

Engine

Engine Mechanical - 2.0L (LTG) - Repair Instructions - On Vehicle - CTS Sedan

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

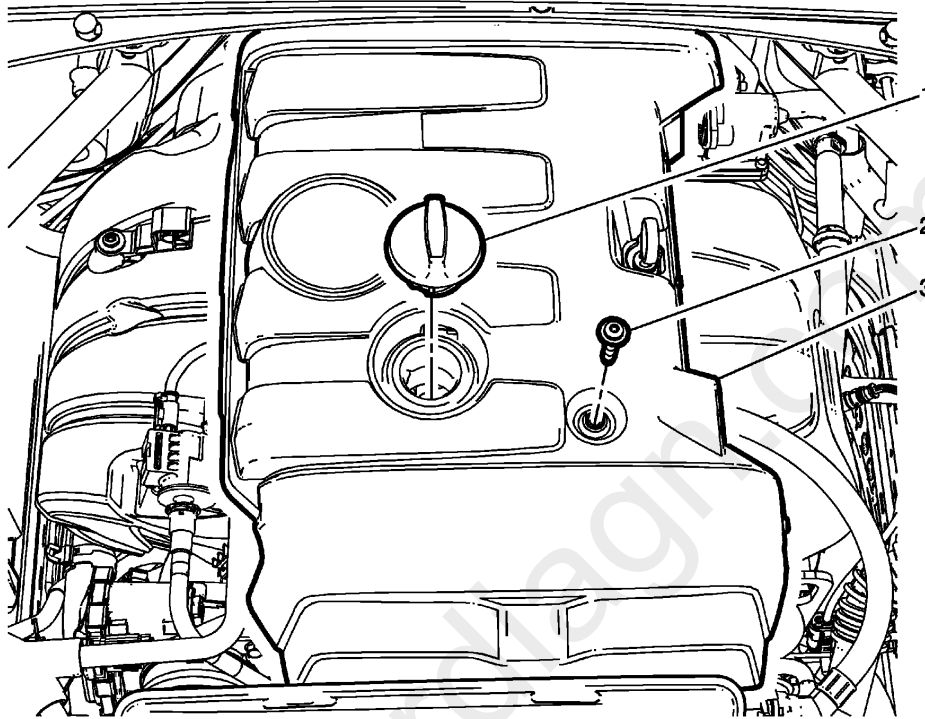


Fig. 1: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement

Callout	Component Name
1	Oil Cap
2	Intake Manifold Cover Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
3	Intake Manifold Cover

DRIVE BELT REPLACEMENT

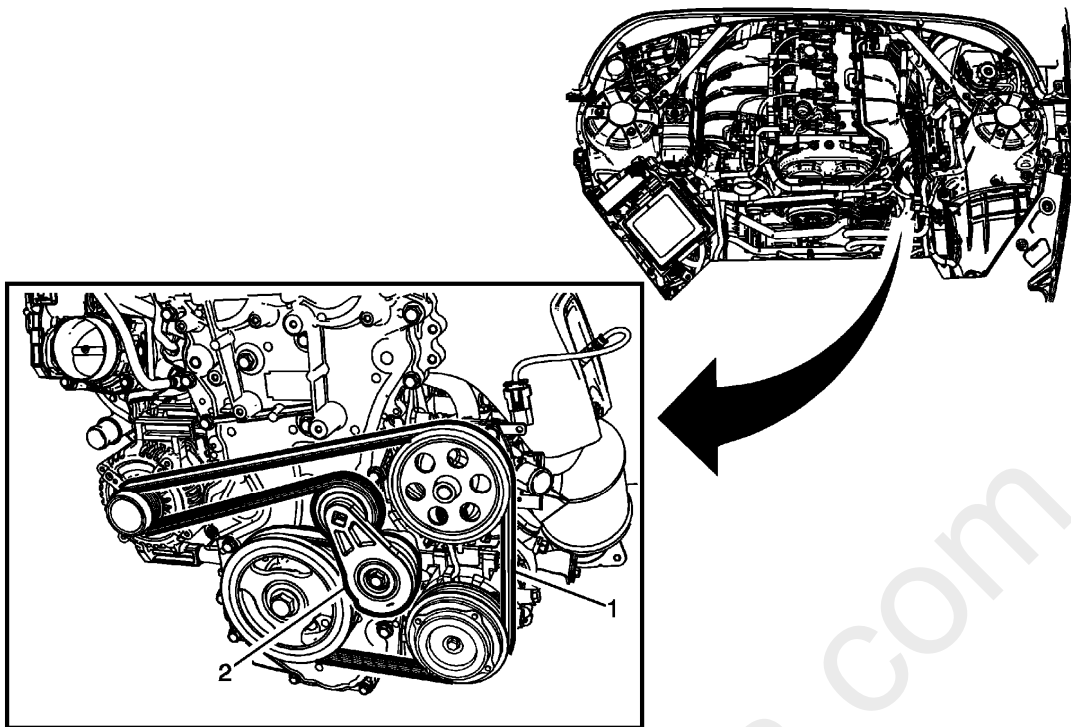


Fig. 2: Drive Belt Routing
 Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

Callout	Component Name
Preliminary Procedure If equipped with engine RPO code LCV, remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	Drive Belt Procedure 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Tensioner Procedure 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

DRIVE BELT TENSIONER REPLACEMENT

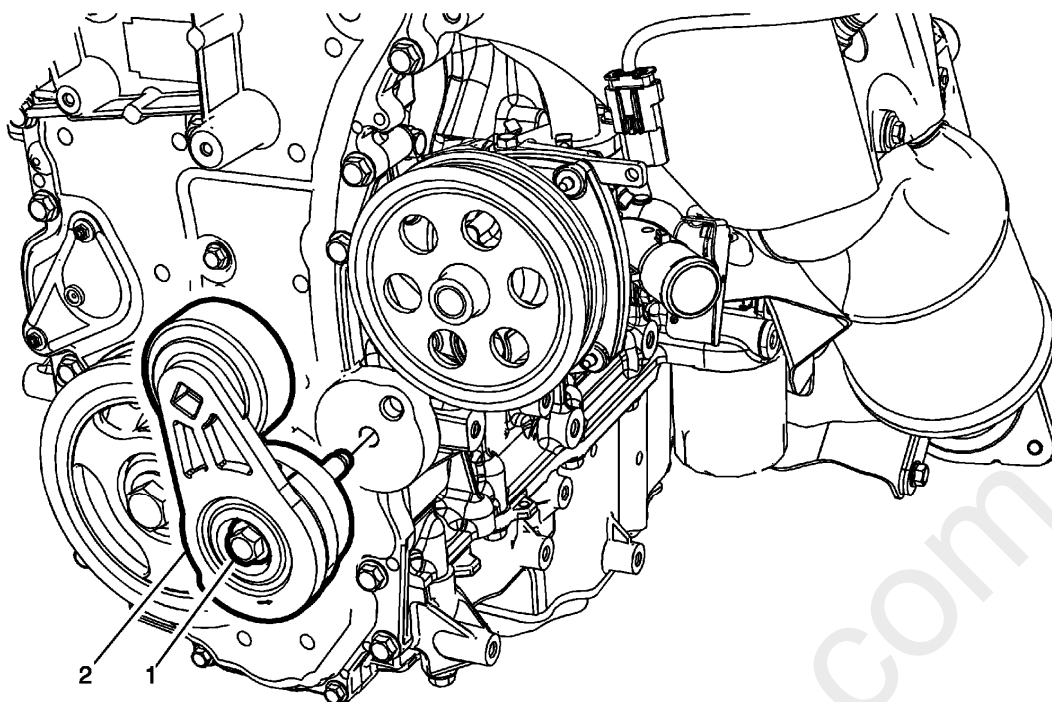


Fig. 3: Drive Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedure	
Remove the drive belt. Refer to <u>Drive Belt Replacement</u> .	
1	Drive Belt Tensioner Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Drive Belt Tensioner

ENGINE MOUNT INSPECTION

CAUTION: The total engine mount vacuum system must be replaced if glycol fluid is found anywhere in the system. Glycol fluid will damage system components and cause them to fail.

CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive

reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket.

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

1. Install 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 split through the center of the engine mount.
 - The GLYCOL™ fluid is leaking from the engine mount.
 - The phenolic spacer under the top mounting stud of the engine mount is missing or damaged.
3. Inspect the system for loose vacuum hose connections or vacuum leaks. Refer to **Vacuum Operated Engine Mounts Description and Operation** , **Vacuum Operated Engine Mounts Description and Operation** .
4. Inspect the engine mount valve assemblies for loose electrical connections. Inspect the electrical system connected to the engine mount valve assemblies. Refer to **Diagnostic System Check - Vehicle** .
5. Inspect for the presence of glycol fluid in the vacuum system. Remove the hose assembly connections at the engine mounts. If fluid is present in the engine mount vacuum system, the entire vacuum system should be replaced.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .

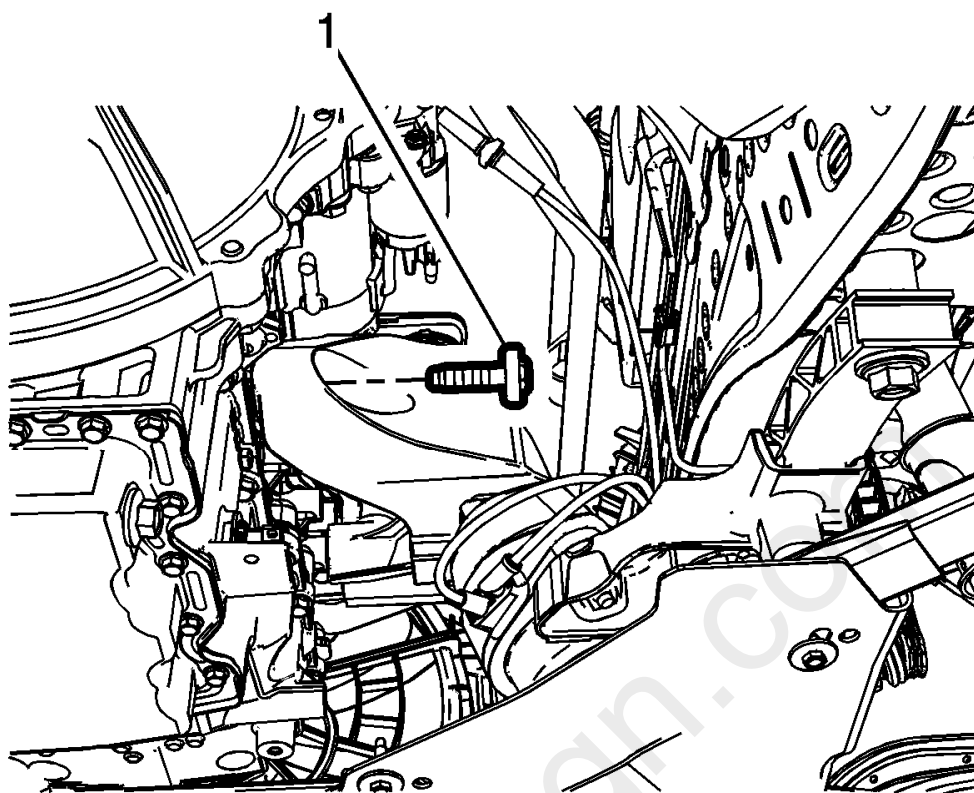


Fig. 4: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine mount bracket bolt (1).

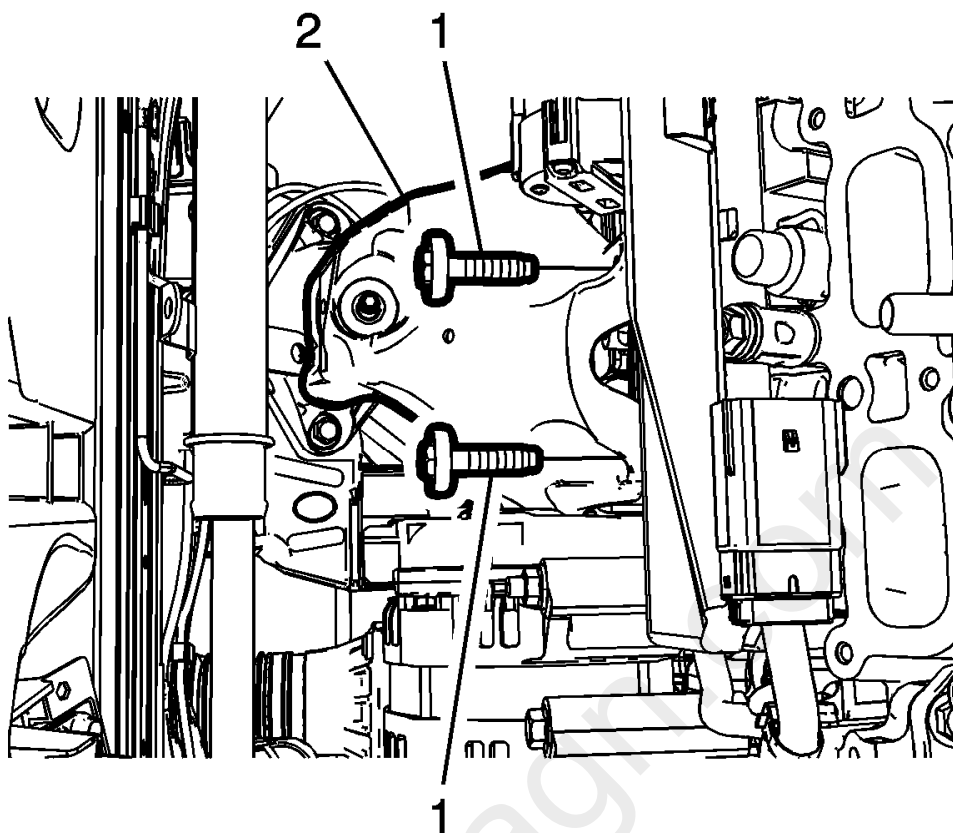


Fig. 5: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

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

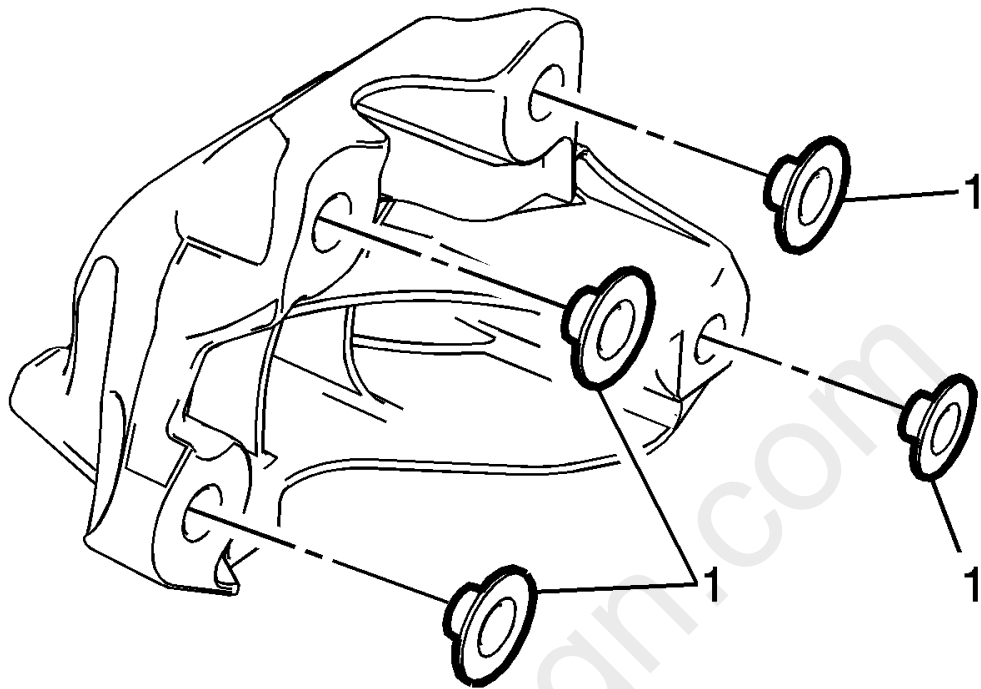


Fig. 6: Engine Mount Bracket Pressed On Spacers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

5. Engine mount bracket spacers (1).

Installation Procedure

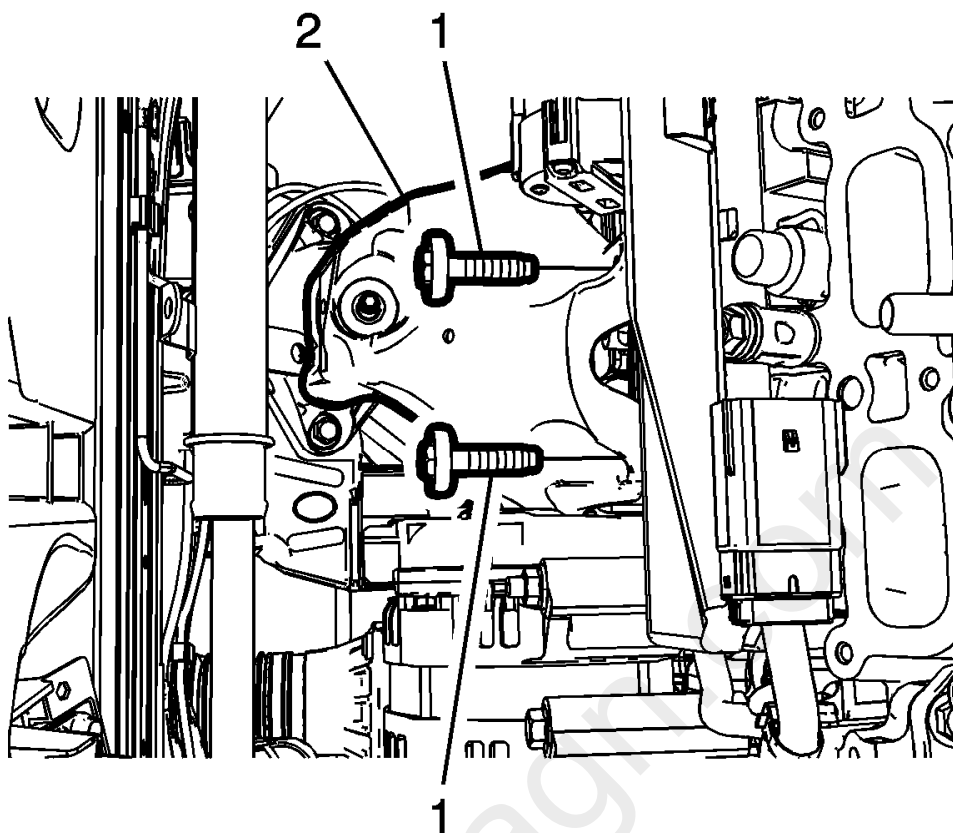


Fig. 7: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket bolt includes a pressed-on aluminum washer. Ensure the washer is in place and not damaged. Replace the bolt if the washer is damaged or missing.

1. Install the engine mount bracket (2).
2. Install engine mount bracket bolts (1) and tighten to 58 (43 lb ft).

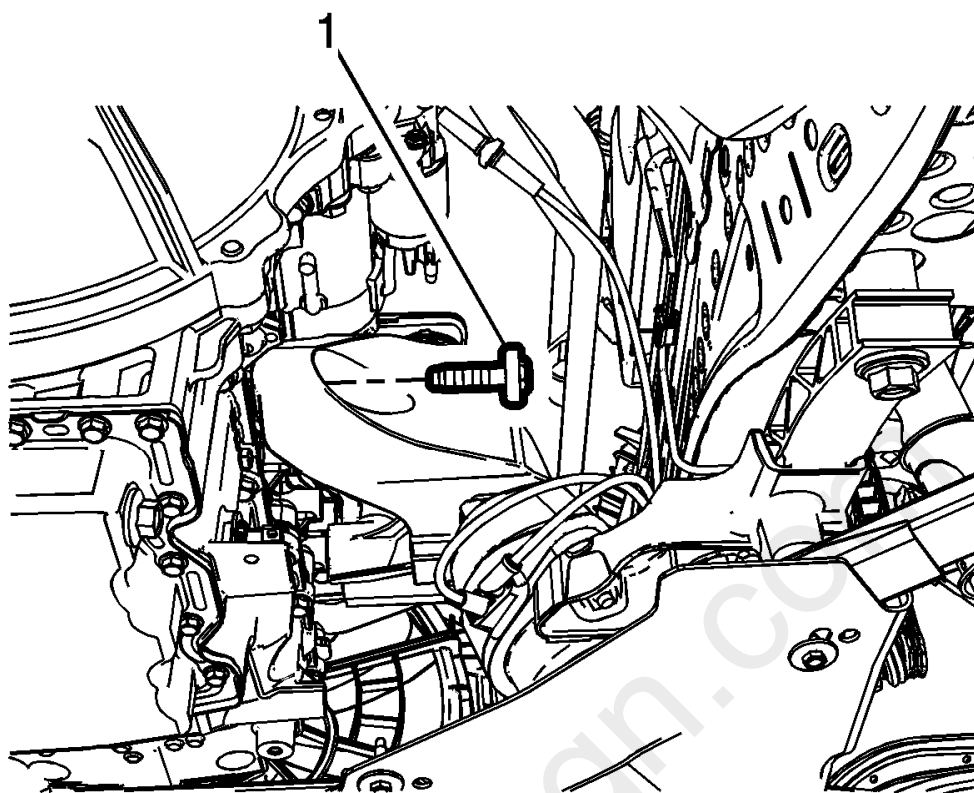


Fig. 8: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket bolt includes a pressed-on aluminum washer. Ensure the washer is in place and not damaged. Replace the bolt if the washer is damaged or missing.

3. Install engine mount bracket bolts (1) and tighten to 58 (43 lb ft).
4. Install the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE (LTG)

Removal Procedure

1. Remove the turbocharger. Refer to **Turbocharger Replacement**.
2. Install the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield**

Replacement .

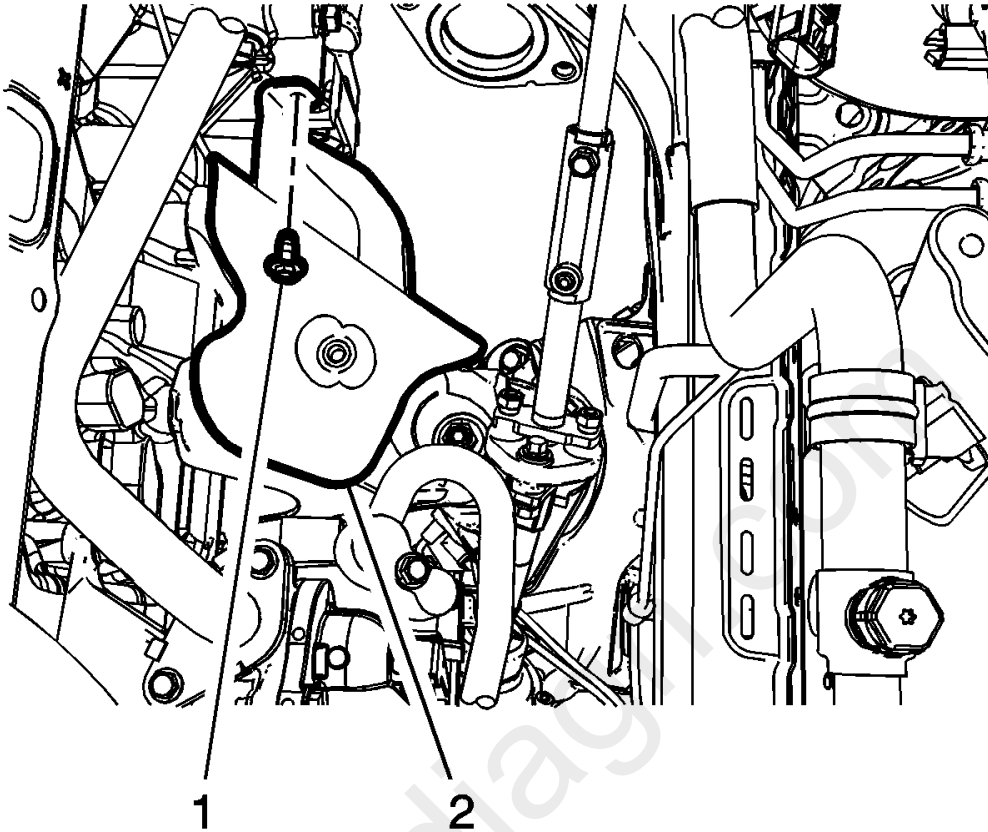


Fig. 9: Oil Pump Flow Control Valve Heat Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump flow control valve heat shield bolt (1).
5. Remove the oil pump flow control valve heat shield (2).
6. Raise the vehicle.

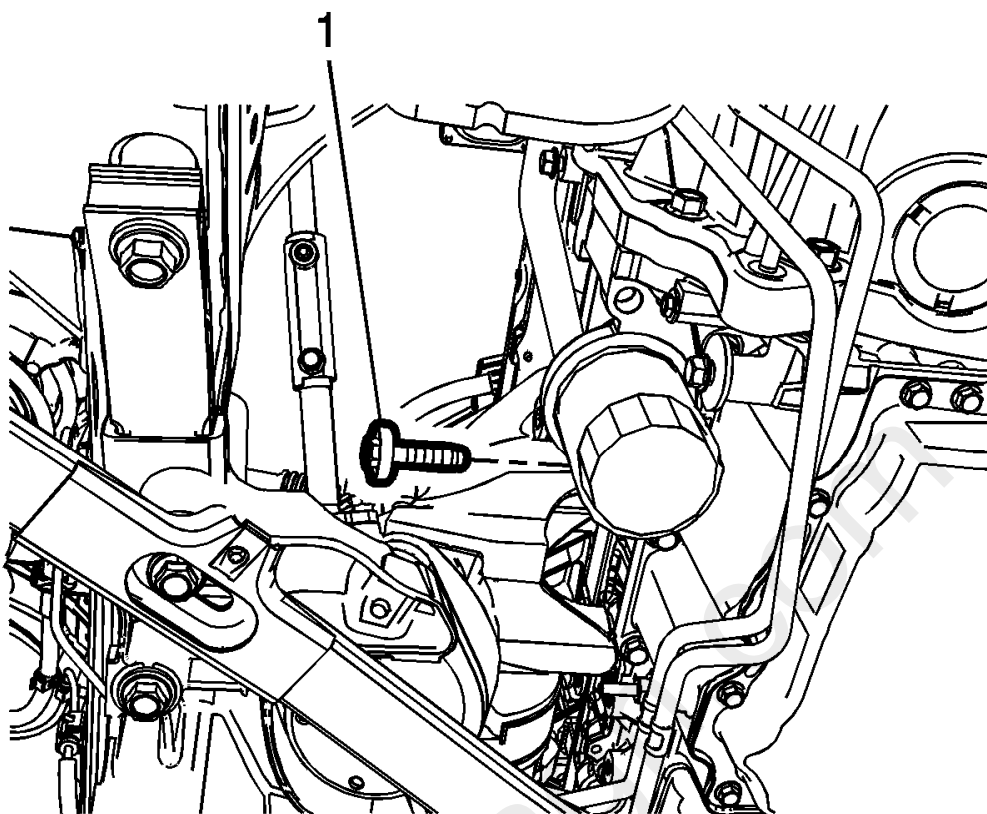


Fig. 10: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine mount bracket bolt (1).

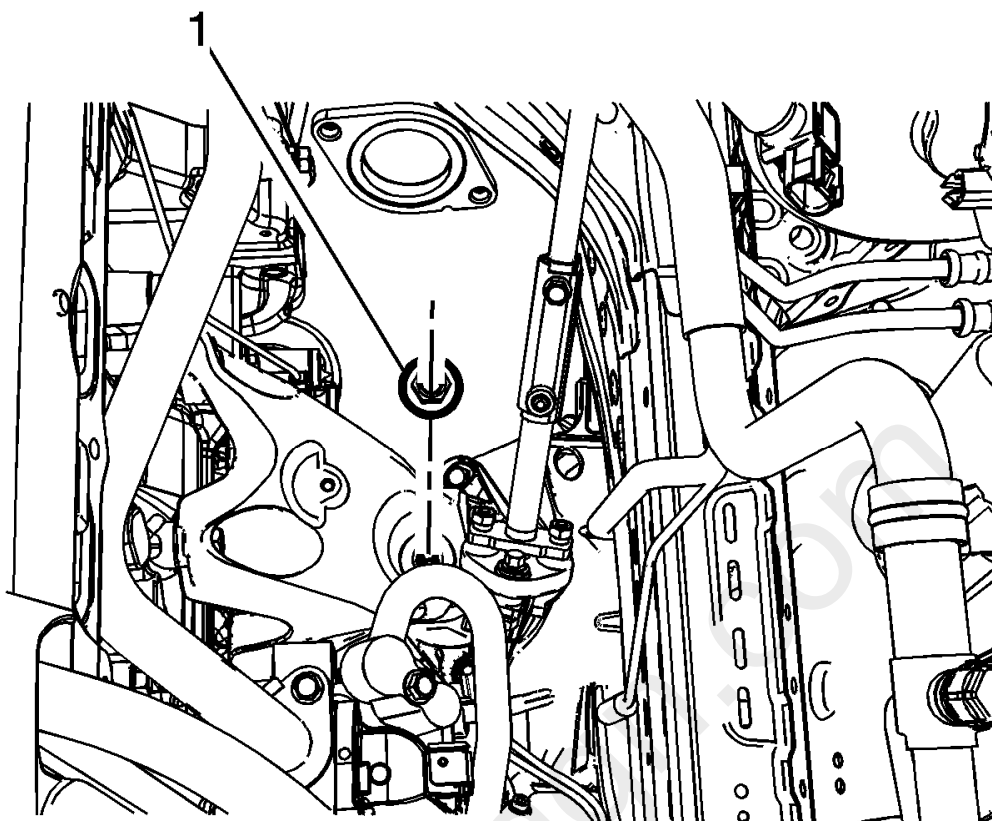


Fig. 11: Engine Mount Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine mount bracket nut (1).

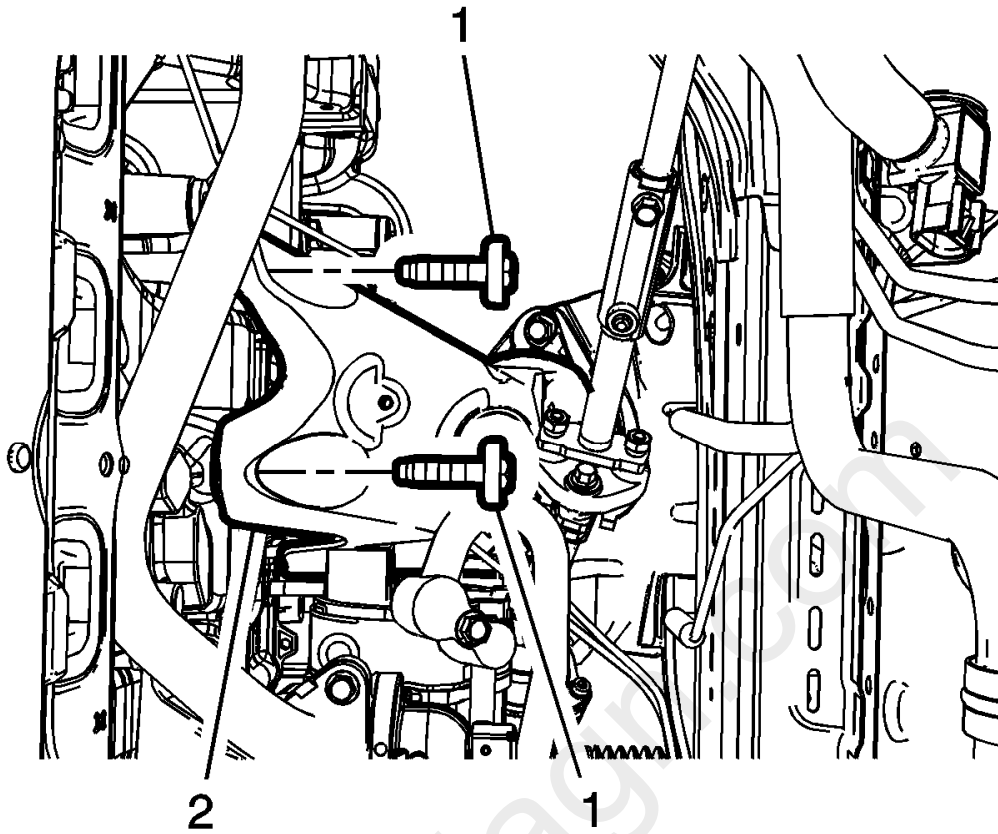


Fig. 12: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine mount bracket bolts (1).
10. Remove the engine mount bracket (2).

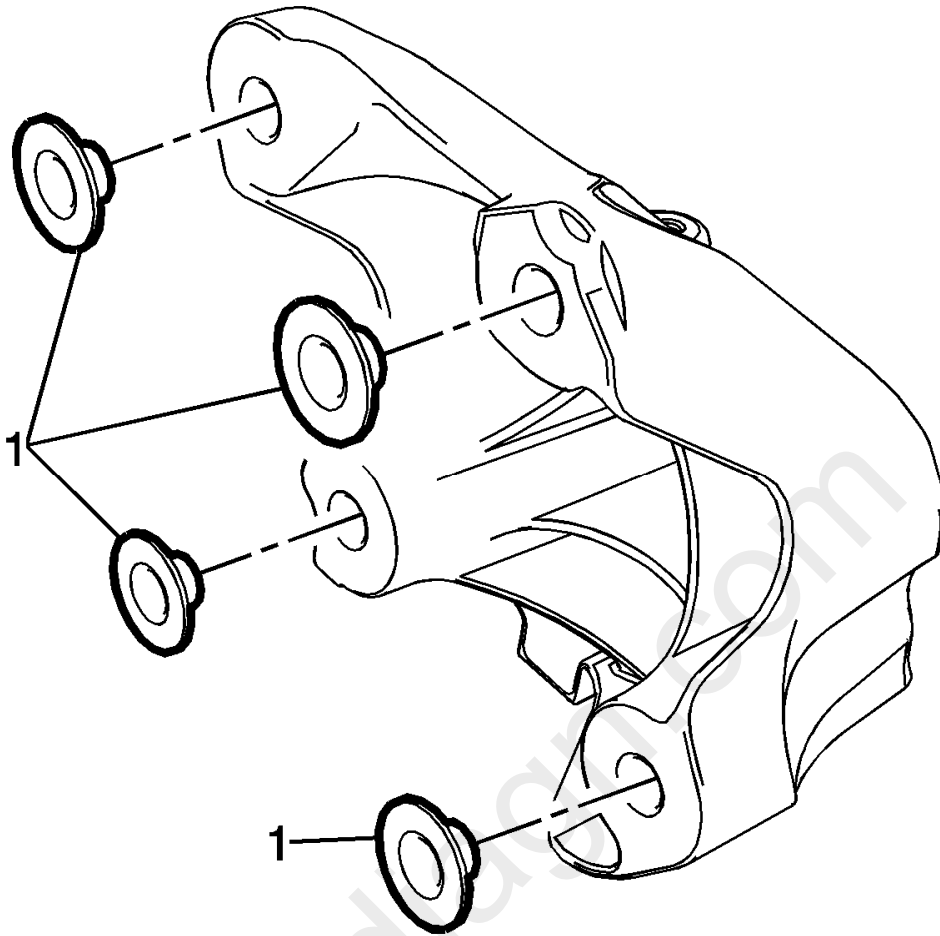


Fig. 13: Engine Mount Pressed On Spacers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

11. If reusing the engine mount bracket, ensure that the engine mount bracket spacers (1) are in place in the engine mount bracket.

Installation Procedure

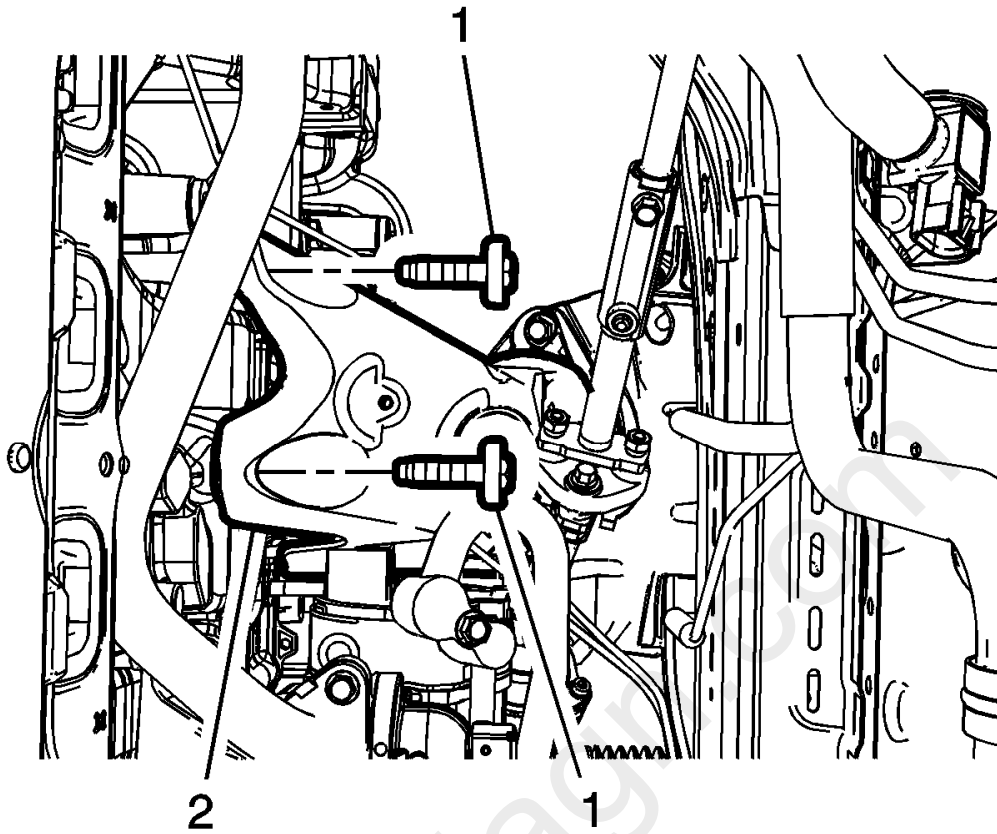


Fig. 14: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket bolt includes a pressed-on aluminum washer. Ensure the washer is in place and not damaged. Replace the bolt if the washer is damaged or missing.

1. Install the engine mount bracket (2).
2. Install engine mount bracket bolts (1) and tighten to 58 (43 lb ft).

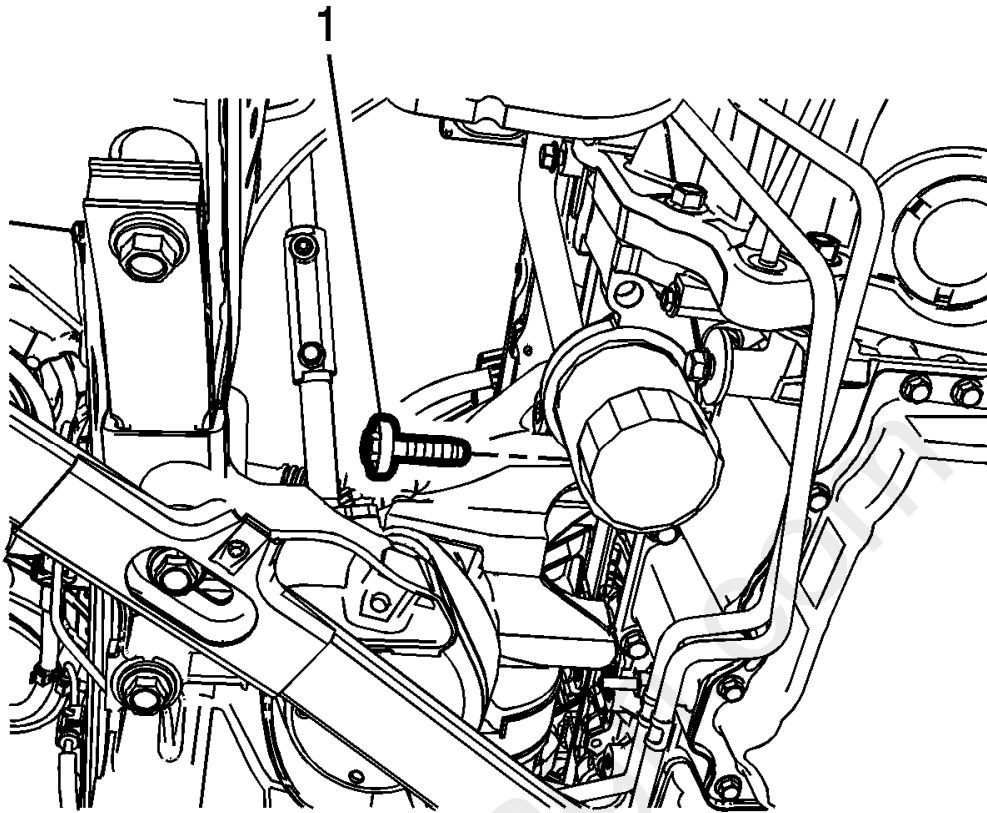


Fig. 15: Engine Mount Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket bolt includes a pressed-on aluminum washer. Ensure the washer is in place and not damaged. Replace the bolt if the washer is damaged or missing.

3. Install engine mount bracket bolts (1) and tighten to 58 (43 lb ft).

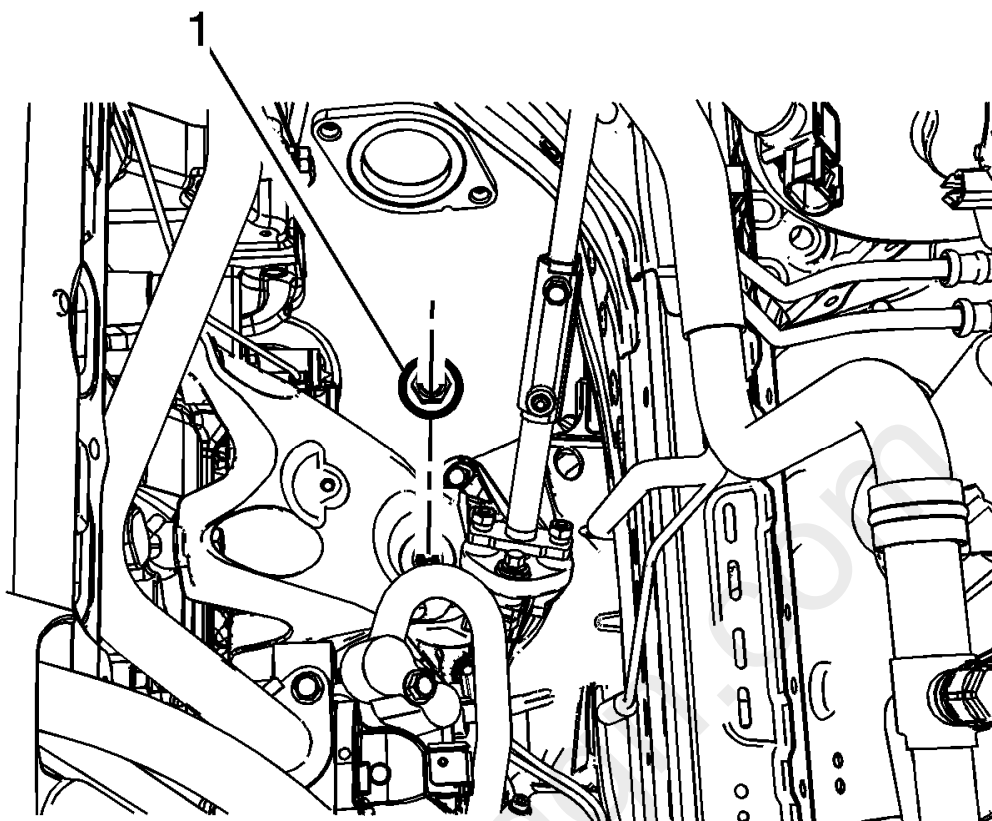


Fig. 16: Engine Mount Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

4. Install engine mount bracket nut (1) and tighten to 70 (52 lb ft).

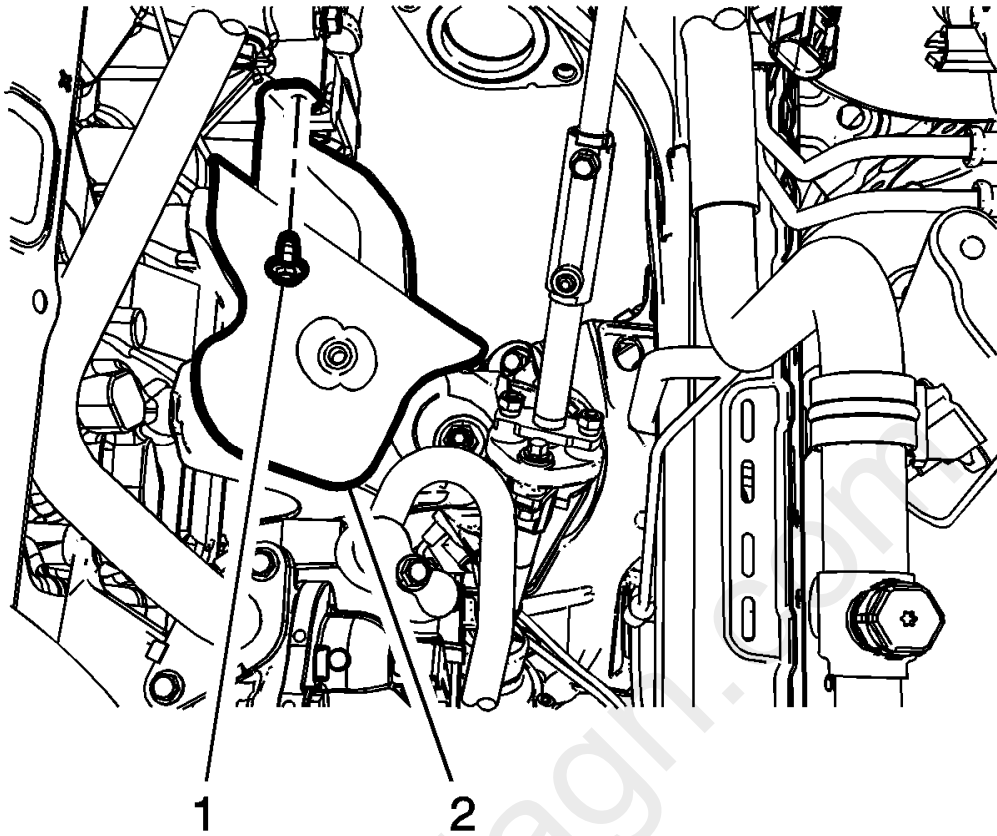


Fig. 17: Oil Pump Flow Control Valve Heat Shield
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pump flow control valve heat shield (2).
6. Install the oil pump flow control valve heat shield bolt (1) and tighten to 9 (7 lb ft).
7. Install the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .
8. Remove the engine support fixture. Refer to **Engine Support Fixture**.
9. Install the turbocharger. Refer to **Turbocharger Replacement**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE (LTG)

Removal Procedure

1. Remove the drivetrain and front suspension frame. Refer to **Drivetrain and Front Suspension Frame Removal and Installation** .
2. Disconnect the engine mount vacuum hose.

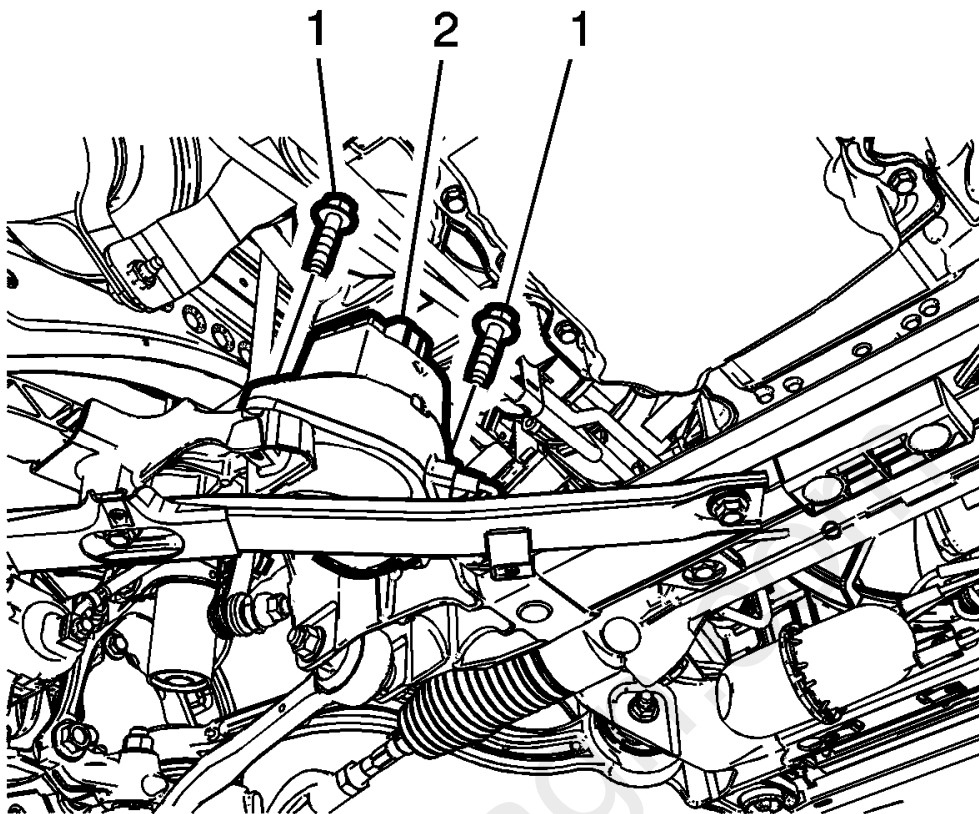


Fig. 18: Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount bolts (1).
4. Remove the engine mount (2).

Installation Procedure

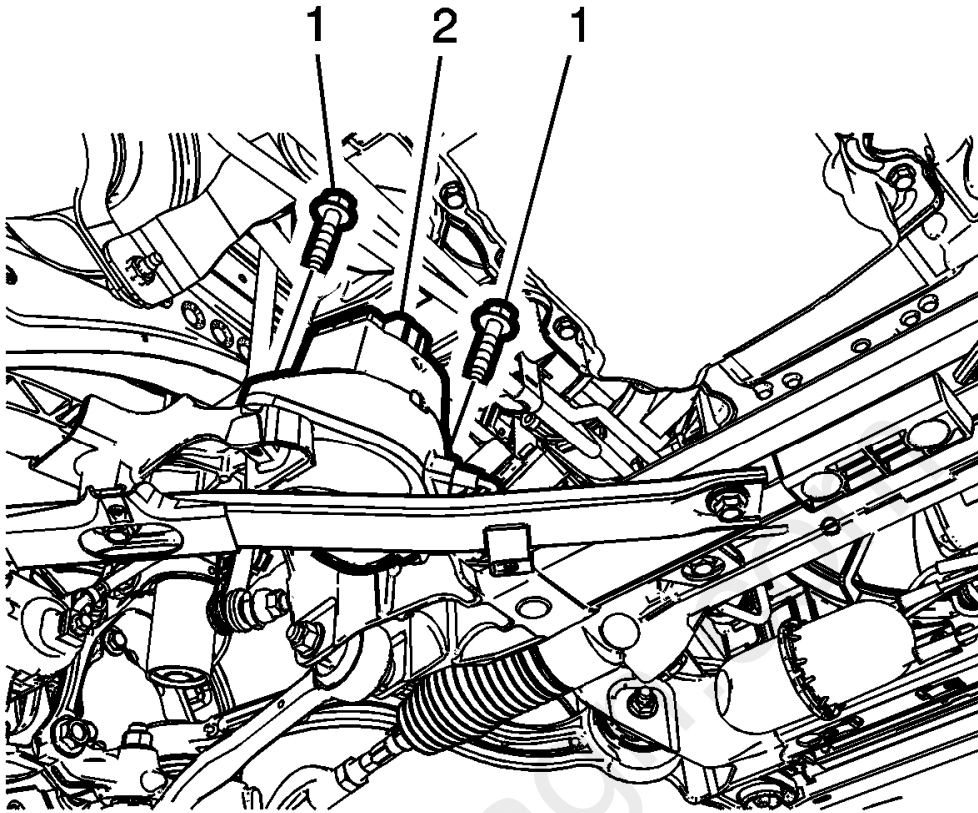


Fig. 19: Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine mount (2).

CAUTION: Refer to Fastener Caution .

2. Install the engine mount bolts (1) and tighten to 62 (46 lb ft).
3. Connect the engine mount vacuum hose.
4. Install the drivetrain and front suspension frame. Refer to Drivetrain and Front Suspension Frame Removal and Installation .

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the drivetrain and front suspension frame. Refer to Drivetrain and Front Suspension Frame

Removal and Installation .

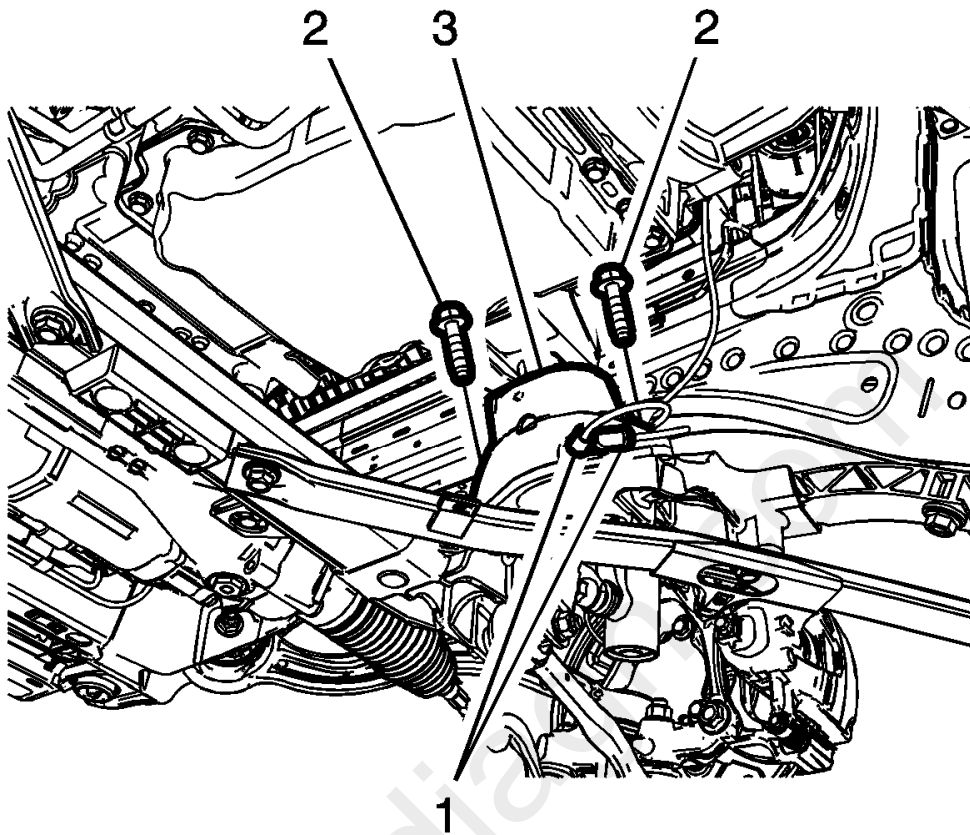


Fig. 20: Engine Mount - Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine mount vacuum hose (1).
3. Remove the engine mount bolts (2).
4. Remove the engine mount (3).

Installation Procedure

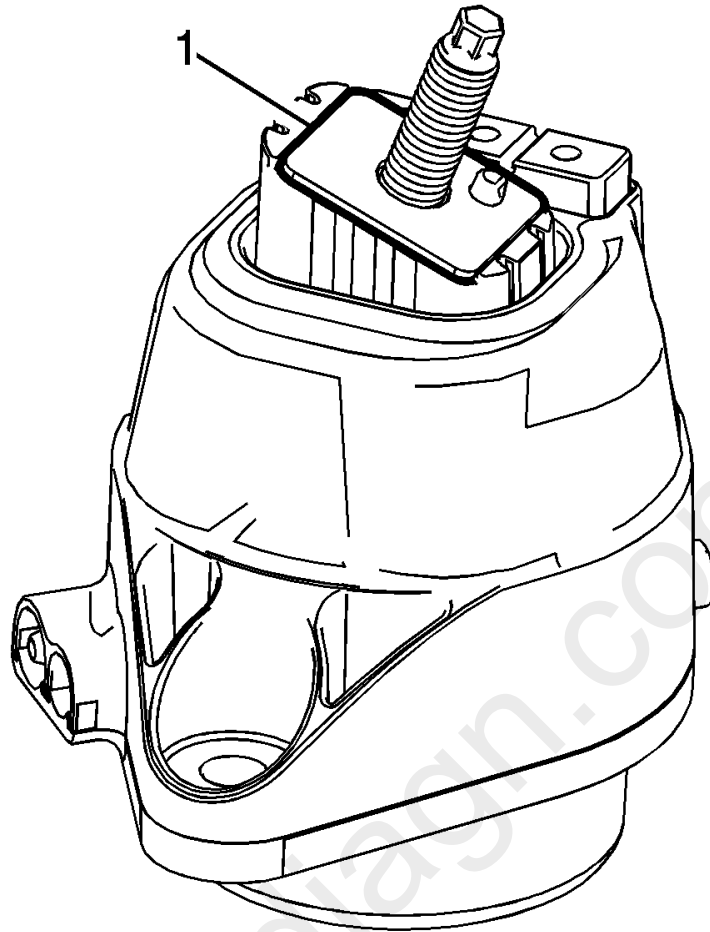


Fig. 21: Phenolic Spacer

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket.

1. Inspect the engine mount to ensure the phenolic spacer (1) is in place and not damaged.

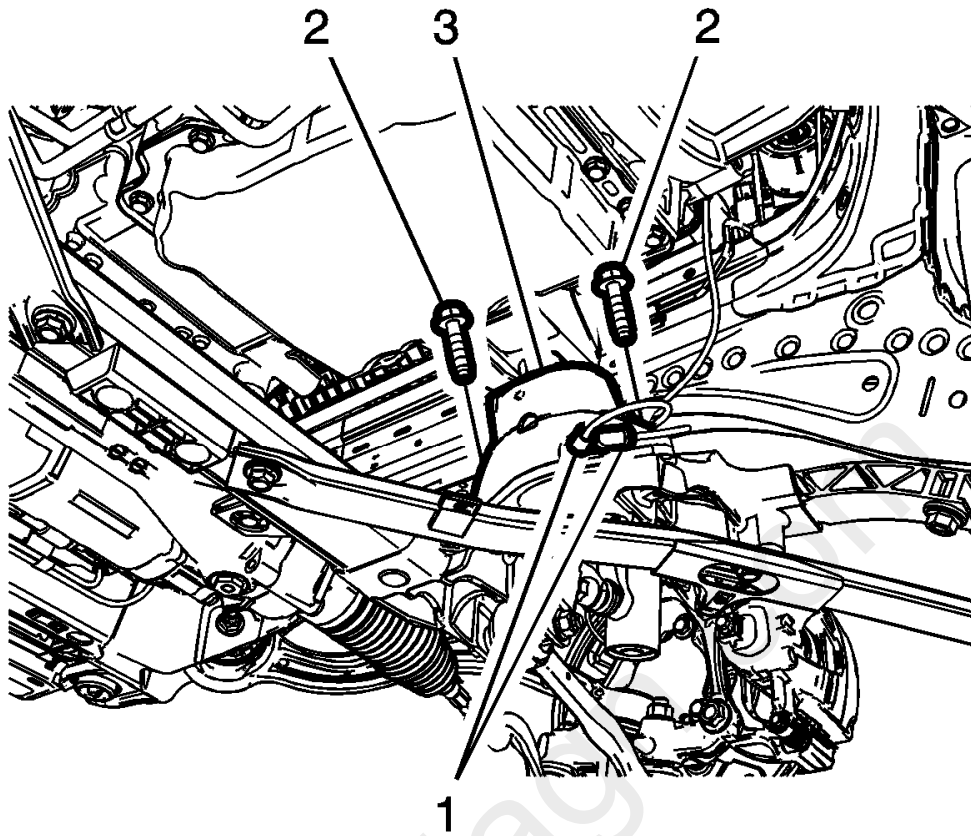


Fig. 22: Engine Mount - Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine mount (3)

CAUTION: Refer to Fastener Caution .

3. Install the engine mount bolts (2) and tighten to 62 (46 lb ft).
4. Connect the engine mount vacuum hose (1)
5. Install the drivetrain and front suspension frame. Refer to Drivetrain and Front Suspension Frame Removal and Installation .

ENGINE MOUNT VACUUM VALVE REPLACEMENT

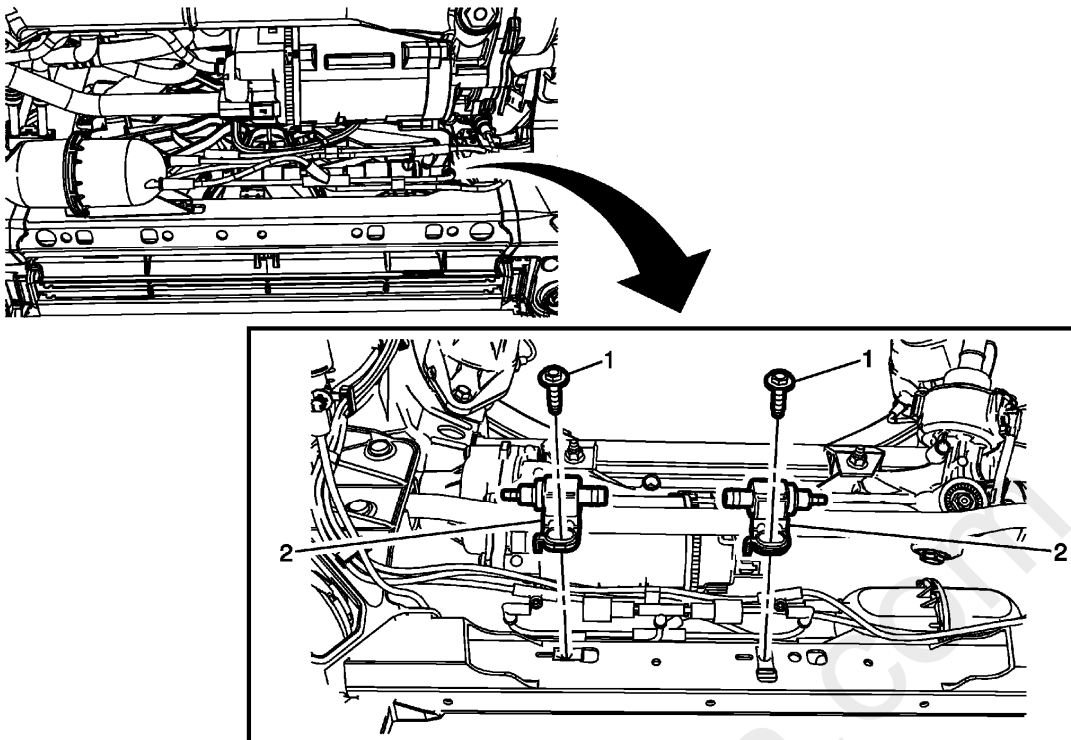


Fig. 23: Engine Mount Vacuum Valve
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Valve Replacement

Callout	Component Name
1	Engine Mount Vacuum Valve Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Disconnect the vacuum lines from the components. Tighten 9 (80 lb in)
2	Engine Mount Vacuum Valve (Qty: 2) Procedure Disconnect electrical connectors as necessary.

ENGINE MOUNT VACUUM FILTER REPLACEMENT

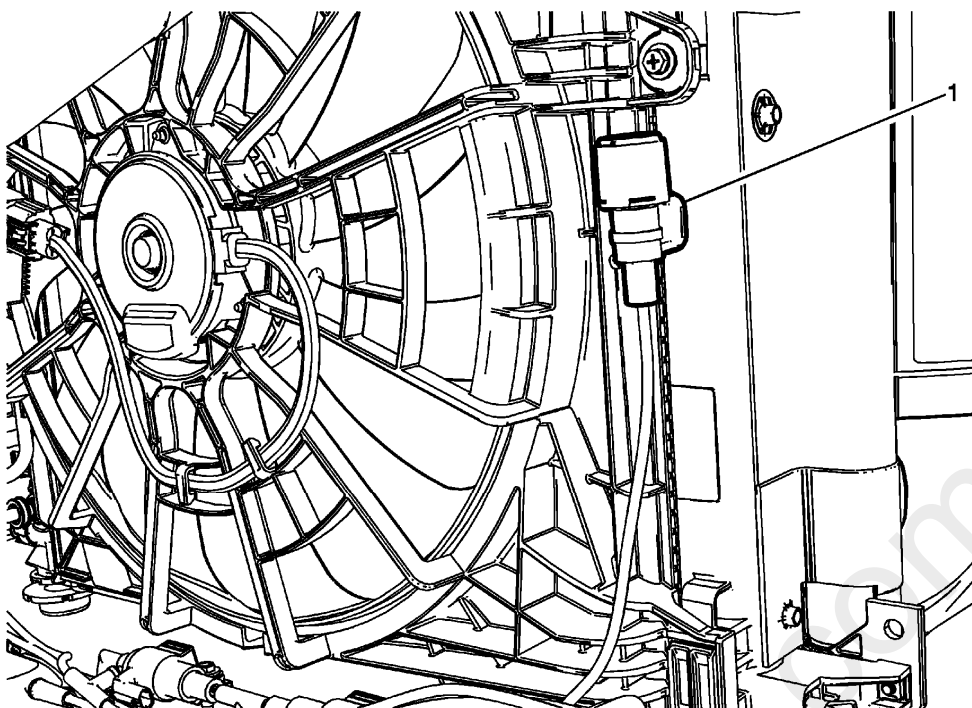


Fig. 24: Engine Mount Vacuum Filter
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Filter Replacement

Callout	Component Name
1	Engine Mount Vacuum Filter Procedure Disconnect the engine mount vacuum hose before removing the filter.

ENGINE MOUNT VACUUM TANK REPLACEMENT

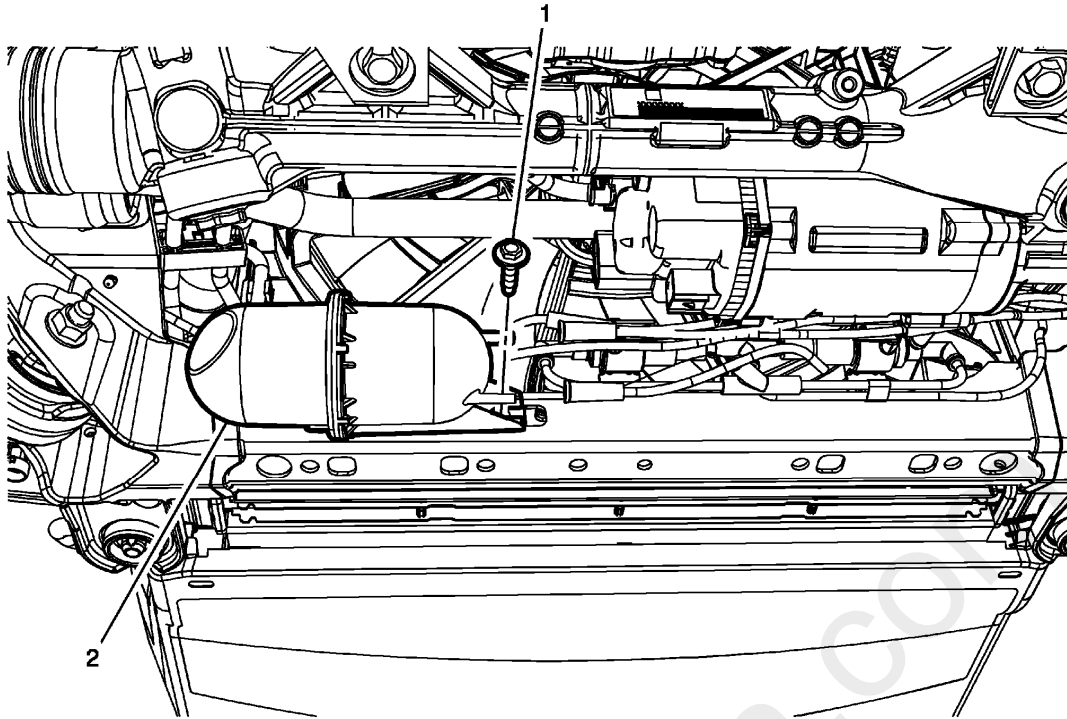


Fig. 25: Engine Mount Vacuum Tank
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Tank Replacement

Callout	Component Name
1	Engine Mount Vacuum Tank Fastener CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Disconnect the vacuum lines from the components. Tighten 9 (80 lb in)
2	Engine Mount Vacuum Tank

ENGINE MOUNT VACUUM HOSE REPLACEMENT

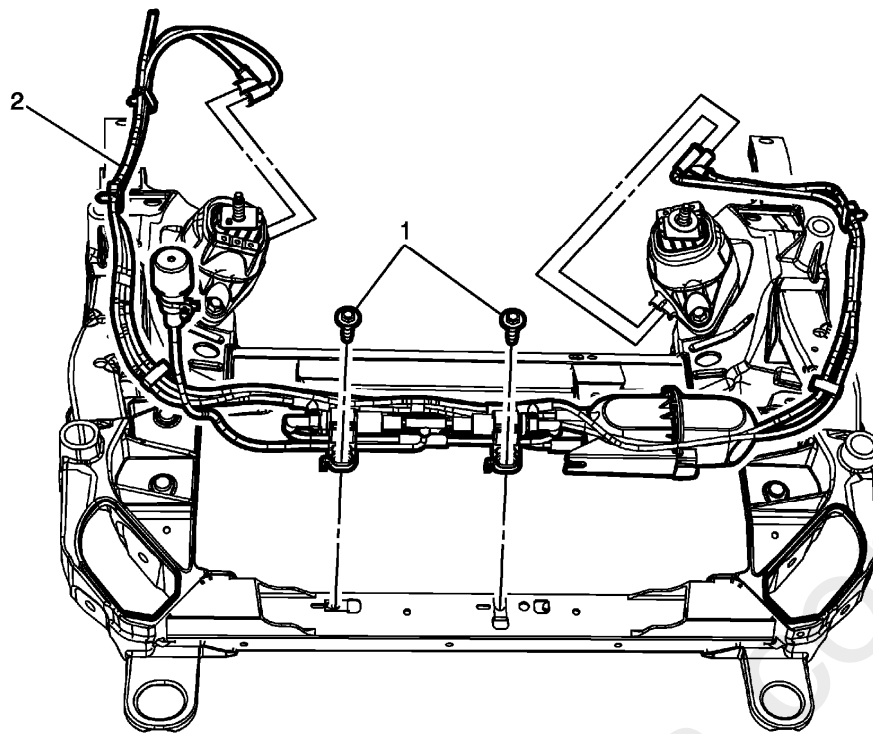


Fig. 26: Engine Mount Vacuum Hose
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Hose Replacement

Callout	Component Name
Preliminary Procedure Remove the drivetrain and front suspension frame. Refer to <u>Drivetrain and Front Suspension Frame Removal and Installation</u> .	
1	Engine Mount Vacuum Hose Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Disconnect the vacuum lines from the components. Tighten 9 (80 lb in)
	Engine Mount Vacuum Hose Procedure 1. Remove the engine mount vacuum tank fastener. Refer to <u>Engine Mount Vacuum Tank Replacement</u> .

2

2. Disconnect the engine mount vacuum hose retainer at the frame.
3. Remove the engine mount vacuum hose assembly from the frame.
4. Remove the vacuum tank and vacuum valves from the engine mount vacuum hose assembly.
5. Remove the vacuum filter from the vacuum hose assembly.

ENGINE SUPPORT FIXTURE

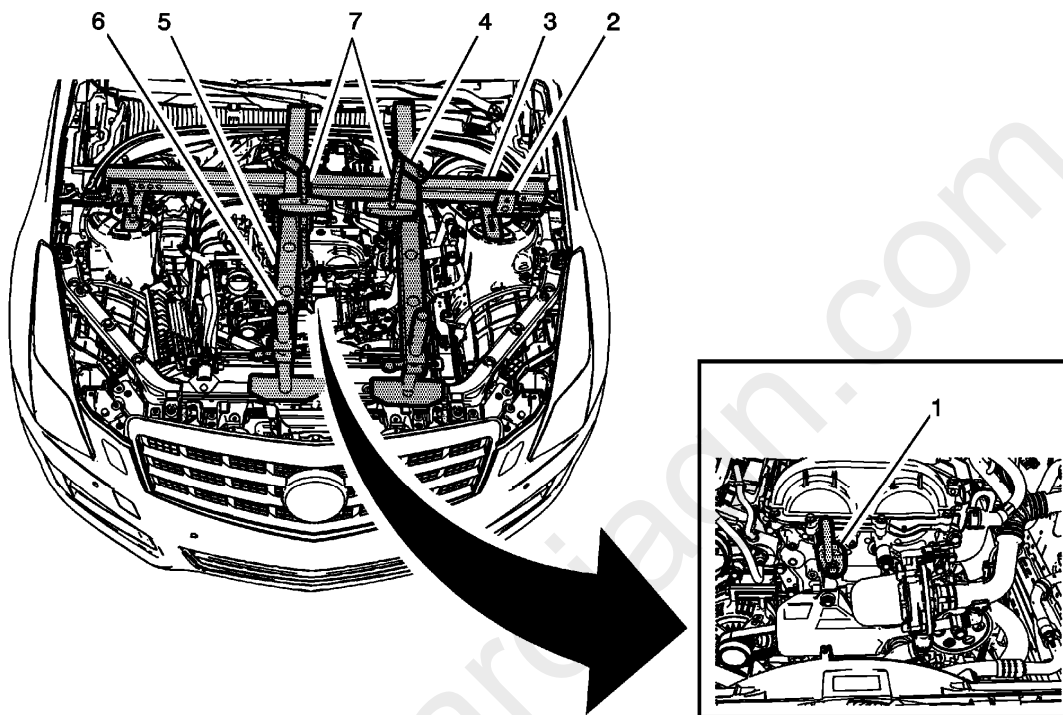


Fig. 27: Engine Support Fixture

Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedure	
1. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 3. Unclip and reposition the engine harness attached to the upper portion of the front cover.	
Special Tools	
• J-28467-B Universal Engine Support Fixture	

- **J-28467-550** Engine Support Beam Adapter
- **J-36857** Engine Lift Bracket

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

1	Engine Lift Bracket CAUTION: Refer to Fastener Caution . Procedure Install engine lift bracket using the engine front cover bolt. Tighten 58 (43 lb ft)
2	Engine Support Fixture Adapter Leg (Qty: 2) Procedure Install the bracket to fender frame. Do not install on top of fender lip.
3	Main Support Beam
4	Cross Bracket (Qty, 2)
5	Engine Support Fixture leg (Qty, 2) Procedure Adjust the length of the engine support fixture leg.
6	Radiator Tube Shelf Assembly
7	Hook Assembly NOTE: If the engine is not equipped with engine lift bracket, install J-36857 engine lift bracket in place.

TURBOCHARGER HEAT SHIELD REPLACEMENT

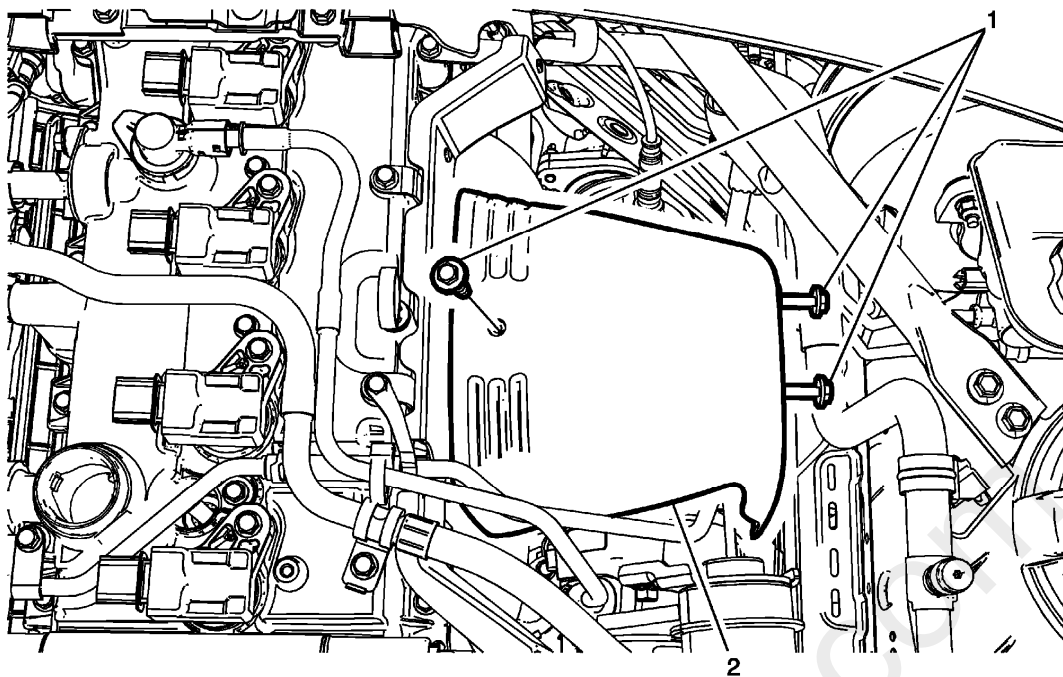


Fig. 28: Turbocharger Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Heat Shield Replacement

Callout	Component Name
1	Turbocharger Heat Shield Fastener (Qty, 3) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt. Tighten 14 (10 lb ft)
2	Turbocharger Heat Shield

TURBOCHARGER REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement.
2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .

3. Drain the coolant system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

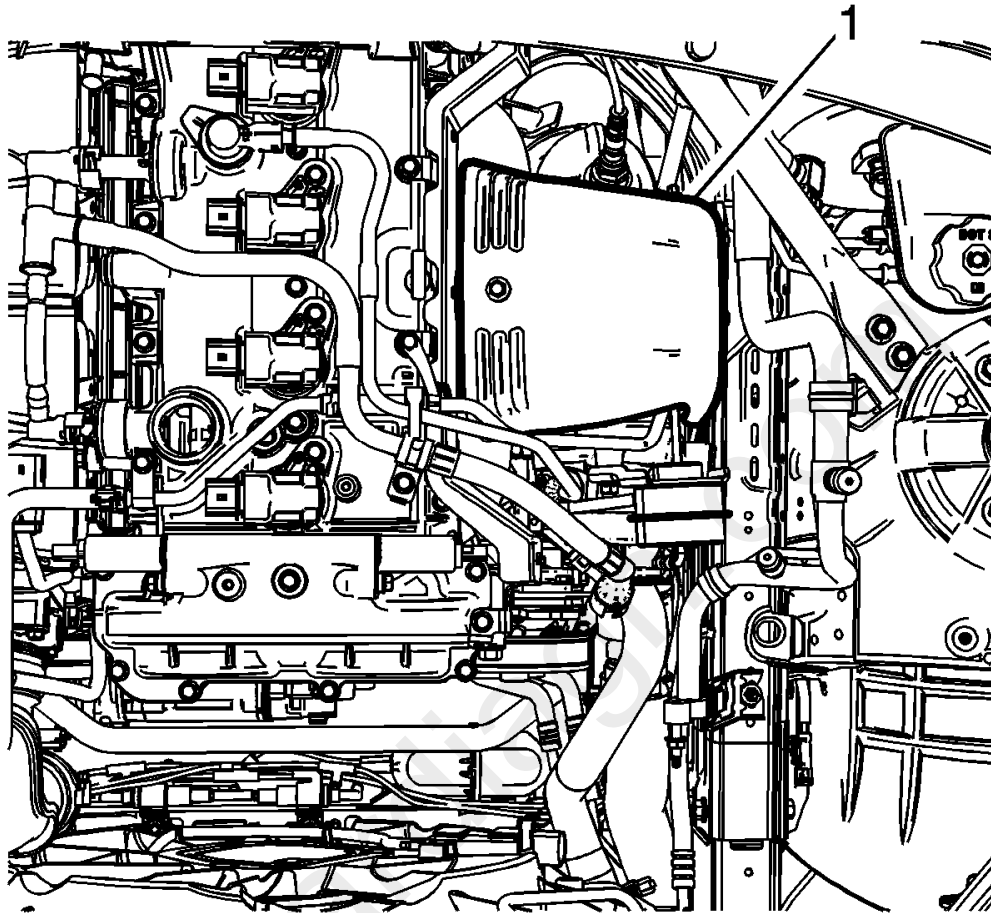


Fig. 29: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

4. Remove the turbocharger heat shield (1). Refer to Turbocharger Heat Shield Replacement.
5. Remove the catalytic converter. Refer to Catalytic Converter Replacement (LTG) .
6. Remove the charger air cooler inlet air tube. Refer to Charge Air Cooler Inlet Air Tube Replacement .

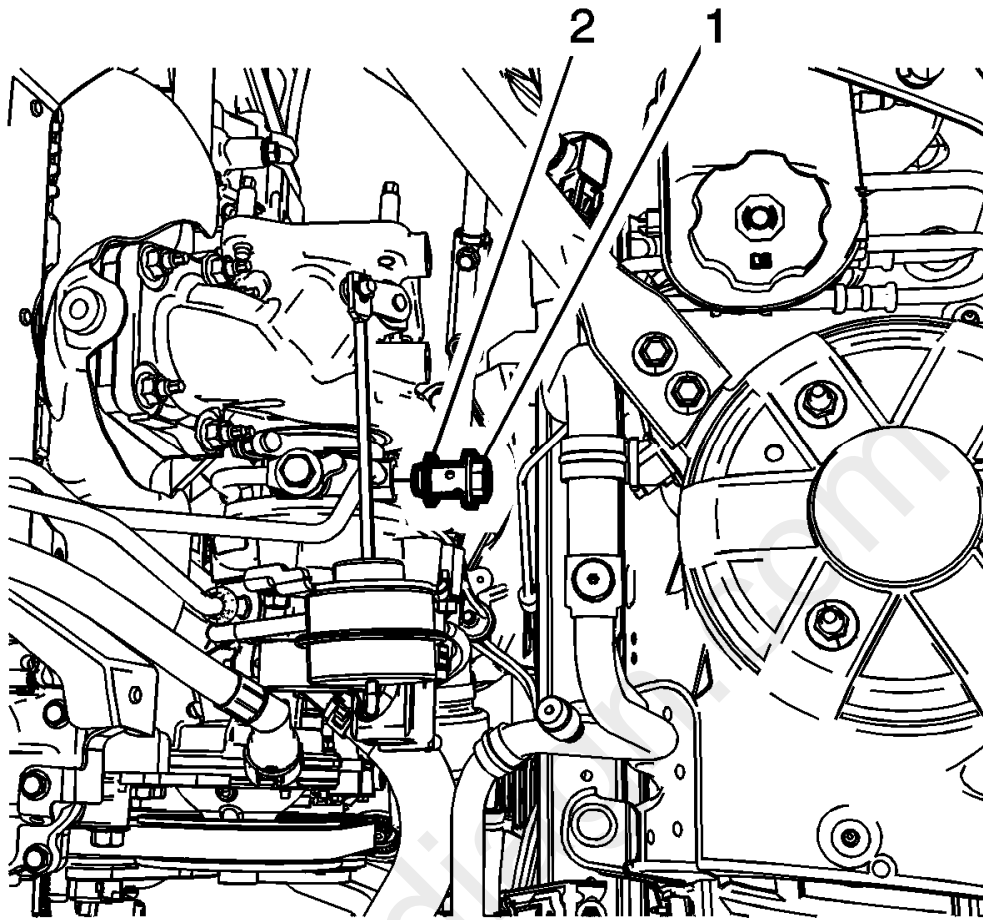


Fig. 30: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger coolant return pipe bolts (1) and DISCARD gasket (2).

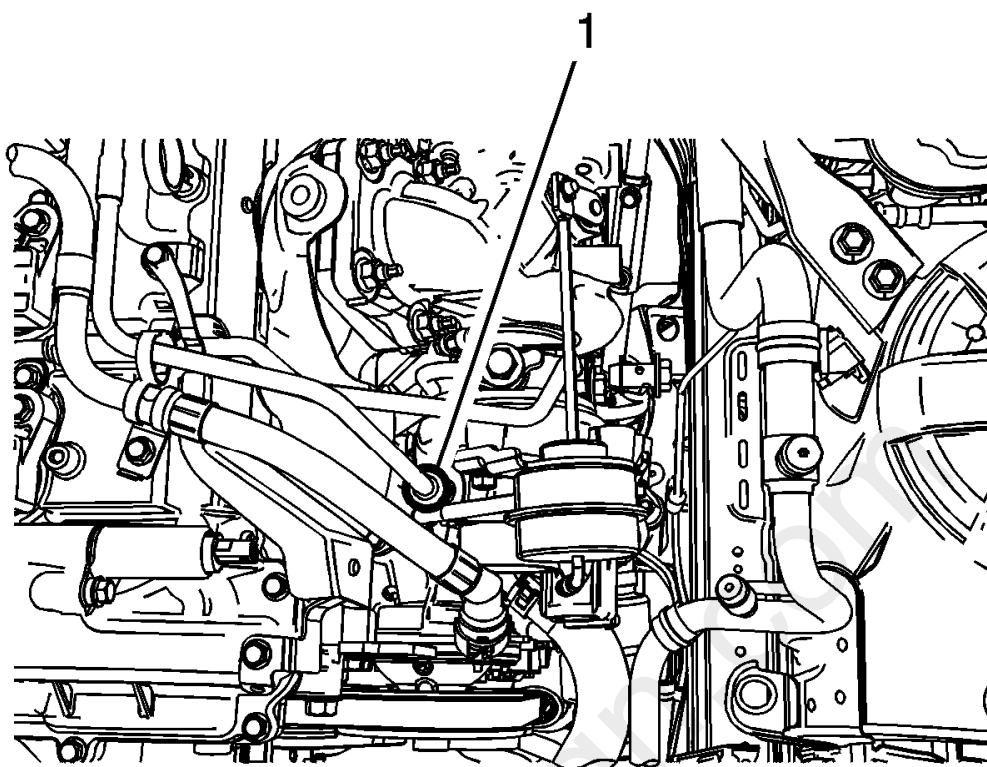


Fig. 31: PCV Hose

Courtesy of GENERAL MOTORS COMPANY

8. Remove the PCV hose (1).

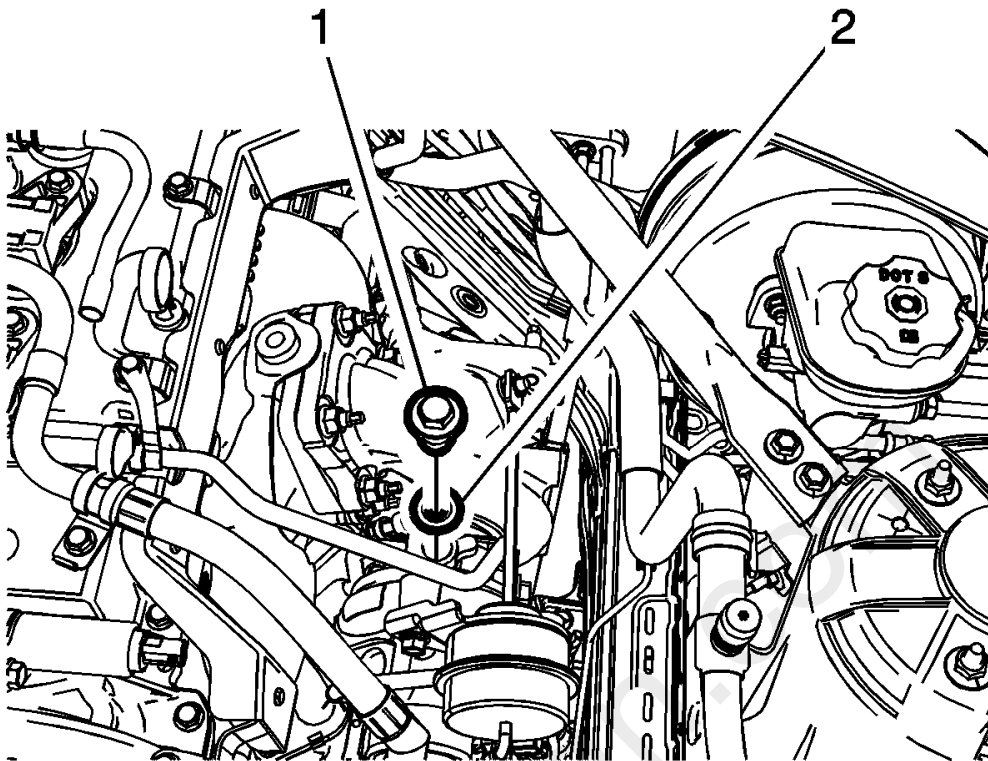


Fig. 32: Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger oil feed pipe bolts (1) and DISCARD gasket (2).

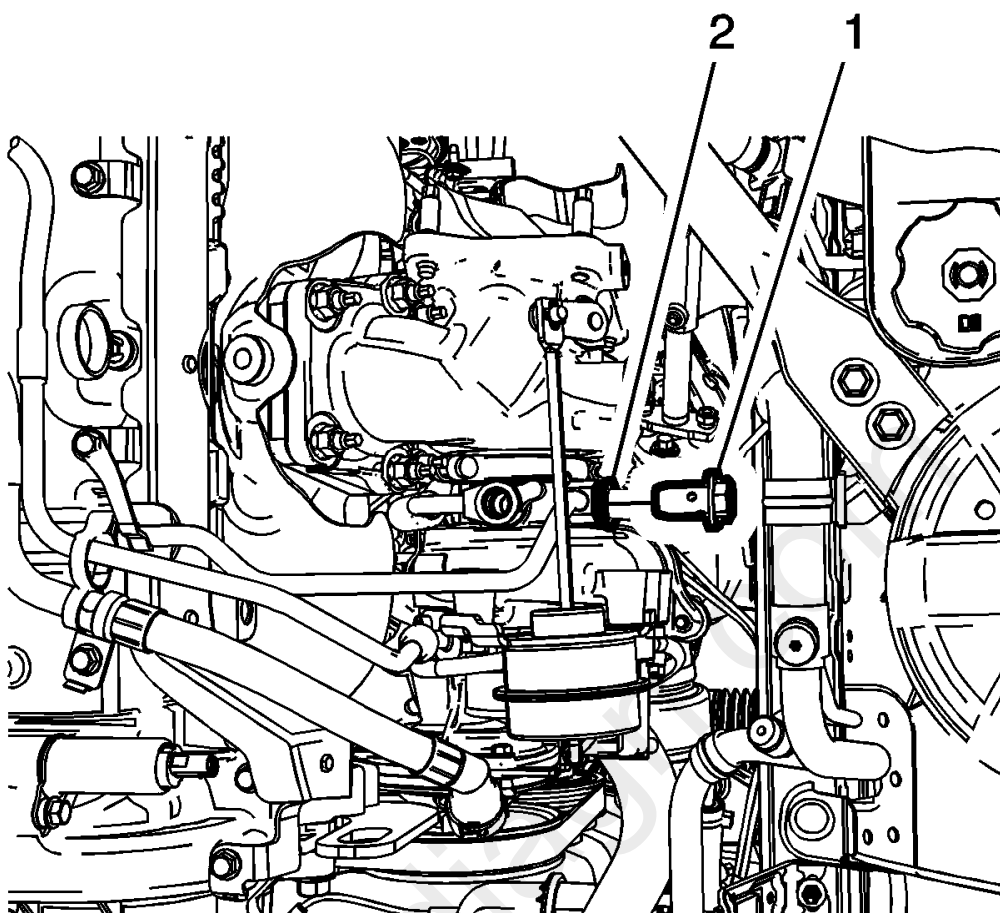


Fig. 33: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Remove the turbocharger coolant return pipe bolts (1) and DISCARD gasket (2).
11. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

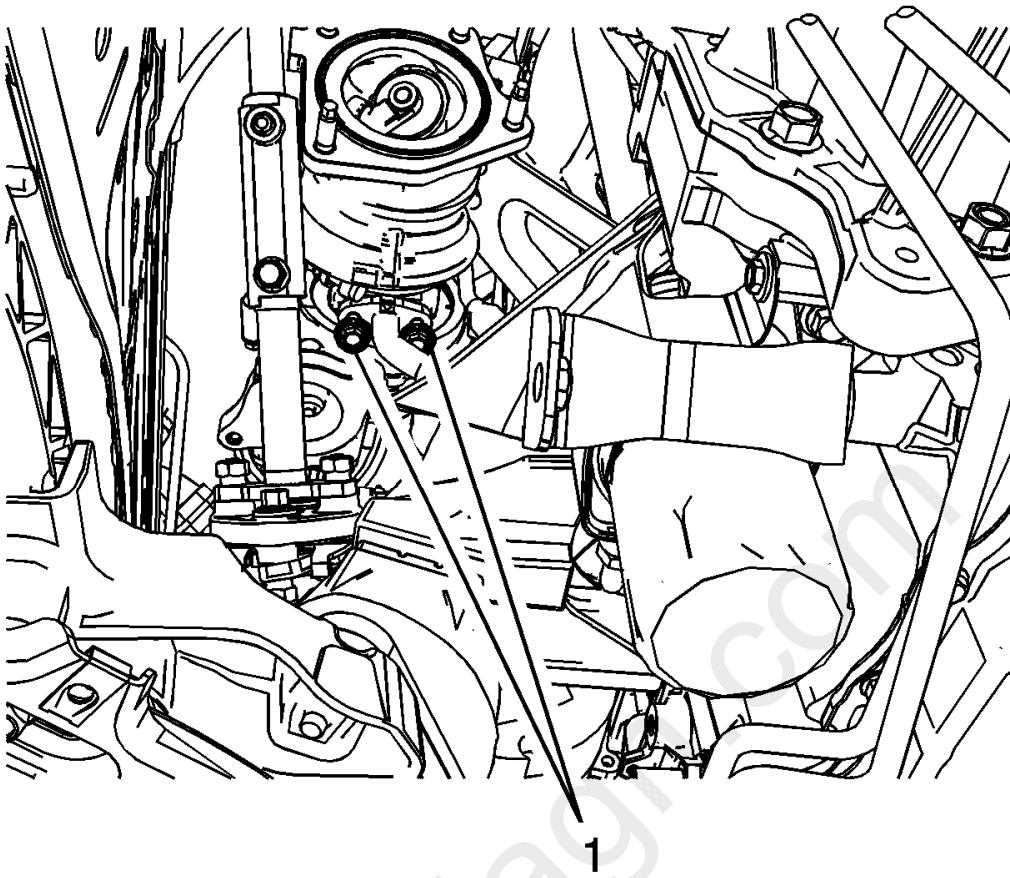


Fig. 34: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

12. Remove the turbocharger oil return pipe bolts (1).
13. Lower the vehicle.
14. Disconnect the electrical connectors at the turbocharger.

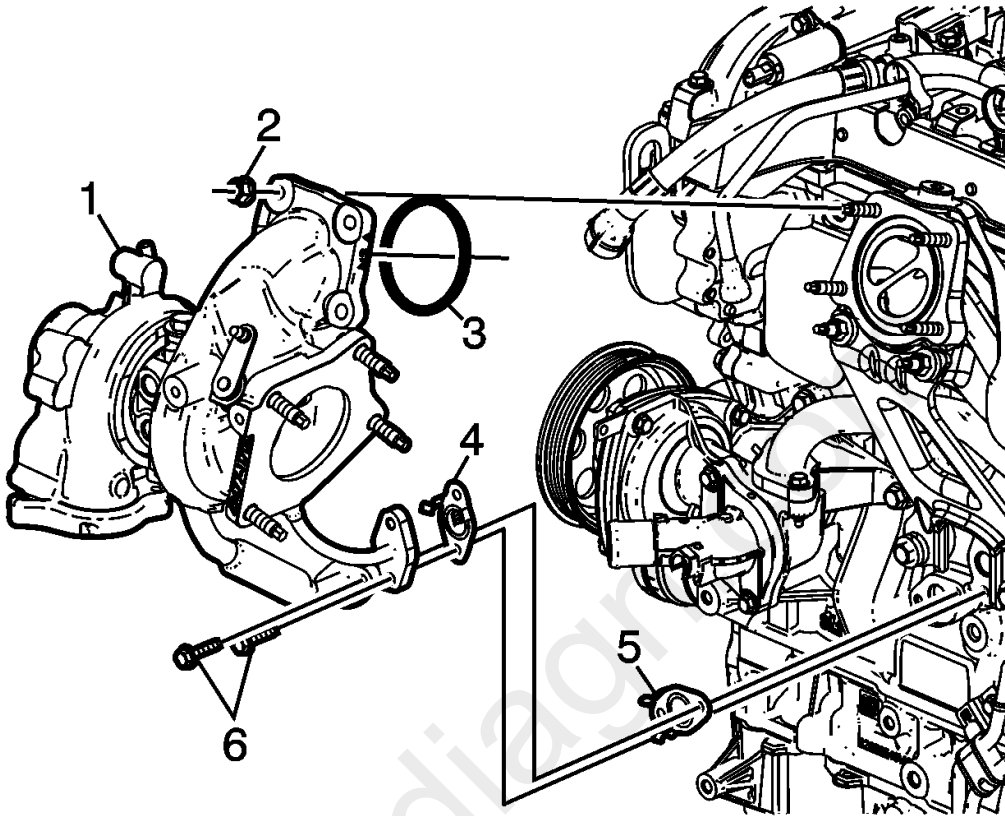


Fig. 35: Turbocharger Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the turbocharger nuts (2) and discard.
16. Remove the turbocharger (1).
17. Remove the turbocharger gasket (3) and discard.
18. For turbocharger cleaning and inspection. Refer to **Turbocharger Cleaning and Inspection** .
19. If replacing the turbocharger, transfer any necessary components.

Installation Procedure

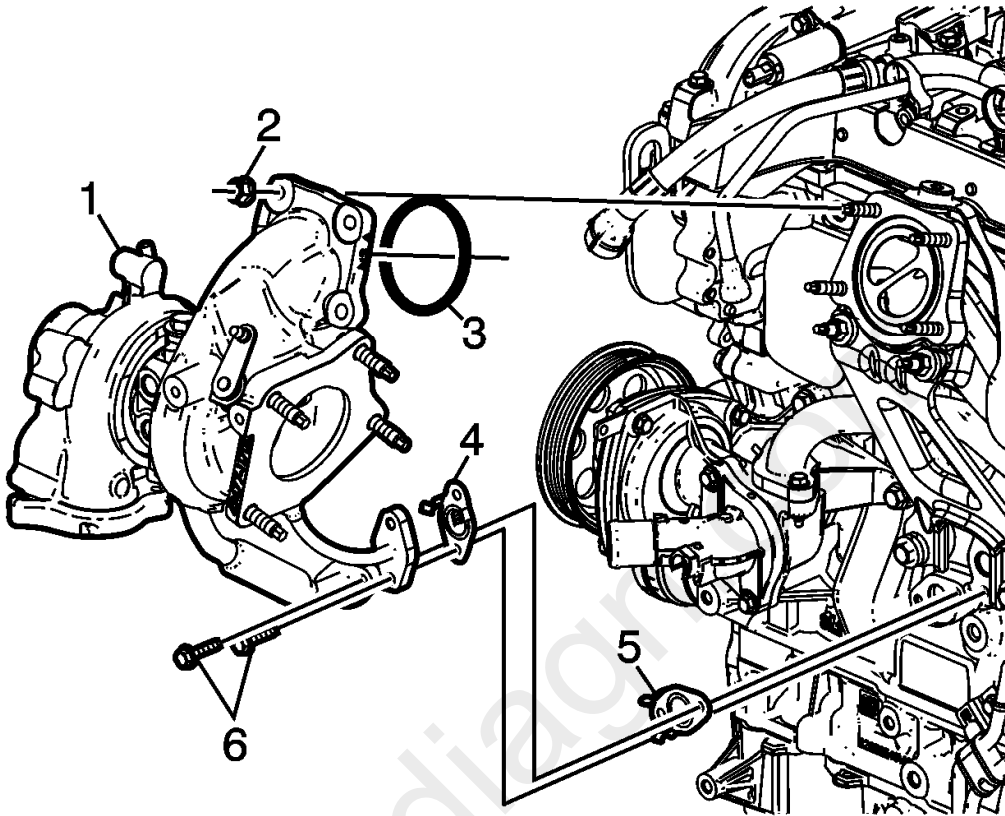


Fig. 36: Turbocharger Nuts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.

1. Install a NEW turbocharger gasket (3) on the turbocharger.
2. Install NEW turbocharger oil feed and oil return pipe gaskets (4, 5).
3. Install the turbocharger (1).
4. Install NEW turbocharger nuts (2) finger tight.

CAUTION: Refer to Fastener Caution .

CAUTION: Refer to Torque-to-Yield Fastener Caution .

5. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. tighten the bolts to 10 (89 lb in).
6. Install the PCV hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.

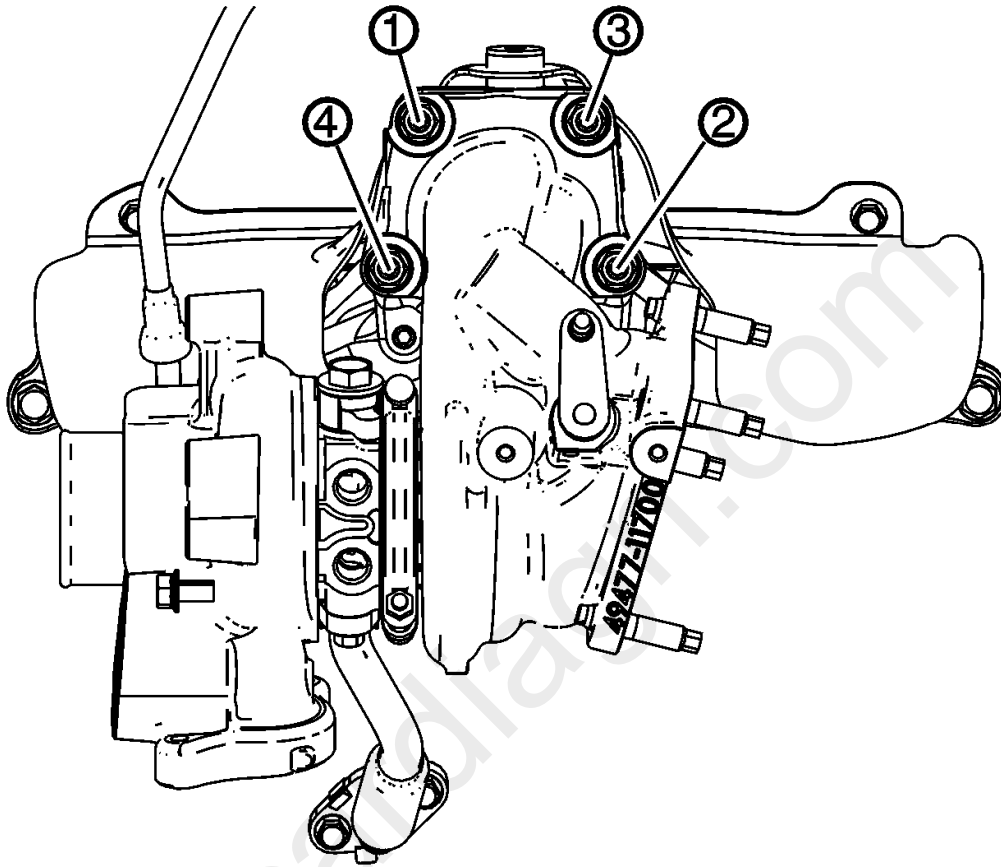


Fig. 37: Turbocharger Nuts In Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the turbocharger nuts in sequence:
 1. First pass 30 (22 lb ft).
 2. Final pass plus 90 degrees.

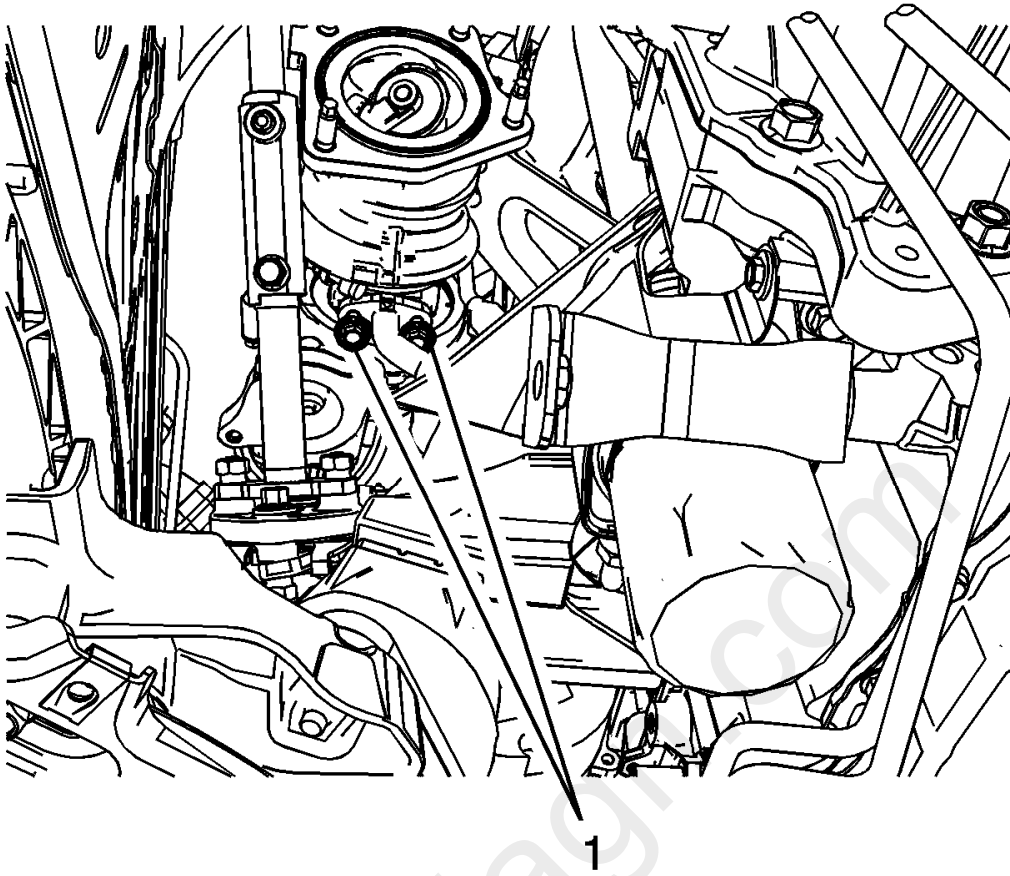


Fig. 38: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Install the turbocharger oil return pipe bolts (1) and a NEW gasket and tighten the bolt to 10 (89 lb in).

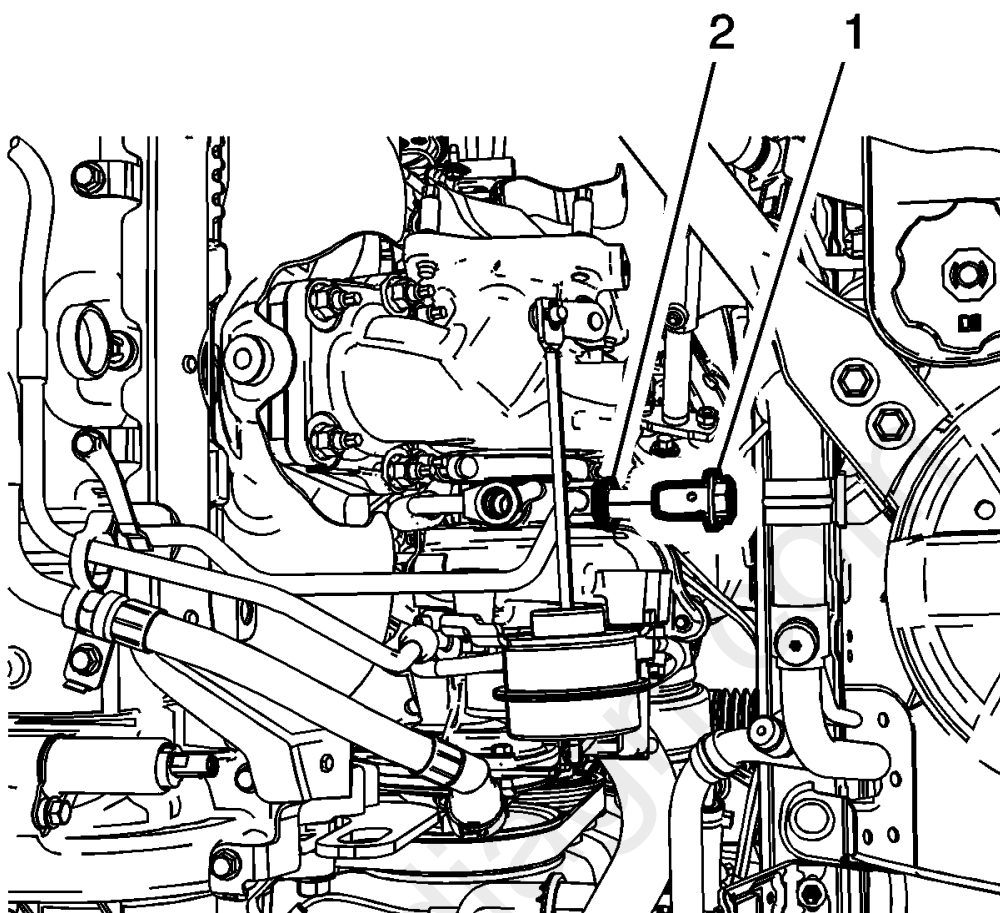


Fig. 39: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Install the turbocharger coolant return pipe bolts (1) and NEW gasket (2) and tighten the bolt to 10 (89 lb in).

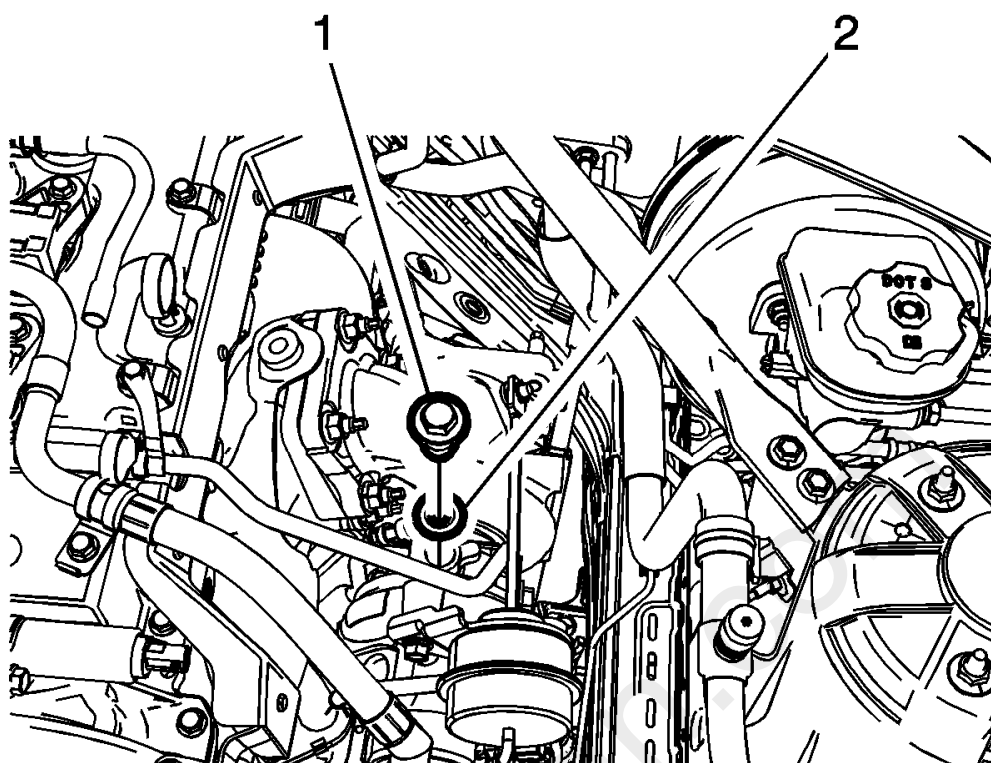


Fig. 40: Turbocharger Oil Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Install the turbocharger oil feed pipe bolts (1) and NEW gasket (2) and tighten the bolt to 10 (89 lb in).

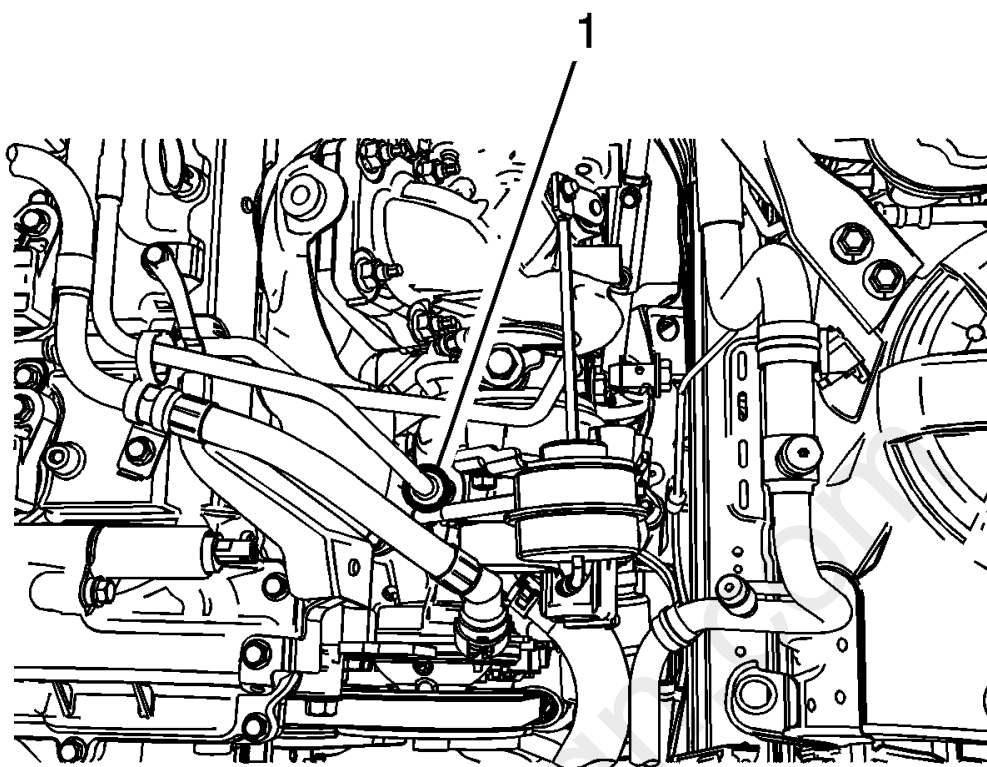


Fig. 41: PCV Hose

Courtesy of GENERAL MOTORS COMPANY

11. Install the PCV hose (1).

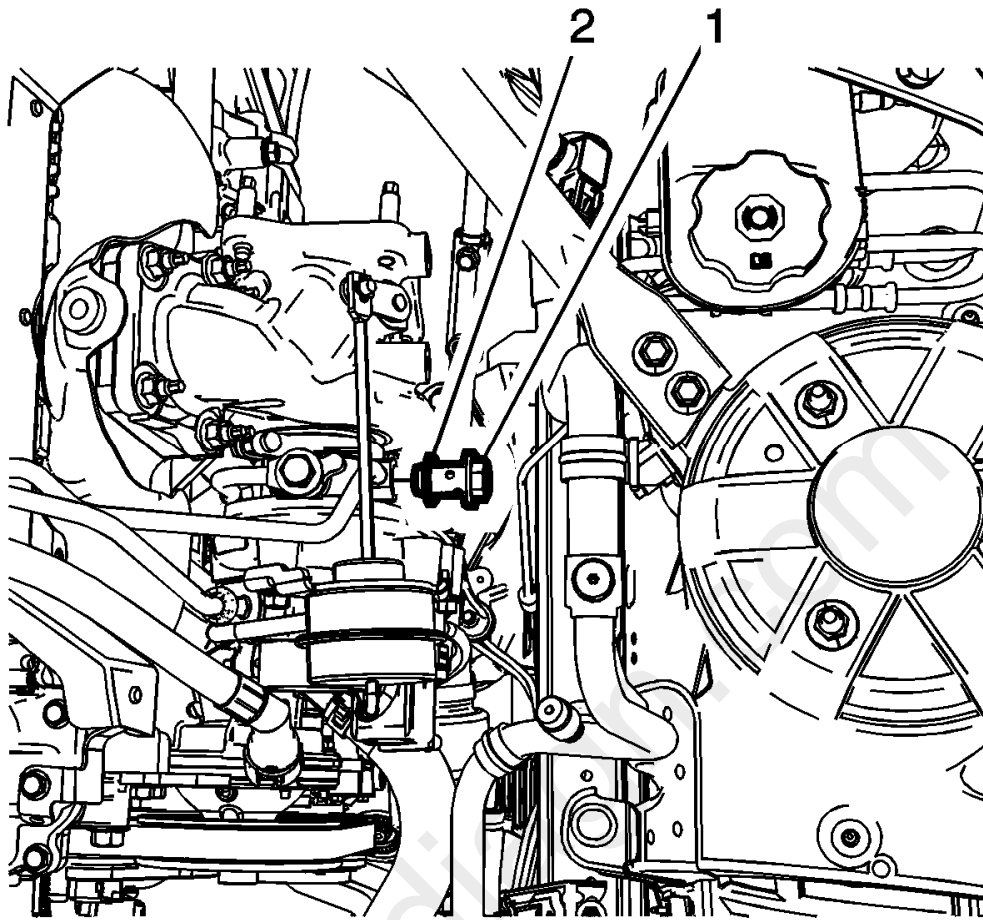


Fig. 42: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

12. Install the turbocharger coolant return pipe bolts (1) and NEW gasket (2) and tighten the bolt to 10 (89 lb in).
13. Connect electrical connectors as necessary.
14. Install the charger air cooler inlet air tube. Refer to **Charge Air Cooler Inlet Air Tube Replacement** .
15. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LTG)** .

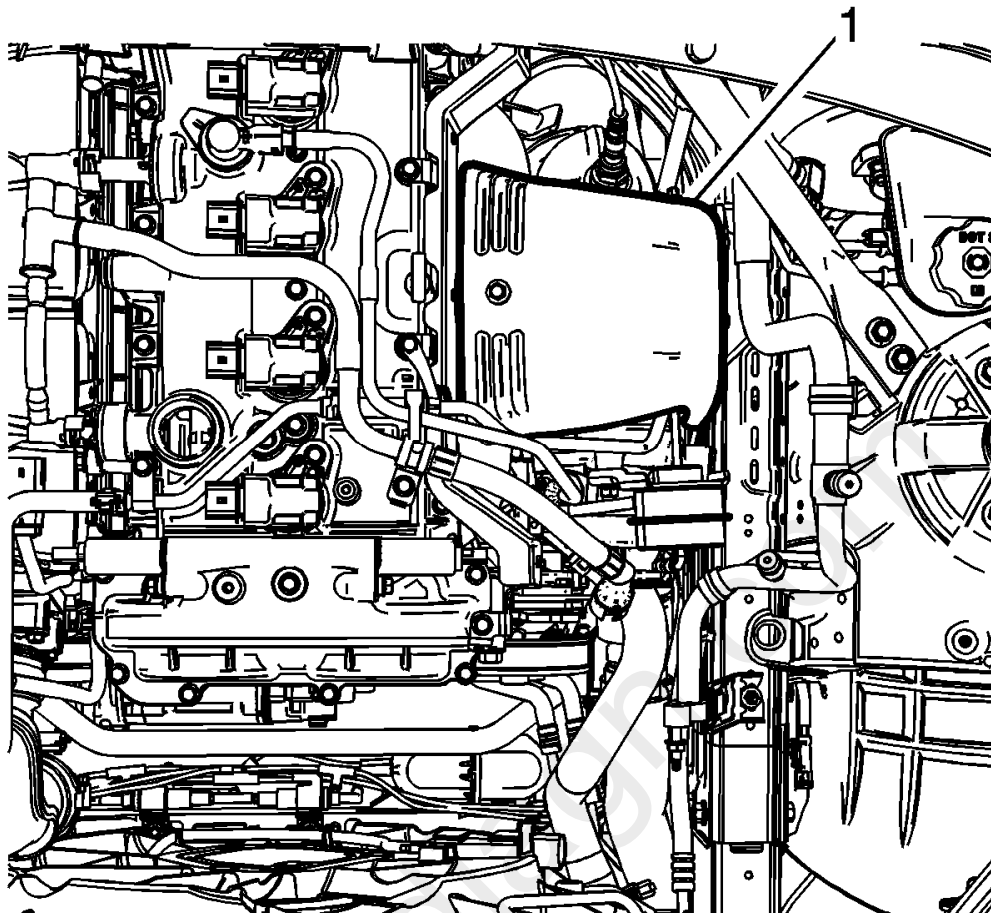


Fig. 43: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

16. Install the turbocharger heat shield (1). Refer to **Turbocharger Heat Shield Replacement**.
17. Fill the coolant system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
18. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
19. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (LTG)

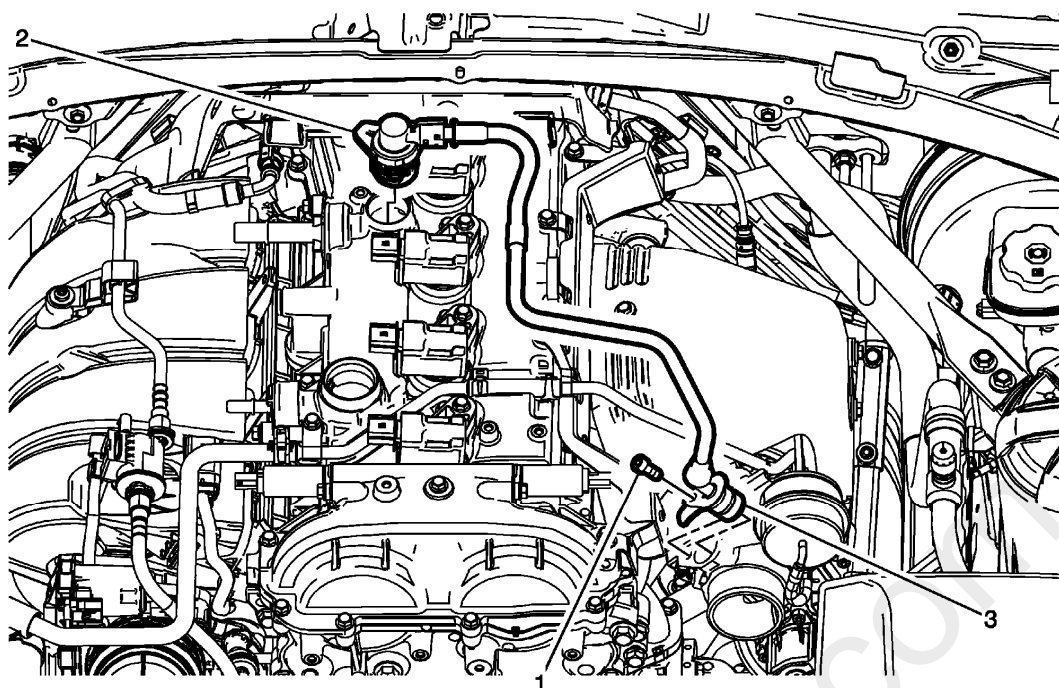


Fig. 44: Positive Crankcase Ventilation Valve
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Valve Replacement (LTG)

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
NOTE: Inspect each component while attached to the camshaft cover. Do not remove the PCV components unless inspection indicates a suspect component. Replace the PCV valve, PCV tube assembly, and PCV hose fitting as an assembly. The connections between these components are permanent.	
1	Positive Crankcase Ventilation Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Positive Crankcase Ventilation Valve Procedure Inspect the PCV valve. If the PCV valve is suspect, use a suitable tool to pry the valve off of the cover. Retrieve any particles that fall onto the baffle in the cover. Discard the valve and particles.

	NOTE: When the PCV valve is removed, small particles of the valve will break and fall into the cover.
3	Positive Crankcase Ventilation Valve

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (FRONT)

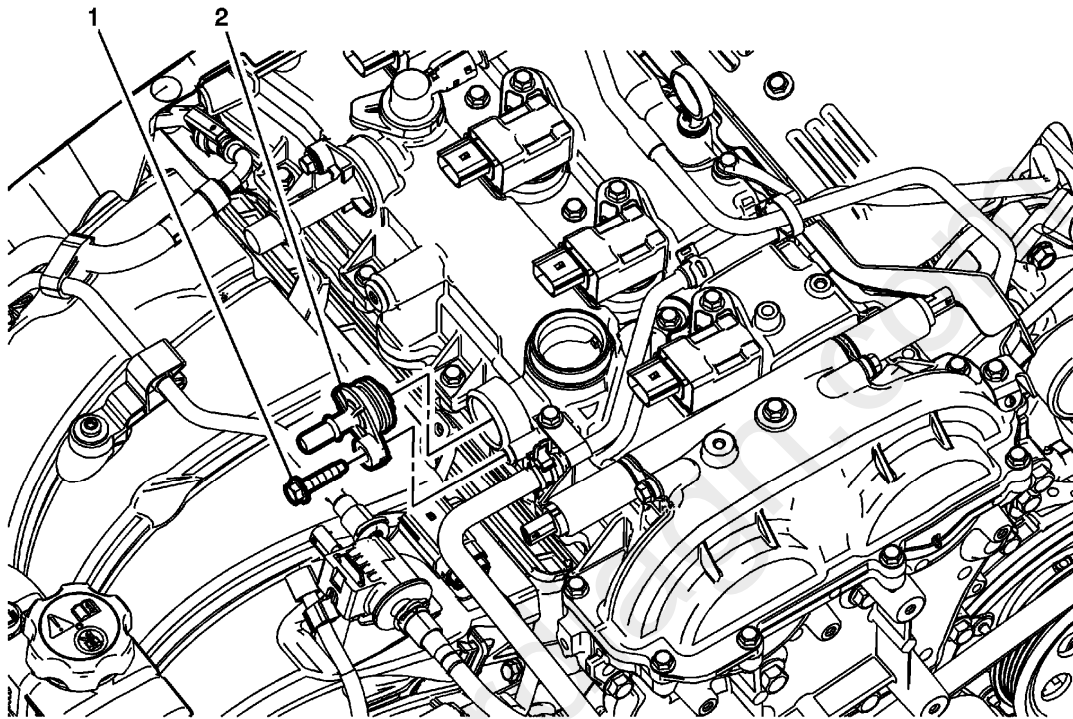


Fig. 45: Positive Crankcase Ventilation Valve (Front)
 Courtesy of GENERAL MOTORS COMPANY

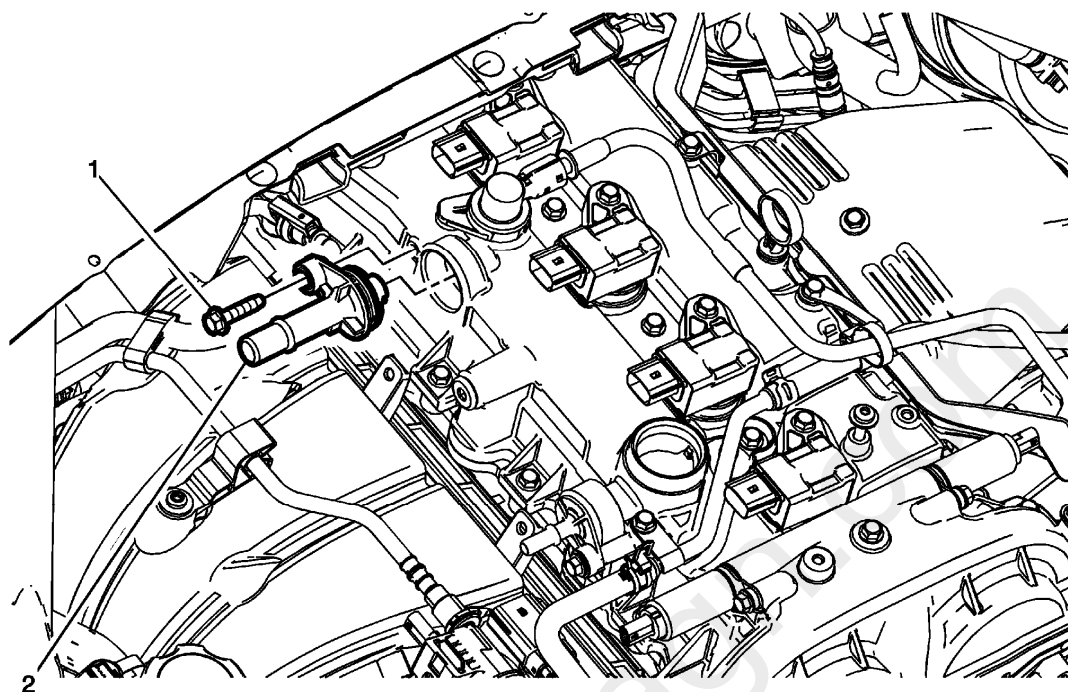
Positive Crankcase Ventilation Valve Replacement (Front)

Callout	Component Name
Preliminary Procedures Remove the positive crankcase ventilation hose. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)</u> .	
1	Positive Crankcase Ventilation Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Positive Crankcase Ventilation Valve

2

Procedure

Inspect each component, O-rings, and fasteners, and replace as necessary.

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (REAR)**Fig. 46: Positive Crankcase Ventilation Valve (Rear)**

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Valve Replacement (Rear)

Callout	Component Name
Preliminary Procedures Remove the positive crankcase ventilation hose. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)</u> .	
1	Positive Crankcase Ventilation Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Positive Crankcase Ventilation Valve Procedure Inspect each component, O-rings, and fasteners, and replace as necessary.

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

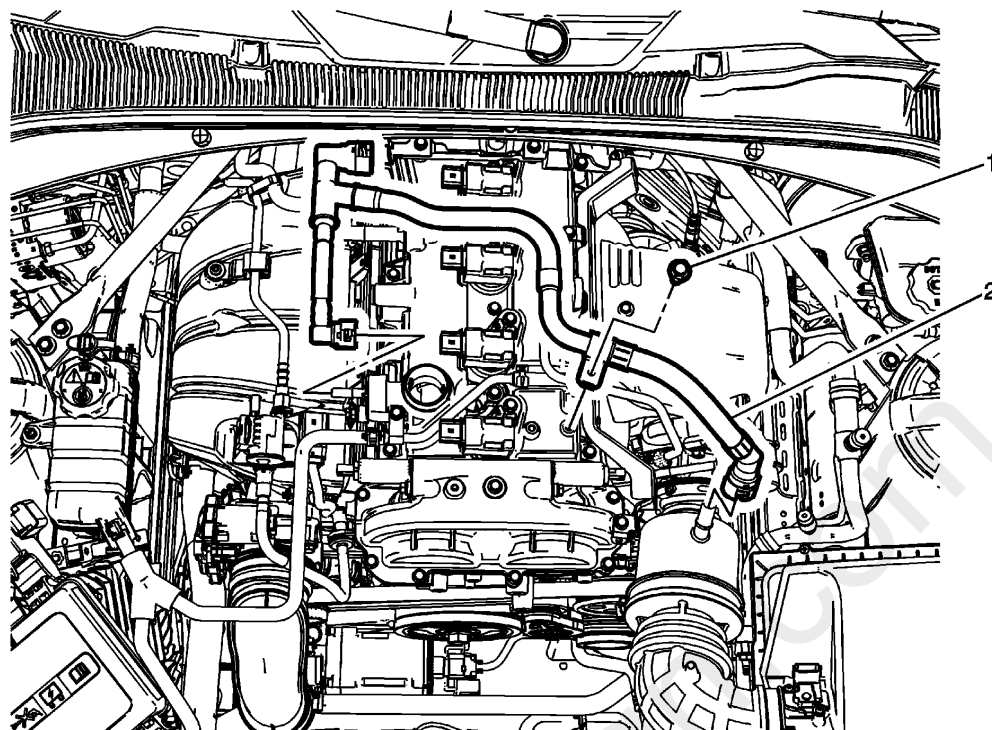


Fig. 47: Positive Crankcase Ventilation Hose/Pipe/Tube
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Positive Crankcase Ventilation Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Positive Crankcase Ventilation Hose

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .
2. Remove the PCV pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.

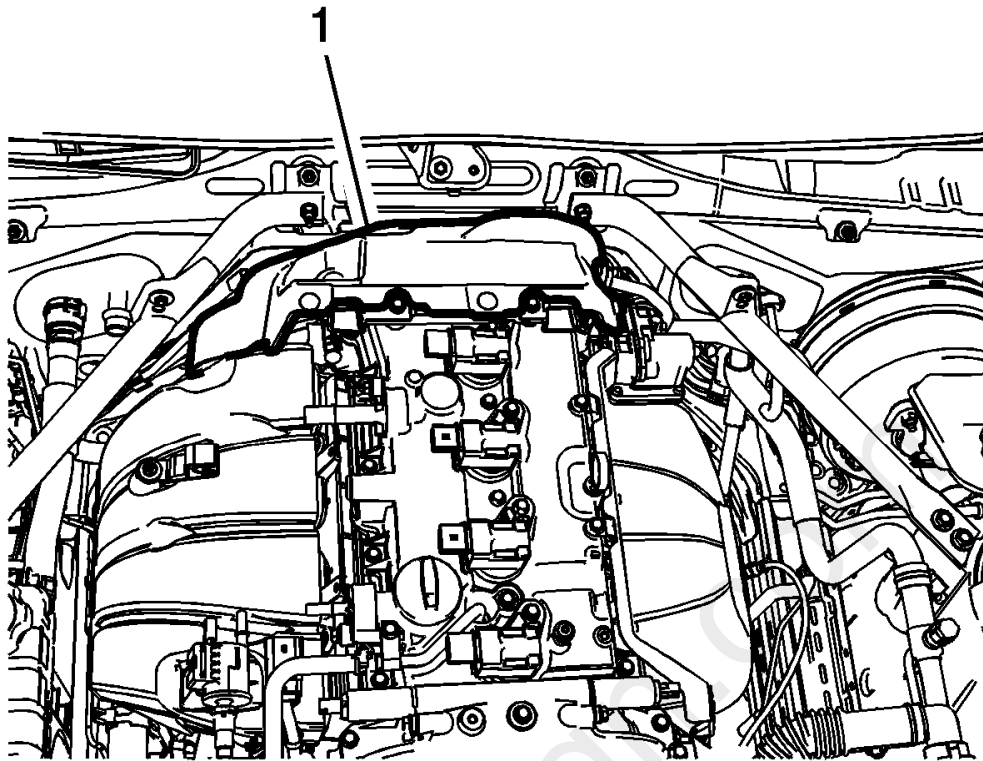


Fig. 48: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement (Inner)** , **Fuel Pump Insulator Replacement (Outer)** .
4. Remove the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
5. Remove the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LTG)** .
6. Remove the generator. Refer to **Generator Replacement (LTG)** .

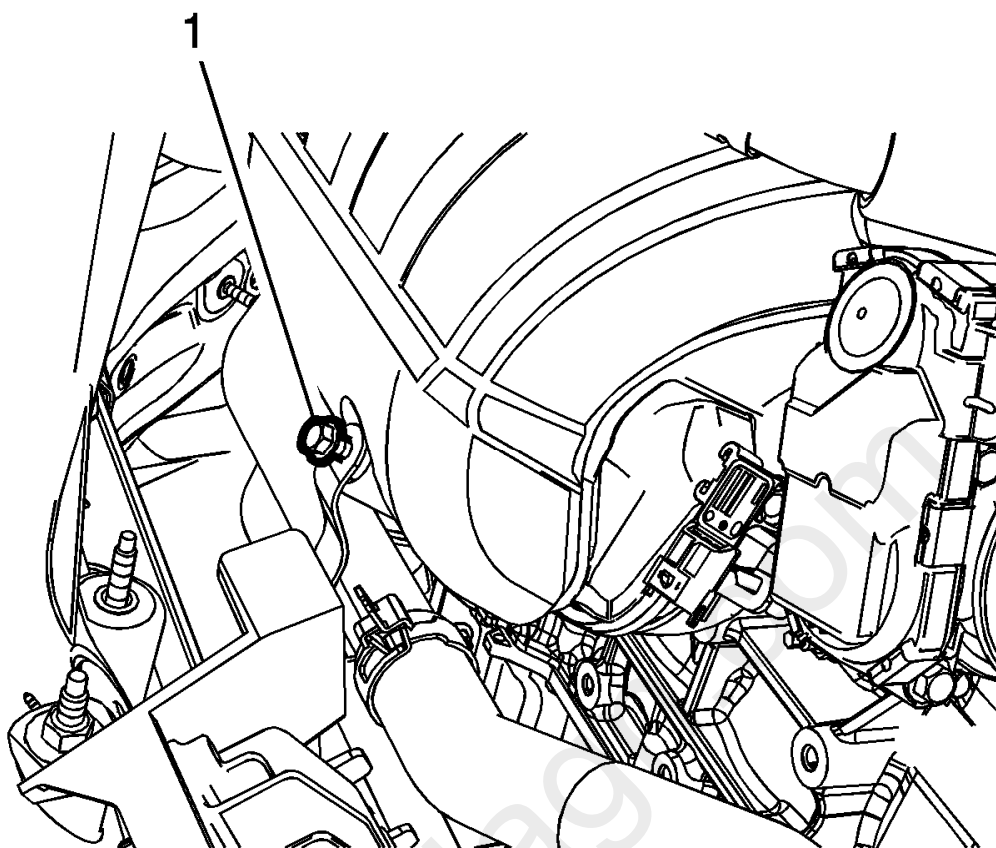


Fig. 49: Radiator Inlet Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Remove the radiator inlet pipe fastener (1).

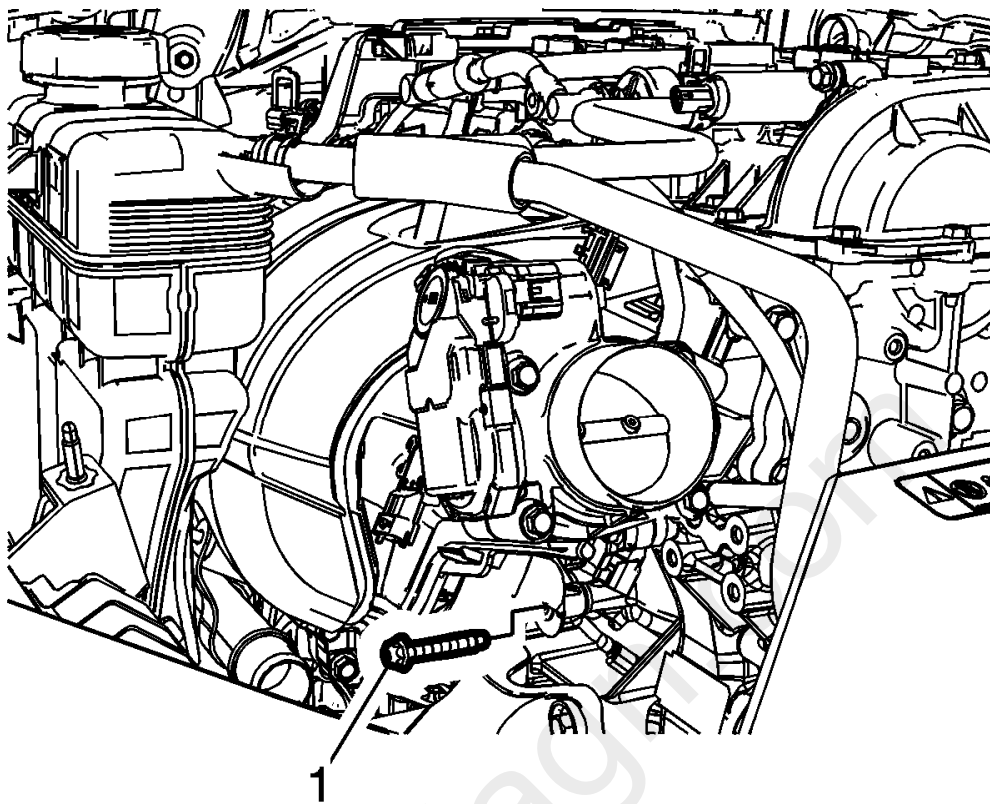


Fig. 50: Lower Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

8. Remove the lower intake manifold fastener (1).
9. Disconnect the wire harness retainers from the intake manifold and reposition the harness aside.
10. Disconnect the vacuum brake booster pipe at the intake manifold.
11. Disconnect the evaporative emission pipe from the intake manifold retainer.
12. If equipped with all-wheel drive, disconnect the front differential vent hose from the retainer at the intake manifold.

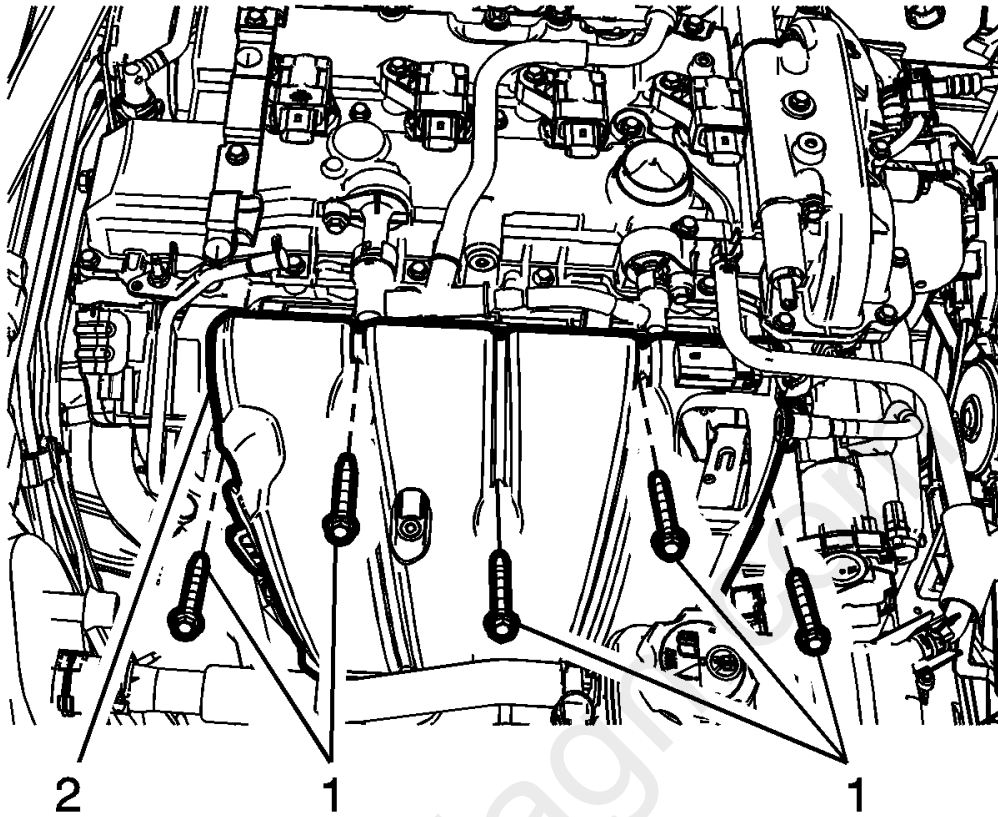


Fig. 51: Upper Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

13. Remove the upper intake manifold fasteners (1).
14. Remove the intake manifold (2) from the vehicle.
15. Disconnect electrical connector as necessary.

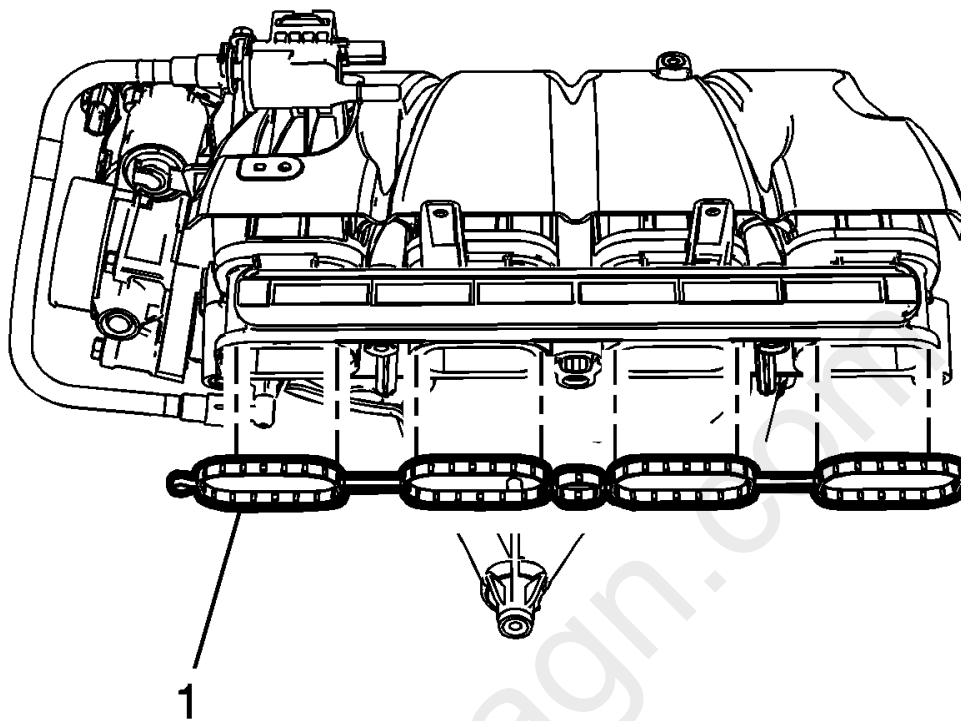


Fig. 52: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

16. Remove the intake manifold gasket (1) and DISCARD.
17. For intake manifold cleaning and inspection. Refer to **Intake Manifold Cleaning and Inspection** .
18. If replacing the intake manifold, transfer all necessary parts.

Installation Procedure

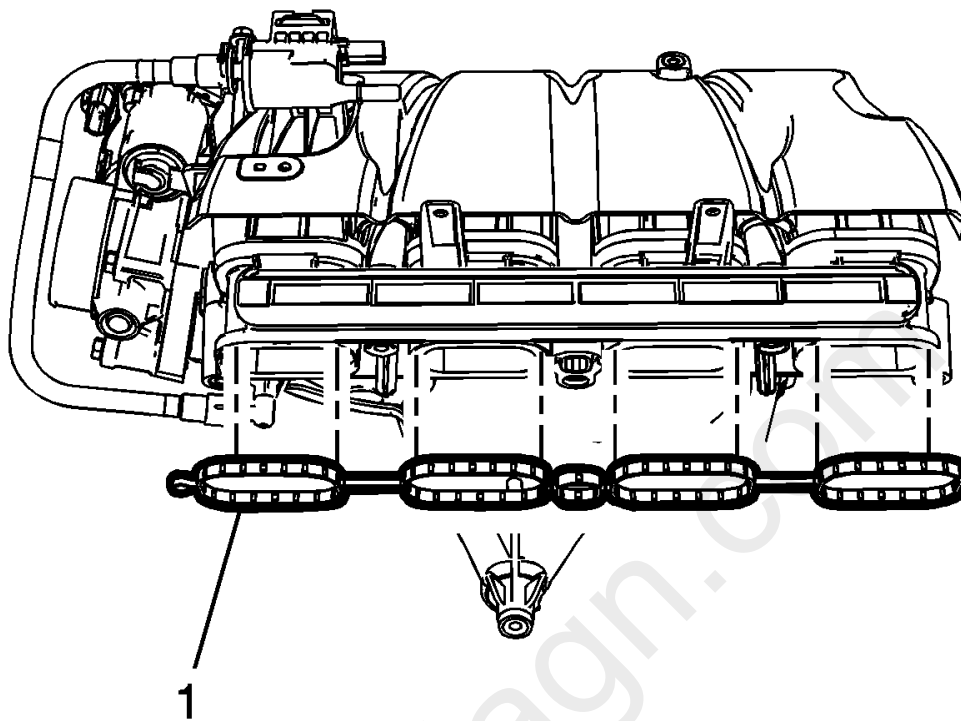


Fig. 53: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold gasket (1).

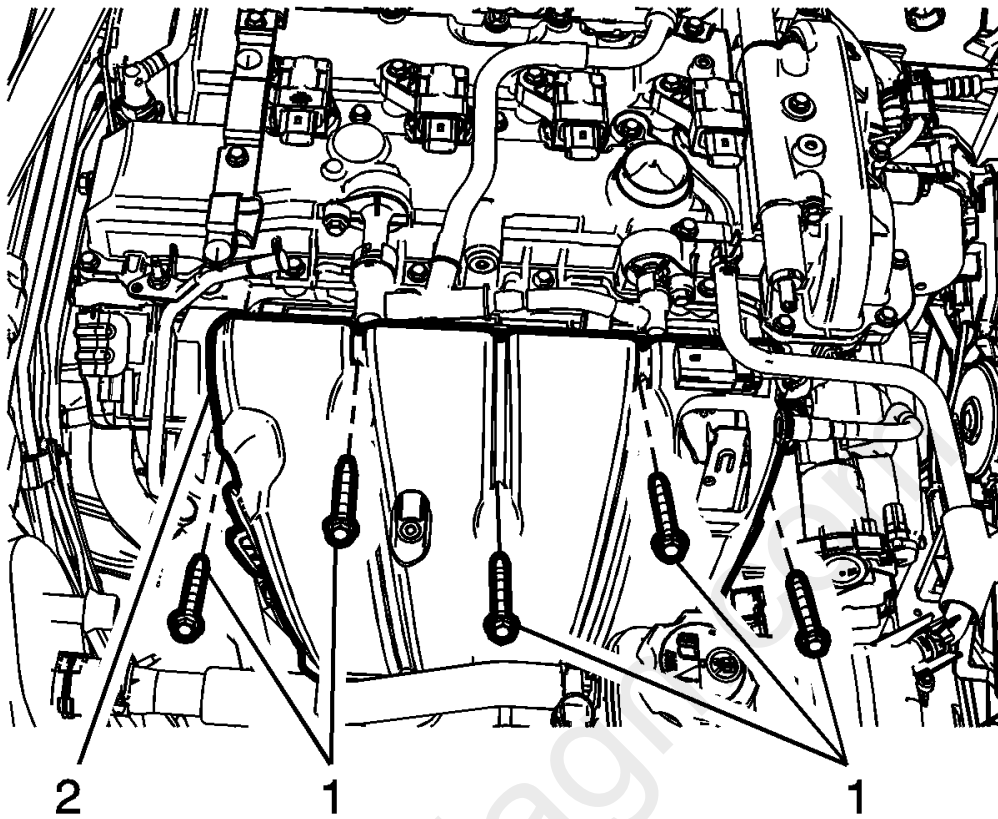


Fig. 54: Upper Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Install the intake manifold upper fasteners (1) and hand tighten.

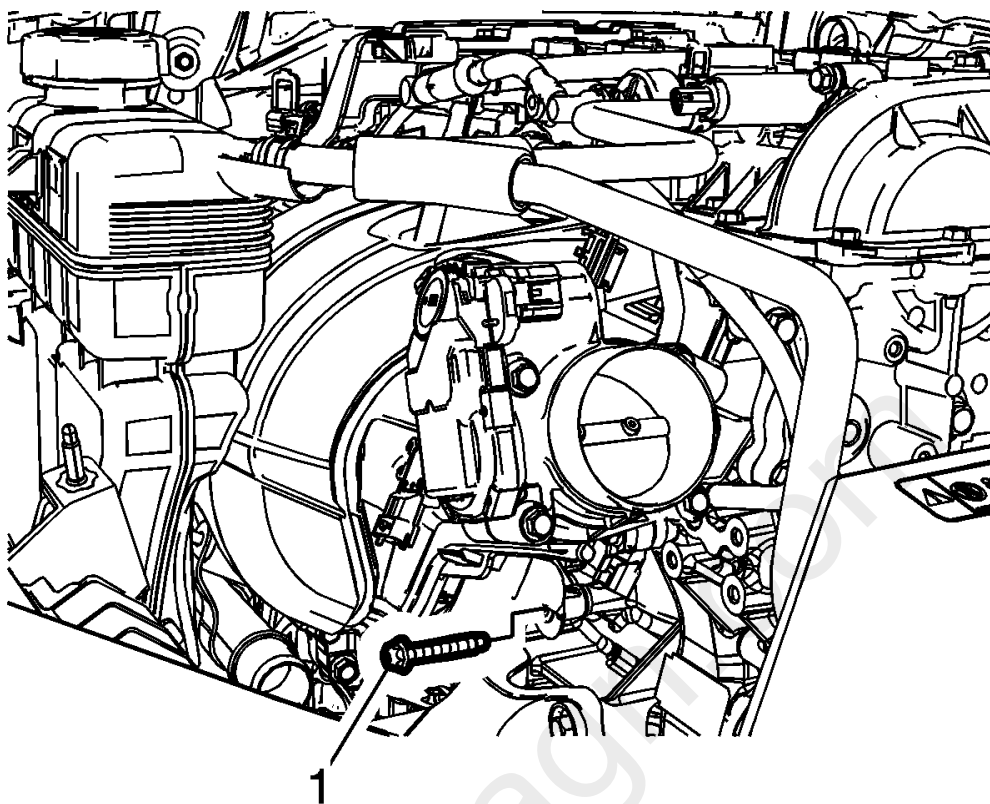


Fig. 55: Lower Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

4. Install the lower intake manifold fastener (1) and hand tighten.

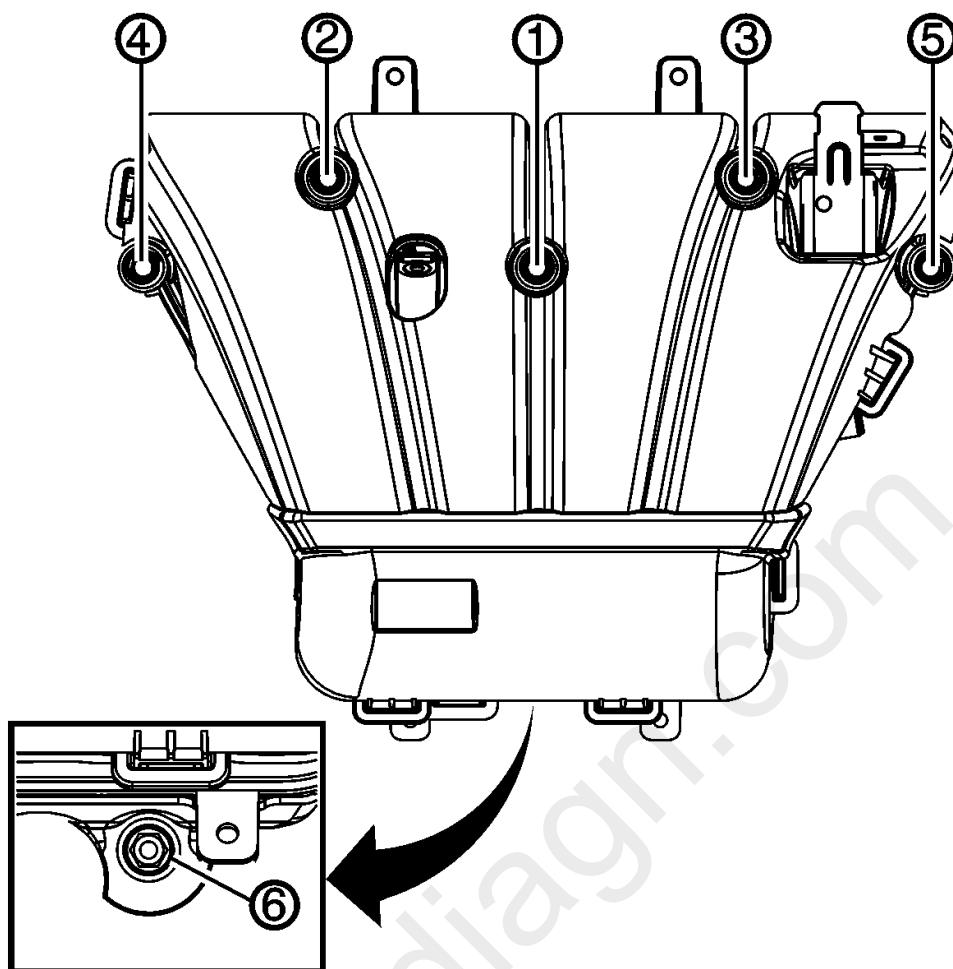


Fig. 56: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the fastener in sequence twice to 12 (106 lb in).

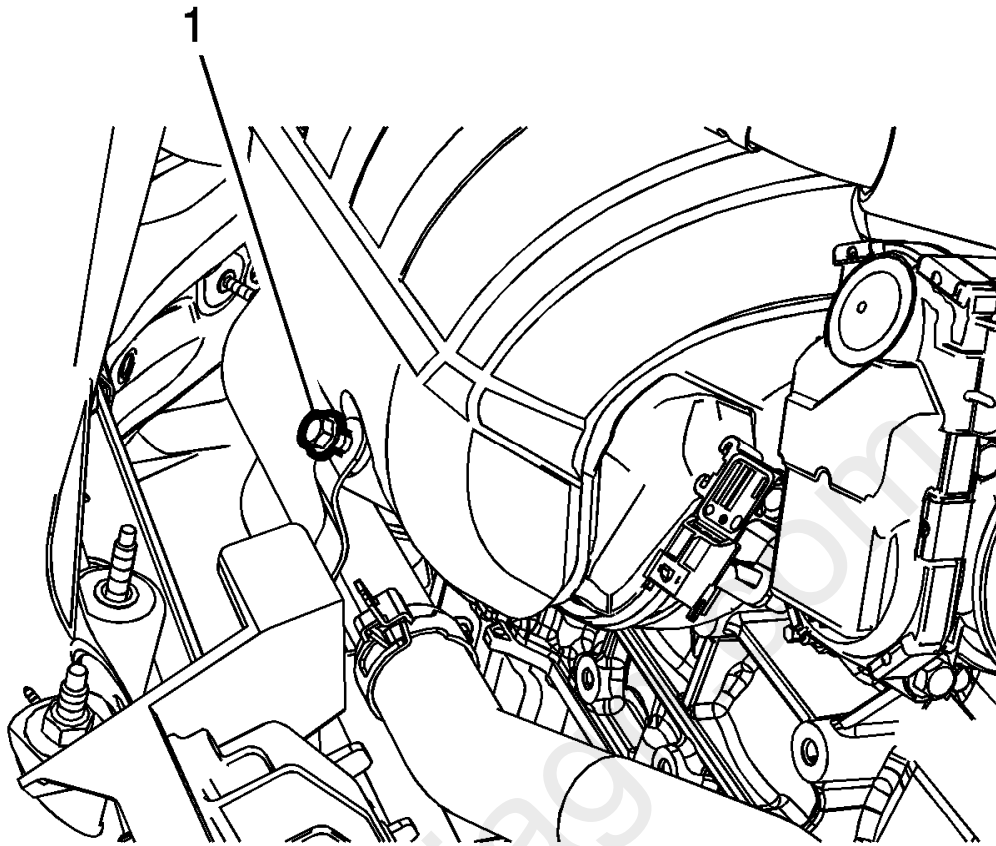


Fig. 57: Radiator Inlet Pipe

Courtesy of GENERAL MOTORS COMPANY

6. Install the radiator inlet pipe fastener (1) and tighten to 10 (89 lb in).
7. Connect the wire harness retainers from the intake manifold and reposition the harness aside.
8. Connect the vacuum brake booster pipe at the intake manifold.
9. Connect the evaporative emission pipe from the intake manifold retainer.
10. If equipped with all-wheel drive, connect the front differential vent hose from the retainer at the intake manifold.
11. Install the generator. Refer to **Generator Replacement (LTG)** .
12. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LTG)** .
13. Install the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

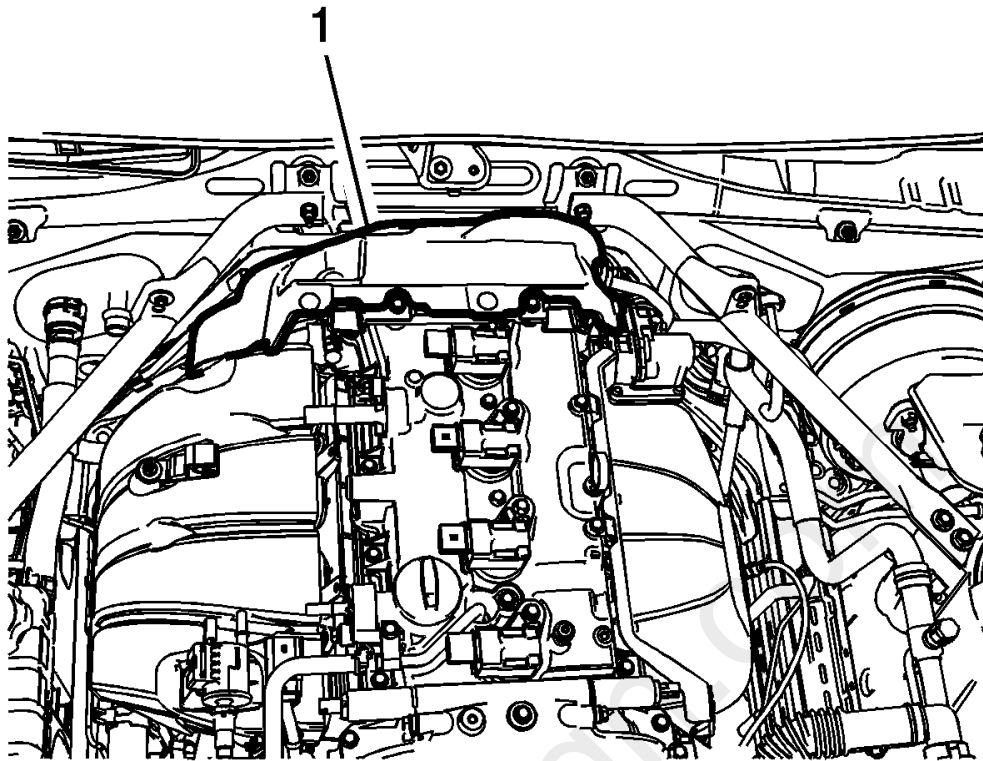


Fig. 58: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement (Inner)** , **Fuel Pump Insulator Replacement (Outer)** .
15. Install the PCV pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.
16. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .

UPPER INTAKE MANIFOLD BRACKET REPLACEMENT

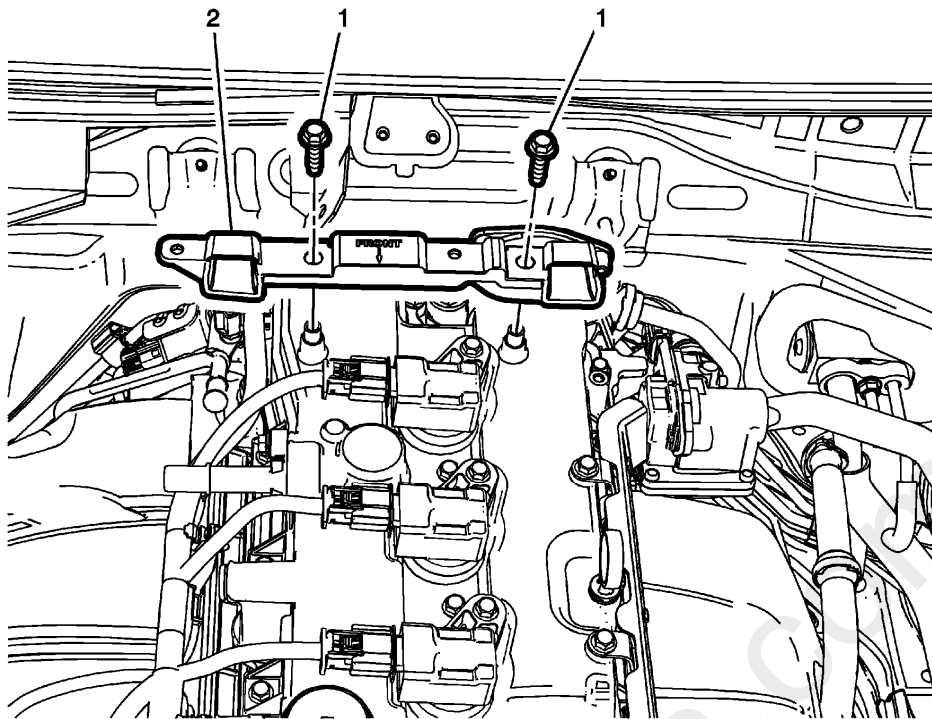


Fig. 59: Upper Intake Manifold Bracket
 Courtesy of GENERAL MOTORS COMPANY

Upper Intake Manifold Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Upper Intake Manifold Bracket Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Upper Intake Manifold Bracket

CRANKSHAFT BALANCER REPLACEMENT

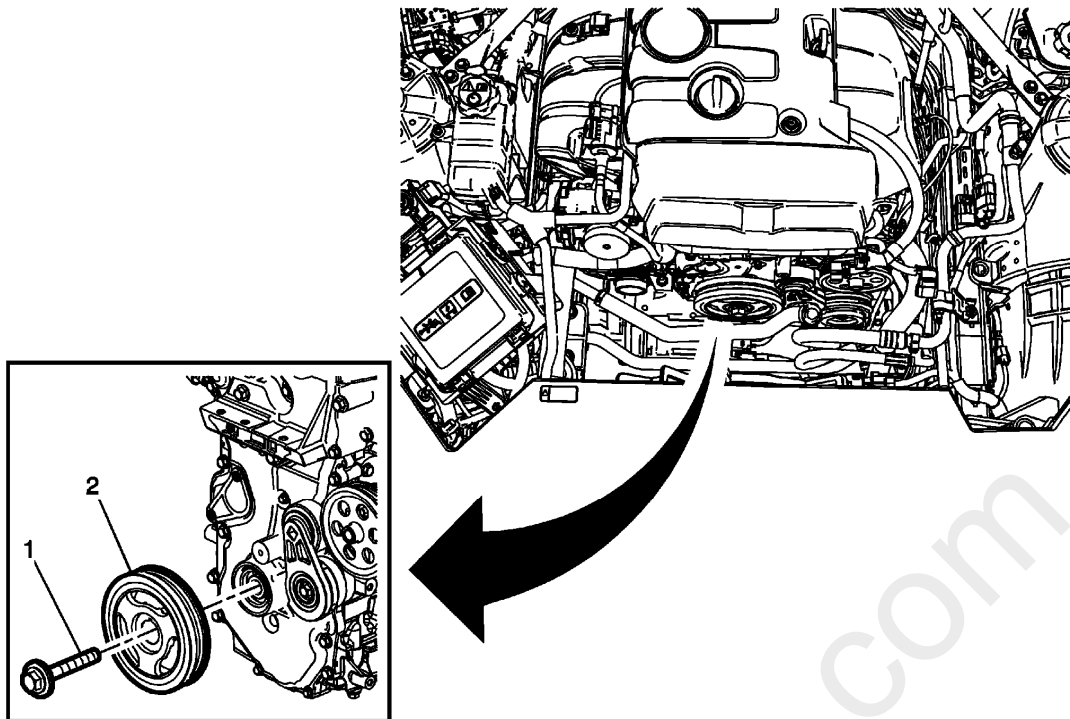


Fig. 60: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Replacement

Callout	Component Name
Preliminary Procedures	
1. Remove the starter. Refer to <u>Starter Replacement (LTG)</u> . 2. Install the EN-50792 Flywheel Holding Tool. 3. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>. 4. Remove the engine fan shroud. Refer to <u>Engine Coolant Fan Shroud Replacement (LTG with V03)</u> , <u>Engine Coolant Fan Shroud Replacement (LTG without V03)</u> .	
Special Tools	
• EN-50792 Flywheel Holding Tool • EN-45059 Angle Meter. • EN-41816 Crankshaft Balancer Remover. • J-38416-A Crankshaft End Protector	
For equivalent regional tools, refer to <u>Special Tools</u> .	
	Crankshaft Bolt
	CAUTION:

	Refer to <u>Fastener Caution</u> . CAUTION: Refer to <u>Torque-to-Yield Fastener Caution</u> . Procedure 1 1. Install the J-38416-A protector to the nose of the crankshaft prior to installing the EN-41816 to remove the balancer. 2. Use the old bolt to seat the balancer. 3. Install a NEW crankshaft bolt and washer. Tighten 150 (111 lb ft) plus 180 degrees.
2	Crankshaft

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

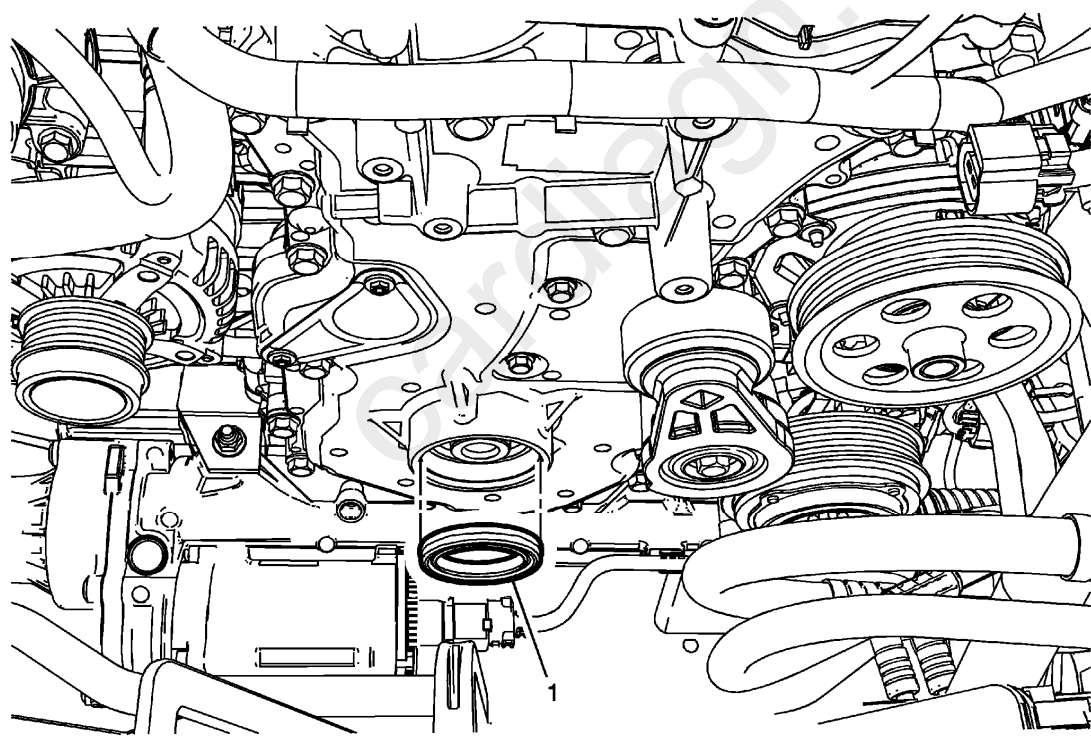


Fig. 61: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Replacement

Callout	Component Name

Preliminary Procedure

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

1	Front Crankshaft Seal Procedure 1. Use a suitable tool to remove the front cover oil seal. 2. Use the EN 50820 Front Crankshaft Seal Installer to install the seal. Special Tools EN 50820 Front Crankshaft Seal Installer For equivalent regional tools, refer to <u>Special Tools</u> .
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ENGINE FRONT COVER REPLACEMENT**Removal Procedure****Special Tools**

EN-50820 Front Crankshaft Seal Installer

KM-470-B Angular Torque Gauge

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

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

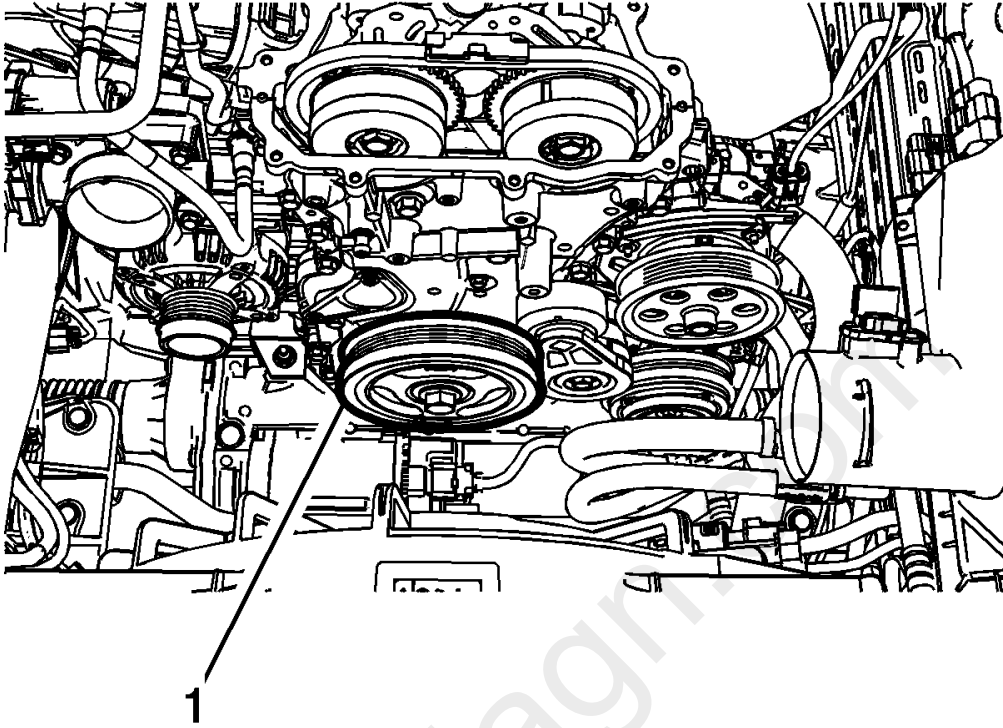


Fig. 62: Crankshaft Balancer

Courtesy of GENERAL MOTORS COMPANY

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

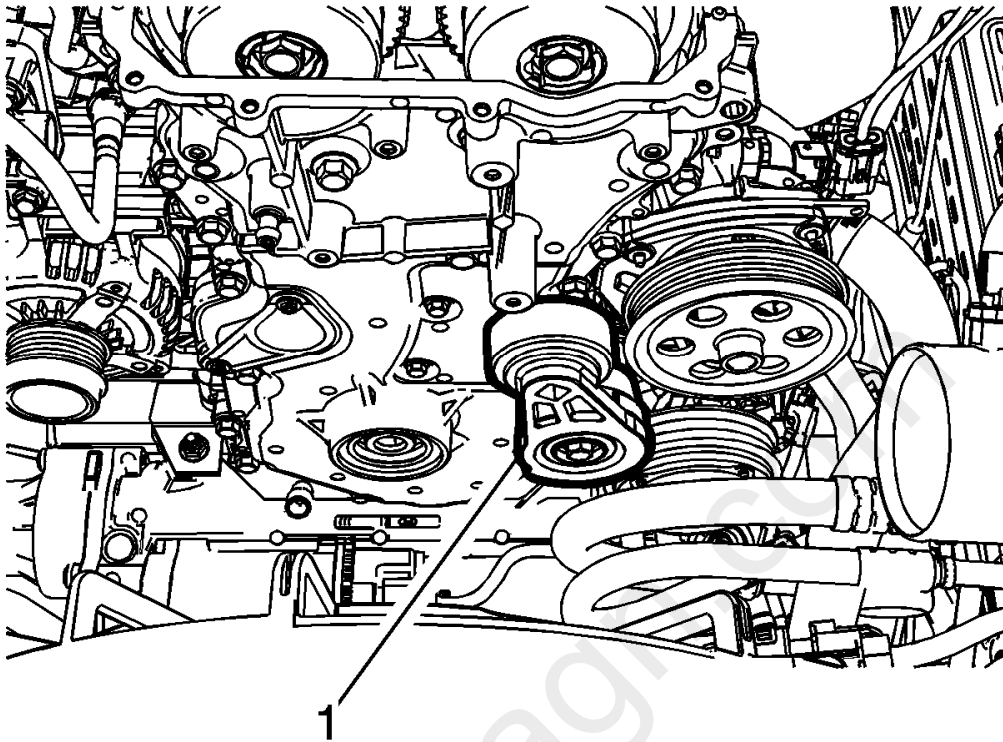


Fig. 63: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. Remove the drive belt tensioner (1). Refer to **Drive Belt Tensioner Replacement**.
4. Disconnect the wire harness retainers from the front cover.

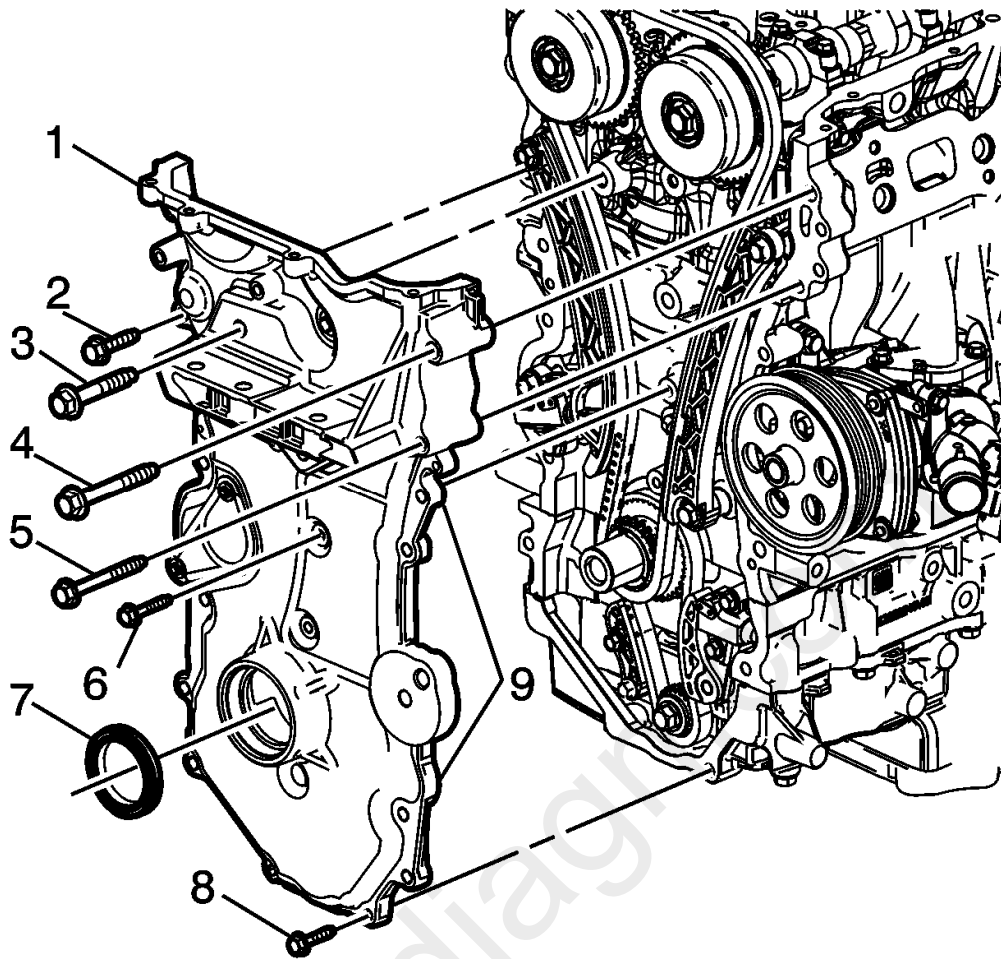


Fig. 64: Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine front cover bolts (2-6, 8).
6. Remove the engine front cover (1).
7. Remove the front oil seal (7) with an appropriate tool.
8. Clean the engine block and cylinder head to front cover sealing surfaces.
9. Clean the front cover sealing surface.

Installation Procedure

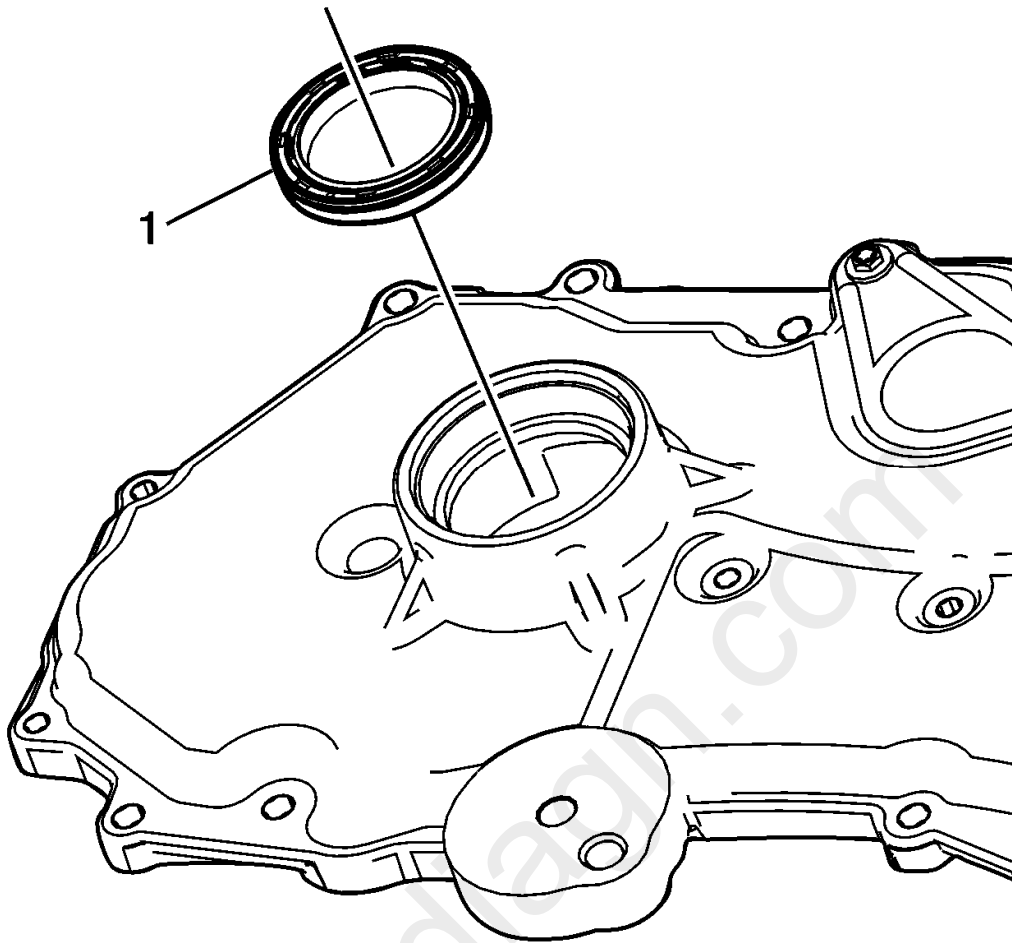


Fig. 65: Front Crankshaft Seal
Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-50820** installer , install the front crankshaft seal (1) into the engine front cover.

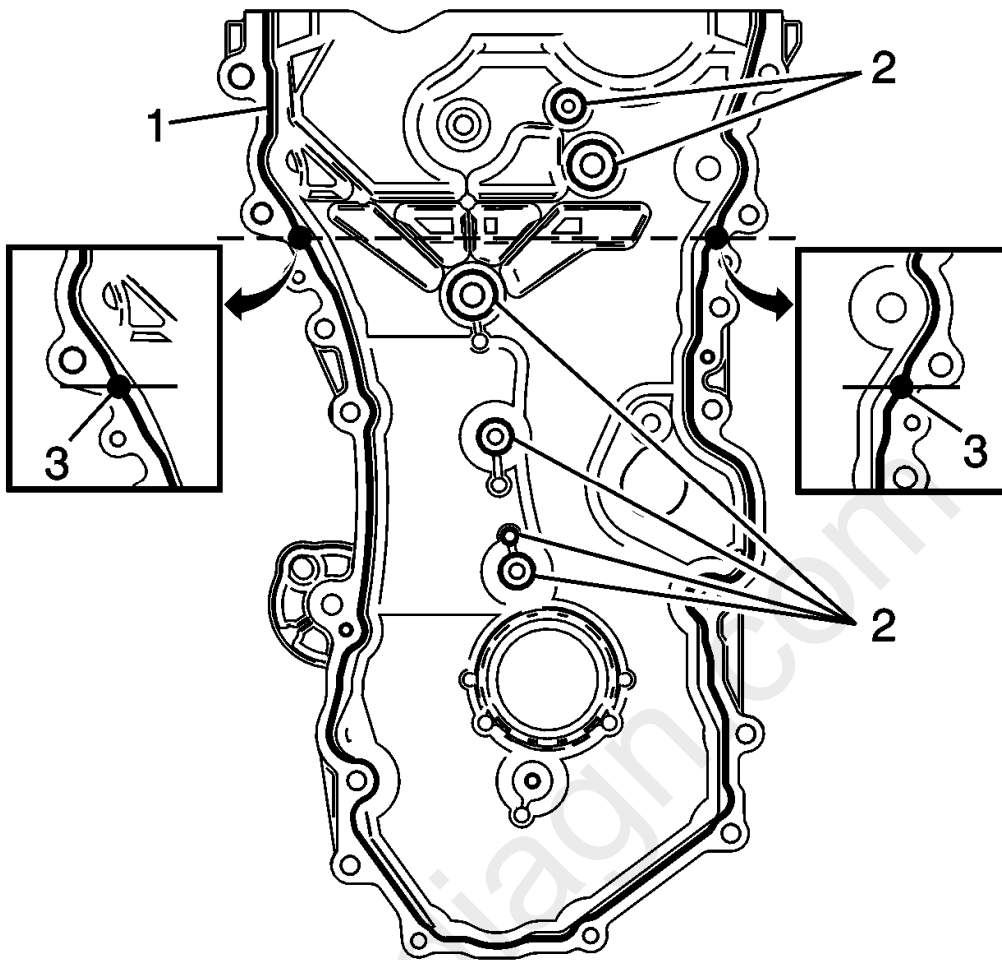


Fig. 66: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The engine front cover surface must be free of contamination prior to applying the sealer.
- Install and align the cover within 20 minutes of applying the sealer.
- The cover must be fastened to final torque specification within 60 minutes of applying the sealer.
- Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.

2. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

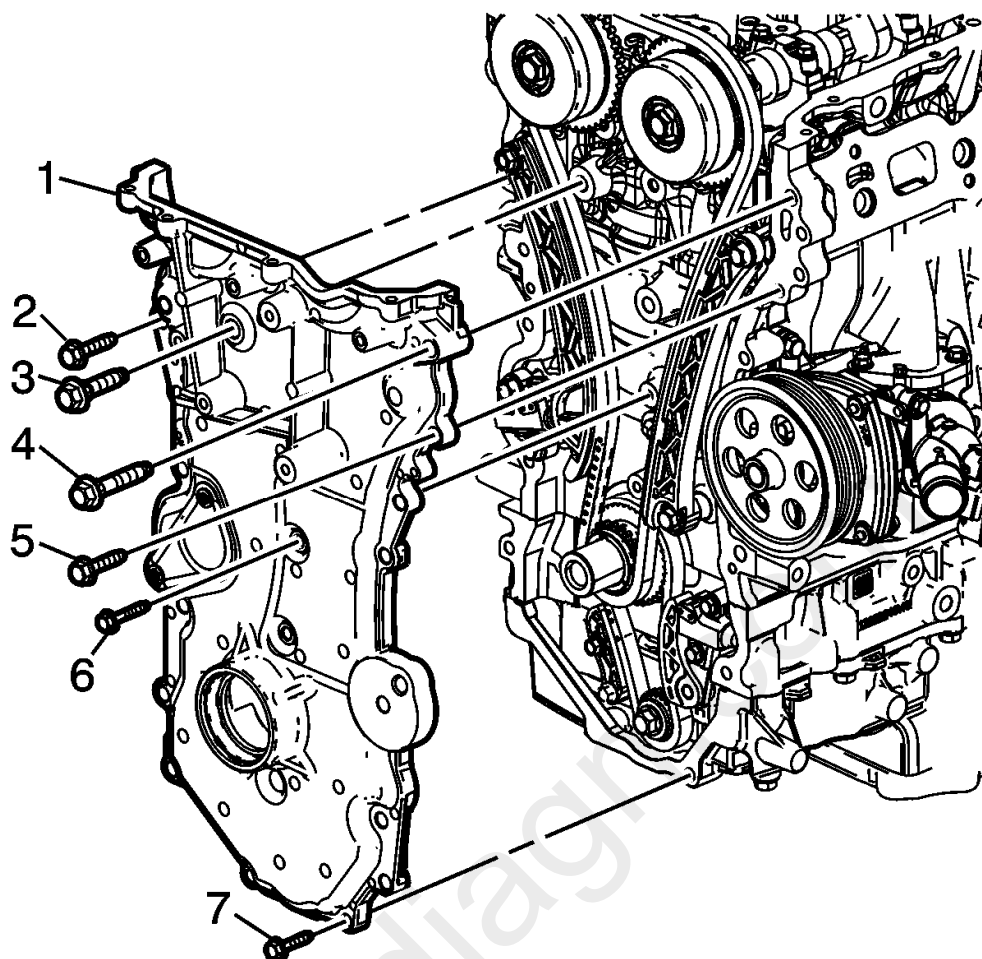


Fig. 67: Exploded View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine front cover (1).
4. Hand start the engine front cover bolts (2-6, 7).

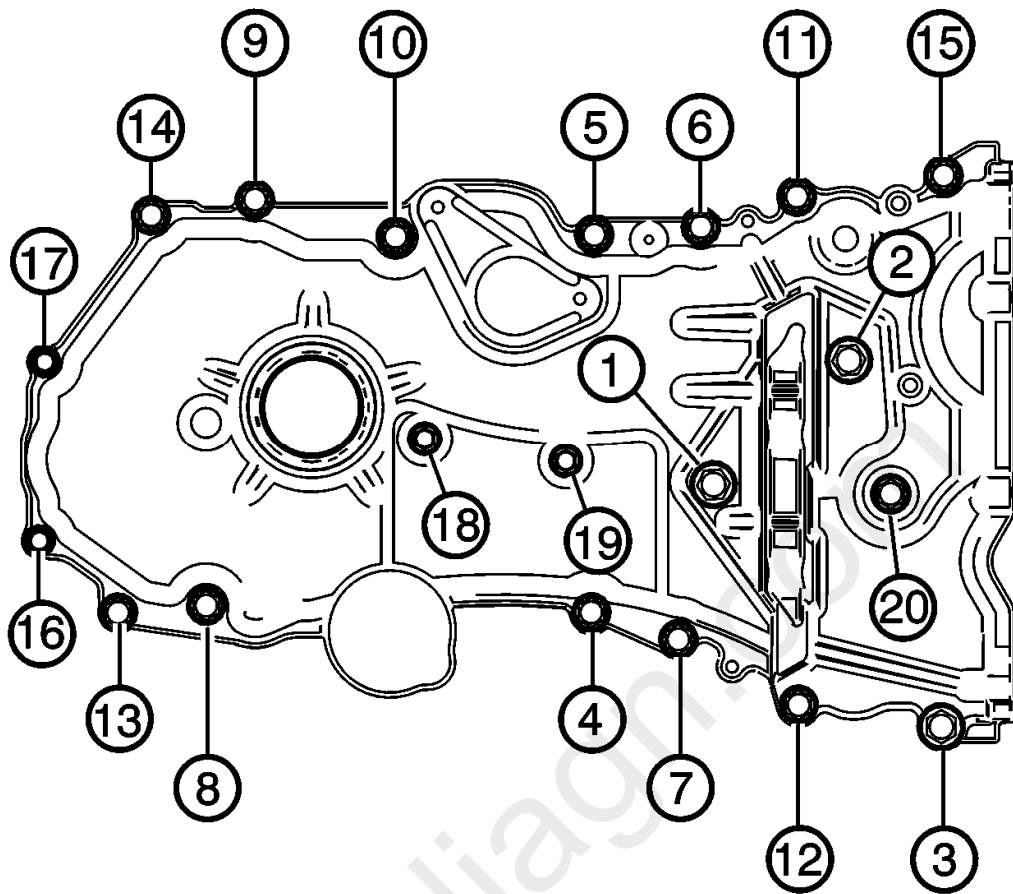


Fig. 68: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Tighten sequence 1-2 bolts to 58 (43 lb ft)
 2. Tighten sequence 3 bolt to 58 (43 lb ft).
 3. Tighten sequence 4-11 bolts to 25 (18 lb ft).
 4. Tighten sequence 12 bolt to 25 (18 lb ft).
 5. Tighten sequence 13-15 bolts to 25 (18 lb ft).
 6. Tighten sequence 16-17 bolts to 10 (89 lb in).
 7. Tighten sequence 18-19 bolts to 10 (89 lb in).
 8. Tighten sequence 20 bolt to 25 (18 lb ft)
6. Connect the wire harness retainers to the front cover.

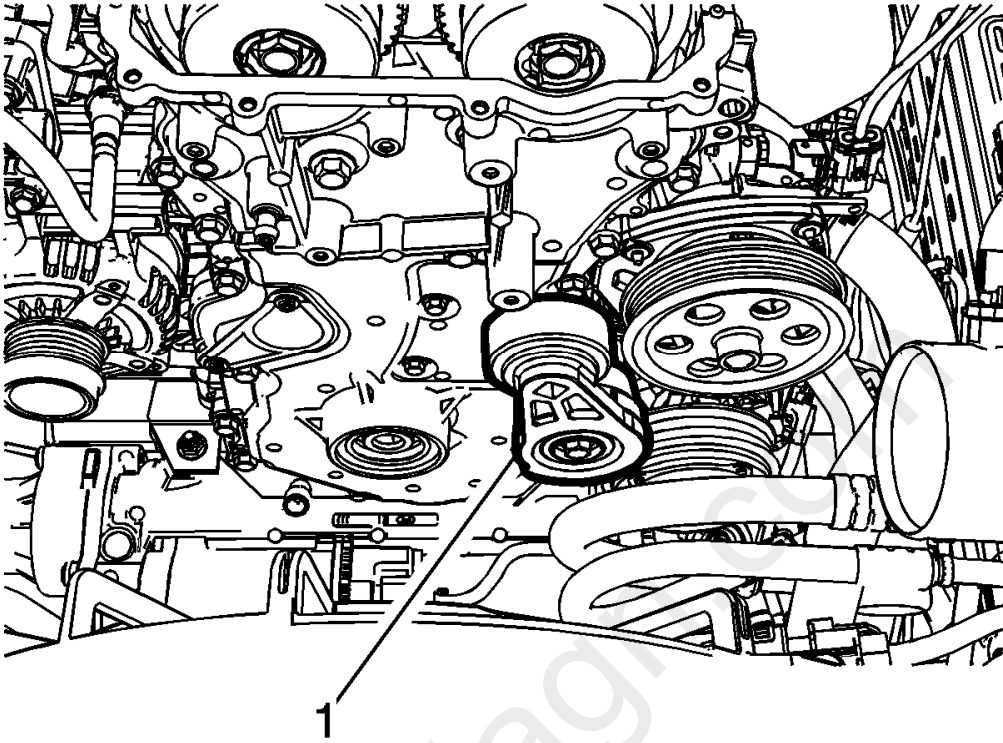


Fig. 69: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

7. Install the drive belt tensioner (1). Refer to **Drive Belt Tensioner Replacement.**

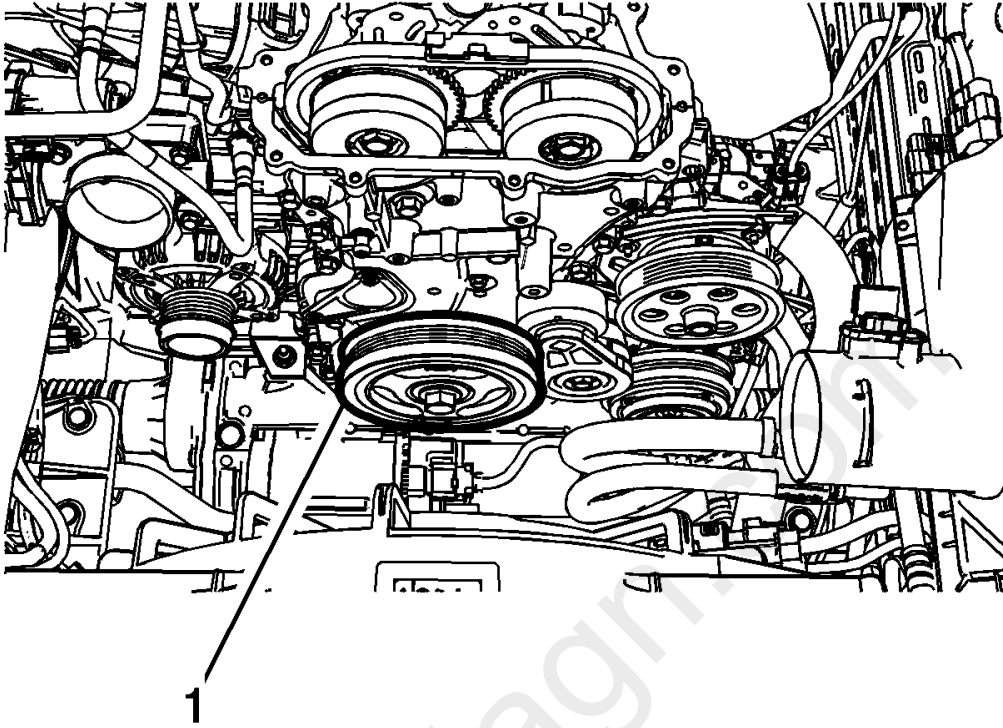


Fig. 70: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

8. Install the crankshaft balancer (1). Refer to Crankshaft Balancer Replacement.
9. Install the camshaft cover. Refer to Camshaft Cover Replacement.

VALVE ROCKER ARM REPLACEMENT (EXHAUST)

Removal Procedure

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

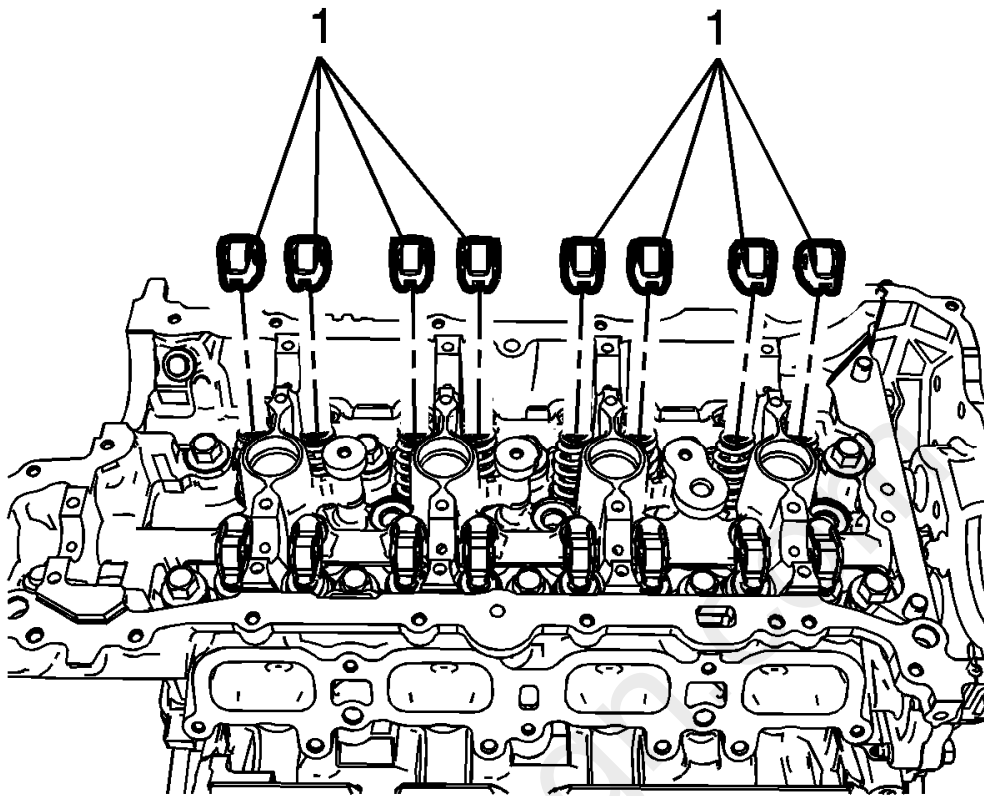


Fig. 71: Exhaust Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the Valve Rocker Arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the exhaust rocker arm (1).

Installation Procedure

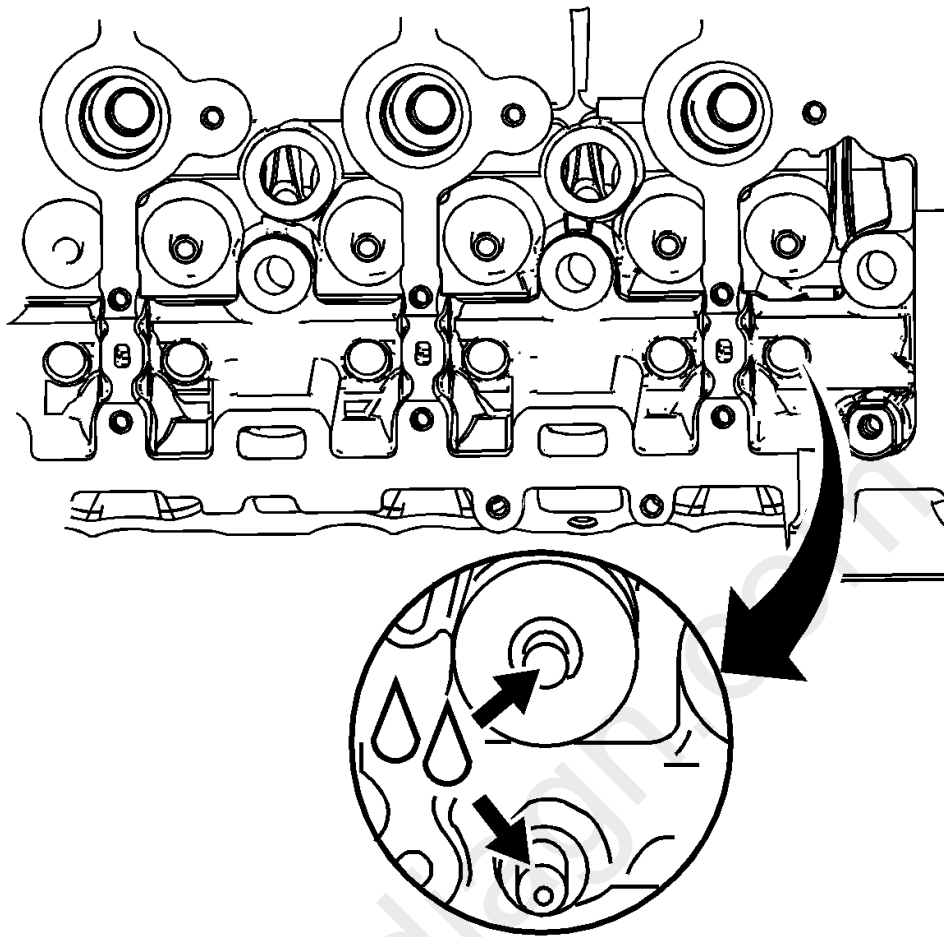


Fig. 72: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

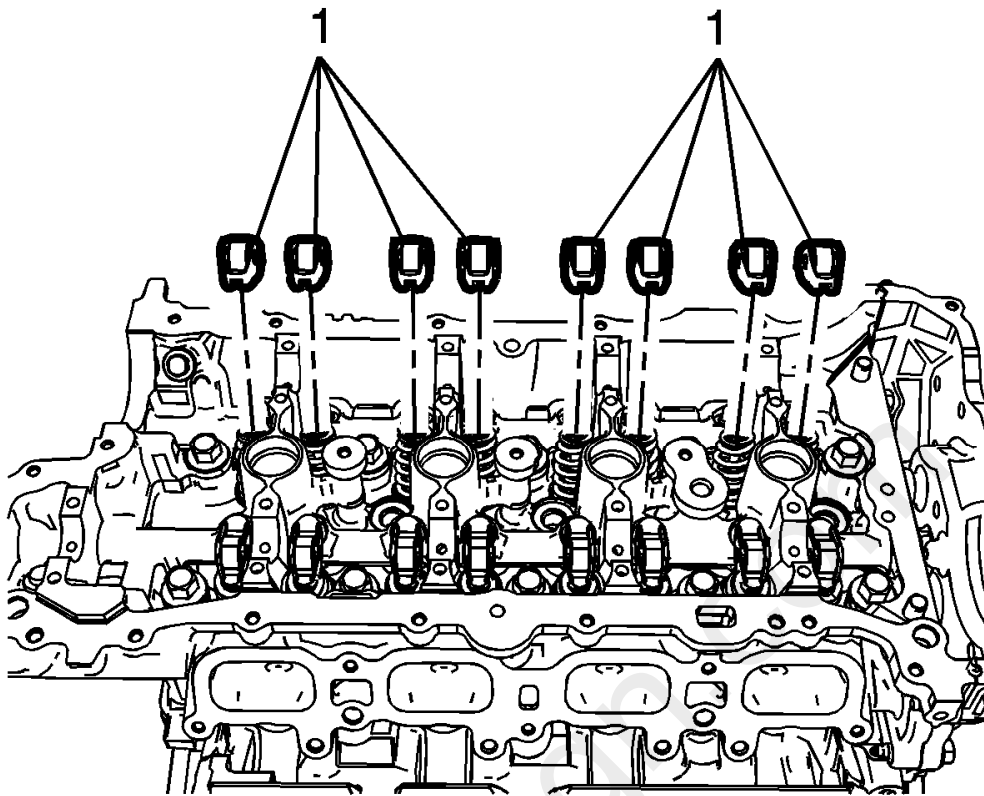


Fig. 73: Exhaust Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
- Pre-oil roller bearings before installation.

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the camshaft position actuator and camshaft - exhaust. Refer to **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

VALVE ROCKER ARM REPLACEMENT (INTAKE)

Removal Procedure

1. Remove the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake.**

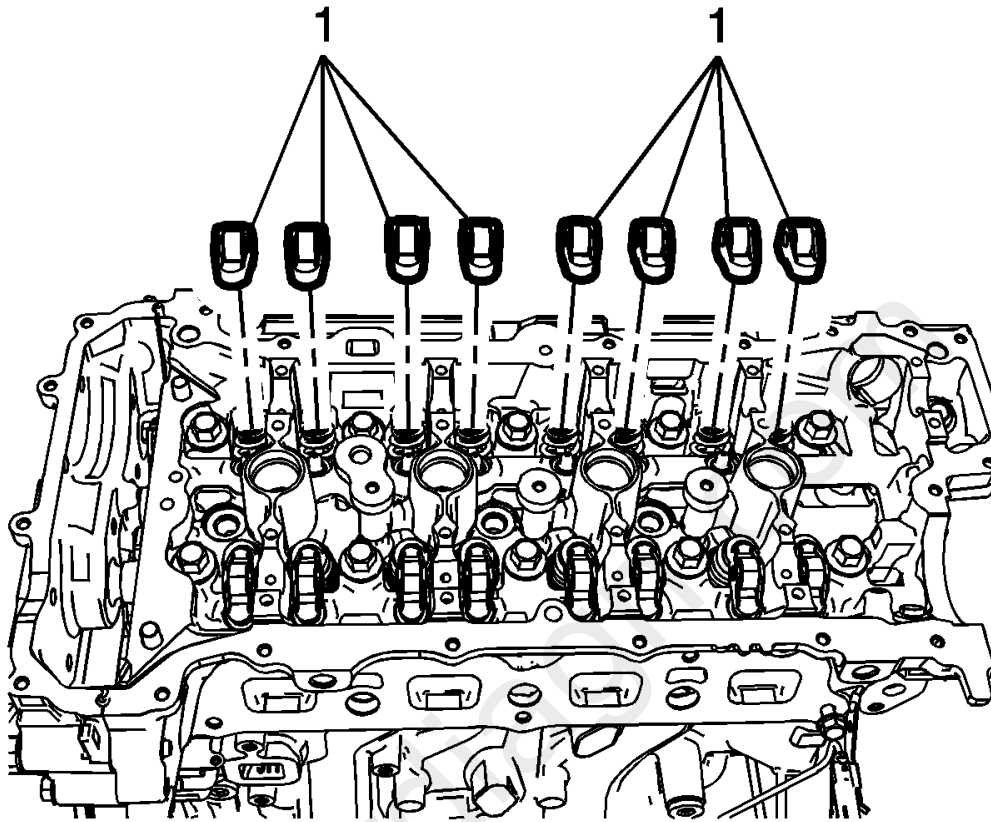


Fig. 74: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE: Keep all of the valve rocker arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.

2. Remove the intake rocker arm (1).

Installation Procedure

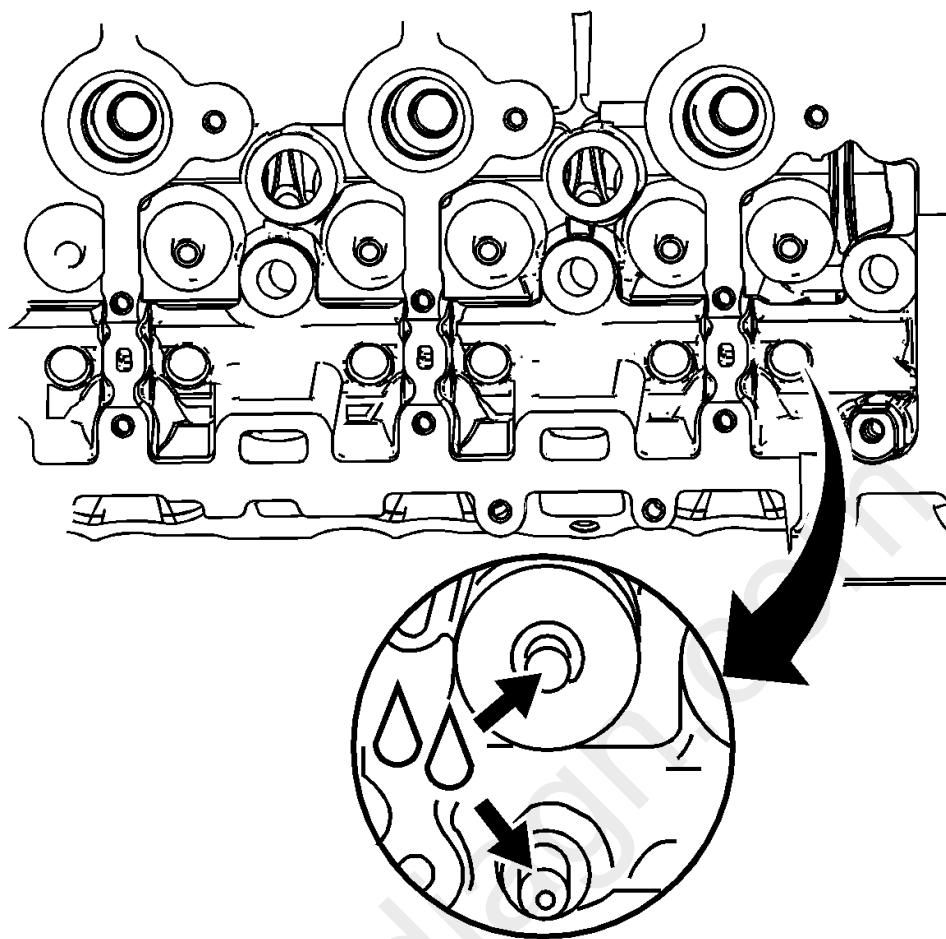


Fig. 75: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

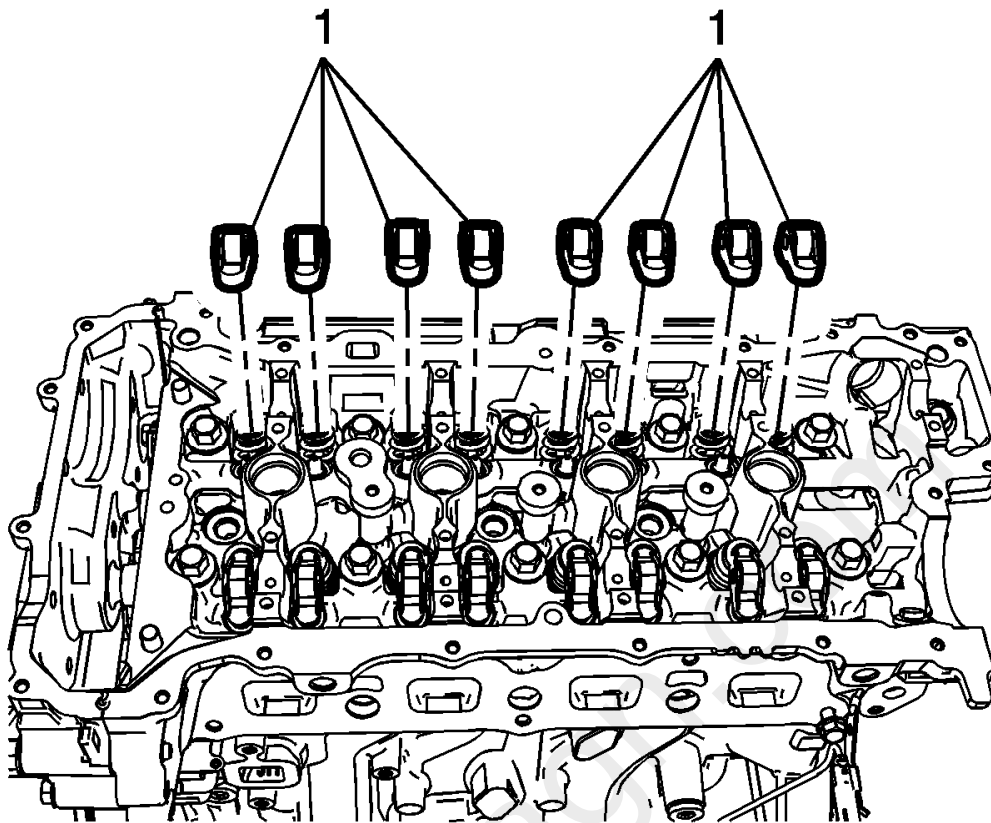


Fig. 76: Intake Rocker Arm

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.
- Pre-oil roller bearings before installation.

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REPLACEMENT

Removal Procedure

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

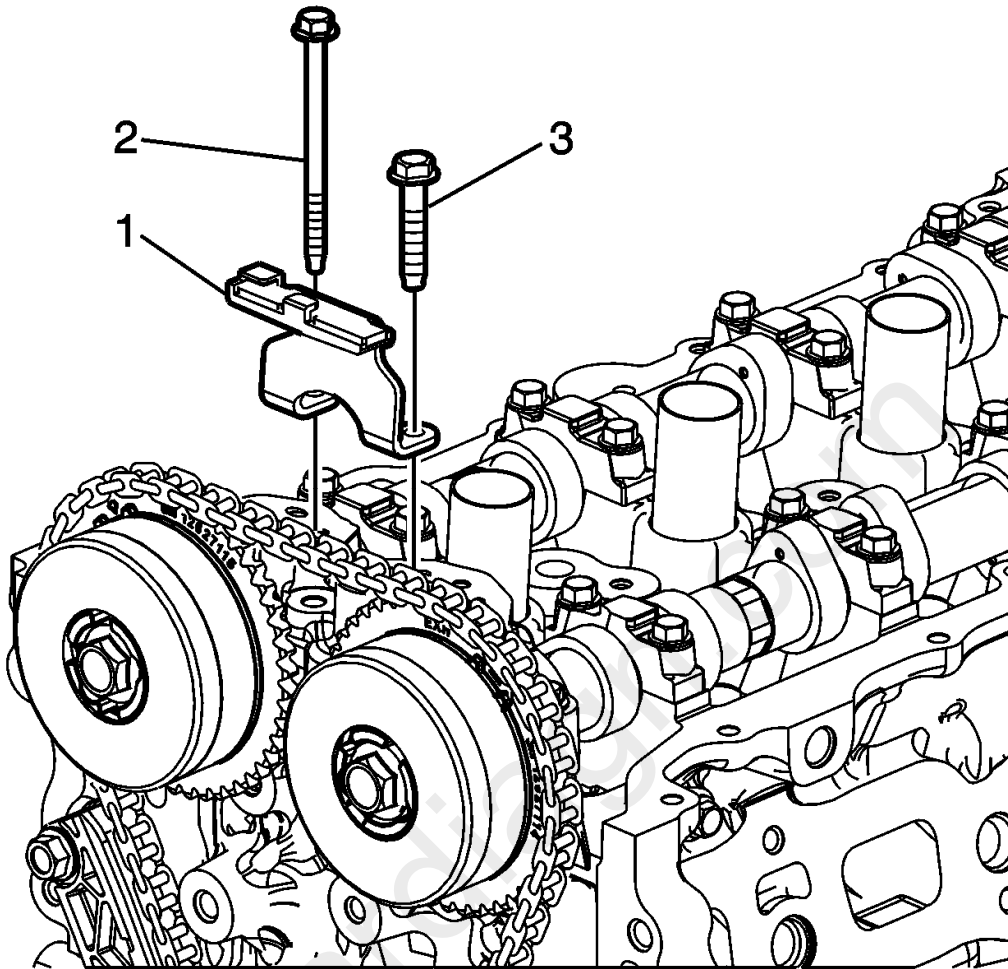


Fig. 77: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

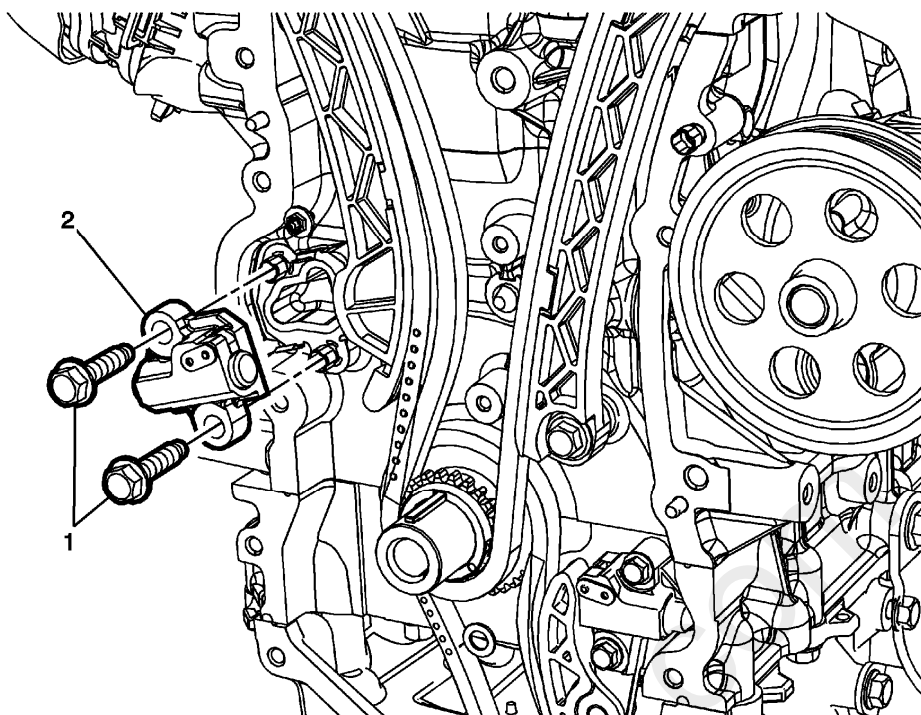


Fig. 78: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

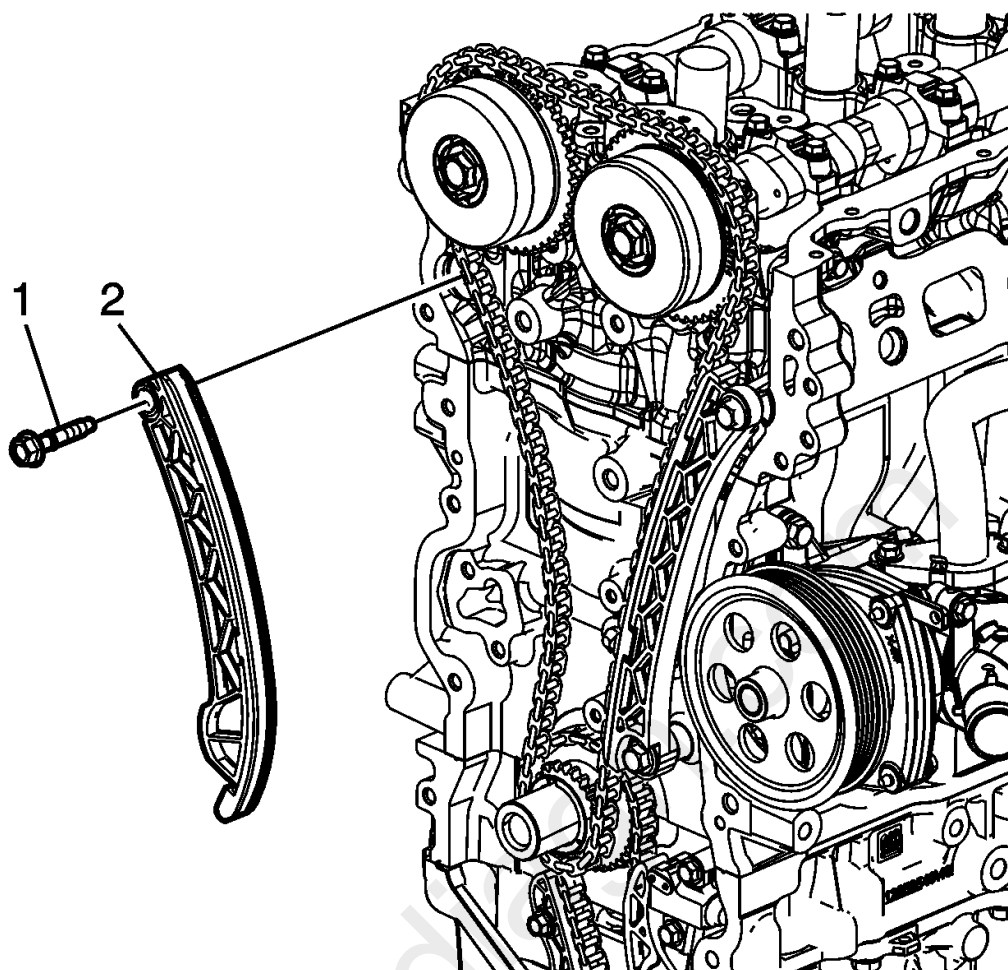


Fig. 79: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

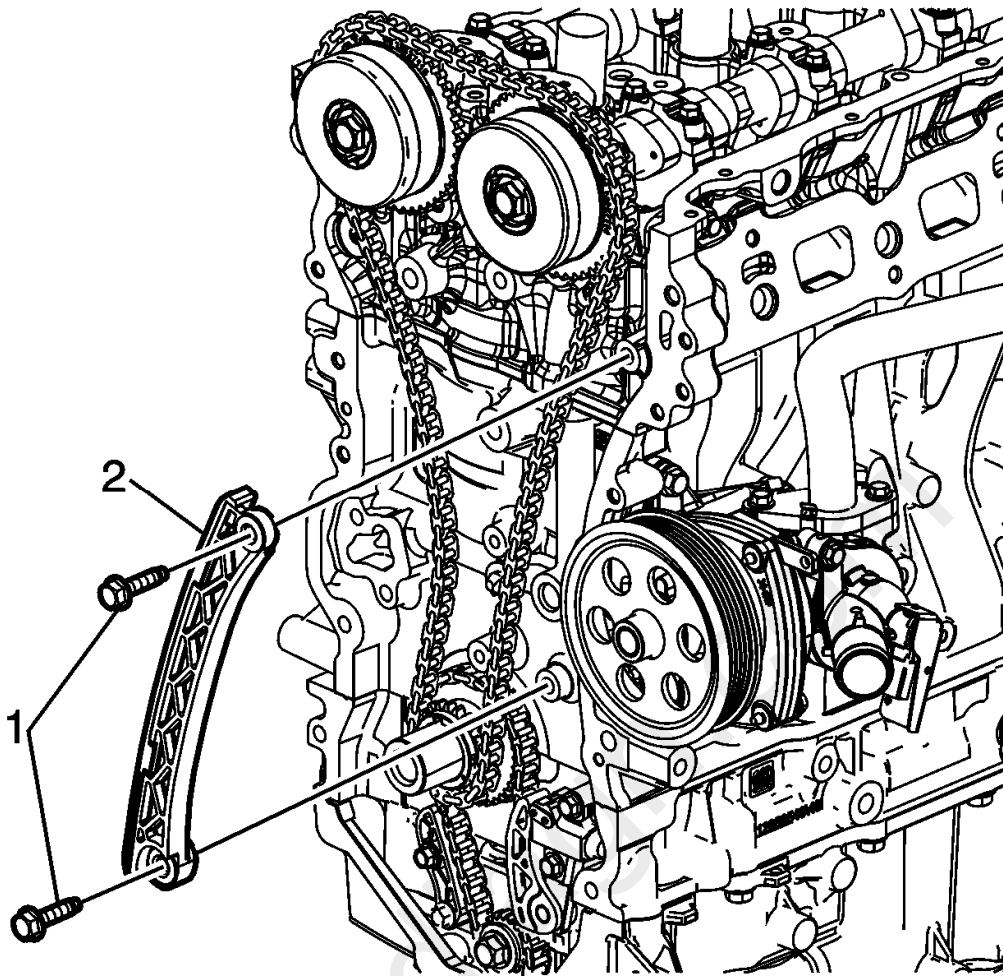


Fig. 80: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

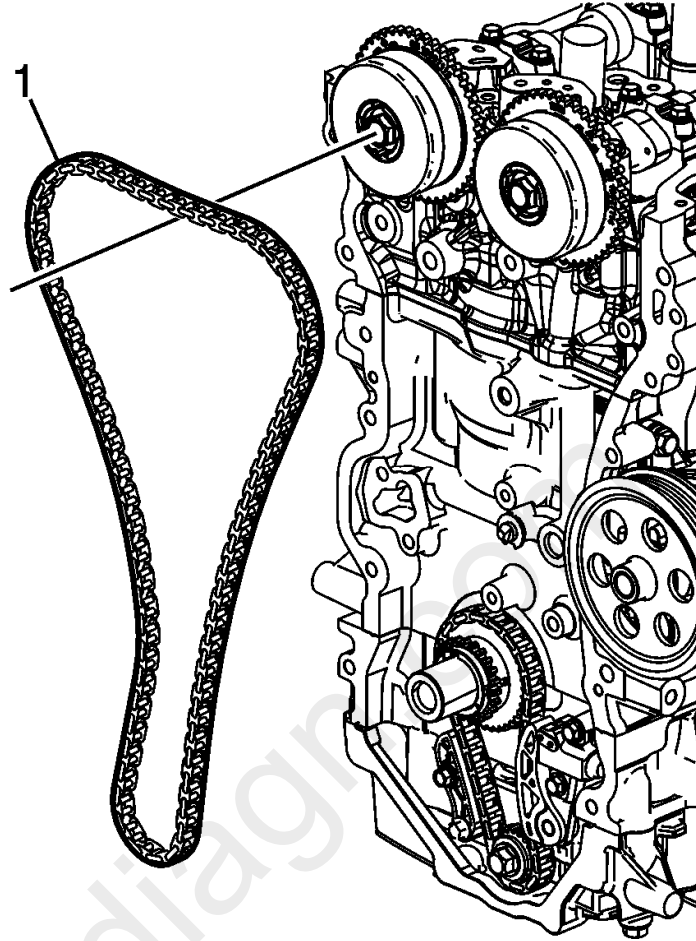


Fig. 81: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

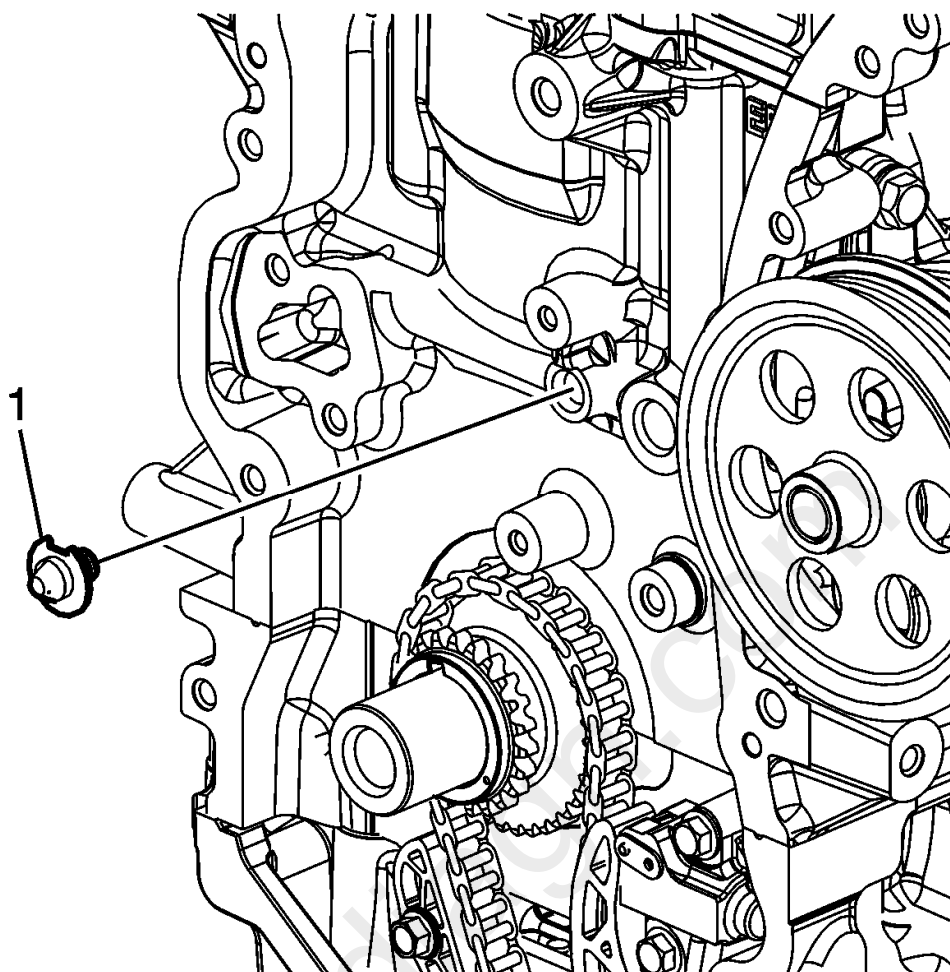


Fig. 82: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

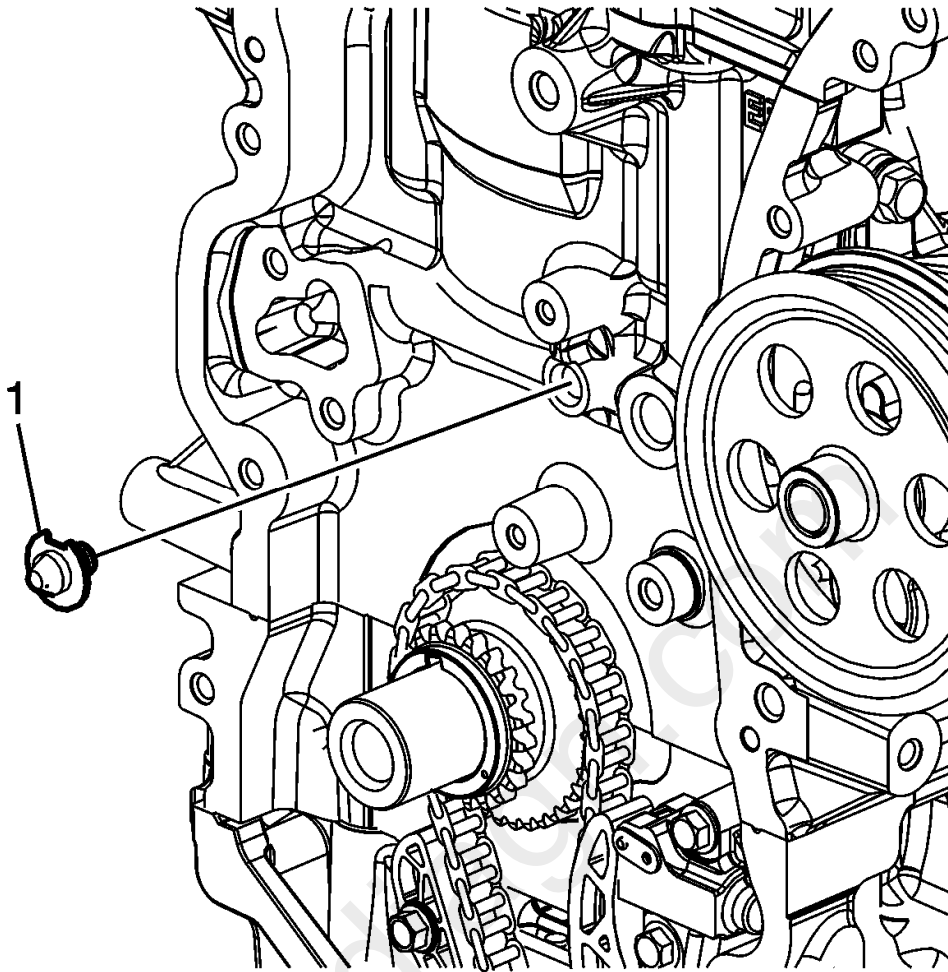


Fig. 83: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

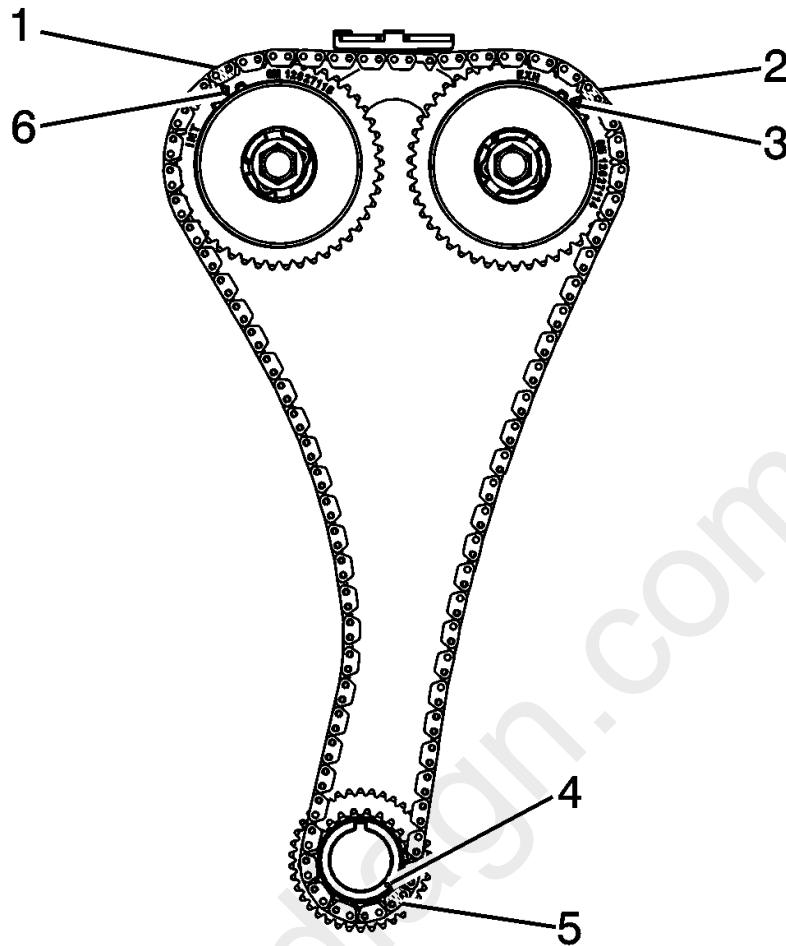


Fig. 84: Timing Chain Oil Nozzle
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The same colored link corresponding to the intake actuator will not initially align with the intake actuator timing mark, nor the unique colored timing chain link align with the crankshaft sprocket timing mark.

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

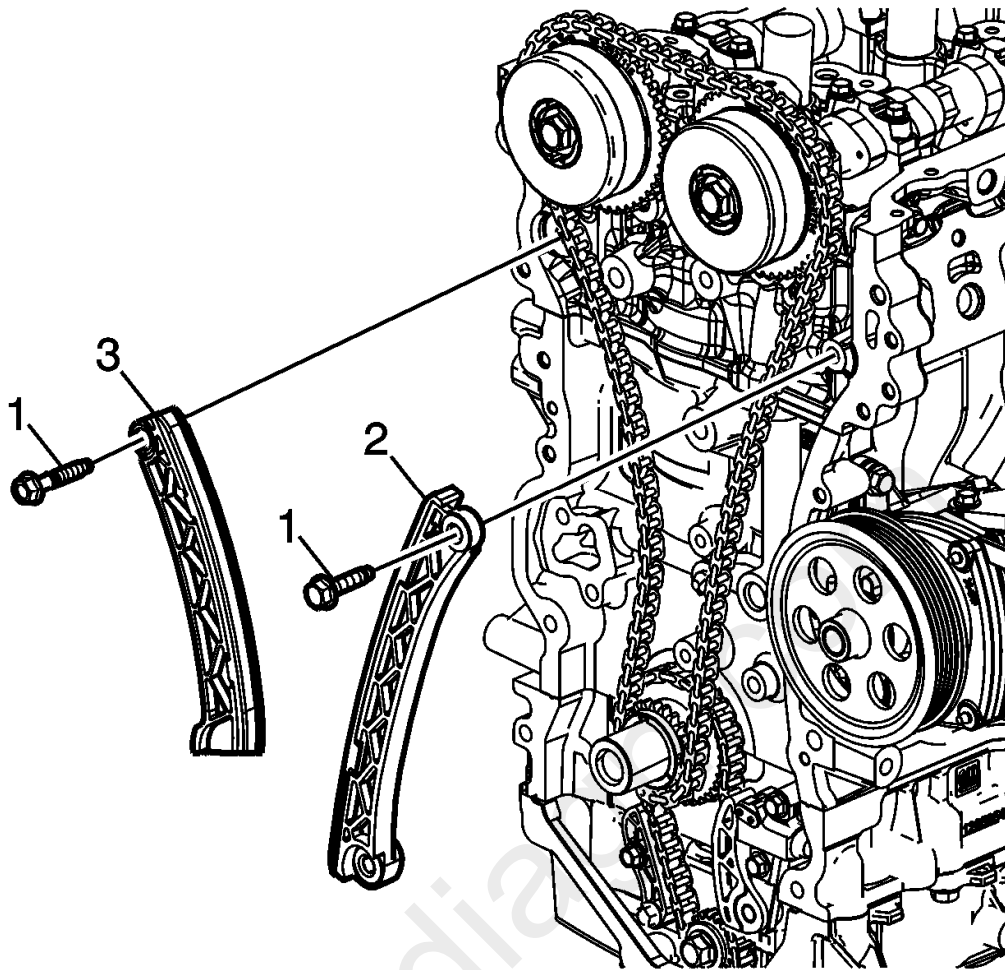


Fig. 85: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

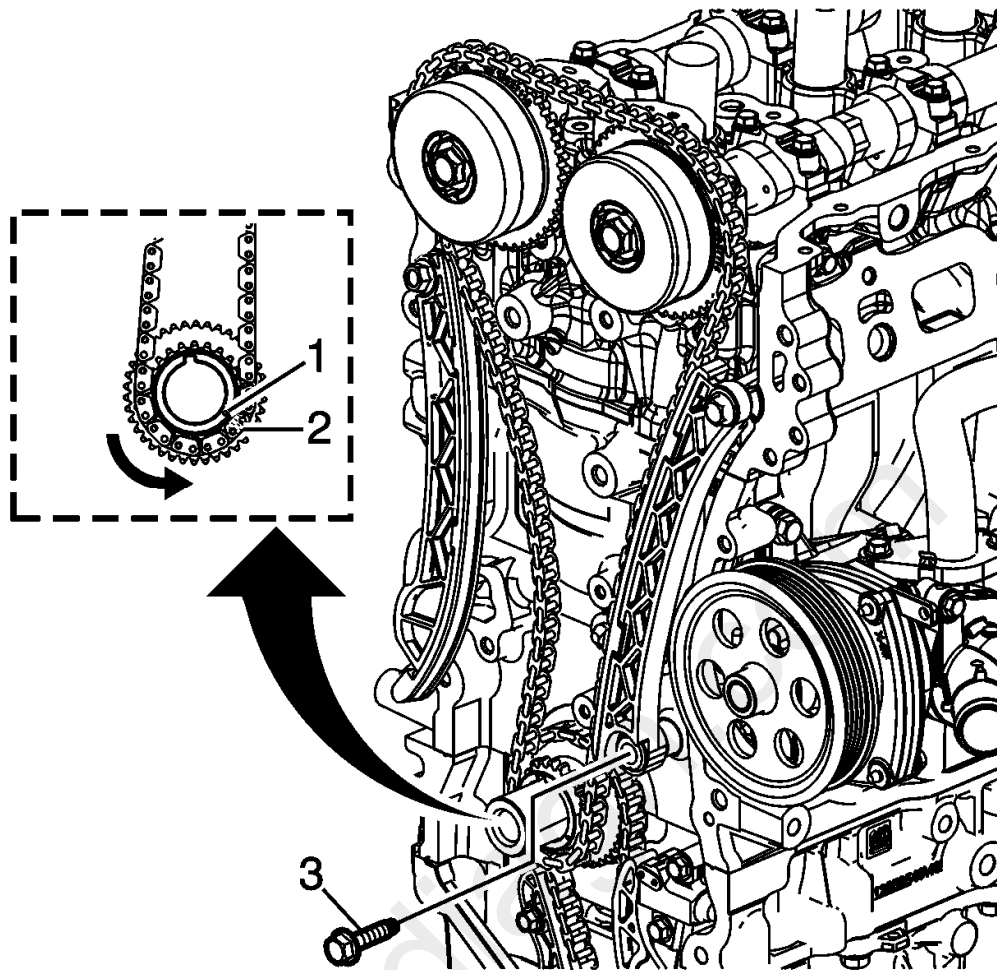


Fig. 86: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

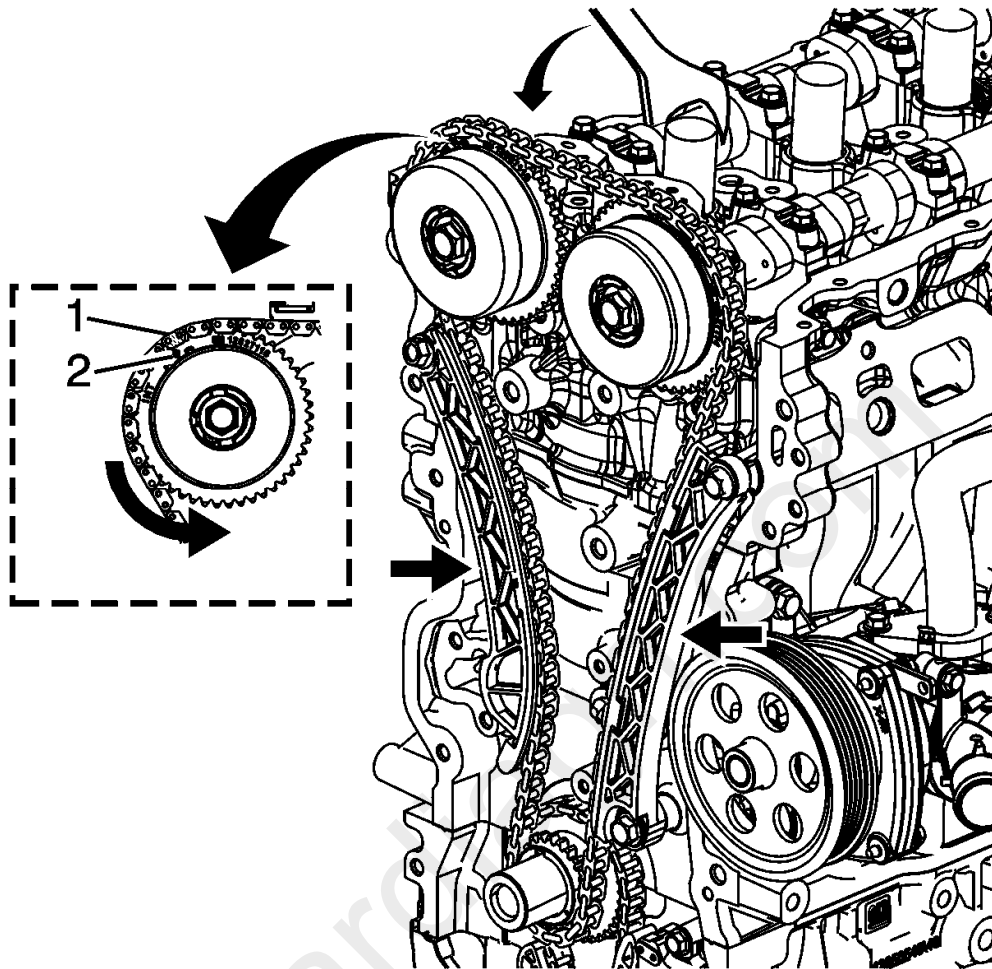


Fig. 87: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
 - Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.
10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

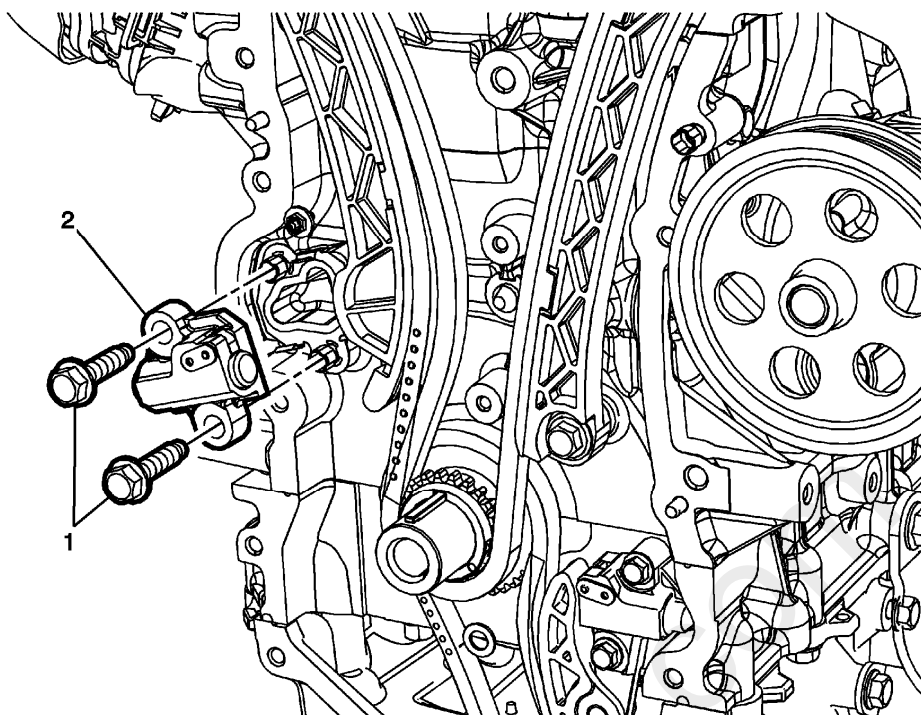


Fig. 88: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

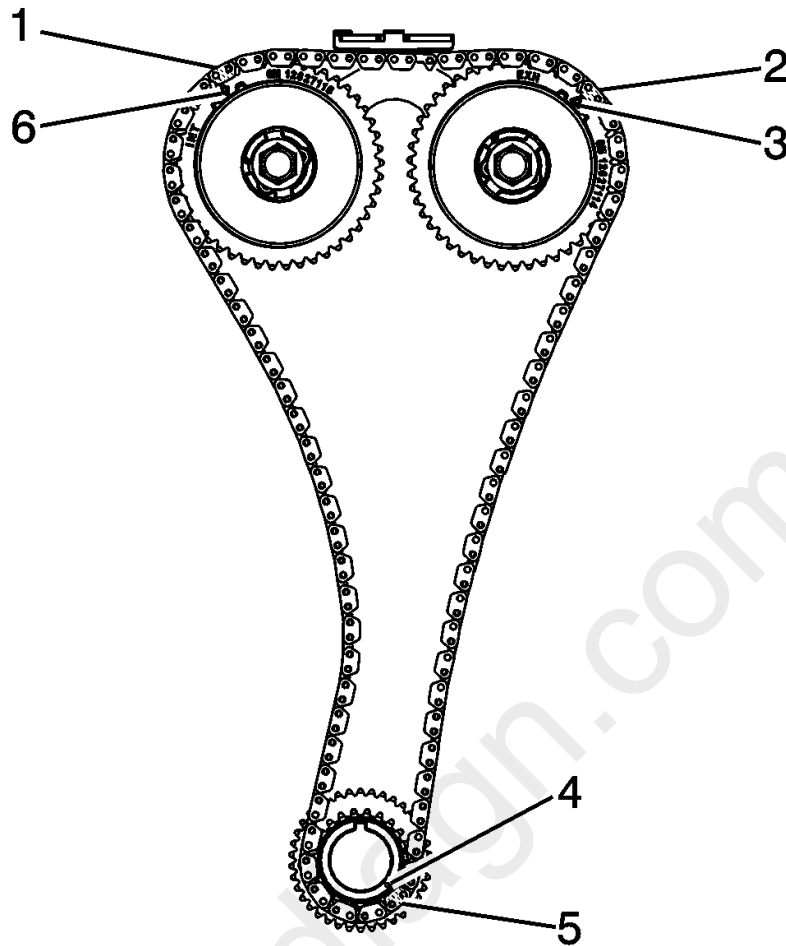


Fig. 89: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

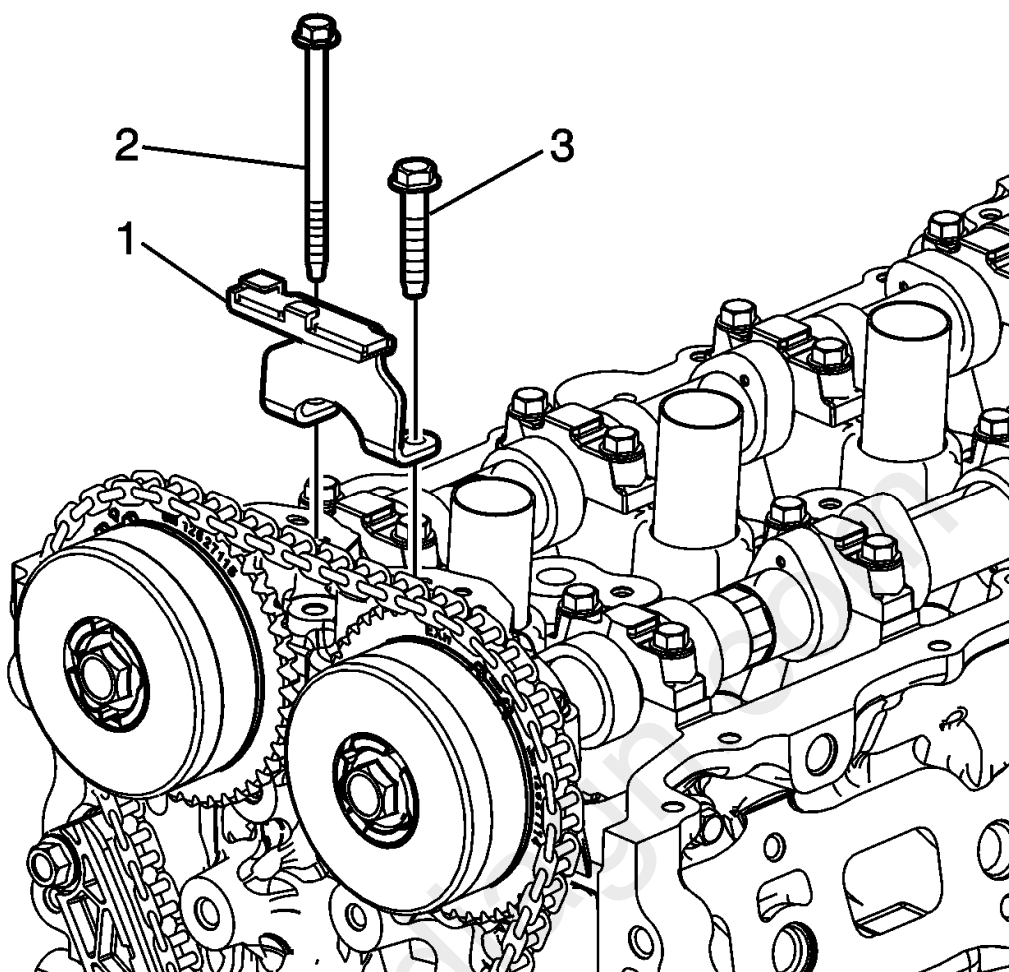


Fig. 90: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

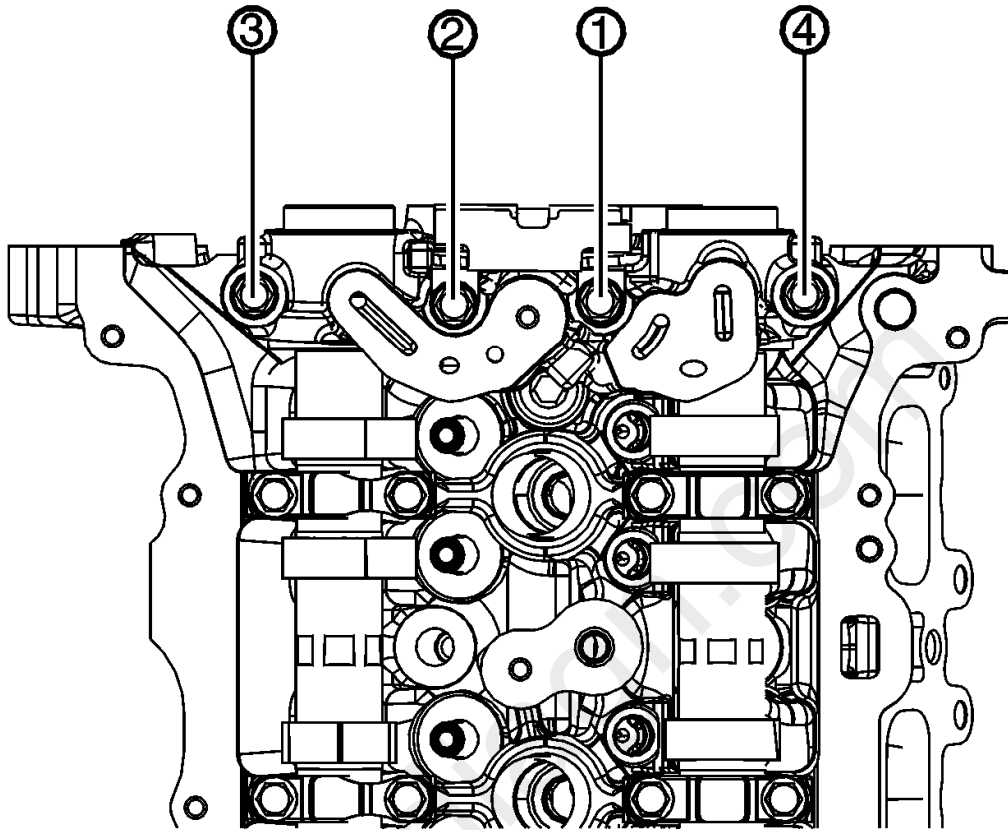


Fig. 91: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

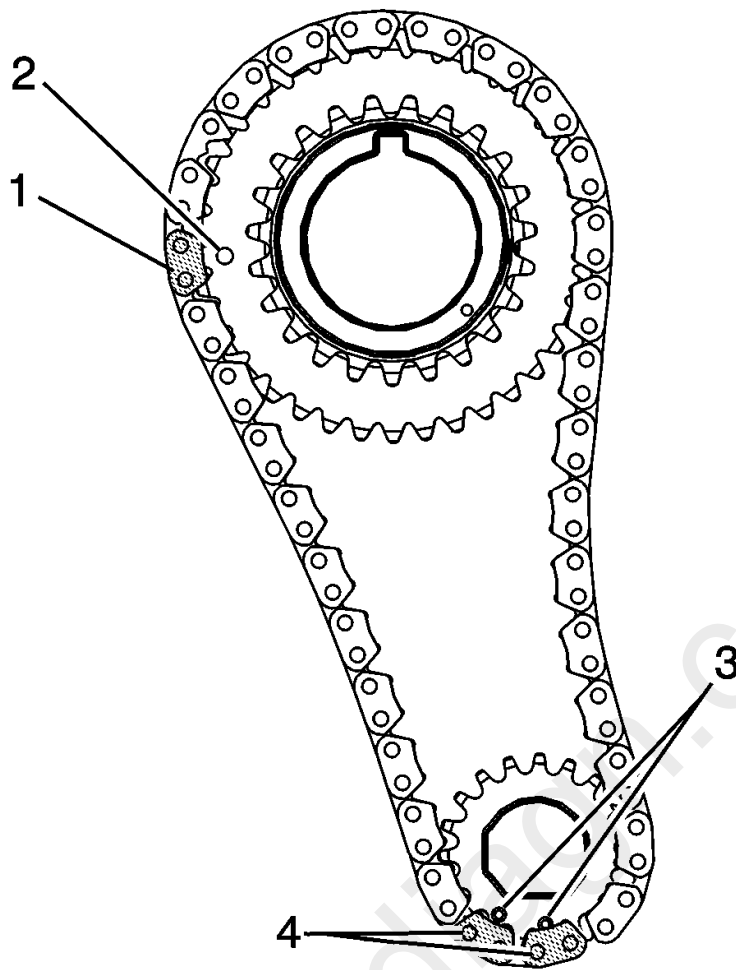


Fig. 92: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT TIMING CHAIN AND TENSIONER REPLACEMENT

Removal Procedure

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

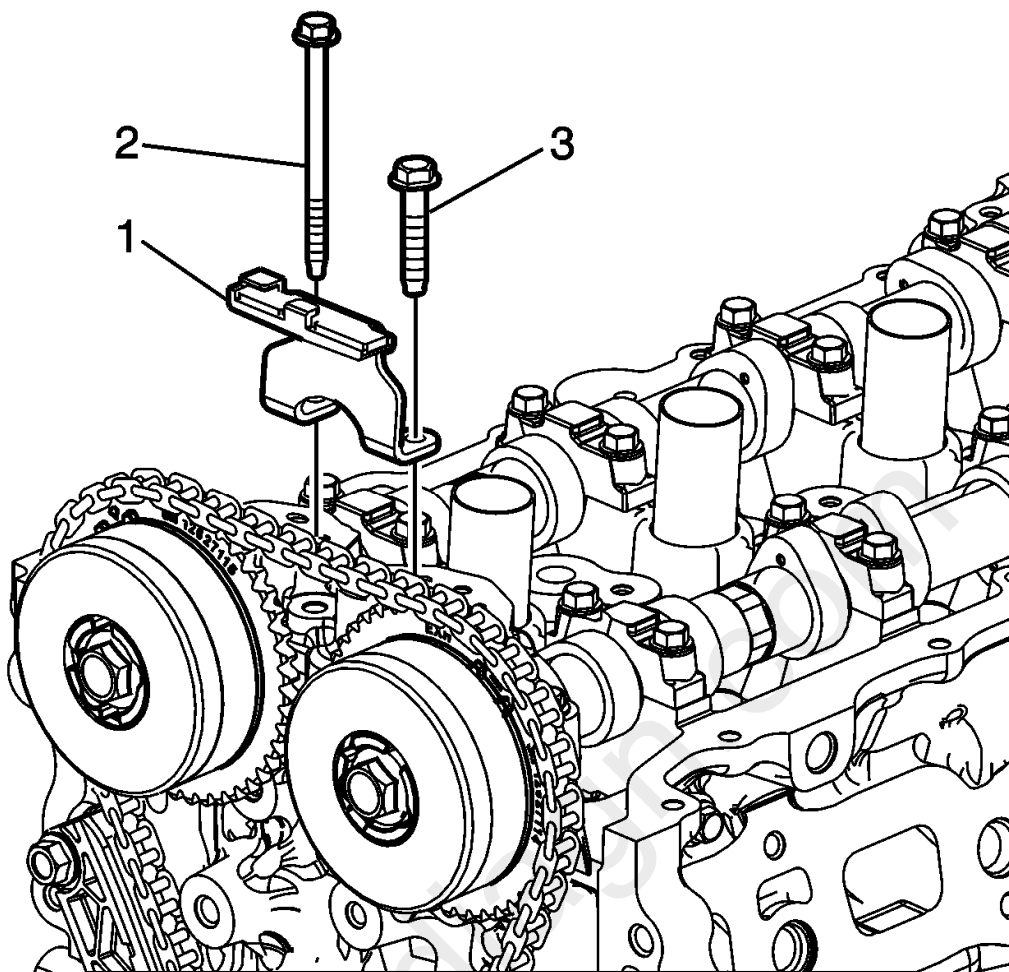


Fig. 93: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

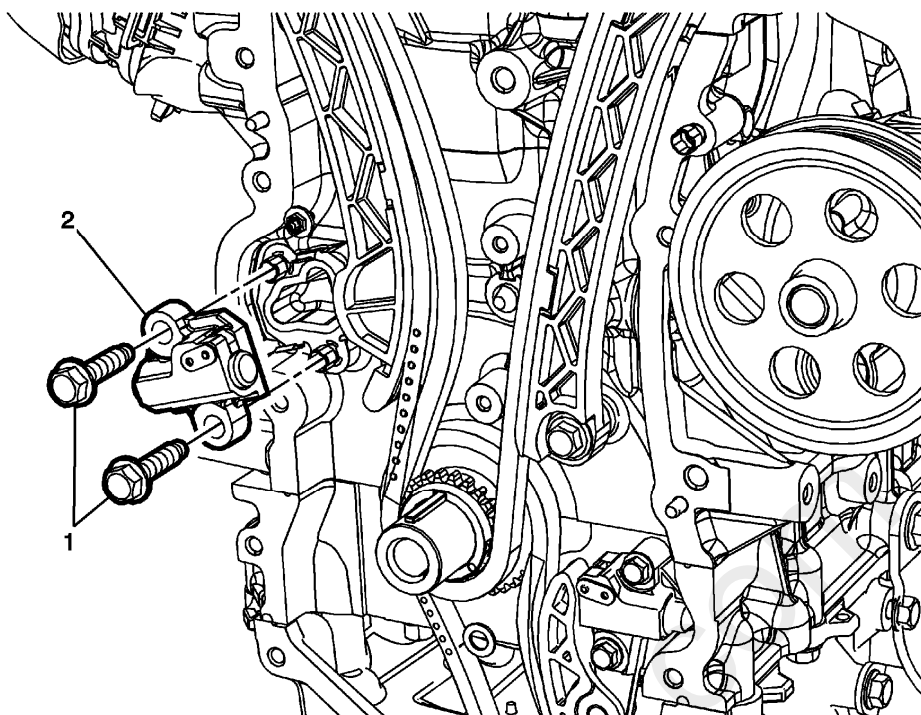


Fig. 94: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).

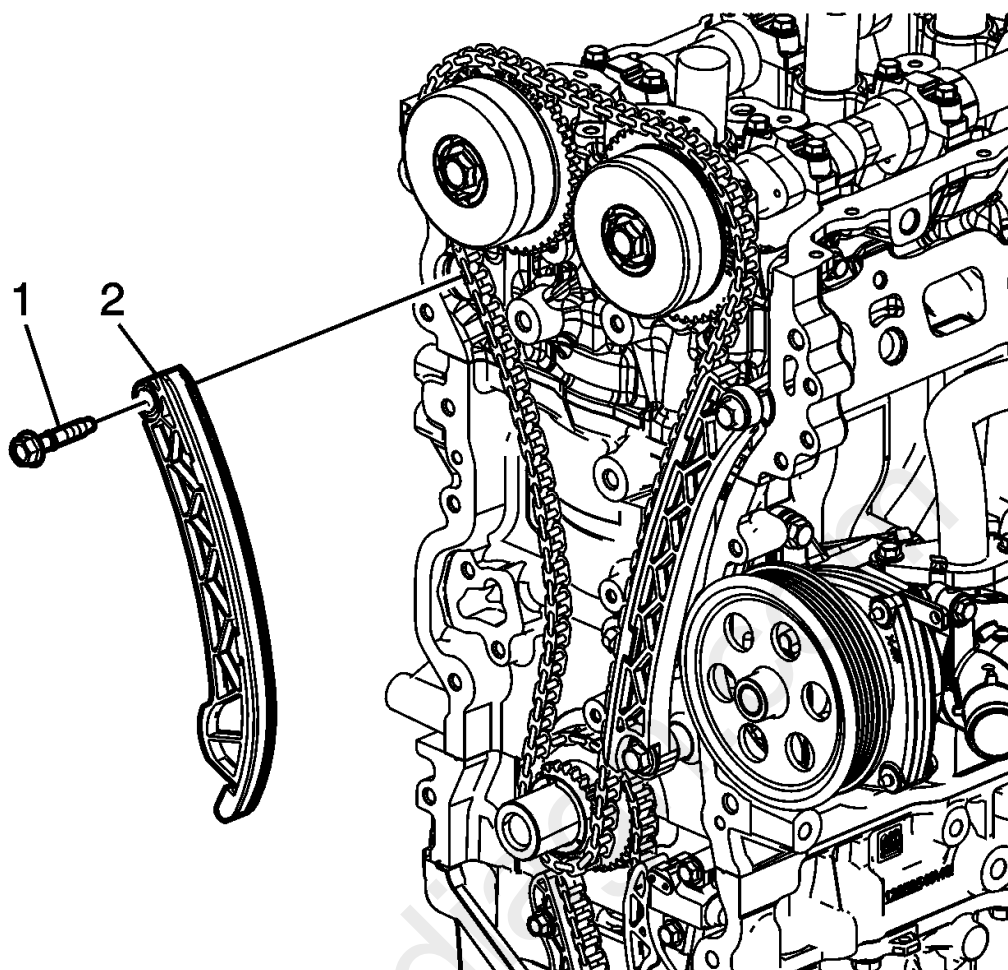


Fig. 95: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the timing chain tensioner pivot arm bolt (1).
6. Remove the timing chain tensioner pivot arm (2).

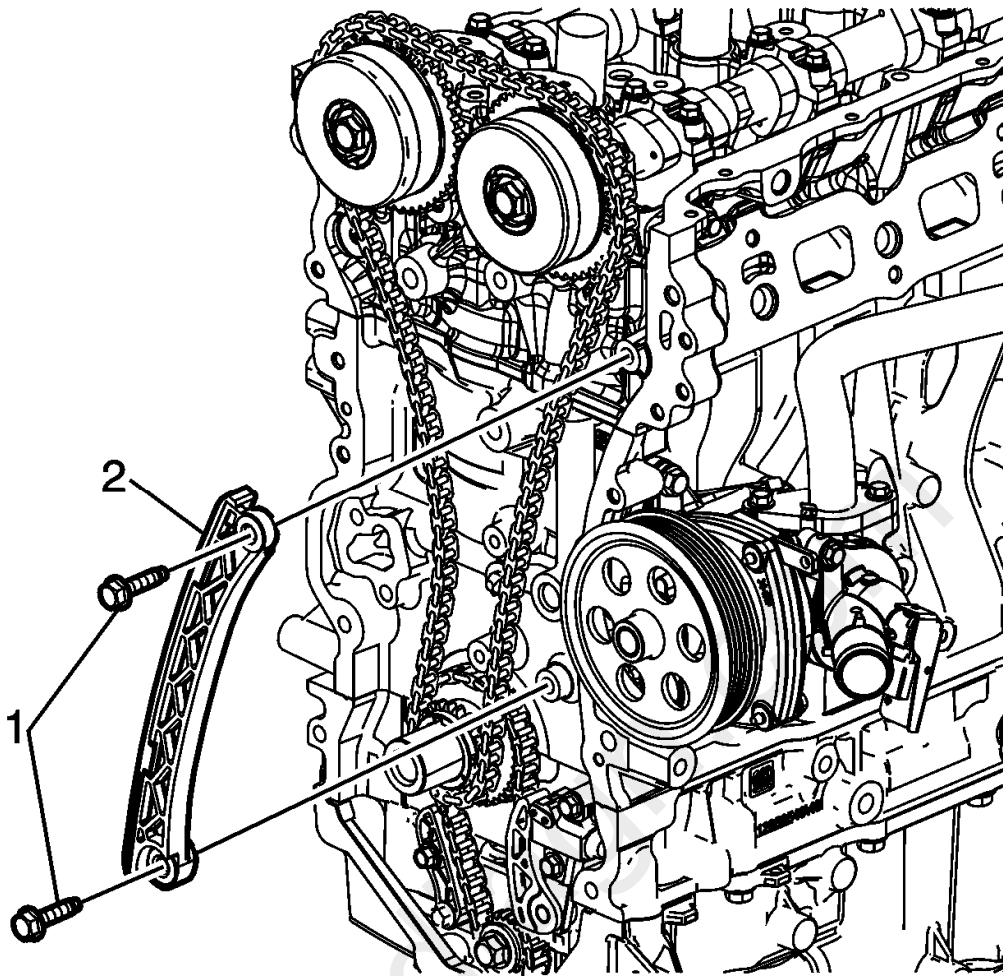


Fig. 96: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain guide bolts (1).
8. Remove the timing chain guide (2).

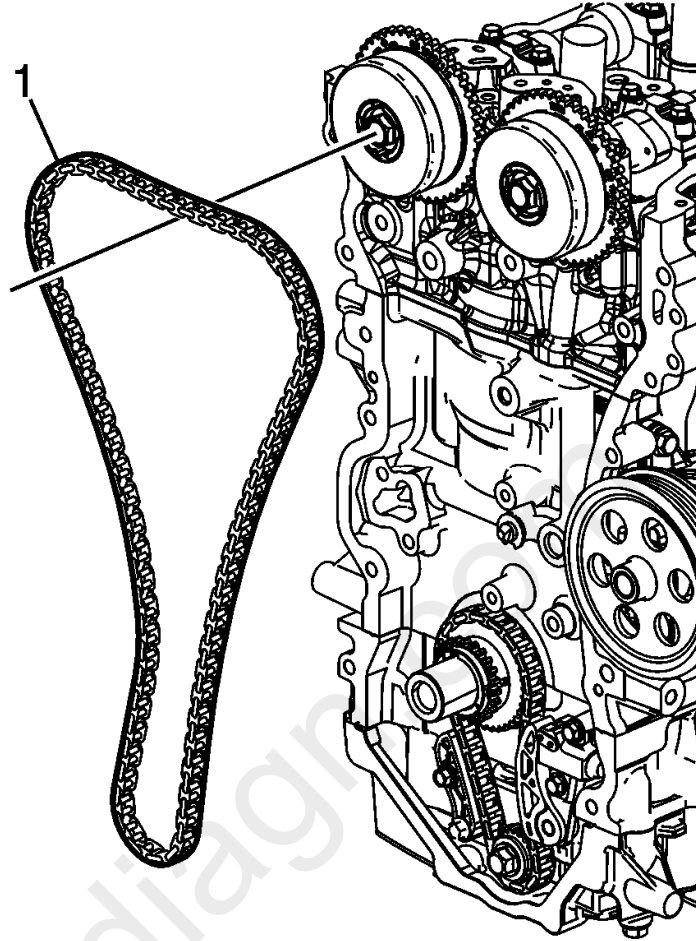


Fig. 97: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

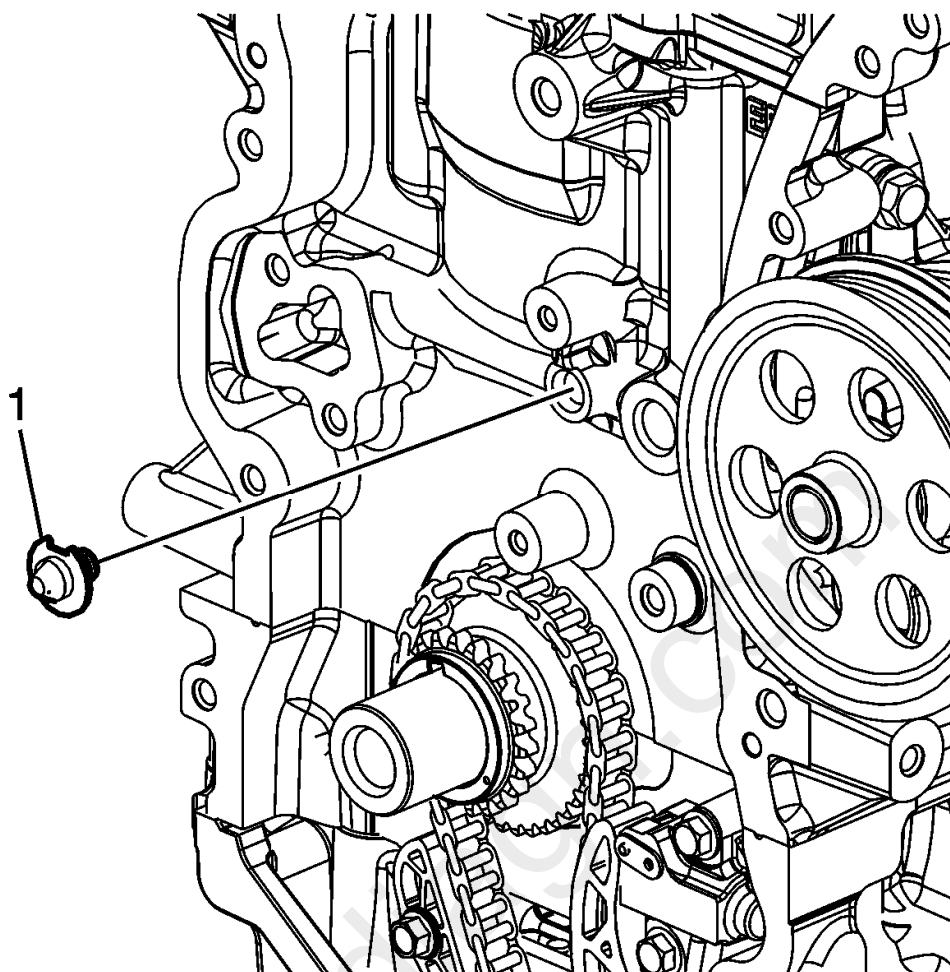


Fig. 98: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain oil nozzle (1).
11. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection** .

Installation Procedure

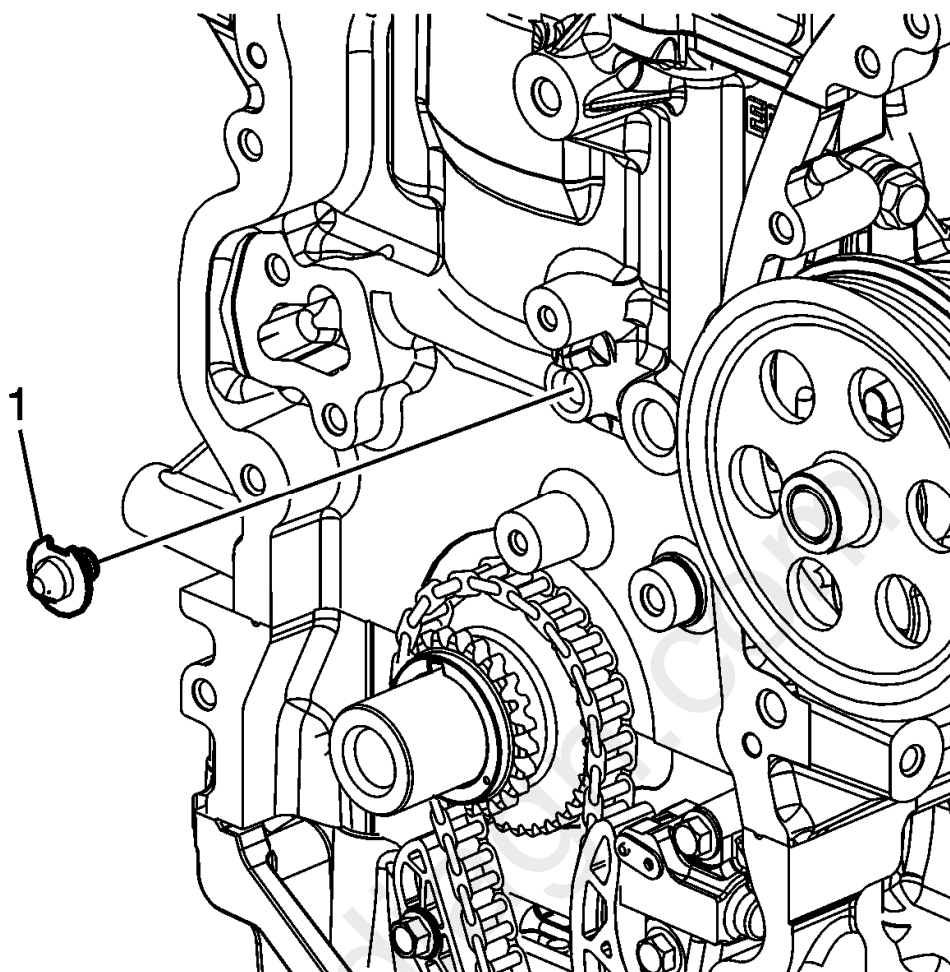


Fig. 99: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the timing chain oil nozzle is rotated with the notch facing upward,
and aligned with the tab on the engine block.

1. Install the timing chain oil nozzle (1).

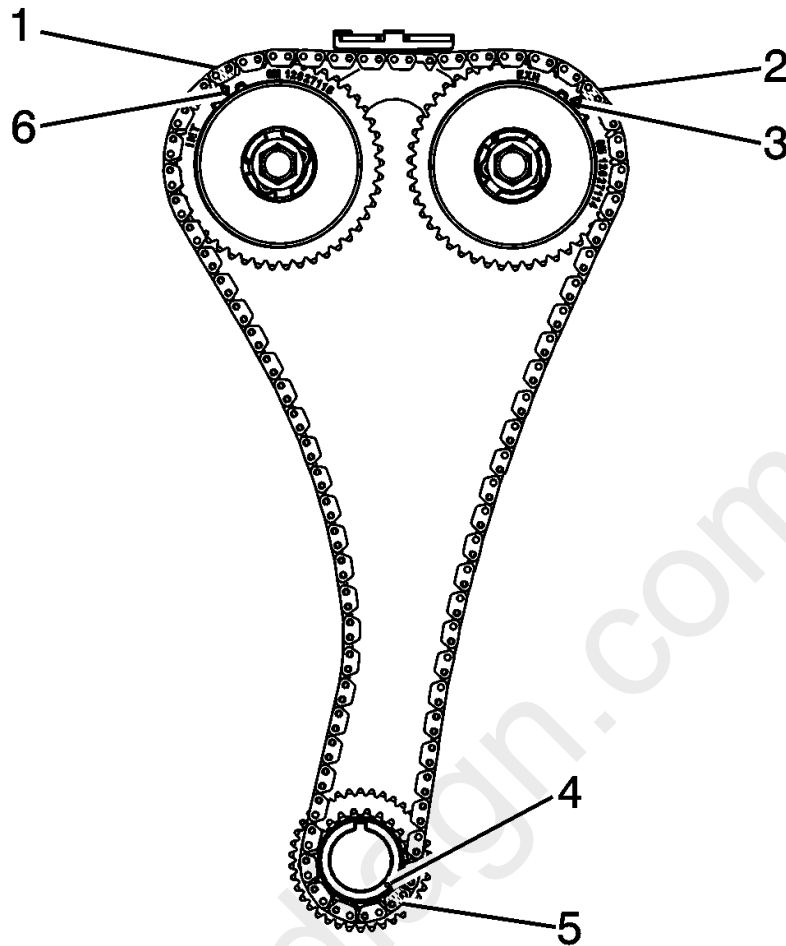


Fig. 100: Timing Chain Oil Nozzle
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning the unique colored link (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: The same colored link corresponding to the intake actuator will not initially align with the intake actuator timing mark, nor the unique colored timing chain link align with the crankshaft sprocket timing mark.

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

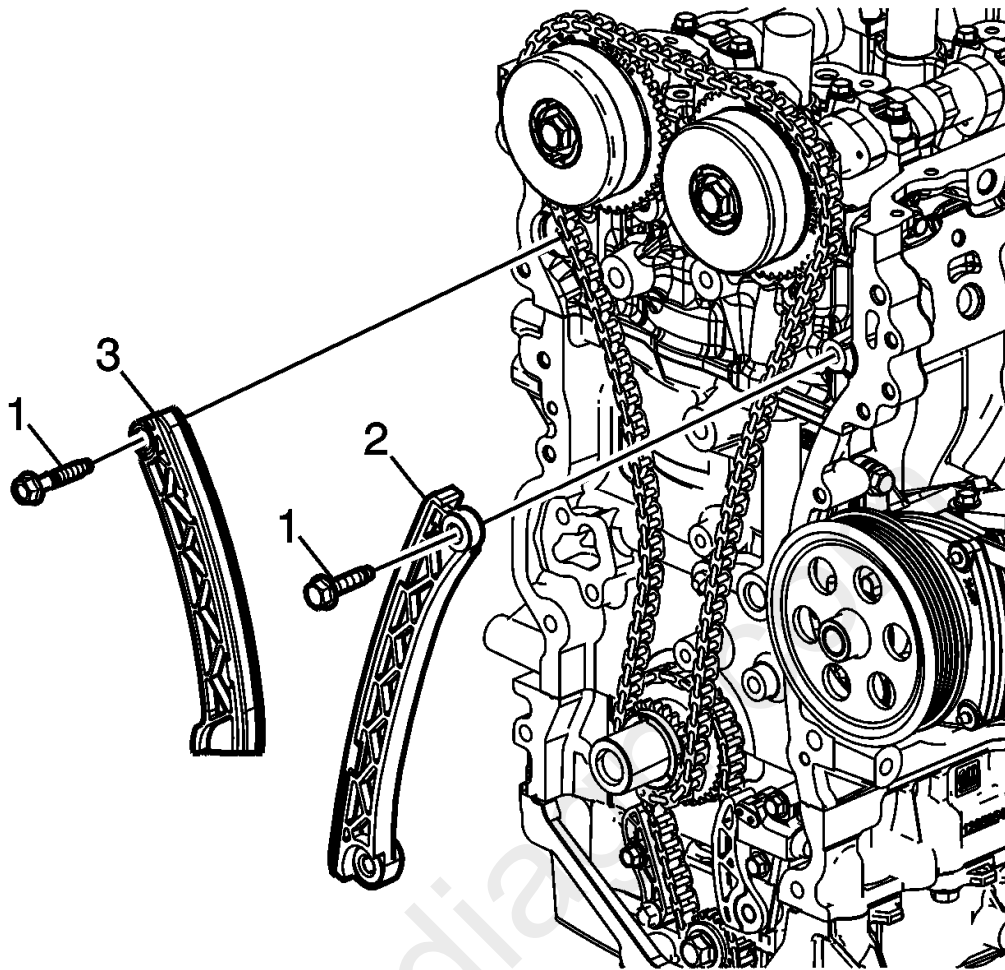


Fig. 101: Timing Chain Guide And Upper Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Timing will be established before the final install and torque of the guide bolts.

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

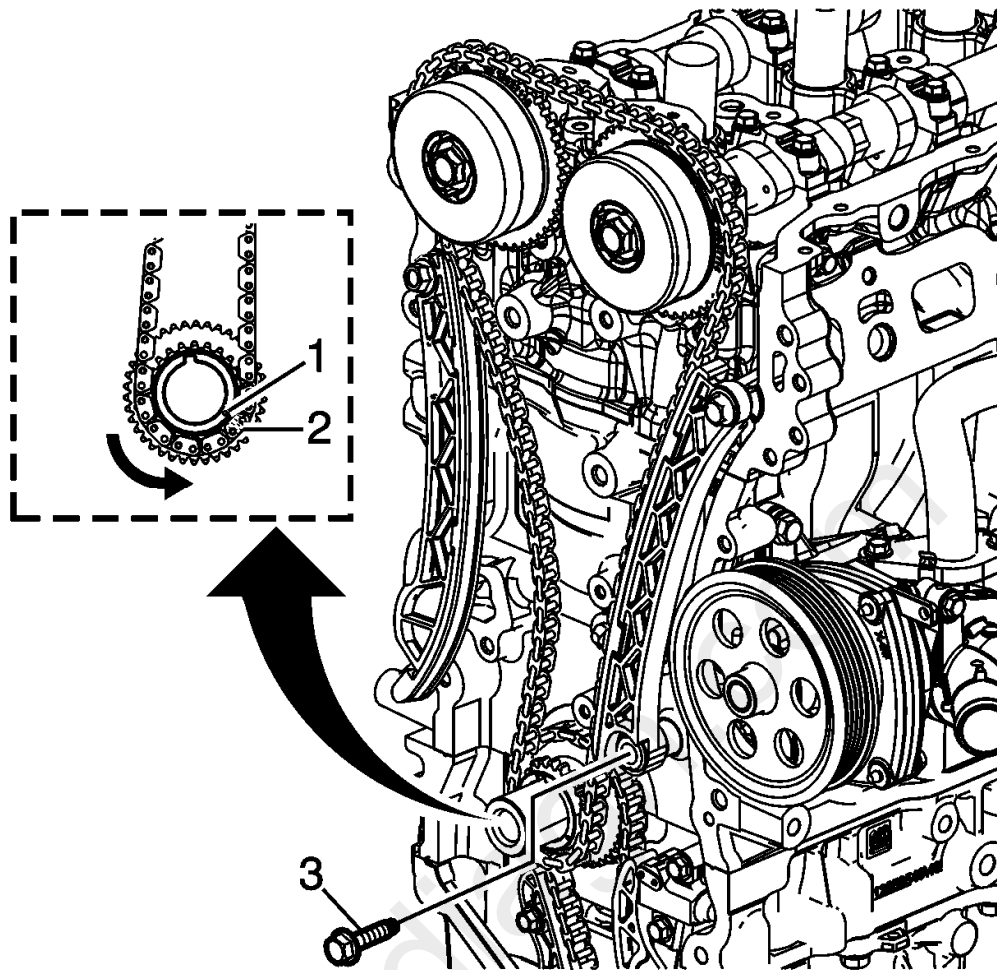


Fig. 102: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.
- Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: Refer to Fastener Caution .

9. Tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

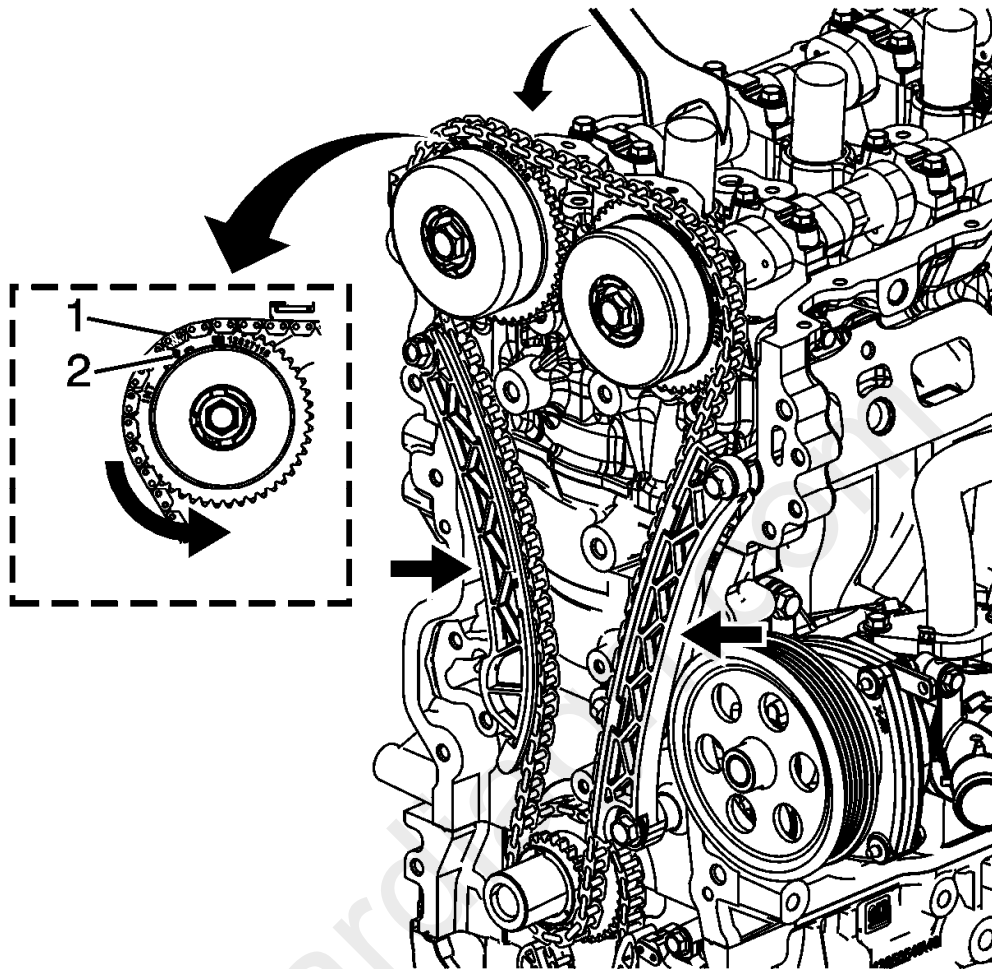


Fig. 103: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.
 - Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.
10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

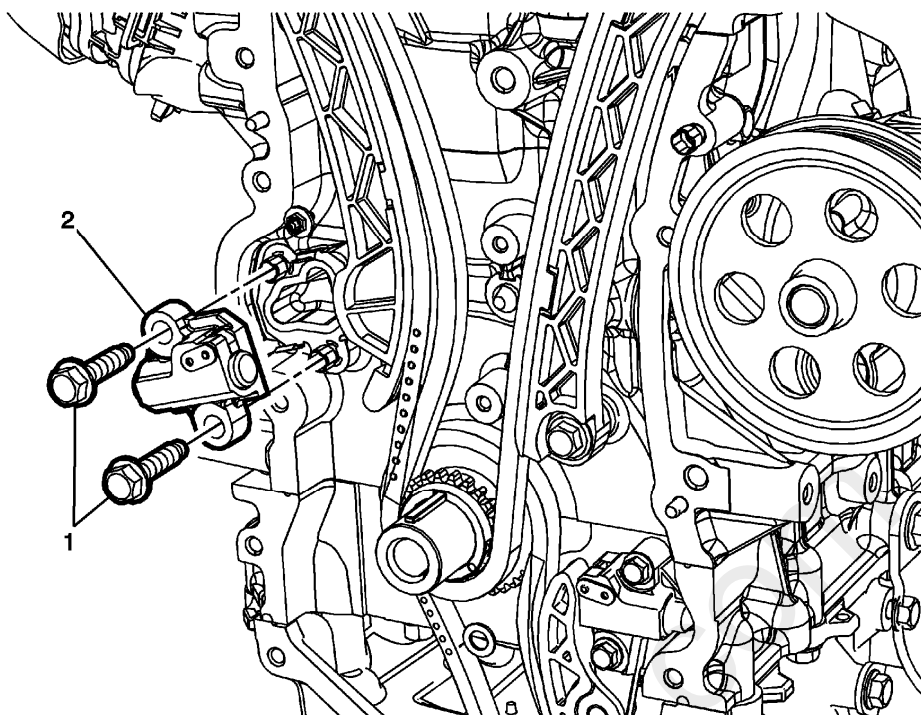


Fig. 104: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the timing chain tensioner (2) and tighten timing chain tensioner bolts (1) to 25 (18 lb ft)

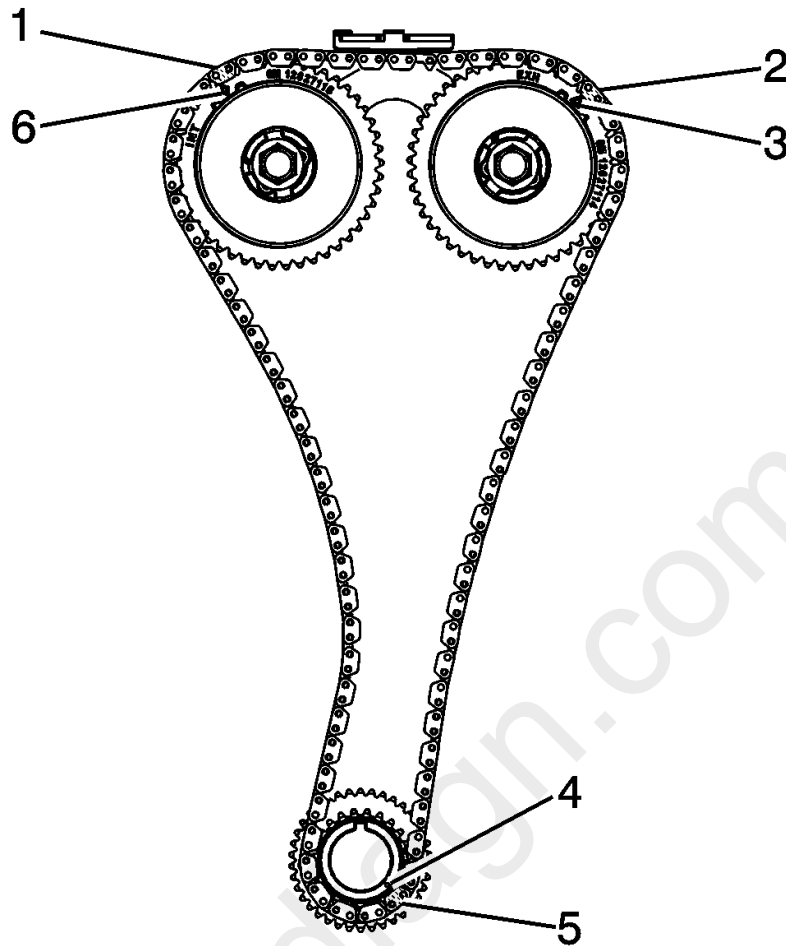


Fig. 105: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

12. Verify the timing links on the timing chain are properly aligned to the timing marks:
 1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
 2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
13. If they are not, repeat the portion of the procedure necessary to align the timing marks.

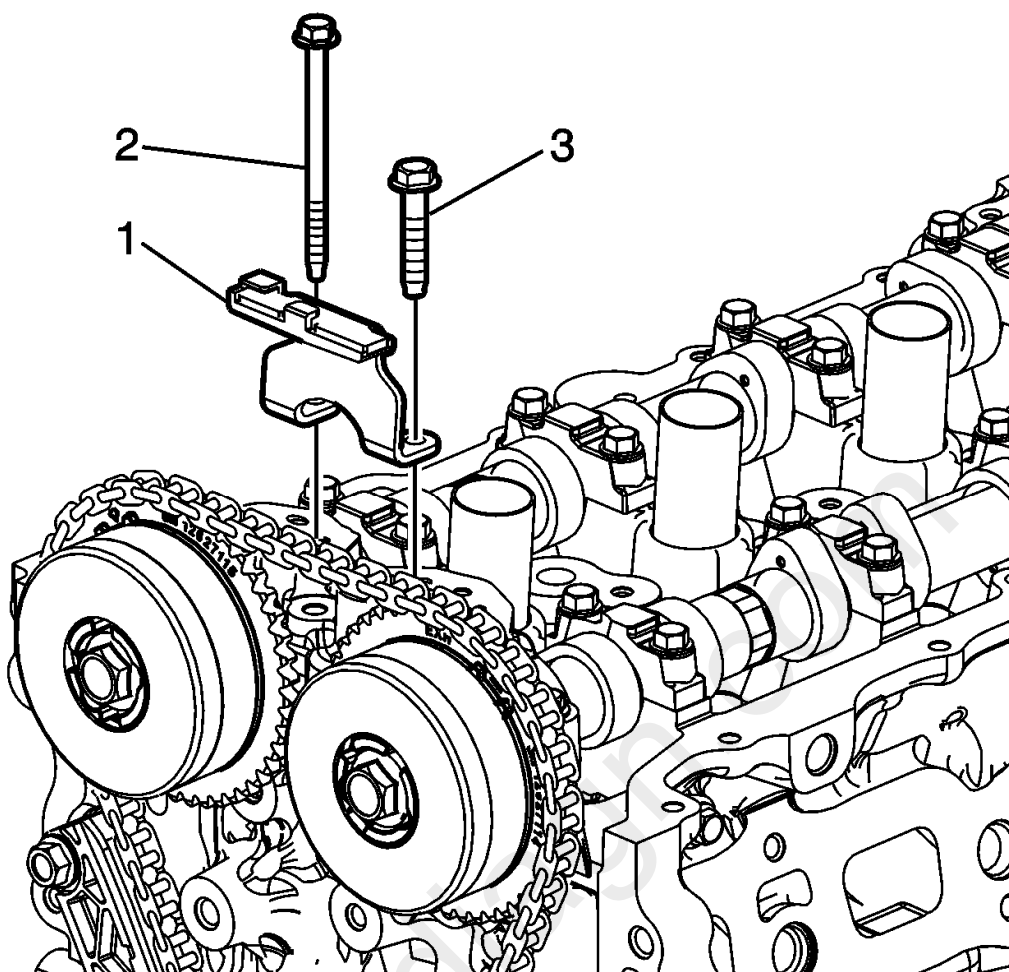


Fig. 106: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the timing chain guide (1) and bolts (2, 3) finger tight.

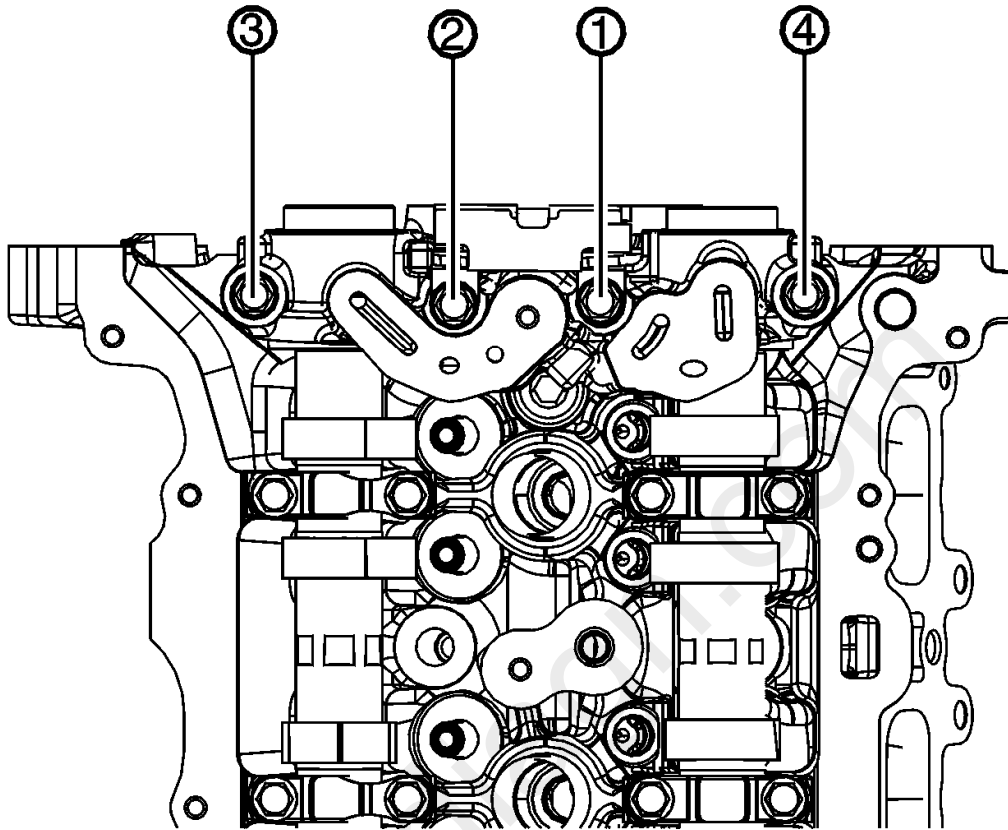


Fig. 107: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.
16. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

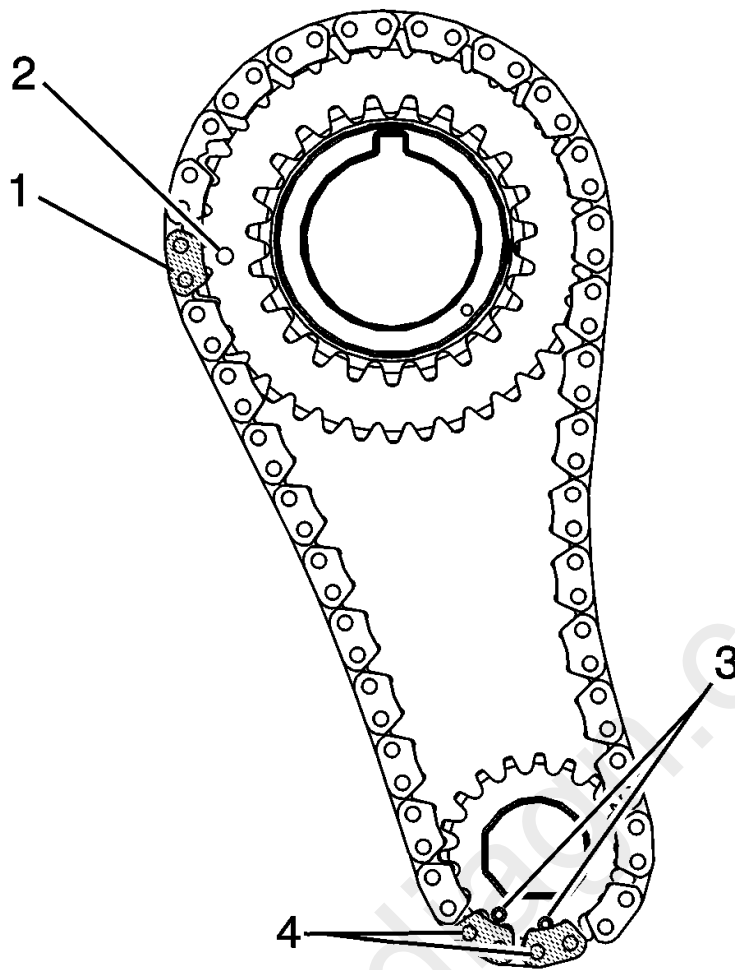


Fig. 108: Timing Link Lines Up And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

17. Verify the timing links on the balance chain are properly aligned to the timing marks:
 1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
 2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.
18. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT COVER REPLACEMENT

Removal Procedure

1. Remove the fuel pump insulator- outer. Refer to **Fuel Pump Insulator Replacement (Inner)** , **Fuel Pump Insulator Replacement (Outer)** .

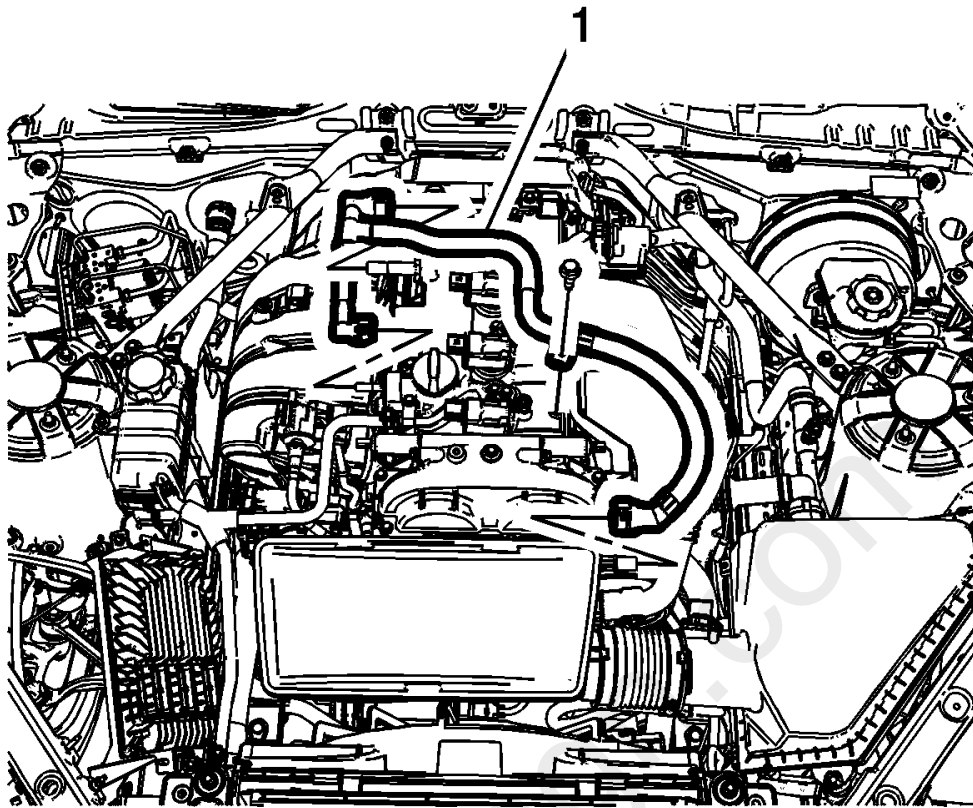


Fig. 109: Positive Crankcase Ventilation Hose/Pipe/Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove the positive crankcase ventilation hose/pipe/tube (1). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.

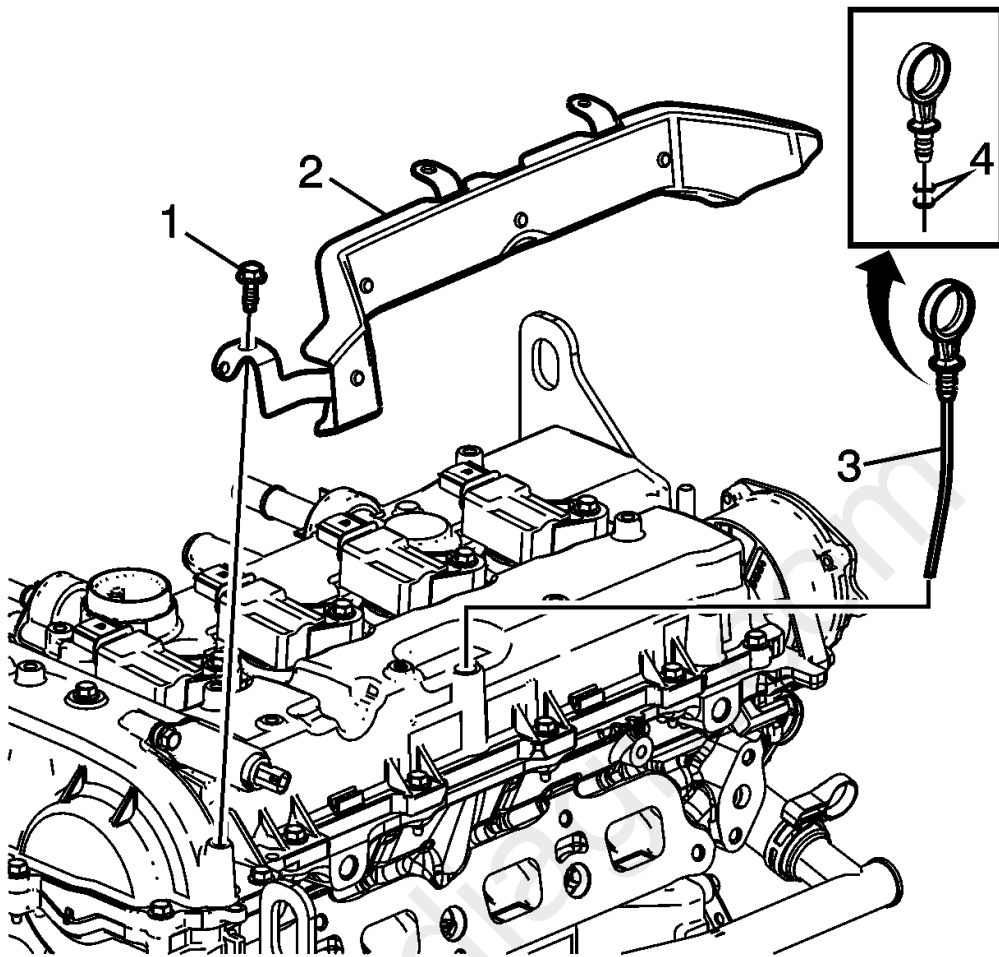


Fig. 110: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
4. If equipped with engine RPO LTG, remove the turbocharger heat shield bolts and heat shield. Refer to **Turbocharger Heat Shield Replacement**.
5. Disconnect the wire harness retainers at the camshaft cover heat shield.
6. Remove the camshaft cover heat shield (2) and bolts (1).
7. Remove the vacuum pump. Refer to **Vacuum Pump Replacement**.
8. Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)**.
9. If equipped with engine RPO LTG, remove the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)**.

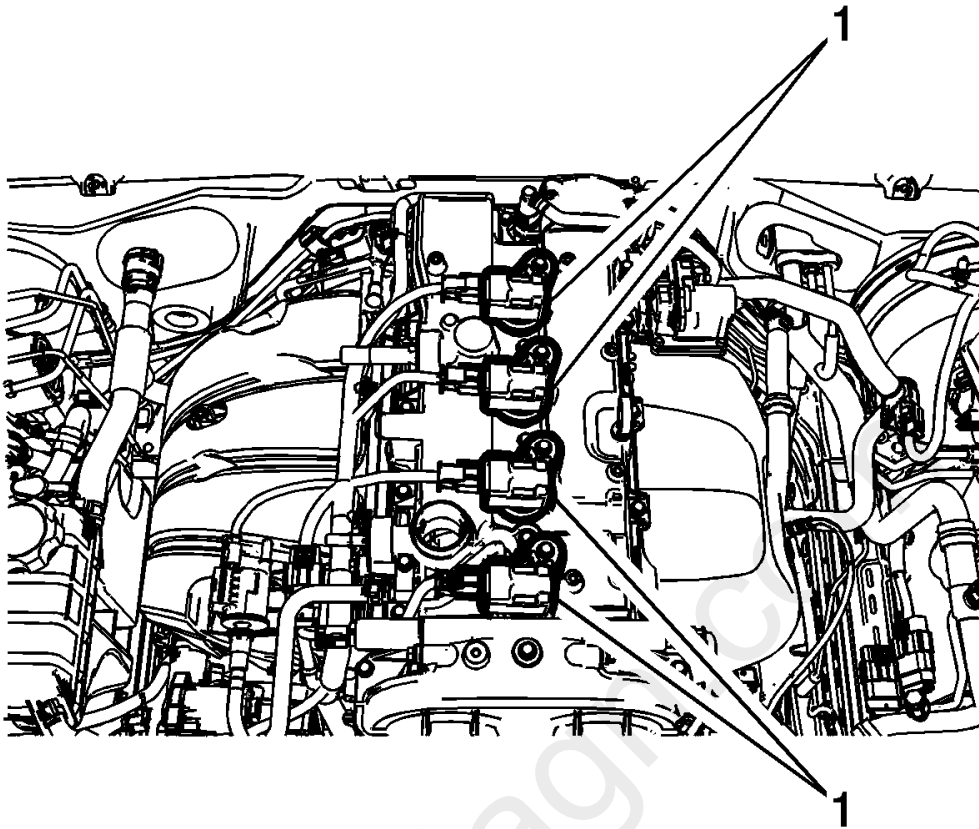


Fig. 111: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

10. Remove the ignition coils (1). Refer to **Ignition Coil Replacement** .
11. Remove the camshaft position actuator intake solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** .
12. Remove the camshaft position actuator exhaust solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .
13. Remove the fuel line bracket retainer stud and reposition bracket.
14. If equipped with engine RPO LTG, remove the turbocharger PCV tube fastener at the turbocharger and reposition the PCV tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.

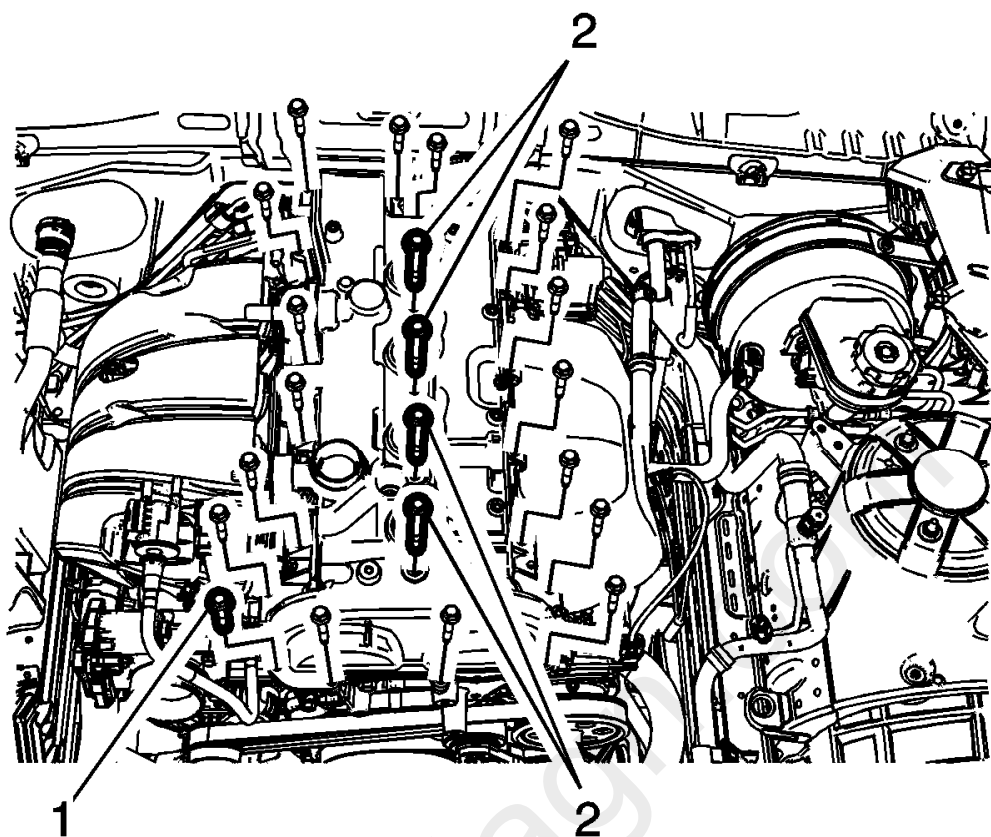


Fig. 112: Identifying Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the camshaft cover short fasteners (1).
16. Remove the camshaft cover longer fastener (2).

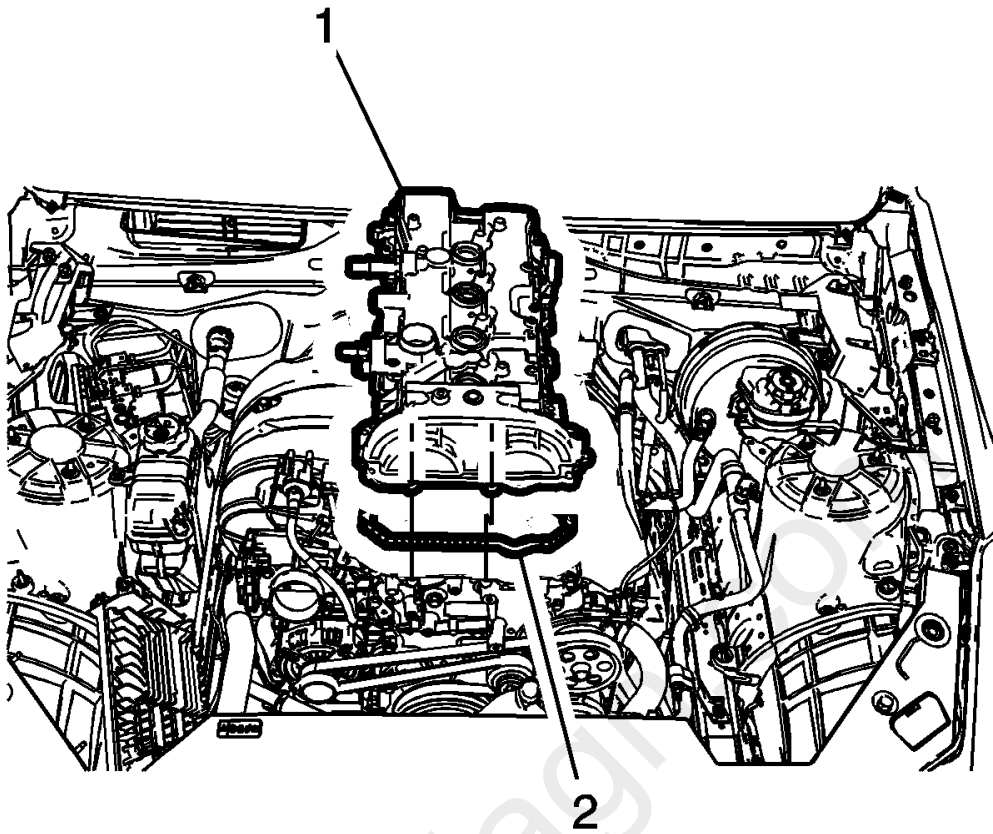


Fig. 113: Camshaft Cover

Courtesy of GENERAL MOTORS COMPANY

17. Remove the camshaft cover (1) and gasket (2).
18. For cleaning and inspection. Refer to **Camshaft Cover Cleaning and Inspection** .

Installation Procedure

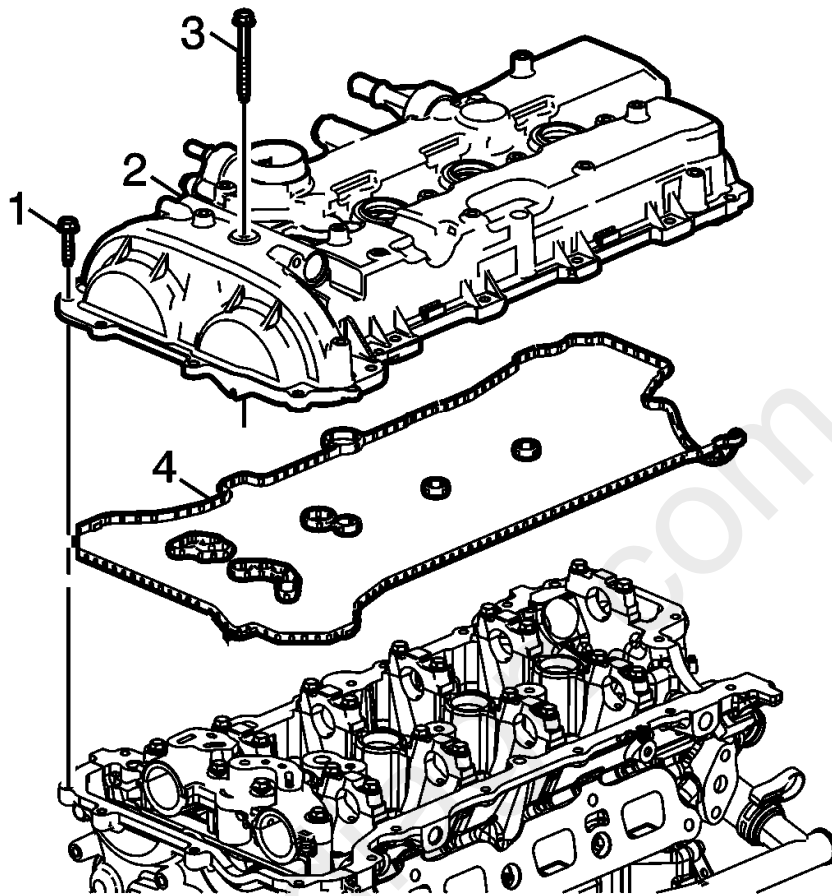


Fig. 114: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: Add 14mm bead of sealant part # 12378521 at right and left T-Joint where front cover meets head and at rear of camshaft cover right and left T-Joint where vacuum pump bolts on.

1. Assemble the camshaft cover (2) and a NEW gasket (4). Ensure that the gasket is located in the retaining groove in the camshaft cover.
2. Install the cover on the cylinder head and hand start the bolts (1, 3).

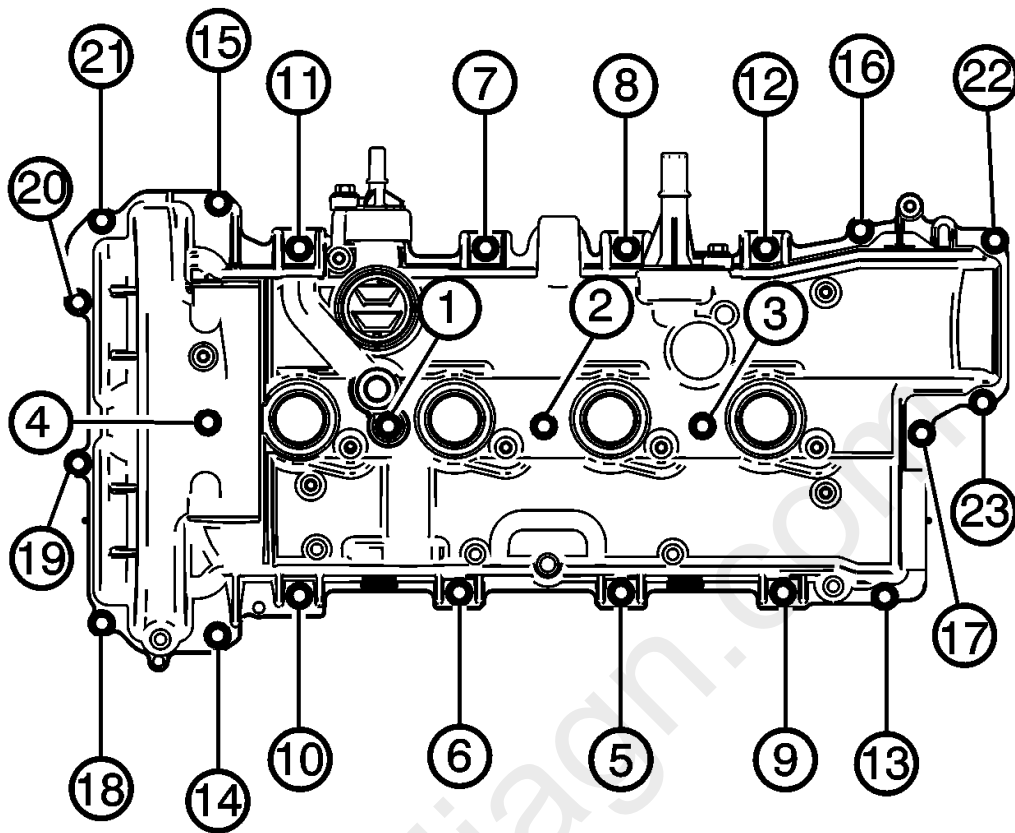


Fig. 115: Camshaft Cover Bolts In Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 (89 lb in).
4. Install the camshaft position actuator intake solenoid valve. Refer to Camshaft Position Actuator Intake Solenoid Valve Replacement .
5. Install the camshaft position actuator exhaust solenoid valve. Refer to Camshaft Position Actuator Exhaust Solenoid Valve Replacement .
6. Install the vacuum pump. Refer to Vacuum Pump Replacement .
7. Install the engine coolant air bleed pipe. Refer to Engine Coolant Air Bleed Pipe Replacement (LTG) .
8. Reinstall the fuel line bracket retainer stud and reposition bracket.
9. If equipped with engine RPO LTG, install the turbocharger PCV tube fastener at the turbocharger and reposition the PCV tube. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG).

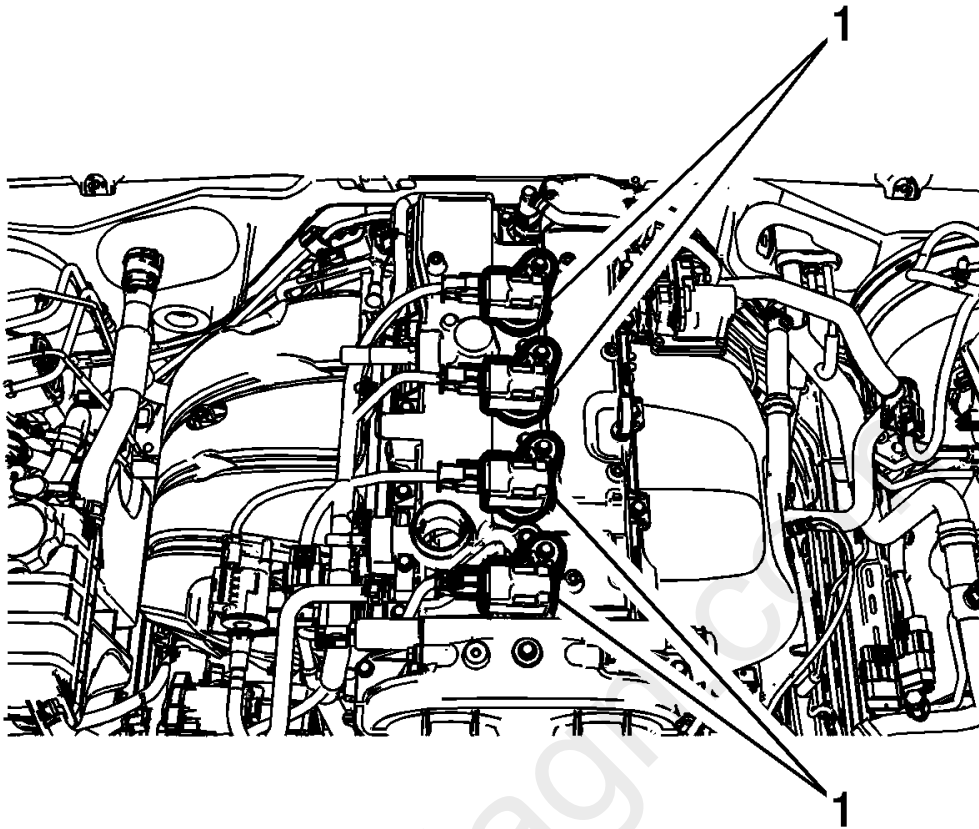


Fig. 116: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

10. Install the ignition coils (1). Refer to **Ignition Coil Replacement** .

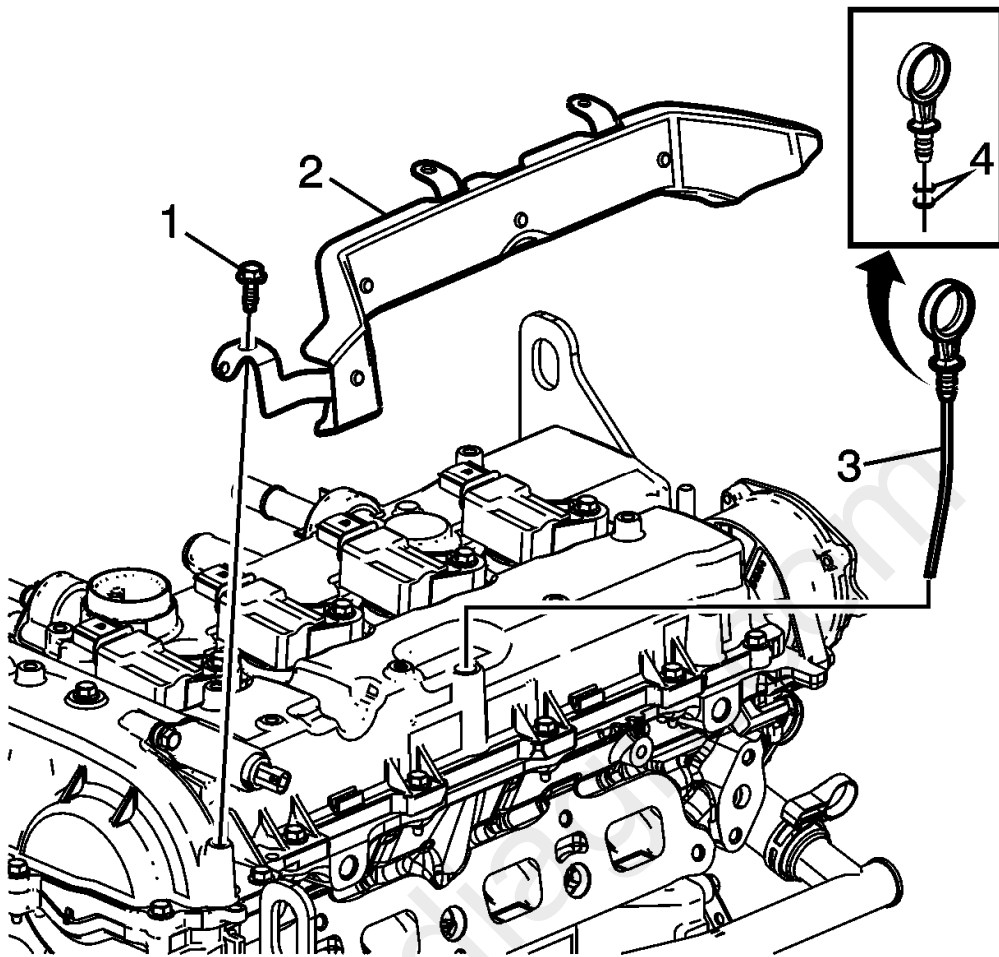


Fig. 117: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

11. Install the camshaft cover heat shield (2) and bolts (1) and tighten the bolts to 10 (89 lb in).
12. Install the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
13. If equipped with engine RPO LTG, install the turbocharger heat shield bolts and heat shield. Refer to **Turbocharger Heat Shield Replacement**.
14. Connect the wire harness retainers at the camshaft cover heat shield.

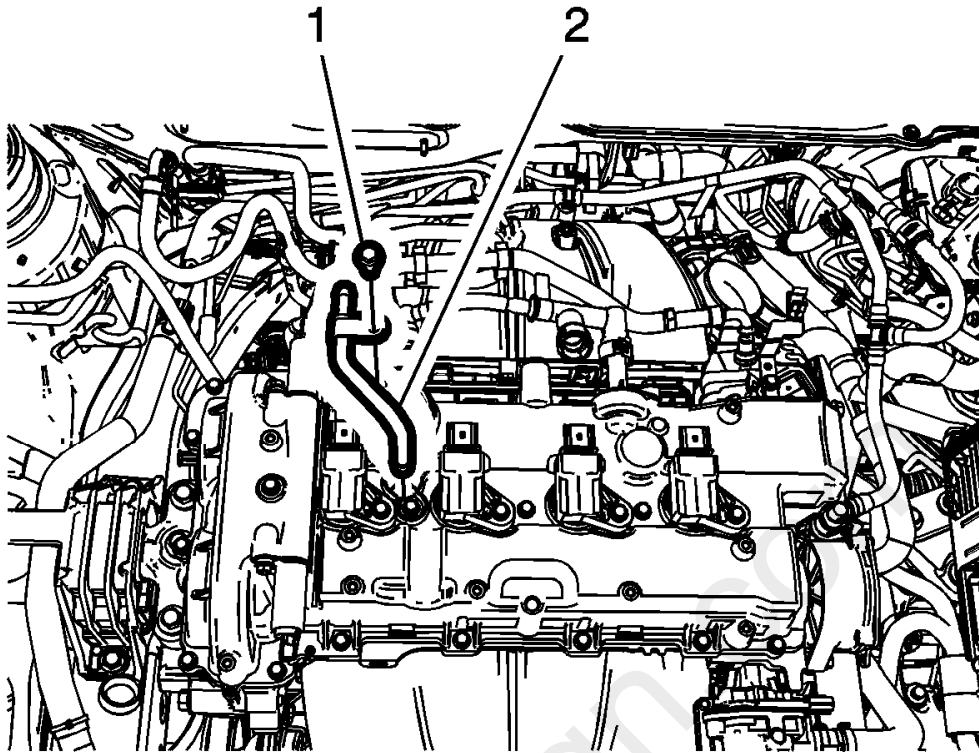


Fig. 118: Engine Coolant Air Bleed Pipe
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the O-ring on the engine coolant air bleed pip. Replace if necessary. Install the engine coolant air bleed pipe (1).
16. Install the pipe fastener and tighten to 10 (89 lb in).
17. If equipped with engine RPO LTG, install the turbocharger coolant return pipe. Refer to **Turbocharger Coolant Return Pipe Replacement (LTG)**

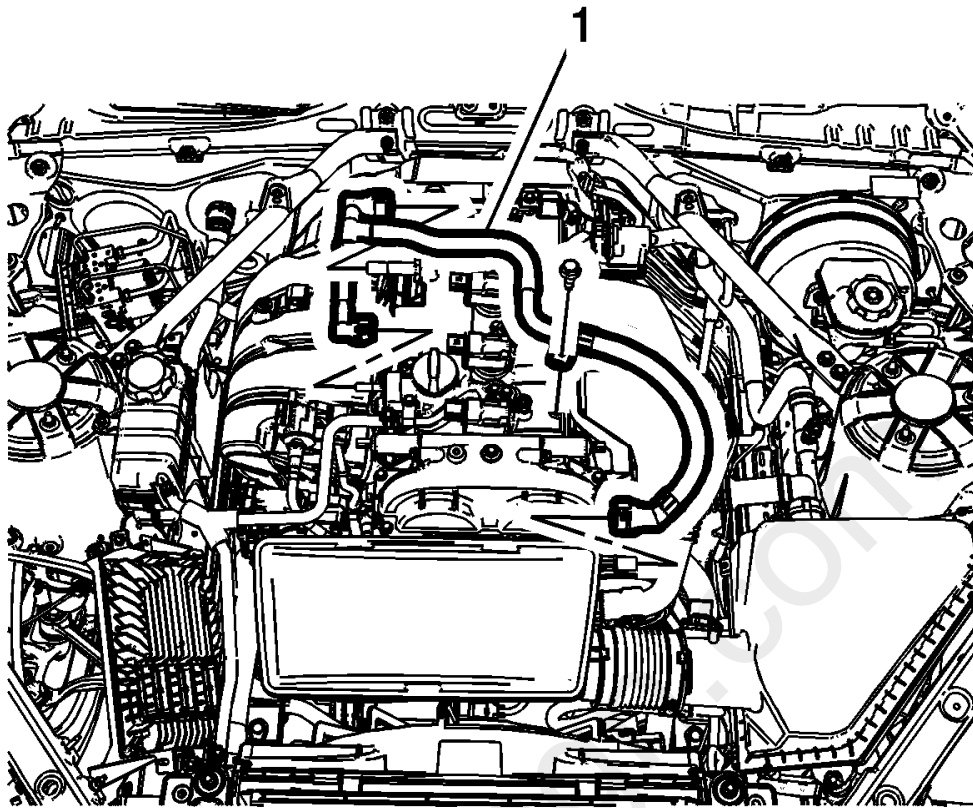


Fig. 119: Positive Crankcase Ventilation Hose/Pipe/Tube
Courtesy of GENERAL MOTORS COMPANY

18. Install the positive crankcase ventilation hose/pipe/tube (1). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LTG)**.
19. Install the fuel pump insulator- outer. Refer to **Fuel Pump Insulator Replacement (Inner)** , **Fuel Pump Insulator Replacement (Outer)** .

TIMING CHAIN TENSIONER REPLACEMENT

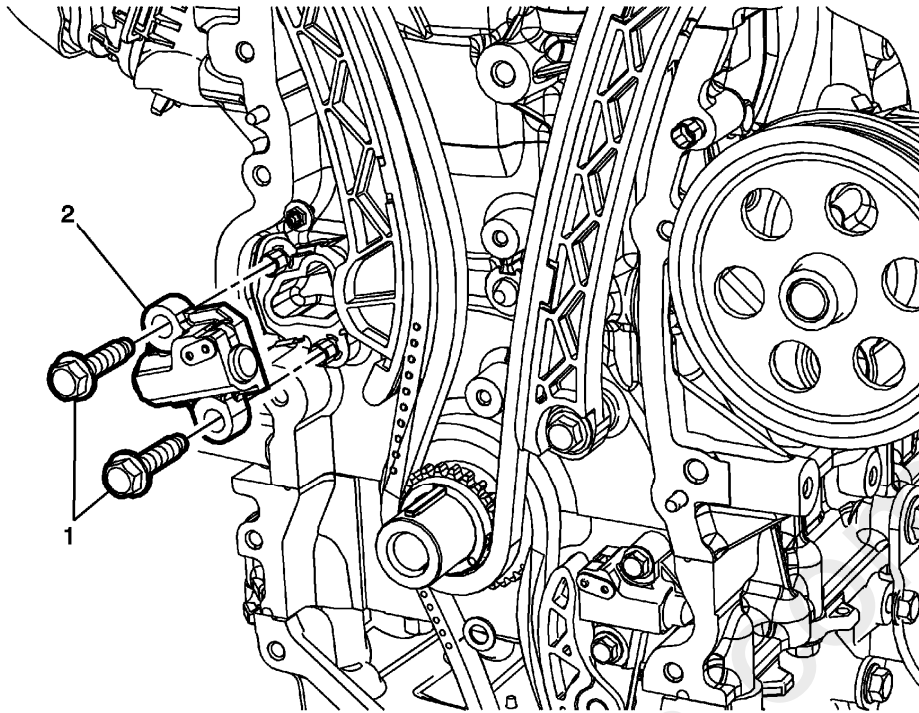


Fig. 120: Timing Chain Tensioner Bolts And Timing Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Timing Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure	
Remove the camshaft timing chain. Refer to <u>Camshaft Timing Chain and Tensioner Replacement</u> .	
1	Timing Chain Tensioner Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Timing Chain Tensioner

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - EXHAUST

Removal Procedure

1. Remove the exhaust valve rocker arm. Refer to Valve Rocker Arm Replacement (Exhaust), Valve Rocker Arm Replacement (Intake).

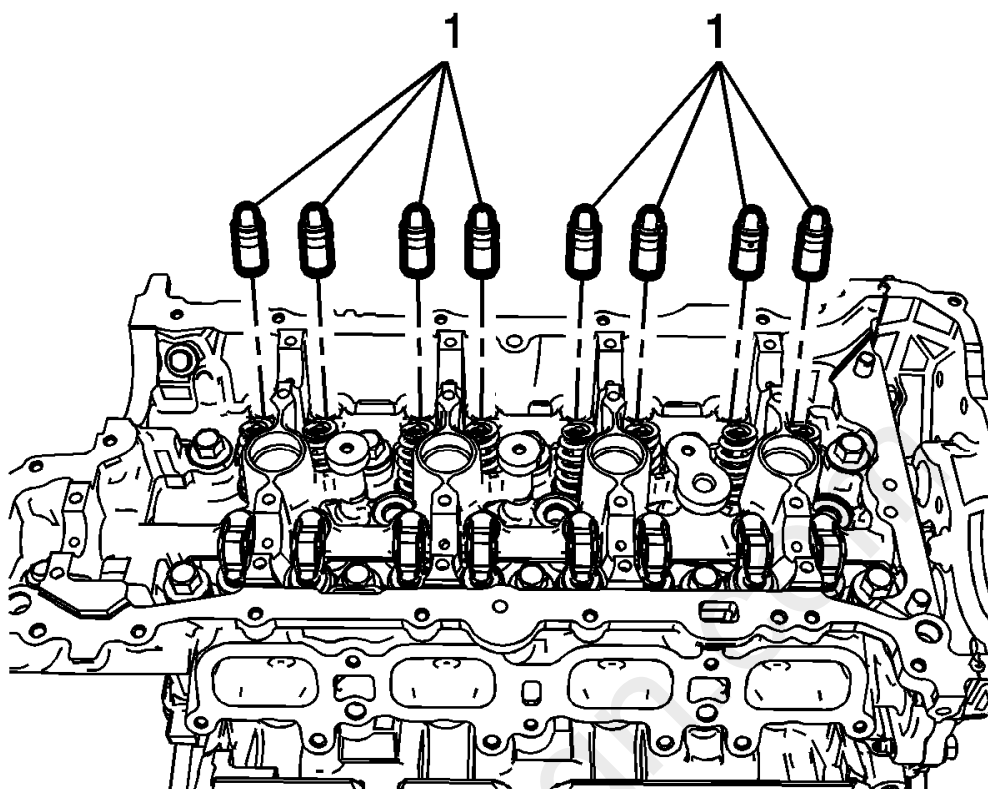


Fig. 121: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

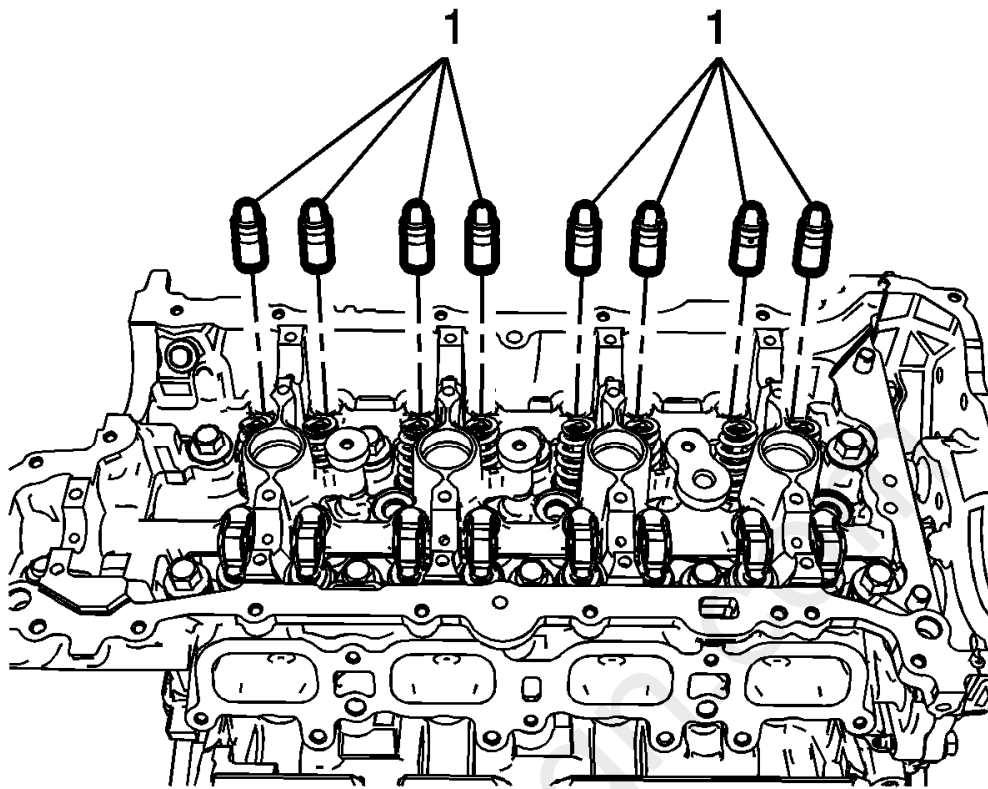


Fig. 122: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the exhaust valve rocker arm. Refer to **Valve Rocker Arm Replacement (Exhaust)**, **Valve Rocker Arm Replacement (Intake)**.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - INTAKE

Removal Procedure

1. Remove the Intake valve rocker arm. Refer to **Valve Rocker Arm Replacement (Exhaust)**, **Valve**

Rocker Arm Replacement (Intake).

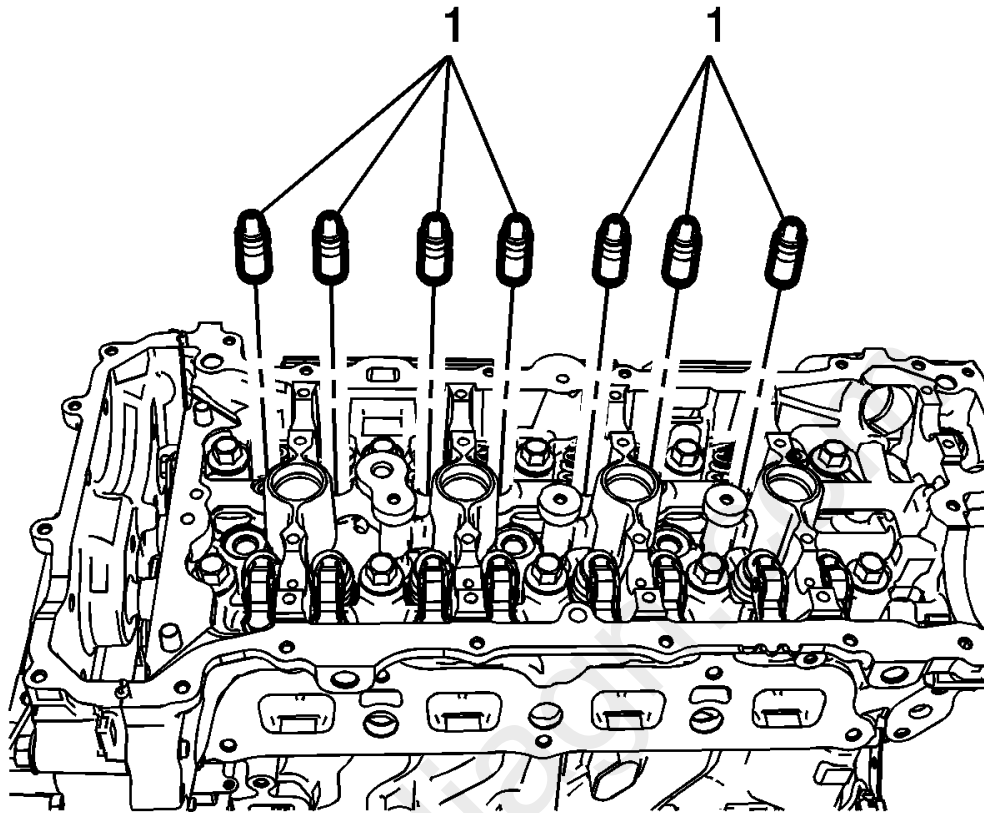


Fig. 123: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

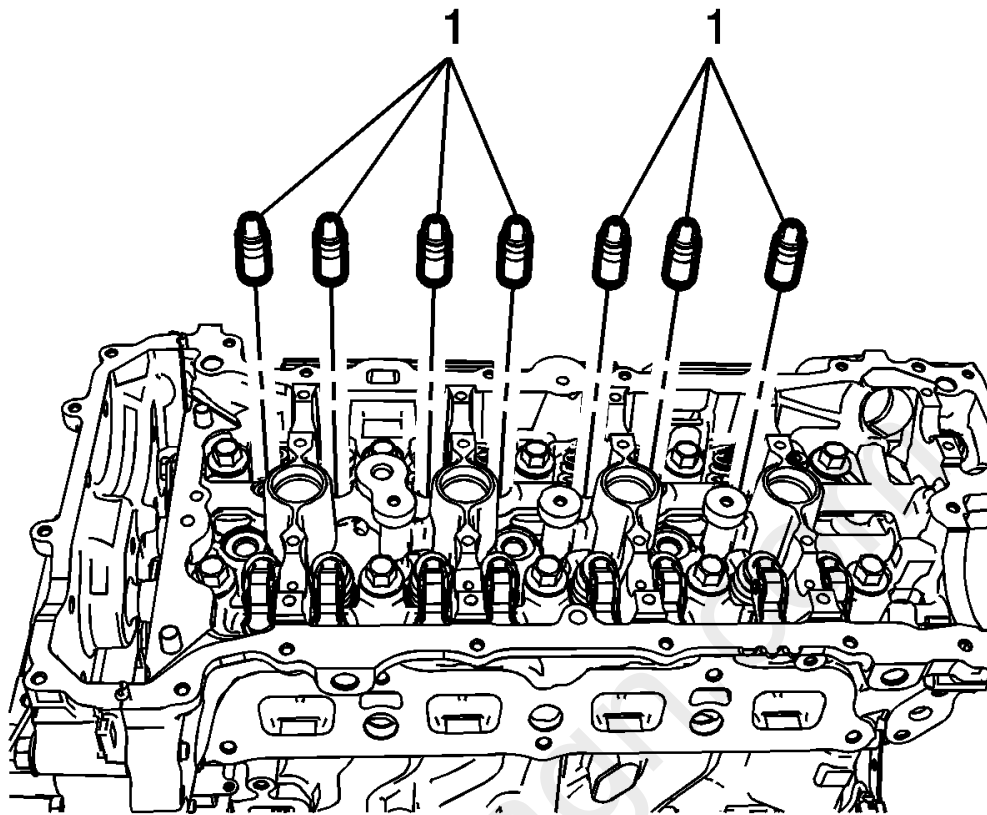


Fig. 124: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2. Install the Intake valve rocker arm. Refer to **Valve Rocker Arm Replacement (Exhaust), Valve Rocker Arm Replacement (Intake)**.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - INTAKE

Special Tools

- EN-50656 Holding Tool
- EN 50793 Locking Tool

For equivalent regional tools, refer to Special Tools .

Removal Procedure

NOTE: Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement.
2. Remove the high pressure fuel pump. Refer to Fuel Pump Replacement .

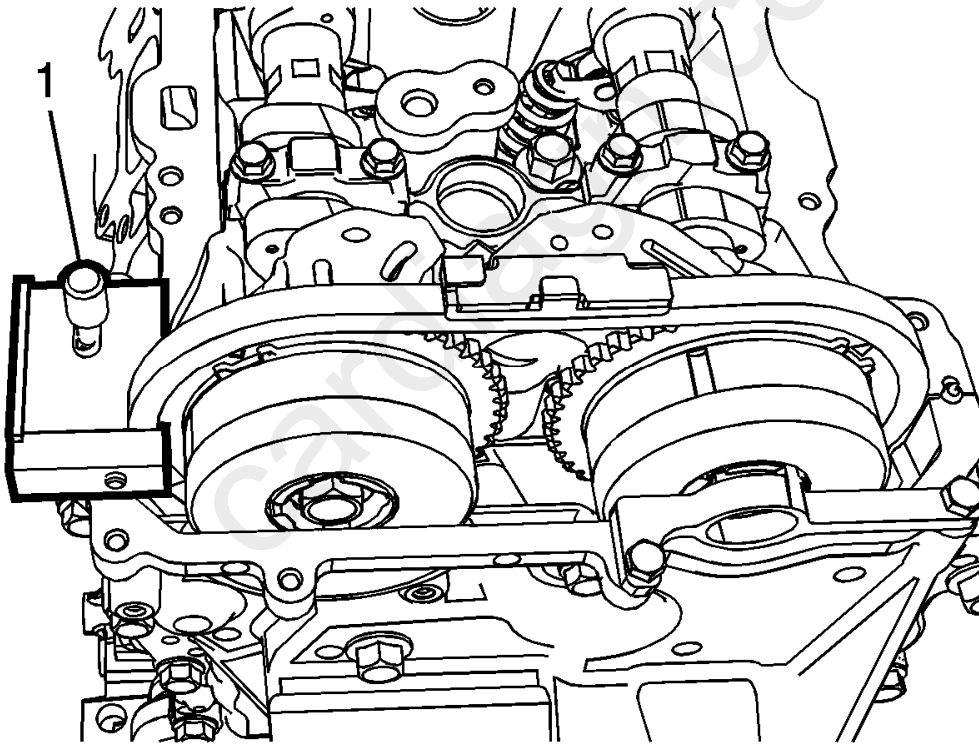


Fig. 125: Identifying EN-50656 Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the EN-50656 holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover

during camshaft actuator replacement.

3. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

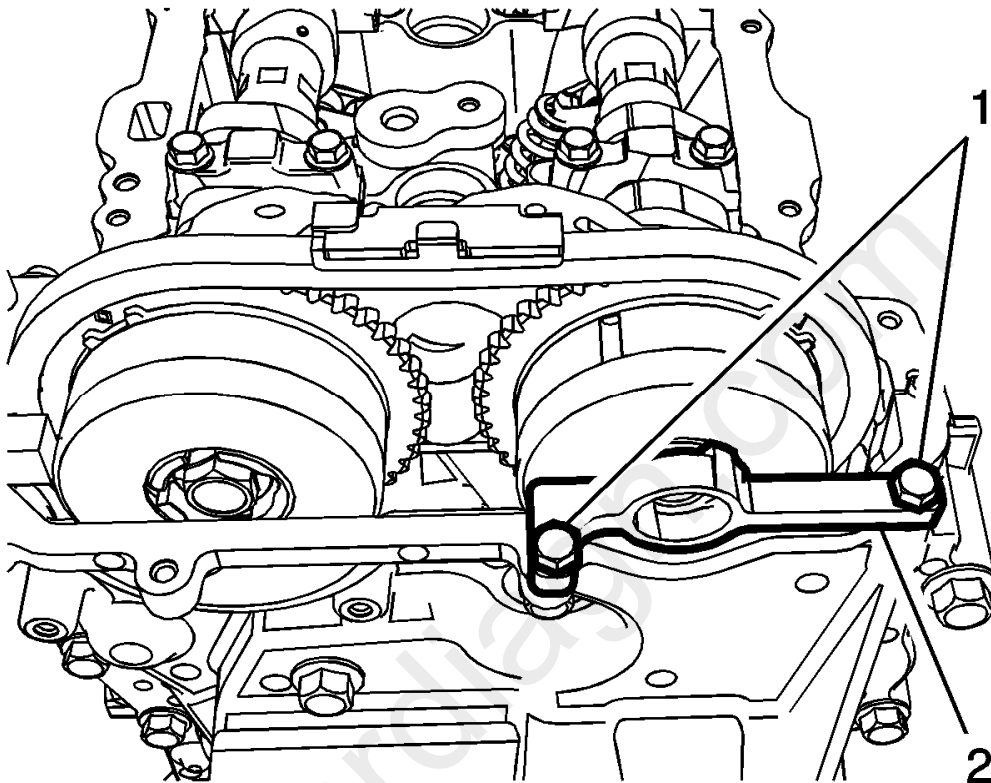


Fig. 126: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure to mark actuator sprocket and chain before removal.

4. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

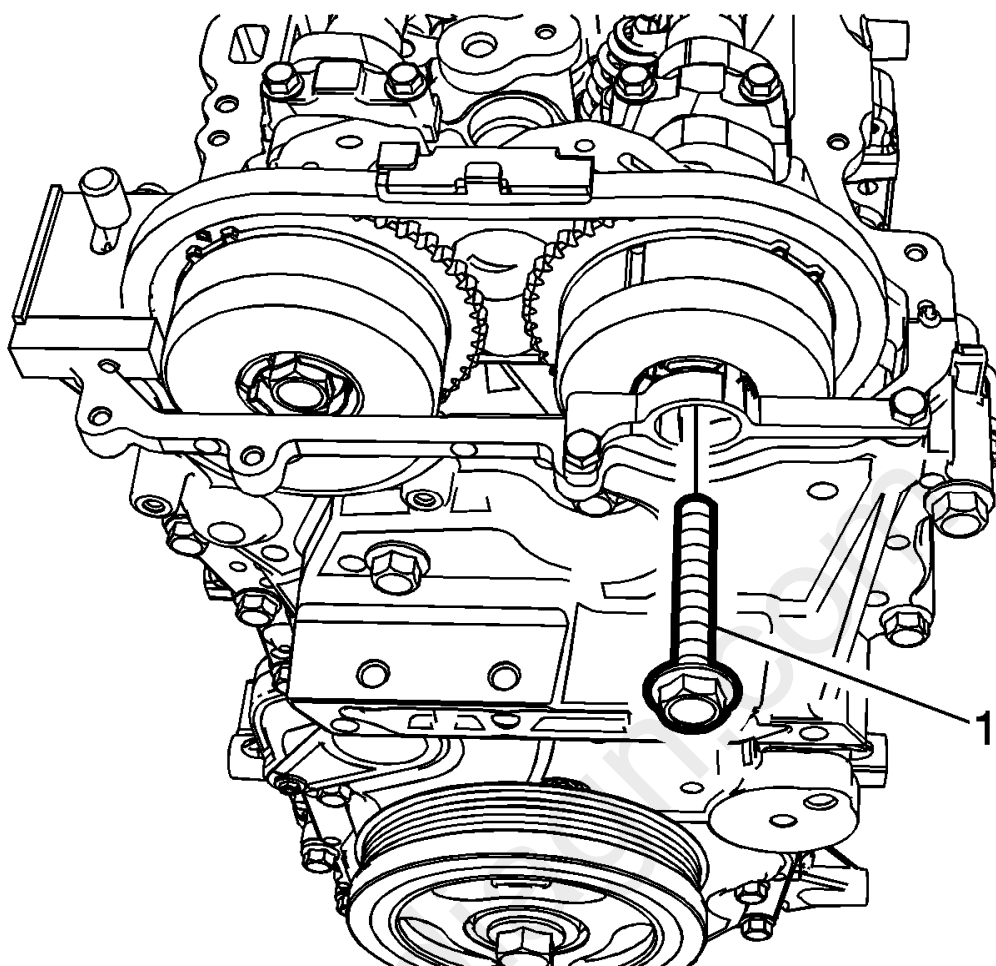


Fig. 127: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the camshaft actuator bolt (1).

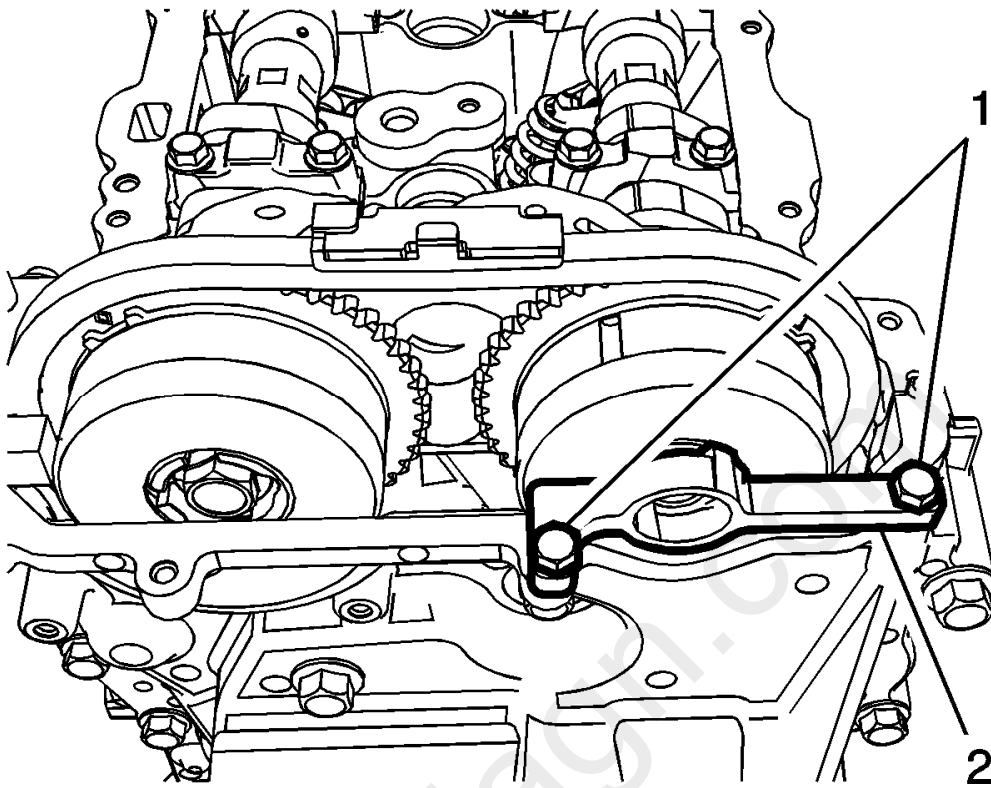


Fig. 128: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50793** holding tool (2).

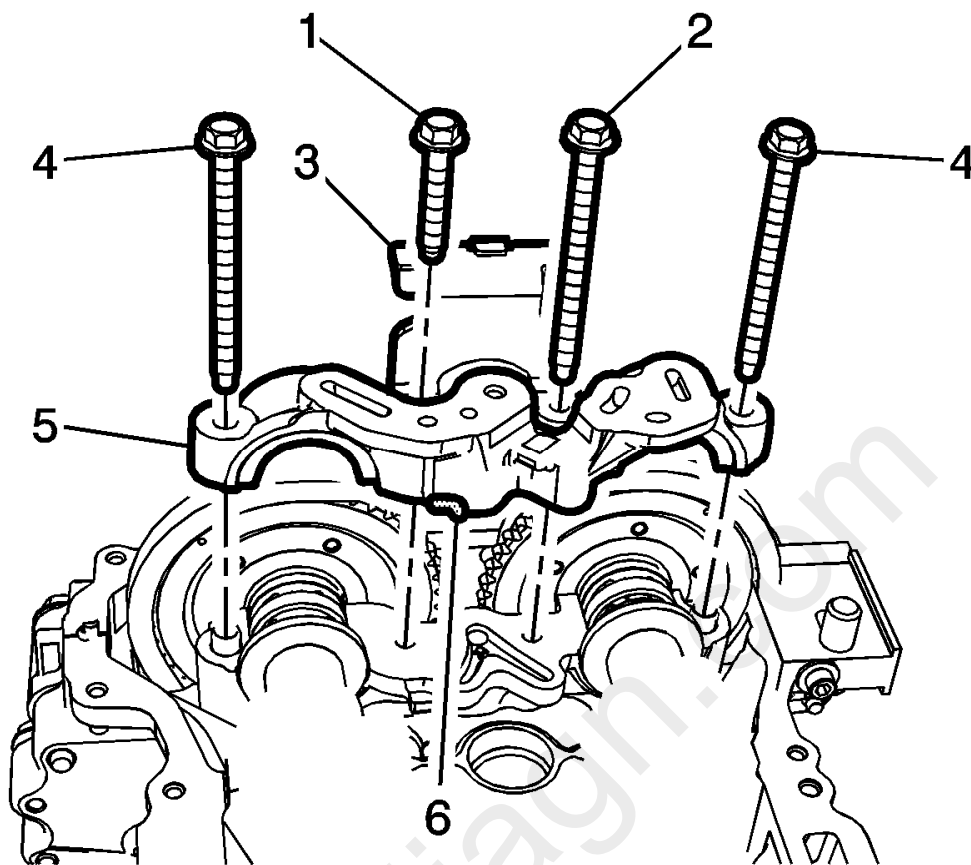


Fig. 129: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper timing chain guide bolts (1, 2).
8. Remove the upper timing chain guide (3).
9. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

10. Remove the camshaft front bearing cap (5).

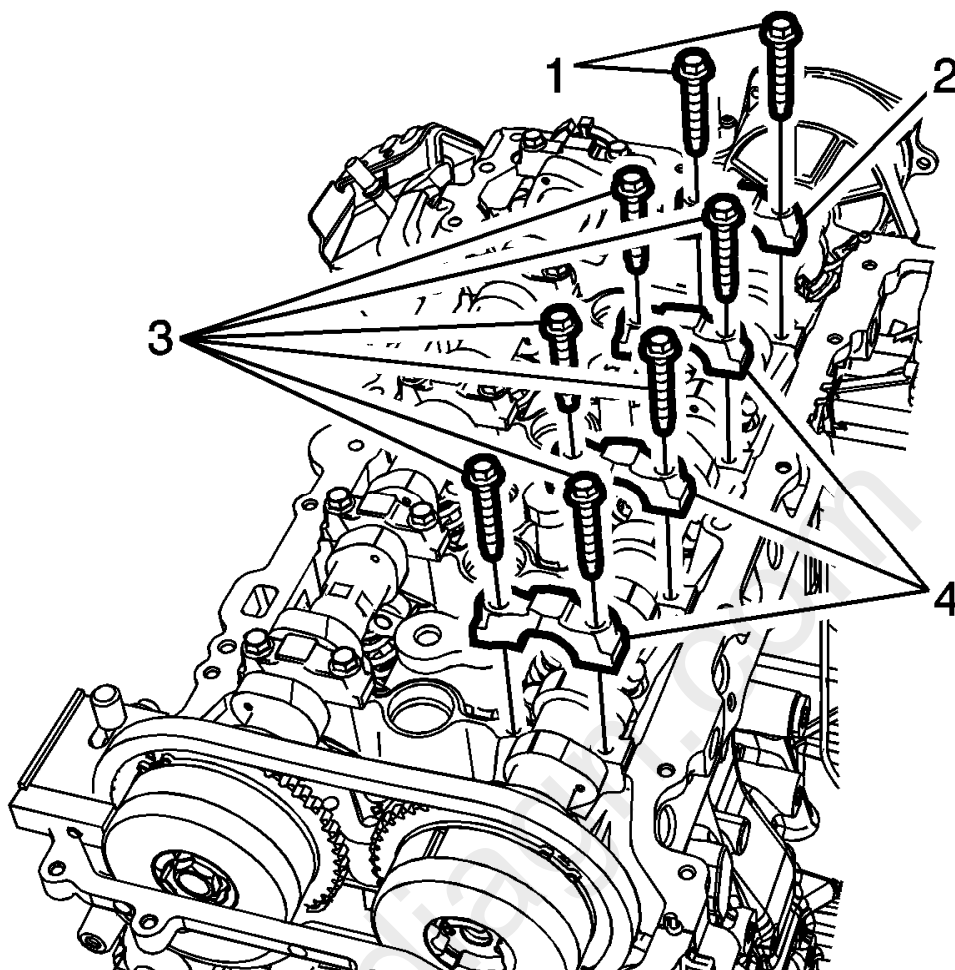


Fig. 130: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

11. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

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

12. Mark the camshaft caps (4) to ensure they are installed in the same position.
13. Remove the exhaust camshaft cap bolts (3).
14. Remove the camshaft caps (4).

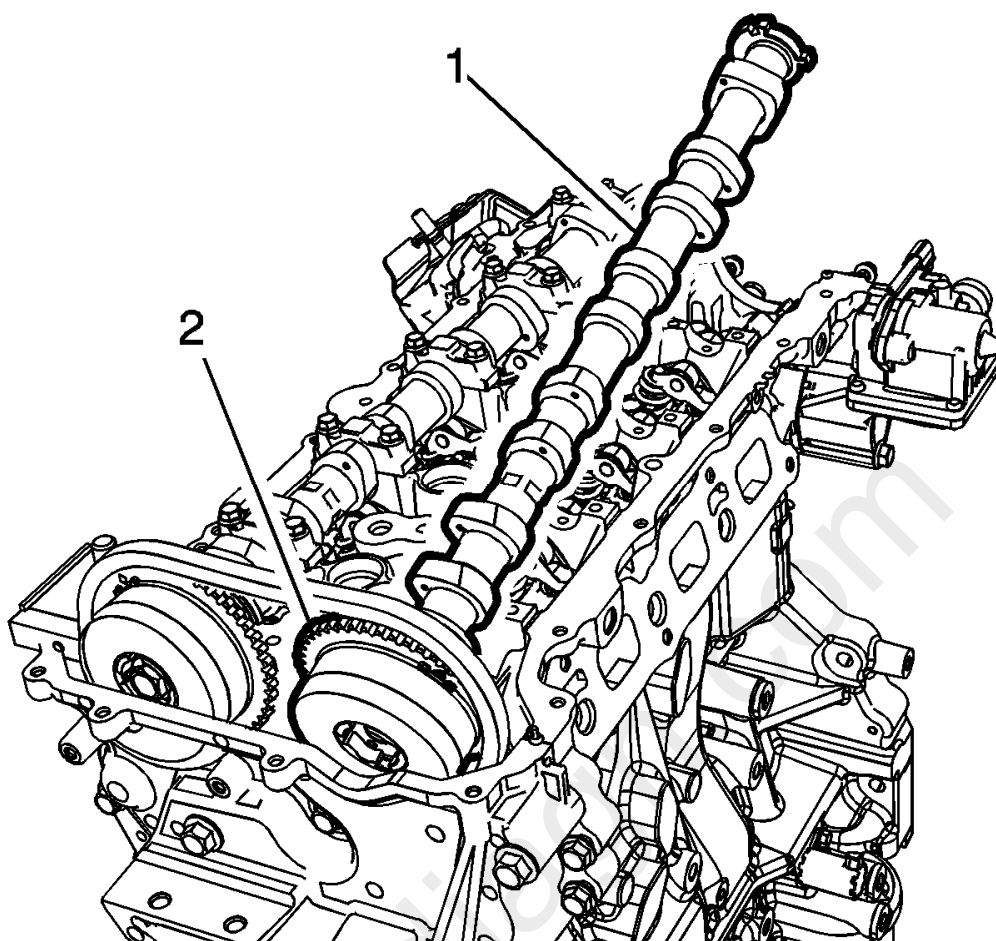


Fig. 131: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

15. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

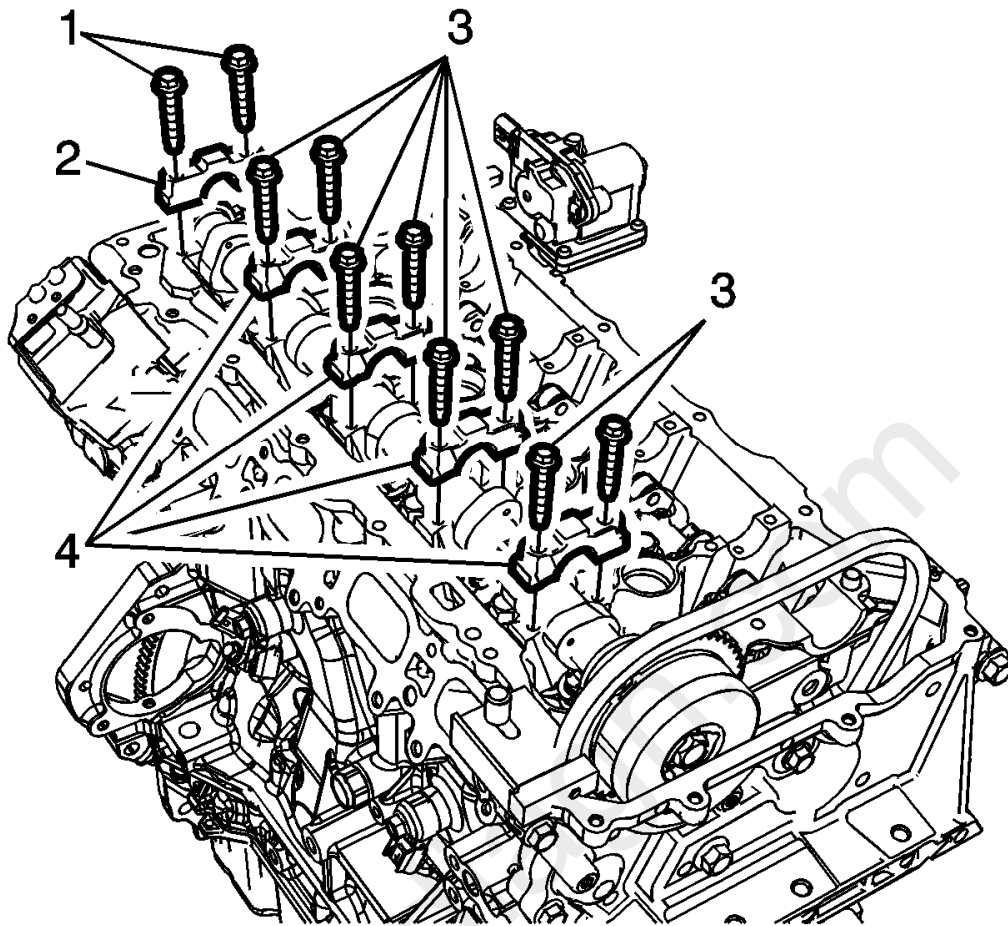


Fig. 132: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

16. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (2).

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

17. Mark the camshaft caps (4) to ensure they are installed in the same position.
18. Remove the intake camshaft cap bolts (3).
19. Remove the camshaft caps (4).
20. Lift and roll intake camshaft assembly from original position over into exhaust camshaft position within engine head assembly.

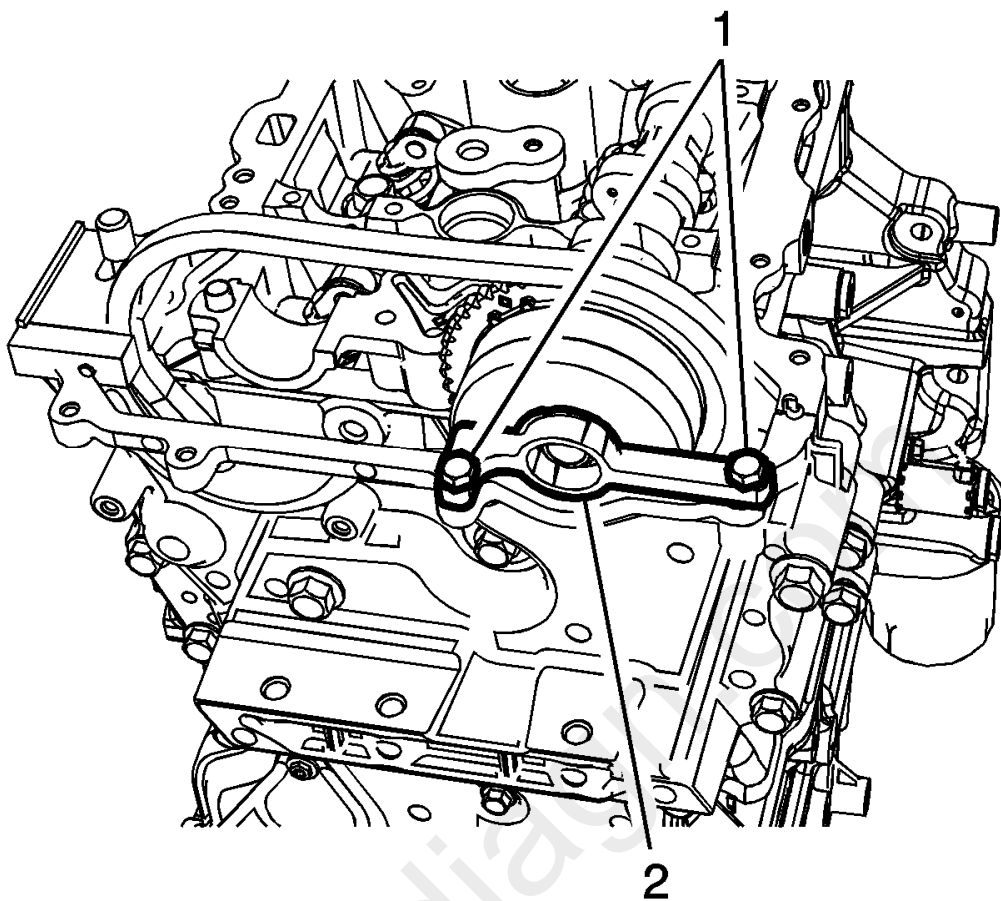


Fig. 133: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

21. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

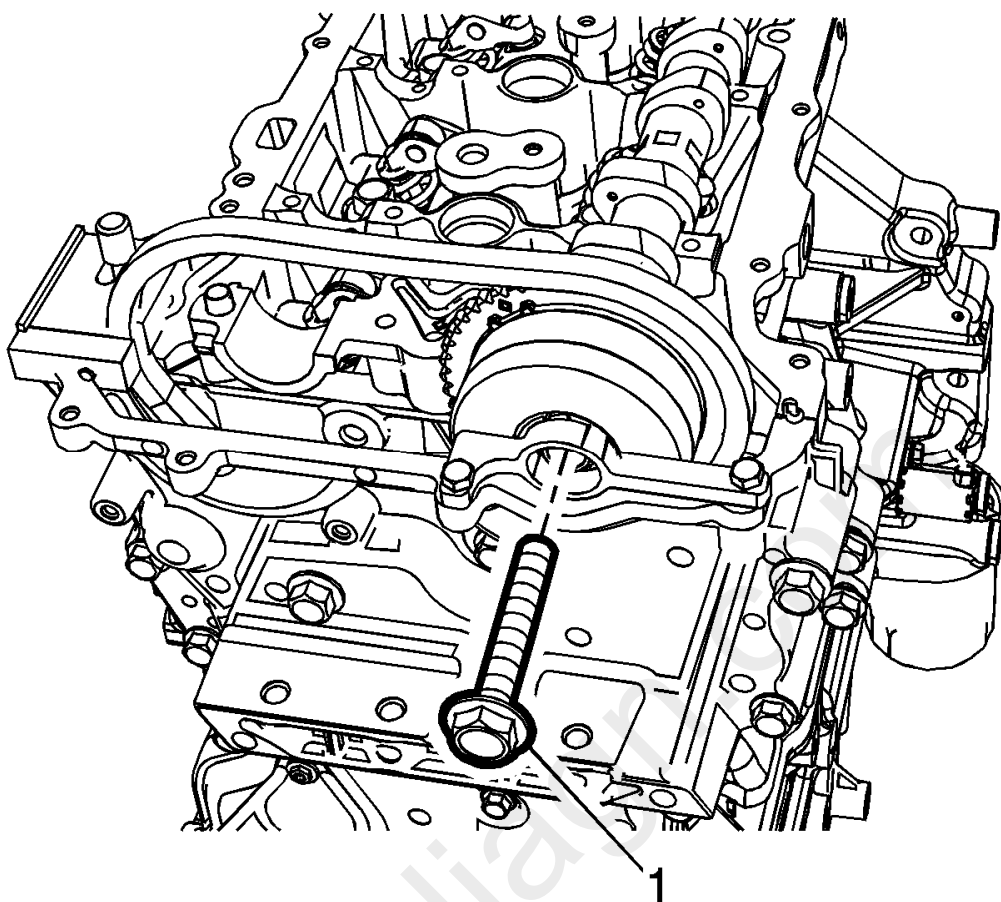


Fig. 134: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

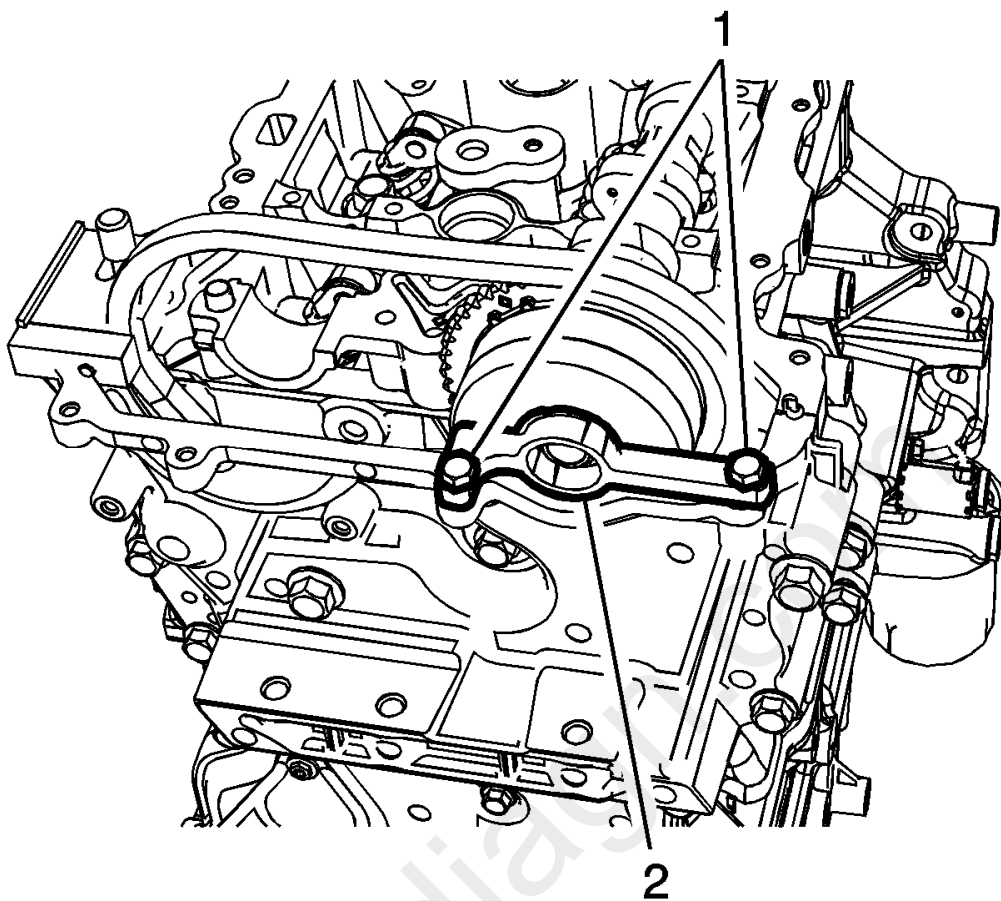


Fig. 135: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

23. Remove the **EN-50793** holding tool (2).

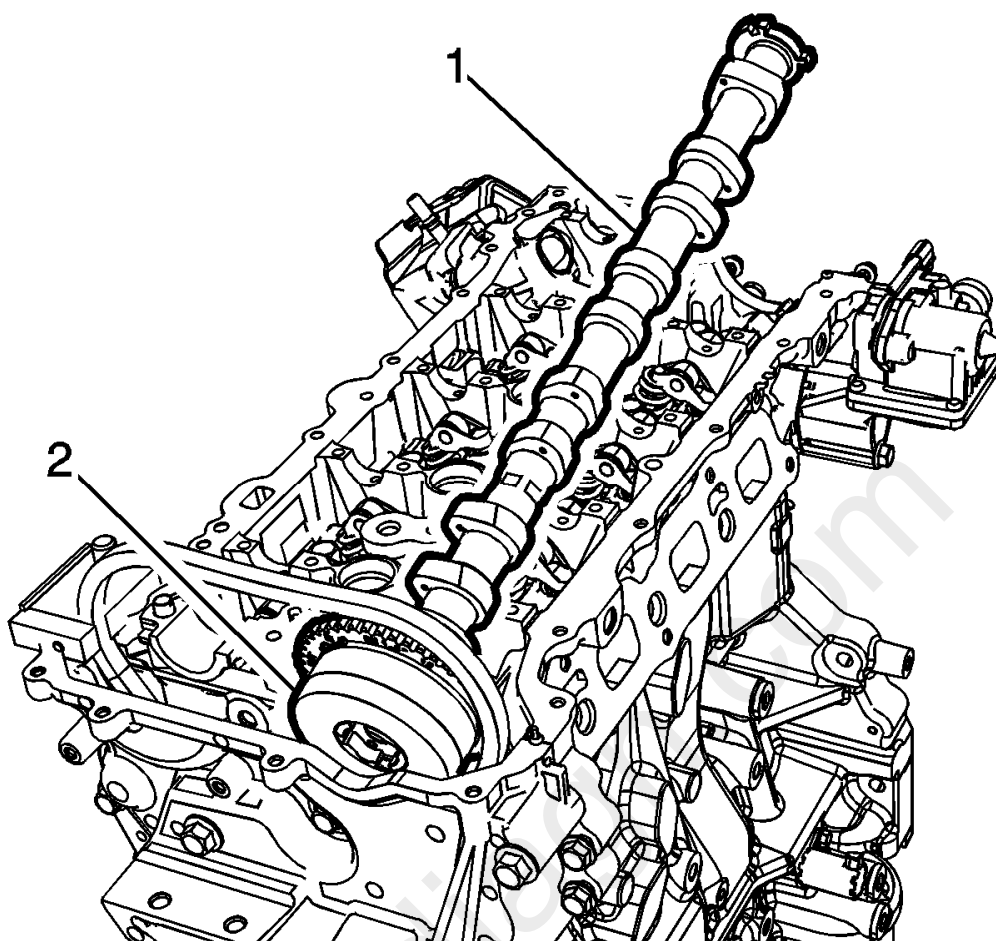


Fig. 136: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

24. Pull intake camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of intake camshaft assembly to a tilt and pull free from intake camshaft actuator assembly (2).

NOTE: If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.

25. Replace the camshaft if necessary.

Installation Procedure

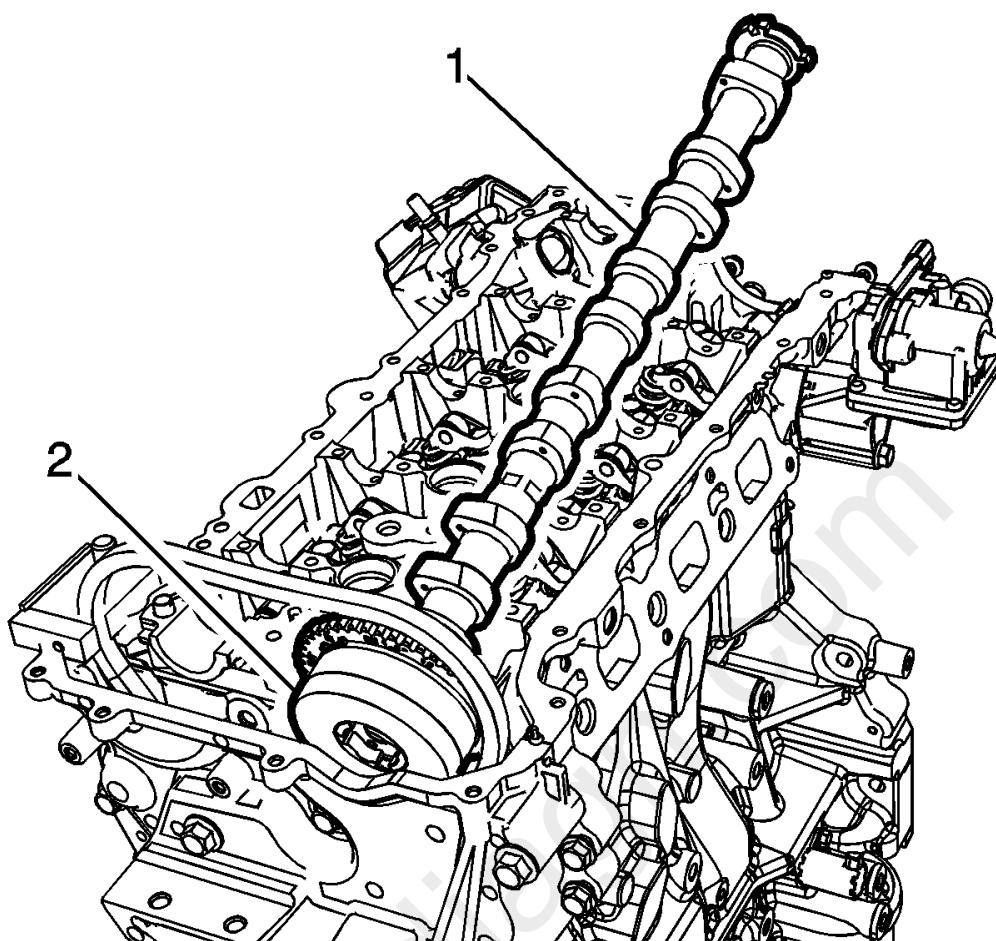


Fig. 137: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft (1) and camshaft actuator (2).

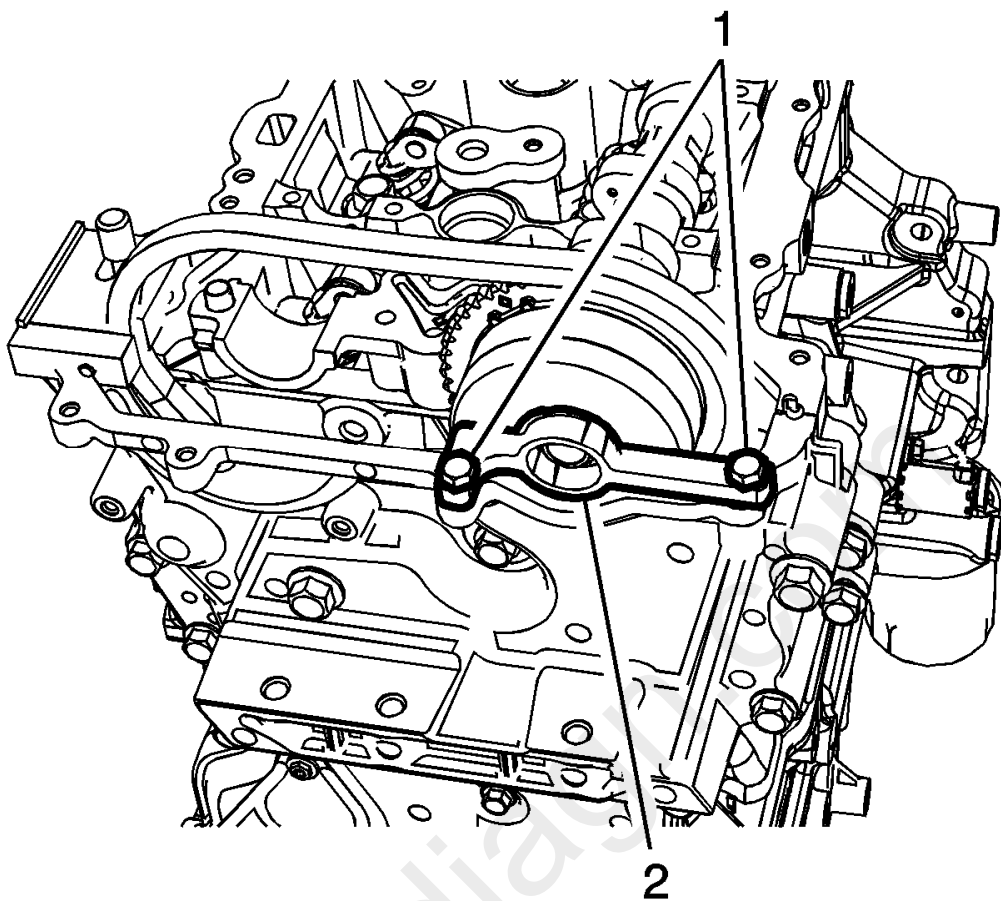


Fig. 138: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

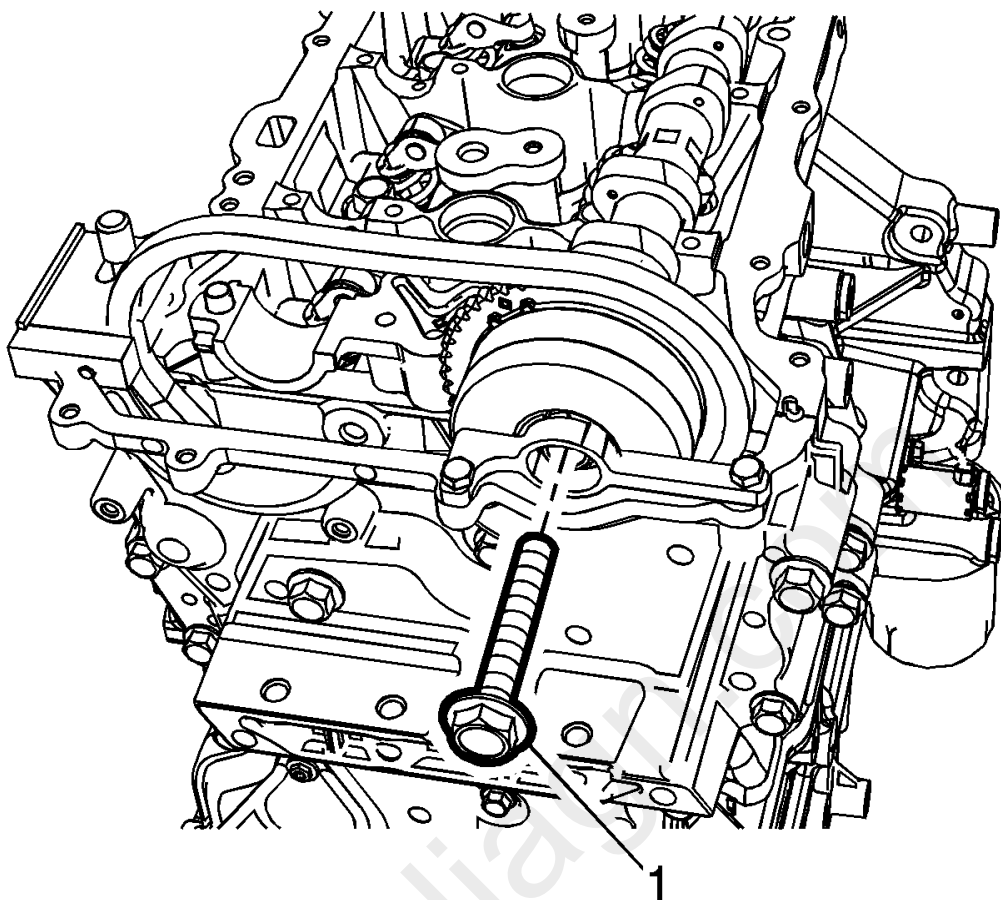


Fig. 139: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.
4. Lift and roll intake camshaft assembly from exhaust camshaft position over into original position.

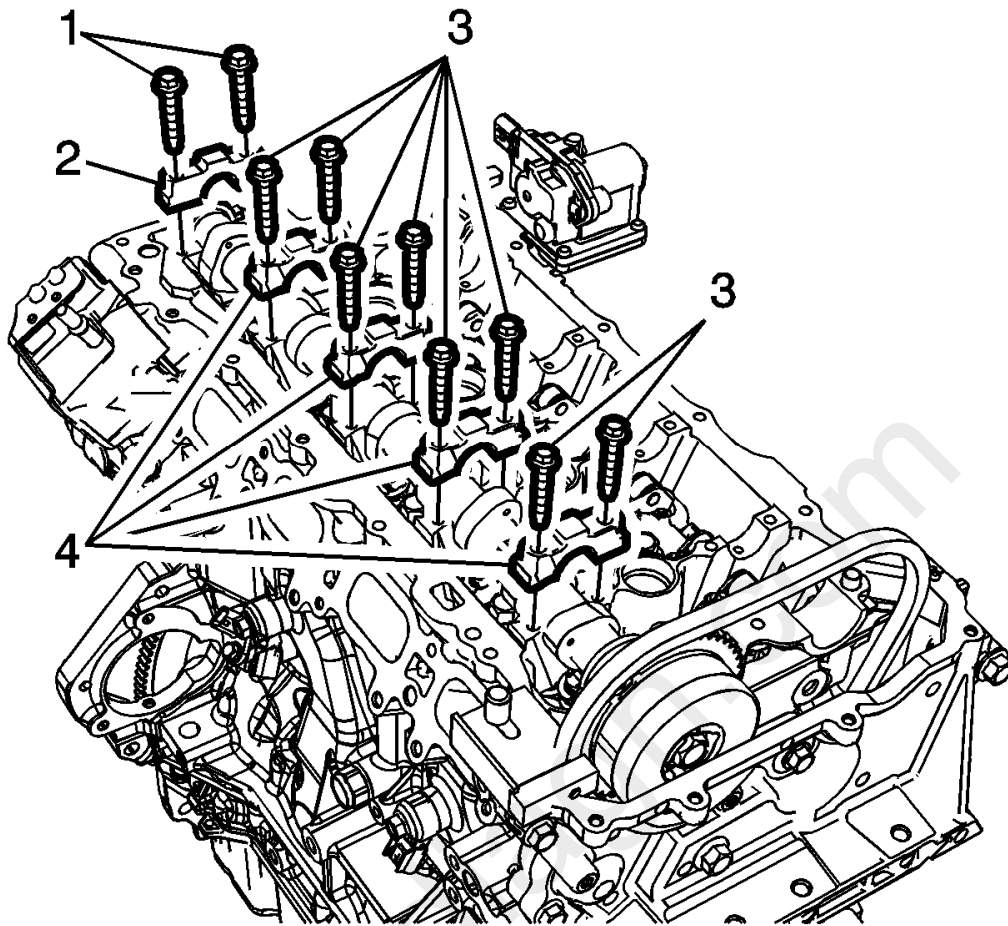


Fig. 140: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

5. Set the intake camshaft on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

6. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
7. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

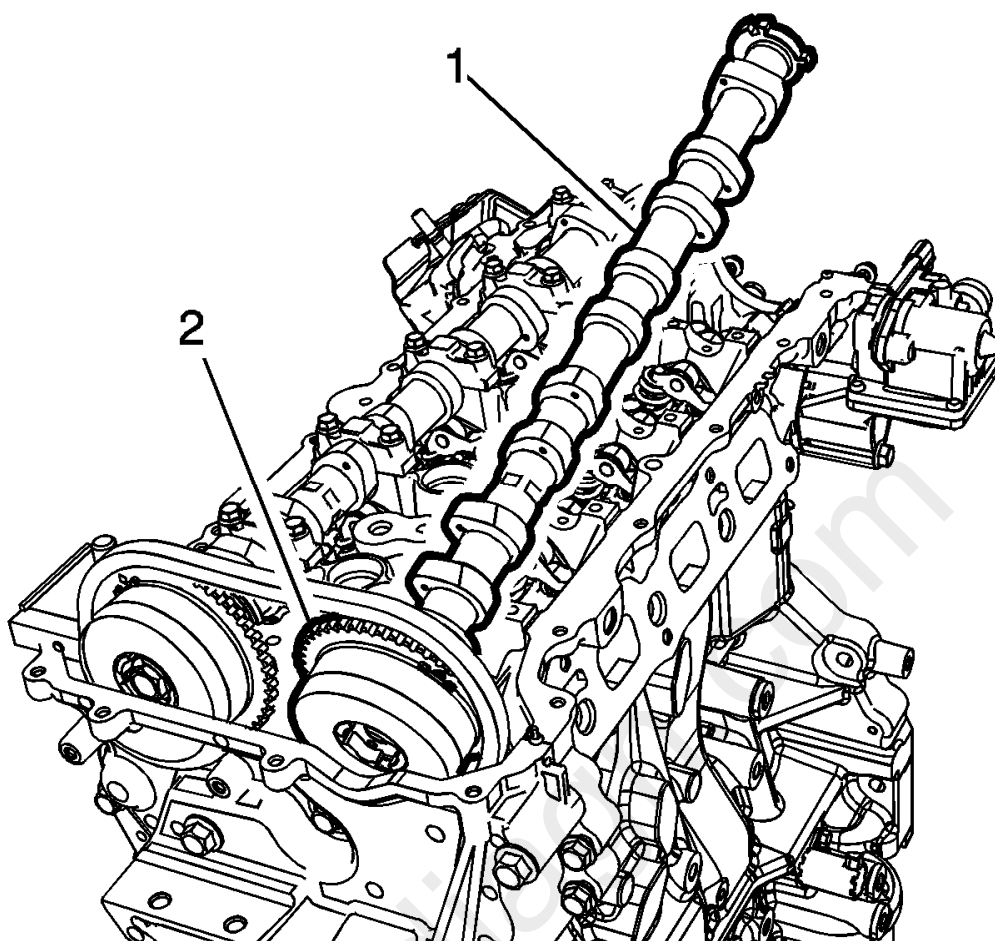


Fig. 141: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft (1) and camshaft actuator (2).

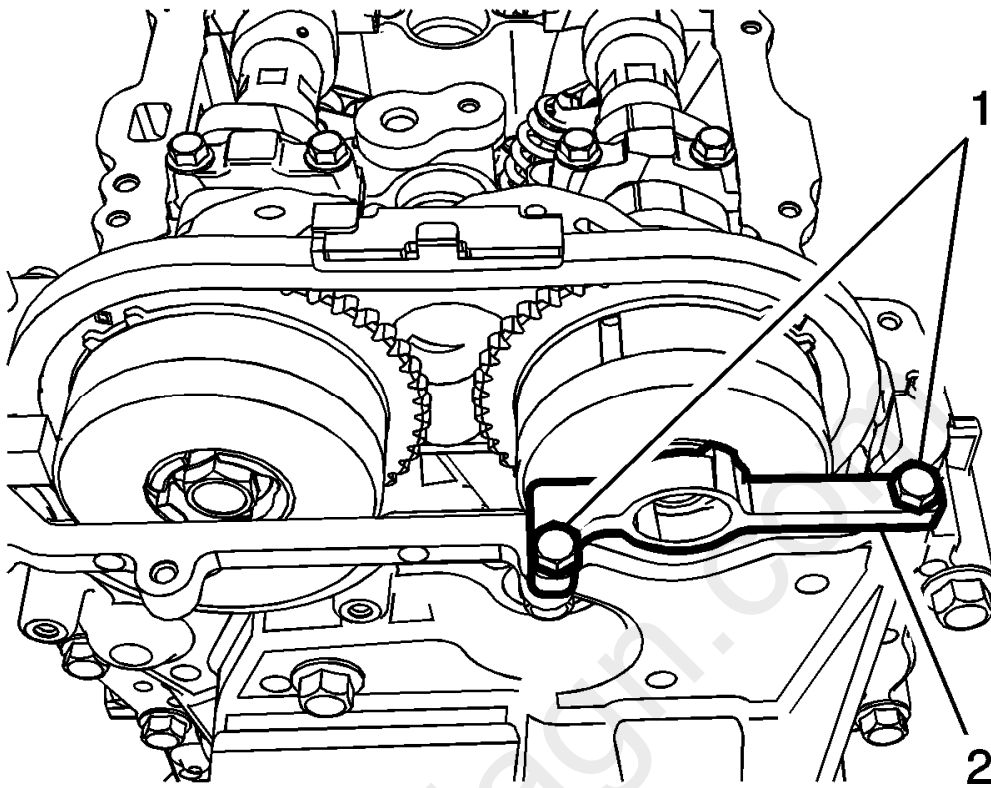


Fig. 142: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

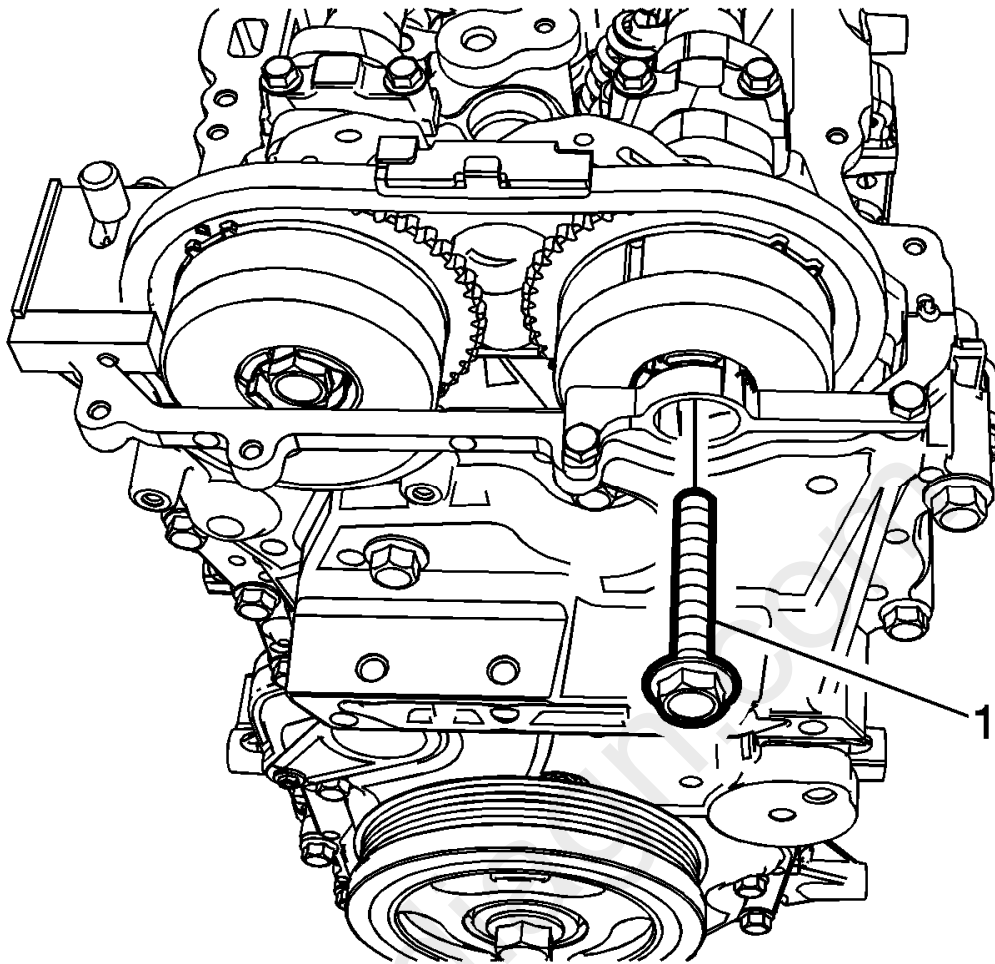


Fig. 143: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

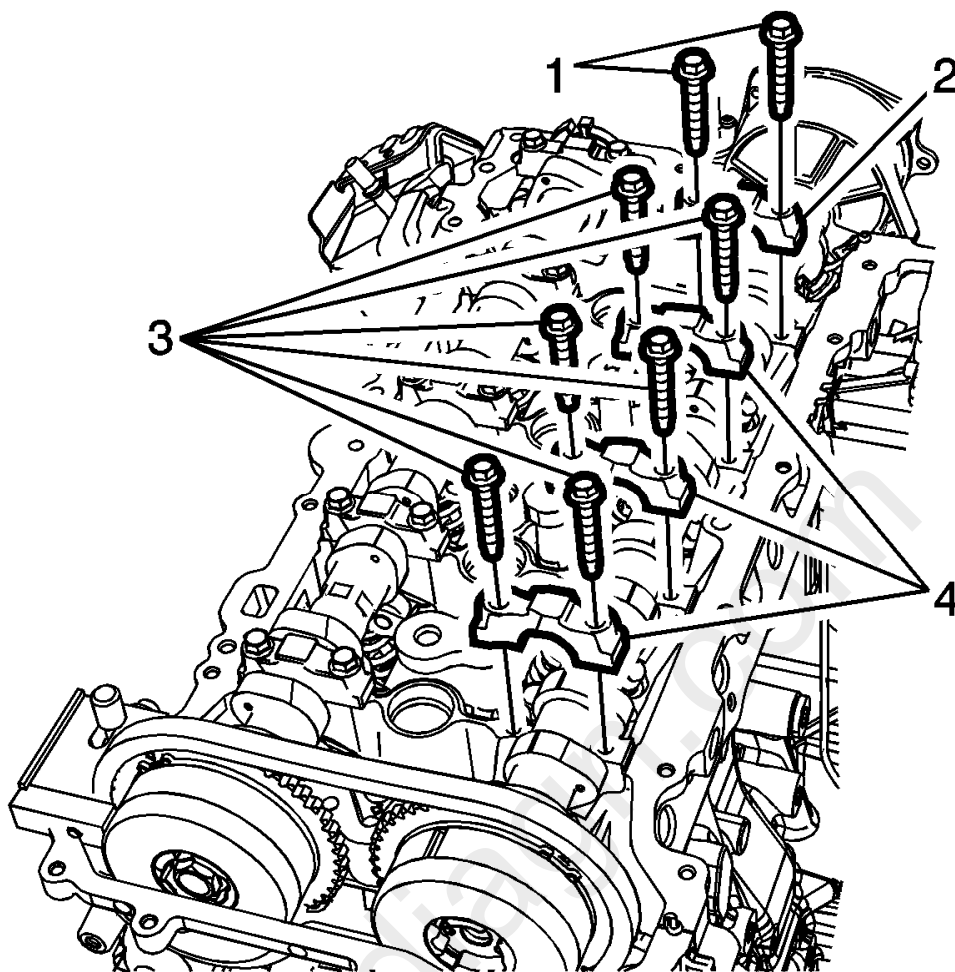


Fig. 144: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

11. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

12. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
13. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

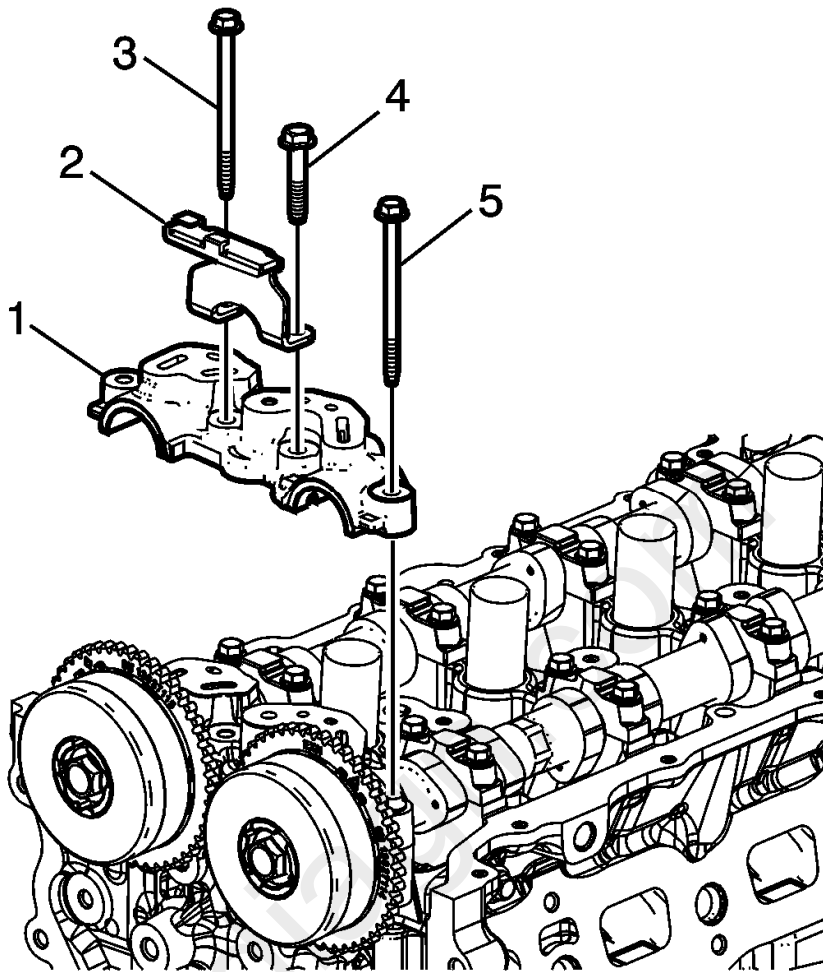


Fig. 145: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

14. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

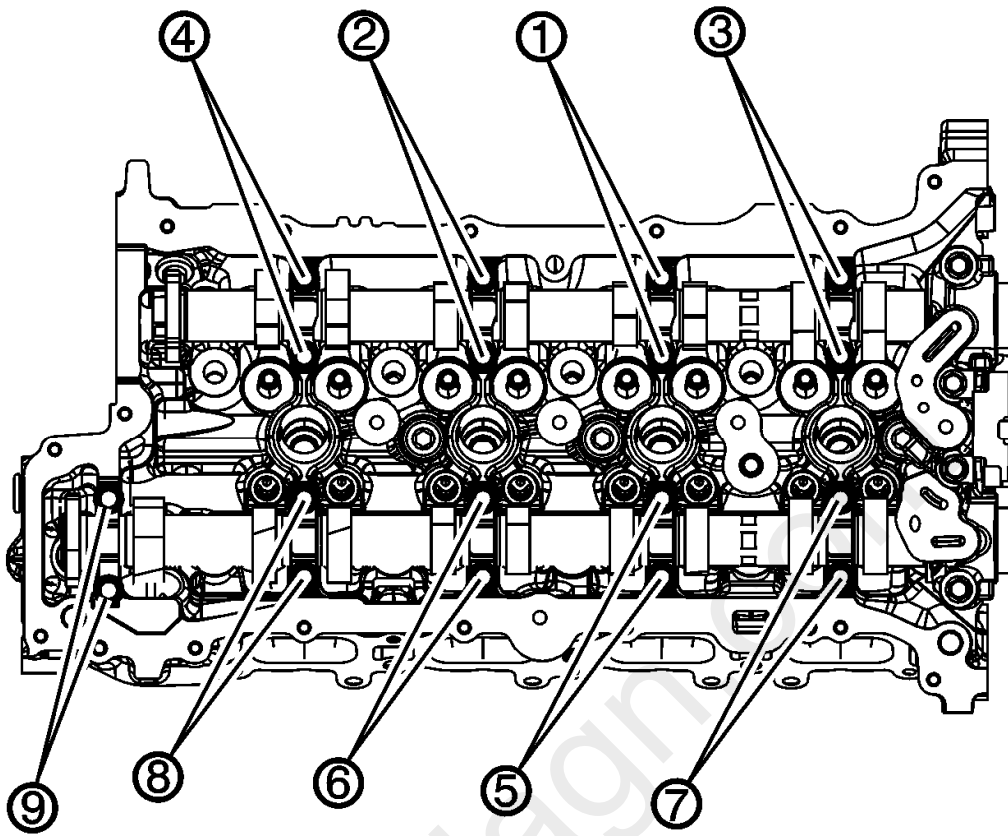


Fig. 146: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

15. Tighten the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

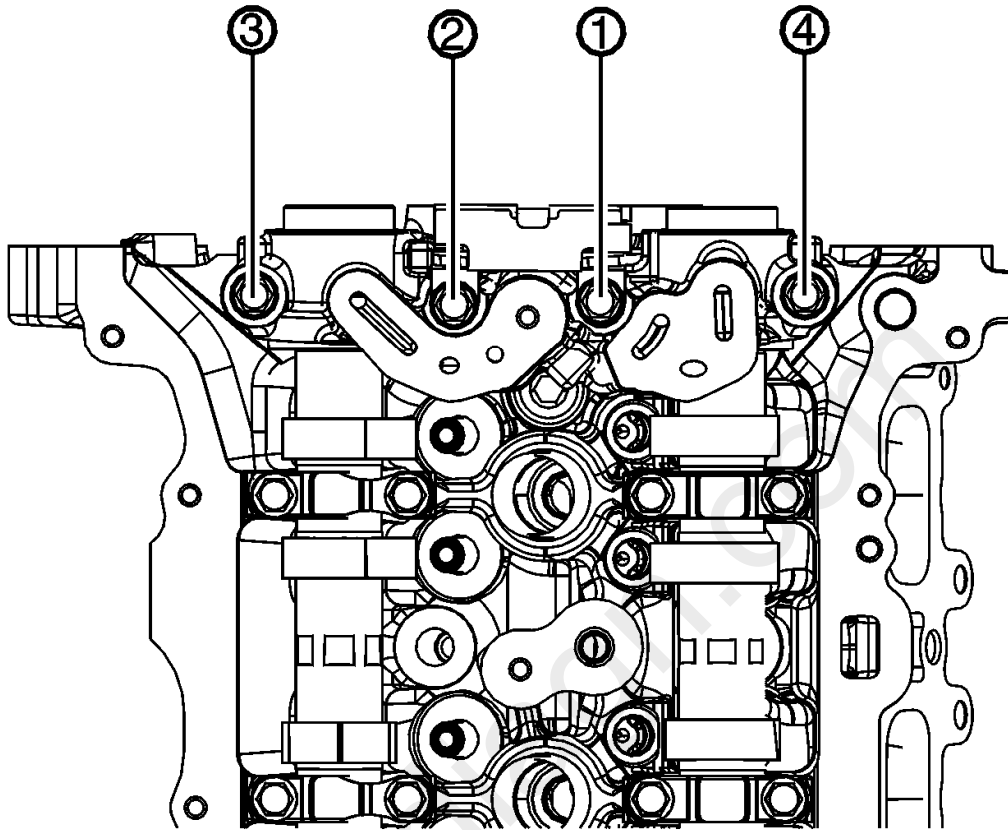


Fig. 147: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

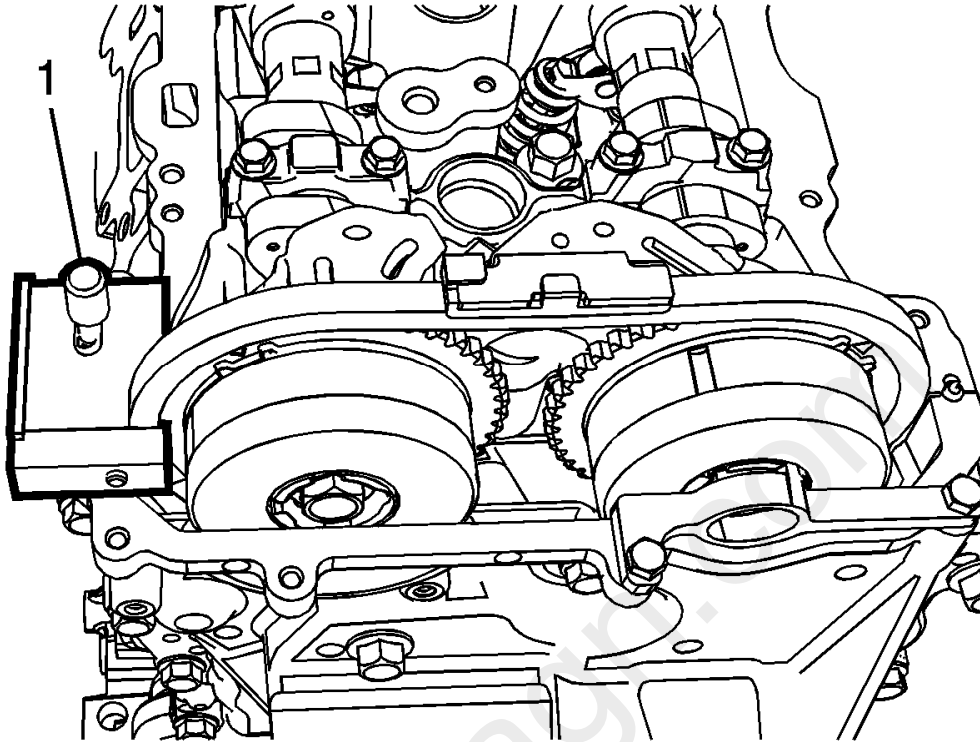


Fig. 148: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
19. Install the high pressure fuel pump. Refer to **Fuel Pump Replacement** .

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - EXHAUST

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.

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

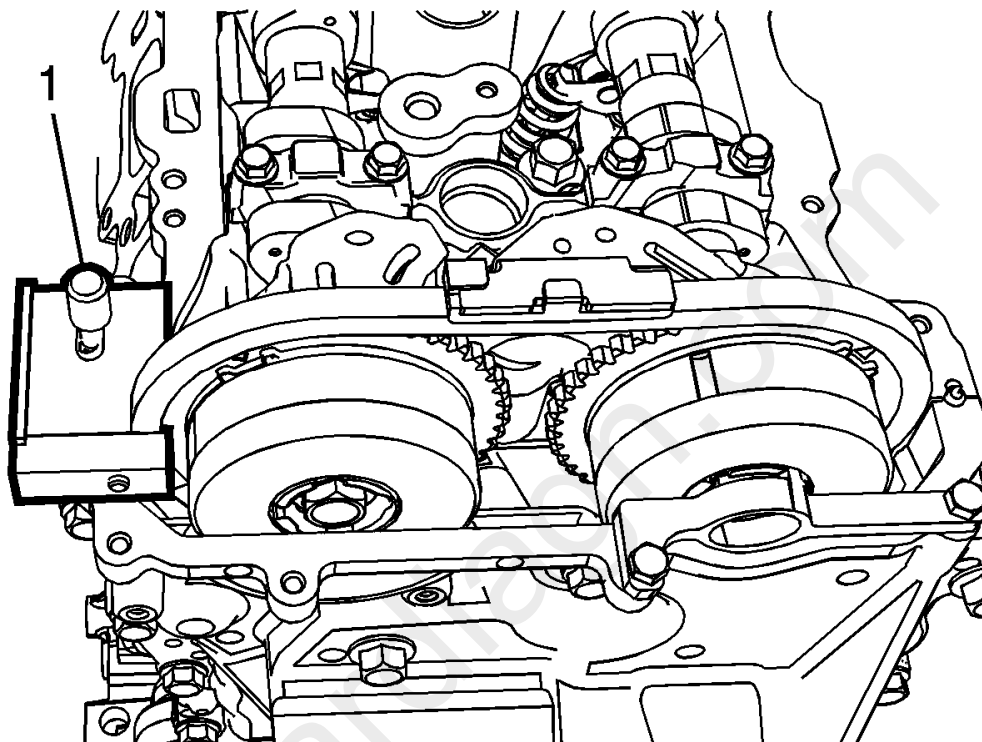


Fig. 149: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the EN-50656 Holding tool is installed and securely tightened to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.

2. Install **EN-50656** timing chain holding tool (1) and tighten to 8 (71 lb in).

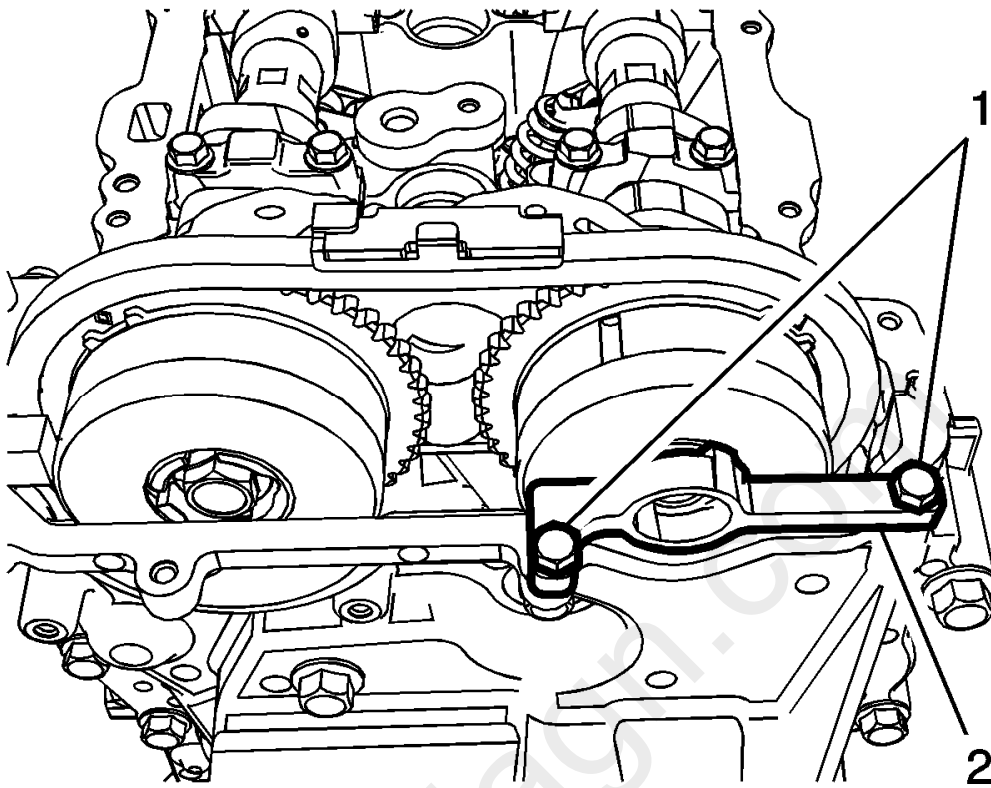


Fig. 150: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Ensure to mark actuator sprocket and chain before removal.

3. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

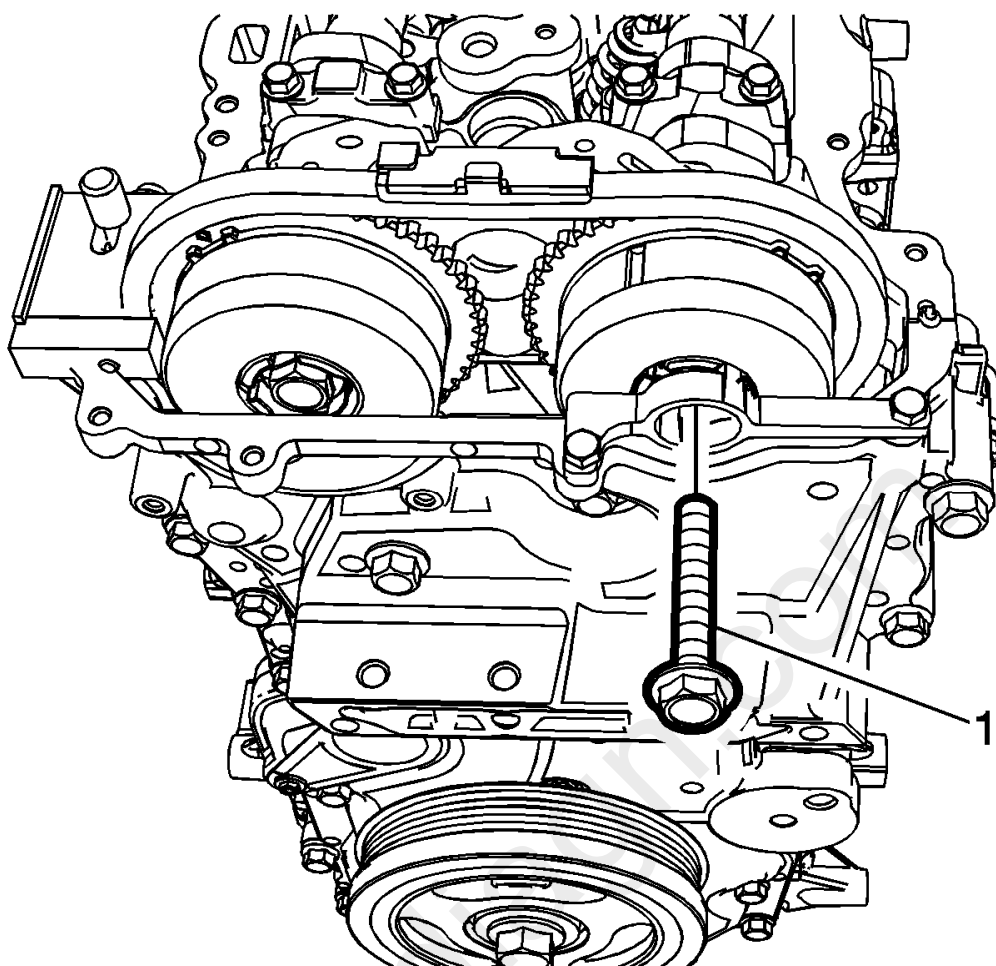


Fig. 151: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the camshaft actuator bolt (1).

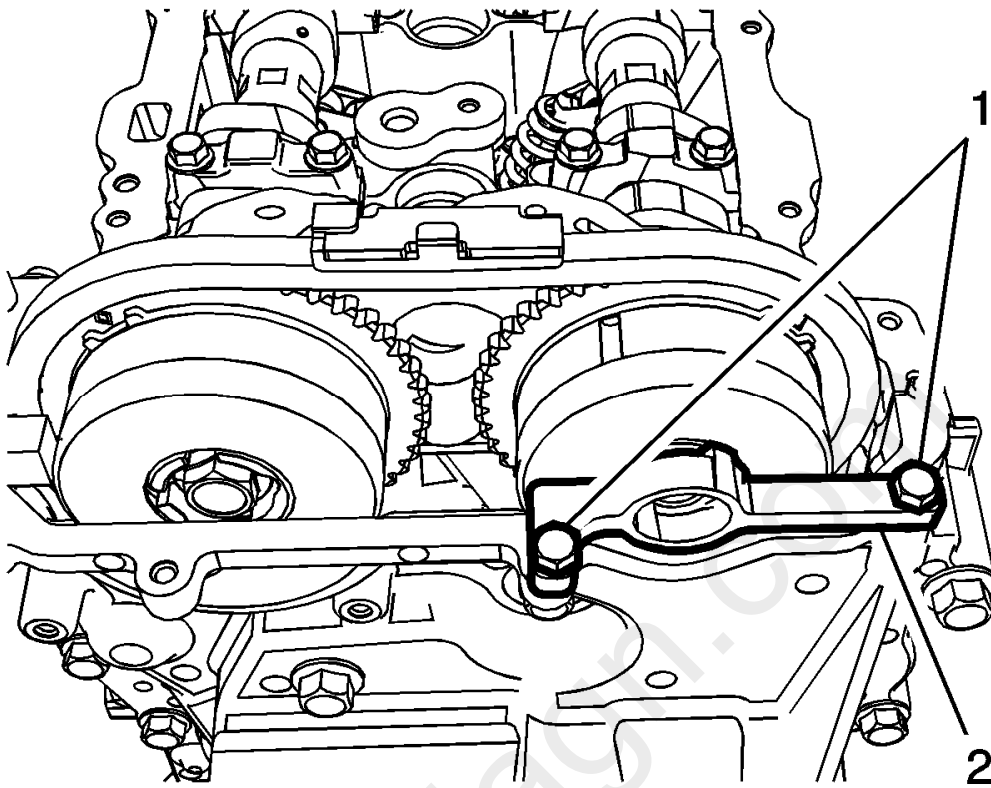


Fig. 152: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50793** holding tool (2).

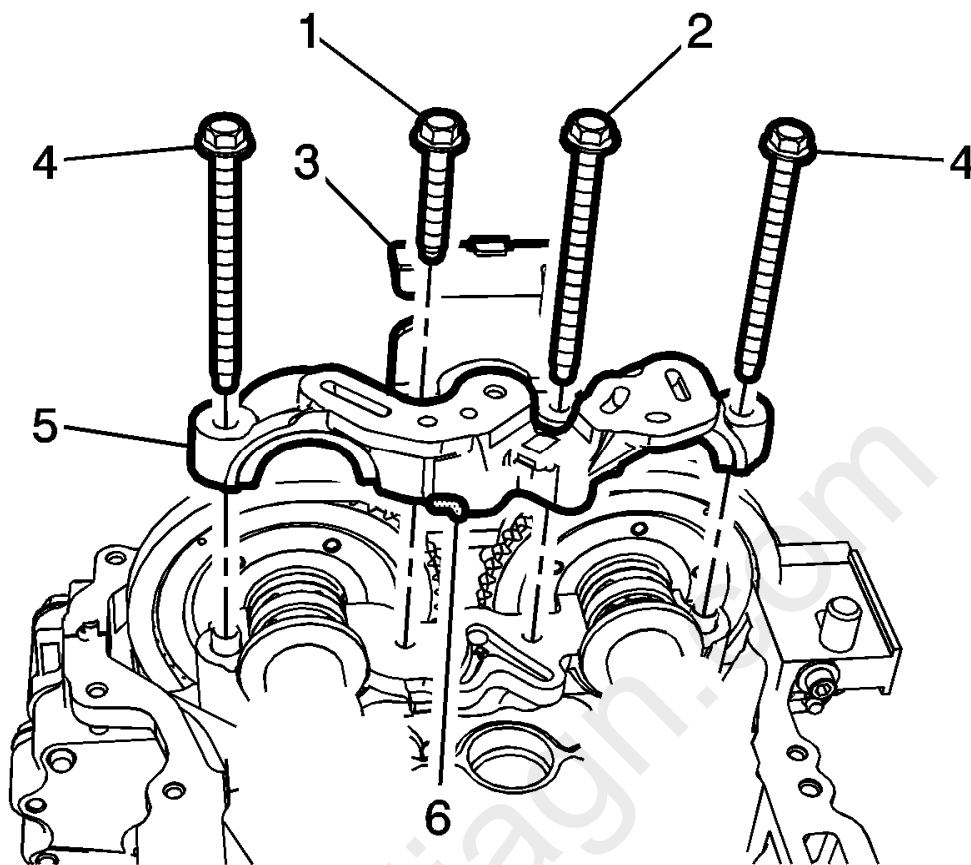


Fig. 153: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts (1, 2).
7. Remove the upper timing chain guide (3).
8. Remove the camshaft front bearing cap bolts (4).

NOTE: Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.

9. Remove the camshaft front bearing cap (5).

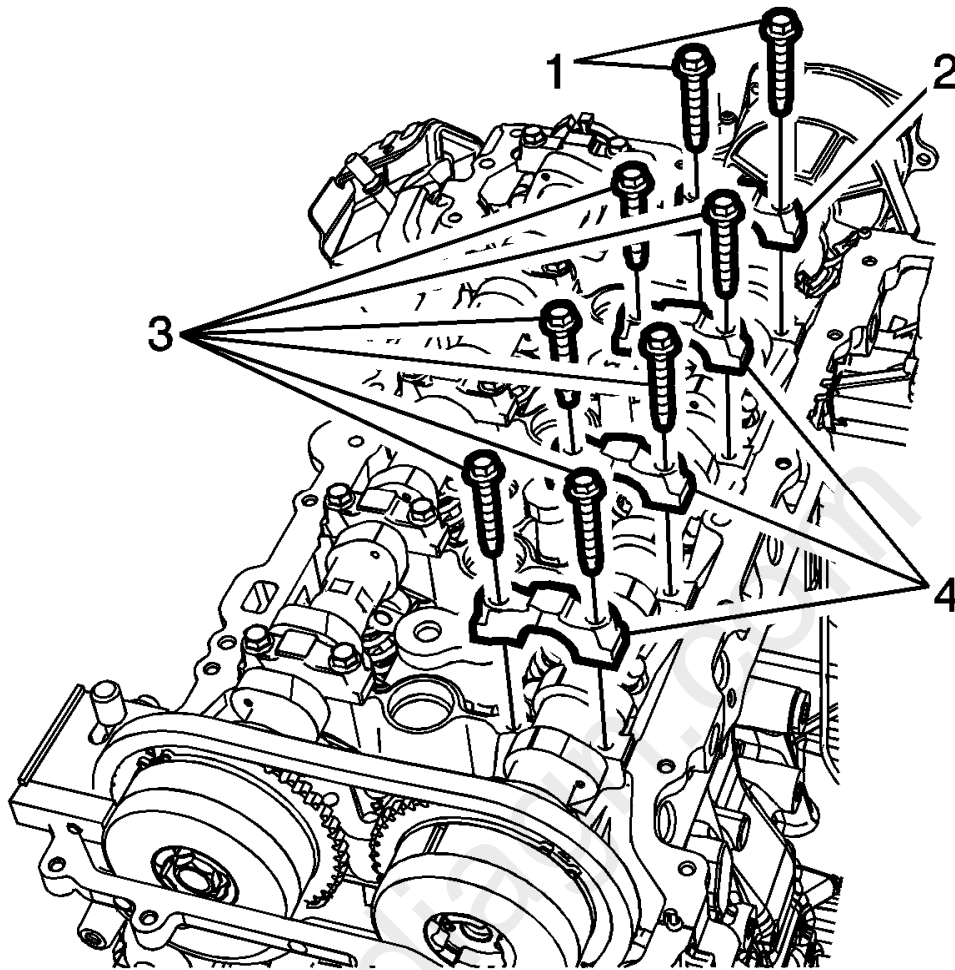


Fig. 154: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

10. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

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

11. Mark the camshaft caps (4) to ensure they are installed in the same position.
12. Remove the exhaust camshaft cap bolts (3).
13. Remove the camshaft caps (4).

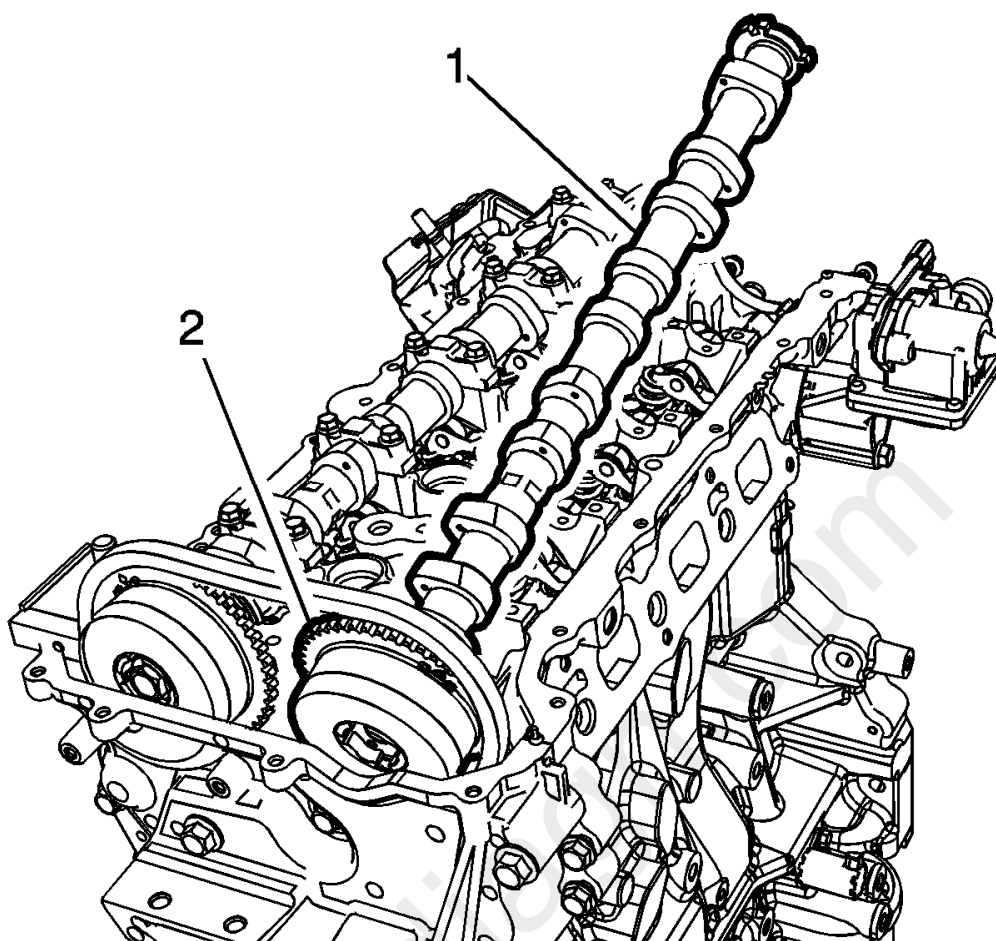


Fig. 155: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

NOTE: If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.

15. Replace the camshaft if necessary.

Installation Procedure

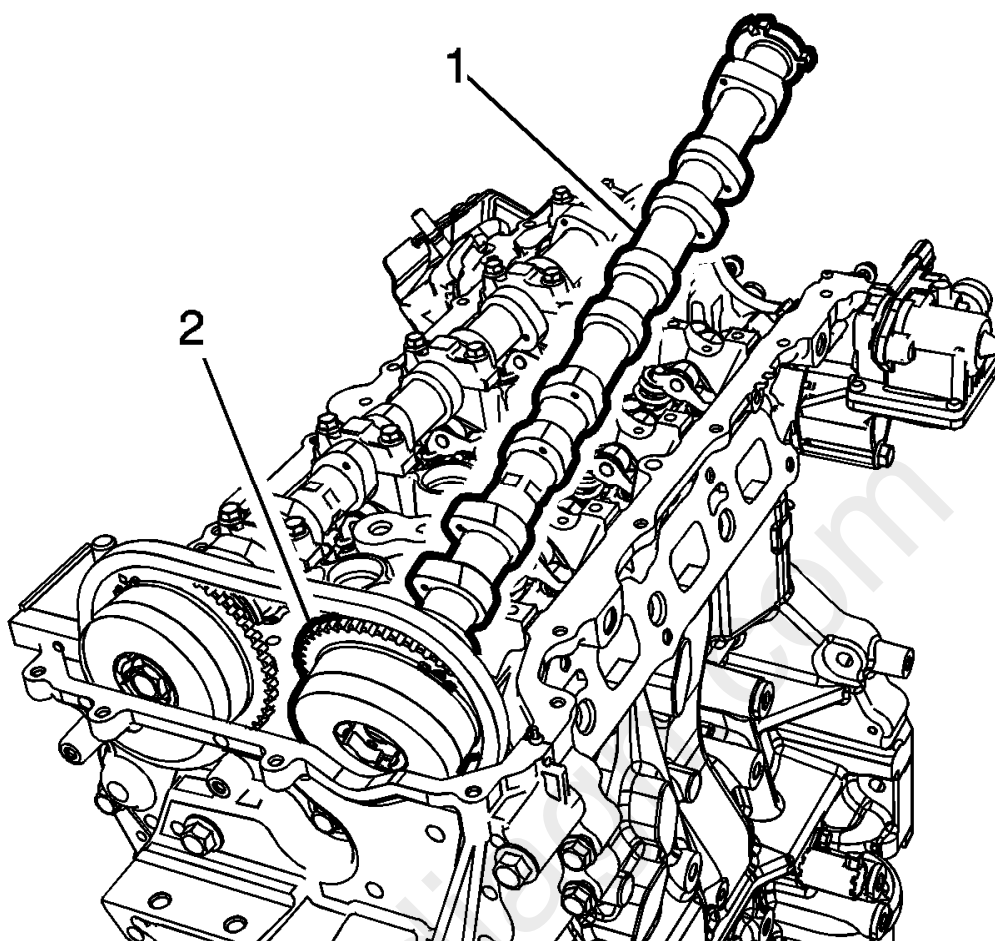


Fig. 156: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft (1) and camshaft actuator (2).

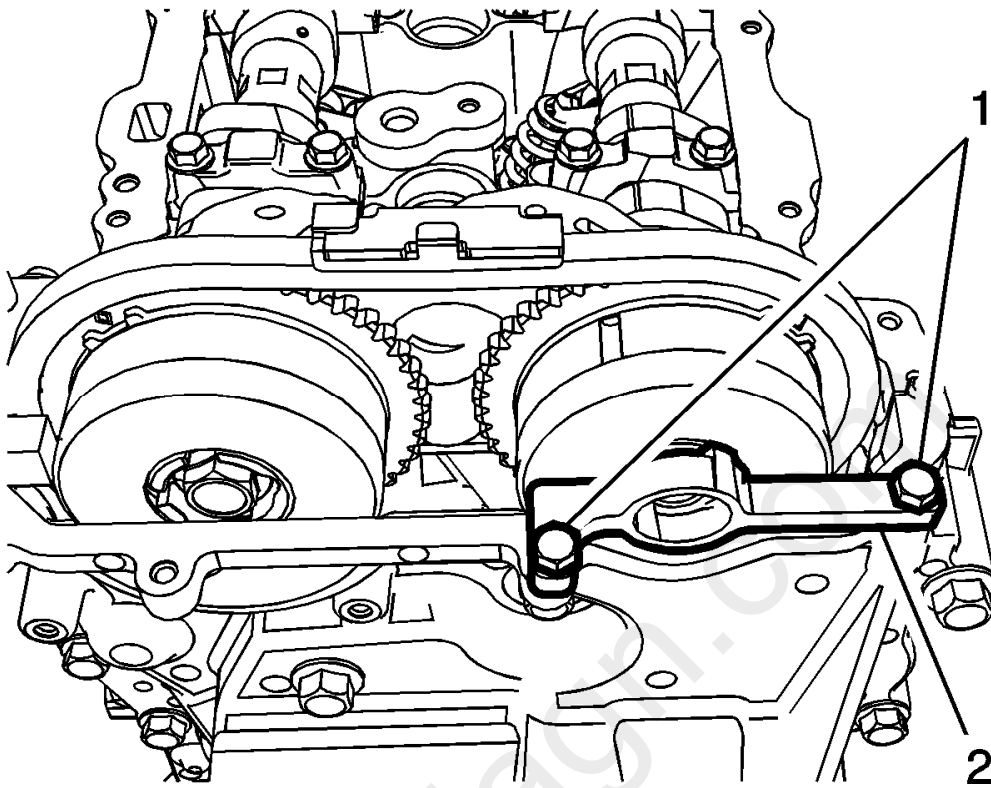


Fig. 157: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 (89 lb in).

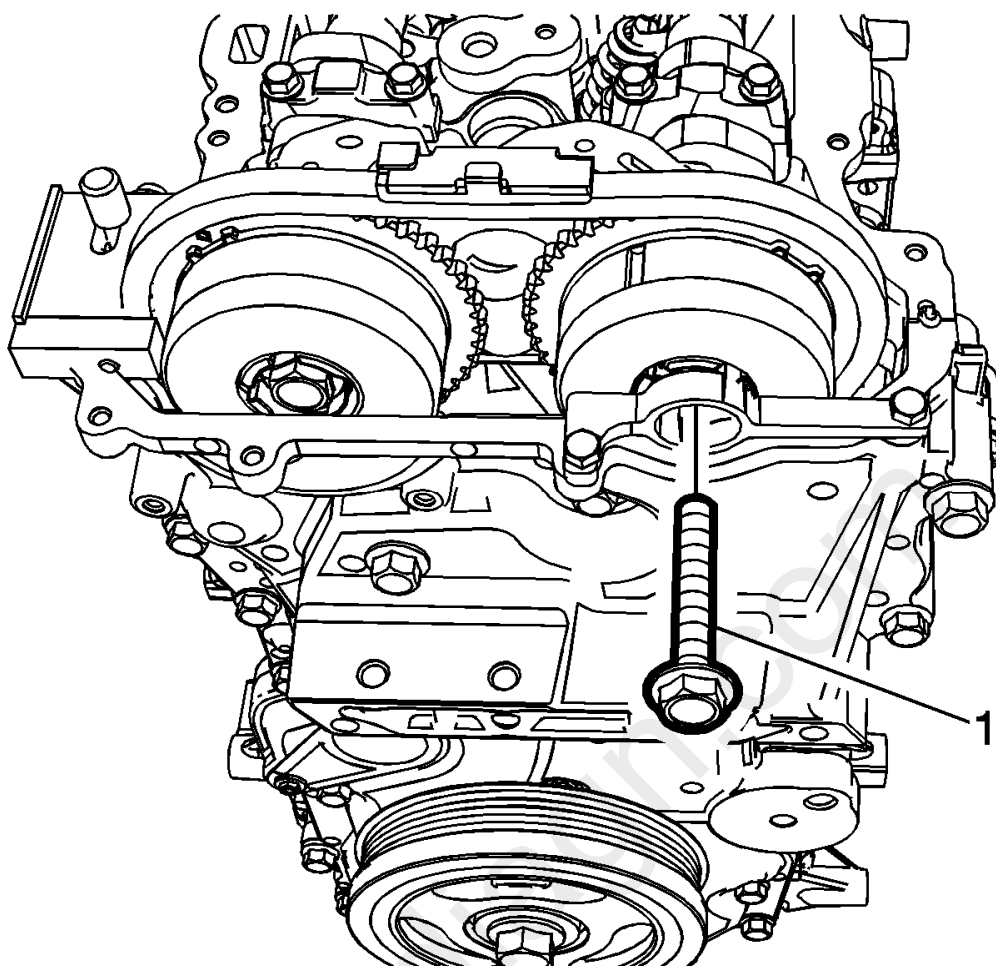


Fig. 158: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 (22 lb ft) plus 100 degrees.

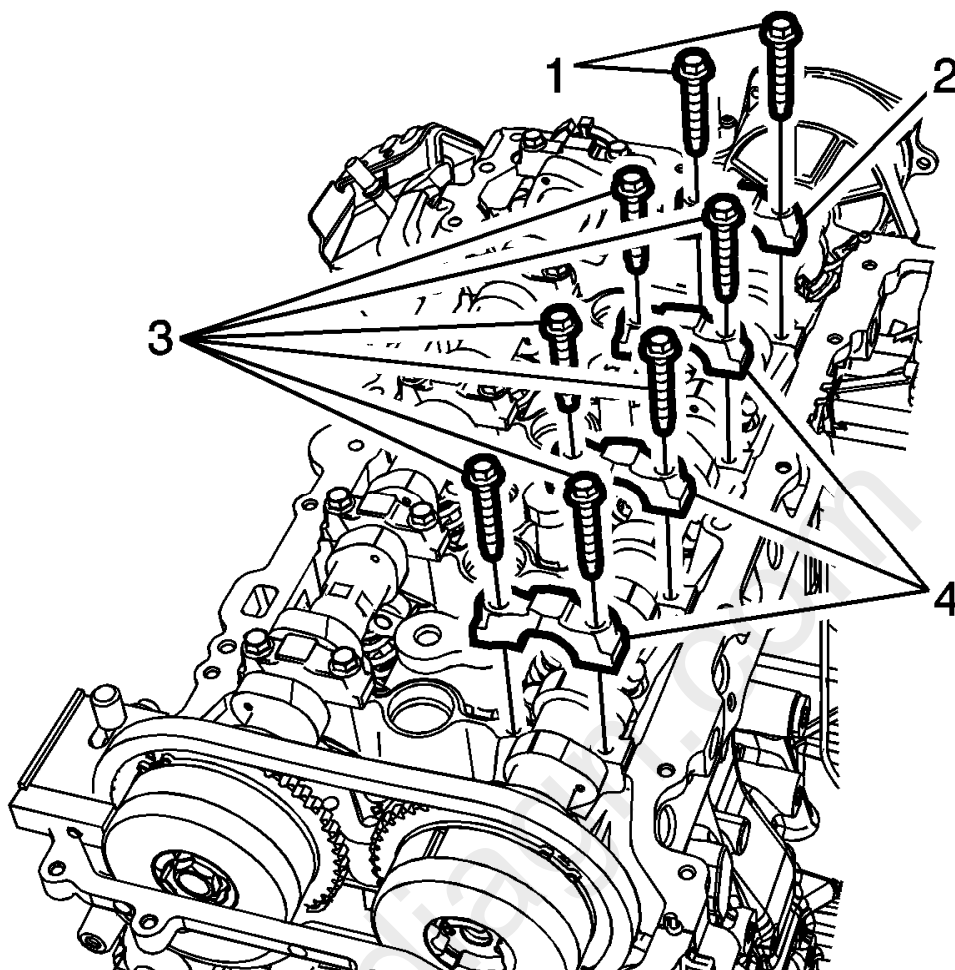


Fig. 159: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

4. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

5. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
6. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

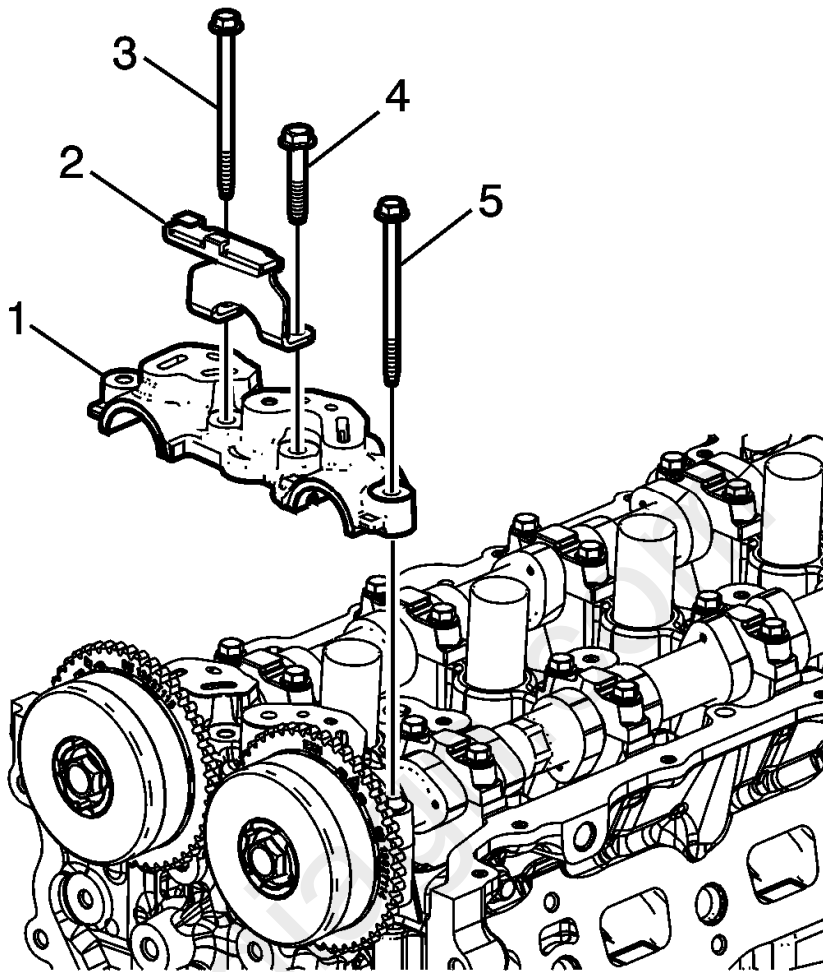


Fig. 160: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

7. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3-5).

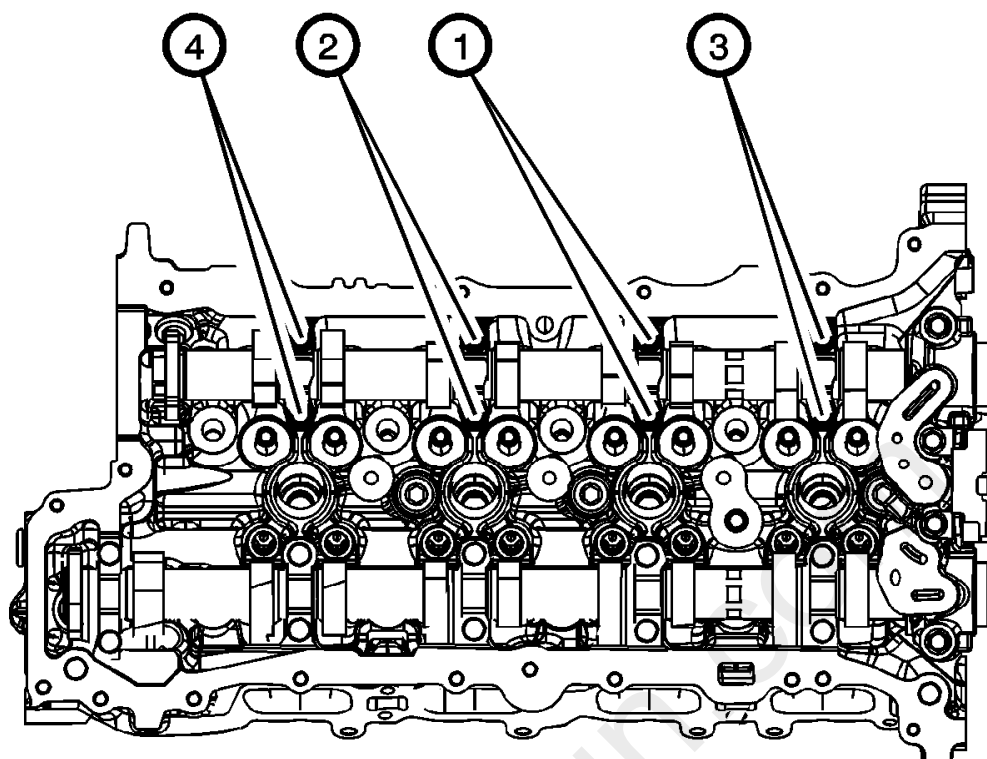


Fig. 161: Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.

8. Install the camshaft cap bolts in sequence using the following procedure:
 1. Tighten the camshaft cap bolts in sequence to 8 (71 lb in).
 2. Loosen both bolts in each cap in sequence to 180 degrees.
 3. Tighten the camshaft cap bolts in sequence to 10 (89 lb in) twice.

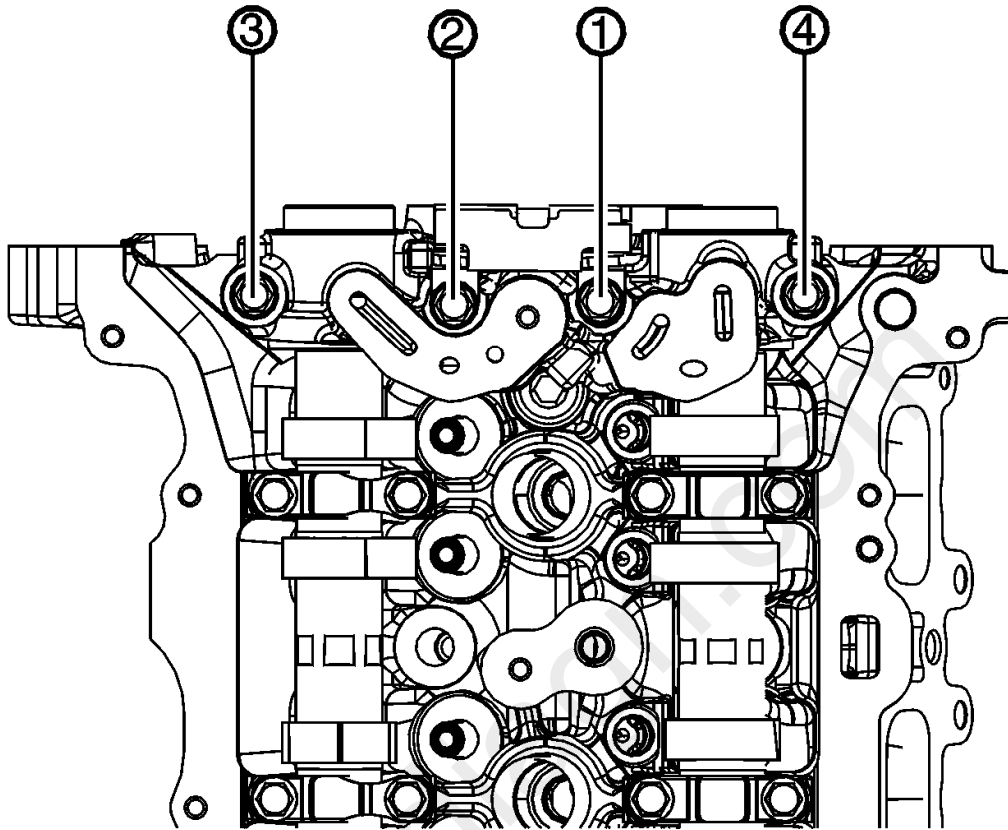


Fig. 162: Front Camshaft Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. Tighten the front camshaft cap bolts in sequence to 10 (89 lb in) twice.

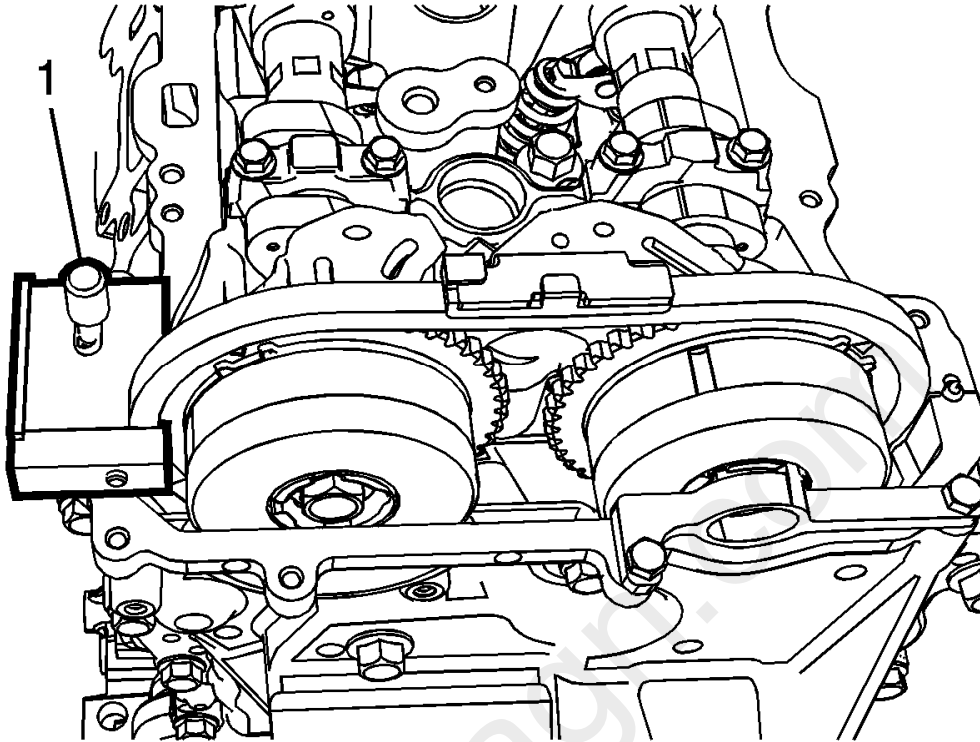


Fig. 163: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove **EN-50656** timing chain holding tool (1).
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

CAMSHAFT COVER HEAT SHIELD REPLACEMENT

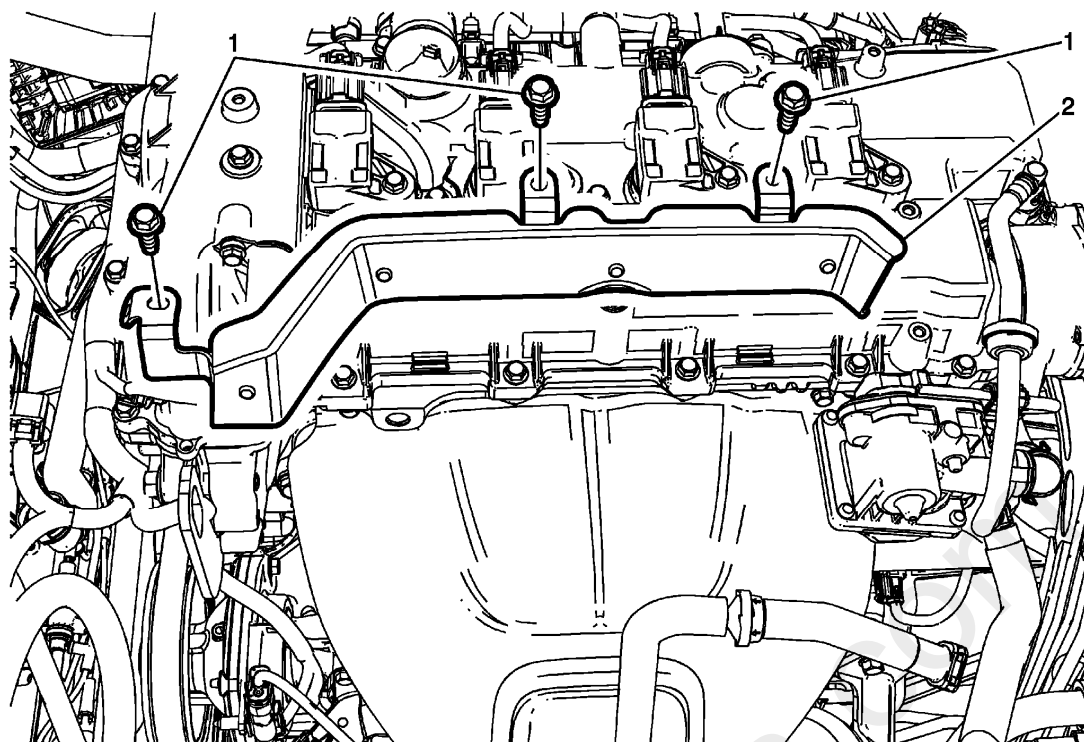


Fig. 164: Camshaft Cover Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Heat Shield Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>. 2. If equipped with LTG, remove the engine coolant air bleed pipe. Refer to <u>Engine Coolant Air Bleed Pipe Replacement (LTG)</u>. 3. If equipped with LTG, remove the turbocharger coolant return pipe. Refer to <u>Turbocharger Coolant Return Pipe Replacement (LTG)</u>.	
1	Camshaft Heat Shield Cover Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Camshaft Heat Shield Cover

CYLINDER HEAD REPLACEMENT

Removal Procedure

Special Tools

- **EN 38188** Cylinder Head Broken Bolt Extractor Kit
- **EN 45059** Angle Meter

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

1. Drain the coolant system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
2. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
3. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
4. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
5. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement (LTG)** .
6. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
7. Remove the camshaft timing chain and tensioner. Refer to **Camshaft Timing Chain and Tensioner Removal** .
8. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
9. Remove the intake and exhaust camshafts. Refer to **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal** .
10. Remove the ground wire bolt and wire at the left front of the cylinder head and reposition the harness retainer
11. Remove the 2 bolt and ground wires at the left rear of the cylinder head.
12. Disconnect the right camshaft position sensor electrical.
13. Disconnect the left camshaft position sensor electrical.
14. Disconnect the thermostat bypass hose from the water outlet housing.
15. Disconnect the heater hose from the water outlet housing.
16. Remove the water outlet housing bolts and housing.
17. Remove the water outlet housing seal.
18. Remove the injector fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement** .

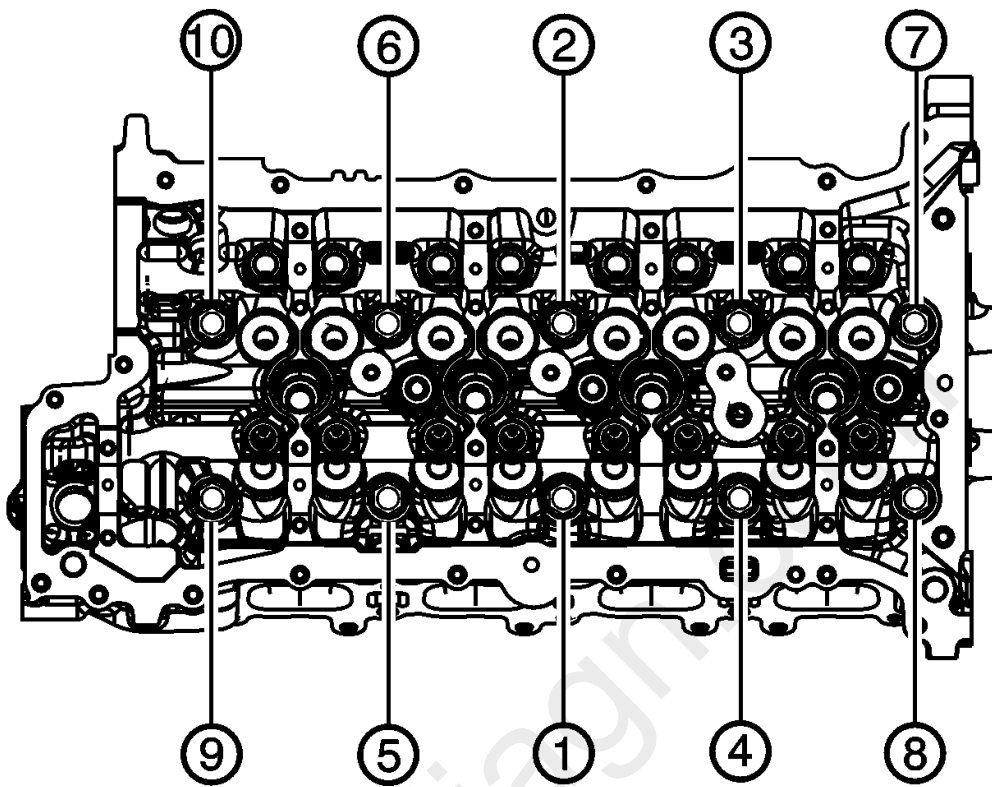


Fig. 165: Cylinder Head Gasket And Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

19. Remove the cylinder head to the block bolts in sequence.
Discard the bolts.

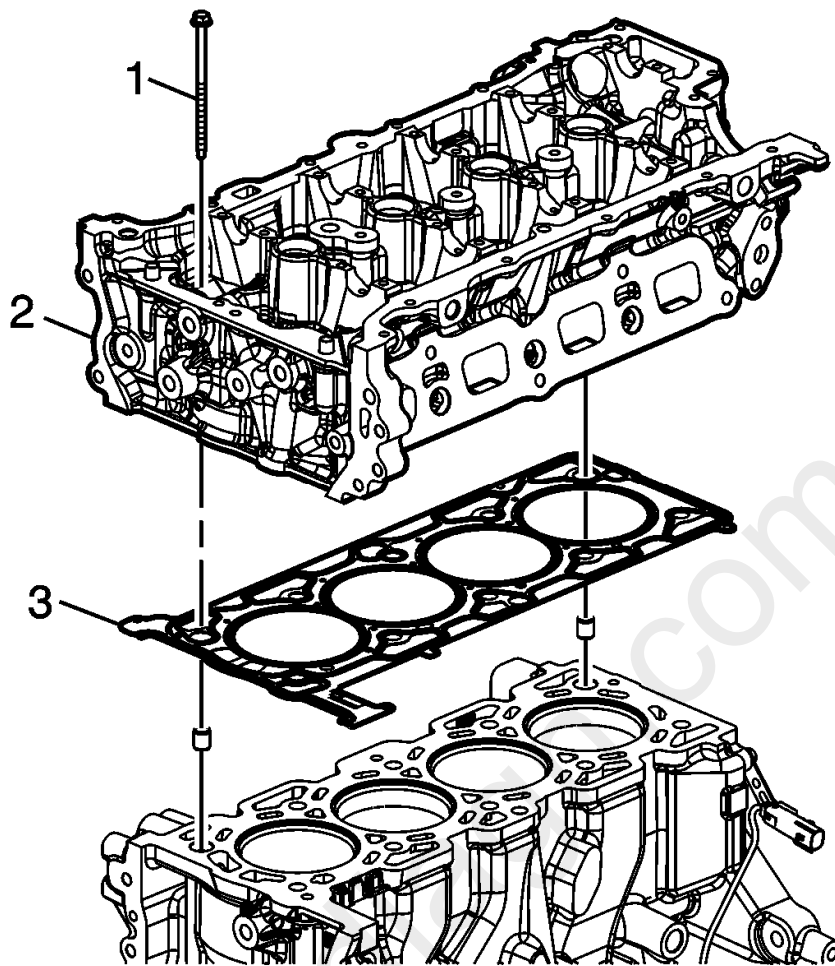


Fig. 166: Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.

20. Remove the cylinder head (2) and bolts (1).
21. Remove the cylinder head gasket (3).
22. Clean all of the gasket surfaces.
23. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
 - Use a gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

NOTE: Do not use any other method or technique to clean these gasket surfaces.

NOTE: Be careful not to gouge or scratch the gasket surfaces. Do not gouge

or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.

•

NOTE: Do not use a tap to clean the cylinder head bolt holes.

24. Clean the old sealer/lube and dirt from the bolt holes.
25. Clean the bolt holes with a nylon bristle brush.

WARNING: Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.

26. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
27. Remove any broken long cylinder head bolts using the **EN 38188** kit.
28. For cylinder head disassemble. Refer to **Cylinder Head Disassemble** .
29. For cylinder head cleaning and inspection. Refer to **Cylinder Head Cleaning and Inspection**

Installation Procedure

1. For cylinder head assemble. Refer to **Cylinder Head Assemble** .
2. Remove **EN-50792** flywheel holding tool.
3. Ensure the number one cylinder is at top dead center. The crankshaft key should be on top at the 12 o'clock position.

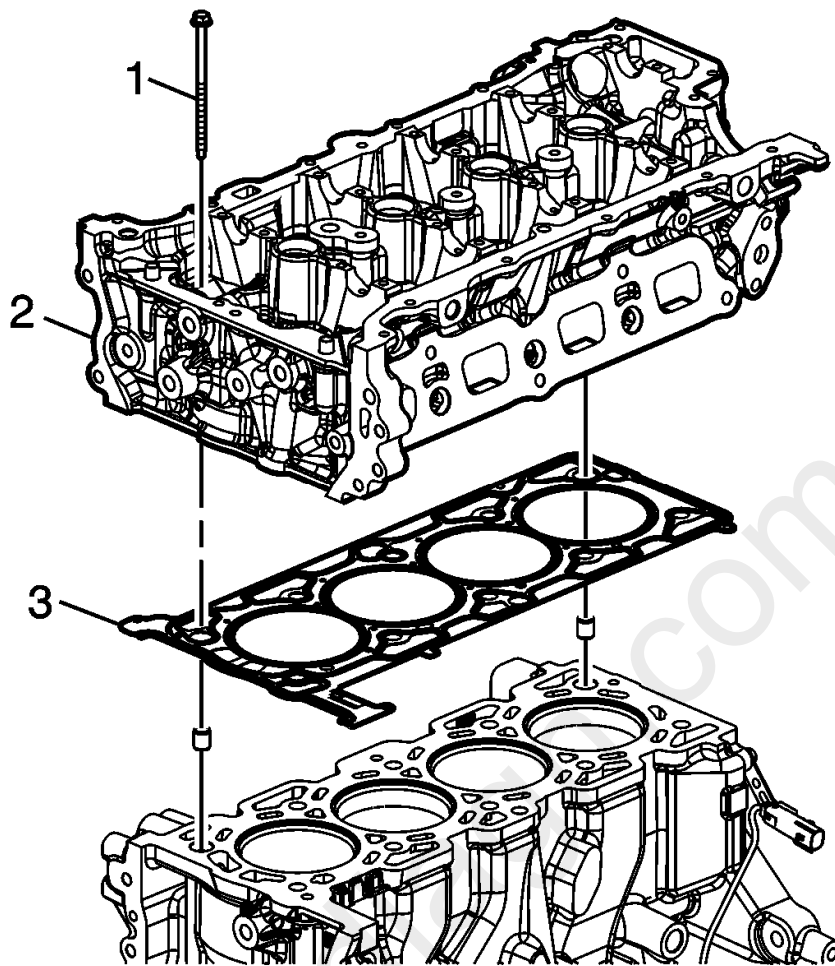


Fig. 167: Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any sealing material.

4. Install the cylinder head gasket (3) to the block.
5. Install the cylinder head (2).

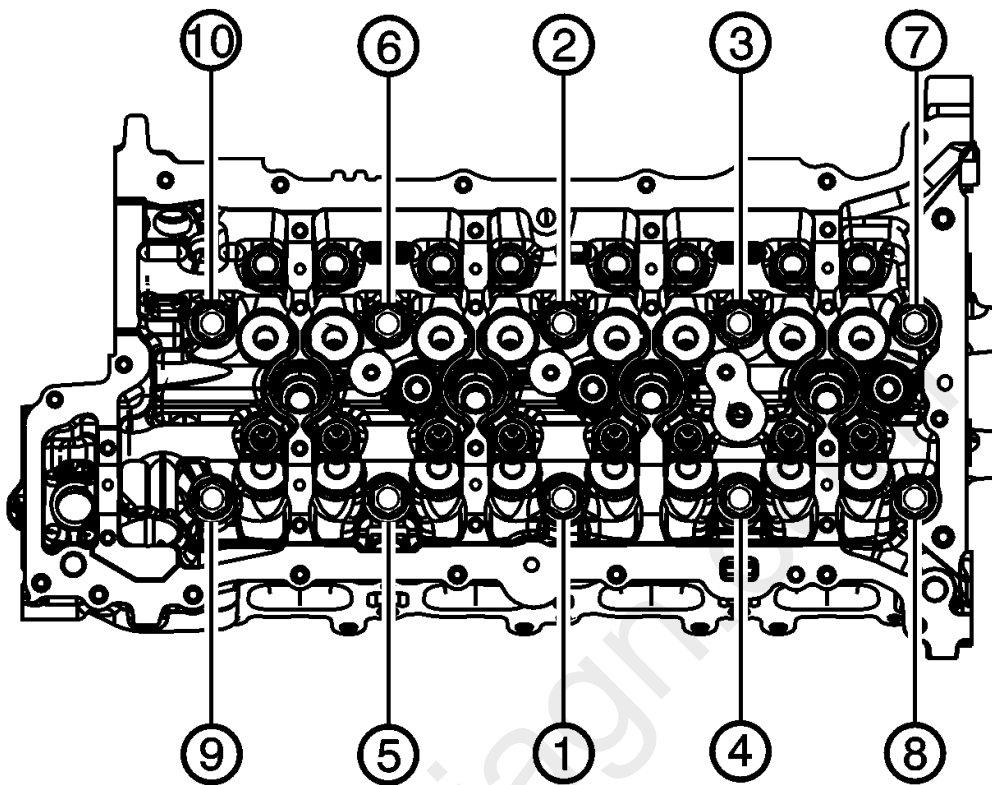


Fig. 168: Cylinder Head Gasket And Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always use **NEW** cylinder head bolts.

6. Install the cylinder head bolts.
 1. Tighten the bolts in sequence to 30 N.m (22 lb ft).
 2. Tighten the bolts an additional 190 degrees in sequence using the **EN-45059** meter.
7. Connect the heater hose to the water outlet.
8. Connect the thermostat bypass hose to the water outlet.
9. Connect the left side camshaft electrical connector.
10. Connect the right side camshaft electrical connector.
11. Install the 2 ground wire and bolt at the left rear of the cylinder head.

12. Install the ground wire and bolt at the left front of the cylinder head.
13. Install the water outlet housing bolts and housing.
14. Install the water outlet housing seal.
15. Install the injector fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement** .
16. Install the intake and exhaust camshafts. Refer to **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Installation** .
17. Install the fuel pump. Refer to **Fuel Pump Replacement** .
18. Install the camshaft timing chain and tensioner. Refer to **Camshaft Timing Chain and Tensioner Installation** .
19. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
20. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LTG)** .
21. Install the intake manifold. Refer to **Intake Manifold Replacement**.
22. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
23. Refill the engine with NEW oil. Refer to **Engine Oil and Oil Filter Replacement**.
24. Refill the coolant system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

ENGINE OIL COOLER REPLACEMENT

Removal Procedure

1. Remove the engine oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

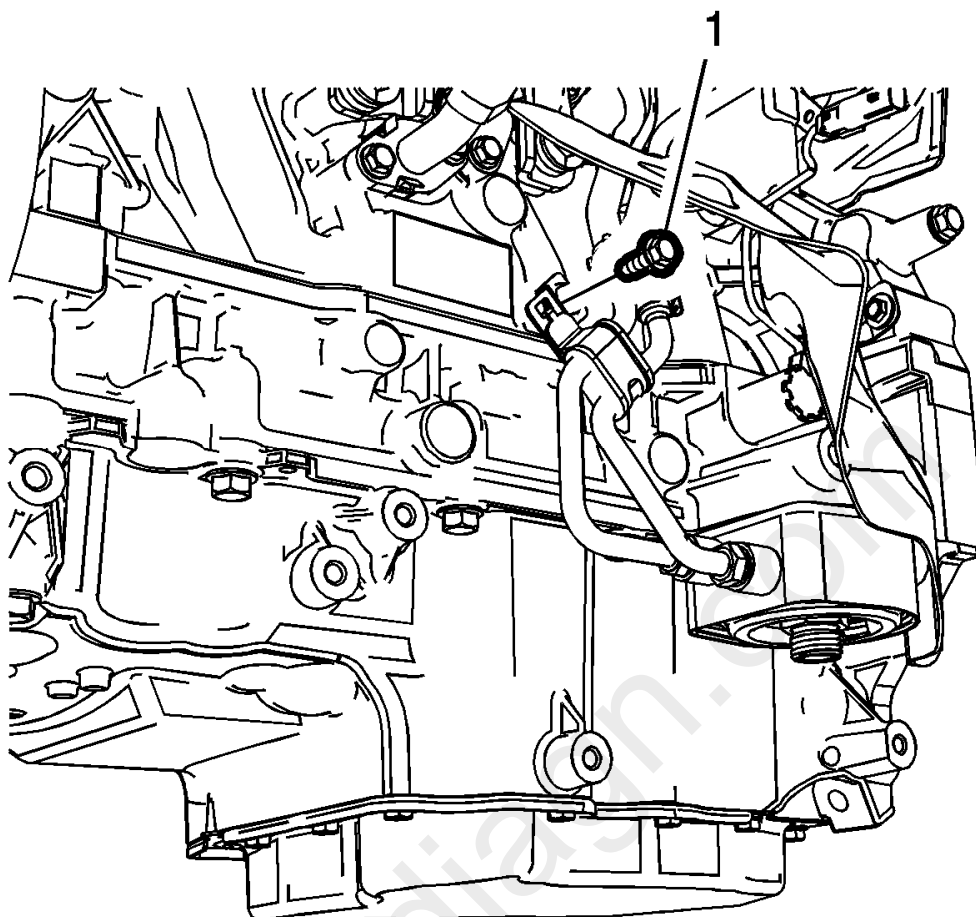


Fig. 169: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil cooler fastener (1).

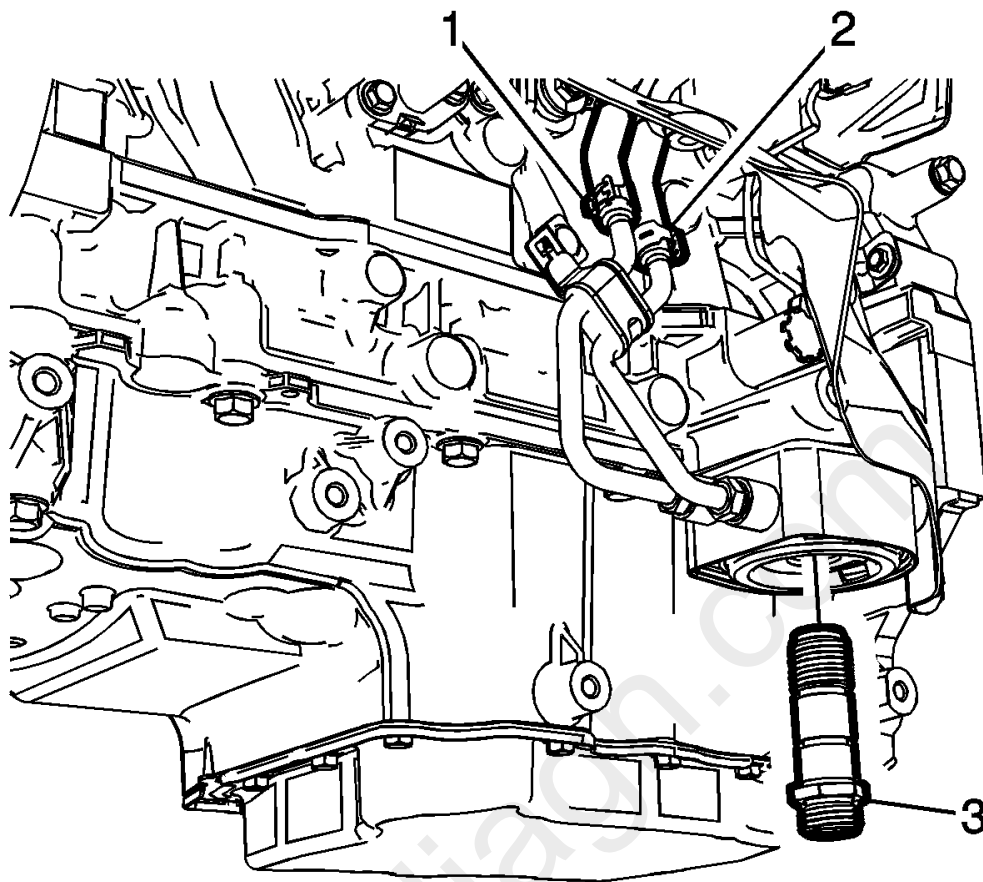


Fig. 170: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil cooler hose (1) and (2).
4. Remove the engine oil cooler connector (3).

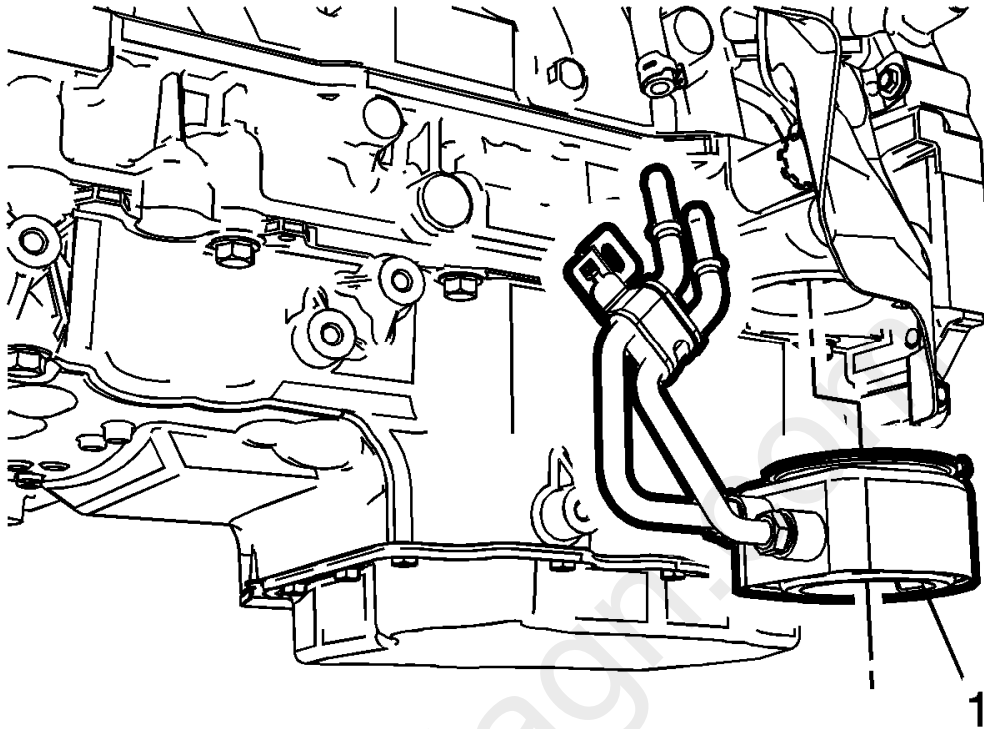


Fig. 171: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

NOTE: DISCARD the old engine oil cooler seal.

5. Remove the engine oil cooler (1).

Installation Procedure

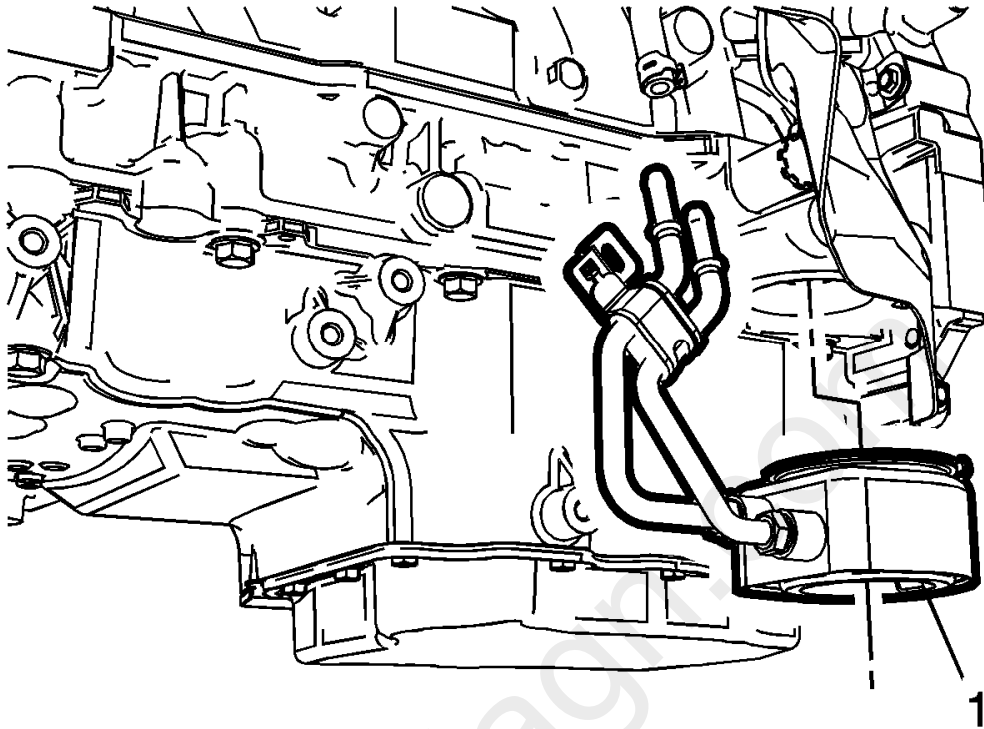


Fig. 172: Engine Oil Cooler

Courtesy of GENERAL MOTORS COMPANY

NOTE: A NEW engine oil cooler seal must be used whenever reinstalling the engine oil cooler.

1. Install the engine oil cooler (1).

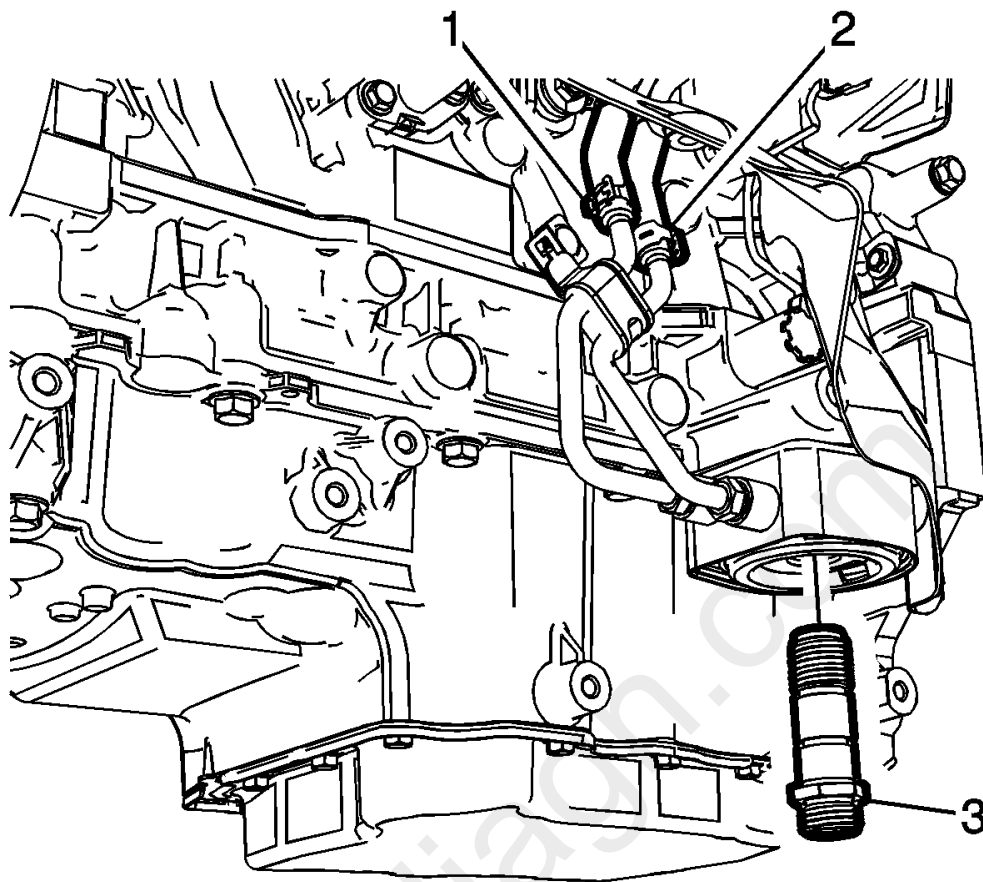


Fig. 173: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler connector (3) and tighten to 50 (37 lb ft).
3. Install the oil cooler hose (1) and (2).

CAUTION: Refer to Fastener Caution .

4. Install the oil cooler fastener (1) and tighten to 10 (89 lb in)
5. Install the engine oil filter. Refer to Engine Oil and Oil Filter Replacement.

OIL PAN REPLACEMENT (2WD)

Removal Procedure

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Unbolt and reposition the A/C compressor without disconnecting the lines. Refer to **Air Conditioning Compressor Replacement (LTG)**.
4. If equipped, remove the engine oil cooler. Refer to **Engine Oil Cooler Replacement**.
5. Remove the frame. Refer to **Drivetrain and Front Suspension Frame Removal and Installation**.

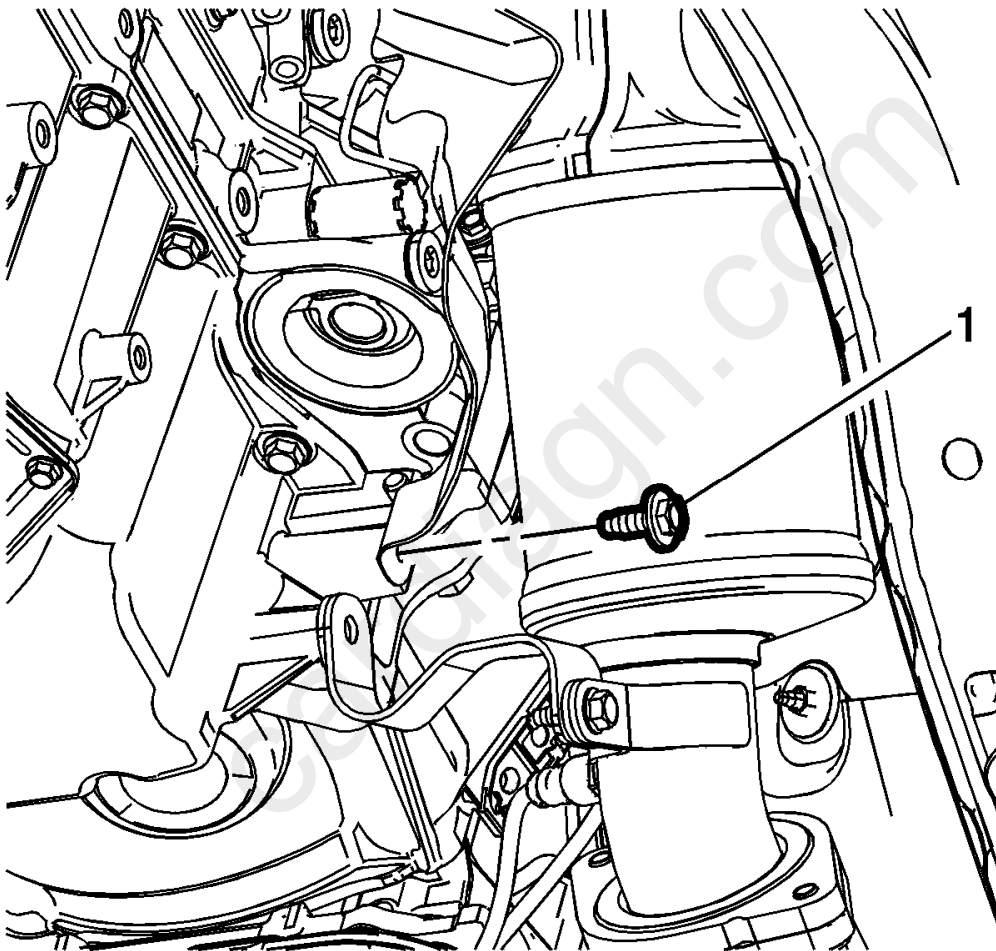


Fig. 174: Oil Pump Exhaust Shield
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pump exhaust shield bolt (1).

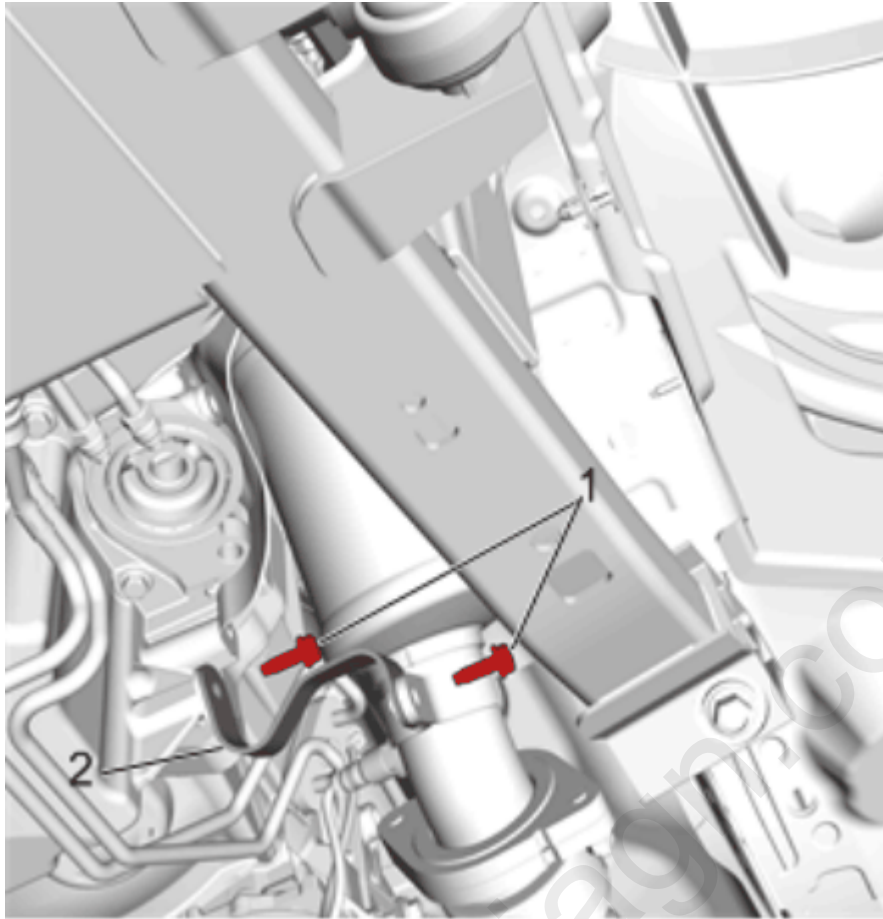


Fig. 175: Exhaust Bracket

Courtesy of GENERAL MOTORS COMPANY

7. Remove the exhaust bracket bolts (1) and bracket (2).
8. Remove the transmission cooler pipe retainer bolt and reposition the pipe assembly. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .

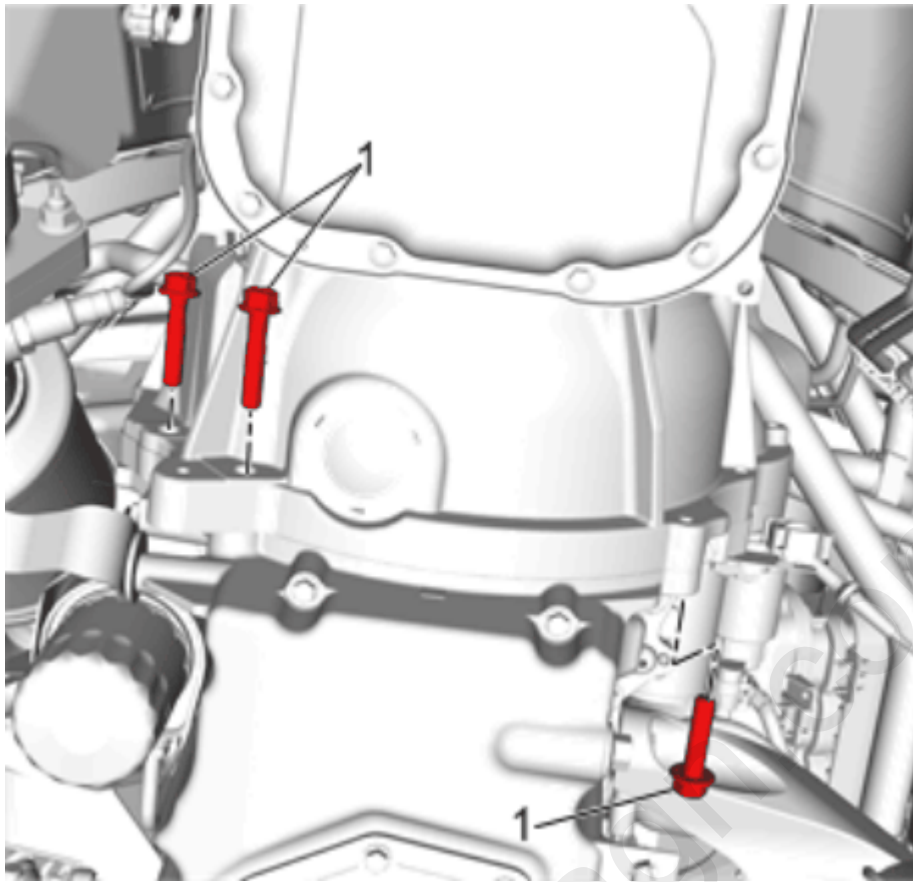


Fig. 176: Transmission Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the transmission bolts (1).

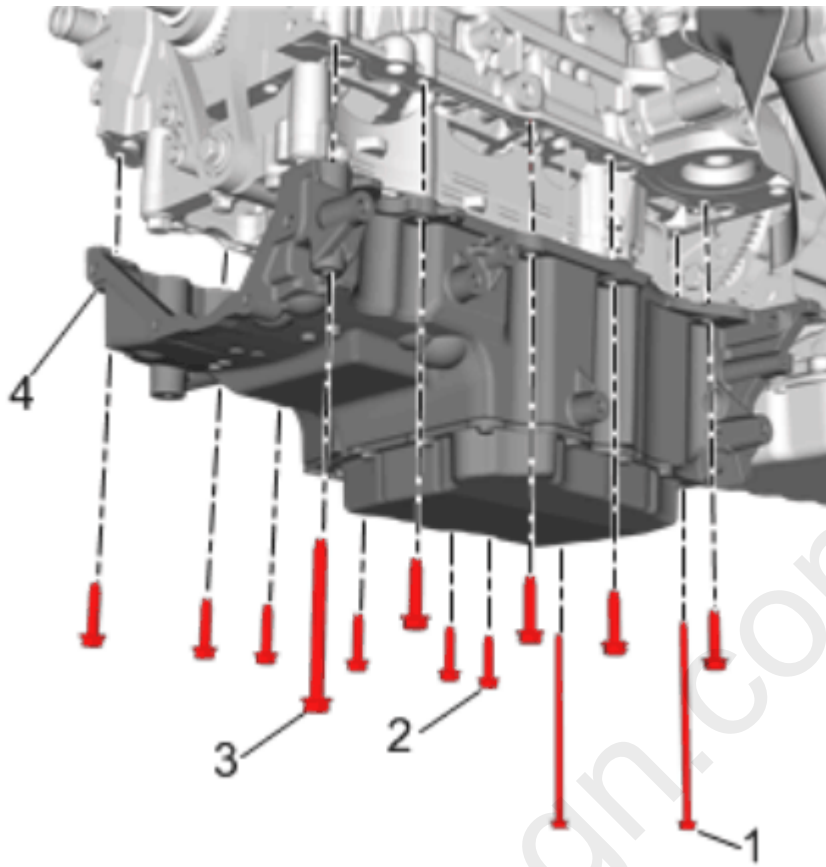


Fig. 177: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the oil pan bolts (1-3).
11. Remove the oil pan (4).
12. Disconnect the electrical connector as necessary.
13. If resealing of the lower oil pan is required, refer to **Lower Oil Pan Replacement (2WD)**, **Lower Oil Pan Replacement (AWD)**.
14. For oil pan cleaning and inspection, refer to **Oil Pan Cleaning and Inspection**.

Installation Procedure

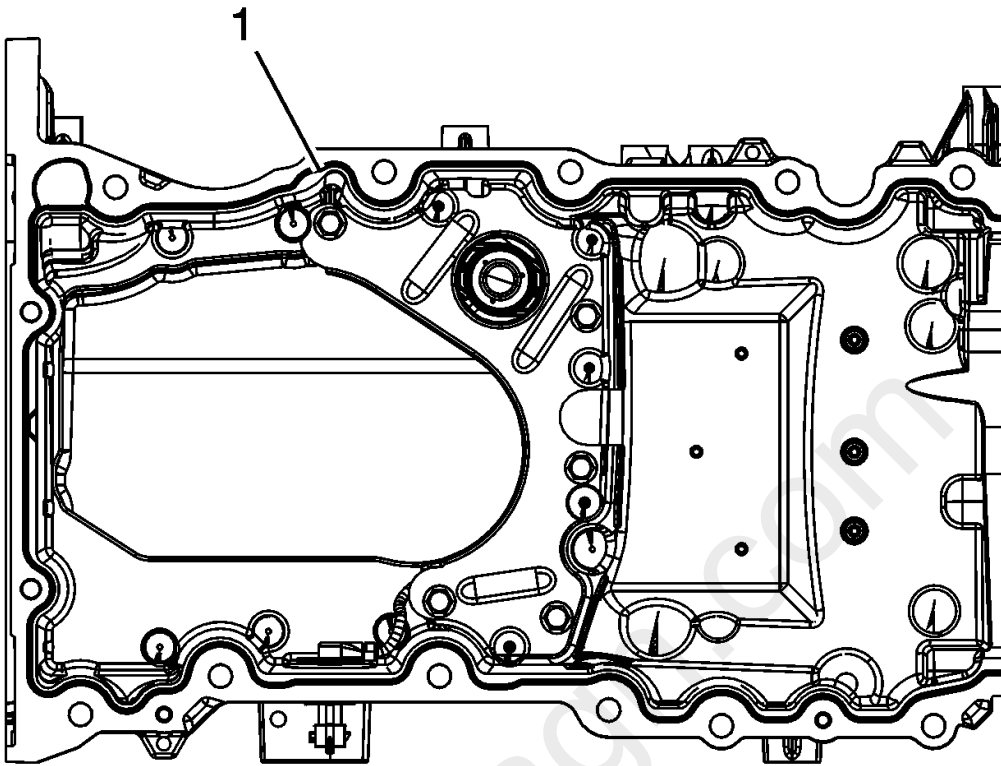


Fig. 178: Short Lower Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

1. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers .

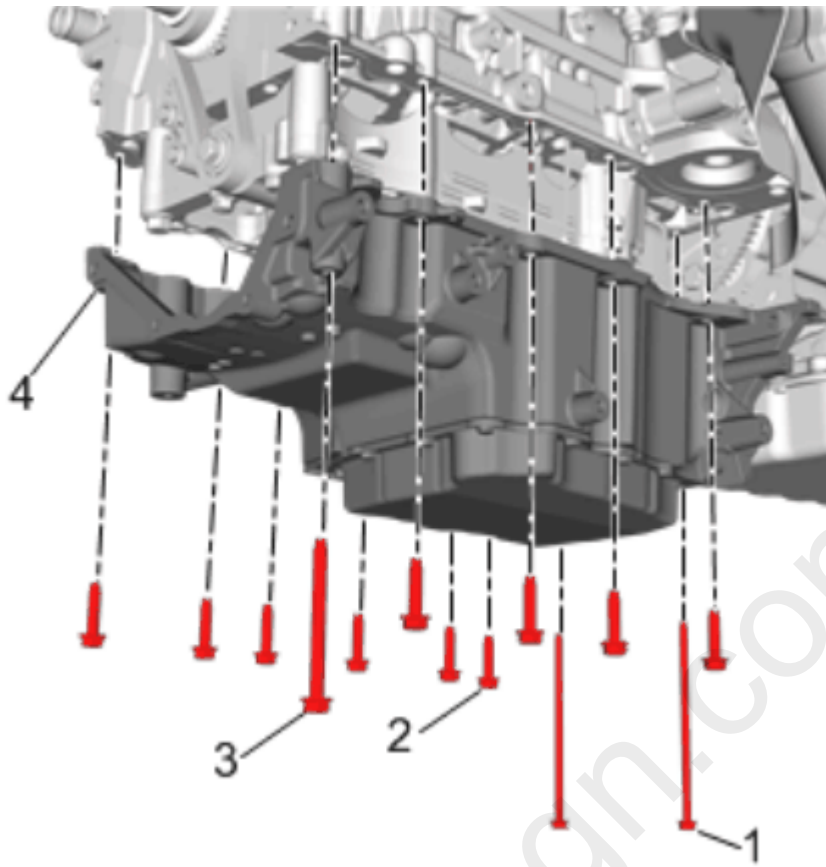


Fig. 179: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pan (4).

CAUTION: Refer to Fastener Caution .

3. Install the oil pan bolts (1-3) finger tight.

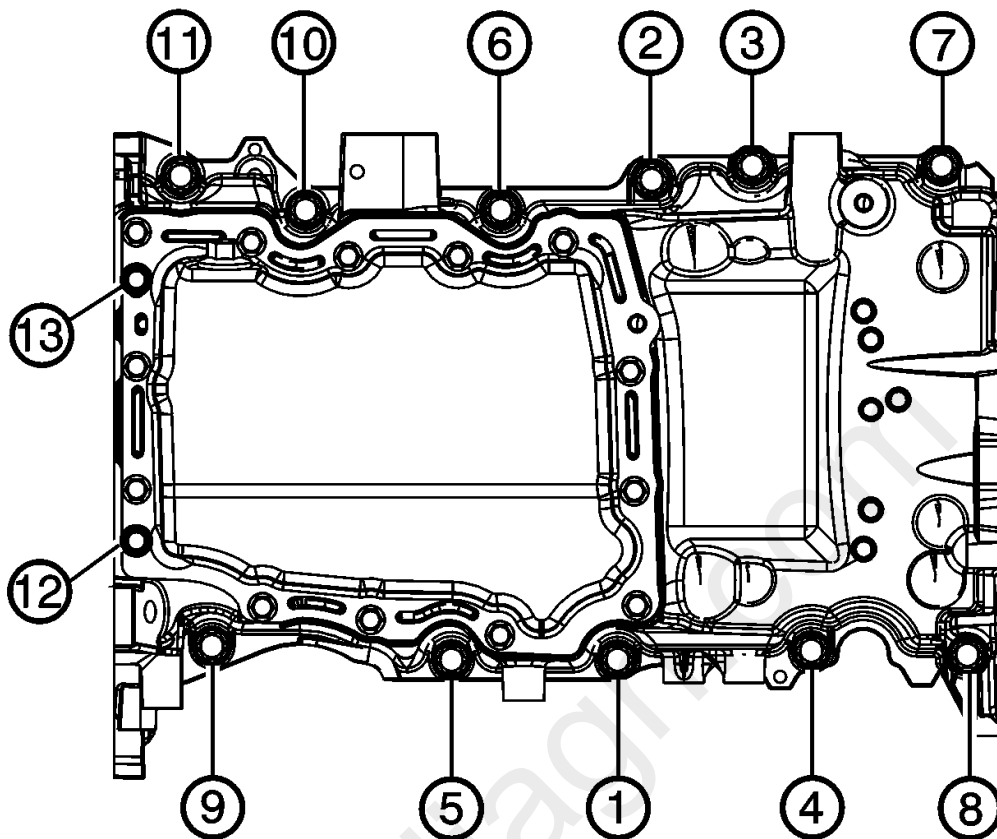


Fig. 180: Engine Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten bolts in sequence 1-11 to 25 (18 lb ft).
 2. Tighten bolts in sequence 12-13 to 10 (89 lb in).

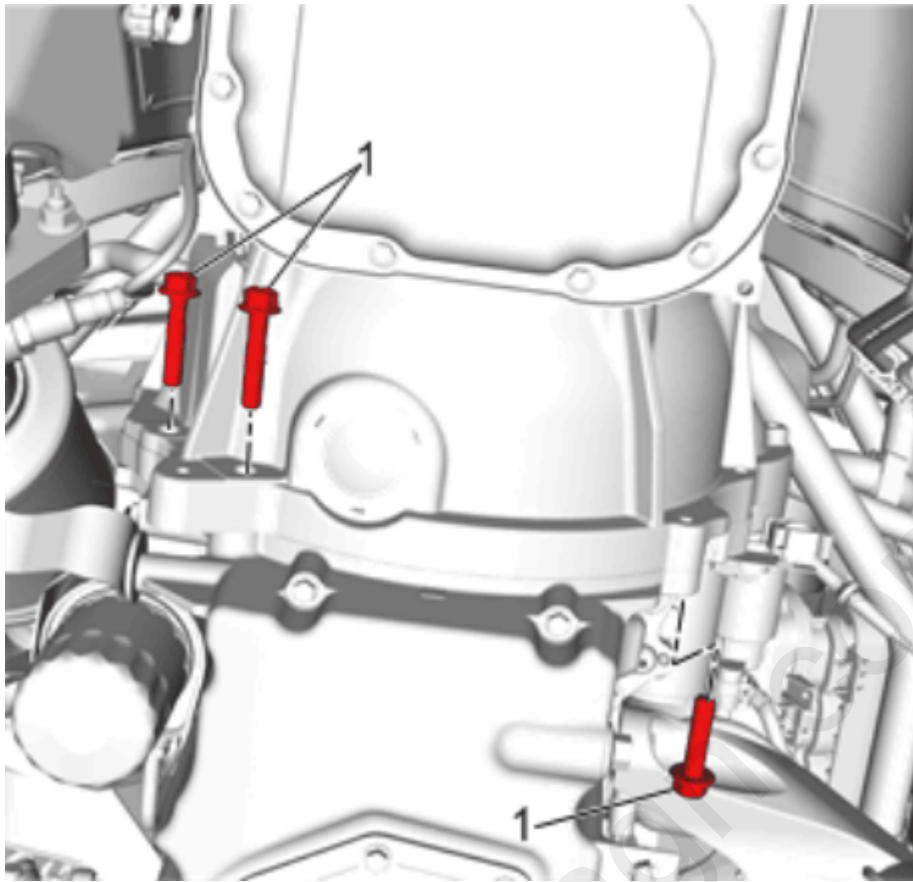


Fig. 181: Transmission Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission bolts (1) and tighten to 50 (37 lb ft).

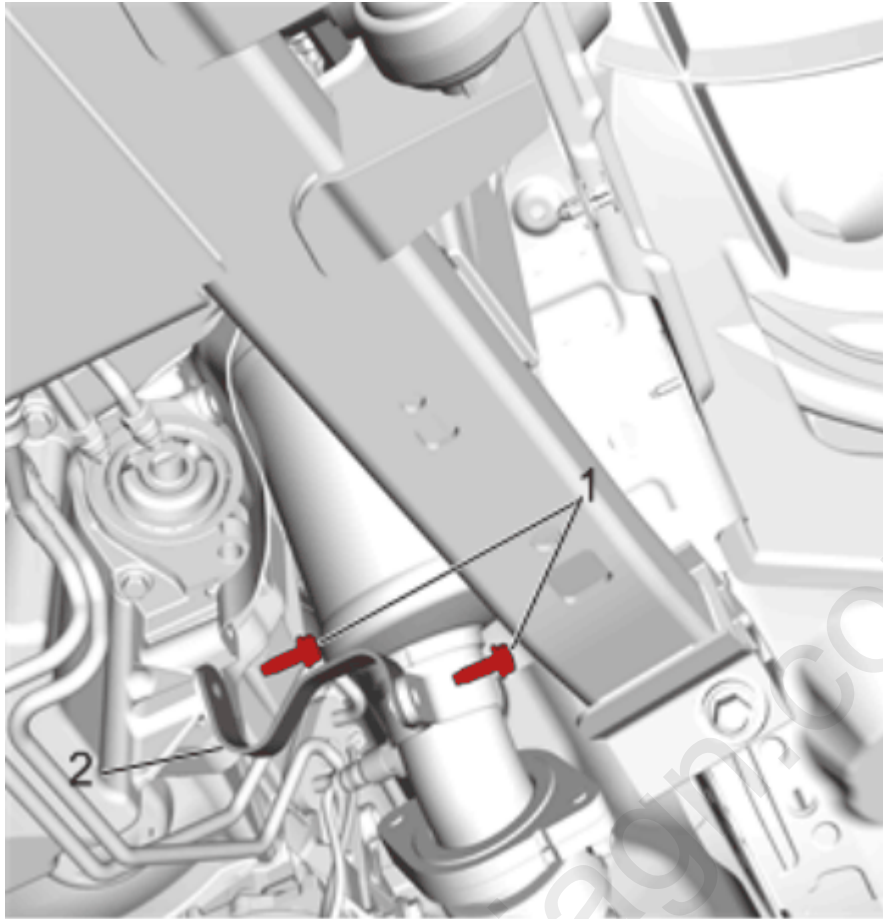


Fig. 182: Exhaust Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Position the exhaust bracket (2).
7. Install the exhaust bolts (1) and tighten to 10 (89 lb in).
8. Install the transmission cooler pipe retainer bolt . Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .

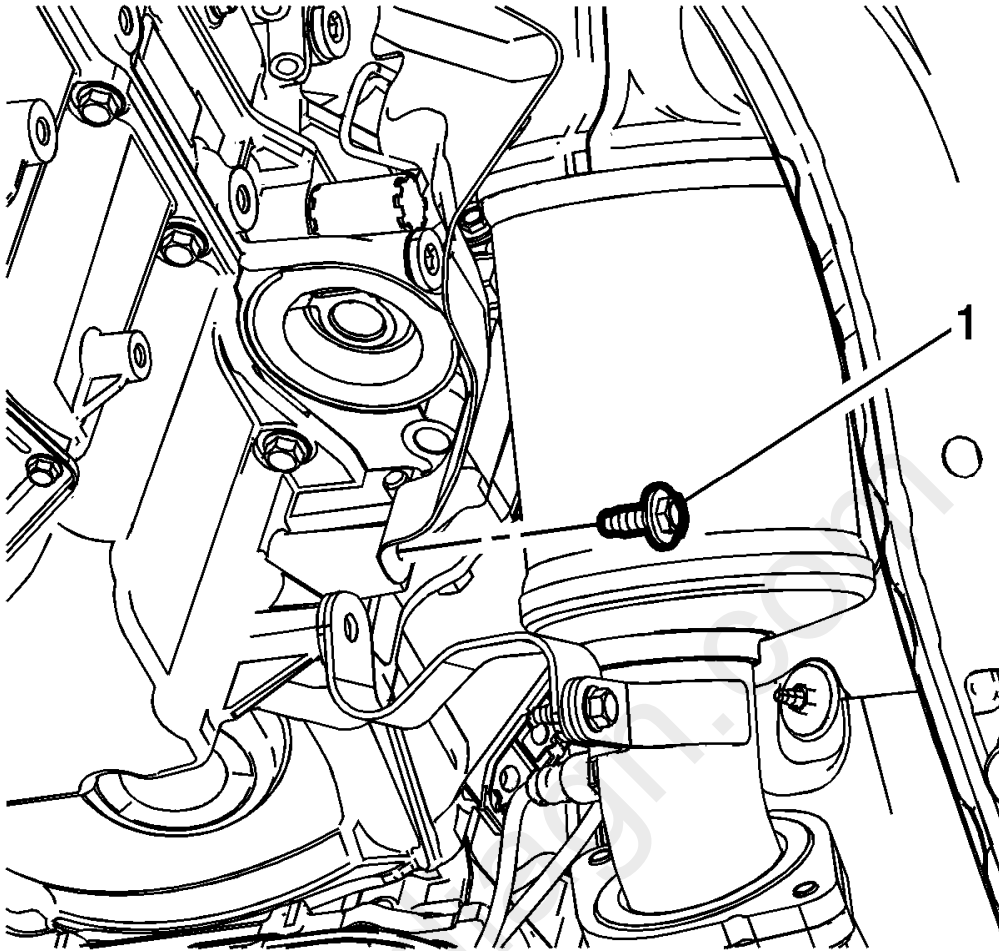


Fig. 183: Oil Pump Exhaust Shield
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pump exhaust shield bolt (1) and tighten to 10 (89 lb in).
10. Connect the electrical connector as necessary.
11. Install the frame. Refer to **Drivetrain and Front Suspension Frame Removal and Installation** .
12. If equipped, install the engine oil cooler. Refer to **Engine Oil Cooler Replacement**.
13. Position the A/C compressor and install the fasteners. Refer to **Air Conditioning Compressor Replacement (LTG)** .
14. Refill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PAN REPLACEMENT (AWD)

Removal Procedure

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

3. Unbolt and reposition the A/C compressor without disconnecting the lines. Refer to **Air Conditioning Compressor Replacement (LTG)** .
4. If equipped, remove the engine oil cooler. Refer to **Engine Oil Cooler Replacement**.
5. Remove the front differential carrier assembly. Refer to **Front Differential Carrier Assembly Replacement** .
6. Remove the front wheel drive intermediate shaft housing. Refer to **Front Wheel Drive Intermediate Shaft Housing Replacement** .

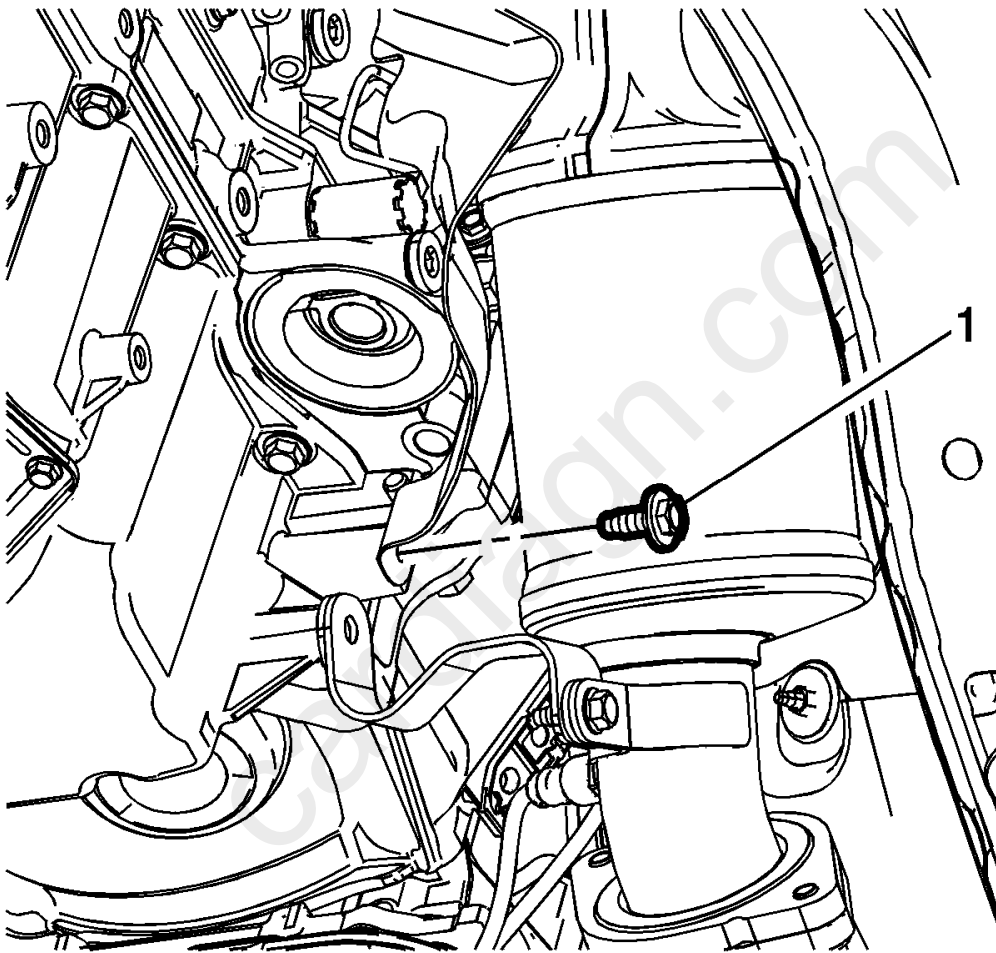


Fig. 184: Oil Pump Exhaust Shield
Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil pump exhaust shield bolt (1).

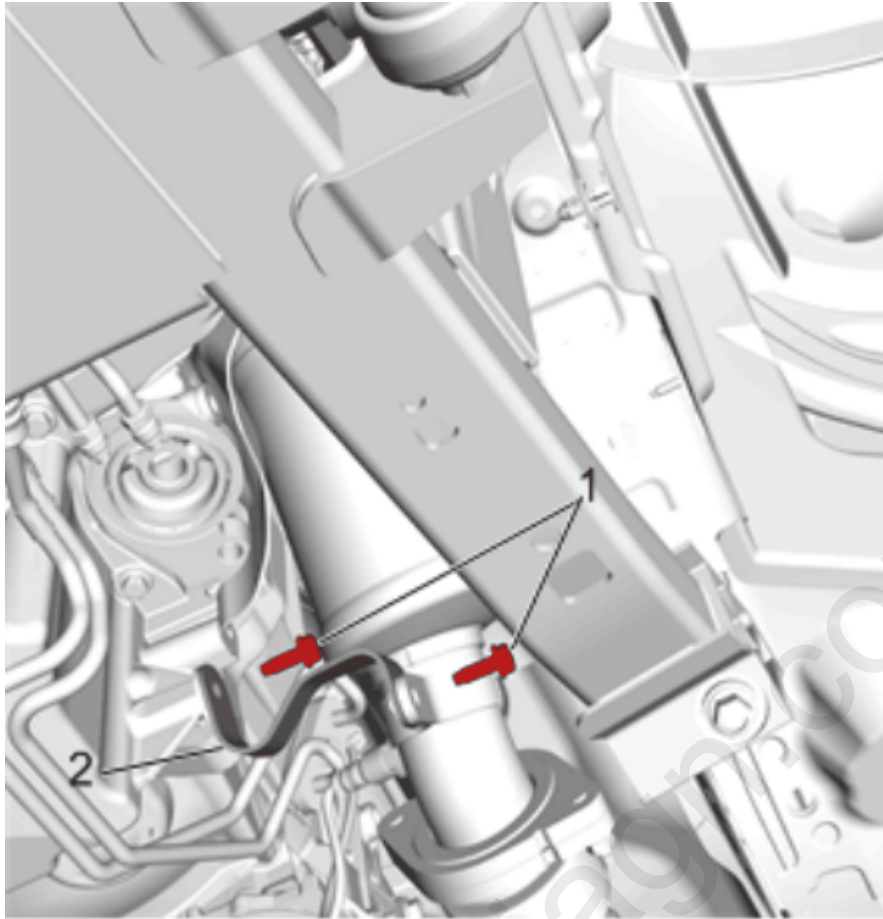


Fig. 185: Exhaust Bracket

Courtesy of GENERAL MOTORS COMPANY

8. Remove the exhaust bracket bolts (1) and bracket (2).
9. Remove the transmission cooler pipe retainer bolt and reposition the pipe assembly. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .

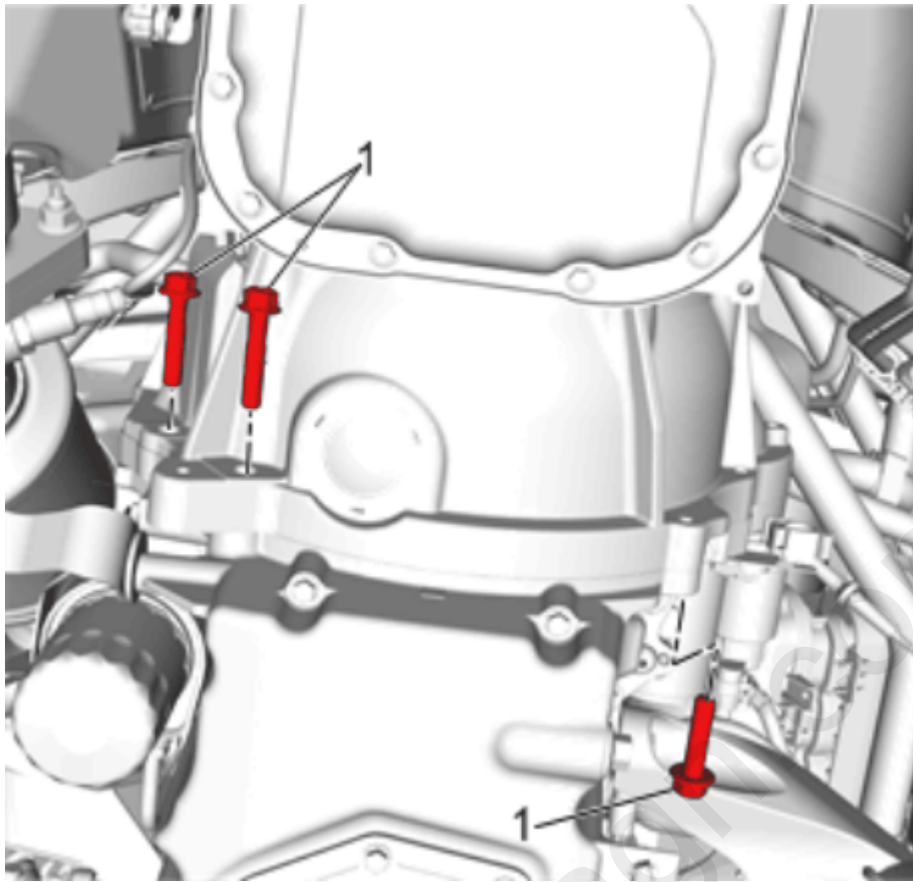


Fig. 186: Transmission Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the transmission bolts (1).
11. Disconnect the electrical connectors as necessary.

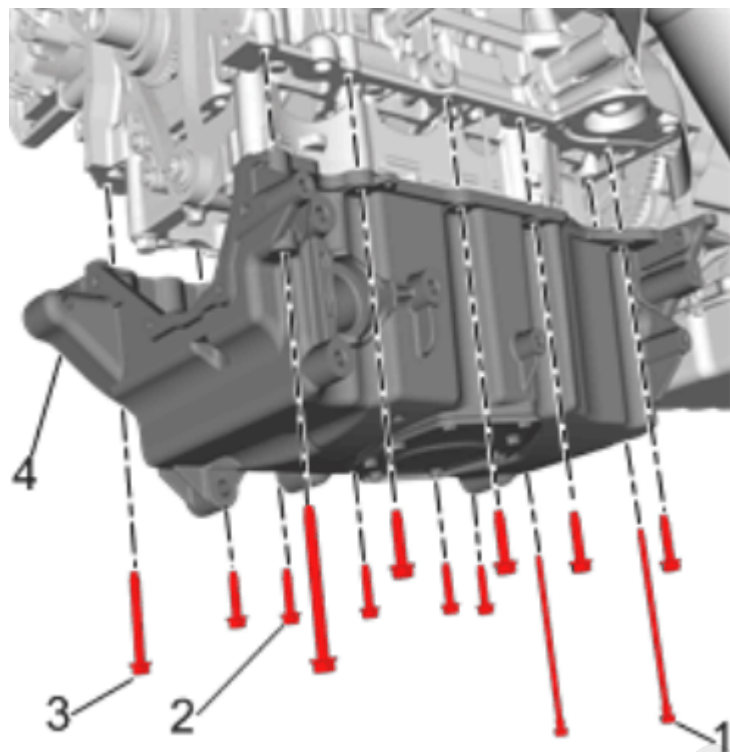


Fig. 187: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil pan bolts (1-3).
13. Remove the oil pan (4).
14. If resealing of the lower oil pan is required, refer to **Lower Oil Pan Replacement (2WD)**, **Lower Oil Pan Replacement (AWD)**.
15. For oil pan cleaning and inspection, refer to **Oil Pan Cleaning and Inspection** .

Installation Procedure

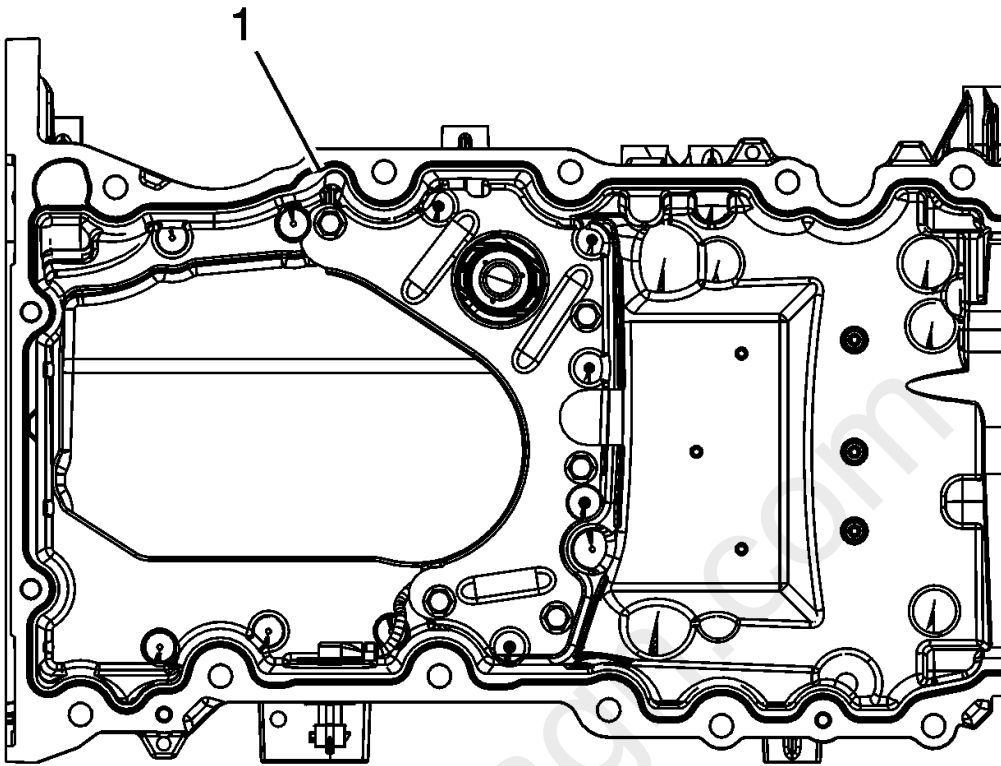


Fig. 188: Short Lower Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

1. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers .

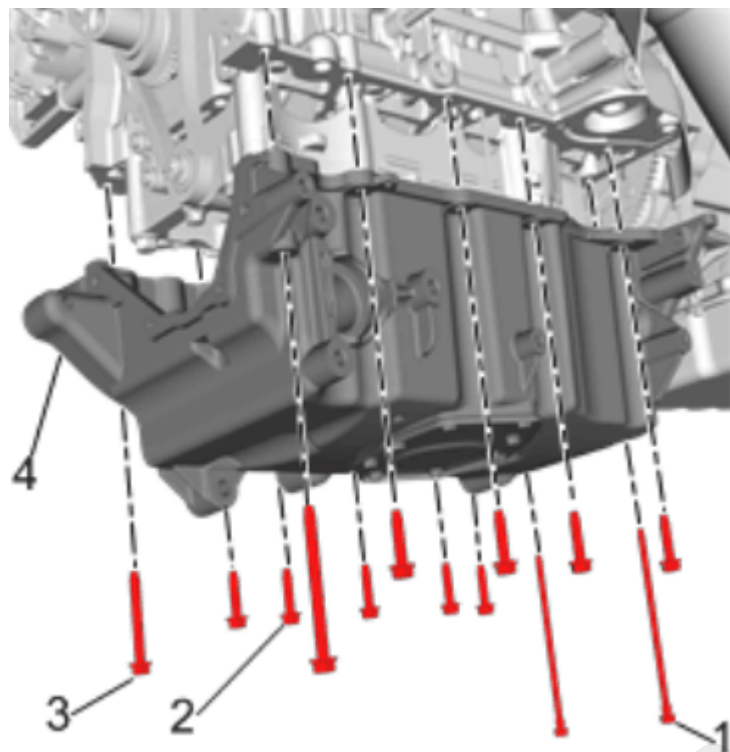


Fig. 189: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pan (4).

CAUTION: Refer to Fastener Caution .

3. Install the oil pan bolts (1-3) finger tight.

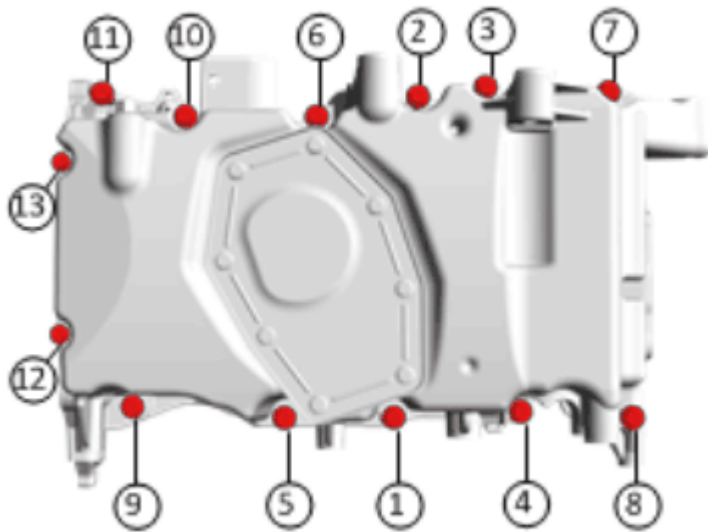


Fig. 190: Engine Oil Pan Bolt Tightening Sequence (2.0L - LTG)

Courtesy of GENERAL MOTORS COMPANY

4. Tighten the oil pan bolts in sequence to final torque twice using the following procedure:
 1. Tighten bolts in sequence 1-11 to 25 (18 lb ft).
 2. Tighten bolts in sequence 12-13 to 10 (89 lb in).

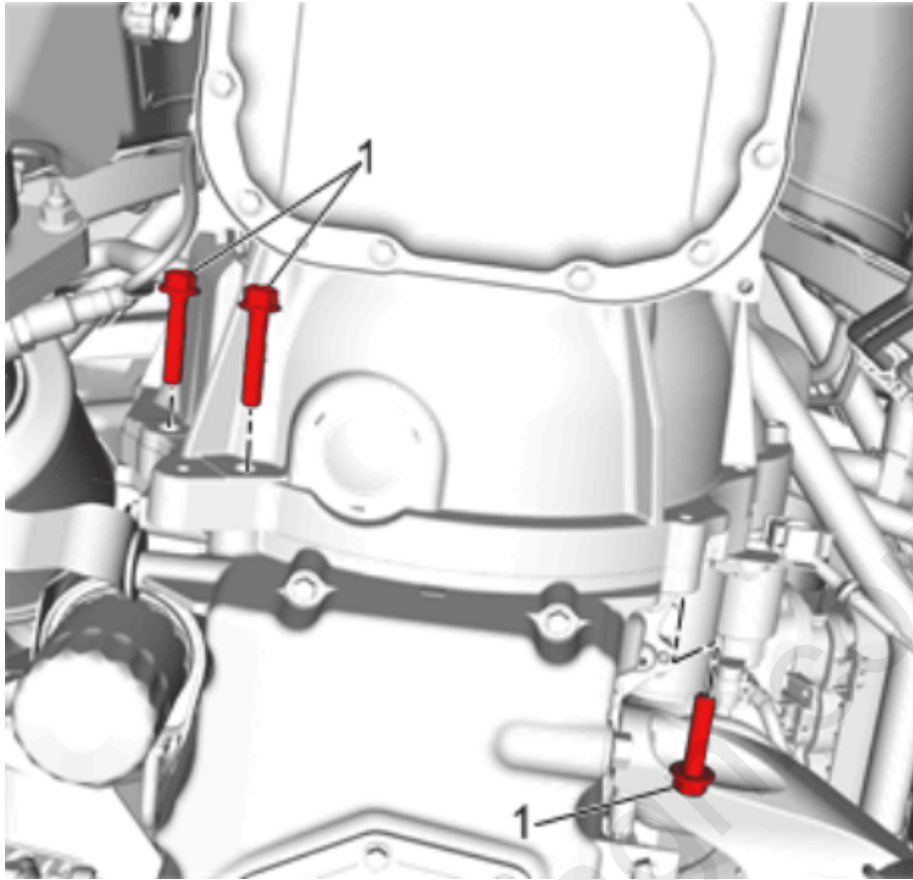


Fig. 191: Transmission Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the transmission bolts (1) and tighten to 50 (37 lb ft).

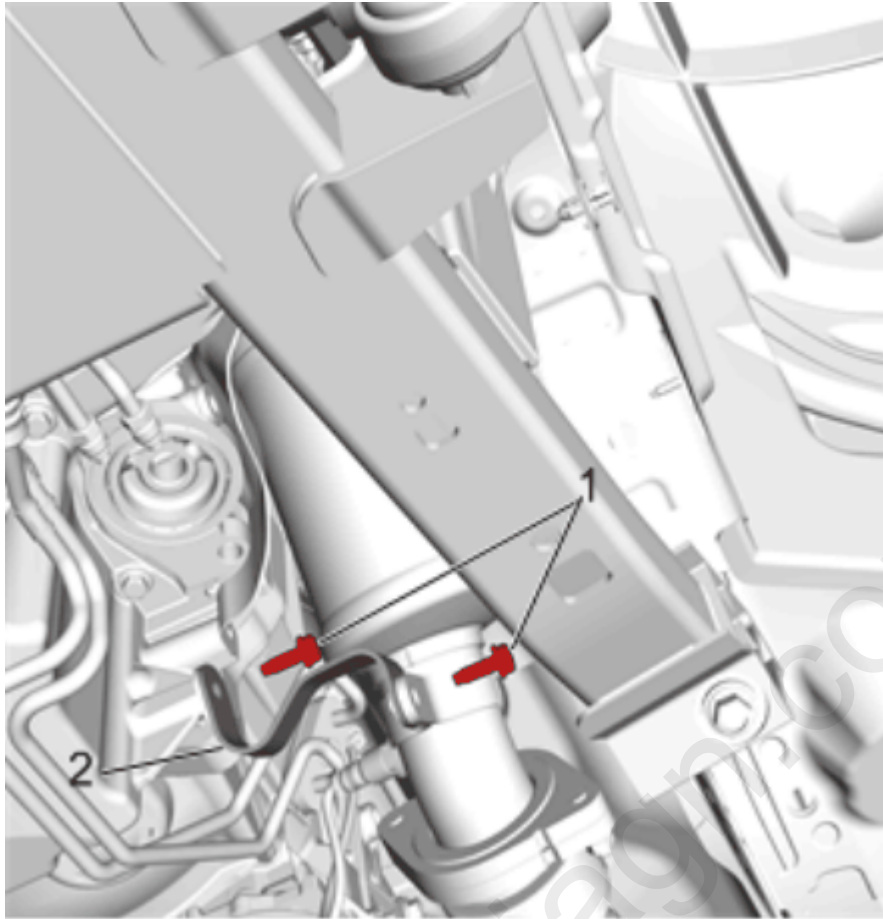


Fig. 192: Exhaust Bracket

Courtesy of GENERAL MOTORS COMPANY

6. Position the exhaust bracket (2).
7. Install the exhaust bracket bolts (1) and tighten to 10 (89 lb in).
8. Install the transmission cooler pipe and retainer bolt . Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)**

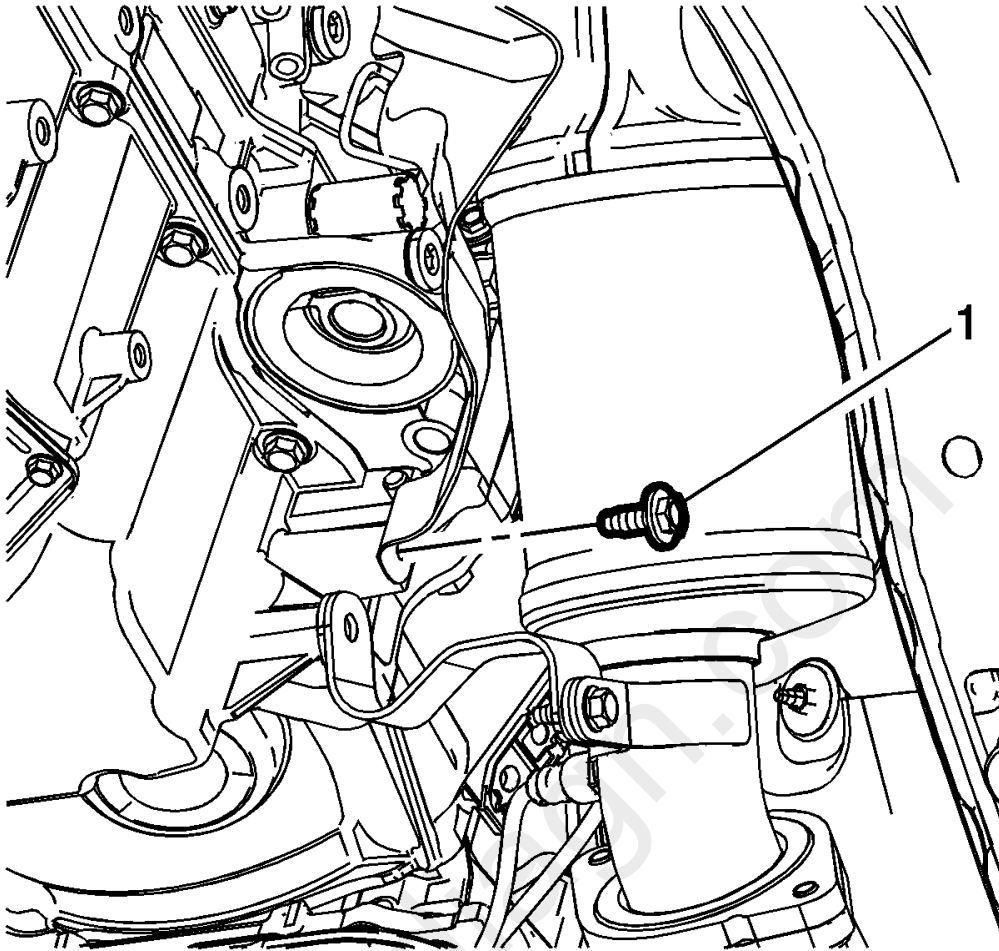


Fig. 193: Oil Pump Exhaust Shield
Courtesy of GENERAL MOTORS COMPANY

9. Install the exhaust shield bolt (1) and tighten to 10 (89 lb in).
10. Connect the electrical connectors as necessary.
11. Install the front wheel drive intermediate shaft housing. Refer to **Front Wheel Drive Intermediate Shaft Housing Replacement** .
12. Install the front differential carrier assembly. Refer to **Front Differential Carrier Assembly Replacement** .
13. If equipped, install the engine oil cooler. Refer to **Engine Oil Cooler Replacement**.
14. Position the A/C compressor and install the fasteners. Refer to **Air Conditioning Compressor Replacement (LTG)** .
15. Install the engine oil filter and refill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

LOWER OIL PAN REPLACEMENT (2WD)

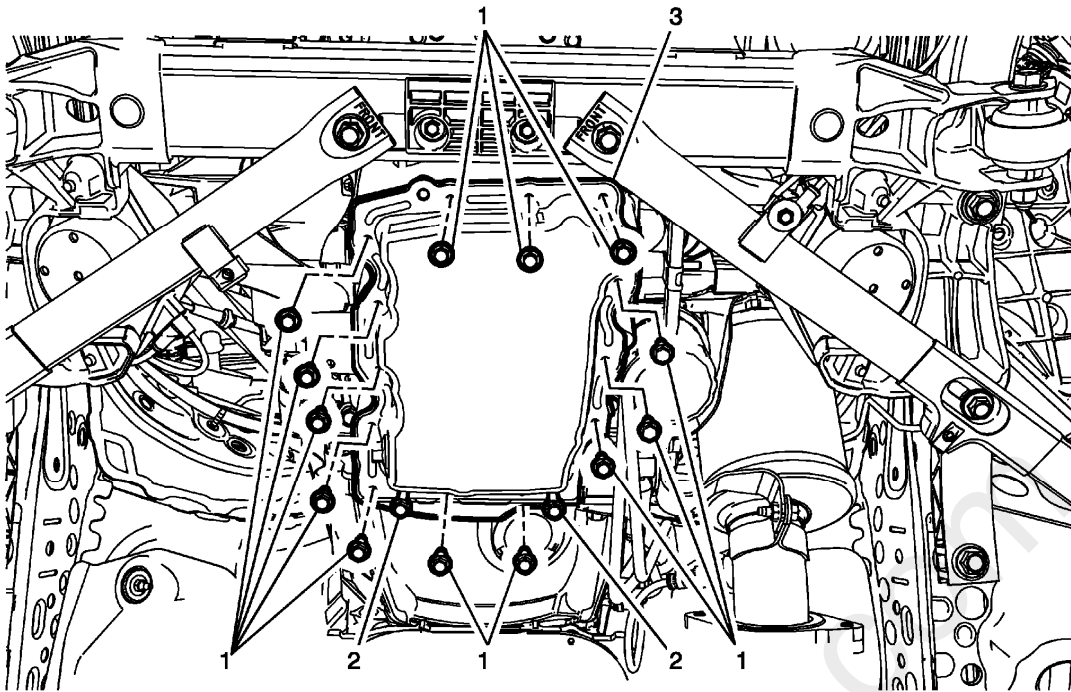


Fig. 194: Oil Pan (LCV Lower)
 Courtesy of GENERAL MOTORS COMPANY

Lower Oil Pan Replacement (2WD)

Callout	Component Name
Preliminary Procedures	
Drain engine oil. Refer to <u>Engine Oil and Oil Filter Replacement</u>	
1	Oil Pan Bolts (Qty 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Oil Pan Bolts (Qty; 13) Tighten 10 (89 lb in)
3	Oil Pan Procedure Apply a 2.25 mm bead of sealer on the level part of the flange around the perimeter of the oil pan. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

LOWER OIL PAN REPLACEMENT (AWD)

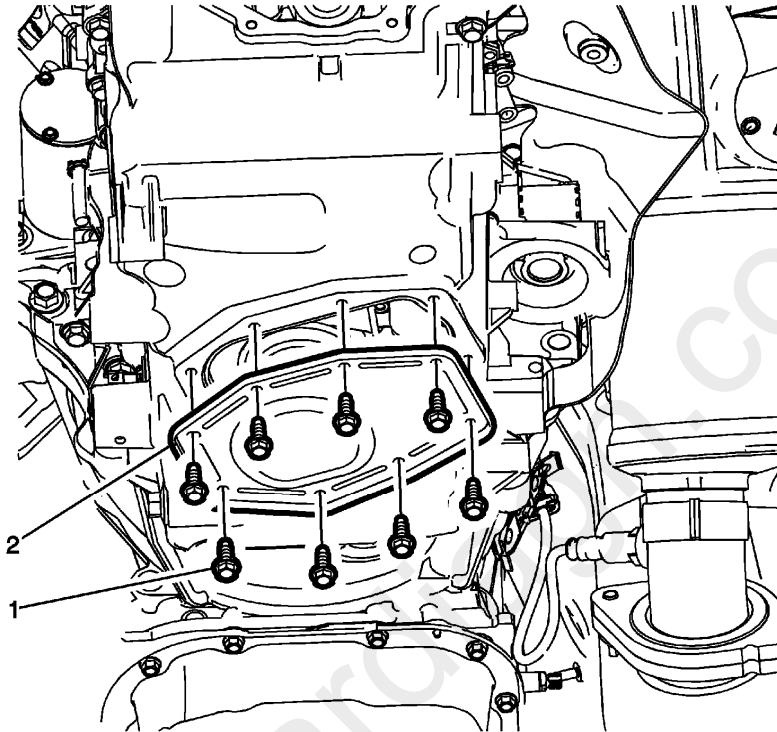


Fig. 195: Lower Oil Pan Cover (AWD)
Courtesy of GENERAL MOTORS COMPANY

Lower Oil Pan Replacement (AWD)

Callout	Component Name
Preliminary Procedures	
Drain engine oil. Refer to <u>Engine Oil and Oil Filter Replacement</u>	
1	Oil Pan Bolts (Qty 8) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Oil Pan

Procedure

Apply a 2.25 mm bead of sealer on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

2

NOTE:

- The lower crankcase surface must be free of contamination prior to applying the sealer.
- Install and align the oil pan to block within 20 minutes of applying the sealer.
- The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement (2WD)**, **Oil Pan Replacement (AWD)**.
2. Disconnect the oil level sensor electrical connector.

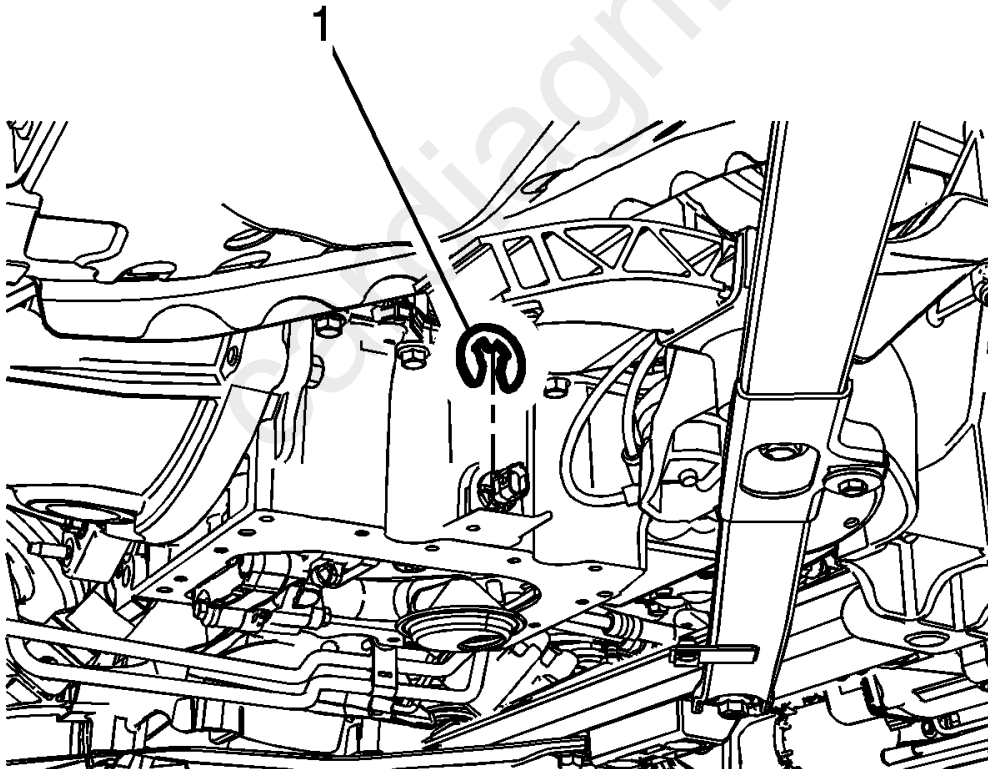


Fig. 196: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil level sensor C-clip (1).

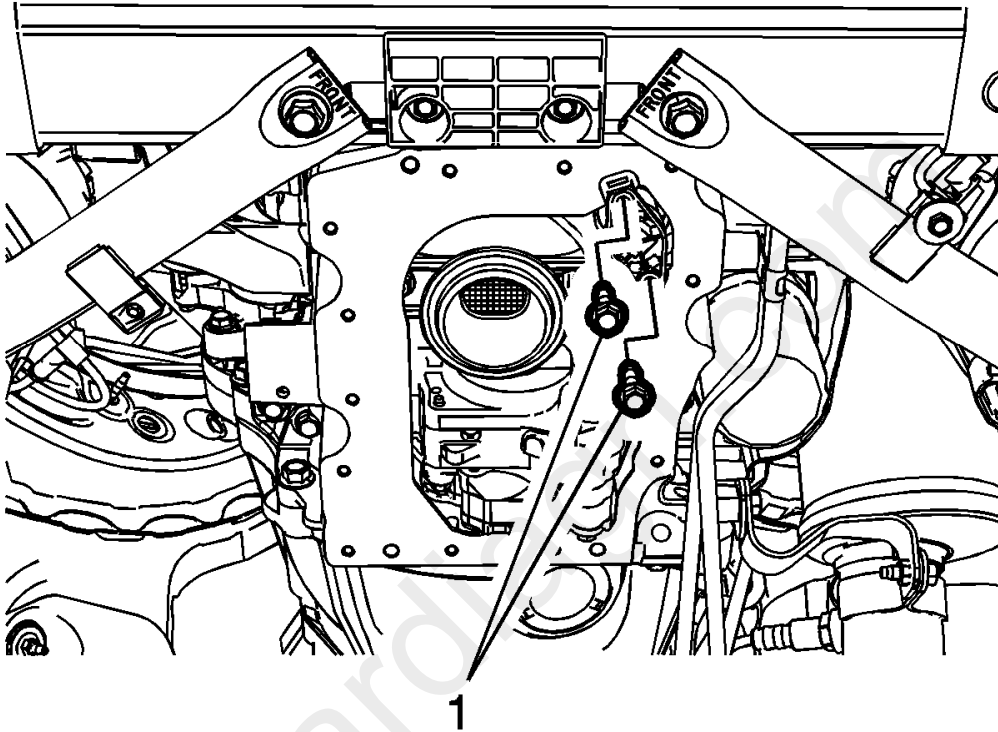


Fig. 197: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil level sensor fasteners (1).

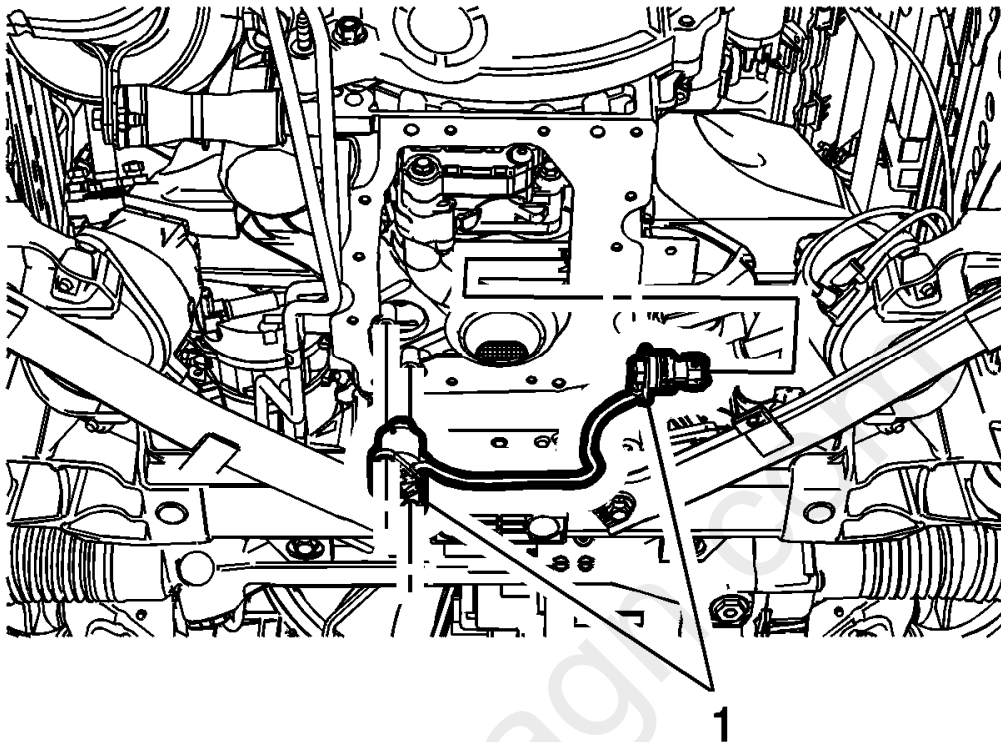


Fig. 198: Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the O-ring around the level sensor.

5. Remove the engine oil level sensor (1) from the oil pan.

Installation Procedure

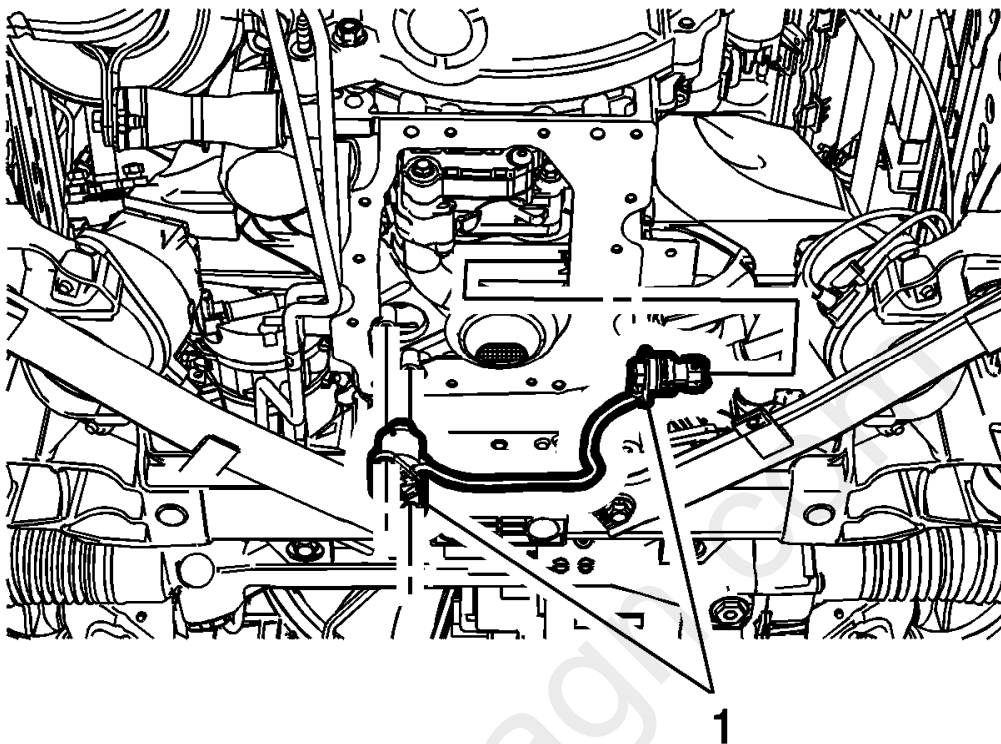


Fig. 199: Oil Level Sensor

Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the O-ring around the level sensor.

1. Install the engine oil level sensor (1).

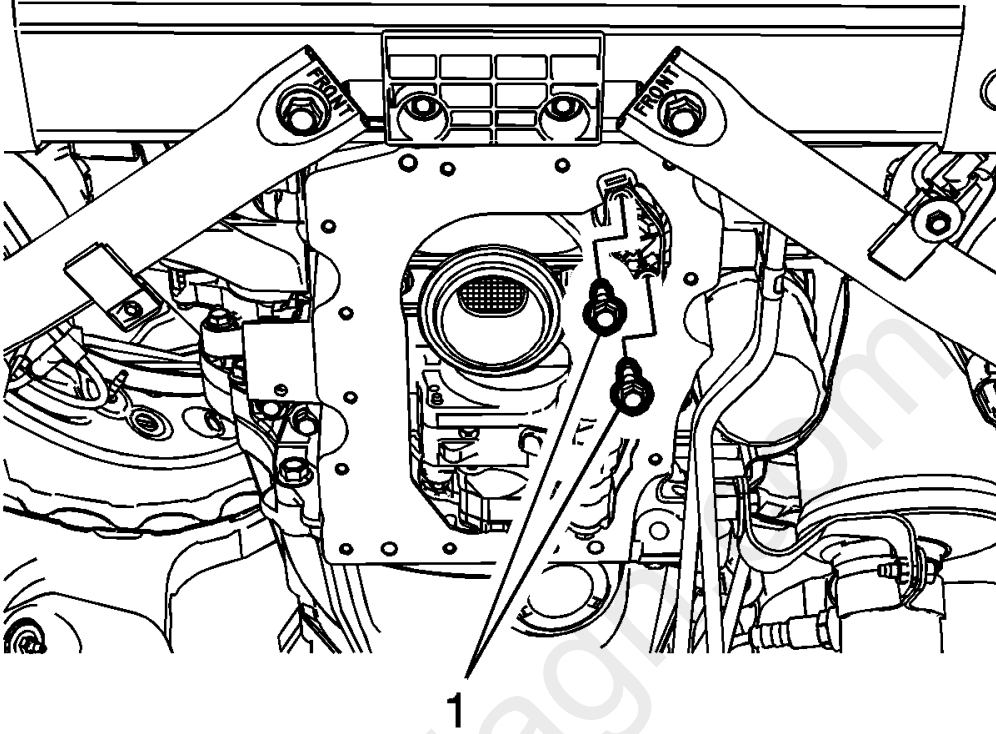


Fig. 200: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the engine oil level sensor fastener (1) and tight to 10 (89 lb in).

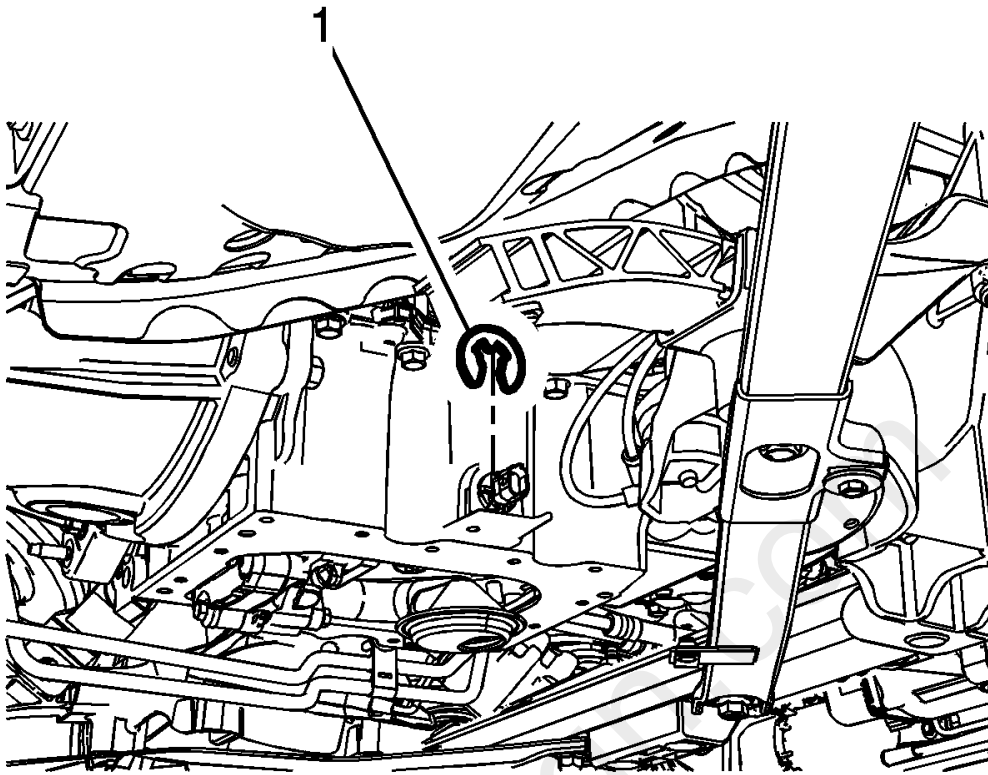


Fig. 201: Engine Oil Level Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine oil level sensor C-clip (1).
4. Connect the oil level sensor electrical connector.
5. Remove the oil pan. Refer to **Oil Pan Replacement (2WD)**, **Oil Pan Replacement (AWD)**.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

Special Tools

- EN 50792 Flywheel Holding Tool
- EN-45059 Angle Meter

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

1. Remove the transmission. Refer to Transmission Replacement (LTG) .

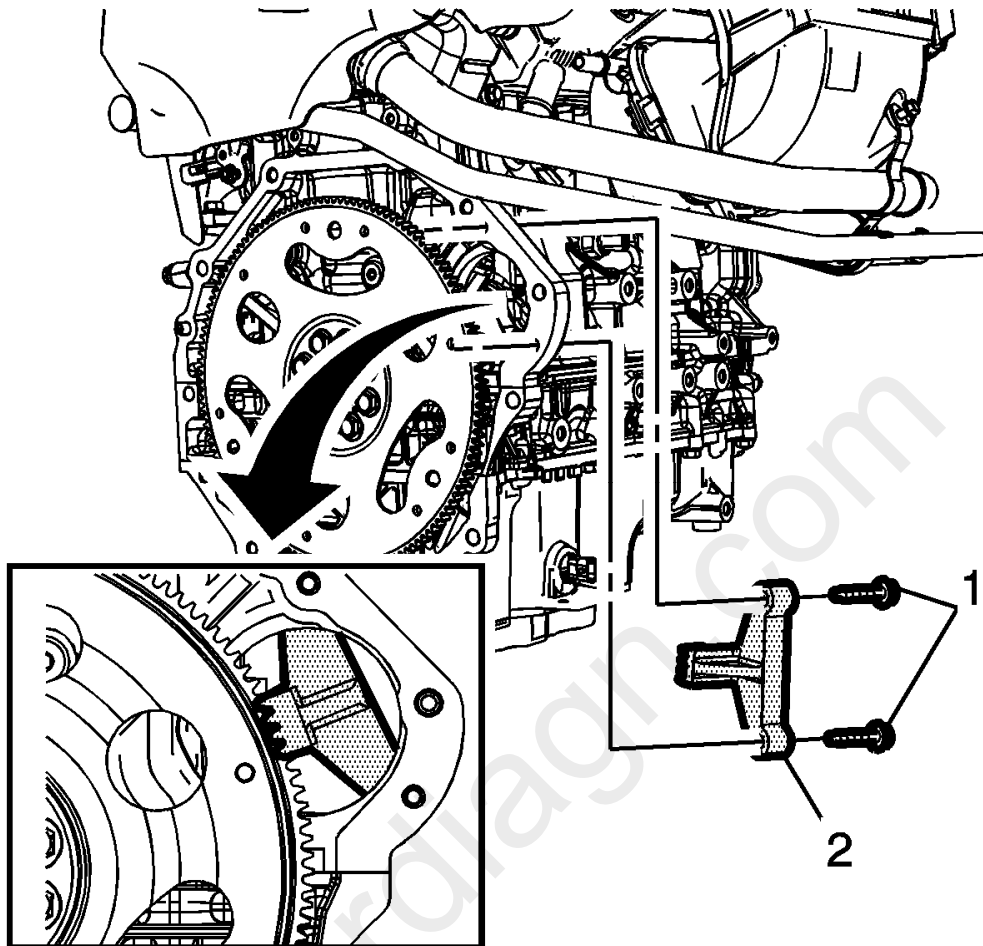


Fig. 202: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install EN 50792 holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the automatic flex plate.

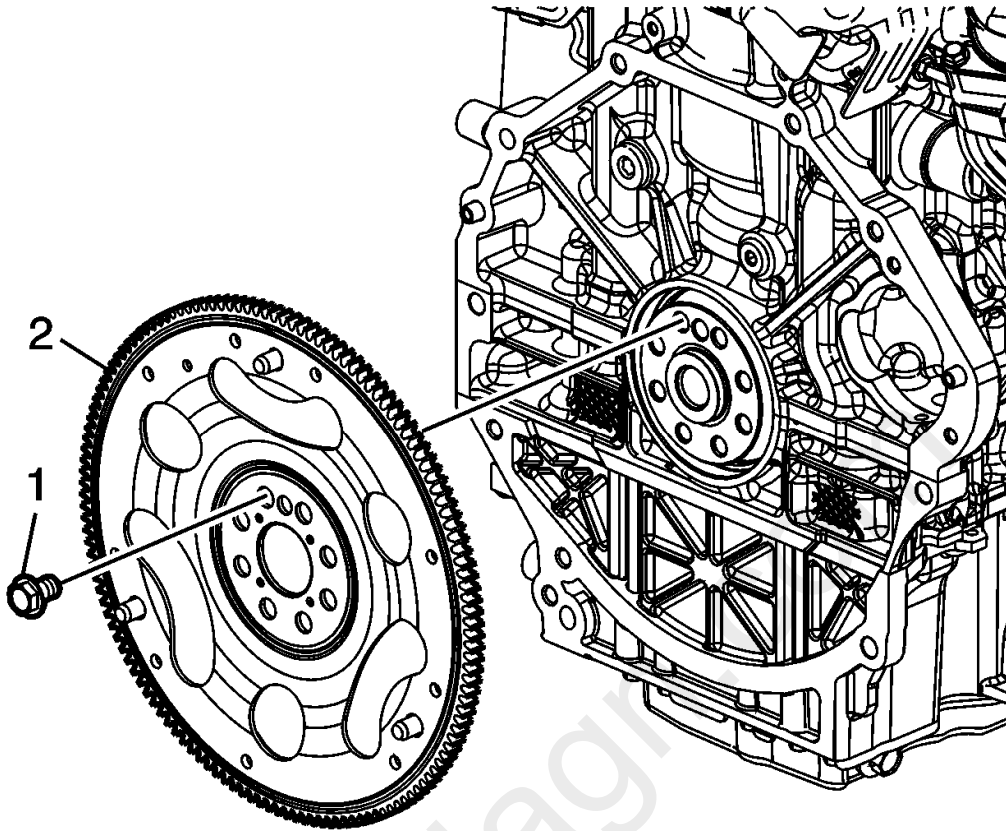


Fig. 203: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the automatic flex plate attaching bolts (1).
4. Remove the automatic flex plate (2).
5. Remove **EN 50792** holding tool.
6. For automatic flex plate cleaning and inspection. Refer to **Automatic Transmission Flex Plate Cleaning and Inspection** .

Installation Procedure

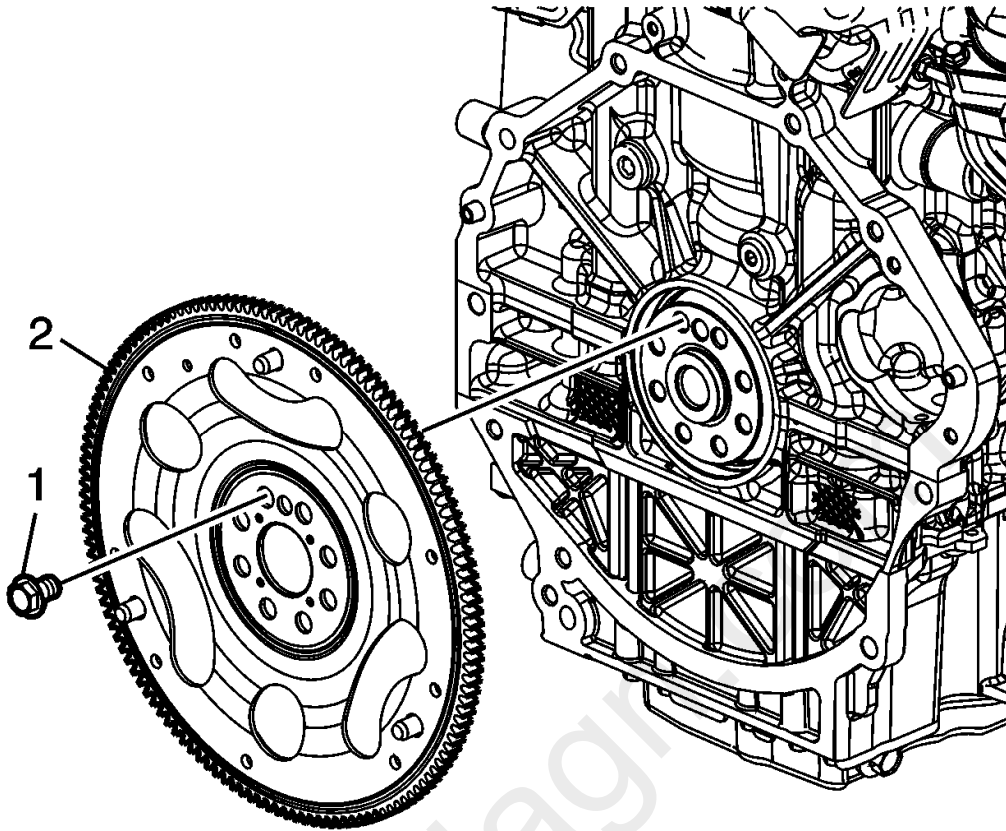


Fig. 204: Flywheel Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Fasteners have adhesive patch and must be tightened to final torque within 5 minutes.

1. Install the automatic flex plate (2) and hand start NEW bolts (1).

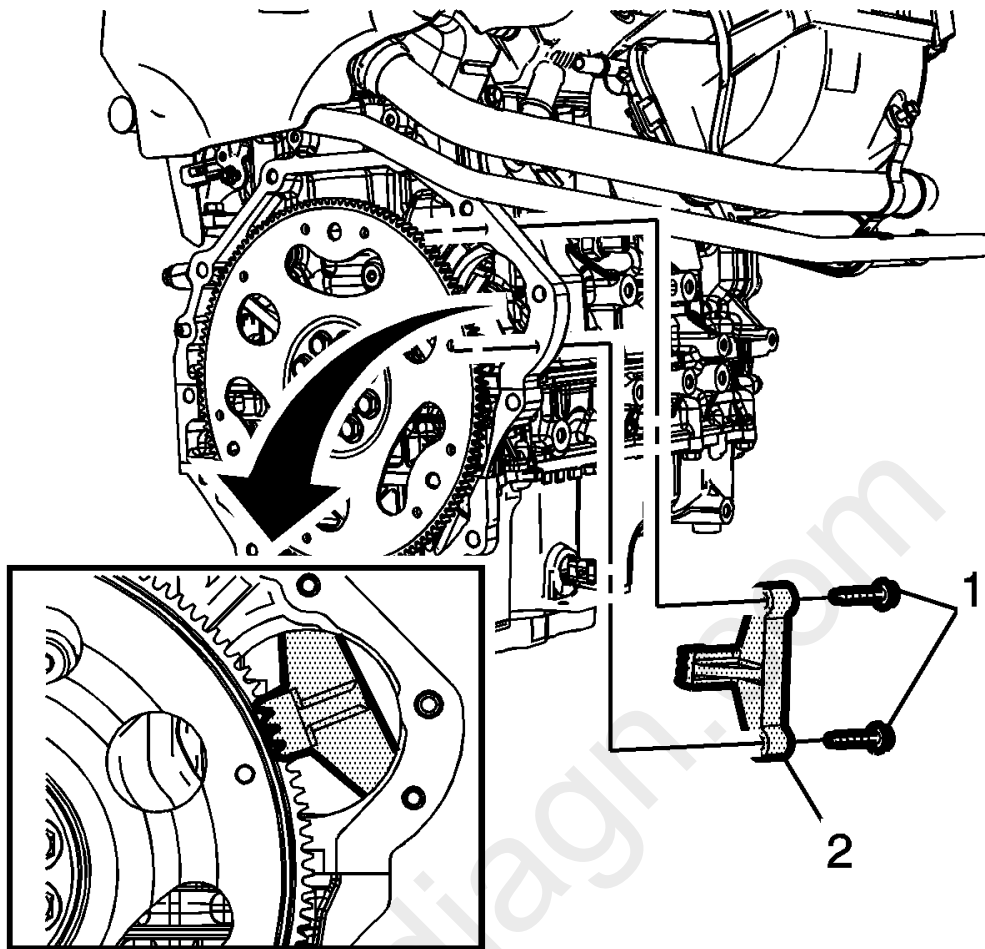


Fig. 205: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-50792** automatic flex plate holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flex plate.

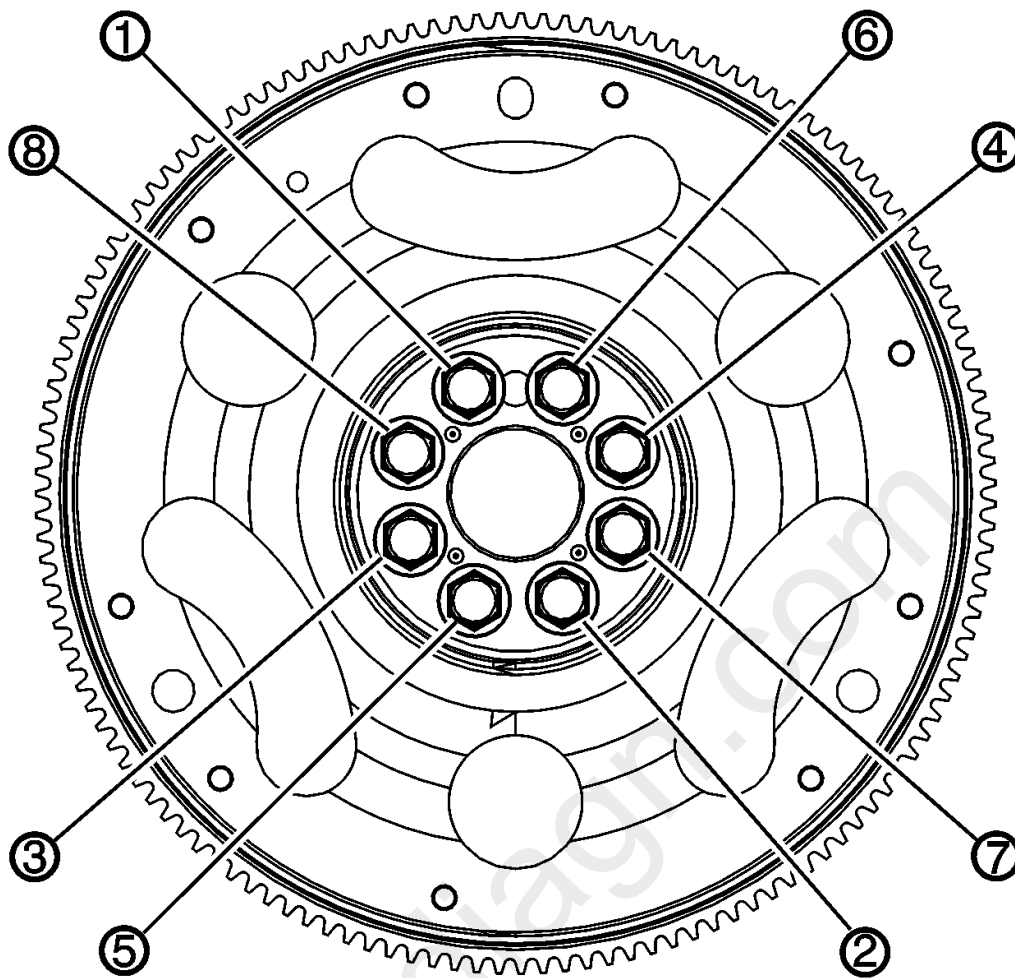


Fig. 206: Flywheel Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the bolts evenly using the following procedure:
 1. Tighten the bolts a first pass in sequence to 20 N.m (15 lb ft).
 2. Tighten the bolts a second pass in sequence to 30 N.m (22 lb ft).
 3. Tighten the bolts a final pass in sequence 40 degrees using the **EN-45059** angle meter.
4. Remove **EN-50792** automatic flex plate holding tool.
5. Install the transmission. Refer to **Transmission Replacement (LTG)** .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-42067 Rear Main Seal Installer

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Remove the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Replacement.

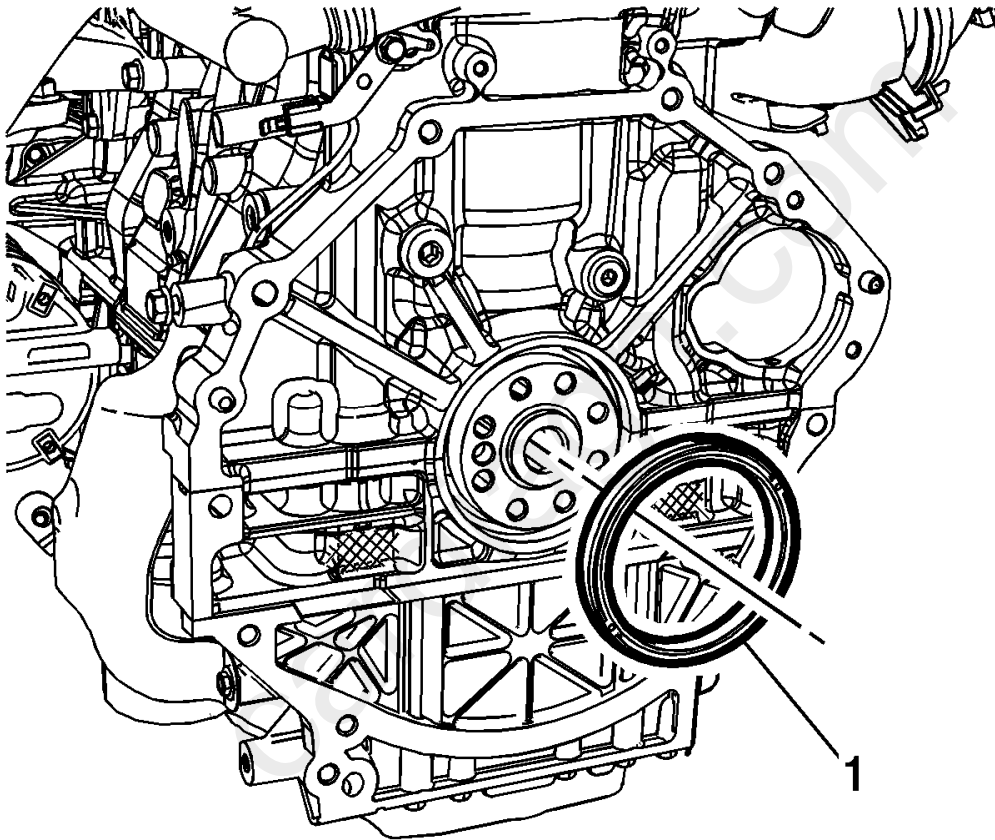


Fig. 207: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

2. Use a suitable tool to remove the crankshaft rear oil seal (1).

Installation Procedure

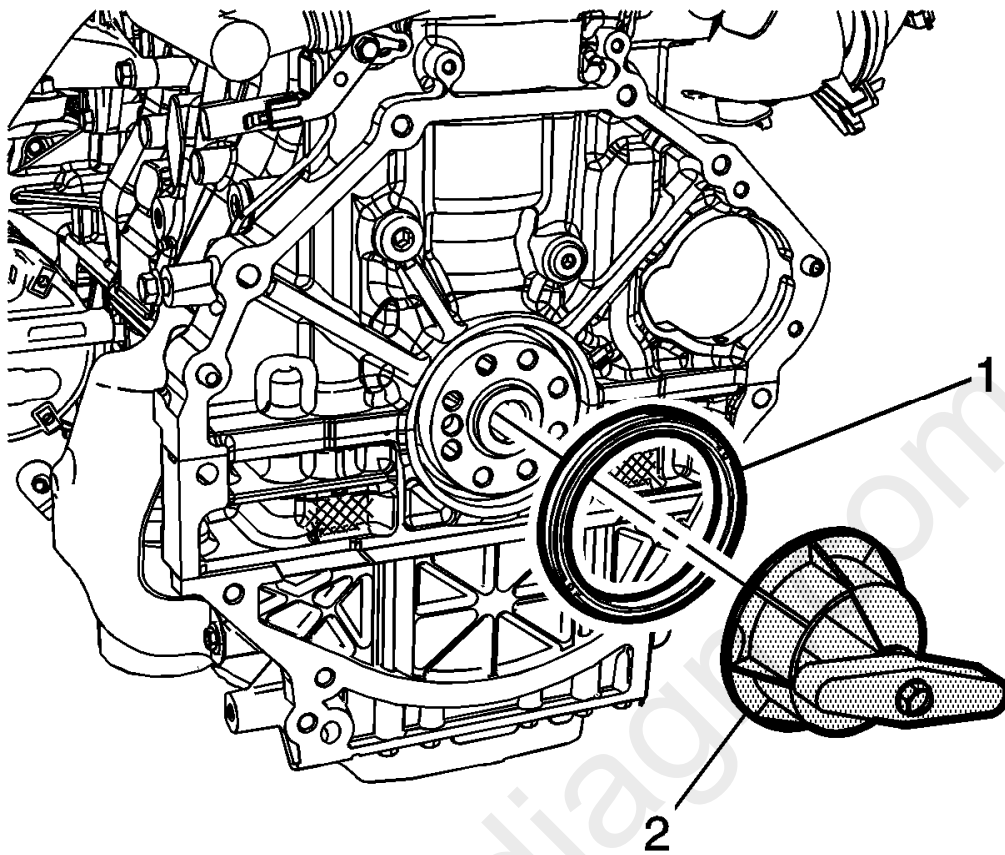


Fig. 208: Crankshaft Real Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-42067** rear main seal installer , install a NEW crankshaft real oil seal (1).
2. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

ENGINE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Recover the refrigerant system . Refer to **Refrigerant Recovery and Recharging (R-134a)** , **Refrigerant Recovery and Recharging (R-1234yf)** .
3. Remove the charge air cooler inlet air tube. Refer to **Charge Air Cooler Inlet Air Tube Replacement** .
4. Remove the charger air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .
5. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System**

Draining and Filling (GE 47716) .

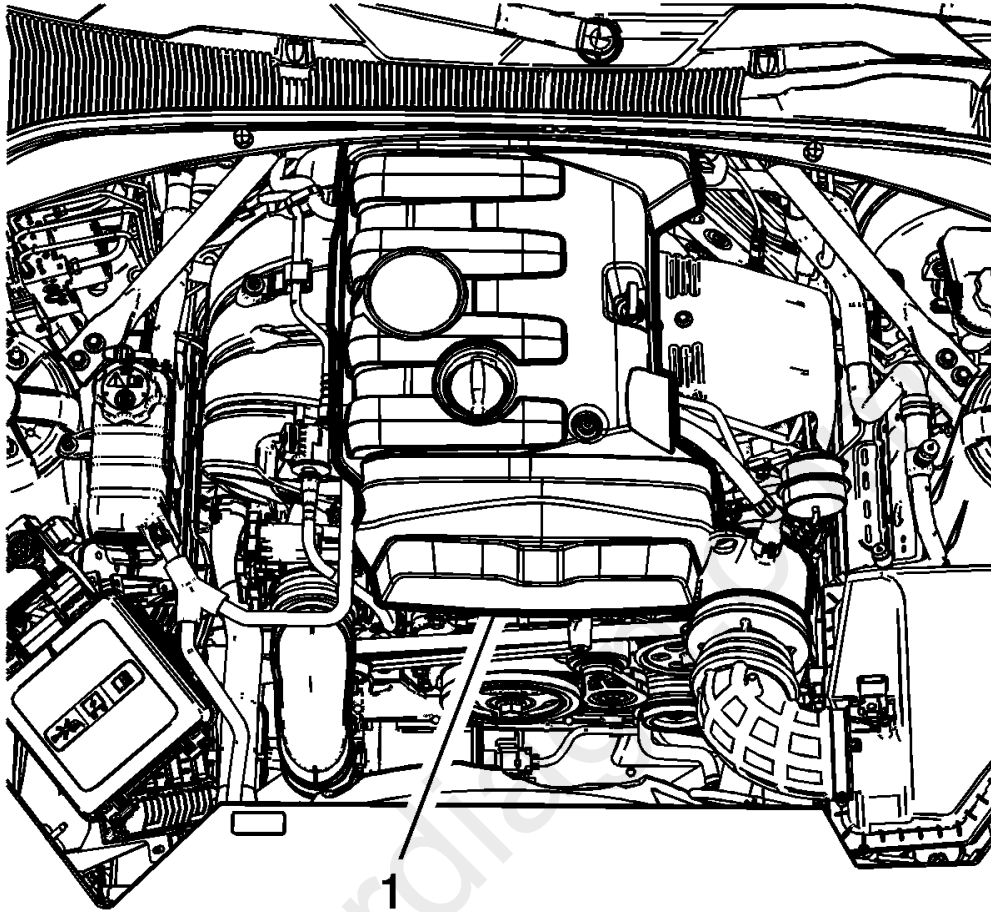


Fig. 209: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

6. Remove the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement.**

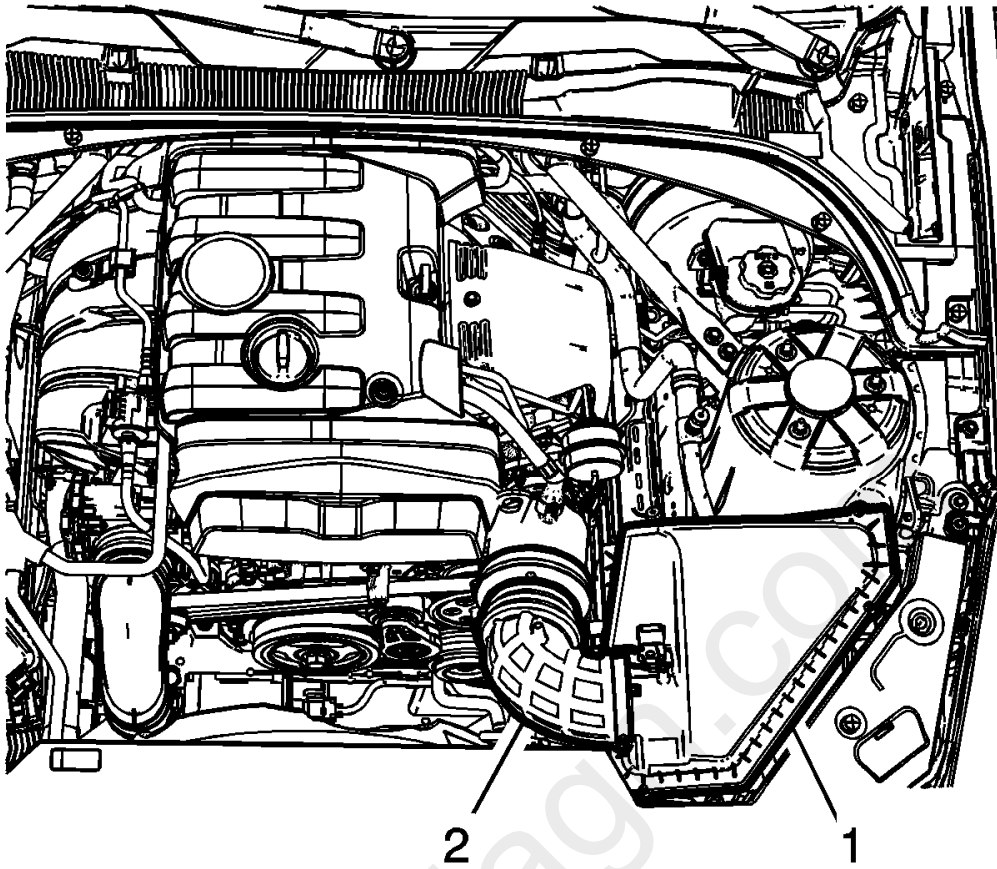


Fig. 210: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
8. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .

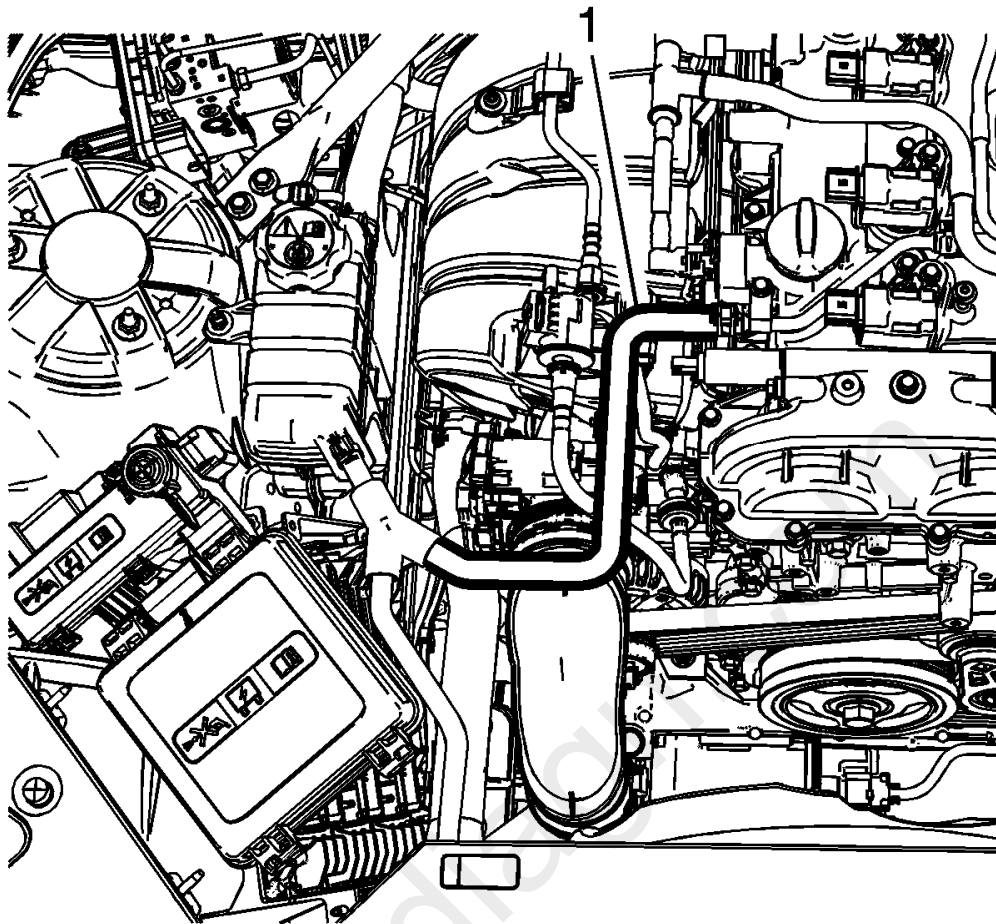


Fig. 211: Radiator Surge Tank Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the radiator surge tank inlet hose (1) from the engine. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)** .
10. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LTG)** .
11. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LTG with V03)** , **Radiator Outlet Hose Replacement (LTG without V03)** .
12. Disconnect the fuel feed hose from the engine. Refer to **Fuel Feed Pipe Replacement** .

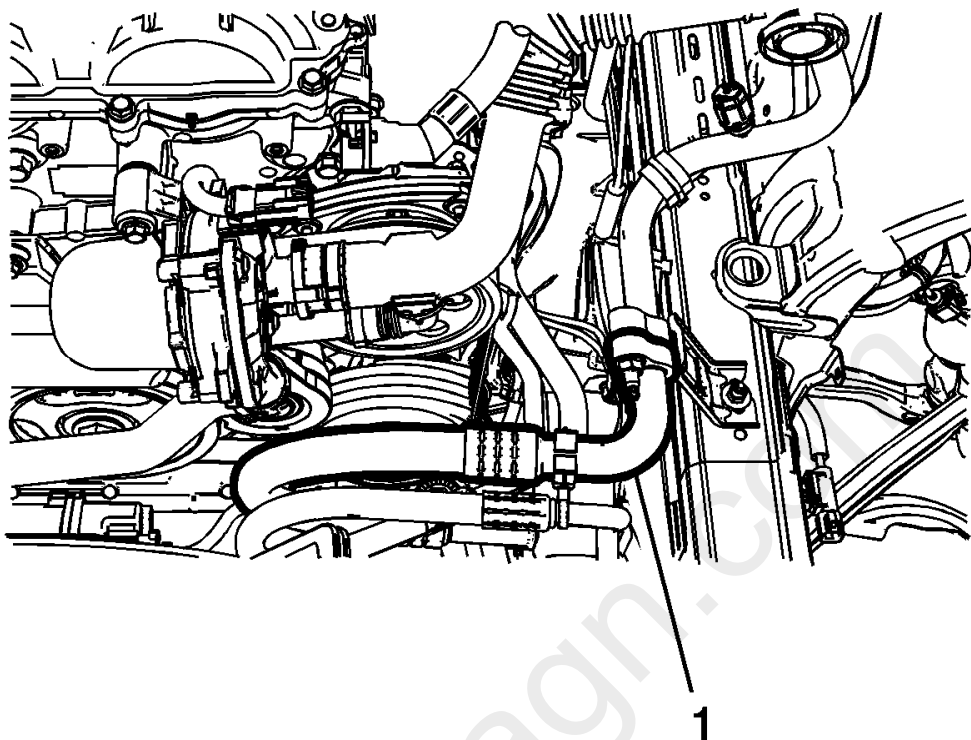


Fig. 212: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LTG)** .
14. Disconnect the range selector lever cable. Refer to **Range Selector Lever Cable Replacement** .
15. Remove the two piece drive shaft. Refer to **Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW)** .
16. Disconnect the transmission cooler pipes from the engine and transmission. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .
17. Disconnect the evaporative emission line at the canister purge solenoid then remove the line from the retainer. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

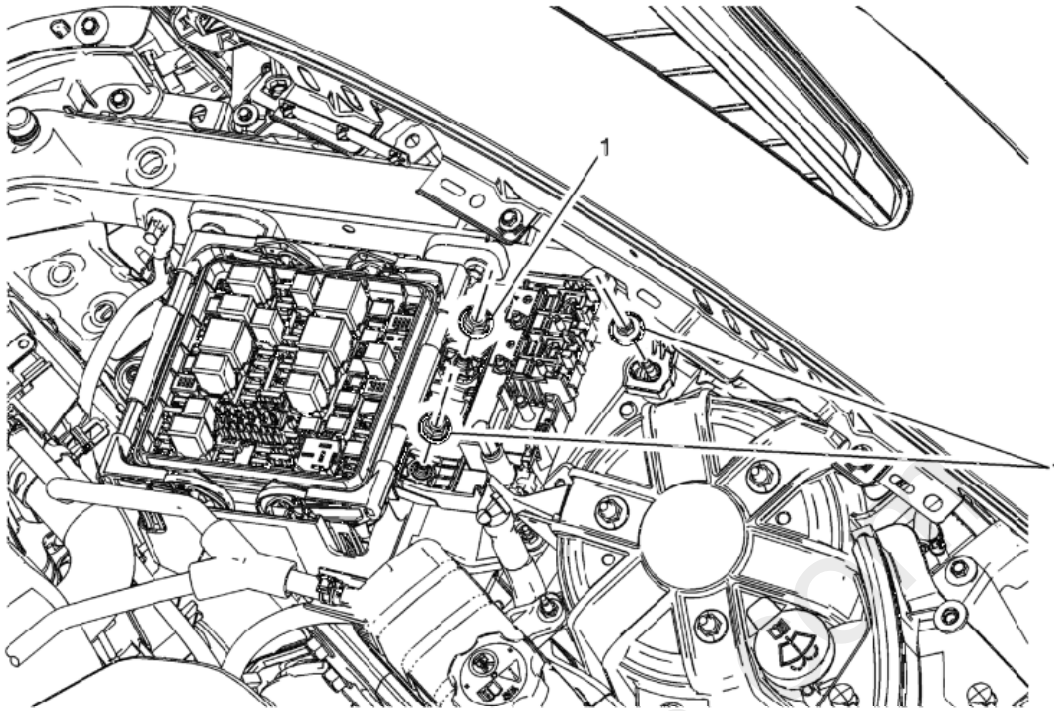


Fig. 213: Pre Fuse Base Nuts

Courtesy of GENERAL MOTORS COMPANY

18. Remove the positive cable fasteners (1) then disconnect the battery positive cables at the 100 amp pre-fuse base.
19. Reposition the cables to the top of the engine for ease of engine removal.
20. Remove the front compartment fuse block housing. Refer to **Front Compartment Fuse Block Housing Replacement** .
21. Remove the ECM. Refer to **Engine Control Module Replacement** .
22. Disconnect the lever lock connector attached to the base of the ECM bracket.

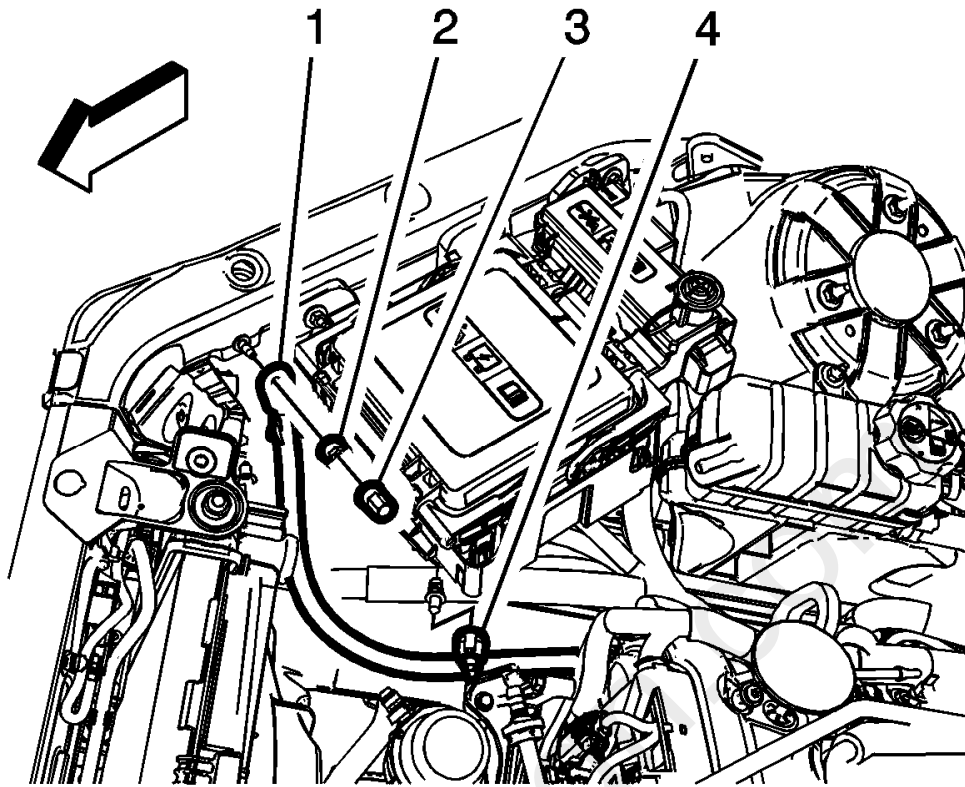


Fig. 214: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

23. Disconnect the battery negative cable extension cable retainer (4) from the engine harness
24. Remove the protective cap (3) and the battery negative cable extension cable fastener (2).
25. Remove the ground cable nut at the right front inner core support and remove the cable (1).
26. Disconnect the engine harness retainers at the right engine compartment frame rail and position the harness to the top of the engine.
27. Disconnect the heater inlet hose at the heater core. Refer to **Heater Inlet Hose Replacement (LTG)** .
28. Disconnect the heater outlet hose at the heater core. Refer to **Heater Outlet Hose Replacement (LTG)** .
29. Disconnect the vacuum line at the brake booster. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement (LTG)** .
30. Disconnect the vacuum brake booster vacuum switch electrical connector.
31. If equipped with AWD, remove the front wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** , and **Front Wheel Drive Shaft Replacement - Right Side** .
32. Ensure when raising the body the following items are clear from the frame:

- Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
33. Remove the drivetrain and front suspension frame with the powertrain attached. Refer to **Drivetrain and Front Suspension Frame Removal and Installation** .
 34. Secure the powertrain to the support table using straps and binders.
 35. Separate the engine from the transmission. Refer to **Transmission Replacement (LTG)** .
 36. Disconnect electrical connectors as necessary.

Installation Procedure

1. Install the engine to the transmission. Refer to **Transmission Replacement (LTG)** .
2. Connect electrical connectors as necessary.
3. Remove the straps and binders securing the powertrain to the support table.
4. Ensure when lowering the body the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
5. Install the drivetrain and front suspension frame with the powertrain attached. Refer to **Drivetrain and Front Suspension Frame Removal and Installation** .
6. If equipped with AWD, install the front wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** , and **Front Wheel Drive Shaft Replacement - Right Side** .
7. Connect the vacuum line at the brake booster. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement (LTG)** .
8. Connect the vacuum brake booster vacuum switch electrical connector.
9. Connect the heater outlet hose at the heater core. Refer to **Heater Outlet Hose Replacement (LTG)** .
10. Connect the heater inlet hose at the heater core. Refer to **Heater Inlet Hose Replacement (LTG)** .
11. Connect the engine harness retainers at the right engine compartment frame rail and position the harness on the engine.

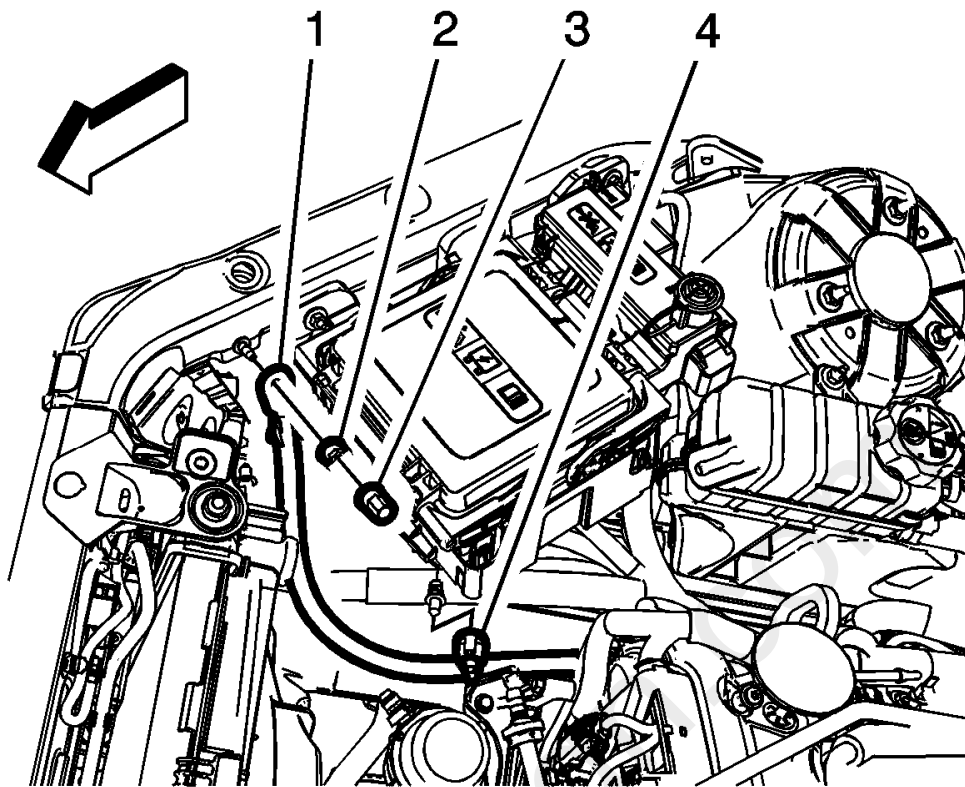


Fig. 215: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

12. Connect the battery ground cable (1) to the right inner core support and install the nut. Tighten the nut (2) to 11 (97 lb in).
13. Install the protective cap (3).
14. Install the battery negative cable extension cable retainer (4).
15. Connect the lever lock connector attached to the base of the ECM bracket.
16. Install the ECM. Refer to **Engine Control Module Replacement** .
17. Install the front compartment fuse block housing. Refer to **Front Compartment Fuse Block Housing Replacement** .

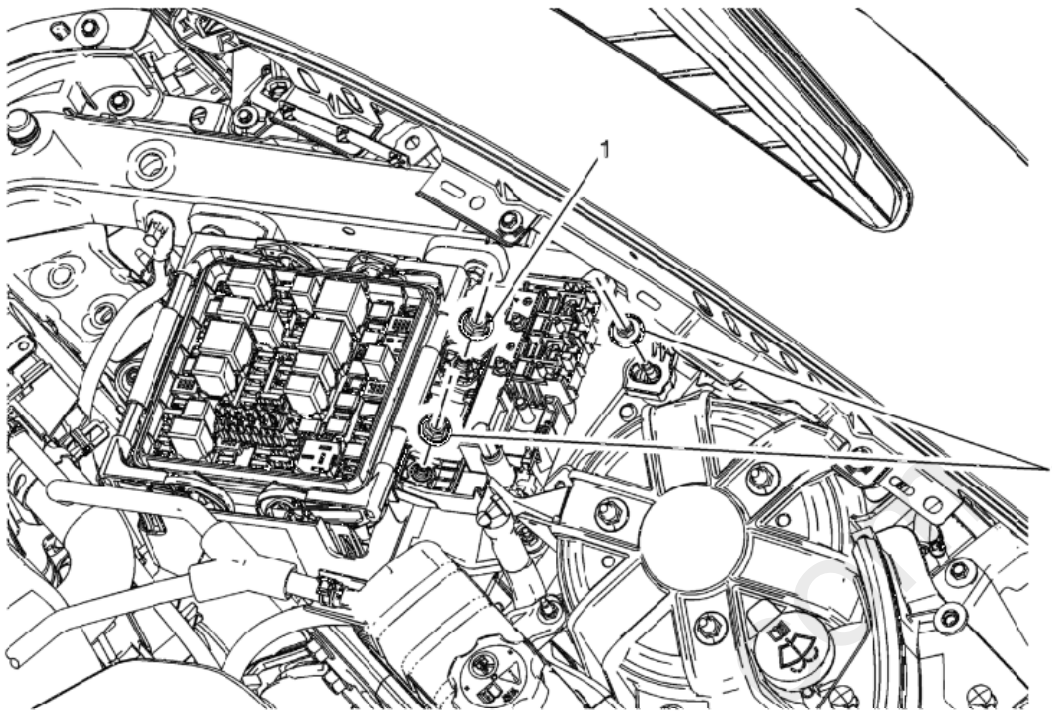


Fig. 216: Pre Fuse Base Nuts

Courtesy of GENERAL MOTORS COMPANY

18. Reposition then connect the battery positive cables at the 100 amp pre-fuse base then install the fasteners (1). Tighten the fasteners to 12 (106 lb in).
19. Install the positive cable at the 100 amp pre-fuse base and position the cable on the engine.
20. Connect the evaporative emission line at the canister purge solenoid and install the line to the retainer.
21. Connect the transmission cooler pipes to the engine and transmission. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** .
22. Install the two piece drive shaft. Refer to **Two-Piece Propeller Shaft Replacement (LTG, LCV, LKW)** .
23. Connect the range selector lever cable. Refer to **Range Selector Lever Cable Replacement** .
24. Connect the air conditioning compressor and condenser hose. Refer to **Air Conditioning Compressor and Condenser Hose Replacement (LTG)** .
25. Connect the fuel feed hose to the engine. Refer to **Fuel Feed Pipe Replacement** .
26. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LTG with V03)** , **Radiator Outlet Hose Replacement (LTG without V03)** , or **Radiator Outlet Hose Replacement (LTG with V03) Radiator Outlet Hose Replacement (LTG without V03)** .
27. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LTG)** .

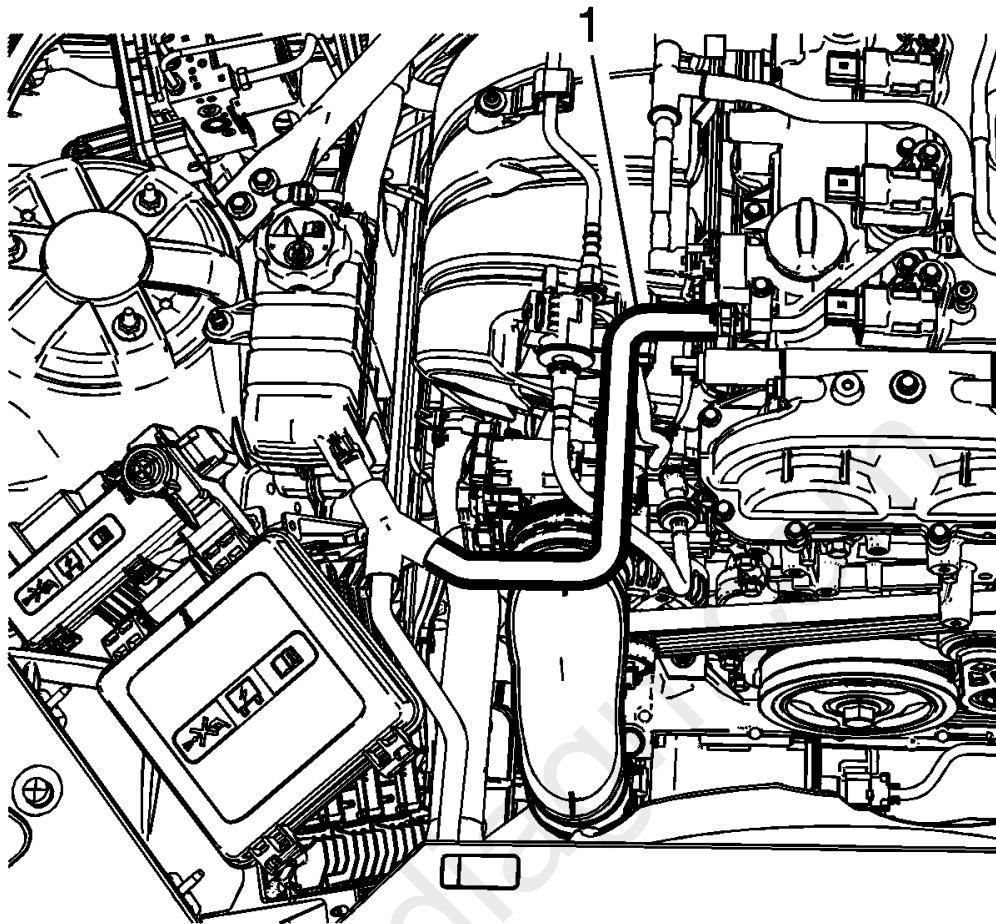


Fig. 217: Radiator Surge Tank Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

28. Connect the radiator surge tank inlet hose (1) to the engine. Refer to **Radiator Surge Tank Inlet Hose Replacement (LTG)** .
29. Refill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

30. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to **Engine Prelubing** .
31. Install the charge air cooler inlet air tube. Refer to **Charge Air Cooler Inlet Air Tube Replacement** .
32. Install the charger air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement** .
33. Recharge the refrigerant system. Refer to **Refrigerant Recovery and Recharging (R-134a)** , **Refrigerant Recovery and Recharging (R-1234yf)** .
34. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

35. Perform the throttle learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**
2. Place a drain pan under the oil drain plug.

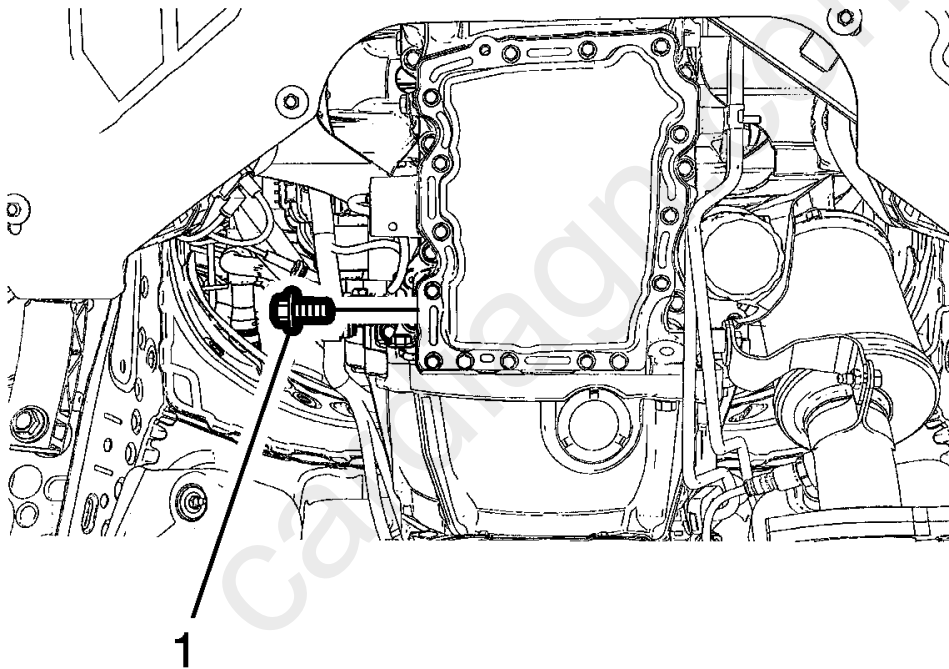


Fig. 218: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1).
4. Allow the oil to drain completely.

CAUTION: Refer to **Component Fastener Tightening Caution** .

NOTE: Clean and inspect the oil drain plug and the ring seal, replace only if damaged.

5. Install the oil pan drain plug (1) and ring seal. Tighten to 25 (18 lb ft).

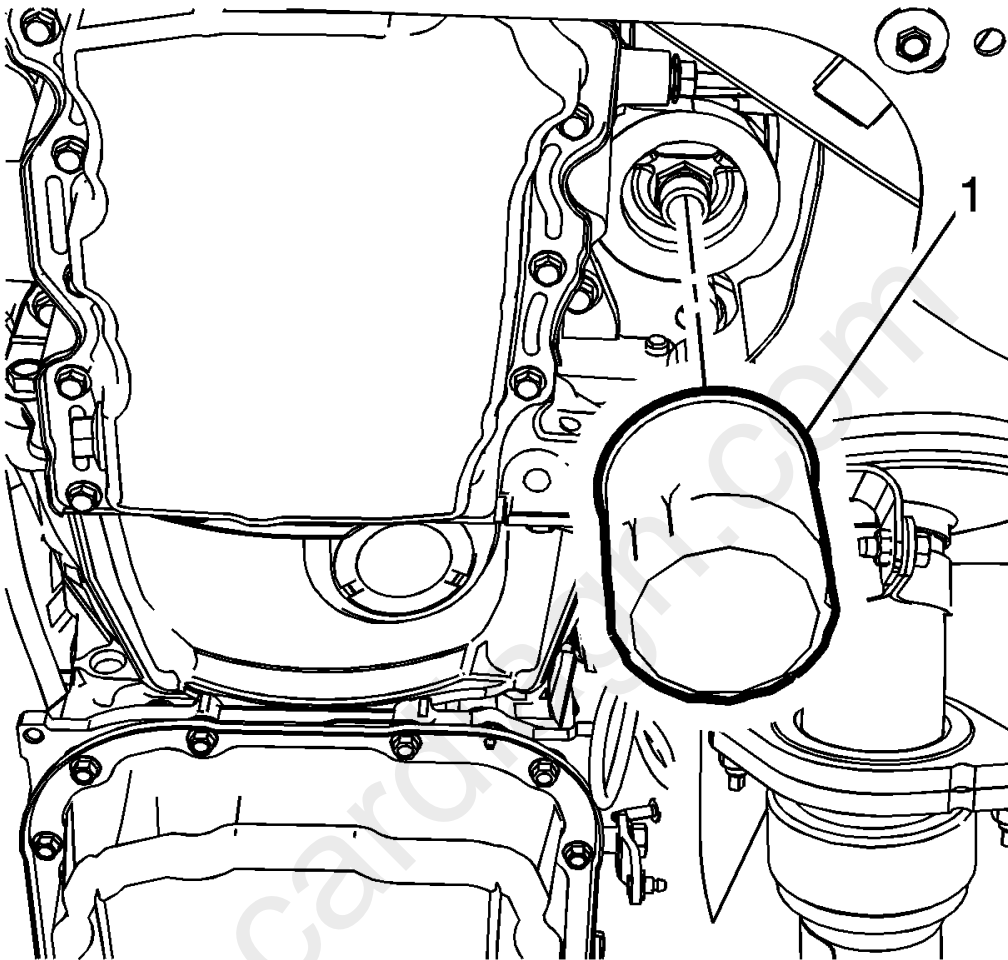


Fig. 219: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

6. Position a suitable drain pan under the oil filter.
7. Remove the oil filter (1).
8. Ensure that the oil filter gasket is still on the old oil filter, if not remove the oil filter gasket from the adapter.

Installation Procedure

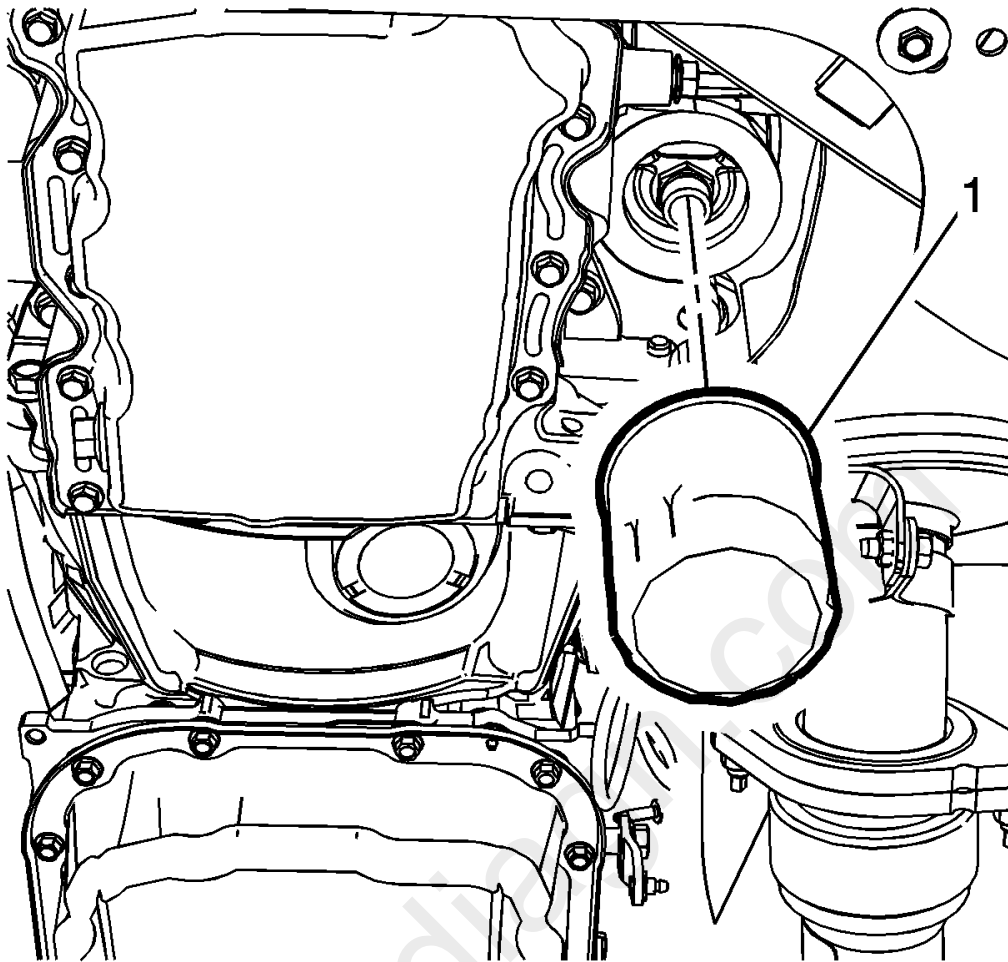


Fig. 220: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

1. Install the oil filter and tighten to 30 (22 lb ft)
2. Remove the oil drain pan from under the vehicle
3. Lower the vehicle.
4. Fill the engine with new engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers .
5. Start the engine.
6. Inspect for oil leaks after engine start up.
7. Reset the oil life monitor. Refer to GM Oil Life System Resetting .