

2011 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - CTS

WATER PUMP AND GENERATOR BELT REPLACEMENT

REMOVAL PROCEDURE

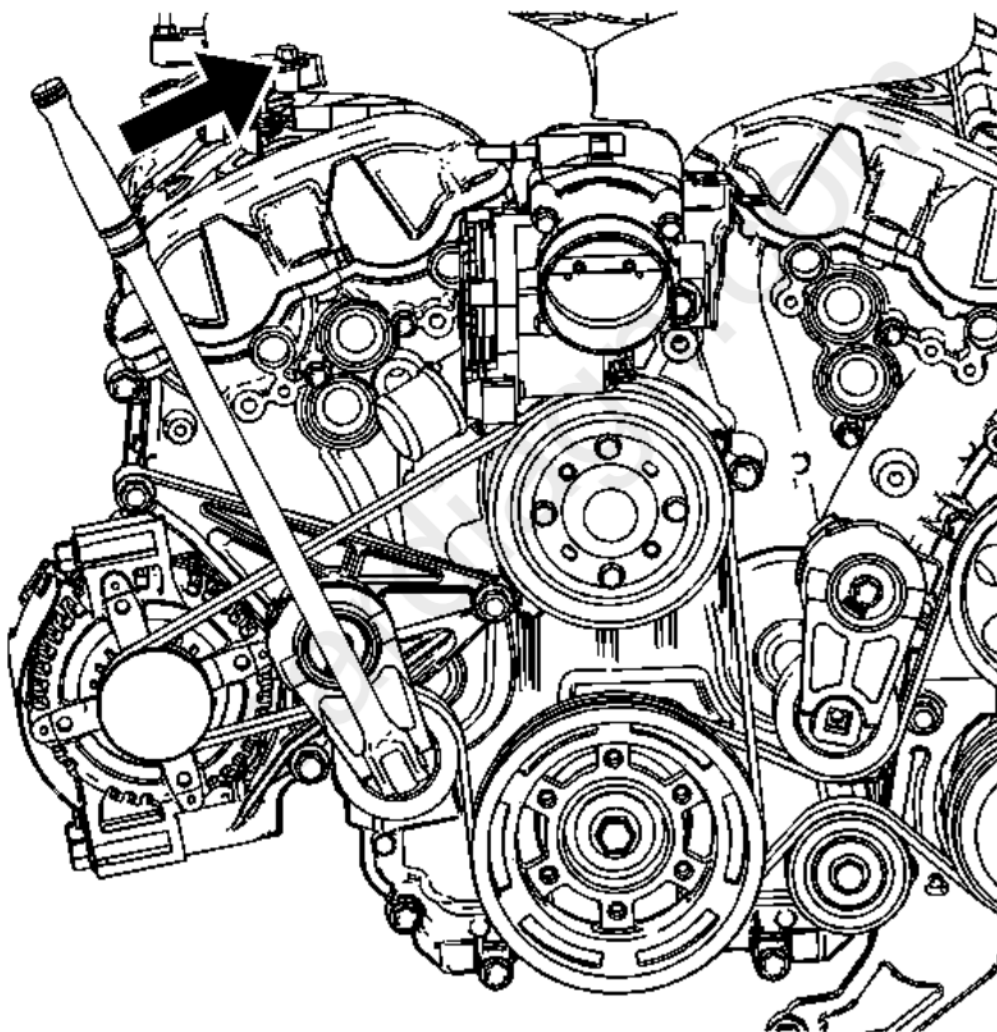


Fig. 1: Generator & Water Pump Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Remove the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement**.
2. Rotate the drive belt tensioner clockwise to release the drive belt tension.
3. Slide the drive belt off of the water pump pulley.
4. Slowly release the drive belt tensioner.
5. Remove the drive belt from the accessory drive pulleys.

INSTALLATION PROCEDURE

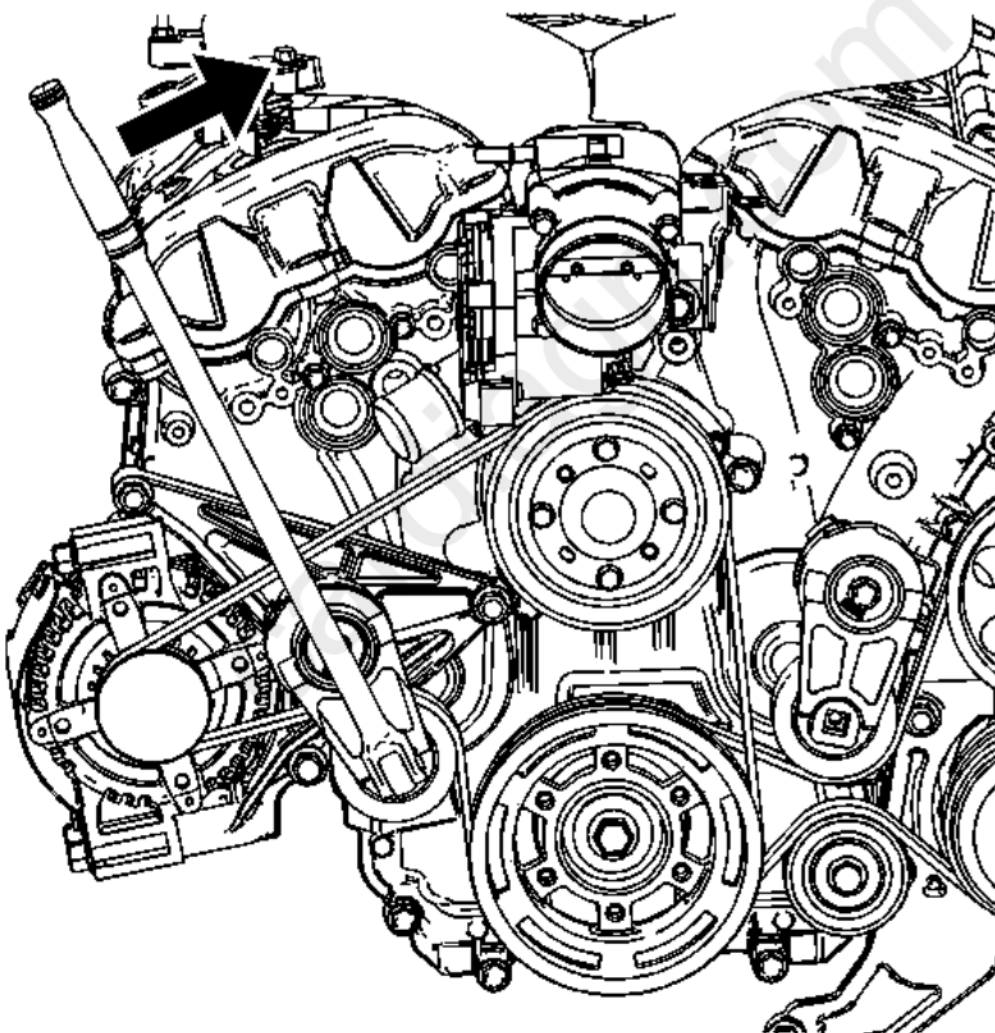


Fig. 2: Generator & Water Pump Drive Belt Routing

Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt to the crankshaft pulley, the tensioner and the generator.
2. Rotate the drive belt tensioner clockwise.
3. Install the drive belt to the water pump.

IMPORTANT: Ensure the drive belt is properly aligned and seated into the grooves of the accessory drive pulleys.

4. Slowly release the drive belt tensioner.
5. Install the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

AIR CONDITIONING COMPRESSOR AND POWER STEERING PUMP BELT REPLACEMENT

REMOVAL PROCEDURE

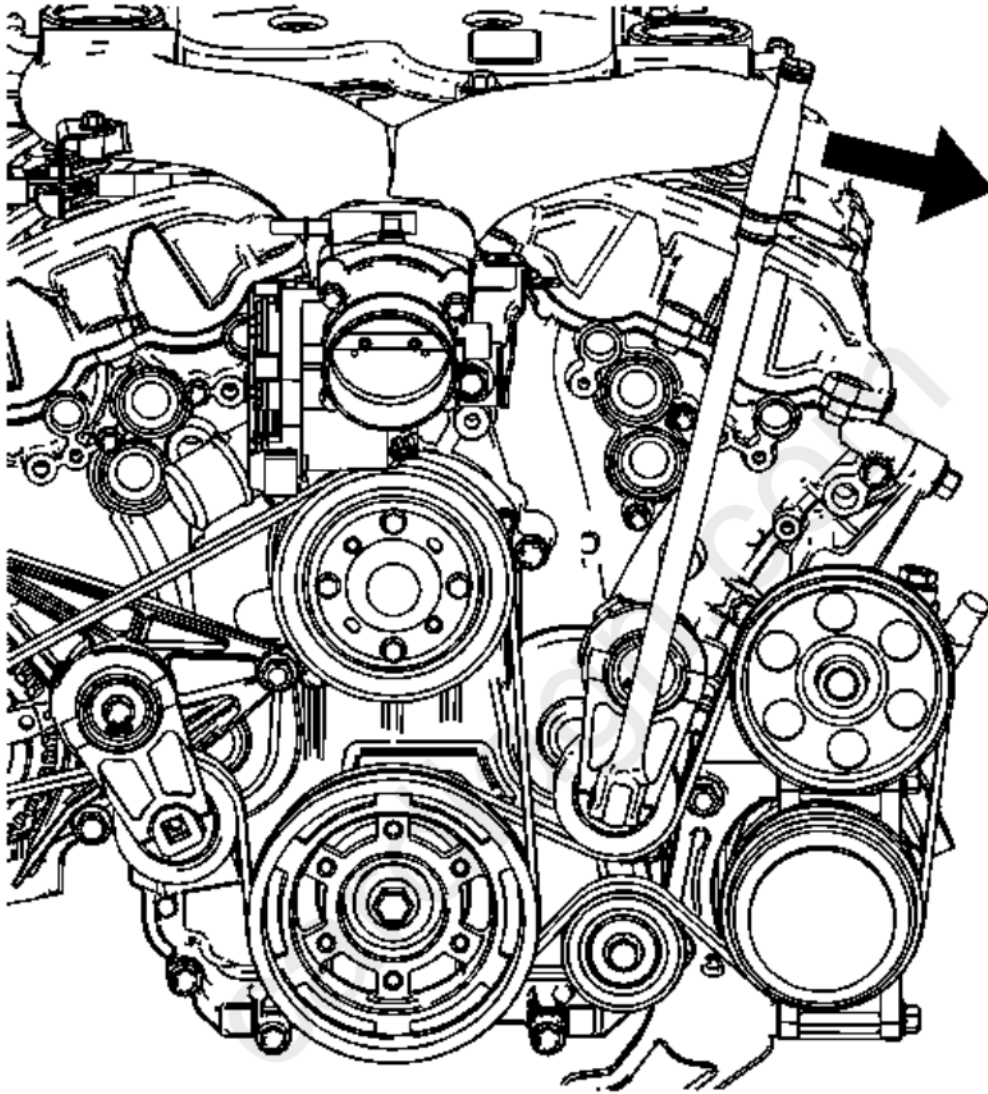


Fig. 3: View Of Power Steering & A/C Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.
3. Rotate the drive belt tensioner clockwise in order to release the drive belt tension.

4. Remove the drive belt from the power steering pulley.
5. Slowly release the drive belt tensioner.
6. Remove the drive belt from the accessory drive pulleys.

INSTALLATION PROCEDURE

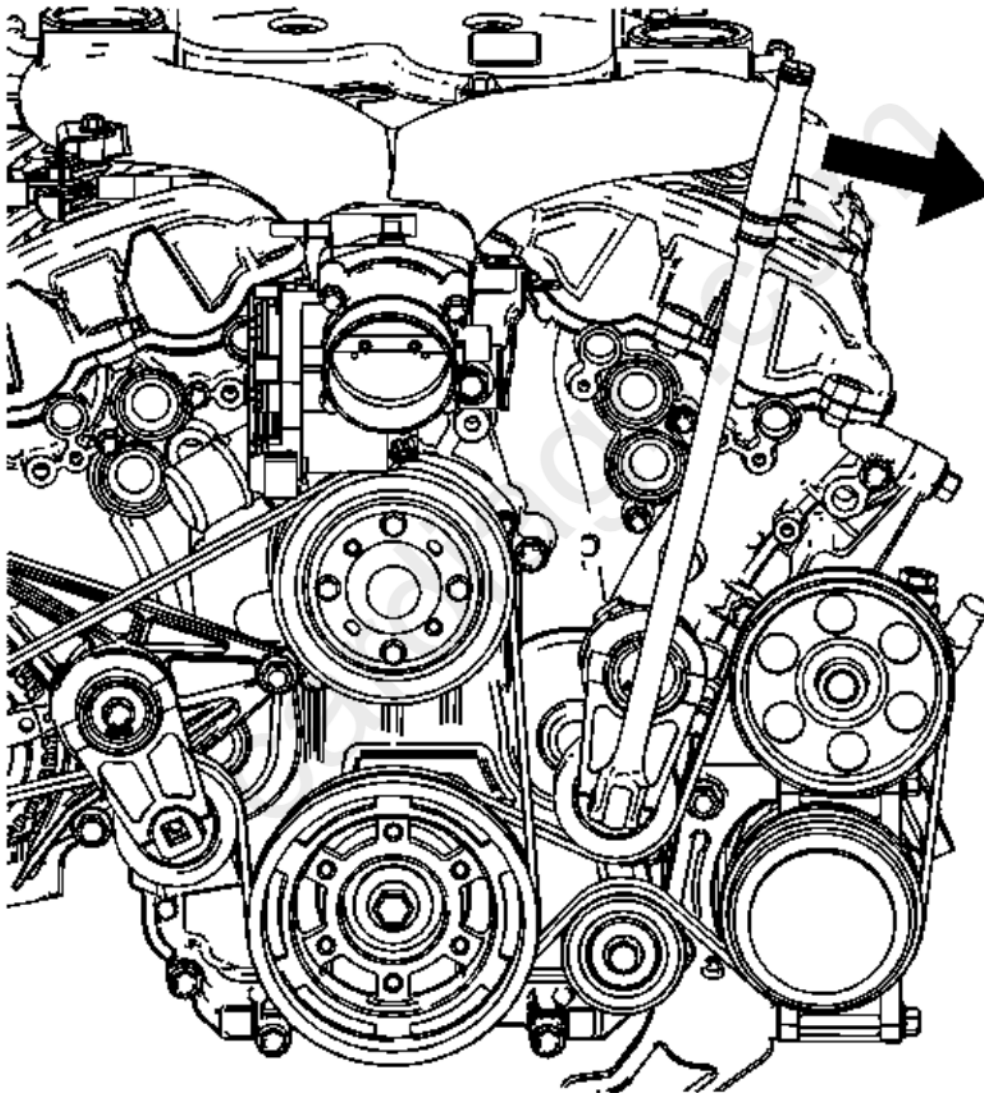


Fig. 4: View Of Power Steering & A/C Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt to the crankshaft pulley, the idler pulley and the A/C compressor.
2. Rotate the drive belt tensioner clockwise.
3. Install the drive belt to the power steering pulley.
4. Slowly release the drive belt tensioner.

IMPORTANT: Ensure the drive belt is properly aligned and seated into the grooves of the accessory drive pulleys.

5. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement \(LF1\)](#) or [Air Cleaner Outlet Duct Replacement \(LLT\)](#) .
6. Install the generator and water pump drive belt. Refer to [Water Pump and Generator Belt Replacement](#).

WATER PUMP AND GENERATOR BELT TENSIONER REPLACEMENT

REMOVAL PROCEDURE

1. Remove the generator and water pump drive belt. Refer to [Water Pump and Generator Belt Replacement](#).

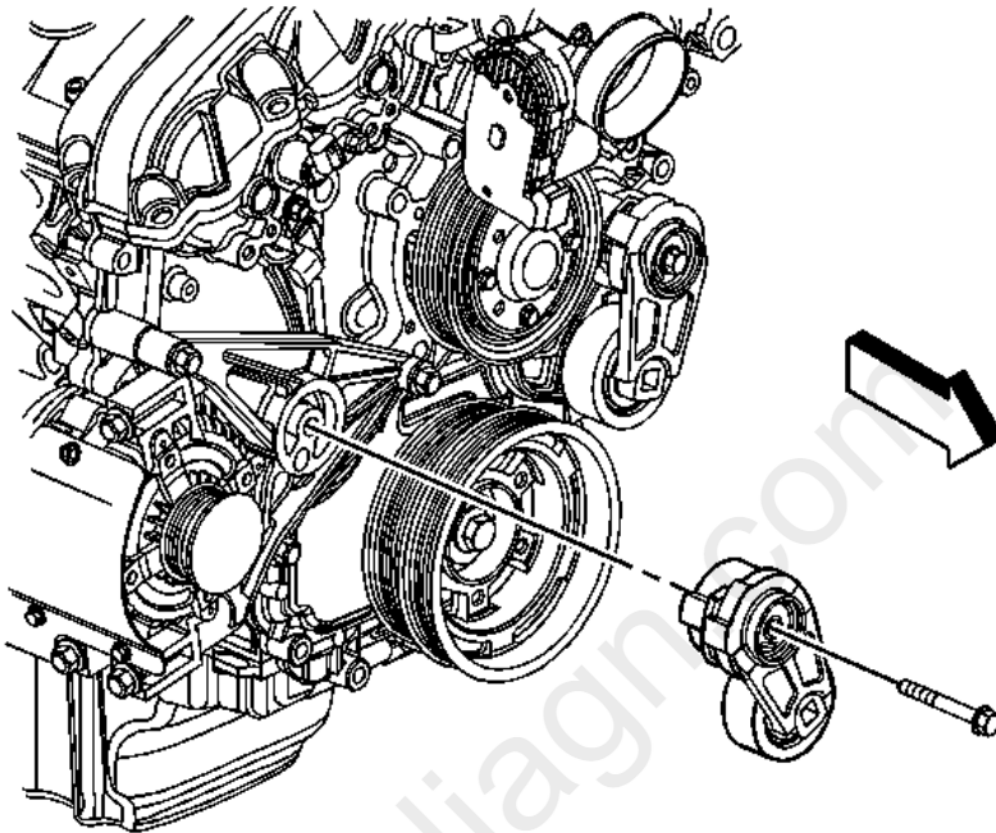


Fig. 5: View Of Generator & Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Loosen the drive belt tensioner bolt.
3. Remove the drive belt tensioner and bolt from the engine.

INSTALLATION PROCEDURE

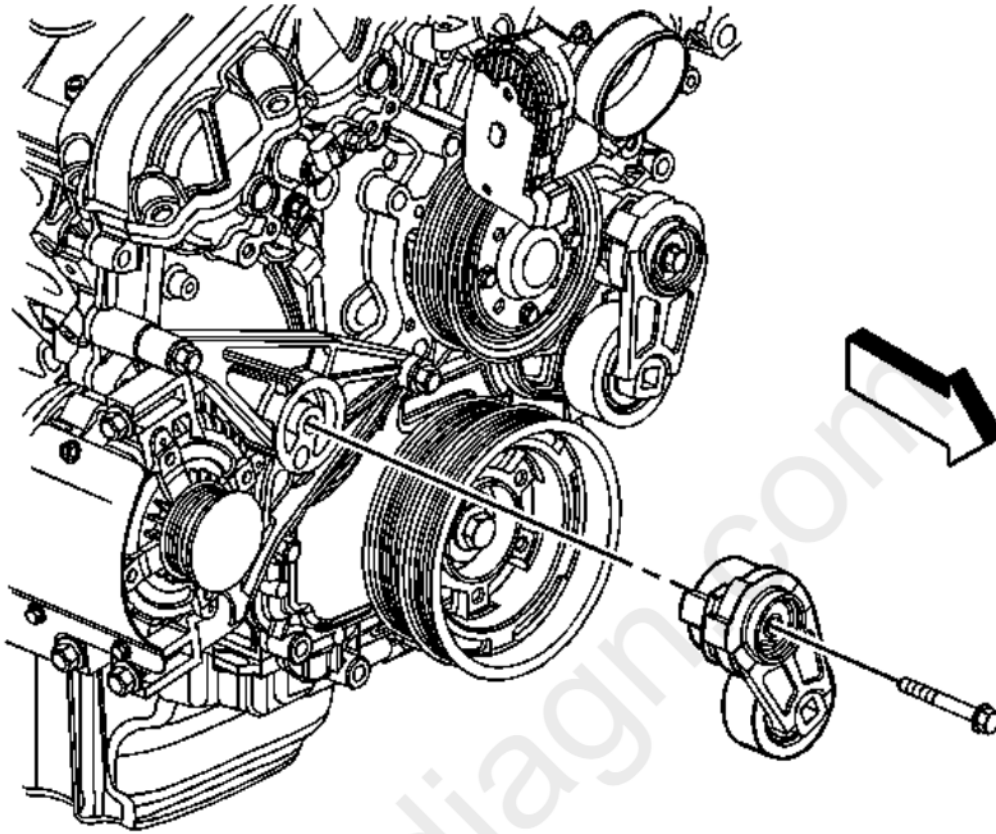


Fig. 6: View Of Generator & Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner and bolt to the engine as an assembly.
2. Ensure that the alignment pin on the rear of the tensioner assembly is aligned with the locating hole on the engine.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the drive belt tensioner bolt and tighten to 50 N.m (37 lb ft).
4. Install the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.

AIR CONDITIONING COMPRESSOR AND POWER STEERING PUMP BELT

TENSIONER REPLACEMENT

REMOVAL PROCEDURE

1. Remove the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.
2. Remove the power steering and air conditioning drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.

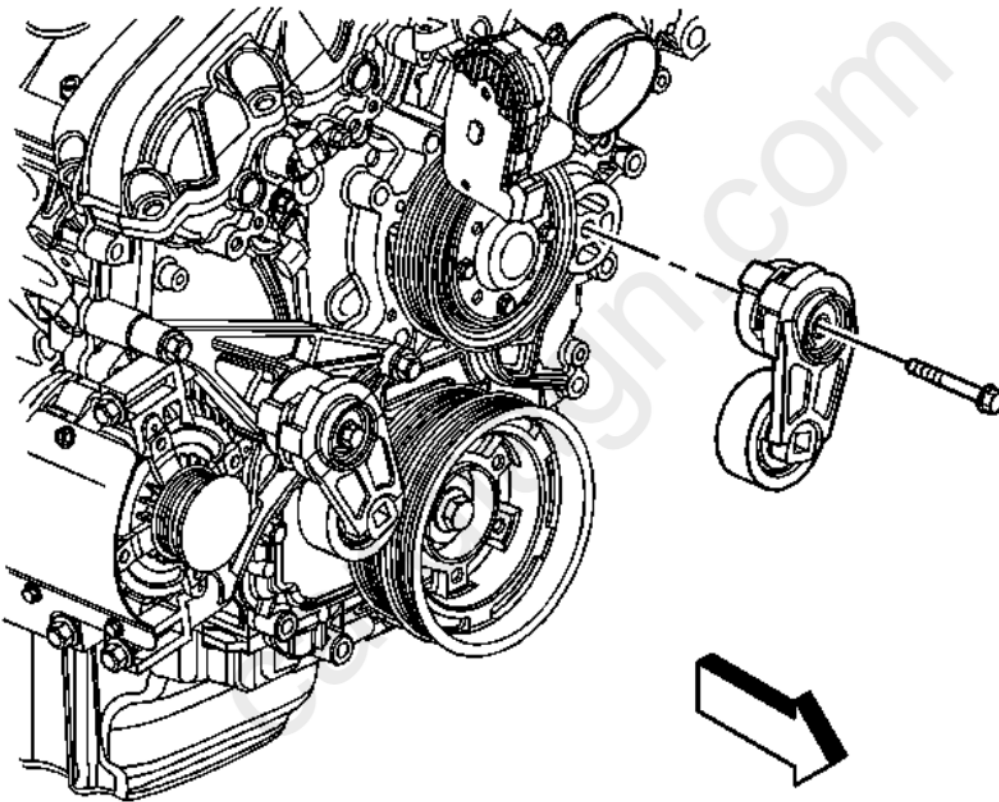


Fig. 7: View Of Power Steering & A/C Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Loosen the drive belt tensioner bolt.
4. Remove the drive belt tensioner and bolt from the engine.

INSTALLATION PROCEDURE

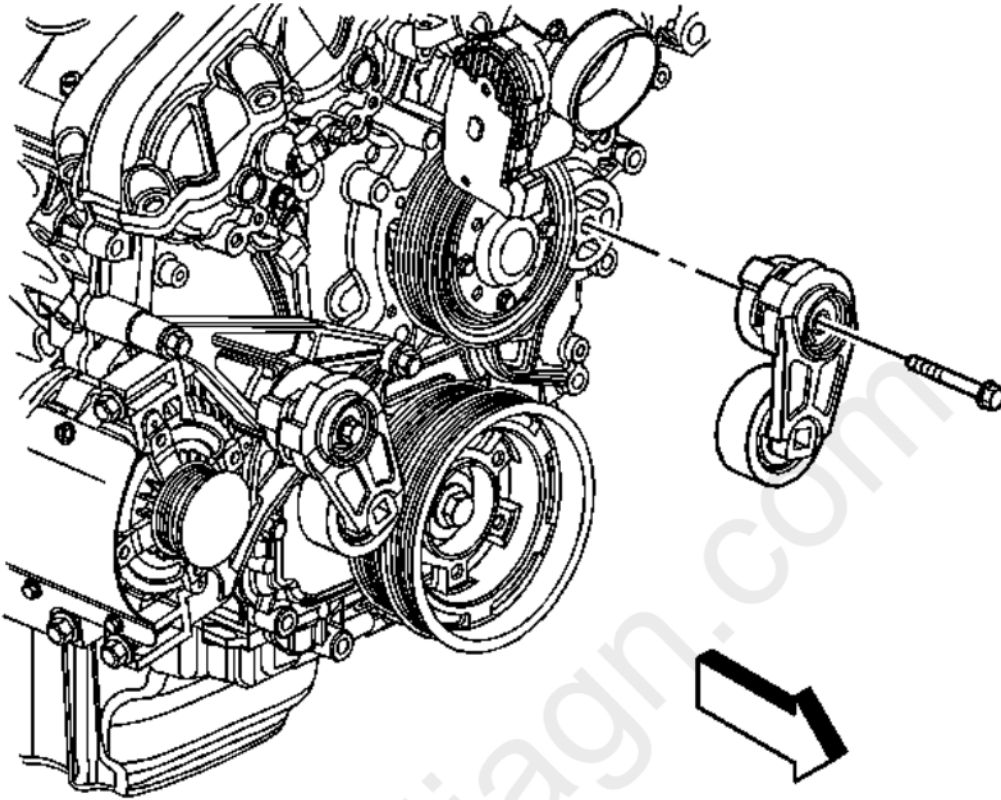


Fig. 8: View Of Power Steering & A/C Drive Belt Tensioner
 Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner and bolt to the engine as an assembly.
2. Ensure that the alignment pin on the rear of the tensioner assembly is aligned with the locating hole on the engine.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the drive belt tensioner bolt and tighten to 50 N.m (37 lb ft).
4. Install the power steering and air conditioning drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.
5. Install the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.

DRIVE BELT IDLER PULLEY REPLACEMENT

REMOVAL PROCEDURE

NOTE: Do not remove the generator and water pump belt.

1. Remove the power steering and air conditioning drive belt from the power steering pump. Refer to [Air Conditioning Compressor and Power Steering Pump Belt Replacement](#).

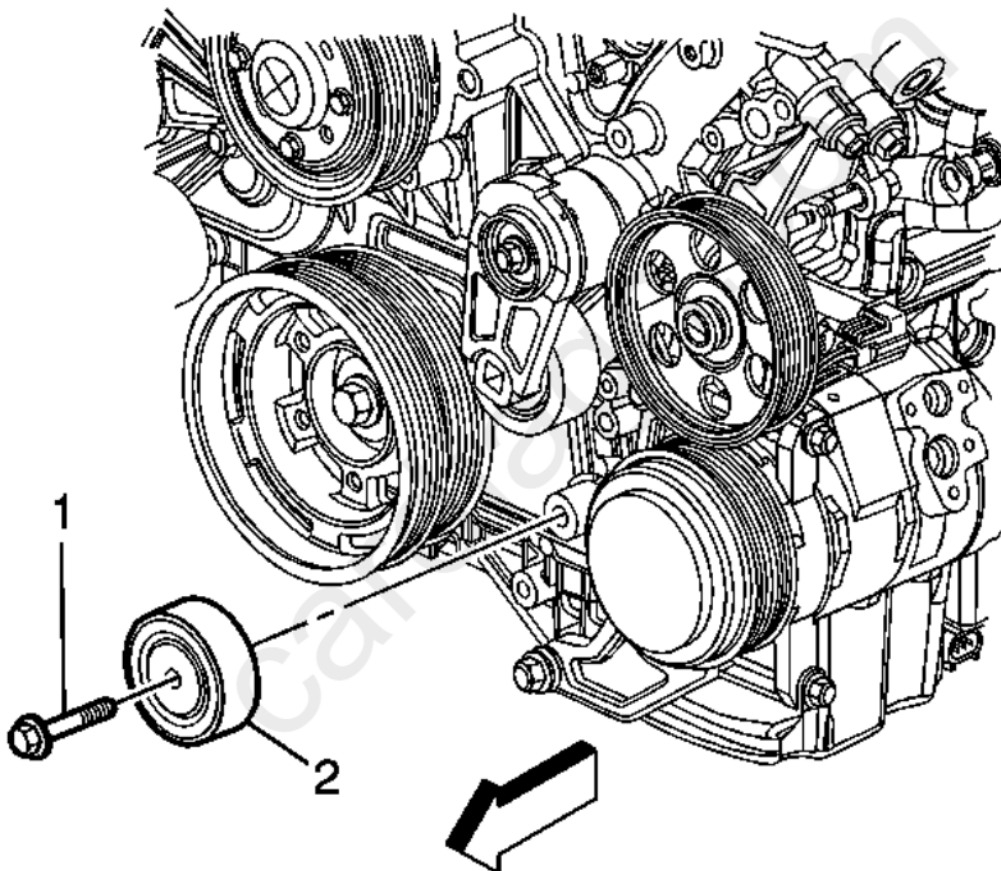


Fig. 9: Identifying Drive Belt Idler Pulley Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley.

INSTALLATION PROCEDURE

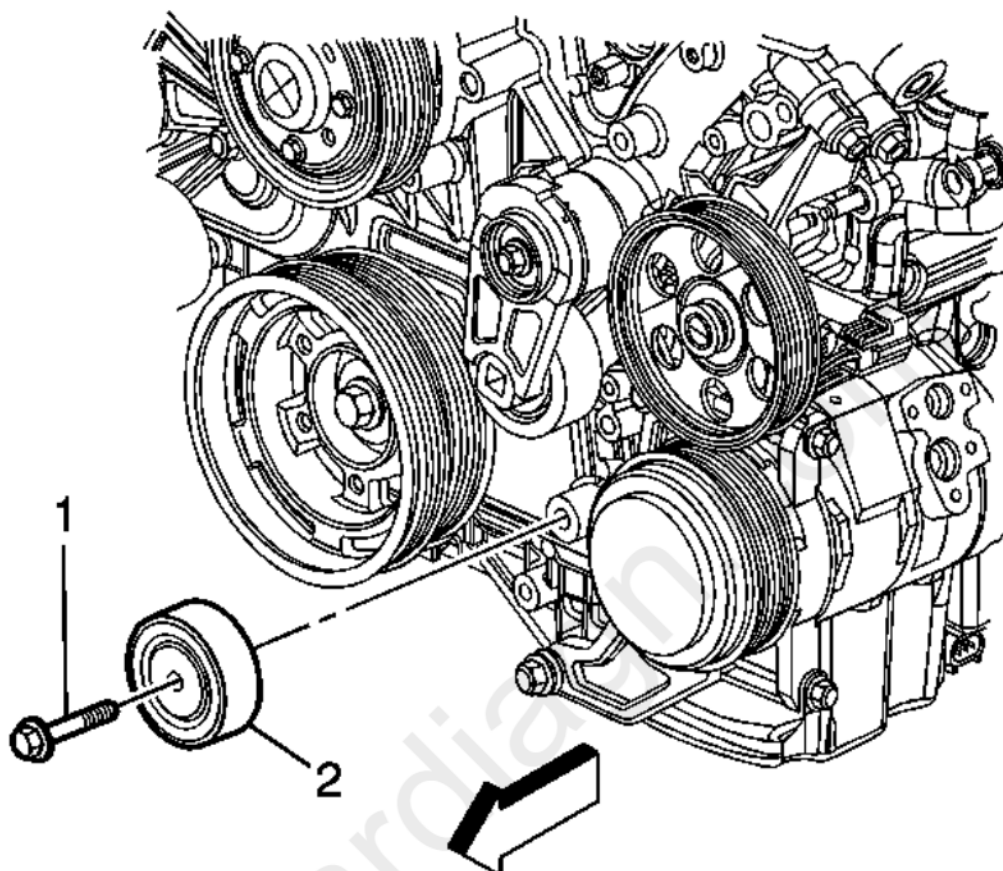


Fig. 10: Identifying Drive Belt Idler Pulley Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.

CAUTION: Refer to **FASTENER CAUTION** .

2. Install the drive belt idler pulley bolt and tighten to 50 N.m (37 lb ft).
3. Install the drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.

ENGINE SUPPORT FIXTURE

SPECIAL TOOLS

- **J 28467-B** Universal Engine Support Fixture. See Special Tools .
- **J-28467-550** Engine Support Beam Adapter
- **J 36857** Engine Lift Bracket. See Special Tools .

INSTALLATION PROCEDURE

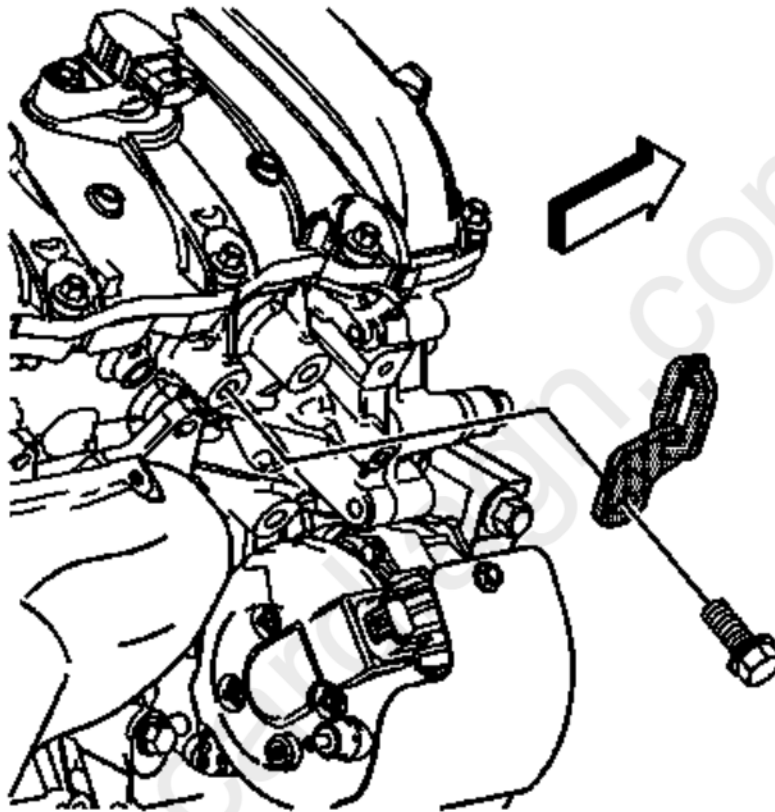


Fig. 11: View of Engine Lift Bracket Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine compartment sight shields. Refer to Front Compartment Sight Shields Replacement .
2. Remove the cross vehicle brace. Refer to Cross Vehicle Brace Replacement .
3. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT).

CAUTION: Refer to FASTENER CAUTION .

4. Use a grade 10.9, M10 X 1.5 X 35 bolt, GM P/N 11519182, or equivalent, in order to install **J 36857** , or equivalent, to the right cylinder head in the location shown in illustration. Tighten the bolt to 65 N.m (48 lb ft). See **Special Tools** .
5. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .
6. Remove the vacuum pump and position aside, if equipped.

NOTE: It is not necessary to remove the hoses from the power steering reservoir.

7. Remove the power steering reservoir and position aside. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
8. Remove the Bank 2 (Left Side) exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .

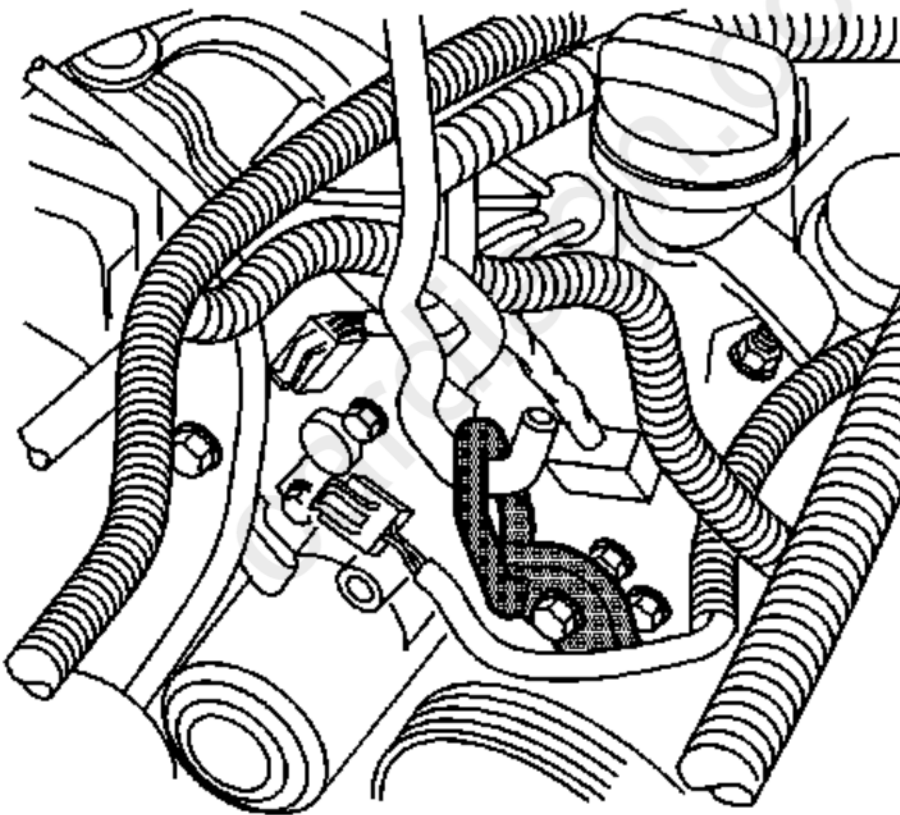


Fig. 12: Lift Hook Assembly & Left Side Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

9. Use a grade 10.9, M10 X 1.5 X 35 bolt, GM P/N 11519182, or equivalent, in order to install, **J 36857** , or equivalent, to the front of the left cylinder head in the location shown in illustration. Tighten the bolt to 65 N.m (48 lb ft). See **Special Tools** .

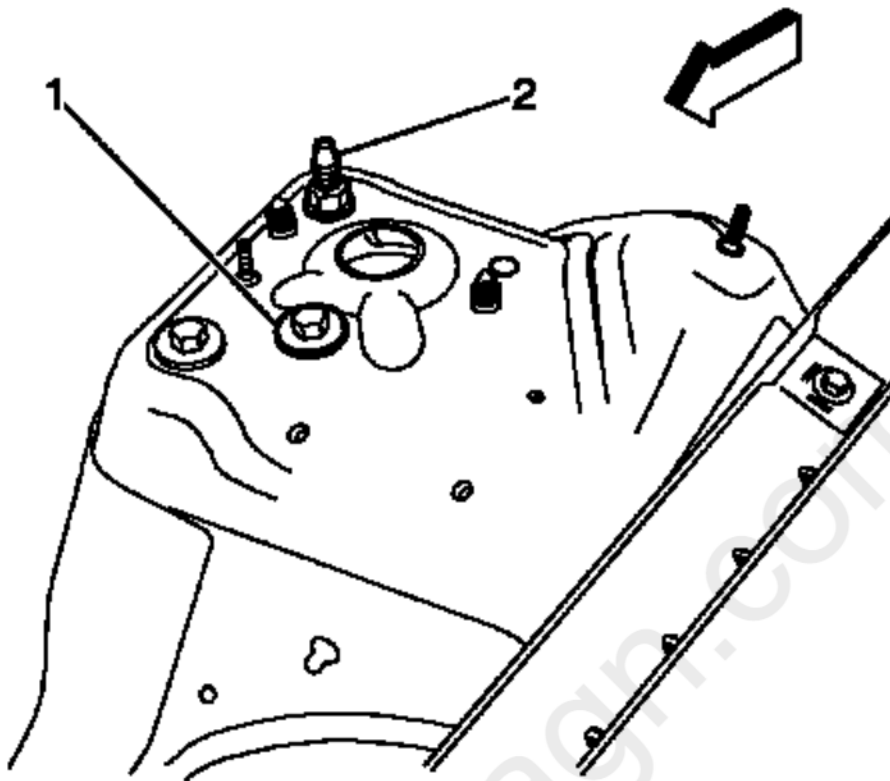


Fig. 13: Identifying Shock Module Mounting Stud & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the shock module mounting stud (2) and bolt (1) from the left and right shock tower.

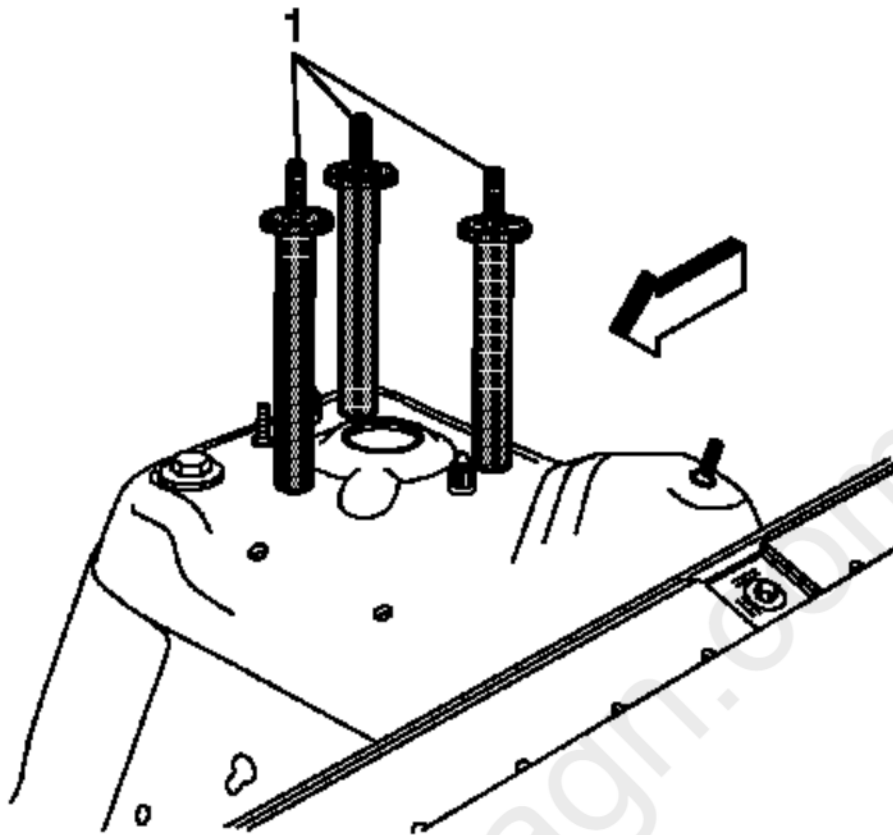


Fig. 14: Identifying Special Tool J-28467-550 Of Right & Left Shock Towers
Courtesy of GENERAL MOTORS CORP.

11. Install the J-28467-550 (1) in the location shown on the left and right shock towers.

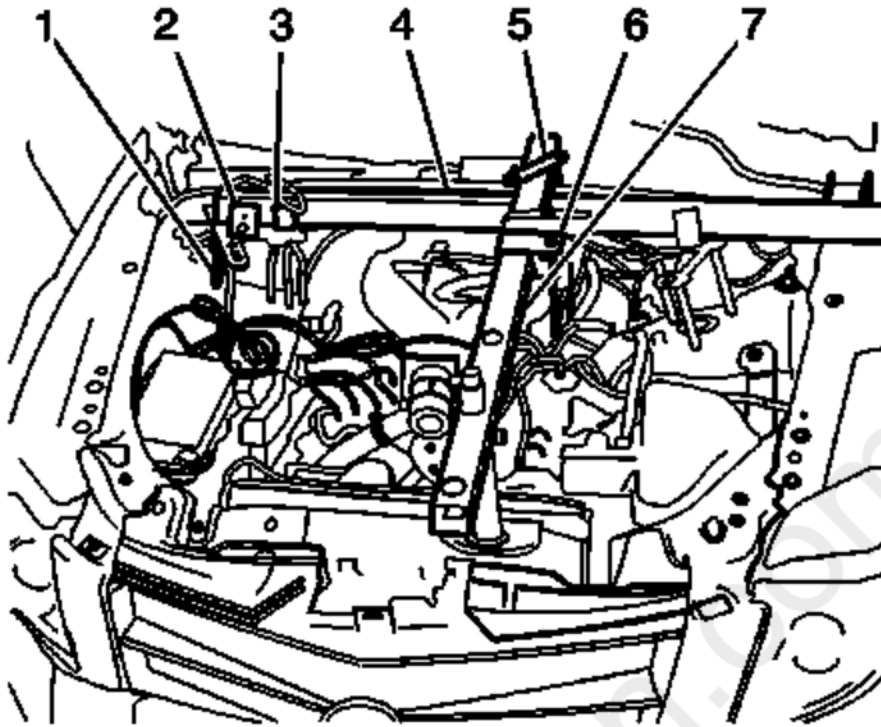


Fig. 15: Identifying Strut Tower & Engine Support Beam Adapter Components
Courtesy of GENERAL MOTORS CORP.

12. Ensure the strut tower support assemblies (2) are secured to the engine support beam adapters (1) with wing nuts.
13. Secure the strut tower tube (4) to the strut tower support (2) with quick release pins.
14. Secure the strut tower tube (4) to the radiator shelf tube (7) with the cross bracket assembly (5).
15. Tighten the cross bracket wing nuts.

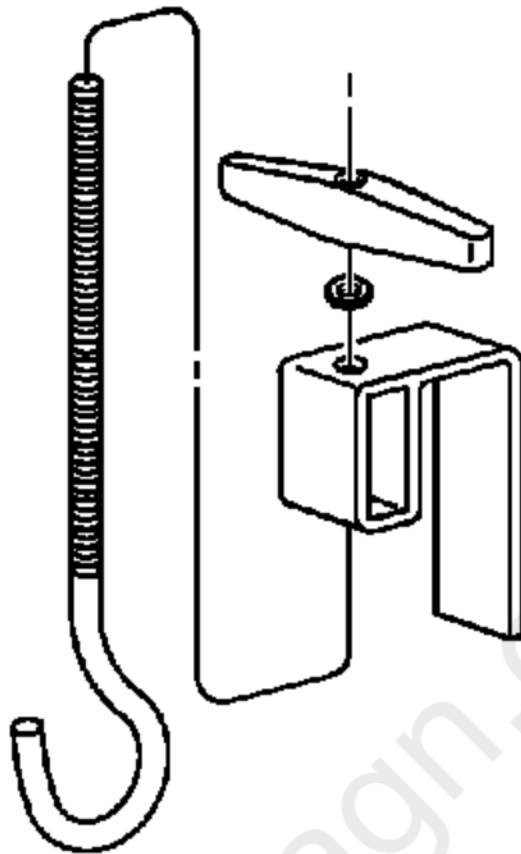


Fig. 16: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

16. Assemble the lift hook wing nut and the lift hook bracket to the lift hook.

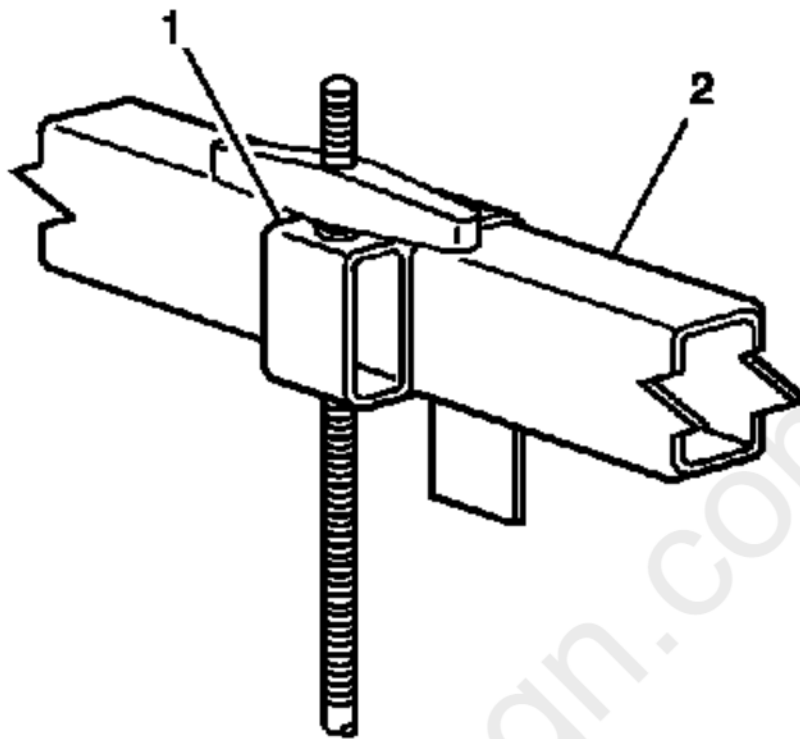


Fig. 17: View Of Lift Hook & radiator shelf tube Assembly
Courtesy of GENERAL MOTORS CORP.

17. Install lift hook assembly (1) to the radiator shelf tube (2).

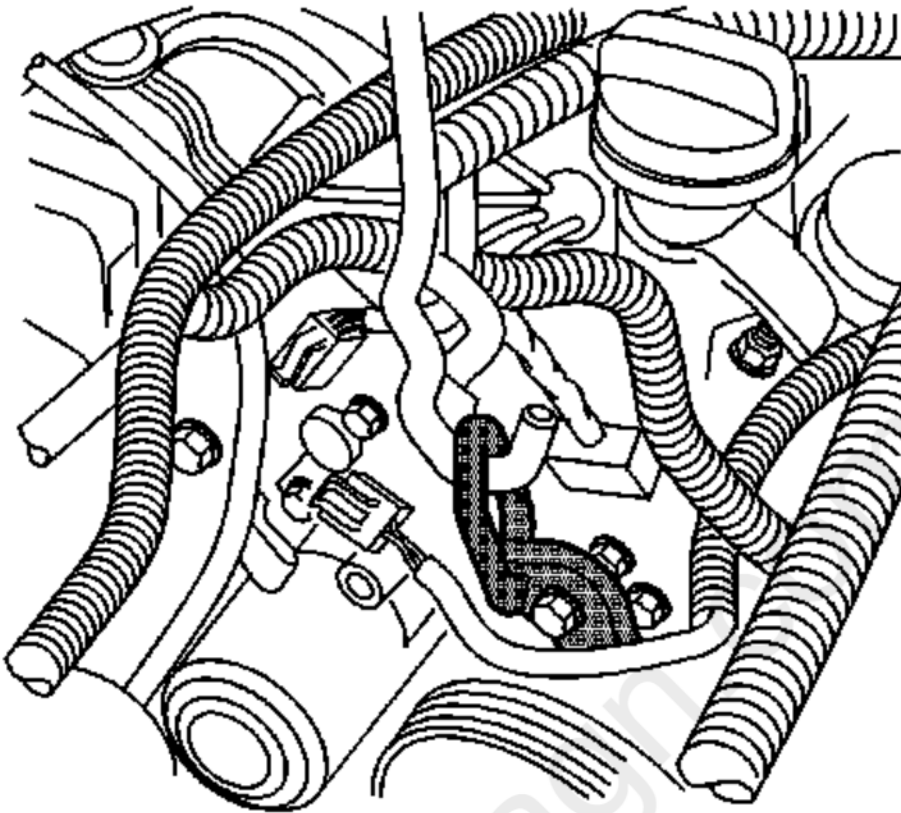


Fig. 18: Lift Hook Assembly & Left Side Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

18. Install lift hook assembly to left side engine lift hook bracket.

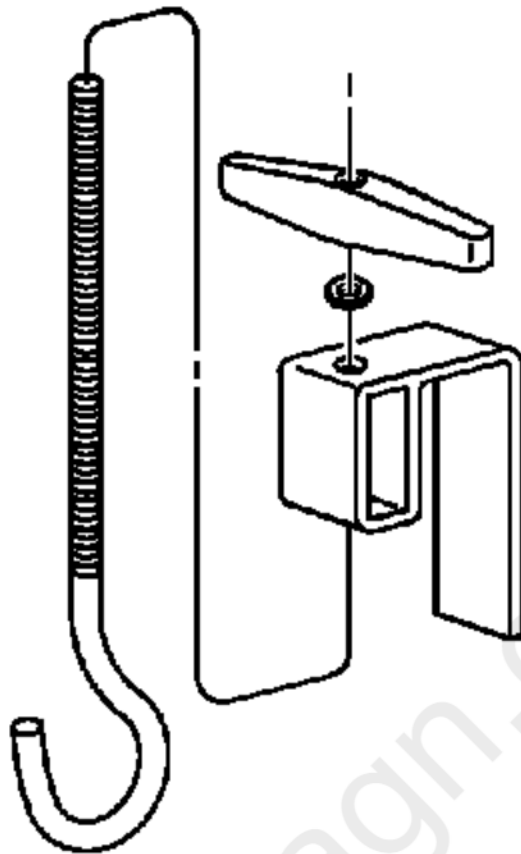


Fig. 19: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

19. Assemble the lift hook wing nut and the lift hook bracket to the lift hook.

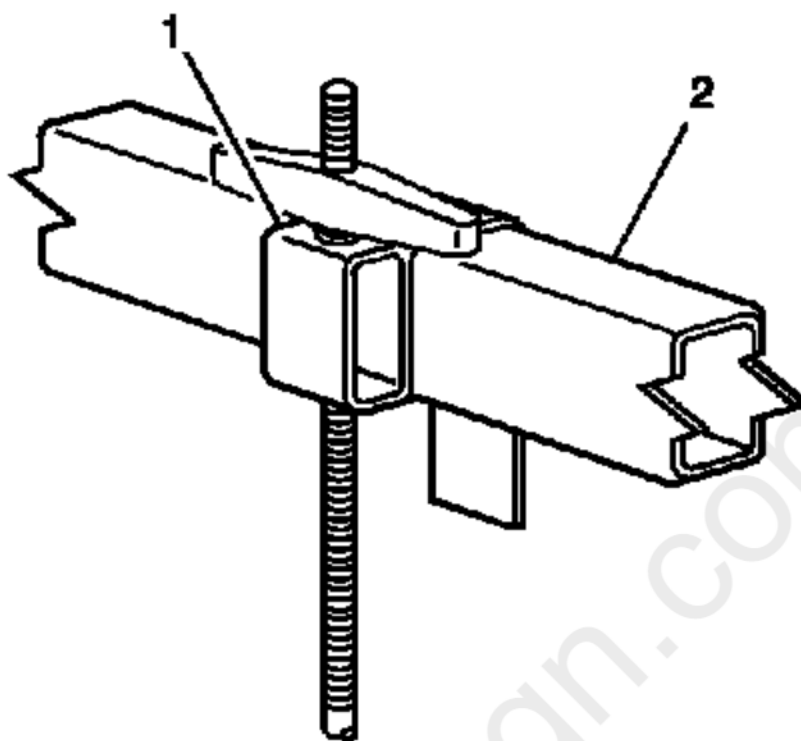


Fig. 20: View Of Lift Hook & radiator shelf tube Assembly
Courtesy of GENERAL MOTORS CORP.

20. Install lift hook assembly (1) to the strut tower tube (2).

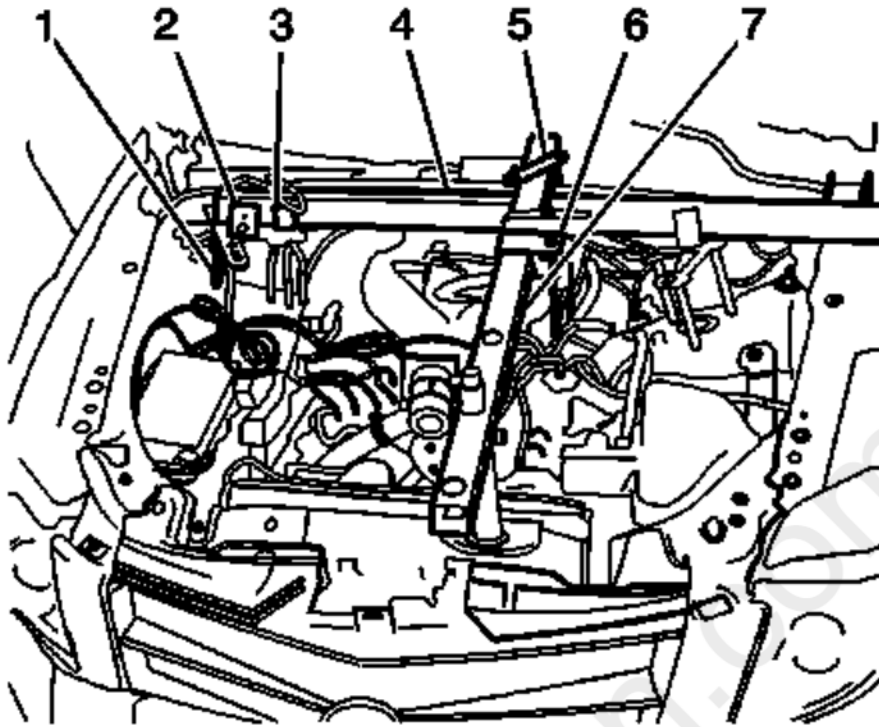


Fig. 21: Identifying Strut Tower & Engine Support Beam Adapter Components
Courtesy of GENERAL MOTORS CORP.

21. Hand tighten the lift hooks (3, 6) in order to remove all slack from the engine support fixture.

REMOVAL PROCEDURE

1. Remove the **J 28467-B** . See **Special Tools** .
2. Remove the **J-28467-550** .

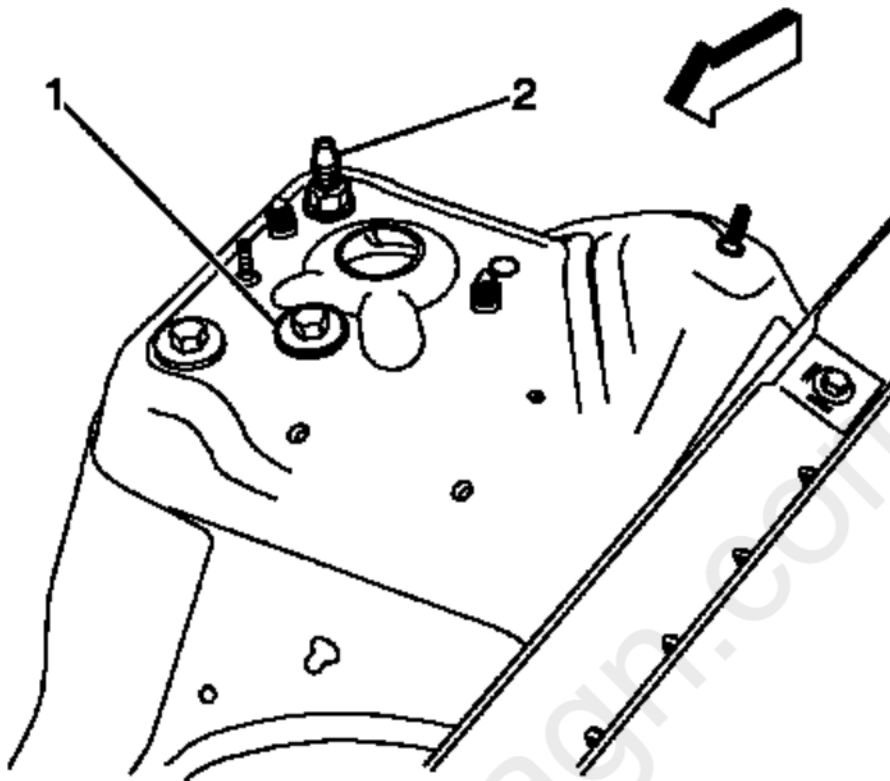


Fig. 22: Identifying Shock Module Mounting Stud & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the shock module mounting stud (2) and bolt (1) to the left and right shock towers then tighten to 112 N.m (83 lb ft).
4. Remove the right and left engine lift brackets from the engine.
5. Install the Bank 2 (Left Side) exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
6. Install the power steering reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
7. Install the vacuum pump, if equipped.
8. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .
9. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
10. Install the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .
11. Install the engine compartment sight shields. Refer to **Front Compartment Sight Shields Replacement** .

ENGINE MOUNT INSPECTION

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

1. Install the engine support fixture. Refer to Engine Support Fixture. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface 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 GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to Engine Mount Replacement - Left Side (AWD) or Engine Mount Replacement - Left Side (RWD) or Engine Mount Replacement - Right Side (AWD) or Engine Mount Replacement - Right Side (RWD).

ENGINE MOUNT REPLACEMENT - LEFT SIDE (AWD)

REMOVAL PROCEDURE

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

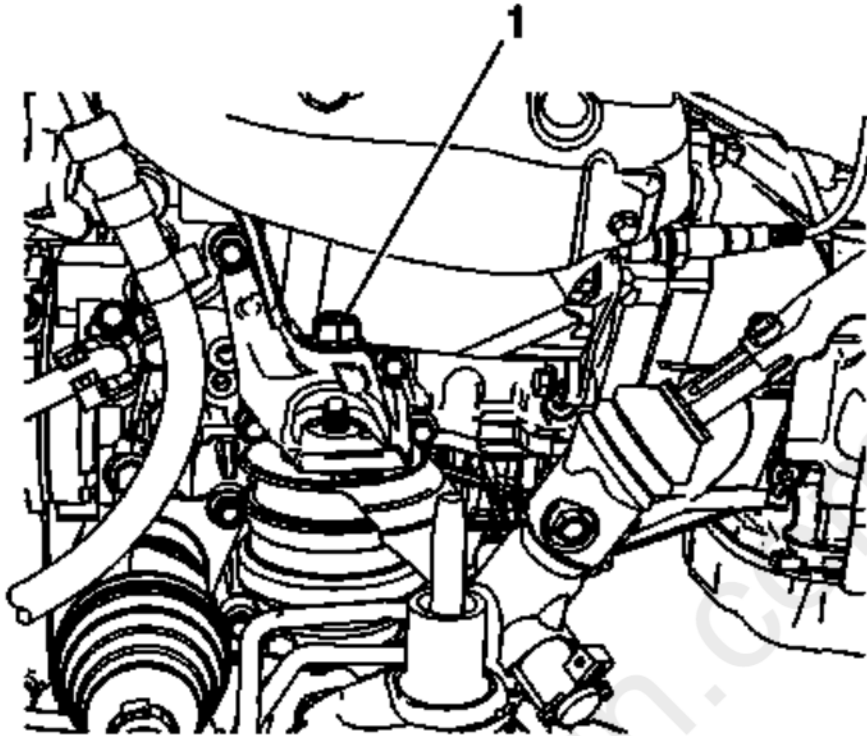


Fig. 23: Identifying Engine Mount Retaining Nut
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection (Sedan,Wagon)** or **Battery Negative Cable Disconnection and Connection (Coupe)** .
2. Remove the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .
3. Remove the exhaust system. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)** .
4. Remove the right and left lower engine mount retaining nuts.
5. Disconnect the lower intermediate steering shaft from the steering gear and position the shaft aside. Refer to **Intermediate Steering Shaft Replacement** .
6. Remove the upper engine mount retaining nut (1).

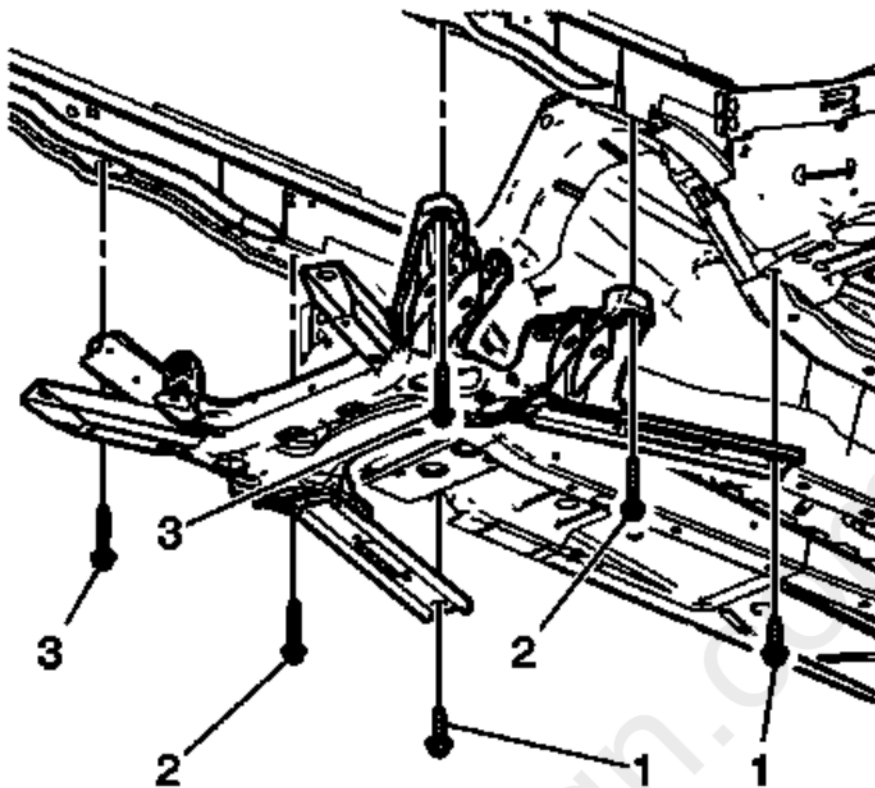


Fig. 24: View of Cross Vehicle Brace Assembly
 Courtesy of GENERAL MOTORS CORP.

7. Install a screw jack with a block of wood under the oil pan for support.
8. Support the rear of the front frame with a screw jack.
9. Remove the frame rear (1) and center (2) mounting bolts.
10. Loosen the front frame bolts (3) 12.7 mm (0.5 in) to 25.4 mm (1 in).
11. Lower the rear section of the frame.
12. Raise the engine using the screw jack until the weight is removed from the mount.
13. Lower the screw jack under the frame.
14. Remove the engine mount (1) from the vehicle.

INSTALLATION PROCEDURE

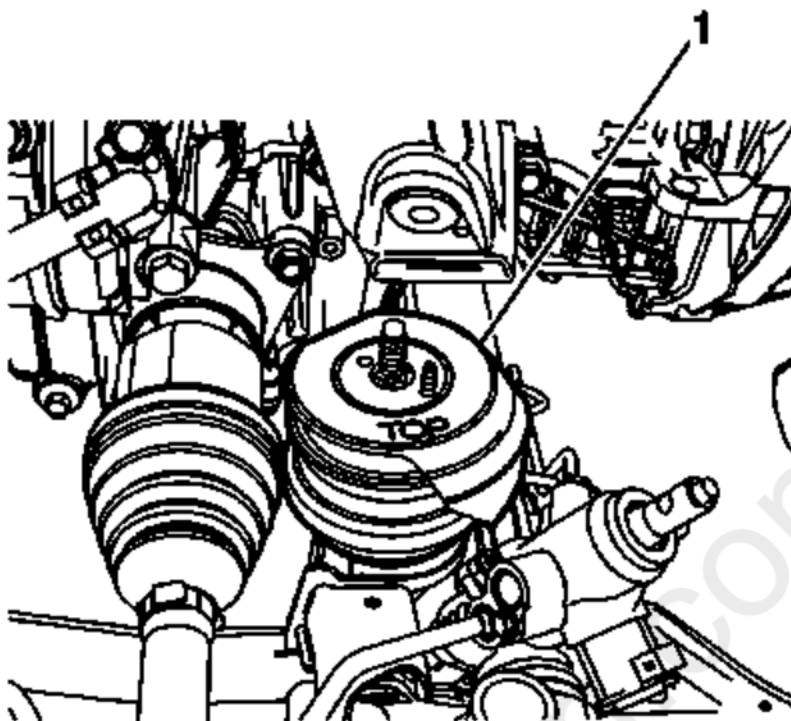


Fig. 25: Identifying Engine Mount Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount (1).
2. Raise the rear section of the frame.

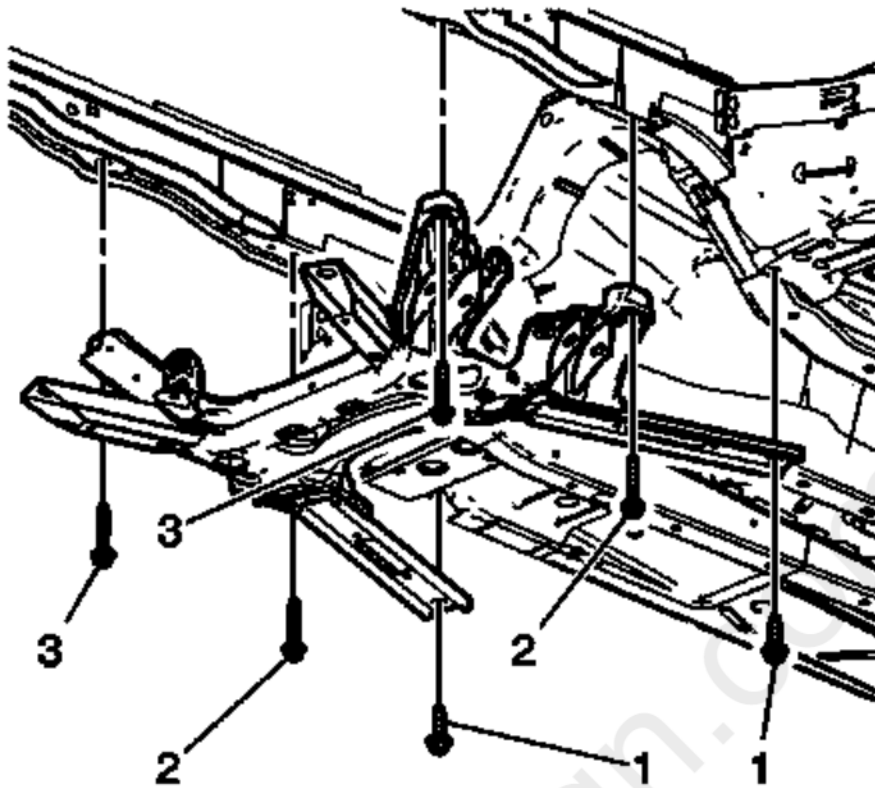


Fig. 26: View of Cross Vehicle Brace Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install but do not tighten the frame rear (1) and center (2) mounting bolts.

CAUTION: Refer to FASTENER CAUTION .

NOTE: **Ensure to tighten the frame bolts in sequence.**

4. Tighten the frame bolts.
 1. Tighten the left front frame bolt to 191 N.m (141 lb ft).
 2. Tighten the right front frame bolt to 191 N.m (141 lb ft).
 3. Tighten the center front frame bolts to 191 N.m (141 lb ft).
 4. Tighten the rear front frame bolts to 191 N.m (141 lb ft).
5. Remove the screw jack from the rear of the front frame.
6. Remove the screw jack and block of wood from under the oil pan.

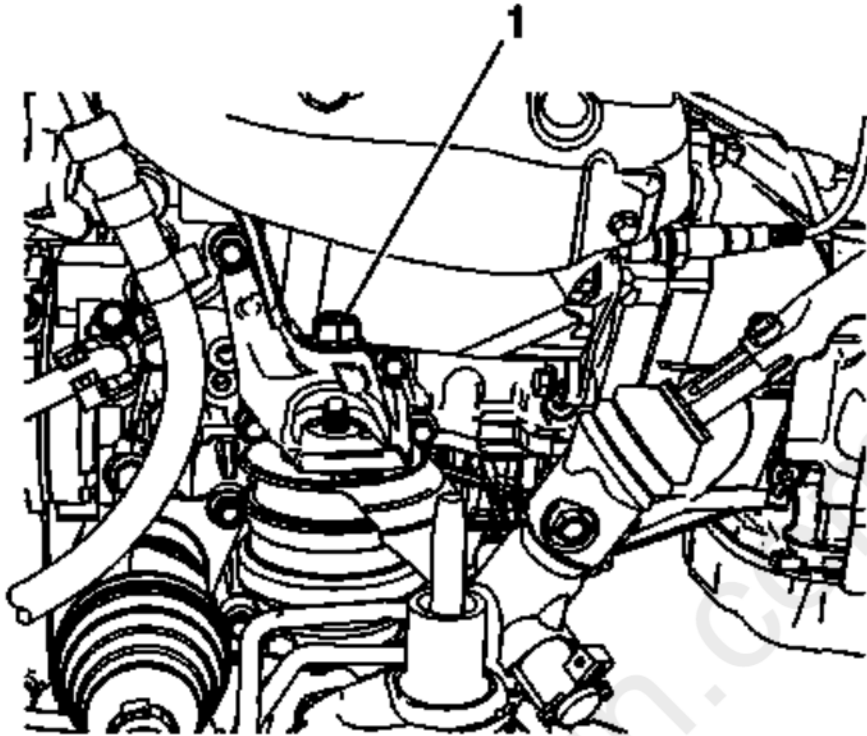


Fig. 27: Identifying Engine Mount Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the upper engine mount retaining nut (1) and tighten to 80 N.m (59 lb ft).
8. Install the right and left lower engine mount retaining nuts and tighten to 80 N.m (59 lb ft).
9. Connect the lower intermediate steering shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
10. Install the exhaust system. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)** .
11. Lower the vehicle.
12. Install the cross vehicle brace. Refer to **Cross Vehicle Brace Replacement** .
13. Connect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection (Sedan,Wagon)** or **Battery Negative Cable Disconnection and Connection (Coupe)** .

ENGINE MOUNT REPLACEMENT - LEFT SIDE (RWD)

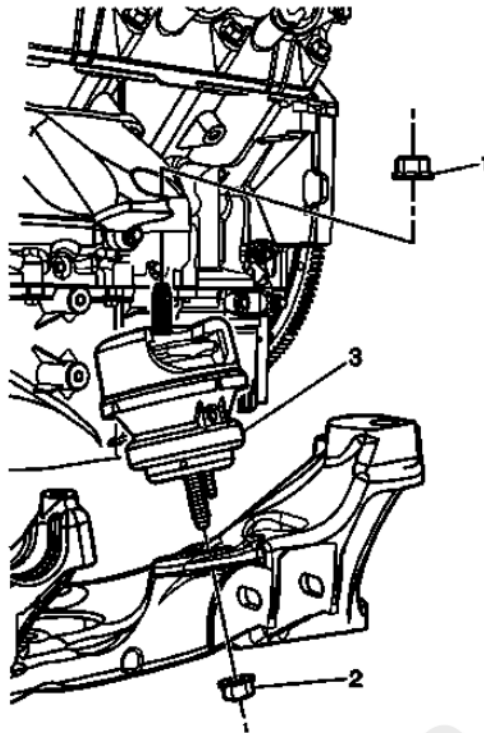


Fig. 28: Identifying Engine Mount - Left Side (RWD)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Discharge the air conditioning (A/C) system. Refer to <u>Refrigerant Recovery and Recharging</u> . 2. Remove the tower brace. Refer to <u>Cross Vehicle Brace Replacement</u> . 3. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 4. Remove the suction hose from the A/C compressor. Refer to <u>Air Conditioning Compressor Hose Replacement (LF1, LLT)</u> . 5. Position the hose aside to gain access to the engine mount top nut. 6. Lower the vehicle.	
1	Engine Mount Fastener CAUTION: Refer to. Procedure 1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Position a screw jack and a block of wood under the engine oil pan.

	Tighten: 80 N.m (59 lb ft)
2	Engine Mount Fastener Tighten: 80 N.m (59 lb ft)
3	Engine Mount Procedure 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (AWD)

REMOVAL PROCEDURE

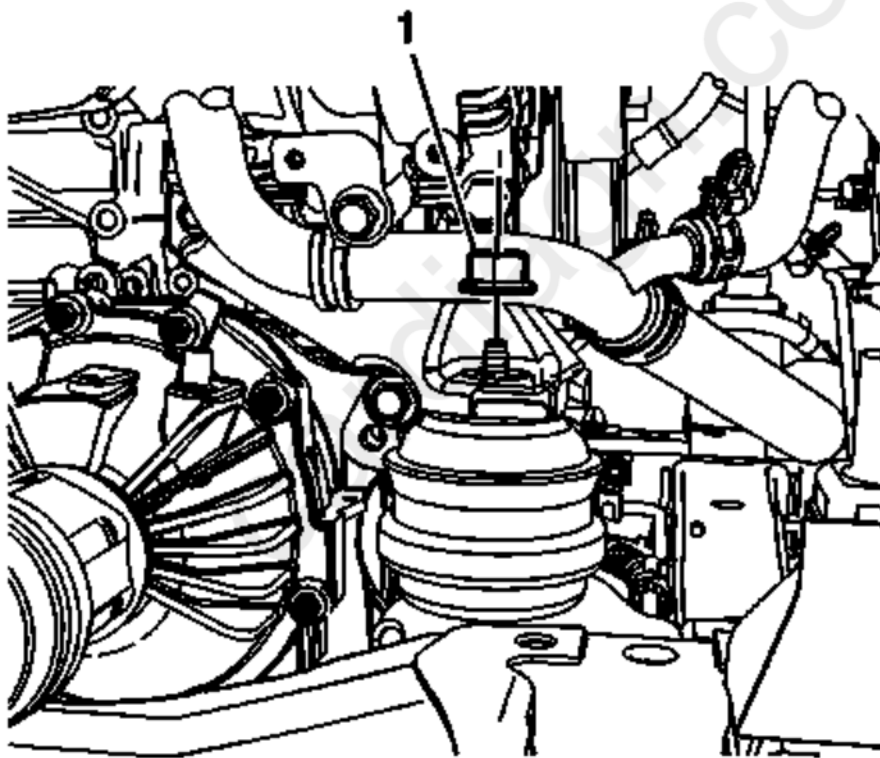


Fig. 29: Identifying Upper Engine Mount Retaining Nut
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection (Sedan,Wagon)** or **Battery Negative Cable Disconnection and Connection (Coupe)** .

2. Remove the cross vehicle brace. Refer to [Cross Vehicle Brace Replacement](#) .
3. Remove the exhaust system. Refer to [Exhaust System Replacement \(LF1-Single\)](#) or [Exhaust System Replacement \(LF1-Sedan/Wagon\)](#) or [Exhaust System Replacement \(LLT-Coupe\)](#) or [Exhaust System Replacement \(LLT-Sedan/Wagon\)](#) .
4. Remove the upper engine mount retaining nut (1).

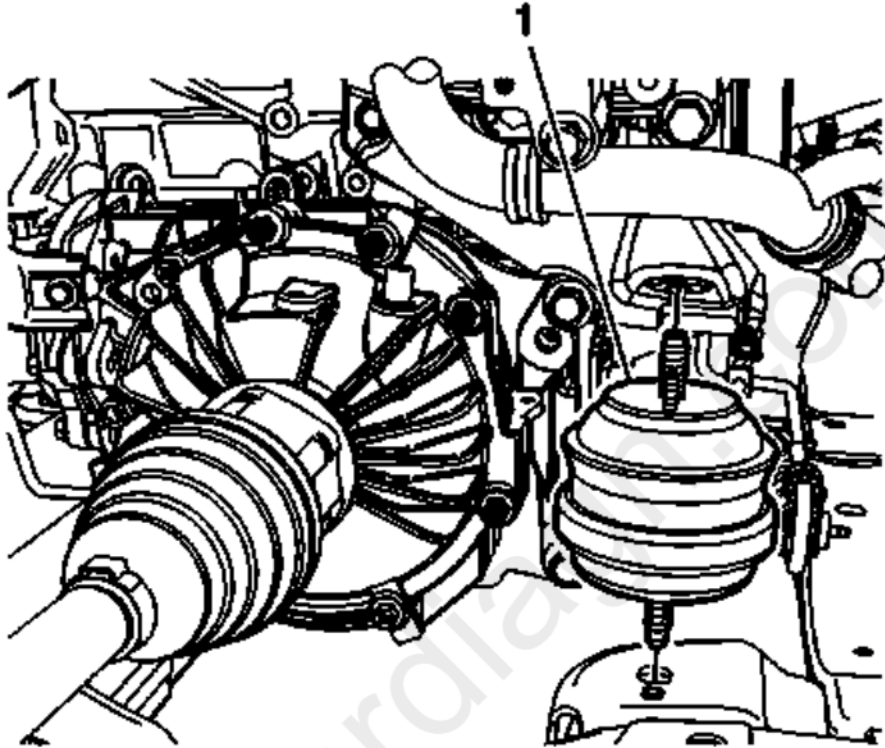


Fig. 30: Identifying Engine Mount
Courtesy of GENERAL MOTORS CORP.

5. Remove the lower engine mount retaining nuts.
6. Install a screw jack with a block of wood under the oil pan for support.

NOTE: **Note position of the engine mount prior to removing mount.**

7. Using the screw jack, raise the engine enough to remove the engine mount.
8. Remove the engine mount (1) from the vehicle.

INSTALLATION PROCEDURE

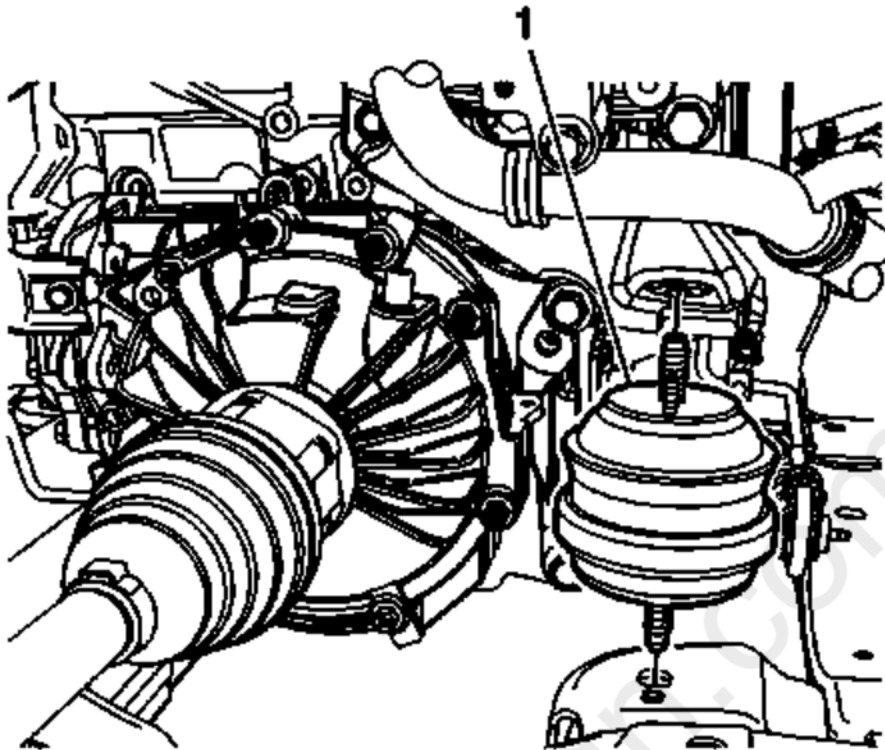


Fig. 31: Identifying Engine Mount
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the engine mount is positioned correctly.

1. Install the engine mount (1) to the vehicle.
2. Using the screw jack, lower the engine.
3. Remove the screw jack and block of wood supporting the engine.

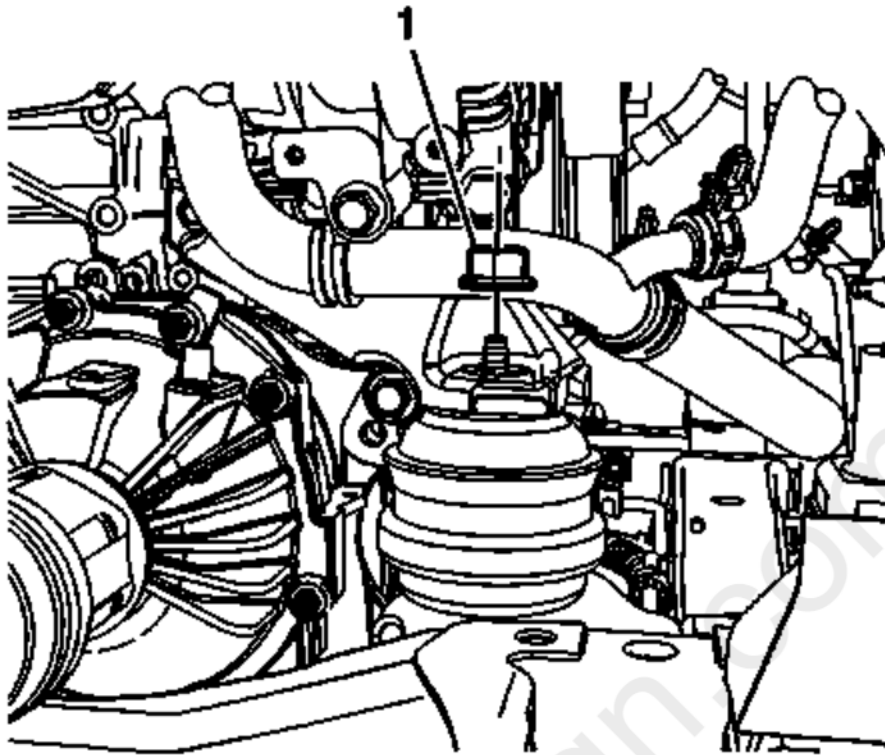


Fig. 32: Identifying Upper Engine Mount Retaining Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

4. Install the upper engine mount retaining nut (1) and tighten to 80 N.m (59 lb ft).
5. Install the right and left lower engine mount retaining nuts and tighten to 80 N.m (59 lb ft).
6. Install the exhaust system. Refer to Exhaust System Replacement (LF1-Single) or Exhaust System Replacement (LF1-Sedan/Wagon) or Exhaust System Replacement (LLT-Coupe) or Exhaust System Replacement (LLT-Sedan/Wagon) .
7. Install the cross vehicle brace. Refer to Cross Vehicle Brace Replacement .
8. Connect the battery ground cable. Refer to Battery Negative Cable Disconnection and Connection (Sedan,Wagon) or Battery Negative Cable Disconnection and Connection (Coupe) .

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (RWD)

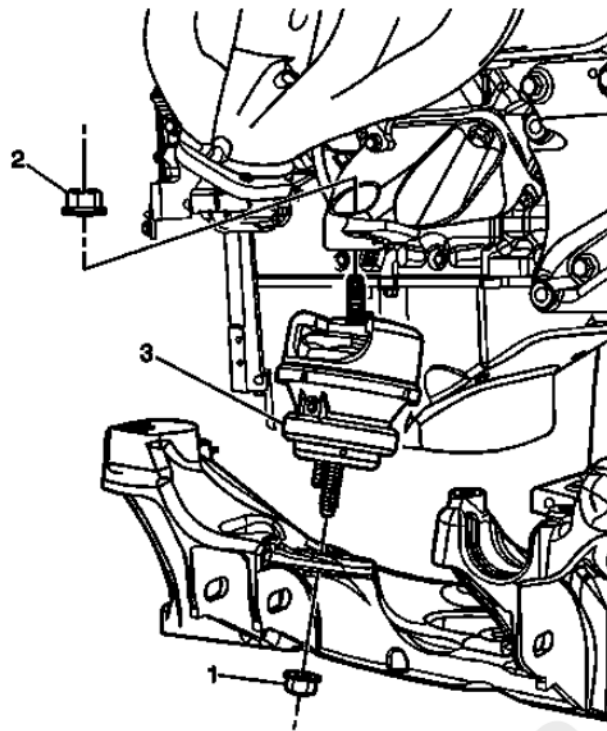


Fig. 33: Identifying Engine Mount - Right Side (RWD)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Discharge the air conditioning (A/C) system. Refer to <u>Refrigerant Recovery and Recharging</u> . 2. Remove the tower brace. Refer to <u>Cross Vehicle Brace Replacement</u> . 3. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 4. Remove the suction hose from the A/C compressor. Refer to <u>Air Conditioning Compressor Hose Replacement (LF1, LLT)</u> . 5. Position the hose aside to gain access to the engine mount top nut. 6. Lower the vehicle.	
1	Engine Mount Fastener CAUTION: Refer to. Procedure 1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Position a screw jack and a block of wood under the engine oil pan.

	Tighten: 80 N.m (59 lb ft)
2	Engine Mount Fastener Tighten: 80 N.m (59 lb ft)
3	Engine Mount Procedure 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE (AWD)

REMOVAL PROCEDURE

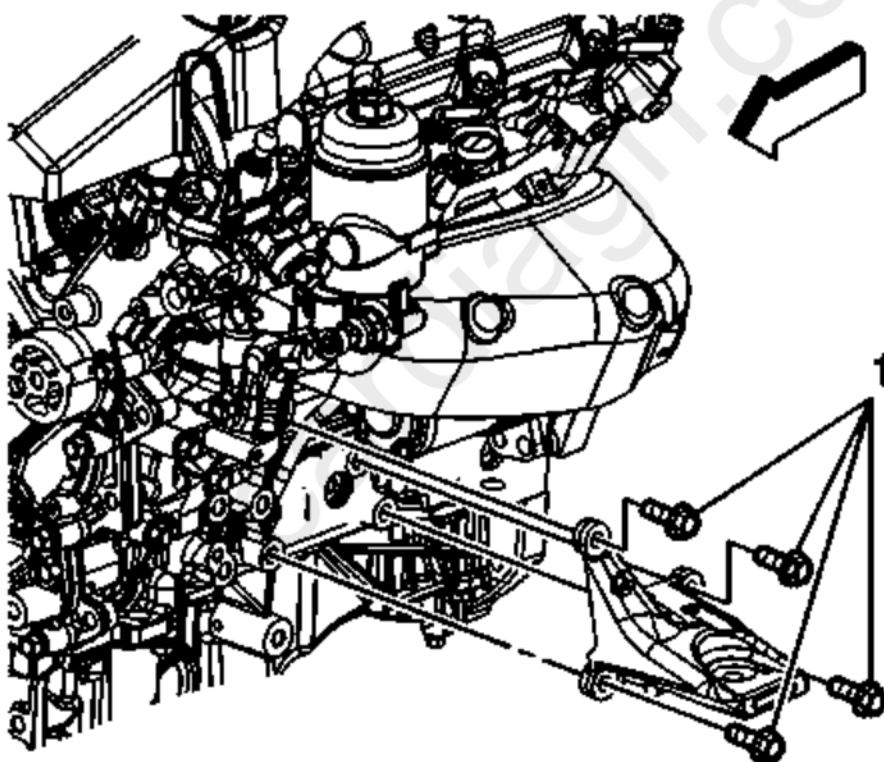


Fig. 34: View of Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount. Refer to [Engine Mount Replacement - Left Side \(AWD\)](#) or [Engine Mount Replacement - Left Side \(RWD\)](#).

2. Remove the left engine mount bracket retaining bolts (1).
3. Remove the left engine mount bracket.

INSTALLATION PROCEDURE

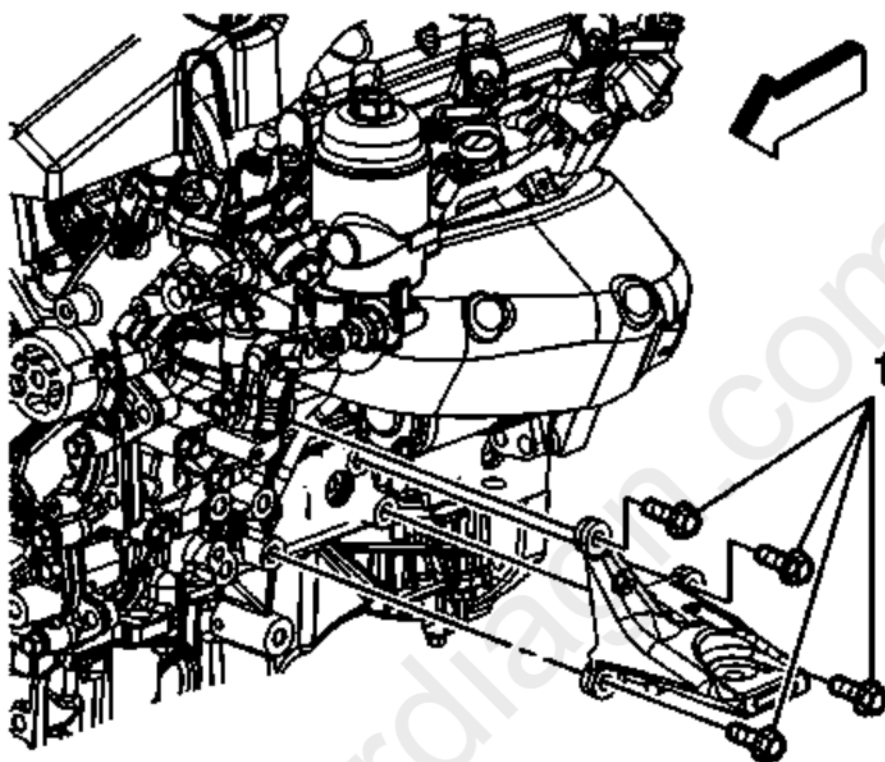


Fig. 35: View of Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Install the left engine mount bracket assembly.

CAUTION: Refer to FASTENER CAUTION .

2. Install the left engine mount bracket retaining bolts (1) and tighten to 60 N.m (44 lb ft).
3. Install the engine mount. Refer to Engine Mount Replacement - Left Side (AWD) or Engine Mount Replacement - Left Side (RWD).

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE (RWD)

REMOVAL PROCEDURE

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

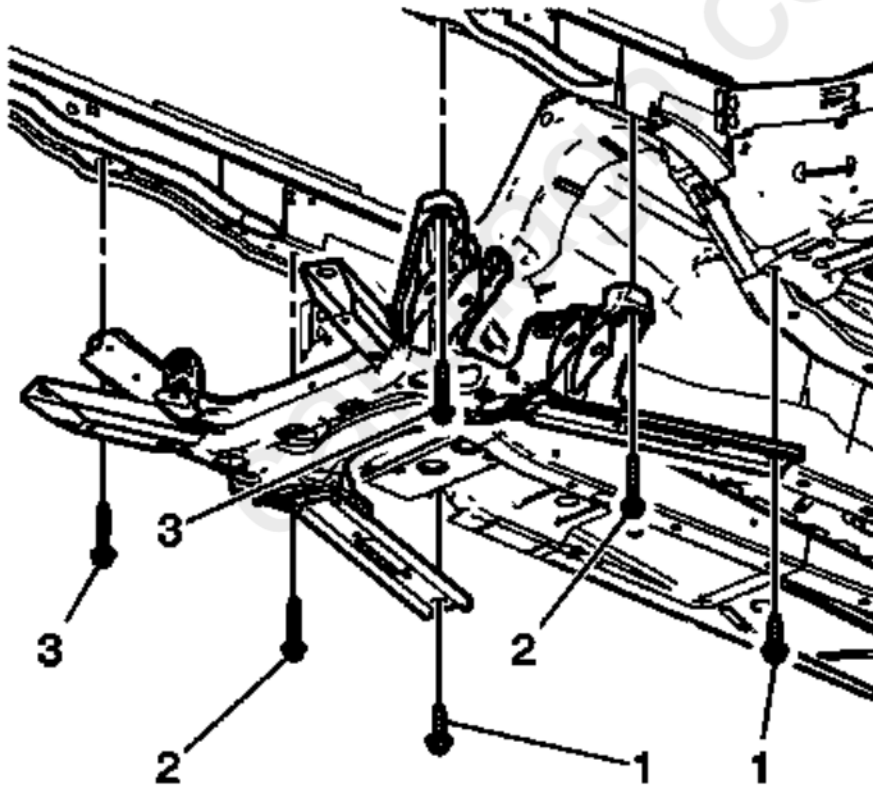


Fig. 36: View of Cross Vehicle Brace Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the tower brace. Refer to Cross Vehicle Brace Replacement .

2. Secure the steering wheel in place.
3. Remove the lower section of the steering intermediate shaft. Refer to **Lower Intermediate Steering Shaft Replacement**.
4. Remove the left and right lower engine mount nuts.
5. Install a screw jack with a block of wood under the oil pan for support.
6. Support the rear of the front frame with a screw jack.
7. Remove the frame rear (1) and center (2) mounting bolts.
8. Loosen the front frame bolts (3) 12.7 mm (0.5 in) to 25.4 mm (1 in).
9. Lower the rear section of the frame.

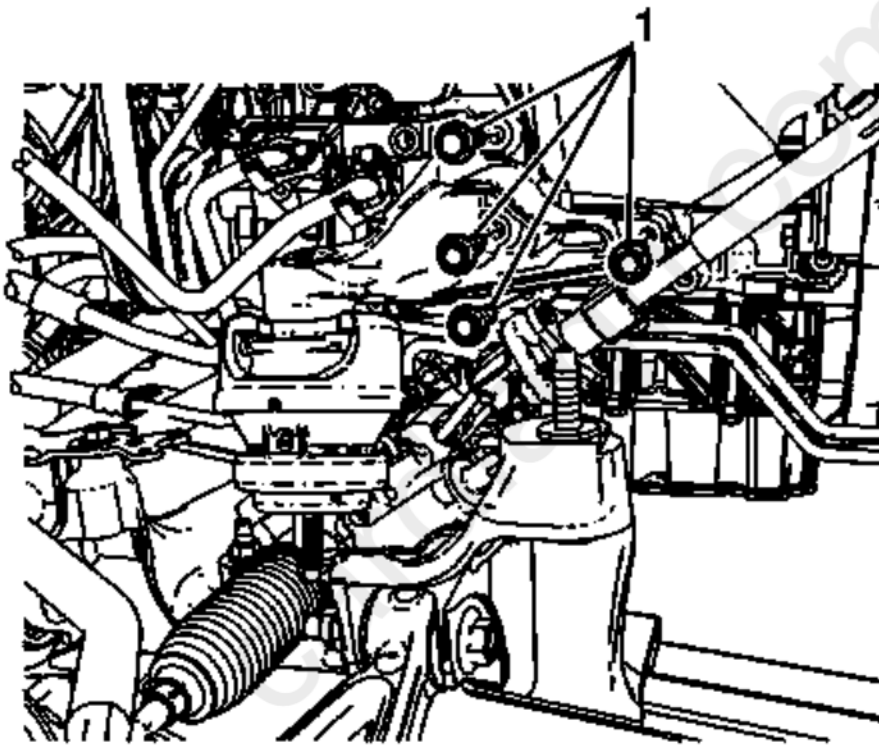


Fig. 37: Identifying Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine mount bracket bolts (1).
11. Remove the engine mount and engine mount bracket as an assembly.

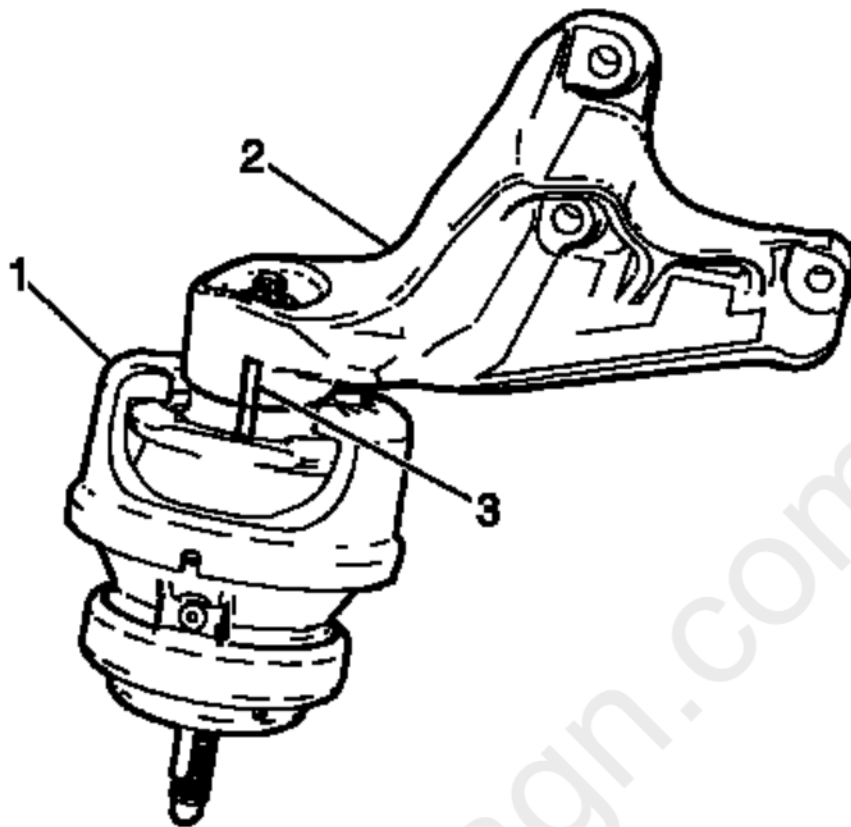


Fig. 38: View of Engine Mount, Bracket and Alignment Mark
Courtesy of GENERAL MOTORS CORP.

12. Mark the location of the engine mount (1) to the engine mount bracket (2).

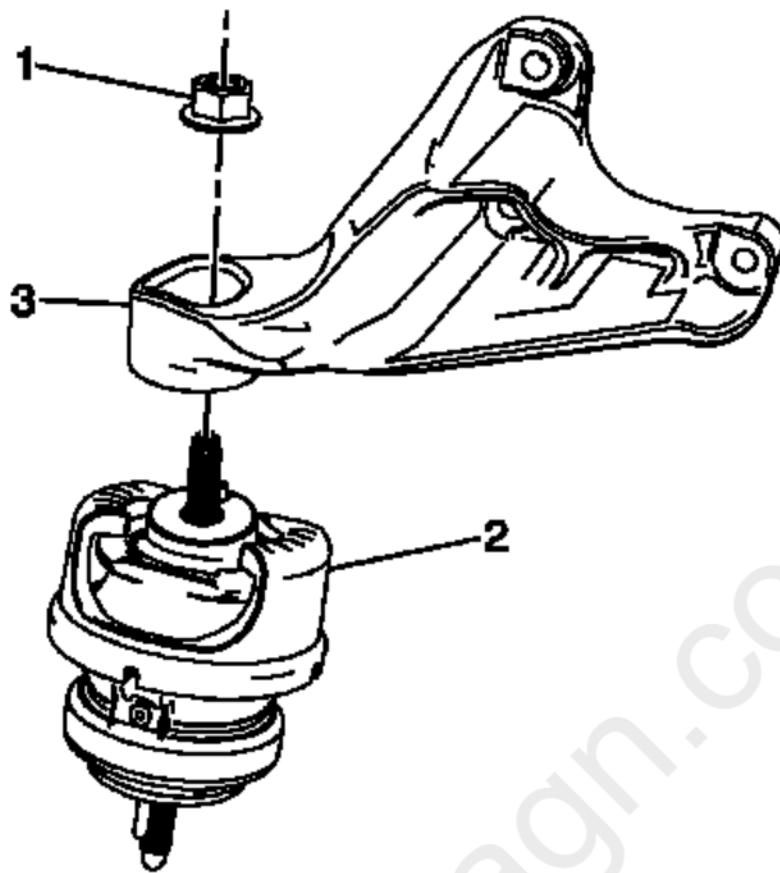


Fig. 39: View Of Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

13. Remove the upper engine mount retaining nut (1).
14. Separate the engine mount (2) from the engine mount bracket (3).

INSTALLATION PROCEDURE

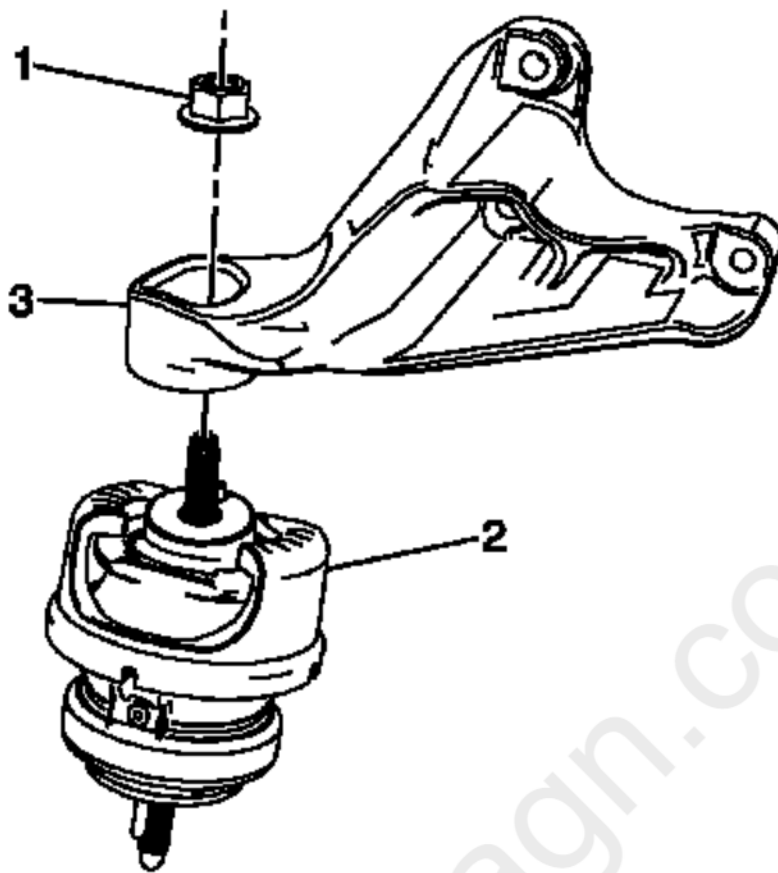


Fig. 40: View Of Left Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket (3) to the engine mount (2).

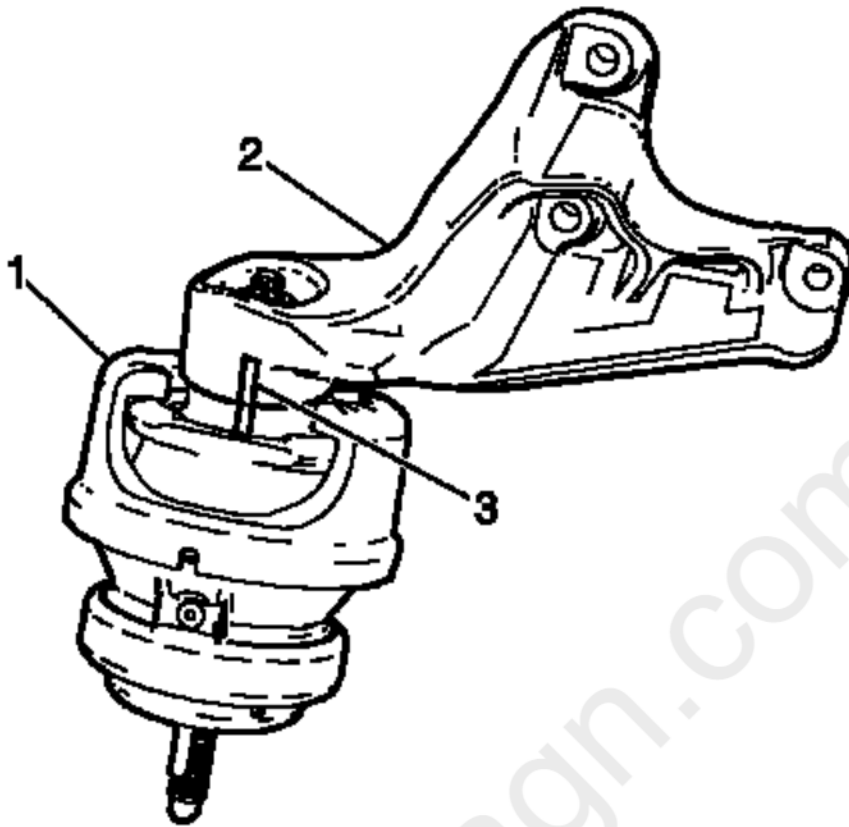


Fig. 41: View of Engine Mount, Bracket and Alignment Mark
Courtesy of GENERAL MOTORS CORP.

2. Align the location mark (3) of the engine mount (1) to the engine mount bracket (2).

CAUTION: Refer to FASTENER CAUTION .

3. Install the upper engine mount retaining nut and tighten to 80 N.m (59 lb ft).

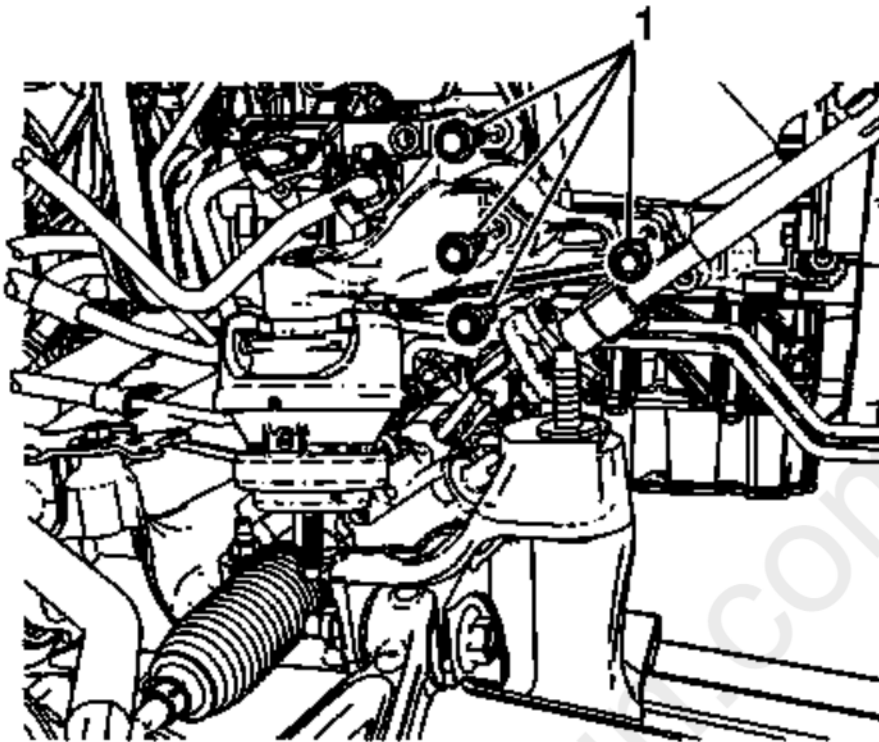


Fig. 42: Identifying Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the engine mount and engine mount bracket as an assembly.
5. Install the engine mount bracket bolts (1) and tighten to 60 N.m (44 lb ft).
6. Raise the rear section of the frame.

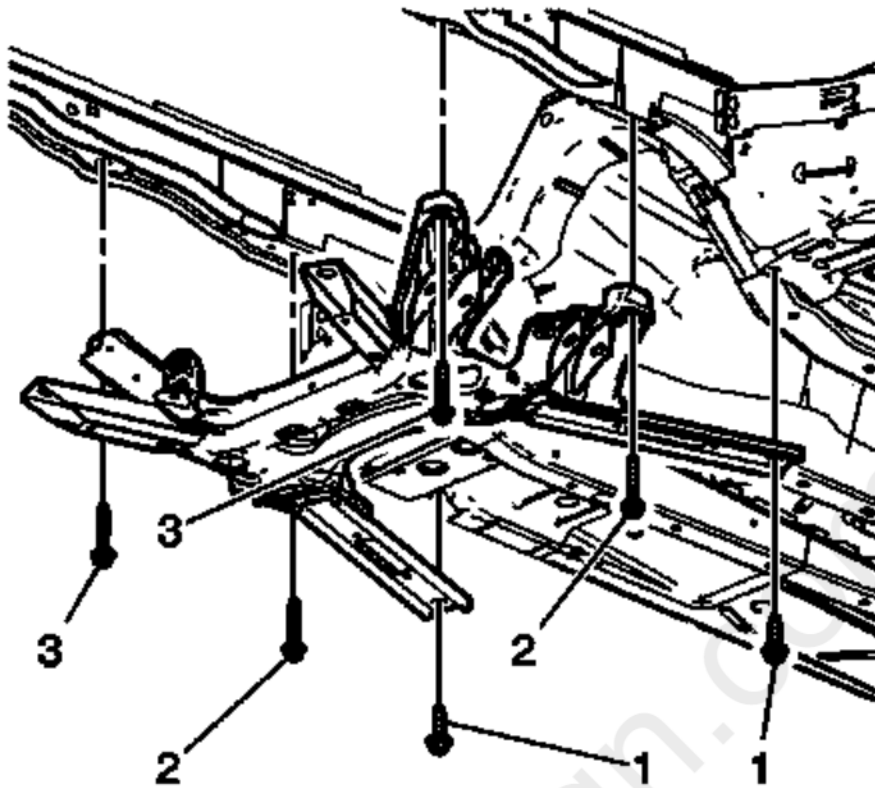


Fig. 43: View of Cross Vehicle Brace Assembly
Courtesy of GENERAL MOTORS CORP.

7. Install but do not tighten the frame rear (1) and center (2) mounting bolts. Tighten the bolts to 191 N.m (141 lb ft).

NOTE: **Ensure to tighten the frame bolts in sequence.**

8. Tighten the frame bolts.
 1. Tighten the left front frame bolt to 191 N.m (141 lb ft).
 2. Tighten the right front frame bolt to 191 N.m (141 lb ft).
 3. Tighten the center front frame bolts to 191 N.m (141 lb ft).
 4. Tighten the rear front frame bolts to 191 N.m (141 lb ft).
9. Remove the screw jack from the rear of the front frame.
10. Remove the screw jack and block of wood from under the oil pan.
11. Install the left and right lower engine mount nuts and tighten to 80 N.m (59 lb ft).
12. Install the lower section of the steering intermediate shaft. Refer to **Lower Intermediate Steering Shaft Replacement**.
13. Unsecure the steering wheel.

14. Install the tower brace. Refer to [Cross Vehicle Brace Replacement](#) .

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (W/RWD)

REMOVAL PROCEDURE

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- The steering column
- The intermediate shaft(s)
- The steering gear

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

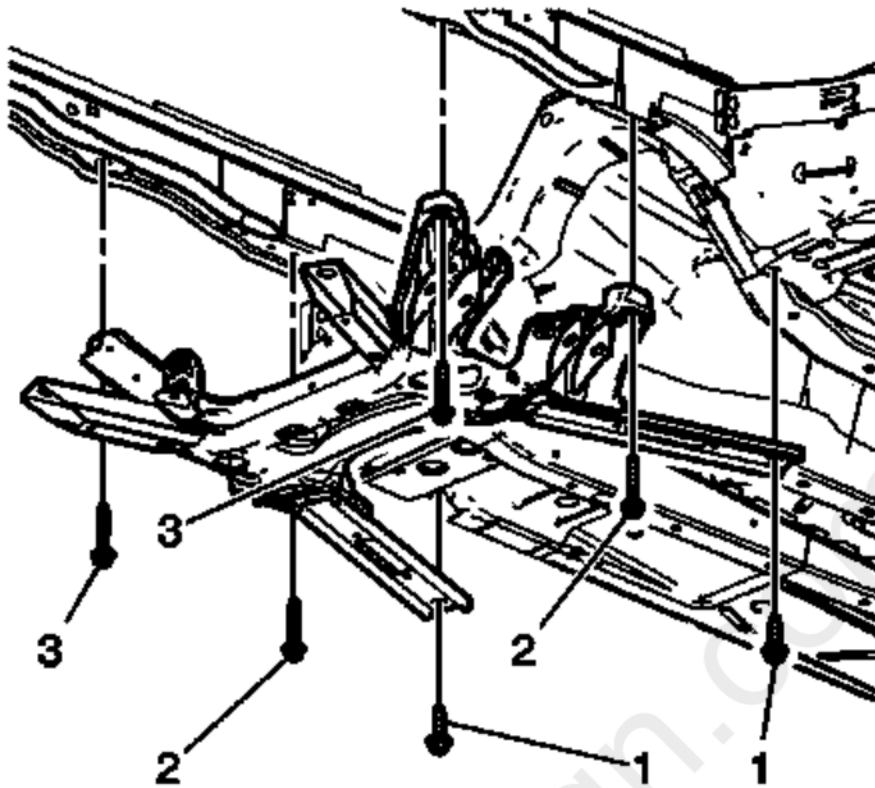


Fig. 44: View of Cross Vehicle Brace Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the tower brace. Refer to **Cross Vehicle Brace Replacement** .
2. Secure the steering wheel in place.
3. Remove the lower section of the steering intermediate shaft. Refer to **Lower Intermediate Steering Shaft Replacement** .
4. Remove the left and right lower engine mount nuts.
5. Install a screw jack with a block of wood under the oil pan for support.
6. Support the rear of the front frame with a screw jack.
7. Remove the frame rear (1) and center (2) mounting bolts.
8. Loosen the front frame bolts (3) 12.7 mm (0.5 in) to 25.4 mm (1 in).
9. Lower the rear section of the frame.

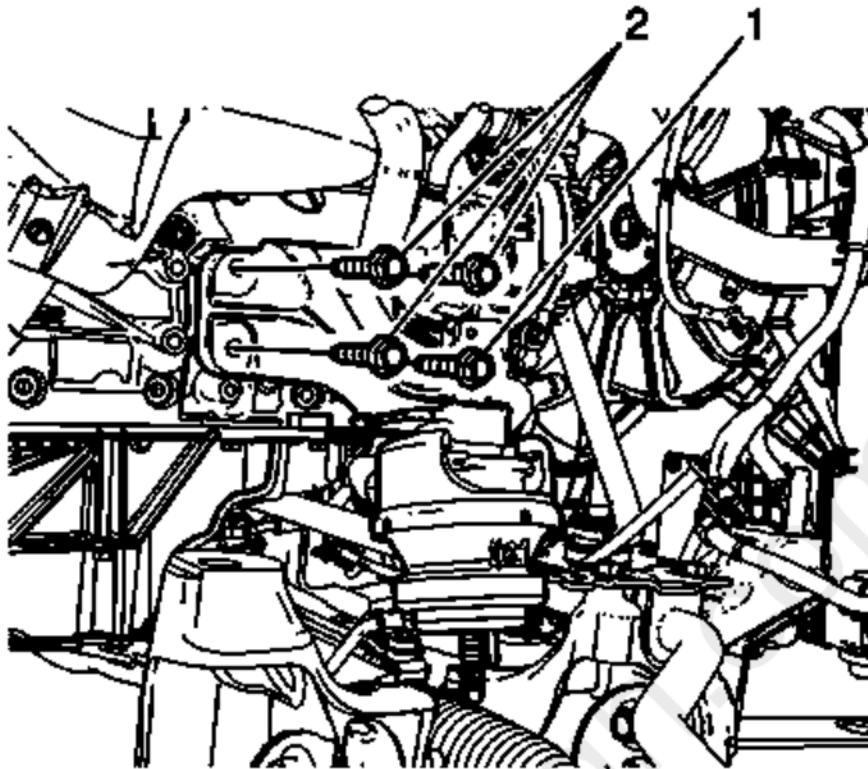


Fig. 45: Identifying Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine mount bracket bolts (1).
11. Remove the engine mount and engine mount bracket as an assembly.

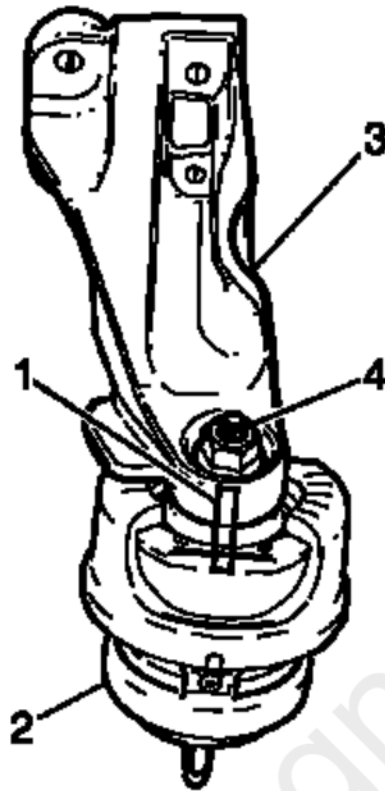


Fig. 46: View of Engine Mount and Bracket Assembly
Courtesy of GENERAL MOTORS CORP.

12. Place a location mark (1) on the engine mount (2) and the engine mount bracket (3).
13. Remove the upper engine mount retaining nut (4).
14. Separate the engine mount (2) from the engine mount bracket (3).

INSTALLATION PROCEDURE

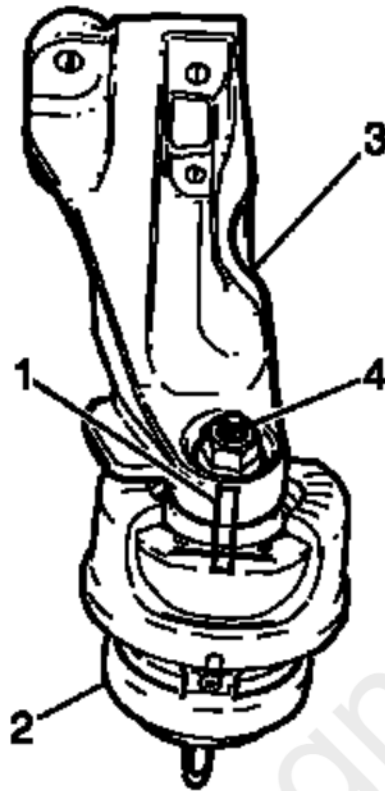


Fig. 47: View of Engine Mount and Bracket Assembly
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount bracket (3) to the engine mount (2).
2. Ensure to align the location mark (1) of the engine mount (2) to the engine mount bracket (3).

CAUTION: Refer to FASTENER CAUTION .

3. Install the upper engine mount retaining nut (4) and tighten to 80 N.m (59 lb ft).
4. Position the engine mount bracket (3) to the engine mount (2).

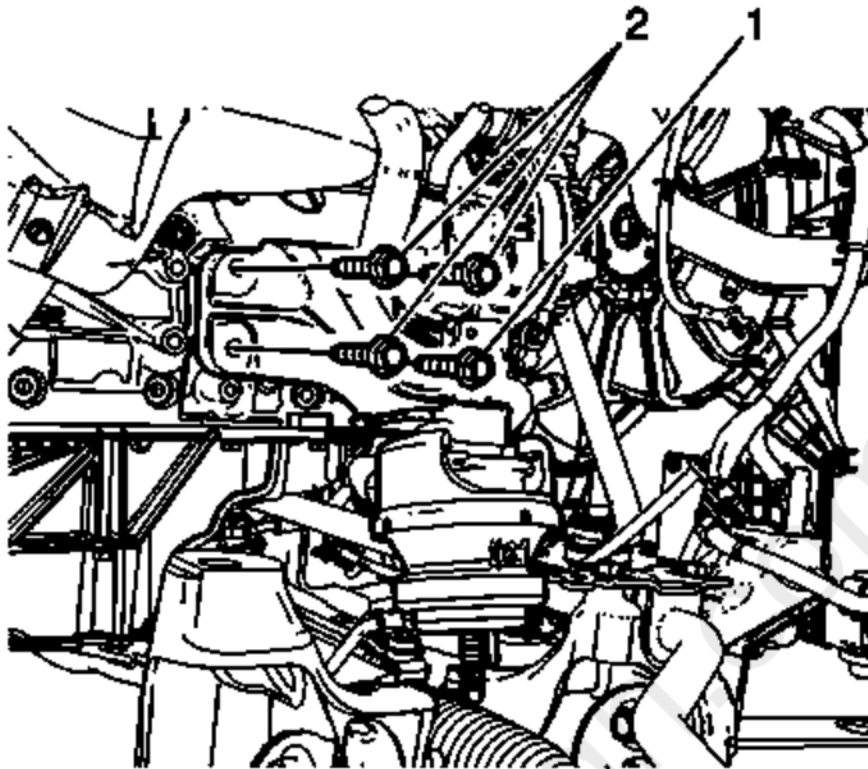


Fig. 48: Identifying Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount and engine mount bracket as an assembly.
6. Install the engine mount bracket bolts (1) and tighten to 22 N.m (16 lb ft) and tighten (2) Bolt to 60 N.m (44 lb ft)
7. Raise the rear section of the frame.

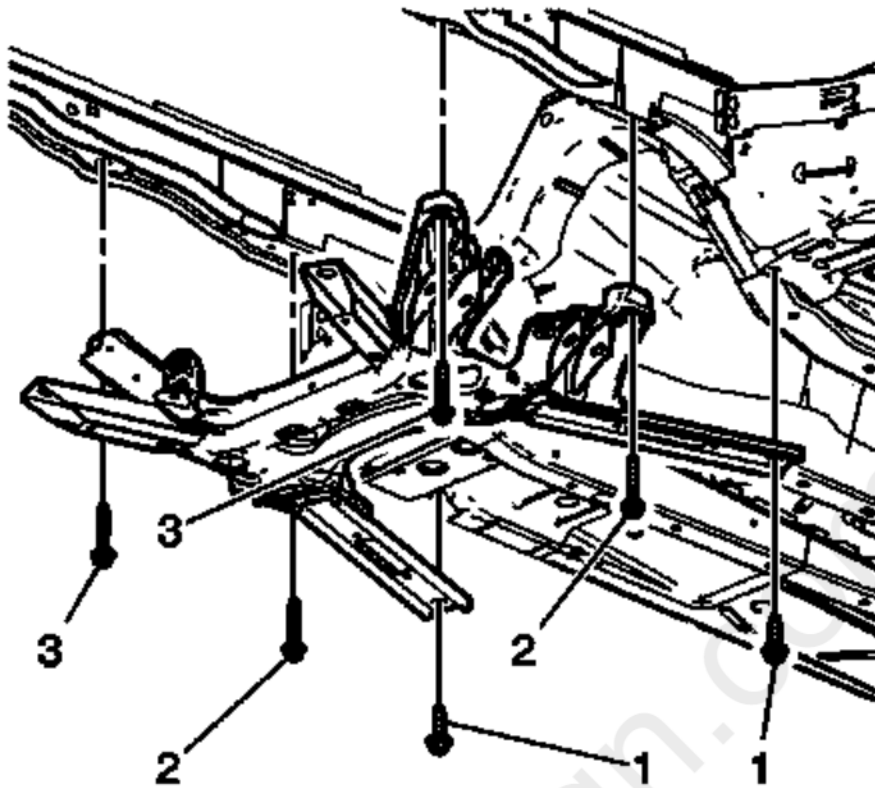


Fig. 49: View of Cross Vehicle Brace Assembly
Courtesy of GENERAL MOTORS CORP.

8. Install but do not tighten the frame rear (1) and center (2) mounting bolts. Tighten the bolts to 191 N.m (141 lb ft).

NOTE: **Ensure to tighten the frame bolts in sequence.**

9. Tighten the frame bolts.
 1. Tighten the left front frame bolt to 191 N.m (141 lb ft).
 2. Tighten the right front frame bolt to 191 N.m (141 lb ft).
 3. Tighten the center front frame bolts to 191 N.m (141 lb ft).
 4. Tighten the rear front frame bolts to 191 N.m (141 lb ft).
10. Remove the screw jack from the rear of the front frame.
11. Remove the screw jack and block of wood from under the oil pan.
12. Install the left and right lower engine mount nuts and tighten to 80 N.m (59 lb ft).
13. Install the lower section of the steering intermediate shaft. Refer to **Lower Intermediate Steering Shaft Replacement**.
14. Unsecure the steering wheel.

15. Install the tower brace. Refer to Cross Vehicle Brace Replacement .

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (W/AWD)

REMOVAL PROCEDURE

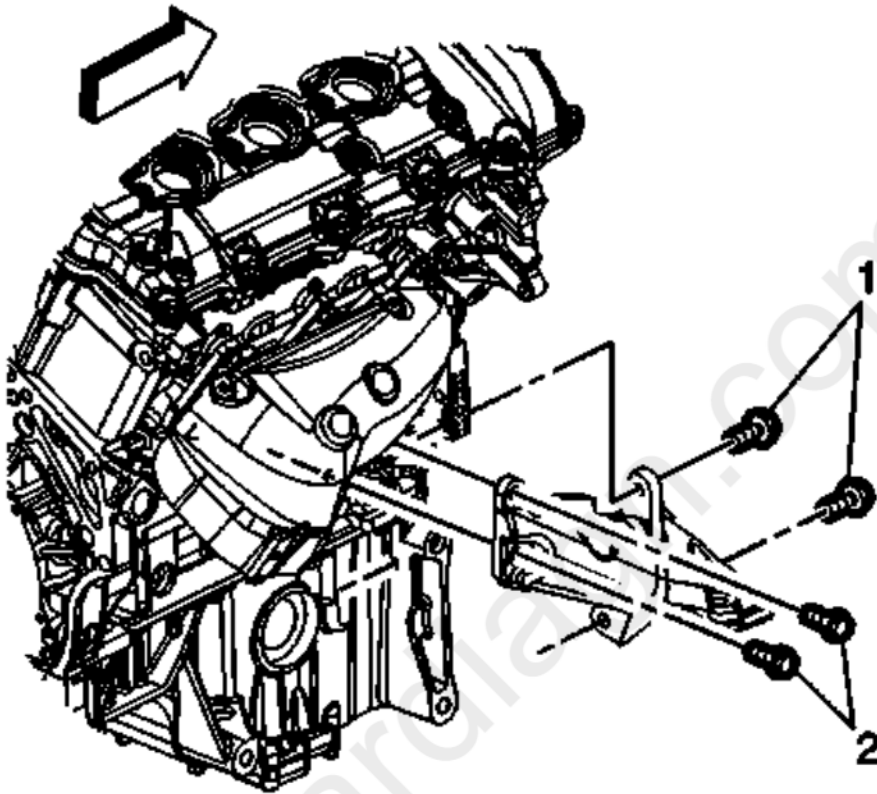


Fig. 50: Engine Mount Bracket - Right Side (W/AWD)
Courtesy of GENERAL MOTORS CORP.

1. Remove the right side engine mount. Refer to Engine Mount Replacement - Right Side (AWD) or Engine Mount Replacement - Right Side (RWD).
2. Remove the front engine mount bracket mounting bolts (1).
3. Remove the rear engine mount bracket mounting bolts (2).

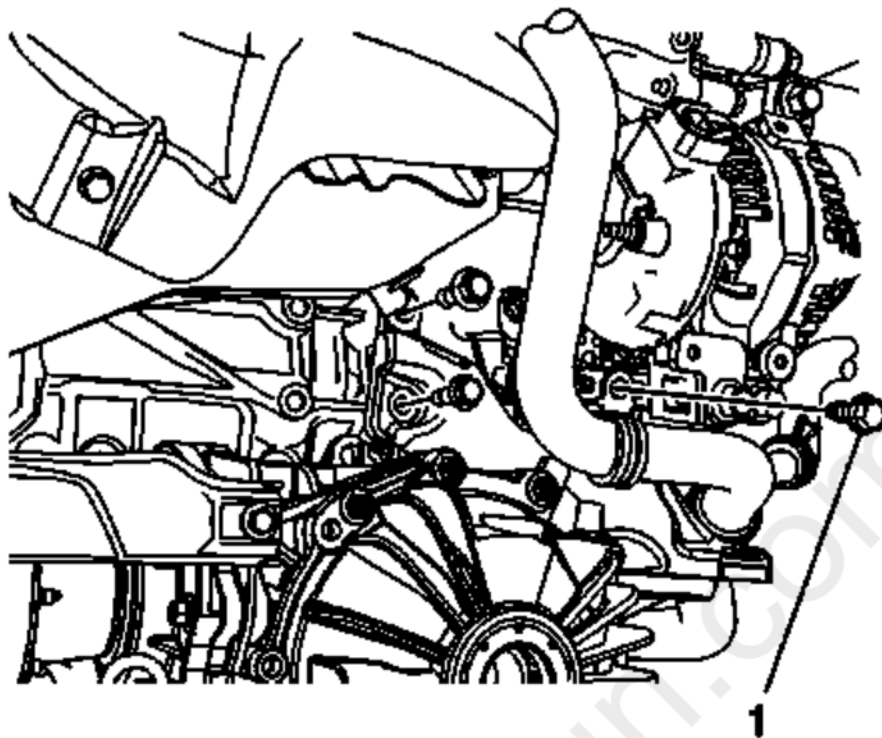


Fig. 51: Identifying Coolant Tube Retaining Clamp Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the coolant tube retaining clamp bolt (1).
5. Reposition the coolant tube aside.

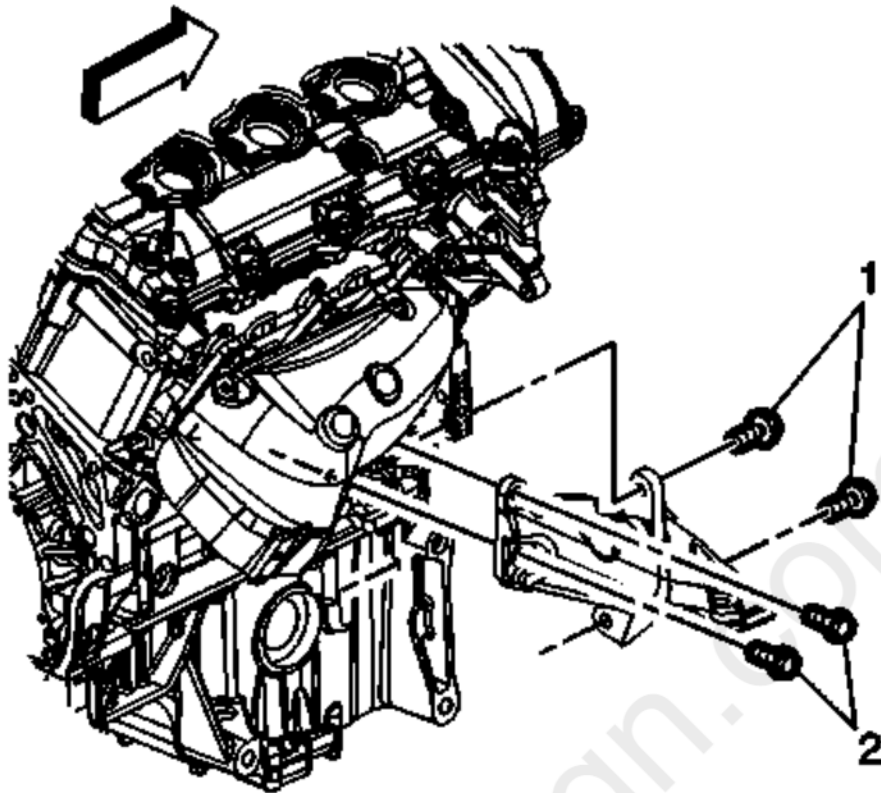


Fig. 52: Engine Mount Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine mount bracket retaining bolt (3) behind the engine coolant tube.
7. Remove the engine mount bracket from the vehicle.

INSTALLATION PROCEDURE

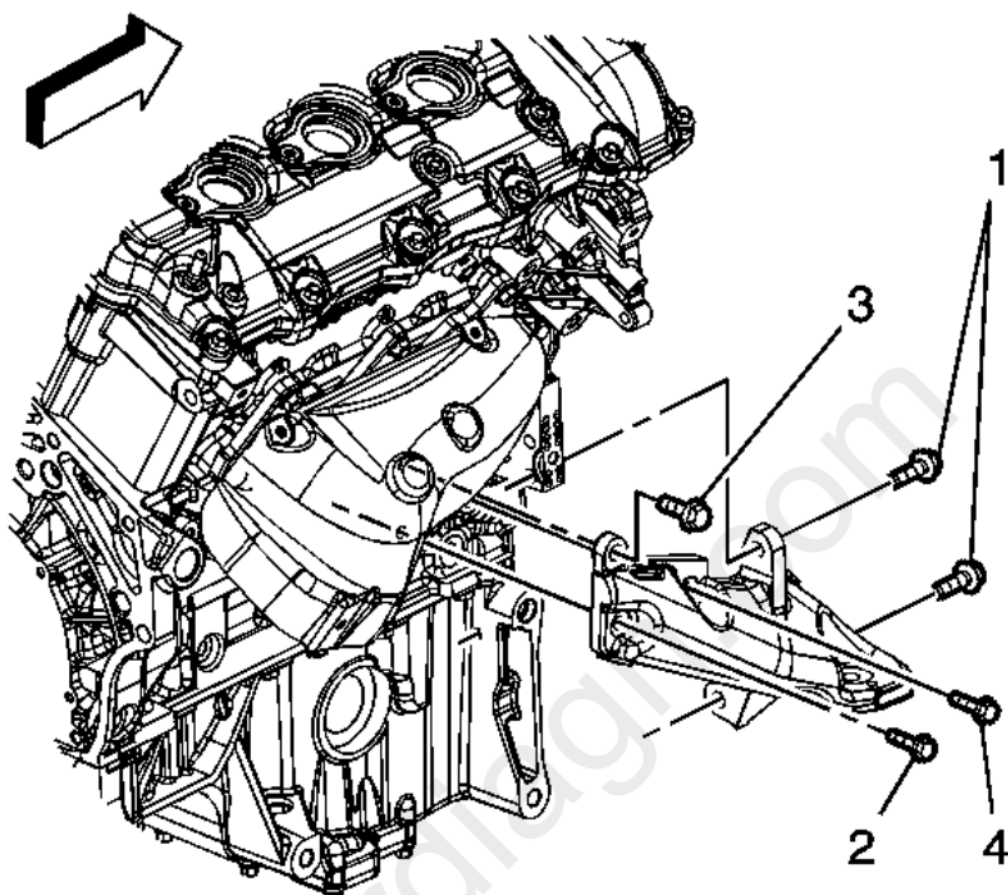


Fig. 53: Identifying Engine Mount Bracket Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket to the vehicle.
2. Install but do not tighten the rear engine mount bracket retaining bolts (2).
3. Install but do not tighten the front engine mount bracket retaining bolts (1).

CAUTION: Refer to FASTENER CAUTION .

4. Install the engine mount bracket retaining bolt behind the engine coolant tube (3) and tighten to 38 N.m (28 lb ft).
5. Tighten the rear lower engine mount bracket retaining bolts (2) to 38 N.m (28 lb ft).
6. Tighten the front engine mount bracket retaining bolts (1) to 60 N.m (42 lb ft).

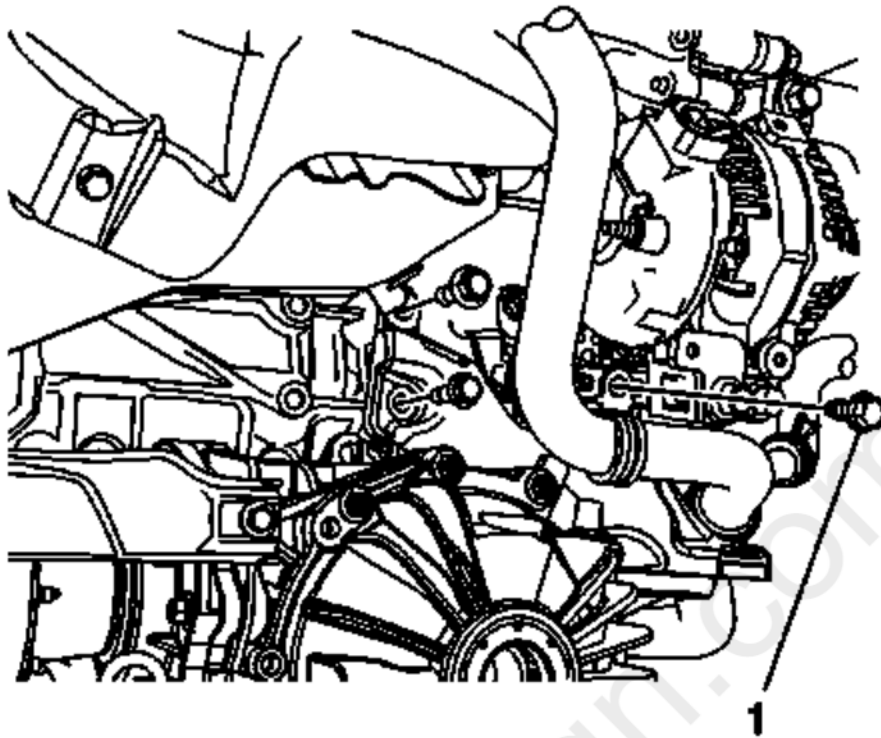


Fig. 54: Identifying Coolant Tube Retaining Clamp Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the coolant tube retaining clamp bolt (1) and tighten to 10 N.m (87 in ft).
8. Install the right side engine mount. Refer to **Engine Mount Replacement - Right Side (AWD)** or **Engine Mount Replacement - Right Side (RWD)**.

FUEL INJECTOR SIGHT SHIELD REPLACEMENT (LP1, LY7)

REMOVAL PROCEDURE

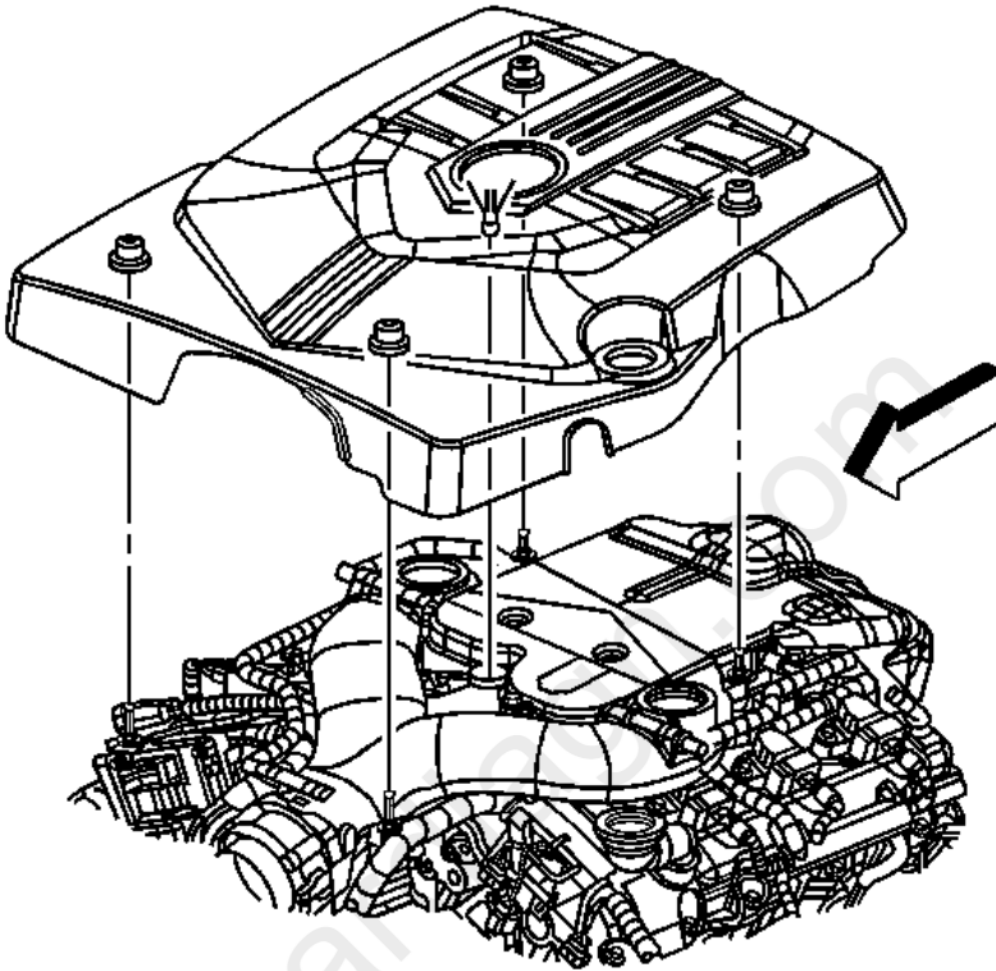


Fig. 55: View Of Engine Cover/Sight Shield
 Courtesy of GENERAL MOTORS CORP.

1. Remove the cross car brace, if necessary. Refer to **Cross Vehicle Brace Replacement** .
2. Remove the oil fill cap.
3. Disengage the cover/shield from the ball studs by pulling up firmly on the right rear and left front of the engine cover.
4. Remove the engine cover/sight shield.
5. Remove the front compartment sight shield, if necessary. Refer to **Front Compartment Sight Shields Replacement** .

INSTALLATION PROCEDURE

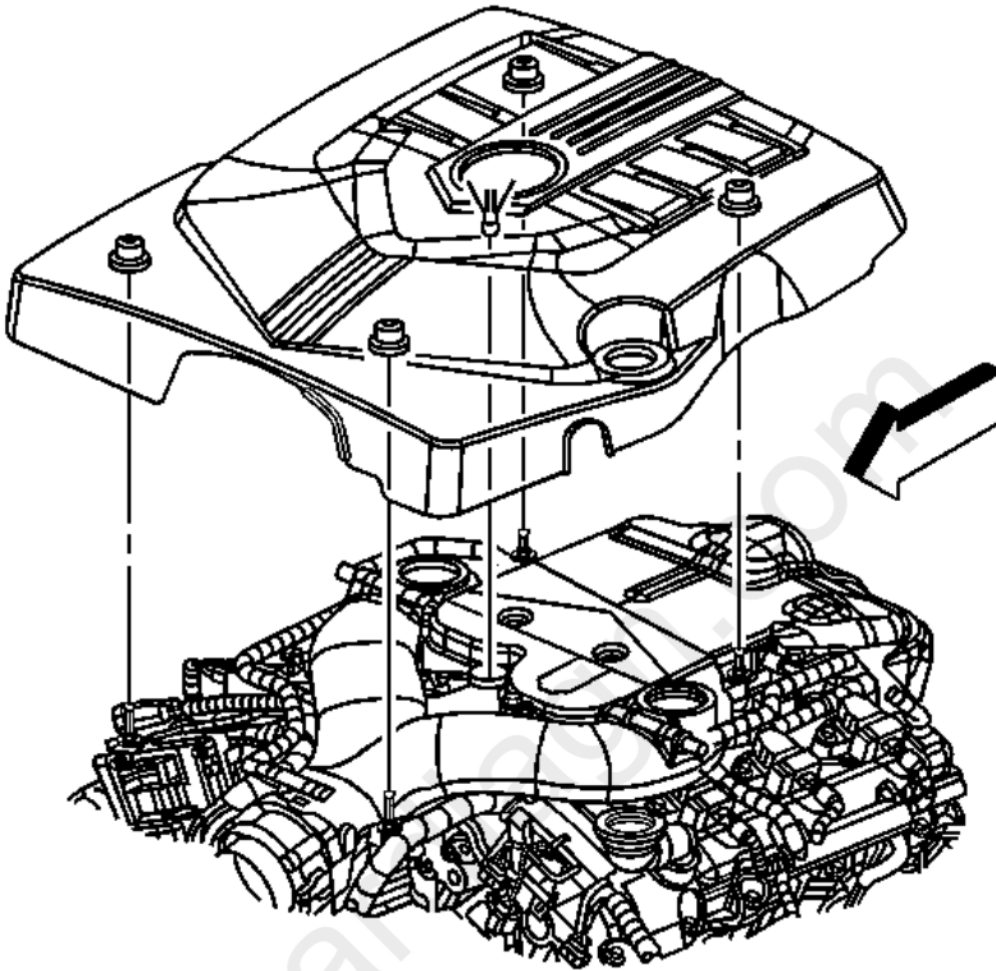


Fig. 56: View Of Engine Cover/Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Install the front compartment sight shield, if necessary. Refer to **Front Compartment Sight Shields Replacement** .
2. Position the engine cover/sight shield over the intake manifold so the grommets are aligned with the ball studs.
3. Press the engine cover/sight shield down firmly near the ball studs in order to install the engine cover/sight shield.
4. Install the oil fill cap.
5. Install the cross car brace, if necessary. Refer to **Cross Vehicle Brace Replacement** .

FUEL INJECTOR SIGHT SHIELD REPLACEMENT (LLT)

REMOVAL PROCEDURE

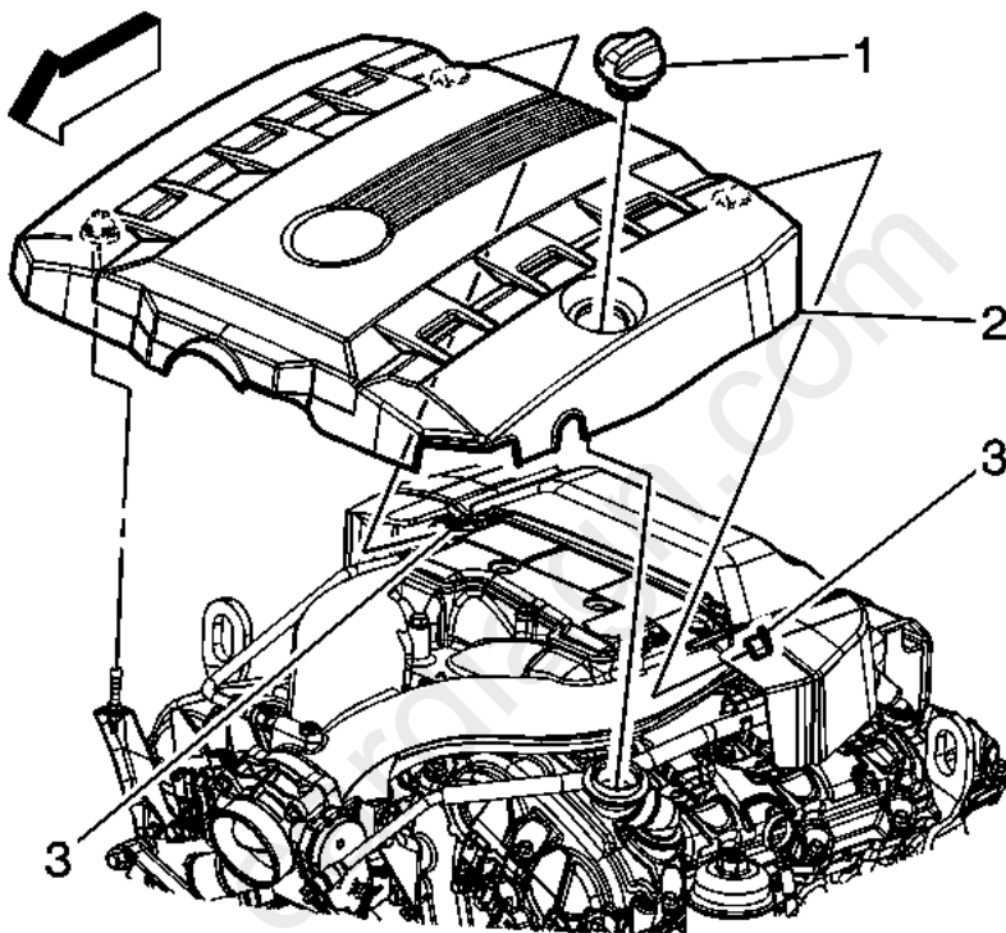


Fig. 57: Engine Cover/Sight Shield, Rear Tabs And Oil Fill Cap
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill cap (1).
2. Disengage the cover/shield (2) from the ball studs by pulling up firmly on the right and left front of the engine cover.
3. Pull the fuel injector sight shield forward to remove from the rear tabs (3).

INSTALLATION PROCEDURE

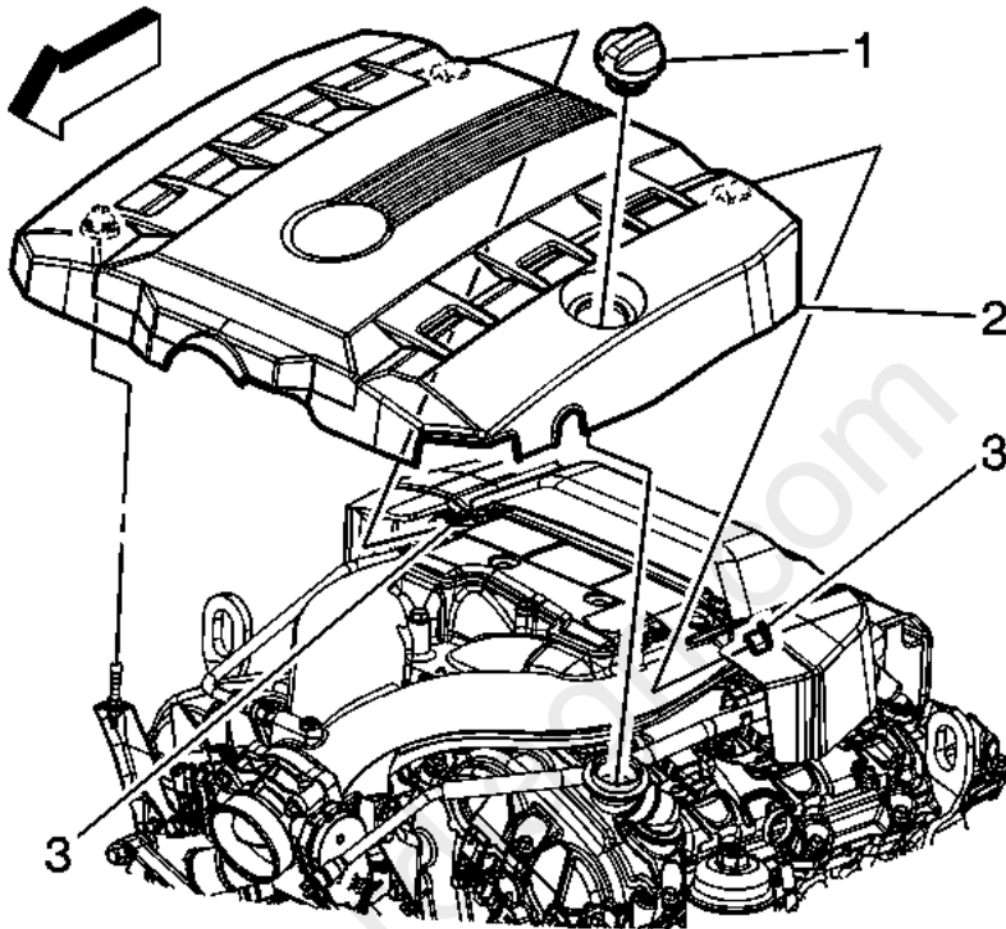


Fig. 58: Engine Cover/Sight Shield, Rear Tabs And Oil Fill Cap

Courtesy of GENERAL MOTORS CORP.

1. Raise the front edge of the fuel injector sight shield (2) while inserting the rear tabs (3).
2. Lower the front edge of the fuel injector sight shield and slide fuel injector sight shield rearward so that the rear tabs slide under the retainers.
3. Align the fuel injector sight shield over the oil fill tube.
4. Press the fuel injector sight shield down firmly on the ball stud at the right front corner.
5. Install the oil fill cap (1).

INTAKE MANIFOLD COVER REPLACEMENT - REAR

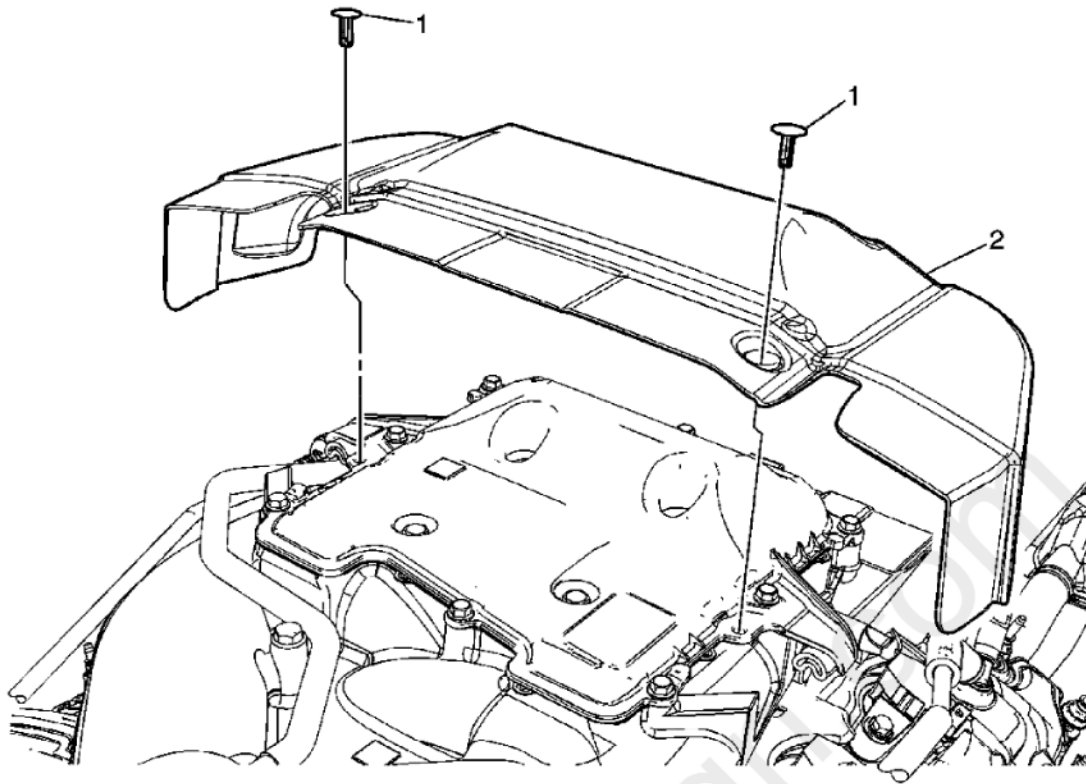


Fig. 59: Intake Manifold Cover - Rear
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injection sight shield. Refer to <u>Fuel Injector Sight Shield Replacement (LP1, LY7)</u> or <u>Fuel Injector Sight Shield Replacement (LLT)</u> .	
1	Intake Manifold Cover Retainer (Qty: 2)
2	Intake Manifold Cover
Procedure: Transfer components as necessary.	

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LP1, LY7)

REMOVAL PROCEDURE

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

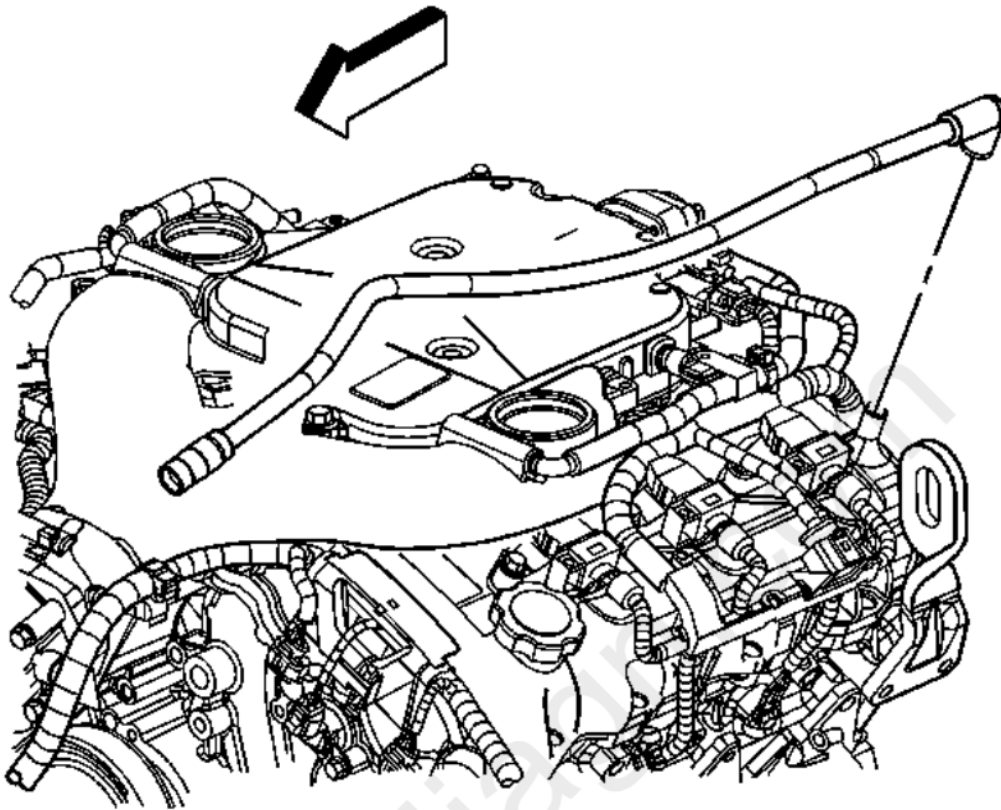


Fig. 60: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the positive crankcase ventilation (PCV) fresh air tube from the left camshaft cover.
3. Remove the PCV fresh air tube from the air inlet.

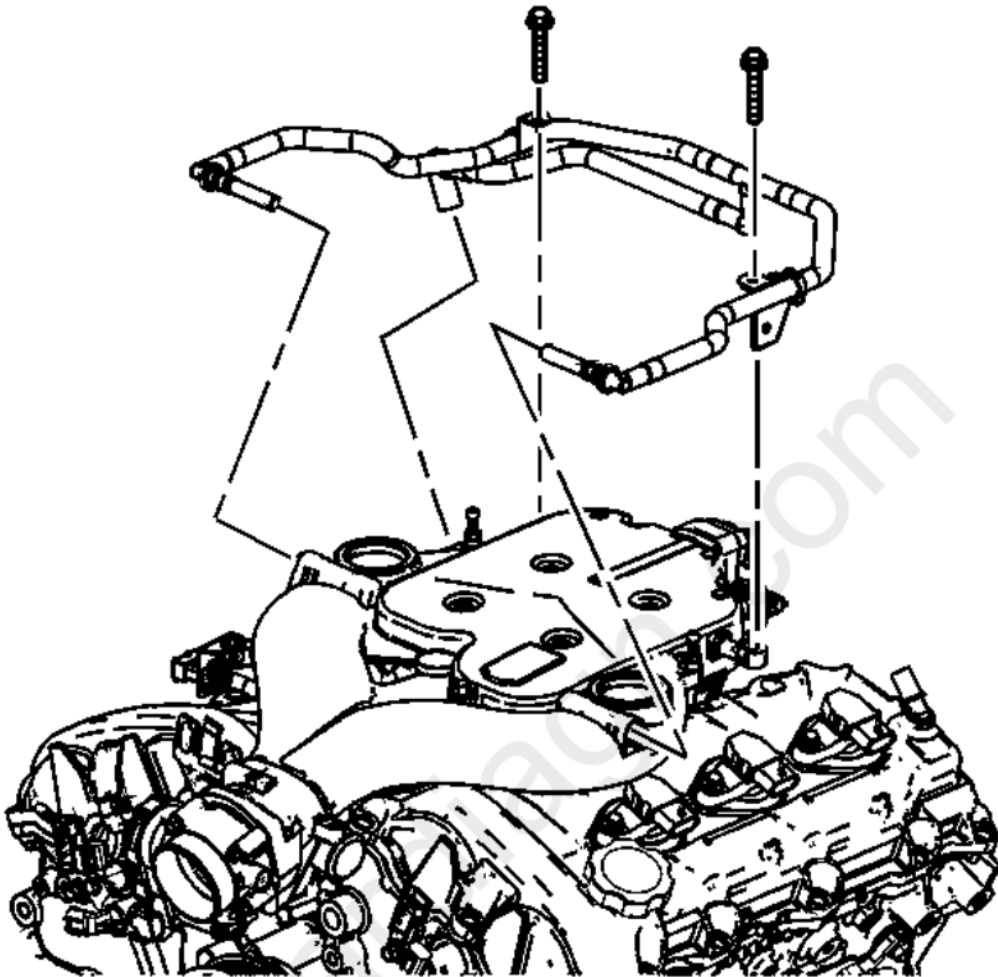


Fig. 61: View Of PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Remove the PCV tube bracket bolts.
5. Remove the PCV dirty air tube from the right camshaft cover.
6. Remove the PCV dirty air tube from the intake manifold.

INSTALLATION PROCEDURE

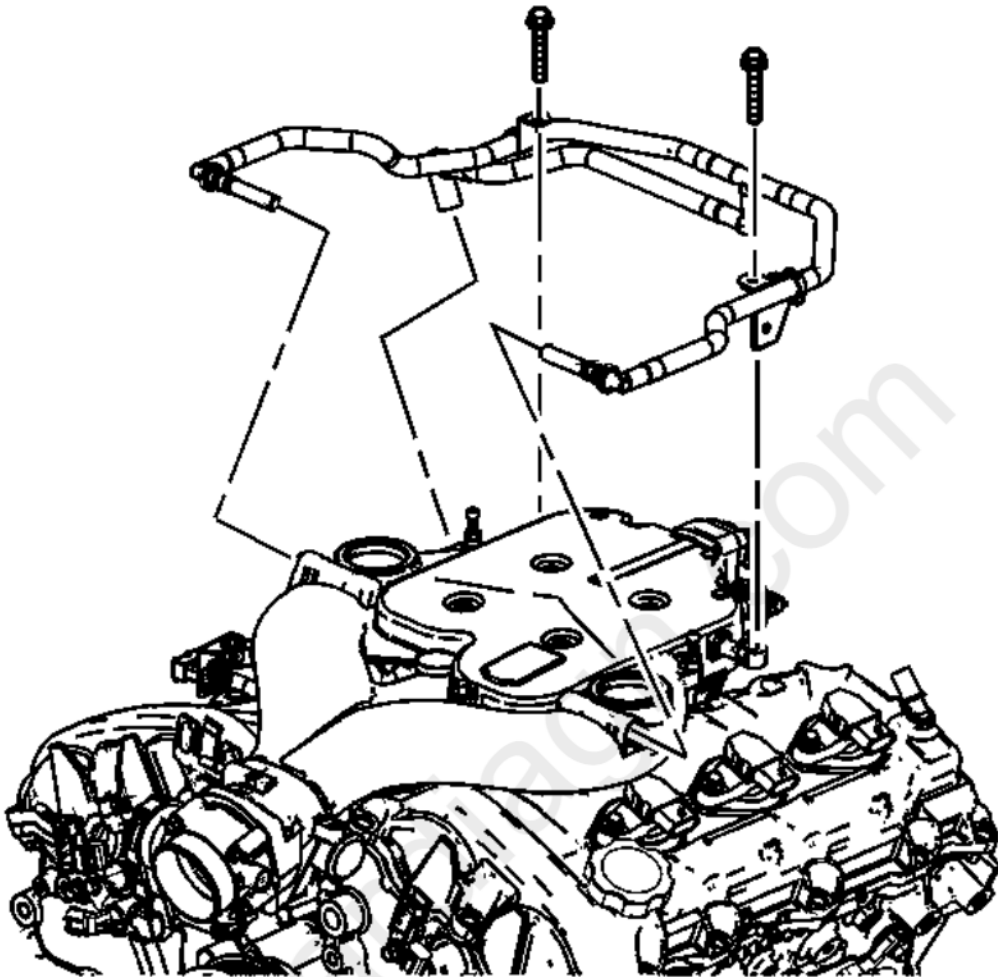


Fig. 62: View Of PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV dirty air tube to the intake manifold.
2. Install the PCV dirty air tube to the right camshaft cover.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the PCV tube bracket bolts and tighten to 10 N.m (89 lb in).

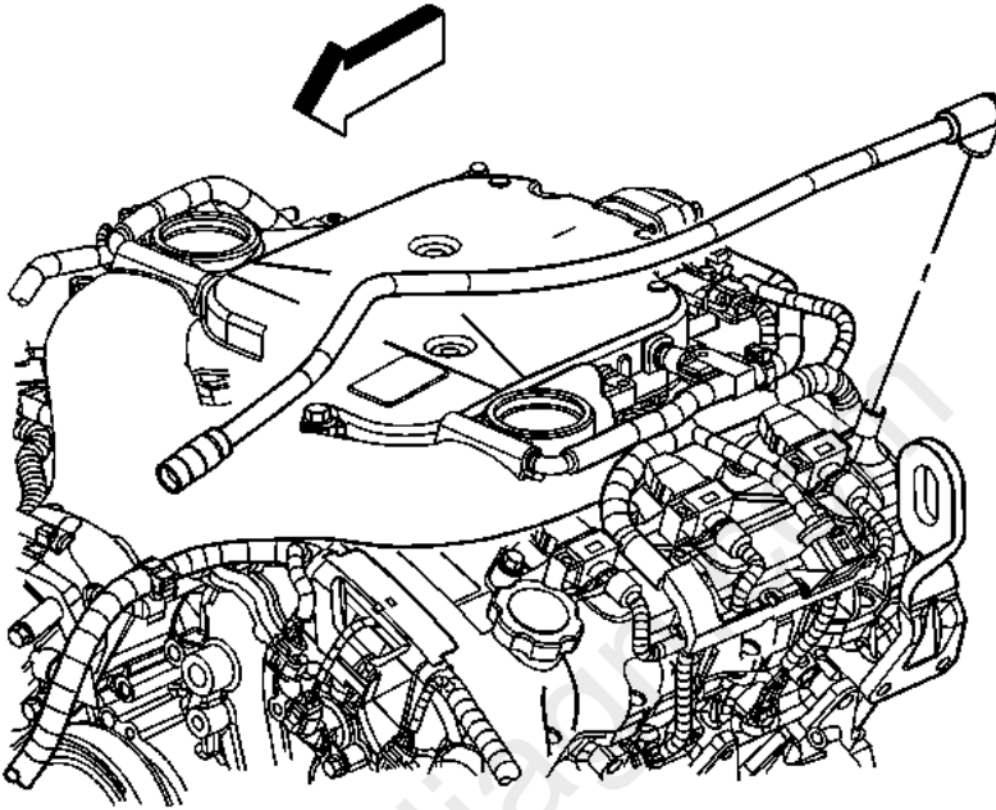


Fig. 63: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Install the PCV fresh air tube to the air inlet.
5. Install the PCV fresh air tube to the left camshaft cover.
6. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LLT)

REMOVAL PROCEDURE

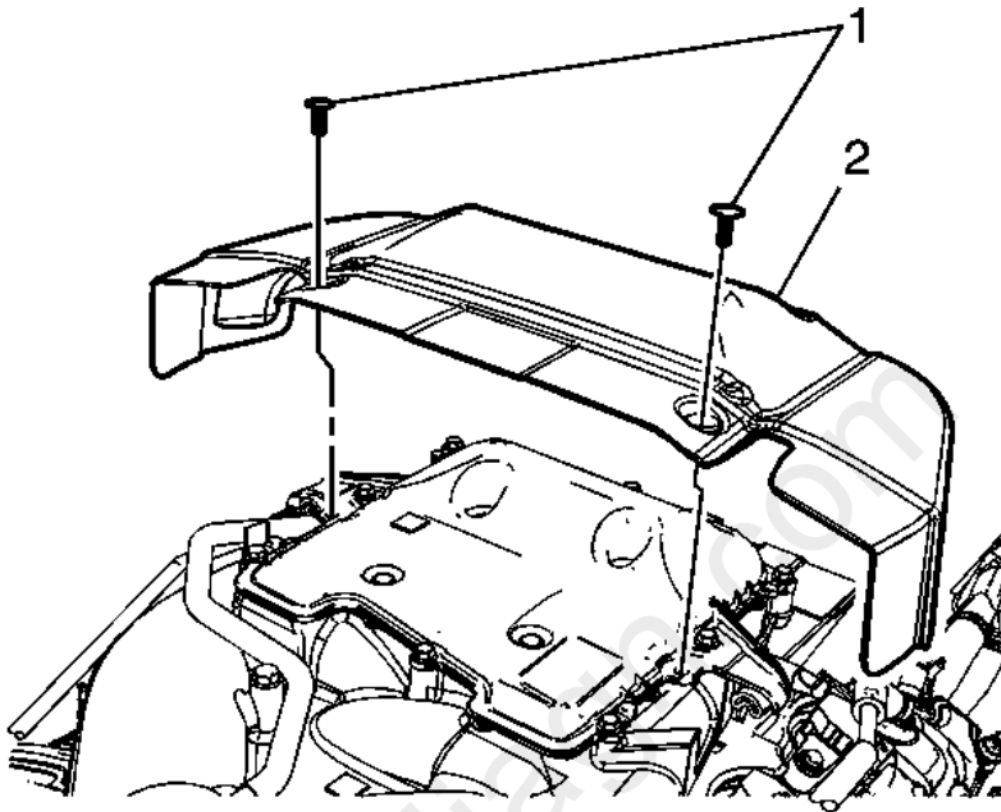


Fig. 64: Intake Manifold Insulator & Pins
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Remove two intake manifold insulator retaining pins (1)
3. Remove the intake manifold insulator (2)

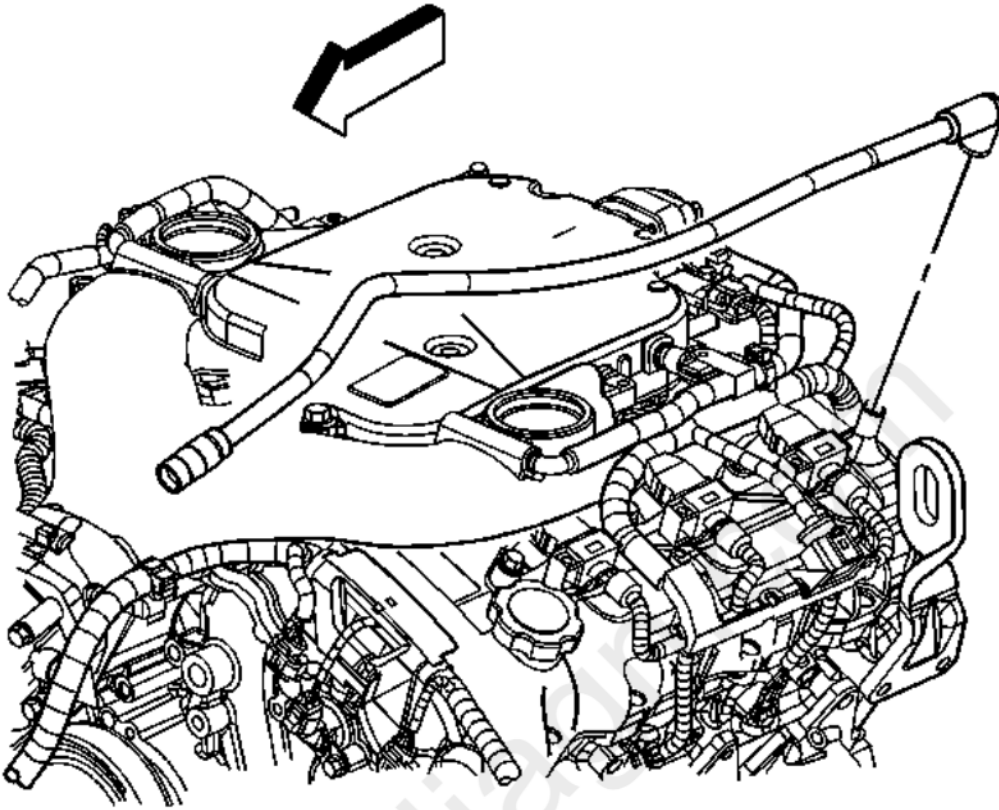


Fig. 65: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Remove the positive crankcase ventilation (PCV) fresh air tube from the left camshaft cover.
5. Remove the PCV fresh air tube from the air inlet.

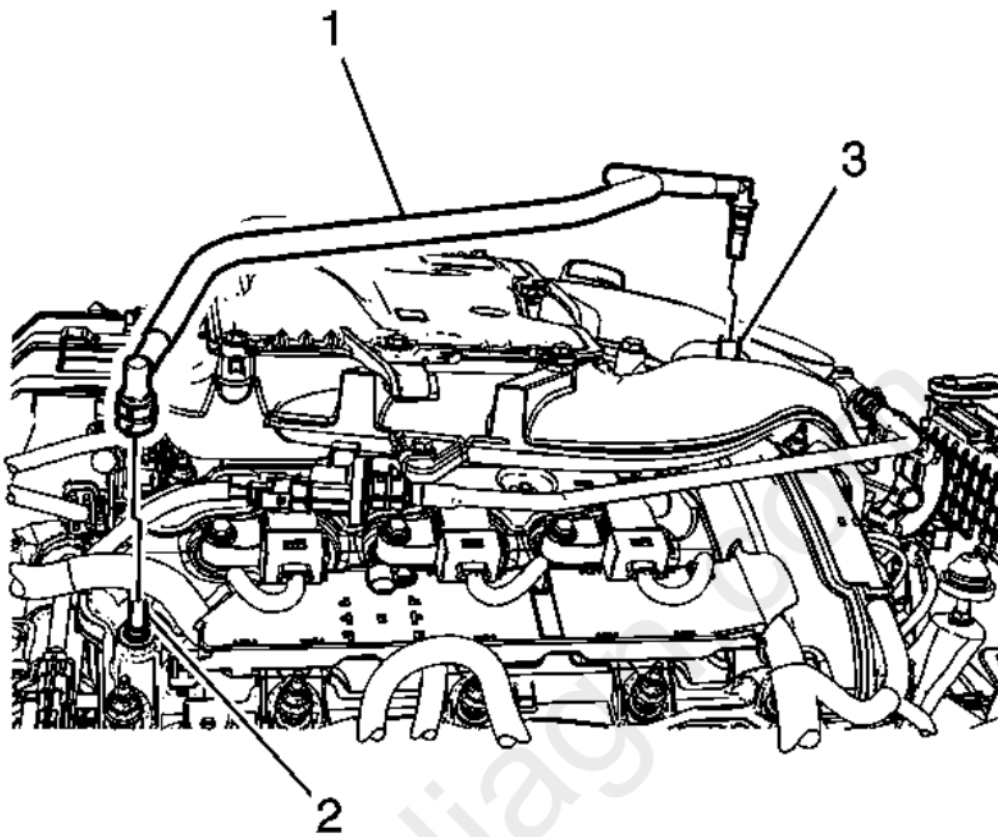


Fig. 66: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

6. Remove the PCV dirty air tube (1) from the right camshaft cover (2).
7. Remove the PCV dirty air tube (1) from the intake manifold (3).

INSTALLATION PROCEDURE

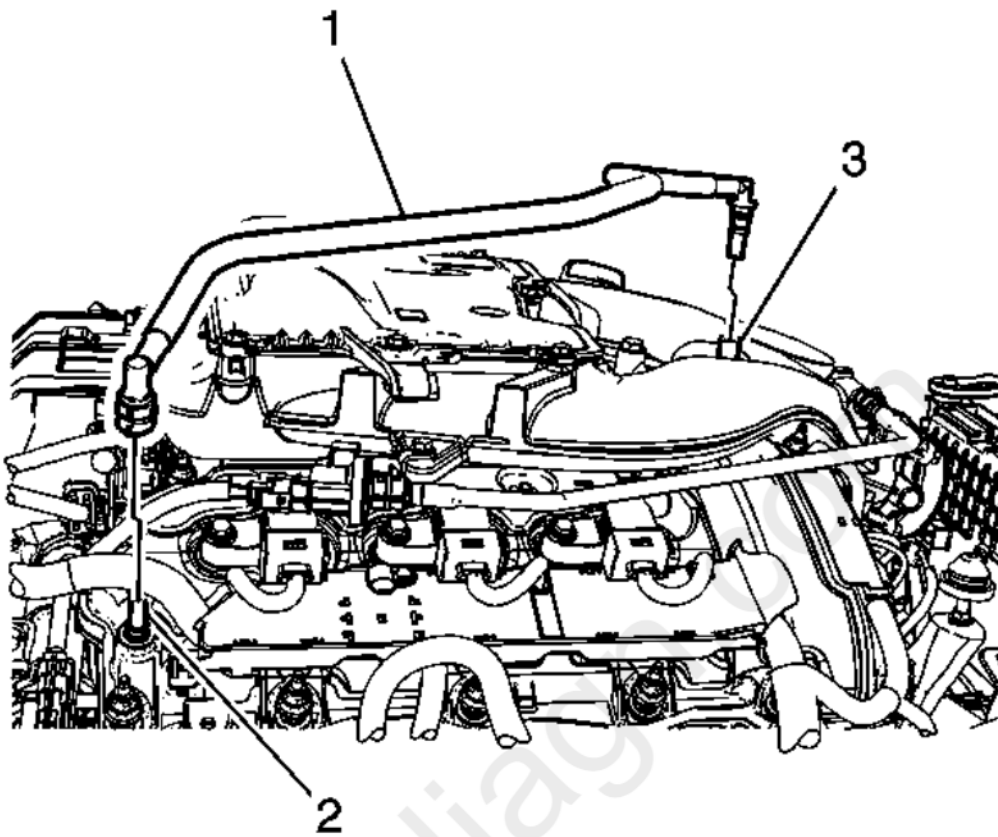


Fig. 67: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV dirty air tube (1) to the intake manifold (3).
2. Install the PCV dirty air tube (1) to the right camshaft cover (2).

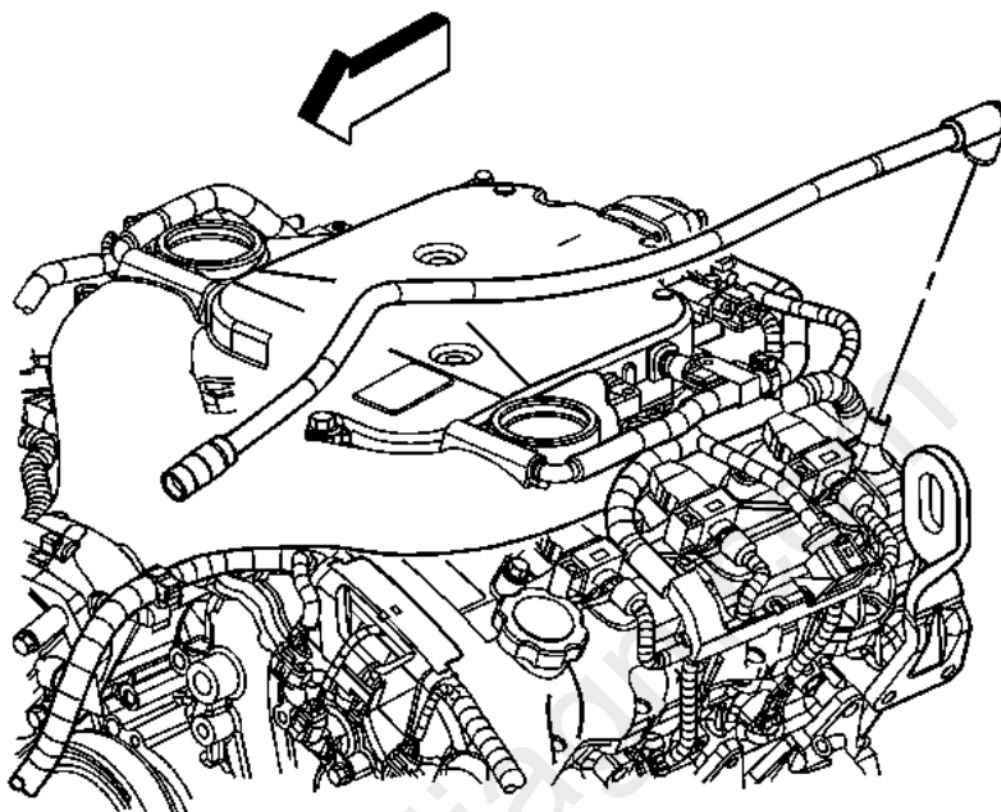


Fig. 68: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

3. Install the PCV fresh air tube to the air inlet.
4. Install the PCV fresh air tube to the left camshaft cover.

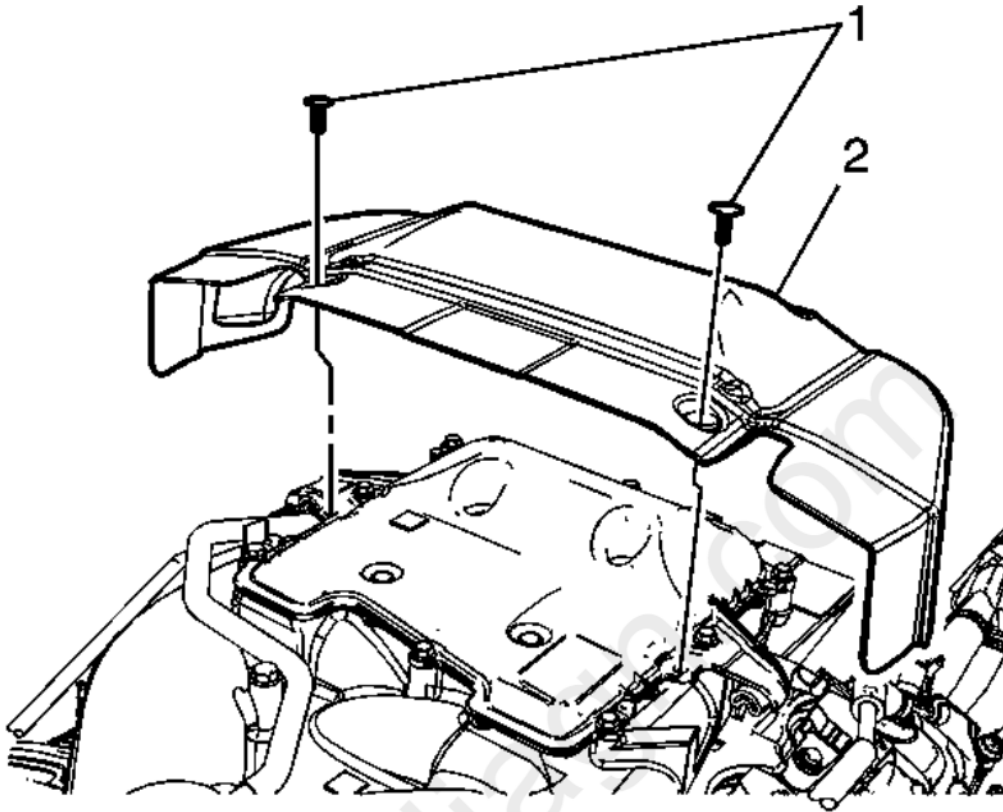


Fig. 69: Intake Manifold Insulator & Pins
Courtesy of GENERAL MOTORS CORP.

5. Install the intake manifold insulator (2)
6. Install two intake manifold insulator retaining pins (1)
7. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

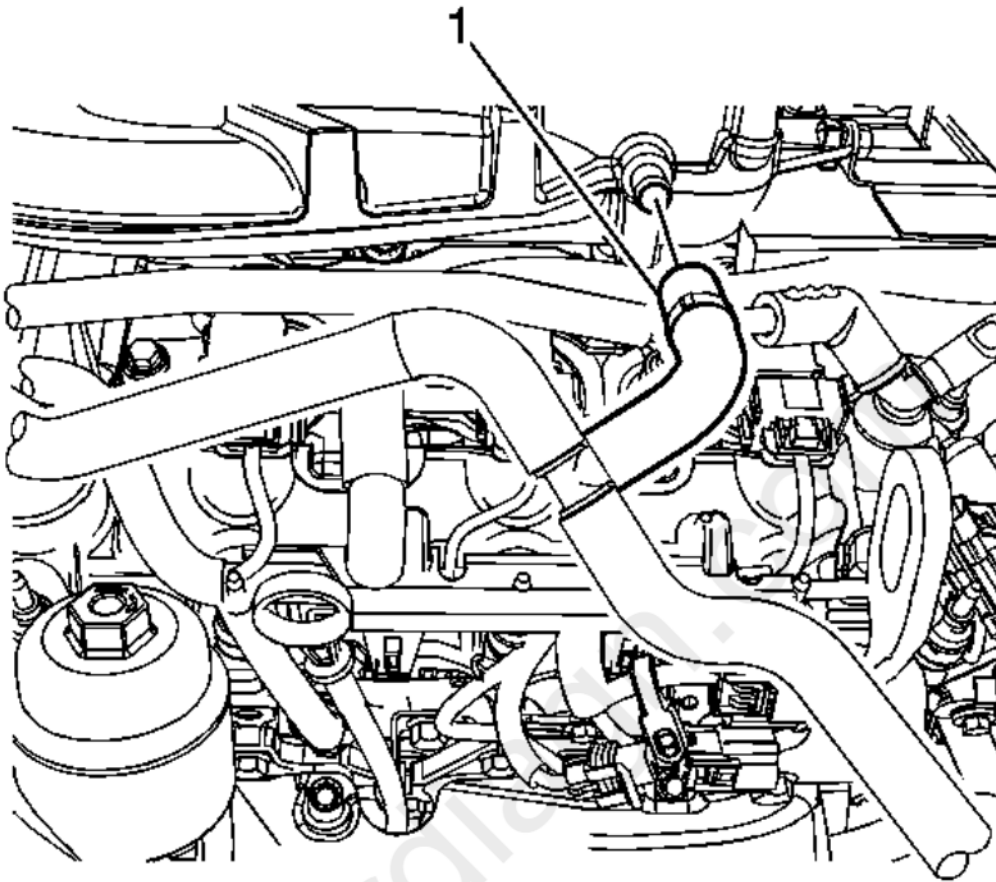


Fig. 70: Identifying Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)** .
2. Remove the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .
3. Disconnect the brake booster vacuum hose (1) from the intake manifold.

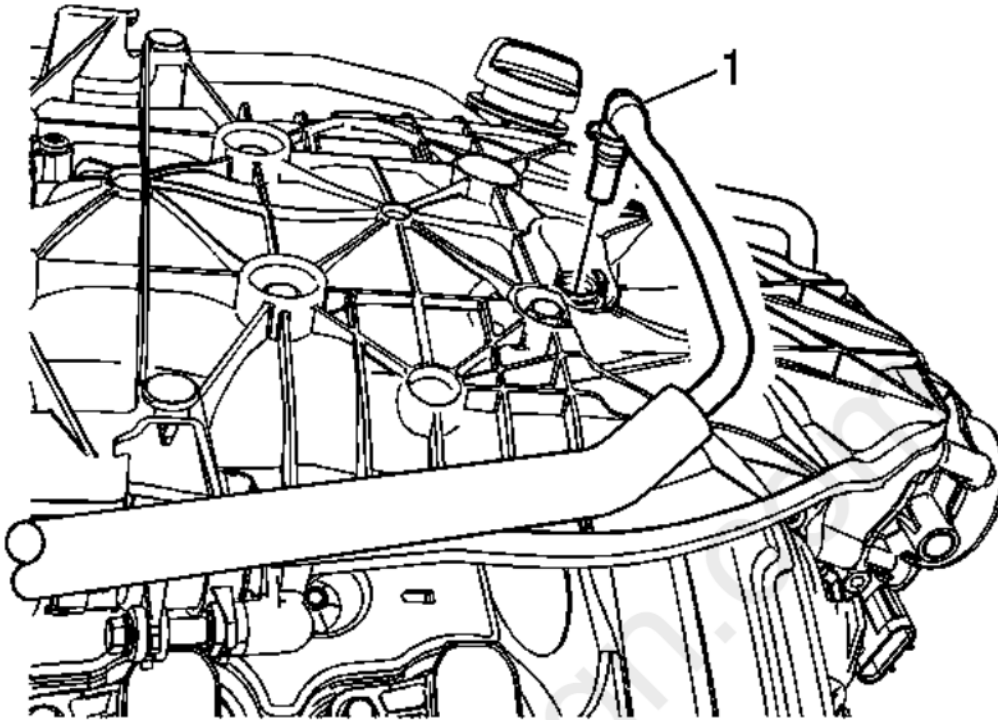


Fig. 71: Identifying Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the positive crankcase ventilation (PCV) hose (1) from the intake manifold.

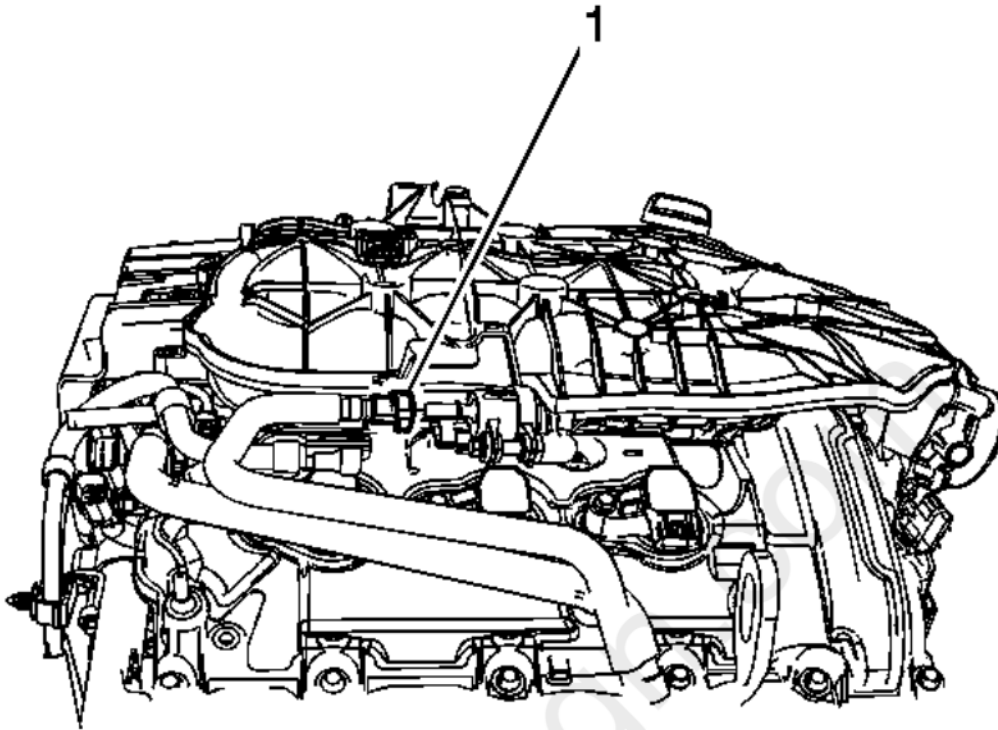


Fig. 72: Identifying Evaporative Emission (EVAP) Hose
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the evaporative emission (EVAP) hose (1) from the EVAP solenoid.
6. Disconnect the electrical connectors as necessary.

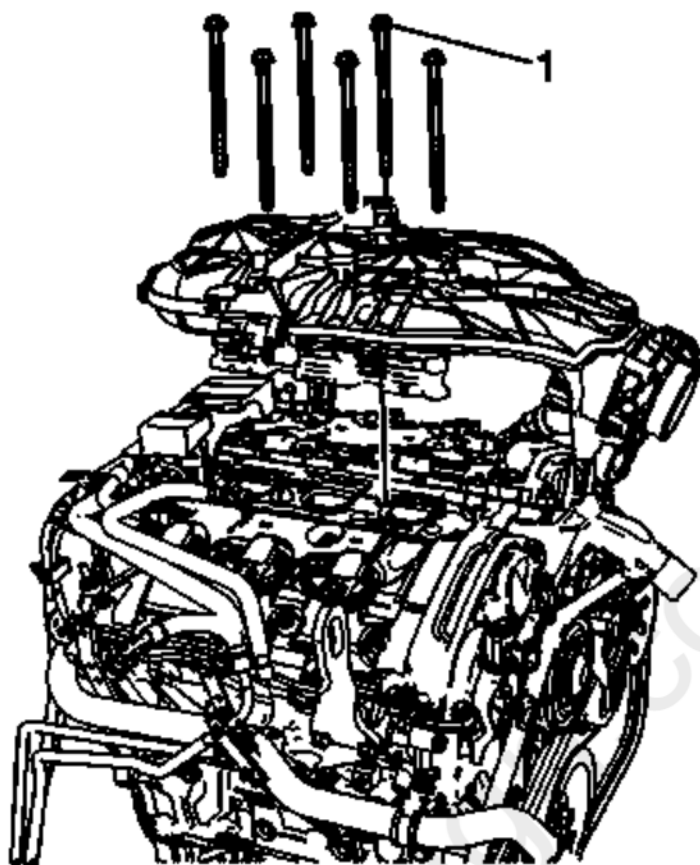


Fig. 73: View Of Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the intake manifold bolts (1).
8. Remove the intake manifold.

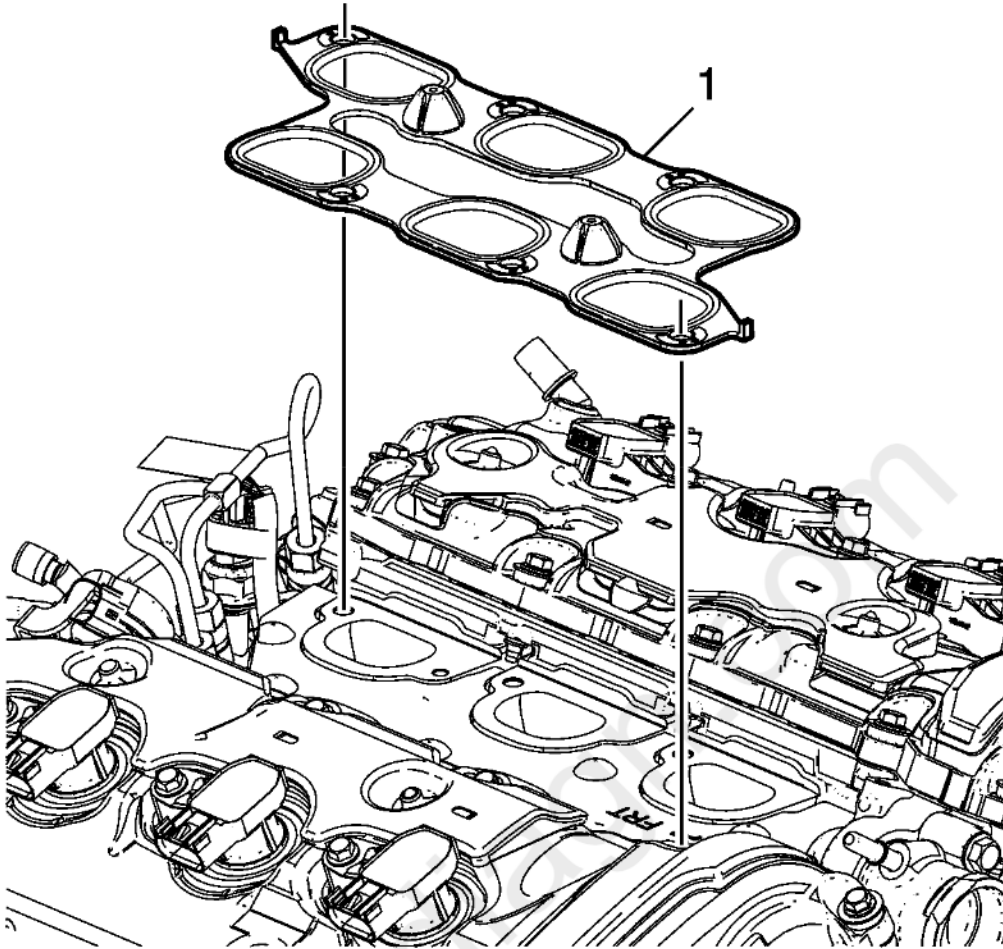


Fig. 74: Intake Manifold Gasket
 Courtesy of GENERAL MOTORS CORP.

9. Remove and discard the intake manifold gasket (1).
10. If replacing the intake manifold, disassemble the intake manifold. Refer to **Intake Manifold Disassemble (LLT)** or **Intake Manifold Disassemble (LF1 or LFW)**.

INSTALLATION PROCEDURE

1. If installing a new intake manifold, assemble the intake manifold. Refer to **Intake Manifold Assemble (LLT)** or **Intake Manifold Assemble (LF1 or LFW)**.

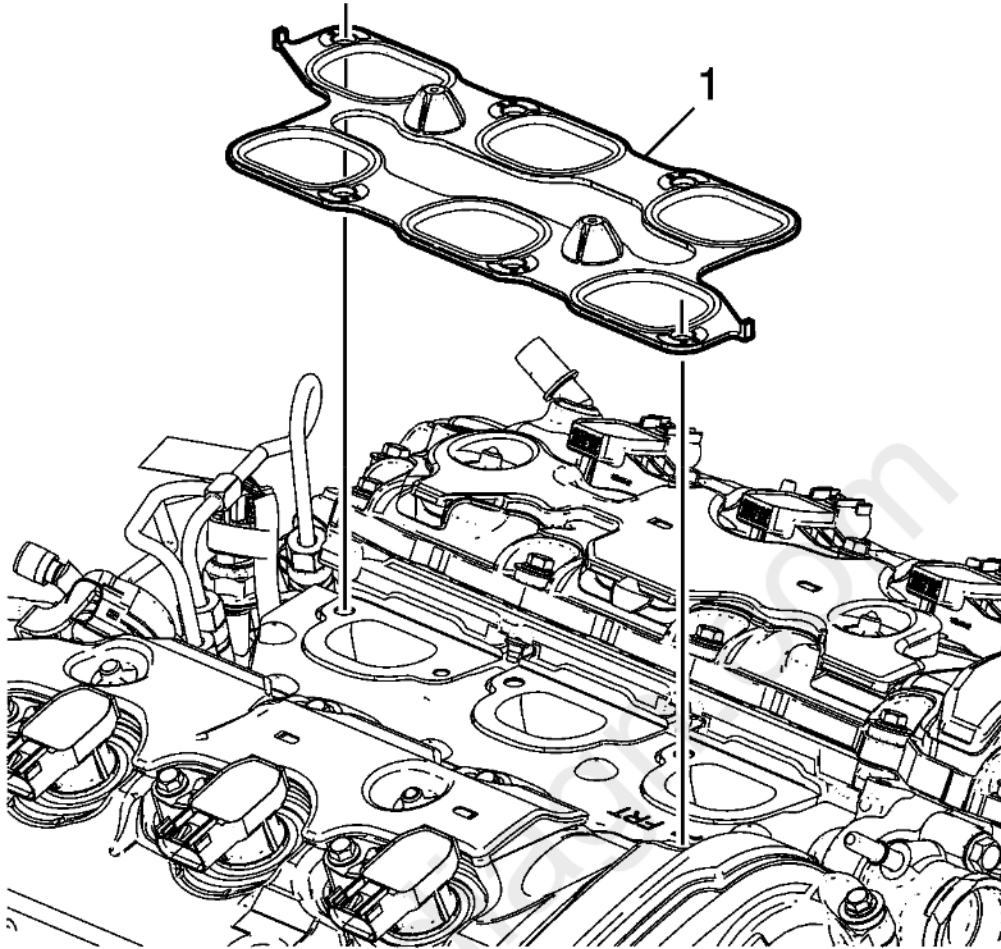


Fig. 75: Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW intake manifold gasket (1).

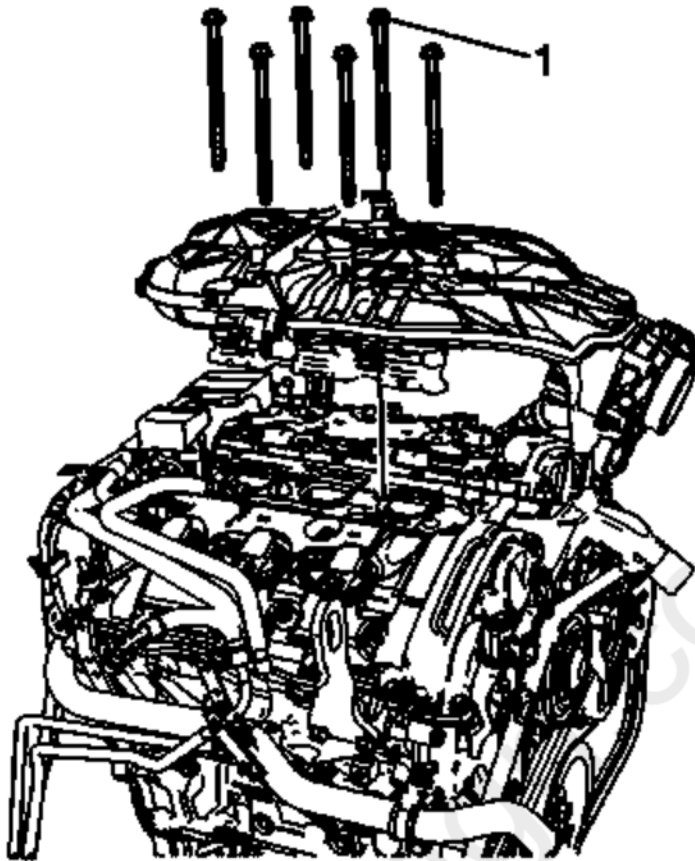


Fig. 76: View Of Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the intake manifold.
4. Install the intake manifold bolts (1).

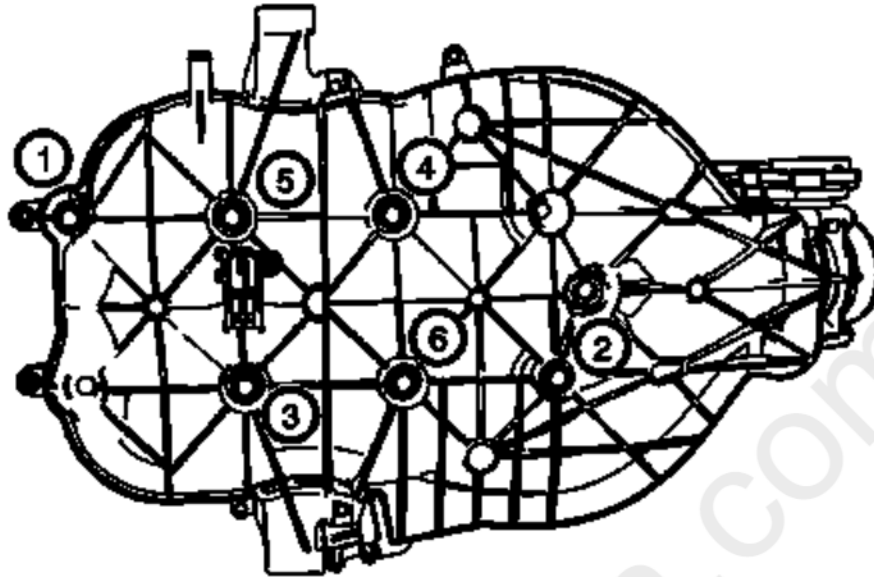


Fig. 77: Identifying Intake Manifold Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

5. Tighten the intake manifold bolts in sequence shown to 23N.m (17 lb ft).
6. Connect the electrical connectors as necessary.

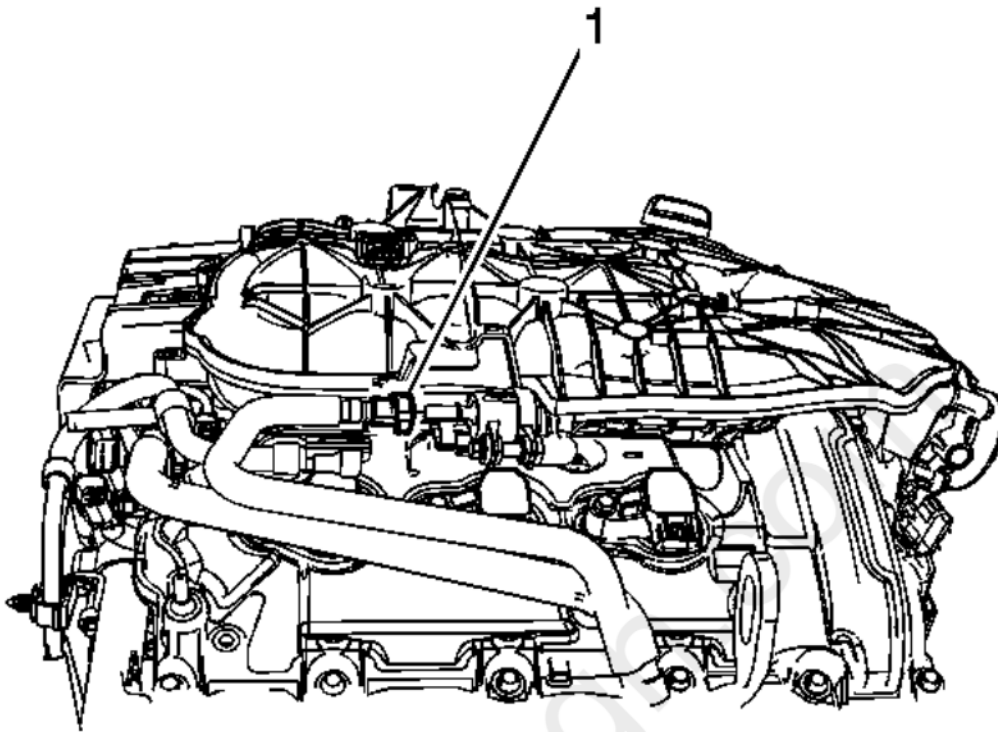


Fig. 78: Identifying Evaporative Emission (EVAP) Hose
Courtesy of GENERAL MOTORS CORP.

7. Connect the evaporative emission (EVAP) hose (1) to the EVAP solenoid.

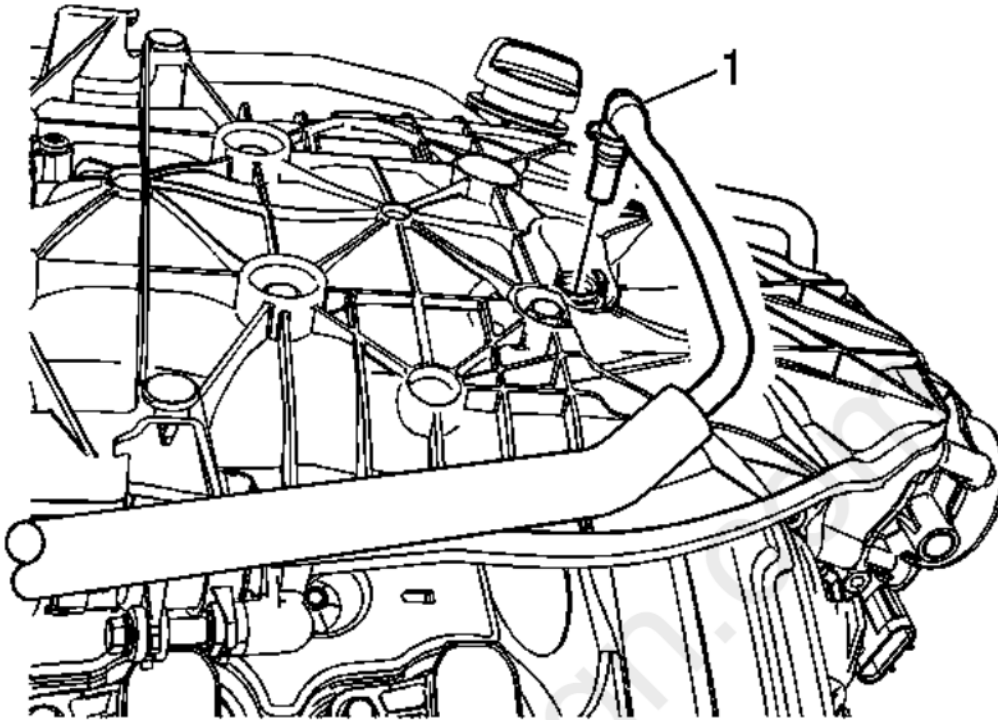


Fig. 79: Identifying Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

8. Connect the PCV hose (1) to the intake manifold.

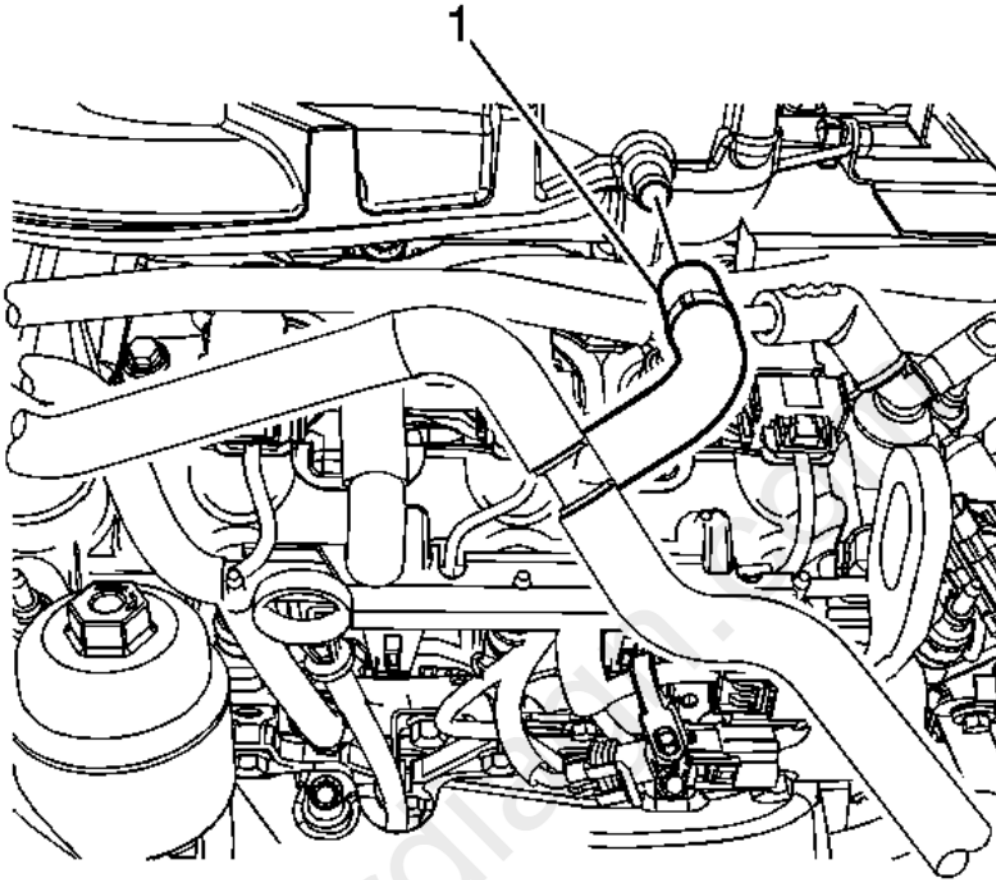


Fig. 80: Identifying Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

9. Connect the brake booster vacuum hose (1) from the intake manifold.
10. Install the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)** .

UPPER INTAKE MANIFOLD REPLACEMENT (LP1, LY7)

REMOVAL PROCEDURE

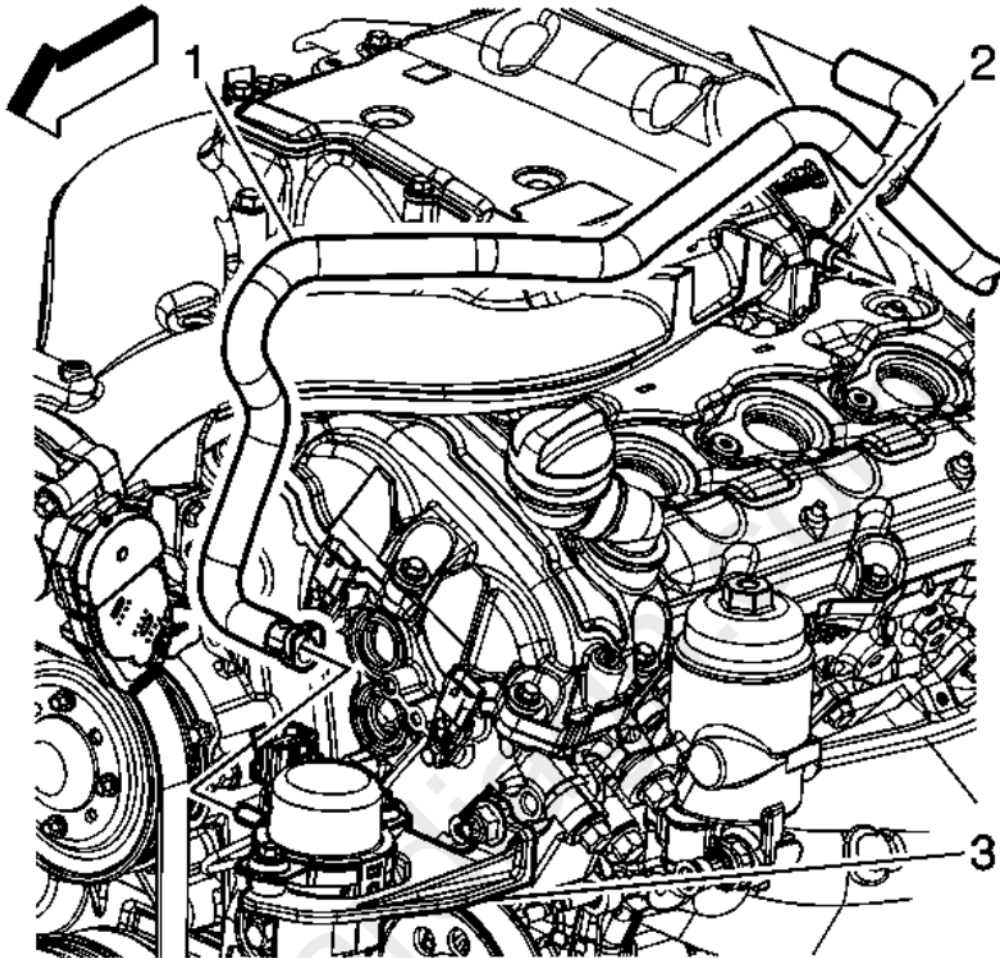


Fig. 81: View of Brake Booster Hose and Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
3. Remove the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.
4. Disconnect the brake booster vacuum hose (1) from the intake manifold (2) and the power steering booster pump (3).

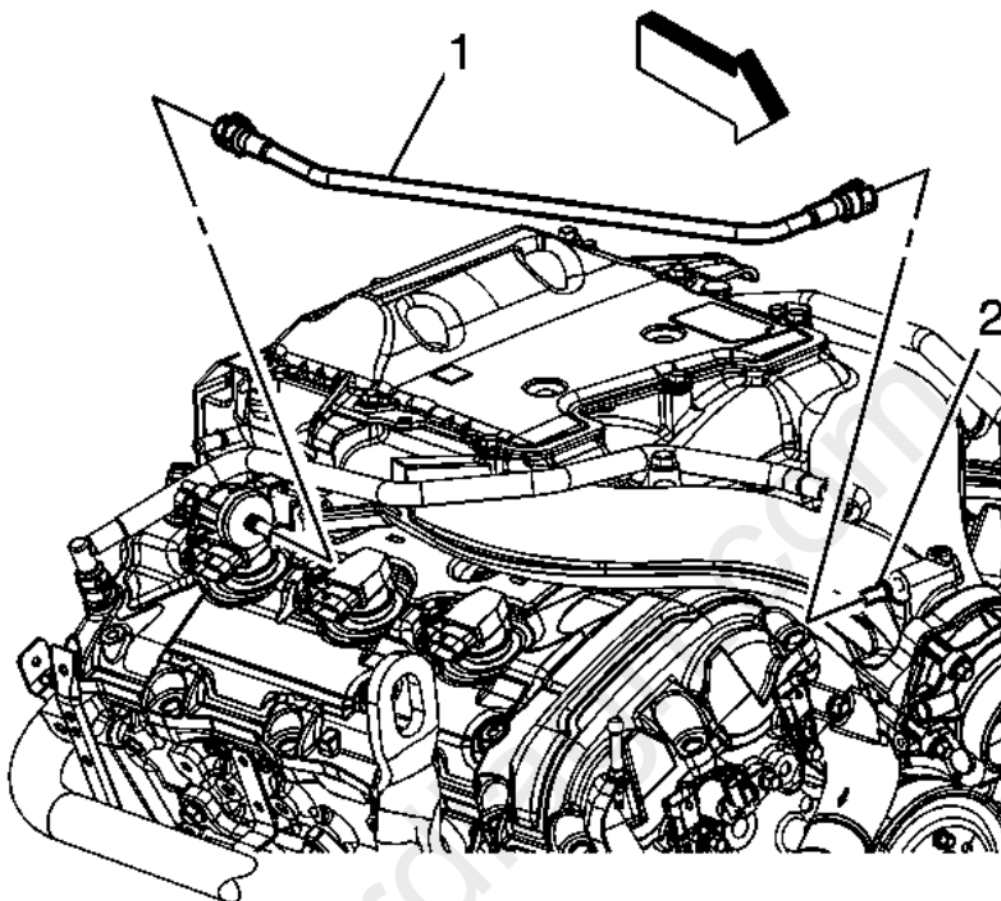


Fig. 82: View of Purge Line and Intake Manifold
Courtesy of GENERAL MOTORS CORP.

5. Remove the purge solenoid valve bracket.
6. Disconnect the purge line (1) from the intake manifold (2).

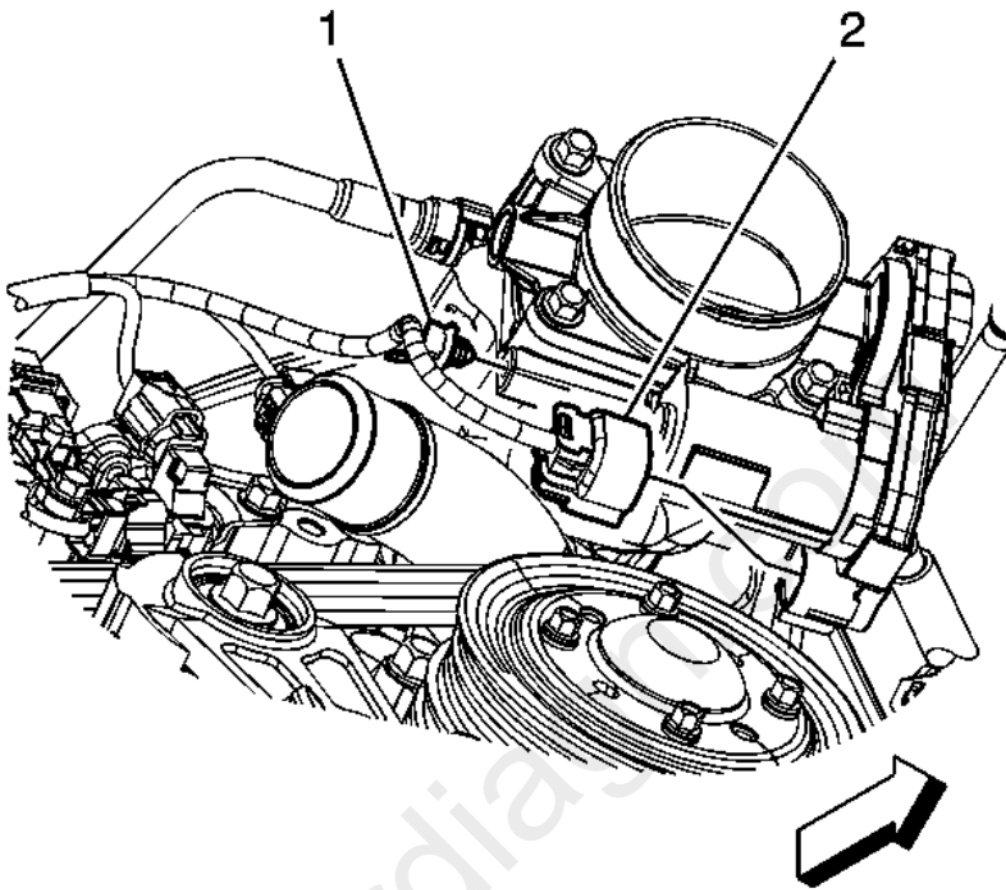


Fig. 83: View of Throttle Body Harness and Retainer
Courtesy of GENERAL MOTORS CORP.

7. Remove the throttle body harness electrical harness retainer (1).
8. Disconnect the throttle body electrical connector (2).

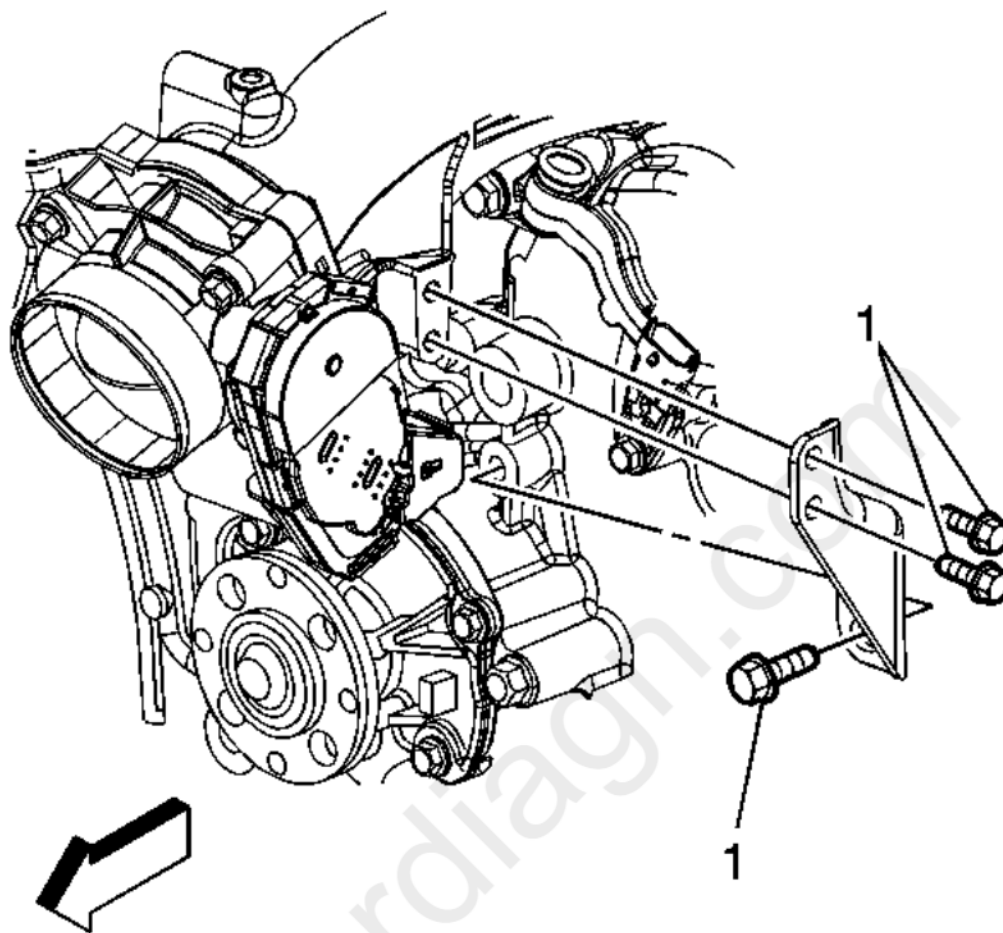


Fig. 84: View of Intake Manifold Brace Assembly
Courtesy of GENERAL MOTORS CORP.

9. Remove the intake manifold brace bolts (1).
10. Remove the intake manifold brace.

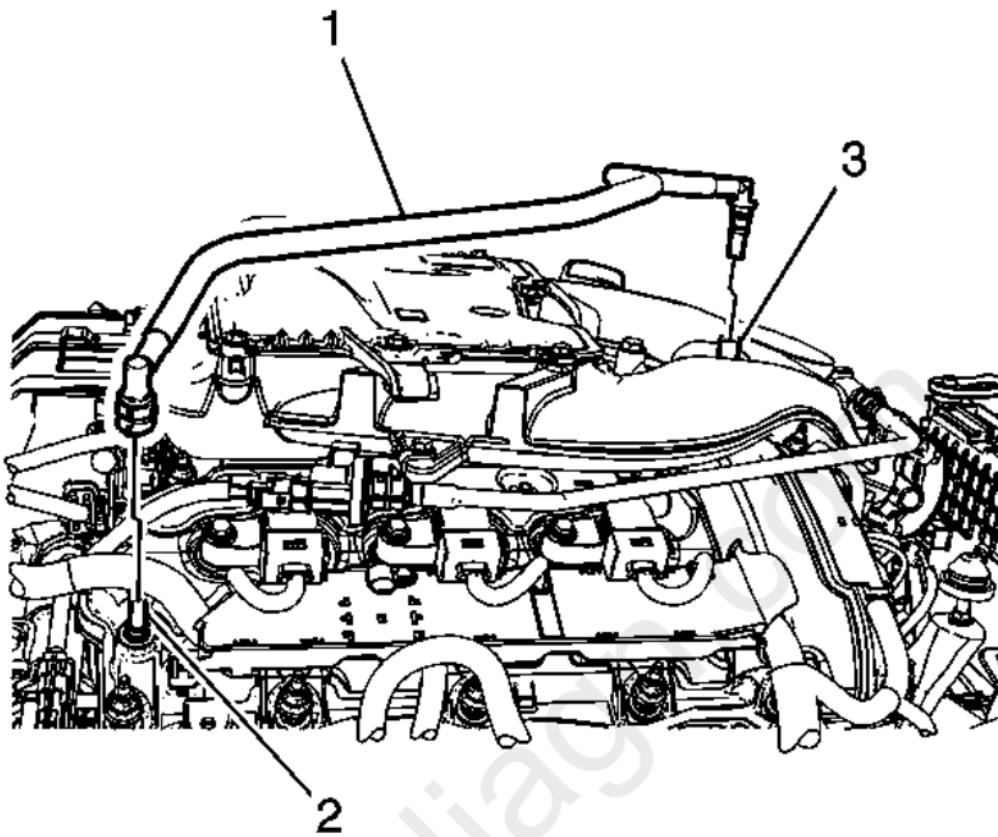


Fig. 85: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the positive crankcase ventilation (PCV) hose (1) from the intake manifold (3).

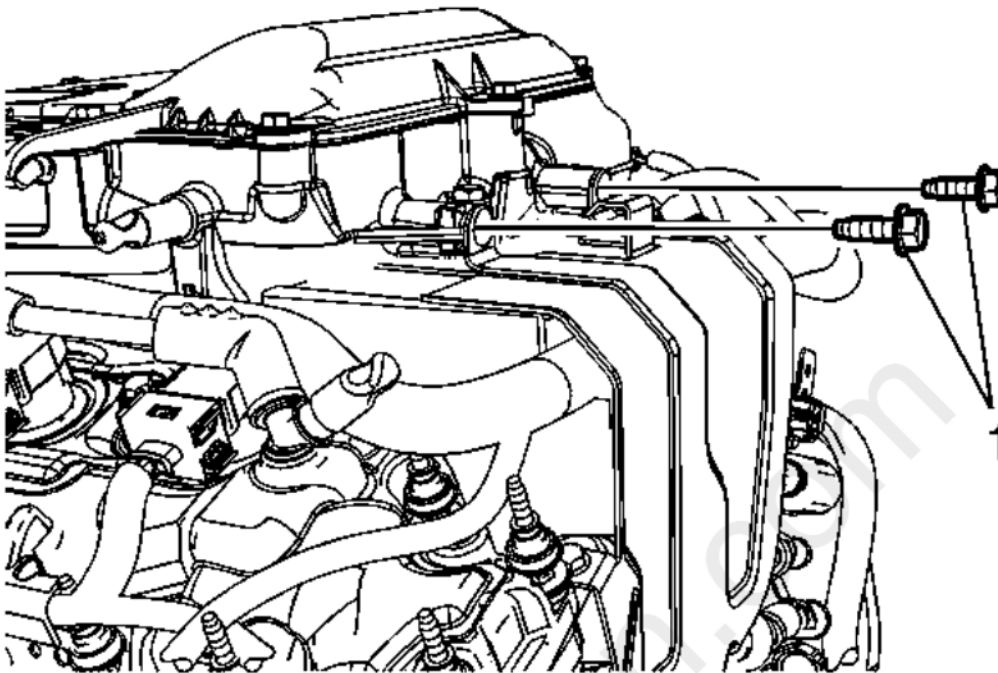


Fig. 86: View of Intake Manifold Rear Heat Shield Bolts
Courtesy of GENERAL MOTORS CORP.

12. Unclip the engine harness from the left side of the intake manifold.
13. Remove the intake manifold rear heat shield bolts (1).

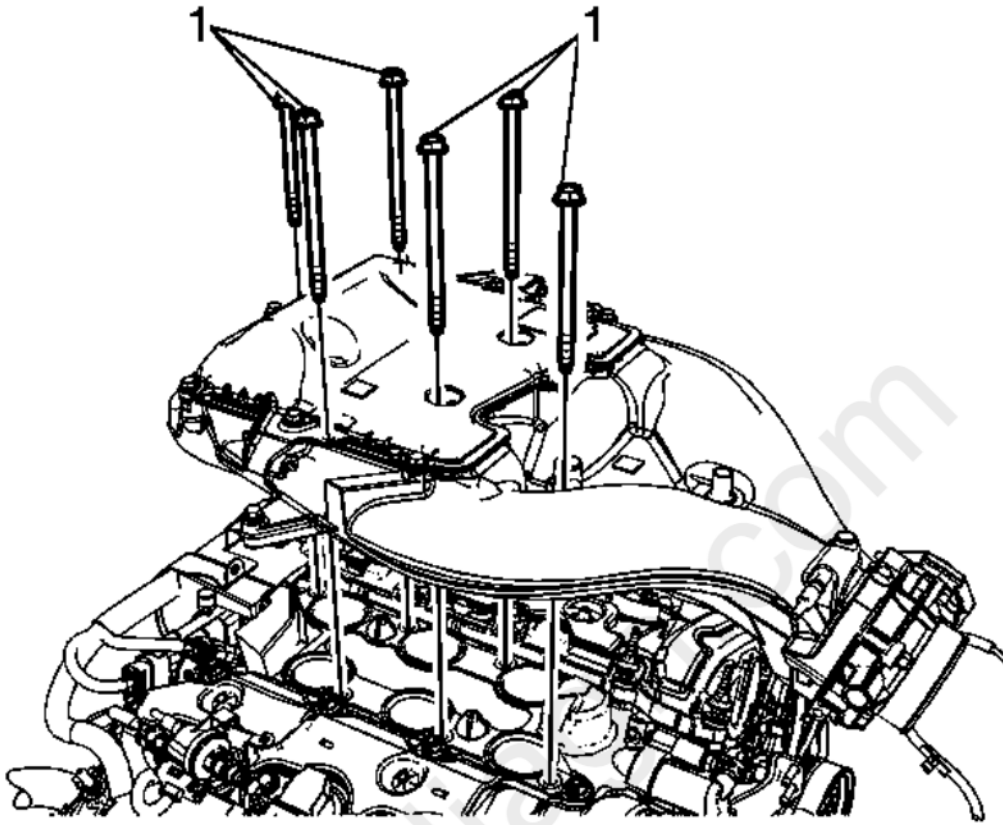


Fig. 87: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the intake manifold bolts (1). Some deflection of the cowl panel may be necessary to extract the right rear bolt.
15. Remove the intake manifold with the throttle body.
16. If the intake manifold is being replaced, disassemble the intake manifold. Refer to **Intake Manifold Disassemble (LLT)** or **Intake Manifold Disassemble (LF1 or LFW)** .
17. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection (LLT)** or **Intake Manifold Cleaning and Inspection (LF1 or LFW)** .

INSTALLATION PROCEDURE

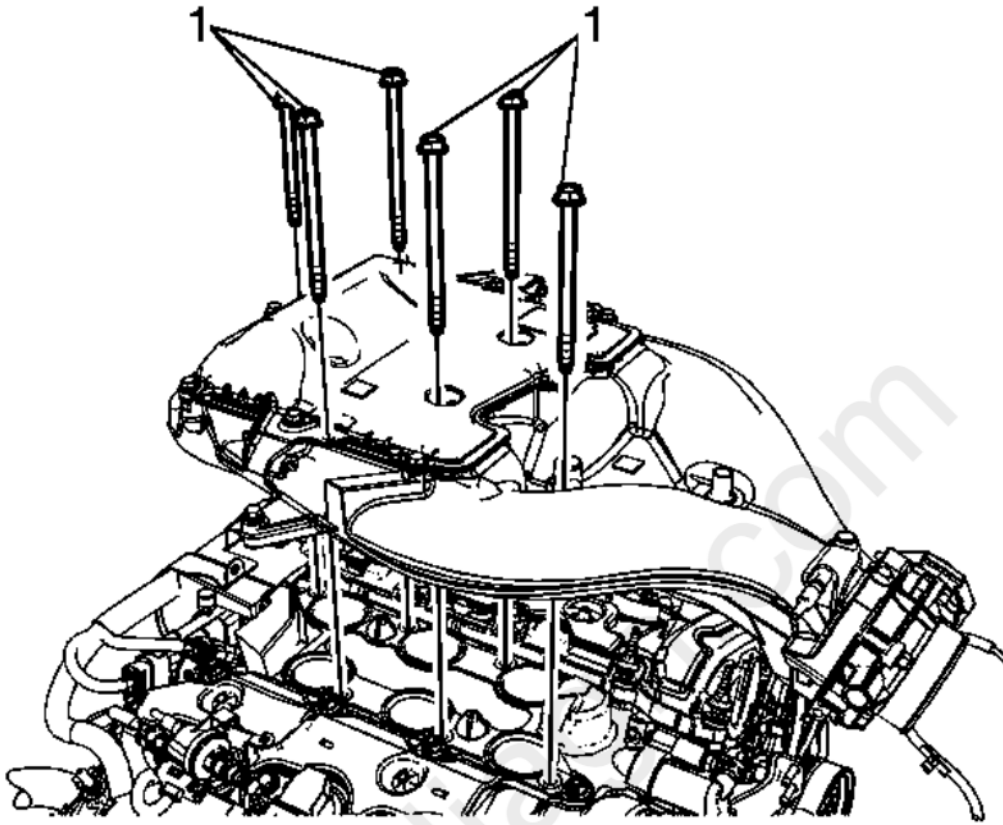


Fig. 88: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

1. If the intake manifold is being replaced, assemble the intake manifold. Refer to **Intake Manifold Assemble (LLT)** or **Intake Manifold Assemble (LF1 or LFW)** .
2. Install a NEW intake manifold gasket.
3. Install the intake manifold.

CAUTION: Refer to **FASTENER CAUTION** .

NOTE: Tighten the intake manifold bolts in a circular pattern starting at the center (long bolts) and moving outward.

4. Install the intake manifold bolts (1) and tighten to 23 N.m (17 lb ft).

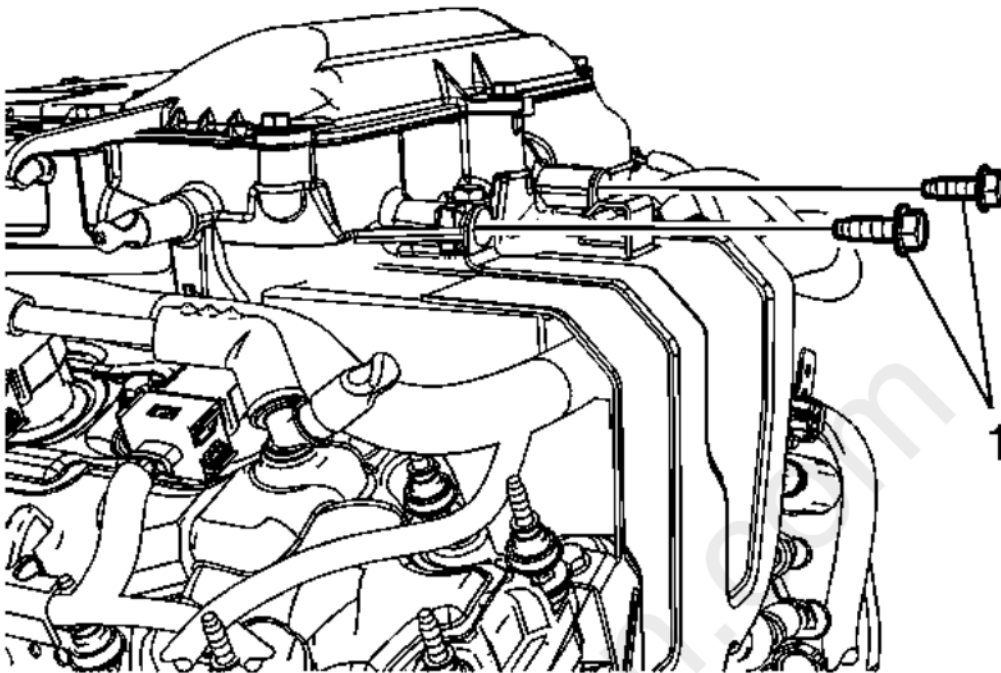


Fig. 89: View of Intake Manifold Rear Heat Shield Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the intake manifold rear heat shield bolts (1) and tighten to 23 N.m (17 lb ft).
6. Clip the engine harness from the left side of the intake manifold.

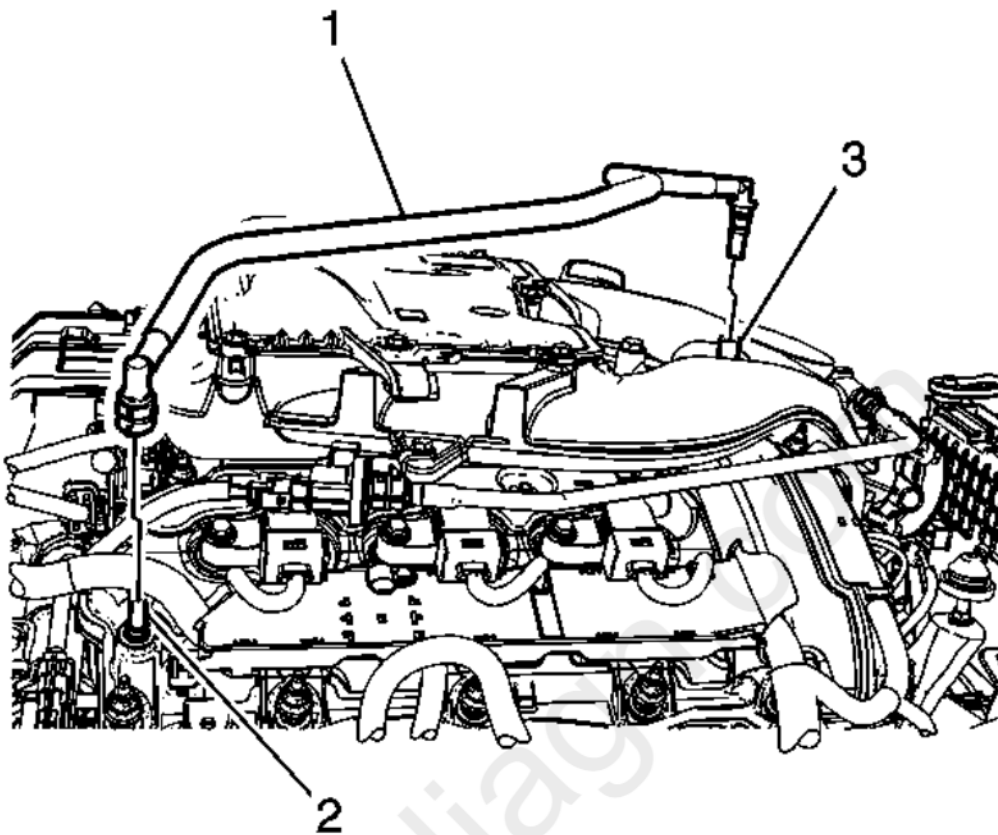


Fig. 90: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

7. Connect the positive crankcase ventilation (PCV) hose (1) to the intake manifold (3).

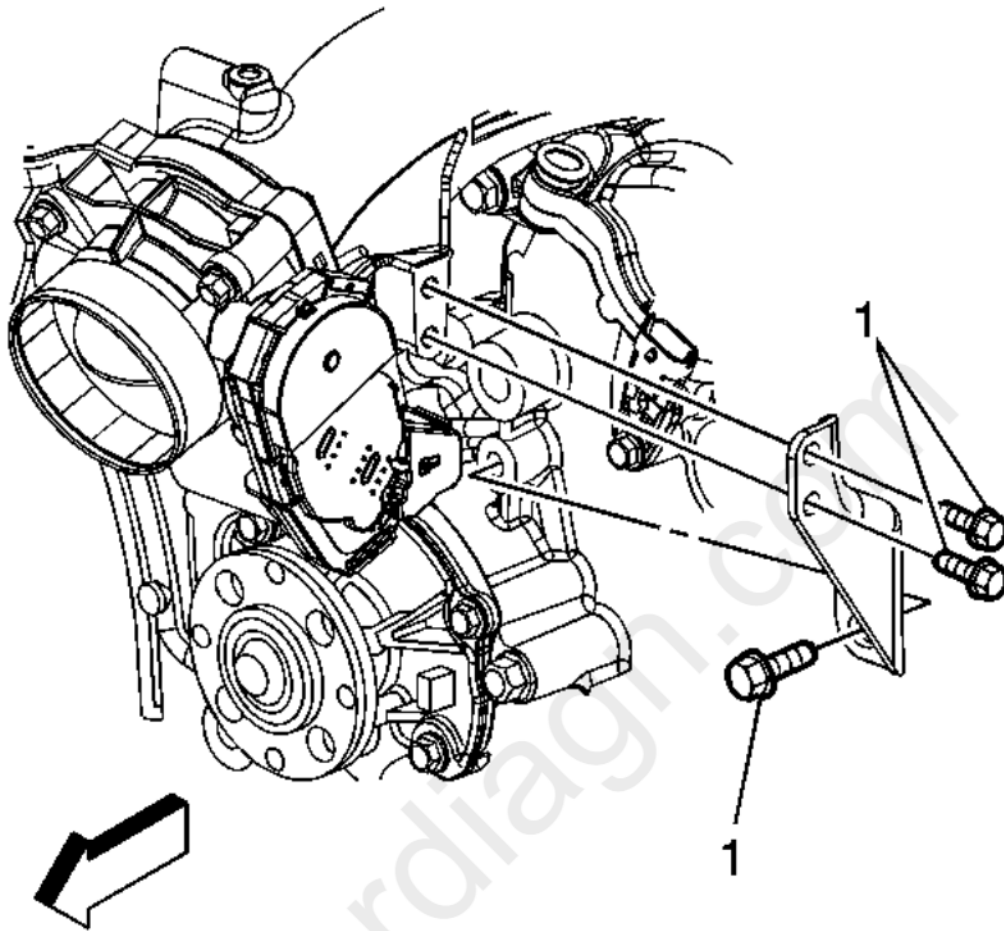


Fig. 91: View of Intake Manifold Brace Assembly
Courtesy of GENERAL MOTORS CORP.

8. Position the intake manifold brace.
9. Install the intake manifold brace bolts (1) and tighten to 23 N.m (17 lb ft).

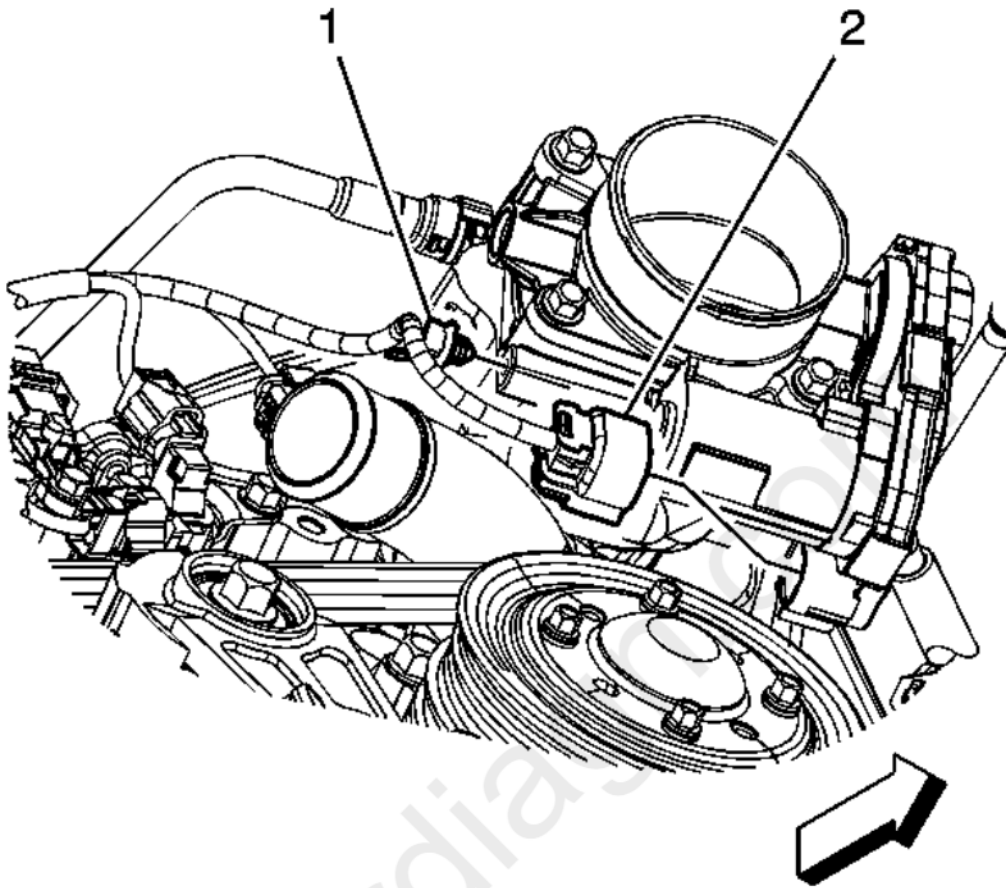


Fig. 92: View of Throttle Body Harness and Retainer
Courtesy of GENERAL MOTORS CORP.

CAUTION: Ensure proper engagement of the wiring harness connector. The wiring harness connector must be installed straight onto the component connector and firmly seated. Visually inspect the connector to ensure that the connector latches are engaged and locked. Any damage to the connector or wiring must be repaired. Failure to follow this procedure can lead to an intermittent electrical connection, driveability concerns, and/or wiring harness or wiring harness connector damage or failure.

10. Connect the electrical connector (2) to the throttle body.
11. Install the throttle body harness electrical harness retainer (1).

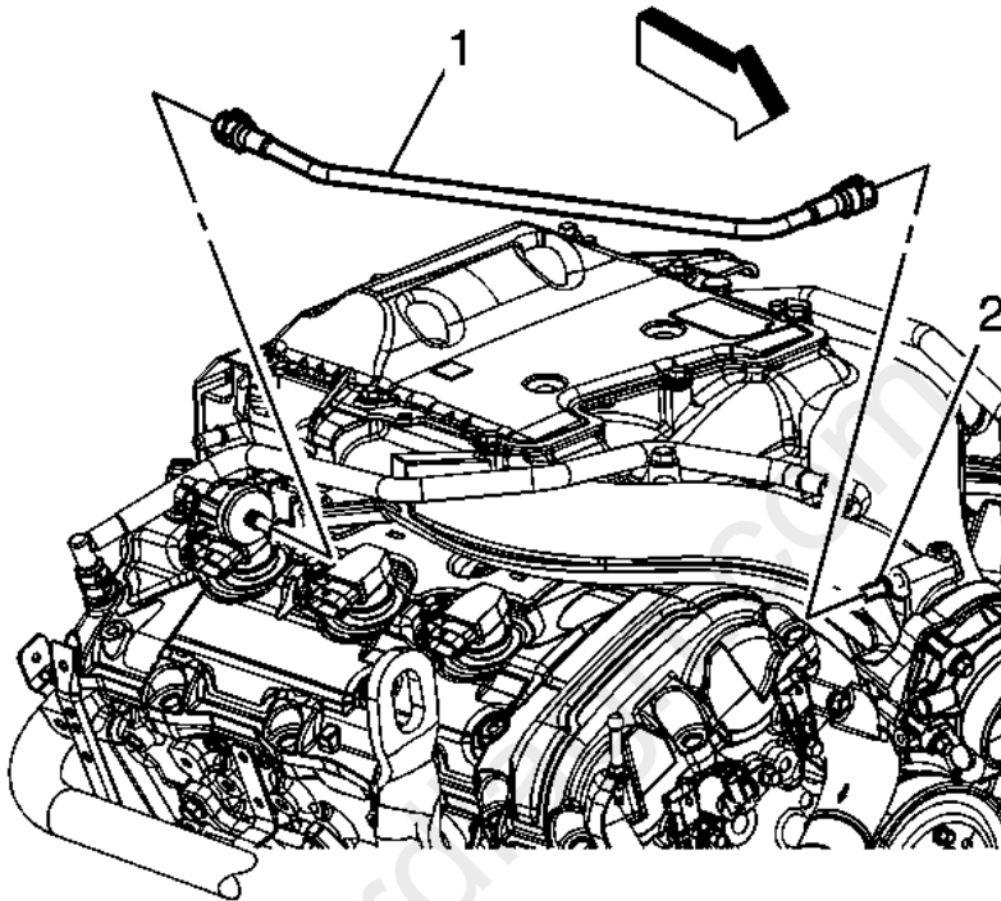


Fig. 93: View of Purge Line and Intake Manifold
Courtesy of GENERAL MOTORS CORP.

12. Connect the purge line (1) to the intake manifold (2).
13. Install the purge solenoid valve bracket and bolts to tighten to 23 N.m (17 lb ft).

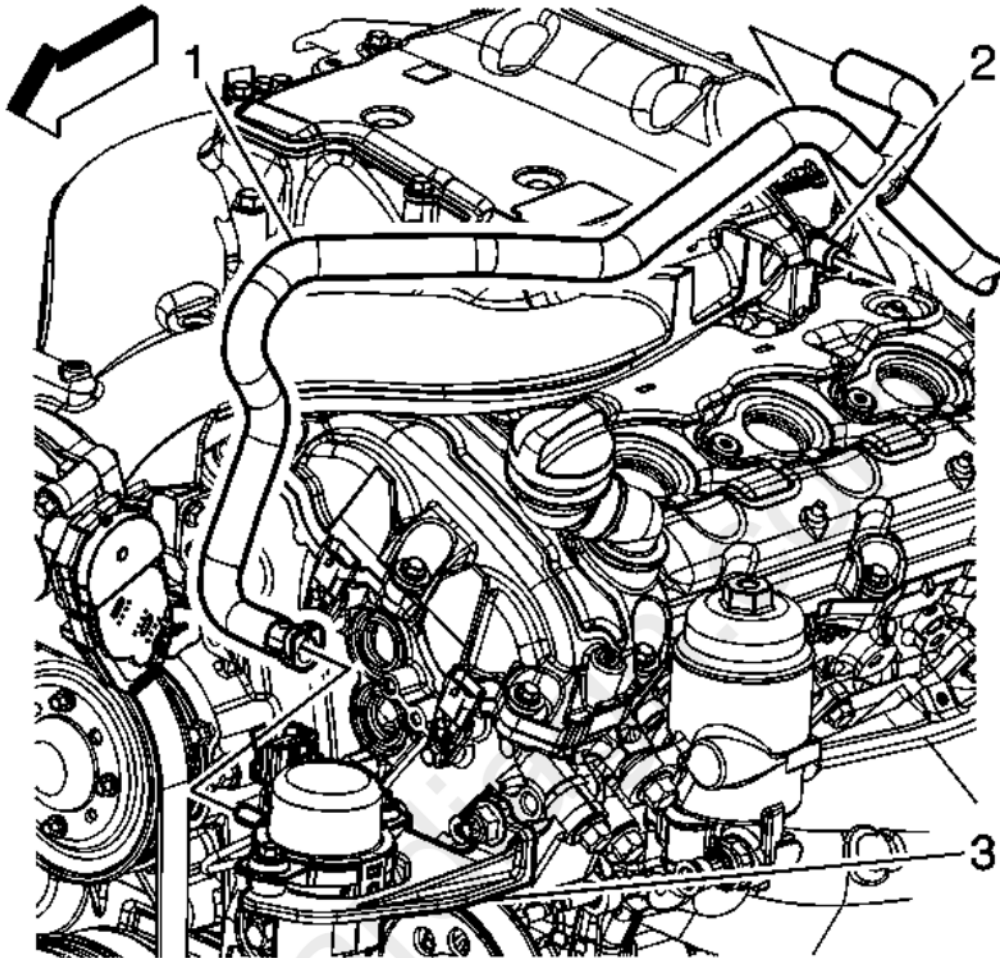


Fig. 94: View of Brake Booster Hose and Intake Manifold
Courtesy of GENERAL MOTORS CORP.

14. Connect the brake booster vacuum hose (1) to the power steering booster pump (3) and the intake manifold (2).
15. Install the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.

Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

LOWER INTAKE MANIFOLD REPLACEMENT (LP1, LY7)

REMOVAL PROCEDURE

1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

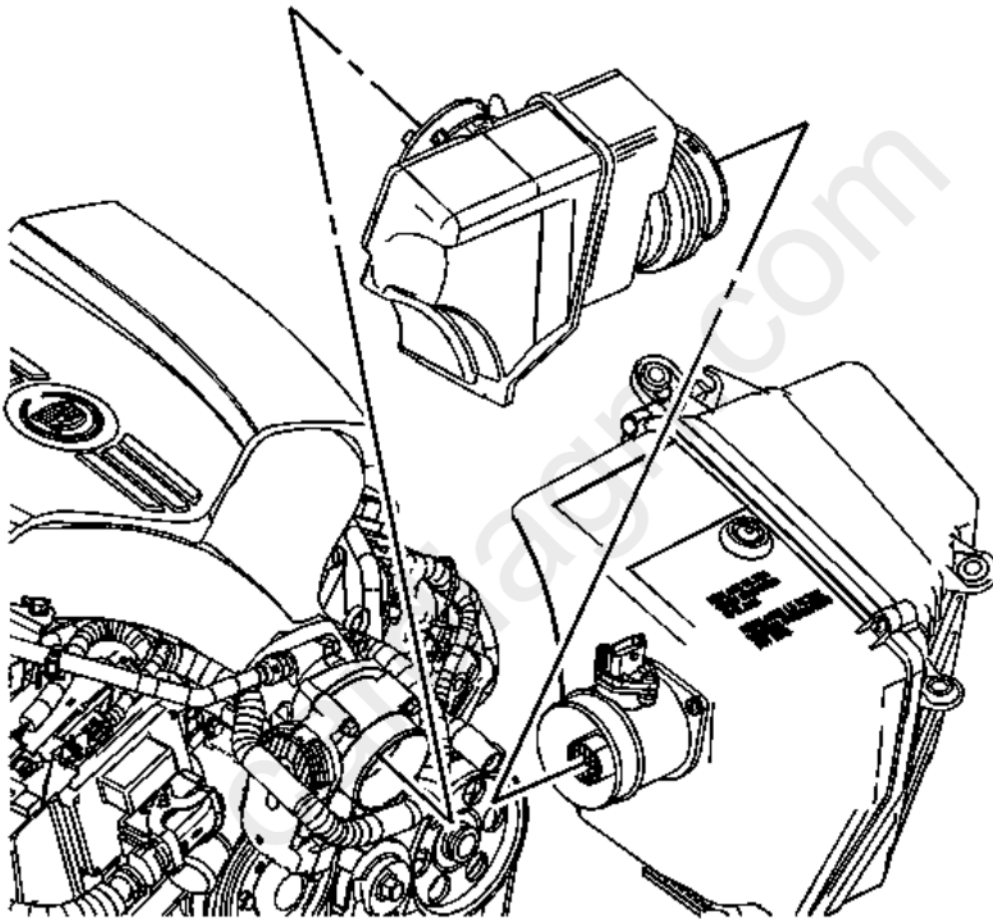


Fig. 95: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

3. Remove the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)**.
4. Note the booster hose routing. Disconnect the brake booster check valve and hose from the brake booster.
5. Reposition the brake booster hose to the intake manifold.

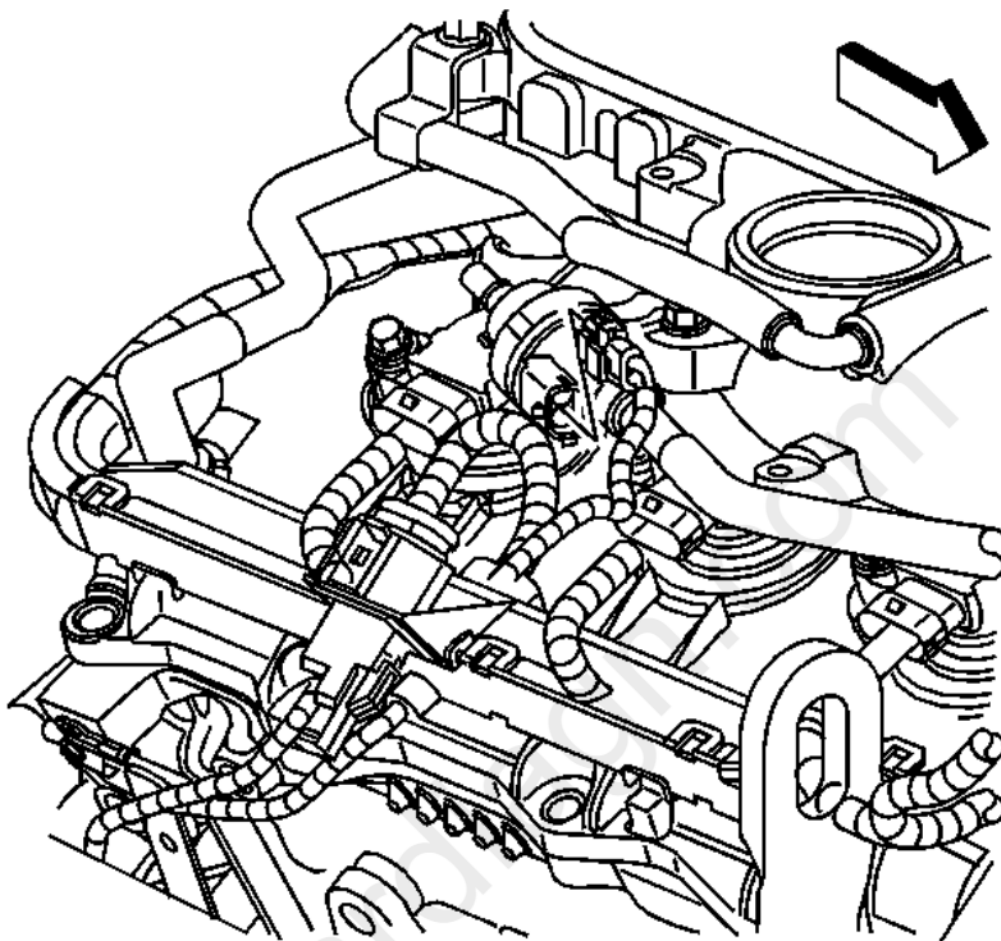


Fig. 96: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the purge solenoid valve electrical connector.

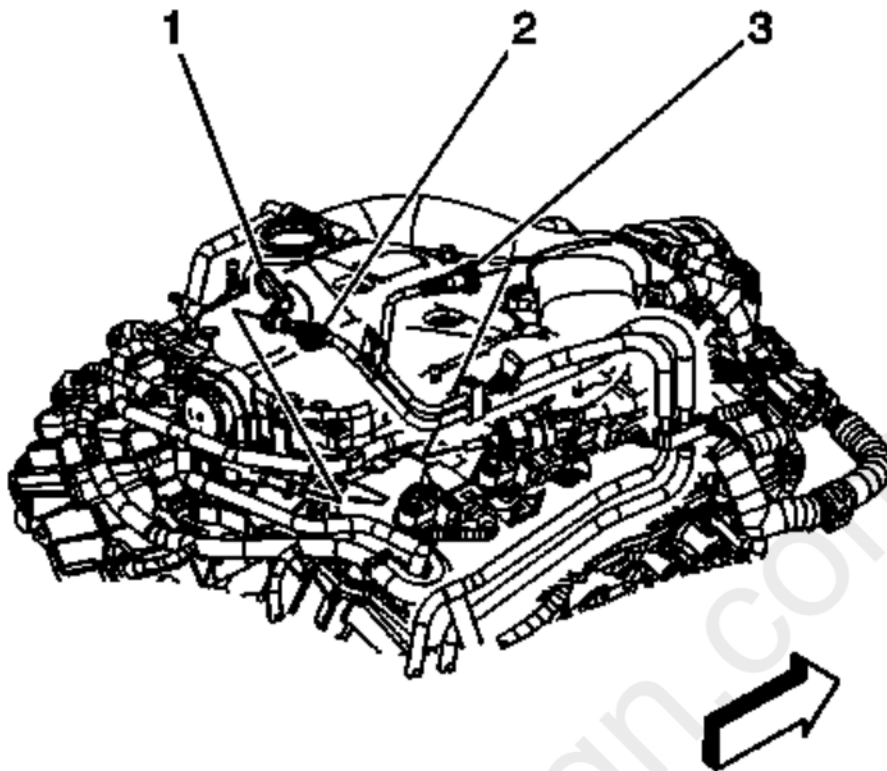


Fig. 97: Top Of Engine View

Courtesy of GENERAL MOTORS CORP.

7. Disconnect the purge line (3) from the purge solenoid valve.

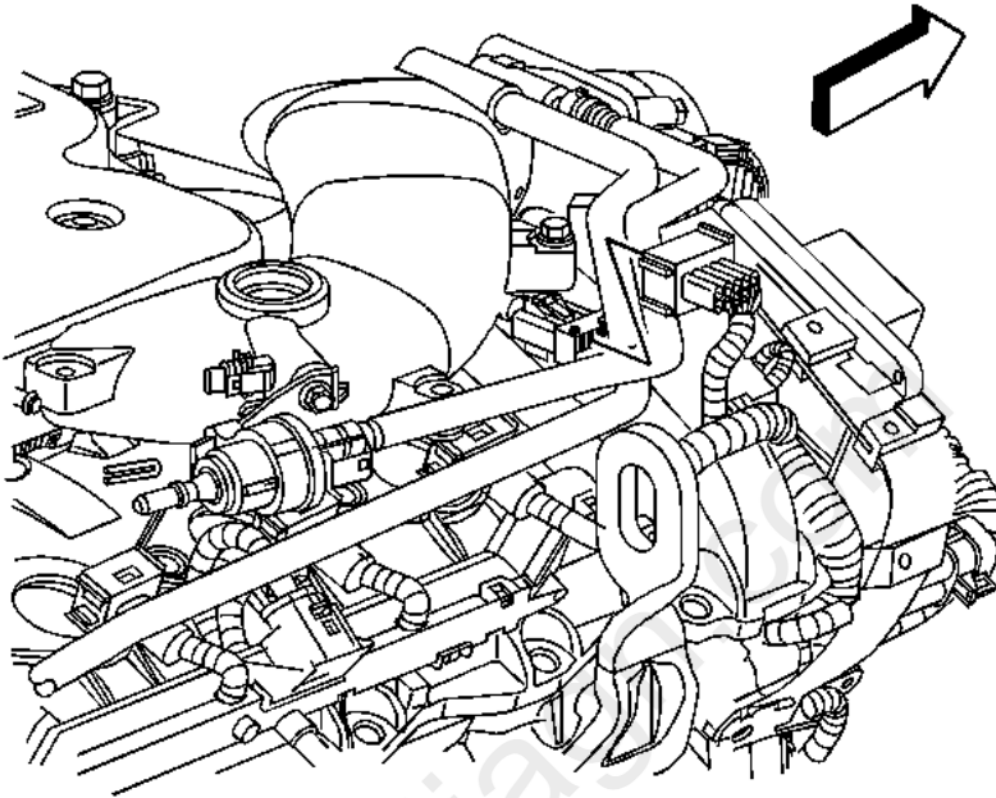


Fig. 98: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel injector harness electrical connector.

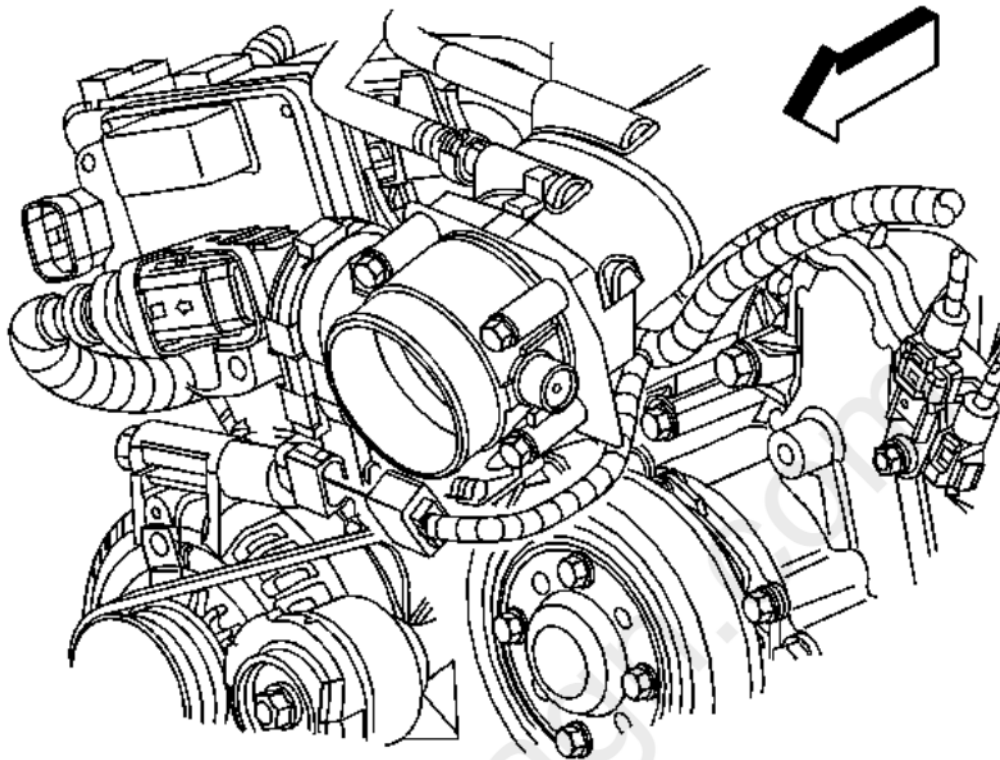


Fig. 99: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the throttle body electrical connector.

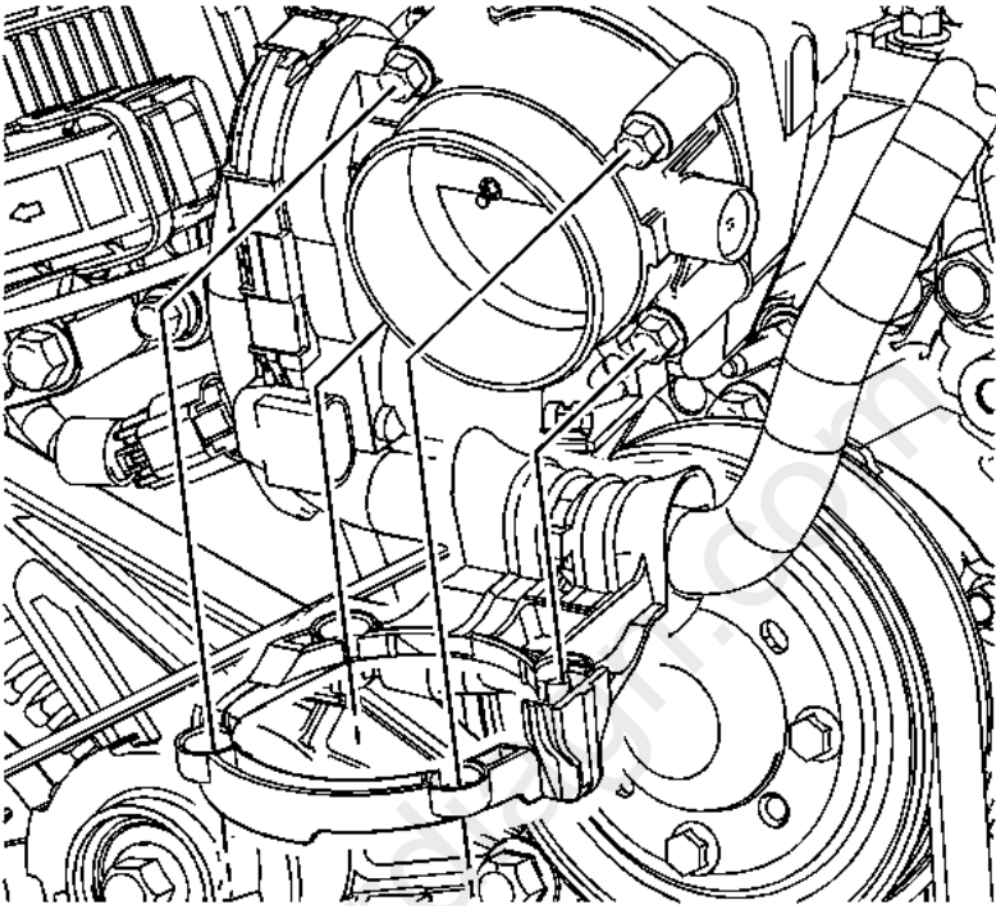


Fig. 100: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

10. Remove the wiring harness retainer.

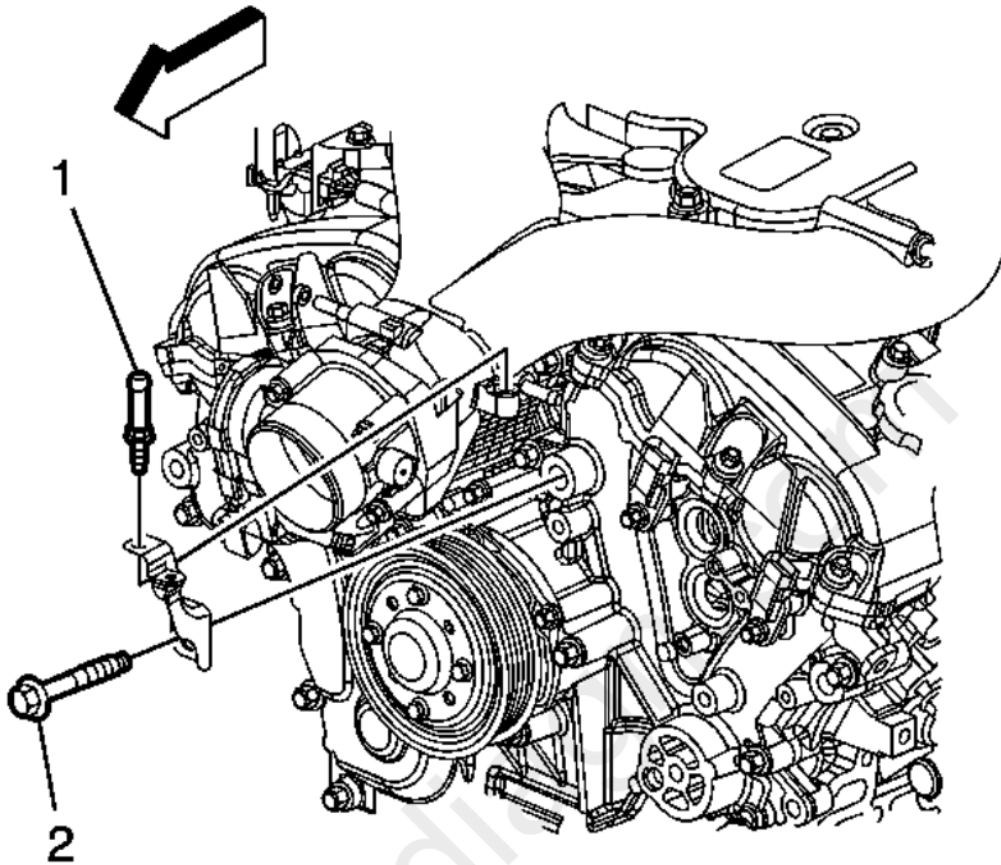


Fig. 101: Identifying Upper Intake Manifold Brace Stud, Bolt & Brace
Courtesy of GENERAL MOTORS CORP.

11. Remove the upper intake manifold brace stud (1) and bolt (2), reposition the brace with the wiring harness.
12. Remove the wiring harness retainer from the right side of the throttle body.
13. Disconnect the positive crankcase ventilation (PCV) hose from the right bank camshaft cover.

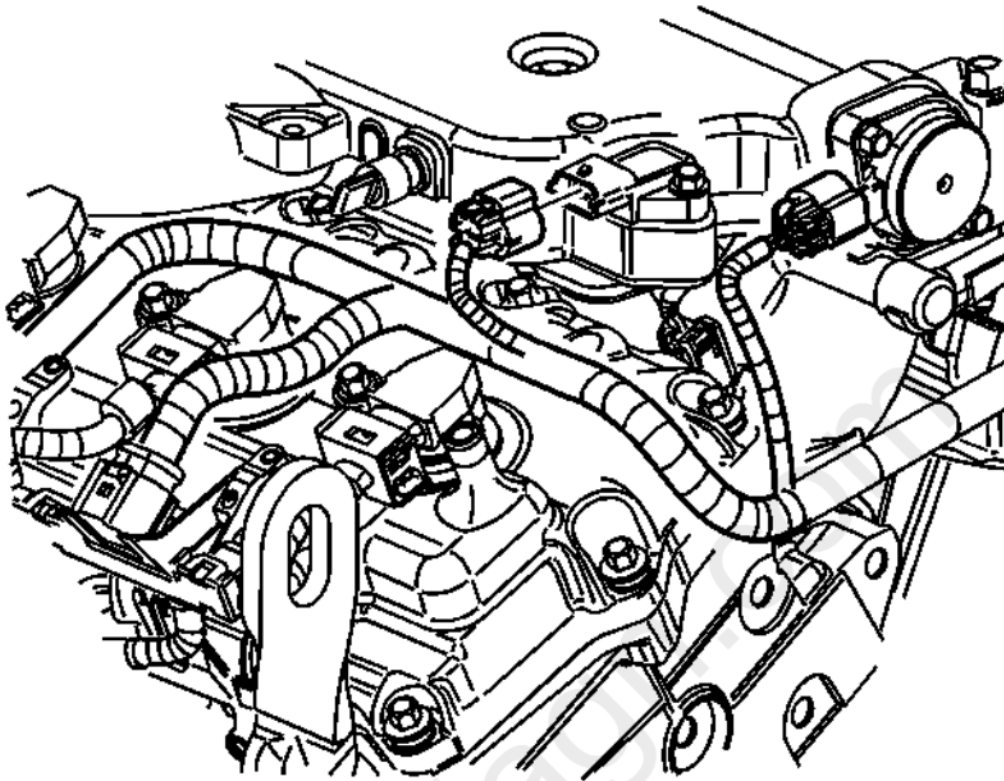


Fig. 102: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the barometric pressure sensor electrical connector.

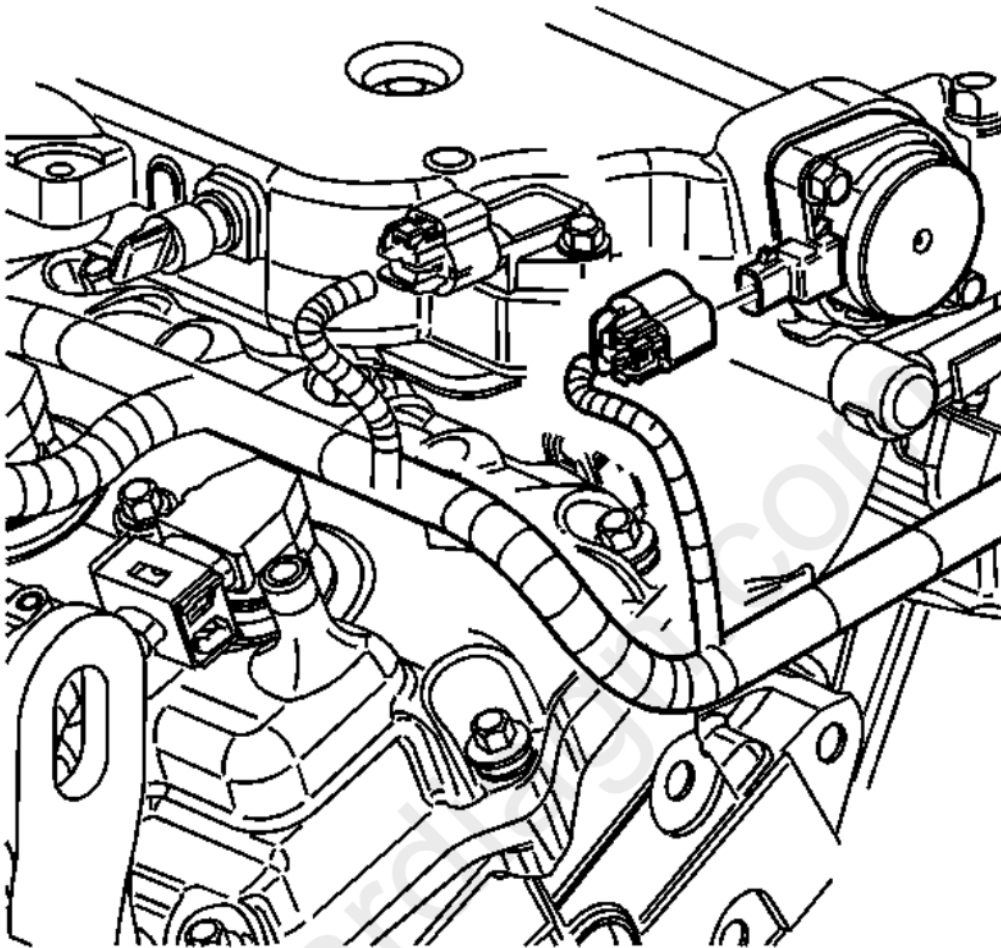


Fig. 103: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

15. Disconnect the intake manifold runner control solenoid electrical connector.
16. Remove the left bank ignition coil wiring harness from the bracket.

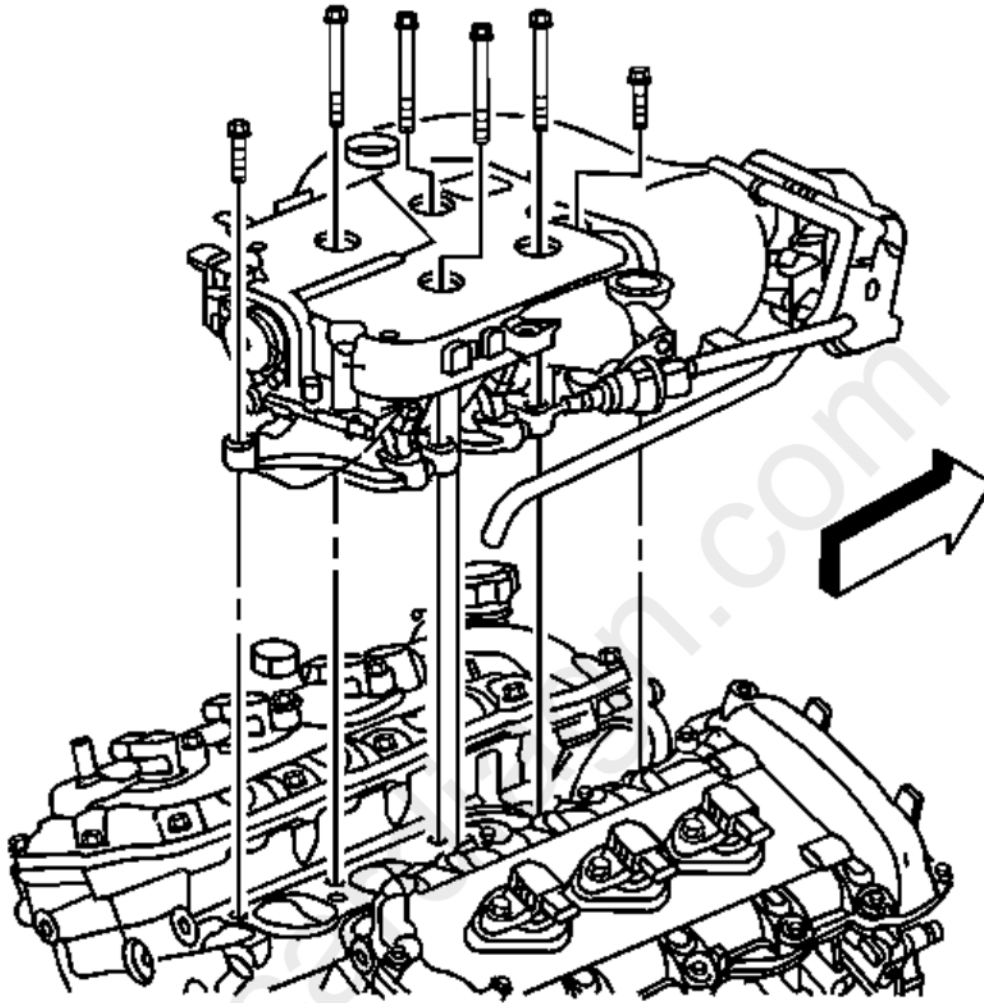


Fig. 104: View Of Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Do not remove the upper to lower intake manifold bolts.
- DO NOT kink or damage the fuel pipe.

17. Remove the intake manifold bolts.
18. Reposition the intake manifold to gain access to the fuel pipe connector.

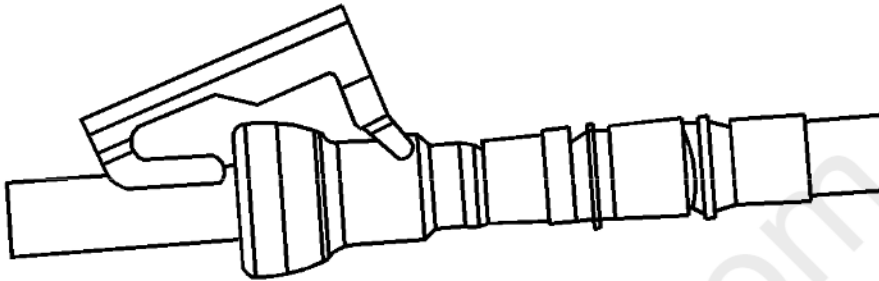


Fig. 105: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

19. Remove the fuel feed pipe retainer.
20. Disconnect the fuel feed pipe from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
21. Disassemble the intake manifold as necessary. Refer to **Intake Manifold Disassemble (LLT)** or **Intake Manifold Disassemble (LF1 or LFW)** .
22. Clean and inspect the intake manifold and the sealing surfaces. Refer to **Intake Manifold Cleaning and Inspection (LLT)** or **Intake Manifold Cleaning and Inspection (LF1 or LFW)** .

INSTALLATION PROCEDURE

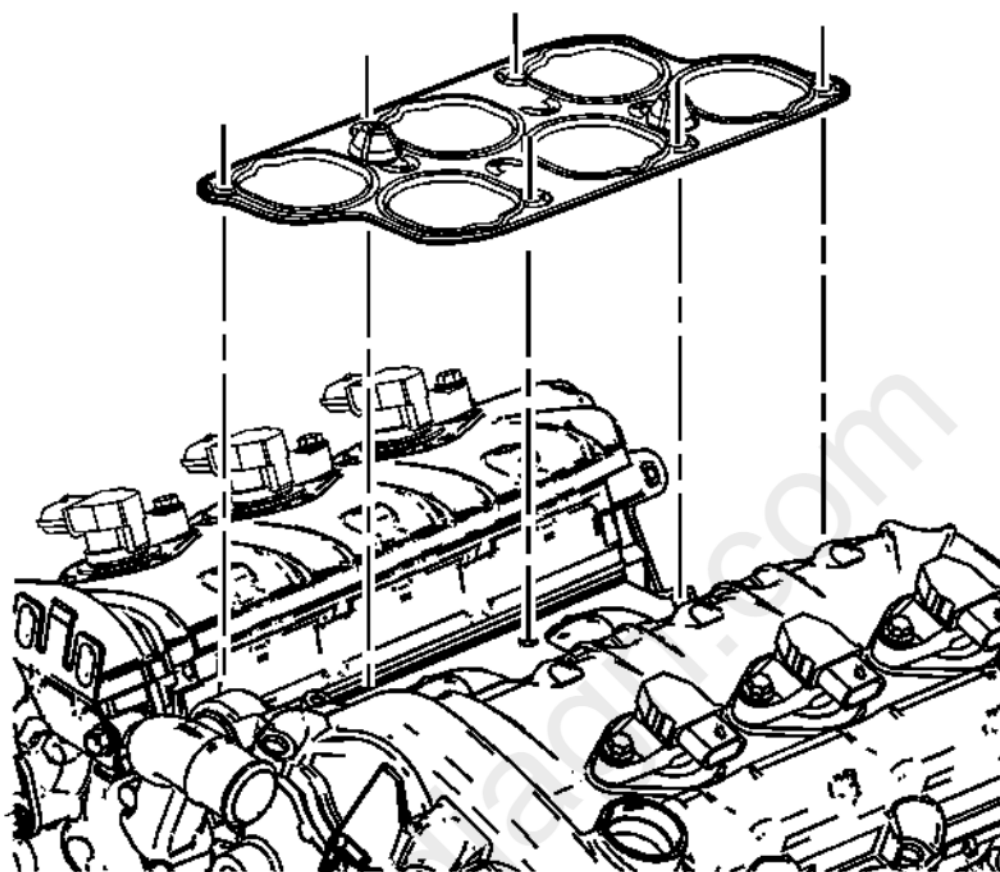


Fig. 106: View Of Lower Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Assemble the intake manifold as necessary. Refer to Intake Manifold Assemble (LLT) or Intake Manifold Assemble (LF1 or LFW) .

NOTE: **Inspect and replace the lower intake manifold gasket only if the gasket is worn or damaged.**

2. Install the lower intake manifold gasket.

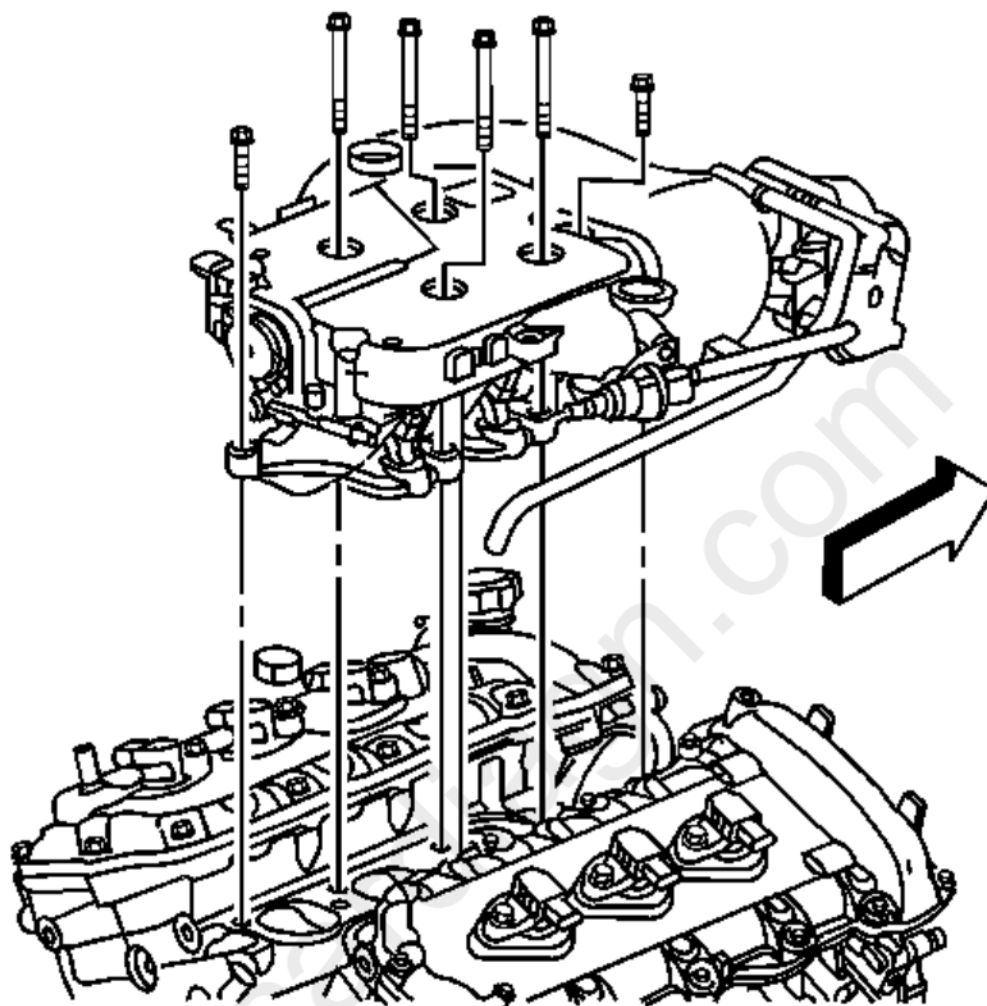


Fig. 107: View Of Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

3. Install the intake manifold. Refer to **Intake Manifold Installation (LLT)** or **Intake Manifold Installation (LF1 or LFW)**.

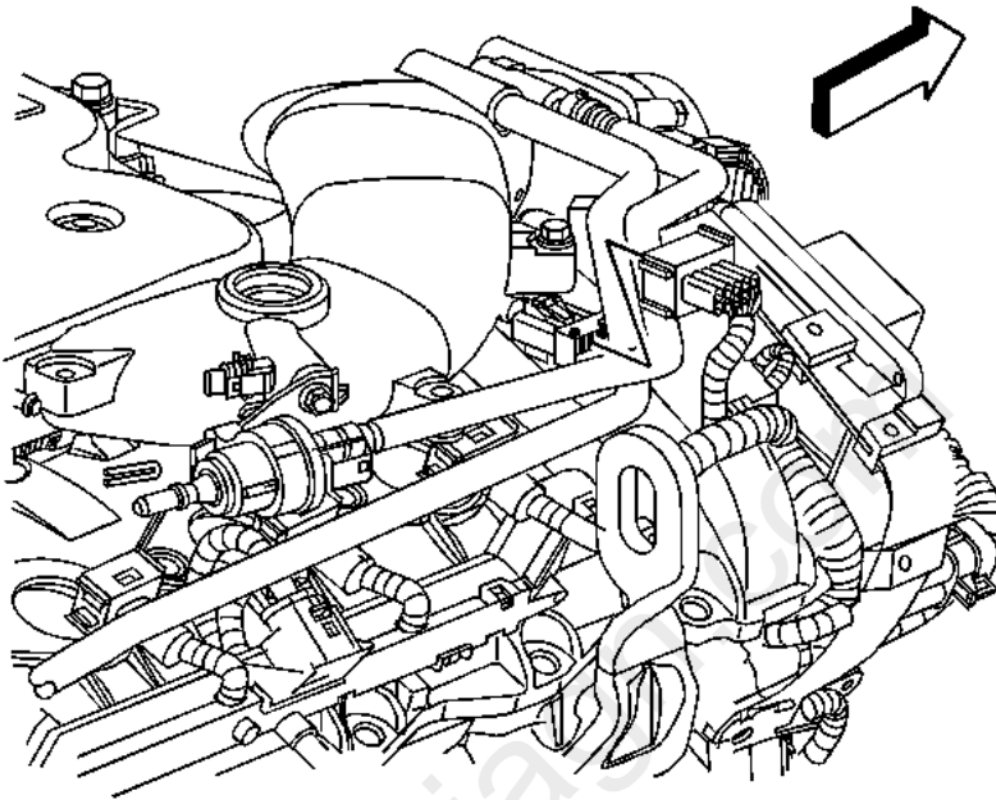


Fig. 108: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel injector harness electrical connector.

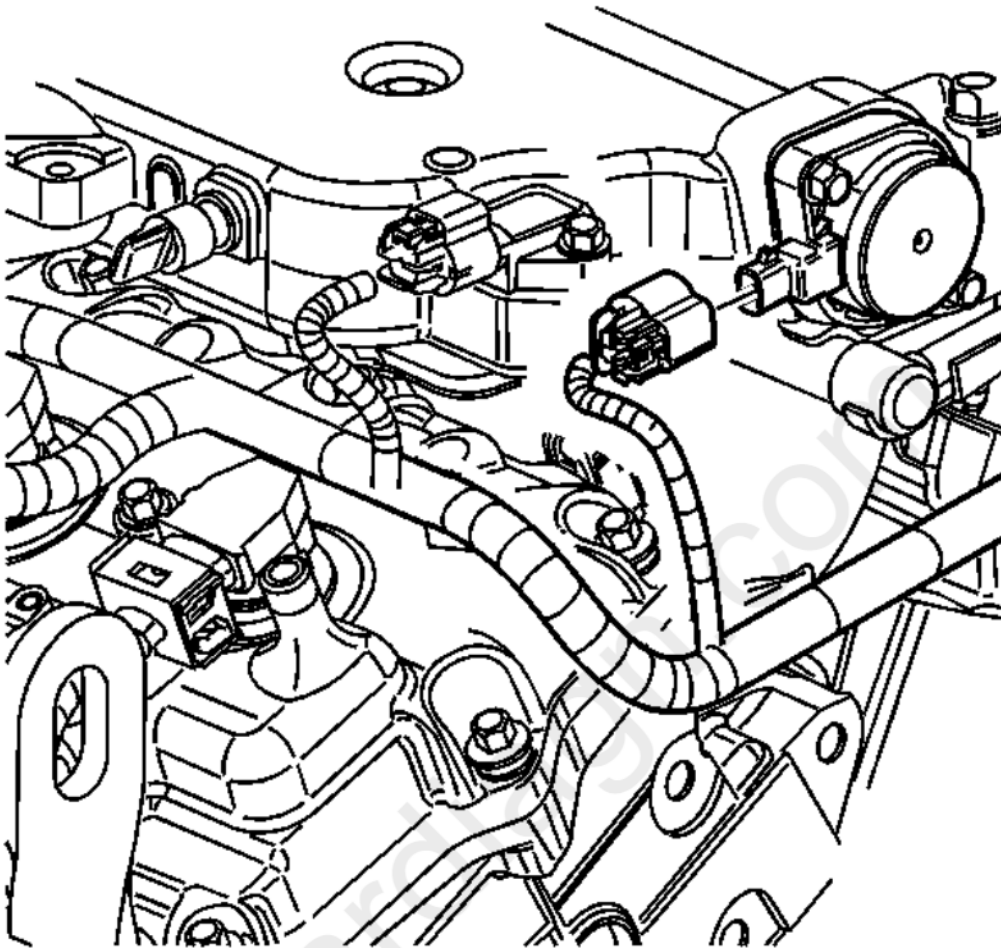


Fig. 109: View Of Communicator And Intake Manifold Runner Control Solenoid Electrical Connectors

Courtesy of GENERAL MOTORS CORP.

5. Connect the intake manifold runner control solenoid electrical connector.

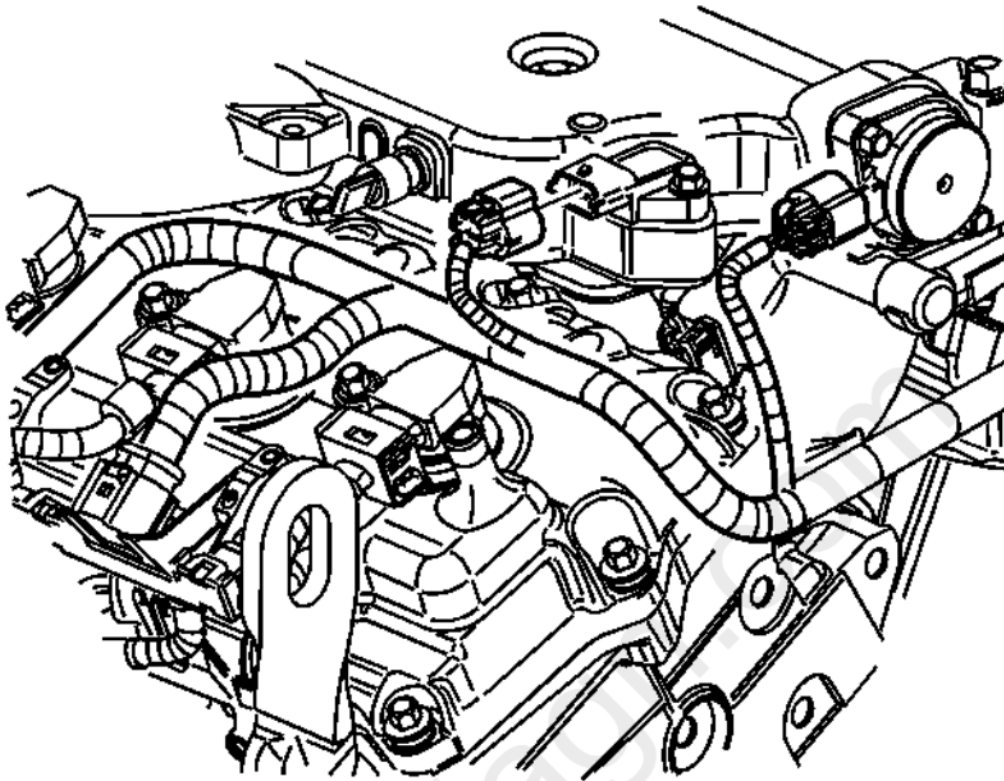


Fig. 110: Identifying Barometric Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the barometric pressure sensor electrical connector.
7. Connect the PCV hose from the right bank camshaft cover.

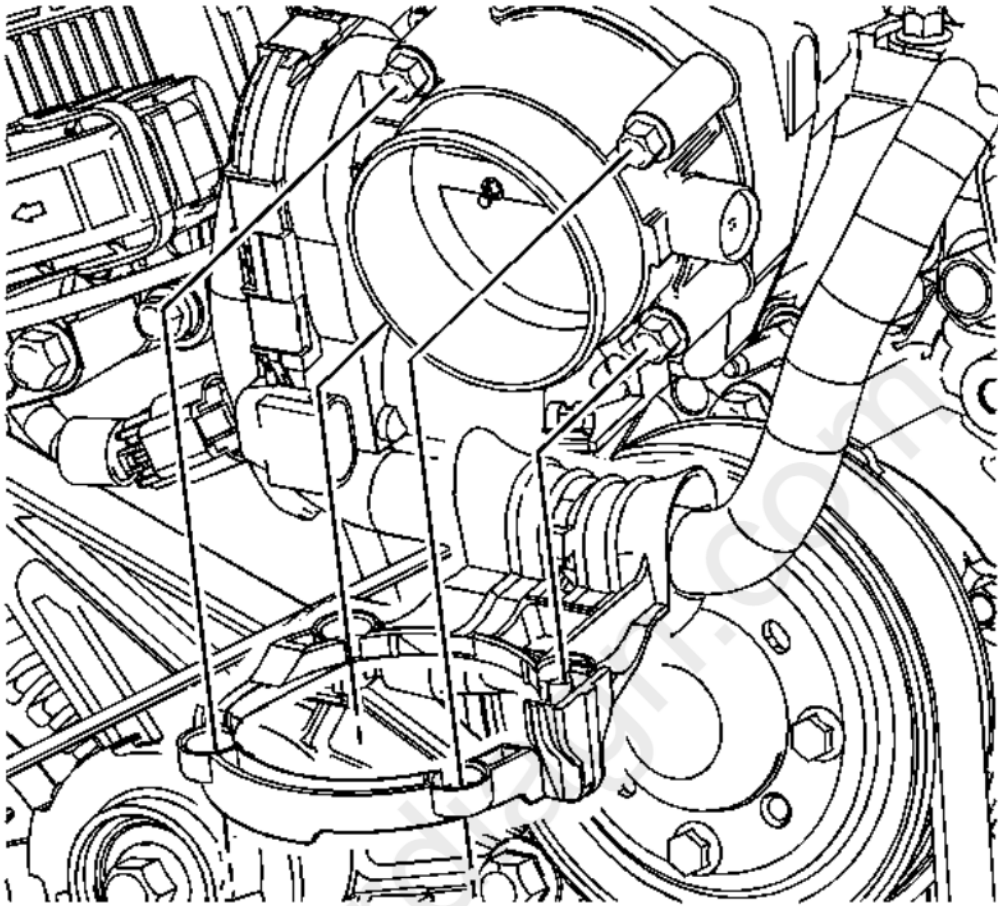


Fig. 111: View Of Wiring Harness Conduit
Courtesy of GENERAL MOTORS CORP.

8. Install the wiring harness retainer.

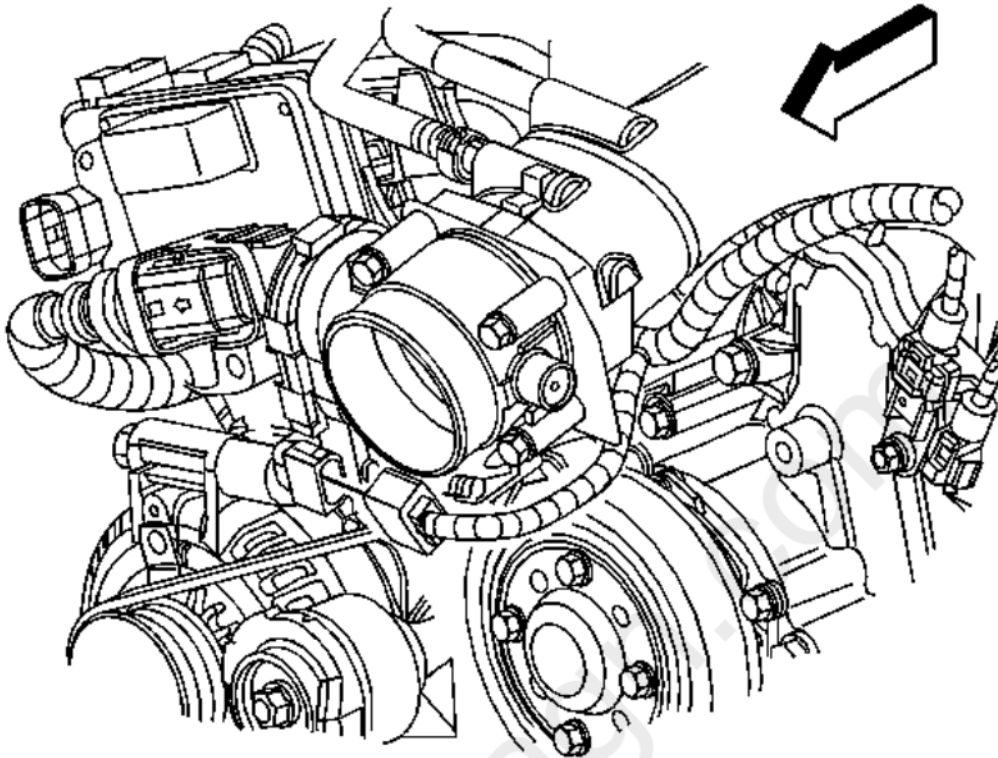


Fig. 112: View Of Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

CAUTION: Ensure proper engagement of the wiring harness connector. The wiring harness connector must be installed straight onto the component connector and firmly seated. Visually inspect the connector to ensure that the connector latches are engaged and locked. Any damage to the connector or wiring must be repaired. Failure to follow this procedure can lead to an intermittent electrical connection, driveability concerns, and/or wiring harness or wiring harness connector damage or failure.

9. Connect the throttle body electrical connector.

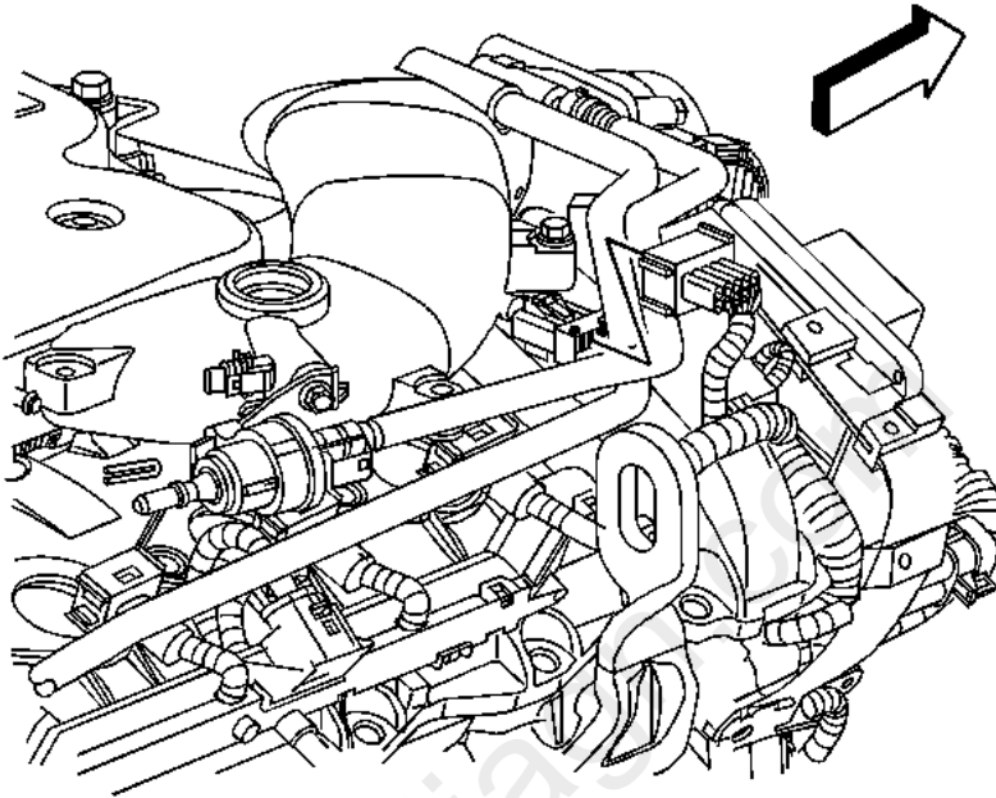


Fig. 113: View Of Fuel Injector Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

10. Connect the fuel injector harness electrical connector.

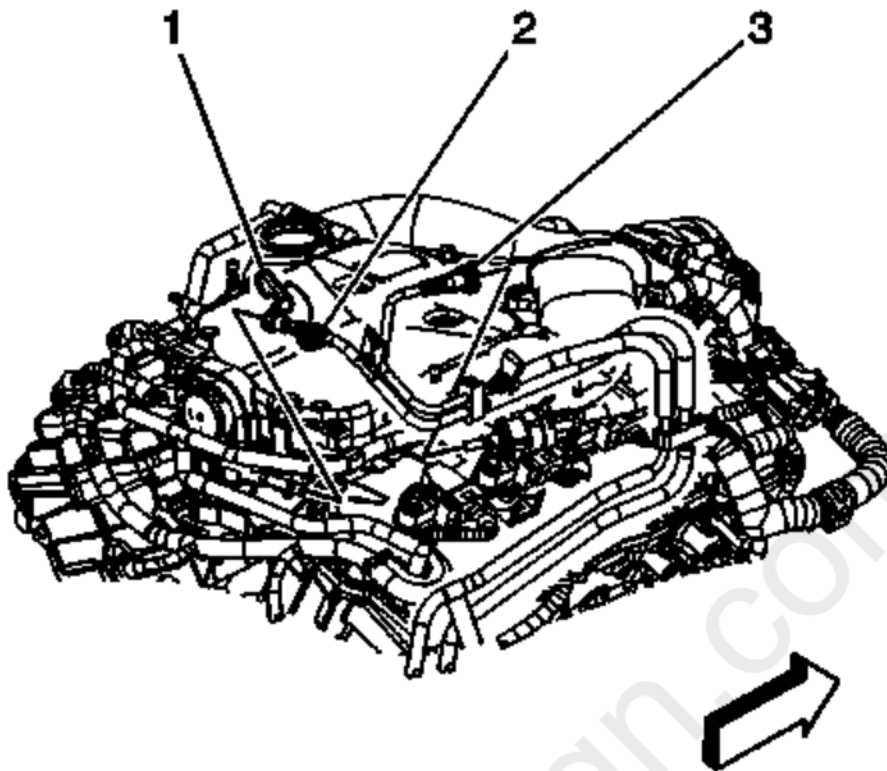


Fig. 114: Top Of Engine View

Courtesy of GENERAL MOTORS CORP.

11. Connect the fuel feed pipe (1) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
12. Connect the purge line (3) to the purge solenoid valve.

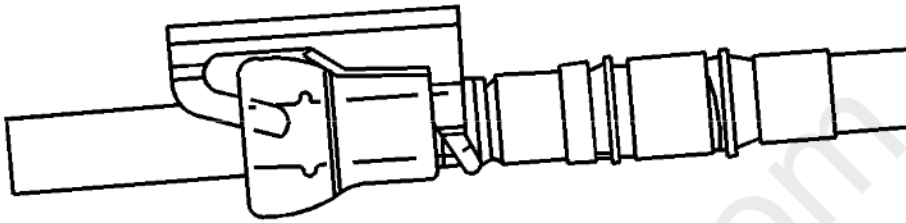


Fig. 115: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

13. Install the fuel pipe retainer.

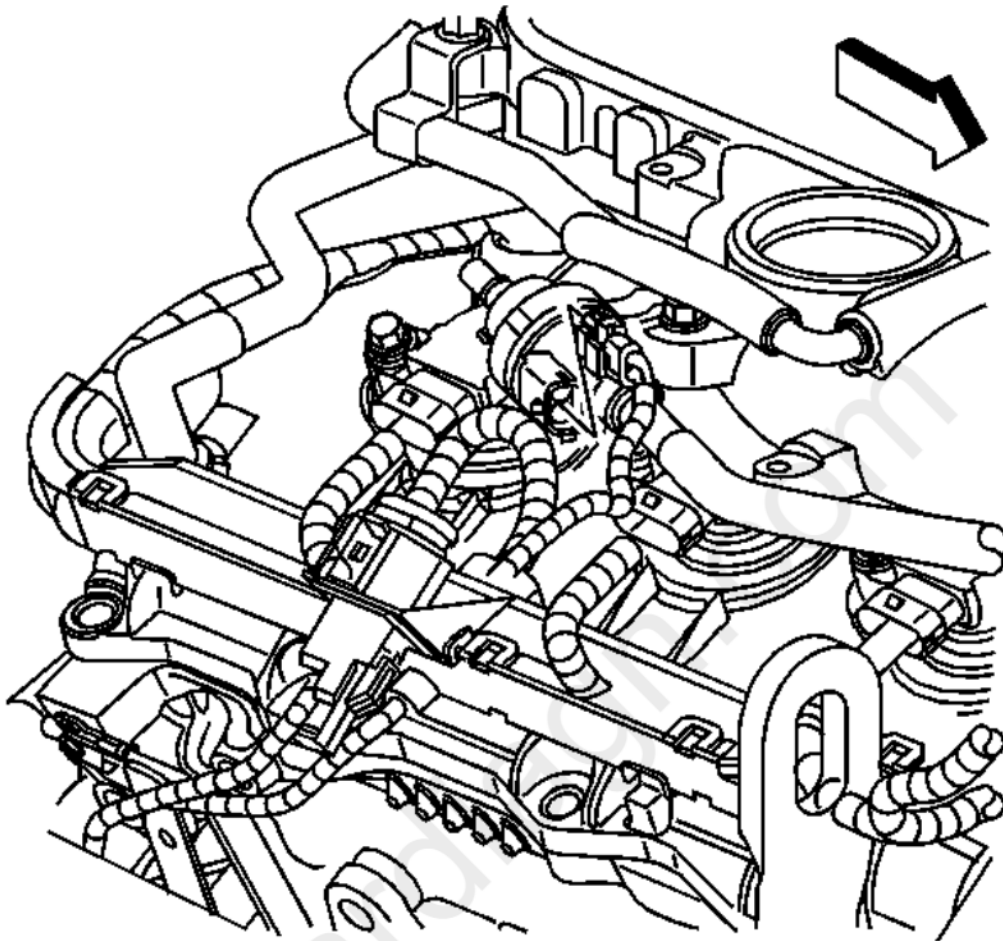


Fig. 116: View Of Purge Solenoid Valve And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the purge solenoid valve electrical connector.
15. Install the brake booster hose and check valve to the brake booster.

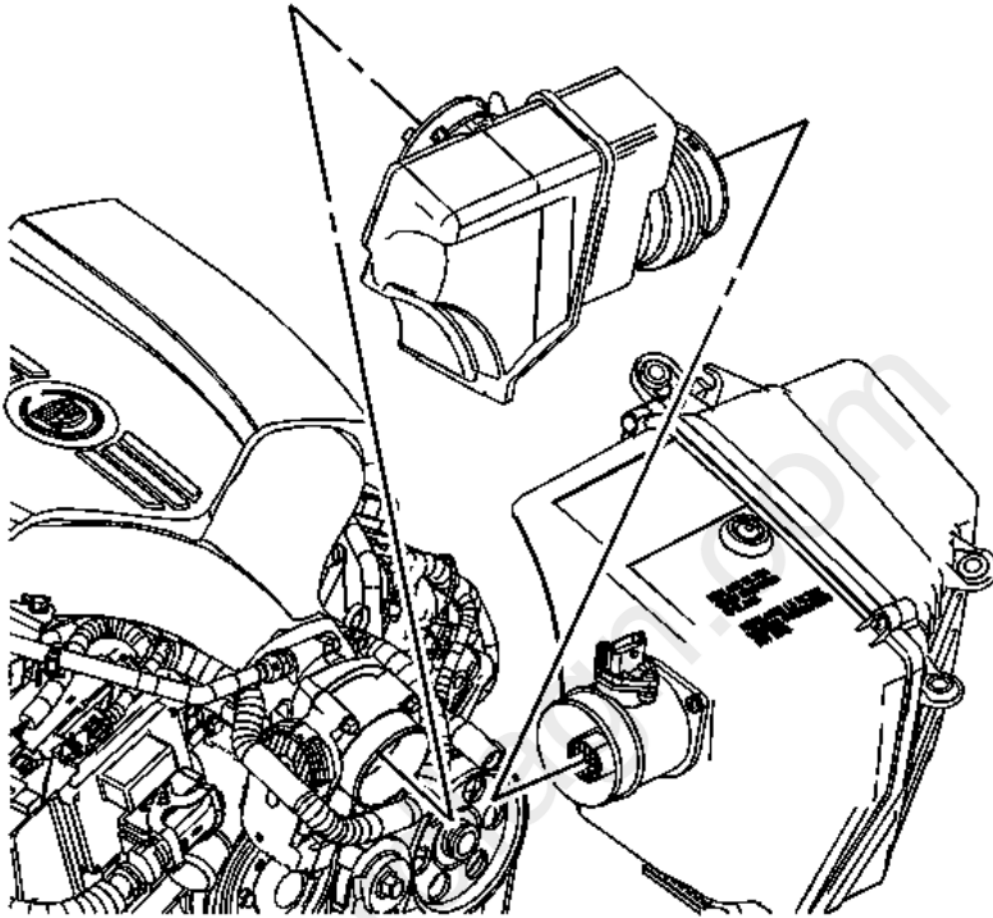


Fig. 117: View Of Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

16. Install the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .
17. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

OIL LEVEL INDICATOR TUBE REPLACEMENT (LF1)

REMOVAL PROCEDURE

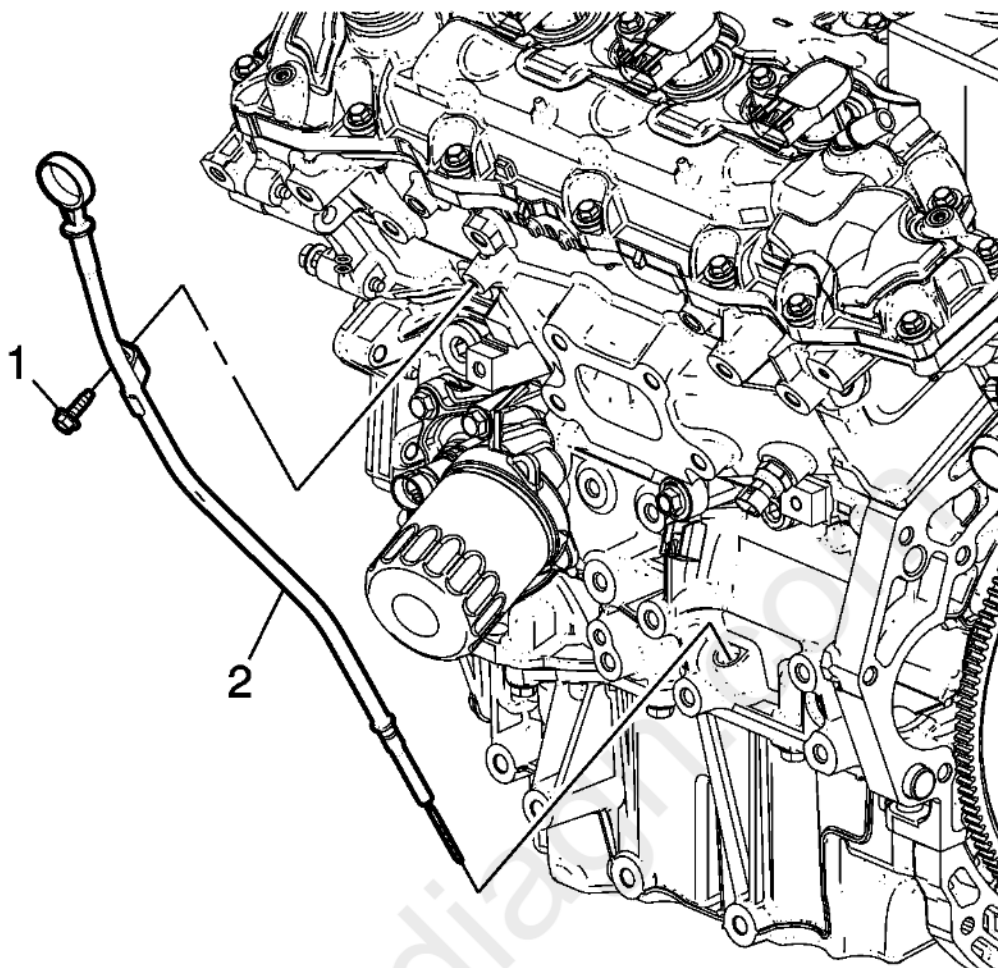


Fig. 118: Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Remove the oil level indicator tube bracket bolt (1).
3. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.

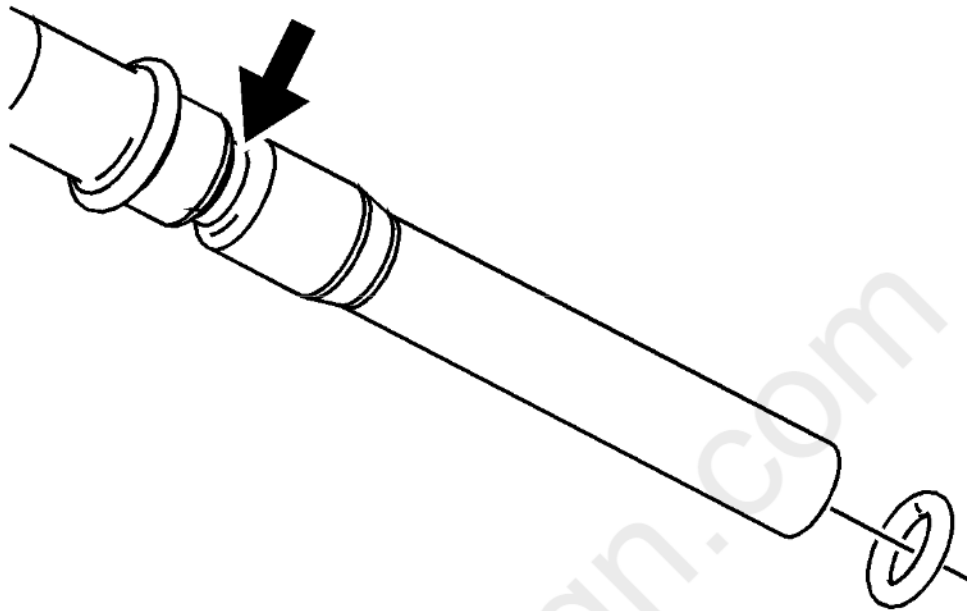


Fig. 119: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the O-ring from the oil level indicator tube if damaged.

INSTALLATION PROCEDURE

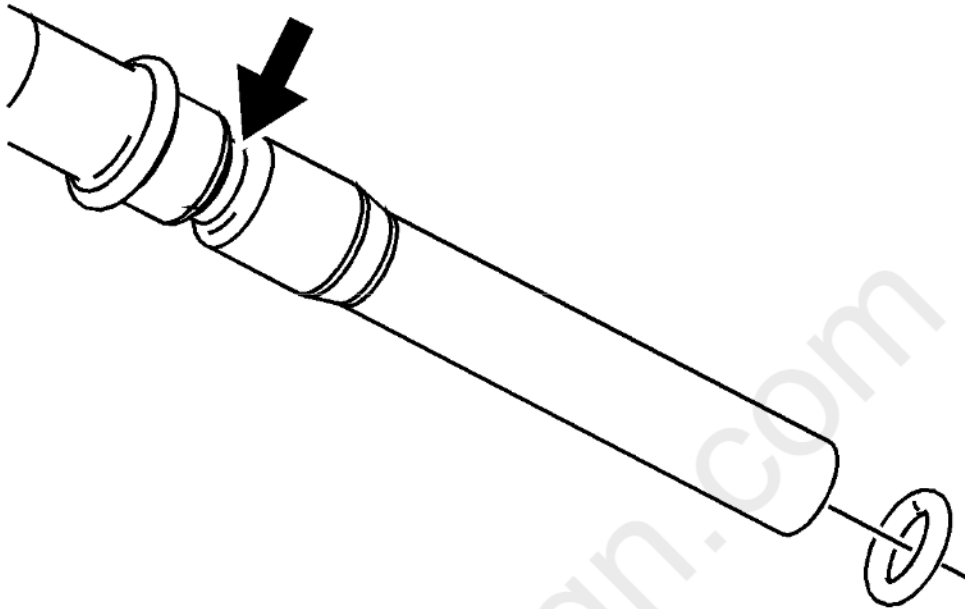


Fig. 120: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW O-ring on the oil level indicator tube.

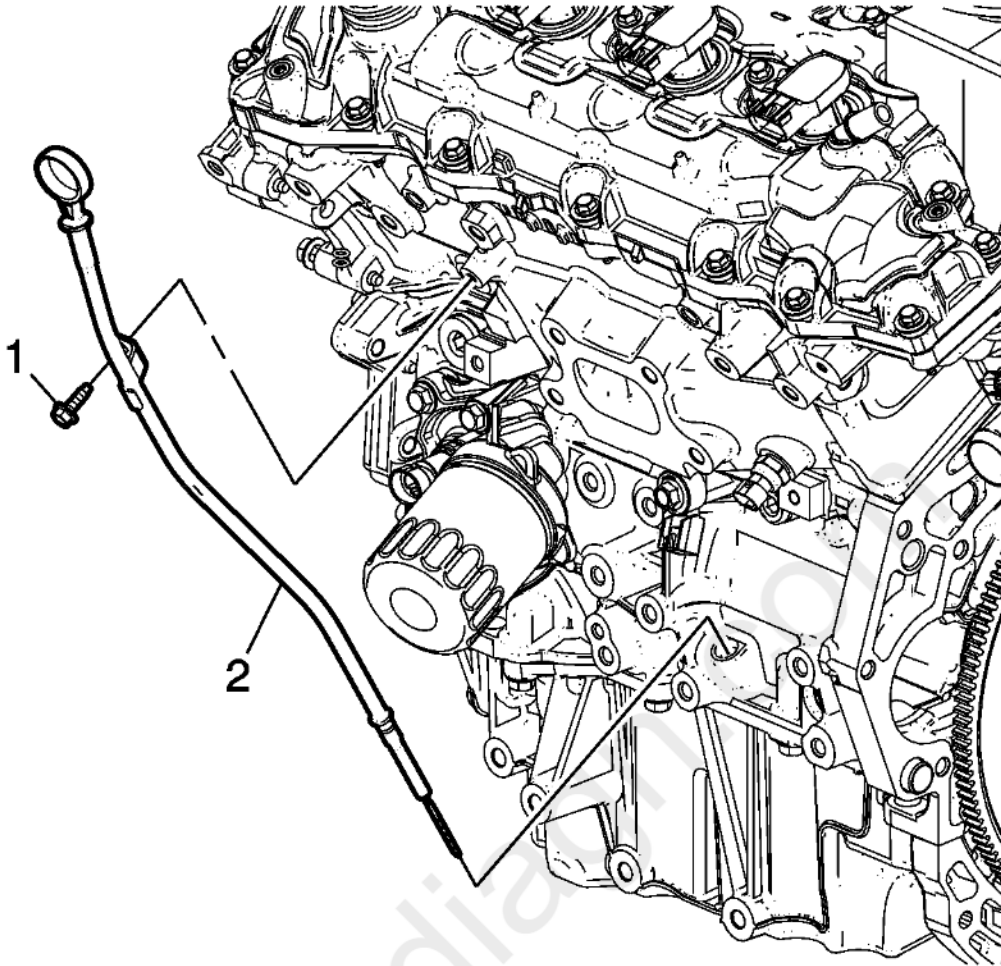


Fig. 121: Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the oil level indicator and tube (2) by sliding the tube down through the lower crankcase hole.

CAUTION: Refer to **FASTENER CAUTION** .

3. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).

OIL LEVEL INDICATOR TUBE REPLACEMENT (LLT)

REMOVAL PROCEDURE

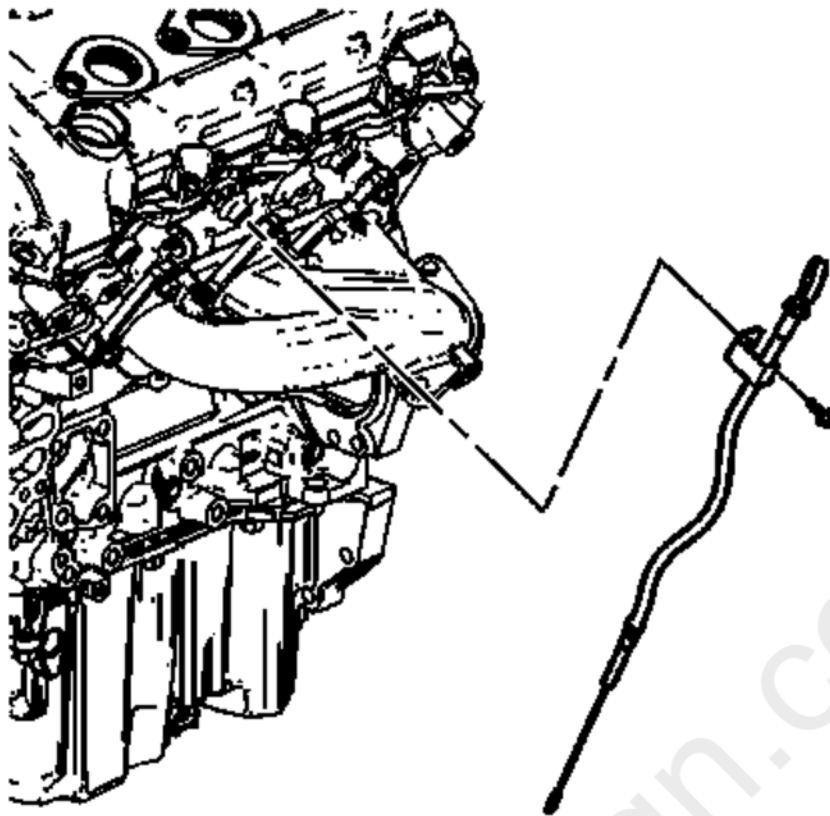


Fig. 122: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .
2. Remove the oil level indicator from the oil level indicator tube.
3. Remove the oil level indicator tube bolt.
4. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .
5. Lower the vehicle.
6. Remove the knock sensor bank 2. Refer to **Knock Sensor Replacement - Bank 2** .
7. Remove the oil level indicator tube up through the exhaust manifold.
8. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

INSTALLATION PROCEDURE

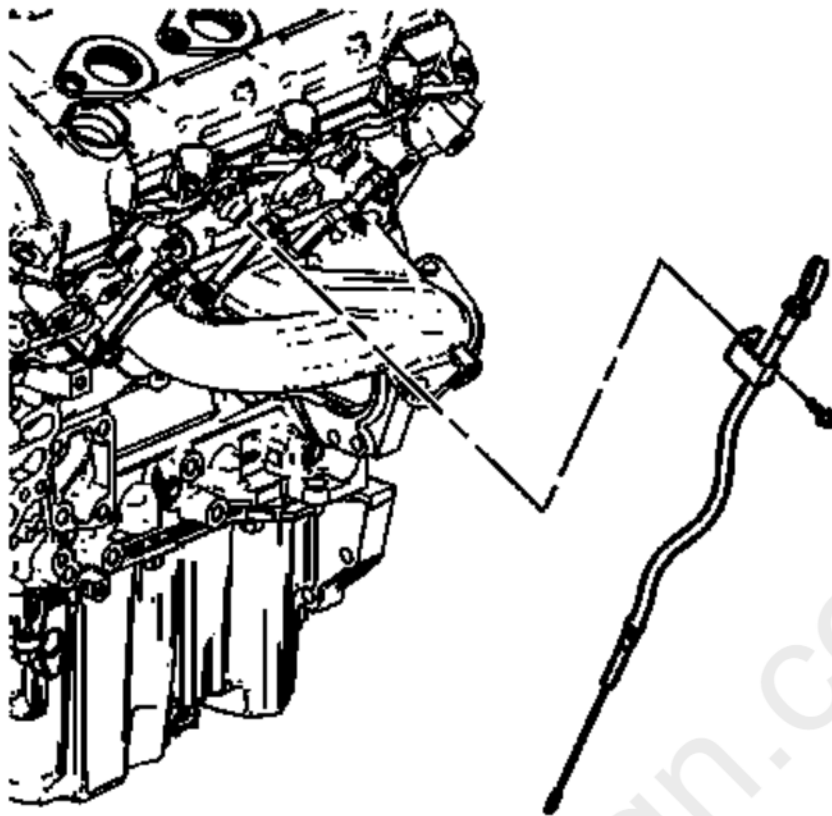


Fig. 123: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Installation (LLT)** or **Oil Level Indicator and Tube Installation (LF1 or LFW)** .
2. Install the knock sensor bank 2. Refer to **Knock Sensor Replacement - Bank 2** .
3. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
4. Lower the vehicle.
5. Install the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

OIL FILTER ADAPTER REPLACEMENT (LF1)

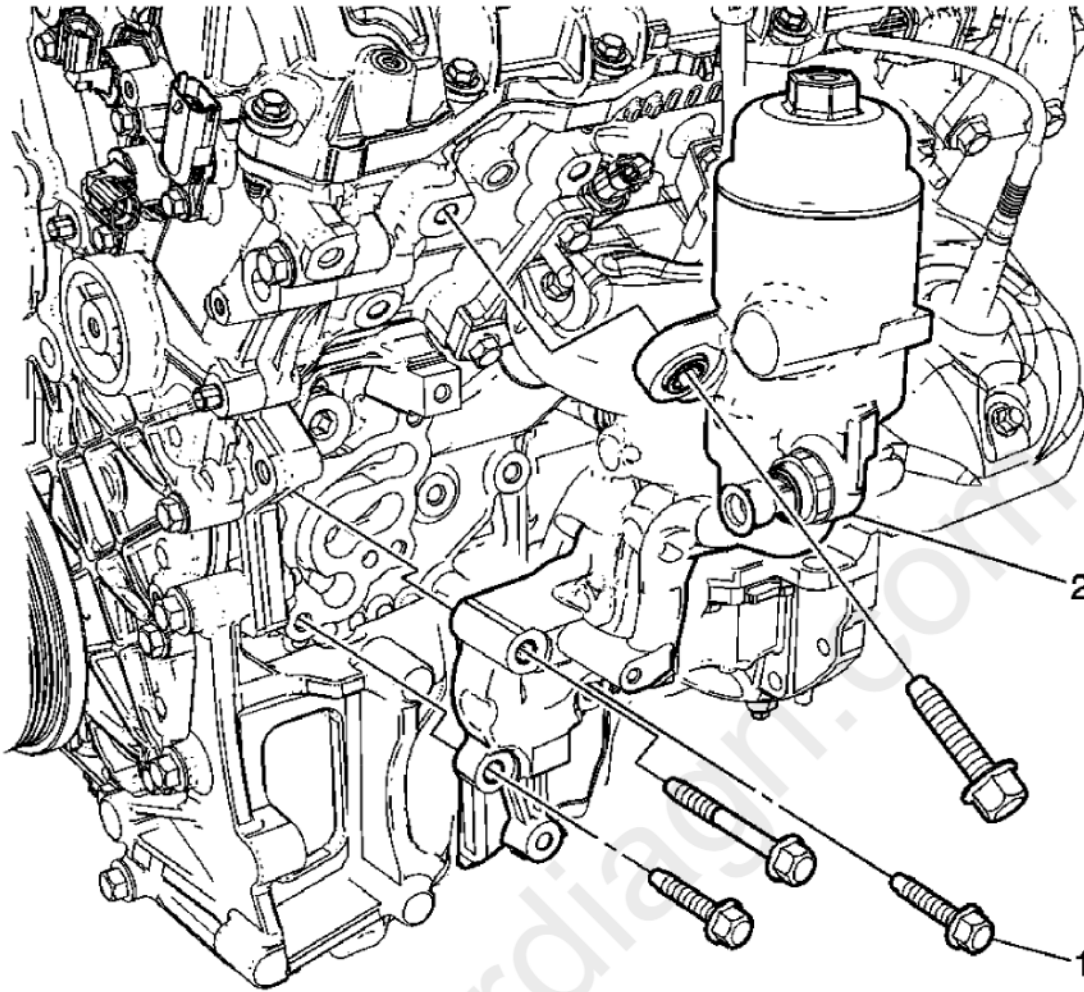


Fig. 124: Oil Filter Adapter (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT) .	
1	Oil Filter Adapter Fastener (Qty: 4) CAUTION: Refer to. Tighten: 25 N.m (18 lb ft)
2	Oil Filter Adapter Procedure: Transfer components as necessary.

OIL FILTER ADAPTER REPLACEMENT (LLT)

REMOVAL PROCEDURE

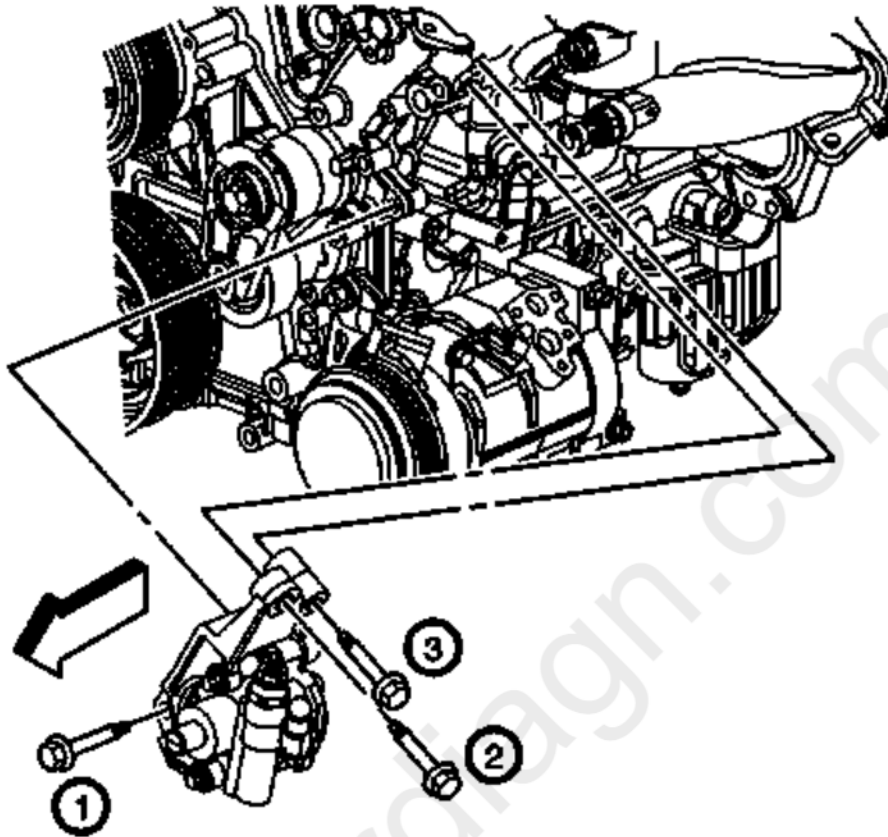


Fig. 125: View Of Power Steering Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection (Sedan,Wagon) or Battery Negative Cable Disconnection and Connection (Coupe) .
2. Remove the oil filter. Refer to Engine Oil and Oil Filter Replacement .
3. Remove the A/C compressor and power steering drive belt. Refer to Air Conditioning Compressor and Power Steering Pump Belt Replacement.
4. Disconnect the oil pressure sensor electrical connector.

NOTE: Do not disconnect the power steering lines from the power steering pump.

5. Remove the power steering pump bolts (1-3) and position the pump aside in order to gain access to the oil filter adapter fasteners. Refer to Power Steering Pump Replacement (V6) .
6. Raise the vehicle. Refer to Lifting and Jacking the Vehicle .

NOTE: Do not disconnect the A/C pipes from the A/C compressor.

7. Remove the A/C compressor bolts and reposition the A/C compressor in order to gain access to the oil filter adapter fasteners. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)**.

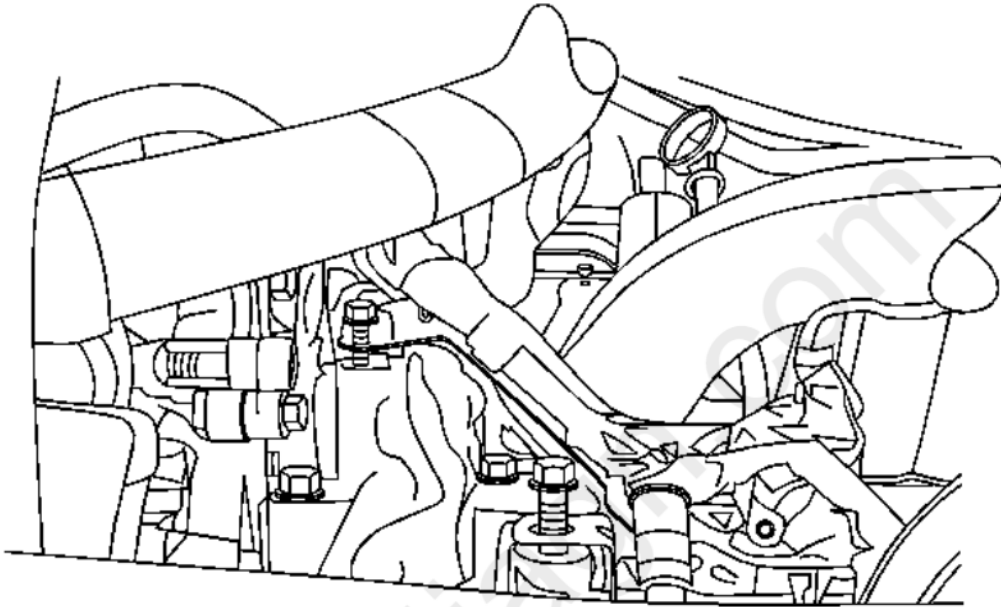


Fig. 126: A/C Compressor
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolts securing the wire harness bracket to the oil filter adapter.

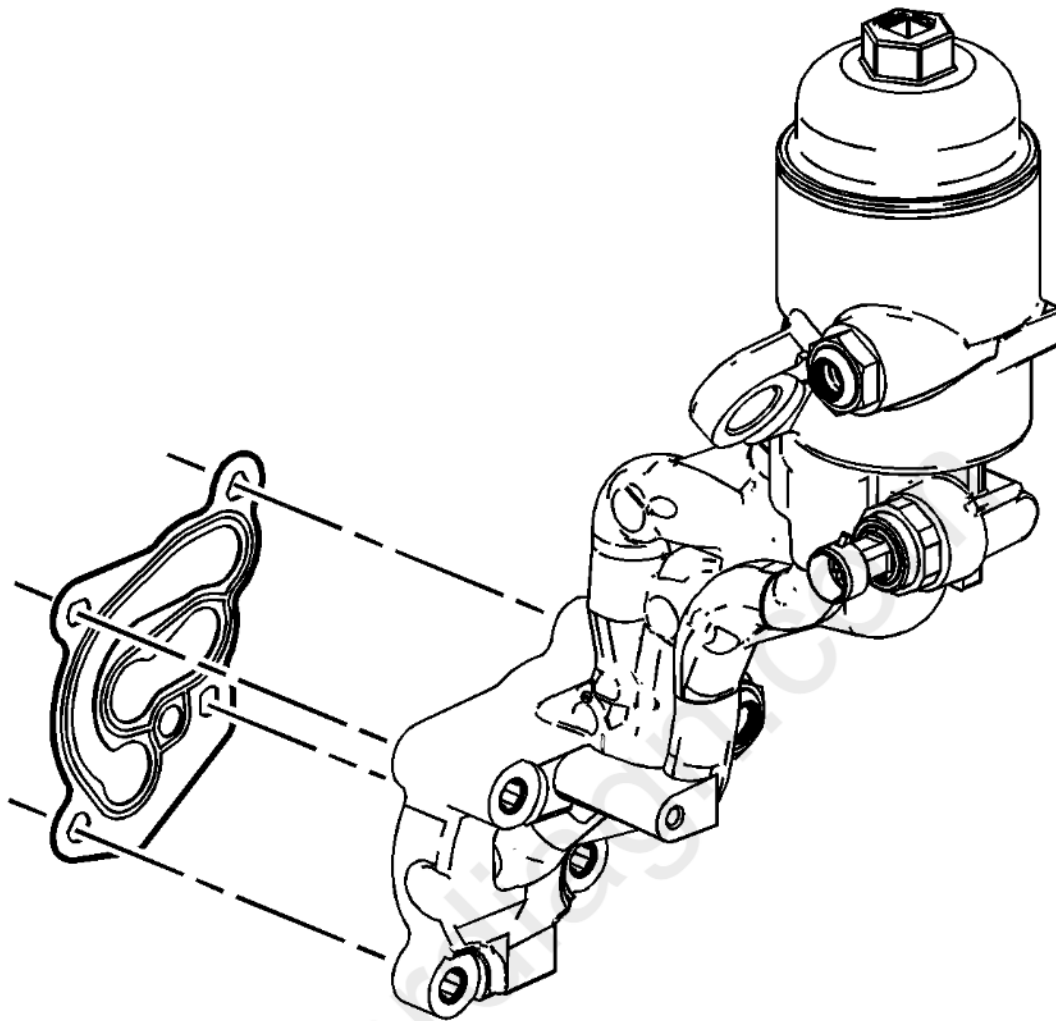


Fig. 127: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

9. Place a drain pan under the vehicle.
10. Remove the oil filter adapter bolts.
11. Lower the vehicle.
12. Remove the oil filter adapter.

INSTALLATION PROCEDURE

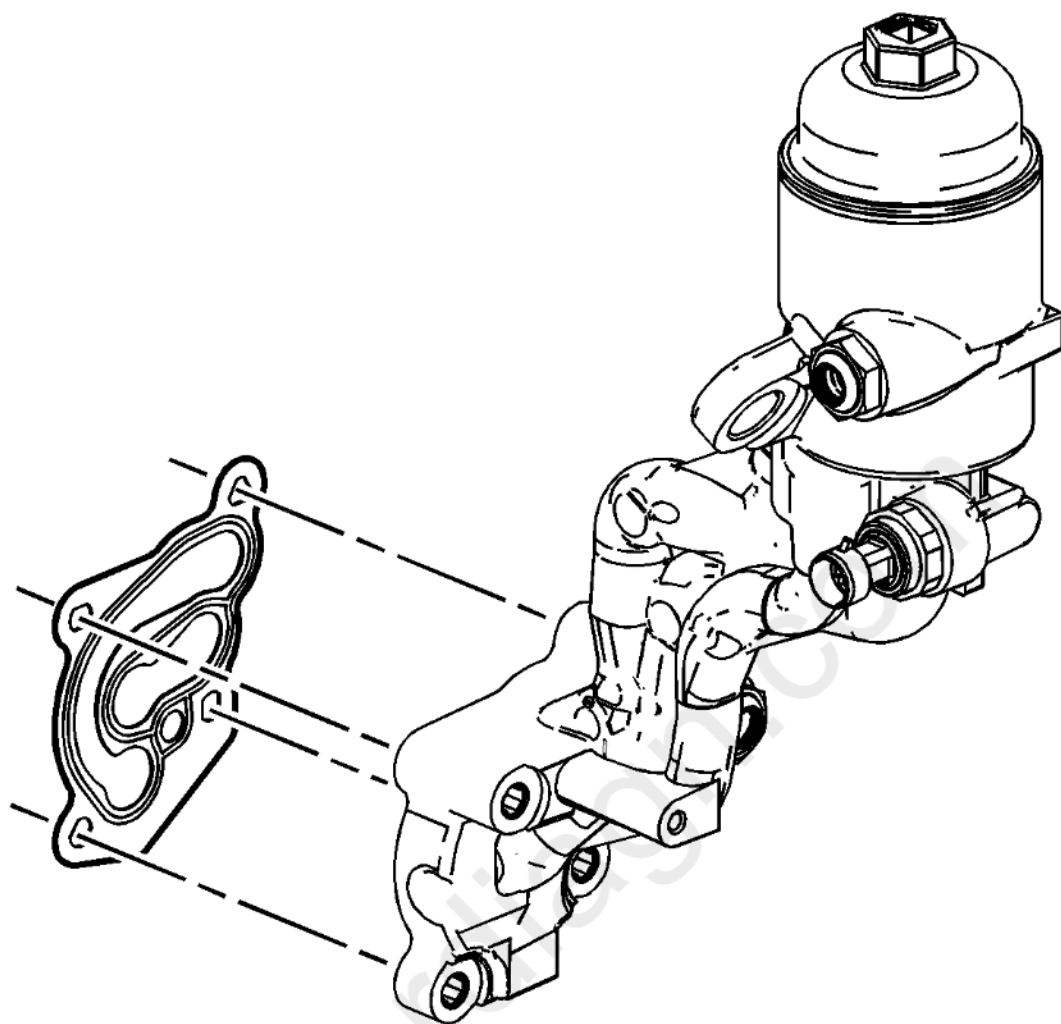


Fig. 128: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter adapter.

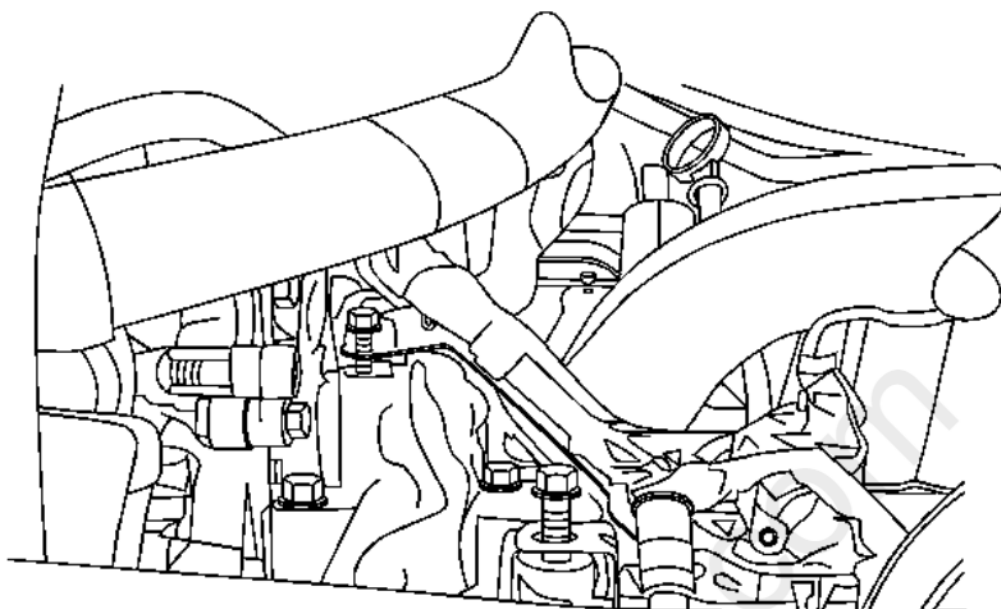


Fig. 129: A/C Compressor

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

2. Install the bolts securing the wire harness bracket to the oil filter adapter.
 1. Tighten the large wire harness bracket bolt to 23 N.m (17 lb ft).
 2. Tighten the small wire harness bracket bolt to 10 N.m (89 lb in).
3. Install the A/C compressor with the A/C pipes to the engine. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)** .
4. Lower the vehicle.

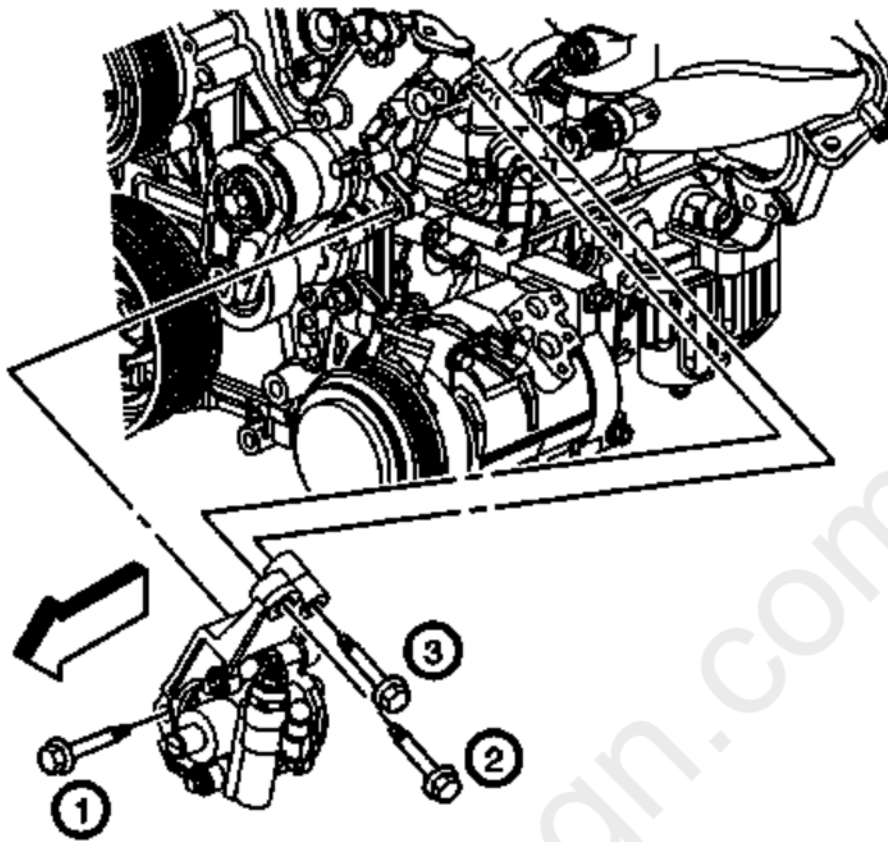


Fig. 130: View Of Power Steering Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the power steering pump bolts (1-3). Refer to **Power Steering Pump Replacement (V6)** .
6. Connect the oil pressure sensor electrical connector.
7. Install the A/C compressor and power steering drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.
8. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement** .
9. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection (Sedan,Wagon)** or **Battery Negative Cable Disconnection and Connection (Coupe)** .
10. Check and add engine oil as necessary.

CRANKSHAFT BALANCER REPLACEMENT

TOOLS REQUIRED

EN-48018 Flywheel Holding Tool

REMOVAL PROCEDURE

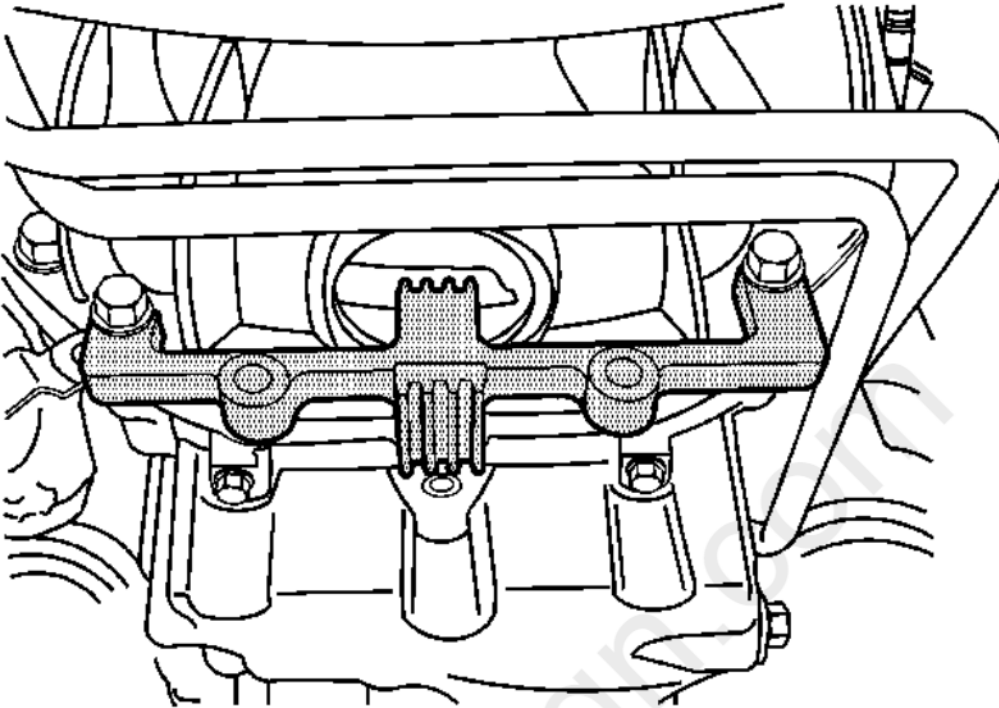


Fig. 131: View Of Flywheel Holding Tool
 Courtesy of GENERAL MOTORS CORP.

1. Remove the A/C compressor and power steering pump drive belt. Refer to **Water Pump and Generator Belt Tensioner Replacement**.
2. Remove the generator and water pump drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Tensioner Replacement**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the transmission bell housing inspection hole cover.
5. Install the **EN-48018** flywheel holding tool as shown in illustration.
6. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .

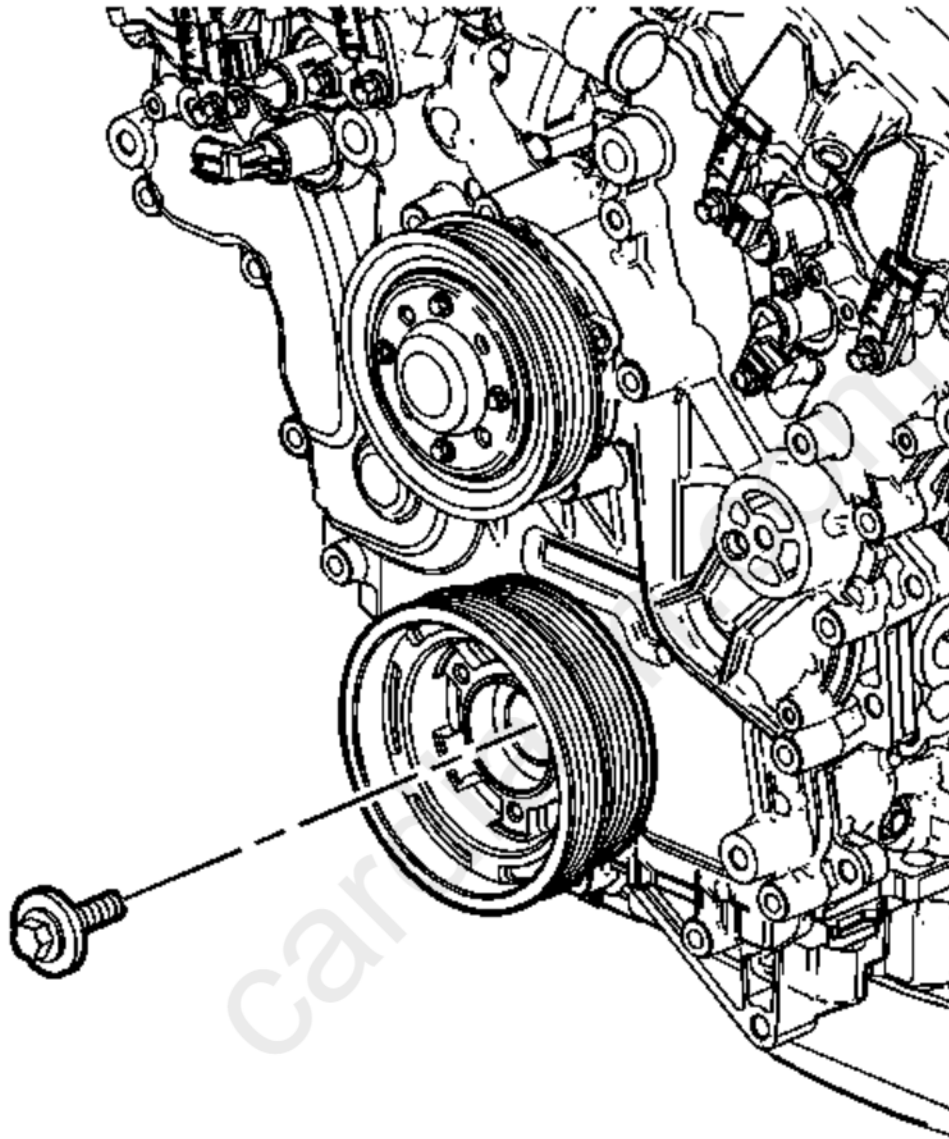


Fig. 132: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.

INSTALLATION PROCEDURE

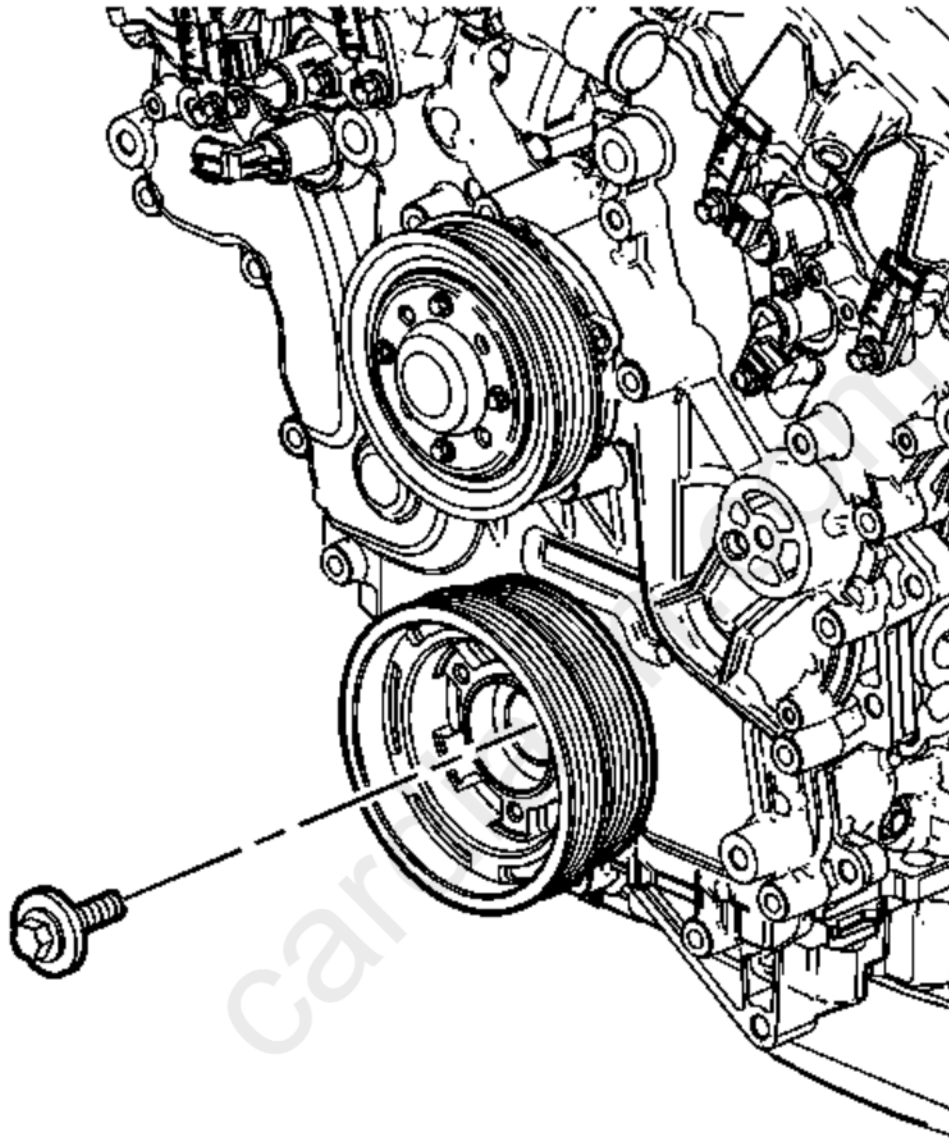


Fig. 133: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .

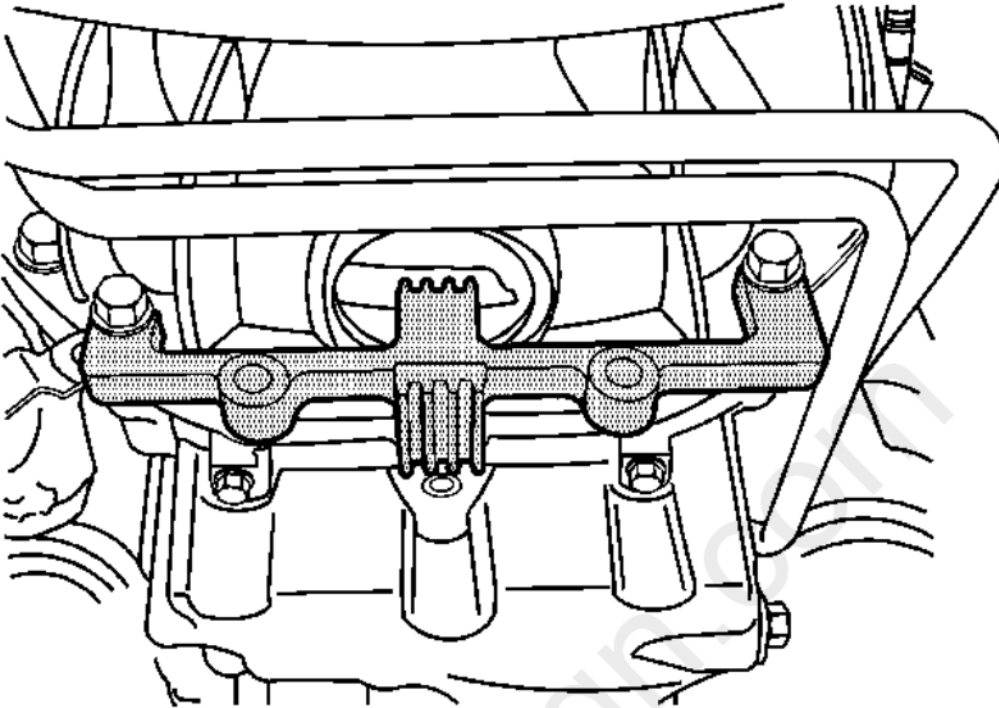


Fig. 134: View Of Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

2. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
3. Remove the **EN-48018** flywheel holding tool.
4. Install the transmission bell housing inspection hole cover.
5. Install the generator and water pump drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Tensioner Replacement**.
6. Install the A/C compressor and power steering pump drive belt. Refer to **Water Pump and Generator Belt Tensioner Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

TOOLS REQUIRED

J 29184 Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

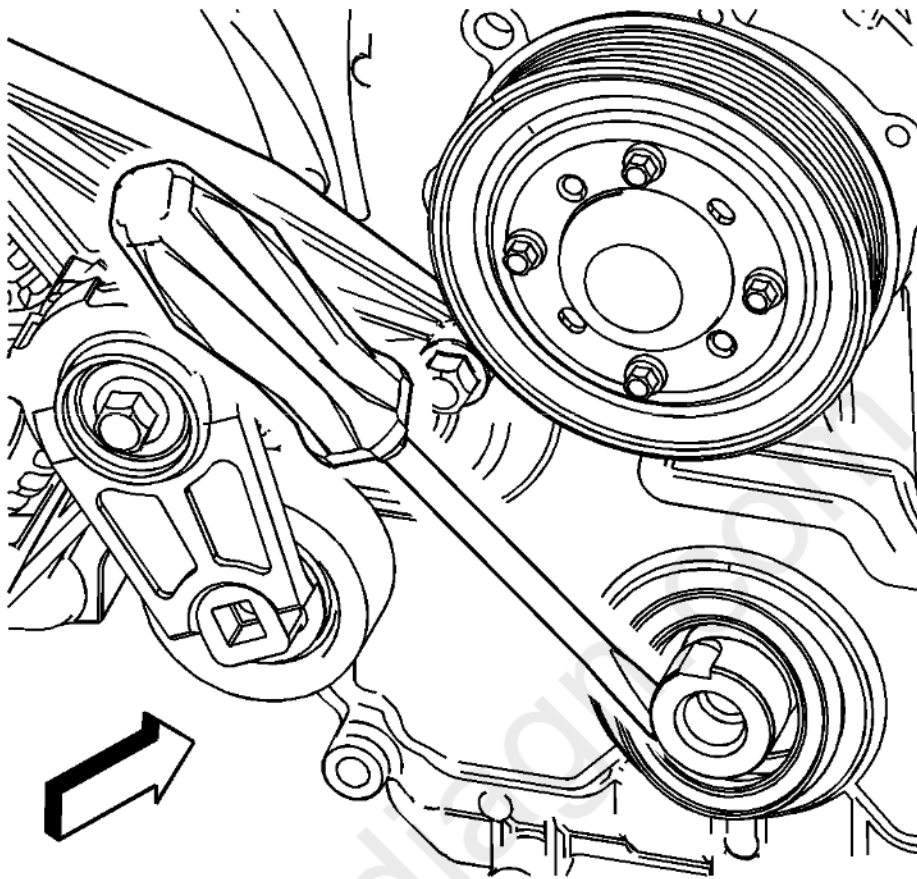


Fig. 135: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the A/C compressor and power steering pump drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.
2. Remove the generator and water pump drive belt. Refer to **Water Pump and Generator Belt Replacement**.
3. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
4. Use a flat-bladed tool in order to remove the crankshaft oil seal.

INSTALLATION PROCEDURE

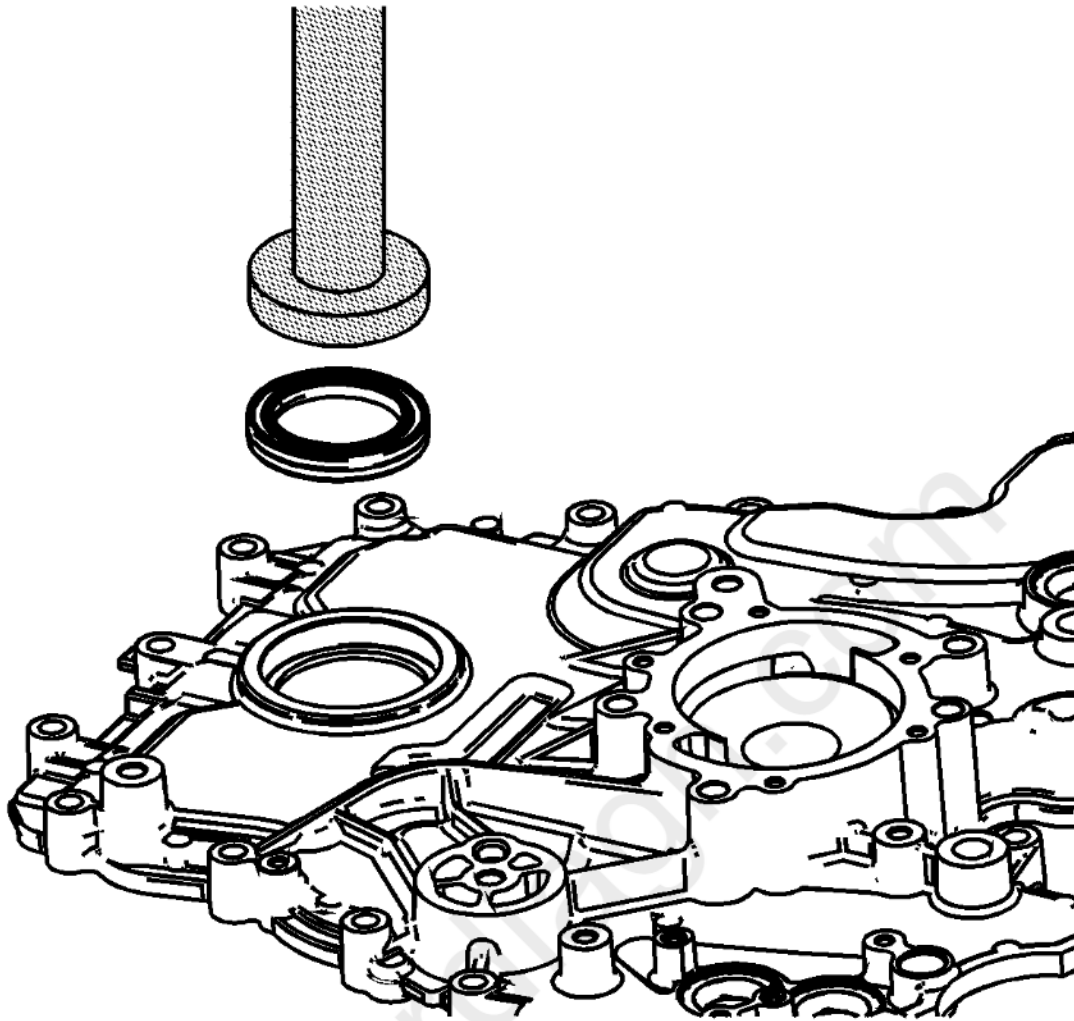


Fig. 136: View of Crankshaft Front Oil Seal Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

1. Use the **J 29184** or equivalent to install the crankshaft front oil seal. See **Special Tools** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
3. Install the generator and water pump drive belt. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Tensioner Replacement**.
4. Install the A/C compressor and power steering pump drive belt. Refer to **Water Pump and Generator Belt Tensioner Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE (LP1, LY7)

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)**.

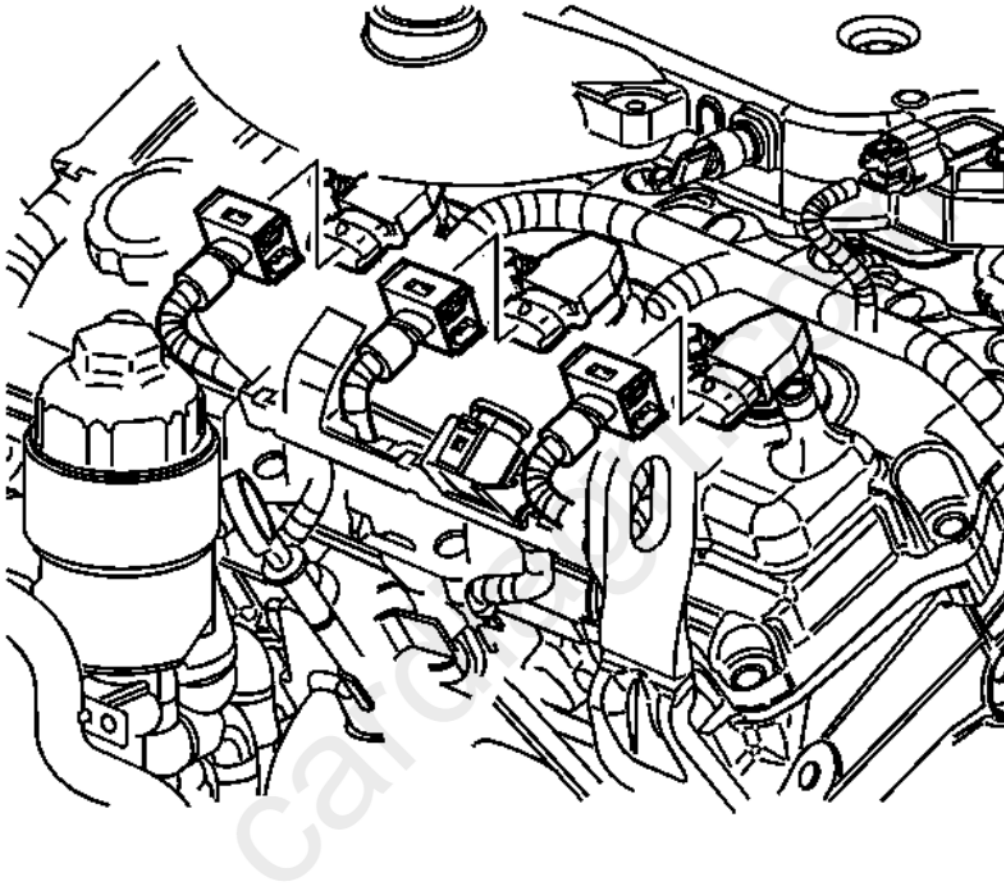


Fig. 137: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the ignition coil electrical connectors.

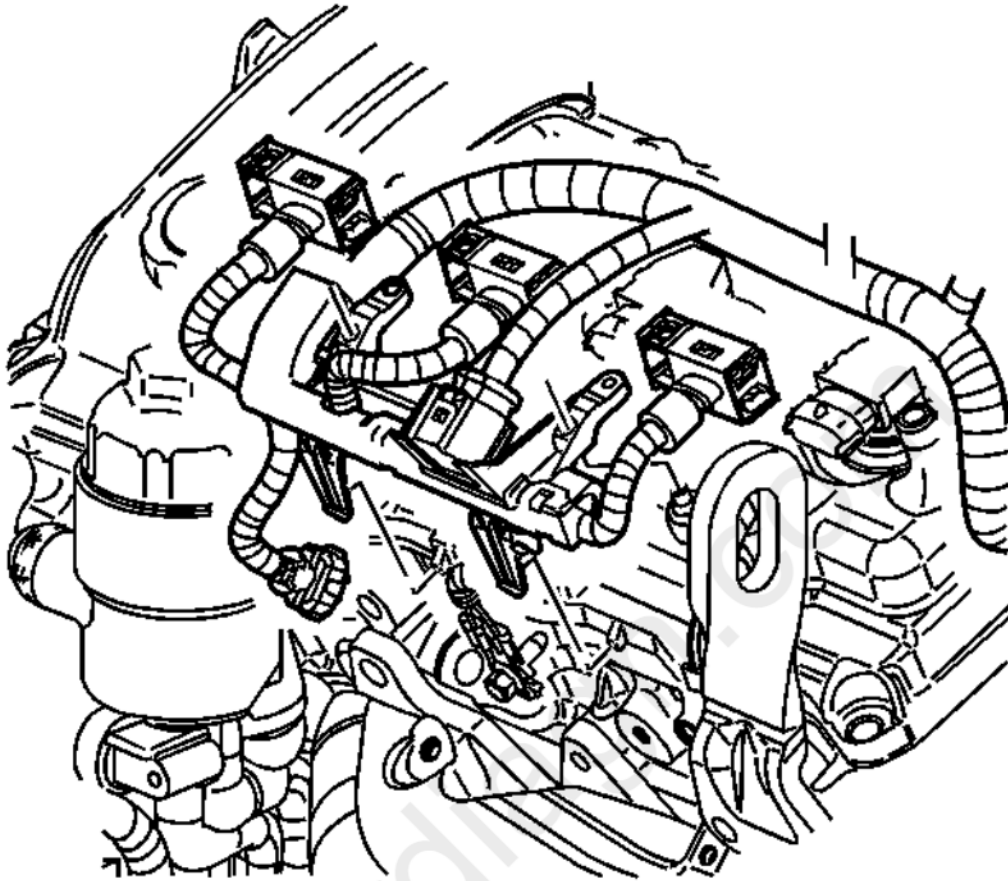


Fig. 138: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
5. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

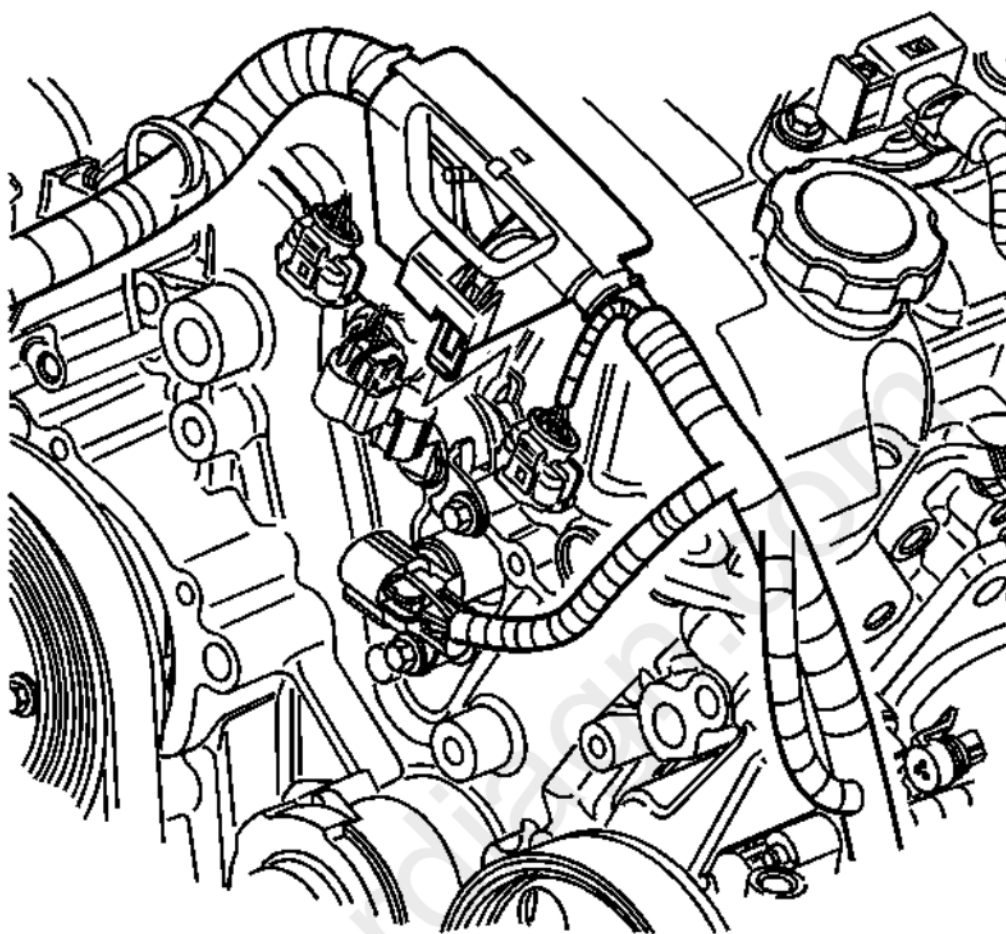


Fig. 139: View Of Left Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: It is not necessary to disconnect the engine front cover electrical connectors.

6. Remove the wiring harness from the front of the camshaft cover.
7. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

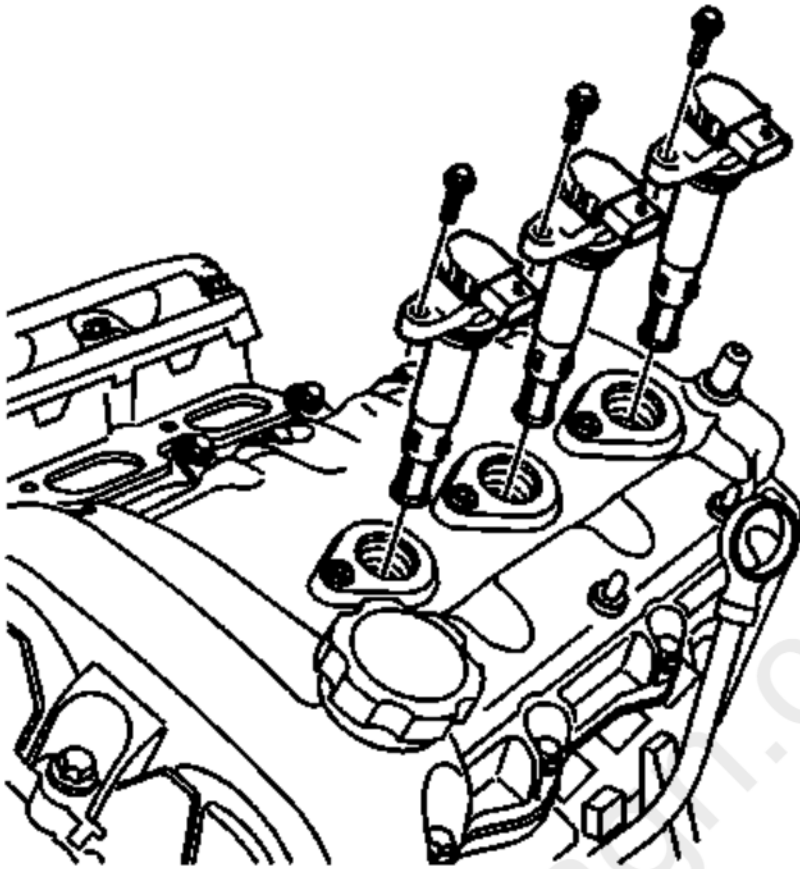


Fig. 140: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coils.

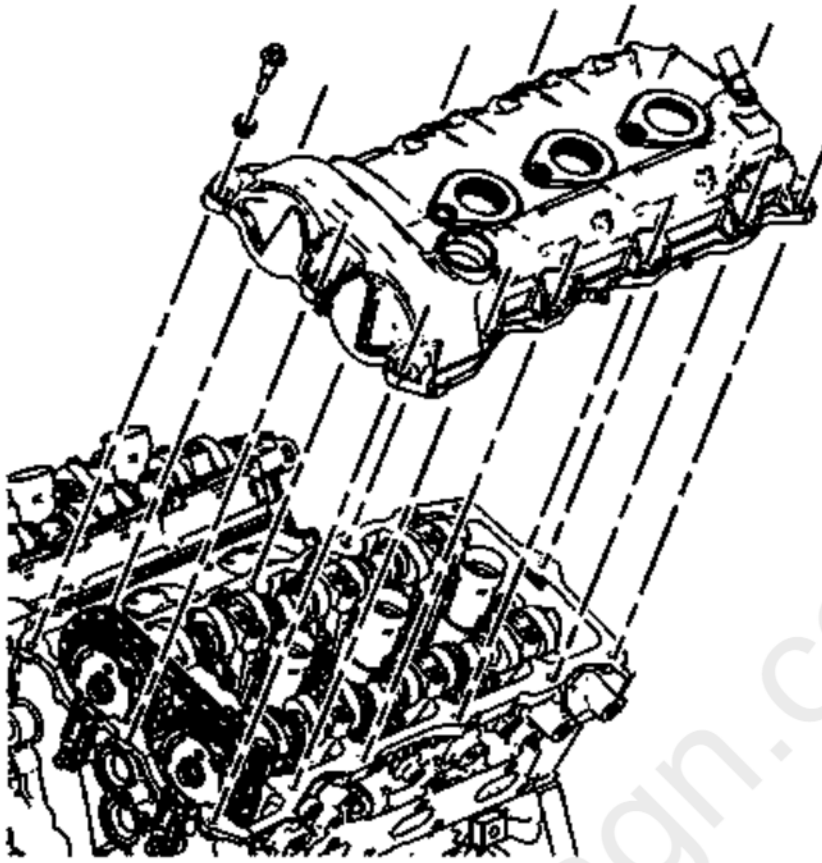


Fig. 141: Identifying Left Camshaft Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft cover.
10. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

1. Install a NEW camshaft cover seal and NEW grommets.

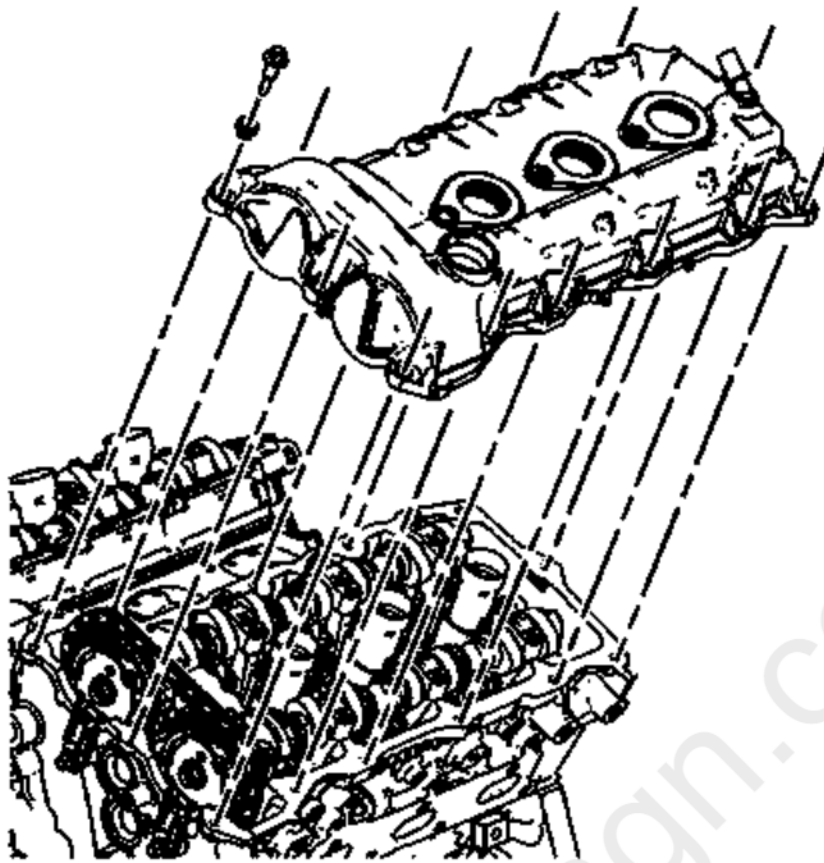


Fig. 142: Identifying Left Camshaft Cover And Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Left Side** .

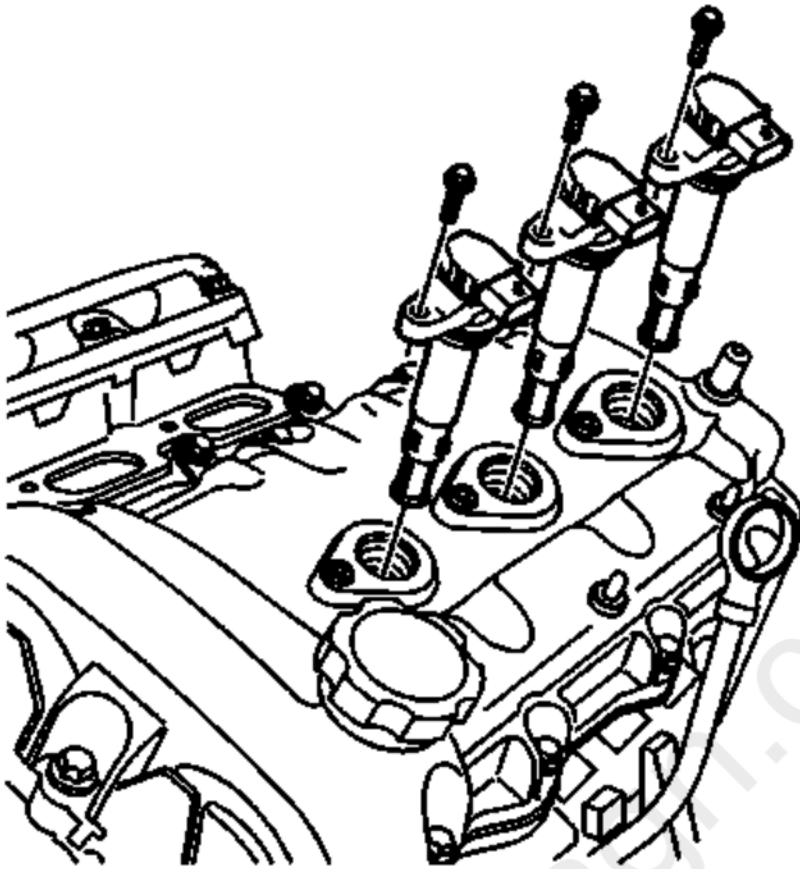


Fig. 143: Identifying Left Cylinder Head Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils.

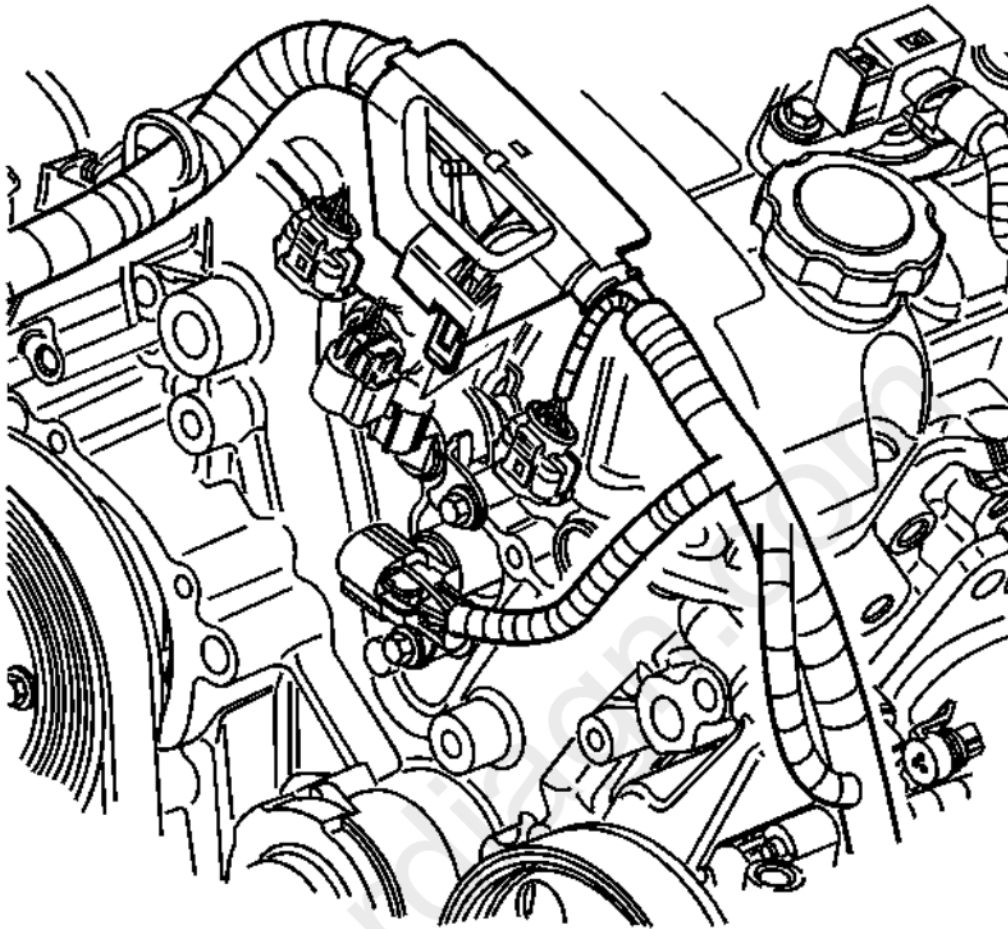


Fig. 144: View Of Left Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness to the front of the camshaft cover.
5. Install the wiring harness conduit retainers to the wiring harness conduit.

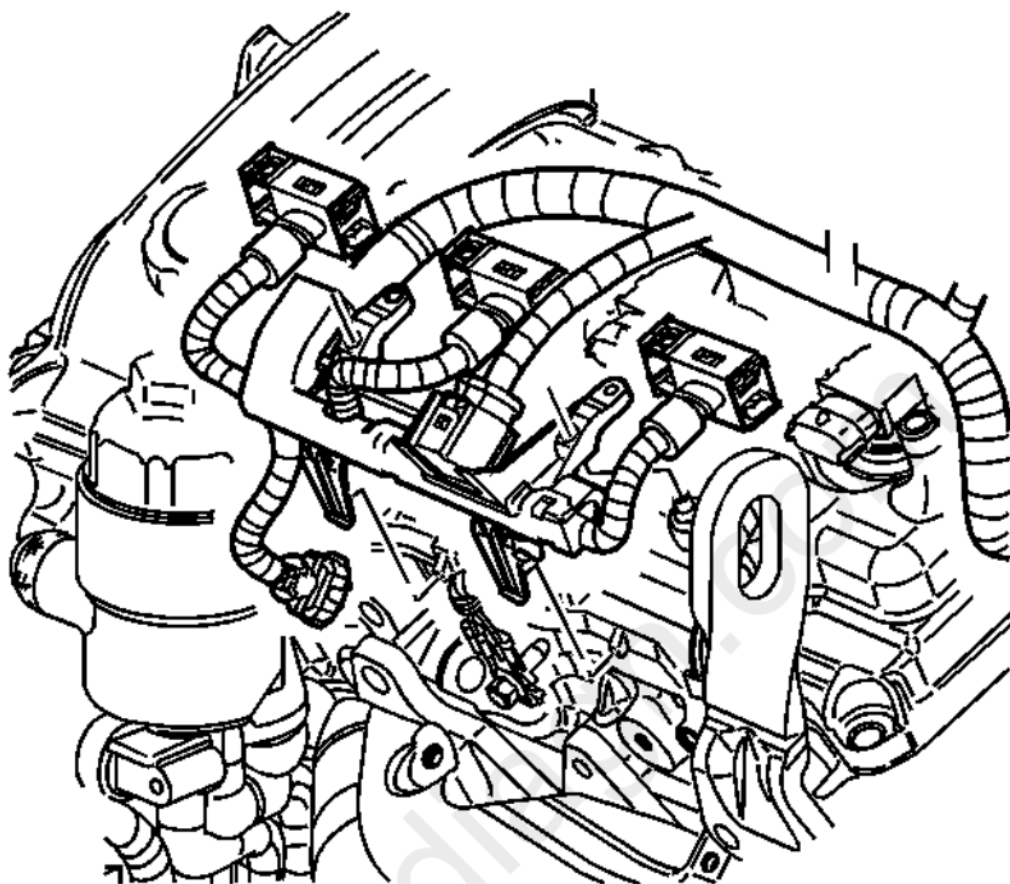


Fig. 145: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

6. Install the wiring harness to the side of the camshaft cover.

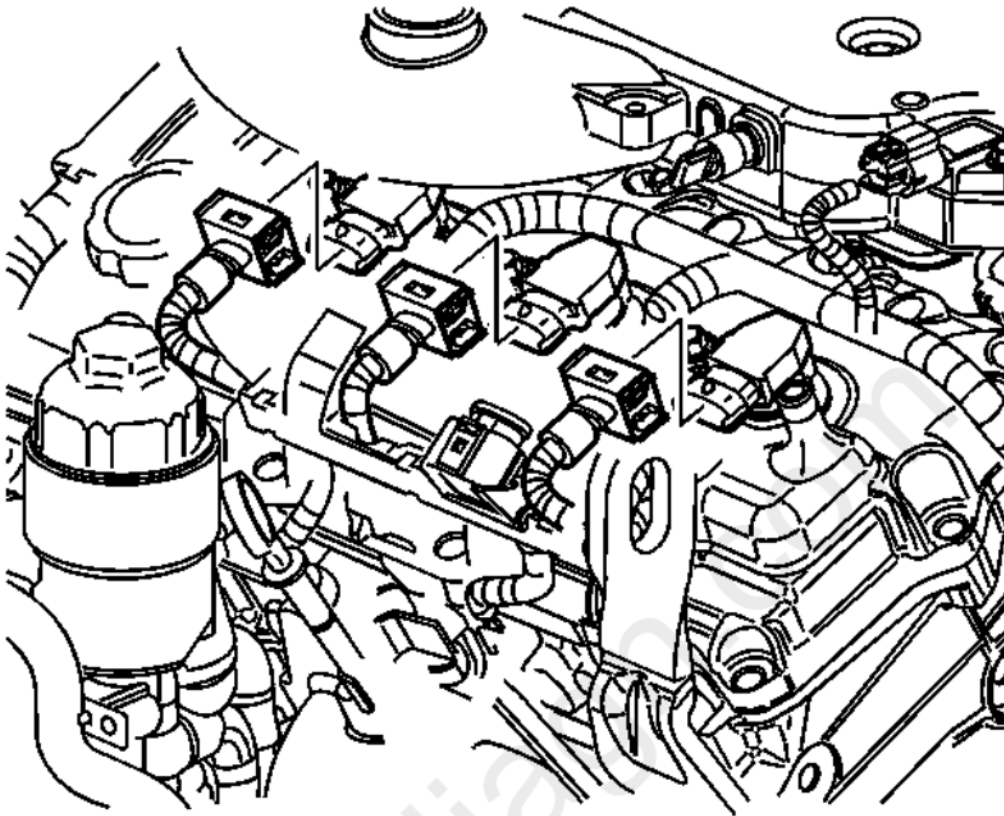


Fig. 146: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the ignition coil electrical connectors.
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)**.
9. Install the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE (LLT)

REMOVAL PROCEDURE

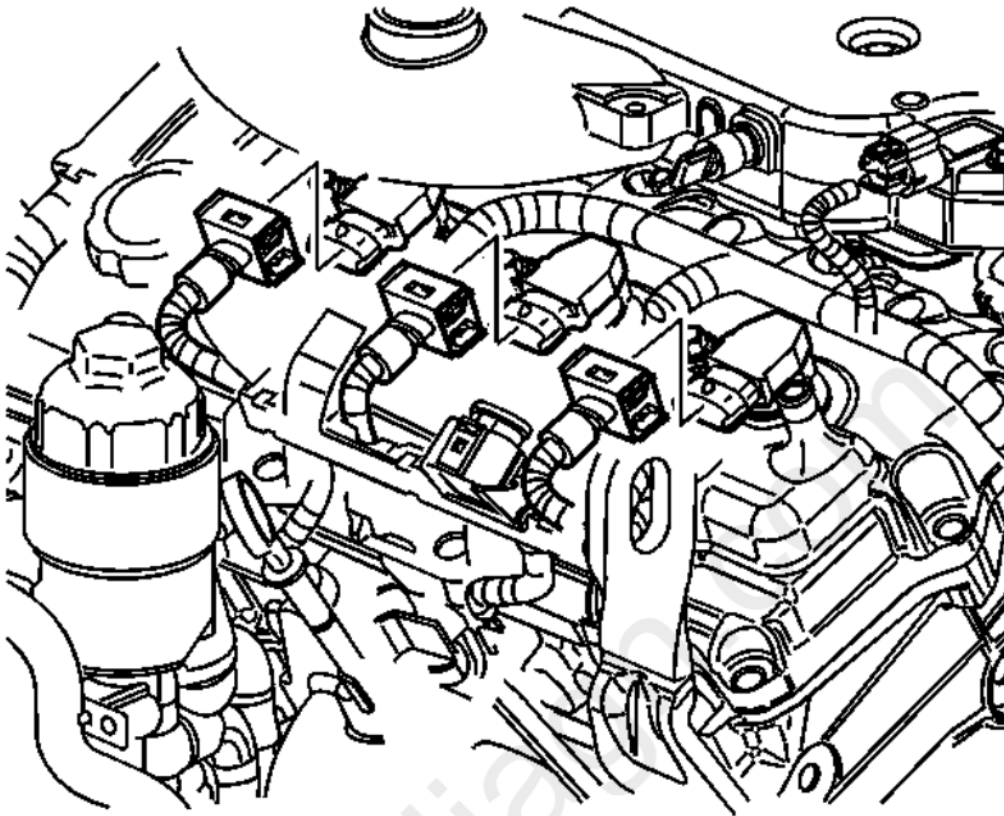


Fig. 147: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
3. Remove the crankcase ventilation pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LP1, LY7)** or **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LLT)**.
4. Disconnect the ignition coil electrical connectors.

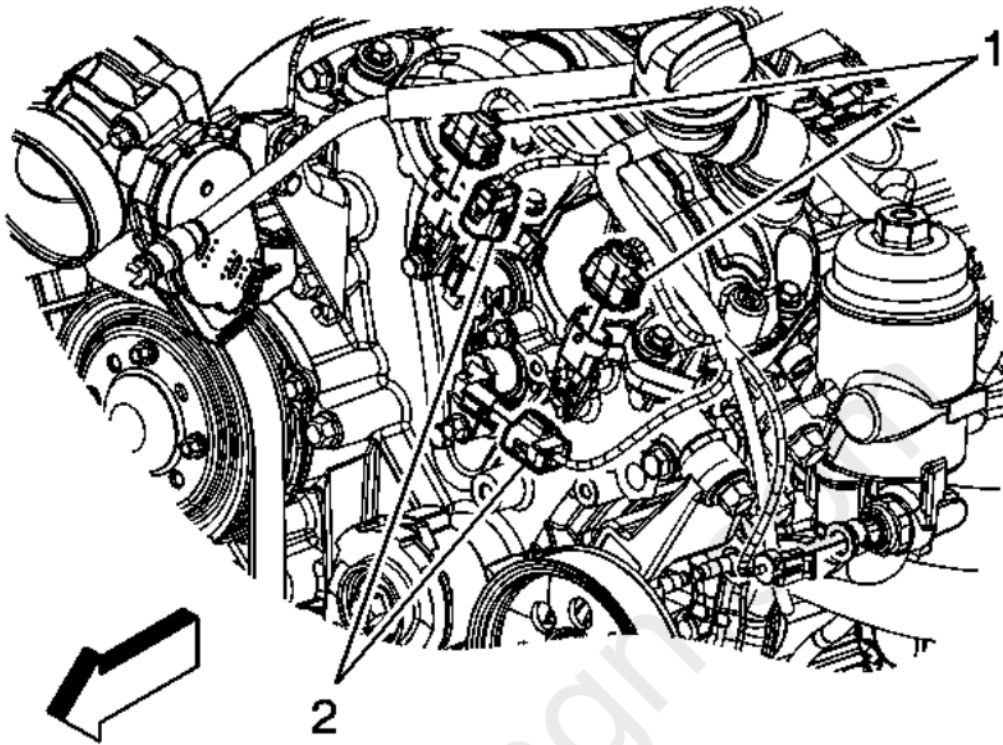


Fig. 148: Identifying Camshaft Actuator Valves, Position Sensor & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
6. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

NOTE: It is not necessary to disconnect the engine front cover electrical connectors.

7. Disconnect the camshaft position sensors (1) and camshaft actuator valve (2) electrical connectors.
8. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

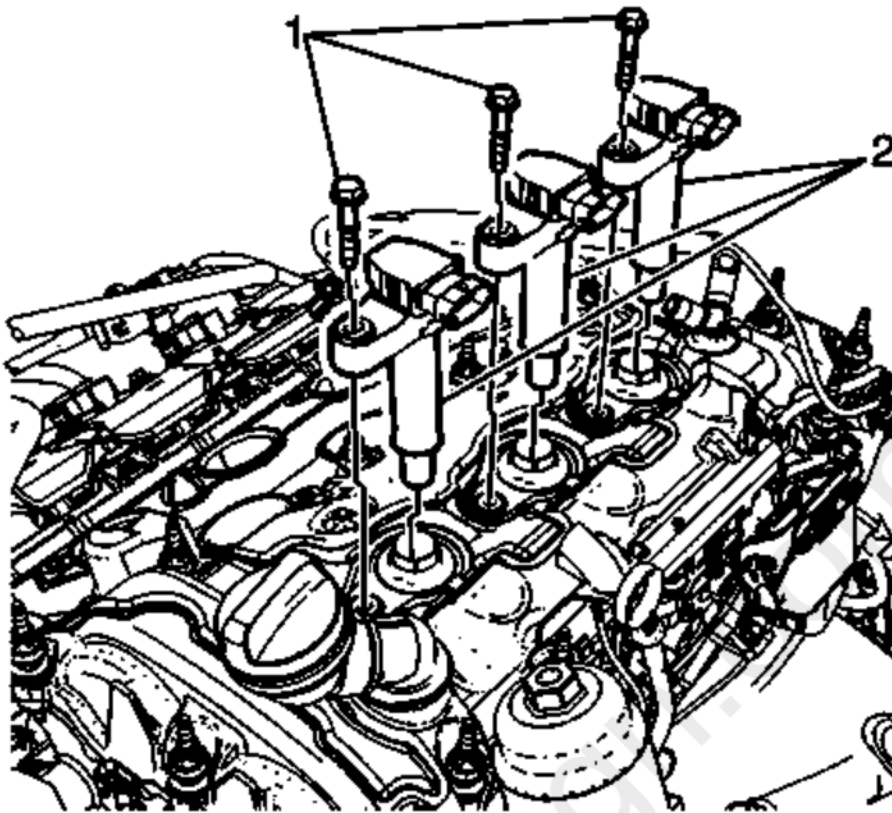


Fig. 149: Identifying Ignition Coils & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the ignition coil bolts (1).
10. Remove the ignition coils (2).

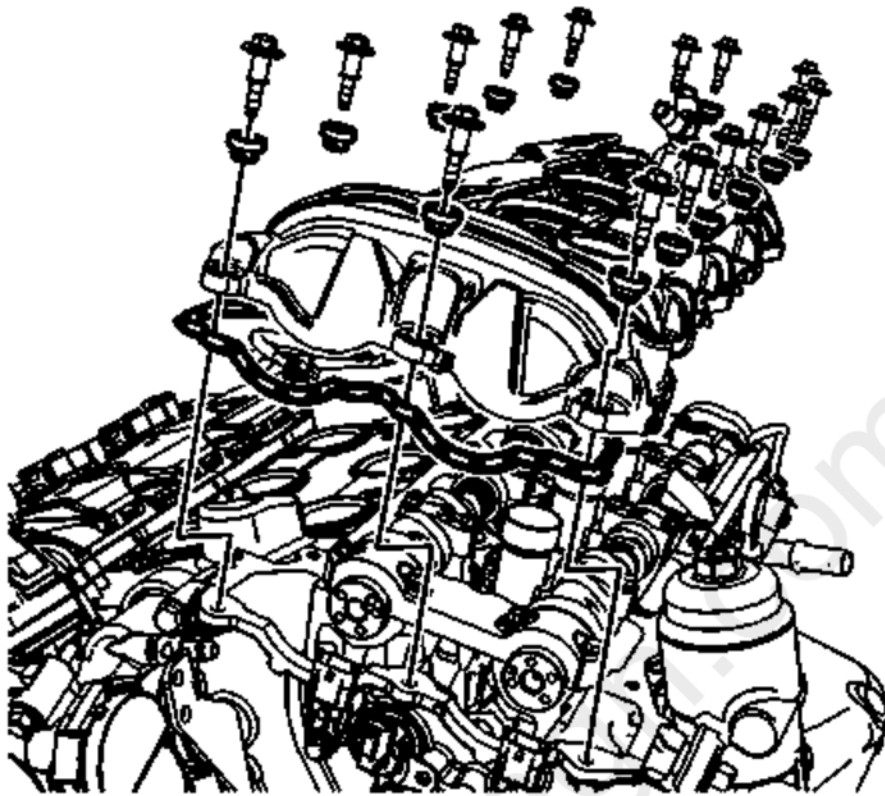


Fig. 150: Identifying Camshaft Cover Seal & Grommets
Courtesy of GENERAL MOTORS CORP.

11. Remove the camshaft cover.
12. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

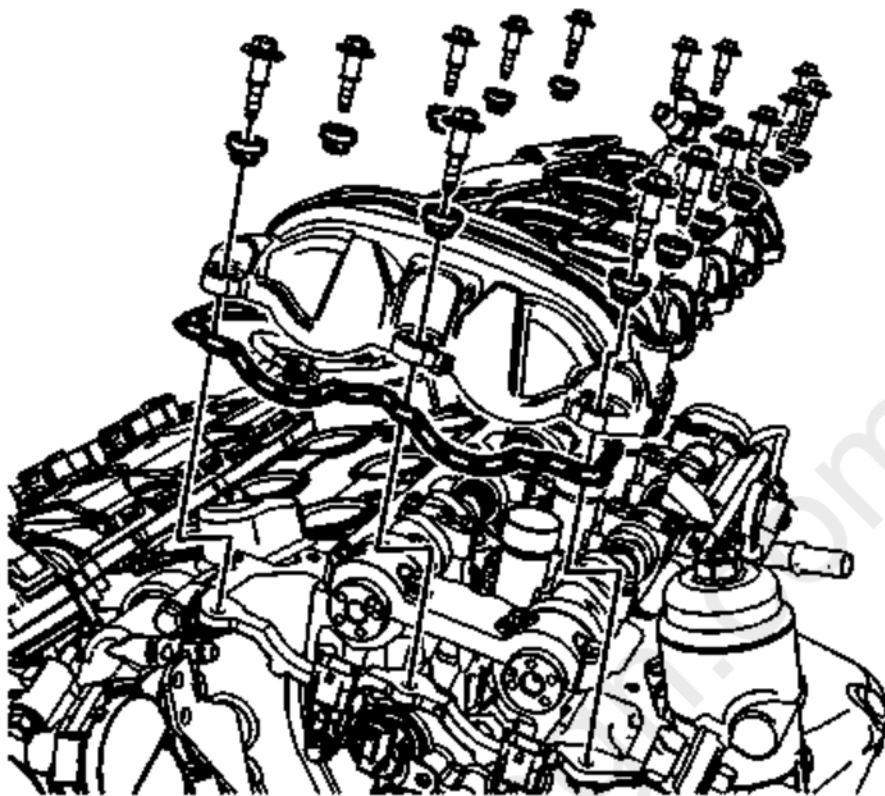


Fig. 151: Identifying Camshaft Cover Seal & Grommets
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW camshaft cover seal and NEW grommets.
2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Left Side** .

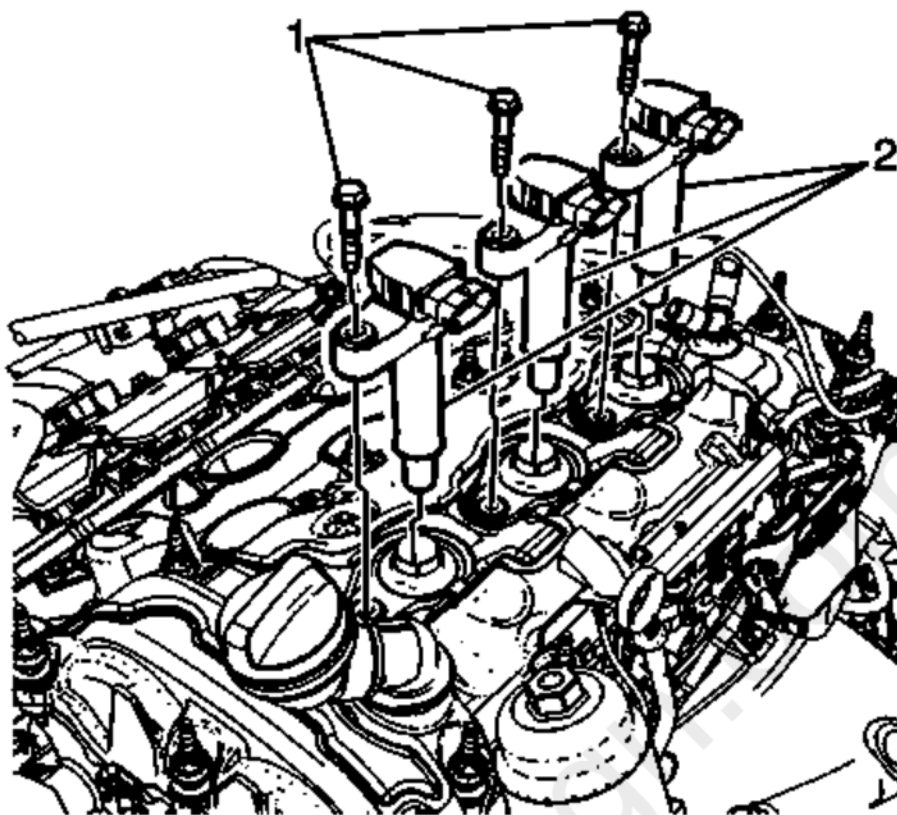


Fig. 152: Identifying Ignition Coils & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils (2).

CAUTION: Refer to FASTENER CAUTION .

4. Install the ignition coil bolts (1) and tighten to 10 N.m (89 lb in).

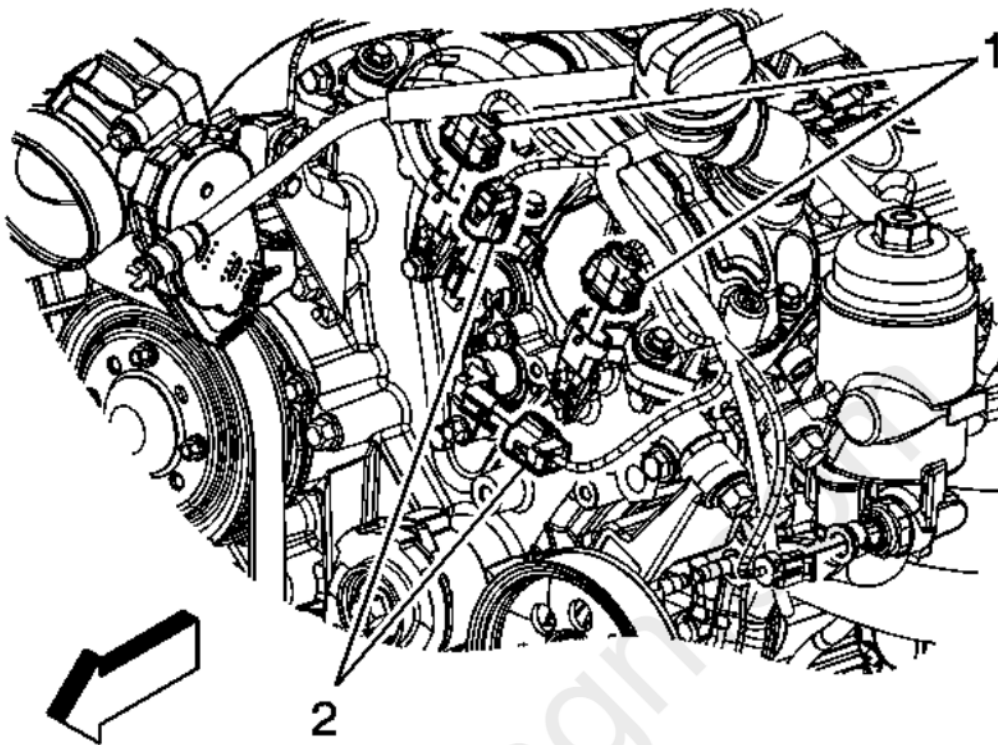


Fig. 153: Identifying Camshaft Actuator Valves, Position Sensor & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Connect the camshaft actuator valves (2) and the camshaft position sensor (1) electrical connectors.
6. Install the wiring harness conduit retainers to the wiring harness conduit.

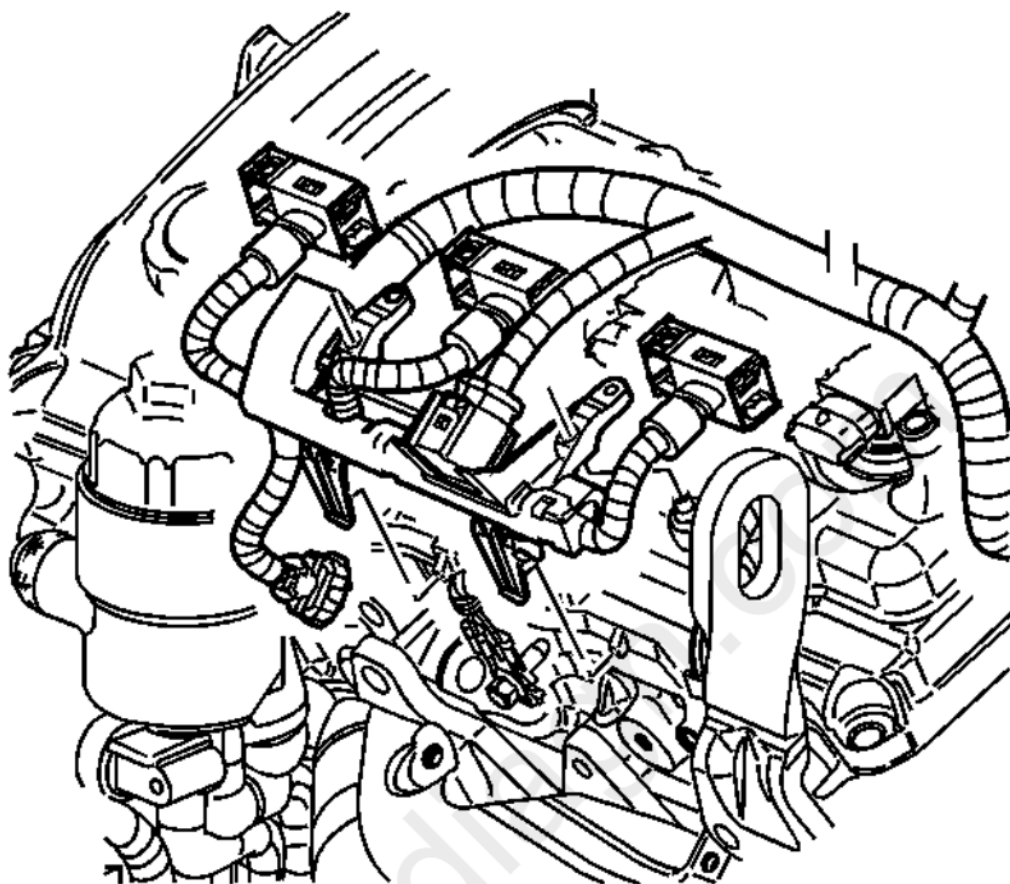


Fig. 154: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

7. Install the wiring harness to the side of the camshaft cover.

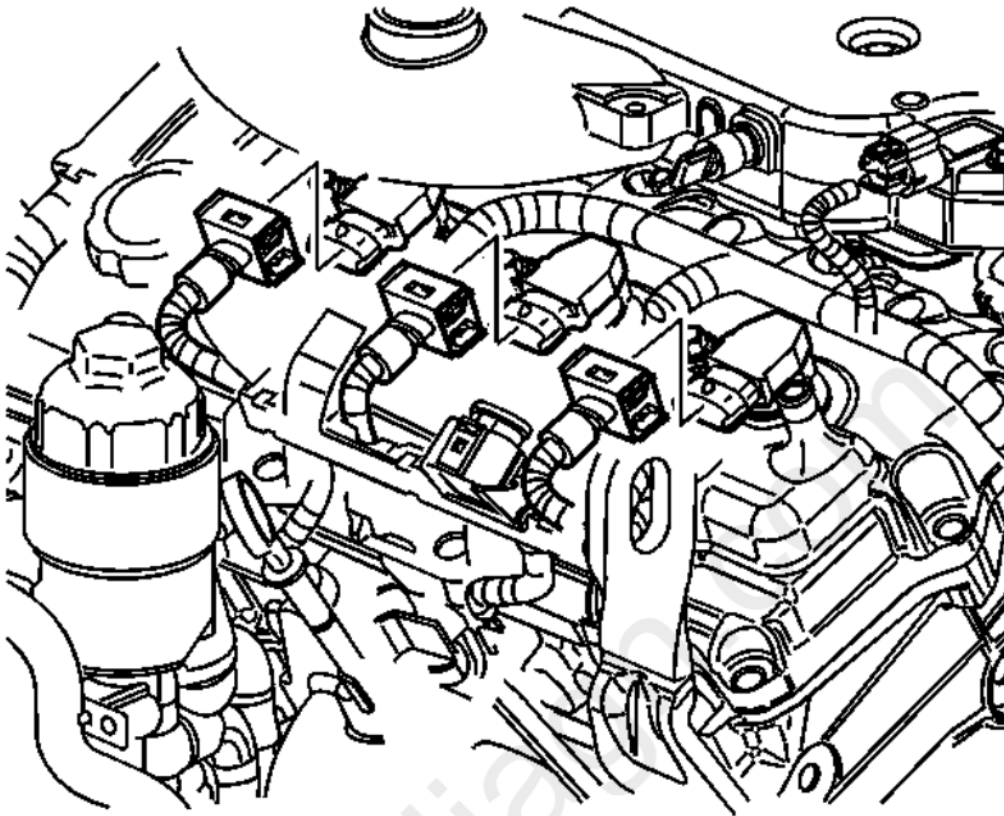


Fig. 155: View Of Left Ignition Coils Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

8. Connect the ignition coil electrical connectors.
9. Install the crankcase ventilation pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LP1, LY7)** or **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LLT)**.
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)** or **Fuel Pipe Shield Replacement (LLT)**.
11. Install the intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold**

Replacement (LP1, LY7).

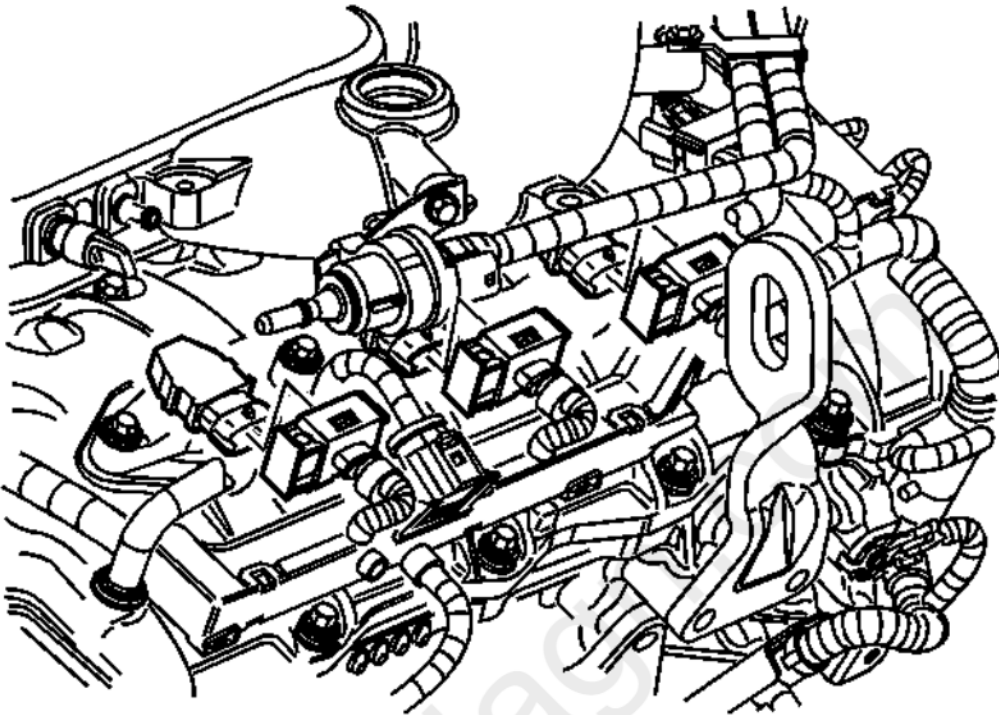


Fig. 156: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the ignition coil electrical connectors.

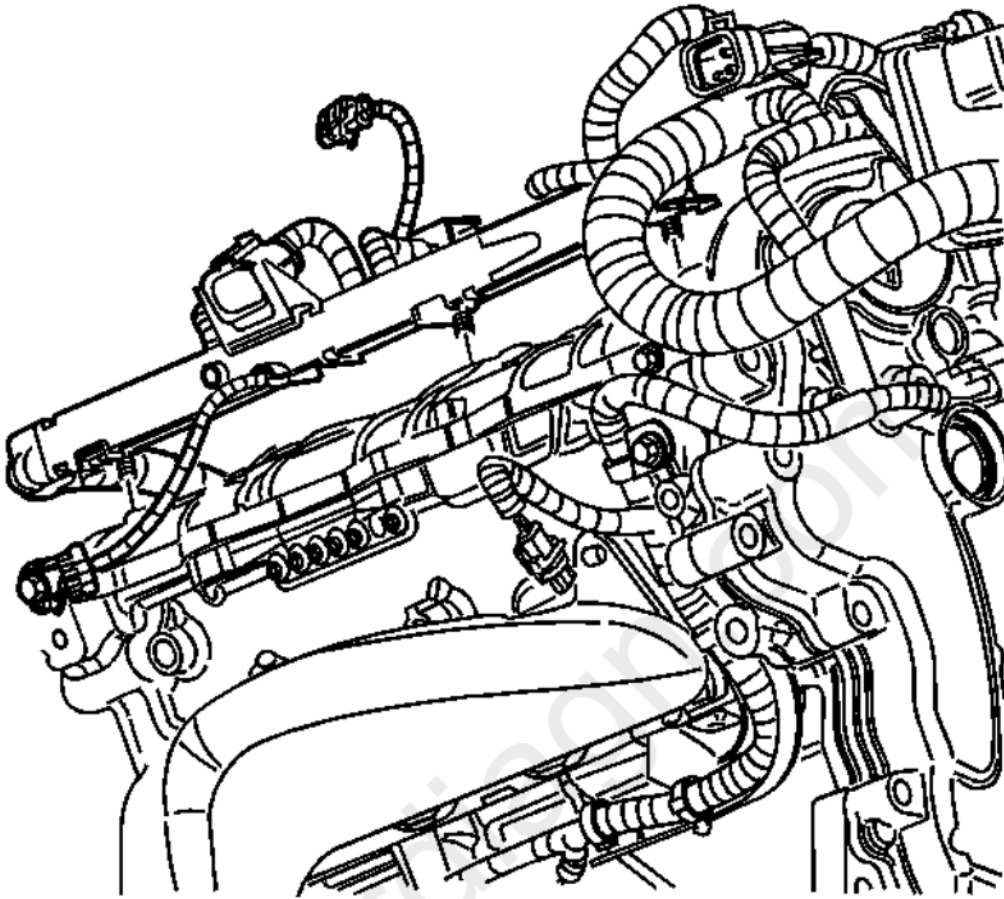


Fig. 157: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
5. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

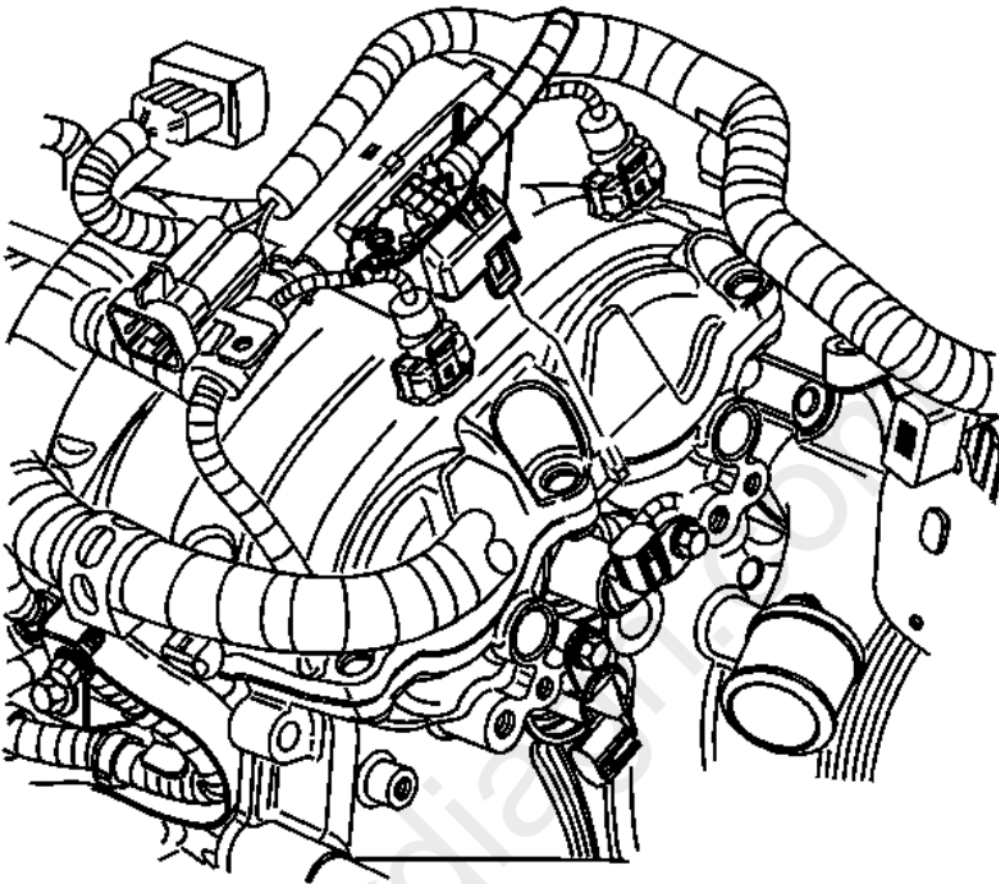


Fig. 158: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: It is not necessary to disconnect the engine front cover electrical connectors.

6. Remove the wiring harness from the front of the camshaft cover.
7. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

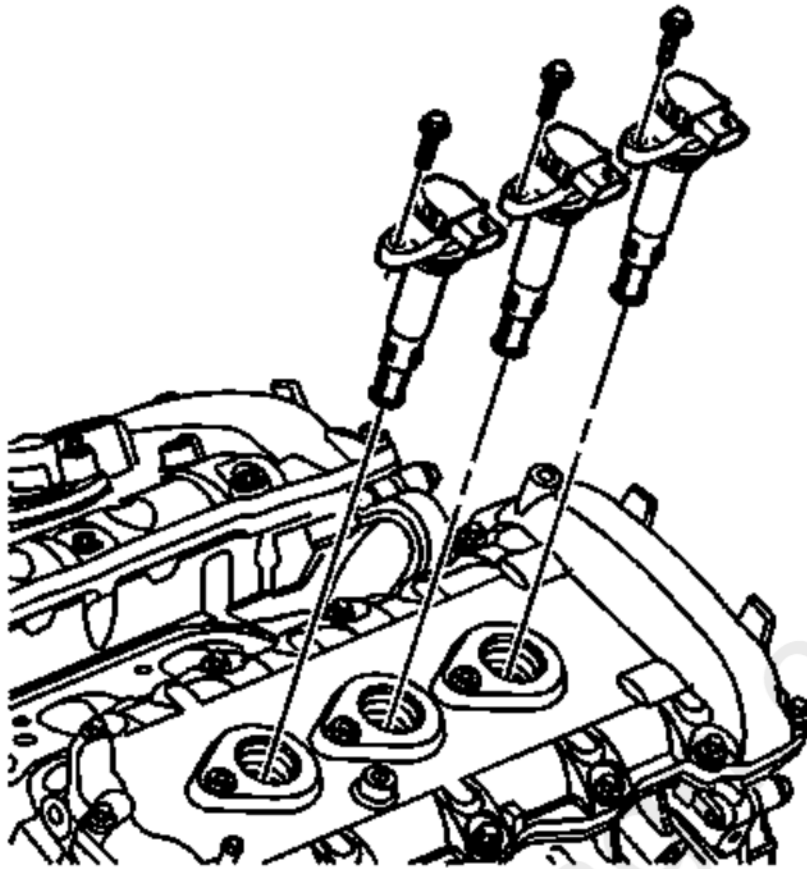


Fig. 159: Ignition Coil View

Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coils.

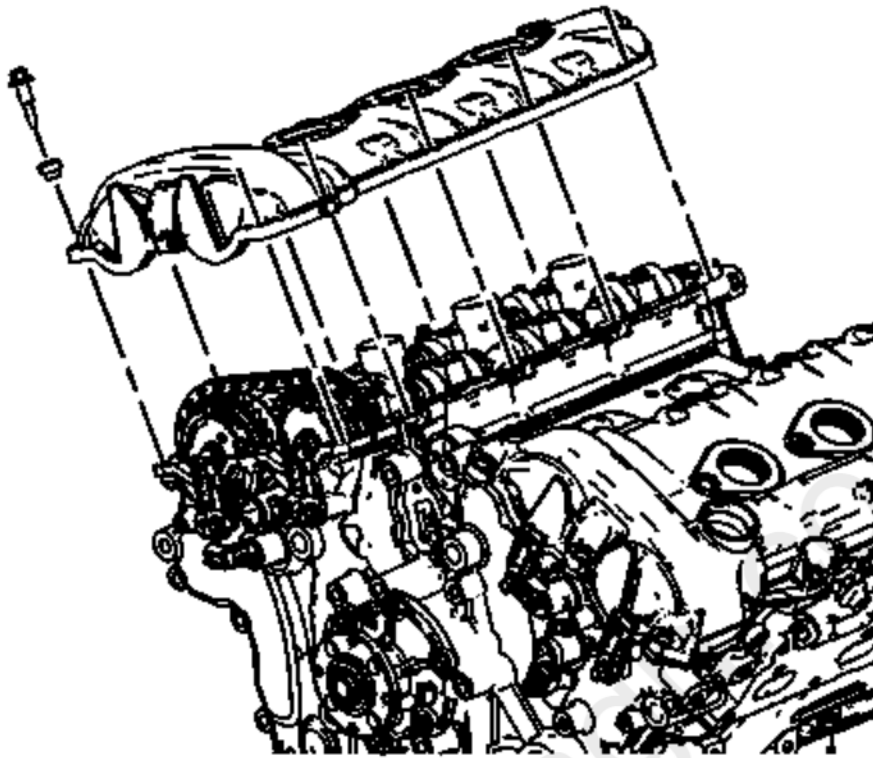


Fig. 160: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft cover.
10. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

1. Install a NEW camshaft cover seal and NEW grommets.

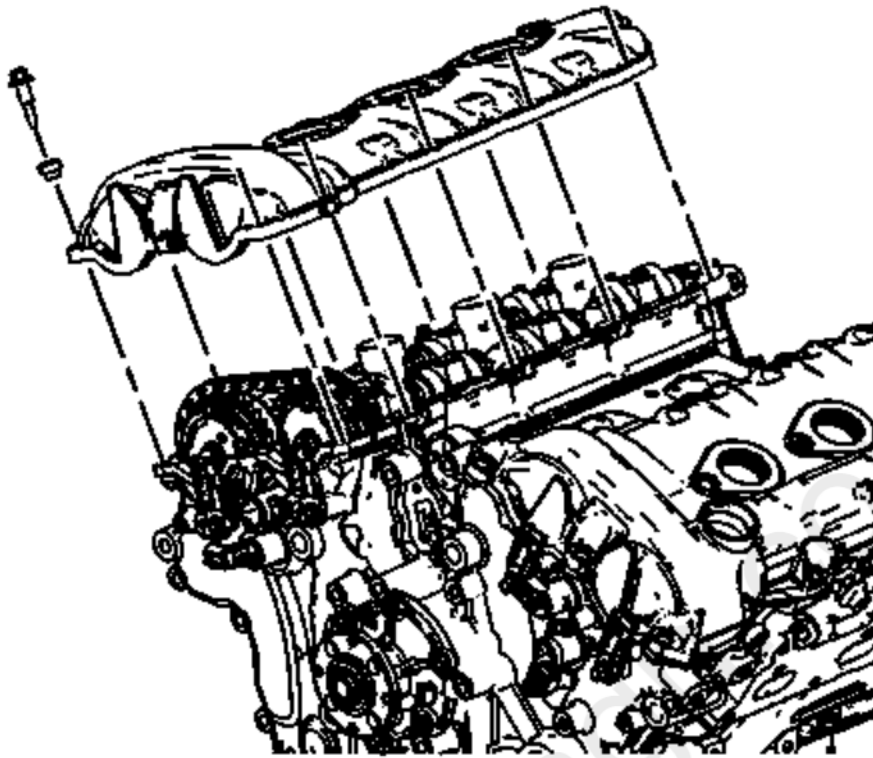


Fig. 161: View Of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Right Side** .

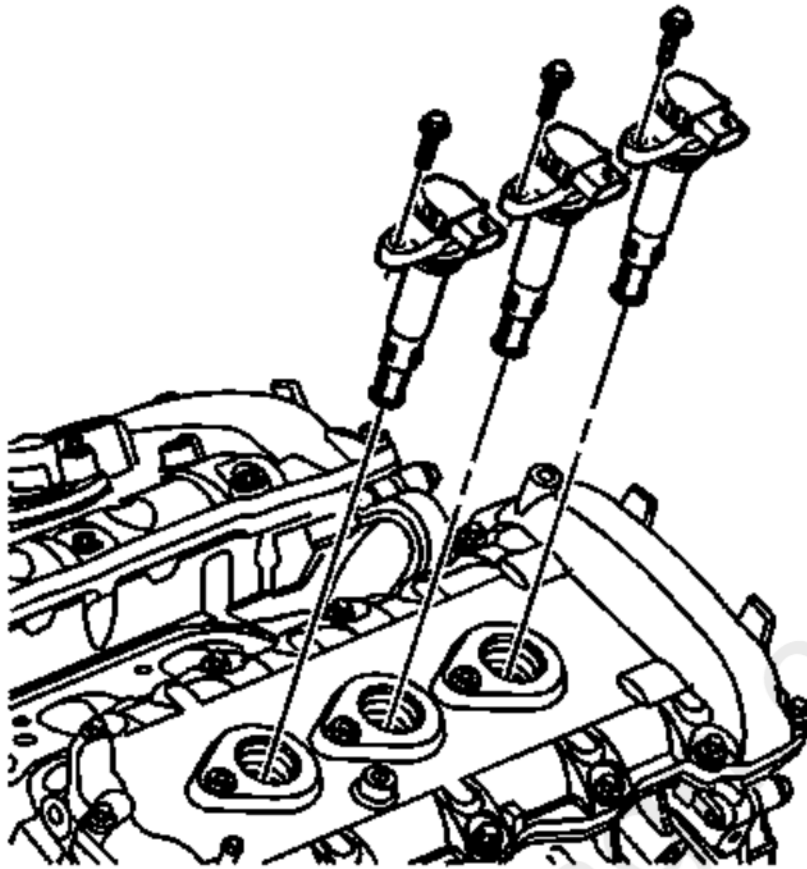


Fig. 162: Ignition Coil View

Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils.

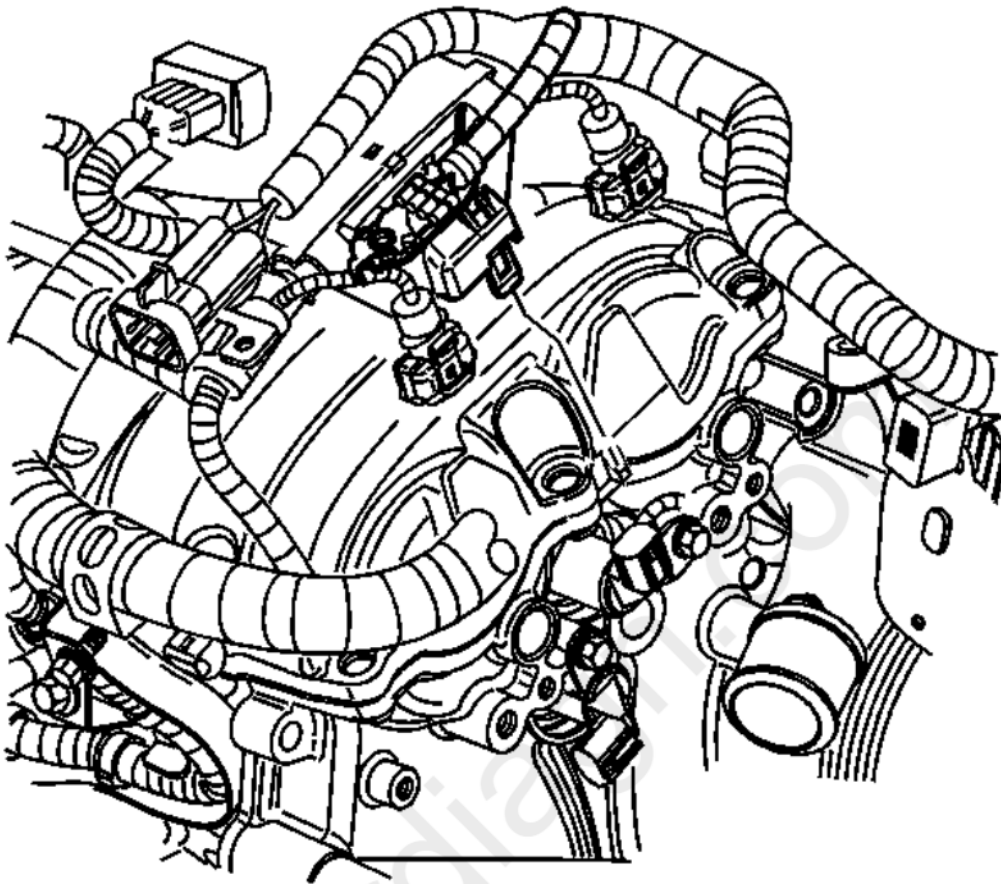


Fig. 163: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness to the front of the camshaft cover.
5. Install the wiring harness conduit retainers to the wiring harness conduit.

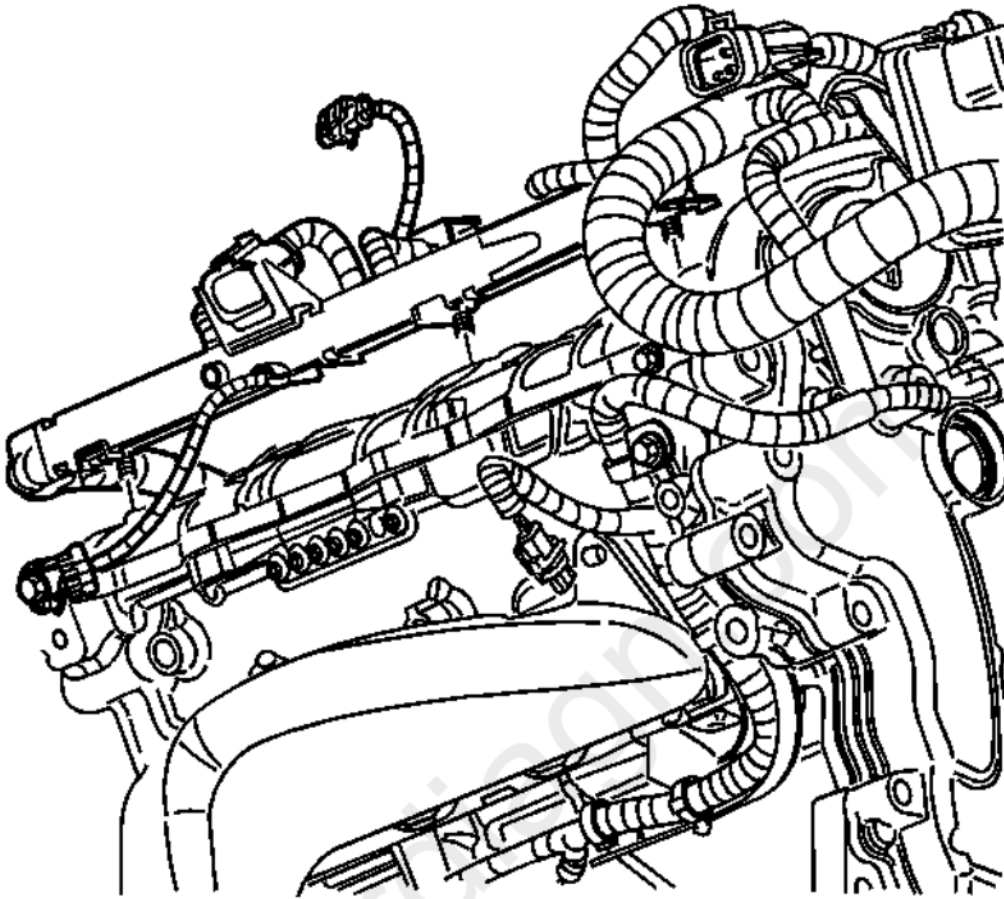


Fig. 164: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

6. Install the wiring harness to the side of the camshaft cover.

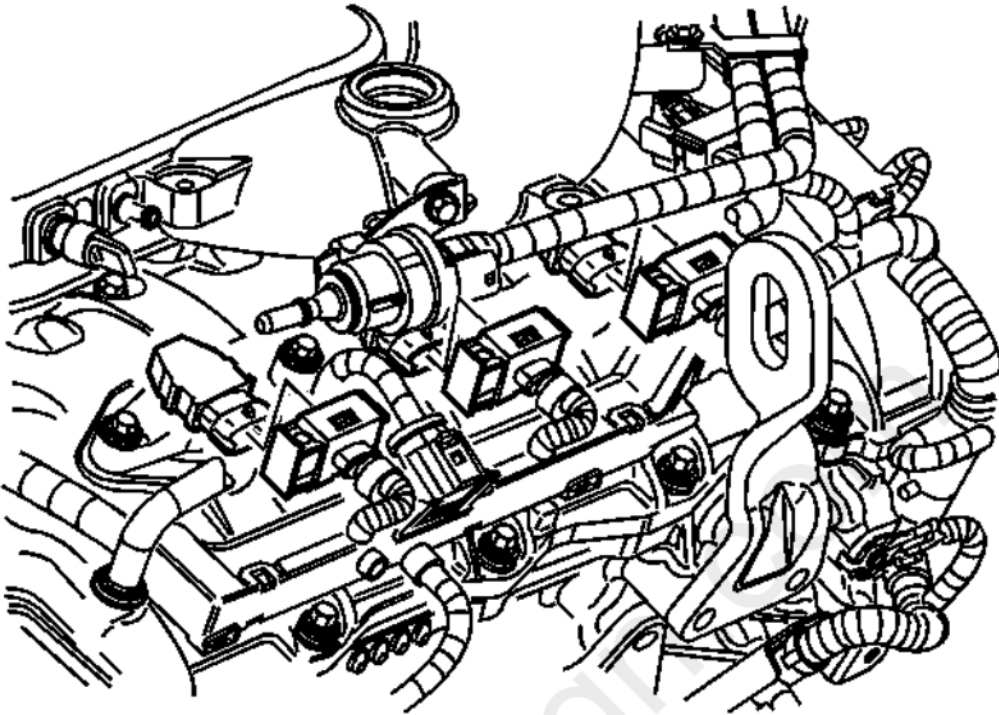


Fig. 165: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the ignition coil electrical connectors.
8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)**.
9. Install the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.

ENGINE FRONT COVER REPLACEMENT

SPECIAL TOOLS

EN 46109 Engine Front Cover Installation Guide Pins. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)**.
2. On models equipped with LP1 and LY7 engines, remove the upper intake manifold with the lower intake

manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)**.

3. On models equipped with LLT engines, remove the intake manifold. Refer to **Intake Manifold Replacement**.
4. On all models remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7)** or **Camshaft Cover Replacement - Left Side (LLT)** and **Camshaft Cover Replacement - Right Side**.
5. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Static Fill LF1, LLT)** or **Cooling System Draining and Filling (GE 47716 LF1, LLT)**.
6. Disconnect the purge vent hose from the water outlet.
7. Remove the water outlet with the radiator hose and reposition aside. Refer to **Water Outlet Replacement (LF1/LLT)**.
8. Remove the accessory drive belts. Refer to **Water Pump and Generator Belt Replacement** and **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.
9. Remove the A/C compressor and power steering belt tensioner. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Tensioner Replacement**.
10. Remove the generator bracket with the generator and the belt tensioner.

IMPORTANT: Do not disconnect the power steering pipes or drain the power steering fluid.

11. Remove the power steering fluid reservoir and reposition the power steering fluid reservoir in order to provide access.
12. Remove the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (V6)**.

IMPORTANT: Do not disconnect the power steering pipes/hoses.

13. Remove the power steering pump upper front bolt and loosen the remaining two bolts. Refer to **Power Steering Pump Pulley Replacement (V6)**.
14. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
15. Remove the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**, **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**, **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**.
16. Remove the camshaft position actuator solenoid valves from the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**, **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**, **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**, and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**.

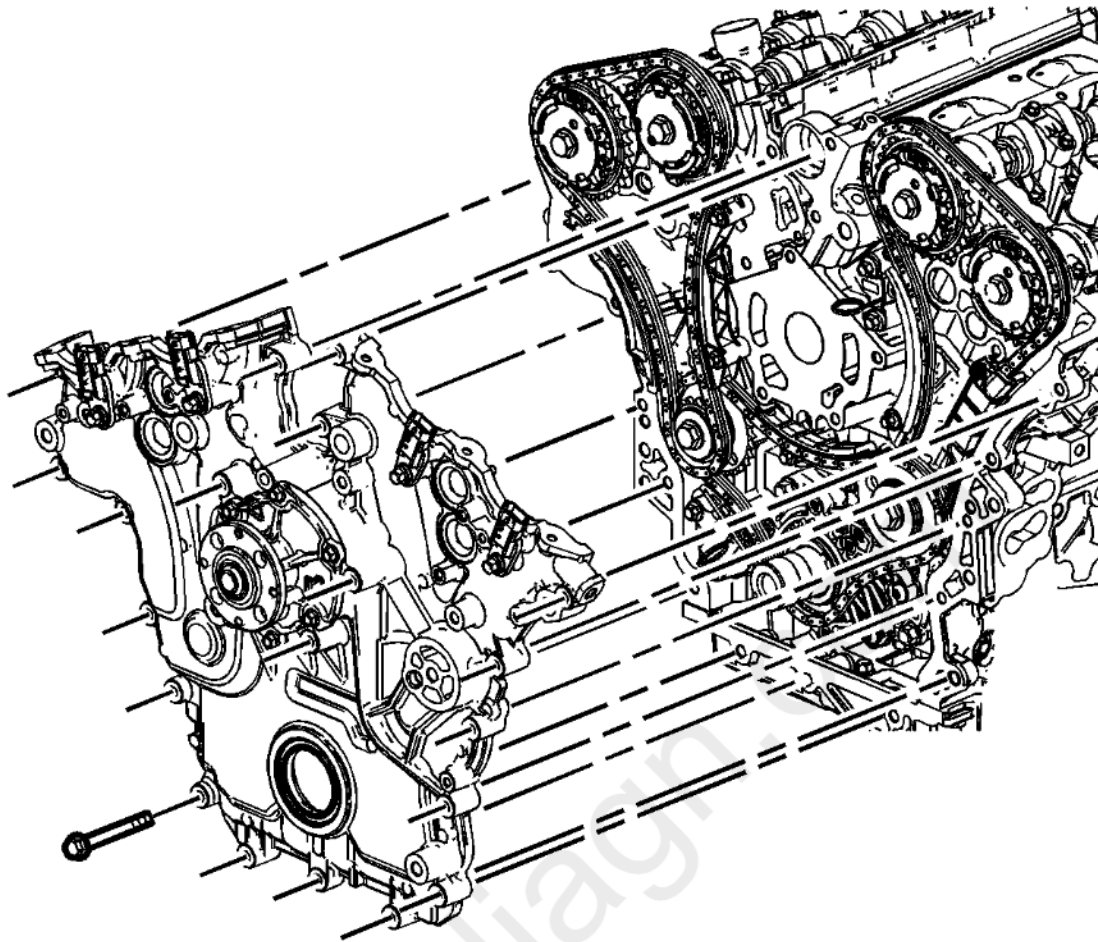


Fig. 166: Engine Front Cover

Courtesy of GENERAL MOTORS CORP.

17. Remove the engine front cover with the water pump. Refer to **Engine Front Cover Removal**.
18. Disassemble the engine front cover. Refer to **Engine Front Cover Disassemble**.

IMPORTANT: Do NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.

19. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection**.

IMPORTANT: Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

20. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and**

Inspection .

21. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

INSTALLATION PROCEDURE

1. Assemble the engine front cover. Refer to **Engine Front Cover Assemble** .

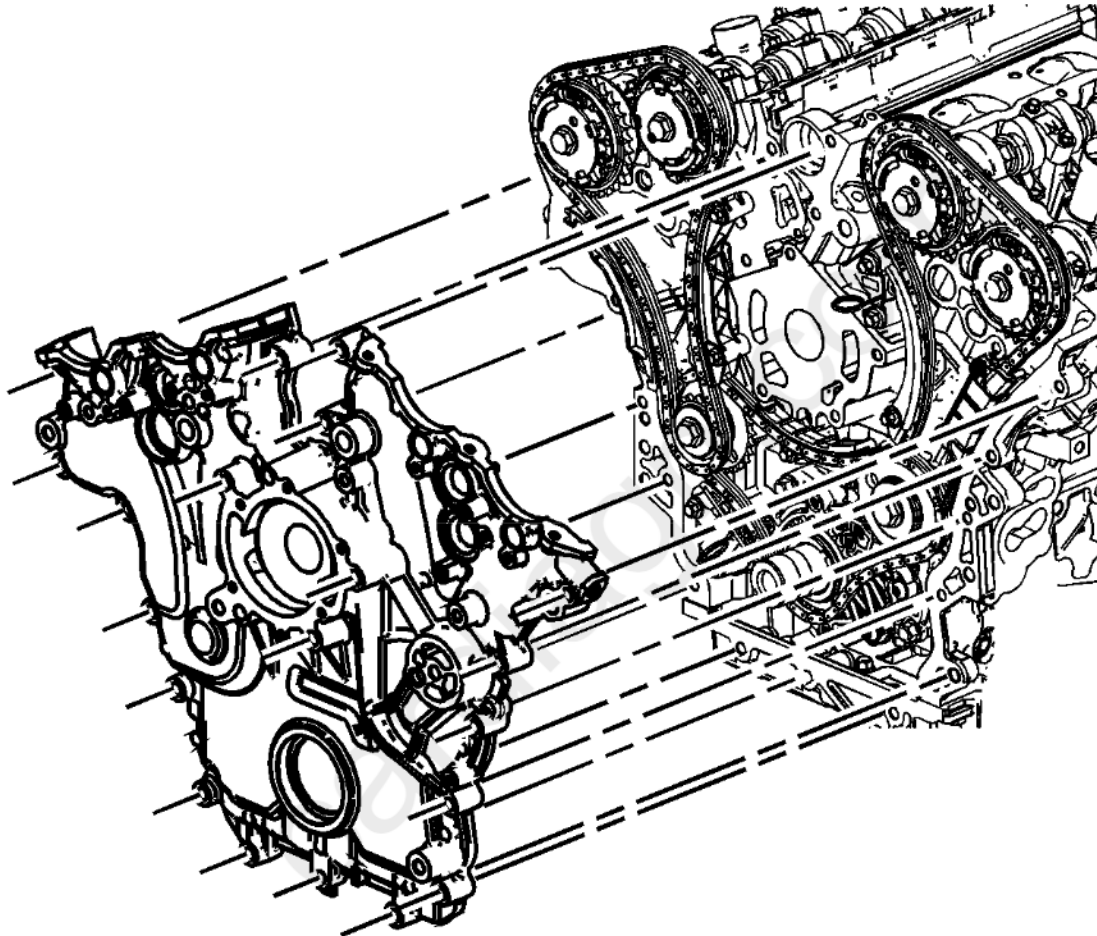


Fig. 167: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Use the EN 46109 in order to install the engine front cover. Refer to **Engine Front Cover Installation** . See **Special Tools** .
3. Install the camshaft position actuator solenoid valves to the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position**

Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .

4. Install the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
5. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
6. Install the power steering pump. Refer to **Power Steering Pump Pulley Replacement (V6)** .
7. Install the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement (V6)** .
8. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
9. Install the generator bracket with the generator and the belt tensioner.
10. Install the A/C compressor and power steering belt tensioner. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Tensioner Replacement**.
11. Install the accessory drive belts. Refer to **Air Conditioning Compressor and Power Steering Pump Belt Replacement** and **Water Pump and Generator Belt Replacement**.
12. Install the water outlet. Refer to **Water Outlet Replacement (LF1/LLT)** .
13. Install the purge vent hose to the water outlet.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1, LLT) or Cooling System Draining and Filling (GE 47716 LF1, LLT)** .
15. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7) or Camshaft Cover Replacement - Left Side (LLT)** and **Camshaft Cover Replacement - Right Side**.
16. On models equipped with LLT engines, install the intake manifold. Refer to **Intake Manifold Replacement**.
17. On models equipped with LP1 and LY7 engines, install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)**.
18. On all models, install the engine cover. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT)**.
19. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1, LLT) or Cooling System Draining and Filling (GE 47716 LF1, LLT)** .

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE**REMOVAL PROCEDURE**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate**

Drive Chain Removal - Right Side .

6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .
10. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .
11. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side** .
12. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .
13. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

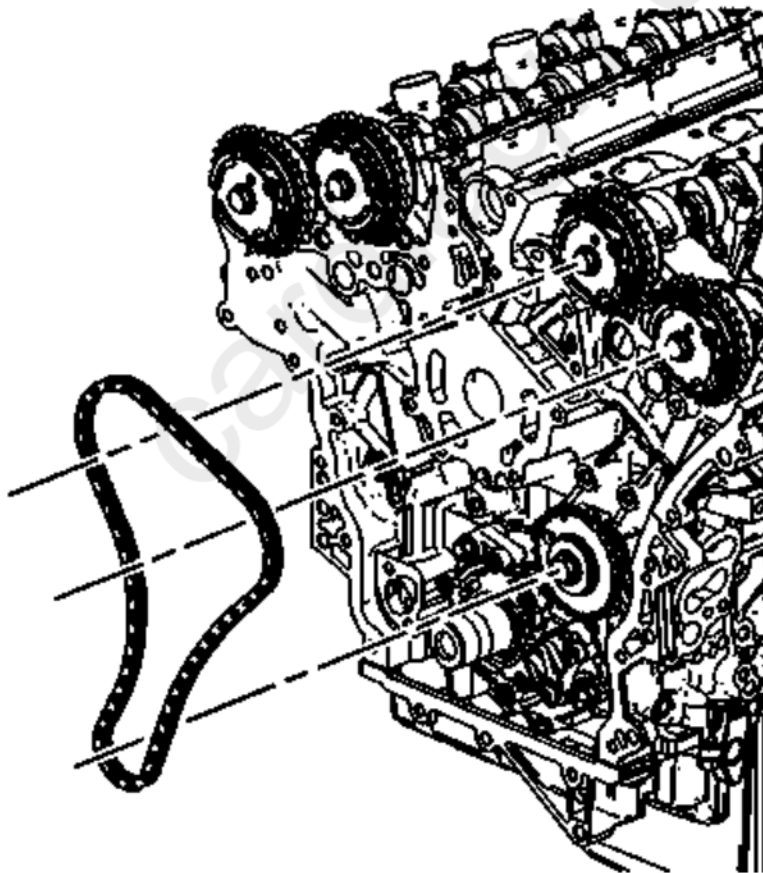


Fig. 168: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

14. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Left Side**.
15. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection**. Replace components as necessary.

INSTALLATION PROCEDURE

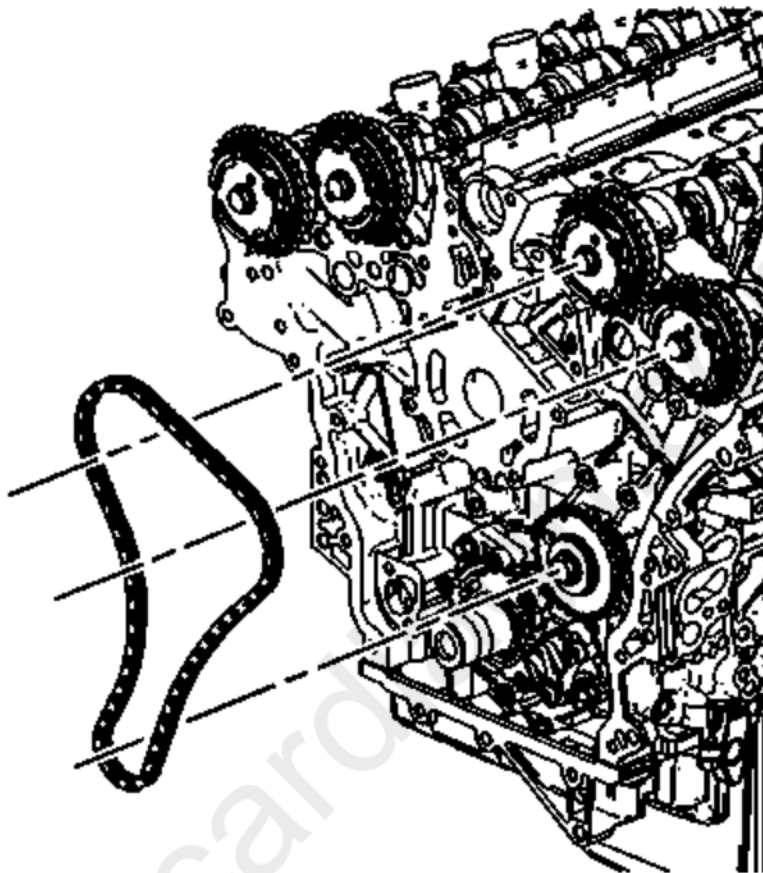


Fig. 169: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side (LLT)**.
2. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side**.
3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side**.
4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side**.
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side**.
6. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket**

Installation - Right Side .

7. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
8. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
9. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)** .
10. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
11. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
12. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
13. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
14. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE**REMOVAL PROCEDURE**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .

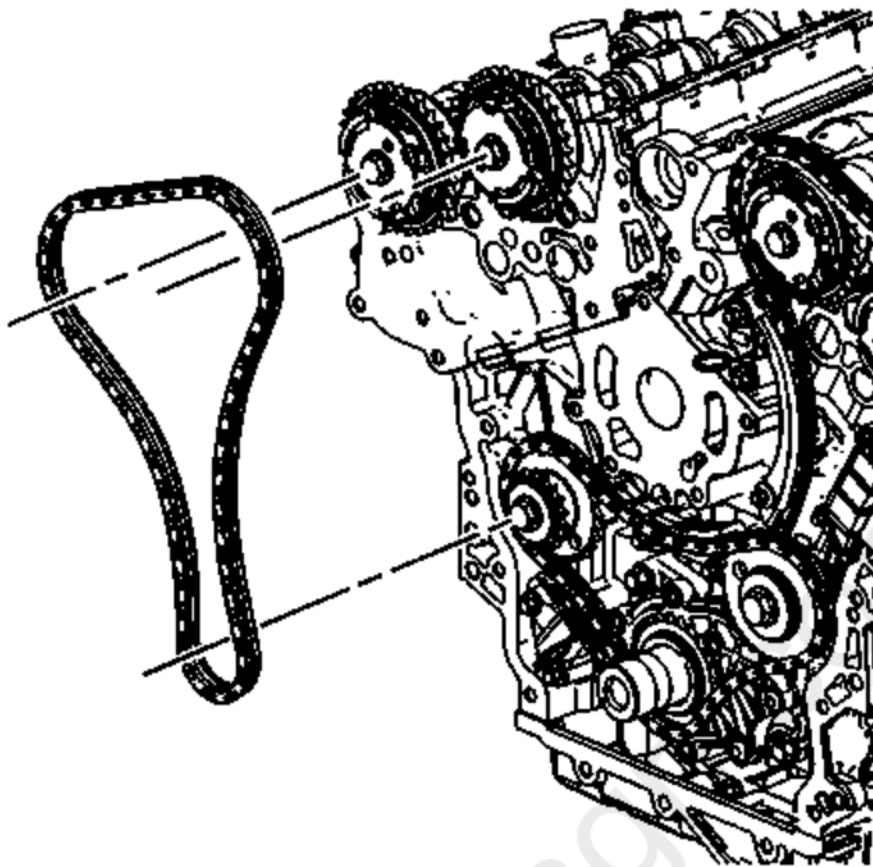


Fig. 170: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

INSTALLATION PROCEDURE

1. Ensure the stage 1 camshaft timing is correct. Refer to **Setting Camshaft Timing**.

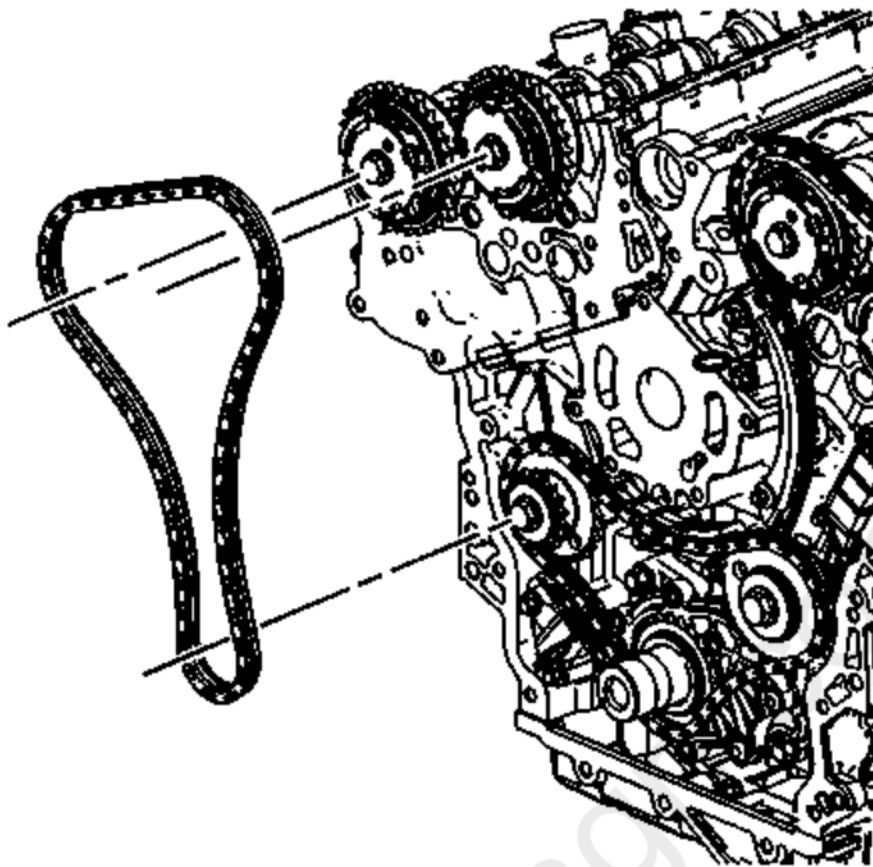


Fig. 171: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

2. Install the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Intermediate Drive Chain Installation - Right Side .
3. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Timing Chain Guide Installation - Right Side .
4. Install the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Installation - Right Side .
5. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Right Side .
6. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.

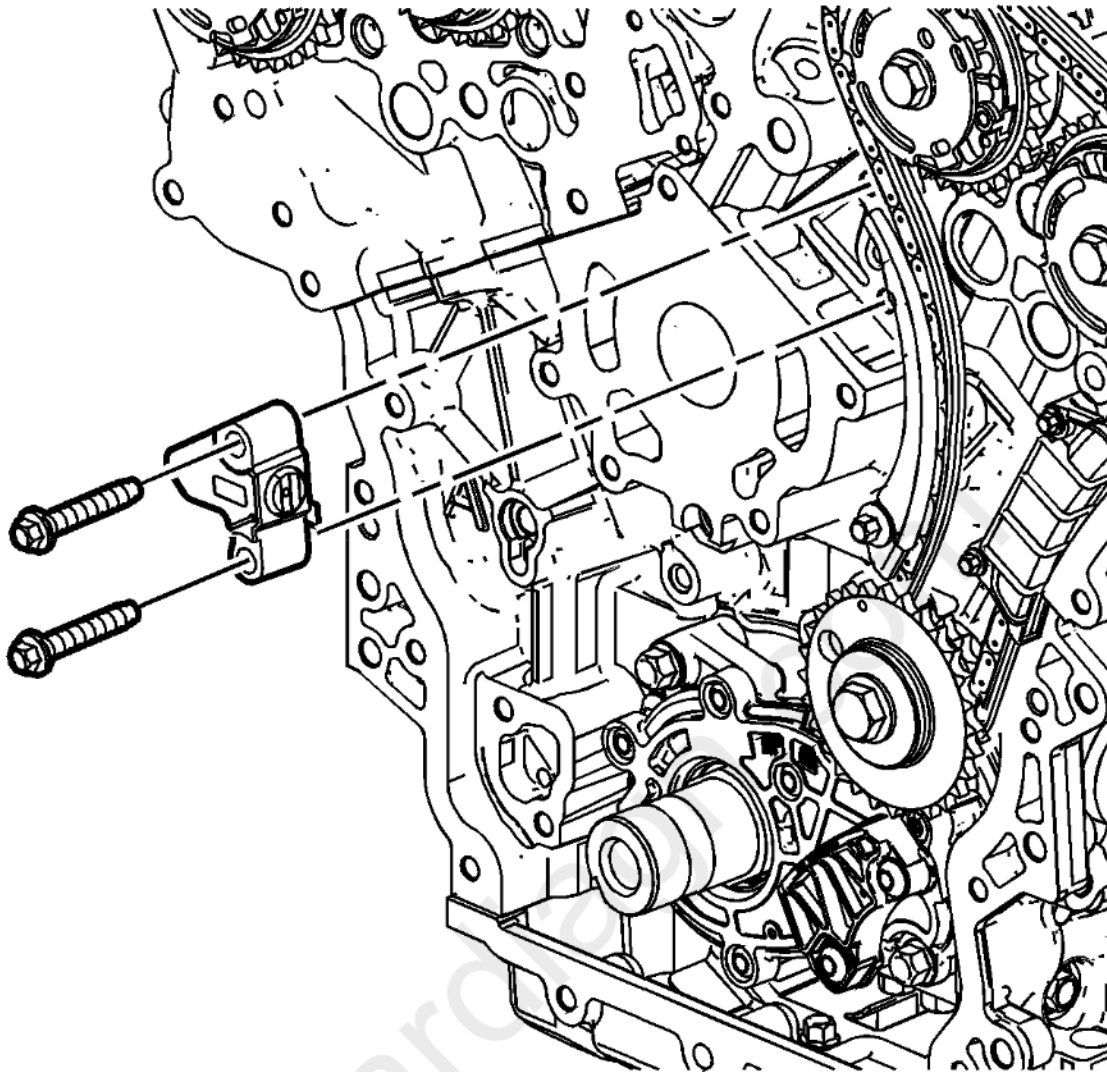


Fig. 172: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

INSTALLATION PROCEDURE

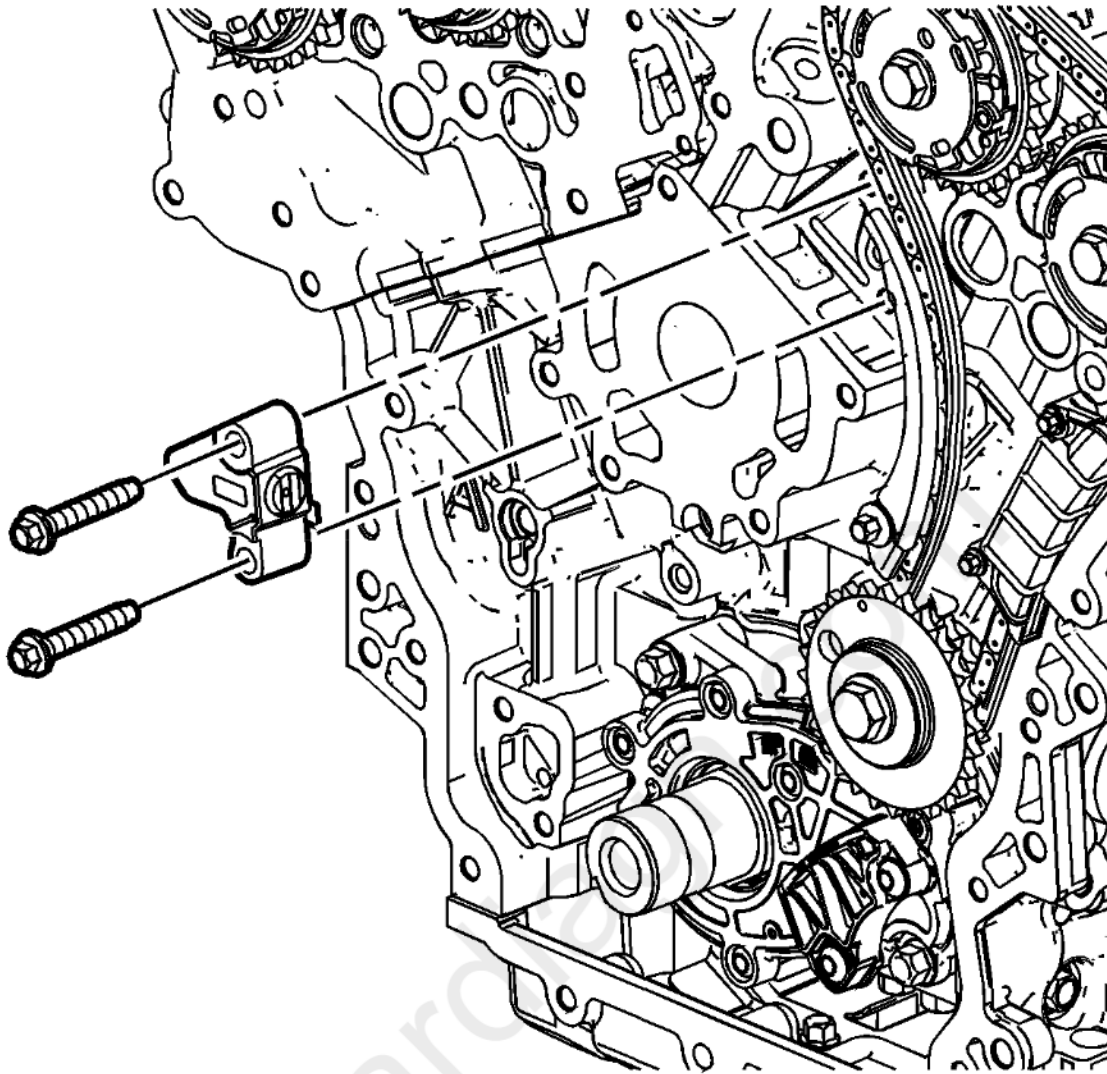


Fig. 173: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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

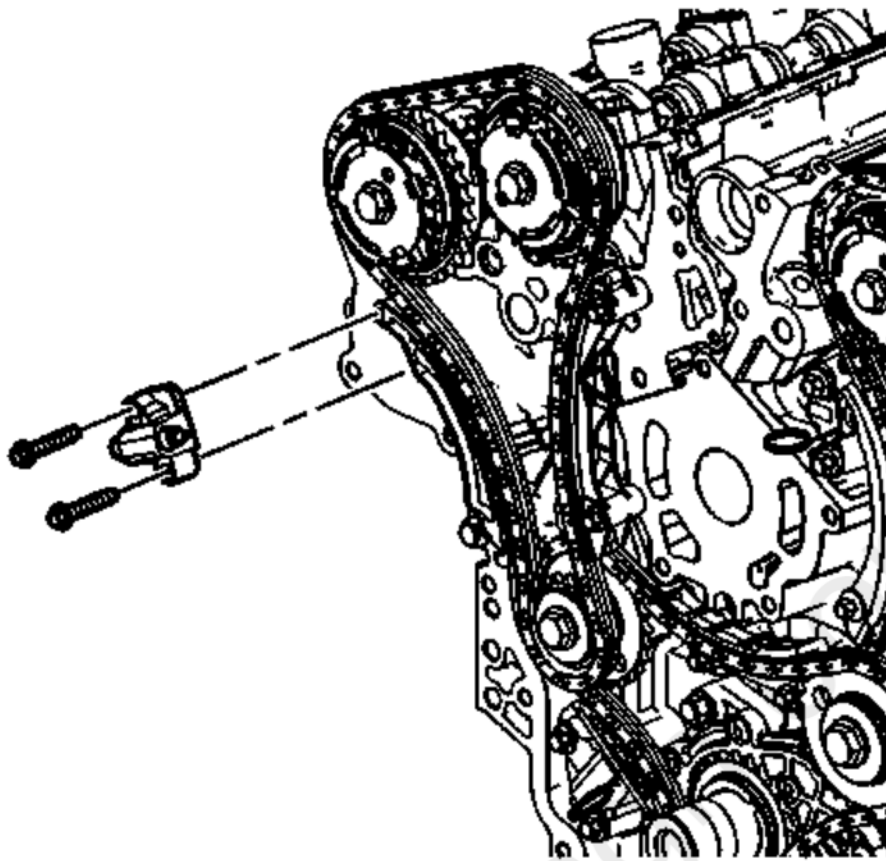


Fig. 174: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

INSTALLATION PROCEDURE

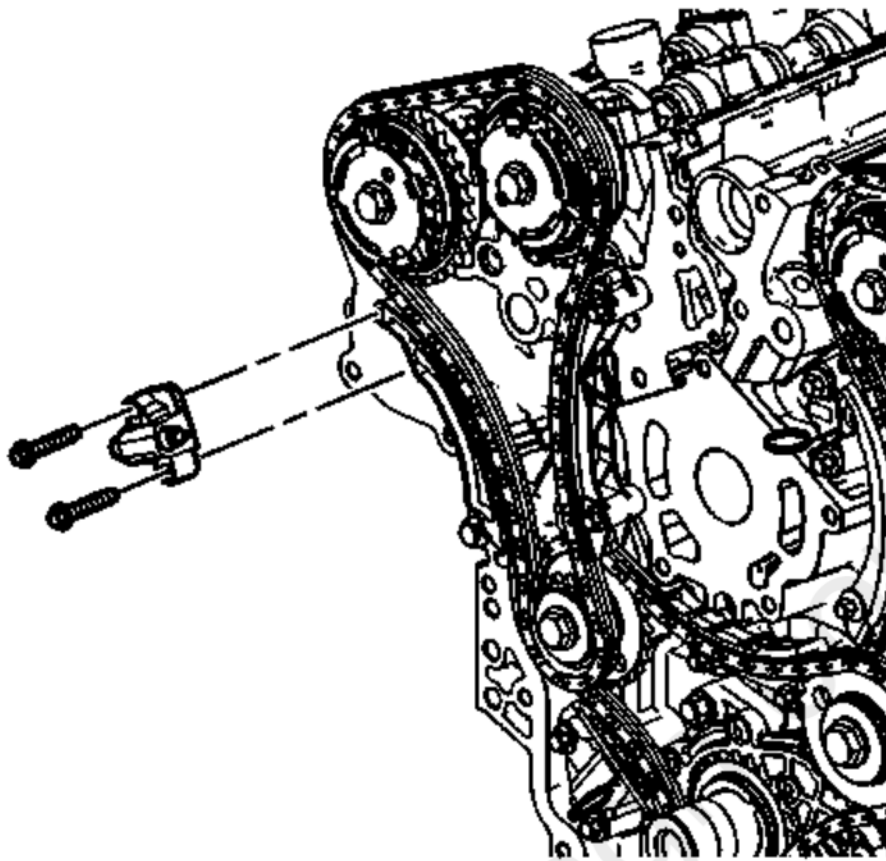


Fig. 175: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

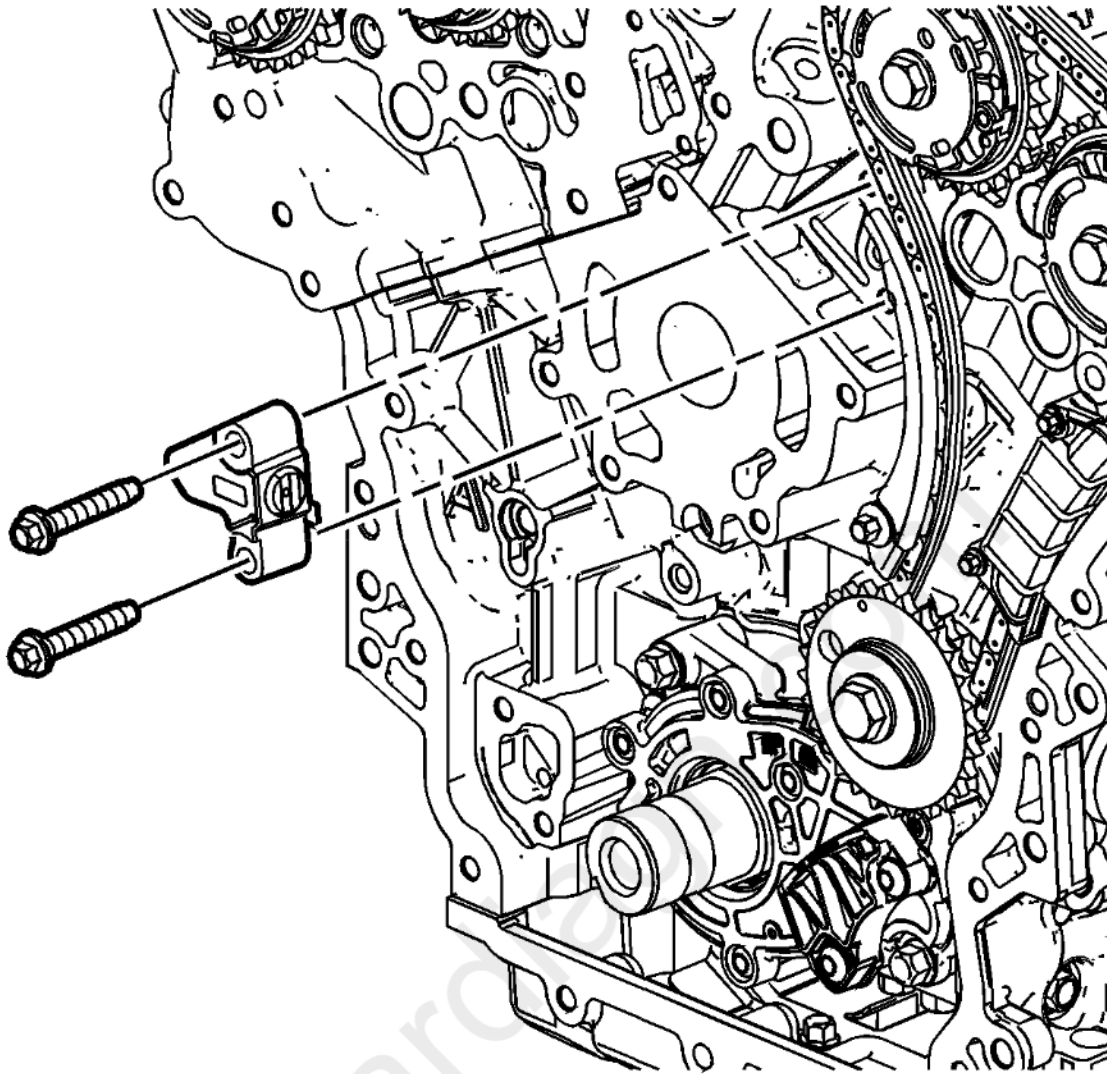


Fig. 176: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

INSTALLATION PROCEDURE

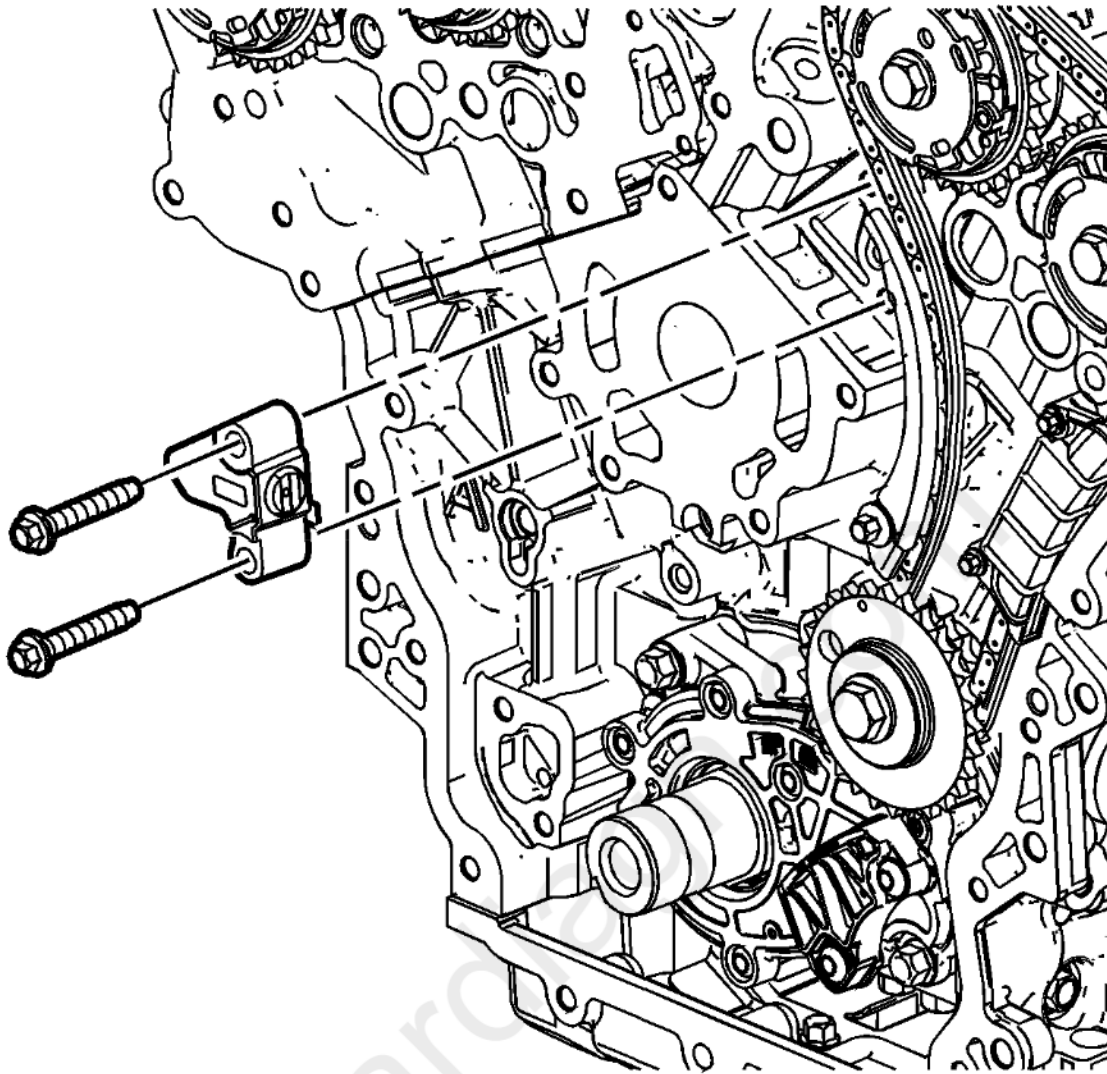


Fig. 177: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

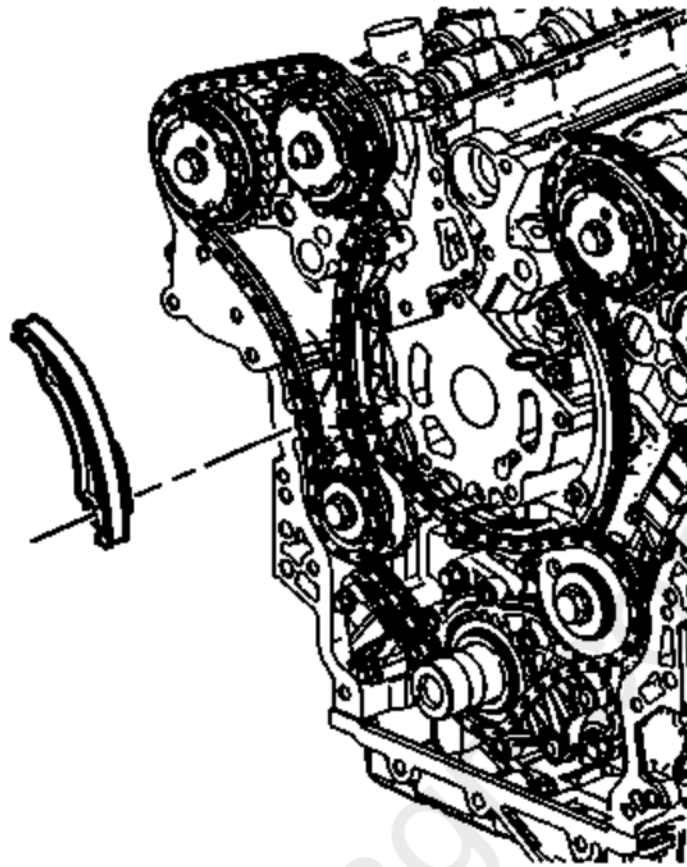


Fig. 178: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.

INSTALLATION PROCEDURE

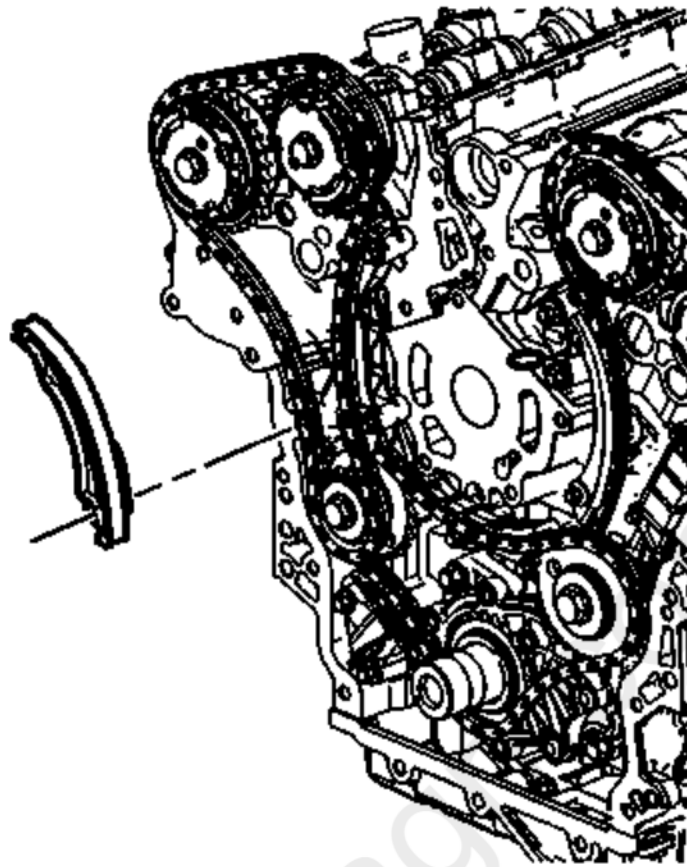


Fig. 179: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

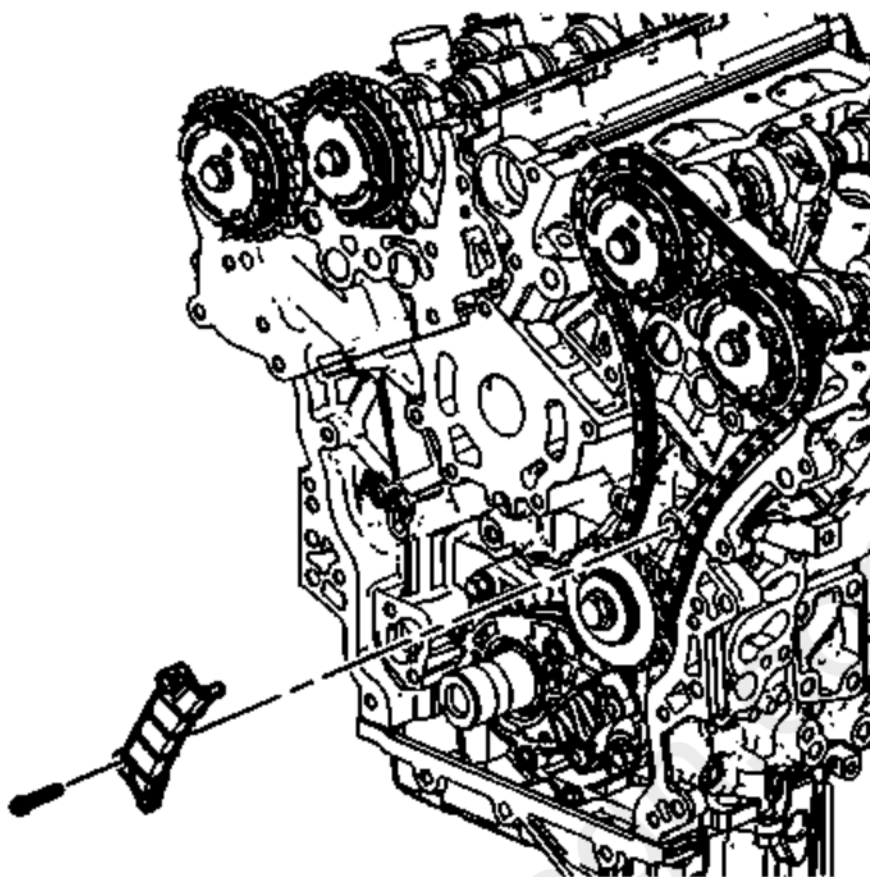


Fig. 180: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side**.

INSTALLATION PROCEDURE

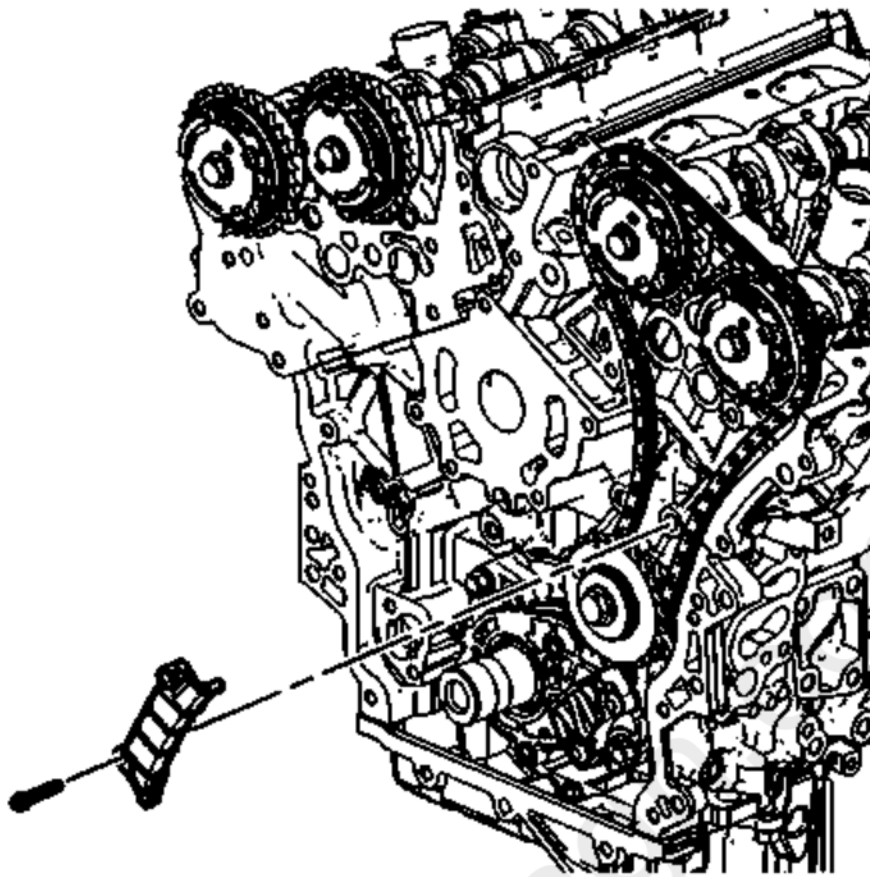


Fig. 181: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain guide. Refer to [Secondary Timing Chain Guide Installation - Left Side](#) .
2. Install the left bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Installation - Left Side](#) .
3. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to [Secondary Timing Chain Tensioner Removal - Right Side](#) .

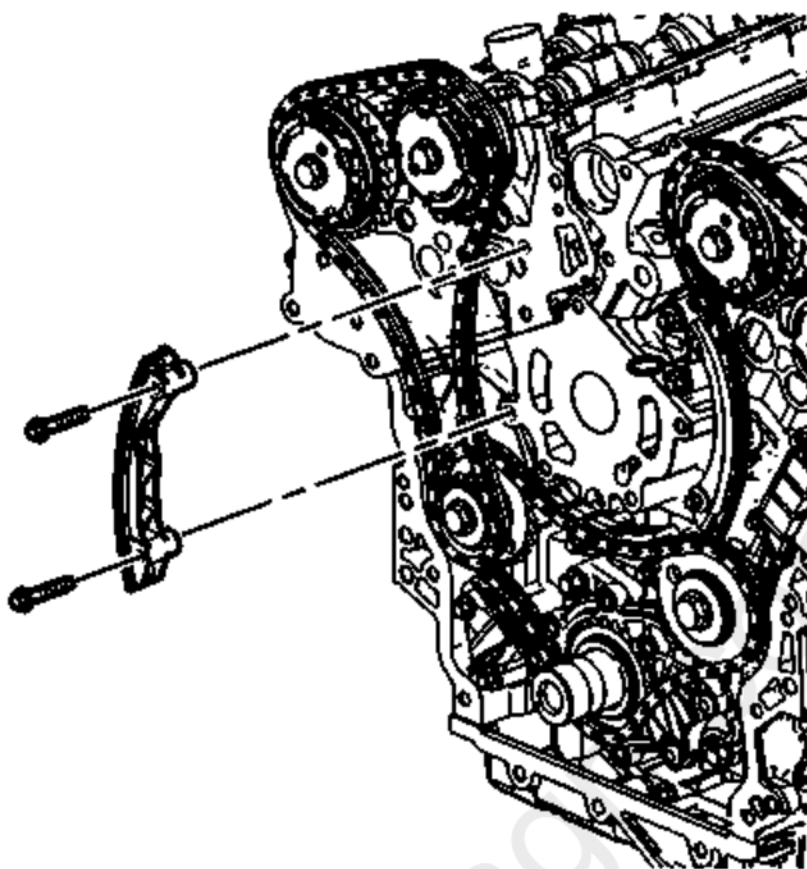


Fig. 182: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .

INSTALLATION PROCEDURE

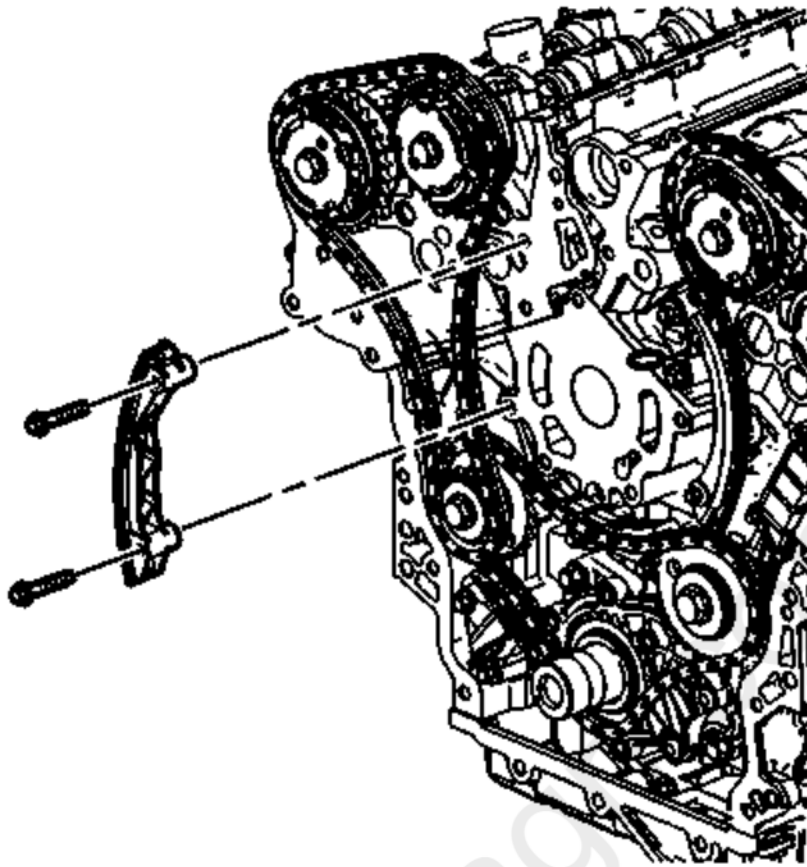


Fig. 183: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain guide. Refer to Secondary Timing Chain Guide Installation - Right Side.
2. Install the right bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Installation - Right Side.
3. Install the engine front cover. Refer to Engine Front Cover Replacement.

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Removal - Right Side.
3. Remove the right bank secondary camshaft drive chain shoe. Refer to Secondary Camshaft Drive Chain Shoe Removal - Right Side.
4. Remove the right bank secondary camshaft drive chain guide. Refer to Secondary Timing Chain Guide Removal - Right Side.
5. Remove the right bank secondary camshaft drive chain. Refer to Secondary Camshaft Intermediate

Drive Chain Removal - Right Side .

6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary camshaft drive chain upper guide. **Primary Timing Chain Guide Removal - Upper** .

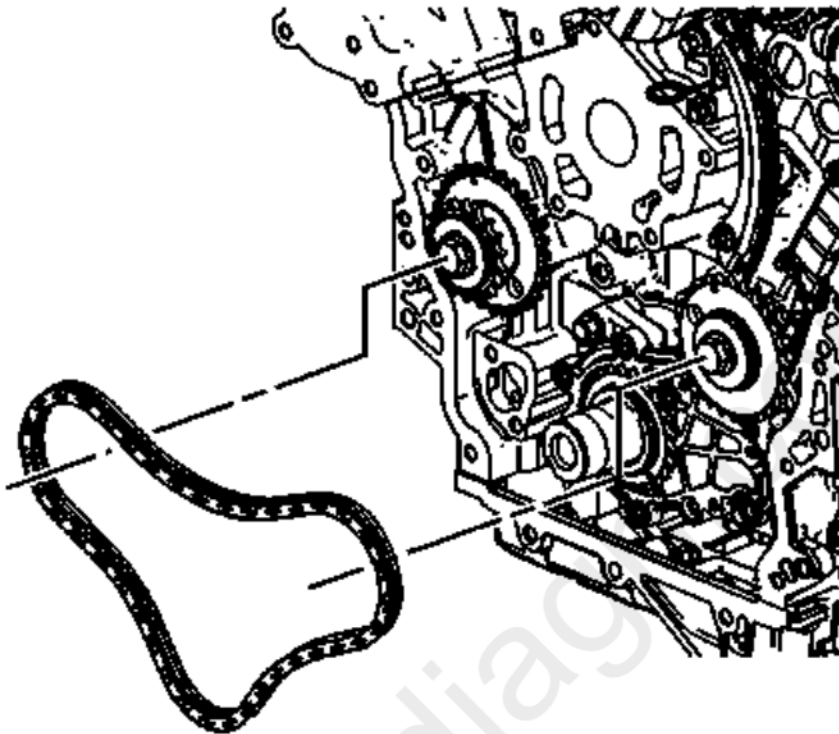


Fig. 184: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Remove the primary camshaft timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

INSTALLATION PROCEDURE

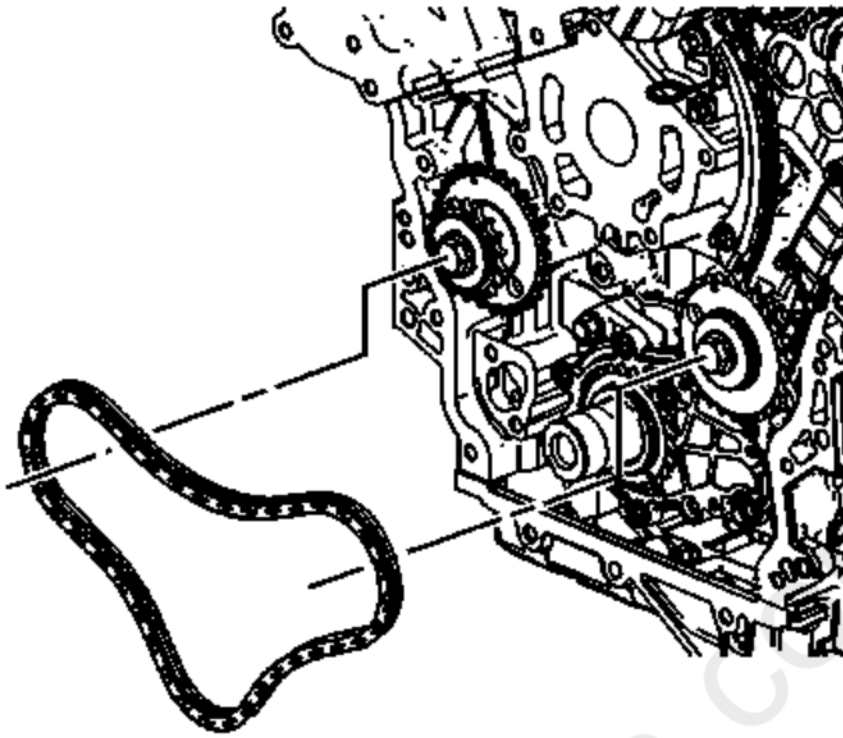


Fig. 185: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the primary camshaft timing chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation**.
2. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper**.
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)**.
4. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side**.
5. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side**.
6. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side**.
7. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

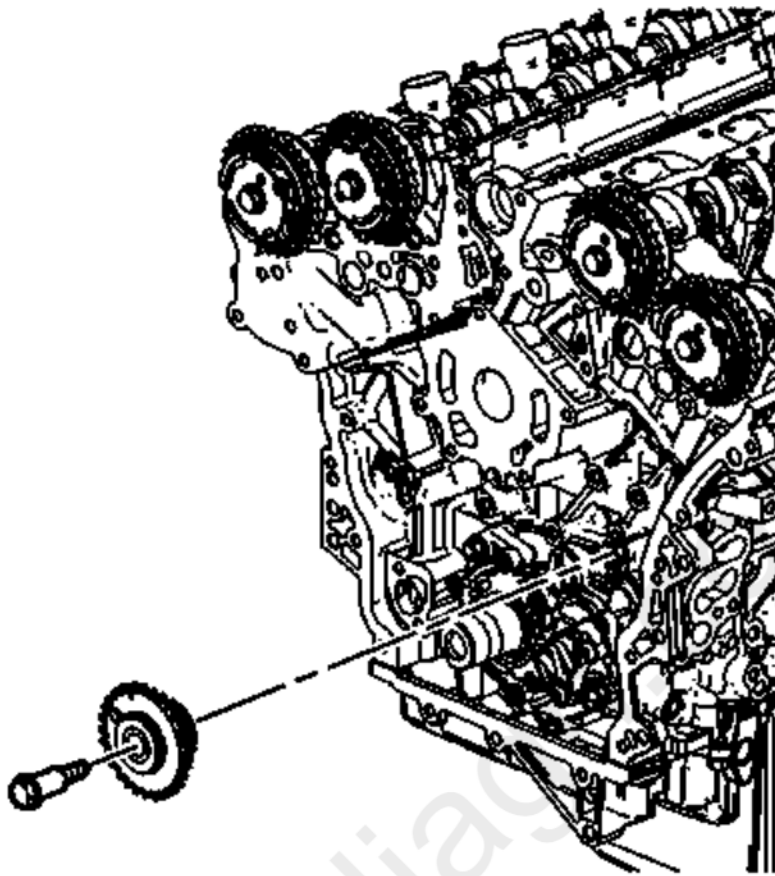
REMOVAL PROCEDURE

Fig. 186: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side**.
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side**.
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal**.
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper**.
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal**.
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket**

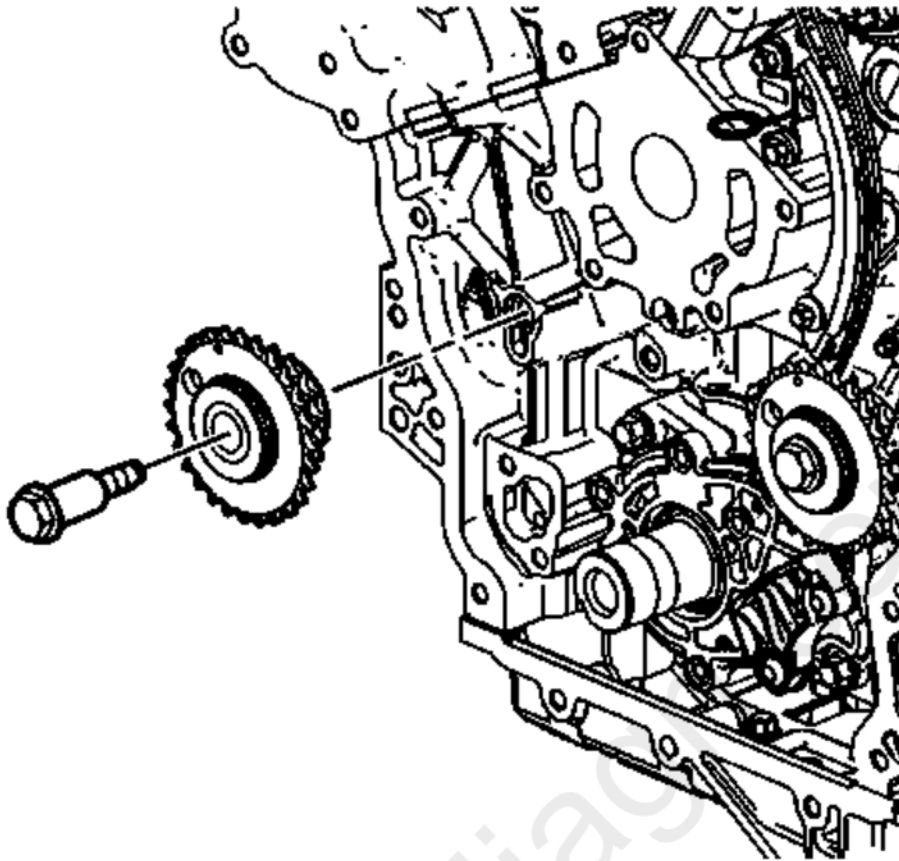
Removal - Right Side .

Fig. 187: View Of Right & Left Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS CORP.

10. If you are servicing the left bank camshaft intermediate drive chain idler, perform the following steps:
 1. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .
 2. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side** .
 3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .
 4. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Left Side** .
 5. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

INSTALLATION PROCEDURE

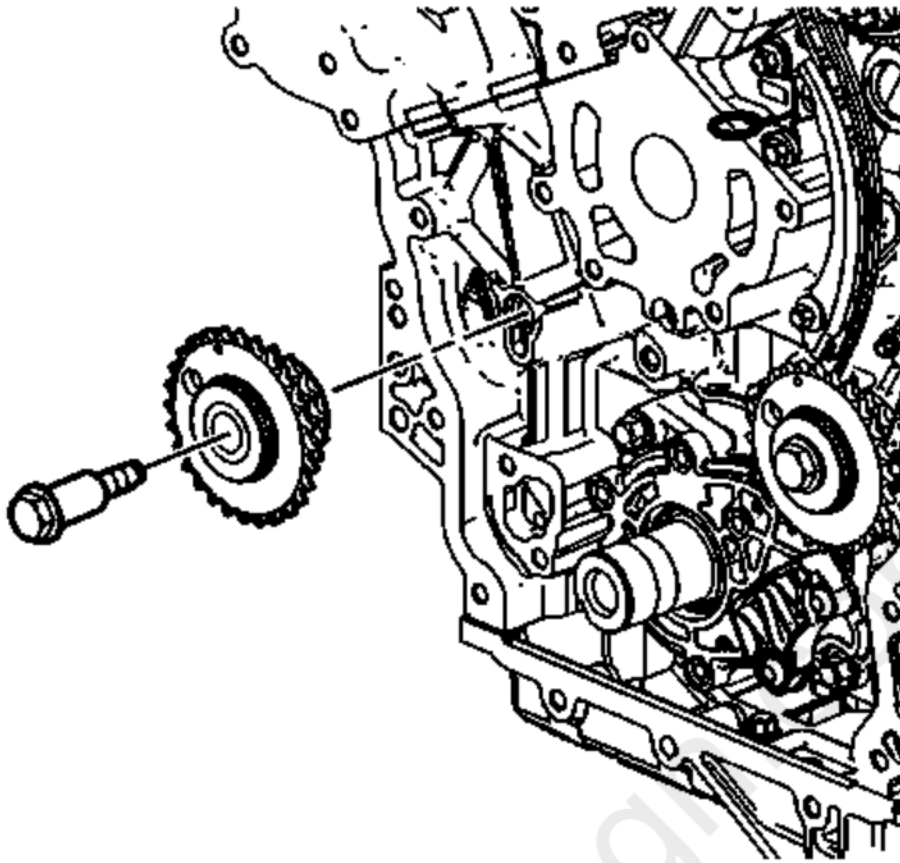


Fig. 188: View Of Right & Left Camshaft Intermediate Drive Chain Idlers
 Courtesy of GENERAL MOTORS CORP.

1. If you are servicing the left bank idler sprocket, perform the following steps:
 1. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
 2. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side (LLT)** .
 3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .
 4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side** .
 5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .

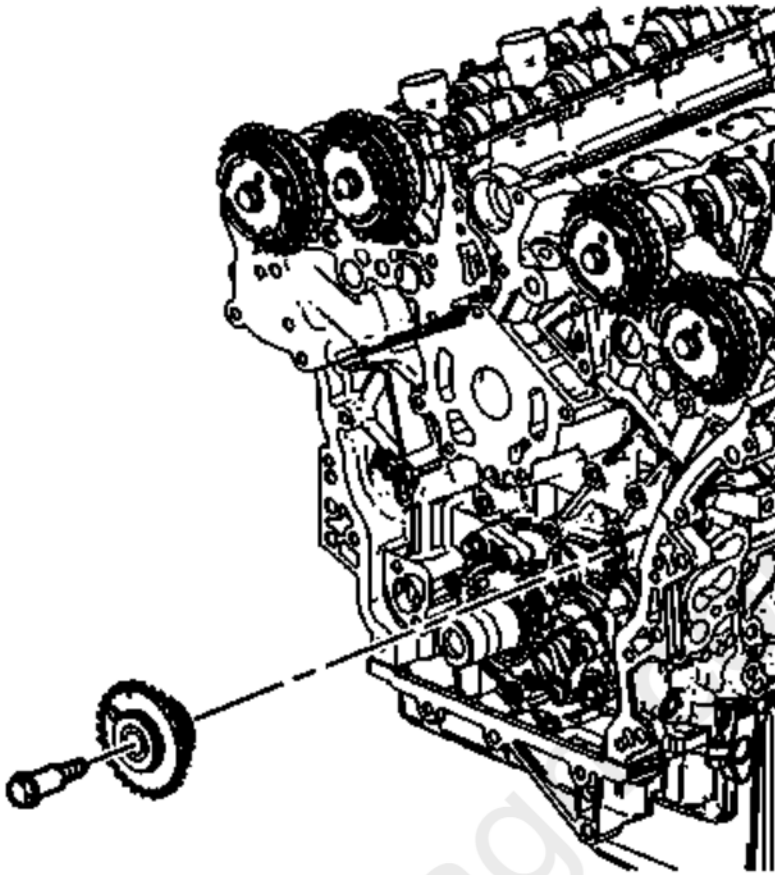


Fig. 189: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket
Courtesy of GENERAL MOTORS CORP.

2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side**.
3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation**.
4. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper**.
5. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)**.
6. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side**.
7. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side**.
8. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side**.
9. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

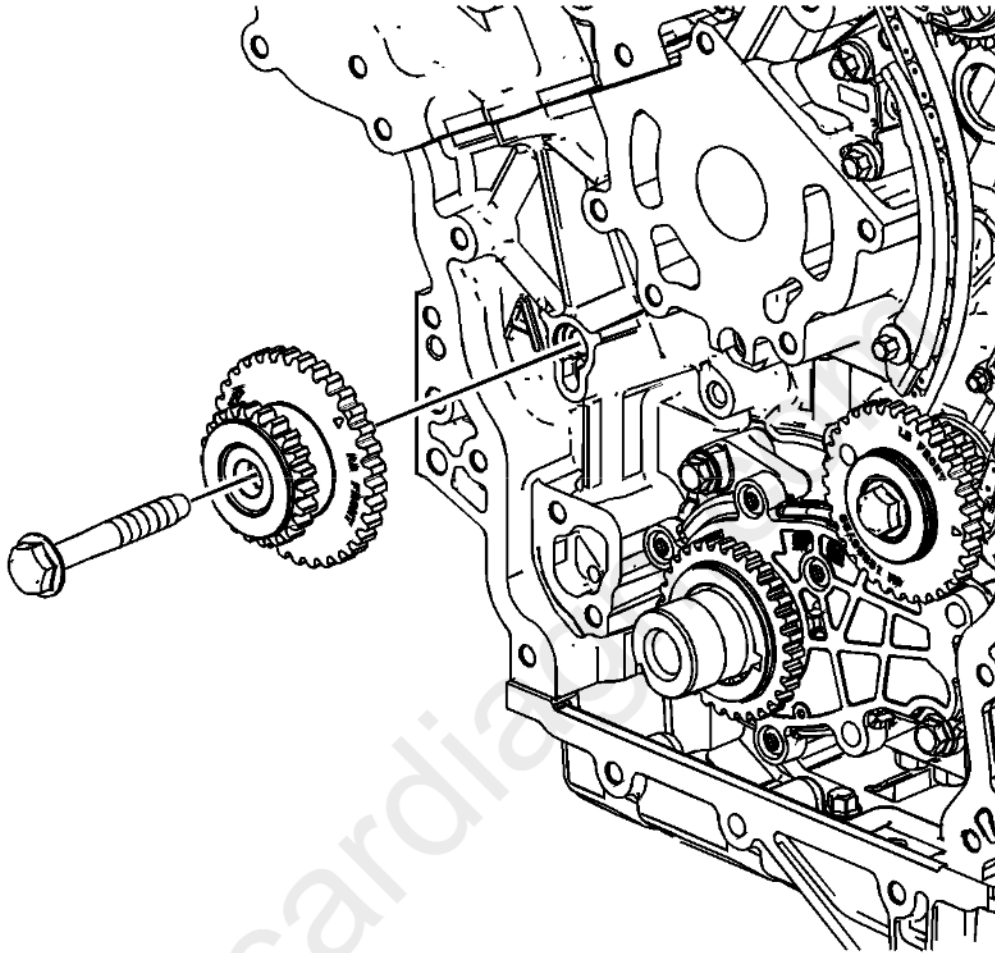


Fig. 190: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement**.
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side**.
4. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side**.
5. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side**.
6. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side**.

7. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
8. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
9. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
10. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

INSTALLATION PROCEDURE

1. Ensure stage 1 camshaft timing is correct. Refer to **Setting Camshaft Timing**.

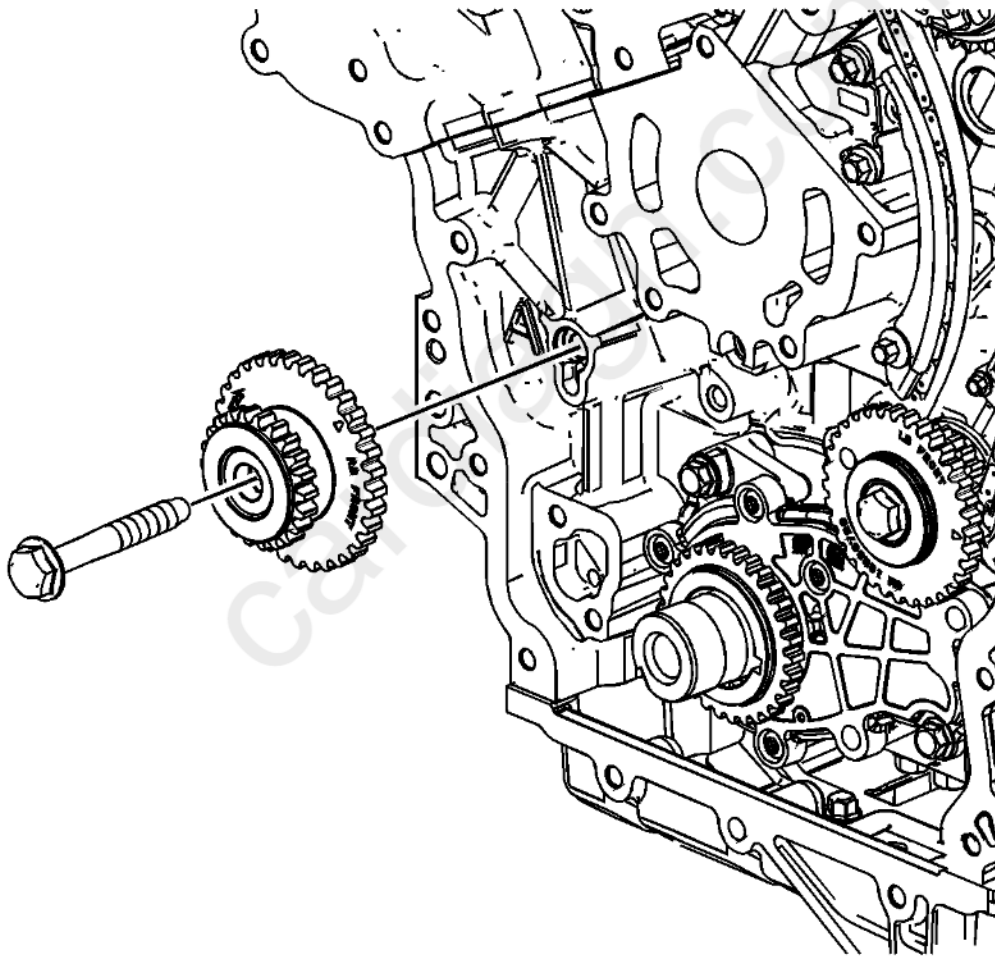


Fig. 191: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .

3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
4. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
5. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)** .
6. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
7. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
8. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
9. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
10. Install the spark plugs. Refer to **Spark Plug Replacement** .
11. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

REMOVAL PROCEDURE

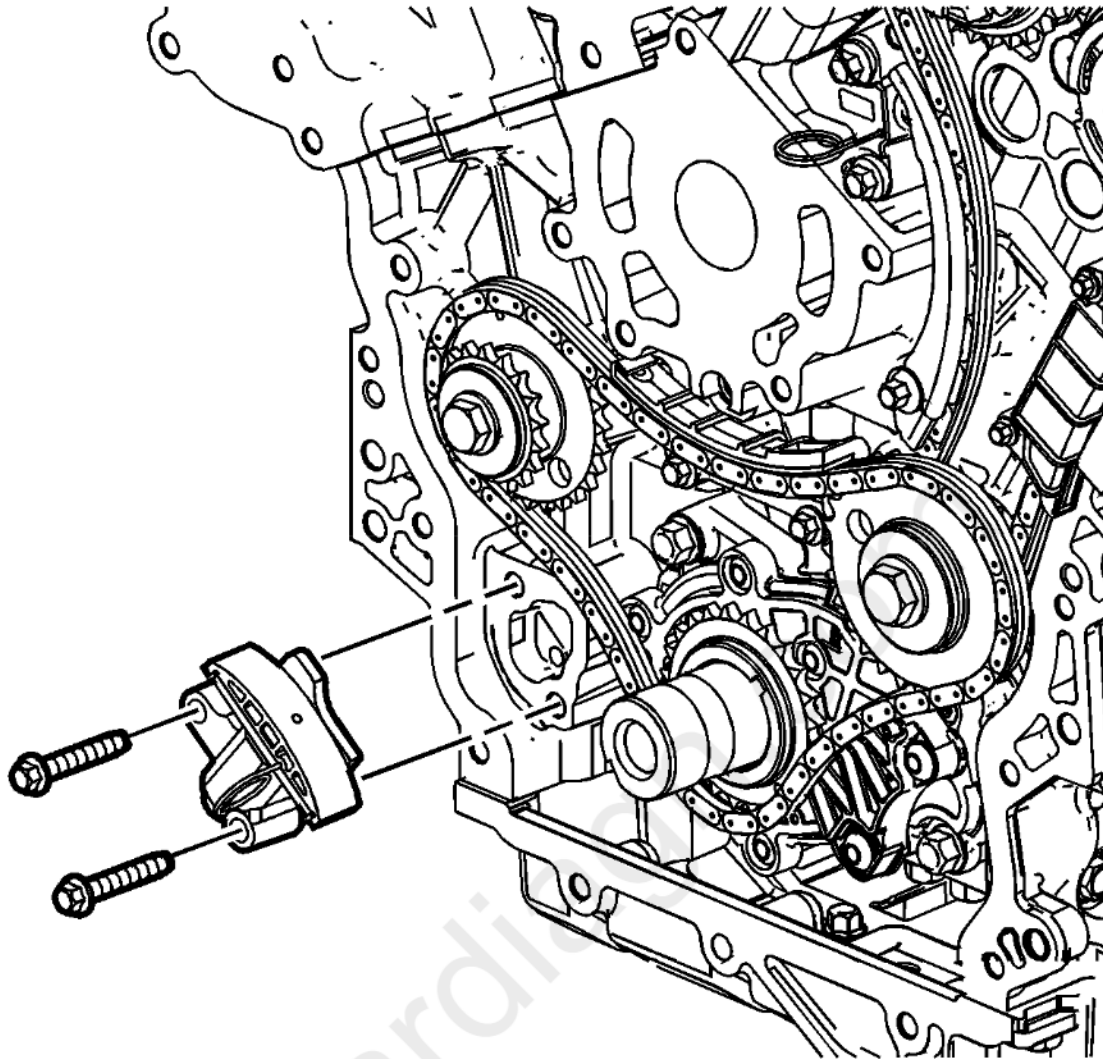


Fig. 192: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.

IMPORTANT: If the entire camshaft timing system is not in Stage 2, Timing Chain Alignment Diagram , mark the timing chain and sprockets in order to ensure proper reassembly.

2. Remove the primary camshaft drive chain tensioner. Refer to Primary Camshaft Intermediate Drive Chain Tensioner Removal .

INSTALLATION PROCEDURE

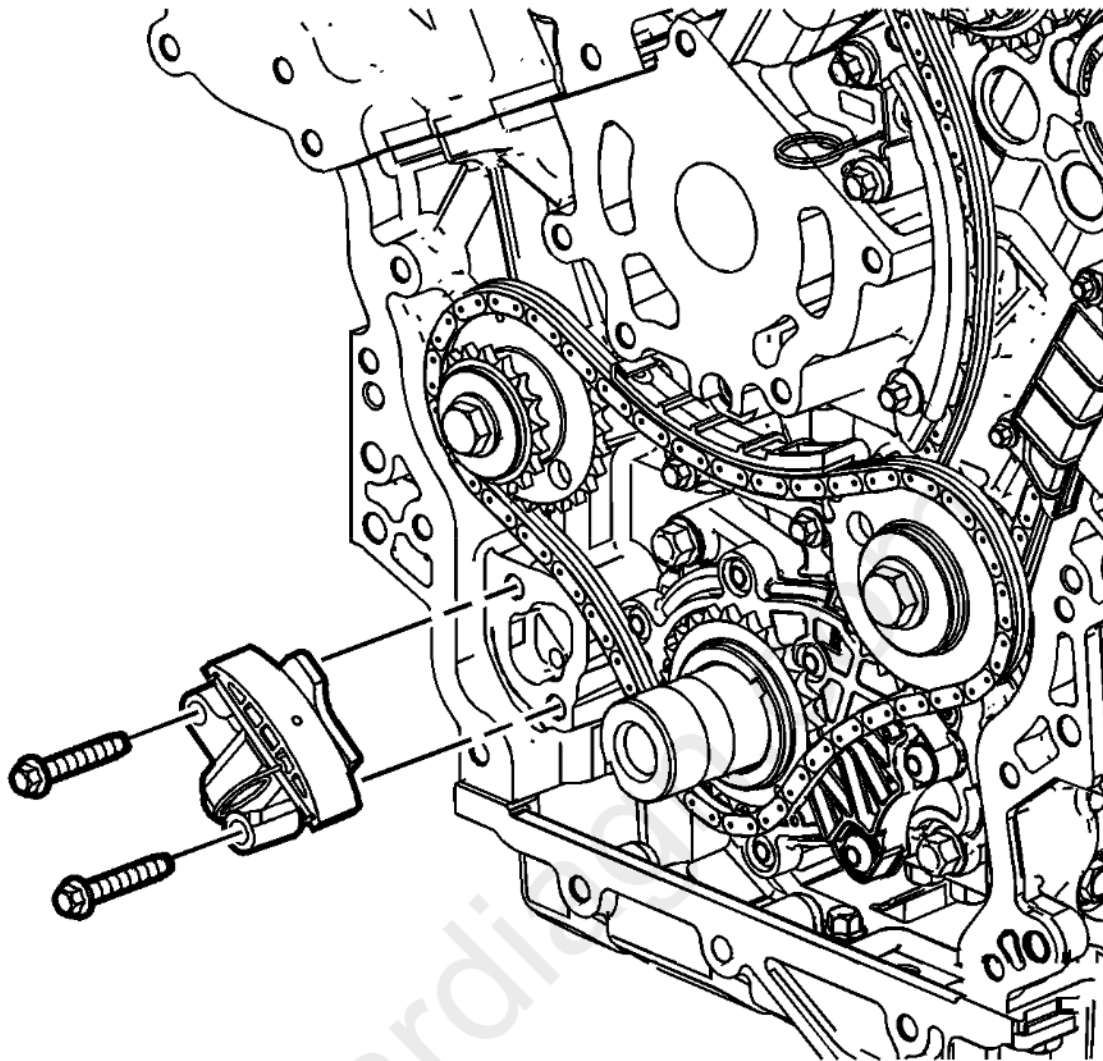


Fig. 193: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)**.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

REMOVAL PROCEDURE

1. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

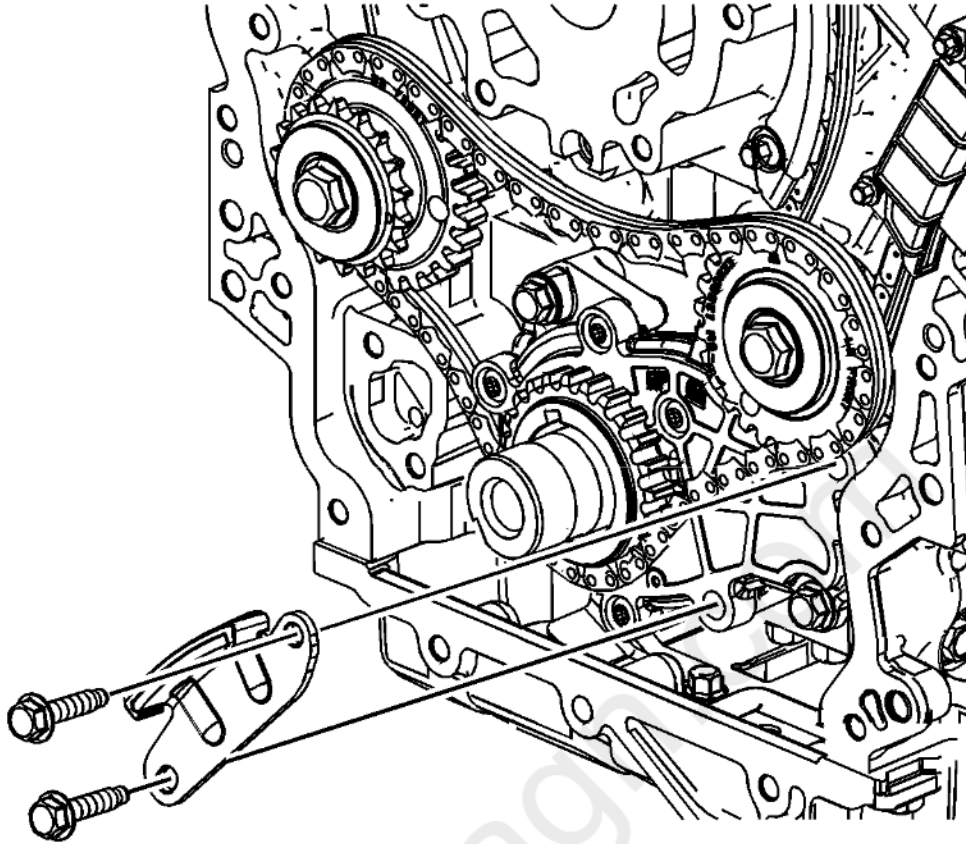


Fig. 194: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

INSTALLATION PROCEDURE

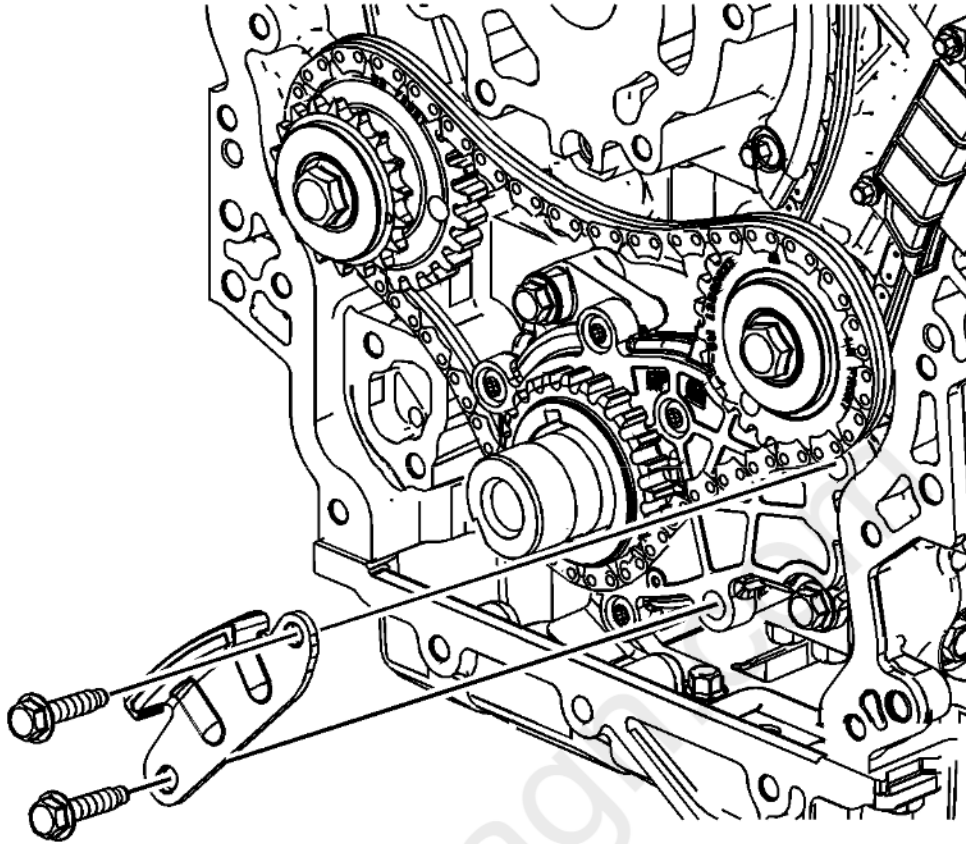


Fig. 195: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the primary camshaft drive chain lower guide to the oil pump.

CAUTION: Refer to.

2. Install the primary camshaft drive chain lower guide bolts and tighten to 23 N.m (17 lb ft).
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

REMOVAL PROCEDURE

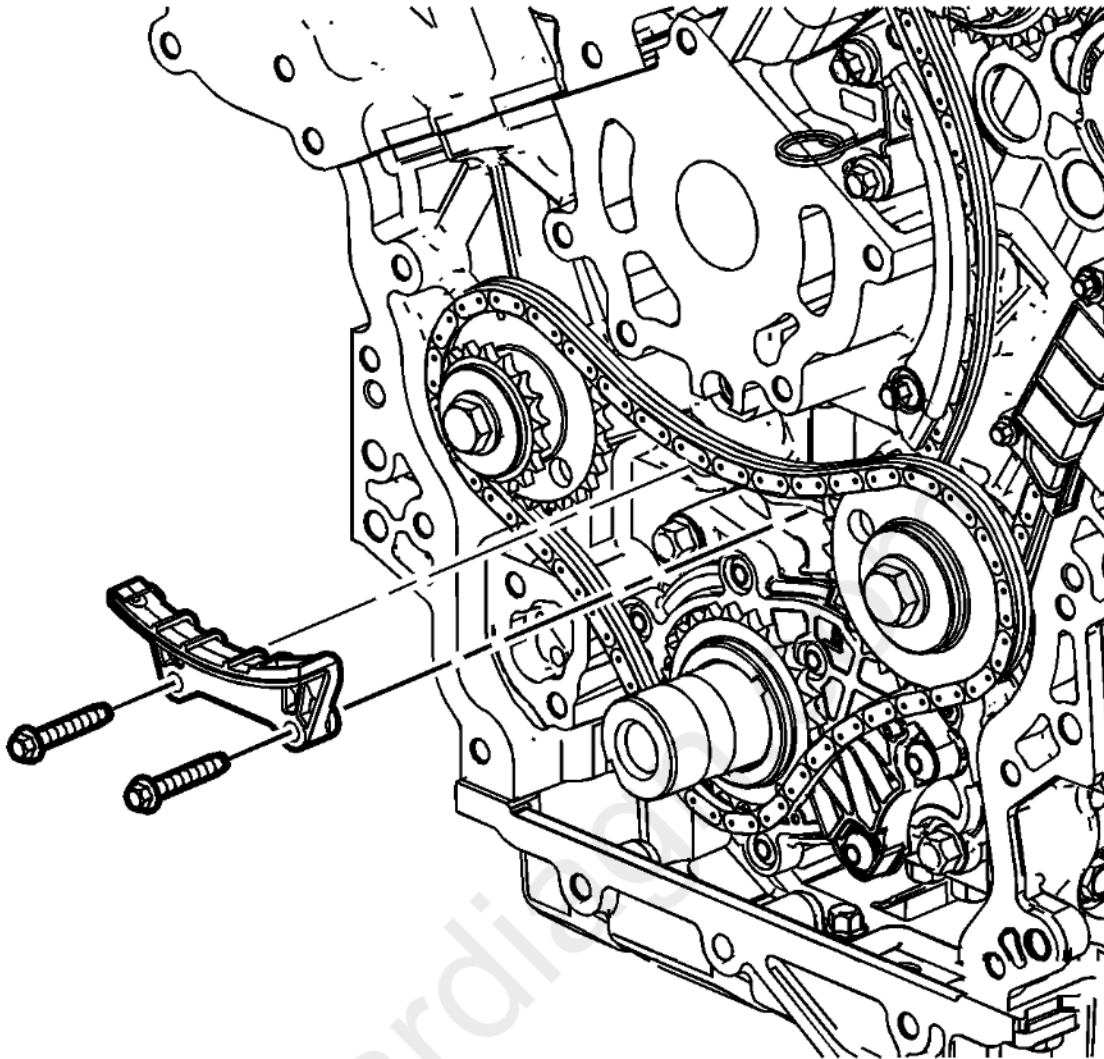


Fig. 196: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal**.
3. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper**.

INSTALLATION PROCEDURE

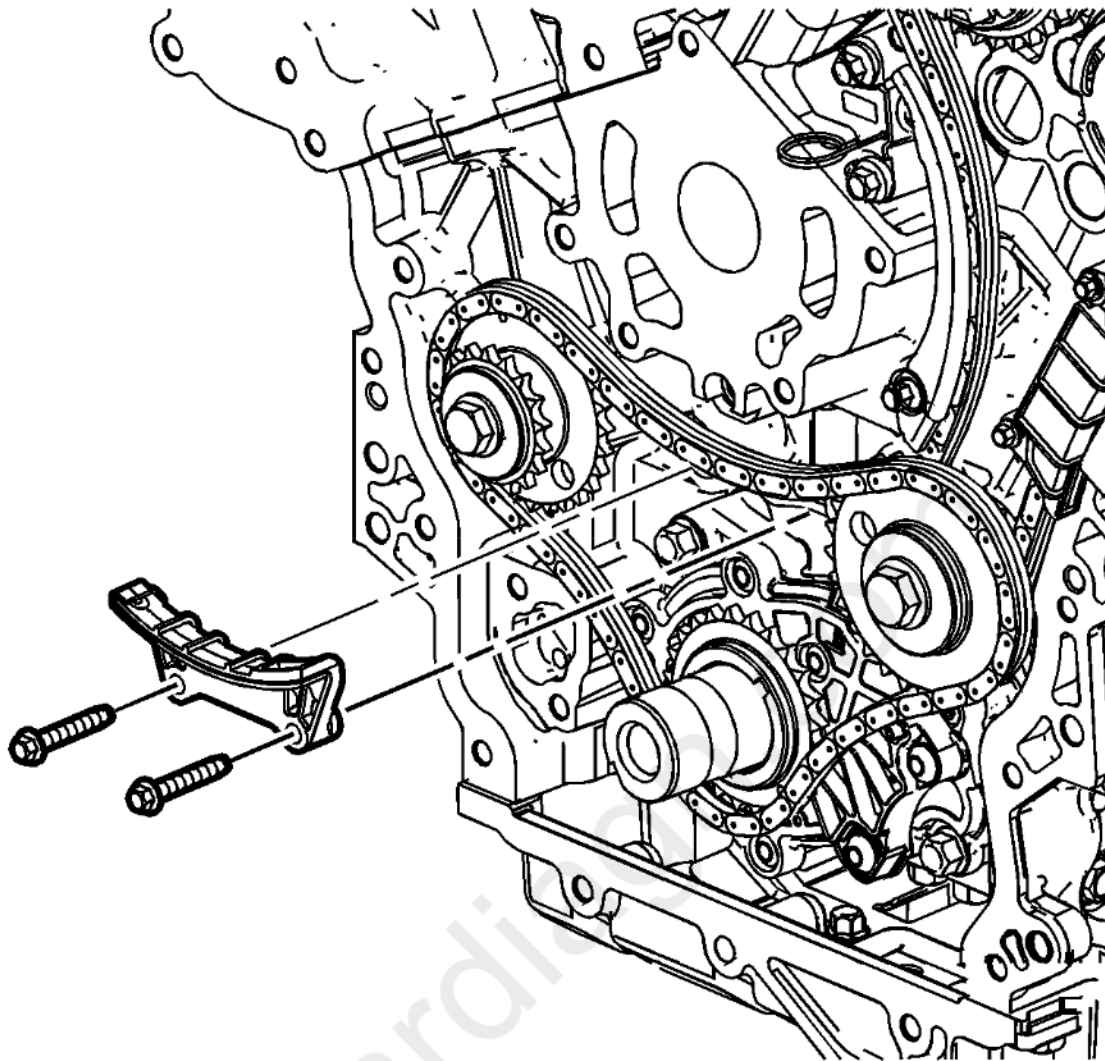


Fig. 197: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper**.
2. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation (LLT or LCS)**.
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1 (LF1 OR LFW)

SPECIAL TOOLS

- EN49982-1: Timing Chain Retainer
- EN49982-2: Timing Chain Retainer

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

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the camshaft position actuator solenoid valve solenoid - intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
3. Remove the intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** .
5. Remove the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
6. Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on "base circle" and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.

NOTE: **Do NOT remove or back out the camshaft position actuator bolt(s) significantly, simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.**

7. Loosen intake and/or exhaust camshaft position actuator retaining bolts, depending on which camshaft position actuator and/or camshaft you will be servicing. If servicing both camshaft position actuators and/or camshafts, loosen both bolts.

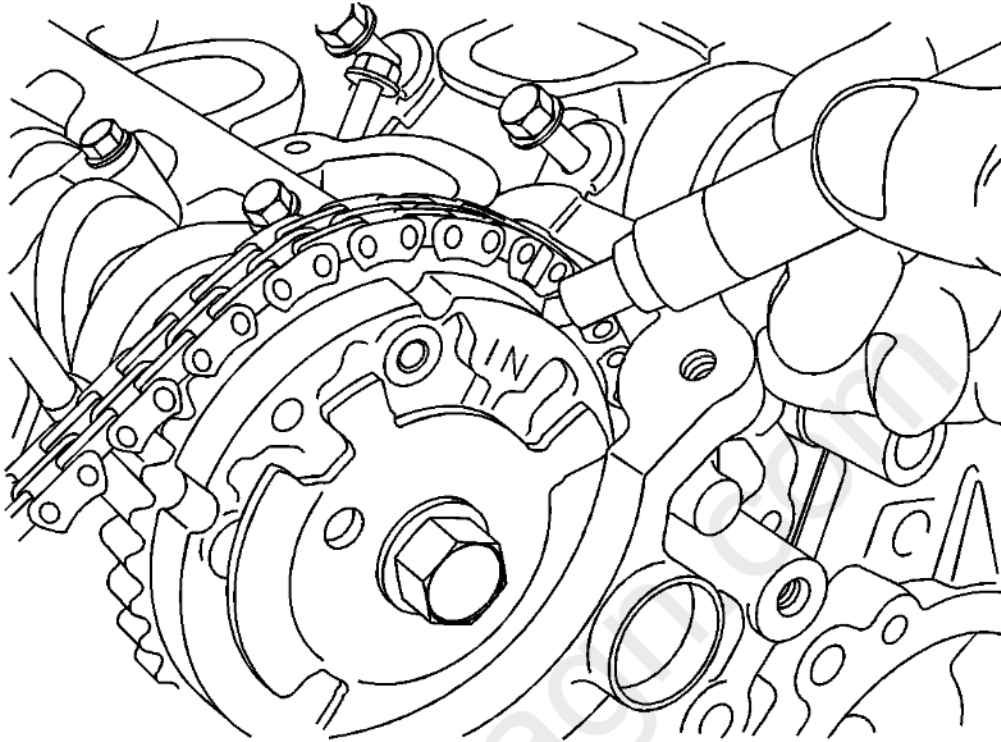


Fig. 198: Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS CORP.

NOTE: Be certain to clearly mark the position of the chain to the camshaft position actuator(s). Though the engine does not need to be set to a specific timing mark before starting the procedure, the relationship of the chain to the actuator(s) is critical and must be reestablished on assembly.

8. Mark the position of the chain to the camshaft position actuator - intake.

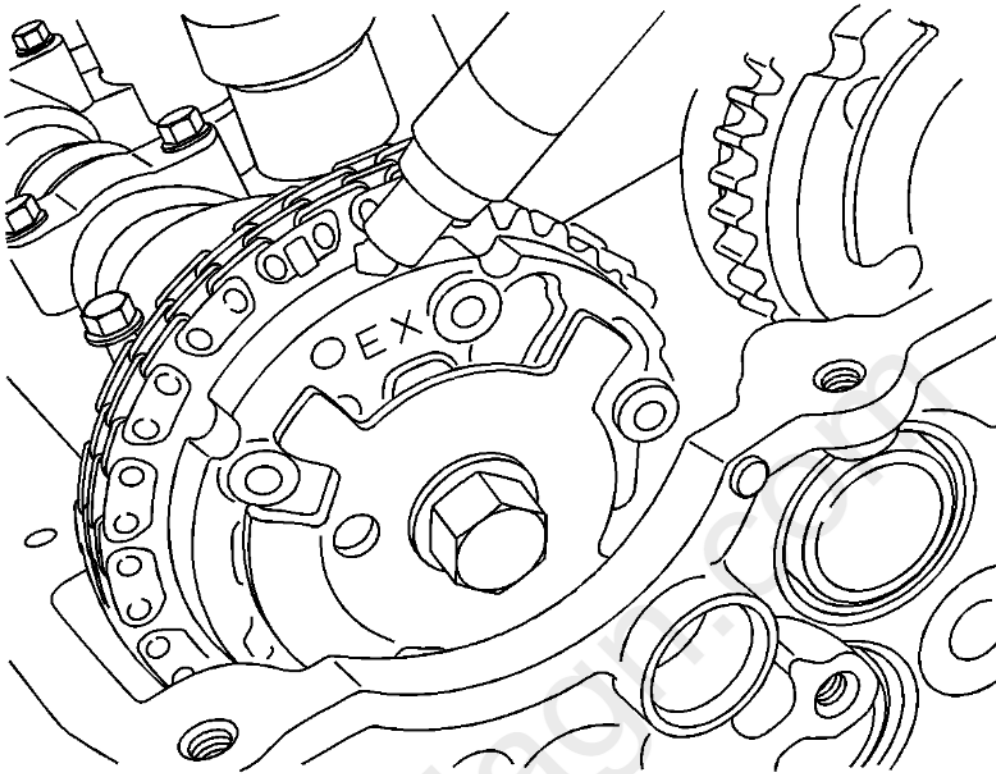


Fig. 199: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS CORP.

9. Mark the position of the chain to the camshaft position actuator - exhaust.

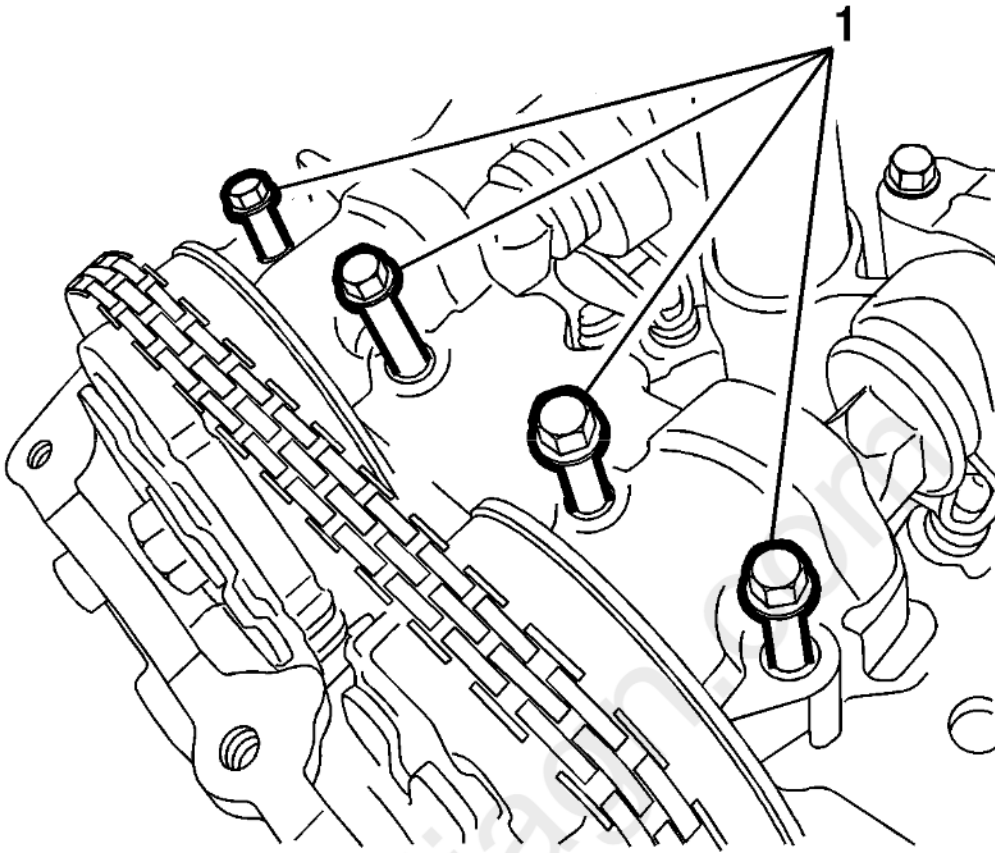


Fig. 200: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove camshaft front cap bolts (1).

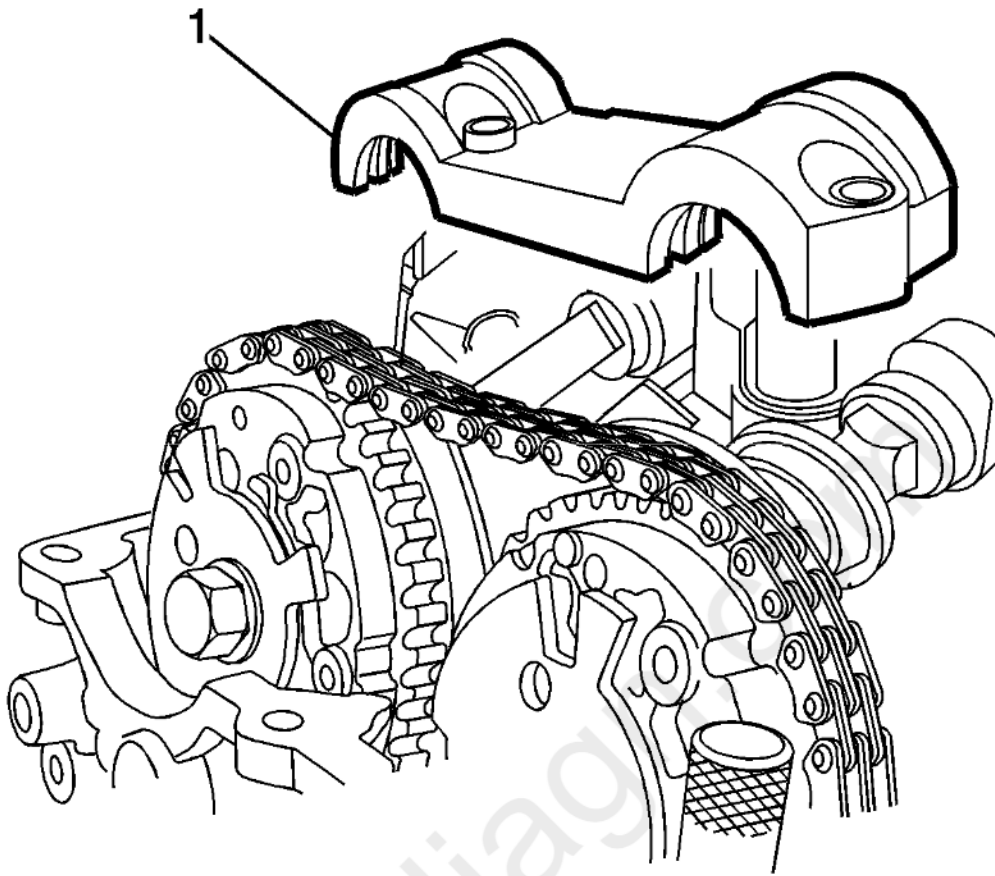


Fig. 201: View Of Camshaft Front Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to eventually remove the camshaft.

11. Remove the camshaft front cap (1).

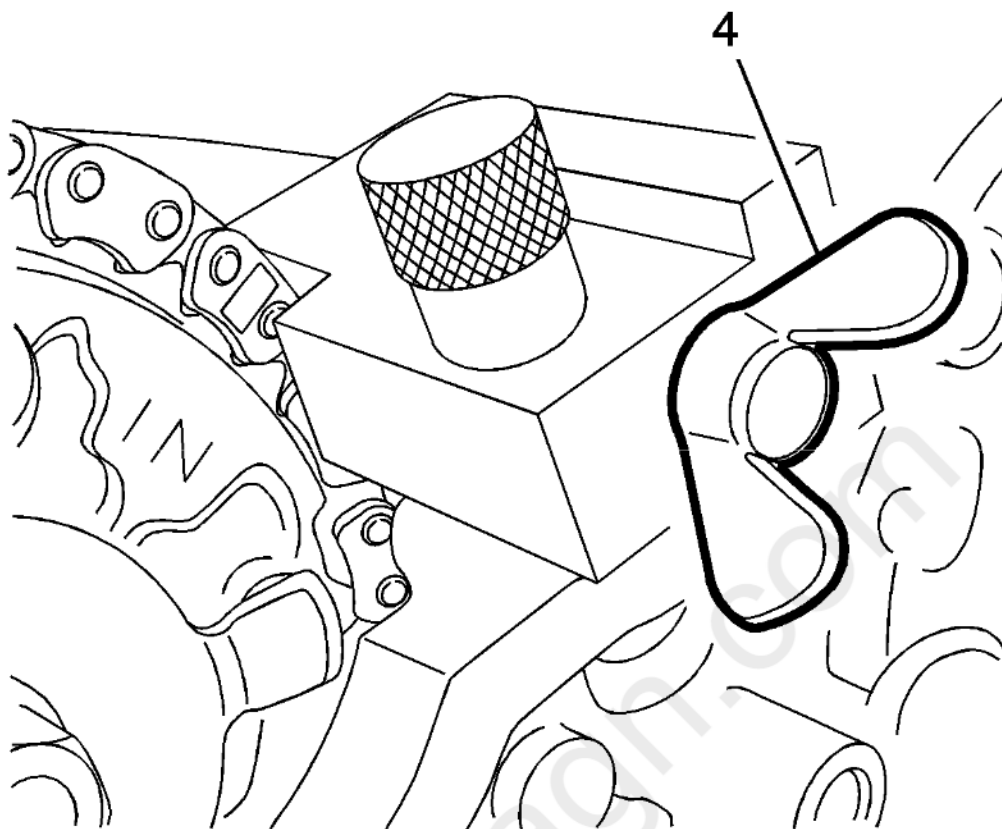


Fig. 202: Retainer Wingnut

Courtesy of GENERAL MOTORS CORP.

12. Loosen wingnut (4) to open the clamping area of EN49982-1: retainer.

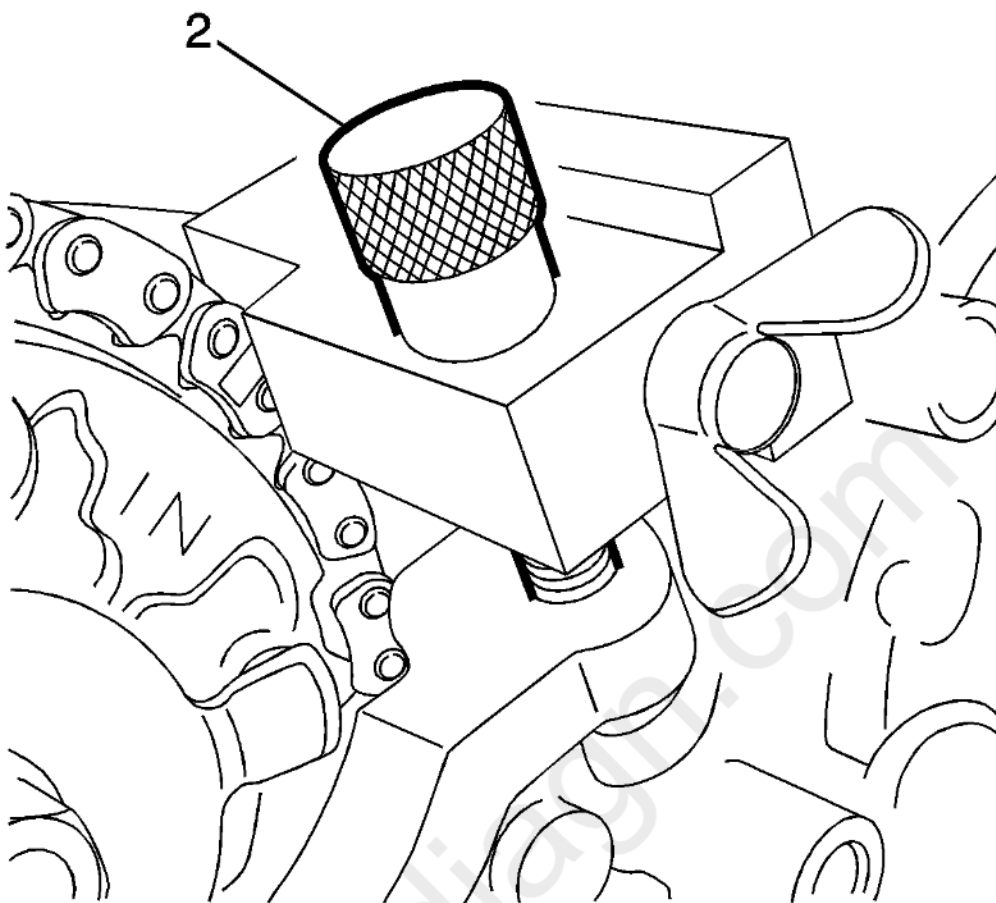


Fig. 203: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS CORP.

NOTE: Do NOT overtighten the thumbscrew. The EN49982-1: retainer should be able to slide slightly via the slot the screw goes through. This fore/aft movement will allow easier removal and installation of the chain later.

13. Install EN49982-1: retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the EN49982-1: retainer finger-tight.

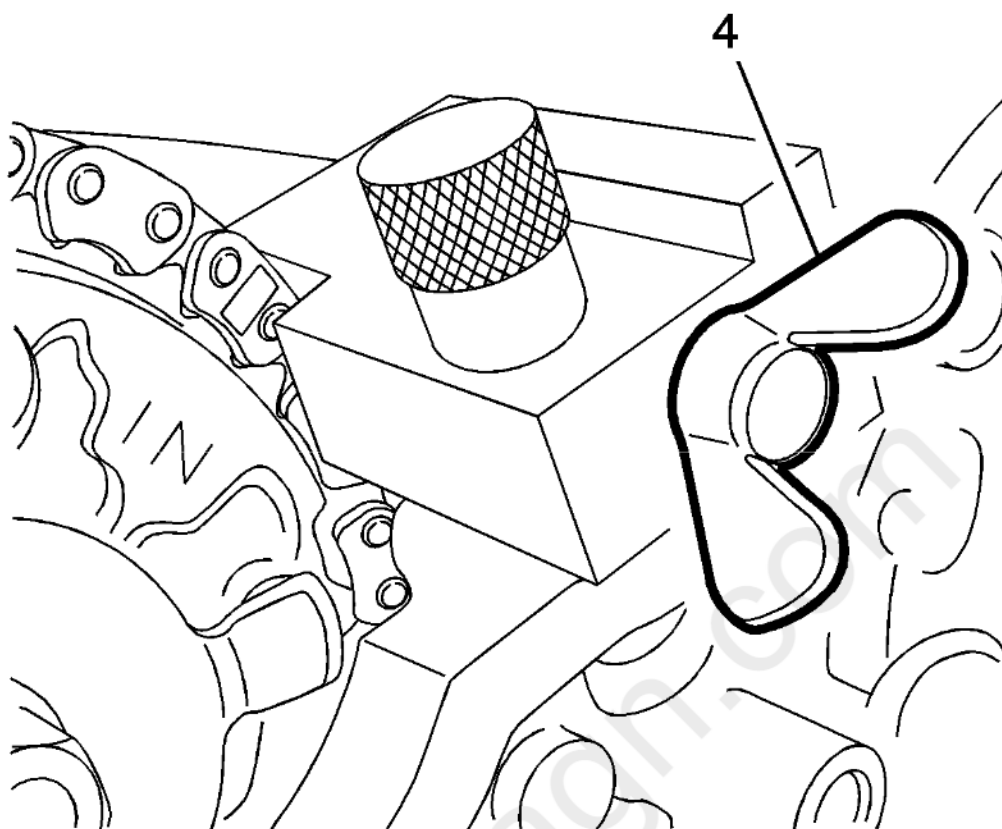


Fig. 204: Retainer Wingnut

Courtesy of GENERAL MOTORS CORP.

NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

14. Tighten wingnut (4) so **EN49982-1**: retainer closes over and firmly grasps timing chain.

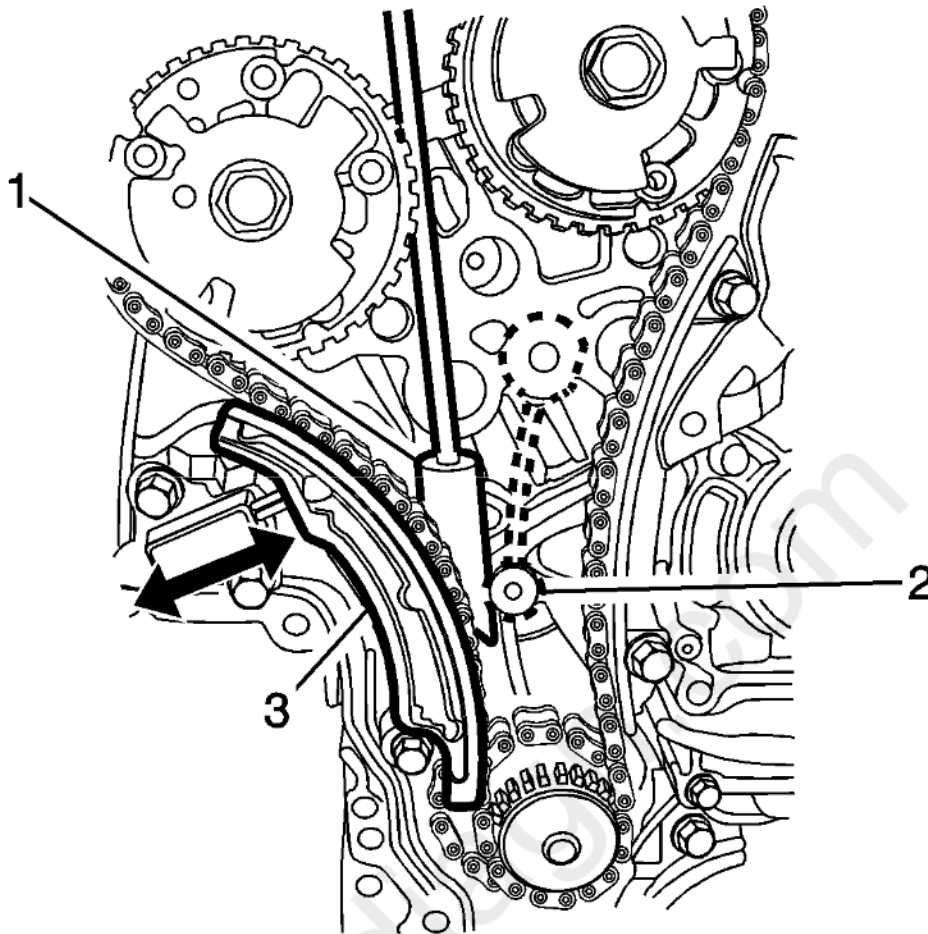


Fig. 205: Retainer Wedge

Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover is removed for clarity in the following graphics, but is **NOT** required to be removed to perform the procedure.

15. **EN49982-2:** retainer (1) will be installed in the following steps such that it wedges between an internal rib (2) that is cast into the inside of the front cover (shown in dotted line above) and the timing chain and spring-loaded tensioner shoe (3), holding the chain in position. The wedge will be left in place during the cam position actuator and/or camshaft service.

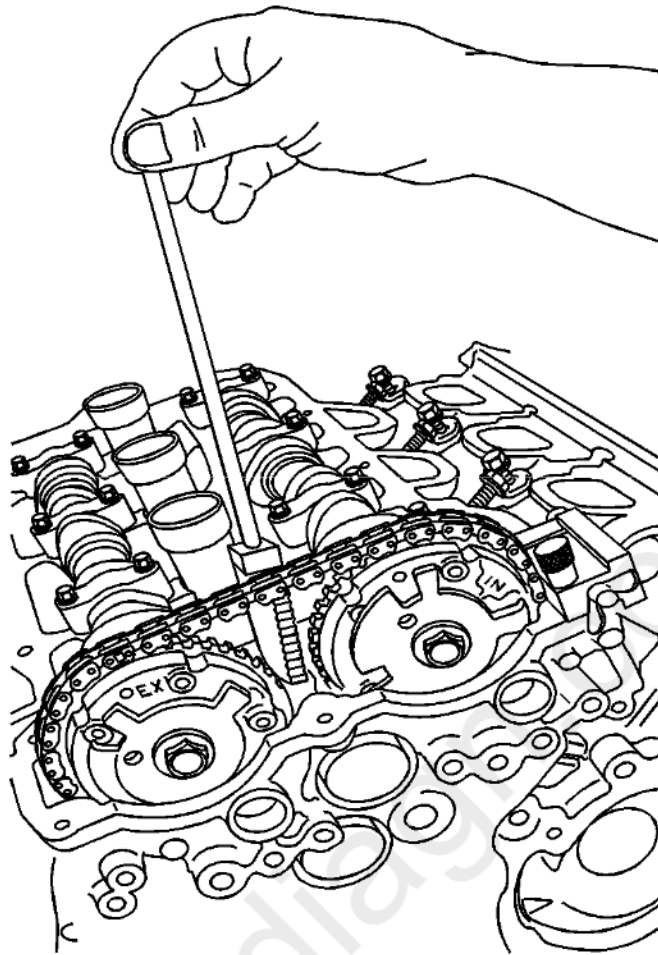


Fig. 206: Inserting Retainer

Courtesy of GENERAL MOTORS CORP.

16. Insert the **EN49982-2:** retainer between the two camshaft position actuators with the "teeth" on the **EN49982-2:** retainer facing toward the front cover.

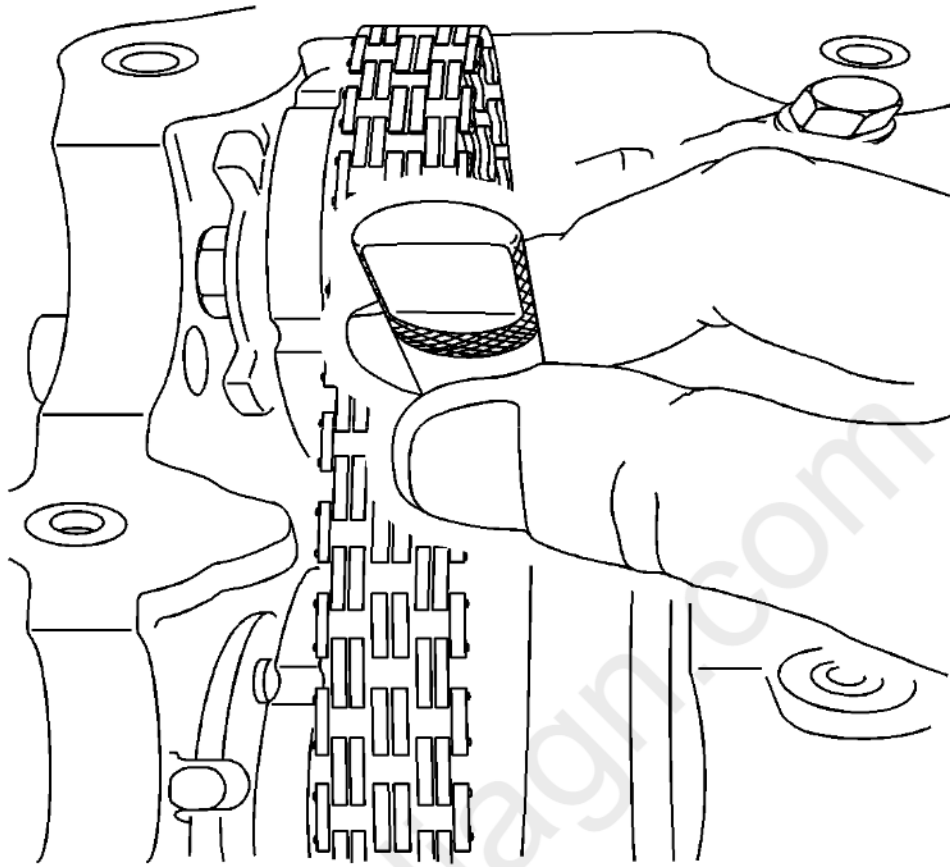


Fig. 207: Orienting Retainer Teeth
Courtesy of GENERAL MOTORS CORP.

17. Once the wedge portion of **EN49982-2:** retainer is below the camshaft position actuators, rotate the **EN49982-2:** retainer until the flat in the handle faces toward the intake camshaft position actuator. This orients the "teeth" toward the chain.

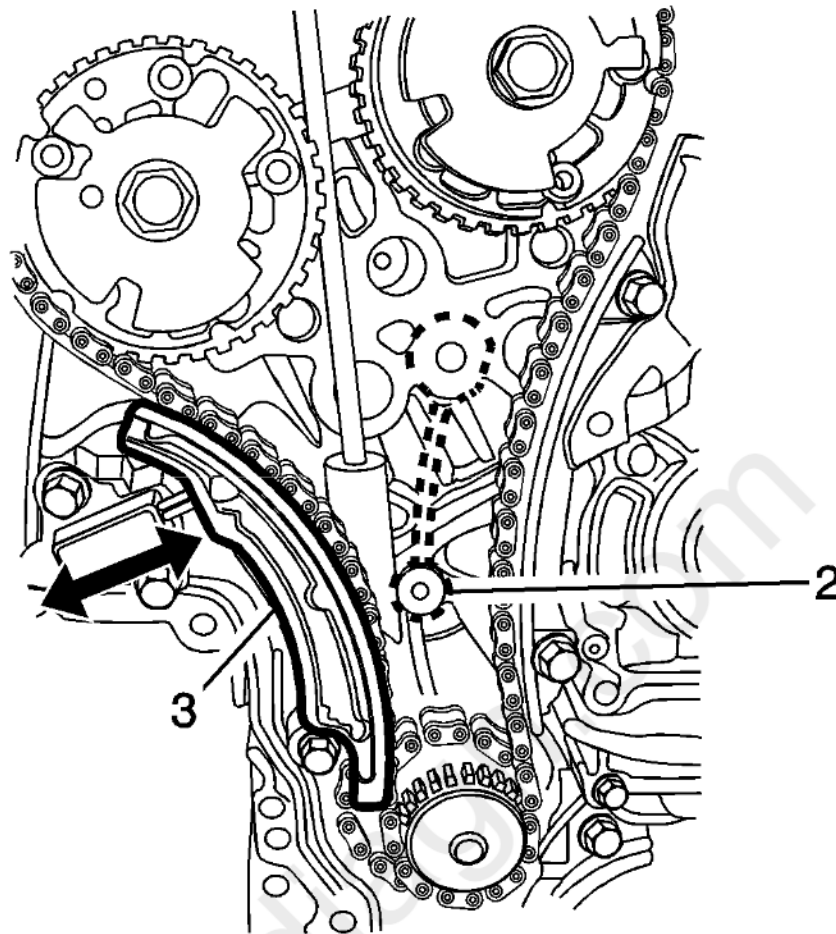


Fig. 208: View Of Dropping Wedge Down
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not try to force the wedge into position, simply ensure it is loosely engaged in the timing chain and in the correct overall position.

18. Drop the wedge down until it begins to engage the timing chain and the belt casting (2).

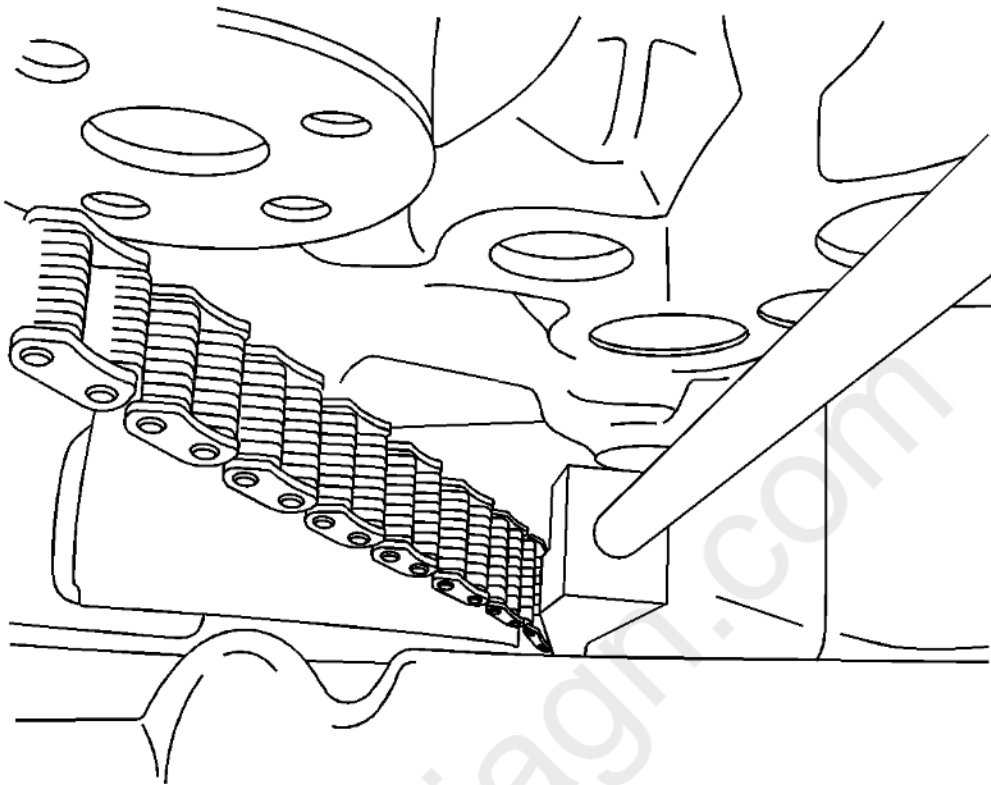


Fig. 209: Identifying Wedge Position
Courtesy of GENERAL MOTORS CORP.

19. If possible shine a strong light down from above, between the camshaft position actuators, and see the wedge in overall position as shown in the above graphic.

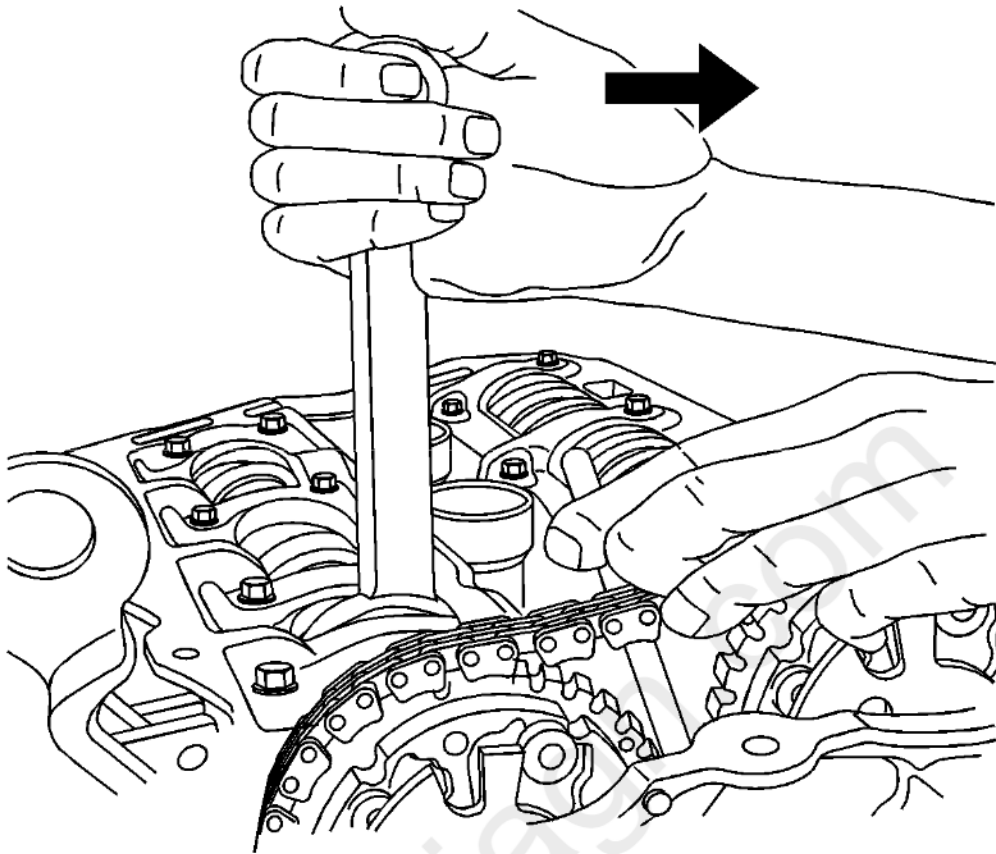


Fig. 210: Rotating Camshaft
Courtesy of GENERAL MOTORS CORP.

20. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the **EN49982-2**: retainer.

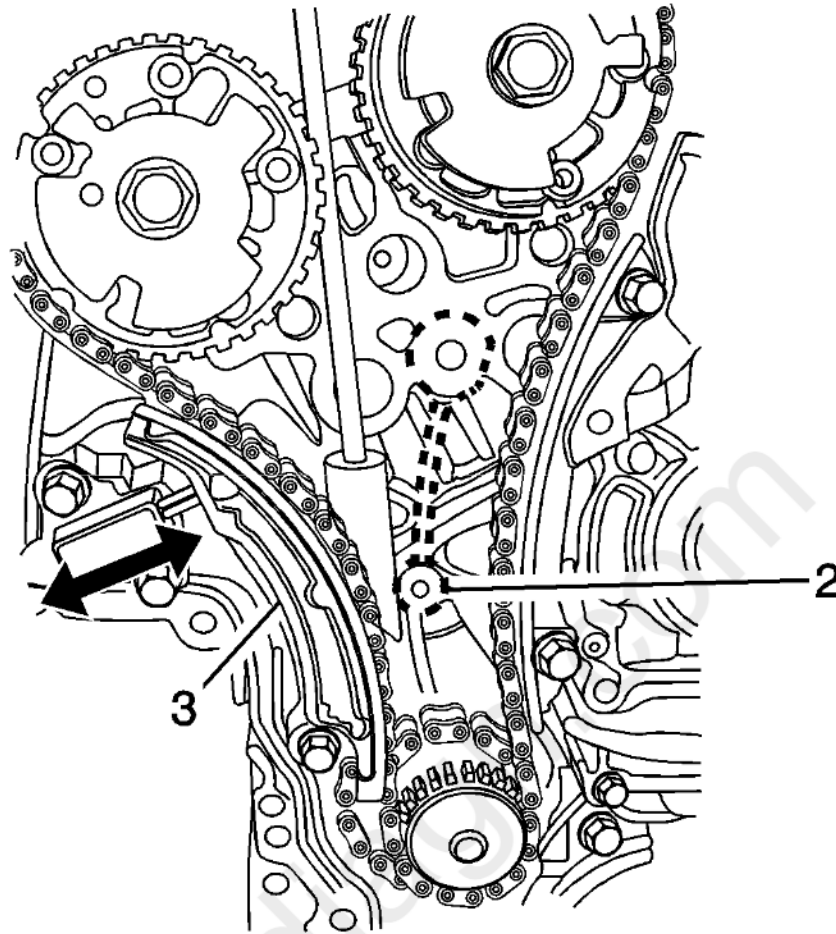


Fig. 211: Opening Gap Between Chain & Internal Rib In Front Cover
Courtesy of GENERAL MOTORS CORP.

21. This rotation of the camshaft will compress the tensioner shoe (3) against the spring force of the tensioner, opening up a gap between the chain and the internal rib in the front cover. The wedge will then drop into this gap. You will feel a distinct click as the teeth engage the chain.

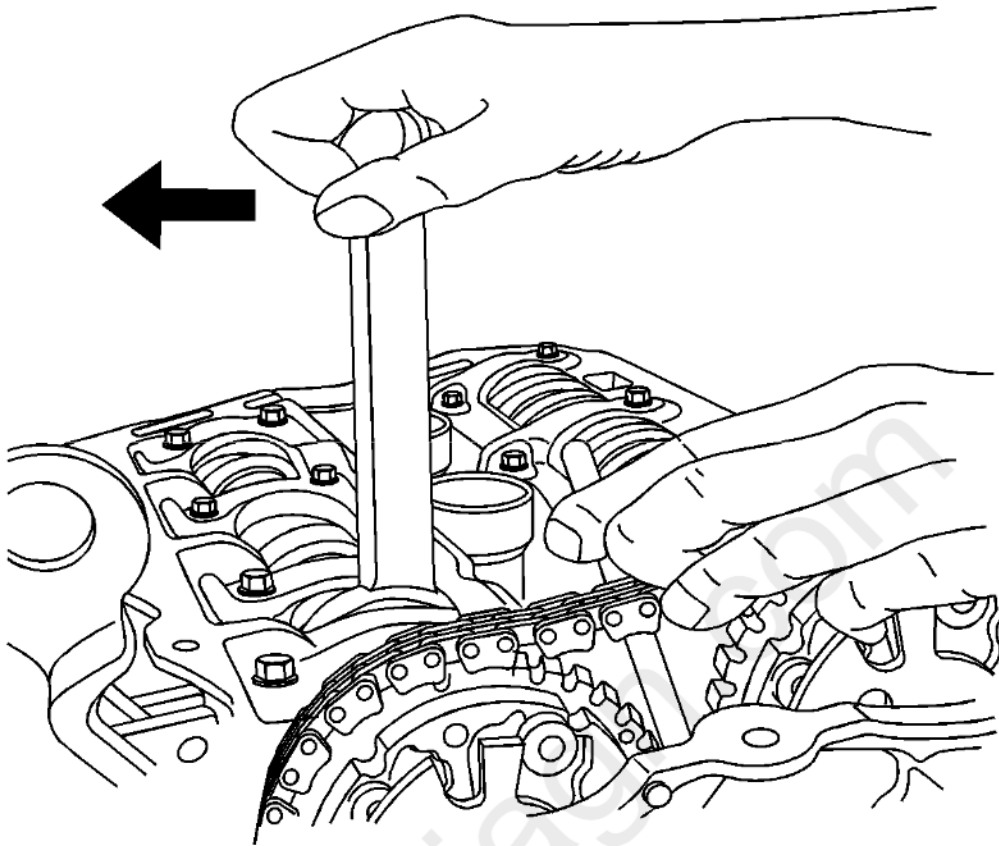


Fig. 212: Releasing Force On Wrench
Courtesy of GENERAL MOTORS CORP.

CAUTION: Be sure the EN49982-2 is captured firmly as described before continuing. This is critical to ensuring the camshaft drive chains stay properly timed.

22. Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of **EN49982-2**: retainer. You should be able to lightly tug on the **EN49982-2**: retainer and it should stay in position. Repeat Steps 20 and 21 if necessary to re-insert the **EN49982-2**: retainer until you are certain it is in position and will stay in position.

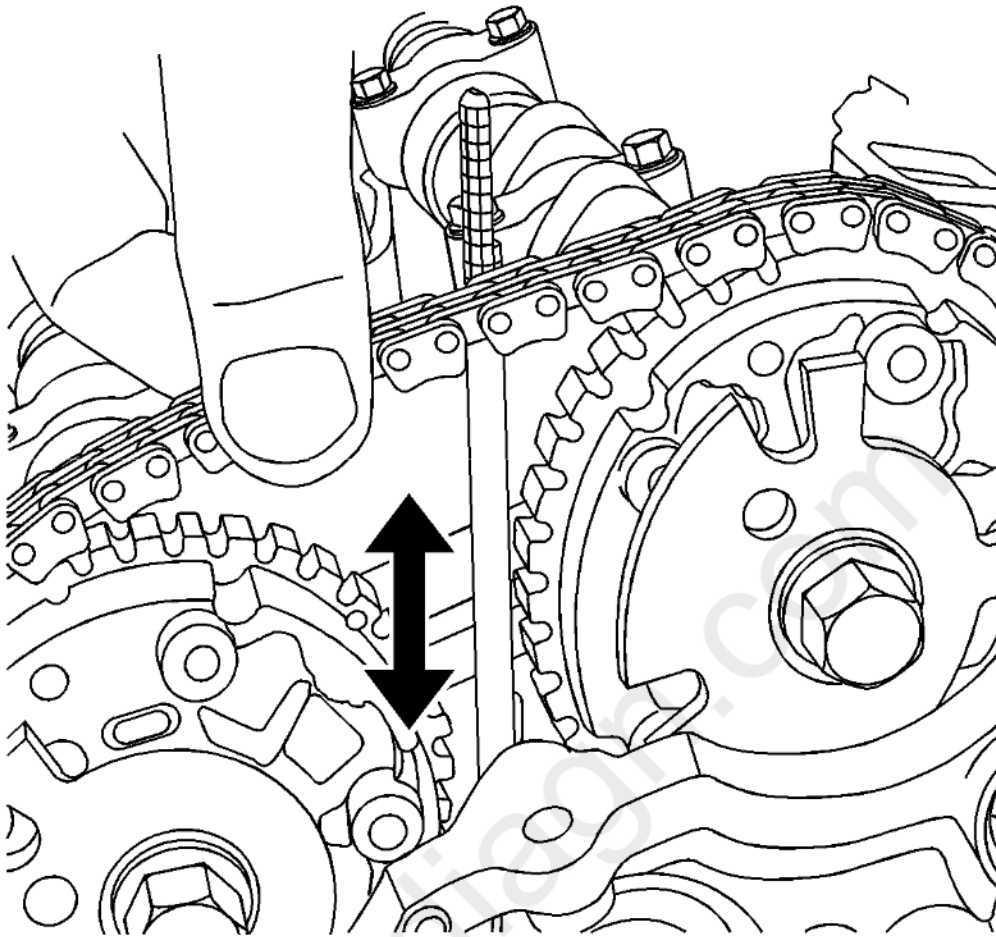


Fig. 213: Slack In Timing Drive Chain
Courtesy of GENERAL MOTORS CORP.

23. With **EN49982-2**: retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown.

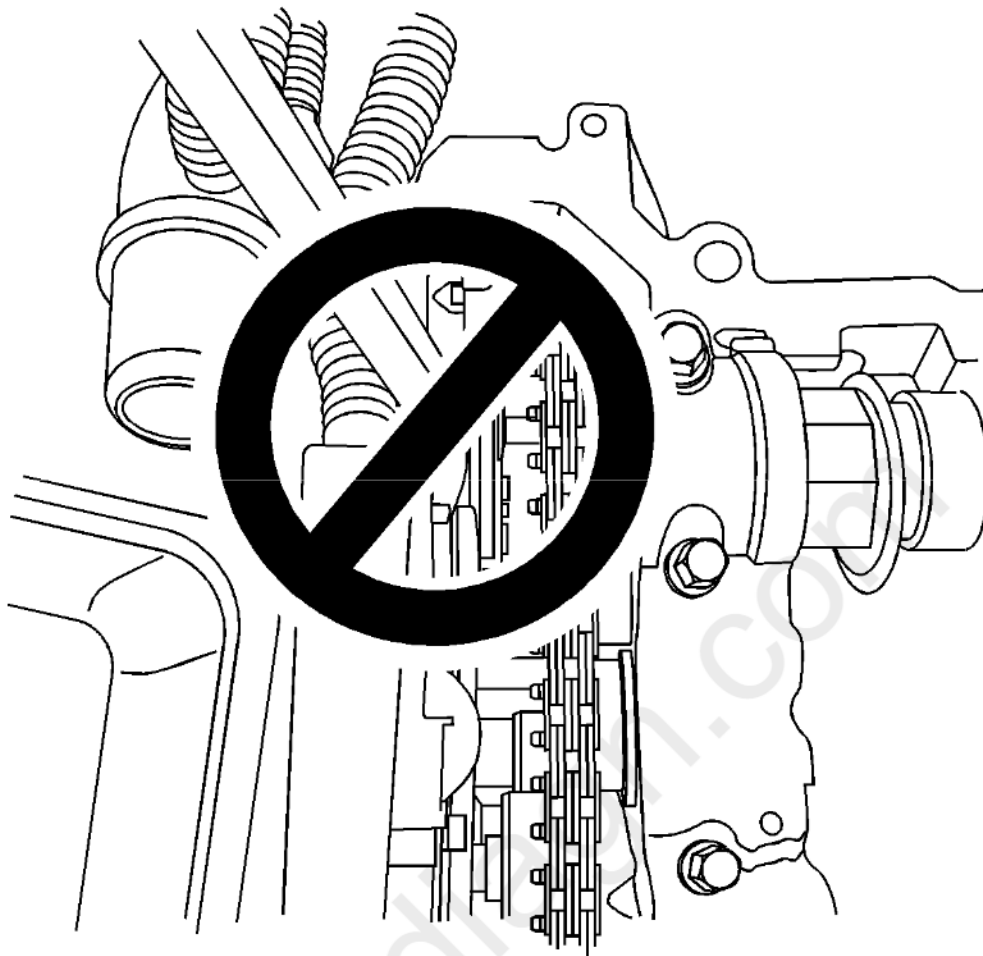


Fig. 214: Do Not Pry Warning
Courtesy of GENERAL MOTORS CORP.

24. Do not pry against the face of the camshaft position actuators or the position actuator retaining bolt.

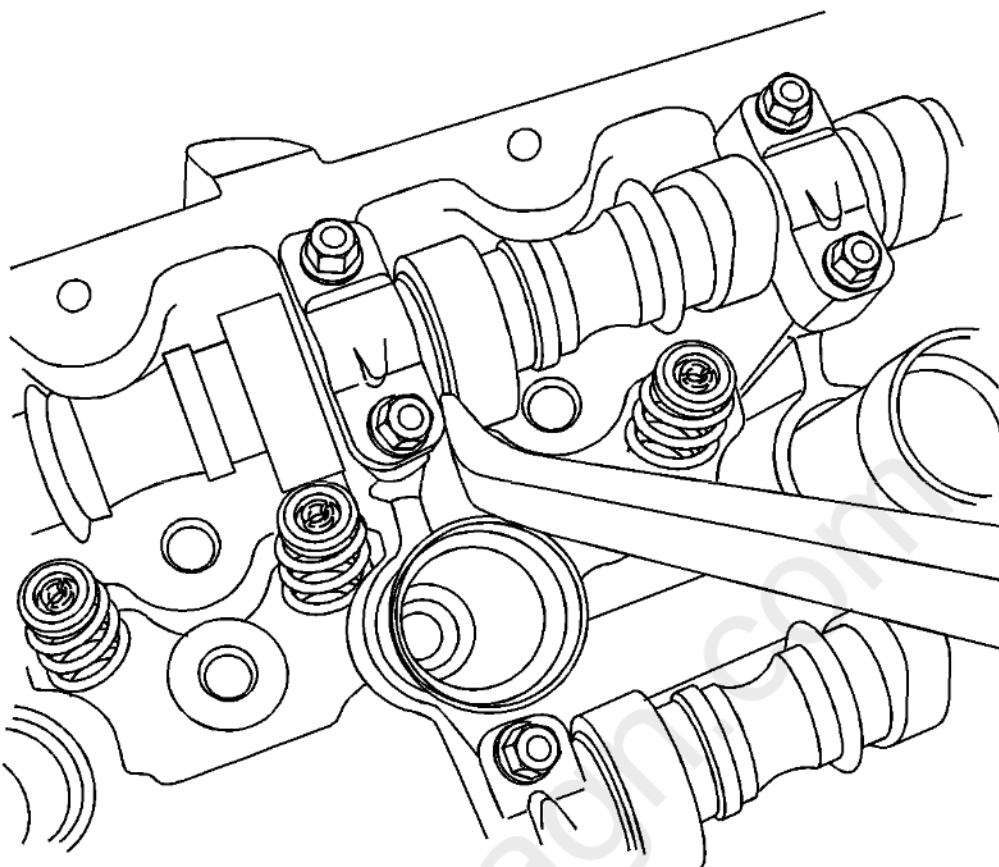


Fig. 215: Prying Camshaft Forward
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine.

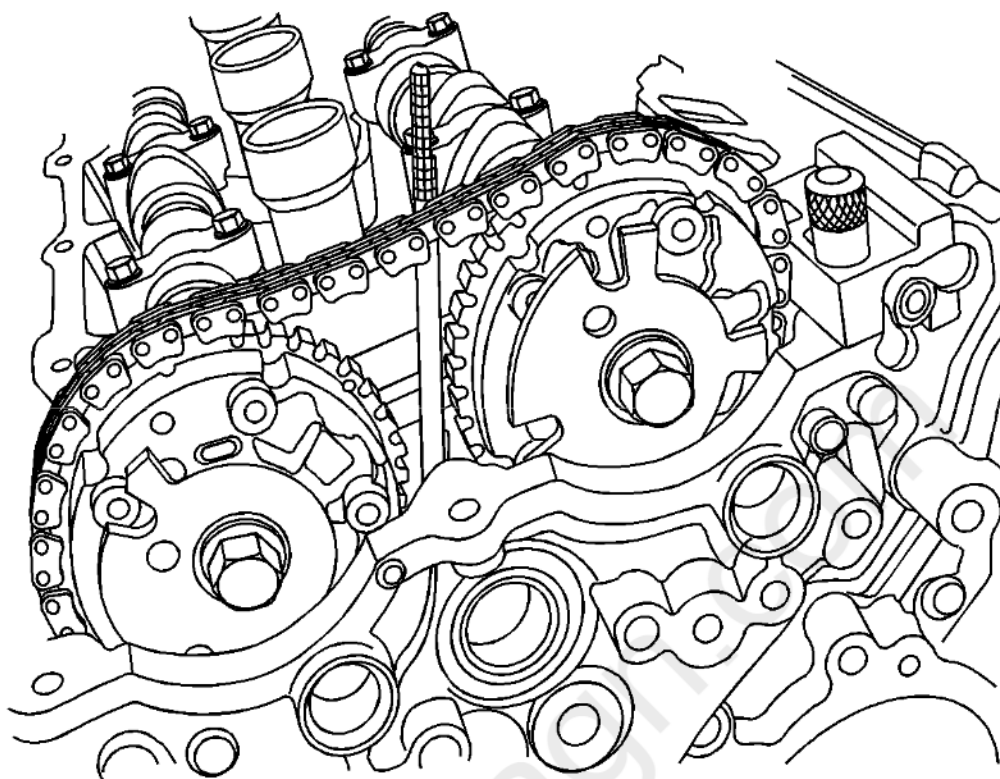


Fig. 216: Identifying Retainer Position
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not move or disturb the EN49982: retainer components after their installation or the timing chains may be lost inside the front cover.

26. The EN49982-1: retainer and EN49982-2: retainer should be in position as shown in illustration , they must be left in position during the servicing of the camshaft position actuator(s) and/or camshaft(s).

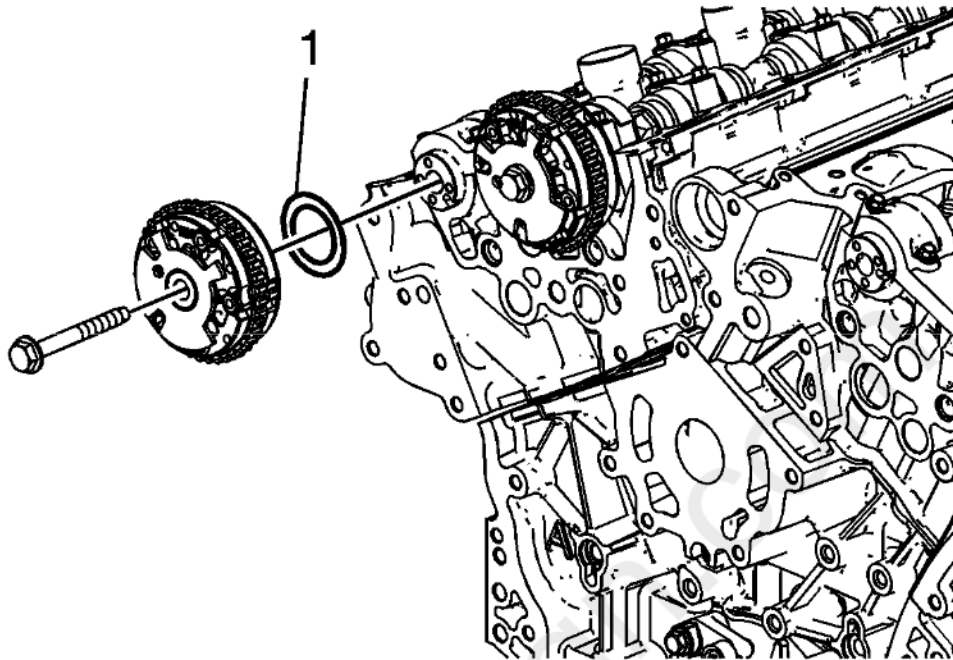


Fig. 217: Plastic Thrust Washers
Courtesy of GENERAL MOTORS CORP.

27. Remove and capture the plastic thrust washers (1) in the following steps. Ensure the plastic thrust washer does not fall into the front cover area.

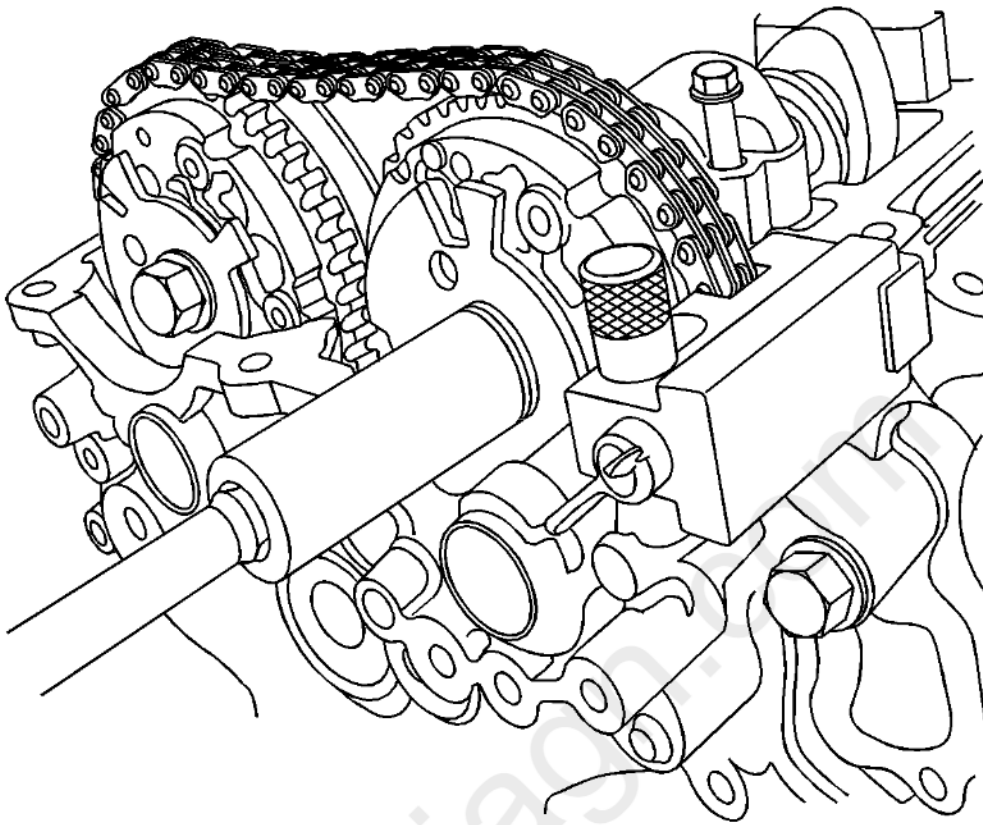


Fig. 218: View Of Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS CORP.

28. To remove the intake camshaft position actuator, remove the loosened retaining bolt. To remove only the exhaust camshaft position actuator, skip the steps for removing the intake camshaft position actuator. However, the **EN49982-1**: retainer **MUST** be installed as discussed even if the intake side will not be serviced or the timing of the camshaft chains will be lost.

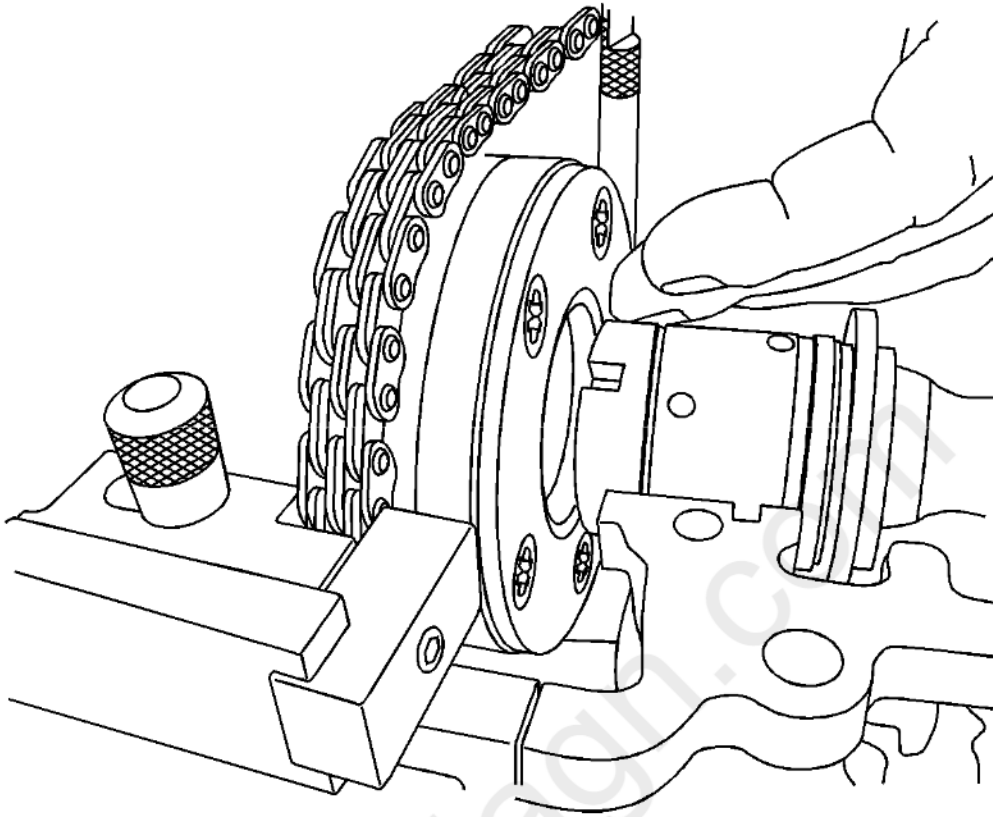


Fig. 219: Sliding Camshaft Position Actuator Off End Of Intake Camshaft
 Courtesy of GENERAL MOTORS CORP.

29. Slide the camshaft position actuator forward and off the end of the intake camshaft. The slot in the **EN49982-1**: retainer will allow the tool to move forward enough to disengage the camshaft position actuator from the front of the camshaft. Remove the plastic thrust washer when removing the camshaft position actuator from the end of the camshaft.

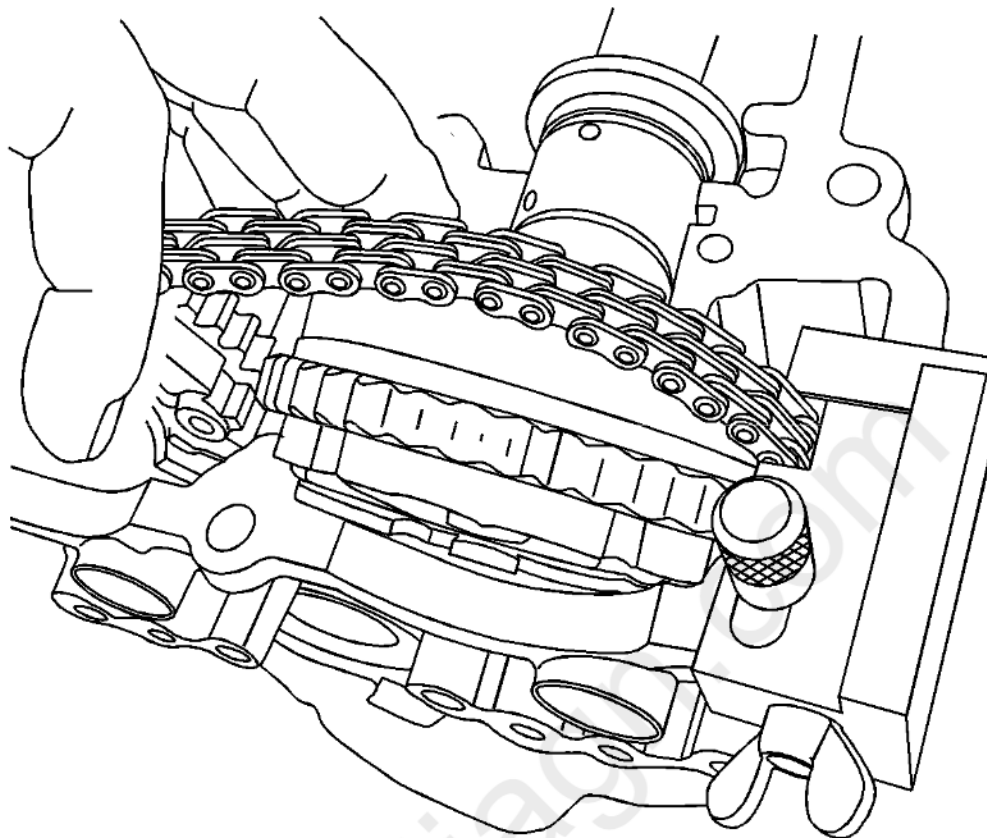


Fig. 220: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS CORP.

30. Tilt the camshaft position actuator forward and out/away from the engine.

NOTE: **DO NOT** remove the EN49982: retainers. They are holding the cam chains to maintain their properly-timed positions.

31. Allow the chain to rest on the EN49982-1: retainer and EN49982-2: retainer in position during service.

INSTALLATION PROCEDURE

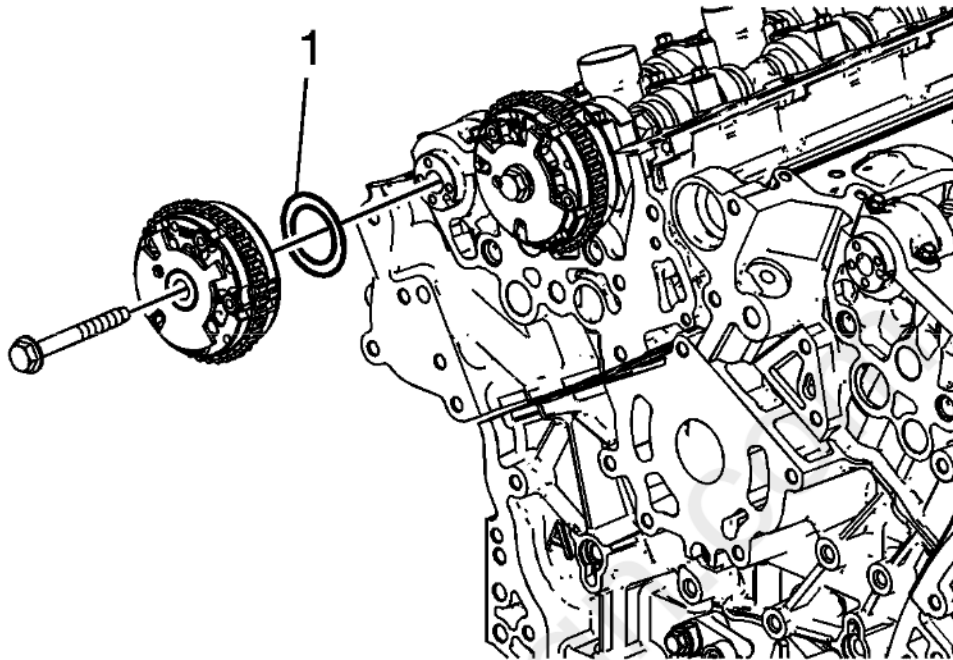


Fig. 221: Plastic Thrust Washers
Courtesy of GENERAL MOTORS CORP.

1. Install plastic camshaft position actuator thrust washer (1) between cylinder head face and camshaft position actuator on assembly.

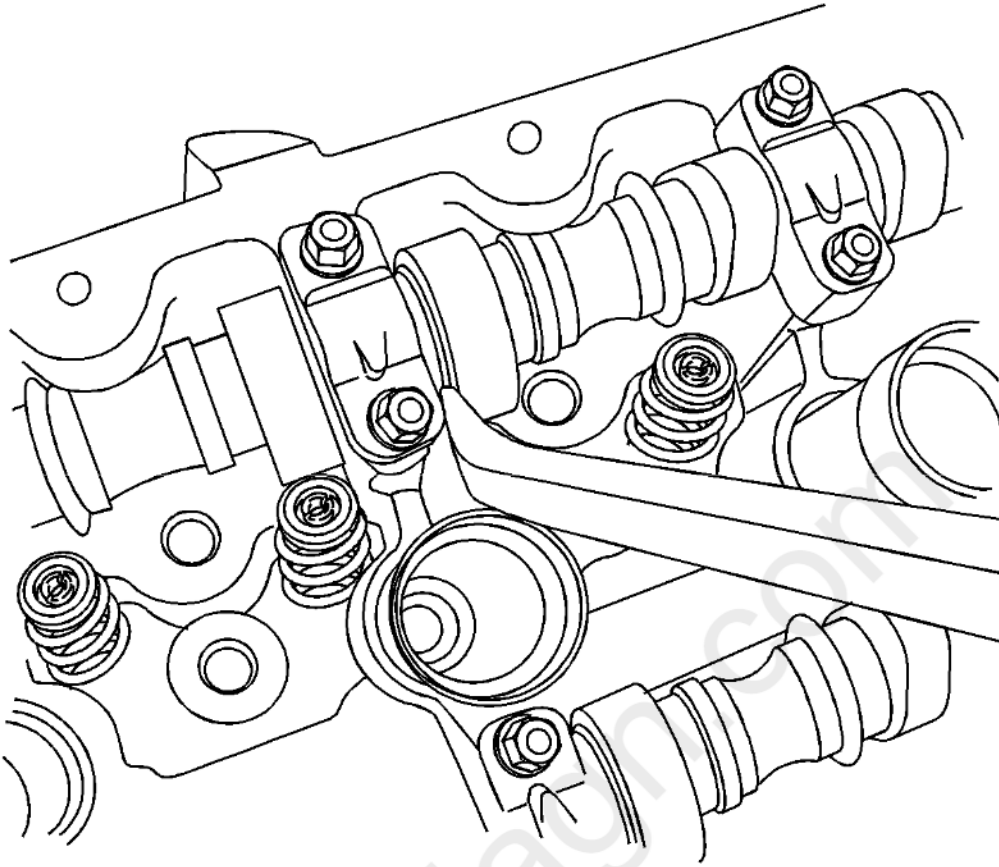


Fig. 222: Prying Camshaft Forward
Courtesy of GENERAL MOTORS CORP.

2. It may help to carefully pry the camshaft forward and to move the **EN49982-1**: retainer backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.

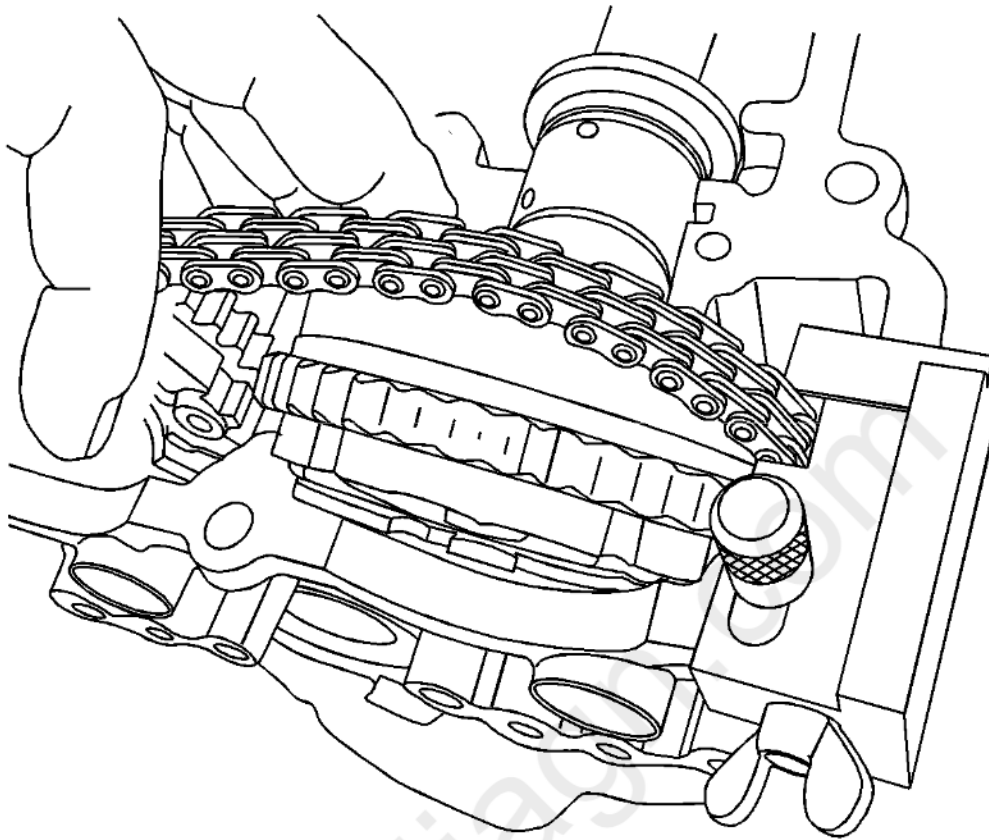


Fig. 223: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure plastic thrust washer is in place before installing the actuator.

3. Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator.

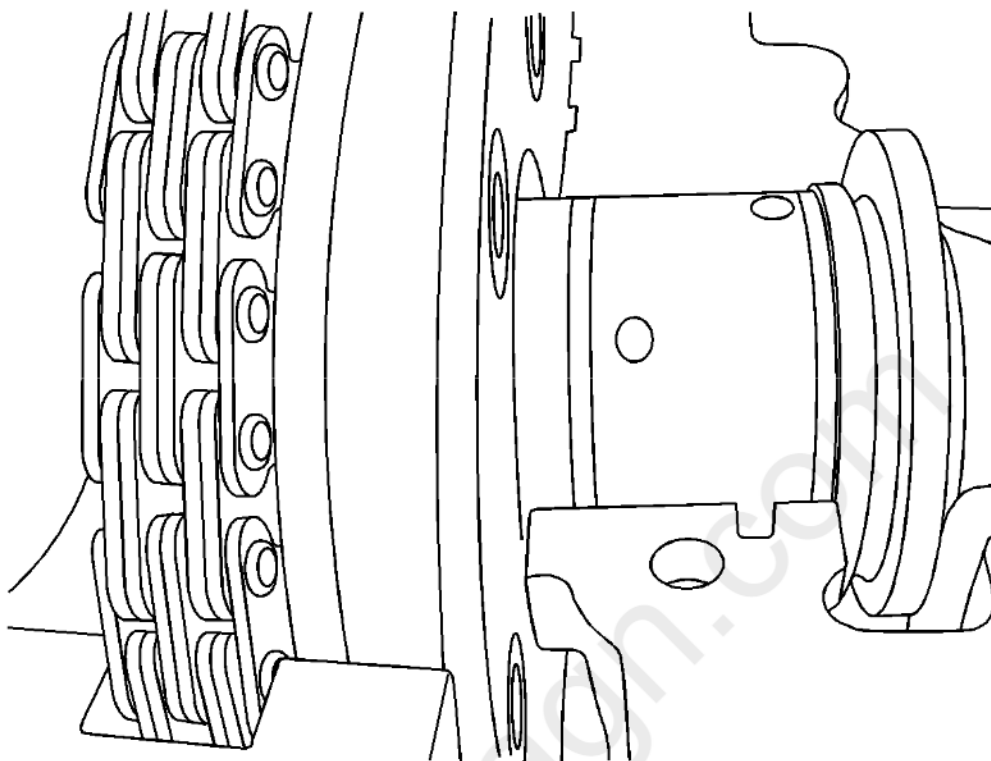


Fig. 224: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS CORP.

4. Ensure the camshaft position actuator fits snugly to the end of the camshaft.

CAUTION: Refer to.

5. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
6. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
7. Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.

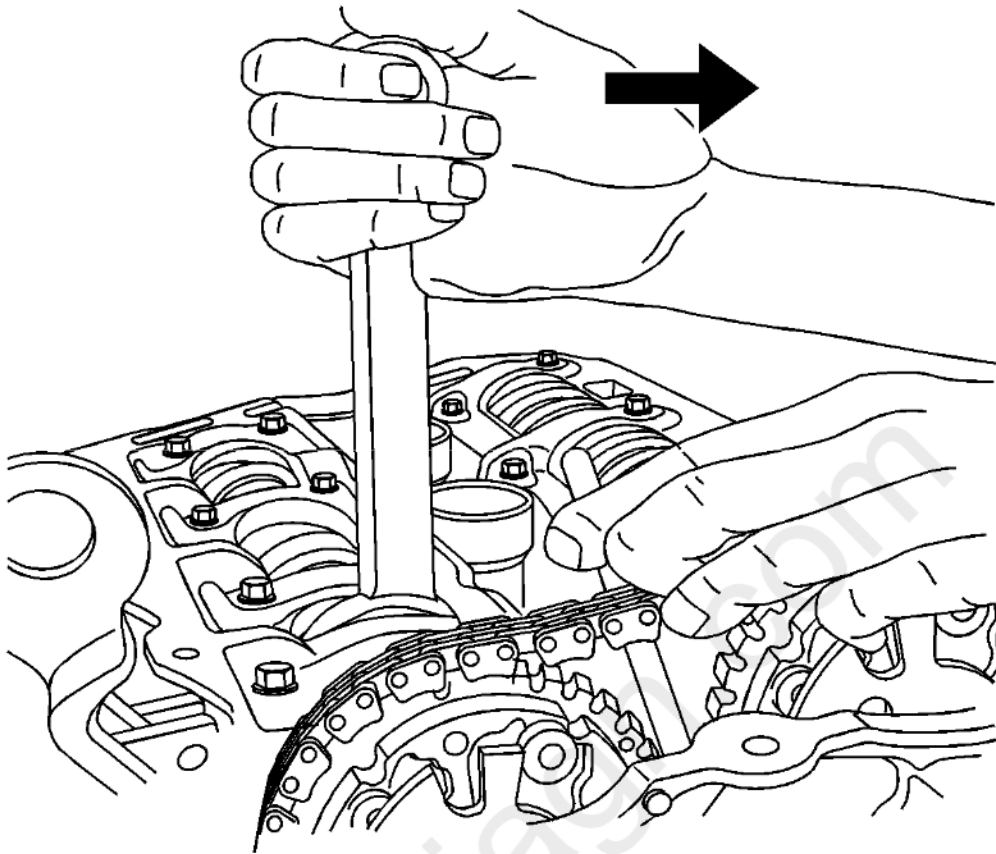


Fig. 225: Rotating Camshaft

Courtesy of GENERAL MOTORS CORP.

8. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the **EN49982-2** retainer.
9. Remove EN49982-2 retainer.
10. Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.

NOTE: **Double-check the marks on the camshaft position actuators and chains to ensure they are correct.**

11. Torque one or both camshaft position actuator retaining bolts to 58 N.m (43 lb ft).

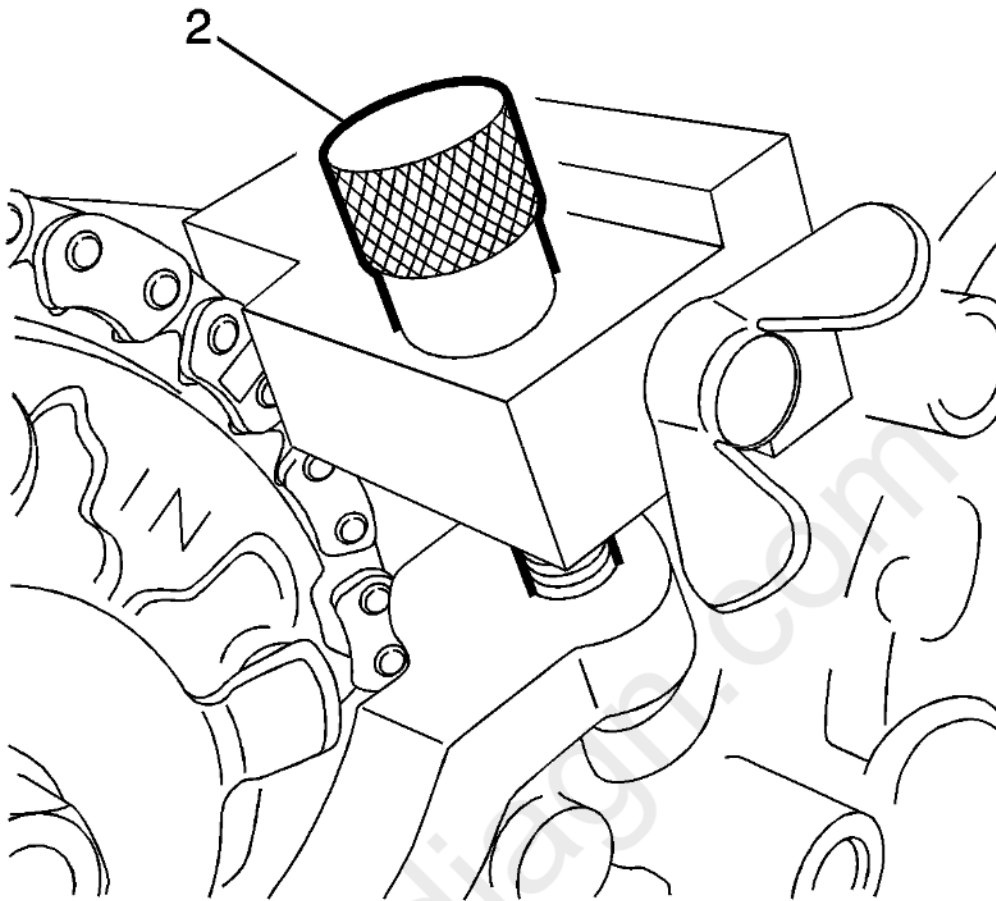


Fig. 226: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS CORP.

12. Unscrew the wingnut on **EN49982-1**: retainer to release timing chain, and then remove **EN49982-1**: retainer from the front cover by unscrewing the thumbscrew (2).

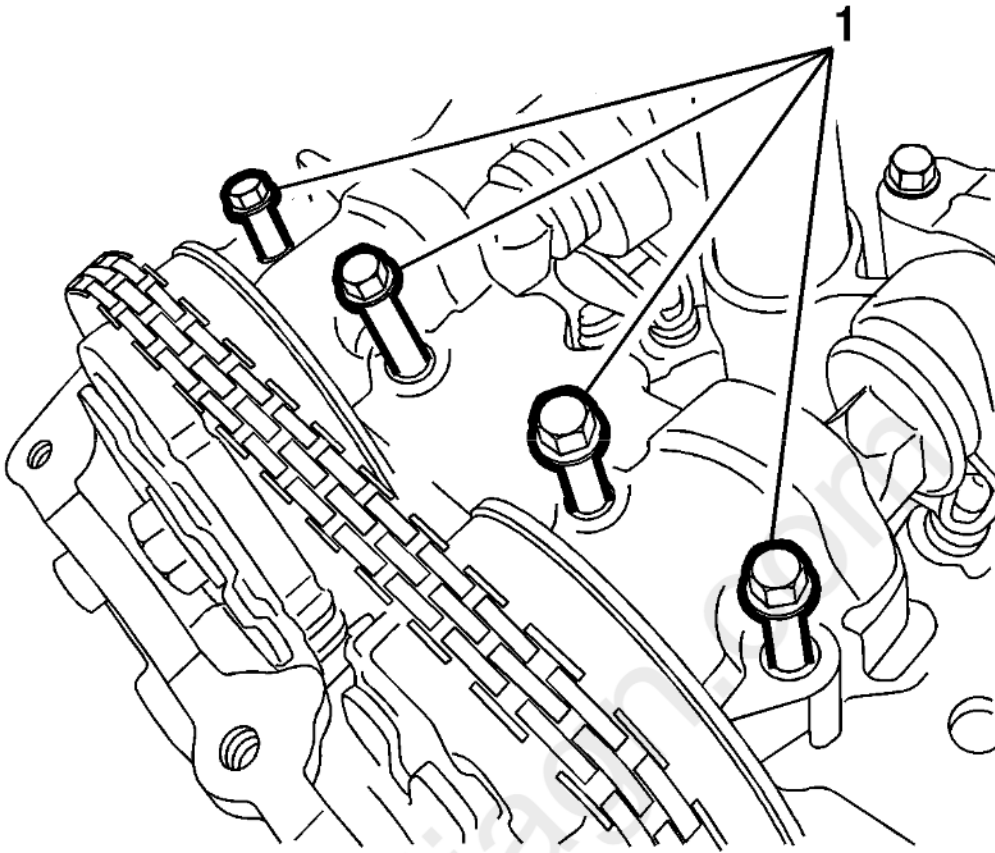


Fig. 227: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install camshaft front cap and bolts (1).
14. Tighten the camshaft front cap outer bolts to 10 N.m (89 lb in).
15. Tighten the camshaft front cap inner bolts to 10 N.m (89 lb in).
16. Install the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
17. Install the camshaft position actuator solenoid valve solenoid-intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
18. Install the intake camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
19. Install the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** .
20. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LF1 OR LFW)

SPECIAL TOOLS

EN-48313: Timing Chain Retention Tool

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

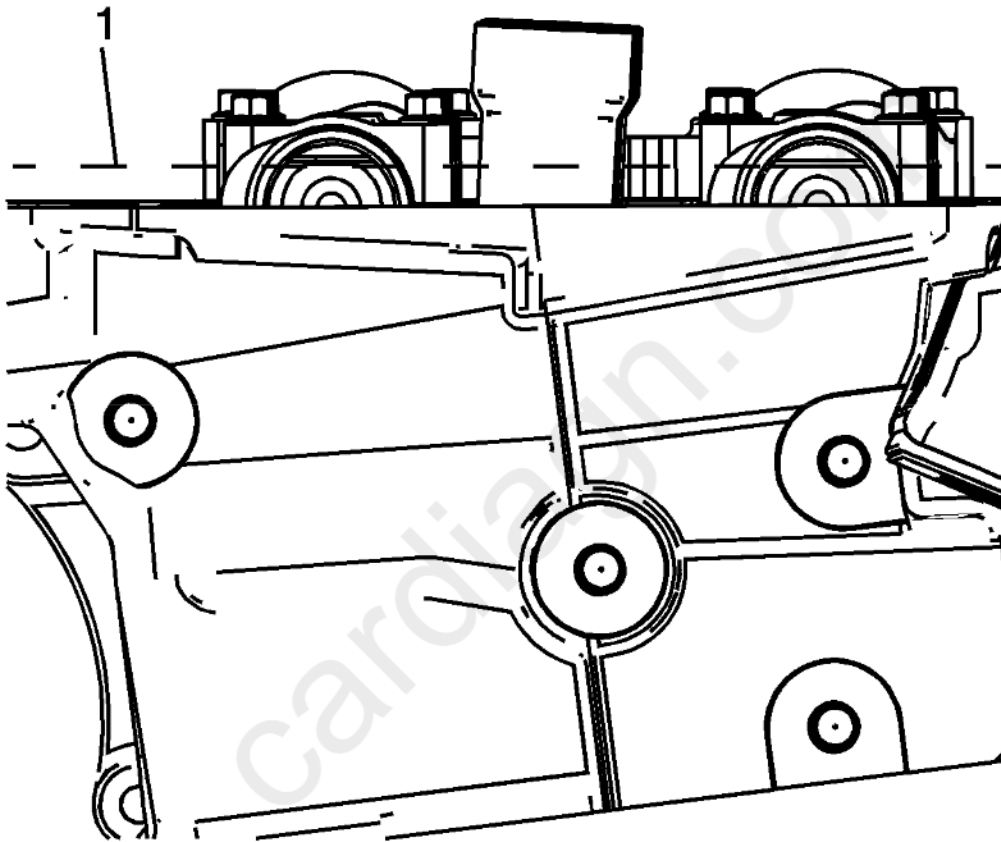
REMOVAL PROCEDURE

Fig. 228: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7)** or **Camshaft Cover Replacement - Left Side (LLT)**.
3. Remove the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
4. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position**

Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust .

NOTE: Rotate the crankshaft balancer bolt in a clockwise direction **ONLY**.

5. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).

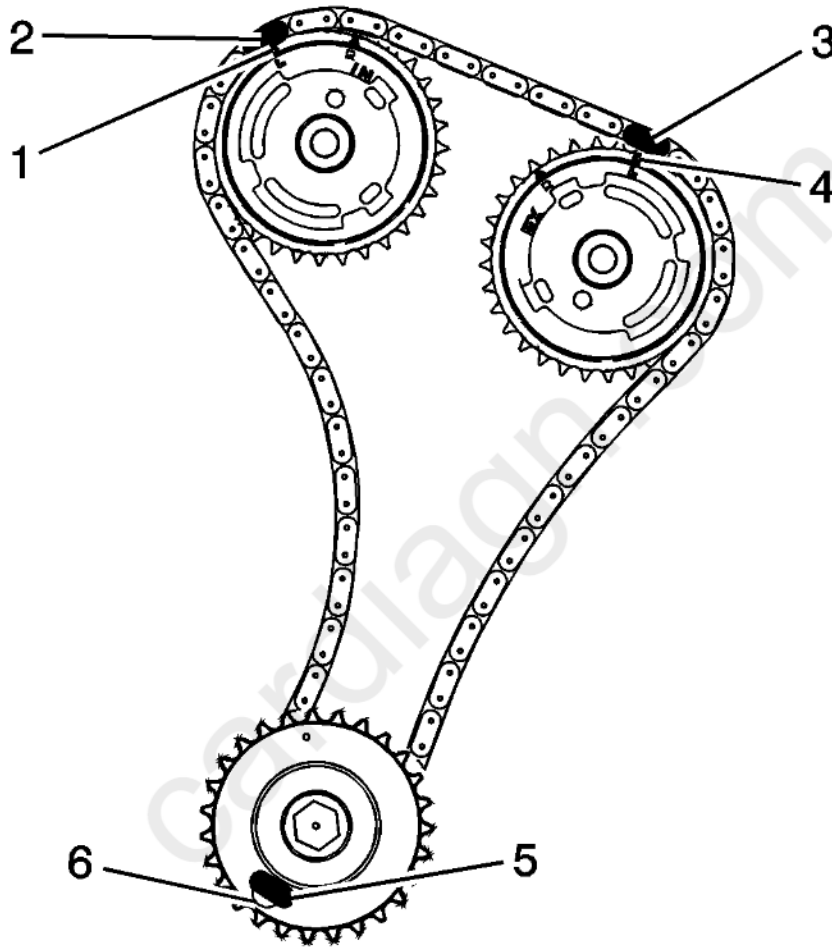


Fig. 229: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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

6. Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1).
7. Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

8. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

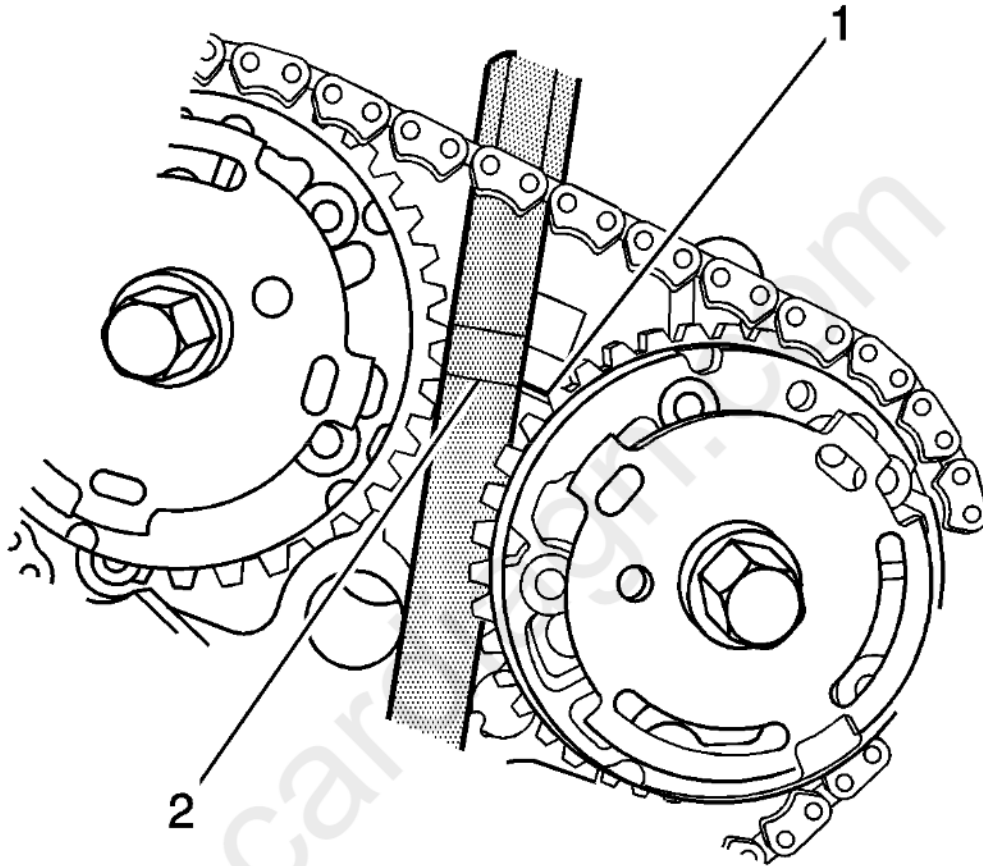


Fig. 230: View Of Retention Tool & Cylinder Head
Courtesy of GENERAL MOTORS CORP.

9. Unscrew the **EN-48313**: tool so that the legs of the tool are retracted.
10. Insert the **EN-48313**: tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.

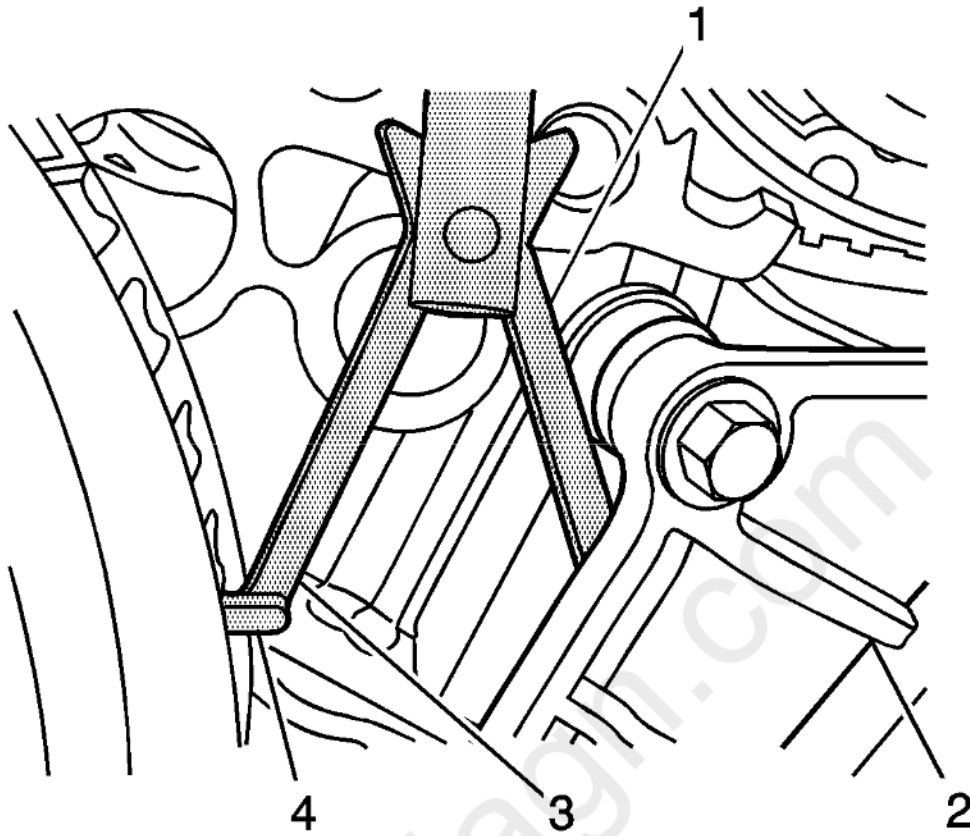


Fig. 231: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover is removed for clarity in the following graphics, but **NOT** required to perform the procedure.

11. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
12. Partially expand the legs (1, 3) of the **EN-48313** tool by turning the T-shaped handle clockwise.
13. Insert the leg of the tool (1) behind the timing chain guide (2).
14. Continue expanding the **EN-48313** tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.

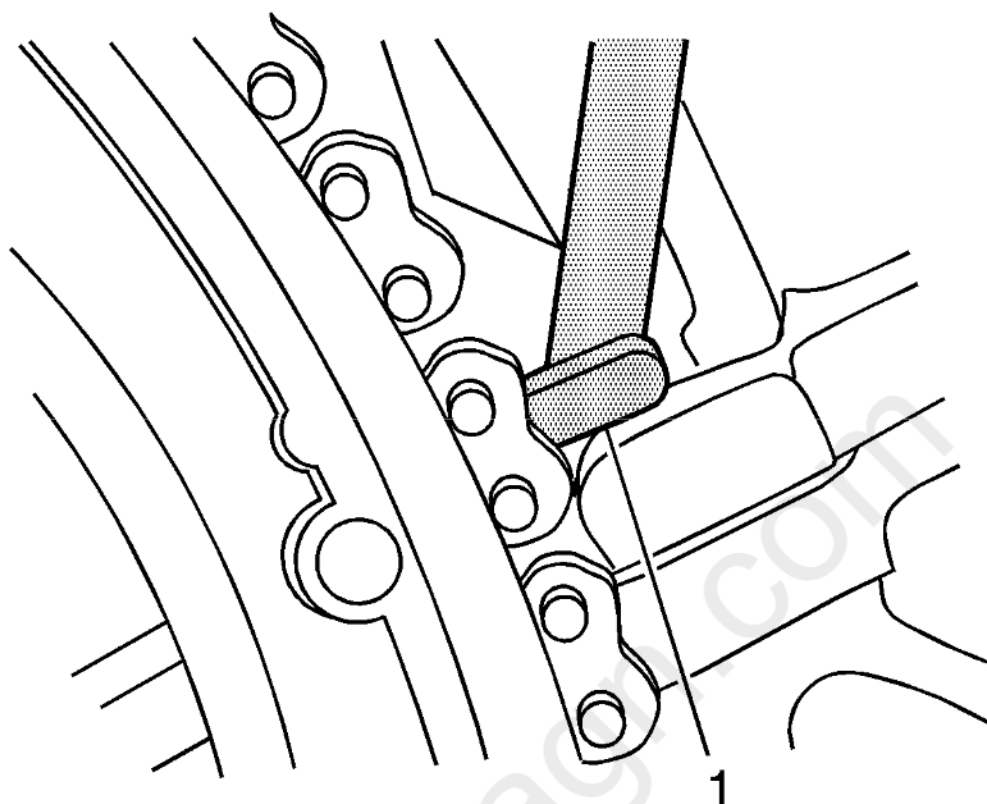


Fig. 232: Foot of Timing Chain Retention Tool EN-48313
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the foot (1) of the EN-48313: tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313: tool.

15. Hand tighten the **EN-48313:** tool.
16. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

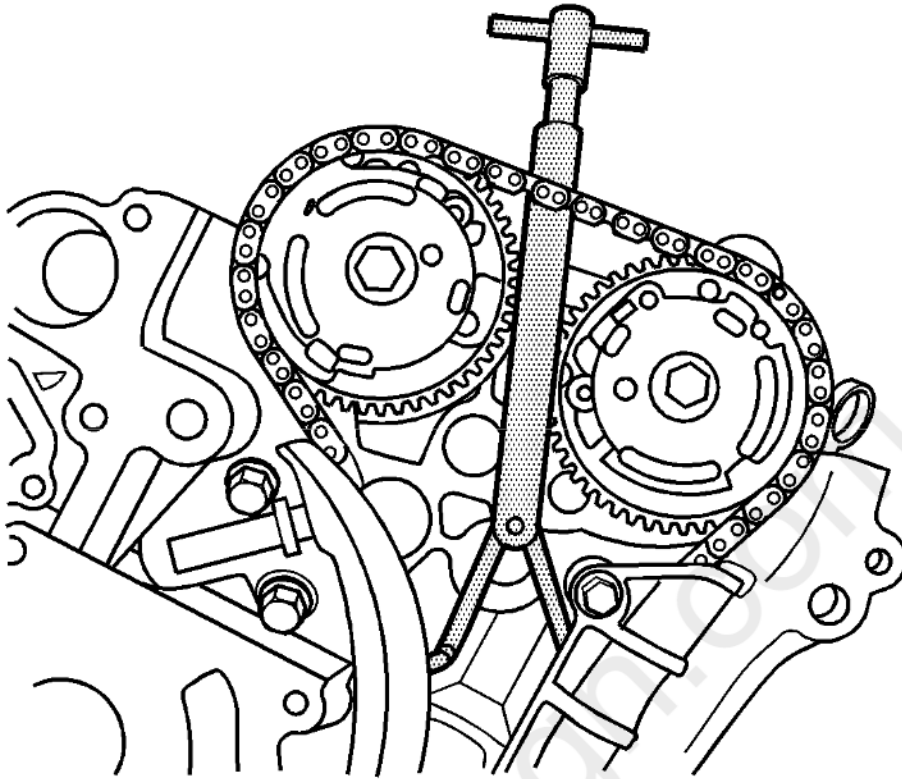


Fig. 233: Timing Chain Retention Tool EN-48313
Courtesy of GENERAL MOTORS CORP.

17. The **EN-48313** tool is now properly installed to hold the timing chain in position.

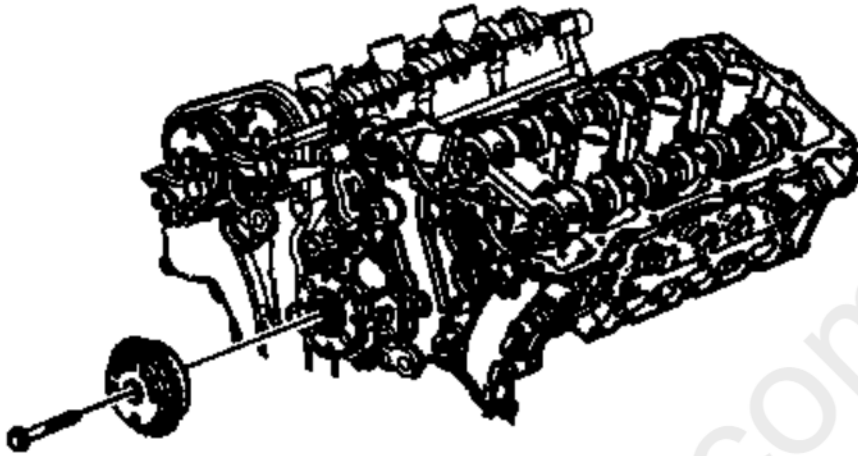


Fig. 234: View of Left Exhaust Camshaft Position Actuator And Bolt
Courtesy of GENERAL MOTORS CORP.

18. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
19. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
20. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
21. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313** tool once the actuators have been removed.
22. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
23. Remove the camshaft thrust washer.

INSTALLATION PROCEDURE

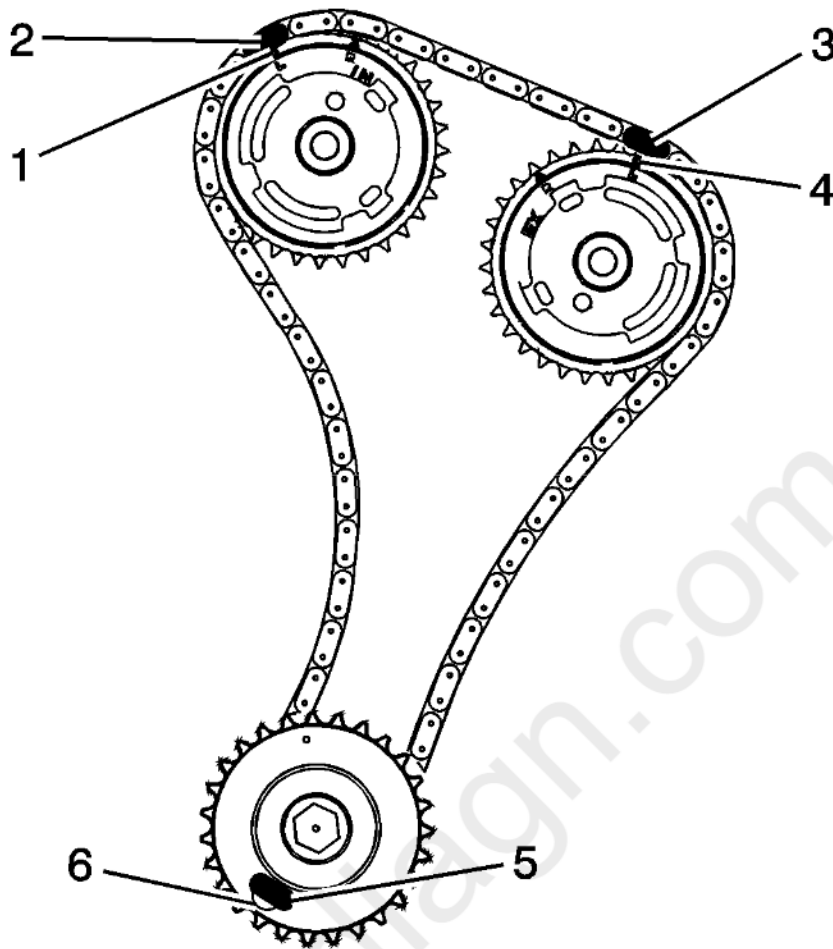


Fig. 235: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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

1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.
2. Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
3. Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
4. Remove the **EN-48313** tool.

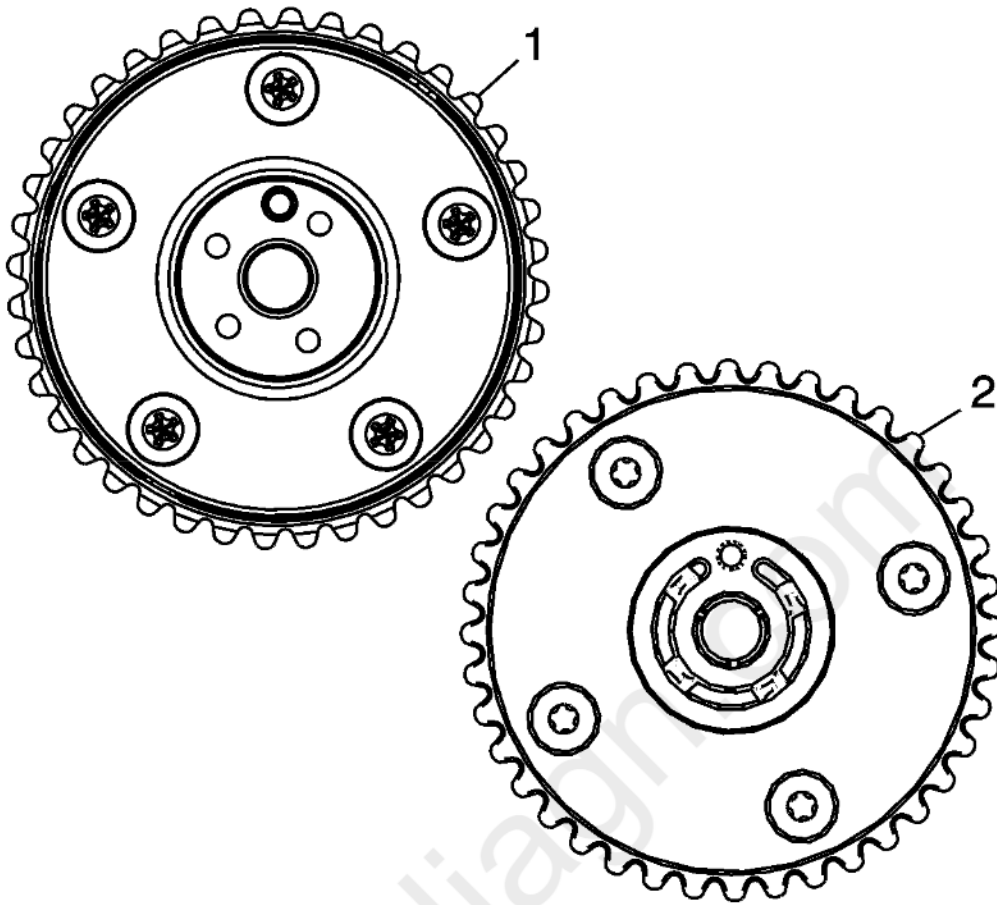


Fig. 236: Identifying Different Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE:

- The camshaft position actuator will vary depending on application.
- Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.

5. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).
6. Install the thrust washer, if applicable.

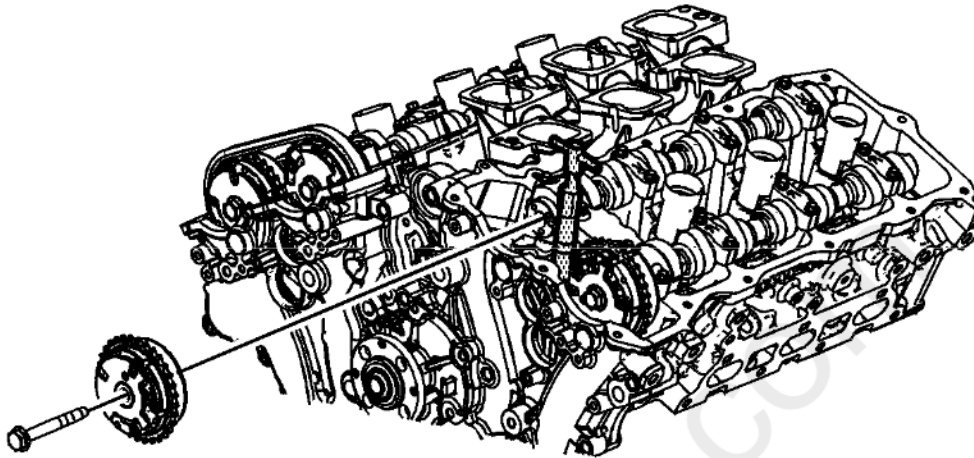


Fig. 237: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to.

7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
8. If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
9. If both the exhaust and intake has been replaced, then tighten bolt to 58 N.m (43 lb ft).
10. Install the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
11. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
12. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7) or Camshaft Cover Replacement - Left Side (LLT)**.

13. Install the intake manifold. Refer to [Intake Manifold Replacement](#).

SETTING CAMSHAFT TIMING

IMPORTANT: Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.

Follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to [Secondary Camshaft Intermediate Drive Chain Replacement - Left Side](#).

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2011 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - CTS

CAMSHAFT REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

EN-48313 Timing Chain Retention Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)** .
2. Remove the left bank camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7)** or **Camshaft Cover Replacement - Left Side (LLT)** .
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
4. Remove the camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** .

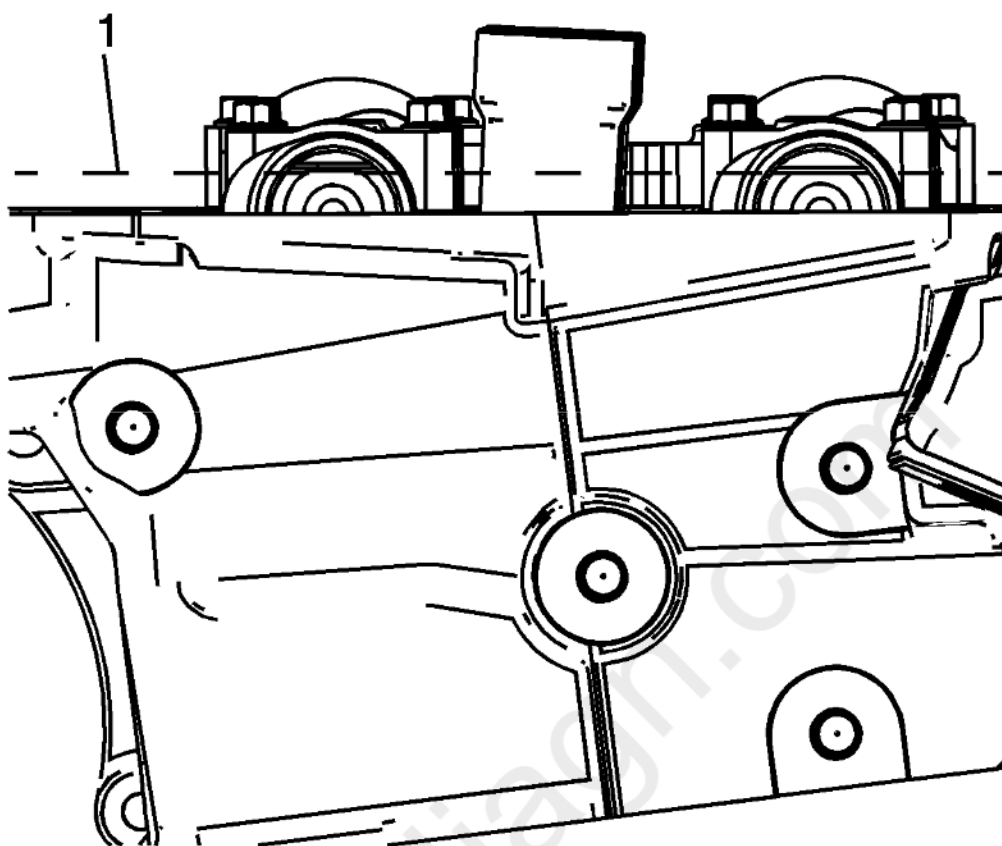


Fig. 1: Camshaft Flats Parallel with Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

NOTE: Rotate the crankshaft balancer in a clockwise rotation ONLY.

5. Rotate the crankshaft using the crankshaft balancer bolt until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).

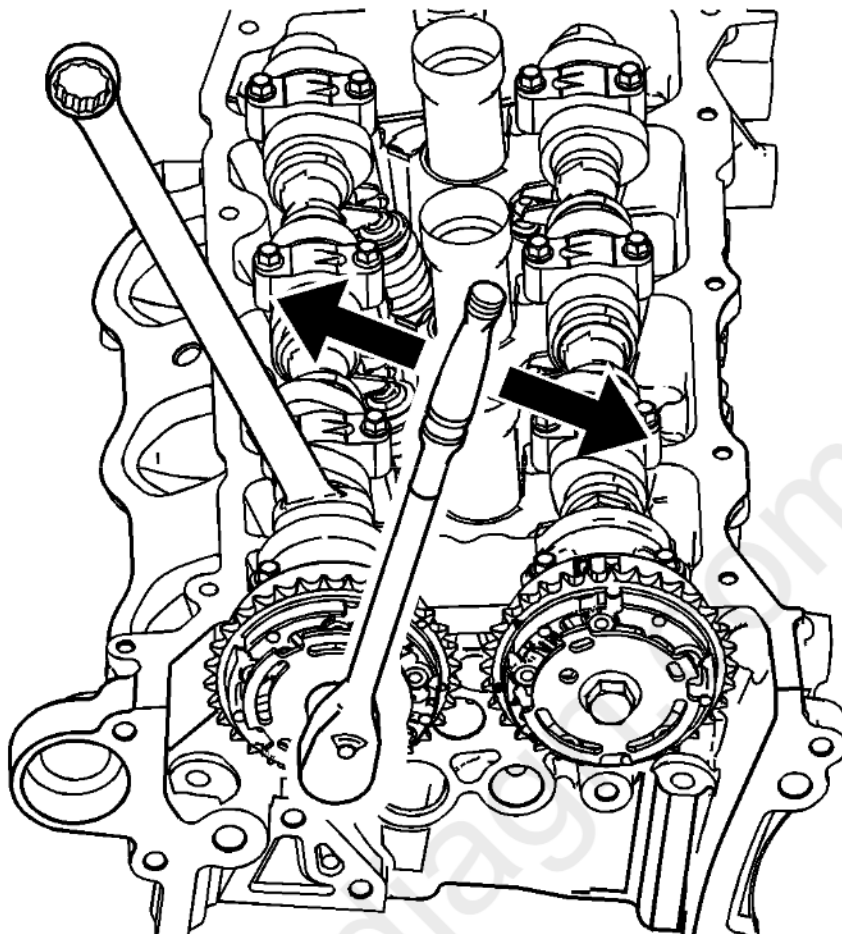


Fig. 2: View of Camshaft/Engine Rotation Prevention Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE:

- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator bolt at this time.

6. Loosen the camshaft position actuator bolt.

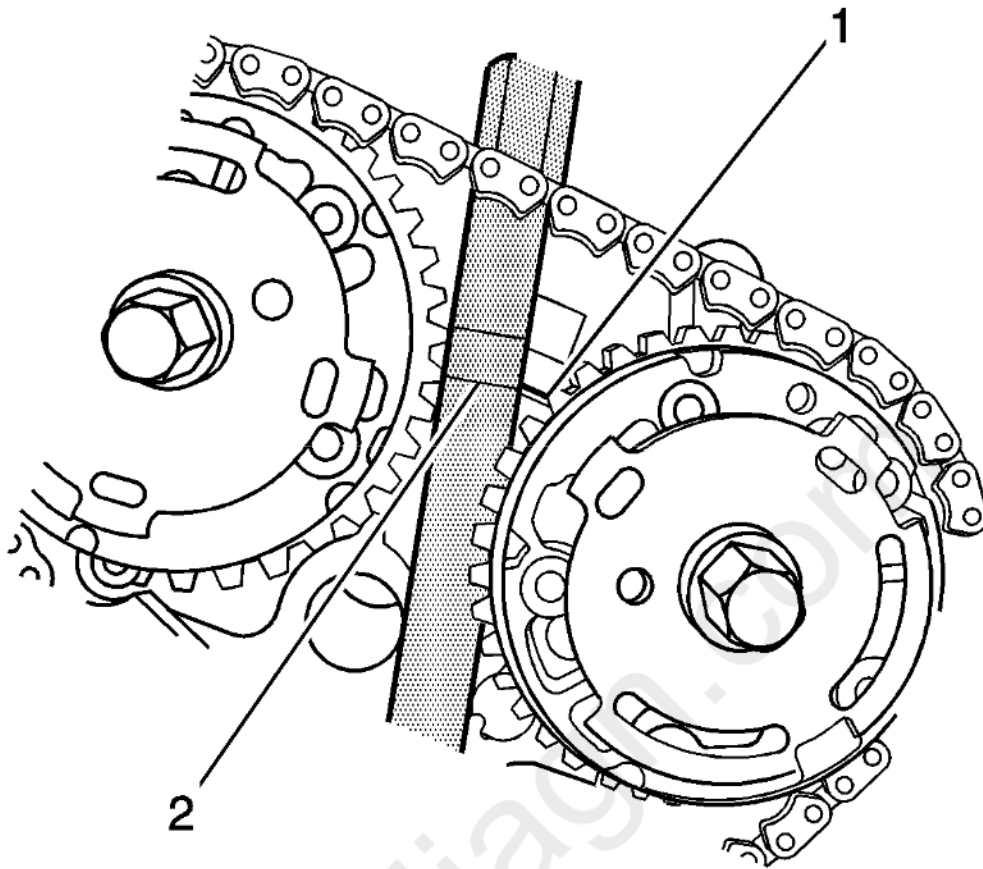


Fig. 3: View Of Retention Tool & Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Unscrew the **EN-48313** so that the legs of the tool are retracted. See **Special Tools** .
8. Insert the **EN-48313** between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position. See **Special Tools** .

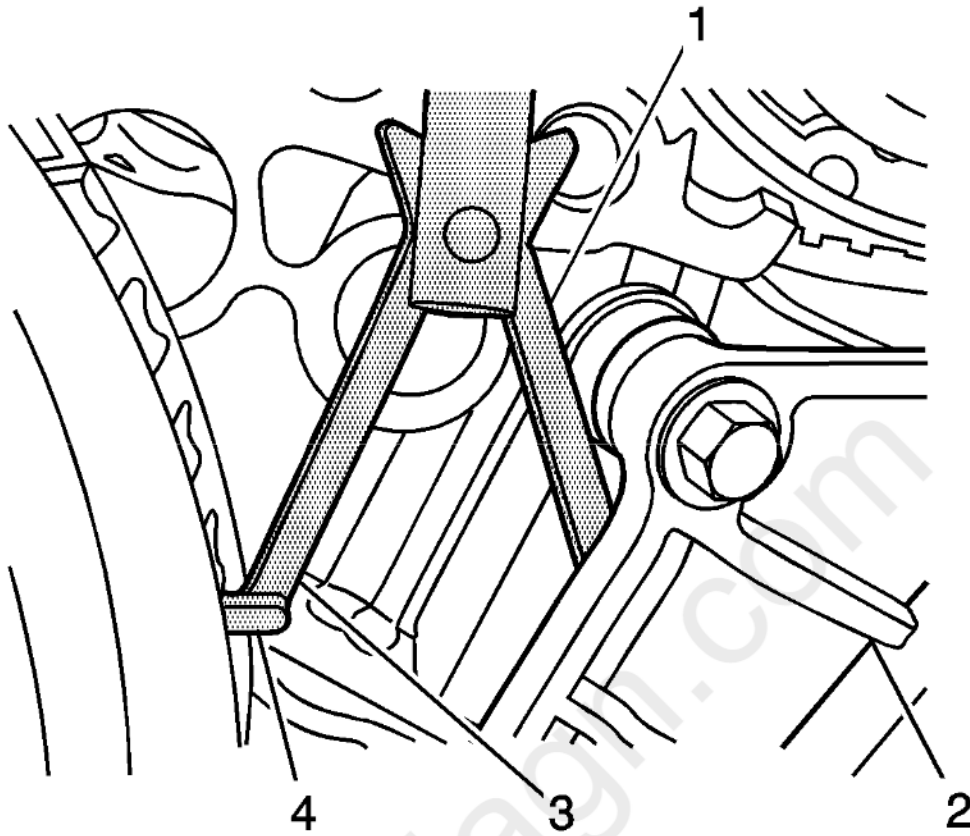


Fig. 4: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover is removed for clarity in the following graphics, but NOT required to perform the procedure.

9. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
10. Partially expand the legs (1, 3) of the **EN-48313** by turning the T-shaped handle clockwise. See **Special Tools** .
11. Insert the leg of the tool (1) behind the timing chain guide (2).
12. Continue expanding the **EN-48313** until the legs (1, 3) contact the timing chain. Do not tighten at this time. See **Special Tools** .

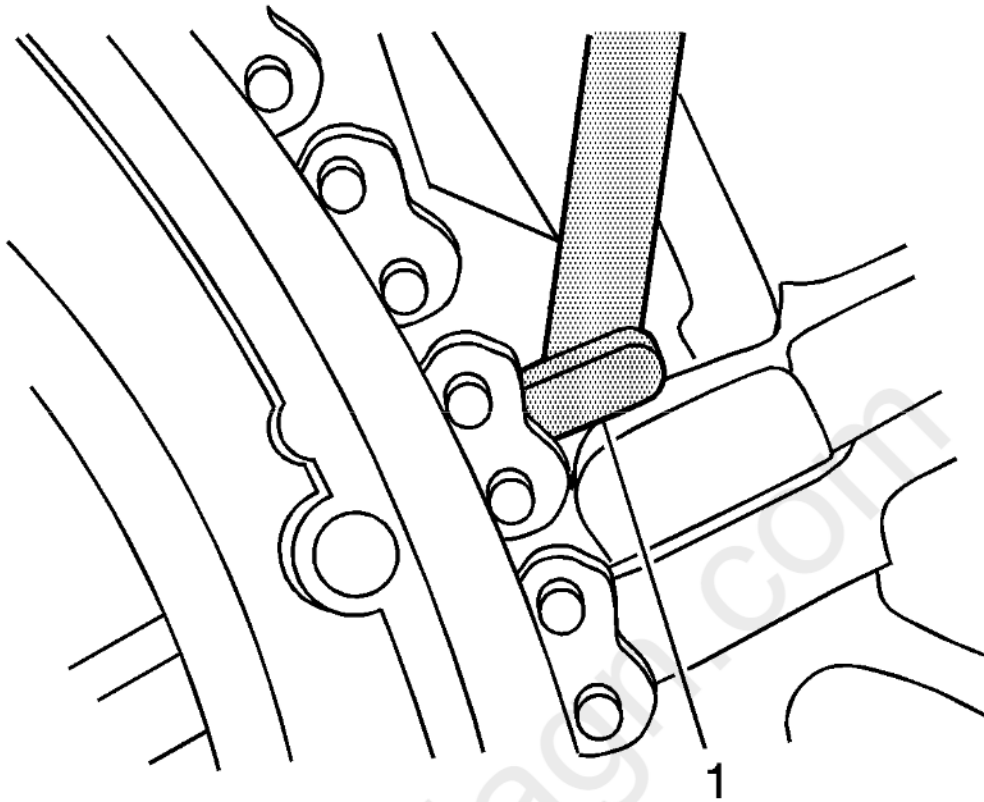


Fig. 5: Foot of Timing Chain Retention Tool EN-48313

Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the foot (1) of the EN-48313 is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313 . See Special Tools .

13. Hand tighten the EN-48313 . See Special Tools .

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

14. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

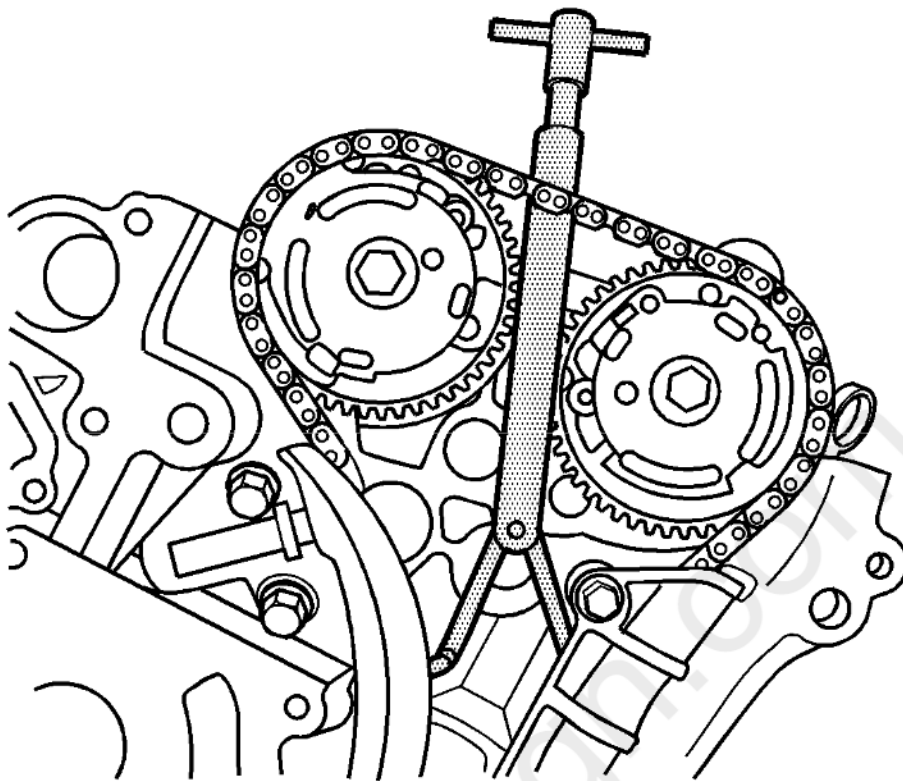


Fig. 6: Timing Chain Retention Tool EN-48313
Courtesy of GENERAL MOTORS CORP.

15. The **EN-48313** is now properly installed to hold the timing chain in position. See **Special Tools** .

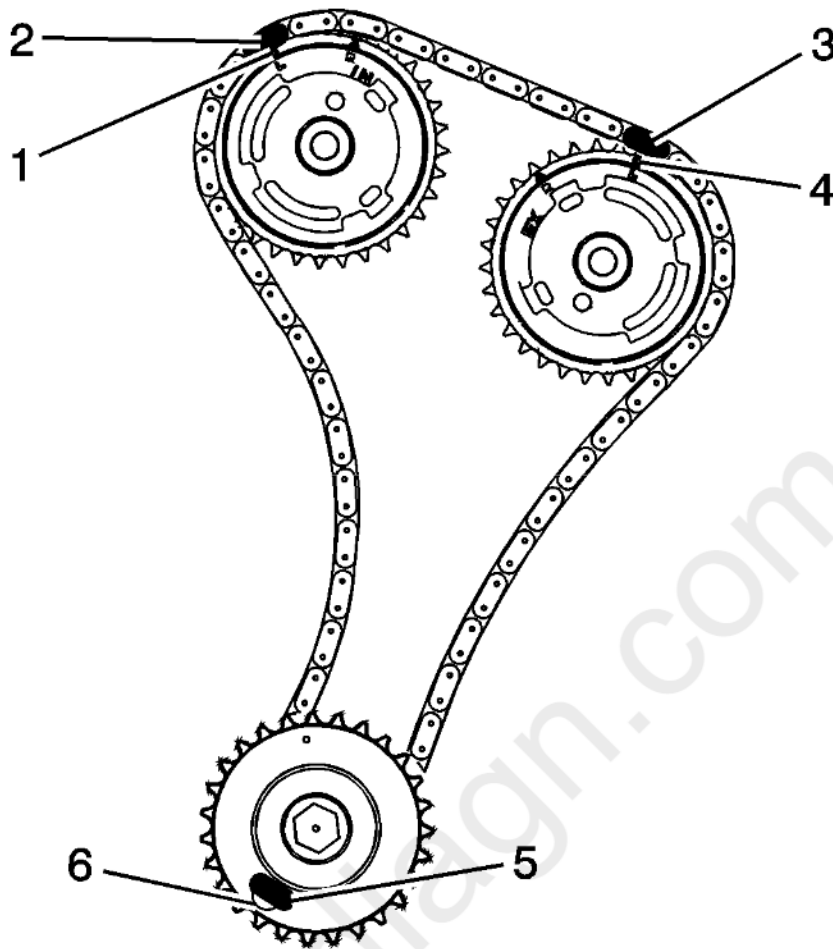


Fig. 7: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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

16. Mark the timing chain and the respective locations on the camshaft position actuators (1-4).
17. Remove the camshaft position actuator bolt.
18. Remove the camshafts. Refer to **Camshaft Removal - Left Side** .

INSTALLATION PROCEDURE

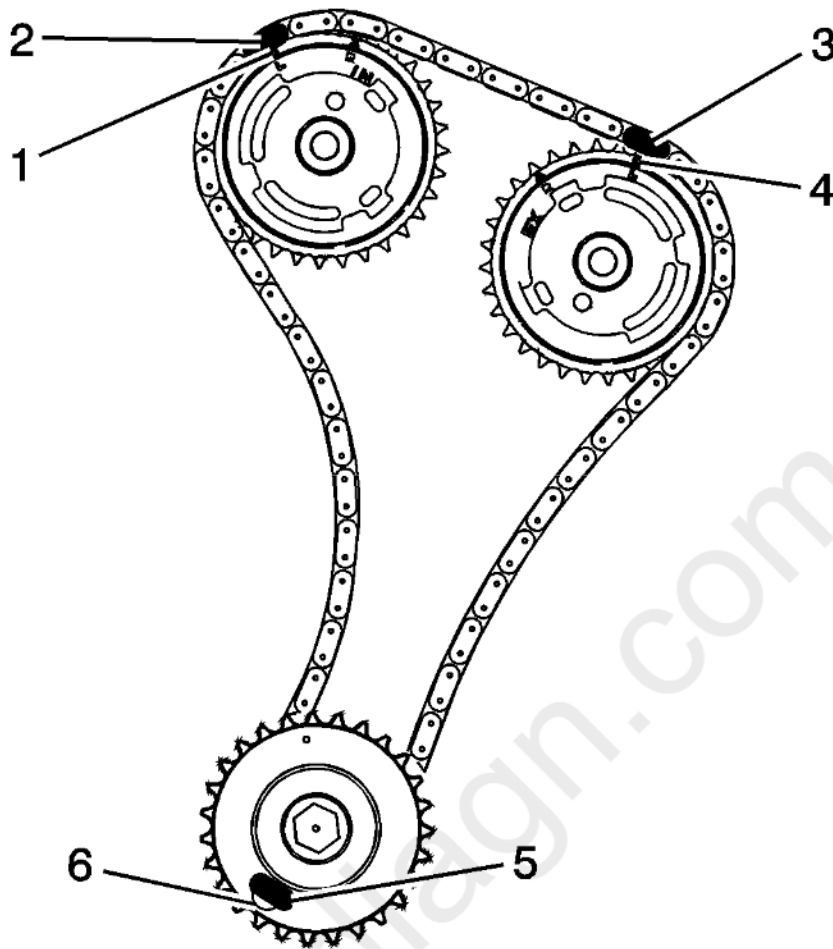


Fig. 8: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

NOTE:

- Ensure that the marks on the camshaft position actuator and the timing chain (1-4) are aligned.
- DO NOT tighten the camshaft position actuator bolt at this time.

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Left Side**.
3. Remove the **EN-48313**. See **Special Tools**.

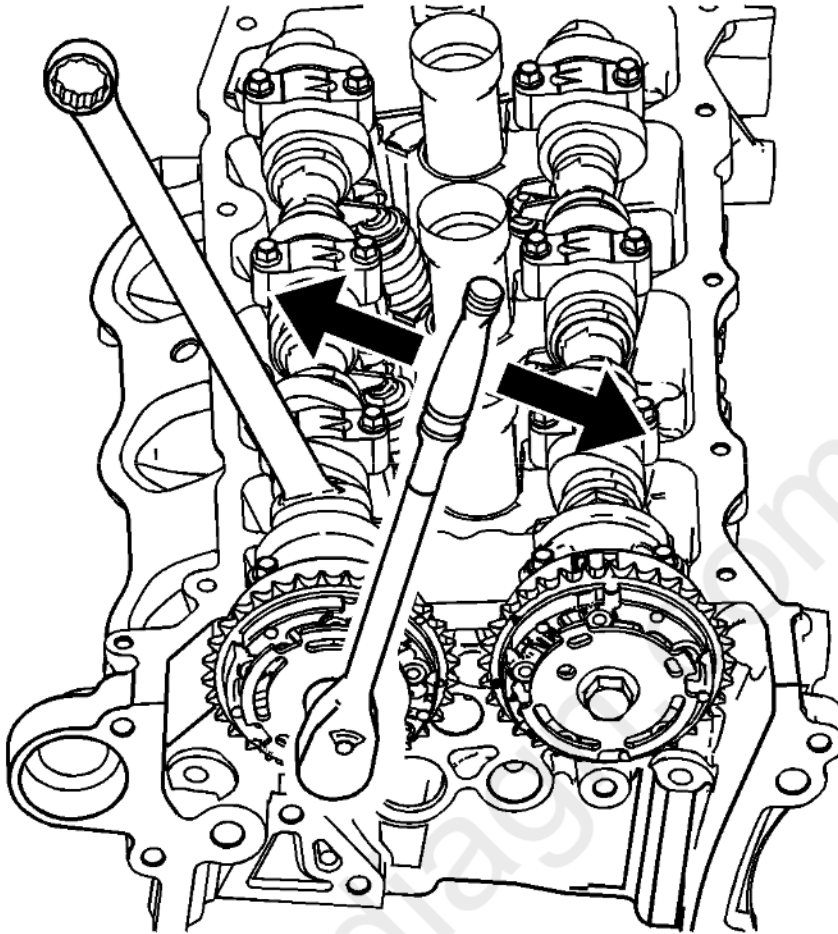


Fig. 9: View of Camshaft/Engine Rotation Prevention Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

4. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Left Side Intake and Camshaft Position Actuator Installation - Left Side Exhaust .
5. Install the intake camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake .
6. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake .
7. Install the camshaft cover. Refer to Camshaft Cover Replacement - Left Side (LP1, LY7) or Camshaft Cover Replacement - Left Side (LLT) .

8. Install the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)** .

CAMSHAFT REPLACEMENT - RIGHT SIDE (LP1, LY7)

SPECIAL TOOLS

EN-48313 Timing Chain Retention Tool. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the upper intake manifold with the lower intake manifold. Refer to **Lower Intake Manifold Replacement (LP1, LY7)** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side** .
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .

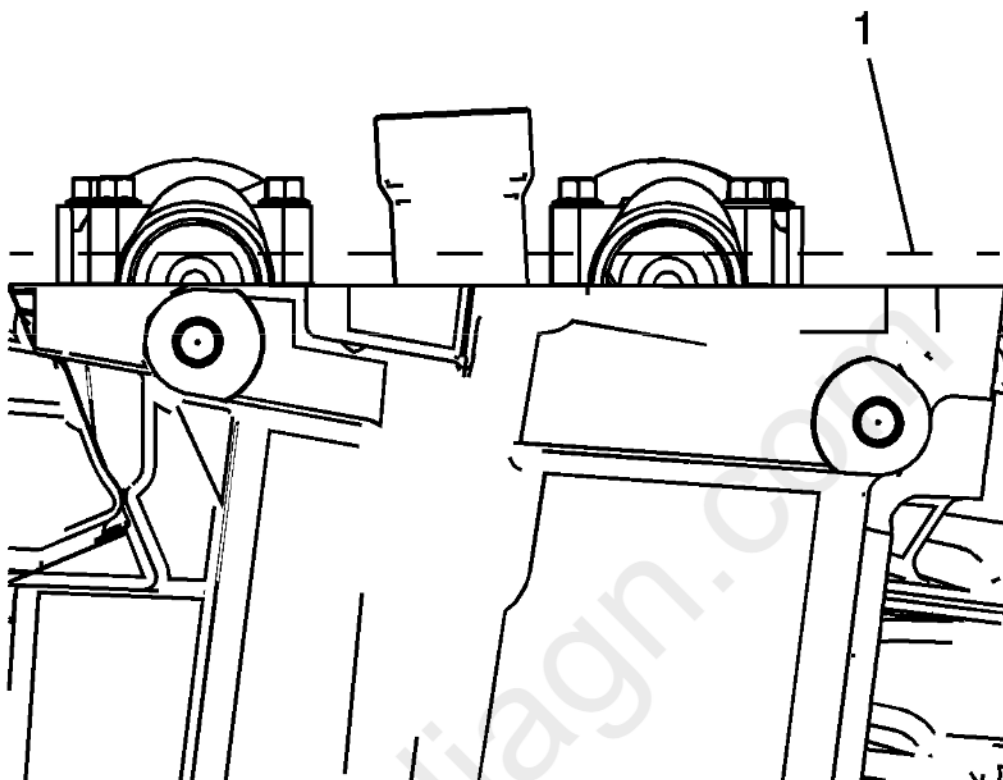


Fig. 10: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS CORP.

NOTE: Rotate the crankshaft balancer in a clockwise rotation ONLY.

5. Rotate the crankshaft using the crankshaft balancer bolt until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).

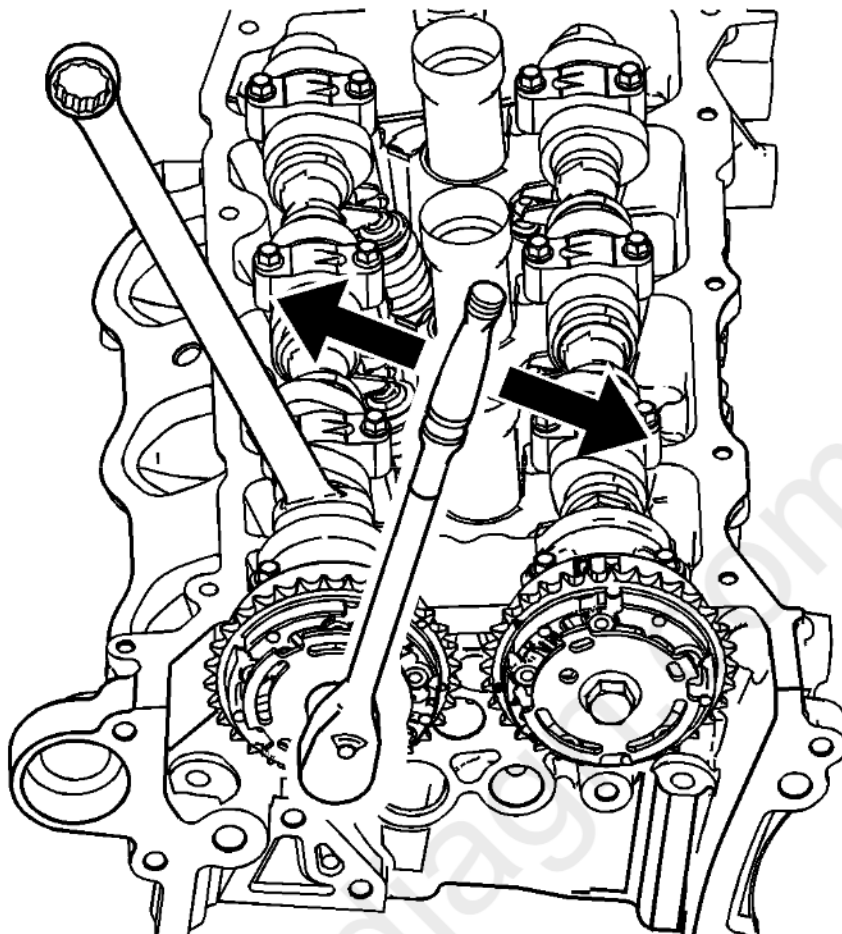


Fig. 11: View of Camshaft/Engine Rotation Prevention Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE:

- Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.
- DO NOT remove the camshaft position actuator bolt at this time.

6. Loosen the camshaft position actuator bolt.

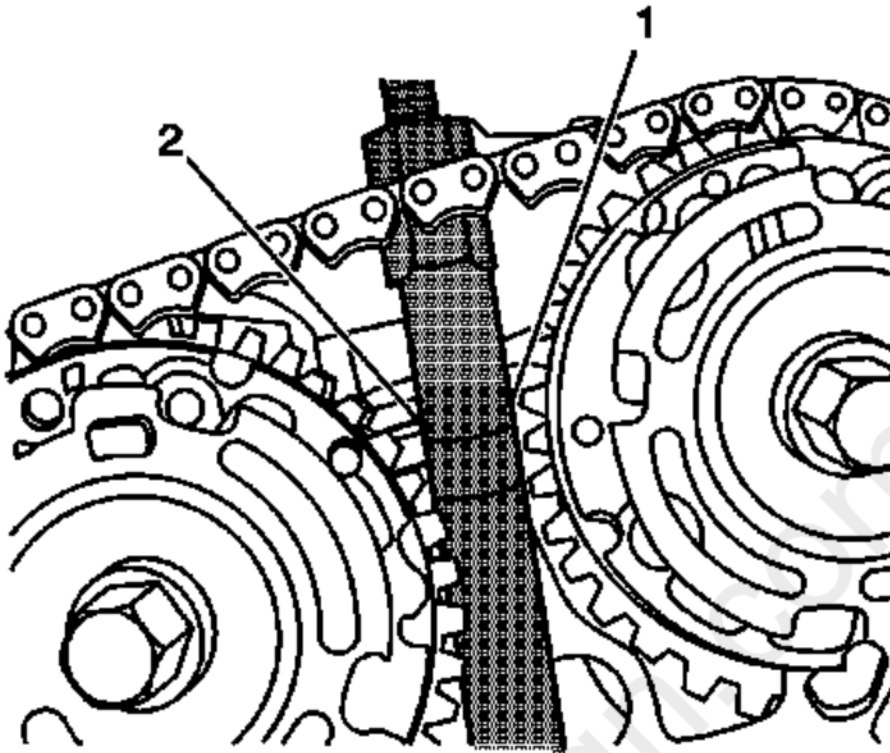


Fig. 12: View Of Special Tool EN-48313 & Camshaft Actuators
Courtesy of GENERAL MOTORS CORP.

7. Unscrew the **EN-48313** so that the legs of the tool are retracted. See **Special Tools** .
8. Insert the **EN-48313** between the camshaft actuators, rearward of the timing chain until the top line that is scribed in the body of the tool (1) is adjacent to the top surface of the cylinder head (2). This is the approximate installed position. See **Special Tools** .

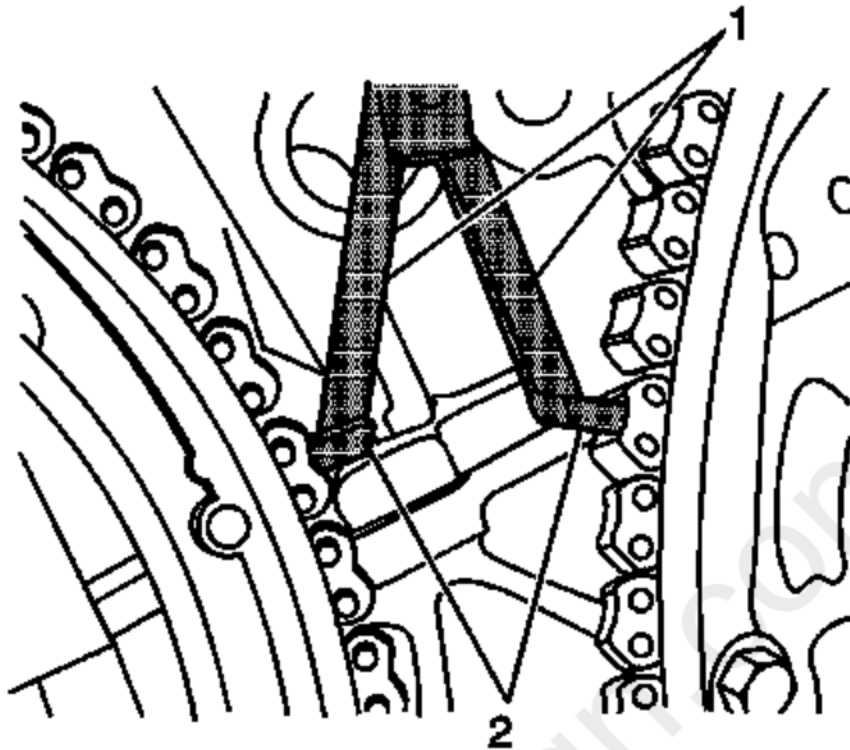


Fig. 13: View Of Feet, Legs of Special Tool & Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover is removed for clarity in the following graphics, but NOT required to perform the procedure.

9. Ensure that the feet (2) on the legs of the tool are facing the front of the engine.
10. Partially expand the legs (1) of the **EN-48313** by turning the T-shaped handle clockwise. See **Special Tools**.
11. Continue expanding the **EN-48313** until the feet (1) contact the timing chain. Do not tighten at this time. See **Special Tools**.

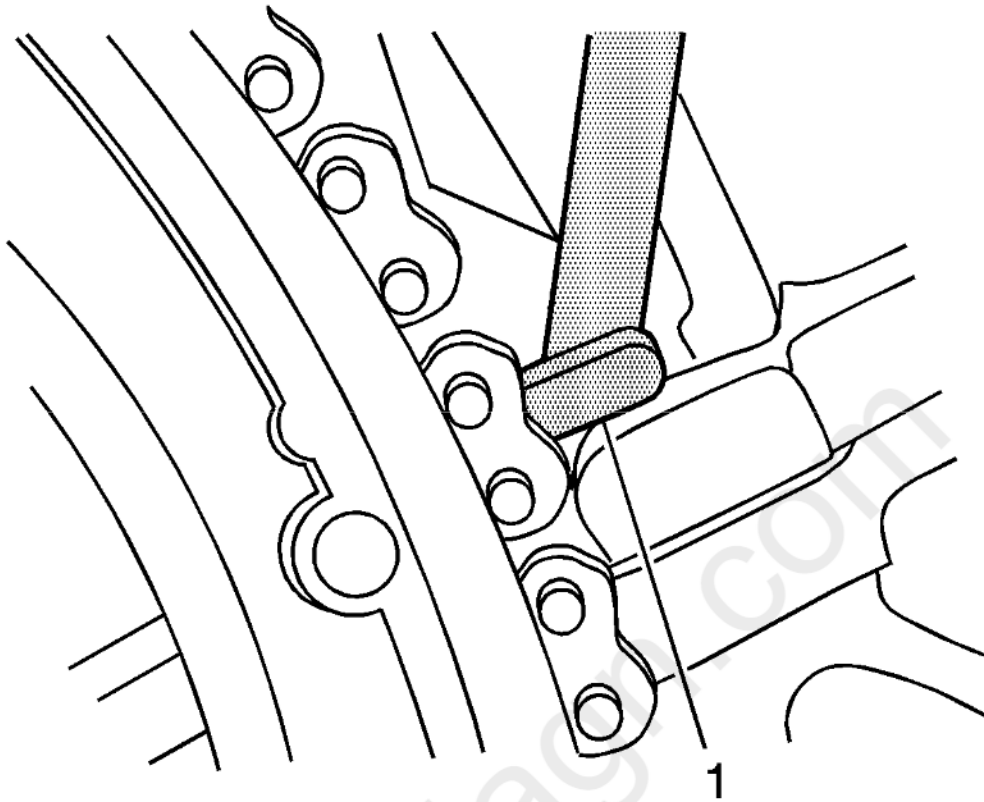


Fig. 14: Foot of Timing Chain Retention Tool EN-48313

Courtesy of GENERAL MOTORS CORP.

NOTE:

- Ensure that the foot (1) of the EN-48313 is engaged into one of the link pockets to prevent chain slippage during tightening of the EN-48313 . See Special Tools .
- Do not allow the body of the EN-48313 to rotate when tightening the T-handle. See Special Tools .

12. Hand tighten the **EN-48313** . See Special Tools .
13. Use an open end wrench on the hex cast into the body of the **EN-48313** and hand tighten the T-handle. See Special Tools .
14. Use an open end wrench on the hex cast into the right intake and exhaust camshafts and rotate the camshafts towards each other in order to create slack in the chain between the actuators.

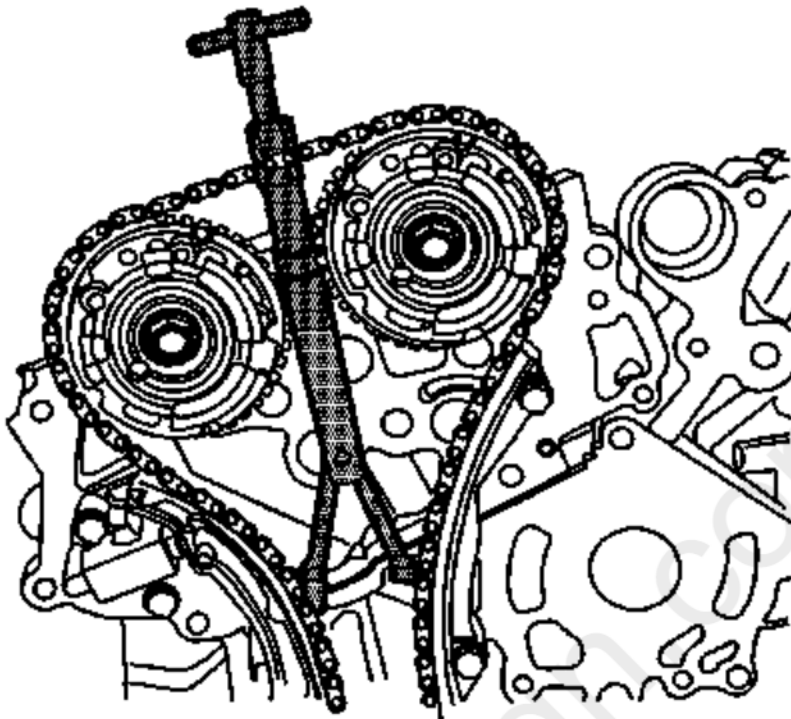


Fig. 15: View Of EN-48313 Between Actuators
Courtesy of GENERAL MOTORS CORP.

15. The **EN-48313** is now properly installed to hold the timing chain in position. See **Special Tools** .

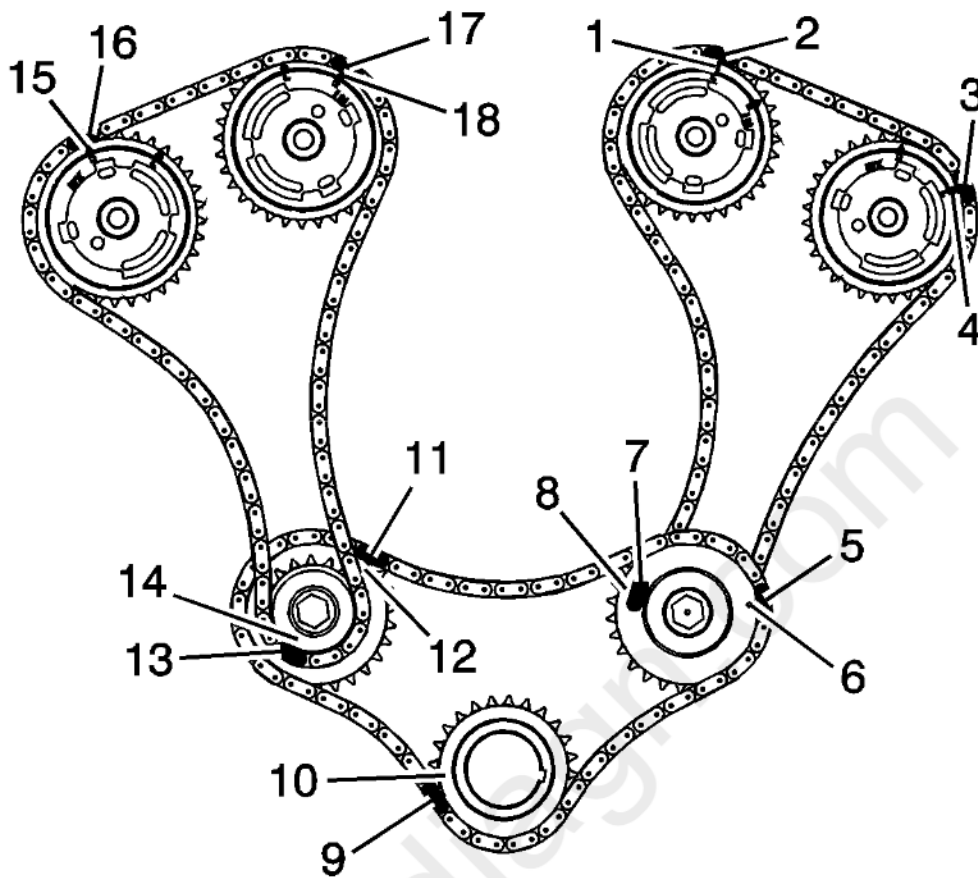


Fig. 16: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators

Courtesy of GENERAL MOTORS CORP.

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

16. Mark the timing chain and the respective locations on camshaft position actuators (15-18).
17. Remove the camshaft position actuator bolt.
18. Remove the camshaft bearing caps and the camshaft. Refer to Camshaft Removal - Right Side.

INSTALLATION PROCEDURE

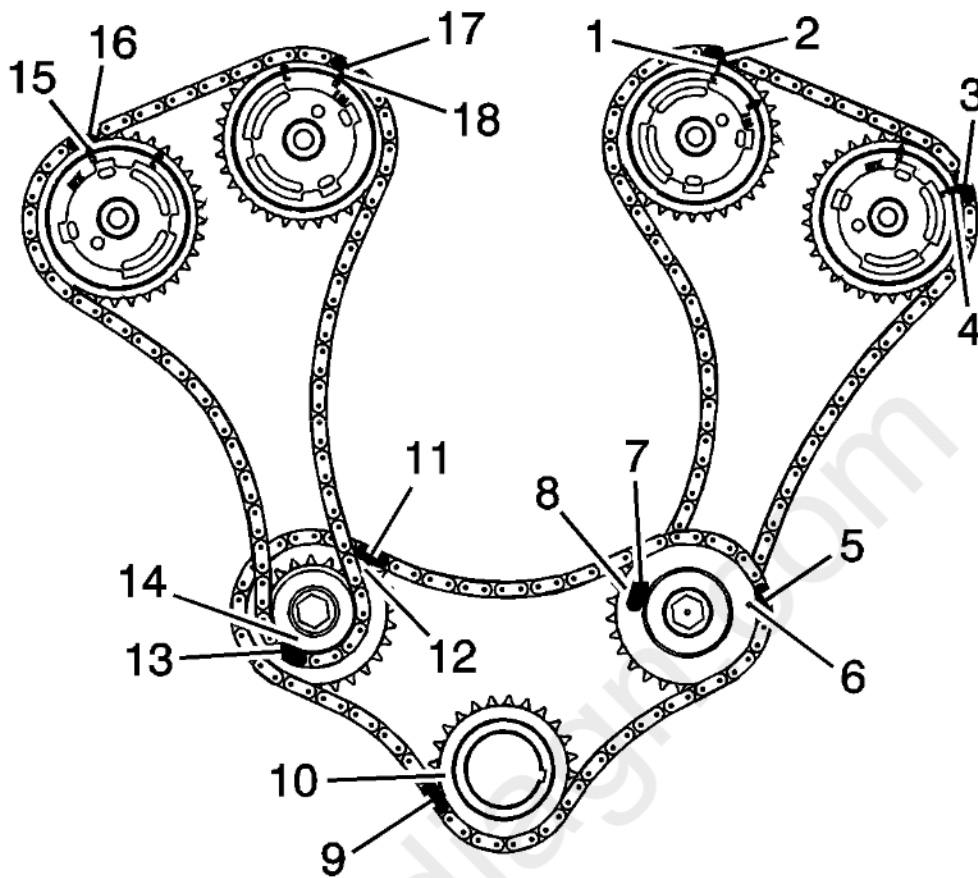


Fig. 17: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators

Courtesy of GENERAL MOTORS CORP.

NOTE:

- Ensure that the marks on the camshaft position actuators and the timing chain (15-18) are aligned.
- DO NOT tighten the camshaft position actuator bolt at this time.

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Right Side**.
3. Remove the EN-48313. See **Special Tools**.

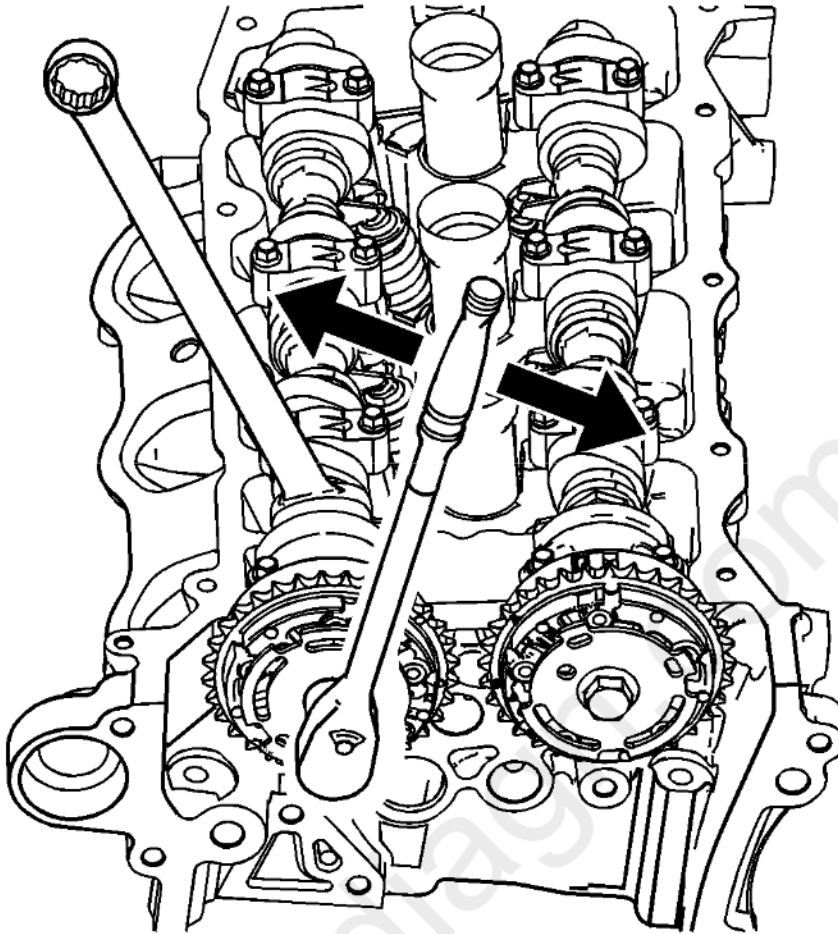


Fig. 18: View of Camshaft/Engine Rotation Prevention Using Open-End Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

4. Install and tighten the camshaft position actuators. Refer to Camshaft Position Actuator Installation - Right Side Intake and Camshaft Position Actuator Installation - Right Side Exhaust .
5. Install the intake camshaft position actuator solenoid. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake .
6. Install the camshaft sensors. Refer to Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust and Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake .
7. Install the camshaft cover. Refer to Camshaft Cover Replacement - Right Side .
8. Install the upper intake manifold with the lower intake manifold. Refer to Lower Intake Manifold Replacement (LP1, LY7) .

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Left Side**.

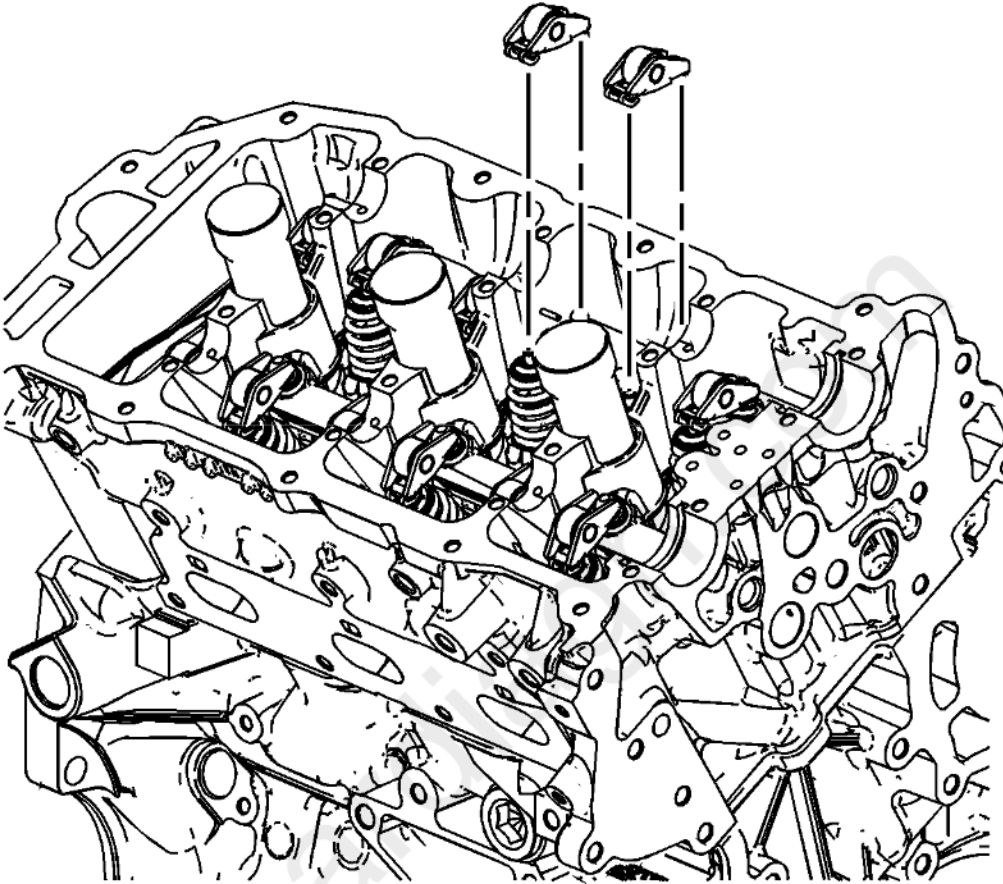


Fig. 19: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Left Side**.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifter Cleaning and Inspection**.

INSTALLATION PROCEDURE

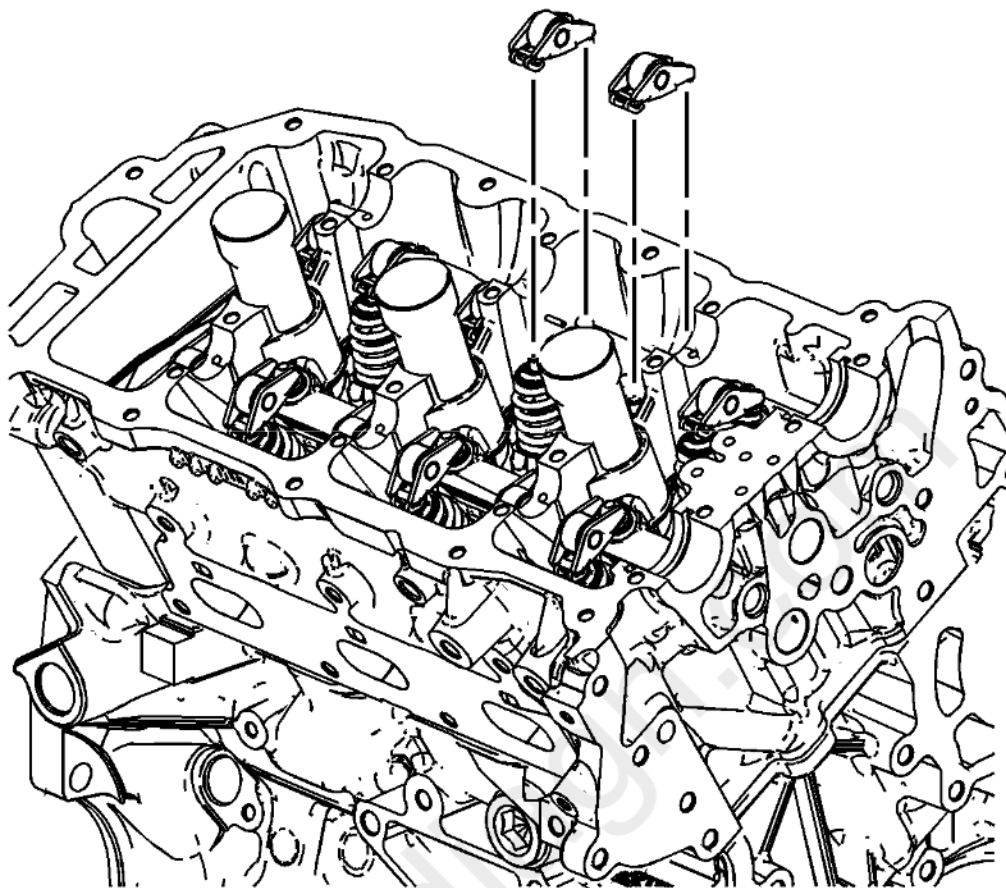


Fig. 20: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

1. Install the rocker arms. Refer to Valve Rocker Arm Installation - Left Side .
2. Install the applicable camshaft(s). Refer to Camshaft Replacement - Left Side.

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Right Side (LP1, LY7).

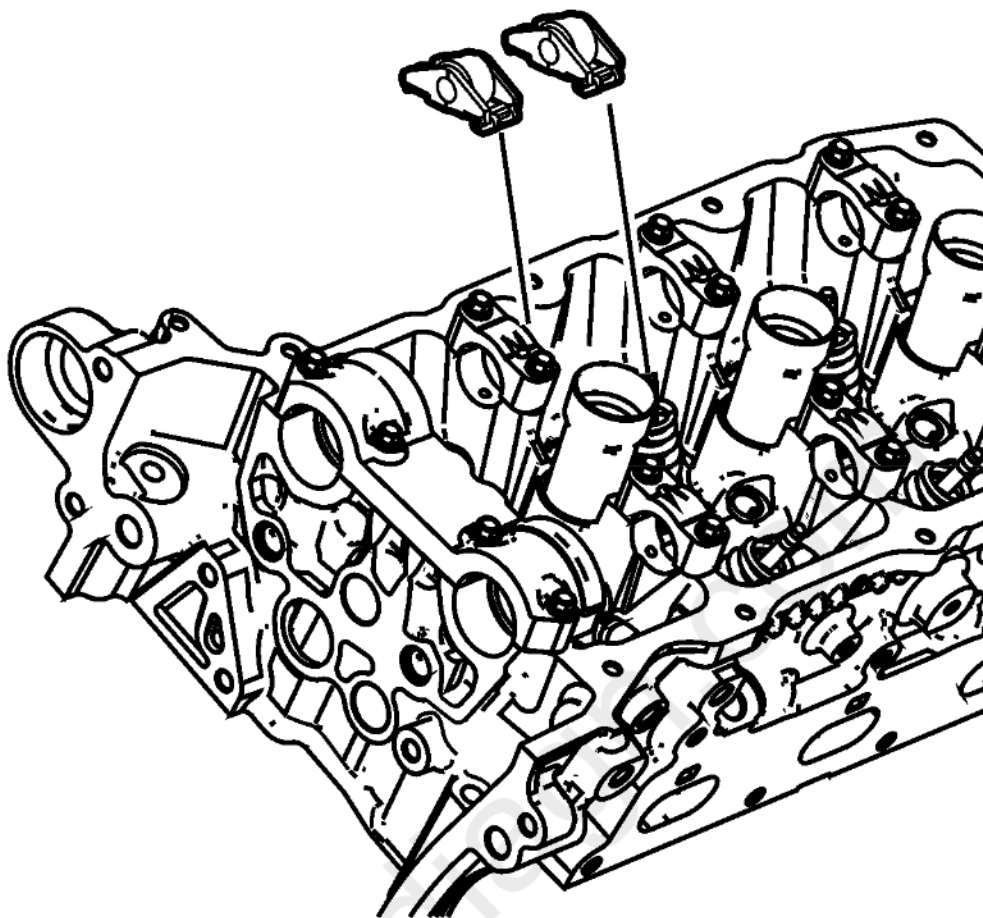


Fig. 21: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side** .
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifter Cleaning and Inspection** .

INSTALLATION PROCEDURE

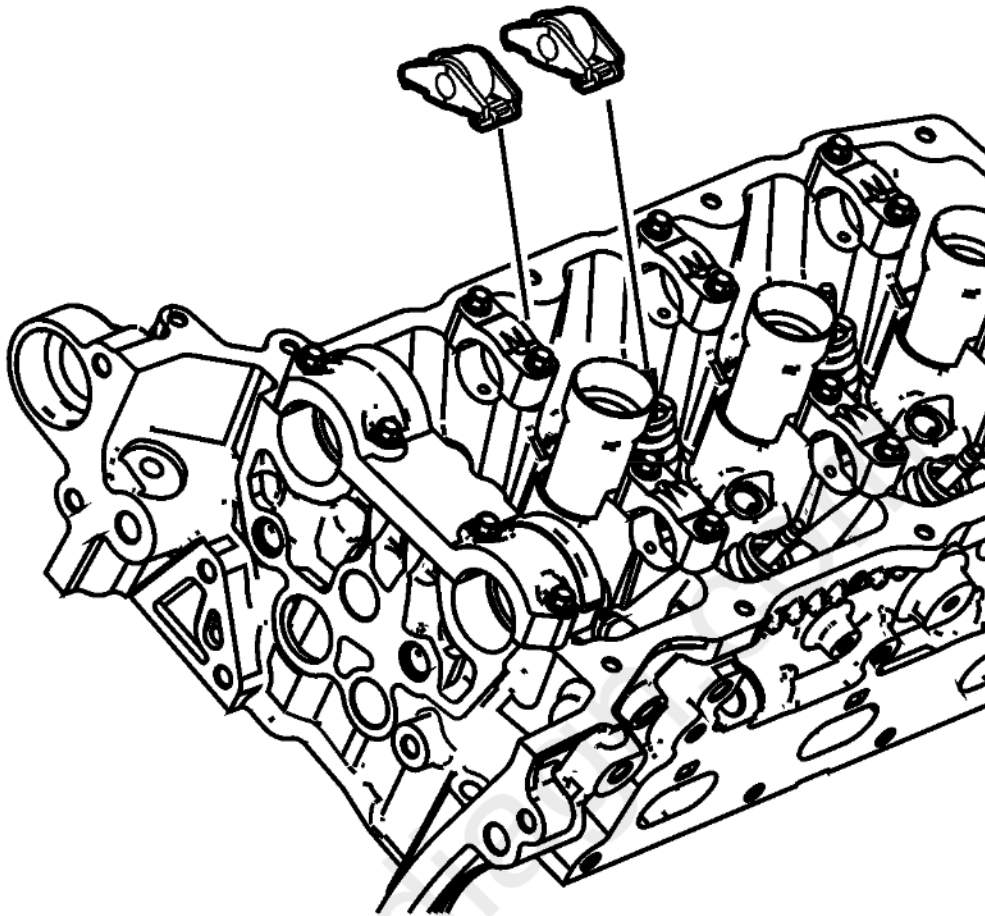


Fig. 22: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

1. Install the rocker arms.
2. Install the applicable camshaft(s). Refer to Valve Rocker Arm Installation - Right Side .

VALVE LIFTER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

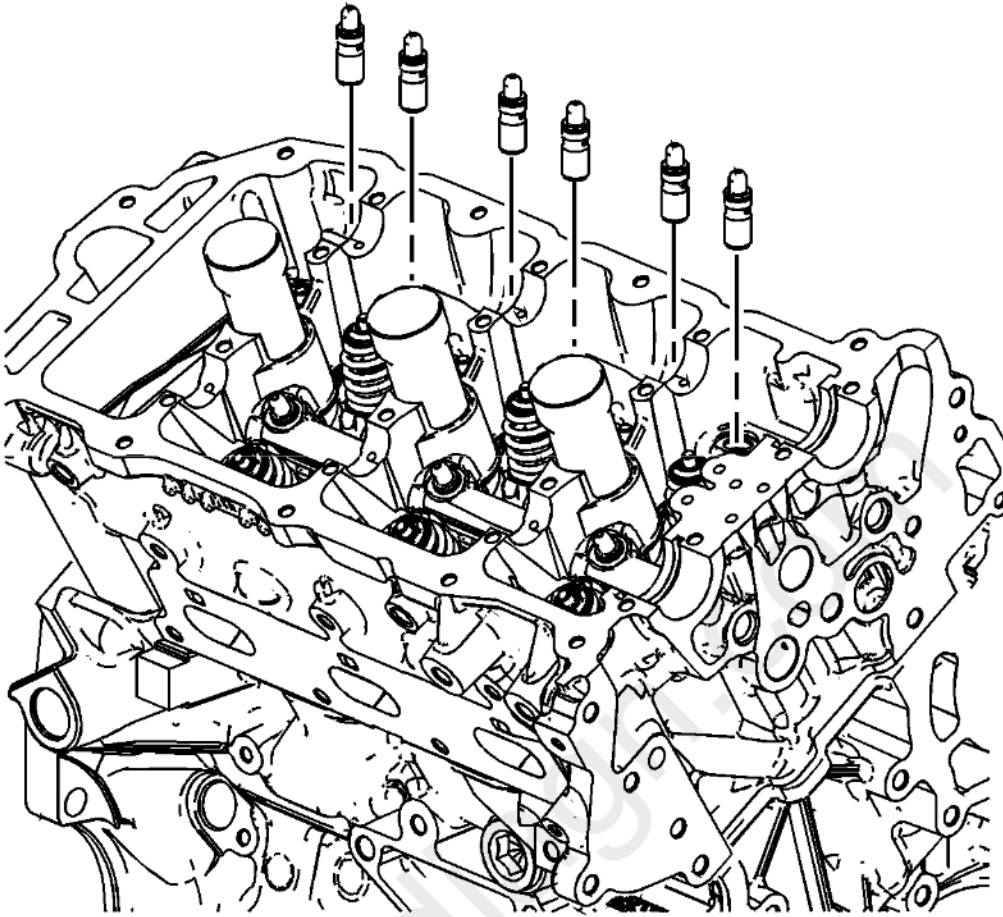


Fig. 23: Identifying Stationary Hydraulic Lash Adjuster (SHLA)

Courtesy of GENERAL MOTORS CORP.

1. Remove the applicable camshafts. Refer to Camshaft Replacement - Left Side.
2. Remove the rocker arms. Refer to Valve Rocker Arm Replacement - Left Side.
3. Remove the lifters. Refer to Valve Lifter Replacement - Left Side.
4. Clean and inspect the camshafts, rocker arms and lifters. Repair or replace as necessary. Refer to Camshaft Cleaning and Inspection , Valve Rocker Arm Cleaning and Inspection and Valve Lifter Cleaning and Inspection .

INSTALLATION PROCEDURE

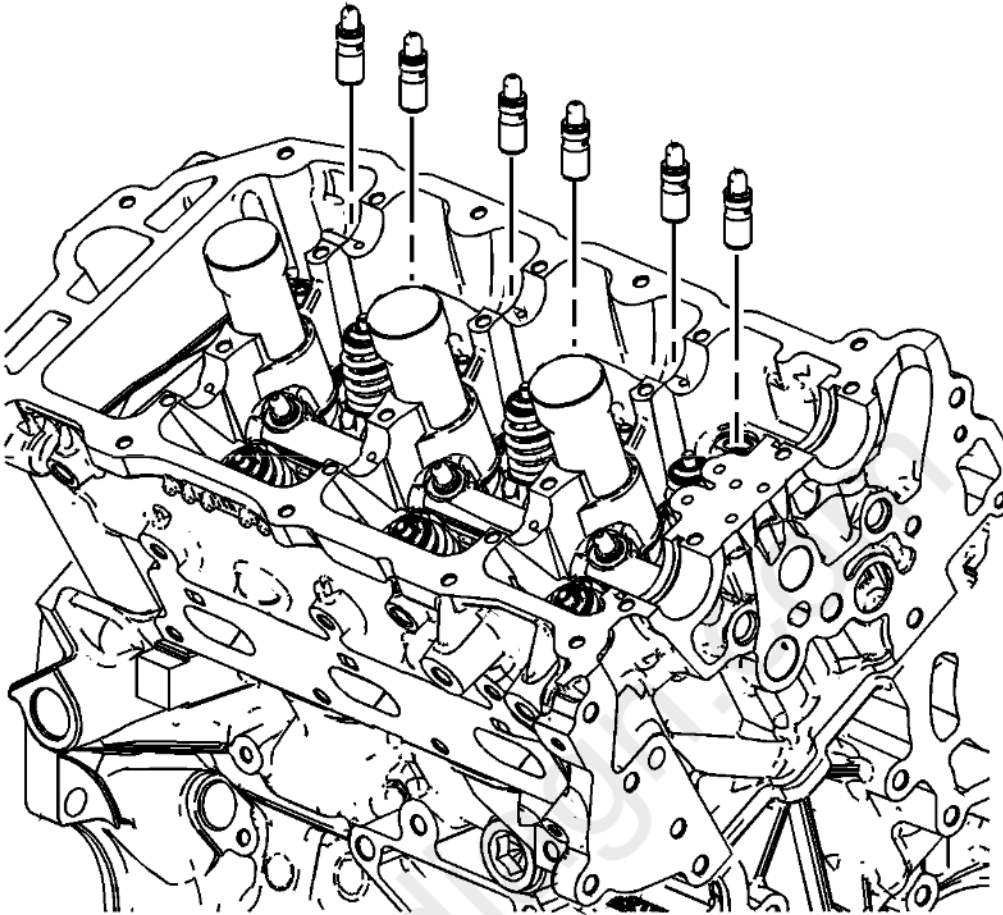


Fig. 24: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS CORP.

1. Install the lifters. Refer to Valve Lifter Replacement - Left Side.
2. Install the rocker arms. Refer to Valve Rocker Arm Replacement - Left Side.
3. Install the applicable camshafts. Refer to Camshaft Replacement - Left Side.

VALVE LIFTER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to Camshaft Replacement - Right Side (LP1, LY7).
2. Remove the rocker arms. Refer to Valve Rocker Arm Removal - Right Side.

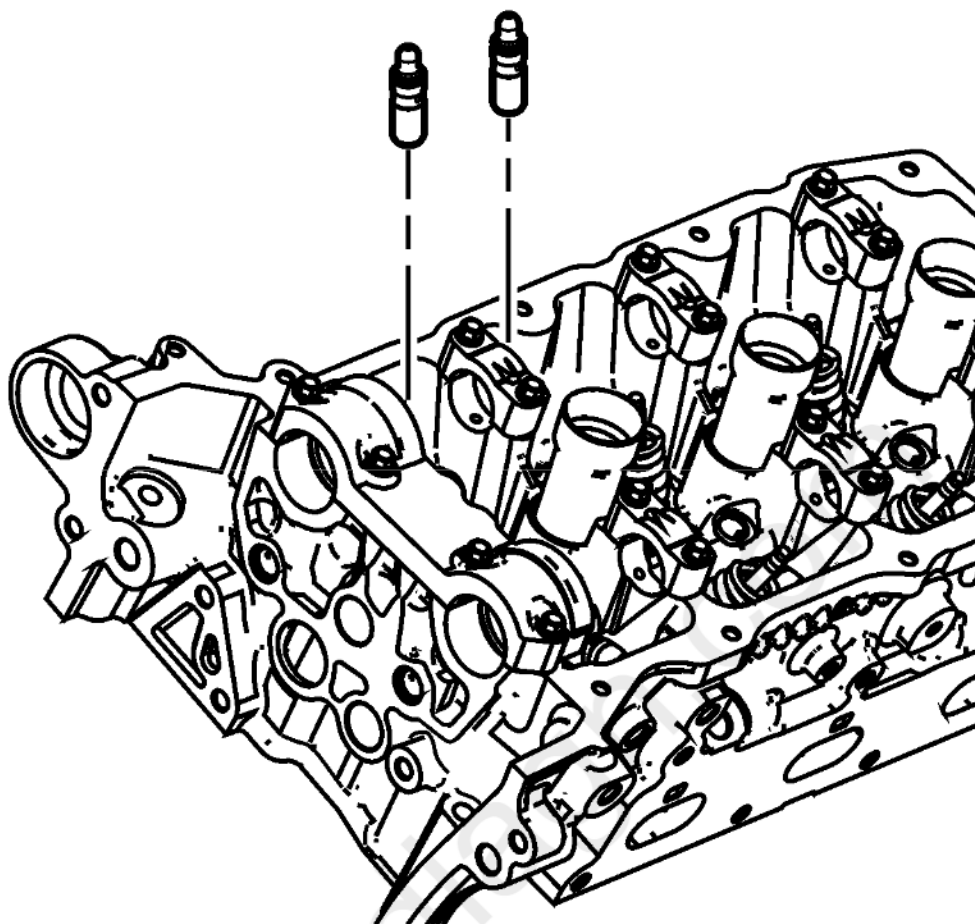


Fig. 25: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS CORP.

3. Remove the lifters. Refer to **Valve Lifter Replacement - Right Side**.
4. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifter Cleaning and Inspection**.

INSTALLATION PROCEDURE

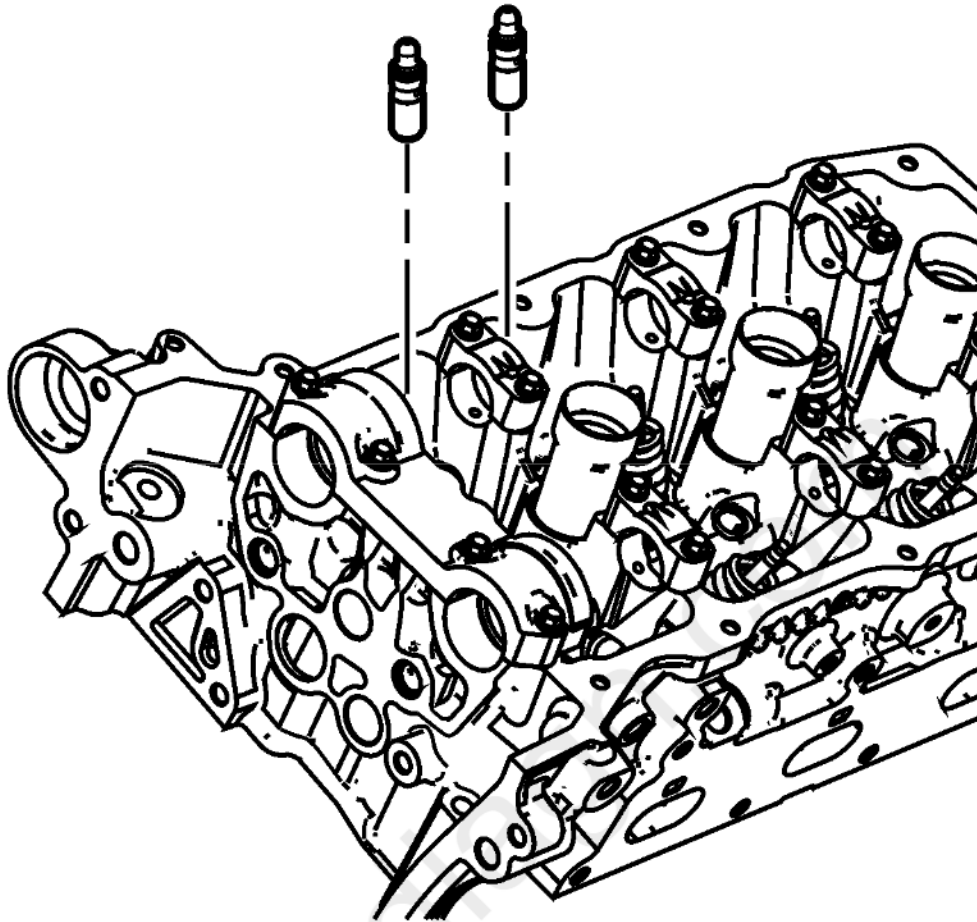


Fig. 26: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS CORP.

1. Install the lifters. Refer to Valve Lifter Installation - Right Side .
2. Install the rocker arms. Refer to Valve Rocker Arm Installation - Right Side .
3. Install the applicable camshaft(s). Refer to Camshaft Replacement - Right Side (LP1, LY7).

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

SPECIAL TOOLS

- J 39313 Spark Plug Port Adapter
- EN 46106 Flywheel Holding Tool. See Special Tools .
- EN 46108 Timing Chain Retention Tool
- EN 46110 On-Vehicle Valve Spring Compressor. See Special Tools .
- EN 46116 Valve Stem Seal Remover/Installer. See Special Tools .

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to **Starter Replacement (LF1/LLT)**.

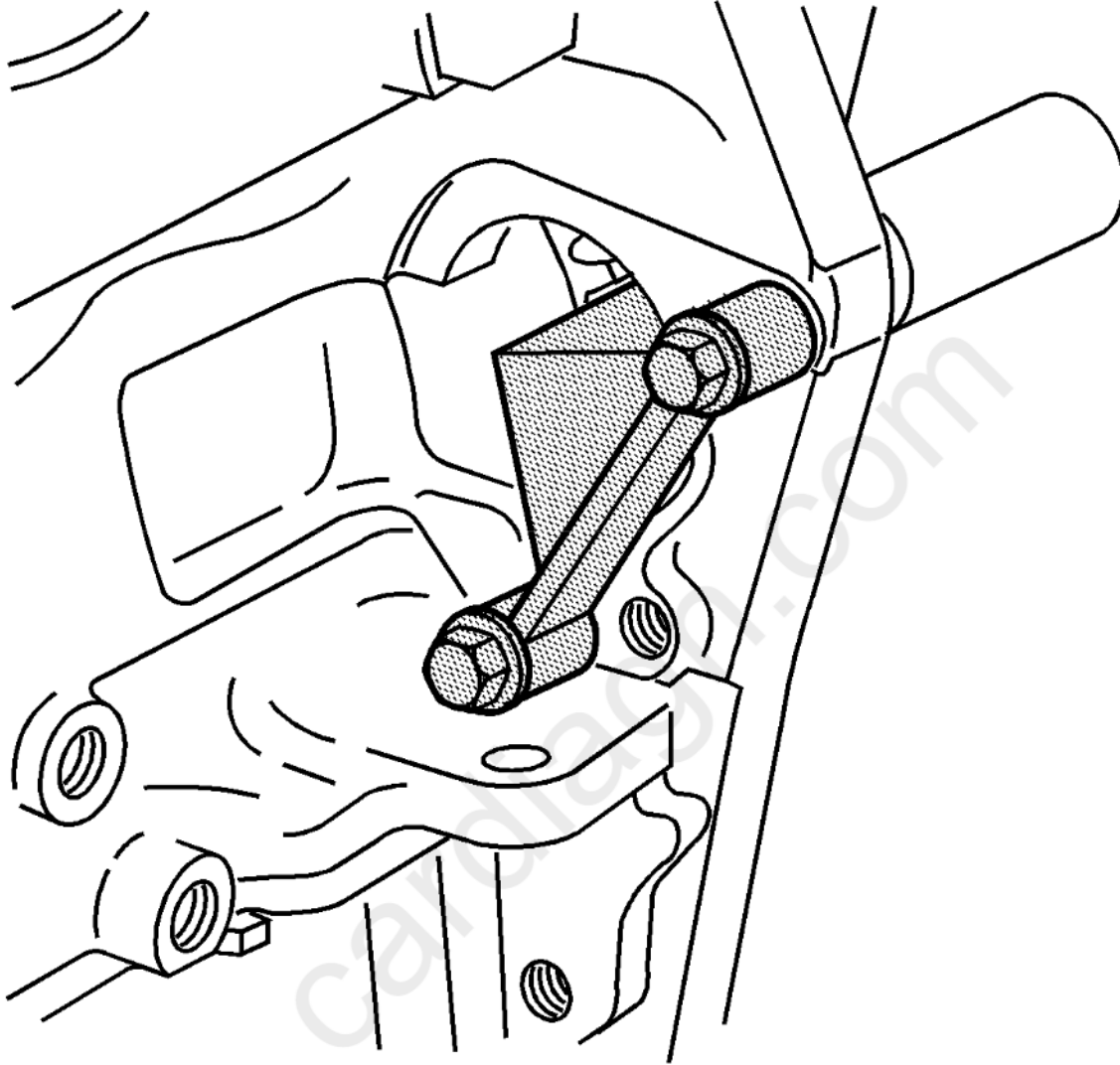


Fig. 27: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the EN 46106 is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required. See **Special Tools**.

2. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools**.
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Left Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement**.
5. Install the **J 39313** to the applicable cylinder.
6. Connect the **J 39313** to a compressed air source.

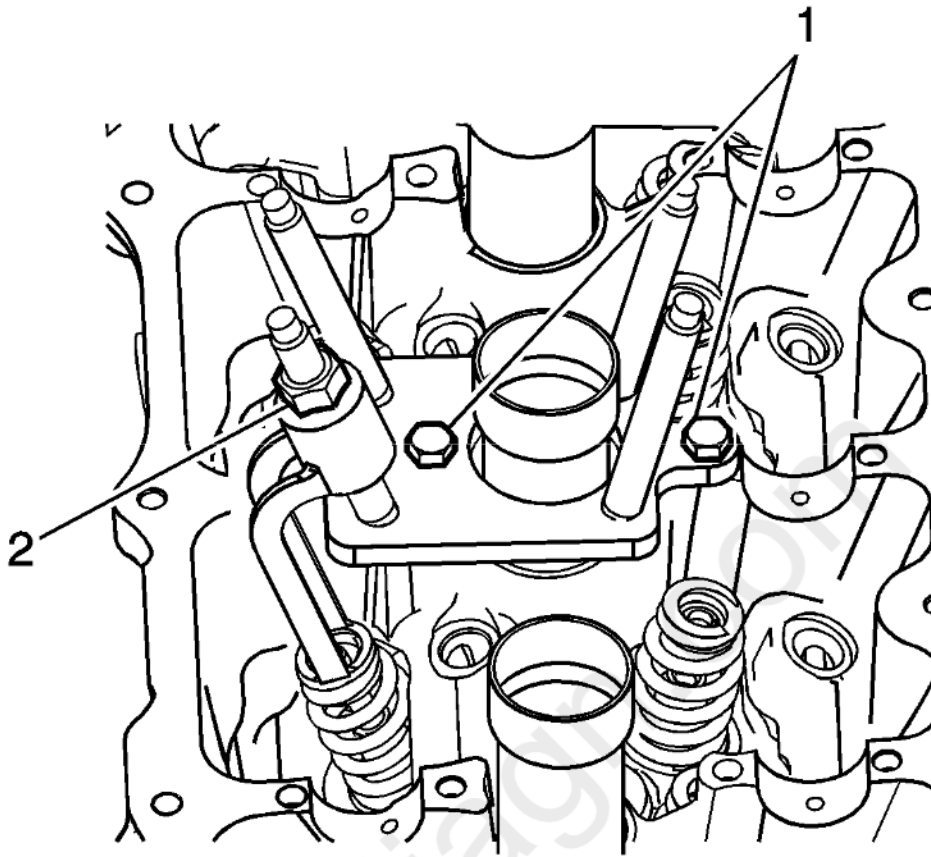


Fig. 28: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown in illustration. See **Special Tools** .
8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

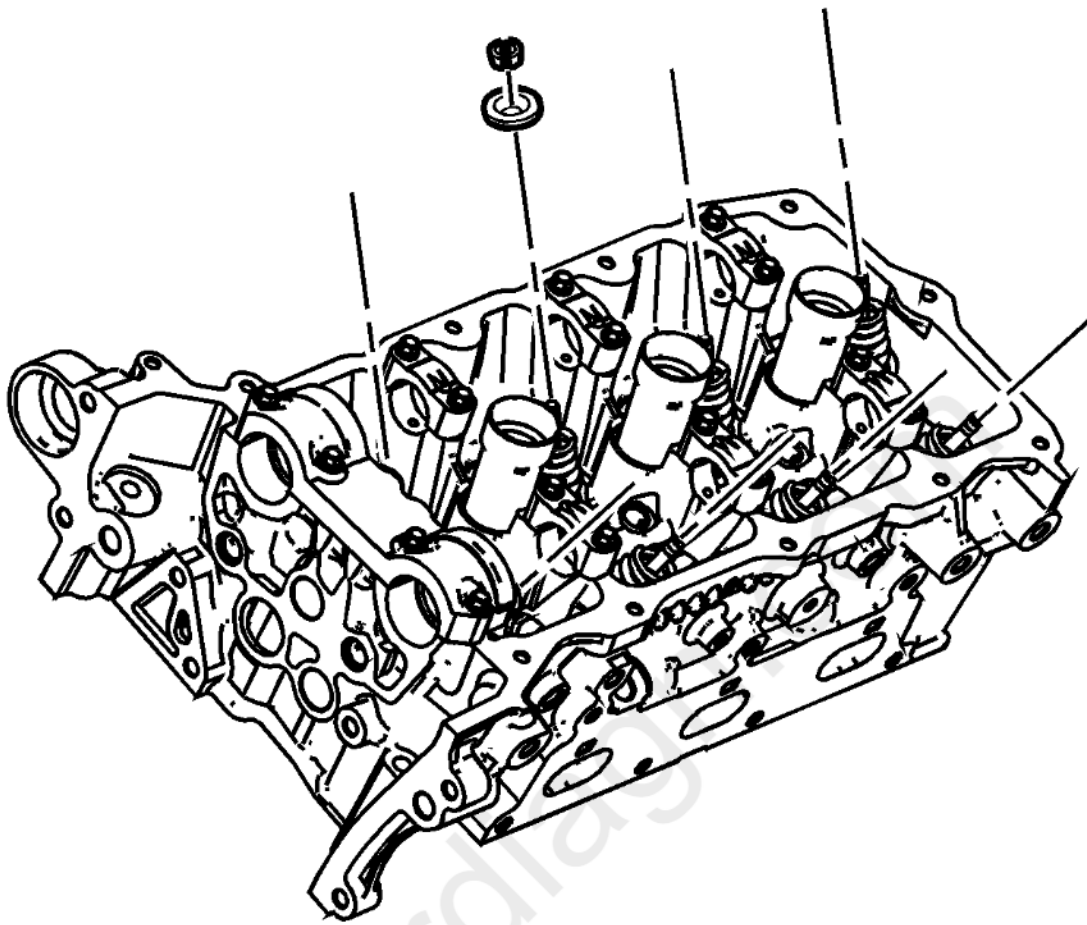


Fig. 29: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keepers.
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

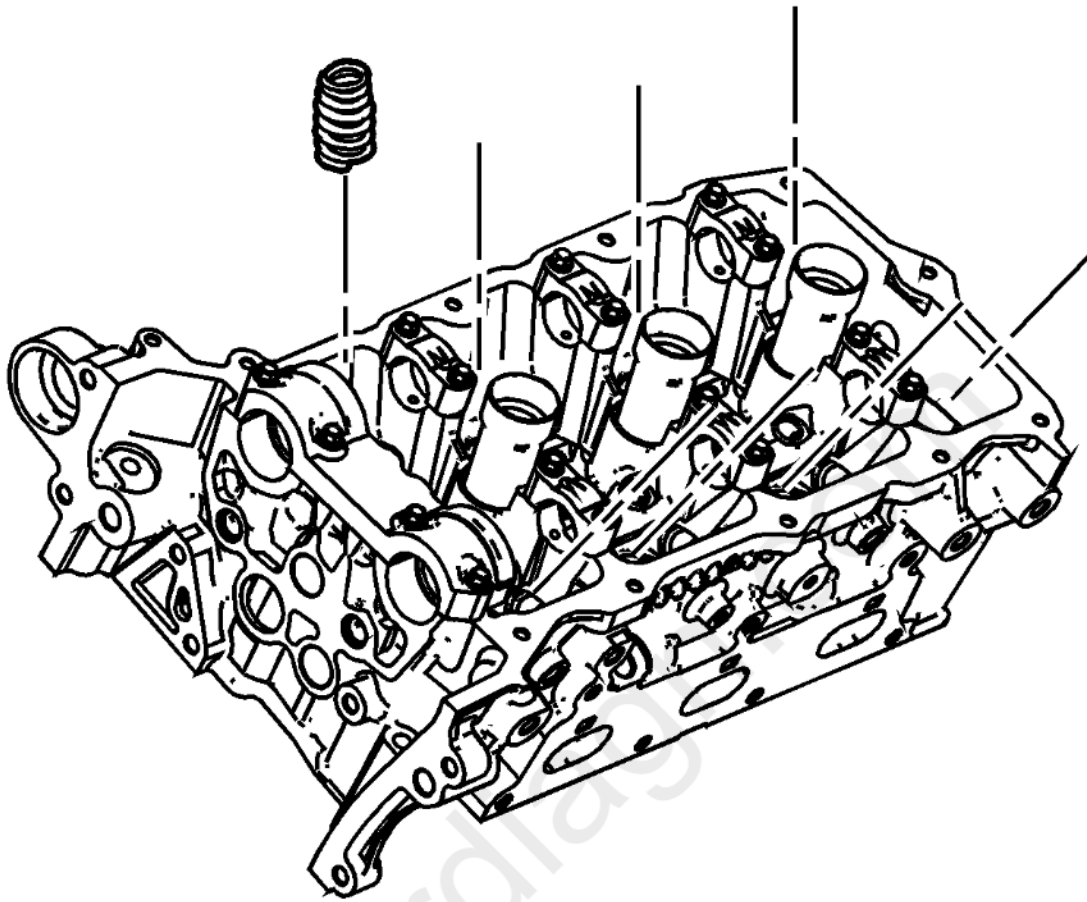


Fig. 30: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve spring.

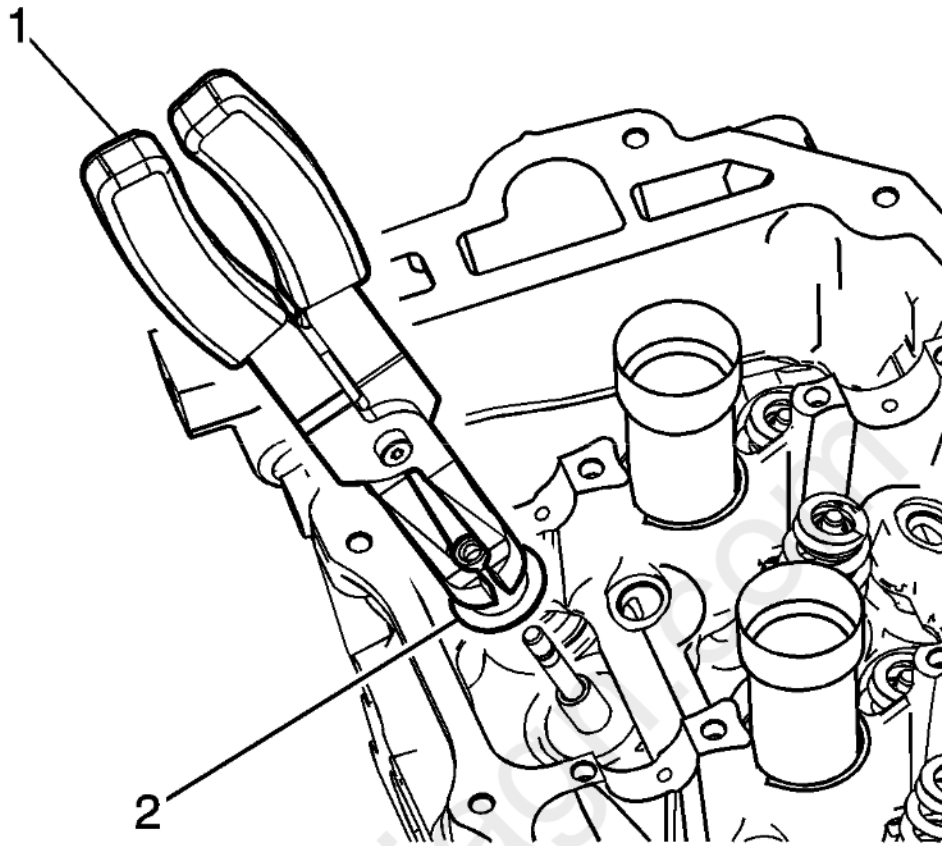


Fig. 31: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

INSTALLATION PROCEDURE

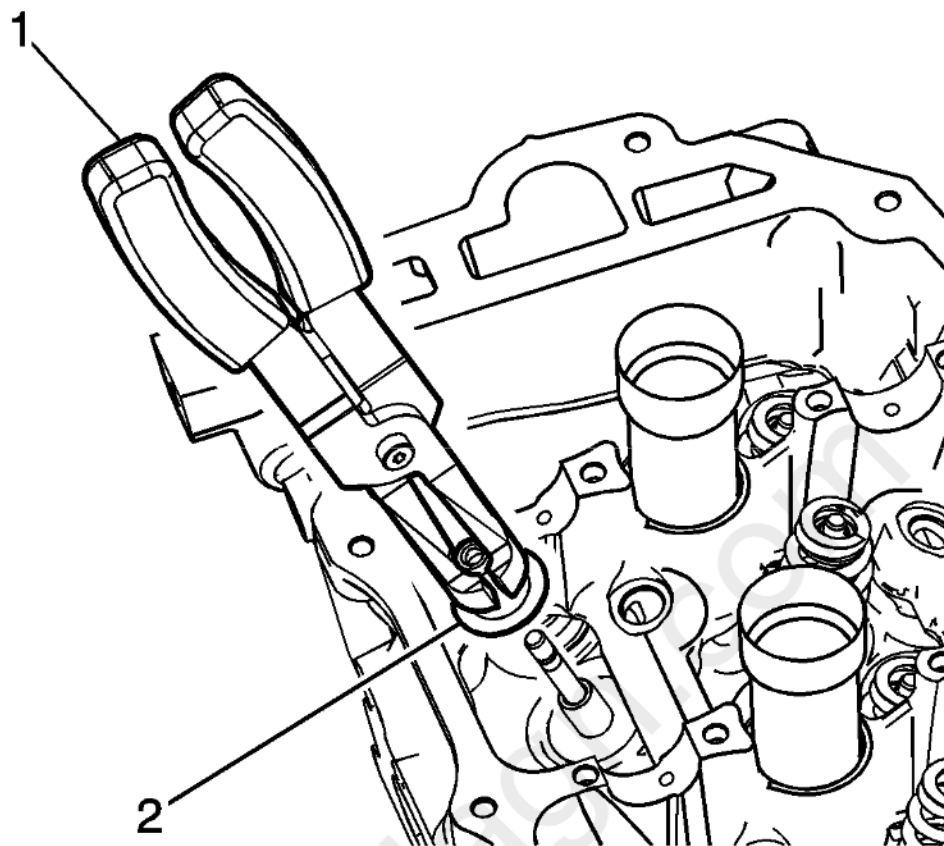


Fig. 32: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seal (2). See **Special Tools** .

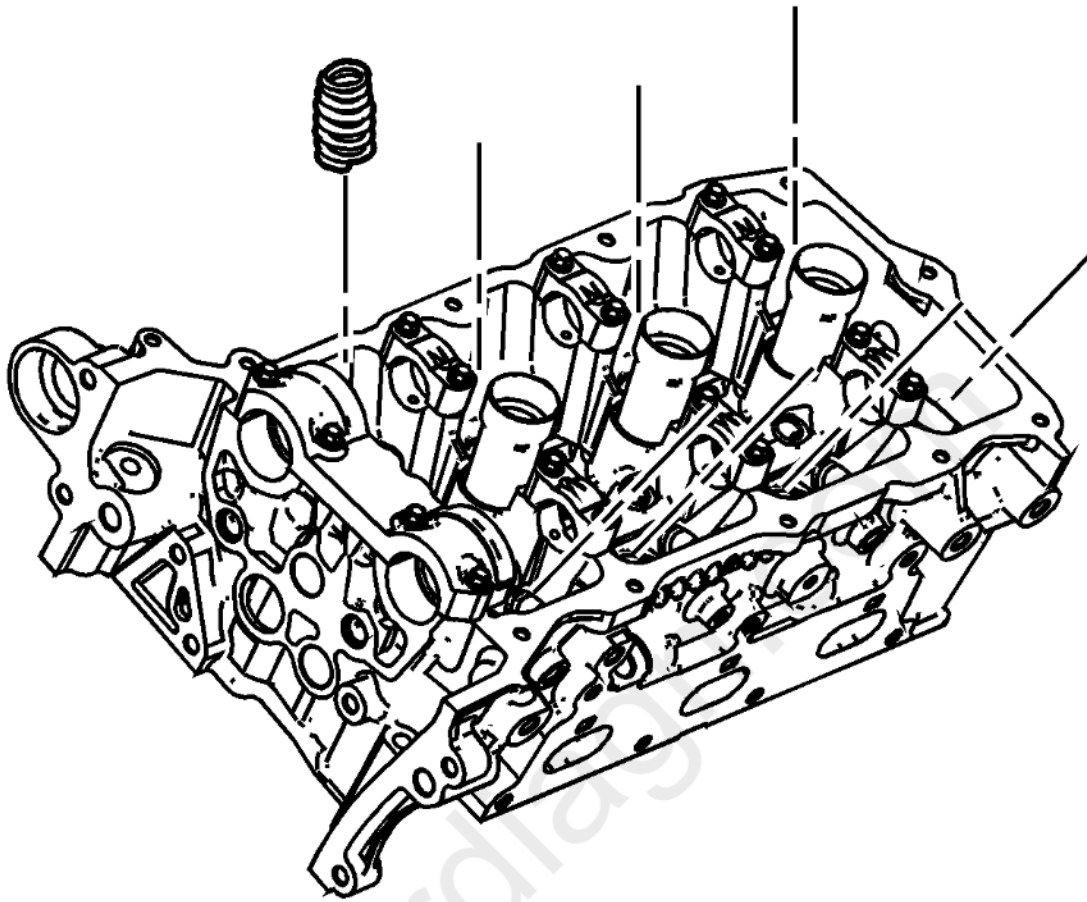


Fig. 33: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.
3. Install the valve spring retainer.

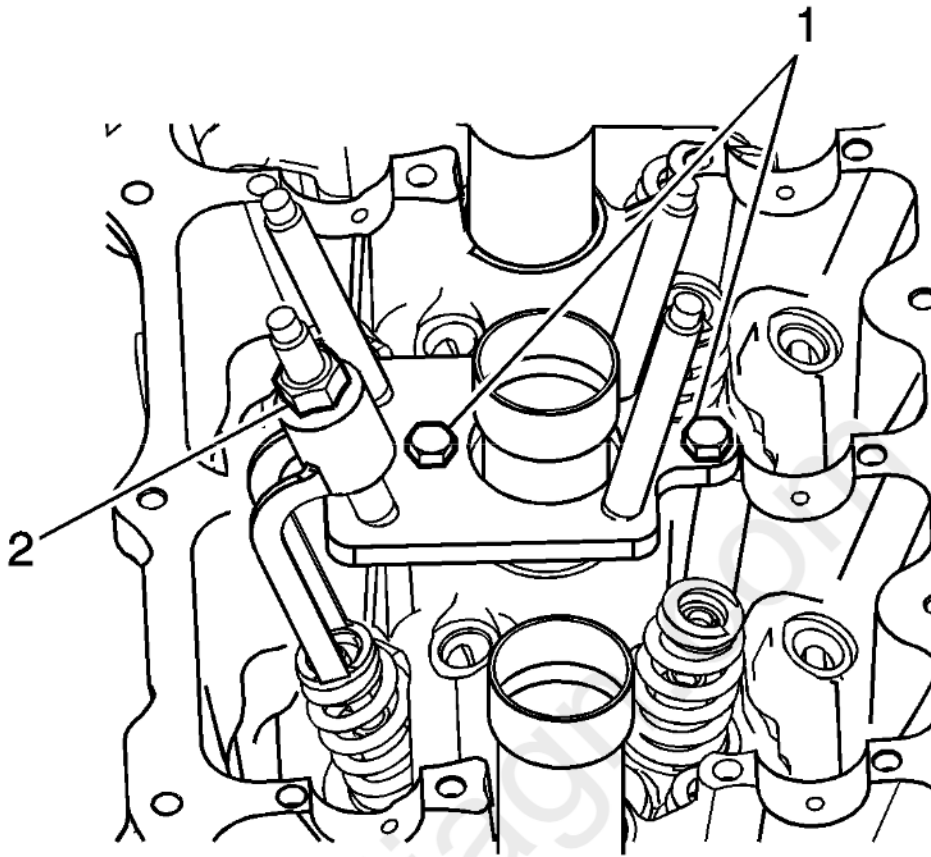


Fig. 34: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown in illustration. See **Special Tools** .
Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

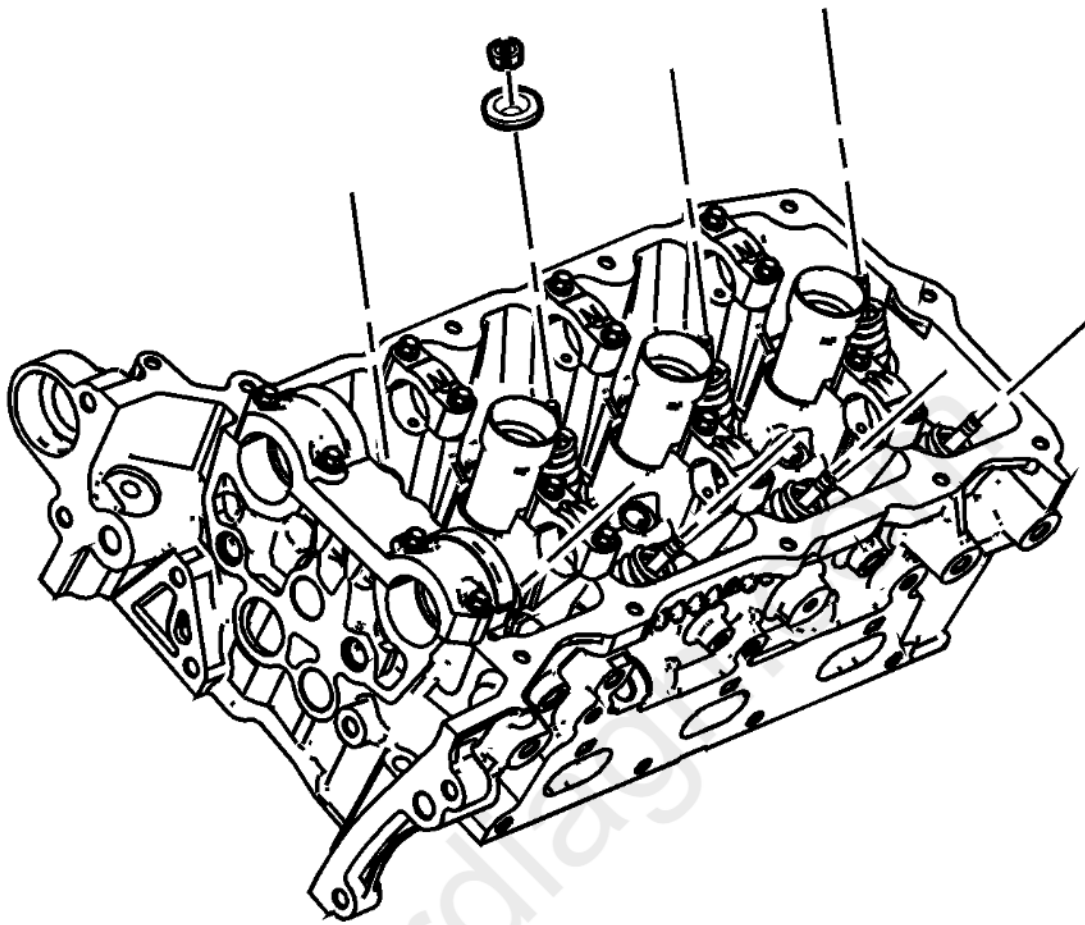


Fig. 35: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See Special Tools .
7. Disconnect the **J 39313** from the compressed air source.
8. Remove the **J 39313** .
9. Install the spark plugs. Refer to Spark Plug Replacement .
10. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Left Side.
11. Remove the **EN 46106** in order to prevent crankshaft rotation. See Special Tools .
12. Install the starter motor. Refer to Starter Replacement (LF1/LLT) .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

SPECIAL TOOLS

- EN 46106 Flywheel Holding Tool. See Special Tools .
- EN 46108 Timing Chain Retention Tool
- EN 46110 On-Vehicle Valve Spring Compressor. See Special Tools .
- EN 46116 Valve Stem Seal Remover/Installer. See Special Tools .
- J 39313 Spark Plug Port Adapter

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to Starter Replacement (LF1/LLT) .

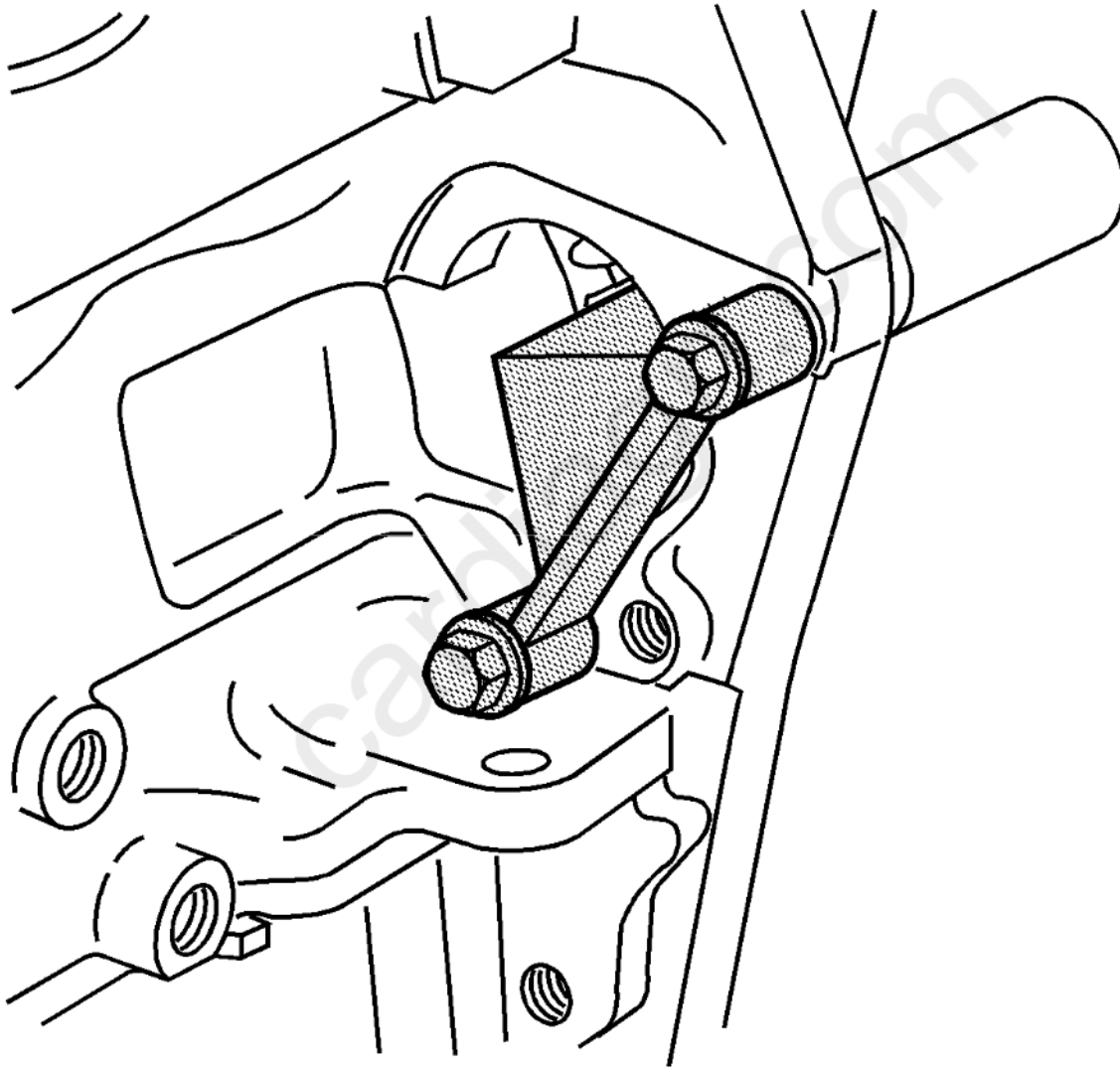


Fig. 36: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the EN 46106 is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required. See Special Tools .

2. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Right Side (LP1, LY7)**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** to the applicable cylinder.
6. Connect the **J 39313** to a compressed air source.

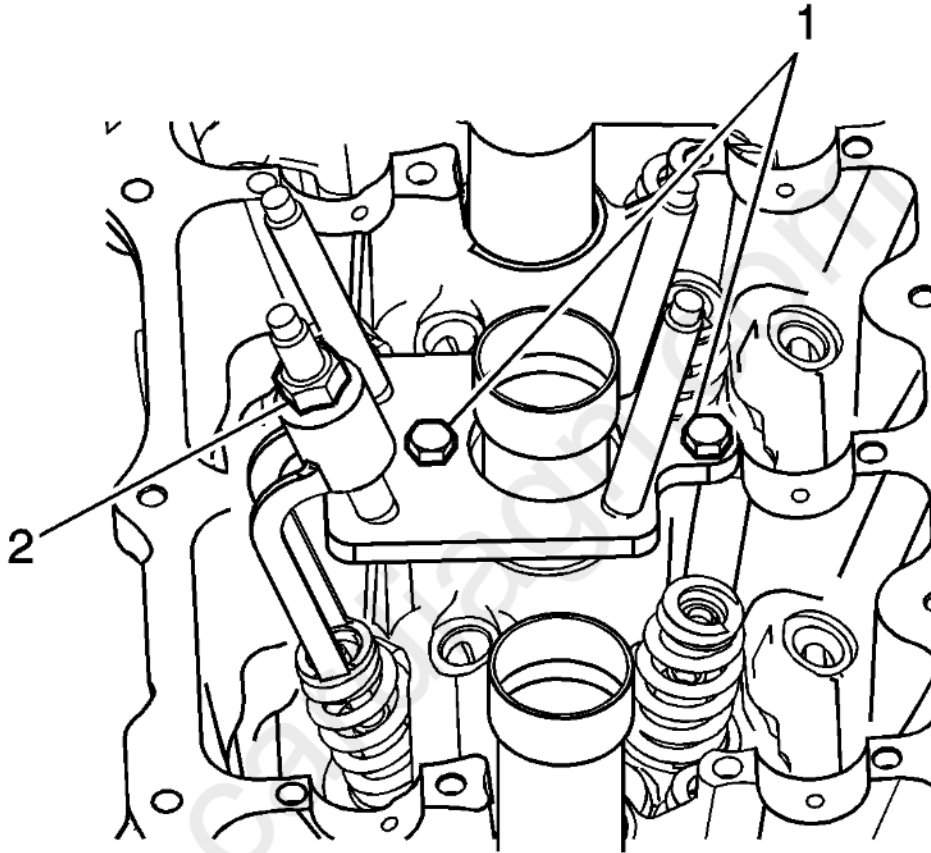


Fig. 37: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown in illustration. See **Special Tools** .
8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

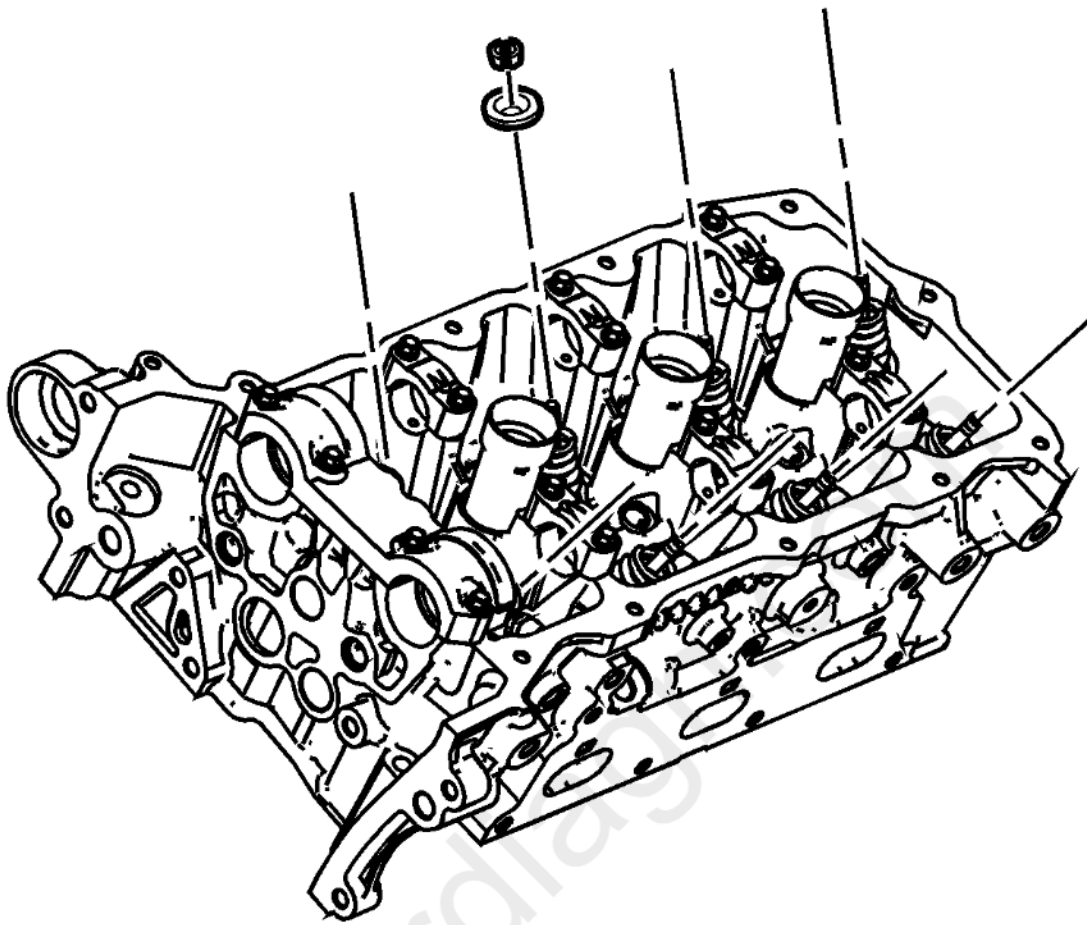


Fig. 38: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keepers.
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

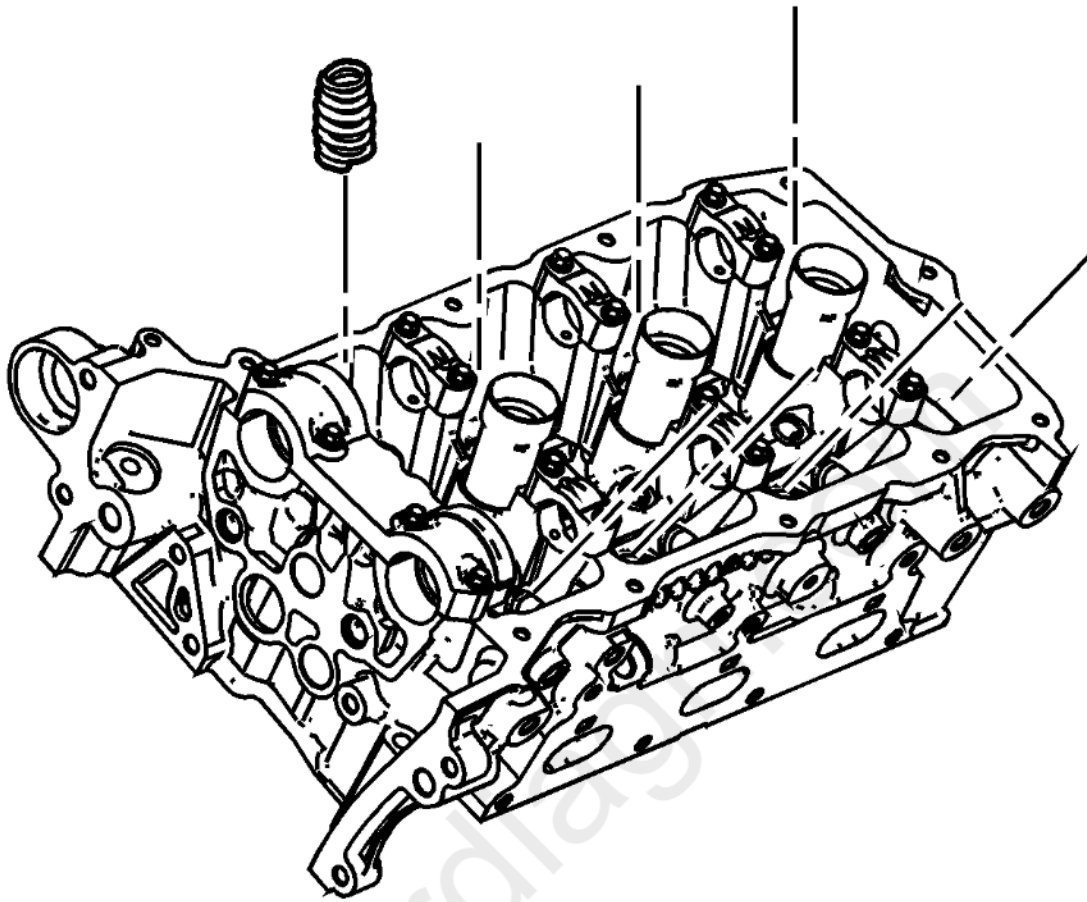


Fig. 39: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve springs.

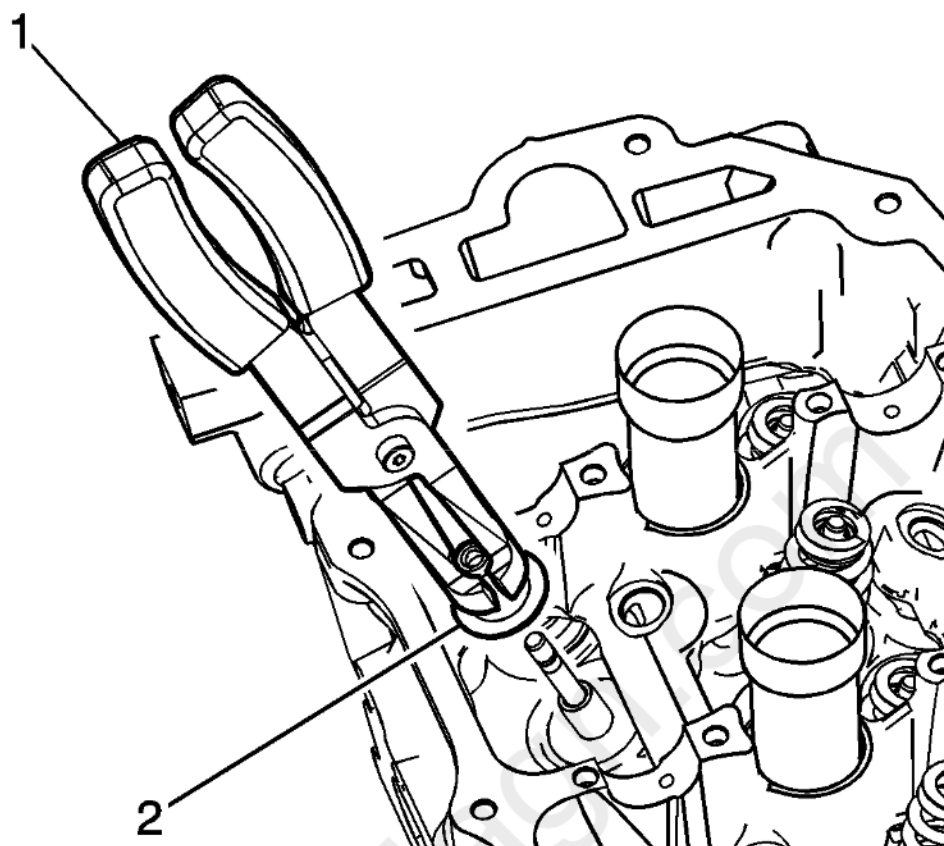


Fig. 40: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

INSTALLATION PROCEDURE

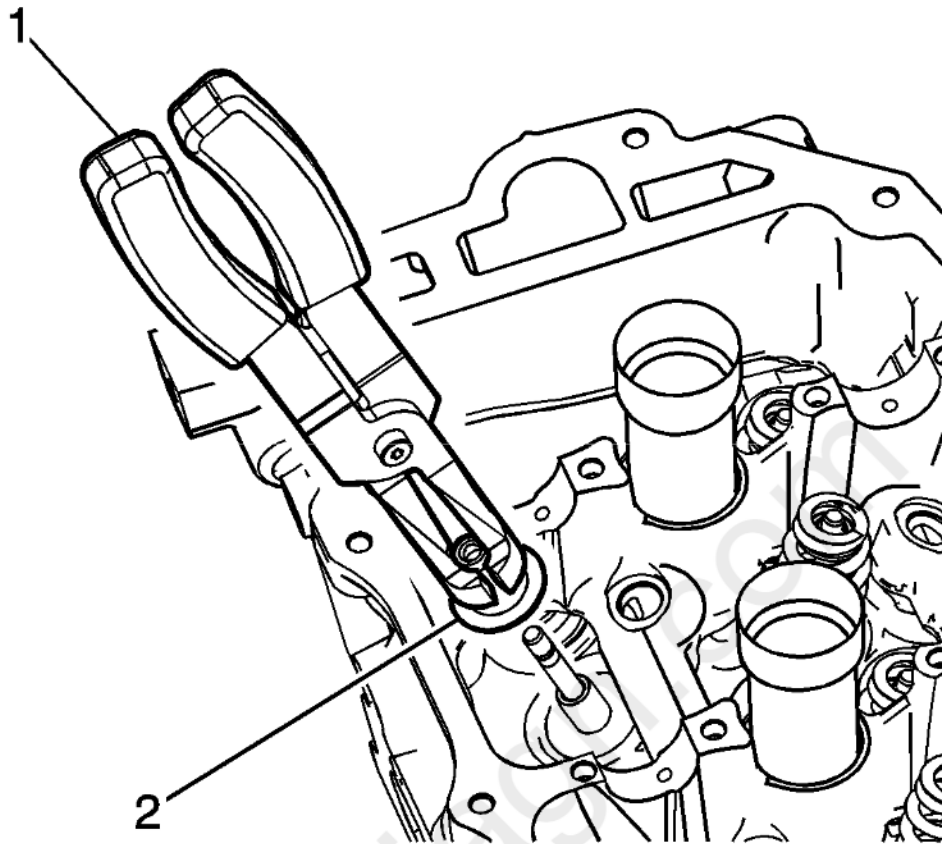


Fig. 41: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seals (2). See **Special Tools** .

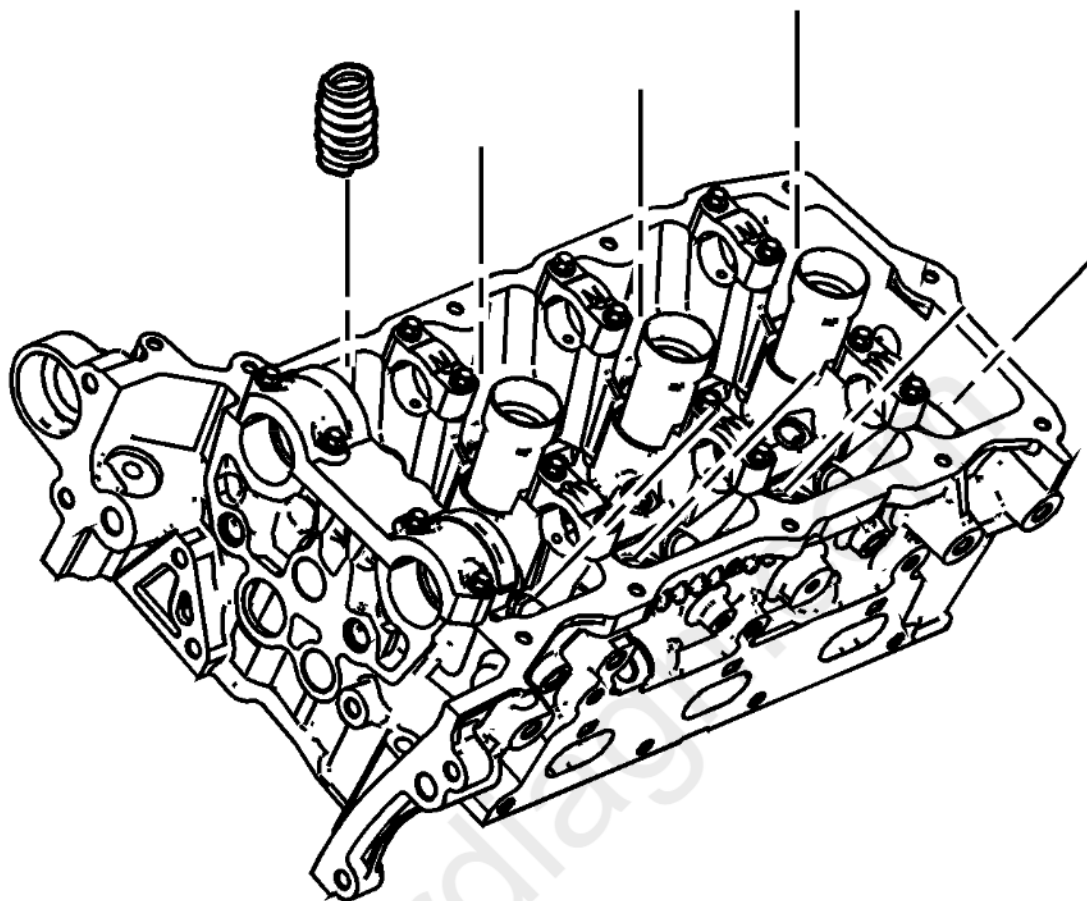


Fig. 42: View Of Valve Spring

Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.
3. Install the valve spring retainer.

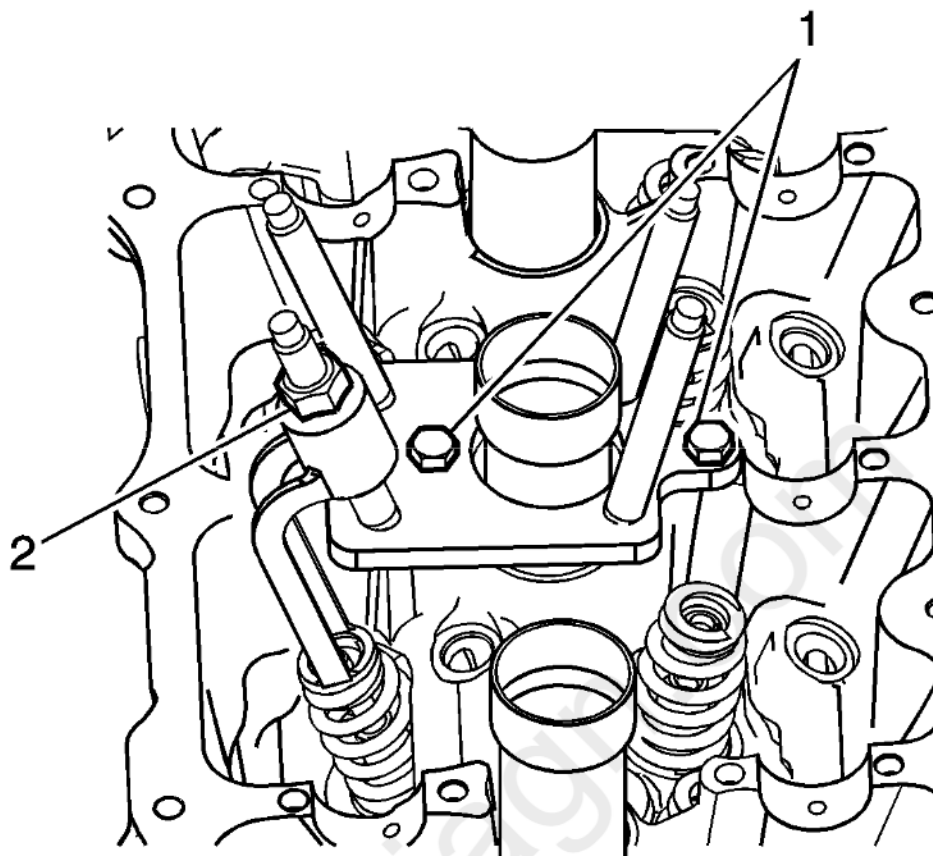


Fig. 43: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown in illustration. See **Special Tools** .
Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

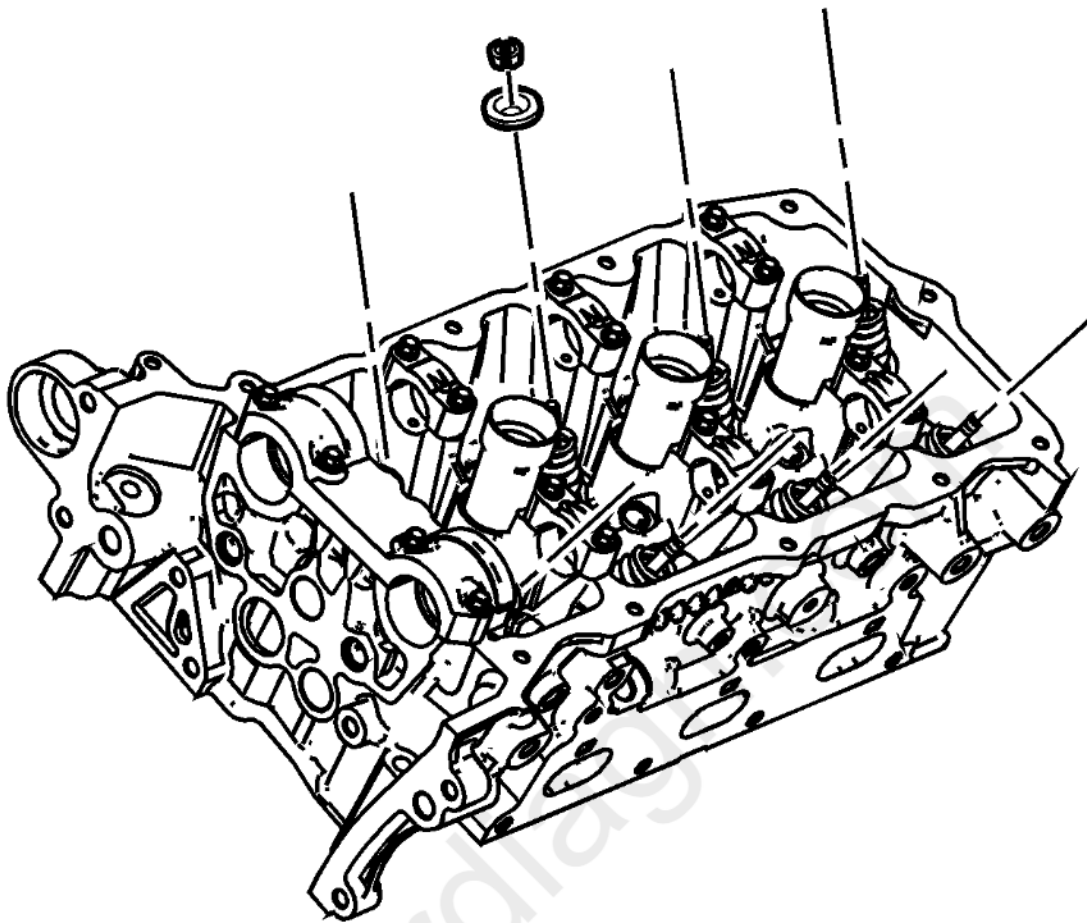


Fig. 44: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See Special Tools .
7. Disconnect the **J 39313** from the compressed air source.
8. Remove the **J 39313** .
9. Install the spark plugs. Refer to Spark Plug Replacement .
10. Install the rocker arms and camshafts. Refer to Camshaft Replacement - Right Side (LP1, LY7).
11. Remove the **EN 46106** . See Special Tools .
12. Install the starter motor. Refer to Starter Replacement (LF1/LLT) .

CYLINDER HEAD REPLACEMENT - LEFT SIDE (LF1)

SPECIAL TOOLS

J-45059: Angle Meter

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

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7)** or **Camshaft Cover Replacement - Left Side (LLT)** .
2. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side** .
3. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
4. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement (LF1)** or **Oil Filter Adapter Replacement (LLT)** .
5. Remove the power steering pump bracket. Refer to **Power Steering Pump Bracket Replacement** .
6. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LLT)** .

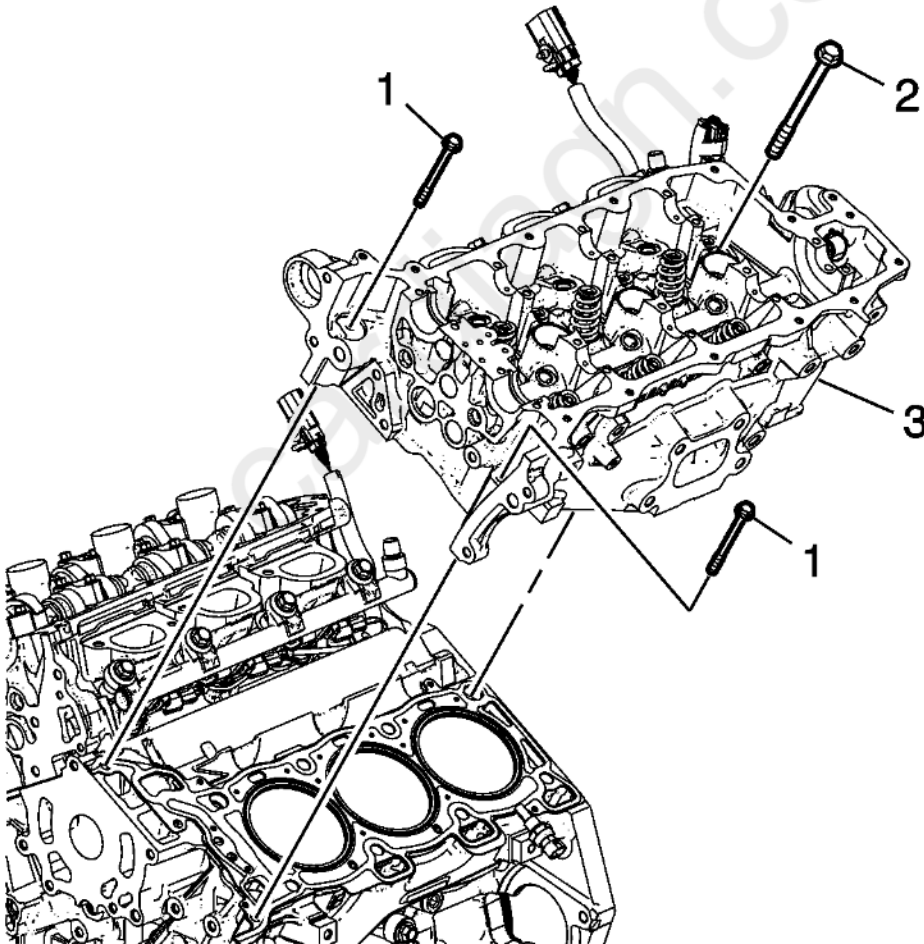


Fig. 45: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the 2 front M8 left cylinder head bolts (1).
8. Remove the left cylinder head bolts (2).
9. Remove the left cylinder head (3).

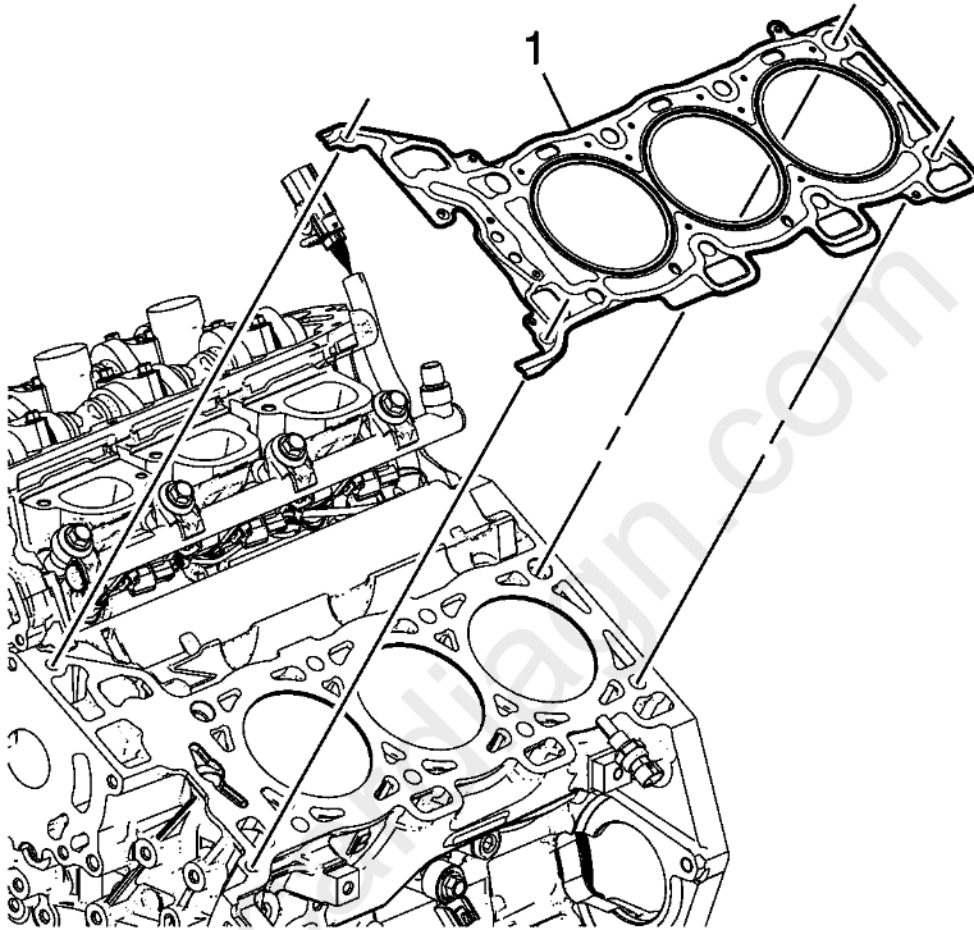


Fig. 46: View Of Left Cylinder Head Gasket
 Courtesy of GENERAL MOTORS CORP.

10. Remove and discard the left cylinder head gasket (1).
11. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection .
12. If cylinder head disassembly is necessary, refer to Cylinder Head Disassemble (LLT) or Cylinder Head Disassemble (LF1 or LFW) .

INSTALLATION PROCEDURE

NOTE: If the fuel injectors were removed from the cylinder head, the injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and

Inspection (LLT) or Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW) .

1. If the cylinder head was disassembled, assemble the cylinder head. Refer to **Cylinder Head Assemble (LLT or LCS)** or **Cylinder Head Assemble (LF1 or LFW)** .

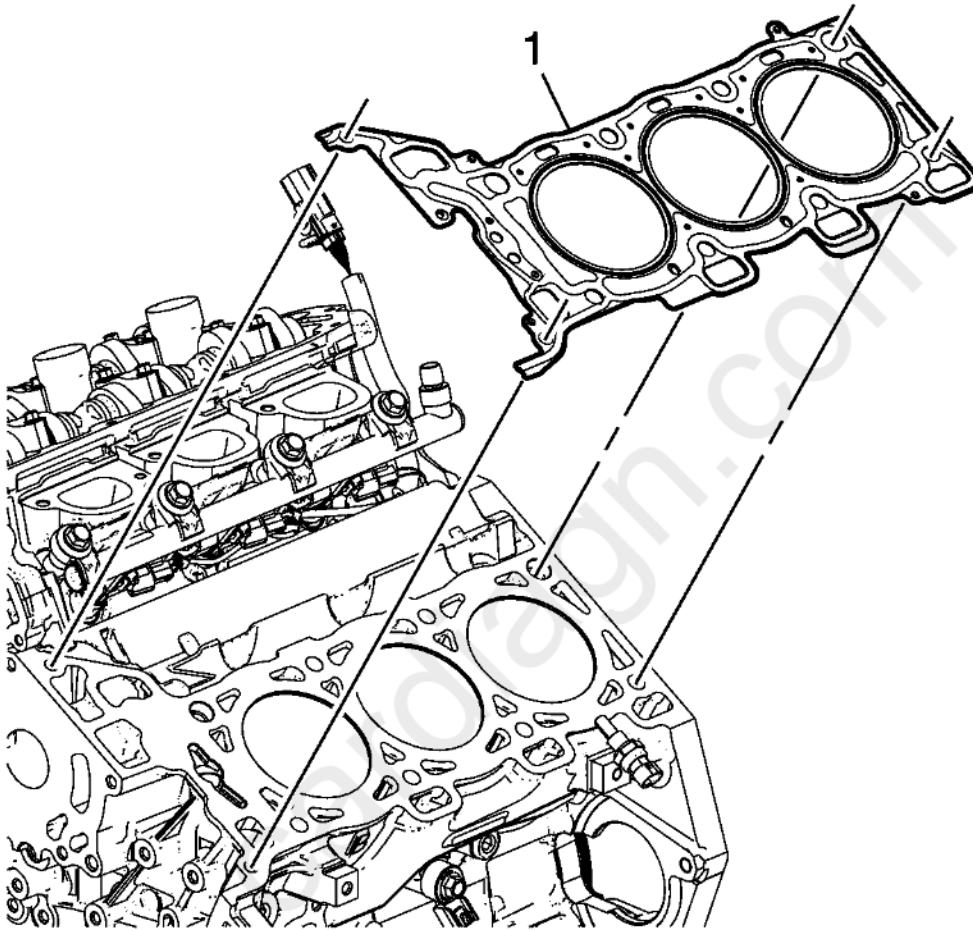


Fig. 47: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.

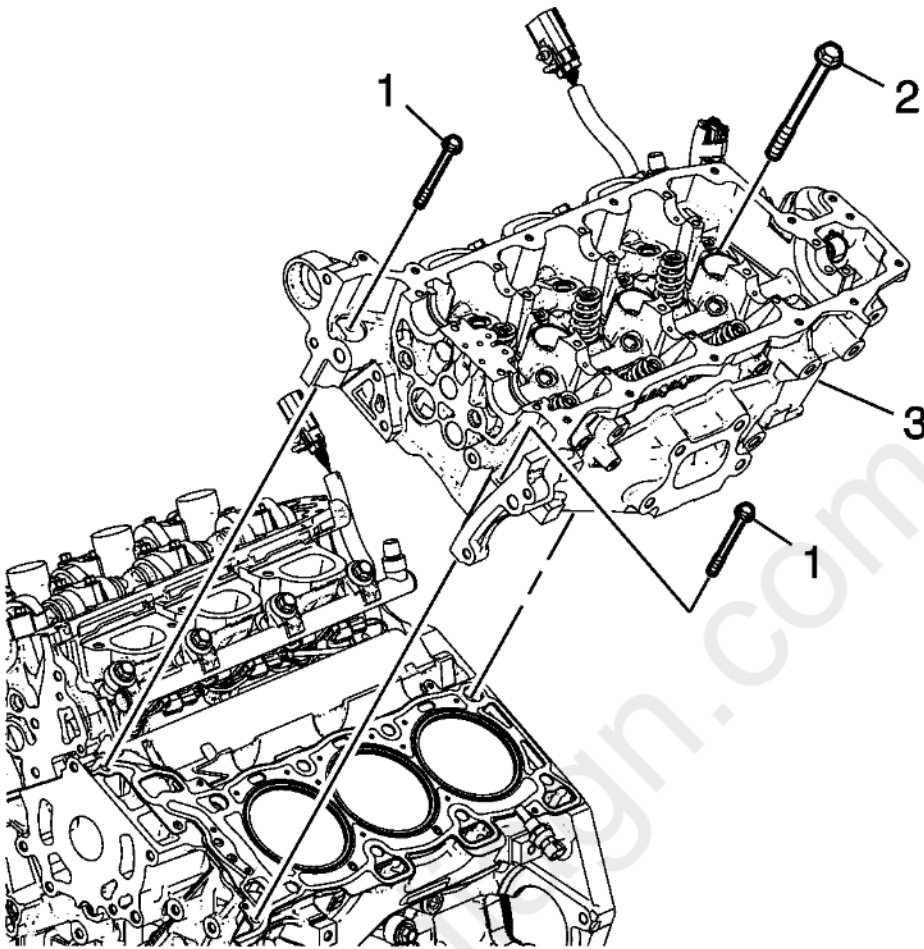


Fig. 48: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Align the left cylinder head (3) with the deck face locating pins.
5. Place the left cylinder head in position on the deck face.

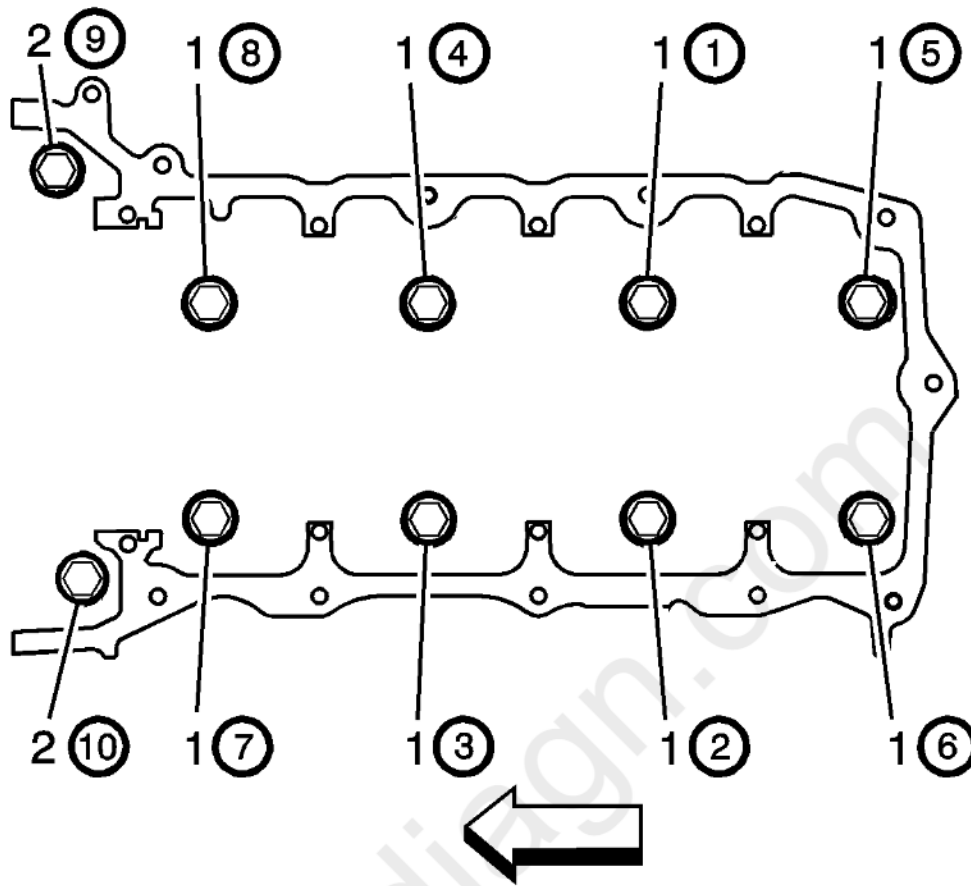


Fig. 49: Identifying M11 Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

NOTE:

- **DO NOT** allow oil on the cylinder head bolt bosses.
- **DO NOT** reuse the old cylinder head bolts.

6. Install the NEW M11 cylinder head bolts (1).
 1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
 2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **J-45059**: meter.
7. Install the 2 NEW front M8 left cylinder head bolts (2).
 1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft).
 2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the **J-**

45059: meter.

8. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side** .
9. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side (LP1, LY7)** or **Camshaft Cover Replacement - Left Side (LLT)** .
10. Install the fuel pump. Refer to **Fuel Pump Replacement** .
11. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement (LF1)** or **Oil Filter Adapter Replacement (LLT)** .
12. Install the power steering pump bracket. Refer to **Power Steering Pump Bracket Replacement** .
13. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LLT)** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE (LLT)

REMOVAL PROCEDURE

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side** .
2. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement (LF1)** or **Oil Level Indicator Tube Replacement (LLT)** .
3. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

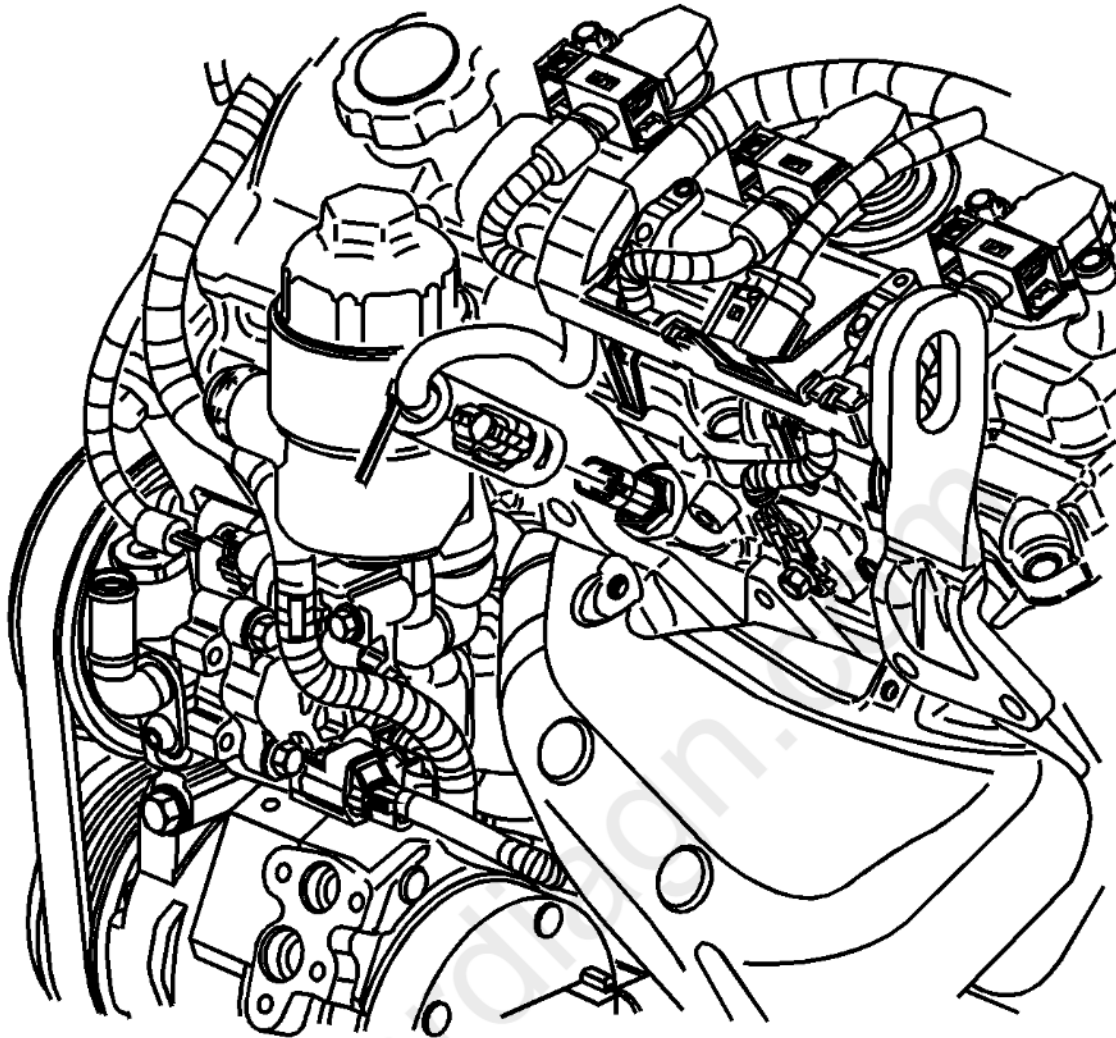


Fig. 50: View Of Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Remove the heat shield from the coolant temperature sensor and disconnect the coolant temperature sensor electrical connector.

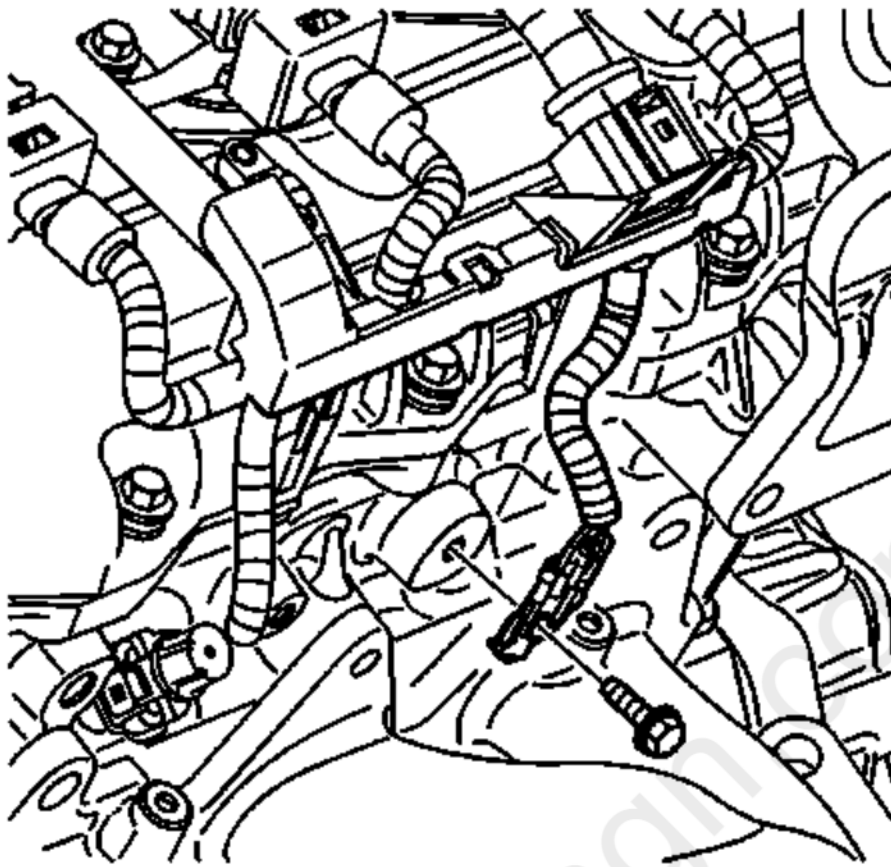


Fig. 51: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the wiring harness ground from the cylinder head.
6. Disconnect the wiring harness electrical connector located at the side of the cylinder head.
7. Remove the wiring harness connector bracket from the side of the cylinder head.

NOTE: **DO NOT disconnect the power steering pipes and/or hoses.**

8. Remove the power steering pump bolts. Refer to **Power Steering Pump Replacement (V6)** .
9. Remove the surge tank hose from the bracket at the rear of the cylinder head.
10. Remove the wiring harness bracket from the rear of the cylinder head.
11. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LF1)** or **Catalytic Converter Replacement - Left Side (LLT)** .
12. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement (LF1)** or **Oil Level Indicator Tube Replacement (LLT)** .

NOTE: **Do not remove the oil filter adapter.**

13. Remove the oil filter adapter upper bolt.

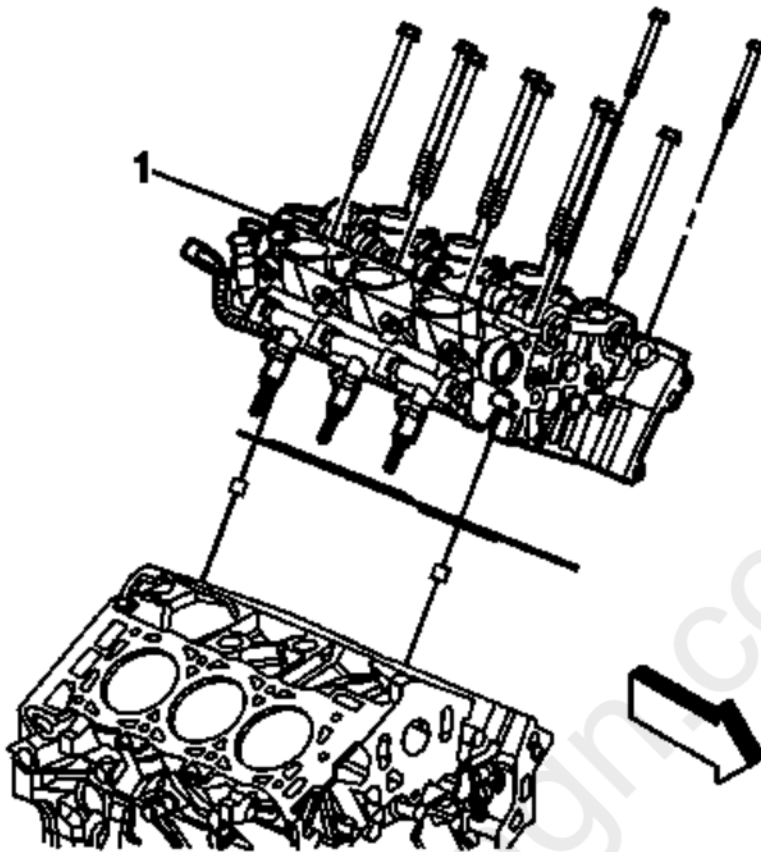


Fig. 52: Identifying Cylinder Head and Exhaust Manifold Assembly
Courtesy of GENERAL MOTORS CORP.

14. Remove the cylinder head (1) with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side (LLT)** or **Cylinder Head Removal - Right Side (LF1 or LFW)** .

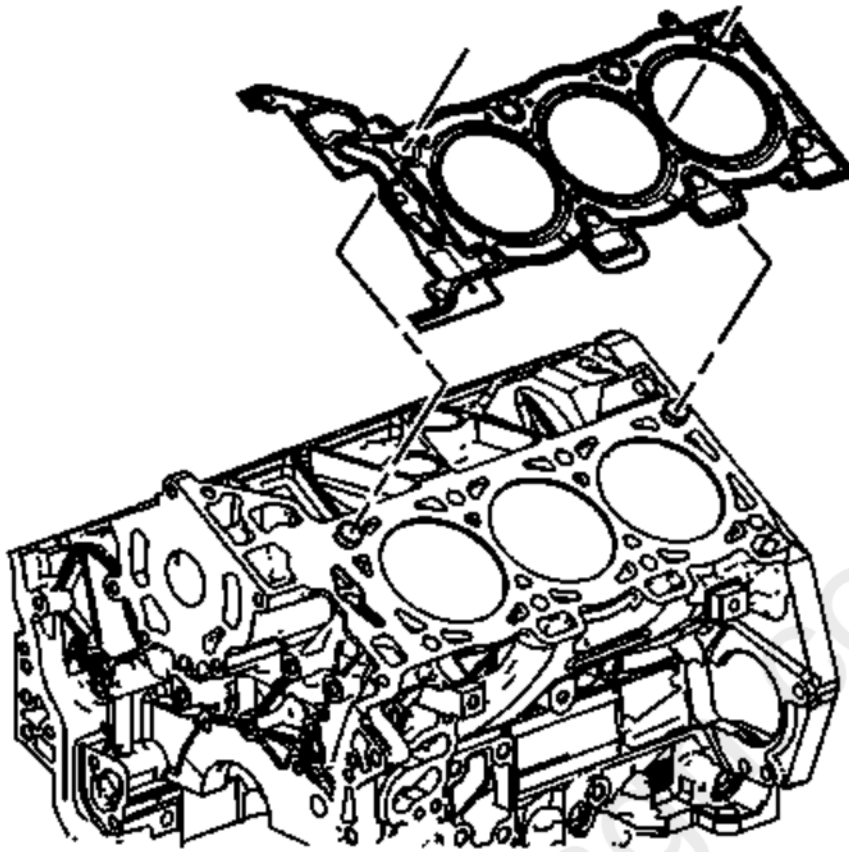


Fig. 53: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

15. Remove and discard the cylinder head gasket.
16. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection.
17. If necessary, perform the following steps:
 1. Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Left Side.
 2. Disassemble the cylinder head. Refer to Cylinder Head Disassemble (LLT) or Cylinder Head Disassemble (LF1 or LFW).

INSTALLATION PROCEDURE

1. If necessary, perform the following steps:

NOTE: If the fuel injectors were removed from the cylinder head, the injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and Inspection (LLT) or Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW).

1. Assemble the cylinder head. Refer to Cylinder Head Assemble (LLT or LCS) or Cylinder Head

Assemble (LF1 or LFW) .

2. Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Left Side** .

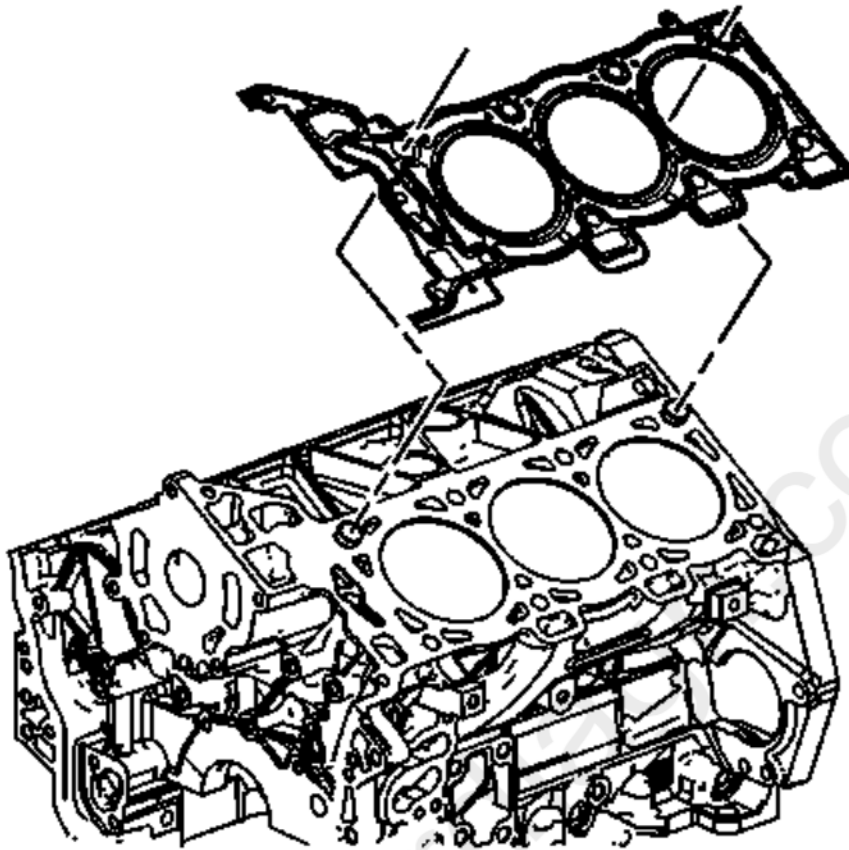


Fig. 54: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.

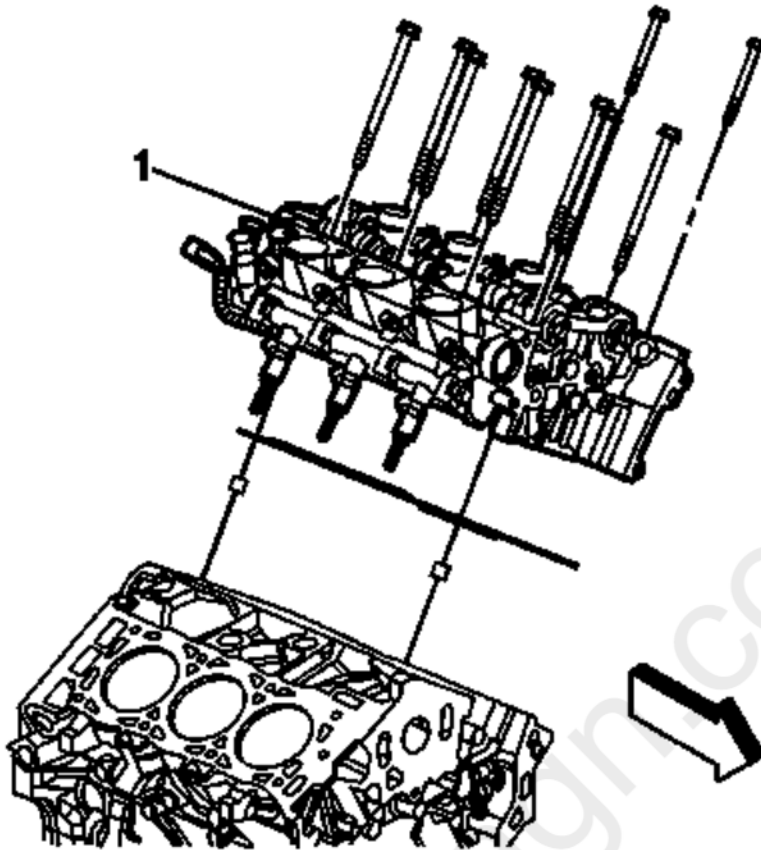


Fig. 55: Identifying Cylinder Head and Exhaust Manifold Assembly
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head (1) with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side (LLT)** or **Cylinder Head Installation - Left Side (LF1 or LFW)** .
4. Install the oil filter adapter upper bolt. Refer to **Oil Filter Adapter Installation** .
5. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement (LF1)** or **Oil Level Indicator Tube Replacement (LLT)** .
6. Install the catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (LF1)** or **Catalytic Converter Replacement - Left Side (LLT)** .
7. Install the wiring harness bracket to the rear of the cylinder head.
8. Install the surge tank hose to the bracket at the rear of the cylinder head.
9. Install the power steering pump bolts. Refer to **Power Steering Pump Replacement (V6)** .
10. Install the wiring harness connector bracket from the side of the cylinder head.
11. Disconnect the wiring harness electrical connector located at the side of the cylinder head.

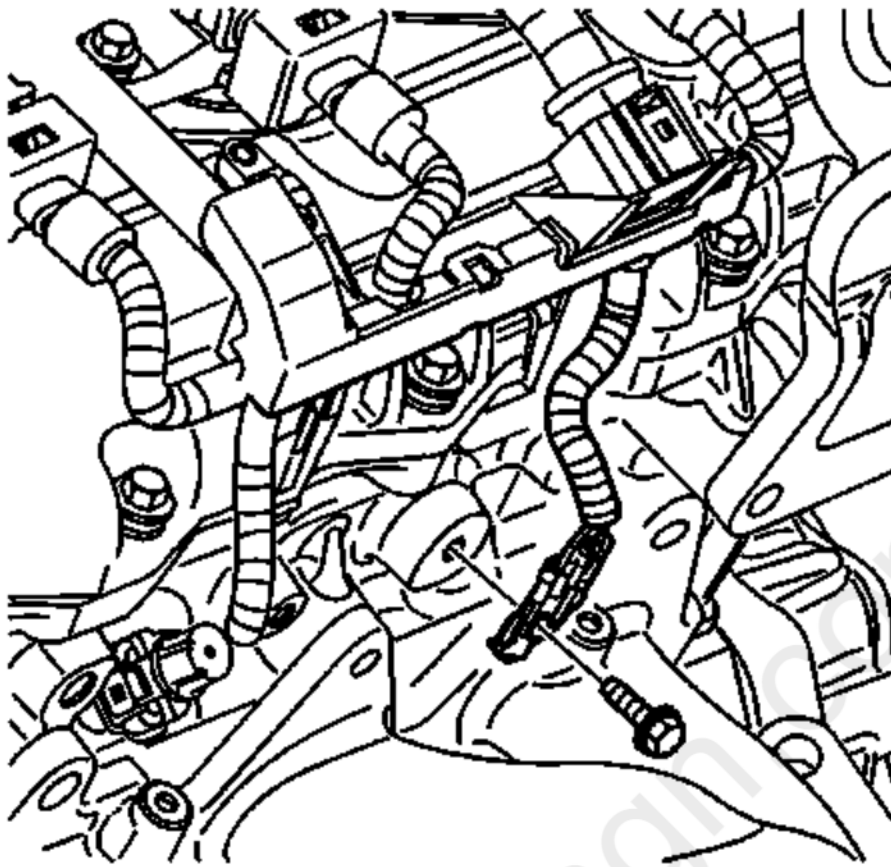


Fig. 56: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

12. Install the wiring harness ground to the cylinder head and tighten the bolt to 10 N.m (89 lb in).

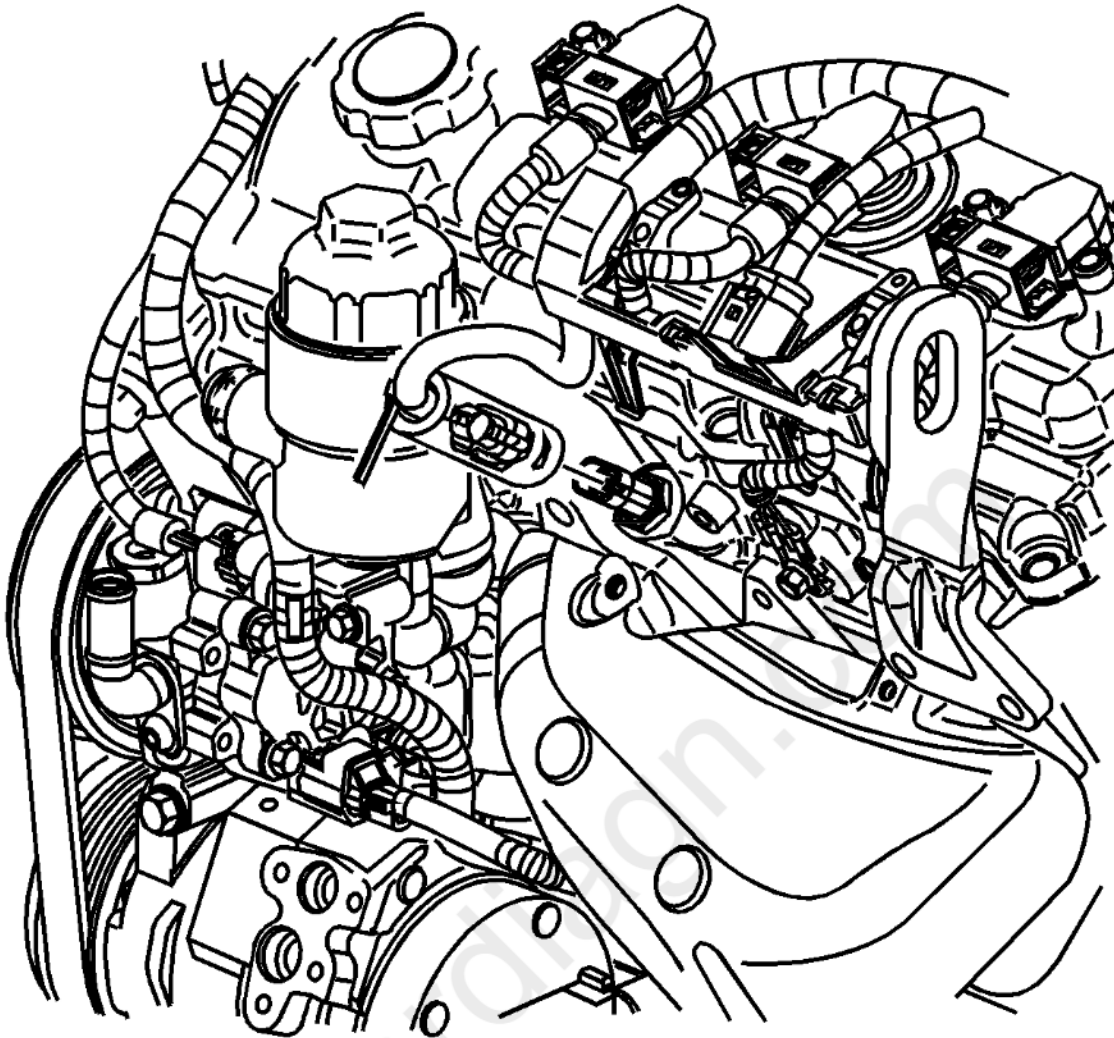


Fig. 57: View Of Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Install the coolant temperature sensor electrical connector heat shield.
14. Install the fuel pump. Refer to **Fuel Pump Replacement** .
15. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement (LF1)** or **Oil Level Indicator Tube Replacement (LLT)** .
16. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side** .

CYLINDER HEAD REPLACEMENT - RIGHT SIDE (LF1)

SPECIAL TOOLS

J-45059: Angle Meter

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

REMOVAL PROCEDURE

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side** .
2. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side** .
3. Remove the coolant inlet pipe bolts and reposition the coolant inlet pipe to provide access. Refer to **Engine Coolant Inlet Pipe Replacement** .
4. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LLT)** .
5. Remove the generator bracket.

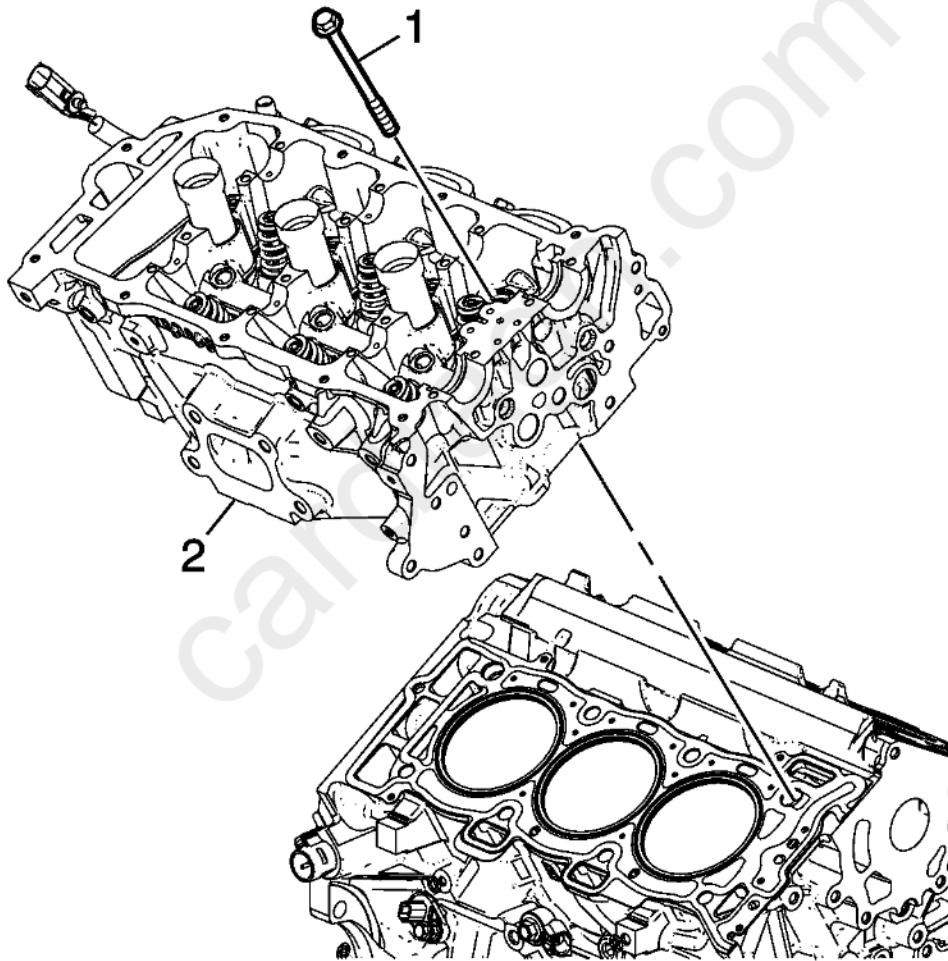


Fig. 58: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the right cylinder head bolts (1).
7. Remove the right cylinder head (2).

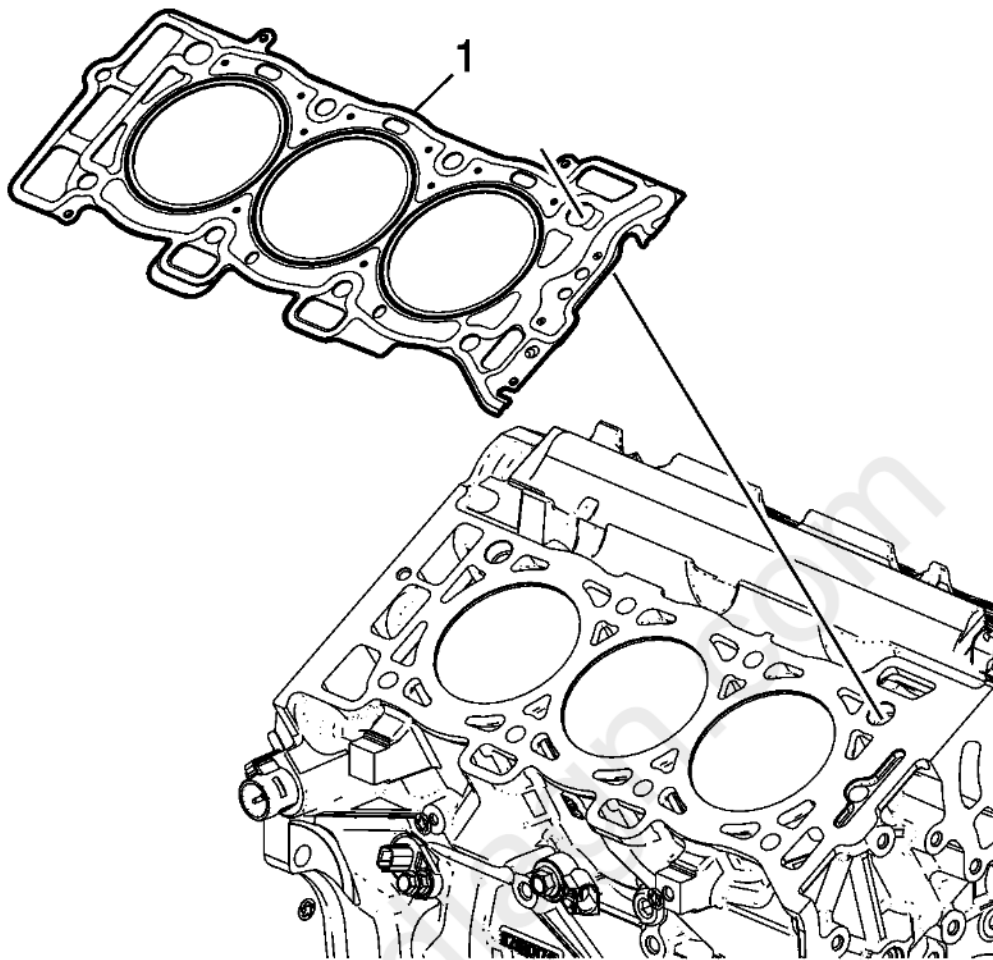


Fig. 59: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the cylinder head gasket.
9. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection .
10. If cylinder head disassembly is necessary, refer to Cylinder Head Disassemble (LLT) or Cylinder Head Disassemble (LF1 or LFW) .

INSTALLATION PROCEDURE

NOTE: If the fuel injectors were removed from the cylinder head, the injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and Inspection (LLT) or Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW) .

1. If the cylinder head was disassembled, assemble the cylinder head. Refer to Cylinder Head Assemble (LLT or LCS) or Cylinder Head Assemble (LF1 or LFW) .

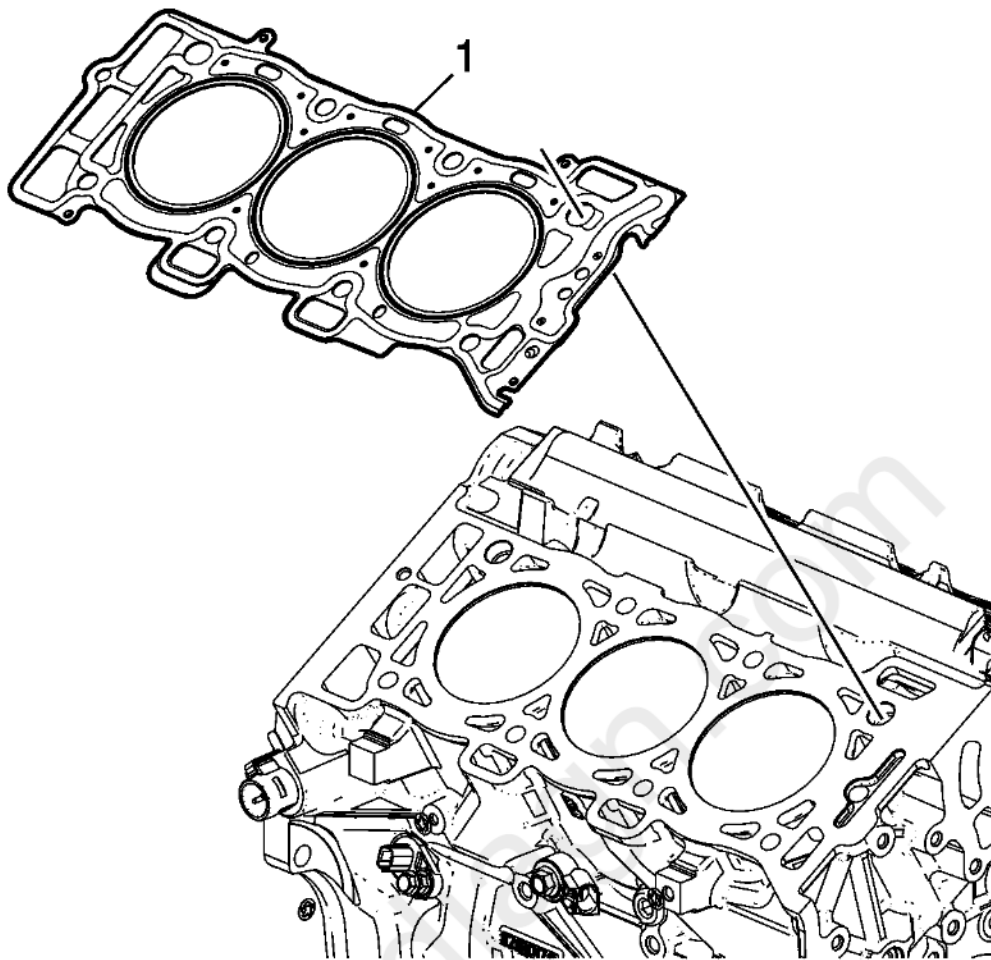


Fig. 60: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.

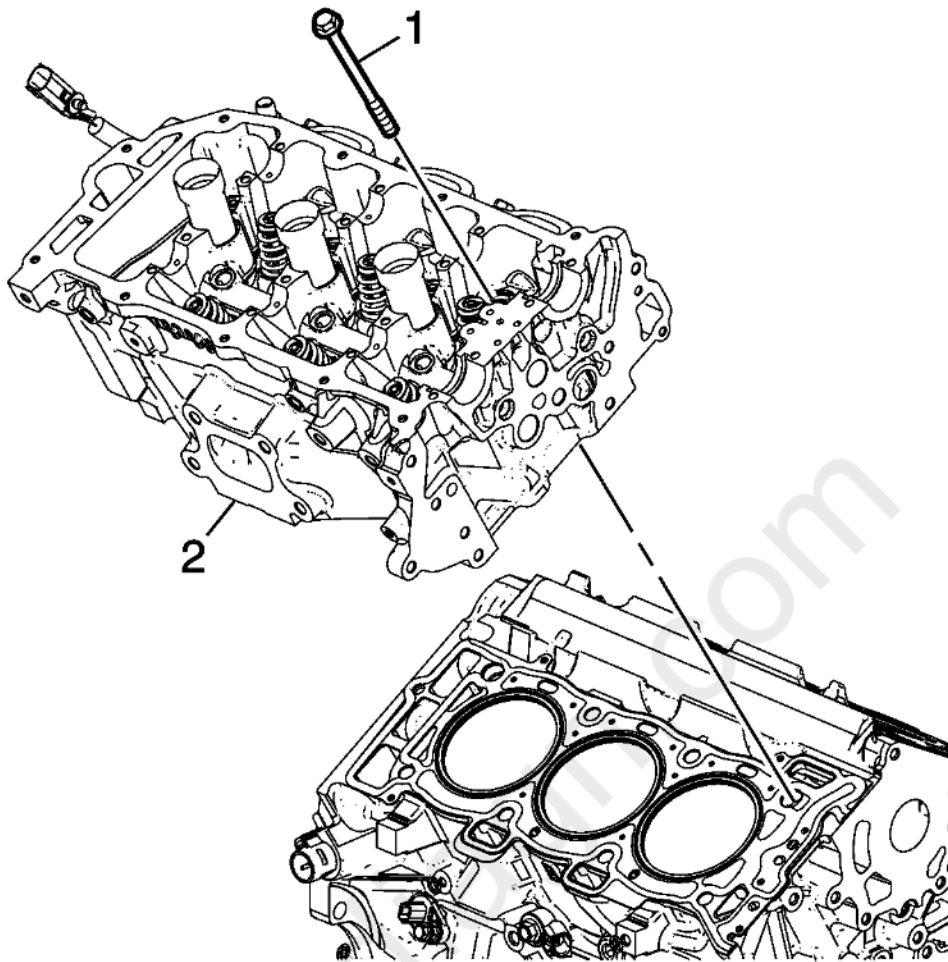


Fig. 61: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Align the right cylinder head (2) with the deck face locating pins.
5. Place the right cylinder head in position on the deck face.

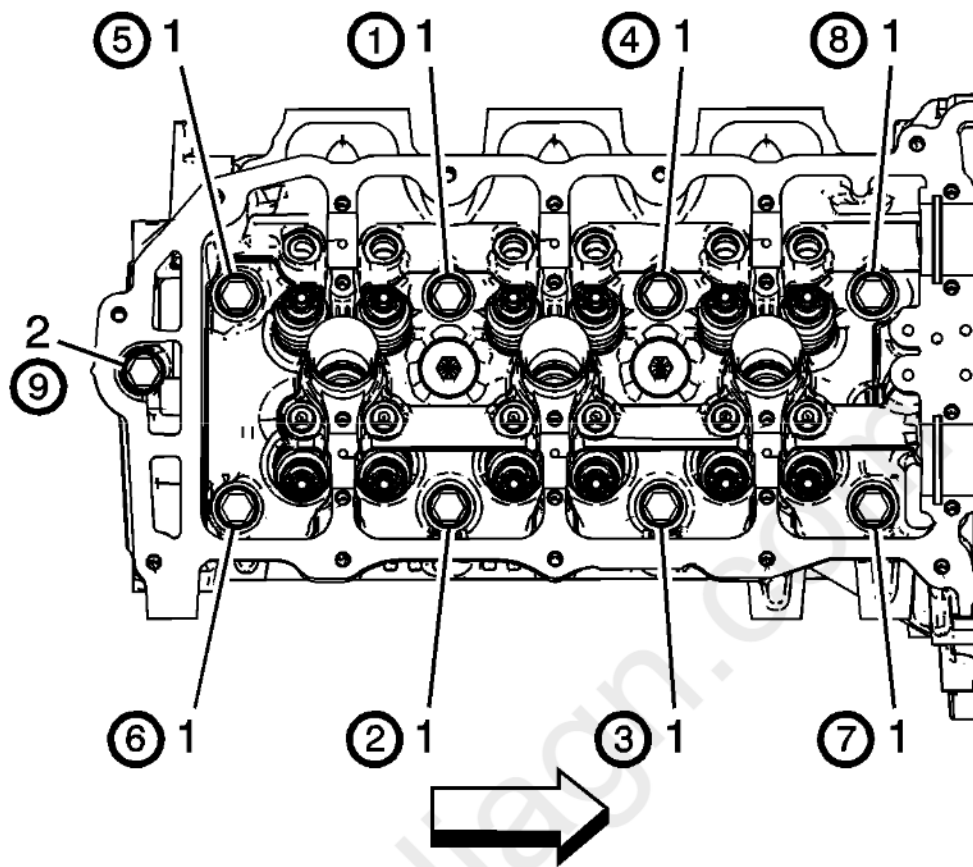


Fig. 62: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

NOTE:

- DO NOT allow oil on the cylinder head bolt bosses.
- DO NOT reuse the old cylinder head bolts.

6. Install the NEW M11 cylinder head bolts (1).
 1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
 2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **J-45059**: meter.
7. Install the NEW M8 cylinder head bolt (2).
 1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
 2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **J-45059**: meter.

8. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side** .
9. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LLT)** .
10. Install the coolant inlet pipe bolts. Refer to **Engine Coolant Inlet Pipe Replacement** .
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side** .
12. Remove the generator bracket.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE (LLT)

REMOVAL PROCEDURE

1. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side** .
2. Remove the coolant inlet pipe bolts and reposition the coolant inlet pipe to provide access. Refer to **Engine Coolant Inlet Pipe Replacement** .
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LF1)** or **Catalytic Converter Replacement - Right Side (LLT)** .

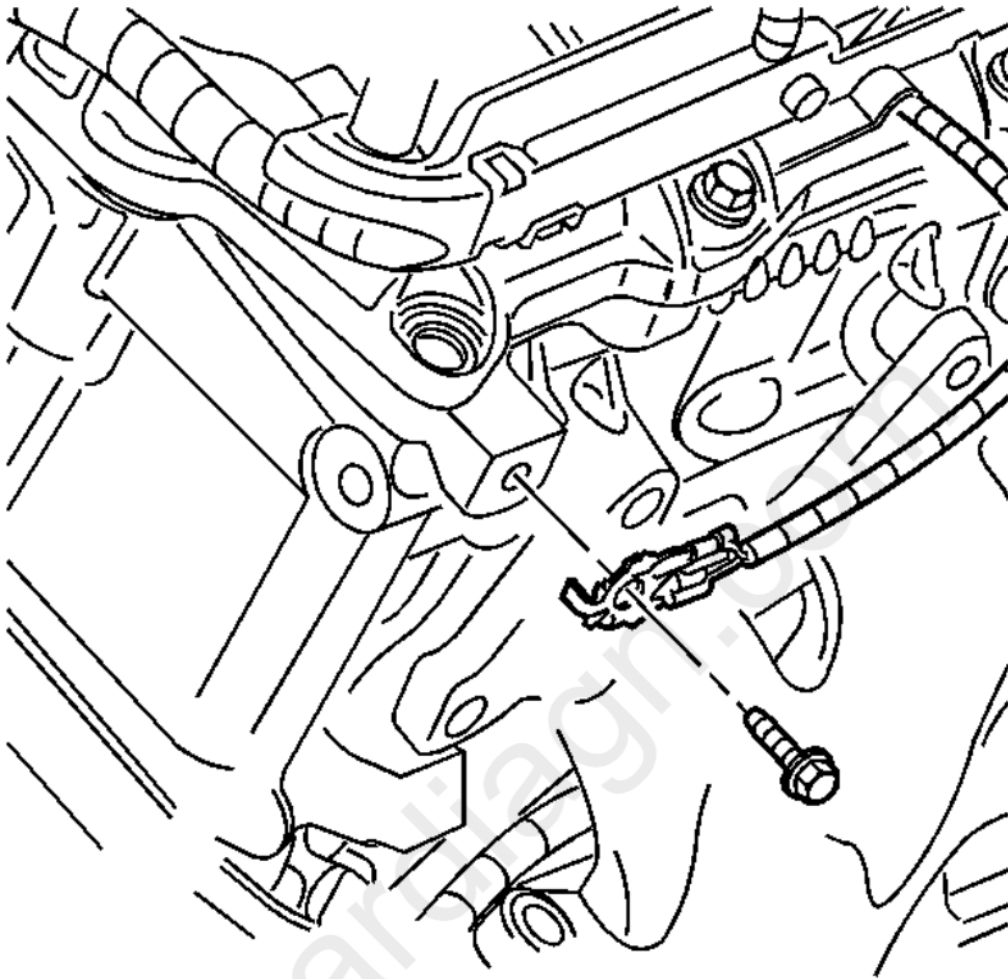


Fig. 63: View Of Wiring Harness Ground Bolt At Side Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness ground from the side of the cylinder head.

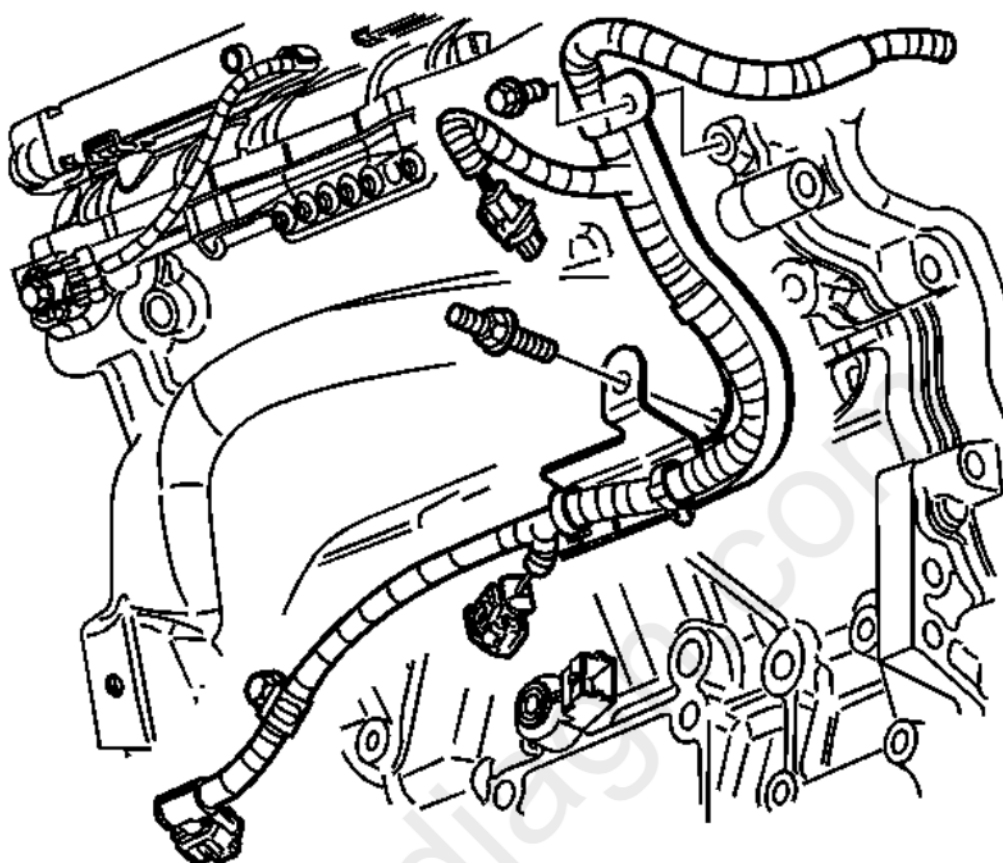


Fig. 64: Locating Engine Wiring Harness Bracket Bolt & Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

5. Remove the wiring harness conduit upper bolt from the cylinder head and reposition the conduit to provide access.
6. Remove the battery cable from the cylinder head. Refer to **Battery Negative Cable Replacement** .

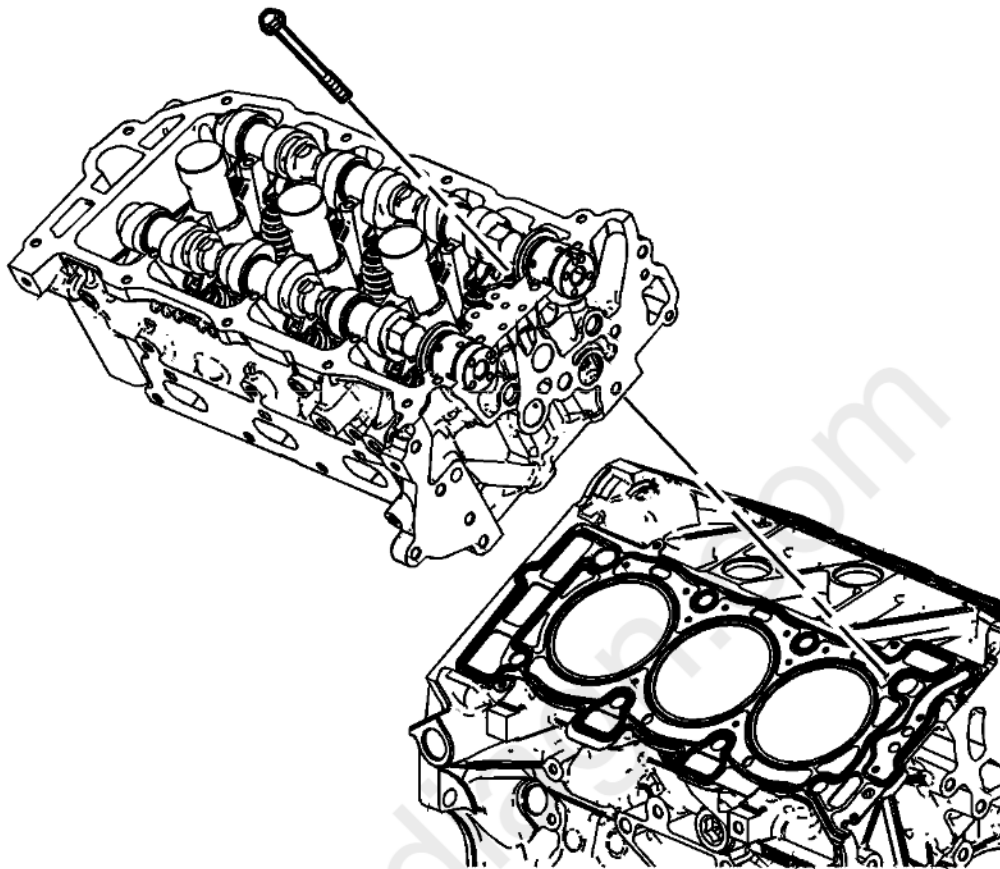


Fig. 65: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Remove the cylinder head with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side (LLT)** or **Cylinder Head Removal - Right Side (LF1 or LFW)** .

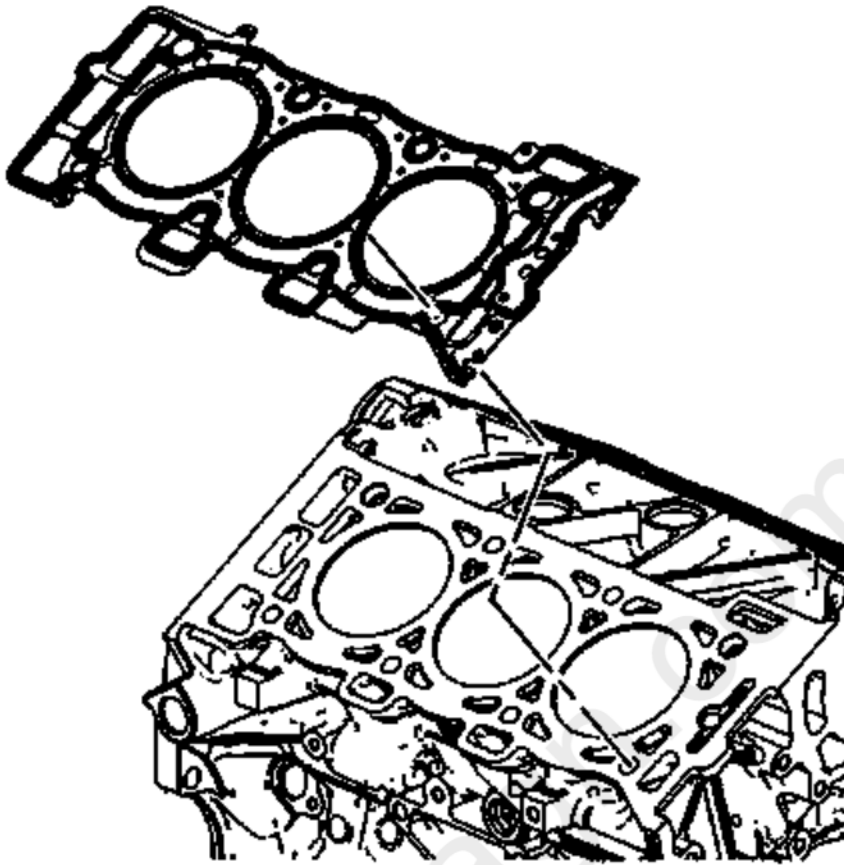


Fig. 66: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the cylinder head gasket.
9. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to Cylinder Head Cleaning and Inspection and Engine Block Cleaning and Inspection .
10. If necessary, perform the following steps:
 - Remove the exhaust manifold from the cylinder head. Refer to Exhaust Manifold Removal - Right Side .
 - Disassemble the cylinder head. Refer to Cylinder Head Disassemble (LLT) or Cylinder Head Disassemble (LF1 or LFW) .

INSTALLATION PROCEDURE

1. If necessary, perform the following steps:

NOTE: If the fuel injectors were removed from the cylinder head, the injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and Inspection (LLT) or Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW) .

- Assemble the cylinder head. Refer to Cylinder Head Assemble (LLT or LCS) or Cylinder Head Assemble (LF1 or LFW) .
- Install the exhaust manifold to the cylinder head. Refer to Exhaust Manifold Installation - Right Side .

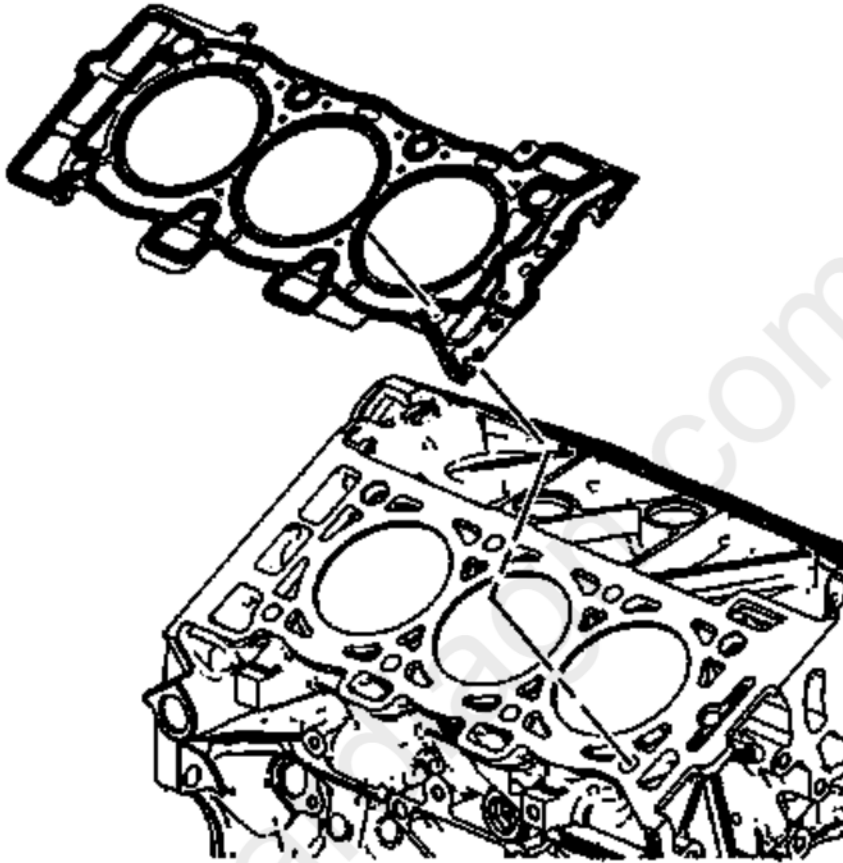


Fig. 67: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.

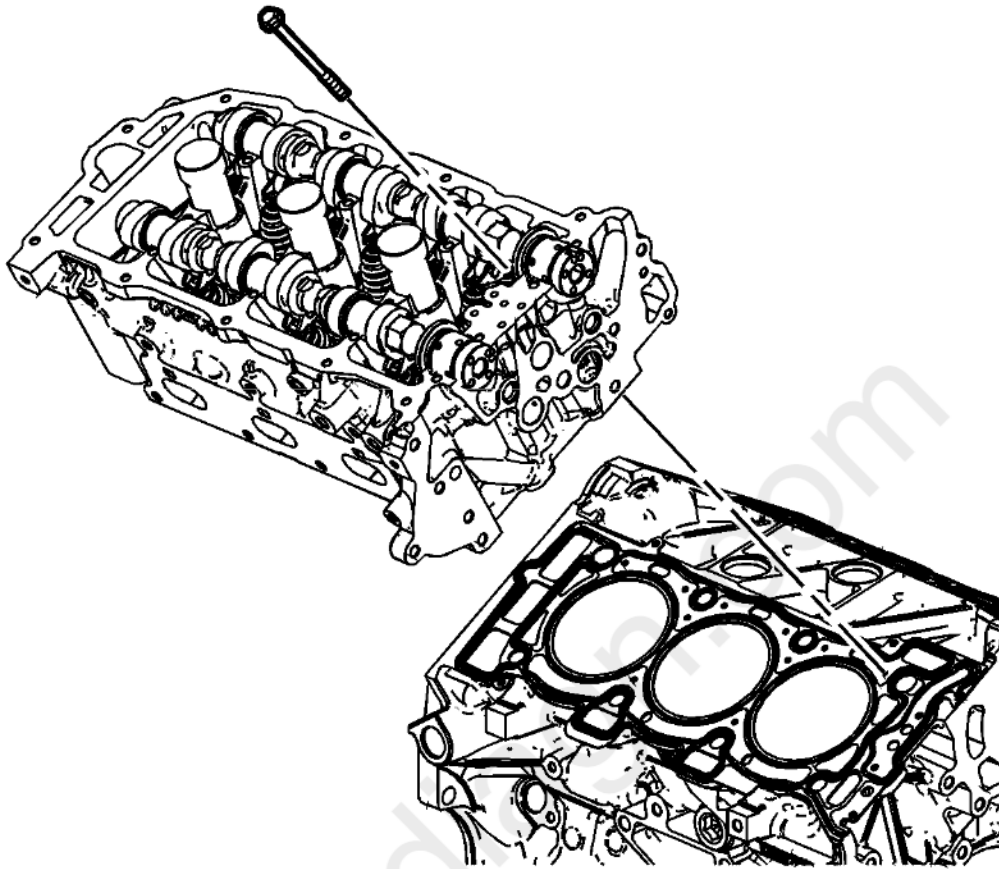


Fig. 68: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Right Side (LLT)** or **Cylinder Head Installation - Right Side (LF1 or LFW)** .
4. Connect the catalytic converter to the exhaust manifold.
5. Install the battery negative cable to the cylinder head. Refer to **Battery Negative Cable Replacement** .

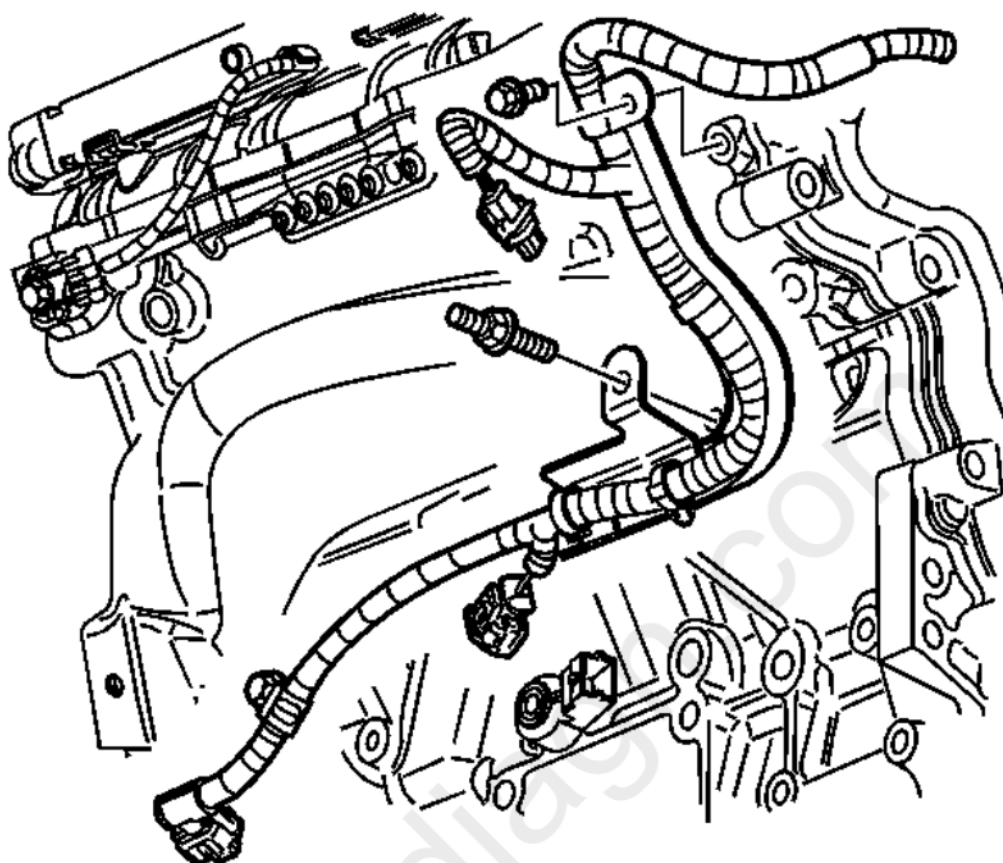


Fig. 69: Locating Engine Wiring Harness Bracket Bolt & Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to **FASTENER CAUTION** .

6. Install the wiring harness conduit to the cylinder head. Tighten the wiring harness upper bolt to 10 N.m (89 lb in).

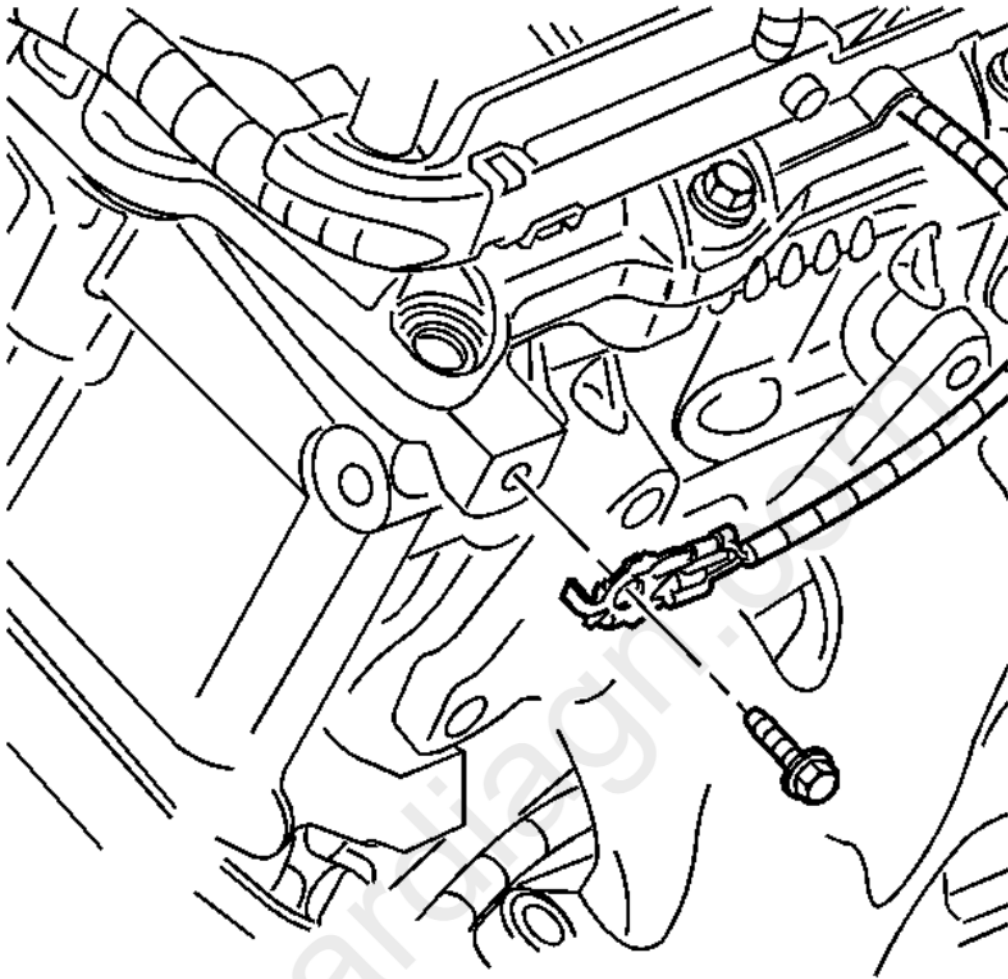
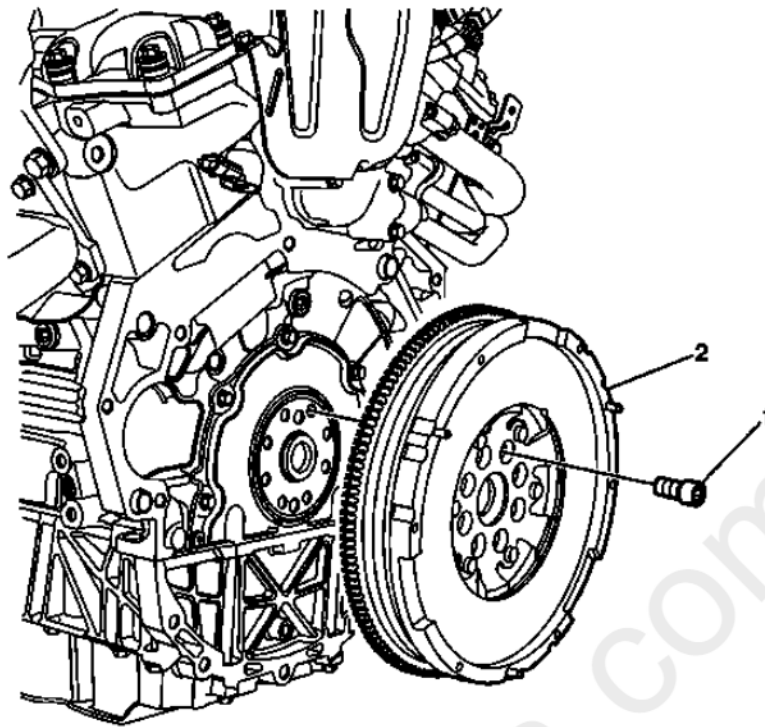


Fig. 70: View Of Wiring Harness Ground Bolt At Side Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Install the wiring harness ground to the side of the cylinder head. Tighten the wiring harness ground bolt to 10 N.m (89 lb in).
8. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LF1)** or **Catalytic Converter Replacement - Right Side (LLT)** .
9. Install the coolant inlet pipe. Refer to **Engine Coolant Inlet Pipe Replacement** .
10. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side** .

ENGINE FLYWHEEL REPLACEMENT

**Fig. 71: Engine Flywheel (Manual)**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Procedure: Remove the Clutch Assembly. Refer to <u>Clutch Assembly Replacement (CTS)</u> or <u>Clutch Assembly Replacement (CTS-V)</u> .	
1	Flywheel Fastener (Qty, 8) CAUTION: Refer to. Tighten: 67 N.m (49 lb ft) Procedure: New bolts must be used whenever removing the flywheel
2	Flywheel Procedure: Transfer parts as needed.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

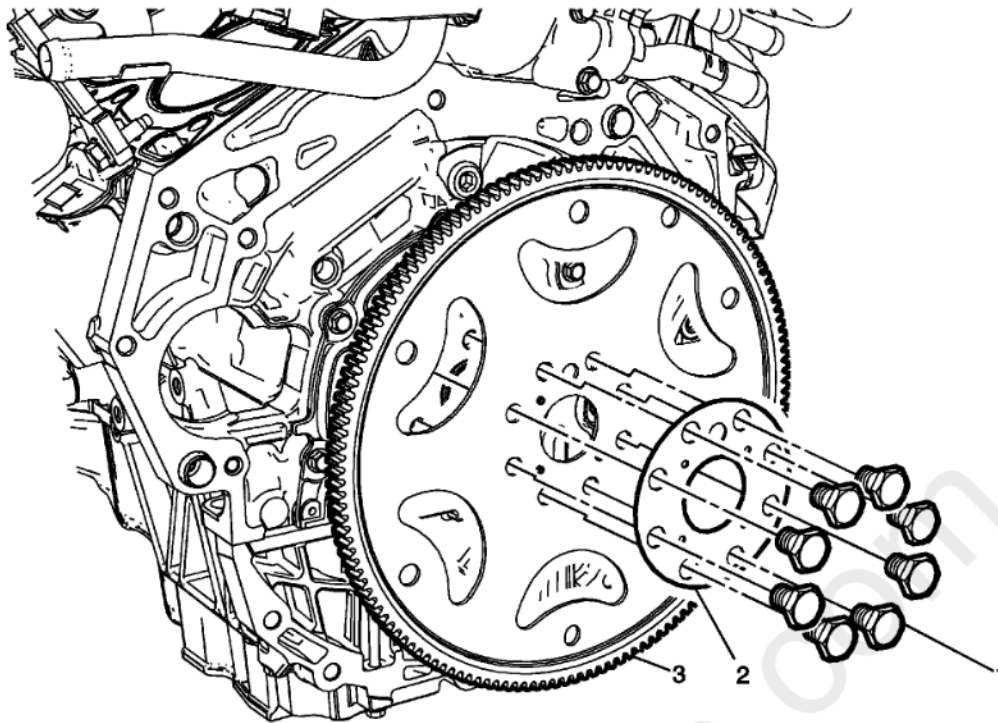


Fig. 72: Automatic Transmission Flex Plate
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Procedure: Remove the transmission. Refer to <u>Transmission Replacement (All Wheel Drive)</u> or <u>Transmission Replacement (Rear Wheel Drive)</u> .	
Special Tools • EN 46106: Flywheel Holding Tool. • EN 45059: Angle Meter.	
For equivalent regional tools. Refer to <u>Special Tools</u> .	
1	Automatic Transmission Flex Plate Fastener (Qty, 8) CAUTION: Refer to. Tighten: 30N.m (22 lb ft) plus 45 degrees. Procedure: New bolts must be used whenever removing the Automatic Transmission Flex Plate.

2	Automatic Transmission Flex Spacer Plate
	Automatic Transmission Flex Plate
3	Procedure 1. For cleaning and inspection. Refer to <u>Engine Flywheel Cleaning and Inspection (Automatic Transmission)</u> or <u>Engine Flywheel Cleaning and Inspection (Manual Transmission)</u> . 2. Transfer parts as necessary.

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine flywheel. Refer to Engine Flywheel Replacement.
2. Remove the oil pan. Refer to Oil Pan Replacement.

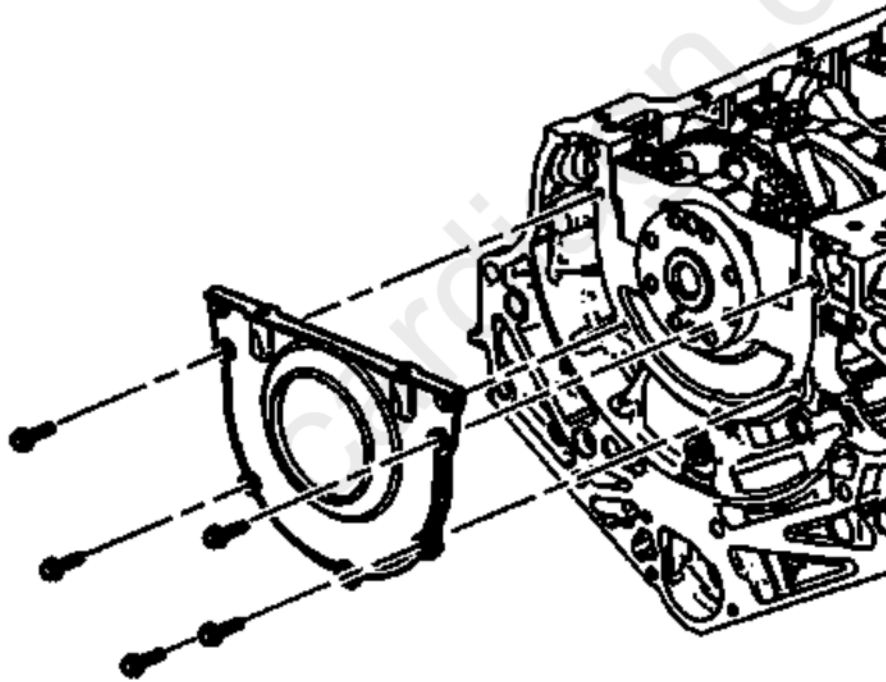


Fig. 73: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft rear oil seal and housing. Refer to Crankshaft Rear Oil Seal and Housing Removal .

INSTALLATION PROCEDURE

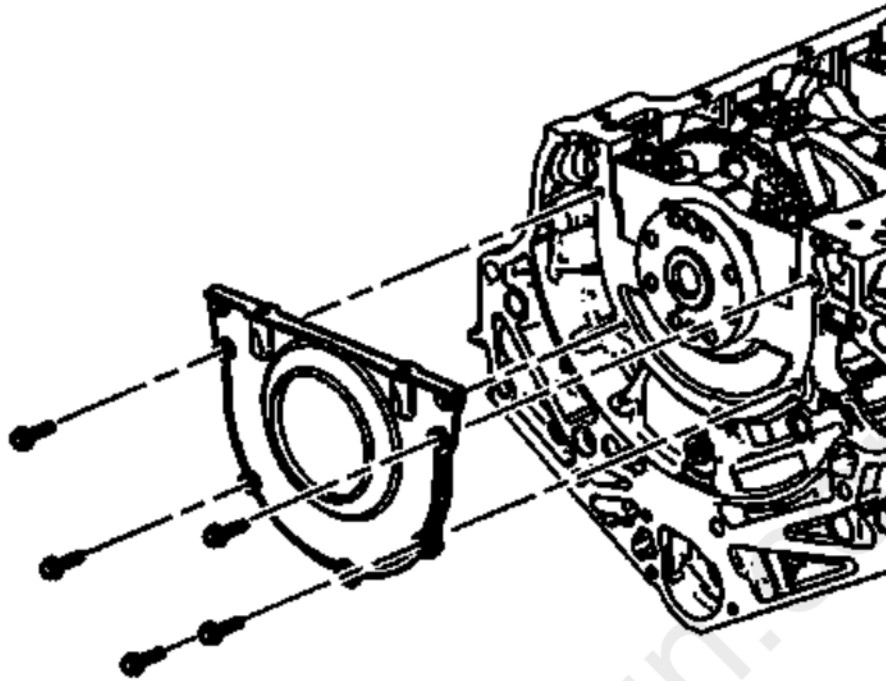


Fig. 74: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Installation** .
2. Install the oil pan. Refer to **Oil Pan Replacement**.
3. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

OIL PUMP REPLACEMENT

REMOVAL PROCEDURE

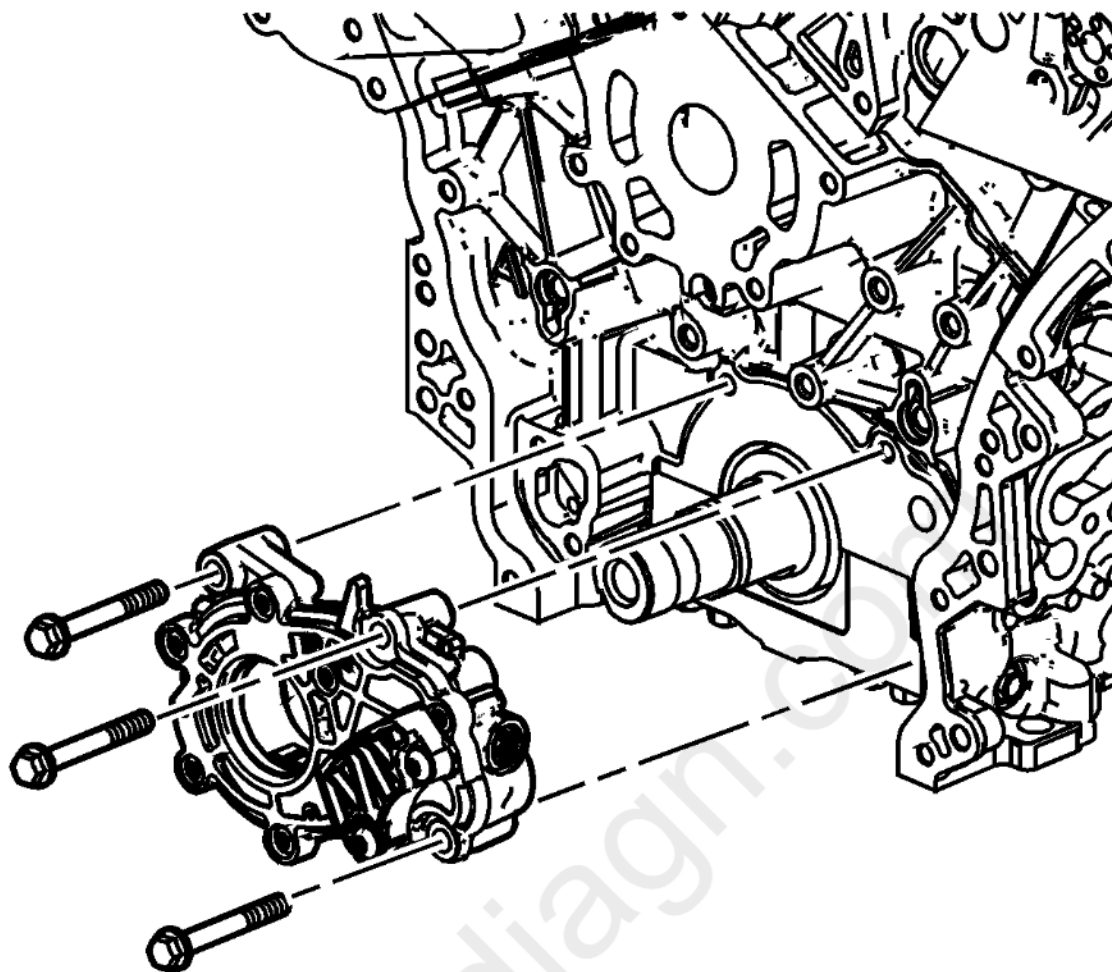


Fig. 75: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not remove the left bank idler sprocket.

1. Remove the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement** .
2. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal** .
3. Remove the oil pump bolts and the oil pump. Refer to **Oil Pump Removal** .

INSTALLATION PROCEDURE

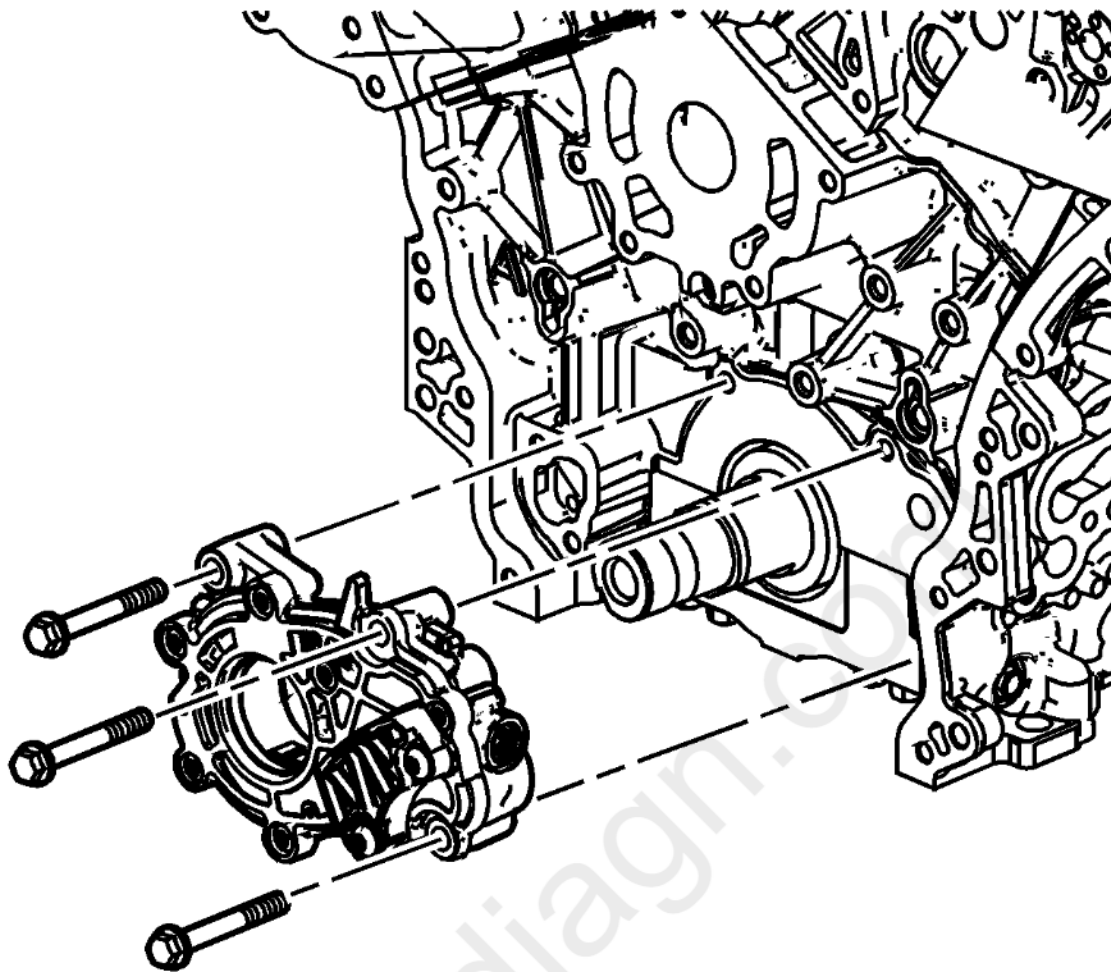


Fig. 76: View Of Oil Pump & Mounting Bolts
 Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump. Refer to **Oil Pump Installation** .
2. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation** .
3. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement** .

OIL PAN REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement** .
2. Remove the power steering hose retainer from the A/C compressor bracket.

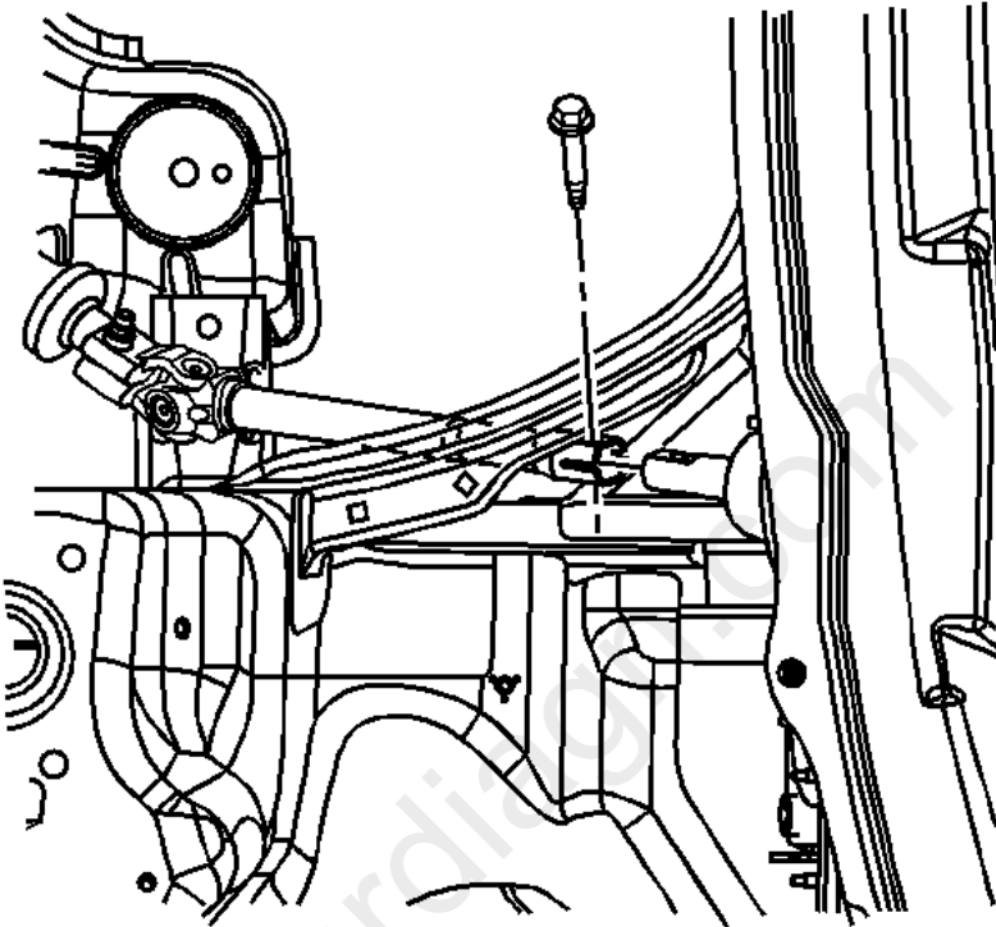


Fig. 77: View Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the intermediate steering shaft.

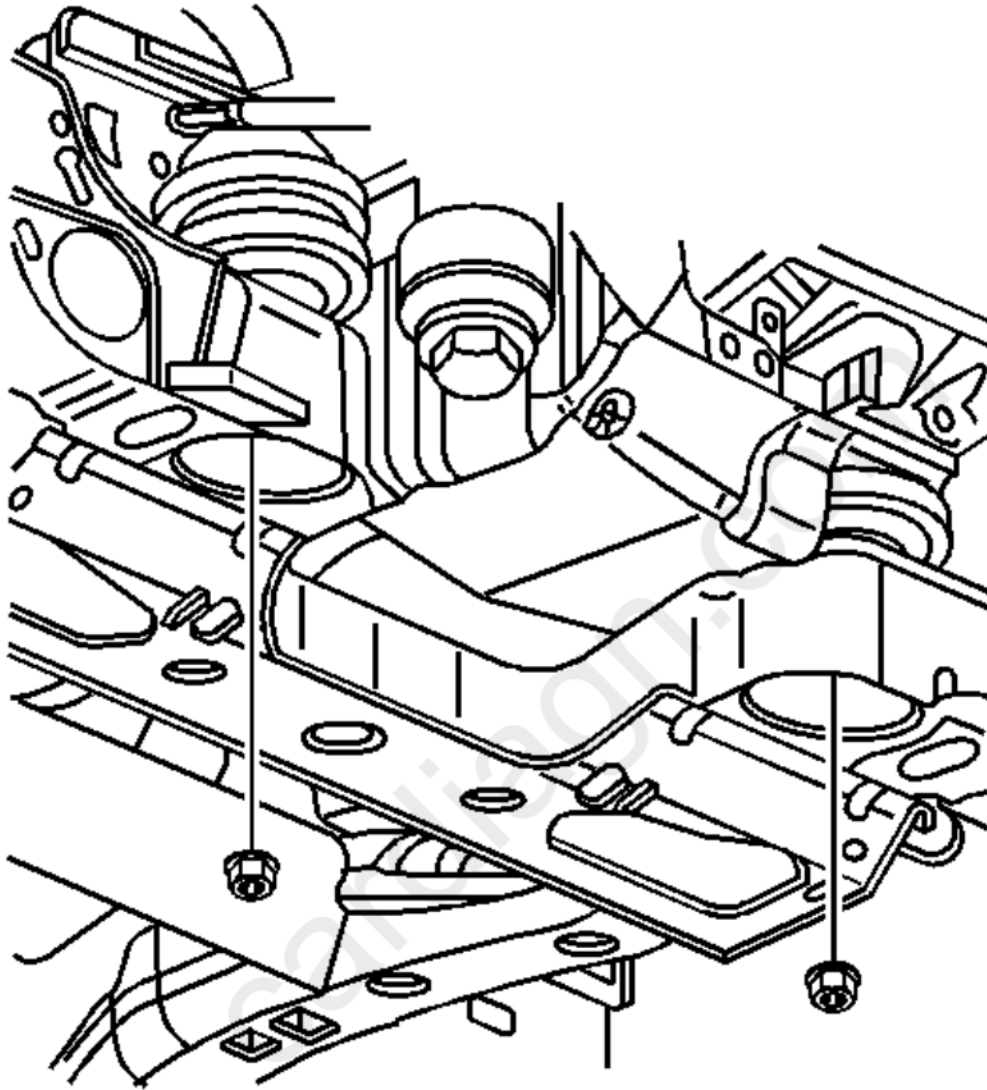


Fig. 78: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount lower nuts.

NOTE: Do NOT disconnect the A/C pipes and/or hoses.

5. Remove the A/C compressor bracket bolts and reposition aside. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)**.

2011 Cadillac CTS

2011 ENGINE Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - CTS

6. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
7. Remove the transmission oil cooler pipe retainer from the engine right side.
8. Install the engine support fixture. Refer to **Engine Support Fixture**.
9. Tighten the support fixture wing nuts in order to provide clearance for the oil pan.
10. Remove the front differential carrier, if equipped. Refer to **Differential Carrier Assembly Replacement**.
11. Remove the oil pan. Refer to **Oil Pan Removal (RWD)** or **Oil Pan Removal (AWD)**.
12. Perform the following steps as necessary:
 1. Disassemble the oil pan. Refer to **Oil Pan Disassemble (RWD)** or **Oil Pan Disassemble (AWD)**.
 2. Clean and inspect the oil pan. Refer to **Oil Pan Cleaning and Inspection (RWD)** or **Oil Pan Cleaning and Inspection (AWD)**.

INSTALLATION PROCEDURE

1. Assemble the oil pan as necessary. Refer to **Oil Pan Assemble (RWD)** or **Oil Pan Assemble (AWD)**.
2. Install the oil pan. Refer to **Oil Pan Installation (RWD)** or **Oil Pan Installation (AWD)**.
3. Install the front differential carrier, if equipped. Refer to **Differential Carrier Assembly Replacement**.
4. Loosen the engine support fixture wing nuts in order to lower the engine and engage the engine mounts to the frame.
5. Remove the engine support fixture. Refer to **Engine Support Fixture**.
6. Remove the transmission oil cooler pipe retainer from the engine right side.
7. Fill the engine with new engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
8. Install the A/C compressor bracket with the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)**.

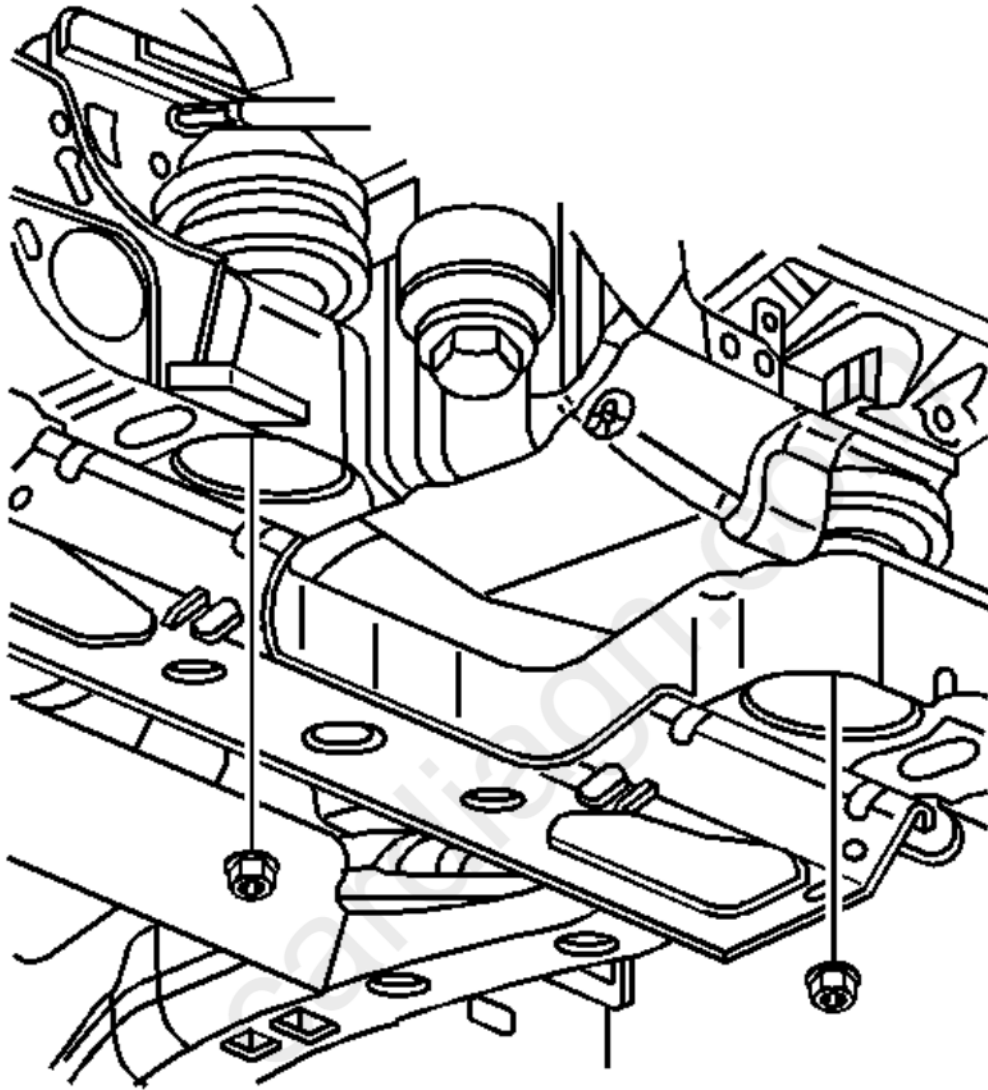


Fig. 79: Identifying Frame Mounting Nuts

Courtesy of GENERAL MOTORS CORP.

9. Install the engine mount lower nuts. Refer to **Engine Mount Replacement - Left Side (AWD)** or **Engine Mount Replacement - Left Side (RWD)** and **Engine Mount Replacement - Right Side (AWD)** or **Engine Mount Replacement - Right Side (RWD)** .

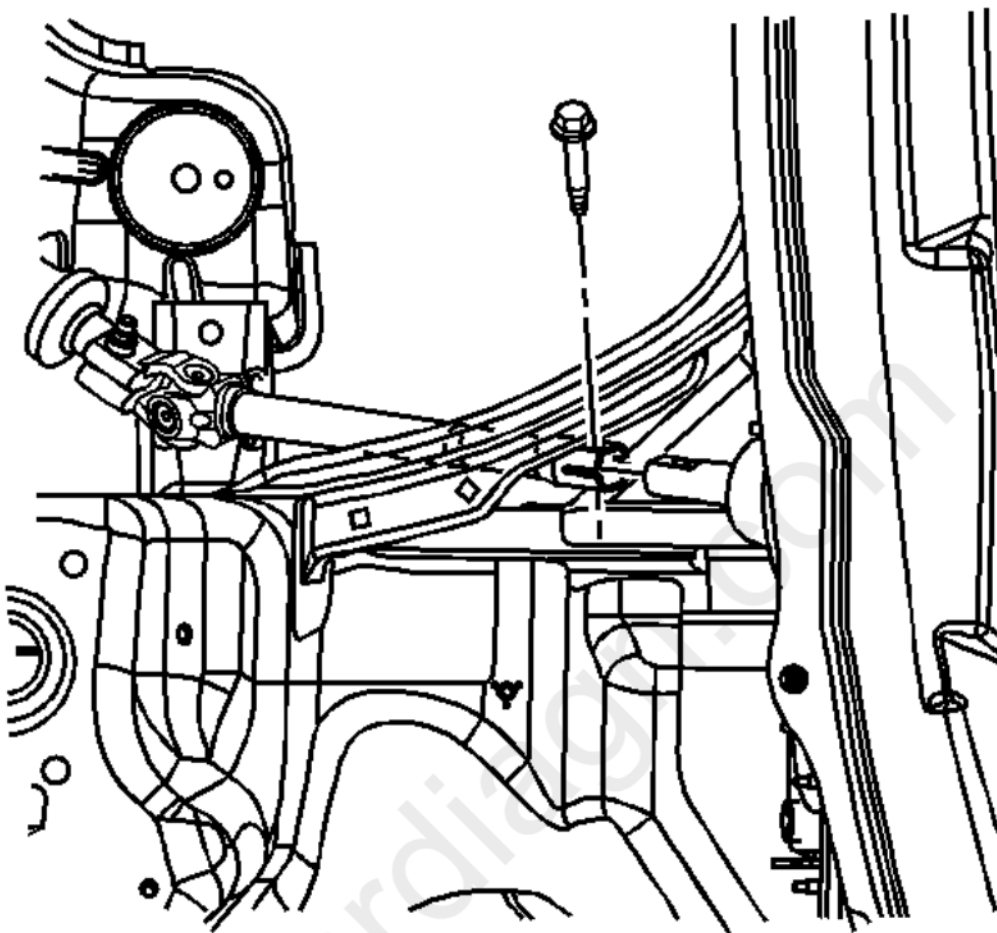


Fig. 80: View Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS CORP.

10. Connect the intermediate steering shaft. Refer to **Upper Intermediate Steering Shaft Replacement** .
11. Install the power steering hose retainer to the A/C compressor bracket.
12. Install the engine front cover. Refer to **Engine Front Cover Replacement** .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

REMOVAL PROCEDURE

1. Turn the ignition OFF.
2. Disconnect the oil pressure sensor electrical connector.

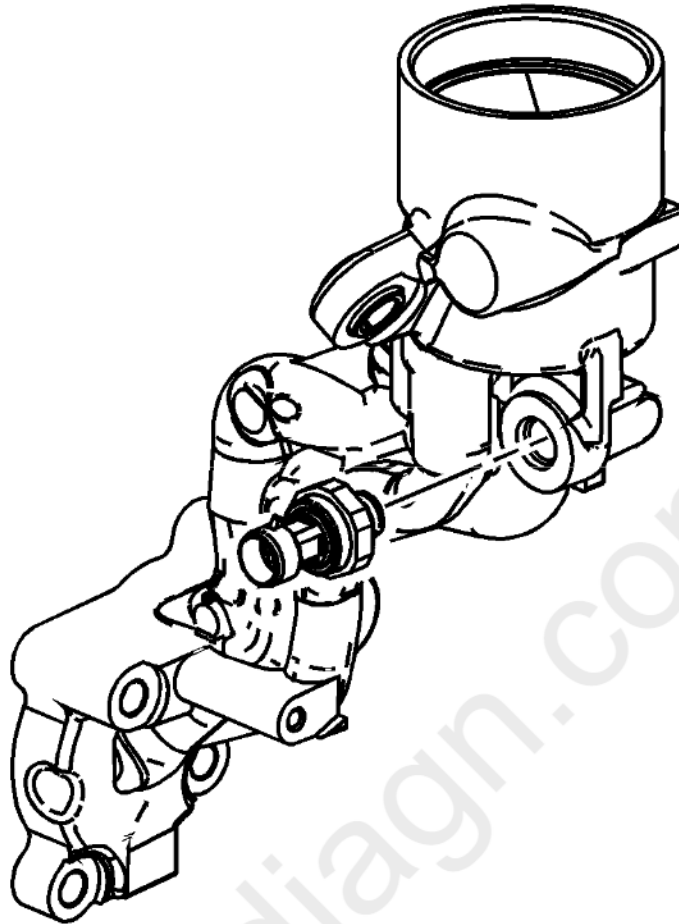


Fig. 81: View Of Oil Pressure Sender
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor.

INSTALLATION PROCEDURE

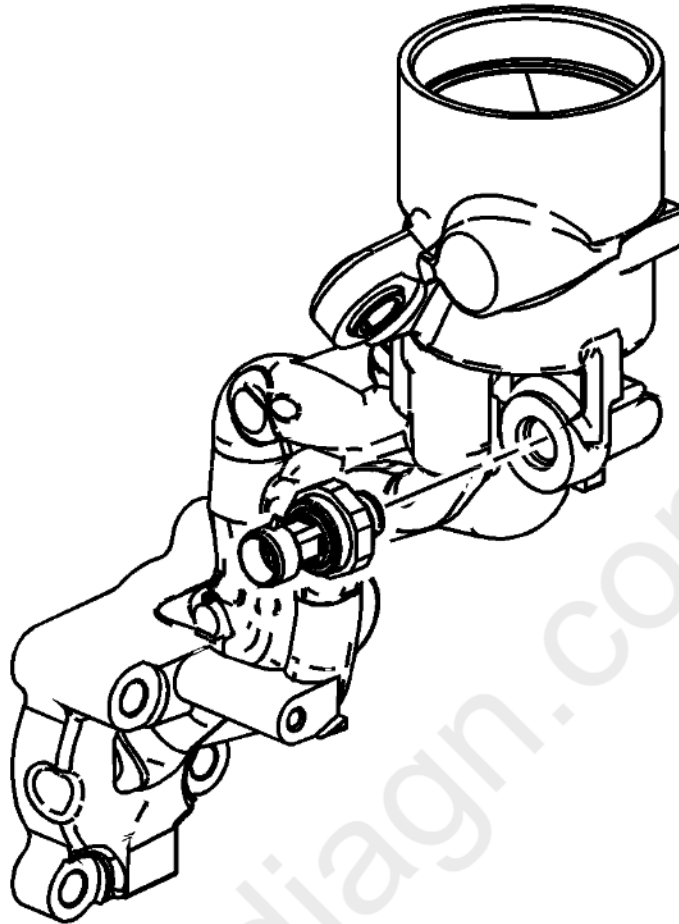


Fig. 82: View Of Oil Pressure Sender
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

1. Install the oil pressure sensor and tighten to 20 N.m (15 lb ft).
2. Connect the oil pressure sensor electrical connector.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

REMOVAL PROCEDURE

1. Remove the oil pan. Refer to Oil Pan Replacement.

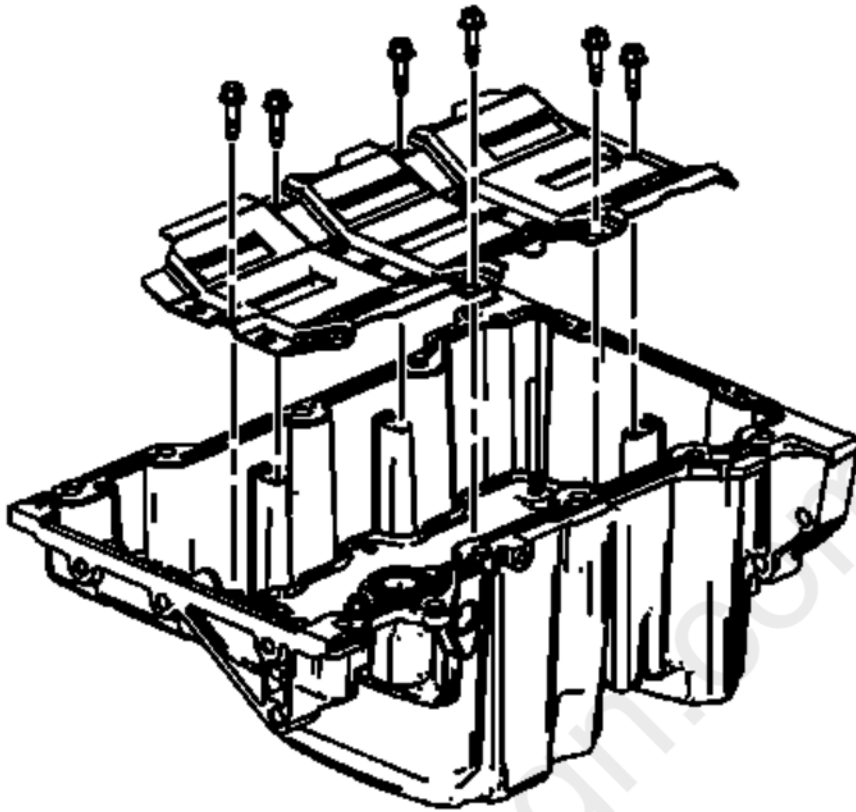


Fig. 83: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.

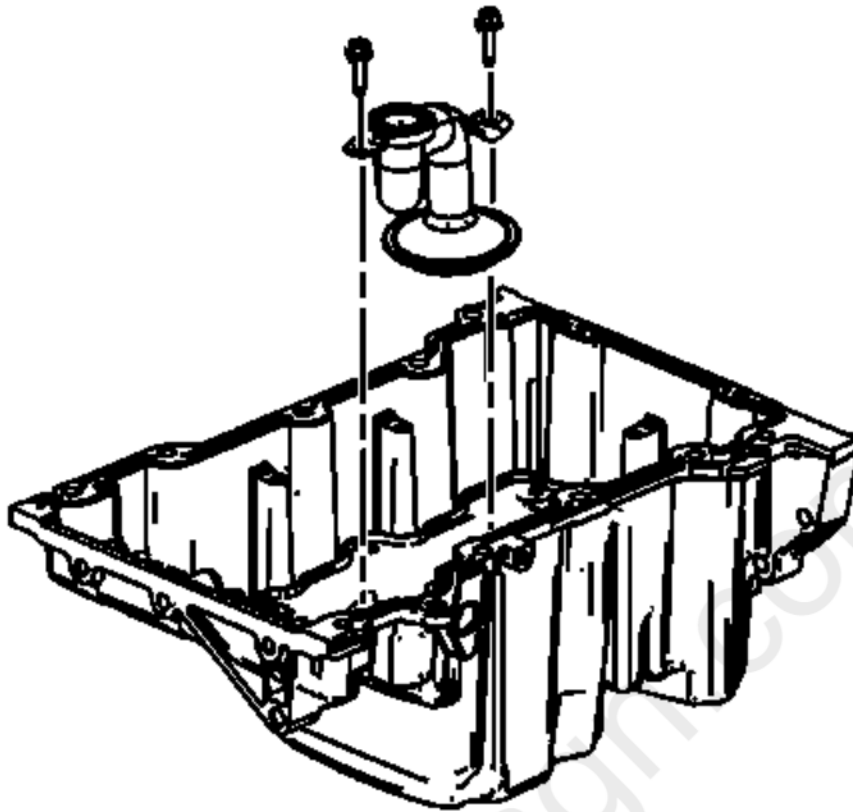


Fig. 84: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.

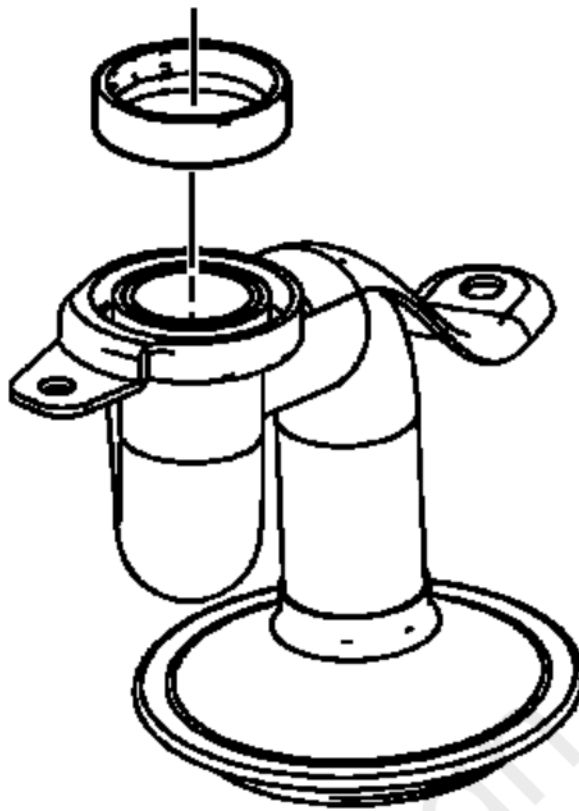


Fig. 85: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

INSTALLATION PROCEDURE

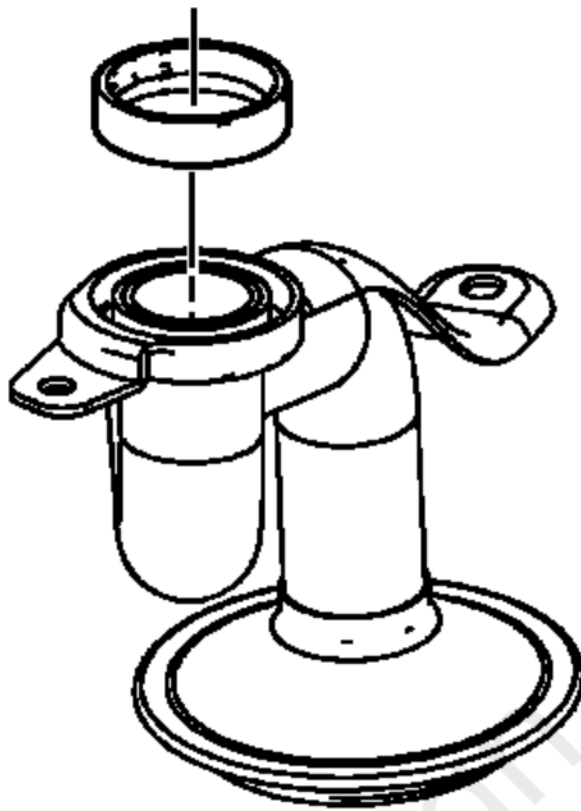


Fig. 86: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil suction tube seal onto the oil suction tube. DO NOT reuse the old oil suction tube seal.

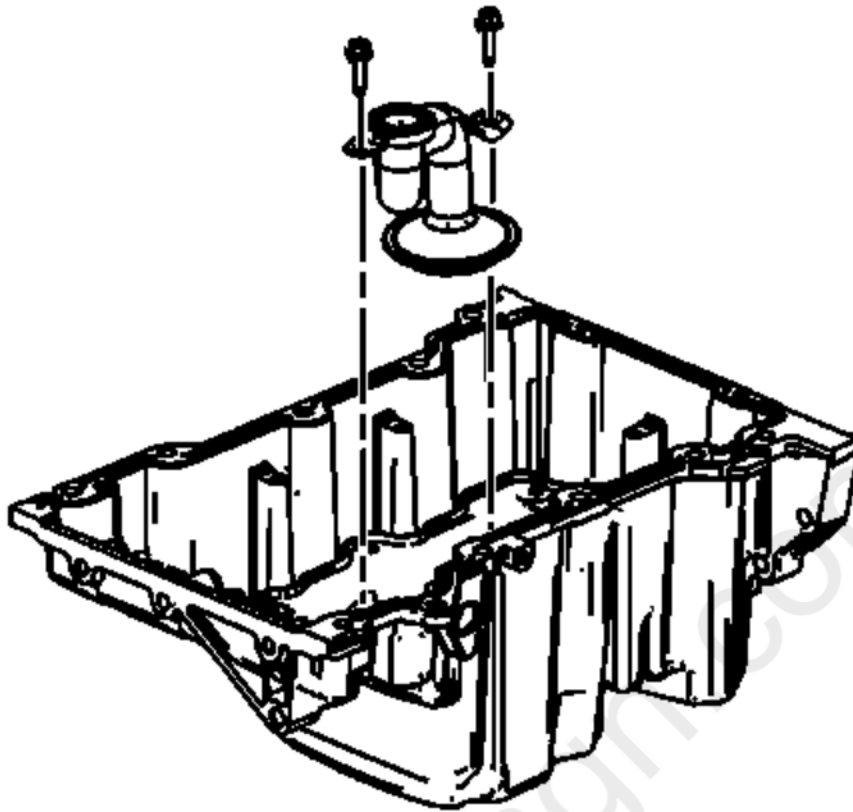


Fig. 87: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS CORP.

2. Install the oil suction pipe.

CAUTION: Refer to FASTENER CAUTION .

3. Install the oil suction pipe bolts and tighten to 10 N.m (89 lb in).

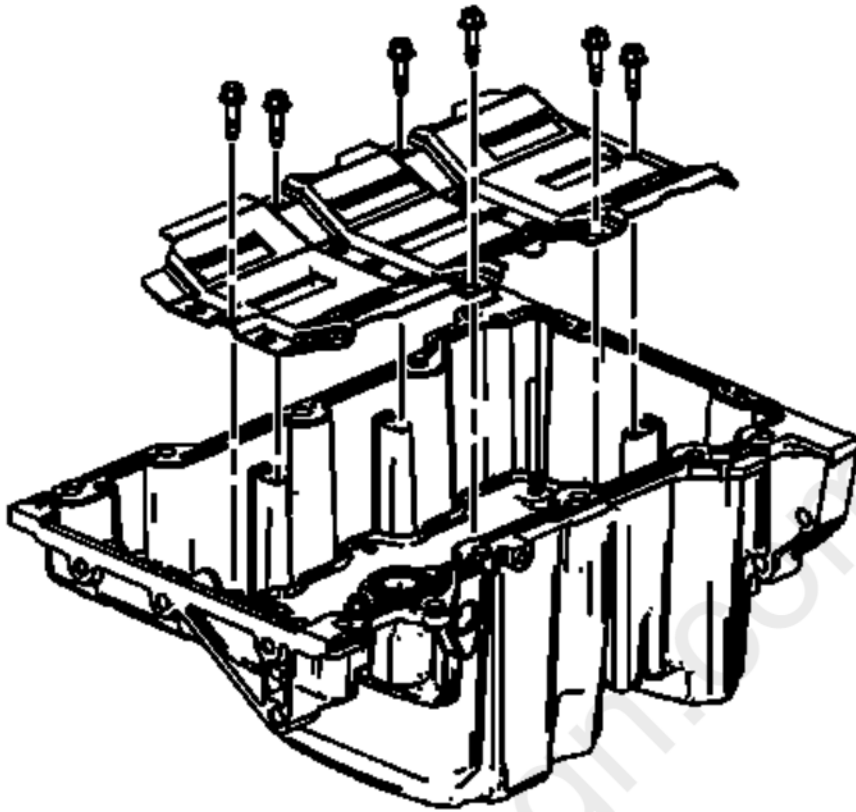


Fig. 88: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan scraper.
5. Install the oil pan scraper bolts and tighten to 10 N.m (89 lb in).
6. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE REPLACEMENT

SPECIAL TOOLS

EN 46114 Engine Lift Brackets. See **Special Tools** .

REMOVAL PROCEDURE

1. Turn the ignition OFF.

NOTE: Do NOT disconnect the battery cables from the engine.

2. Disconnect the negative cable from the battery and the body on the right strut tower. Refer to **Battery Negative Cable Replacement** .

3. Position and secure the battery cables to the engine.
4. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement (LP1, LY7) or Fuel Injector Sight Shield Replacement (LLT).
5. Remove the air cleaner duct. Refer to Air Cleaner Outlet Duct Replacement (LF1) or Air Cleaner Outlet Duct Replacement (LLT).

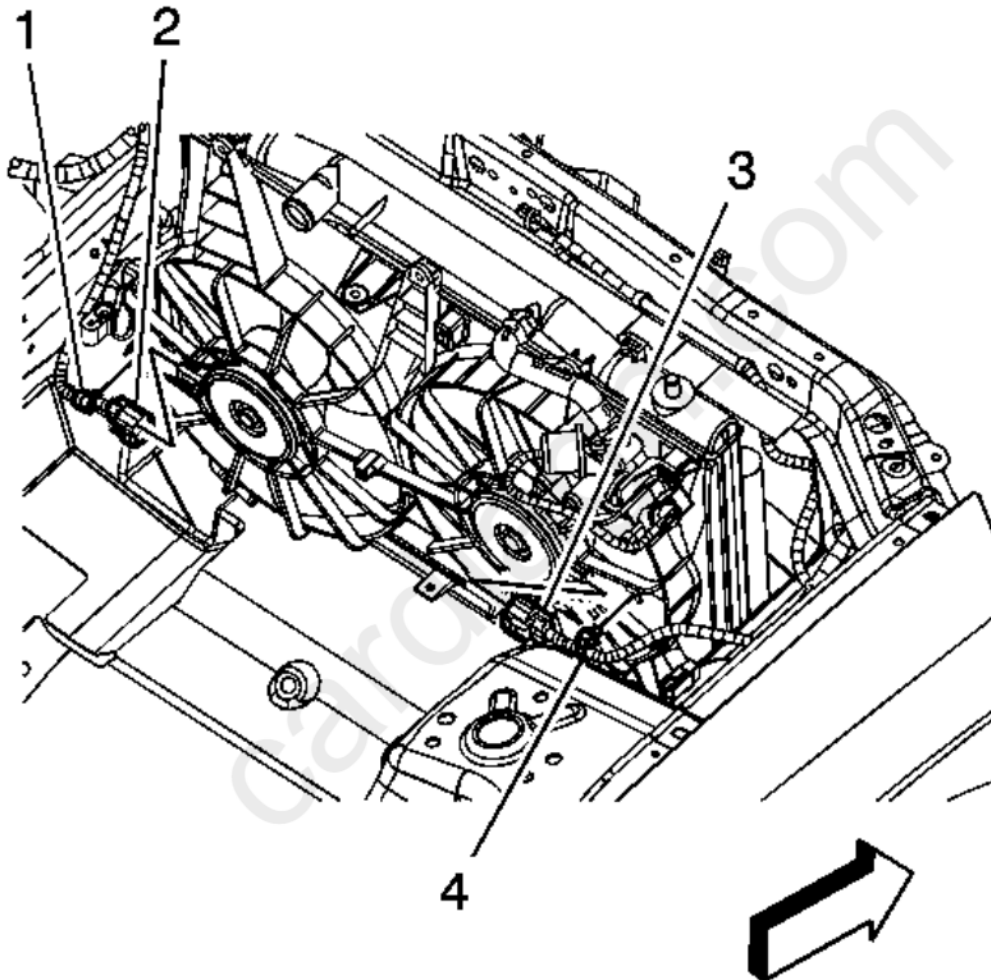


Fig. 89: View Of Cooling Fan Wiring Harness & Electrical Connectors
 Courtesy of GENERAL MOTORS CORP.

6. Disconnect the cooling fan electrical connectors (2, 3).
7. Remove the cooling fan wiring harnesses (1, 4) from the fan shroud.

8. Secure the wiring harnesses to the vehicle.
9. Drain the cooling system. Refer to Cooling System Draining and Filling (Static Fill LF1, LLT) or Cooling System Draining and Filling (GE 47716 LF1, LLT) .

NOTE: Do NOT disconnect the surge hoses from the engine or the radiator.

10. Disconnect the surge tank outlet hose from the surge tank. Refer to Radiator Surge Tank Inlet Hose/Pipe Replacement (LF1, LLT) .
11. Position and secure the surge hose to the engine.
12. Disconnect the surge tank inlet hose from the water outlet housing and the radiator. Refer to Radiator Surge Tank Engine Hose Replacement (LF1, LLT) .
13. Position and secure the surge tank inlet hose to the vehicle.
14. Disconnect the heater hoses from the heater core. Refer to Heater Inlet Hose Replacement and to Heater Outlet Hose Replacement .

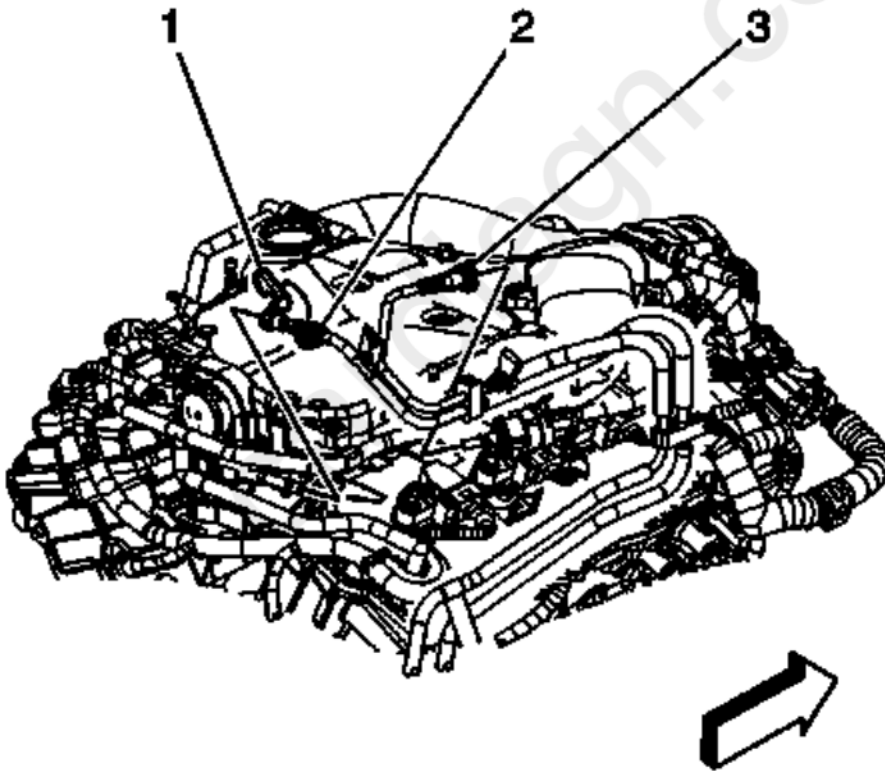


Fig. 90: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the purge line (3) from the purge solenoid.
16. Disconnect the fuel pipe (2) from the fuel rail. Refer to Metal Collar Quick Connect Fitting Service .

17. Plug the fuel pipe and cap the fuel rail to prevent fuel loss or contamination.
18. Evacuate the air conditioning system. Refer to Refrigerant Recovery and Recharging .
19. Remove the wiper module. Refer to Windshield Wiper Transmission Replacement .

NOTE: Do NOT disconnect the suction hose from the A/C compressor.

20. Disconnect the air conditioning suction hose from the evaporator and remove the suction hose bracket from the shock tower.
21. Position and secure the suction hose to the engine.

NOTE: Do NOT disconnect the liquid line from the condenser.

22. Disconnect the air conditioning pressure switch electrical connector and remove the liquid line.

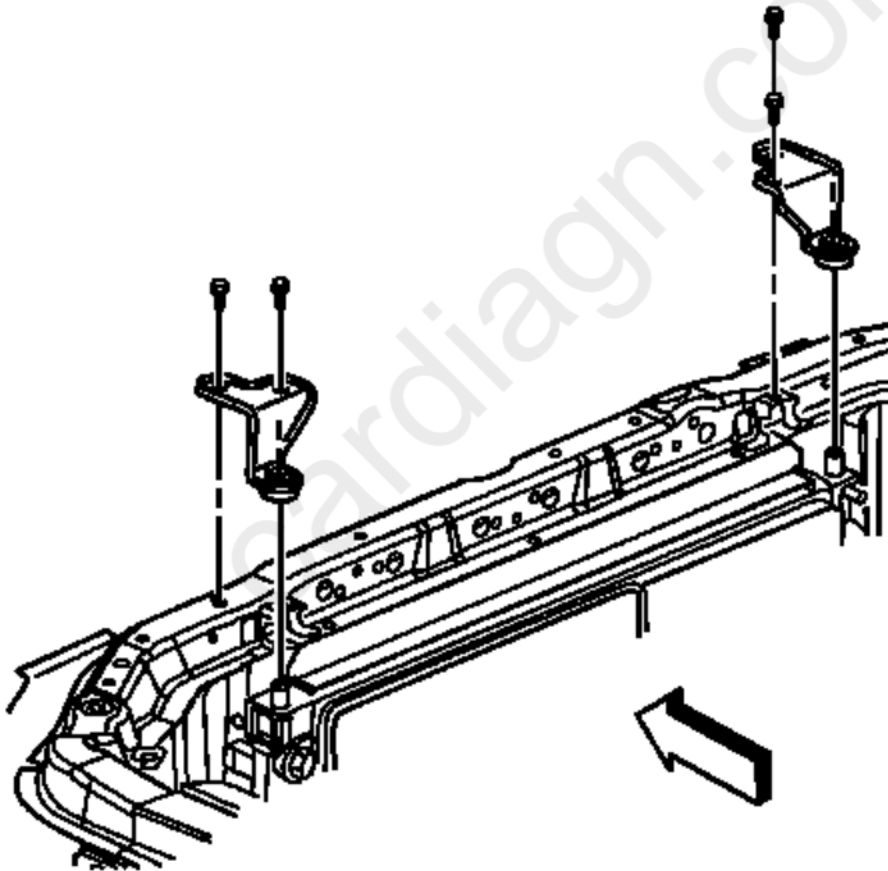


Fig. 91: View Of Radiator Support Brackets
Courtesy of GENERAL MOTORS CORP.

23. Remove the radiator support bolts.
24. Remove the radiator support brackets.

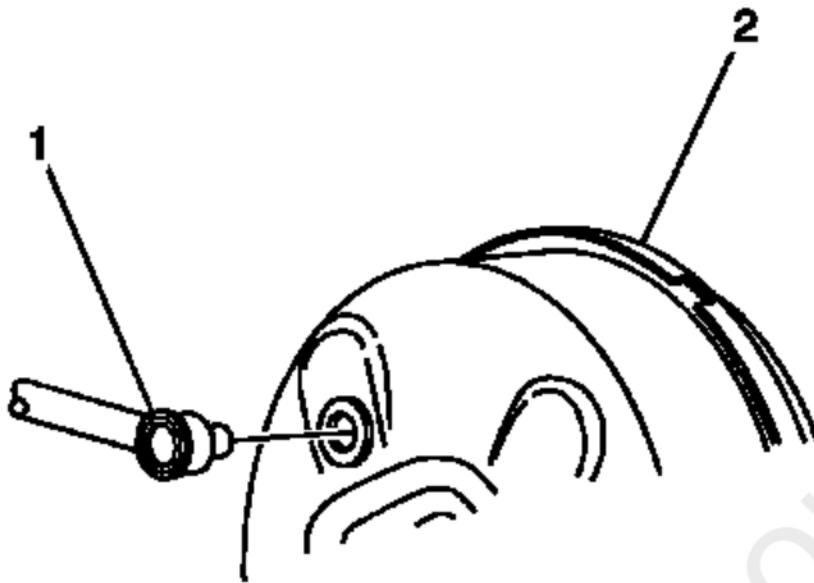


Fig. 92: View Of Vacuum Check Valve & Brake Booster
Courtesy of GENERAL MOTORS CORP.

25. Disconnect the brake booster check valve and vacuum hose (1) from the brake booster (2).
26. Position and secure the brake booster hose to the engine.
27. Disconnect all engine harness electrical connectors.

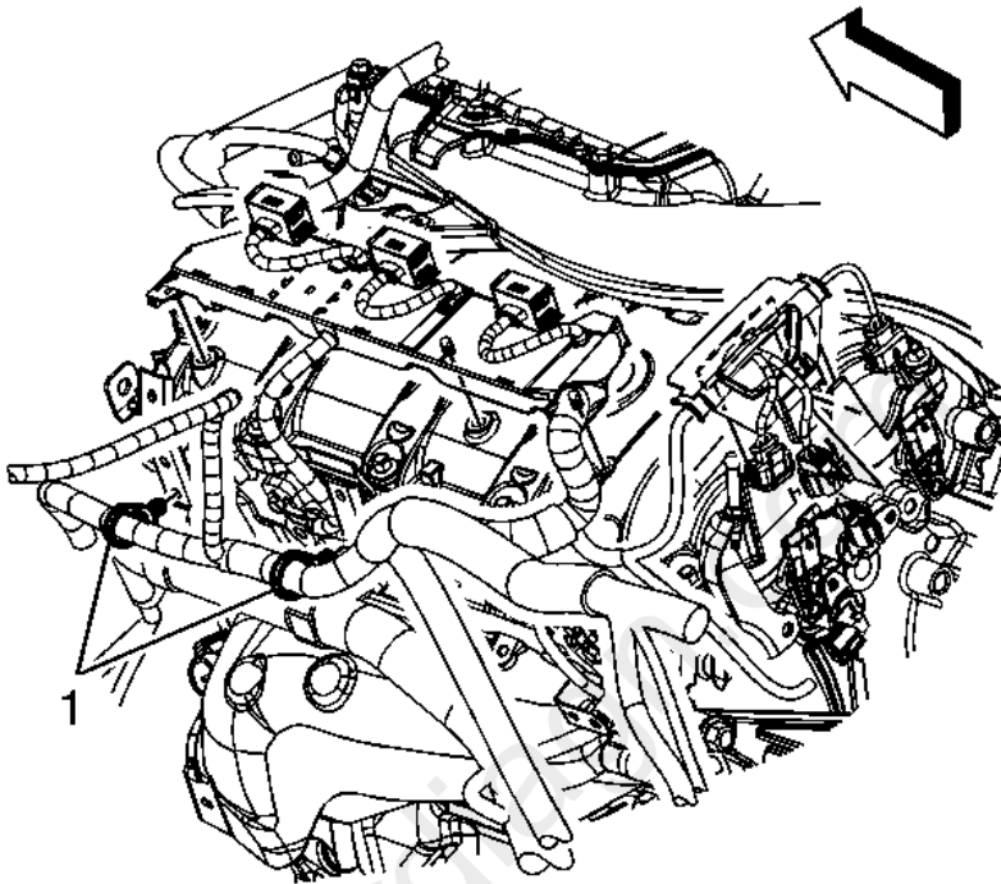


Fig. 93: Identifying Right Side Engine Harness Retaining Clips
Courtesy of GENERAL MOTORS CORP.

28. Remove the right side engine harness retaining clips (1).

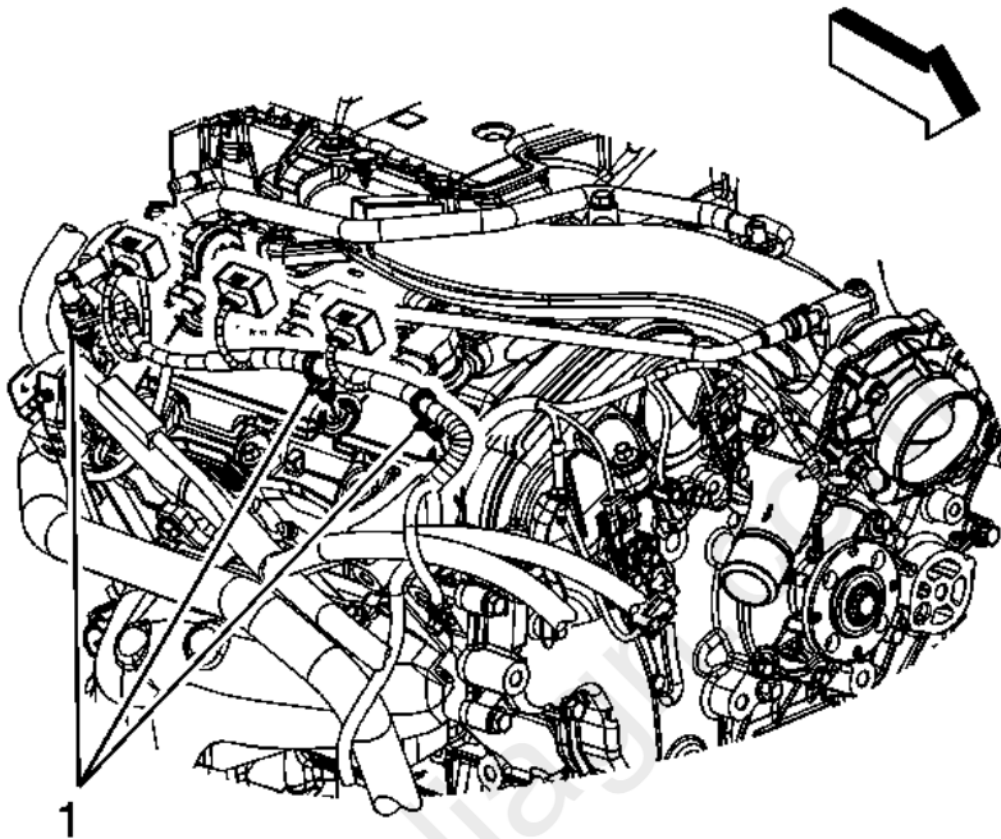


Fig. 94: Identifying Right Side Engine Harness To Valve Cover Retaining Clips
Courtesy of GENERAL MOTORS CORP.

29. Remove the right side engine harness to valve cover retaining clips (1).

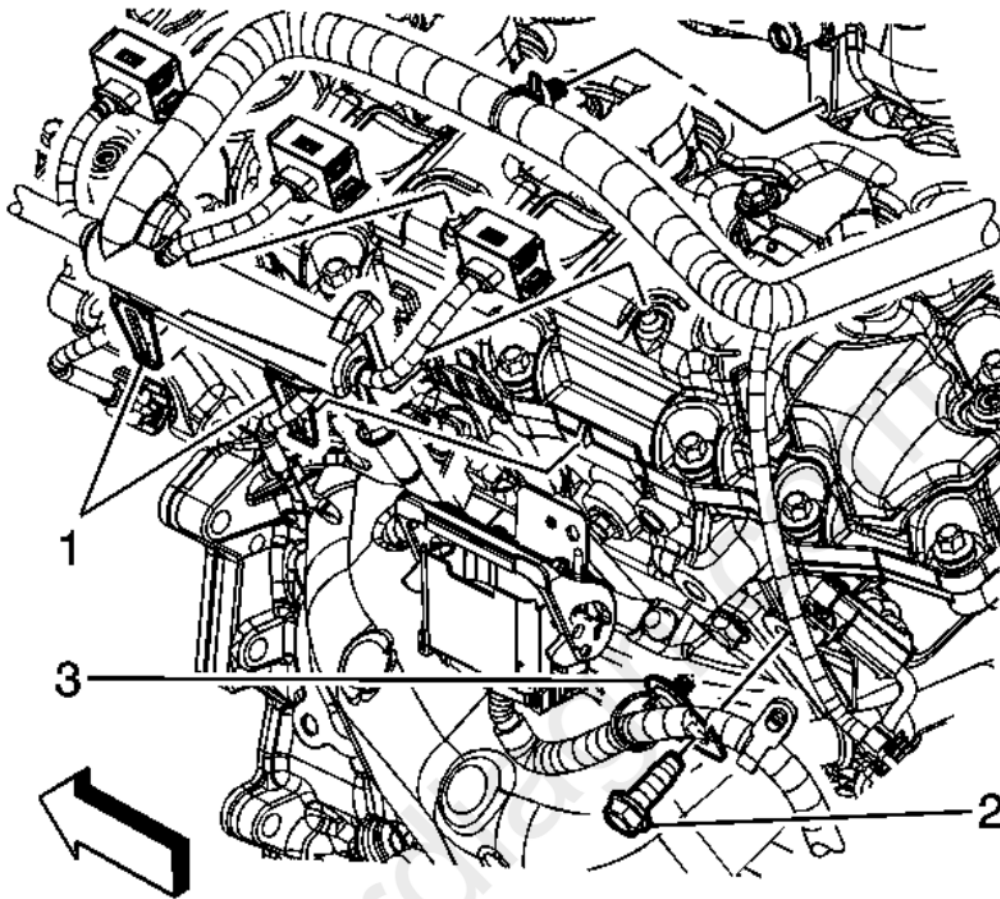


Fig. 95: Identifying Left Side Engine Harness Retainer Components
Courtesy of GENERAL MOTORS CORP.

30. Remove the left side engine harness retaining clips (1).
31. Remove the bolt (2) from the engine harness retainer (3).

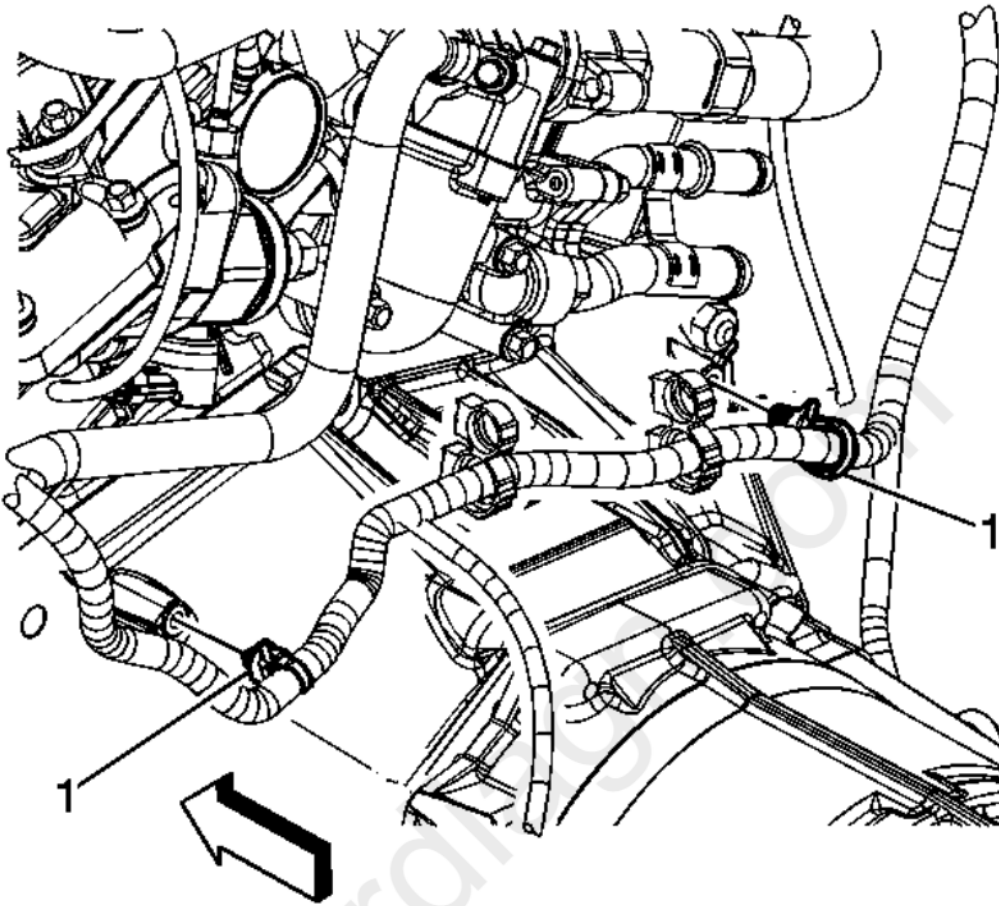


Fig. 96: Identifying Engine Harness To Transmission Retaining Clips
Courtesy of GENERAL MOTORS CORP.

32. Remove the engine harness to transmission retaining clips (1).

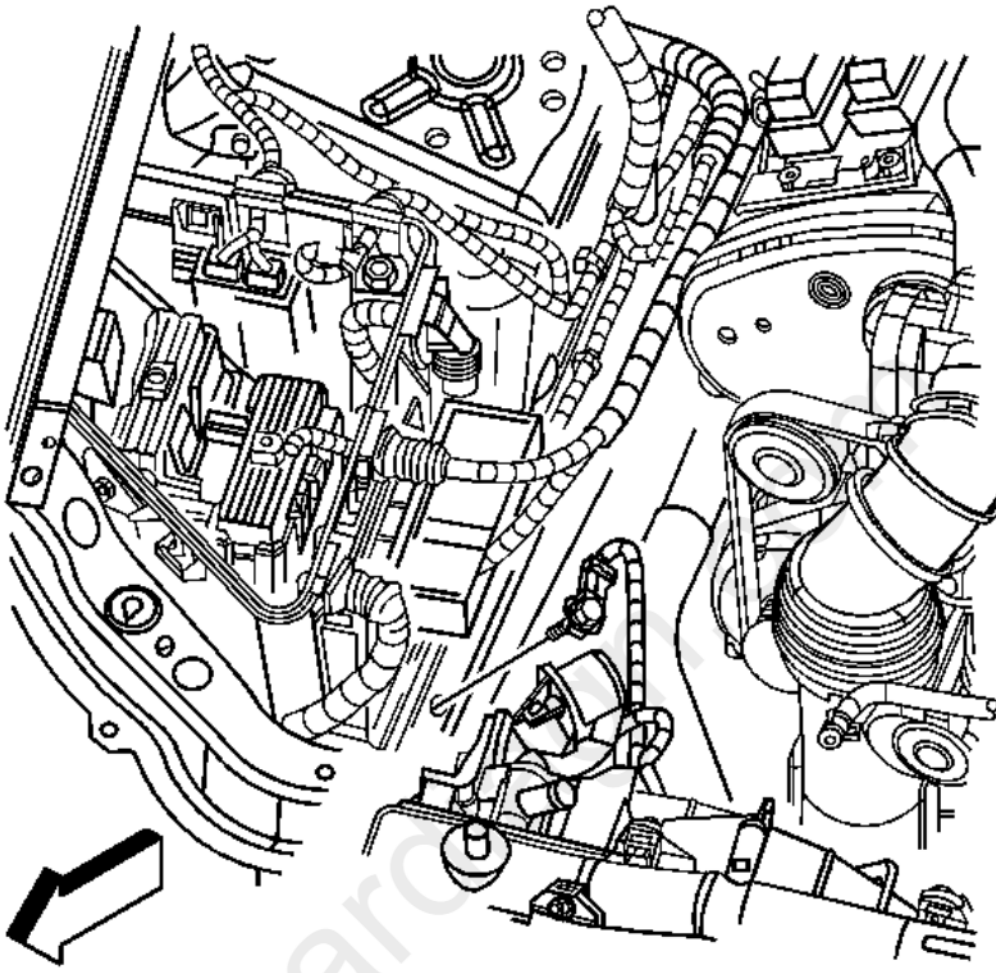


Fig. 97: View Of Ground Bolt & Wire
Courtesy of GENERAL MOTORS CORP.

33. Remove the ground bolt and wire from the longitudinal rail.

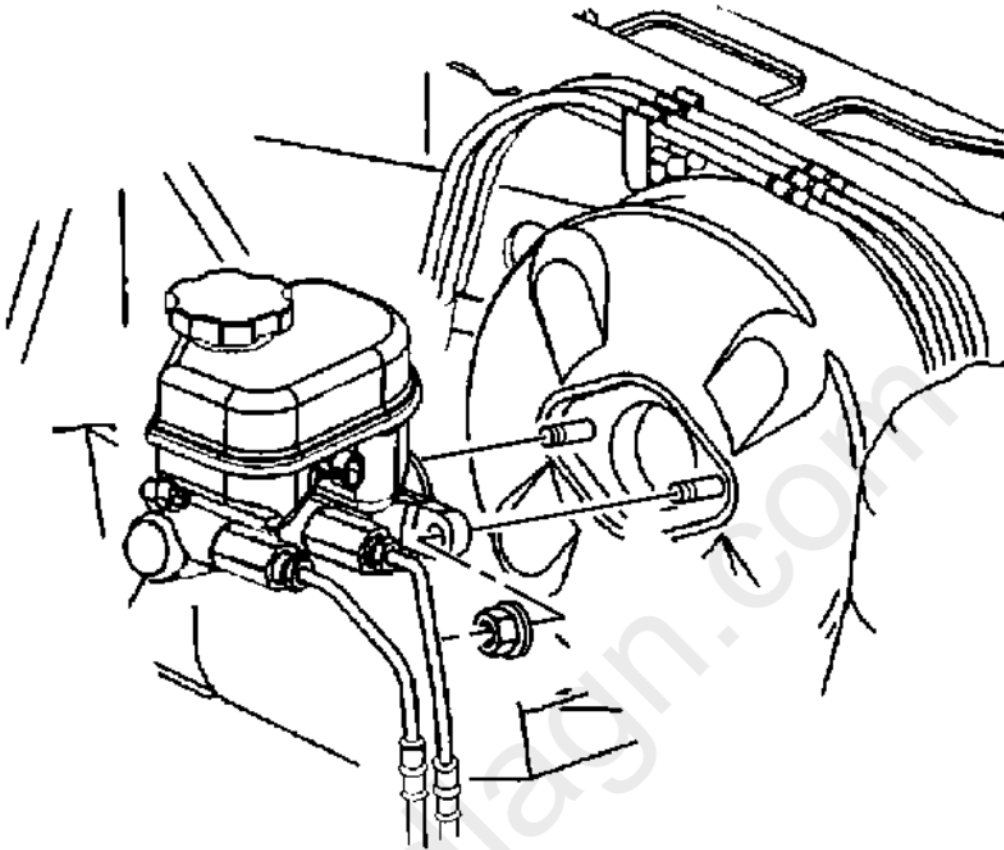


Fig. 98: View of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

NOTE: Do NOT disconnect the brake pipes from the master cylinder.

34. Remove the master cylinder nuts.
35. Reposition and secure the master cylinder to the engine.
36. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

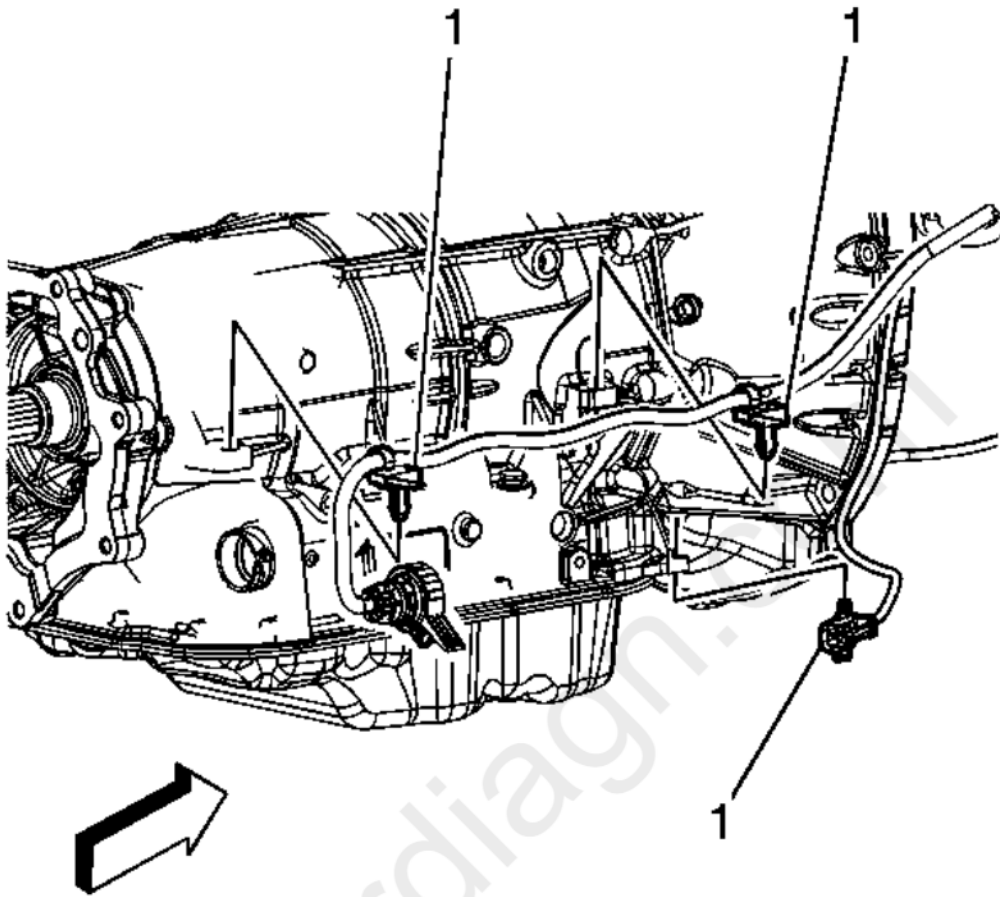


Fig. 99: Identifying Engine Harness To Transmission Retaining Clips
Courtesy of GENERAL MOTORS CORP.

37. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
38. Remove the engine harness to transmission retaining clips (1).
39. Remove the muffler assembly. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)** .
40. Remove the propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LLT, LF1 with MXO)** or **Rear Propeller Shaft Replacement (RPO LLT/LF1with MX7 or MN6)** .
41. Remove the transfer case, if equipped. Refer to **Transfer Case Assembly Replacement** .
42. Remove the air deflector. Refer to **Front Air Deflector Replacement** .

NOTE: **DO NOT** remove the water bottle.

2011 Cadillac CTS

2011 ENGINE Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - CTS

43. Remove the washer bottle bracket. Refer to **Windshield Washer Solvent Container Replacement (With CE4)** or **Windshield Washer Solvent Container Replacement (Without CE4)** .
44. Disconnect the side air baffles from the radiator.
45. Disconnect the left front brake pipe retainer along with the brake pipe from the longitudinal rail.
46. Remove the right front brake pipe from the brake pipe bundle retainer.
47. Disconnect the rear brake pipes from the brake pressure modulator valve (BPMV). Refer to **Brake Pressure Modulator Valve Replacement (CTS)** or **Brake Pressure Modulator Valve Replacement (CTS-V)** .
48. Plug the brake pipes and the brake modulator valve in order to minimize brake fluid loss.
49. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
50. Remove the lower intermediate steering shaft. Refer to **Lower Intermediate Steering Shaft Replacement** .

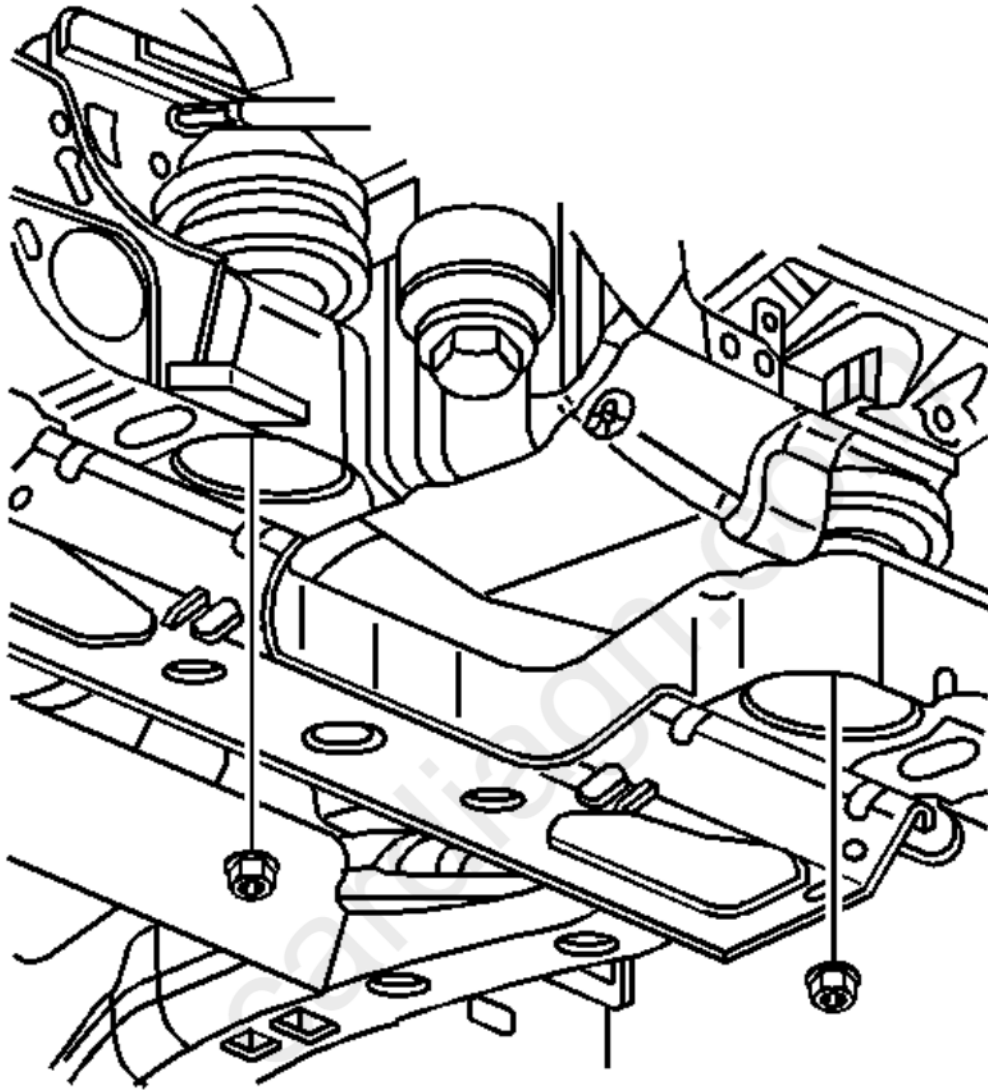


Fig. 100: Identifying Frame Mounting Nuts

Courtesy of GENERAL MOTORS CORP.

51. Remove the lower engine mount nuts. Refer to **Engine Mount Replacement - Left Side (AWD)** or **Engine Mount Replacement - Left Side (RWD)** and to **Engine Mount Replacement - Right Side (AWD)** or **Engine Mount Replacement - Right Side (RWD)** .

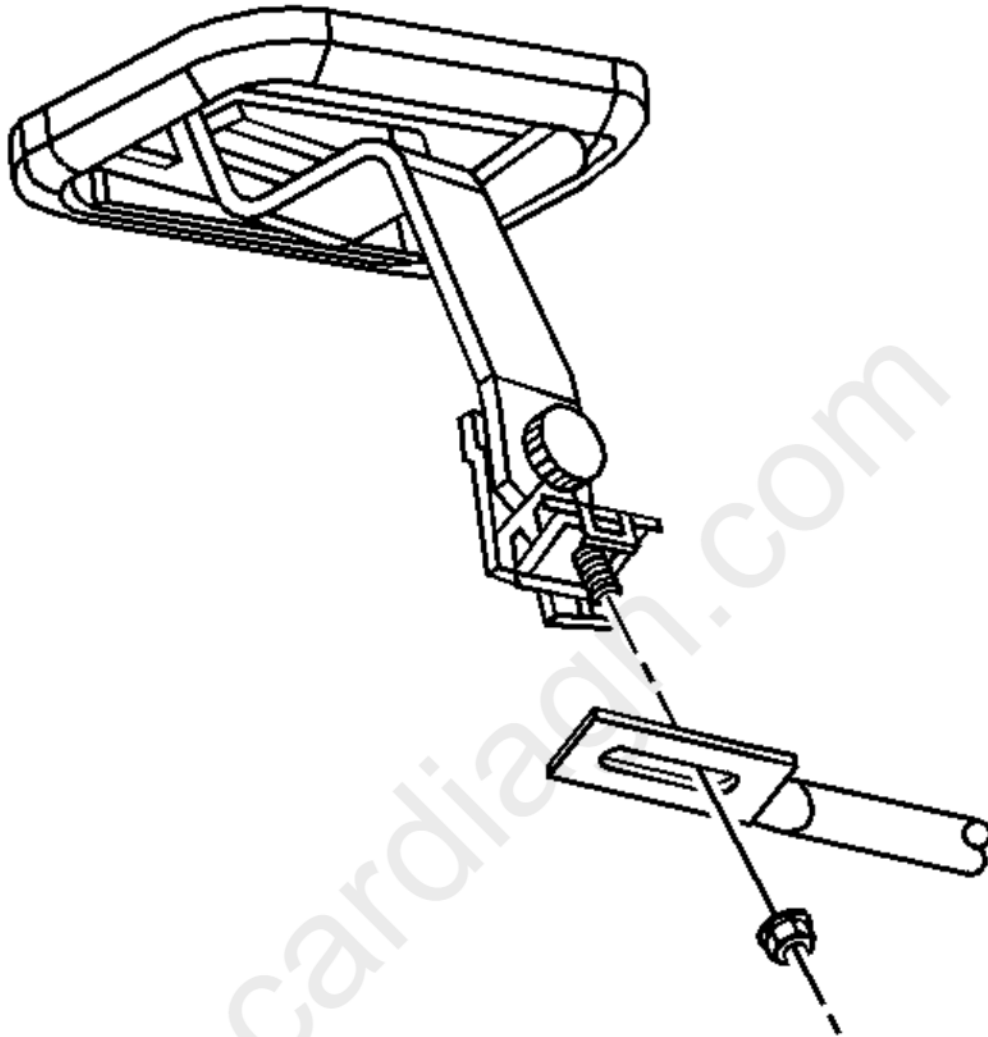


Fig. 101: View Of Transmission Shift Linkage
Courtesy of GENERAL MOTORS CORP.

52. Disconnect the transmission shift linkage from the transmission.
53. Disconnect the electrical connector to the low oil level sensor.

Secure the electrical connector and the harness to the engine mount bracket.

54. Remove the headlamp leveling sensors. Refer to **Headlamp Leveling Front Suspension Height Sensor Replacement**.

55. Secure the shock modules to the lower control arms with a suitable strap in order to prevent damage to the front brake hoses.

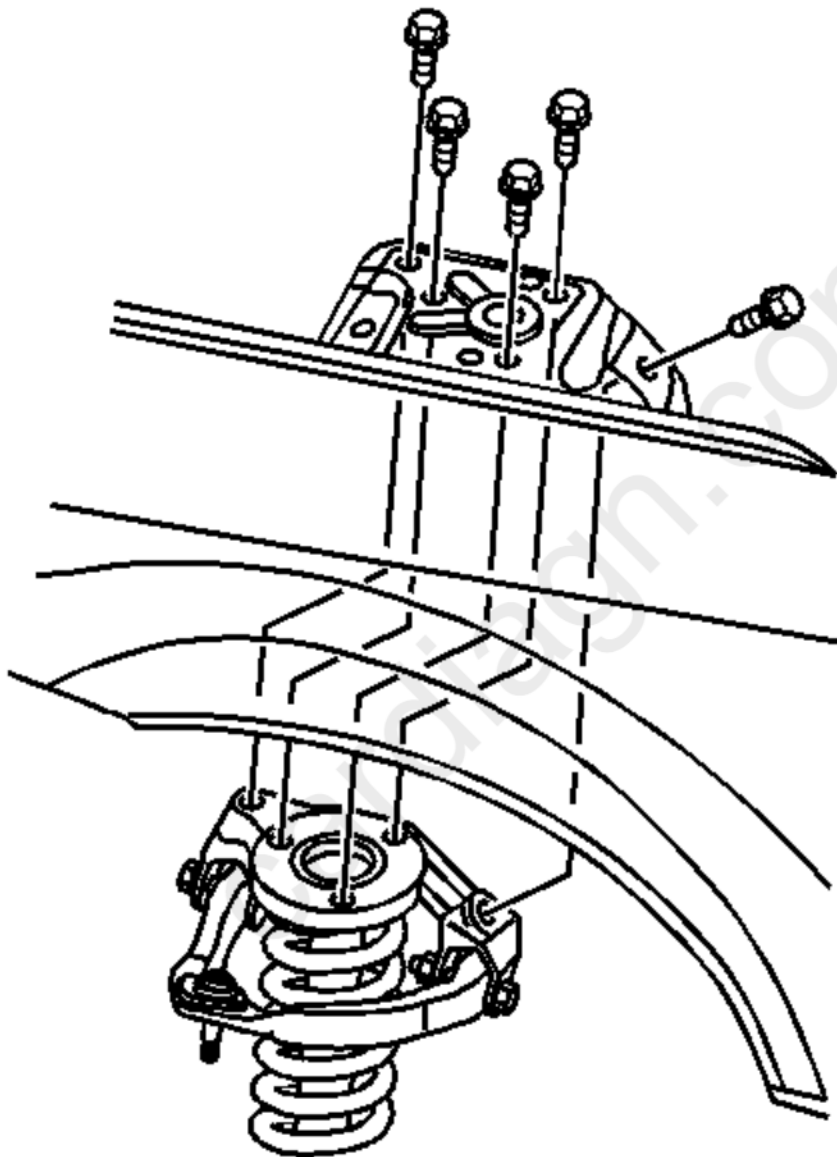


Fig. 102: View Of Shock Module & Upper Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

56. Remove the upper mounting bolts from the right and left shock module. Refer to **Shock Absorber and**

Spring Removal and Installation .

57. Raise the vehicle enough to place a suitable lift table under the engine, transmission, front frame and front suspension assembly.
58. Position a suitable powertrain or engine lift table below the frame, engine and transmission.
59. Raise the lift table or lower the vehicle to support the frame, engine and transmission.
60. Remove the bolts which secure the transmission brace to the underbody. Refer to **Transmission Support Replacement (Automatic AWD)** or **Transmission Support Replacement (Automatic CTS-V)** or **Transmission Support Replacement (Automatic RWD except CTS-V)** or **Transmission Support Replacement (Manual CTS-V)** or **Transmission Support Replacement (Manual except CTS-V)** .

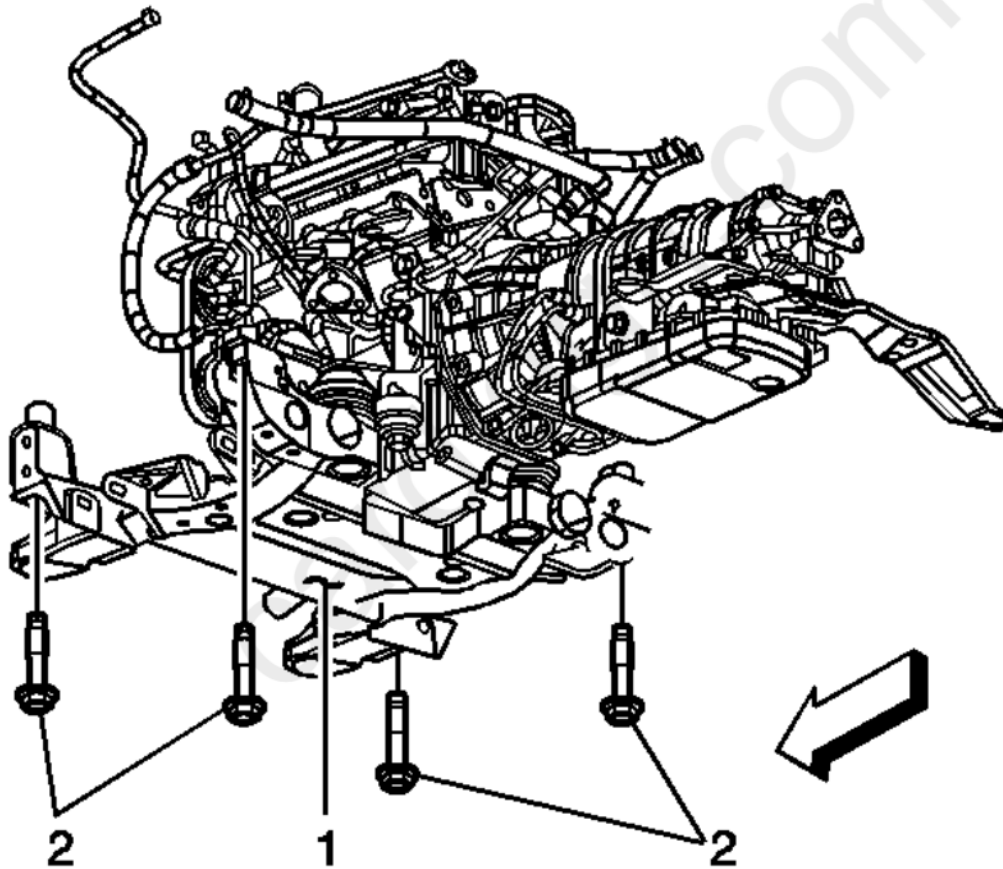


Fig. 103: Identifying Frame Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

61. Remove the front frame bolts (2).

NOTE: Ensure that all the hoses, wires, pipes and shock modules clear the vehicle during the removal process.

62. With the aid of an assistant, lower the table or raise the vehicle to remove the engine, transmission, front frame and front suspension assembly from the vehicle.

NOTE: Do NOT remove the oxygen sensors.

63. Remove the catalytic converters with the oxygen sensors. Refer to Catalytic Converter Replacement - Left Side (LF1) or Catalytic Converter Replacement - Left Side (LLT) and to Catalytic Converter Replacement - Right Side (LF1) or Catalytic Converter Replacement - Right Side (LLT).
64. Remove the thermostat housing with the heater pipes, heater hoses and surge tank outlet hose. Refer to Engine Coolant Thermostat Housing Removal.
65. Remove the starter motor. Refer to Starter Replacement (LF1/LLT).
66. Remove the flywheel bolts.

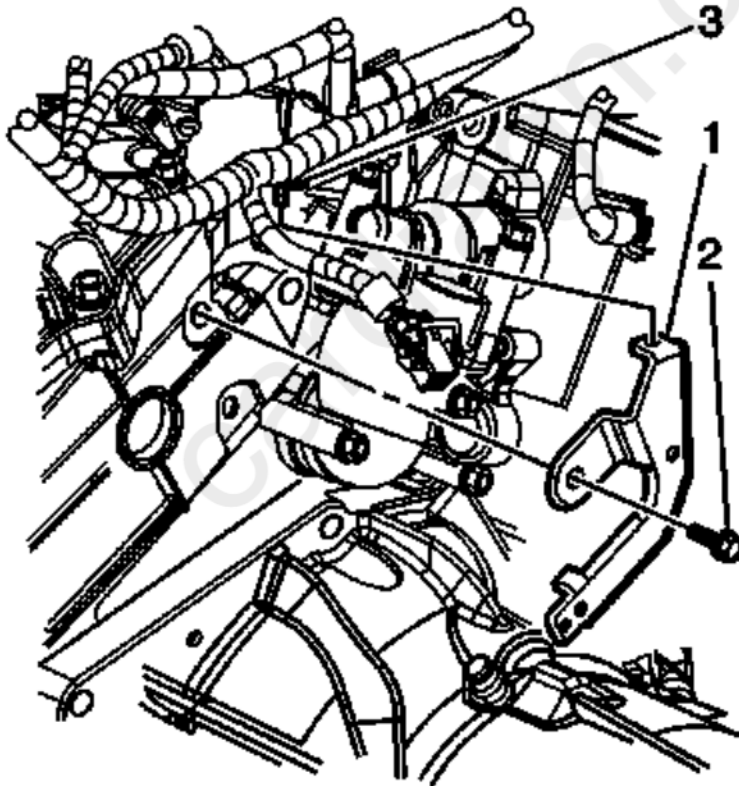


Fig. 104: View Of HO2S Connector Bracket
Courtesy of GENERAL MOTORS CORP.

67. Remove the heated oxygen sensor (HO2S) connector bracket (1) from the left cylinder head.

68. Remove the engine wiring harness and related components.
69. Disconnect the transmission oil cooler pipes from the engine, radiator and the transmission. Refer to **Transmission Fluid Cooler Hose/Pipe Replacement (With VO3)** or **Transmission Fluid Cooler Hose/Pipe Replacement (Without VO3)** and to **Transmission Fluid Auxiliary Cooler Pipe Replacement (With VO3)**.
70. Disconnect the radiator hoses from the water outlet housing and the coolant inlet pipe. Refer to **Radiator Inlet Hose Replacement (LF1, LLT)**.
71. Disconnect the power steering cooler hoses from the condenser radiator and fan module (CRFM). Refer to **Power Steering Cooler Pipe/Hose Replacement (V6 Left Hand Drive)** or **Power Steering Cooler Pipe/Hose Replacement (Right Hand Drive)**.
72. Plug the power steering hoses and pipes in order to prevent fluid loss and contamination.
73. Remove the CRFM with the radiator hoses from the frame.
74. Install **EN 46114** to the engine. Refer to **Engine Support Fixture**. See **Special Tools**.
75. Connect a floor crane to the engine lift brackets and raise the floor crane to partially support the engine.
76. Position a second powertrain lift table below the transmission.
77. Remove the bolts that secure the transmission to the engine.
78. Remove the transmission from the engine. Refer to **Transmission Replacement (All Wheel Drive)** or **Transmission Replacement (Rear Wheel Drive)**.
79. Remove the drive belts. Refer to **Water Pump and Generator Belt Replacement** and to **Air Conditioning Compressor and Power Steering Pump Belt Replacement**.
80. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Removal**.
81. Remove the generator and the generator bracket. Refer to **Starter Replacement (LF1/LLT)**.
82. Remove the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)**.
83. Remove the power steering pump. Refer to **Power Steering Pump Replacement (V6)**.
84. Remove the power steering reservoir from the engine. Refer to **Power Steering Fluid Reservoir Replacement (V6)**.
85. Remove the oil level indicator. Refer to **Oil Level Indicator and Tube Removal (LLT)** or **Oil Level Indicator and Tube Removal (LF1 or LFW)**.
86. Remove the left exhaust manifold. Refer to **Exhaust Manifold Removal - Left Side**.
87. Remove the oil filter adapter. Refer to **Oil Filter Adapter Removal**.
88. Remove the right exhaust manifold. Refer to **Exhaust Manifold Removal - Right Side**.
89. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
90. Remove the flywheel. Refer to **Engine Flywheel Removal (Automatic Transmission)** or **Engine Flywheel Removal (Manual Transmission)**.
91. Remove the intake manifold. Refer to **Intake Manifold Removal (LLT)** or **Intake Manifold Removal (LF1)**.
92. Remove the water outlet. Refer to **Water Outlet Removal**.
93. Remove the block heater. Refer to **Coolant Heater Replacement (LF1/LLT)**.
94. Remove the ECM with the ECM bracket. Refer to **Engine Control Module Replacement**.
95. Remove the front drive shafts, if equipped. Refer to **Front Wheel Drive Shaft Replacement - Left Side**.

and **Front Wheel Drive Shaft Replacement - Right Side** .

96. Use a floor crane in order to remove the engine from the frame.
97. Remove the front drive axle intermediate shaft bearing, if equipped. Refer to **Front Wheel Drive Intermediate Shaft Bearing Replacement** .
98. Remove the front differential, if equipped. Refer to **Differential Carrier Assembly Replacement** .
99. Remove the engine mount brackets with the engine mounts. Refer to **Engine Mount Bracket Replacement - Left Side (AWD)** or **Engine Mount Bracket Replacement - Left Side (RWD)** and to **Engine Mount Bracket Replacement - Right Side (w/RWD)** or **Engine Mount Bracket Replacement - Right Side (W/AWD)** .

INSTALLATION PROCEDURE

1. Install the engine mount brackets with the engine mounts. Refer to **Engine Mount Bracket Replacement - Left Side (AWD)** or **Engine Mount Bracket Replacement - Left Side (RWD)** and to **Engine Mount Bracket Replacement - Right Side (w/RWD)** or **Engine Mount Bracket Replacement - Right Side (W/AWD)** .
2. Install the front differential, if equipped. Refer to **Differential Carrier Assembly Replacement** .
3. Install the front drive axle intermediate shaft bearing, if equipped. Refer to **Front Wheel Drive Intermediate Shaft Bearing Replacement** .
4. Use a floor crane in order to install the engine to the frame.
5. Install the front drive shafts, if equipped. Refer to **Front Wheel Drive Shaft Replacement - Left Side** and **Front Wheel Drive Shaft Replacement - Right Side** .
6. Install the ECM with the ECM bracket. Refer to **Engine Control Module Replacement** .
7. Install the water outlet. Refer to **Water Outlet Installation** .
8. Install the block heater. Refer to **Coolant Heater Replacement (LF1/LLT)** .
9. Install the flywheel. Refer to **Engine Flywheel Installation (Automatic Transmission)** or **Engine Flywheel Installation (Manual Transmission)** .
10. Install the intake manifold. Refer to **Intake Manifold Installation (LLT)** or **Intake Manifold Installation (LF1 or LFW)** .
11. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
12. Install the right exhaust manifold. Refer to **Exhaust Manifold Installation - Right Side** .
13. Install the oil filter adapter. Refer to **Oil Filter Adapter Installation** .
14. Install the left exhaust manifold. Refer to **Exhaust Manifold Installation - Left Side** .
15. Install the oil level indicator. Refer to **Oil Level Indicator and Tube Installation (LLT)** or **Oil Level Indicator and Tube Installation (LF1 or LFW)** .
16. Install the generator and the generator bracket. Refer to **Starter Replacement (LF1/LLT)** .
17. Install the power steering pump. Refer to **Power Steering Pump Replacement (V6)** .
18. Install the power steering reservoir to the engine. Refer to **Power Steering Fluid Reservoir Replacement (V6)** .
19. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement (LF1, LLT)** .
20. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Installation** .

21. Install the drive belts. Refer to **Water Pump and Generator Belt Replacement** and to **Air Conditioning Compressor and Power Steering Pump Belt Replacement** .
22. Install the bolts that secure the transmission to the engine. Refer to **Transmission Replacement (All Wheel Drive)** or **Transmission Replacement (Rear Wheel Drive)** .
23. Install the starter motor. Refer to **Starter Replacement (LF1/LLT)** .
24. Remove **EN 46114** from the engine. Refer to **Engine Support Fixture** . See **Special Tools** .
25. Install the CRFM with the radiator hoses to the frame.
26. Connect the power steering cooler hoses to the CRFM. Refer to **Power Steering Cooler Pipe/Hose Replacement (V6 Left Hand Drive)** or **Power Steering Cooler Pipe/Hose Replacement (Right Hand Drive)** .
27. Connect the radiator hoses to the water outlet housing and the coolant inlet pipe. Refer to **Radiator Inlet Hose Replacement (LF1, LLT)** .
28. Install the transmission oil cooler pipes to the engine, radiator and the transmission. Refer to **Transmission Fluid Cooler Hose/Pipe Replacement (With VO3)** or **Transmission Fluid Cooler Hose/Pipe Replacement (Without VO3)** and to **Transmission Fluid Auxiliary Cooler Pipe Replacement (With VO3)** .
29. Install the engine wiring harness and related components.

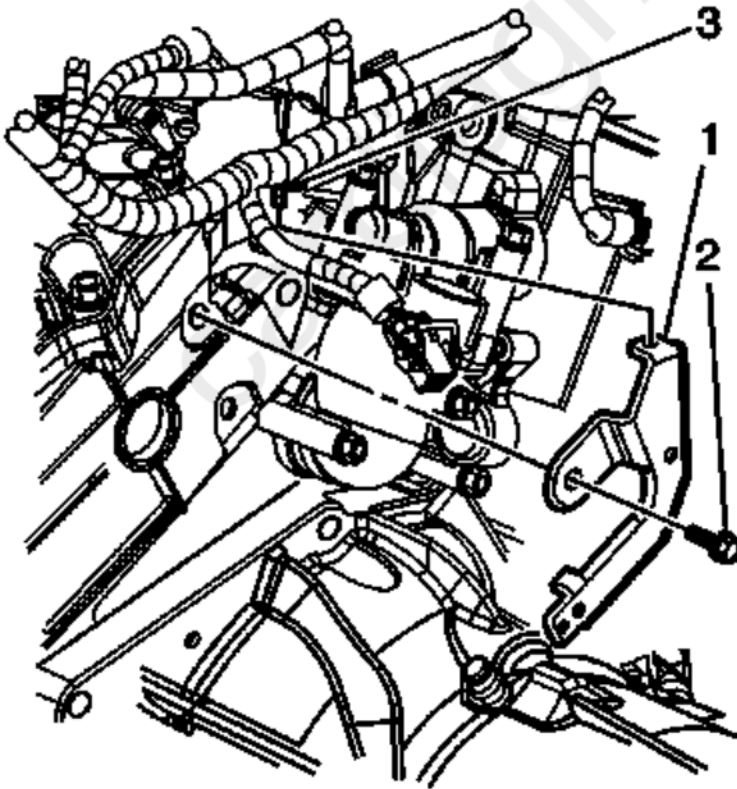


Fig. 105: View Of HO2S Connector Bracket
Courtesy of GENERAL MOTORS CORP.

30. Install the HO2S connector bracket (1) to the left cylinder head.
31. Install the thermostat housing with the heater pipes, heater hoses and surge tank outlet hose. Refer to **Engine Coolant Thermostat Housing Removal** .
32. Install the catalytic converters with the oxygen sensors. Refer to **Catalytic Converter Replacement - Left Side (LF1)** or **Catalytic Converter Replacement - Left Side (LLT)** and to **Catalytic Converter Replacement - Right Side (LF1)** or **Catalytic Converter Replacement - Right Side (LLT)** .
33. Install the fuel lines to the fuel rail and the EVAP purge solenoid. Refer to **Metal Collar Quick Connect Fitting Service** .

NOTE: **Ensure that all the hoses, wires, pipes and shock modules clear the vehicle during the installation process.**

34. With the aid of an assistant, raise the table or lift the vehicle to install the engine, transmission, front frame and front suspension assembly to the vehicle.

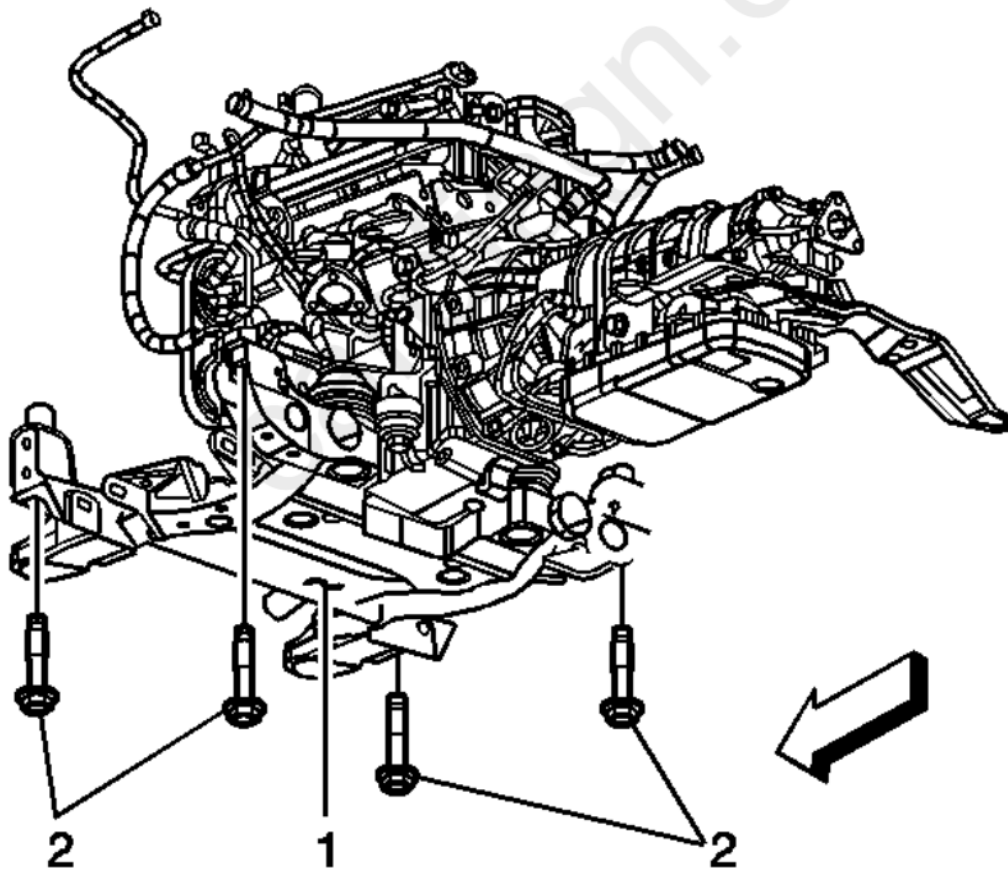


Fig. 106: Identifying Frame Mounting Bolts**Courtesy of GENERAL MOTORS CORP.**

35. Install the front frame bolts (2). Refer to **Drivetrain and Front Suspension Frame Replacement (All Wheel Drive)** or **Drivetrain and Front Suspension Frame Replacement (Rear Wheel Drive)** .
36. Install the transmission support to underbody bolts. Refer to **Transmission Support Replacement (Automatic AWD)** or **Transmission Support Replacement (Automatic CTS-V)** or **Transmission Support Replacement (Automatic RWD except CTS-V)** or **Transmission Support Replacement (Manual CTS-V)** or **Transmission Support Replacement (Manual except CTS-V)** .
37. Remove the powertrain lift/support table.

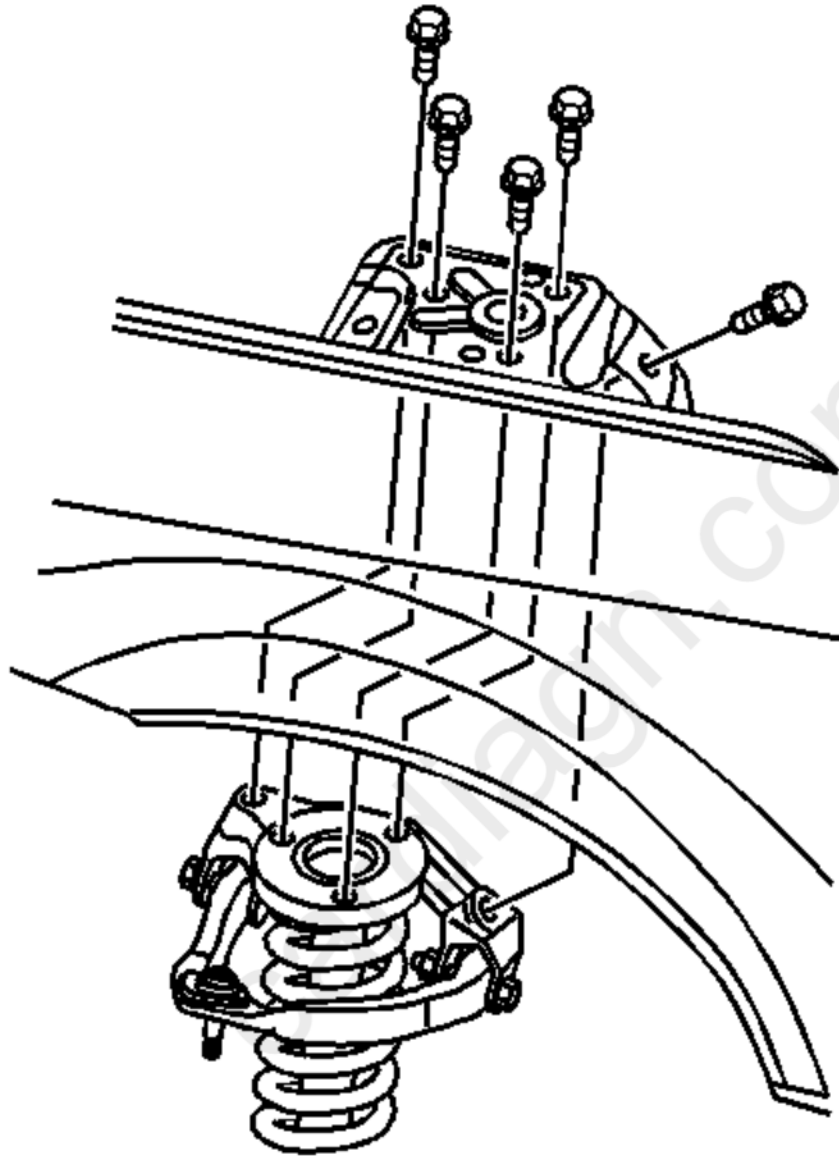


Fig. 107: View Of Shock Module & Upper Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

38. Install the upper mounting bolts to the right and left shock module. Refer to **Shock Absorber and Spring Removal and Installation**.
39. Secure the shock modules to the front frame with mechanics wire to avoid stretching the front brake hoses.

40. Install the headlamp leveling sensors. Refer to **Headlamp Leveling Front Suspension Height Sensor Replacement** .

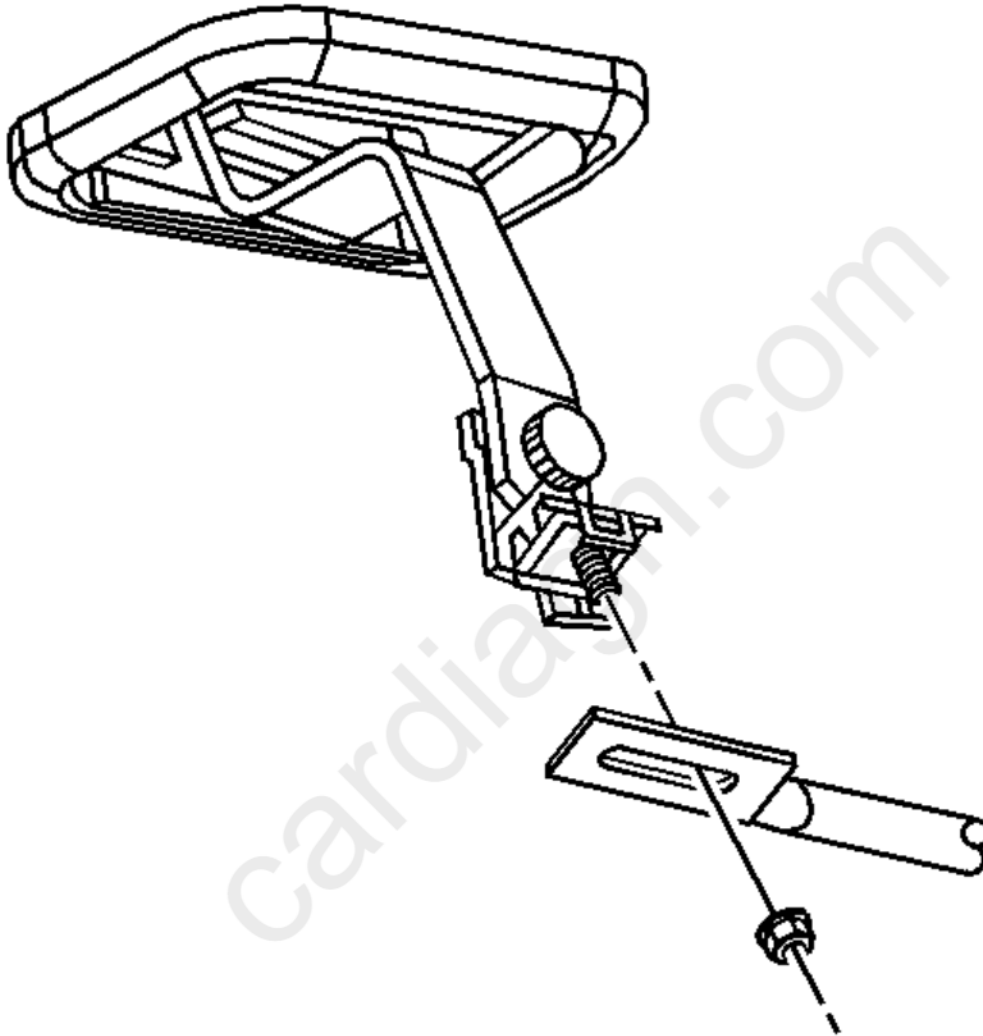


Fig. 108: View Of Transmission Shift Linkage
Courtesy of GENERAL MOTORS CORP.

41. Connect the transmission shift linkage to the transmission.
42. Connect electrical connector to the low oil level sensor.

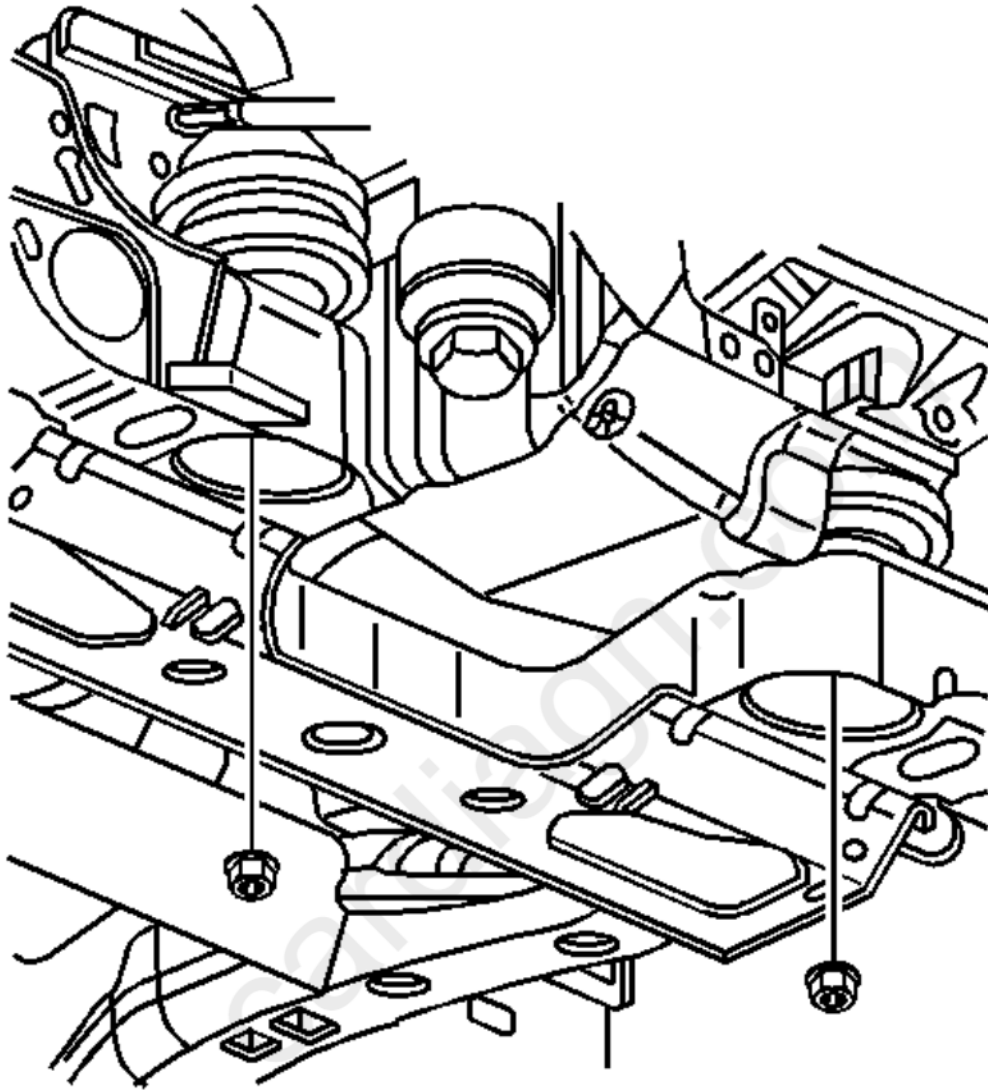


Fig. 109: Identifying Frame Mounting Nuts
Courtesy of GENERAL MOTORS CORP.

43. Install the lower engine mount nuts. Refer to **Engine Mount Replacement - Left Side (AWD)** or **Engine Mount Replacement - Left Side (RWD)** and to **Engine Mount Replacement - Right Side (AWD)** or **Engine Mount Replacement - Right Side (RWD)** .
44. Install the lower intermediate steering shaft. Refer to **Lower Intermediate Steering Shaft Replacement** .
45. Install the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .

46. Install the front brake pipes and retainers to the underbody.
47. Connect the rear brake pipes to the BPMV. Refer to **Brake Pressure Modulator Valve Replacement (CTS)** or **Brake Pressure Modulator Valve Replacement (CTS-V)**.
48. Connect the side air baffles to the radiator.
49. Install the washer bottle bracket. Refer to **Windshield Washer Solvent Container Replacement (With CE4)** or **Windshield Washer Solvent Container Replacement (Without CE4)**.
50. Install the air deflector. Refer to **Front Air Deflector Replacement**.
51. Install the transfer case, if equipped. Refer to **Transfer Case Assembly Replacement**.
52. Install the propeller shaft. Refer to **Rear Propeller Shaft Replacement (RPO LLT, LF1 with MXO)** or **Rear Propeller Shaft Replacement (RPO LLT/LF1with MX7 or MN6)**.
53. Install the muffler assembly. Refer to **Exhaust System Replacement (LF1-Single)** or **Exhaust System Replacement (LF1-Sedan/Wagon)** or **Exhaust System Replacement (LLT-Coupe)** or **Exhaust System Replacement (LLT-Sedan/Wagon)**.

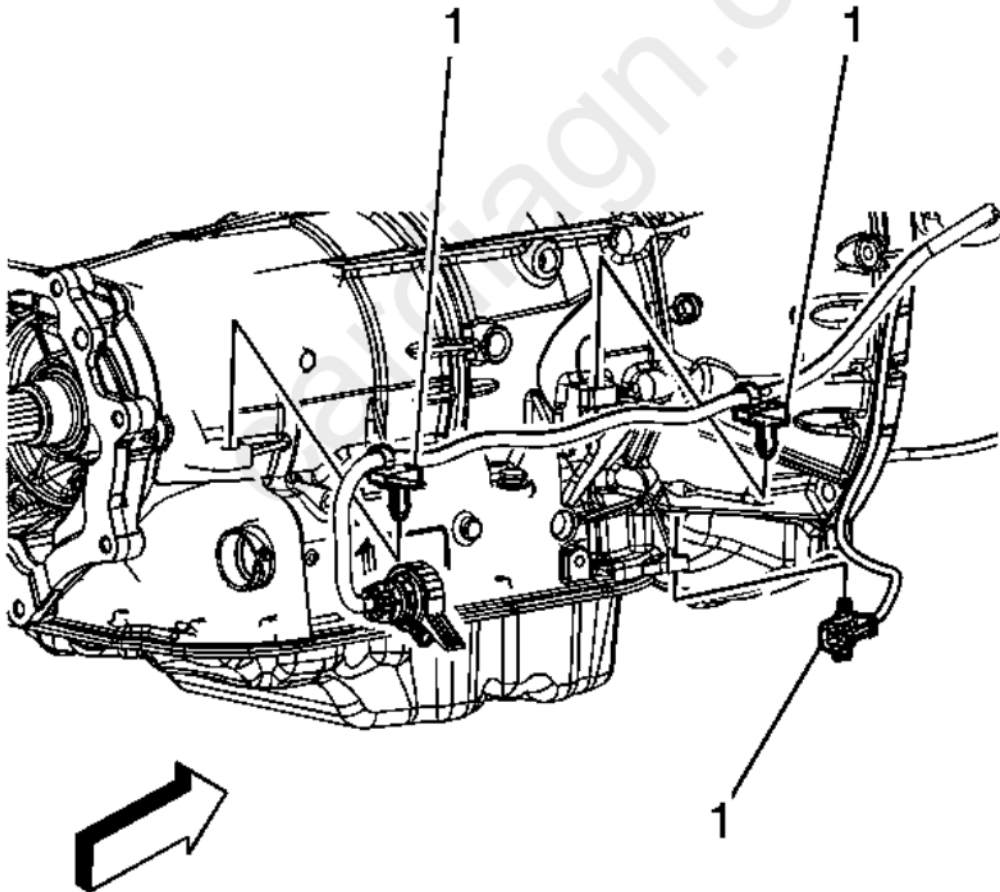


Fig. 110: Identifying Engine Harness To Transmission Retaining Clips
Courtesy of GENERAL MOTORS CORP.

54. Install the engine harness to transmission retaining clips (1).

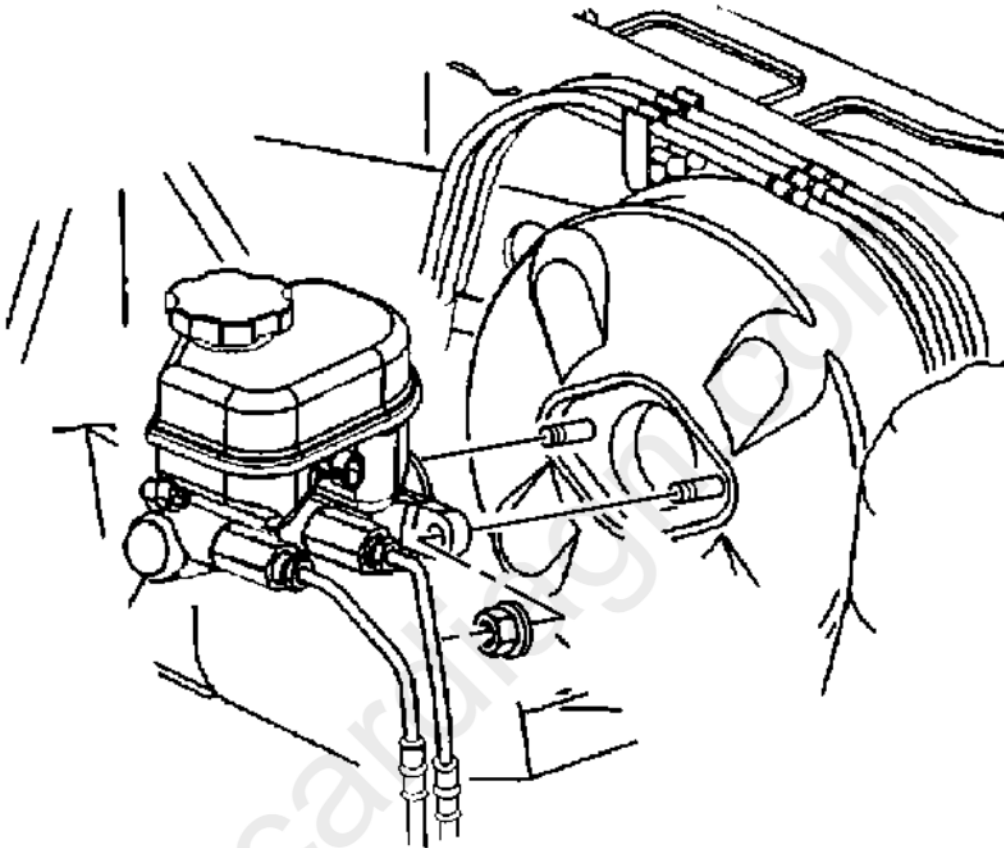


Fig. 111: View of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

55. Install the master cylinder. Refer to **Master Cylinder Replacement (LHD)** or **Master Cylinder Replacement (RHD)** .

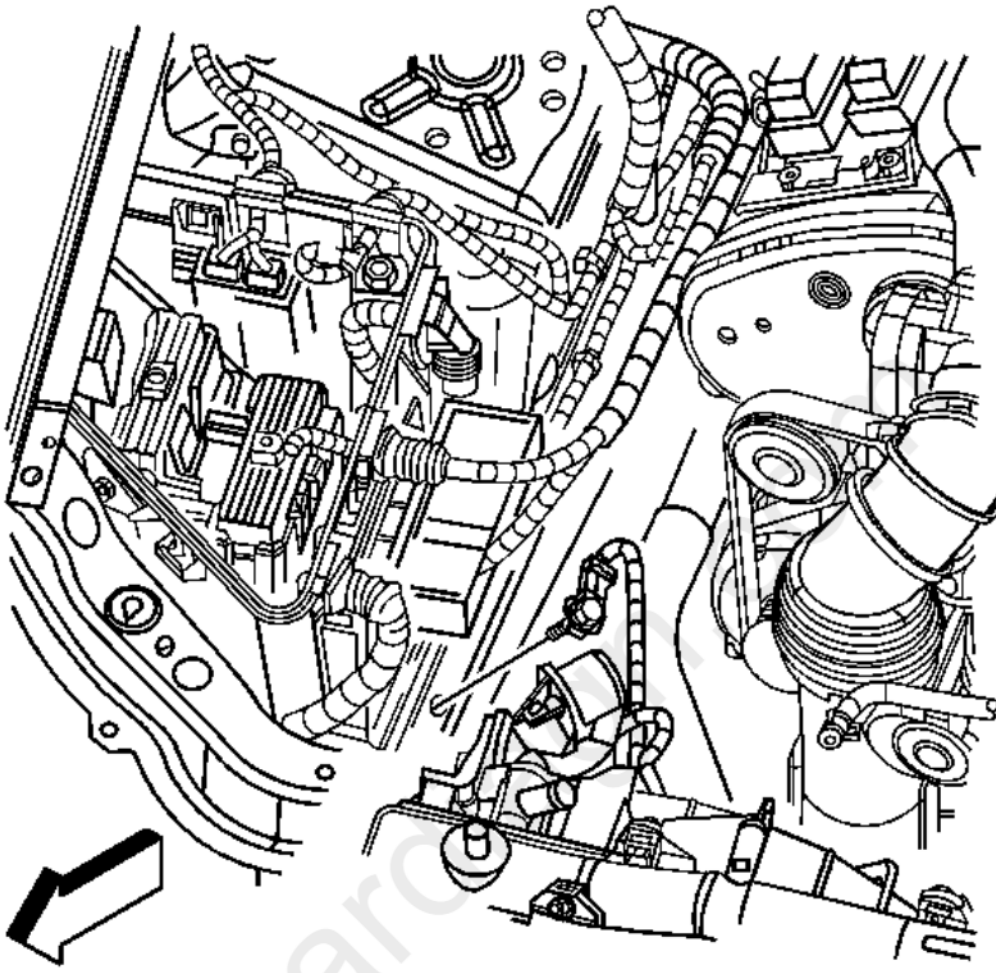


Fig. 112: View Of Ground Bolt & Wire
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

56. Install the ground wire and bolt to the longitudinal rail. Tighten the bolt to 10 N.m (89 lb in).

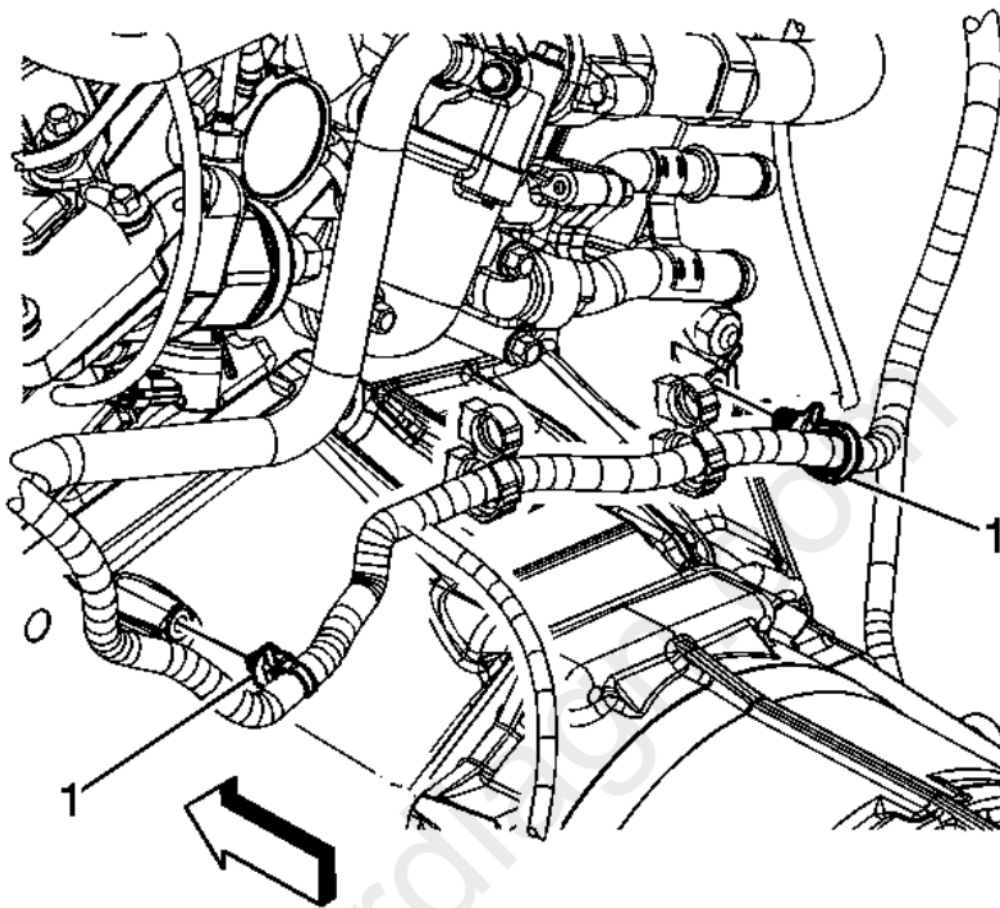


Fig. 113: Identifying Engine Harness To Transmission Retaining Clips
Courtesy of GENERAL MOTORS CORP.

57. Install the engine harness to transmission retaining clips (1).

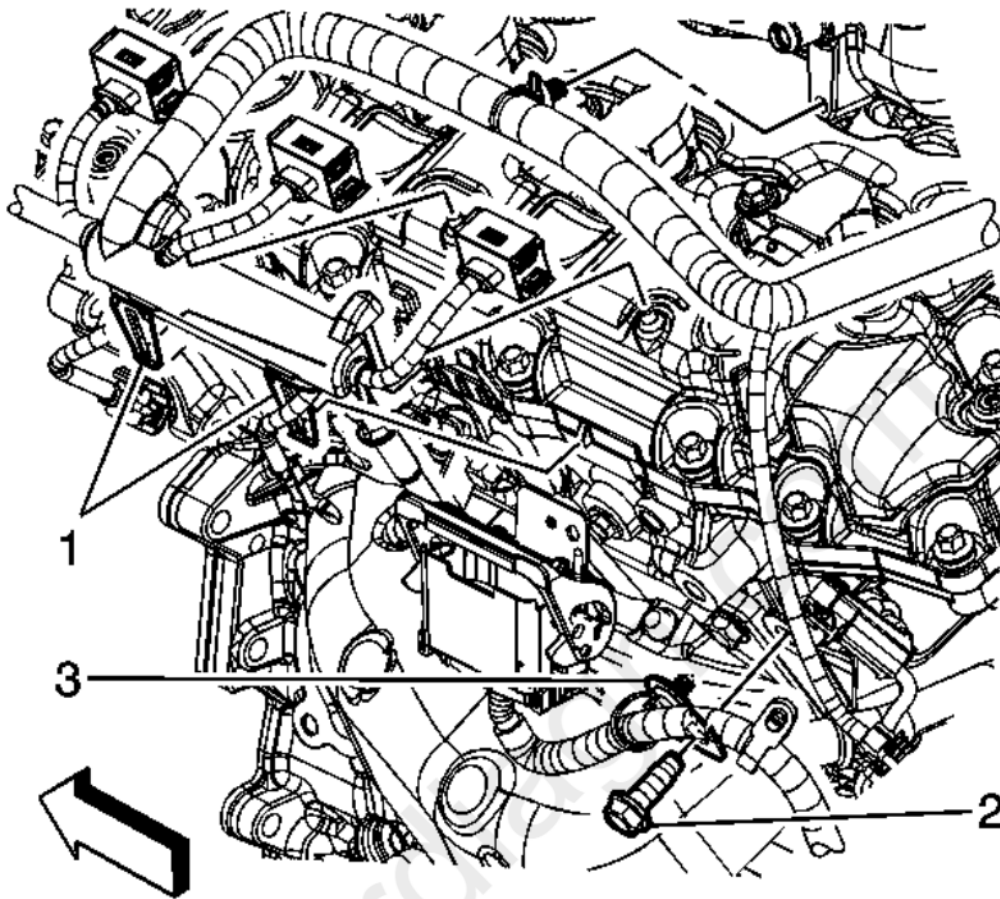


Fig. 114: Identifying Left Side Engine Harness Retainer Components
Courtesy of GENERAL MOTORS CORP.

58. Install the left side engine harness retaining clips (1).
59. Install the bolt (2) to the engine harness retainer (3) and tighten to 10 N.m (89 lb in).

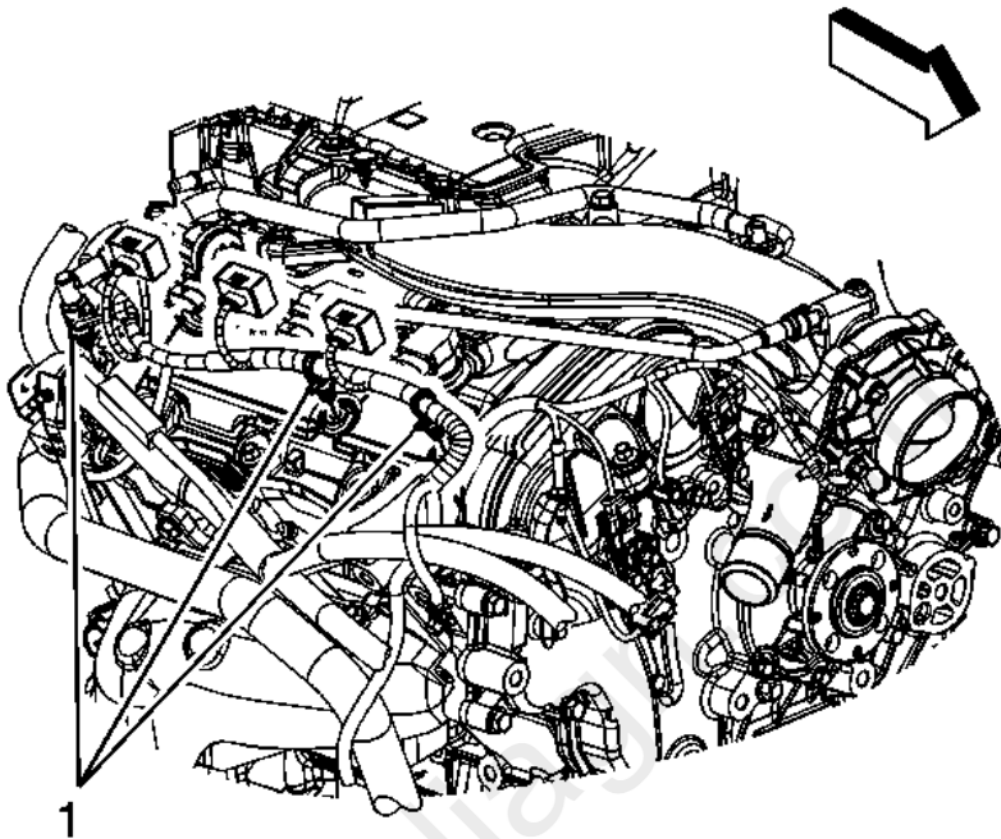


Fig. 115: Identifying Right Side Engine Harness To Valve Cover Retaining Clips
Courtesy of GENERAL MOTORS CORP.

60. Install the right side engine harness to valve cover retaining clips (1).

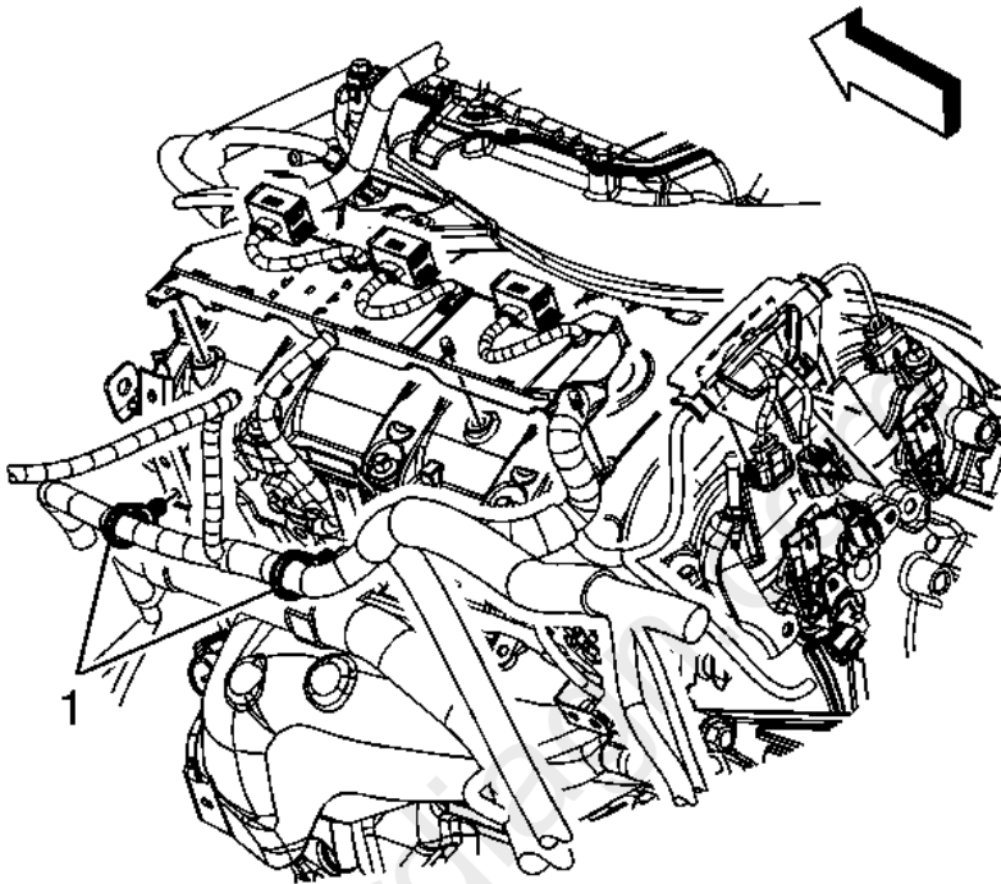


Fig. 116: Identifying Right Side Engine Harness Retaining Clips
Courtesy of GENERAL MOTORS CORP.

61. Install the right side engine harness retaining clips (1).
62. Connect all engine harness electrical connectors.

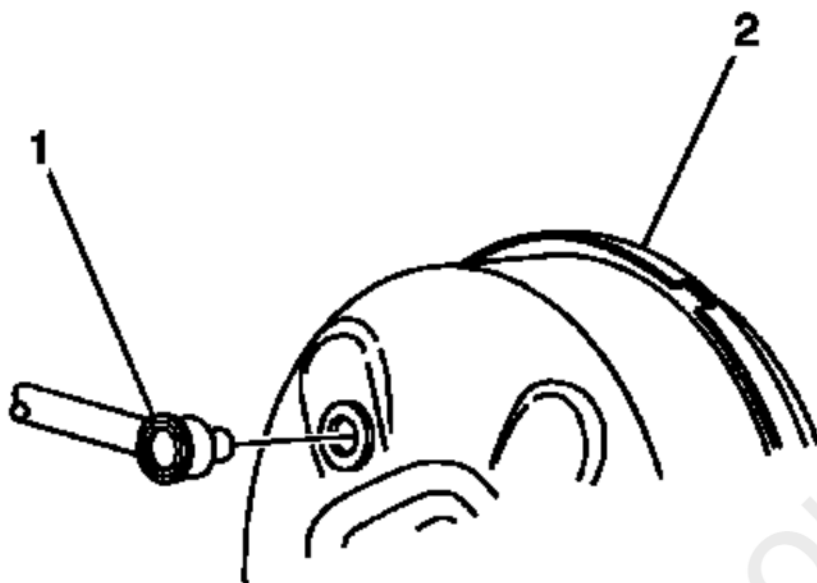


Fig. 117: View Of Vacuum Check Valve & Brake Booster
Courtesy of GENERAL MOTORS CORP.

63. Connect the brake booster vacuum hose (1) to the brake booster (2).

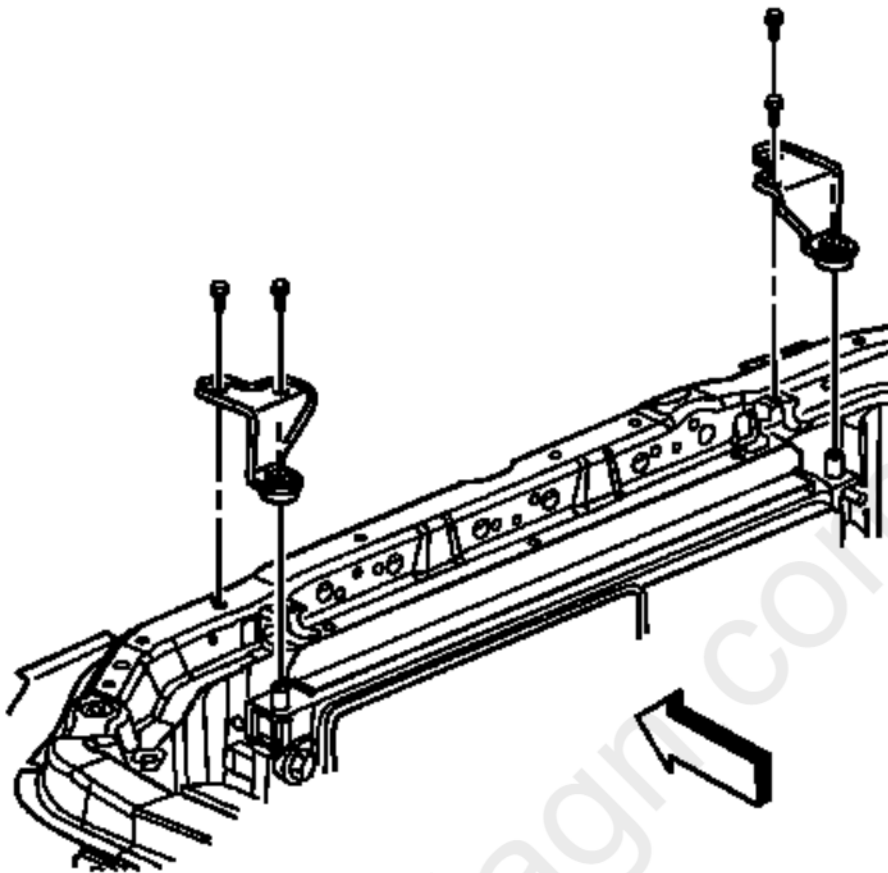


Fig. 118: View Of Radiator Support Brackets
Courtesy of GENERAL MOTORS CORP.

64. Install the radiator support brackets.
65. Install the radiator support bolts and tighten to 9 N.m (80 lb in).

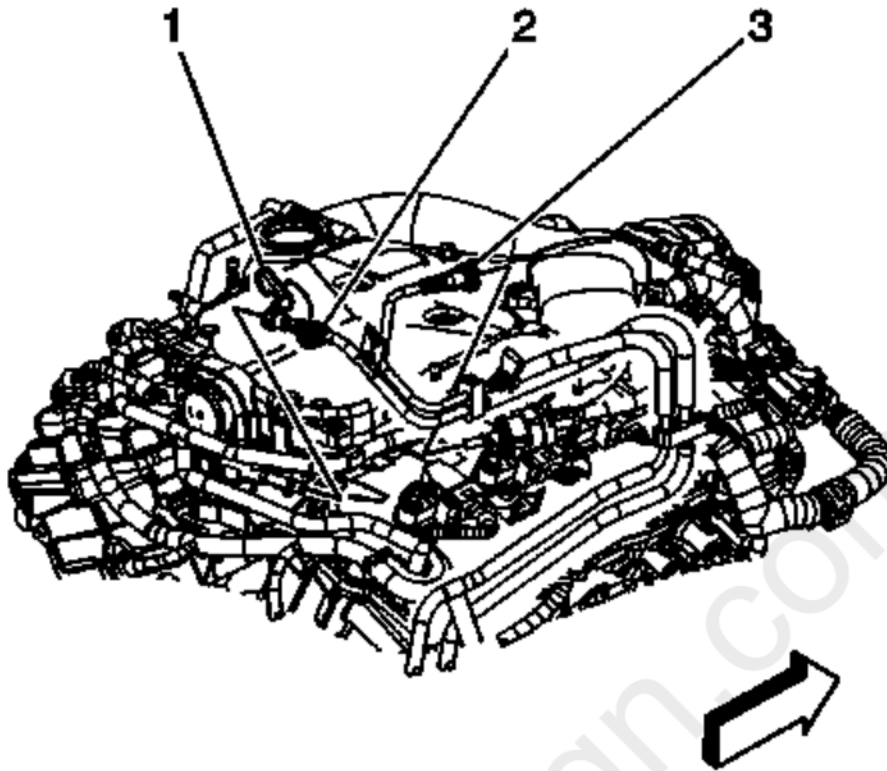


Fig. 119: Top Of Engine View
Courtesy of GENERAL MOTORS CORP.

66. Connect the purge line (3) to the purge solenoid.
67. Connect the fuel pipe (2) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
68. Connect the heater hoses to the heater core. Refer to **Heater Inlet Hose Replacement** and to **Heater Outlet Hose Replacement** .
69. Position and secure the surge tank inlet hose to the vehicle.
70. Connect the surge tank inlet hose to the water outlet housing and to the radiator. Refer to **Radiator Surge Tank Engine Hose Replacement (LF1, LLT)** .
71. Connect the outlet hose to the surge tank. Refer to **Radiator Surge Tank Inlet Hose/Pipe Replacement (LF1, LLT)** .
72. Connect the electrical connector for the air conditioning pressure switch and the liquid line to the evaporator.
73. Connect the air conditioning suction hose to the evaporator and install the suction hose bracket to the shock tower.
74. Install the air cleaner duct. Refer to **Air Cleaner Outlet Duct Replacement (LF1)** or **Air Cleaner Outlet Duct Replacement (LLT)** .

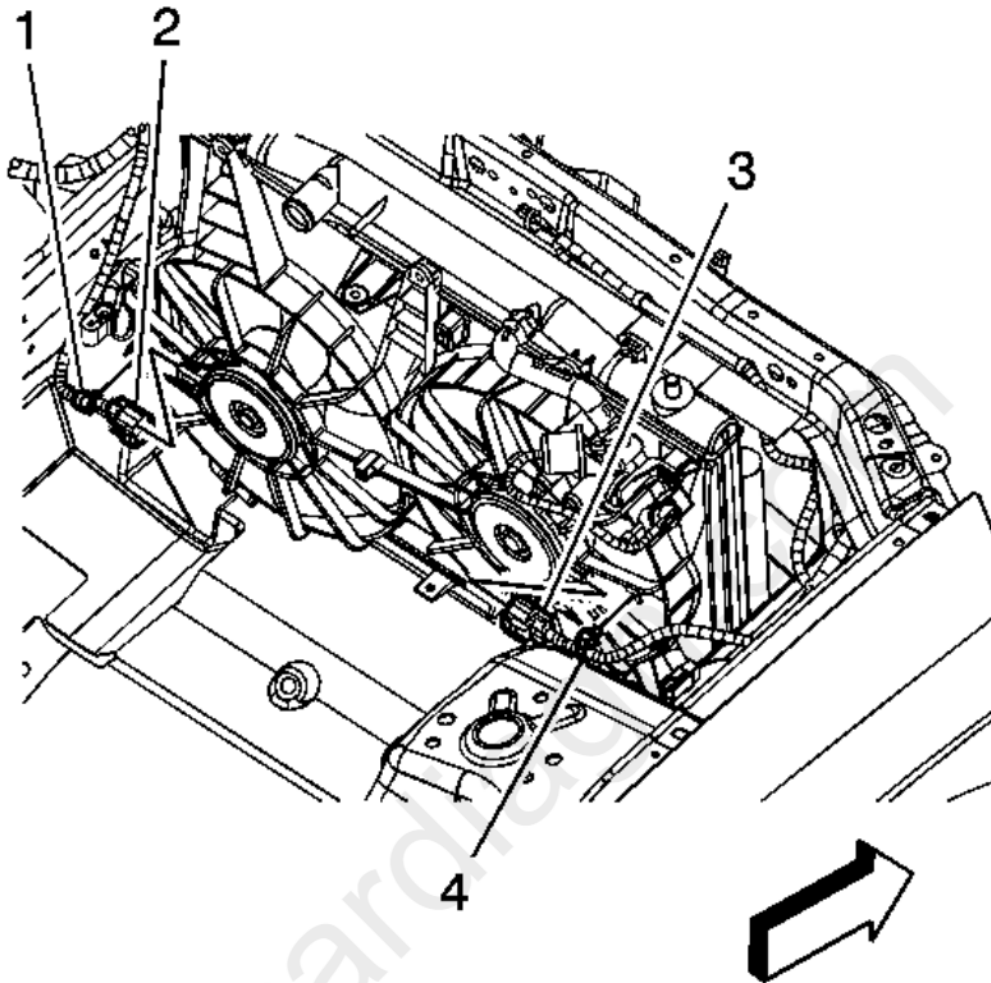


Fig. 120: View Of Cooling Fan Wiring Harness & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

75. Install the cooling fan wiring harnesses (1, 4) to the fan shroud.
76. Install the cooling fan electrical connectors (2, 3).
77. Install the wiper module. Refer to **Windshield Wiper Transmission Replacement** .
78. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement (LP1, LY7)** or **Fuel Injector Sight Shield Replacement (LLT)** .
79. Connect the negative cable from the battery and the body at the top of the right strut tower. Refer to **Battery Negative Cable Replacement** .
80. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill LF1, LLT)** or

Cooling System Draining and Filling (GE 47716 LF1, LLT) .

81. Charge the air conditioning system. Refer to **Refrigerant Recovery and Recharging** .
82. Bleed the brake rear circuits. Refer to **HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)** or **HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)** ..

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

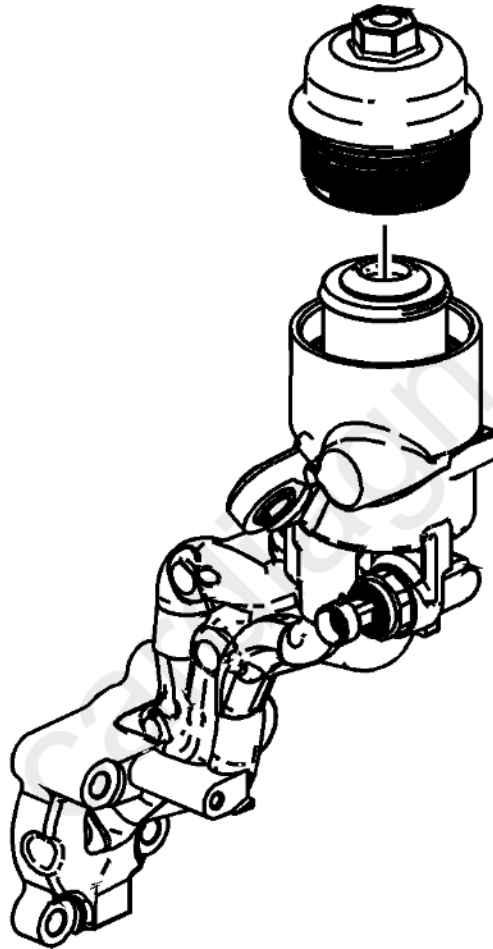


Fig. 121: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement** .

NOTE: Use a 6-point socket to remove the oil filter cap.

3. Remove the oil filter cap.

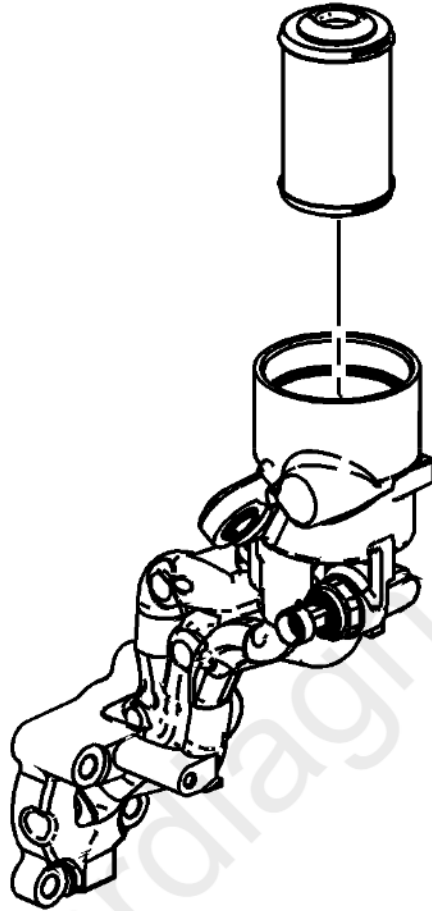


Fig. 122: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

NOTE: It is normal for oil to drain from the oil filter chamber in the oil filter adapter housing. Do NOT replace the oil filter adapter for this condition.

4. Remove and discard the oil filter cartridge.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Place a suitable drain below the oil pan drain plug.

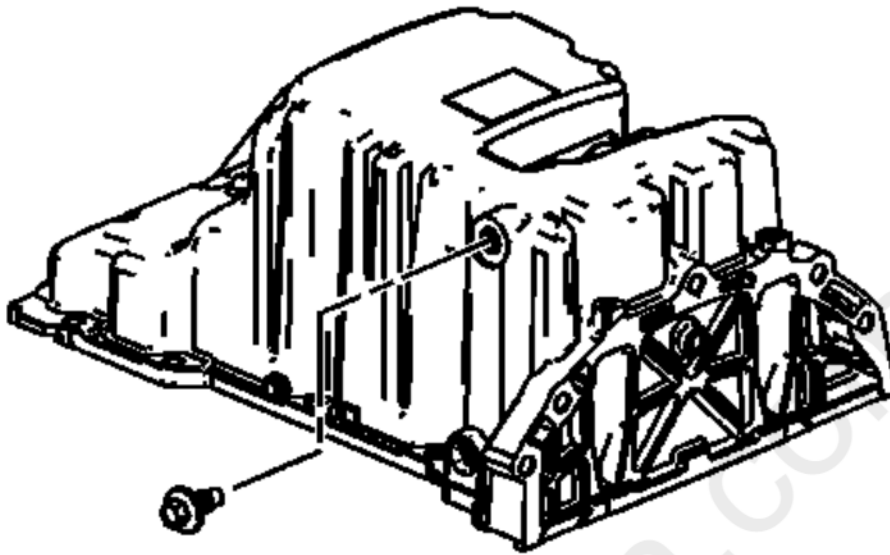


Fig. 123: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pan drain plug.
8. Allow the oil to drain completely.

INSTALLATION PROCEDURE

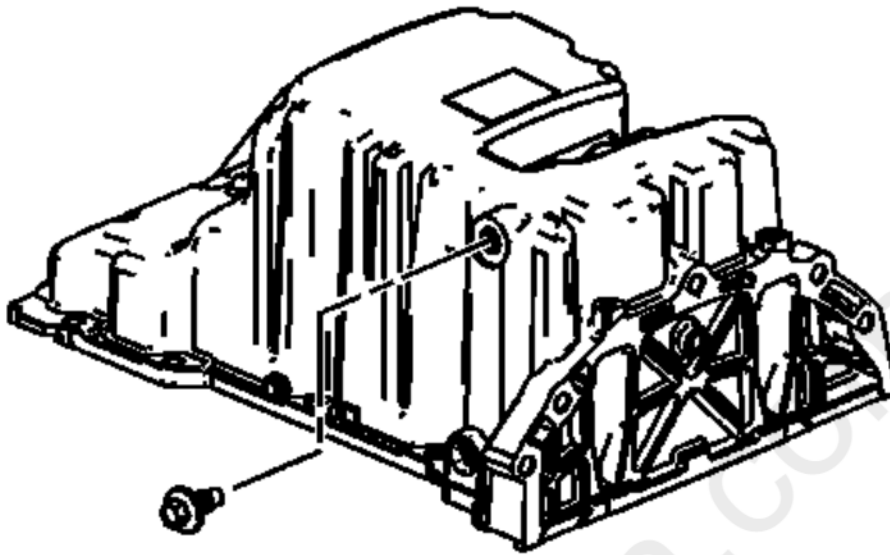


Fig. 124: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to FASTENER CAUTION .

1. Install the oil pan drain plug and NEW O-ring seal and tighten to 25 N.m (18 lb ft).
2. Lower the vehicle.

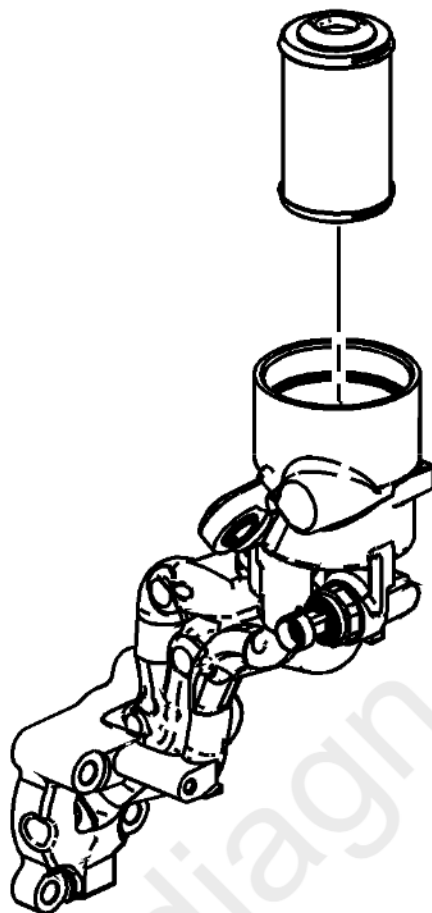


Fig. 125: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW oil filter cartridge.

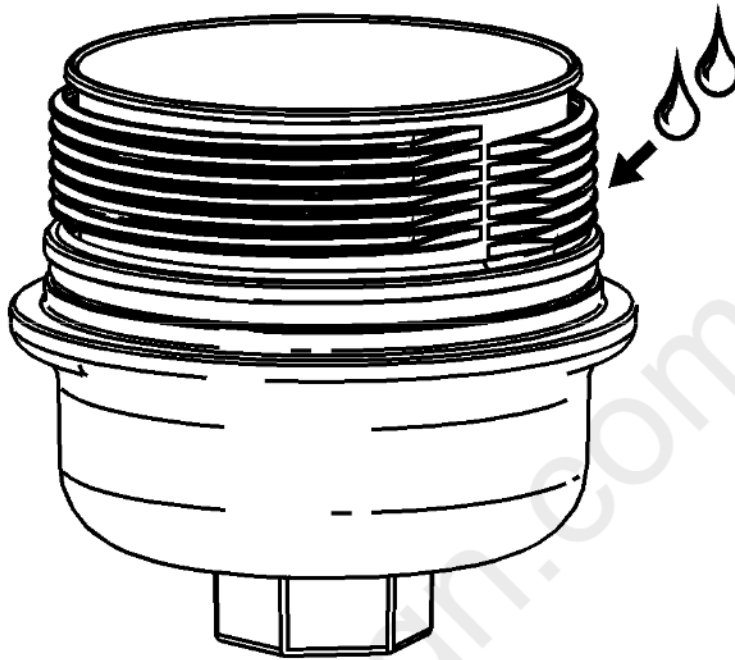


Fig. 126: Lubricating Threads Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

4. Lubricate the oil filter cap threads with clean engine oil.

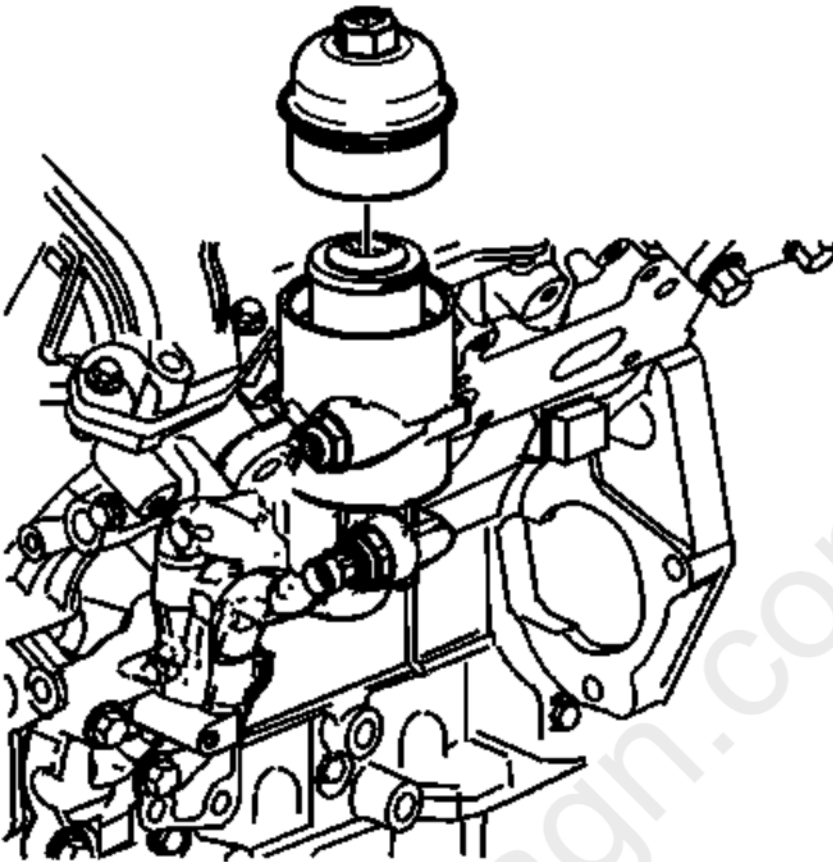


Fig. 127: Oil Filter Cap

Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

NOTE: Use a 6-point socket to install the oil filter cap.

5. Install the oil filter cap and tighten to 25 N.m (18 lb in).
6. Install the oil fill cap.
7. Fill the engine with the appropriate oil type and quantity. Refer to **Fluid and Lubricant Recommendations** and **Approximate Fluid Capacities**.
8. Install the front compartment sight shield as necessary. Refer to **Front Compartment Sight Shields Replacement**.