

2010 ENGINE

Engine Mechanical - 2.4L - Repair Instructions - On Vehicle - Solstice & Sky

INTAKE MANIFOLD COVER REPLACEMENT

REMOVAL PROCEDURE

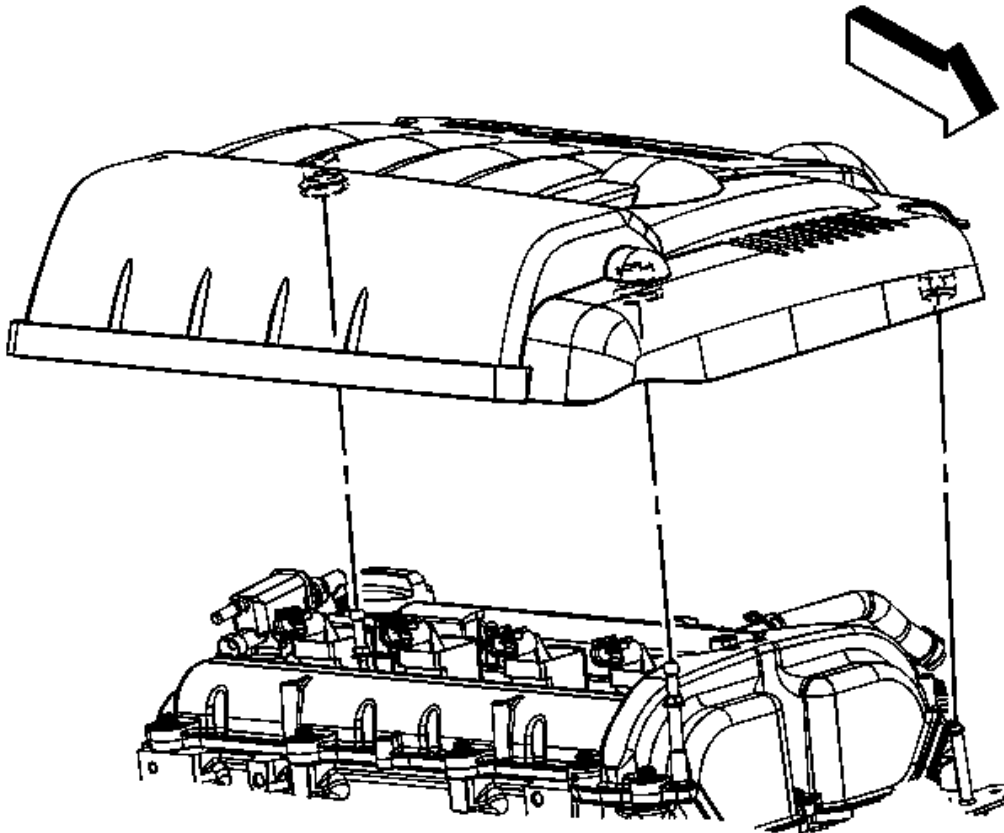


Fig. 1: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

1. Grasp the intake manifold cover by the front right corner and pull up in order to disengage the cover from the stud.
2. Grasp the intake manifold cover by the front left corner and pull up in order to disengage the cover from the stud.
3. Grasp the intake manifold cover by the rear and pull up in order to disengage the cover from the stud.

4. Remove the intake manifold cover.

INSTALLATION PROCEDURE

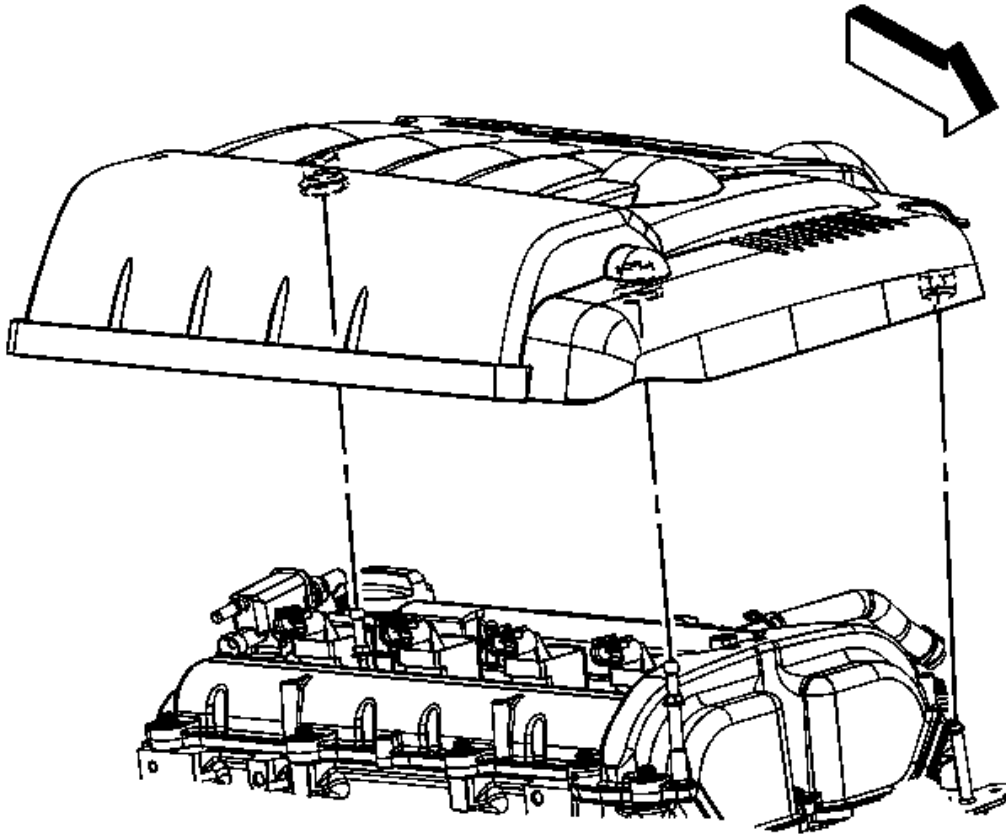


Fig. 2: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

1. Place the intake manifold cover onto the engine over the studs.
2. Push down on the intake manifold cover directly over the rear stud in order to engage the cover to the stud.
3. Push down on the intake manifold cover directly over the front right stud in order to engage the cover to the stud.
4. Push down on the intake manifold cover directly over the front left stud in order to engage the cover to the stud.

DRIVE BELT REPLACEMENT (WITH A/C)

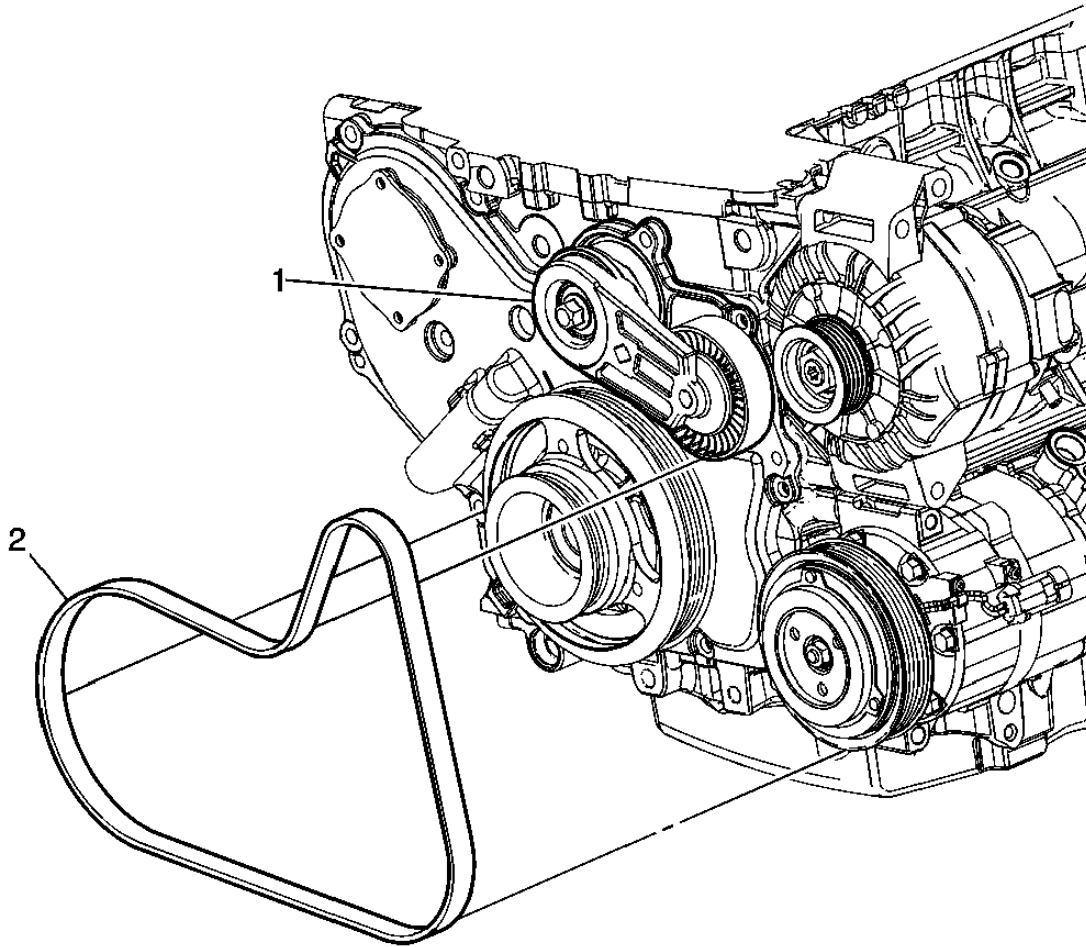


Fig. 3: Identifying Drive Belt (With A/C)
 Courtesy of GENERAL MOTORS CORP.

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

DRIVE BELT REPLACEMENT (WITHOUT A/C)

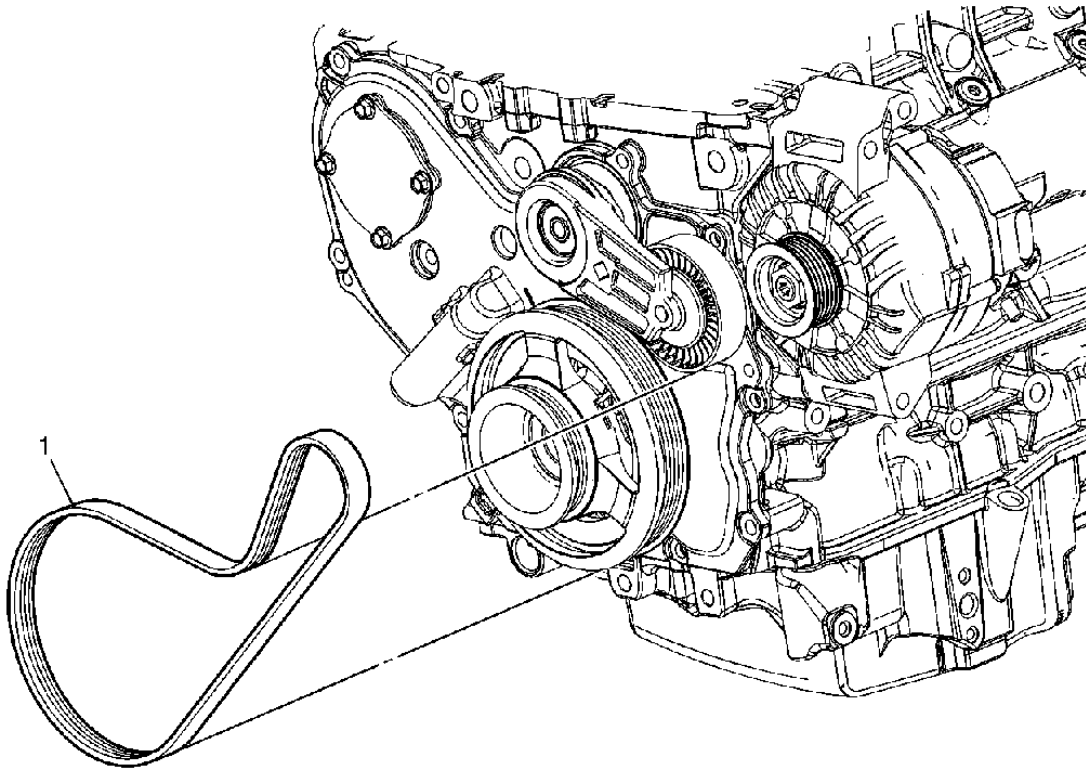


Fig. 4: Identifying Drive Belt (Without A/C)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Fastener Tightening Specifications: Refer to <u>Fastener Tightening Specifications</u> .	
Preliminary Procedures	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Remove the power steering pump drive belt. Refer to <u>Power Steering Pump Belt Replacement</u> . 3. Lower the vehicle. 4. Remove the air cleaner. Refer to <u>Air Cleaner Assembly Replacement</u> .	
1	Belt, Accessory Drive

DRIVE BELT TENSIONER REPLACEMENT

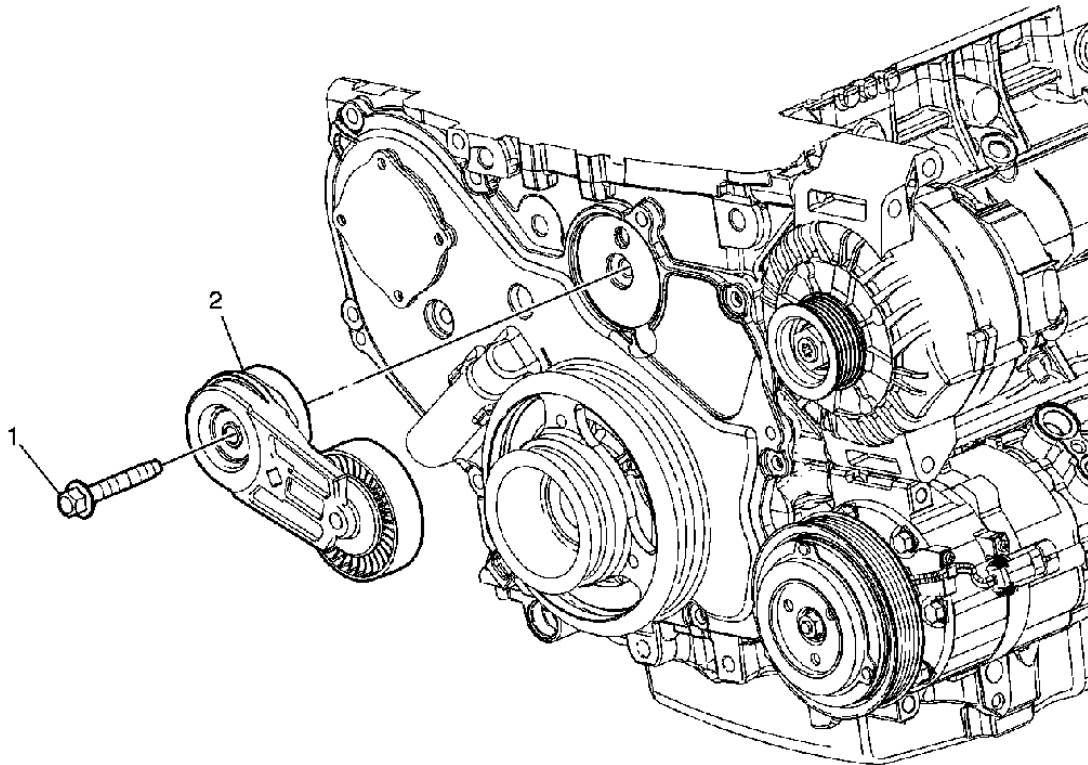


Fig. 5: Identifying Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove the drive belt. Refer to <u>Drive Belt Replacement (With A/C)</u> or <u>Drive Belt Replacement (Without A/C)</u> .	
1	Drive Belt Tensioner Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 45 N.m (33 lb ft)
2	Drive Belt Tensioner

ENGINE OIL PRESSURE SENSOR REPLACEMENT

REMOVAL PROCEDURE

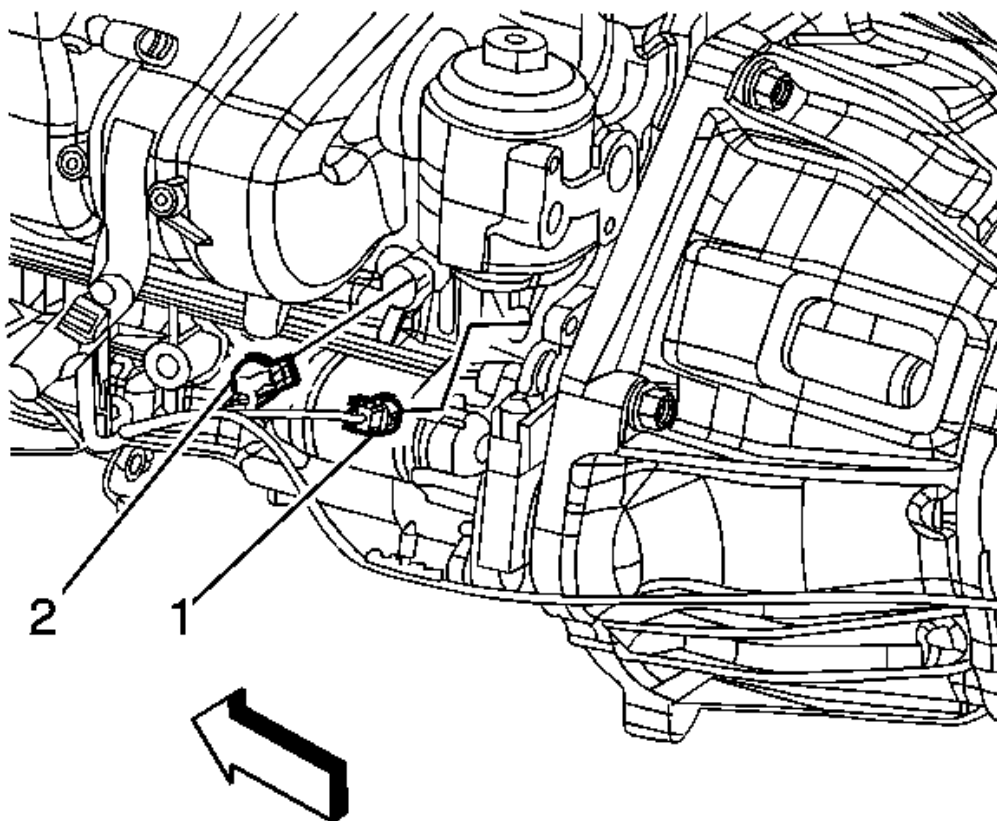


Fig. 6: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

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

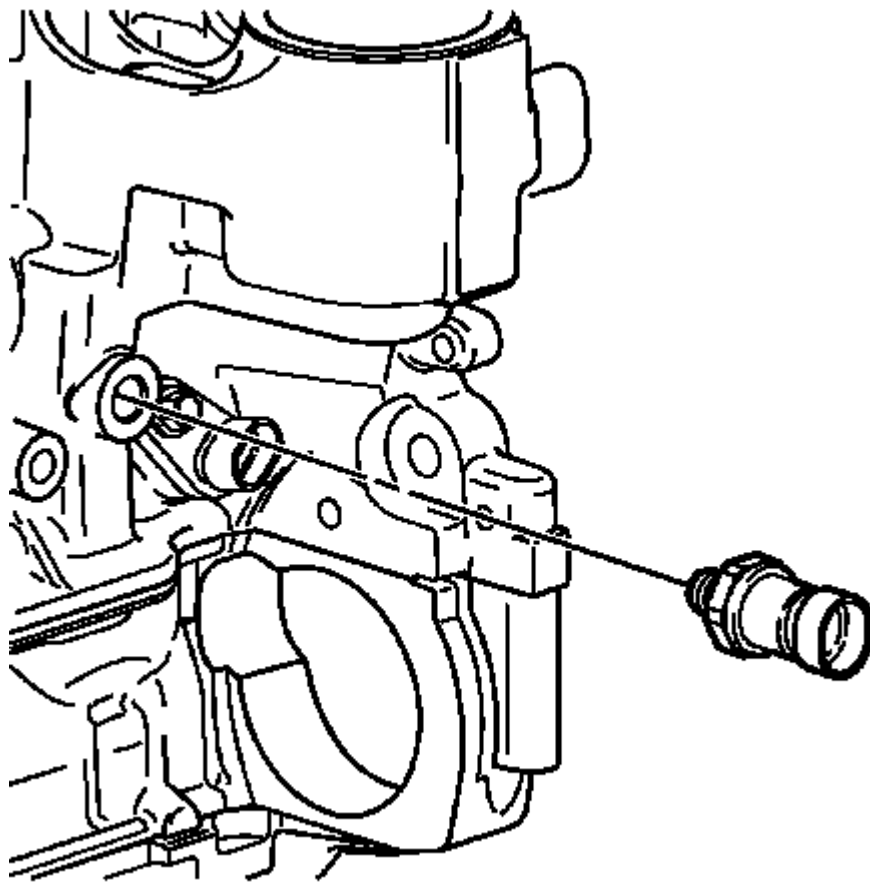


Fig. 7: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil pressure sensor.

INSTALLATION PROCEDURE

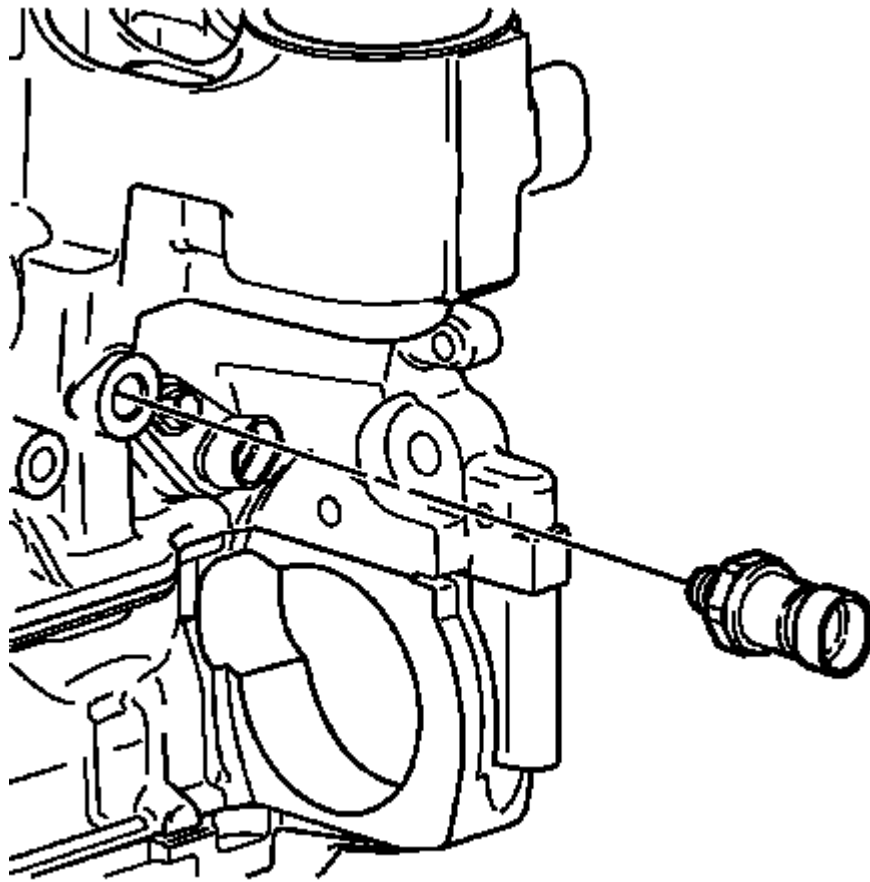


Fig. 8: View Of Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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

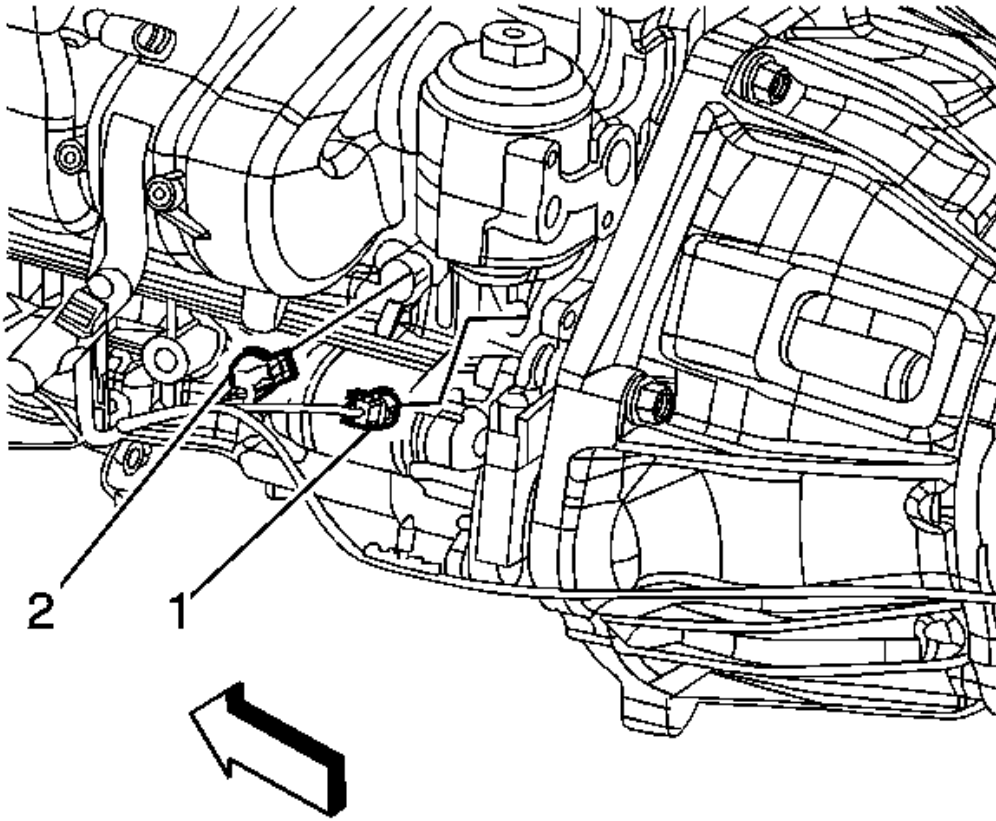


Fig. 9: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

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

ENGINE MOUNT INSPECTION

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

1. Install a engine hoist and raise the engine slightly.
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.

- The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount is leaking fluid.
4. For engine mount replacement, refer to Engine Mount Replacement - Left Side and/or Engine Mount Replacement - Right Side.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

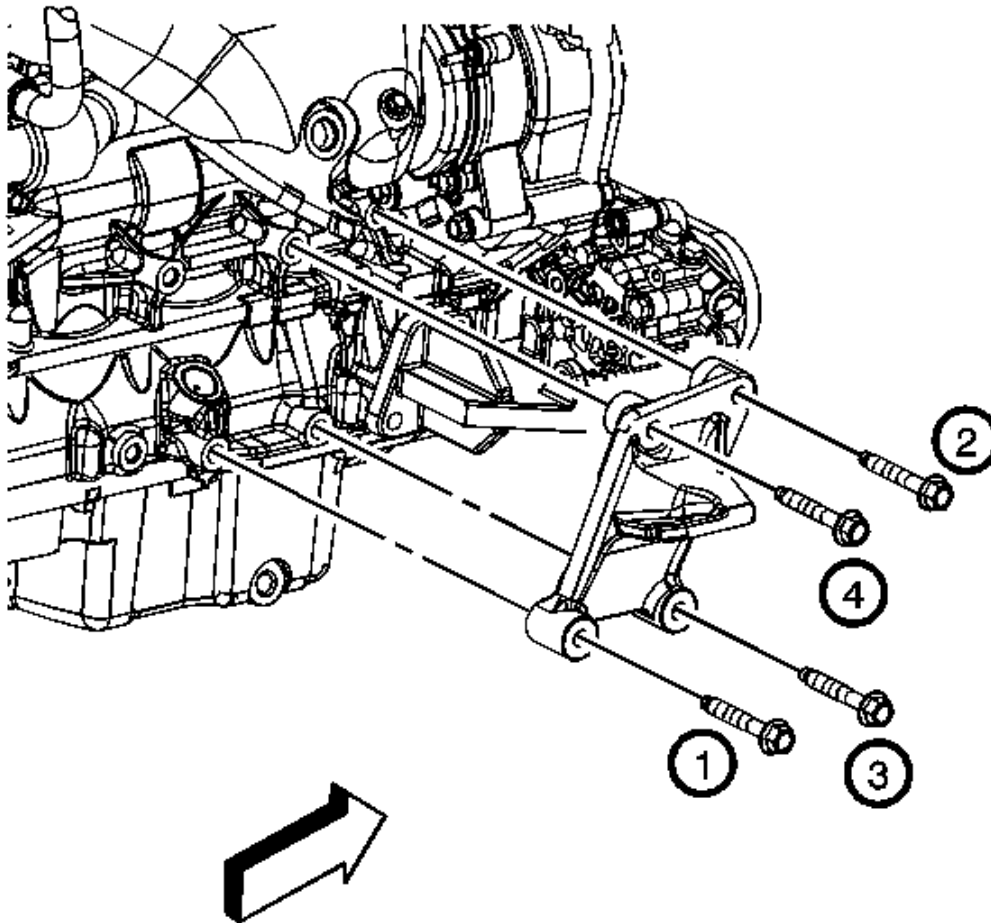


Fig. 10: View Of Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

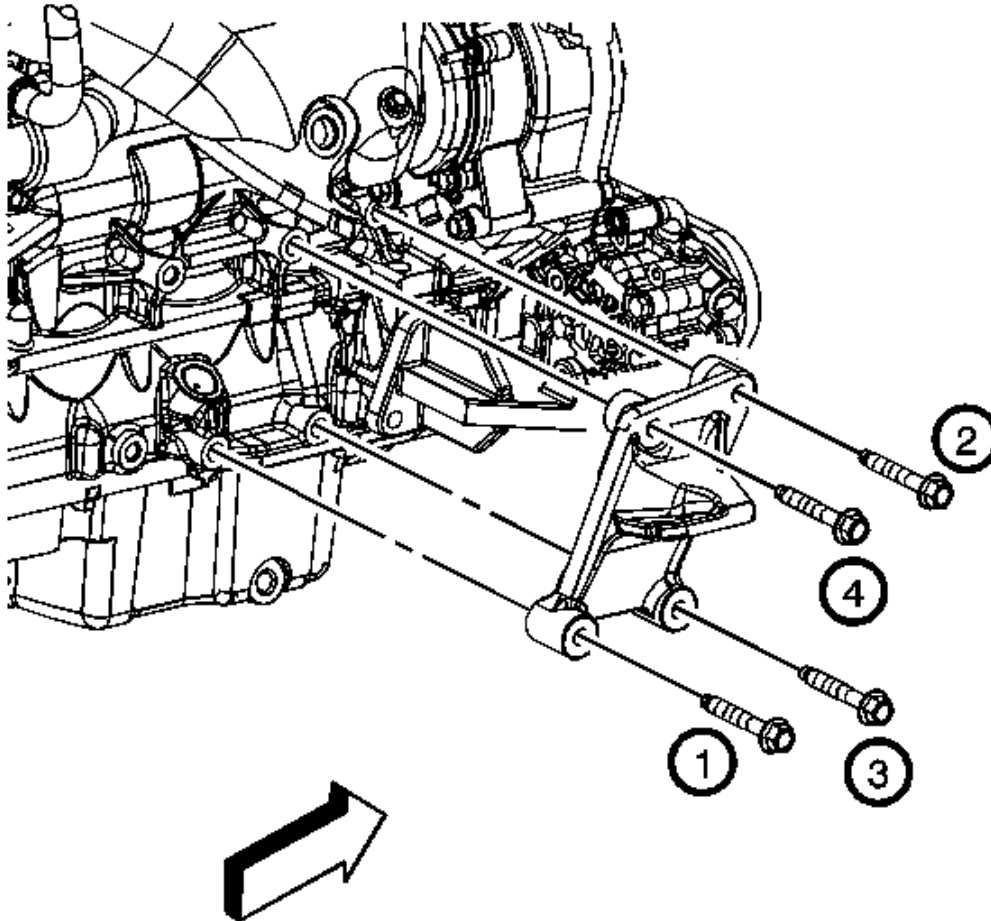


Fig. 11: Identifying Engine Mount Bracket & Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

3. Tighten the right engine mount bracket bolts.

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

4. Install the right engine mount. Refer to Engine Mount Replacement - Right Side.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

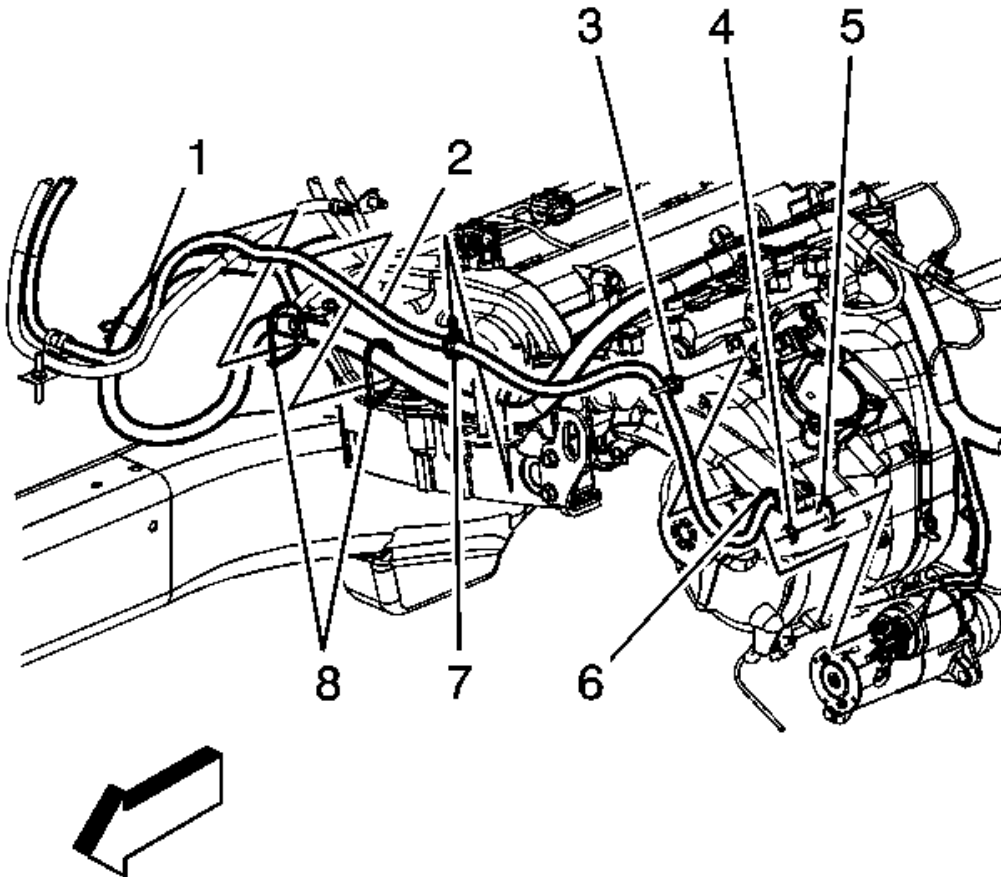


Fig. 12: Identifying Engine Harness Tie Straps & Cable Clips
Courtesy of GENERAL MOTORS CORP.

1. Remove the left engine mount. Refer to Engine Mount Replacement - Left Side.
2. Remove the tire and wheel. Refer to Tire and Wheel Removal and Installation.

3. Remove the starter solenoid positive battery cable nut (4) from the starter.
4. Remove the positive battery cable terminal (5) from the starter.

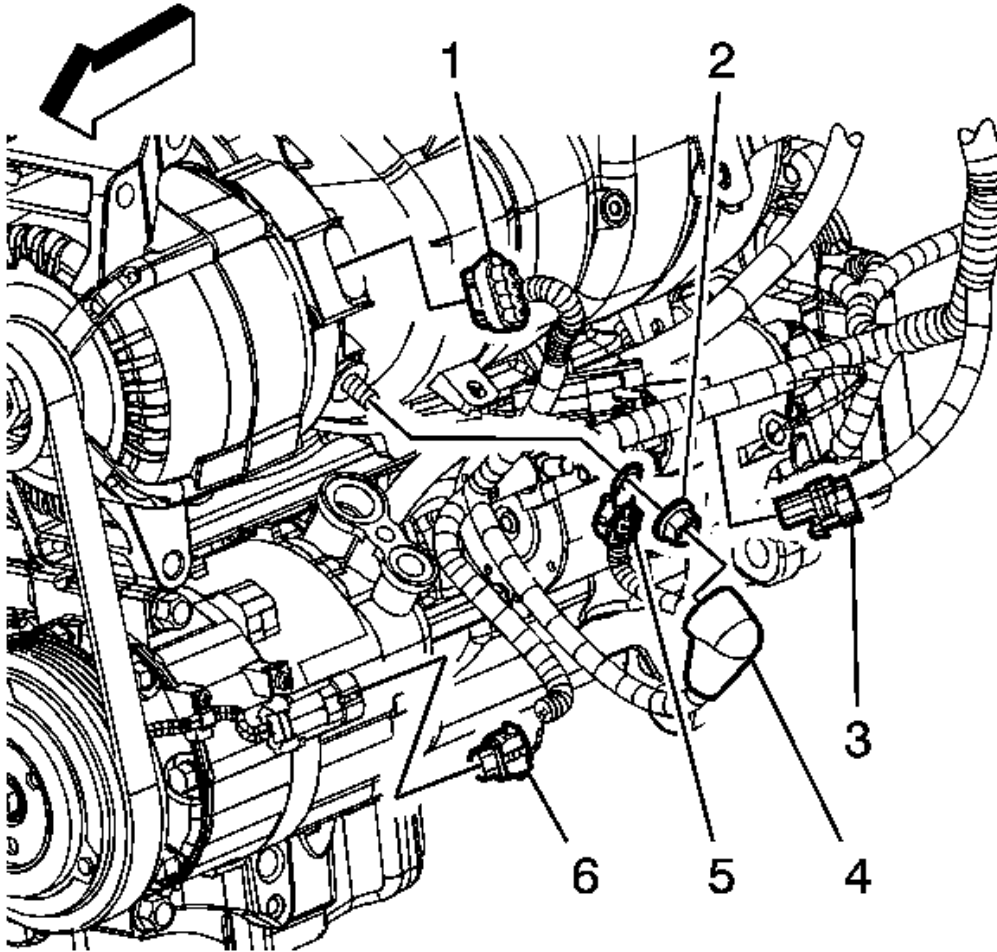


Fig. 13: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Reposition the positive battery cable boot (4).
6. Remove the generator positive battery cable nut (2) from the generator.
7. Remove the positive battery cable terminal (5) from the generator.

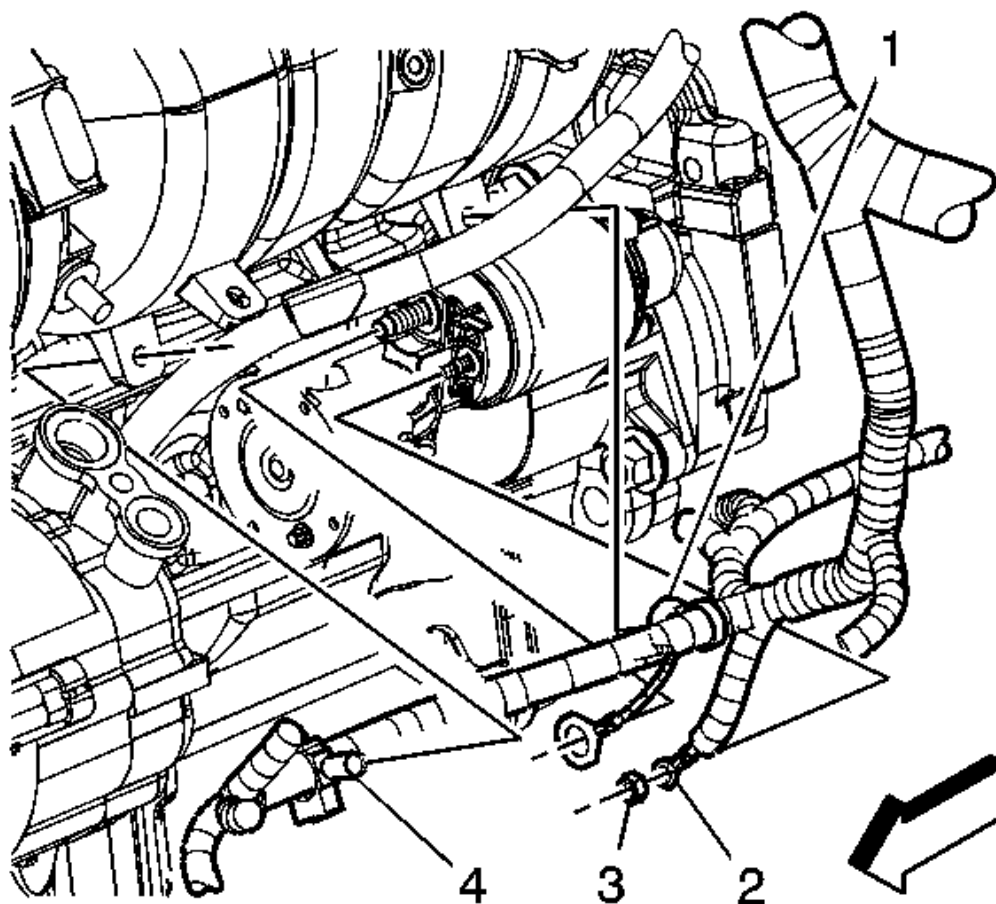


Fig. 14: Identifying Intake Manifold Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine harness clip (4) from the intake manifold.

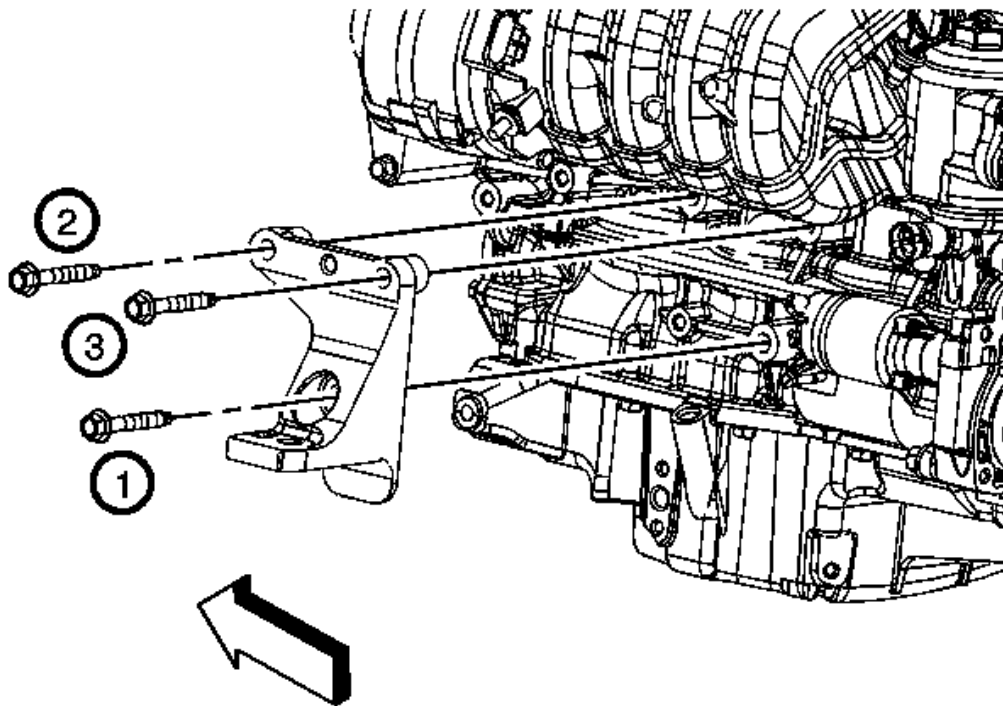


Fig. 15: View Of Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the left side engine mount bracket bolts and bracket.

INSTALLATION PROCEDURE

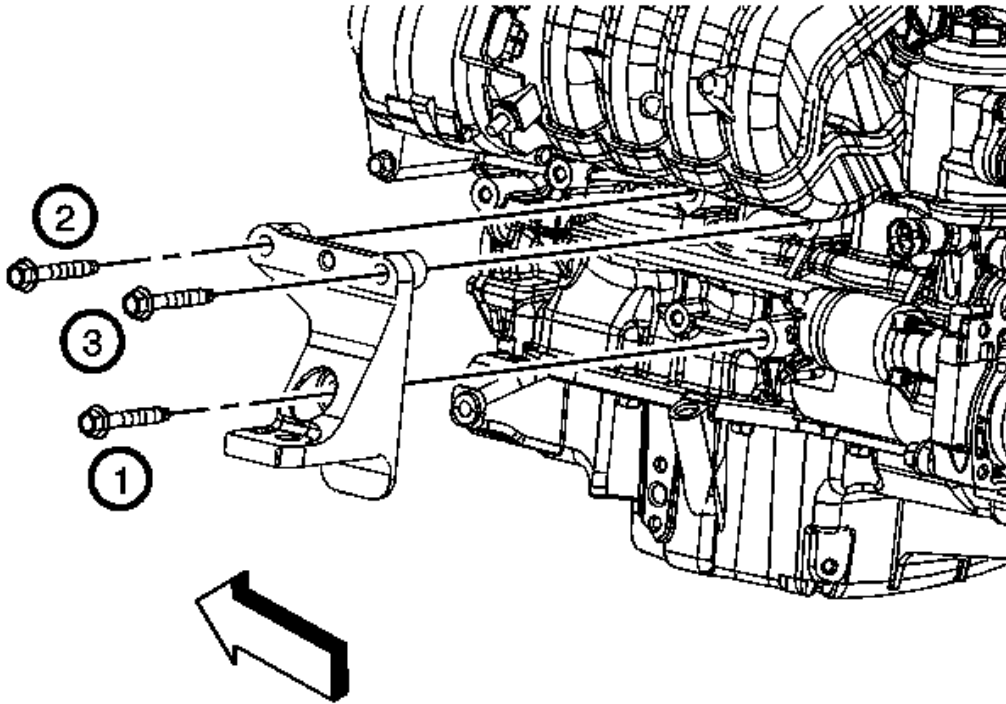


Fig. 16: Identifying Left Engine Mount Bracket & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

3. Tighten the left engine mount bracket bolts.

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

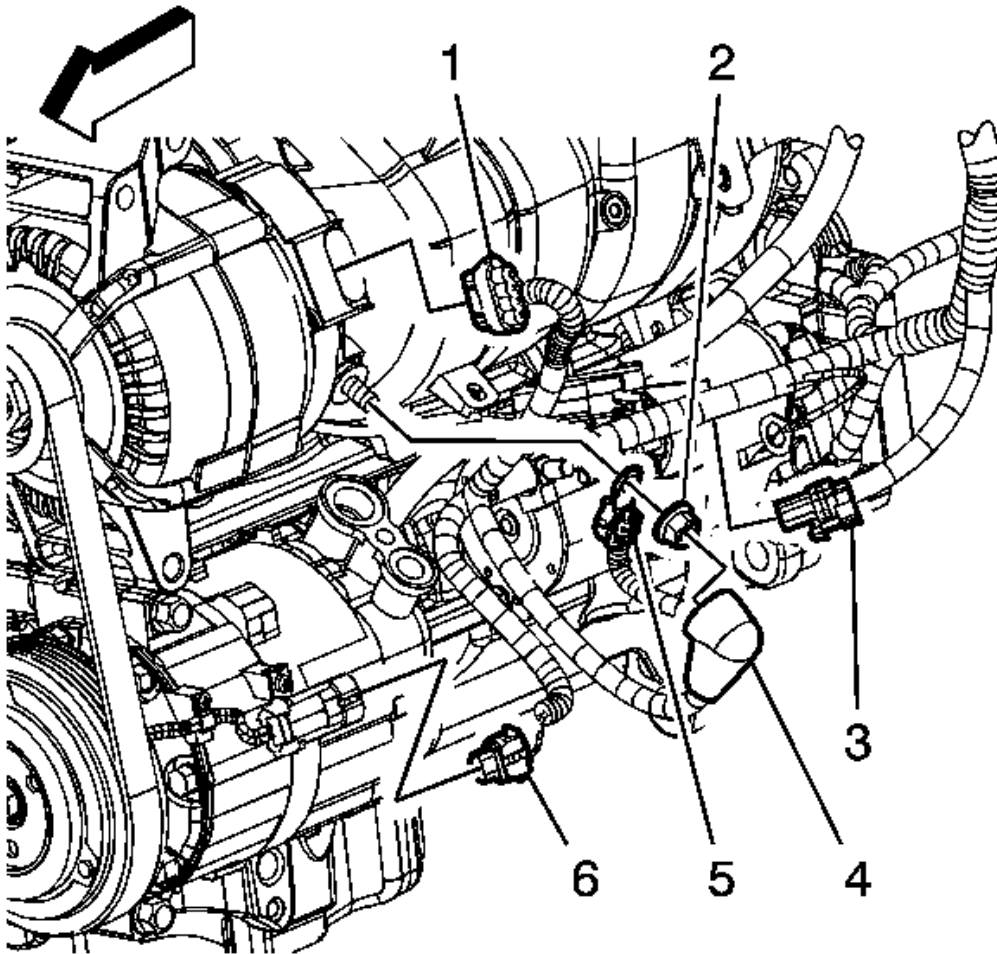


Fig. 17: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Install the positive battery cable terminal (5) to the generator.
5. Install the generator positive battery cable nut (2) to the generator.

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

6. Position the positive battery cable boot (4).

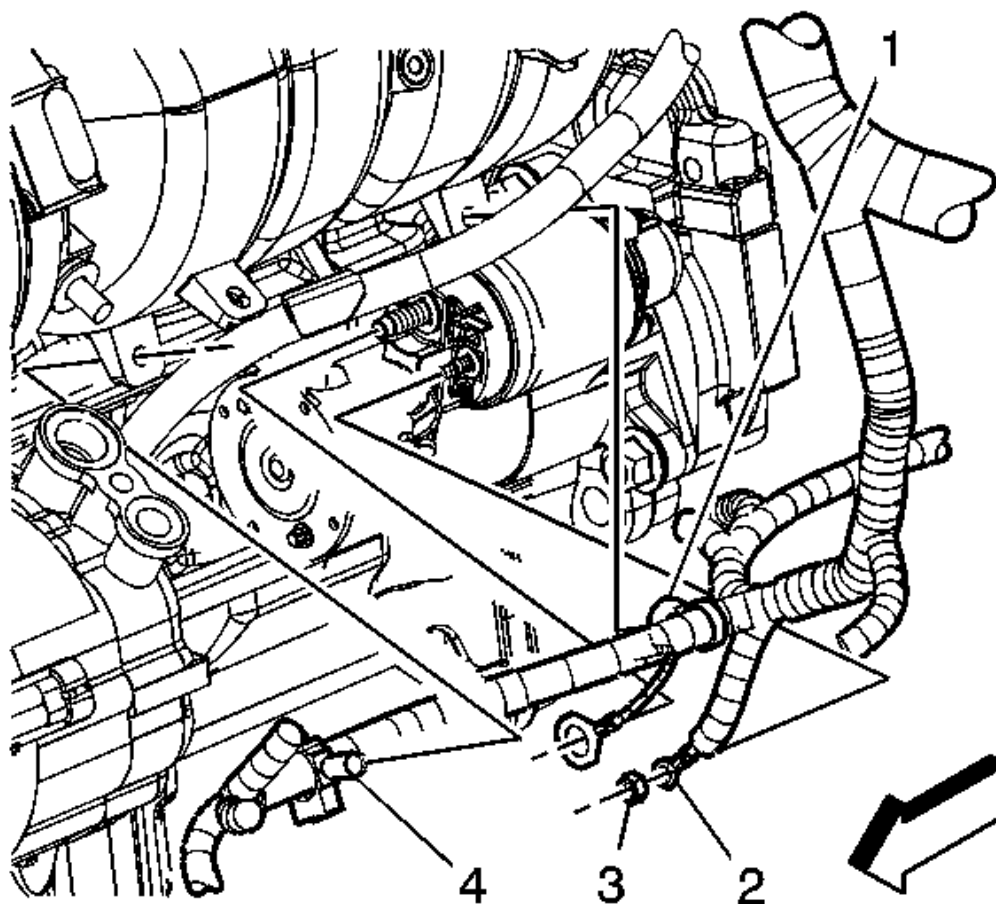


Fig. 18: Identifying Intake Manifold Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

7. Install the engine harness clip (4) to the intake manifold.

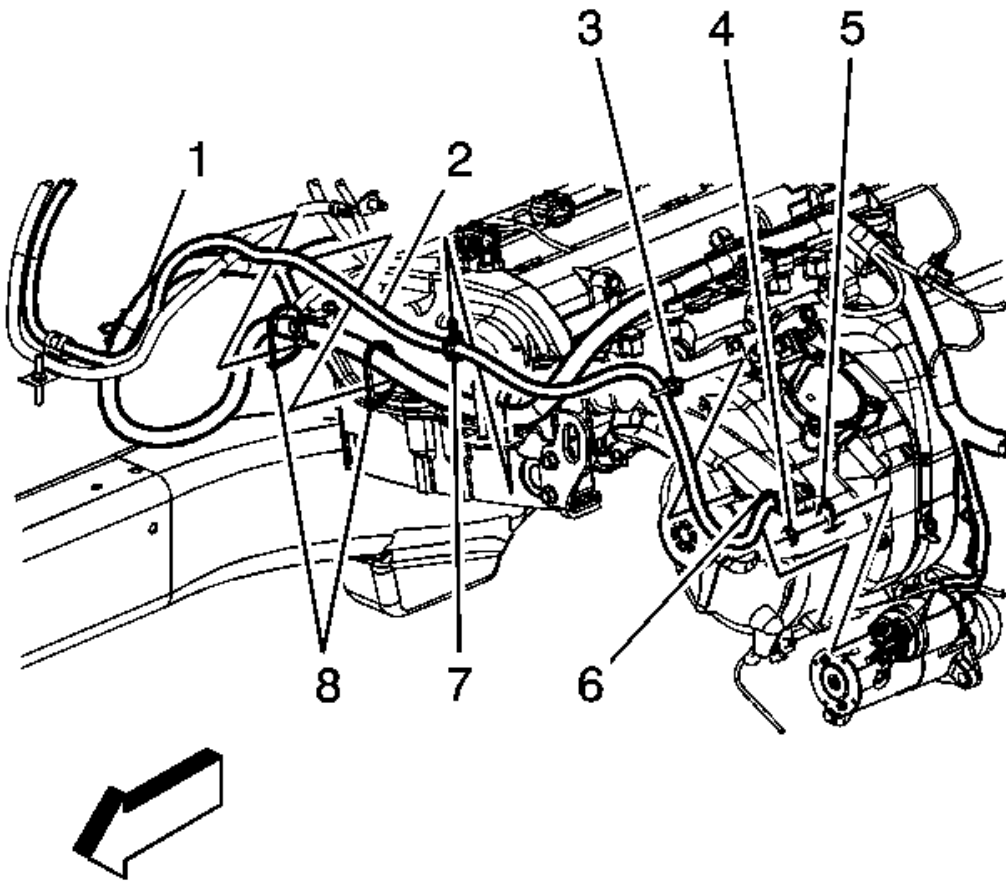


Fig. 19: Identifying Engine Harness Tie Straps & Cable Clips
Courtesy of GENERAL MOTORS CORP.

8. Install the positive battery cable terminal (5) to the starter.
9. Install the starter solenoid positive battery cable nut (4) to the starter.

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

10. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation**.
11. Install the left engine mount. Refer to **Engine Mount Replacement - Left Side**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

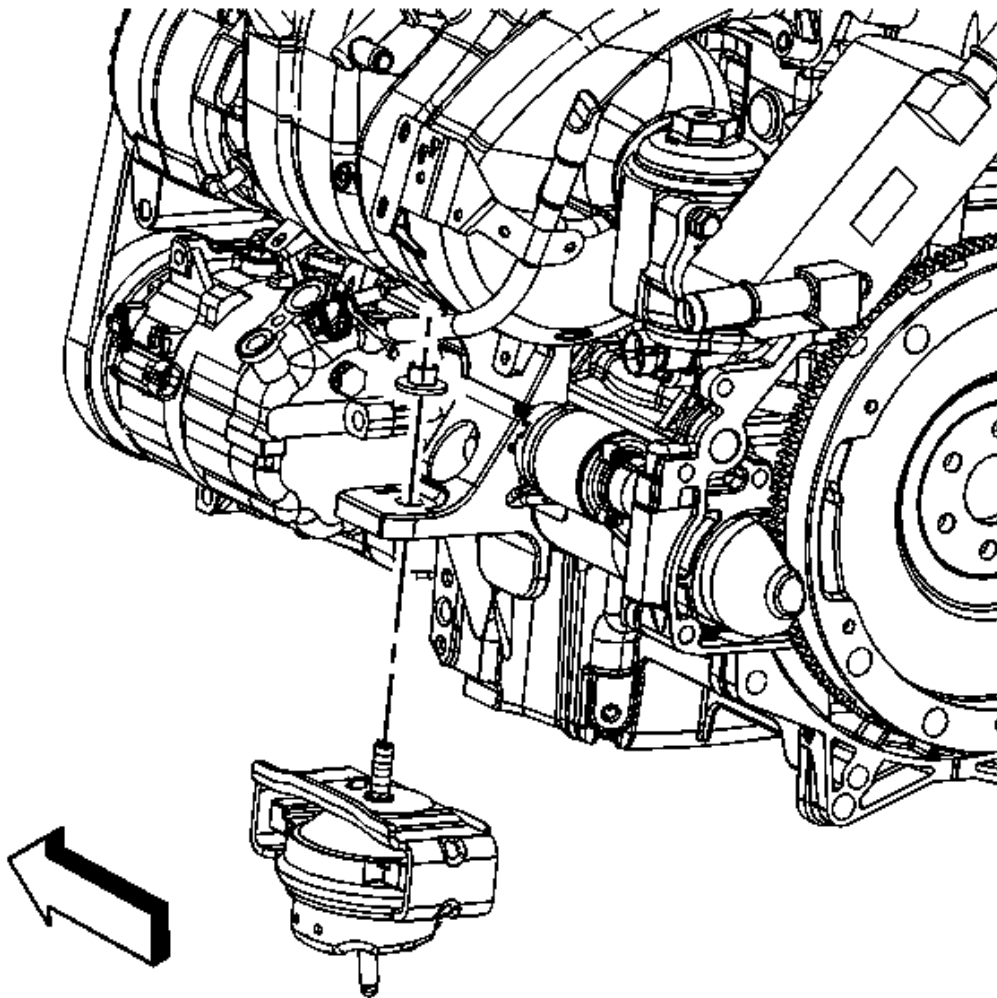


Fig. 20: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet resonator. Refer to [Air Cleaner Outlet Resonator Replacement](#) .
2. Remove the left engine mount upper nut.
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

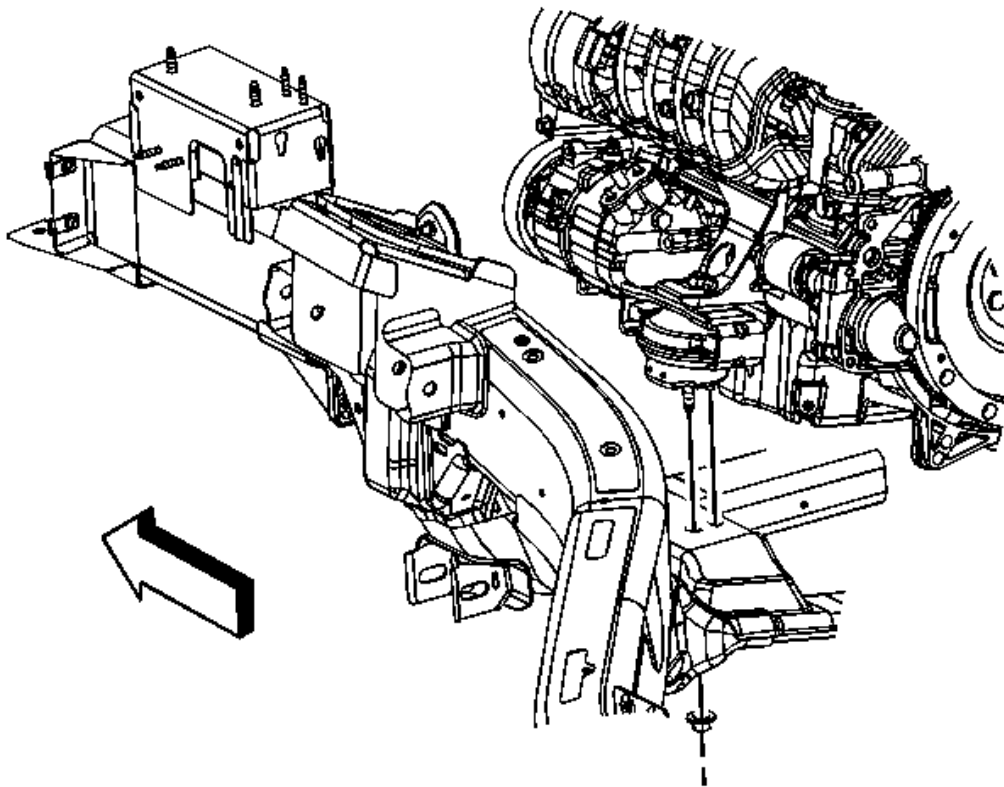


Fig. 21: View Of Left Engine Mount Lower Nut
Courtesy of GENERAL MOTORS CORP.

4. Remove the left engine mount lower nut.
5. Loosen the transmission mount nuts.

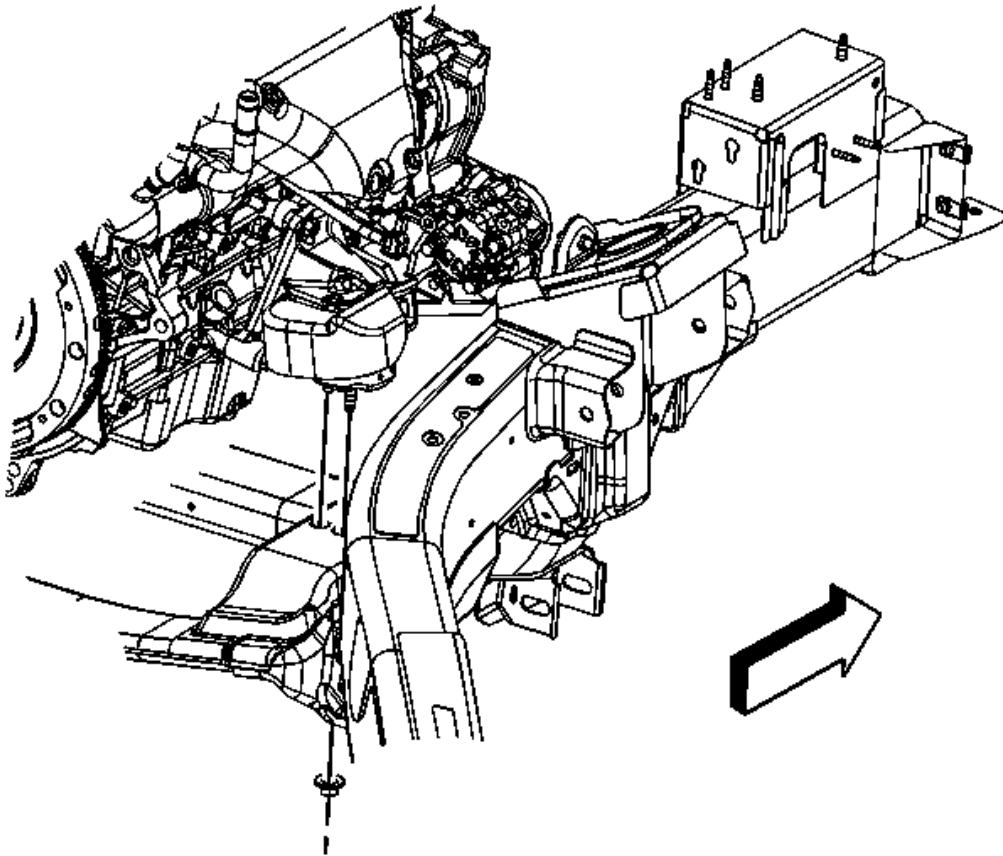


Fig. 22: View Of Right Engine Mount & Lower Nut
Courtesy of GENERAL MOTORS CORP.

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

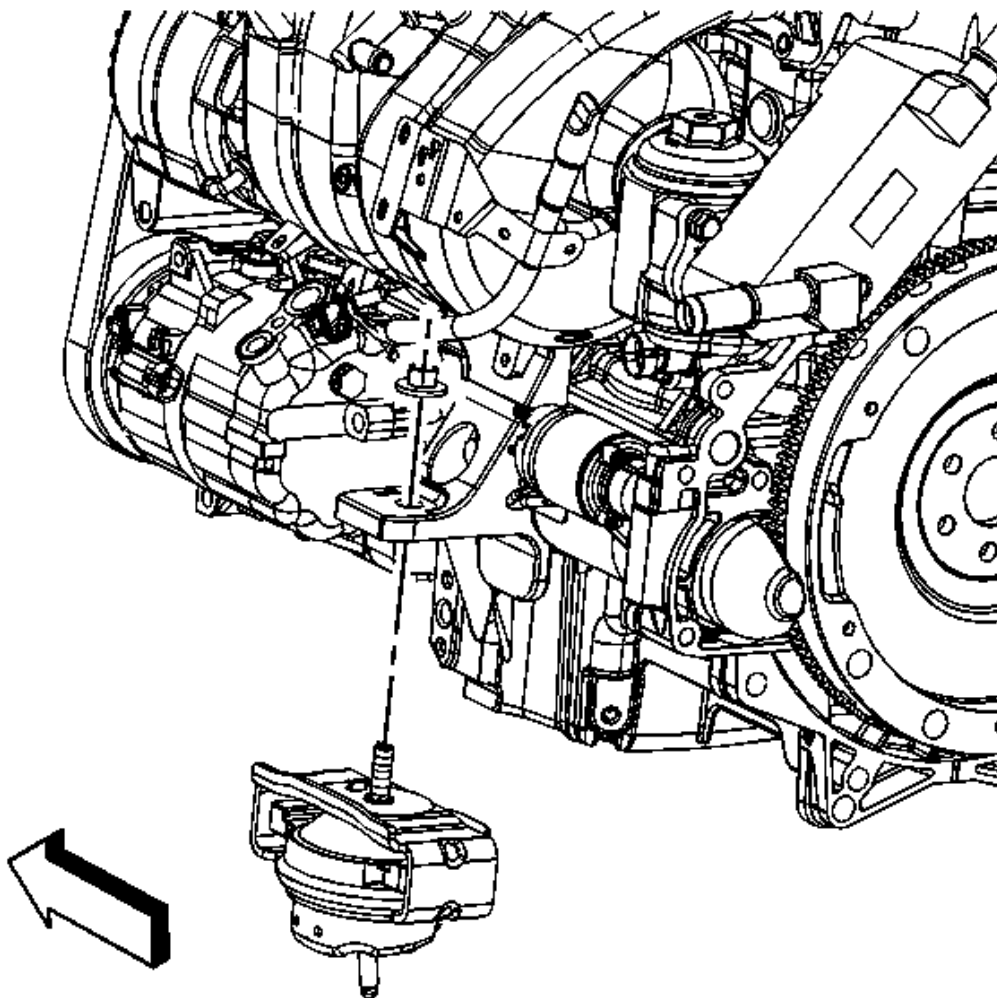


Fig. 23: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

9. Remove the left engine mount.

INSTALLATION PROCEDURE

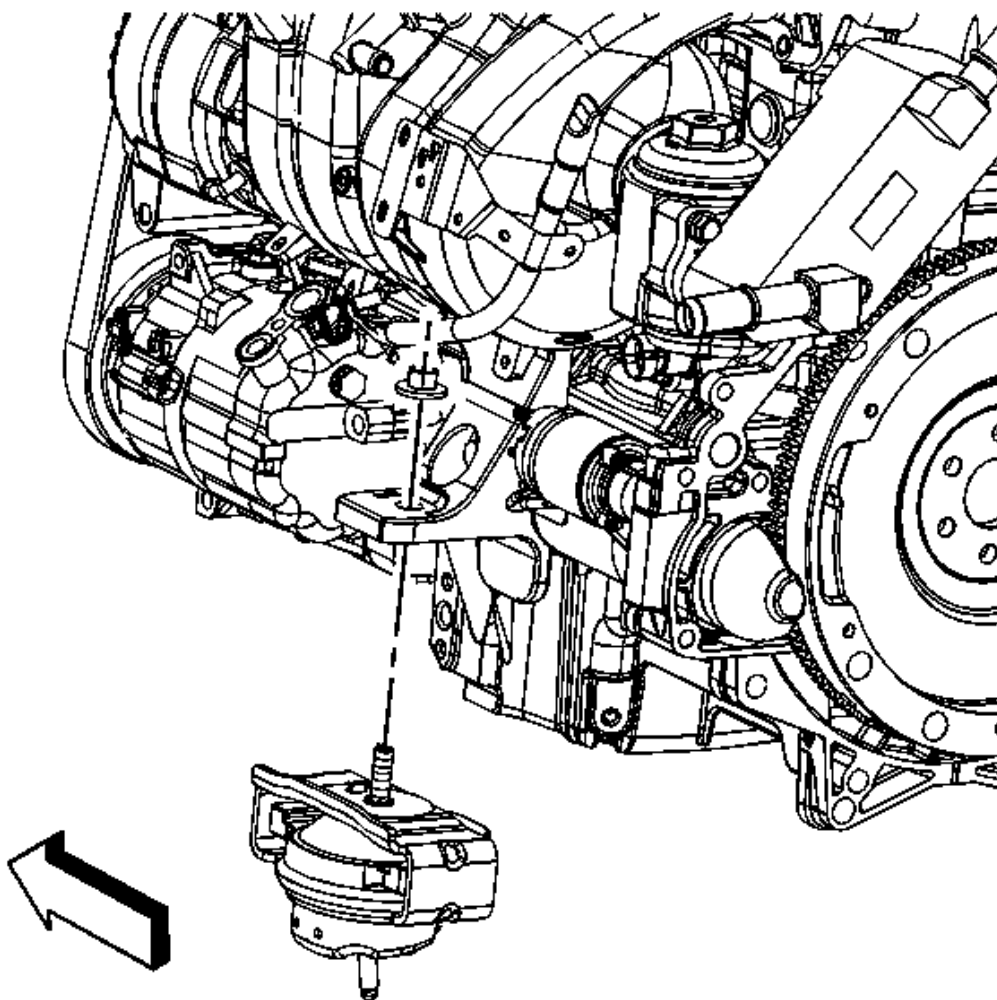


Fig. 24: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

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

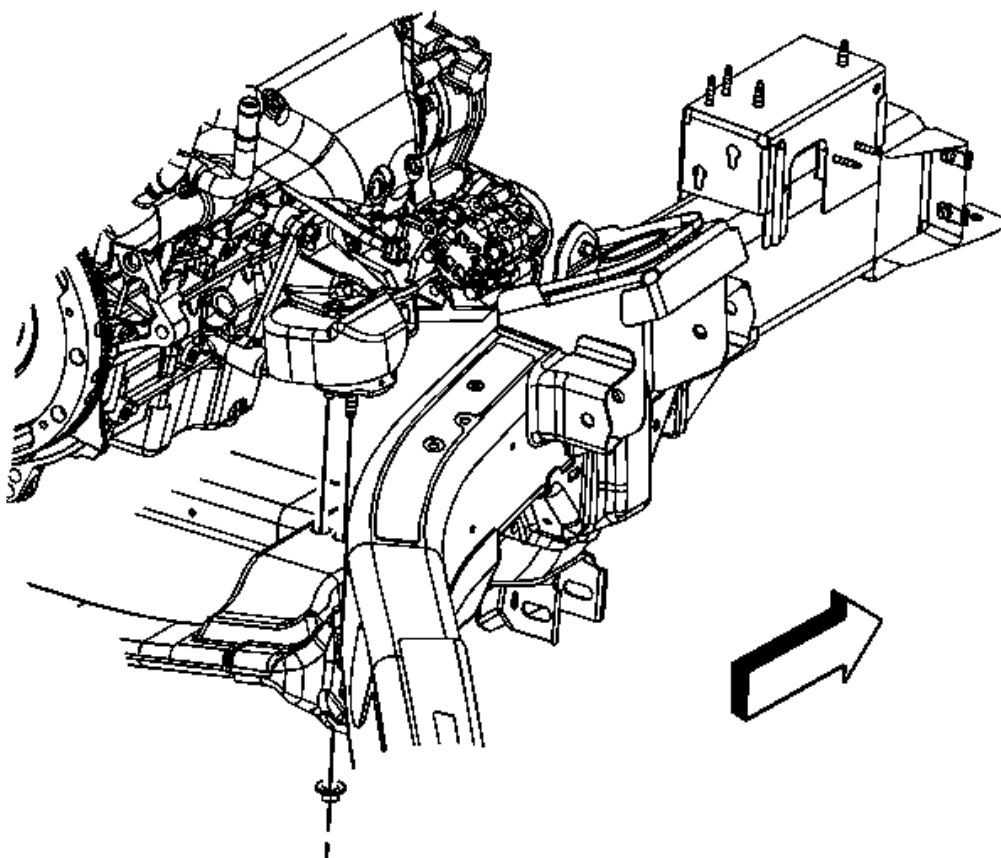


Fig. 25: View Of Right Engine Mount & Lower Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the right engine mount lower nut.

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

5. Tighten the transmission mount nuts.

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

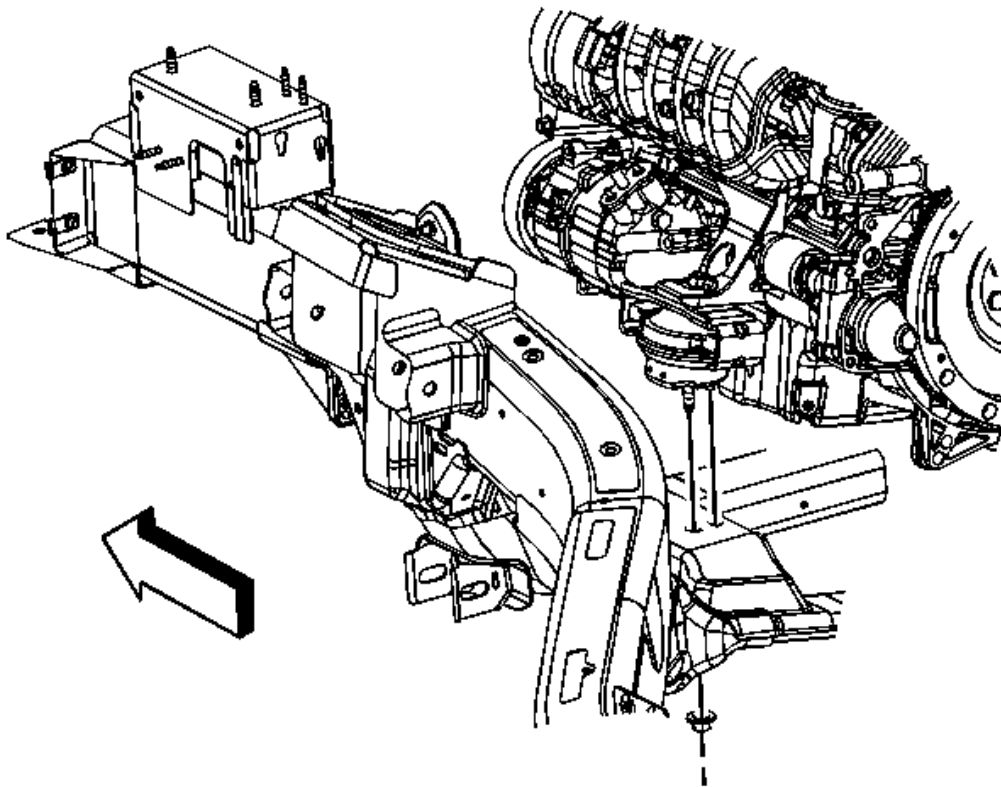


Fig. 26: View Of Left Engine Mount Lower Nut
Courtesy of GENERAL MOTORS CORP.

6. Install the left engine mount lower nut.

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

7. Lower the vehicle.

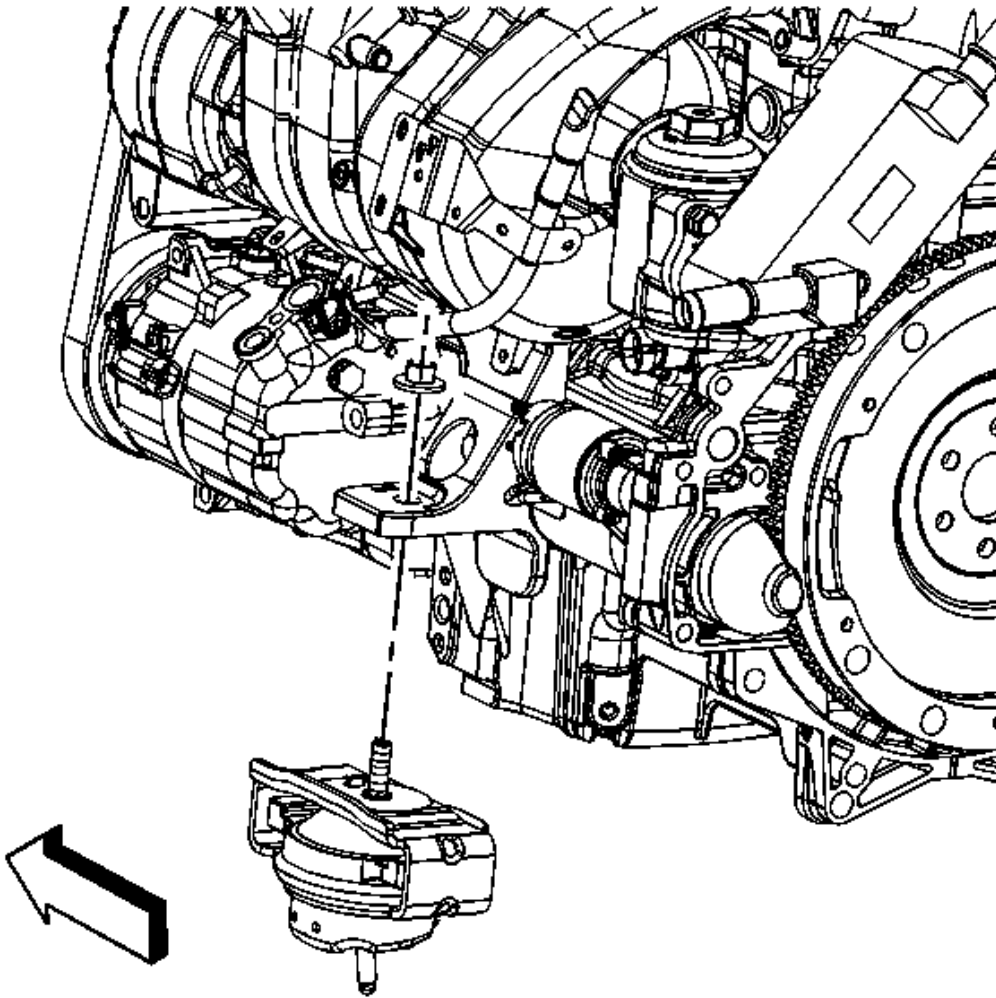


Fig. 27: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

8. Install the left engine mount upper nut.

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

9. Install the air cleaner outlet resonator. Refer to [Air Cleaner Outlet Resonator Replacement](#).

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

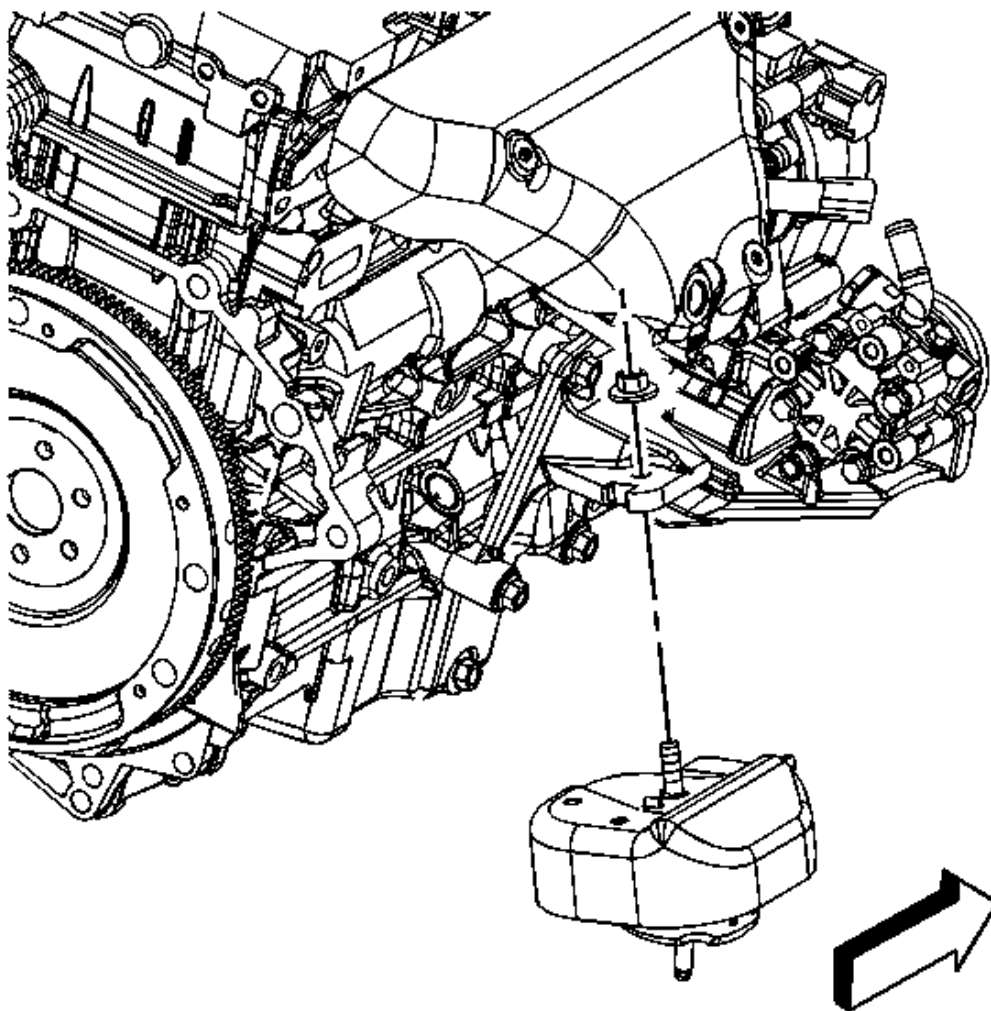


Fig. 28: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
2. Remove the right engine mount upper nut.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

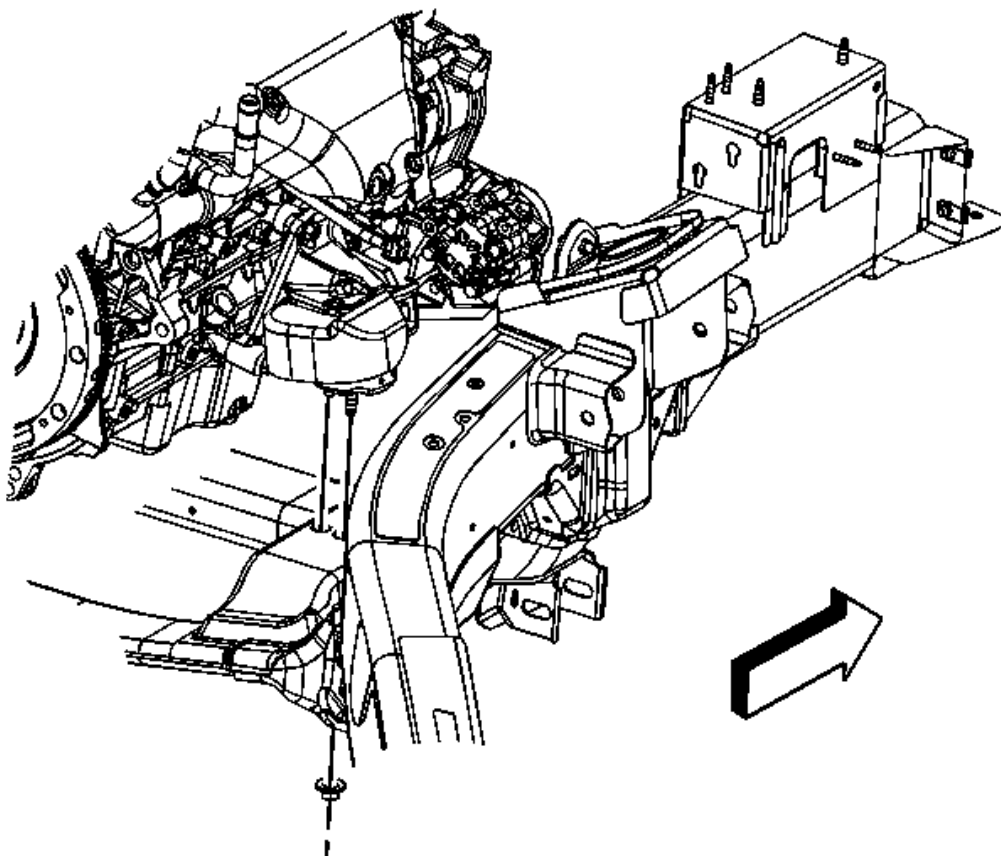


Fig. 29: View Of Right Engine Mount & Lower Nut
Courtesy of GENERAL MOTORS CORP.

4. Remove the right engine mount lower nut.
5. Loosen the transmission mount nuts.

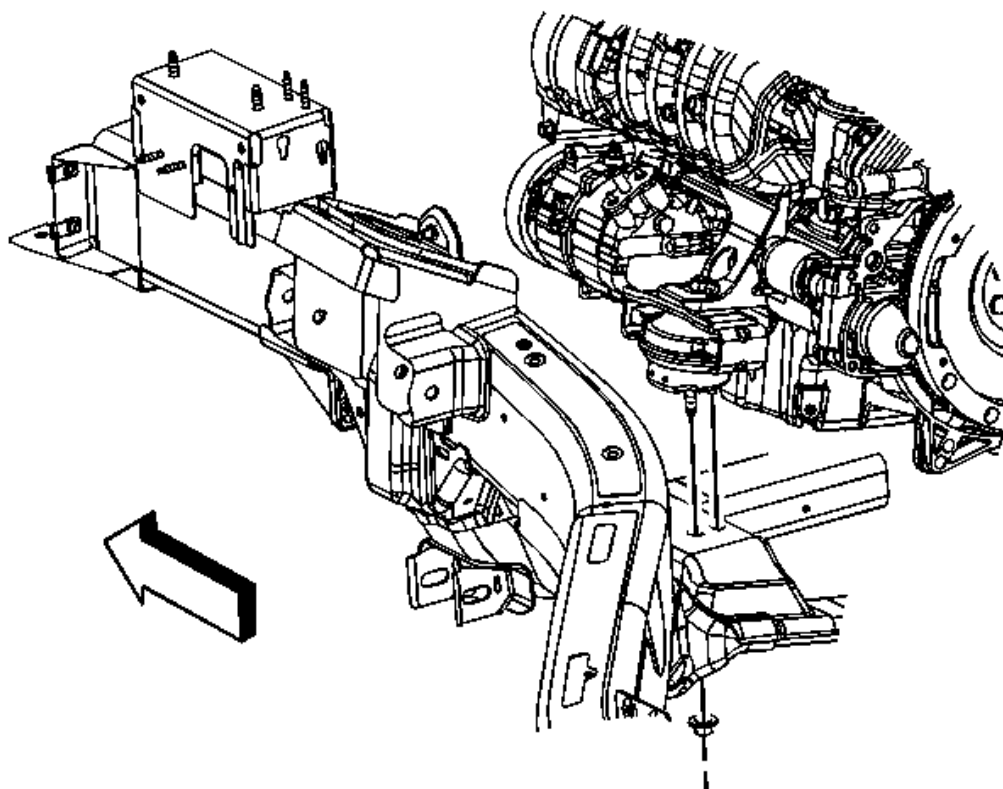


Fig. 30: View Of Left Engine Mount Lower Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the left engine mount lower nut.

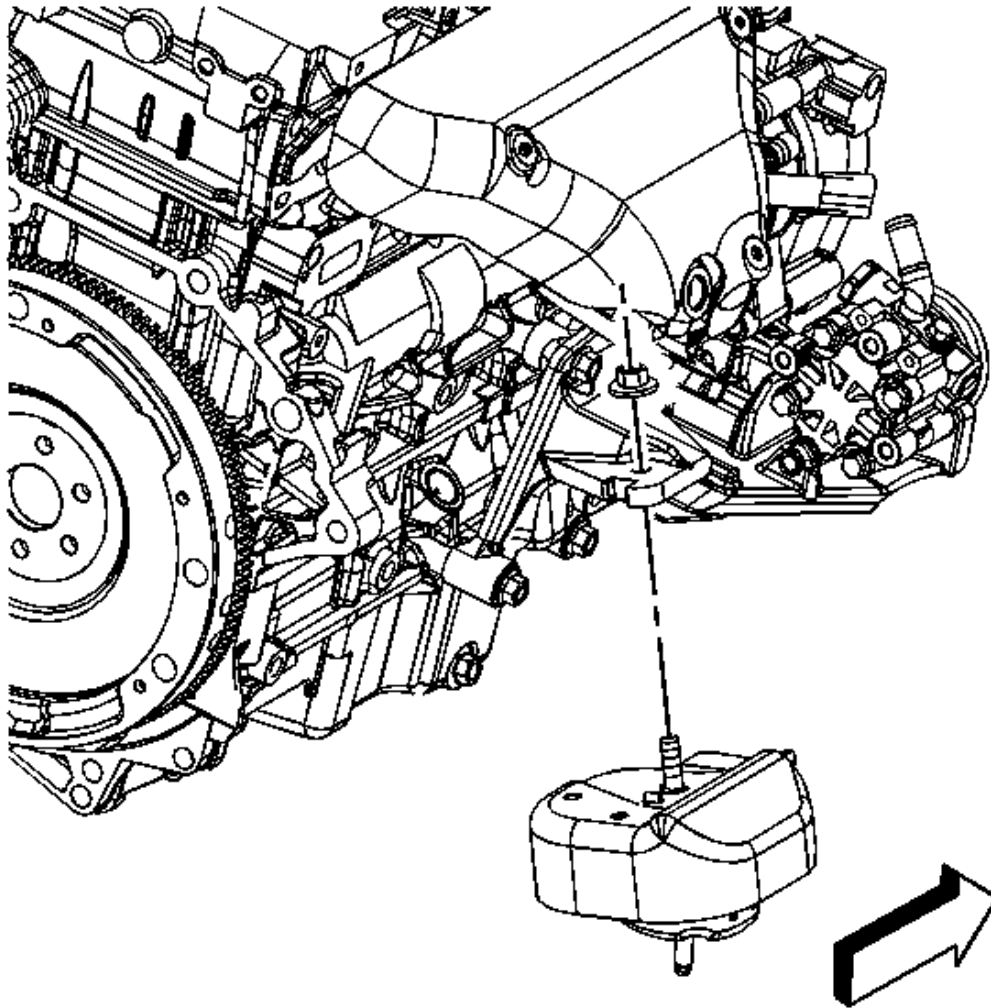


Fig. 31: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

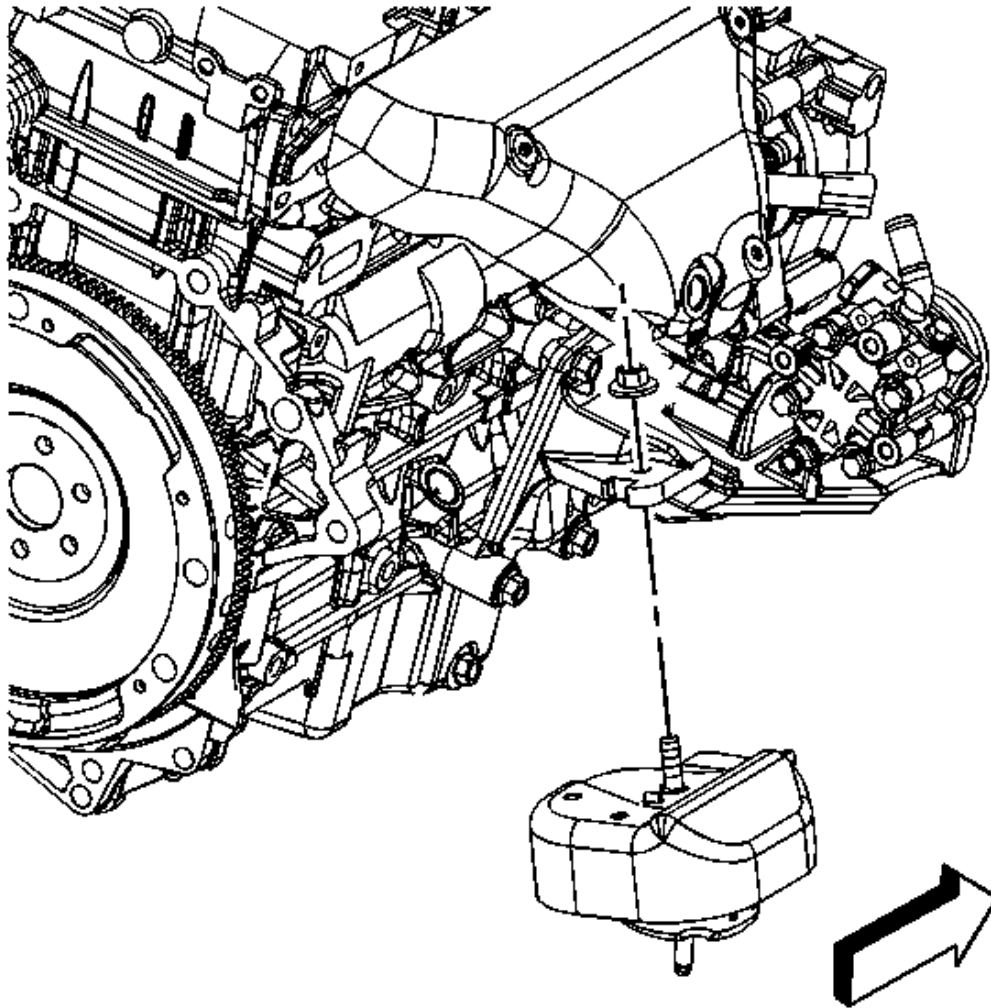


Fig. 32: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

5. Install the right brake hose bracket bolt.

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

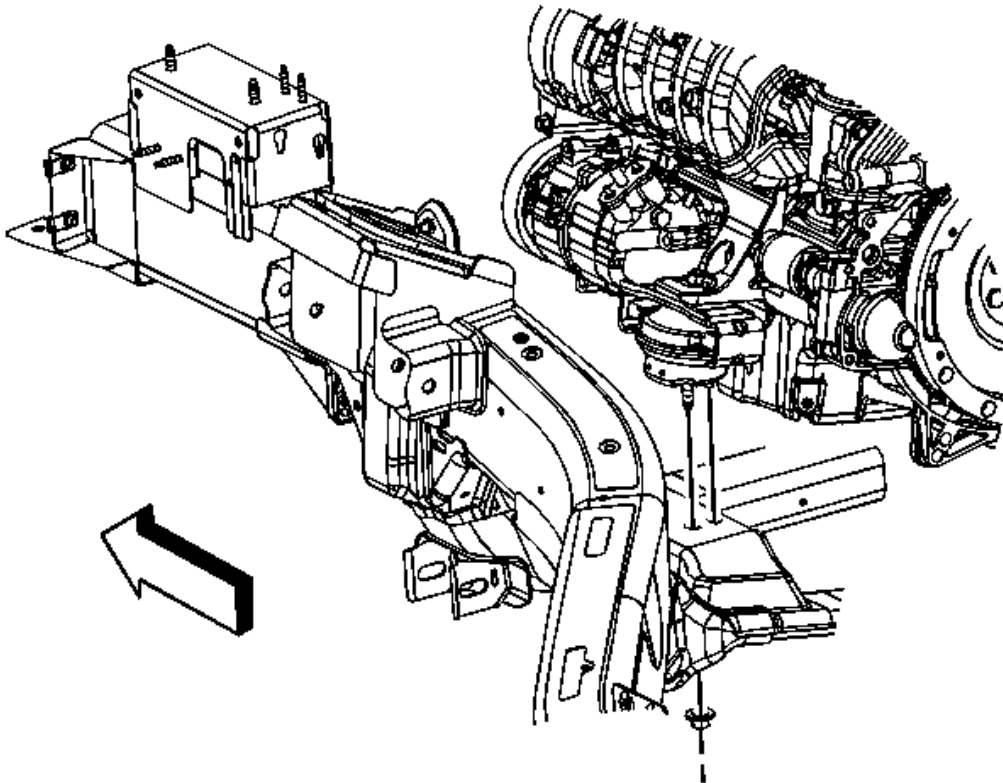


Fig. 33: View Of Left Engine Mount Lower Nut
Courtesy of GENERAL MOTORS CORP.

6. Install the left engine mount lower nut.

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

7. Tighten the transmission mount nuts.

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

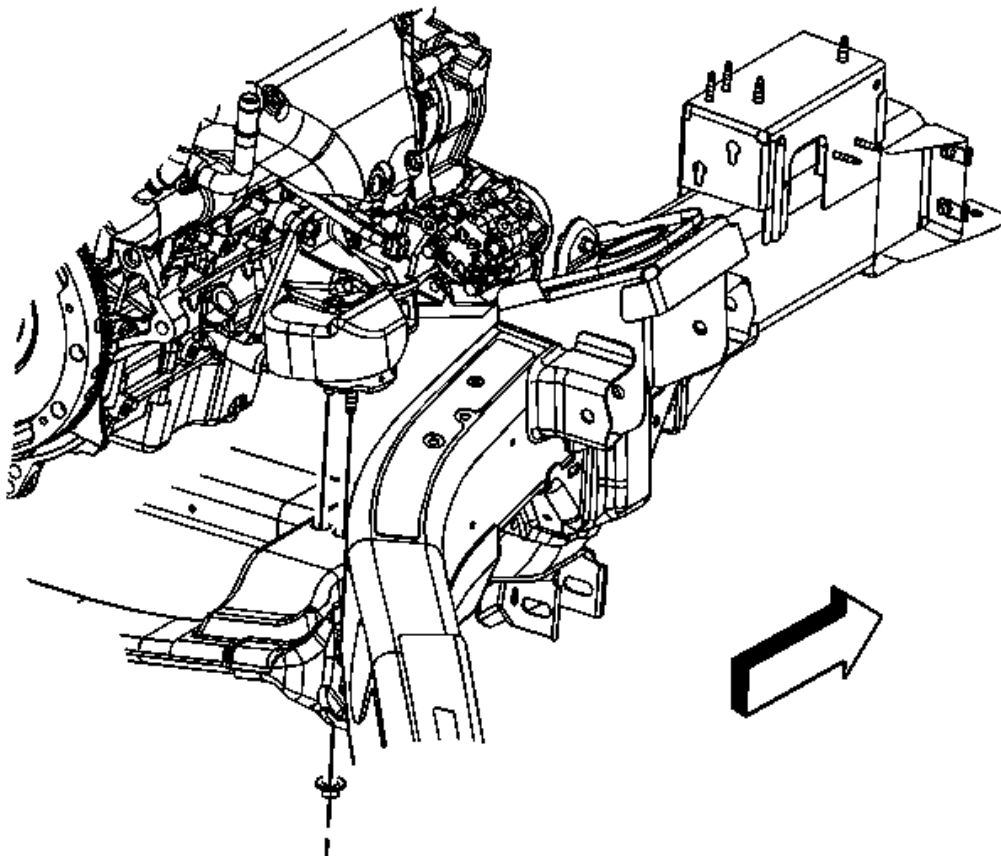


Fig. 34: View Of Right Engine Mount & Lower Nut
Courtesy of GENERAL MOTORS CORP.

8. Remove the right engine mount lower nut.

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

9. Lower the vehicle.

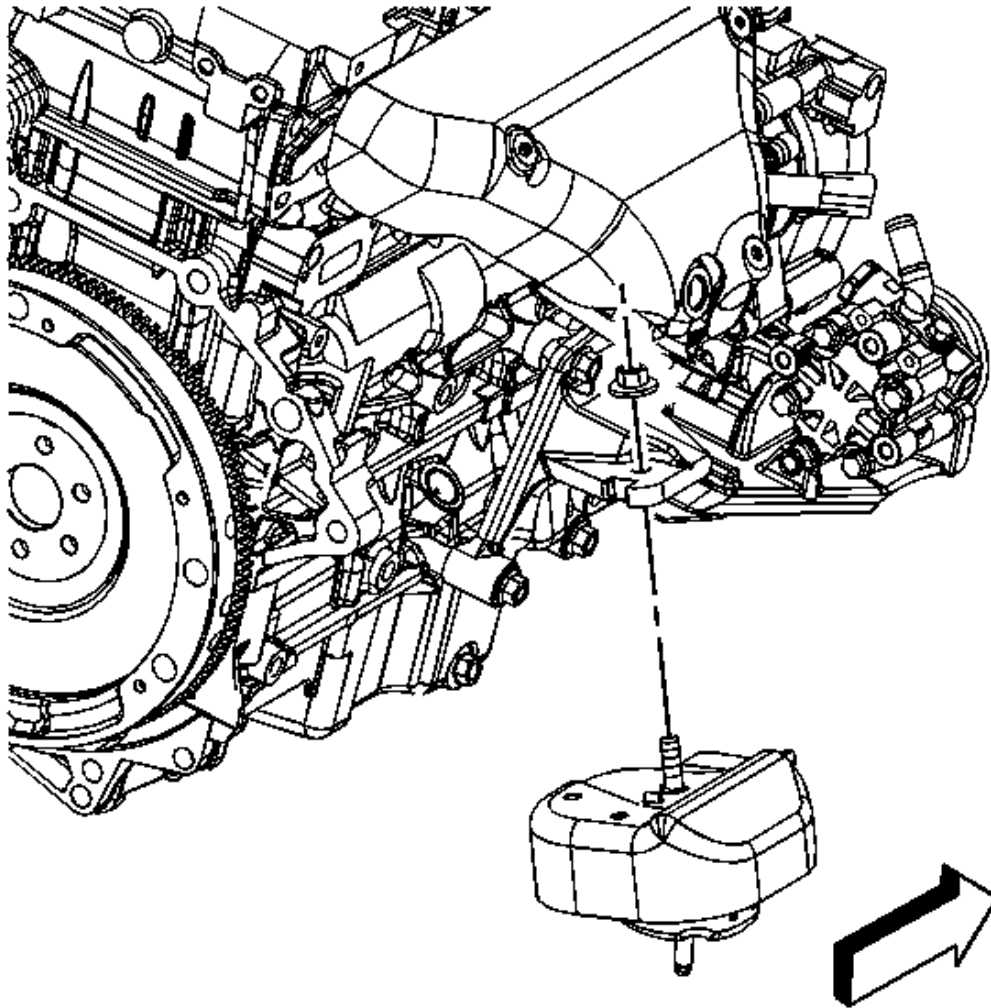


Fig. 35: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

10. Install the right engine mount upper nut.

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

11. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

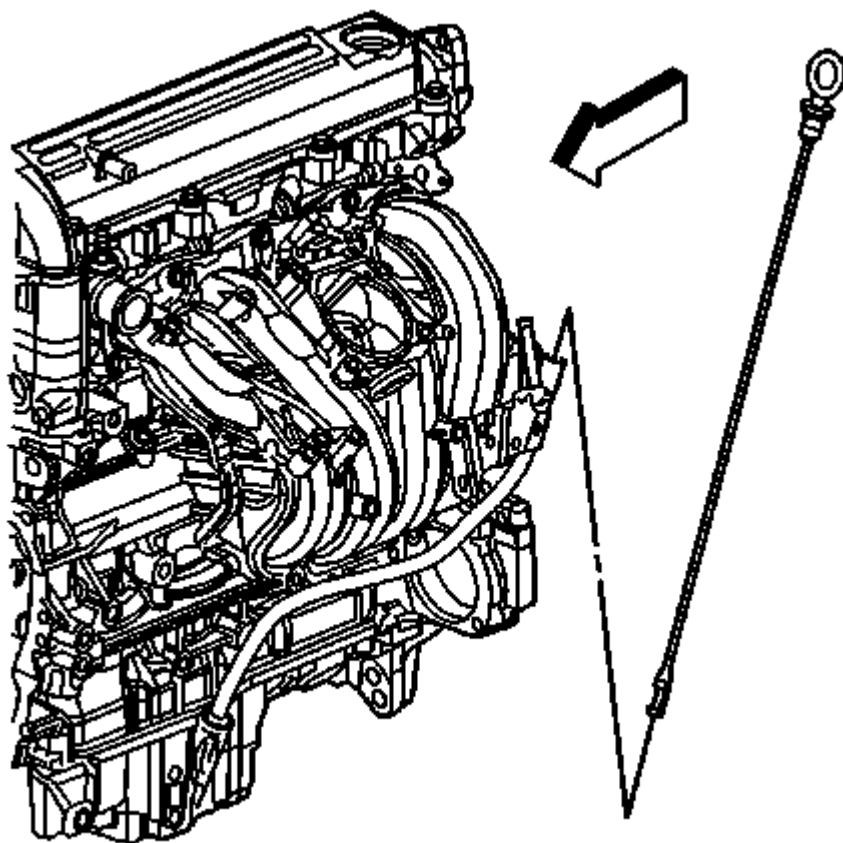


Fig. 36: Identifying Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet resonator. Refer to [Air Cleaner Outlet Resonator Replacement](#) .
2. Remove the oil level indicator.

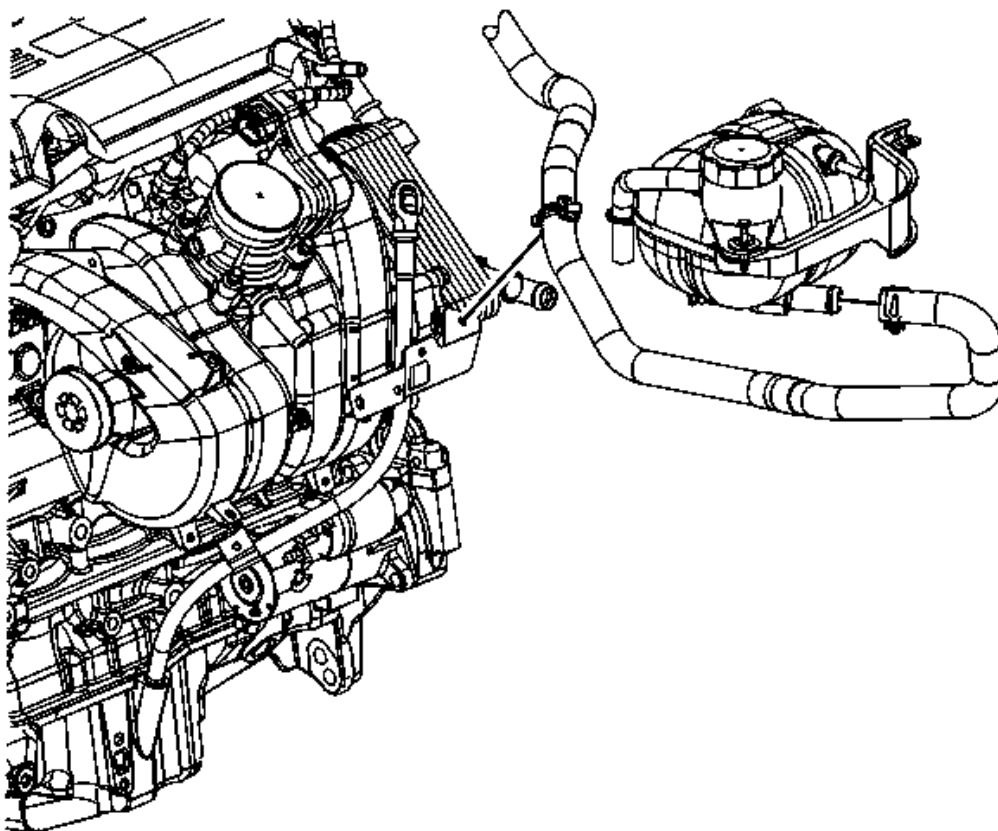


Fig. 37: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

3. If the vehicle is equipped with a engine oil cooler, remove the radiator surge tank outlet hose clip from the oil level indicator tube.

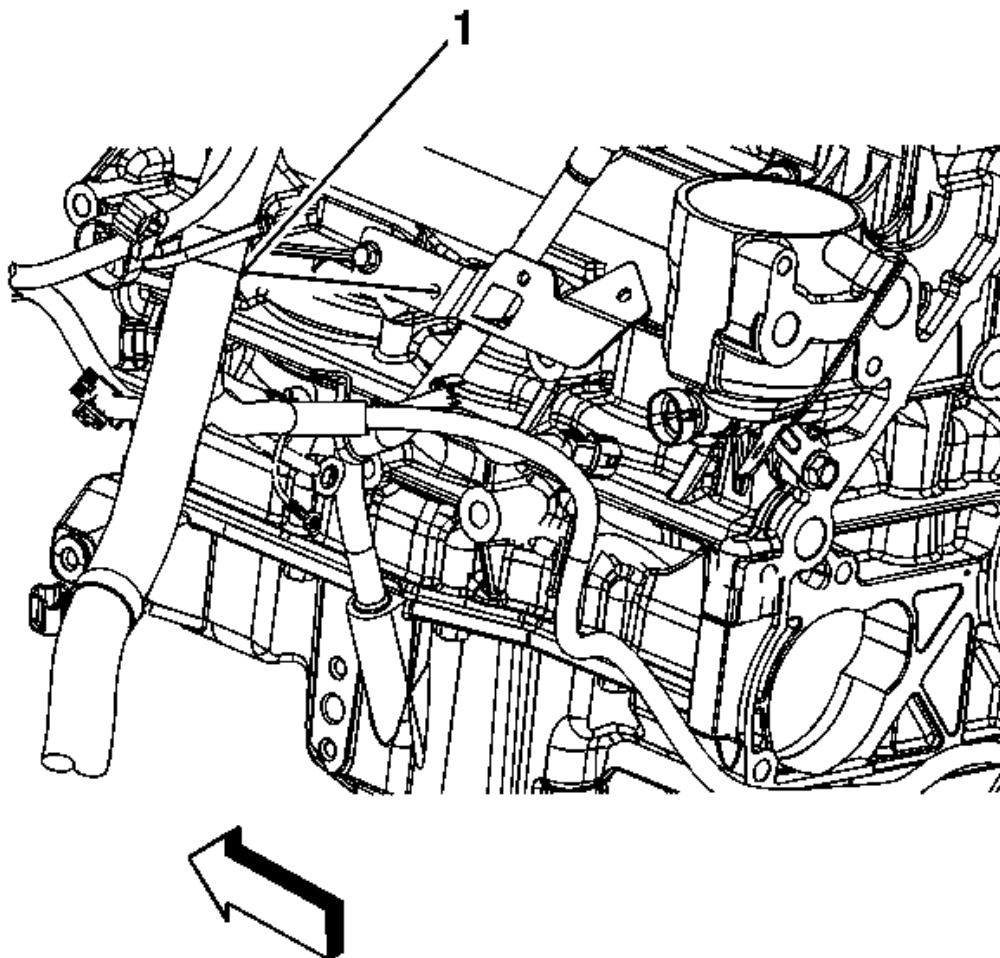


Fig. 38: Identifying Oil Level Indicator Tube Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

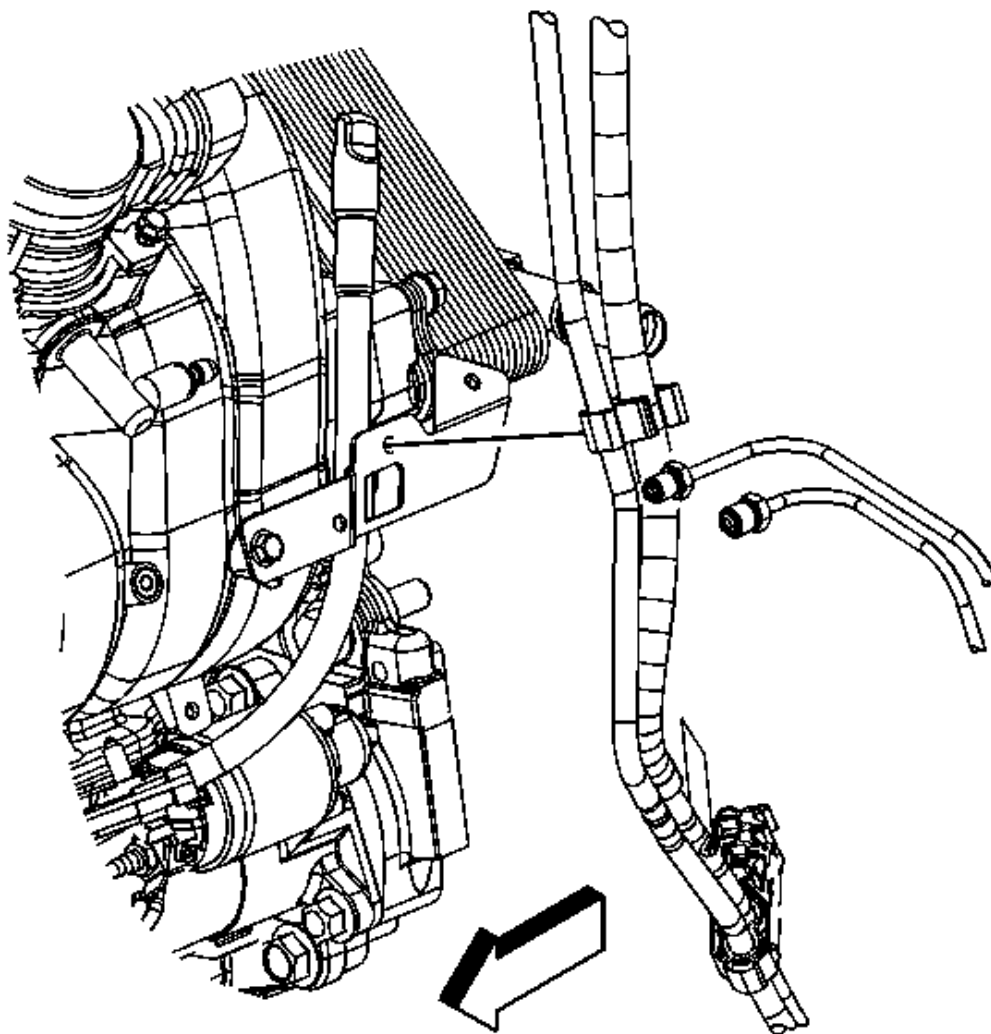


Fig. 39: View Of Fuel Feed & EVAP Pipe Clip
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel line clip from the oil level indicator tube.
6. Remove the knock sensor clip from the oil level indicator tube.

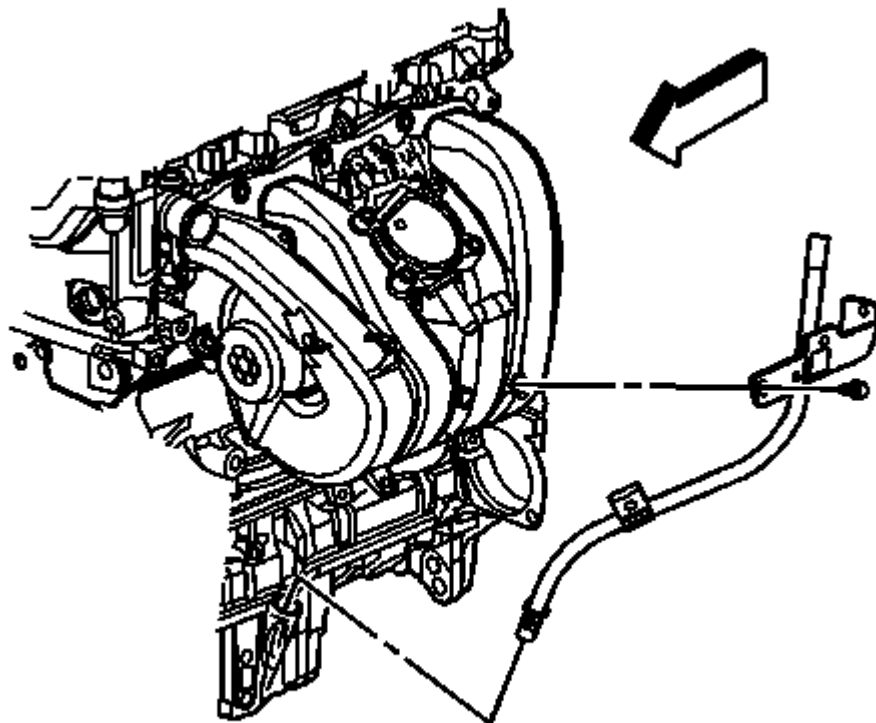


Fig. 40: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

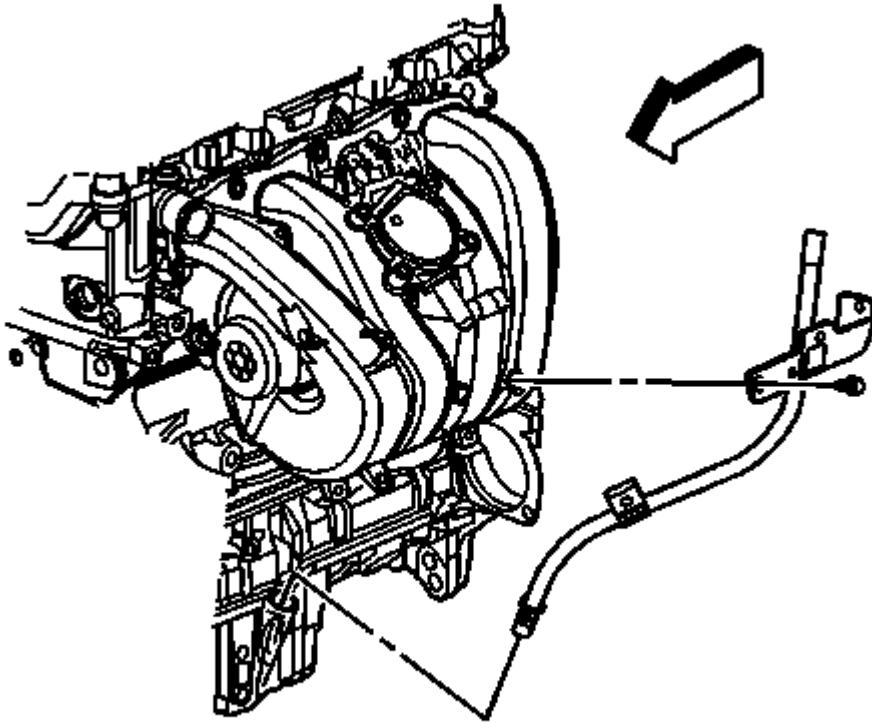


Fig. 41: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to **Fastener Caution** .

3. Install the oil level indicator tube bolt.

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

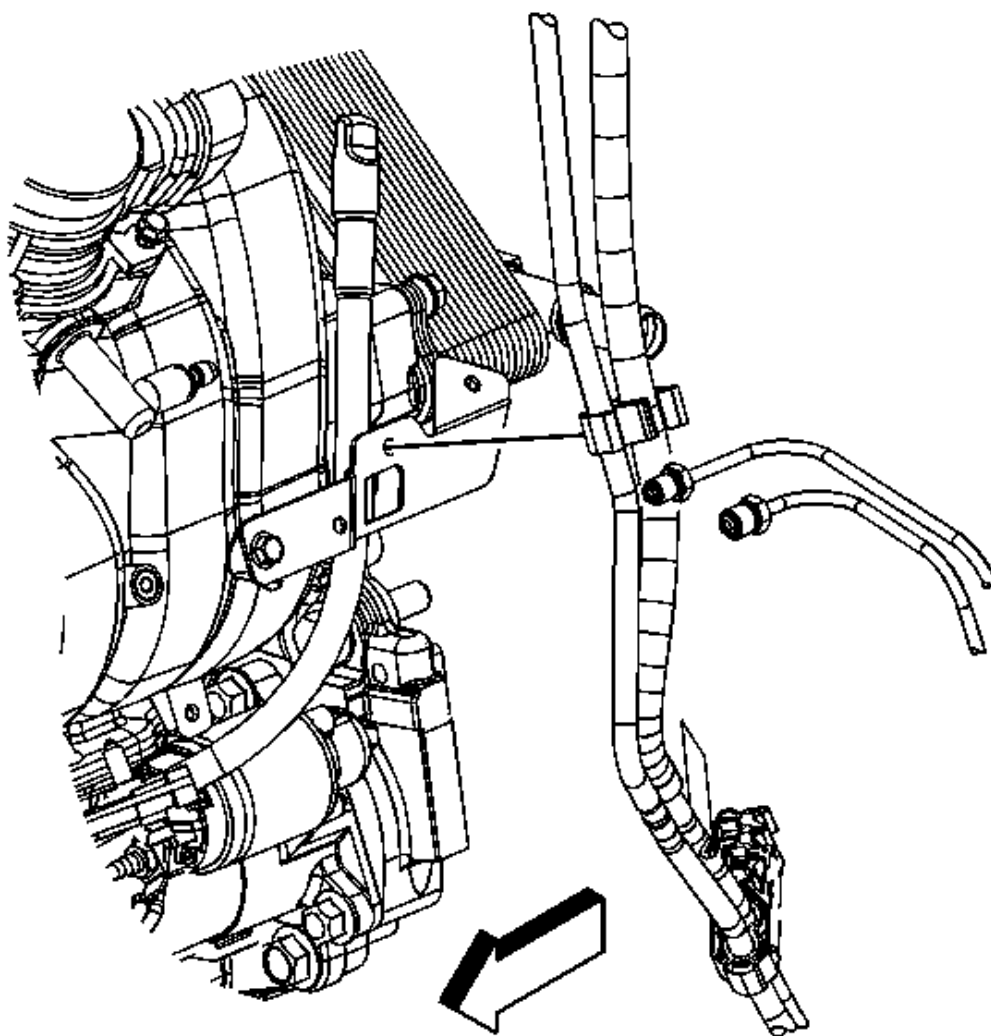


Fig. 42: View Of Fuel Feed & EVAP Pipe Clip
Courtesy of GENERAL MOTORS CORP.

4. Install the knock sensor clip to the oil level indicator tube.
5. Install the fuel line clip to the oil level indicator tube.

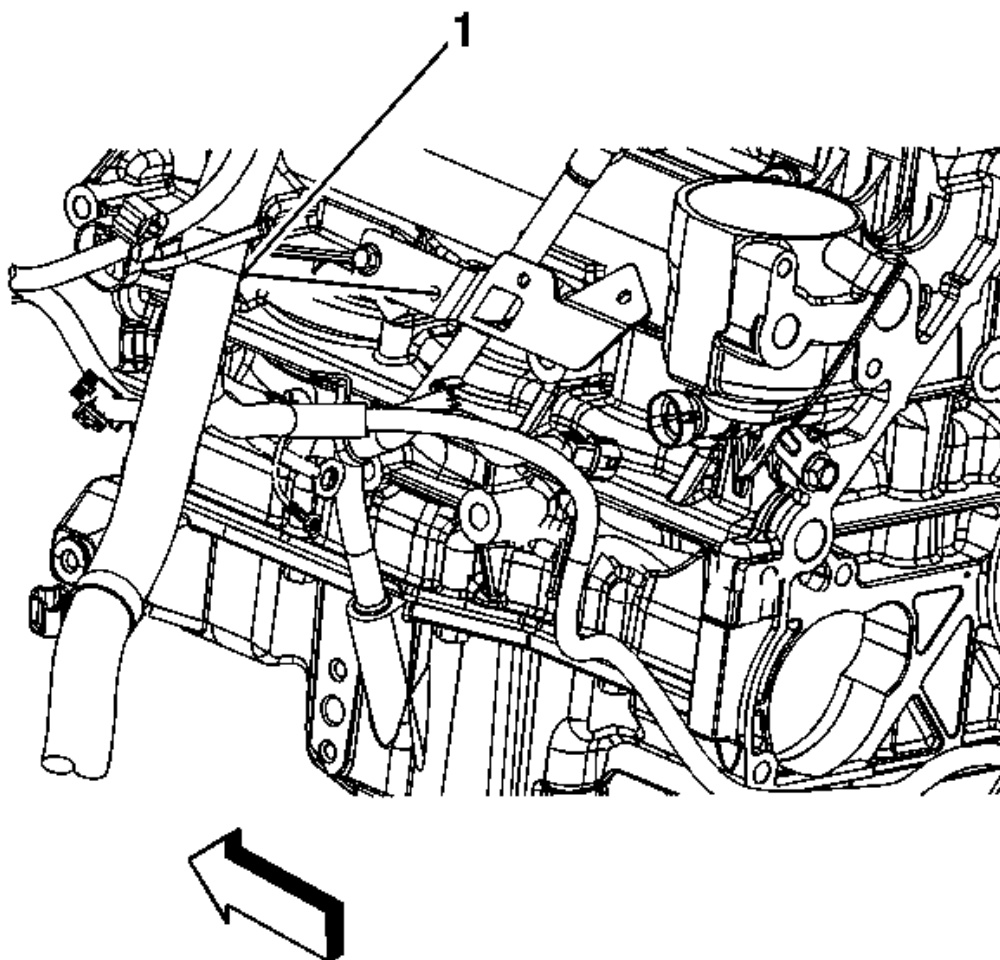


Fig. 43: Identifying Oil Level Indicator Tube Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

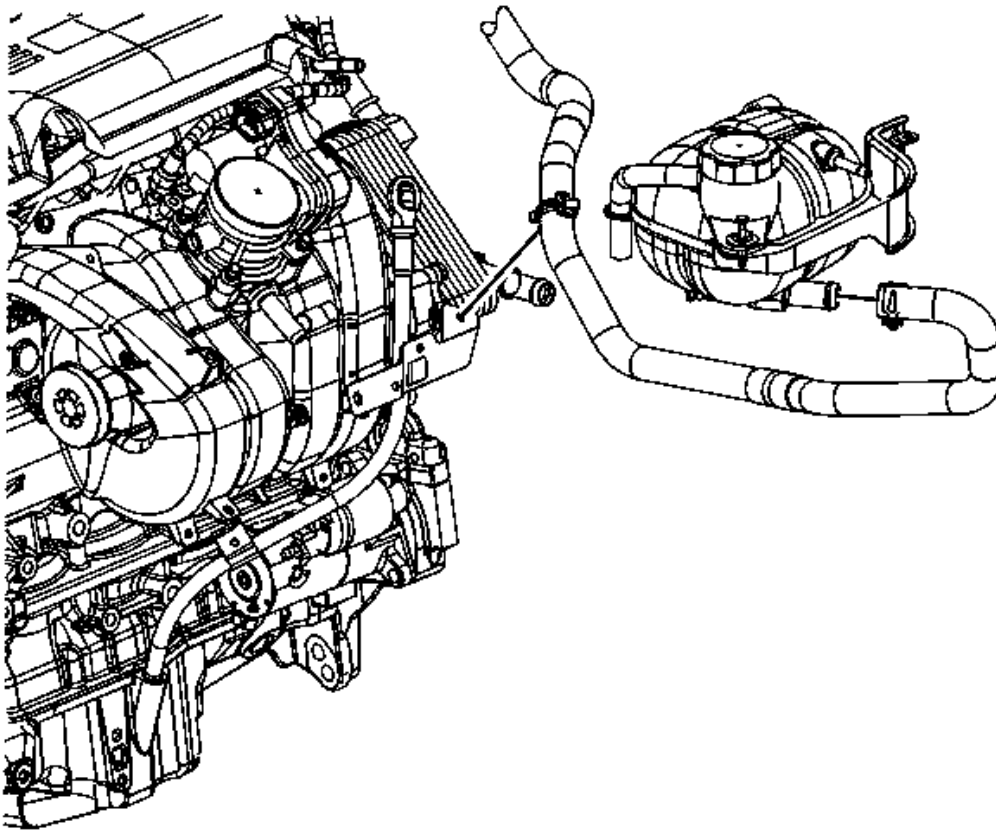


Fig. 44: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

7. If the vehicle is equipped with a engine oil cooler, install the radiator surge tank outlet hose clip to the oil level indicator tube.

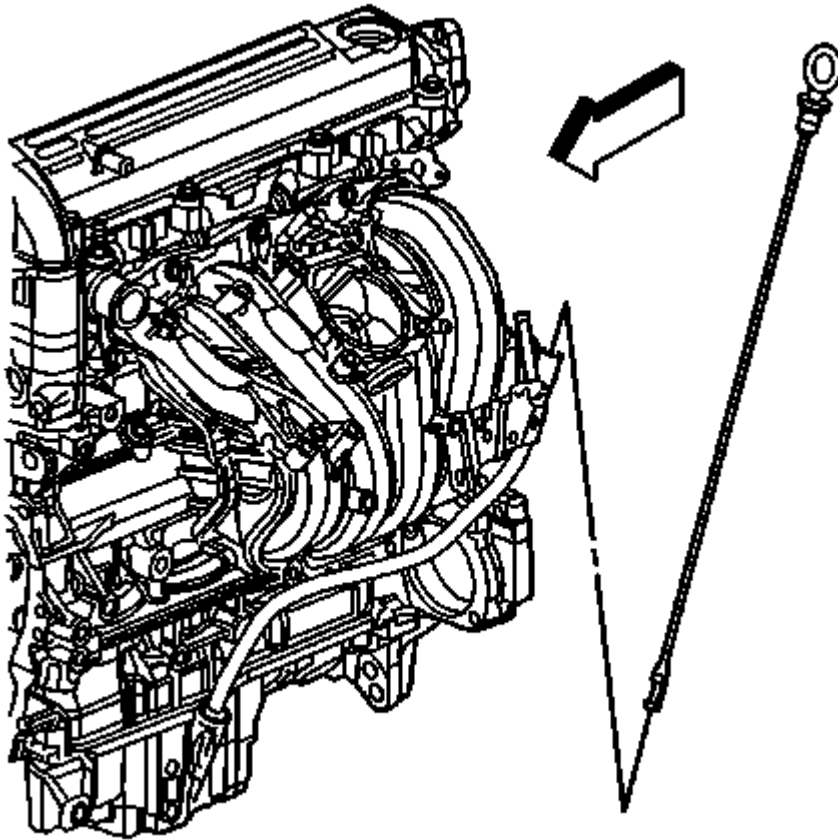


Fig. 45: Identifying Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

8. Install the oil level indicator.
9. Install the air cleaner outlet resonator. Refer to [Air Cleaner Outlet Resonator Replacement](#) .

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

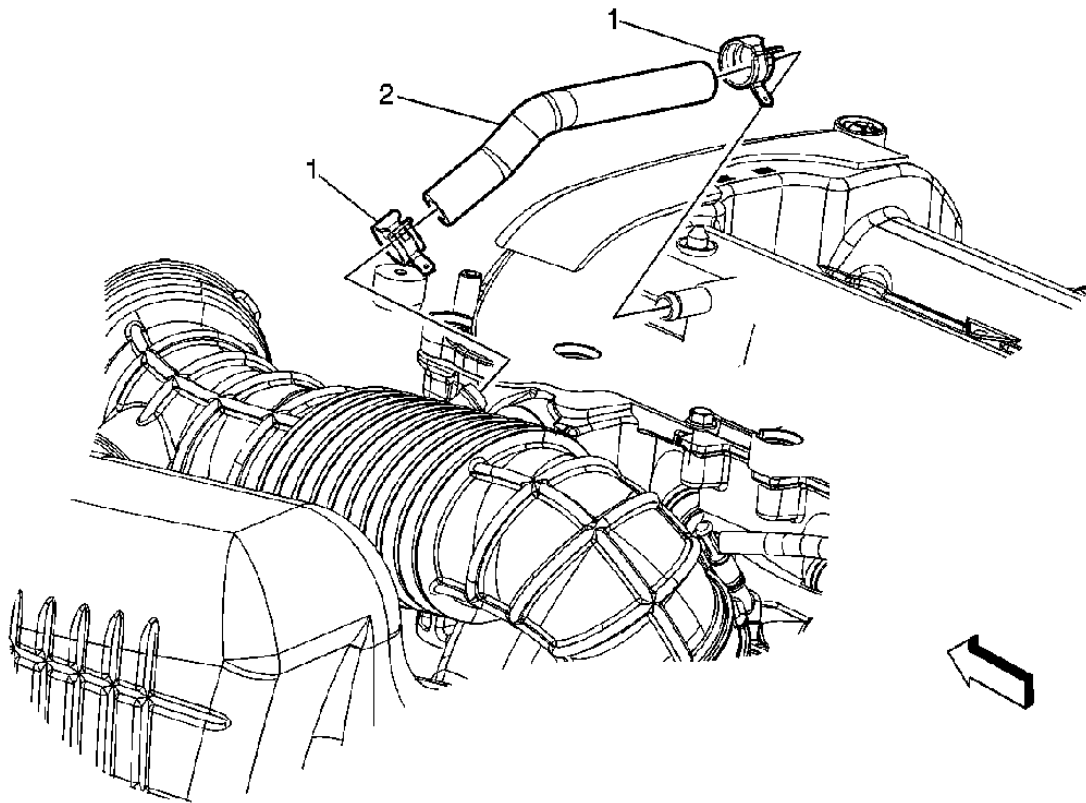


Fig. 46: Identifying Positive Crankcase Ventilation Hose/Pipe/Tube
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Fastener Tightening Specifications: Refer to <u>Fastener Tightening Specifications</u> .	
Preliminary Procedures: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Clamp, Positive Crankcase Ventilation Hose (PCV) (Qty: 2)
2	Hose, PCV

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

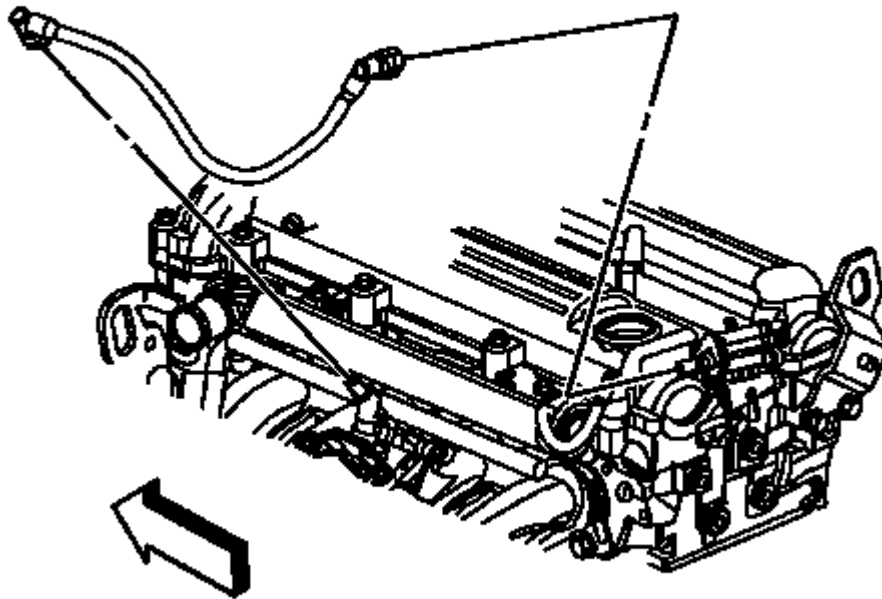


Fig. 47: Identifying EVAP Canister Purge Solenoid Valve Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the throttle body. Refer to **Throttle Body Assembly Replacement**.
3. Remove the fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.
4. Remove the evaporative emission (EVAP) canister purge solenoid valve tube. Refer to **Plastic Collar Quick Connect Fitting Service**.

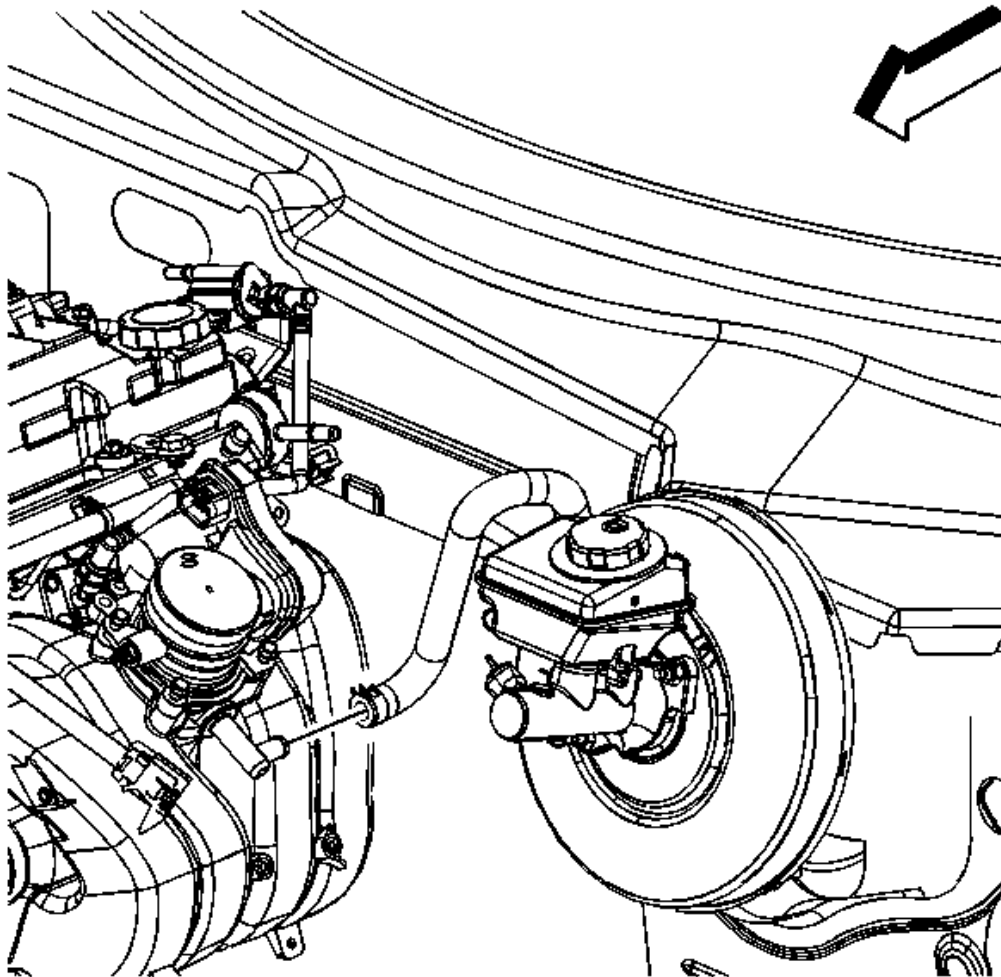


Fig. 48: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

5. Reposition the brake booster vacuum hose clamp at the intake manifold.
6. Remove the brake booster hose from the intake manifold.
7. Remove the oil level indicator tube bolt.

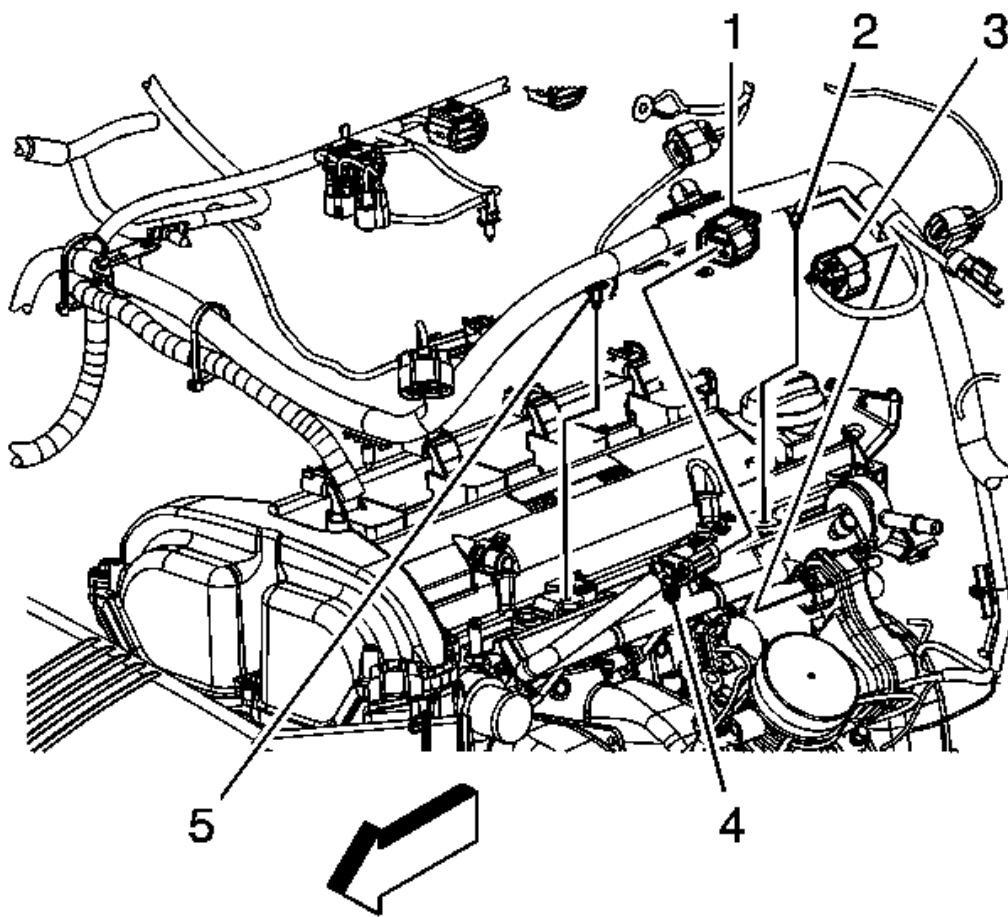


Fig. 49: View Of Fuel System Electrical Connectors & Harness Clips
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the engine harness electrical connector (1) from the fuel injector electrical connector.
9. Disconnect the electronic throttle actuator electrical connector (3).

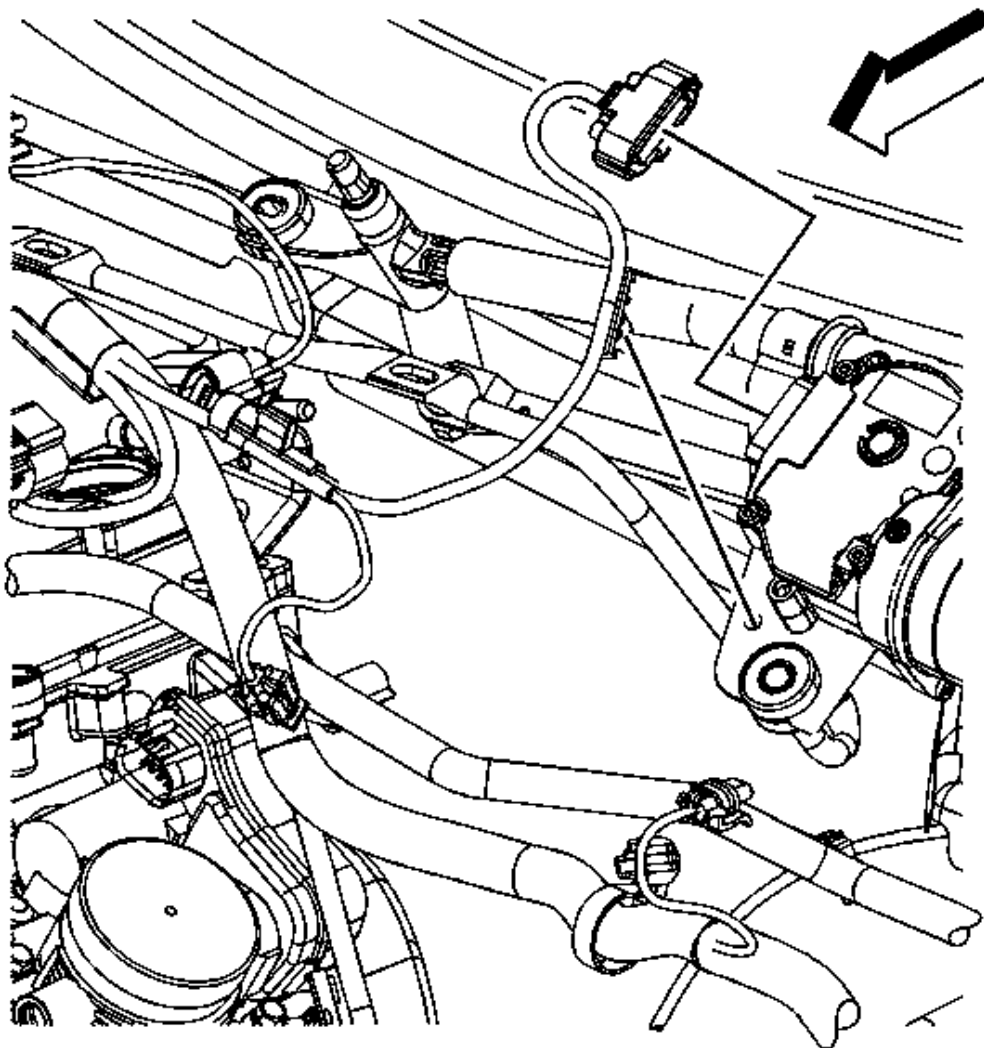


Fig. 50: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the windshield wiper motor electrical connector.
11. Remove the engine harness clip from the wiper motor.

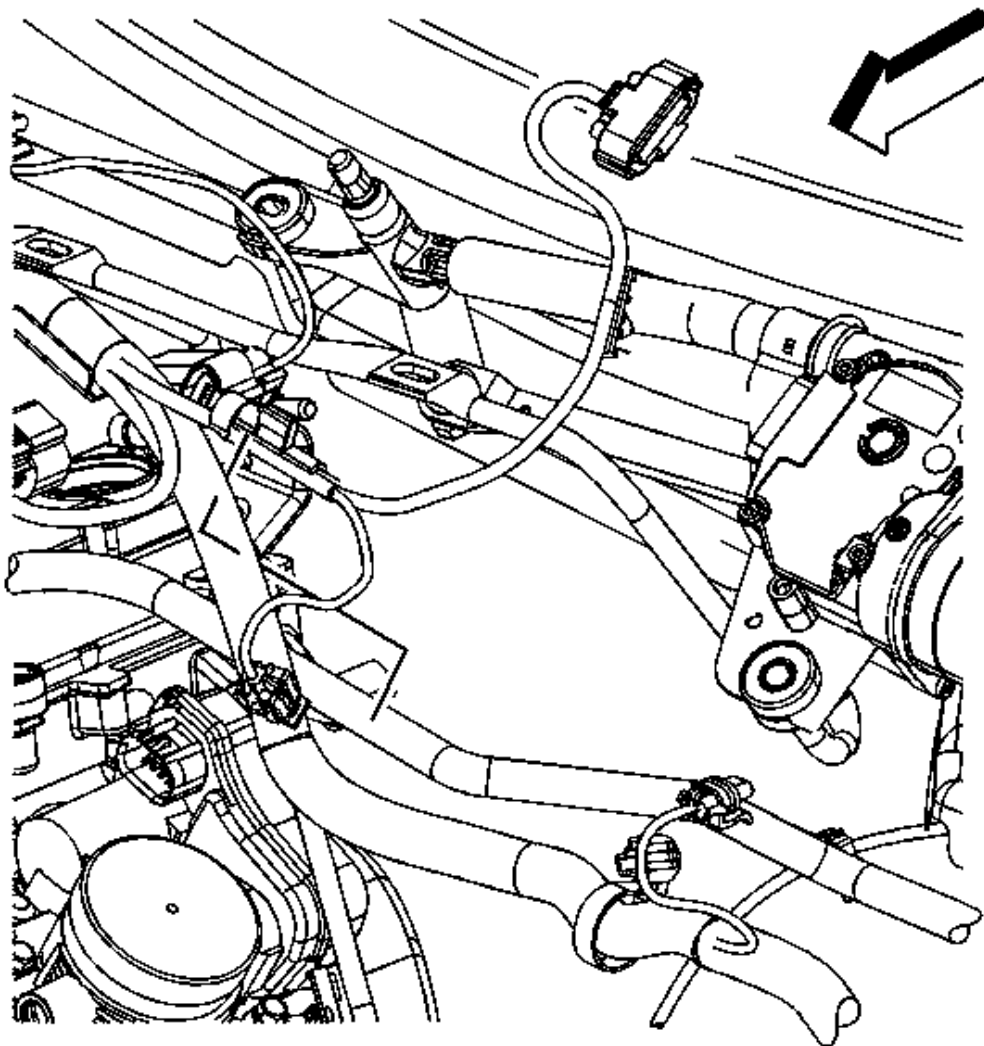


Fig. 51: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

12. Remove the engine harness clip from the surge tank air bleed hose.

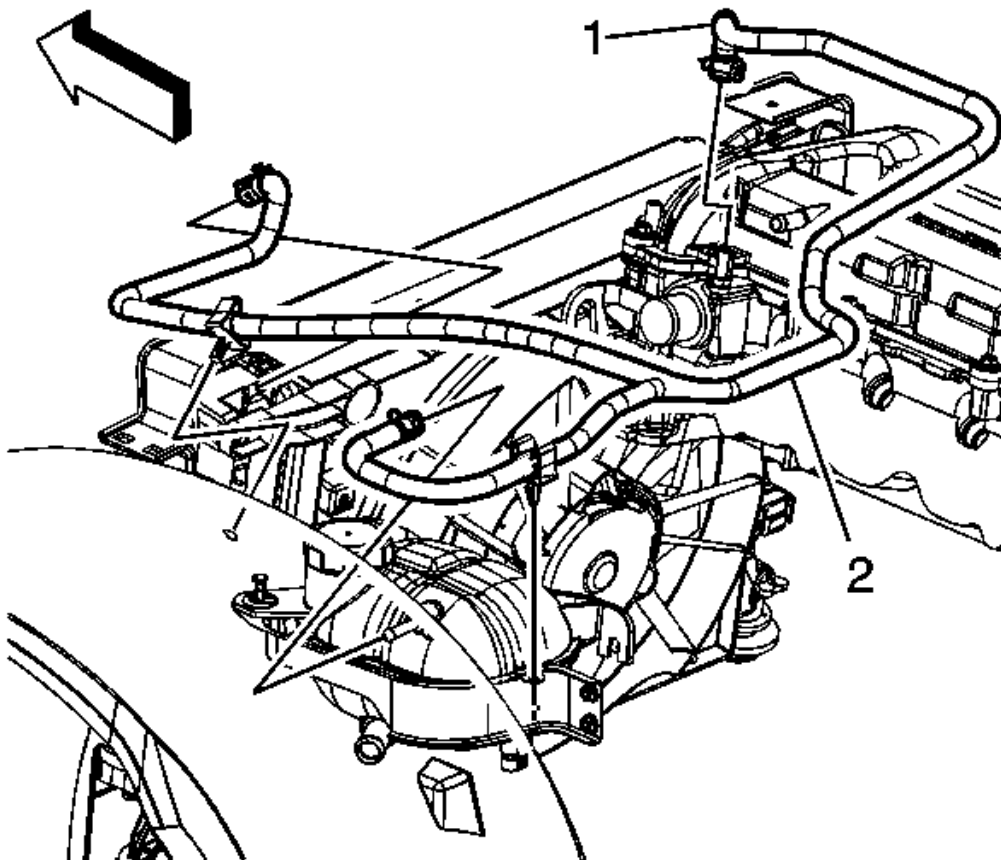


Fig. 52: Identifying Air Bleed Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

13. Reposition the radiator surge tank air bleed hose clamp at the engine (1).
14. Remove the air bleed hose (2) from the engine and reposition.

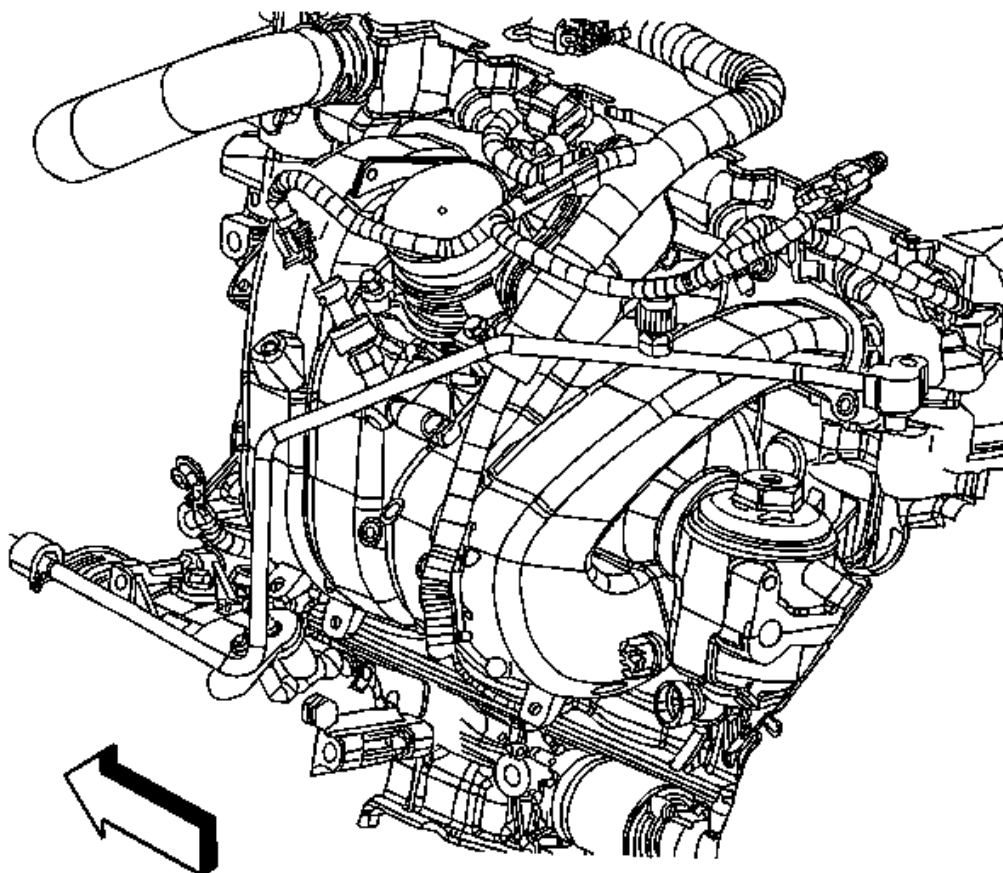


Fig. 53: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the air conditioning (A/C) refrigerant pressure sensor electrical connector.

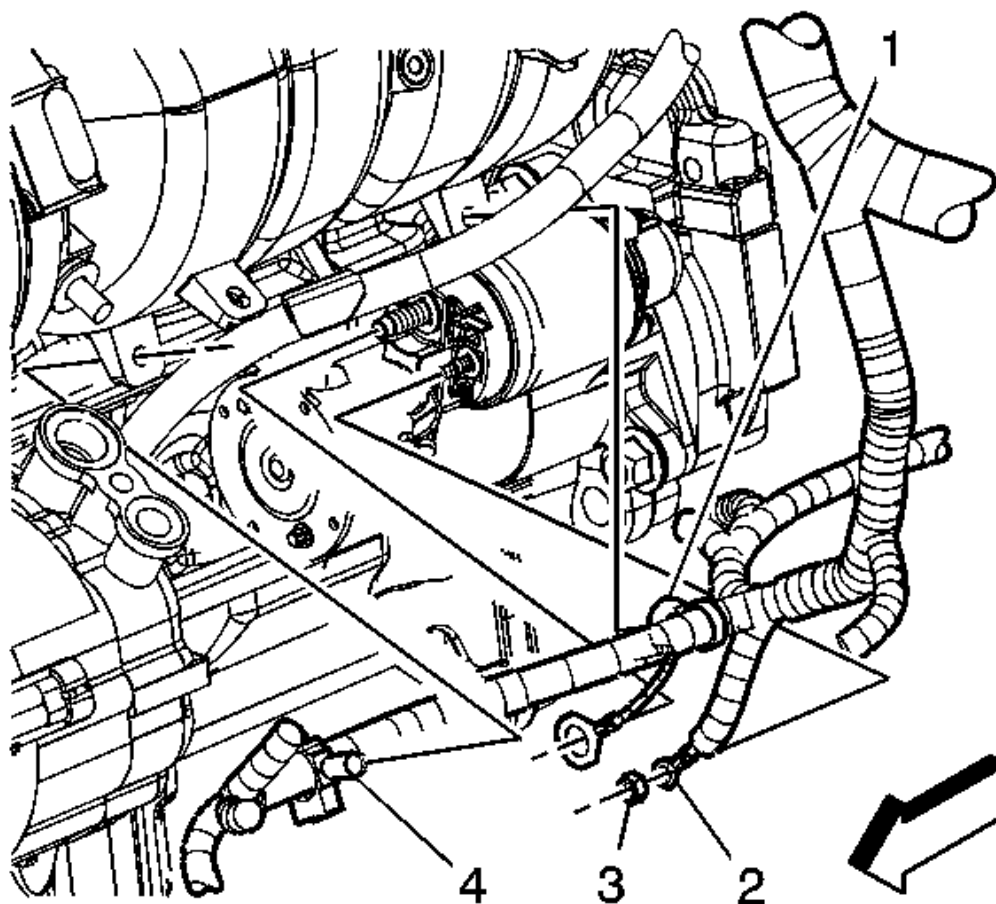


Fig. 54: Identifying Intake Manifold Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

16. Remove the engine harness clip (4) from the intake manifold.

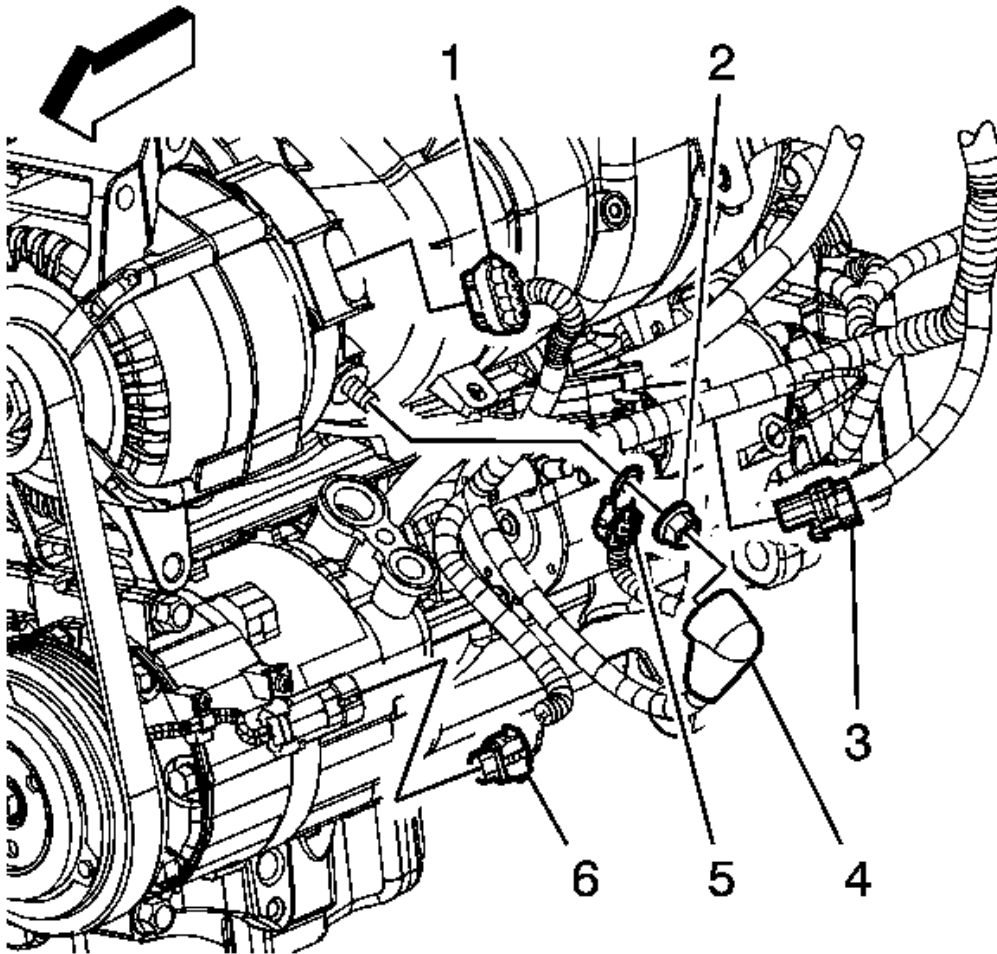


Fig. 55: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the engine harness electrical connector (3) from the knock sensor harness.
18. Remove the knock sensor connector clip from the oil level indicator tube.
19. Reposition the engine harness.

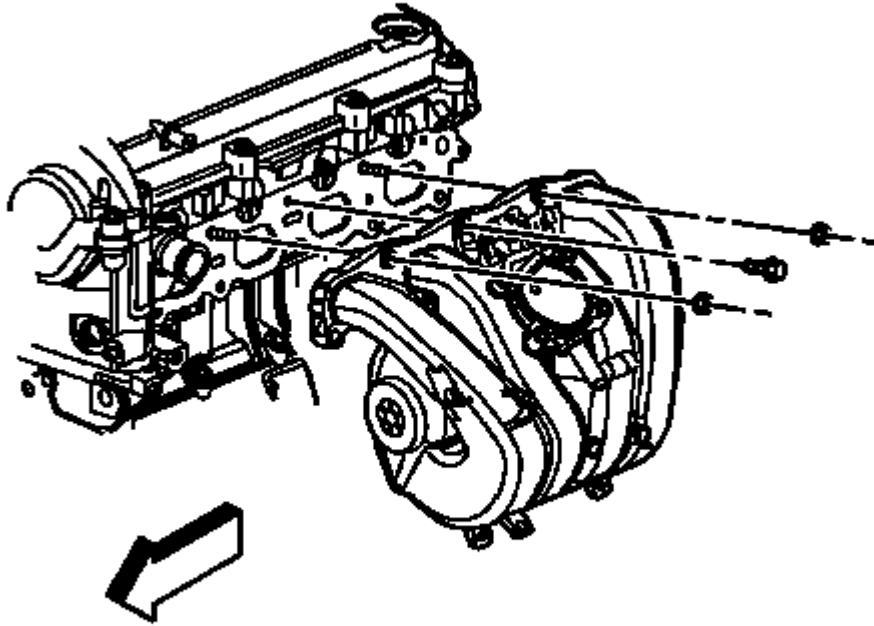


Fig. 56: Identifying Intake Manifold, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

20. Remove the intake manifold bolts and nuts.
21. Remove the intake manifold.

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

22. Remove the intake manifold gasket, if necessary.

INSTALLATION PROCEDURE

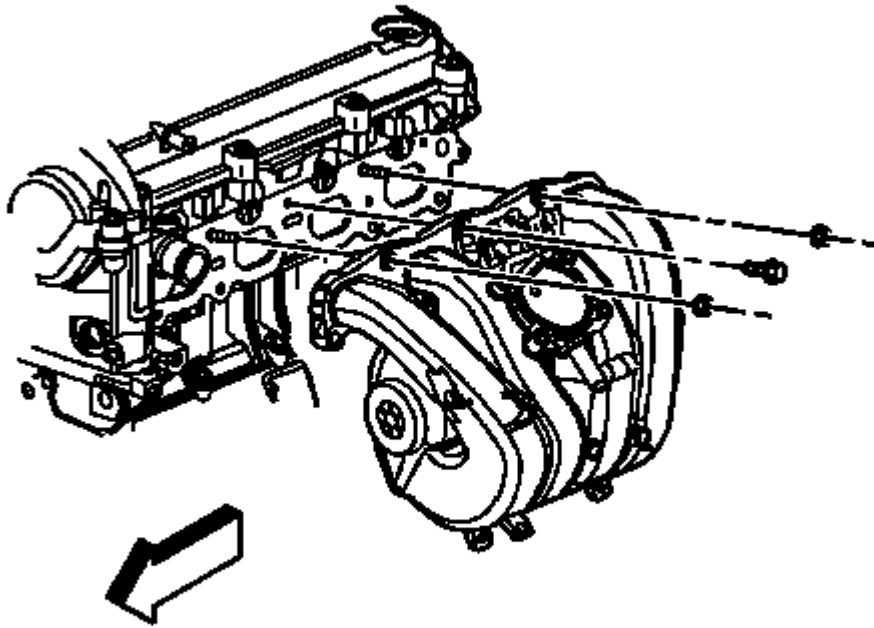


Fig. 57: Identifying Intake Manifold, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold gasket, if necessary.
2. Install the intake manifold.

CAUTION: Refer to Fastener Caution .

3. Install the intake manifold bolts and nuts.

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

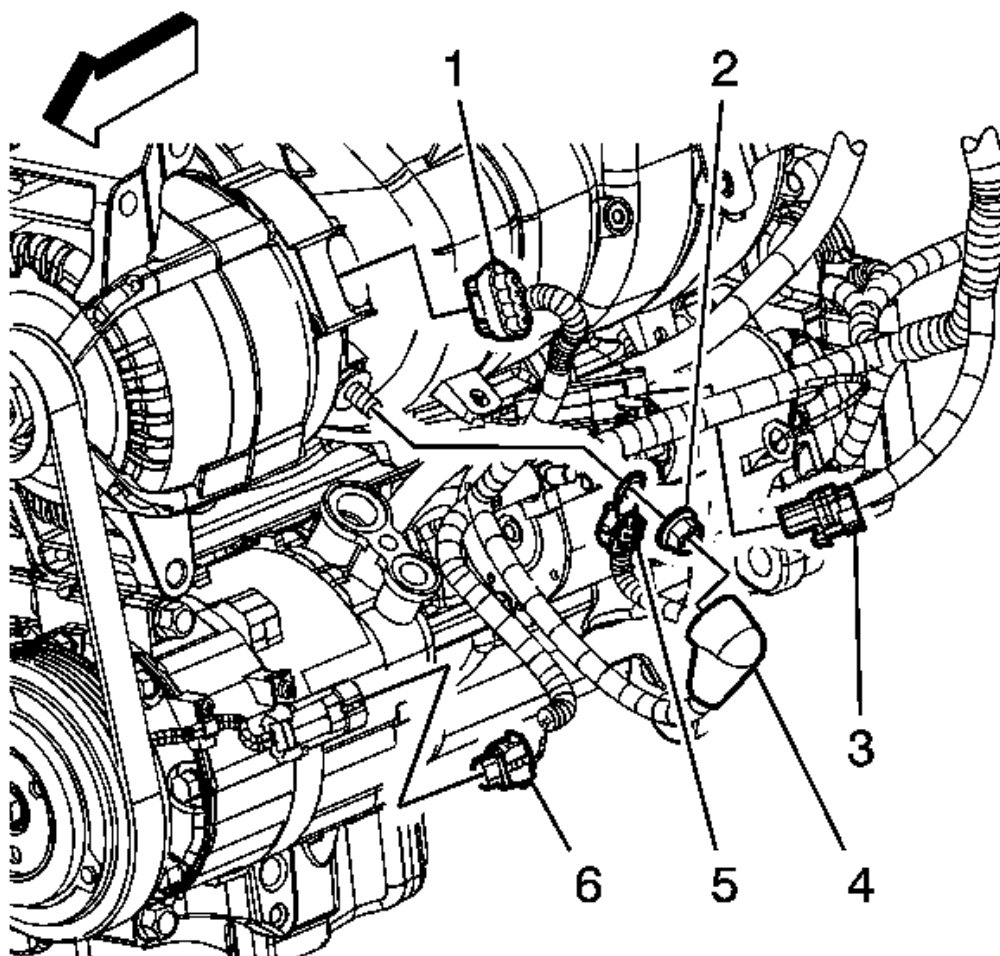


Fig. 58: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Position the engine harness.
5. Install the knock sensor connector clip to the oil level indicator tube.
6. Connect the engine harness electrical connector (3) to the knock sensor harness.

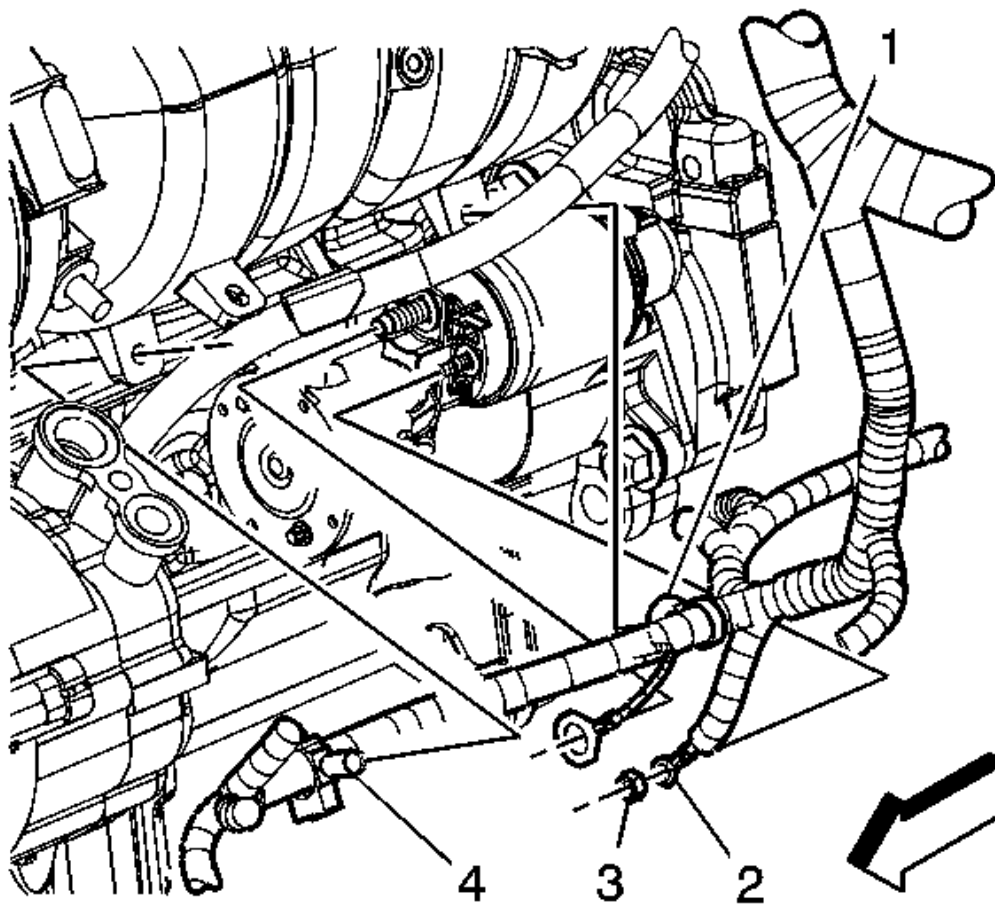


Fig. 59: Identifying Intake Manifold Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

7. Install the engine harness clip (4) to the intake manifold.

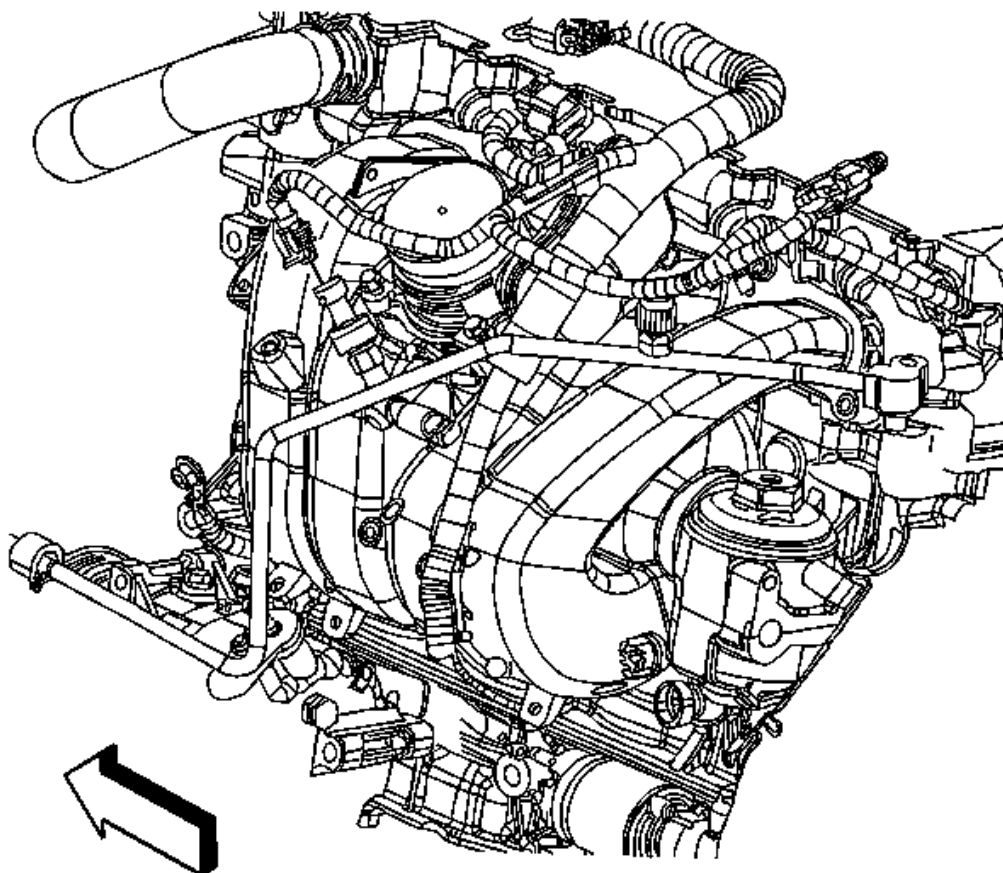


Fig. 60: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Connect the A/C refrigerant pressure sensor electrical connector.

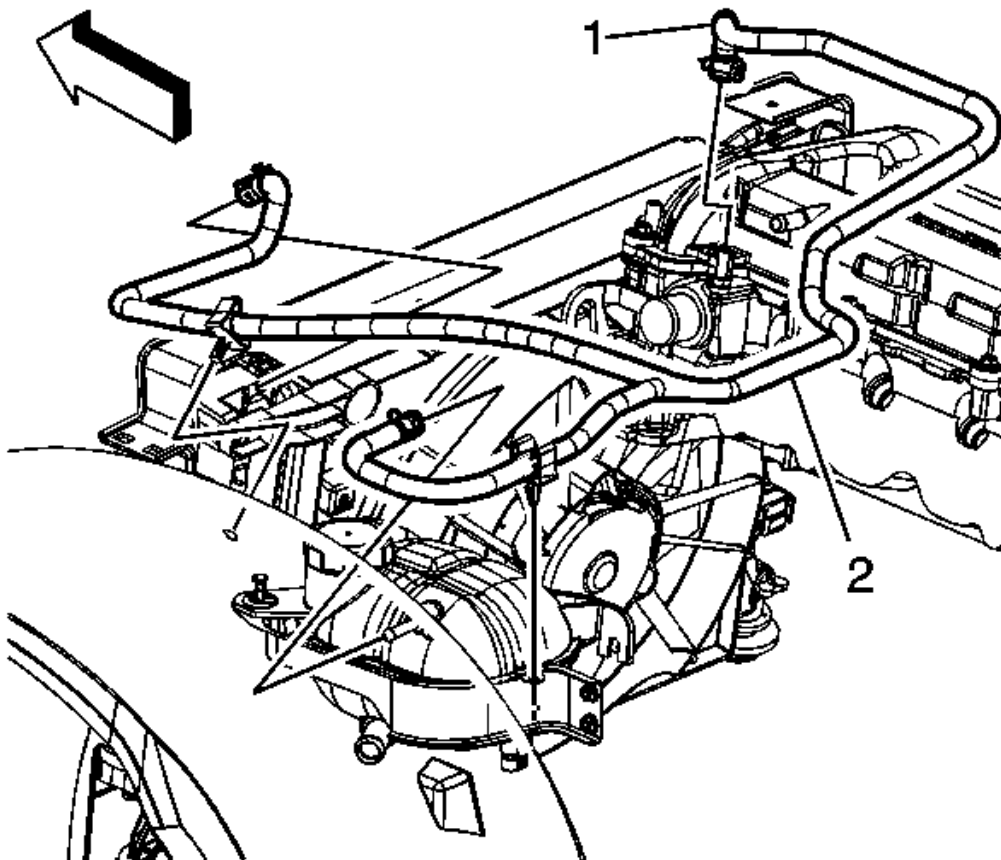


Fig. 61: Identifying Air Bleed Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

9. Position and install the air bleed hose (2) to the engine.
10. Position the radiator surge tank air bleed hose clamp at the engine (1).

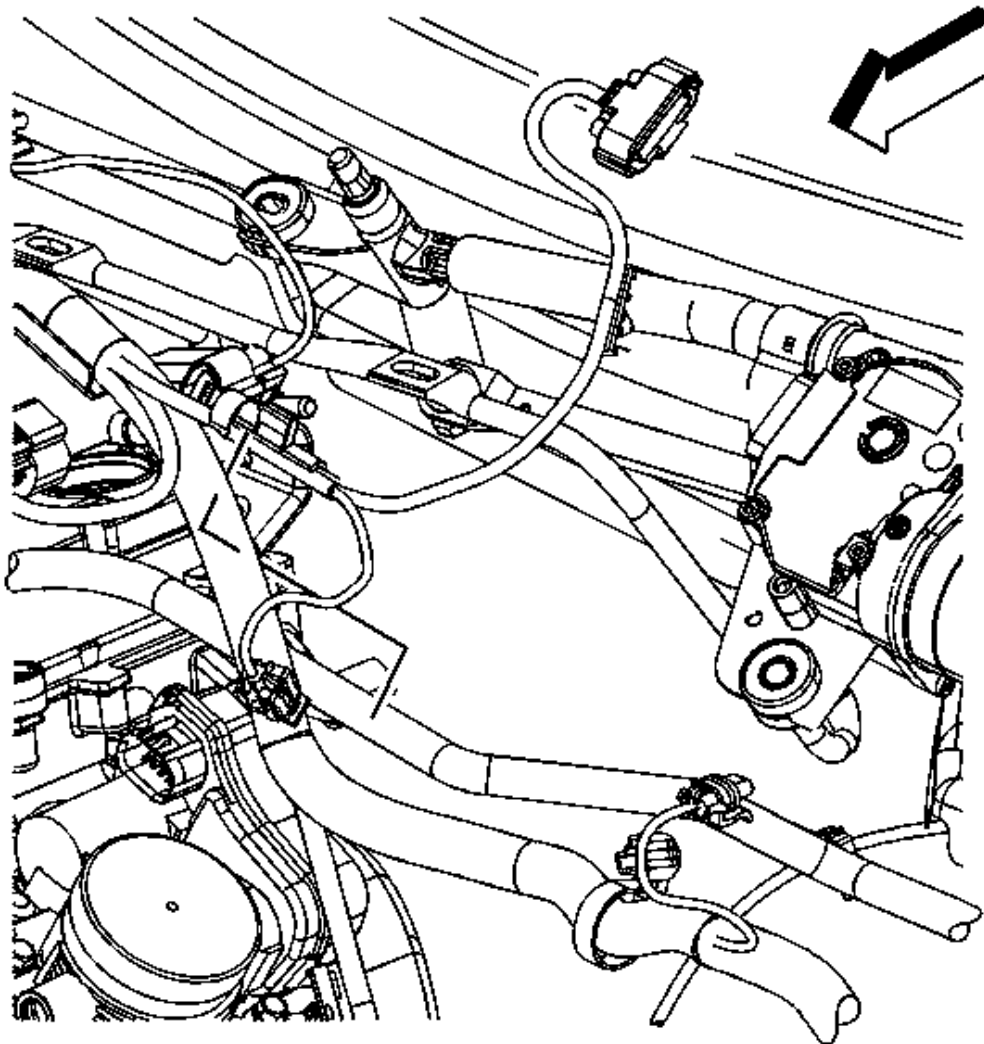


Fig. 62: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

11. Install the engine harness clip to the surge tank air bleed hose.

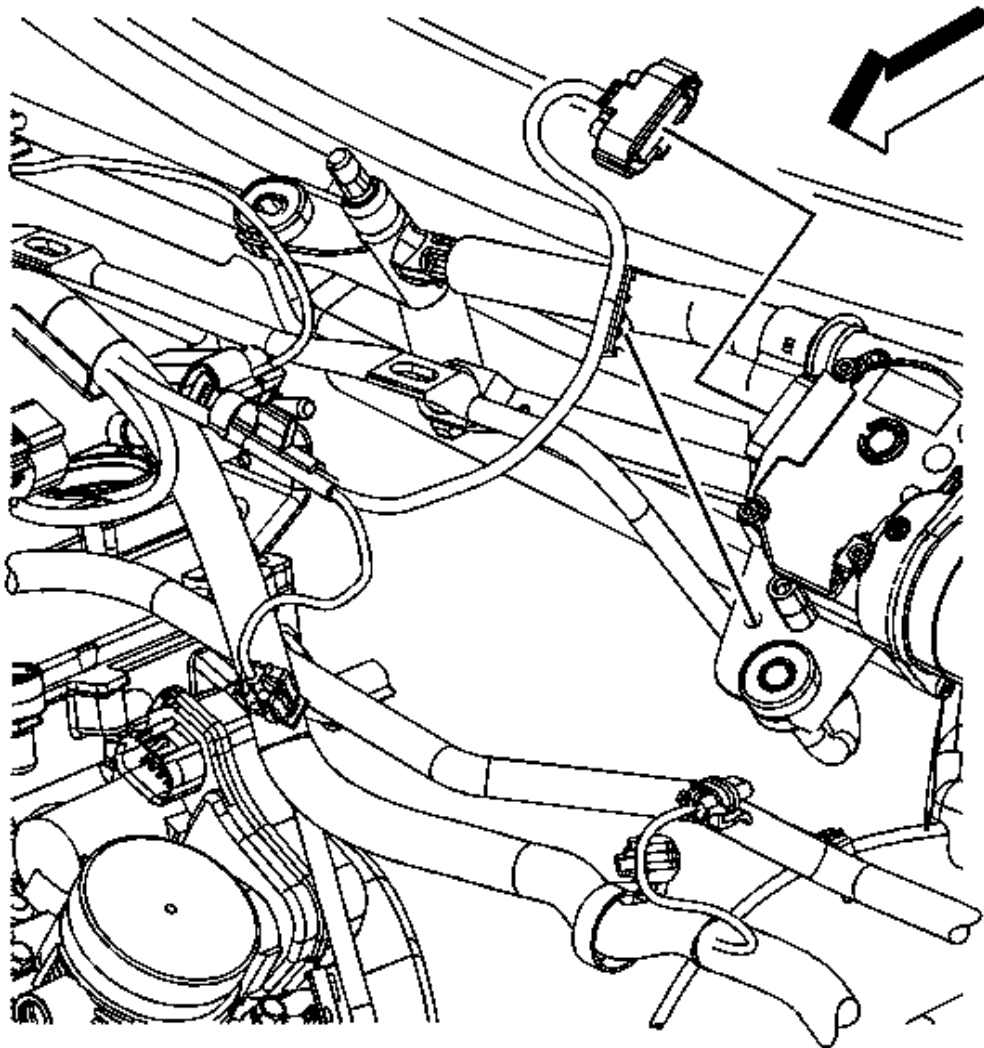


Fig. 63: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Connect the windshield wiper motor electrical connector.
13. Install the engine harness clip to the wiper motor.

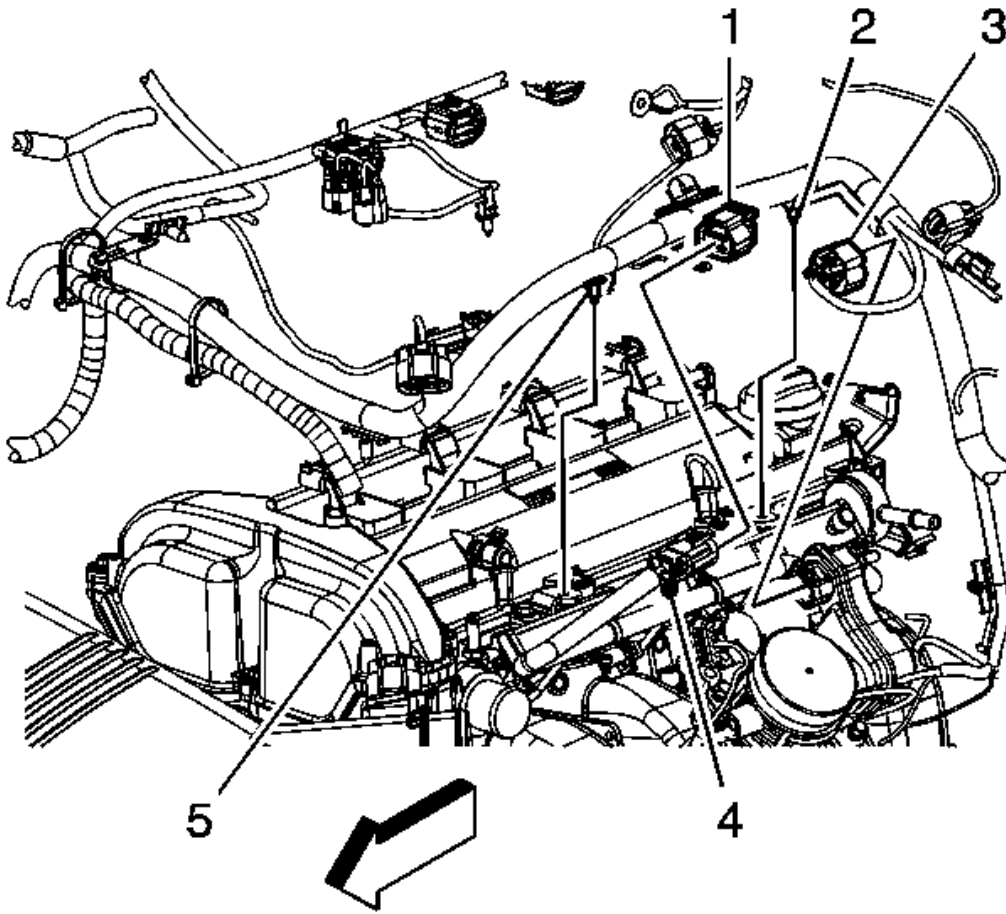


Fig. 64: View Of Fuel System Electrical Connectors & Harness Clips
Courtesy of GENERAL MOTORS CORP.

14. Connect the electronic throttle actuator electrical connector (3).
15. Connect the engine harness electrical connector (1) to the fuel injector electrical connector.
16. Install the oil level indicator tube bolt.

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

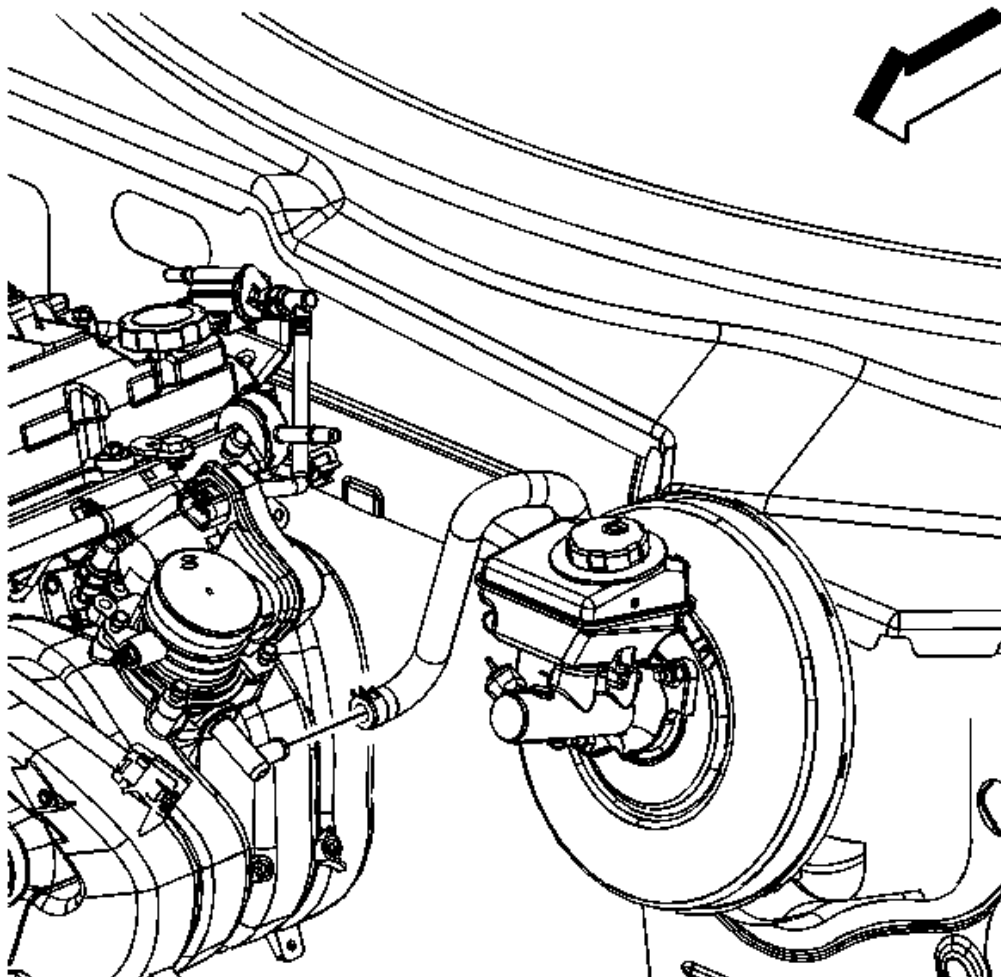


Fig. 65: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

17. Install the brake booster hose to the intake manifold.
18. Position the brake booster vacuum hose clamp at the intake manifold.

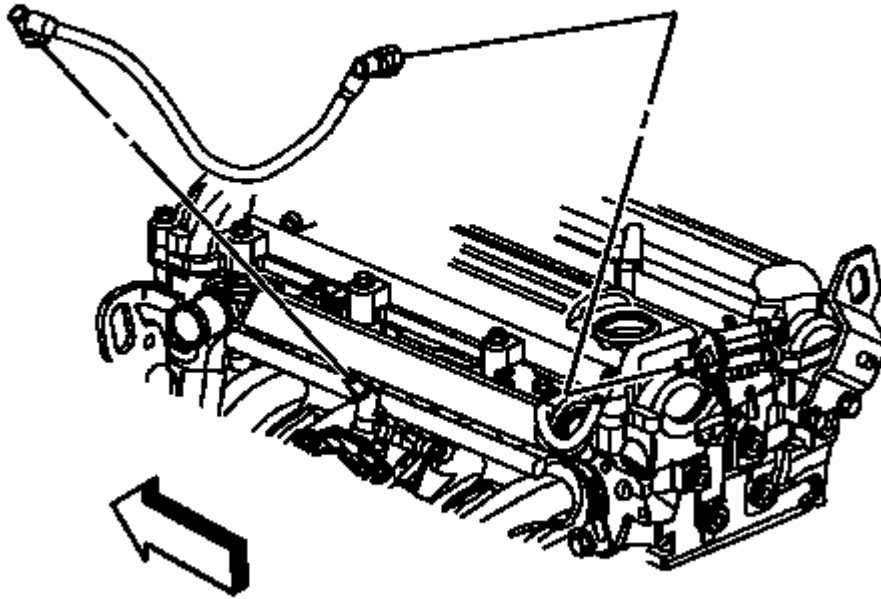


Fig. 66: Identifying EVAP Canister Purge Solenoid Valve Tube
Courtesy of GENERAL MOTORS CORP.

19. Install the EVAP canister purge solenoid valve tube. Refer to Plastic Collar Quick Connect Fitting Service .
20. Install the fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement .
21. Install the throttle body. Refer to Throttle Body Assembly Replacement .
22. Install the intake manifold cover. Refer to Intake Manifold Cover Replacement.

CRANKSHAFT BALANCER REPLACEMENT

SPECIAL TOOLS

- **J 43653** Flywheel Holding Tool. See Special Tools .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

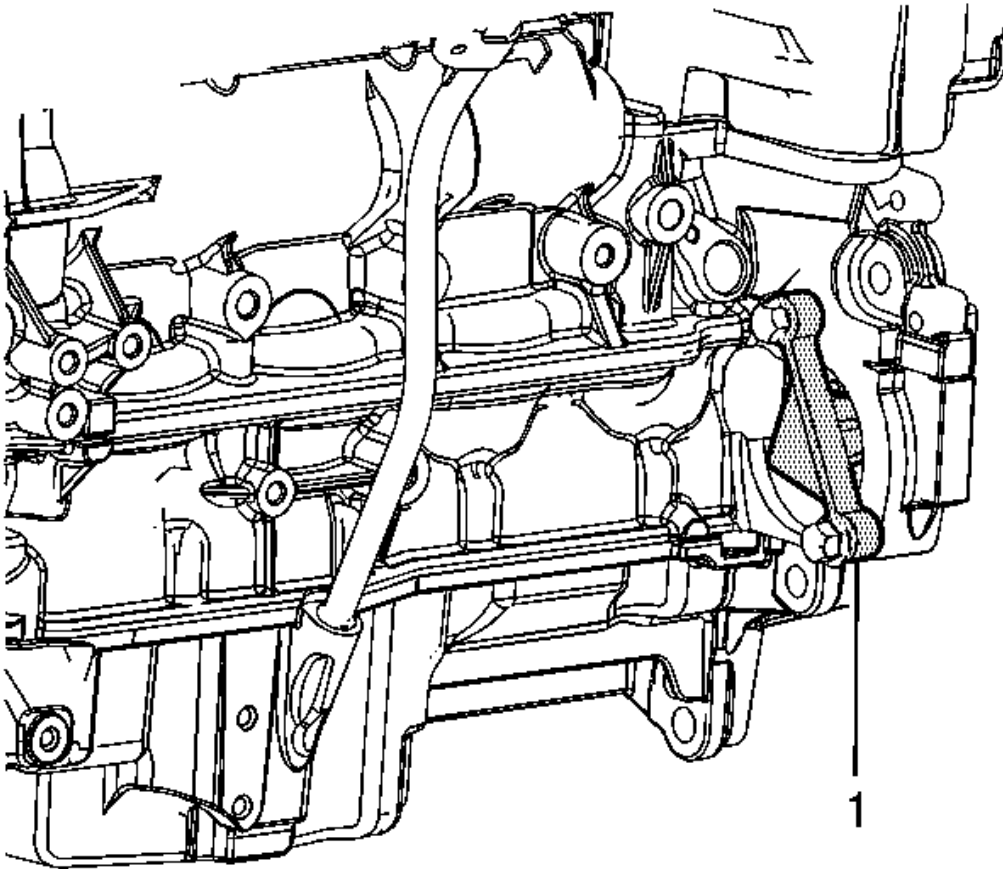


Fig. 67: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

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

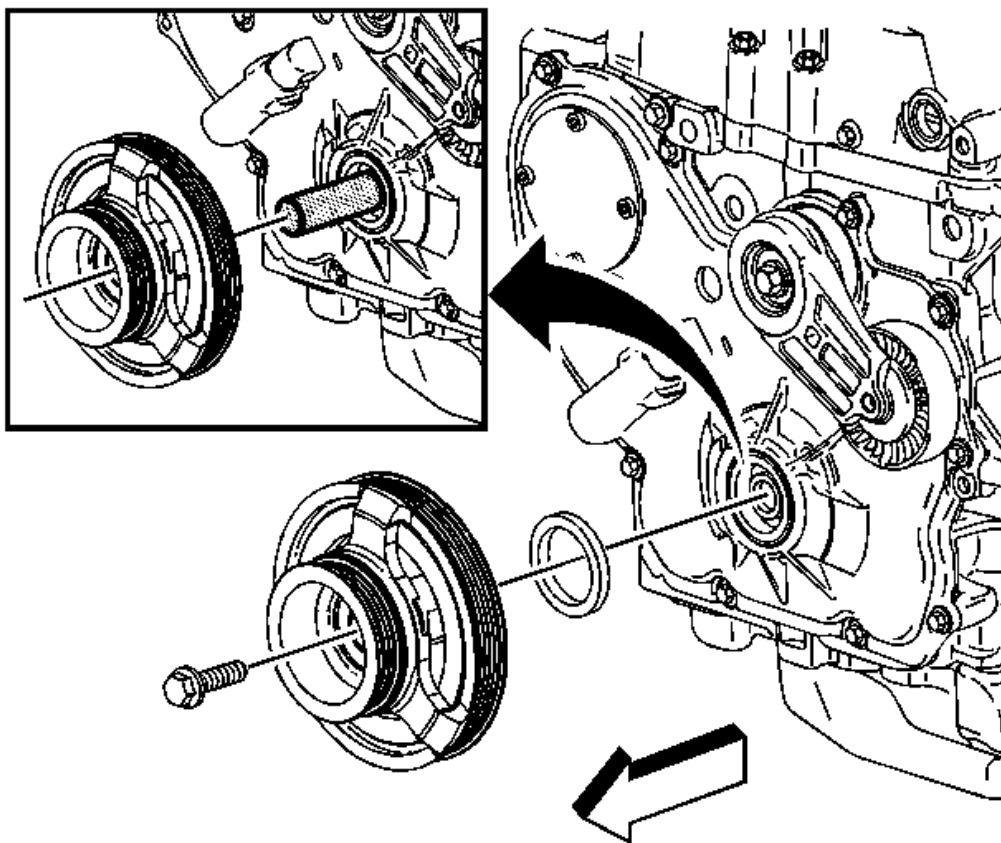


Fig. 68: View Of Crankshaft Balancer, Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

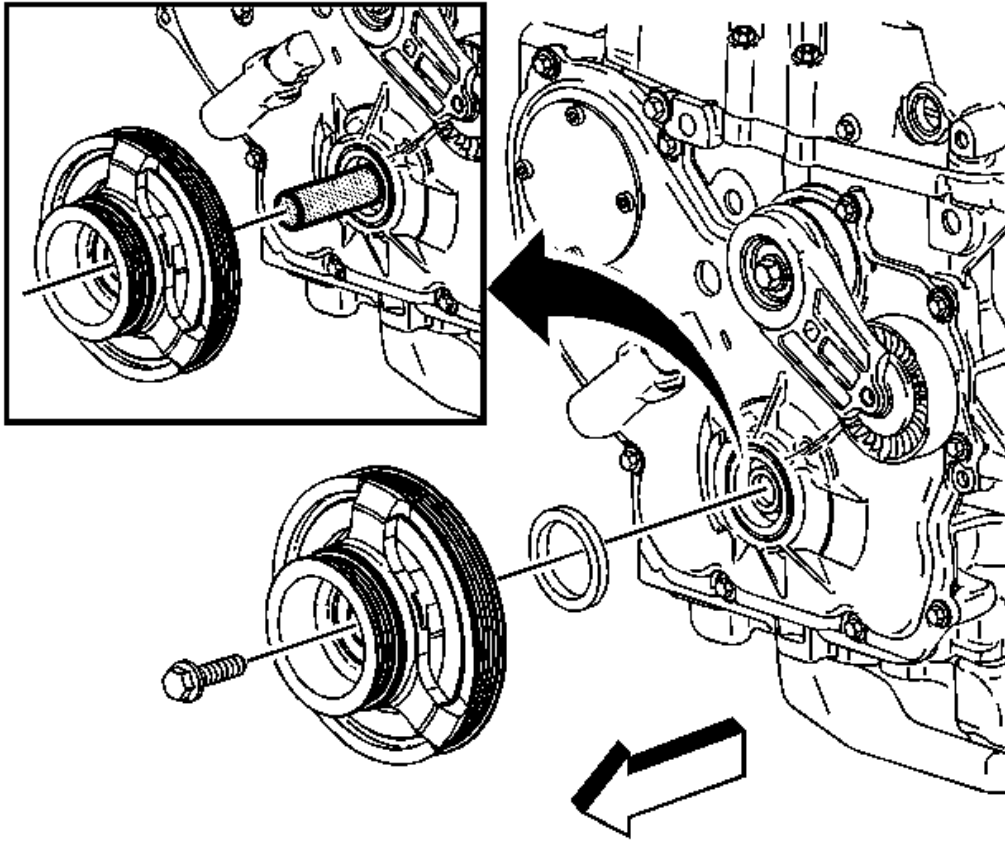


Fig. 69: View Of Crankshaft Balancer, Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

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

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

CAUTION: Refer to Fastener Caution .

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

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

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

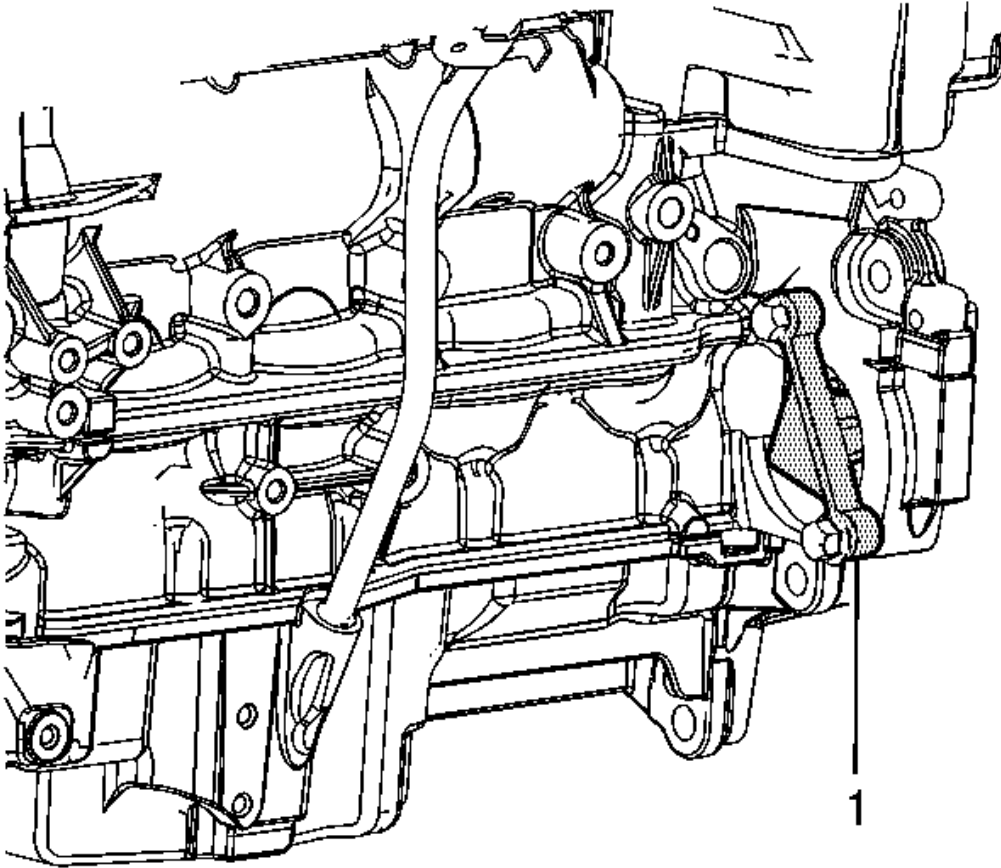


Fig. 70: Identifying Engine Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

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

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 35268-A Camshaft/Front Main Seal Installer. See Special Tools .

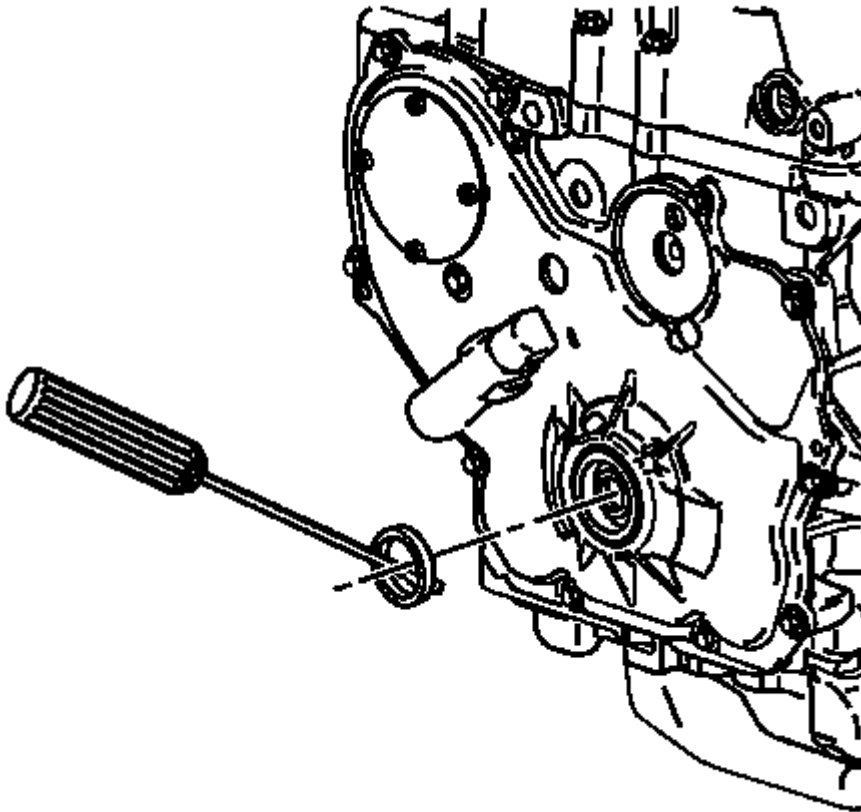
REMOVAL PROCEDURE

Fig. 71: View Of Crankshaft Front Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

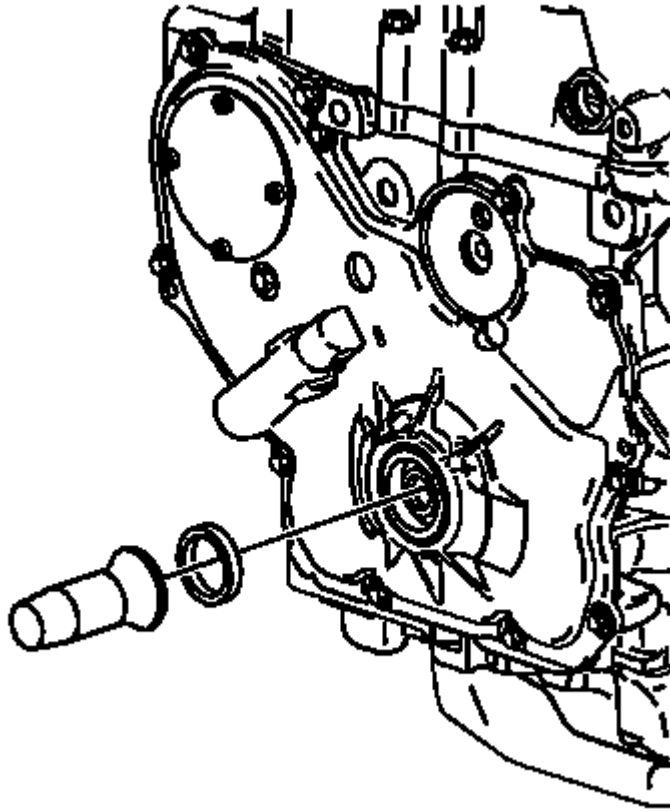


Fig. 72: Identifying Crankshaft Front Oil Seal & Special Tool J 35268-A
Courtesy of GENERAL MOTORS CORP.

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

ENGINE FRONT COVER REPLACEMENT

REMOVAL PROCEDURE

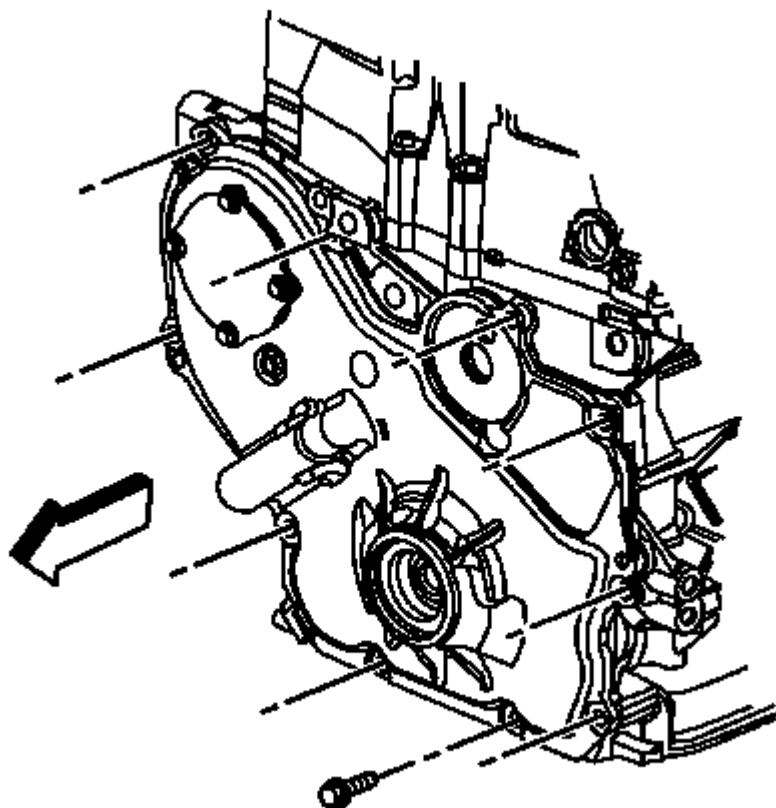


Fig. 73: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

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

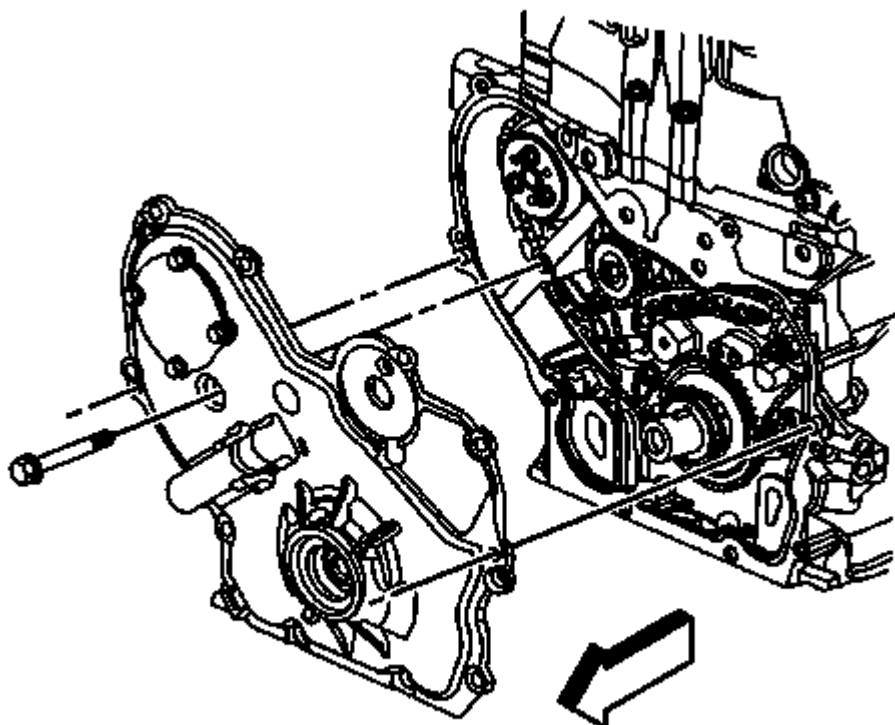


Fig. 74: Identifying Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

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

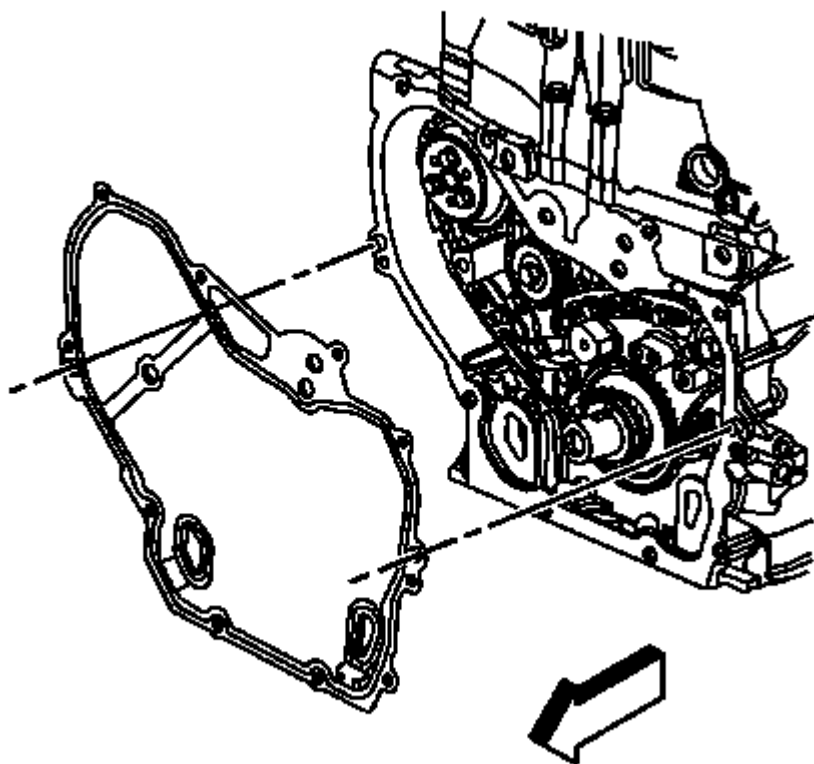


Fig. 75: Identifying Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the engine front cover gasket.

INSTALLATION PROCEDURE

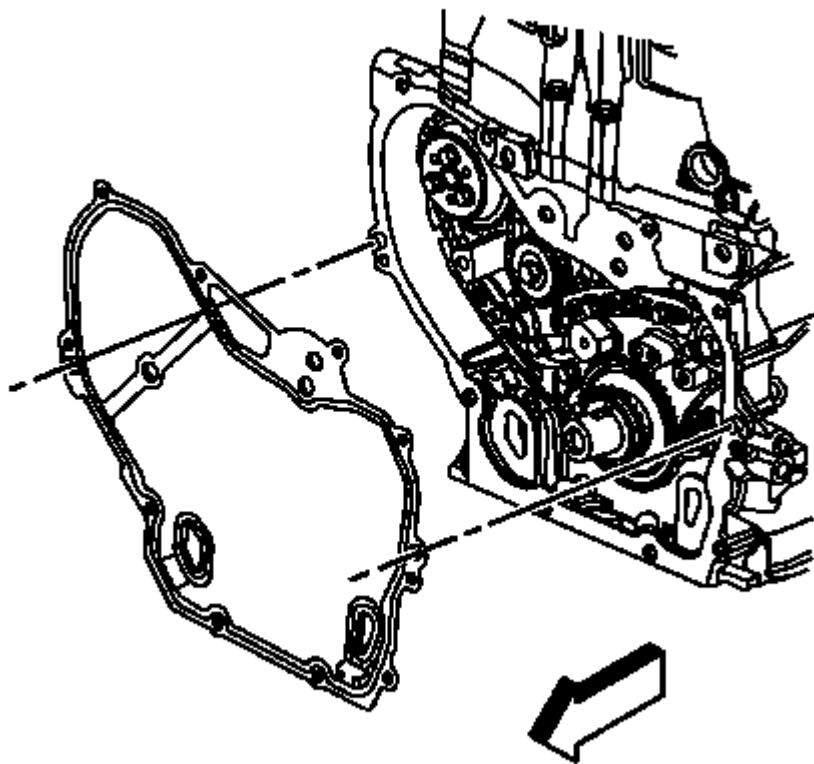


Fig. 76: Identifying Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Position and install a NEW engine front cover gasket to the dowel pins.

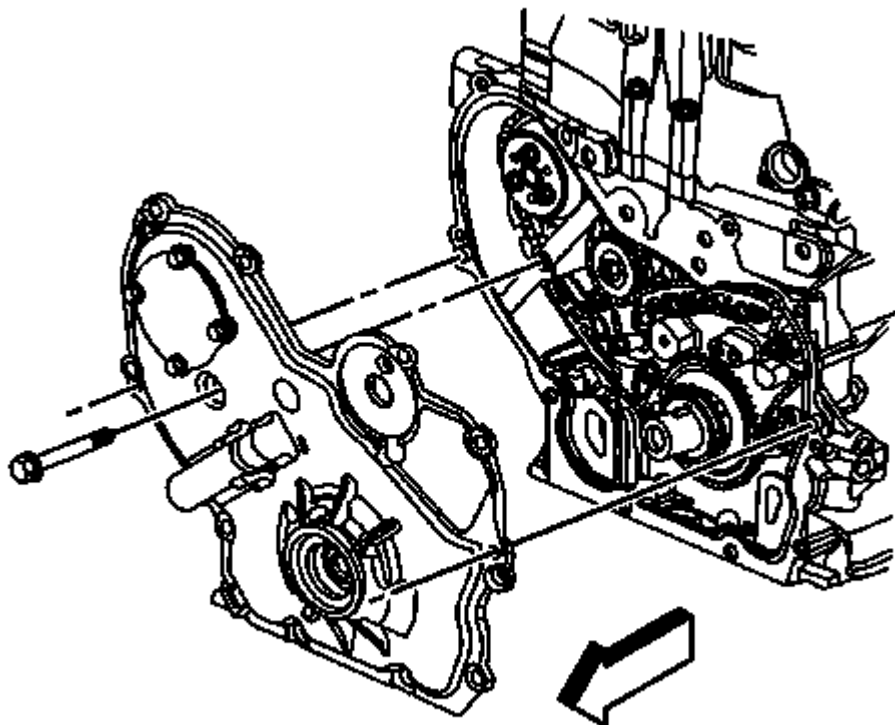


Fig. 77: Identifying Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Position and install the engine front cover.

CAUTION: Refer to Fastener Caution .

3. Install the engine front cover to water pump bolt.

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

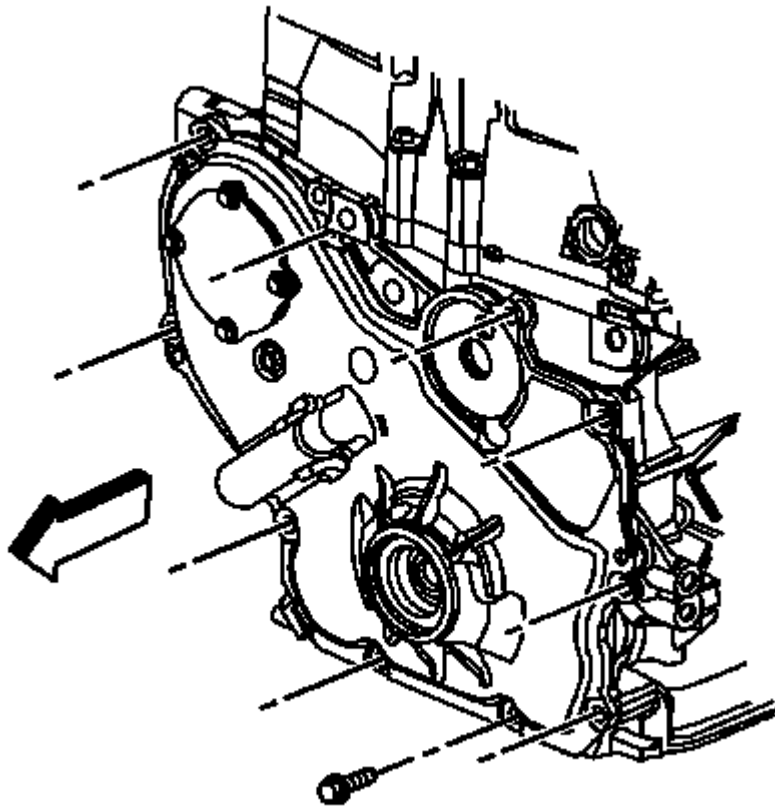


Fig. 78: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the engine front cover bolts.

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

5. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
6. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
7. Install the hood. Refer to [Hood Replacement](#).

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

SPECIAL TOOLS

- J 45027 Tensioner Tool
- J 45059 Angle Meter

REMOVAL PROCEDURE

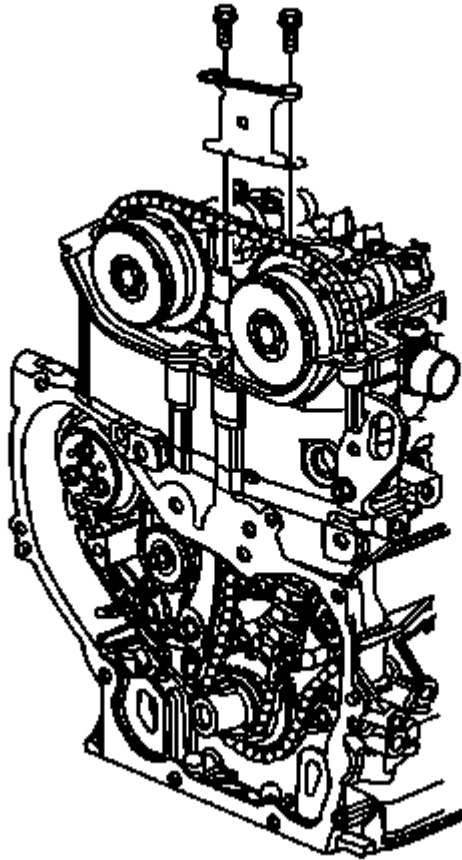


Fig. 79: View Of Upper Timing Chain Guide Bolts And Guide
 Courtesy of GENERAL MOTORS CORP.

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

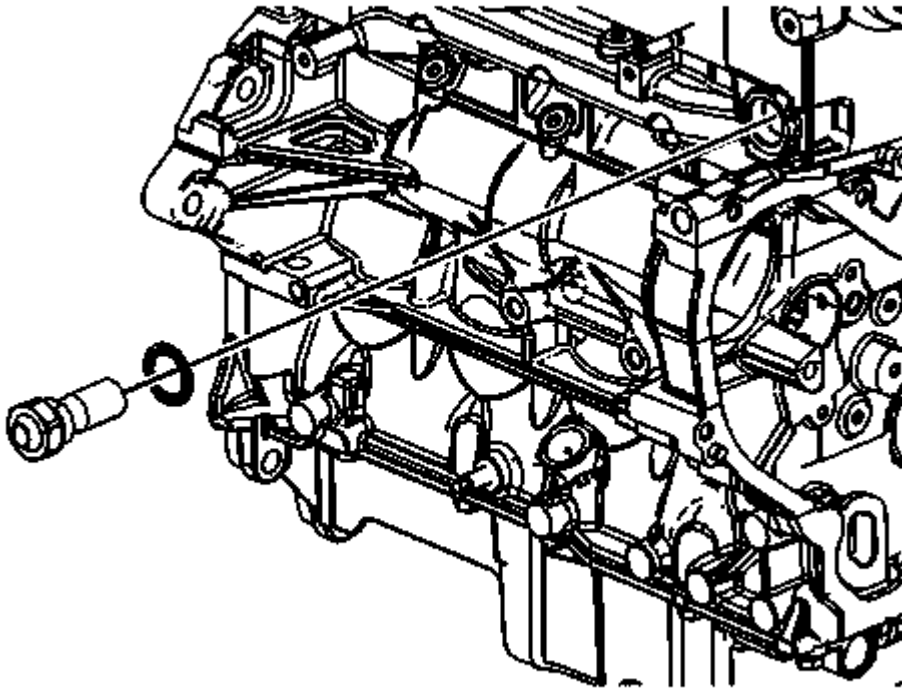


Fig. 80: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

7. Remove the timing chain tensioner.

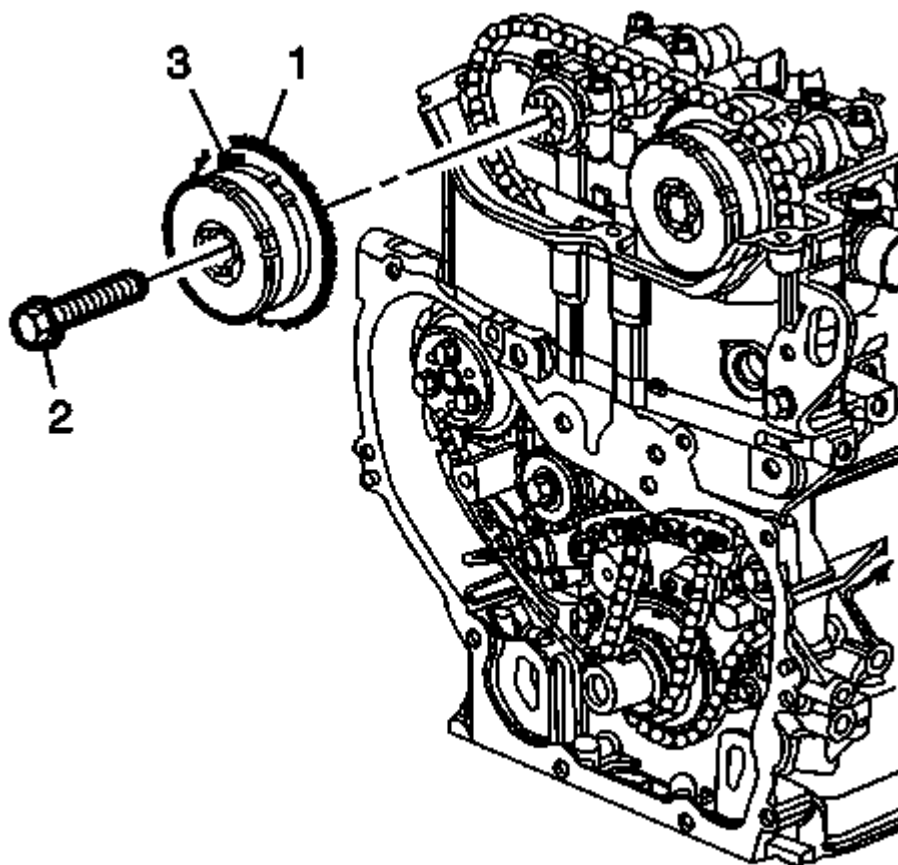


Fig. 81: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

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

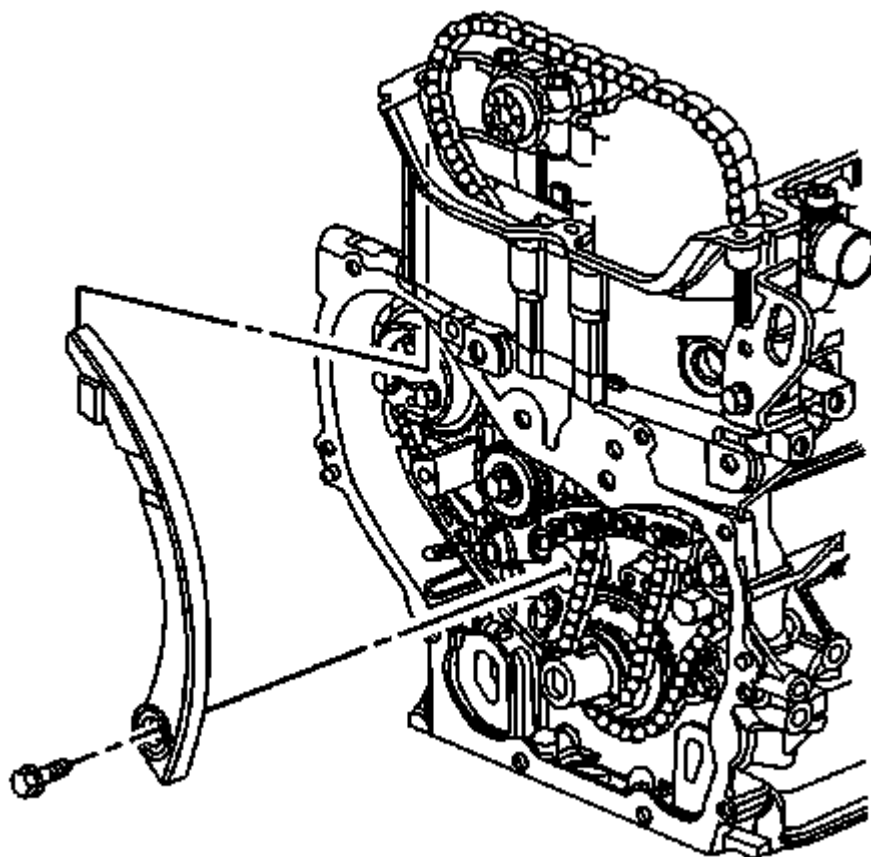


Fig. 82: Identifying Timing Chain Tensioner & Guide
Courtesy of GENERAL MOTORS CORP.

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

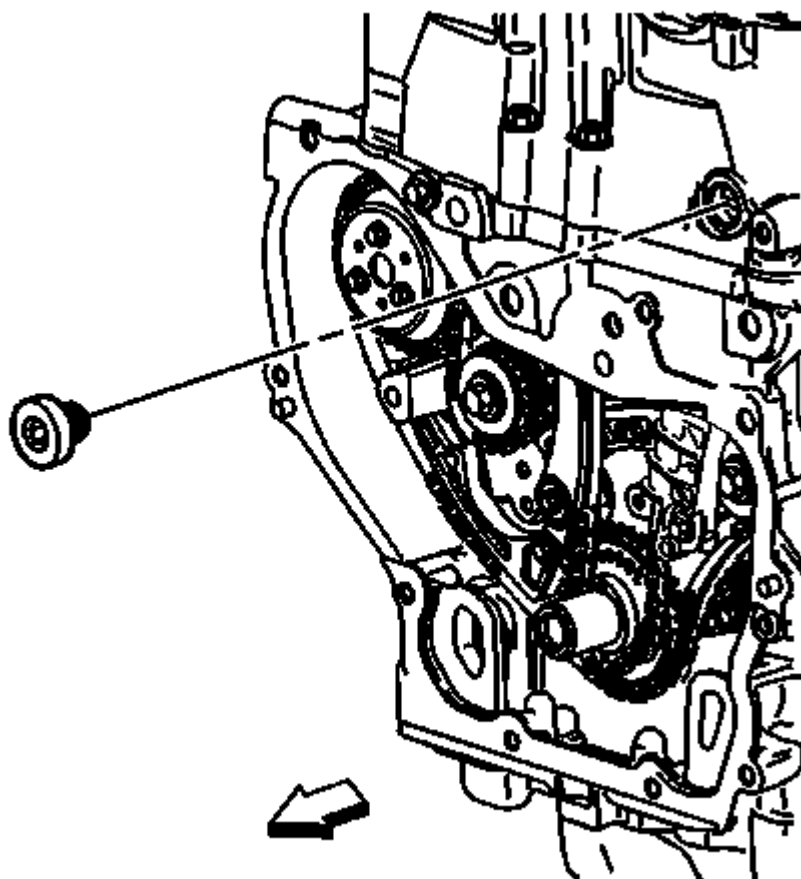


Fig. 83: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

12. Remove the fixed timing chain guide access plug.

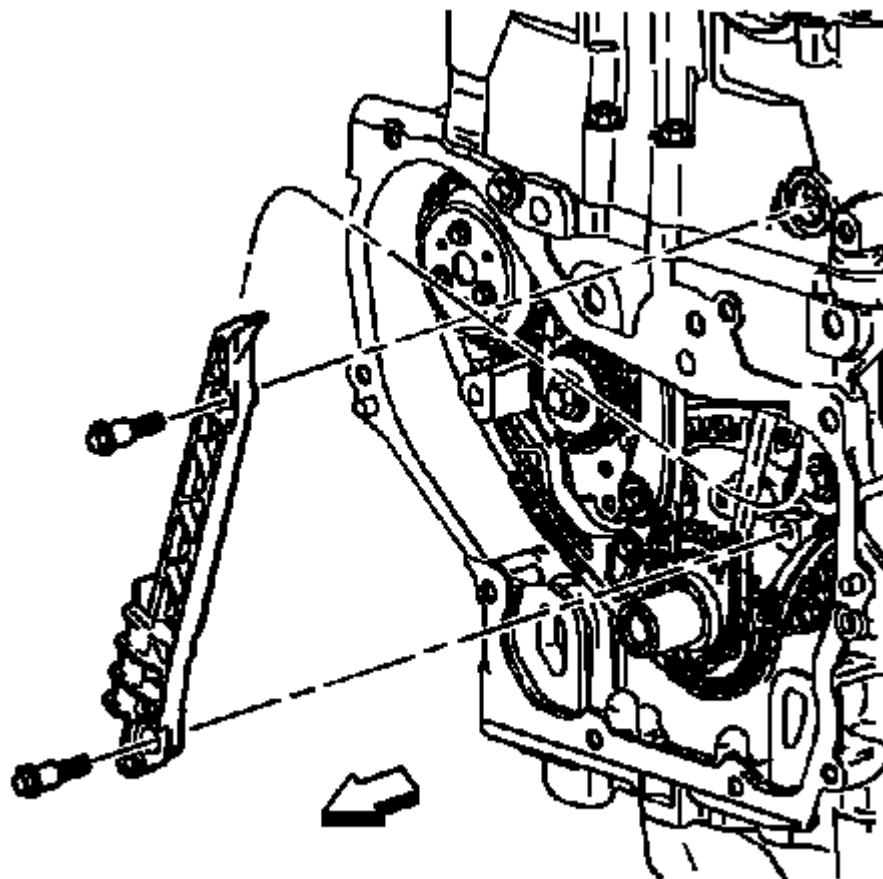


Fig. 84: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

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

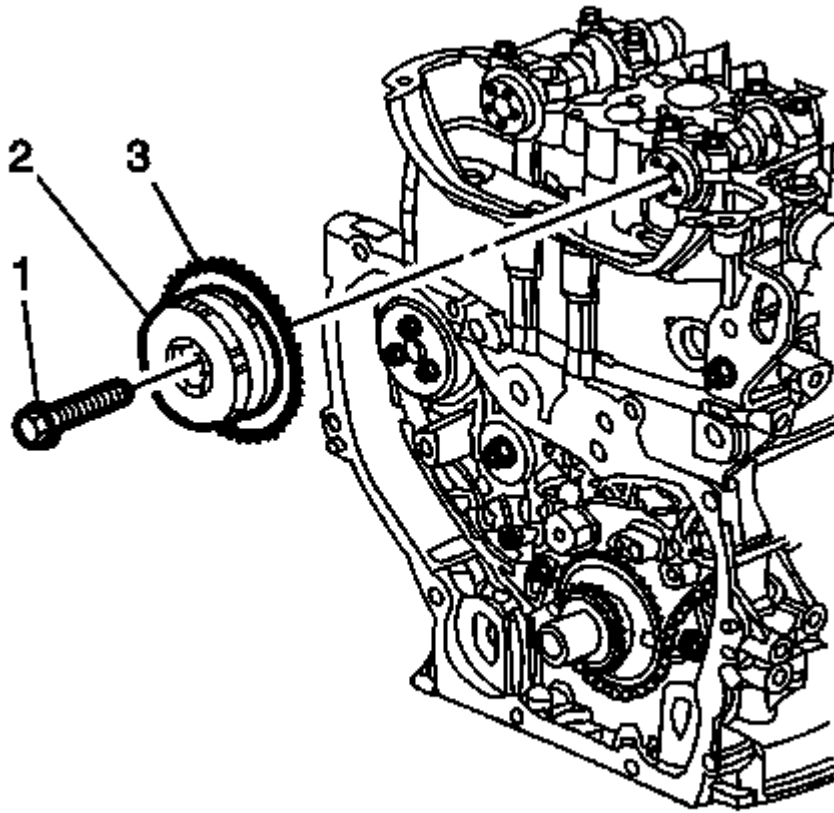


Fig. 85: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

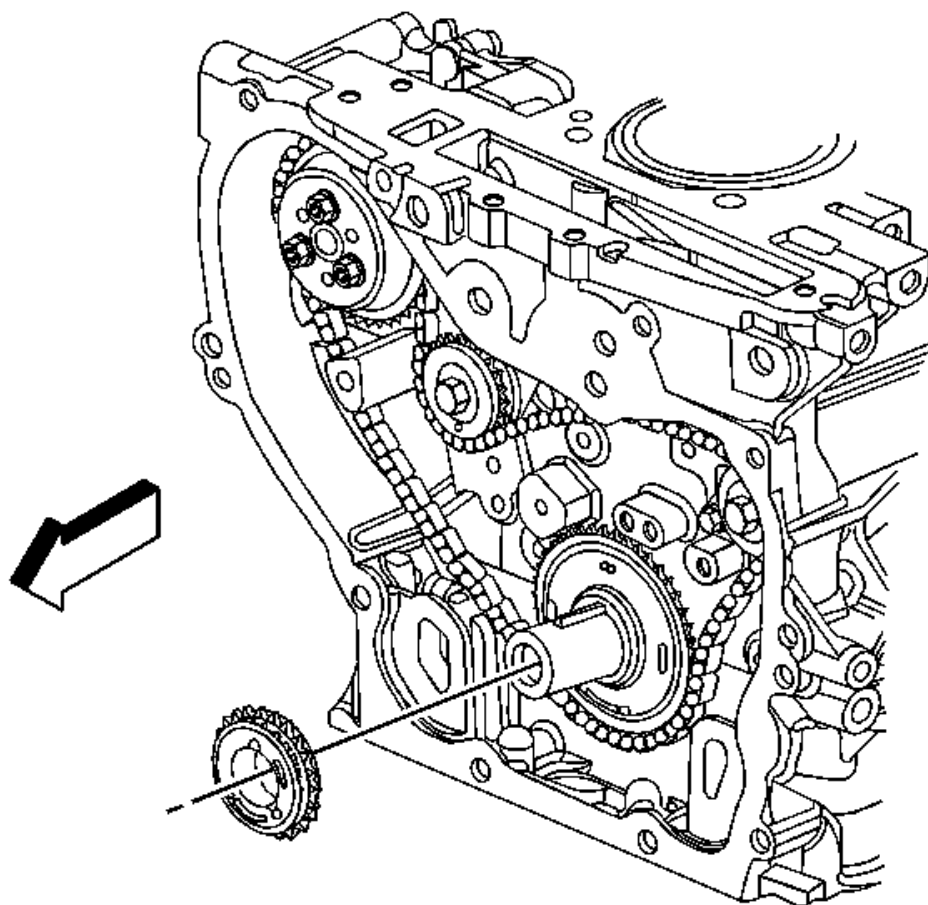


Fig. 86: Identifying Timing Chain Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

17. Remove the timing chain crankshaft sprocket.

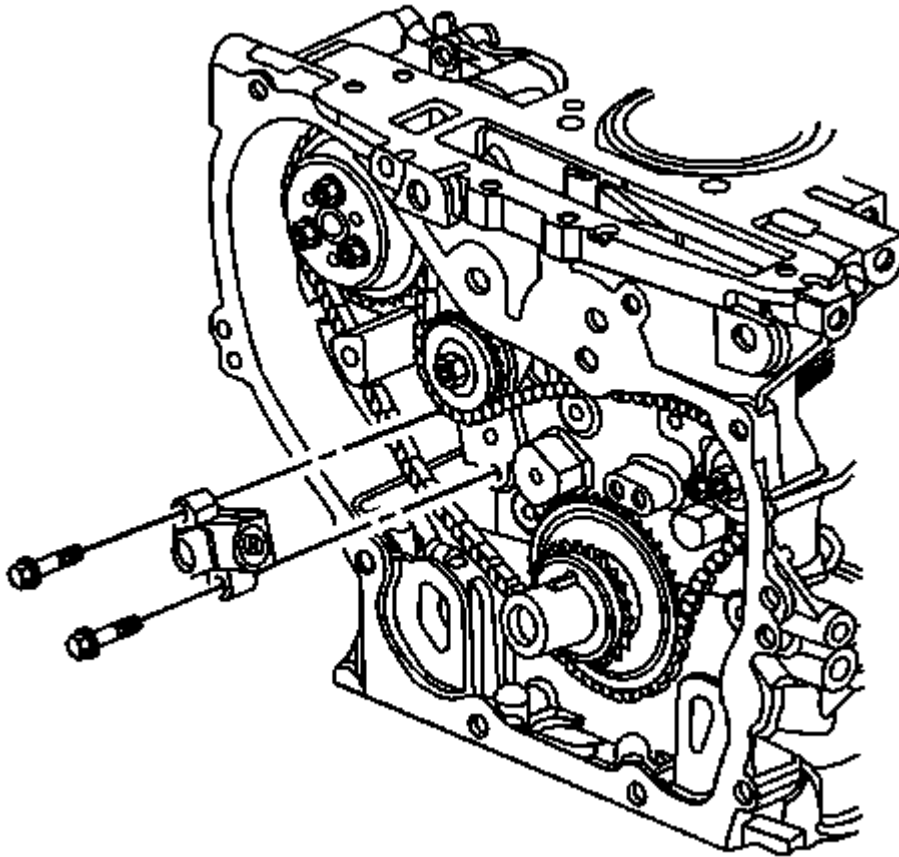


Fig. 87: Identifying Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

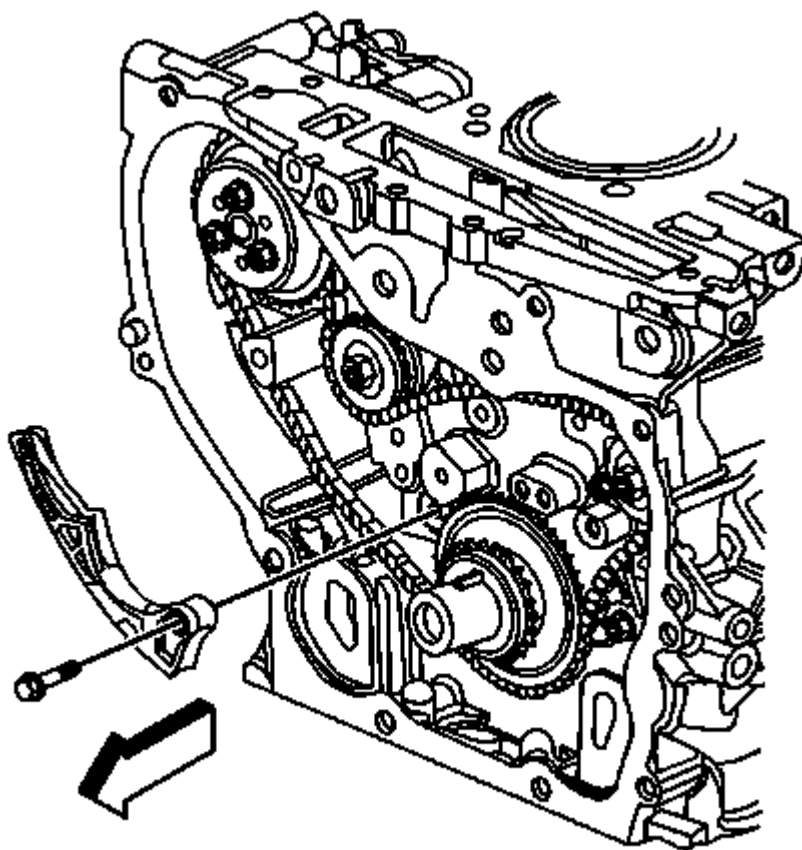


Fig. 88: Identifying Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

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

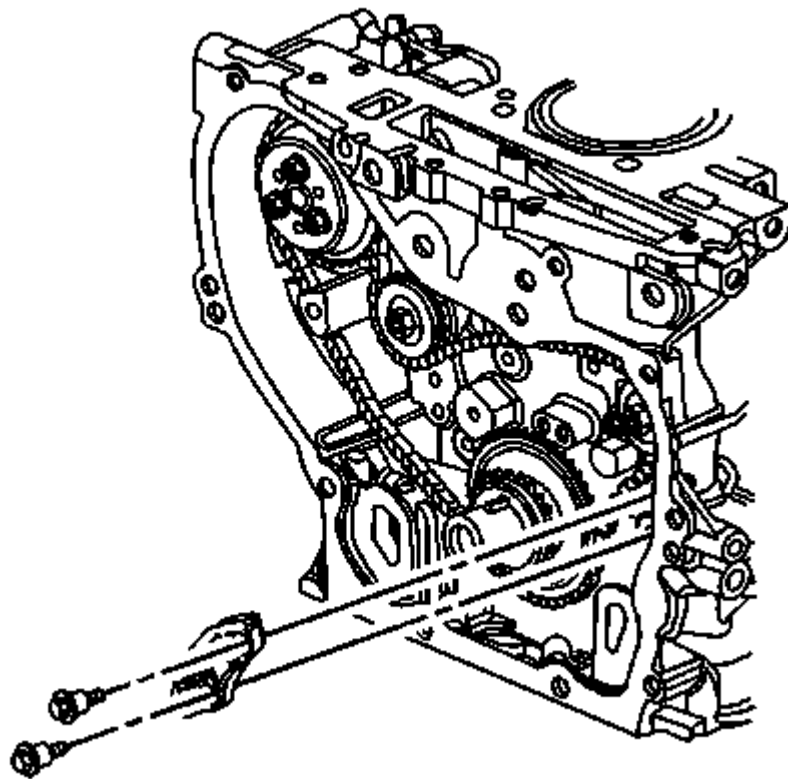


Fig. 89: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

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

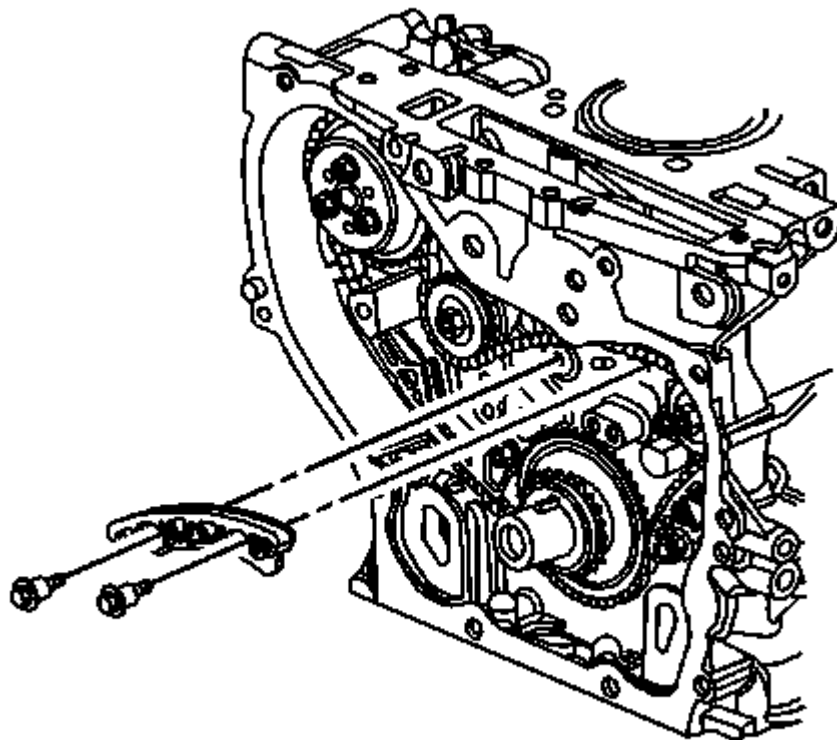


Fig. 90: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

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

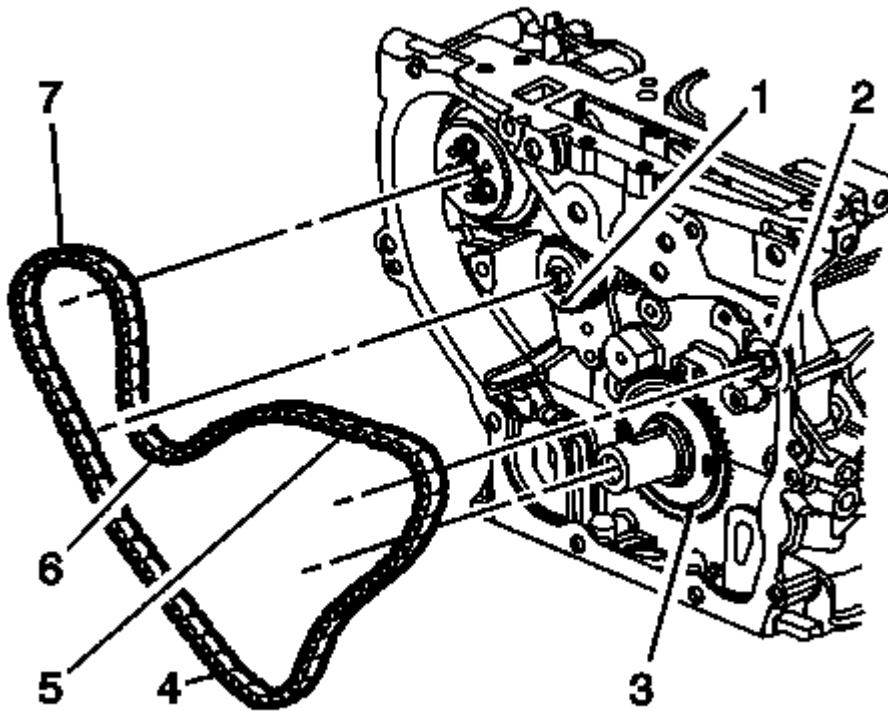


Fig. 91: Identifying Balance Shaft Drive Chain Components
Courtesy of GENERAL MOTORS CORP.

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

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

INSTALLATION PROCEDURE

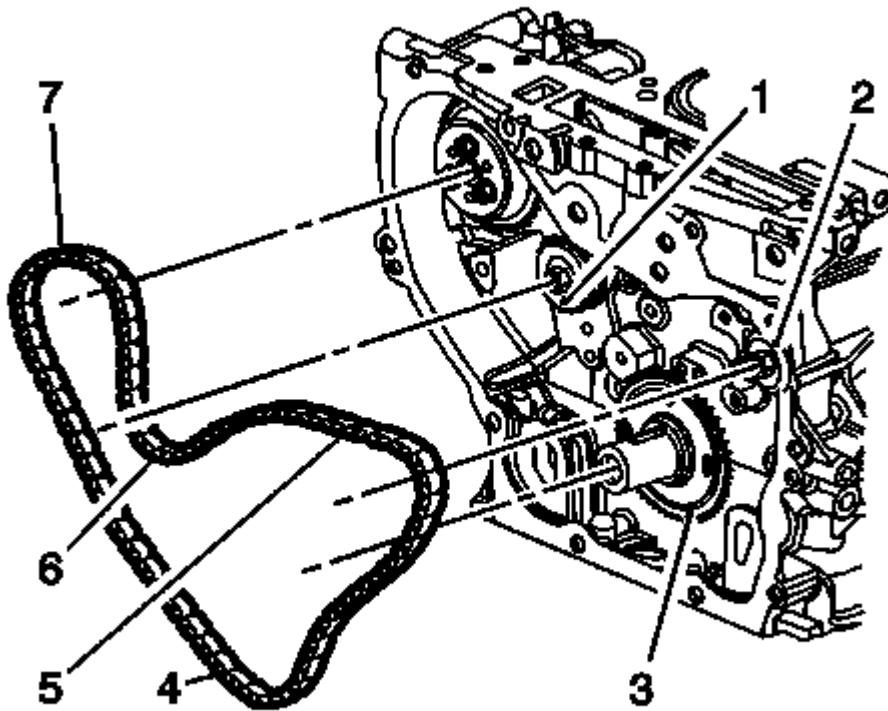


Fig. 92: Identifying Balance Shaft Drive Chain Components
Courtesy of GENERAL MOTORS CORP.

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

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

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

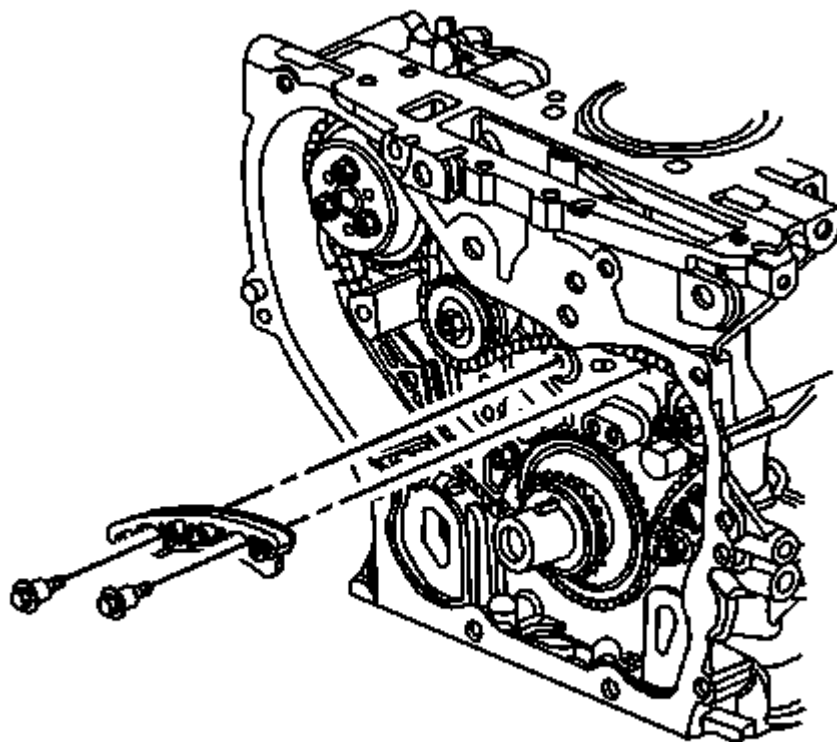


Fig. 93: Identifying Upper Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the upper balance shaft drive chain guide and bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

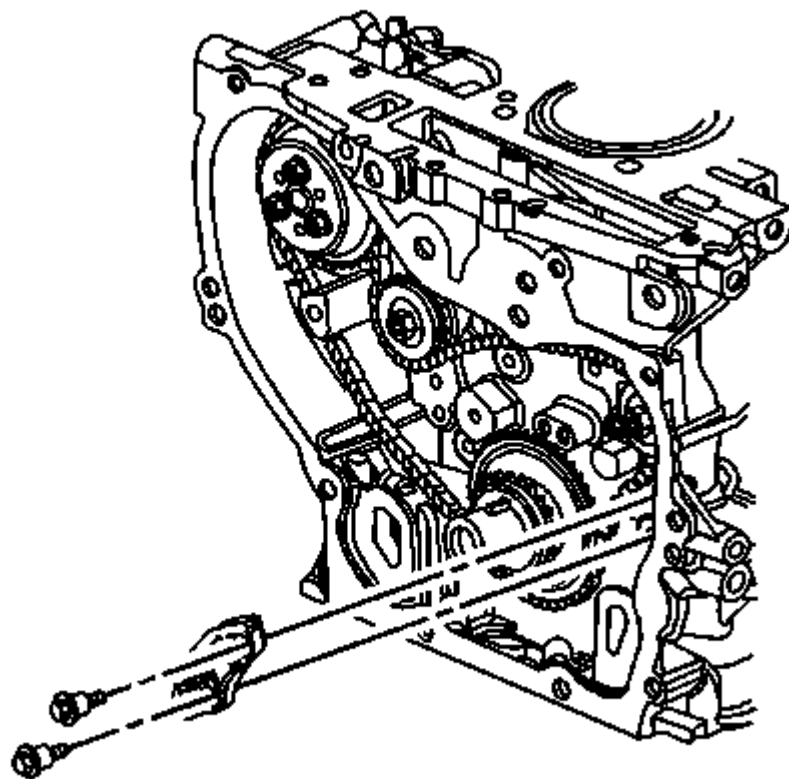


Fig. 94: Identifying Small Balance Shaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

5. Install the small balance shaft drive chain guide and bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

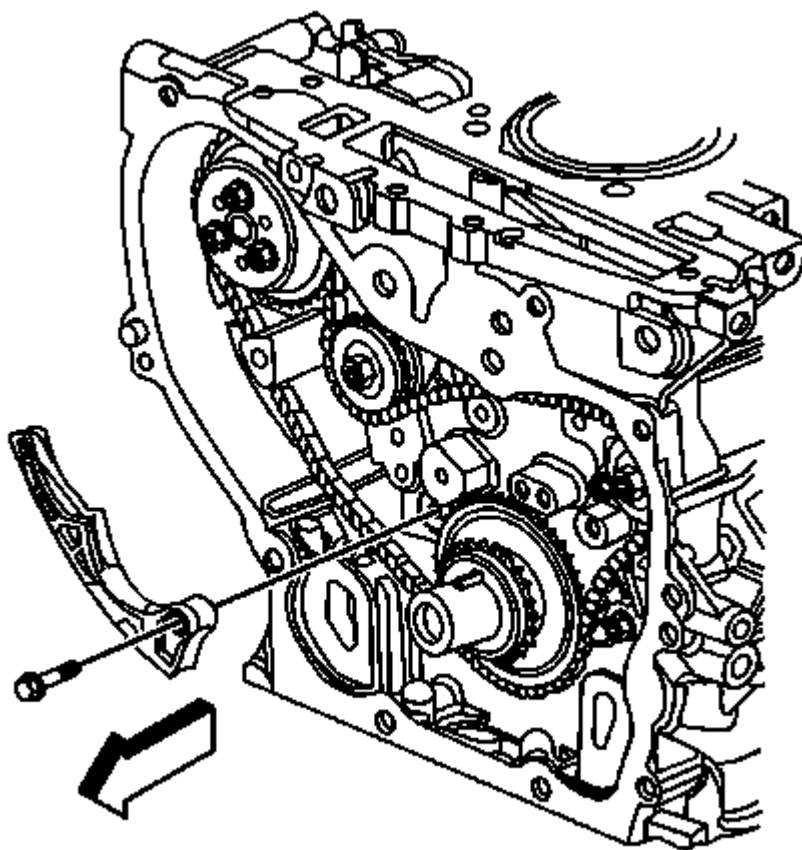


Fig. 95: Identifying Adjustable Balance Shaft Chain Guide
Courtesy of GENERAL MOTORS CORP.

6. Install the adjustable balance shaft chain guide and bolt.

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

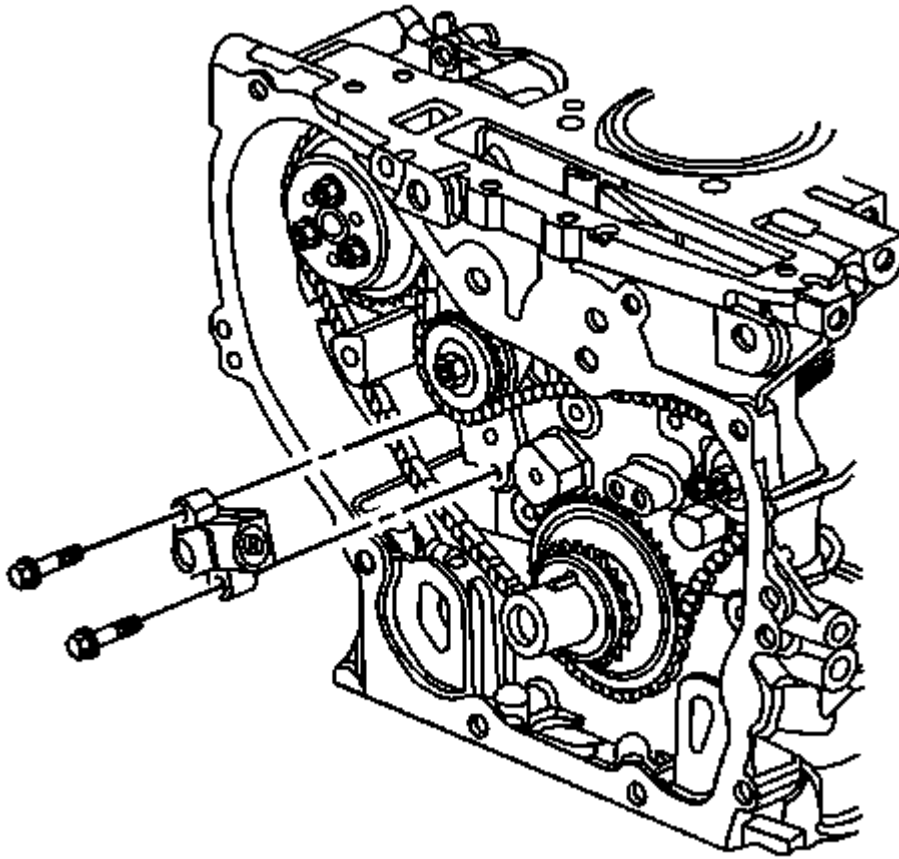


Fig. 96: Identifying Balance Shaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Reset the timing chain tensioner by performing the following steps:
 - Rotate the tensioner plunger 90 degrees in its bore and compress the plunger.
 - Rotate the tensioner back to the original 12 o'clock position and insert a paper clip through the hole in the plunger body and into the hose in the tensioner plunger.
8. Install the balance shaft drive chain tensioner and bolts.

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

9. Remove the paper clip from the balance shaft drive chain tensioner.

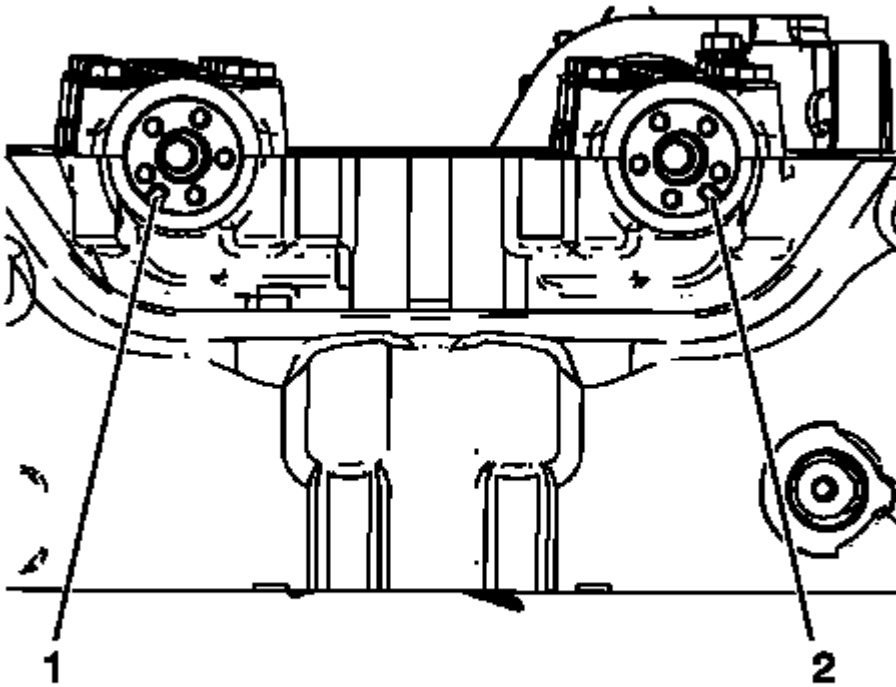


Fig. 97: Identifying Proper Exhaust/Intake Camshaft Alignment positions
Courtesy of GENERAL MOTORS CORP.

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

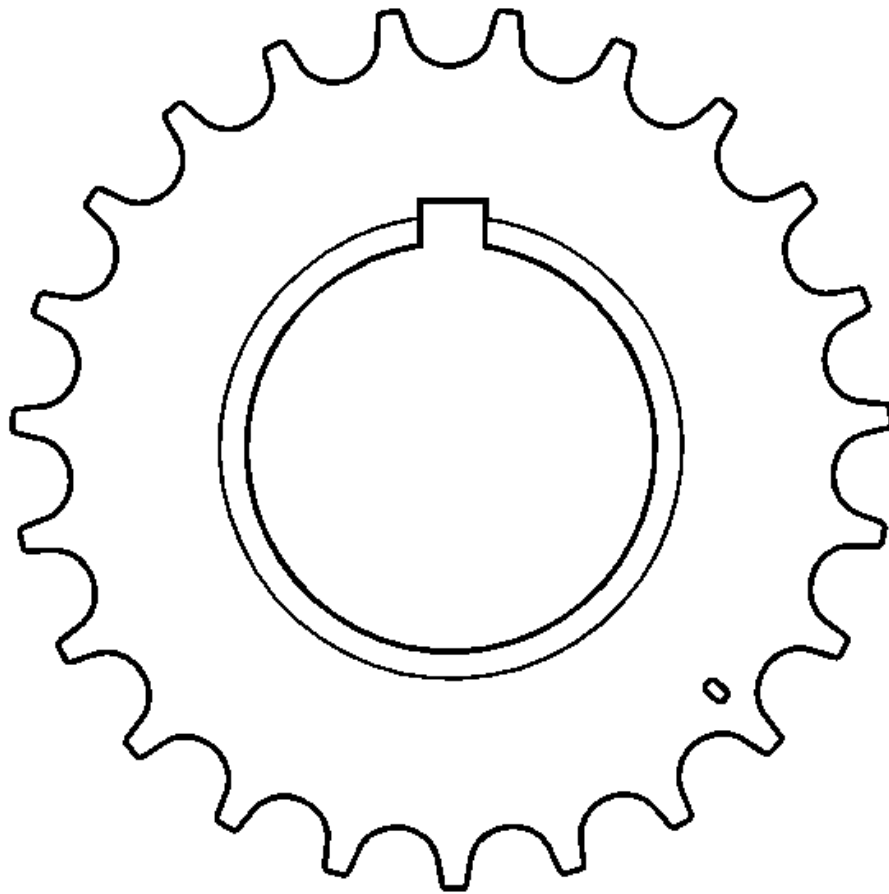


Fig. 98: View Of Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

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

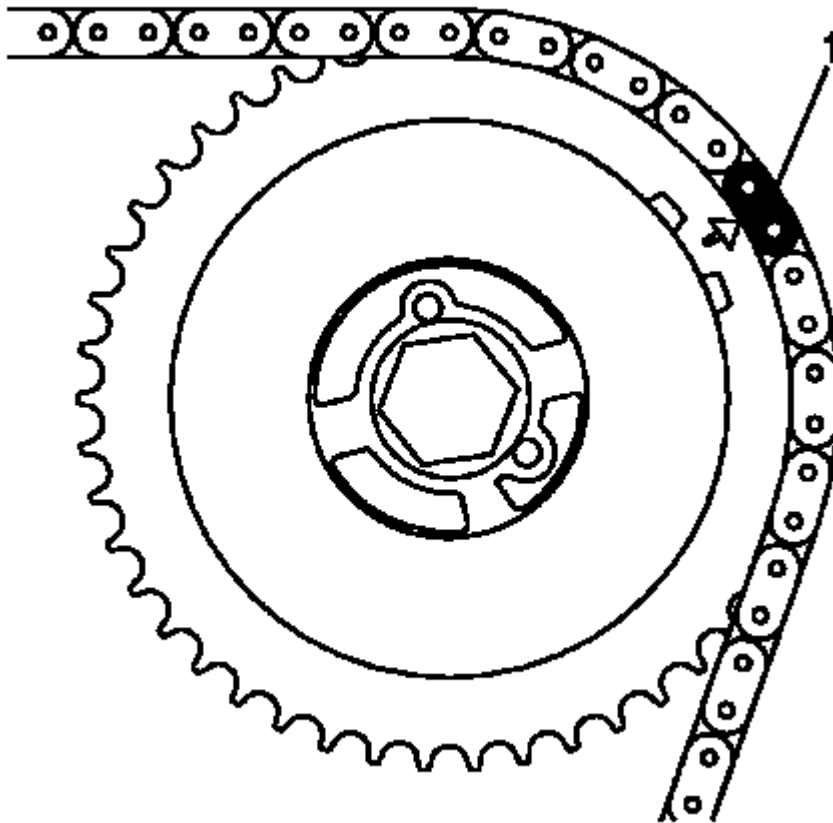


Fig. 99: Identifying Colored Links On Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE:

- There are 3 colored links on the timing chain. 2 links are of matching color, and 1 link is of a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.
- Always use new actuator bolts.

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

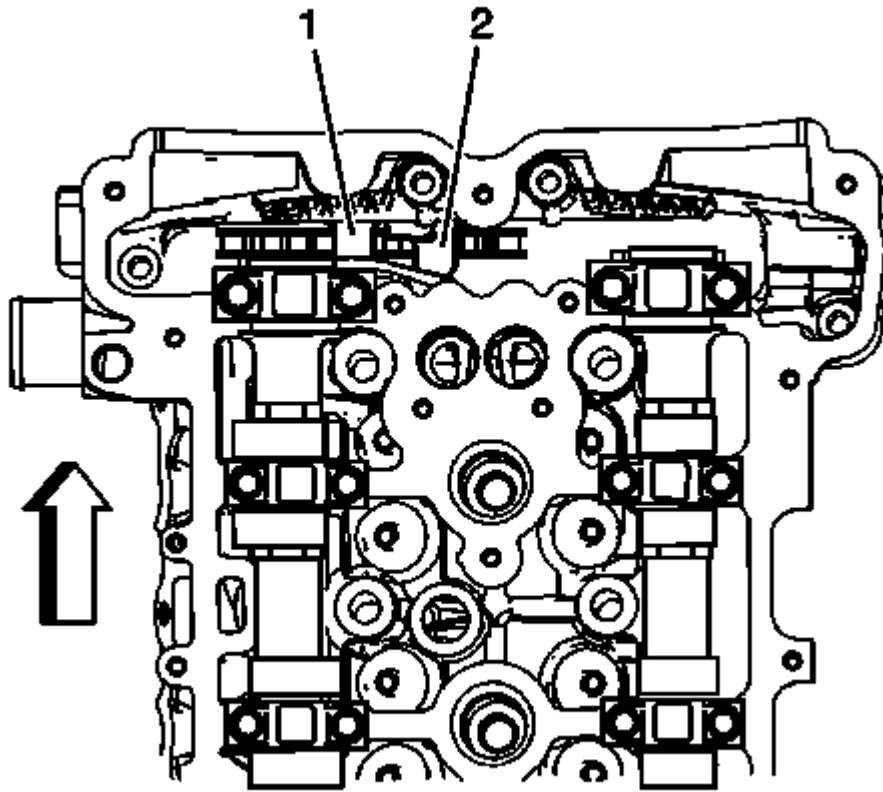


Fig. 100: Identifying Cylinder Head Opening
Courtesy of GENERAL MOTORS CORP.

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

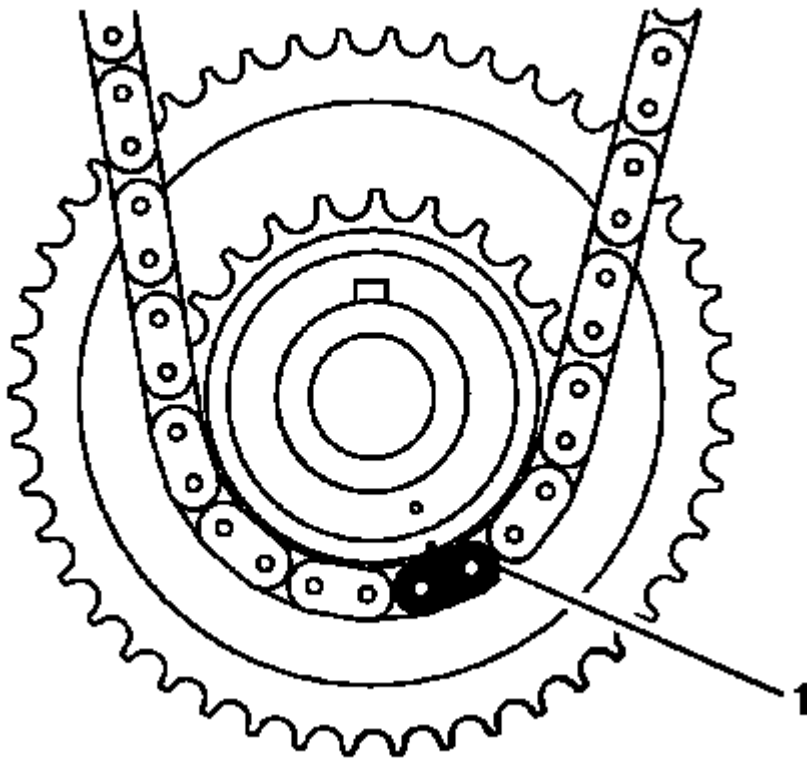


Fig. 101: Lining Up First Pink Link With Timing Mark On Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

16. Route the timing chain around the crankshaft sprocket and line up the first matching colored link with the timing mark on the crankshaft sprocket, in approximately the 5 o'clock position.

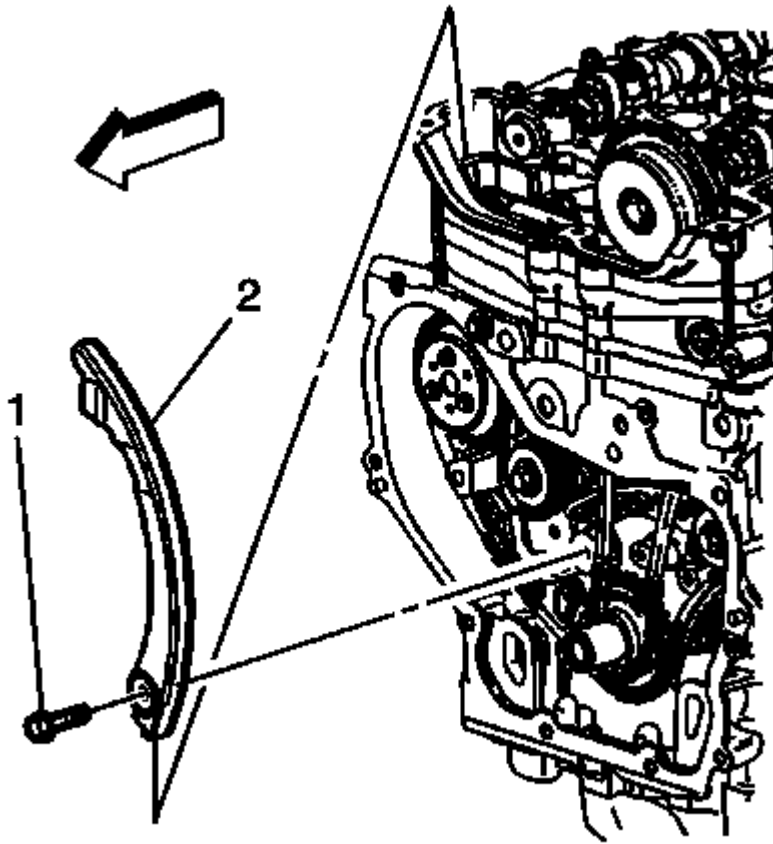


Fig. 102: Identifying Adjustable Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

17. Rotate the crankshaft clockwise to remove all chain slack. Do not rotate the intake camshaft.
18. Install the adjustable timing chain guide down through the opening in the cylinder head and install the adjustable timing chain bolt.

Tighten: Tighten the adjustable timing chain guide bolt to 10 N.m (89 lb in).

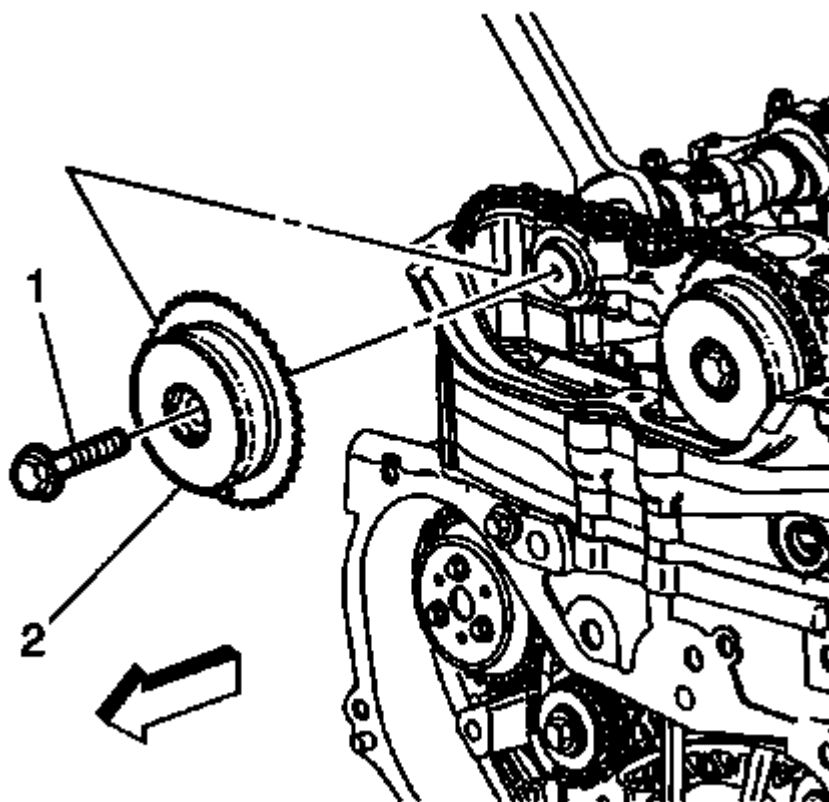


Fig. 103: Locating Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

NOTE: Always install NEW actuator bolts.

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

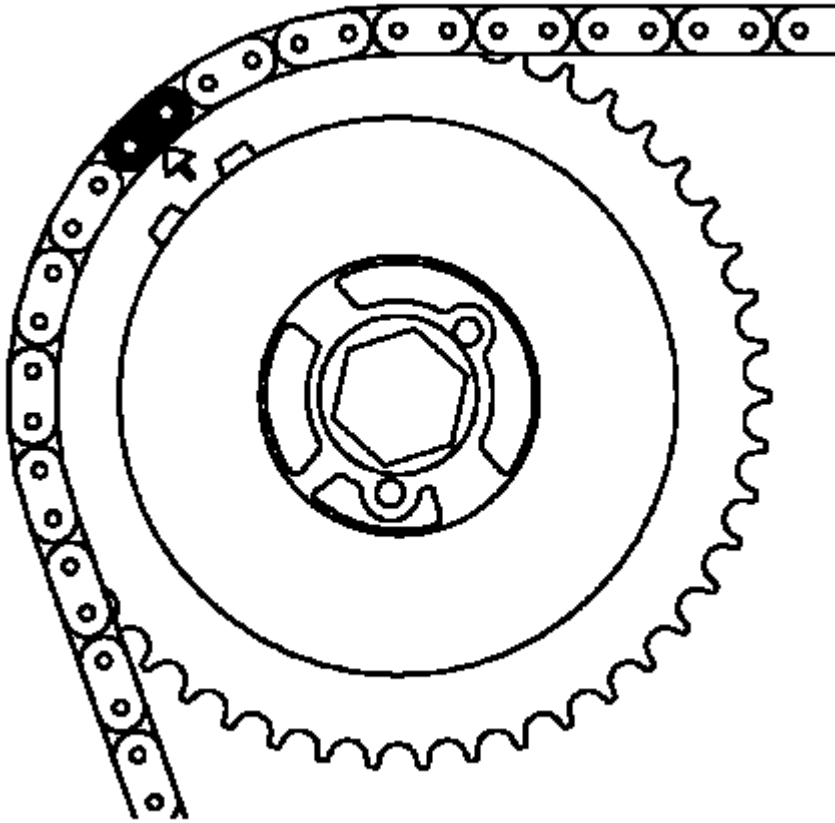


Fig. 104: Aligning Timing Mark On Actuator With Last Pink Colored Link
Courtesy of GENERAL MOTORS CORP.

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

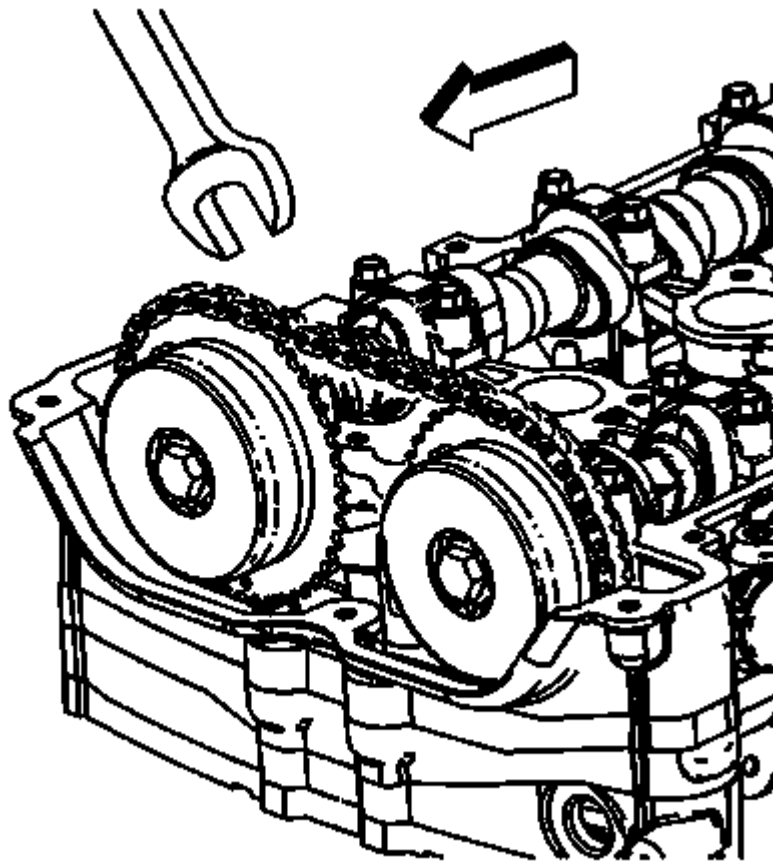


Fig. 105: Identifying Cam Actuator, Camshaft & Chain
 Courtesy of GENERAL MOTORS CORP.

22. When the actuator seats on the cam, tighten the new exhaust camshaft actuator bolt hand tight.
23. Verify that all of the colored links and the appropriate timing marks are still aligned. If they are not aligned, repeat the portion of the procedure necessary to align the timing marks.

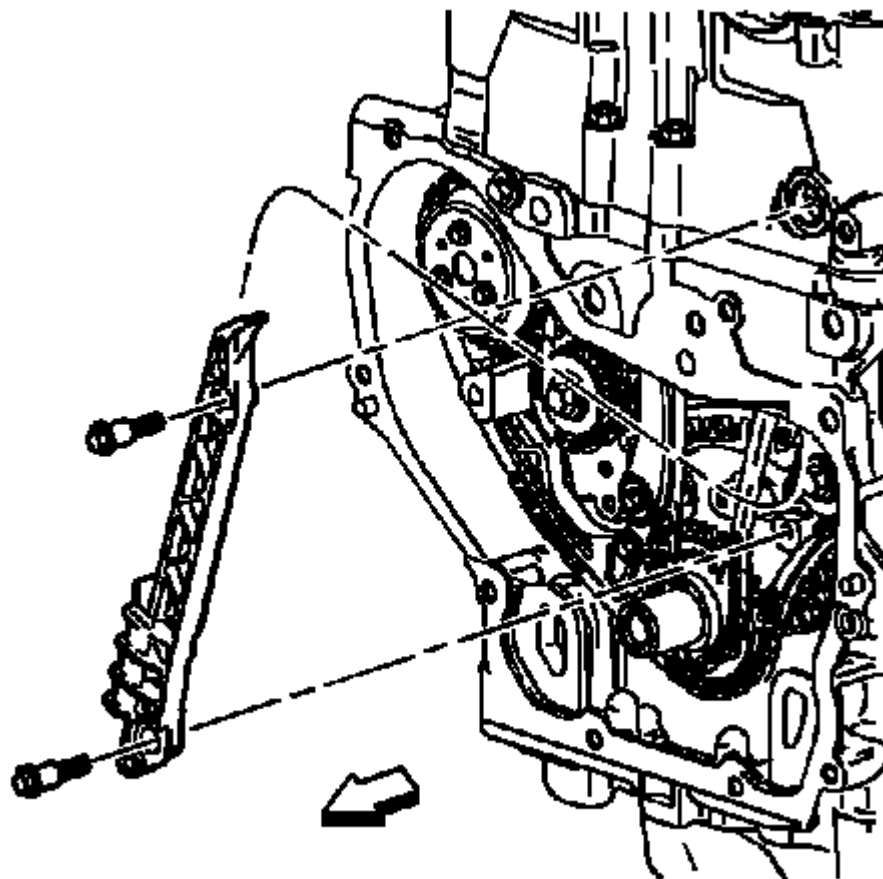


Fig. 106: View Of Fixed Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

24. Install the fixed timing chain guide and bolts.

Tighten: Tighten the fixed timing chain guide bolts to 12 N.m (106 lb in).

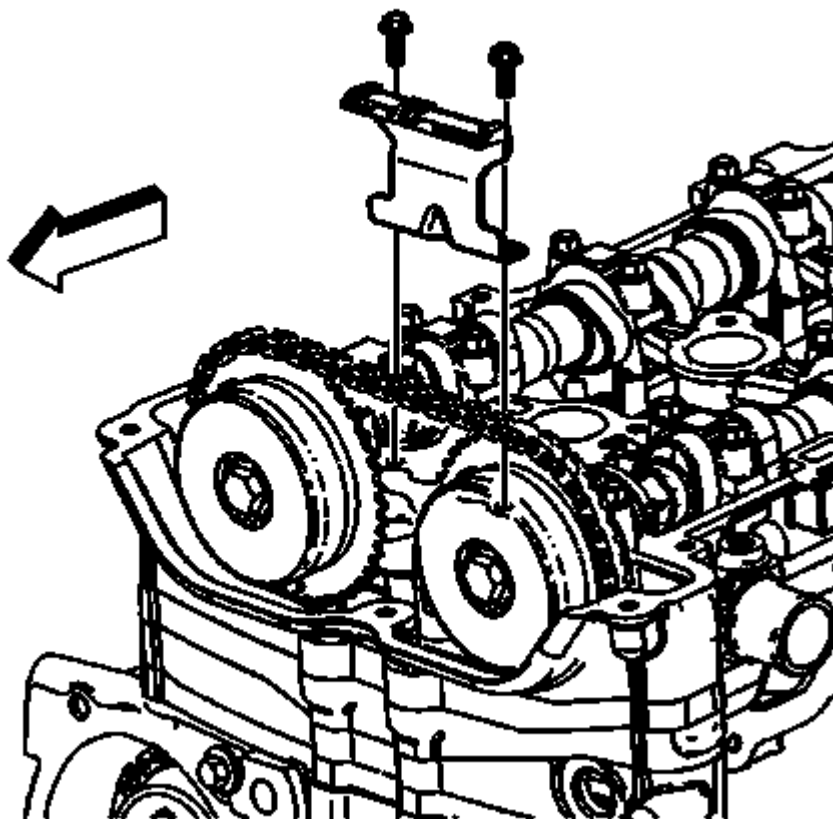


Fig. 107: View Of Upper Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

25. Install the upper timing chain guide and bolts.

Tighten: Tighten the upper timing chain guide bolts to 10 N.m (89 lb in).

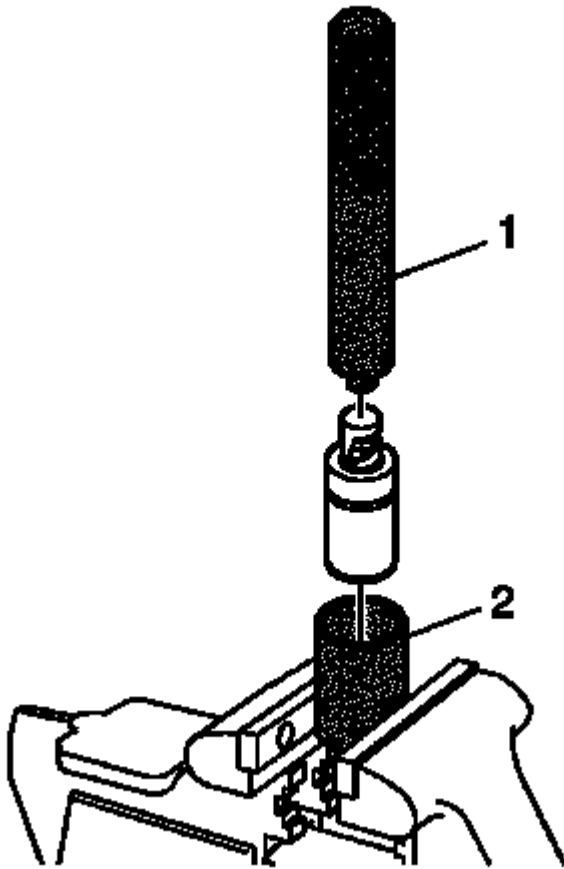


Fig. 108: View of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

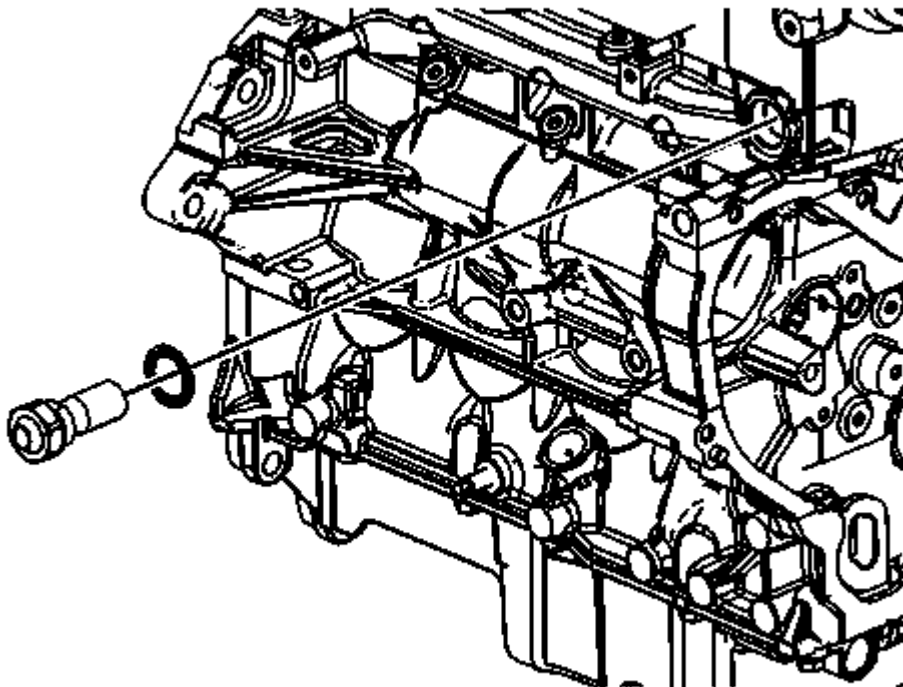


Fig. 109: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

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

29. Install the timing chain tensioner assembly.

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

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

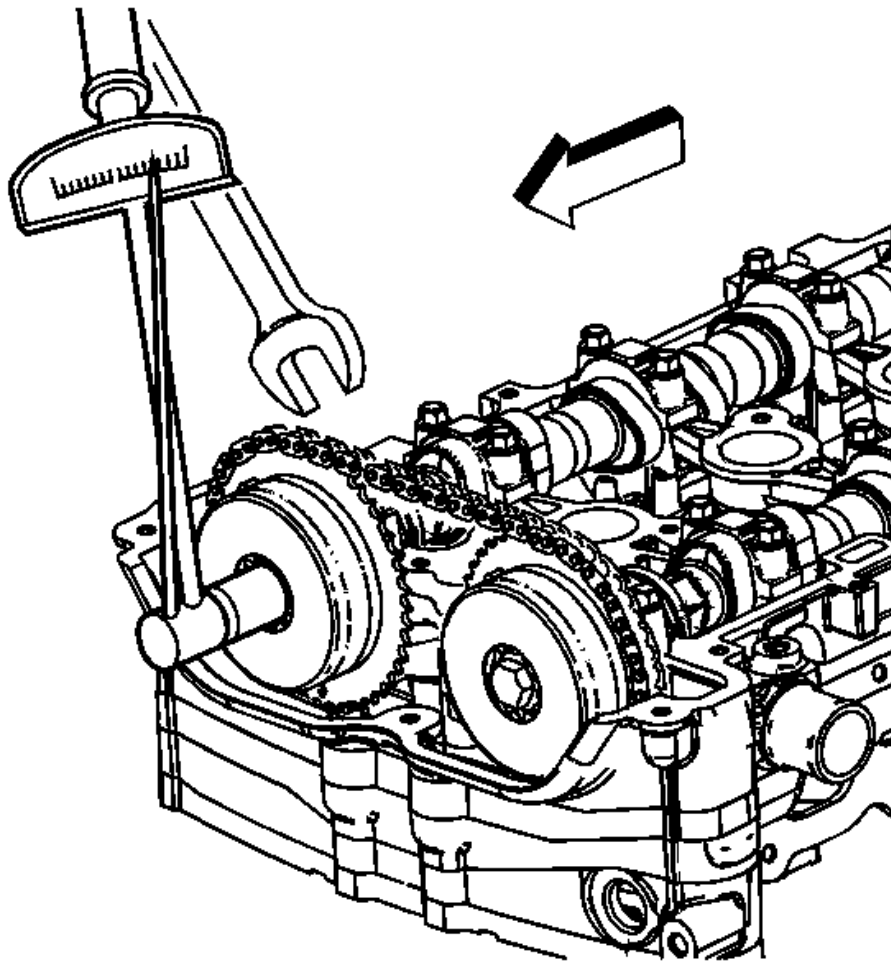


Fig. 110: View of Tightening Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

31. Using a 23 mm wrench, engage the hex on the intake camshaft, and using a torque wrench, tighten the camshaft actuator bolt.

Tighten: Tighten the intake camshaft position actuator bolt to 30 N.m (22 lb ft), plus 100 degrees using the **J 45059**.

32. Using a 23 mm wrench, engage the hex on the exhaust camshaft, and using a torque wrench, tighten the camshaft actuator bolt.

Tighten: Tighten the exhaust camshaft position actuator bolt to 30 N.m (22 lb ft), plus 100 degrees using the **J 45059**.

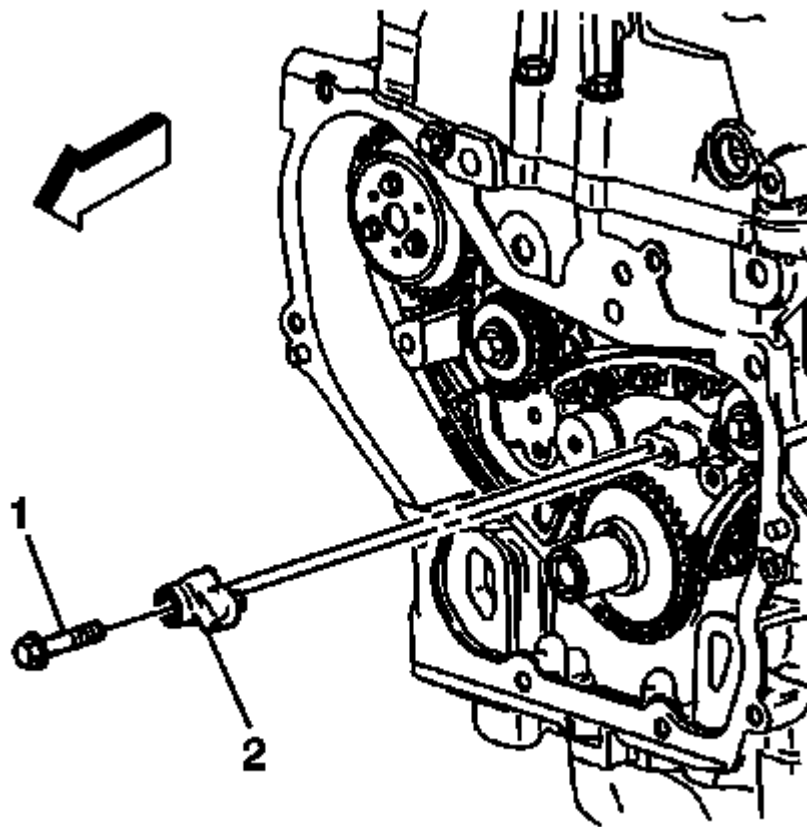


Fig. 111: View Of Oil Nozzle & Bolt
Courtesy of GENERAL MOTORS CORP.

33. Install the timing chain oiling nozzle.

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

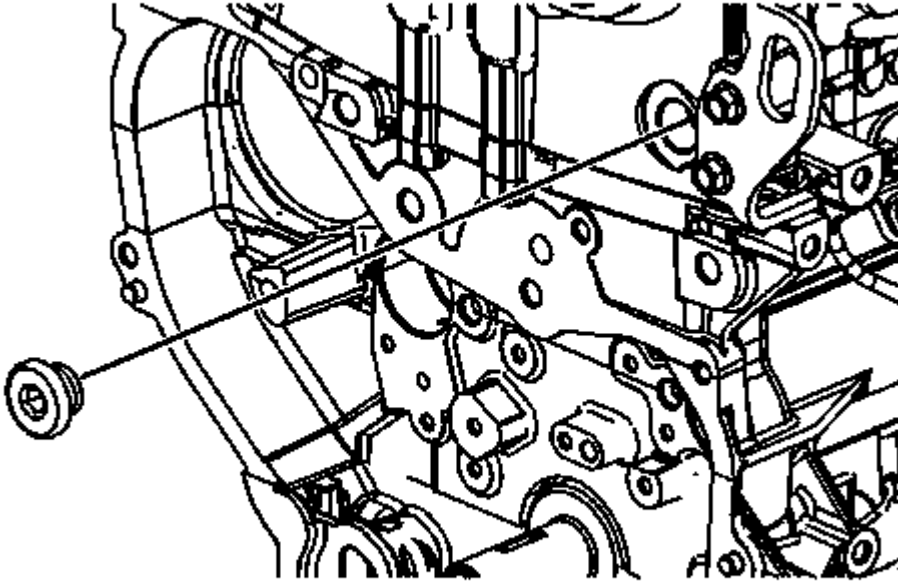


Fig. 112: View Of Timing Chain Guide Bolt Access Hole & Plug
Courtesy of GENERAL MOTORS CORP.

34. Apply sealer to the thread of the timing chain guide bolt access hole plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.
35. Install the timing chain guide bolt access hole plug.

Tighten: Tighten the access hole plug to 90 N.m (66 lb ft).

36. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
37. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
38. Install the number 1 cylinder spark plug. Refer to **Spark Plug Replacement**.
39. Install the hood. Refer to **Hood Replacement**.

BALANCE SHAFT REPLACEMENT - RIGHT SIDE

SPECIAL TOOLS

J 43650 Balance Shaft Bearing Remover and Installer

REMOVAL PROCEDURE

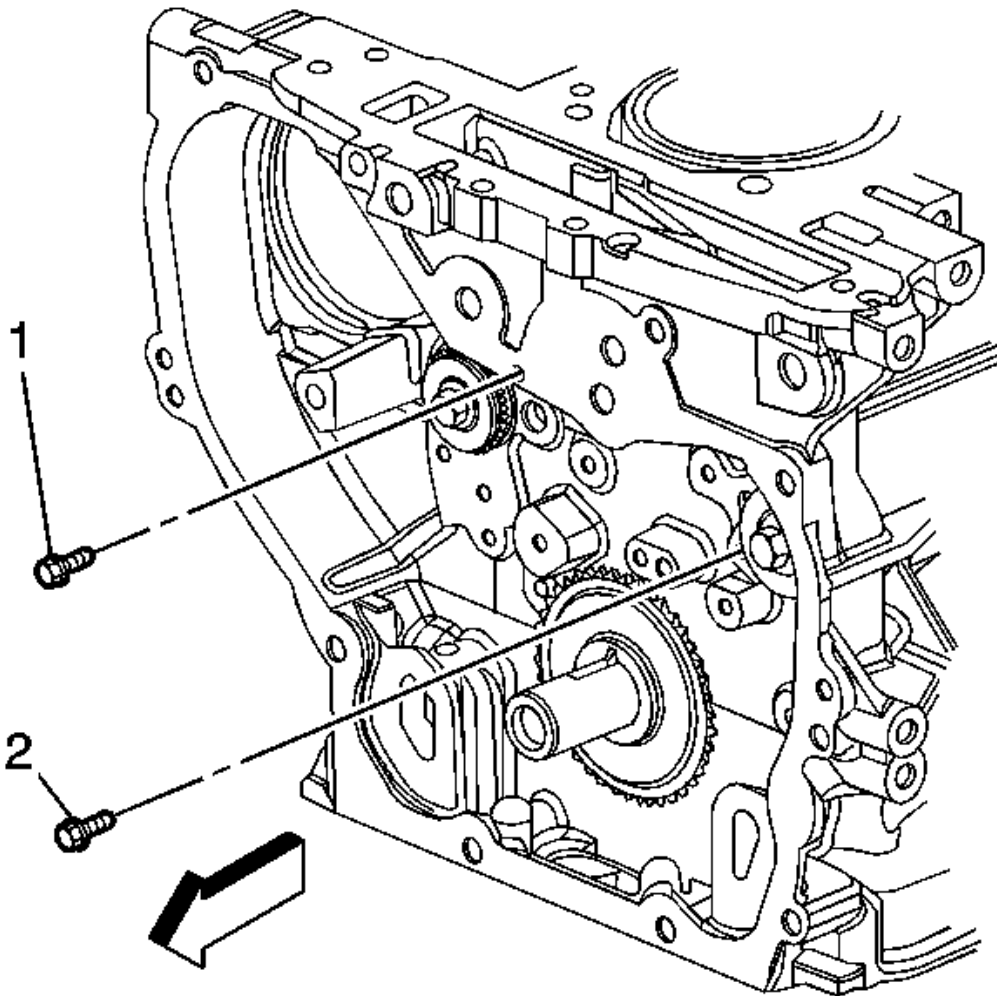


Fig. 113: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

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

NOTE: DO NOT remove the bolt holding the sprocket.

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

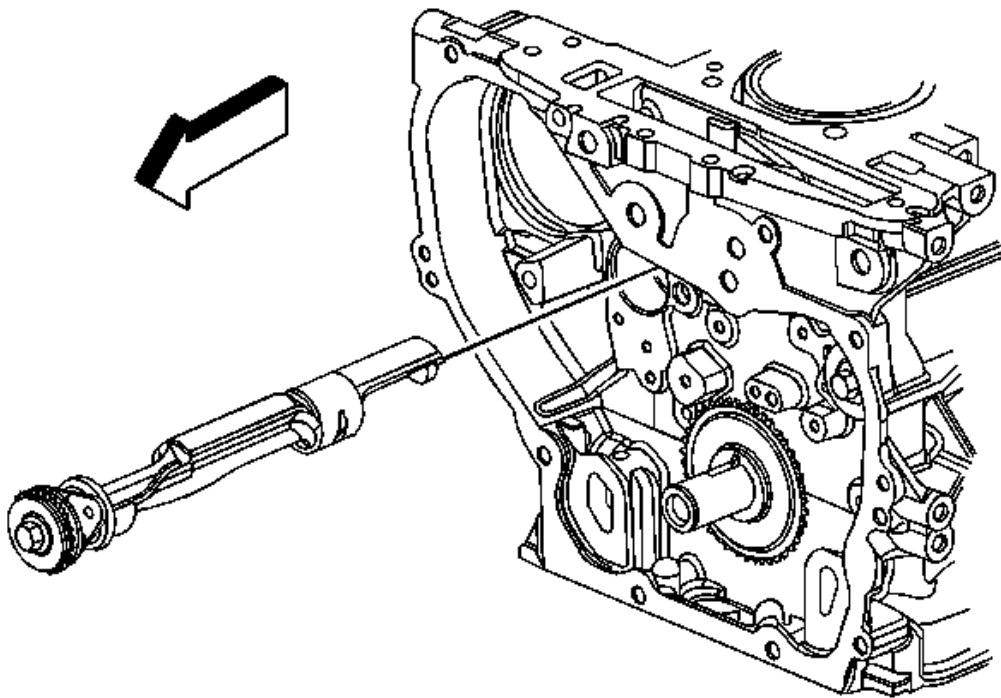


Fig. 114: View Of Right Intake Balance Shaft
Courtesy of GENERAL MOTORS CORP.

5. Remove the right intake balance shaft.

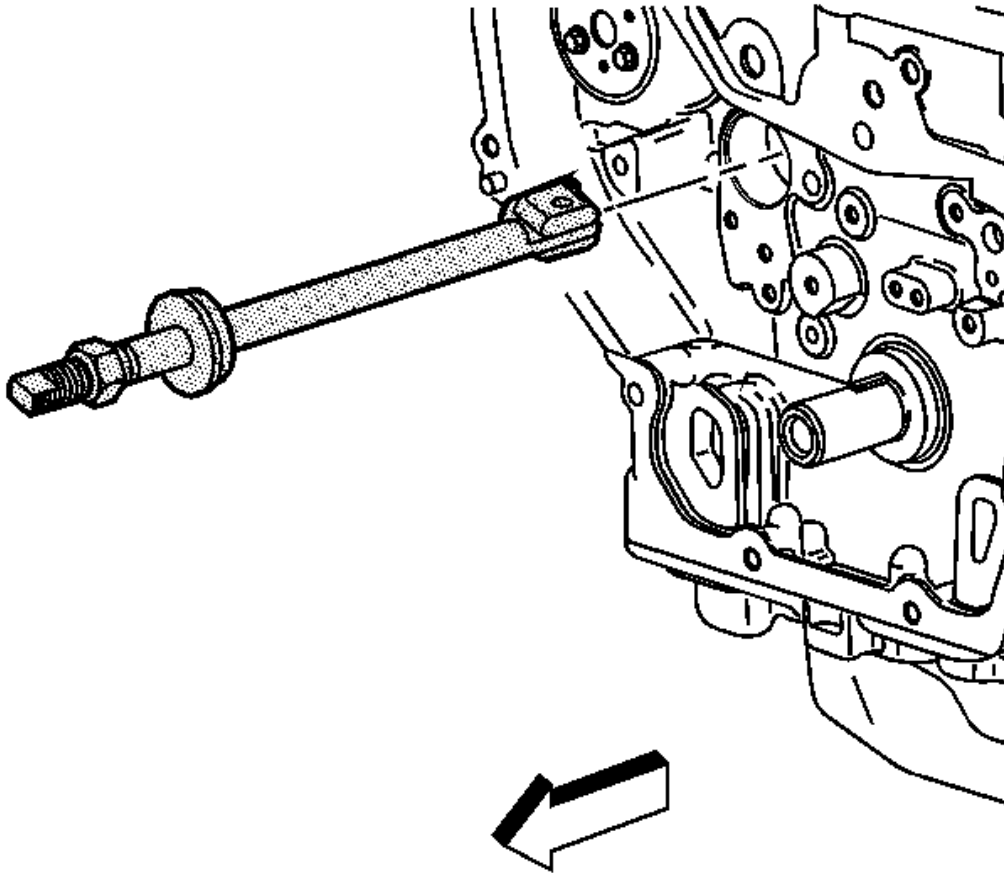


Fig. 115: View Of Balancer Shaft Bearing Remover & Installer
Courtesy of GENERAL MOTORS CORP.

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

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

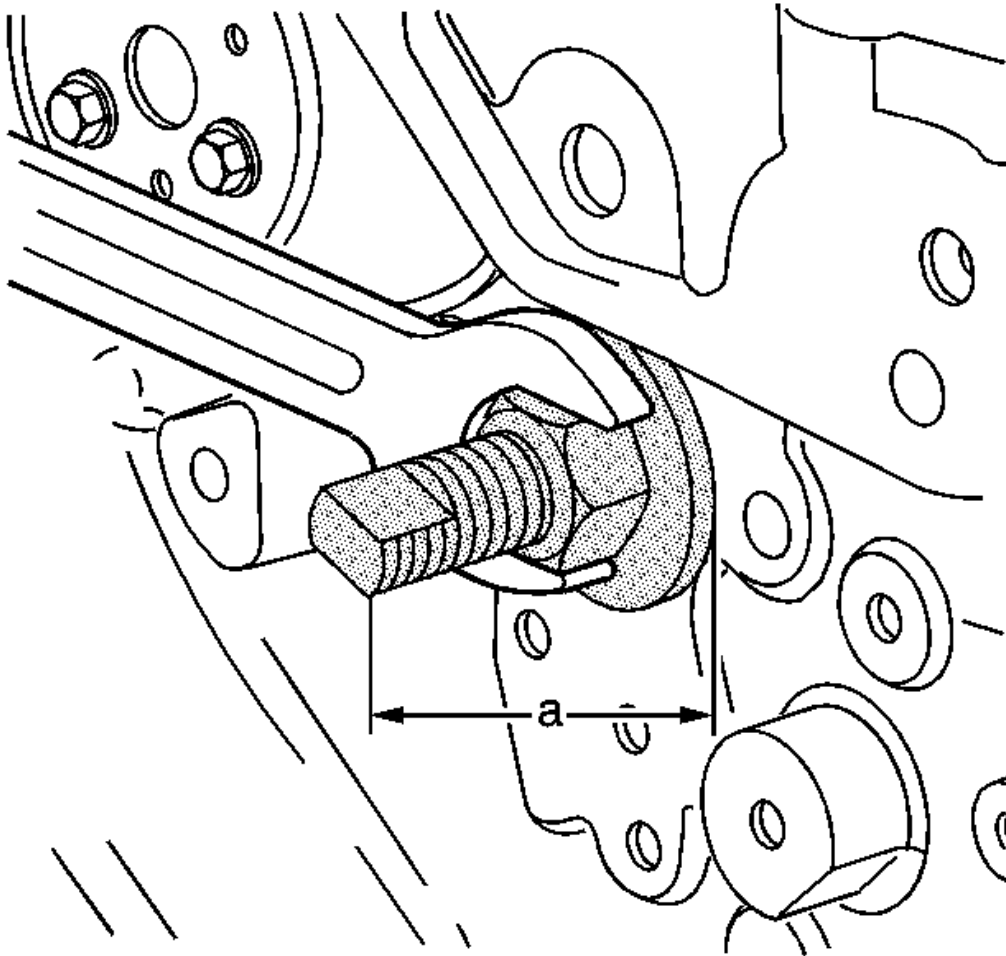


Fig. 116: Checking Special Tool Installation
Courtesy of GENERAL MOTORS CORP.

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

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

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

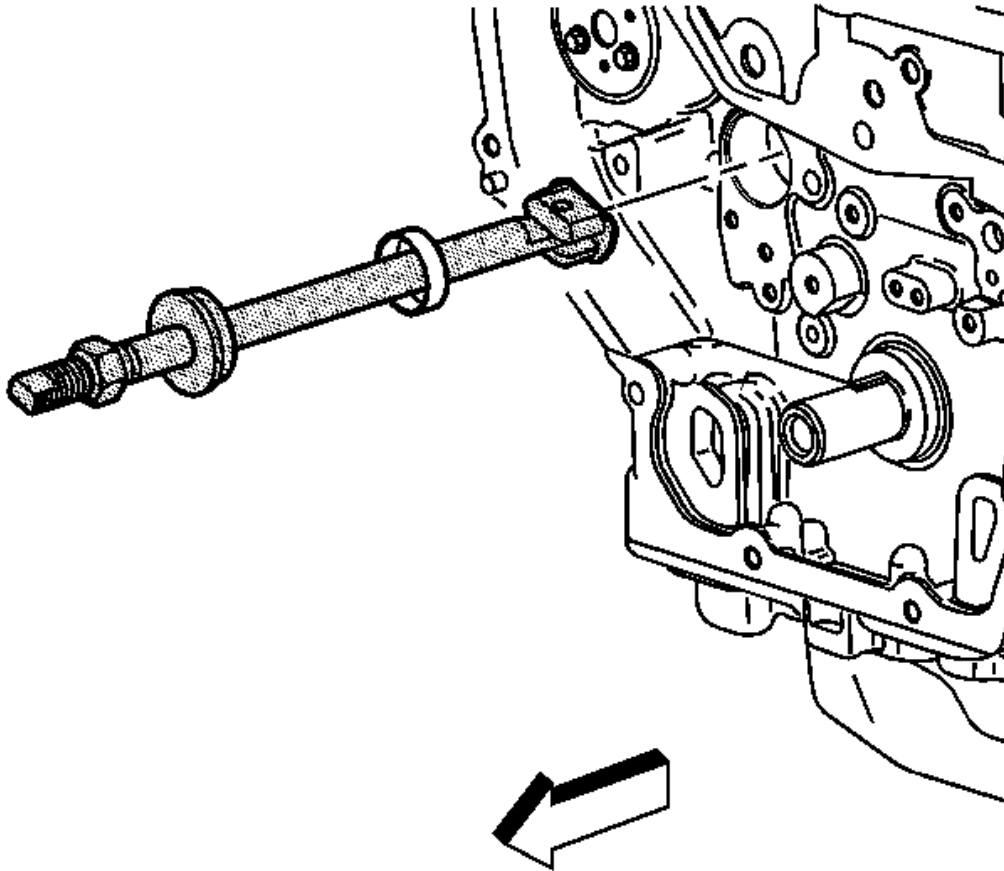


Fig. 117: View Of Balance Shaft & Bushing
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

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

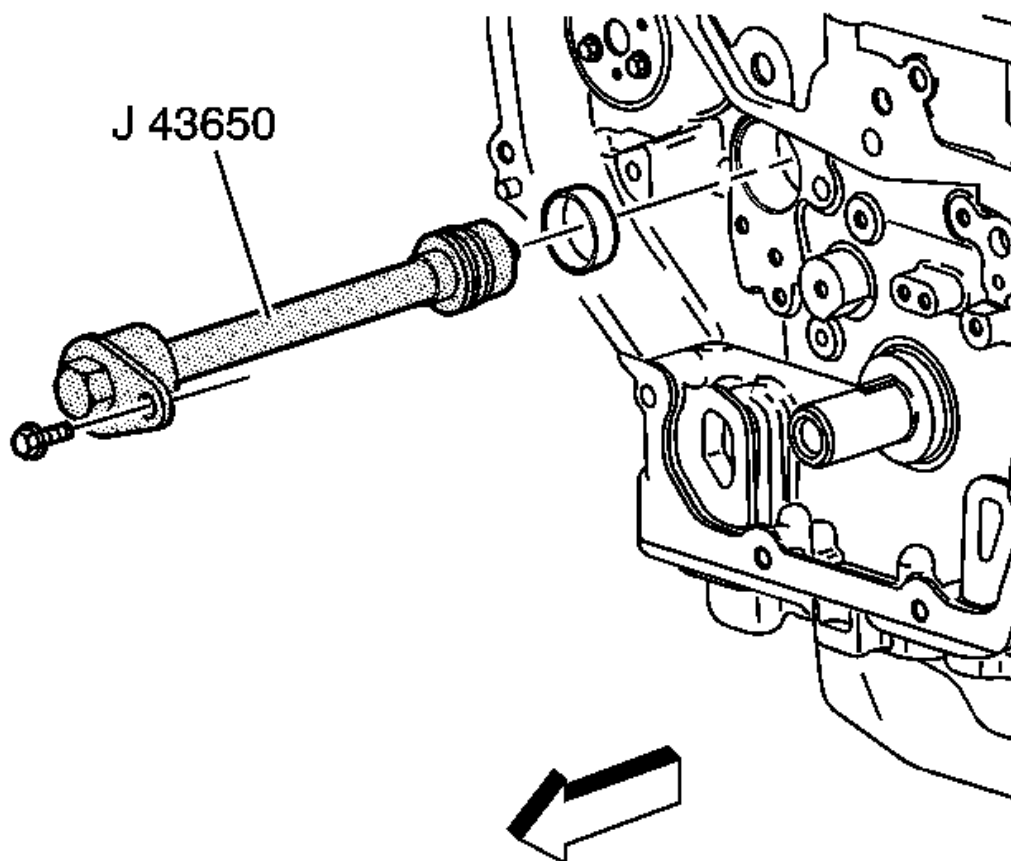


Fig. 118: View of Balance Shaft & Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

1. Install the balance shaft bushing using the **J 43650** .

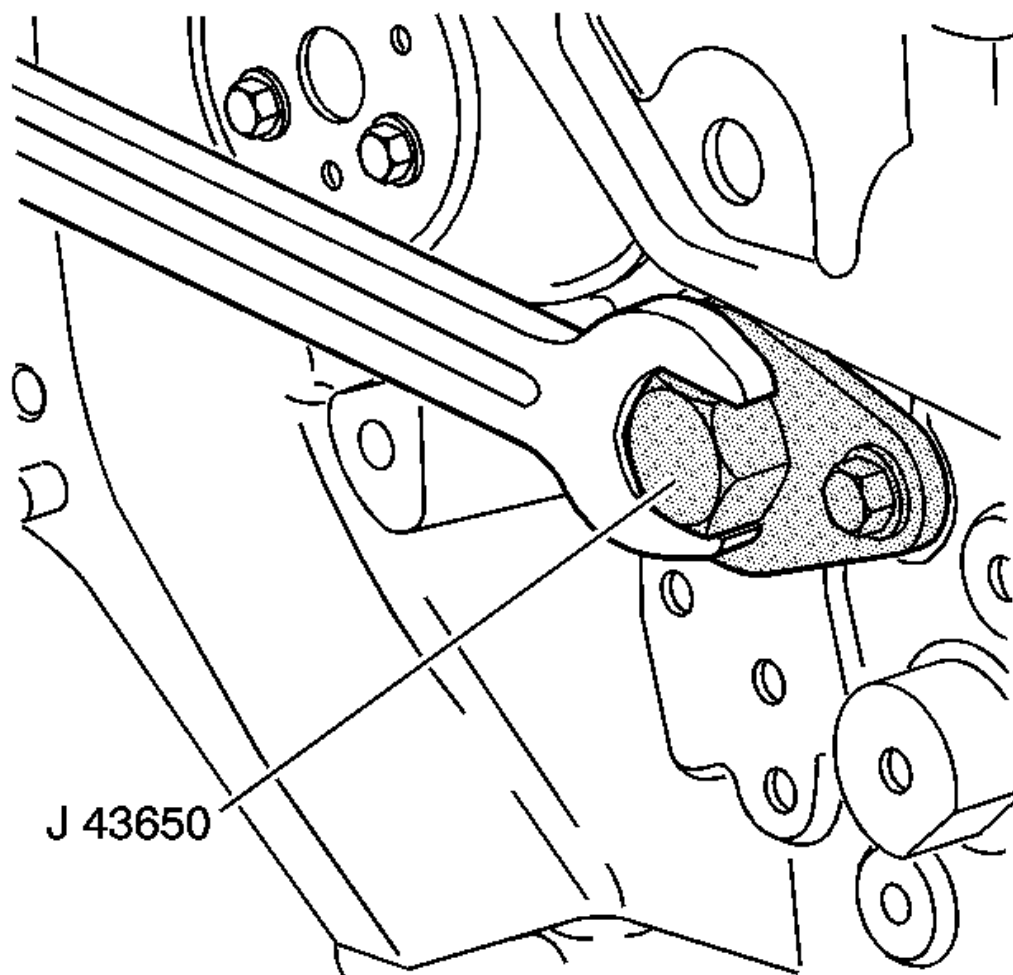


Fig. 119: Seating Balance Shaft Bushing Into Bore Using Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

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

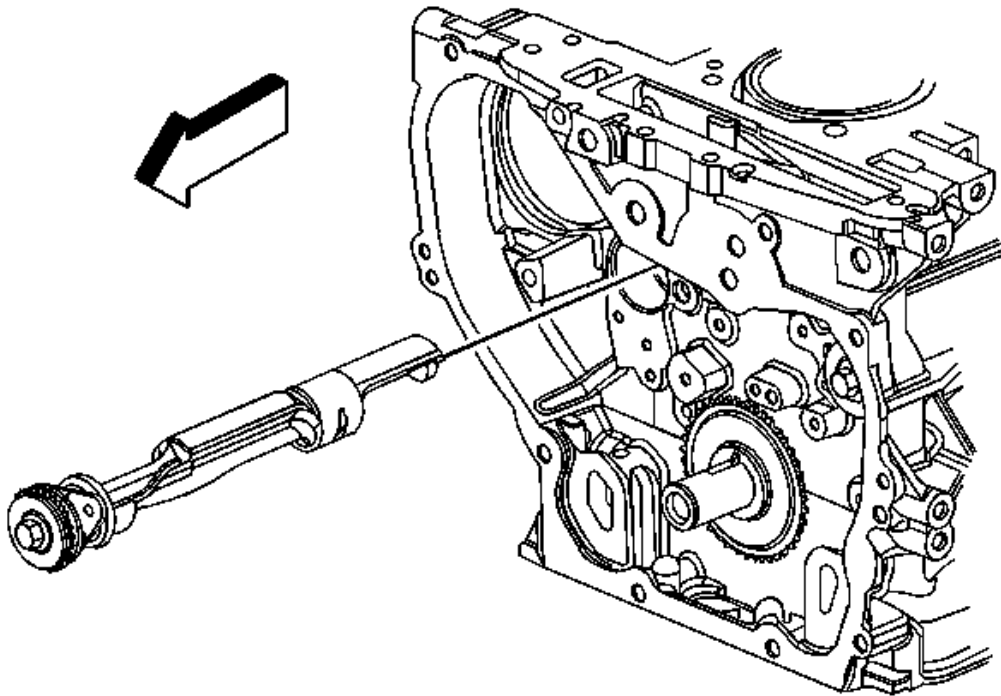


Fig. 120: View Of Right Intake Balance Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE:

- If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.
 - Install the balance shaft to the engine using the following steps:
4. Place the number one cylinder at top dead center (TDC).
 5. Lubricate the balance shaft lobes with engine oil.
 6. Install the right intake balance shaft.

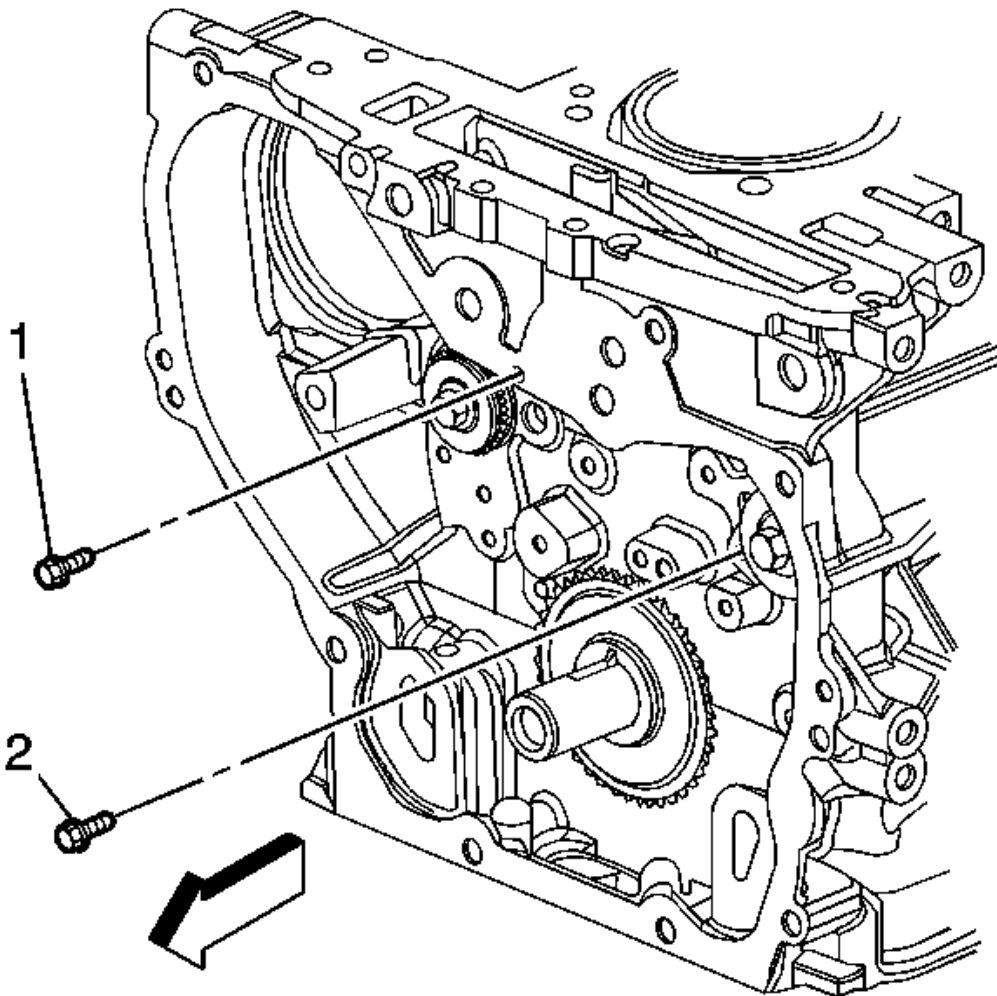


Fig. 121: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Install the right intake balance shaft bolt (1).

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

8. Install the timing chain, sprocket and tensioner. Refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

9. Install the condenser. Refer to [Air Conditioning Condenser Replacement](#) .
10. Install the radiator. Refer to [Radiator Replacement](#) .

BALANCE SHAFT REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

J 43650 Balance Shaft Bearing Remover and Installer

REMOVAL PROCEDURE

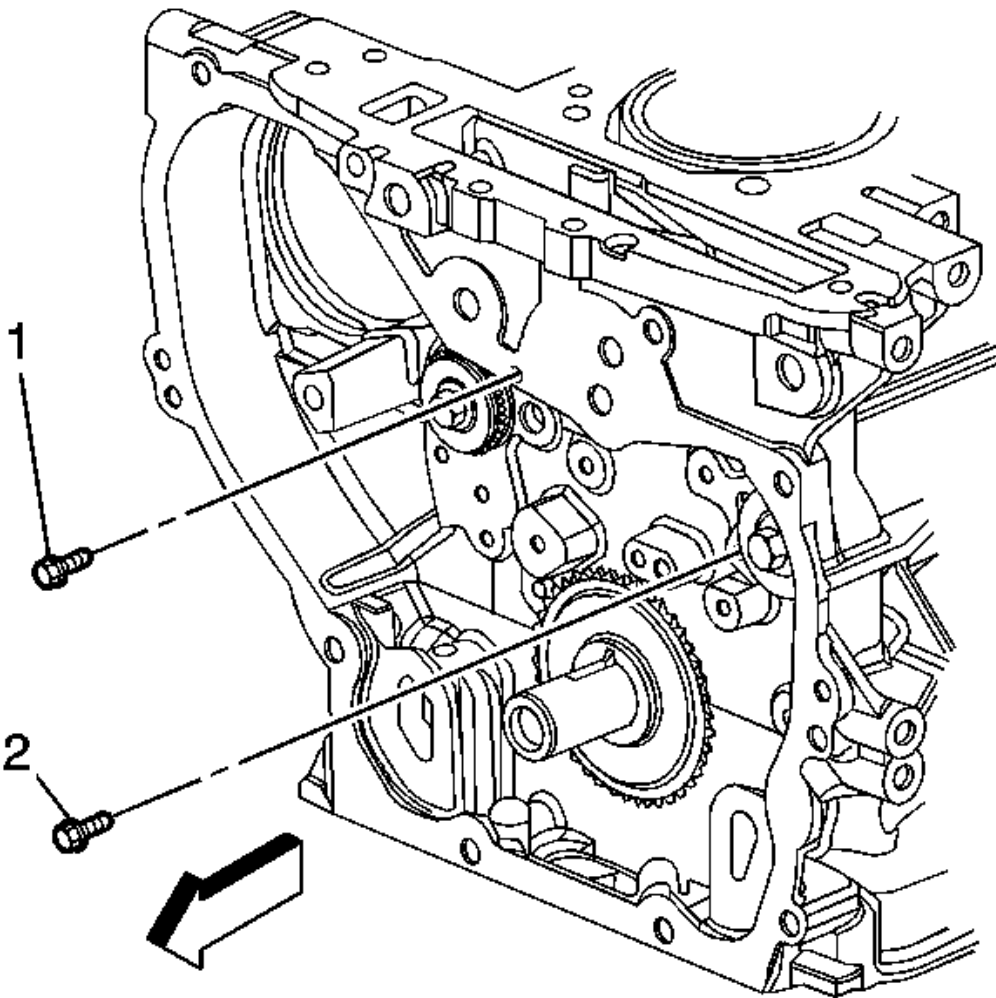


Fig. 122: Identifying Balance Shaft Bolts

Courtesy of GENERAL MOTORS CORP.

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

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

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

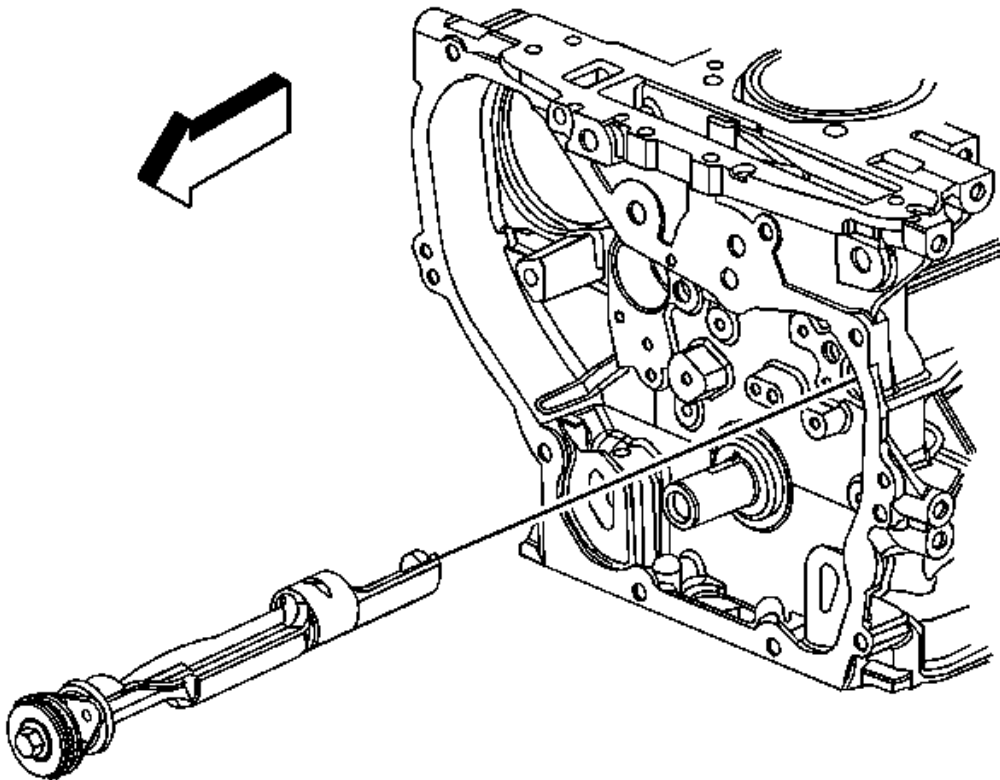


Fig. 123: View Of Left (Exhaust) Balance Shaft
Courtesy of GENERAL MOTORS CORP.

5. Remove the left exhaust balance shaft.

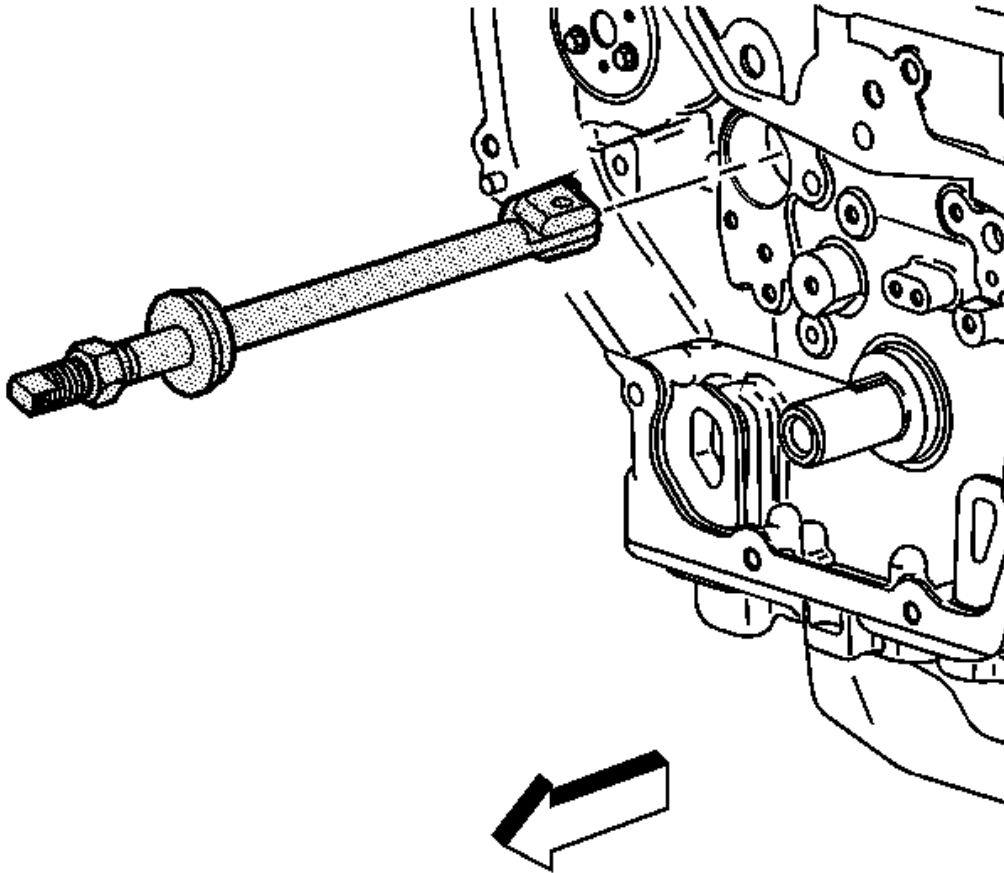


Fig. 124: View Of Balancer Shaft Bearing Remover & Installer
Courtesy of GENERAL MOTORS CORP.

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

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

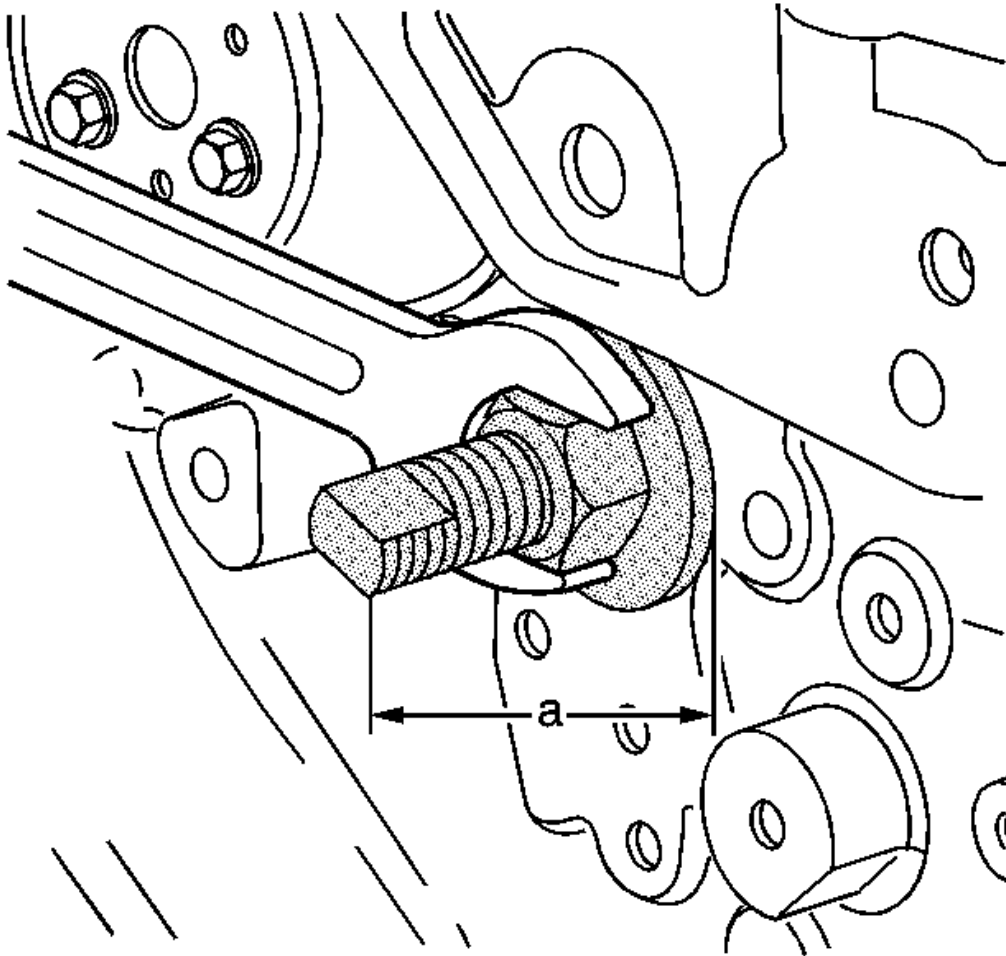


Fig. 125: Checking Special Tool Installation
Courtesy of GENERAL MOTORS CORP.

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

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

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

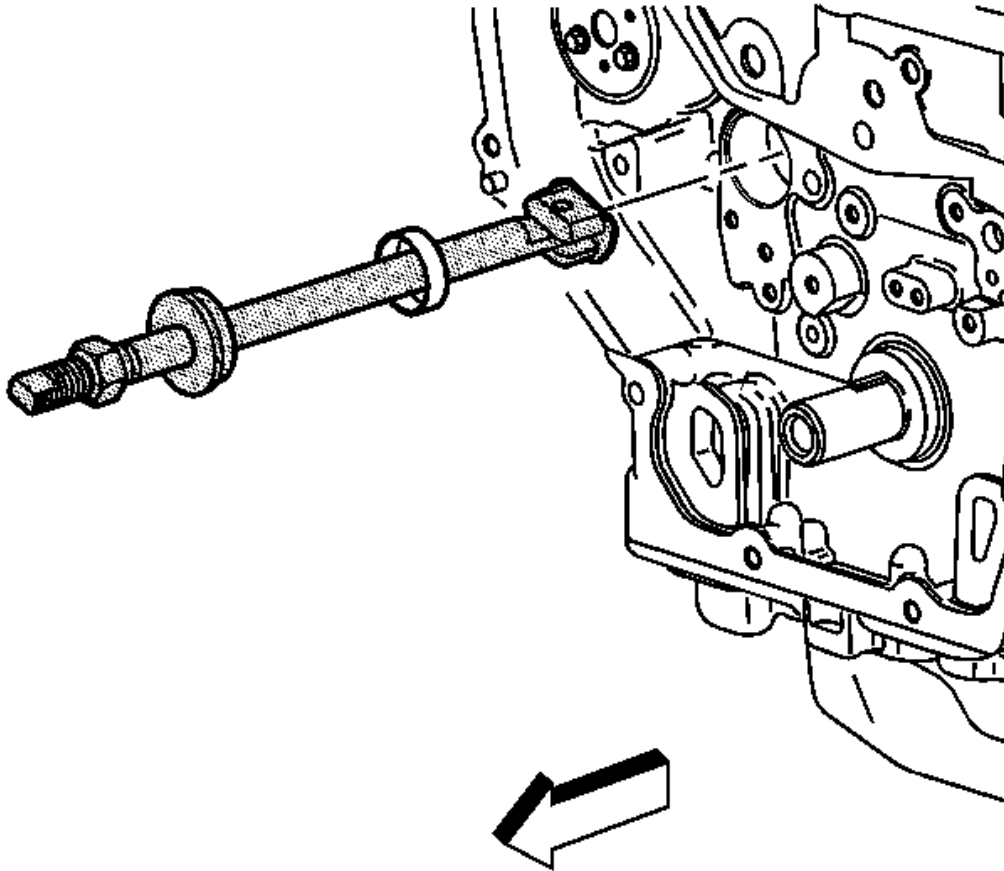


Fig. 126: View Of Balance Shaft & Bushing
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

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

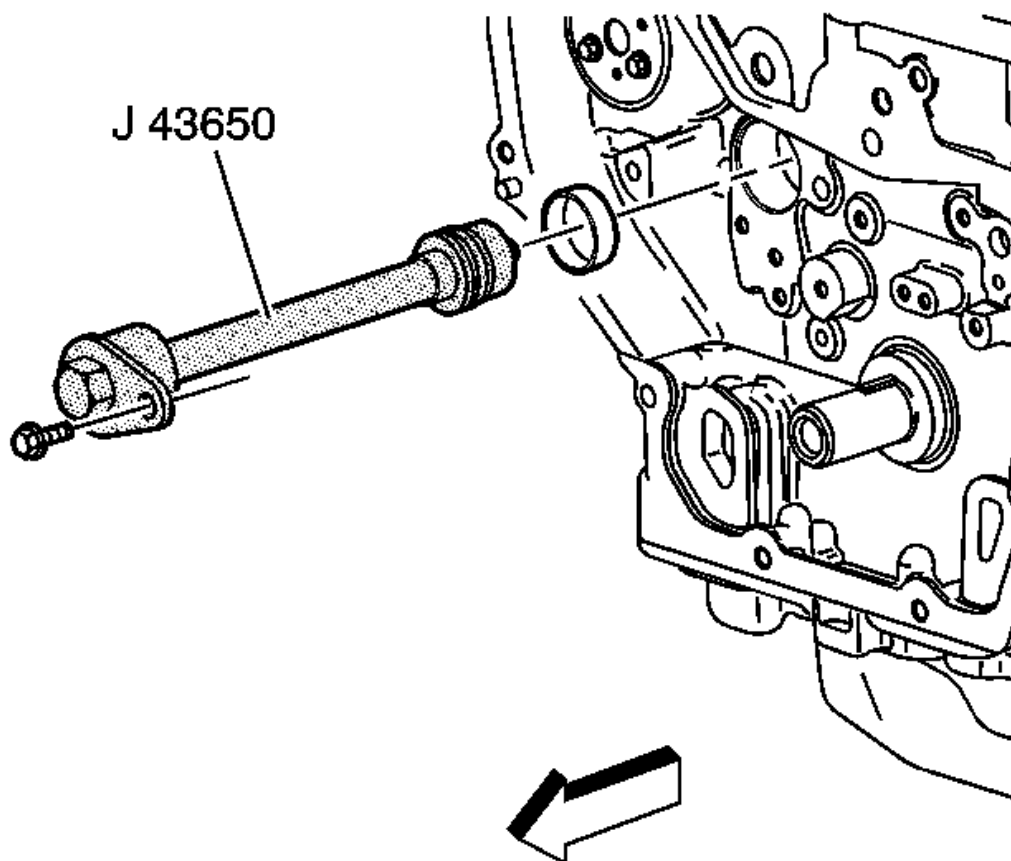


Fig. 127: View of Balance Shaft & Special Tool J 43650
Courtesy of GENERAL MOTORS CORP.

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

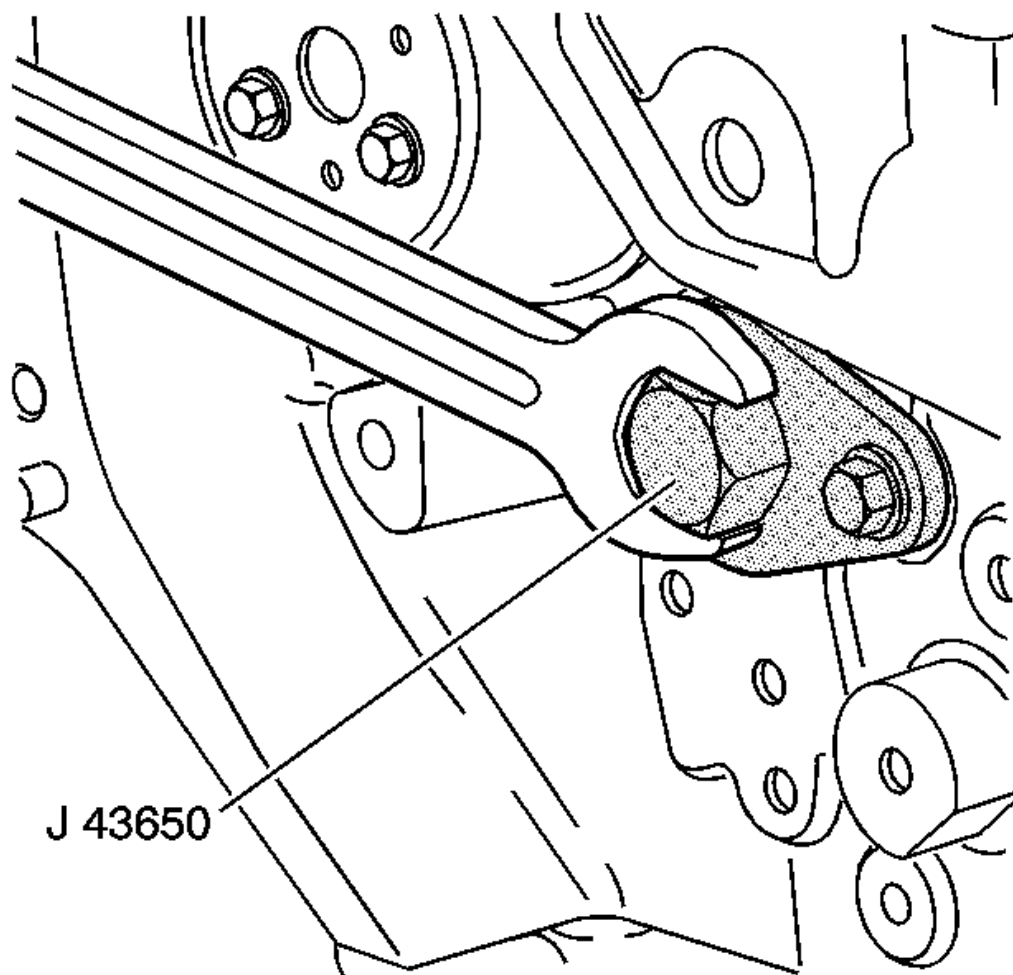


Fig. 128: Seating Balance Shaft Bushing
Courtesy of GENERAL MOTORS CORP.

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

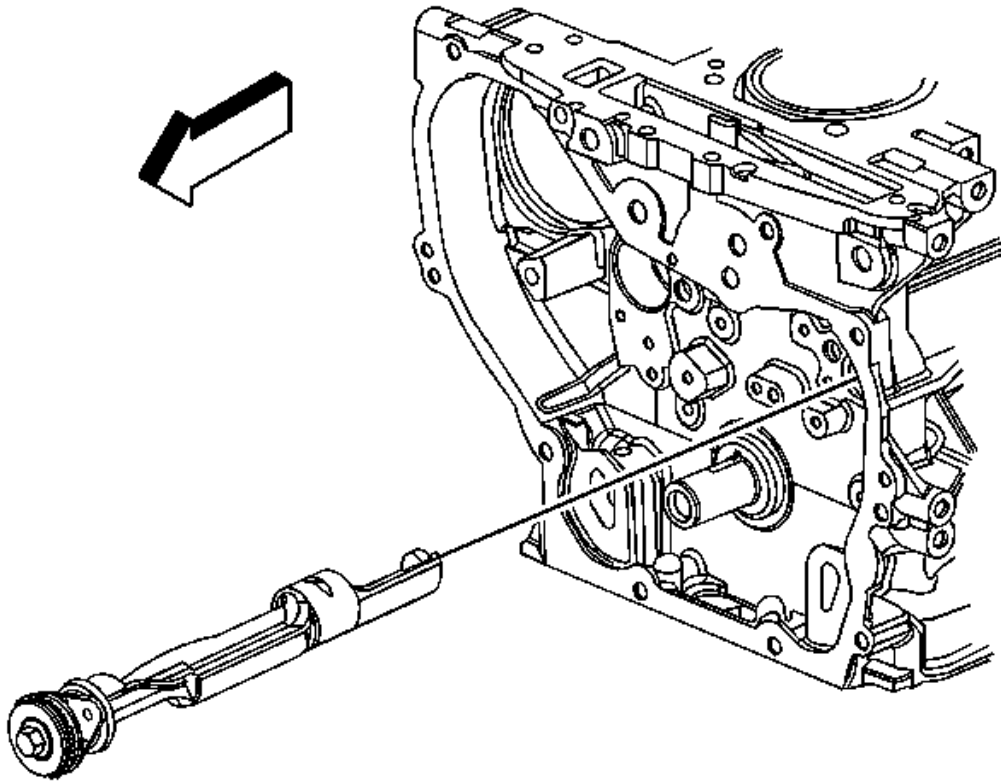


Fig. 129: View Of Left (Exhaust) Balance Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE:

- If the balance shafts are not properly timed to the engine, the engine may vibrate or make noise.
 - Install the balance shaft to the engine using the following steps:
4. Place the number one cylinder at top dead center (TDC).
 5. Lubricate the balance shaft lobes with engine oil.
 6. Install the left exhaust balance shaft.

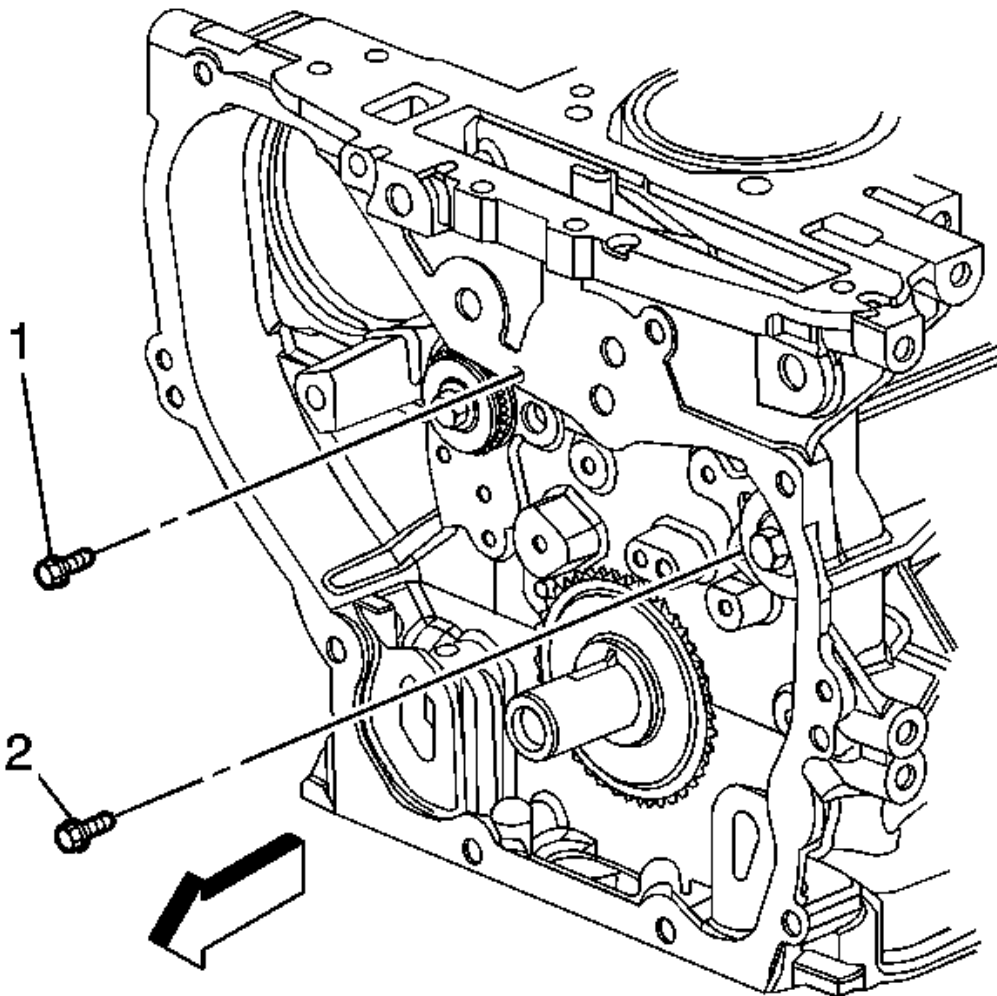


Fig. 130: Identifying Balance Shaft Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Install the left exhaust balance shaft bolt (2).

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

8. Install the timing chain, sprocket and tensioner. Refer to Camshaft Timing Chain, Sprocket, and Tensioner Replacement.

9. Install the condenser. Refer to [Air Conditioning Condenser Replacement](#) .
10. Install the radiator. Refer to [Radiator Replacement](#) .

CAMSHAFT COVER REPLACEMENT

REMOVAL PROCEDURE

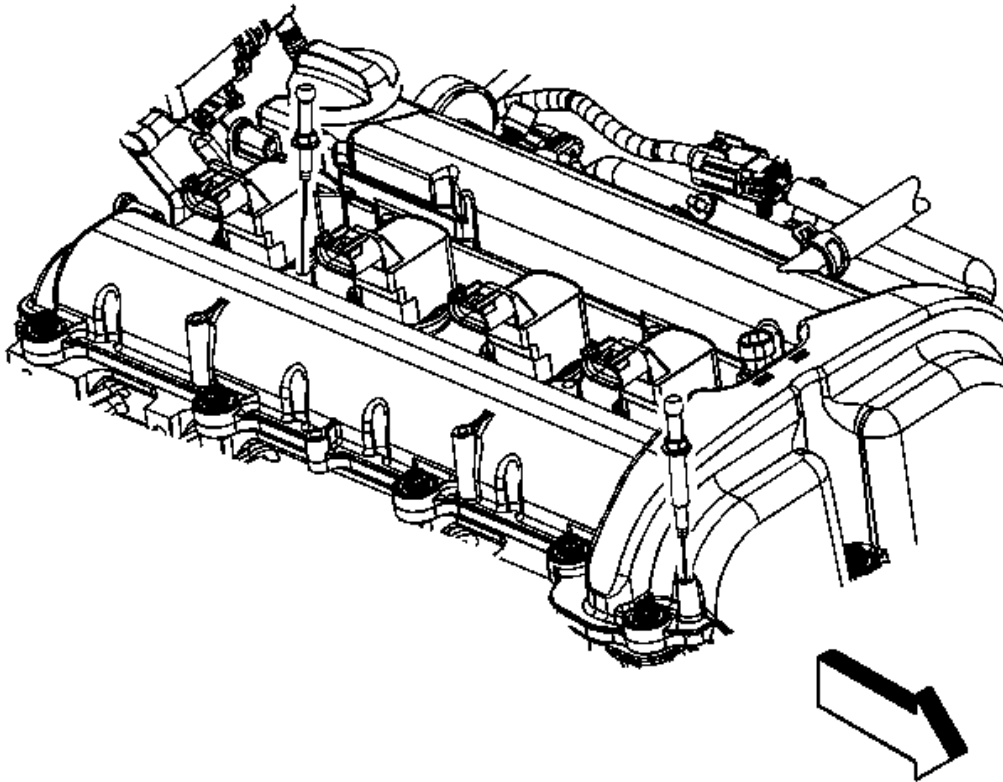


Fig. 131: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

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

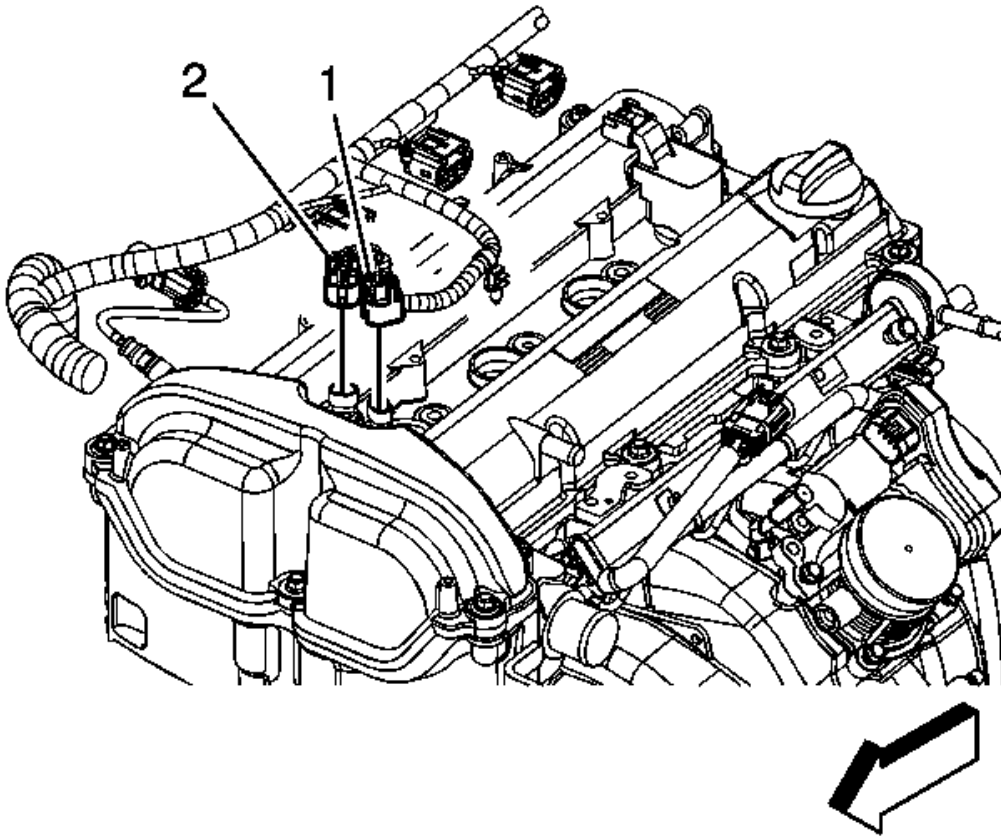


Fig. 132: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Remove the air cleaner outlet resonator. Refer to **Air Cleaner Outlet Resonator Replacement** .
4. Reposition the positive crankcase ventilation (PCV) hose clamp.
5. Remove the PCV hose from the cover.
6. Disconnect the intake (1) and exhaust (2) camshaft position actuator solenoid valve electrical connectors.

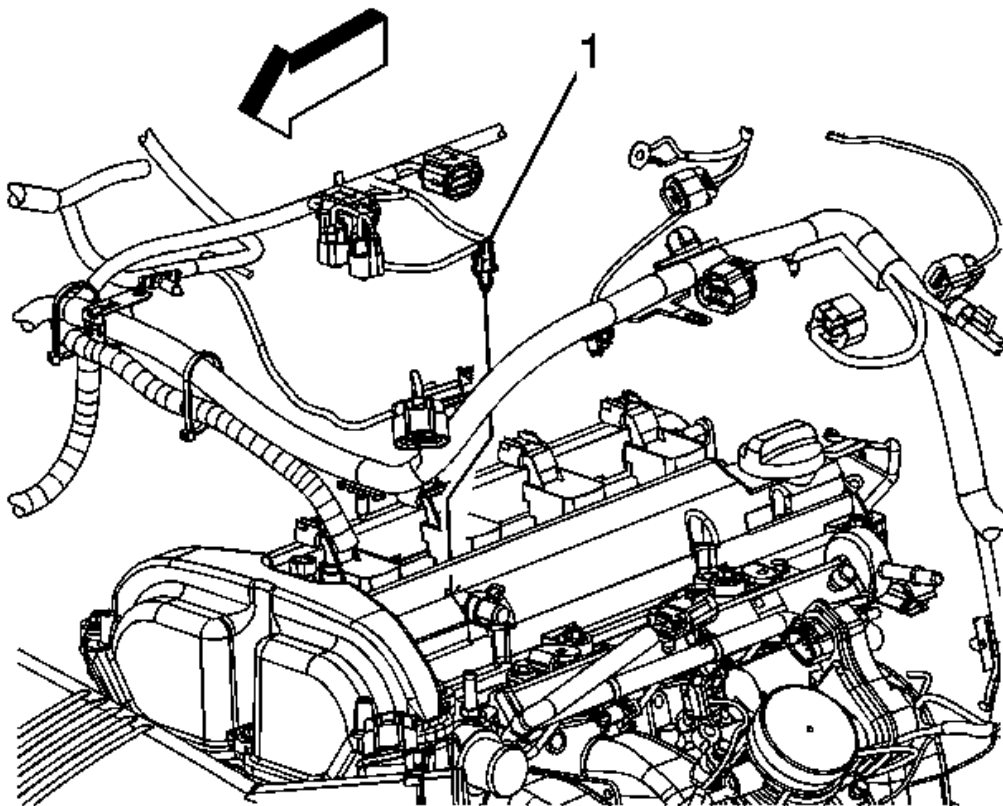


Fig. 133: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

7. Remove the engine harness clip (1) from the cam cover.

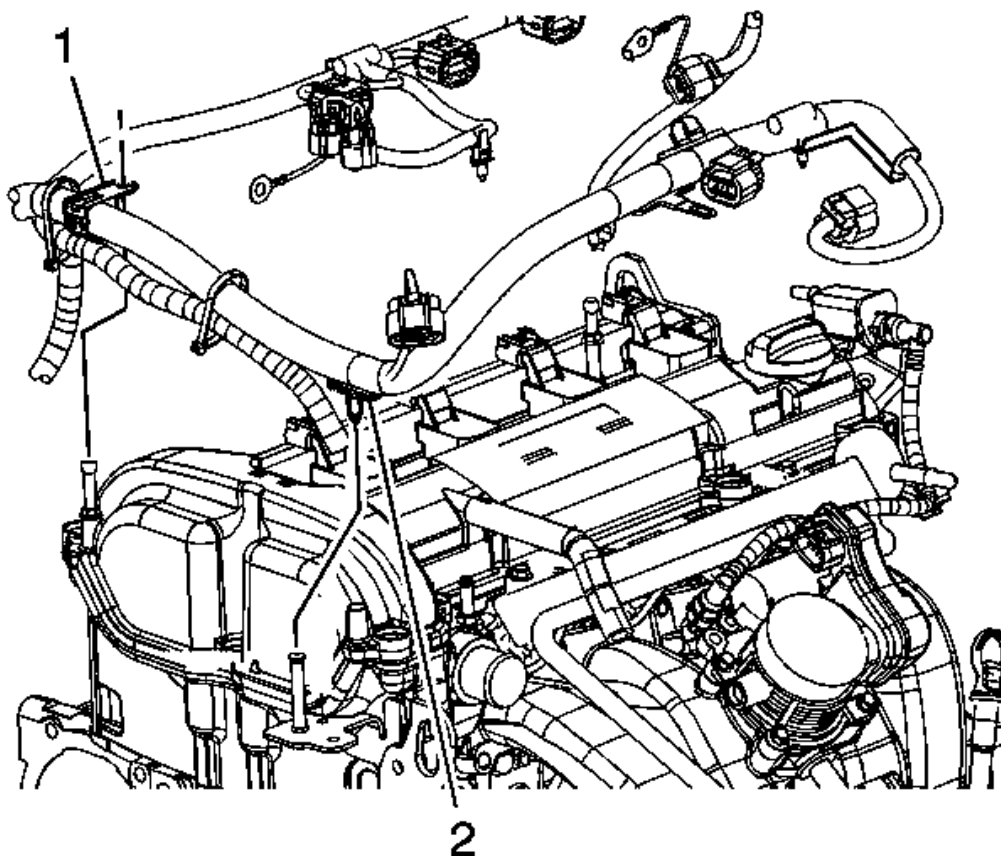


Fig. 134: Identifying Engine Harness Bracket
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine harness bracket (1) from the intake manifold cover stud.

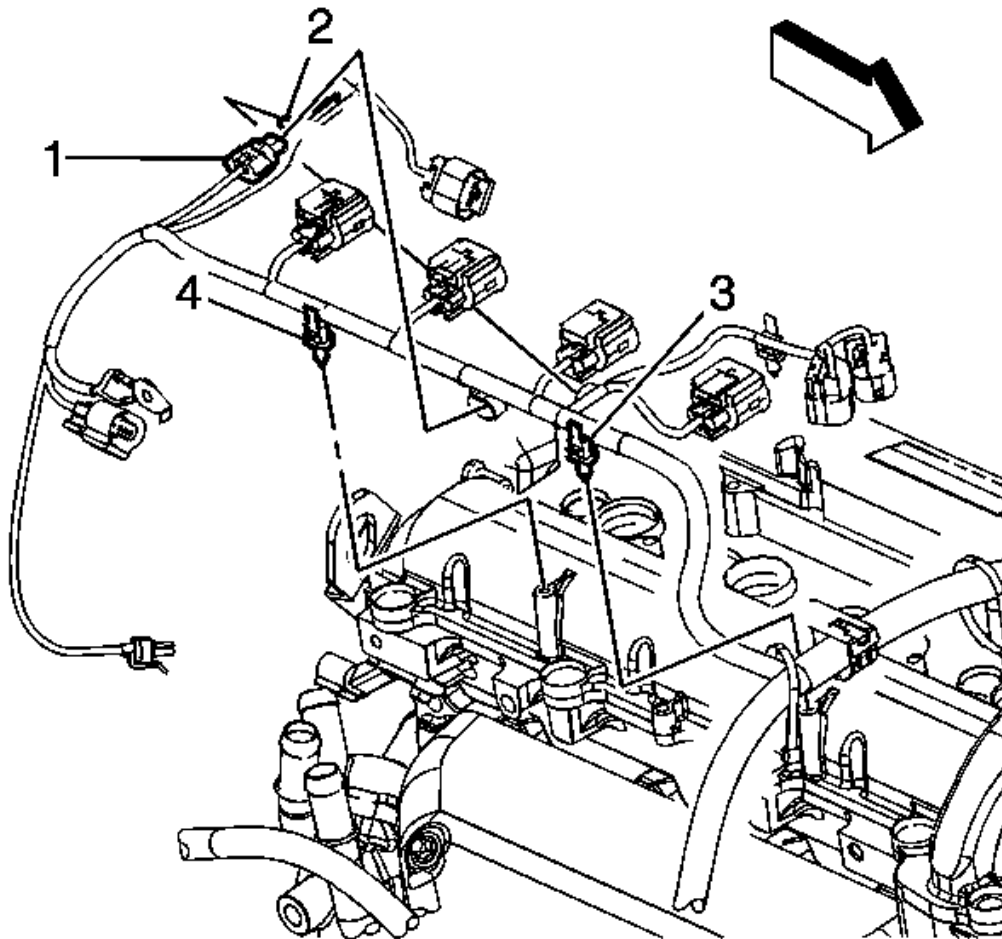


Fig. 135: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the evaporative emission (EVAP) canister purge solenoid valve electrical connector (1).
10. Remove the engine harness clip (2) from the EVAP purge solenoid bracket.
11. Remove the engine harness clips (3, 4) from the cam cover.
12. Remove the ignition coils. Refer to **Ignition Coil Replacement** .

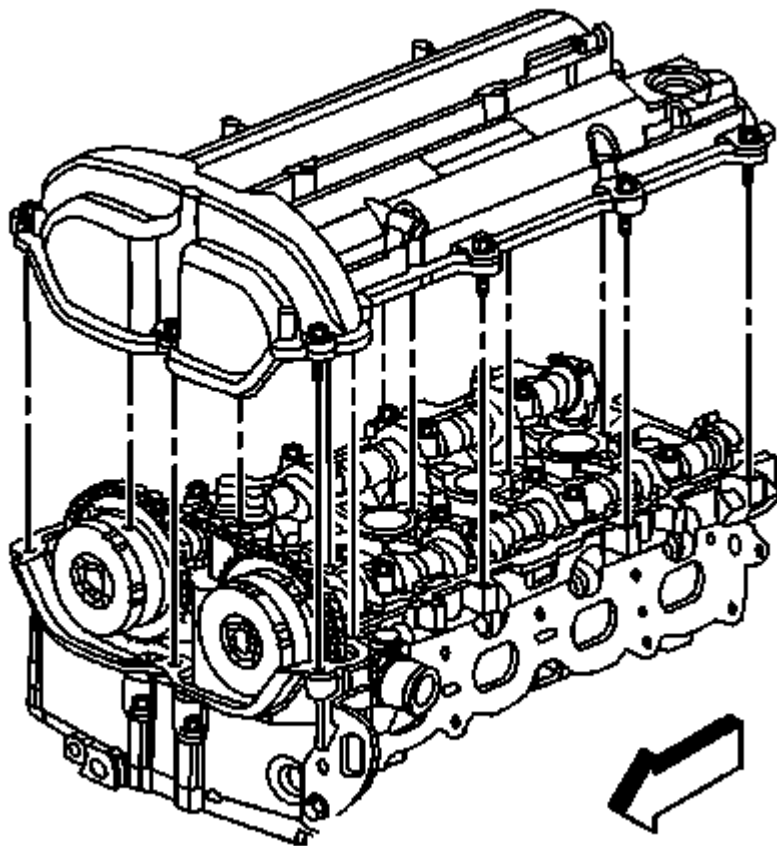


Fig. 136: Identifying Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

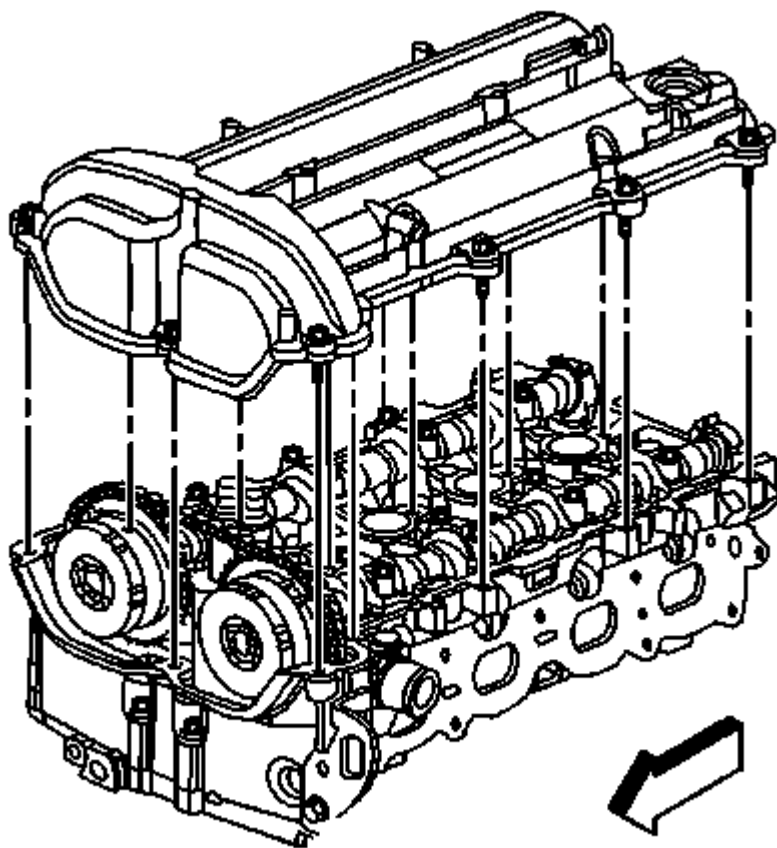


Fig. 137: Identifying Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the camshaft cover and bolts.

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

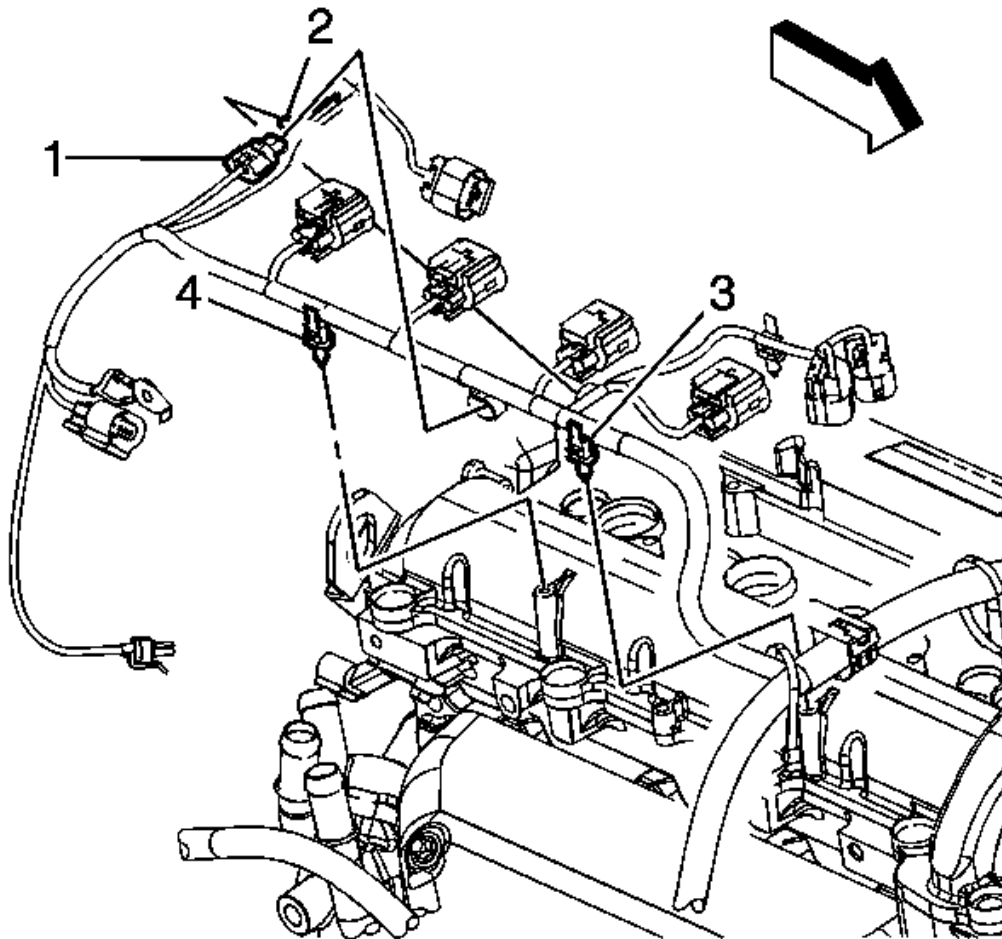


Fig. 138: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
 Courtesy of GENERAL MOTORS CORP.

2. Install the ignition coils. Refer to **Ignition Coil Replacement** .
3. Install the engine harness clips (3, 4) to the cam cover.
4. Install the engine harness clip (2) to the EVAP purge solenoid bracket.
5. Connect the EVAP canister purge solenoid valve electrical connector (1).

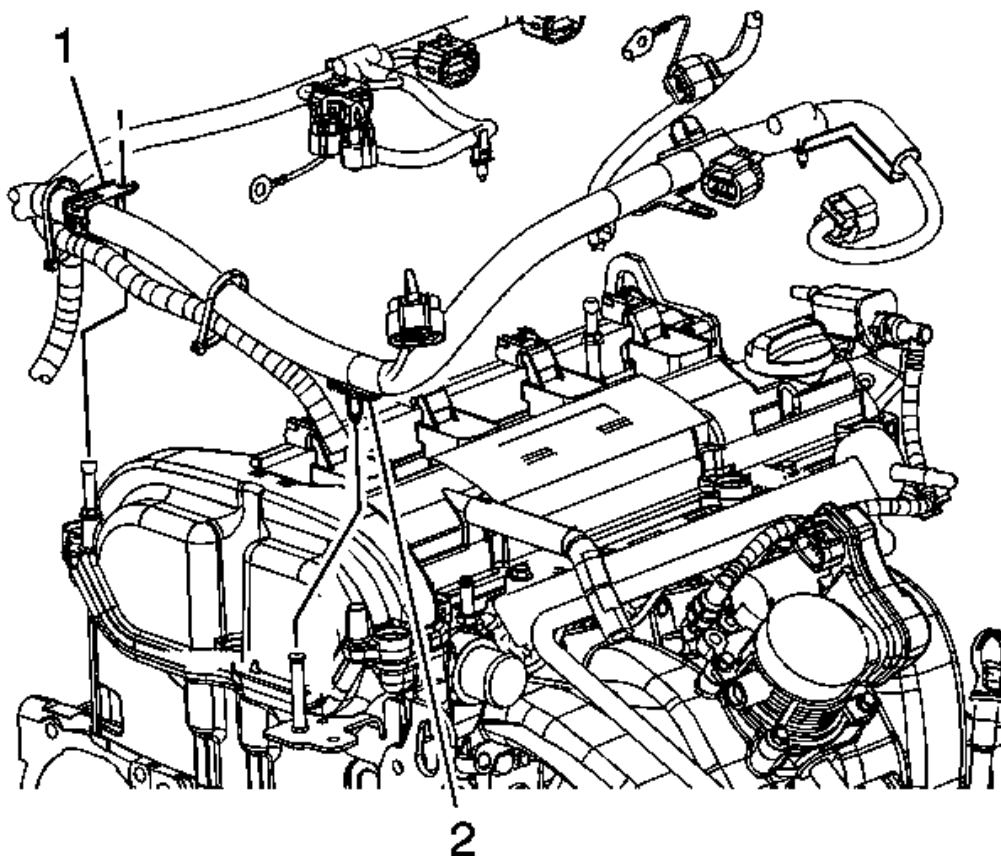


Fig. 139: Identifying Engine Harness Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the engine harness bracket (1) to the intake manifold cover stud.

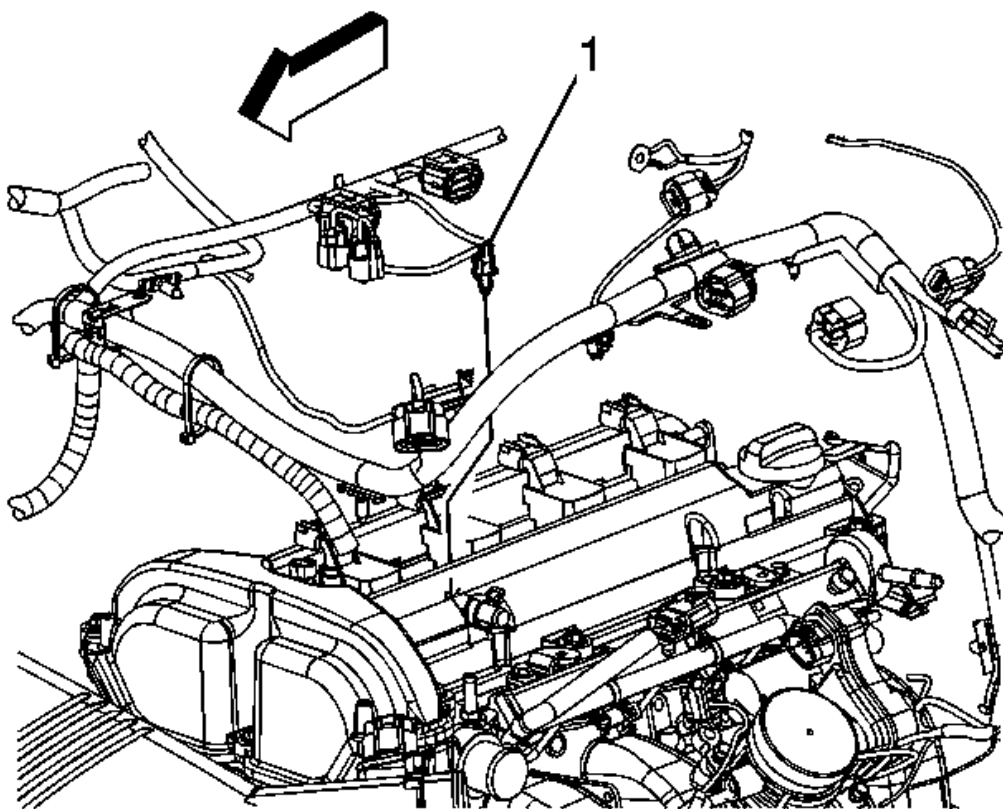


Fig. 140: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

7. Install the engine harness clip (1) to the cam cover.

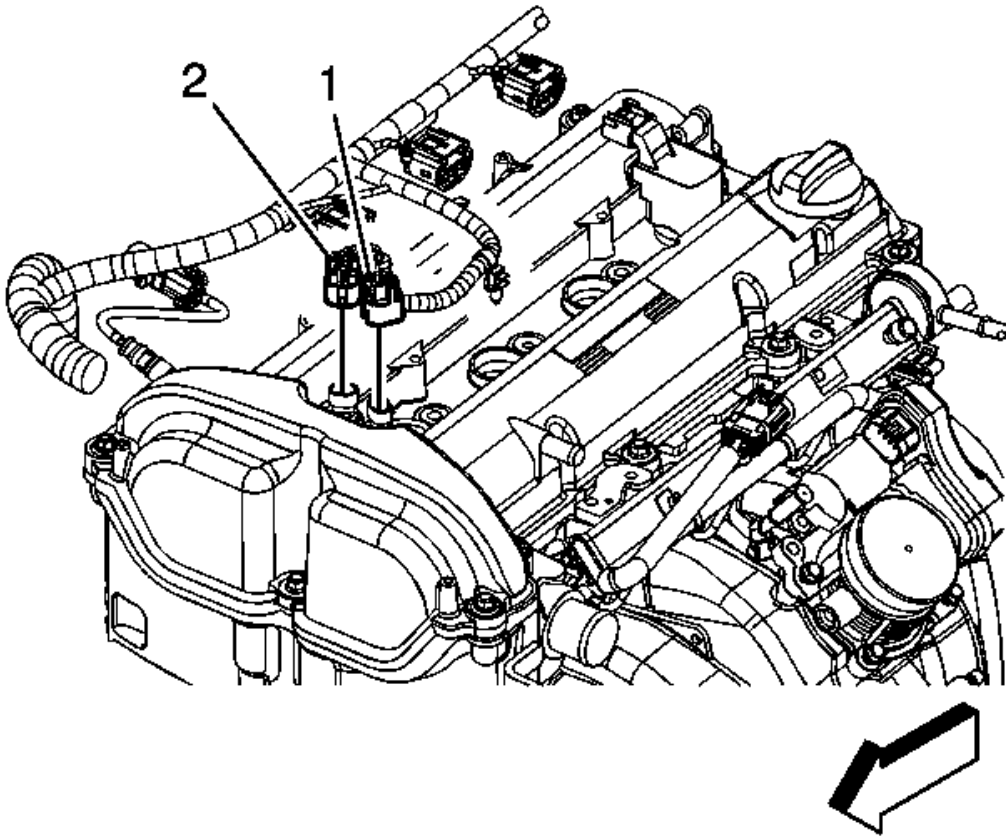


Fig. 141: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

8. Connect the intake (1) and exhaust (2) camshaft position actuator solenoid valve electrical connectors.
9. Install the PCV hose from the cover.
10. Position the PCV hose clamp.
11. Install the air cleaner outlet resonator. Refer to [Air Cleaner Outlet Resonator Replacement](#) .

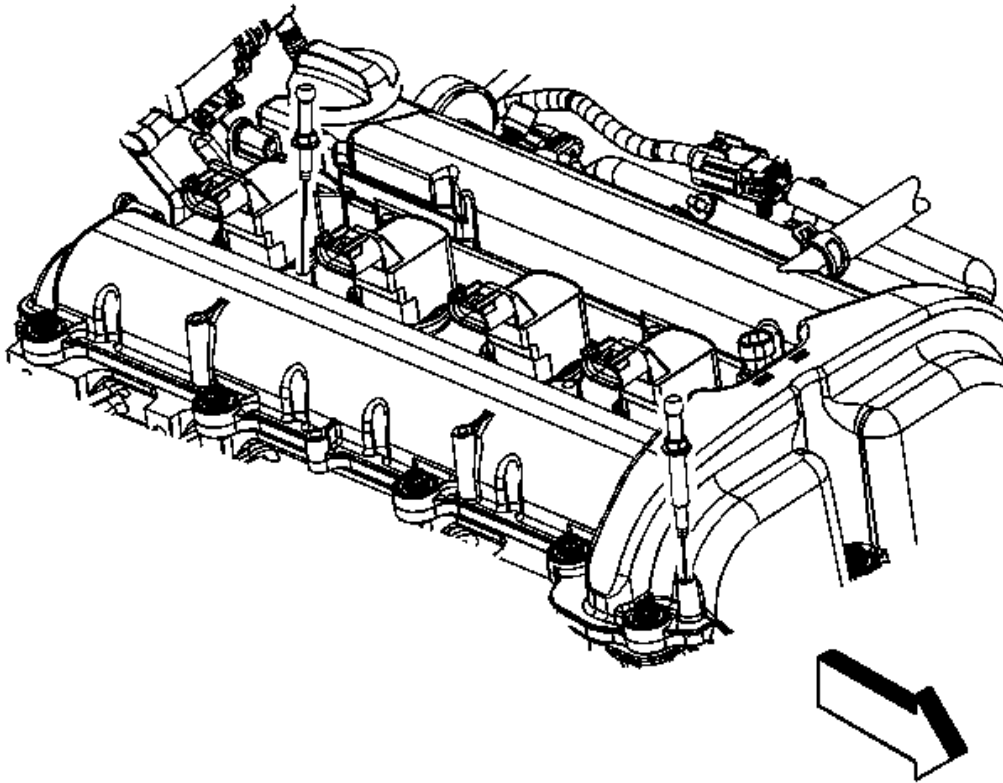


Fig. 142: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

12. Install the intake manifold cover studs.

Tighten: Tighten the studs to 9 N.m (80 lb in).

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

TIMING CHAIN TENSIONER REPLACEMENT

SPECIAL TOOLS

J 45027 Tensioner Tool

REMOVAL PROCEDURE

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

Connection .

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

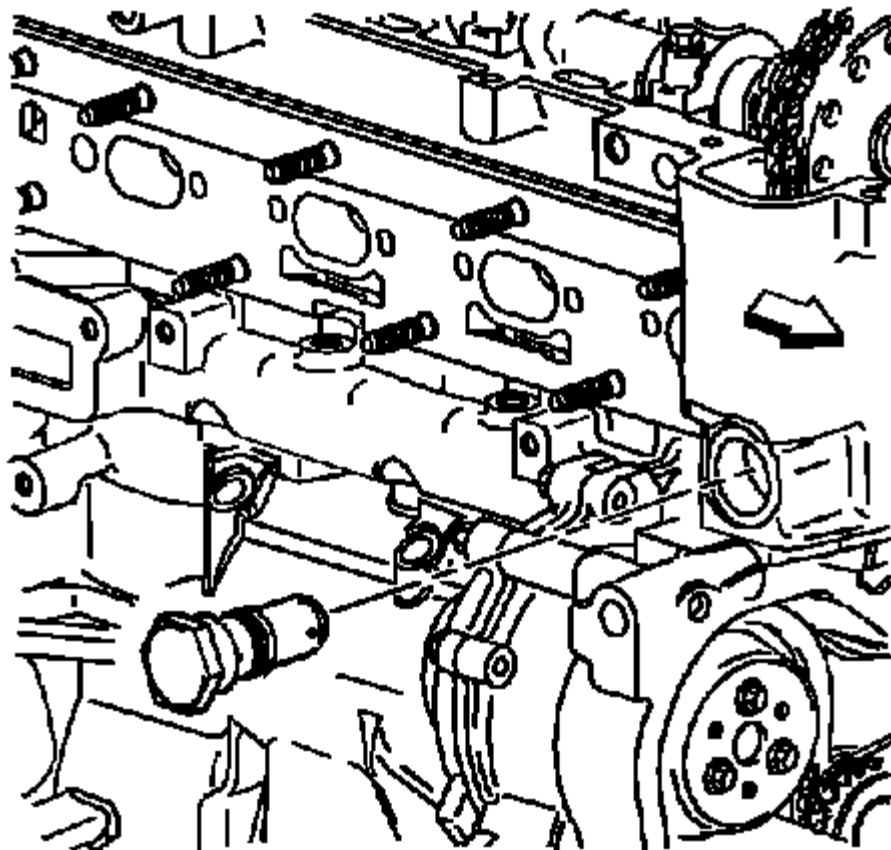


Fig. 143: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

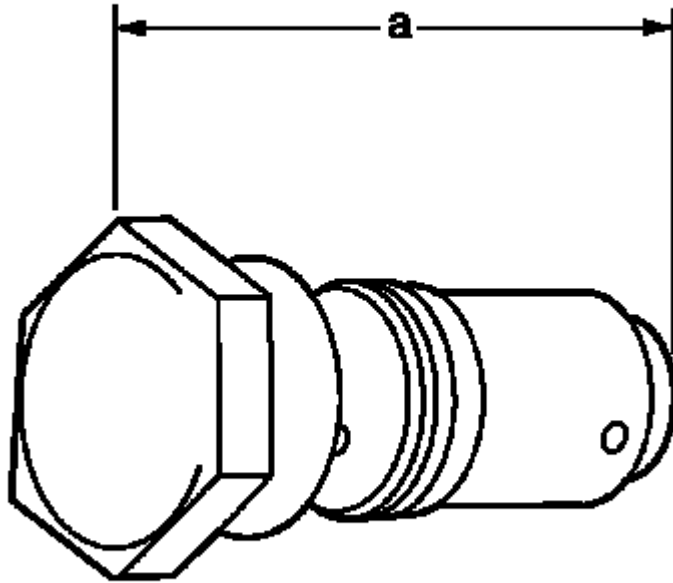


Fig. 144: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

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

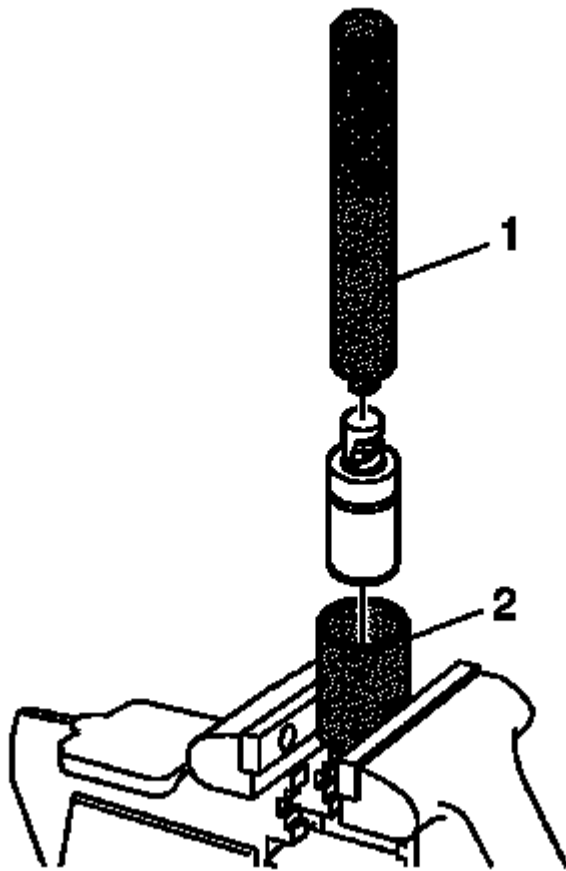


Fig. 145: View of Compressing Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

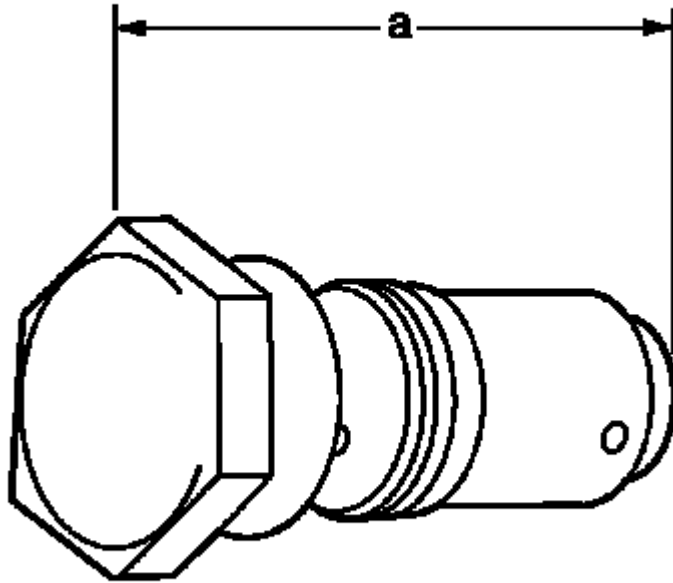


Fig. 146: Measuring Timing Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

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

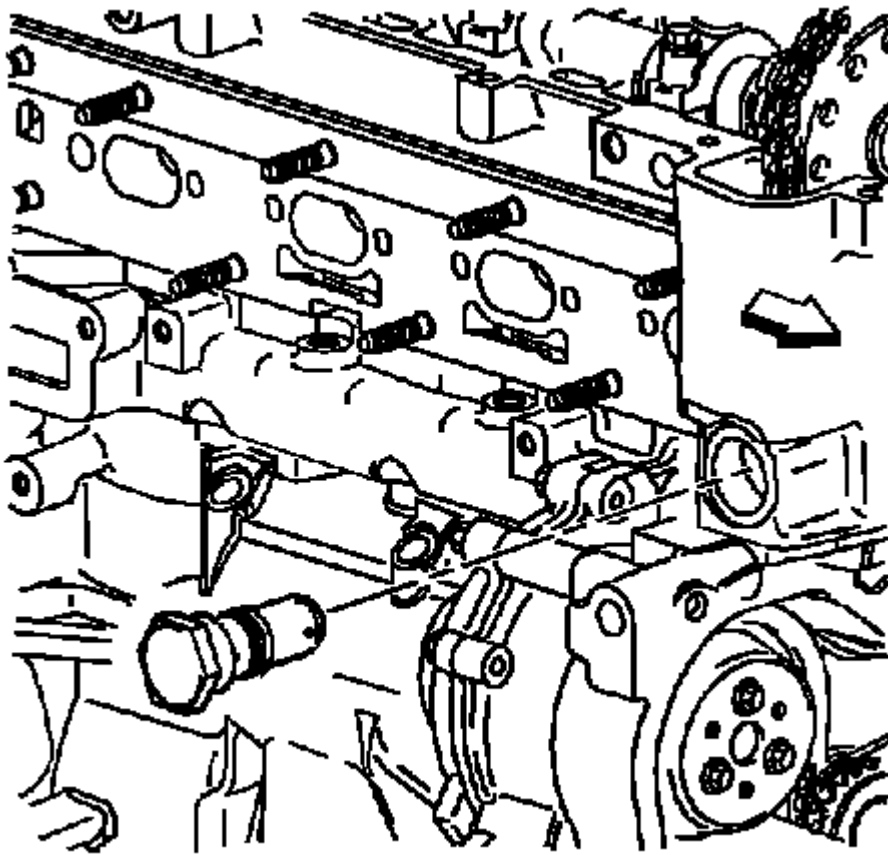


Fig. 147: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

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

8. Install the timing chain tensioner assembly. Tighten the timing chain tensioner to 75 N.m (55 lb ft).
9. The timing chain tensioner is released by compressing the tensioner 2 mm (0.079 in) which will release the locking mechanism in the ratchet. To release the timing chain tensioner, use a suitable tool with a rubber tip on the end. Feed the tool down through the cam drive chest to rest on the cam chain. Then give a sharp jolt diagonally downwards to release the tensioner.
10. Install the camshaft cover. Refer to Camshaft Cover Replacement.
11. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

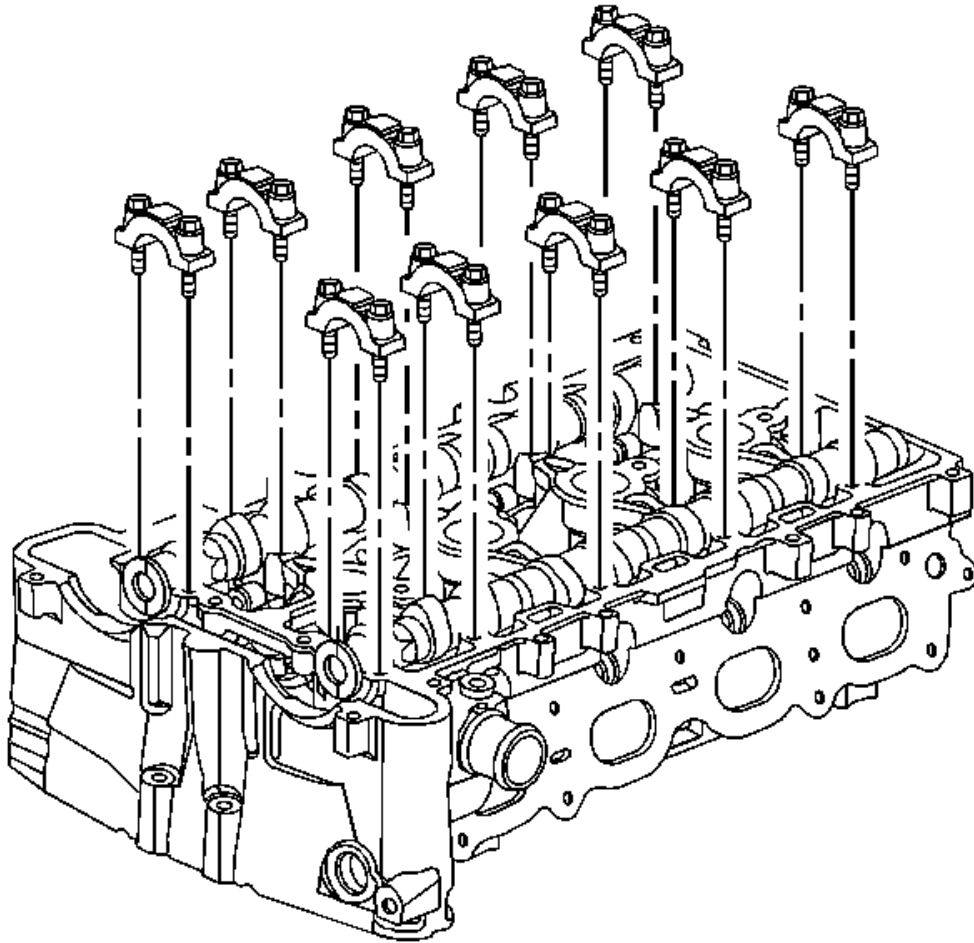


Fig. 148: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake camshaft position actuator. Refer to [Camshaft Position Intake Actuator Replacement](#).

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

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

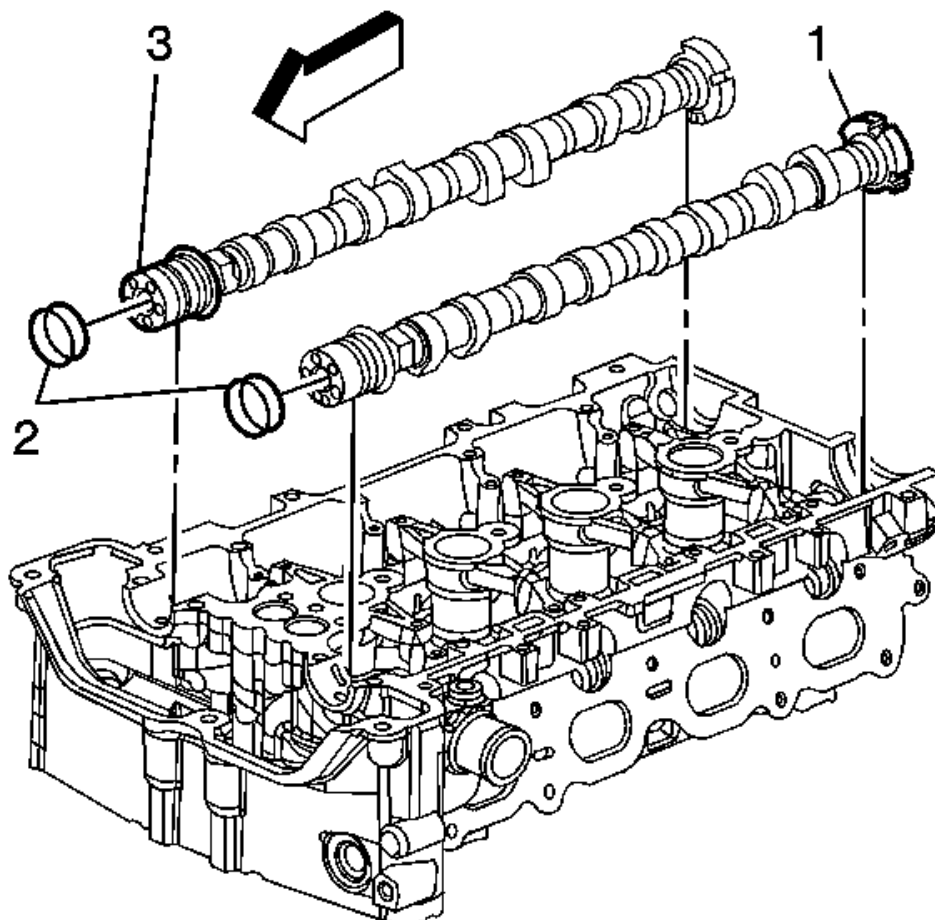


Fig. 149: Identifying Intake/Exhaust Camshafts
 Courtesy of GENERAL MOTORS CORP.

5. Remove the intake camshaft (1).

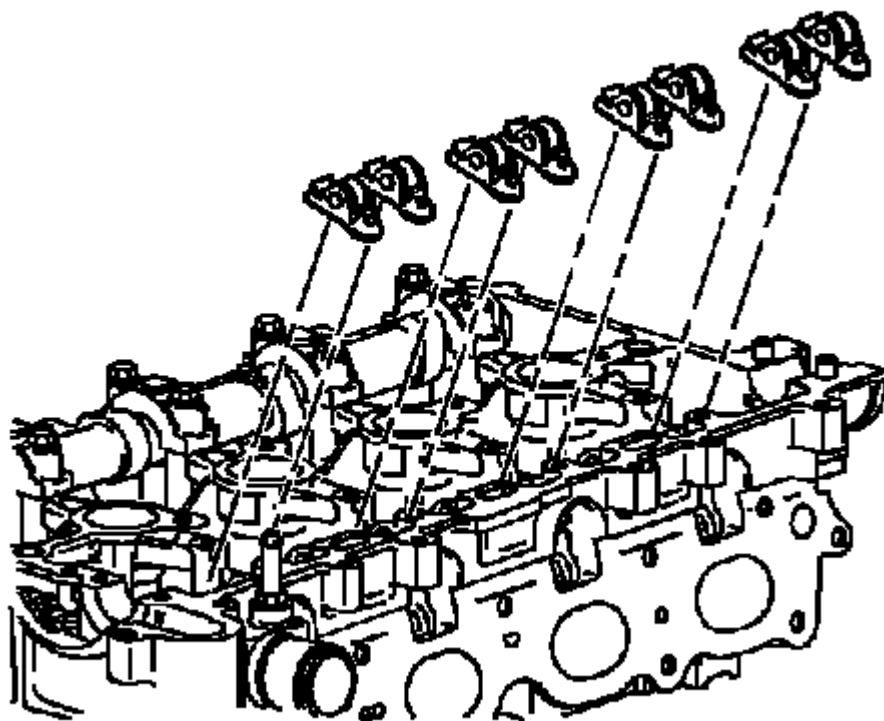


Fig. 150: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

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

6. Remove the camshaft roller followers.

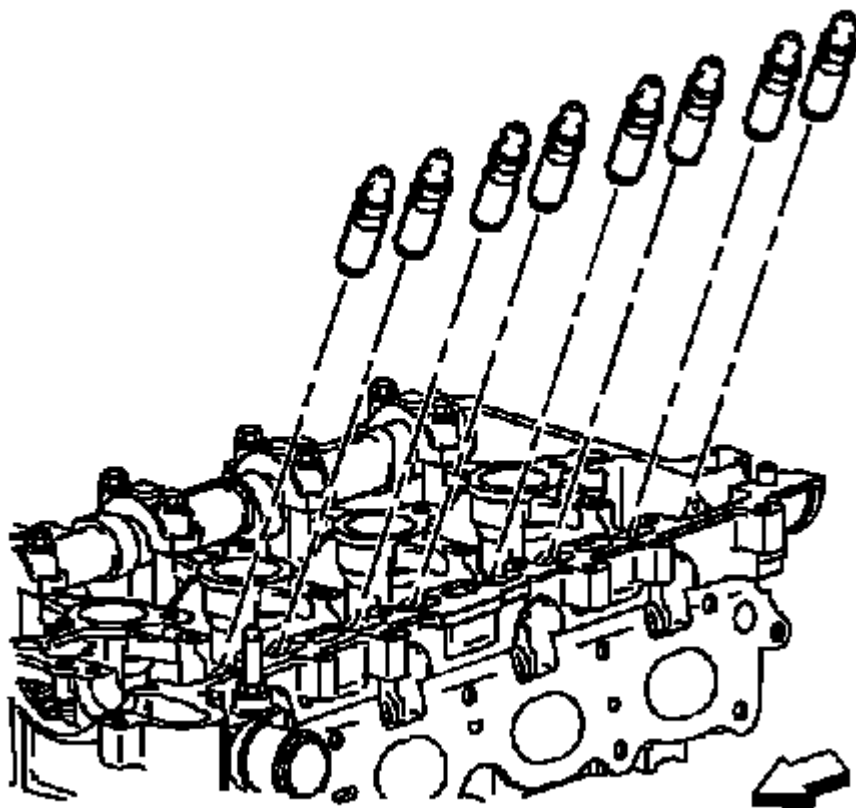


Fig. 151: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

7. Remove the hydraulic element adjusters.

INSTALLATION PROCEDURE

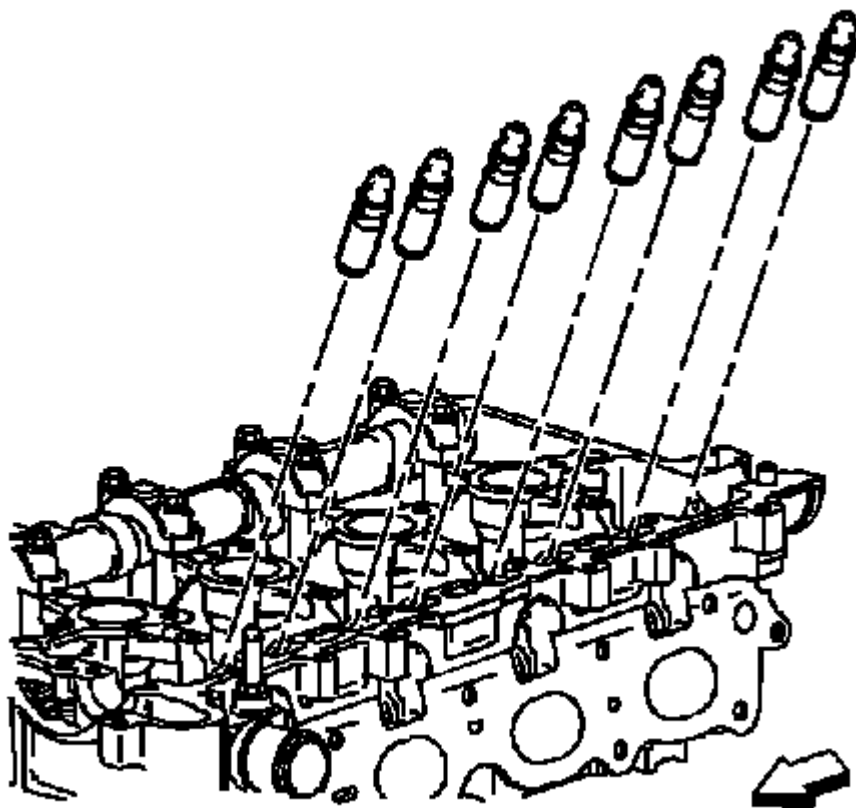


Fig. 152: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic element lash adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters with GM PN 12345501 (Canadian PN 992704) or equivalent.

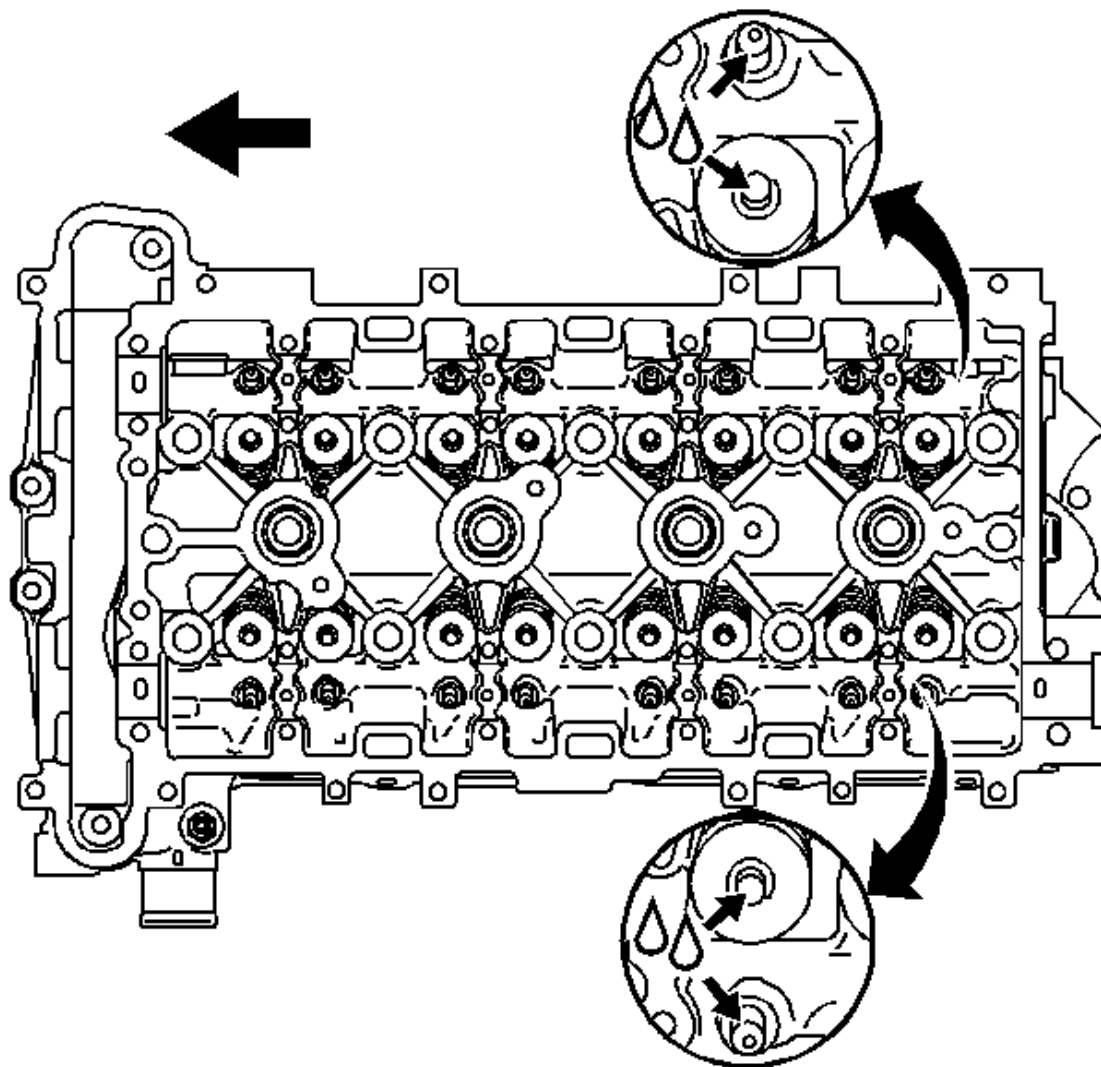


Fig. 153: Identifying Valve Tips

Courtesy of GENERAL MOTORS CORP.

3. Lubricate the valve tips with GM PN 12345501 (Canadian PN 992704) or equivalent.

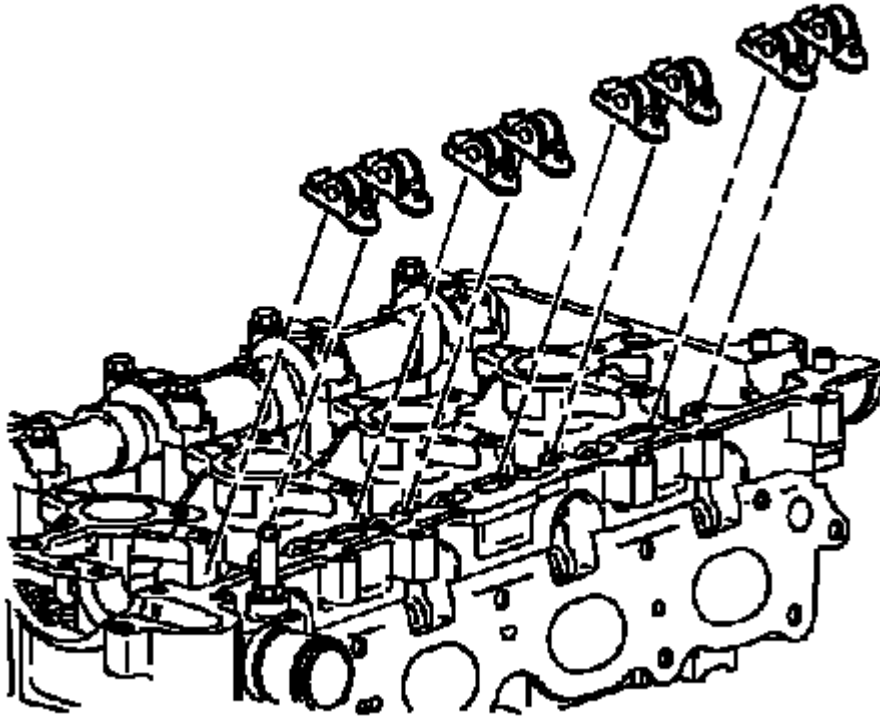


Fig. 154: View Of Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Used roller followers **MUST** be returned to their original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the camshaft roller followers on the tip of the valve stem and on the lash adjuster. Lubricate the roller followers with GM PN 12345501 (Canadian PN 992704) or equivalent.

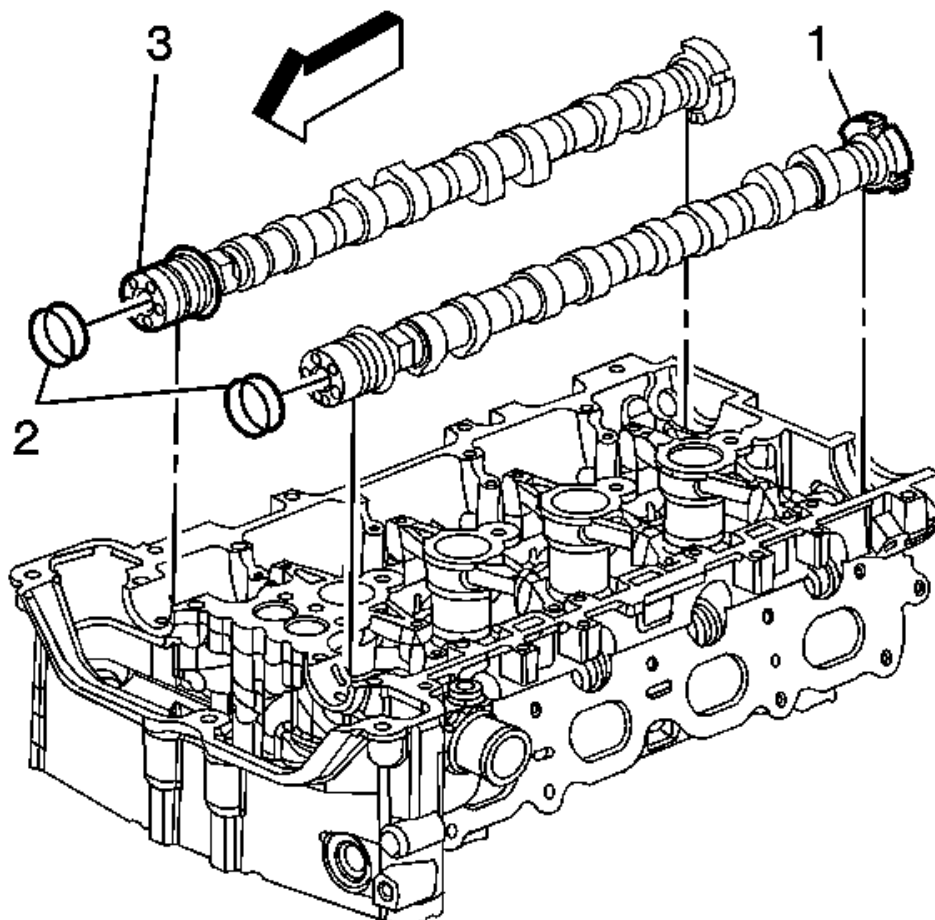


Fig. 155: Identifying Intake/Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Install the intake camshaft (1). Lubricate with GM PN 12345501 (Canadian PN 992704) or equivalent.

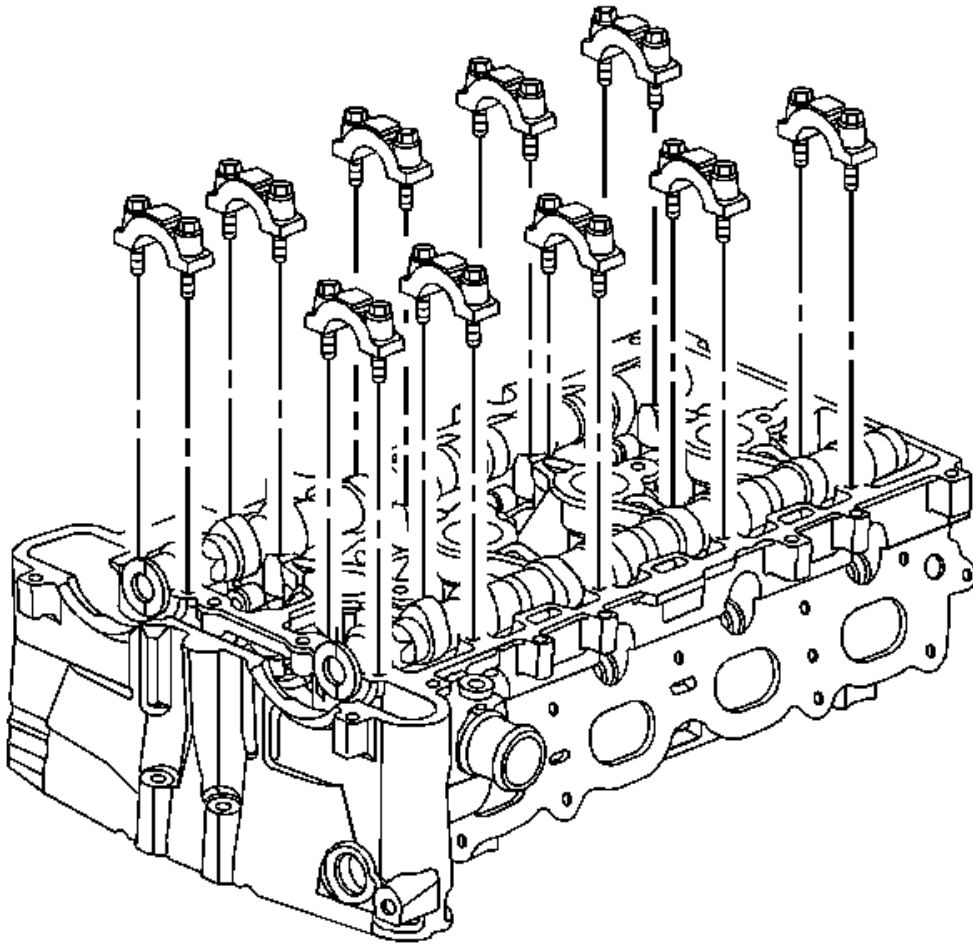


Fig. 156: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft bearing caps. Hand tighten the cap bolts.

CAUTION: Refer to Fastener Caution .

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

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

8. Install the intake camshaft position actuator. Refer to Camshaft Position Intake Actuator Replacement.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

REMOVAL PROCEDURE

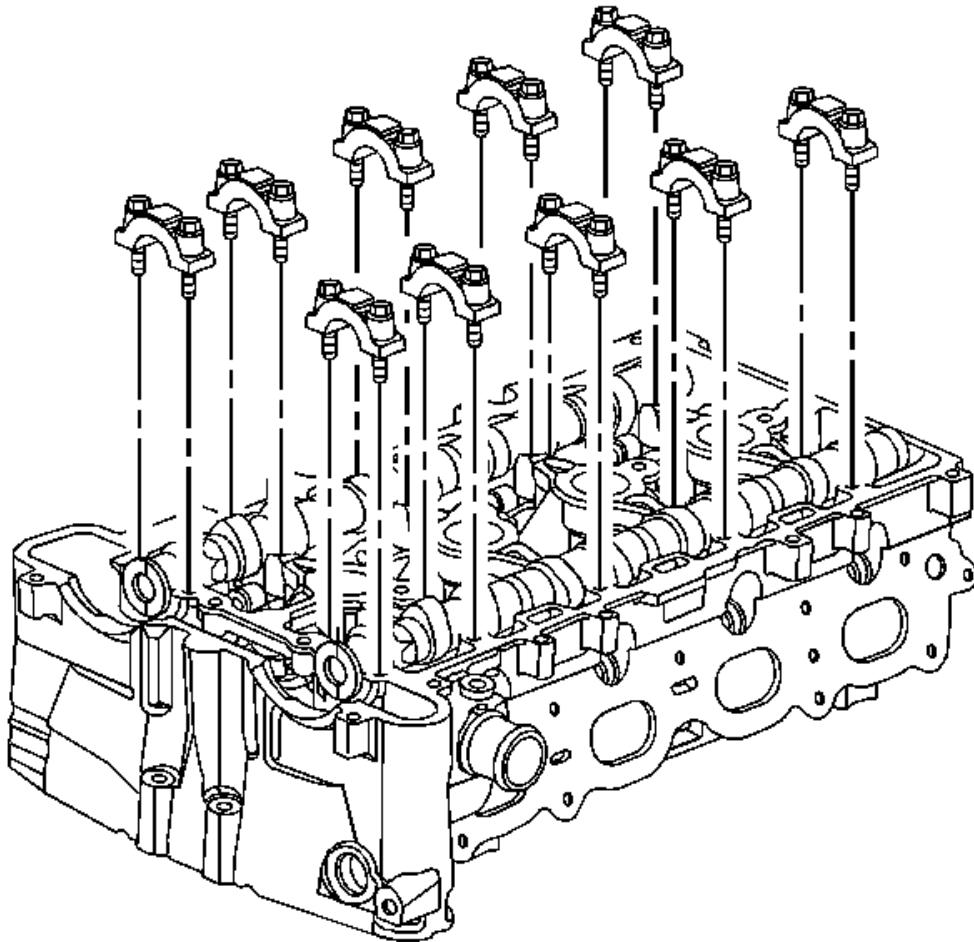


Fig. 157: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

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

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

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

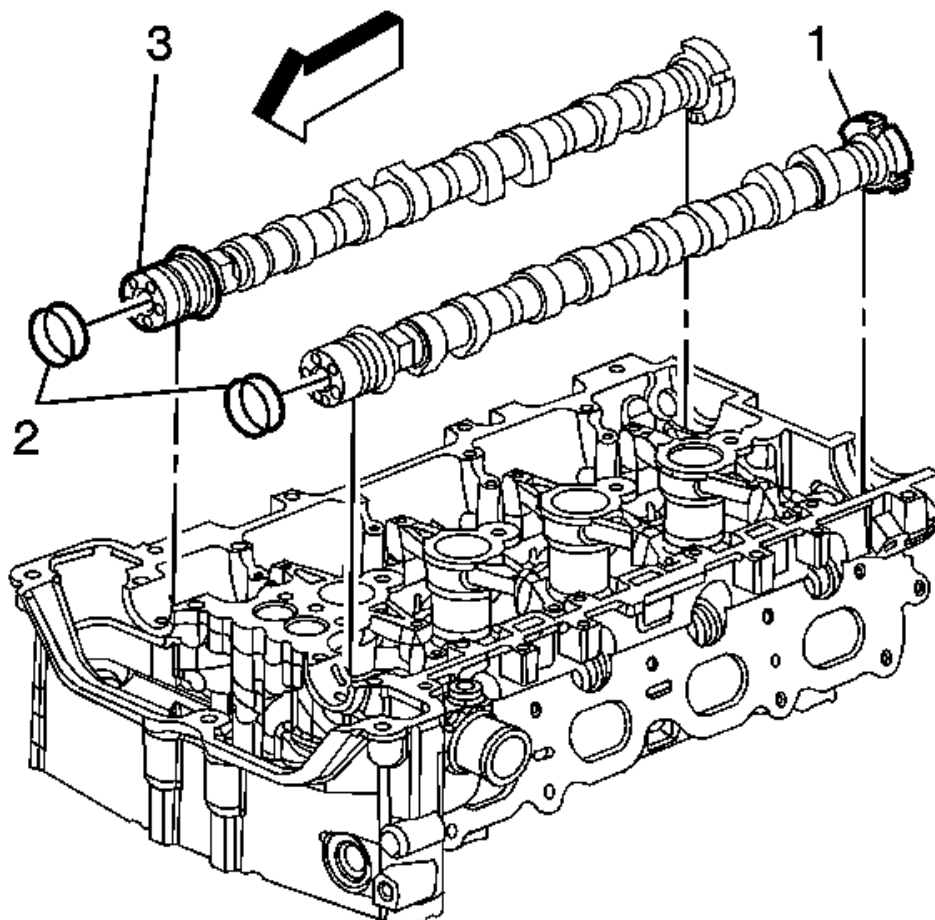


Fig. 158: Identifying Intake/Exhaust Camshafts
 Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust camshaft (3).

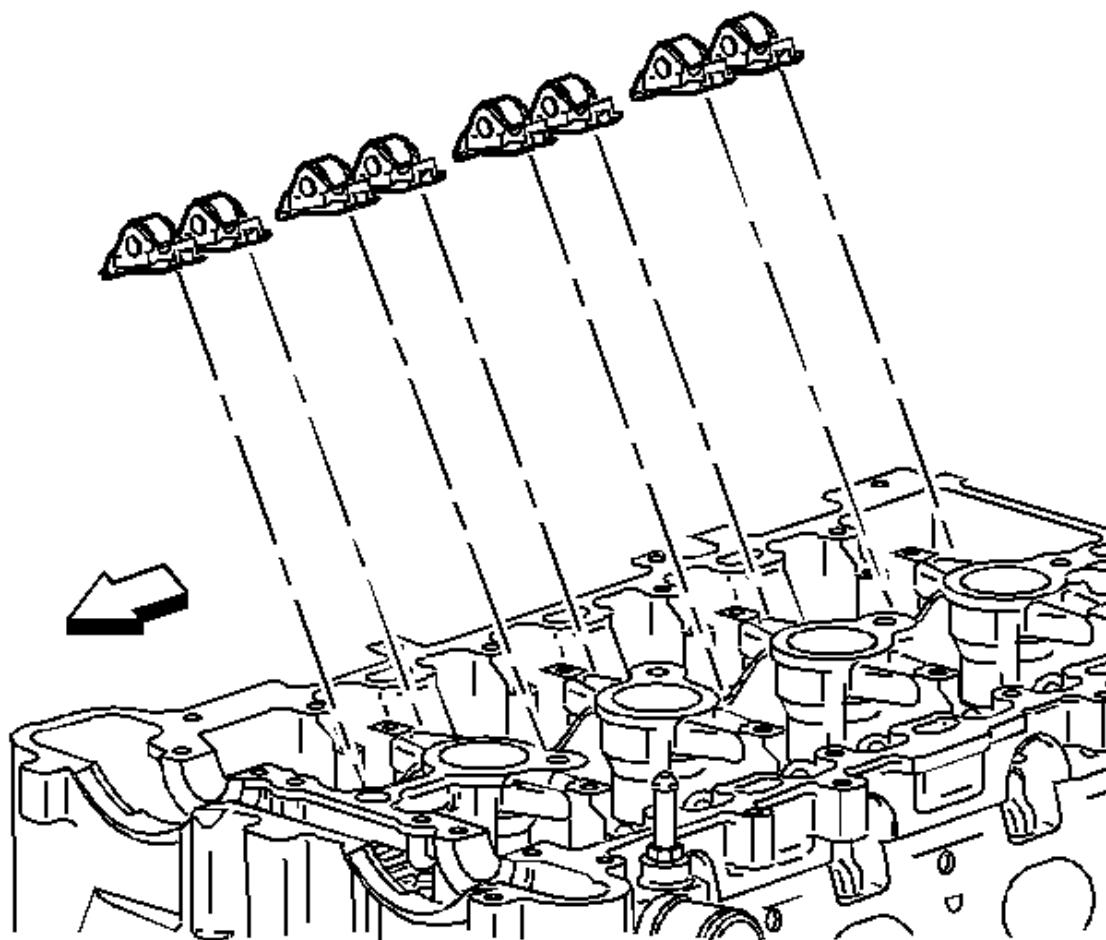


Fig. 159: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

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

6. Remove the camshaft roller followers.

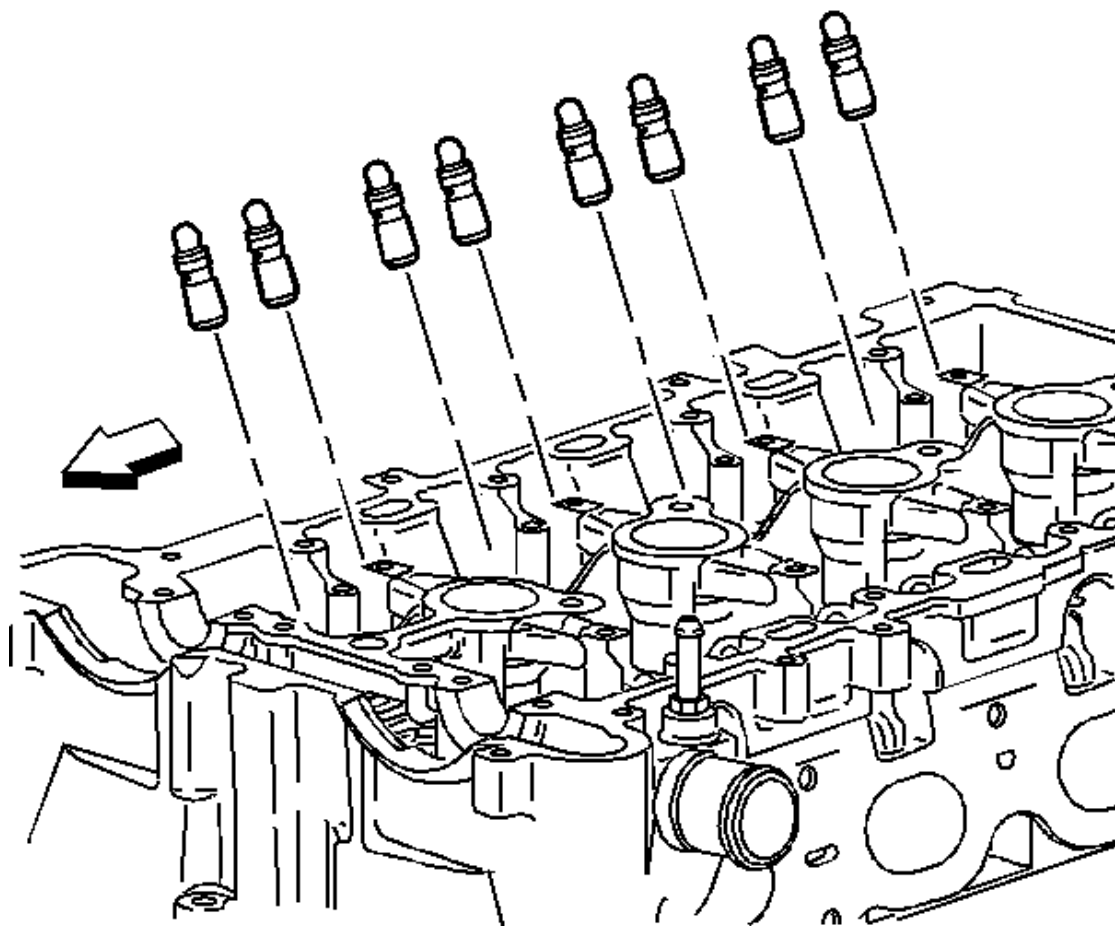


Fig. 160: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

7. Remove the hydraulic element adjusters.

INSTALLATION PROCEDURE

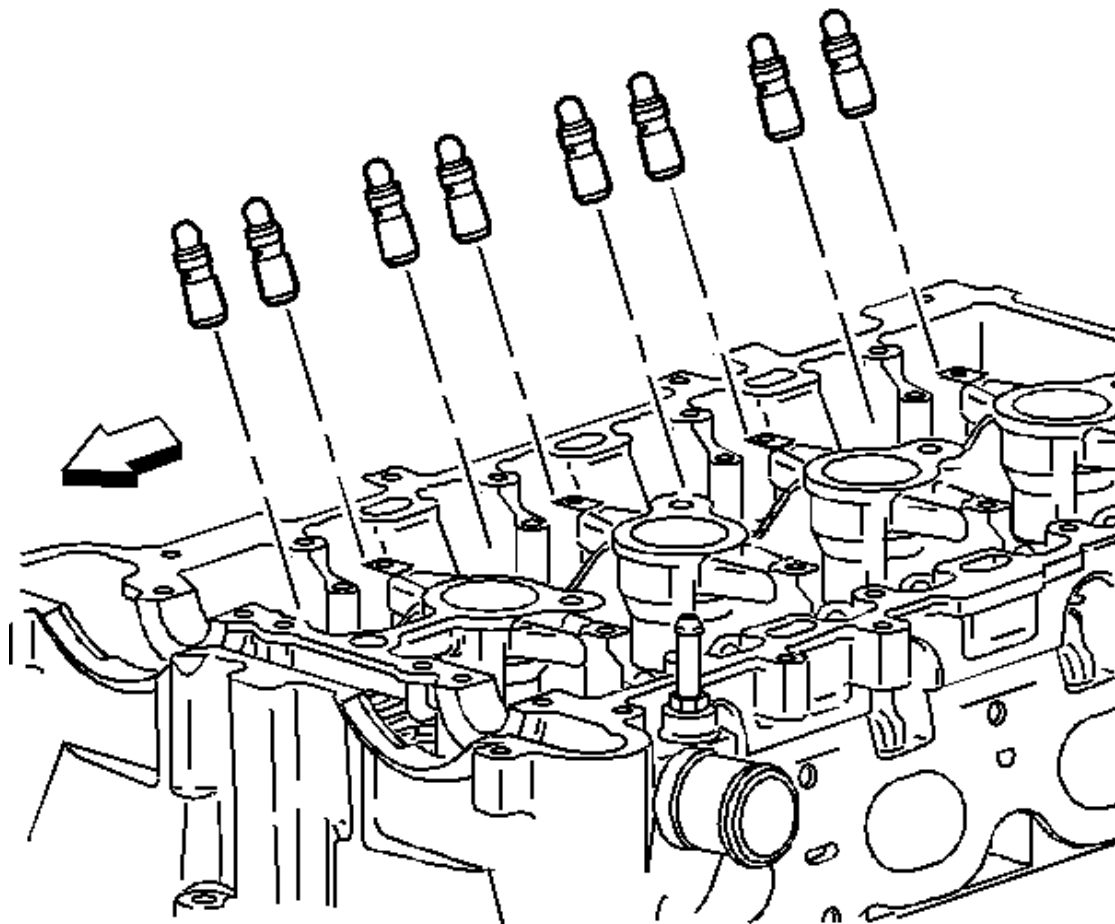


Fig. 161: View Of Hydraulic Element Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the hydraulic element adjusters into their bores in the cylinder head.
2. Lubricate the hydraulic lash adjusters with GM PN 12345501 (Canadian PN 992704) or equivalent.

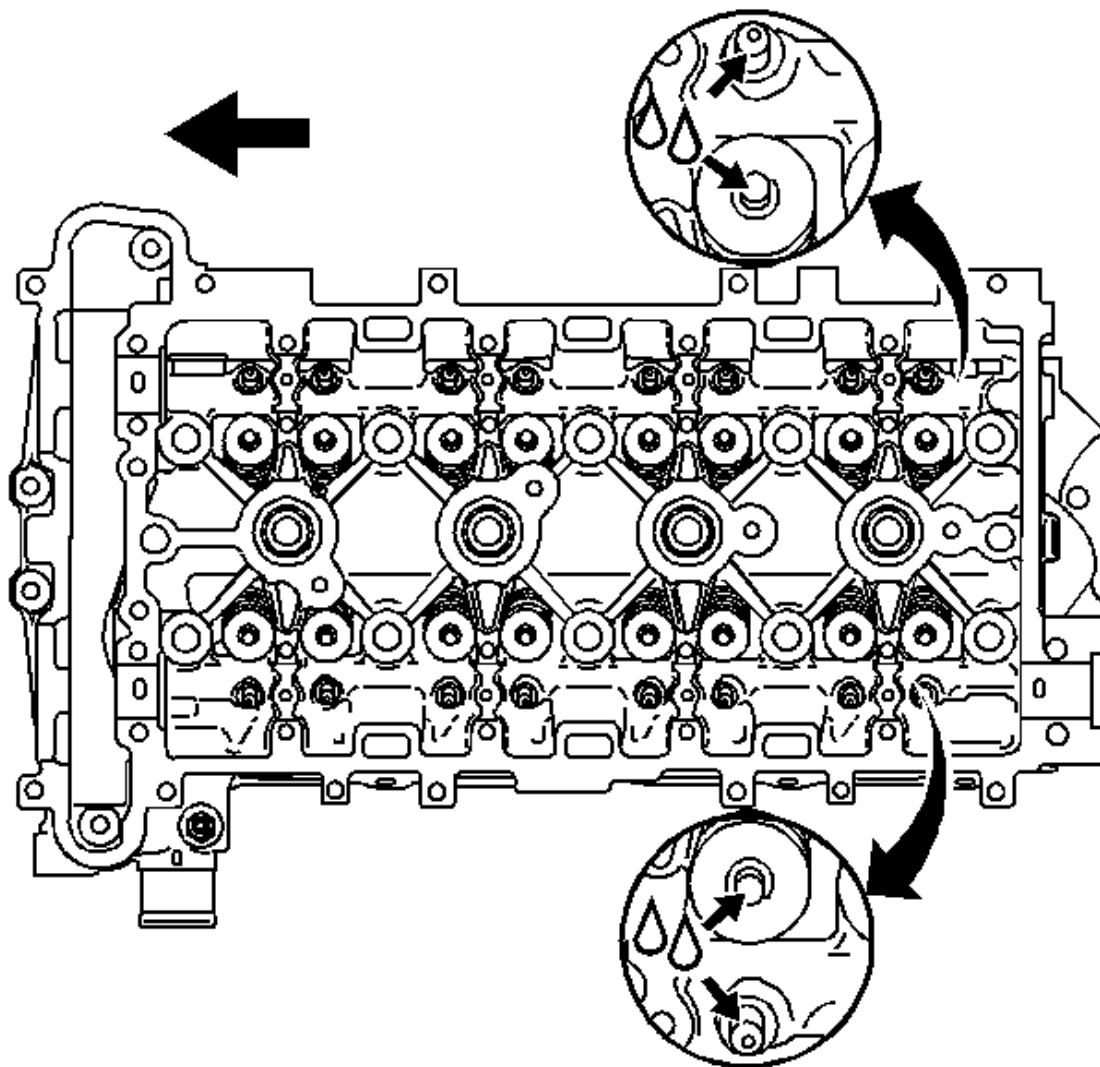


Fig. 162: Identifying Valve Tips

Courtesy of GENERAL MOTORS CORP.

3. Lubricate the valve tips with GM PN 12345501 (Canadian PN 992704) or equivalent.

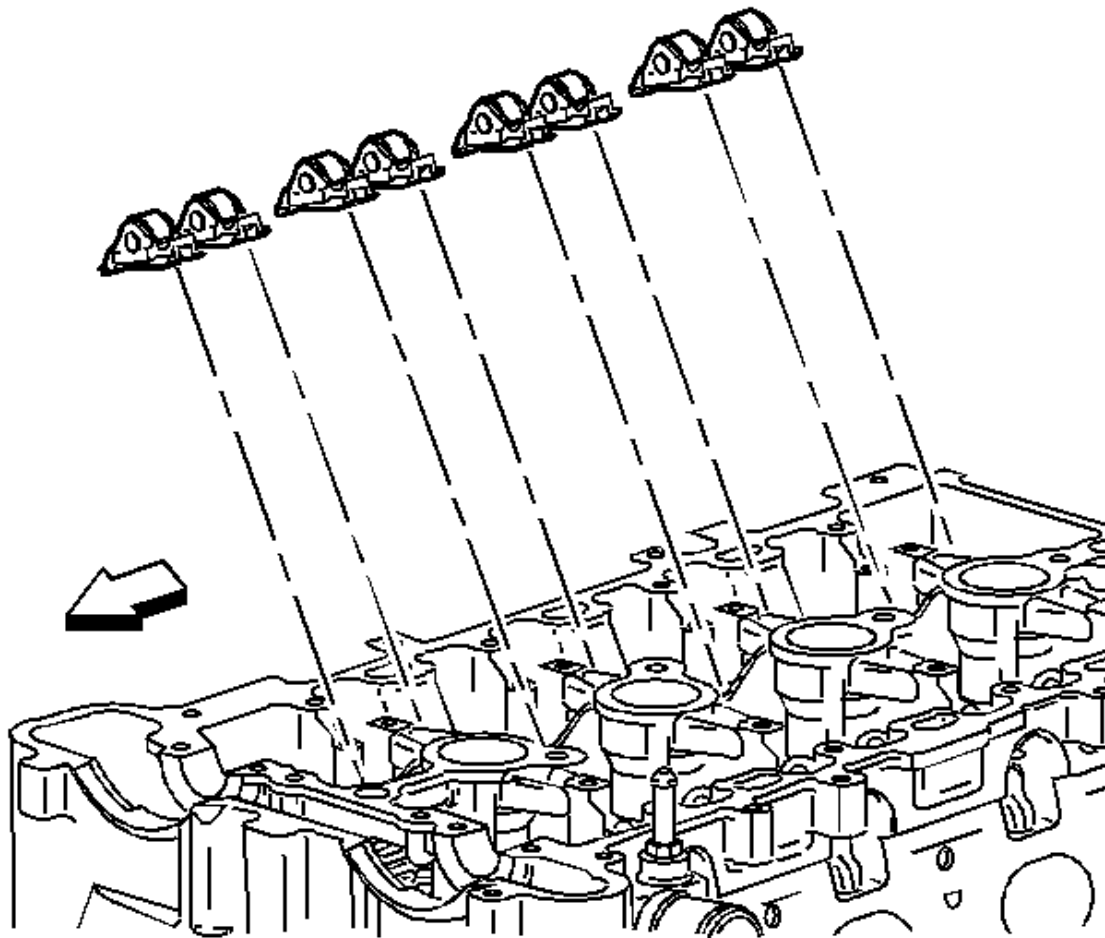


Fig. 163: Identifying Exhaust Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

NOTE: Used roller followers **MUST** be returned to the original position on the camshaft. If the camshaft is being replaced, the roller followers actuated by the camshaft must also be replaced.

4. Position the roller followers on the tip of the valve stem and on the lash adjuster, apply lubricate GM PN 12345501 (Canadian PN 992704) or equivalent.

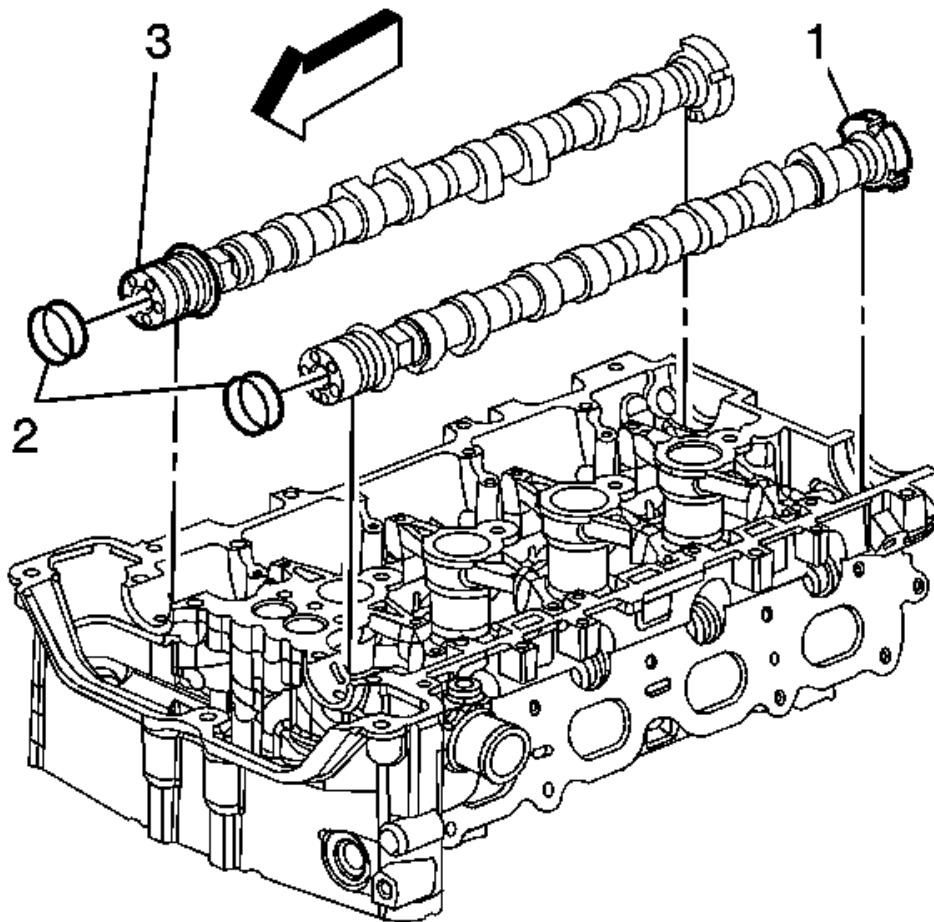


Fig. 164: Identifying Intake/Exhaust Camshafts
Courtesy of GENERAL MOTORS CORP.

5. Install the exhaust camshaft (3). Lubricate with GM PN 12345501 (Canadian PN 992704) or equivalent.

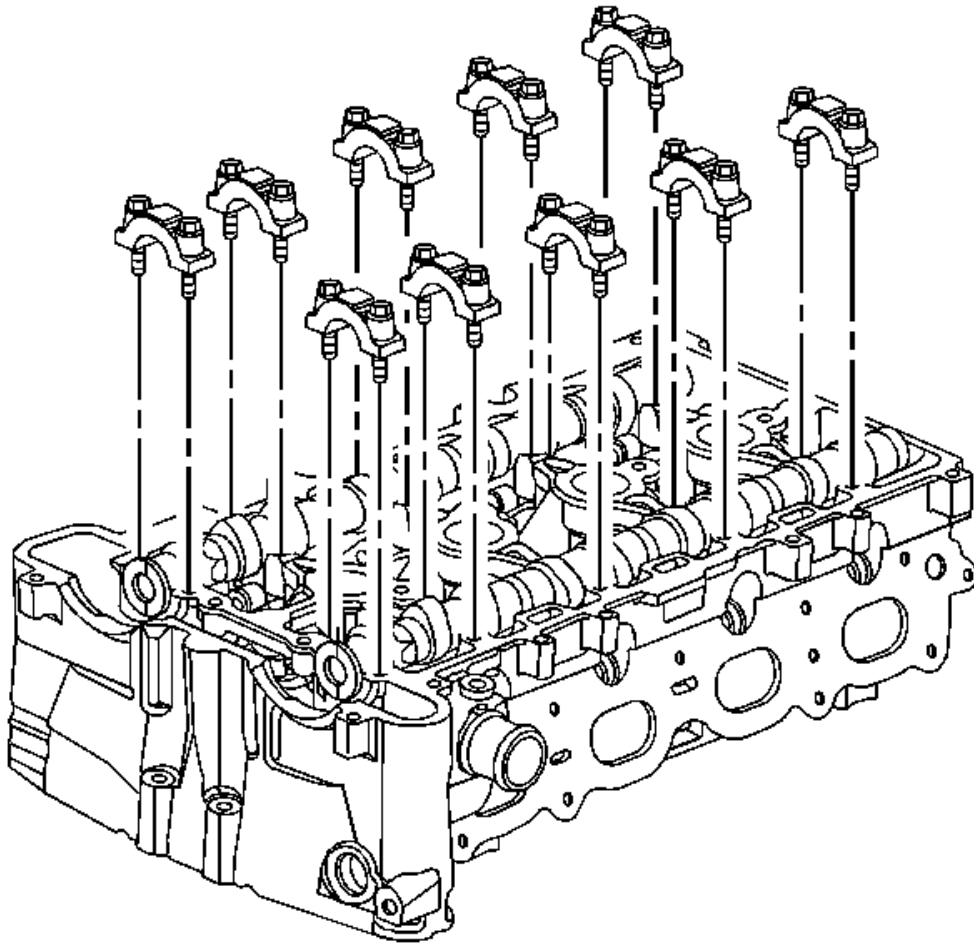


Fig. 165: View Of Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft bearing caps. Hand tighten the cap bolts.

CAUTION: Refer to Fastener Caution .

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

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

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

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

SPECIAL TOOLS

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

For equivalent regional tools, refer to **Special Tools** .

REMOVAL PROCEDURE

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

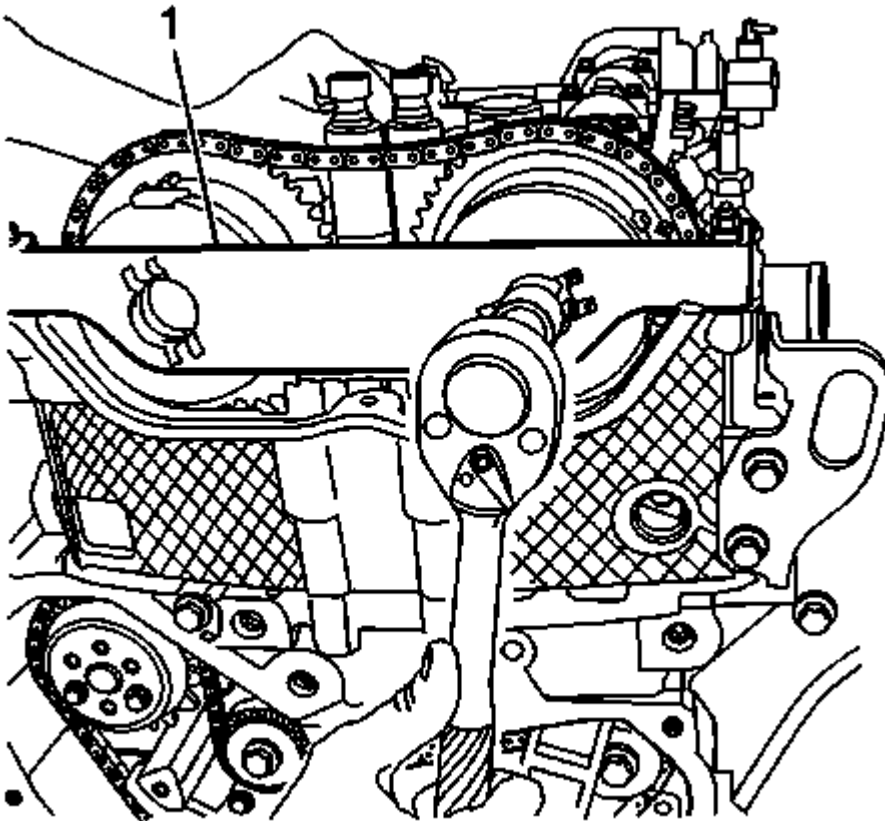


Fig. 166: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the **EN-48953:** retention tool (1).

CAUTION: Refer to **Fastener Caution** .

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

5. Loosen, but DO NOT remove the intake camshaft actuator bolt.
6. Remove the **EN-48953**: locking tool (1).
7. Clean the timing chain and gears with solvent.

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

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

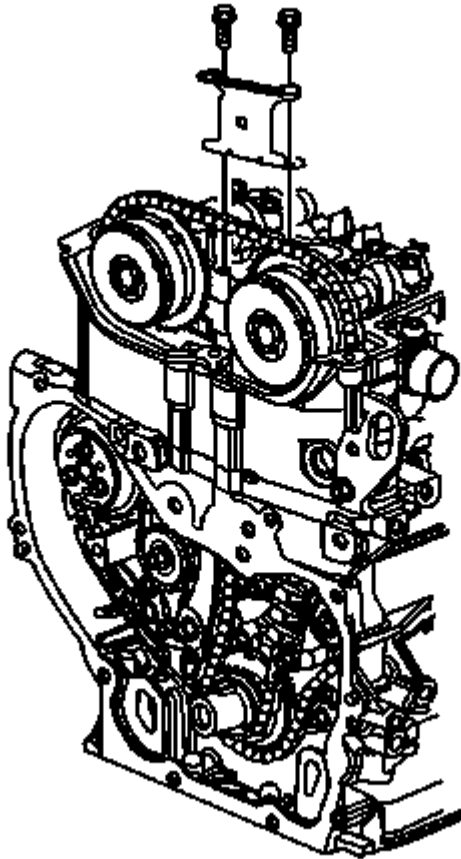


Fig. 167: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

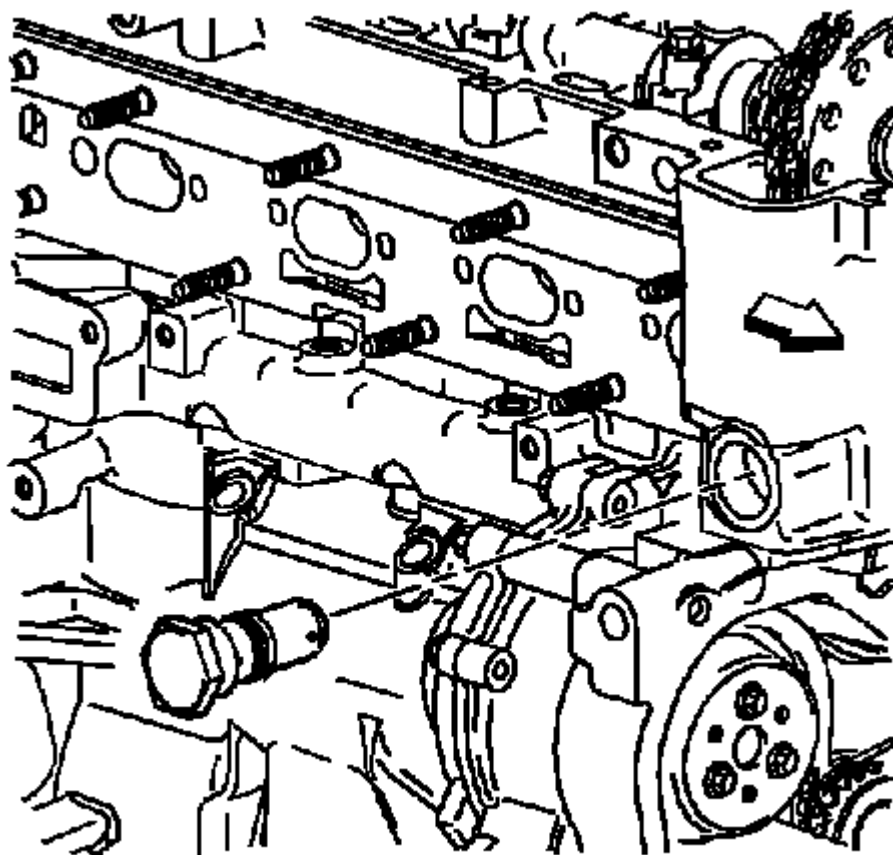


Fig. 168: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

10. Remove the timing chain tensioner.

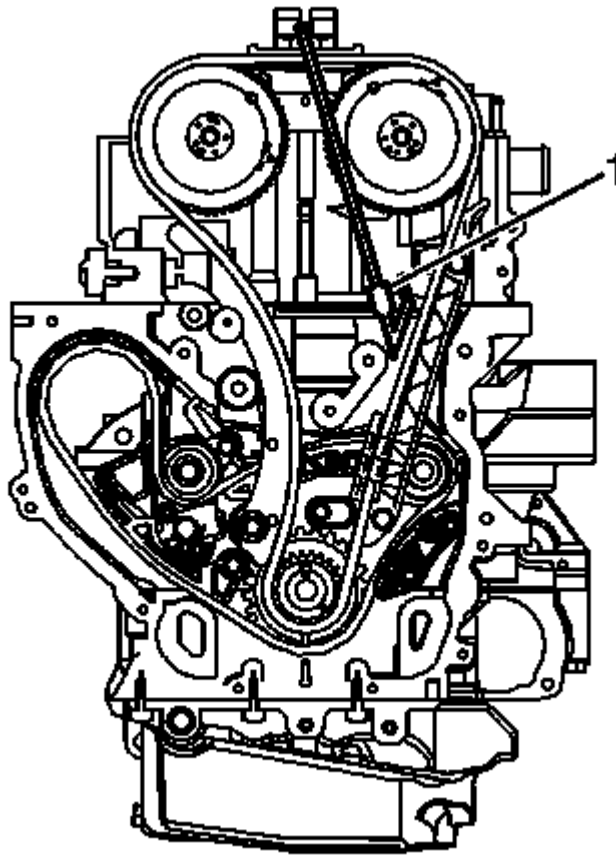


Fig. 169: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

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

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

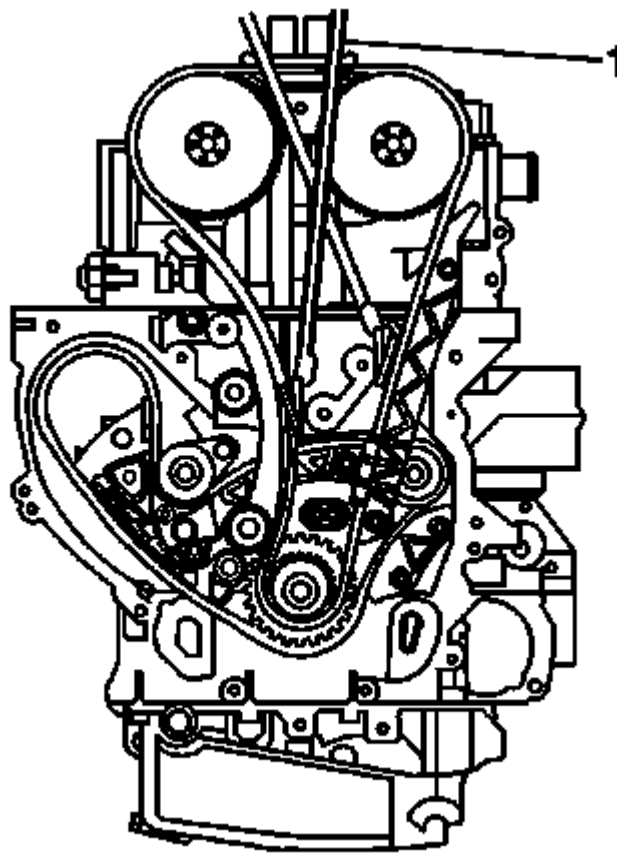


Fig. 170: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

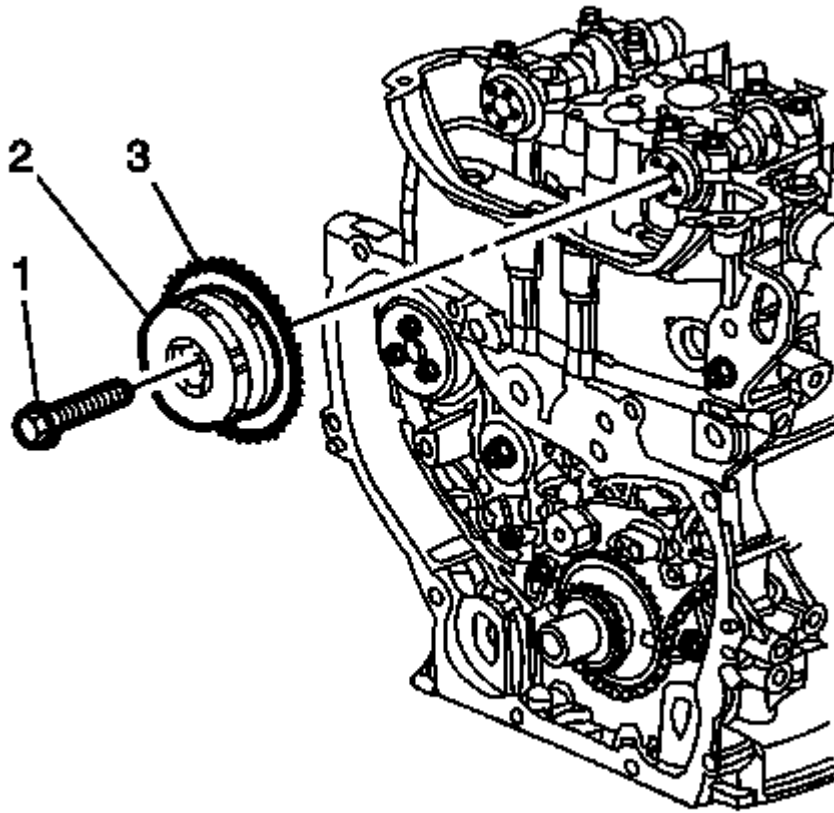


Fig. 171: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

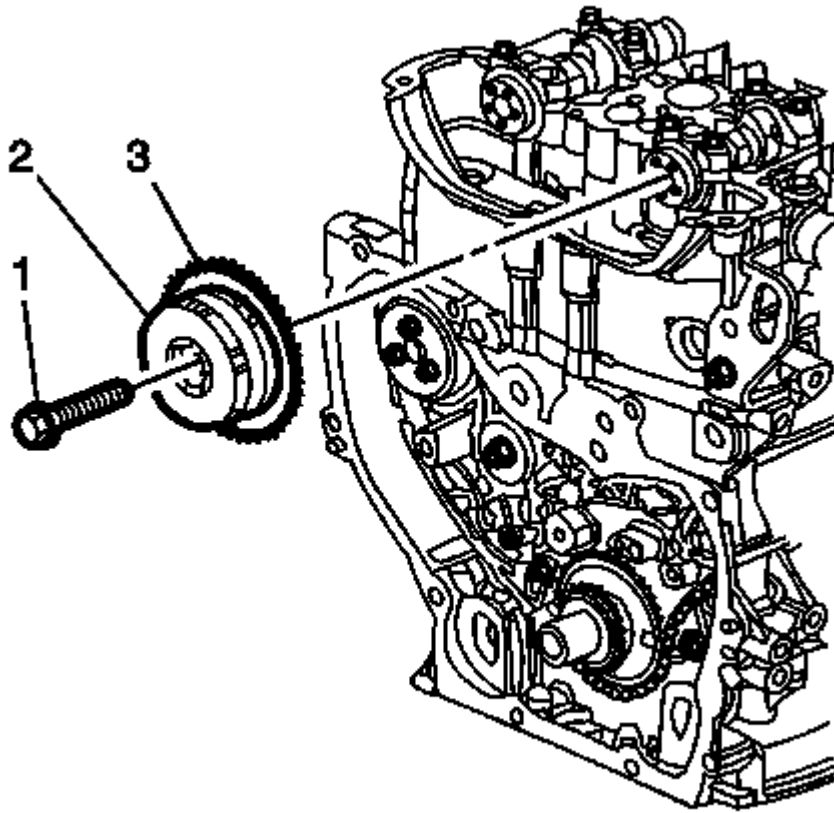


Fig. 172: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

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

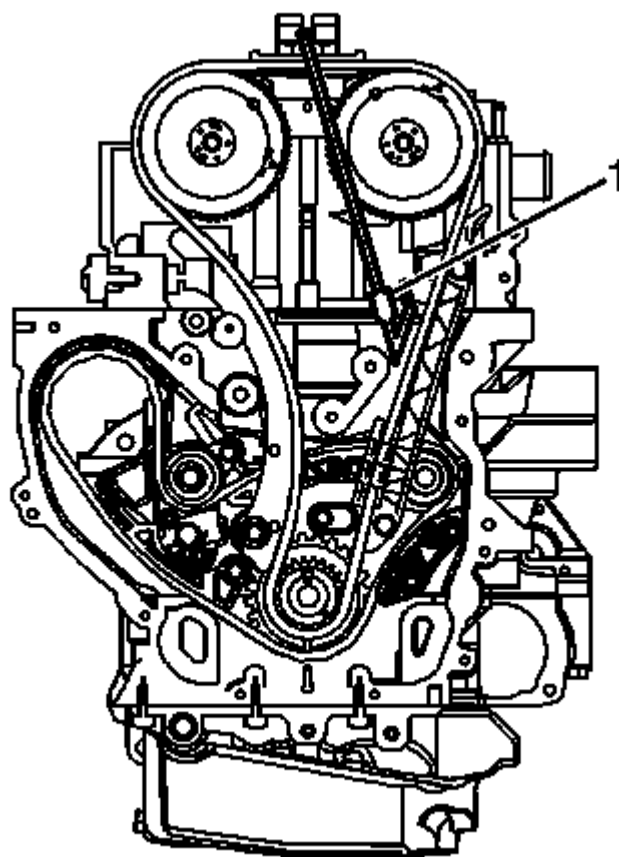


Fig. 173: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

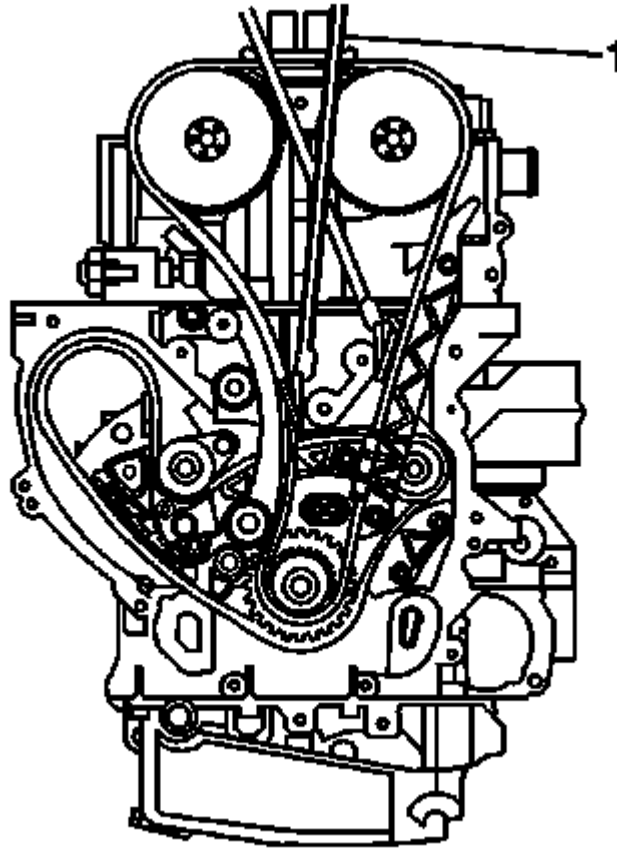


Fig. 174: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

5. Remove the timing chain retention tool (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

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

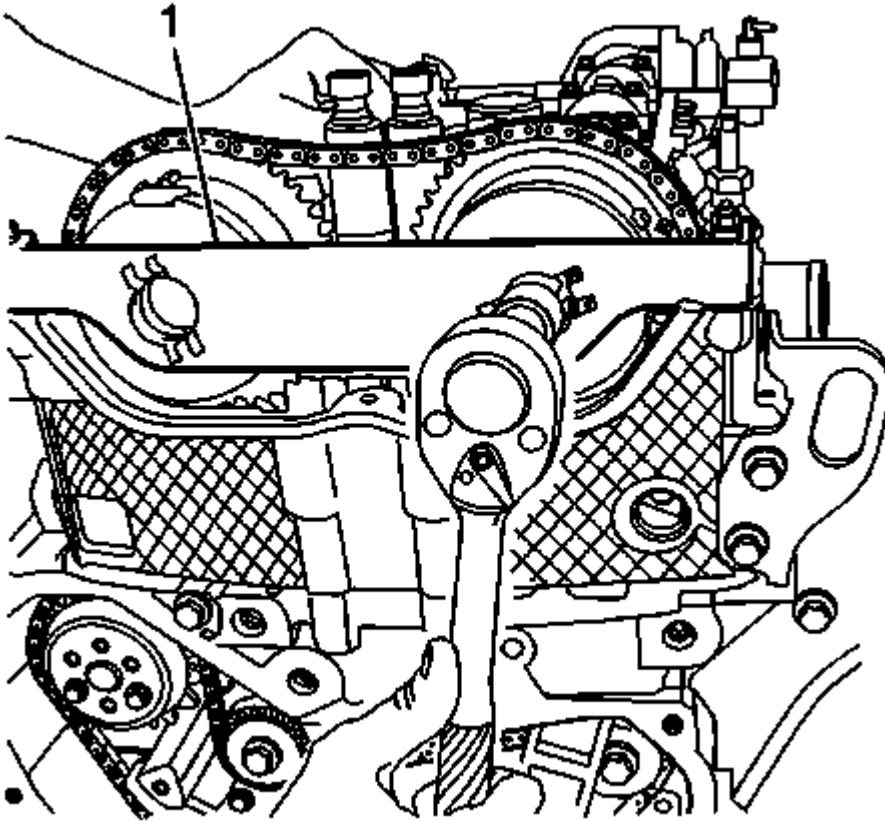


Fig. 175: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

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

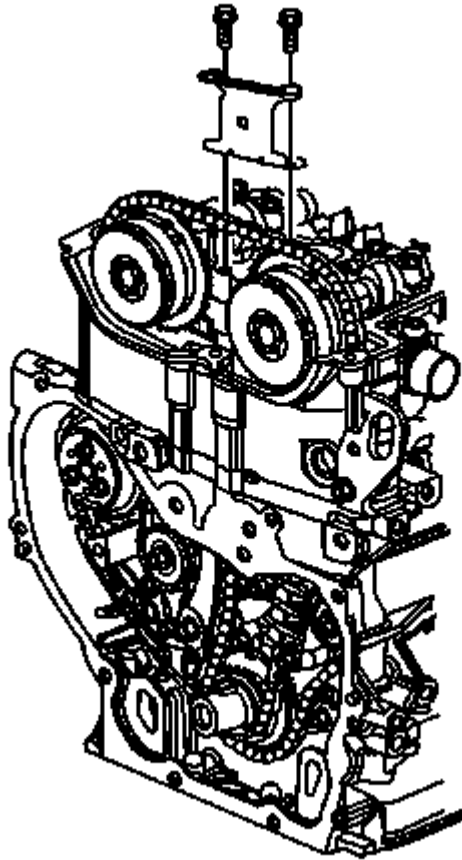


Fig. 176: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

SPECIAL TOOLS

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

For equivalent regional tools, refer to **Special Tools** .

REMOVAL PROCEDURE

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

2. Remove the spark plugs. Refer to Spark Plug Replacement .

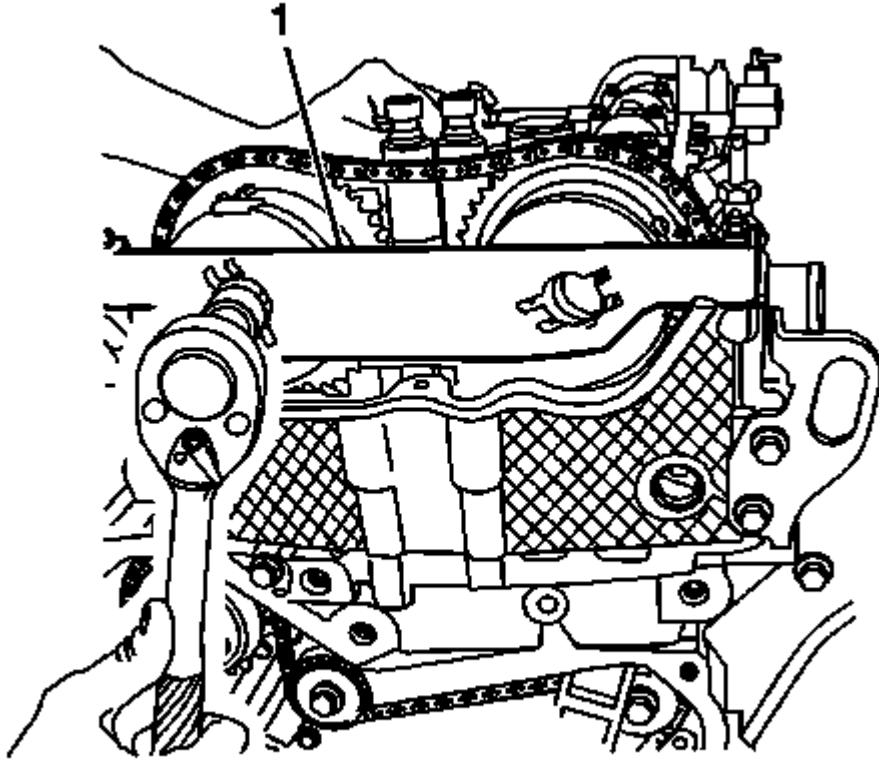


Fig. 177: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft clockwise and install the **EN-48953**: retention tool (1).

CAUTION: Refer to Fastener Caution .

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

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

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

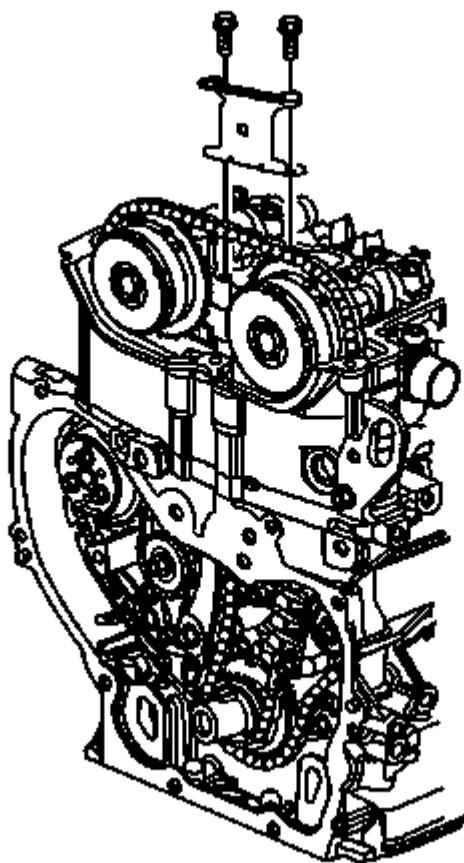


Fig. 178: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

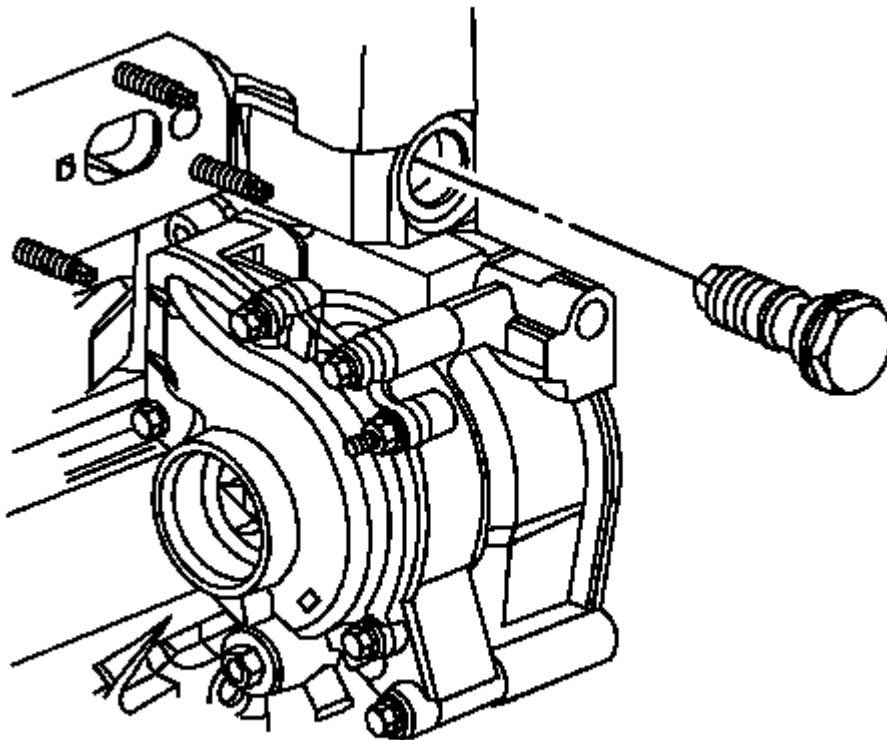


Fig. 179: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

9. Remove the timing chain tensioner.

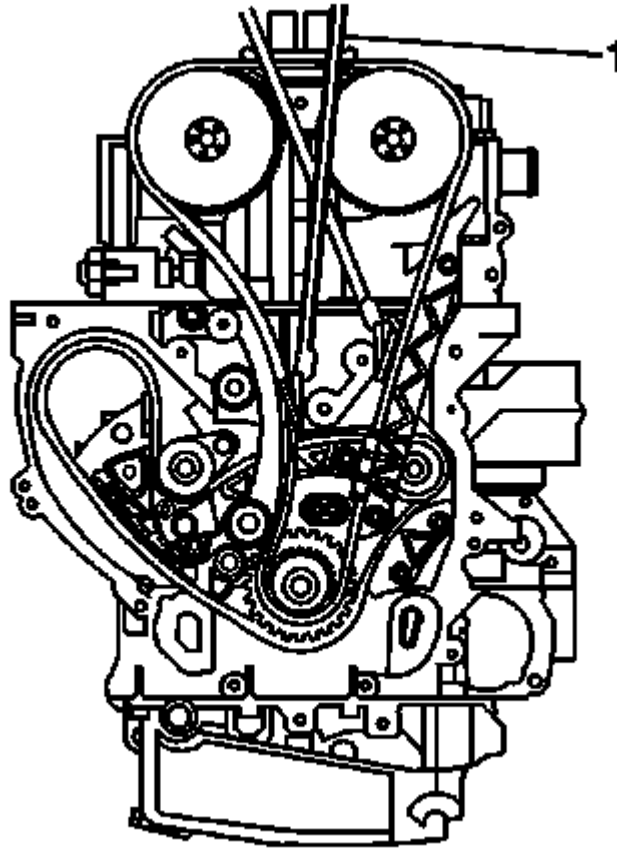


Fig. 180: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

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

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

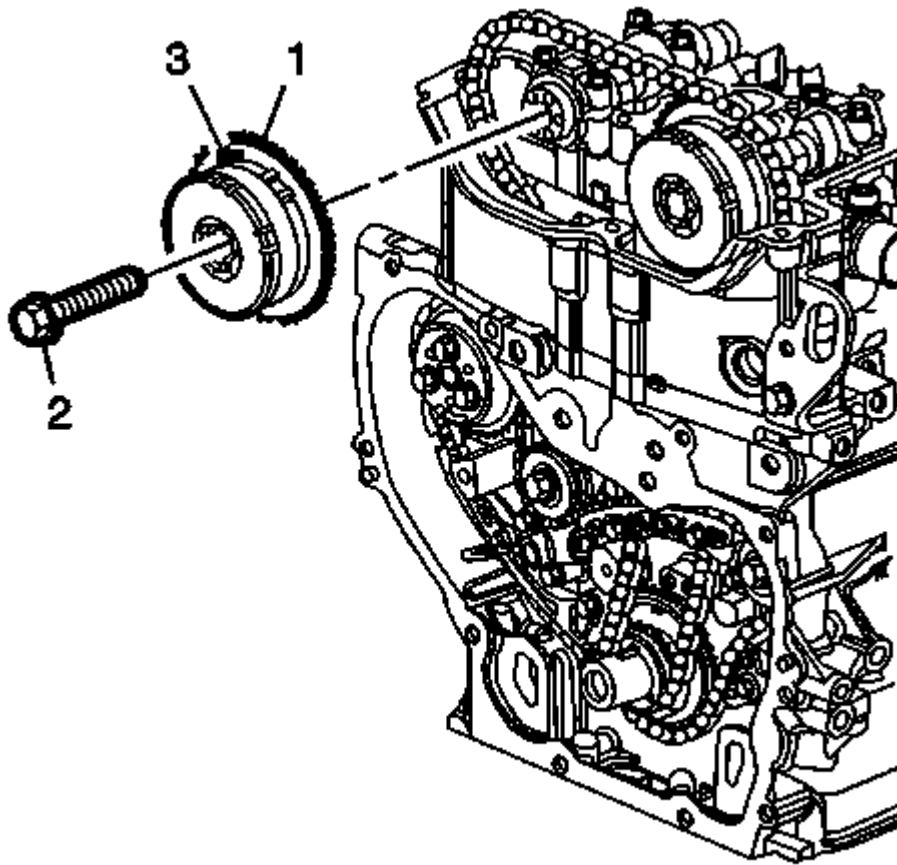


Fig. 181: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

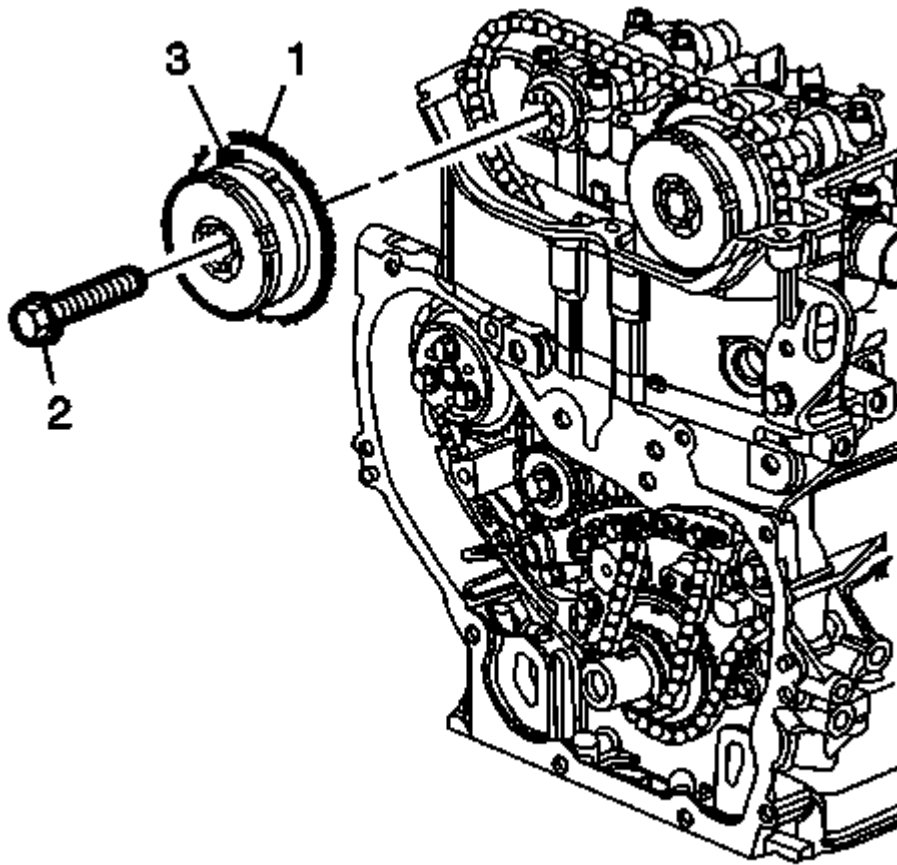


Fig. 182: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

NOTE:

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

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

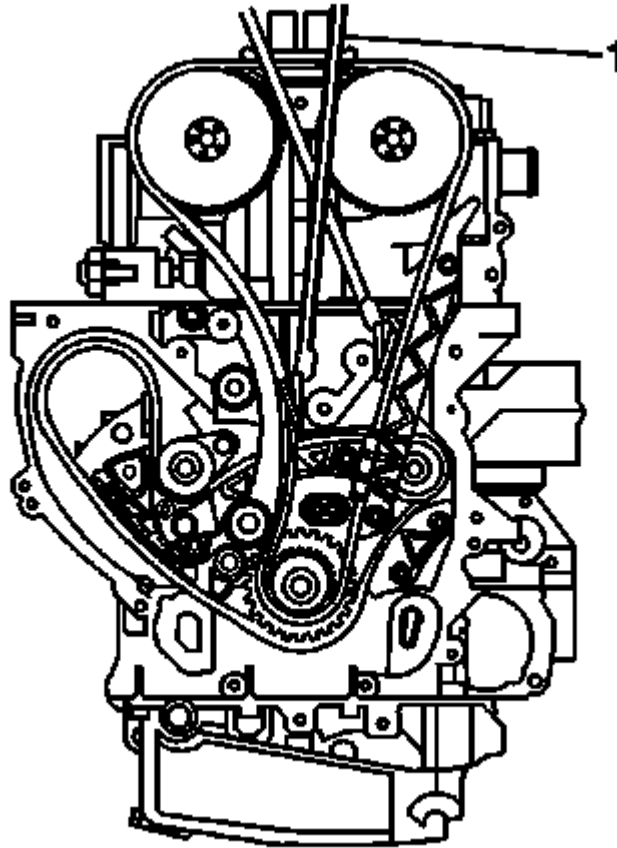


Fig. 183: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

4. Remove the **EN-48749**: retention tool (1) from the exhaust side of the timing chain.

NOTE: Failure to reset the tensioner will allow the tensioner to over extend, limiting the timing chain life.

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

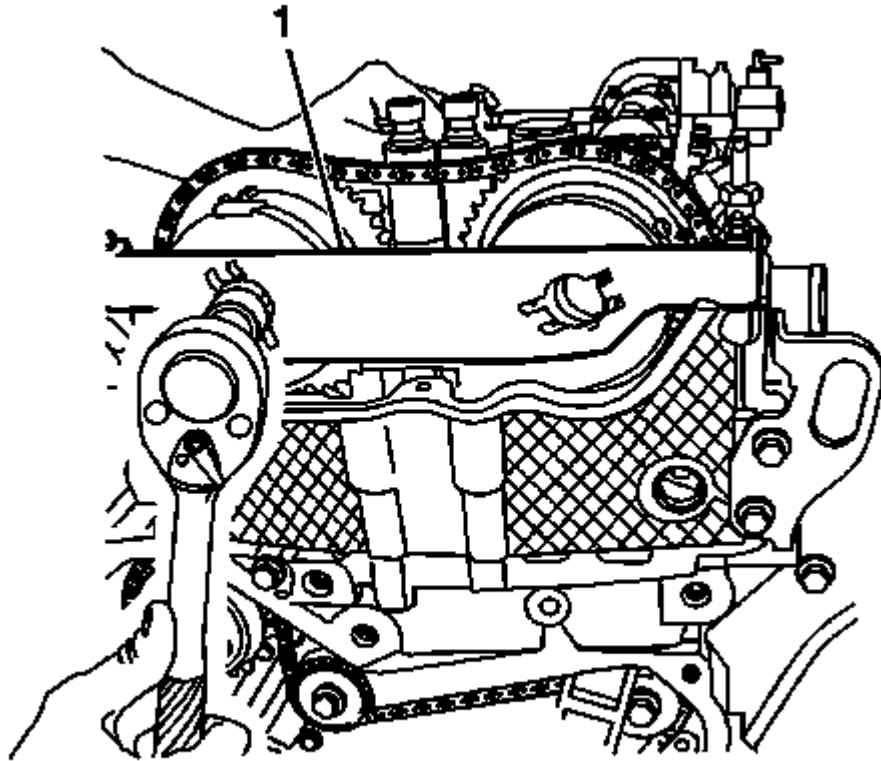


Fig. 184: View of Camshaft Actuator Retainer
Courtesy of GENERAL MOTORS CORP.

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

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

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

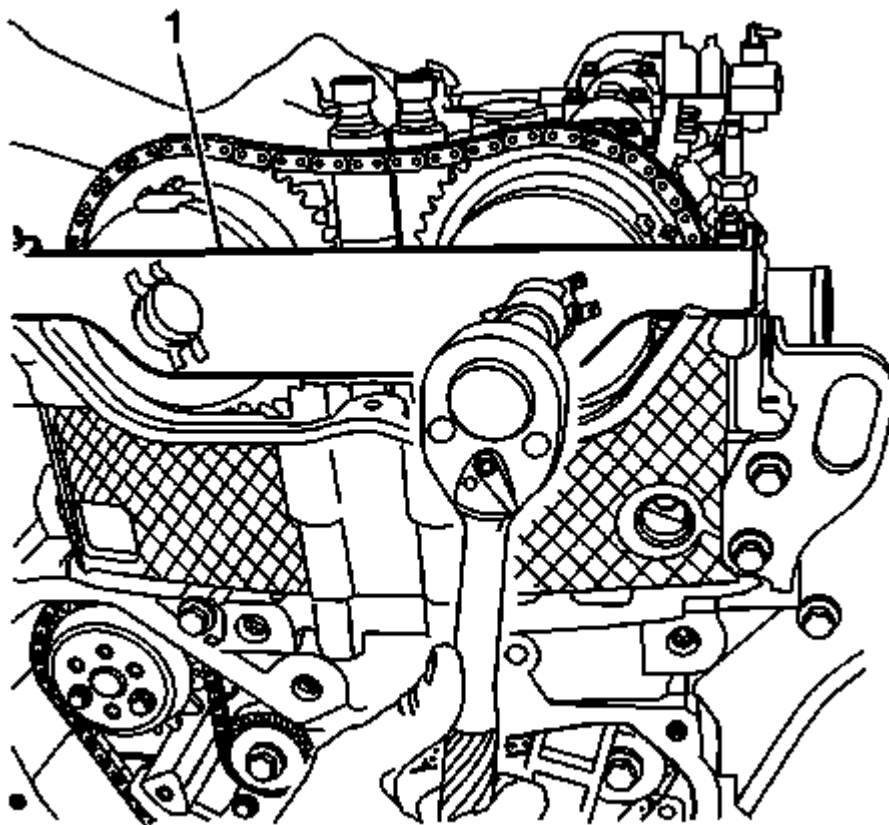


Fig. 185: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

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

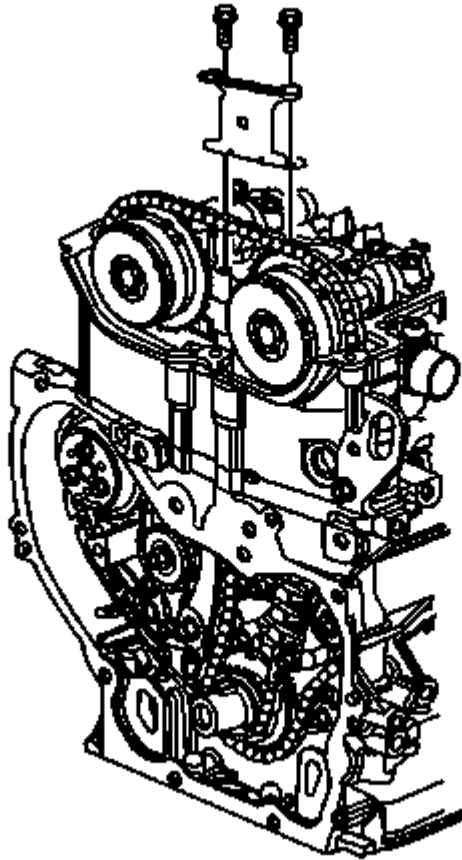


Fig. 186: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

SPECIAL TOOLS

- **EN-36017:** Valve Guide Seal Remover
- **EN-43649:** Valve Spring Compressor
- **EN-43649-10:** Valve Spring Compressor Adaptor Set
- **EN-43653:** Flywheel Holding Tool

For equivalent regional tools refer to Special Tools.

REMOVAL PROCEDURE

NOTE: Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause damage to EN-43653: holding tool.

1. If equipped, with a manual transmission leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped, with an automatic transmission, remove the starter. Refer to **Starter Replacement** .
3. Install EN-43653: holding tool.
4. Remove the camshaft. Refer to **Intake Camshaft and Valve Lifter Replacement** or **Exhaust Camshaft and Valve Lifter Replacement**.

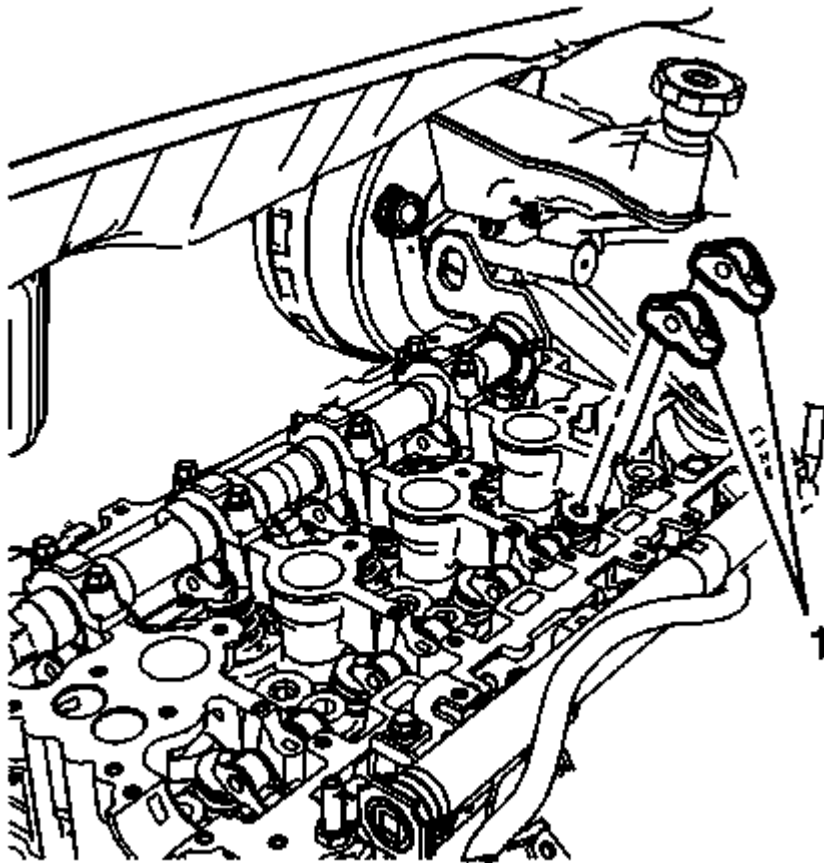


Fig. 187: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft roller followers (1).

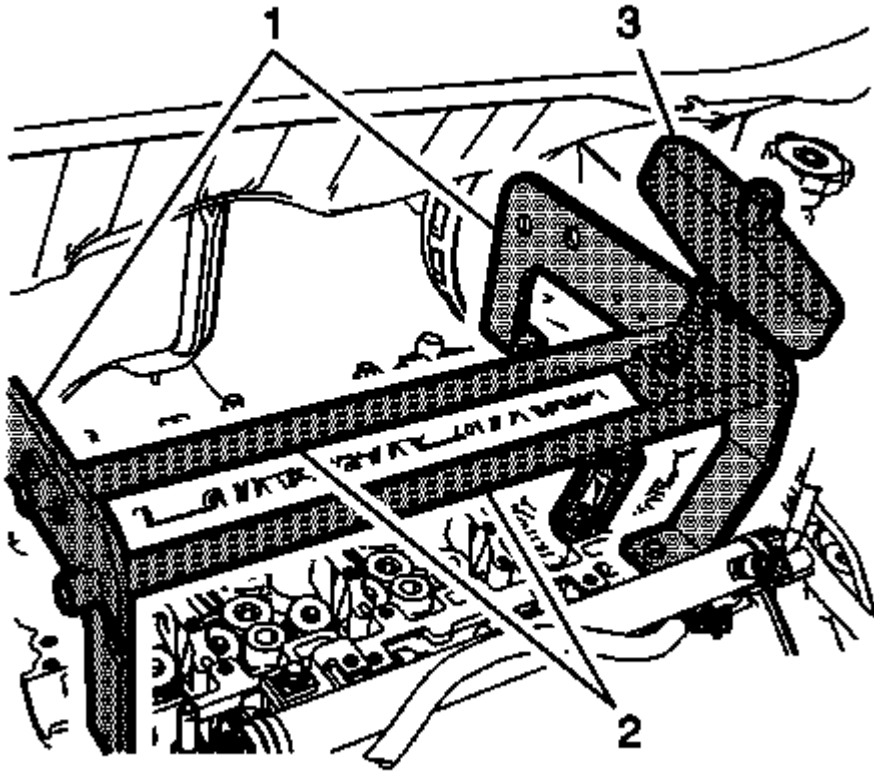


Fig. 188: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS CORP.

6. Install the **EN-43649-10:** adaptor set (1) to the front and rear of the cylinder head.
7. Install the cross bars and locks (2) of the **EN-43649:** compressor to the valve spring compressor adaptors.
8. Remove the spark plugs. Refer to **Spark Plug Replacement** .
9. Install an air hose adapter into the spark plug hole.
10. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
11. Compress the valve spring using the valve spring compressor (3).

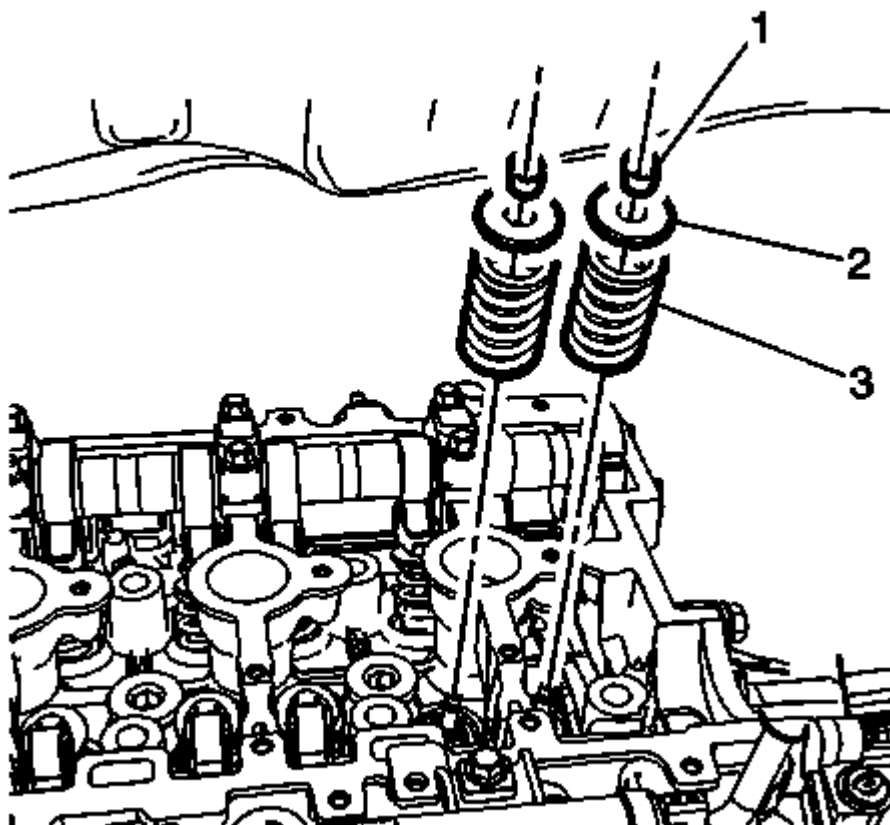


Fig. 189: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve spring keepers (1).
13. Remove the valve spring (3) and retainer (2).

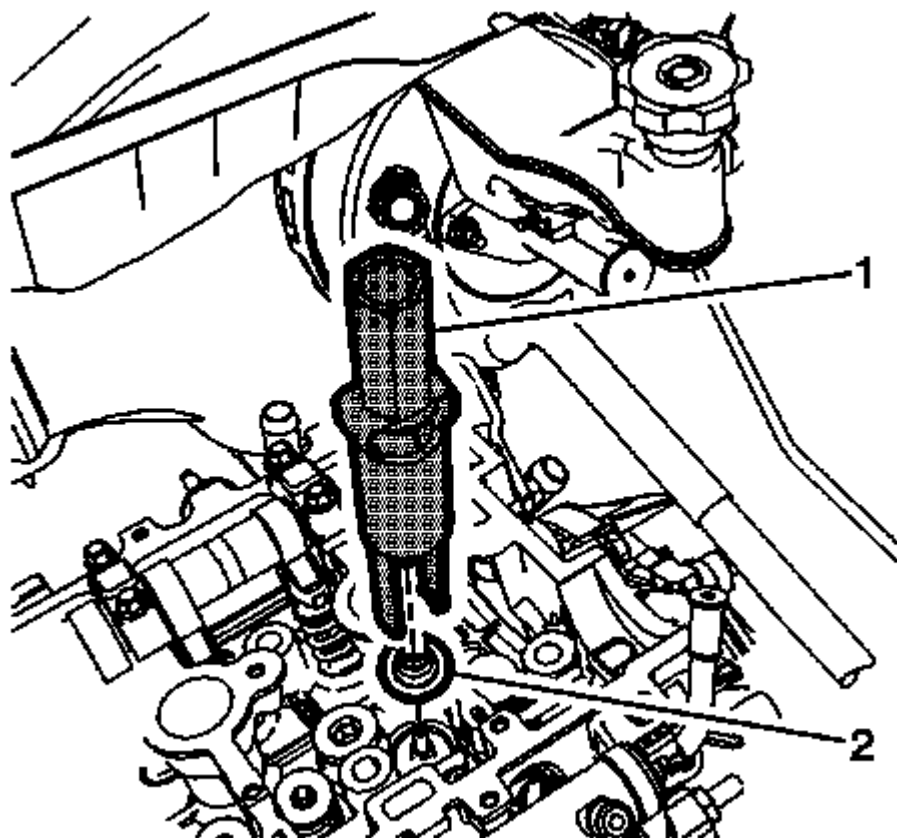


Fig. 190: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS CORP.

14. Use the **EN-36017**: seal remover (1) to remove the valve seal.

INSTALLATION PROCEDURE

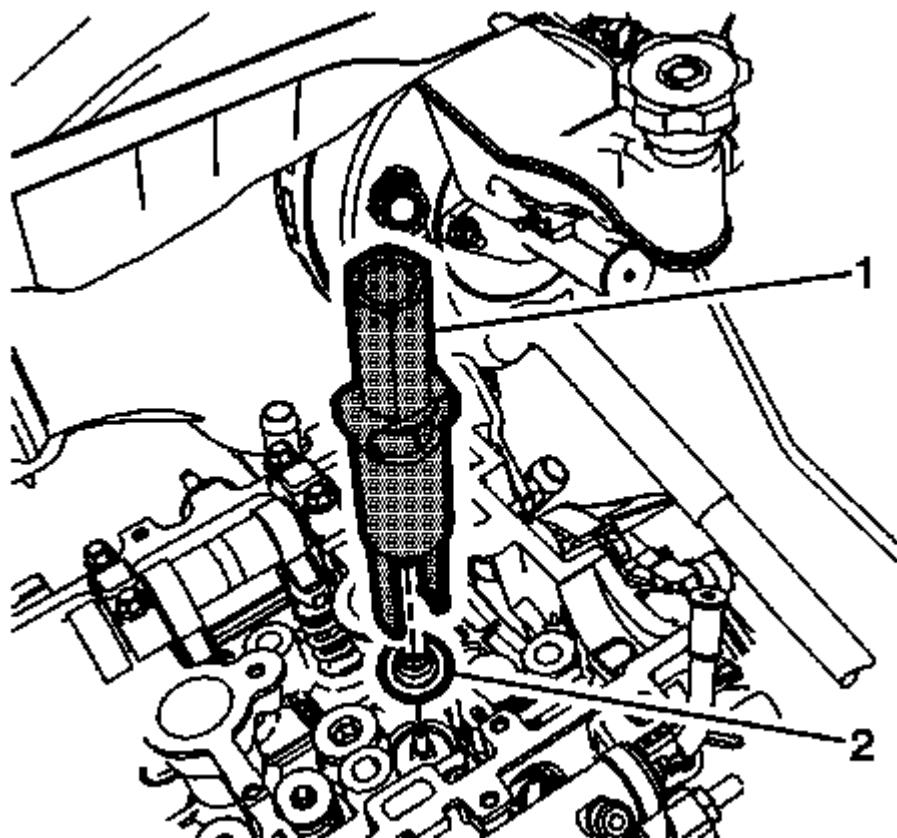


Fig. 191: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS CORP.

1. Using the **EN-36017**: seal remover (1) install the NEW valve seal. Fully seat the seal onto the valve guide.

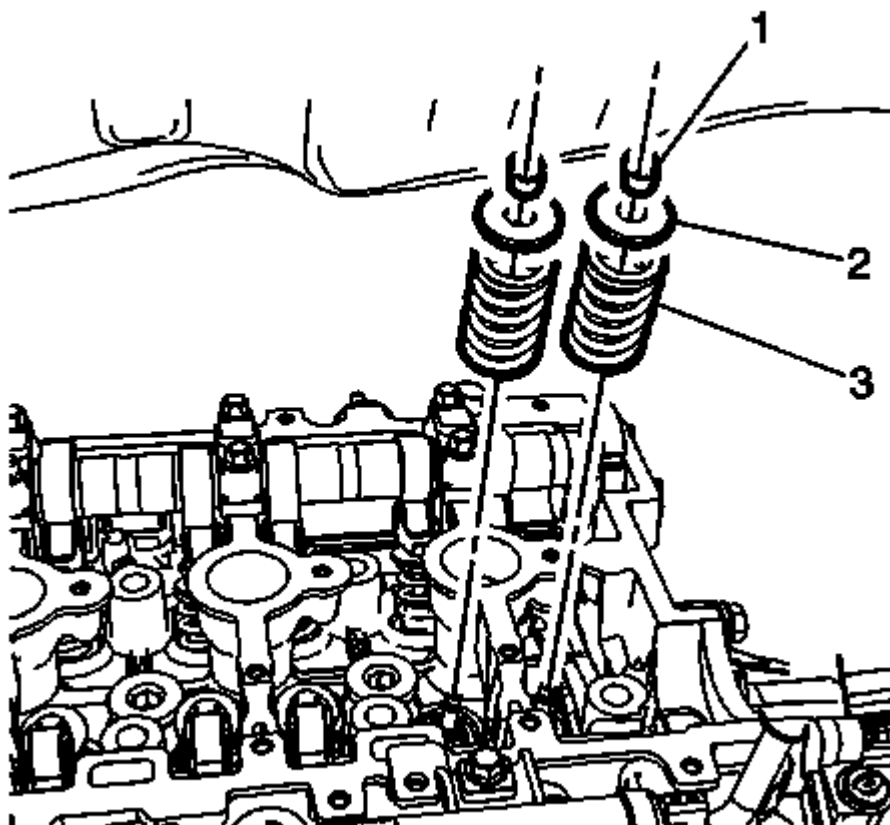


Fig. 192: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring (3) and retainer (2).
3. Compress the valve spring using the valve spring compressor.
4. Install the valve spring keepers (1).
5. Disconnect the air hose and air hose adapter.

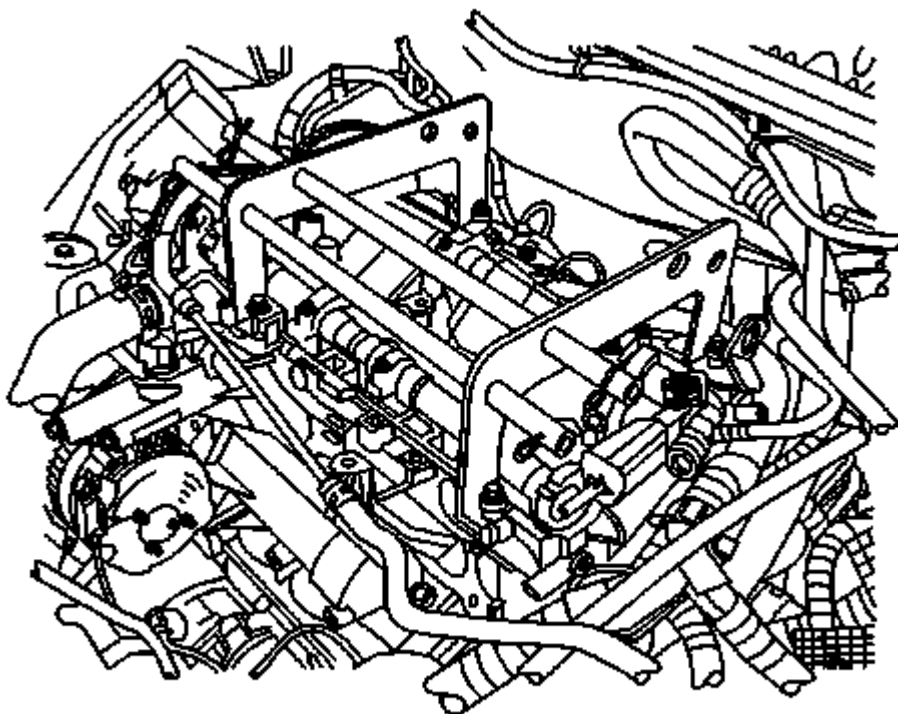


Fig. 193: View Of J 43649 Valve Spring Compressor (Cylinder Head)
Courtesy of GENERAL MOTORS CORP.

6. Remove the **EN-43649:** compressor and **EN-43649-10:** adaptor set from the cylinder head.
7. Install the spark plugs. Refer to **Spark Plug Replacement** .

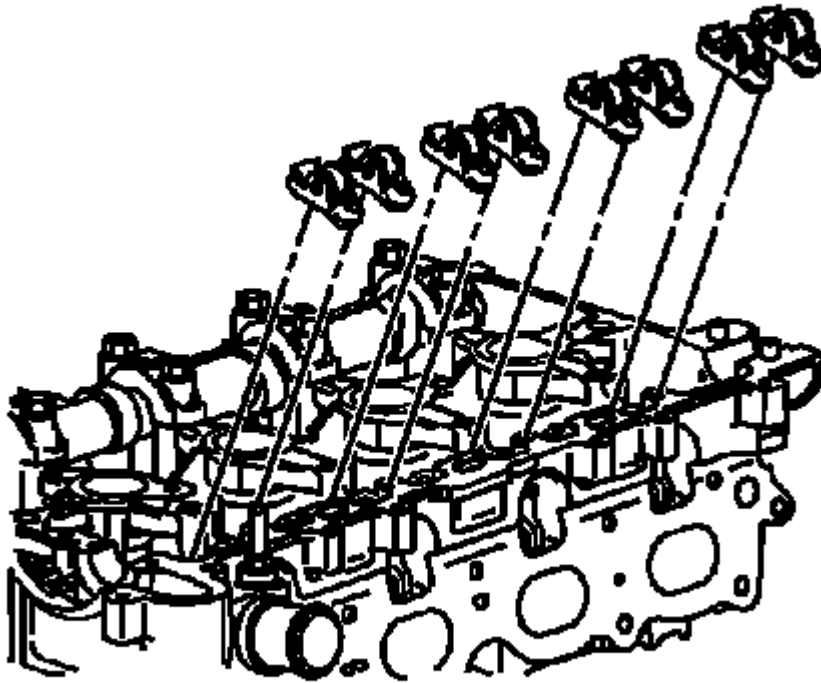


Fig. 194: Identifying Camshaft Roller Followers
Courtesy of GENERAL MOTORS CORP.

8. Install the camshaft roller followers.
9. Install the camshaft. Refer to Intake Camshaft and Valve Lifter Replacement or Exhaust Camshaft and Valve Lifter Replacement.
10. If used, remove the EN-43653: holding tool.
11. If removed, install the starter. Refer to Starter Replacement .

CYLINDER HEAD REPLACEMENT

SPECIAL TOOLS

- J 38185 Hose Clamp Pliers
- J 45059 Angle Meter
- EN-48749 Timing Chain Retention Tool Kit
- EN-48953 Camshaft Actuator Locking Tool

REMOVAL PROCEDURE

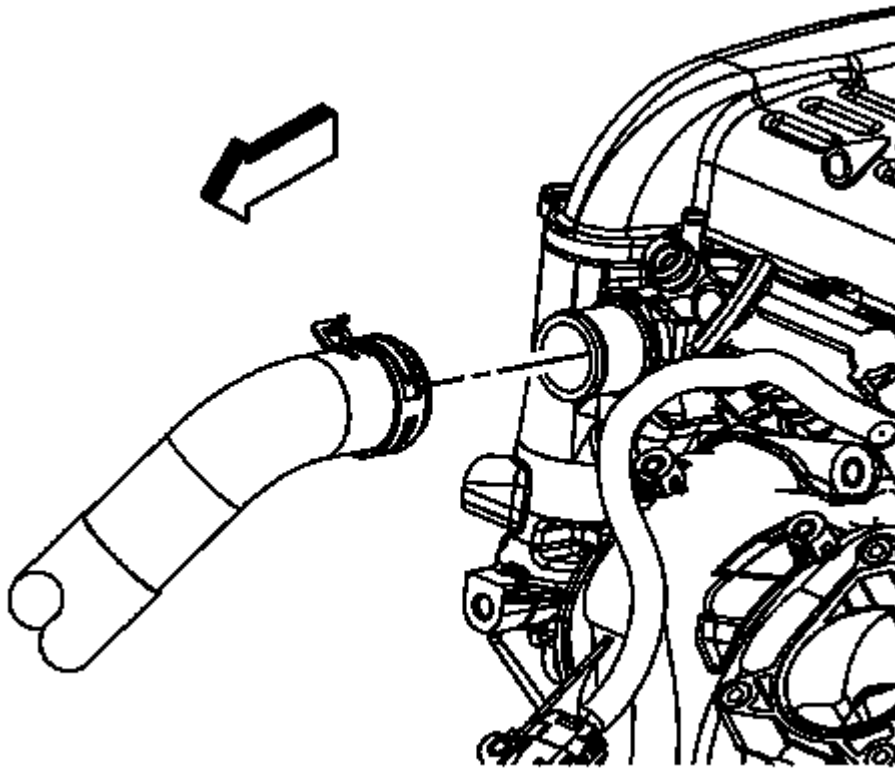


Fig. 195: View Of Radiator Inlet Hose To Engine
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE-47716) or Cooling System Draining and Filling (2.4L LE5).
2. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LE5).
3. Remove the intake manifold. Refer to Intake Manifold Replacement.
4. Reposition the radiator surge tank air bleed hose clamp.
5. Remove the radiator surge tank air bleed hose from the cylinder head.
6. Reposition the radiator inlet hose clamp using the **J 38185**.
7. Remove the radiator inlet hose from the cylinder head.
8. Disconnect all electrical connectors as necessary.
9. Remove the spark plugs. Refer to Spark Plug Replacement.
10. Remove the camshaft cover. Refer to Camshaft Cover Replacement.

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

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

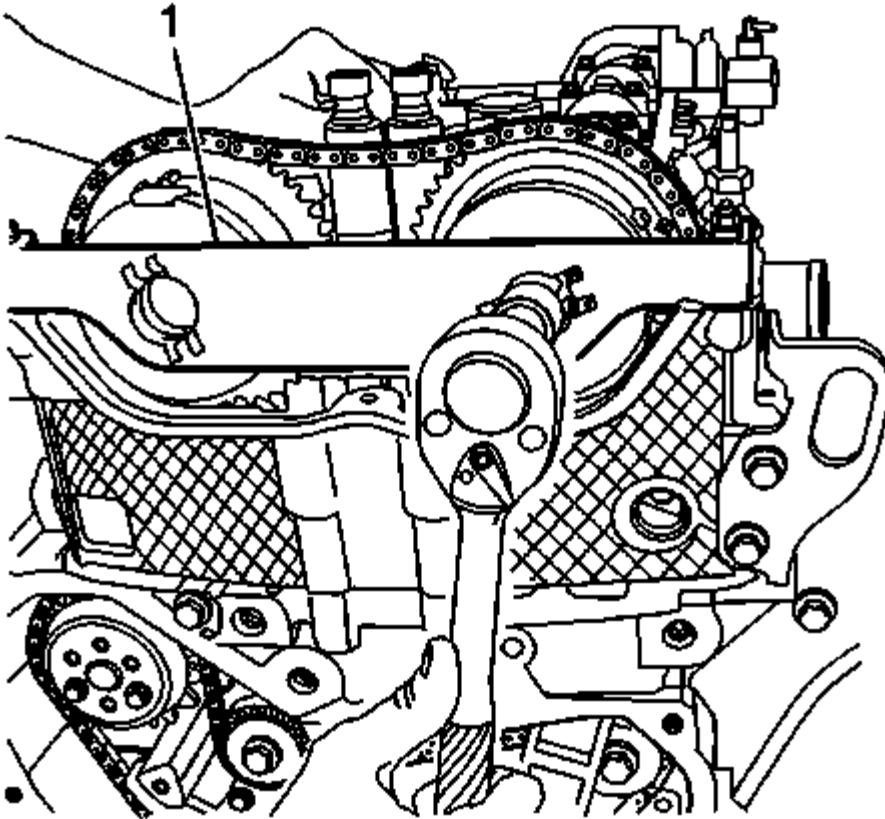


Fig. 196: Loosening/Tightening Camshaft Actuator Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

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

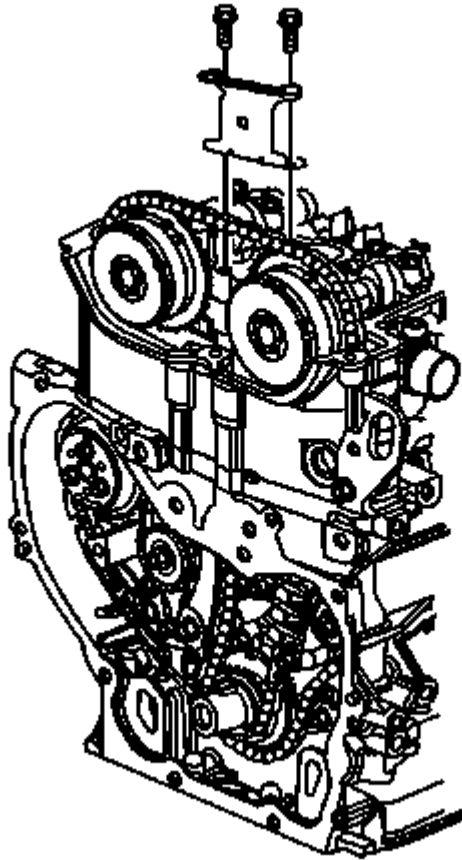


Fig. 197: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

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

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

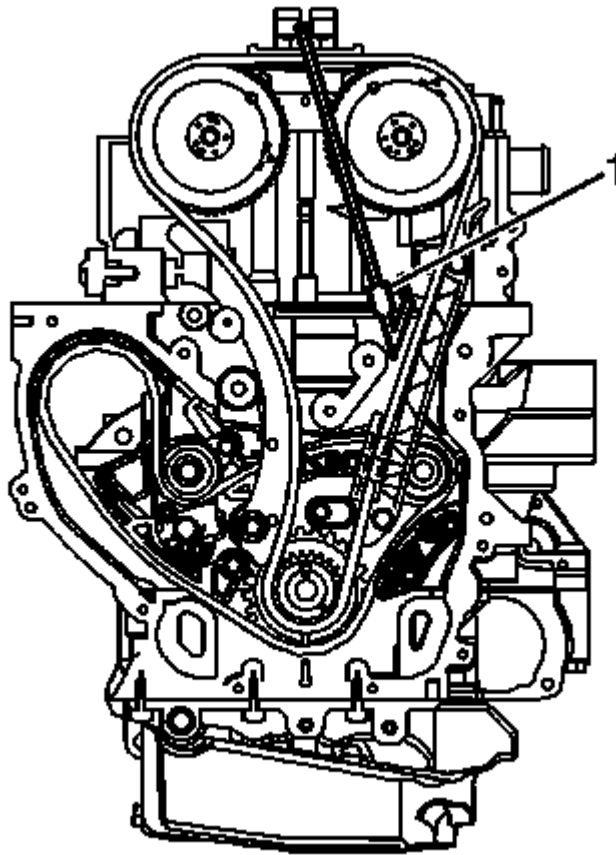


Fig. 198: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

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

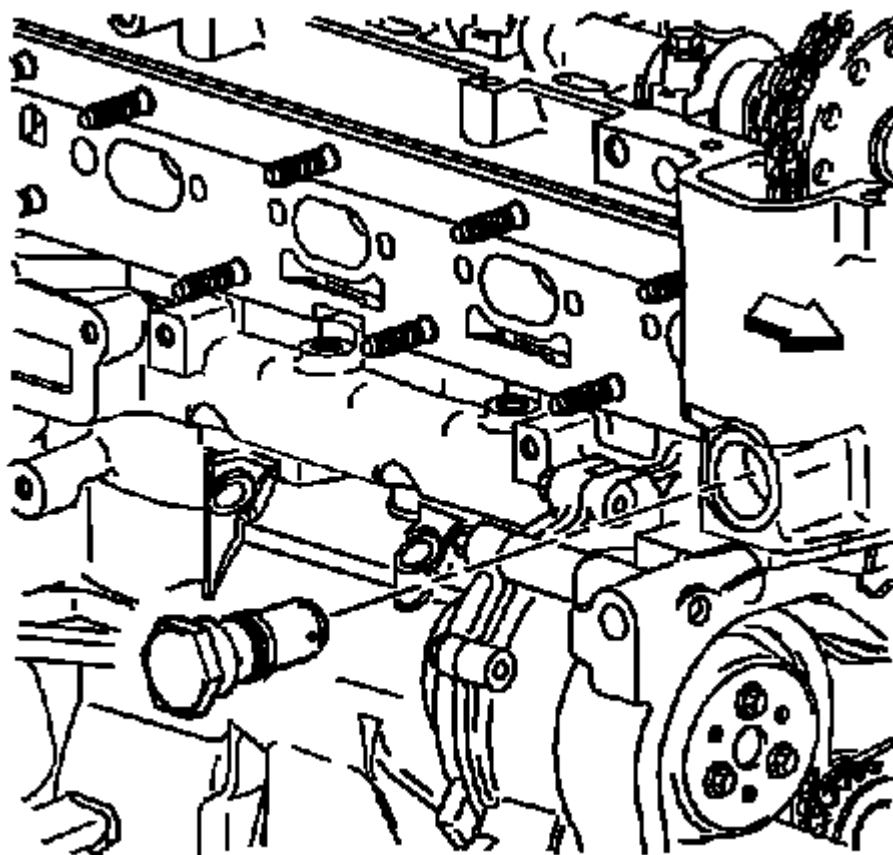


Fig. 199: Identifying Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

20. Remove the timing chain tensioner.

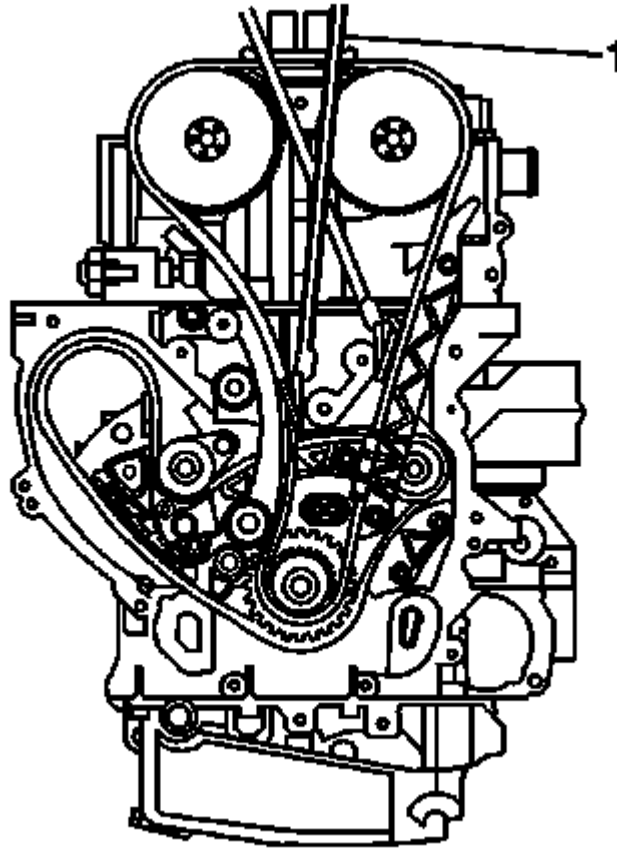


Fig. 200: Identifying Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

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

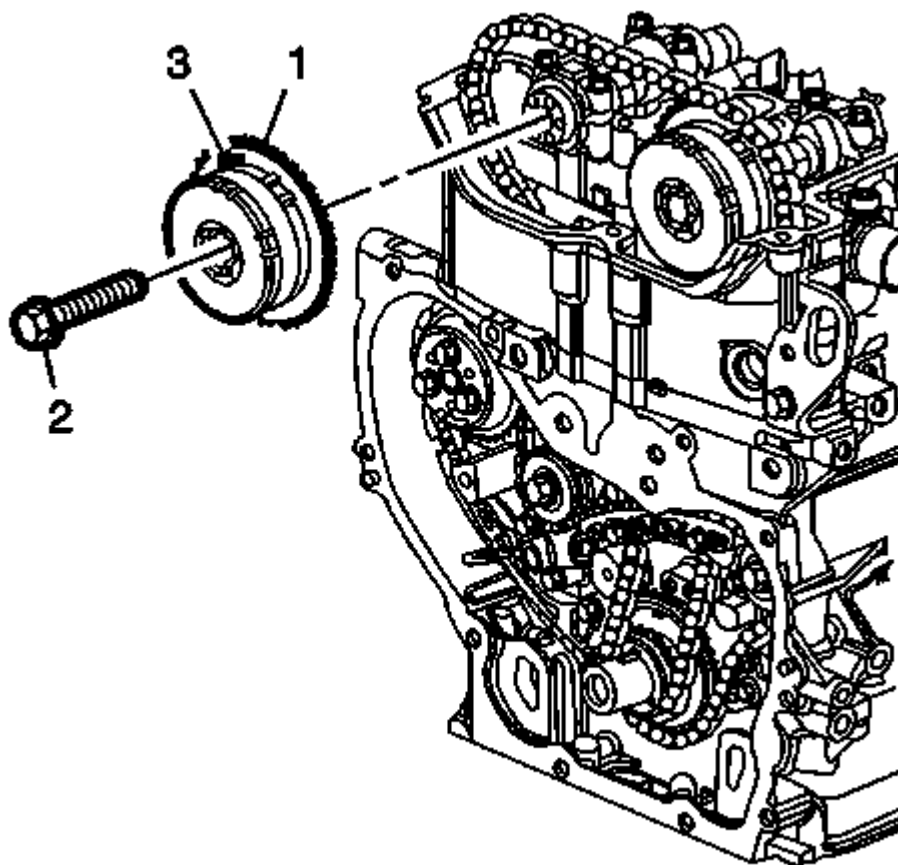


Fig. 201: Identifying Exhaust Camshaft Sprocket
 Courtesy of GENERAL MOTORS CORP.

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

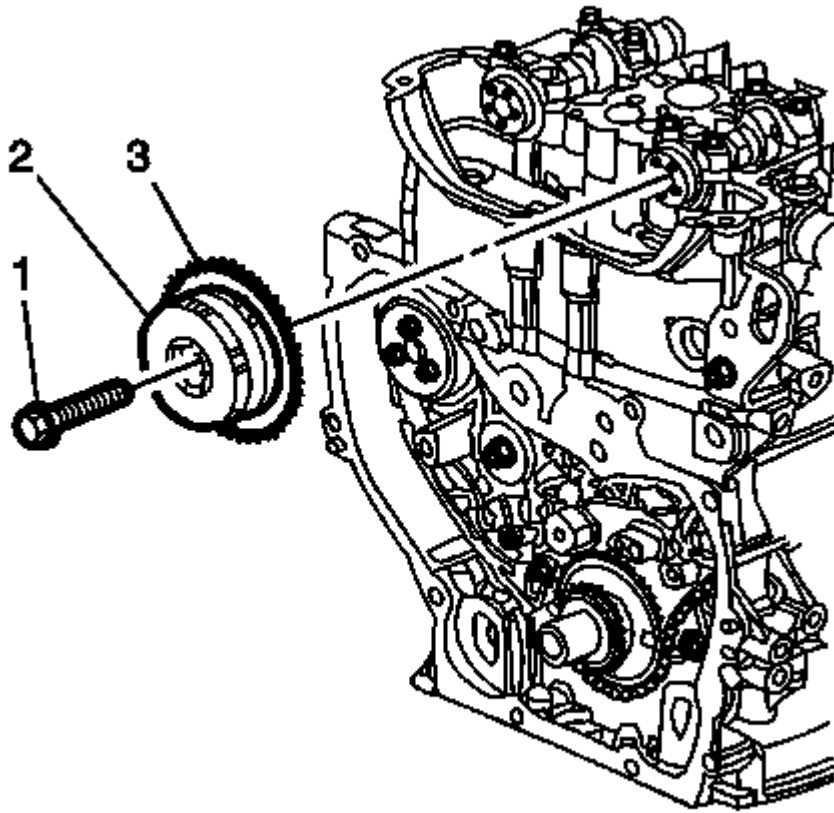


Fig. 202: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

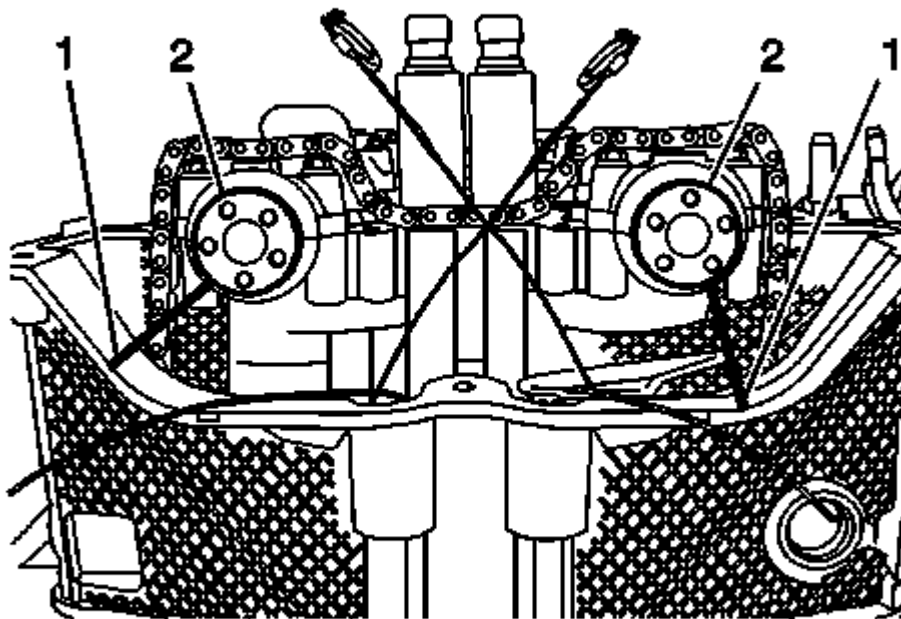


Fig. 203: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

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

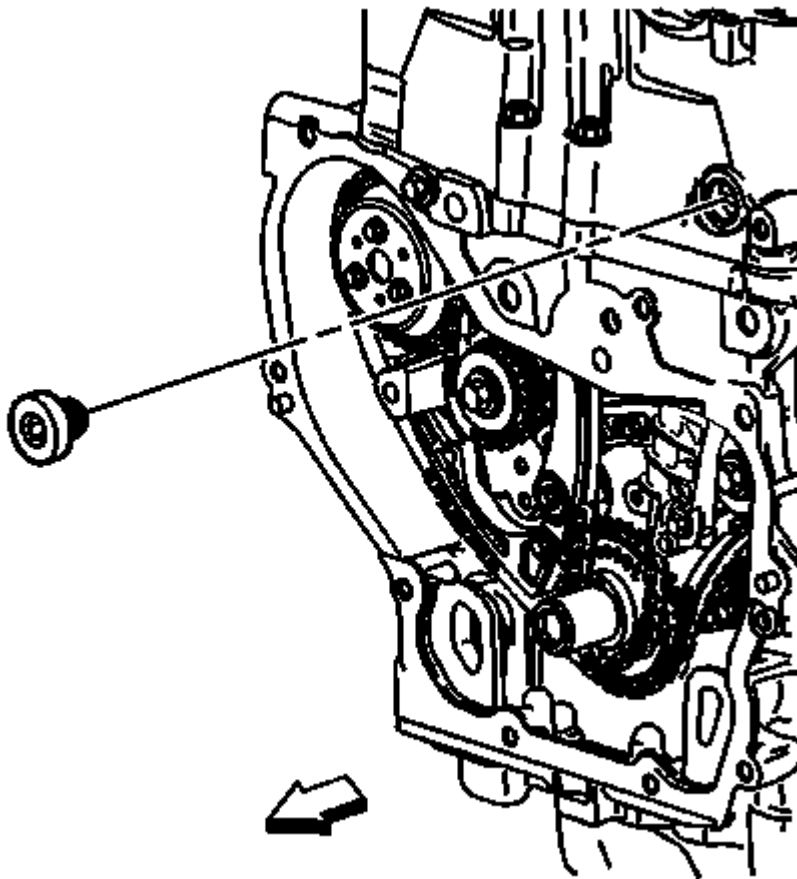


Fig. 204: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

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

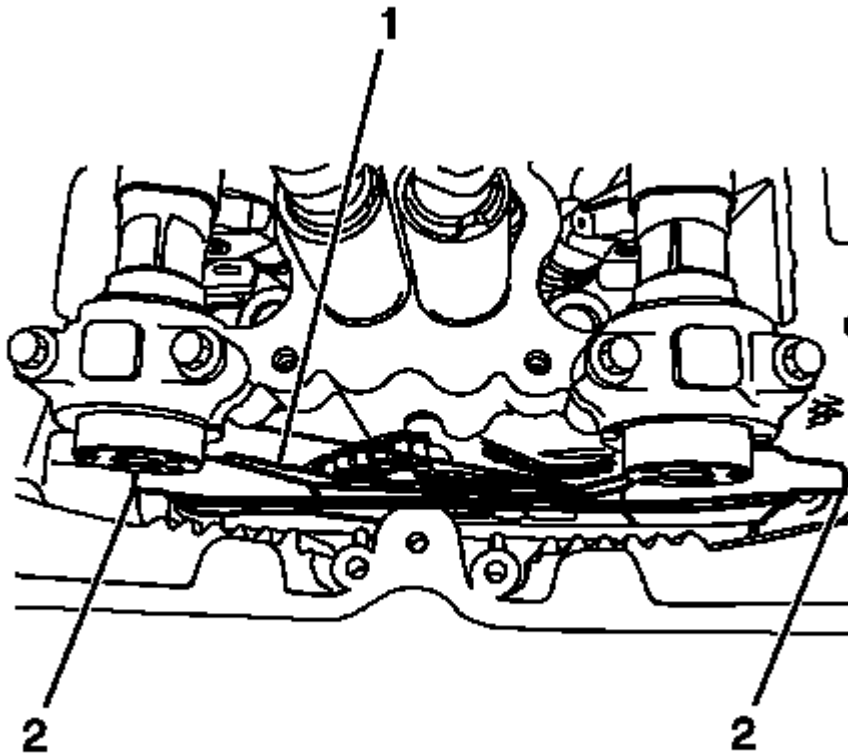


Fig. 205: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

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

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

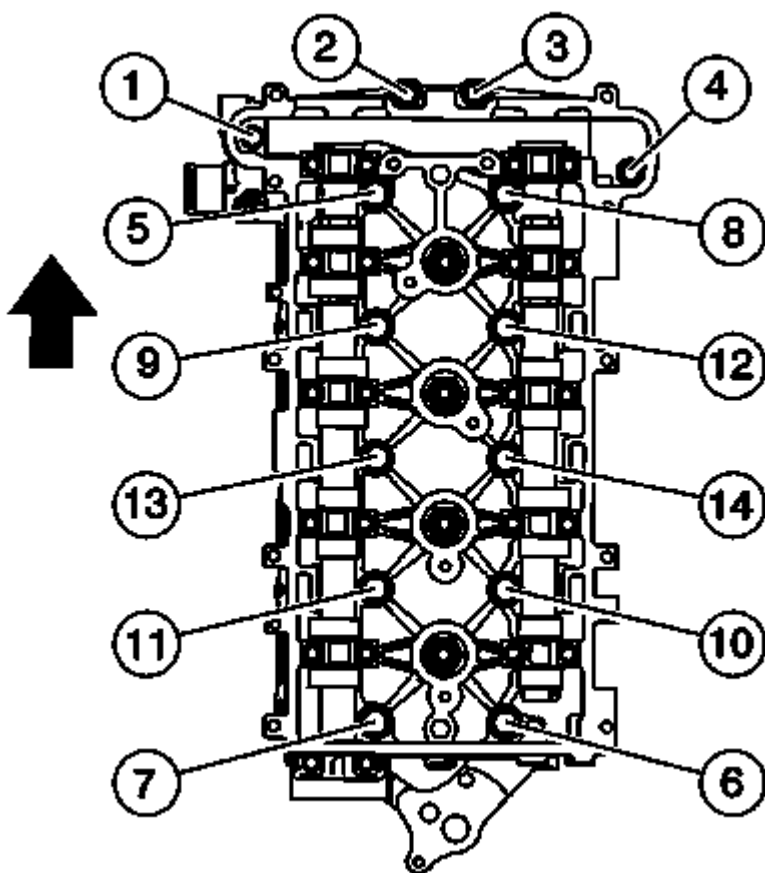


Fig. 206: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

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

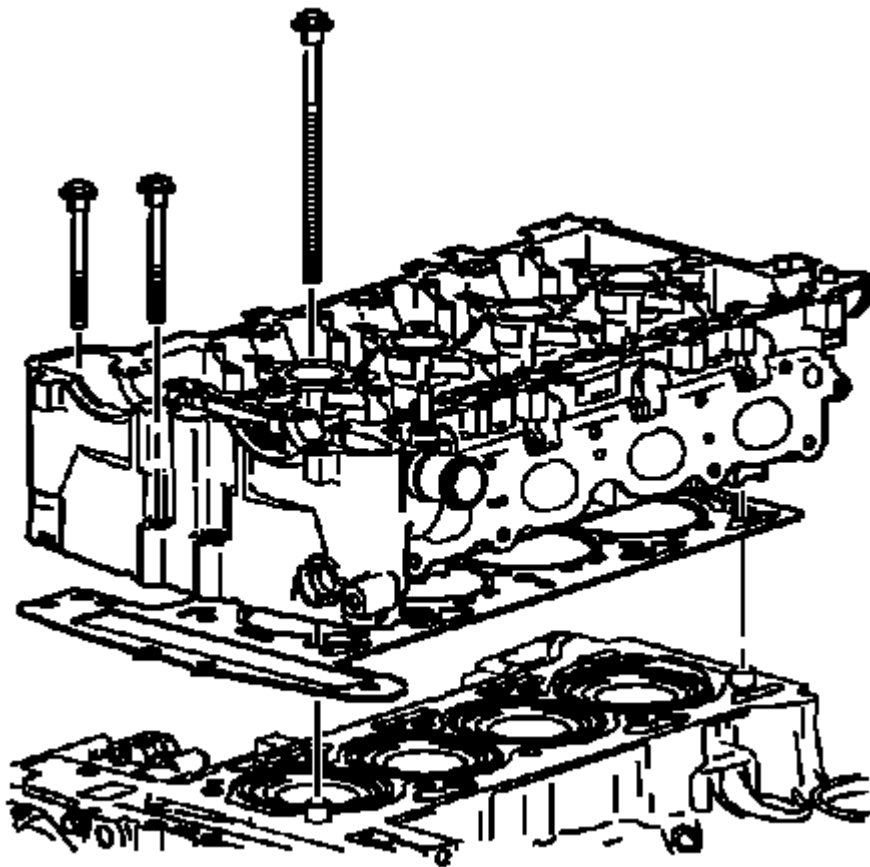


Fig. 207: View Of Cylinder Head & Gasket
Courtesy of GENERAL MOTORS CORP.

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

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

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

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

by the **NEW** gasket.

- Hold the razor blade as parallel to the gasket surface as possible.
35. Clean the old sealer/lube and any dirt from around the bolt holes.

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

36. Clean the bolts holes with a nylon bristle brush.
37. When cleaning the cylinder head bolt holes use suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.
38. If replacing the cylinder head, transfer all parts as necessary.

INSTALLATION PROCEDURE

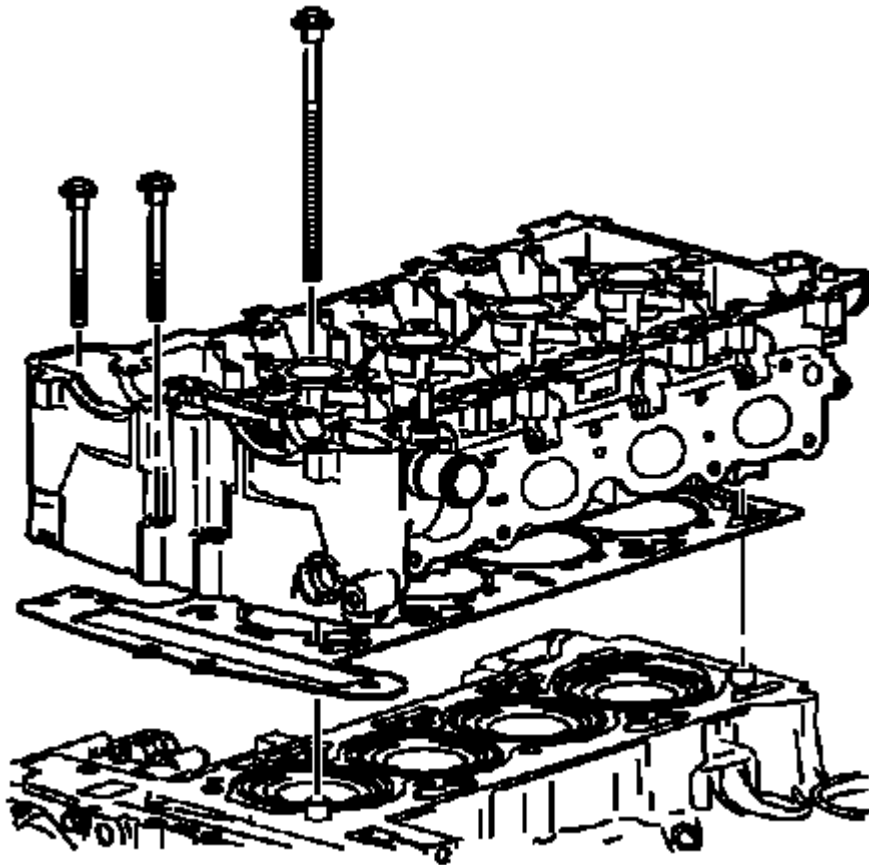


Fig. 208: View Of Cylinder Head & Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: **DO NOT use any sealing material.**

1. Install the cylinder head gasket.

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

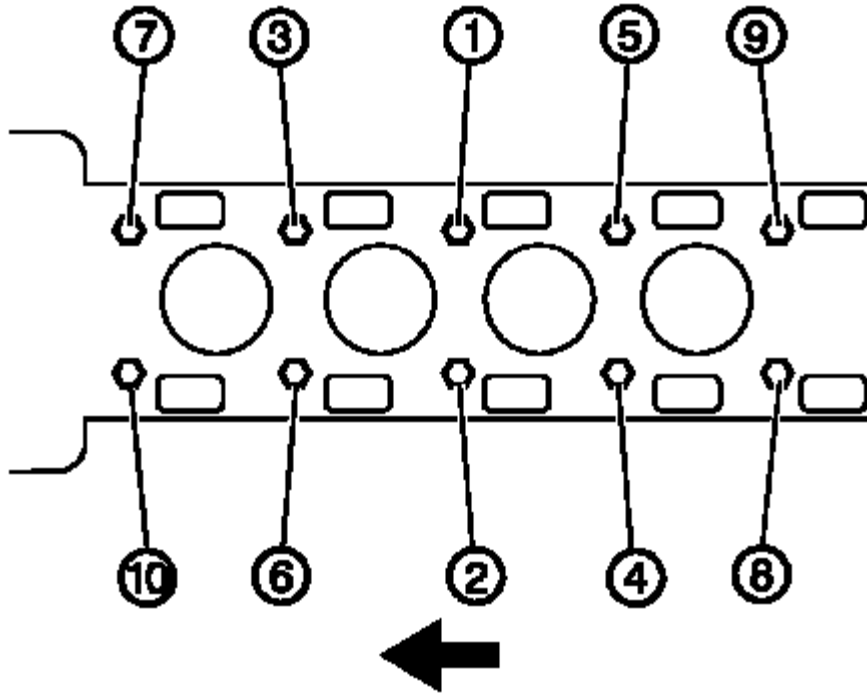


Fig. 209: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

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

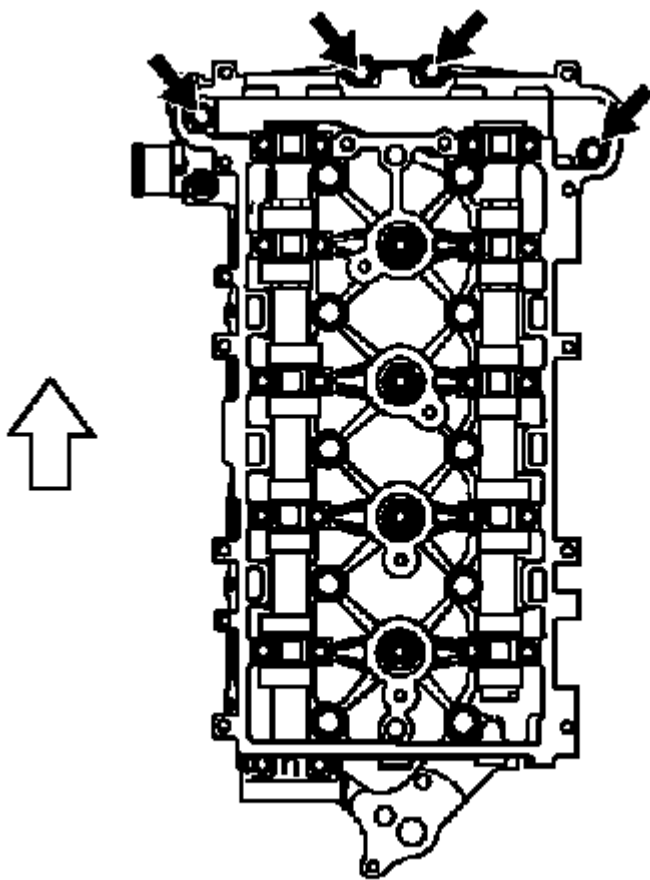


Fig. 210: Locating Front Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

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

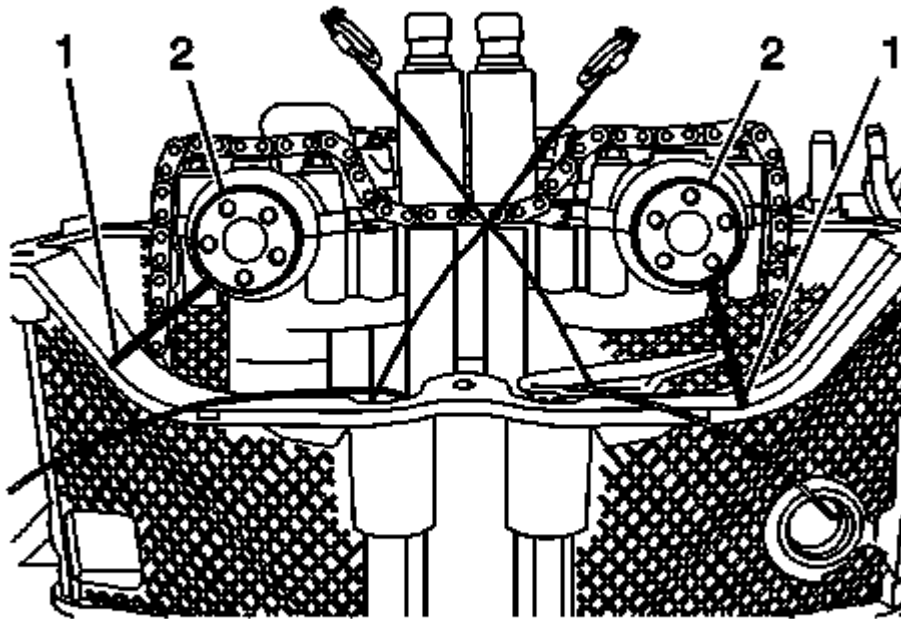


Fig. 211: Aligning Marks On Cylinder Head In Relationship To Camshaft Actuator Notches
Courtesy of GENERAL MOTORS CORP.

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

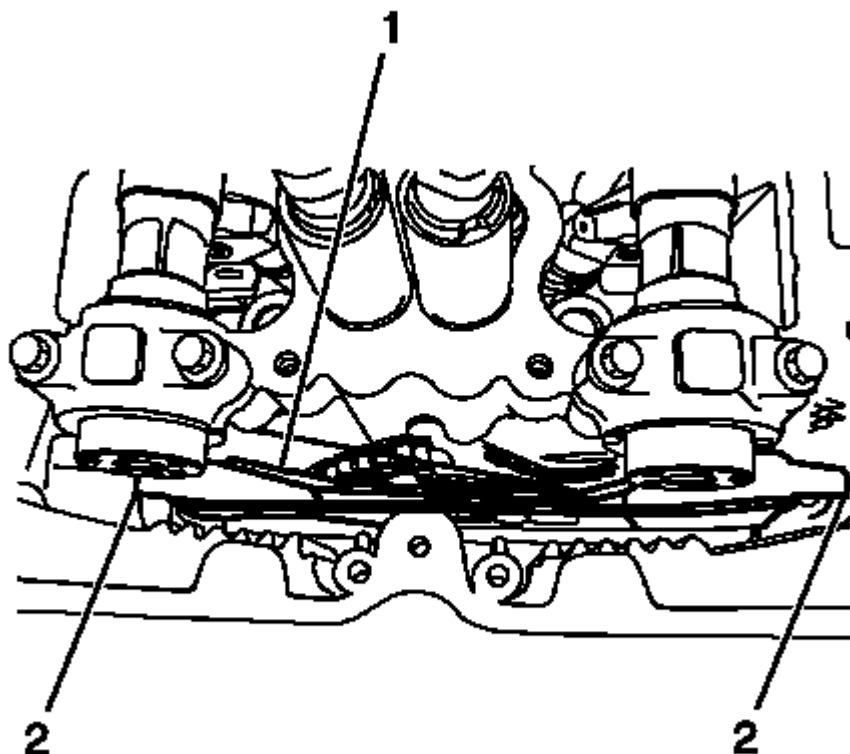


Fig. 212: View Of Rubber Band To Pull Guides Together
Courtesy of GENERAL MOTORS CORP.

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

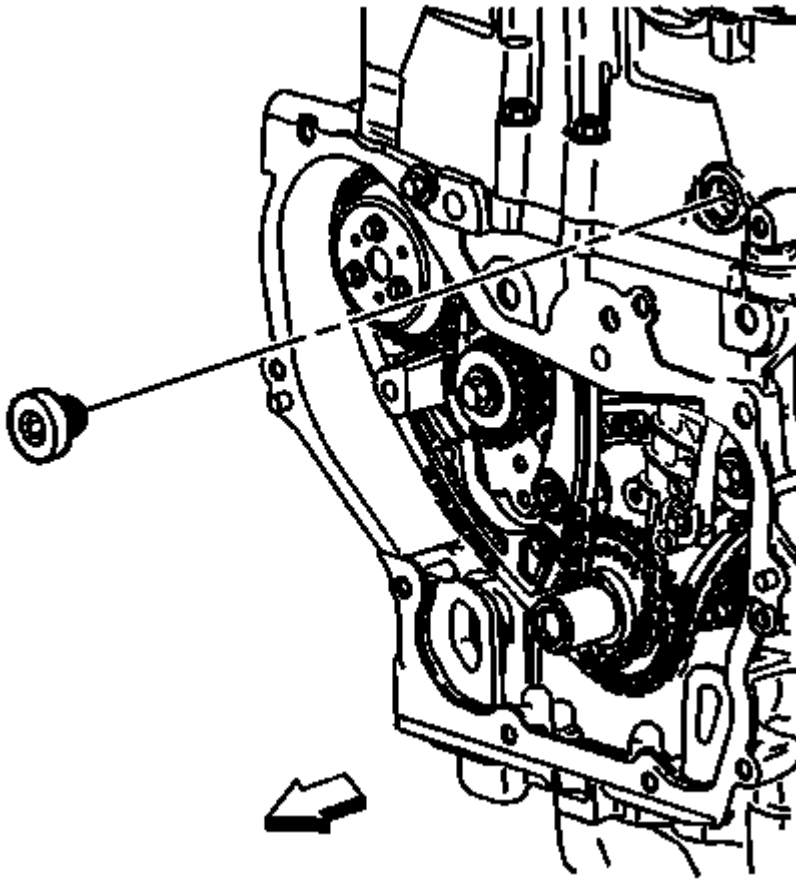


Fig. 213: View Of Fixed Timing Chain Guide Access Plug
Courtesy of GENERAL MOTORS CORP.

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

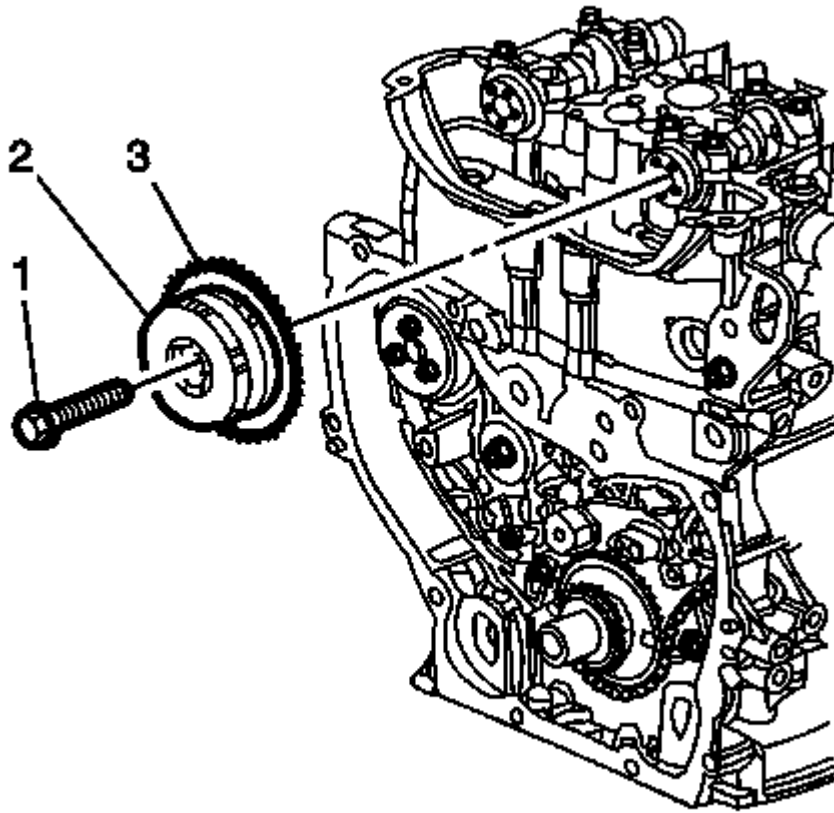


Fig. 214: Identifying Timing Chain & Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

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

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

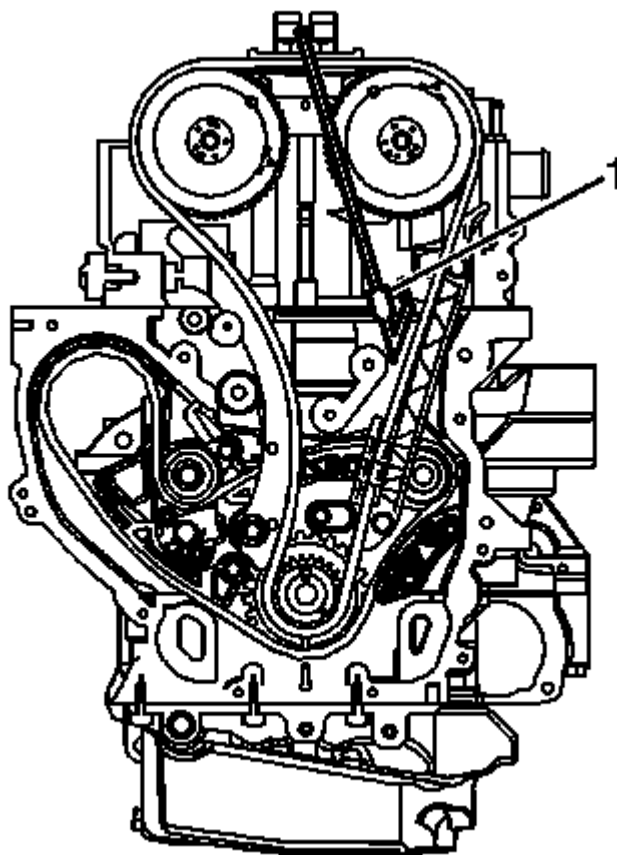


Fig. 215: View Of Timing Chain & Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

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

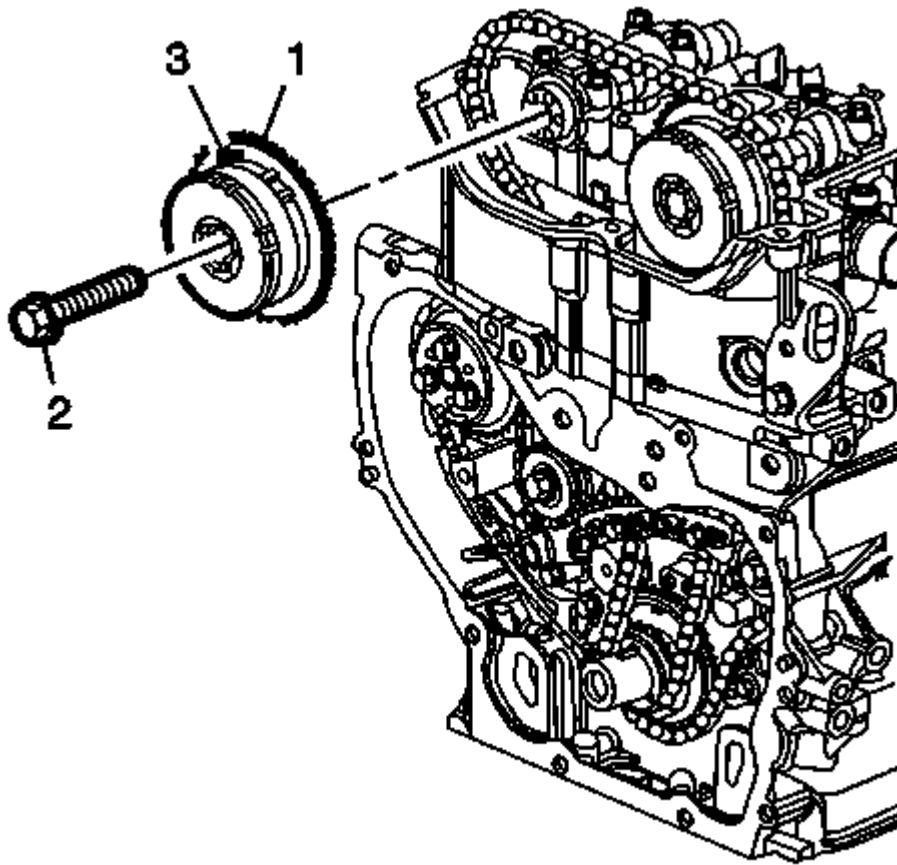


Fig. 216: Identifying Exhaust Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

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

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

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

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

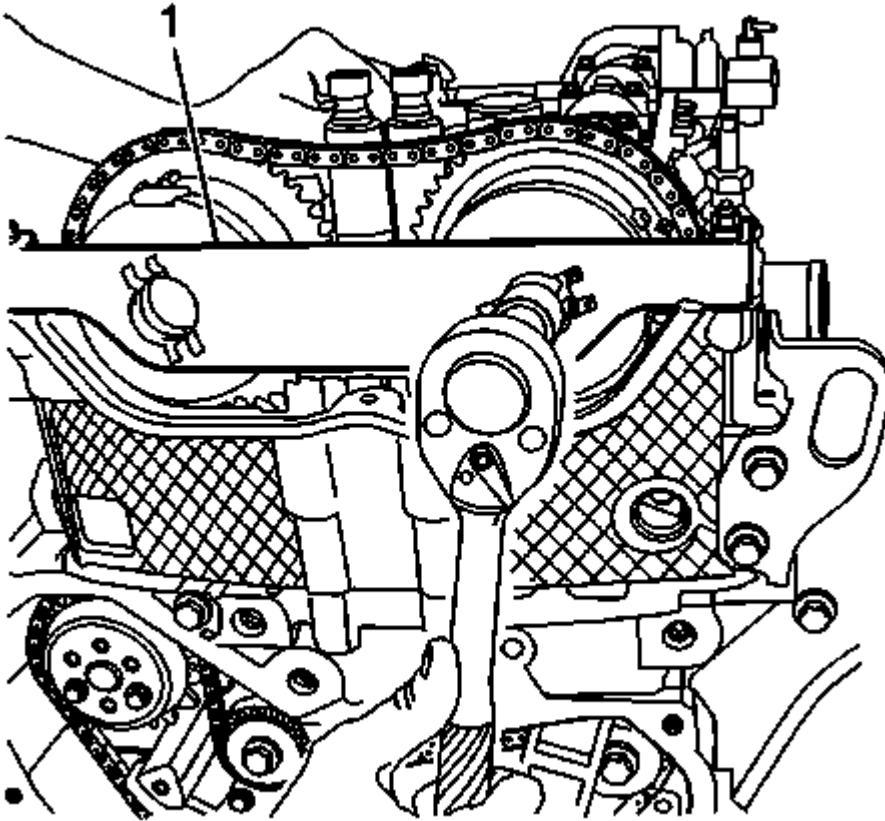


Fig. 217: Loosening/Tightening Camshaft Actuator Retainer Bolts
 Courtesy of GENERAL MOTORS CORP.

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

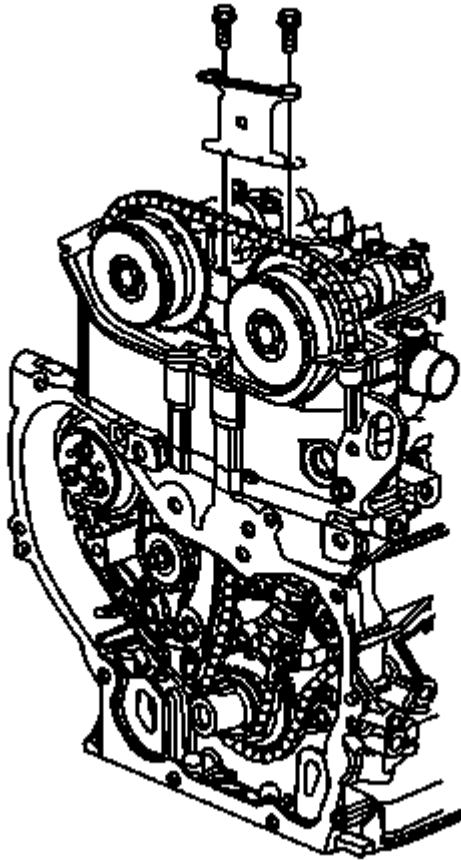


Fig. 218: View Of Upper Timing Chain Guide Bolts And Guide
Courtesy of GENERAL MOTORS CORP.

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

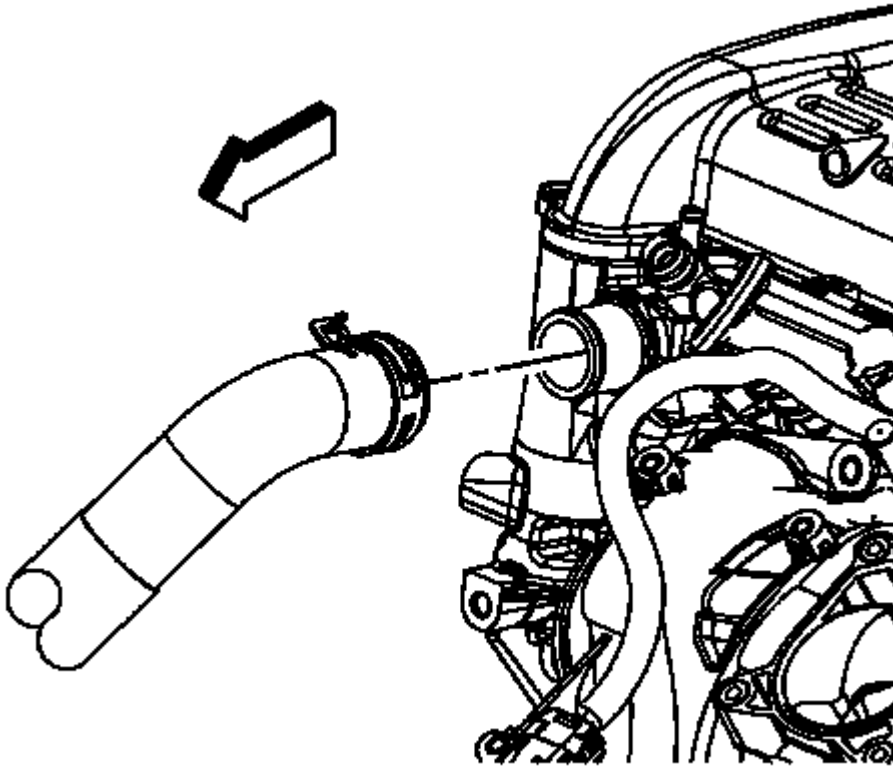


Fig. 219: View Of Radiator Inlet Hose To Engine
Courtesy of GENERAL MOTORS CORP.

28. Connect all electrical connectors as necessary.
29. Install the radiator inlet hose to the cylinder head.
30. Position the radiator inlet hose clamp using the **J 38185**.
31. Install the radiator surge tank air bleed hose to the cylinder head.
32. Position the radiator surge tank air bleed hose clamp.
33. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LE5)**.
34. Install the intake manifold. Refer to **Intake Manifold Replacement**.
35. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE-47716)** or **Cooling System Draining and Filling (2.4L LE5)**.

ENGINE FLYWHEEL REPLACEMENT

SPECIAL TOOLS

- **J 38122-A** Harmonic Balancer Holder
- **J 45059** Angle Meter

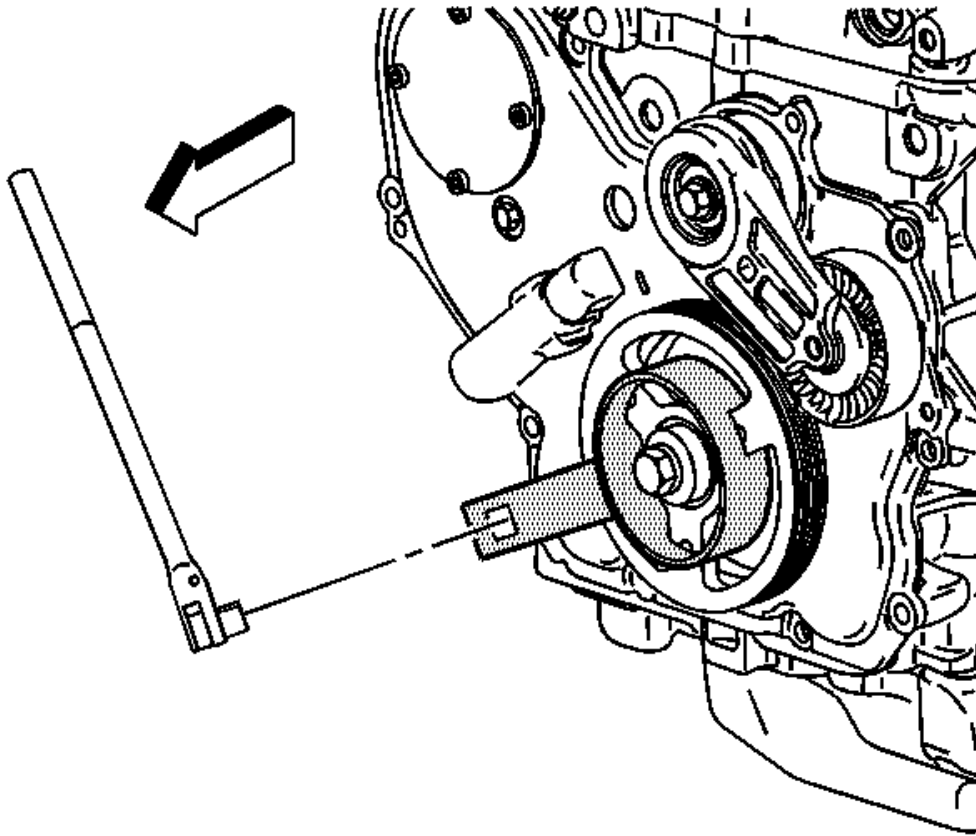
REMOVAL PROCEDURE

Fig. 220: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission, if equipped. Refer to **Transmission Replacement** .
2. Remove the clutch, if equipped. Refer to **Clutch Pressure and Driven Plate Replacement** .
3. Using the **J 38122-A** , hold the crankshaft balancer.

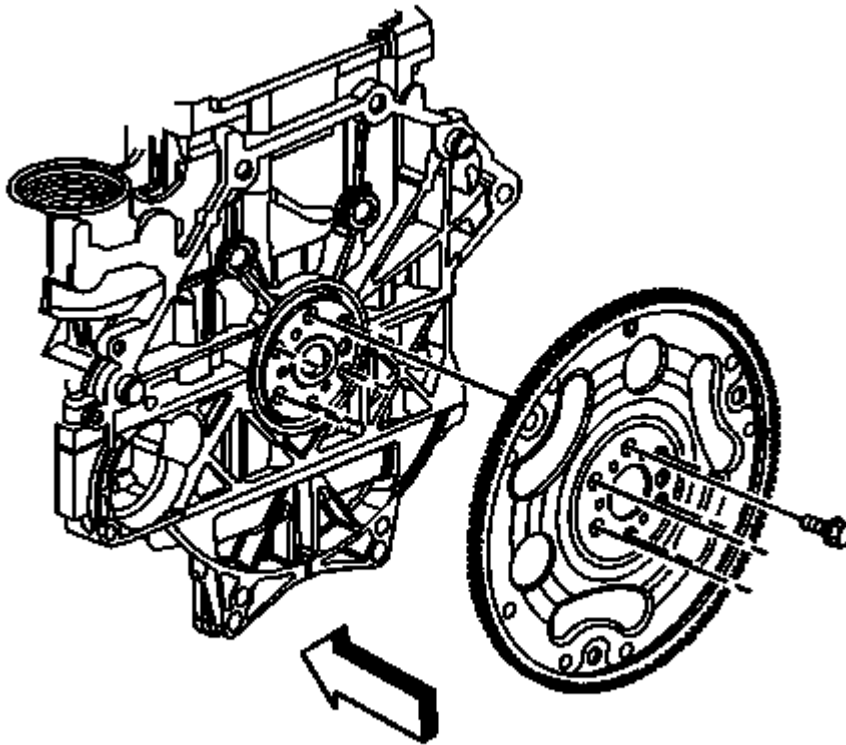


Fig. 221: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

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

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

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

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

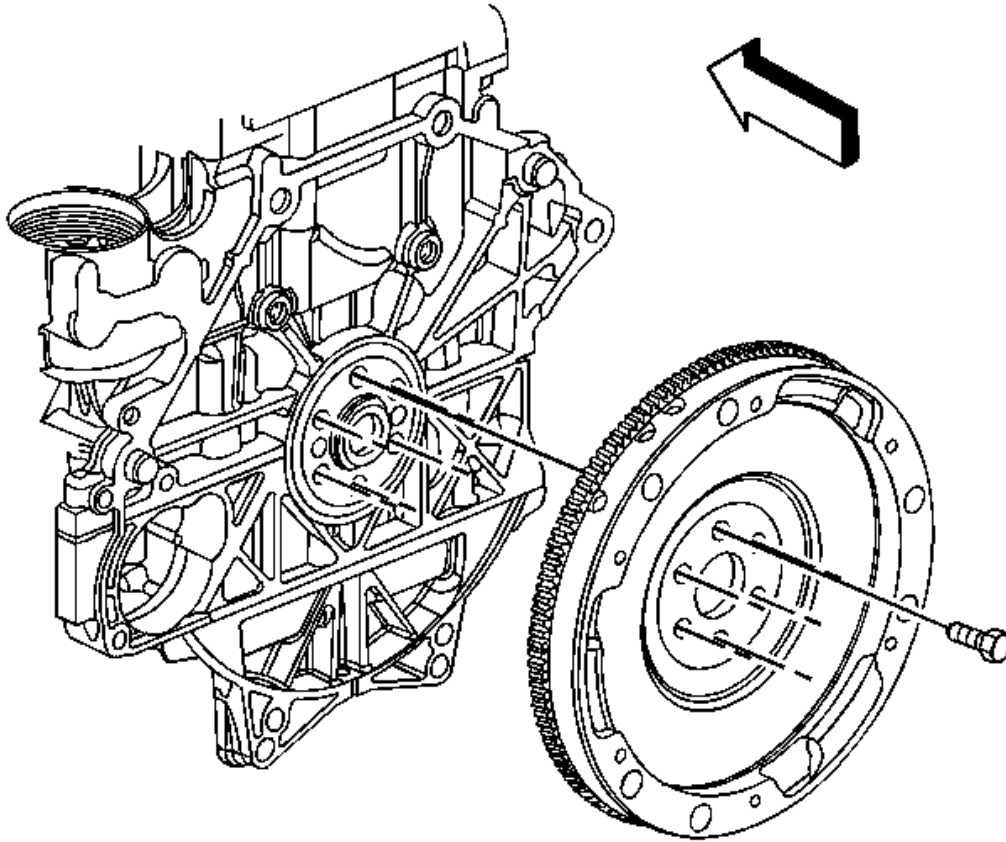


Fig. 222: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

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

INSTALLATION PROCEDURE

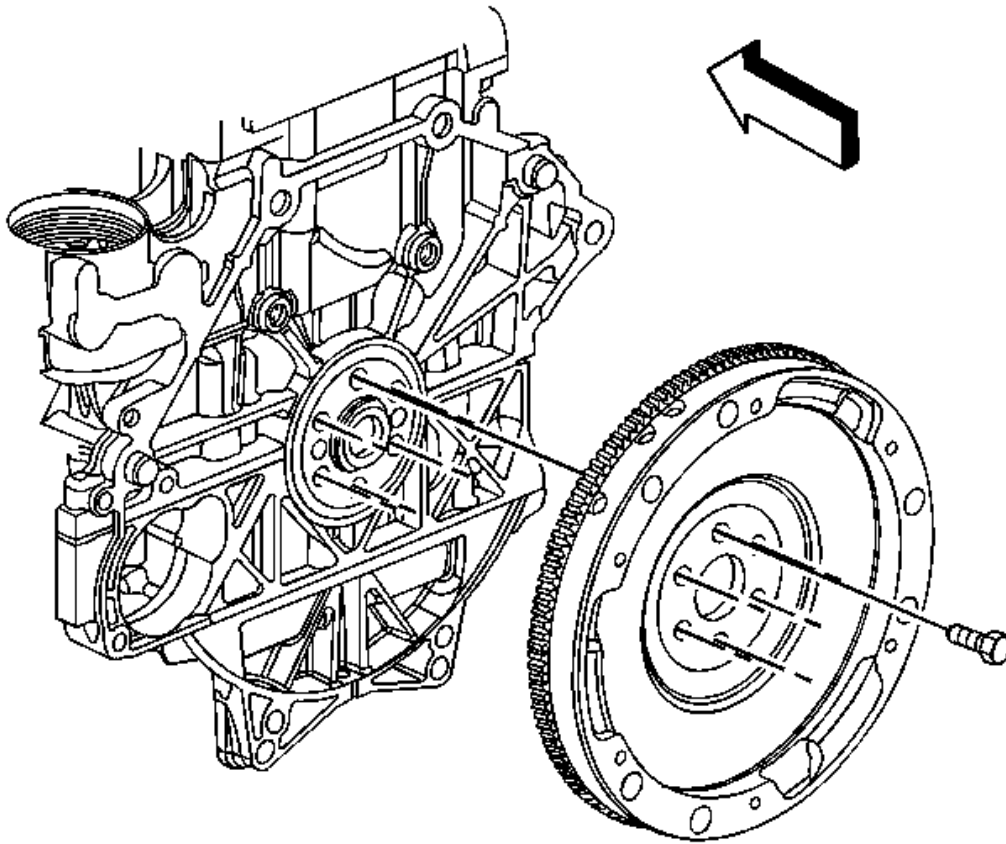


Fig. 223: View Of Flywheel & Bolt (Manual Transmission)
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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

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

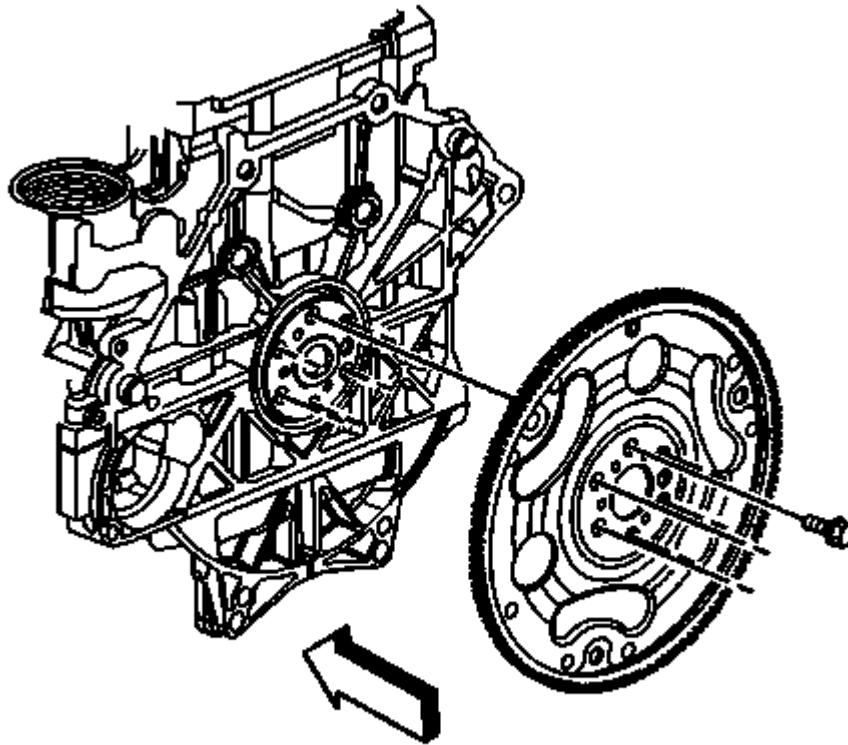


Fig. 224: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

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

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

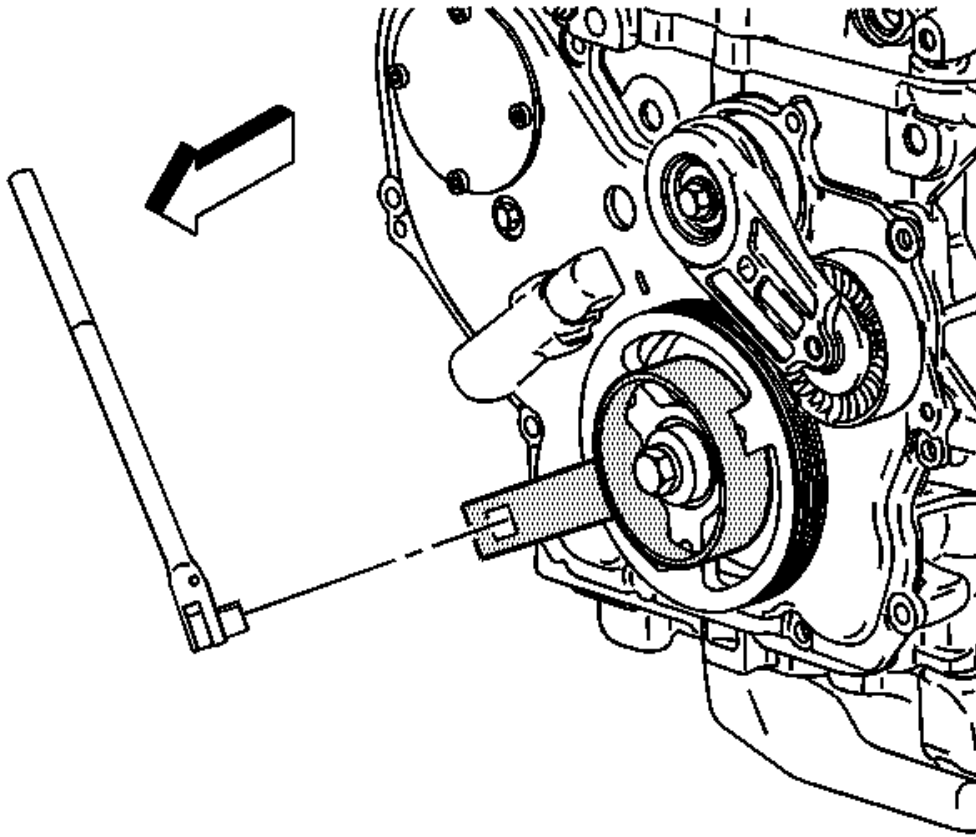


Fig. 225: View Of Harmonic Balancer Holder J38122-A
Courtesy of GENERAL MOTORS CORP.

5. Remove the **J 38122-A** .
6. Install the clutch, if equipped. Refer to **Clutch Pressure and Driven Plate Replacement** .
7. Install the automatic transmission, if equipped. Refer to **Transmission Replacement** .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 42067 Rear Main Seal Installer

REMOVAL PROCEDURE

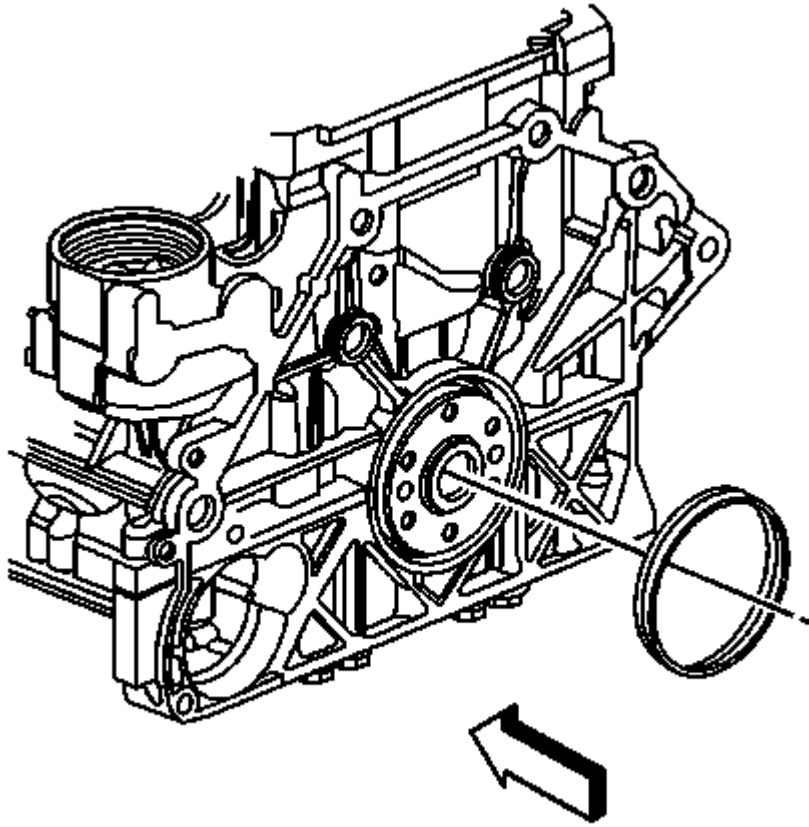


Fig. 226: Identifying Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel. Refer to **Engine Flywheel Replacement**.

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

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

INSTALLATION PROCEDURE

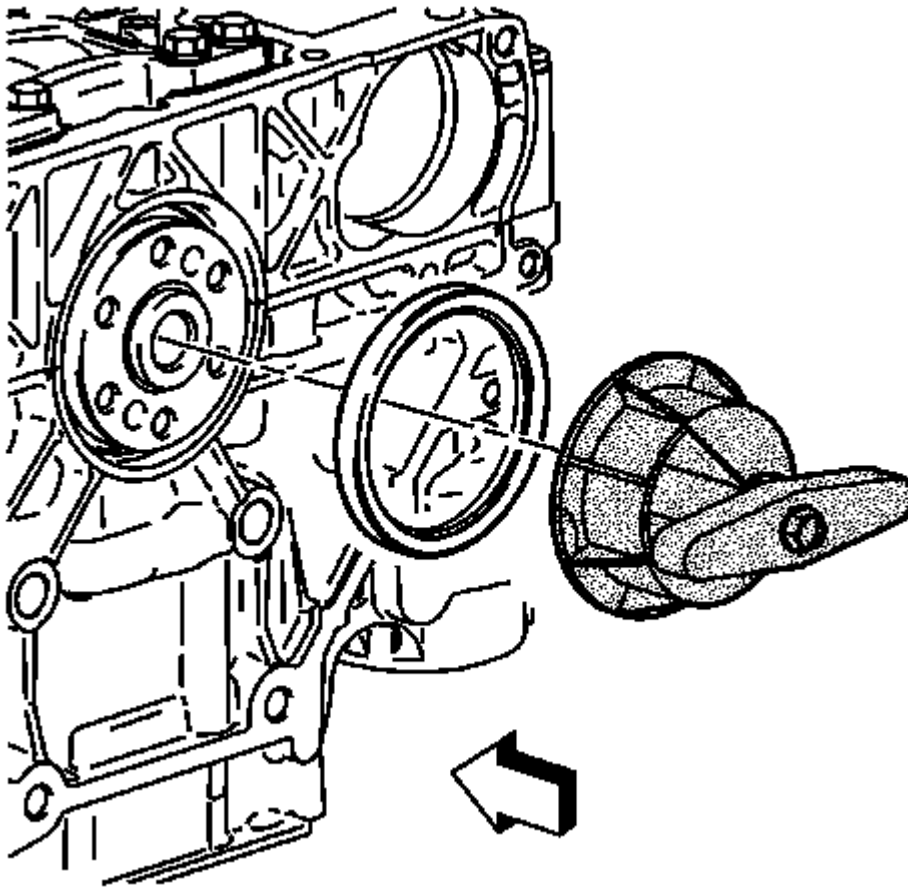


Fig. 227: View Of Crankshaft Rear Oil Seal & Special Tool J 42067
Courtesy of GENERAL MOTORS CORP.

1. Using the **J 42067** , install a NEW crankshaft rear oil seal.
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE REPLACEMENT (W/MANUAL TRANSMISSION)

SPECIAL TOOLS

- **J 42451-1** Engine Support Adapter
- **J 45059** Angle Meter

REMOVAL PROCEDURE

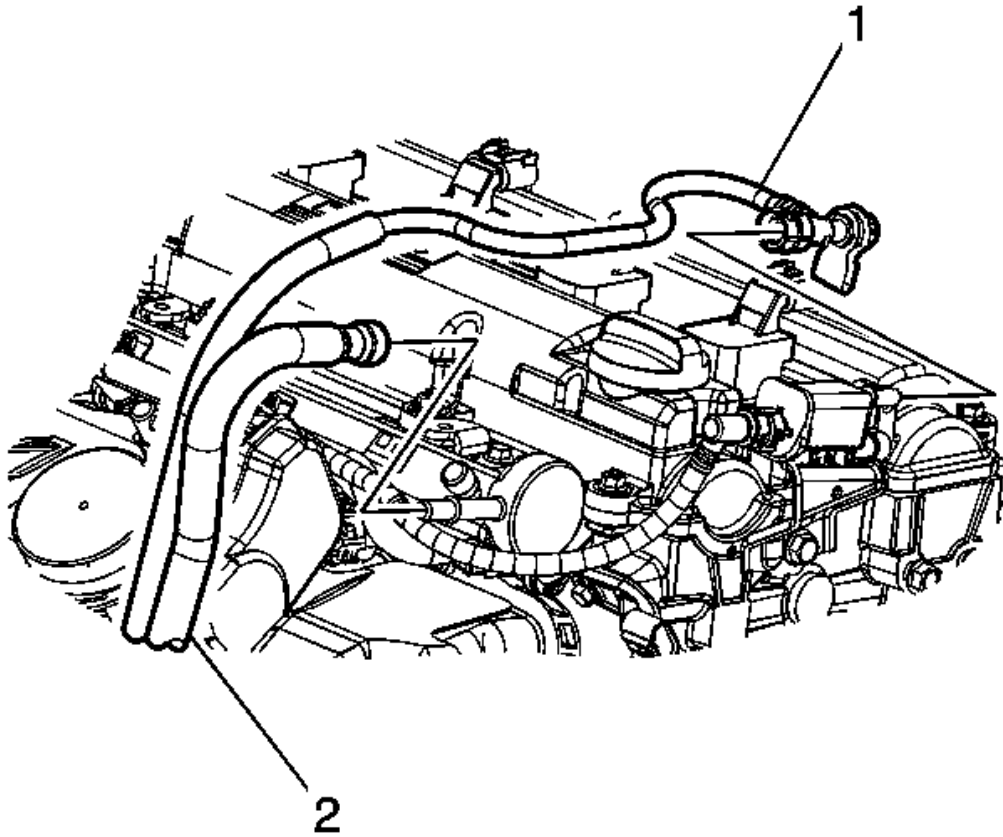


Fig. 228: View Of Fuel Feed Pipe & EVAP Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

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

9. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
10. Remove the transmission. Refer to **Transmission Replacement (With ZOK)** .
11. After the transmission is removed, reinstall the bolt from the differential case bracket assembly to body, in order to remove the support from under the rear drive module.

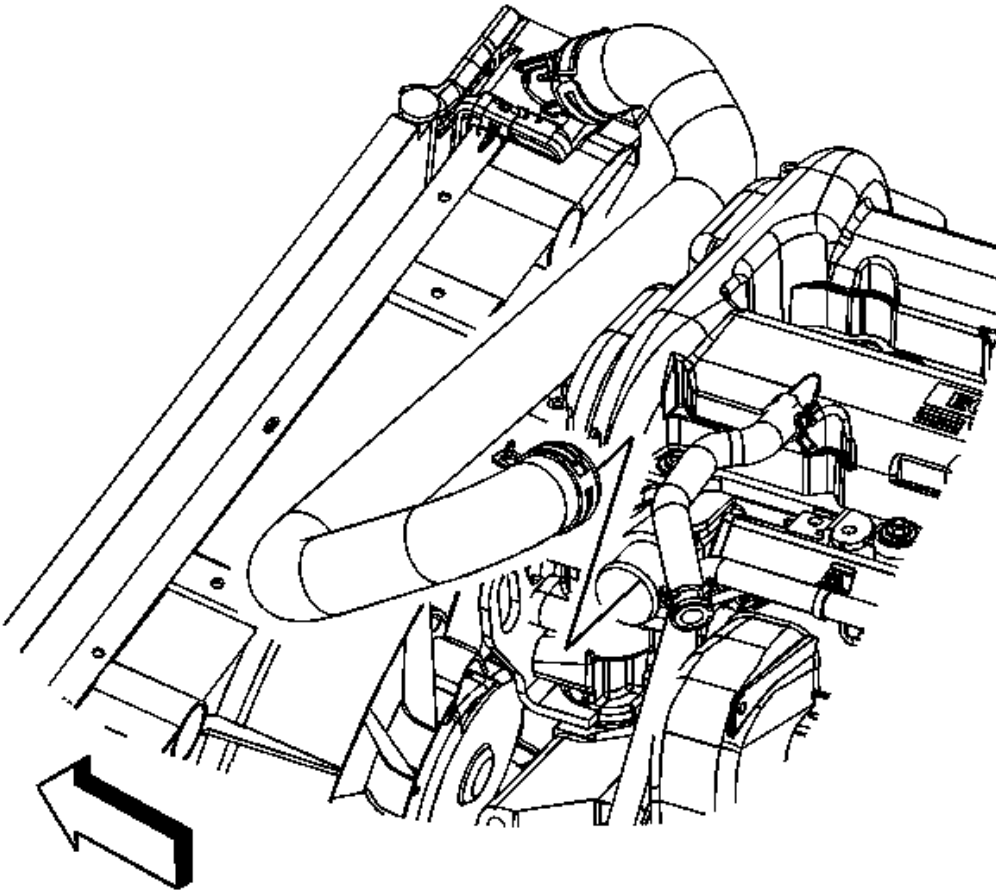


Fig. 229: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

12. Reposition the radiator inlet hose clamp at the engine.
13. Remove the radiator inlet hose.

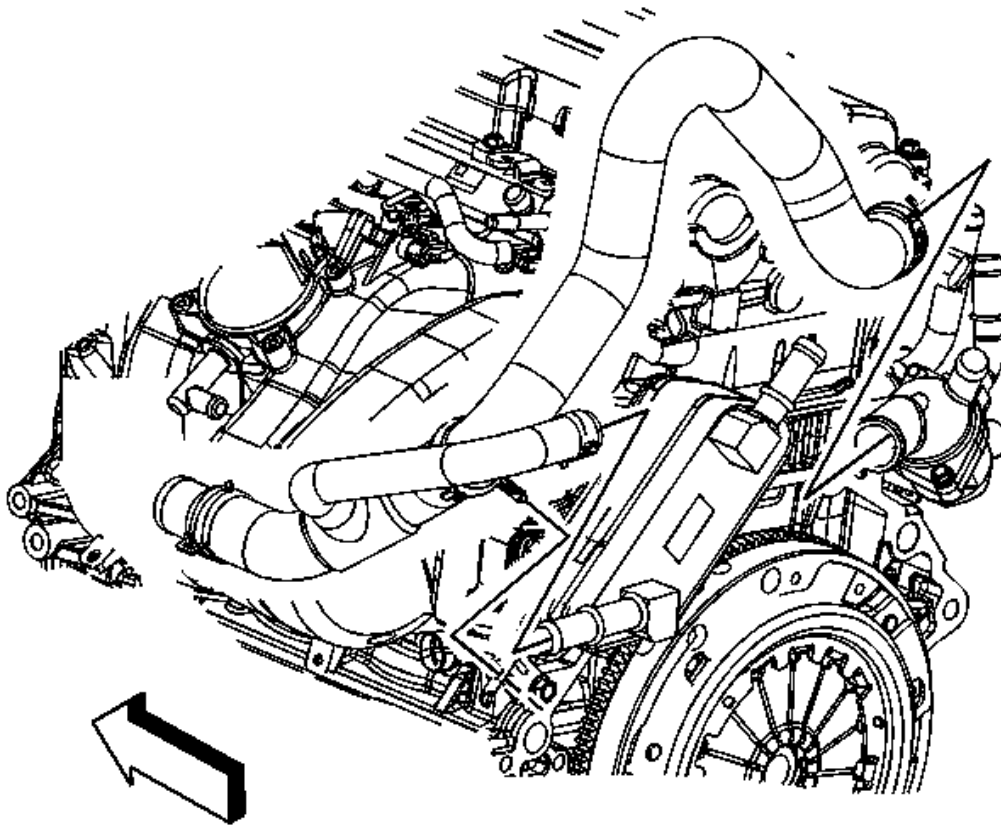


Fig. 230: View Of Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

14. If the vehicle is equipped with a engine oil cooler perform the following steps, otherwise proceed to step 23.
15. Reposition the radiator outlet hose clamps at the thermostat housing and oil cooler.
16. Remove the radiator outlet hose from the thermostat housing and oil cooler.
17. Reposition the outlet hose out of the way.

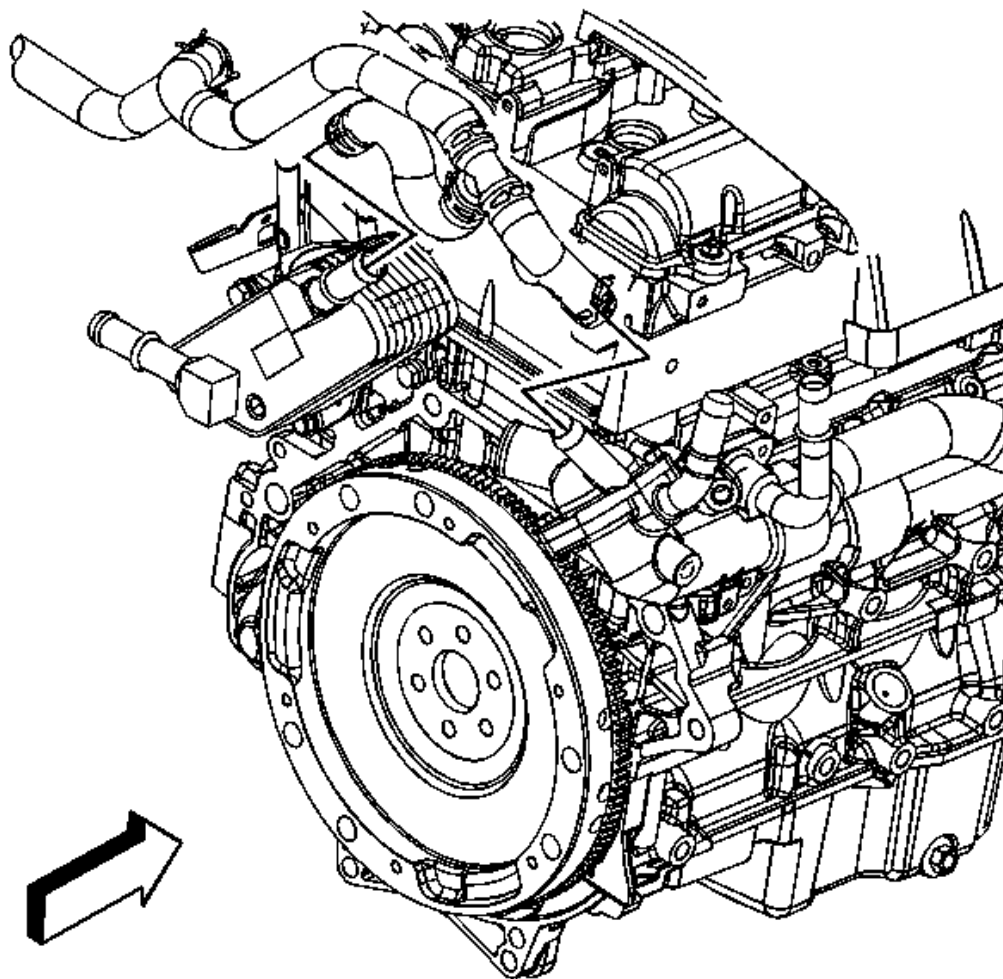


Fig. 231: View Of Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

18. Reposition the surge tank outlet hose clamps at the thermostat housing and oil cooler.
19. Remove the surge tank outlet hose from the thermostat housing and oil cooler.

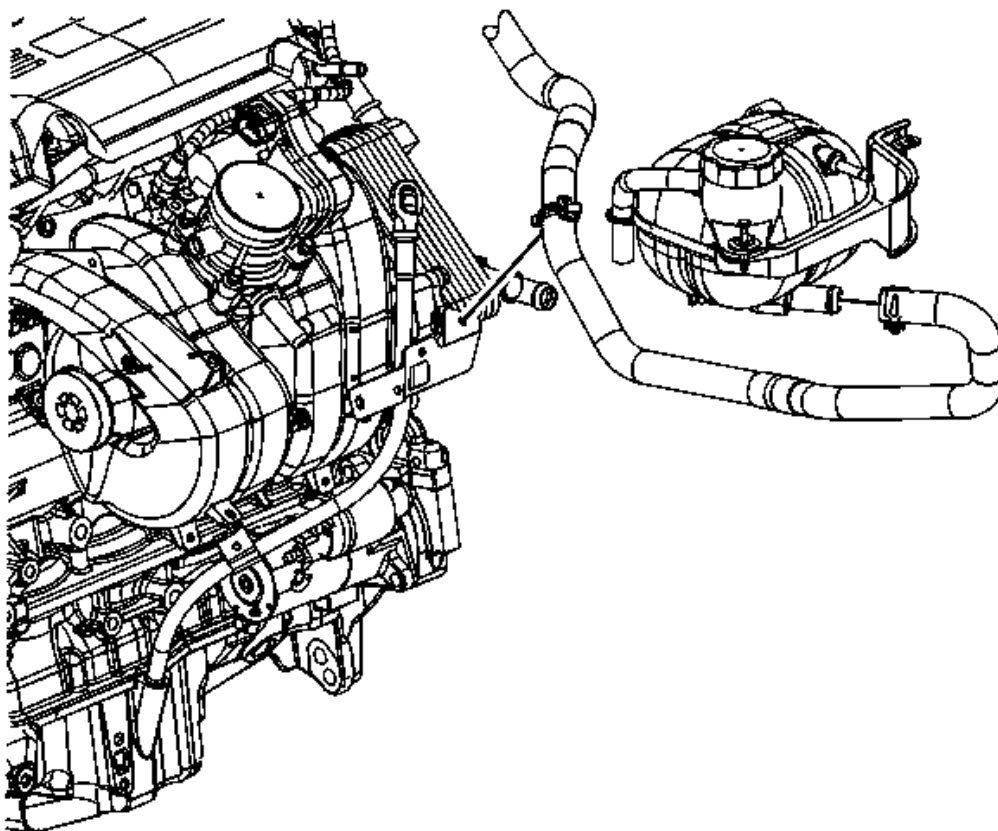


Fig. 232: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

20. Reposition the surge tank outlet hose clamp at the surge tank.
21. Remove the surge tank clip from the oil level indicator tube bracket.
22. Remove the surge tank outlet hose. Proceed to step 26.

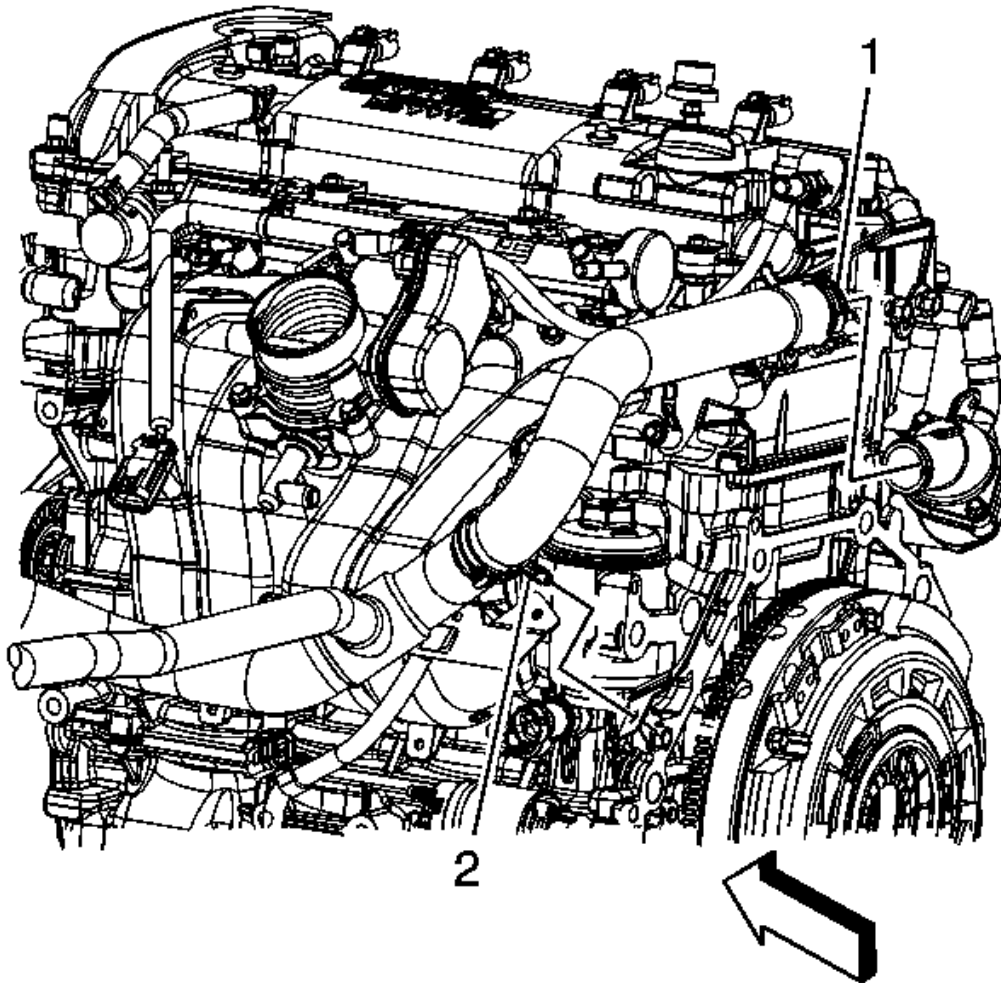


Fig. 233: Identifying Radiator Outlet Hose Clip
 Courtesy of GENERAL MOTORS CORP.

23. If the vehicle is not equipped with a engine oil cooler, reposition the radiator outlet hose clamp at the thermostat housing.
24. Remove the radiator outlet hose from the thermostat housing.
25. Remove the radiator outlet hose clip (1) from the outlet hose bracket.

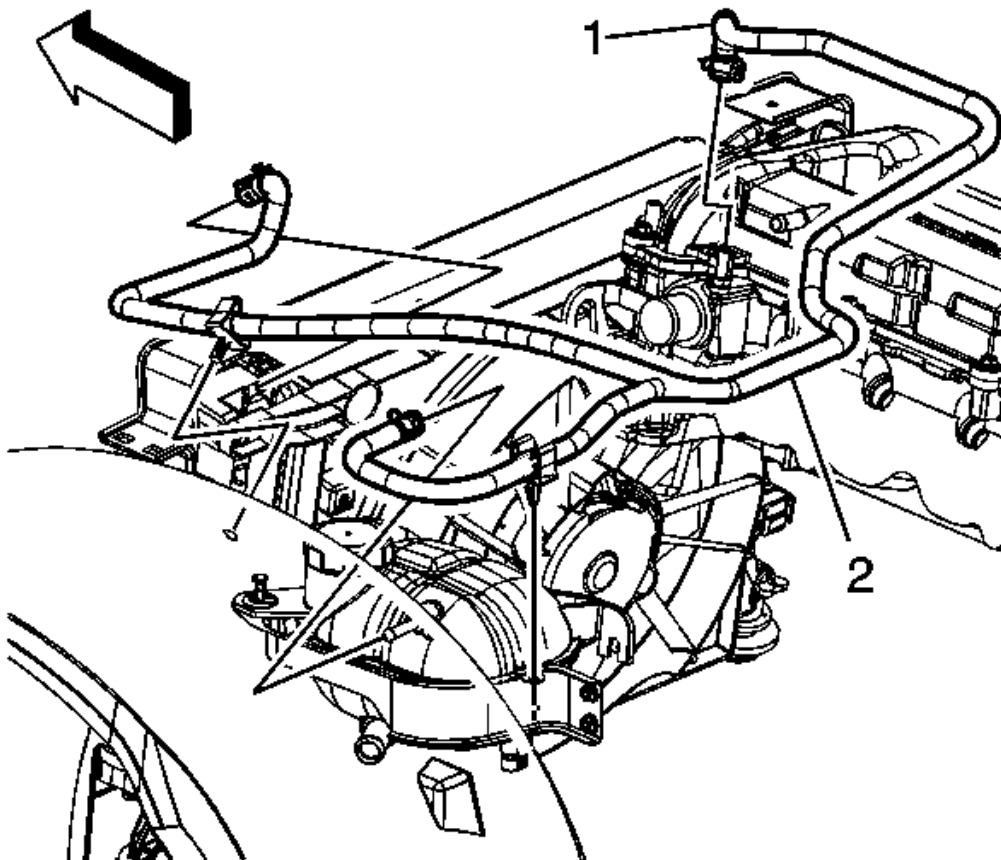


Fig. 234: Identifying Air Bleed Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

26. Reposition the surge tank air bleed hose clamp at the engine.
27. Remove the surge tank air bleed hose (1) from the engine.
28. Reposition the air bleed hose (2) out of the way.

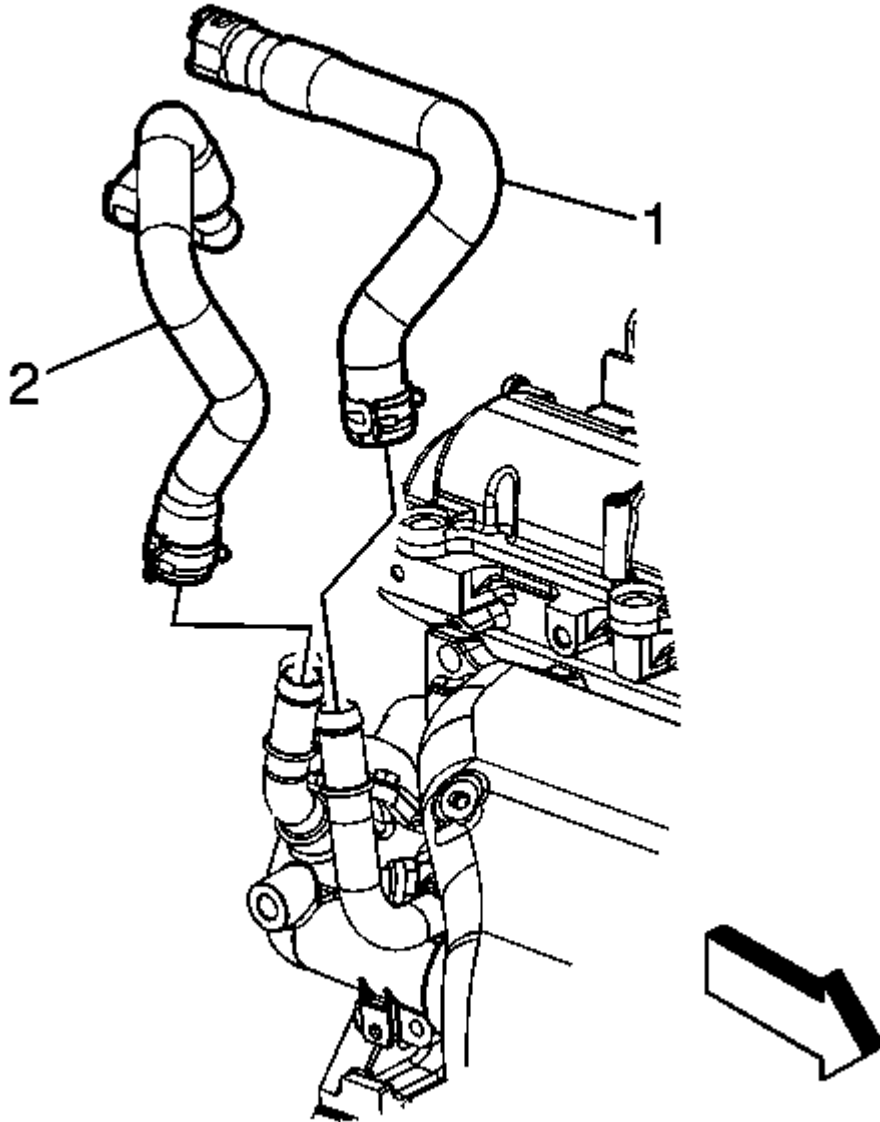


Fig. 235: Identifying Heater Inlet & Outlet Hoses
 Courtesy of GENERAL MOTORS CORP.

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

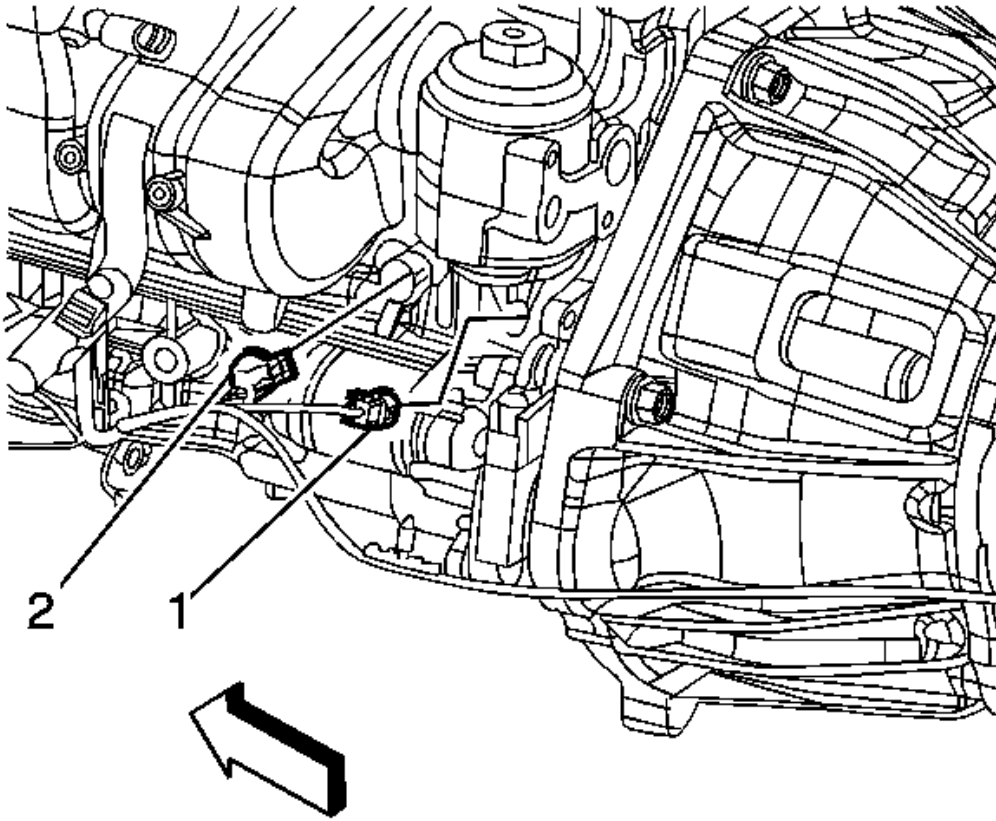


Fig. 236: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

33. Disconnect the engine wiring harness electrical connector (1) from the crankshaft position (CKP) sensor.
34. Disconnect the engine wiring harness electrical connector (2) from the oil pressure sensor.
35. Lower the vehicle.
36. Remove the positive battery cable clip from the bracket.
37. Cut the engine harness tie straps.

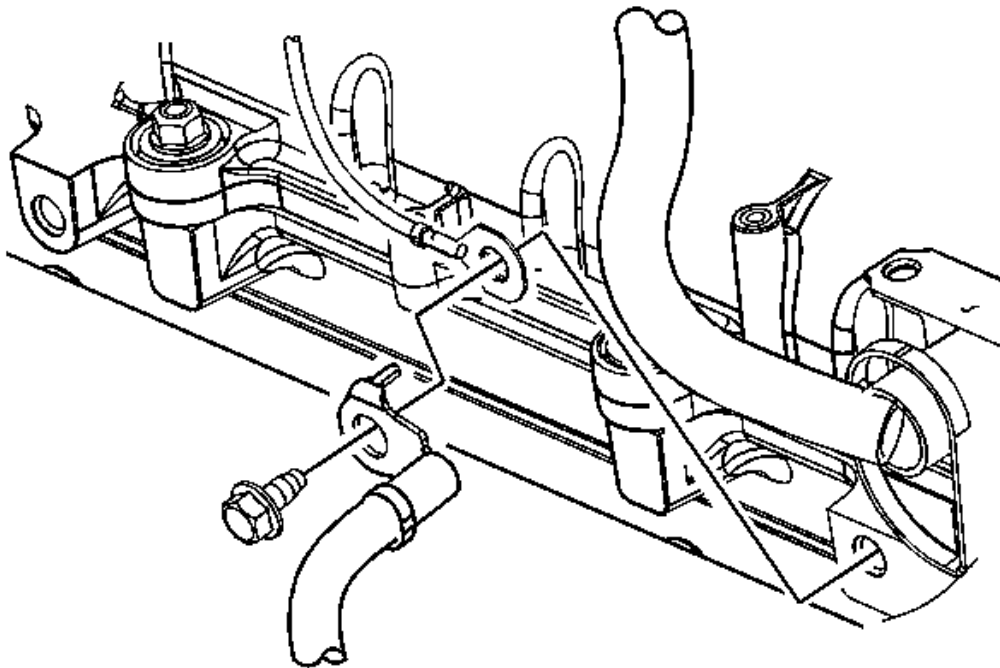


Fig. 237: View Of Negative Battery Cable Ground Bolt
Courtesy of GENERAL MOTORS CORP.

38. Remove the negative battery cable ground bolt.
39. Remove the negative battery cable ground terminal and engine harness ground terminal from the cylinder head.

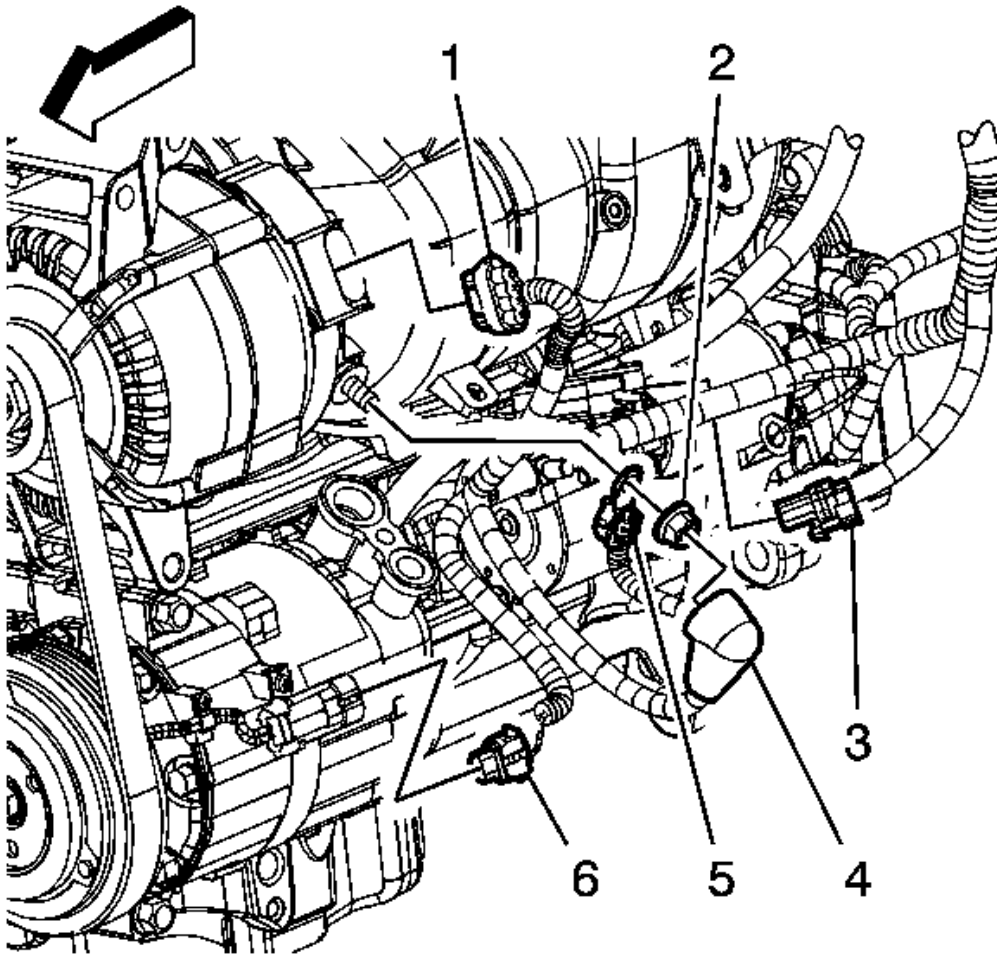


Fig. 238: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

40. Disconnect the engine wiring harness electrical connector (1) from the generator.
41. Reposition the positive battery cable terminal boot (4).
42. Remove the generator terminal nut (2).
43. Remove the positive battery cable terminal from the generator (5).
44. Disconnect the engine wiring harness electrical connector (6) from the A/C compressor.
45. Reposition the negative/positive battery cable.

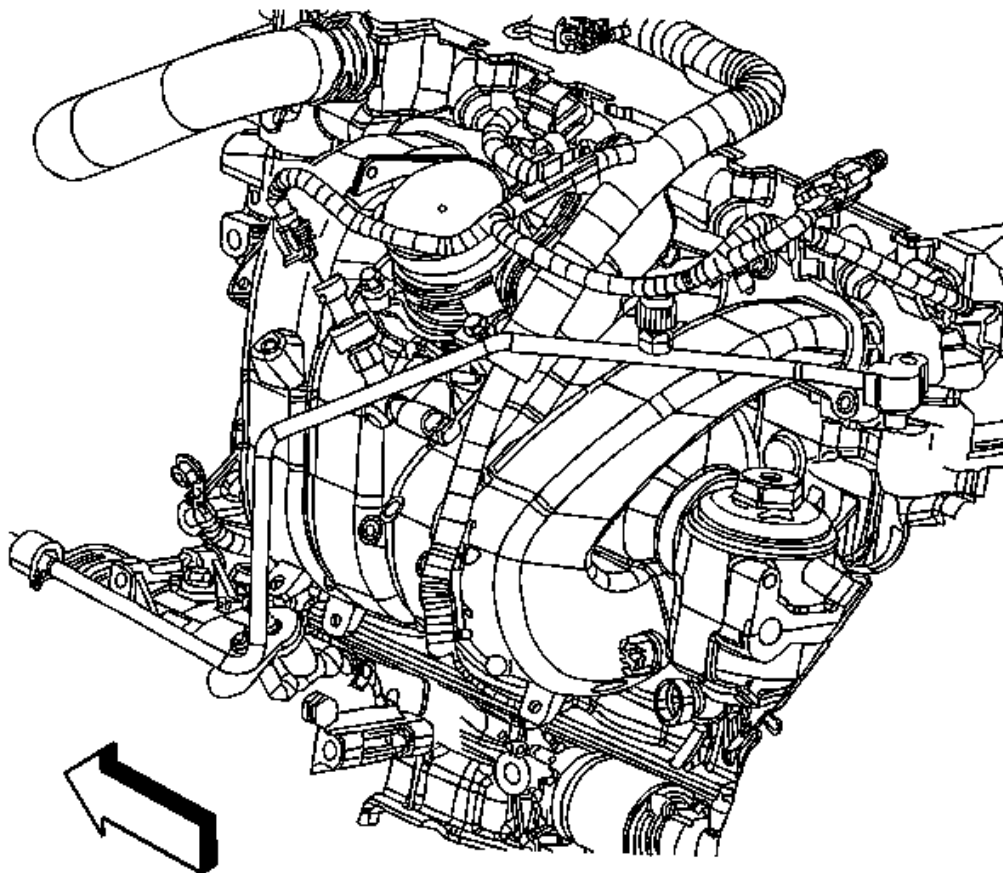


Fig. 239: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

46. Disconnect the engine wiring harness electrical connector from the A/C refrigerant pressure sensor.

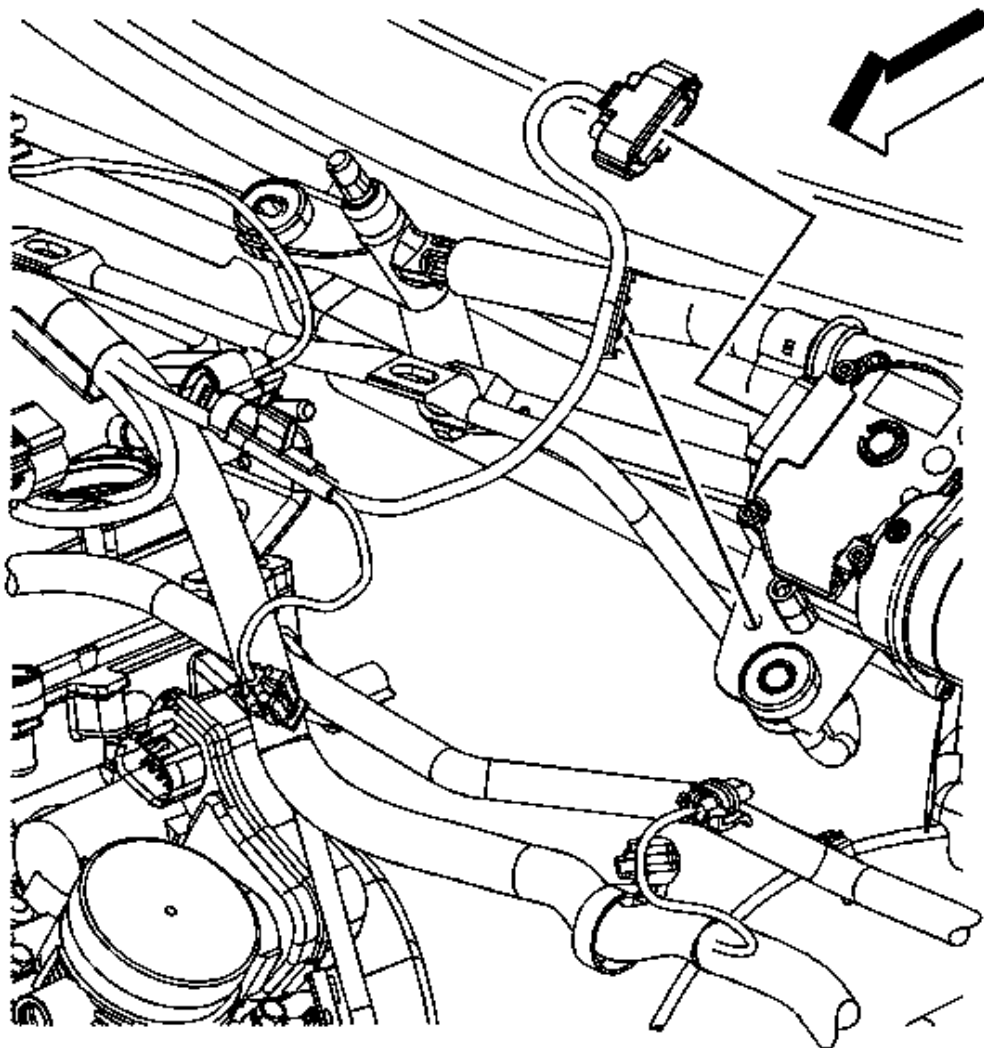


Fig. 240: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

47. Disconnect the engine wiring harness electrical connector from the windshield wiper motor.
48. Remove the engine harness clip from the wiper motor hole.

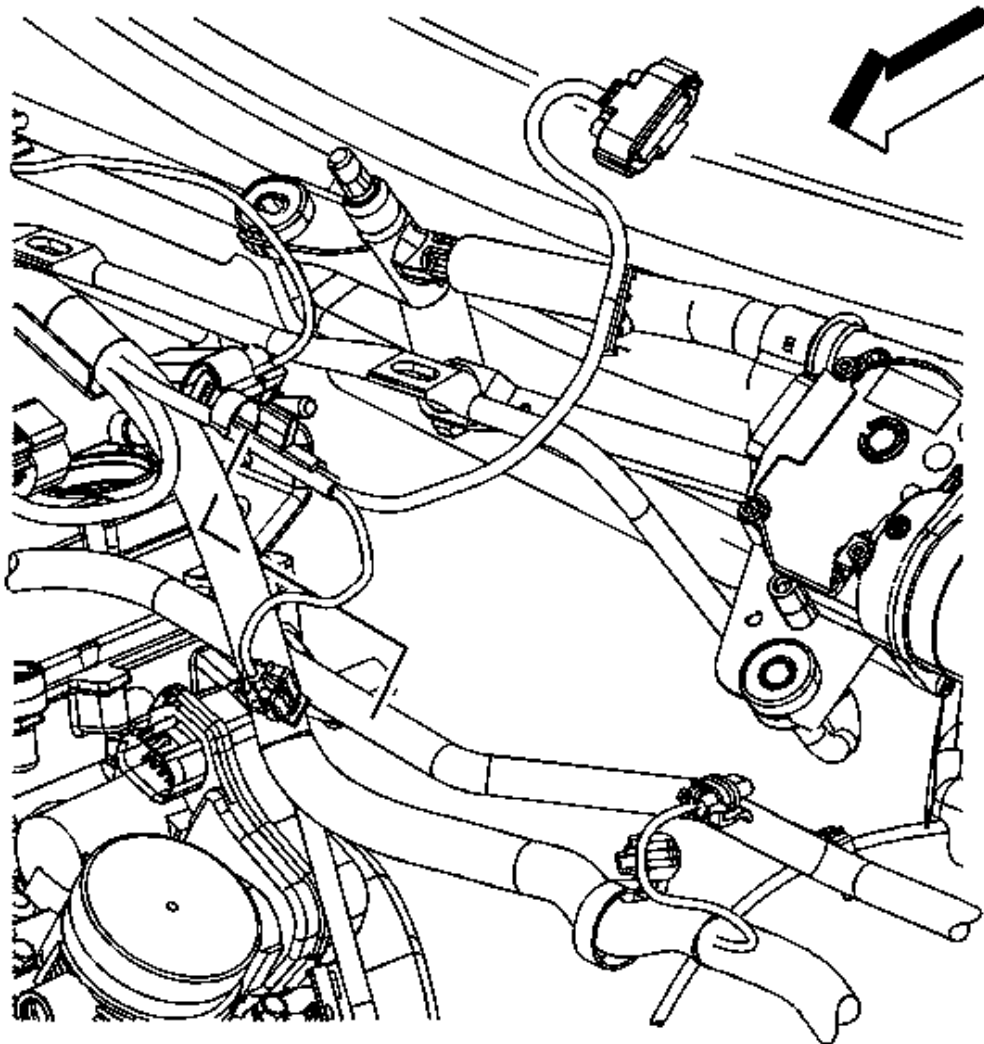


Fig. 241: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

49. Remove the engine harness clip from the surge tank air bleed hose.

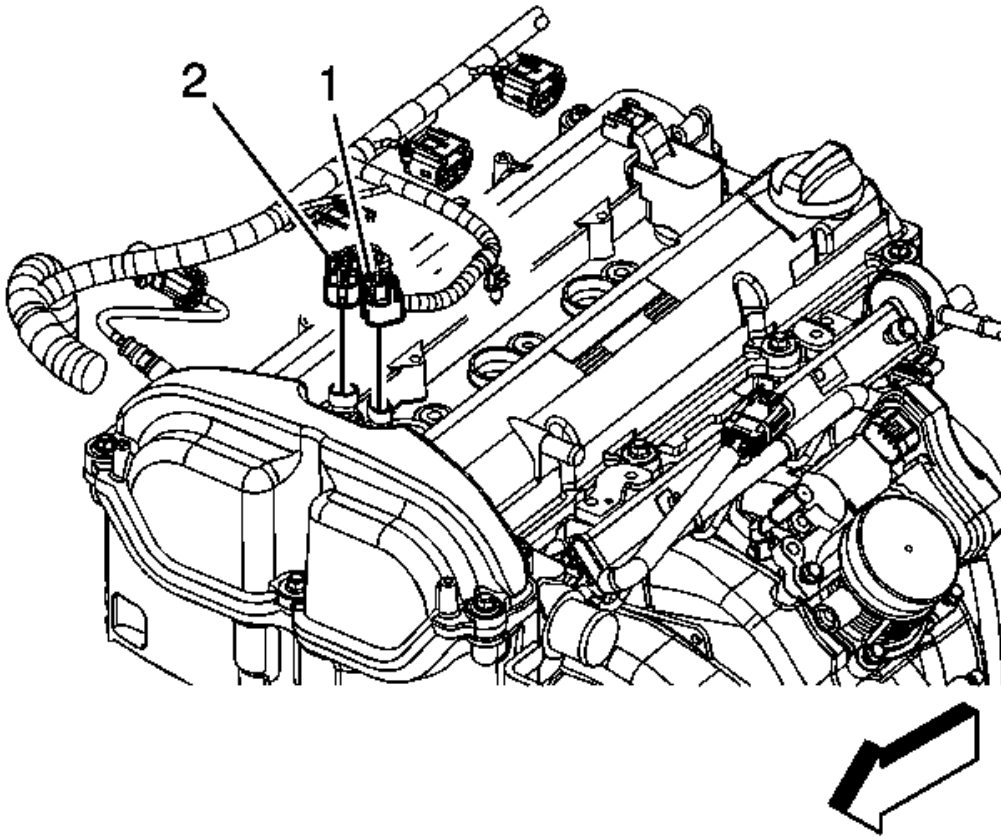


Fig. 242: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

50. Disconnect the engine wiring harness electrical connector (1) from the intake camshaft position (CMP) actuator.
51. Disconnect the engine wiring harness electrical connector (2) from the exhaust CMP actuator.

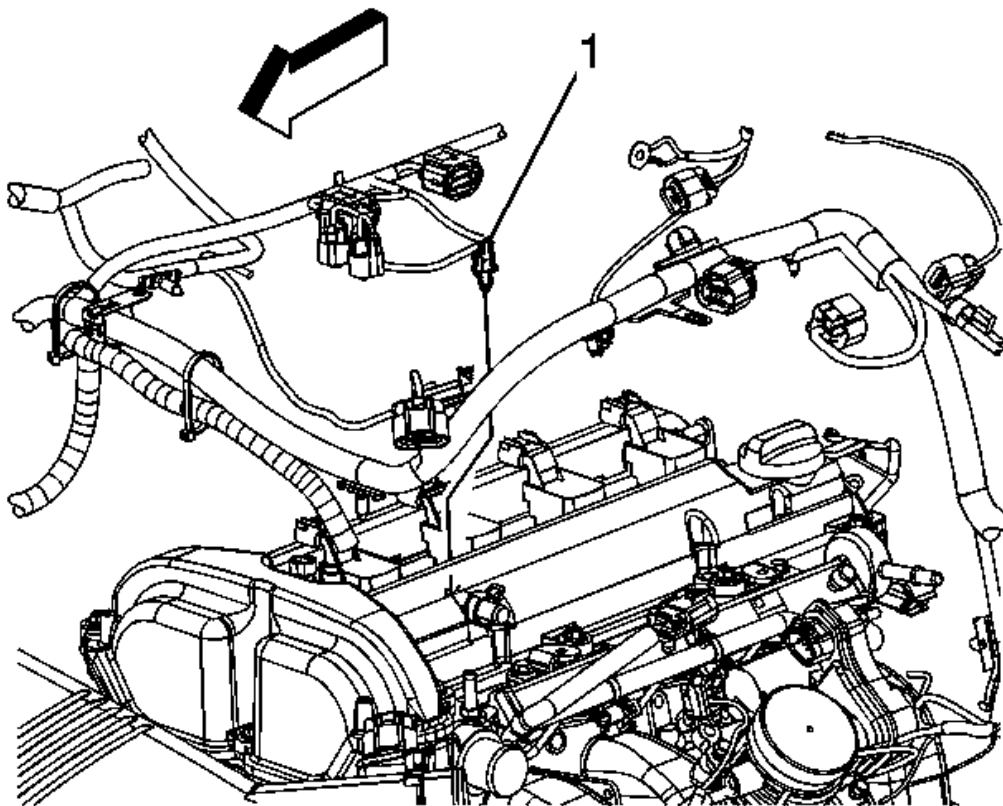


Fig. 243: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

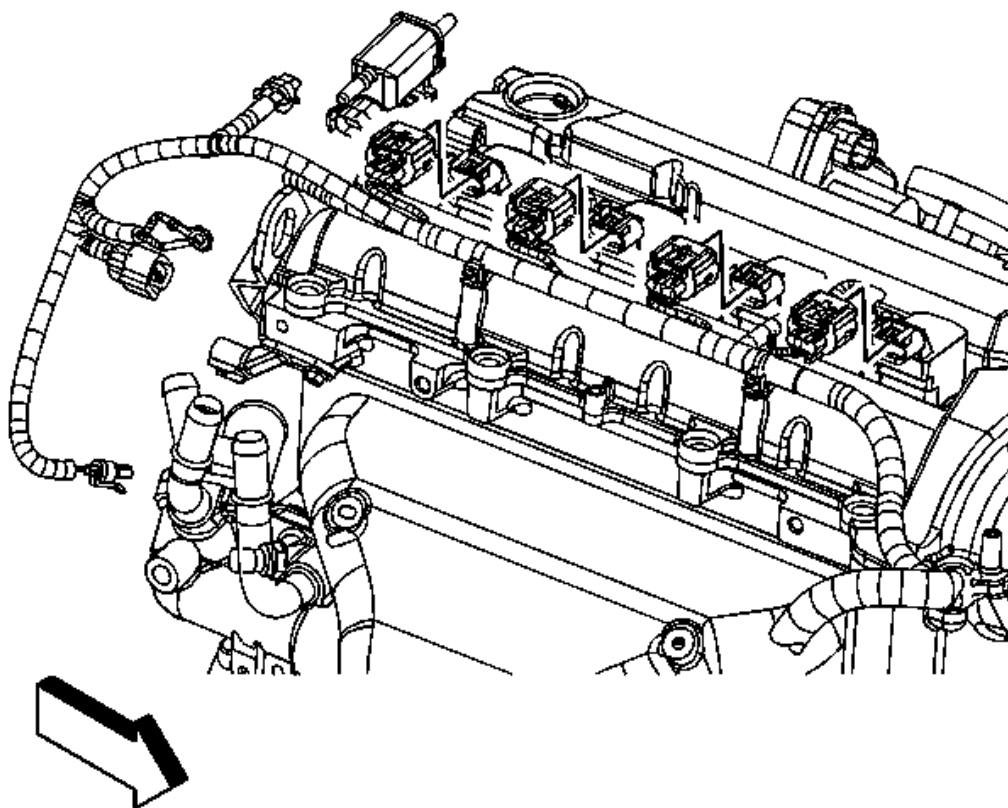


Fig. 244: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

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

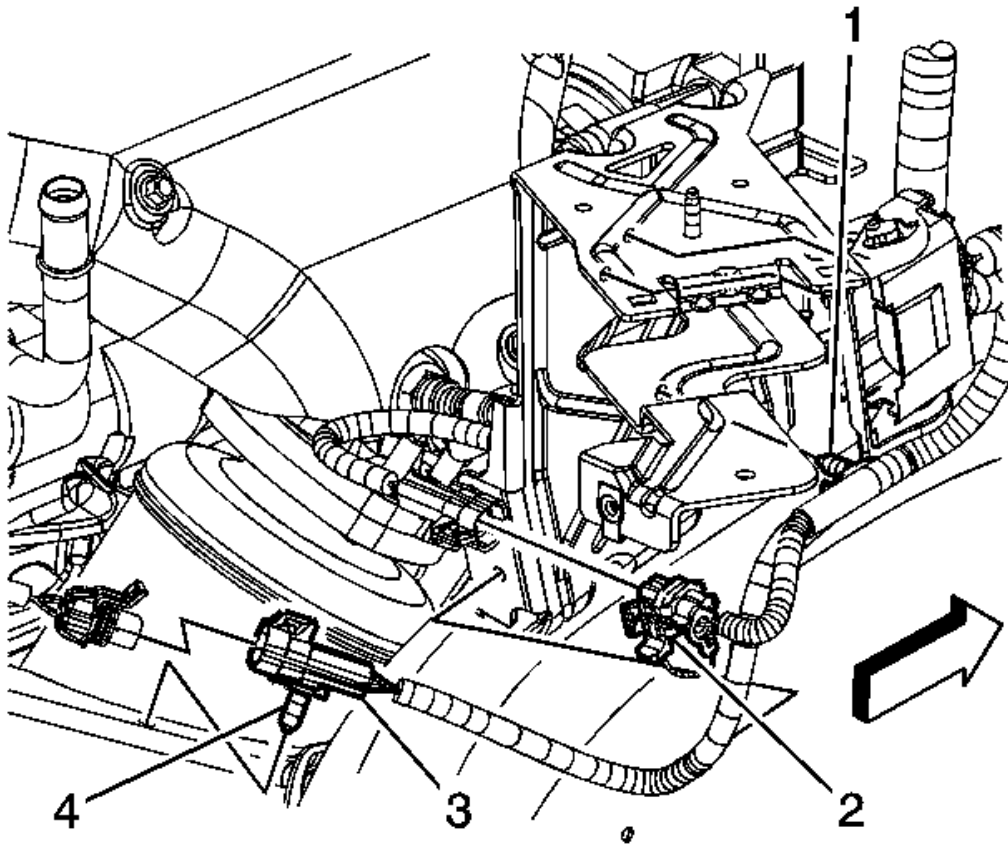


Fig. 245: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

54. Remove the connector position assurance (CPA) retainers from the heated oxygen sensor (HO2S) electrical connectors.
55. Disconnect the engine wiring harness electrical connector (1) from the front HO2S.
56. Disconnect the engine wiring harness electrical connector (2) from the rear HO2S.
57. Disconnect the engine harness clips (1) from the junction block bracket.
58. Disconnect the HO2S electrical connector clip (4) from the strut.

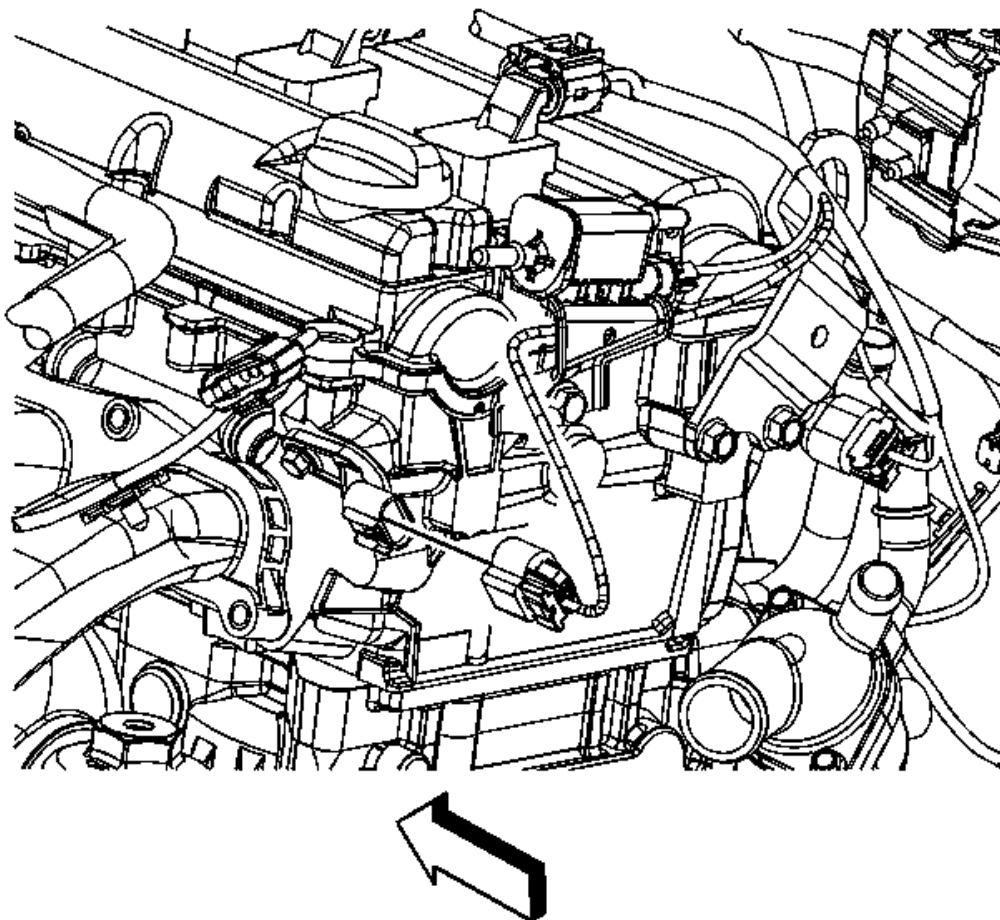


Fig. 246: View Of Intake CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

59. Disconnect the engine wiring harness electrical connector from the intake CMP sensor.

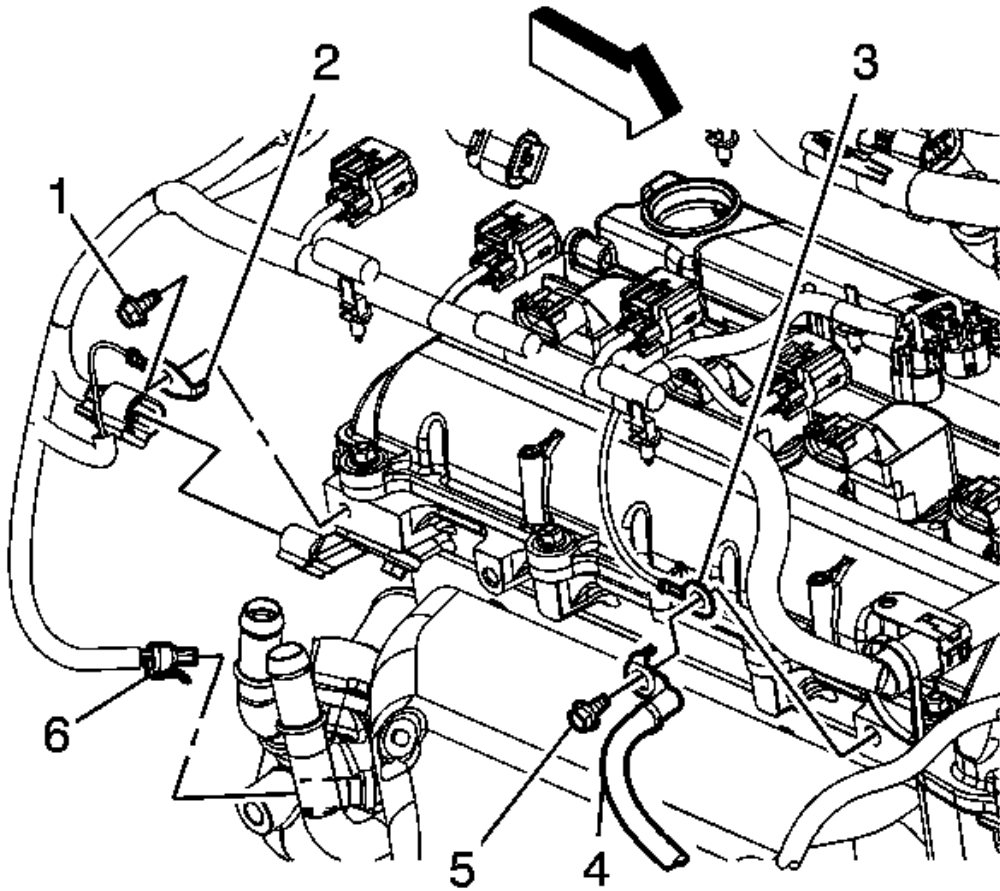


Fig. 247: View Of CMP Sensor & ECT Sensor Electrical Connectors
 Courtesy of GENERAL MOTORS CORP.

60. Disconnect the engine wiring harness electrical connector from the exhaust CMP sensor.
61. Remove the engine harness ground terminal bolt (1) and reposition the engine harness ground terminal (2).
62. Disconnect the engine wiring harness electrical connector (6) from the engine coolant temperature (ECT) sensor.

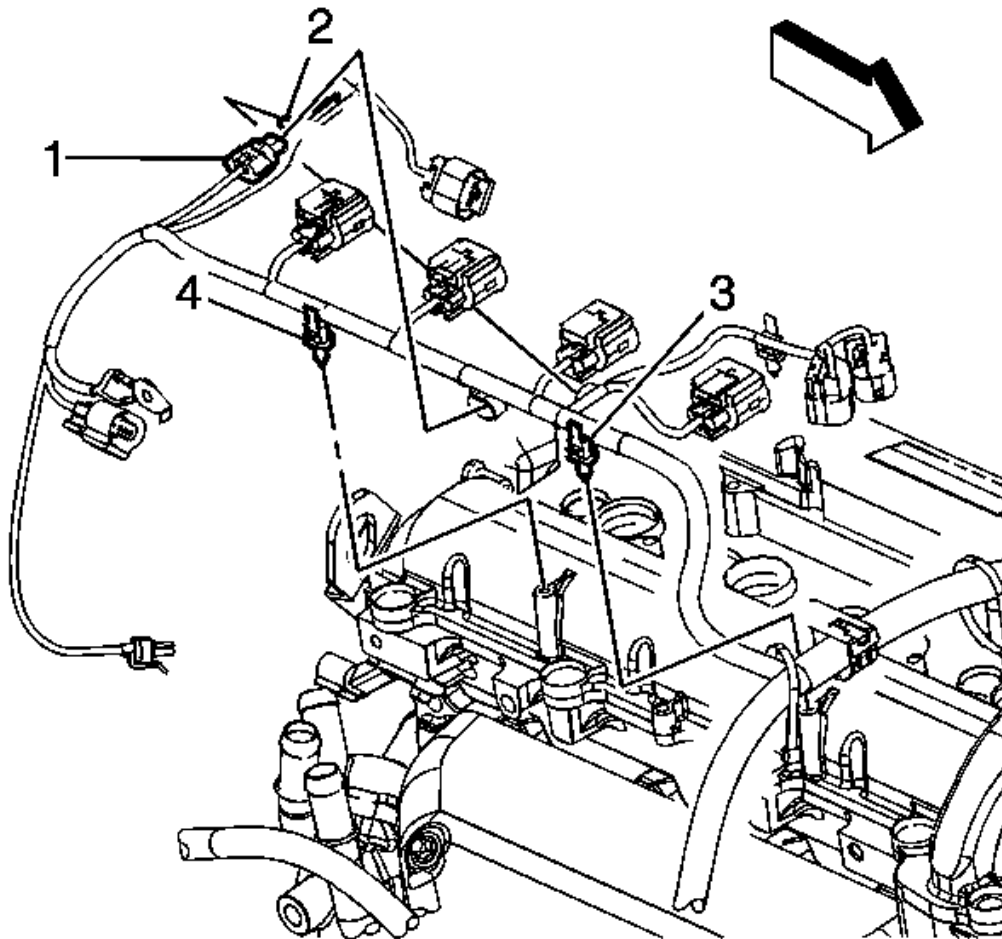


Fig. 248: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS CORP.

63. Disconnect the engine wiring harness electrical connector (1) from the EVAP canister purge solenoid.
64. Disconnect the engine harness clip (2) from the EVAP canister purge solenoid valve bracket.
65. Disconnect the engine harness clips (3, 4) from the camshaft cover.
66. Remove the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

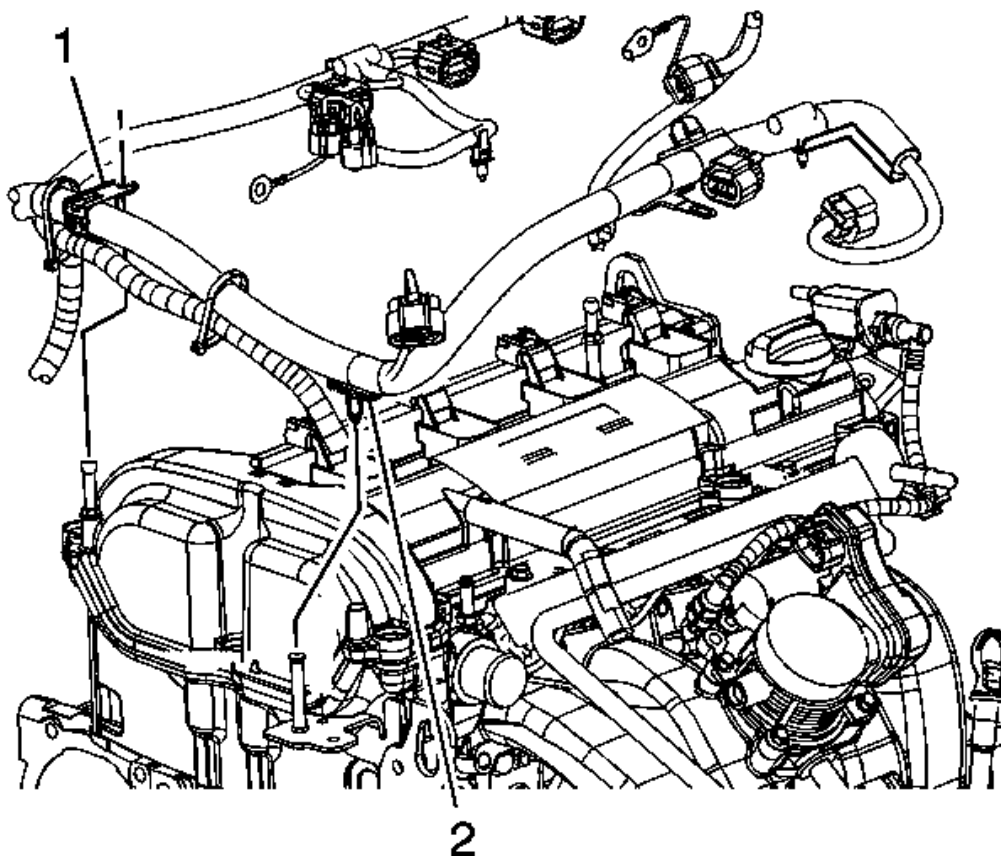


Fig. 249: Identifying Engine Harness Bracket
Courtesy of GENERAL MOTORS CORP.

67. Remove the engine harness bracket (1) from the intake manifold cover stud.
68. Disconnect the engine harness clip (2) from the bracket.

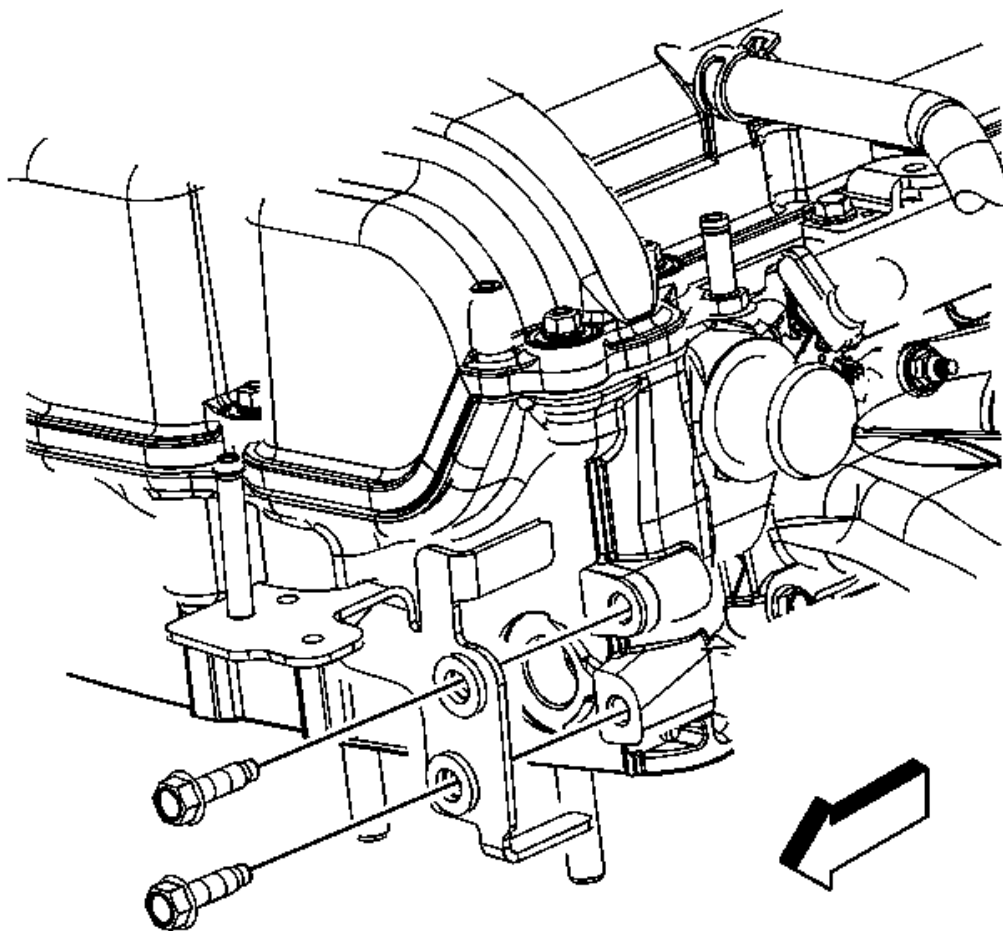


Fig. 250: View Of Intake Manifold Cover Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

69. Remove the intake manifold cover bracket bolts and bracket.
70. Gather all branches of the engine harness and lay off to the side.

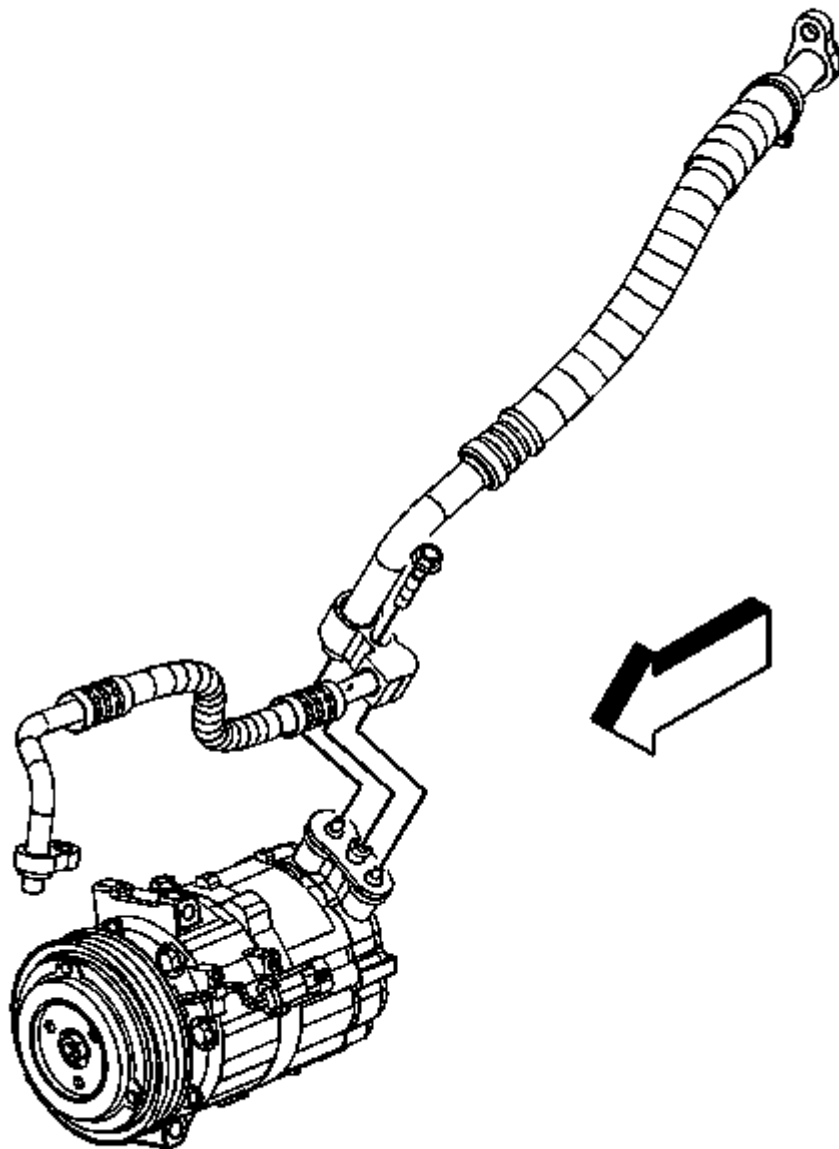


Fig. 251: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

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

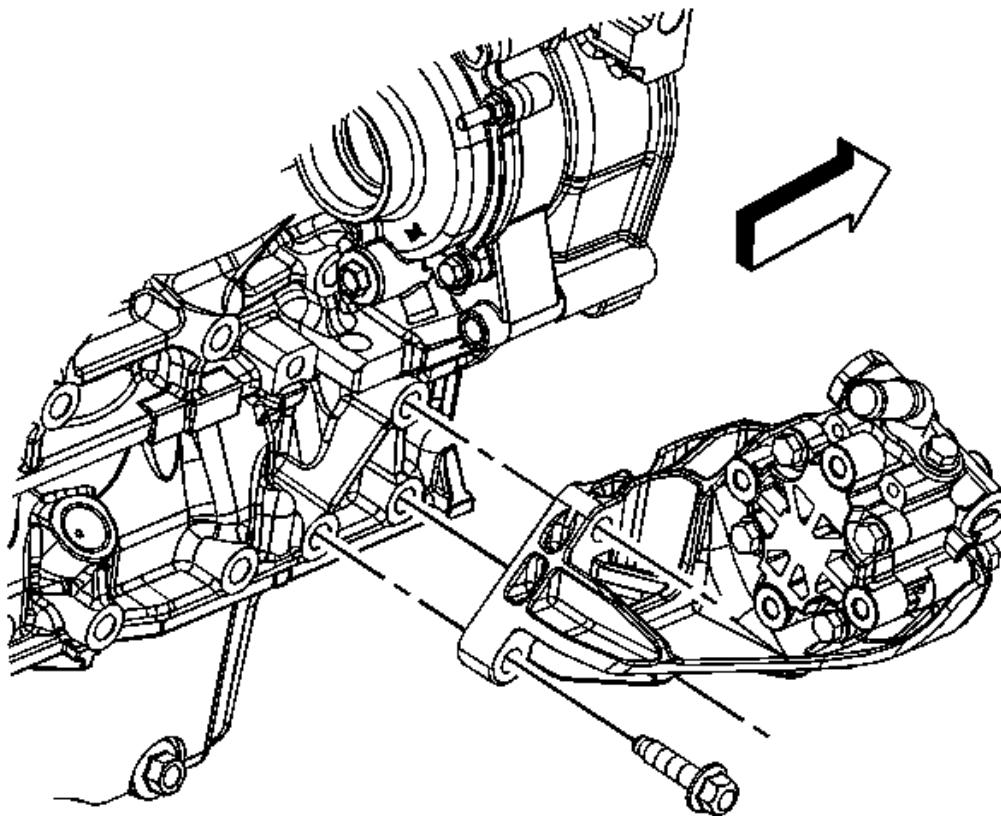


Fig. 252: View Of Power Steering Pump, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

73. Remove the power steering pump bracket bolts and reposition the pump and bracket off to the side.
74. Lower the vehicle.

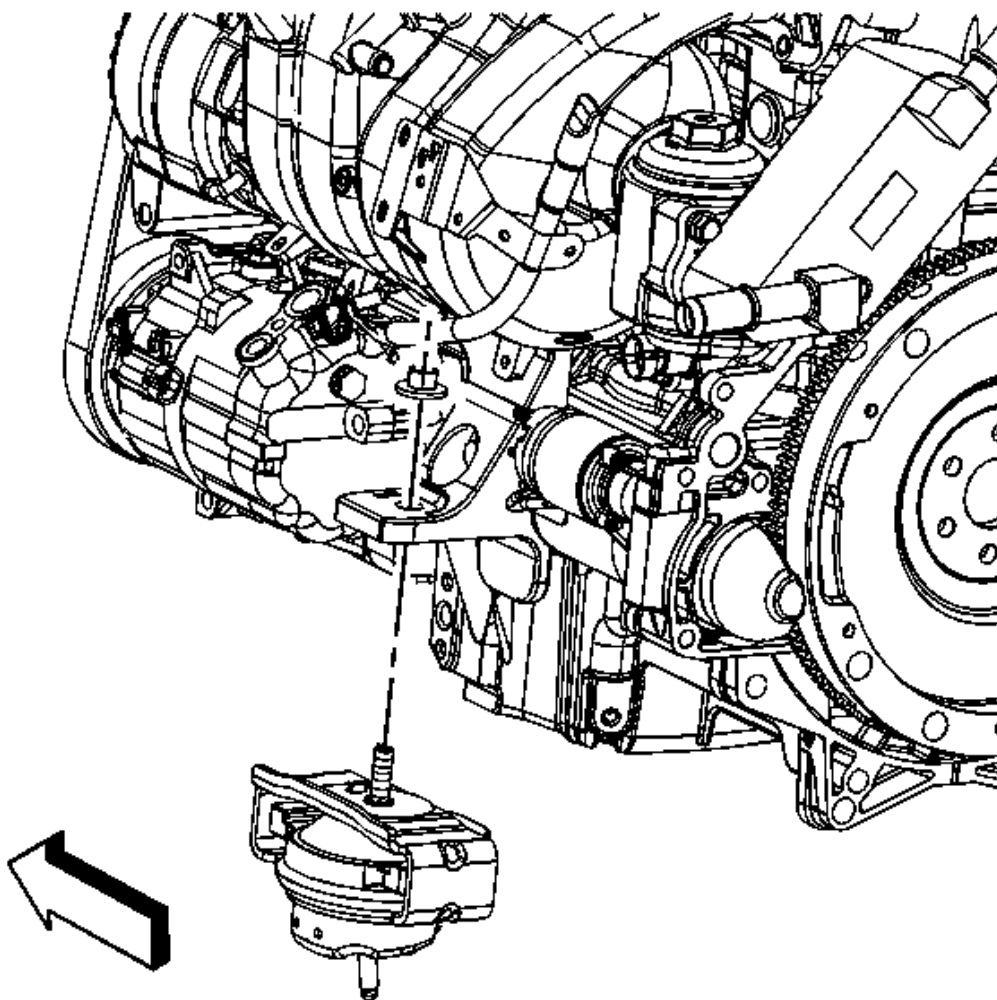


Fig. 253: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

75. Remove the left engine mount upper nut.

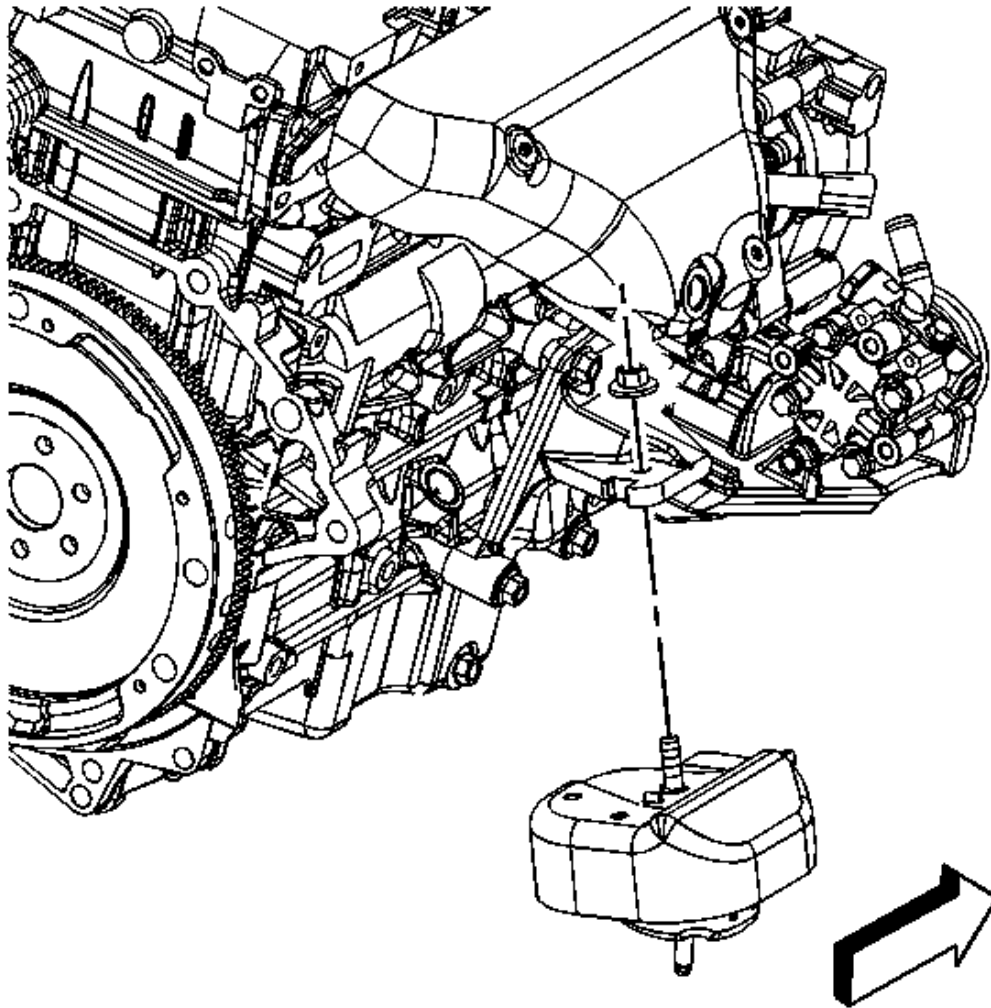


Fig. 254: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

76. Remove the right engine mount upper nut.
77. Install the **J 42451-1** to the engine.
78. Install a suitable engine lifting device to the engine.
79. Remove the engine from the vehicle.
80. Remove the clutch pressure plate and disc. Refer to **Clutch Pressure and Driven Plate Replacement** .

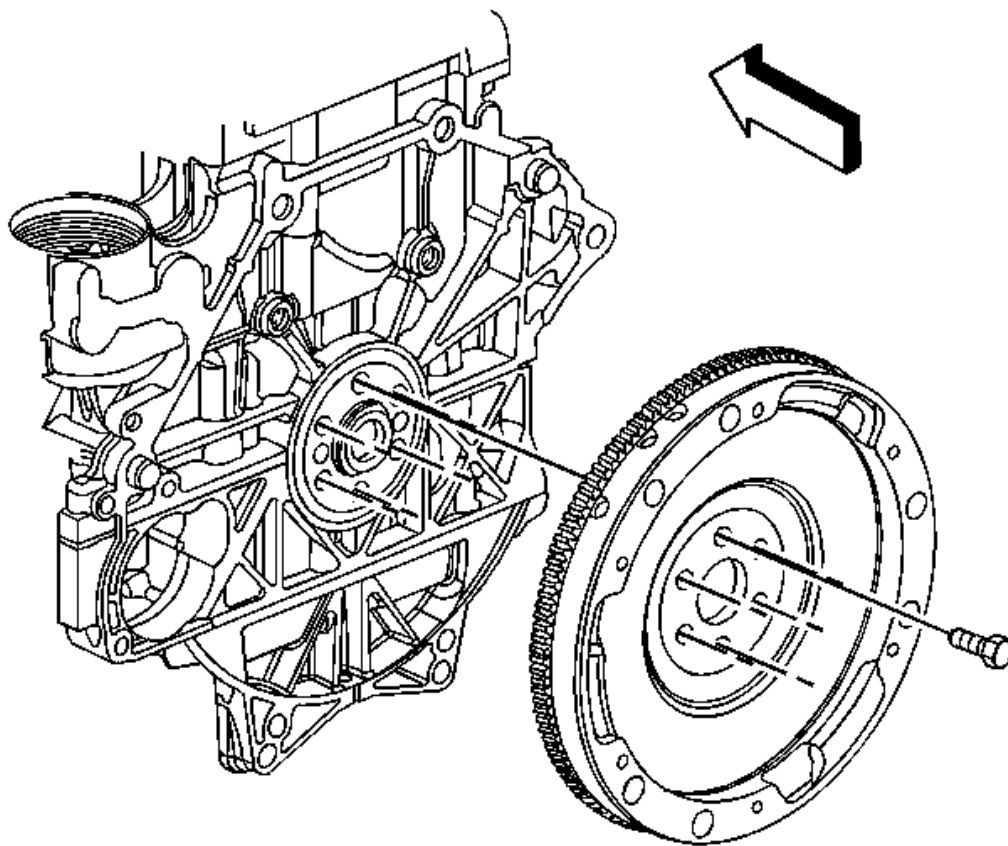


Fig. 255: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

81. Remove the flywheel bolts and flywheel.
82. Install the engine to an engine stand.

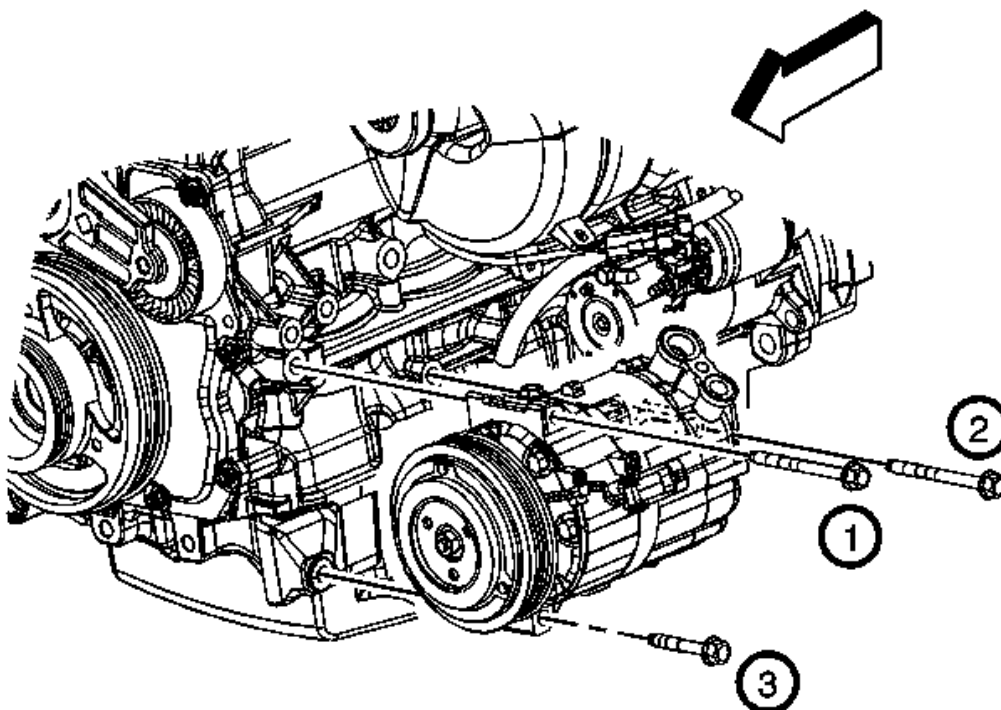


Fig. 256: Identifying A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

83. Remove the A/C compressor bolt and compressor.

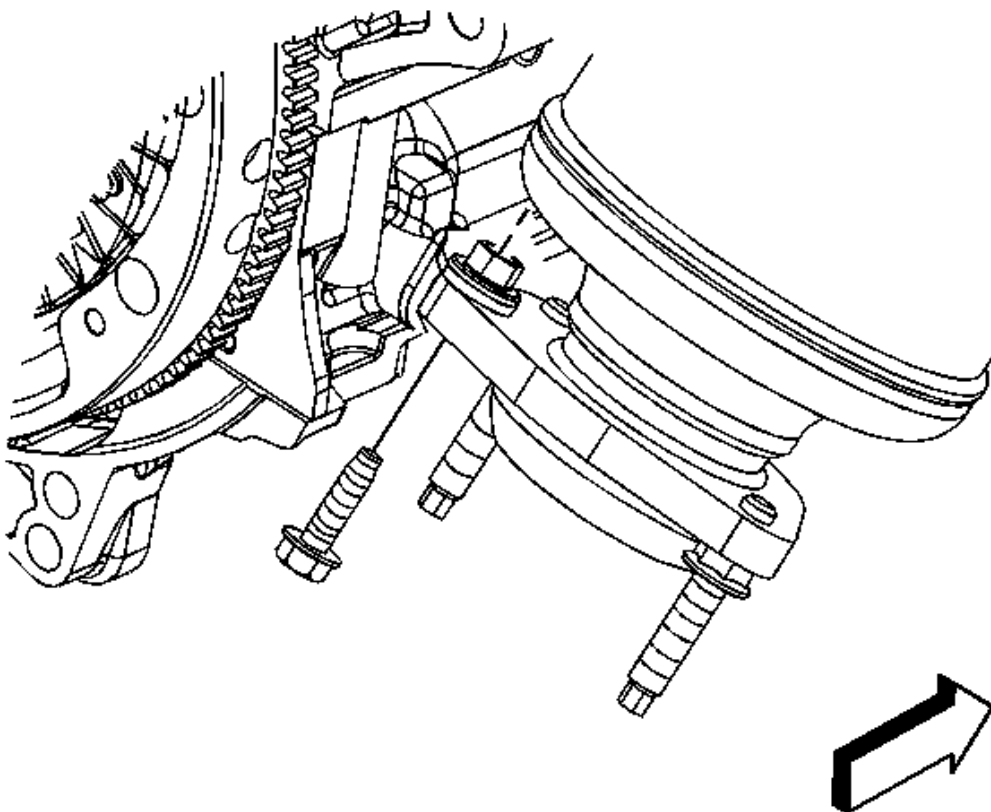


Fig. 257: View Of Catalytic Converter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

84. Remove the catalytic converter to bracket bolt.

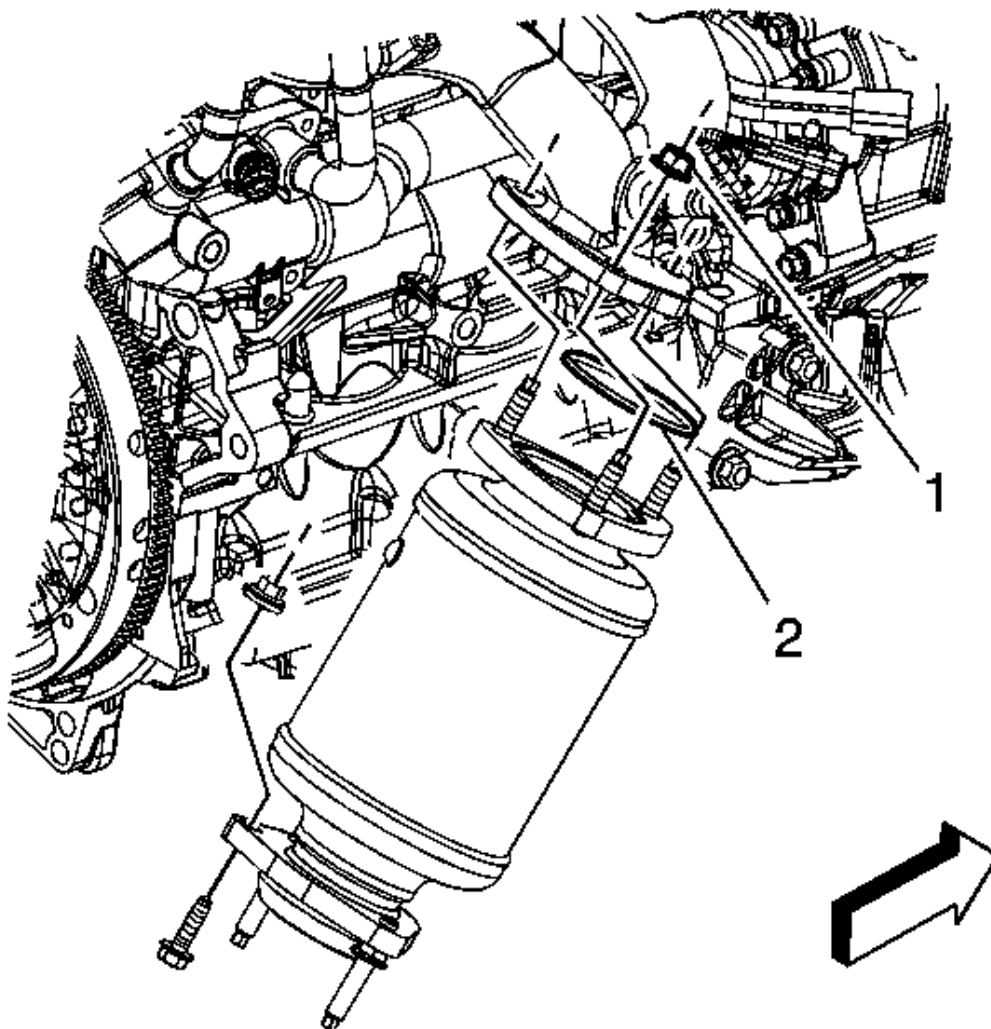


Fig. 258: View Of Catalytic Converter, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

85. Remove the catalytic converter nuts (1).
86. Remove the catalytic converter gasket (2) and converter from the engine.

INSTALLATION PROCEDURE

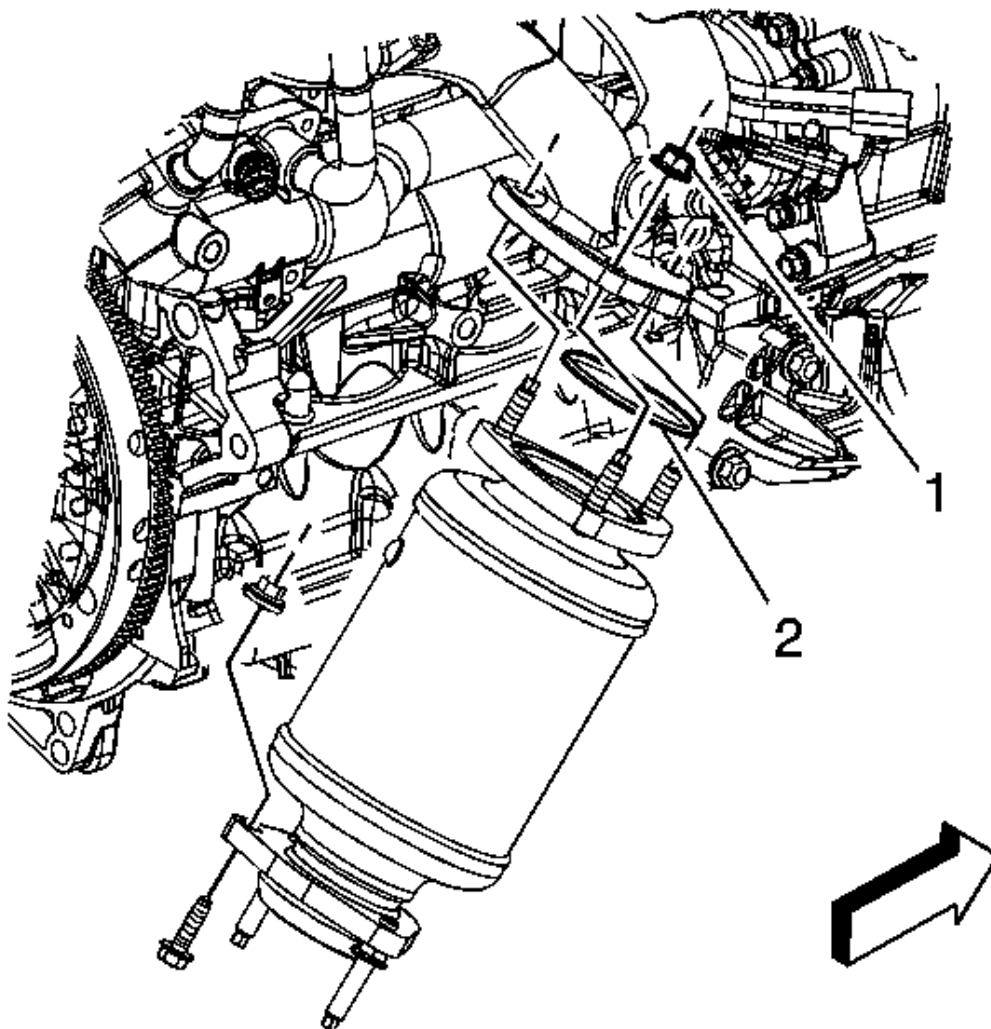


Fig. 259: View Of Catalytic Converter, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the catalytic converter gasket (2) and converter to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the catalytic converter nuts (1).

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

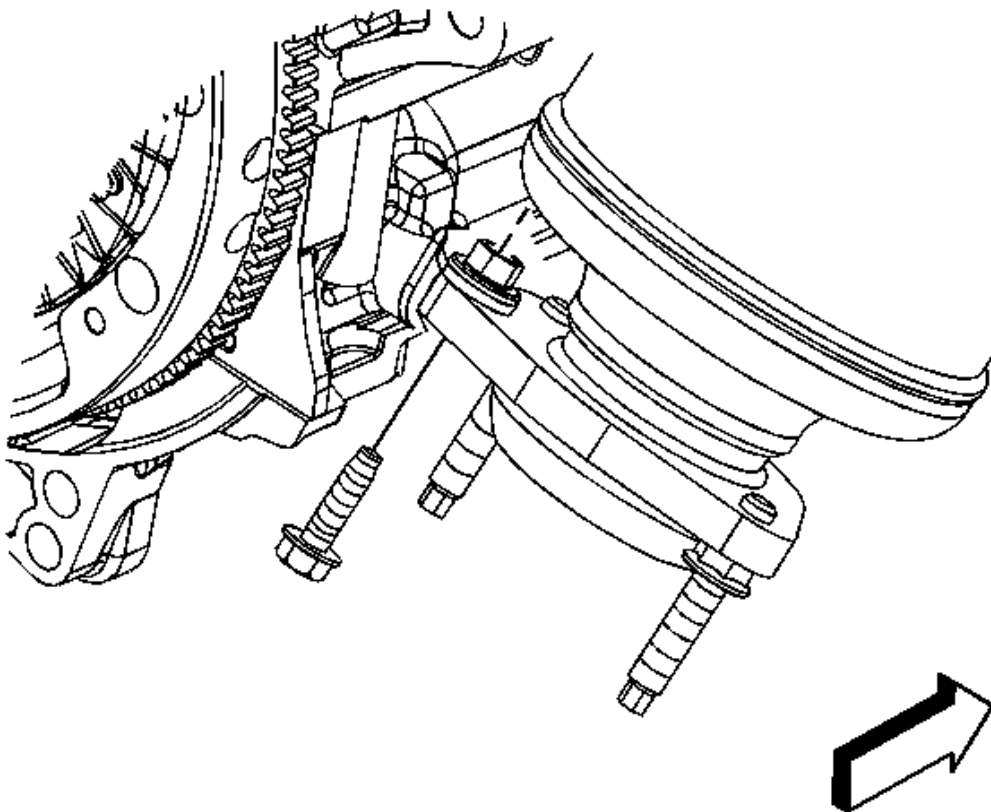


Fig. 260: View Of Catalytic Converter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the catalytic converter to bracket bolt.

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

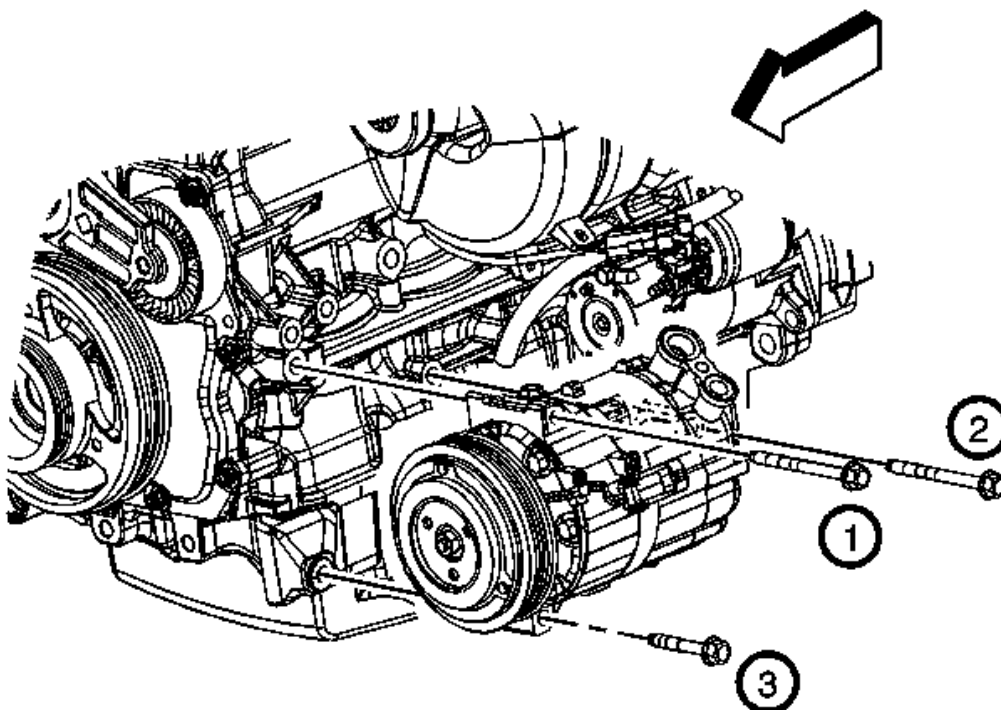


Fig. 261: Identifying A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the A/C compressor and bolts.

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

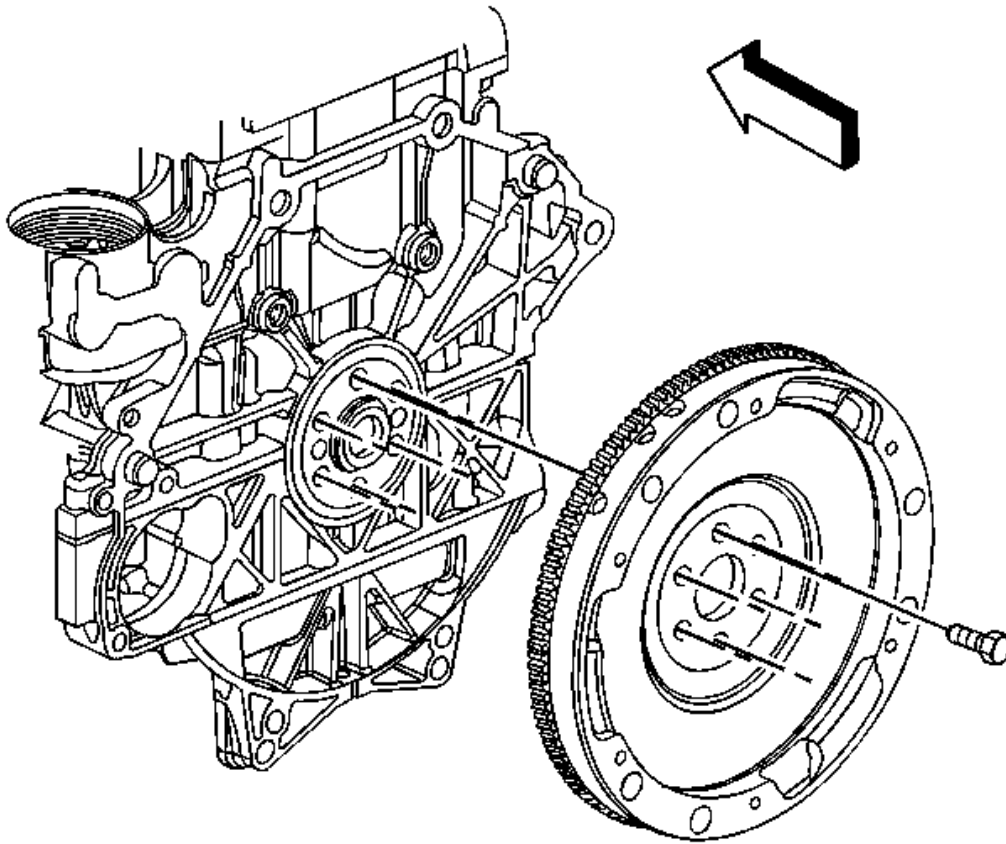


Fig. 262: View Of Flywheel & Bolt (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

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

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

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

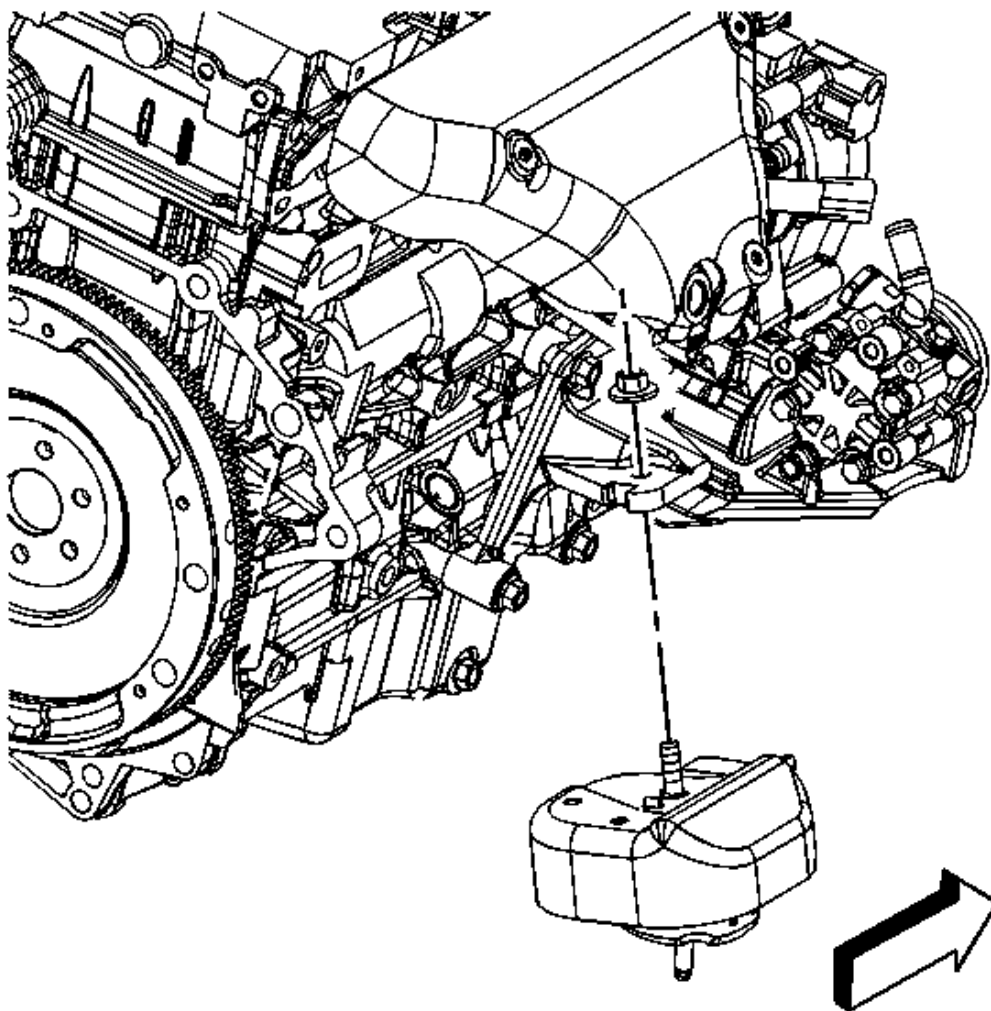


Fig. 263: View Of Right Engine Mount Upper Nut
 Courtesy of GENERAL MOTORS CORP.

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

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

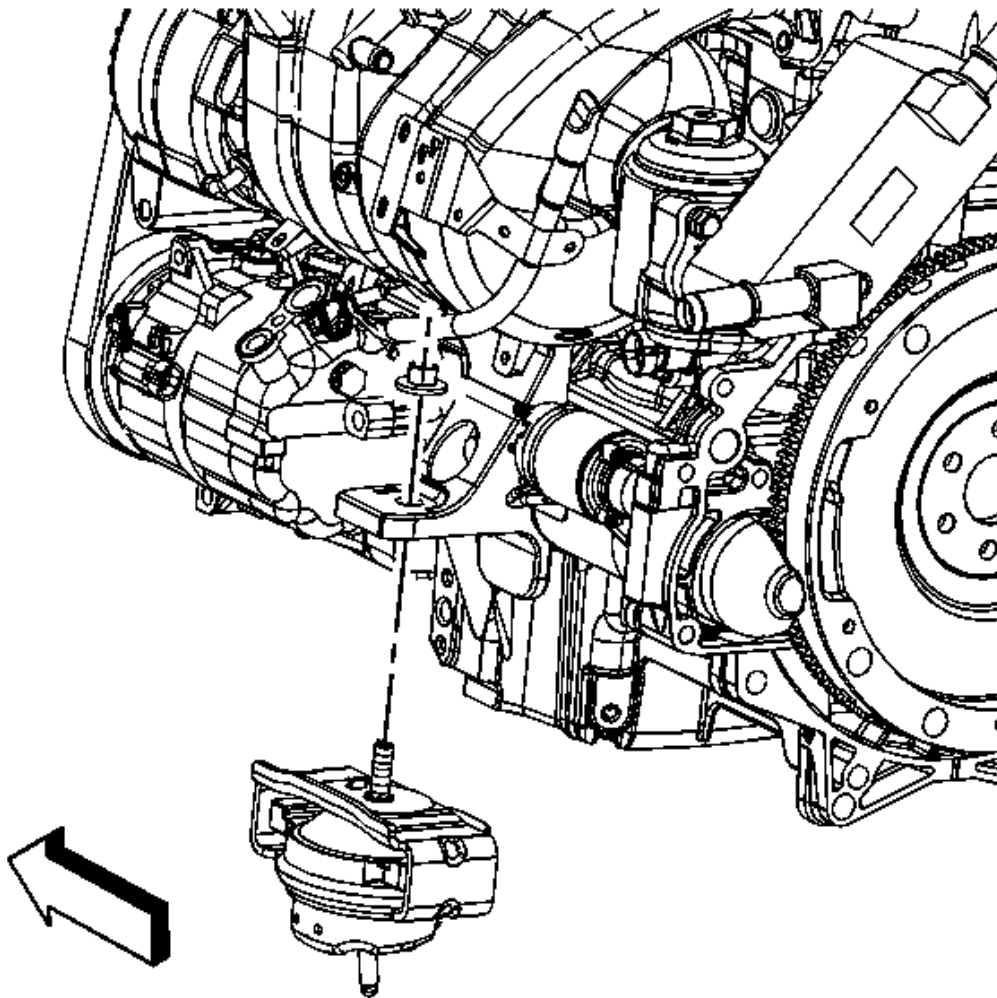


Fig. 264: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

12. Install the left engine mount upper nut.

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

13. Remove the **J 42451-1** from the engine.
14. Raise and support the vehicle.

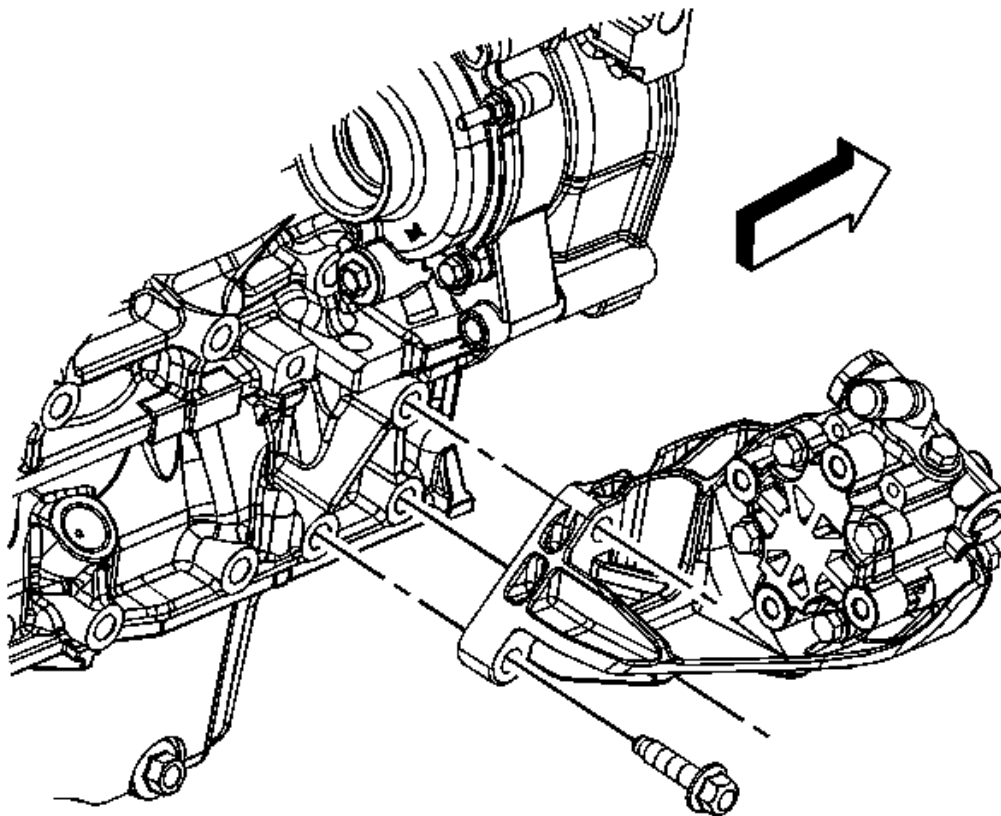


Fig. 265: View Of Power Steering Pump, Bracket & Bolts
 Courtesy of GENERAL MOTORS CORP.

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

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

16. Lower the vehicle.

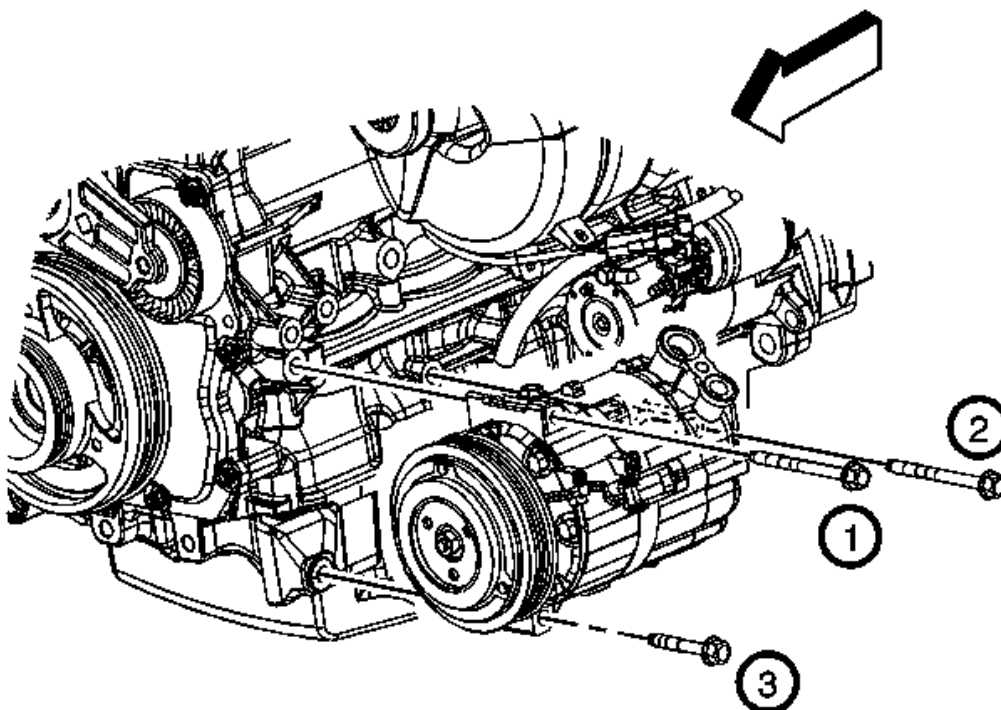


Fig. 266: Identifying A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

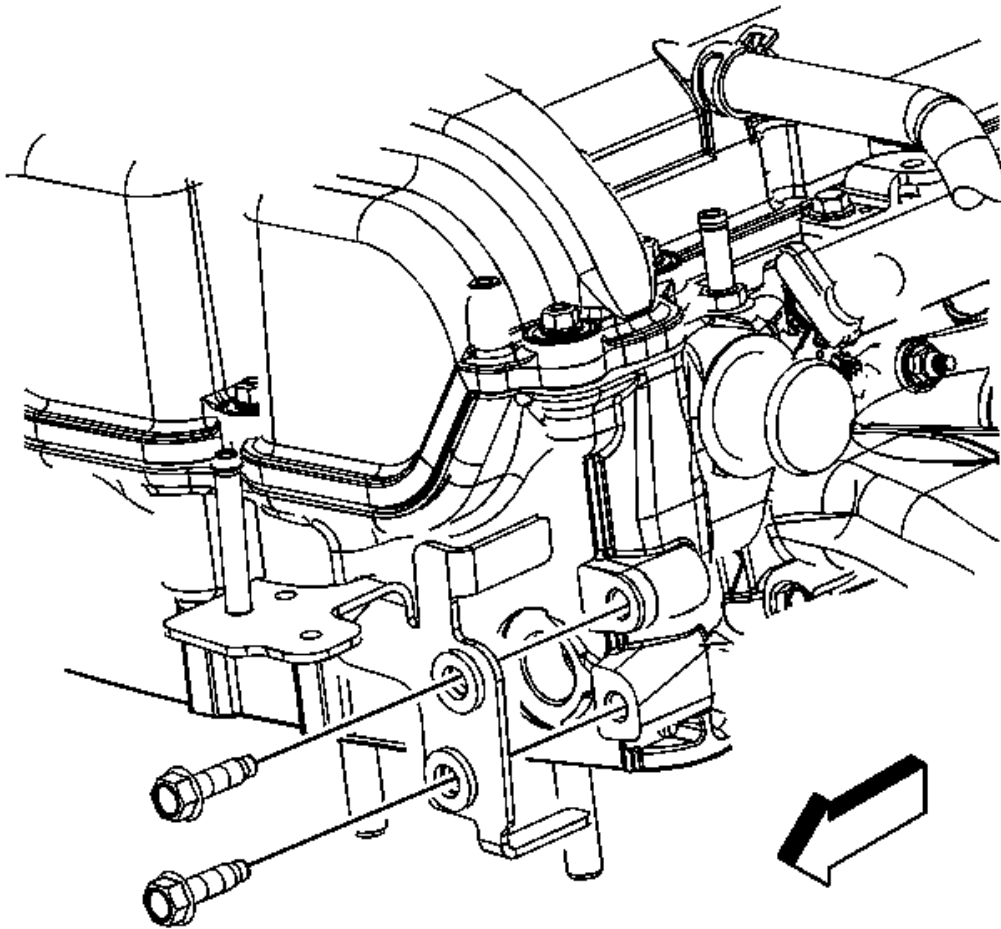


Fig. 267: View Of Intake Manifold Cover Bracket & Bolts
 Courtesy of GENERAL MOTORS CORP.

18. Install the intake manifold cover bracket and bolts.

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

19. Position the branches of the engine harness to the engine.

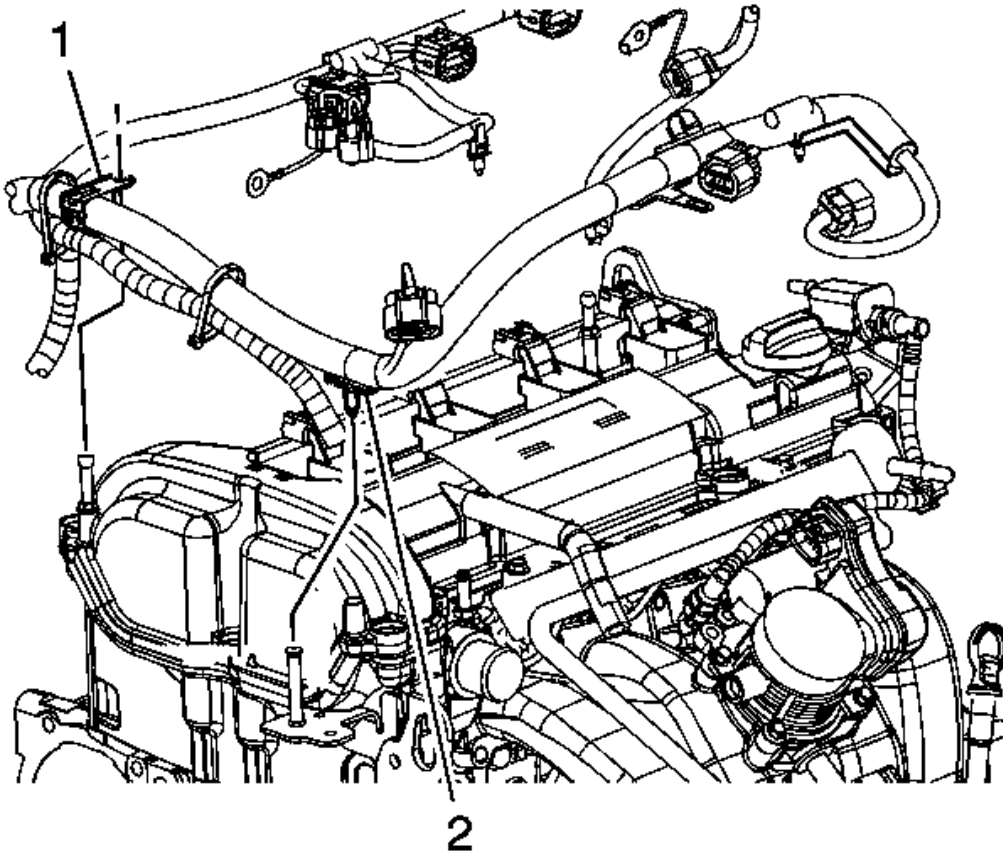


Fig. 268: Identifying Engine Harness Bracket
 Courtesy of GENERAL MOTORS CORP.

20. Connect the engine harness clip (2) to the bracket.
21. Install the engine harness bracket (1) to the intake manifold cover stud.
22. Install the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

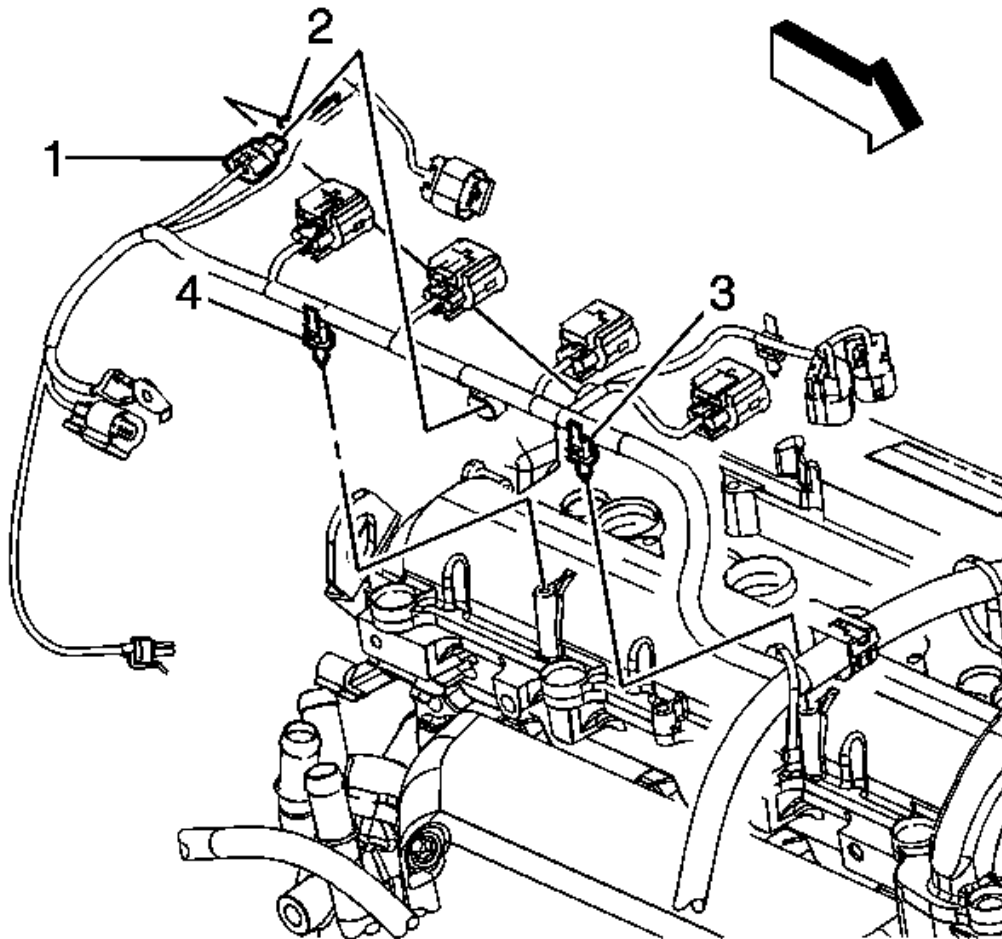


Fig. 269: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS CORP.

23. Connect the engine harness clips (3, 4) to the camshaft cover.
24. Connect the engine harness clip (2) to the EVAP canister purge solenoid valve bracket.
25. Connect the engine wiring harness electrical connector (1) to the EVAP canister purge solenoid.

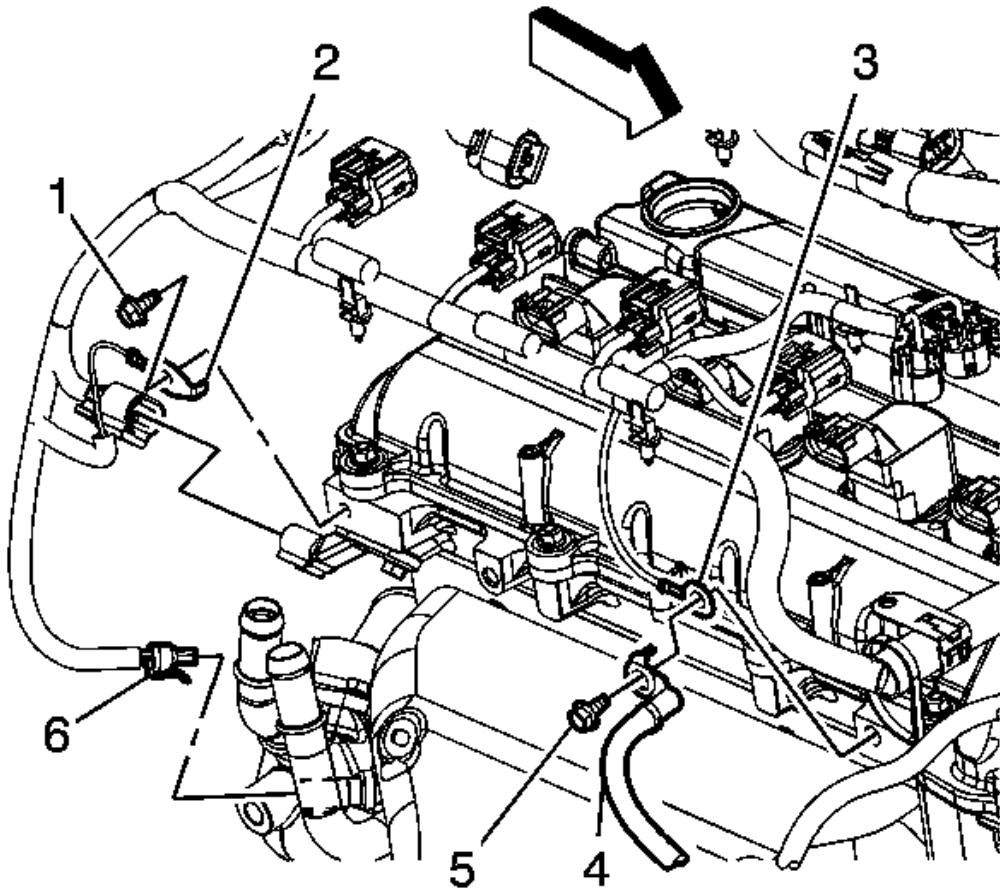


Fig. 270: View Of CMP Sensor & ECT Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

26. Connect the engine wiring harness electrical connector (6) to the ECT sensor.
27. Position the engine wiring harness ground terminal (2) and install the bolt (1).

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

28. Connect the engine wiring harness electrical connector to the exhaust CMP sensor.

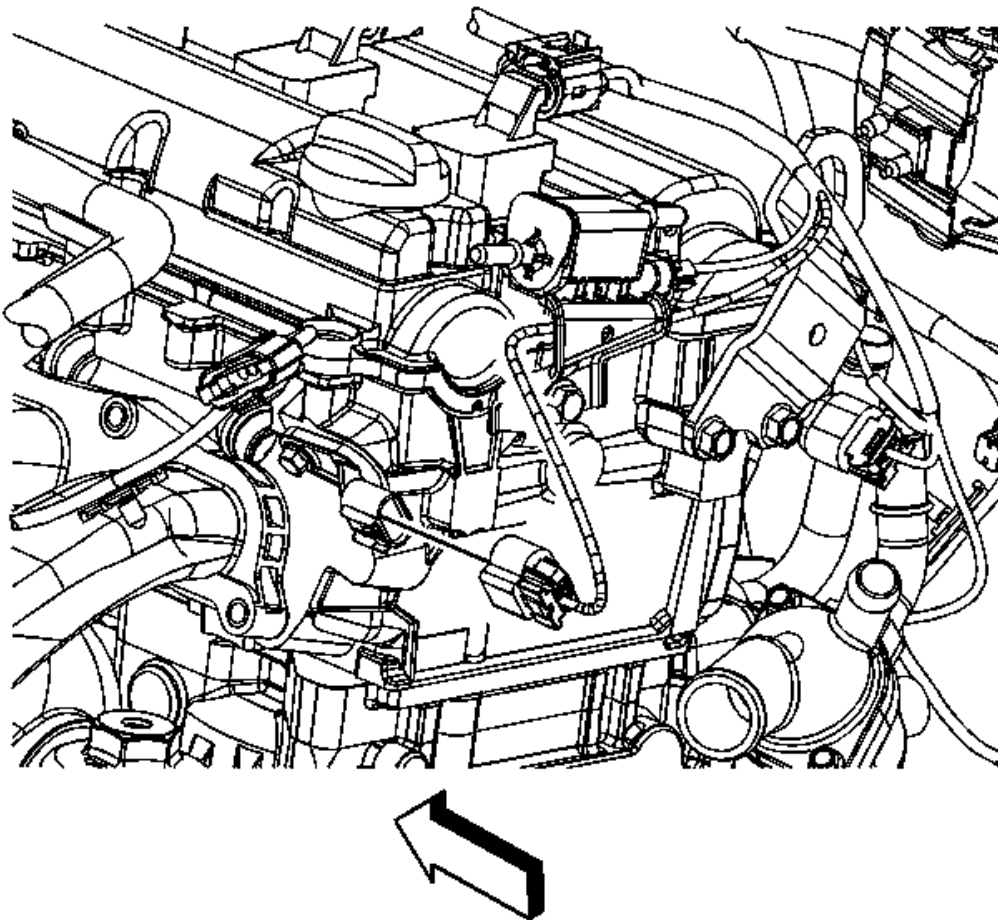


Fig. 271: View Of Intake CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

29. Connect the engine wiring harness electrical connector to the intake CMP sensor.

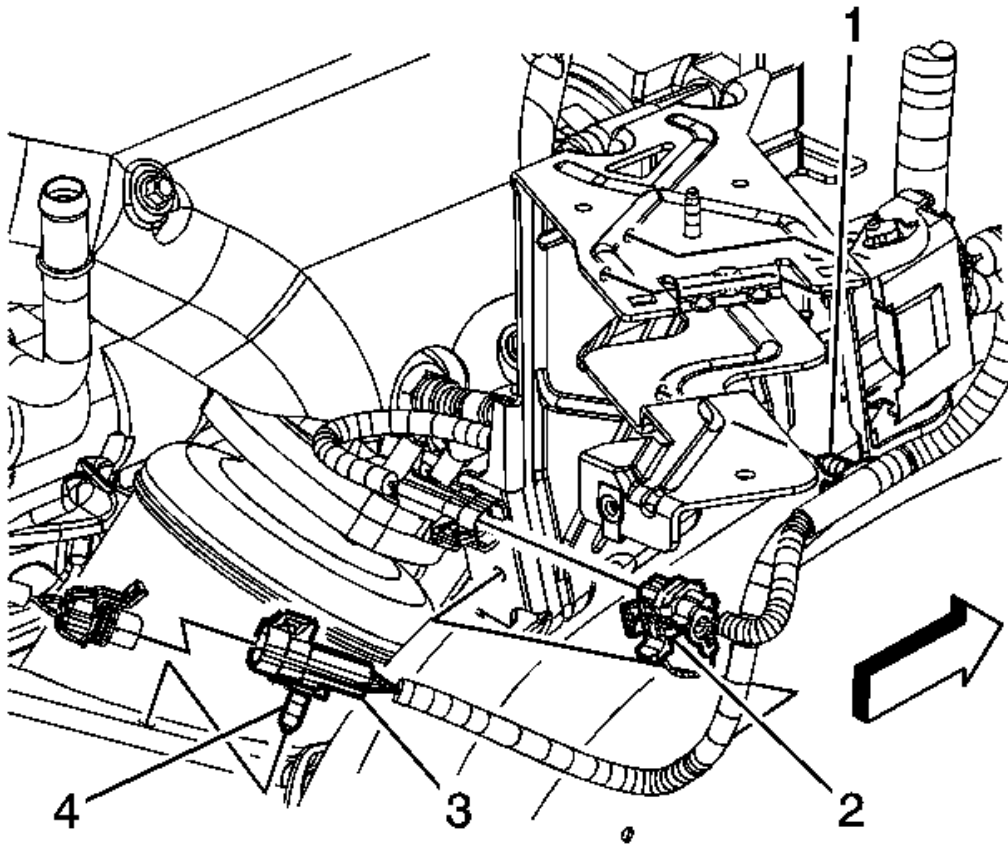


Fig. 272: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

30. Connect the HO2S electrical connector clip (4) to the strut.
31. Connect the engine harness clips (1) to the junction block bracket.
32. Connect the engine wiring harness electrical connector (2) to the rear HO2S.
33. Connect the engine wiring harness electrical connector (1) to the front HO2S.
34. Install the CPA retainers to the HO2S electrical connectors.

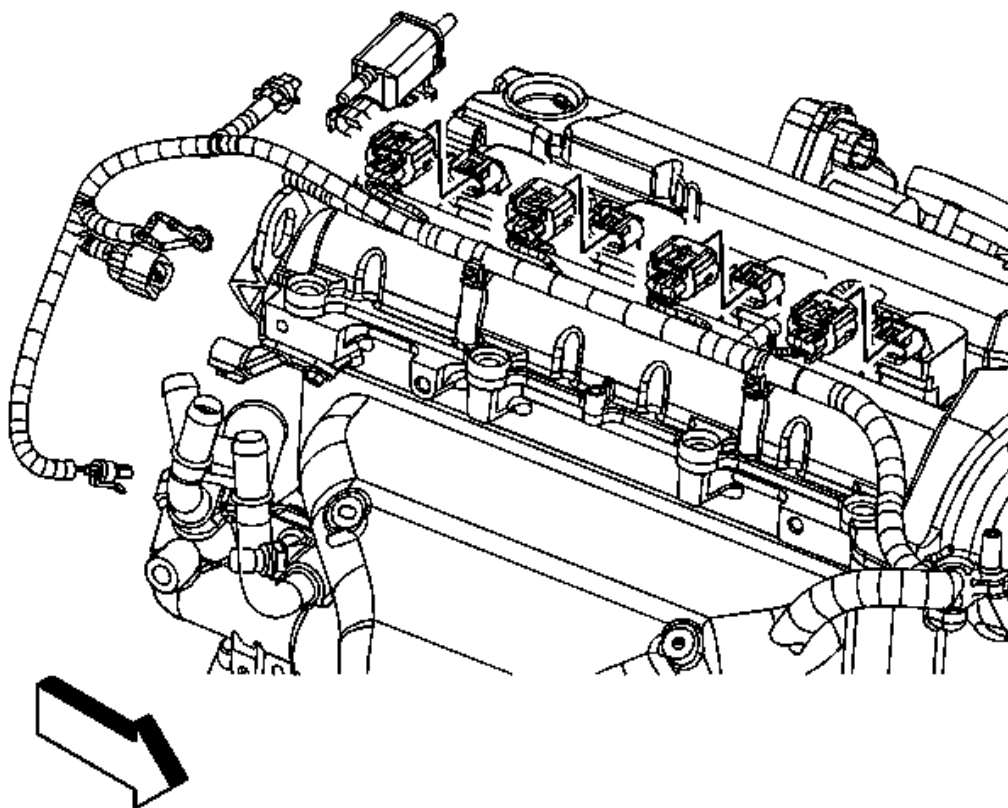


Fig. 273: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

35. Connect the engine wiring harness electrical connectors to the ignition coils.

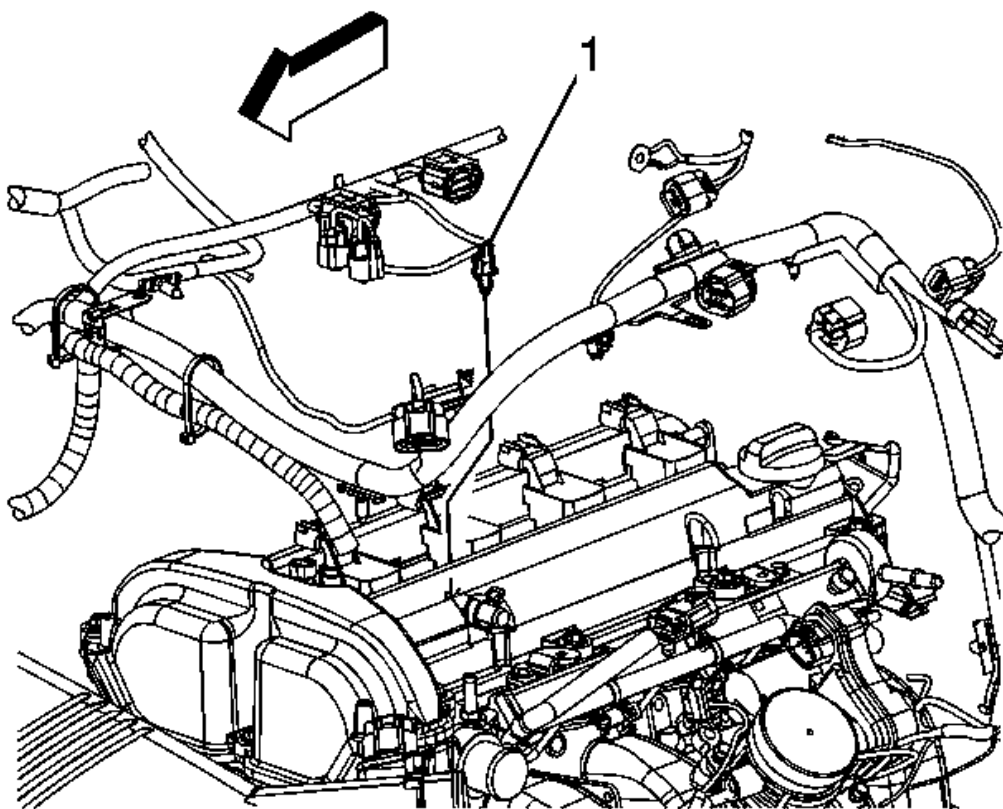


Fig. 274: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

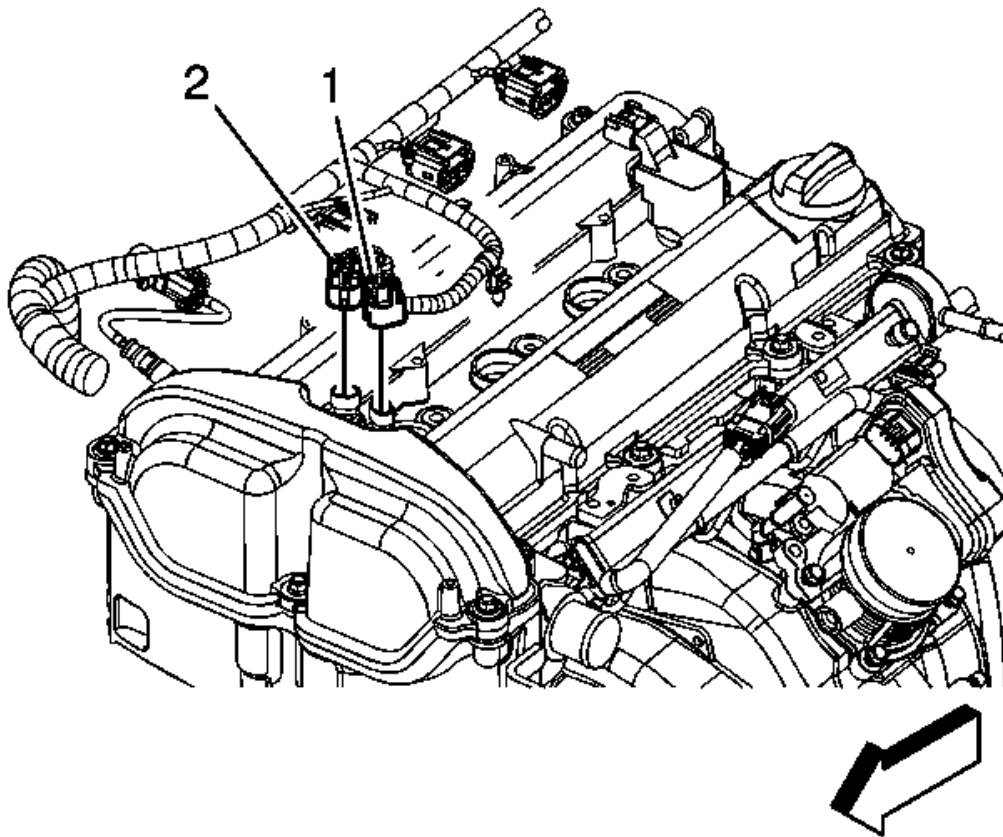


Fig. 275: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

37. Connect the engine wiring harness electrical connector (2) to the exhaust CMP actuator.
38. Connect the engine wiring harness electrical connector (1) to the intake CMP actuator.

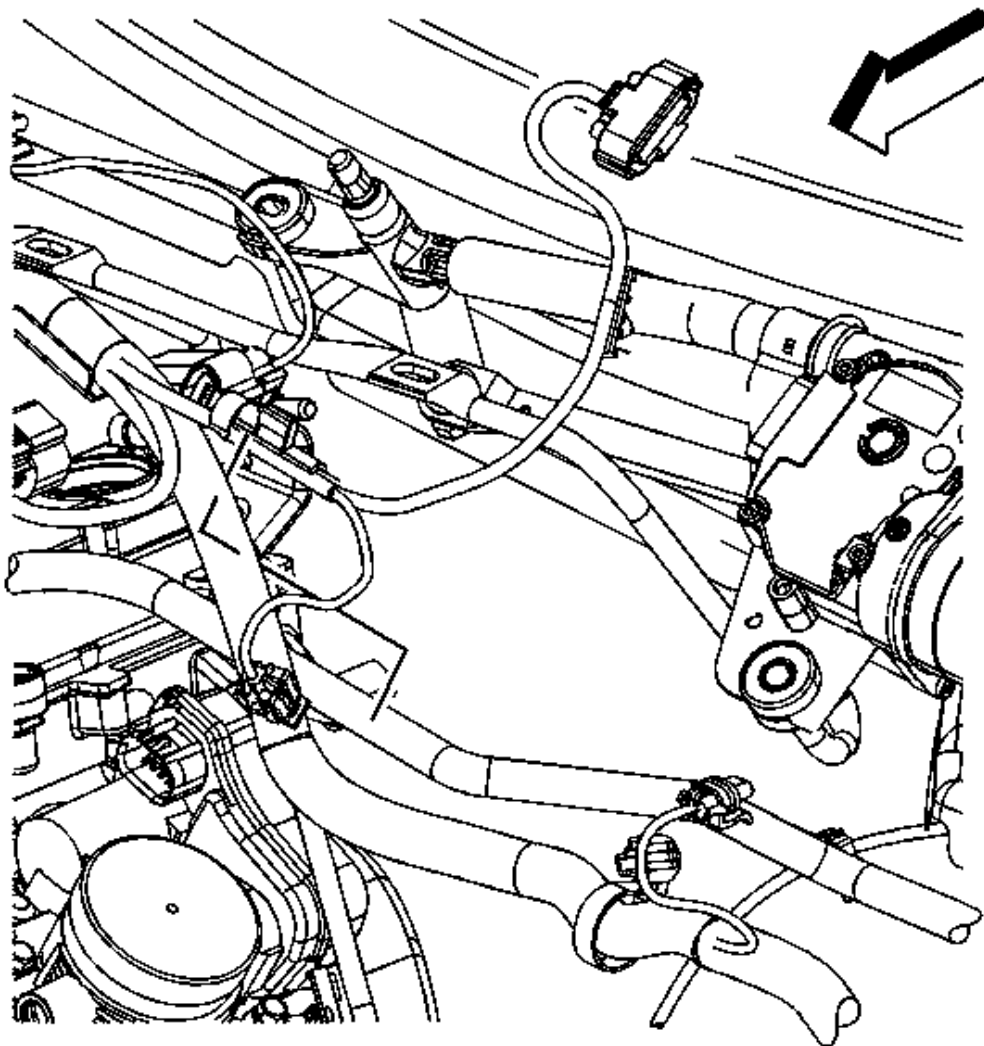


Fig. 276: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

39. Install the engine harness clip to the surge tank air bleed hose.

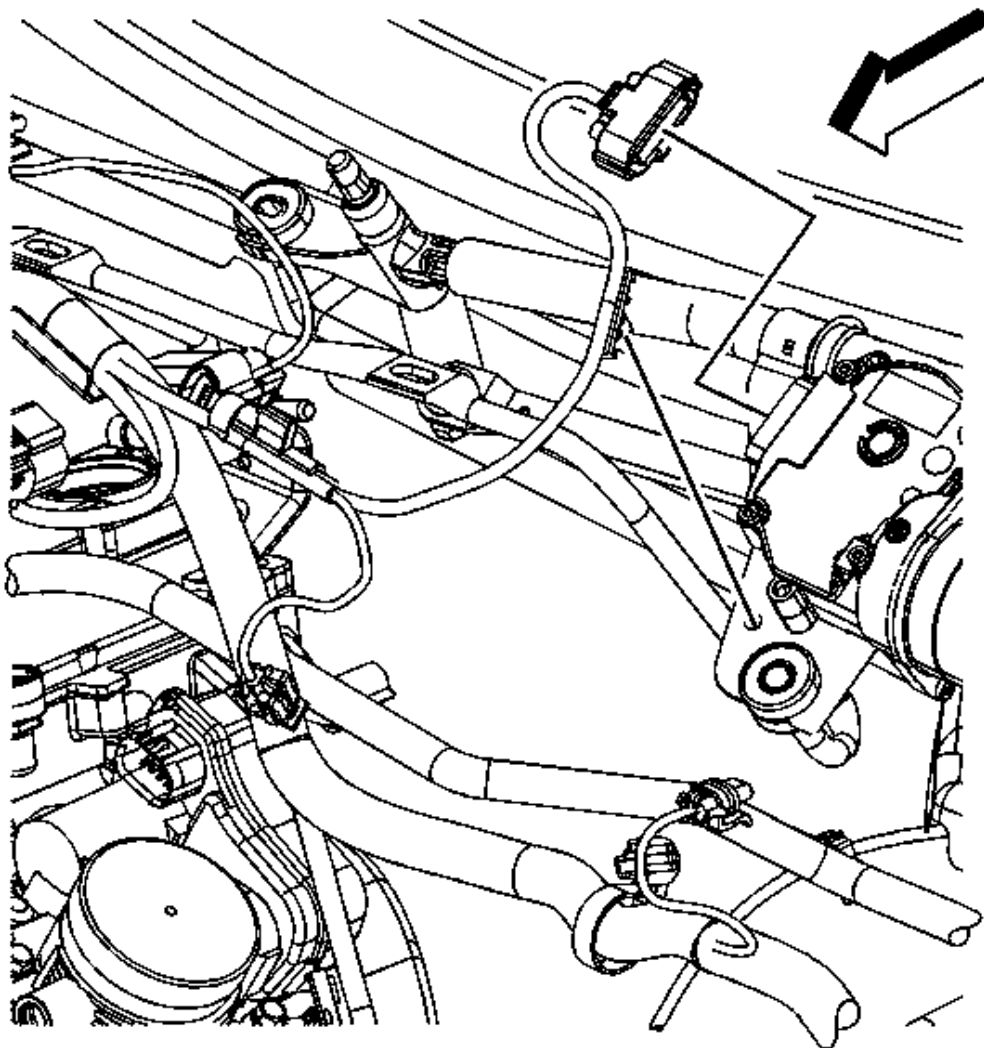


Fig. 277: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

40. Connect the engine wiring harness electrical connector to the windshield wiper motor.
41. Install the engine harness clip to the wiper motor hole.

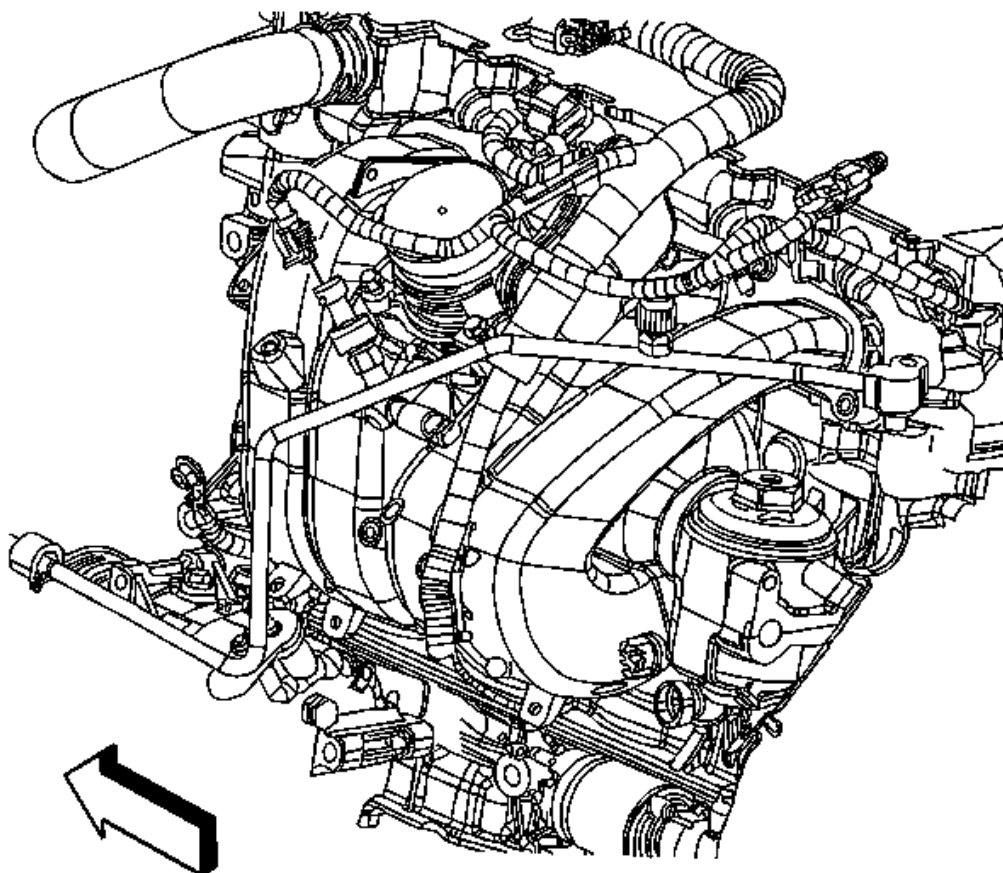


Fig. 278: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

42. Connect the engine wiring harness electrical connector to the A/C refrigerant pressure sensor.

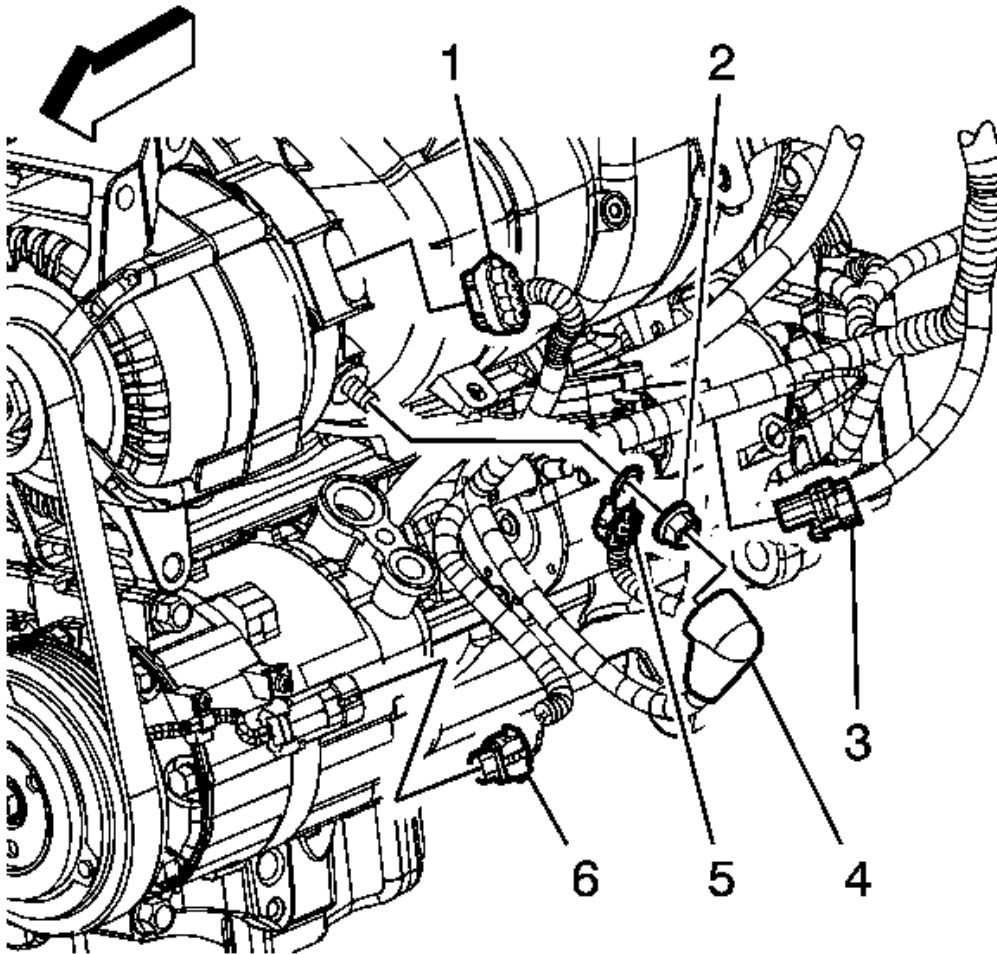


Fig. 279: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

43. Position the negative/positive battery cable.
44. Connect the engine wiring harness electrical connector (6) to the A/C compressor.
45. Install the positive battery cable terminal to the generator (5).
46. Install the generator terminal nut (2).

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

47. Position the positive battery cable terminal boot (4).
48. Connect the engine wiring harness electrical connector (1) to the generator.

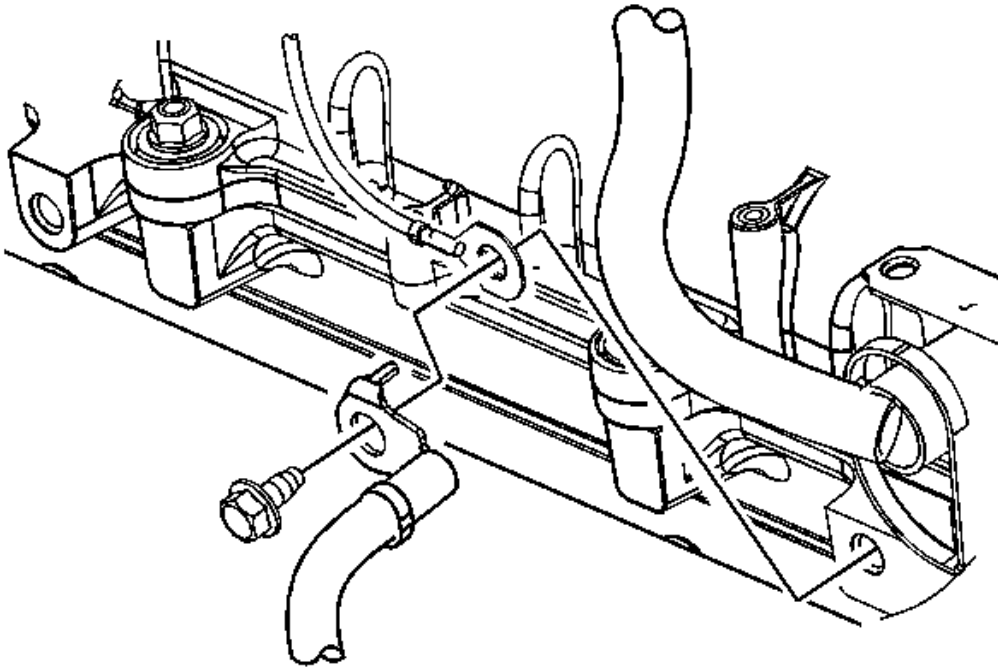


Fig. 280: View Of Negative Battery Cable Ground Bolt
Courtesy of GENERAL MOTORS CORP.

49. Position the engine harness ground terminal behind the negative battery cable terminal and position against the cylinder head.
50. Install the negative battery cable ground terminal bolt.

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

51. Install NEW tie straps to the engine harness.
52. Install the positive battery cable clip to the bracket.
53. Raise and support the vehicle.

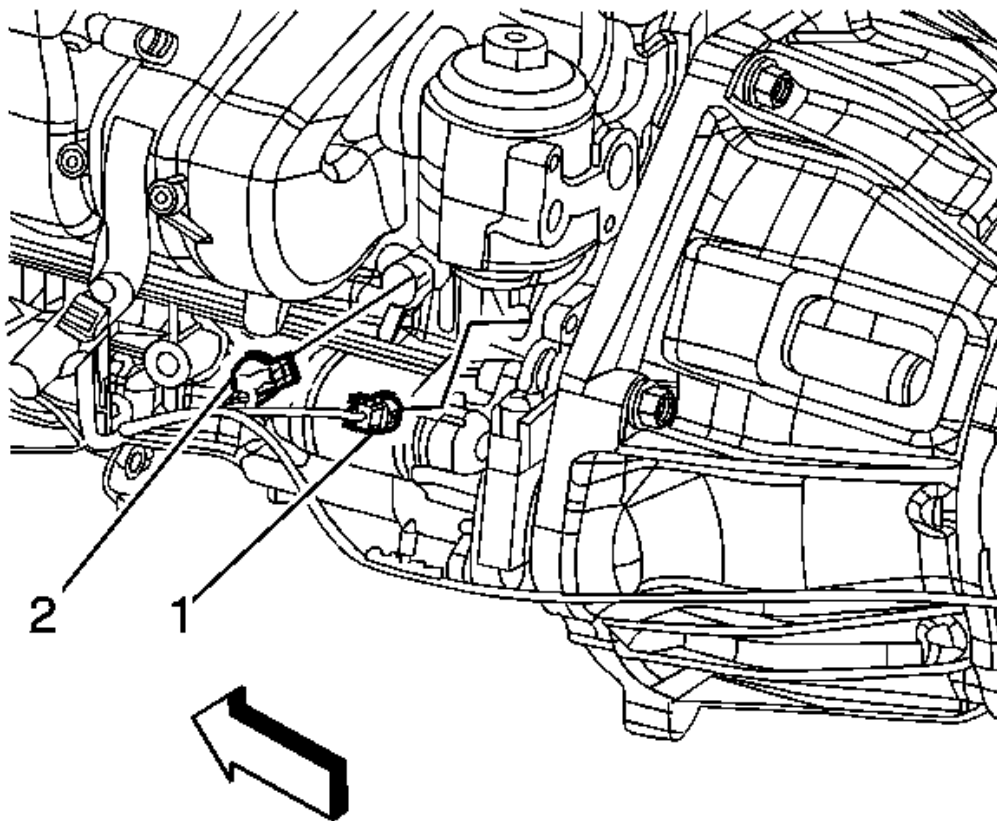


Fig. 281: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

54. Connect the engine wiring harness electrical connector (2) to the oil pressure sensor.
55. Connect the engine wiring harness electrical connector (1) to the CKP sensor.
56. Lower the vehicle.

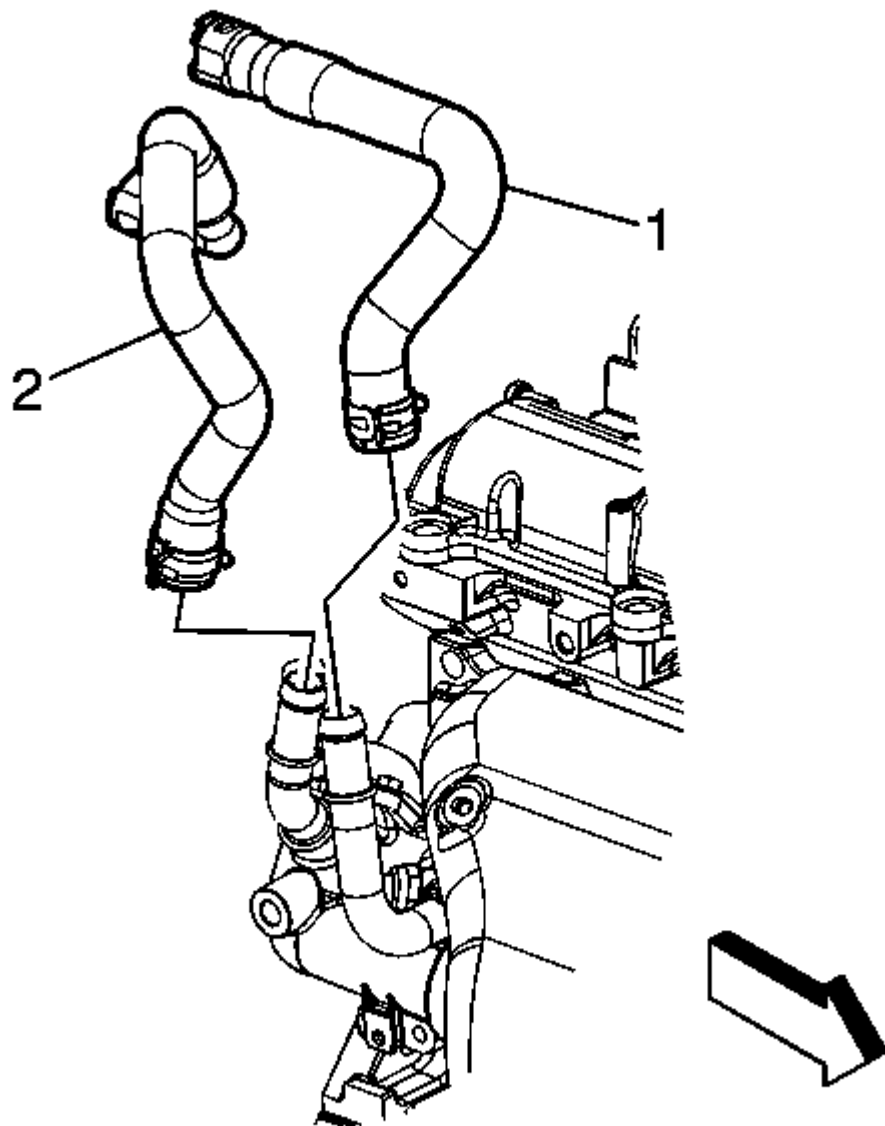


Fig. 282: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS CORP.

57. Install the heater inlet (2) and outlet (1) hoses to the thermostat housing.
58. Position the heater inlet and outlet hose clamps at the thermostat housing.

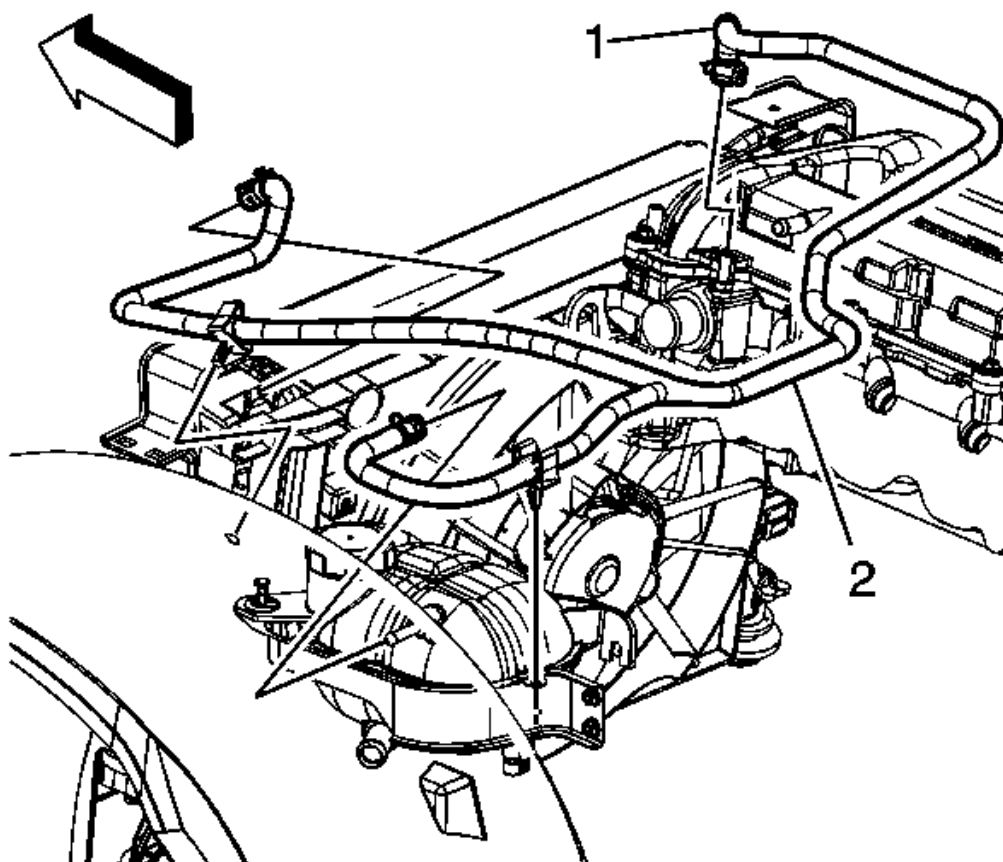


Fig. 283: Identifying Air Bleed Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

59. Position the air bleed hose (2).
60. Install the surge tank air bleed hose (1) to the engine.
61. Position the surge tank air bleed hose clamp at the engine.

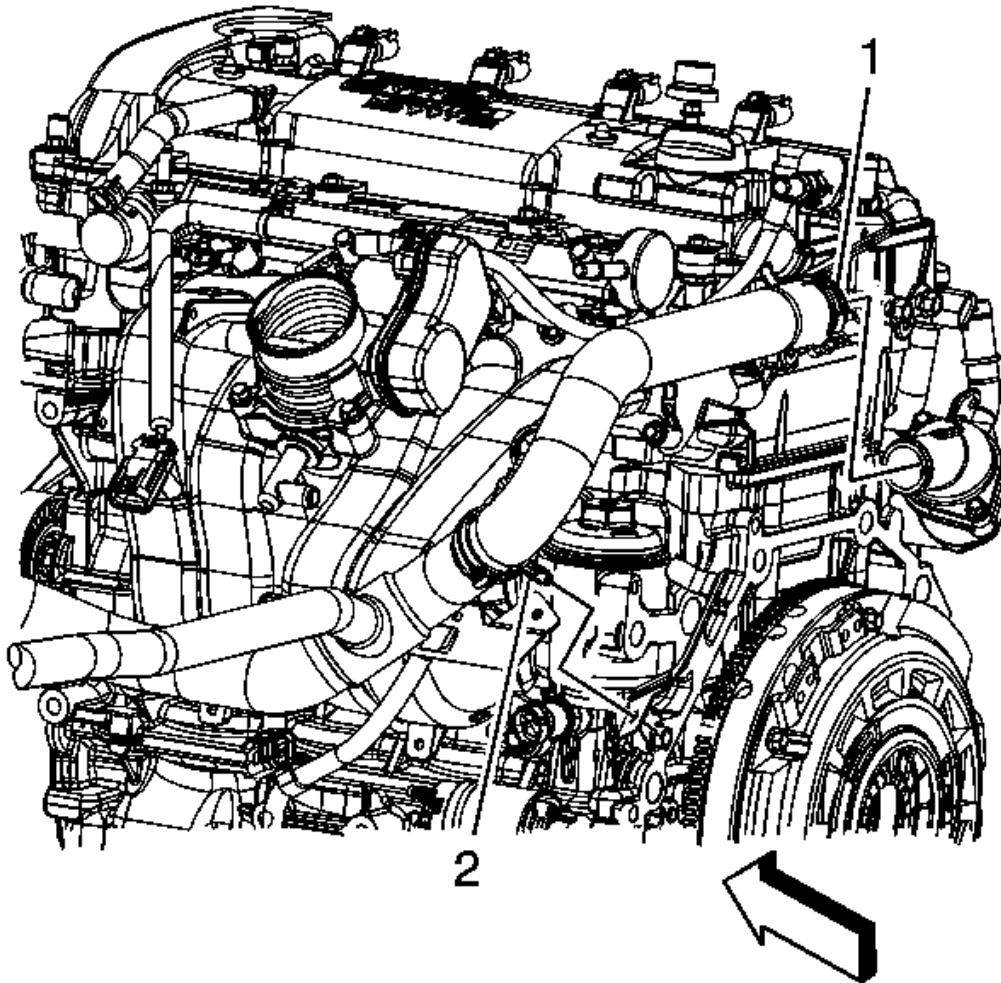


Fig. 284: Identifying Radiator Outlet Hose Clip
Courtesy of GENERAL MOTORS CORP.

62. If the vehicle is not equipped with a engine oil cooler perform the following steps, otherwise proceed to step 66.
63. Install the radiator outlet hose to the thermostat housing.
64. Reposition the radiator outlet hose clamp at the thermostat housing.
65. Install the radiator outlet hose clip (1) to the outlet hose bracket. Proceed to step 71.

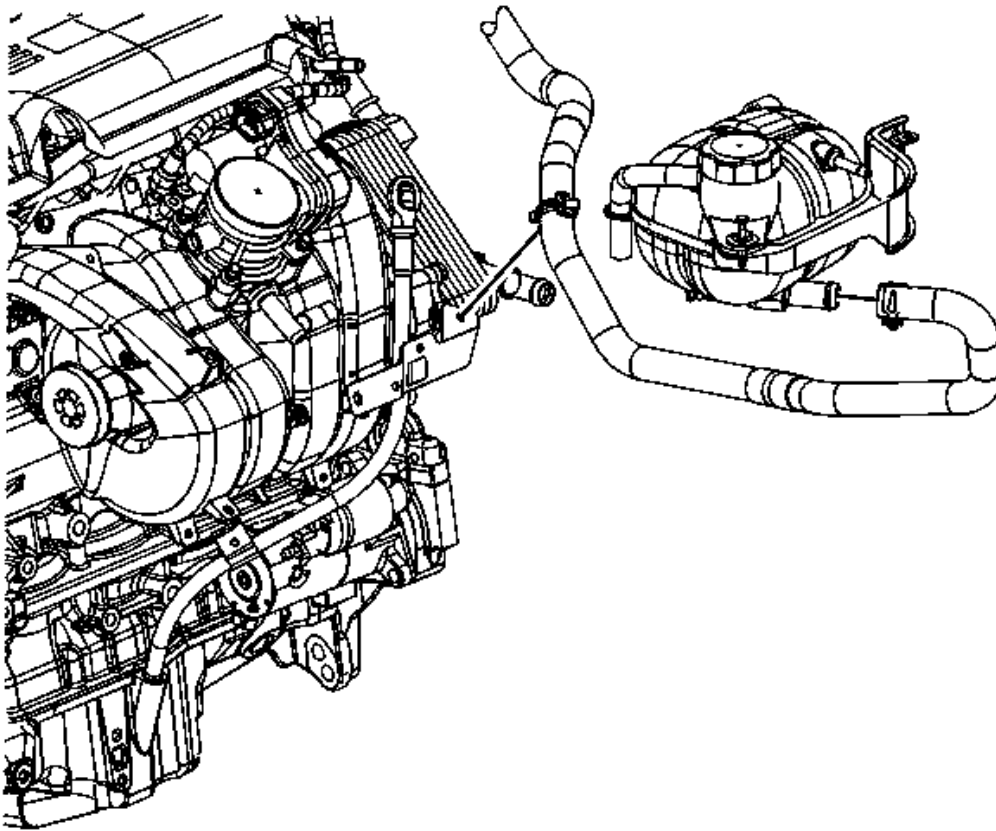


Fig. 285: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

66. If the vehicle is equipped with a engine oil cooler, install the surge tank outlet hose.
67. Install the surge tank clip to the oil level indicator tube bracket.
68. Position the surge tank outlet hose clamp at the surge tank.

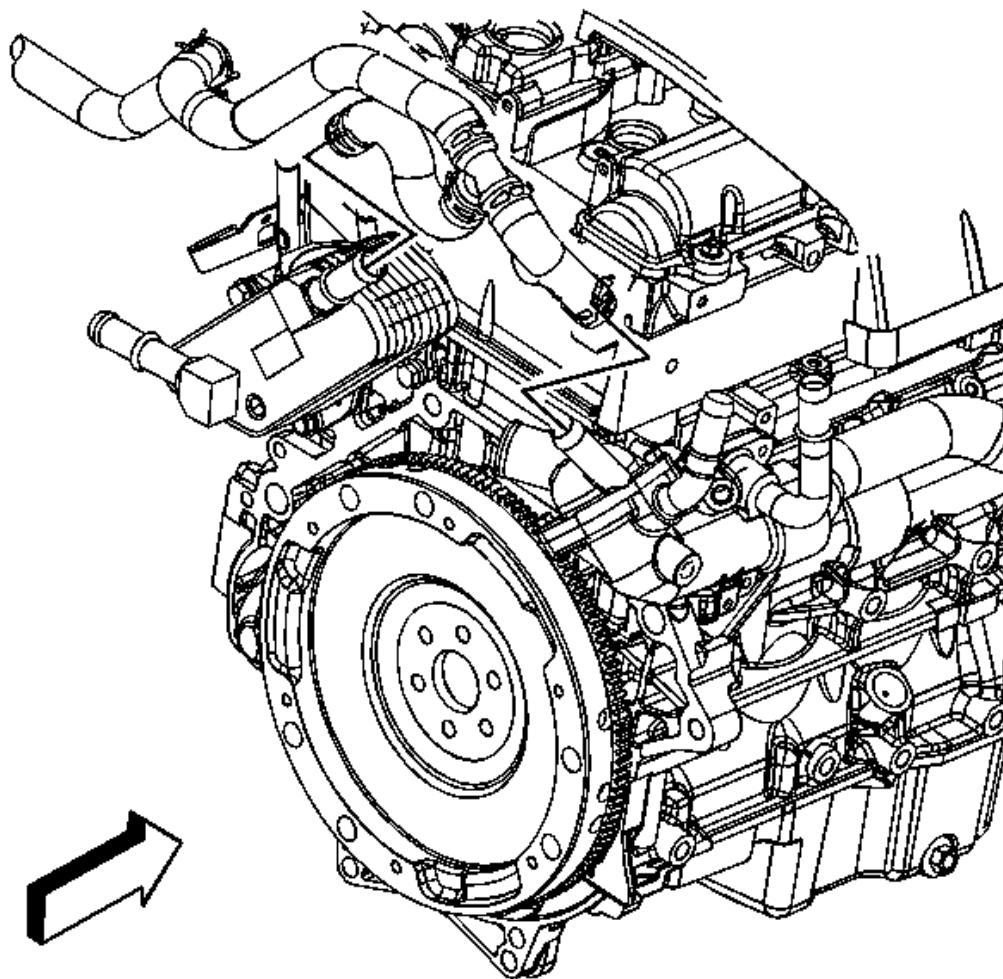


Fig. 286: View Of Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

69. Install the surge tank outlet hose to the thermostat housing and oil cooler.
70. Position the surge tank outlet hose clamps at the thermostat housing and oil cooler.

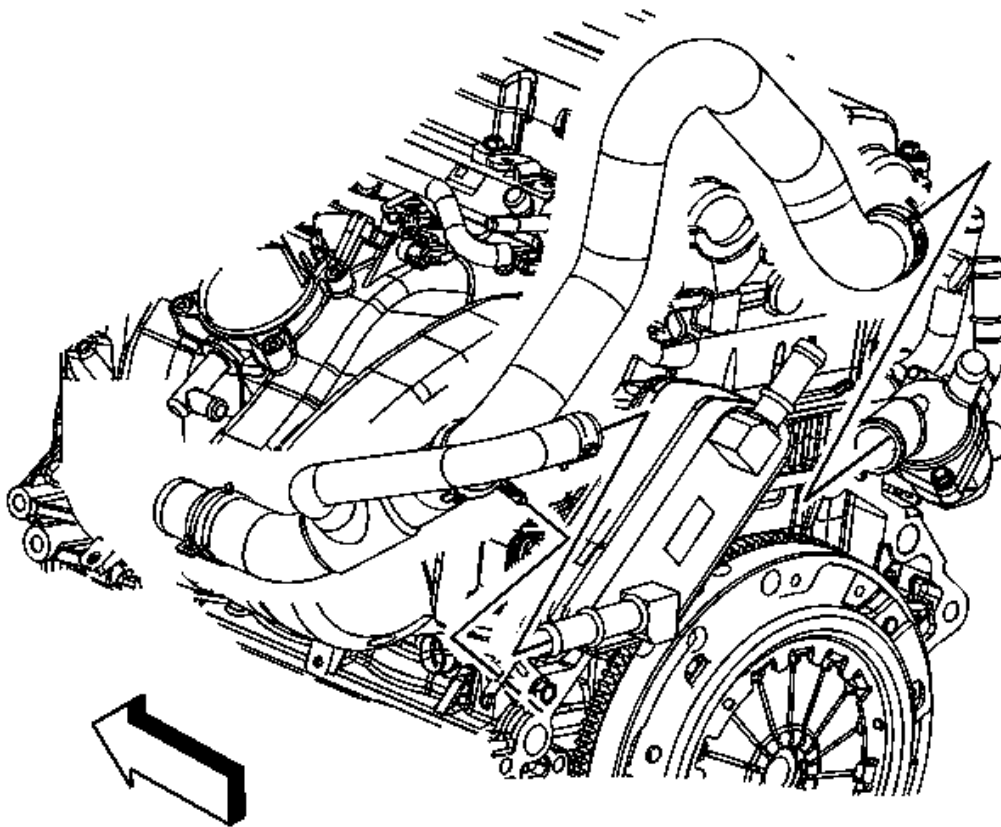


Fig. 287: View Of Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

71. Position the outlet hose.
72. Install the radiator outlet hose to the thermostat housing and oil cooler.
73. Position the radiator outlet hose clamps at the thermostat housing and oil cooler.

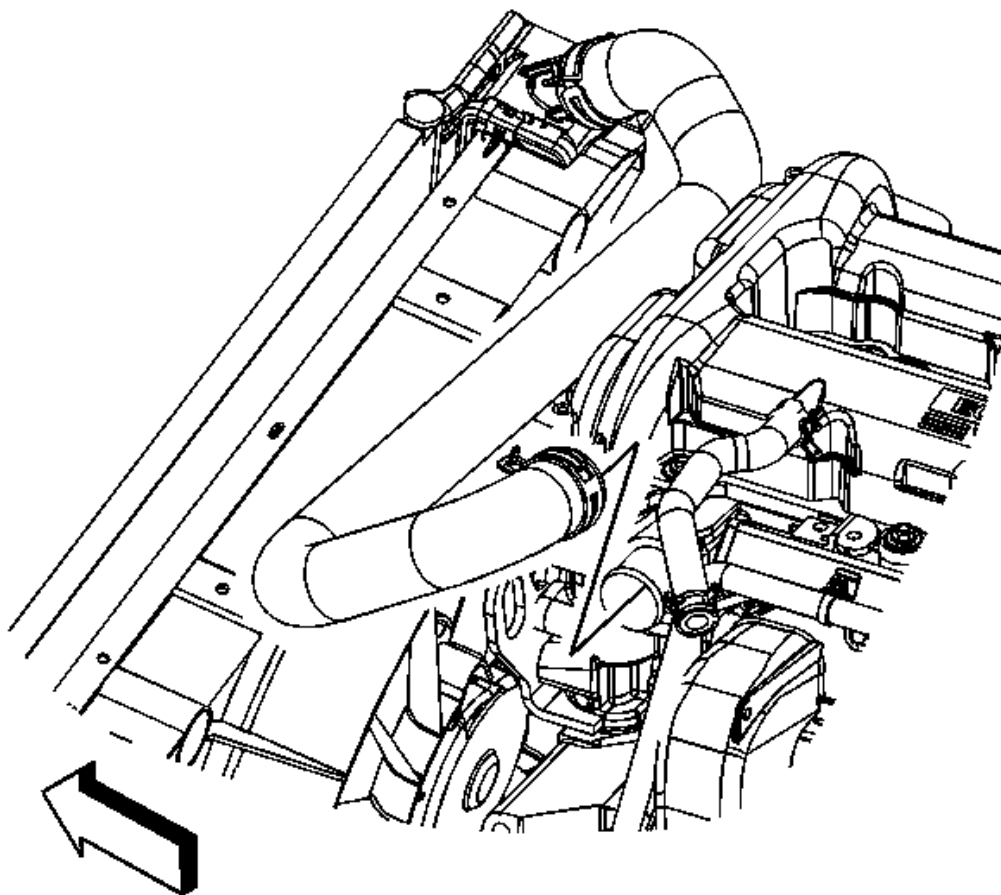


Fig. 288: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

74. Install the radiator inlet hose.
75. Position the radiator inlet hose clamp at the engine.
76. Install the transmission. Refer to **Transmission Replacement (With ZOK)** .
77. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .

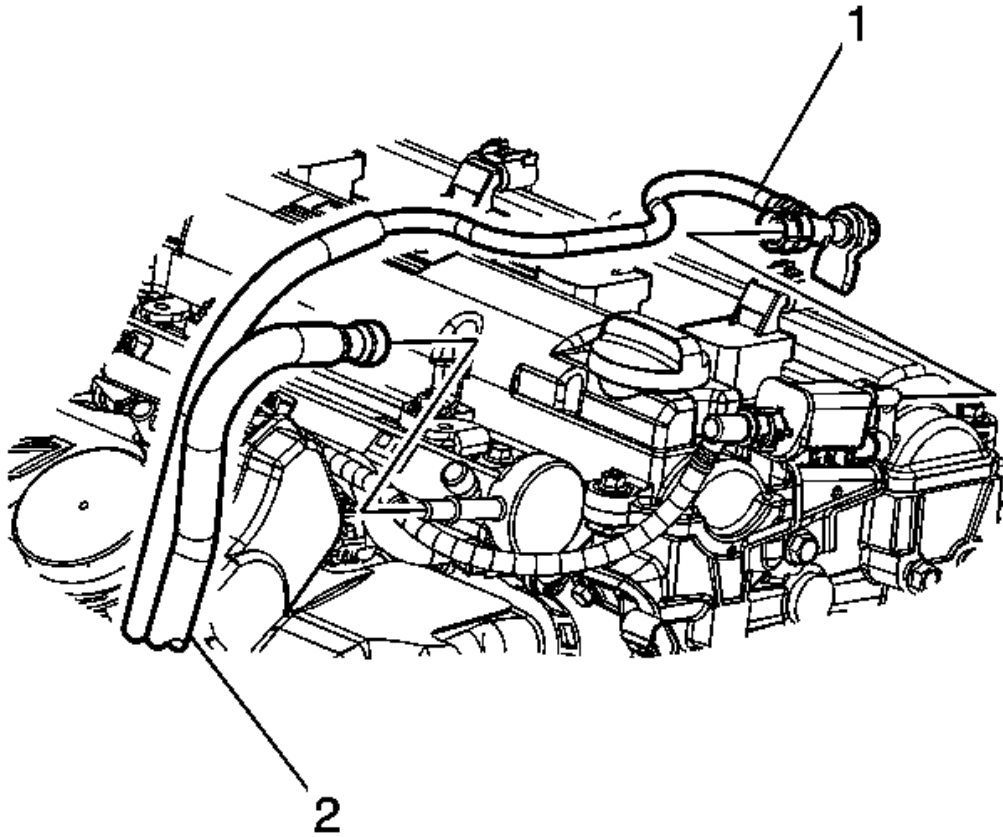


Fig. 289: View Of Fuel Feed Pipe & EVAP Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

78. Connect the fuel feed pipe (2) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
79. Connect the EVAP canister purge solenoid tube to the valve (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
80. Install the radiator. Refer to **Radiator Replacement** .
81. Install the drive belt. Refer to **Drive Belt Replacement (With A/C)** or **Drive Belt Replacement (Without A/C)**.
82. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
83. Install the hood. Refer to **Hood Replacement** .
84. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
85. Fill the engine oil.

ENGINE REPLACEMENT (W/AUTOMATIC TRANSMISSION)

SPECIAL TOOLS

- **J 42451-1** Engine Support Adapter
- **J 45059** Angle Meter

REMOVAL PROCEDURE

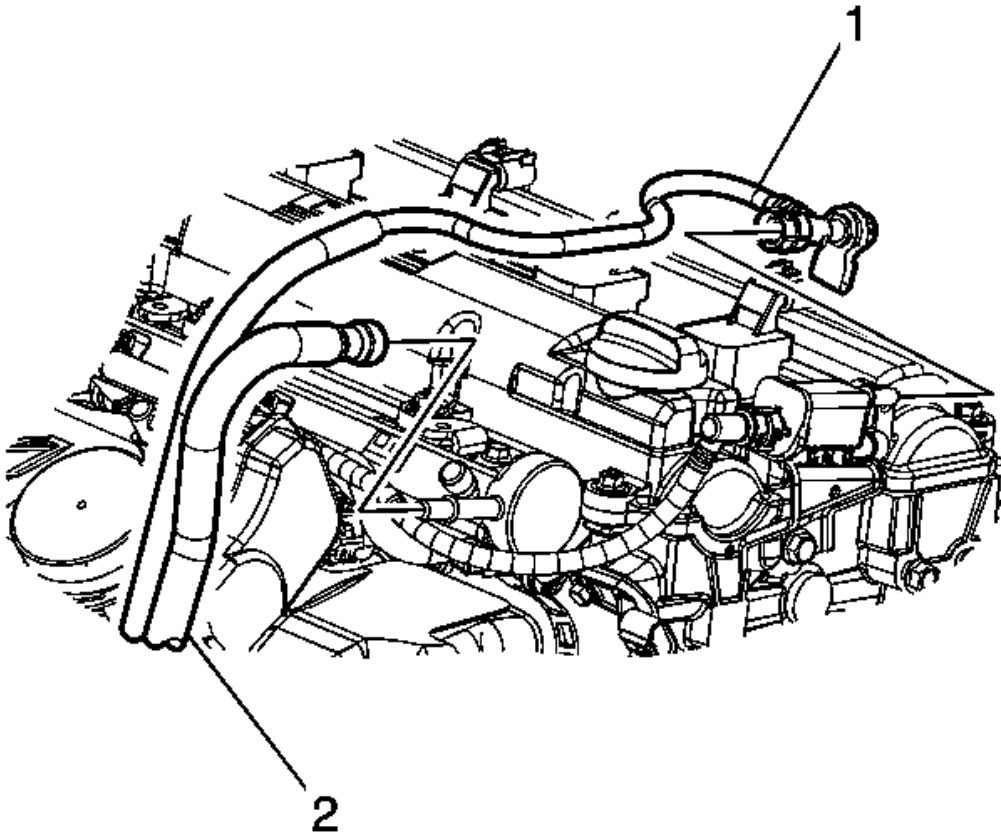


Fig. 290: View Of Fuel Feed Pipe & EVAP Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

1. Remove the hood. Refer to **Hood Replacement** .
2. Recover the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
3. Remove the drive belt. Refer to **Drive Belt Replacement (With A/C)** or **Drive Belt Replacement (Without A/C)**.
4. Remove the radiator. Refer to **Radiator Replacement** .
5. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (CH 48027-100)** or **Fuel Pressure Relief**

(Without CH 48027-100) .

6. Disconnect the evaporative emission (EVAP) canister purge solenoid tube from the valve (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
7. Disconnect the fuel feed pipe (2) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
8. Remove the transmission. Refer to **Transmission Replacement** .
9. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .
10. Remove the starter. Refer to **Starter Replacement** .

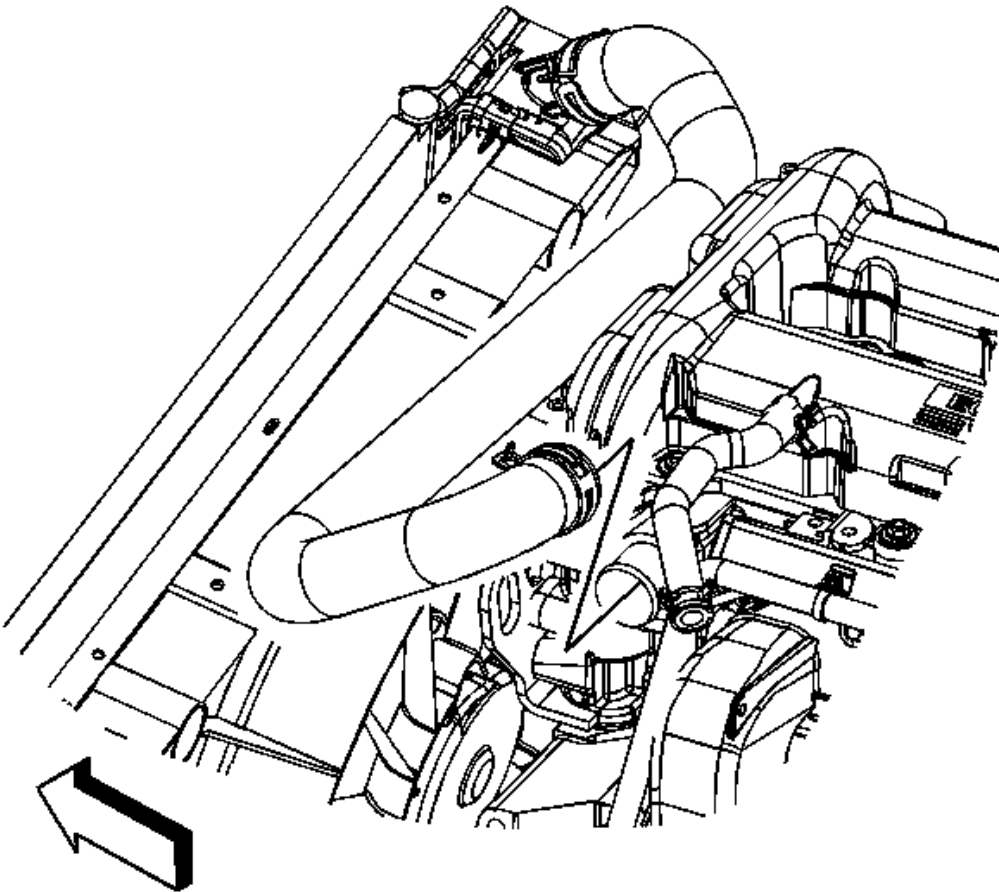


Fig. 291: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

11. Reposition the radiator inlet hose clamp at the engine.

12. Remove the radiator inlet hose.

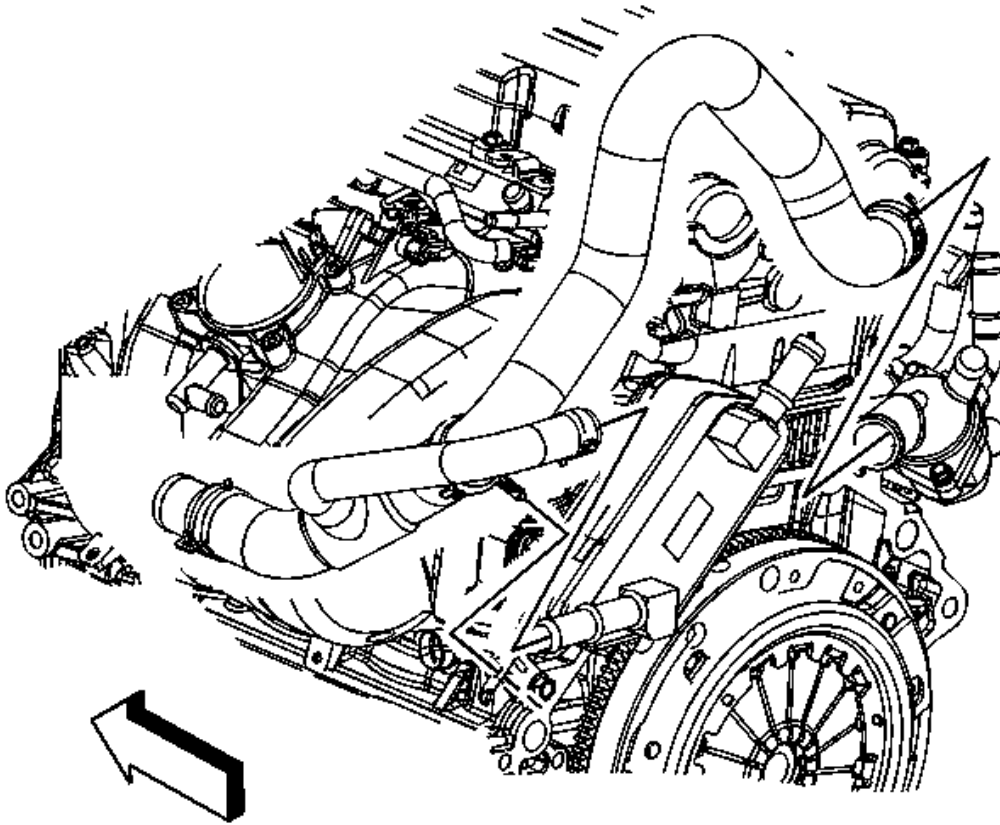


Fig. 292: View Of Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

13. If the vehicle is equipped with a engine oil cooler perform the following steps, otherwise proceed to step 23.
14. Reposition the radiator outlet hose clamps at the thermostat housing and oil cooler.
15. Remove the radiator outlet hose from the thermostat housing and oil cooler.
16. Reposition the outlet hose out of the way.

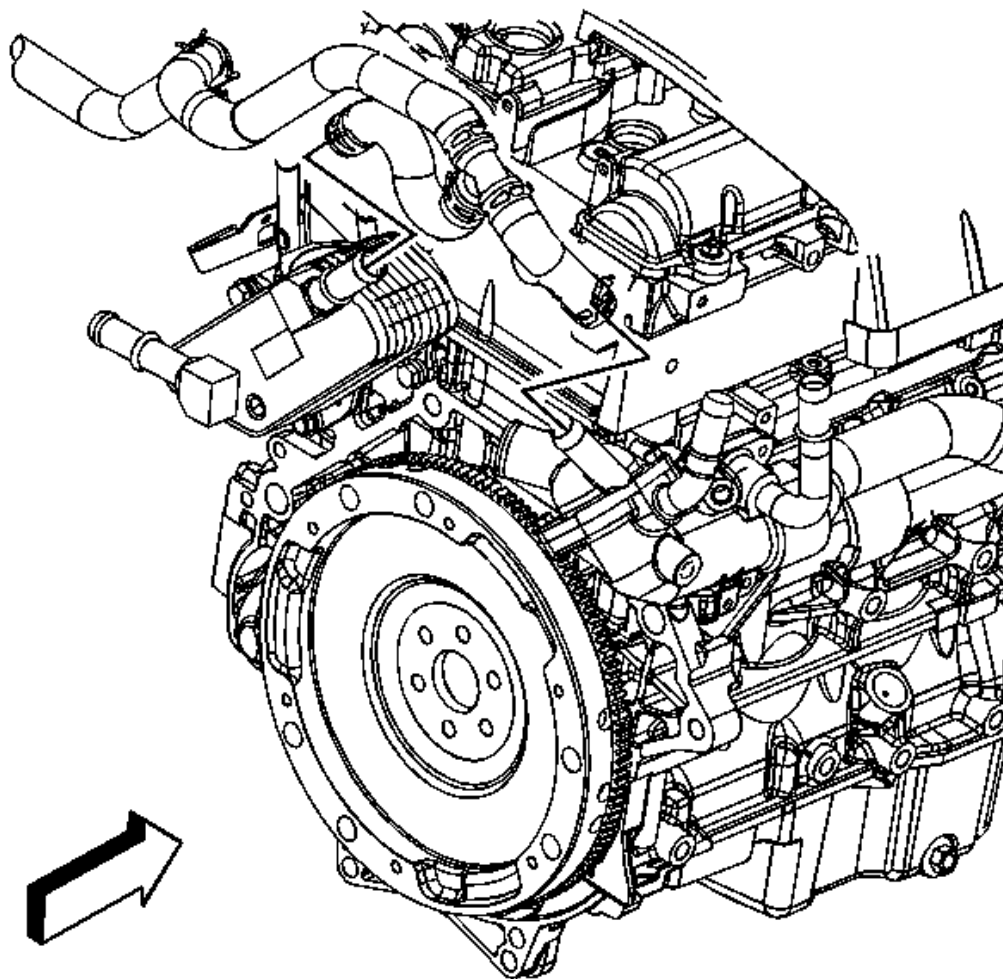


Fig. 293: View Of Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

17. Reposition the surge tank outlet hose clamps at the thermostat housing and oil cooler.
18. Remove the surge tank outlet hose from the thermostat housing and oil cooler.

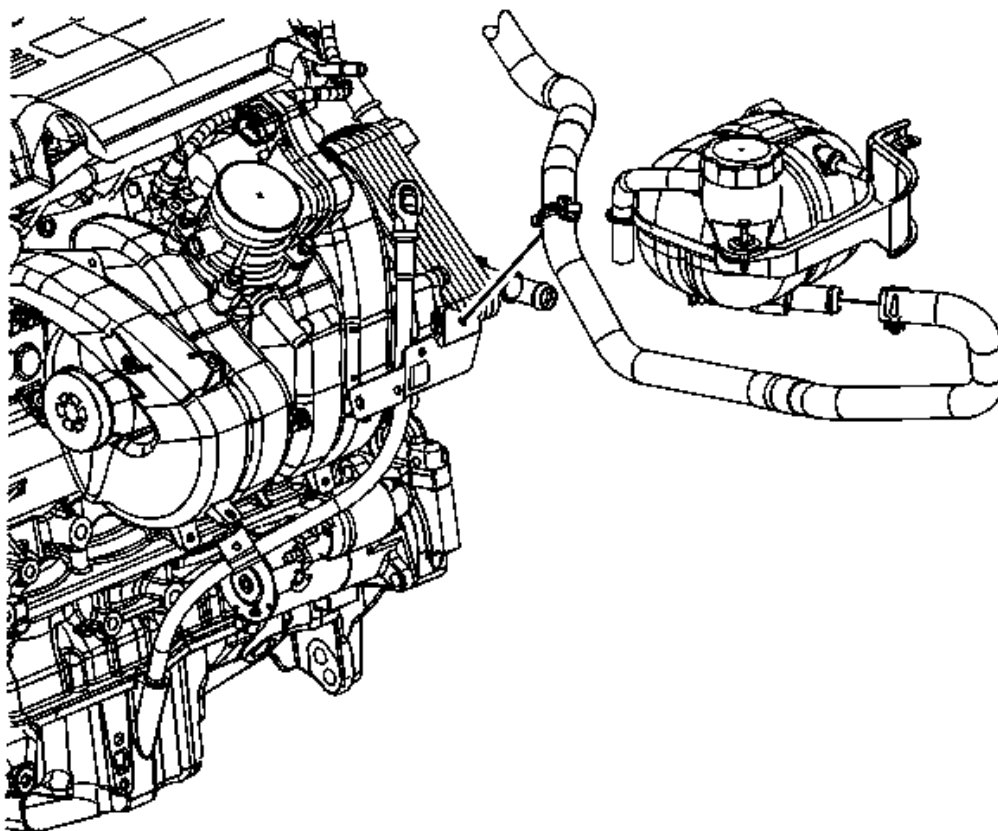


Fig. 294: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

19. Reposition the surge tank outlet hose clamp at the surge tank.
20. Remove the surge tank clip from the oil level indicator tube bracket.
21. Remove the surge tank outlet hose. Proceed to step 26.

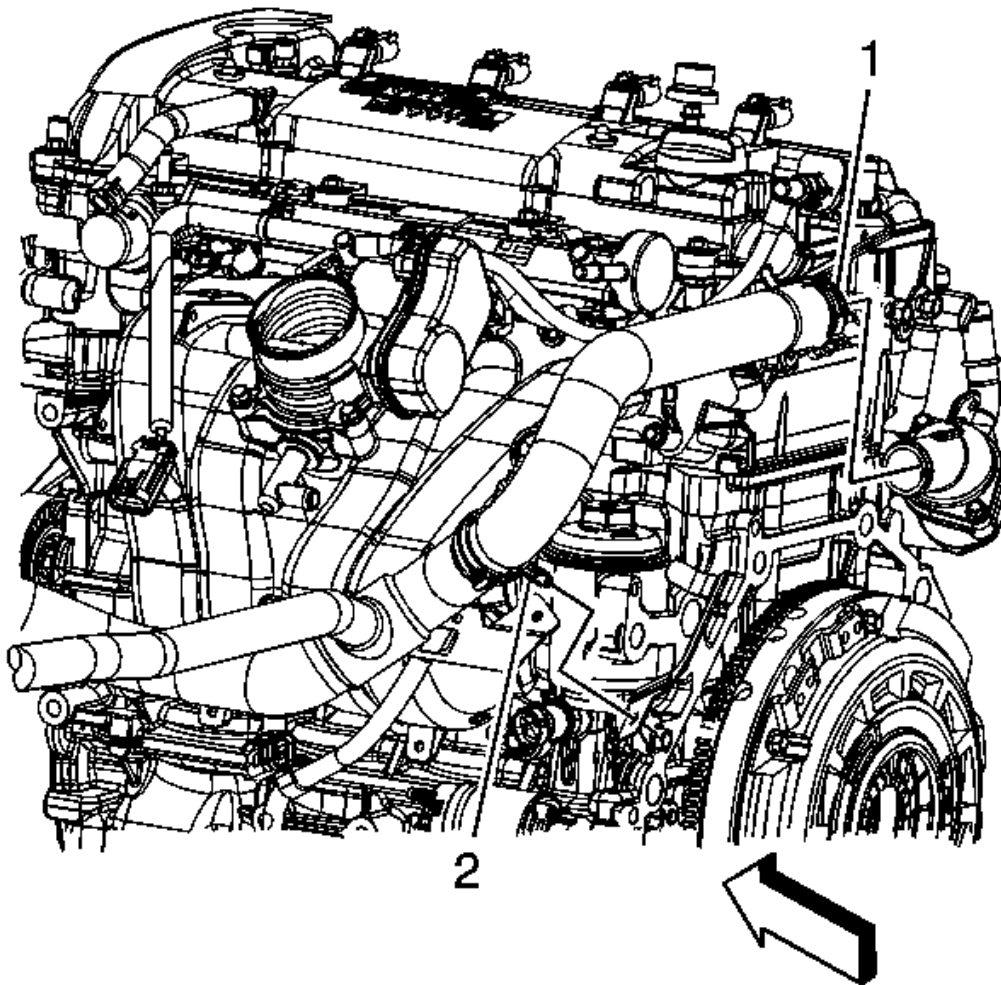


Fig. 295: Identifying Radiator Outlet Hose Clip
 Courtesy of GENERAL MOTORS CORP.

22. If the vehicle is not equipped with a engine oil cooler, reposition the radiator outlet hose clamp at the thermostat housing.
23. Remove the radiator outlet hose from the thermostat housing.
24. Remove the radiator outlet hose clip (1) from the outlet hose bracket.

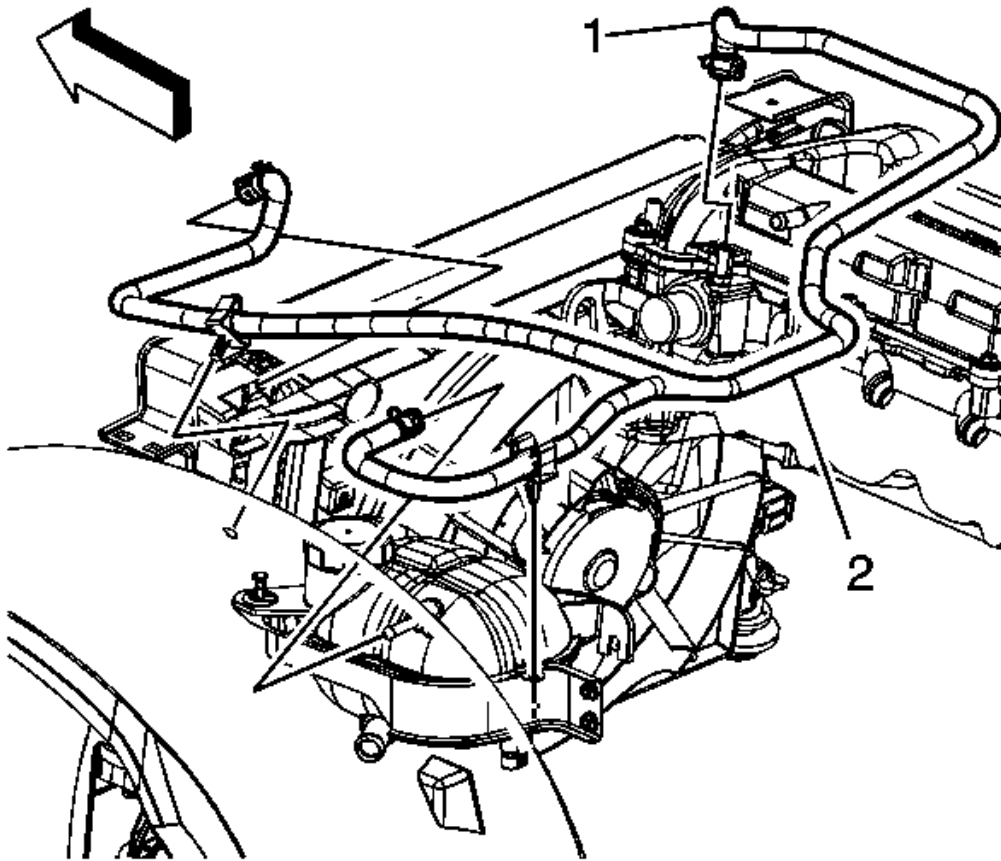


Fig. 296: Identifying Air Bleed Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

25. Reposition the surge tank air bleed hose clamp at the engine.
26. Remove the surge tank air bleed hose (1) from the engine.
27. Reposition the air bleed hose (2) out of the way.

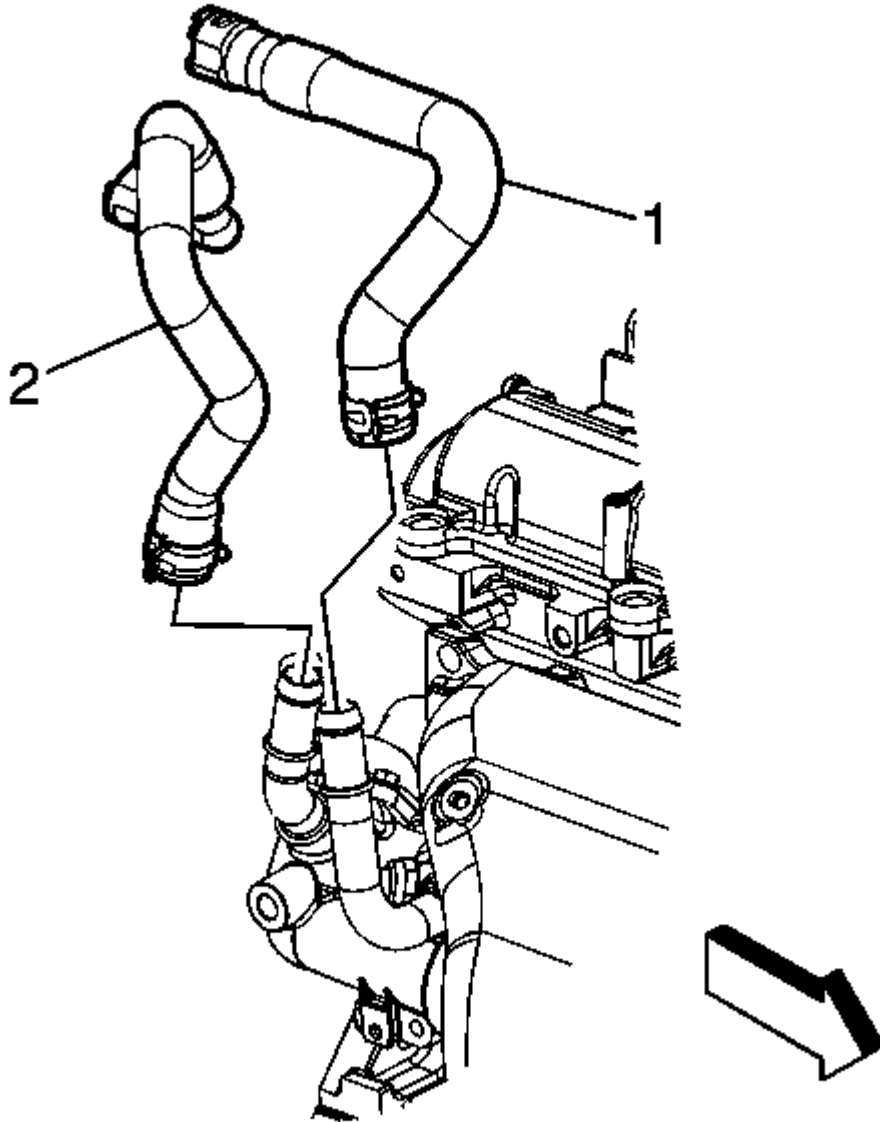


Fig. 297: Identifying Heater Inlet & Outlet Hoses
 Courtesy of GENERAL MOTORS CORP.

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

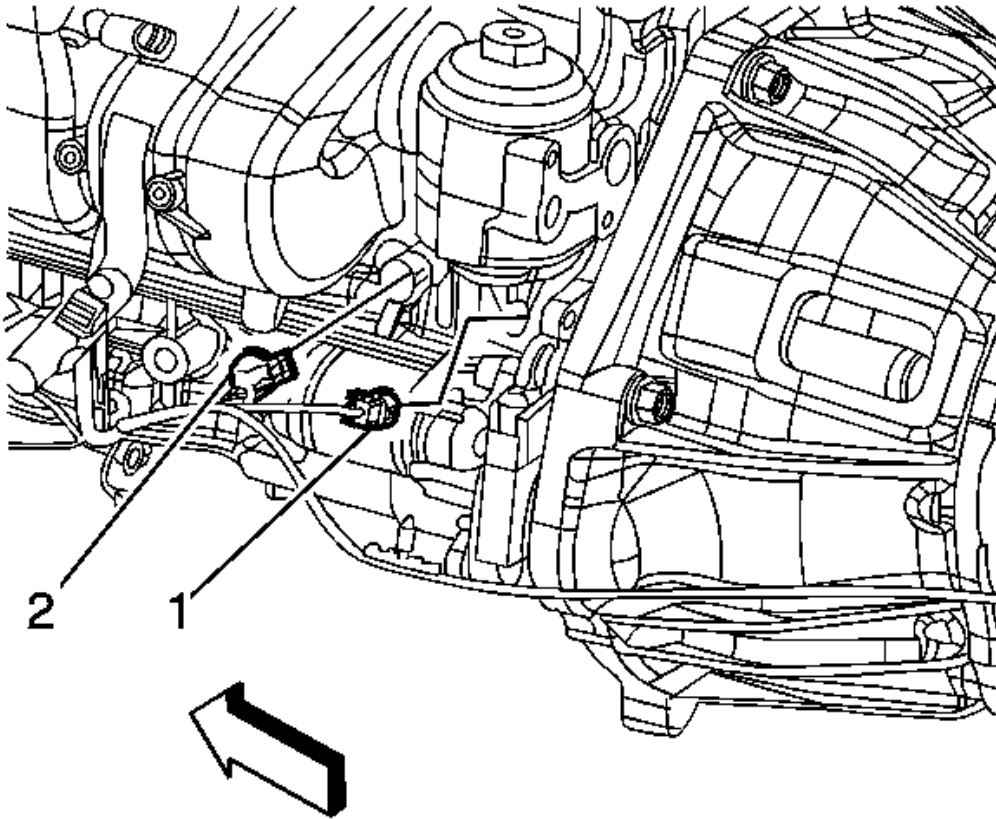


Fig. 298: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

32. Disconnect the engine wiring harness electrical connector (1) from the crankshaft position (CKP) sensor.
33. Disconnect the engine wiring harness electrical connector (2) from the oil pressure sensor.
34. Lower the vehicle.
35. Remove the positive battery cable clip from the bracket.
36. Cut the engine harness tie straps.

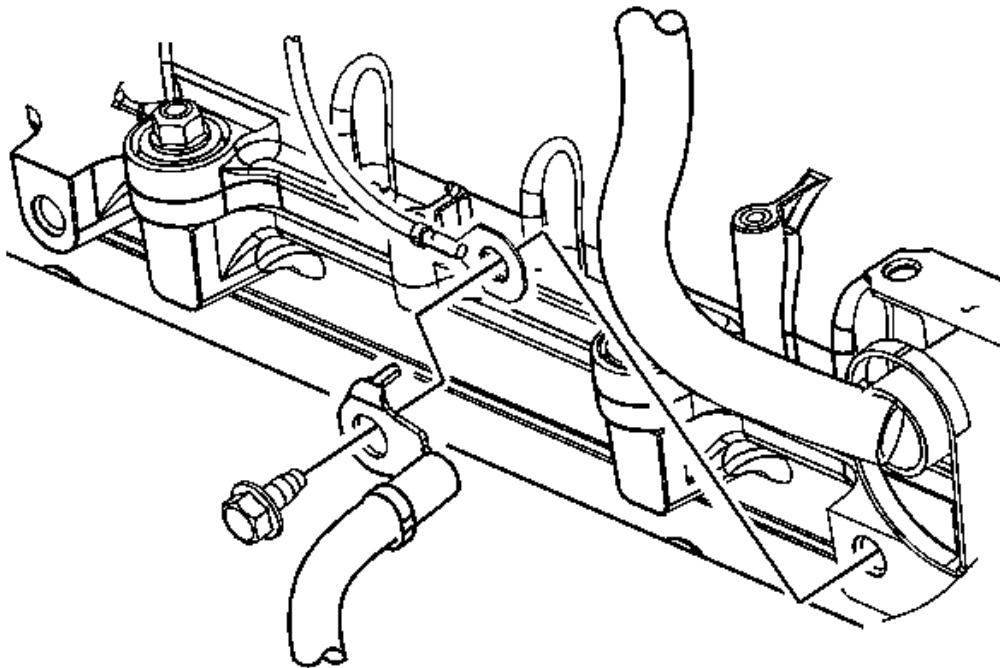


Fig. 299: View Of Negative Battery Cable Ground Bolt
Courtesy of GENERAL MOTORS CORP.

37. Remove the negative battery cable ground bolt.
38. Remove the negative battery cable ground terminal and engine harness ground terminal from the cylinder head.

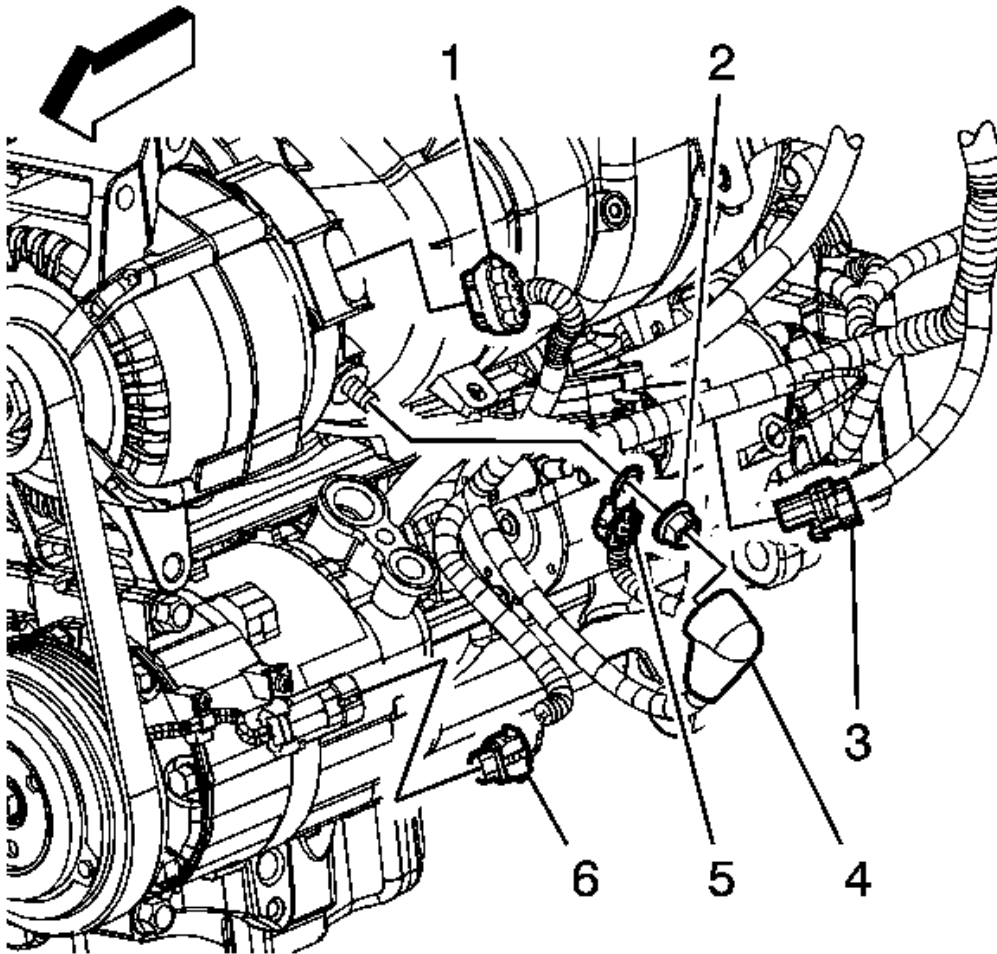


Fig. 300: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

39. Disconnect the engine wiring harness electrical connector (1) from the generator.
40. Reposition the positive battery cable terminal boot (4).
41. Remove the generator terminal nut (2).
42. Remove the positive battery cable terminal from the generator (5).
43. Disconnect the engine wiring harness electrical connector (6) from the A/C compressor.
44. Reposition the negative/positive battery cable.

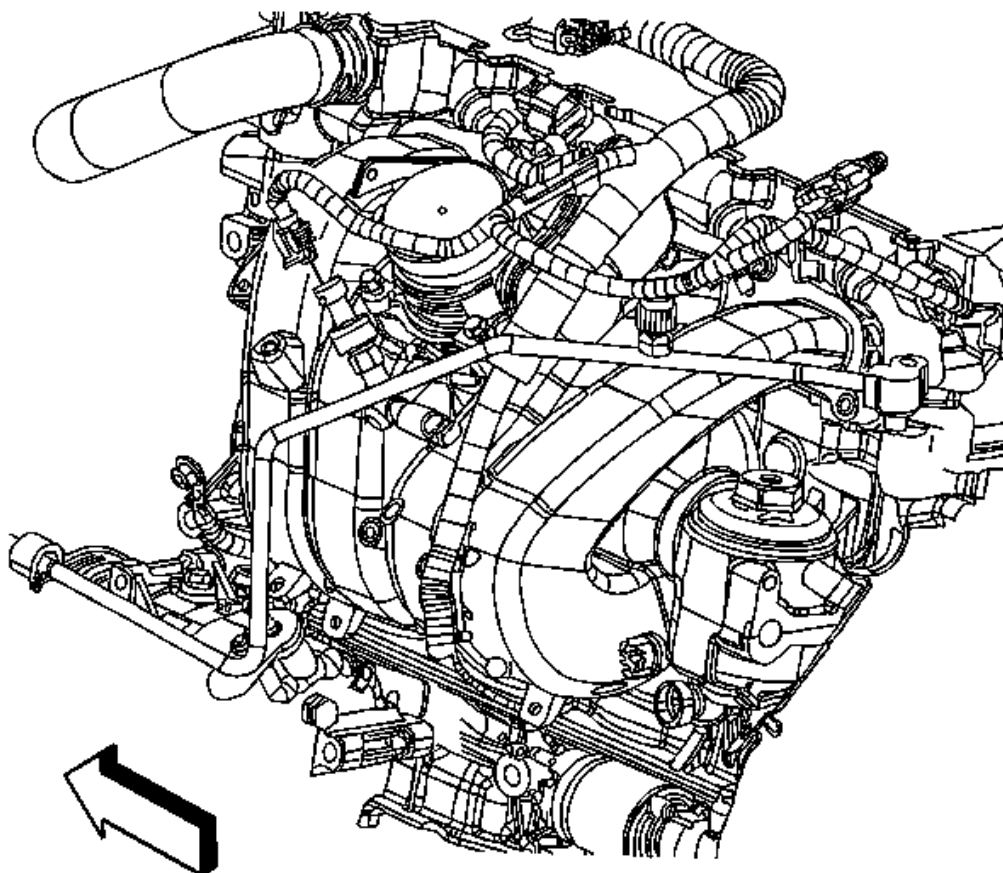


Fig. 301: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

45. Disconnect the engine wiring harness electrical connector from the A/C refrigerant pressure sensor.

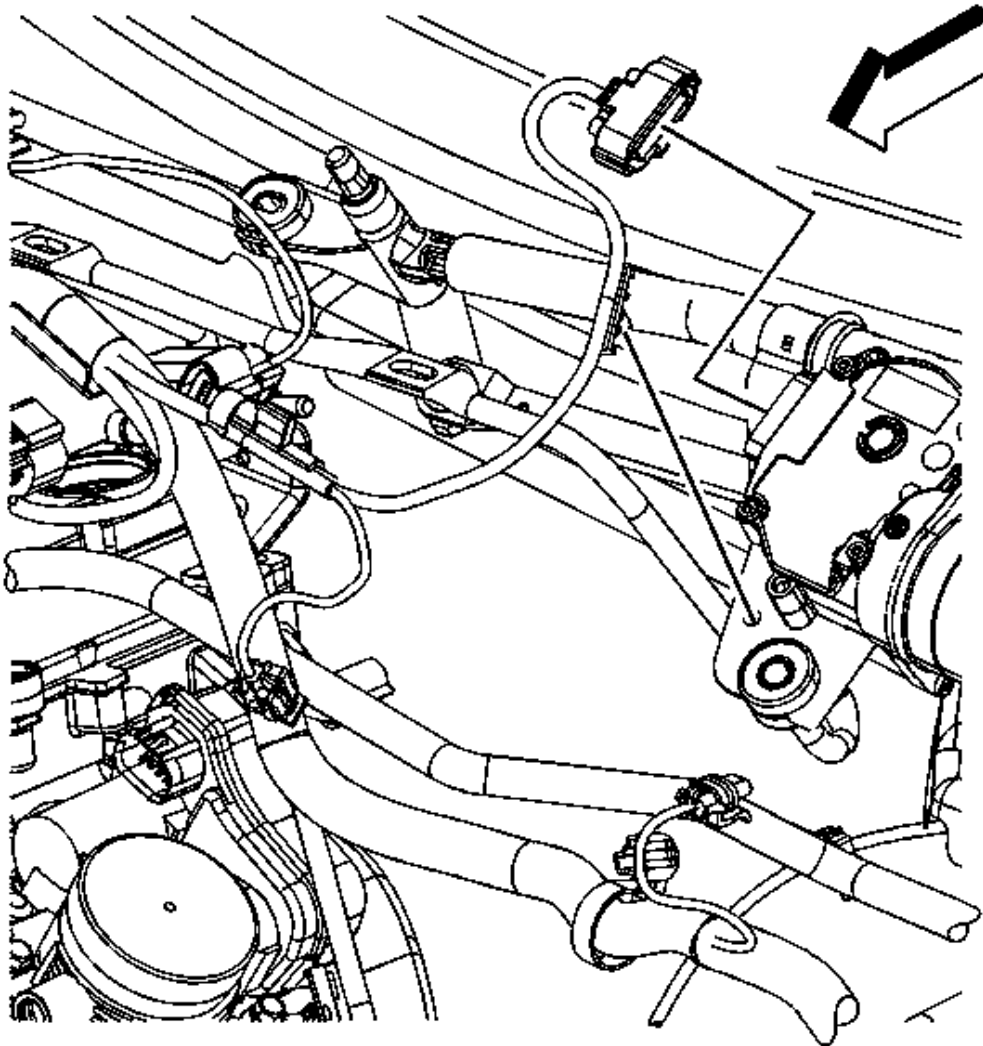


Fig. 302: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

46. Disconnect the engine wiring harness electrical connector from the windshield wiper motor.
47. Remove the engine harness clip from the wiper motor hole.

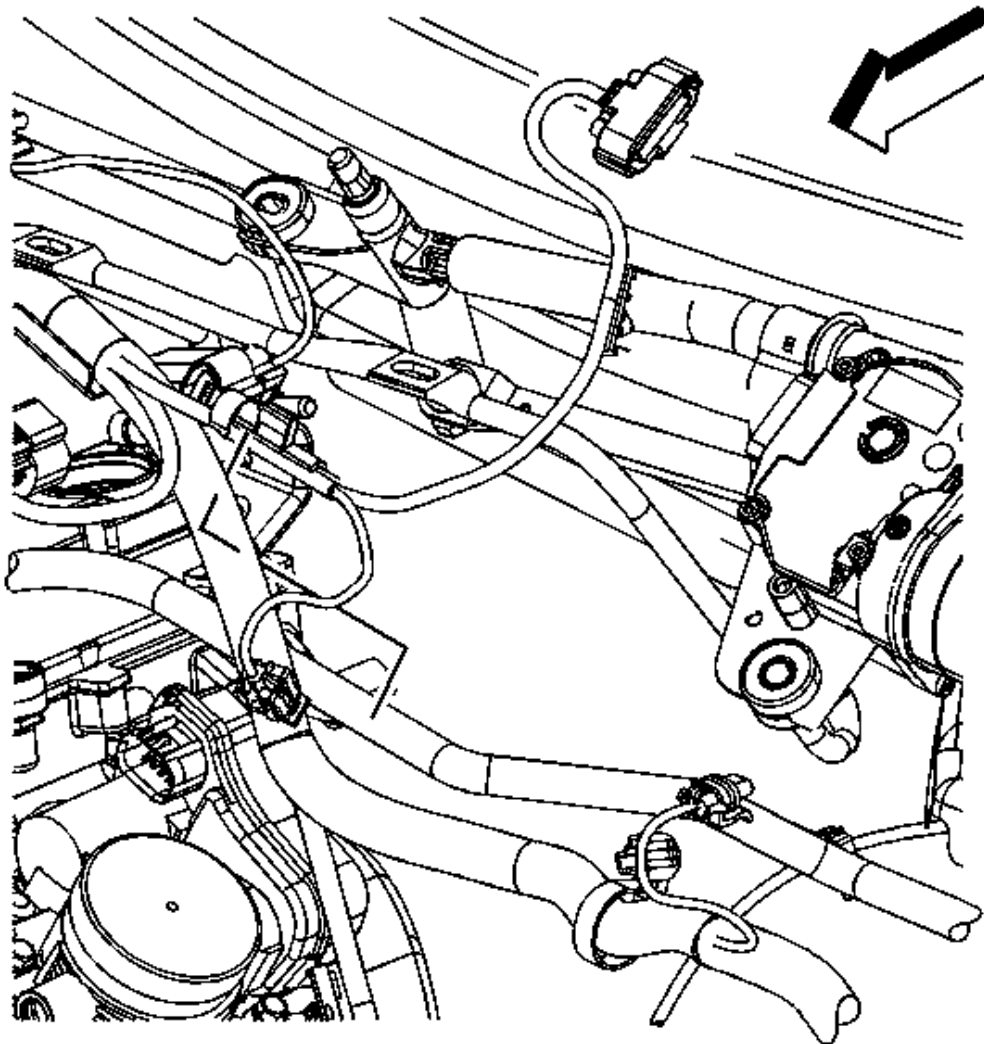


Fig. 303: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

48. Remove the engine harness clip from the surge tank air bleed hose.

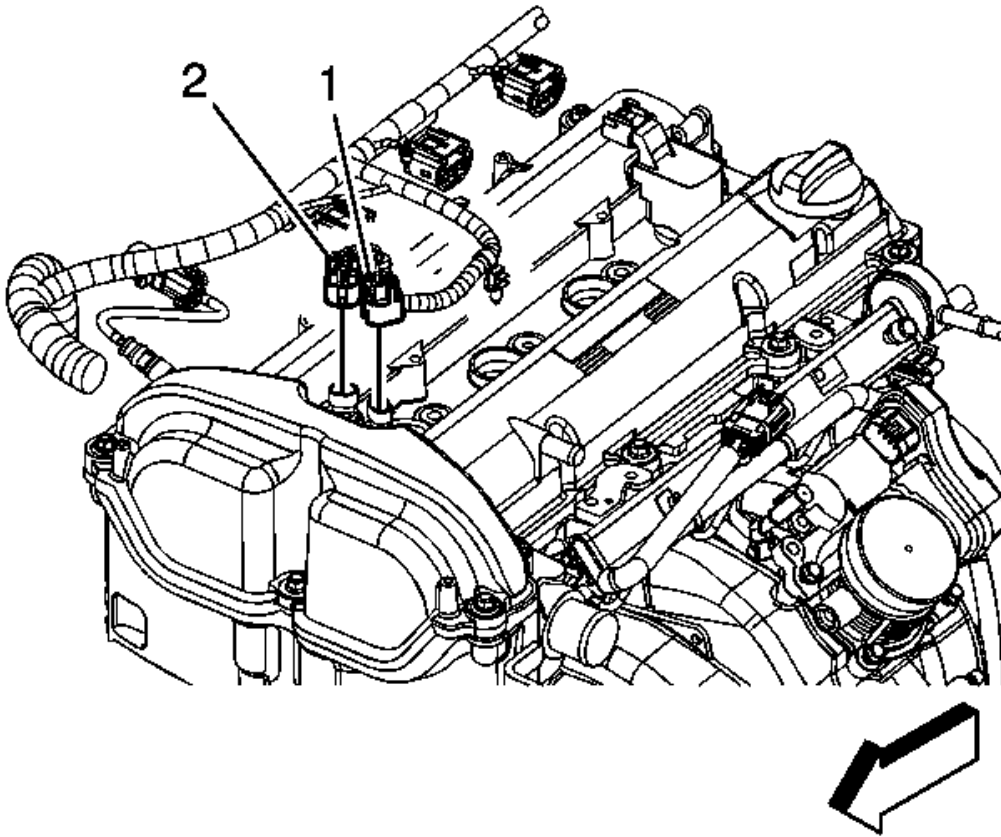


Fig. 304: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

49. Disconnect the engine wiring harness electrical connector (1) from the intake camshaft position (CMP) actuator.
50. Disconnect the engine wiring harness electrical connector (2) from the exhaust CMP actuator.

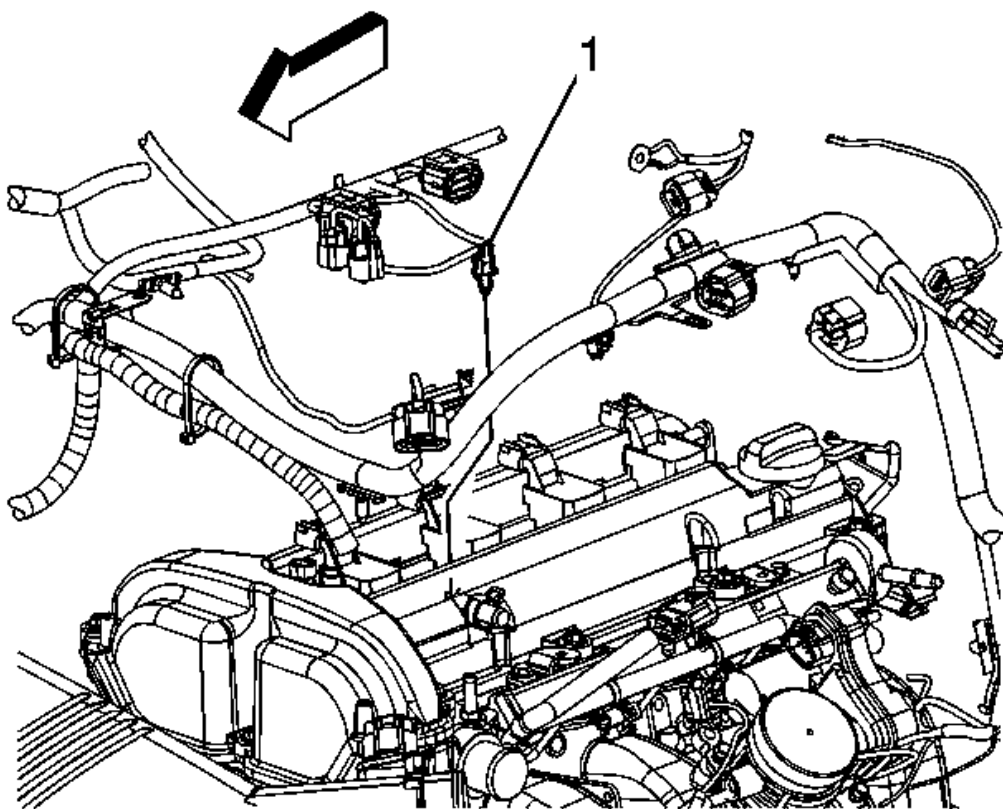


Fig. 305: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

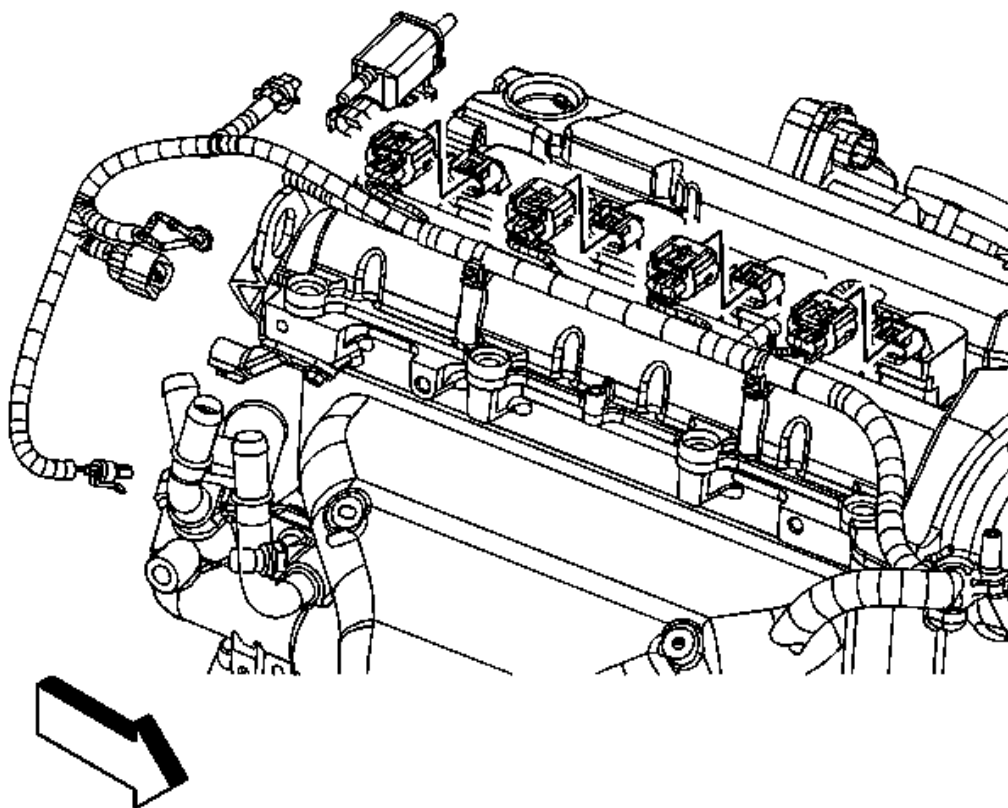


Fig. 306: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

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

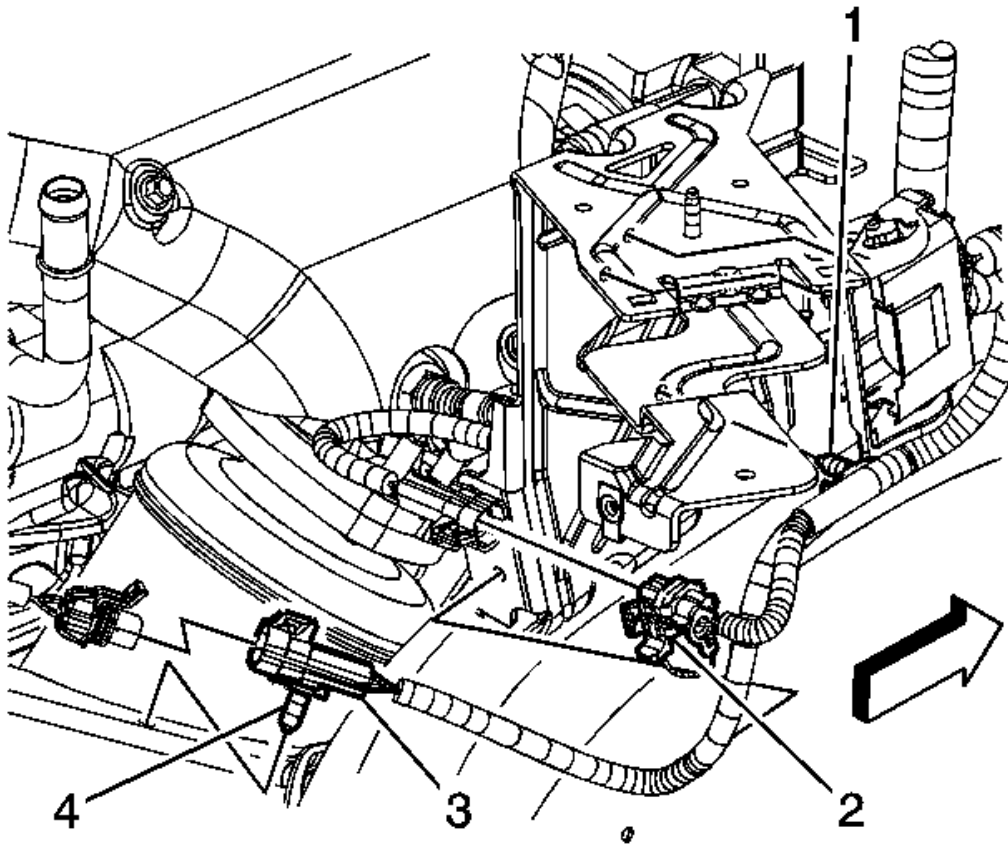


Fig. 307: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

53. Remove the connector position assurance (CPA) retainers from the heated oxygen sensor (HO2S) electrical connectors.
54. Disconnect the engine wiring harness electrical connector (1) from the front HO2S.
55. Disconnect the engine wiring harness electrical connector (2) from the rear HO2S.
56. Disconnect the engine harness clips (1) from the junction block bracket.
57. Disconnect the HO2S electrical connector clip (4) from the strut.

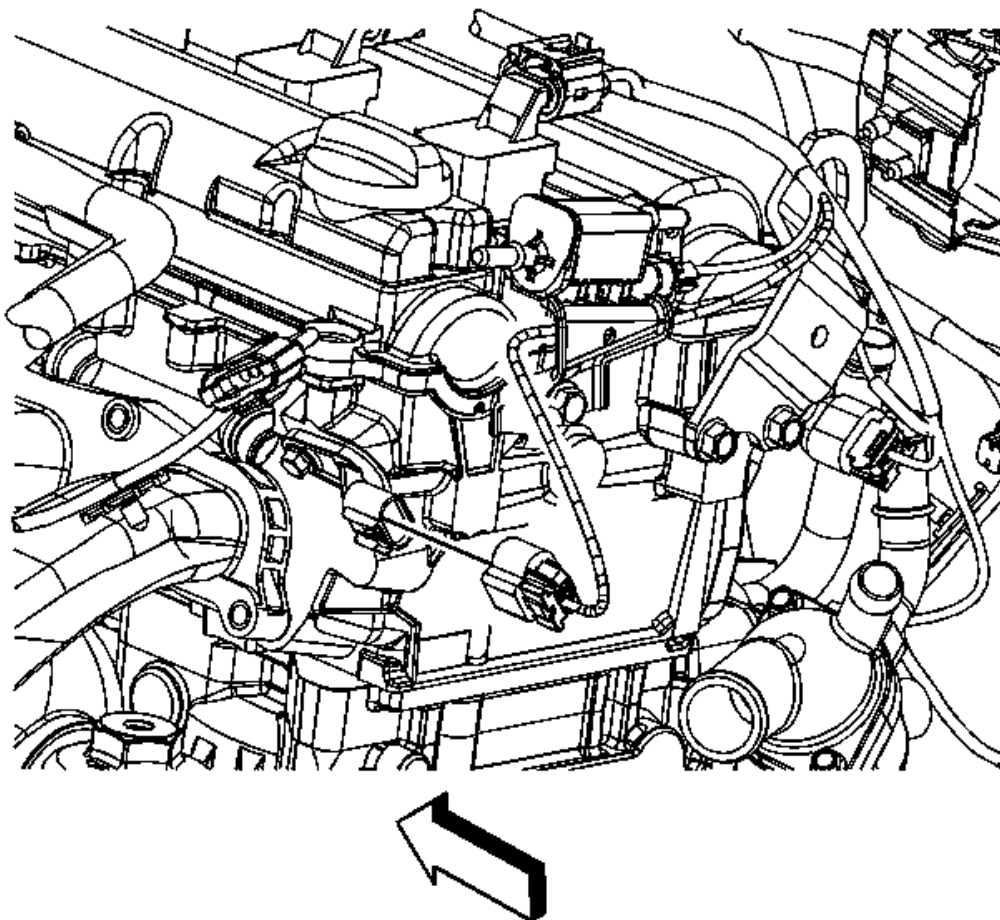


Fig. 308: View Of Intake CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

58. Disconnect the engine wiring harness electrical connector from the intake CMP sensor.

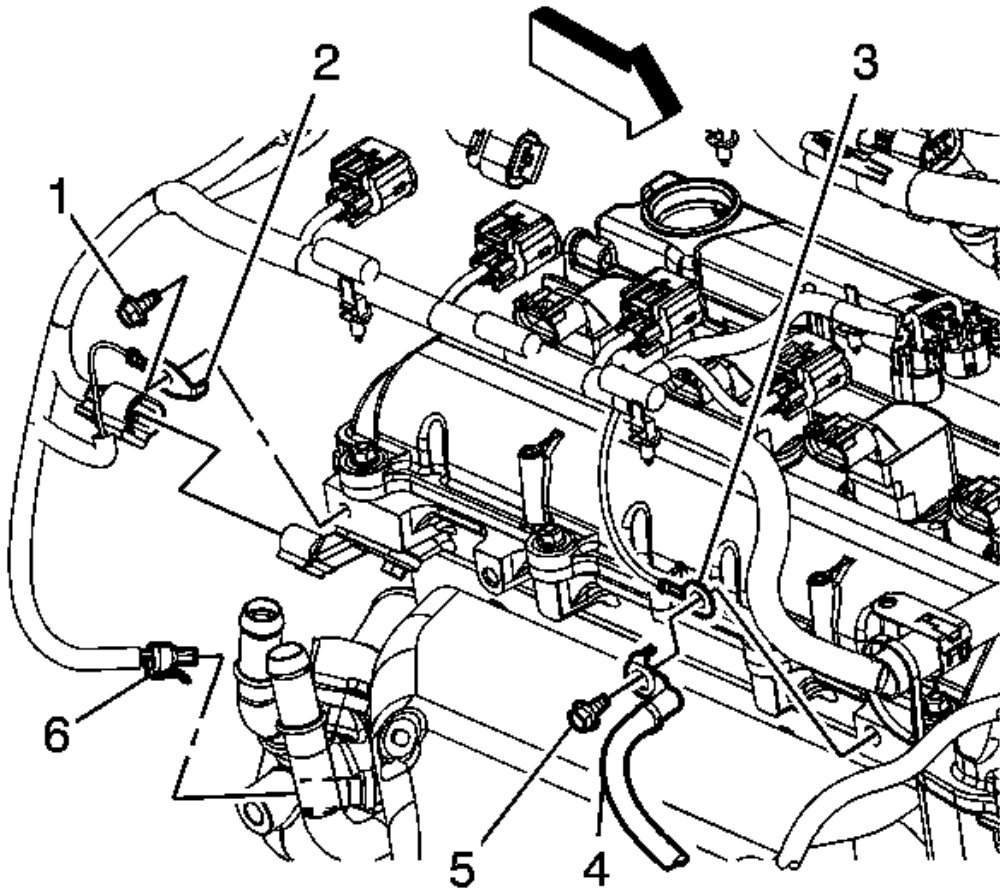


Fig. 309: View Of CMP Sensor & ECT Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

59. Disconnect the engine wiring harness electrical connector from the exhaust CMP sensor.
60. Remove the engine harness ground terminal bolt (1) and reposition the engine harness ground terminal (2).
61. Disconnect the engine wiring harness electrical connector (6) from the engine coolant temperature (ECT) sensor.

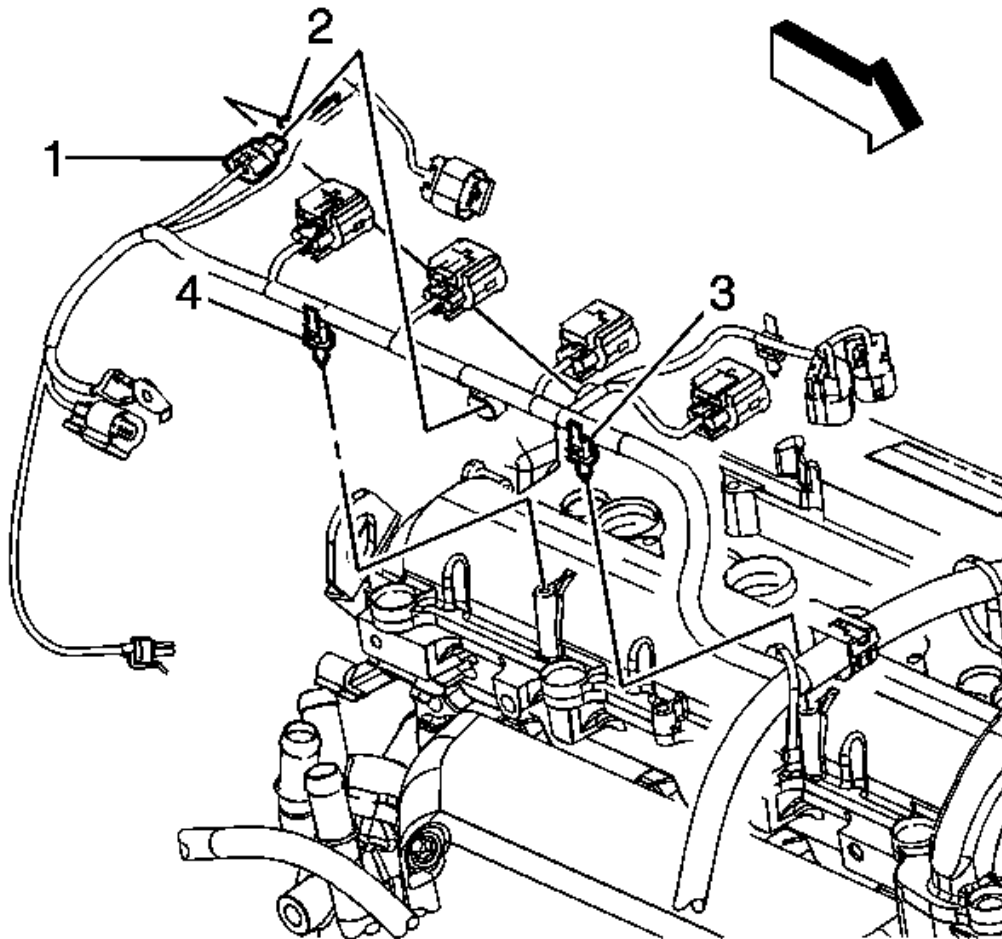


Fig. 310: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS CORP.

62. Disconnect the engine wiring harness electrical connector (1) from the EVAP canister purge solenoid.
63. Disconnect the engine harness clip (2) from the EVAP canister purge solenoid valve bracket.
64. Disconnect the engine harness clips (3, 4) from the camshaft cover.
65. Remove the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

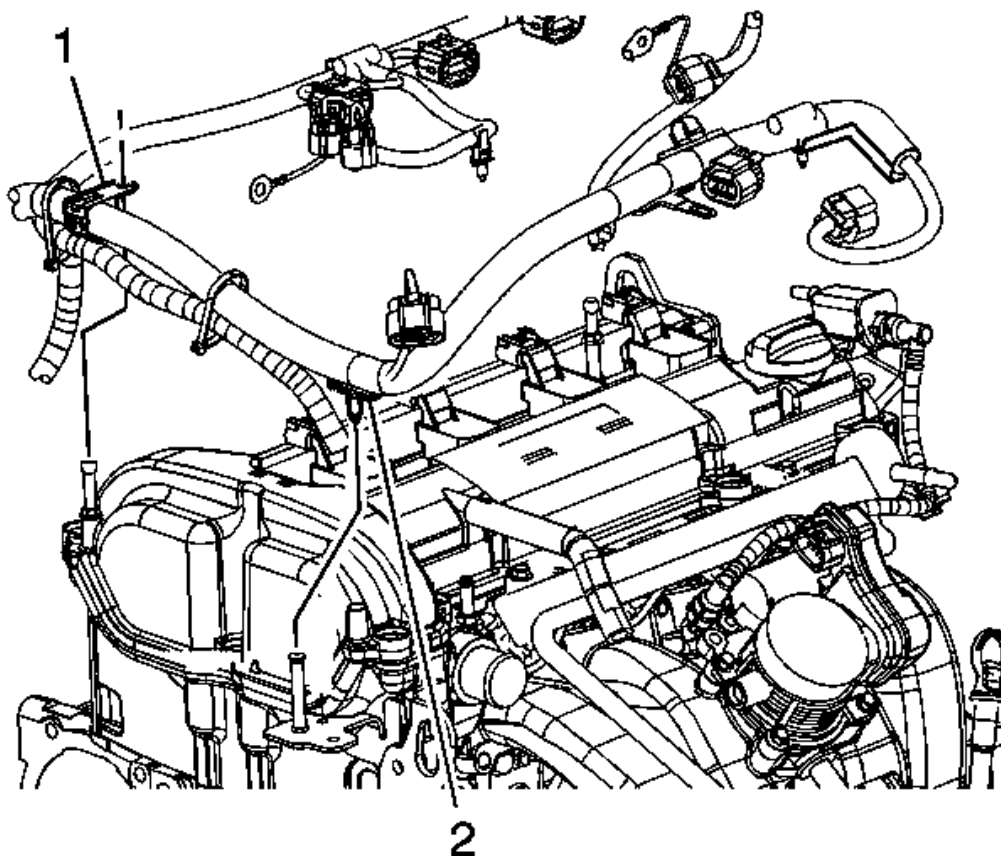


Fig. 311: Identifying Engine Harness Bracket
Courtesy of GENERAL MOTORS CORP.

66. Remove the engine harness bracket (1) from the intake manifold cover stud.
67. Disconnect the engine harness clip (2) from the bracket.

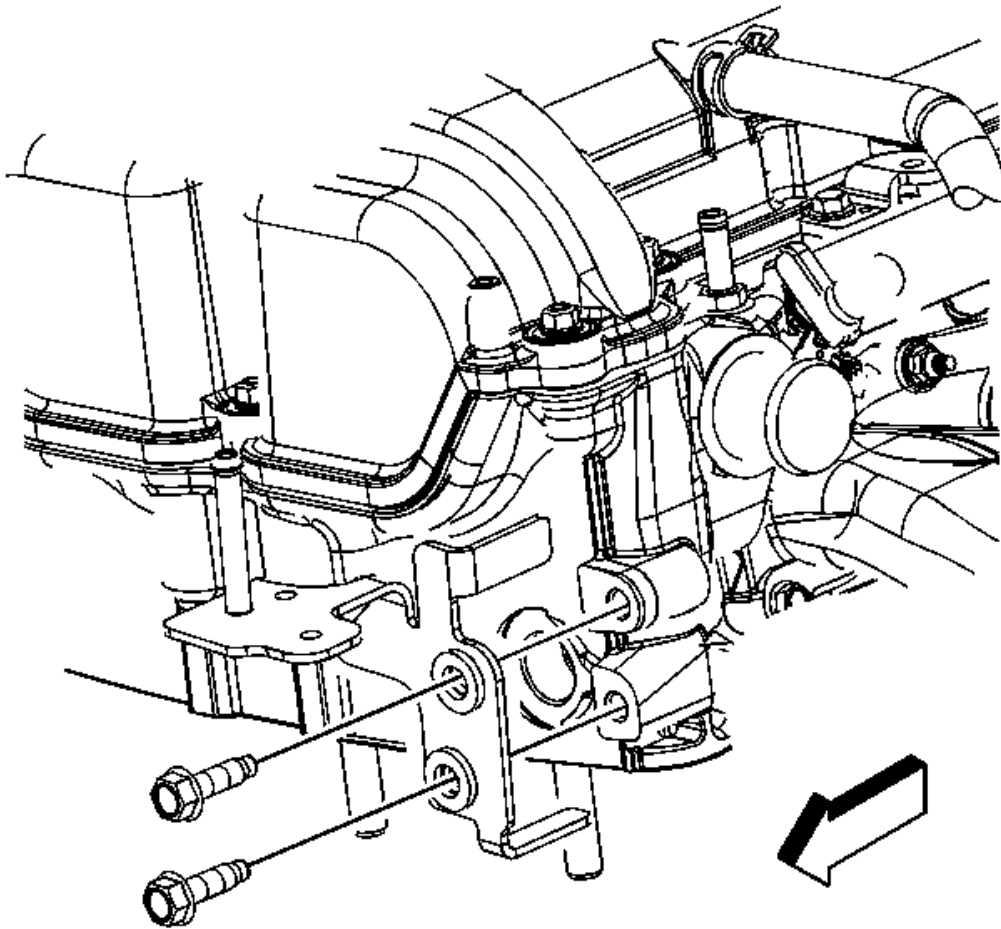


Fig. 312: View Of Intake Manifold Cover Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

68. Remove the intake manifold cover bracket bolts and bracket.
69. Gather all branches of the engine harness and lay off to the side.

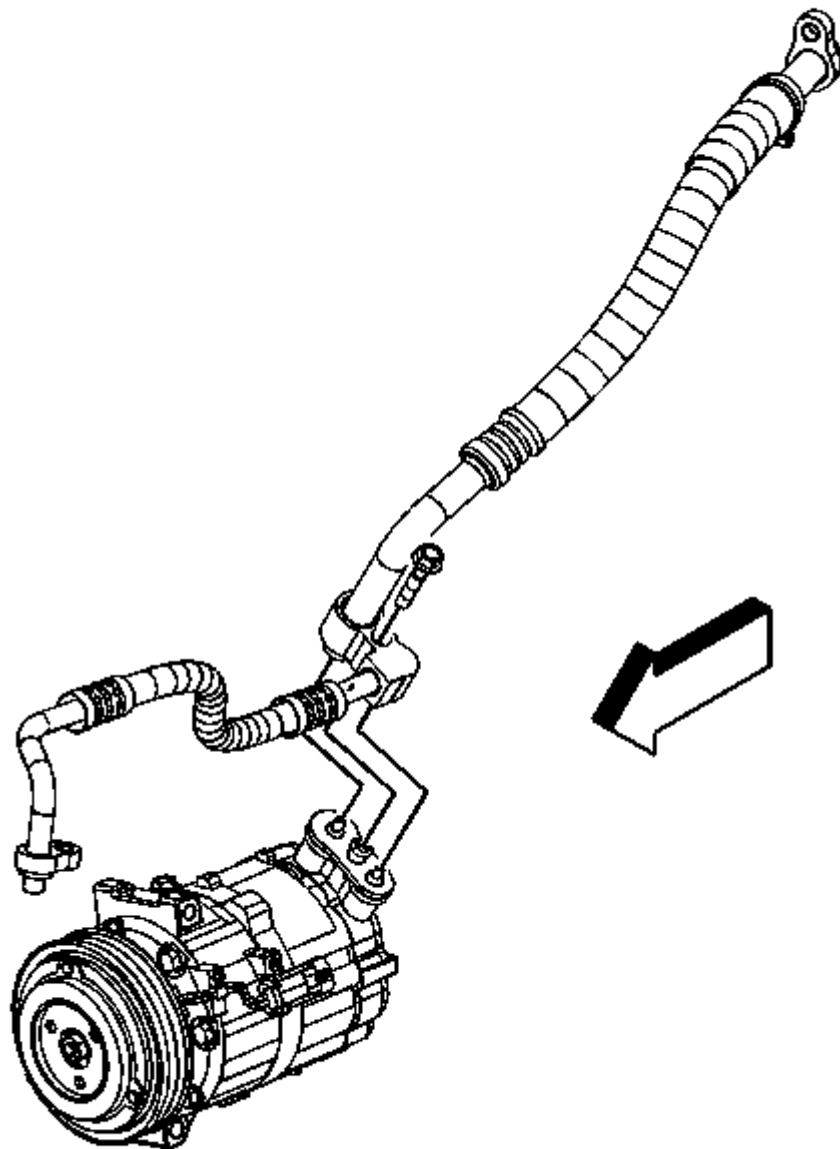


Fig. 313: View Of A/C Compressor Line
Courtesy of GENERAL MOTORS CORP.

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

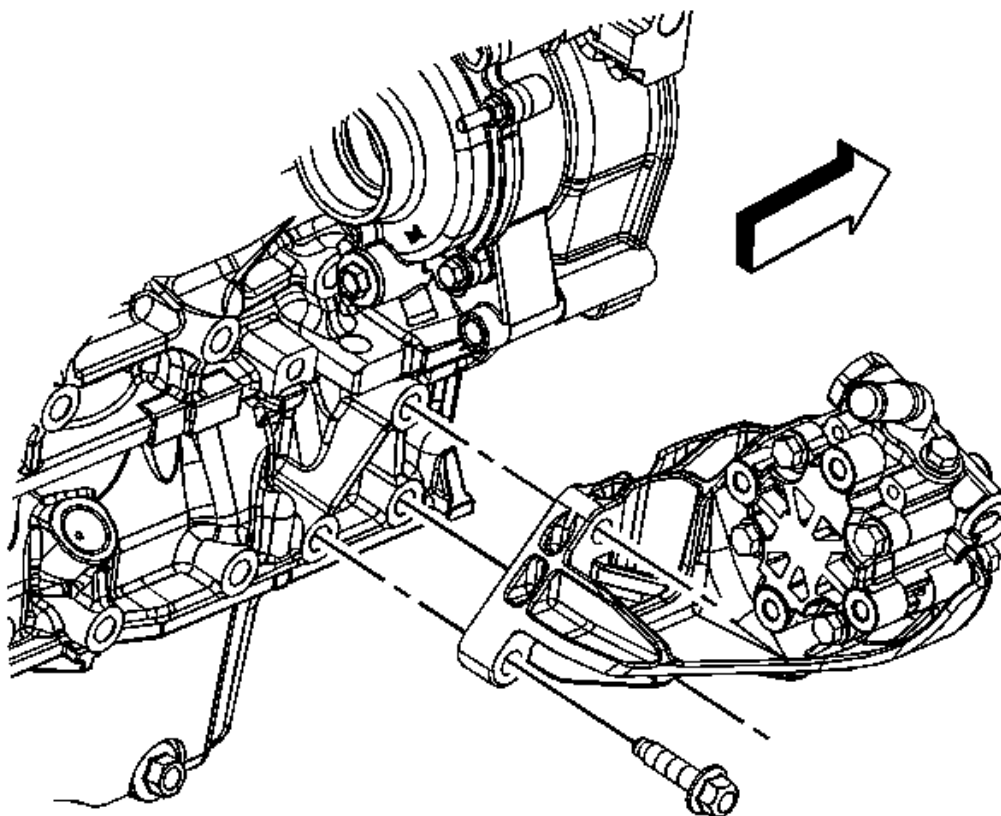


Fig. 314: View Of Power Steering Pump, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

72. Remove the power steering pump bracket bolts and reposition the pump and bracket off to the side.
73. Lower the vehicle.

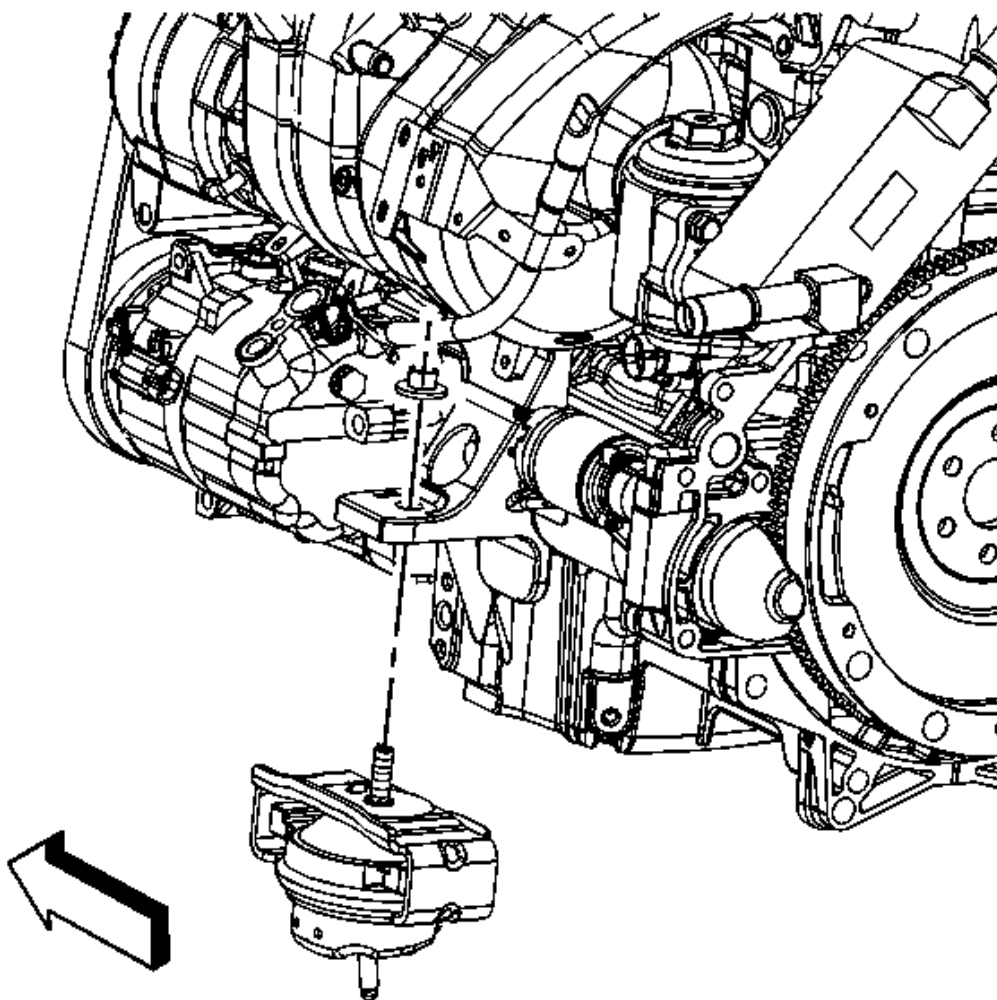


Fig. 315: View Of Left Engine Mount
Courtesy of GENERAL MOTORS CORP.

74. Remove the left engine mount upper nut.

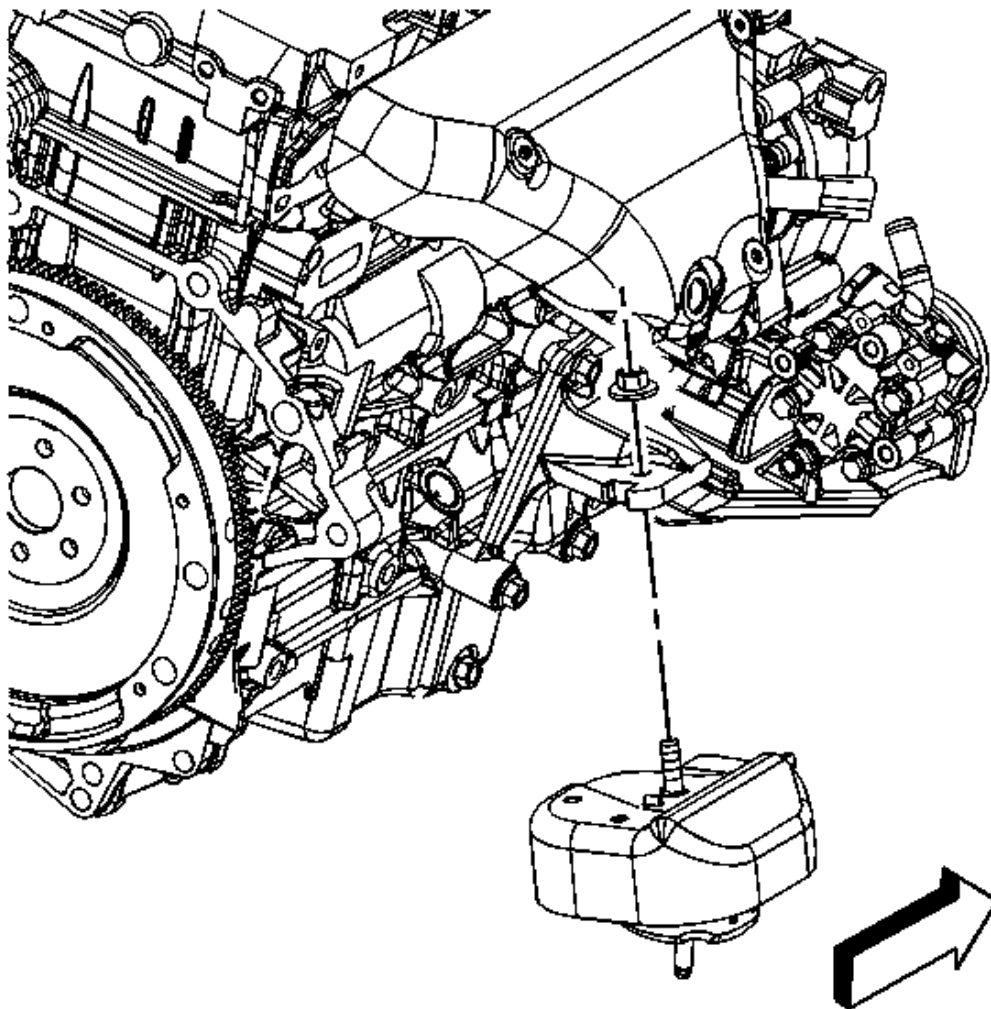


Fig. 316: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

75. Remove the right engine mount upper nut.
76. Install the **J 42451-1** to the engine.
77. Install a suitable engine lifting device to the engine.
78. Remove the engine from the vehicle.

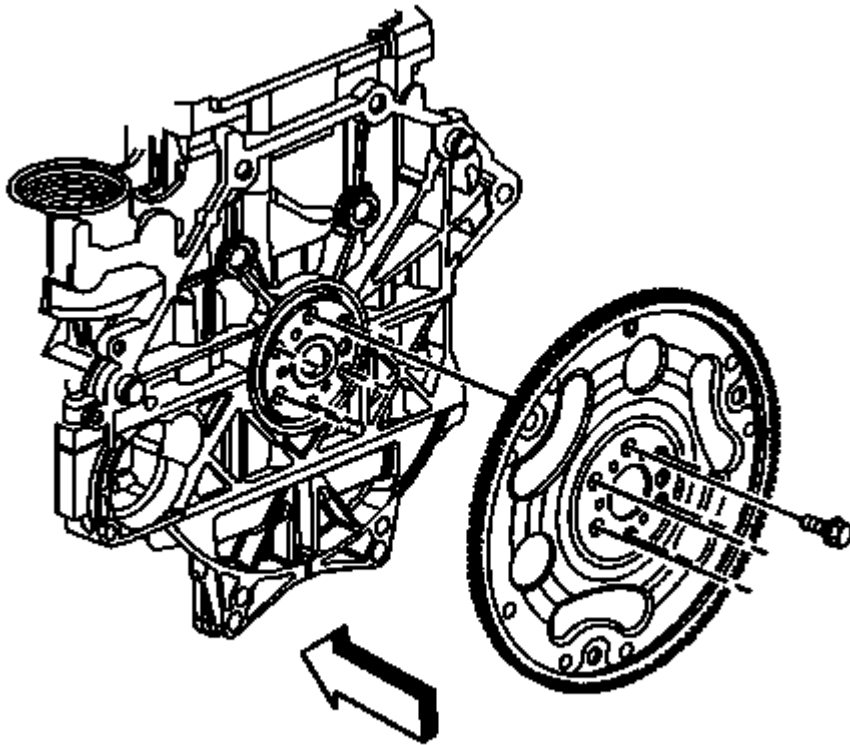


Fig. 317: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

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

79. Remove the flywheel bolts and flywheel.
80. Install the engine to an engine stand.

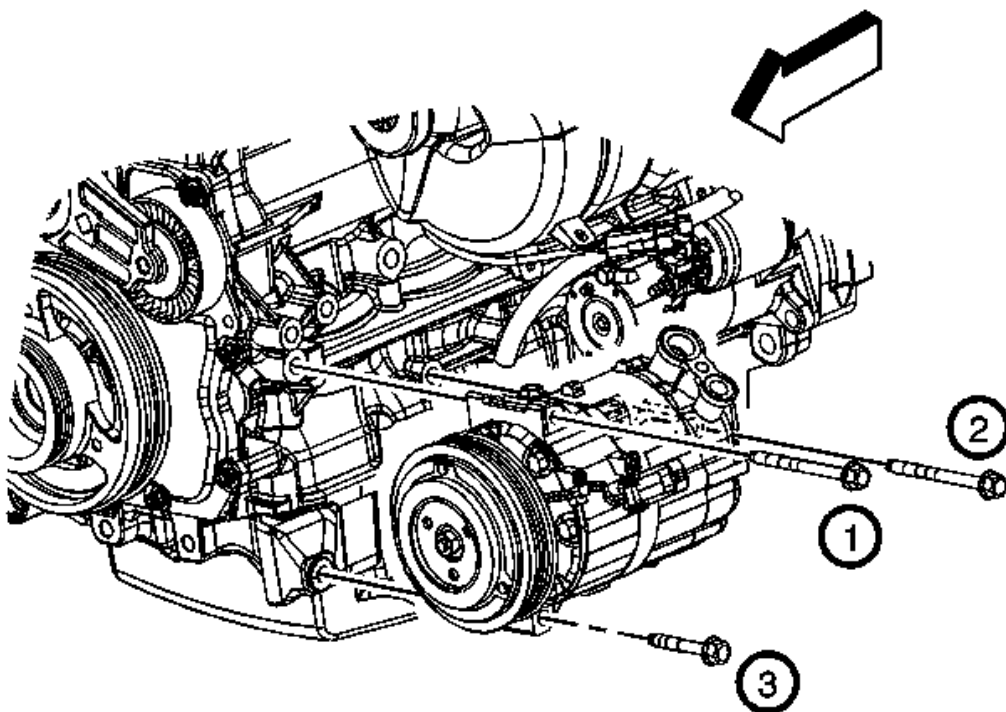


Fig. 318: Identifying A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

81. Remove the A/C compressor bolt and compressor.

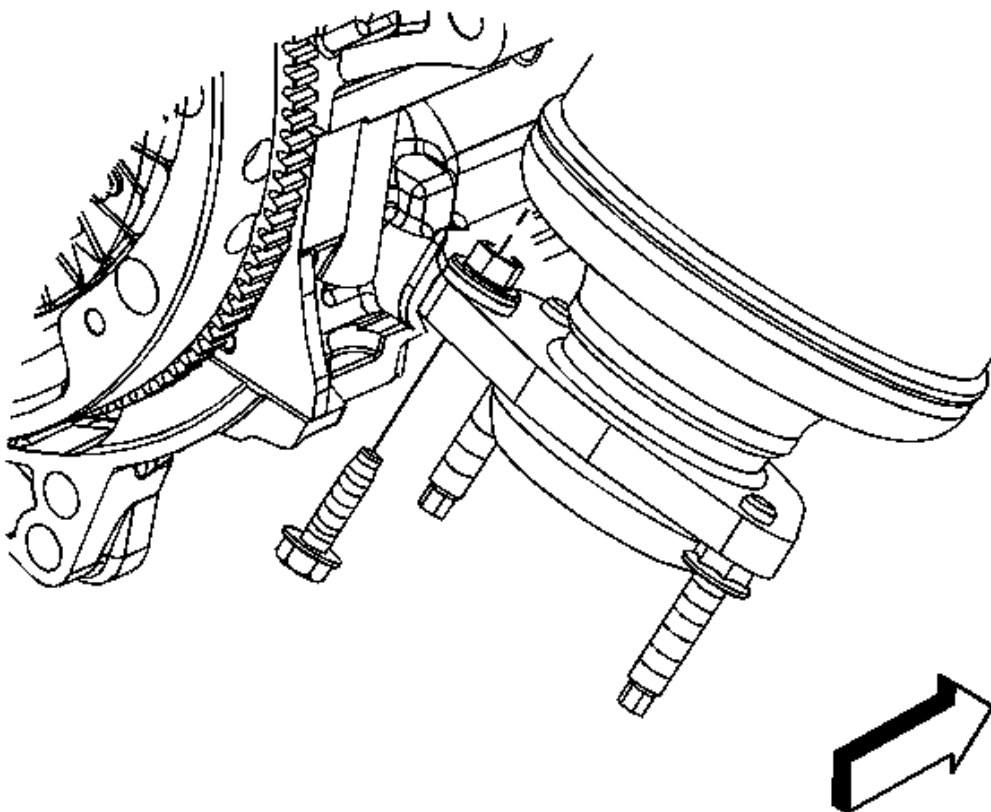


Fig. 319: View Of Catalytic Converter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

82. Remove the catalytic converter to bracket bolt.

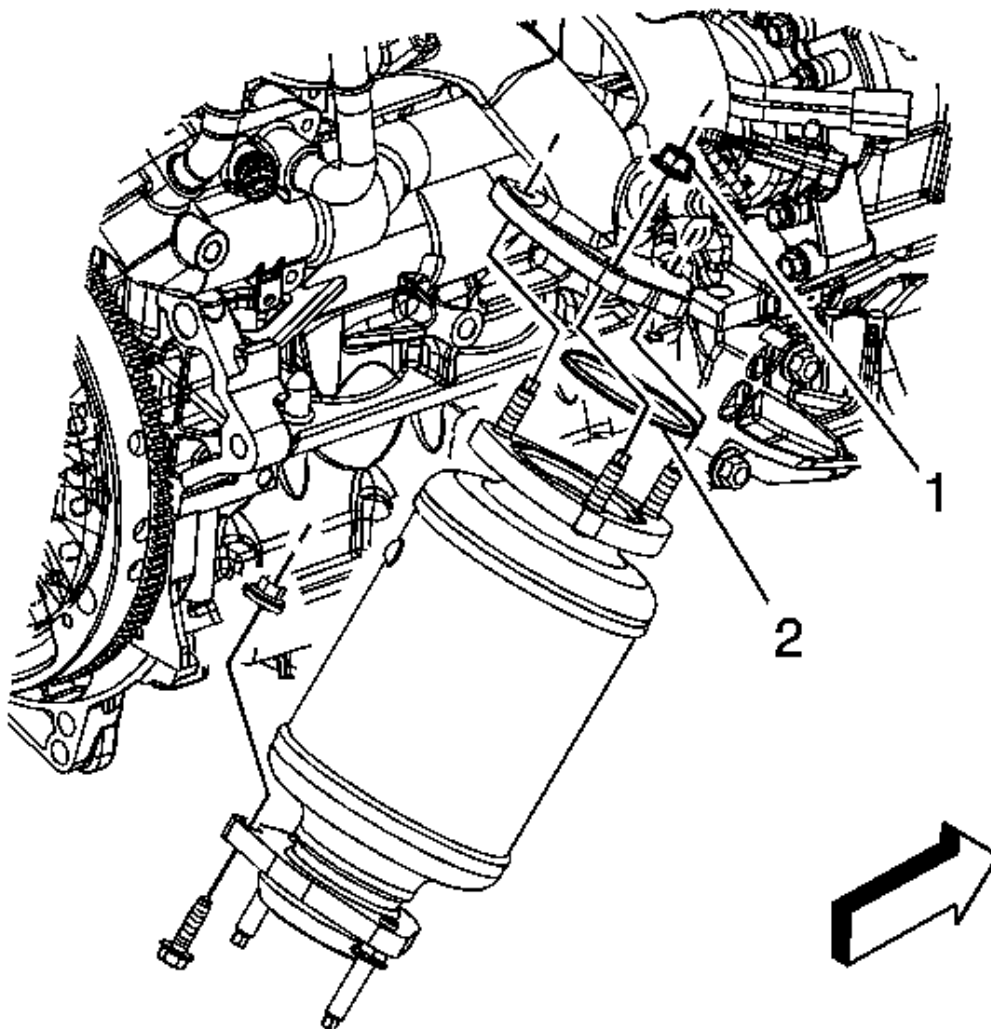


Fig. 320: View Of Catalytic Converter, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

83. Remove the catalytic converter nuts (1).
84. Remove the catalytic converter gasket (2) and converter from the engine.

INSTALLATION PROCEDURE

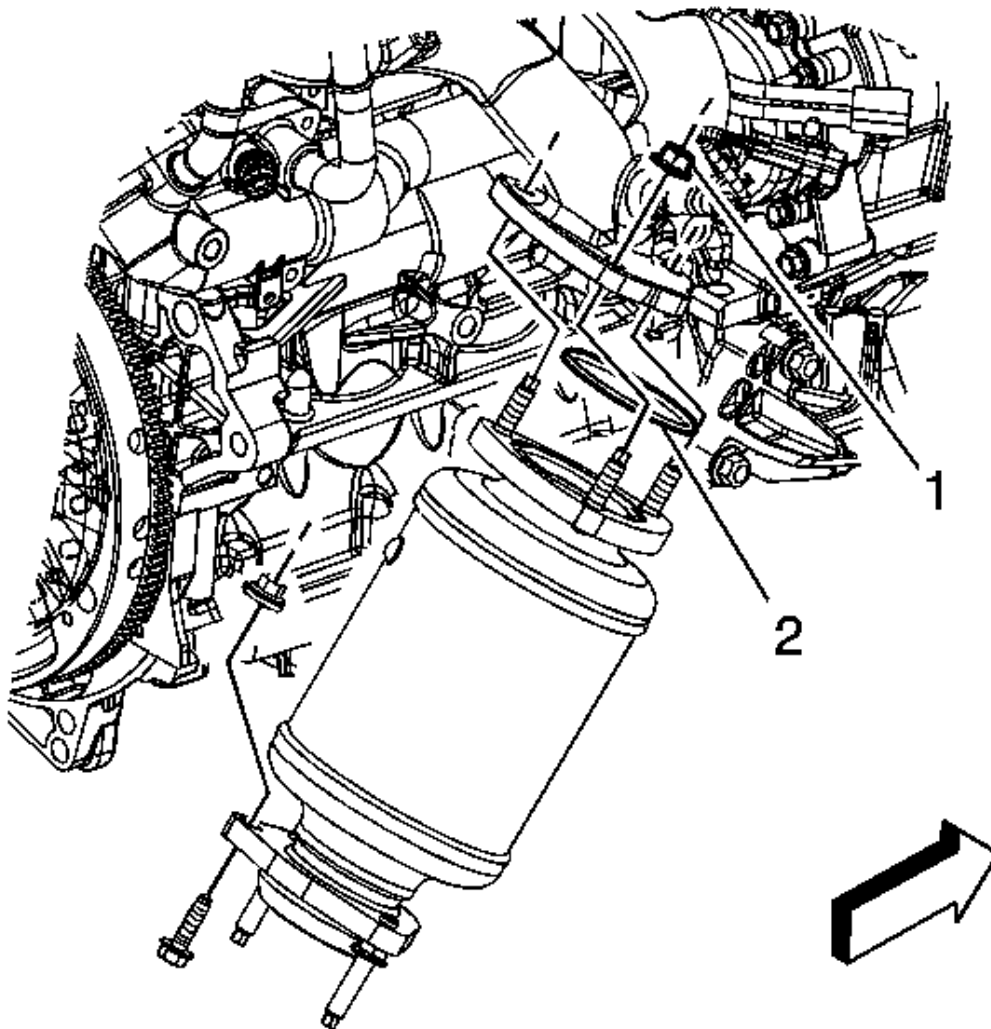


Fig. 321: View Of Catalytic Converter, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the catalytic converter gasket (2) and converter to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the catalytic converter nuts (1).

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

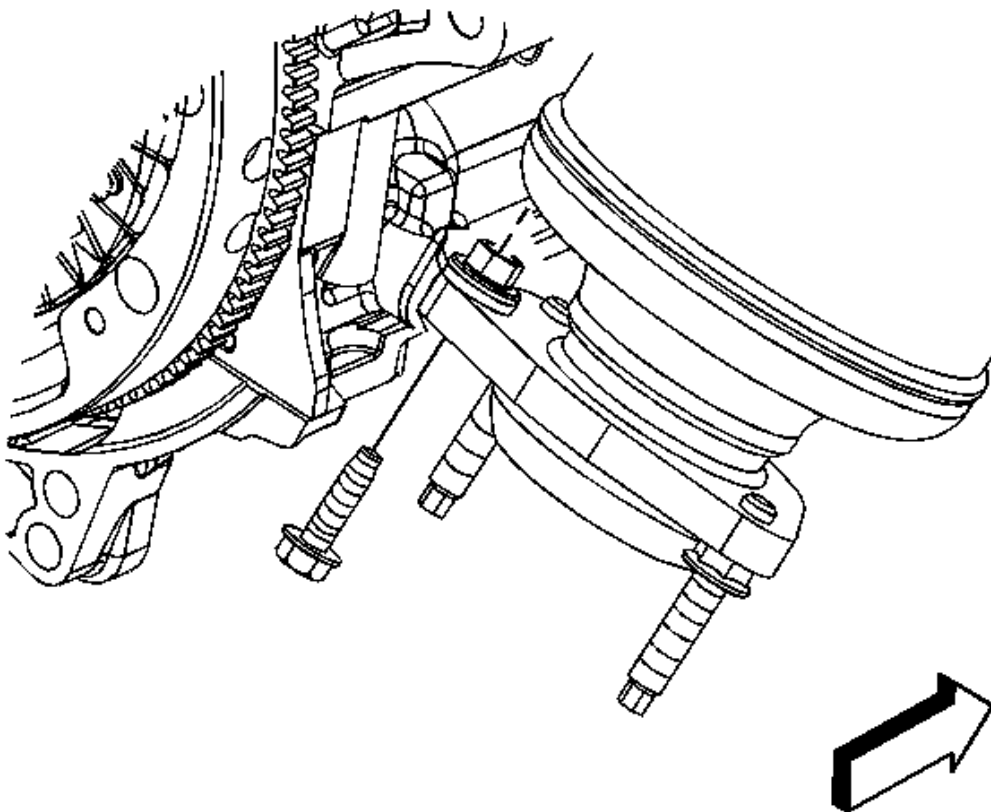


Fig. 322: View Of Catalytic Converter Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the catalytic converter to bracket bolt.

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

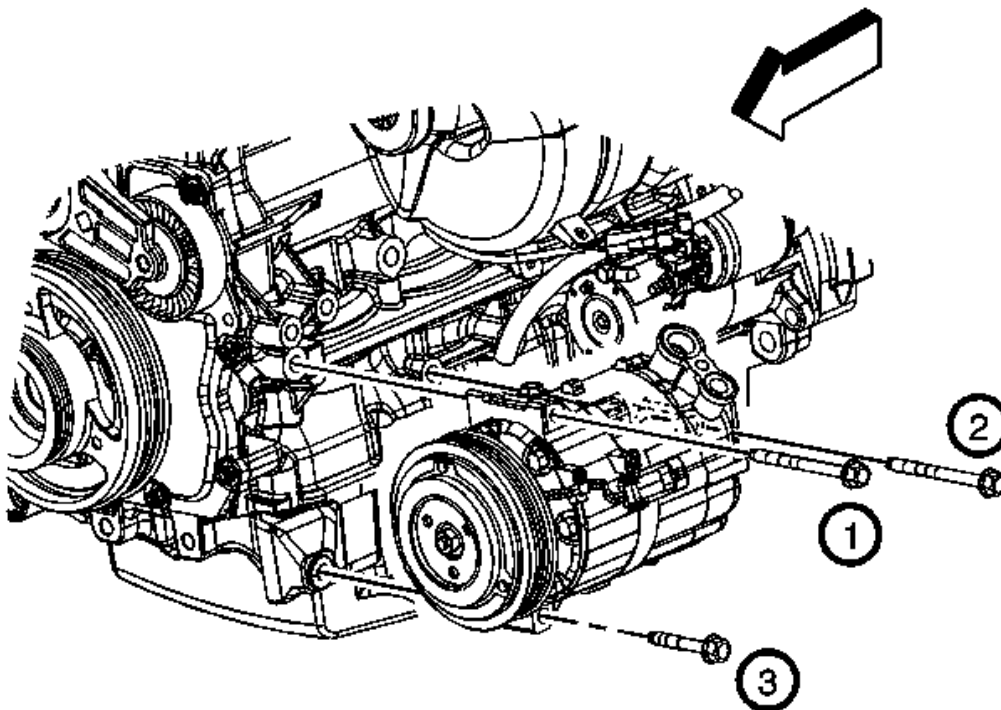


Fig. 323: Identifying A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the A/C compressor and bolts.

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

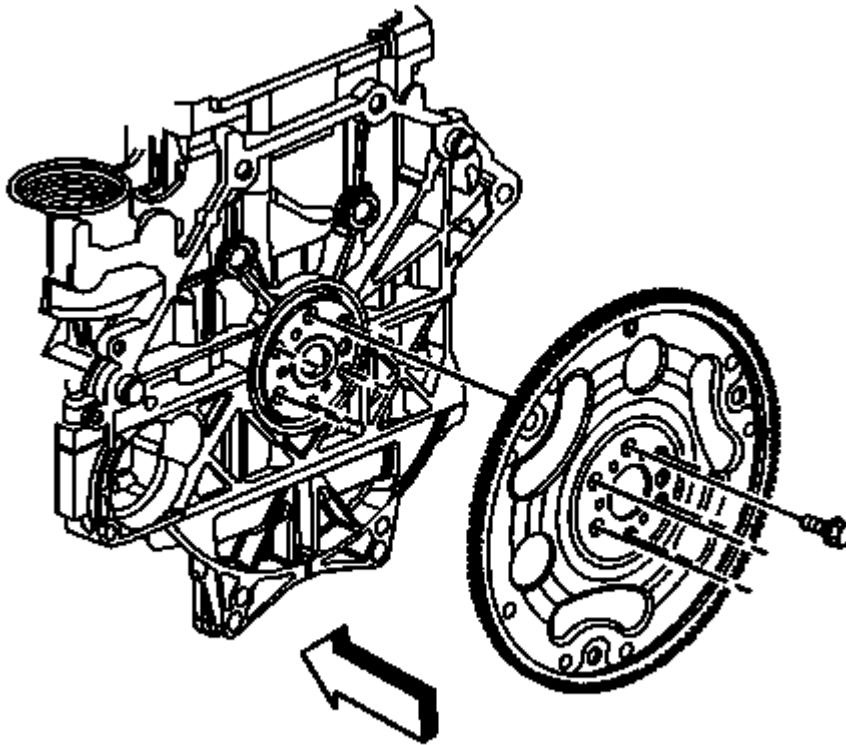


Fig. 324: View Of Flywheel (Automatic Transaxle)
Courtesy of GENERAL MOTORS CORP.

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

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

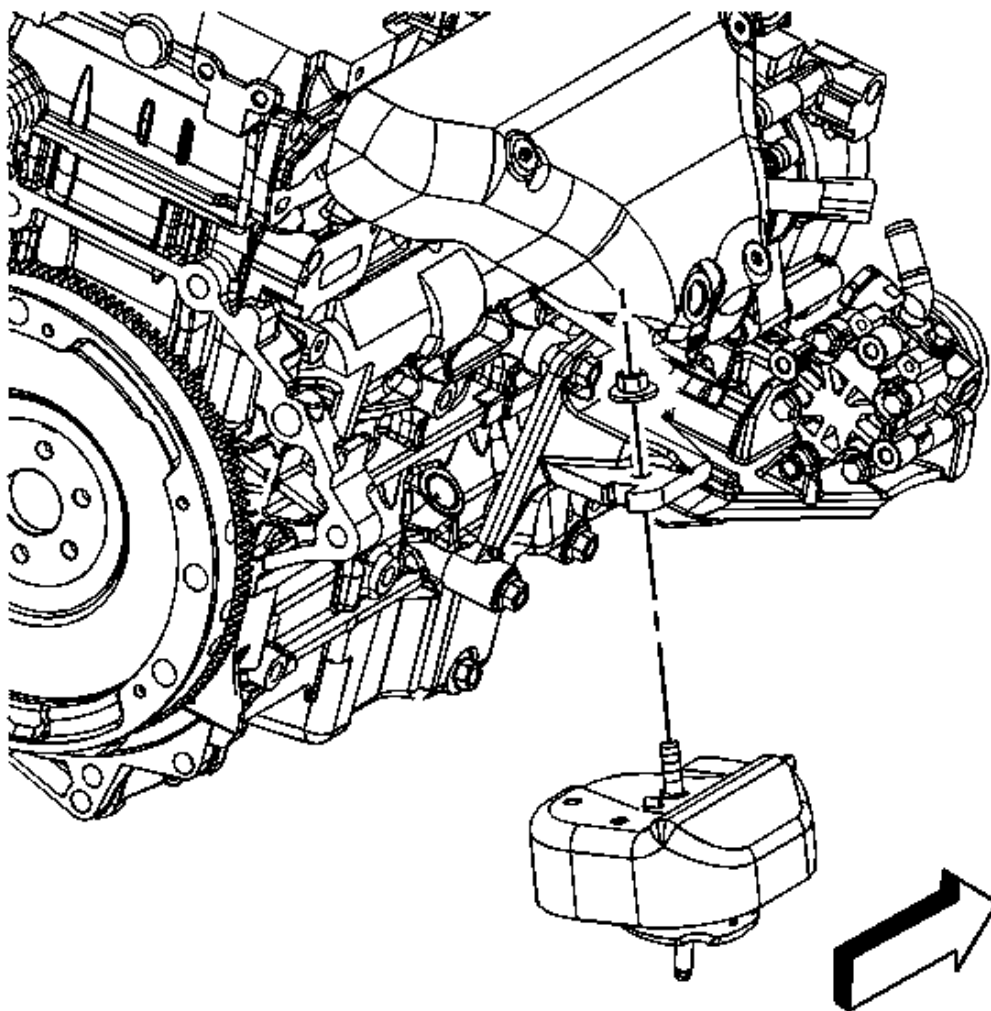


Fig. 325: View Of Right Engine Mount Upper Nut
Courtesy of GENERAL MOTORS CORP.

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

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

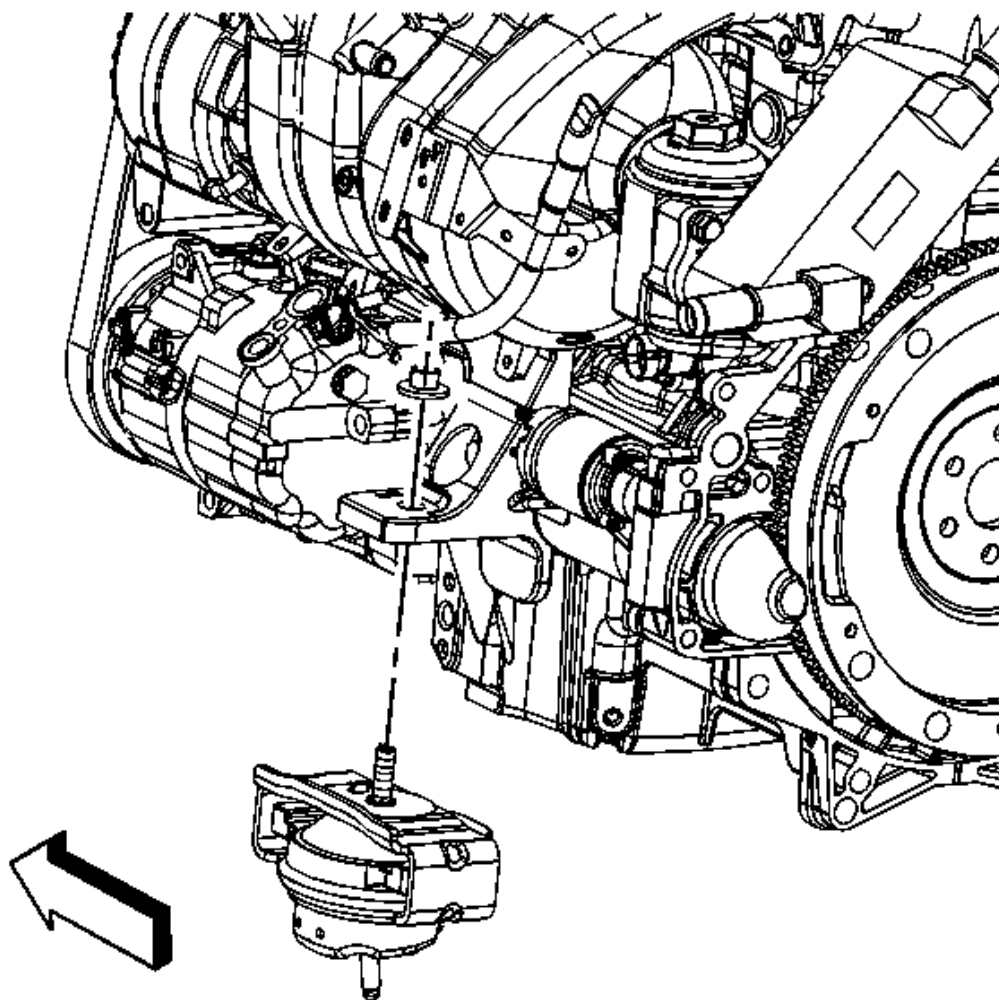


Fig. 326: View Of Left Engine Mount
 Courtesy of GENERAL MOTORS CORP.

11. Install the left engine mount upper nut.

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

12. Remove the **J 42451-1** from the engine.
13. Raise and support the vehicle.

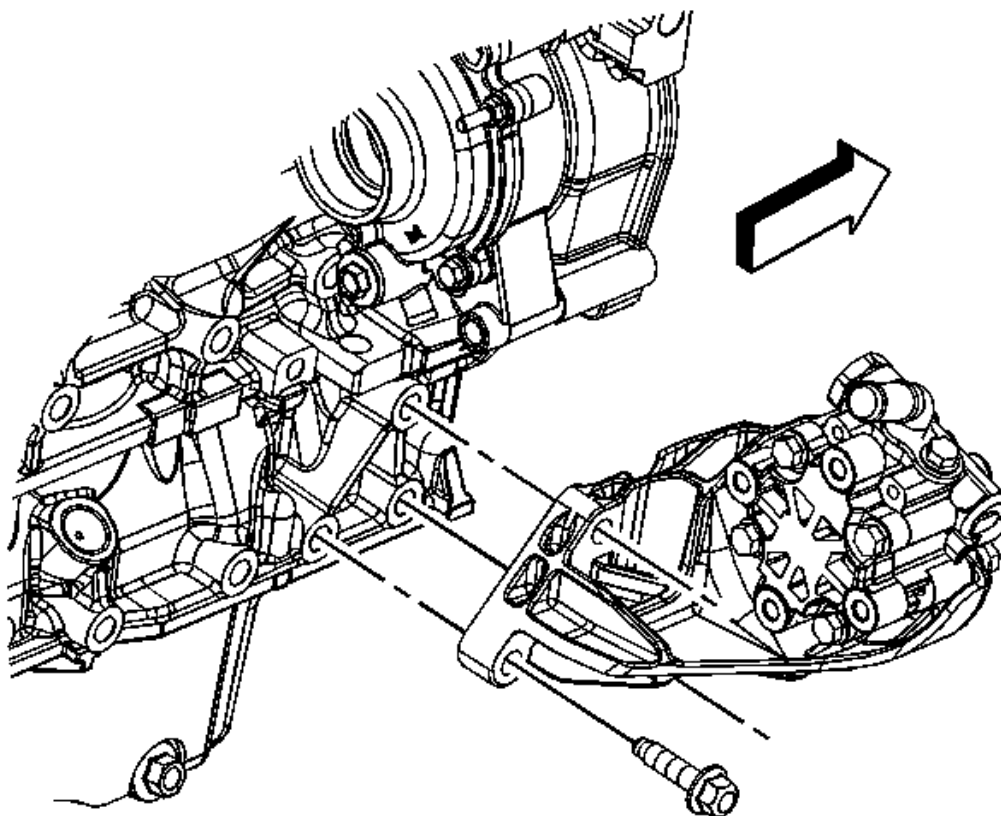


Fig. 327: View Of Power Steering Pump, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

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

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

15. Lower the vehicle.

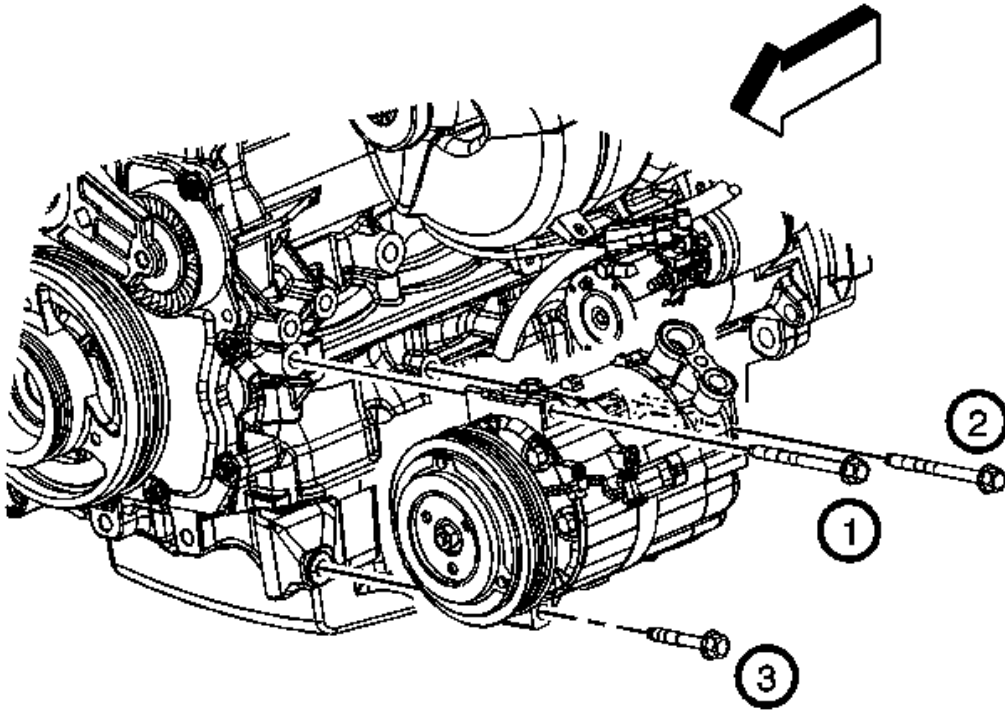


Fig. 328: Identifying A/C Compressor & Bolts
 Courtesy of GENERAL MOTORS CORP.

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

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

17. Install the transmission. Refer to **Transmission Replacement**.
18. Lower the vehicle.

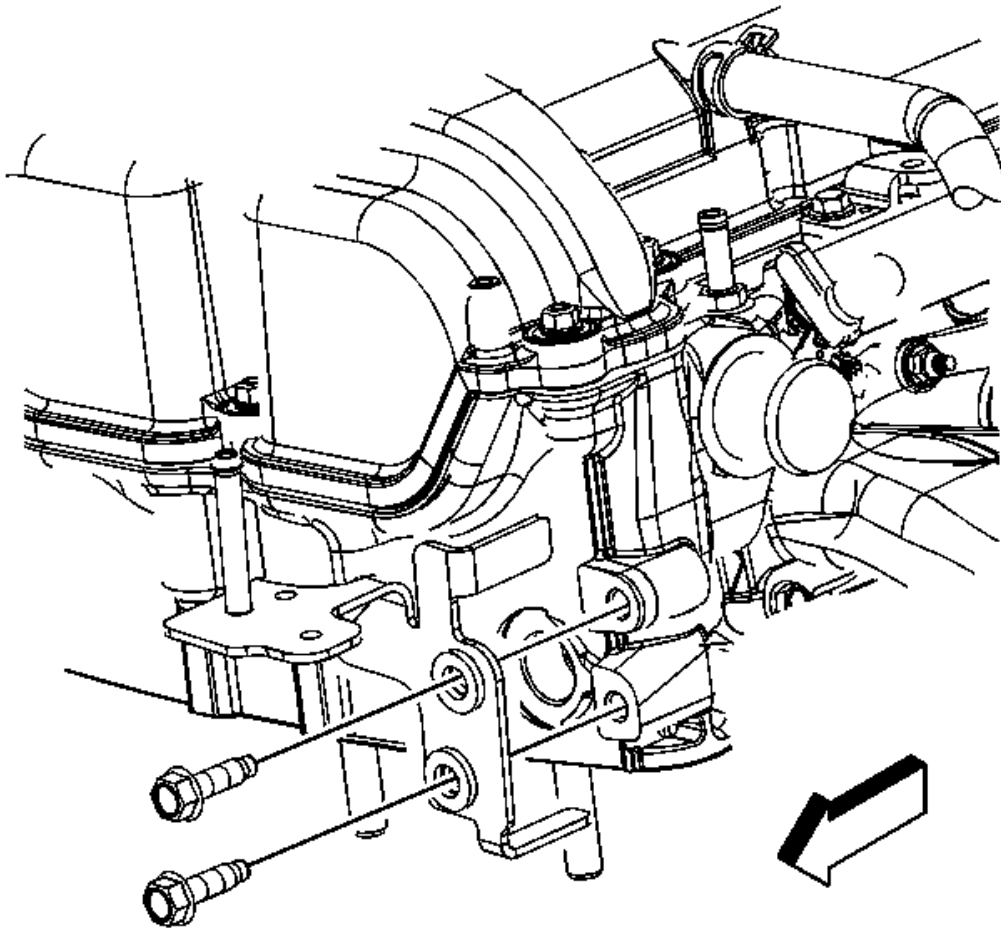


Fig. 329: View Of Intake Manifold Cover Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the intake manifold cover bracket and bolts.

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

20. Position the branches of the engine harness to the engine.

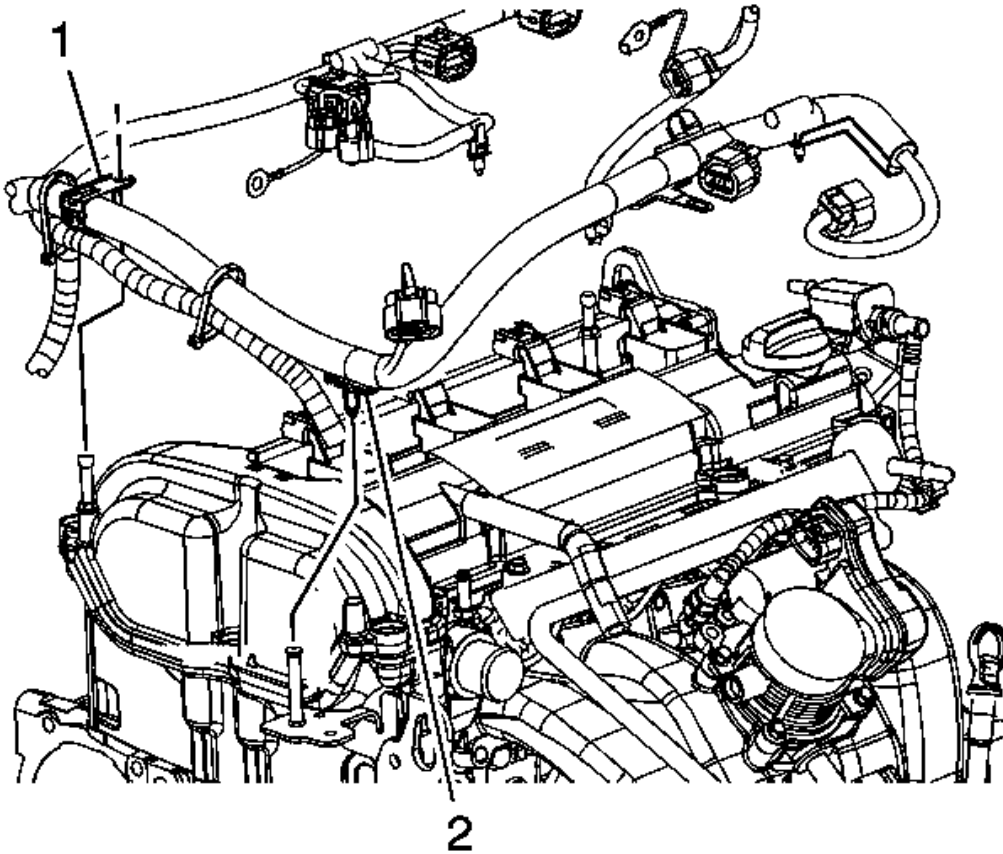


Fig. 330: Identifying Engine Harness Bracket
 Courtesy of GENERAL MOTORS CORP.

21. Connect the engine harness clip (2) to the bracket.
22. Install the engine harness bracket (1) to the intake manifold cover stud.
23. Install the EVAP canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

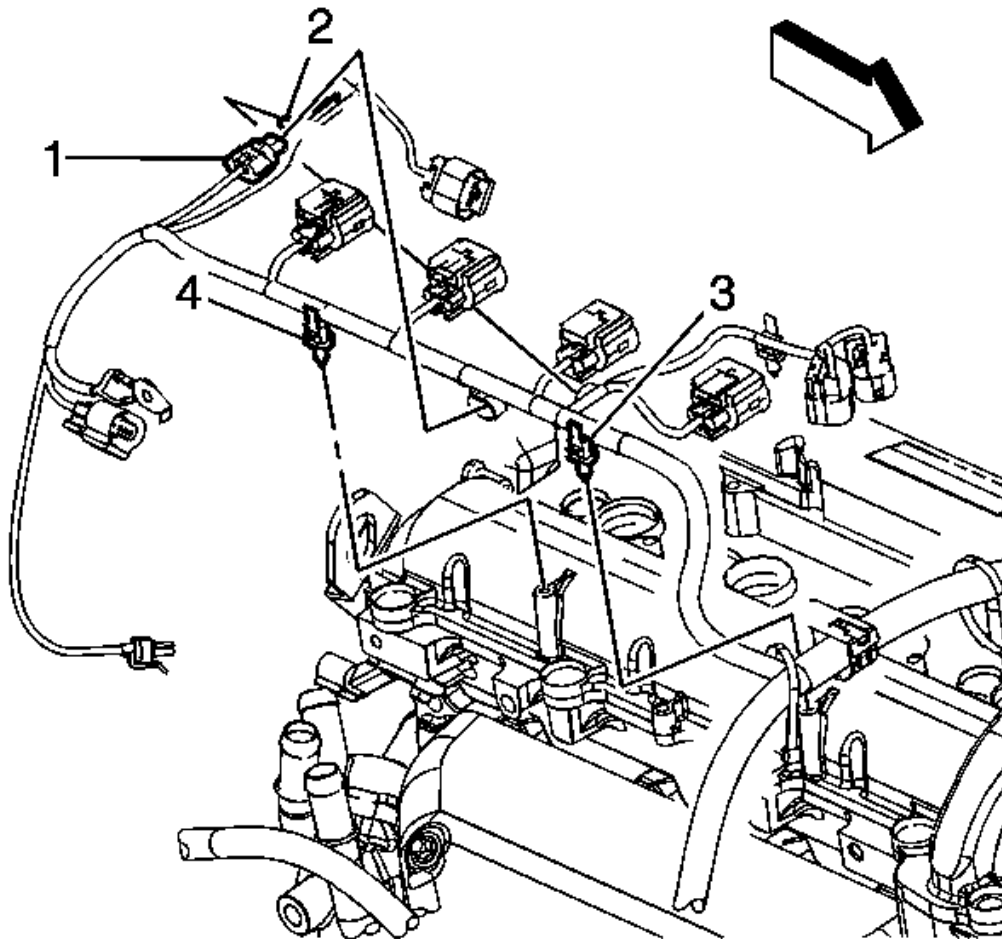


Fig. 331: Locating EVAP Canister Purge Valve Electrical Connector & Harness Clips
Courtesy of GENERAL MOTORS CORP.

24. Connect the engine harness clips (3, 4) to the camshaft cover.
25. Connect the engine harness clip (2) to the EVAP canister purge solenoid valve bracket.
26. Connect the engine wiring harness electrical connector (1) to the EVAP canister purge solenoid.

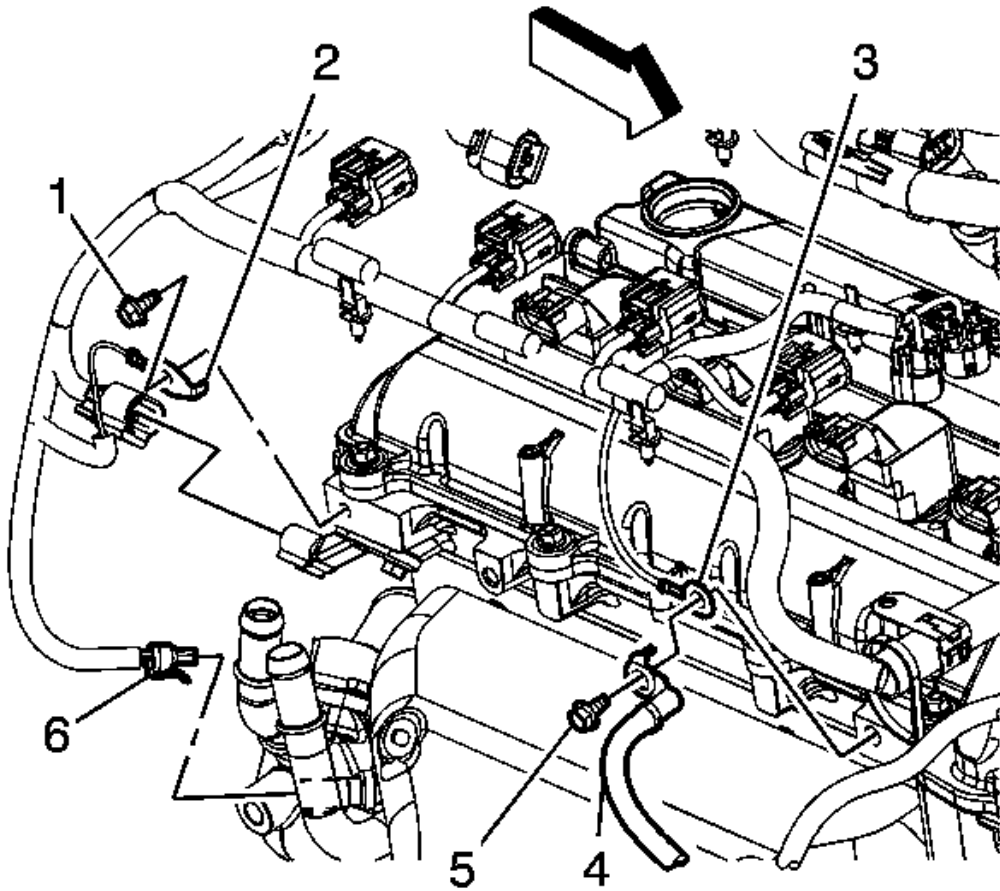


Fig. 332: View Of CMP Sensor & ECT Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

27. Connect the engine wiring harness electrical connector (6) to the ECT sensor.
28. Position the engine wiring harness ground terminal (2) and install the bolt (1).

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

29. Connect the engine wiring harness electrical connector to the exhaust CMP sensor.

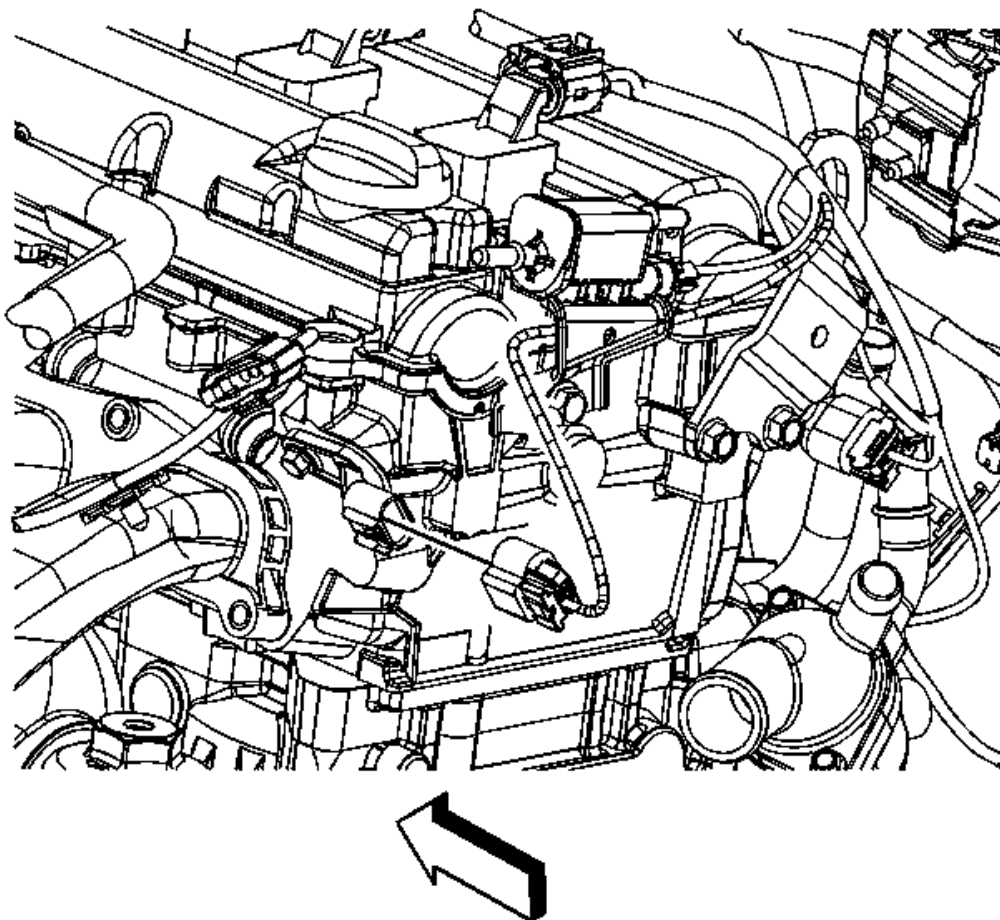


Fig. 333: View Of Intake CMP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

30. Connect the engine wiring harness electrical connector to the intake CMP sensor.

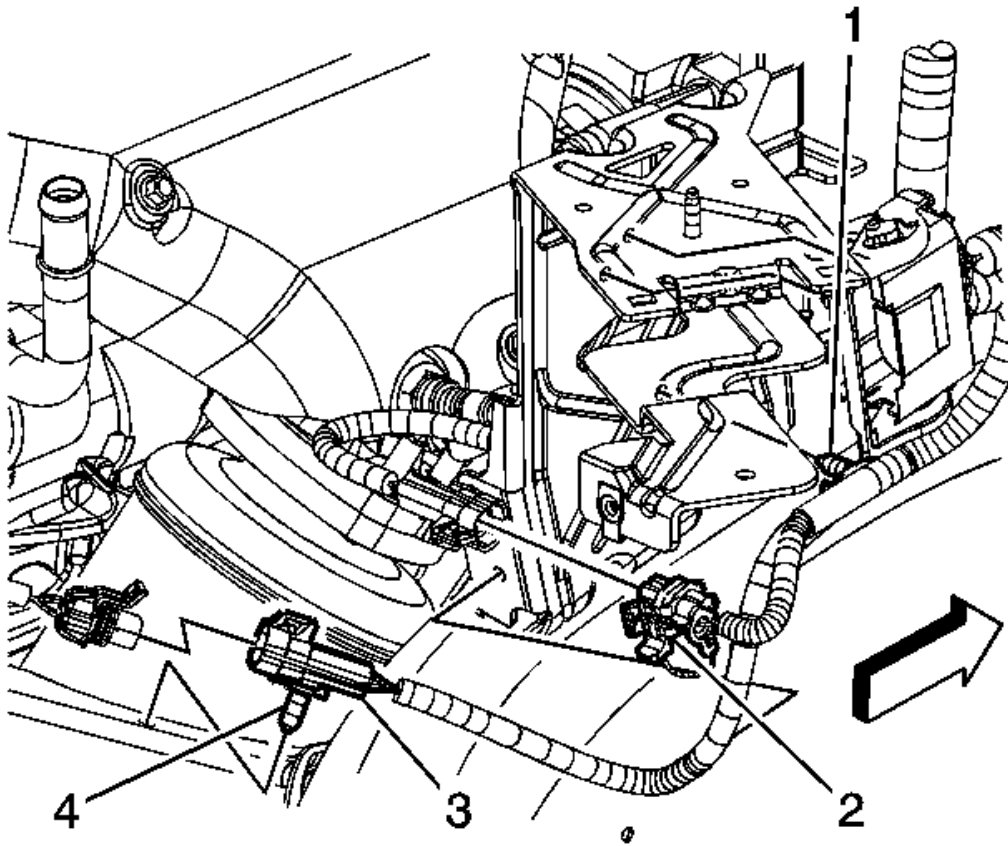


Fig. 334: Identifying CPA Retainer & HO2S Electrical Connector
Courtesy of GENERAL MOTORS CORP.

31. Connect the HO2S electrical connector clip (4) to the strut.
32. Connect the engine harness clips (1) to the junction block bracket.
33. Connect the engine wiring harness electrical connector (2) to the rear HO2S.
34. Connect the engine wiring harness electrical connector (1) to the front HO2S.
35. Install the CPA retainers to the HO2S electrical connectors.

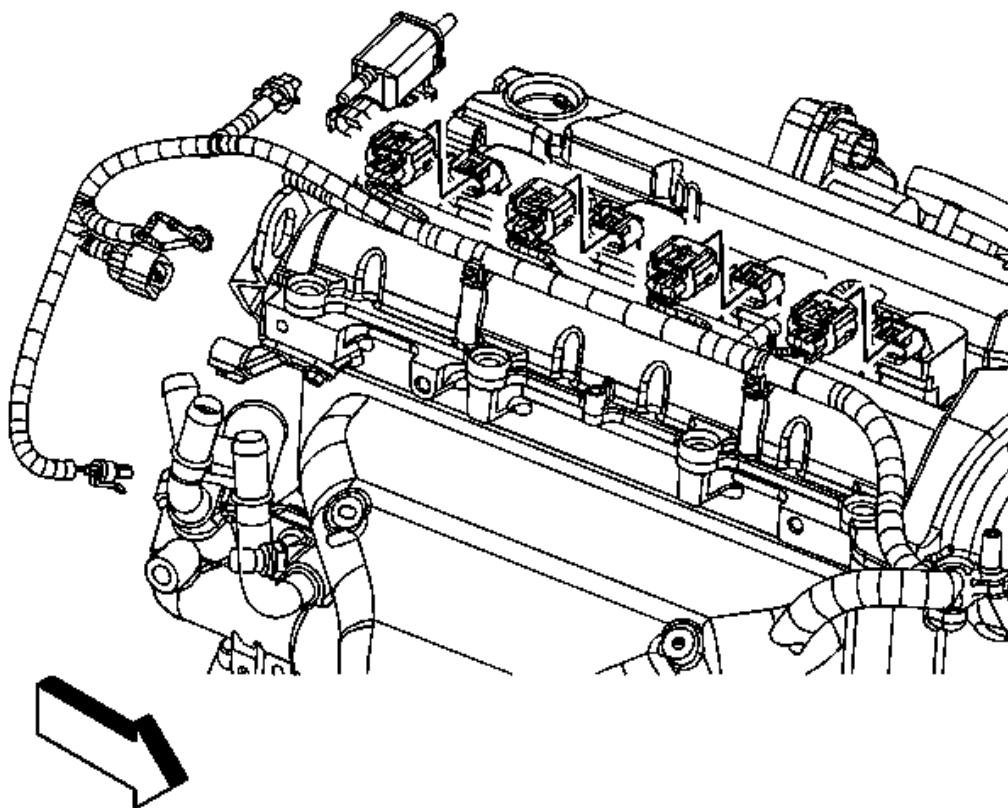


Fig. 335: View Of Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

36. Connect the engine wiring harness electrical connectors to the ignition coils.

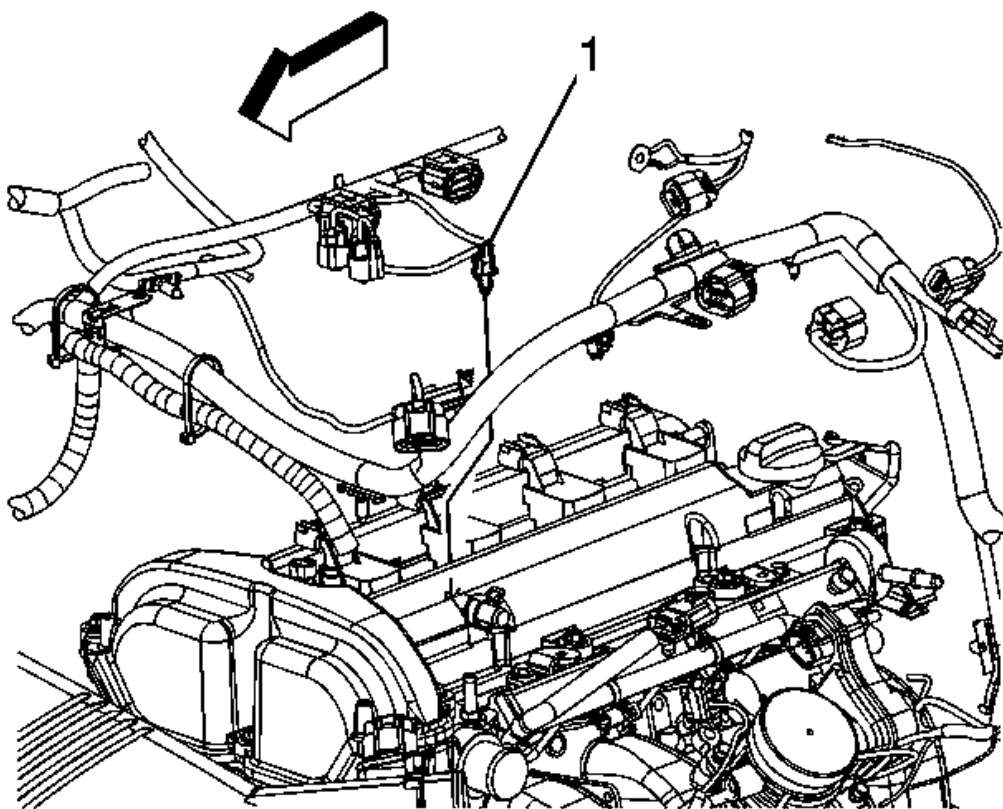


Fig. 336: Identifying Cam Cover Engine Harness Clip
Courtesy of GENERAL MOTORS CORP.

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

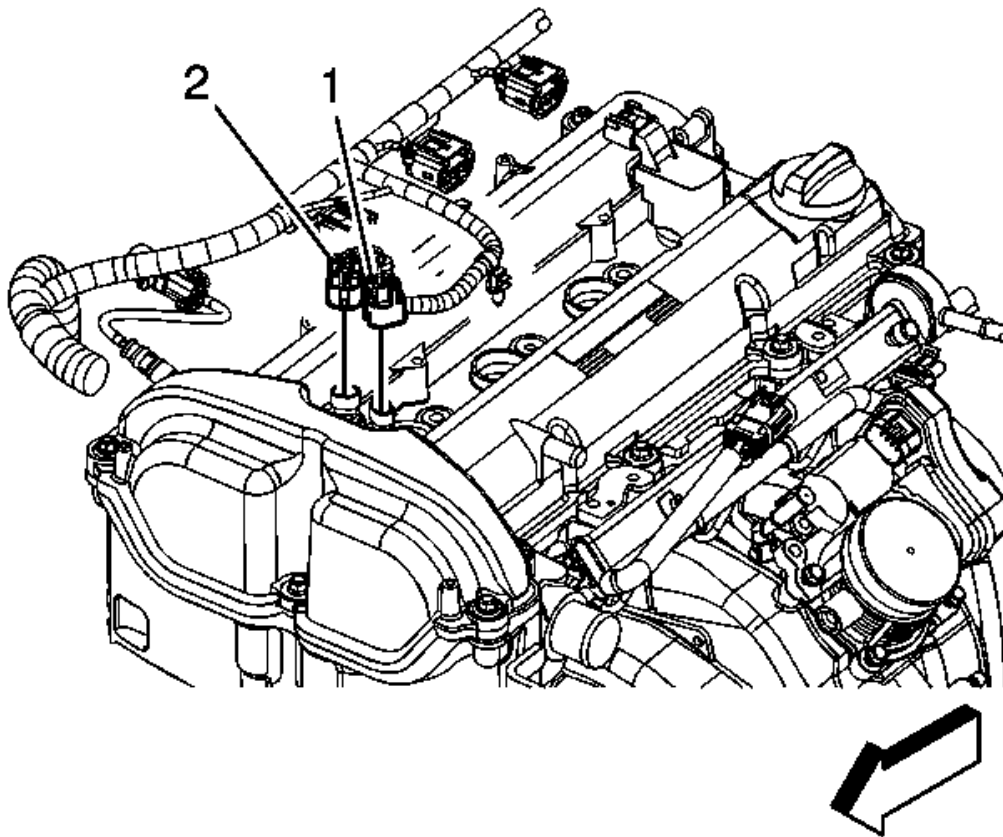


Fig. 337: Identifying Camshaft Position Actuator Solenoid Valve Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

38. Connect the engine wiring harness electrical connector (2) to the exhaust CMP actuator.
39. Connect the engine wiring harness electrical connector (1) to the intake CMP actuator.

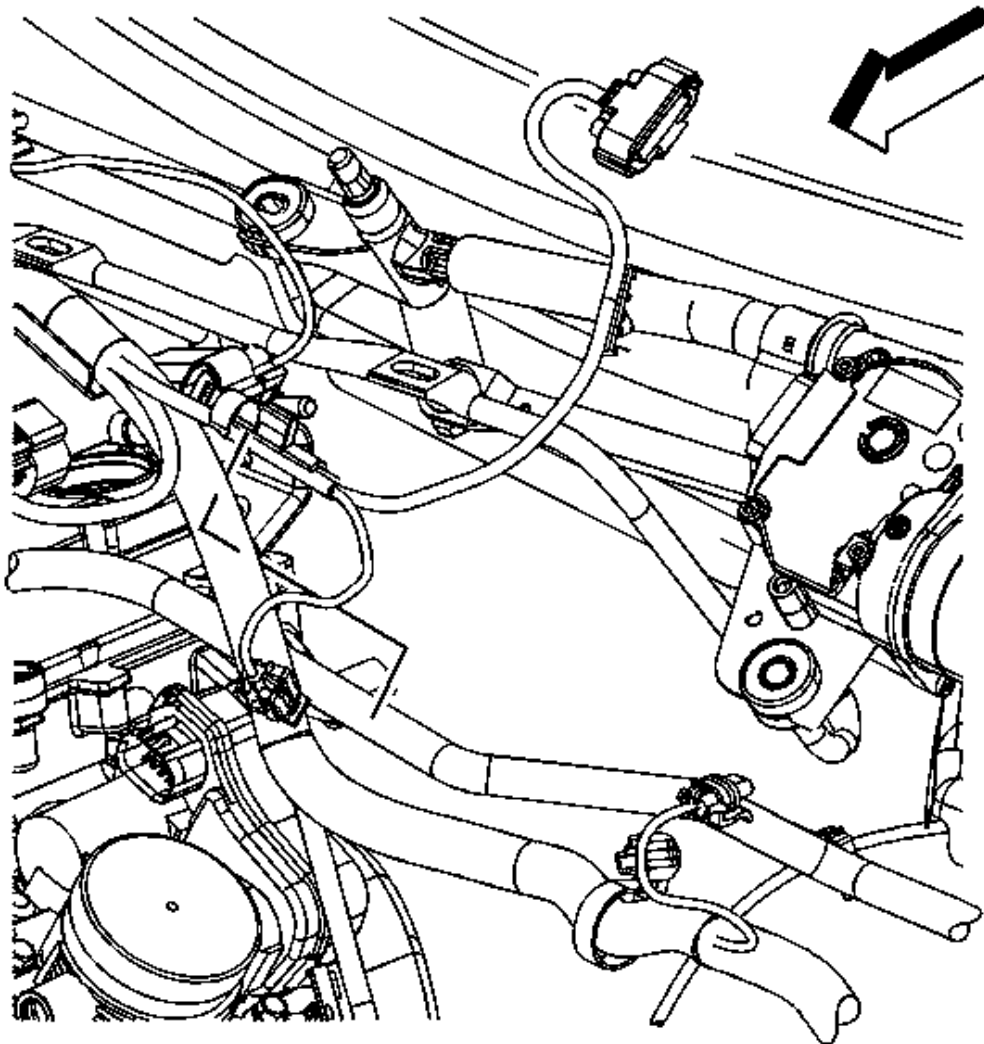


Fig. 338: View Of Engine Harness Clip To Surge Tank Air Bleed Hose
Courtesy of GENERAL MOTORS CORP.

40. Install the engine harness clip to the surge tank air bleed hose.

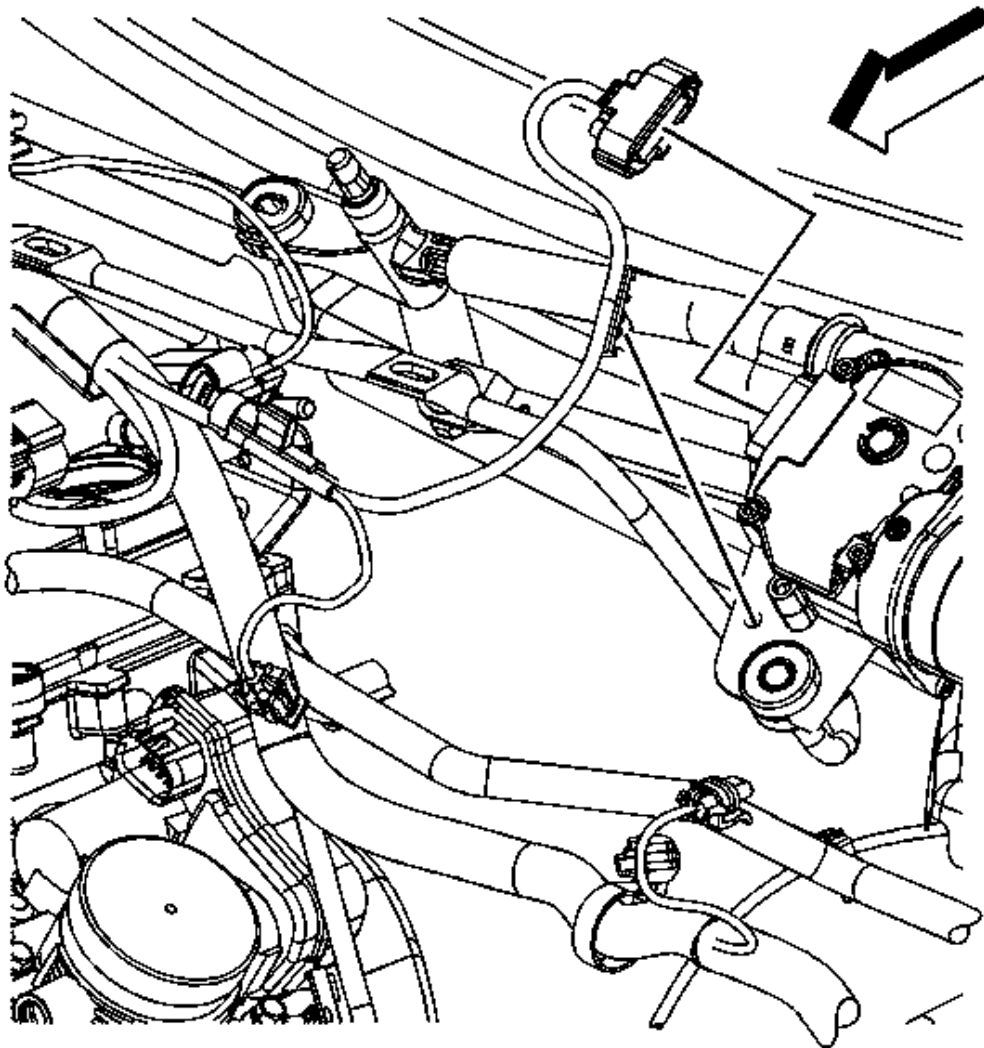


Fig. 339: Identifying Windshield Wiper Motor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

41. Connect the engine wiring harness electrical connector to the windshield wiper motor.
42. Install the engine harness clip to the wiper motor hole.

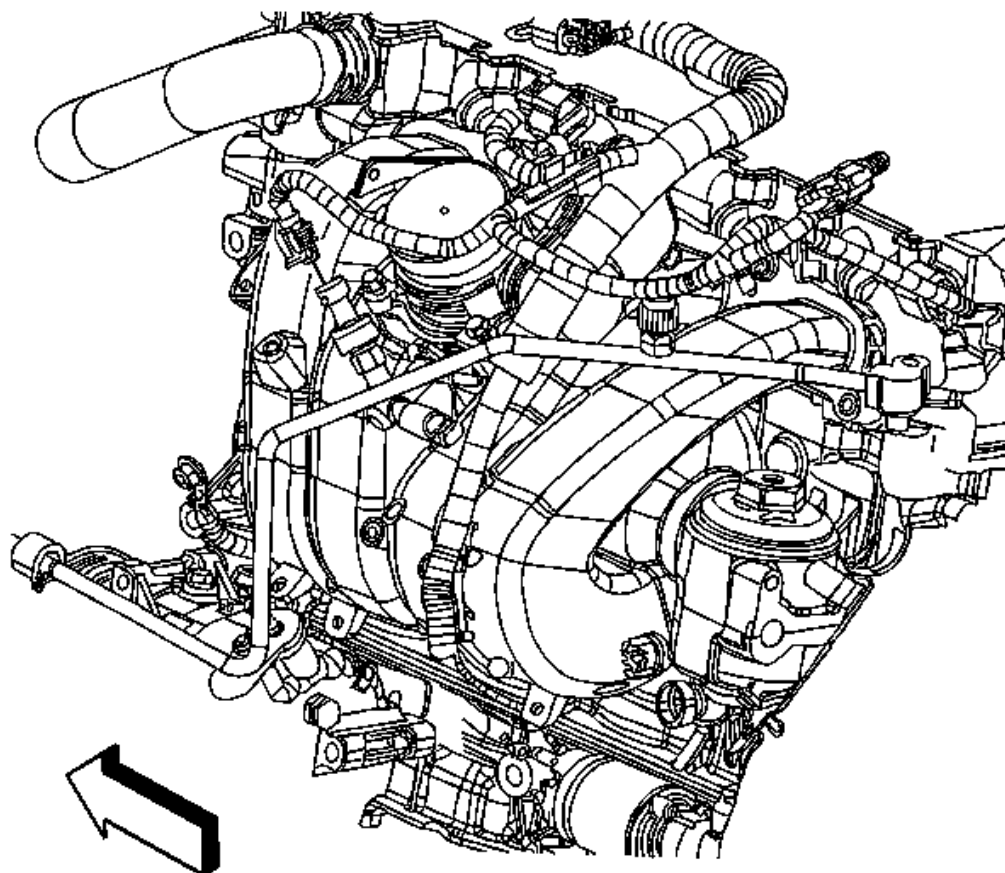


Fig. 340: Locating A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

43. Connect the engine wiring harness electrical connector to the A/C refrigerant pressure sensor.

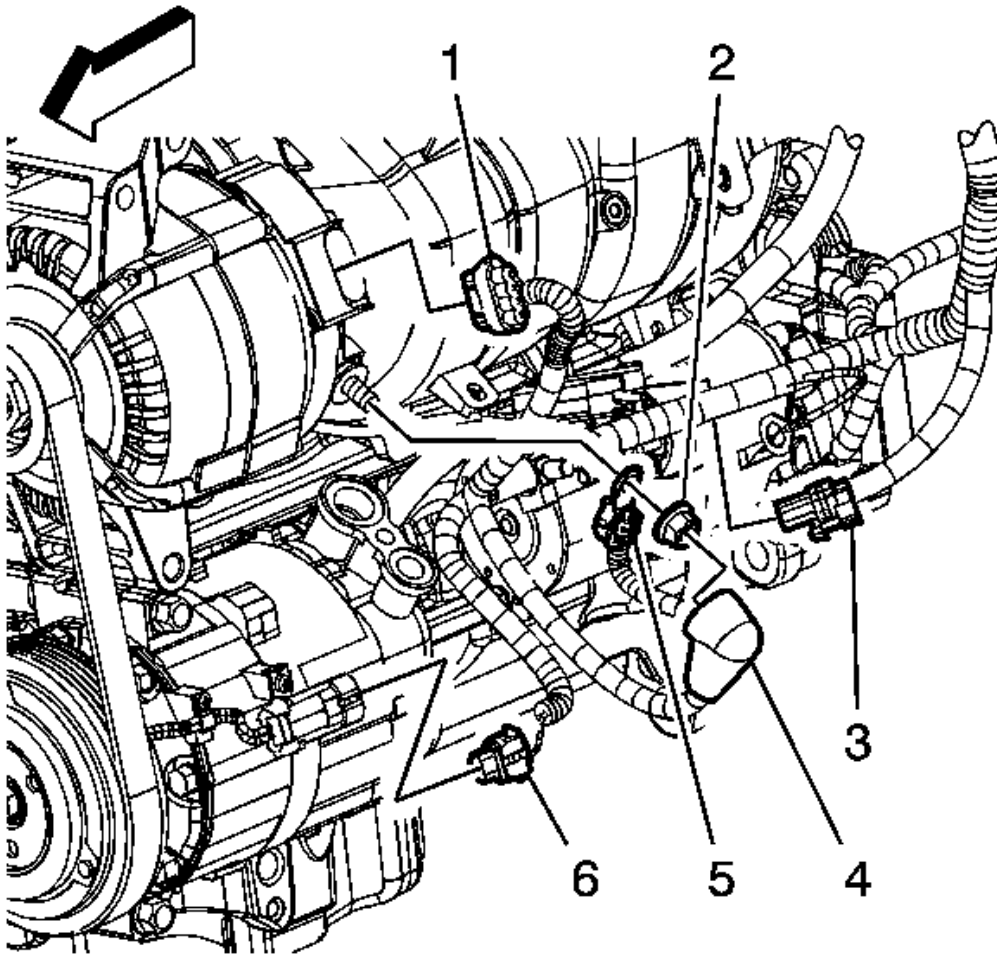


Fig. 341: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

44. Position the negative/positive battery cable.
45. Connect the engine wiring harness electrical connector (6) to the A/C compressor.
46. Install the positive battery cable terminal to the generator (5).
47. Install the generator terminal nut (2).

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

48. Position the positive battery cable terminal boot (4).
49. Connect the engine wiring harness electrical connector (1) to the generator.

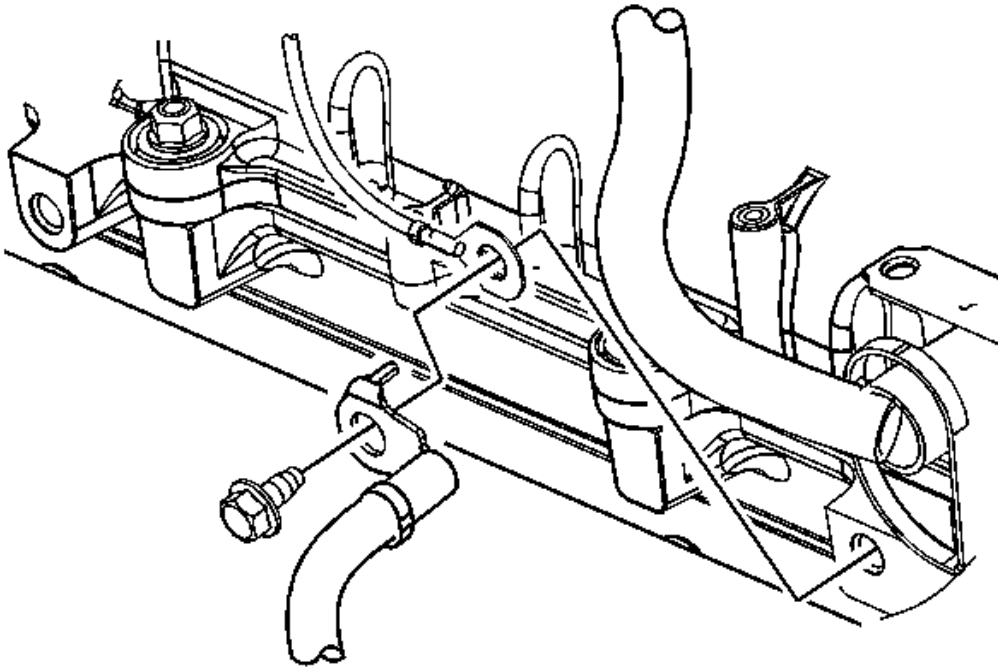


Fig. 342: View Of Negative Battery Cable Ground Bolt
Courtesy of GENERAL MOTORS CORP.

50. Position the engine harness ground terminal behind the negative battery cable terminal and position against the cylinder head.
51. Install the negative battery cable ground terminal bolt.

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

52. Install NEW tie straps to the engine harness.
53. Install the positive battery cable clip to the bracket.
54. Raise and support the vehicle.

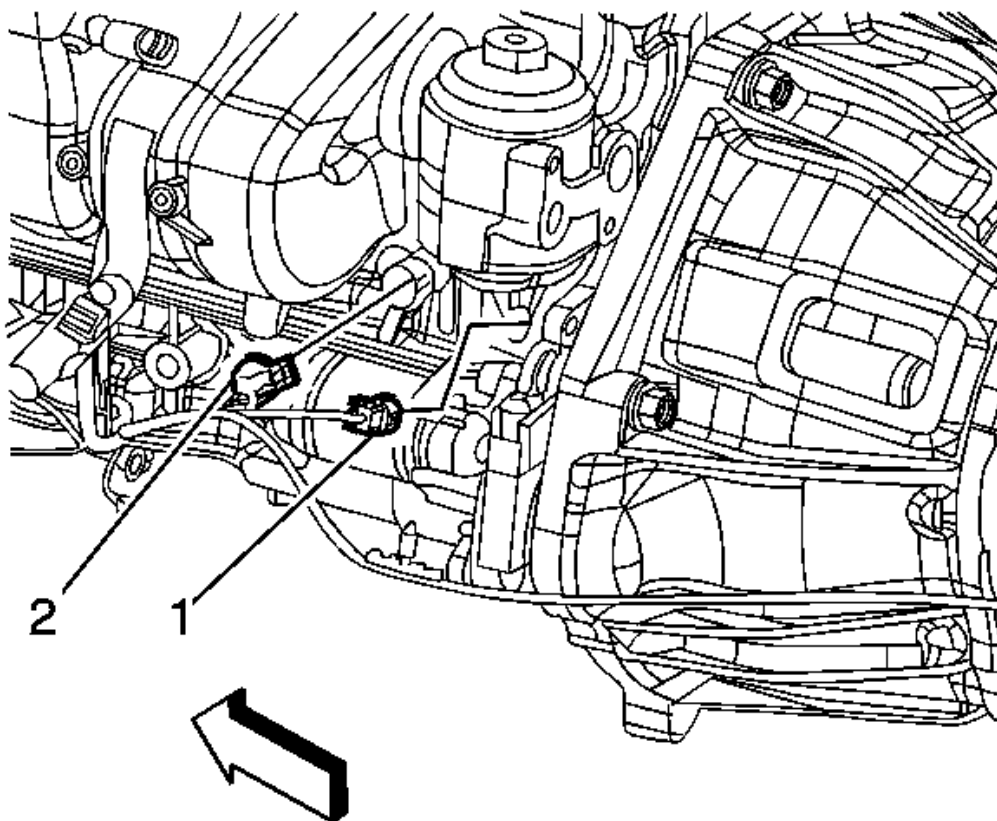


Fig. 343: Identifying CKP & Oil Pressure Sensor Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

55. Connect the engine wiring harness electrical connector (2) to the oil pressure sensor.
56. Connect the engine wiring harness electrical connector (1) to the CKP sensor.
57. Lower the vehicle.

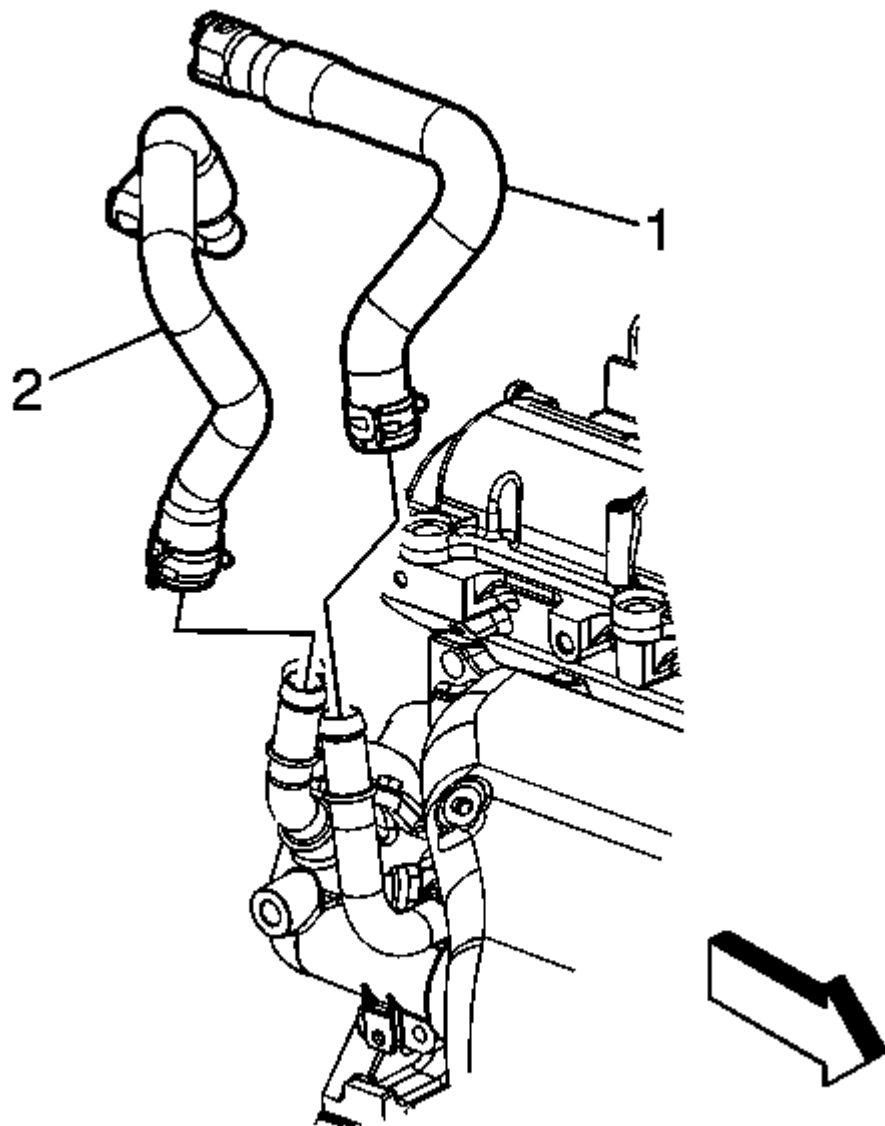


Fig. 344: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS CORP.

58. Install the heater inlet (2) and outlet (1) hoses to the thermostat housing.
59. Position the heater inlet and outlet hose clamps at the thermostat housing.

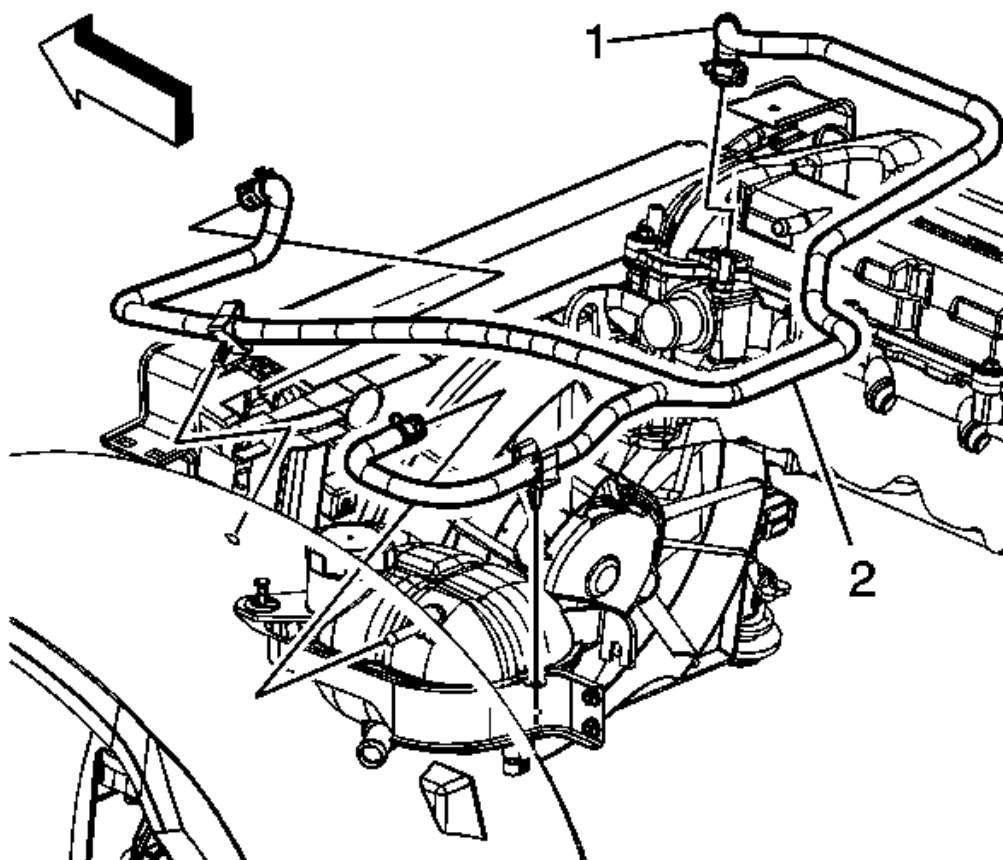


Fig. 345: Identifying Air Bleed Hose & Clamp
 Courtesy of GENERAL MOTORS CORP.

60. Position the air bleed hose (2).
61. Install the surge tank air bleed hose (1) to the engine.
62. Position the surge tank air bleed hose clamp at the engine.

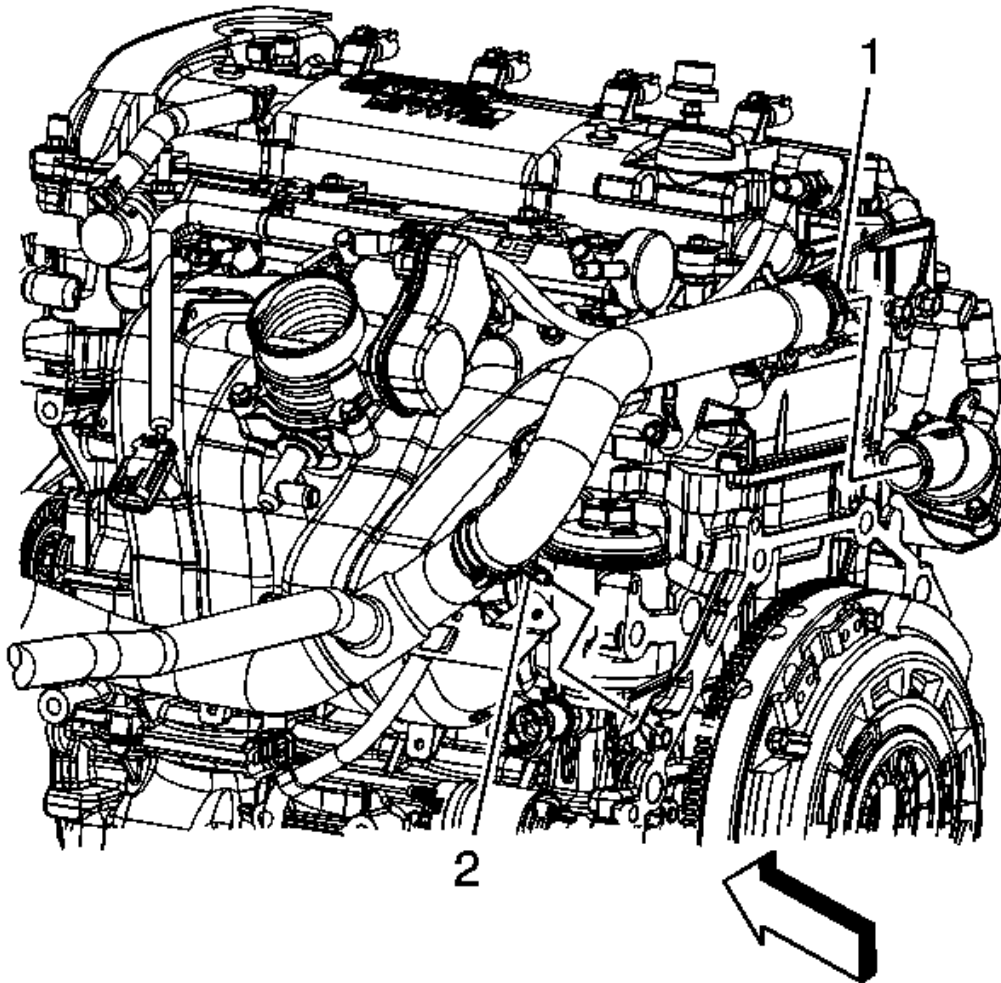


Fig. 346: Identifying Radiator Outlet Hose Clip
Courtesy of GENERAL MOTORS CORP.

63. If the vehicle is not equipped with a engine oil cooler perform the following steps, otherwise proceed to step 66.
64. Install the radiator outlet hose to the thermostat housing.
65. Reposition the radiator outlet hose clamp at the thermostat housing.
66. Install the radiator outlet hose clip (1) to the outlet hose bracket. Proceed to step 71.

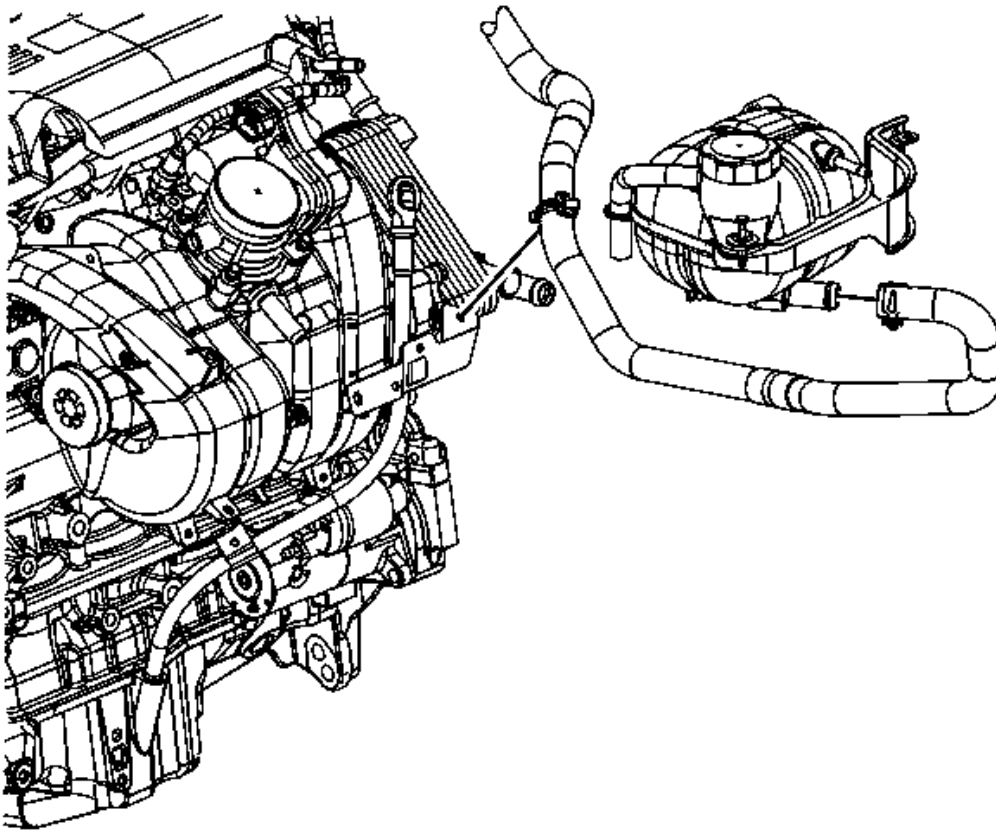


Fig. 347: View Of Radiator Surge Tank
Courtesy of GENERAL MOTORS CORP.

67. If the vehicle is equipped with a engine oil cooler, install the surge tank outlet hose.
68. Install the surge tank clip to the oil level indicator tube bracket.
69. Position the surge tank outlet hose clamp at the surge tank.

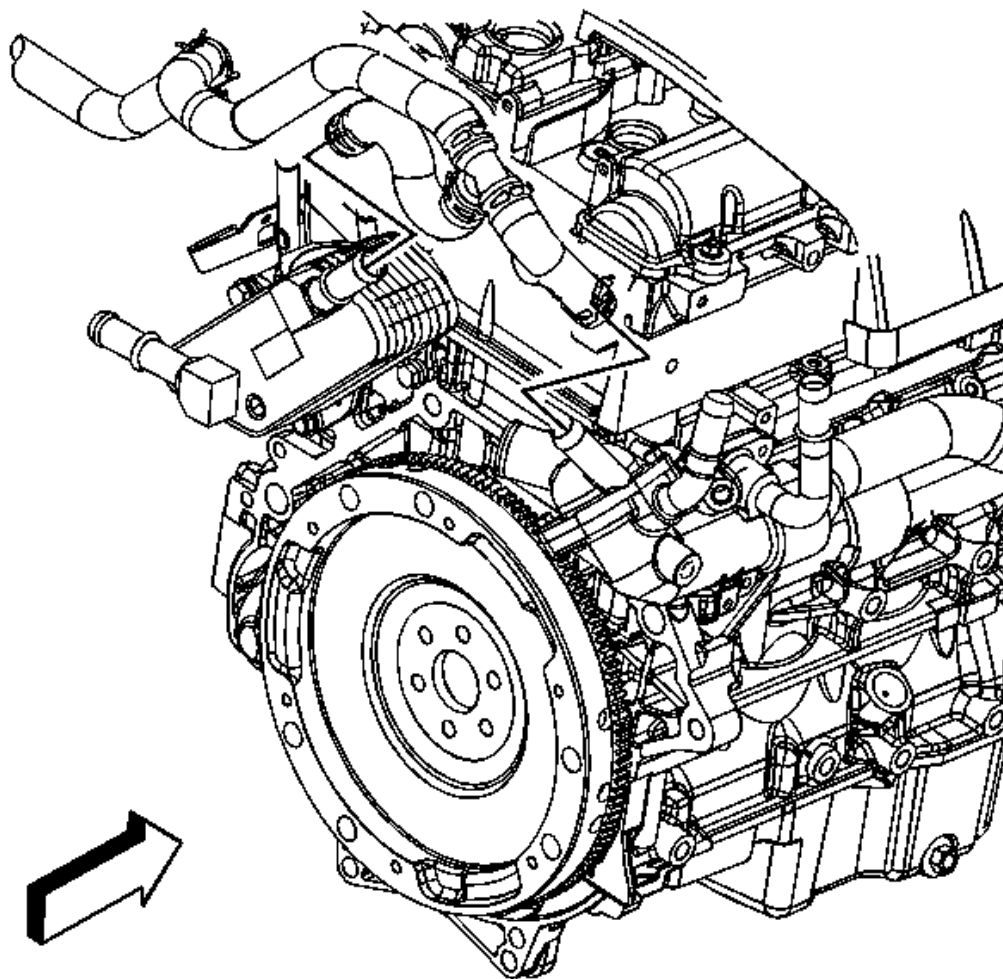


Fig. 348: View Of Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS CORP.

70. Install the surge tank outlet hose to the thermostat housing and oil cooler.
71. Position the surge tank outlet hose clamps at the thermostat housing and oil cooler.

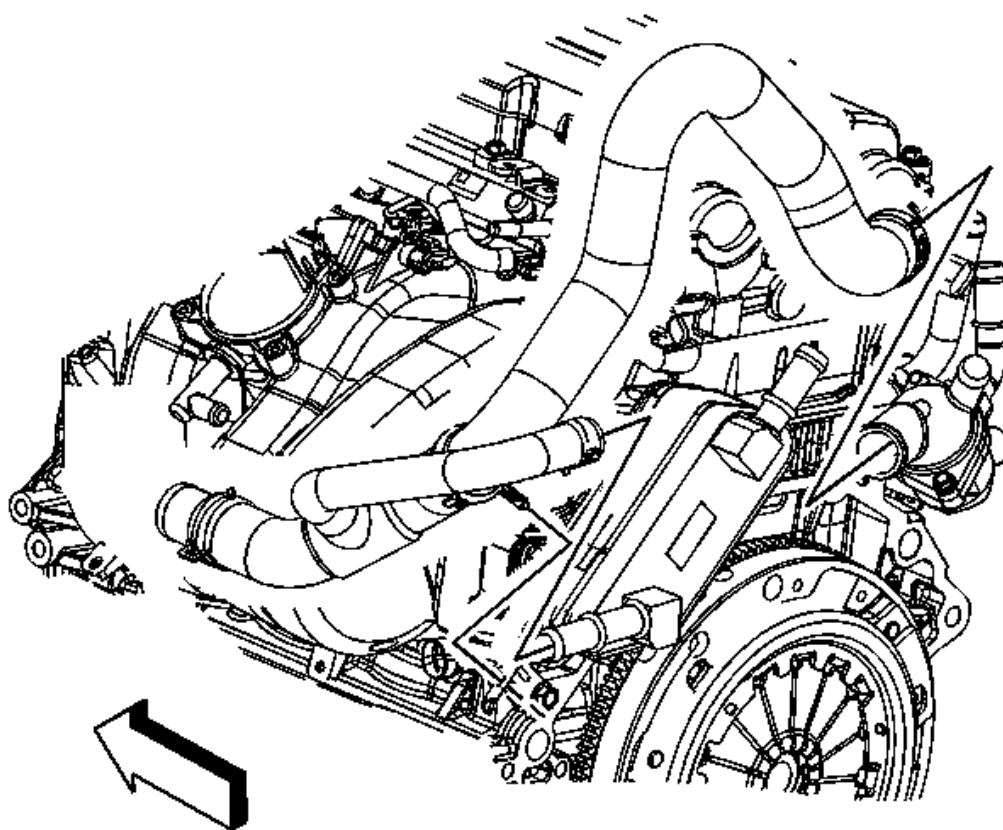


Fig. 349: View Of Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

72. Position the outlet hose.
73. Install the radiator outlet hose to the thermostat housing and oil cooler.
74. Position the radiator outlet hose clamps at the thermostat housing and oil cooler.

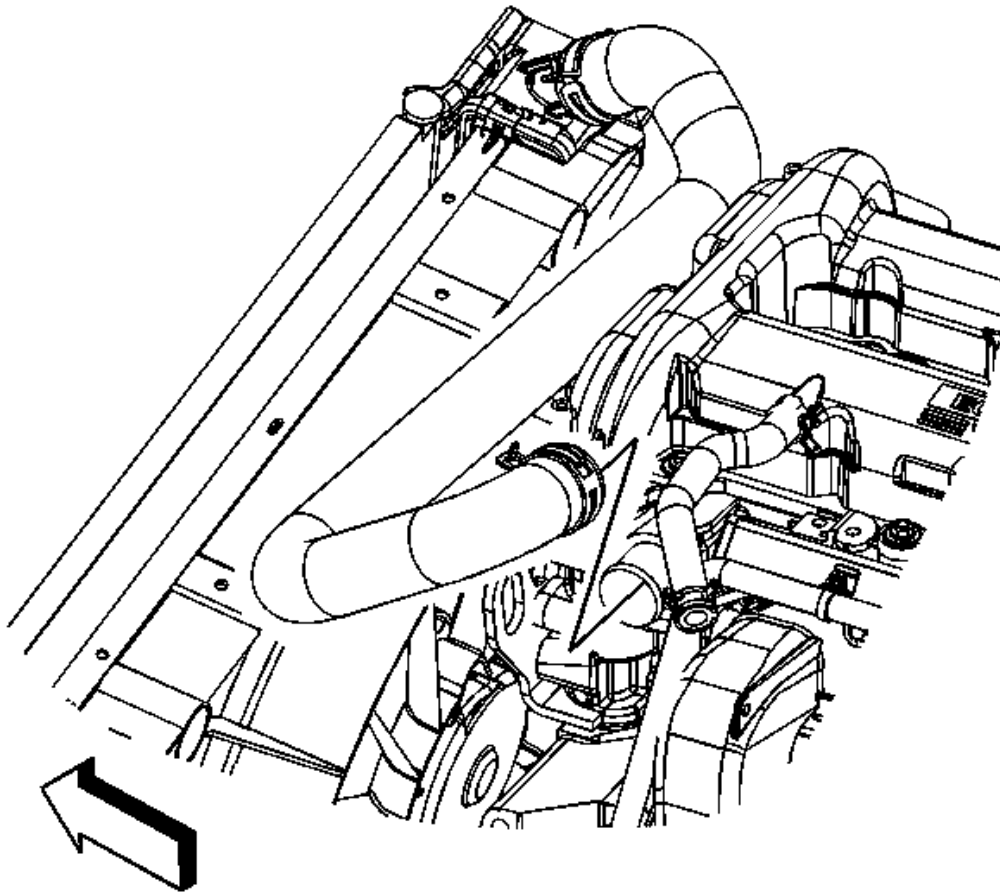


Fig. 350: View Of Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

75. Install the radiator inlet hose.
76. Position the radiator inlet hose clamp at the engine.
77. Install the starter. Refer to **Starter Replacement** .
78. Install the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement (SKY)** or **Air Inlet Grille Panel Replacement (Solstice)** .

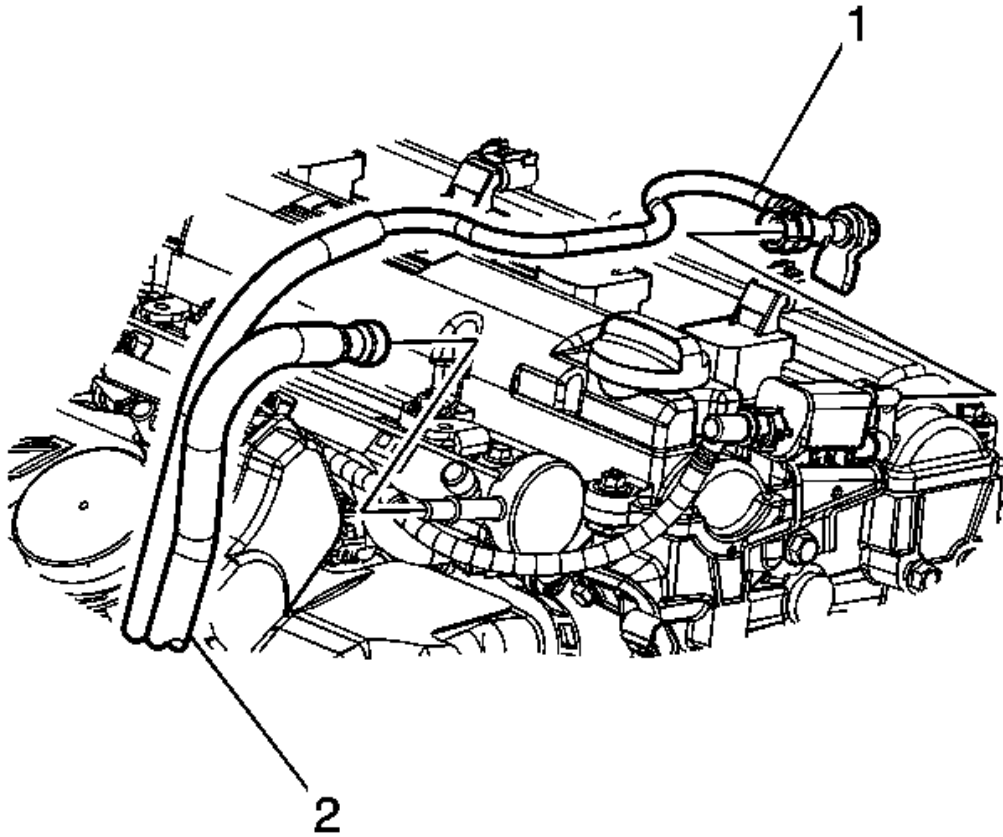


Fig. 351: View Of Fuel Feed Pipe & EVAP Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

79. Connect the fuel feed pipe (2) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
80. Connect the EVAP canister purge solenoid tube to the valve (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
81. Install the radiator. Refer to **Radiator Replacement** .
82. Install the drive belt. Refer to **Drive Belt Replacement (With A/C)** or **Drive Belt Replacement (Without A/C)**.
83. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
84. Install the hood. Refer to **Hood Replacement** .
85. Fill the engine oil.

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

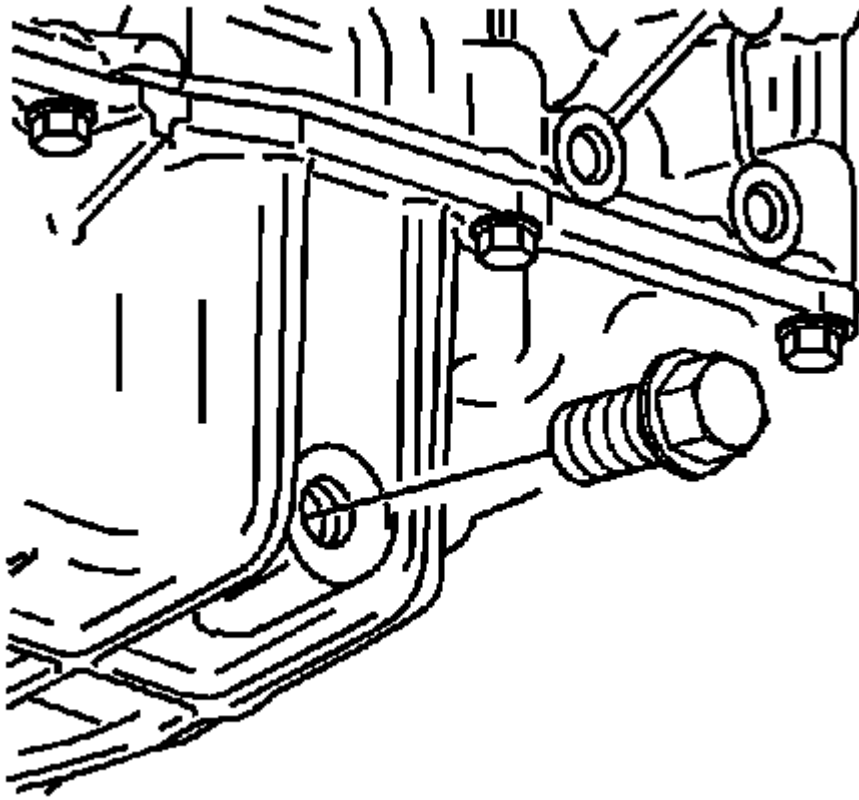


Fig. 352: View Of Oil Pan Drain Bolt
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to **Fastener Caution** .

5. Install the oil pan drain plug.

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

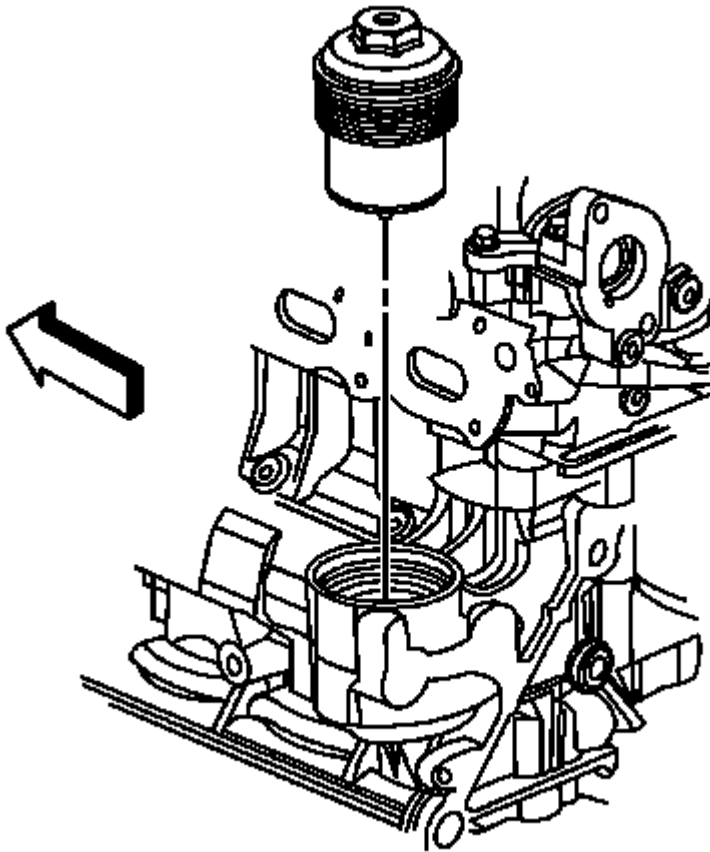


Fig. 353: Locating Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use an open end wrench on the hex on top of the oil filter cap.

6. Use a 32 mm (1 1/4 in) socket on the hex on top of the oil filter cap, or an oil filter wrench on the outside diameter of the oil filter cap.
7. Remove the oil filter cap and filter.

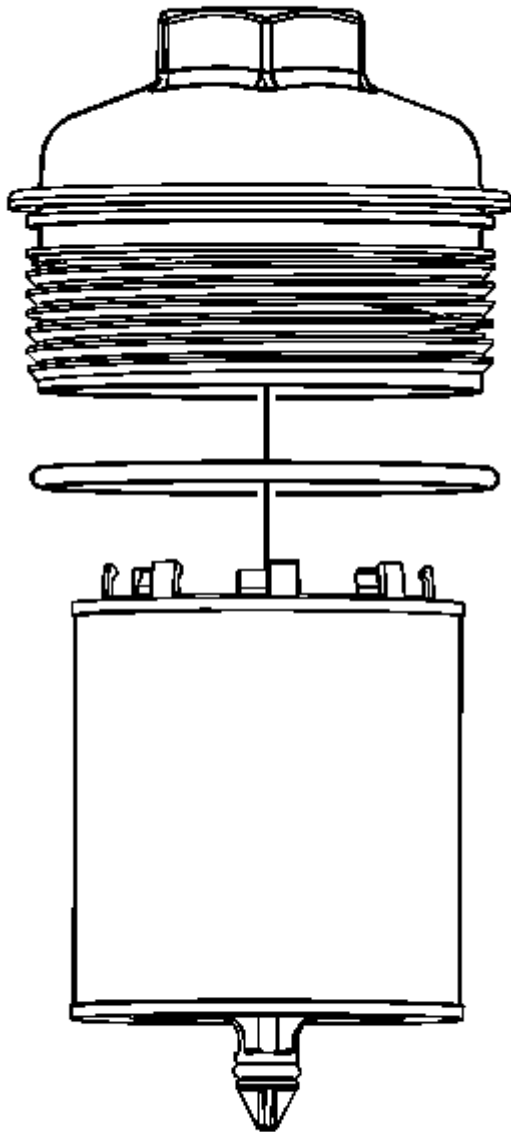


Fig. 354: View Of Oil Filter & Cap O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil filter from the oil filter cap.
9. Inspect the oil filter cap O-ring seal for damage, replace as necessary.

INSTALLATION PROCEDURE

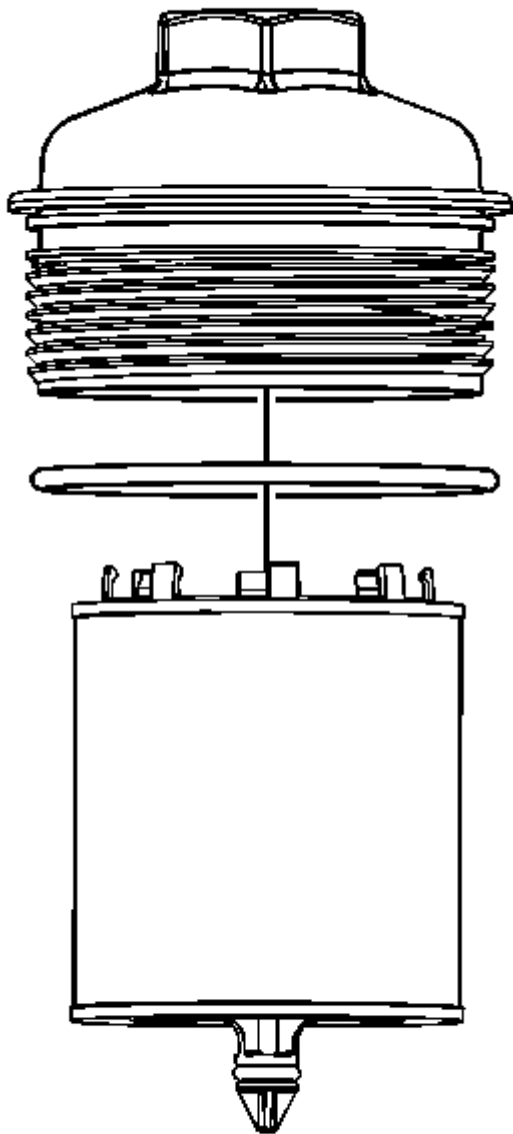


Fig. 355: View Of Oil Filter & Cap O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil filter to the oil filter cap.

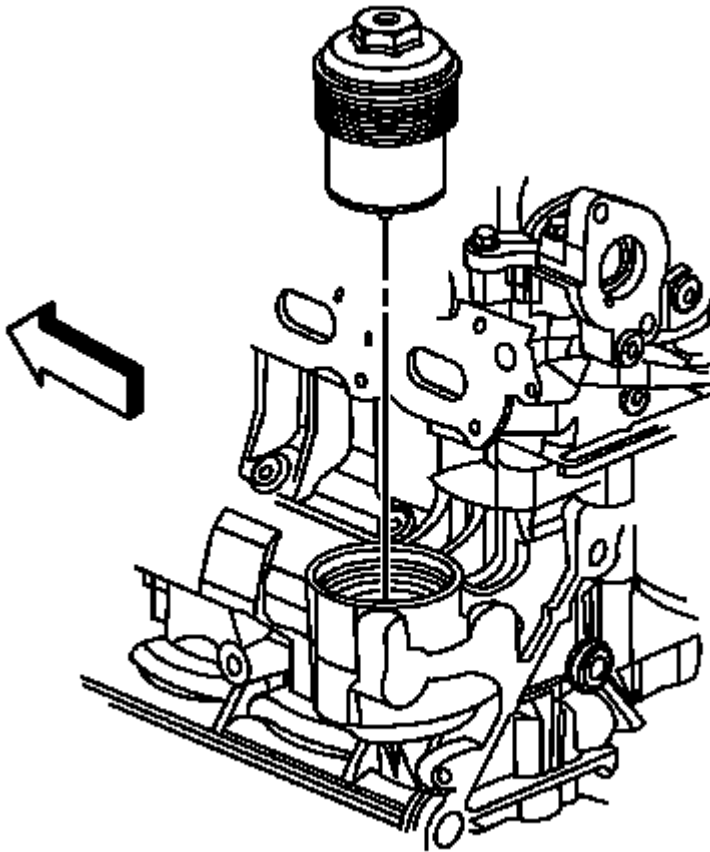


Fig. 356: Locating Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter cap and filter.

CAUTION: Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

NOTE: DO NOT use an open end wrench on the hex on top of the oil filter cap.

3. Use a 32 mm (1 1/4 in) socket on the hex on the top of the oil filter cap, or an oil filter wrench on the outside diameter of the oil filter cap.

Tighten: Tighten the oil filter cap until fully seated. DO NOT exceed 25 N.m (18 lb ft).

4. Lower the vehicle.
5. Fill the engine with oil. Refer to **Fluid and Lubricant Recommendations (USA and Canada)**.