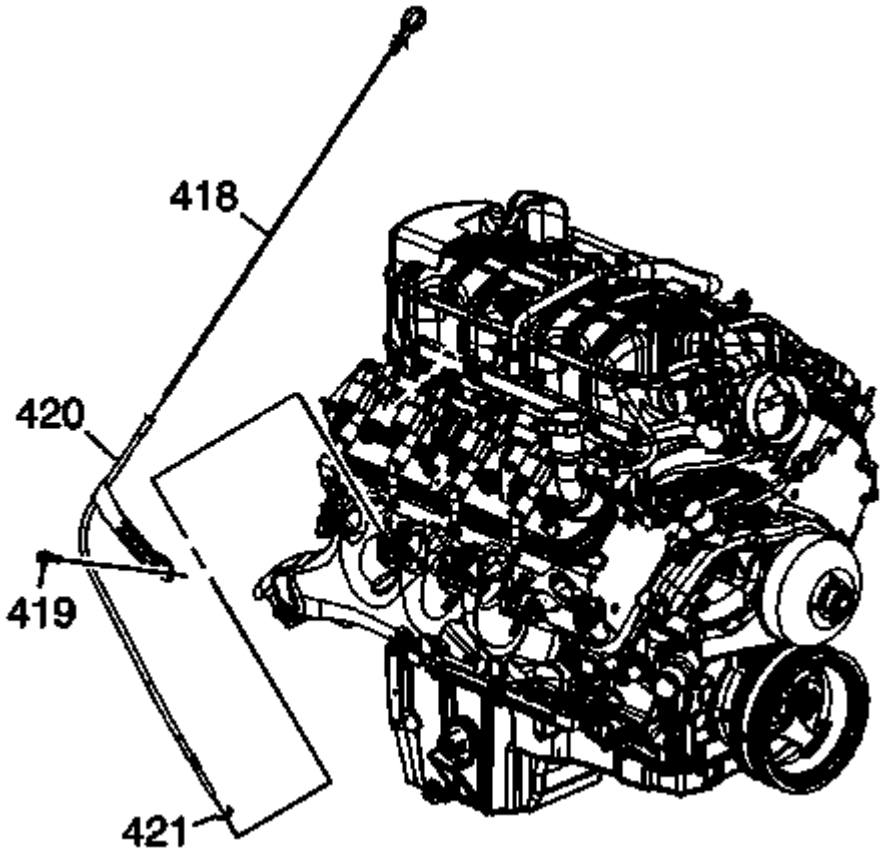

Fig. 95: View Of Oil Level Indicator, Tube Bolt, Indicator Tube & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seal (421) with clean engine oil.
2. Install a NEW O-ring seal onto the oil level indicator tube, if required.
3. Install the oil level indicator tube (420) between the exhaust manifold and engine block.
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Insert the oil level indicator tube into the block.

   The tube must be installed with the collar flush to the block.

6. Lower the vehicle.

CAUTION: Refer to Fastener Caution .

7. Install the oil level indicator tube bolt (419) and tighten to 25 N.m (18 lb ft).
8. Install the oil level indicator (418).
9. Position the coolant recovery reservoir and install the retaining bolt.

10. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

- **J 45059** Angle Meter
- **J 42385-200** Thread Repair Kit. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the generator bracket. Refer to **Generator Replacement (V8)** .
3. Remove the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (With LH8)** .
4. Remove the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (4.8L/5.3L/6.0L)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

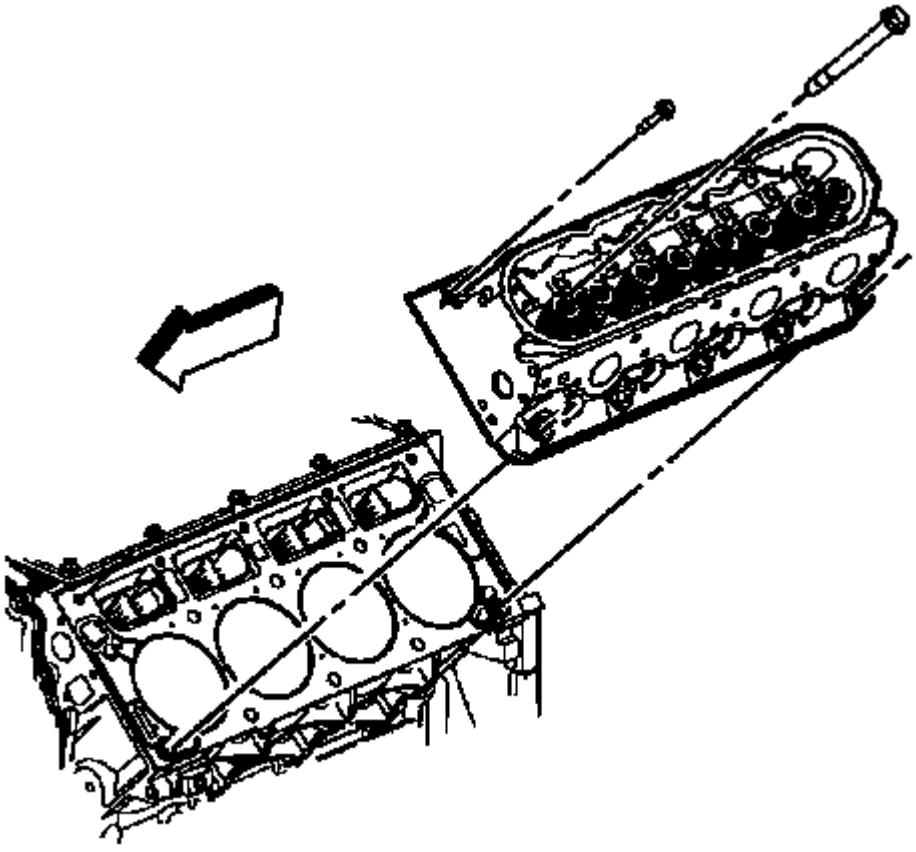

Fig. 96: View Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

6. Remove the cylinder head bolts.
7. Remove the cylinder head.

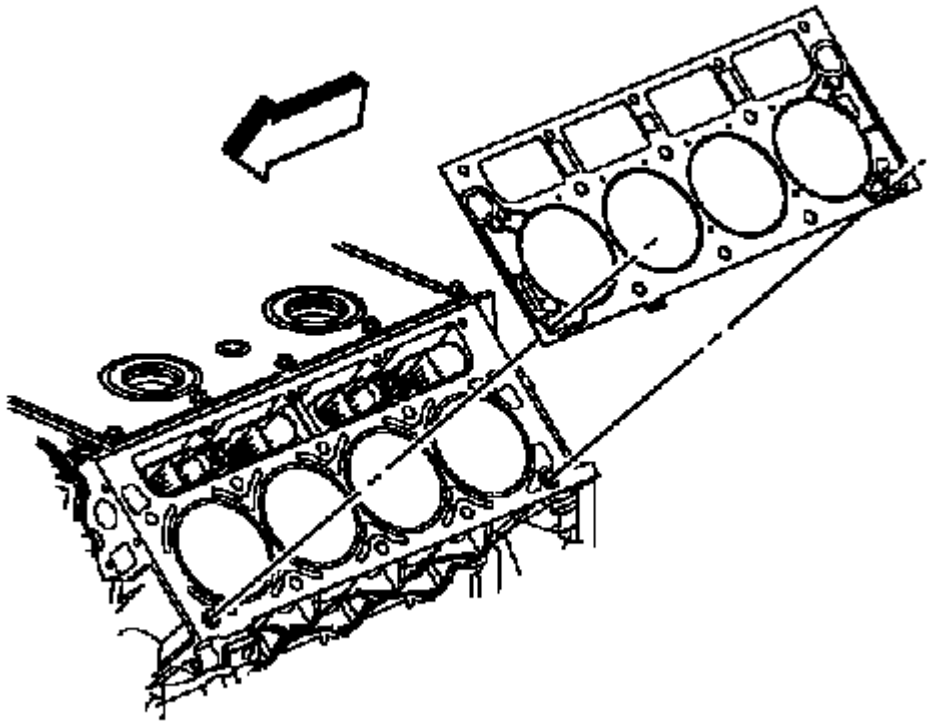

Fig. 97: View Of Left Cylinder Head Gasket & Locator Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head gasket.
9. Discard the gasket.
10. Discard the cylinder head bolts.
11. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

WARNING: Wear safety glasses in order to avoid eye damage.

CAUTION: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

NOTE:

- **Do not reuse the cylinder head bolts. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket (unless specified).**
- **The cylinder head gaskets must be installed in the proper direction and position.**

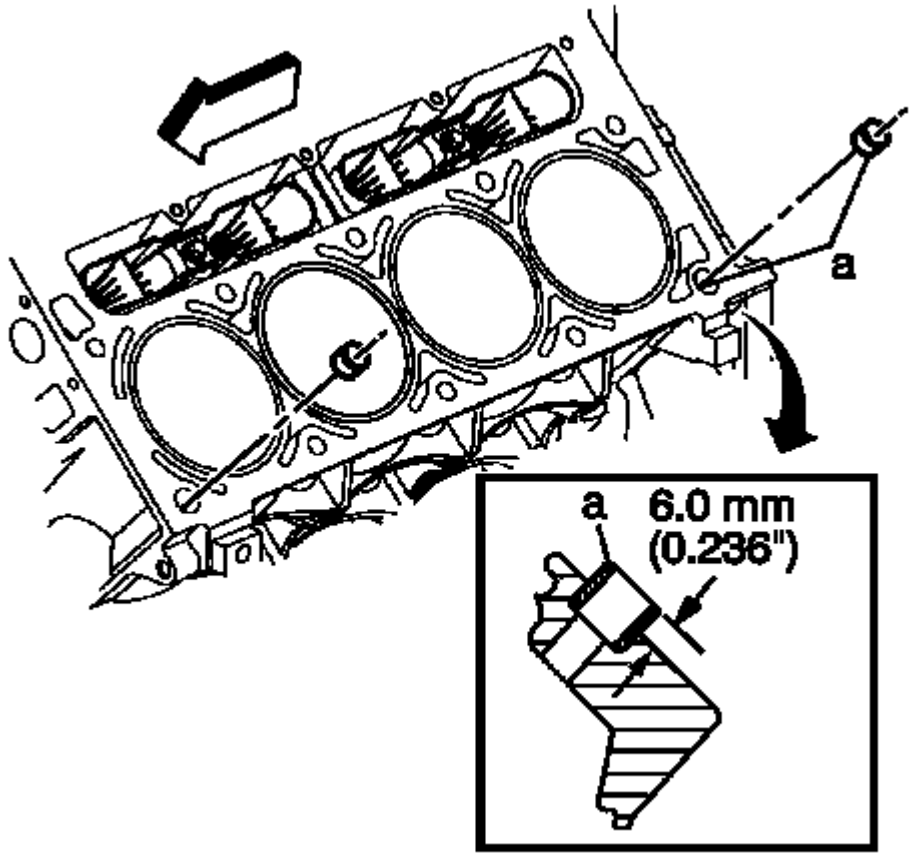

Fig. 98: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes (if required).

   Thread repair tool J 42385-107, found in **J 42385-200** may be used to clean the threads of old threadlocking material. See **Special Tools** .

2. Spray cleaner into the holes. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

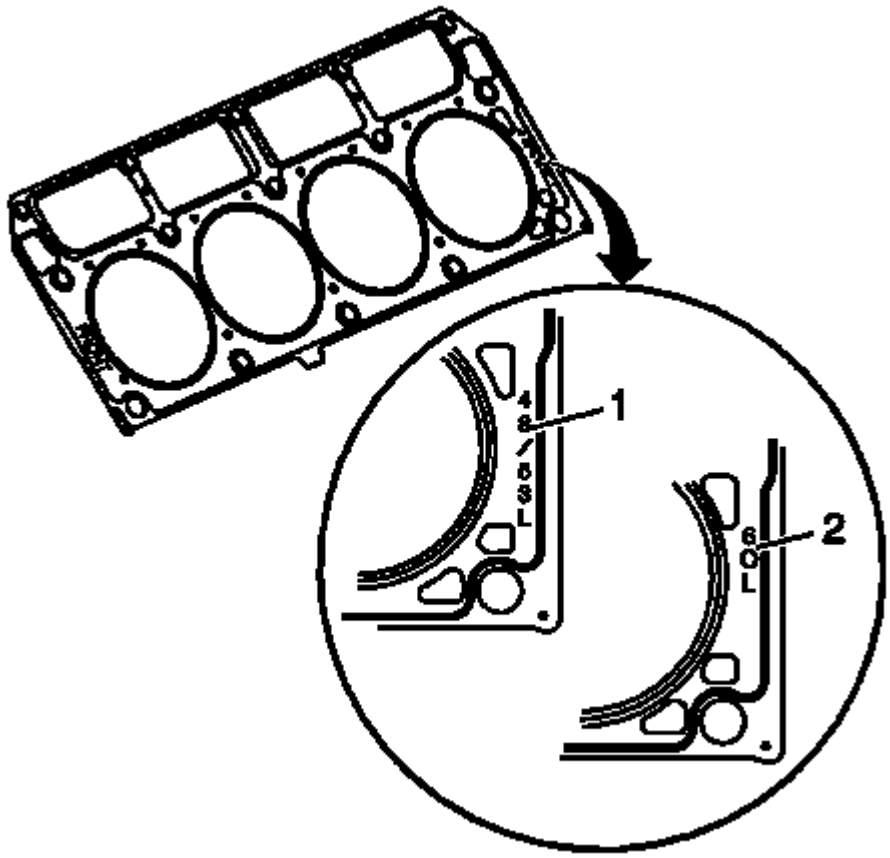

Fig. 99: View Of Cylinder Head Gasket Displacement Markings
Courtesy of GENERAL MOTORS CORP.

NOTE: When properly installed, the tab on the left cylinder head gasket will be located left of center or closer to the front of the engine.

5. Inspect the displacement markings (1) on the gasket for proper usage.

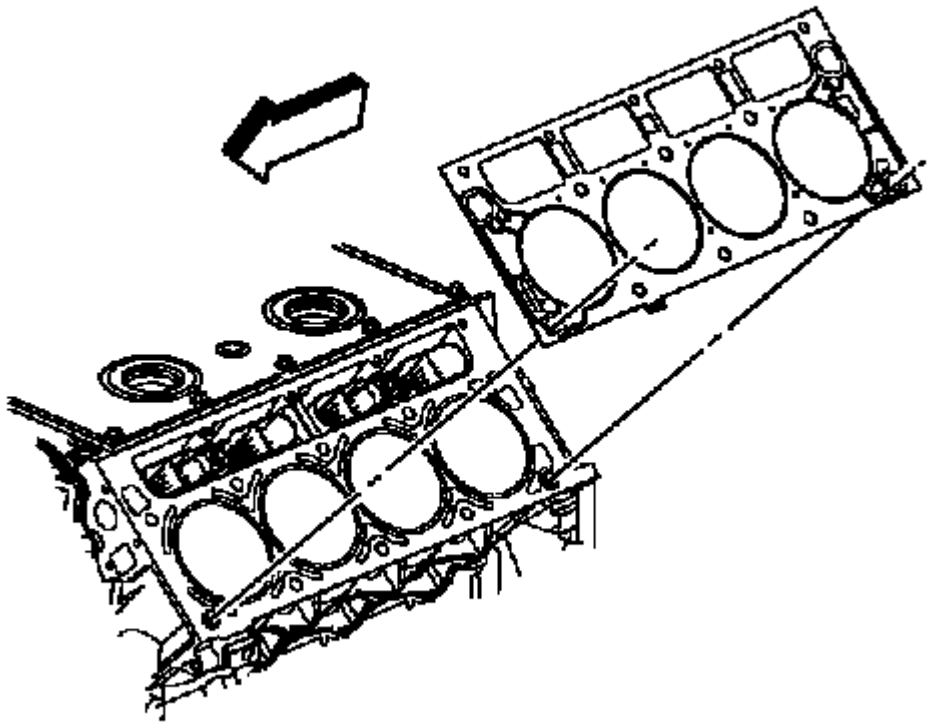

Fig. 100: View Of Left Cylinder Head Gasket & Locator Pins
Courtesy of GENERAL MOTORS CORP.

6. Install the NEW left cylinder head gasket onto the locating pins.

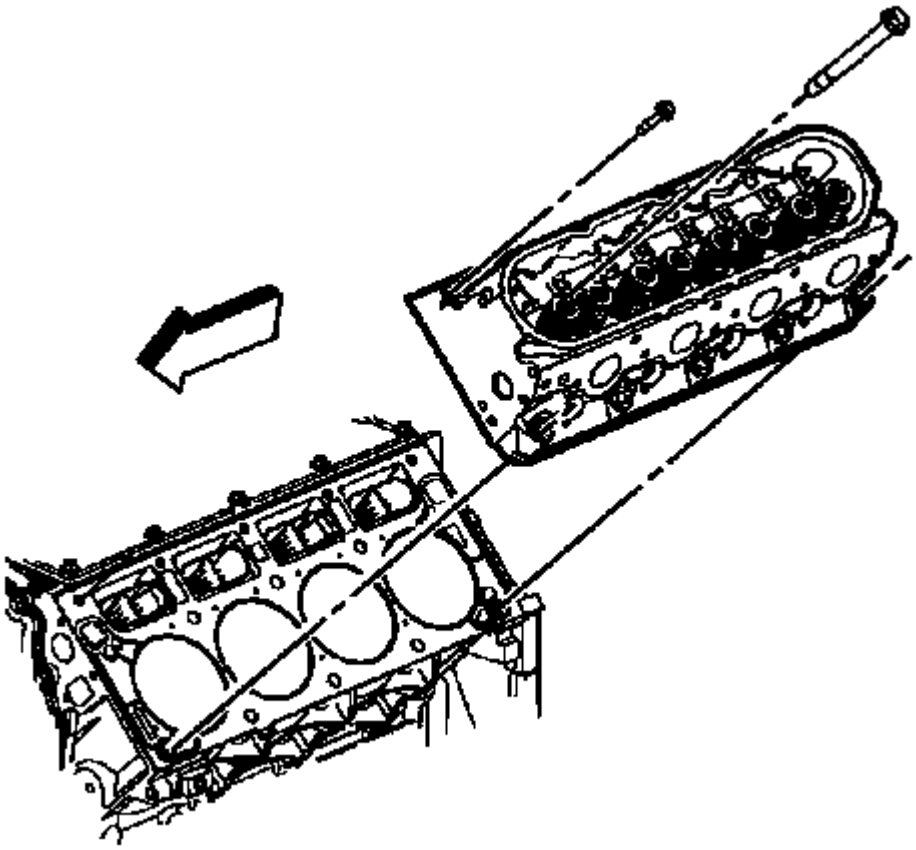

Fig. 101: View Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Install the cylinder head onto the locating pins and gasket.
8. Install the NEW cylinder head bolts.

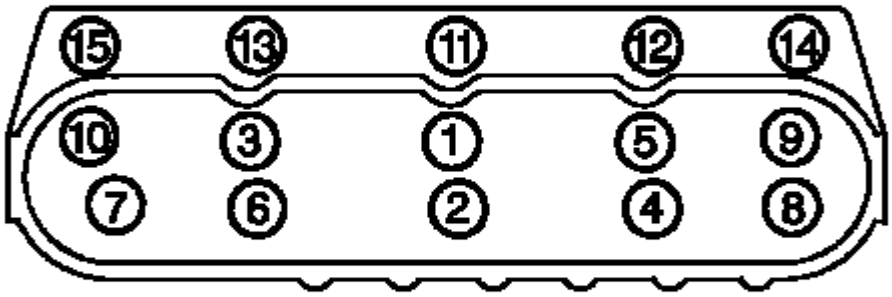

Fig. 102: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1, 10) a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts (1, 10) a second pass in sequence to 90 degrees using **J 45059** .
    3. Tighten the M11 cylinder head bolts (1, 10) a final pass in sequence to 70 degrees using **J 45059** .
    4. Tighten the M8 cylinder head bolts (11, 15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (4.8L/5.3L/6.0L)** .
12. Install the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (With LH8)** .
13. Install the generator bracket. Refer to **Generator Replacement (V8)** .
14. Install the engine cover. Refer to **Engine Cover Replacement** .

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

SPECIAL TOOLS

- **J 45059** Angle Meter
- **J 42385-200** Thread Repair Kit. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
3. Remove the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (With LH8)** .
4. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.8L/5.3L/6.0L)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

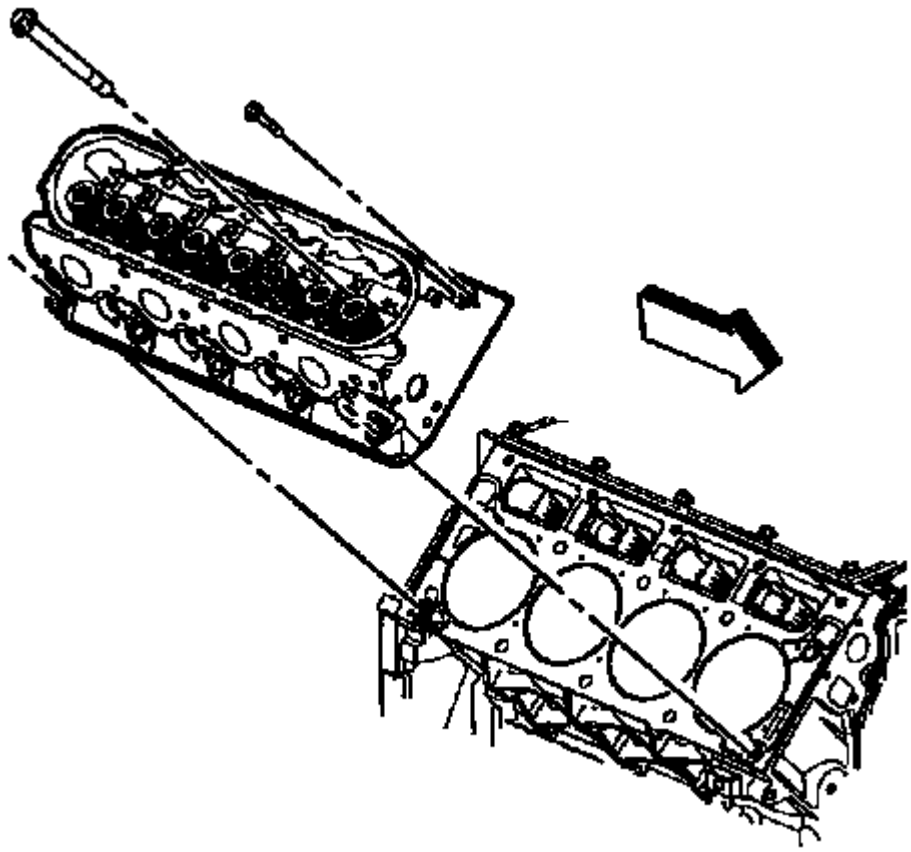

Fig. 103: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

6. Remove the cylinder head bolts.
7. Remove the cylinder head.

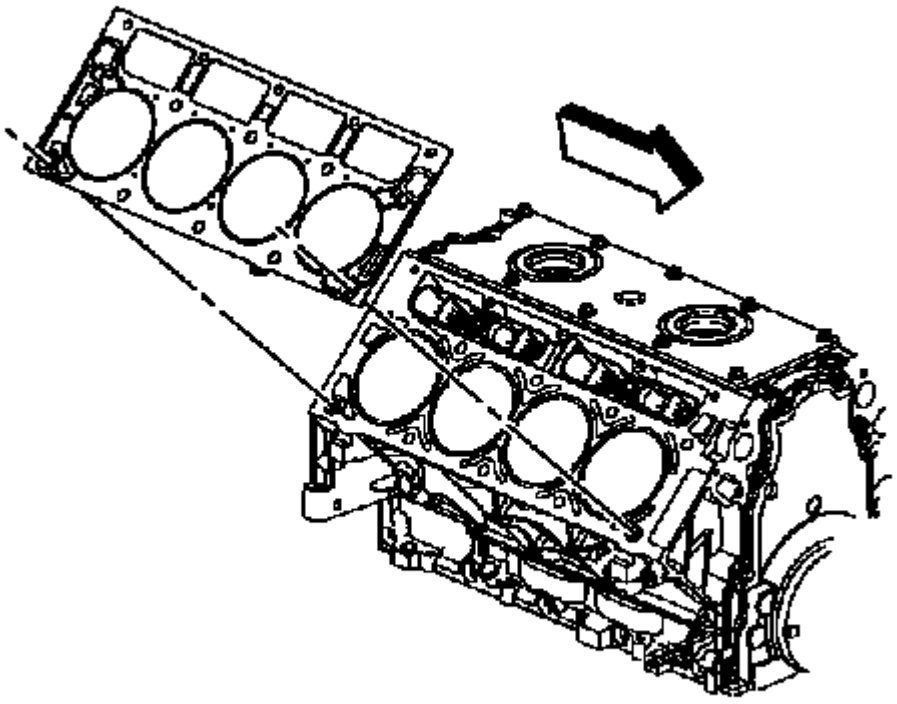

Fig. 104: View Of Right Cylinder Head Gasket And Alignment Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head gasket.
9. Discard the gasket.
10. Discard the cylinder head bolts.
11. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

WARNING: Wear safety glasses in order to avoid eye damage.

CAUTION: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

NOTE:

- **Do not reuse the cylinder head bolts. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket (unless specified).**
- **The cylinder head gaskets must be installed in the proper direction and position.**

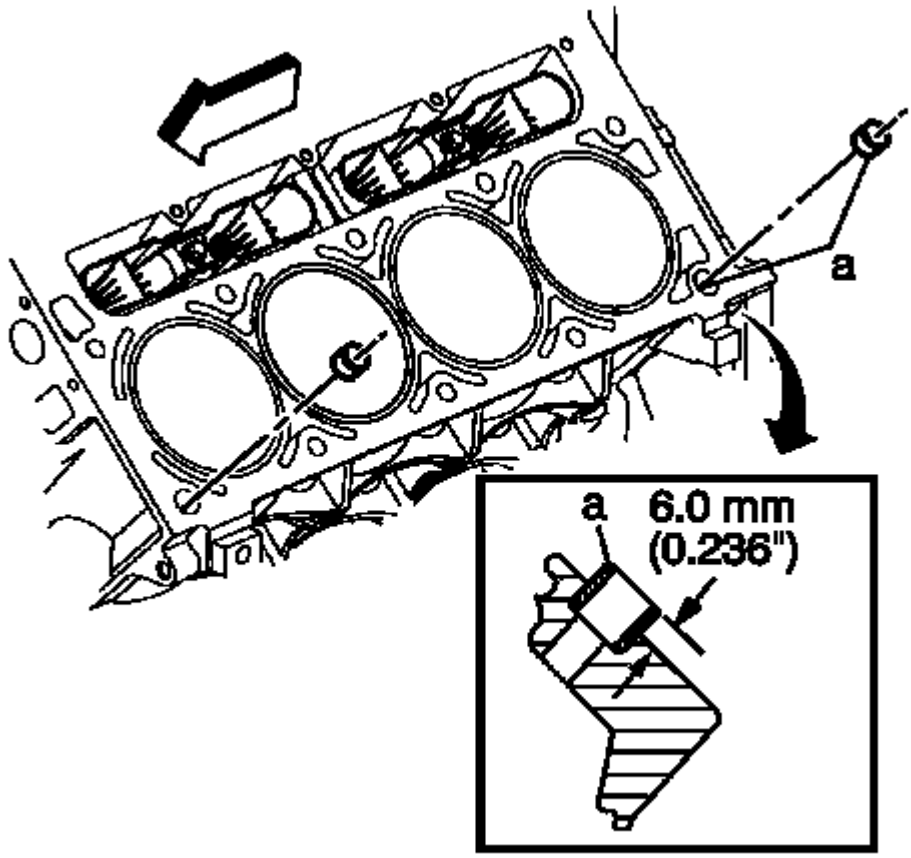

Fig. 105: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes (if required).

Thread repair tool J 42385-107, found in **J 42385-200** may be used to clean the threads of old threadlocking material. See **Special Tools** .

2. Spray cleaner into the holes. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.

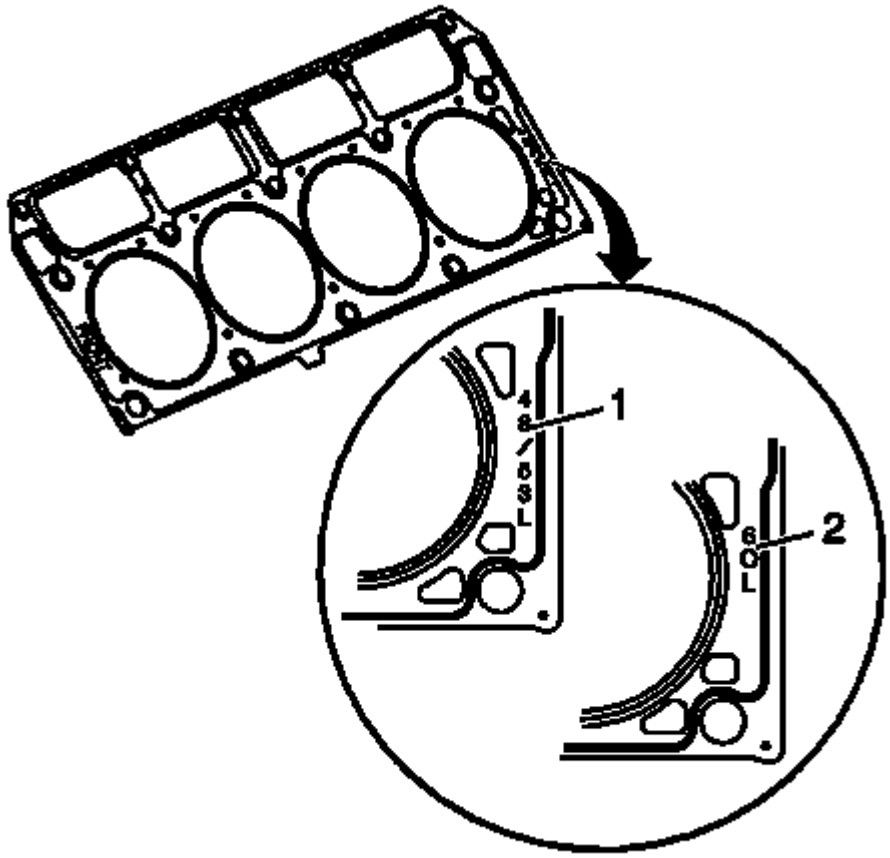

Fig. 106: View Of Cylinder Head Gasket Displacement Markings
Courtesy of GENERAL MOTORS CORP.

NOTE: When properly installed, the tab on the right cylinder head gasket will be located right of center or closer to the front of the engine.

5. Inspect the displacement markings (1) on the gasket for proper usage.

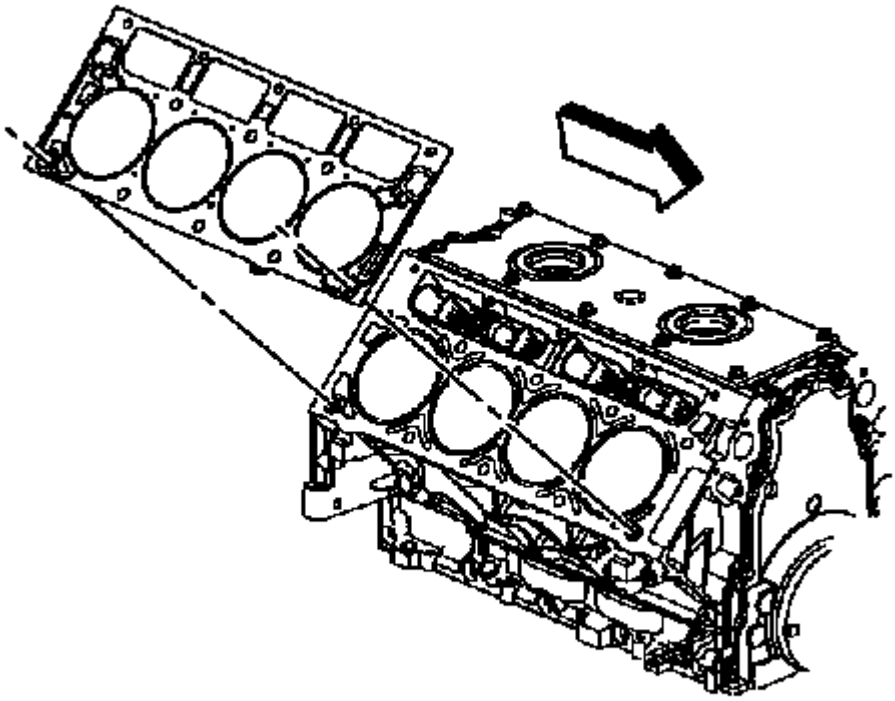

Fig. 107: View Of Right Cylinder Head Gasket And Alignment Pins
Courtesy of GENERAL MOTORS CORP.

6. Install the NEW right cylinder head gasket onto the locating pins.

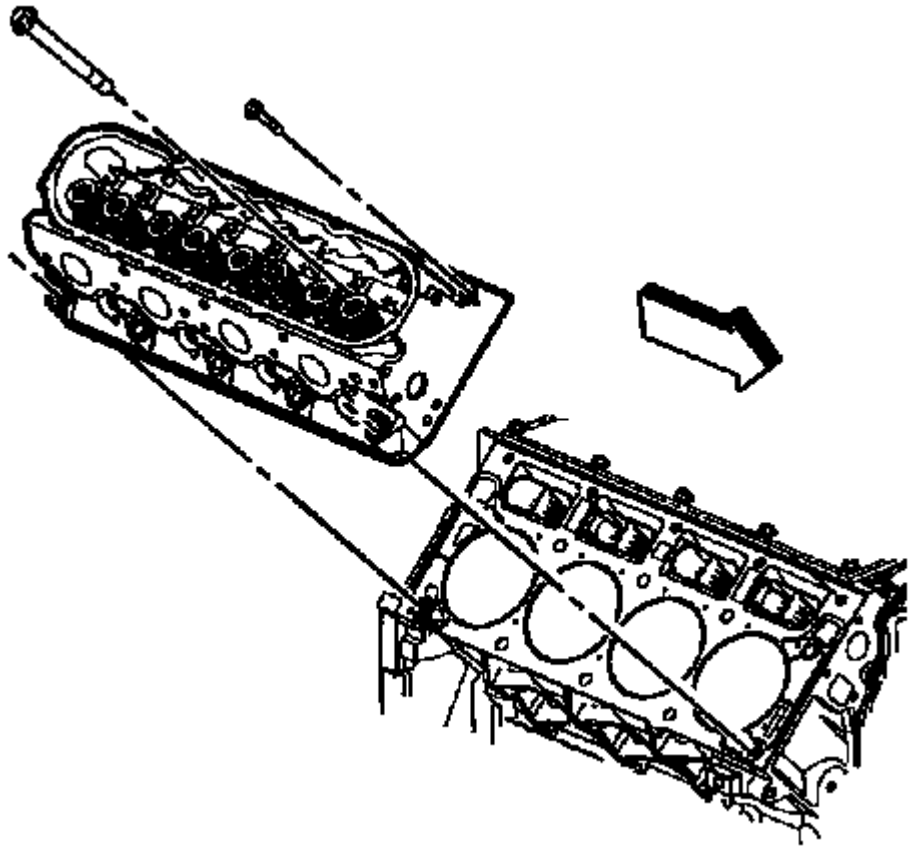

Fig. 108: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Install the cylinder head onto the locating pins and gasket.
8. Install the NEW cylinder head bolts.

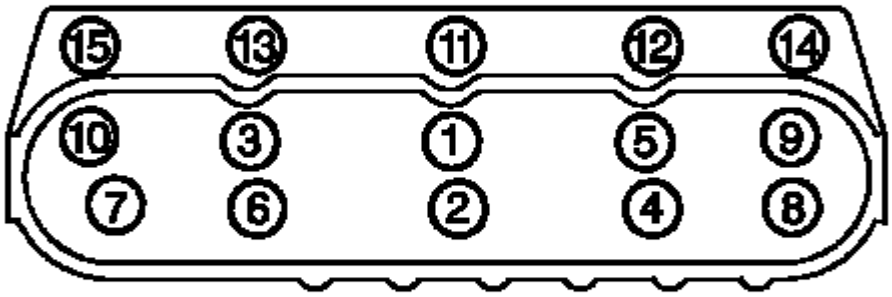

Fig. 109: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1, 10) a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts (1, 10) a second pass in sequence to 90 degrees using **J 45059** .
    3. Tighten the M11 cylinder head bolts (1, 10) in sequence to 70 degrees using **J 45059** .
    4. Tighten the M8 cylinder head bolts (11, 15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (4.8L/5.3L/6.0L)** .
12. Install the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (With LH8)** .
13. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
14. Install the engine cover. Refer to **Engine Cover Replacement** .

VALVE LIFTER REPLACEMENT

SPECIAL TOOLS

J 3049-A Valve Lifter Remover

REMOVAL PROCEDURE

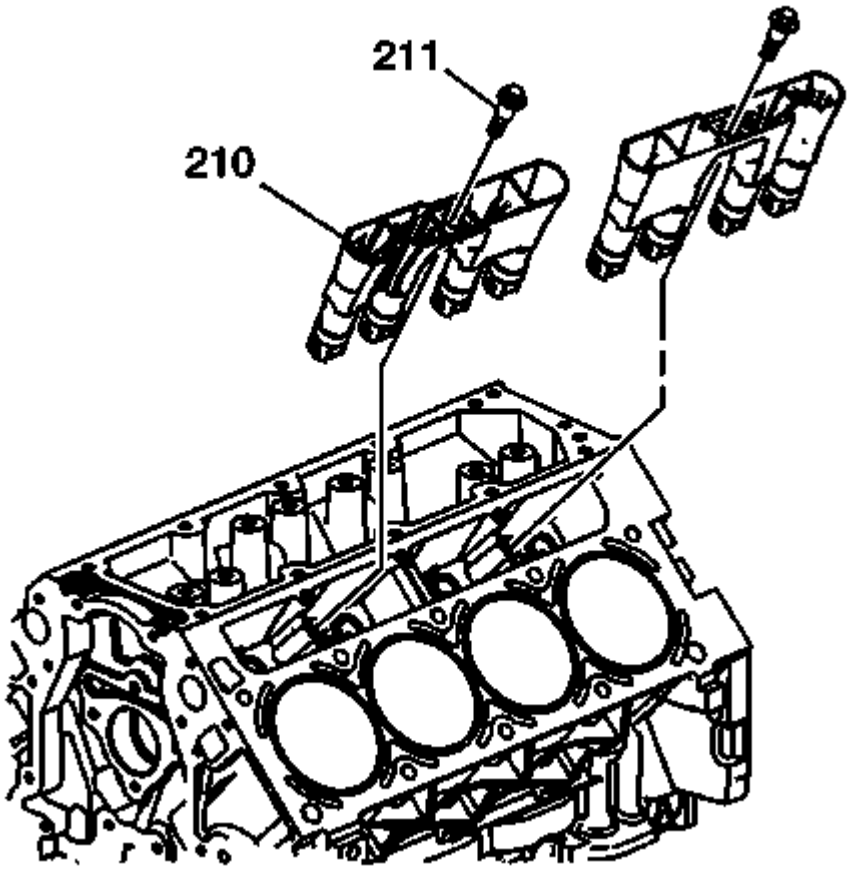

Fig. 110: View Of Valve Lifter Guides, Cylinder Block & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.
2. Remove the valve lifter guide bolts (211)
3. Remove the valve lifters and guide. (210)

NOTE: Some valve lifters may be stuck in their bores because of gum or varnish deposits.

4. Use **J 3049-A** or equivalent in order to remove the valve lifters (if required).

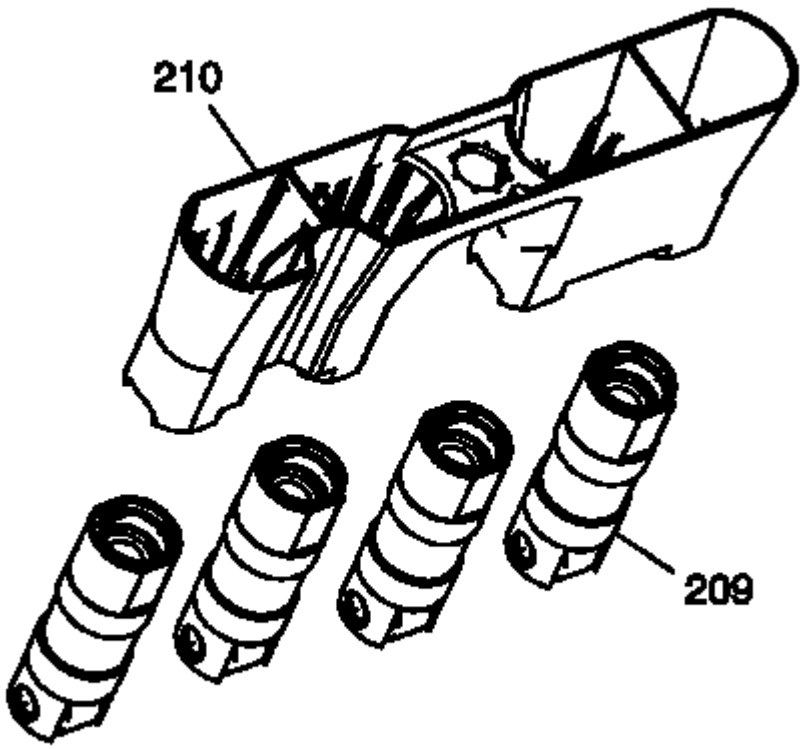

Fig. 111: Identifying Valve Lifters & Guide
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve lifters (209) from the guide (210).
6. Organize or mark the components so that they can be installed in the same location from which they were removed.
7. Clean and inspect the valve lifters. Refer to **Valve Lifter and Guide Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: When reusing valve lifters, install the lifters to their original locations.

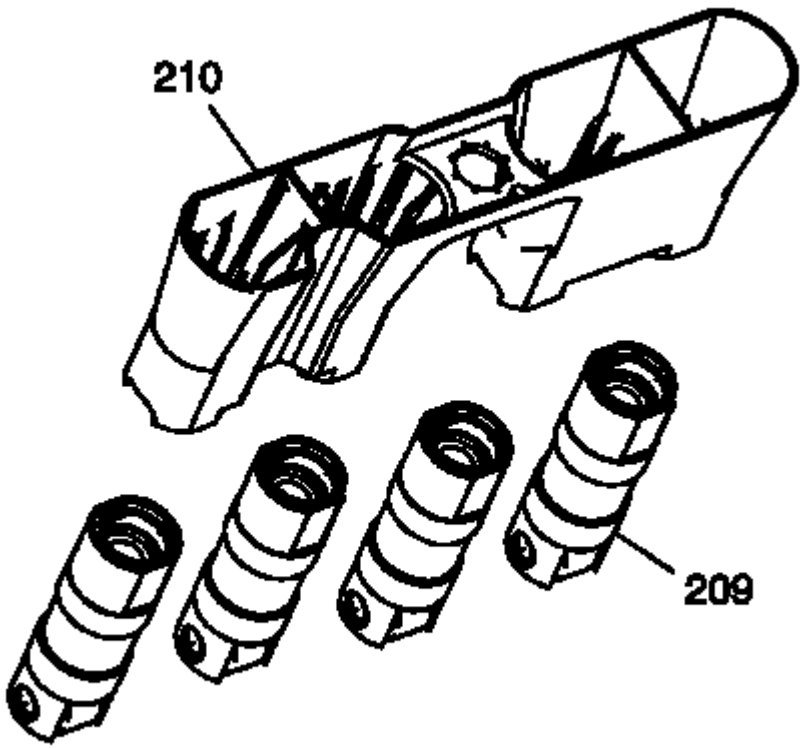

Fig. 112: Identifying Valve Lifters & Guide
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve lifters and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters (209) into the lifter guides (210).

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

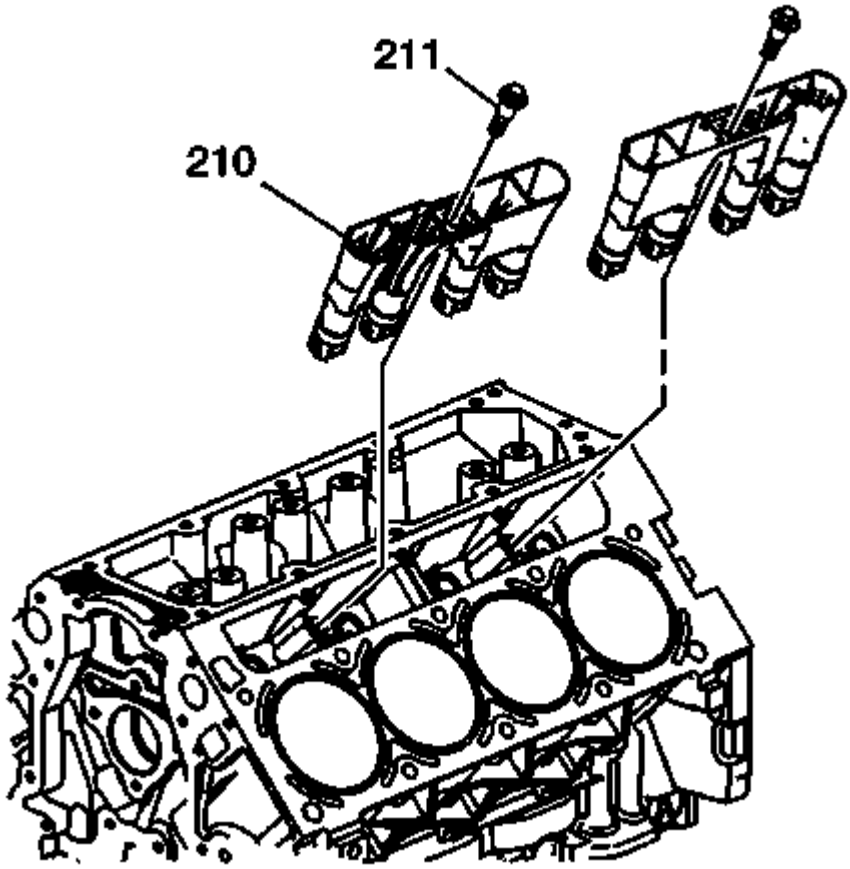

Fig. 113: View Of Valve Lifter Guides, Cylinder Block & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the valve lifters (209) and guide (210) to the engine block.
4. Install the valve lifter guide bolts (211).
5. Install the valve lifter guide bolt (211) and tighten to 12 N.m (106 lb in).
6. Install the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.

CRANKSHAFT BALANCER REPLACEMENT

SPECIAL TOOLS

- **J 45059** Angle Meter
- **J 41816** Crankshaft Balancer Remover
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .

- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the air conditioning (A/C) drive belt, if equipped. Refer to **Air Conditioning Compressor Belt Replacement**.
2. Remove the accessory drive belt, if not equipped with A/C. Refer to **Drive Belt Replacement - Accessory**.
3. Remove the fan shroud - lower. Refer to **Engine Coolant Fan Lower Shroud Replacement (4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L)** .
4. Remove the starter motor. Refer to **Starter Replacement (V8)** .

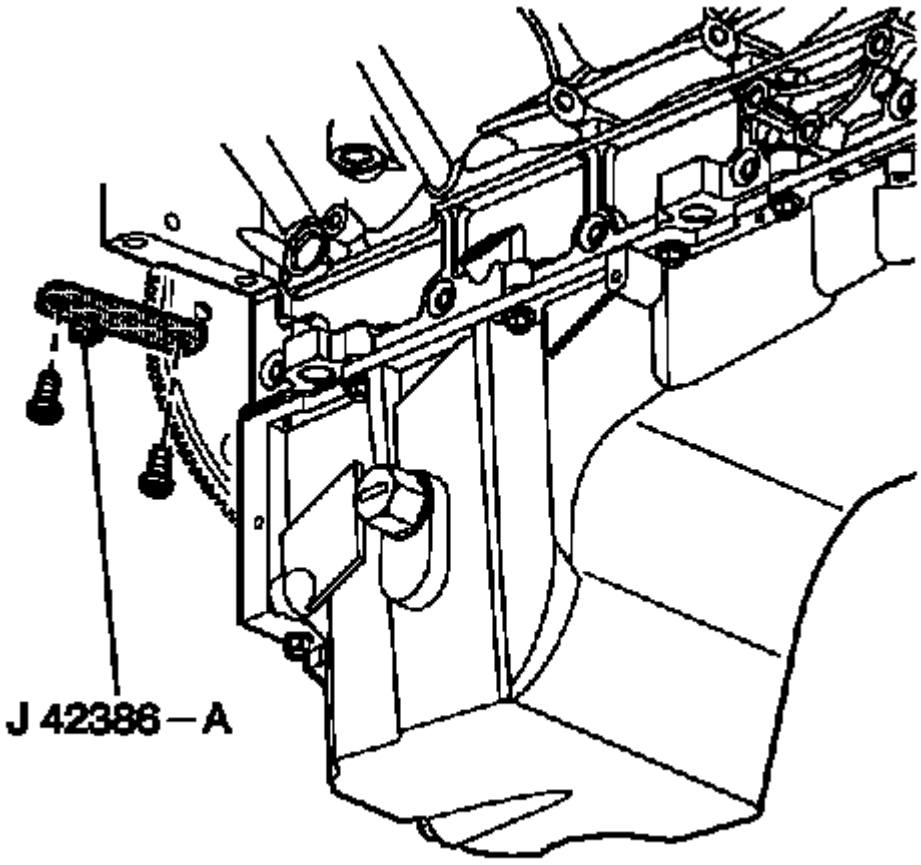

Fig. 114: Using Special Tool J 42386-A To Lock Flywheel
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Make sure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See Special Tools .**

- **The crankshaft balancer is balanced as an individual component. It is not necessary to mark the balancer prior to removal.**

CAUTION: Refer to Fastener Caution .

5. Install the **J 42386-A** and bolts. See **Special Tools** .

   Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** bolts to 50 N.m (37 lb ft).

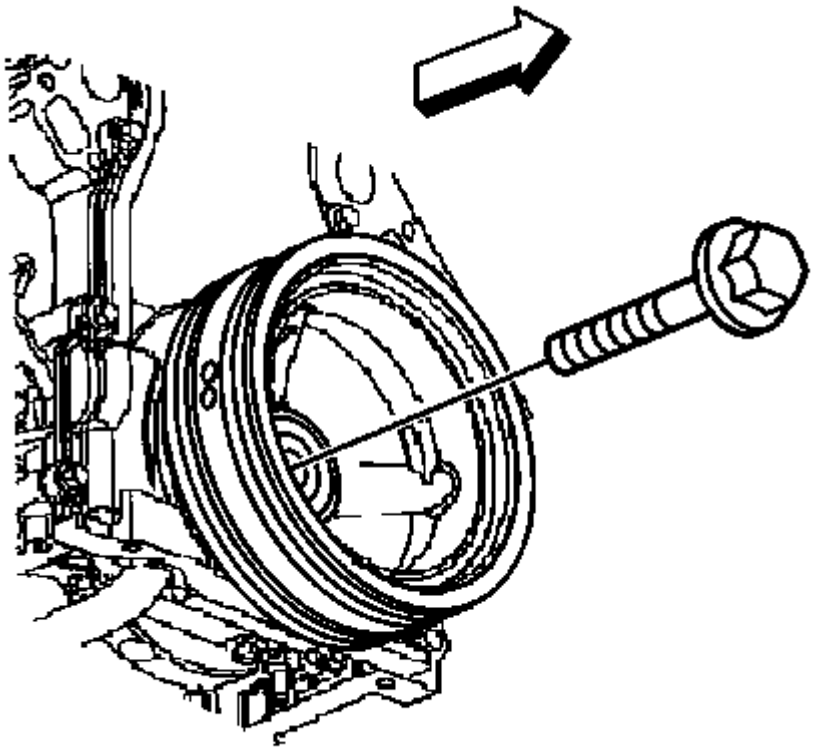

Fig. 115: Identifying Crankshaft Balancer & Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft balancer bolt.

   Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

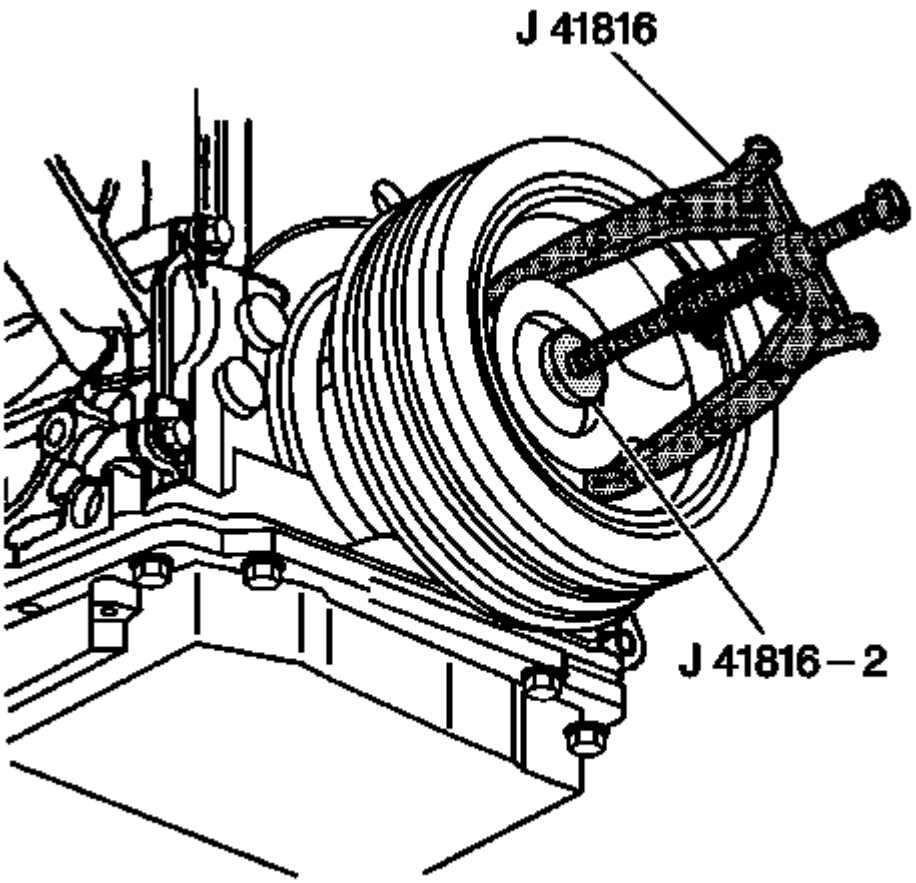

Fig. 116: View Of Crankshaft Balancer, J 41816 & J 41816-2
Courtesy of GENERAL MOTORS CORP.

7. Use the **J 41816** and **J 41816-2** in order to remove the crankshaft balancer. See **Special Tools** .
8. Remove the **J 41816** and the **J 41816-2** from the crankshaft balancer. See **Special Tools** .
9. Clean and inspect the crankshaft balancer. Refer to **Crankshaft Balancer Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE:

- **Make sure that the teeth of J 42386-A mesh with the teeth of the engine flywheel. See Special Tools .**
- **The used crankshaft balancer bolt will be used only during the first pass of the balancer installation procedure. Install a NEW bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.**
- **The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is**

installed completely onto the crankshaft. The second, third, and fourth passes tighten the new bolt to the proper torque.

NOTE: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

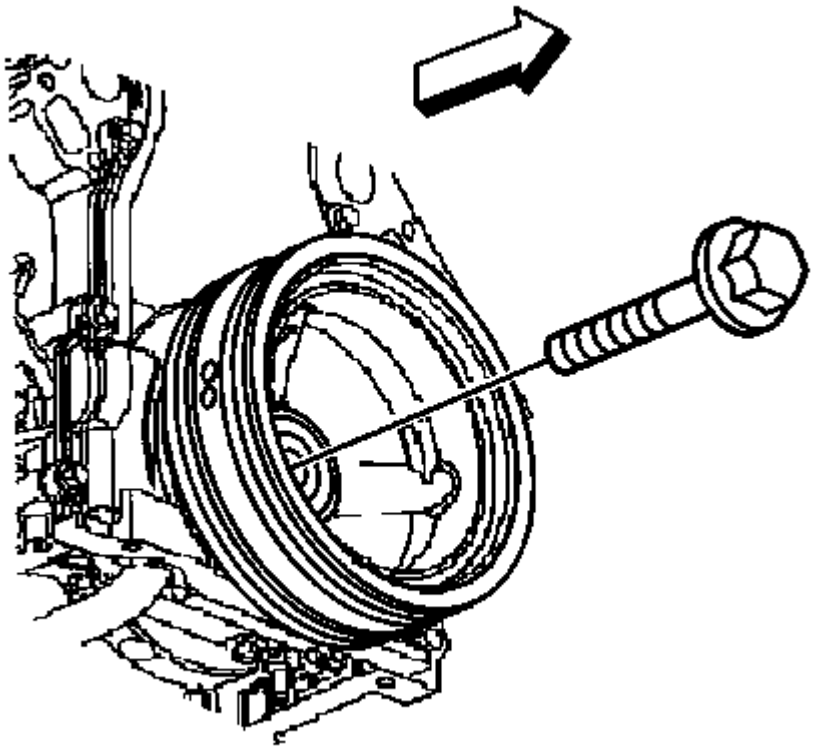

Fig. 117: Identifying Crankshaft Balancer & Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer onto the end of the crankshaft.

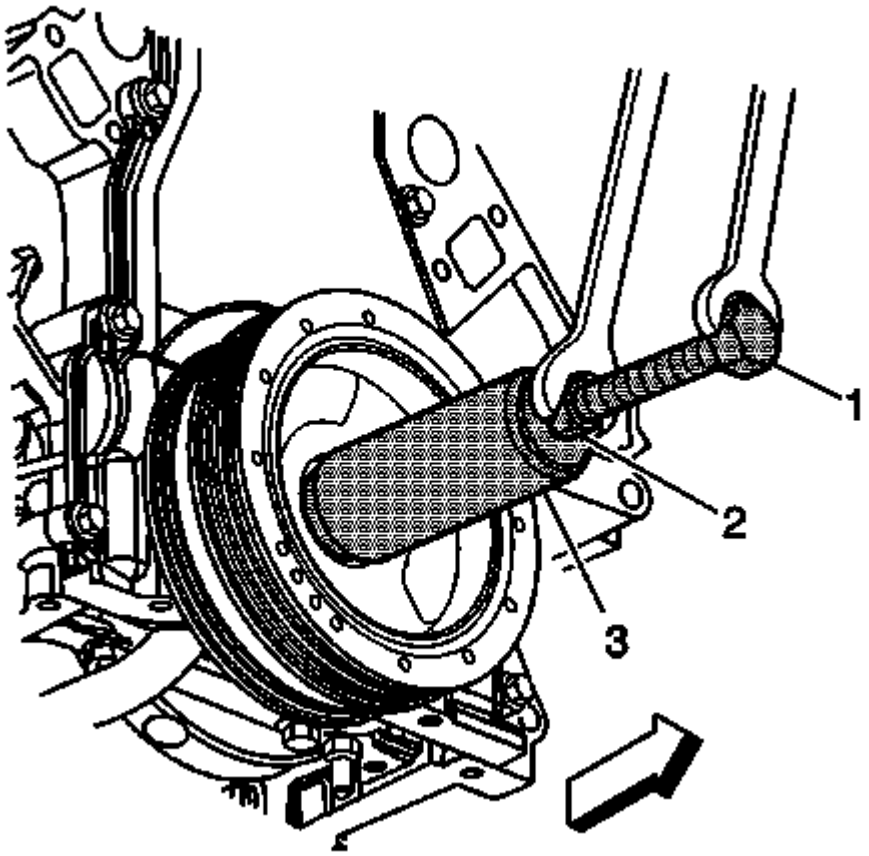

Fig. 118: Identifying crankshaft balancer
Courtesy of GENERAL MOTORS CORP.

2. Use the **J 41665** (2, 3) and the **J 41478** (1) in order to install the crankshaft balancer. See **Special Tools** .
    1. Assemble the **J 41478** (1) threaded rod, nut, washer and installer. See **Special Tools** .

       Insert the smaller end of the installer into the front of the balancer.

    2. Use a wrench and hold the hex end of the threaded rod.
    3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
    4. Remove the tool and reverse the installation tool.

       Position the larger end of the installer against the front of the balancer.

    5. Use a wrench and hold the hex end of the threaded rod.
    6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
    7. Remove the balancer installation tool.

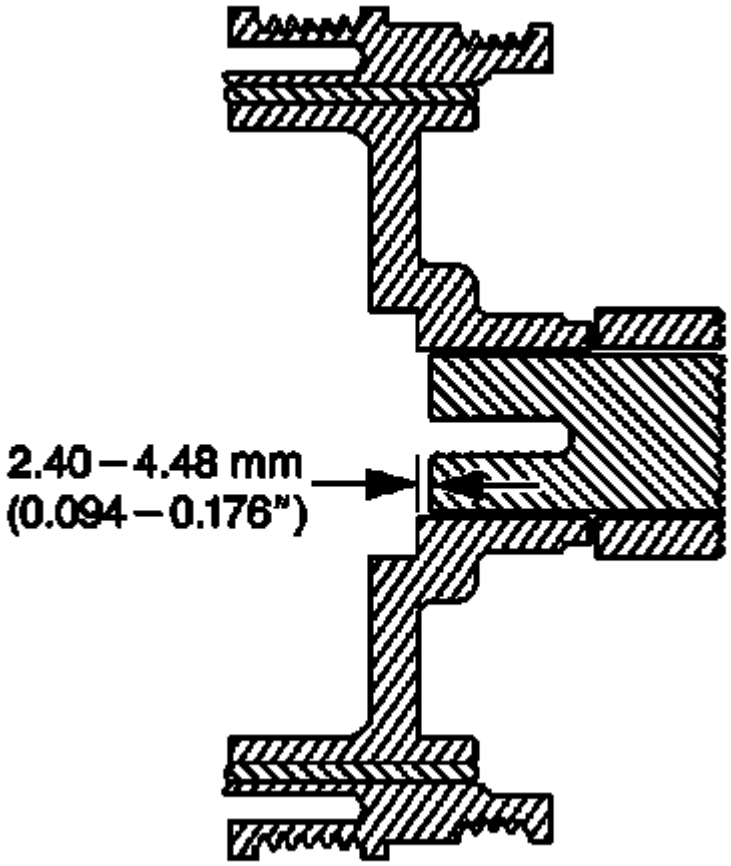

Fig. 119: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

3. Install the used crankshaft balancer bolt and tighten to 330 N.m (240 lb ft).
4. Remove the used crankshaft balancer bolt.

NOTE: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

5. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the **J 41665** and repeat the installation procedure. See **Special Tools** .

6. Install a NEW crankshaft balancer bolt.
   1. Tighten the crankshaft balancer bolt a first pass to 50 N.m (37 lb ft).
   2. Tighten the crankshaft balancer bolt a second pass to 140 degrees using **J 45059** .
7. Remove the **J 42386-A** and bolts. See **Special Tools** .
8. Install the starter motor. Refer to **Starter Replacement (V8)** .

9. Install the fan shroud - lower. Refer to **Engine Coolant Fan Lower Shroud Replacement (4.3L, 4.8L, 5.3L, 6.0L, 6.2L, 7.0L)** .
10. Install the accessory drive belt (if not equipped with A/C). Refer to **Drive Belt Replacement - Accessory**.
11. Install the A/C drive belt (if equipped). Refer to **Air Conditioning Compressor Belt Replacement**.
12. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT (WITH LY6)

SPECIAL TOOLS

J 41478 Crankshaft Front Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

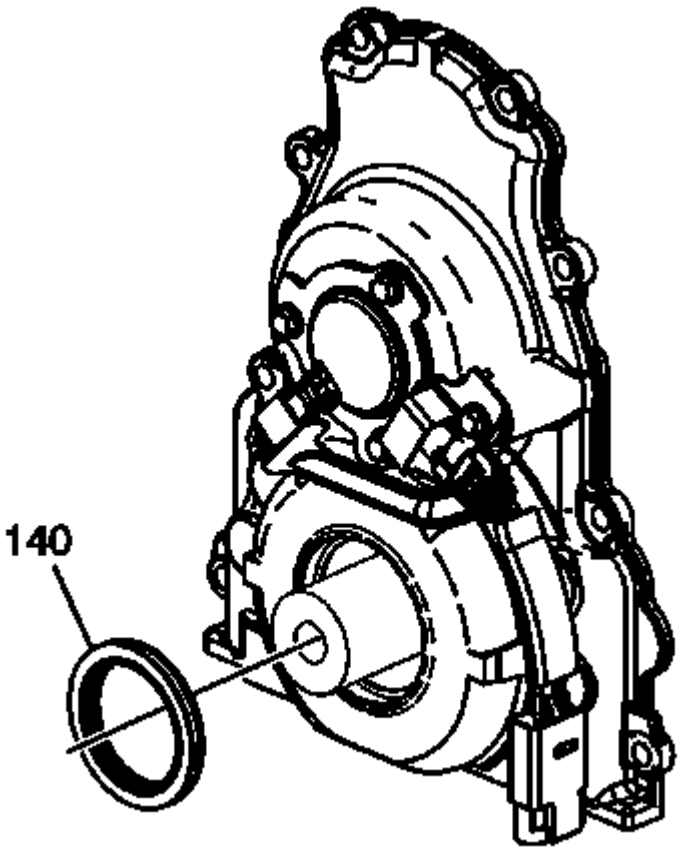

Fig. 120: View Of Outer Edge Of The Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

2. Remove the crankshaft front oil seal (140) from the front cover.

INSTALLATION PROCEDURE

NOTE:

- **Do not lubricate the oil seal sealing surface.**
- **Do not reuse the crankshaft front oil seal.**

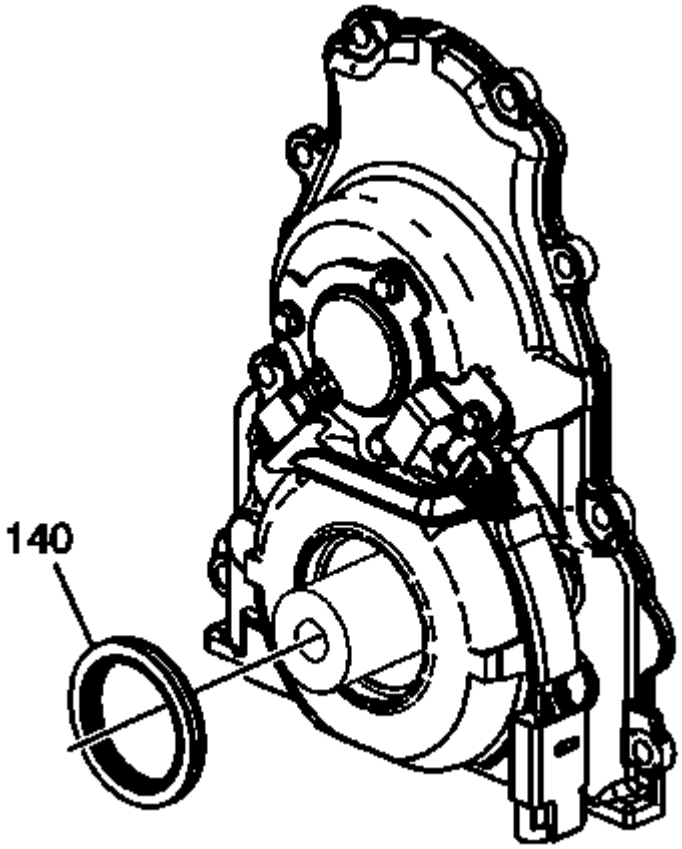

Fig. 121: View Of Outer Edge Of The Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the outer edge of the oil seal (140) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

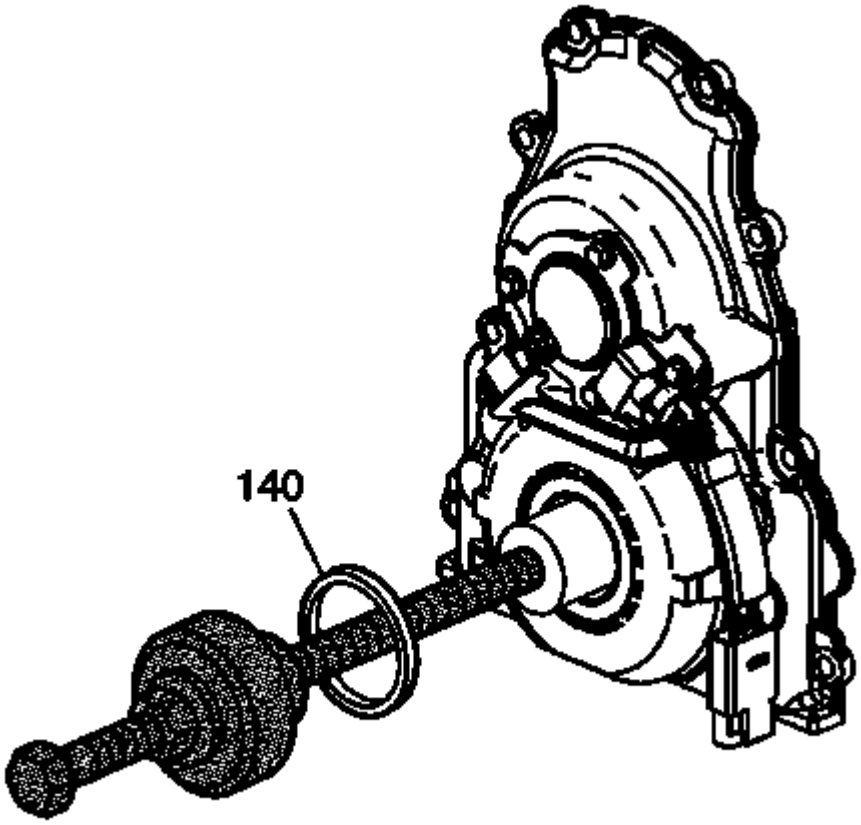

Fig. 122: View Of Front Oil Seal & Special Tool
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal (140) onto the **J 41478** guide. See **Special Tools** .
4. Install the **J 41478** threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft. See **Special Tools** .
5. Use the **J 41478** in order to install the oil seal into the cover bore. See **Special Tools** .
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
    3. Remove the **J 41478** . See **Special Tools** .
    4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.
6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

REMOVAL PROCEDURE

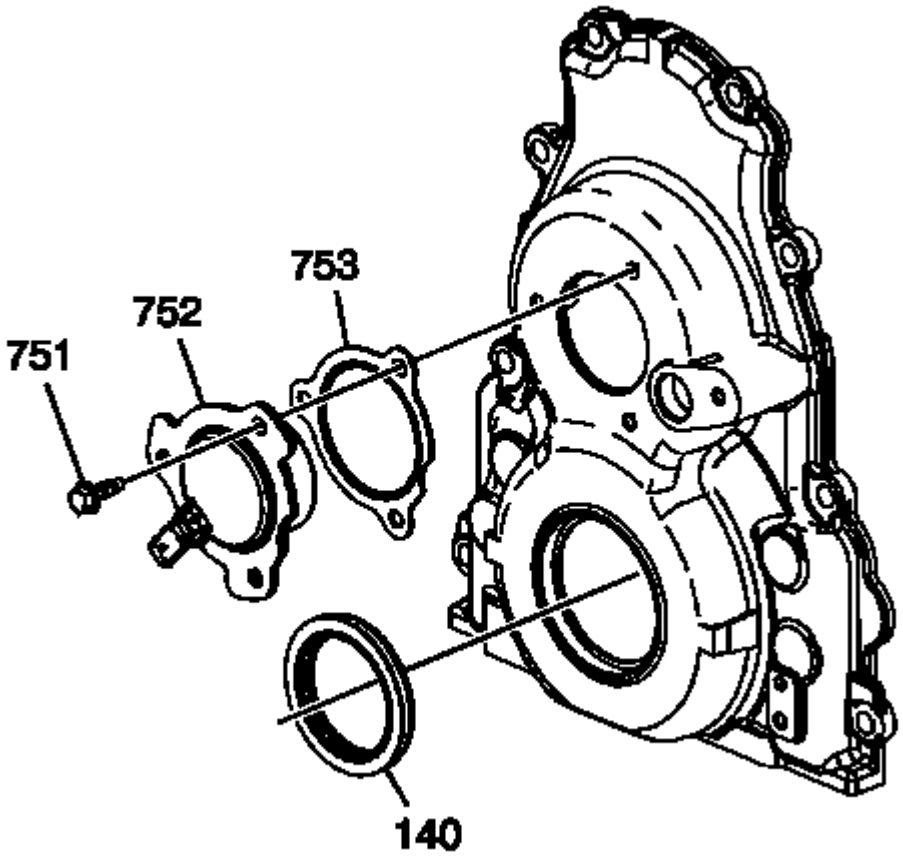

Fig. 123: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (LMF,LY2)** or **Water Pump Replacement (V8)** .
2. Disconnect the engine harness electrical connector from the camshaft position (CMP) actuator magnet.
3. Remove the CMP actuator magnet bolts (751) and magnet (752).
4. Remove and discard the CMP actuator magnet gasket (753).

INSTALLATION PROCEDURE

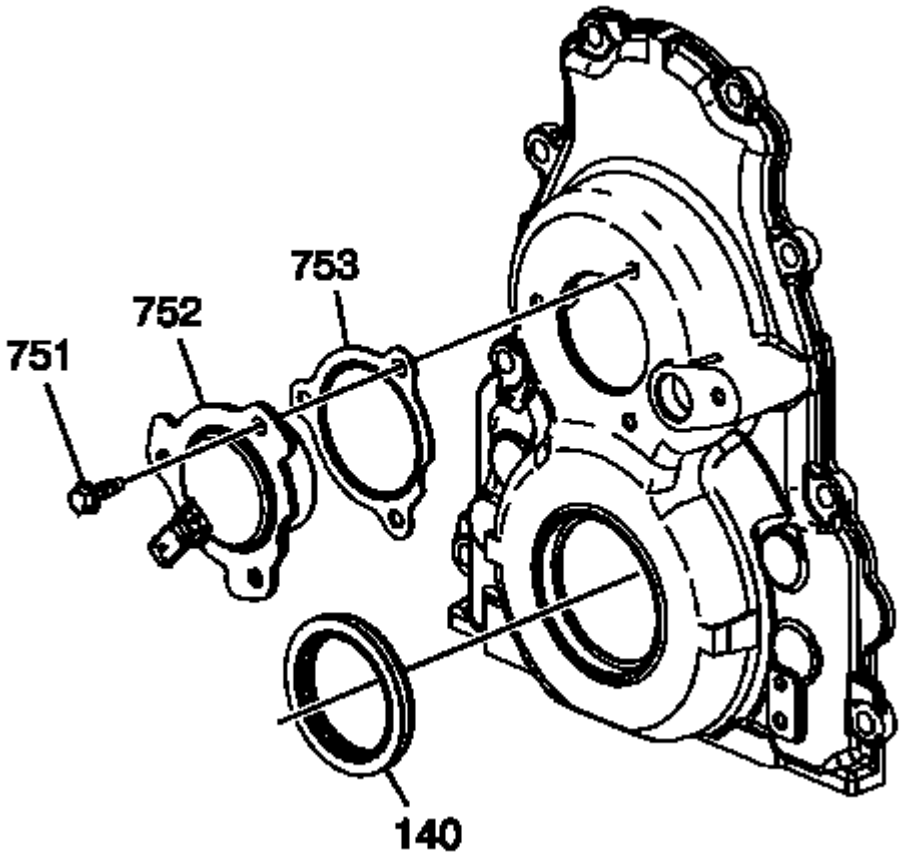

Fig. 124: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface should be free of oil or other foreign material during assembly.

1. Install a NEW CMP actuator magnet gasket (753) onto the CMP actuator magnet.
2. Install the CMP actuator magnet (752) to the front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet bolts (751) and tighten to 12 N.m (106 lb in).
4. Connect the engine harness electrical connector to the CMP actuator magnet.
5. Install the water pump. Refer to **Water Pump Replacement (V8)** .

ENGINE FRONT COVER REPLACEMENT

SPECIAL TOOLS

J 41476 Front and Rear Cover Alignment Tool. See **Special Tools** .

REMOVAL PROCEDURE

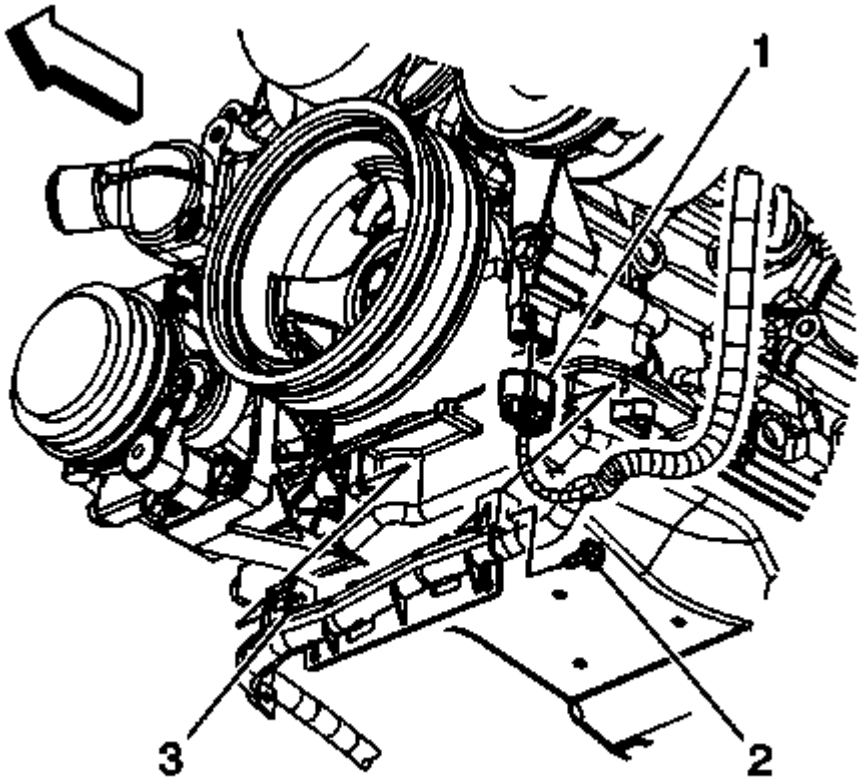

Fig. 125: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (LMF,LY2)** or **Water Pump Replacement (V8)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Disconnect the engine harness electrical connector (1) from the camshaft position (CMP) sensor wire harness electrical connector.

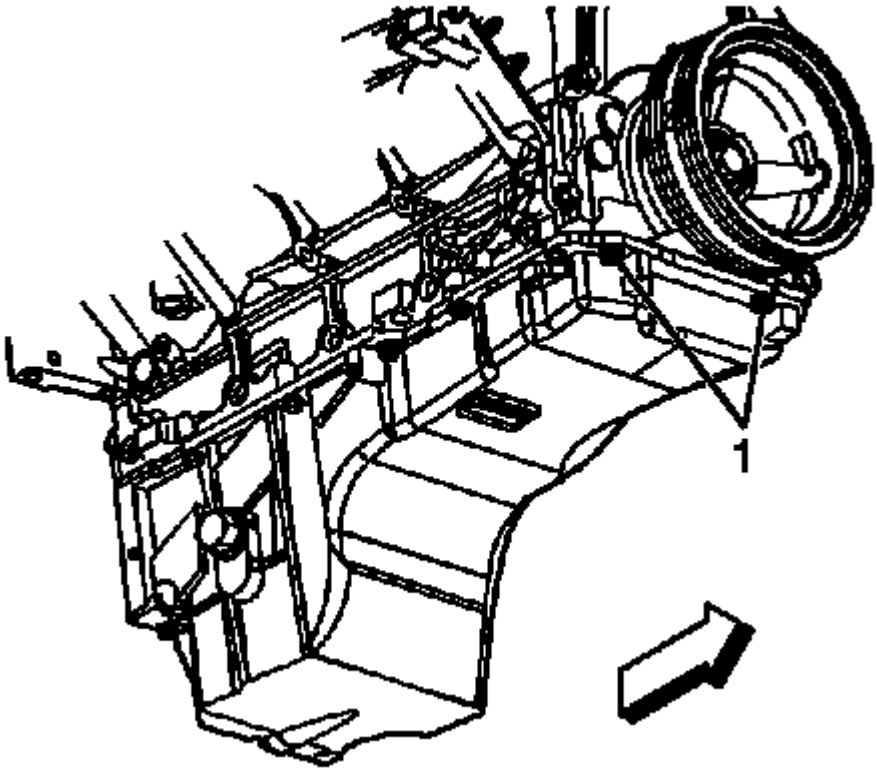

Fig. 126: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan-to-front cover bolts (1).

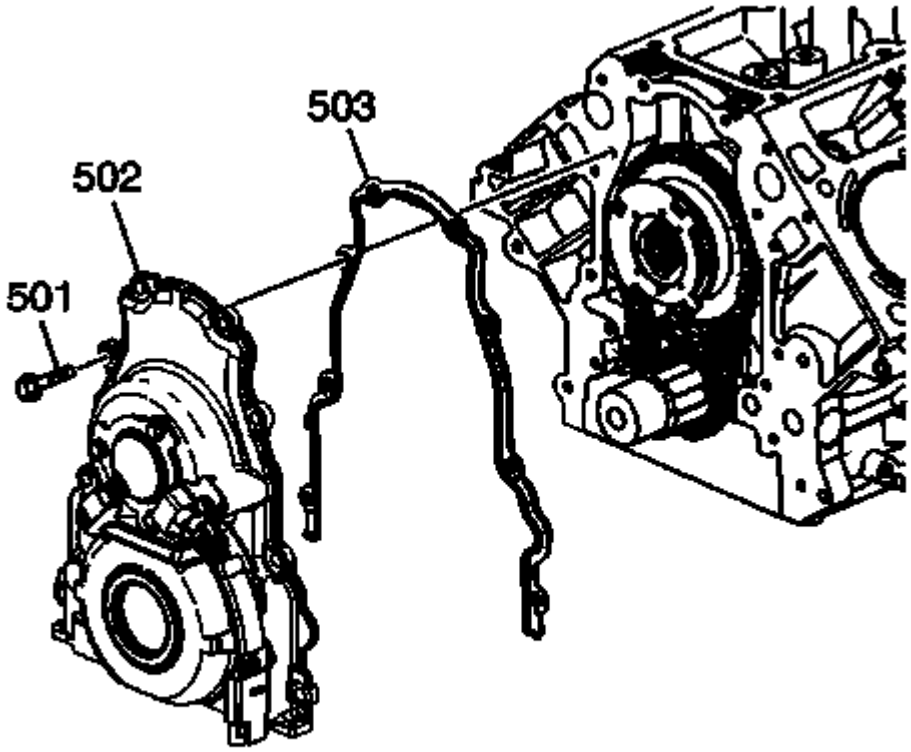

Fig. 127: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove the front cover bolts (501).
6. Remove the front cover (502) and gasket (503).
7. Discard the front cover gasket.
8. Remove the crankshaft front oil seal.

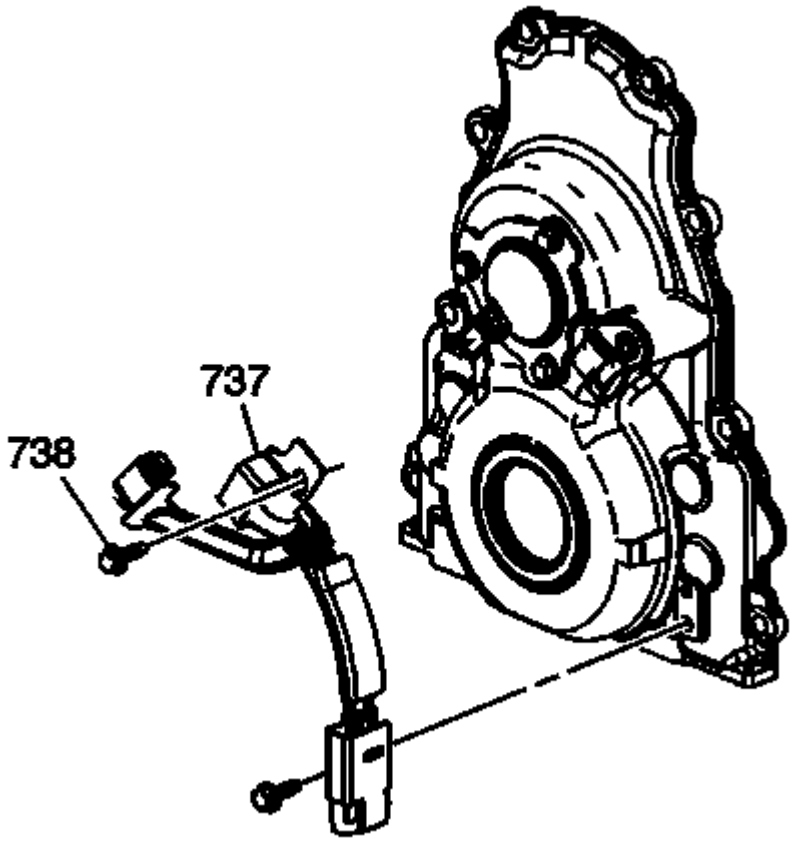

Fig. 128: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

9. If replacing the engine front cover perform the following steps, otherwise proceed to step 10 of the installation procedure.
10. Remove the CMP sensor wire harness bolts (738).
11. Disconnect the CMP sensor wire harness from the CMP sensor.
12. Remove the CMP sensor wire harness (737).

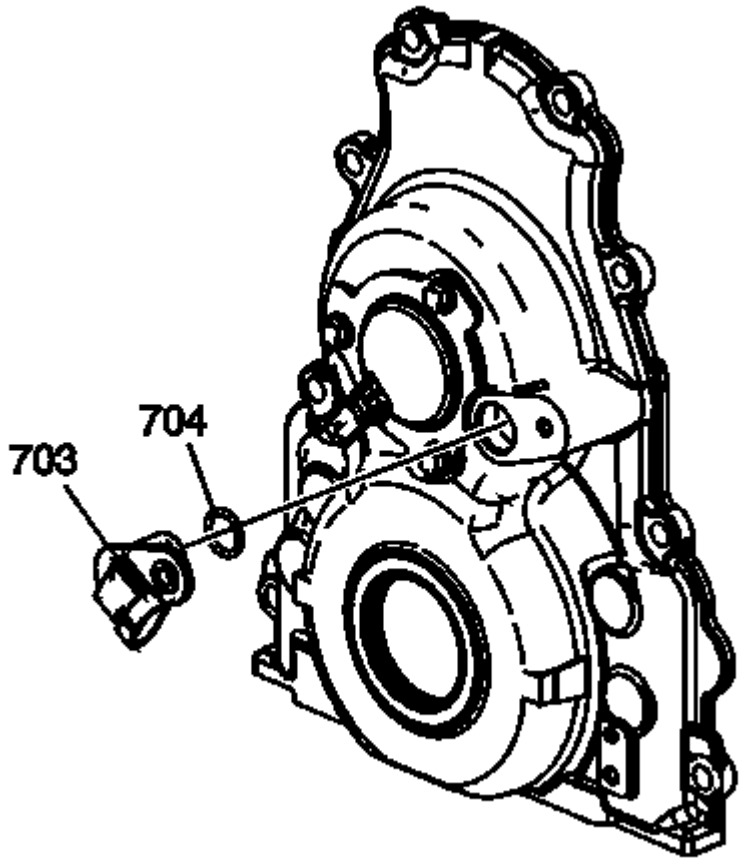

Fig. 129: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

13. Remove the CMP sensor (703).

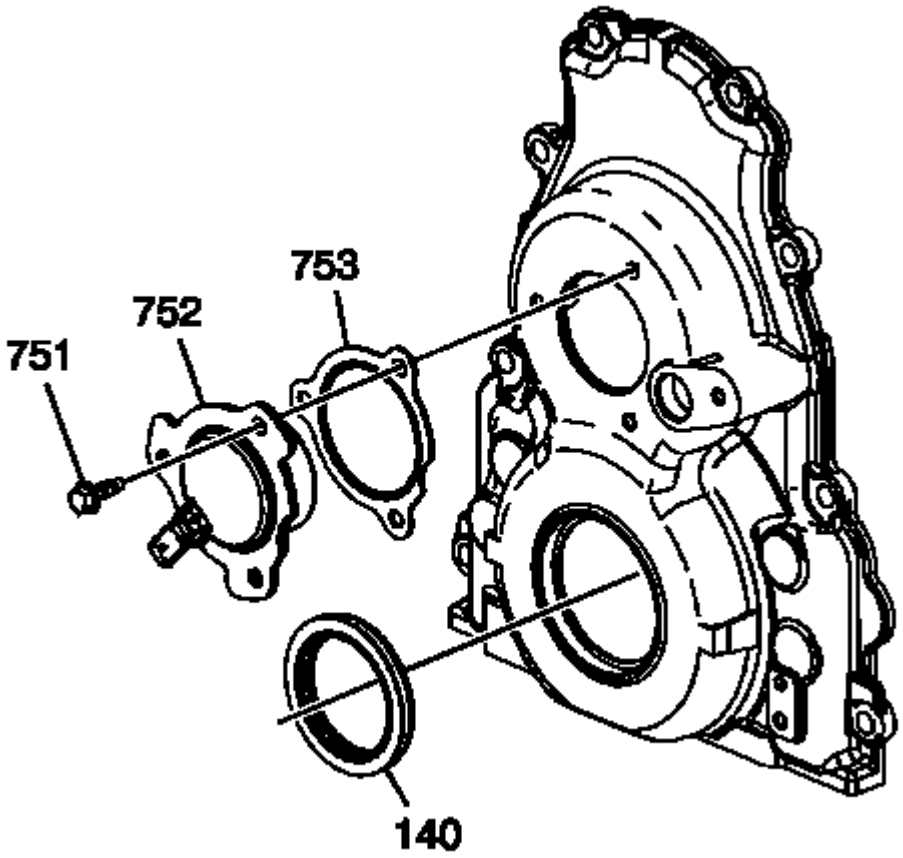

Fig. 130: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

14. Remove the CMP actuator magnet bolts (751), and magnet (752).
15. Remove and discard the CMP actuator magnet gasket (753).

INSTALLATION PROCEDURE

NOTE:

- **Do not reuse the crankshaft oil seal or front cover gasket.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the front crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**
  - **The crankshaft front oil seal MUST be centered in relation to the crankshaft.**
  - **An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.**

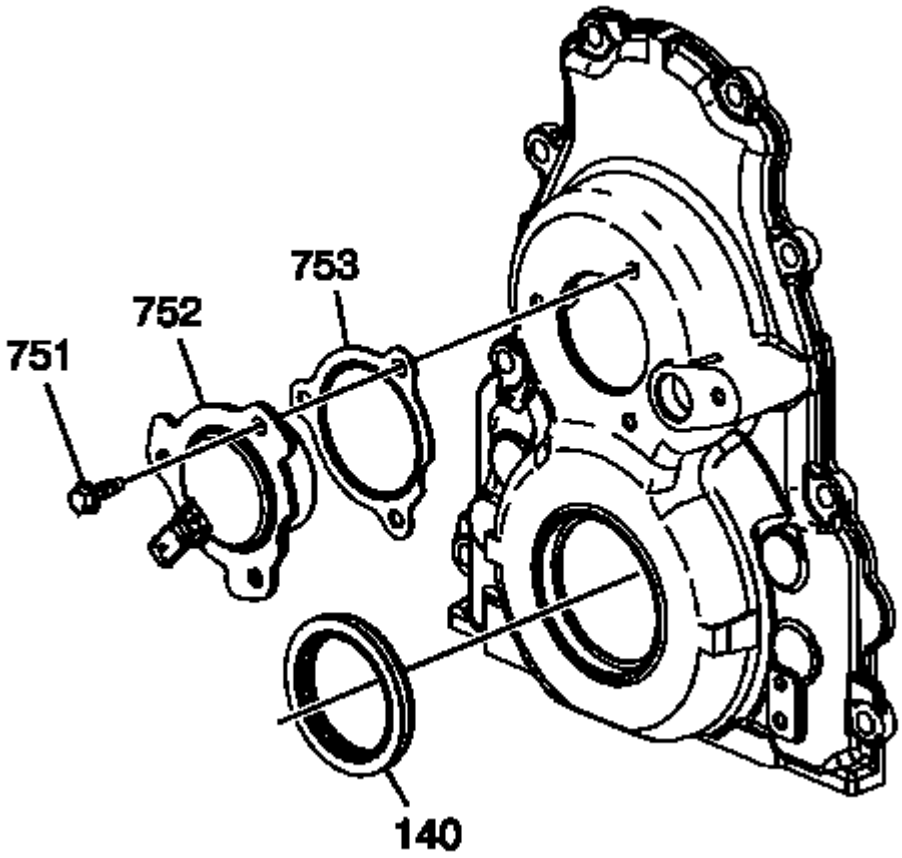

Fig. 131: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. If replacing the front cover perform the following steps, otherwise proceed to step 10.
2. Install a NEW CMP actuator magnet gasket (753) onto the magnet.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet (752) and bolts (751). Tighten the bolts to 12 N.m (106 lb in).

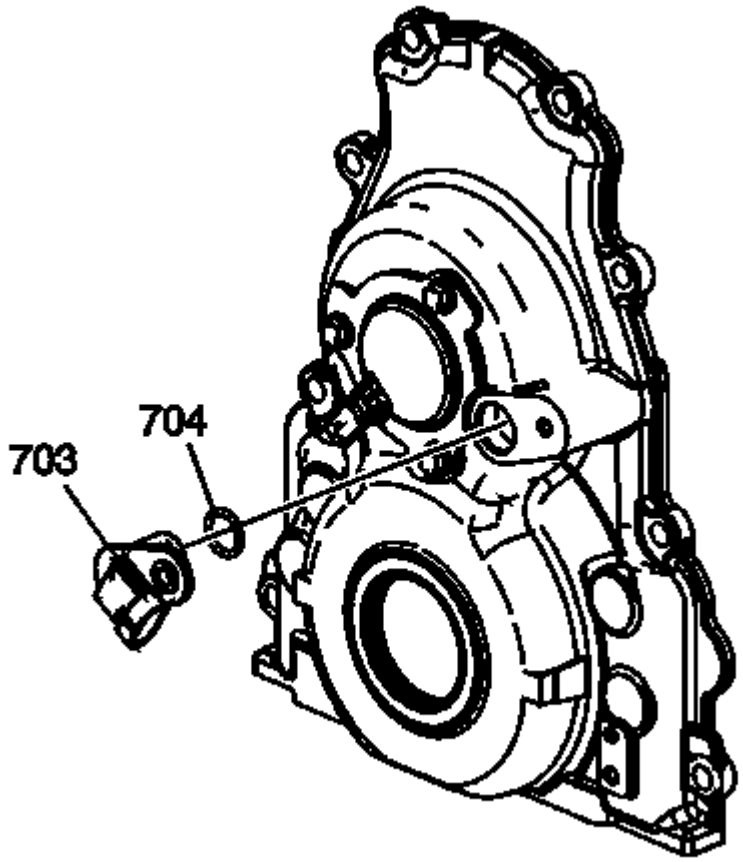

Fig. 132: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Inspect the CMP sensor O-ring seal for cuts or damage. If the seal is not cut or damaged, it may be reused.
5. Lubricate the O-ring seal (704) with clean engine oil.
6. Install the CMP sensor (703).

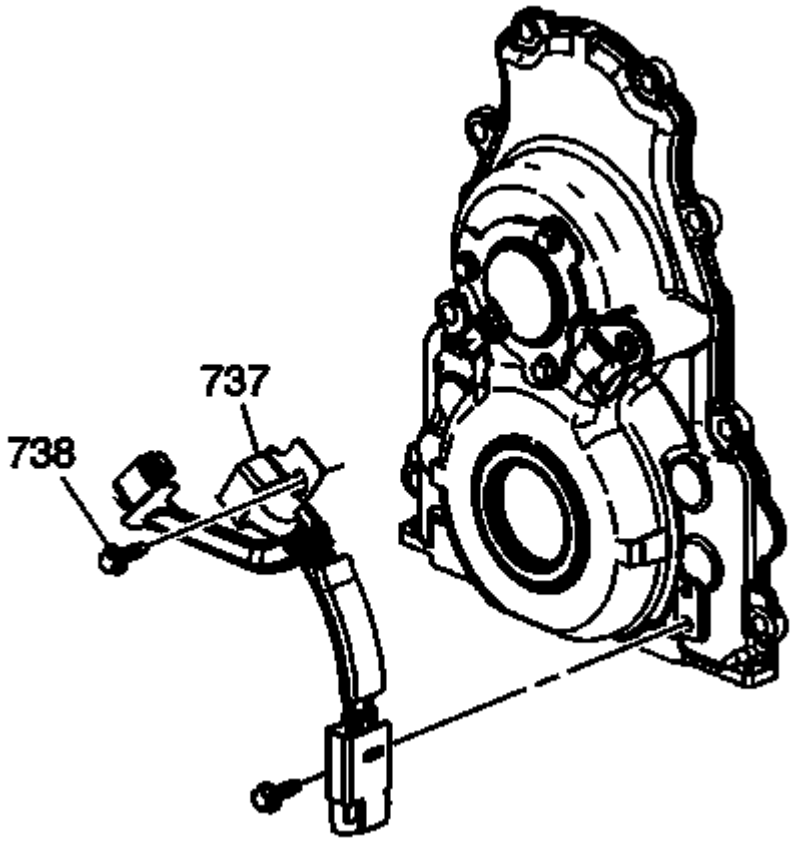

Fig. 133: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Position the CMP sensor wire harness (737) to the front cover
8. Connect the CMP sensor wire harness to the CMP sensor.
9. Install the CMP sensor wire harness bolts (738) and tighten to 12 N.m (106 lb in).

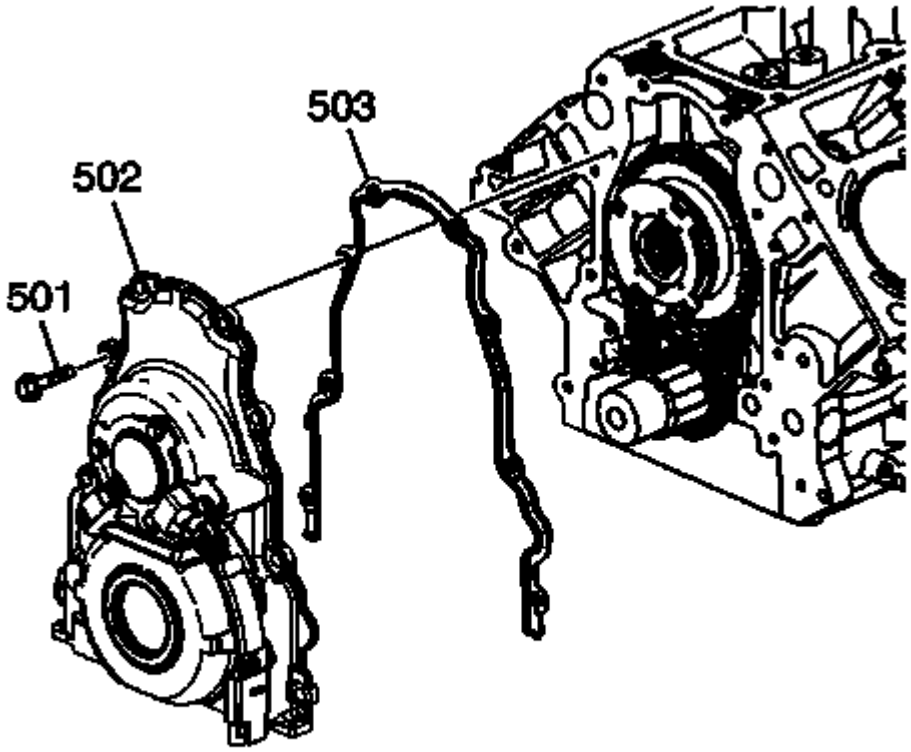

Fig. 134: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

10. Apply a 5 mm (0.20 in) bead of sealant, 20 mm (0.80 in) long to the oil pan to engine block junction. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
11. Position the NEW engine front cover gasket (503) and front cover (502) to the engine.
12. Install the front cover bolts (501) until snug. Do not overtighten.

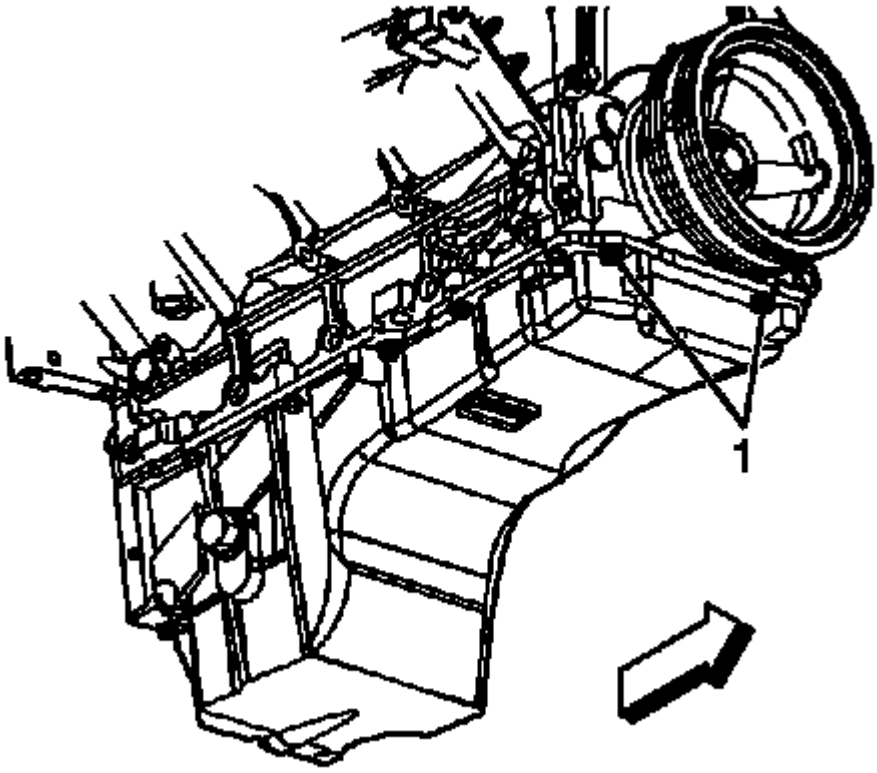

Fig. 135: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the oil pan-to-front cover bolts (1) until snug. Do not over tighten.

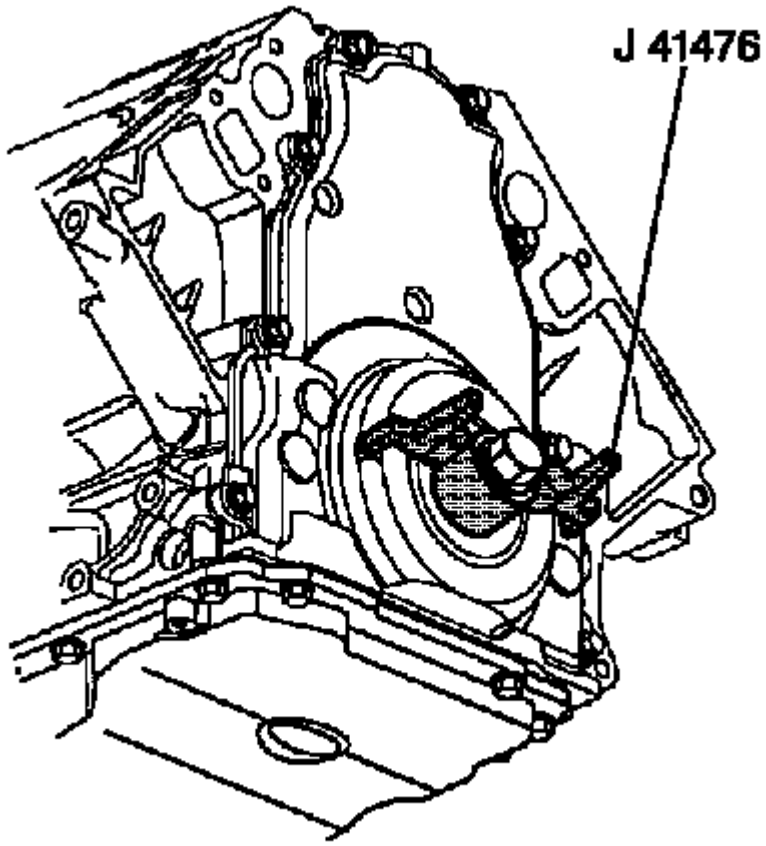

Fig. 136: View of J 41476 Installed To Front Cover
Courtesy of GENERAL MOTORS CORP.

14. Install **J 41476** to the front cover. See **Special Tools** .
15. Align the tapered legs of the **J 41476** with the machined alignment surfaces on the front cover. See **Special Tools** .
16. Install the crankshaft balancer bolt until snug. Do not overtighten.
    1. Tighten the oil pan to front cover bolts to 25 N.m (18 lb ft).
    2. Tighten the engine front cover bolts to 25 N.m (18 lb ft).
17. Remove the **J 41476** . See **Special Tools** .

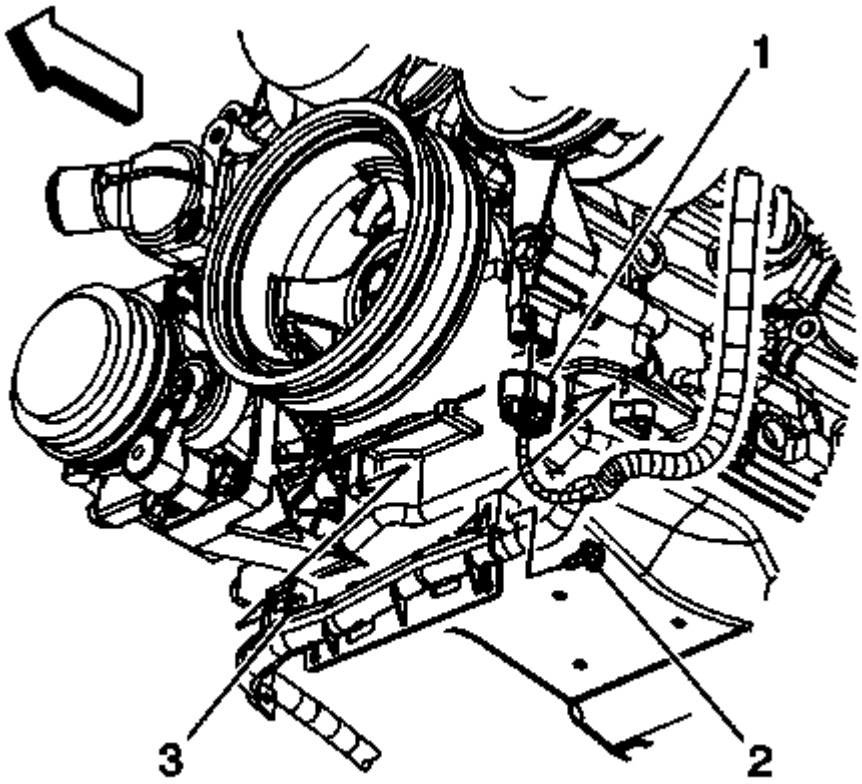

Fig. 137: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

18. Connect the engine harness electrical connector (1) to the CMP sensor wire harness electrical connector.
19. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement (With LY6)**.
20. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
21. Install the water pump. Refer to **Water Pump Replacement (LMF,LY2)** or **Water Pump Replacement (V8)** .

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT

SPECIAL TOOLS

- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

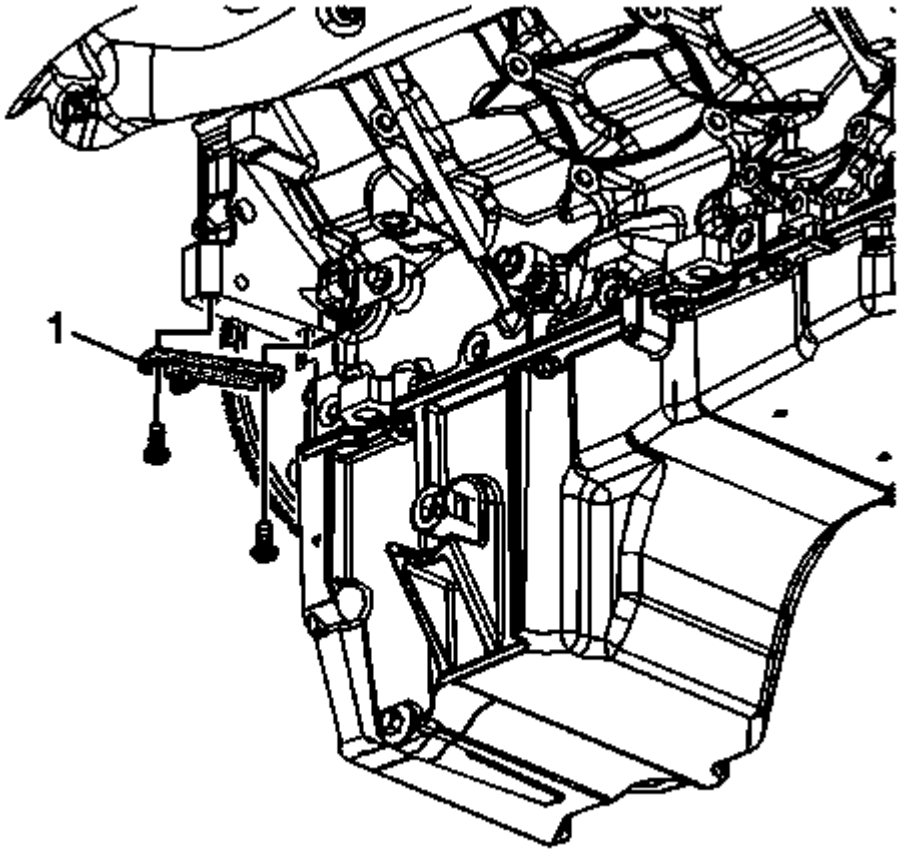

Fig. 138: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** bolts to 50 N.m (37 lb ft).
2. Remove the camshaft position (CMP) actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.

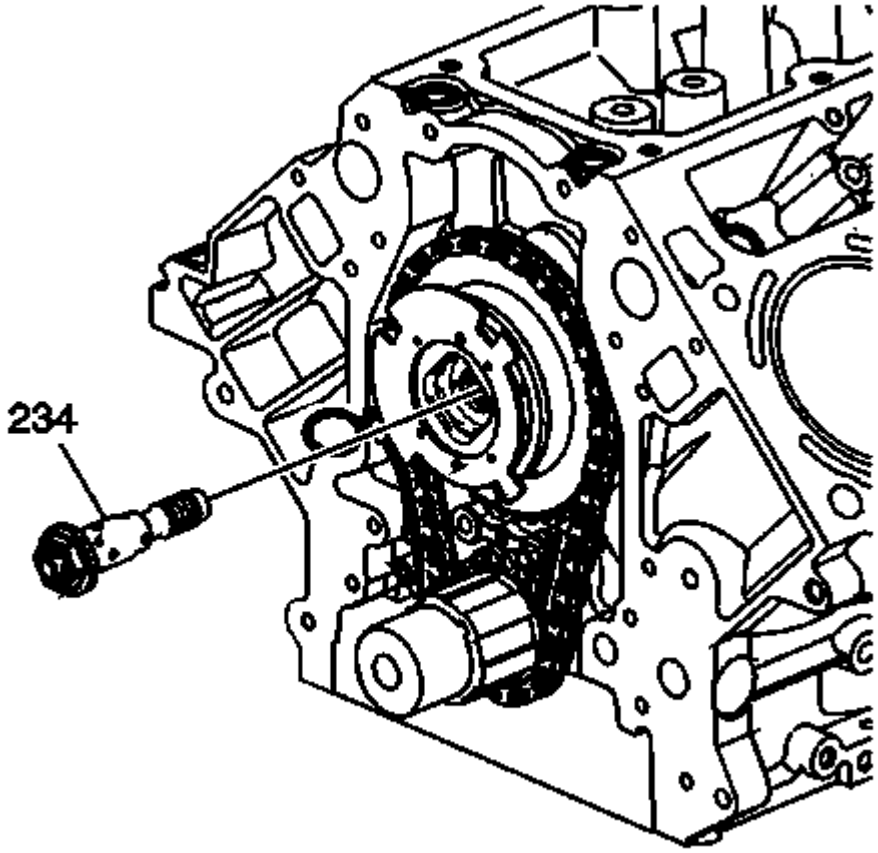

Fig. 139: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

3. Remove the CMP actuator solenoid valve (234).
4. Discard the solenoid valve.

INSTALLATION PROCEDURE

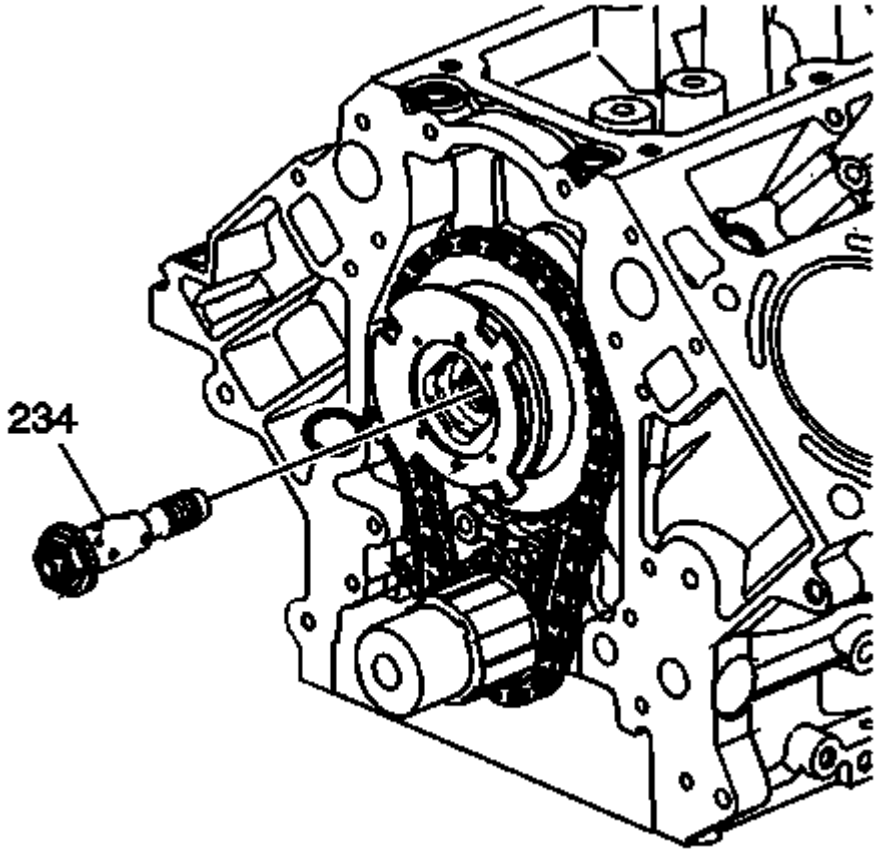

Fig. 140: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW CMP actuator solenoid valve (234).

   With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

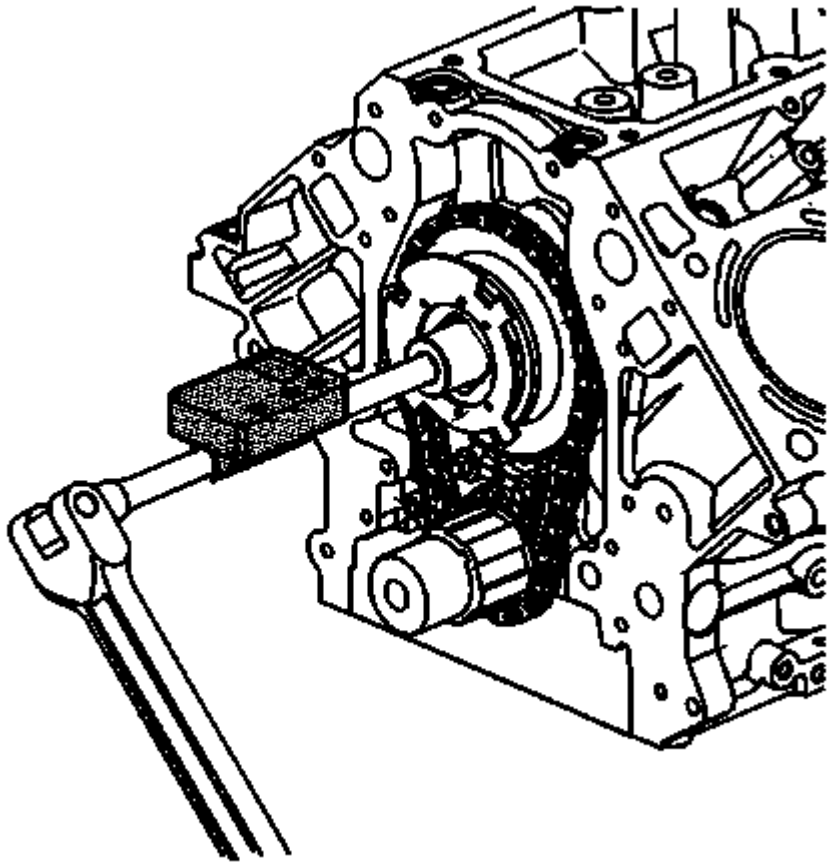

Fig. 141: View Of Tightening The CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

2. Tighten the CMP actuator solenoid valve.
    1. Tighten the CMP actuator solenoid valve a first pass to 65 N.m (48 lb ft).
    2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the **J 45059** .

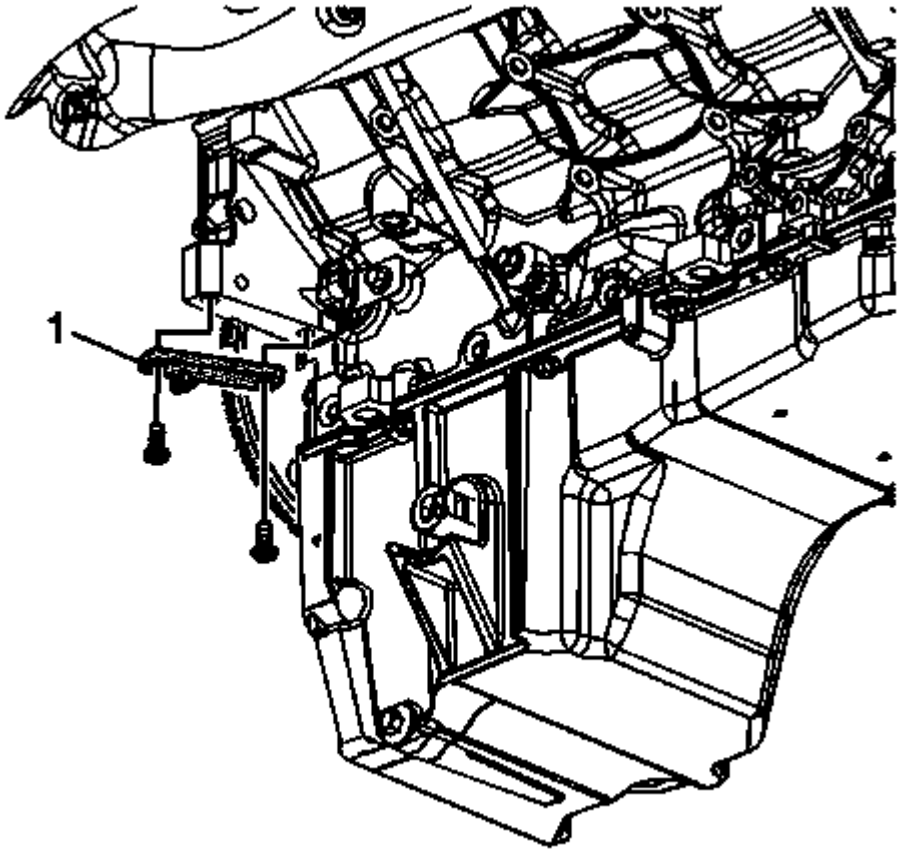

Fig. 142: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the **J 42386-A** (1). See **Special Tools** .
4. Install the CMP actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT

SPECIAL TOOLS

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

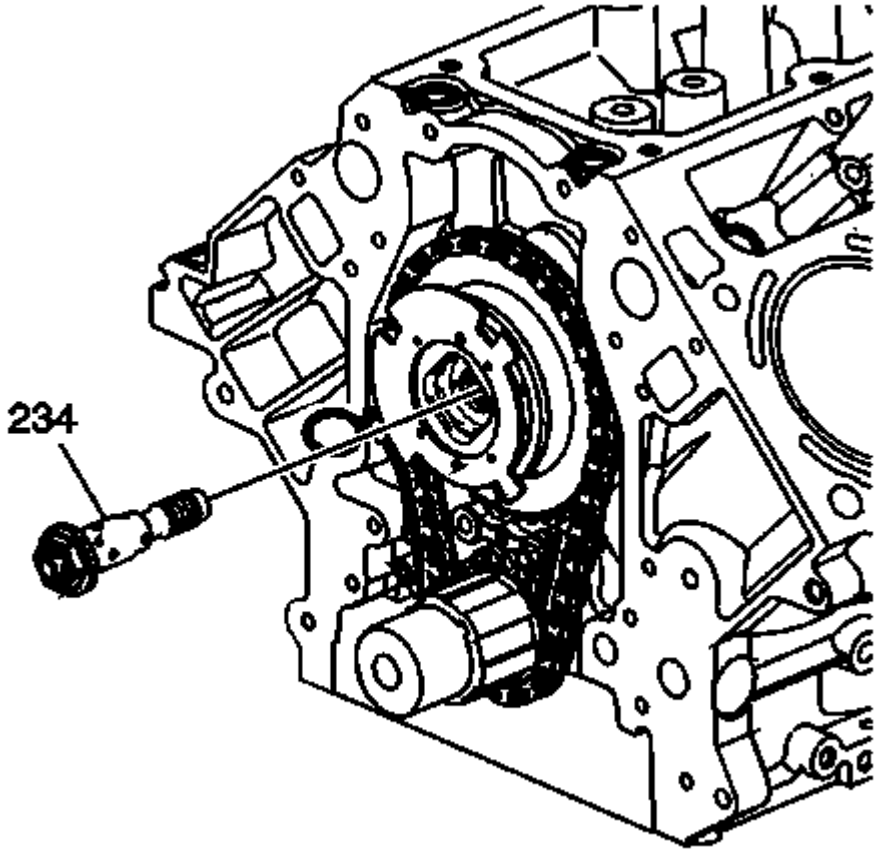

Fig. 143: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
2. Remove and discard the camshaft position (CMP) actuator solenoid valve (234).

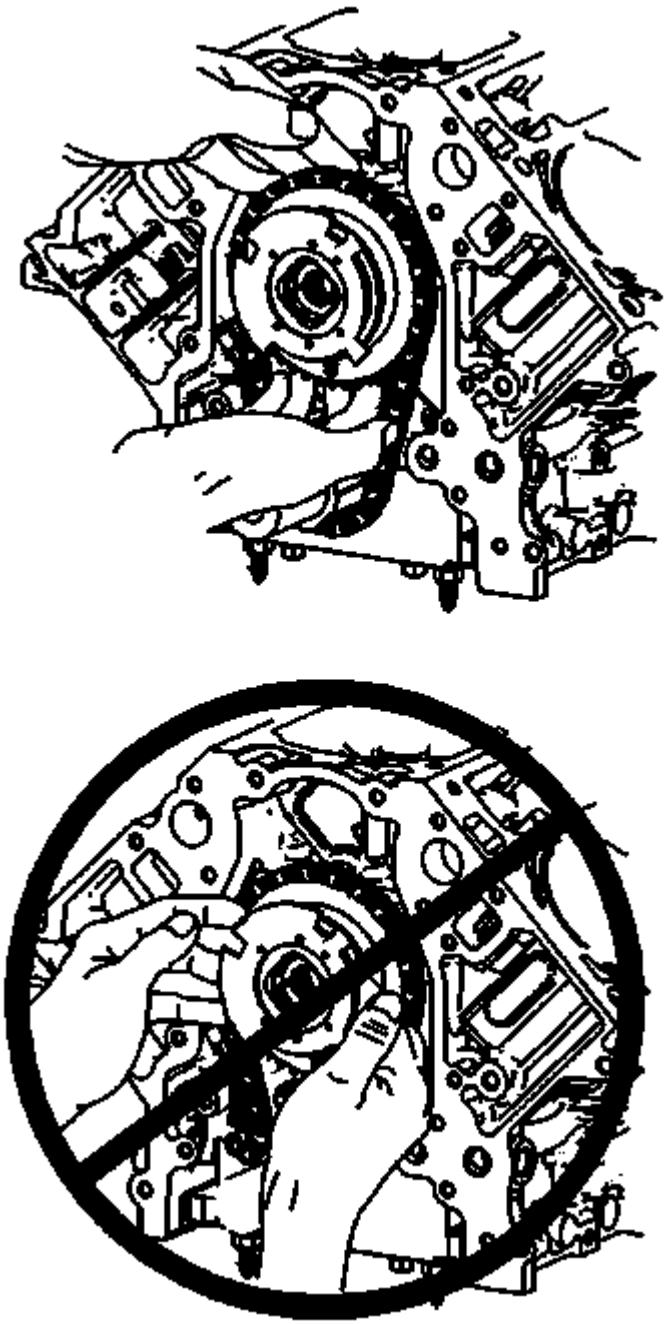

Fig. 144: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

3. Loosen and separate the CMP actuator and timing chain from the camshaft. Position your fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

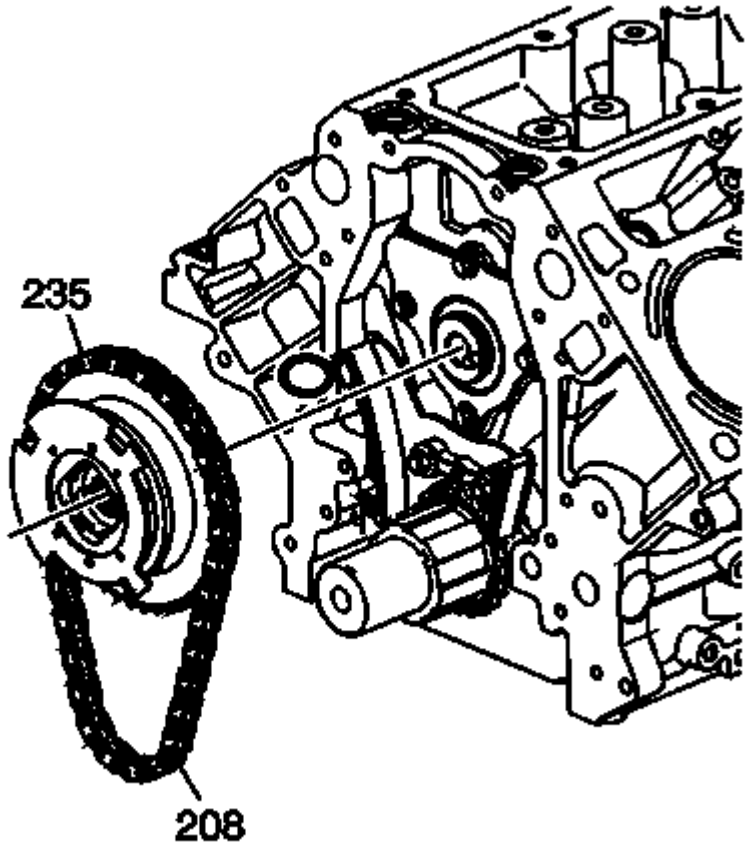

Fig. 145: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

4. Remove the CMP actuator (235) and timing chain (208).

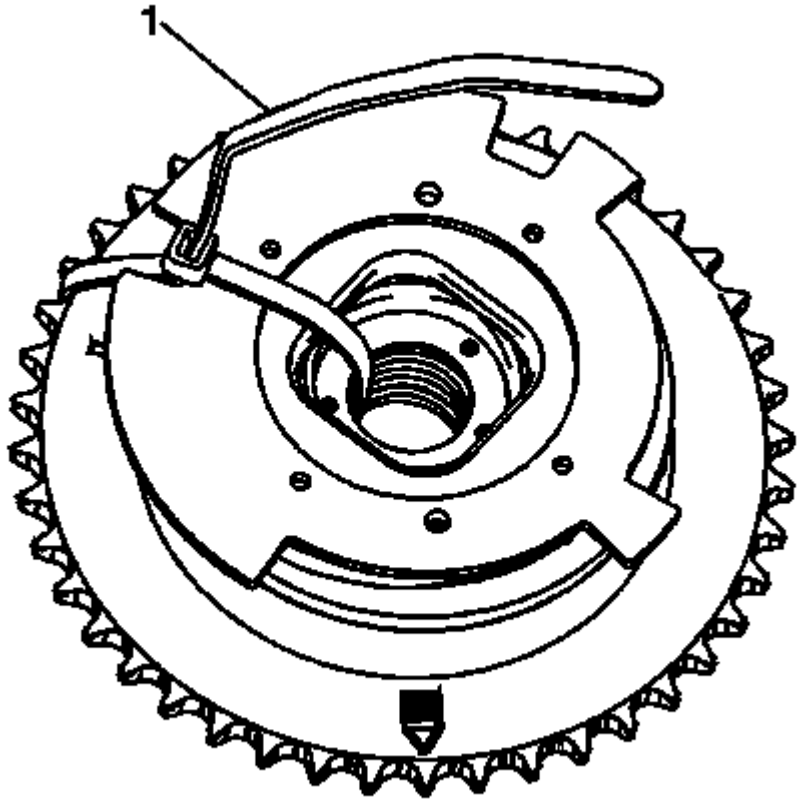

Fig. 146: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

5. Insert and secure a tie strap (1) through the center of the actuator and over the reluctor wheel.

INSTALLATION PROCEDURE

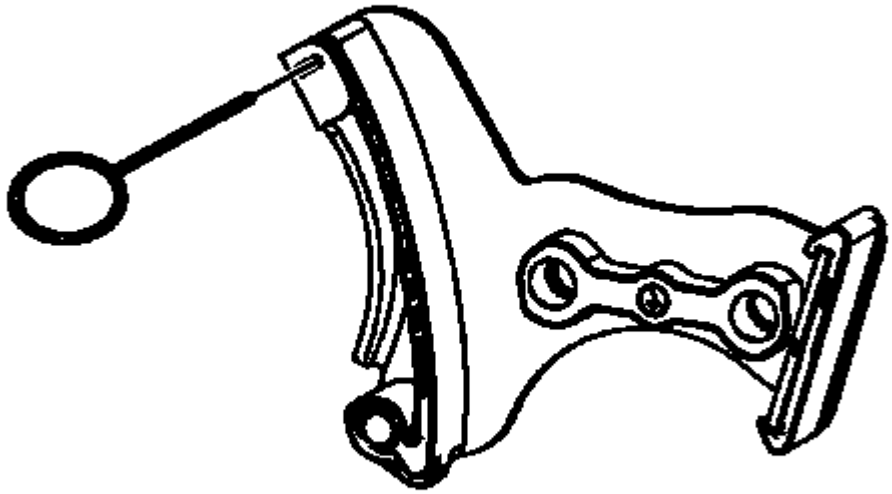

Fig. 147: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

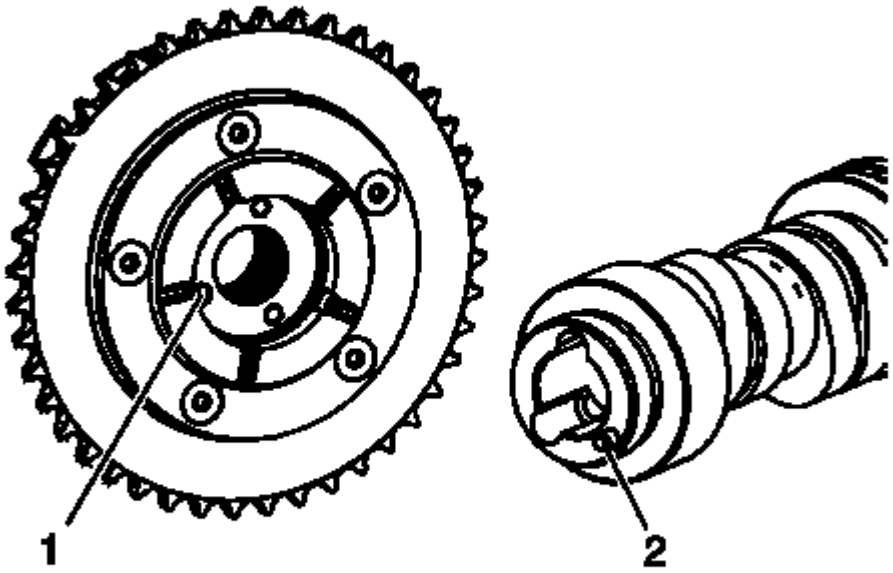

Fig. 148: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator on the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **DO NOT use the CMP solenoid valve again. Install a NEW valve during assembly.**

2. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

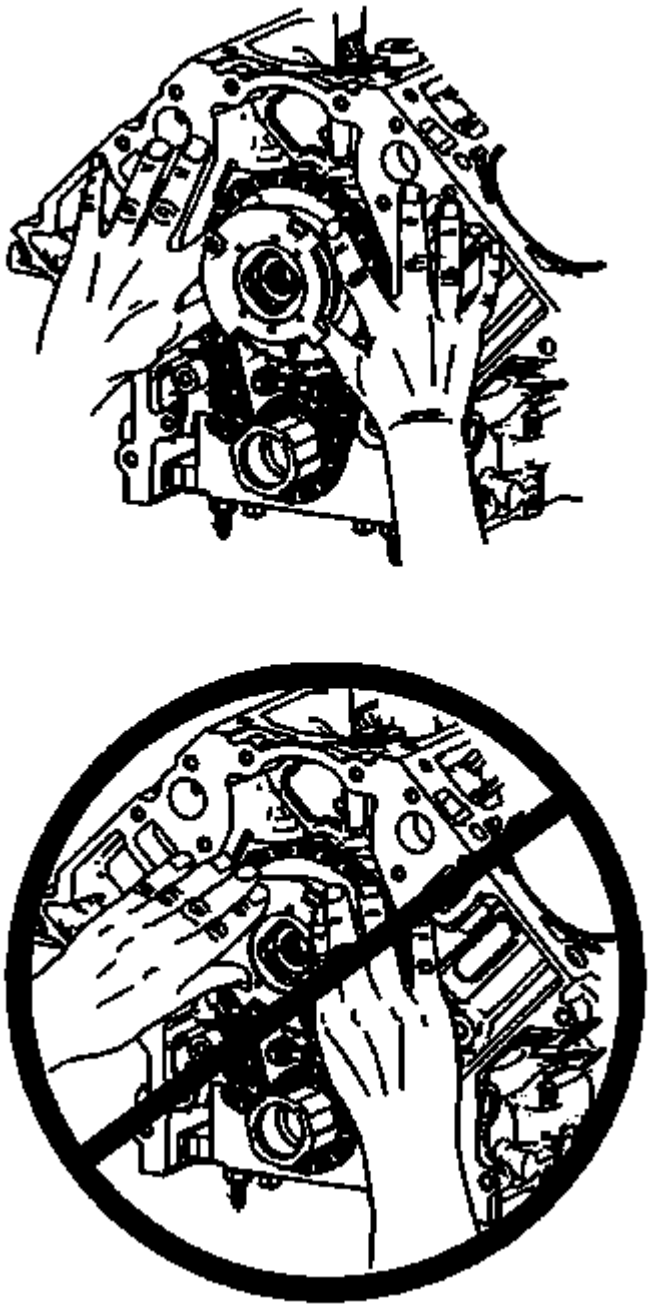

Fig. 149: Identifying Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

3. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position your fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

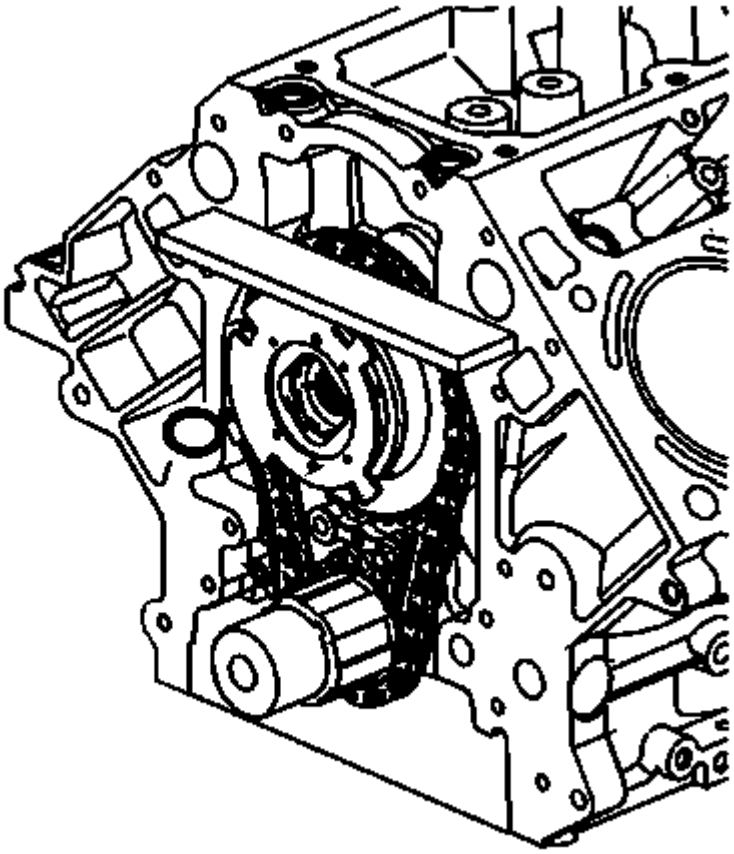

Fig. 150: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

4. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

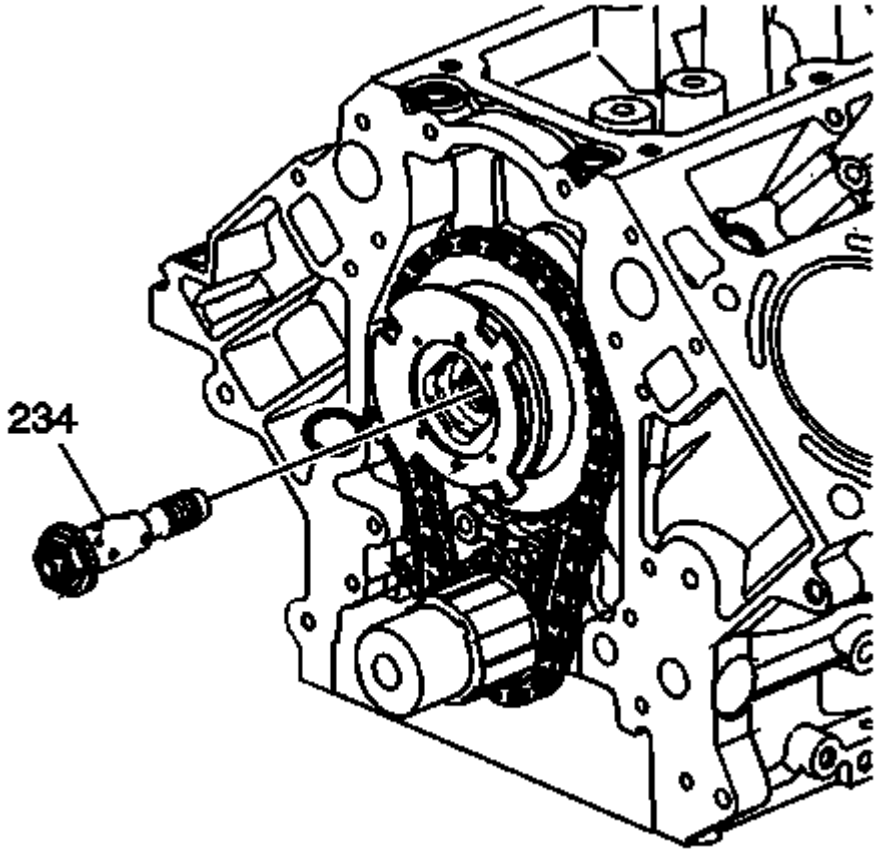

Fig. 151: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

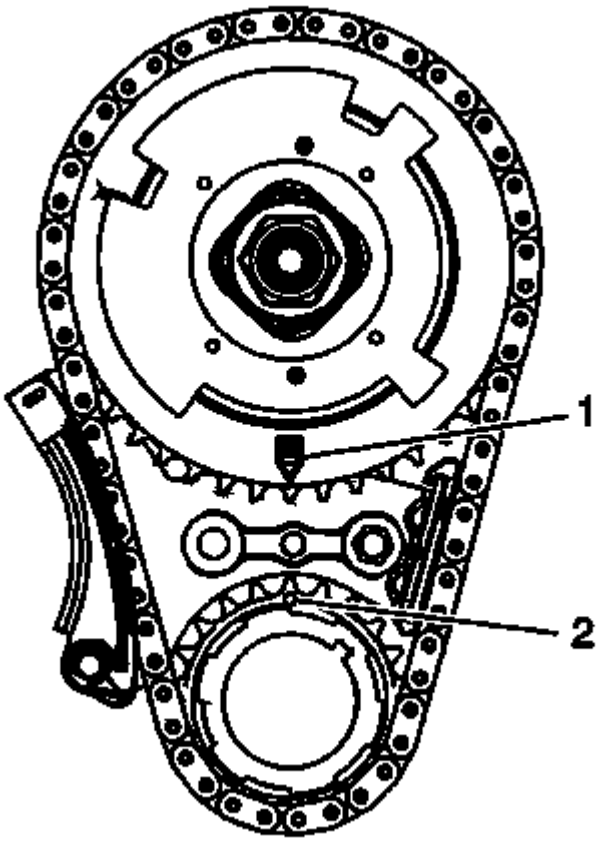

Fig. 152: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

6. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

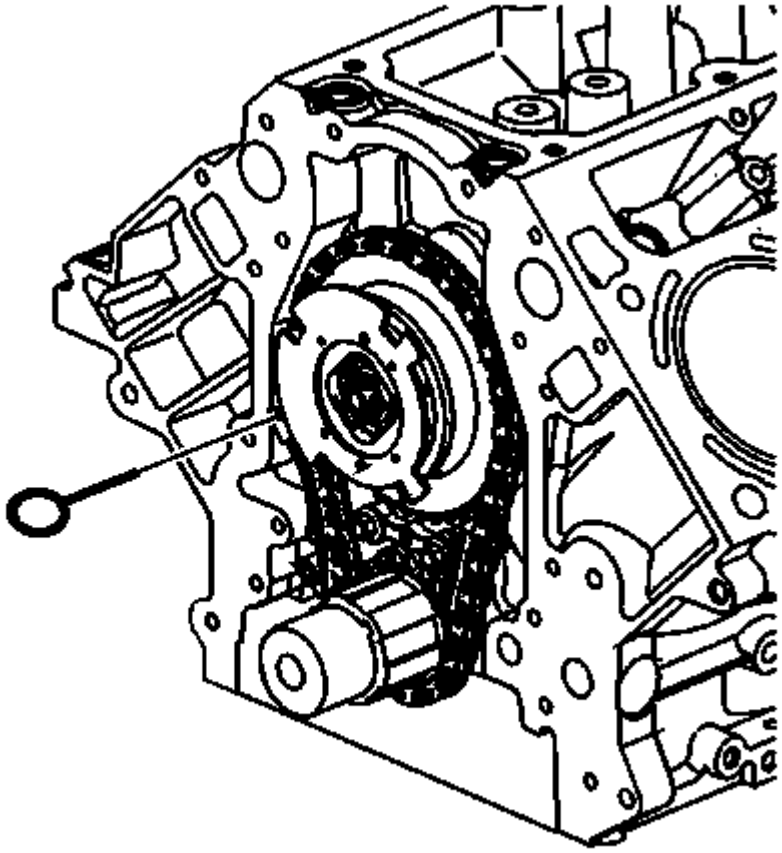

Fig. 153: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

7. Remove the **EN 46330** . See **Special Tools** .

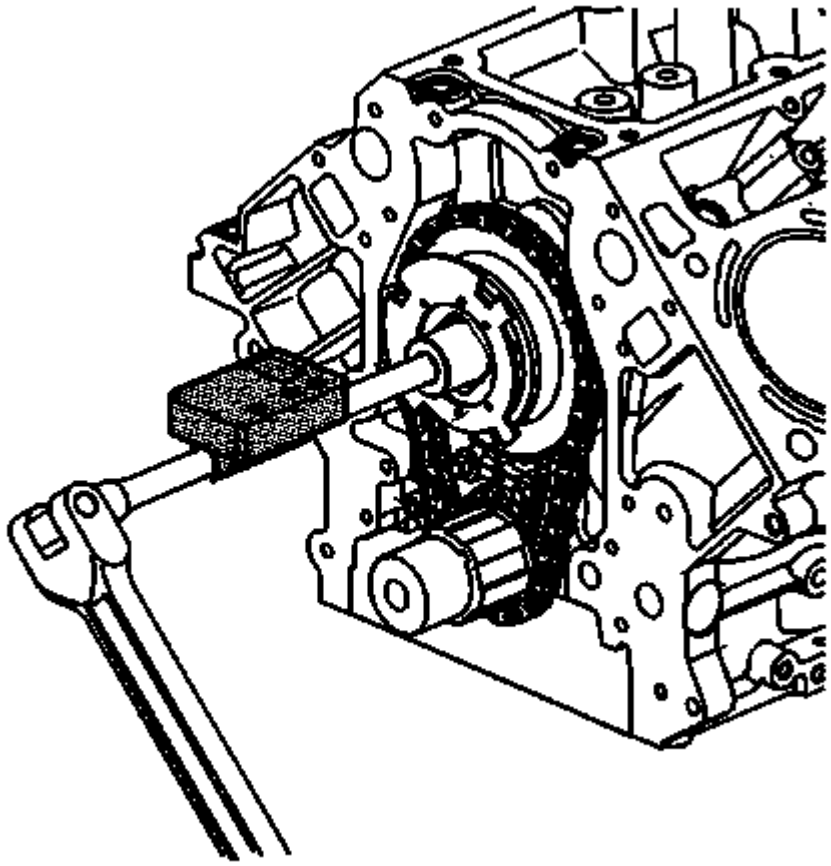

Fig. 154: View Of Tightening The CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the CMP actuator solenoid valve.
    1. Tighten the valve a first pass to 65 N.m (48 lb ft).
    2. Tighten the valve a final pass and additional 90 degrees using **J 45059** .
9. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 41479 Crankshaft Rear Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

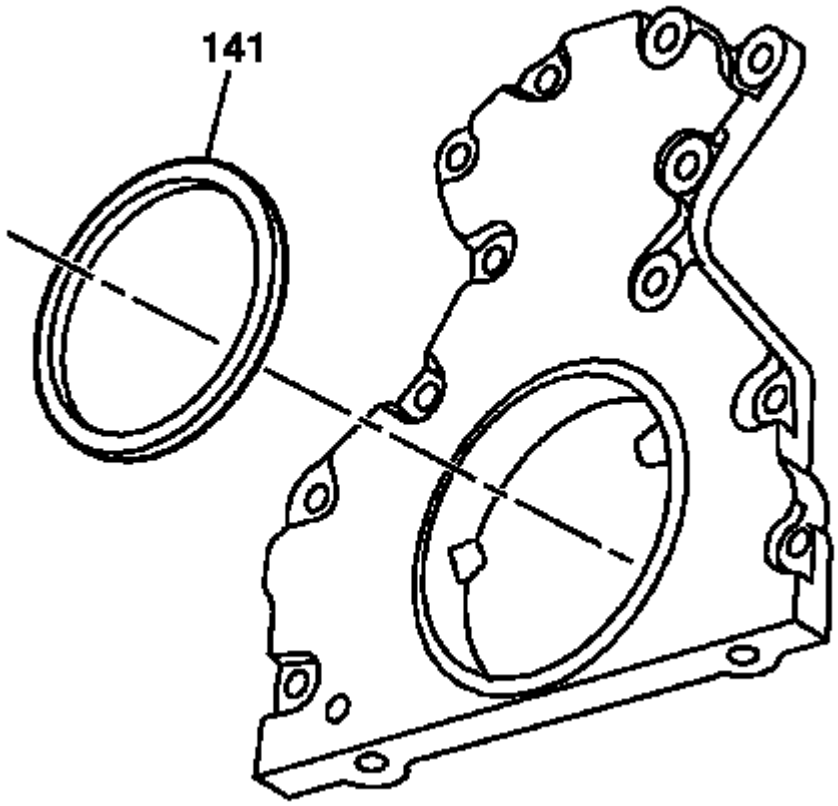

Fig. 155: View Of Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. Remove the crankshaft rear oil seal (141) from the rear housing.

INSTALLATION PROCEDURE

IMPORTANT:

- **The flywheel spacer (if applicable) must be removed prior to oil seal installation.**
- **Do not lubricate the oil seal inside diameter (ID) or the crankshaft surface.**
- **Do not reuse the crankshaft rear oil seal. Install a NEW oil seal.**

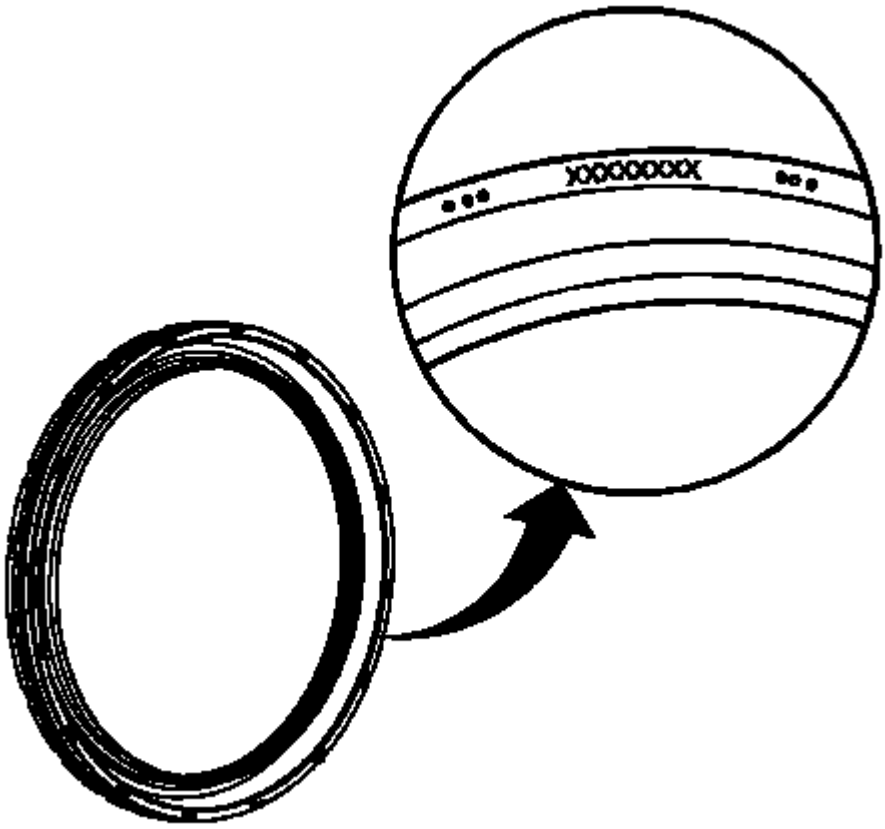

Fig. 156: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the installation direction of the oil seal. The new design oil seal is a reverse lip type seal. For proper orientation, THIS SIDE OUT has been marked on the seal.

1. Lubricate the outside diameter (OD) of the oil seal with clean engine oil.
2. Inspect the seal and identify the THIS SIDE OUT markings for proper orientation.
3. Lubricate the rear housing oil seal bore with clean engine oil.

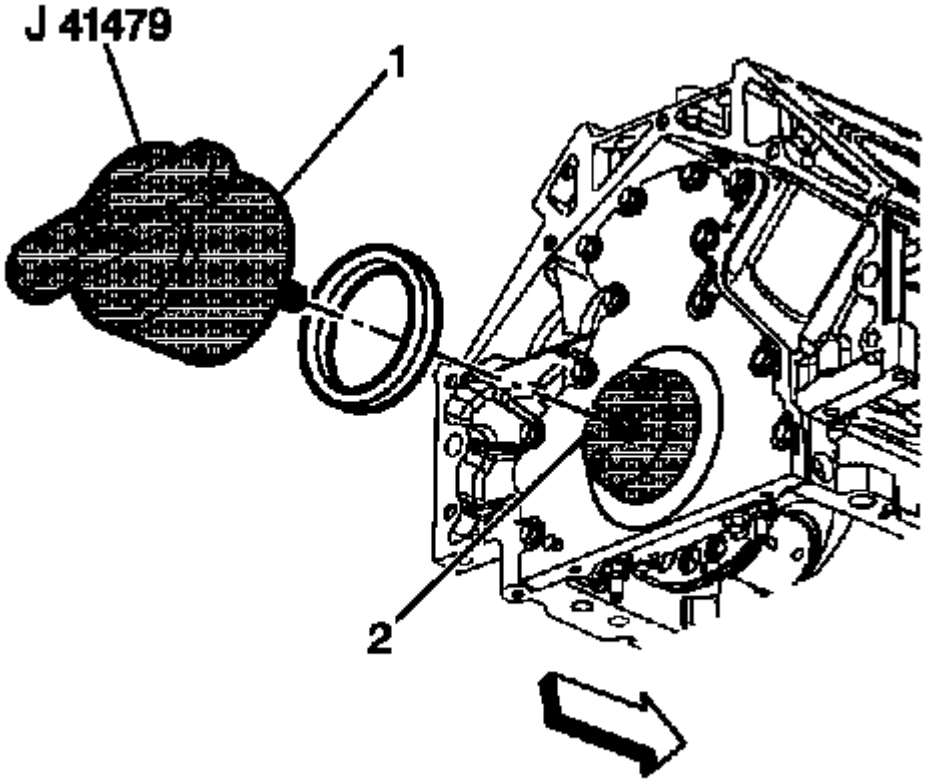

Fig. 157: View Of Special Tool J 41479 Cone & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 41479** tapered cone (2) and bolts onto the rear of the crankshaft. See **Special Tools** .
5. Tighten the bolts until snug. Do not overtighten.
6. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear cover bore. Install the oil seal with the markings THIS SIDE OUT facing away from the engine.
7. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal. See **Special Tools** .
8. Align the oil seal into the tool (1).
9. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
10. Remove the **J 41479** . See **Special Tools** .
11. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

SPECIAL TOOLS

- **J-41476:** Front and Rear Cover Alignment Tool
- **J-41479-2A:** Crankshaft Rear Oil Seal Installation Guide

REMOVAL PROCEDURE

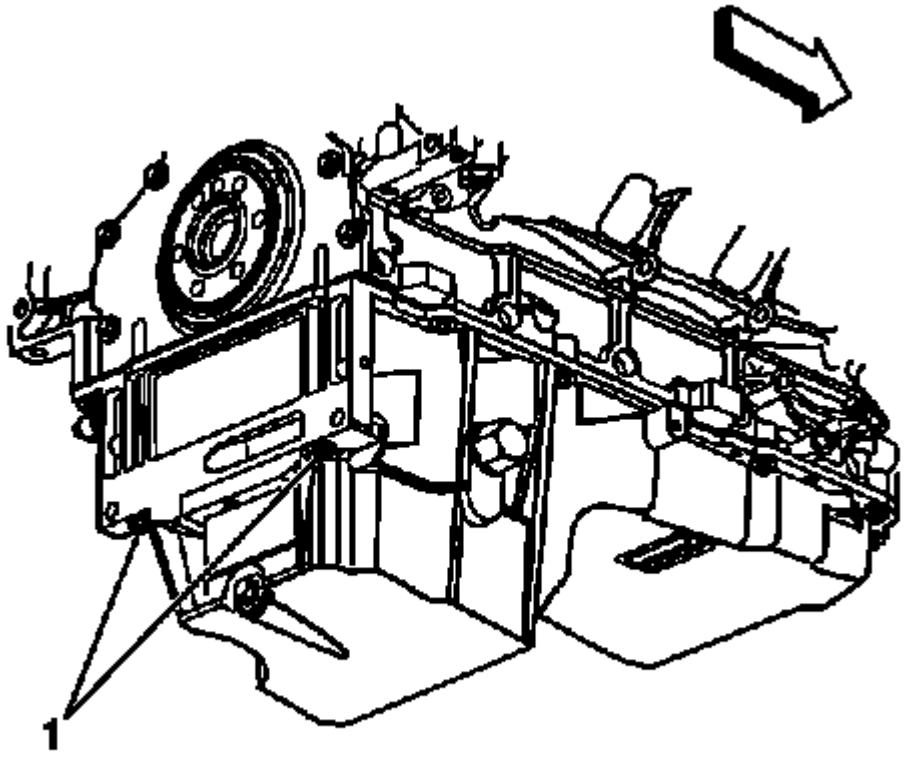

Fig. 158: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission flexplate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. Remove the oil pan-to-rear oil seal housing bolts (1).

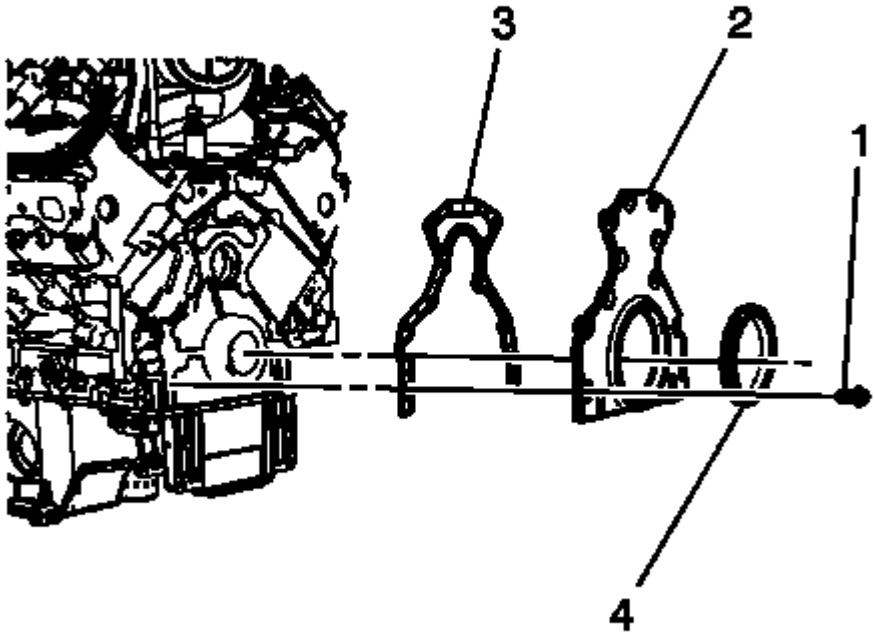

Fig. 159: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS CORP.

3. Remove the rear oil seal housing bolts (1).
4. Remove the rear oil seal housing (2) and gasket (3). Discard the gasket.
5. Remove and discard the rear oil seal (4).

INSTALLATION PROCEDURE

NOTE:

- **Do not reuse the crankshaft oil seal or rear cover gasket.**
- **Do not apply any type of sealant to the rear cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the crankshaft rear oil seal.**
- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **The crankshaft rear oil seal MUST be centered in relation to the crankshaft.**
- **An improperly aligned rear cover may cause premature rear oil seal**

wear and/or engine assembly oil leaks.

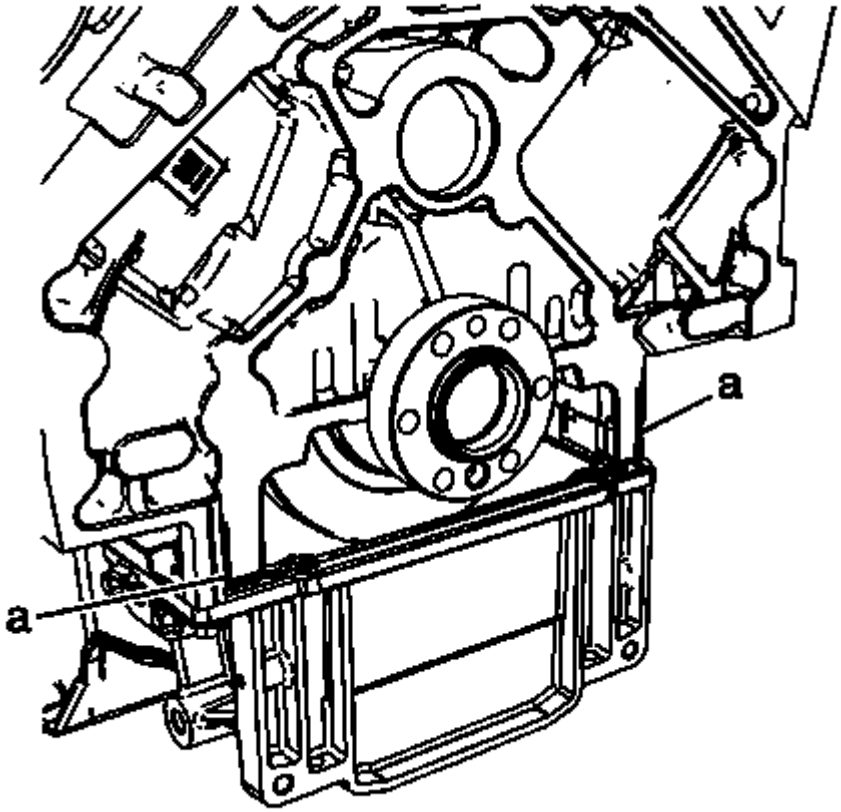

Fig. 160: Locating Joints At Rear Of Block/Pan
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.2 in) bead of sealant, 20 mm (0.8 in) to the 2 joints (a) at the rear of the block/pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

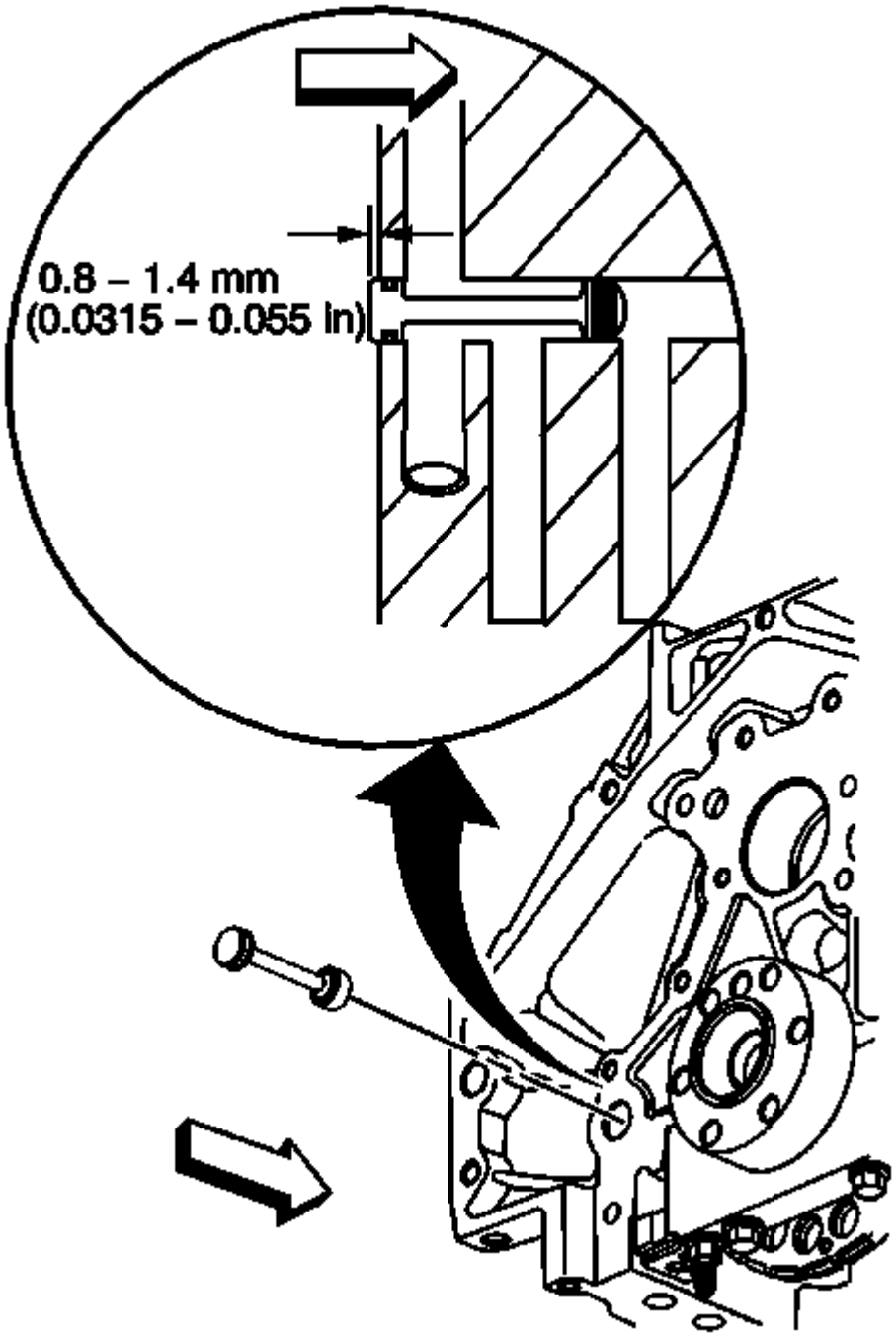

Fig. 161: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

2. Inspect the rear oil gallery plug for proper installation.

INSTALLATION PROCEDURE - COVER WITH SEAL

1. Install the **J-41479-2A:** guide cone and bolts onto the rear of the crankshaft.

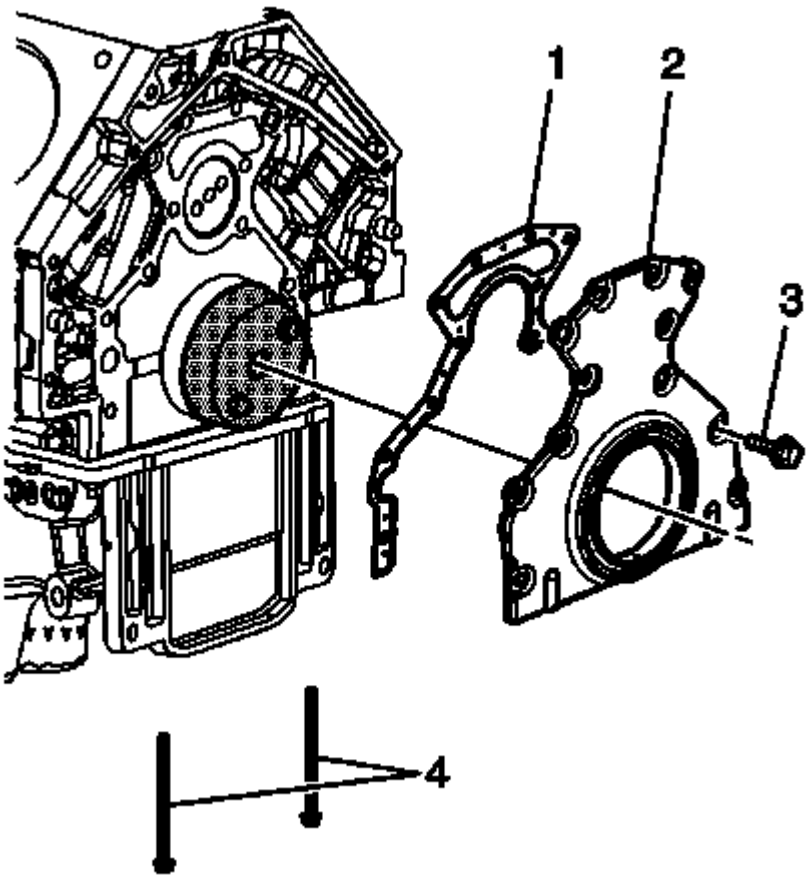

Fig. 162: Identifying Rear Housing Components
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW rear housing gasket (1), rear housing with seal (2), rear housing-to-engine bolts (3) and oil pan-to-rear housing bolts (4).

CAUTION: Refer to Fastener Caution .

3. Tighten the rear housing-to-engine bolts (3) until snug. Do not overtighten.
4. Tighten the oil pan-to-rear housing bolts (4) to 12 N.m (106 lb in).
5. Tighten the rear housing-to-engine bolts (3) to 30 N.m (22 lb ft).
6. Remove the **J-41479-2A:** guide.
7. Install the automatic transmission flexplate. Refer to **Automatic Transmission Flex Plate Replacement**.

INSTALLATION PROCEDURE - COVER WITHOUT SEAL

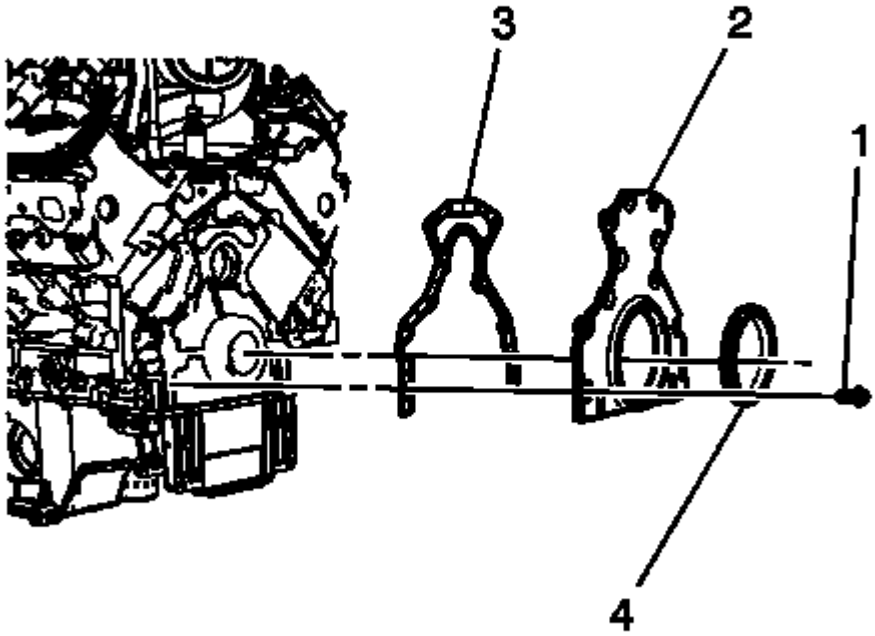

Fig. 163: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS CORP.

1. Position a NEW rear oil seal housing gasket (3) and the housing (2) to the engine.
2. Install the rear oil seal housing bolts (1) until snug. Do not overtighten.
3. Rotate the crankshaft until 2 opposing flywheel bolts holes are parallel to the oil pan surface.

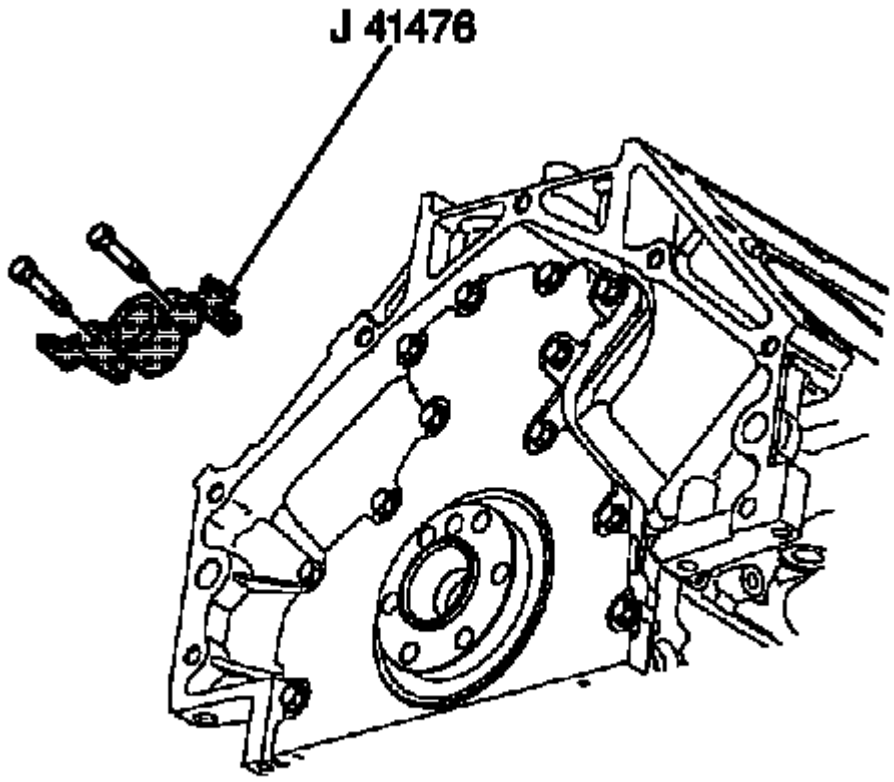

Fig. 164: View Of Special Tool J 41476 & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

4. Install the **J-41476:** tool and bolts onto the rear of the crankshaft.
5. Tighten the **J-41476:** tool bolts until snug. Do not overtighten.

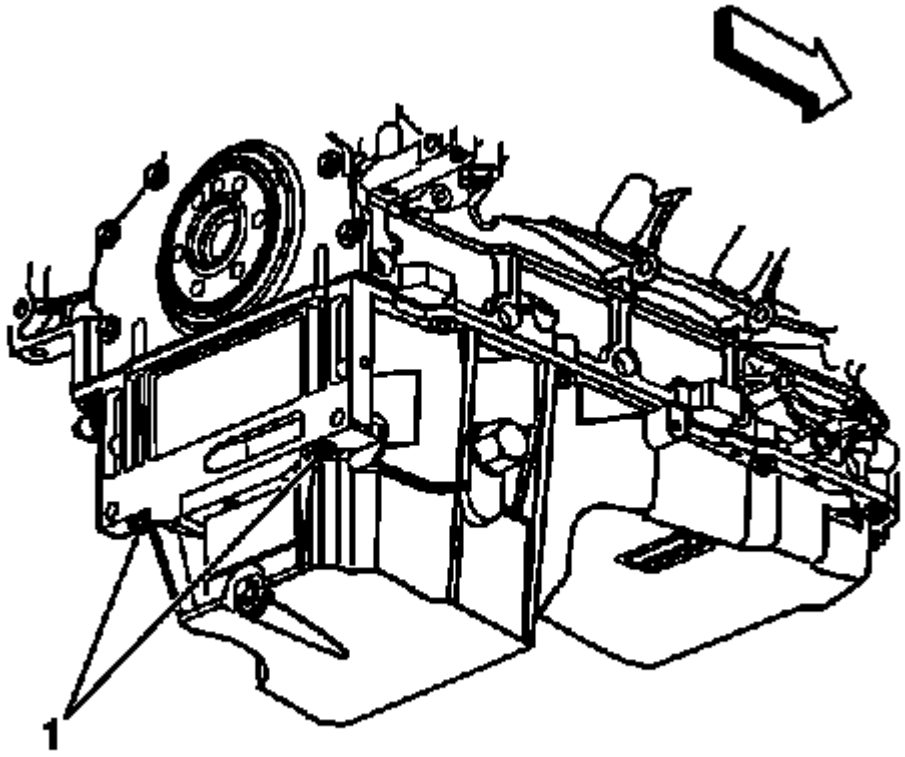

Fig. 165: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan-to-rear oil seal housing bolts (1).
    1. Tighten the oil pan-to-rear cover bolts to 12 N.m (106 lb in).
    2. Tighten the rear oil seal housing-to-engine bolts to 30 N.m (22 lb ft).
7. Remove the **J-41476:** tool.
8. Install a NEW crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
9. Install the automatic transmission flexplate. Refer to **Automatic Transmission Flex Plate Replacement**.

OIL FILTER ADAPTER REPLACEMENT

REMOVAL PROCEDURE

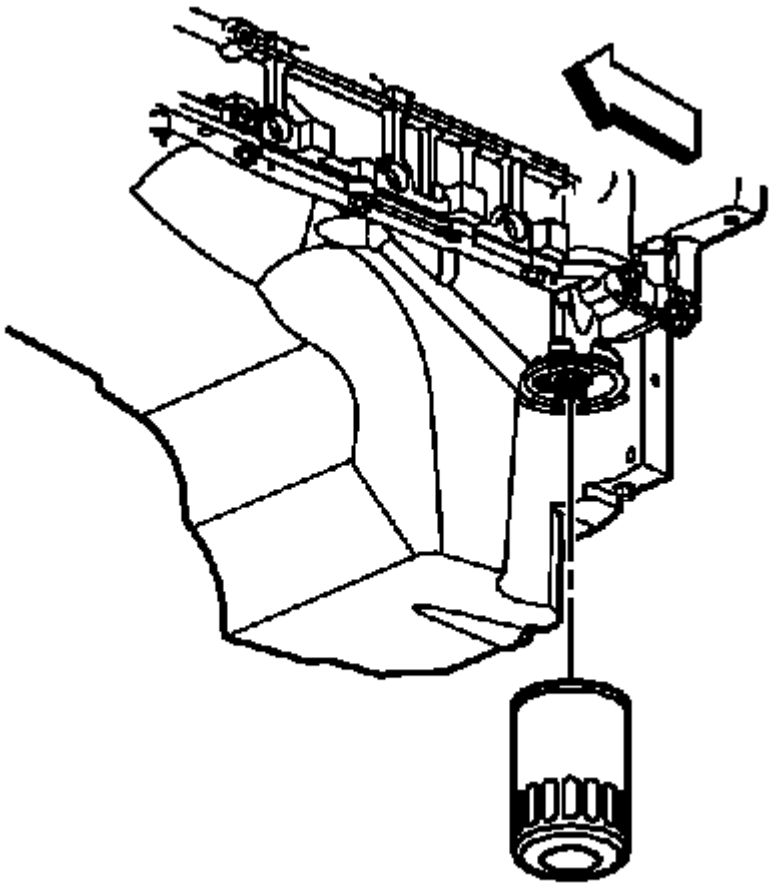

Fig. 166: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil.
2. Remove the oil filter.

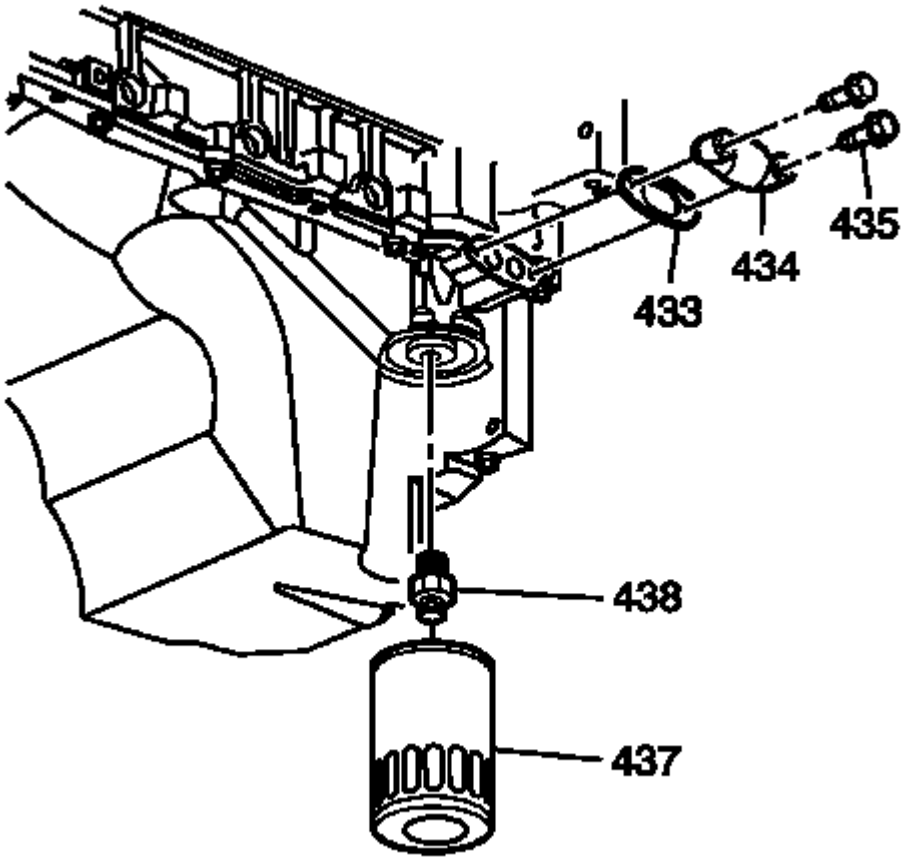

Fig. 167: Identifying Oil Pan Cover, Bolts, Gasket And Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan cover (434), bolts (435), and gasket (433).
4. Discard the gasket.
5. Remove the oil filter fittings (438), if equipped.

INSTALLATION PROCEDURE

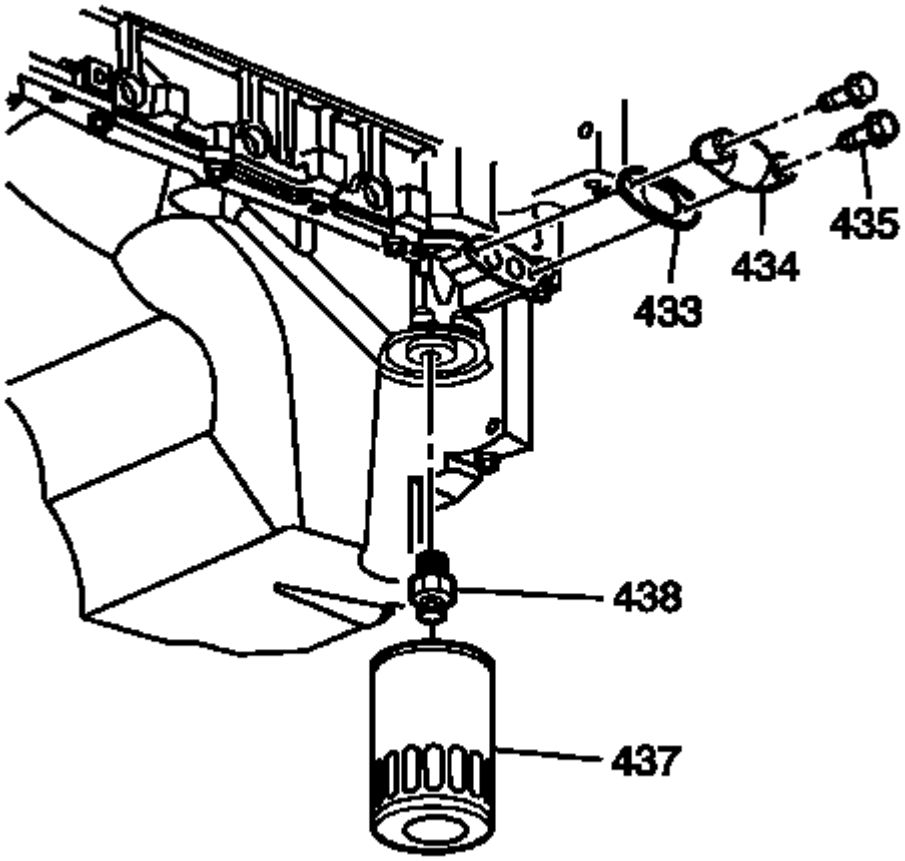

Fig. 168: Identifying Oil Pan Cover, Bolts, Gasket And Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil pan cover (434), bolts (435), and NEW oil pan cover gasket (433). Tighten the oil pan cover bolts to 12 N.m (106 lb in).
2. Install the oil filter fitting (438) and tighten to 55 N.m (40 lb ft).

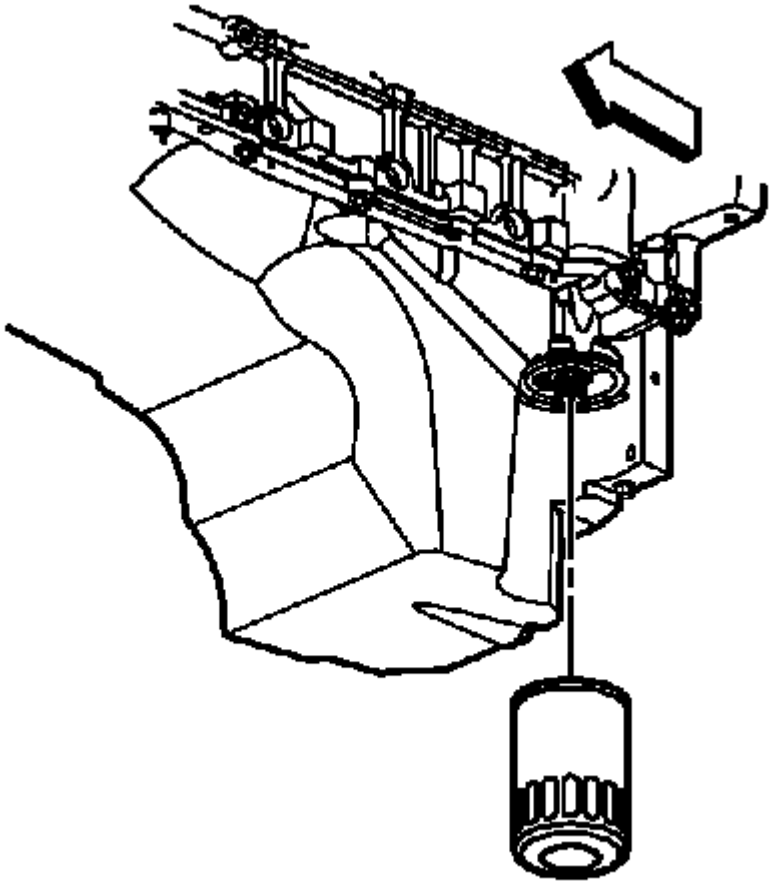

Fig. 169: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Install the oil filter.
4. Refill the engine oil. Refer to **Approximate Fluid Capacities** and/or **Fluid and Lubricant Recommendations (USA and Canada)** .

OIL PAN COVER REPLACEMENT

REMOVAL PROCEDURE

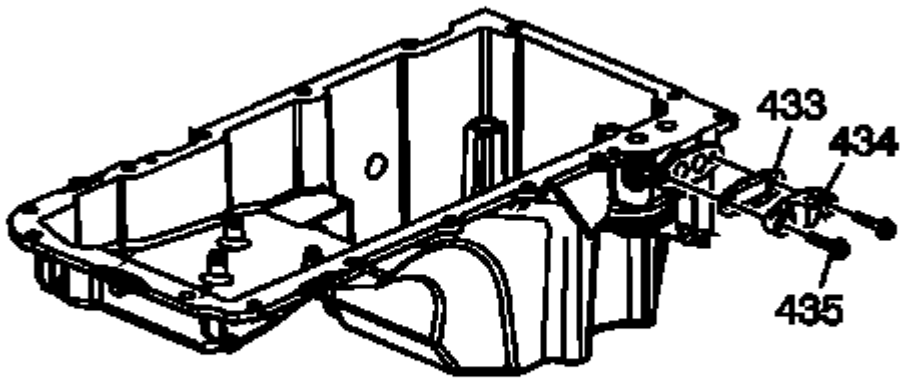

Fig. 170: View Of Oil Pan Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the oil pan cover bolts (435), cover (434), and gasket (433). Discard the gasket.

INSTALLATION PROCEDURE

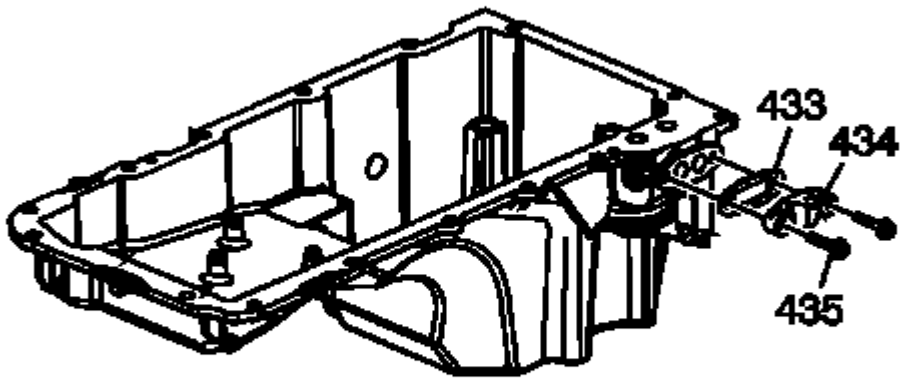

Fig. 171: View Of Oil Pan Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Position a NEW oil pan cover gasket (433) and the cover (434) to the oil pan and install the bolts (435). Tighten the bolts to 12 N.m (106 lb in).
2. Lower the vehicle.

OIL PAN REPLACEMENT

REMOVAL PROCEDURE

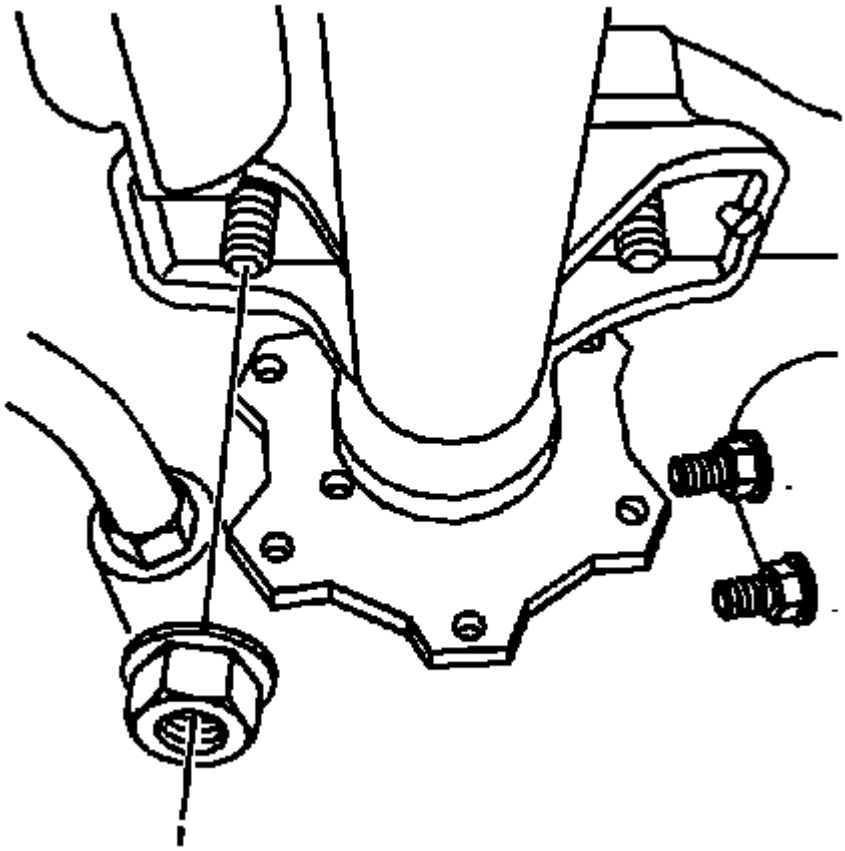

Fig. 172: View Of Inner Axle Housing Nuts
Courtesy of GENERAL MOTORS CORP.

1. If equipped with all wheel drive (AWD), remove the inner axle housing nuts and washers from the bracket.
2. Support the front drive axle with a suitable jack.

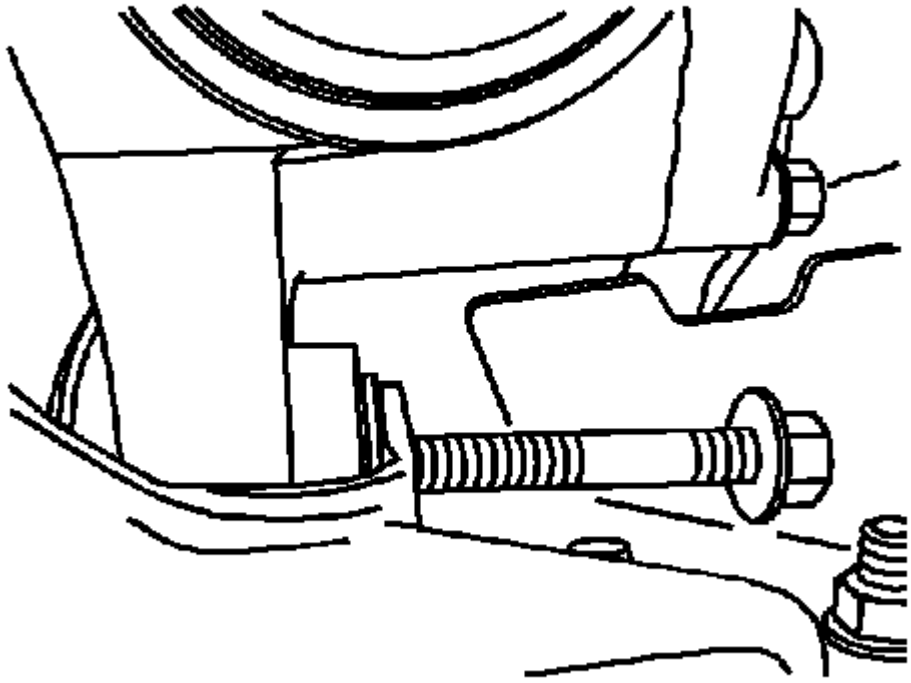

Fig. 173: View Of Differential Carrier Lower Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

3. If equipped with AWD, remove the differential carrier lower mounting bolt and nut.

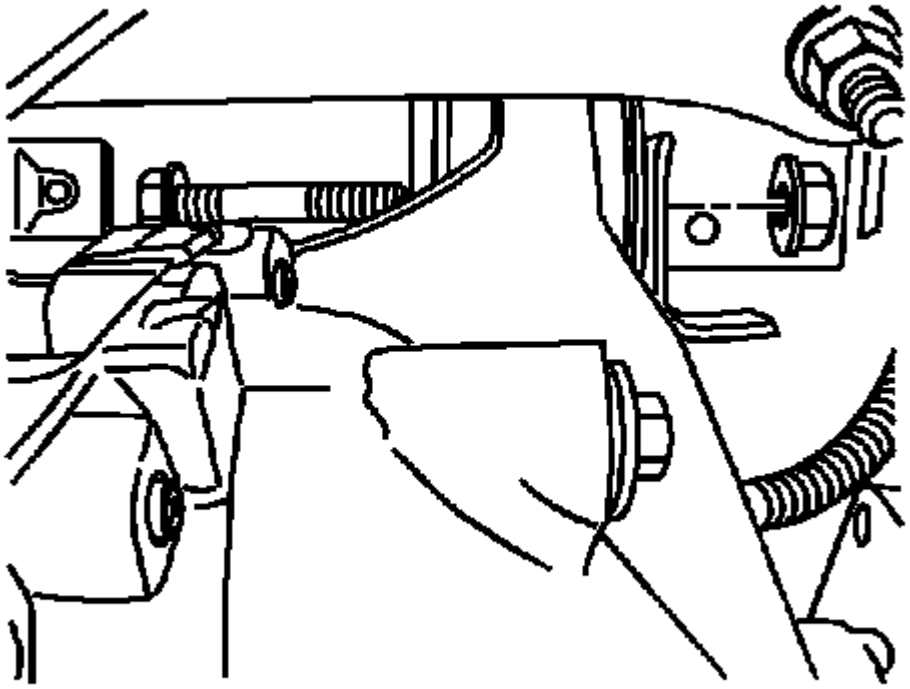

Fig. 174: View Of Differential Carrier Upper Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

4. If equipped with AWD, remove the differential carrier upper mounting bolt and nut.
5. Lower the front drive axle.

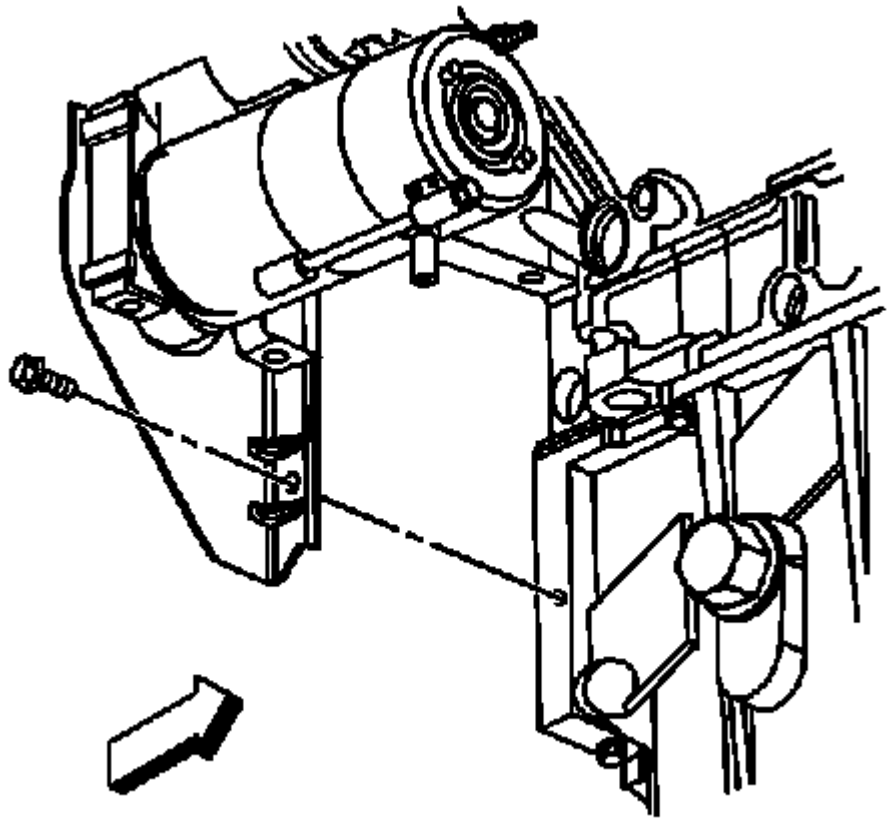

Fig. 175: View Of Transmission Cover Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the transmission cover bolt.

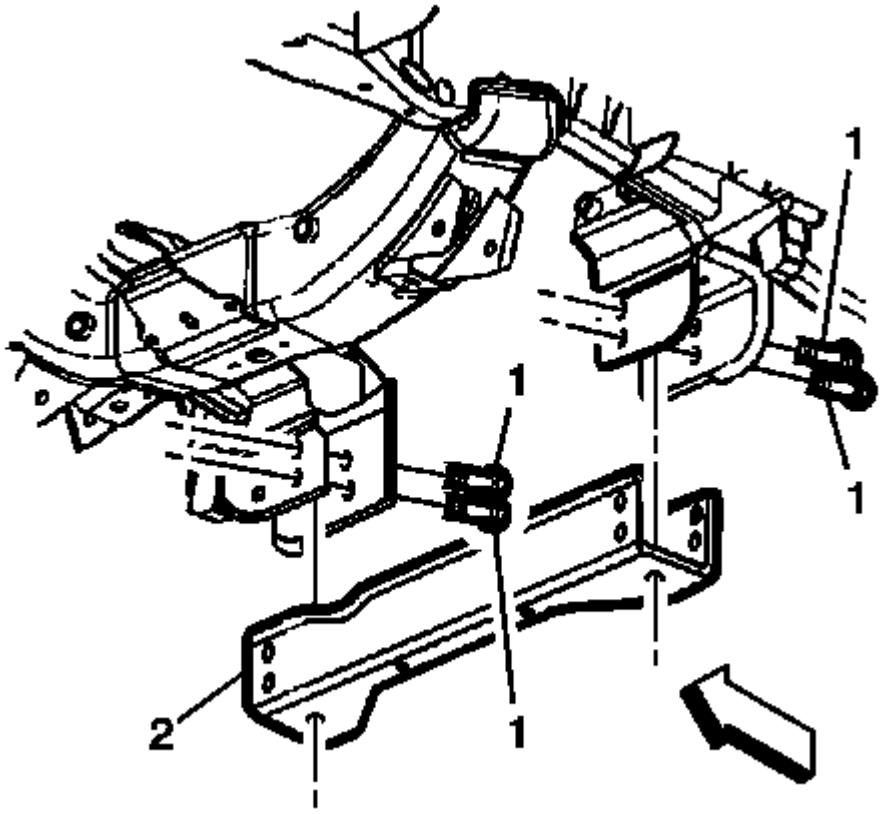

Fig. 176: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

7. Remove the crossbar bolts.
8. Remove the crossbar.

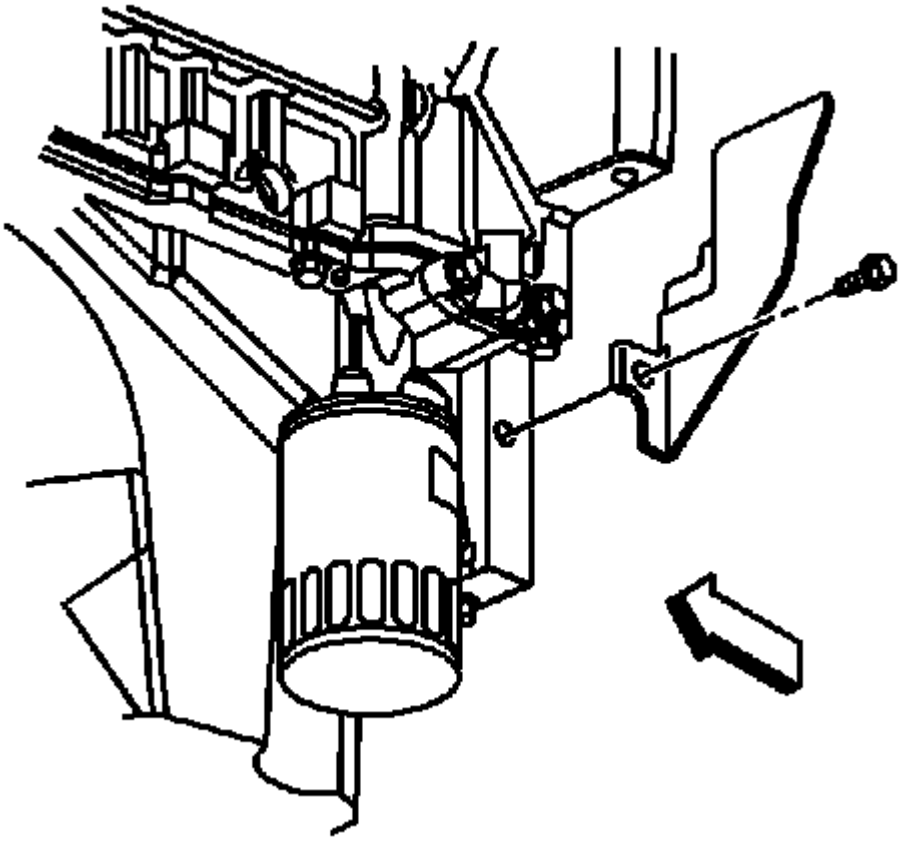

Fig. 177: View Of Transmission Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the transmission cover bolt and cover.
10. Drain the engine oil and remove the engine oil filter.
11. Re-install the drain plug and oil filter until snug.

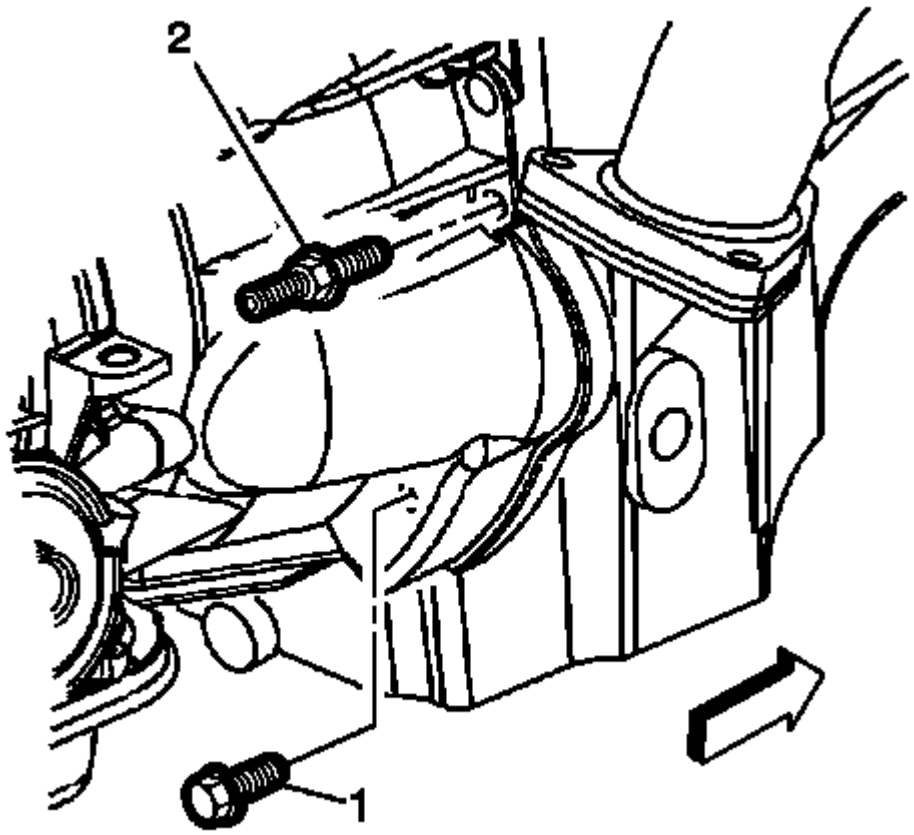

Fig. 178: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

12. If equipped with the 4L60-E automatic transmission, remove the transmission bolt and stud on the right side.

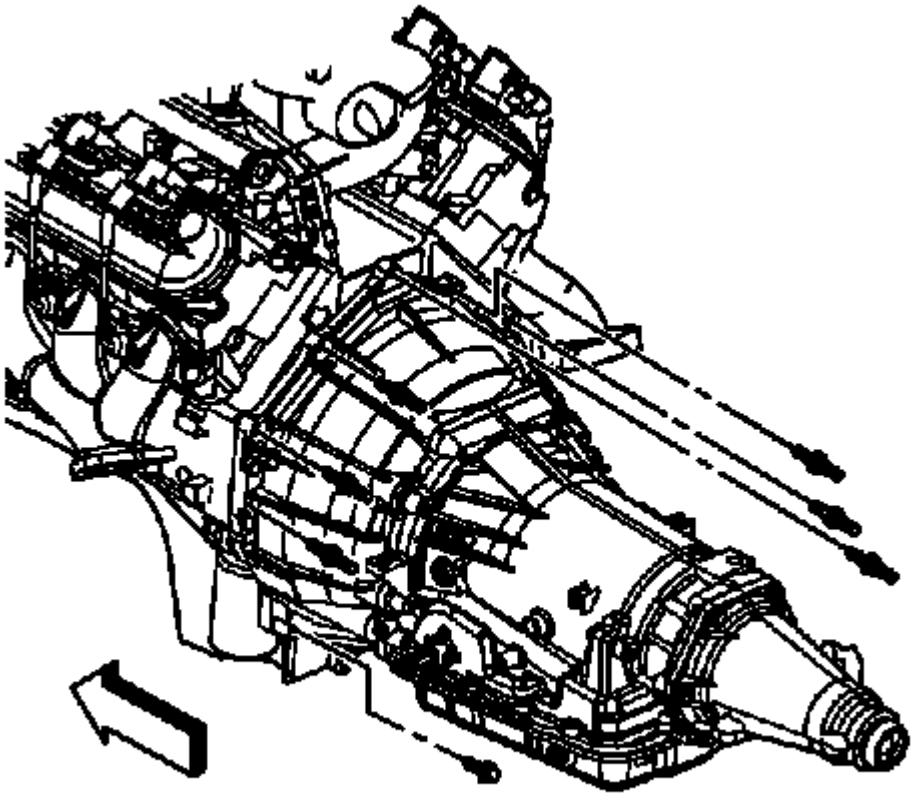

Fig. 179: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

13. Remove the bottom bolt on the left side.

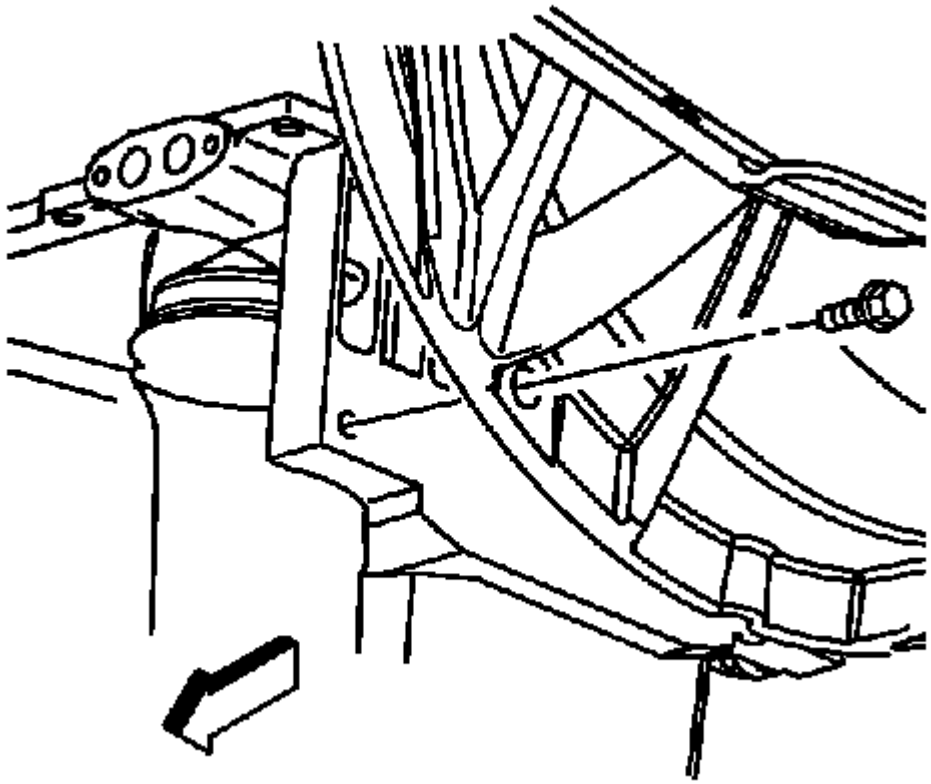

Fig. 180: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

14. If equipped with the 4L80-E automatic transmission, remove the transmission converter cover bolts.

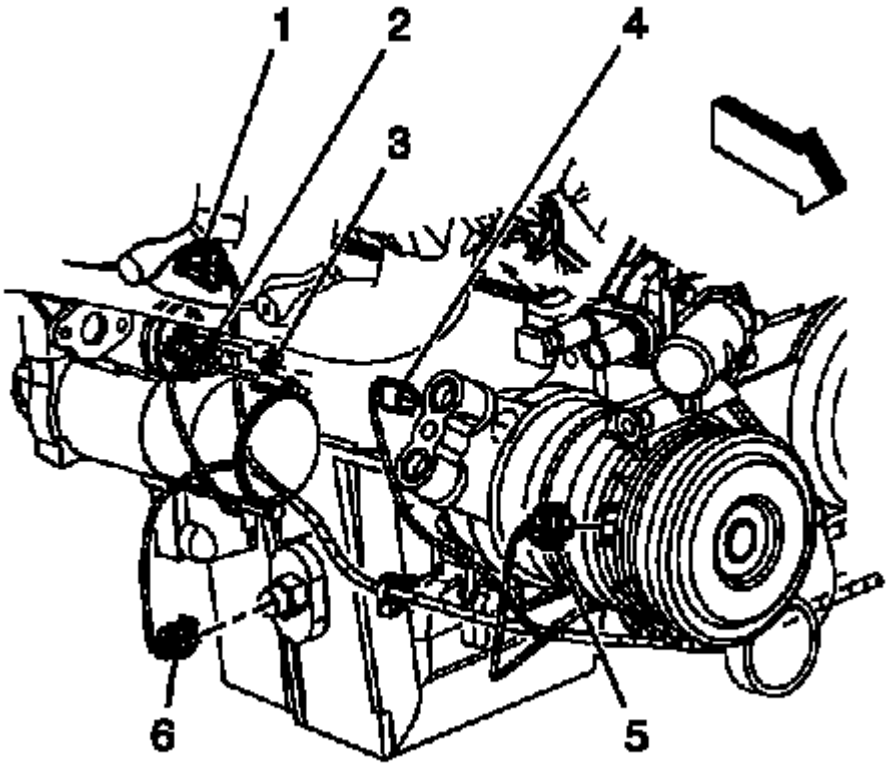

Fig. 181: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the oil level sensor electrical connector (6).

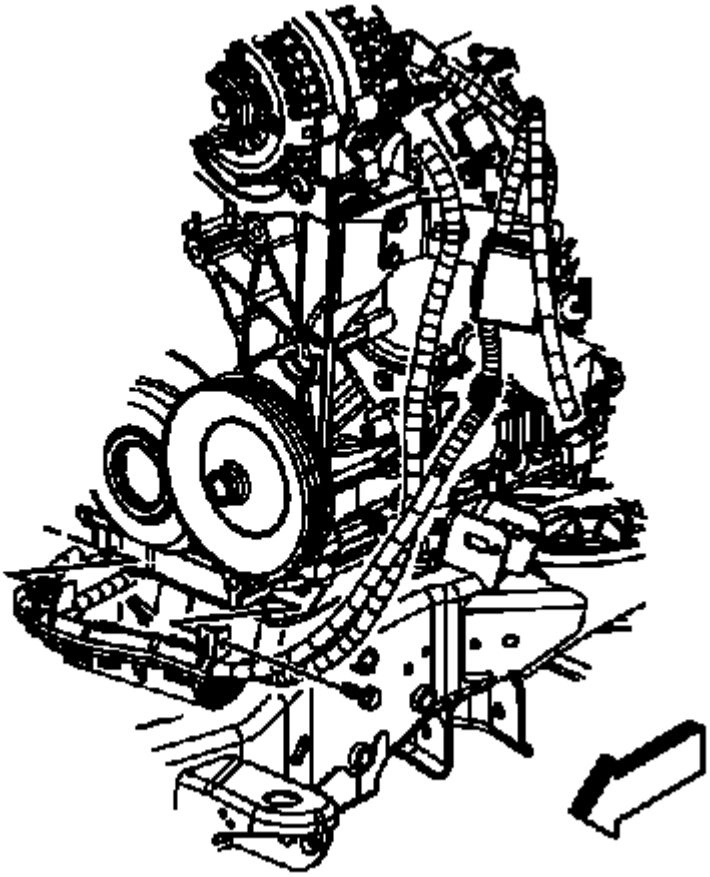

Fig. 182: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

16. Remove the battery cable channel bolt.
17. Slide the channel pin out of the oil pan tab.

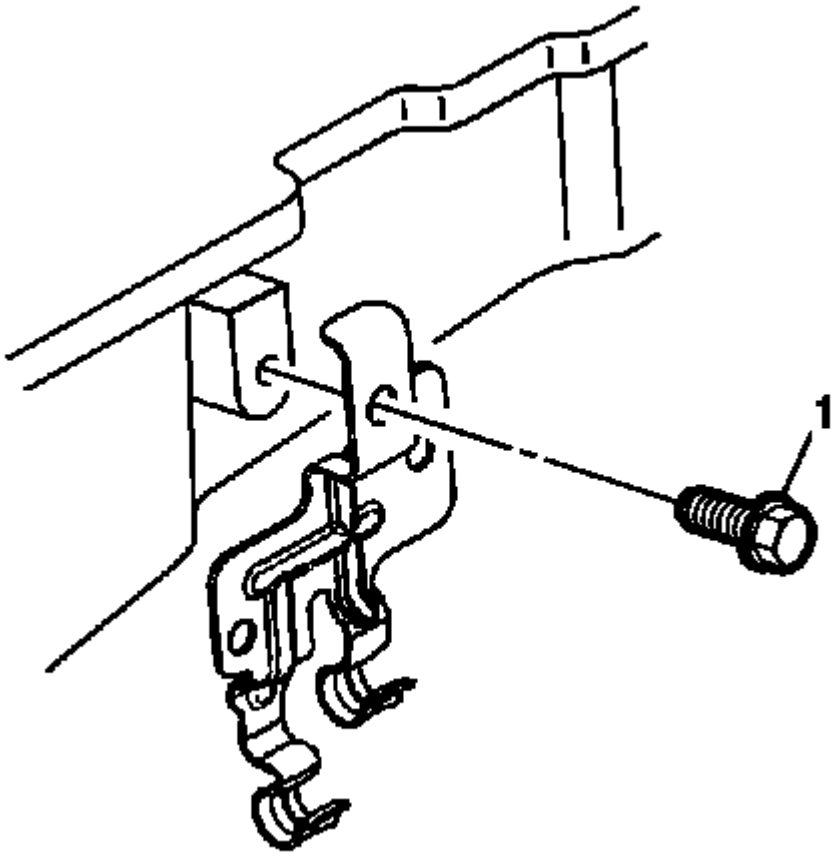

Fig. 183: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

18. Remove the positive battery cable clip bolt.

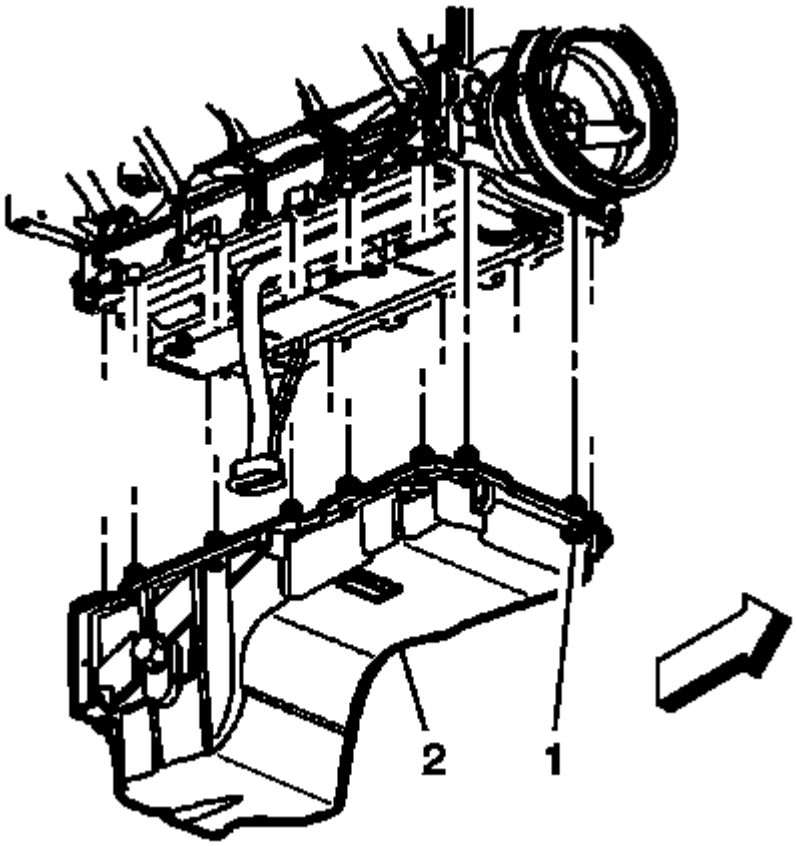

Fig. 184: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

19. Remove the oil pan bolts.
20. Remove the oil pan.

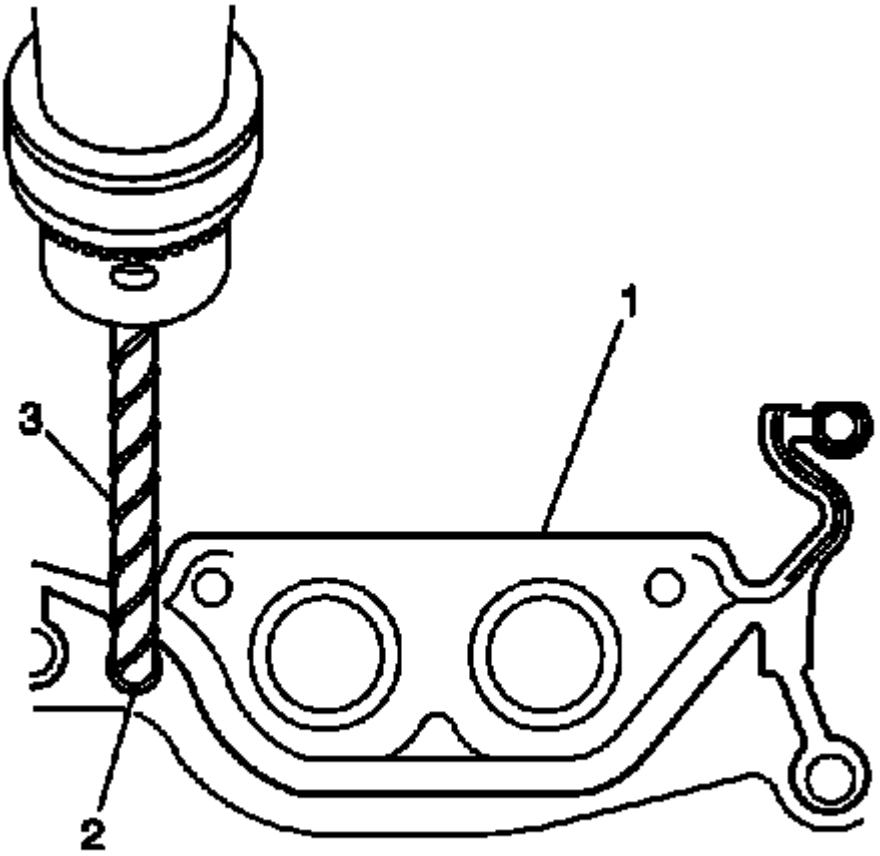

Fig. 185: View Of Oil Pan Gasket, Retaining Rivets & Drill
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT allow foreign material to enter the oil passages of the oil pan, cap or cover the openings as required.

21. Drill (3) out the oil pan gasket retaining rivets (2), if required.
22. Remove the gasket (1) from the pan.
23. Discard the gasket and rivets.
24. If required, clean and inspect the engine oil pan. Refer to **Oil Pan Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE:

- **The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission bellhousing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan must NEVER protrude beyond the engine block and transmission bellhousing plane.**

- **Do not reuse the oil pan gasket.**
- **It is not necessary to rivet the NEW gasket to the oil pan.**

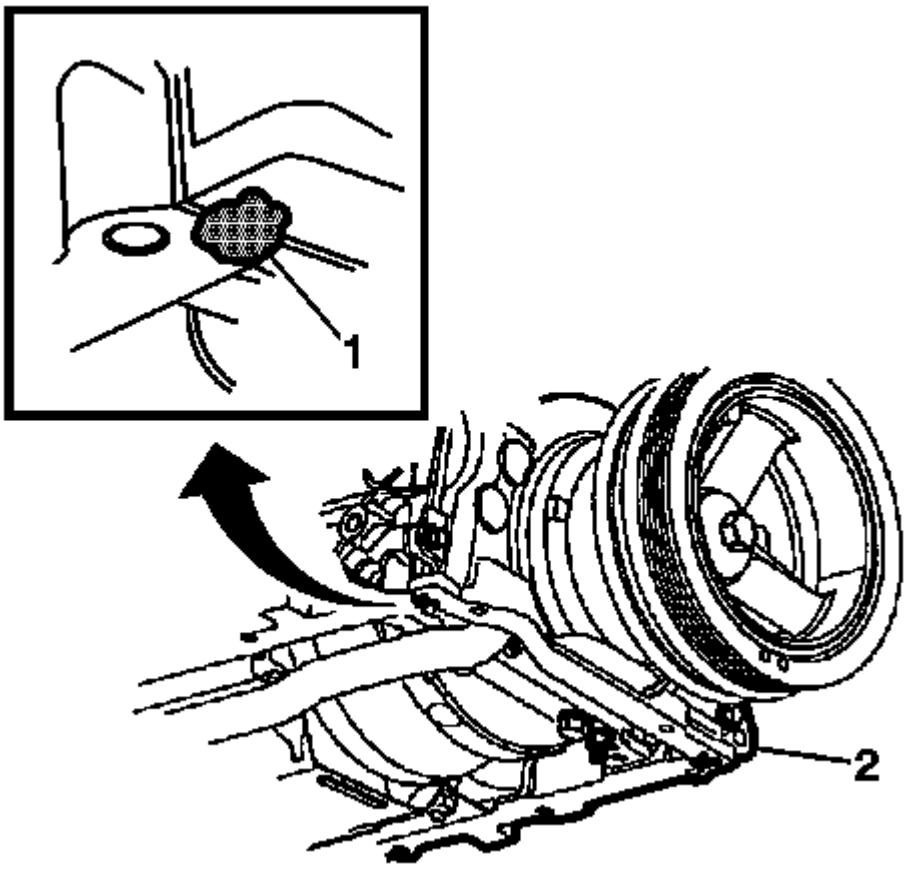

Fig. 186: View Of Sealant Applied To Front Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.20 in) bead of sealant 20 mm (0.80 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Apply the sealant directly onto the tabs of the front cover gasket that protrudes into the oil pan surface.

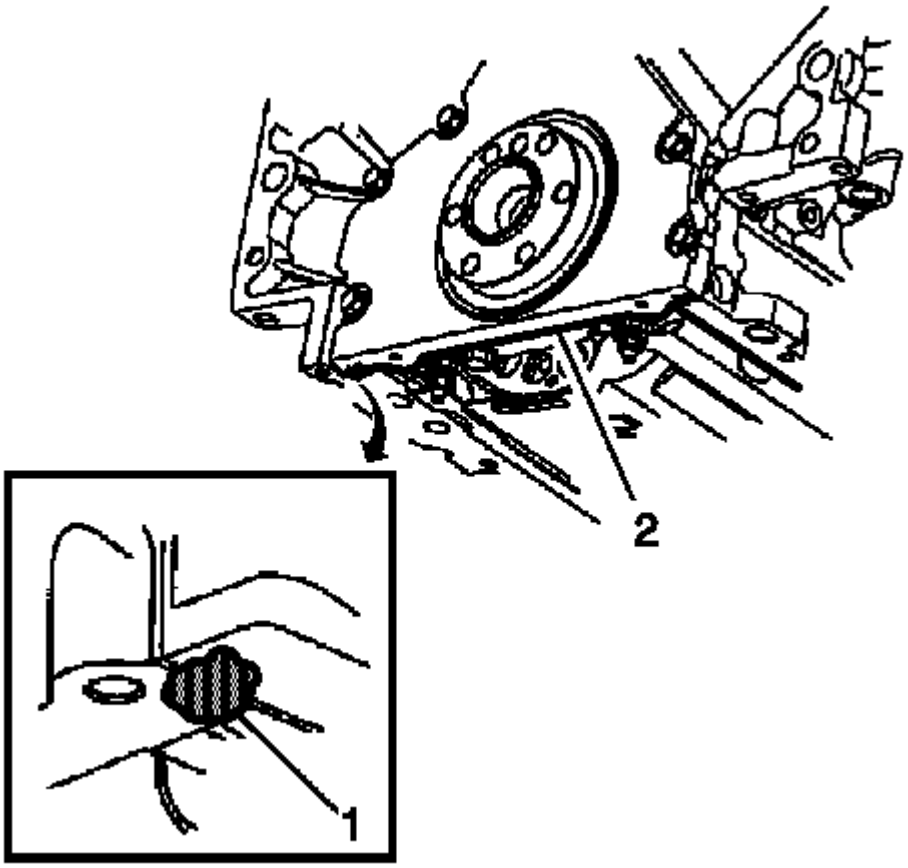

Fig. 187: View Of Sealant Applied To Rear Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.20 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Apply the sealant directly onto the tabs of the rear cover gasket that protrudes into the oil pan surface.

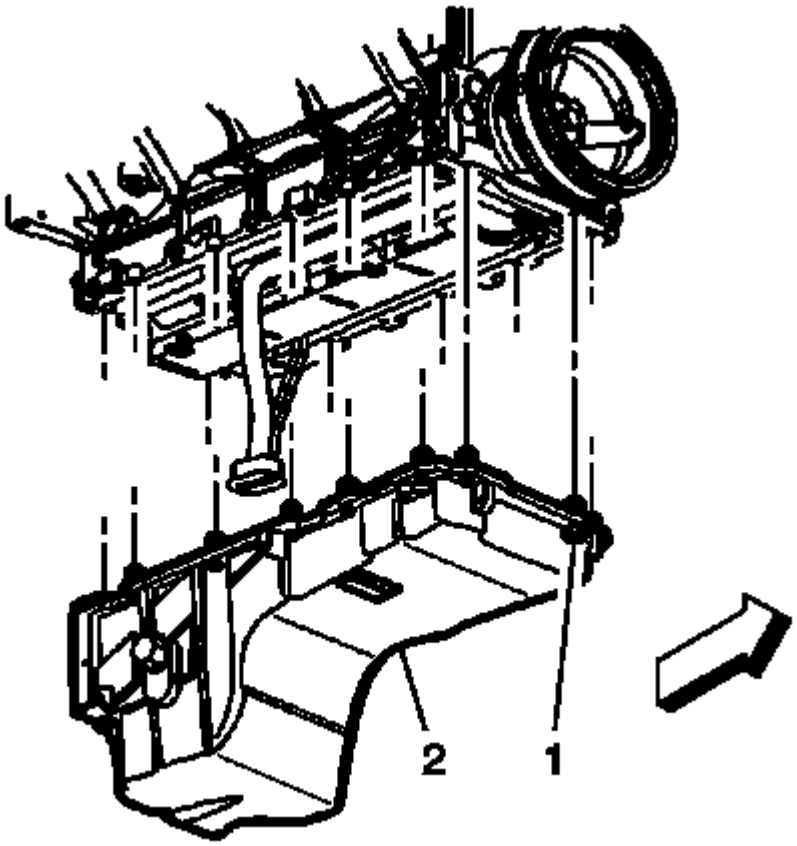

Fig. 188: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure to align the oil gallery passages in the oil pan and engine block properly with the oil pan gasket.

3. Pre-assemble the oil pan gasket to the pan.
   - Install the gasket onto the pan.
   - Install the oil pan bolts to the pan and through the gasket.
4. Install the oil pan, gasket and bolts to the engine block.
5. Tighten the oil pan bolts until snug. Do not overtighten.

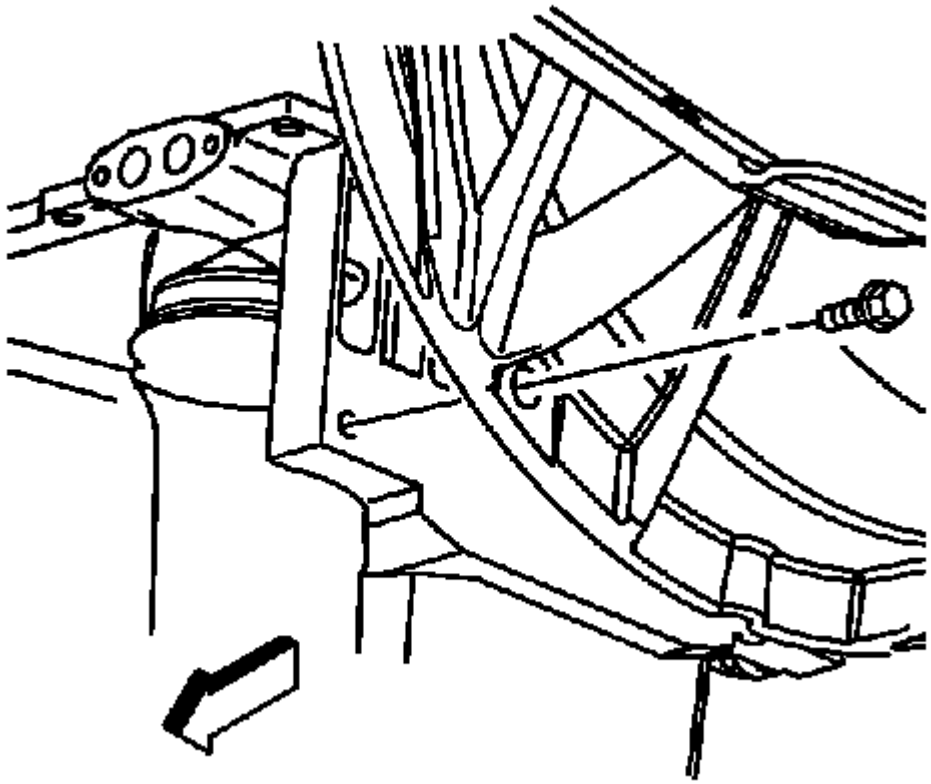

Fig. 189: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

6. Install the transmission converter cover bolts until snug, if equipped with the 4L80-E automatic transmission.

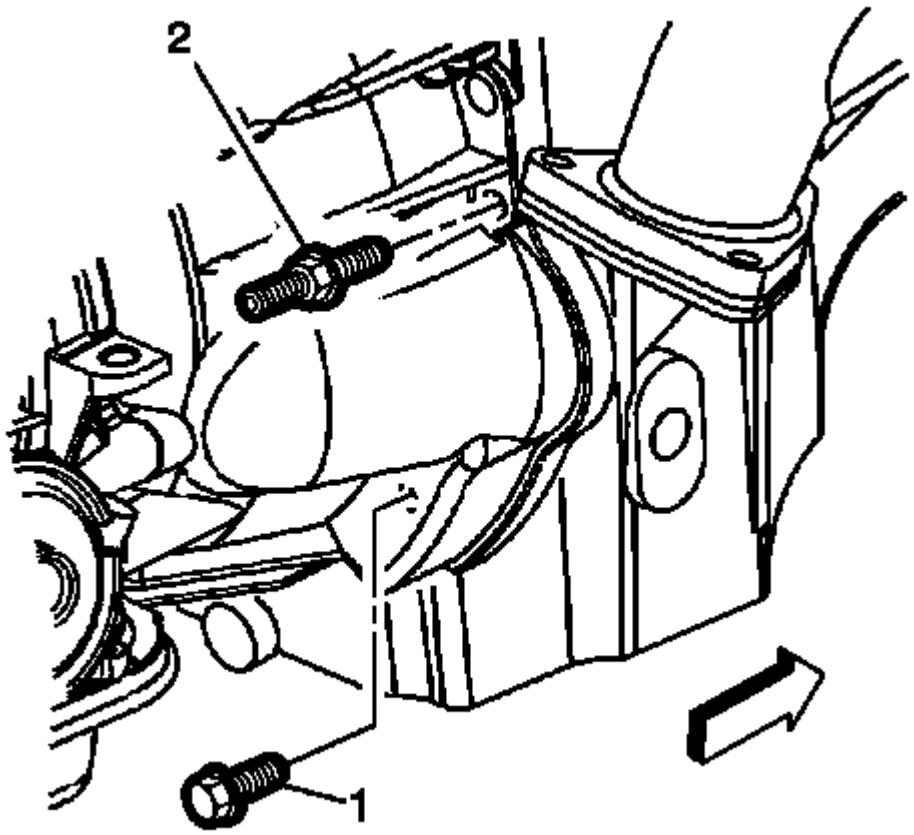

Fig. 190: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

7. Install the transmission bolt and stud on the right side until snug, If equipped with the 4L60-E automatic transmission.

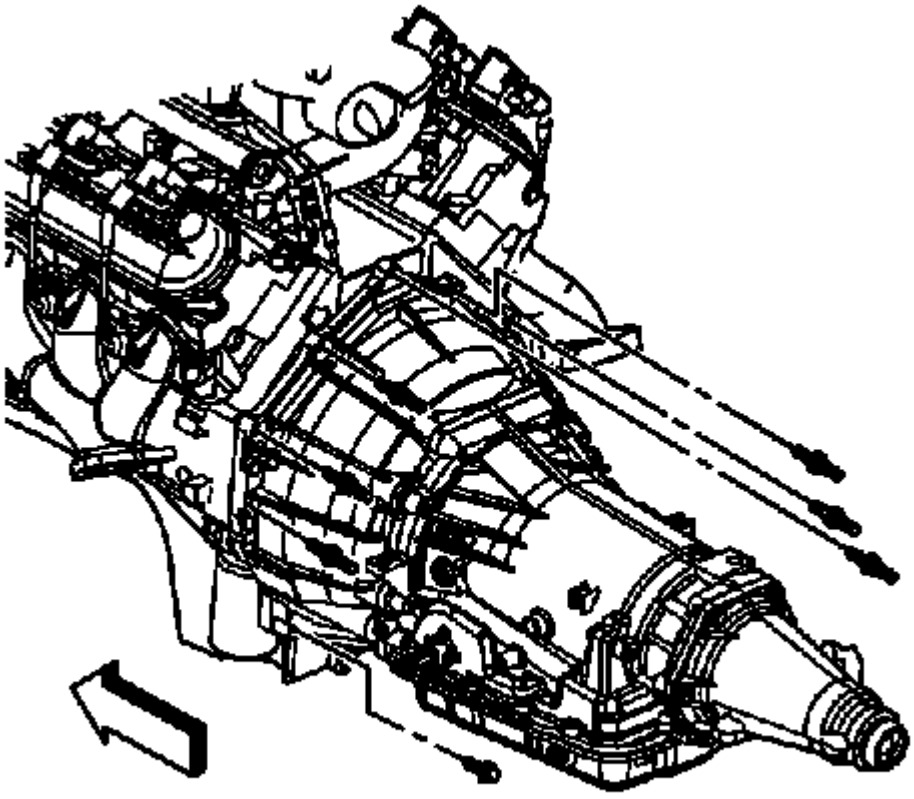

Fig. 191: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Install the bottom bolt on the left side until snug.
    1. Tighten the oil pan-to-front cover bolts to 25 N.m (18 lb ft).
    2. Tighten the oil pan-to-rear cover bolts to 12 N.m (106 lb in).
    3. Tighten the converter cover, and transmission bolts/stud to 50 N.m (37 lb ft).

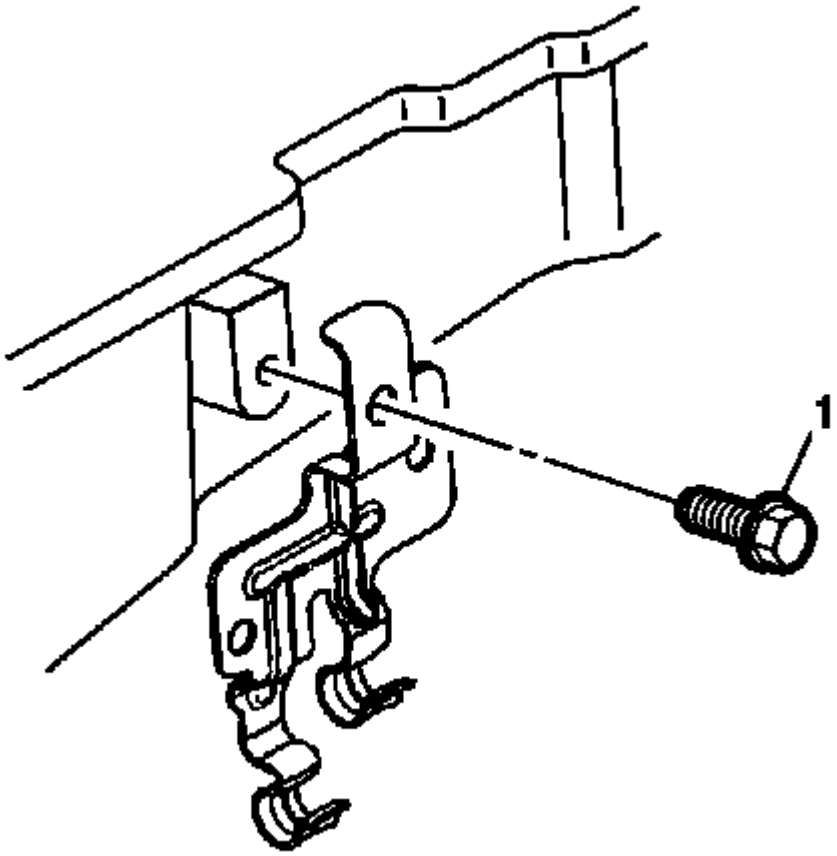

Fig. 192: View Of Positive Battery Cable Clip & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Install the positive battery cable clip bolt and tighten to 9 N.m (80 lb in).

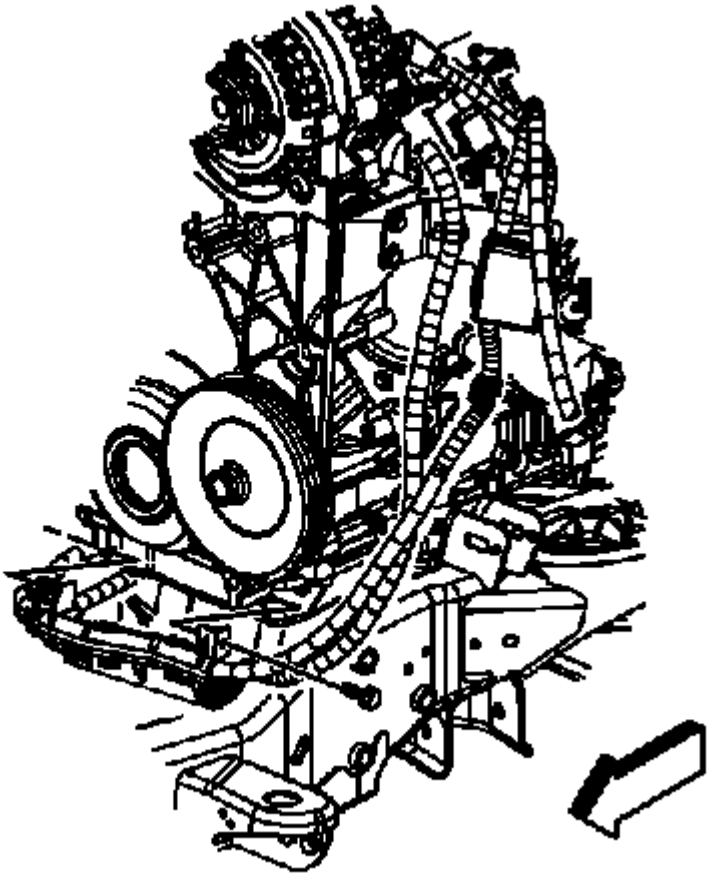

Fig. 193: View Of Positive Battery Cable, Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Slide the channel pin into the oil pan tab.
11. Install the battery cable channel bolt and tighten to 12 N.m (106 lb in).

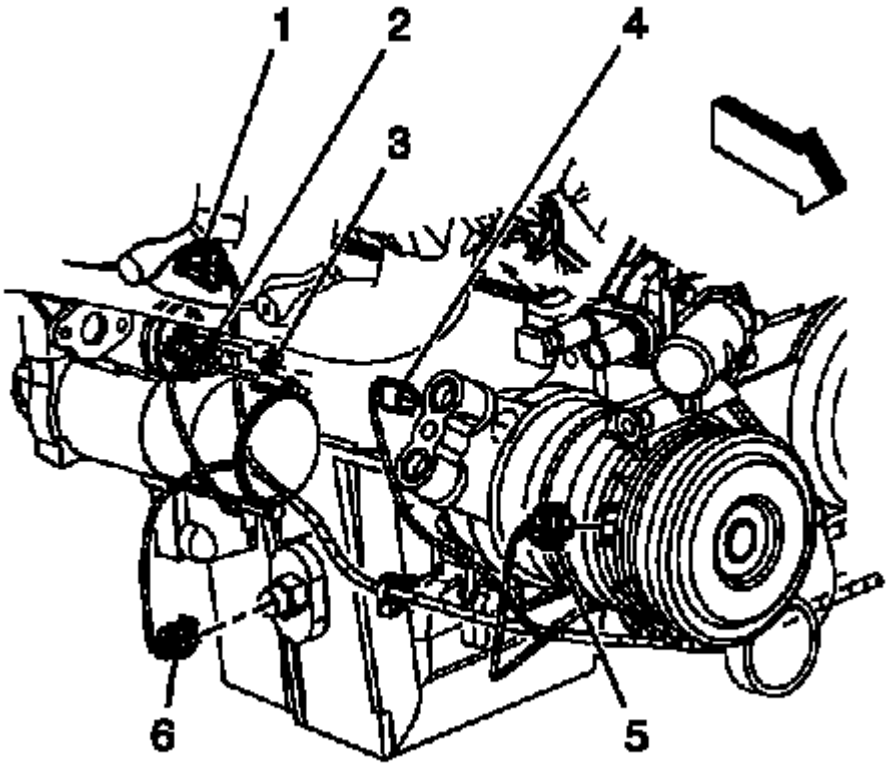

Fig. 194: Identifying Electrical Connector (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

12. Connect the oil level sensor electrical connector (6).

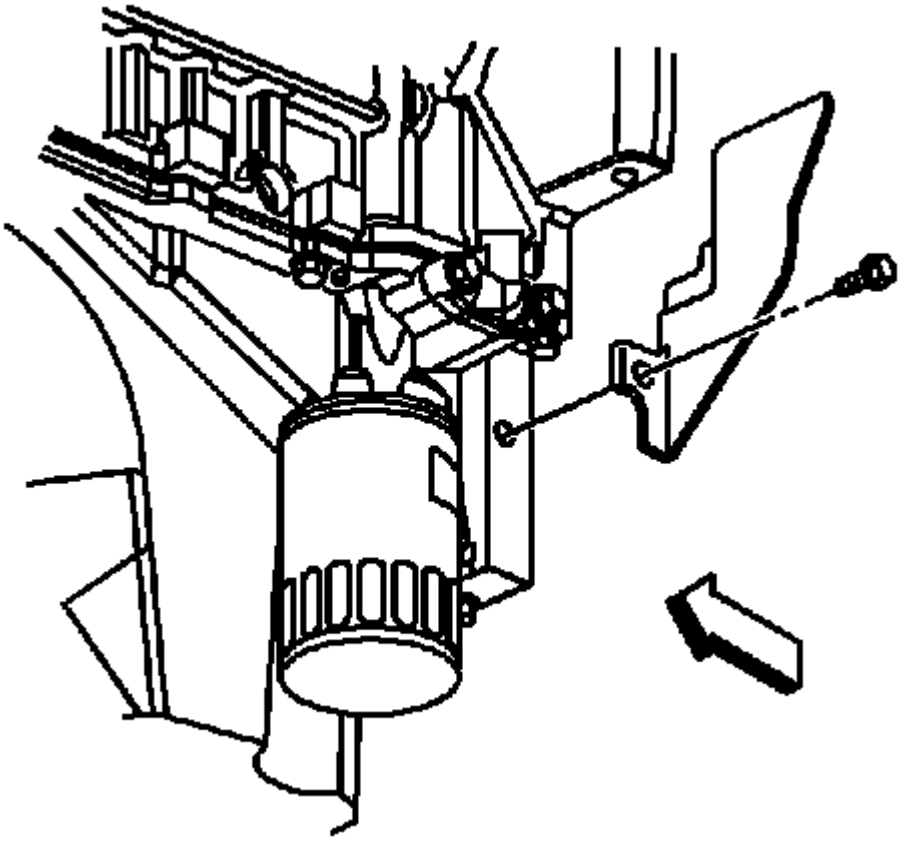

Fig. 195: View Of Transmission Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

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

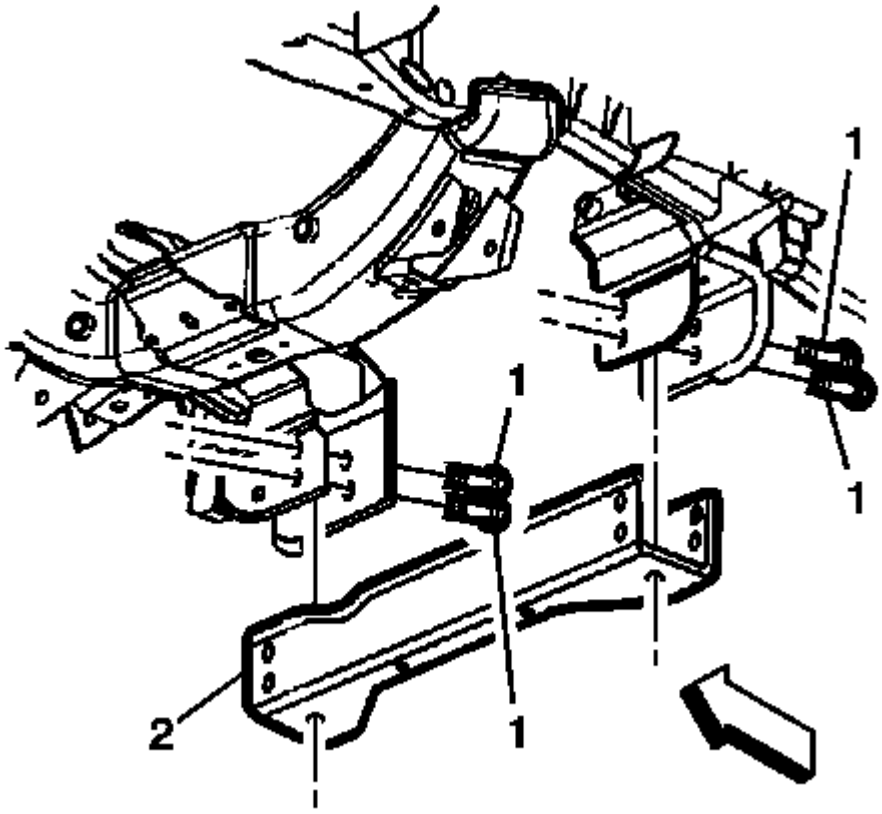

Fig. 196: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

14. Install the crossbar.
15. Install the crossbar bolts and tighten to 100 N.m (74 lb ft).

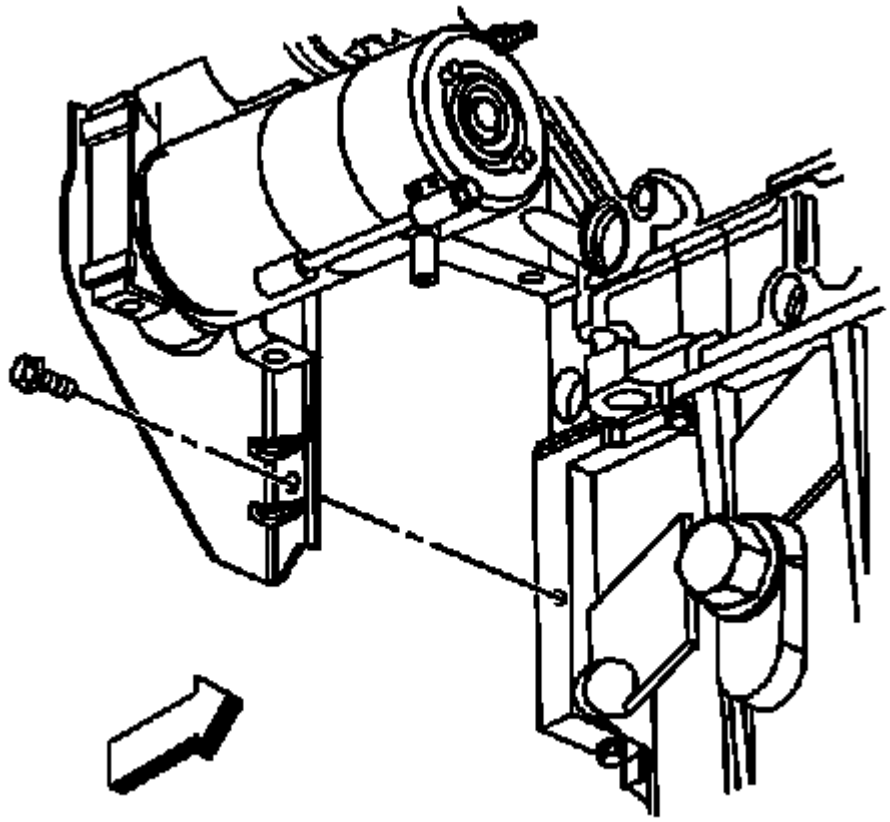

Fig. 197: View Of Transmission Cover Bolt
Courtesy of GENERAL MOTORS CORP.

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

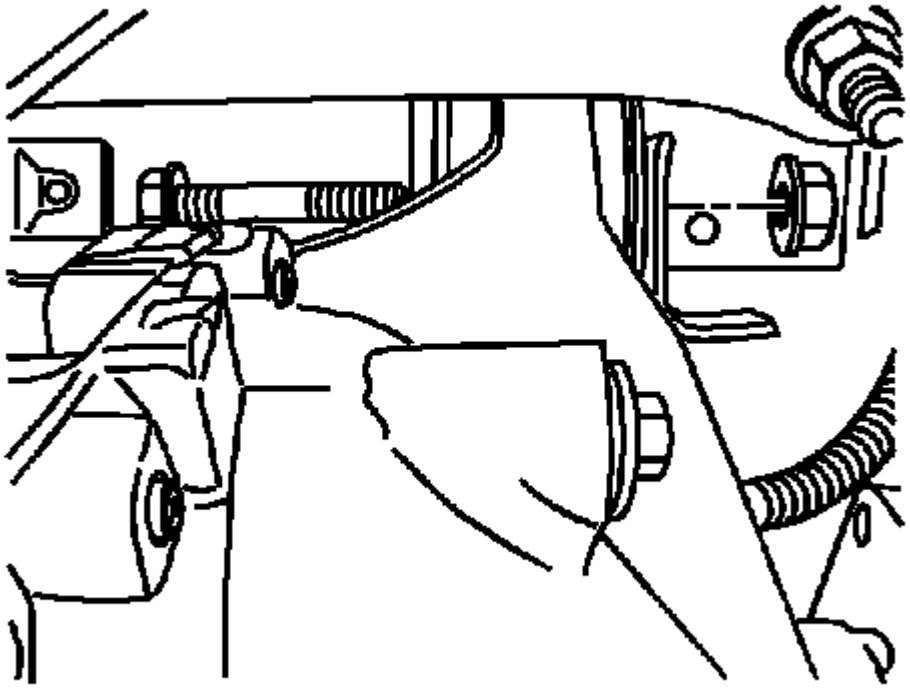

Fig. 198: View Of Differential Carrier Upper Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

17. Raise the front drive axle into position.
18. If equipped with AWD, install the differential carrier upper mounting bolt and nut until snug. Do not tighten at this time.

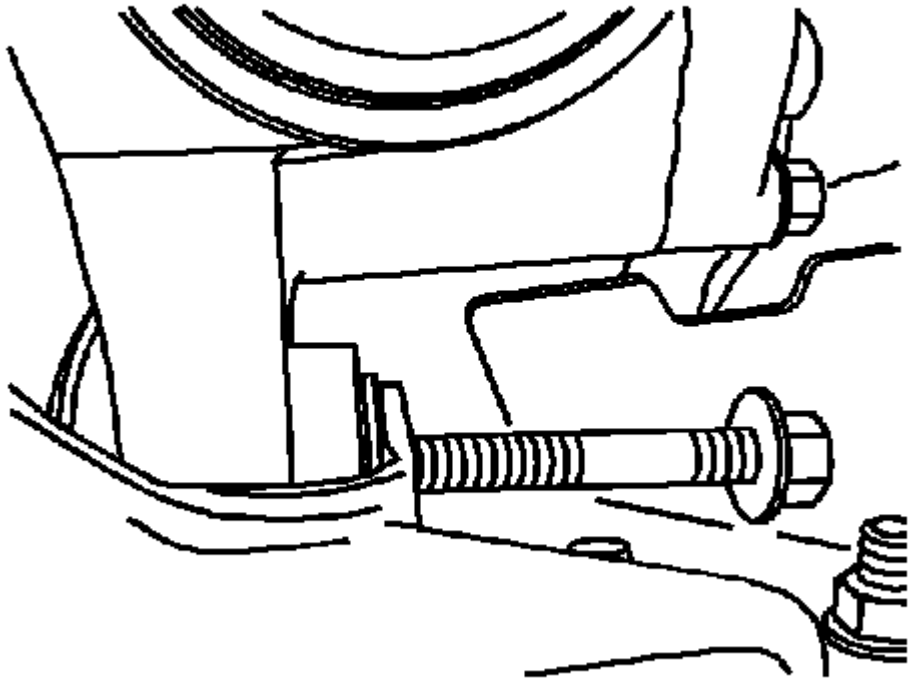

Fig. 199: View Of Differential Carrier Lower Mounting Bolt
Courtesy of GENERAL MOTORS CORP.

19. If equipped with AWD, install the differential carrier lower mounting bolt and nut and tighten to 100 N.m (75 lb ft).

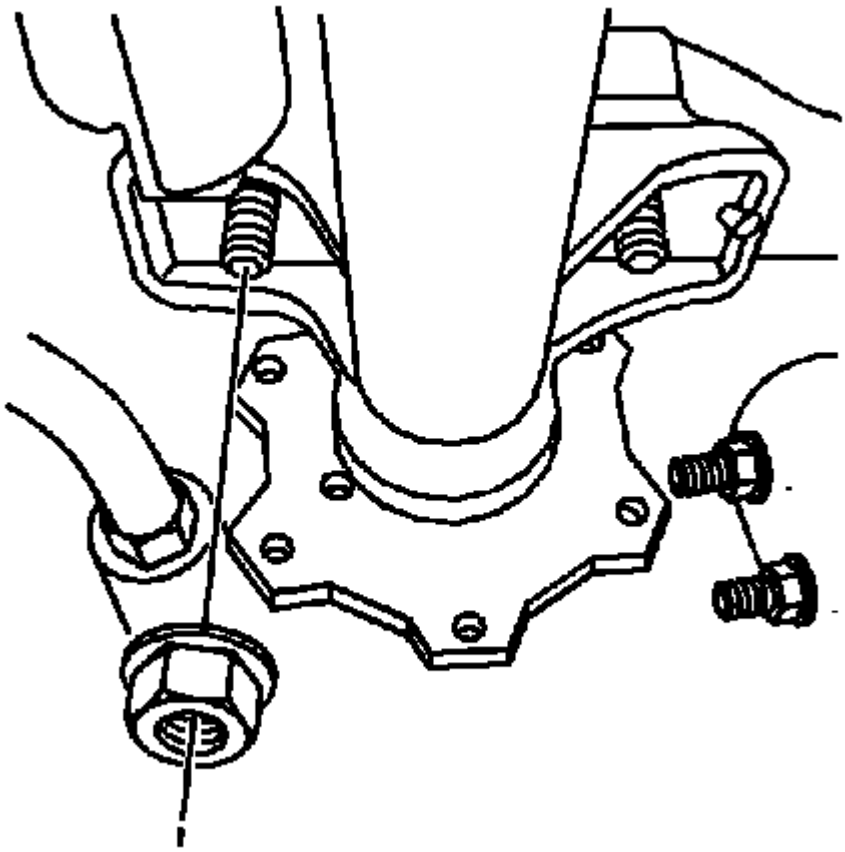

Fig. 200: View Of Inner Axle Housing Nuts
Courtesy of GENERAL MOTORS CORP.

20. If equipped with AWD, install the inner axle housing washers and nuts to the bracket and tighten to 100 N.m (75 lb ft).
21. Remove the jack from the front drive axle.
22. Install new engine oil and a new oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

SPECIAL TOOLS

J 41712 Oil Pressure Sensor Socket

REMOVAL PROCEDURE

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

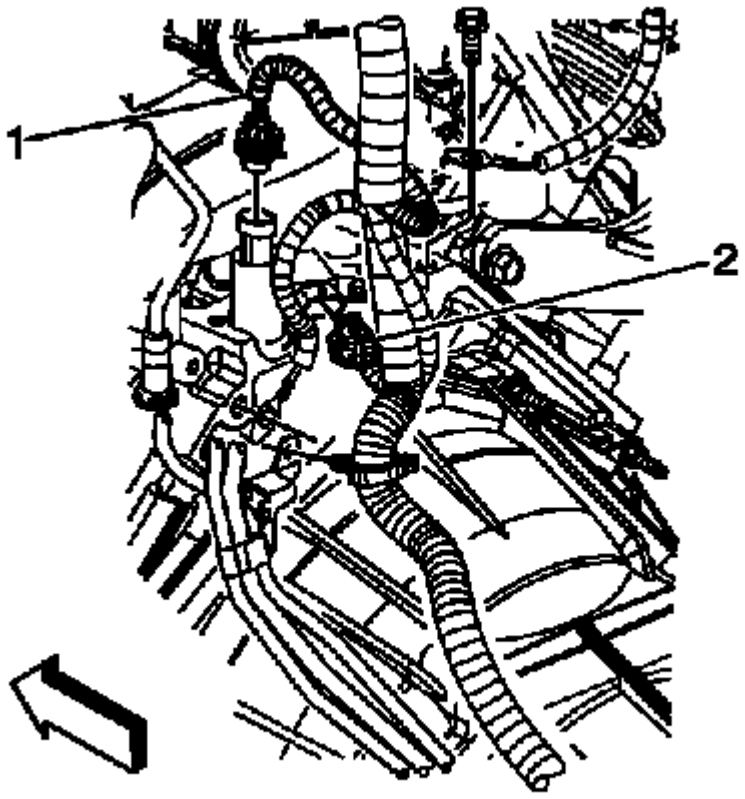

Fig. 201: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

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

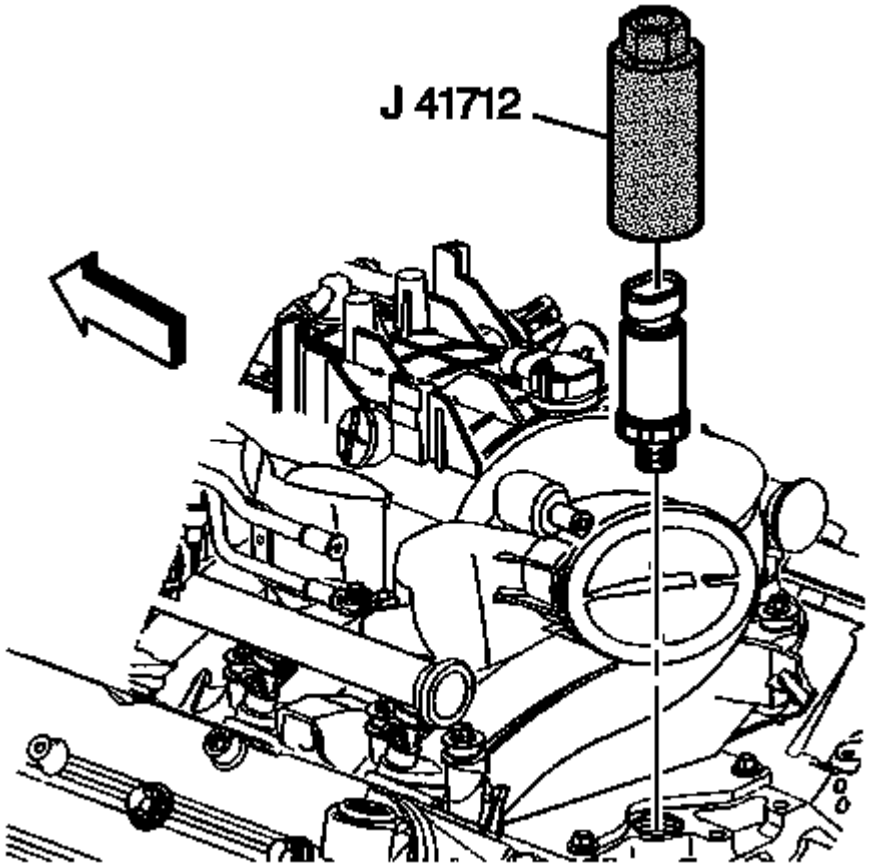

Fig. 202: View Of J 41712 Removing The Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Using **J 41712** or equivalent, remove the oil pressure sensor.

INSTALLATION PROCEDURE

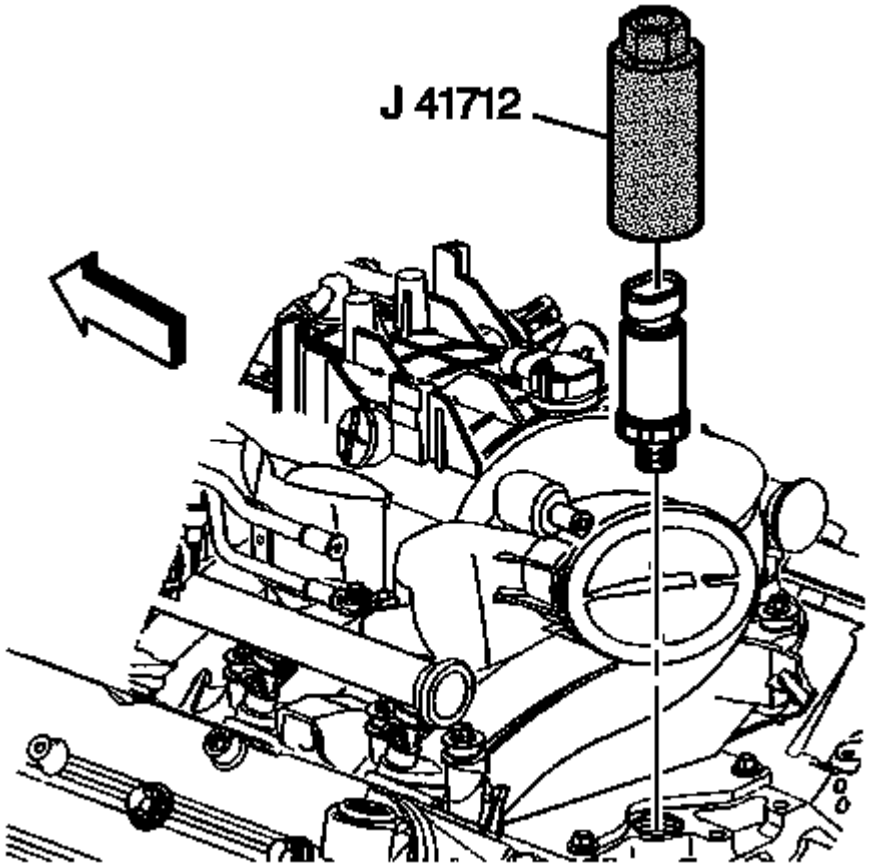

Fig. 203: View Of J 41712 Removing The Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Apply sealant to the threads of the oil pressure sensor. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Using **J 41712** or equivalent, install the oil pressure sensor and tighten to 35 N.m (26 lb ft).

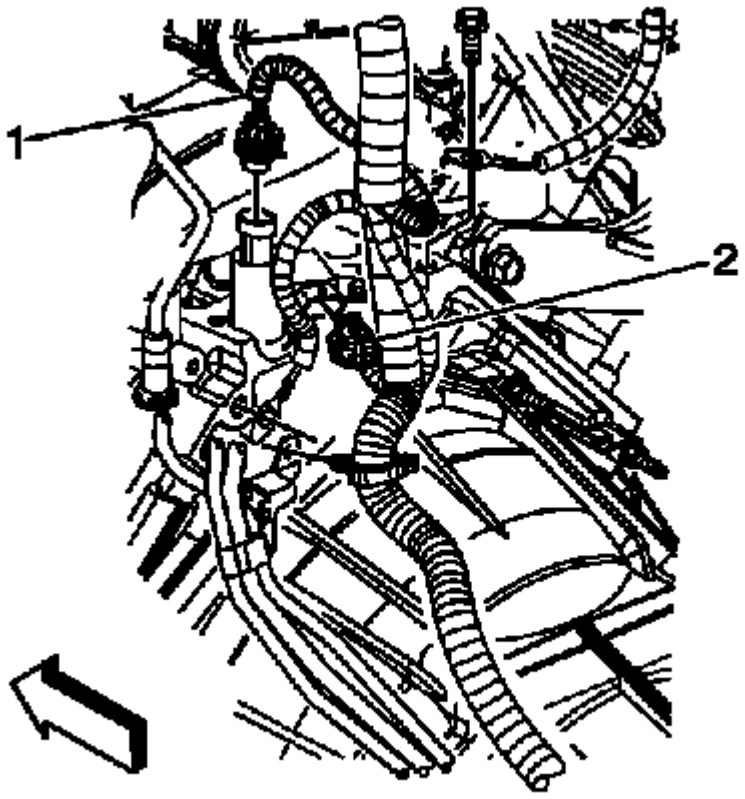

Fig. 204: View Of Oil Pressure Sensor & CMP Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the oil pressure sensor electrical connector (1).
4. Install the engine cover. Refer to **Engine Cover Replacement** .

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT (6.2L AND 7.0L)

REMOVAL PROCEDURE

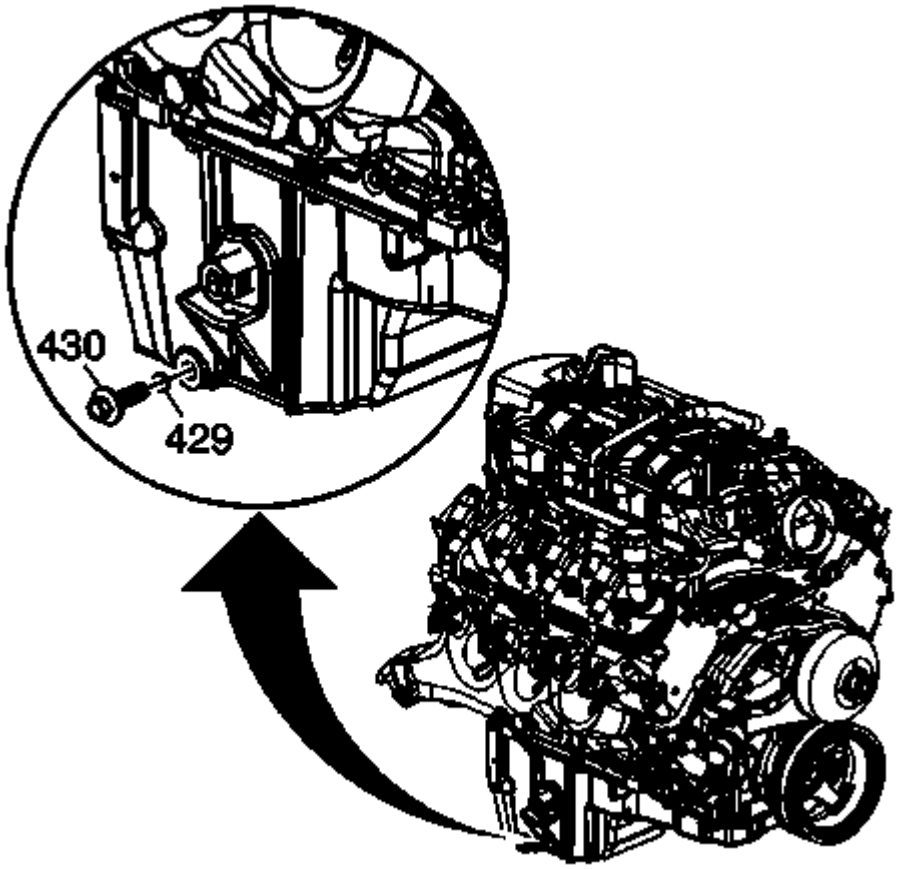

Fig. 205: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a suitable drain pan under the oil pan drain plug.
3. Remove the oil pan drain plug (430).
4. Allow the oil pan to drain completely.
5. Re-install the oil pan drain plug until snug.
6. Remove the drain pan from under the vehicle.

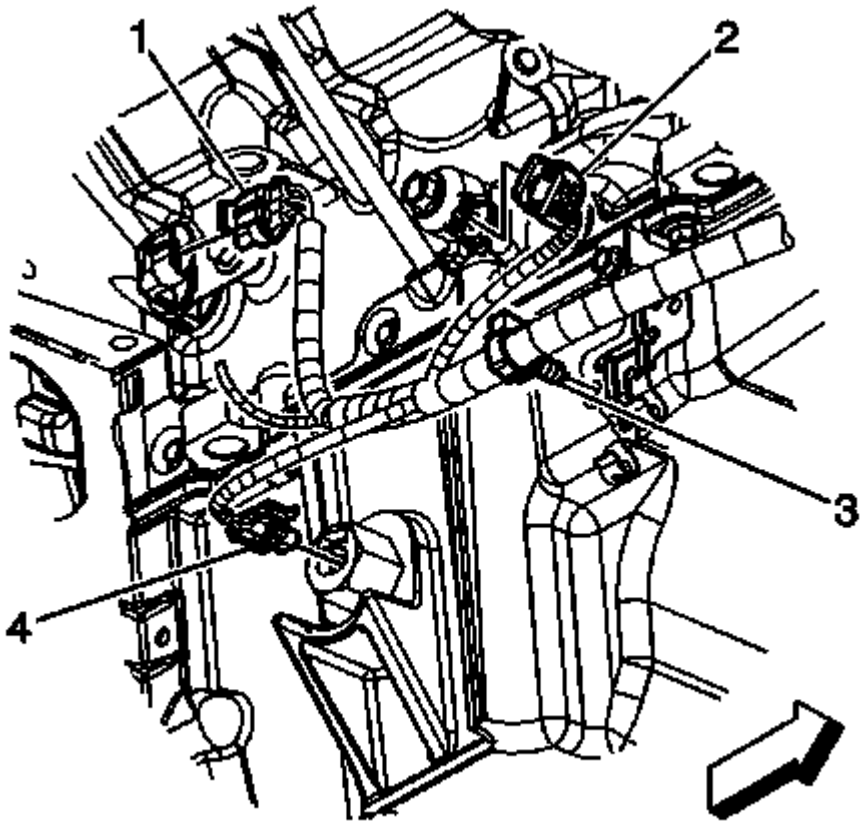

Fig. 206: View Of Engine Wiring Harness Electrical Connector & Components
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the engine harness electrical connector (4) from the oil level sensor.

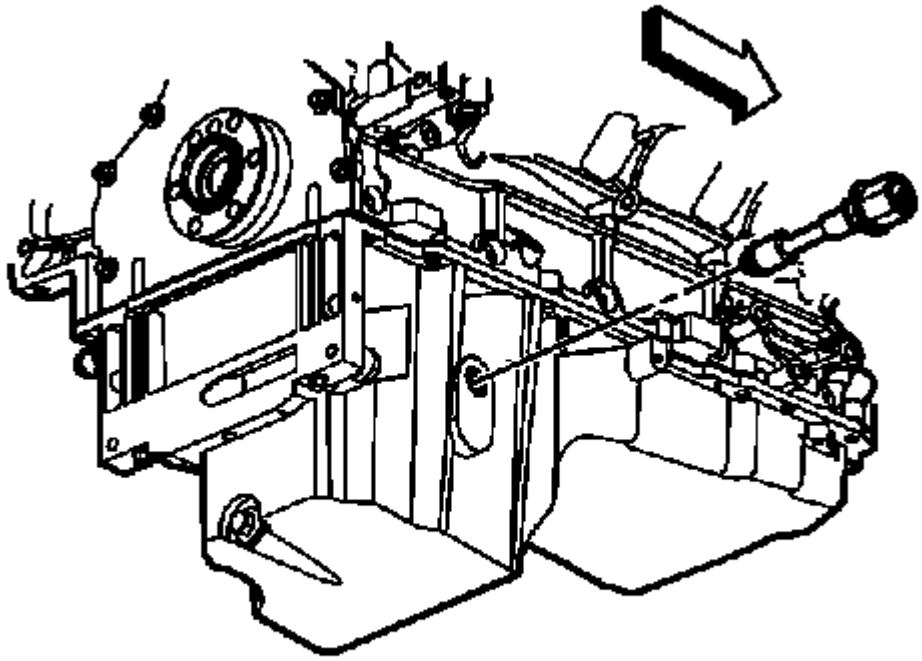

Fig. 207: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil level sensor from the oil pan.

INSTALLATION PROCEDURE

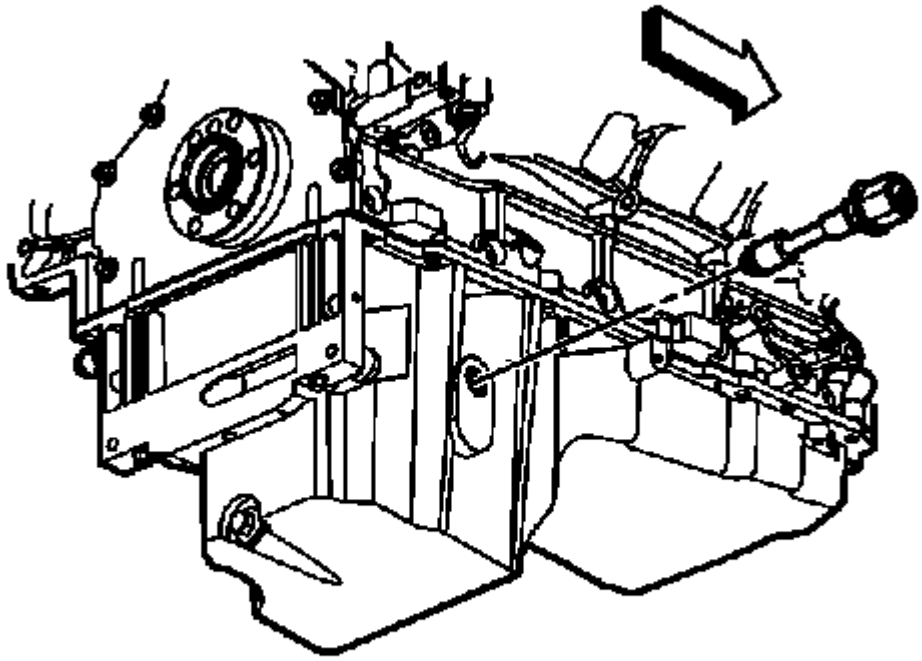

Fig. 208: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil level sensor to the oil pan.

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

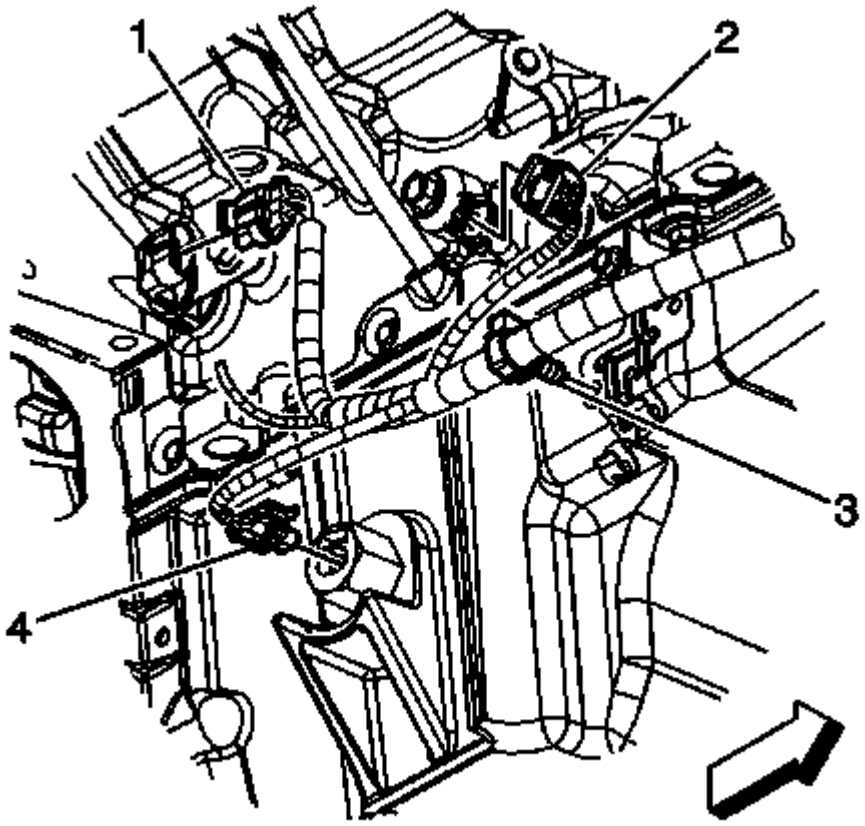

Fig. 209: View Of Engine Wiring Harness Electrical Connector & Components
Courtesy of GENERAL MOTORS CORP.

2. Connect the engine harness electrical connector (4) to the oil level sensor.

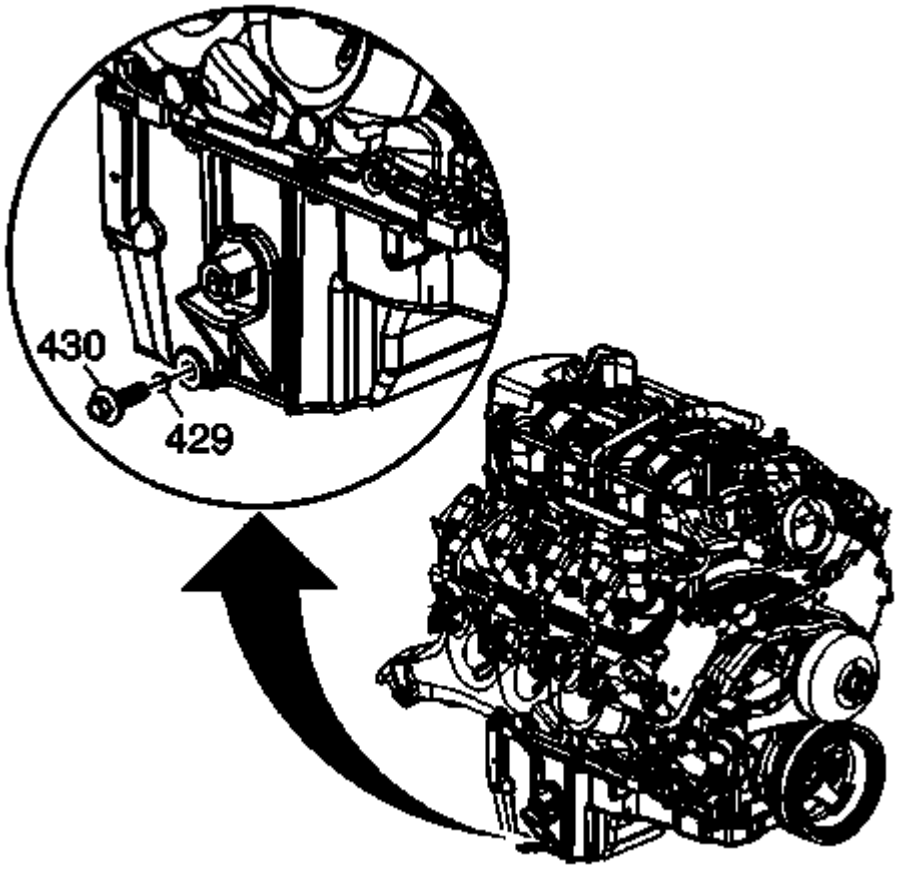

Fig. 210: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

3. Ensure that the oil pan drain plug is tight.

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

4. Lower the vehicle.
5. Fill the engine with NEW engine oil. Refer to **Fluid and Lubricant Recommendations (USA and Canada)** and **Approximate Fluid Capacities** .
6. Start the engine and inspect for leaks.

OIL PUMP, SCREEN, AND CRANKSHAFT OIL DEFLECTOR REPLACEMENT

REMOVAL PROCEDURE

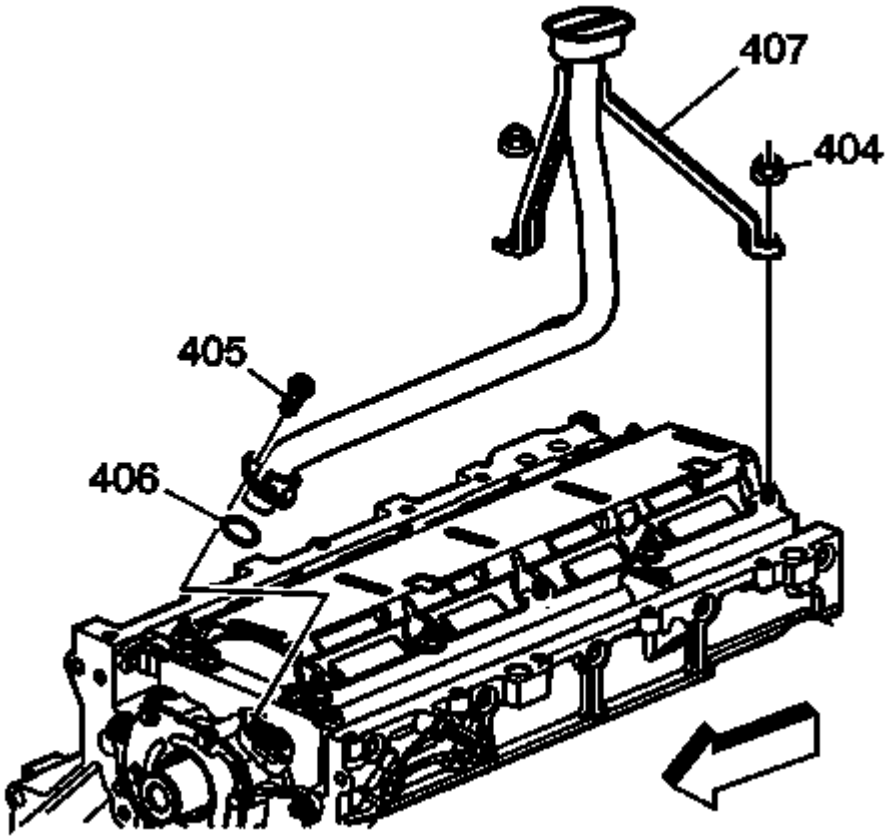

Fig. 211: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the oil pump screen bolt (405) and nuts (404).
4. Remove the oil pump screen (407) with O-ring seal (406).
5. Remove the O-ring seal from the pump screen.
6. Discard the O-ring seal.

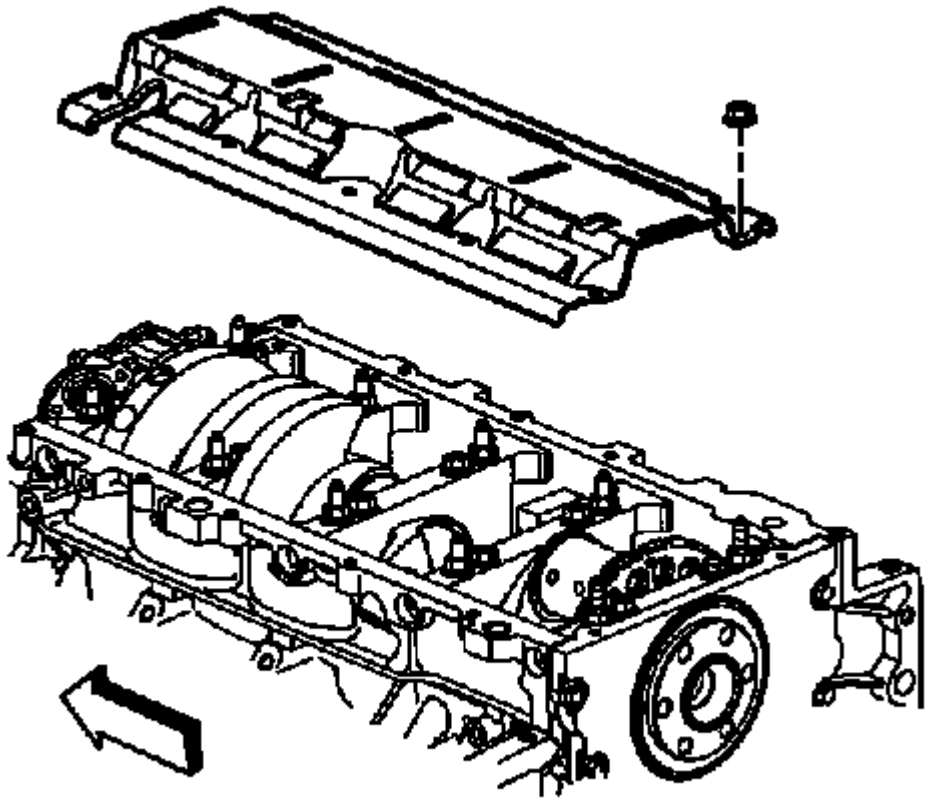

Fig. 212: View Of Crankshaft Oil Deflector
Courtesy of GENERAL MOTORS CORP.

7. Remove the remaining crankshaft oil deflector nuts.
8. Remove the crankshaft oil deflector.

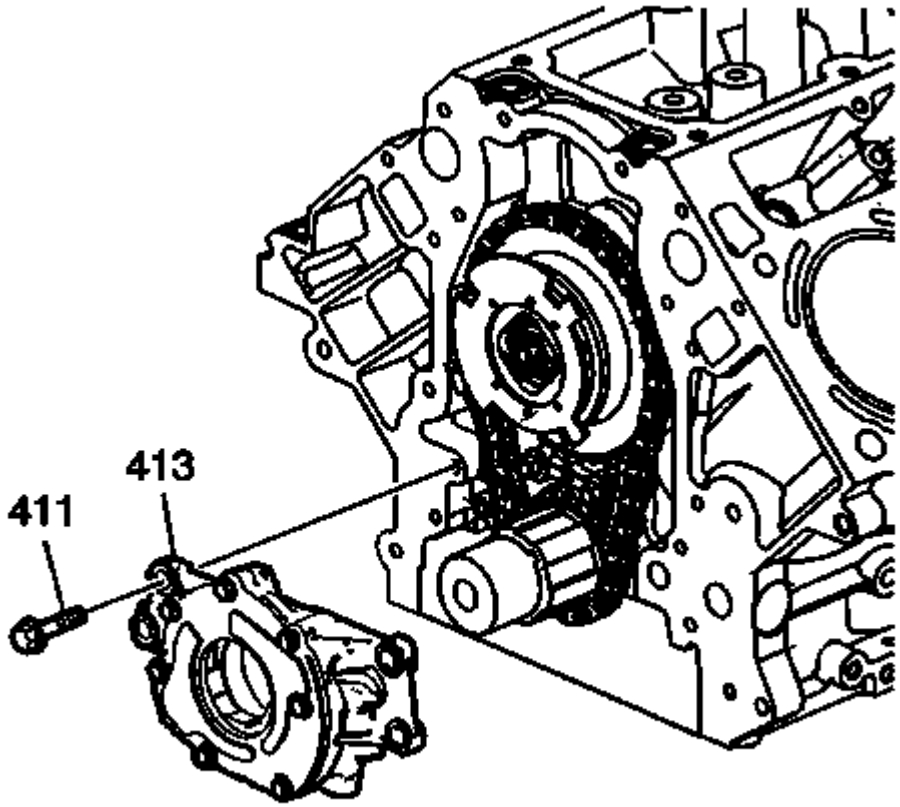

Fig. 213: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow dirt or debris to enter the oil pump assembly, cap end as necessary.

9. Remove the oil pump bolts (411).
10. Remove the oil pump (413).
11. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

INSTALLATION PROCEDURE

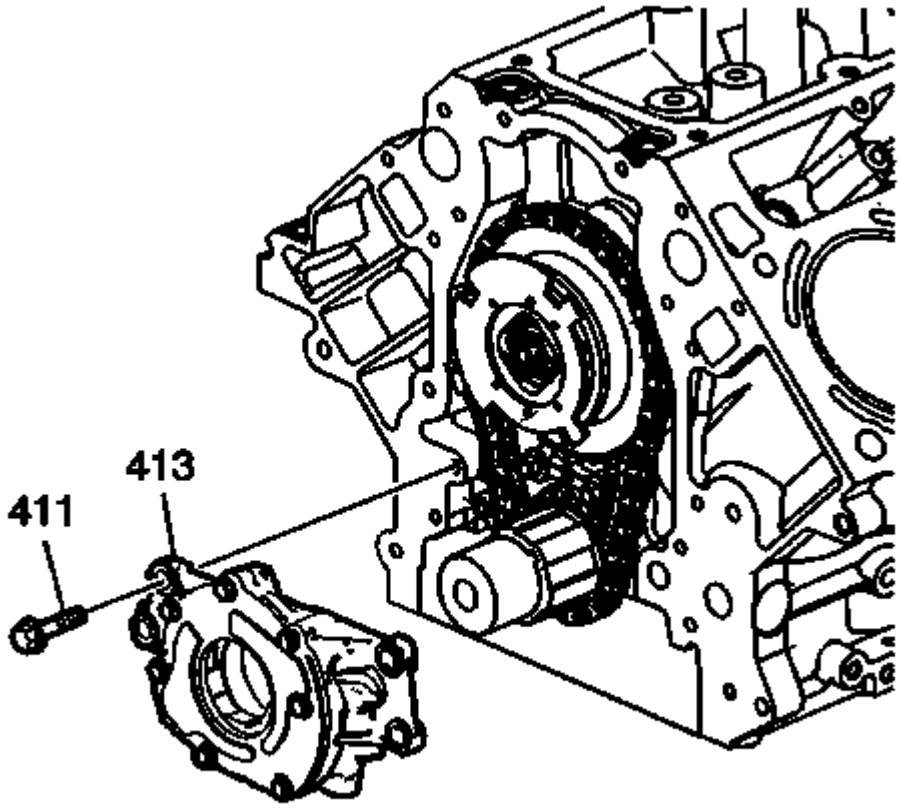

Fig. 214: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts (411) and tighten to 25 N.m (18 lb ft).

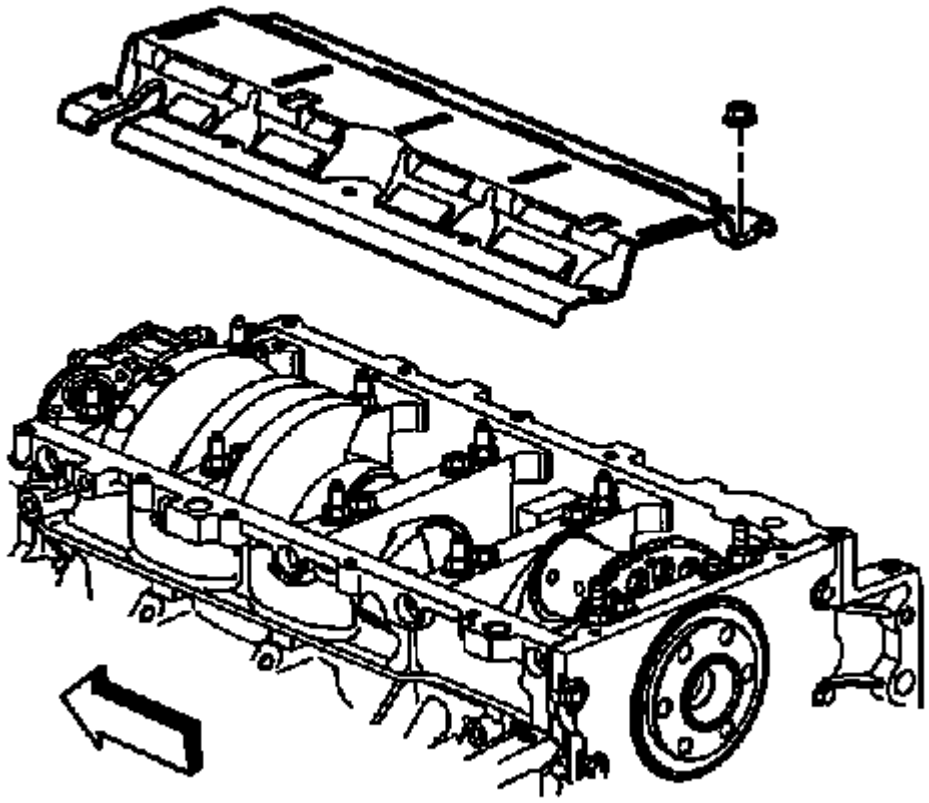

Fig. 215: View Of Crankshaft Oil Deflector
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector and nuts until snug.

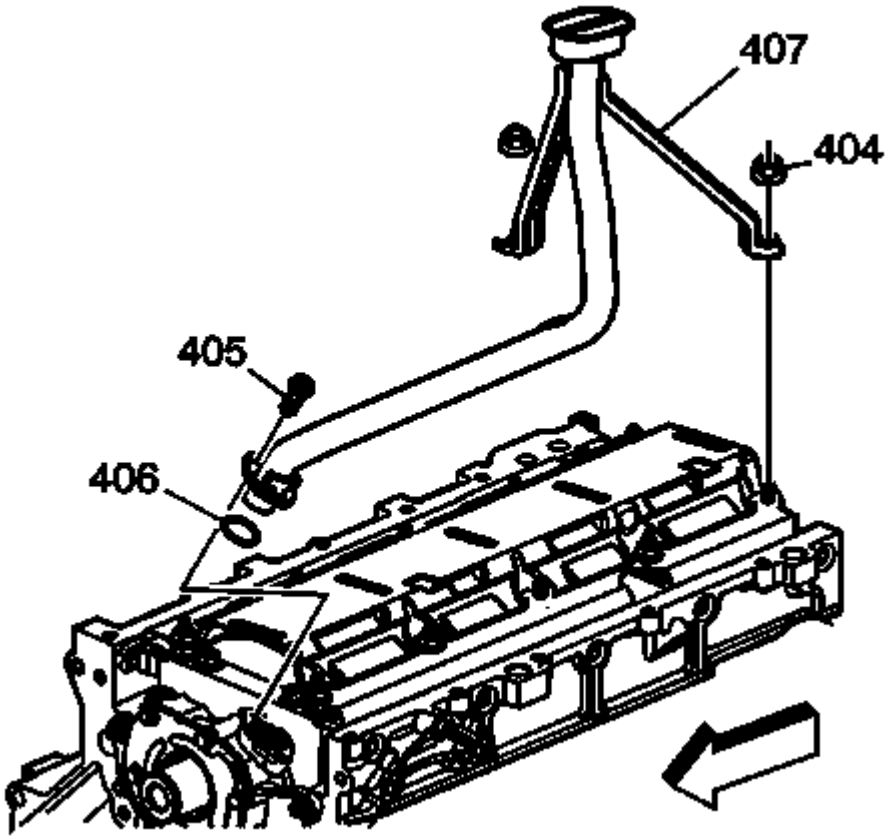

Fig. 216: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

NOTE: Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.

7. Align the oil pump screen mounting brackets with the correct crankshaft bearing cap studs.
8. Install the oil pump screen (407).
9. Install the oil pump screen bolt (405) and nuts (404).
    1. Tighten the oil pump screen bolt to 12 N.m (106 lb in).
    2. Tighten the crankshaft oil deflector/oil pump screen nuts to 25 N.m (18 lb ft).
10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
11. Install the oil pan. Refer to **Oil Pan Replacement**.

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT

SPECIAL TOOLS

- **EN 46330** Timing Chain Tensioner Retaining Pin. See **Special Tools** .
- **J 8433** Puller Bar. See **Special Tools** .
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41558** Crankshaft Sprocket Remover. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

   CAUTION: Refer to Fastener Caution .

   NOTE: Ensure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See Special Tools .

2. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

   Tighten: Tighten the **J 42386-A** bolts to 50 N.m (37 lb ft).

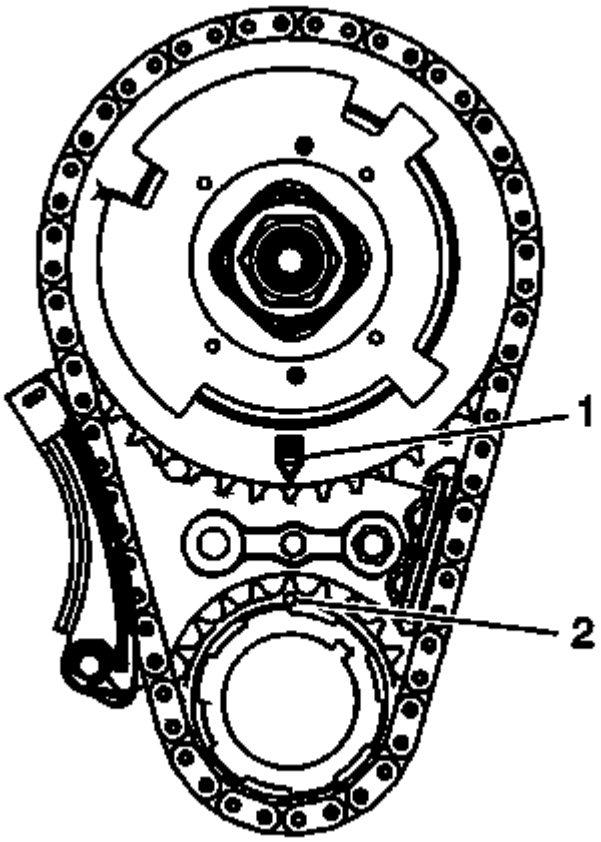

Fig. 217: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft sprocket until the camshaft position (CMP) actuator alignment mark (1) and the crankshaft sprocket alignment mark (2) are aligned.

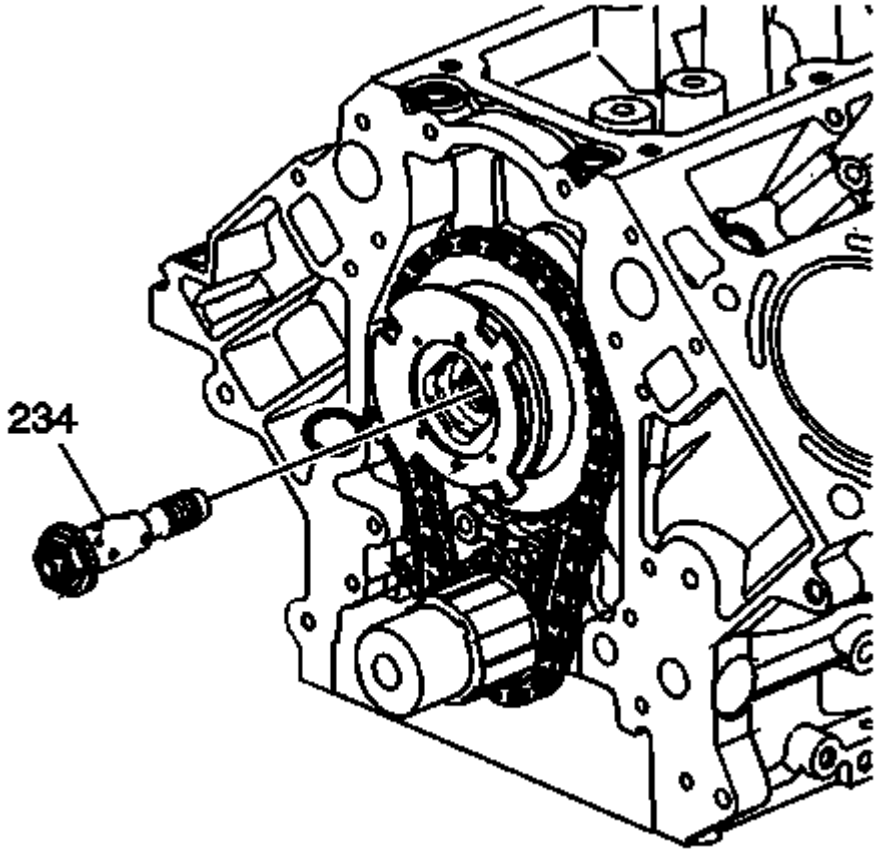

Fig. 218: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the CMP actuator solenoid valve (234).

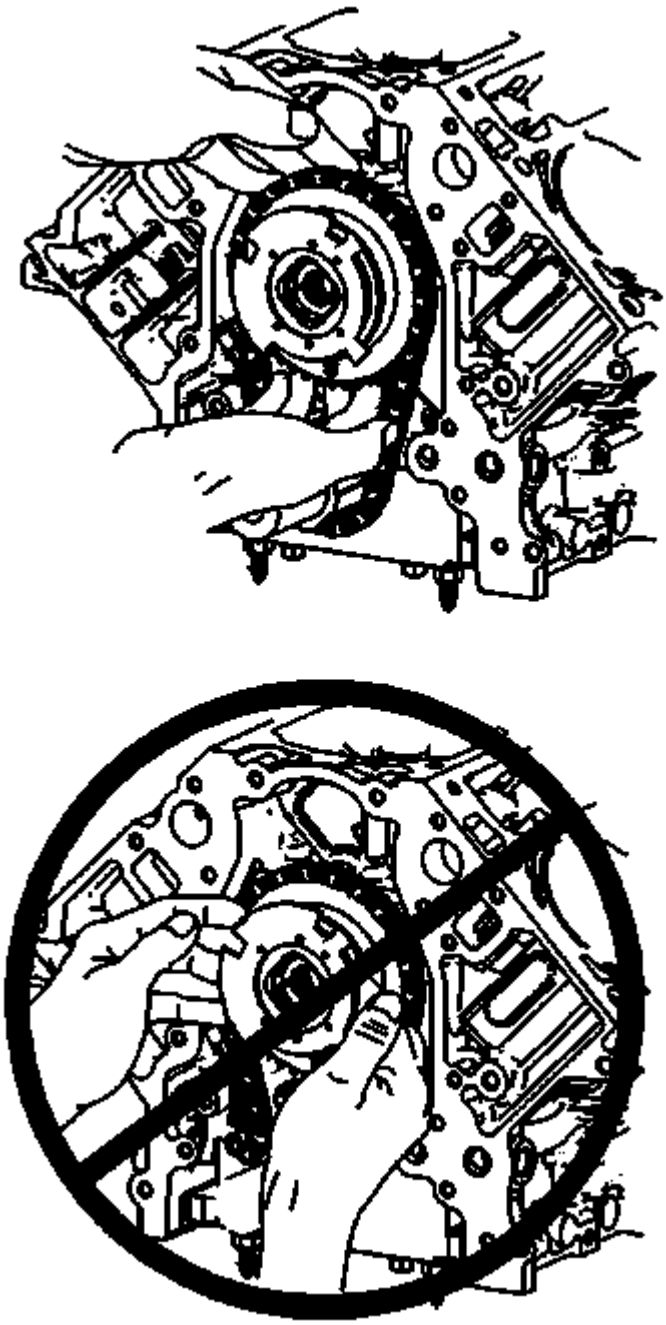

Fig. 219: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position your fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

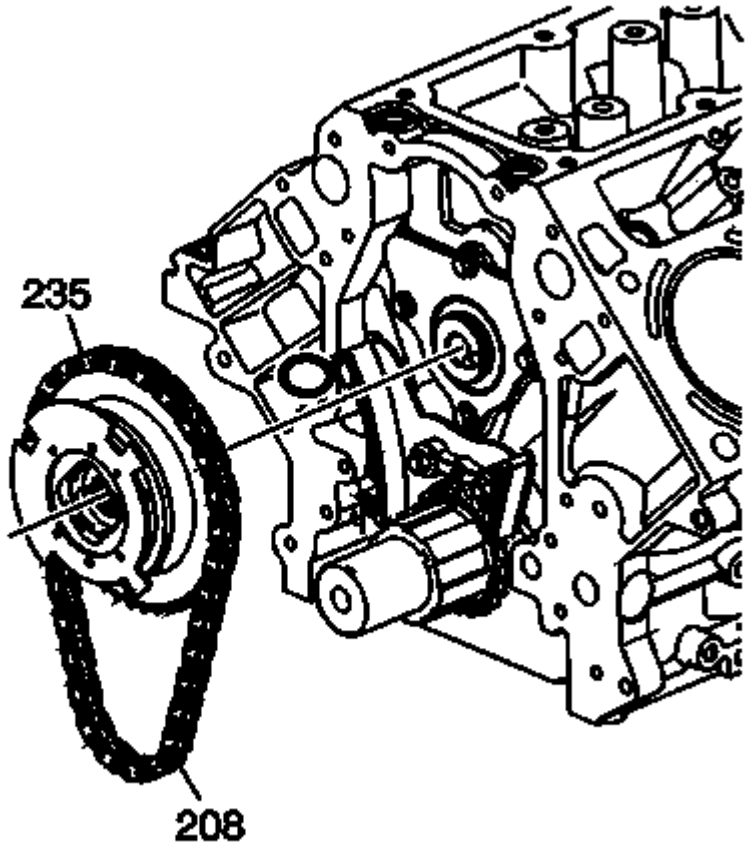

Fig. 220: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

6. Remove the CMP actuator (235) and timing chain (208).

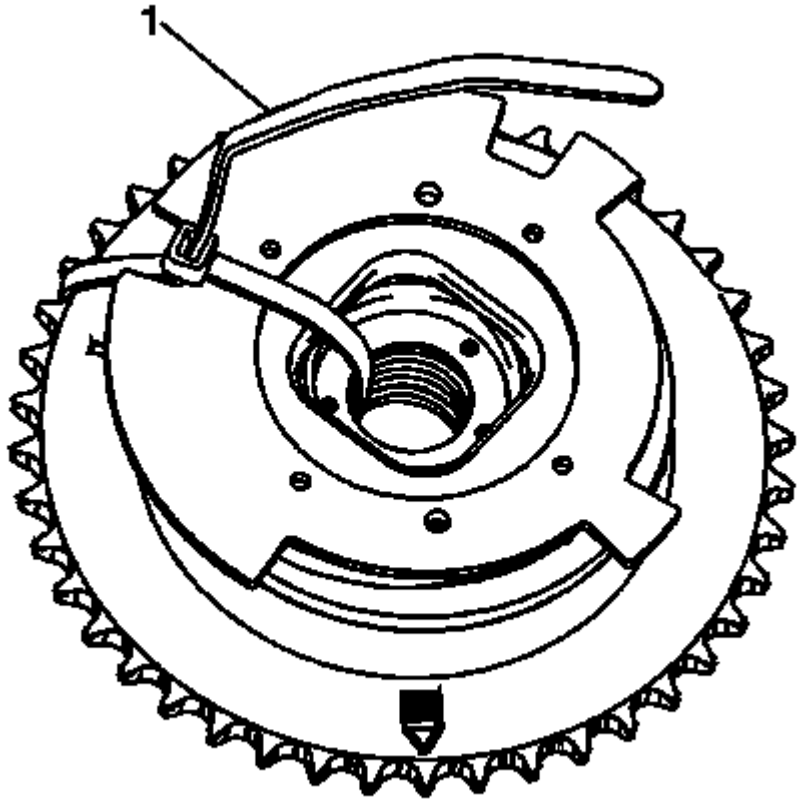

Fig. 221: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

7. Insert and secure a tie strap (1) through the center of the actuator and over the reluctor wheel.

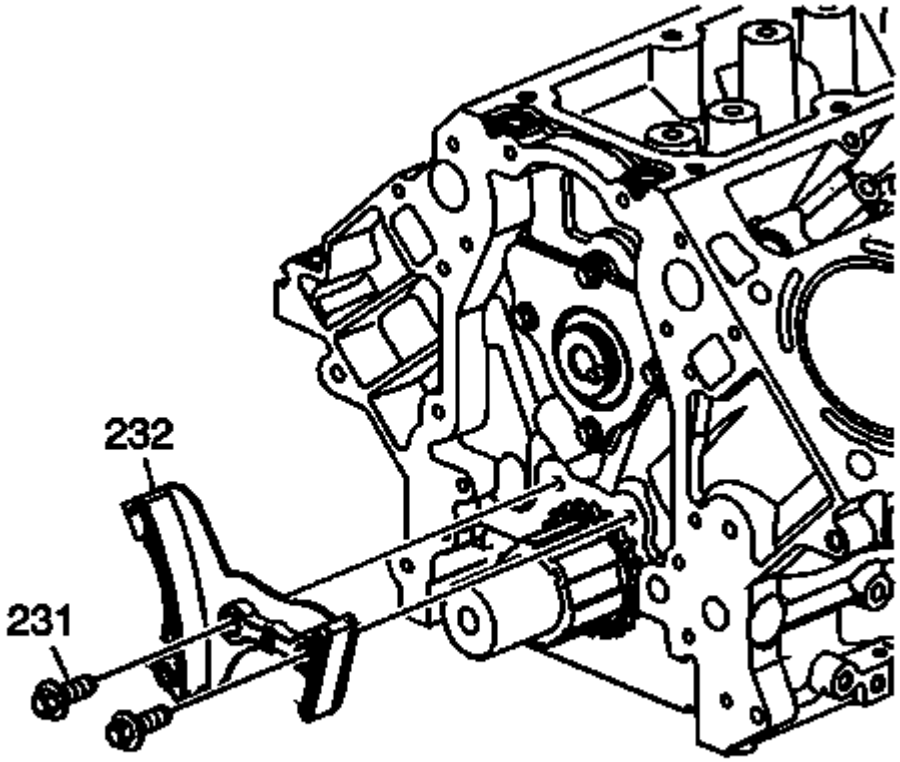

Fig. 222: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the timing chain tension bolts (231) and tensioner (232).

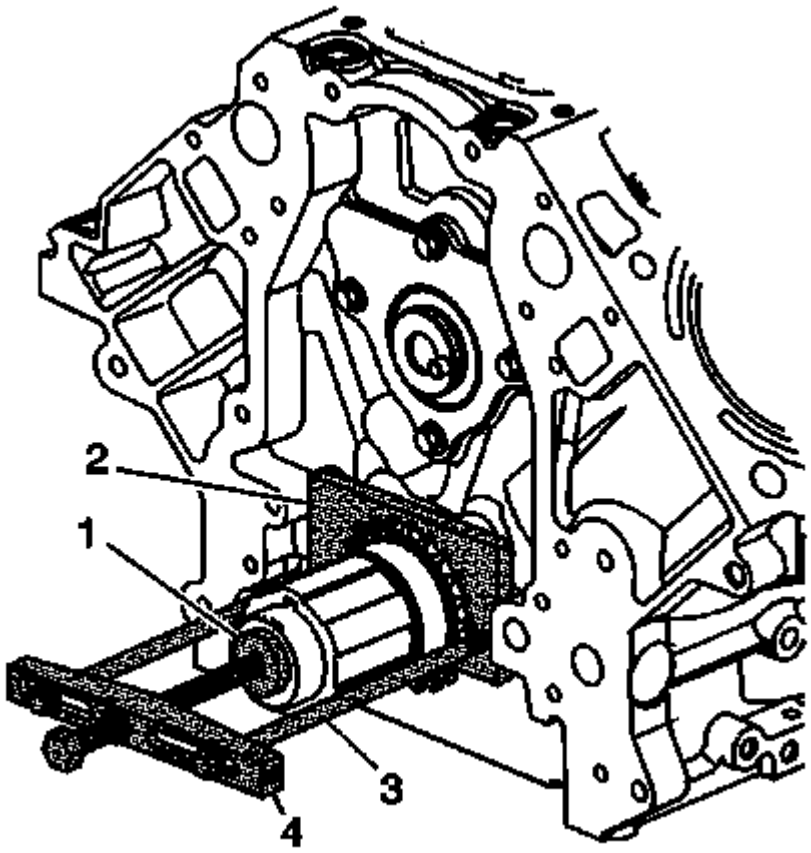

Fig. 223: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

9. Using the **J 41816-2** (1), the **J 41558** (2), bolts (3) and the **J 8433** (4) in order to remove the crankshaft sprocket. See **Special Tools** .

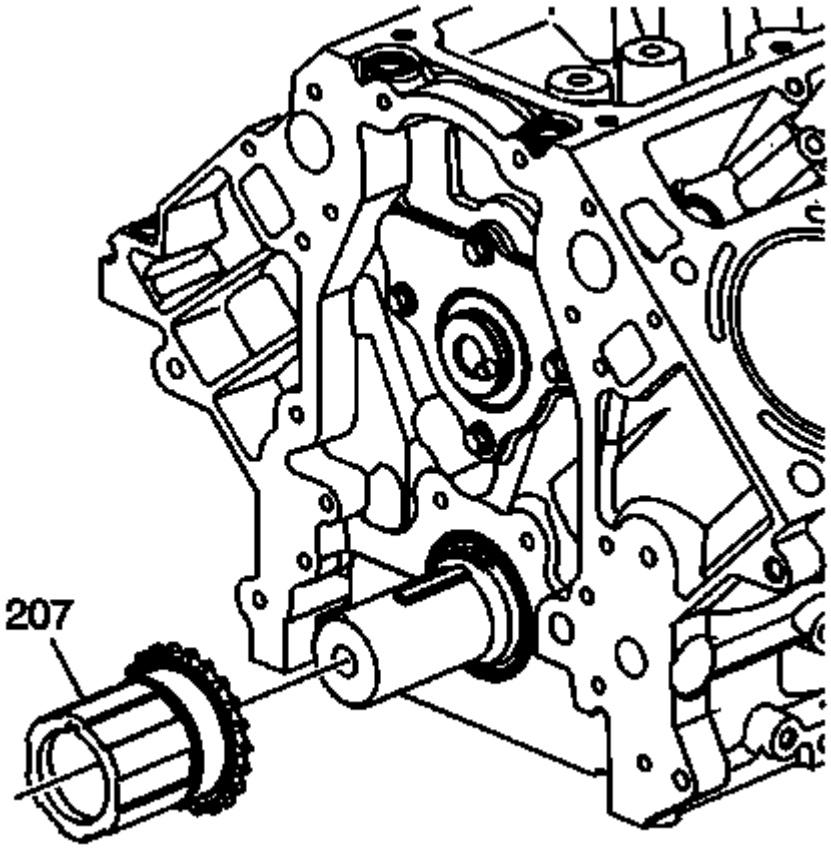

Fig. 224: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

10. Remove the crankshaft sprocket (207).

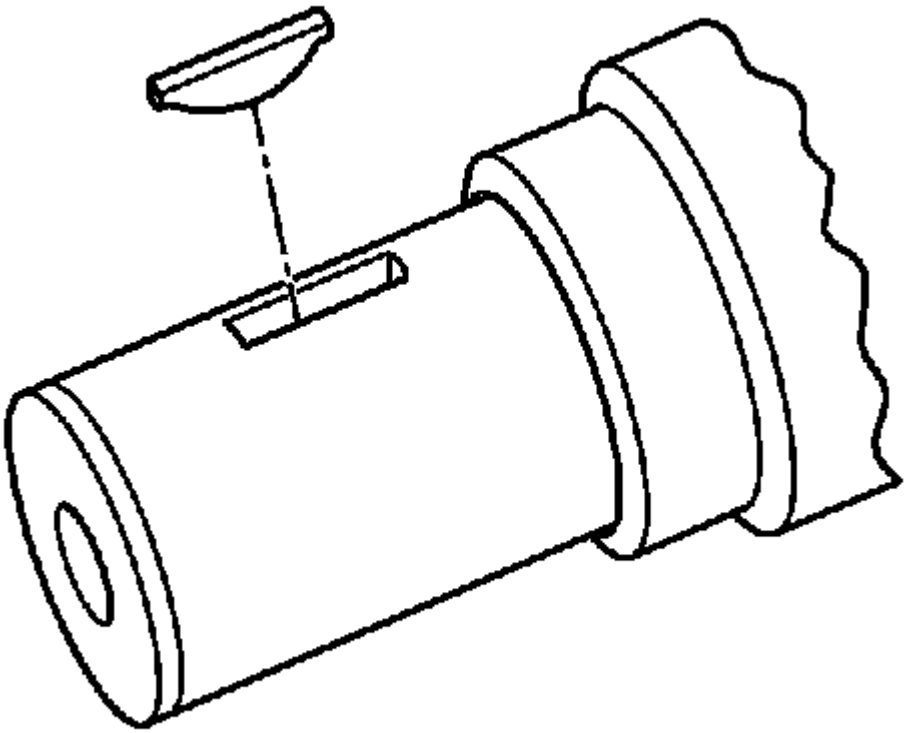

Fig. 225: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft sprocket key, if required.

INSTALLATION PROCEDURE

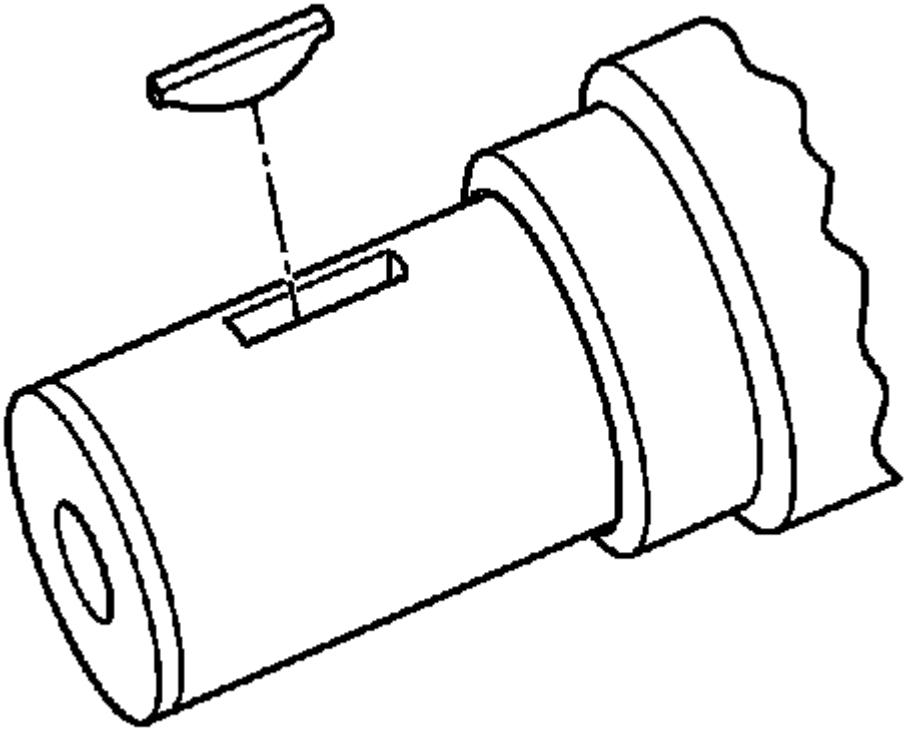

Fig. 226: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

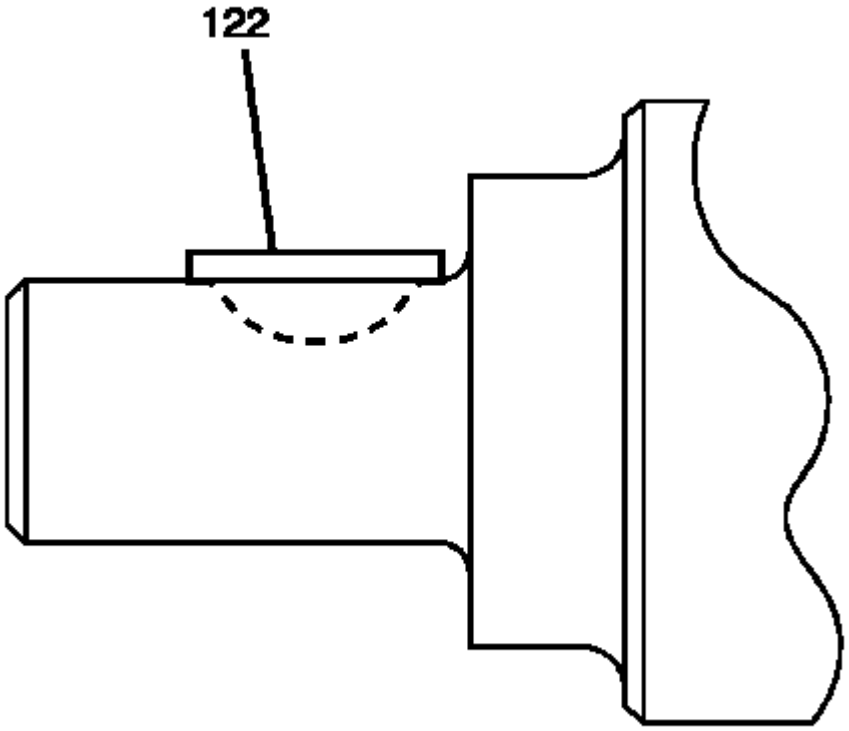

Fig. 227: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

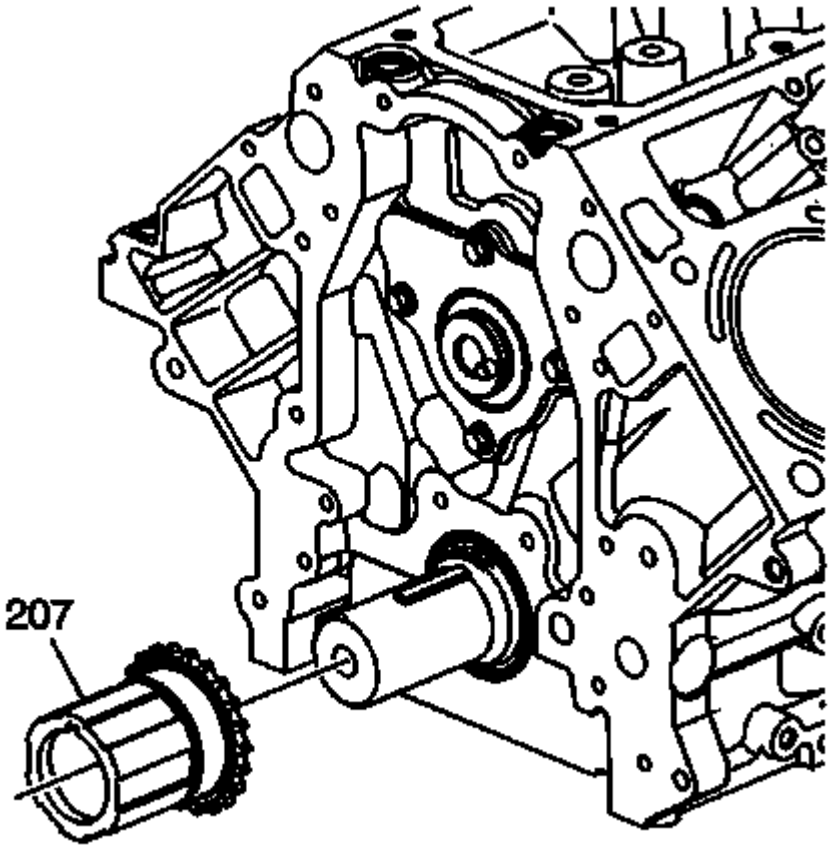

Fig. 228: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

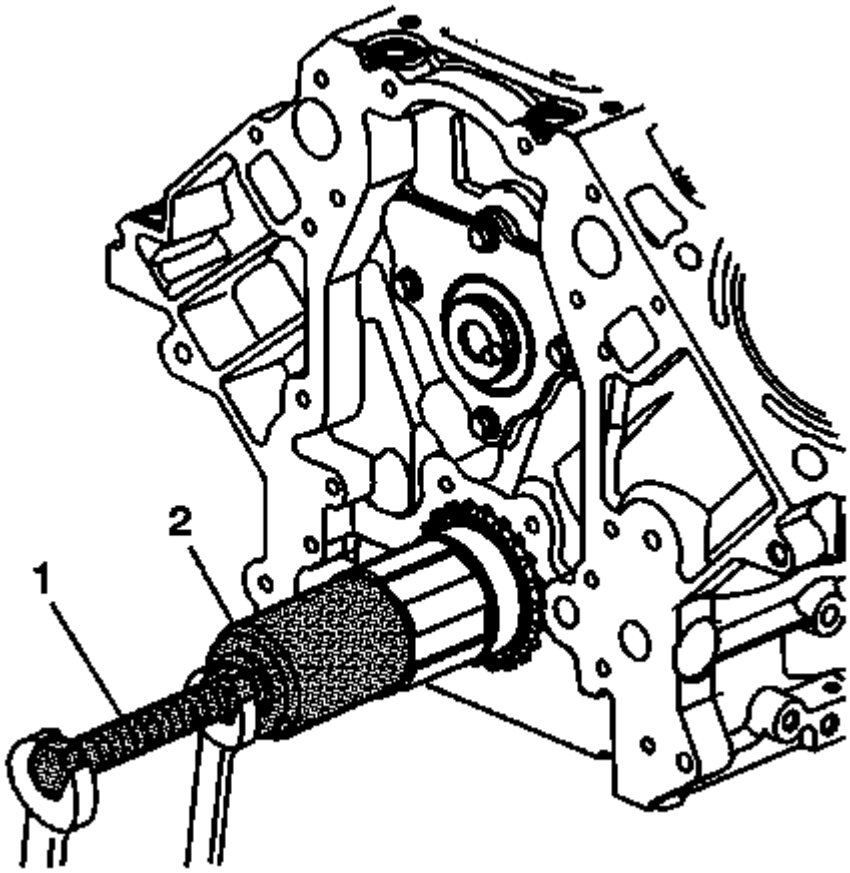

Fig. 229: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478** (1) and the **J 41665** (2) in order to install the crankshaft sprocket. See **Special Tools** . Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

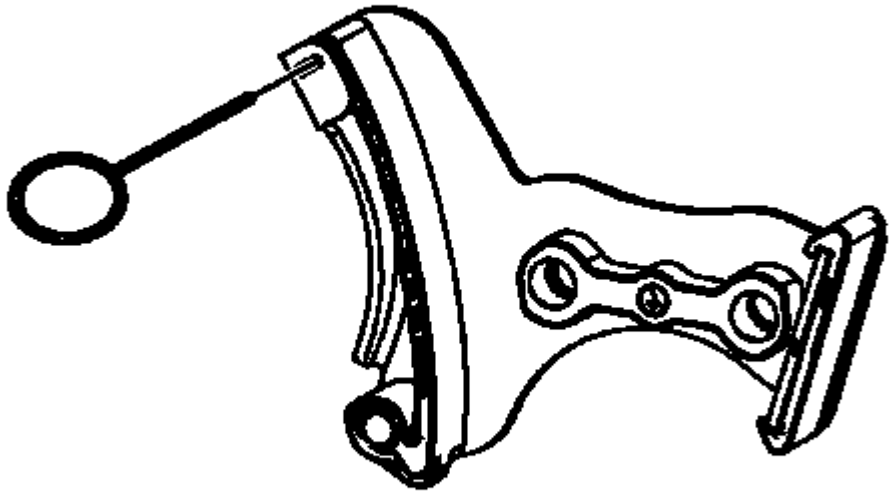

Fig. 230: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

5. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

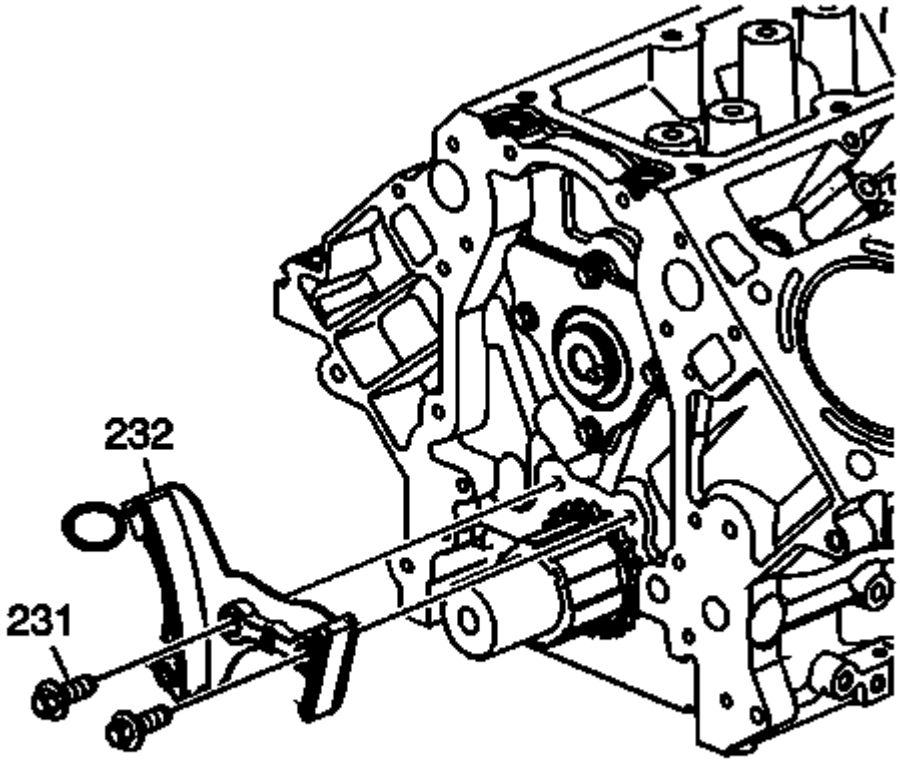

Fig. 231: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the timing chain tensioner (232) and bolts (231).

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

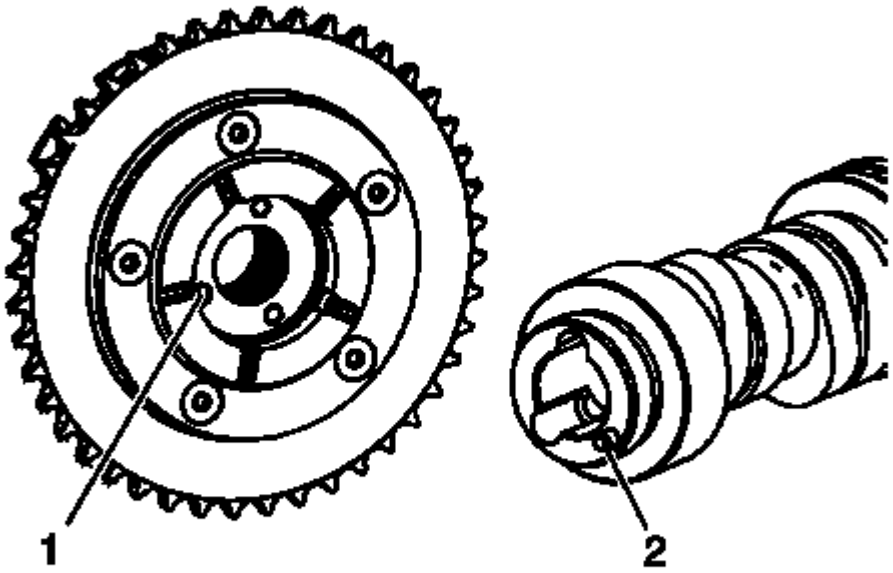

Fig. 232: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain teeth must mesh.**
- **The camshaft and the crankshaft sprocket alignment MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW CMP valve during assembly.**

7. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of he camshaft.

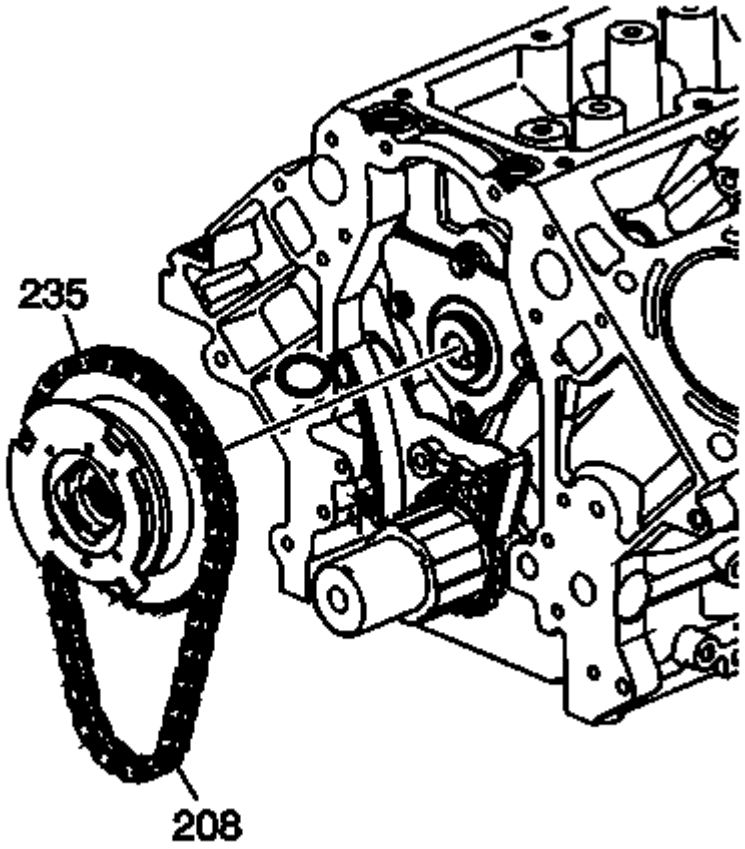

Fig. 233: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Align the CMP actuator so the timing mark is in the 6 o'clock position.
9. Install the CMP actuator (235) and timing chain (208). Align the hole in the face of the CMP actuator with the locating pin on the front face of the camshaft.

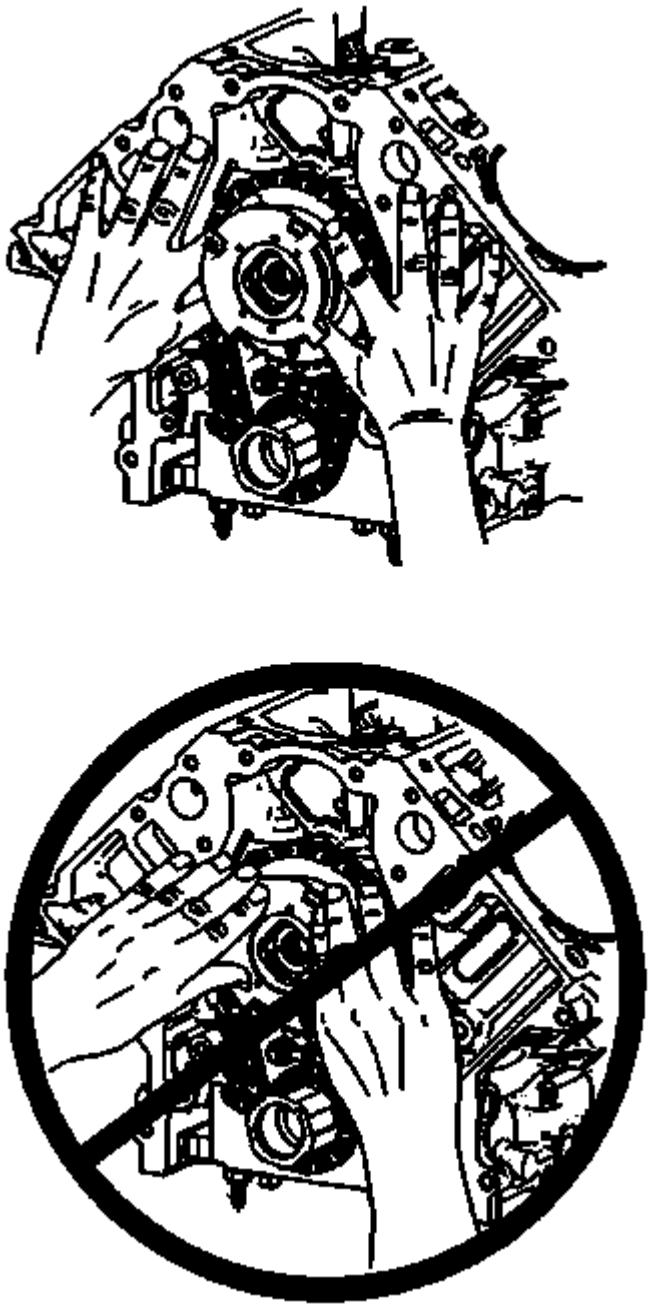

Fig. 234: Identifying Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

10. Use care to install the actuator completely onto the front of the camshaft. Position your fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

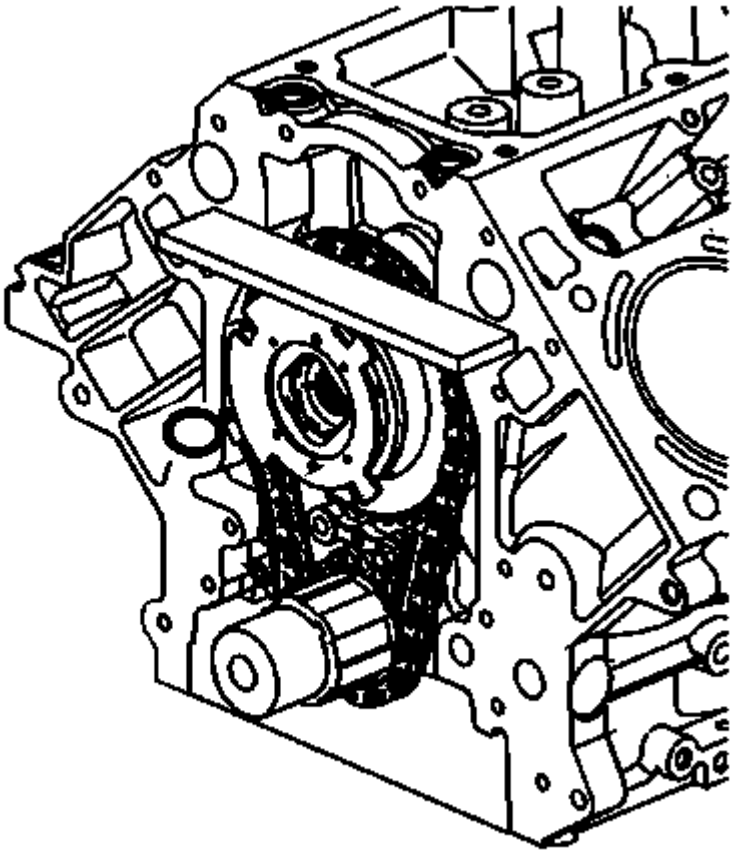

Fig. 235: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

11. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

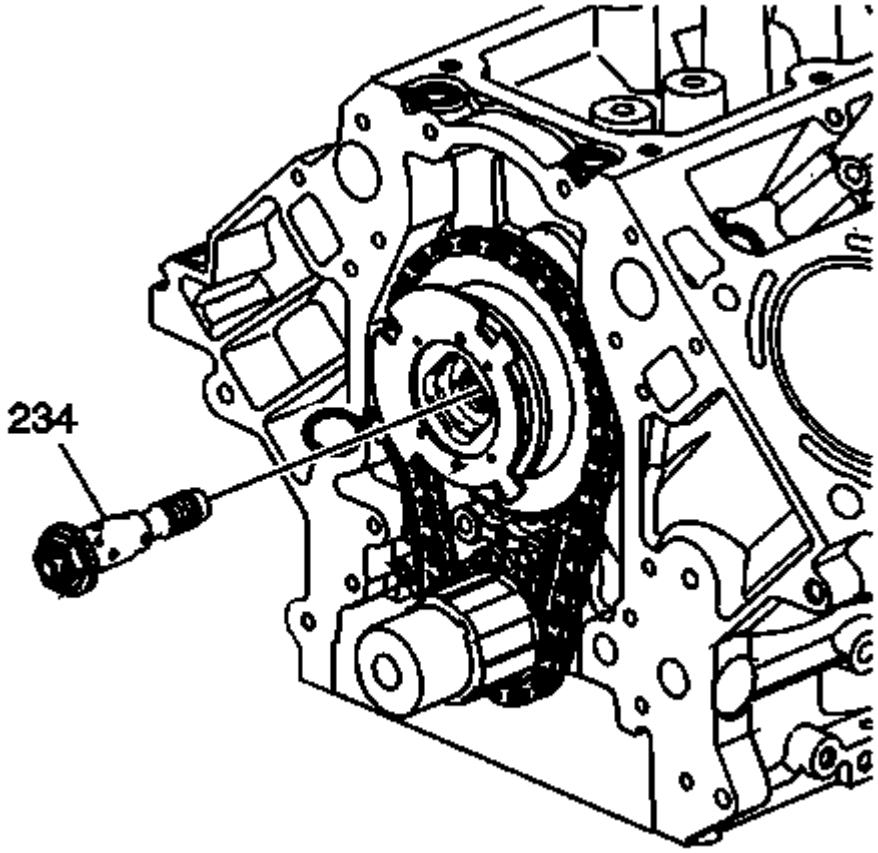

Fig. 236: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW CMP actuator valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

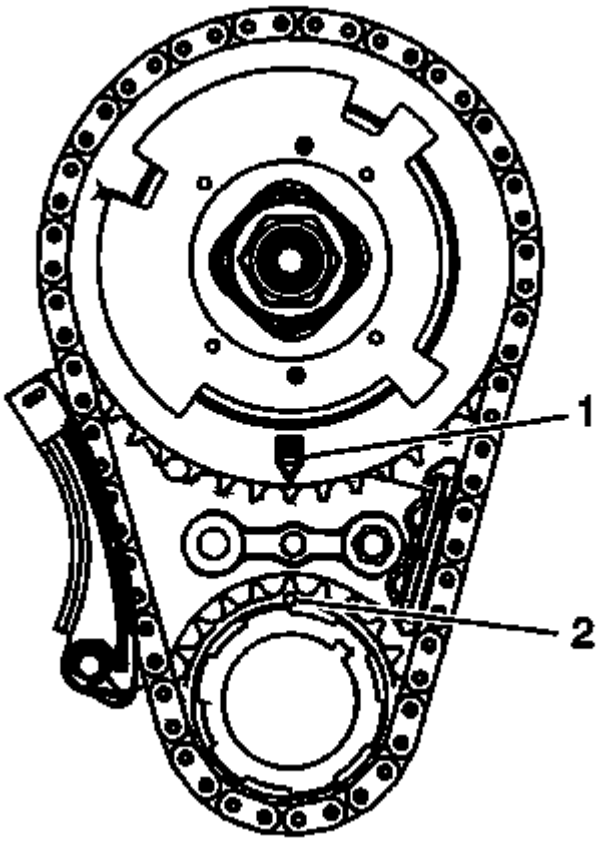

Fig. 237: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

13. Inspect the sprockets for proper alignment. The mark on the CMP (1) actuator sprocket should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

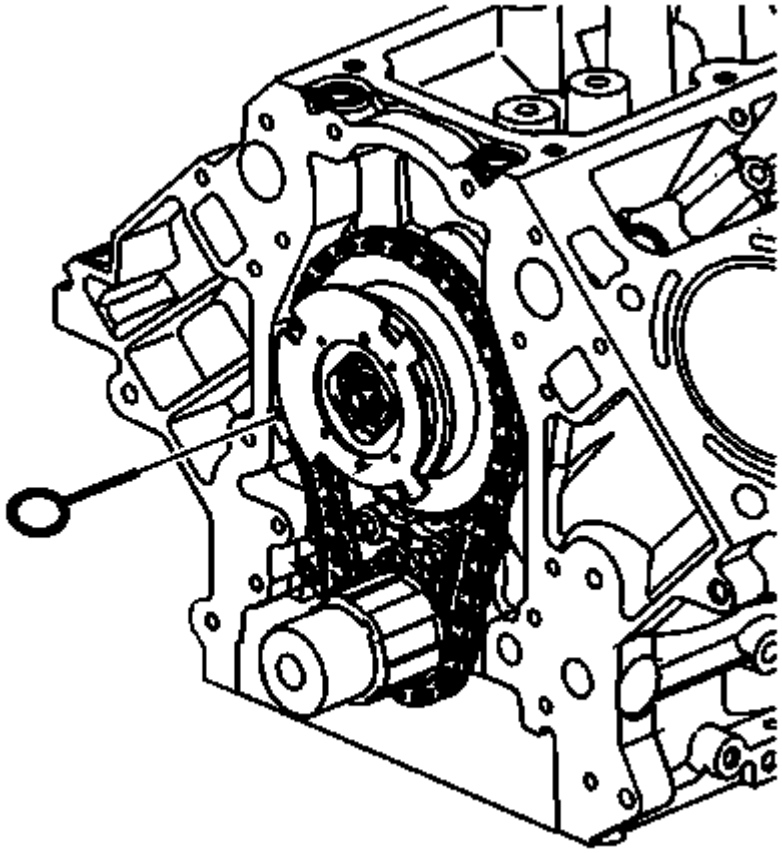

Fig. 238: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

14. Remove the **EN 46330** . See **Special Tools** .

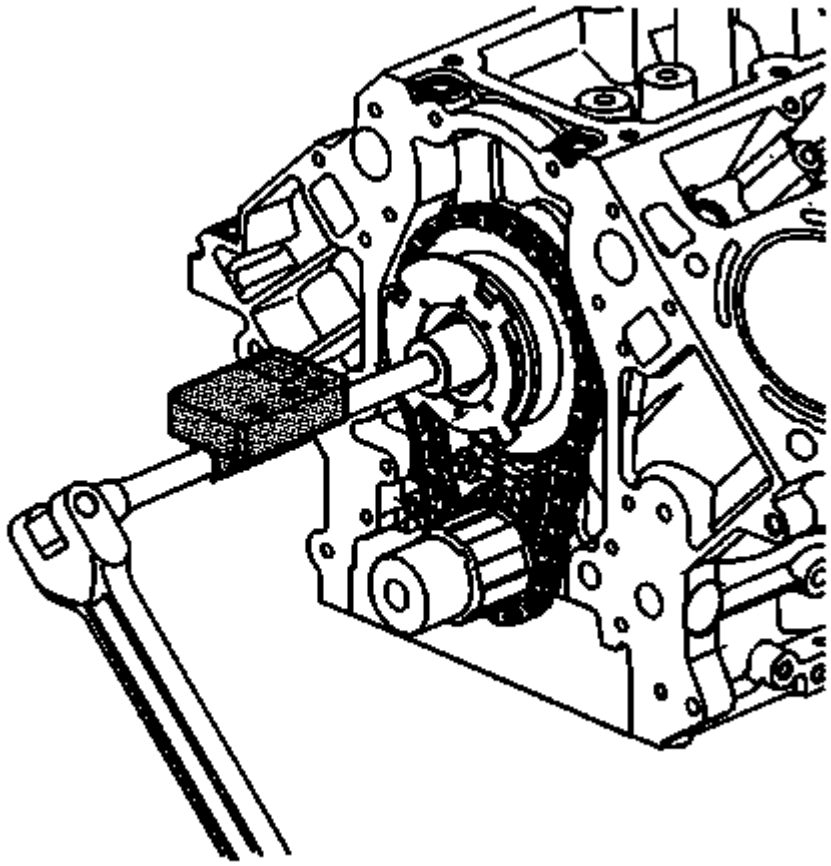

Fig. 239: View Of Tightening The CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

15. Tighten the CMP actuator solenoid valve.

    Tighten:
    1. Tighten the bolt a first pass to 65 N.m (48 lb ft).
    2. Tighten the bolt a final pass an additional 90 degrees using **J 45059** .

16. Remove the **J 42386-A** (1) and bolts. See **Special Tools** .
17. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CAMSHAFT REPLACEMENT

SPECIAL TOOLS

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **EN 46330** Angle Meter. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the radiator support. Refer to **Radiator Support Replacement**
2. Remove the valve lifters. Refer to **Valve Lifter Replacement**
3. Remove the Timing Chain, Camshaft Position Actuator, and Solenoid Valve. Refer to **Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement**

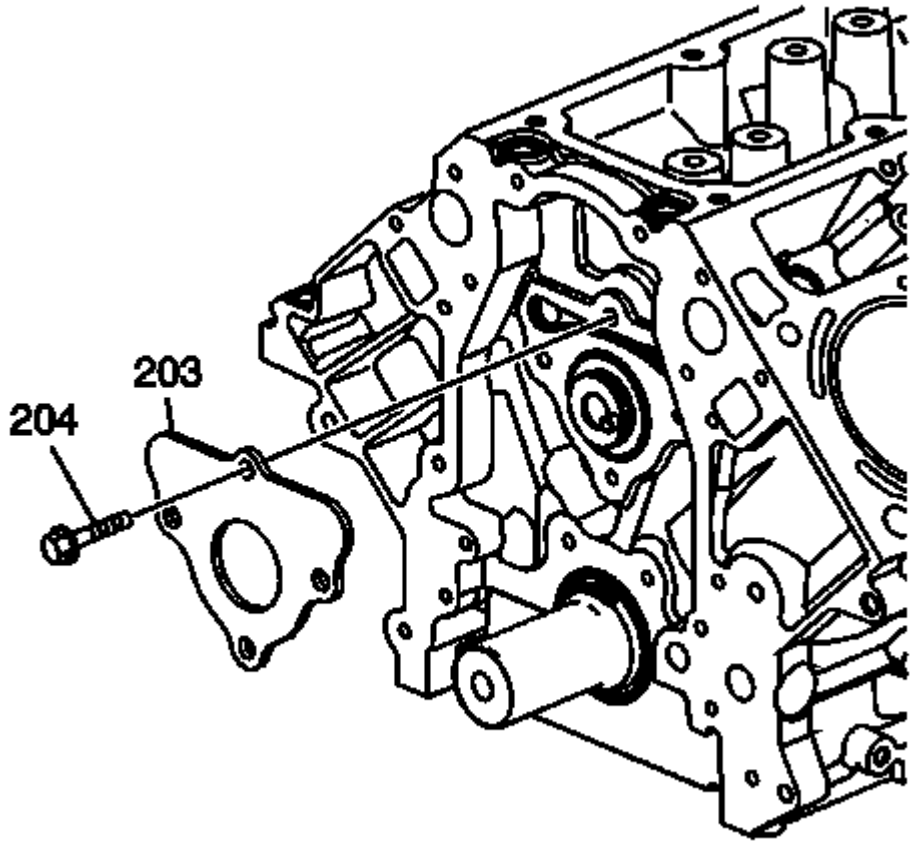

Fig. 240: View Of Camshaft Retainer & Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft retainer bolts (204) and retainer (203).

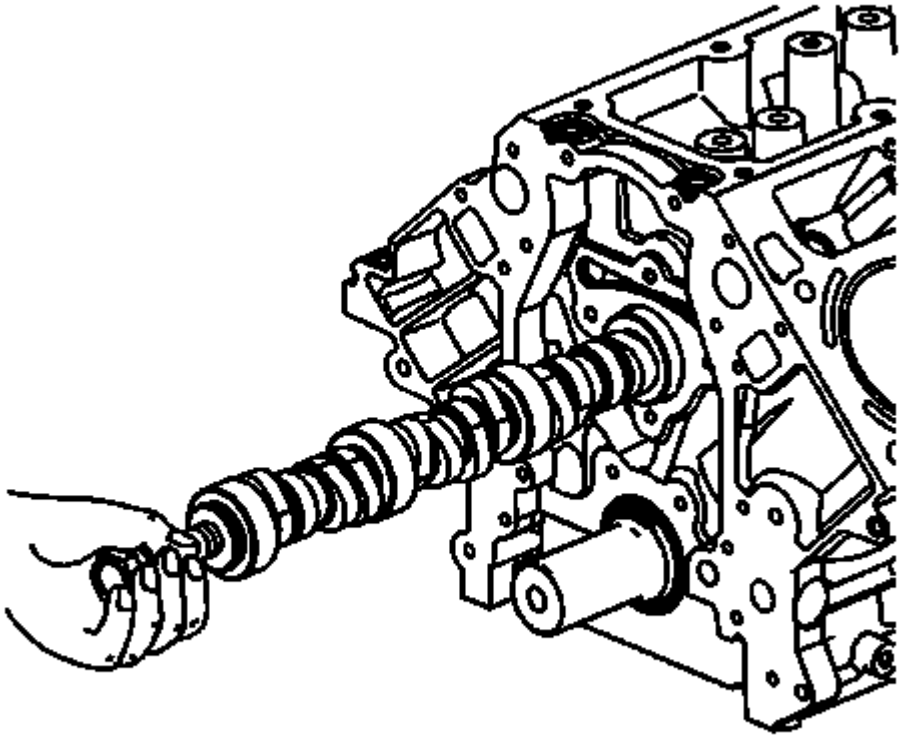

Fig. 241: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

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

5. Install a bolt into the camshaft.
6. Using the bolt as a handle, carefully rotate and pull the camshaft out of the engine block.
7. Clean and inspect the camshaft and bearings. Refer to **Camshaft and Bearings Cleaning and Inspection** .

INSTALLATION PROCEDURE

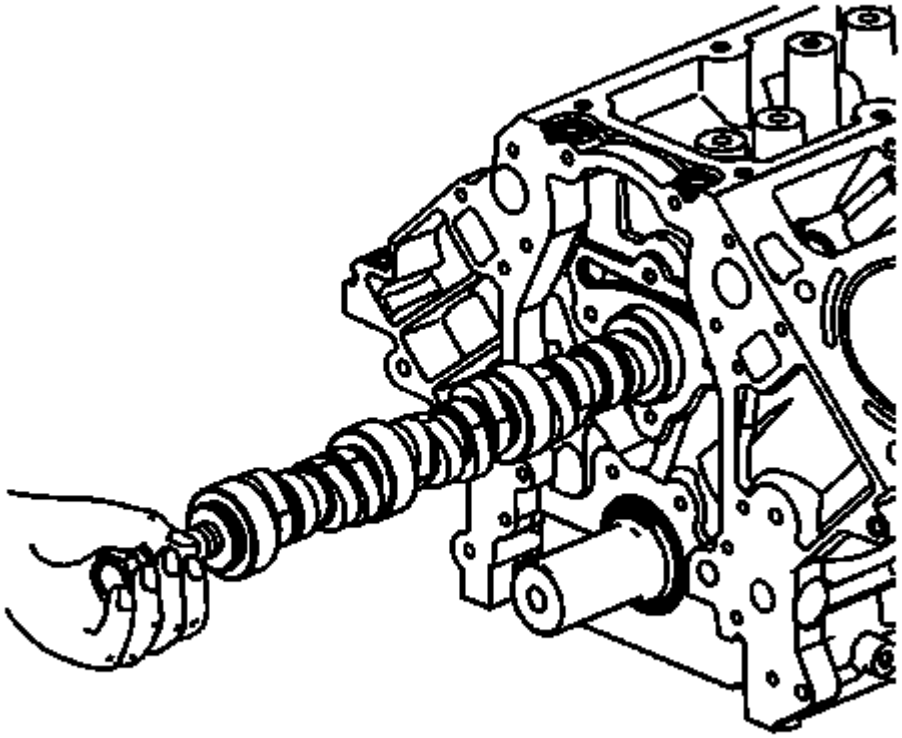

Fig. 242: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.

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

2. Using the bolt as a handle, carefully install the camshaft into the engine block.
3. Remove the bolt from the front of the camshaft.

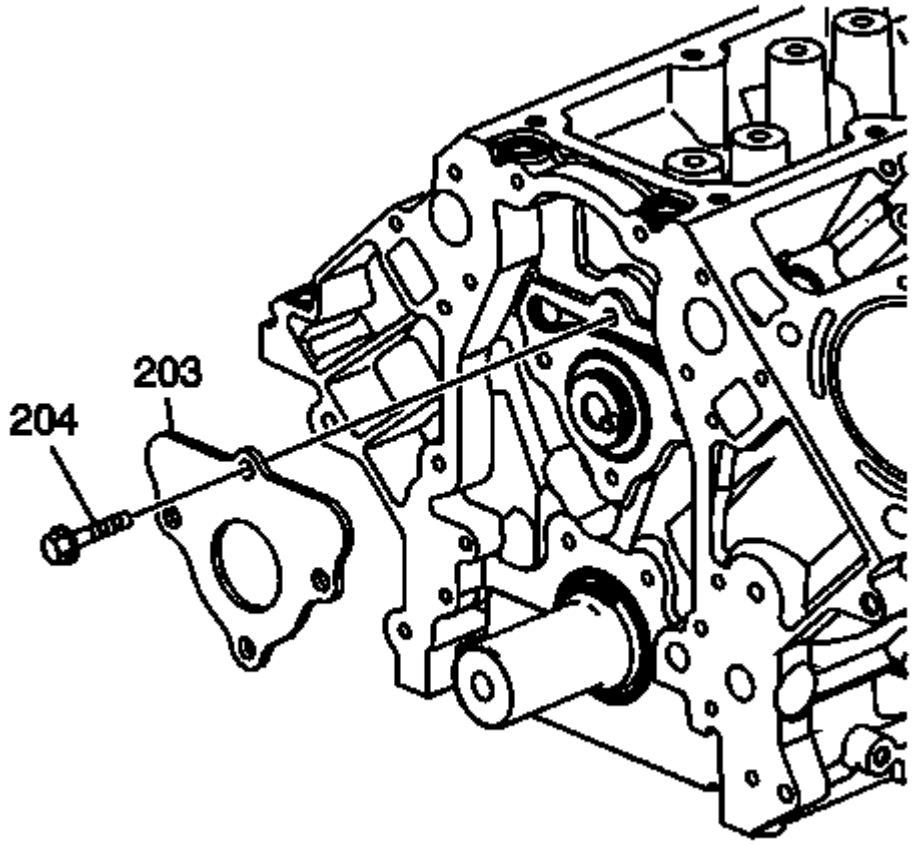

Fig. 243: View Of Camshaft Retainer & Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Install the retainer with the sealing gasket facing the engine block. The gasket surface on the engine block should be clean and free of dirt and/or debris.

4. Install the camshaft retainer (203) and bolts (204).

CAUTION: Refer to Fastener Caution .

5. Tighten the camshaft retainer bolts.

Tighten:

- Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft).
- Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft).

6. Install the Timing Chain, Camshaft Position Actuator, and Solenoid Valve. Refer to **Timing Chain, Crankshaft Sprocket, Camshaft Position Actuator, and Solenoid Valve Replacement**

7. Install the valve lifters. Refer to **Valve Lifter Replacement**.
8. Install the radiator support. Refer to **Radiator Support Replacement** .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

REMOVAL PROCEDURE

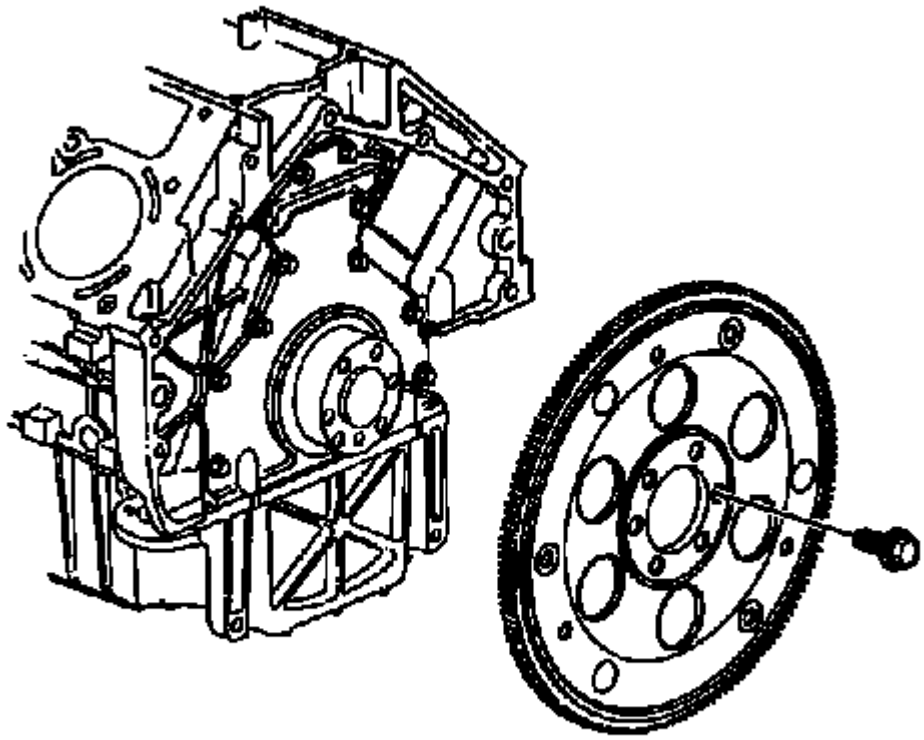

Fig. 244: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission, if equipped. Refer to **Transmission Replacement** for the 4L60-E transmission or **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission.

NOTE: Note the position and direction of the engine flywheel before removal.

2. Remove the engine flywheel bolts.
3. Remove the automatic transmission engine flywheel.
4. Clean and inspect the engine flywheel.
5. Install 2 M11x1.5 mm bolts (1) to the threaded holes of the spacer, if applicable.

6. Rotate the bolts clockwise to remove the spacer.

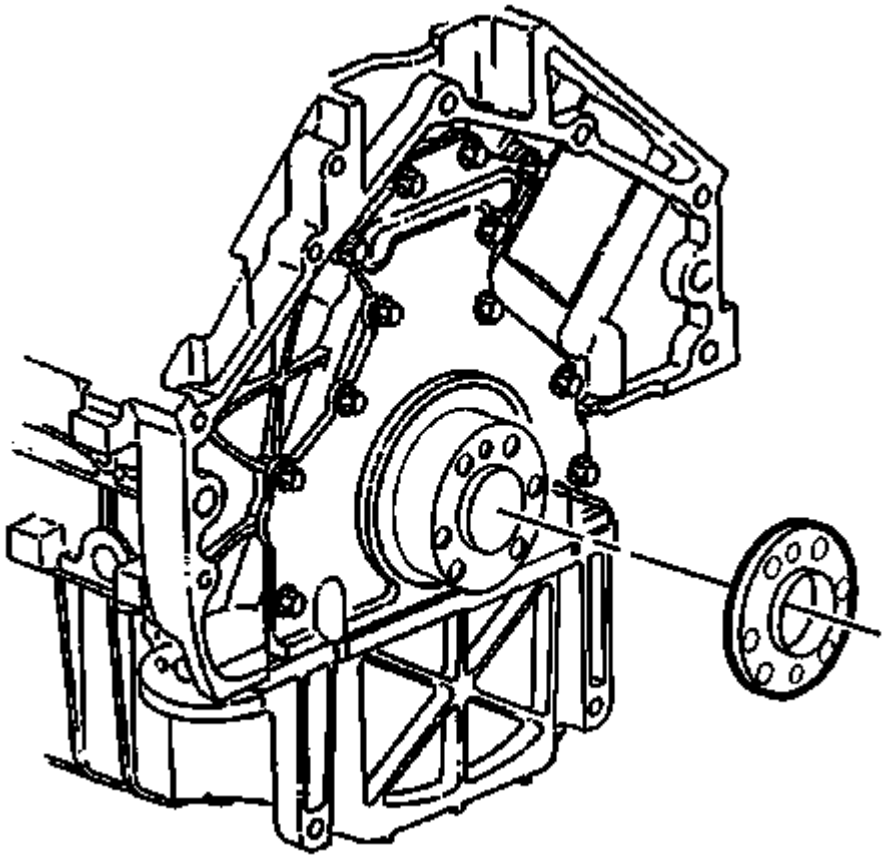

Fig. 245: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS CORP.

7. Remove the spacer from the rear of the crankshaft, if applicable.

INSTALLATION PROCEDURE

NOTE:

- **The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer (if applicable), but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.**
- **Certain applications (4.8 L manual transmissions or all 6.0 L) require a spacer and longer bolts for proper flywheel position.**

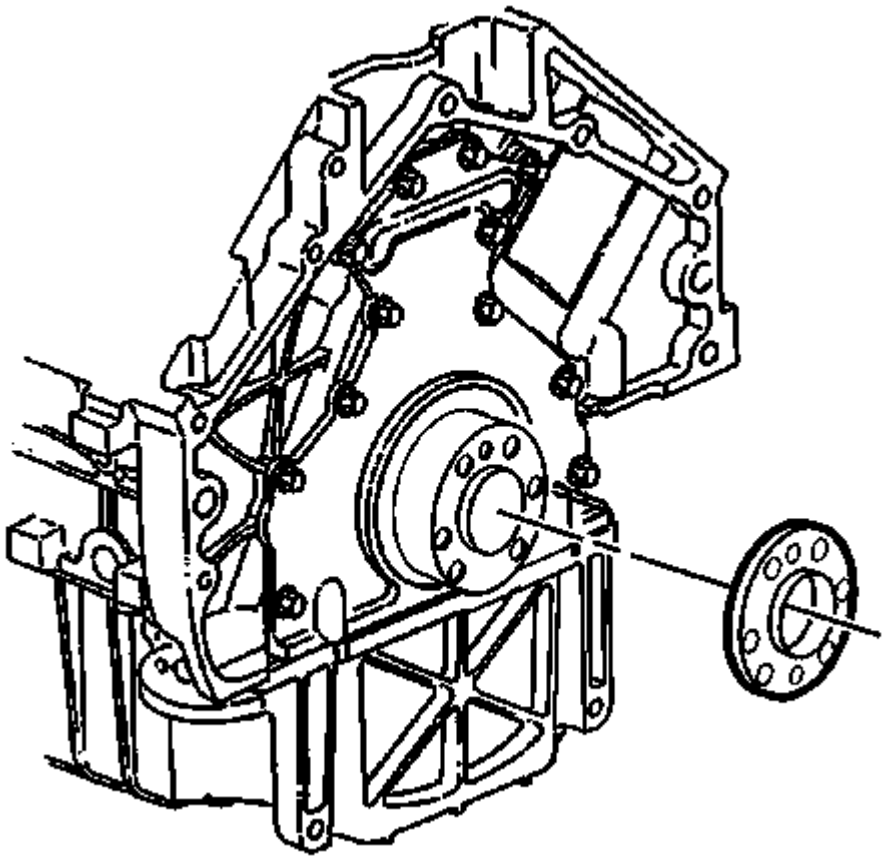

Fig. 246: View Of Spacer & Crankshaft Rear
Courtesy of GENERAL MOTORS CORP.

1. Install the spacer (if applicable) onto the rear of the crankshaft.

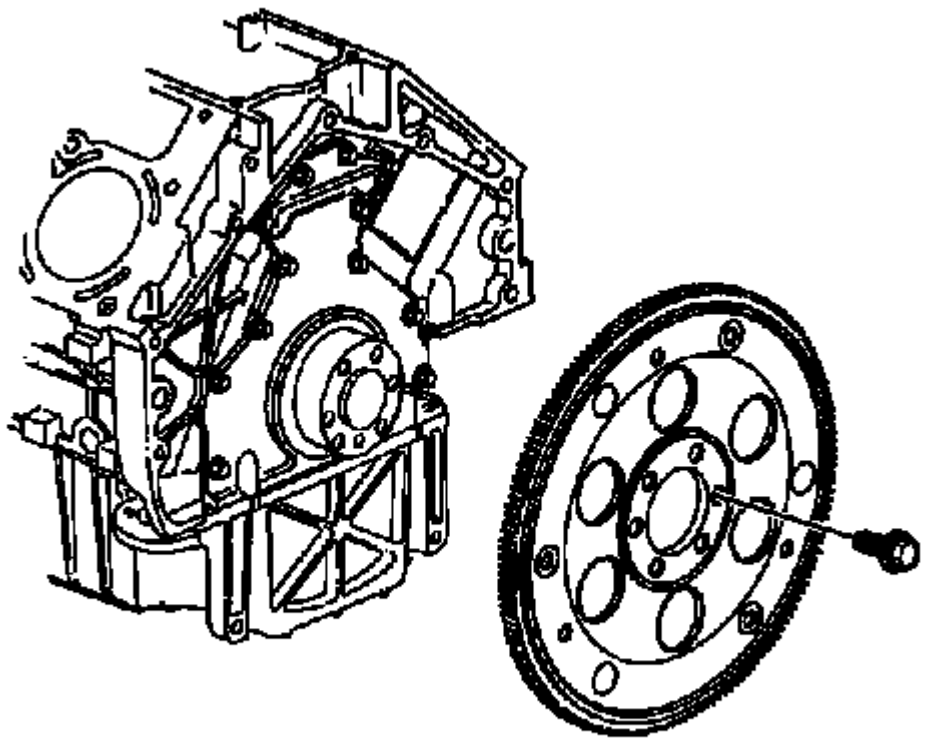

Fig. 247: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the automatic transmission engine flywheel to the crankshaft.

NOTE: Longer flywheel bolts must be used on applications using a flywheel spacer.

3. Apply threadlock to the threads of the flywheel bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

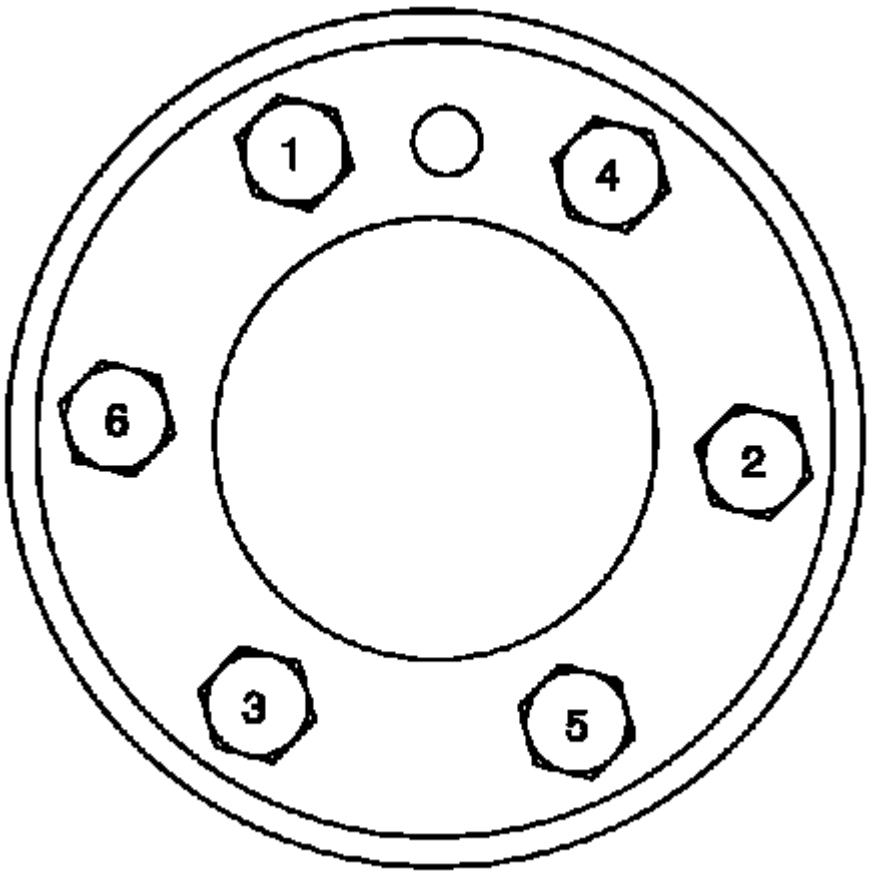

Fig. 248: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the engine flywheel bolts.
    1. Tighten the engine flywheel bolts a first pass in sequence to 20 N.m (15 lb ft).
    2. Tighten the engine flywheel bolts a second pass in sequence to 50 N.m (37 lb ft).
    3. Tighten the engine flywheel bolts a final pass in sequence to 100 N.m (74 lb ft).
5. Install the automatic transmission. Refer to **Transmission Replacement** for the 4L60-E transmission or **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission.

ENGINE REPLACEMENT

SPECIAL TOOLS

- **J 21366** Converter Holding Strap

- **J 42451-1** Engine Support Adapter
- **J 38185** Hose Clamp Pliers

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Engine Cover Replacement** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Recover the HVAC refrigerant. Refer to **Refrigerant Recovery and Recharging** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)** .
5. Remove the sheet metal to radiator support bolts and supports from the vehicle.
6. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
7. Remove the coolant reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
8. Remove the right and left headlamp capsules. Refer to **Headlamp Capsule Replacement (Minus V22)** .
9. Remove the front bumper. Refer to **Front Bumper Replacement** .

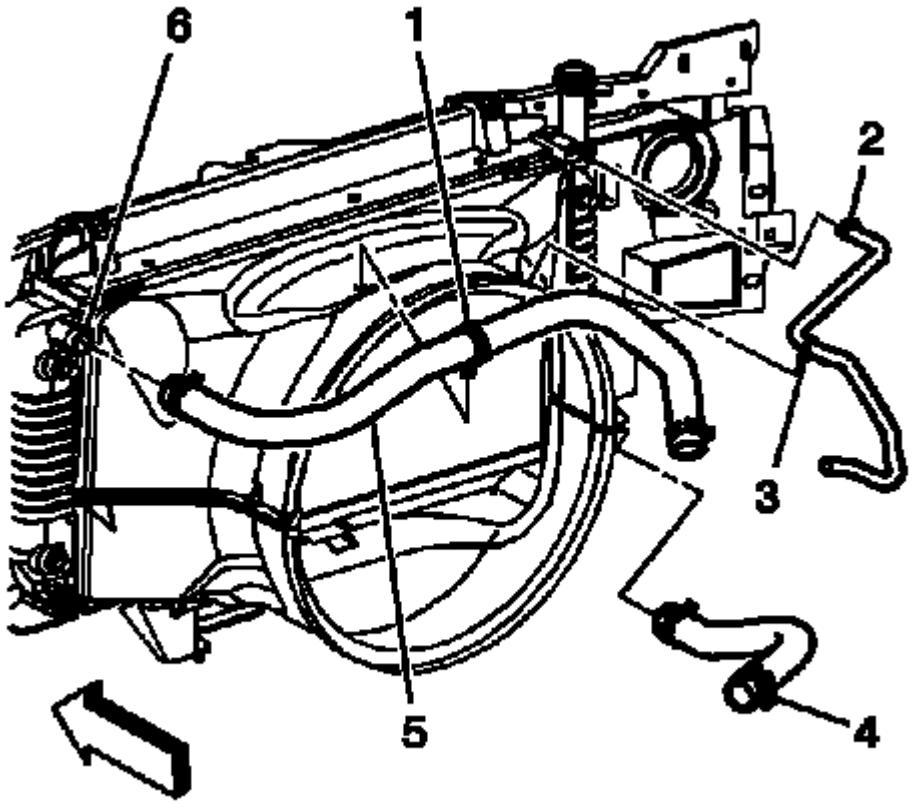

Fig. 249: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

10. Reposition the radiator inlet hose clamp (4) at the water pump.
11. Remove the radiator inlet hose from the water pump.
12. Reposition the radiator outlet hose clamp at the water pump.
13. Remove the radiator outlet hose from the water pump.

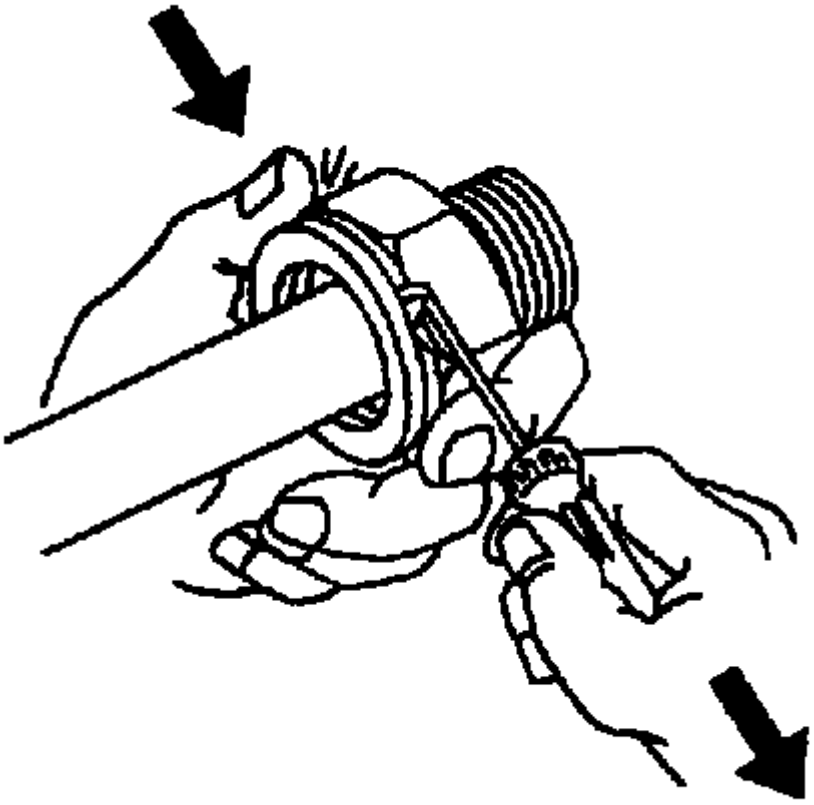

Fig. 250: Identifying Retaining Ring On Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the transmission cooler lines from the radiator. Refer to **Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection** .
15. Disconnect the oil cooler line from the radiator, if equipped.
16. Disconnect the HVAC lines from the condenser.
17. Disconnect the ground G106 from the right hand inner fender. Refer to **Ground Distribution Schematics** .
18. Disconnect the C4 at the underhood fuse block. Refer to **Power Distribution Schematics** .
19. Disconnect the positive battery cable from the underhood fuse block and position aside.

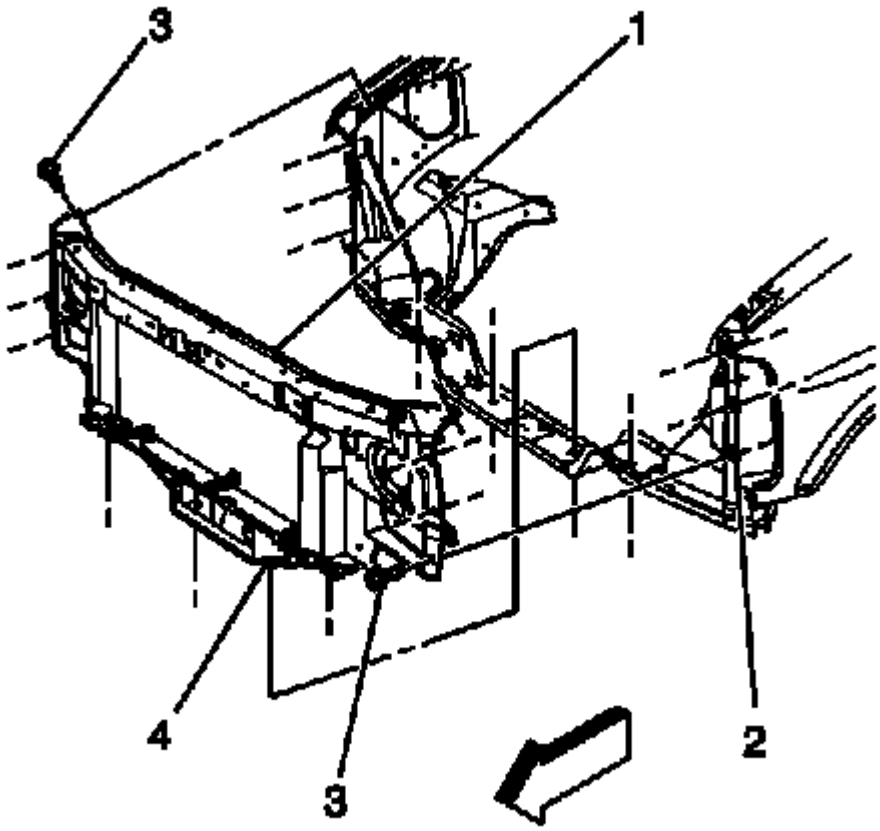

Fig. 251: Identifying Core Support Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

20. Remove the core support retaining bolt (3).
21. With the aid of an assistant, remove the core support assembly with the radiator, condenser radiator hoses and fan shroud intact.
22. Remove the clutch fan. Refer to **Fan Clutch Replacement** .
23. Remove the accessory drive belt.
24. Remove the generator bracket from the engine. Refer to **Generator Bracket Replacement (V8)** .

    Leave the generator and power steering pump retained to the bracket. Use a suitable strap and position the bracket assembly aside.

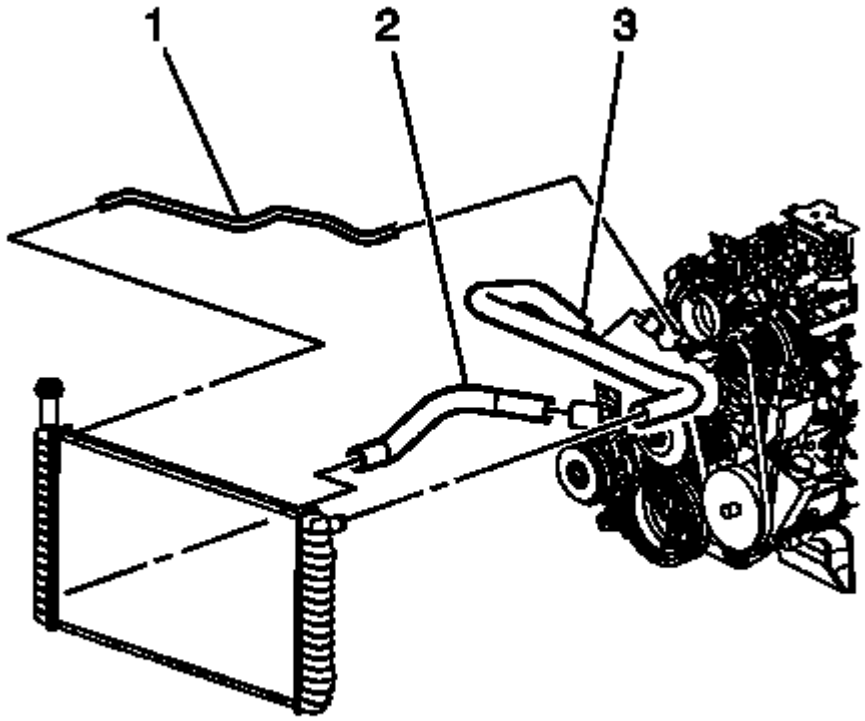

Fig. 252: View Of Vent Hose
Courtesy of GENERAL MOTORS CORP.

25. Remove the radiator vent inlet hose (1) from the throttle body.

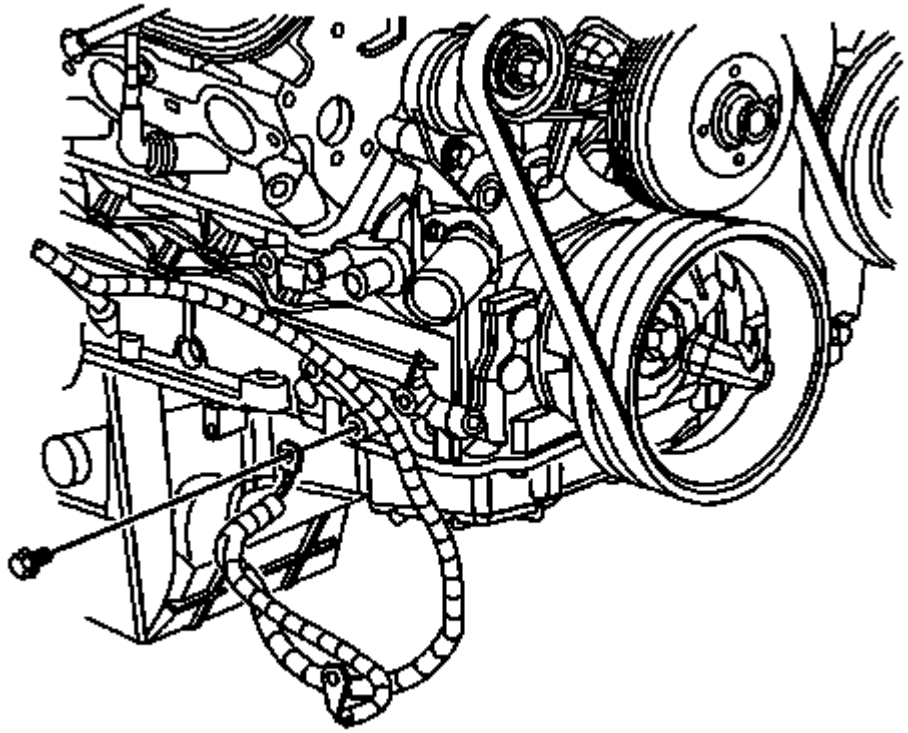

Fig. 253: View Of battery negative cable lead
Courtesy of GENERAL MOTORS CORP.

26. Remove the ground strap from the frame and engine.

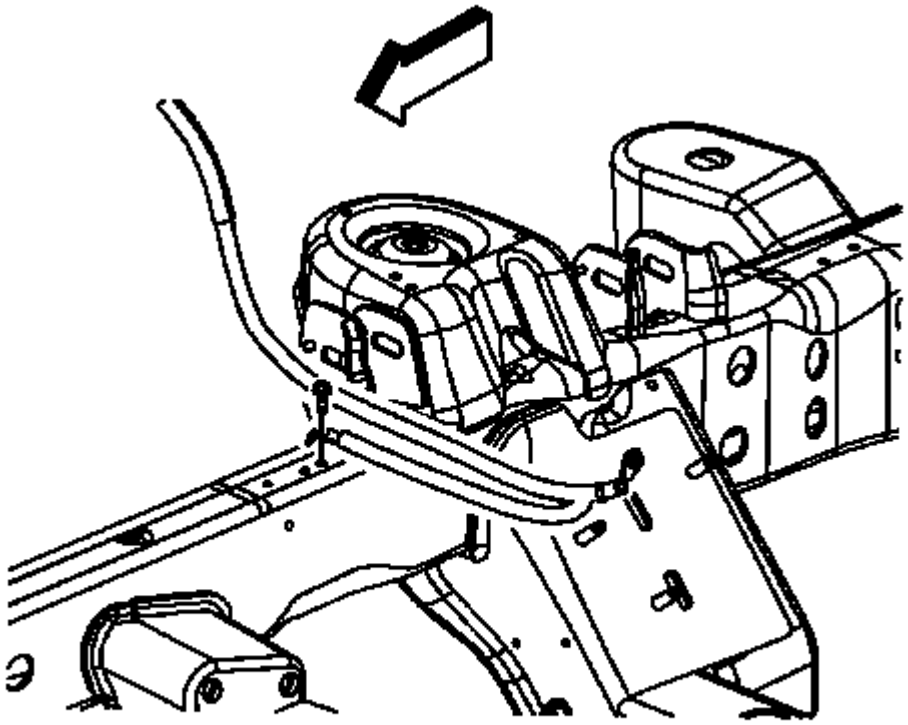

Fig. 254: View Of battery negative cable lead
Courtesy of GENERAL MOTORS CORP.

27. Remove G104 and G105 from the engine. Refer to **Ground Distribution Schematics** .
28. Remove the air conditioning compressor..
29. Disconnect the heater hoses from the water pump.
30. Remove the intake manifold. Refer to **Intake Manifold Removal** .
31. Remove the ignition coils from the engine. Refer to **Ignition Coil Replacement** .
32. Remove the coolant air bleed pipe from the engine. Refer to **Engine Coolant Air Bleed Pipe Replacement (With LH8)** .
33. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
34. Remove the oil drain plug and drain the oil into a suitable container.
35. Remove the starter motor. Refer to **Starter Replacement (V8)** .
36. Disconnect the catalytic converter pipe from the exhaust manifolds. Refer to **Catalytic Converter Replacement (V8)** .
37. Disconnect the following electrical connectors:
    - The crankshaft position (CKP) sensor
    - The engine oil level sensor

- The coolant heater, if equipped

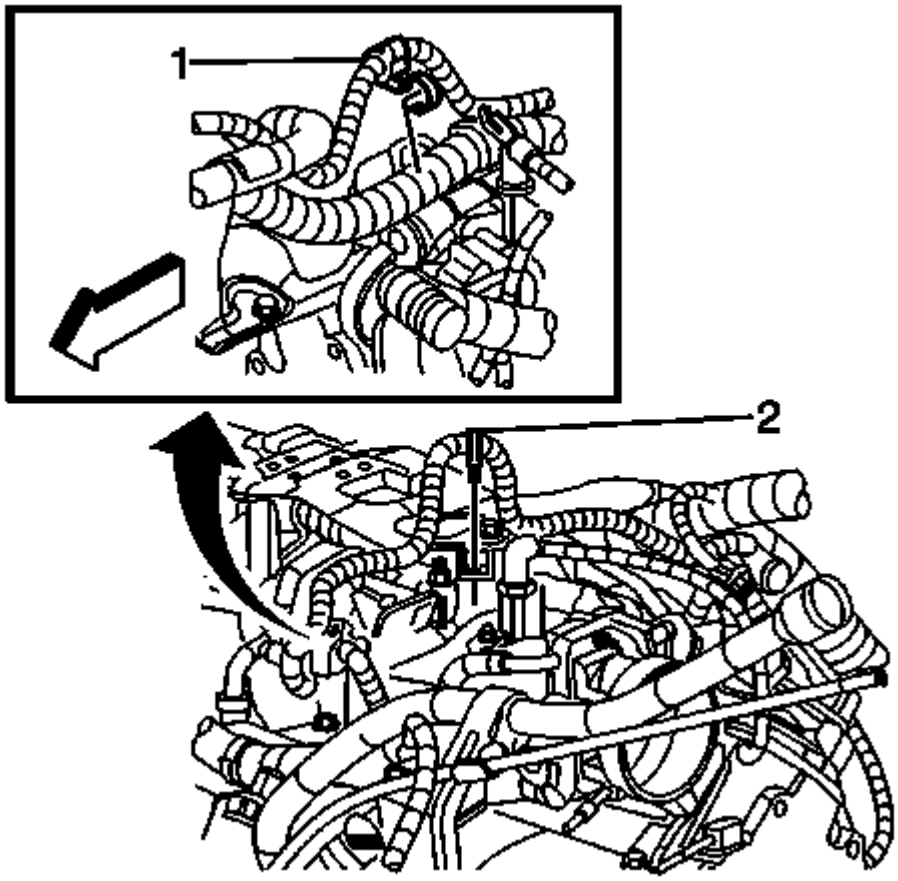

Fig. 255: View Of battery positive cable
Courtesy of GENERAL MOTORS CORP.

38. Unclip the battery positive cable (2) from the harness clip.
39. Gather all branches of the engine wiring harness and reposition off to the side.

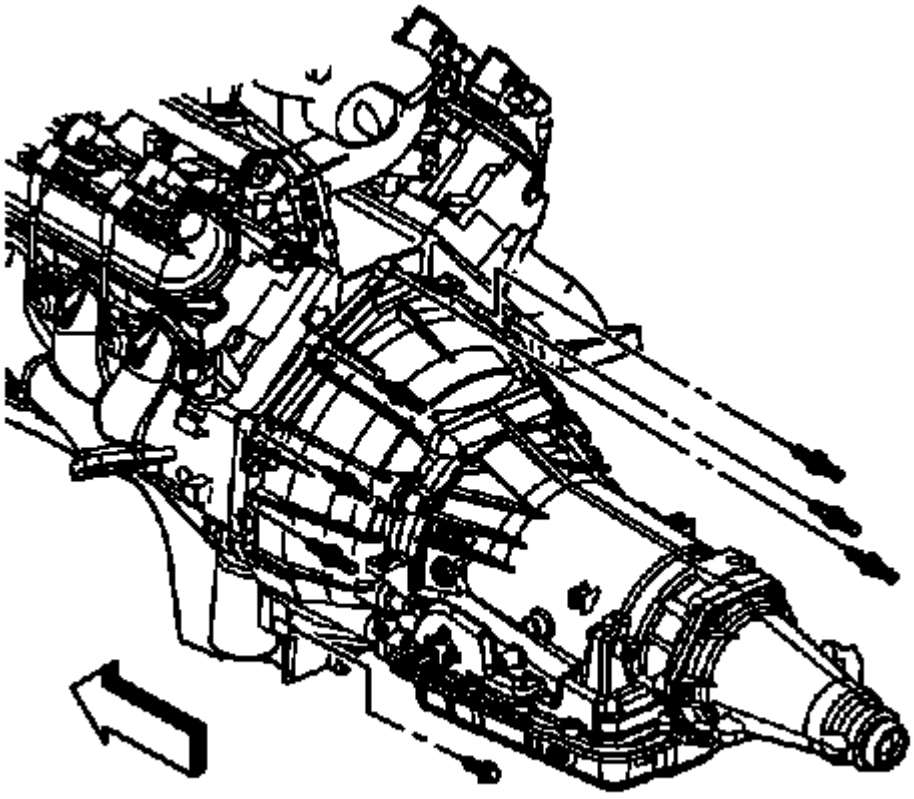

Fig. 256: View Of Lower 6 Bell Housing To Engine Studs & Bolts
Courtesy of GENERAL MOTORS CORP.

40. Remove the lower 6 bell housing to engine studs and bolts. Leave the top 2 studs in place.

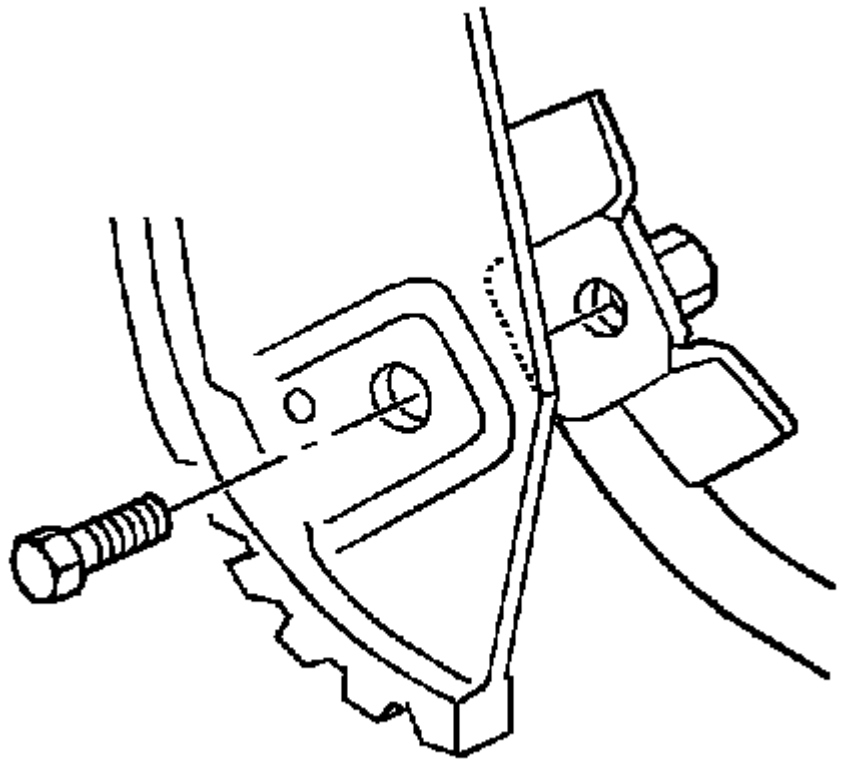

Fig. 257: Identifying Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

41. Remove the torque converter bolts.
42. Lower the vehicle.
43. Remove the left and right exhaust manifolds.

CAUTION: Refer to Fastener Caution .

44. Install the **J 42451-1** to the cylinder heads. Tighten the M10 engine lift bracket bolts to 50 N.m (37 lb ft).

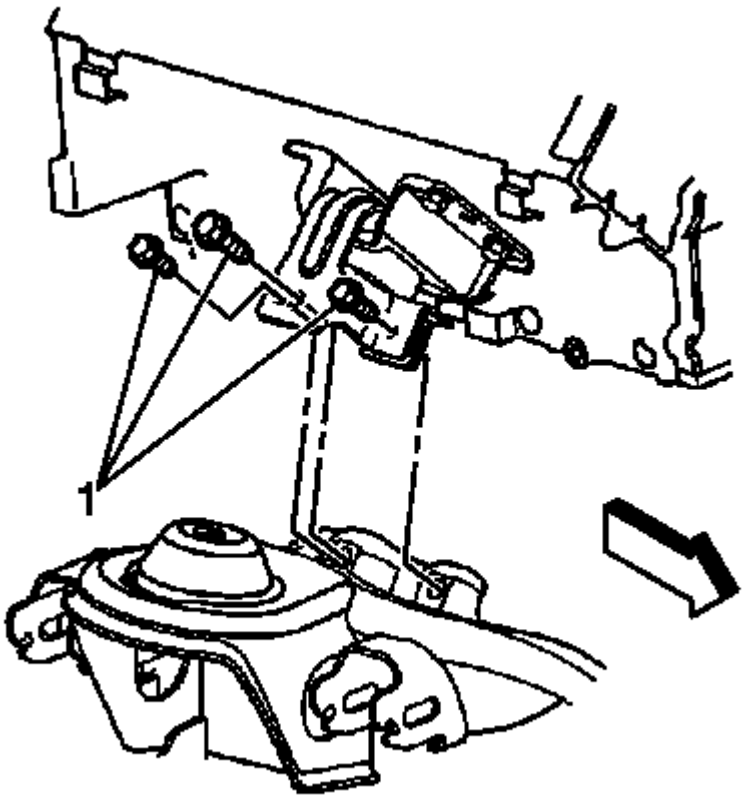

Fig. 258: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

45. Remove the left and right engine mount-to-engine mount bracket bolts.

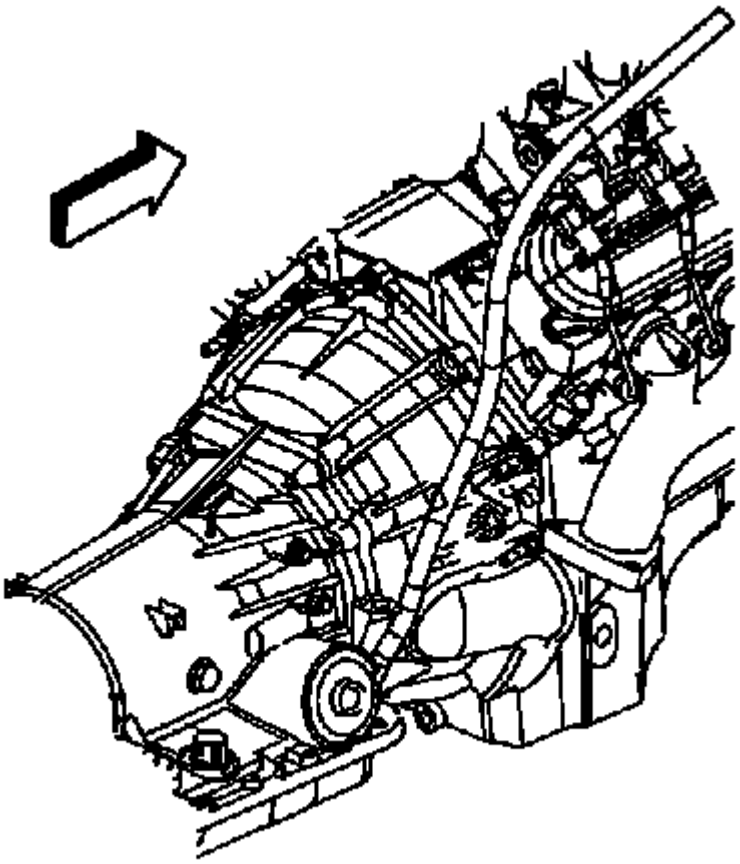

Fig. 259: View Of Oil Level Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

46. Remove the transmission oil level indicator tube nut.

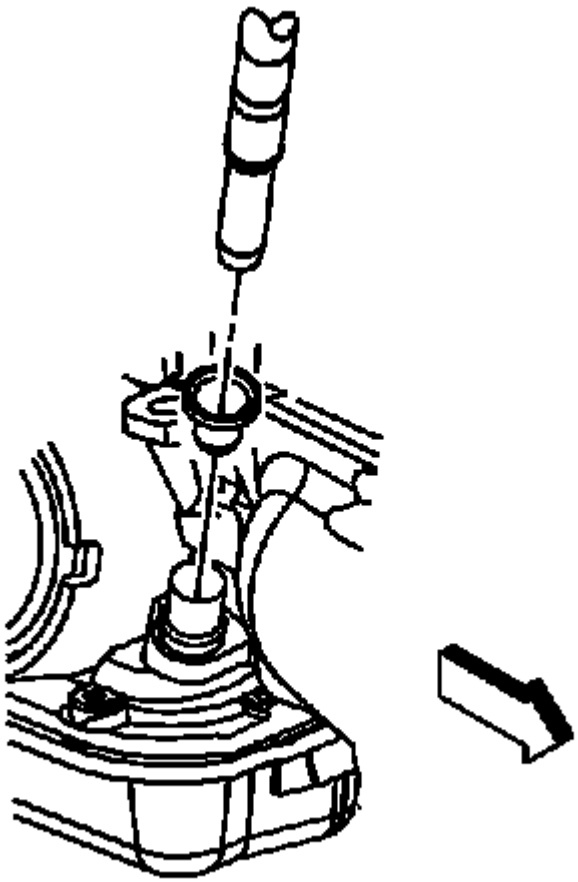

Fig. 260: View Of Oil Level Indicator Tube & Seal
Courtesy of GENERAL MOTORS CORP.

47. Remove the transmission oil level indicator tube.

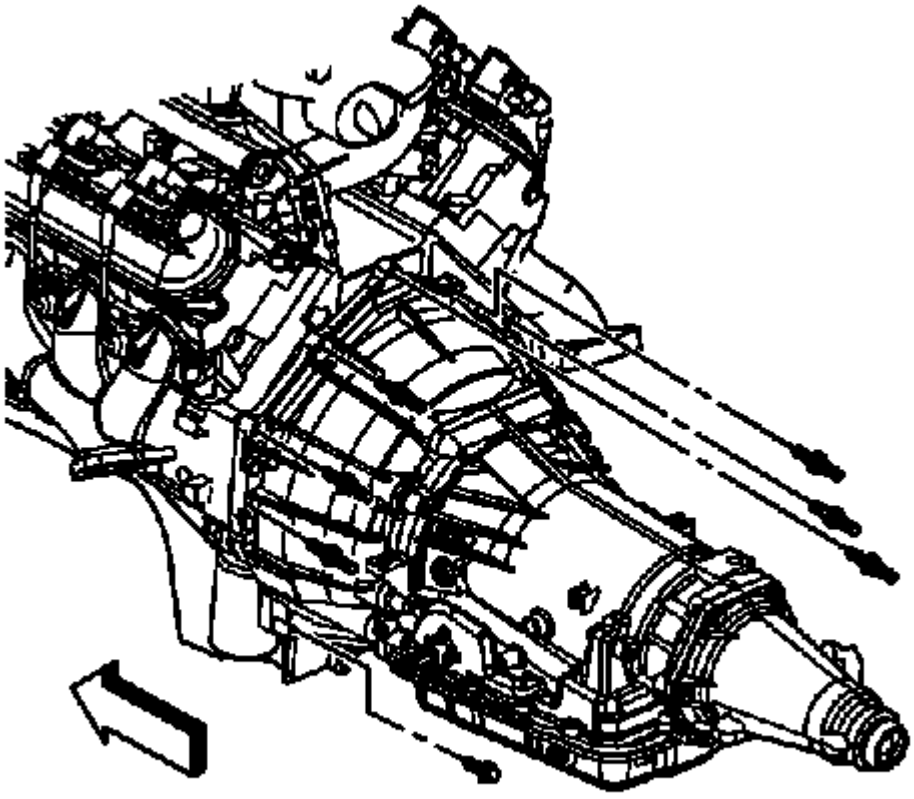

Fig. 261: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

48. Remove the top 2 automatic transmission studs.
49. Install a floor jack under the transmission for support.
50. Install an engine hoist to the **J 42451-1** .
51. Separate the engine from the automatic transmission, if equipped.

    Install the **J 21366** to the transmission in order to hold the torque converter.

52. Remove the engine.
53. Install the engine to an engine stand.
54. Remove the engine hoist.
55. Remove the **J 42451-1** from the engine.

INSTALLATION PROCEDURE

1. Install the **J 42451-1** to the engine. Tighten the M10 engine lift bracket bolts to 50 N.m (37 lb ft).
2. Install an engine hoist to the **J 42451-1** .

3. Remove the engine from the engine stand.
4. Install the engine to the vehicle.
5. Align the engine and transmission.

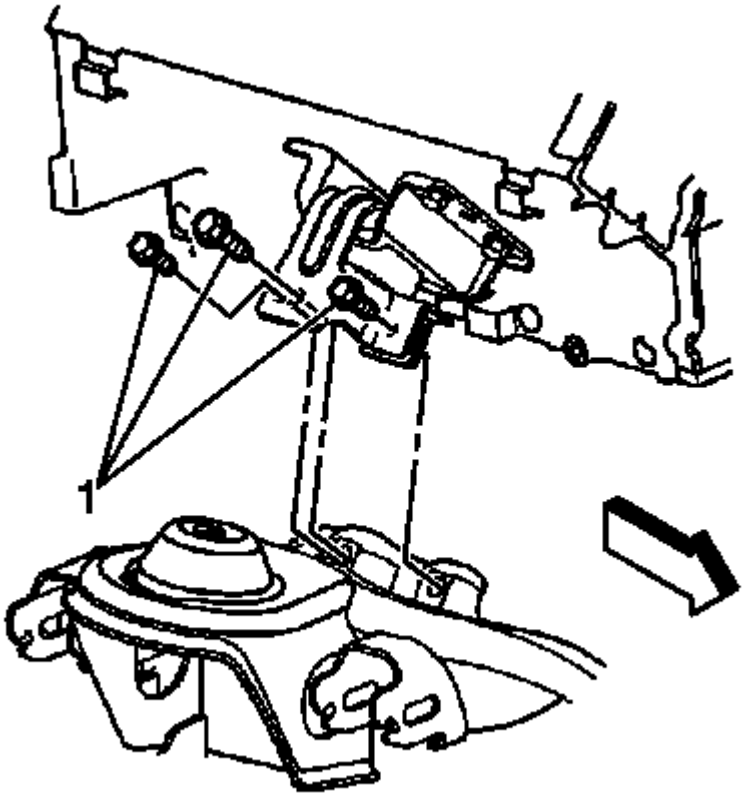

Fig. 262: View Of Engine Mount-To-Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the left and right engine mount-to-engine mount bracket bolts and tighten to 60 N.m (44 lb ft).
7. Install the upper transmission bolts until snug.
8. Remove the floor jack from under the transmission.
9. Remove the engine hoist.
10. Remove the **J 42451-1** from the engine.
11. Install the left and right exhaust manifolds. Refer to **Exhaust Manifold Installation - Left Side** and to **Exhaust Manifold Installation - Right Side** .
12. Install the intake manifold. Refer to **Intake Manifold Installation** .
13. Install the ignition coil(s) and the spark plug wire(s). Refer to **Ignition Coil Replacement** .
14. Raise the vehicle.

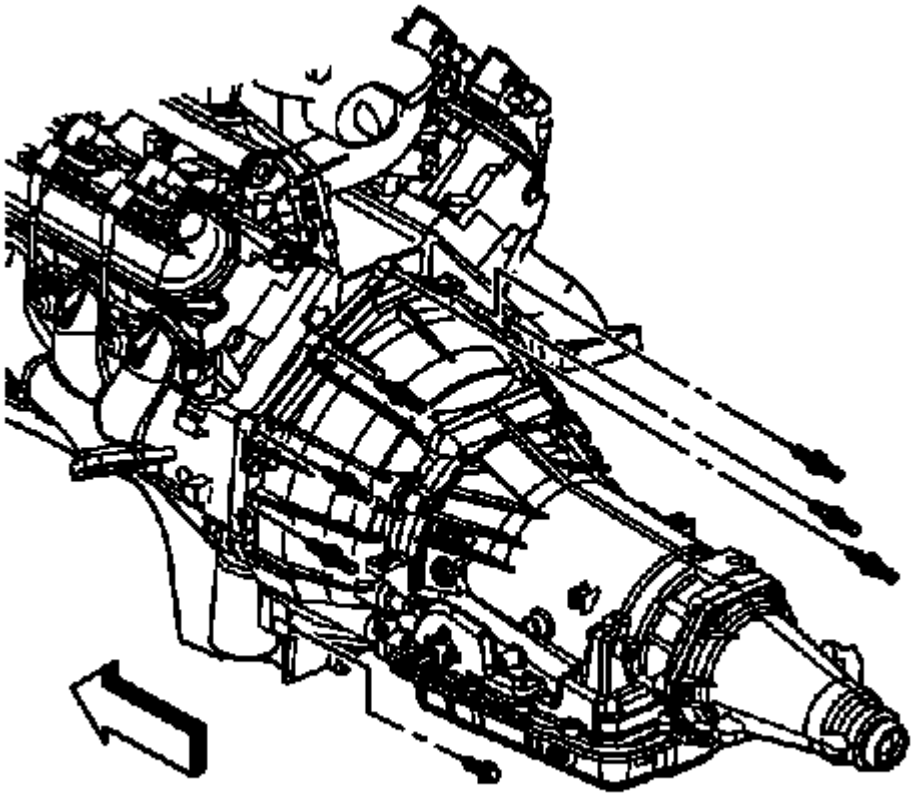

Fig. 263: Identifying Six Studs & One Bolt Securing Transmission To Engine
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 21366** from the transmission.
16. Install the automatic transmission bolt/studs, if equipped.

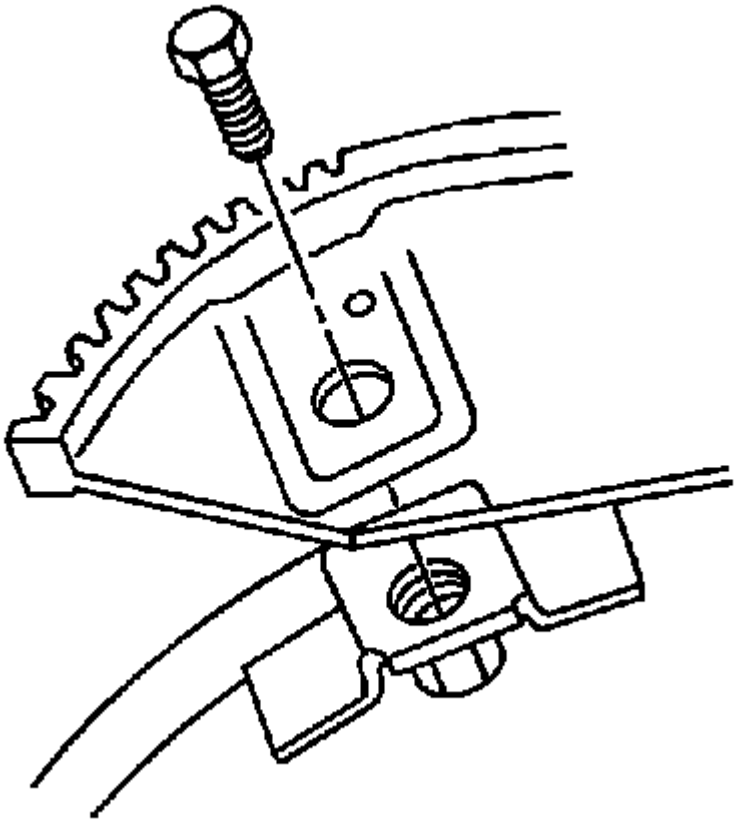

Fig. 264: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the torque converter bolts, if equipped.
    - If equipped with the 4L60-E, tighten the torque converter bolts to 63 N.m (46 lb ft).
    - If equipped with the 4L80-E, tighten the torque converter bolts to 60 N.m (44 lb ft).

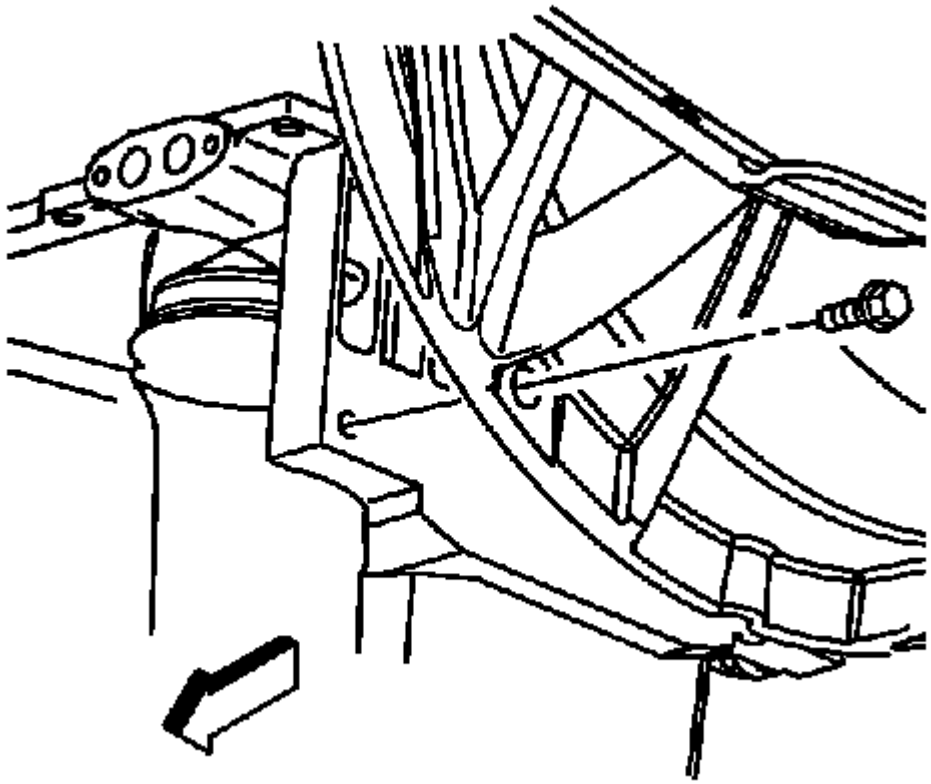

Fig. 265: View Of Transmission Converter Cover Bolt (4L80-E)
Courtesy of GENERAL MOTORS CORP.

18. If equipped with the 4L80-E automatic transmission, install the transmission converter cover bolts and tighten to 33 N.m (24 lb ft).

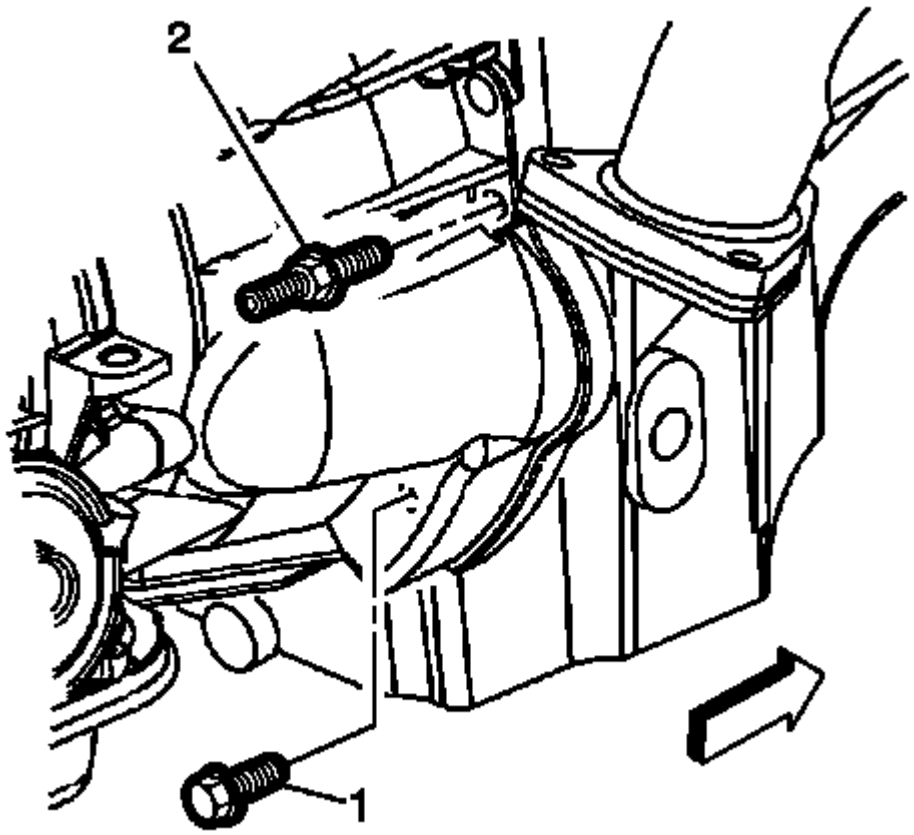

Fig. 266: Identifying Stud & Bolt Securing Transmission To Engine (Right Side)
Courtesy of GENERAL MOTORS CORP.

19. If equipped with the 4L60-E automatic transmission, install the transmission bolt and stud on the right side and tighten to 50 N.m (37 lb ft).

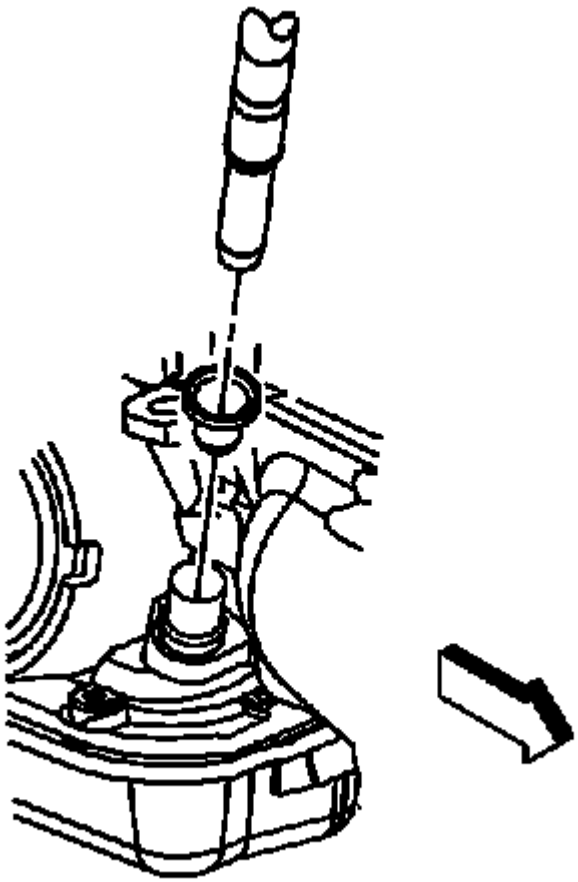

Fig. 267: View Of Oil Level Indicator Tube & Seal
Courtesy of GENERAL MOTORS CORP.

20. Install the automatic transmission oil level indicator tube, if equipped.

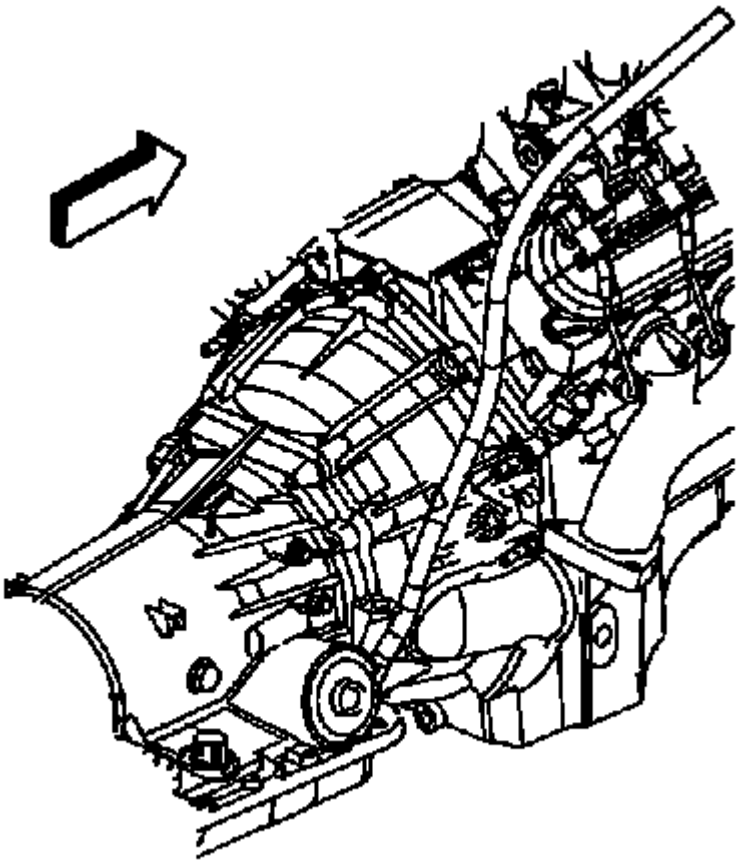

Fig. 268: View Of Oil Level Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

21. Install the automatic transmission oil level indicator tube nut and tighten to 18 N.m (13 lb ft), if equipped.

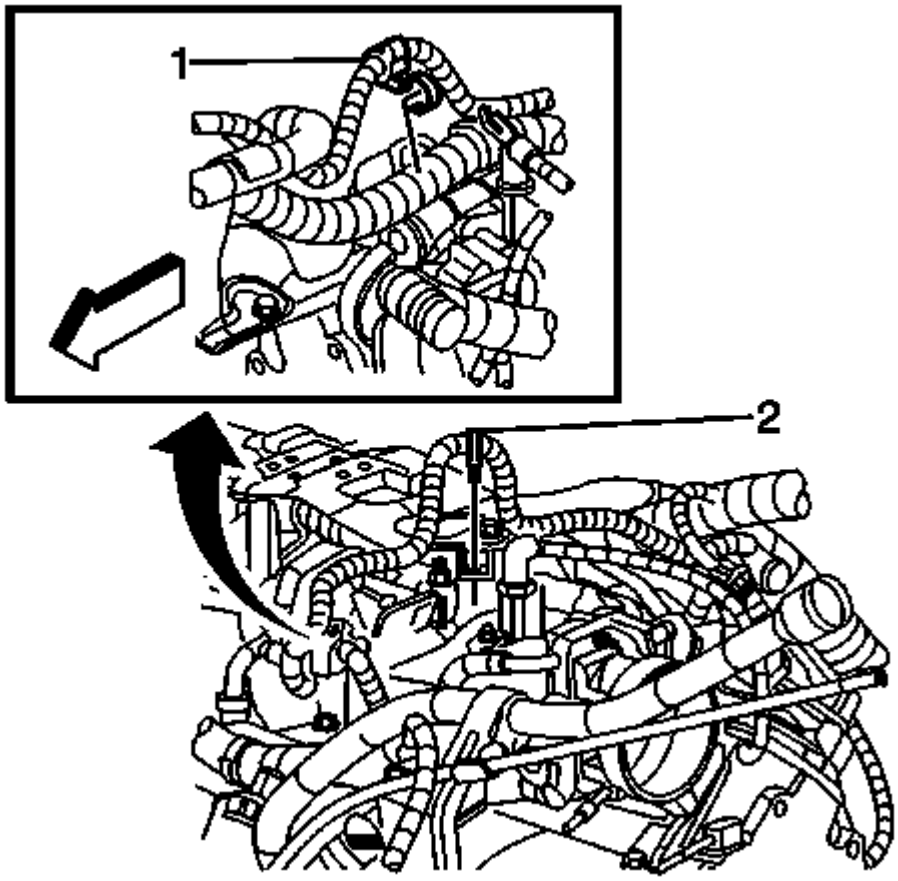

Fig. 269: View Of battery positive cable
Courtesy of GENERAL MOTORS CORP.

22. Install the positive battery cable clip (1).
23. Install the catalytic converter. Refer to **Catalytic Converter Replacement (V8)** .
24. Connect the following electrical connectors:
    - Crankshaft position sensor
    - Engine oil level sensor
    - Coolant heater, if equipped
25. Install the starter motor. Refer to **Starter Replacement (V8)** .
26. Lower the vehicle.
27. Position the generator bracket assembly to the front of the engine.
28. Install the generator bracket assembly. Refer to **Generator Bracket Replacement (V8)** .
29. Install the heater hoses to the water pump.

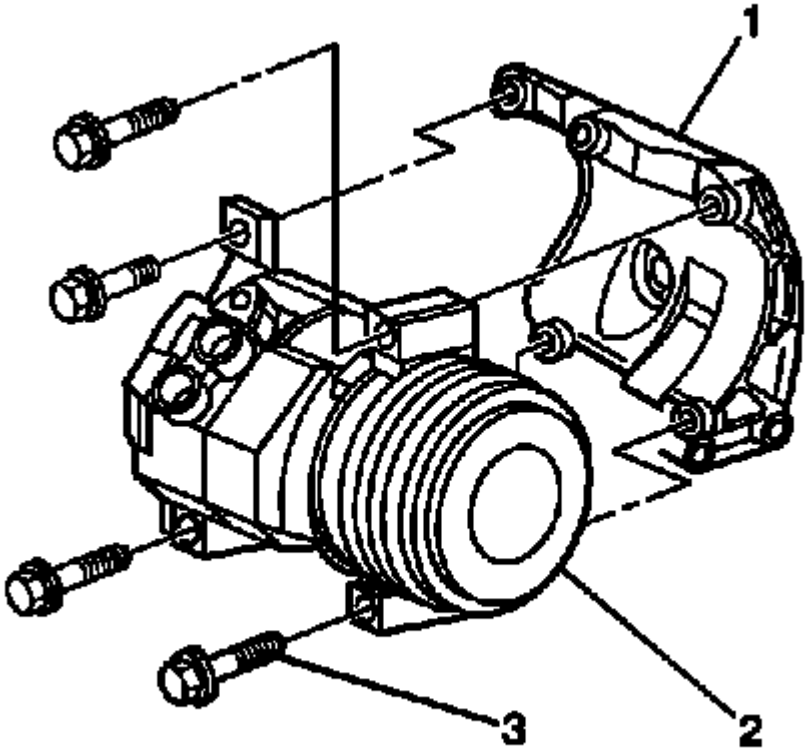

Fig. 270: View of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

30. Install the air conditioning compressor (2) to the engine. Tighten the compressor mounting bolts to 68 N.m (50 lb ft).
31. Install the air conditioning discharge hose to the compressor. Tighten the bolt to 35 N.m (26 lb ft).
32. Install the engine ground strap to the frame. Tighten the bolt to 25 N.m (18 lb ft).
33. Install the ground strap and negative battery cable to the engine. Tighten the nut to 25 N.m (18 lb ft).
34. Install the clutch fan. Refer to **Fan Clutch Replacement** .

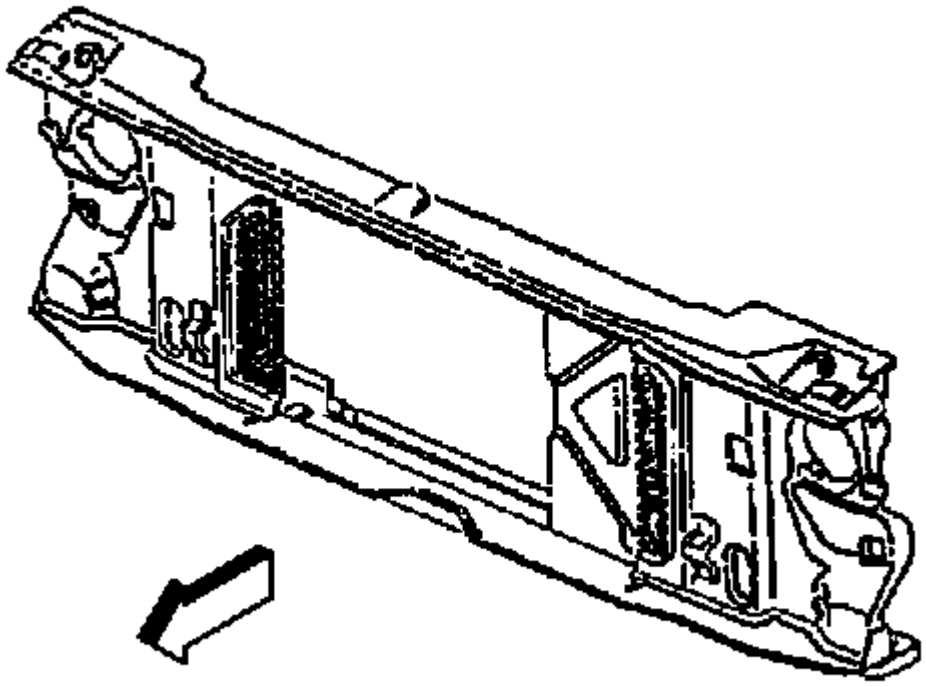

Fig. 271: View Of Core Support Assembly
Courtesy of GENERAL MOTORS CORP.

35. With the aid of an assistant, position the core support assembly to the vehicle.
36. Install the core support bolts.
    - Tighten the core support bolts to 25 N.m (18 lb ft).
    - Tighten the core support nuts to 57 N.m (42 lb ft).
37. Install the positive battery cable to the underhood fuse panel. Tighten the bolt to 12 N.m (106 lb in).
38. Install the G106 to the inner fender. Refer to **Ground Distribution Schematics** . Tighten the bolt to 10 N.m (89 lb in).
39. Connect the C4 to the underhood fuse panel. Refer to **Power Distribution Schematics** .

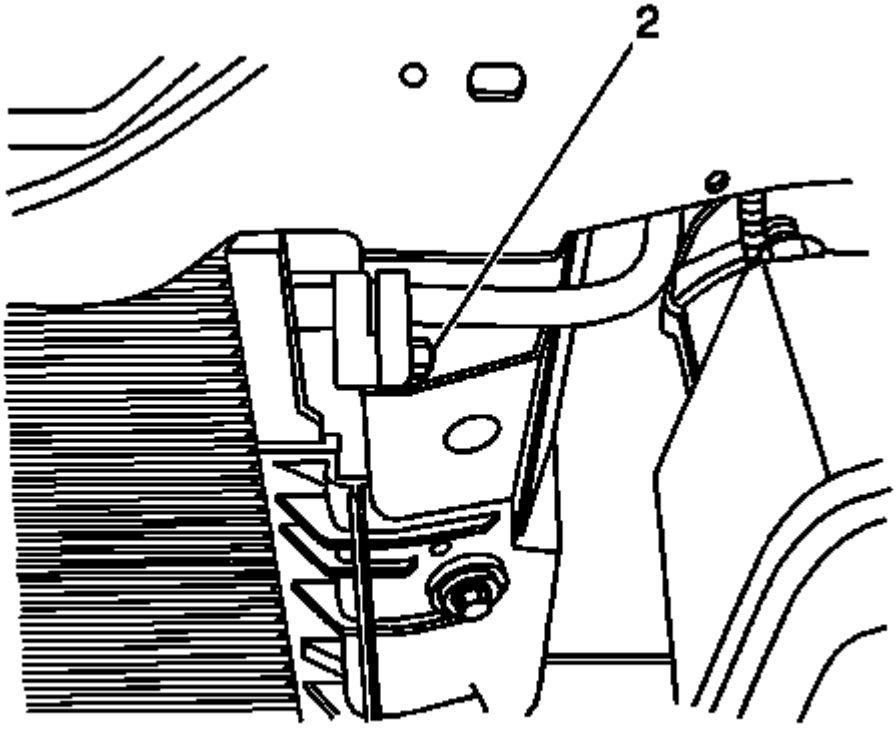

Fig. 272: Identifying Condenser Air Conditioning Lines
Courtesy of GENERAL MOTORS CORP.

40. Install the air conditioning lines (2) to the condenser. Tighten the remaining nuts to 16 N.m (12 lb ft).

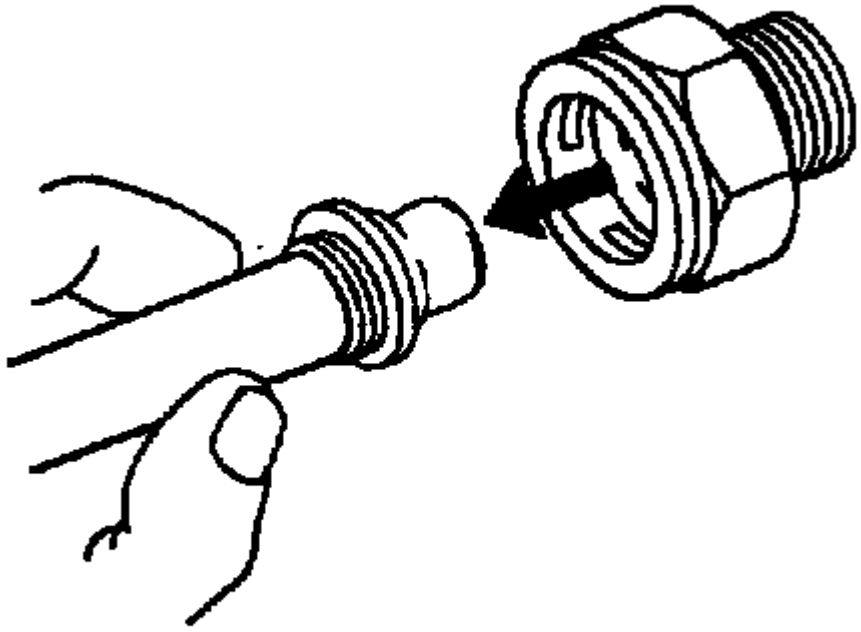

Fig. 273: View Of Cooler Line & Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

41. Install the transmission cooler lines to the radiator.
42. Install the oil cooler lines to the radiator, if equipped.
43. Install the radiator hoses to the thermostat housing and water pump.

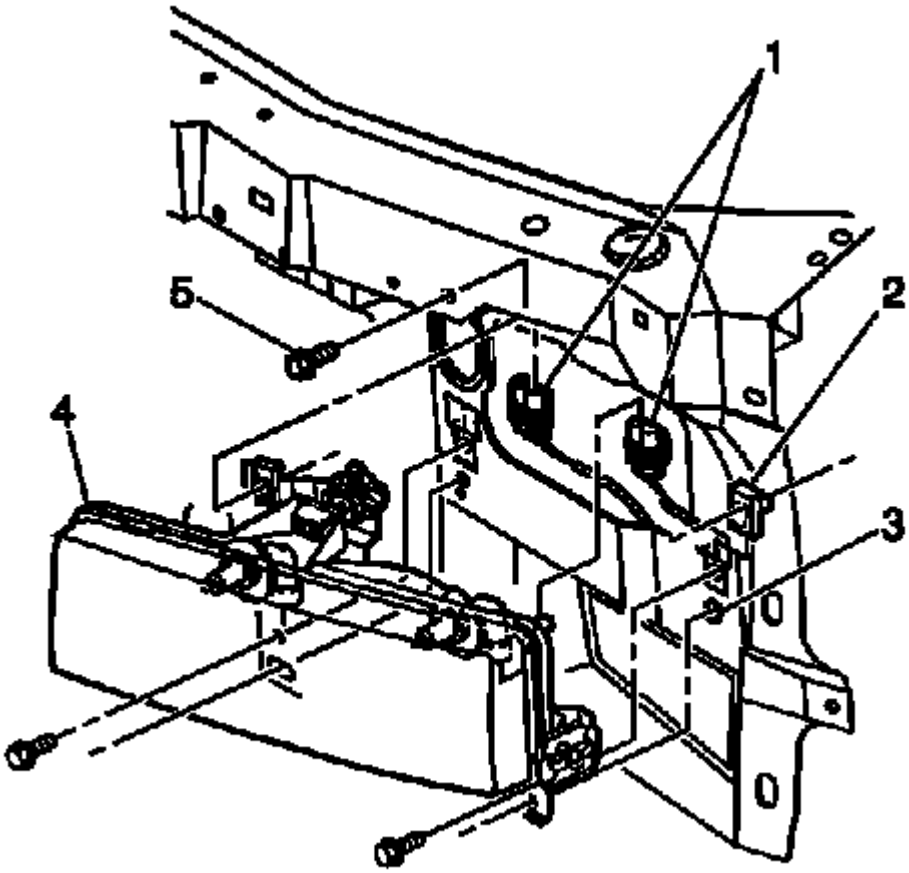

Fig. 274: Identifying Headlamp Capsule
Courtesy of GENERAL MOTORS CORP.

44. Install the headlamp capsules (4). Refer to **Headlamp Capsule Replacement (Minus V22)** .

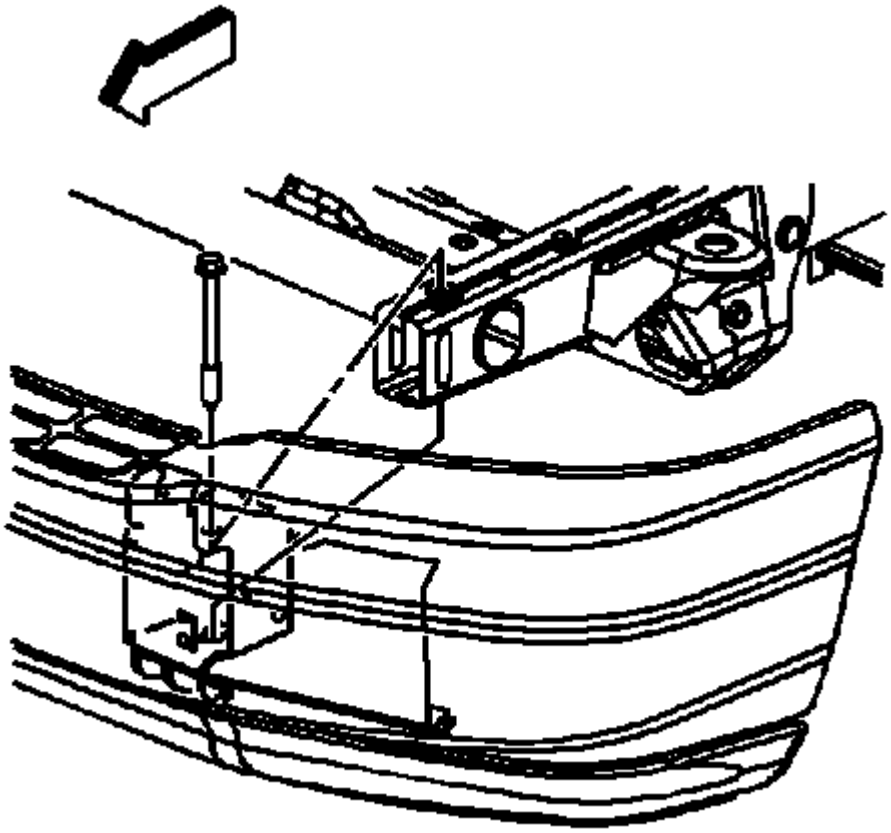

Fig. 275: View Of Bumper, Frame & Bolts
Courtesy of GENERAL MOTORS CORP.

45. Install the front bumper. Refer to **Front Bumper Replacement** .
46. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
47. Install the coolant reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
48. Install the sheet metal to the fender supports. Tighten the bolts to 25 N.m (18 lb ft).
49. Fill the cooling system with coolant. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac N Fill)** .
50. Fill the crankcase with the proper quantity and grade of engine oil. Refer to **Approximate Fluid Capacities** or **Fluid and Lubricant Recommendations (USA and Canada)** .
51. Perform the CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

NOTE: After an overhaul, the engine should be tested. Use the following procedure after the engine is installed in the vehicle.

1. Disable the ignition system.
2. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.

3. Enable the ignition system.
4. Start the engine and listen for unusual noises.
5. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
6. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
7. Listen for sticking lifter and other unusual noises.
8. Inspect for fuel, oil and/or coolant leaks while the engine is running.
9. Perform a final inspection for the proper engine oil and coolant levels.

52. Close the hood.

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

NOTE: In order to completely drain the oil from the oil pan internal baffling, the bottom of the oil pan must be level during the oil drain procedure.

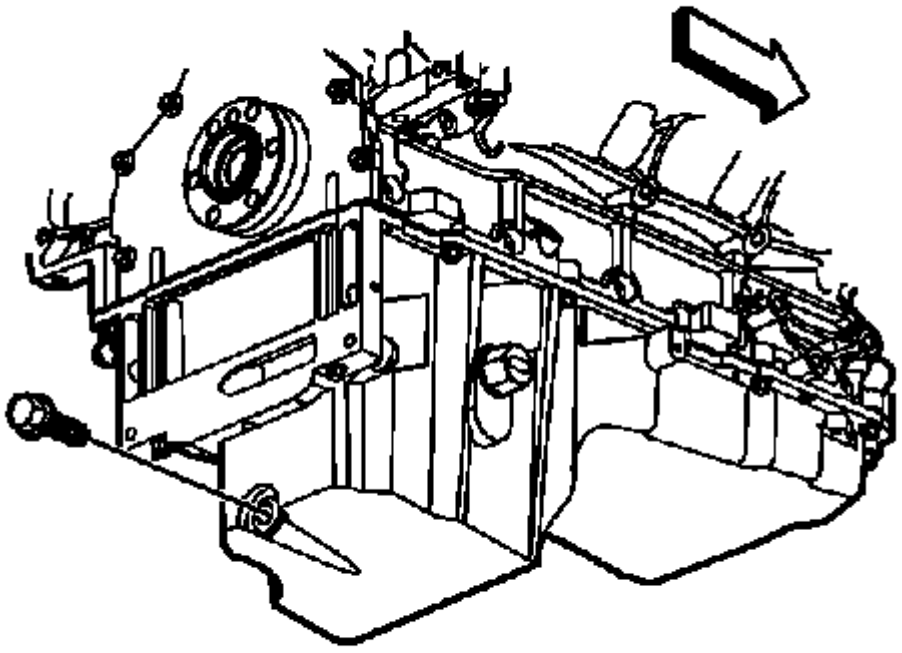

Fig. 276: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Remove the oil fill cap.
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a oil drain pan under the oil pan drain plug.
5. Remove the oil pan drain plug.
6. Drain the engine oil.
7. Wipe the excess oil from the drain plug hole and plug.

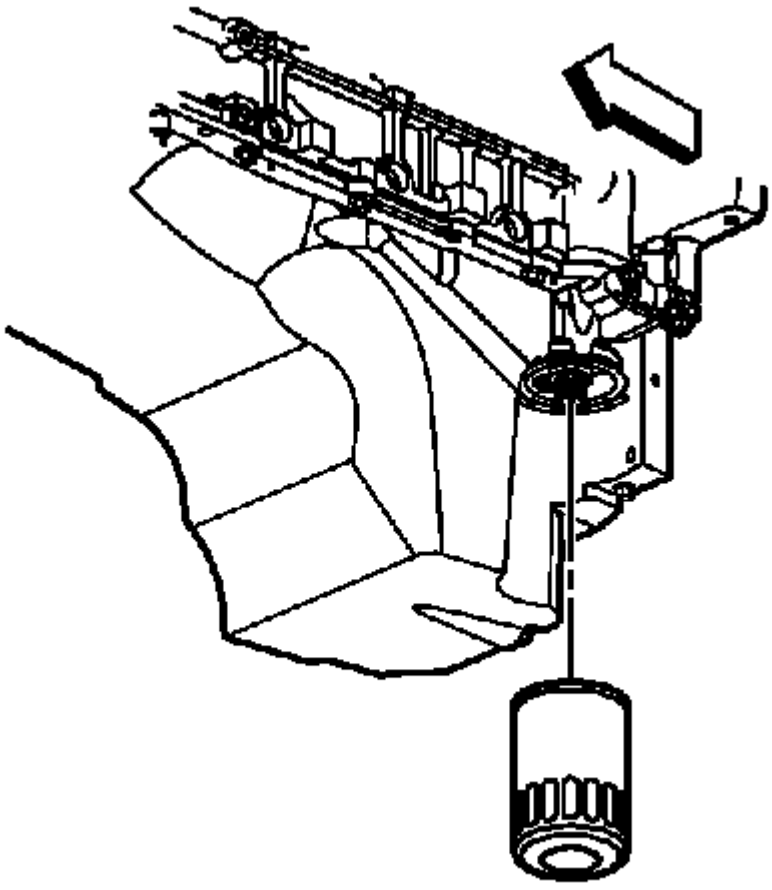

Fig. 277: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Check the old oil filter to ensure that the filter seal is not left on the engine block.

8. Remove the oil filter from the engine block.
9. Wipe the excess oil from the oil filter mounting.

INSTALLATION PROCEDURE

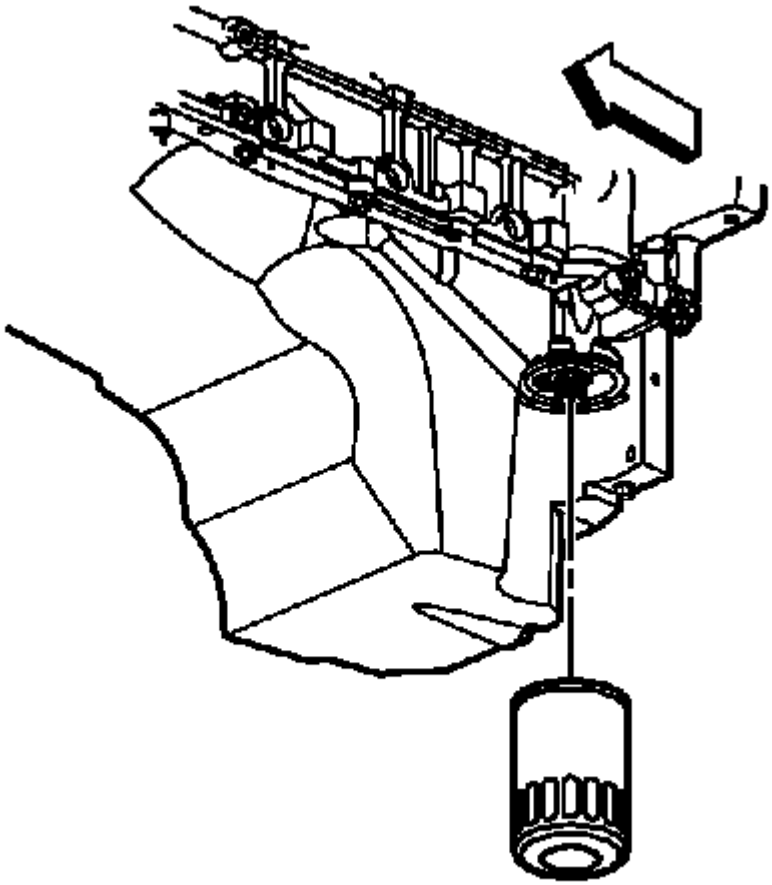

Fig. 278: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Lubricate the oil filter seal with clean engine oil.
2. Install the oil filter to the engine block and tighten to 30 N.m (22 lb ft).

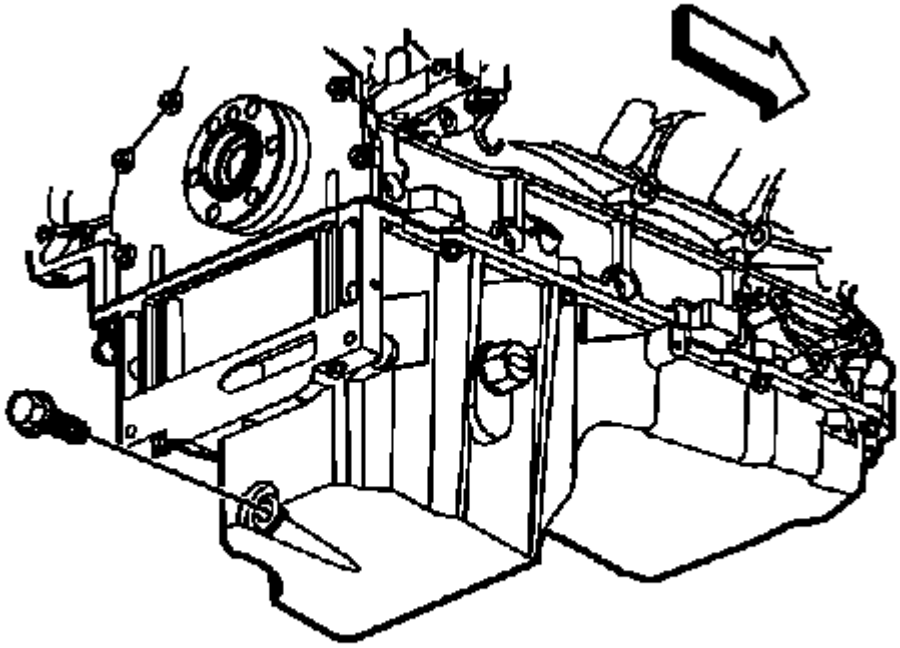

Fig. 279: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the oil drain plug to the engine block and tighten to 25 N.m (18 lb ft).
4. Lower the vehicle.
5. Fill the crankcase with the proper quantity and grade of engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations (USA and Canada)** .
6. Remove the oil level indicator.
7. Wipe the indicator with a clean cloth.
8. Install the oil level indicator.
9. Remove the oil level indicator in order to check the level.
10. Add oil if necessary.
11. Close the hood.

