

2013 ENGINE

Engine Mechanical - 2.0L (LTG) or 2.5L (LCV) - Repair Instructions - On Vehicle - Malibu

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT (LCV)

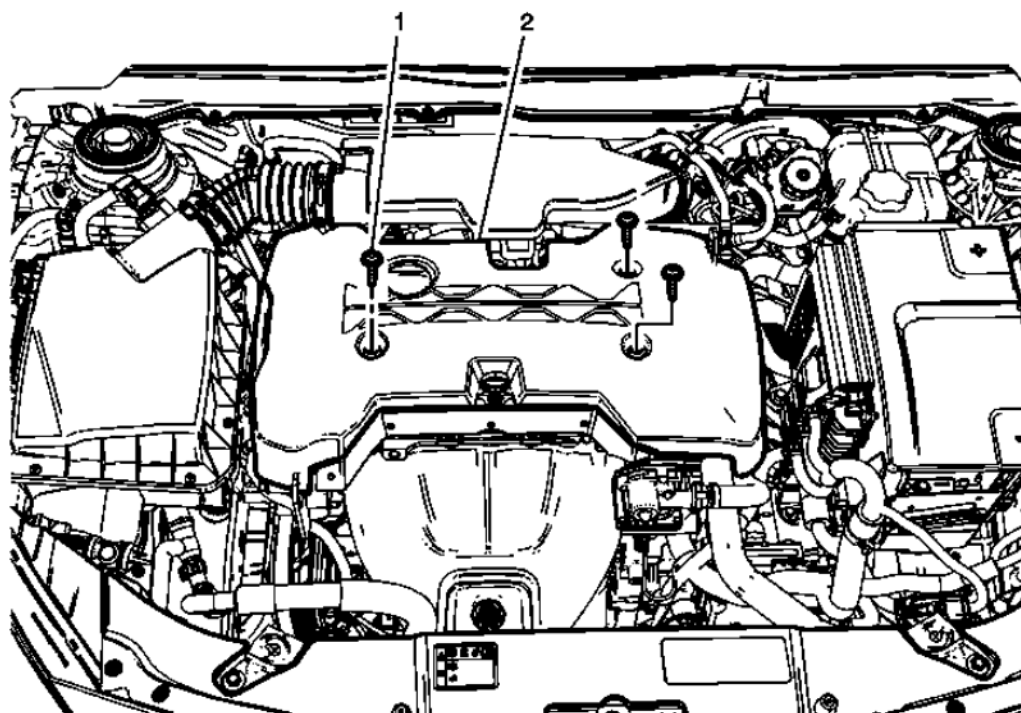


Fig. 1: Intake Manifold Cover (LCV)

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement (LCV)

Callout	Component Name
1	Intake Manifold Cover Fastener (Qty, 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Intake Manifold Cover Procedure Remove the oil cap before removing the intake manifold cover.

INTAKE MANIFOLD COVER REPLACEMENT (LTG)

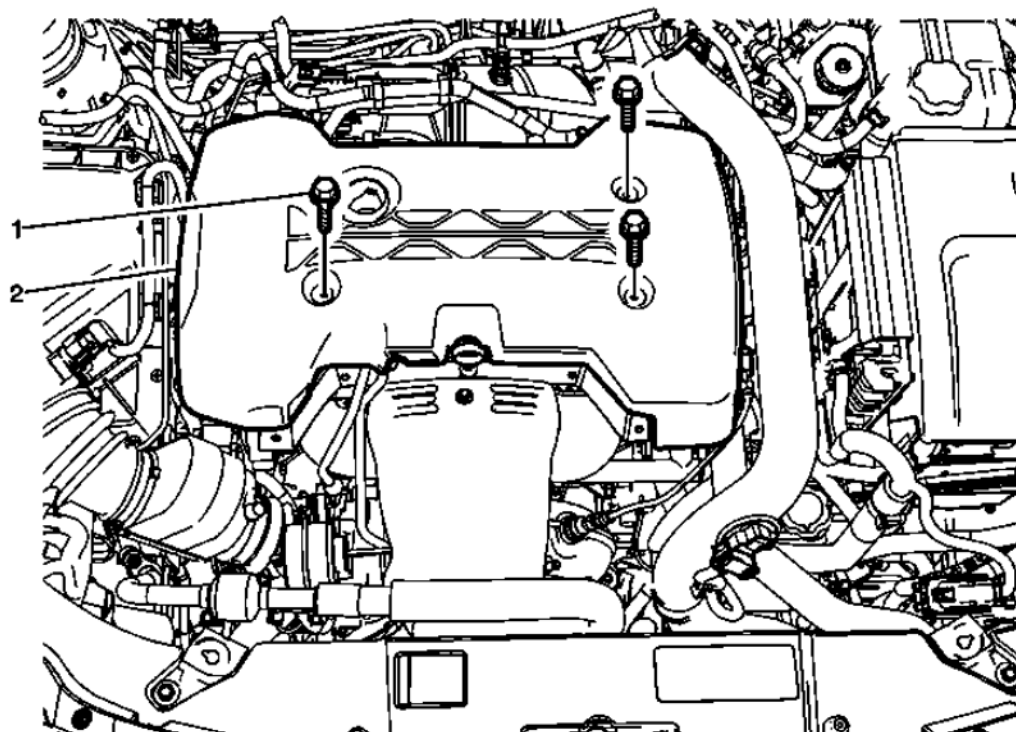


Fig. 2: Intake Manifold Cover (LTG)

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement (LTG)

Callout	Component Name
1	Intake Manifold Cover Fastener (Qty, 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Intake Manifold Cover Procedure Remove the oil cap before removing the intake manifold cover.

DRIVE BELT REPLACEMENT

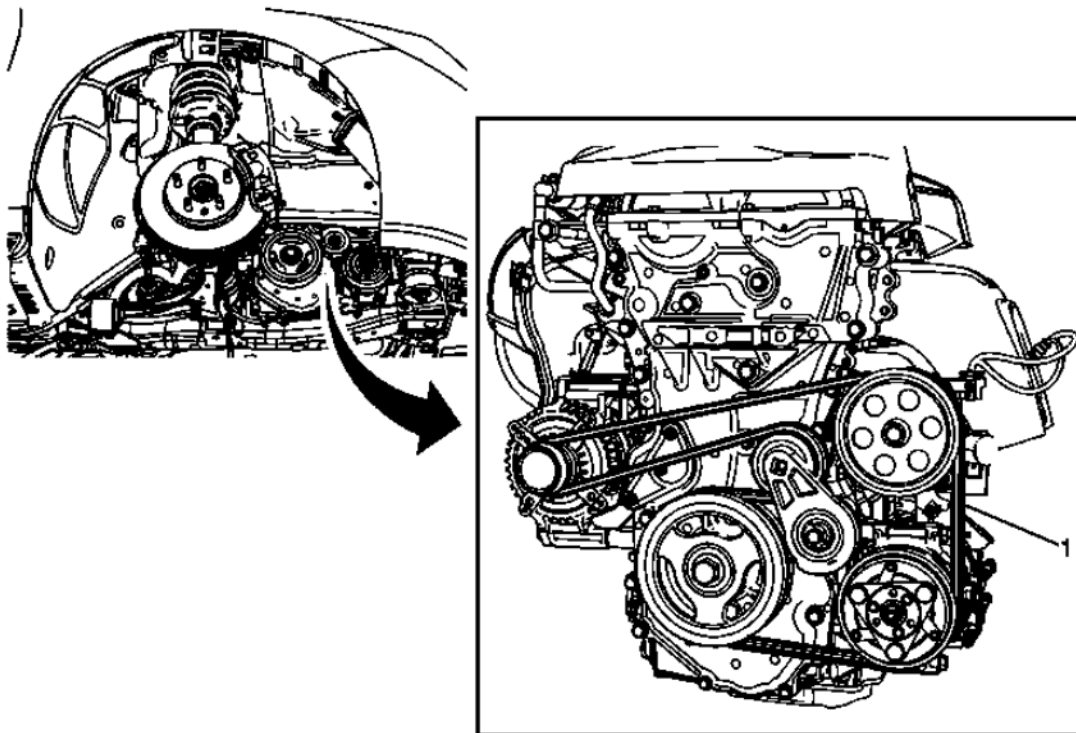


Fig. 3: Drive Belt Routing
 Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

Callout	Component Name
Preliminary Procedure Remove the front wheelhouse front liner. Refer to Front Wheelhouse Front Liner Replacement (Left Side) , Front Wheelhouse Front Liner Replacement (Right Side) .	
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.

DRIVE BELT TENSIONER REPLACEMENT

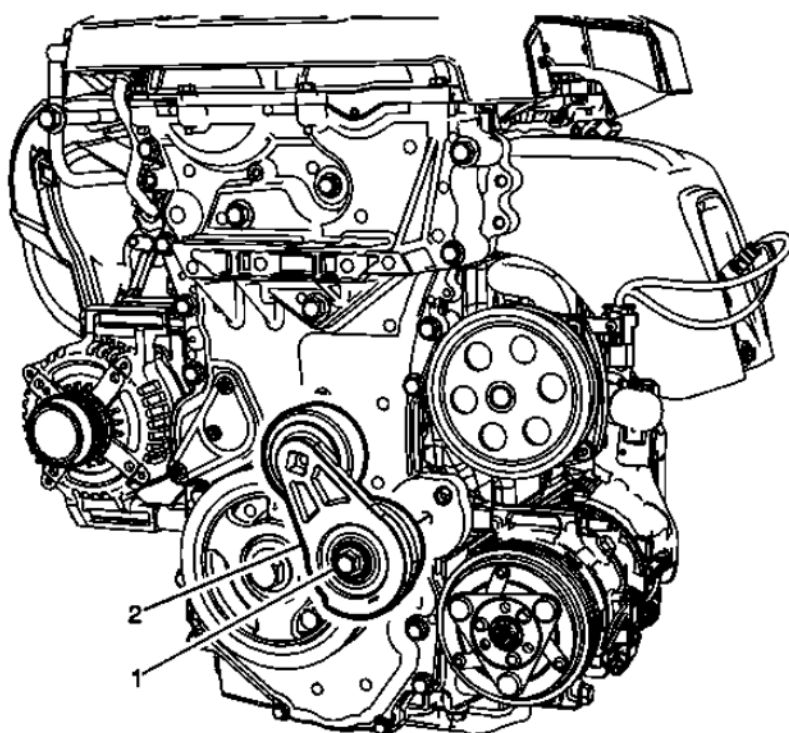


Fig. 4: Drive Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedures 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

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 .
2. Raise the engine slightly and observe the engine mount. Raising the engine removes the weight from the

engine mount and creates a slight tension on the rubber portion.

3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Mount Replacement** .

POWERTRAIN MOUNT BALANCING

IMPORTANT: Follow the balance procedure steps listed below. Powertrain mounts must be tightened in sequence.

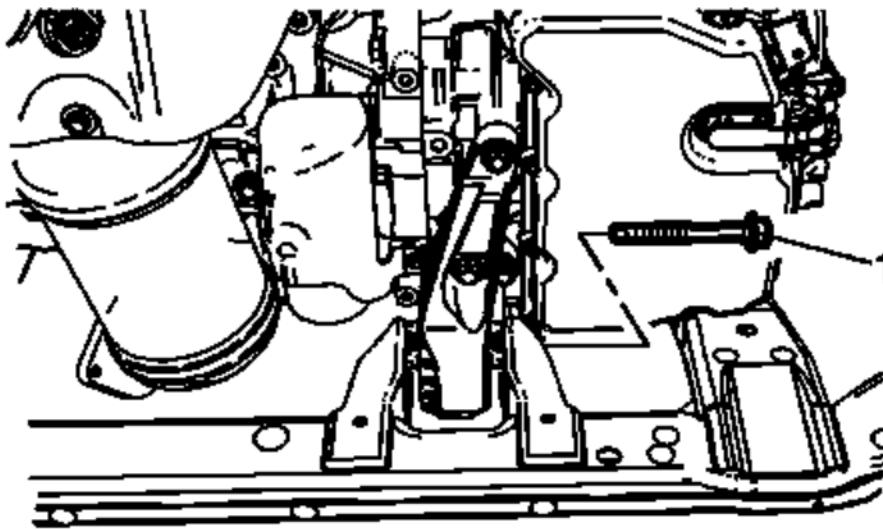


Fig. 5: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LCV)** , **Air Cleaner Assembly Replacement (LTG)** .
2. Remove the battery tray. Refer to **Battery Tray Replacement** .

3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Loosen the front transaxle mount through bolt (1).

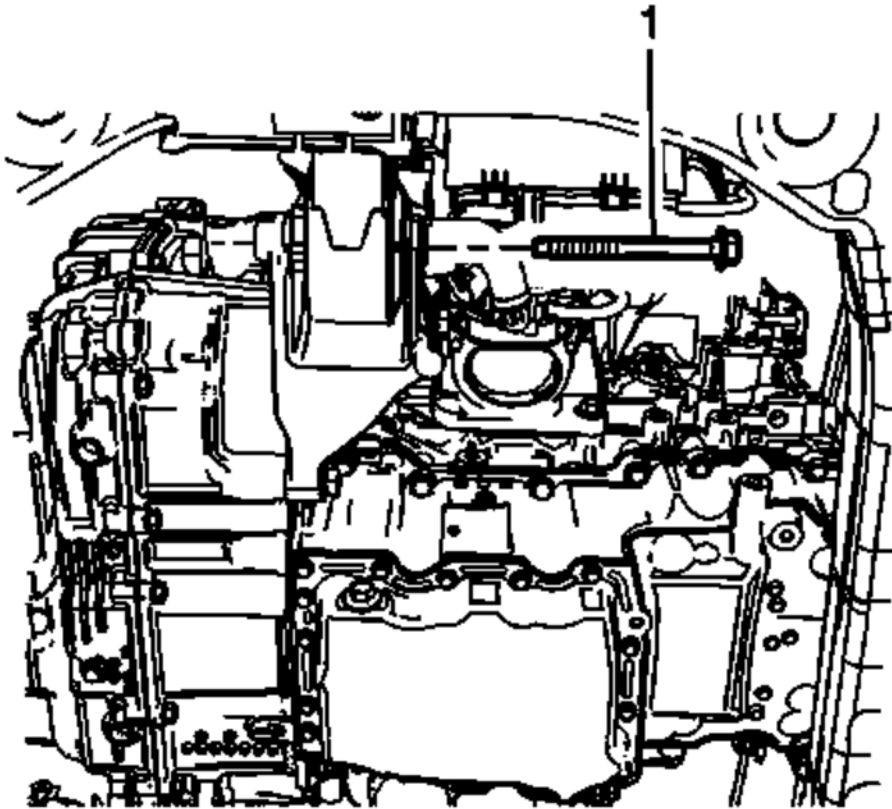


Fig. 6: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the rear transaxle mount through bolt (1).
6. Lower the vehicle.
7. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.

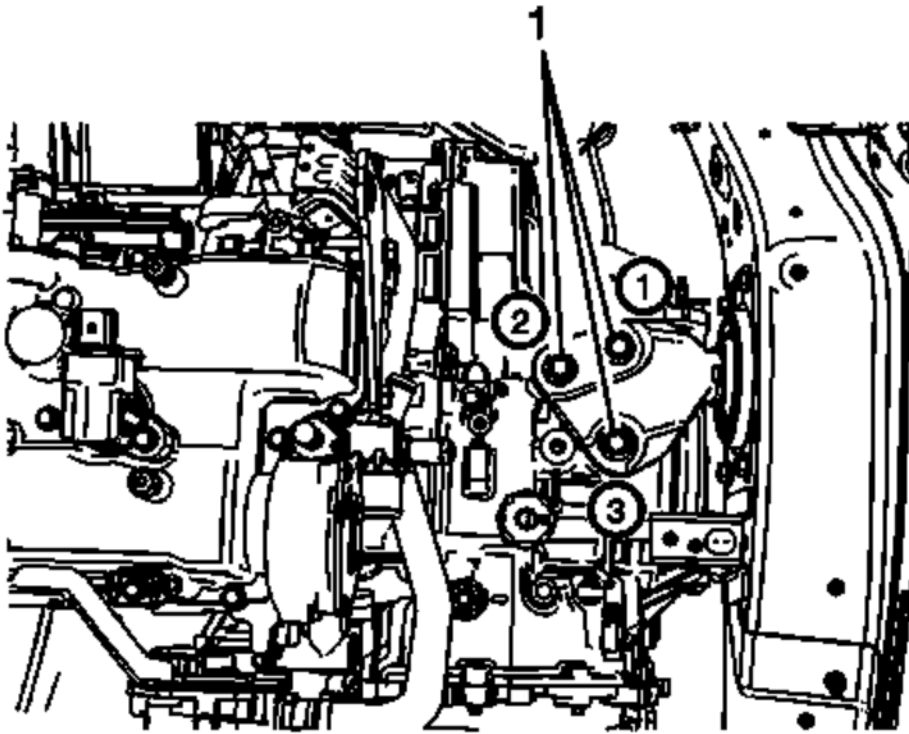


Fig. 7: Transaxle Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Loosen the transaxle mount bolts (1).

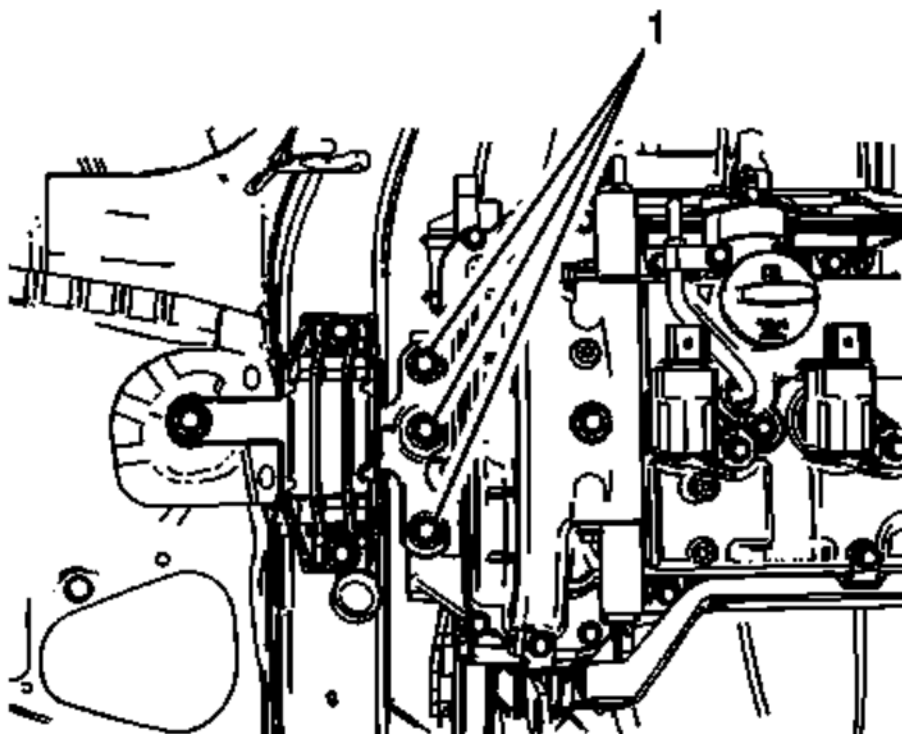


Fig. 8: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

9. Loosen the engine mount to bracket bolts (1).
10. Reposition both floor jacks in order to allow a 1/8 inch gap between the mount and bracket.

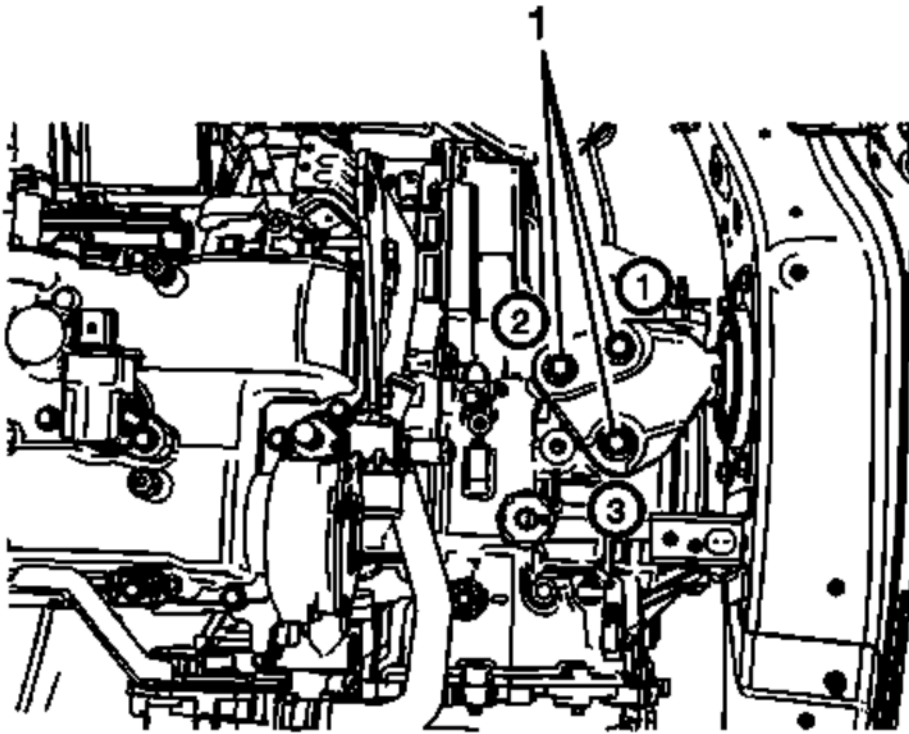


Fig. 9: Transaxle Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the transaxle mount bolts (1) to 50 (37 lb ft) in the following sequence.

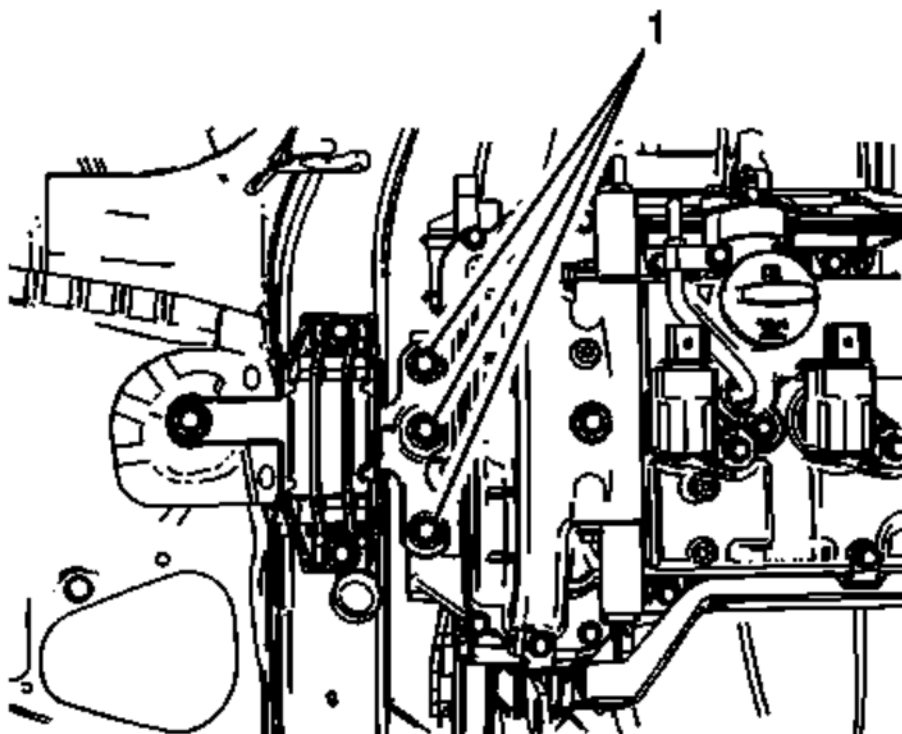


Fig. 10: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

12. Tighten the engine mount to bracket bolts (1) to 62 (46 lb ft) in the following sequence.
13. Remove the floor jacks from under the oil pan.
14. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.
15. Raise the vehicle.

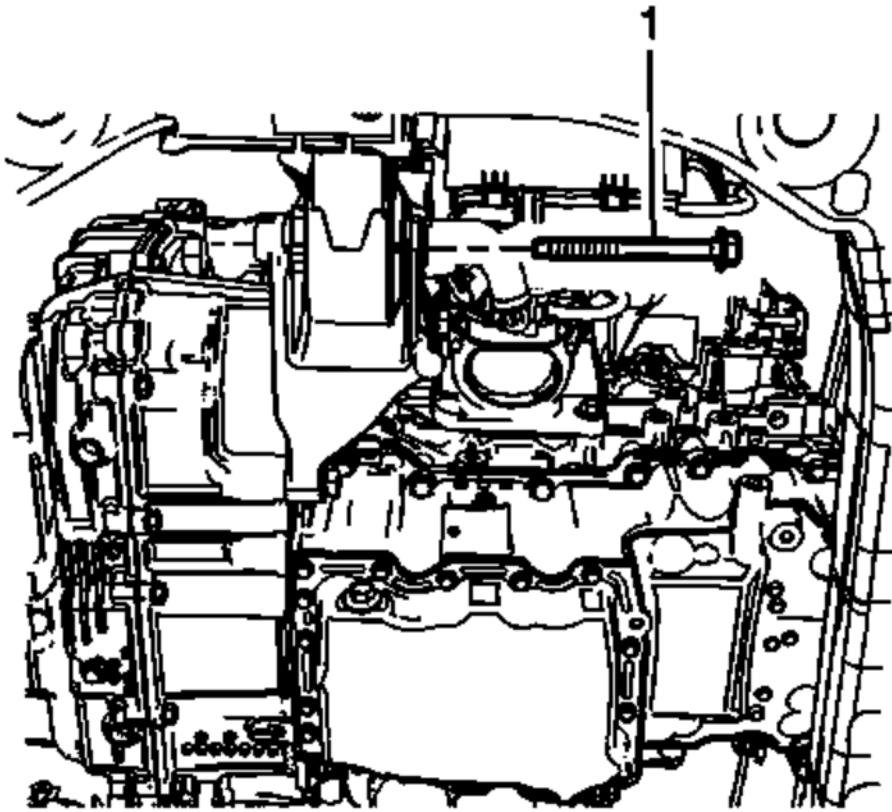


Fig. 11: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the rear transaxle mount through bolt (1).

Tighten

100 (74 lb ft).

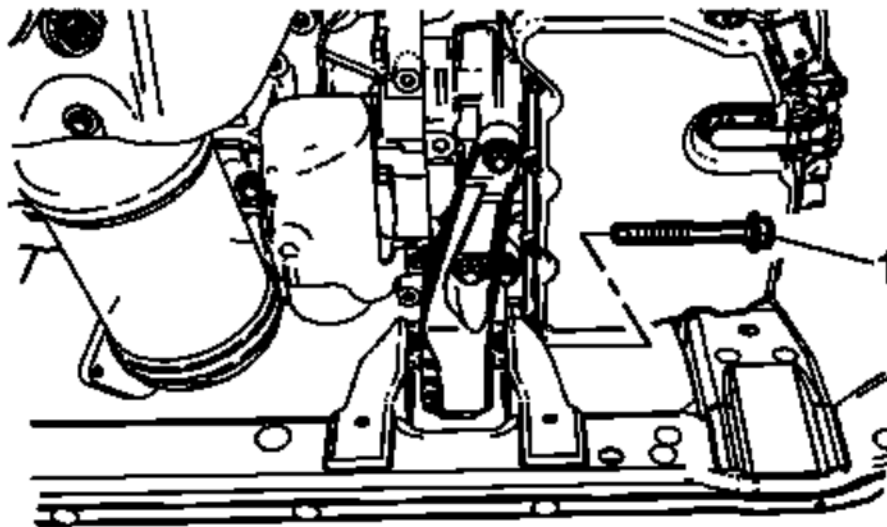


Fig. 12: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Tighten the front transaxle mount through bolt (1).

Tighten

100 (74 lb ft).

18. Lower the vehicle.
19. Install the battery tray. Refer to **Battery Tray Replacement** .
20. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LCV)** , **Air Cleaner Assembly Replacement (LTG)** .

POWERTRAIN MOUNT BALANCING - LOWER

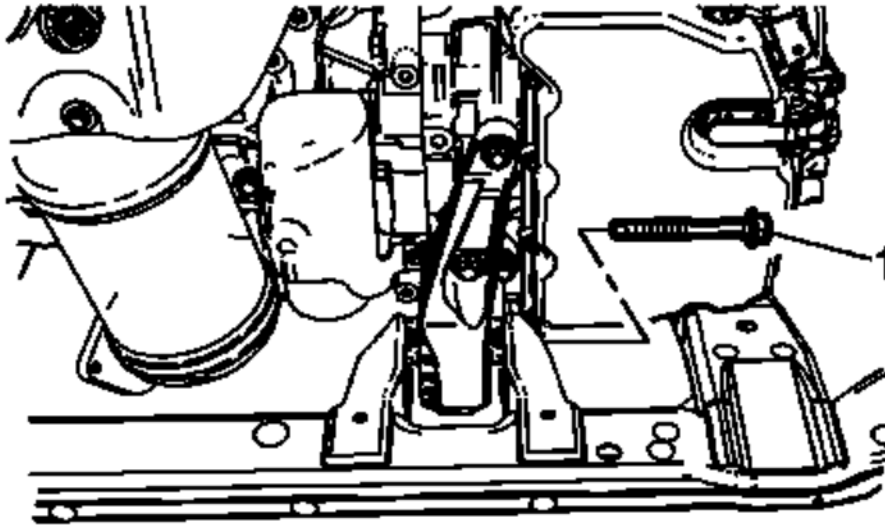


Fig. 13: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Follow the balance procedure steps listed below. Powertrain mounts must be tightened in sequence.

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
2. Loosen the front transaxle mount through bolt.

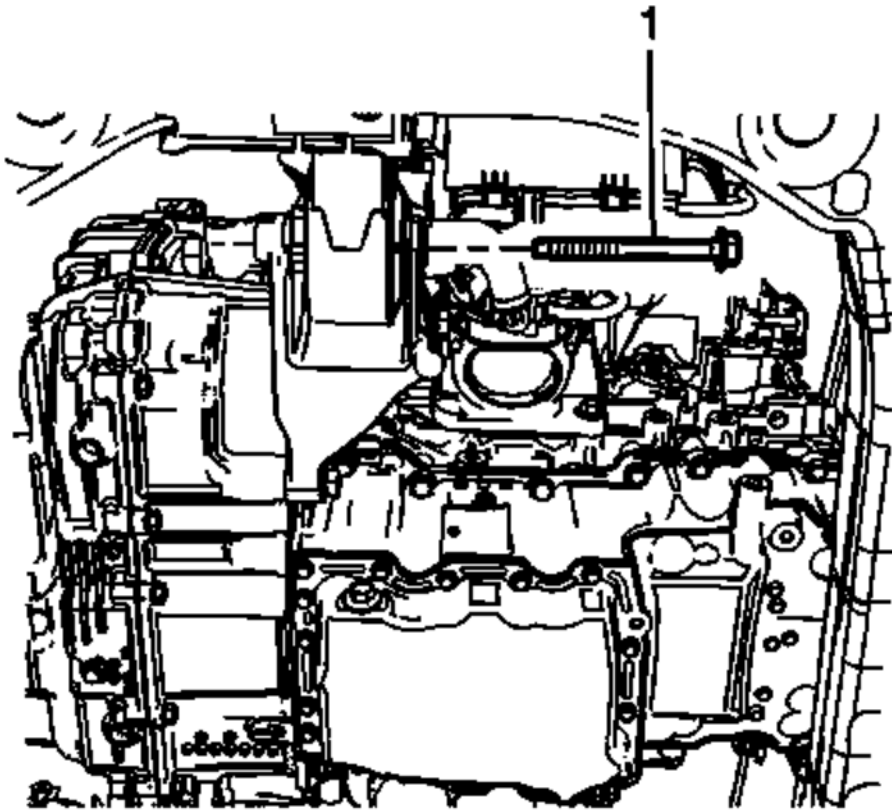


Fig. 14: Rear Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount through bolt.
4. Shake the powertrain vigorously from front to rear and allow the powertrain to settle.

CAUTION: Refer to Fastener Caution .

5. Tighten the rear transaxle mount through bolt to 100 N.m (74 lb ft).

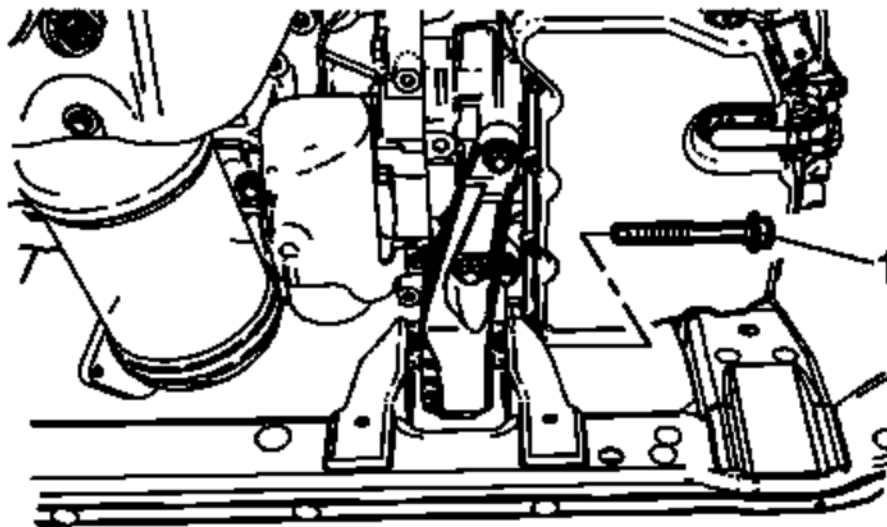


Fig. 15: Front Transaxle Mount Through Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the front transaxle mount through bolt to 100 N.m (74 lb ft).
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT (LCV)

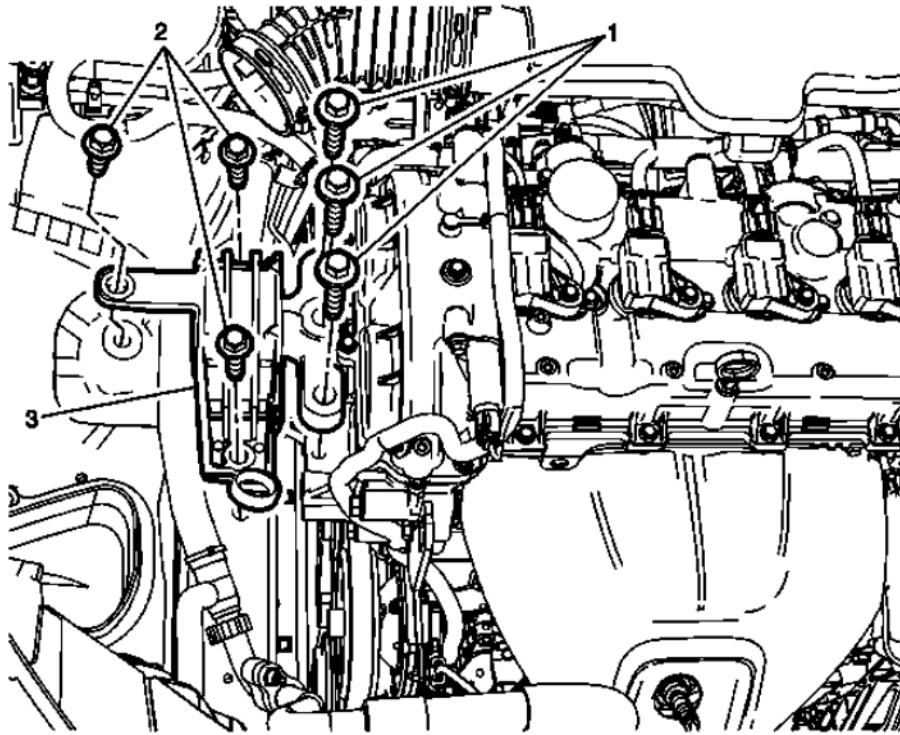


Fig. 16: Engine Mount (LCV)

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement (LCV)

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LCV)</u>. 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LCV)</u>. 3. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>.	
1	Engine Mount Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 62 N.m (46 lb ft)
2	Engine Mount Bolt (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount

ENGINE MOUNT REPLACEMENT (LTG)

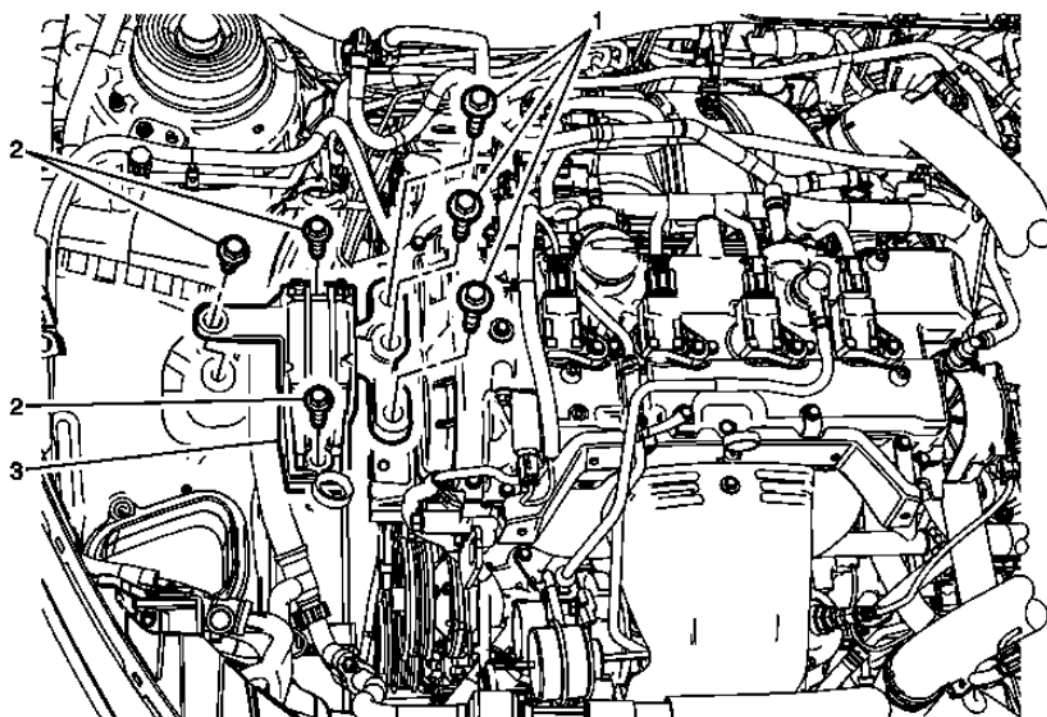


Fig. 17: Engine Mount (LTG)

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement (LTG)

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LTG)</u>. 2. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LTG)</u>. 3. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>.	
1	Engine Mount Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 62 N.m (46 lb ft)
2	Engine Mount Bolt (Qty: 3) Tighten 62 N.m (46 lb ft)
3	Engine Mount

ENGINE SUPPORT FIXTURE

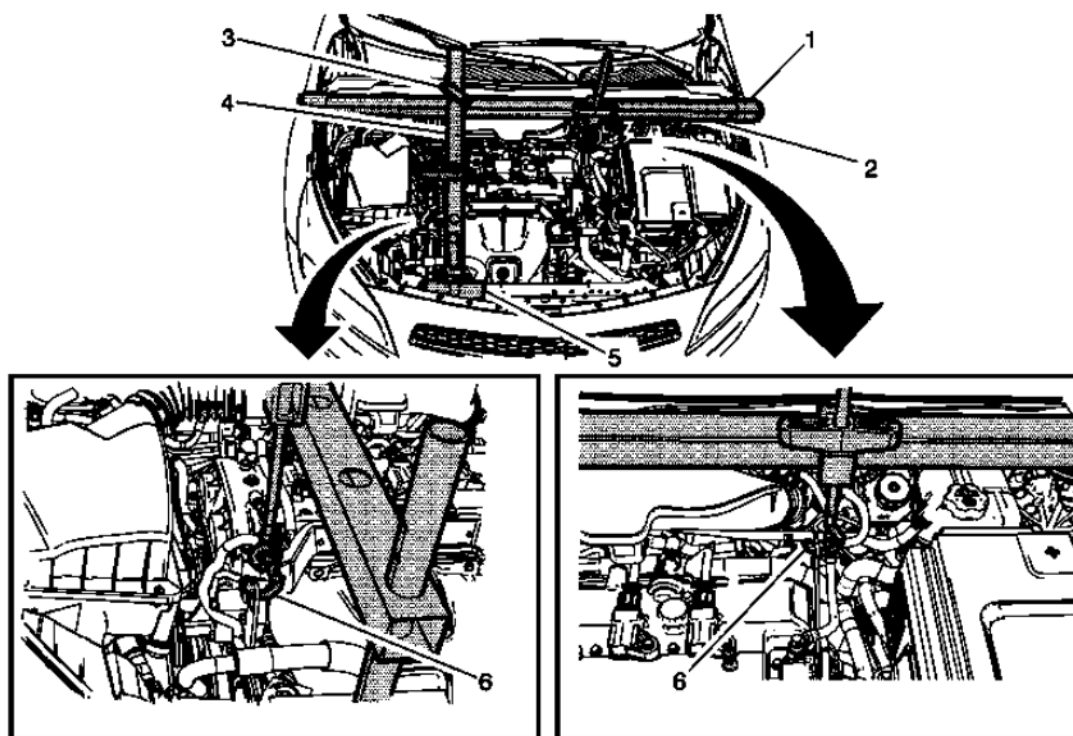


Fig. 18: Engine Support

Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LCV)</u>, <u>Intake Manifold Cover Replacement (LTG)</u>. 2. Disconnect the hood strut. Refer to <u>Hood Strut Replacement</u>.	
Special Tools	
• J-36462-A Engine Support Fixture Kit • J-28467-34 (2) Lift Wing Hook • J-43405-1 Passenger Side Engine Support Adapter • J-43405-2 Driver Side Engine Support Adapter • J-28467-518 Main Support Beam • J-36857 Engine Lift Bracket Set	
For equivalent regional tools. Refer to <u>Special Tools</u> .	
1	Engine Support Fixture Adapter Leg (Qty: 2) Procedure Install the bracket to fender frame. Do not install on top of fender lip.

2	Main Support Beam
3	Cross Bracket
4	Strut Tower Support Assembly Procedure Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly
6	Hook Assembly (Qty: 2) NOTE: If the engine is not equipped with engine lift bracket, install J-36857 engine lift bracket in place.

TURBOCHARGER HEAT SHIELD REPLACEMENT

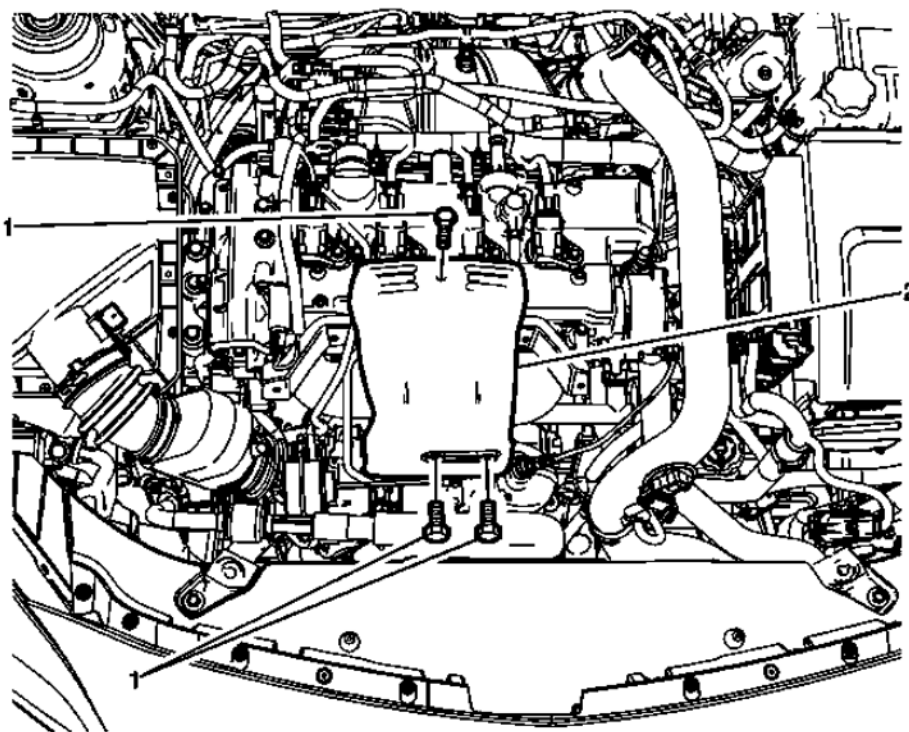


Fig. 19: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Heat Shield Replacement

Callout	Component Name
1	Turbocharger Heat Shield Fastener (Qty;3) CAUTION: Refer to <u>Fastener Caution</u> .

	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 \(LCV\)](#), [Intake Manifold Cover Replacement \(LTG\)](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement \(LCV\)](#), [Air Cleaner Outlet Duct Replacement \(LTG\)](#).

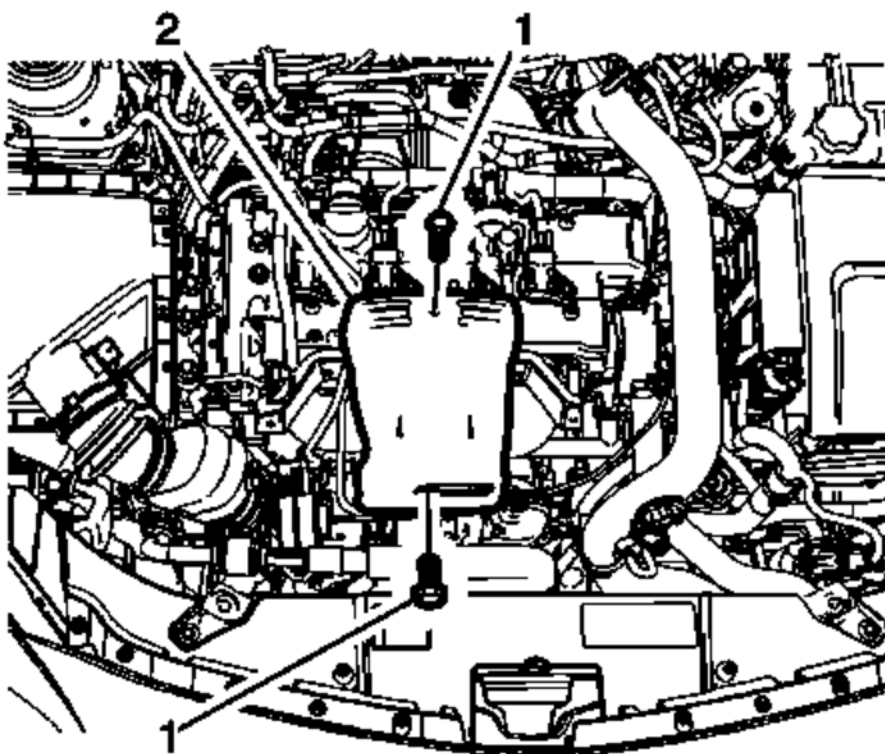


Fig. 20: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turbocharger heat shield (2). Refer to [Turbocharger Heat Shield Replacement](#).
4. Remove the catalytic converter. Refer to [Catalytic Converter Replacement \(LCV\)](#), [Catalytic Converter Replacement \(LTG\)](#).
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

6. Remove the PCV hose. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV), Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct).

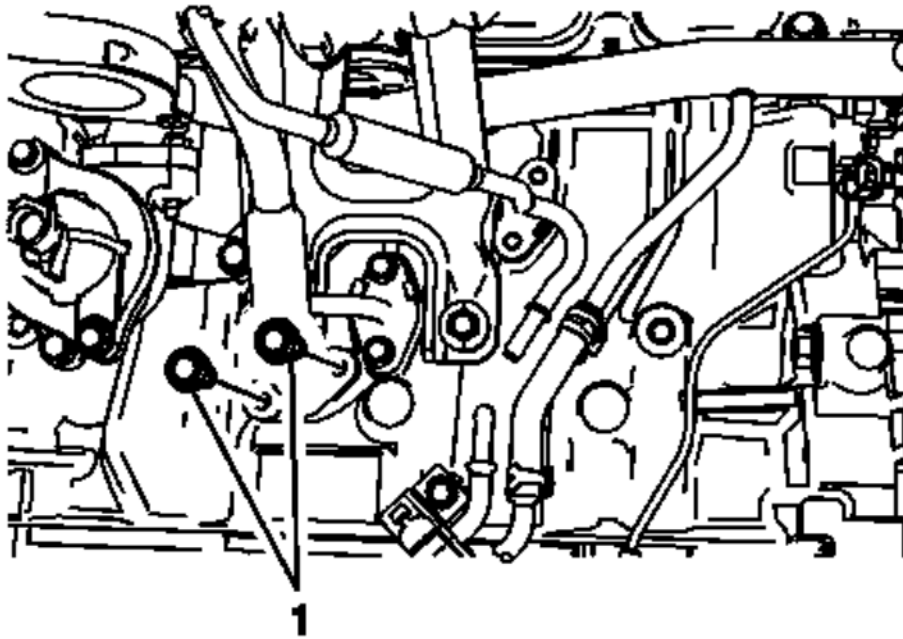


Fig. 21: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger oil return pipe bolts (1).

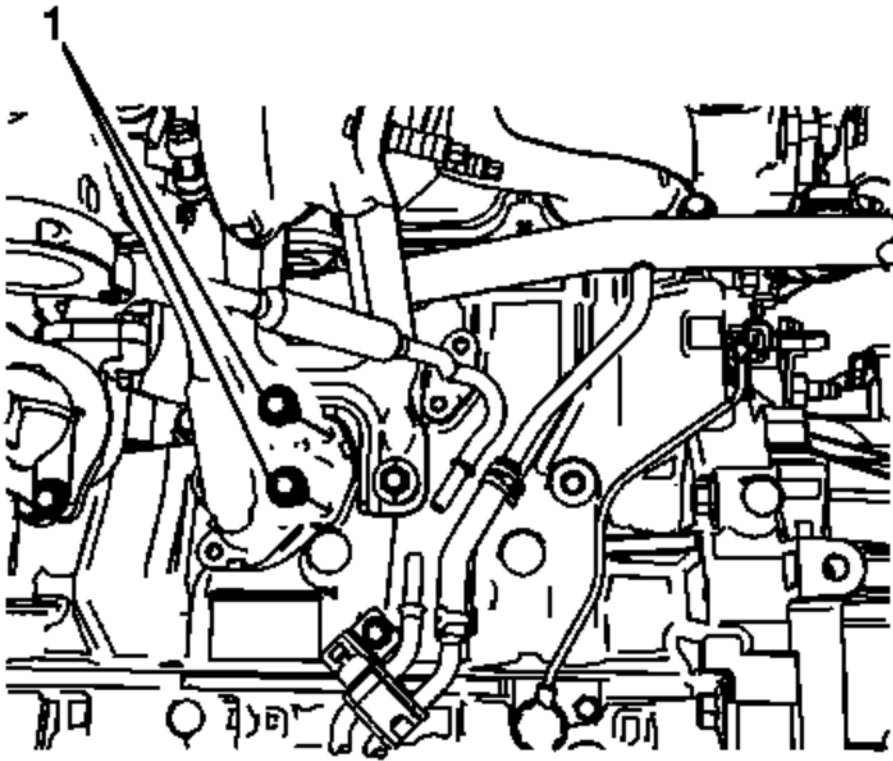


Fig. 22: Turbocharger Oil Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the turbocharger oil feed pipe bolts (1).

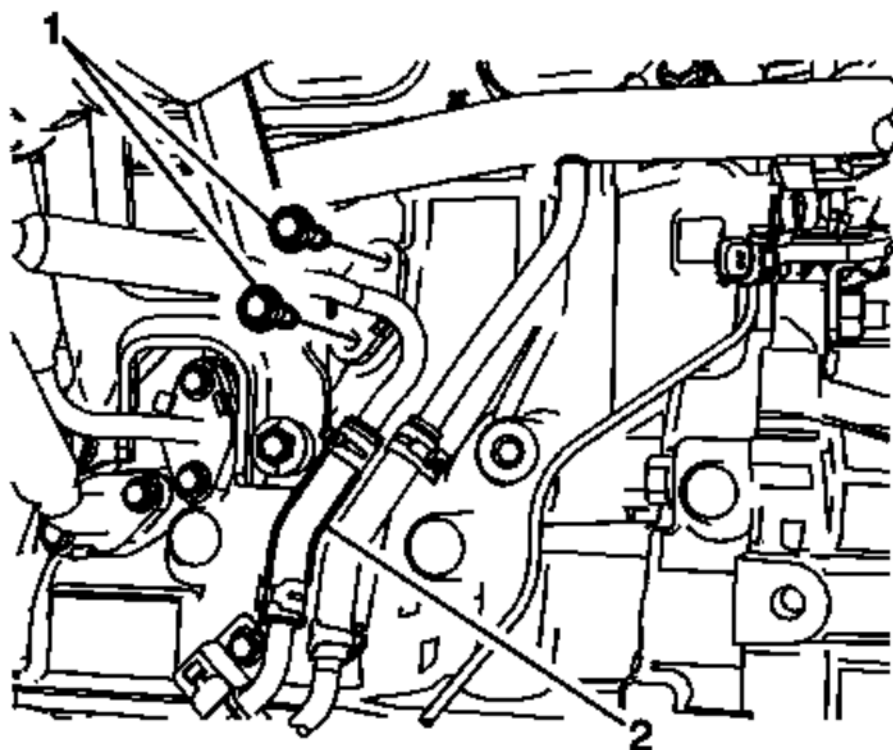


Fig. 23: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger coolant feed pipe bolts (1).

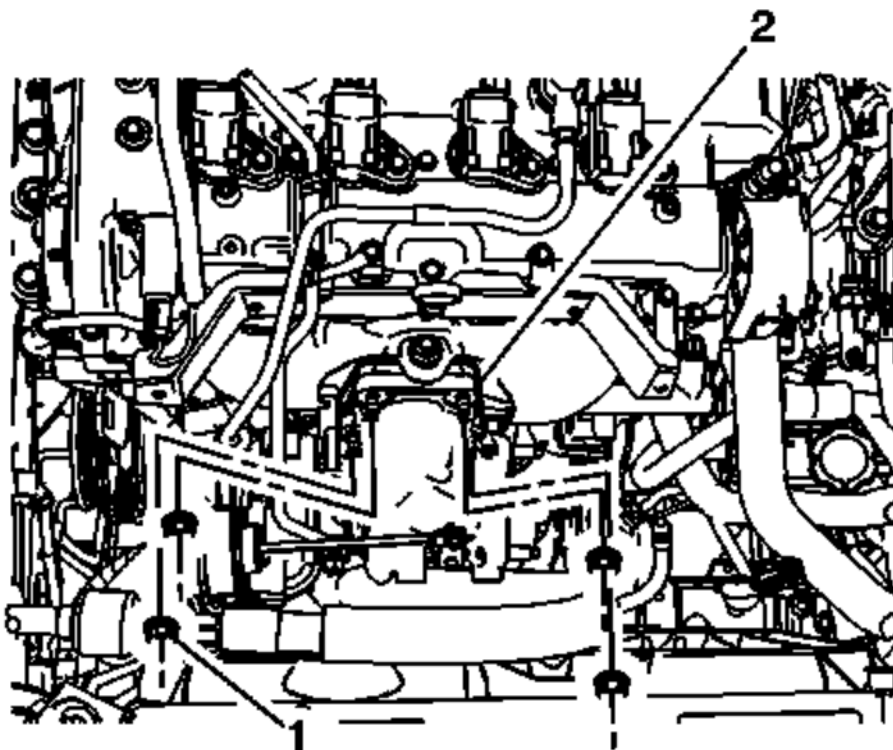
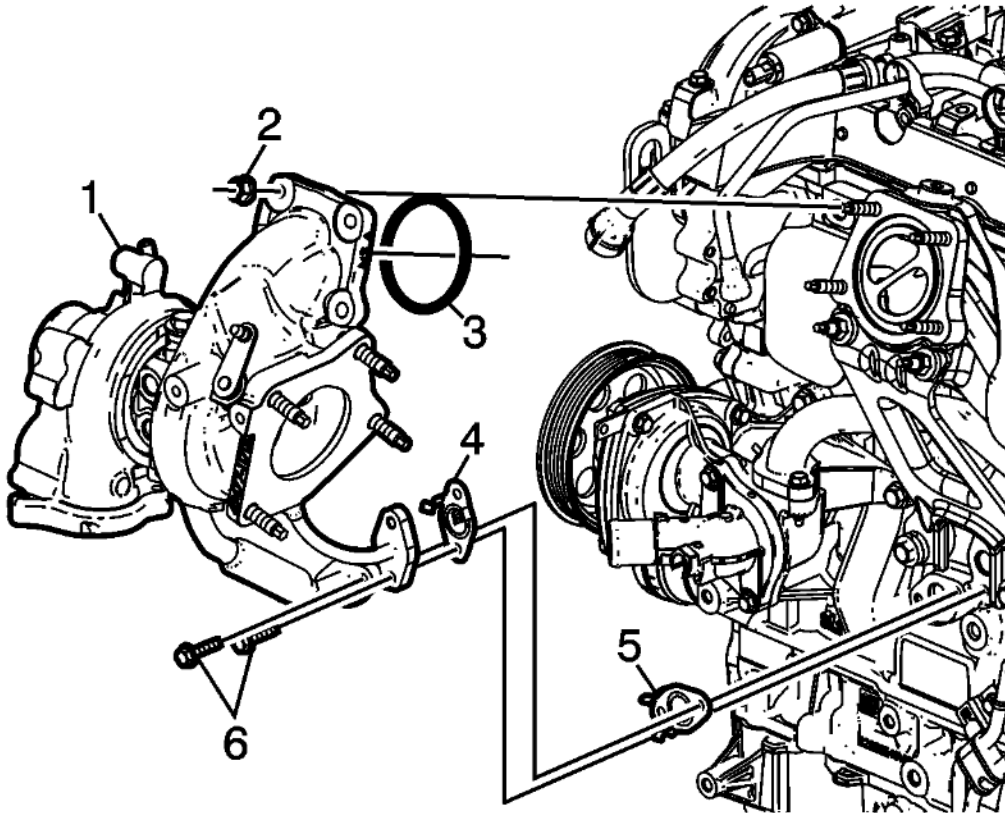


Fig. 24: Turbocharger Nuts And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

10. Remove the turbocharger nuts (1) and turbocharger (2).
11. For turbocharger cleaning and inspection, refer to **Turbocharger Cleaning and Inspection** .

Installation Procedure

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.

Fig. 25: NEW Turbocharger Gasket And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

6. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. Tighten the bolts to 10 (89 lb in).
7. Install the PCV hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

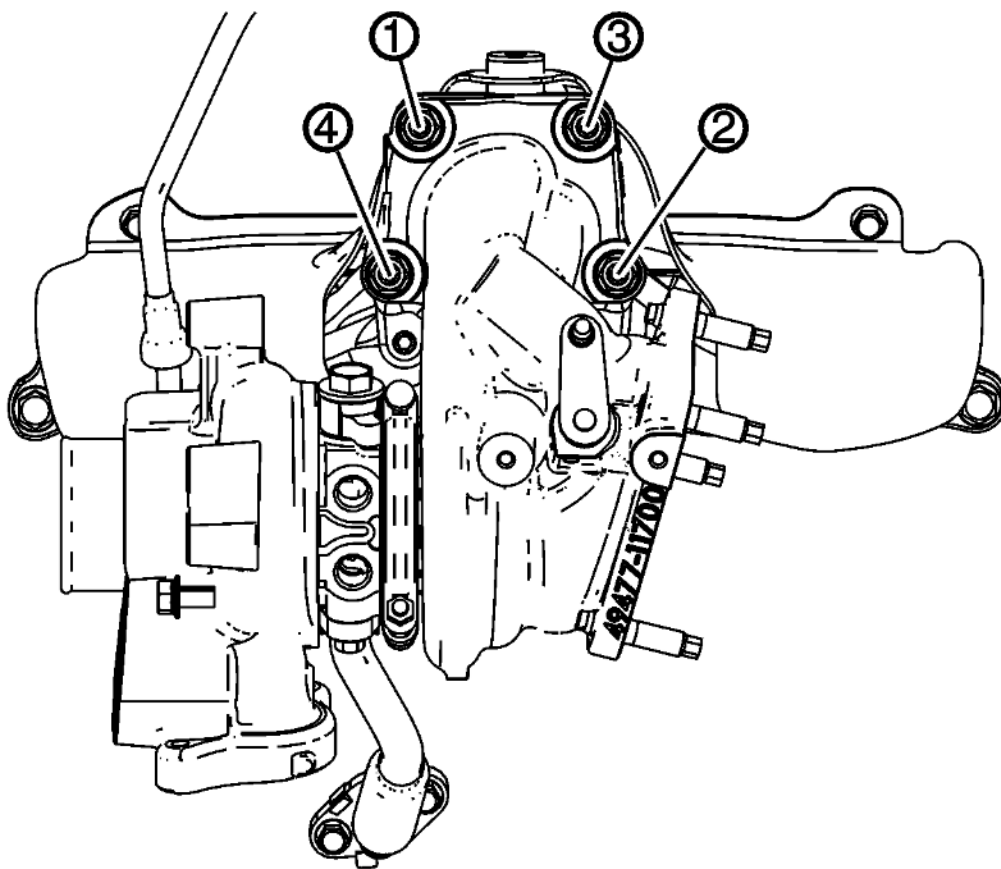


Fig. 26: Turbocharger Nuts In Sequence
Courtesy of GENERAL MOTORS COMPANY

8. Tighten the turbocharger nuts in sequence to 30 (22 lb ft).

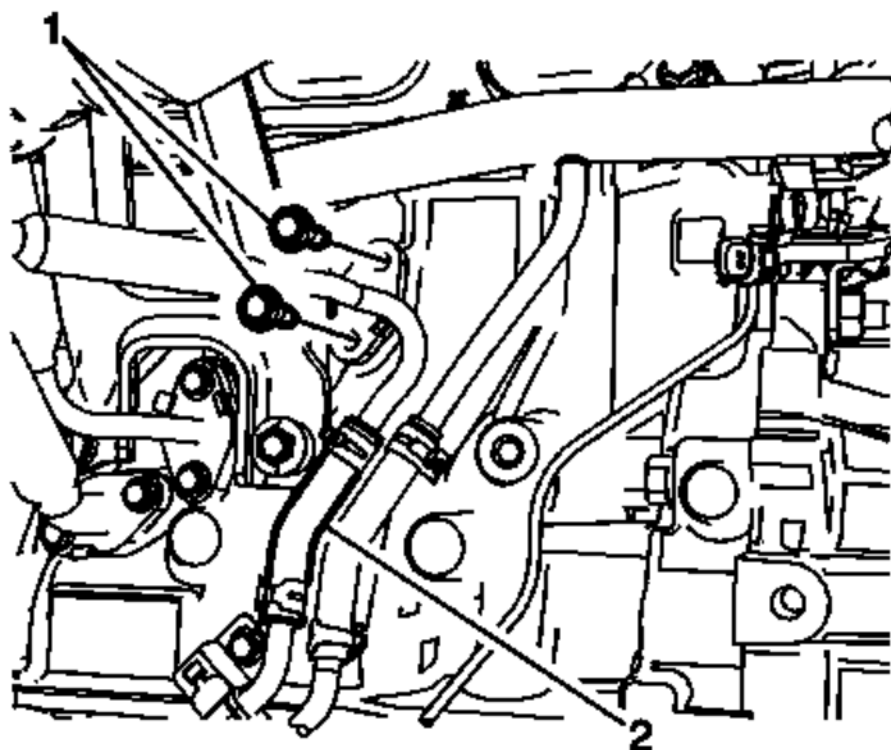


Fig. 27: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the turbocharger coolant feed pipe bolts (1) and tighten to 10 (89 lb in).
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement (LCV)** , **Catalytic Converter Replacement (LTG)** .

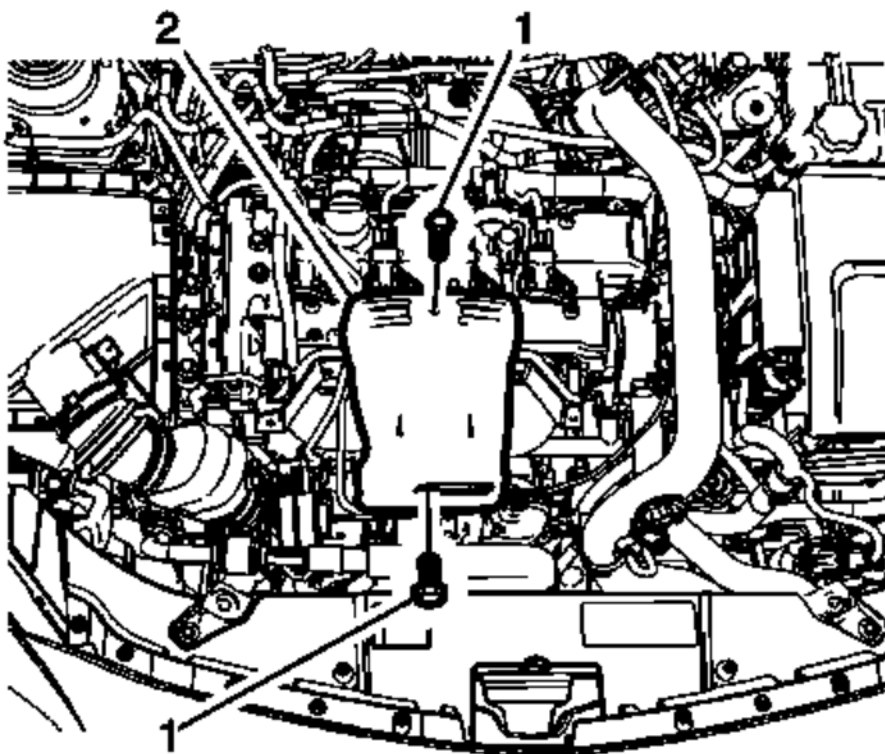


Fig. 28: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

11. Install the turbocharger heat shield (2). Refer to [Turbocharger Heat Shield Replacement](#).
12. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement \(LCV\)](#) , [Air Cleaner Outlet Duct Replacement \(LTG\)](#) .
13. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement \(LCV\)](#), [Intake Manifold Cover Replacement \(LTG\)](#).

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

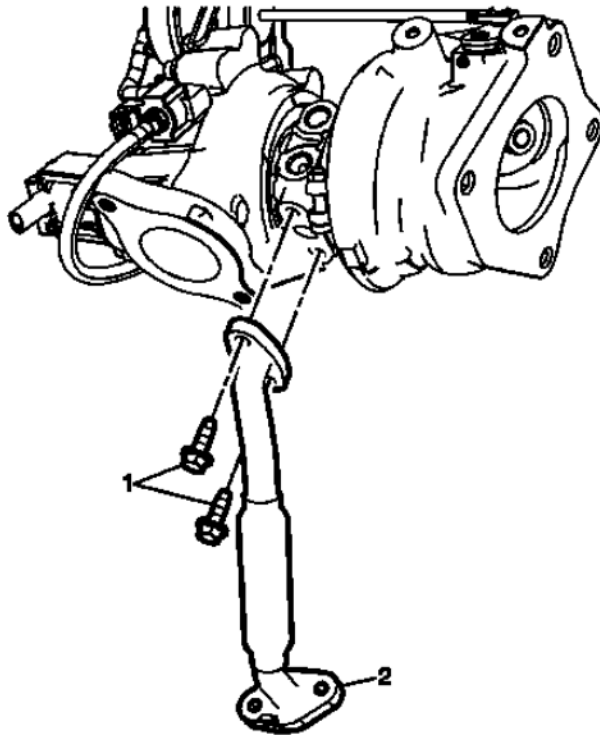


Fig. 29: Turbocharger Oil Return Pipe
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharge. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Return Pipe Fastener (Qty; 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
2	Turbocharger Oil Return Pipe Procedure A NEW turbocharger oil return gasket should be used whenever installing the pipe.

TURBOCHARGER OIL FEED PIPE REPLACEMENT

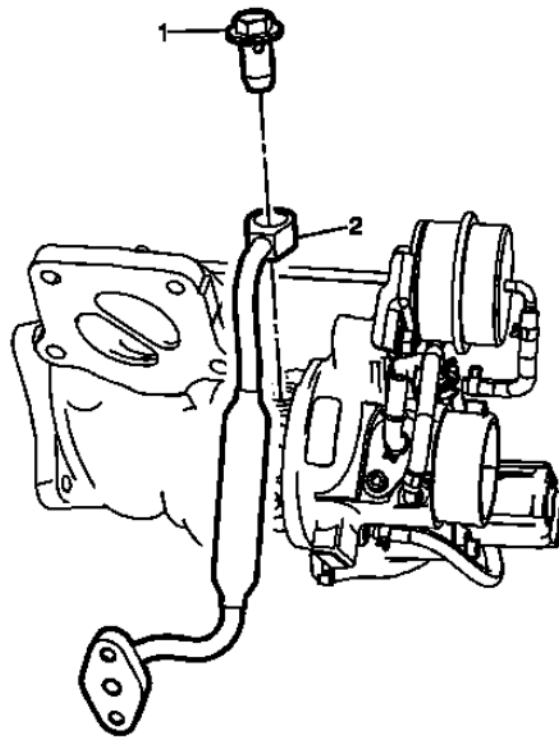


Fig. 30: Turbocharger Oil Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the turbocharge. Refer to <u>Turbocharger Replacement</u> .	
1	Turbocharger Oil Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
2	Turbocharger Oil Feed Pipe NOTE: A NEW turbocharger oil feed gasket should be used whenever the pipe is installed.

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (REAR)

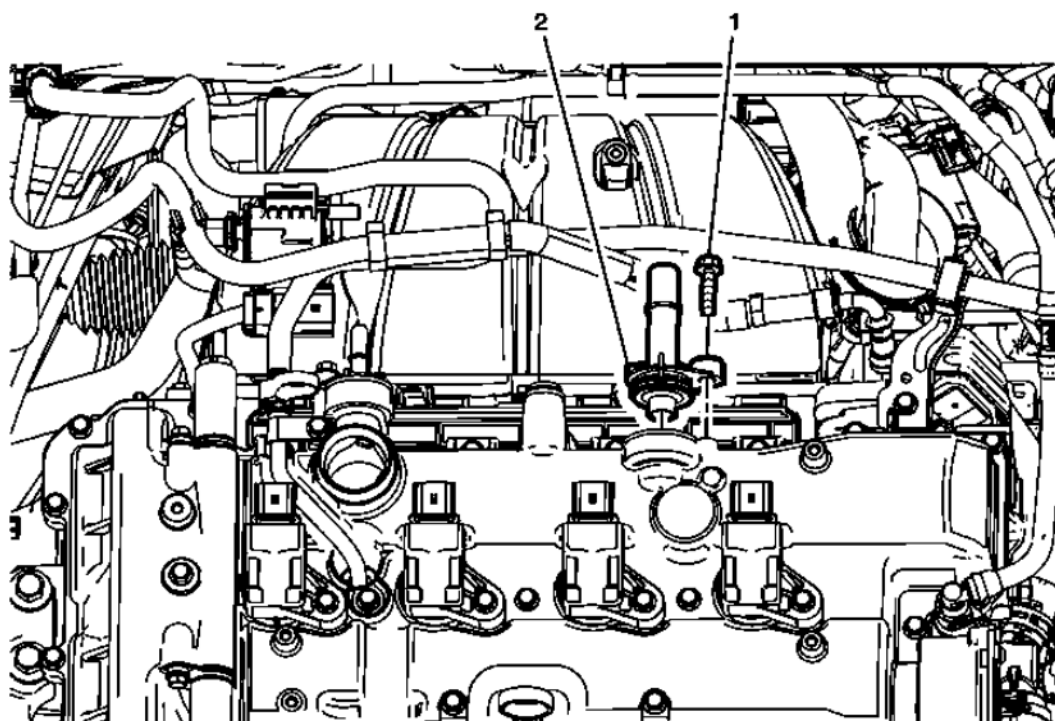


Fig. 31: Positive Crankcase Ventilation Valve (Rear)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Valve Replacement (Rear)

Callout	Component Name
Preliminary Procedures Remove the positive crankcase ventilation hose. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV) , Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct) .	
1	Positive Crankcase Ventilation Valve Fastener CAUTION: Refer to Fastener Caution . 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 VALVE REPLACEMENT (FRONT)

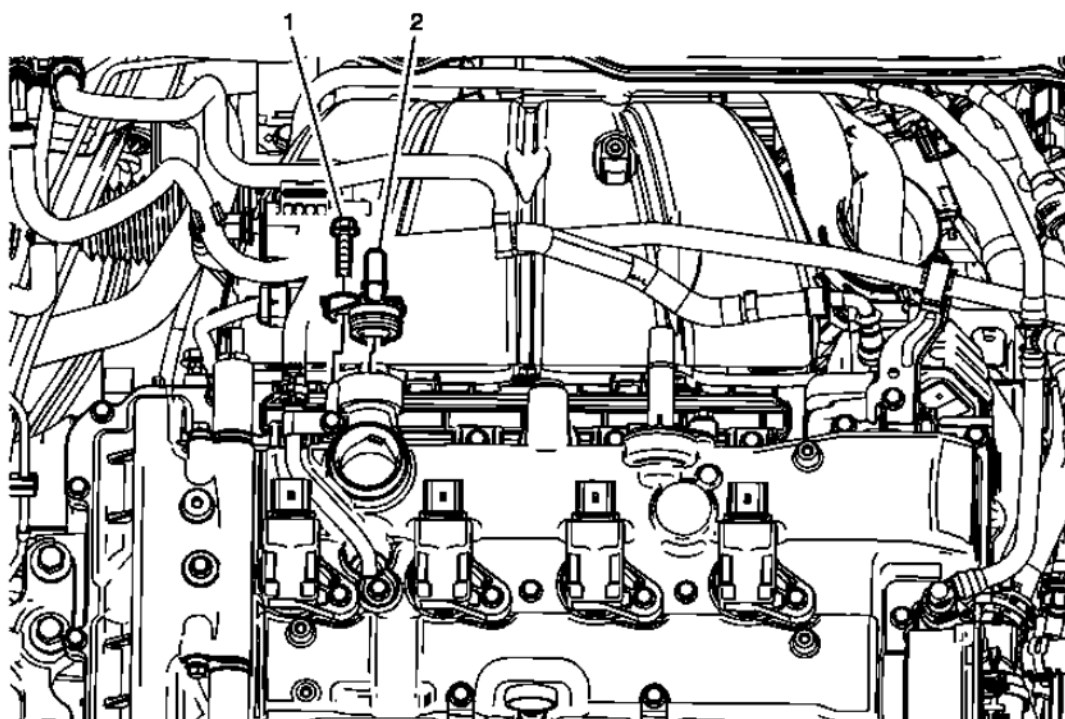


Fig. 32: Positive Crankcase Ventilation Valve (Front)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Valve Replacement (Front)

Callout	Component Name
Preliminary Procedures Remove the positive crankcase ventilation hose. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV) , Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct) .	
1	Positive Crankcase Ventilation Valve Fastener CAUTION: Refer to Fastener Caution . 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 VALVE REPLACEMENT (LTG)

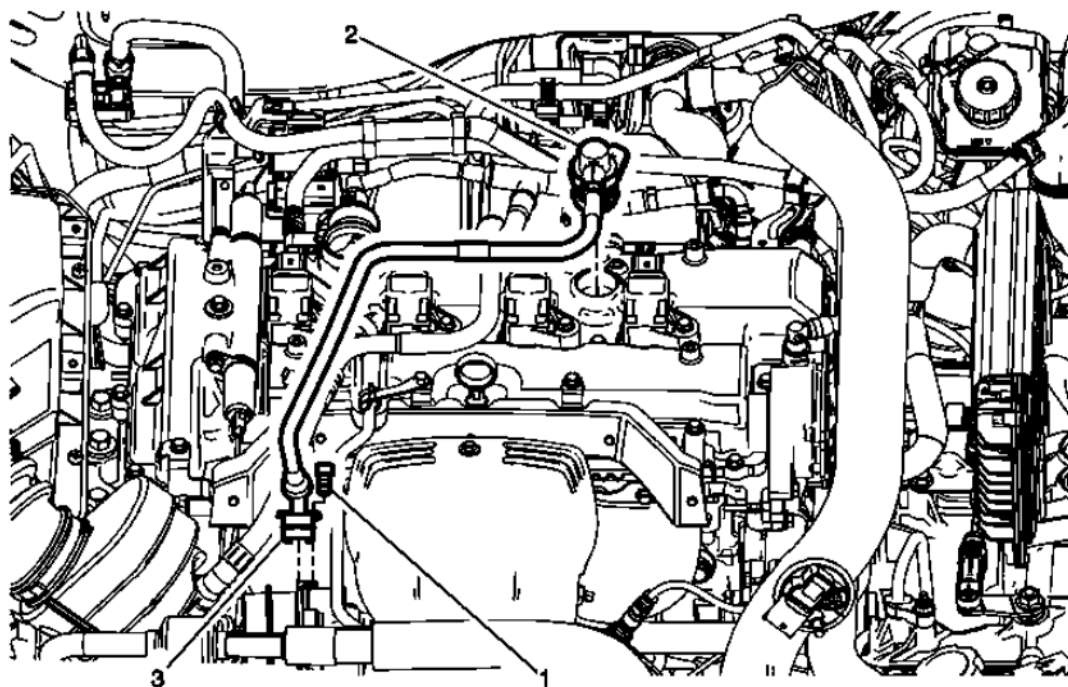


Fig. 33: Positive Crankcase Ventilation Valve (LTG)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Valve Replacement (LTG)

Callout	Component Name
Preliminary Procedures Remove the positive crankcase ventilation hose. Refer to <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)</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)
	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

2	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 HOSE/PIPE/TUBE REPLACEMENT (LCV)

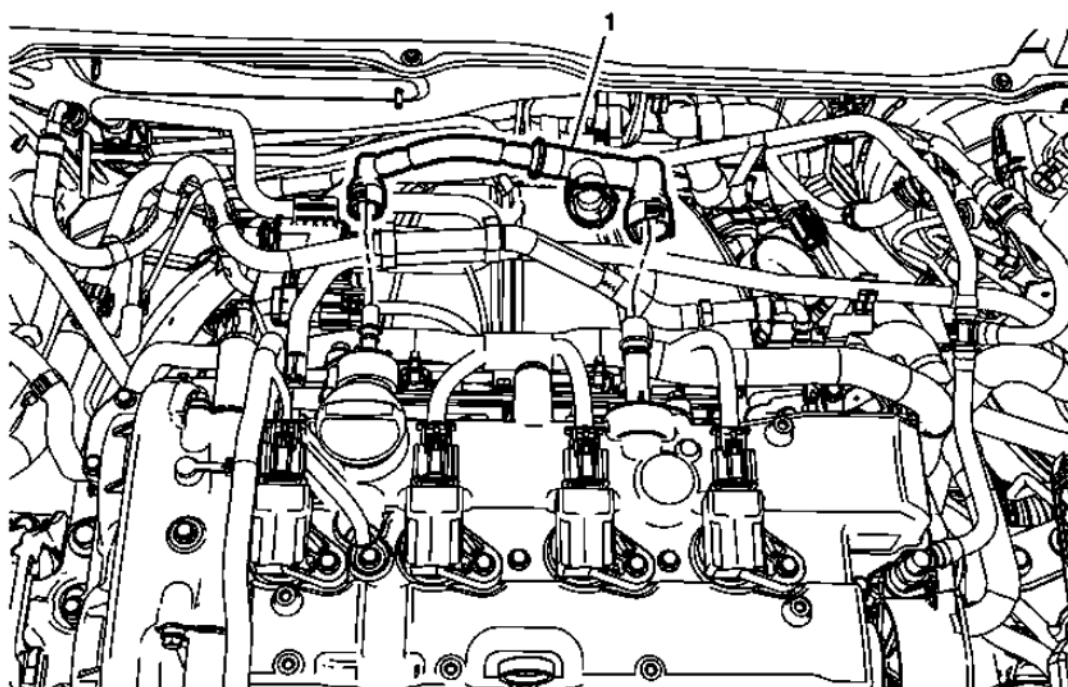


Fig. 34: Positive Crankcase Ventilation Hose/Pipe/Tube (LCV)
Courtesy of GENERAL MOTORS COMPANY

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

Callout	Component Name
Preliminary Procedures	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LCV)</u>. 2. Remove the air cleaner duct resonator. Refer to <u>Air Cleaner Resonator and Outlet Duct Replacement (LCV)</u>.	
1	Positive Crankcase Ventilation Hose

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (CAMSHAFT COVER TO AIR CLEANER RESONATOR TO OUTLET DUCT)

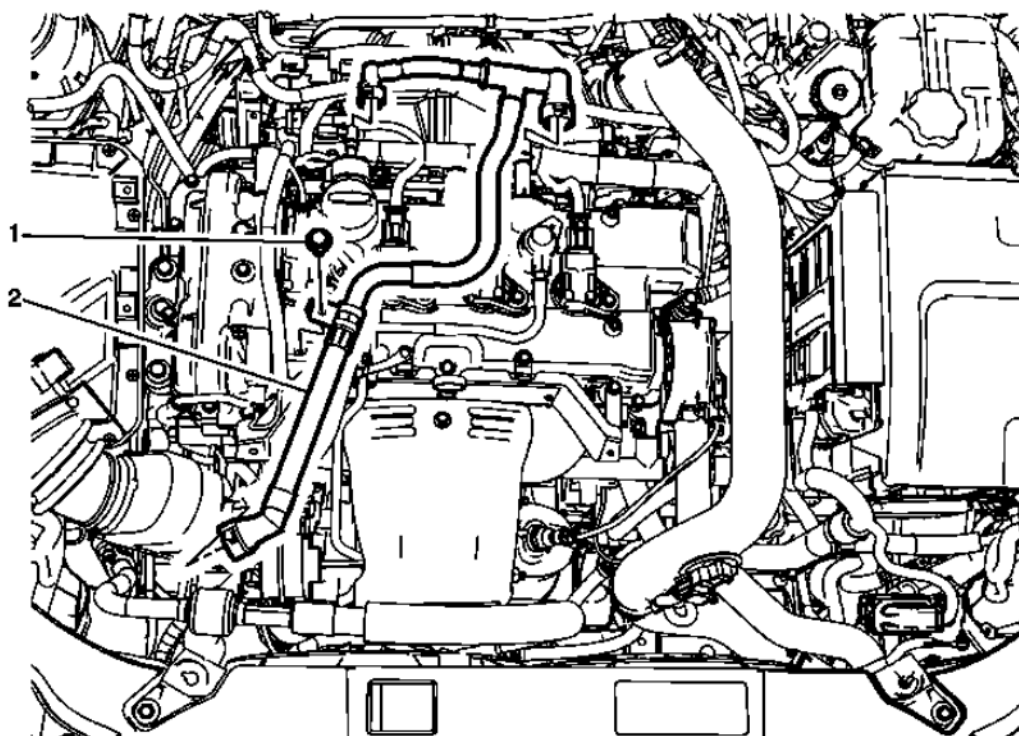


Fig. 35: Positive Crankcase Ventilation Hose/Pipe/Tube
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LCV)</u> , <u>Intake Manifold Cover Replacement (LTG)</u> .	
1	Positive Crankcase Ventilation Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 (80 lb in)
2	Positive Crankcase Ventilation Hose

INTAKE MANIFOLD REPLACEMENT (LCV)

Removal Procedure

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

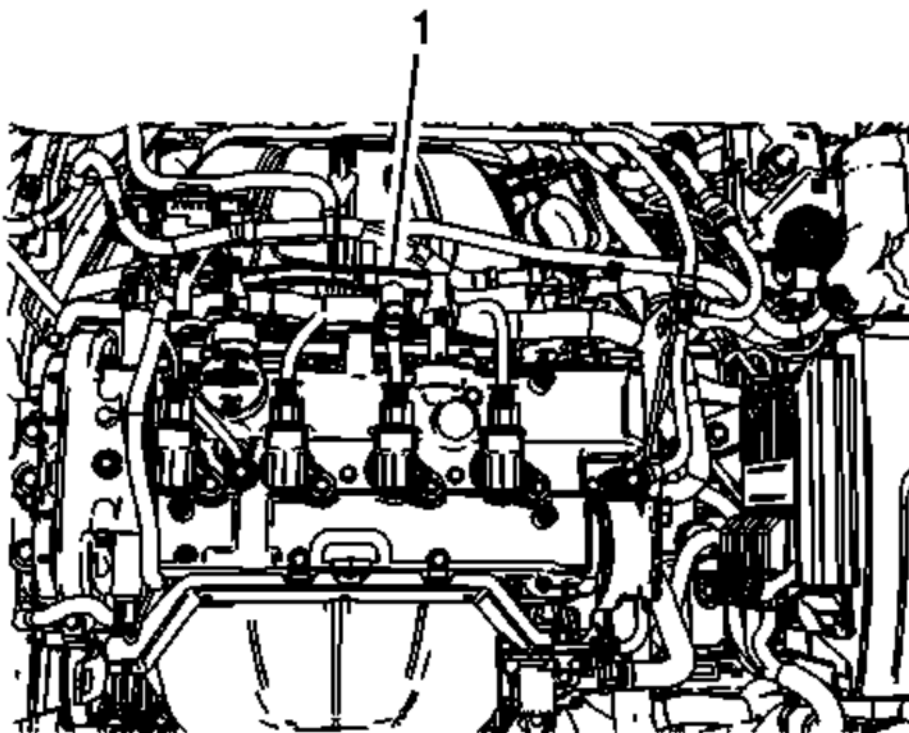


Fig. 36: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

2. Remove the PCV pipe (1). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

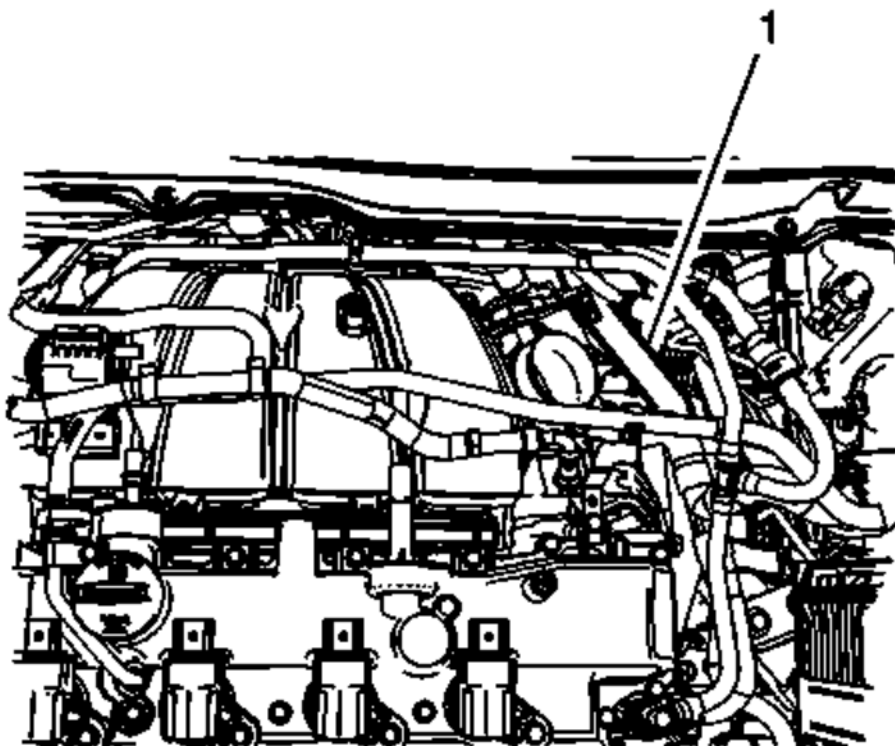


Fig. 37: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

3. Remove the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (2.0L 2.5L)**.

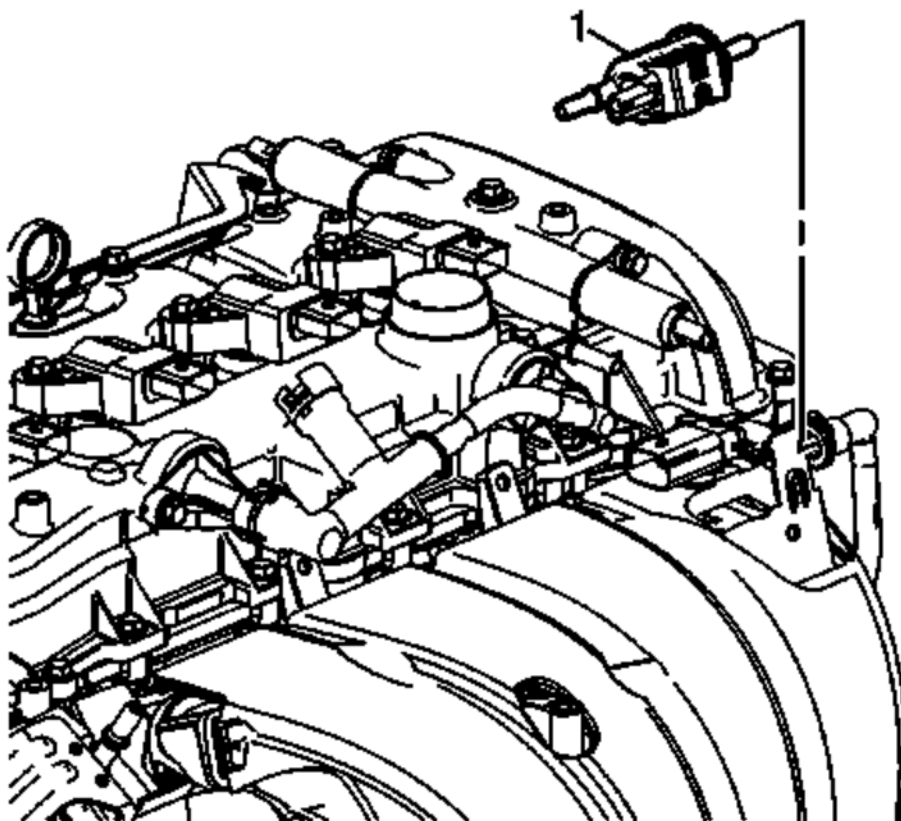


Fig. 38: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

4. Remove the EVAP canister valve (1).
5. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
6. Remove the fuel pump. Refer to **Fuel Injection Fuel Rail Assembly Replacement** .

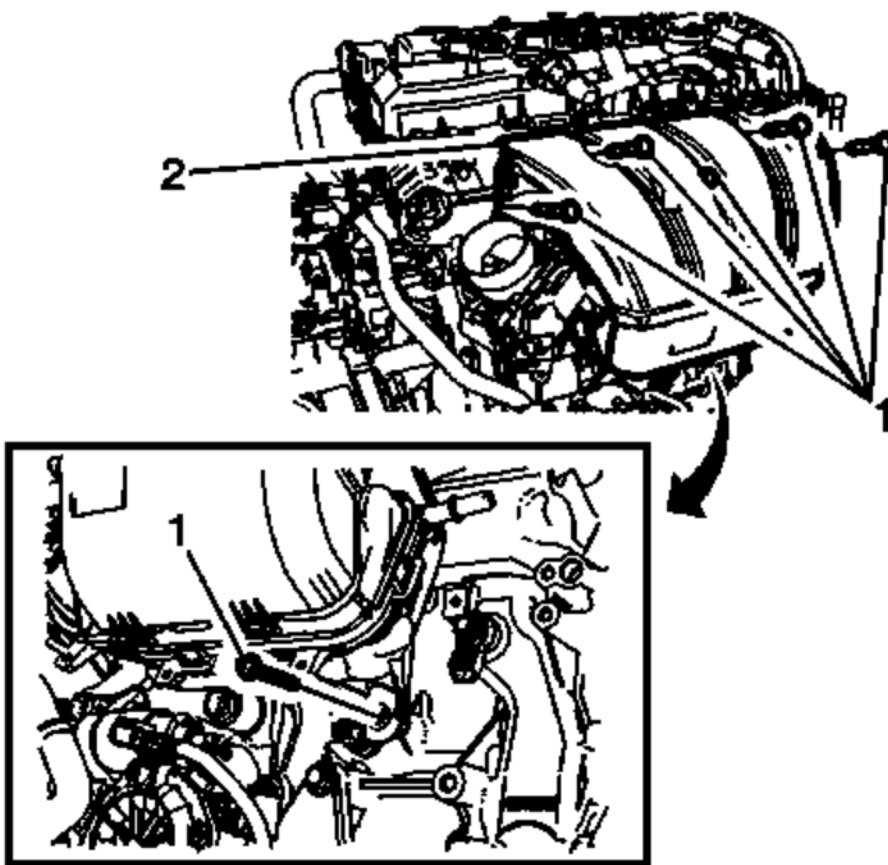


Fig. 39: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Remove the intake bolts (1).
8. Remove the intake manifold (2) from the vehicle.

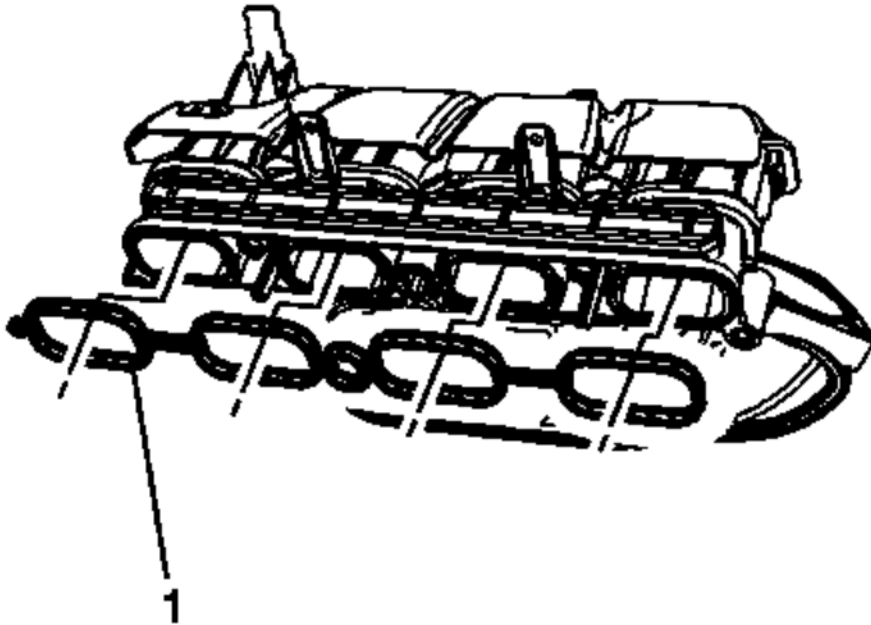


Fig. 40: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold gasket (1) and DISCARD.
10. For intake manifold cleaning and inspection. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

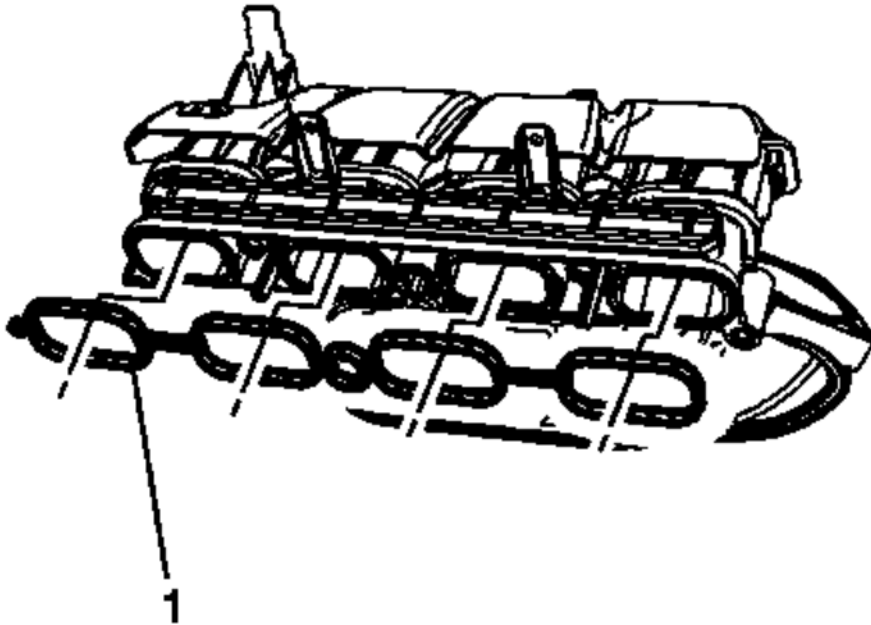


Fig. 41: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold gasket (1).

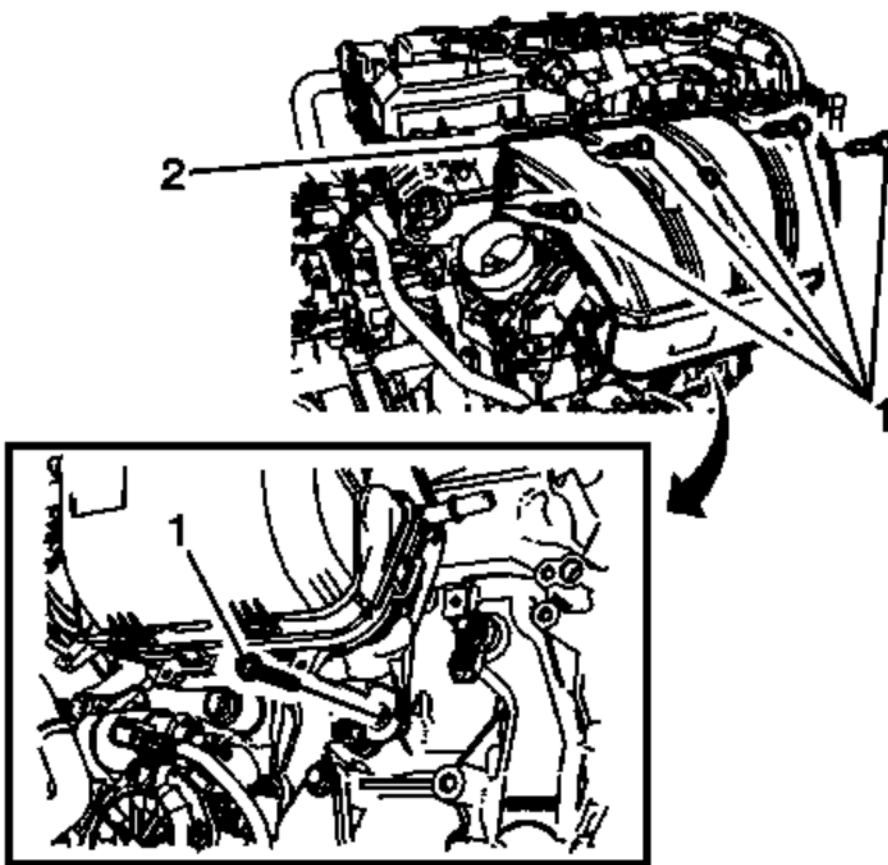


Fig. 42: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Hand start the intake manifold bolts (1).

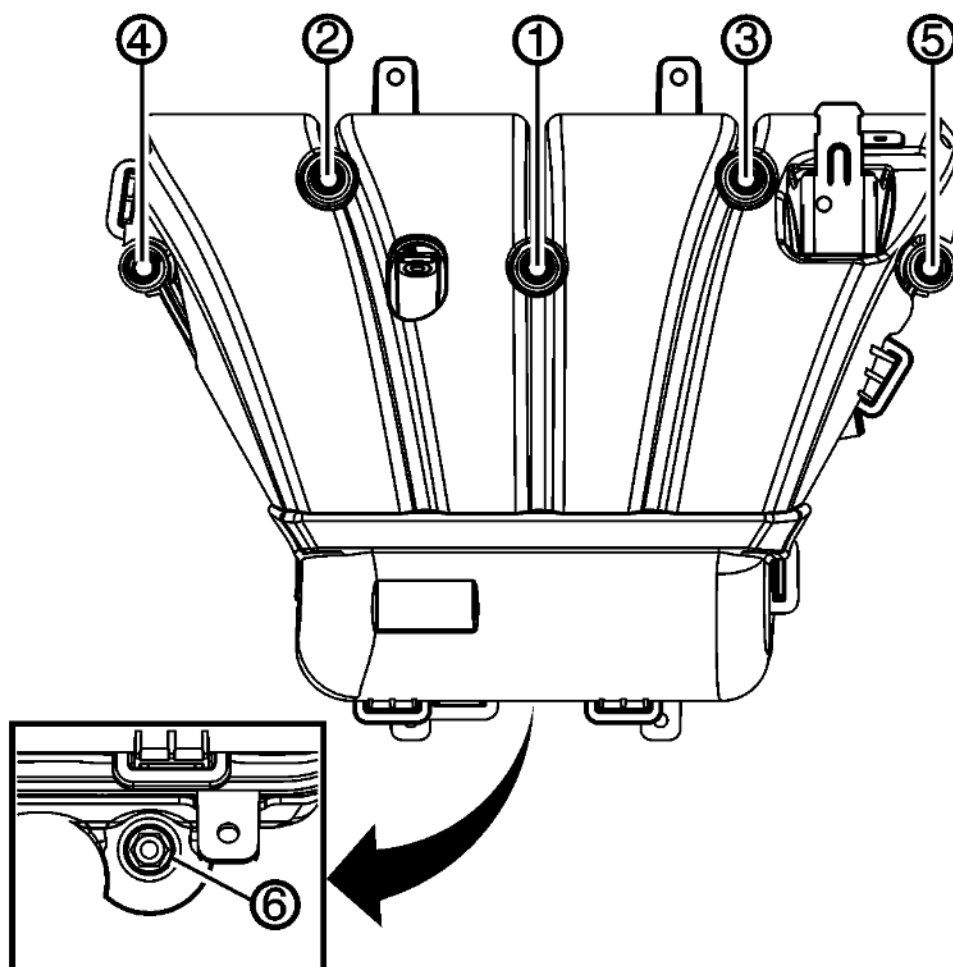


Fig. 43: Tightening Fastener In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the fastener in sequence twice to 12 (106 lb in).
5. Install the fuel pump. Refer to Fuel Injection Fuel Rail Assembly Replacement .
6. Install the throttle body. Refer to Throttle Body Assembly Replacement .

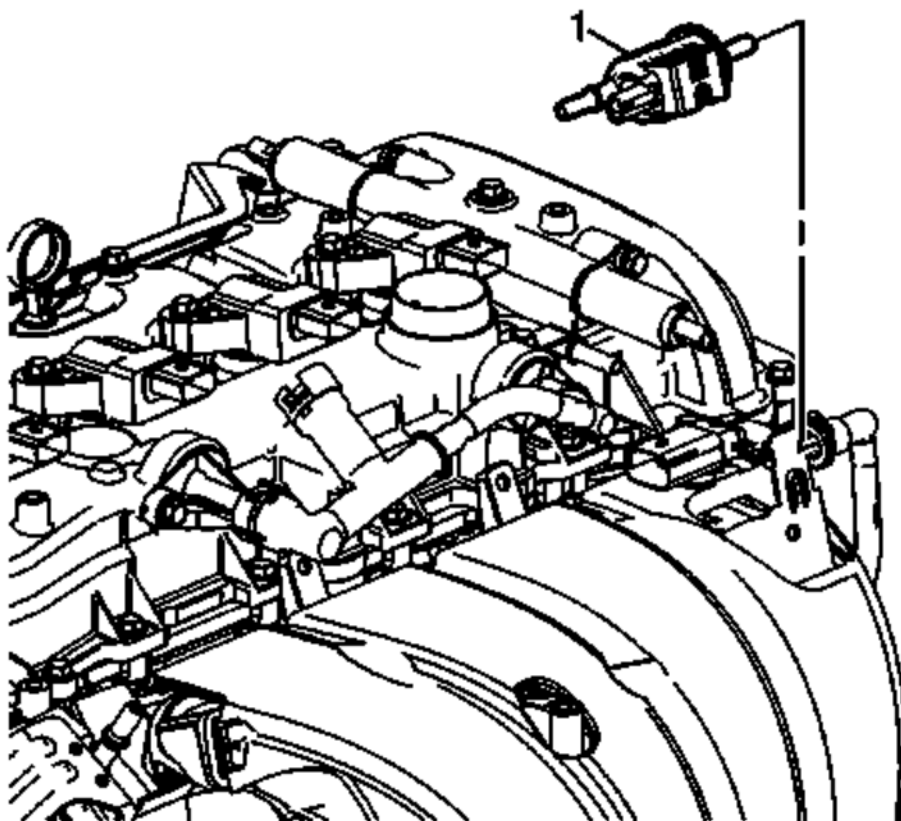


Fig. 44: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

7. Install the EVAP canister valve (1).

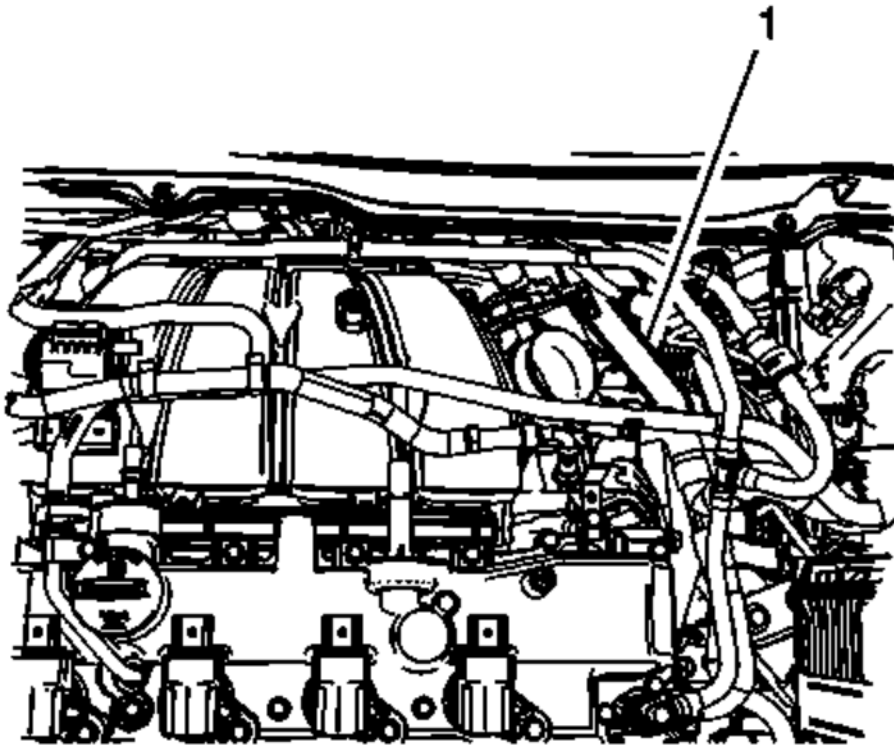


Fig. 45: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Install the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (2.0L 2.5L)**.

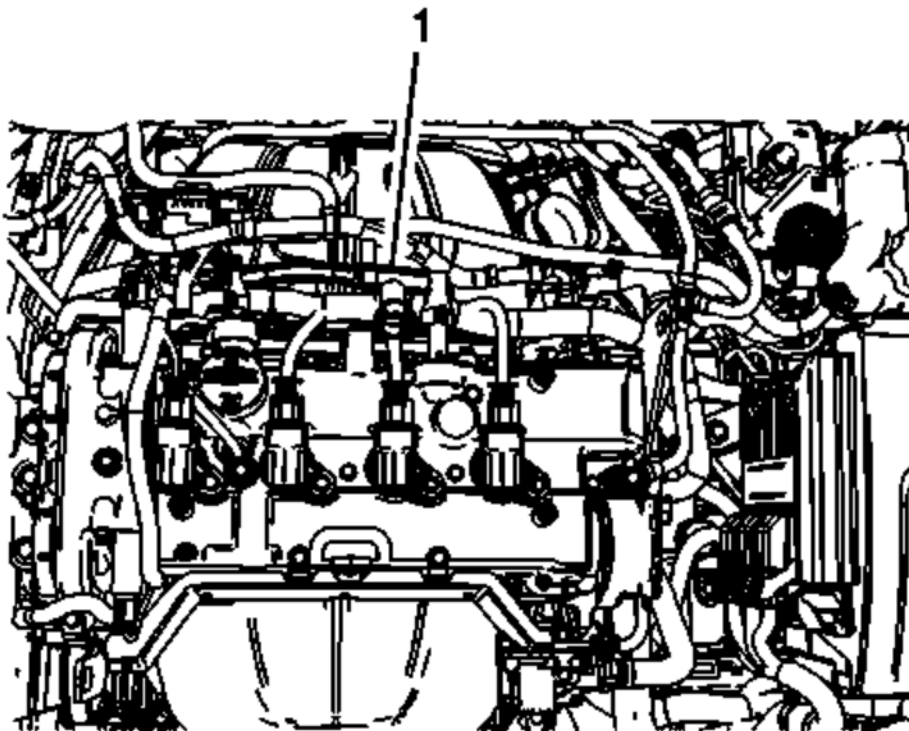


Fig. 46: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Install the PCV pipe (1). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.
10. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LCV)**.

INTAKE MANIFOLD REPLACEMENT (LTG)

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LTG)**.
2. Remove the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement (LTG)**.
3. Disconnect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement (LTG)**.

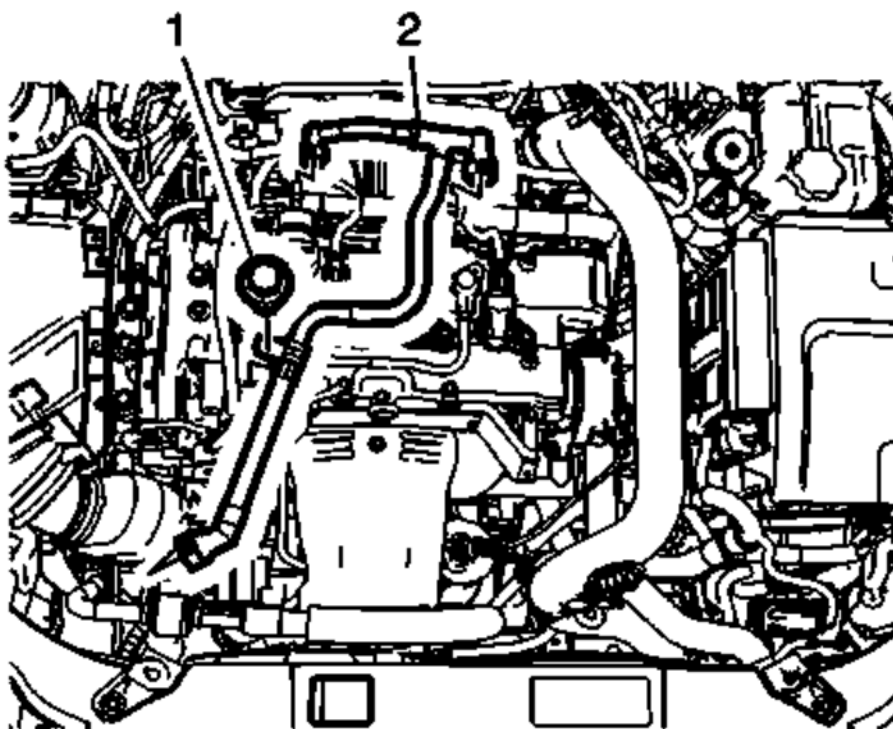


Fig. 47: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

4. Remove the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

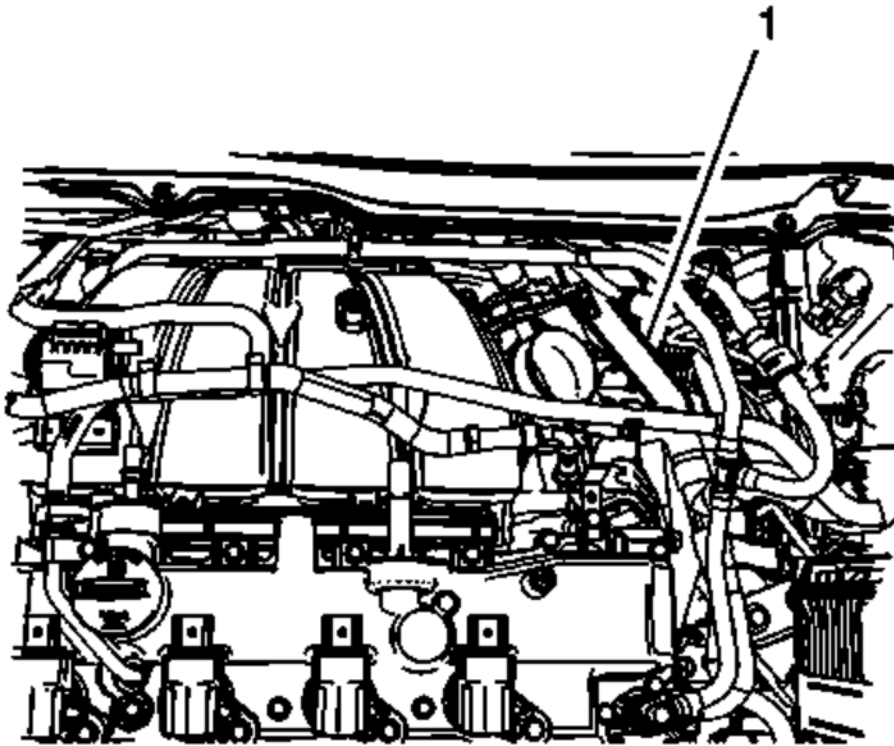


Fig. 48: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (2.0L 2.5L)**.

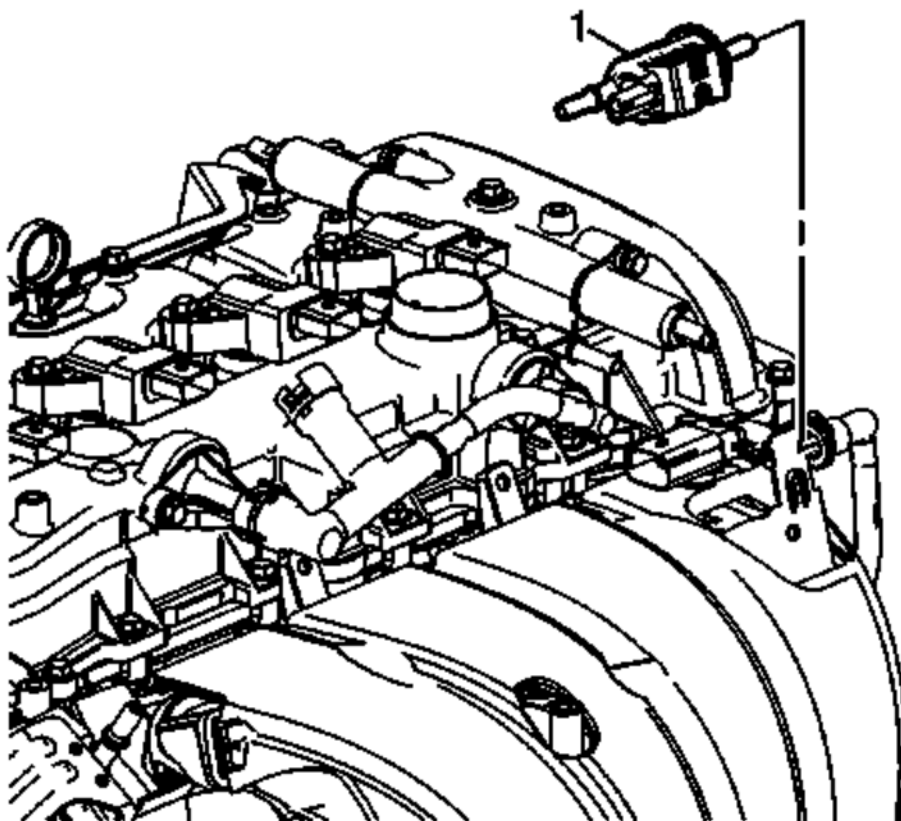


Fig. 49: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

6. Remove the EVAP Canister Purge Solenoid Valve. (1).
7. Remove the throttle body. Refer to **Throttle Body Assembly Replacement** .
8. Remove the fuel pump. Refer to **Fuel Pump Replacement** .

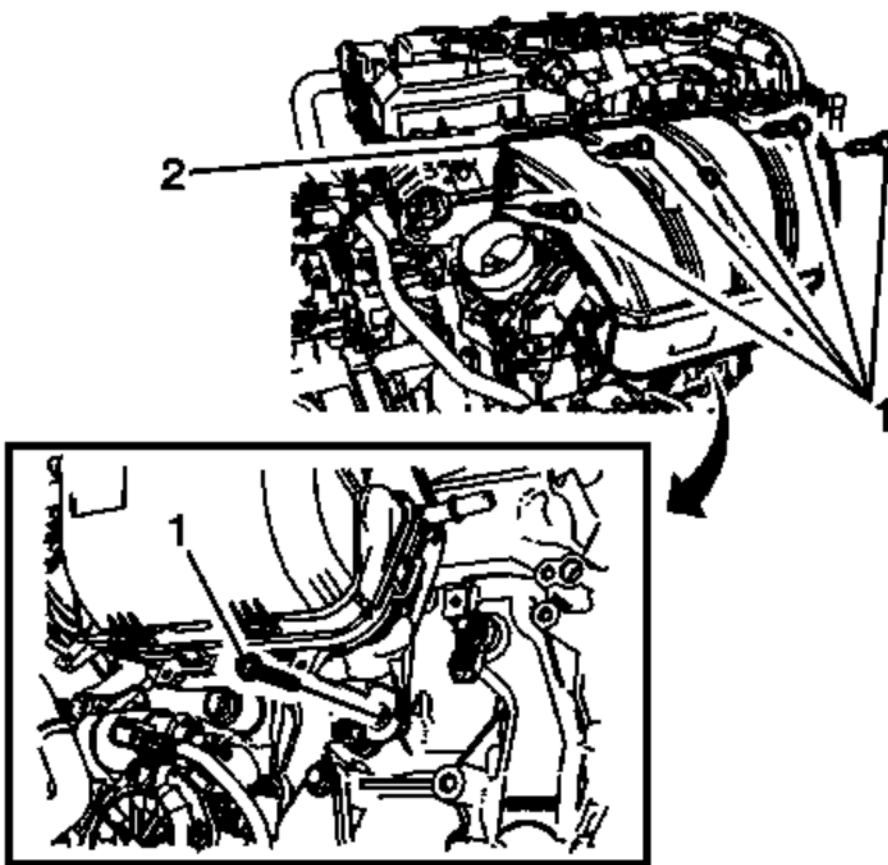


Fig. 50: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake bolts (1).
10. Remove the intake manifold (2) from the vehicle.

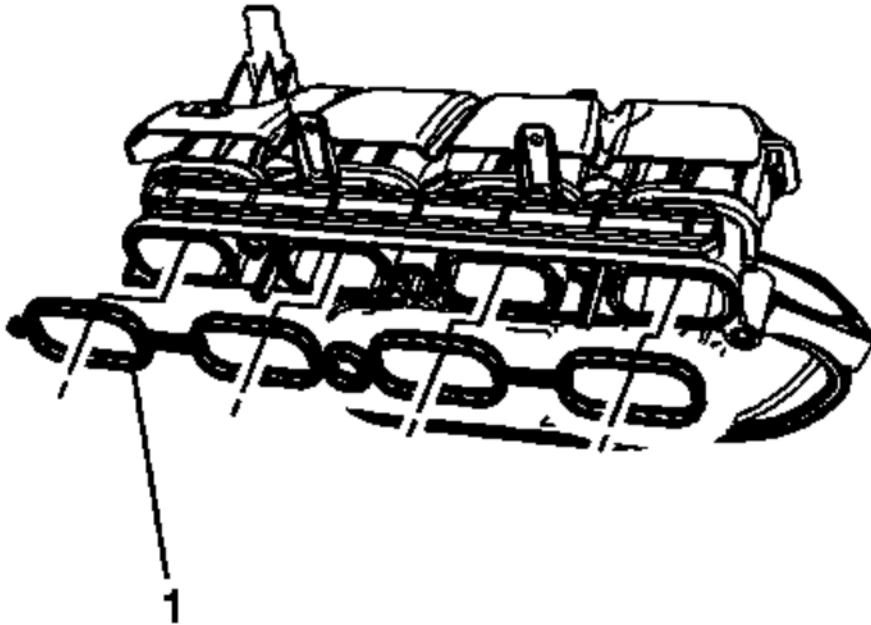


Fig. 51: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold gasket (1) and DISCARD.
12. For intake manifold cleaning and inspection. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

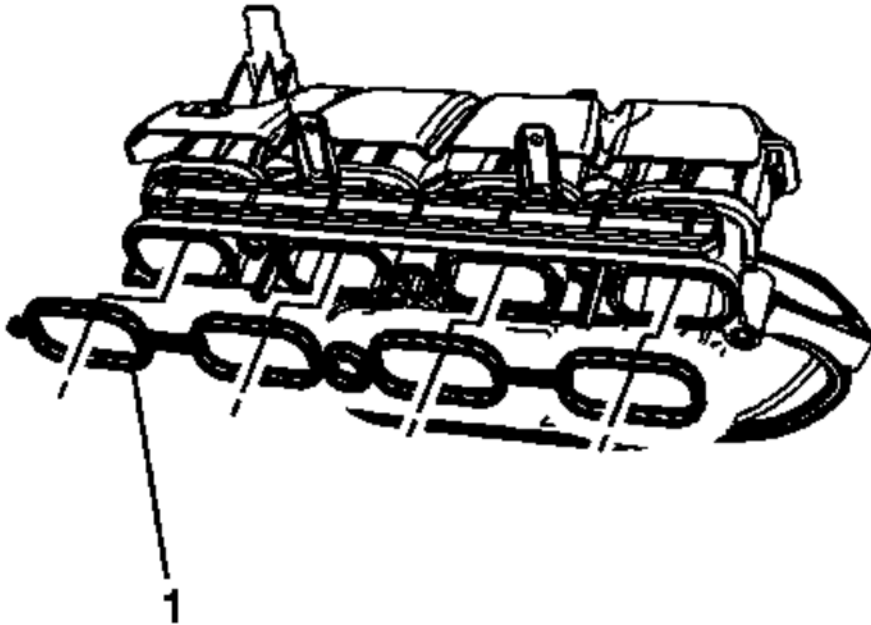


Fig. 52: Intake Manifold Gasket

Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold gasket (1).

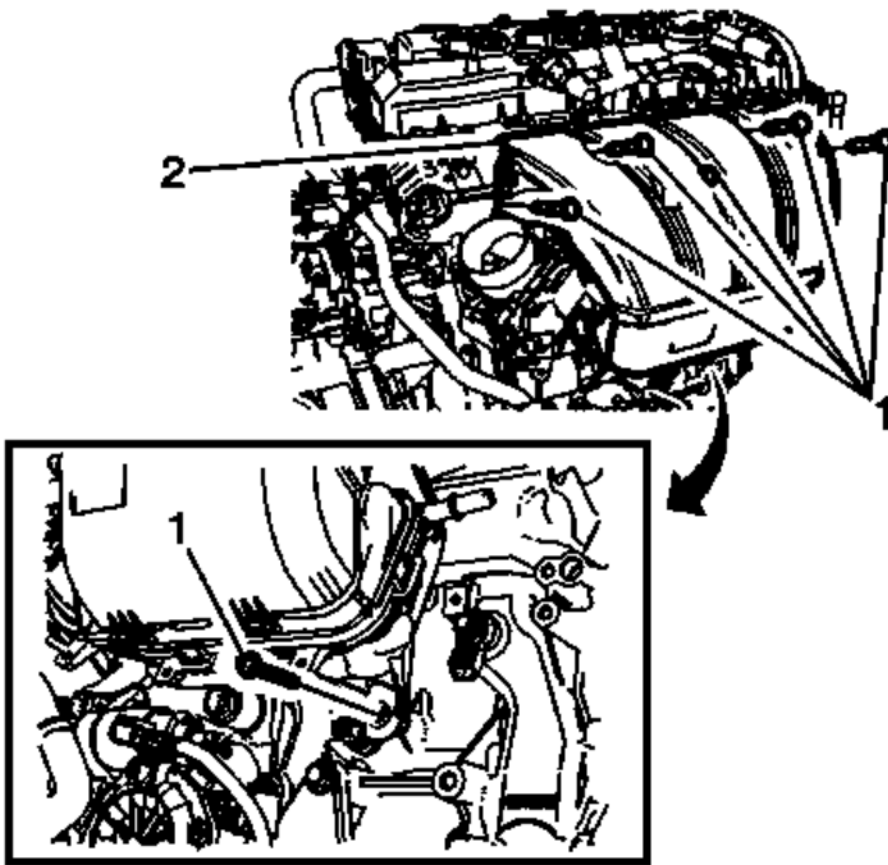


Fig. 53: Intake Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Hand start the intake manifold bolts (1).

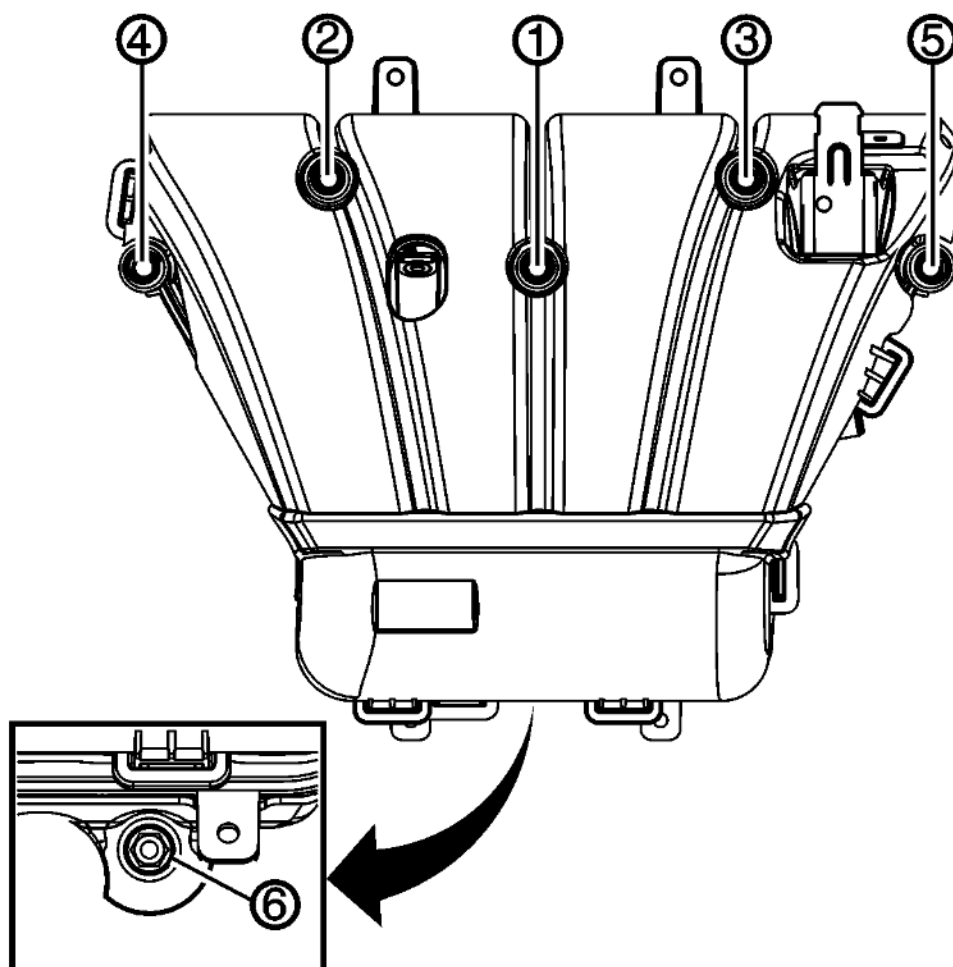


Fig. 54: Tightening Fastener In Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the fastener in sequence twice to 12 (106 lb in).
5. Install the fuel pump. Refer to Fuel Pump Replacement .
6. Install the throttle body. Refer to Throttle Body Assembly Replacement .

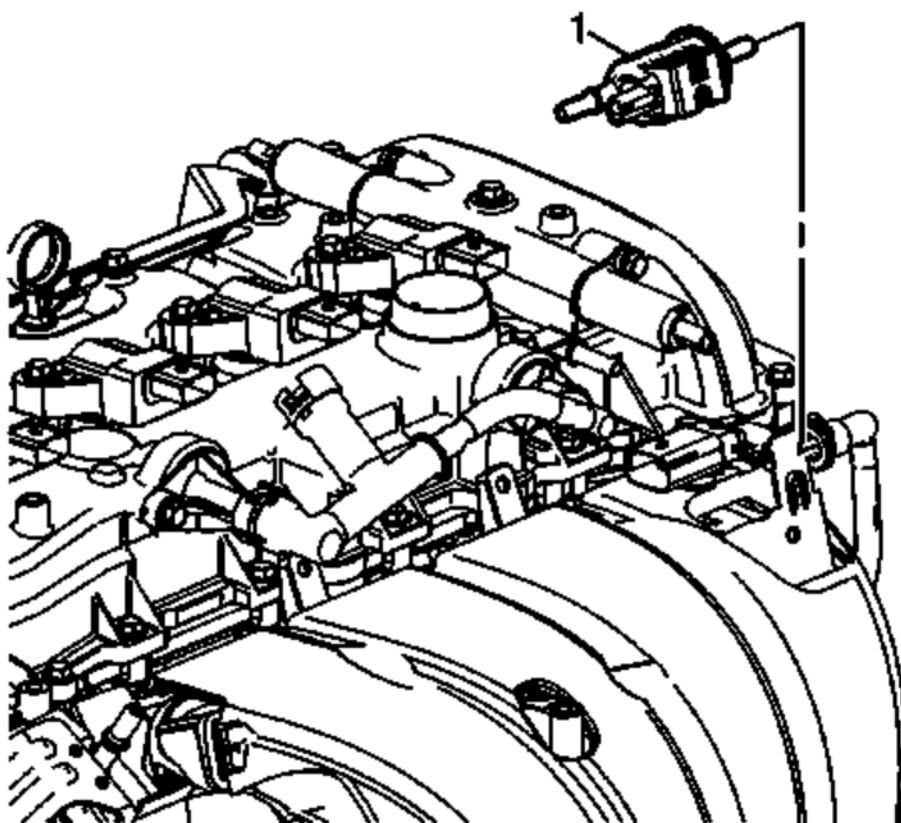


Fig. 55: EVAP Canister Valve

Courtesy of GENERAL MOTORS COMPANY

7. Install the EVAP Canister Purge Solenoid Valve (1).

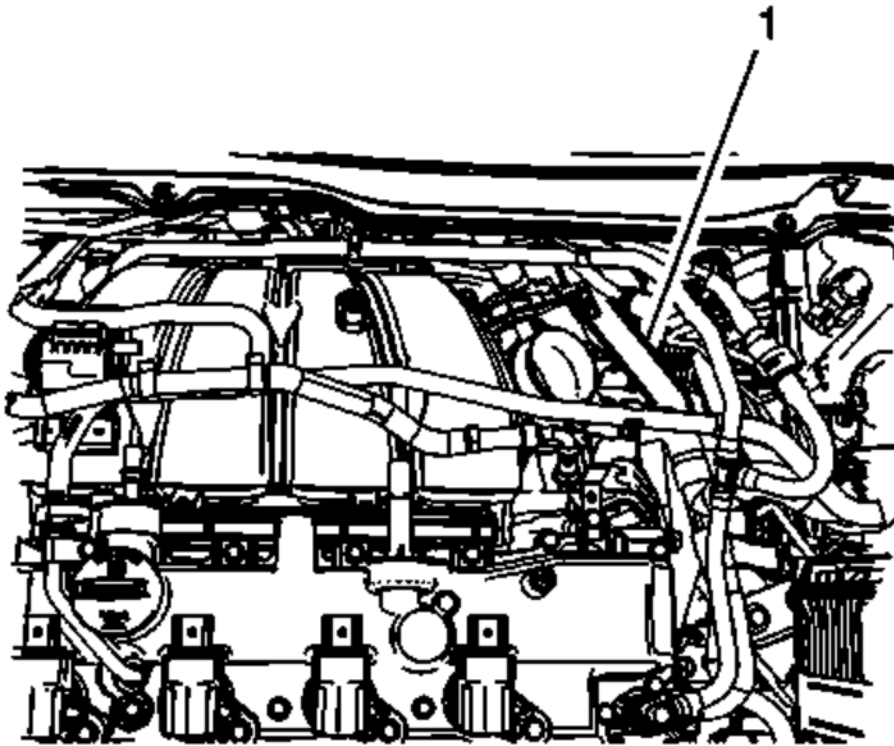


Fig. 56: Brake Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Install the brake vacuum pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (2.0L 2.5L)**.

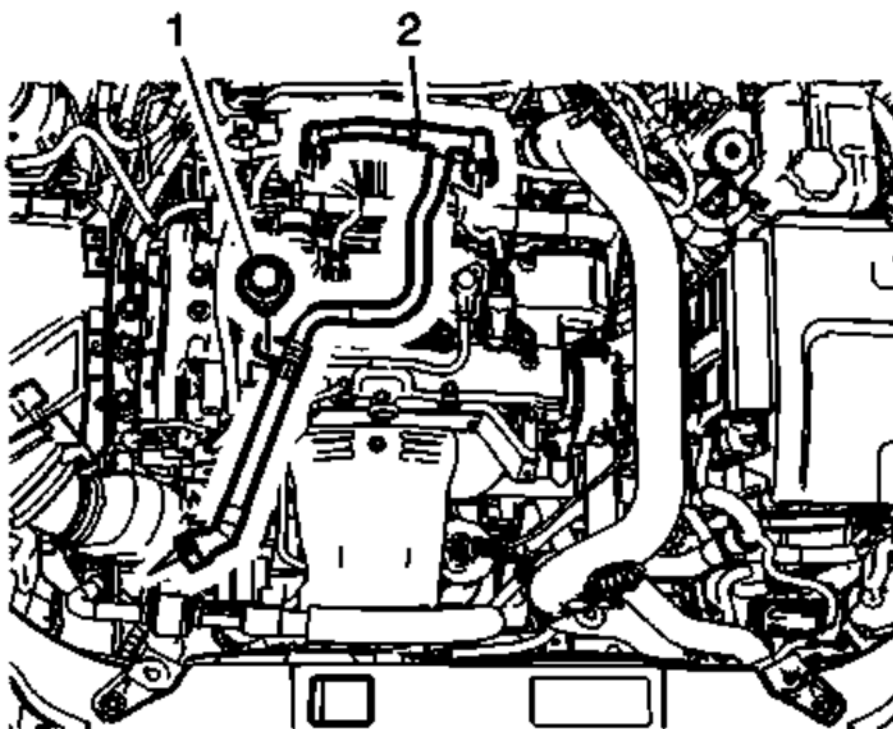


Fig. 57: PCV Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Install the PCV pipe (2). Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.
10. Install the charge air cooler outlet tube. Refer to **Charge Air Cooler Outlet Air Tube Replacement (LTG)**.
11. Connect the fuel feed pipe. Refer to **Fuel Feed Front Pipe Replacement (LTG)**.
12. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LTG)**.

CRANKSHAFT BALANCER REPLACEMENT

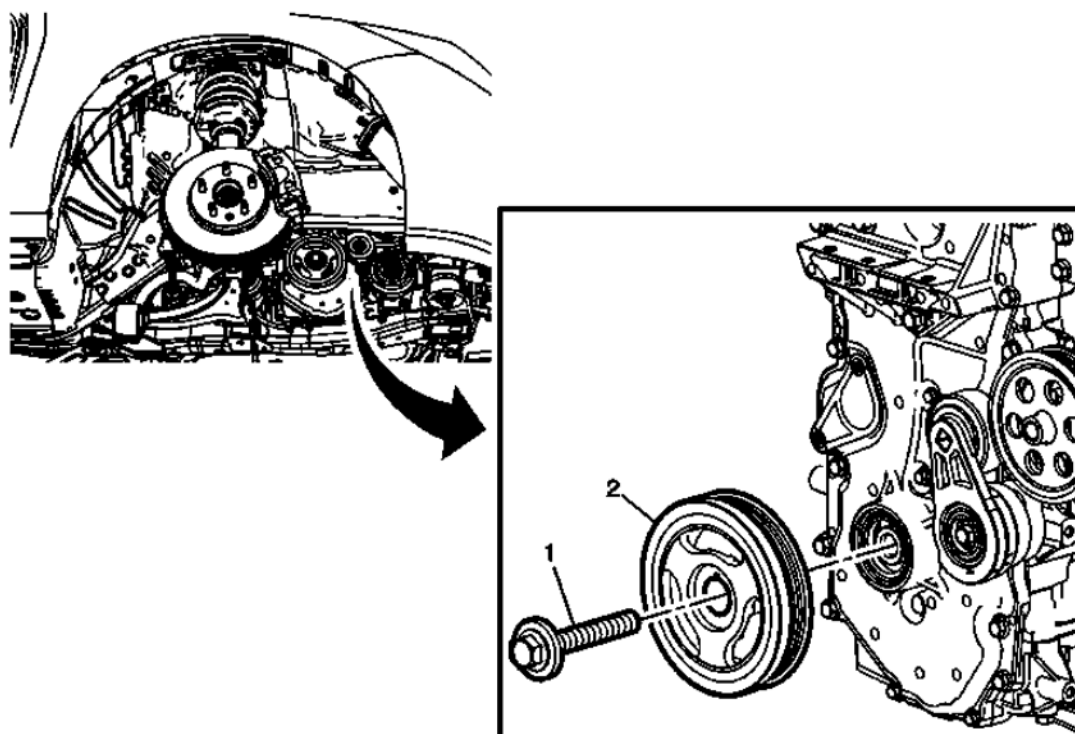


Fig. 58: Crankshaft Balancer
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the starter. Refer to <u>Starter Replacement (LCV, LTG)</u> . 2. Install the EN-50792 Flywheel Holding Tool. 3. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>.	
Special Tools • EN-41816 Crankshaft Balancer Remover • EN-45059 Angle Meter • EN-50792 Flywheel Holding Tool	
For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Crankshaft Balancer Bolt CAUTION: Refer to <u>Fastener Caution</u> .

	Procedure Install a NEW crankshaft bolt and washer. Tighten 150 (111 lb ft) plus 180 degrees.
2	Crankshaft Balancer

TIMING CHAIN CRANKSHAFT SPROCKET REPLACEMENT

Special Tools

EN-50837 Timing Chain Tensioner Retraction Tool

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

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**, **Camshaft Cover Replacement (LTG)**.
2. Remove the timing chain. Refer to **Camshaft Timing Chain and Tensioner Replacement**.

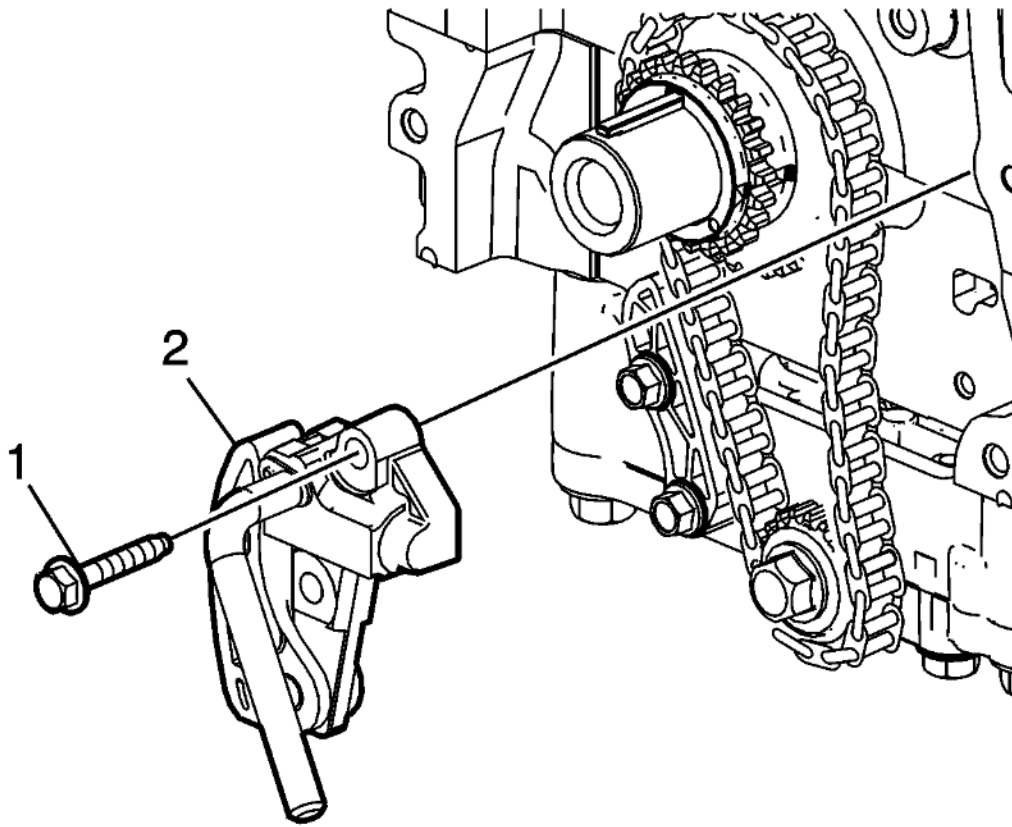


Fig. 59: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the balancer chain tensioner bolt (1).
4. Remove the balancer chain tensioner (2).
5. Compress and lock the tensioner using **EN-50837** retention tool.
 1. Insert **EN-50837** retention tool into the lever arm and push in a counterclockwise direction.
 2. Compress the tensioner while holding lever arm.
 3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
 4. Pull lever clockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

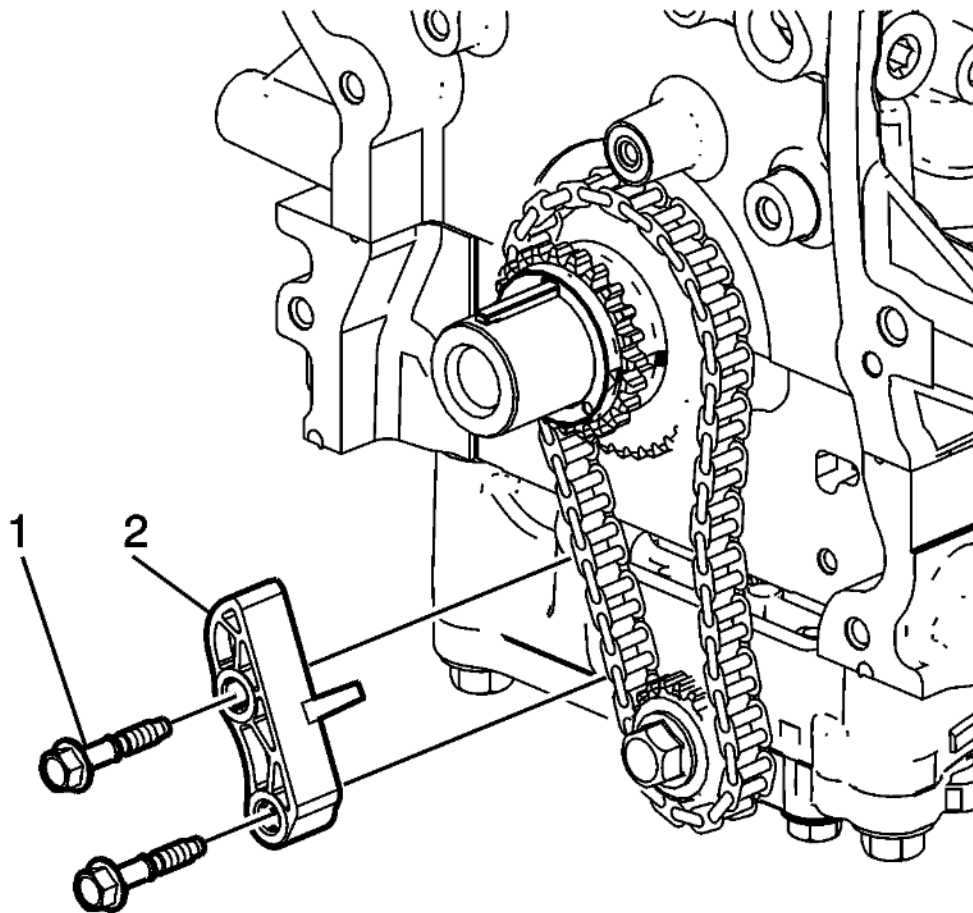


Fig. 60: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the balancer chain guide bolt (1).
7. Remove the balancer chain guide (2).

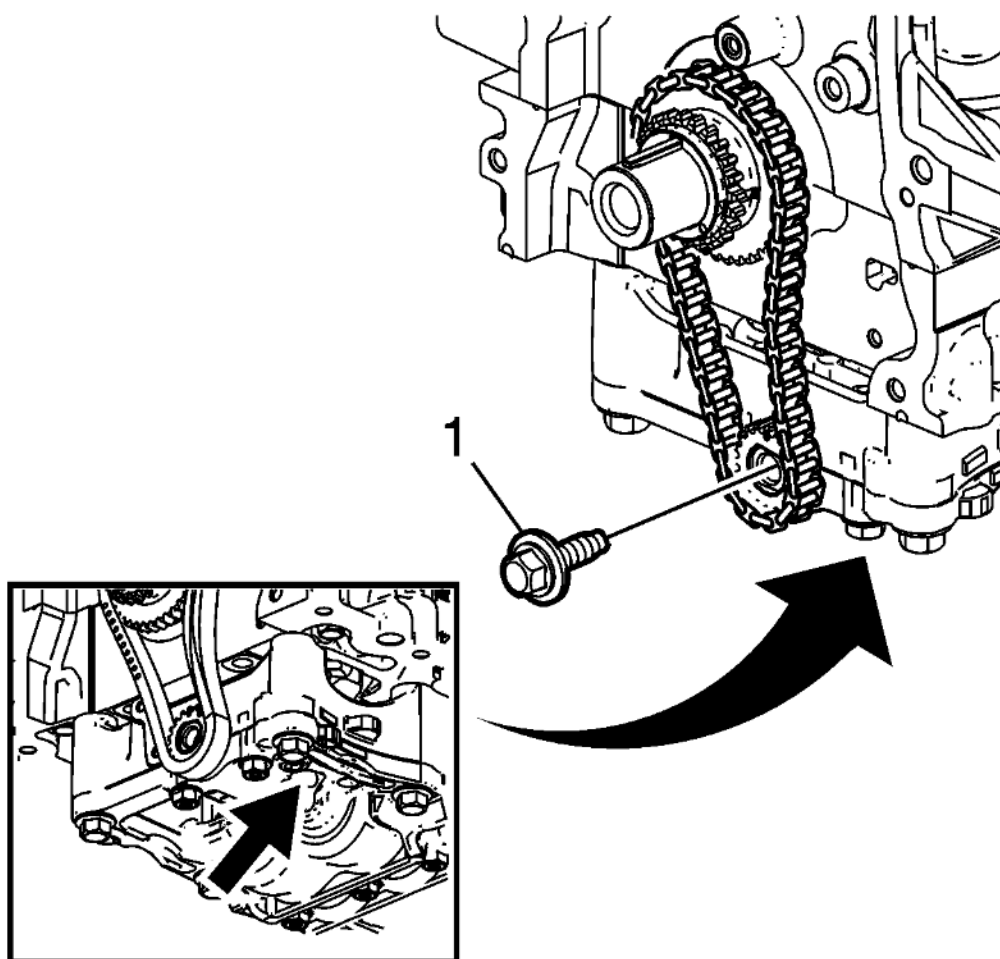


Fig. 61: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove and discard the balancer shaft driven sprocket bolt (1).

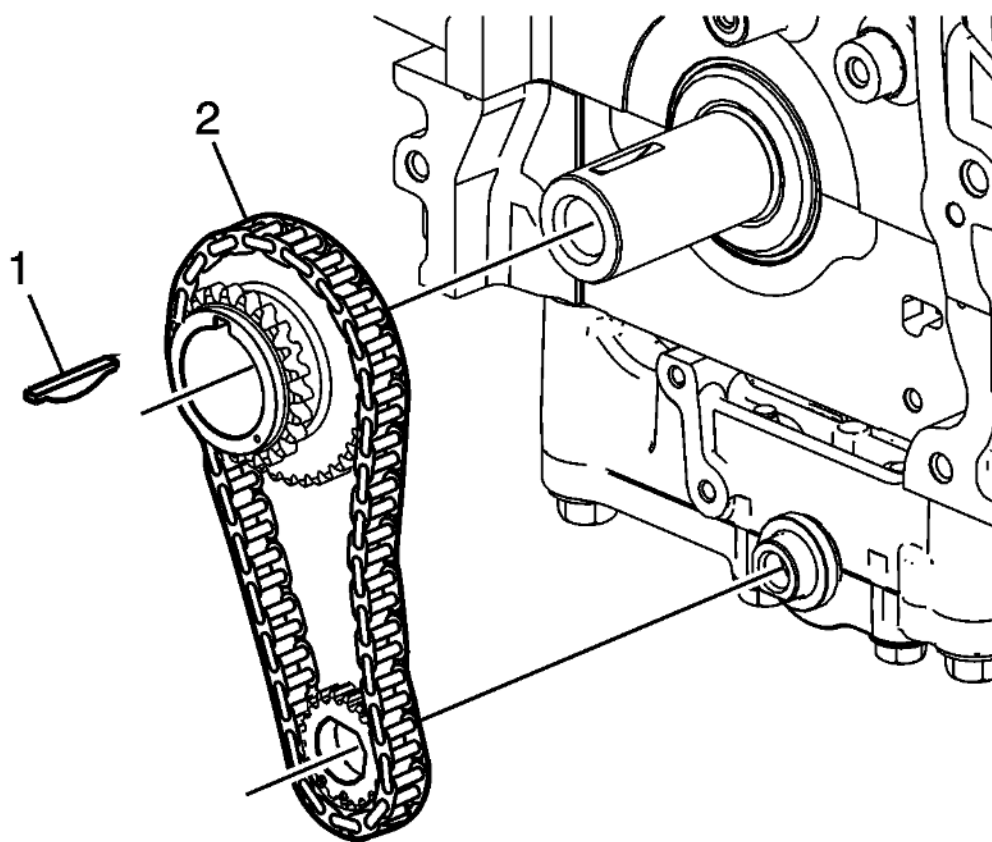


Fig. 62: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain (1) simultaneously.

Installation Procedure

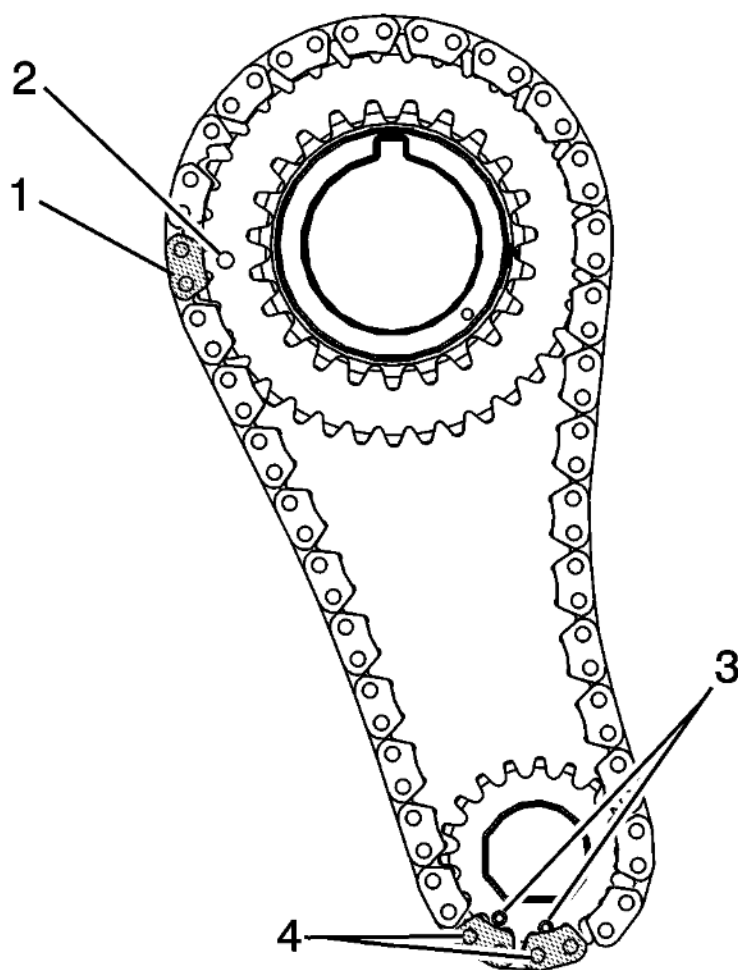


Fig. 63: Timing Link And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: Proper setup is critical to ensure correct timing when installing the sprockets and chain simultaneously onto the shafts. The timing links are heat treated blued steel.

1. Assemble the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain. Ensure the timing link (1) lines up with the timing mark (2) on the crankshaft sprocket. Ensure that both timing teeth (3) on the balancer shaft driven sprocket line up with the timing links (4).

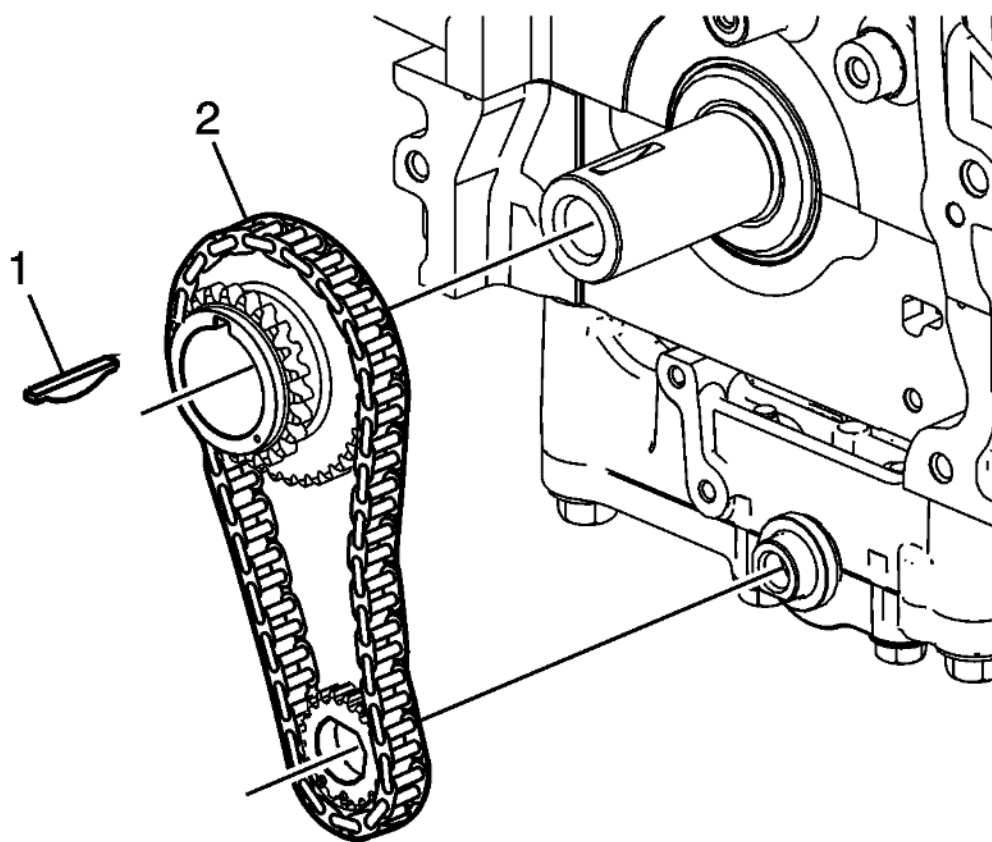


Fig. 64: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft keyway should be in the 12 O'clock position.

2. Install the sprockets and chain (1) as an assembly to the crankshaft and balancer shaft assembly.

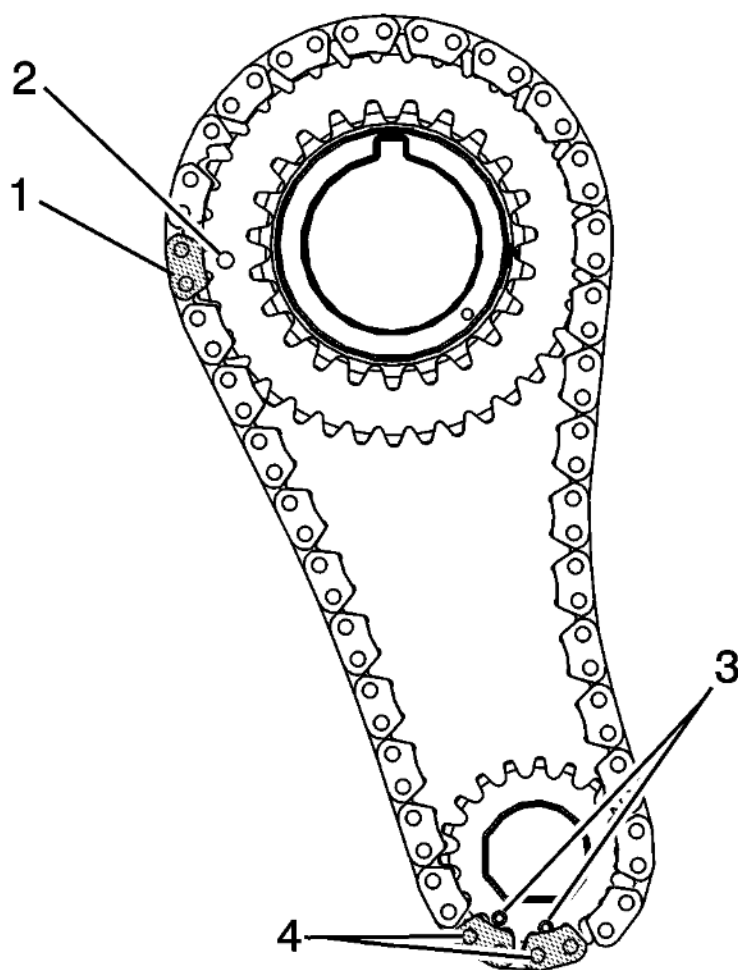


Fig. 65: Timing Link And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the timing link (1) is aligned with the crankshaft sprocket timing mark (2).
4. Ensure the adjacent timing links (4) are aligned with both of the timing marks (3) on the balancer shaft driven sprocket.

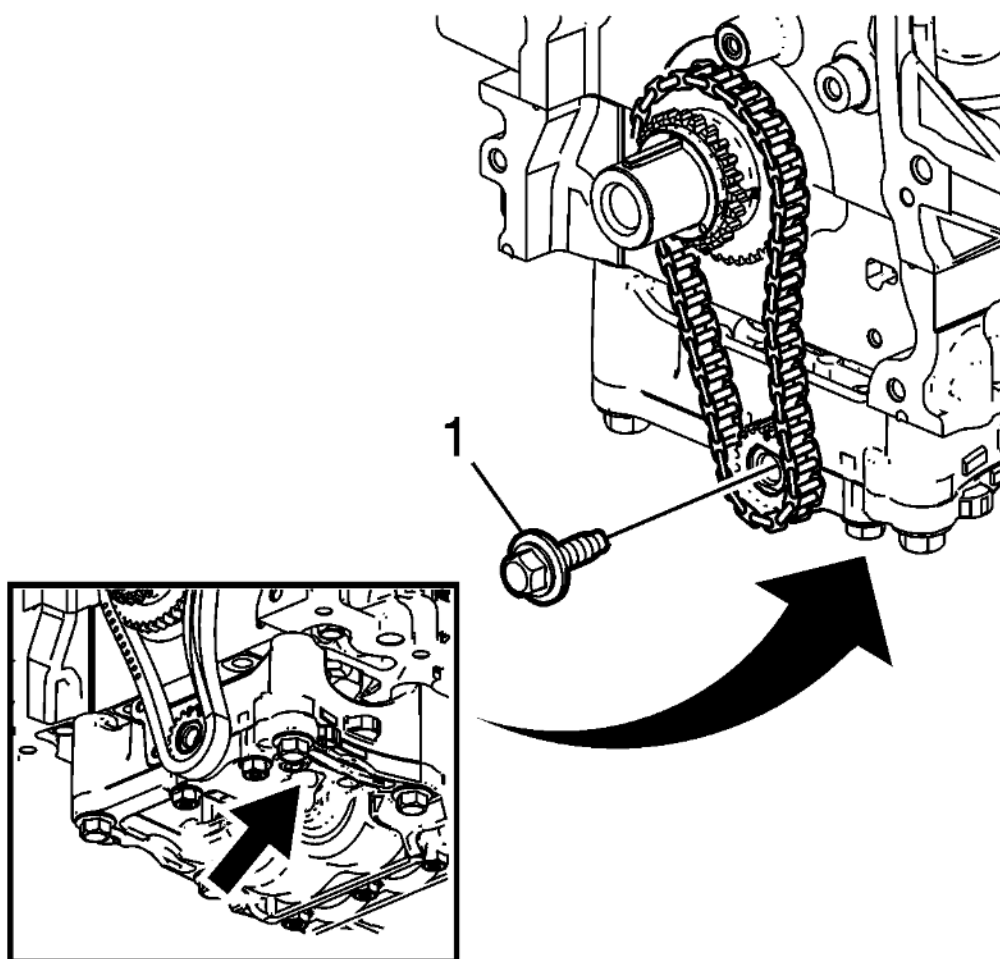


Fig. 66: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

5. Install the NEW balancer shaft driven sprocket bolt (1).

CAUTION: Refer to Fastener Caution .

6. Tighten the balancer shaft driven sprocket bolt to 40 N.m (30 lb ft) plus 50 degrees.

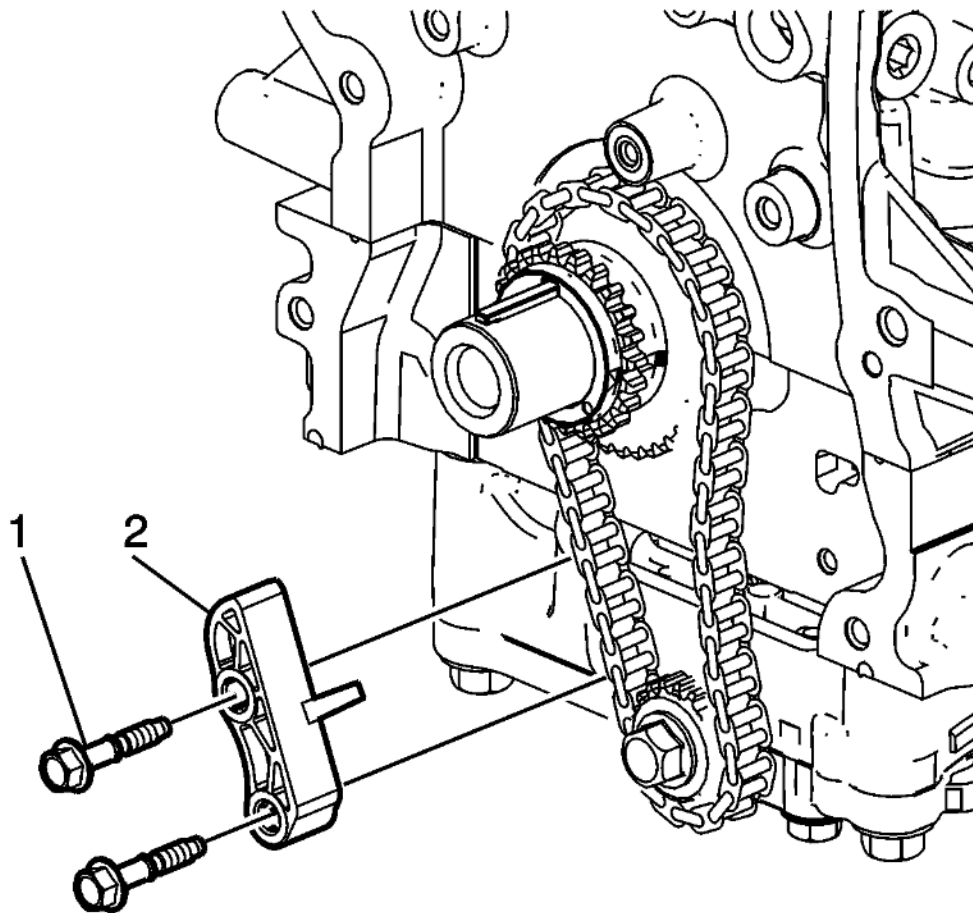


Fig. 67: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure the guide is installed in the correct orientation. The long end must point toward the crankshaft and the flat edge must be adjacent to the balancer chain.

7. Install the balancer chain guide (2).
8. Install the balancer chain guide bolts (1). Tighten the bolts to 10 N.m (89 lb in).

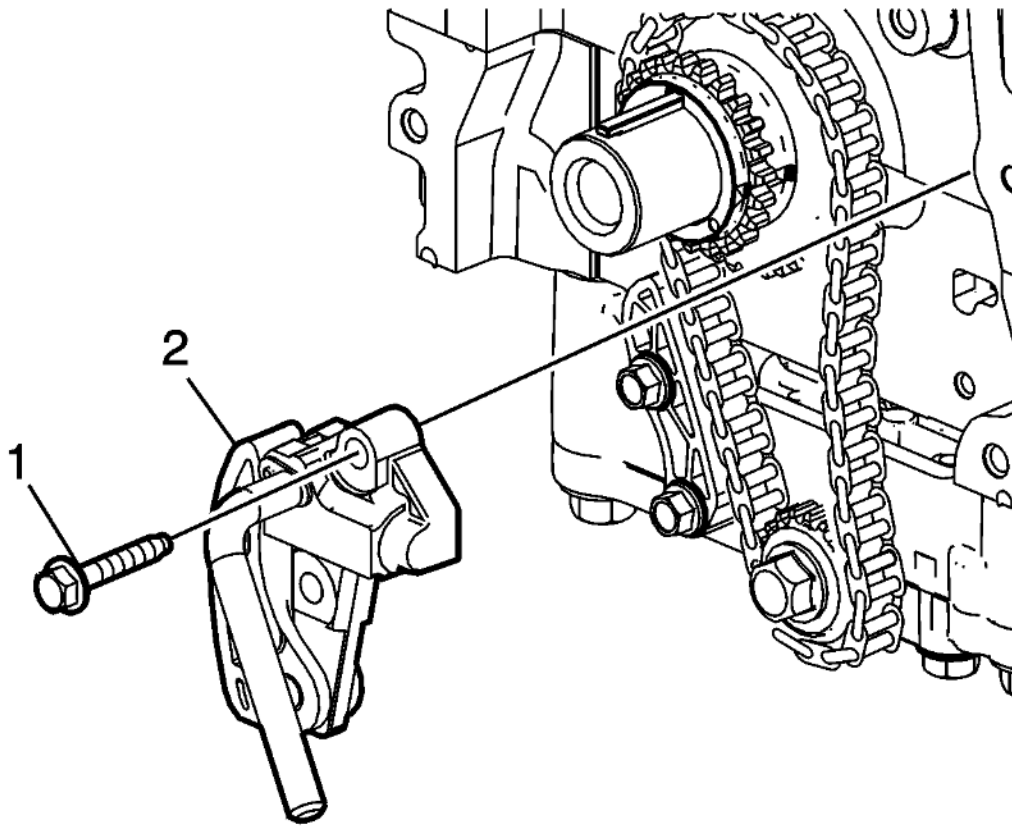


Fig. 68: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install the balancer chain tensioner (2).
10. Install the balancer chain tensioner bolts (1). Tighten the bolts to 10 N.m (89 lb in).
11. Remove **EN-50837** retention tool to restore the tension to the balancer chain.
12. Install the timing chain. Refer to **Camshaft Timing Chain and Tensioner Replacement**.
13. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**, **Camshaft Cover Replacement (LTG)**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

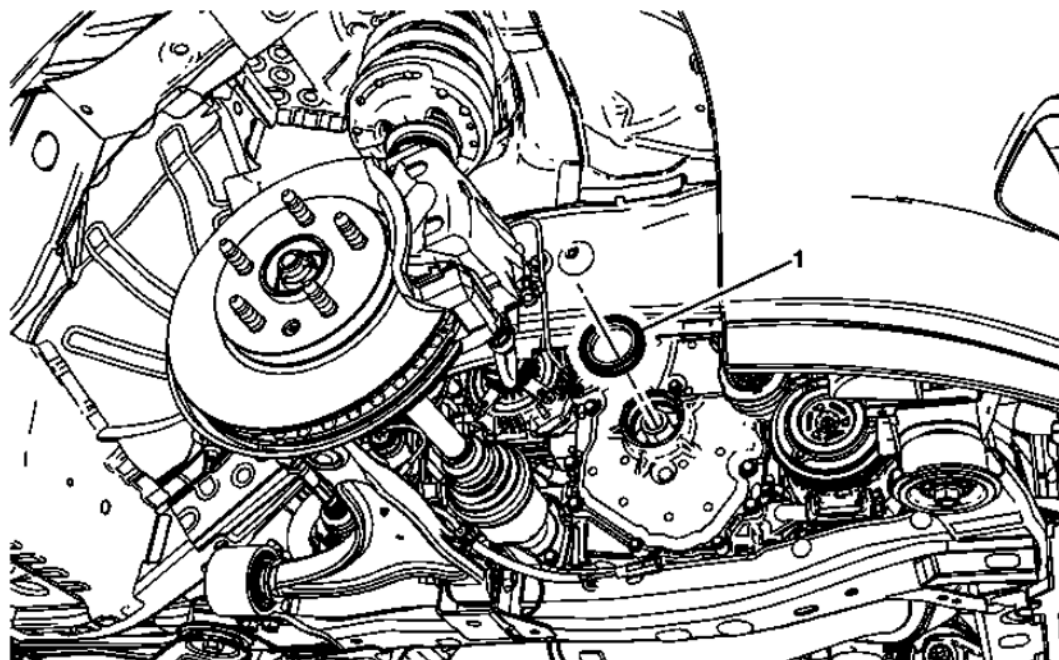


Fig. 69: Crankshaft Front Oil Seal
 Courtesy of GENERAL MOTORS COMPANY

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 Special Tools .

ENGINE FRONT COVER REPLACEMENT (LCV)

Special Tools

EN-50820 Front Crankshaft Seal Installer

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

Removal Procedure

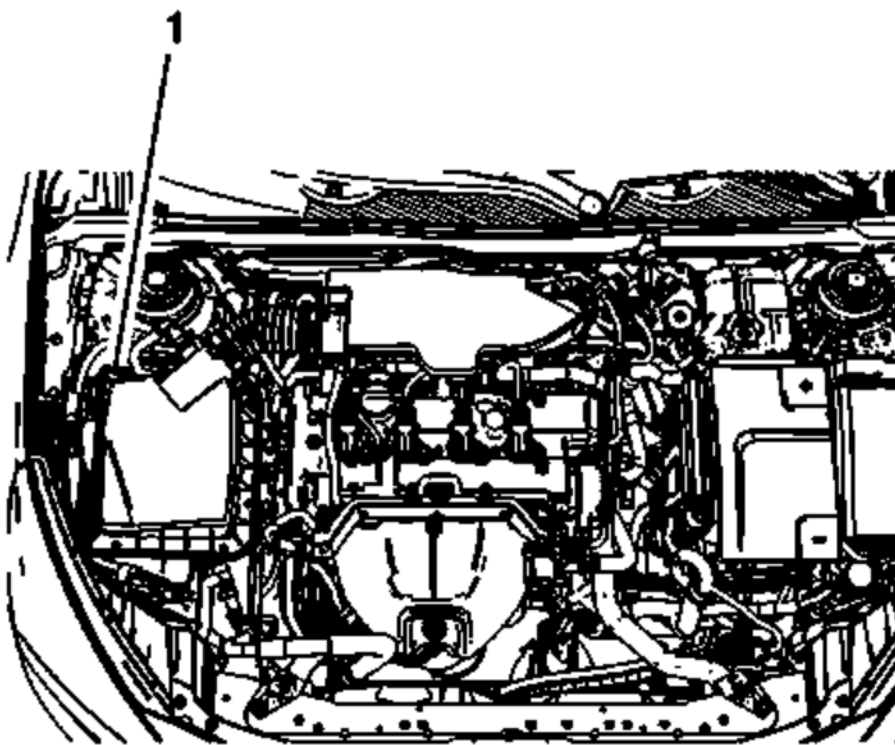


Fig. 70: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**.

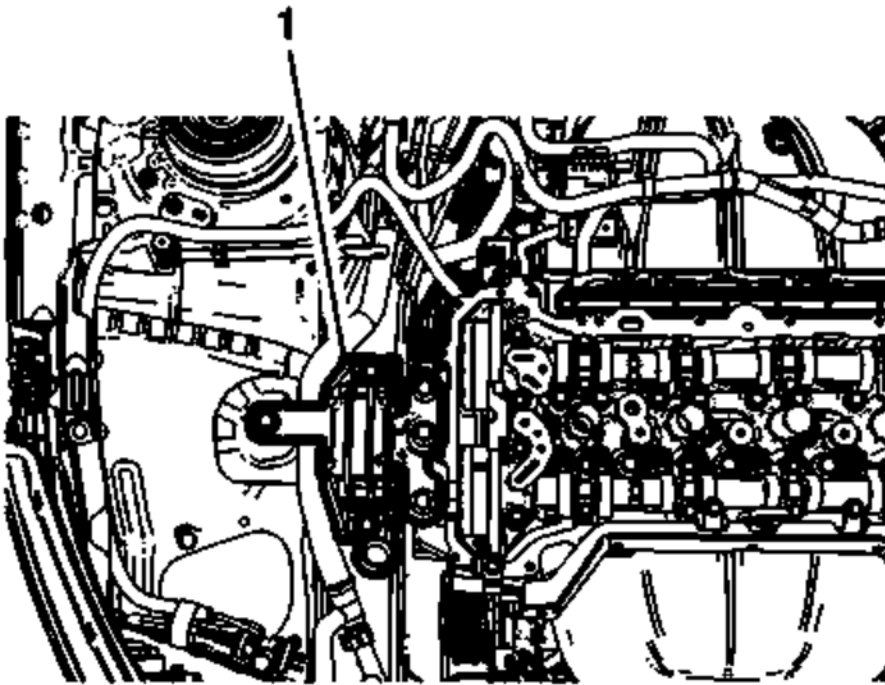


Fig. 71: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount (1). Refer to **Engine Mount Replacement (LCV)**.
4. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

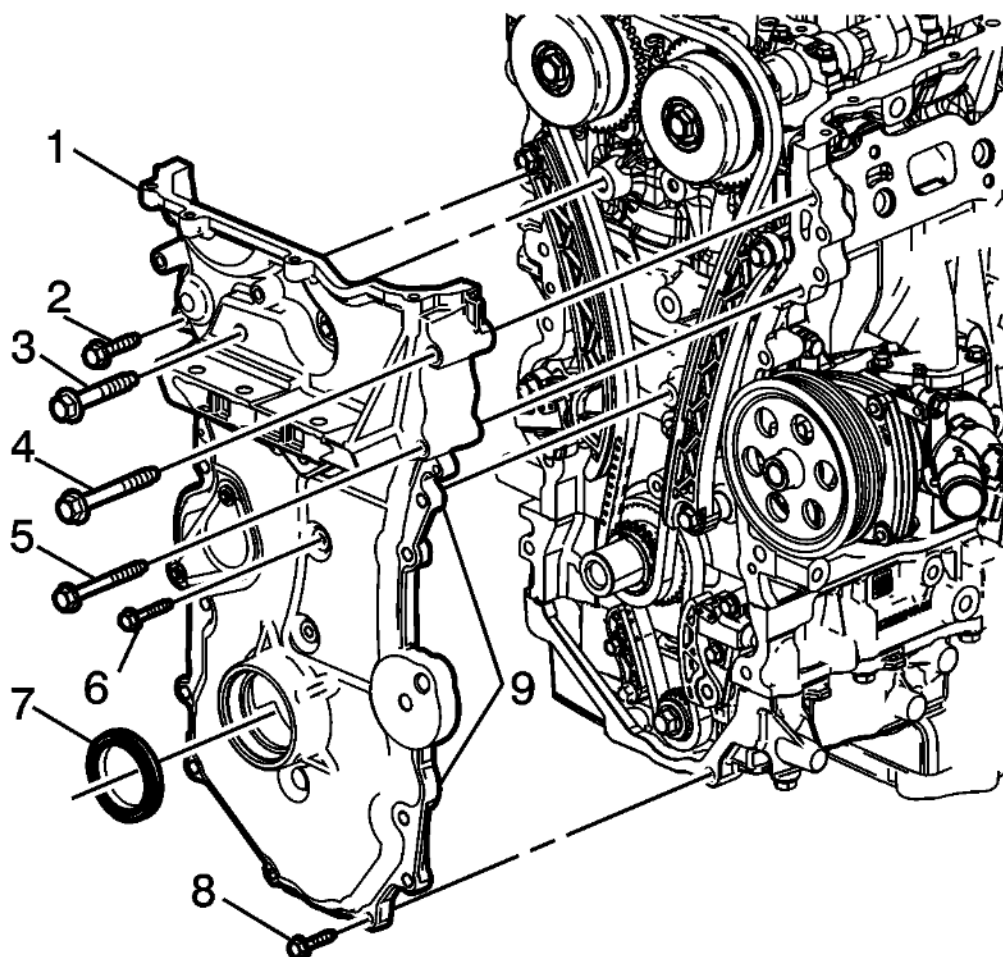


Fig. 72: Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts (2-6, 8).
7. Remove the engine front cover (1).
8. Remove the front oil seal (7) with an appropriate tool.

Installation Procedure

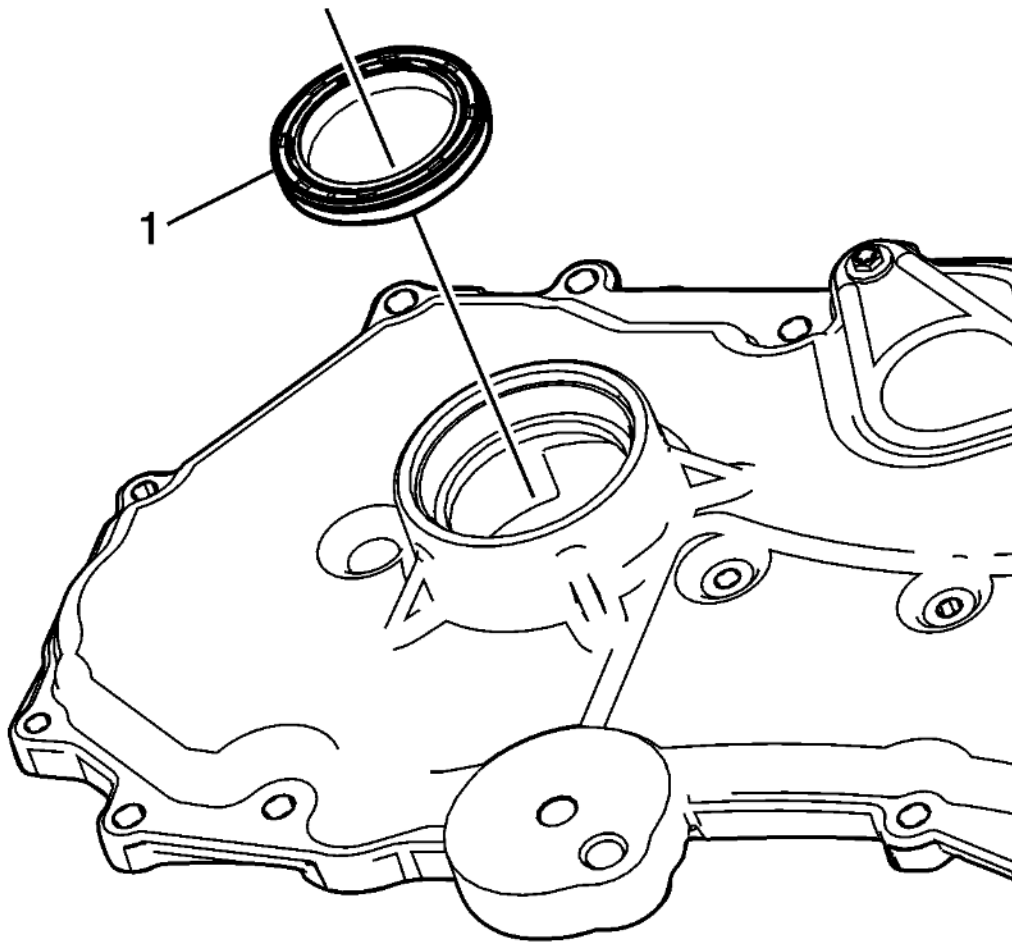


Fig. 73: Front Crankshaft Seal

Courtesy of GENERAL MOTORS COMPANY

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

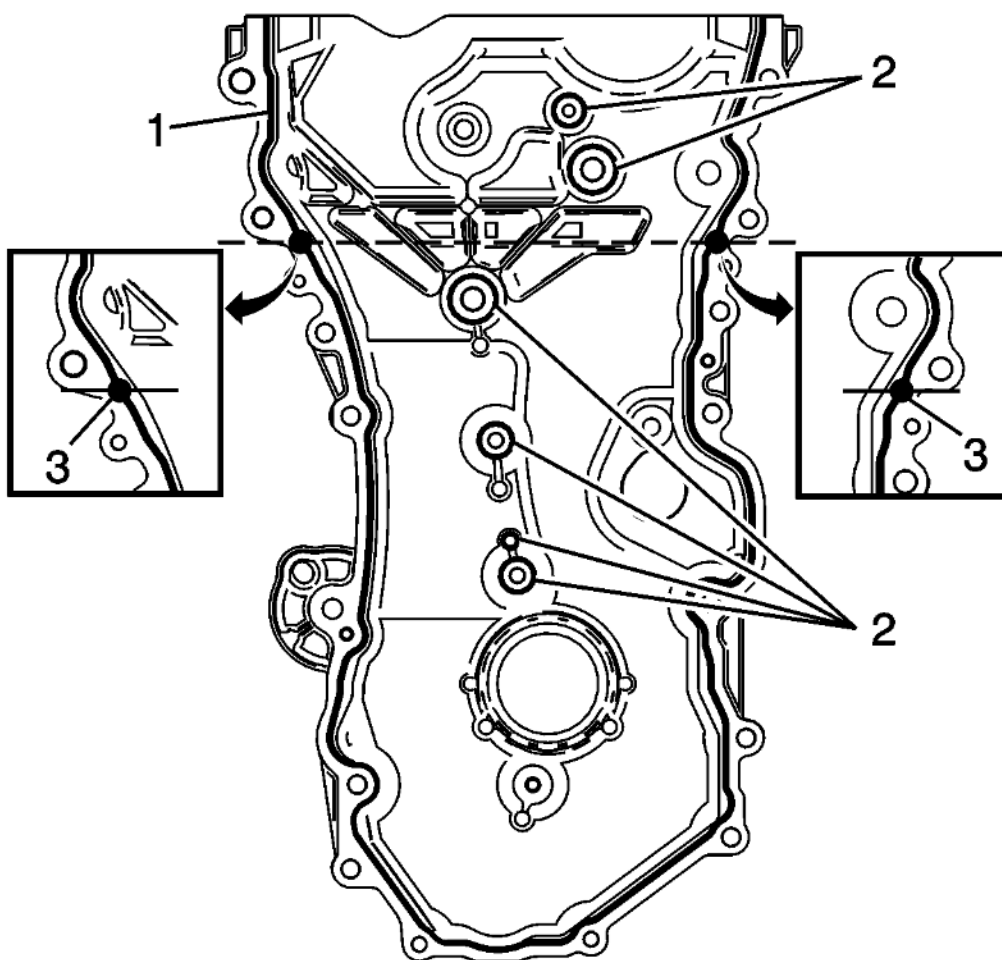


Fig. 74: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

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 (LCV)**.

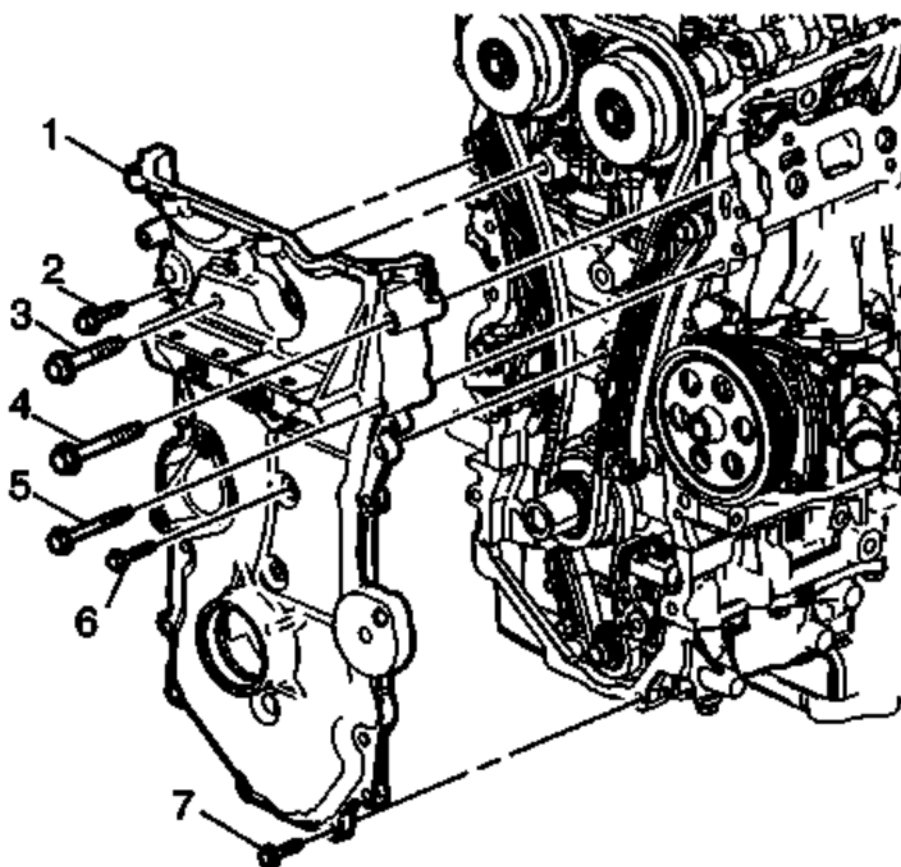


Fig. 75: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

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

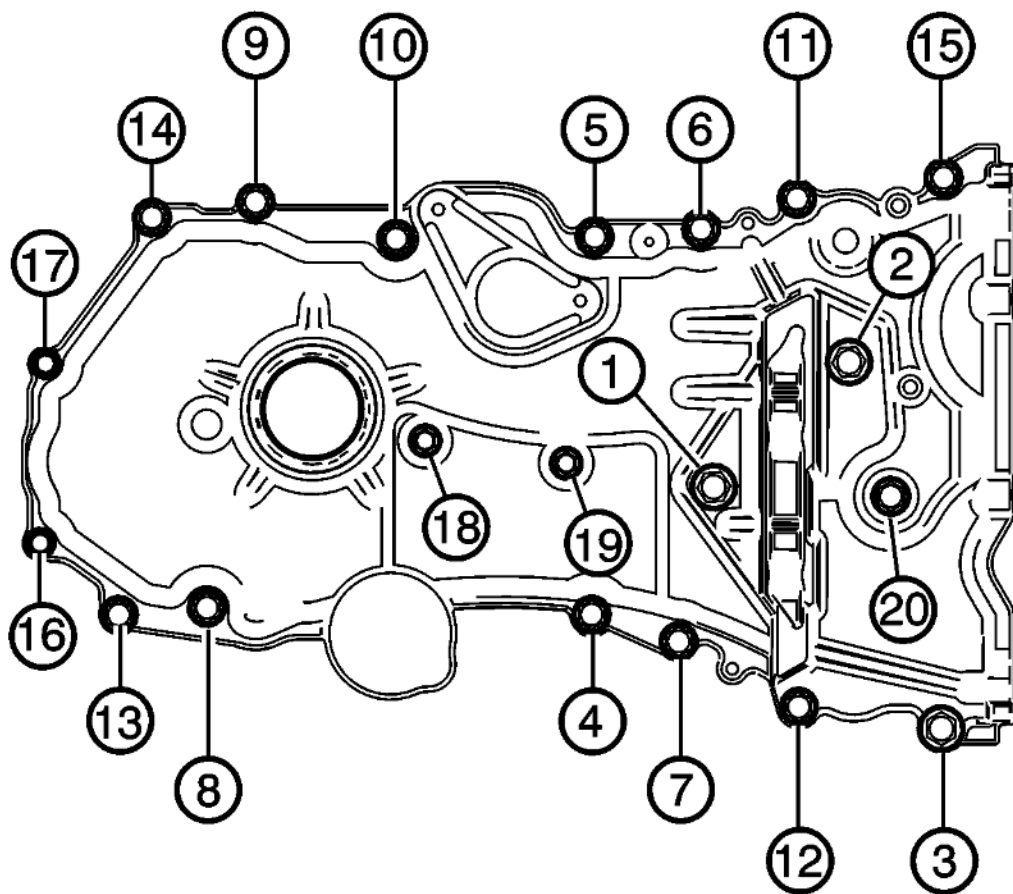


Fig. 76: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Tighten sequence 1-3 bolts to 58 N.m (43 lb ft).
 2. Tighten sequence 4-11 bolts to 25 N.m (18 lb ft).
 3. Tighten sequence 12 bolt to 25 N.m (18 lb ft).
 4. Tighten sequence 13-15 bolts to 25 N.m (18 lb ft).
 5. Tighten sequence 16-17 bolts to 10 N.m (89 lb in).
 6. Tighten sequence 18-19 bolts to 10 N.m (89 lb in).
 7. Tighten sequence 20 bolt to 25 N.m (18 lb ft).
7. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
8. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

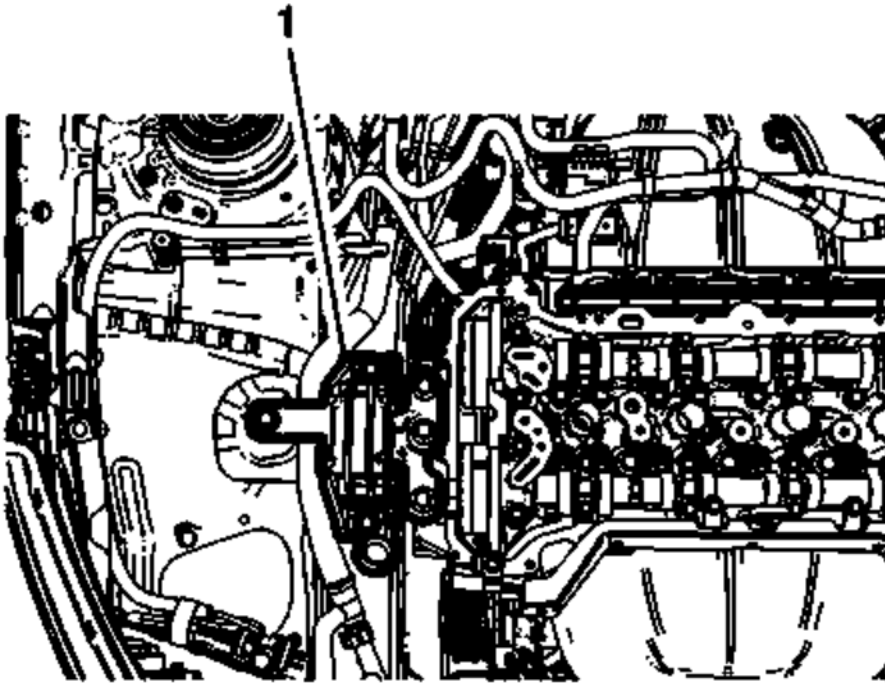


Fig. 77: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

9. Install the engine mount (1). Refer to **Engine Mount Replacement (LCV)**.
10. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**.

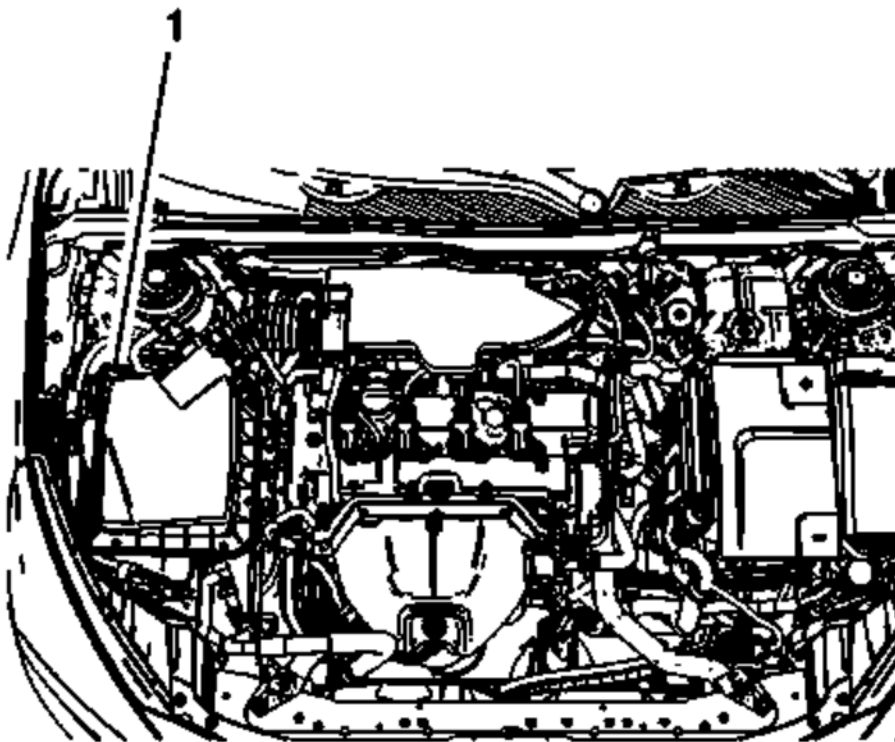


Fig. 78: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement** .

ENGINE FRONT COVER REPLACEMENT (LTG)

Special Tools

EN-50820 Front Crankshaft Seal Installer

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

Removal Procedure

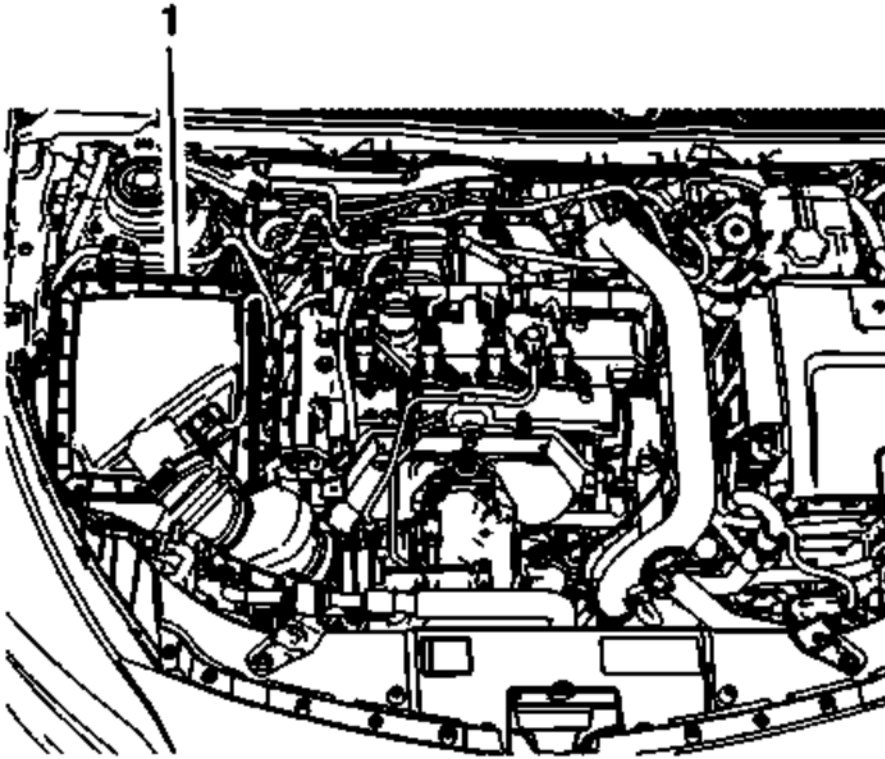


Fig. 79: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Remove the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement (LTG)** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (LTG)**.

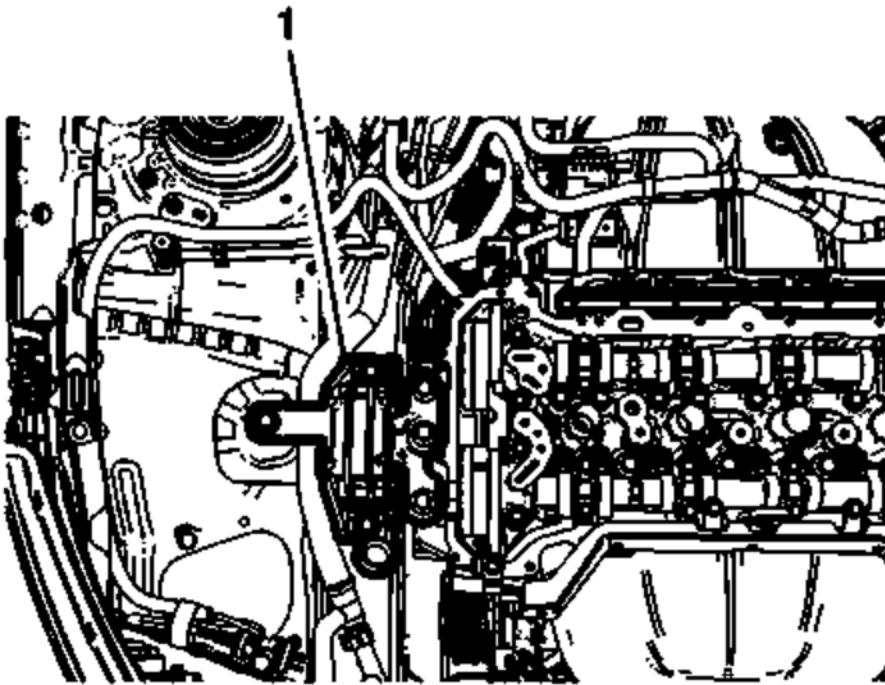


Fig. 80: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount (1). Refer to **Engine Mount Replacement (LTG)**.
4. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

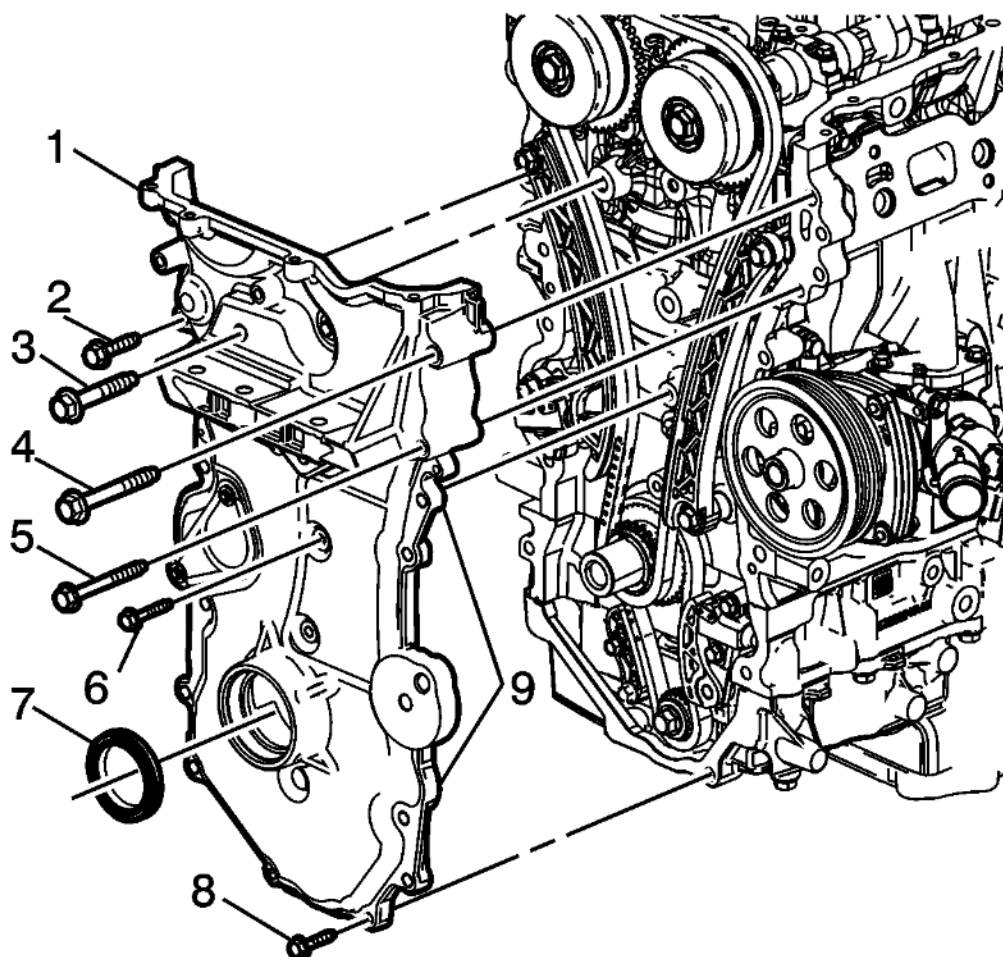


Fig. 81: Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine front cover bolts (2-6, 8).
7. Remove the engine front cover (1).
8. Remove the front oil seal (7) with an appropriate tool.

Installation Procedure

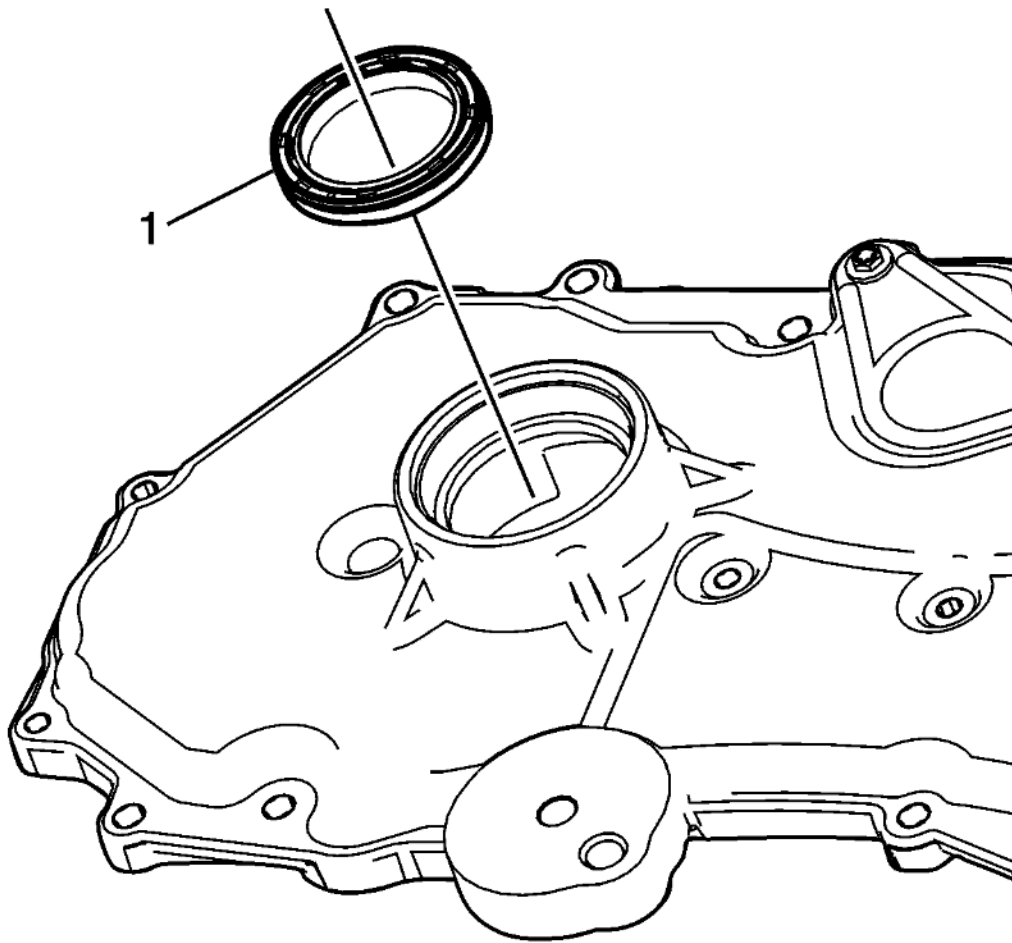


Fig. 82: Front Crankshaft Seal

Courtesy of GENERAL MOTORS COMPANY

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

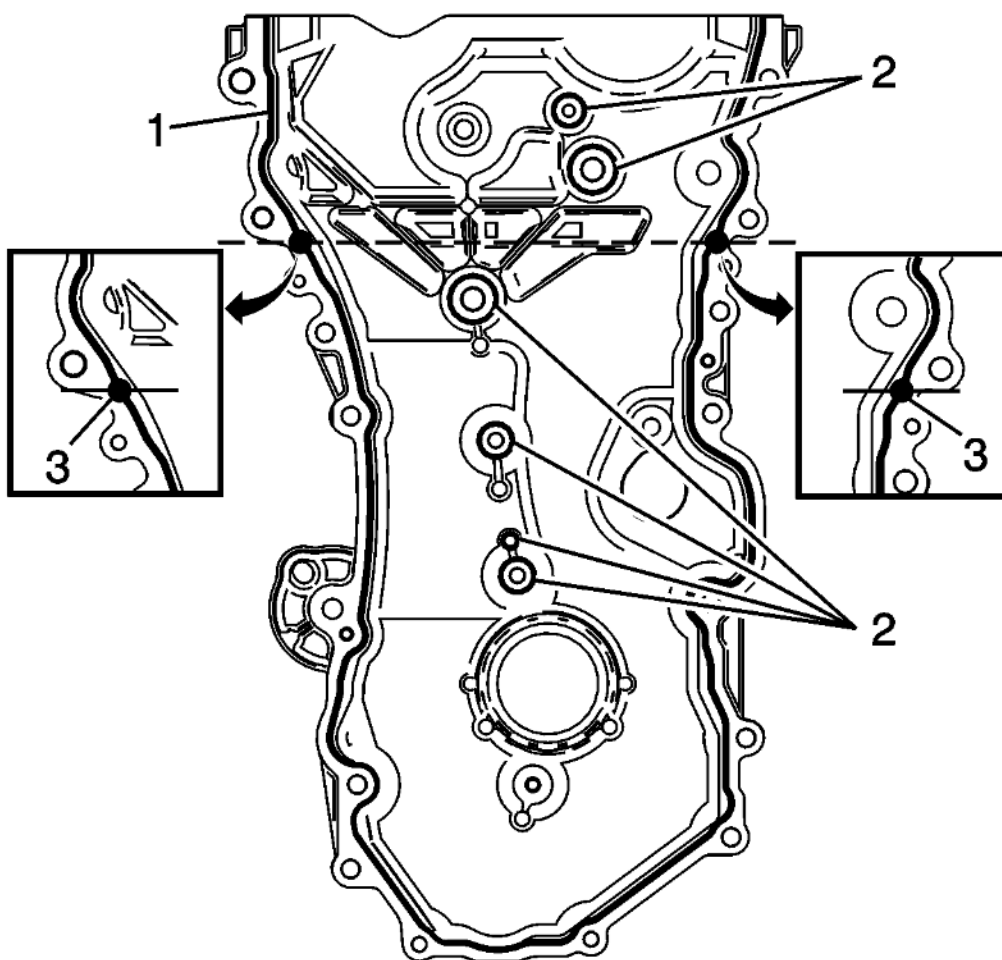


Fig. 83: Applying Bead Of Sealer Directly In Flange
 Courtesy of GENERAL MOTORS COMPANY

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 (LTG)**.

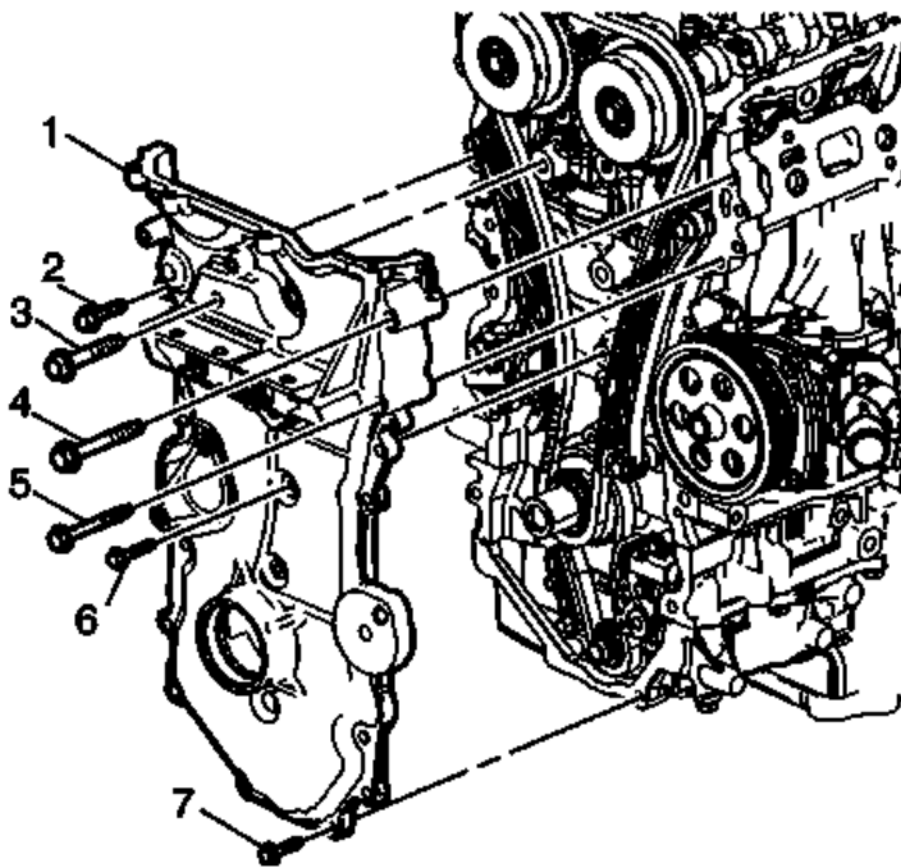


Fig. 84: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

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

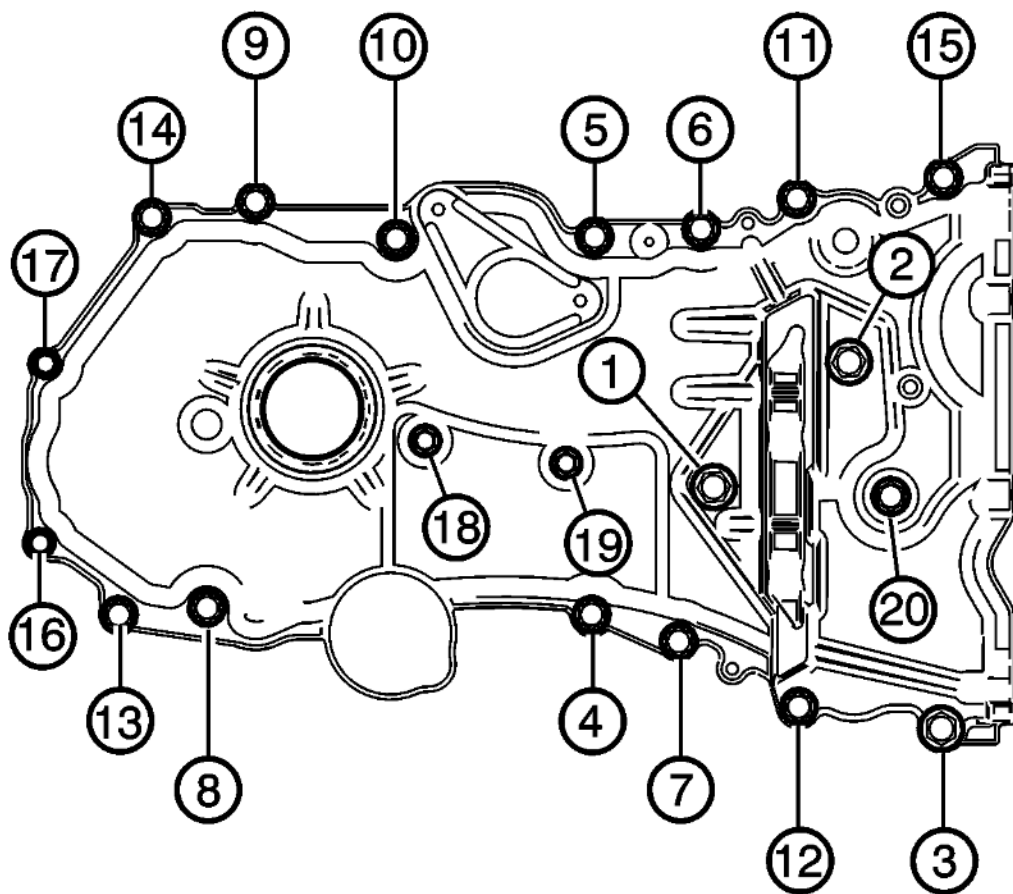


Fig. 85: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the engine front cover bolts in sequence to final torque twice:
 1. Tighten sequence 1-3 bolts to 58 N.m (43 lb ft).
 2. Tighten sequence 4-11 bolts to 25 N.m (18 lb ft).
 3. Tighten sequence 12 bolt to 25 N.m (18 lb ft).
 4. Tighten sequence 13-15 bolts to 25 N.m (18 lb ft).
 5. Tighten sequence 16-17 bolts to 10 N.m (89 lb in).
 6. Tighten sequence 18-19 bolts to 10 N.m (89 lb in).
 7. Tighten sequence 20 bolt to 25 N.m (18 lb ft).
7. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
8. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

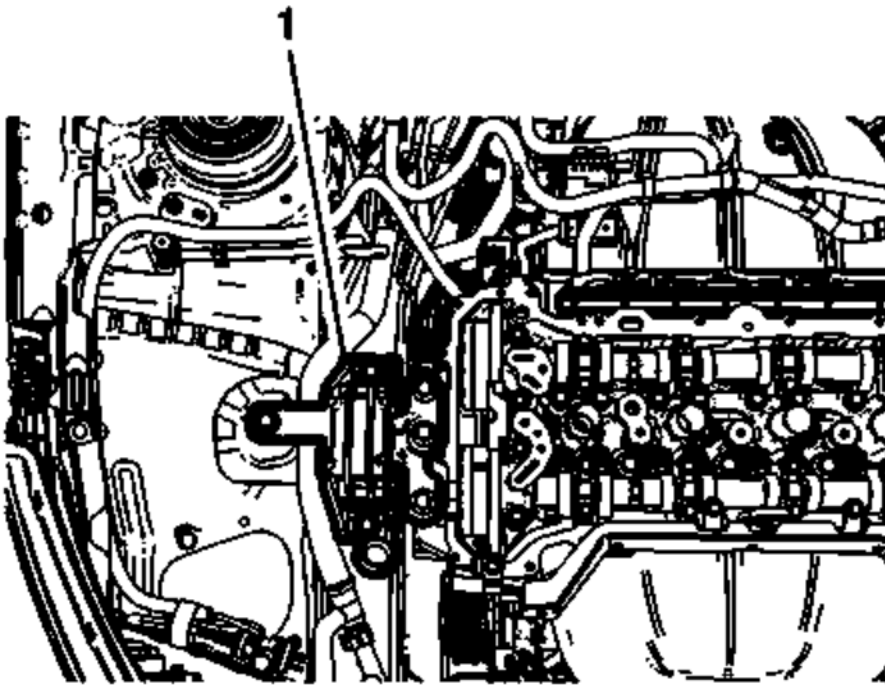


Fig. 86: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

9. Install the engine mount (1). Refer to **Engine Mount Replacement (LTG)**.
10. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LTG)**.

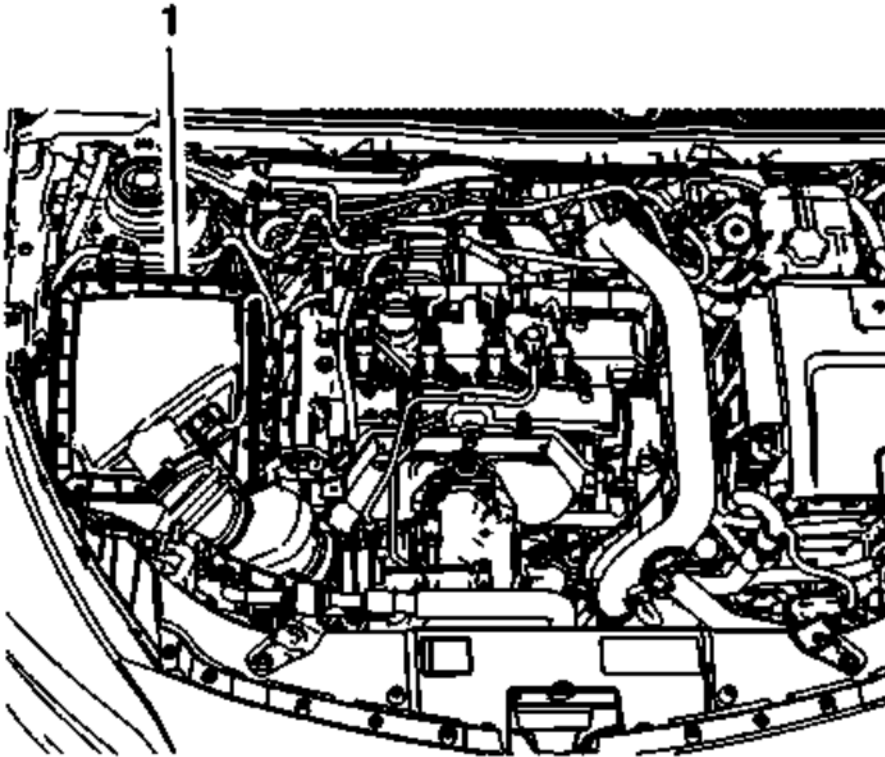


Fig. 87: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

11. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement (LTG)** .

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.**

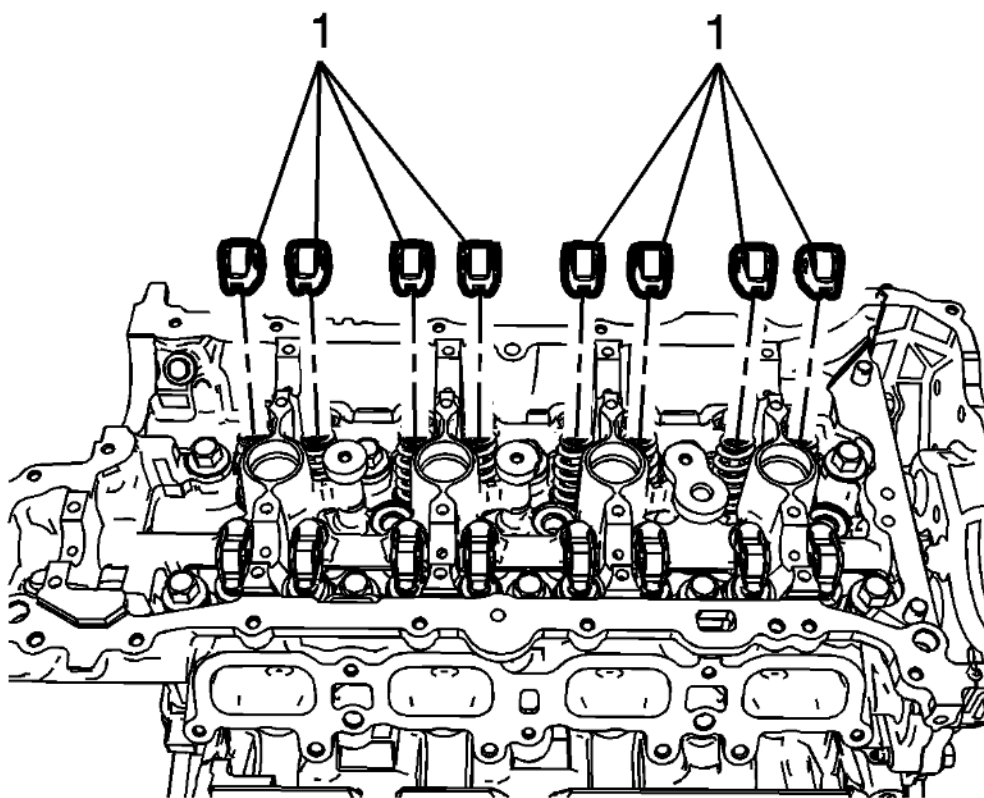


Fig. 88: Exhaust Rocker Arm

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

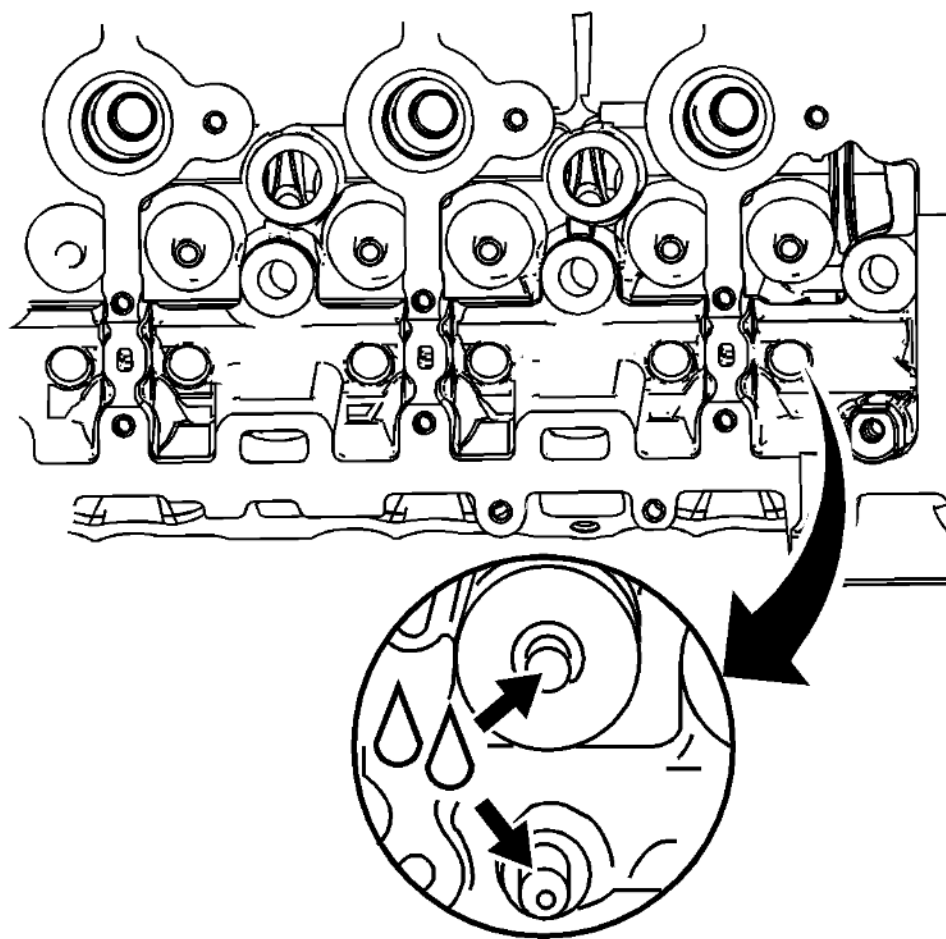


Fig. 89: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .

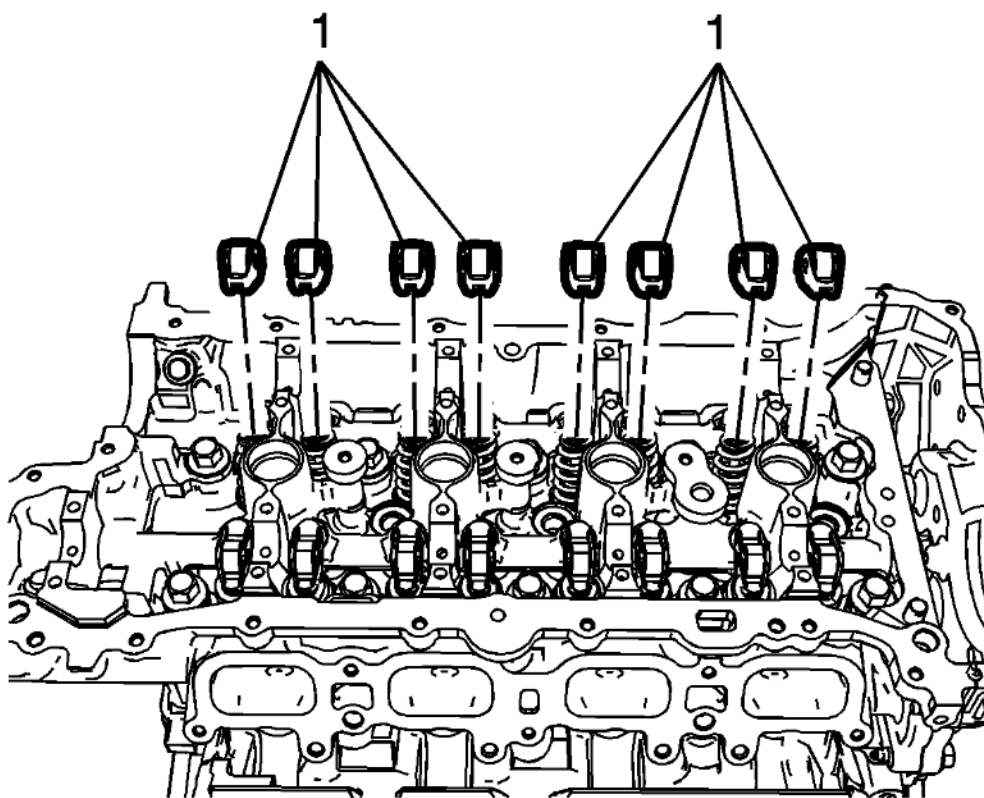


Fig. 90: Exhaust Rocker Arm

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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
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.

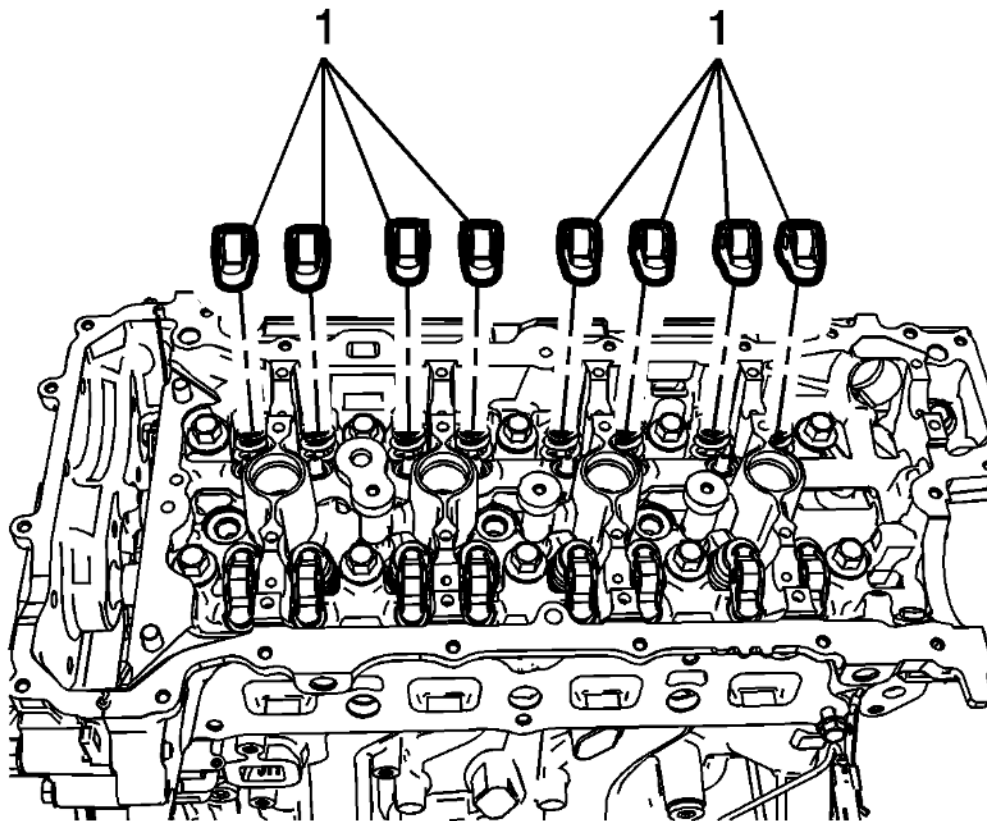


Fig. 91: Intake Rocker Arm

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

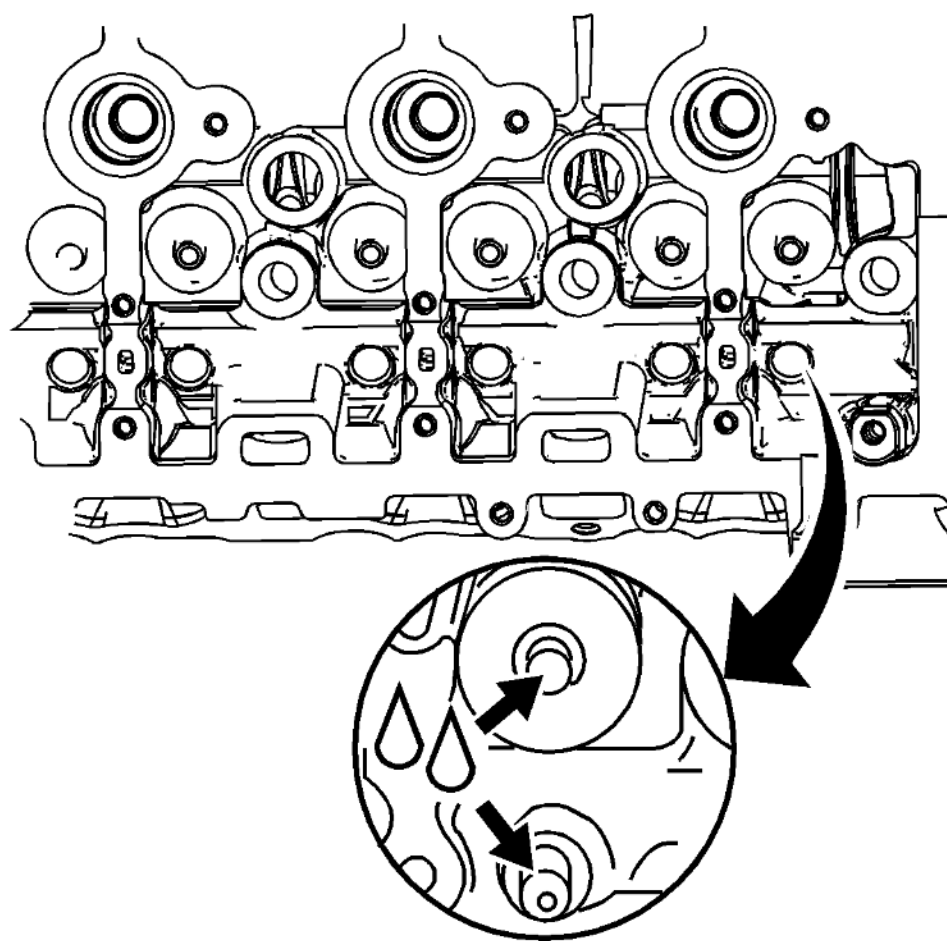


Fig. 92: Valve Tips

Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to Adhesives, Fluids, Lubricants, and Sealers (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .

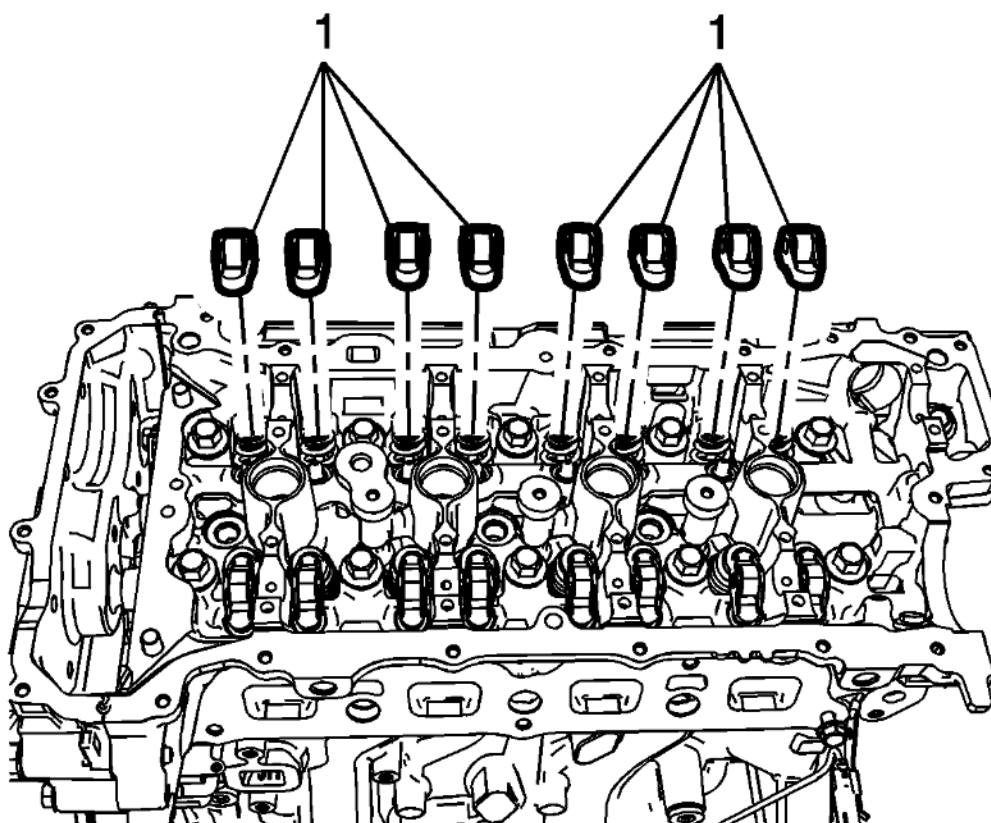


Fig. 93: Intake Rocker Arm

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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
4. Install the camshaft position actuator and camshaft - intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

CAMSHAFT TIMING CHAIN AND TENSIONER REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement (LCV), Engine Front Cover Replacement (LTG).

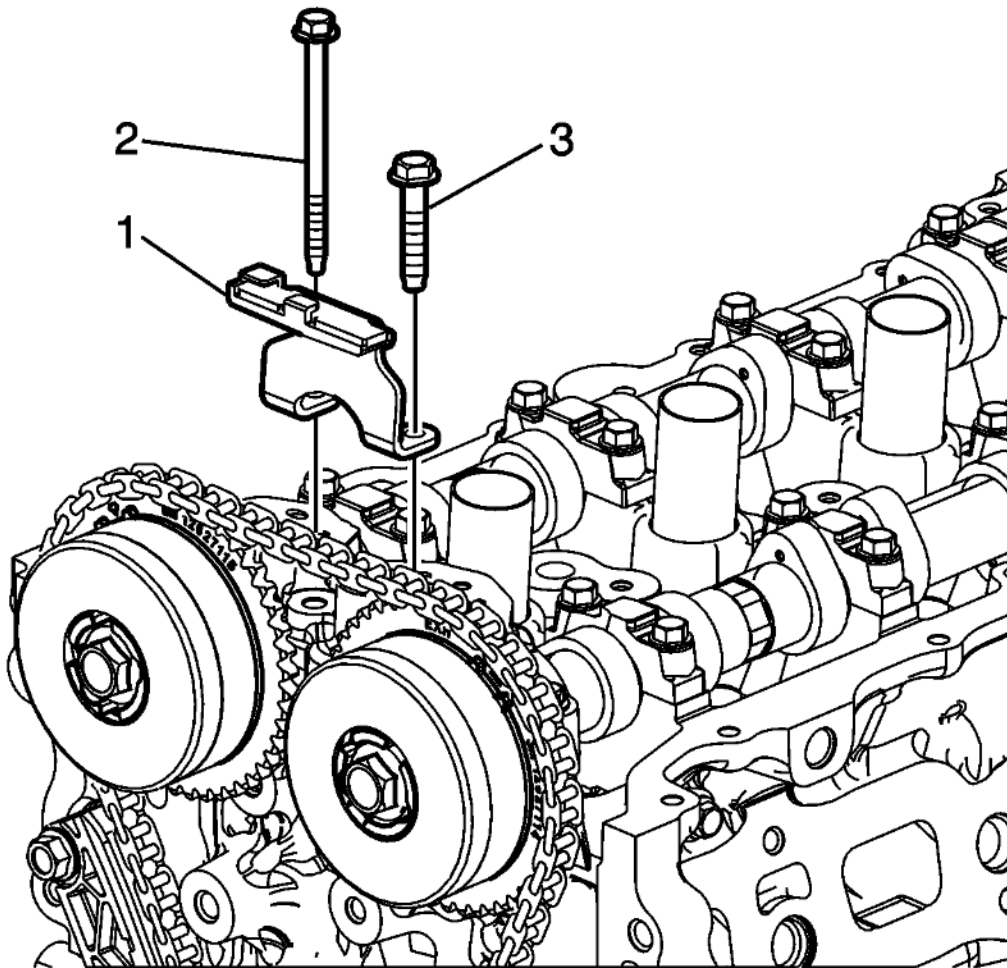


Fig. 94: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

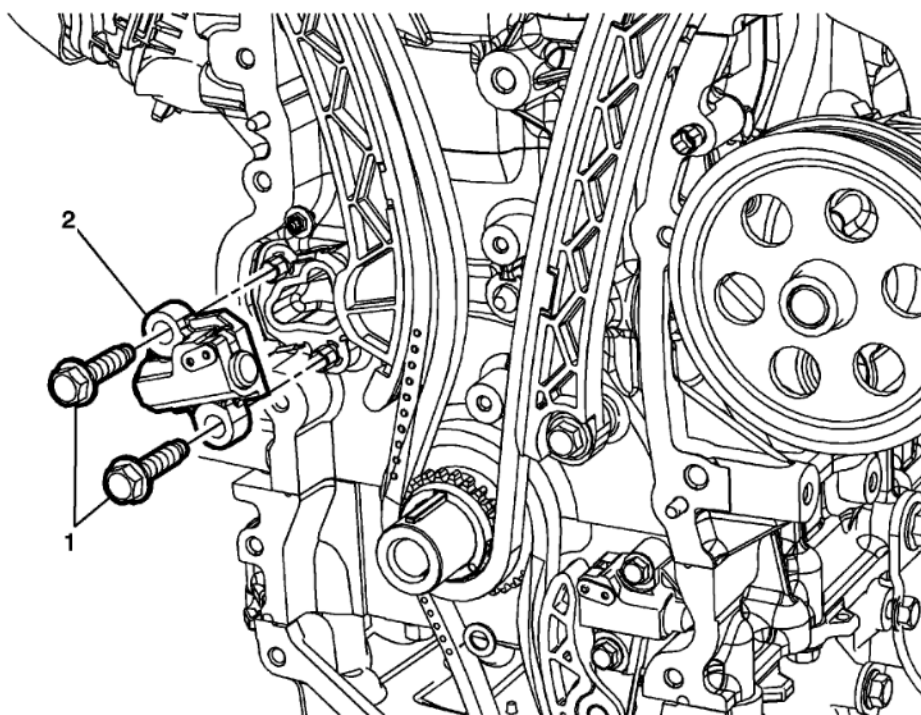


Fig. 95: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

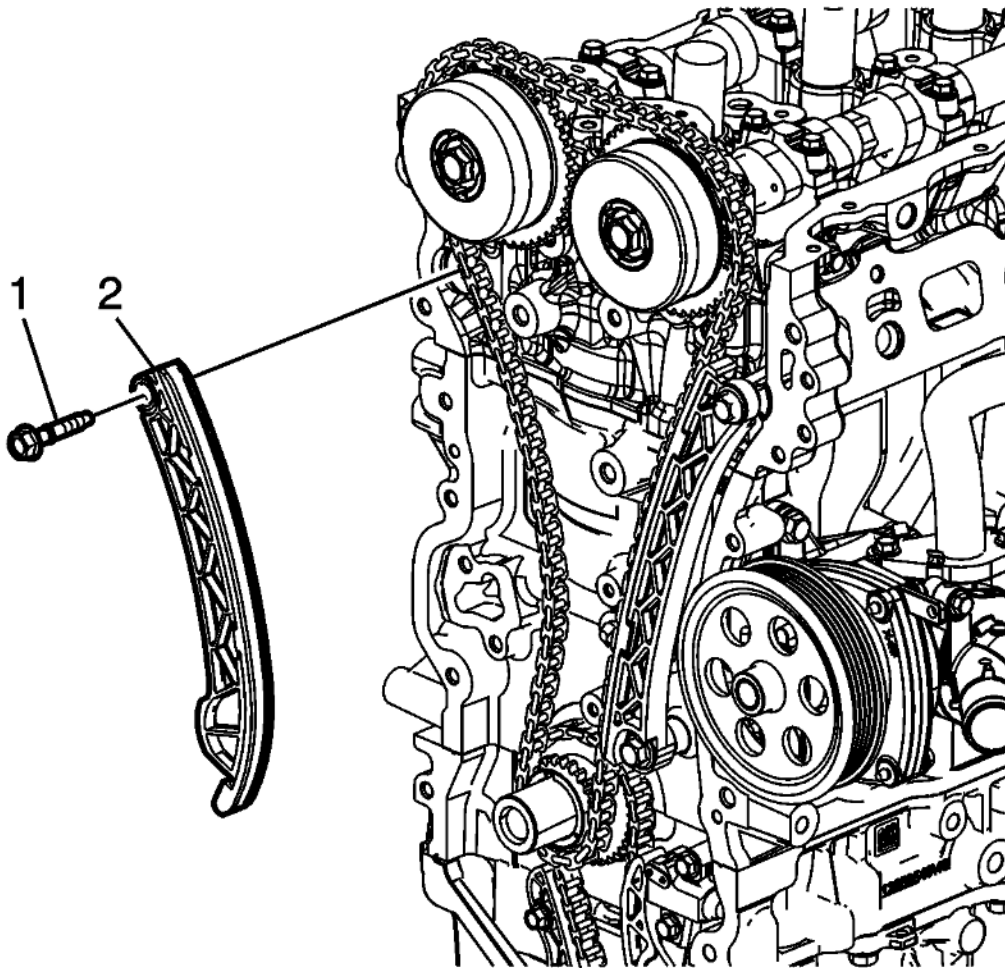


Fig. 96: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

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

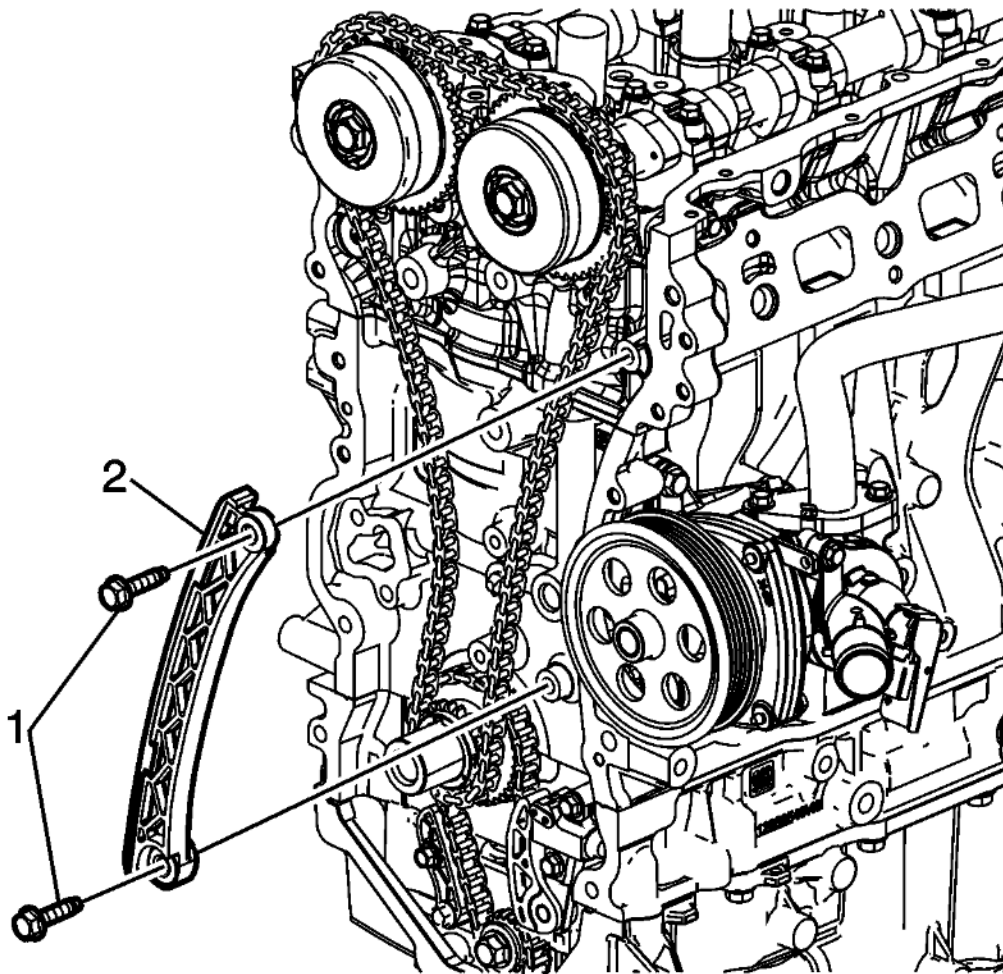


Fig. 97: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

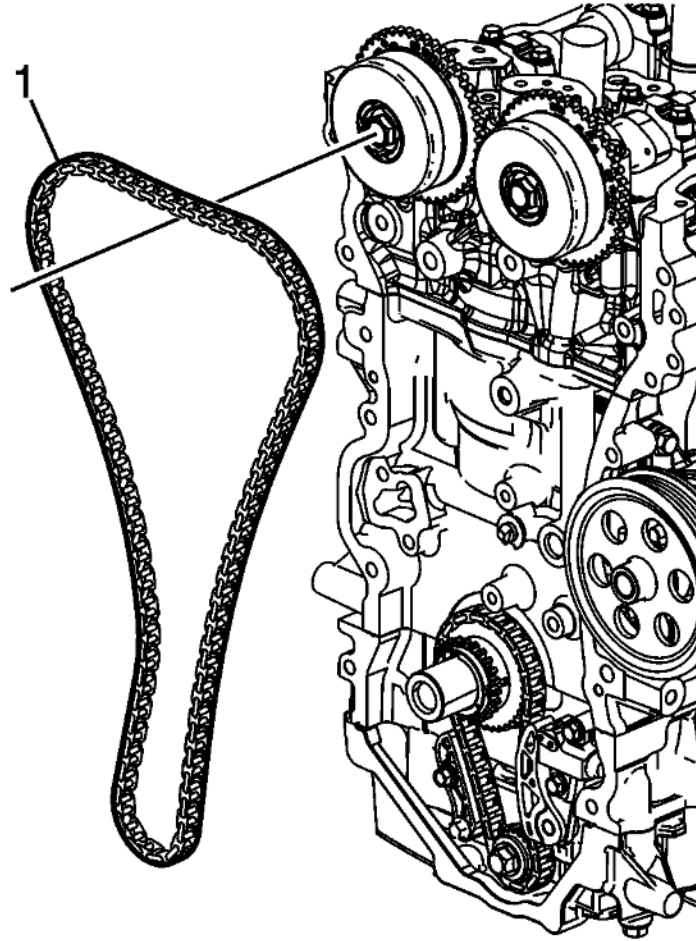


Fig. 98: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain (1).

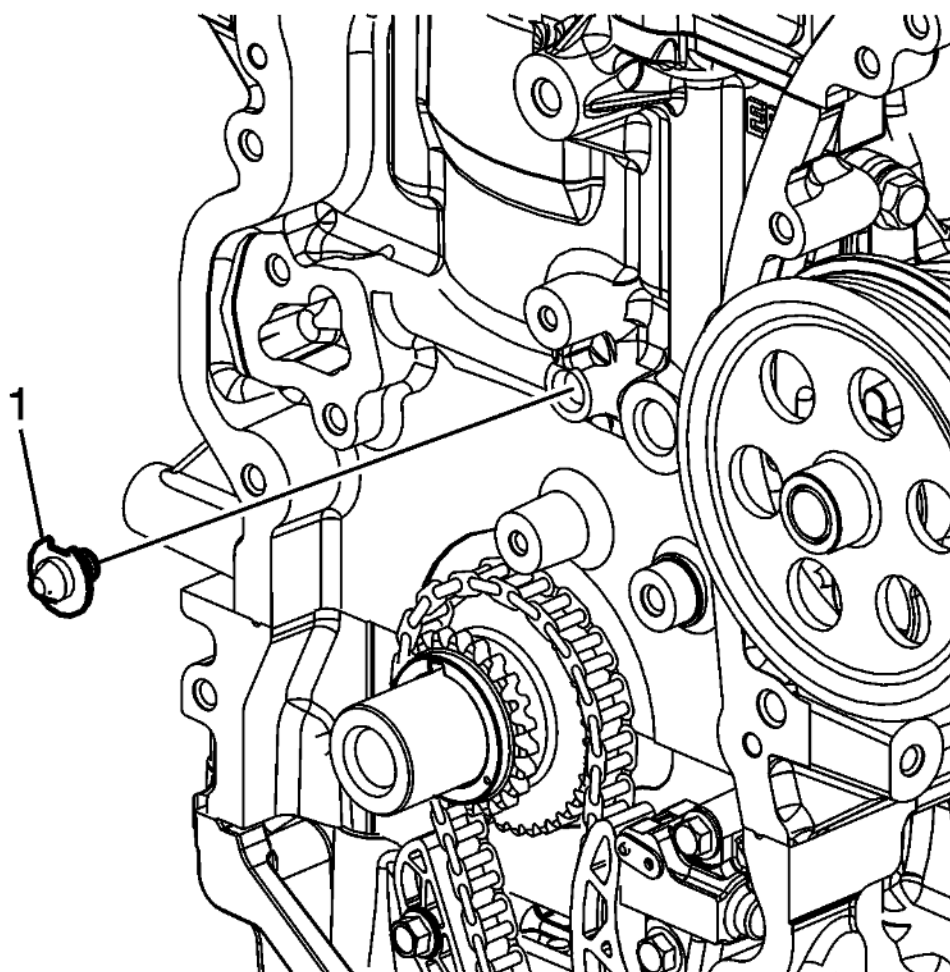


Fig. 99: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

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

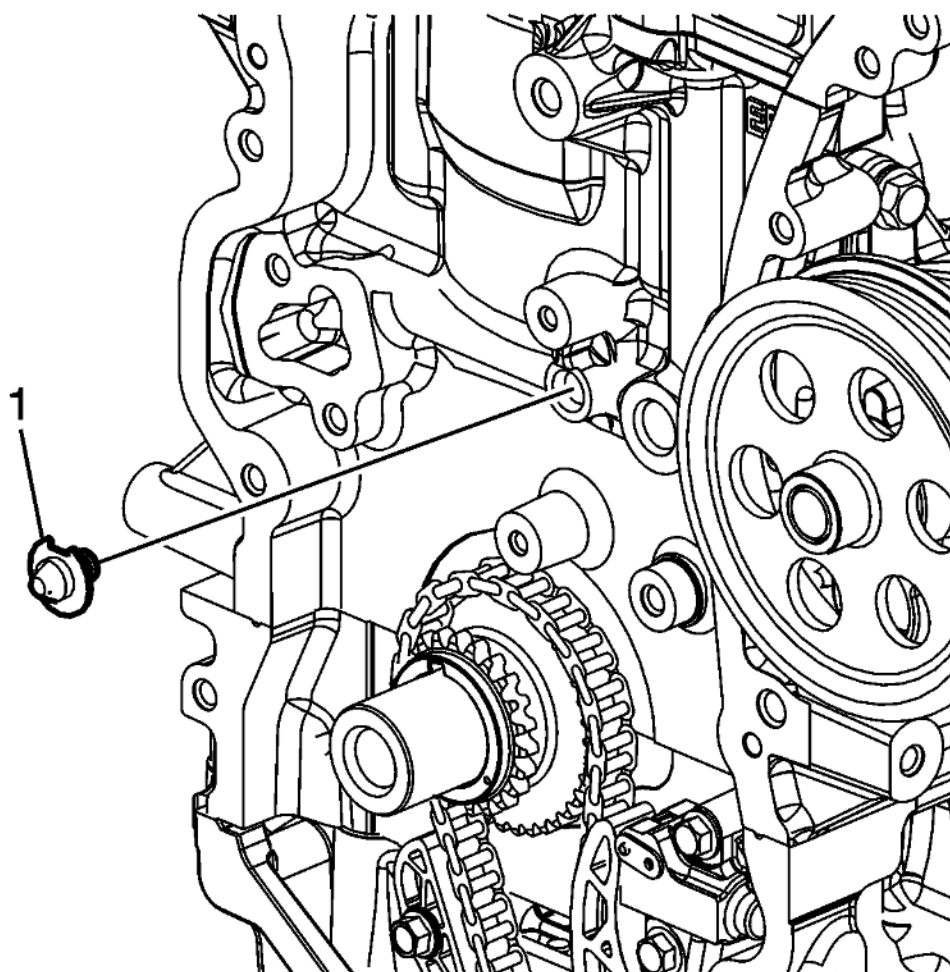


Fig. 100: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

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).

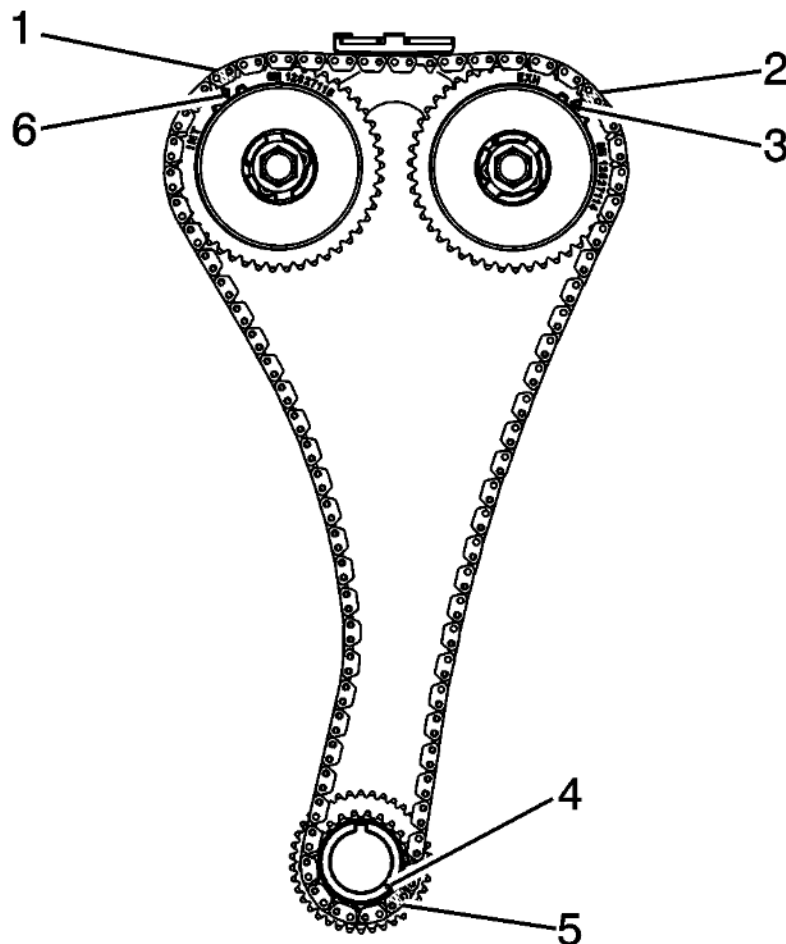


Fig. 101: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

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 unique colored links will not initially align with the intake actuator timing mark or the crankshaft sprocket timing mark.

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

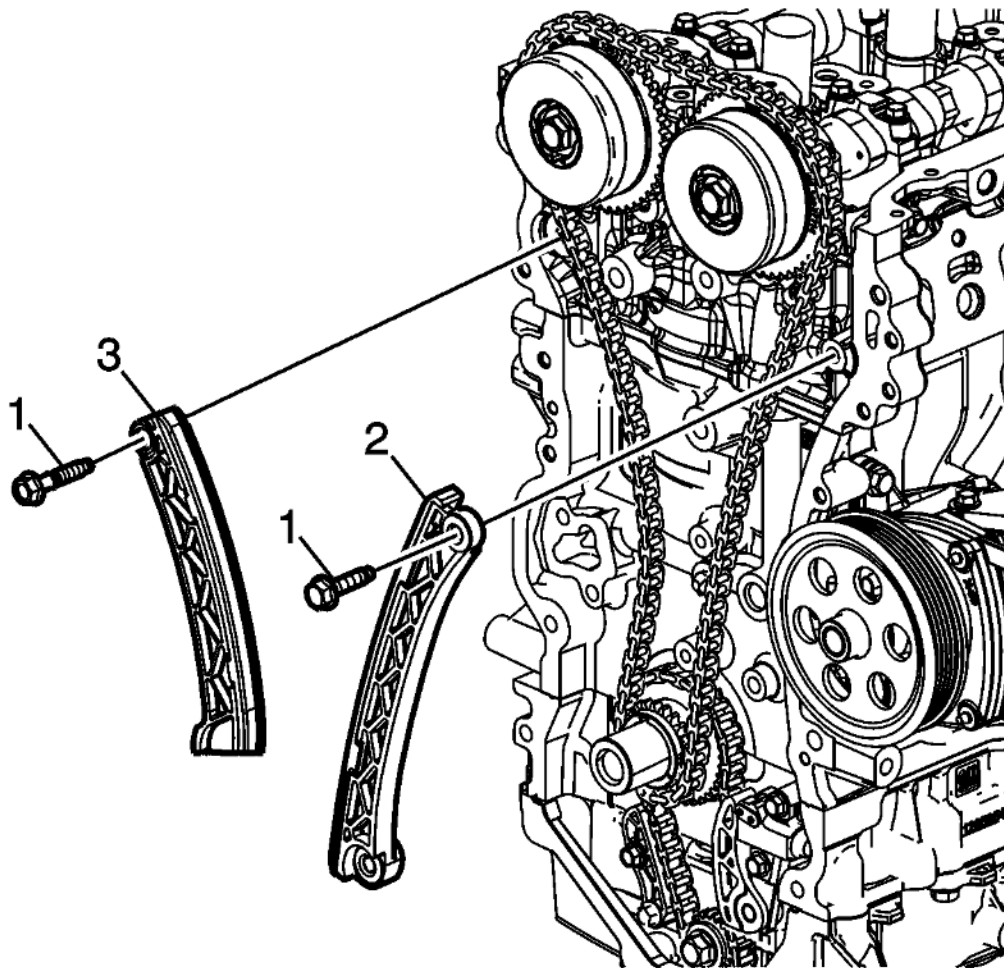


Fig. 102: Timing Chain Guide And Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

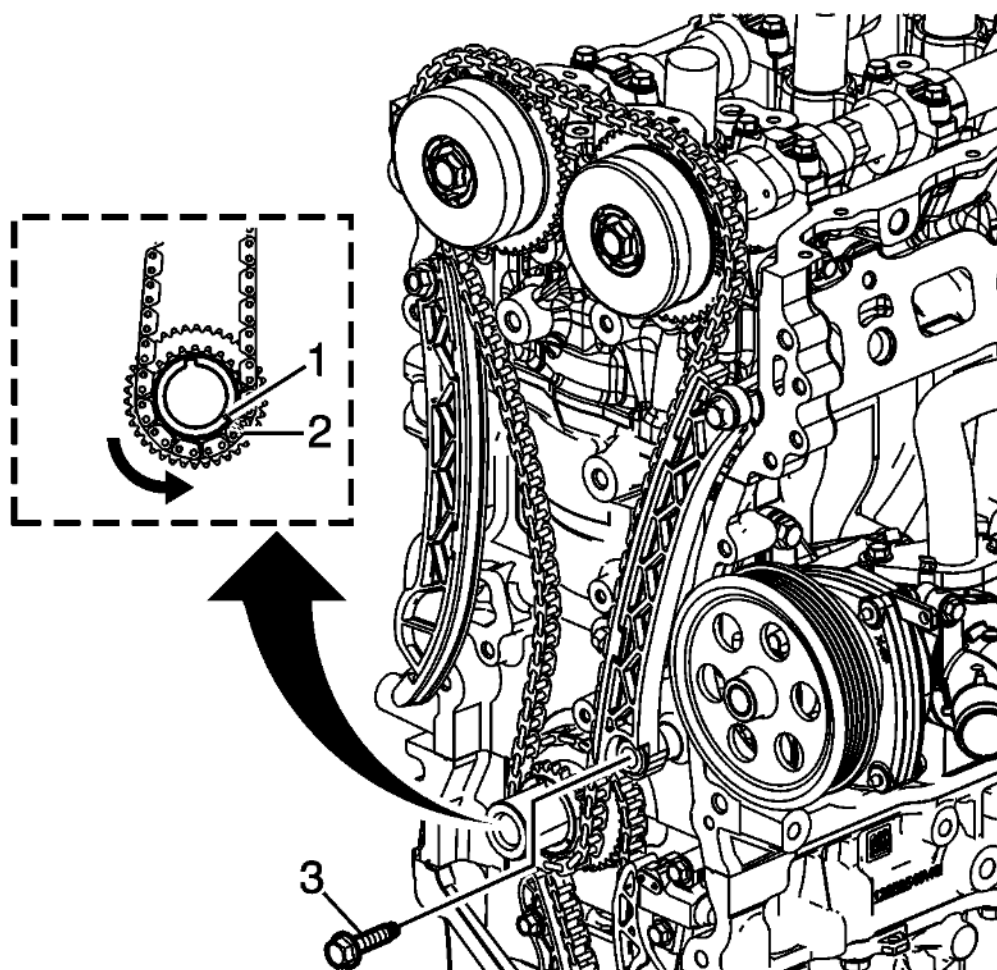


Fig. 103: Crankshaft Sprocket

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).

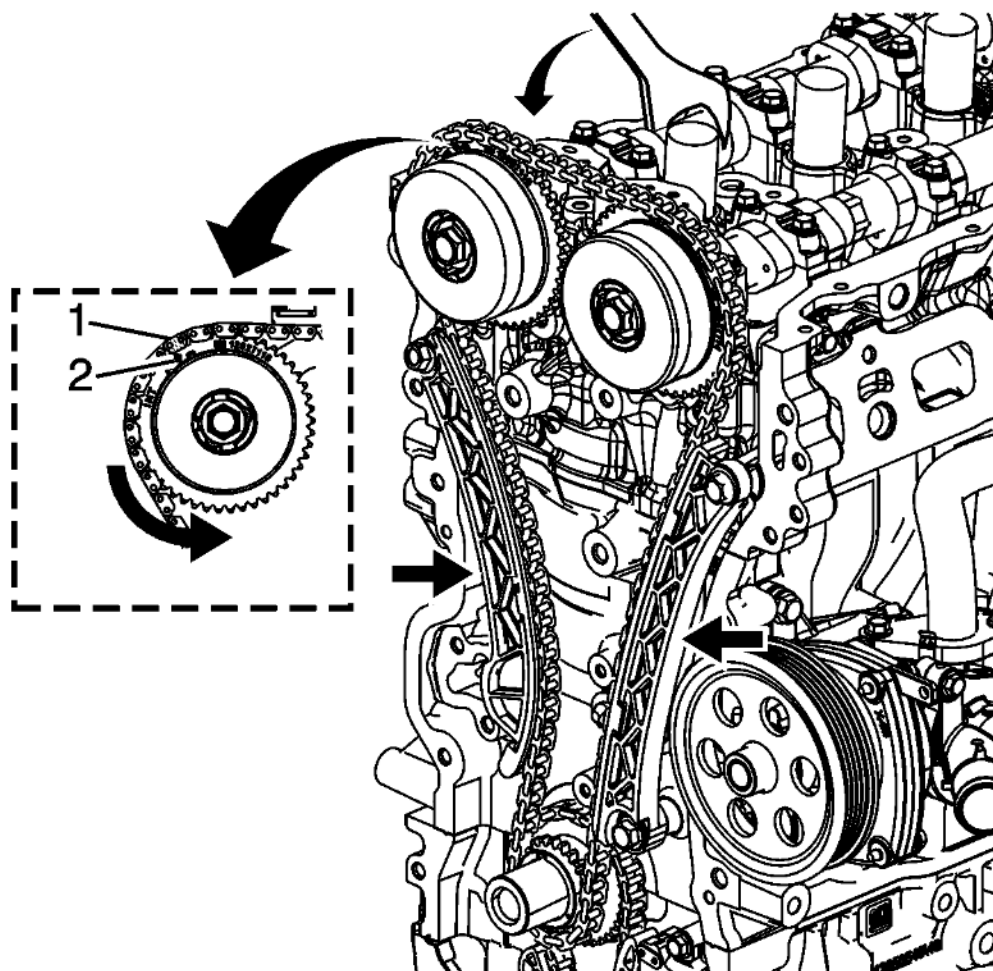


Fig. 104: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

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.

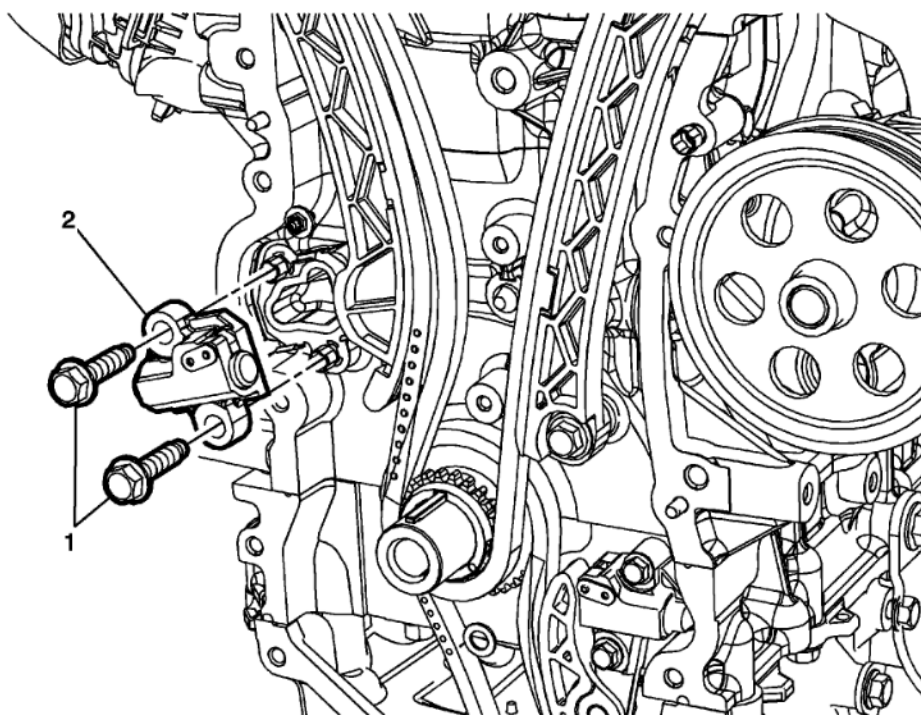


Fig. 105: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

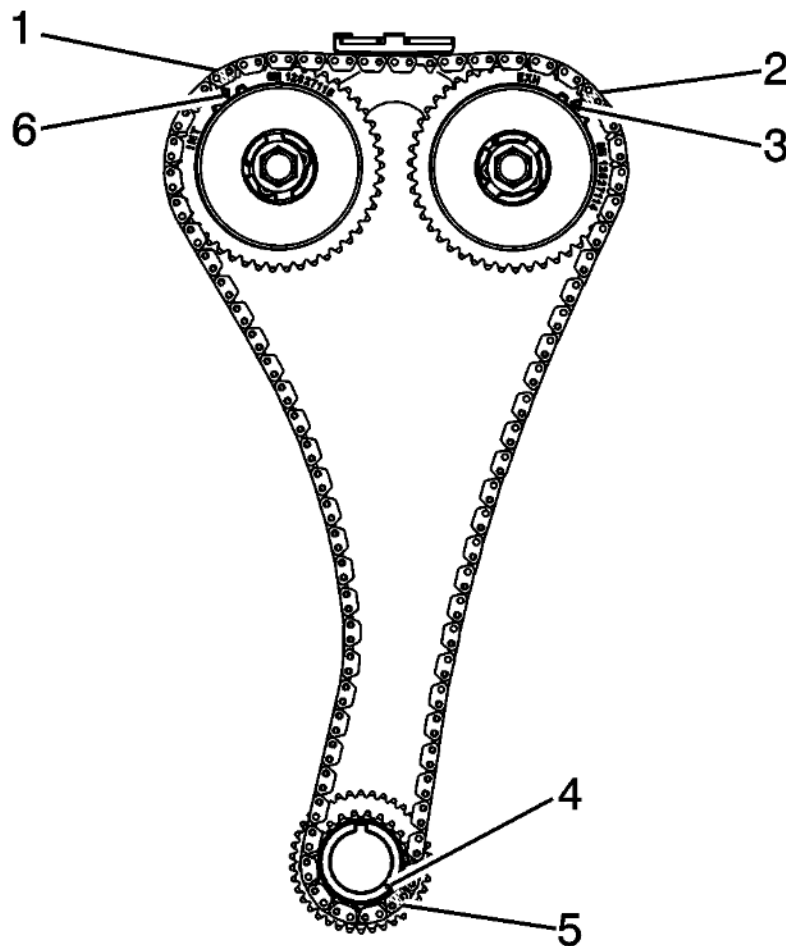


Fig. 106: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

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.

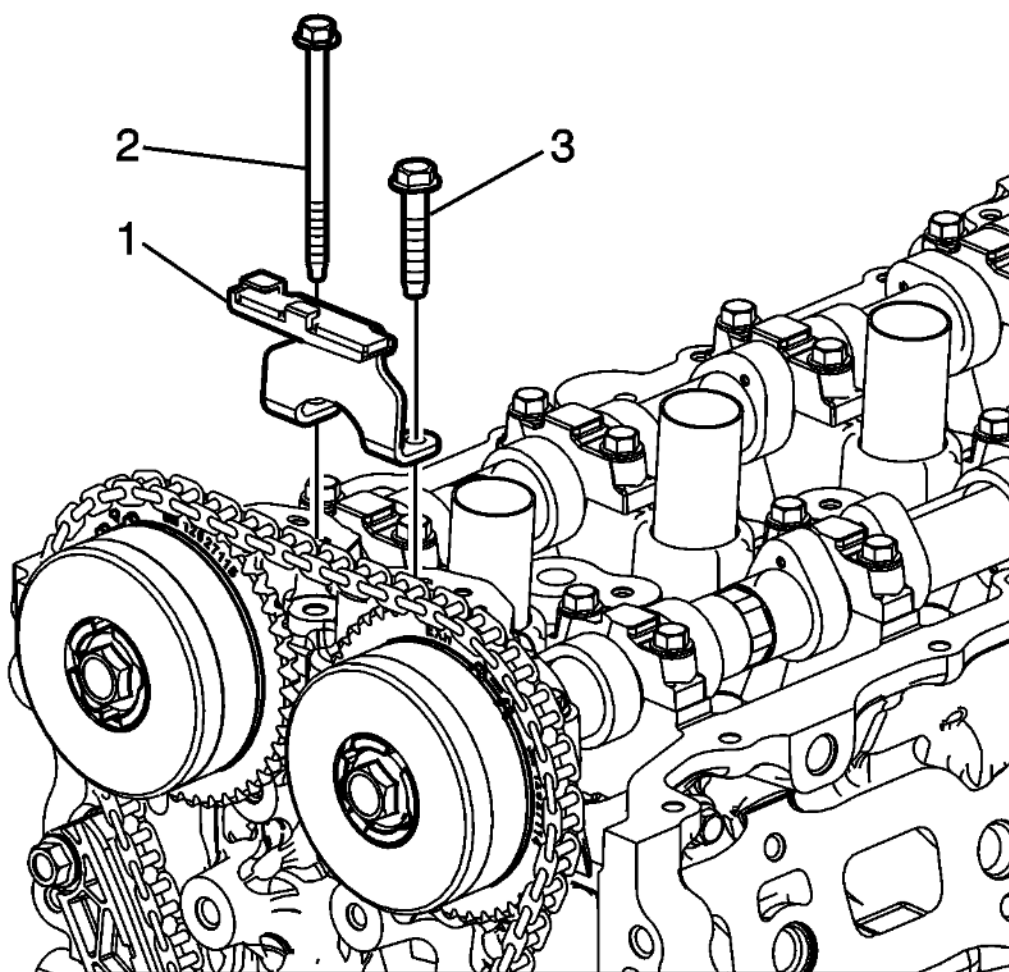


Fig. 107: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

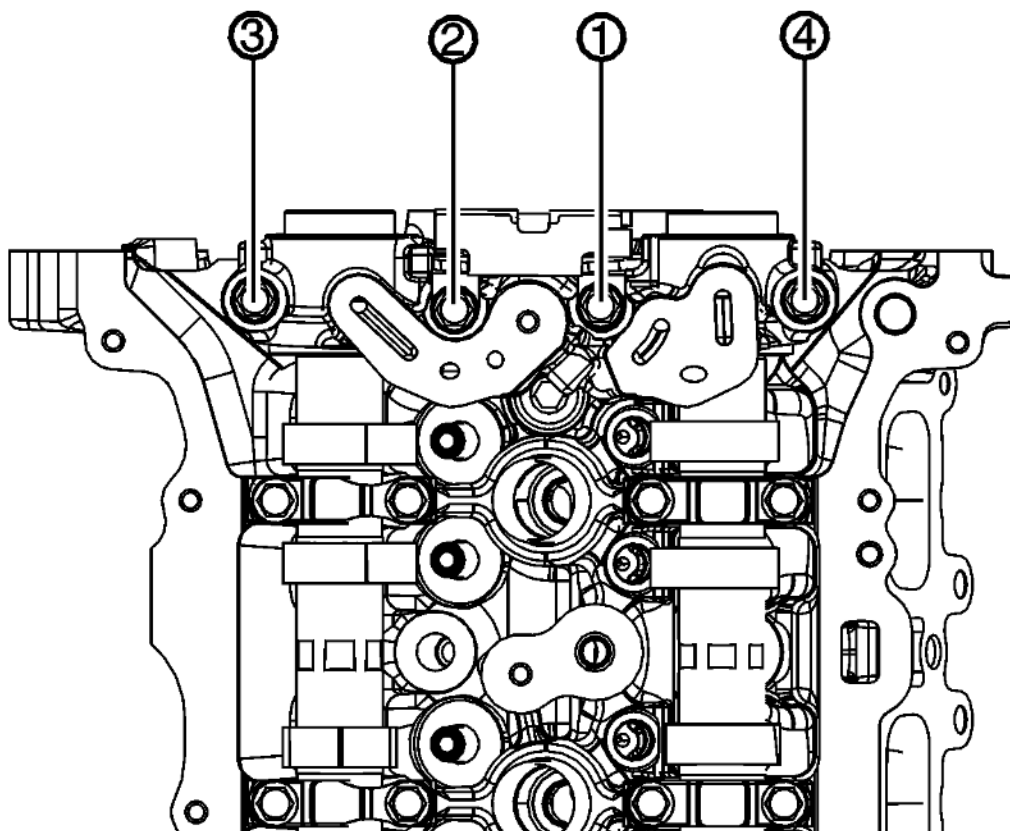


Fig. 108: Front Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

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.

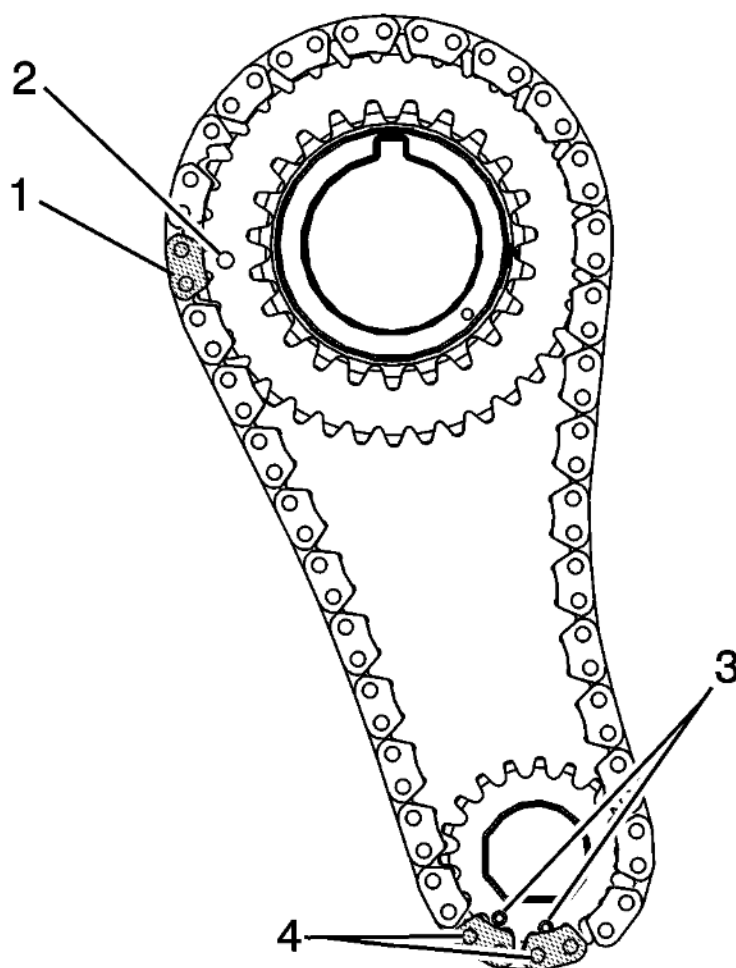


Fig. 109: Timing Link And Timing Mark
Courtesy of GENERAL MOTORS COMPANY

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 (LCV)**, **Engine Front Cover Replacement (LTG)**.

CAMSHAFT COVER REPLACEMENT (LCV)

Removal Procedure

1. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

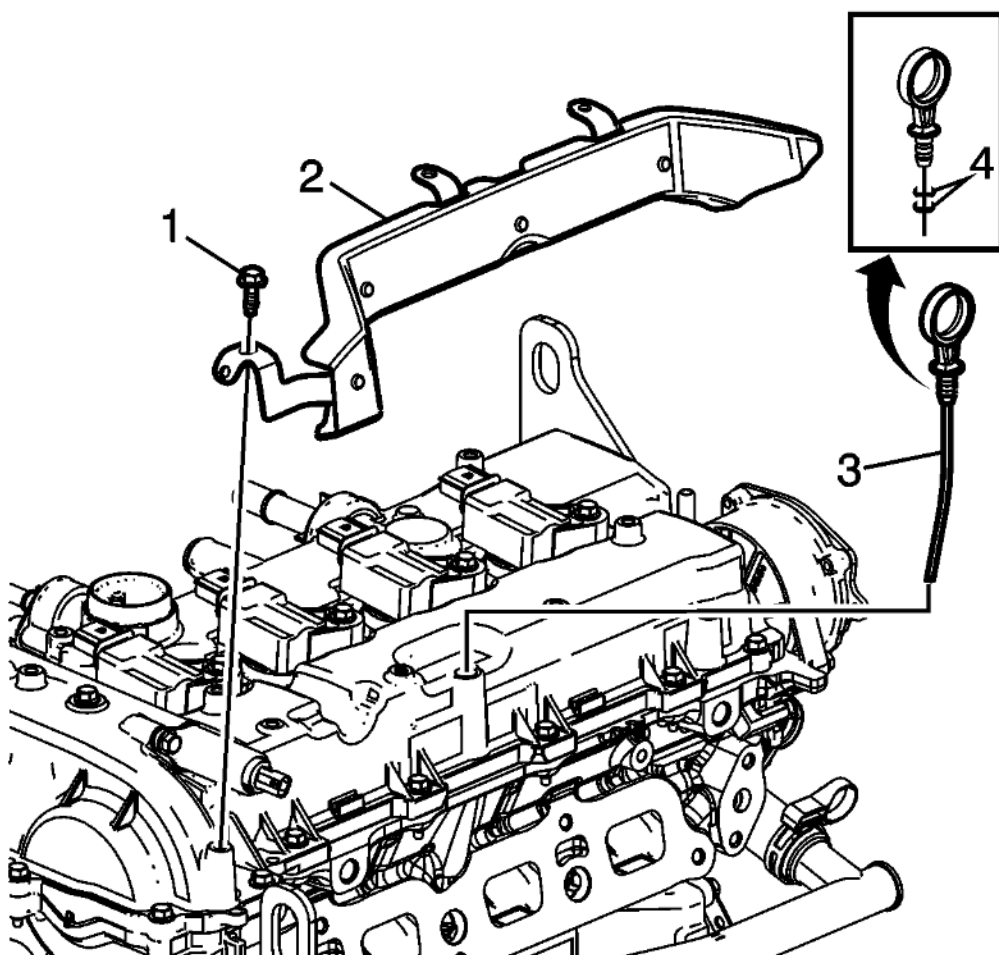


Fig. 110: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
3. Remove the camshaft cover heat shield (2) and bolts (1).

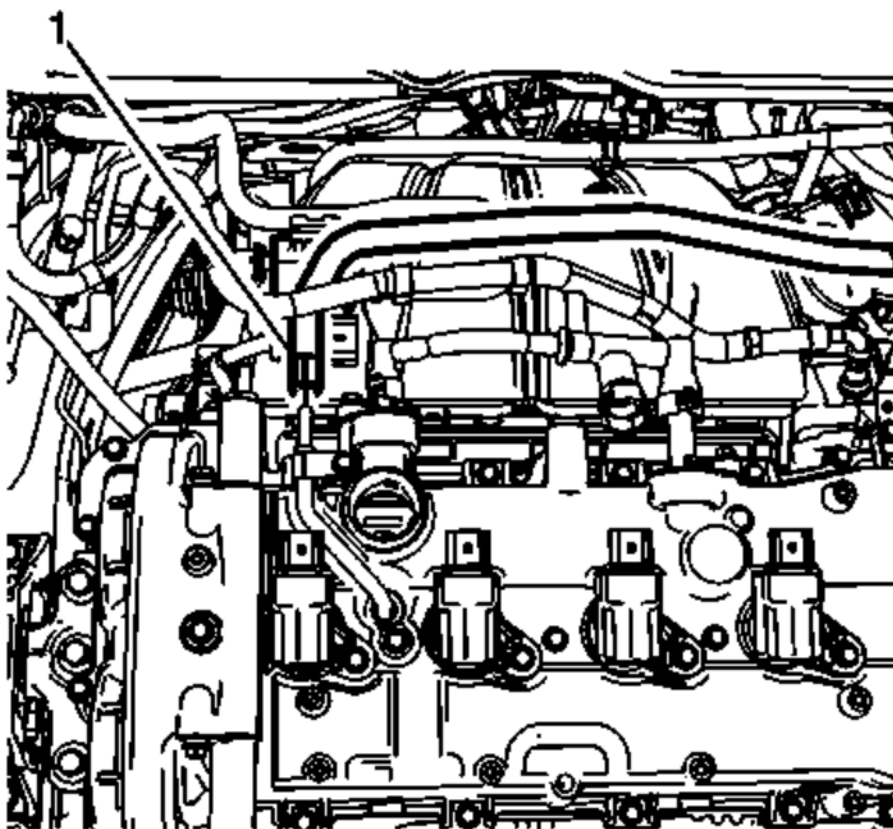


Fig. 111: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the surge tank hose (1).
5. Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LCV)**.

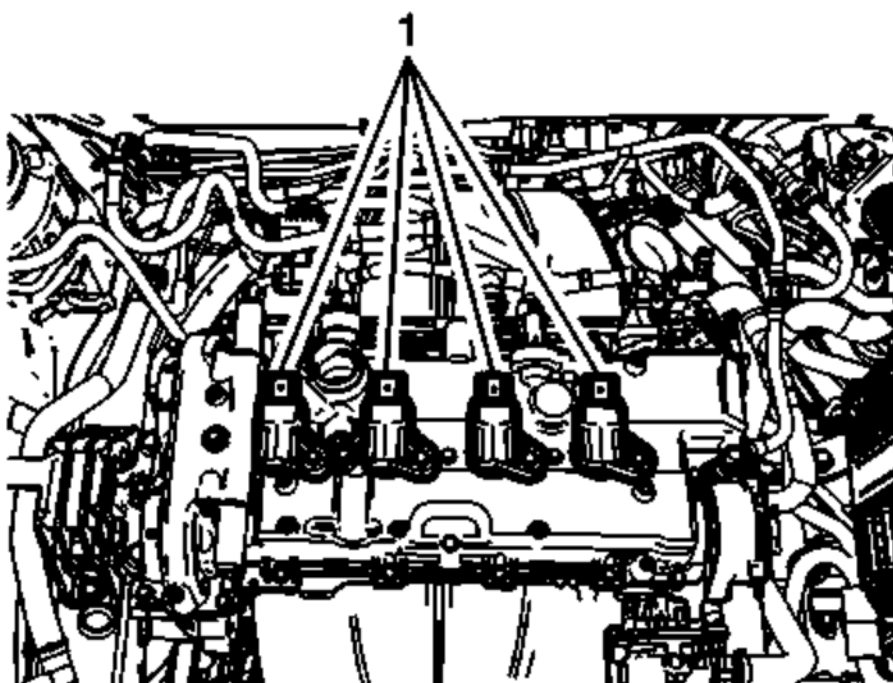


Fig. 112: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

6. Remove the ignition coils (1). Refer to **Ignition Coil Replacement** .

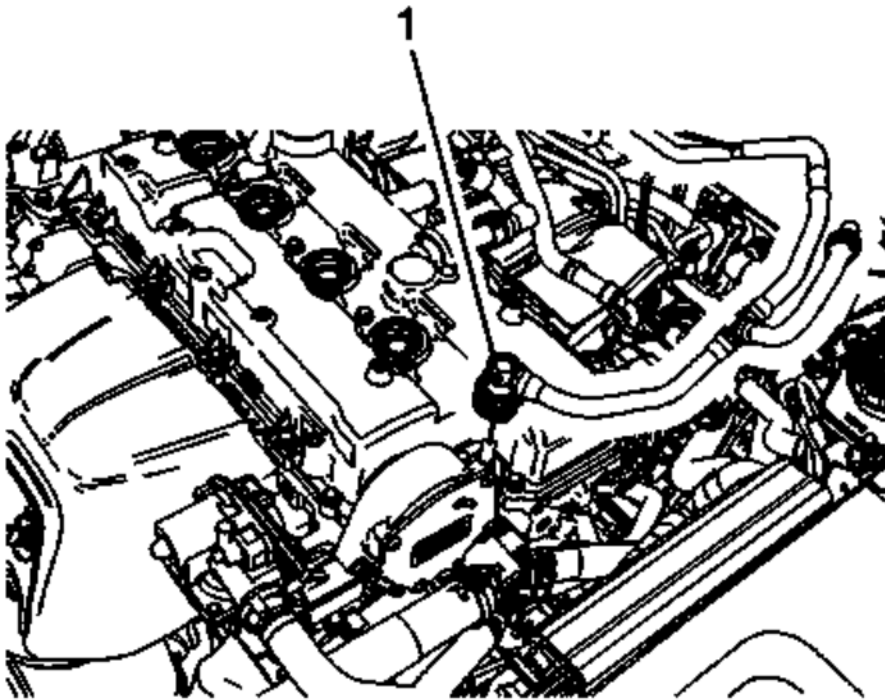


Fig. 113: Vacuum Booster Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect vacuum booster pipe (1).

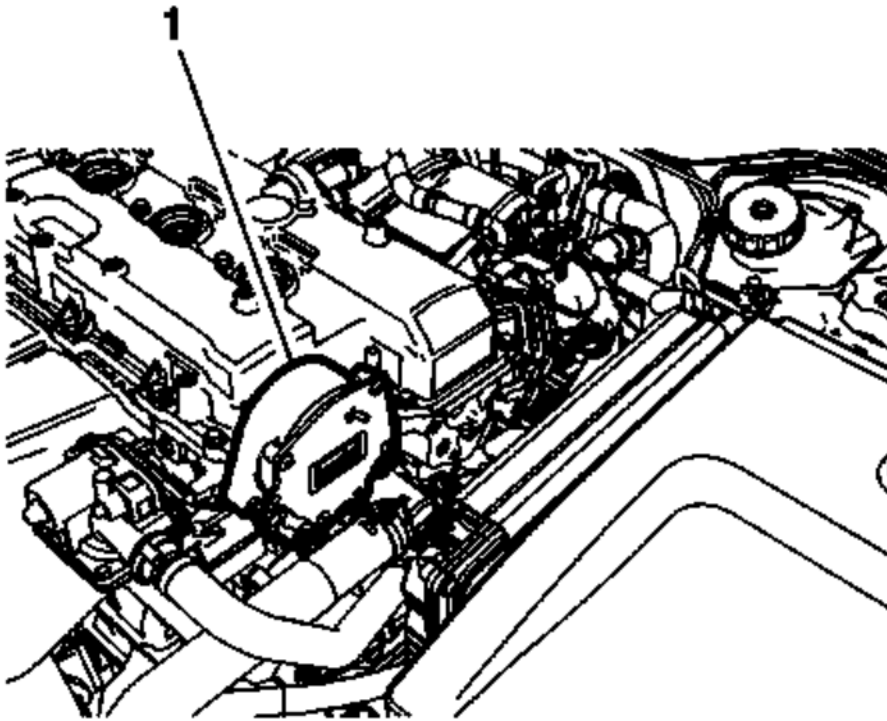


Fig. 114: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

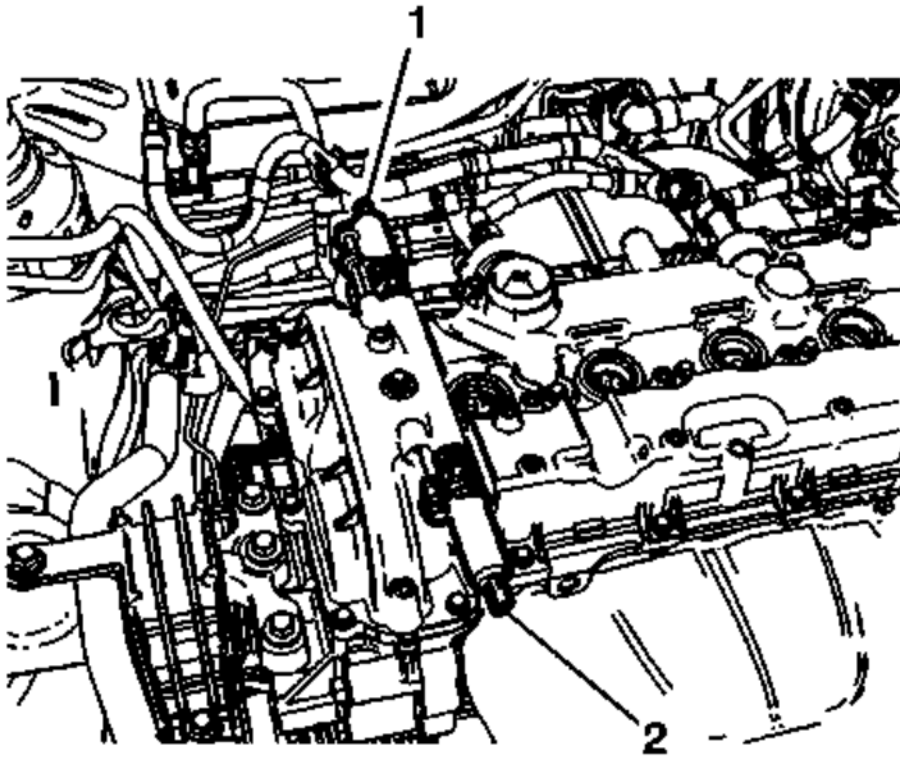


Fig. 115: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement**
10. Remove the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement**

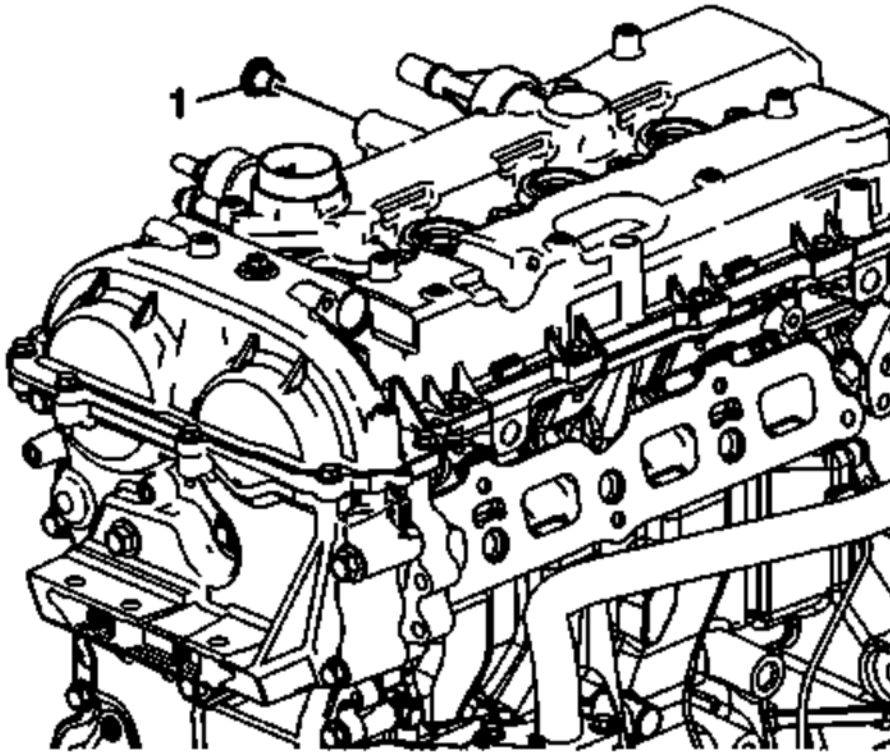


Fig. 116: Camshaft Cover Plug
Courtesy of GENERAL MOTORS COMPANY

11. Remove the camshaft cover plug (1).

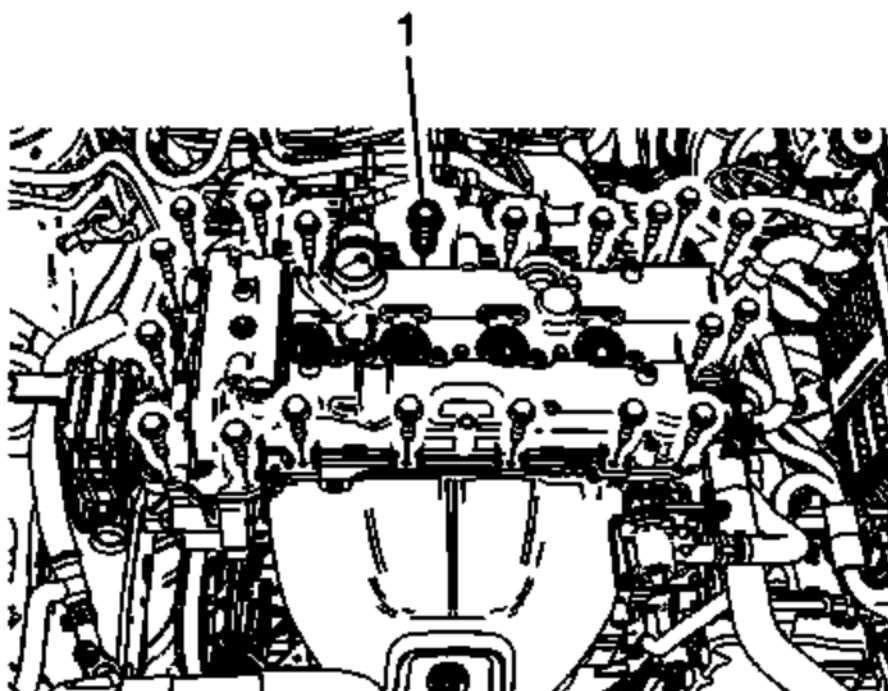


Fig. 117: Camshaft Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft cover fasteners (1).

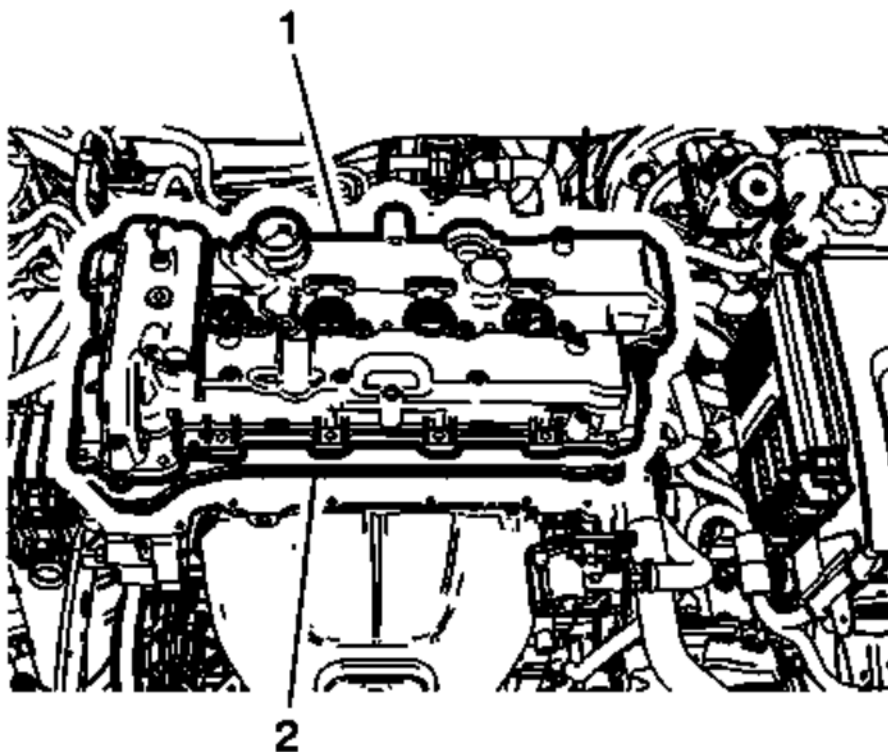


Fig. 118: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

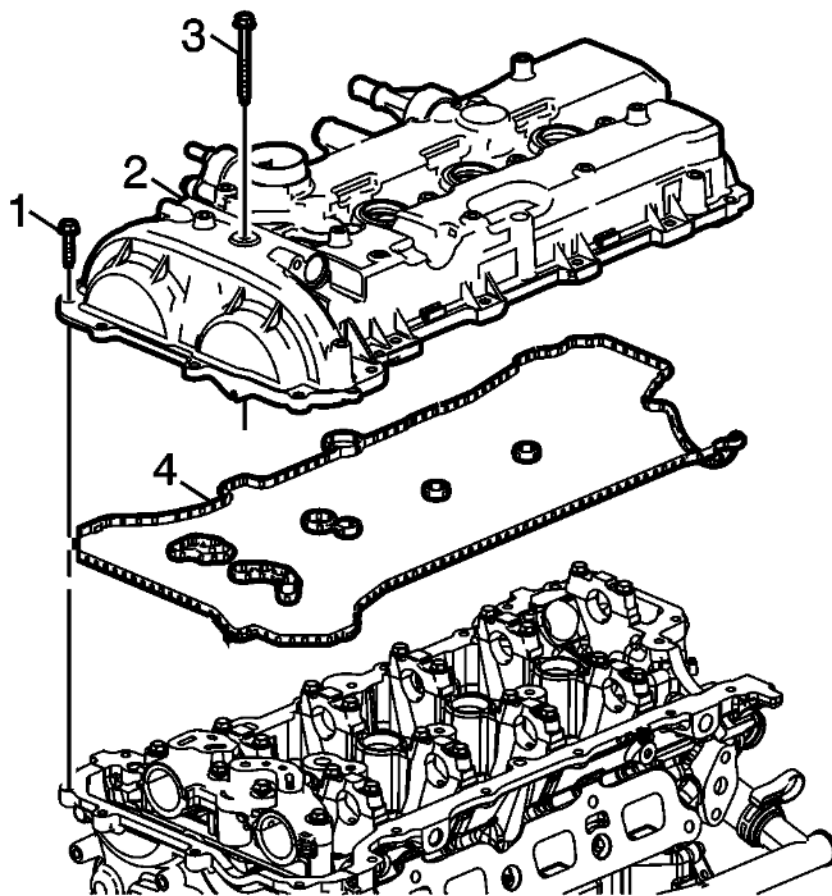


Fig. 119: Camshaft Cover

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).

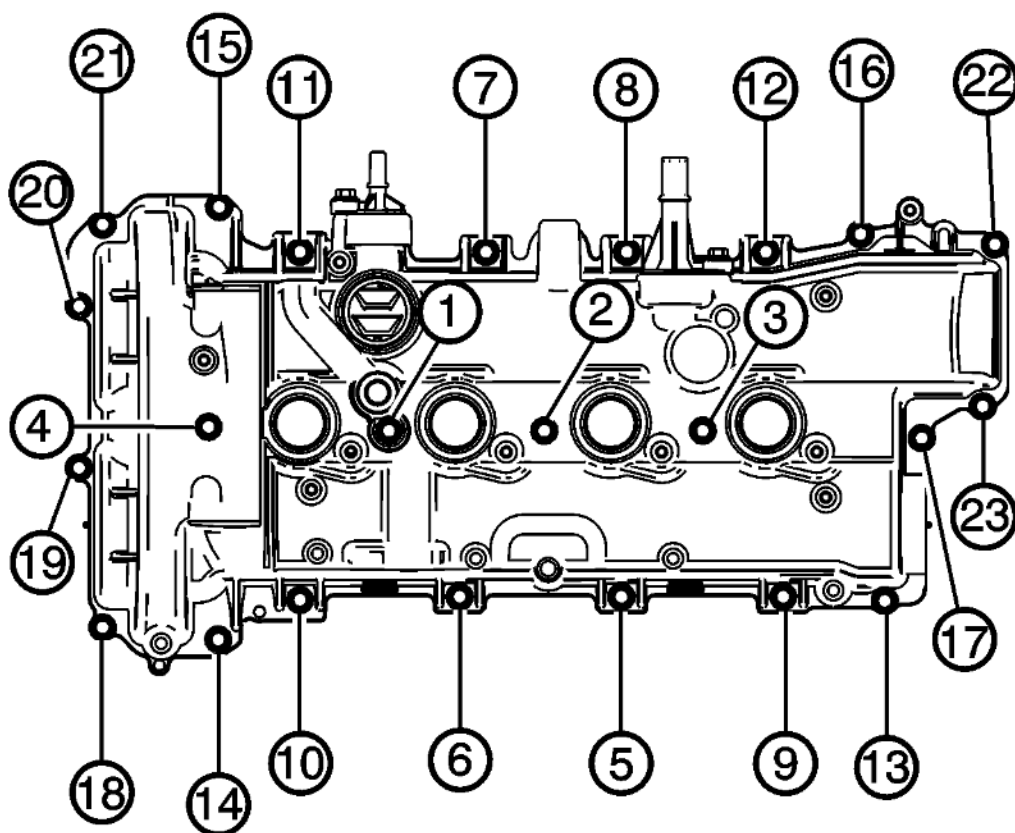


Fig. 120: Camshaft Cover Bolts In Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 (89 lb in).

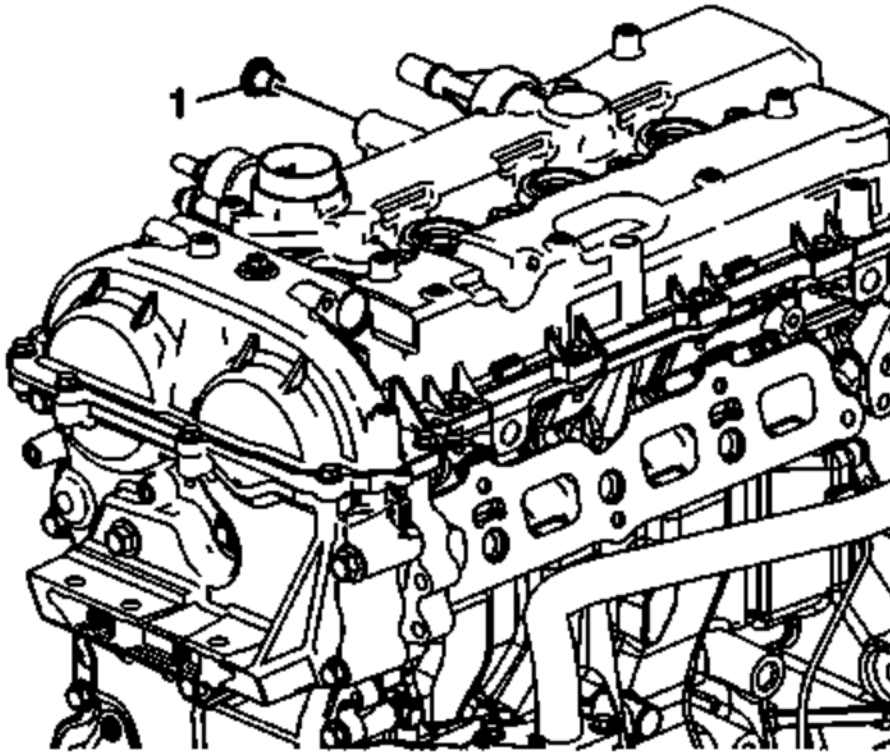


Fig. 121: Camshaft Cover Plug

Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft cover plug (1). Tighten the plug to 35 (26 lb ft).
5. Install the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LCV)** .

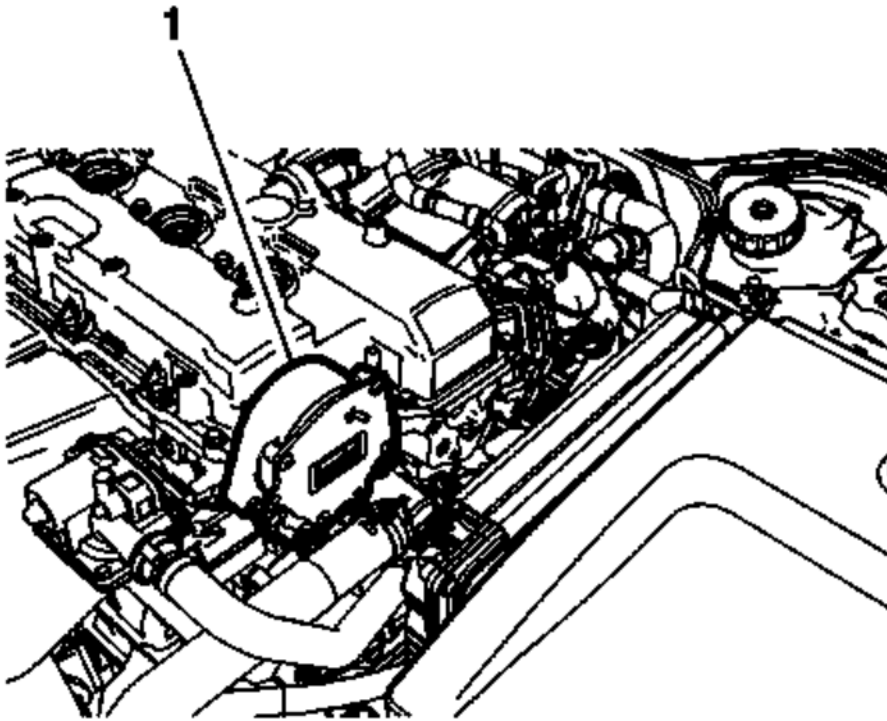


Fig. 122: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

6. Install the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

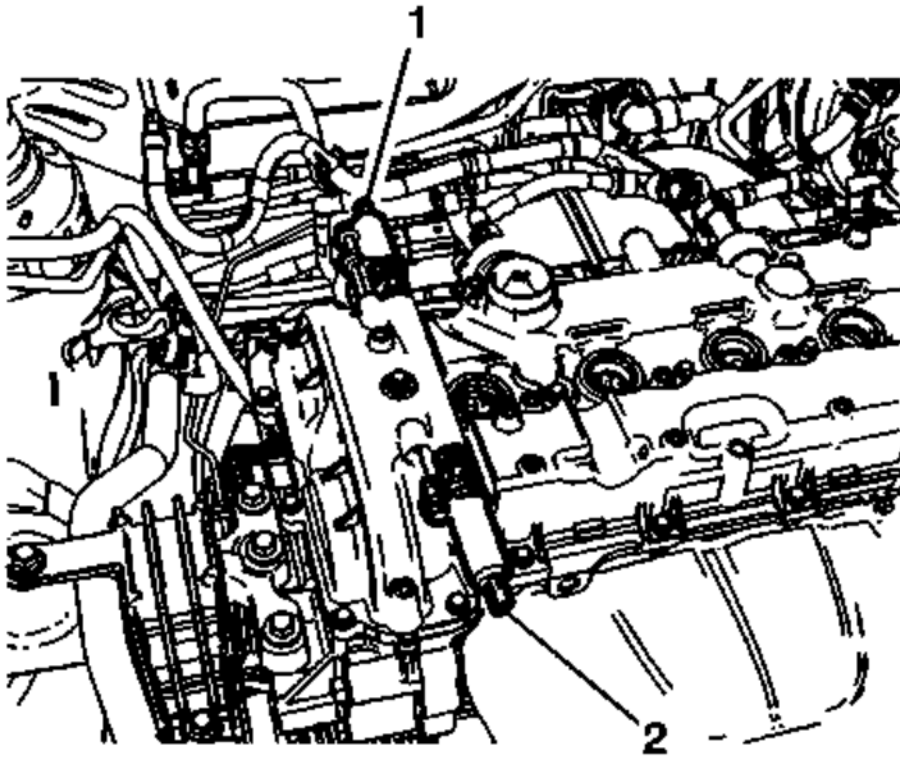


Fig. 123: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

7. Install the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** .
8. Install the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

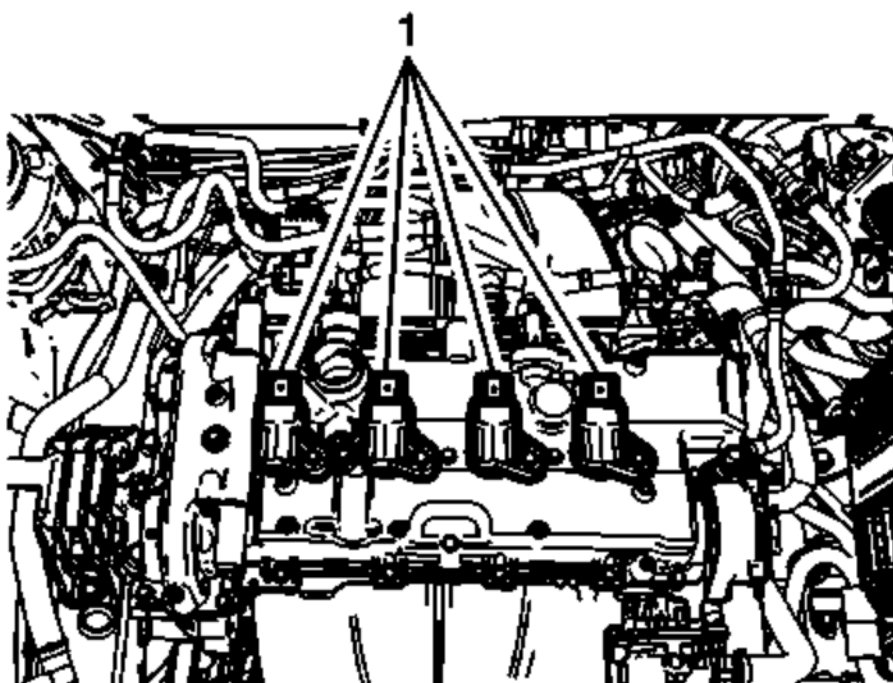


Fig. 124: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

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

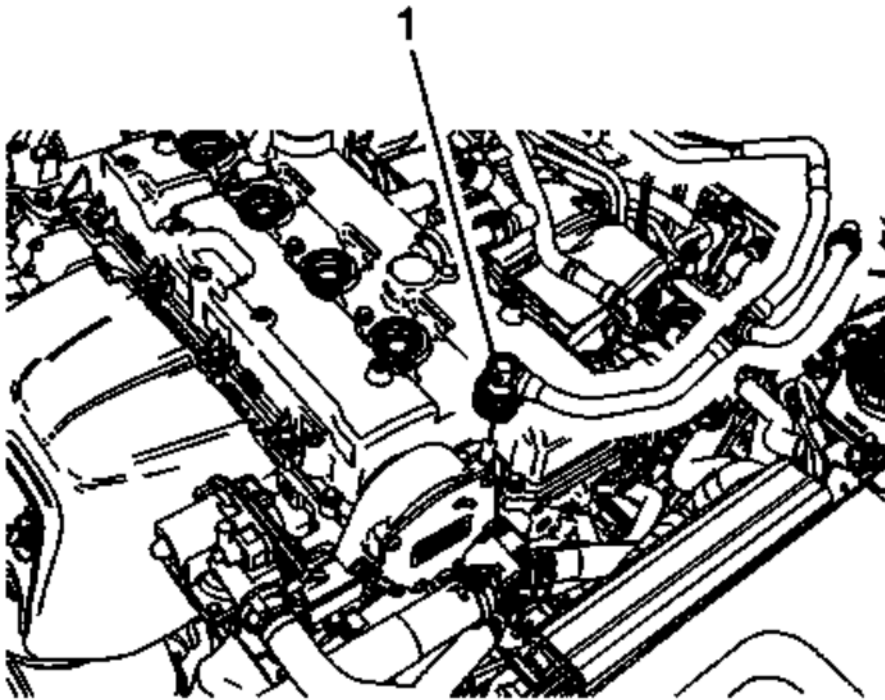


Fig. 125: Vacuum Booster Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Connect vacuum booster pipe (1).

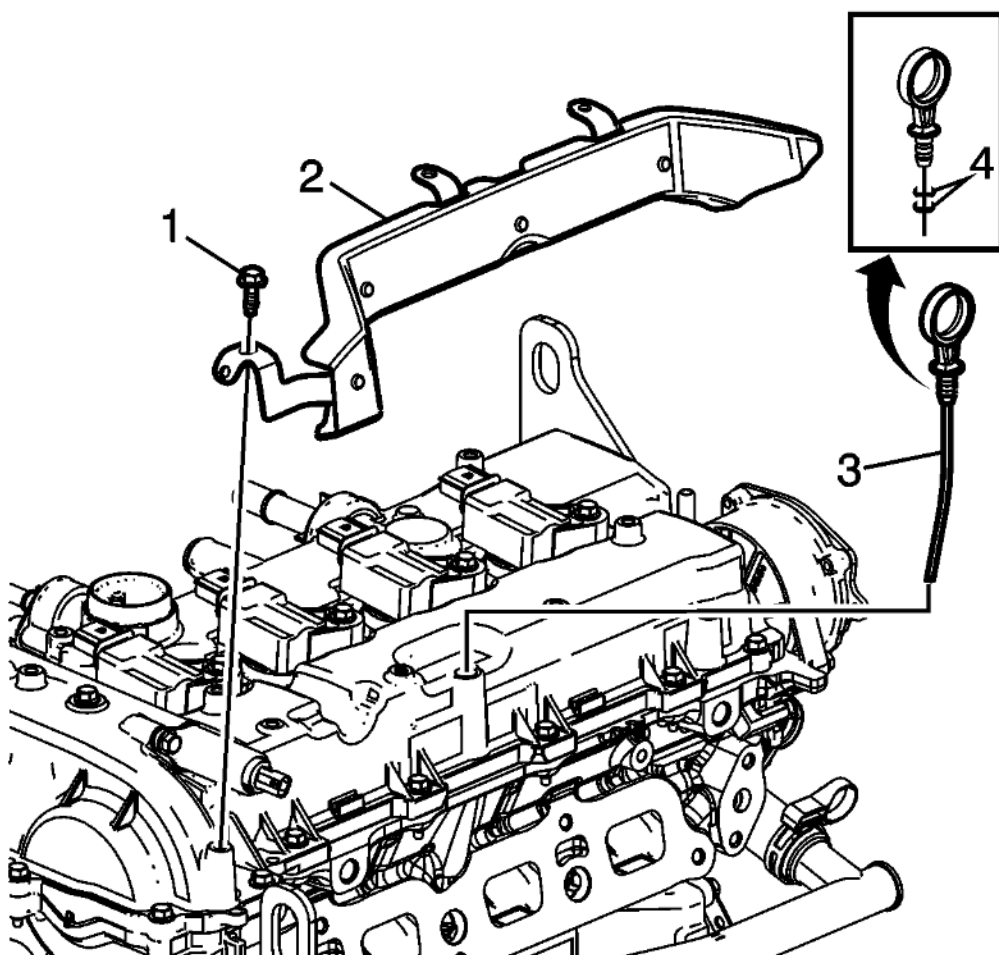


Fig. 126: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

11. Install the camshaft cover heat shield (2) and bolts (1). Tighten the bolts to 10 (89 lb in).
12. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (3).

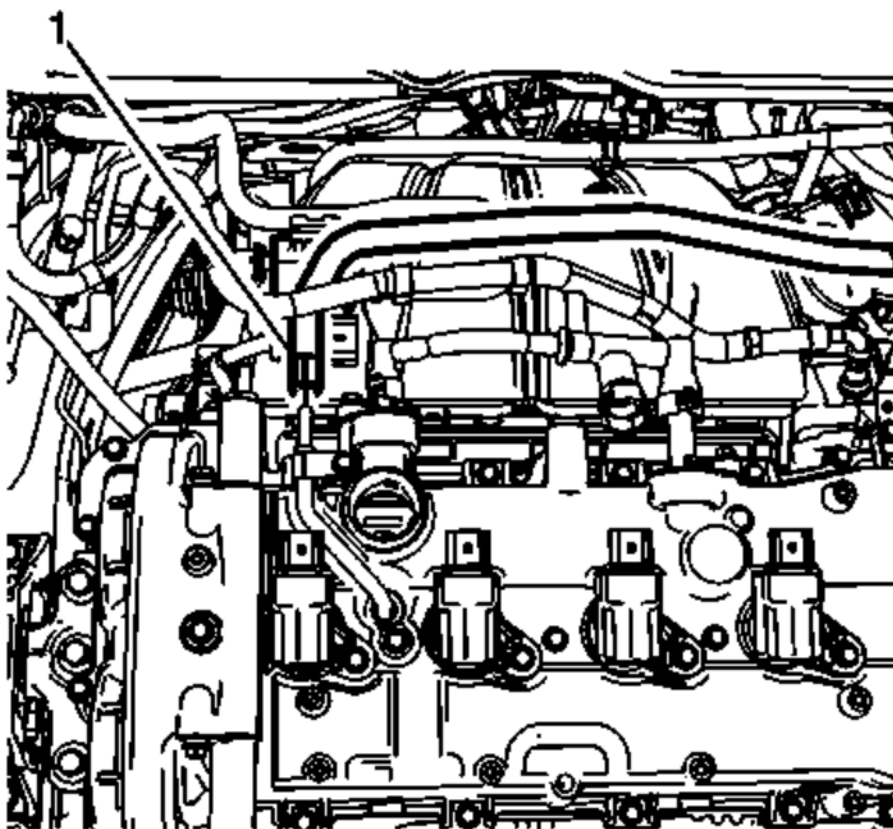


Fig. 127: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

13. Install the surge tank hose (1).
14. Install the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LCV)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

CAMSHAFT COVER REPLACEMENT (LTG)

Removal Procedure

1. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

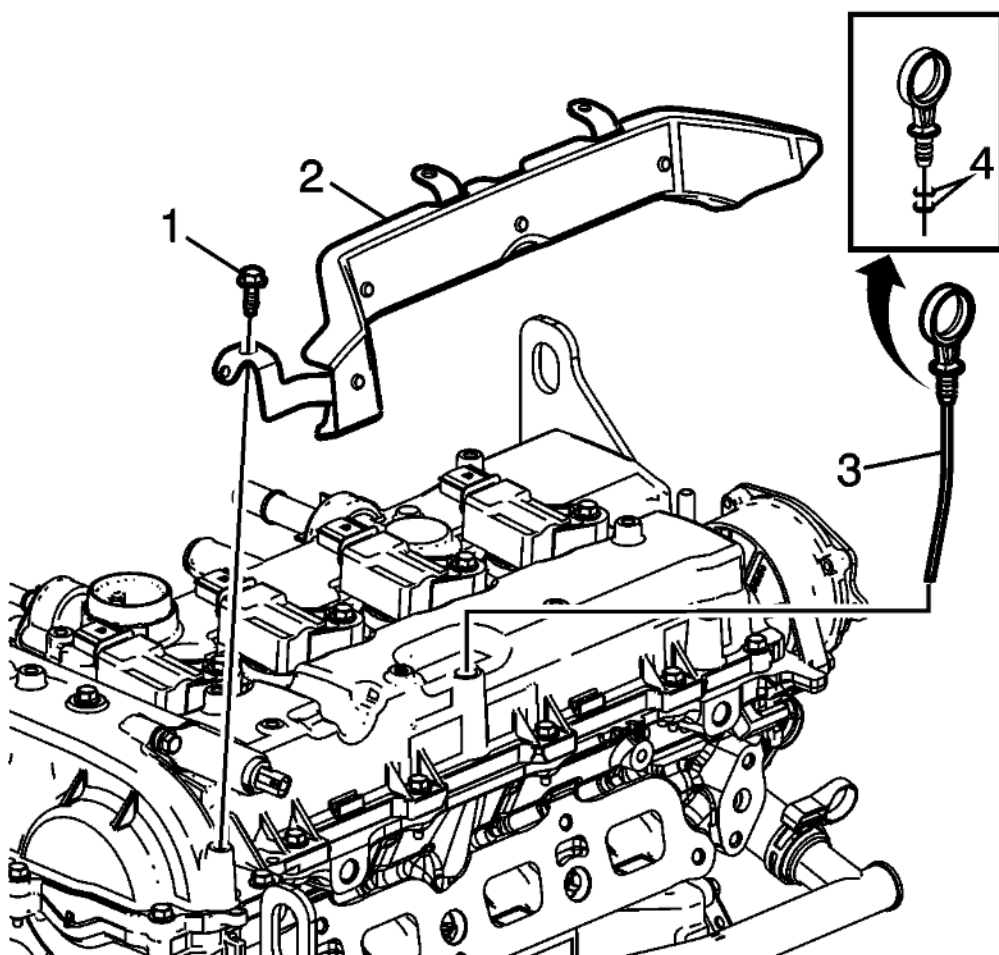


Fig. 128: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
3. Remove the camshaft cover heat shield (2) and bolts (1).

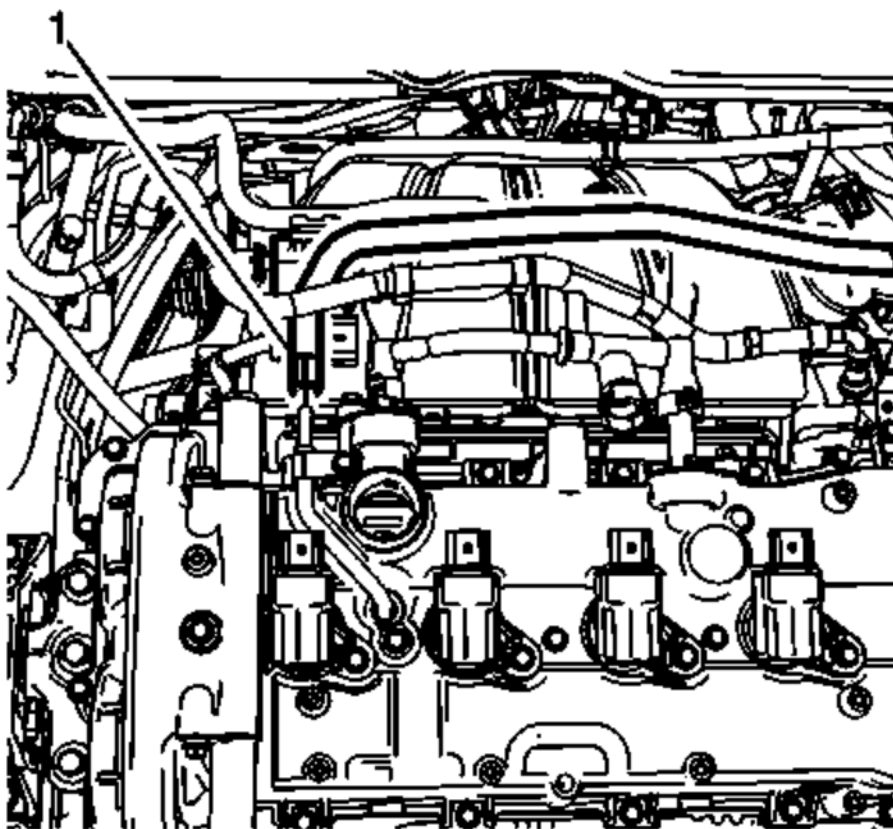


Fig. 129: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

4. Remove the surge tank hose (1).
5. Remove the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)**.

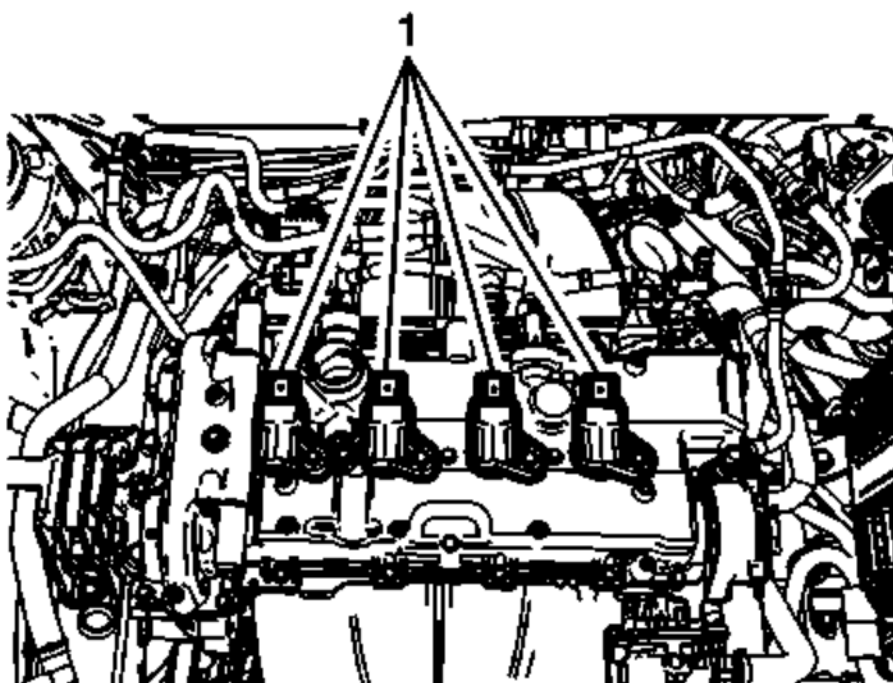


Fig. 130: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

6. Remove the ignition coils (1). Refer to **Ignition Coil Replacement** .

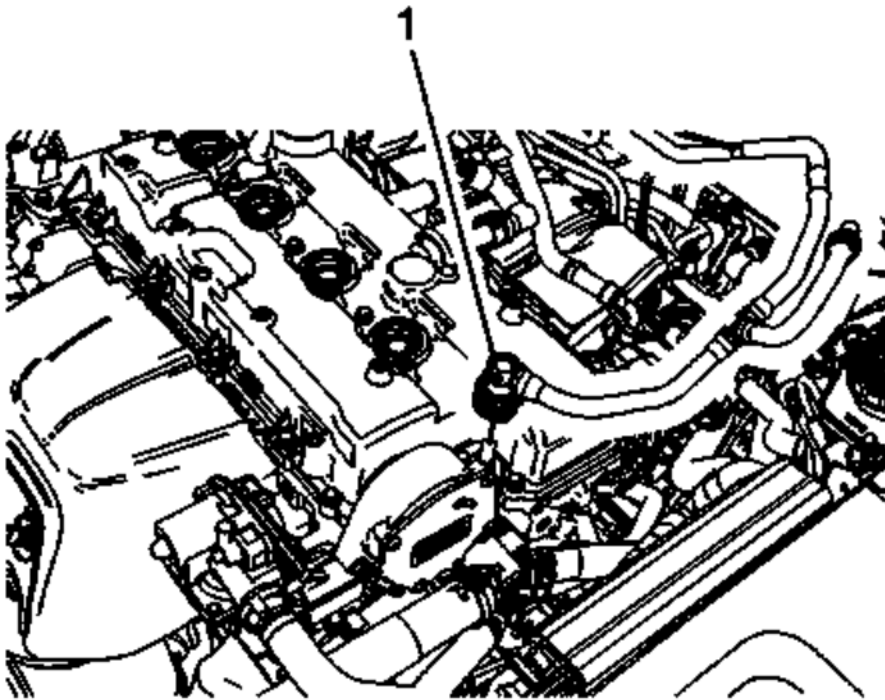


Fig. 131: Vacuum Booster Pipe

Courtesy of GENERAL MOTORS COMPANY

7. Disconnect vacuum booster pipe (1).

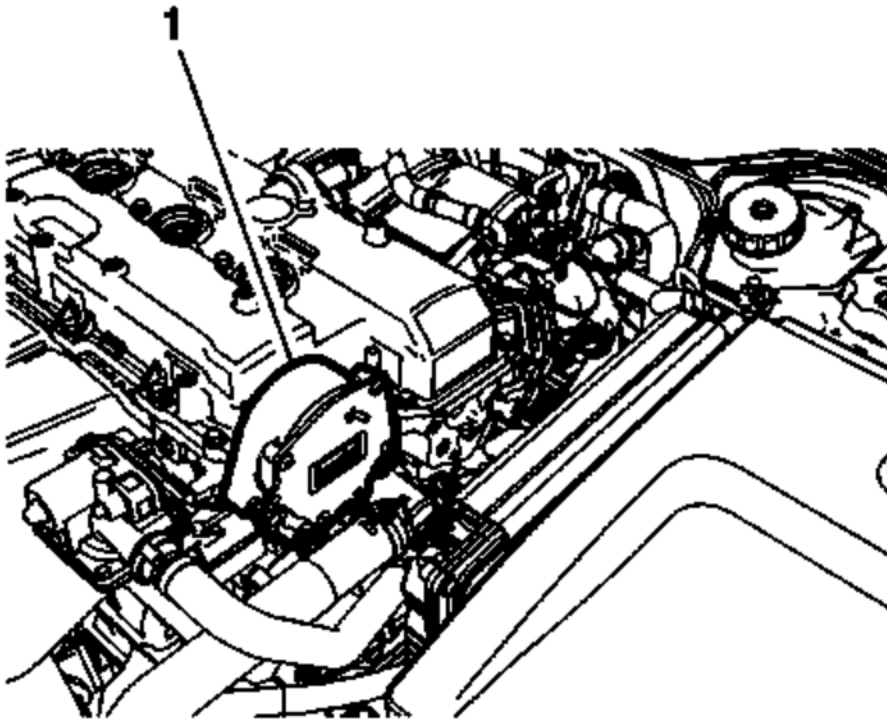


Fig. 132: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the vacuum assembly (1). Refer to **Vacuum Pump Replacement** .

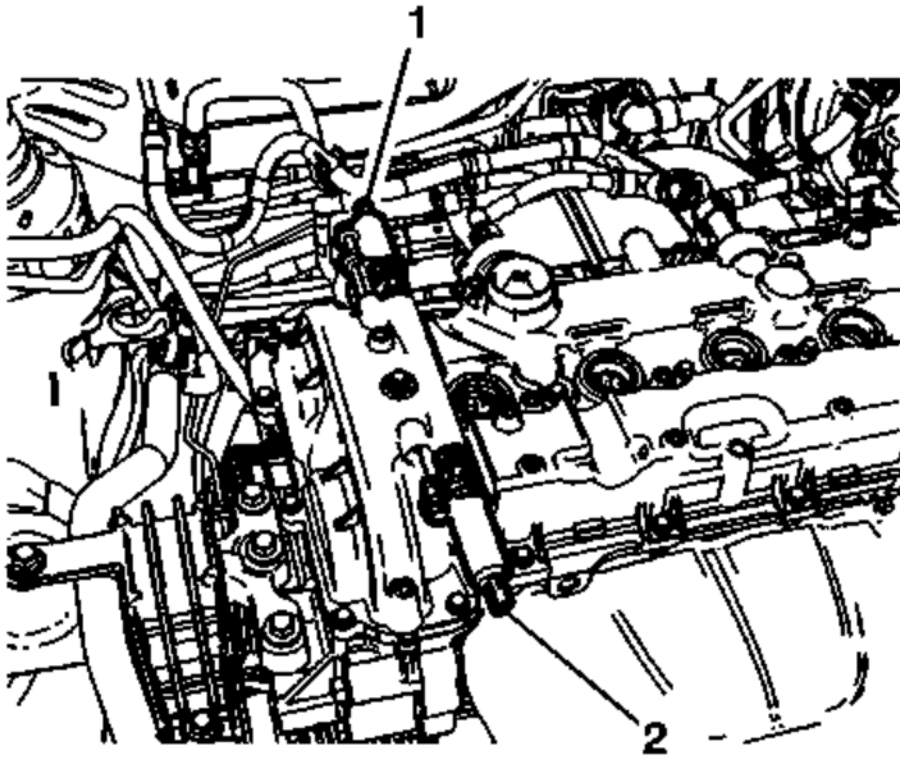


Fig. 133: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

9. Remove the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement**
10. Remove the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement**

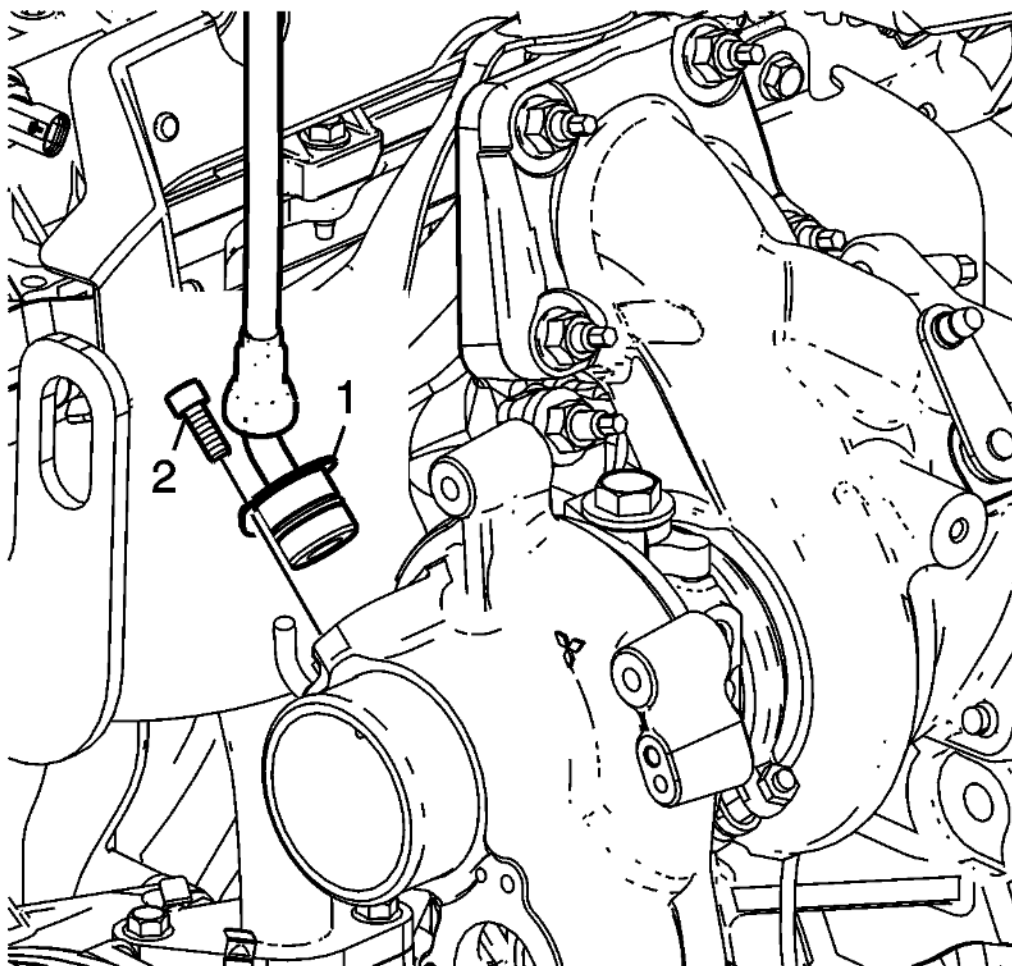


Fig. 134: PCV Hose Fitting Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not disturb the joint between the PCV hose and PCV hose fitting at the turbocharger. This is a permanent connection.

11. Remove the PCV hose fitting bolt (2). Disconnect the PCV hose fitting (1) with the PCV hose attached from the turbocharger.

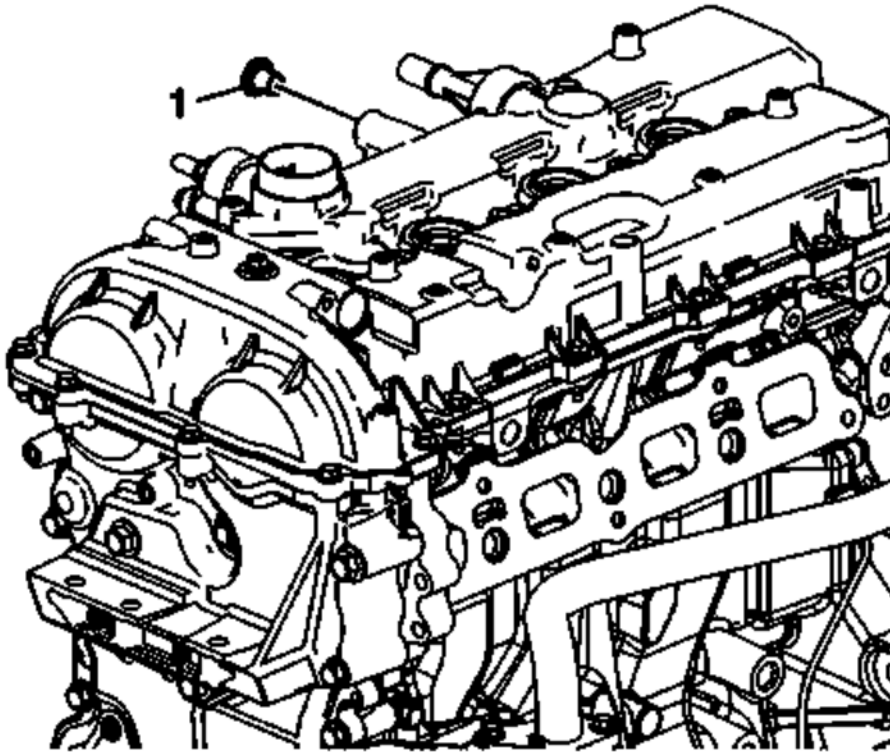


Fig. 135: Camshaft Cover Plug
Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft cover plug (1).

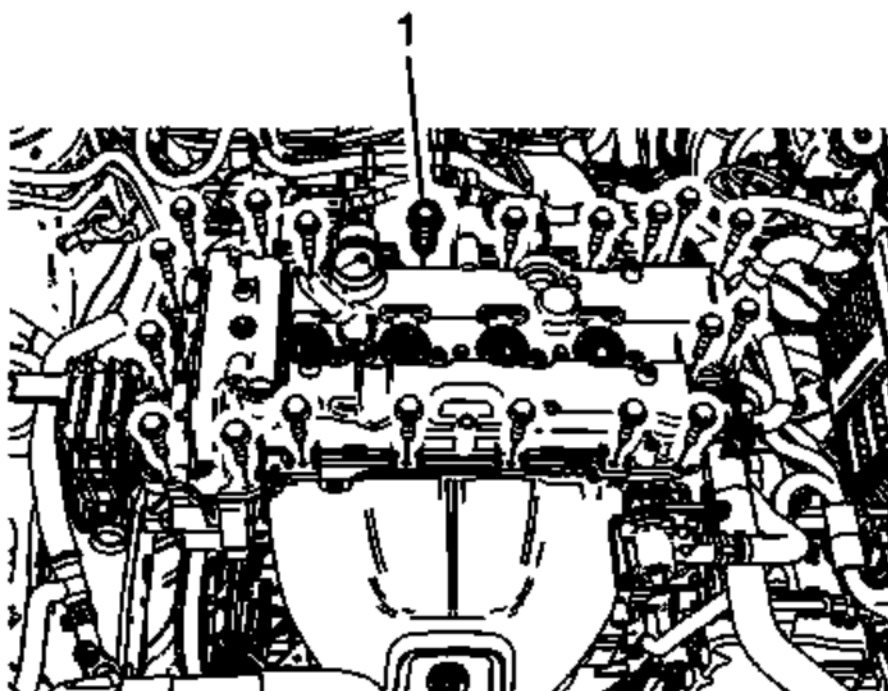


Fig. 136: Camshaft Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

13. Remove the camshaft cover fasteners (1).

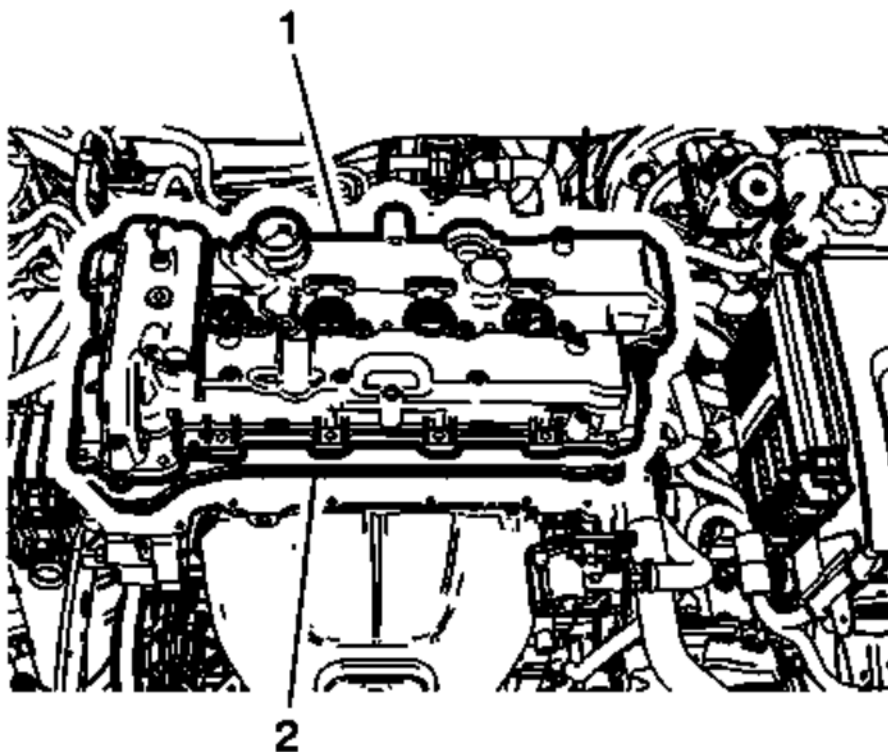


Fig. 137: Camshaft Cover And Gasket
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

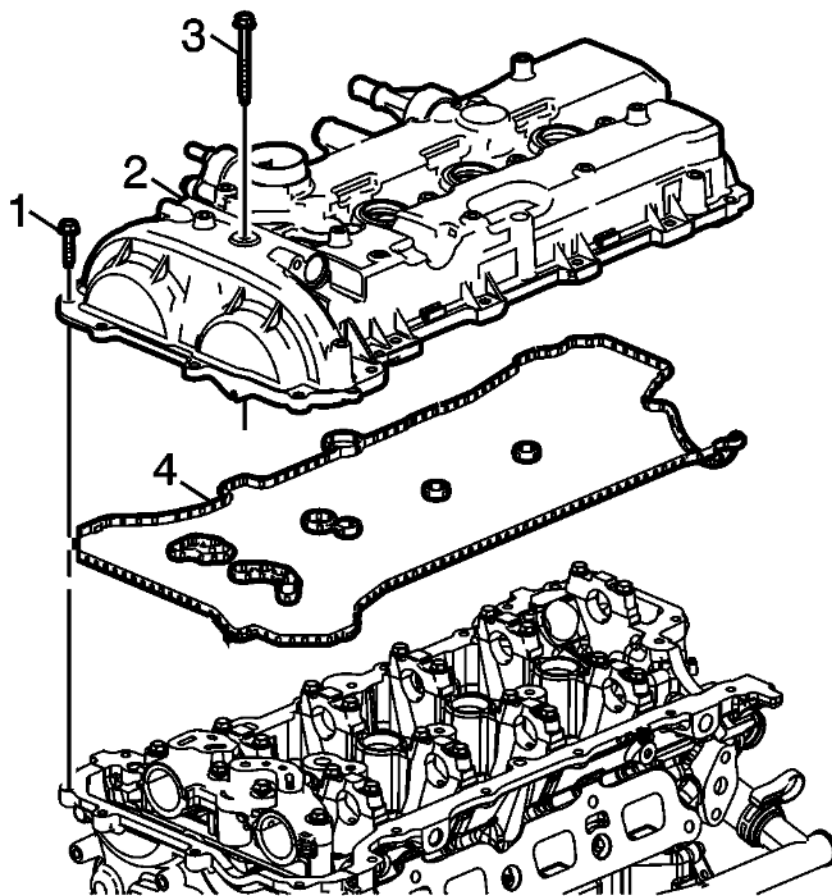


Fig. 138: Camshaft Cover

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).

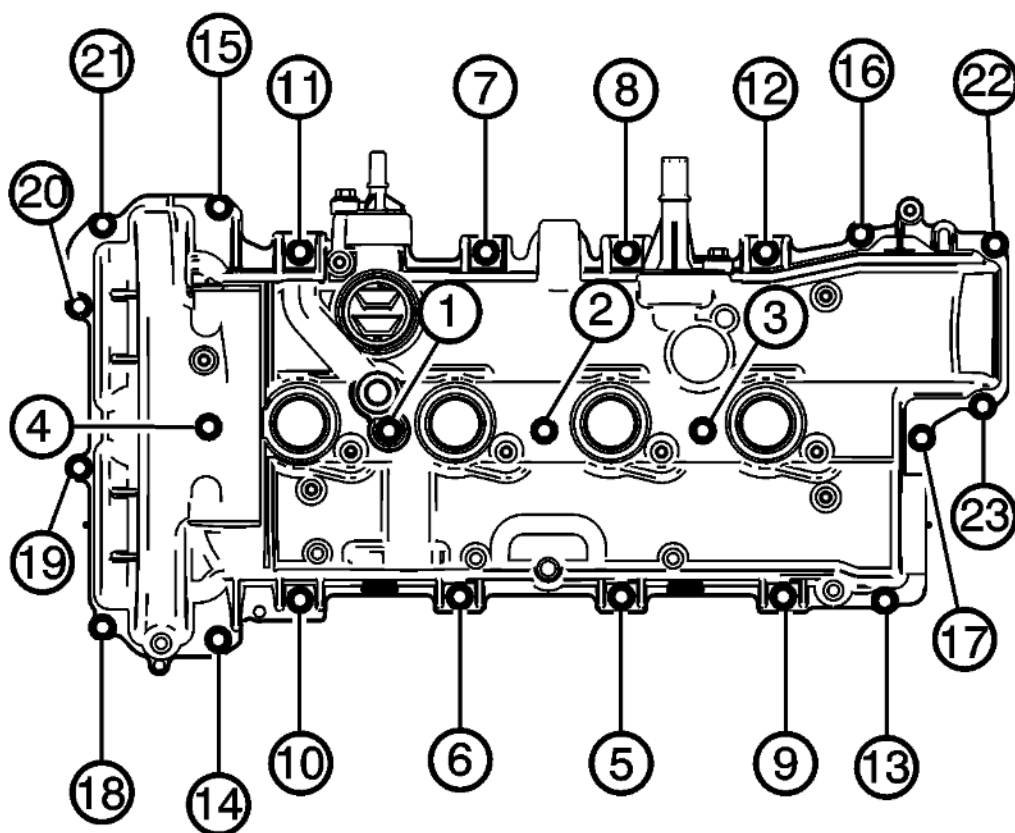


Fig. 139: Camshaft Cover Bolts In Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Tighten the camshaft cover bolts in sequence to 10 (89 lb in).

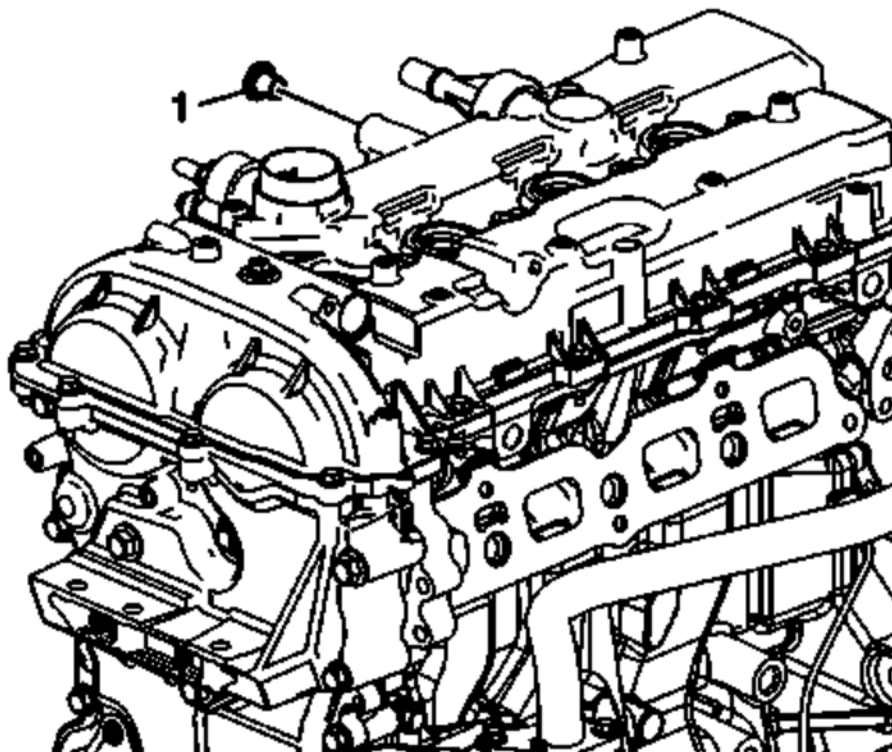


Fig. 140: Camshaft Cover Plug

Courtesy of GENERAL MOTORS COMPANY

4. Install the camshaft cover plug (1). Tighten the plug to 35 (26 lb ft).
5. Install the engine coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement (LTG)** .

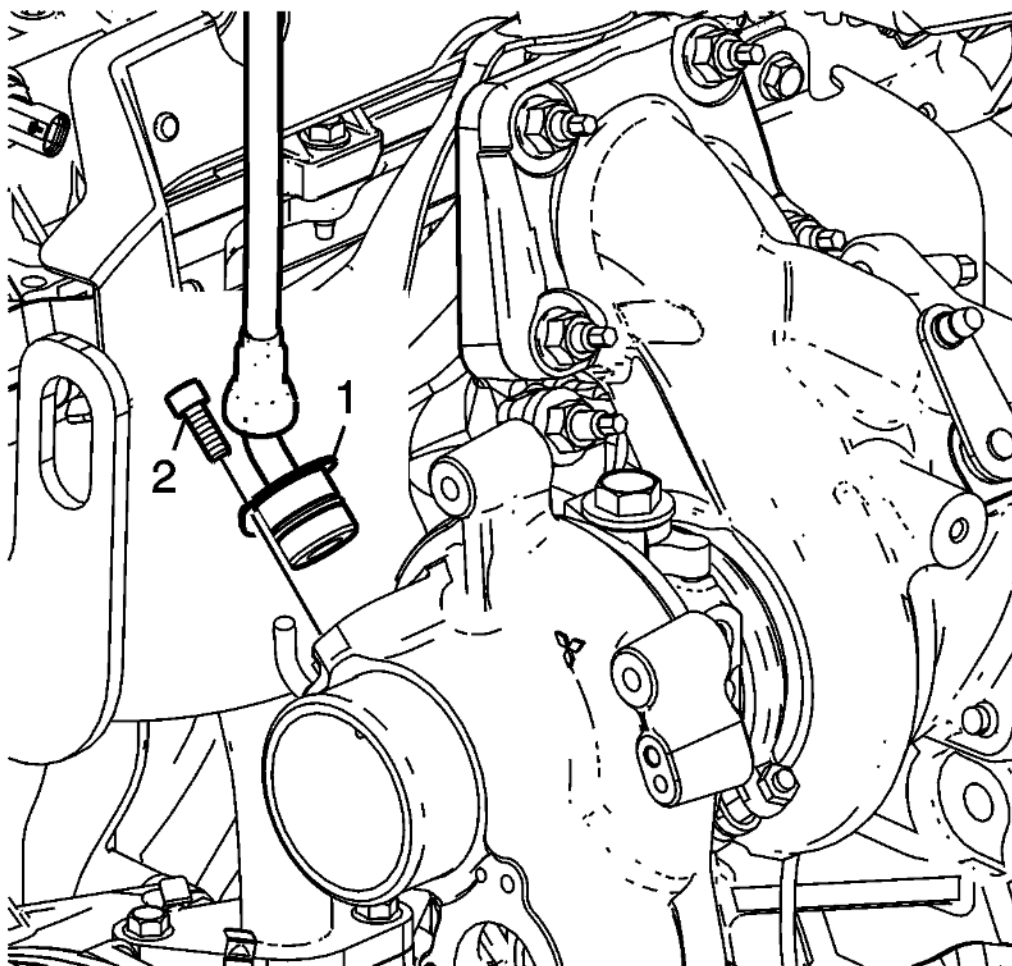


Fig. 141: PCV Hose Fitting Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.

6. Install the PCV hose and fitting assembly (1) to the turbocharger. Install the PCV hose fitting assembly bolt (2) and tighten to 8 (71 lb in).

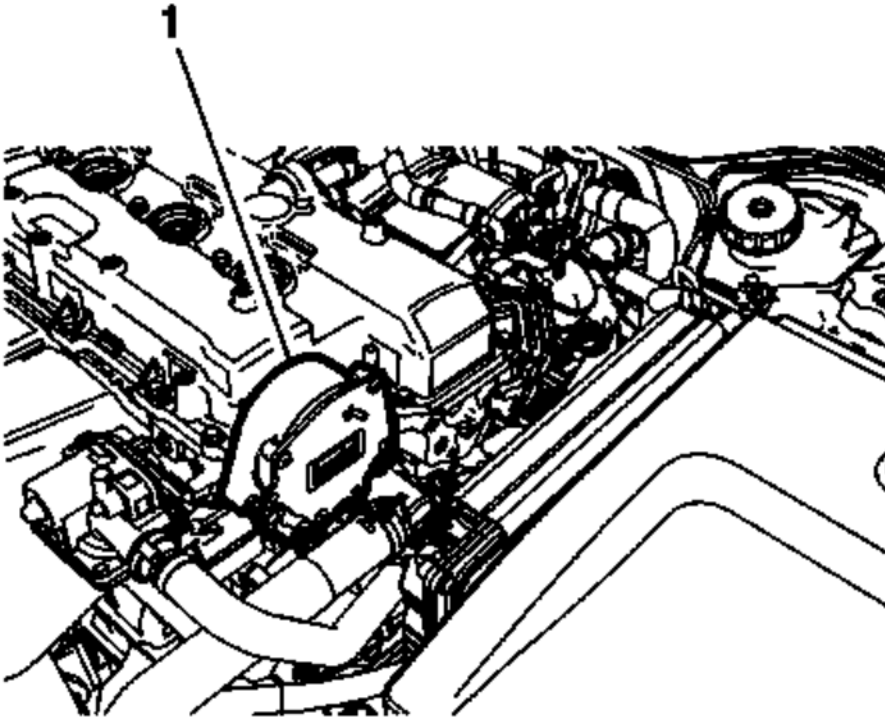


Fig. 142: Vacuum Assembly

Courtesy of GENERAL MOTORS COMPANY

7. Install the vacuum assembly (1). Refer to Vacuum Pump Replacement .

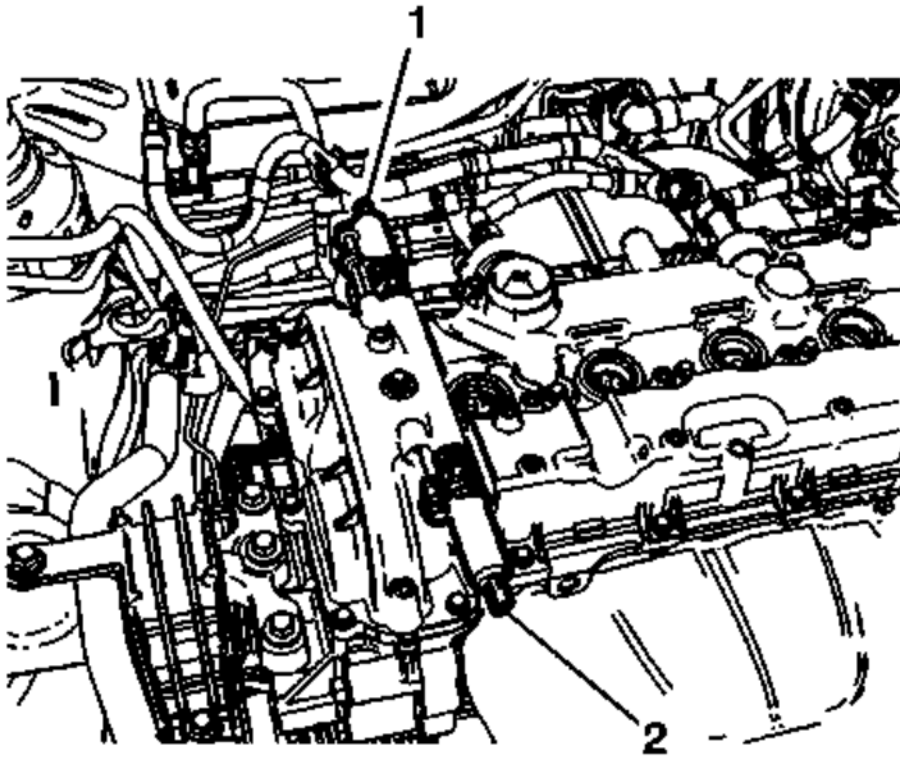


Fig. 143: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft position actuator intake (1) solenoid valve. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** .
9. Install the camshaft position actuator exhaust (2) solenoid valve. Refer to **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

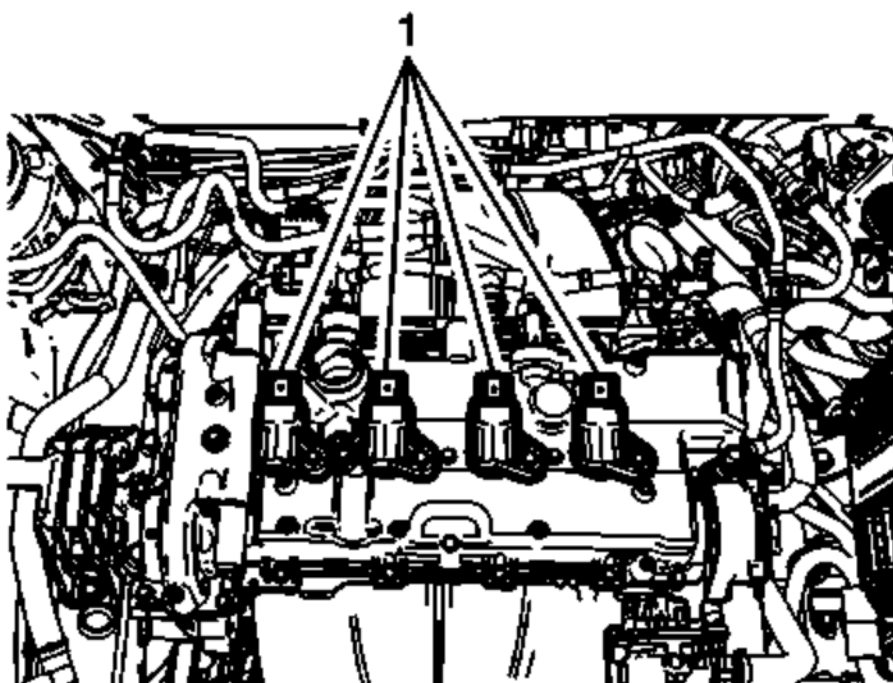


Fig. 144: Ignition Coils

Courtesy of GENERAL MOTORS COMPANY

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

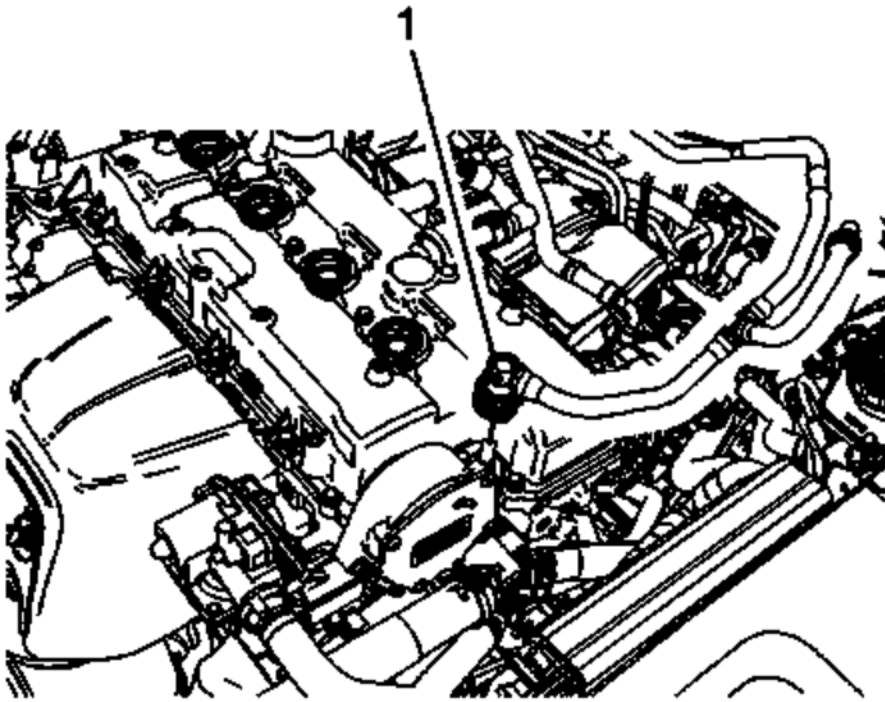


Fig. 145: Vacuum Booster Pipe

Courtesy of GENERAL MOTORS COMPANY

11. Connect vacuum booster pipe (1).
12. Install the camshaft cover heat shield (2) and bolts (1). Tighten the bolts to

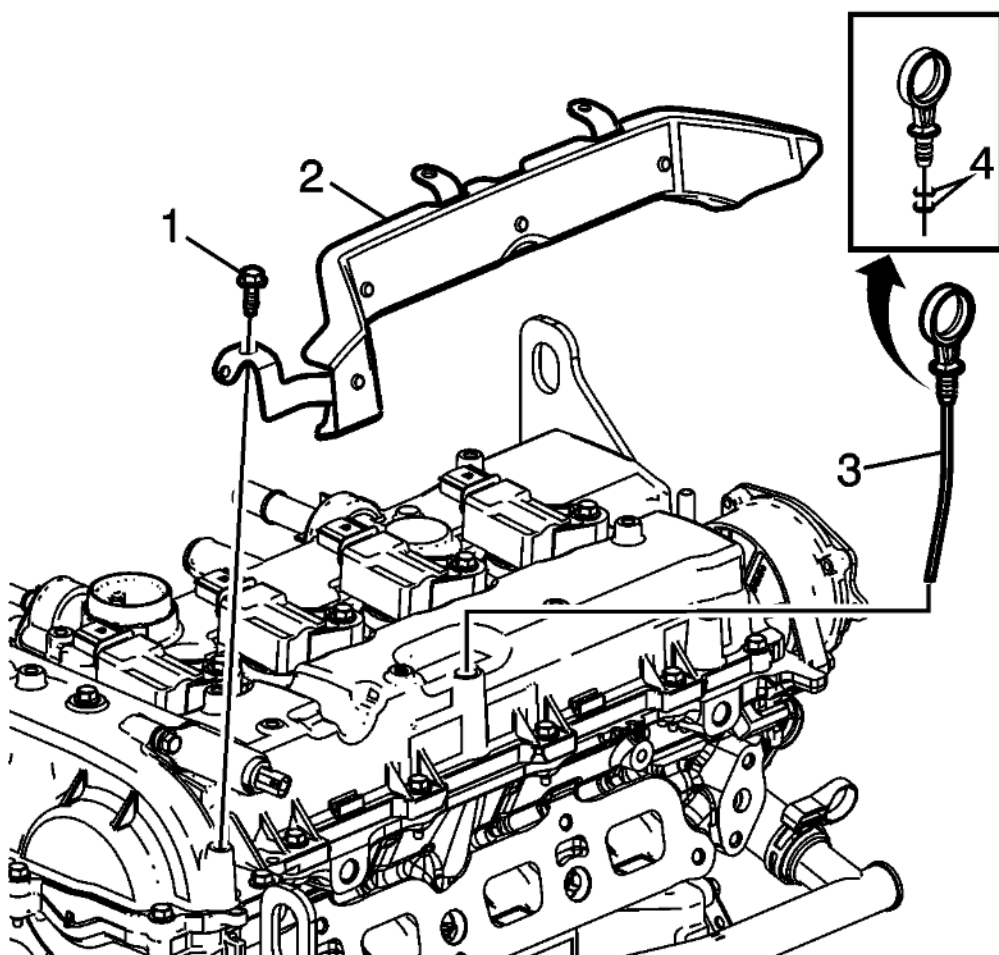


Fig. 146: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

13. Install the camshaft cover heat shield (2) and bolts (1). Tighten the bolts to 10 (89 lb in).
14. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (3).

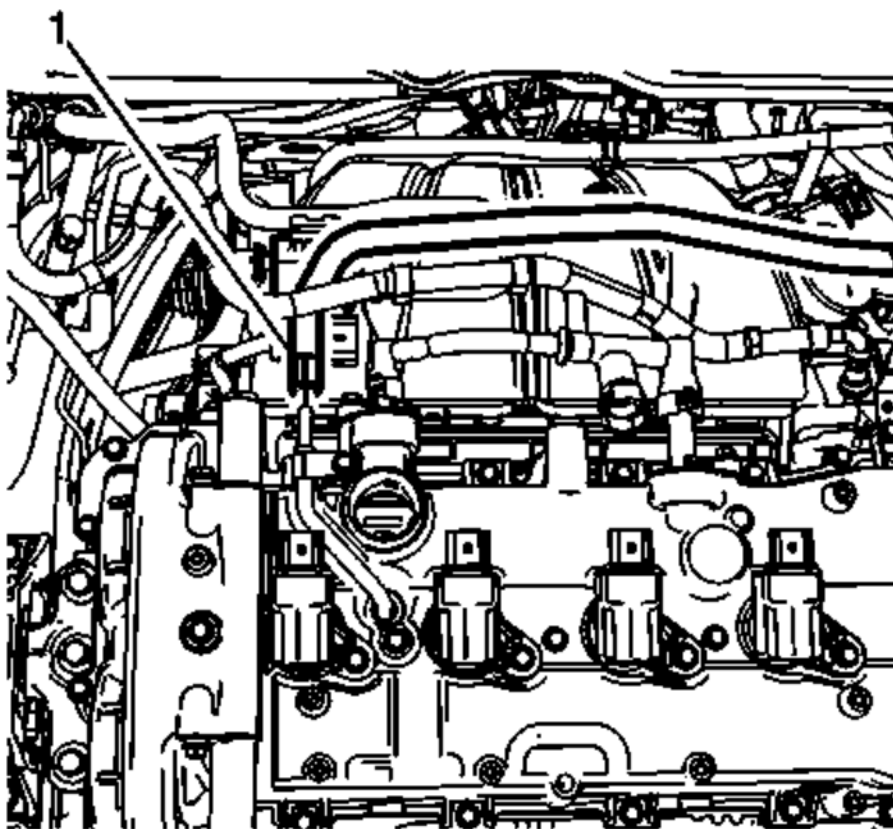


Fig. 147: Surge Tank Hose

Courtesy of GENERAL MOTORS COMPANY

15. Install the surge tank hose (1).
16. Install the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Cleaner Resonator to Outlet Duct)**.

TIMING CHAIN TENSIONER REPLACEMENT

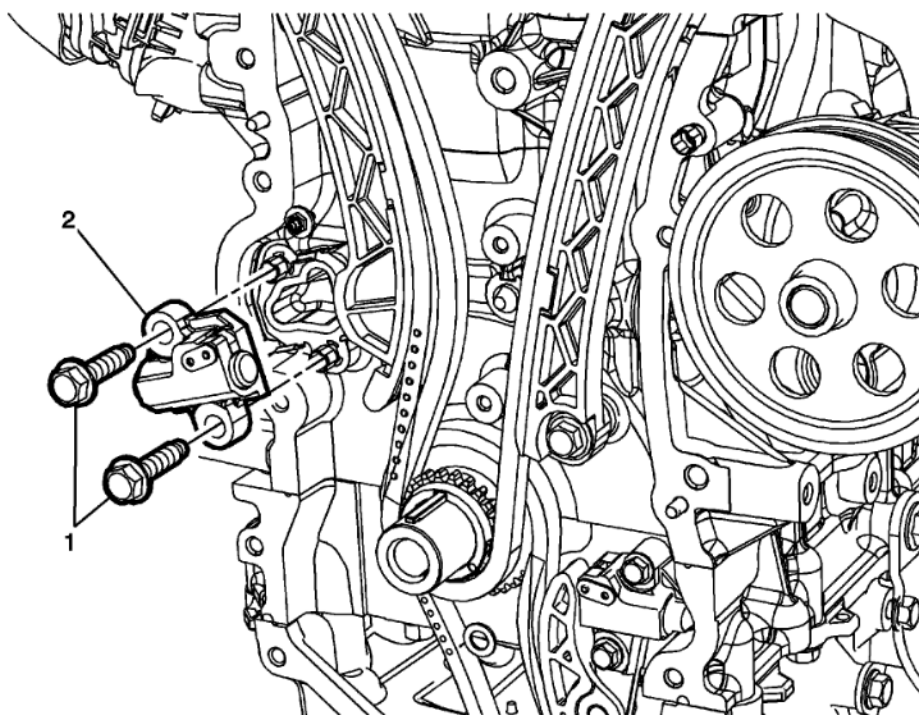


Fig. 148: Timing Chain Tensioner Bolts And Timing Chain Tensioner
 Courtesy of GENERAL MOTORS COMPANY

Timing Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the engine front cover. Refer to <u>Engine Front Cover Replacement (LCV)</u> , <u>Engine Front Cover Replacement (LTG)</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 rocker arm - exhaust. Refer to Valve Rocker Arm Replacement (Exhaust), Valve Rocker Arm Replacement (Intake).

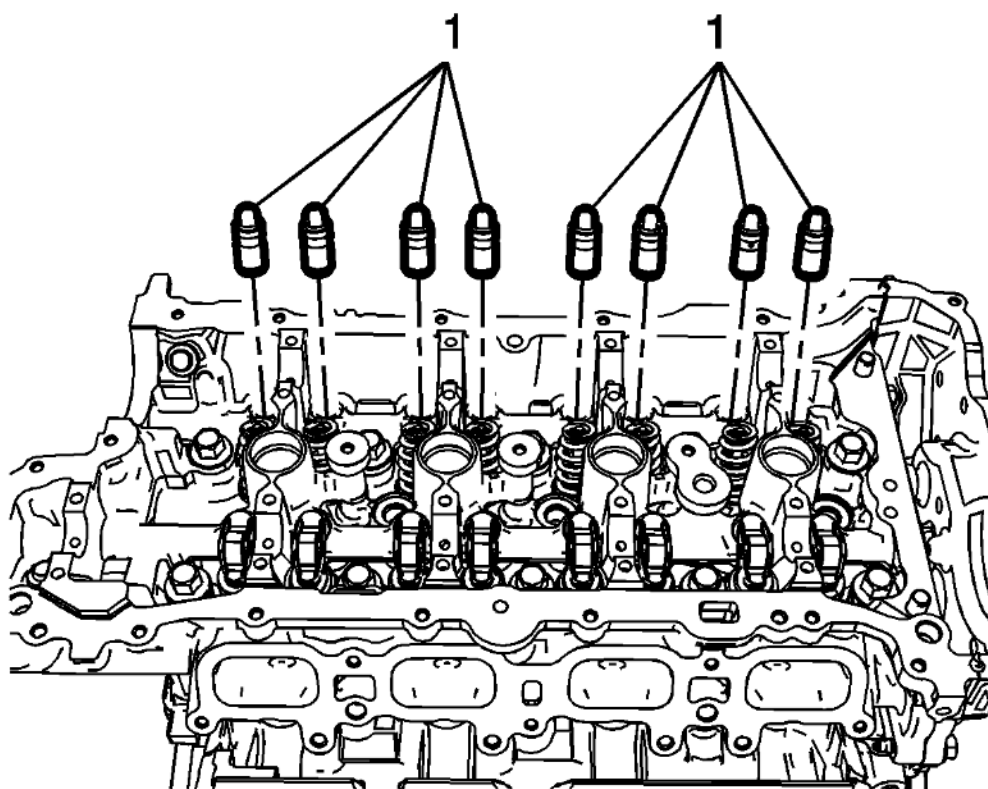


Fig. 149: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

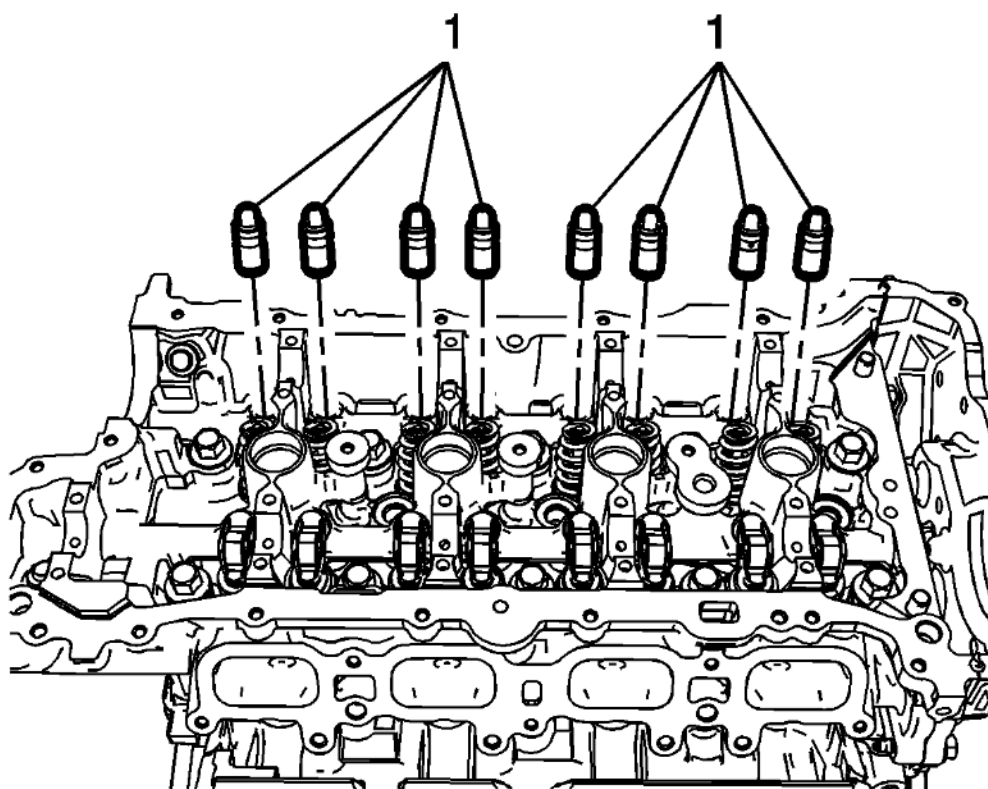


Fig. 150: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
2. Install the rocker arm - exhaust. Refer to Valve Rocker Arm Replacement (Exhaust), Valve Rocker Arm Replacement (Intake).

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - INTAKE

Removal Procedure

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

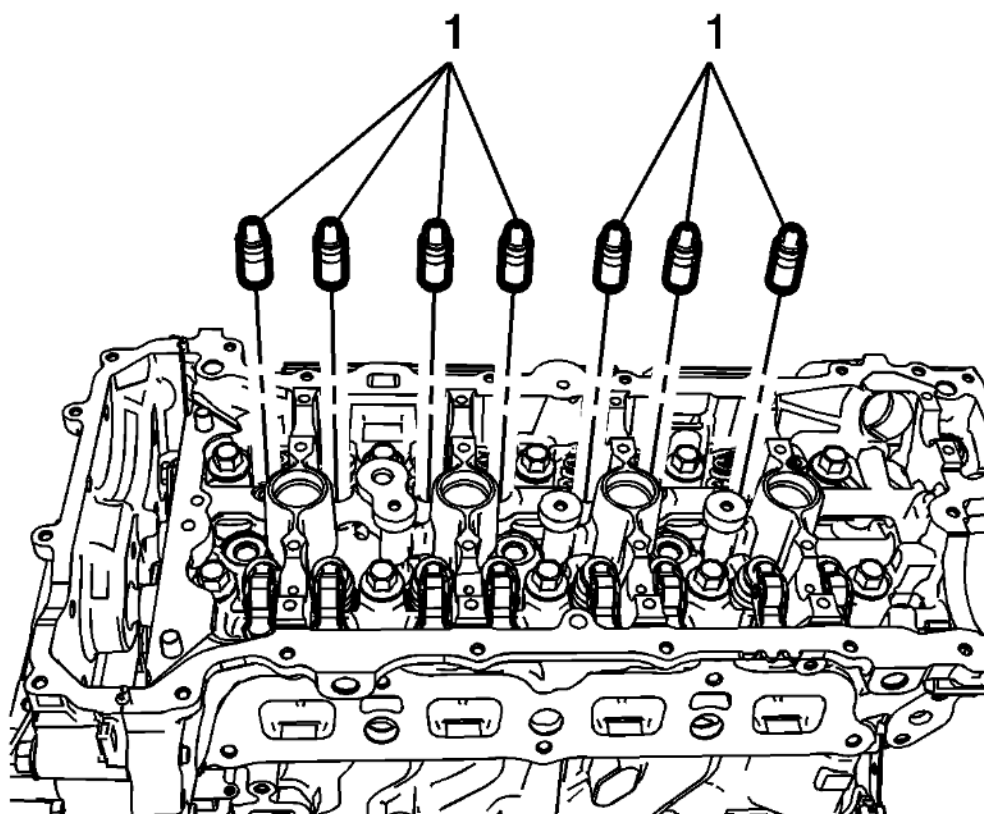


Fig. 151: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

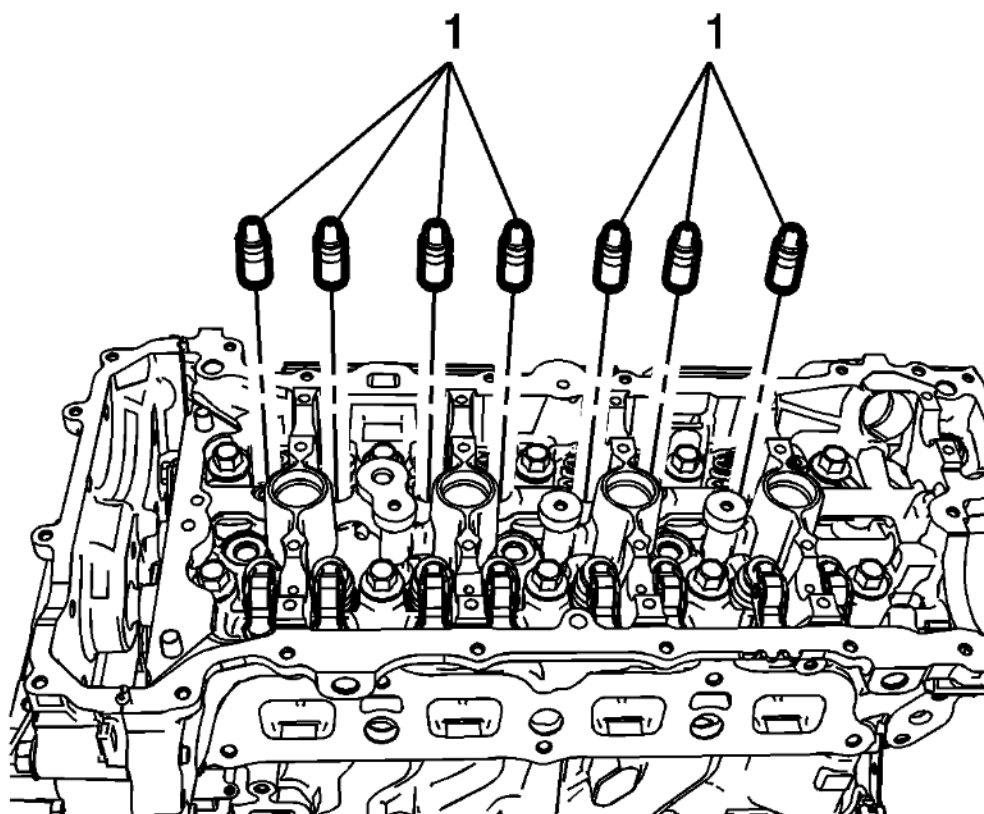


Fig. 152: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

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 (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .
2. Install the rocker arm - intake. 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.

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LCV), Camshaft Cover Replacement (LTG).
2. Remove the high pressure fuel pump. Refer to Fuel Pump Replacement .

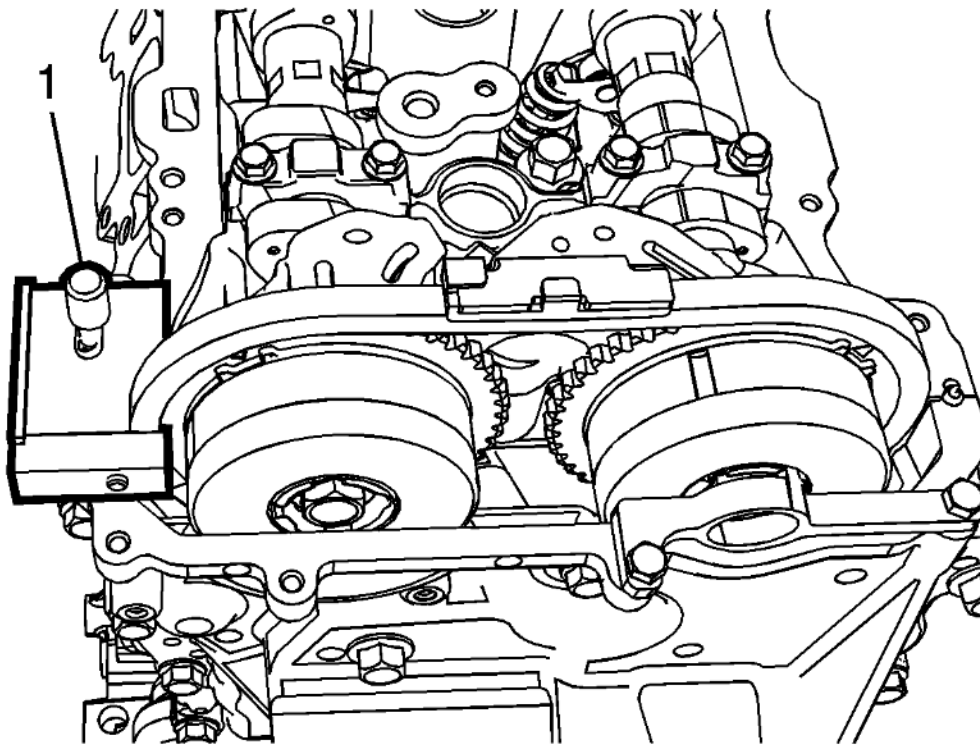


Fig. 153: Identifying EN-50656 Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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).

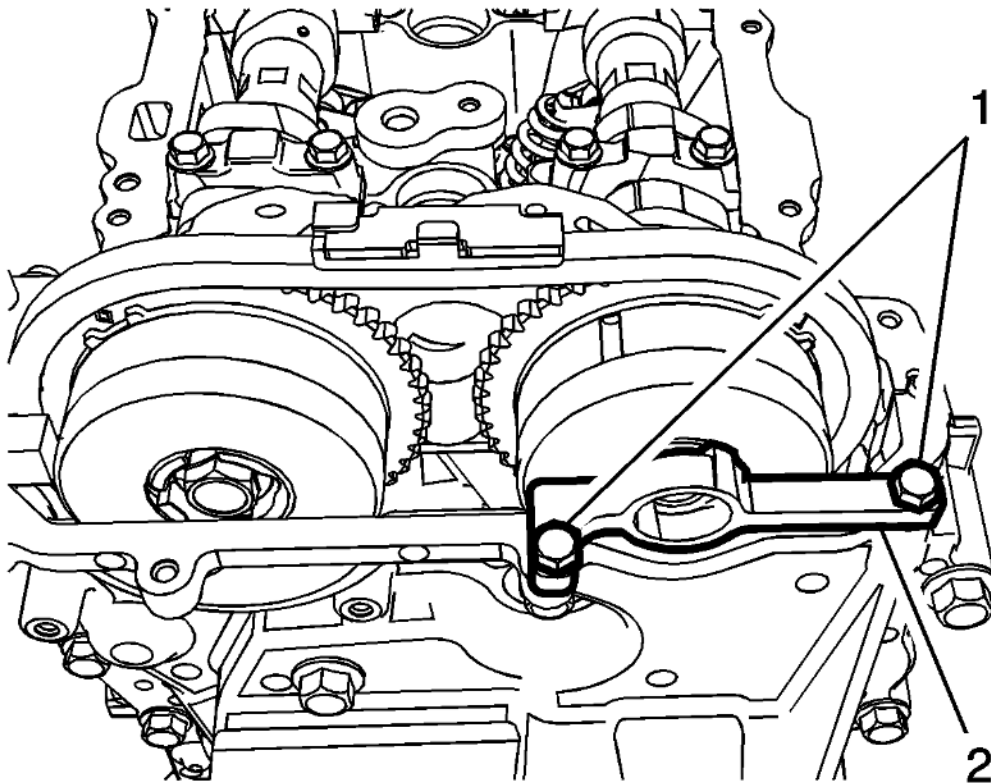


Fig. 154: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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).

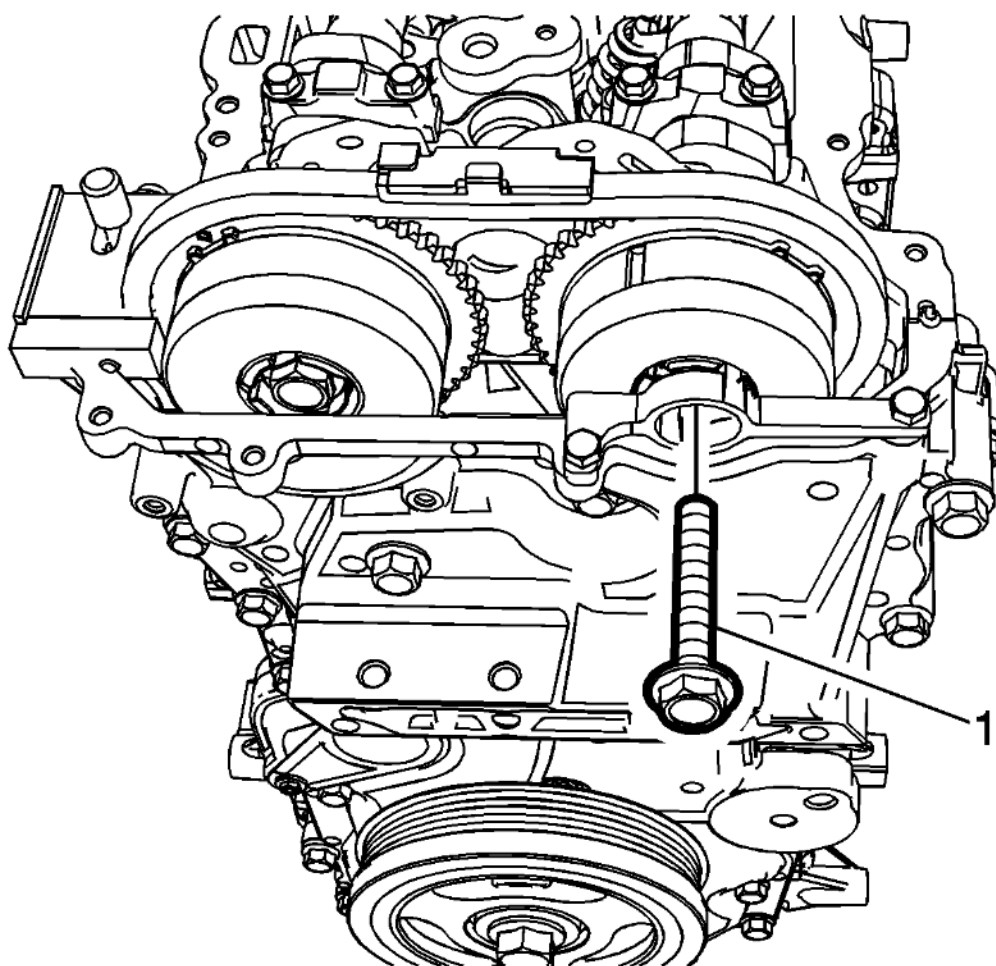


Fig. 155: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

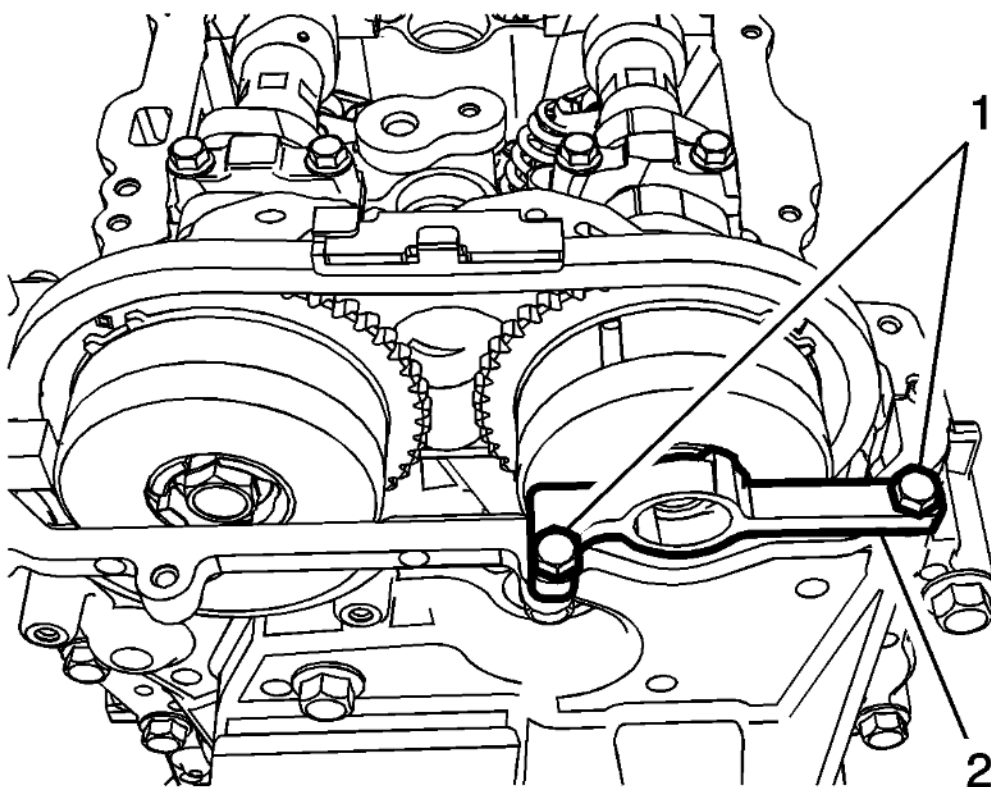


Fig. 156: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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

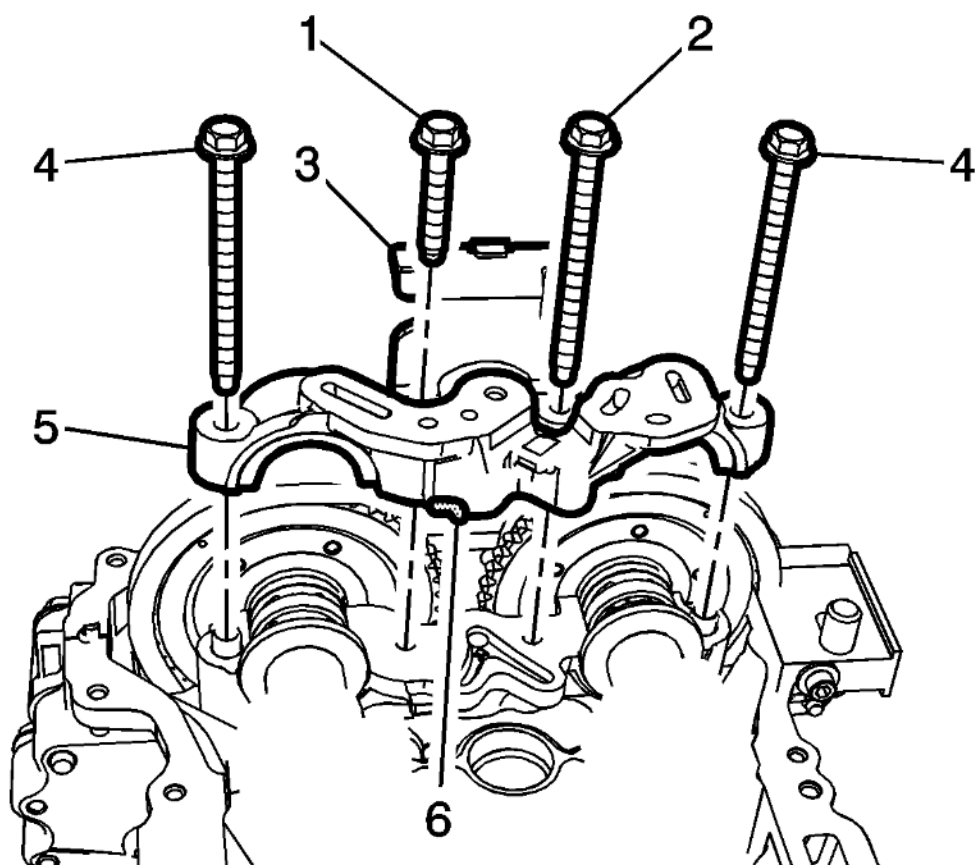


Fig. 157: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

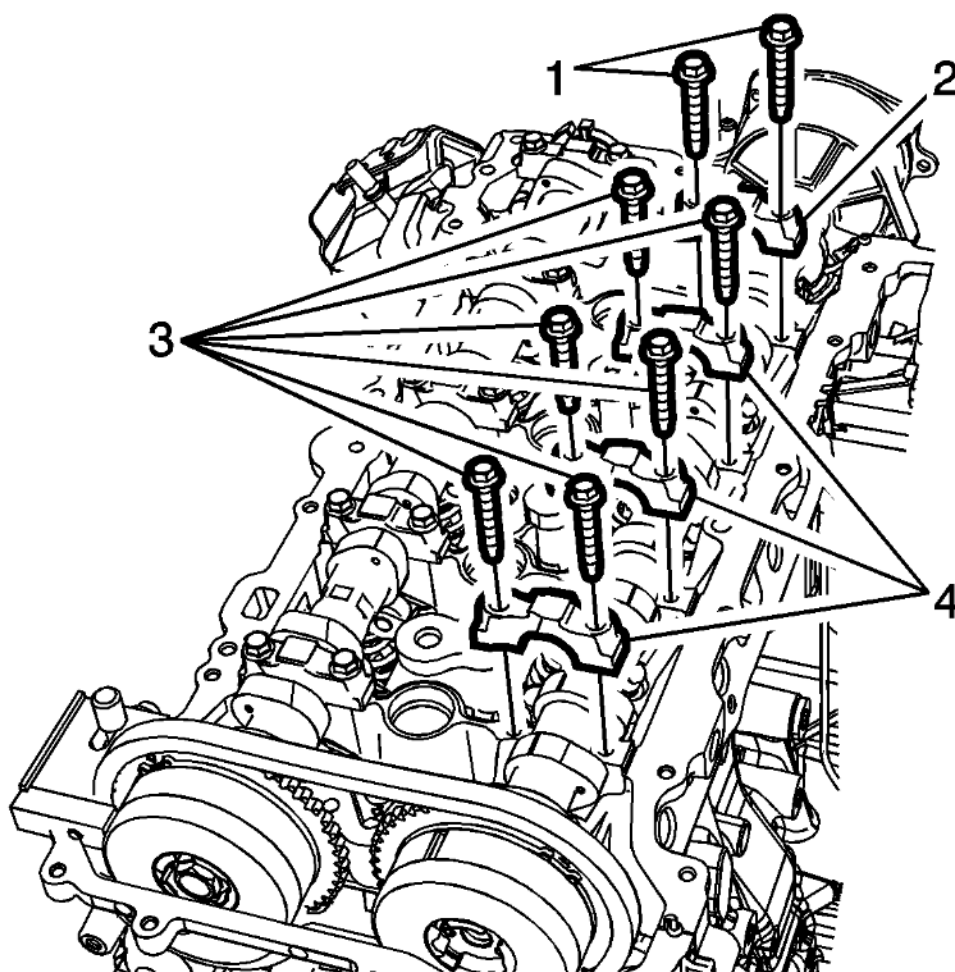


Fig. 158: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

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).

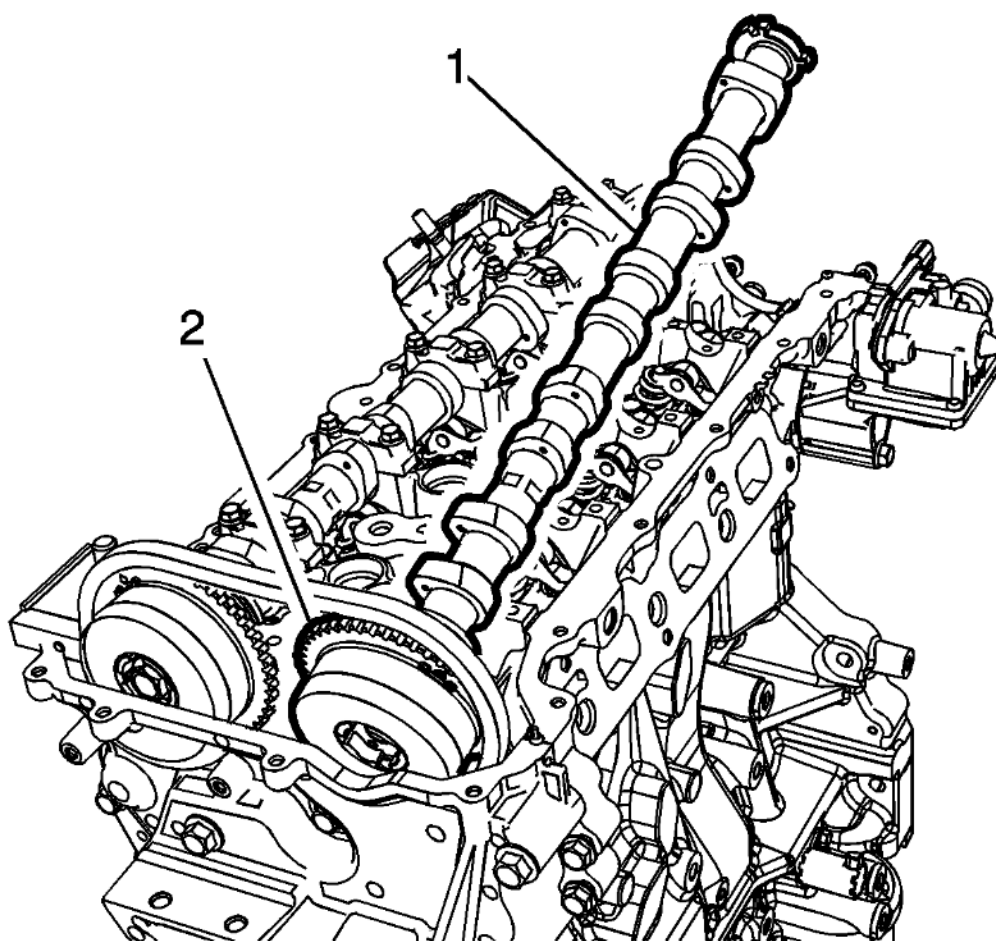


Fig. 159: Camshaft Assembly

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).

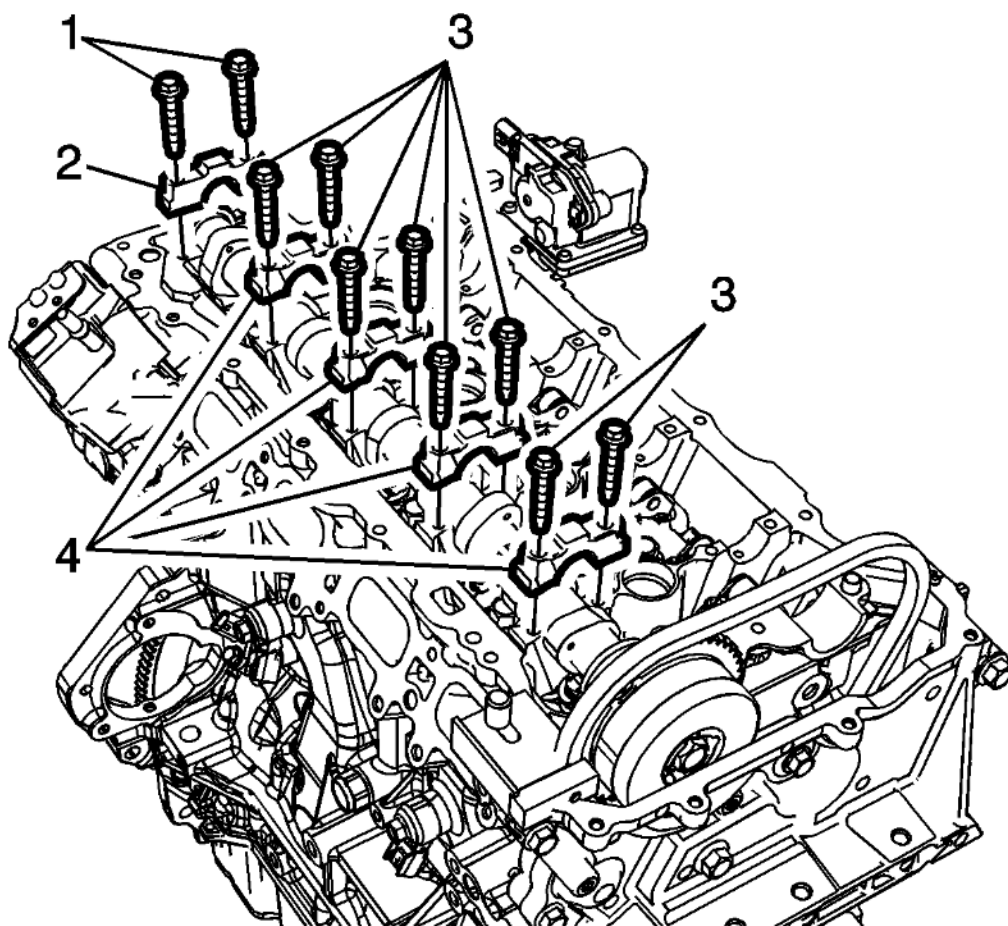


Fig. 160: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

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.

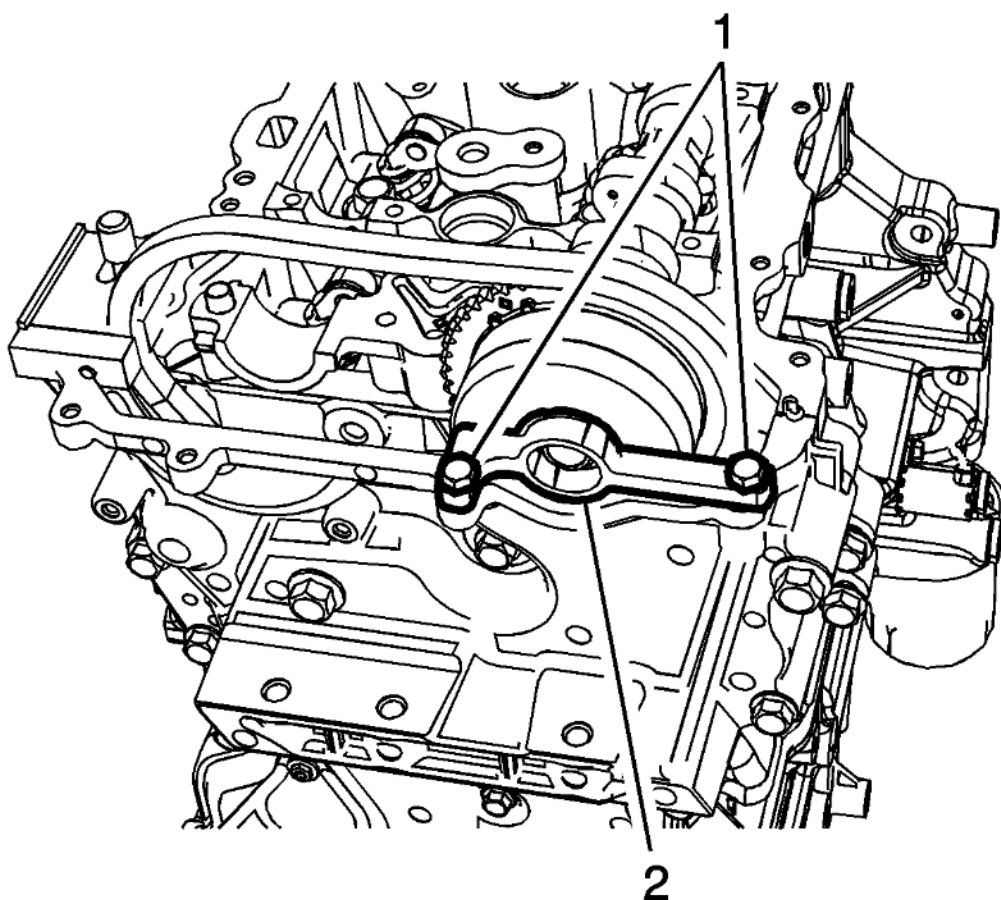


Fig. 161: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

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).

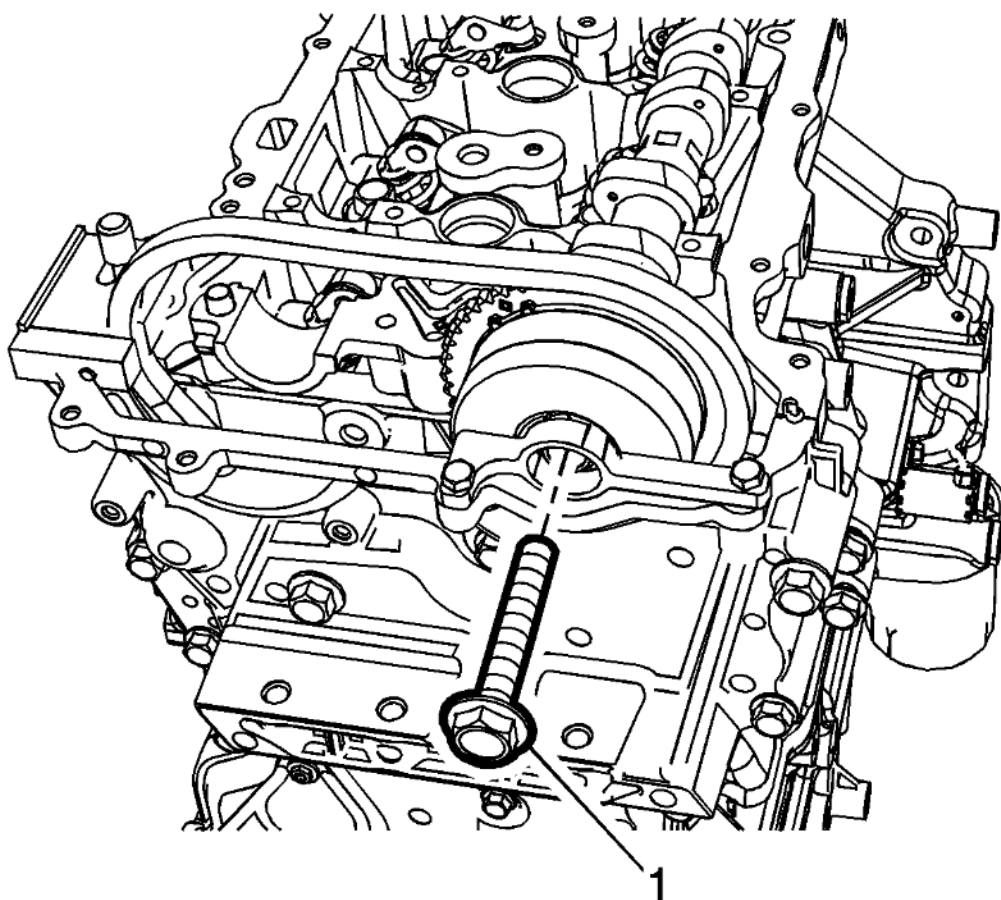


Fig. 162: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

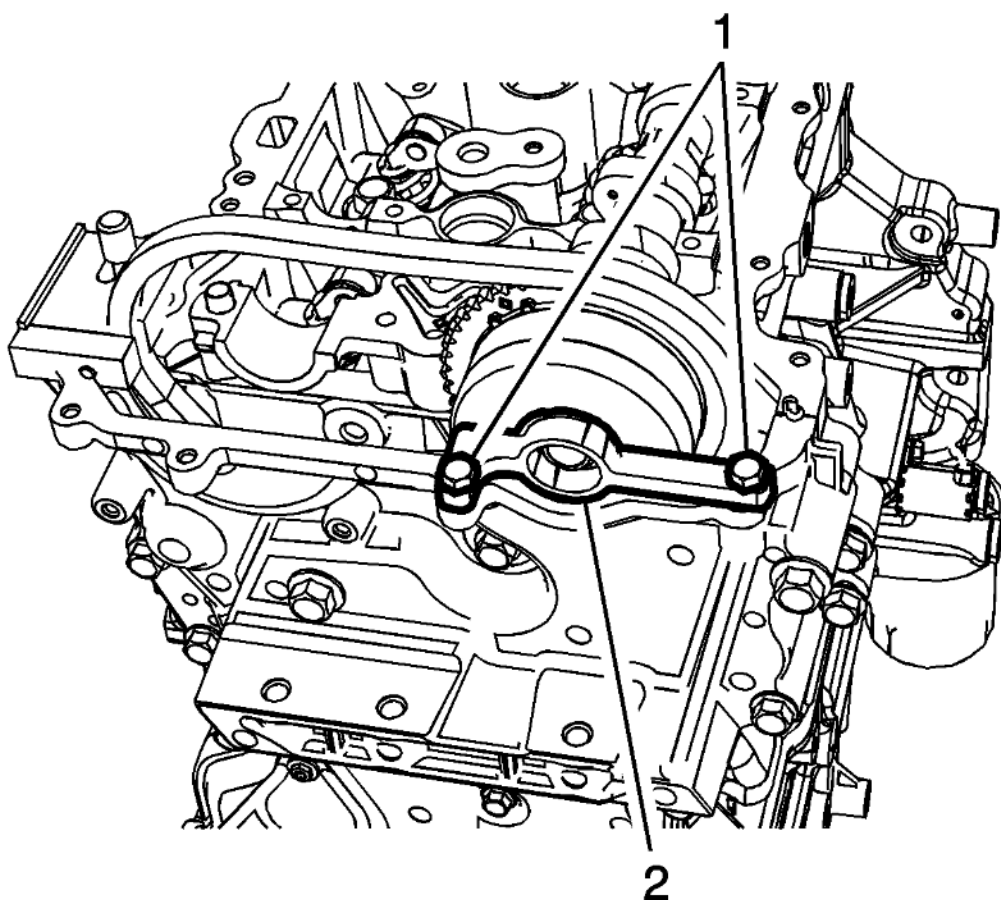


Fig. 163: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

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

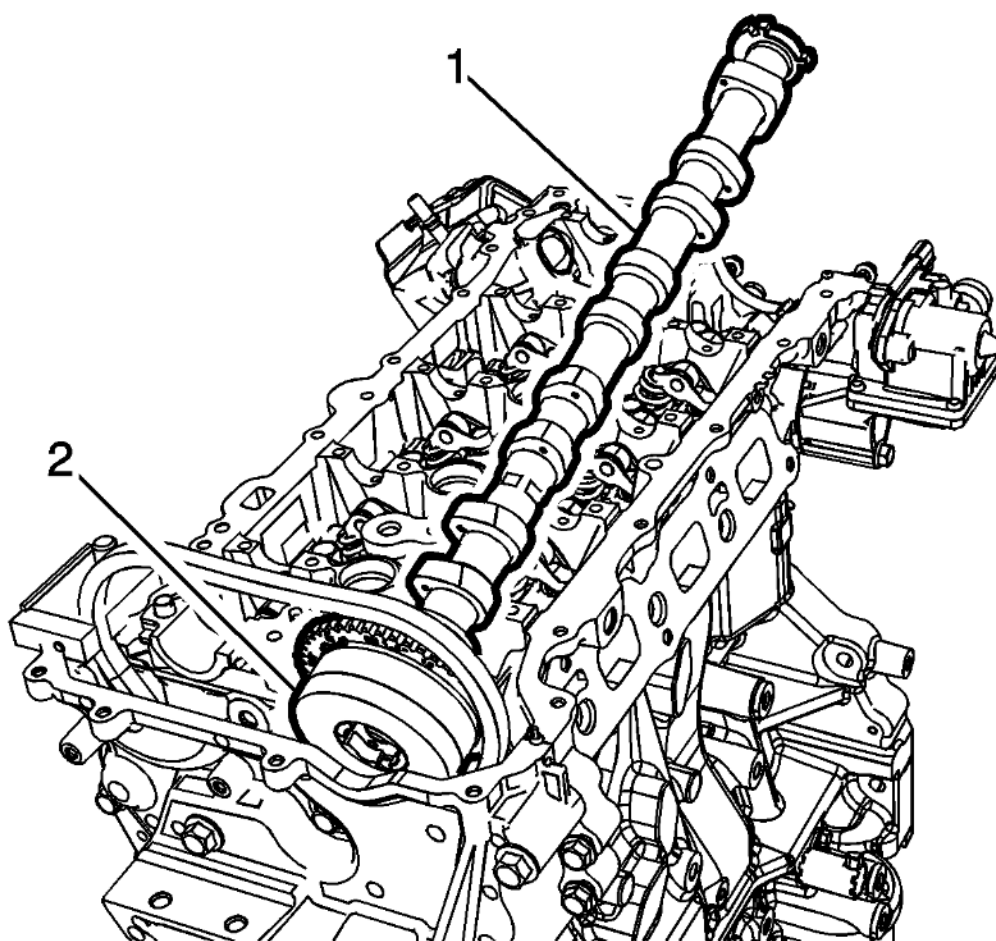


Fig. 164: Camshaft Assembly

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

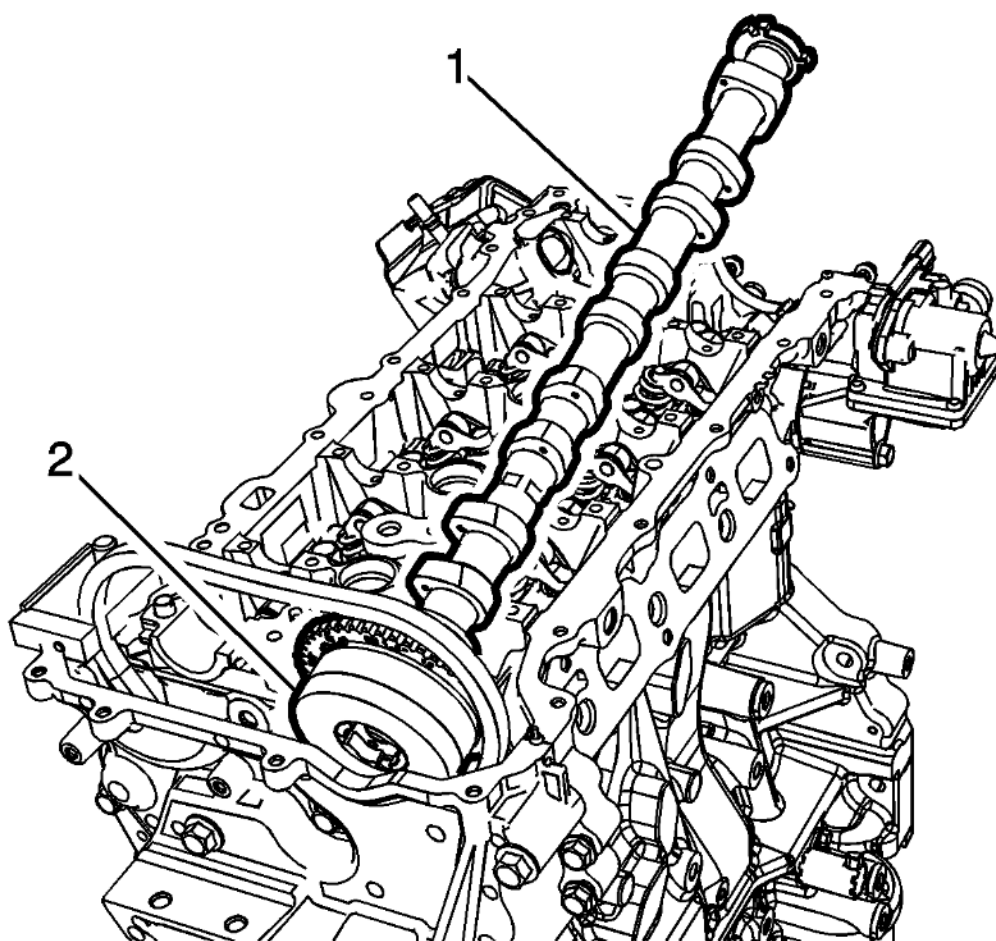


Fig. 165: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

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

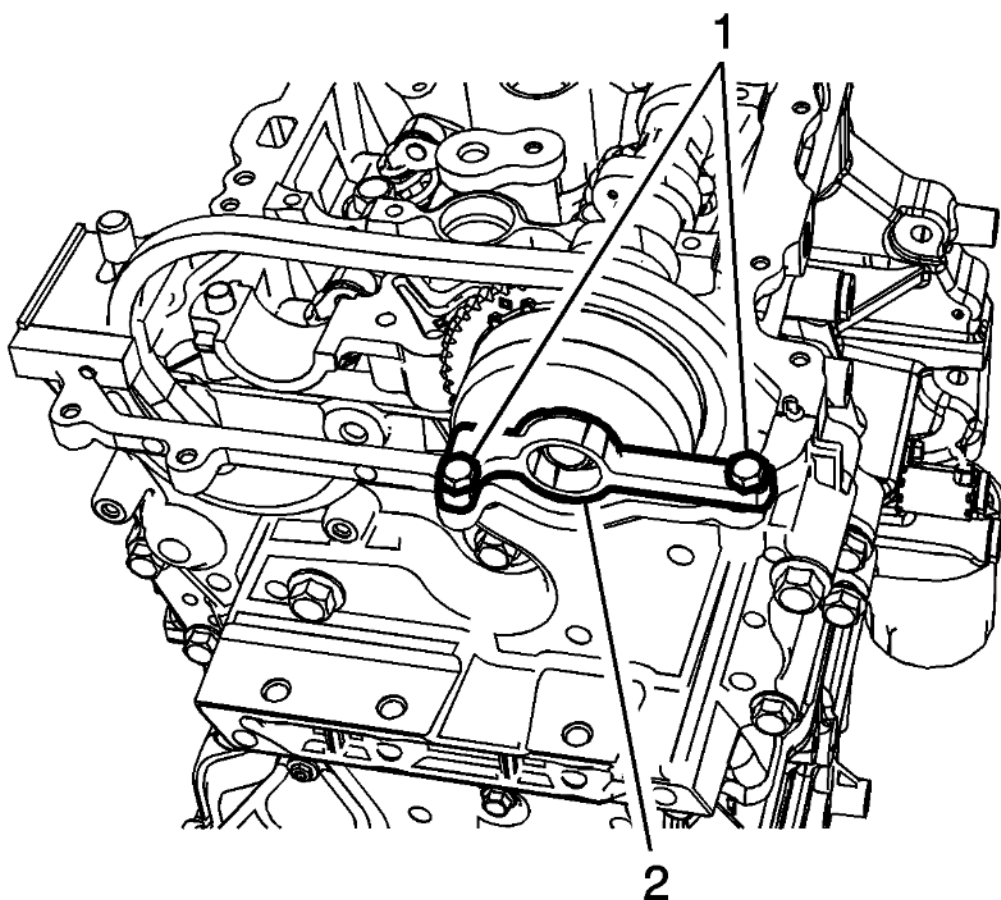


Fig. 166: Camshaft Actuator Locking Tool EN 50793
Courtesy of GENERAL MOTORS COMPANY

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).

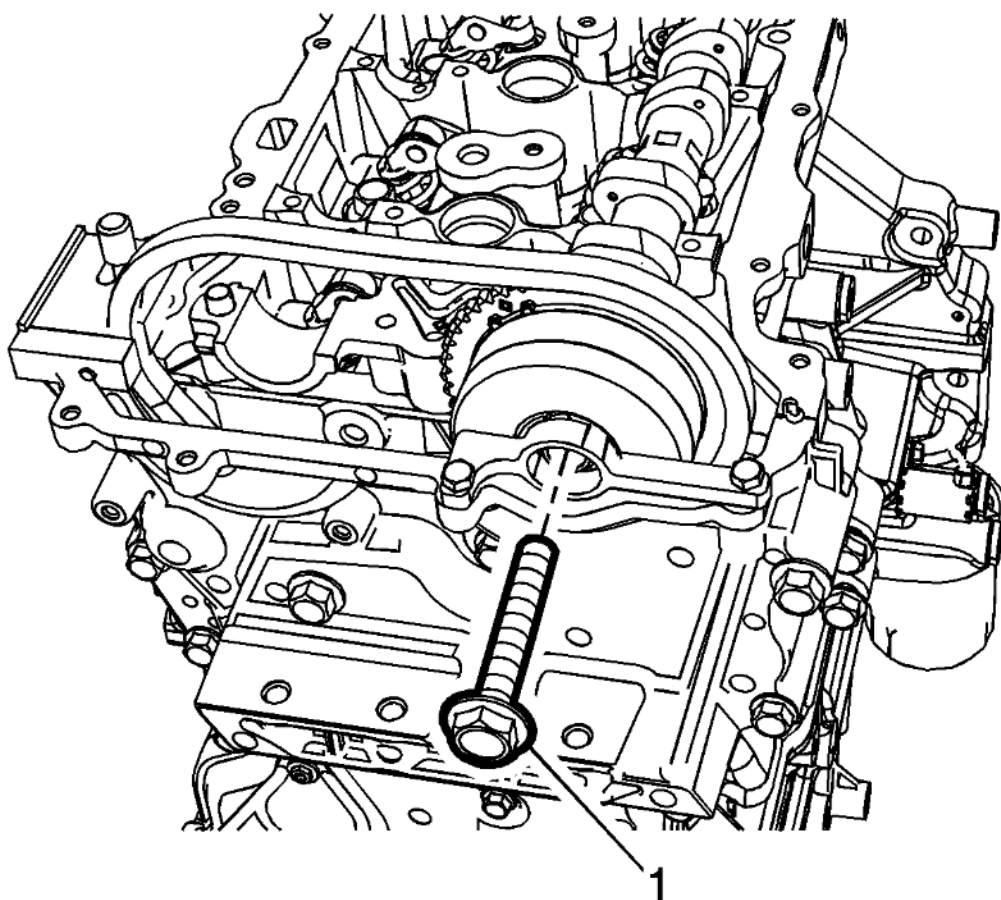


Fig. 167: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

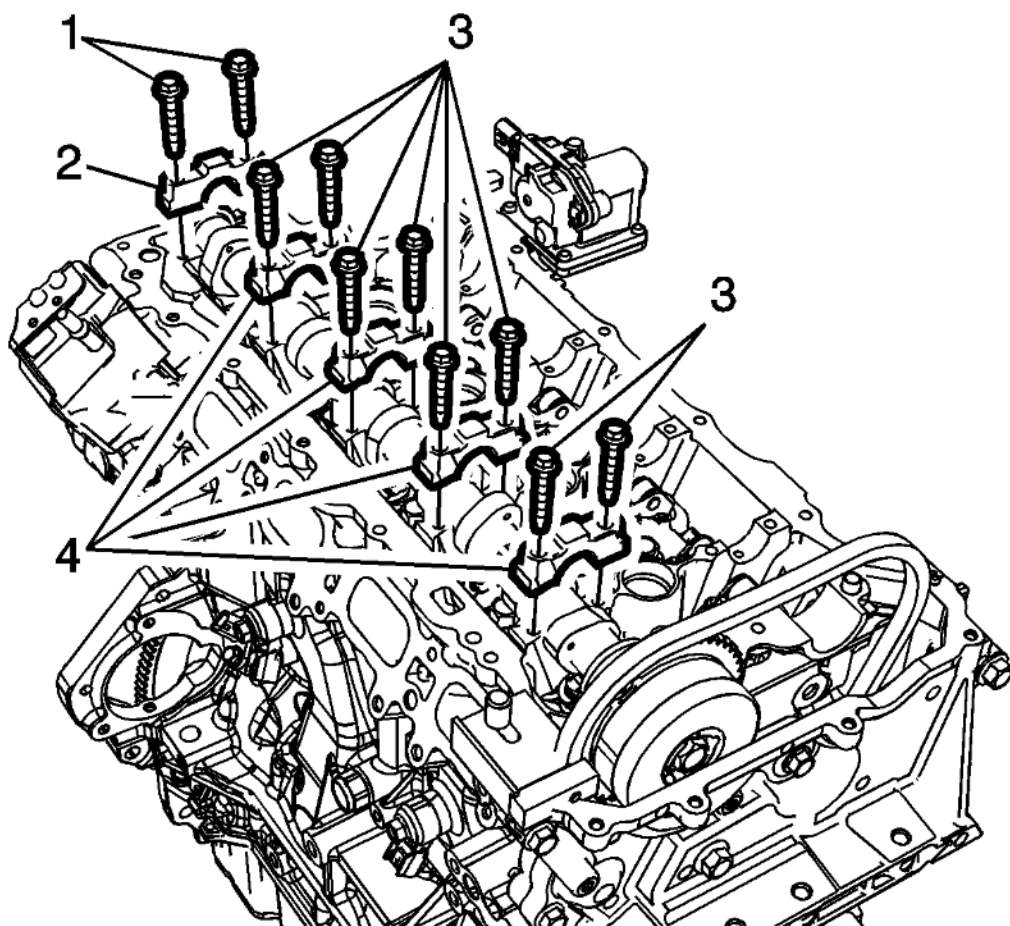


Fig. 168: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

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).

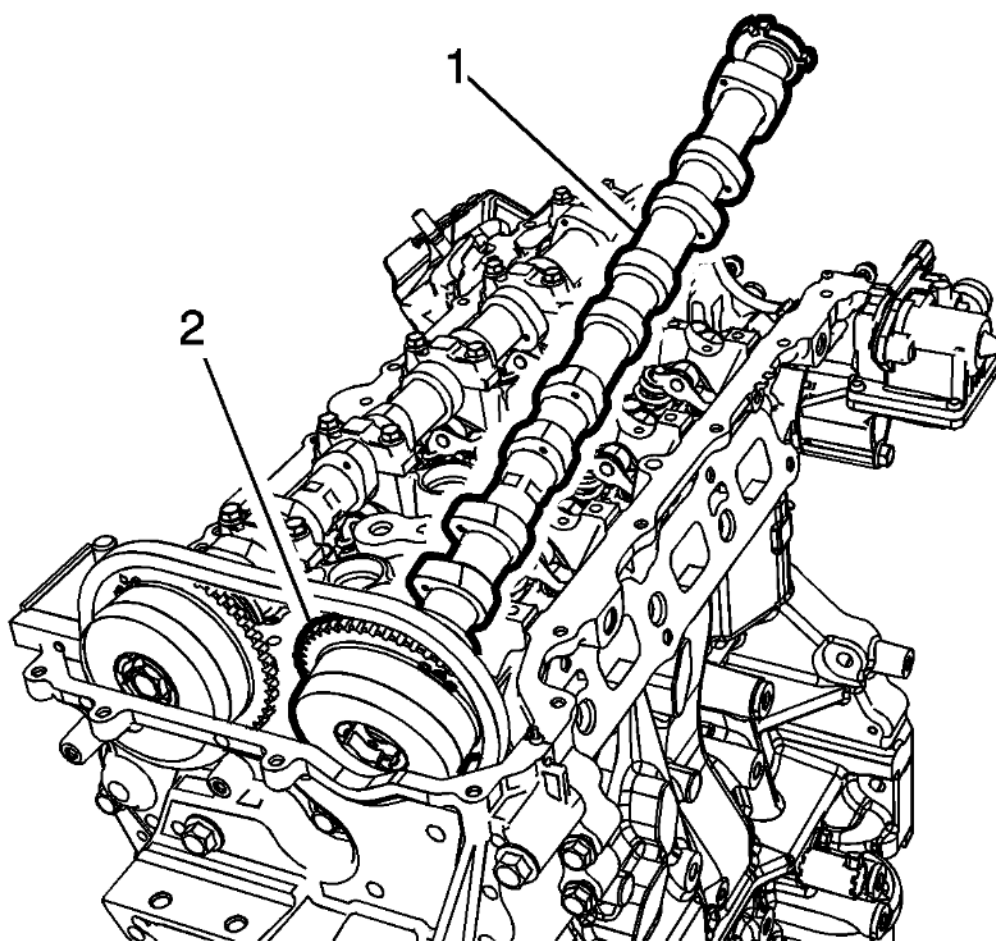


Fig. 169: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

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

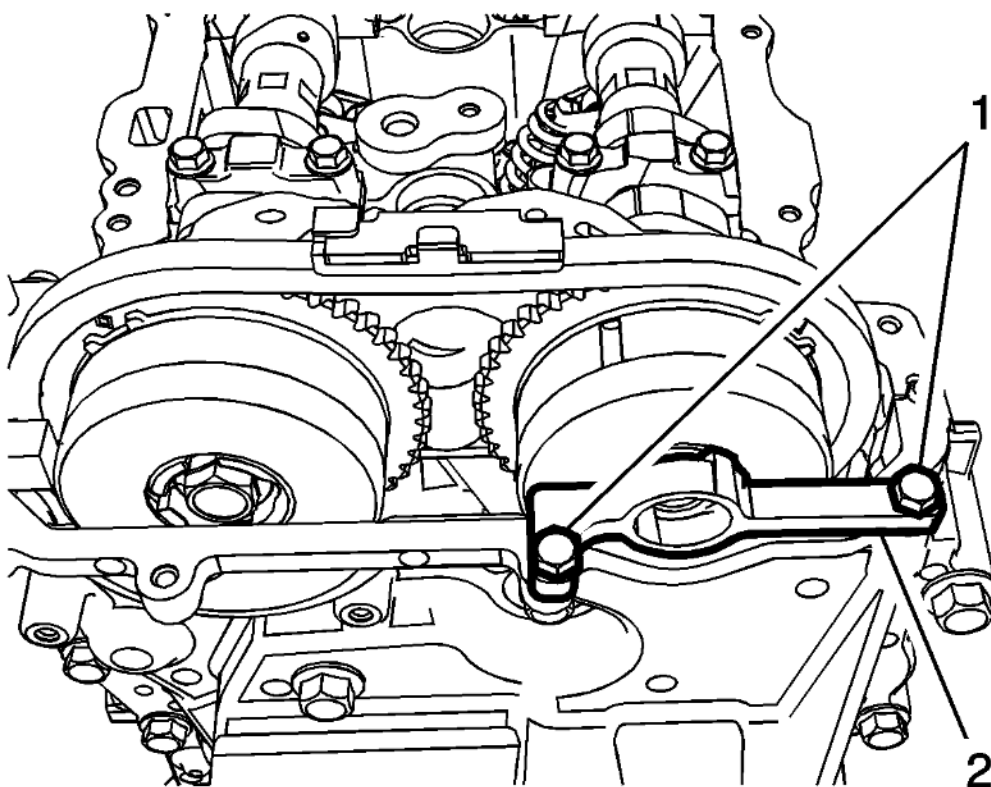


Fig. 170: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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).

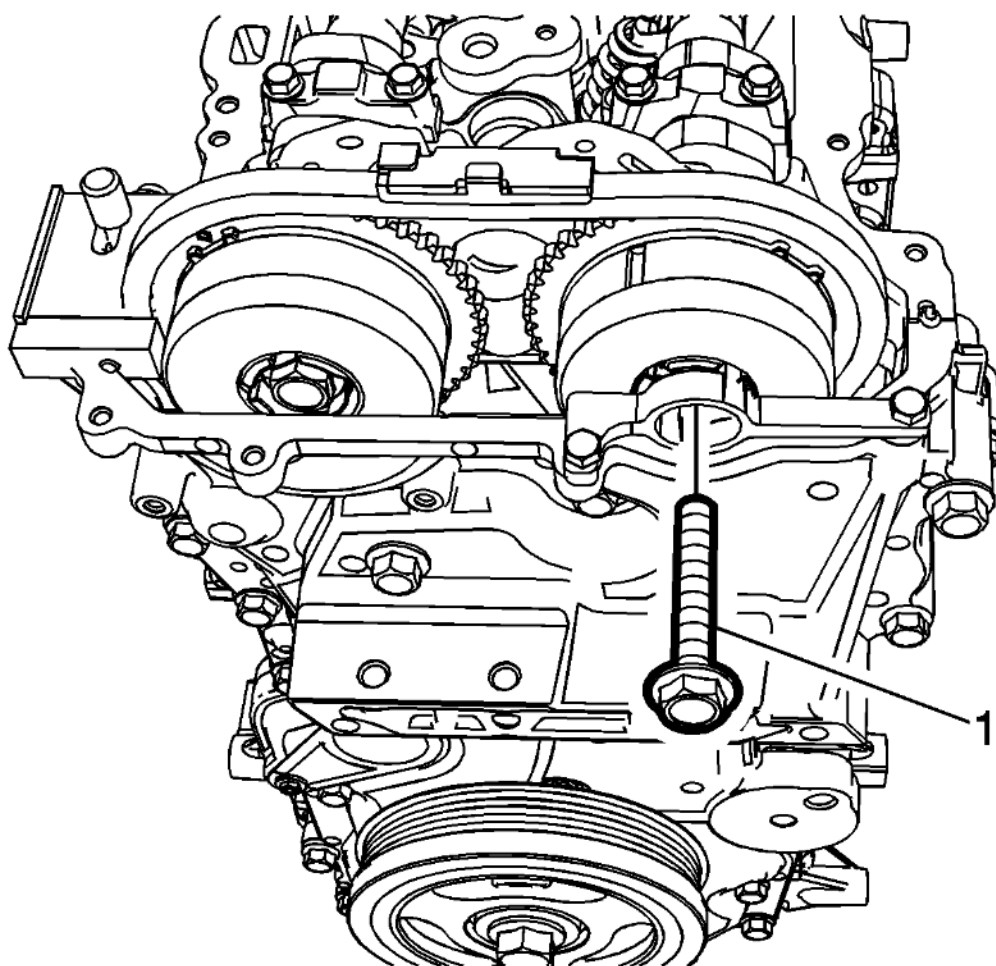


Fig. 171: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

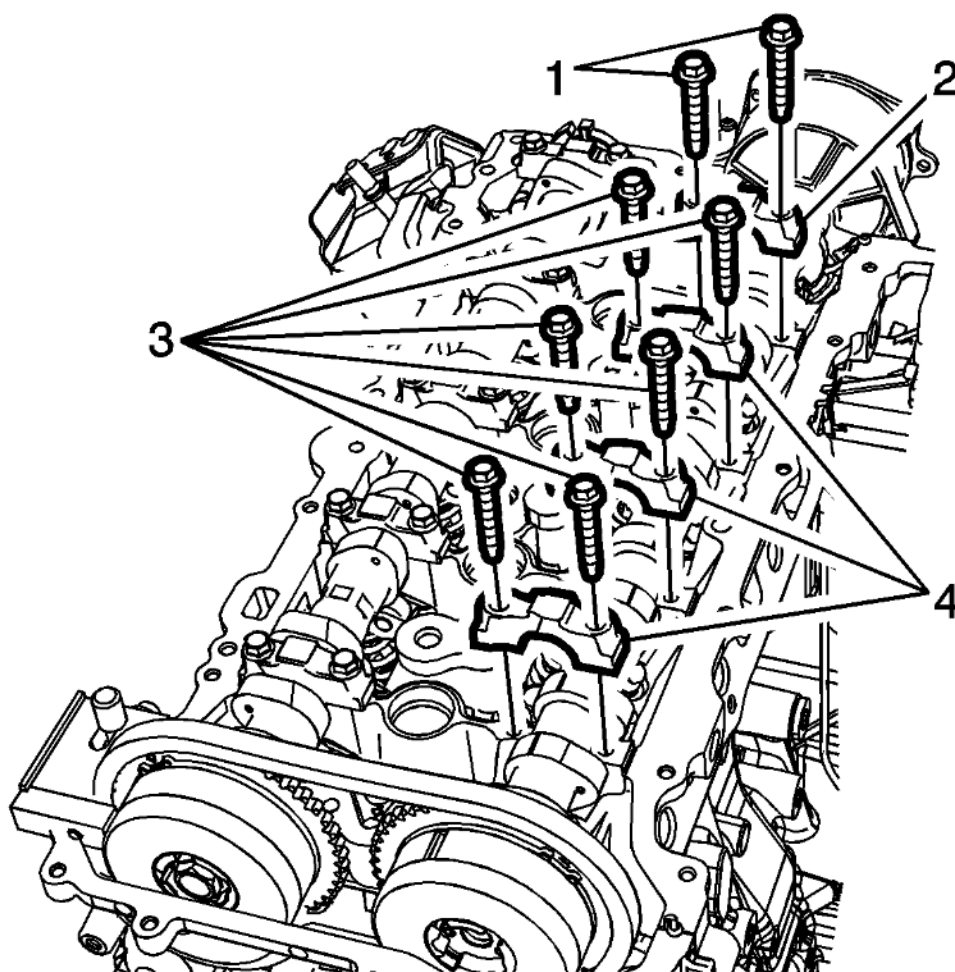


Fig. 172: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
 Courtesy of GENERAL MOTORS COMPANY

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 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.

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).

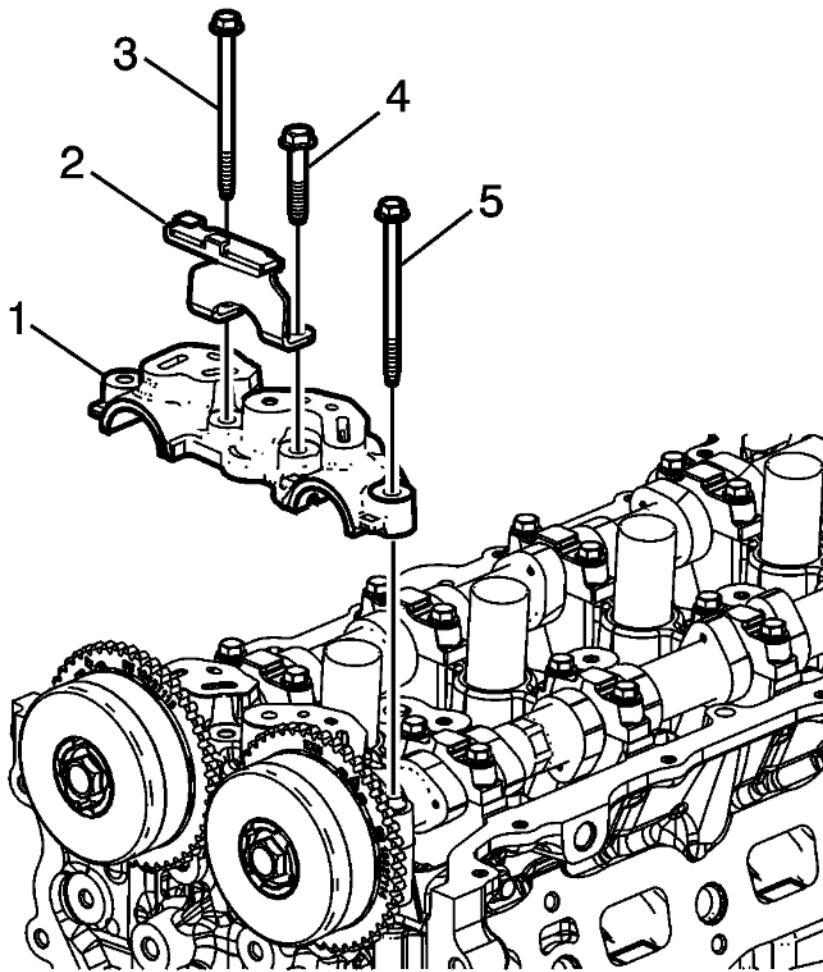


Fig. 173: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

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).

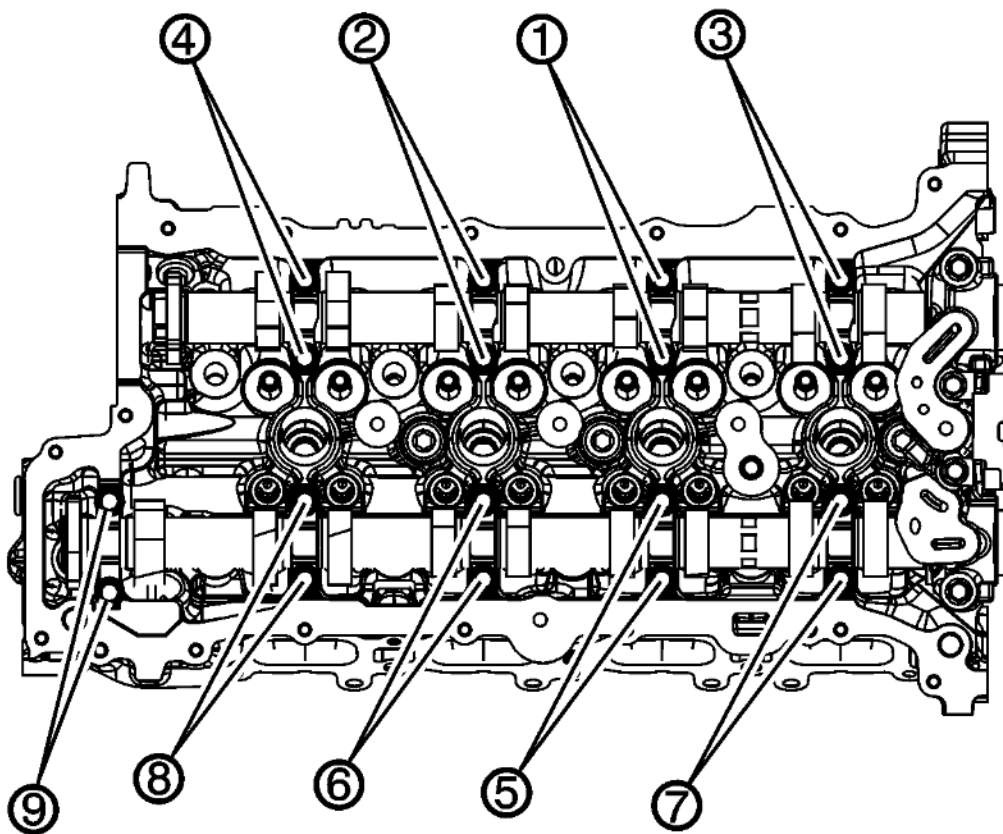


Fig. 174: Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

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.

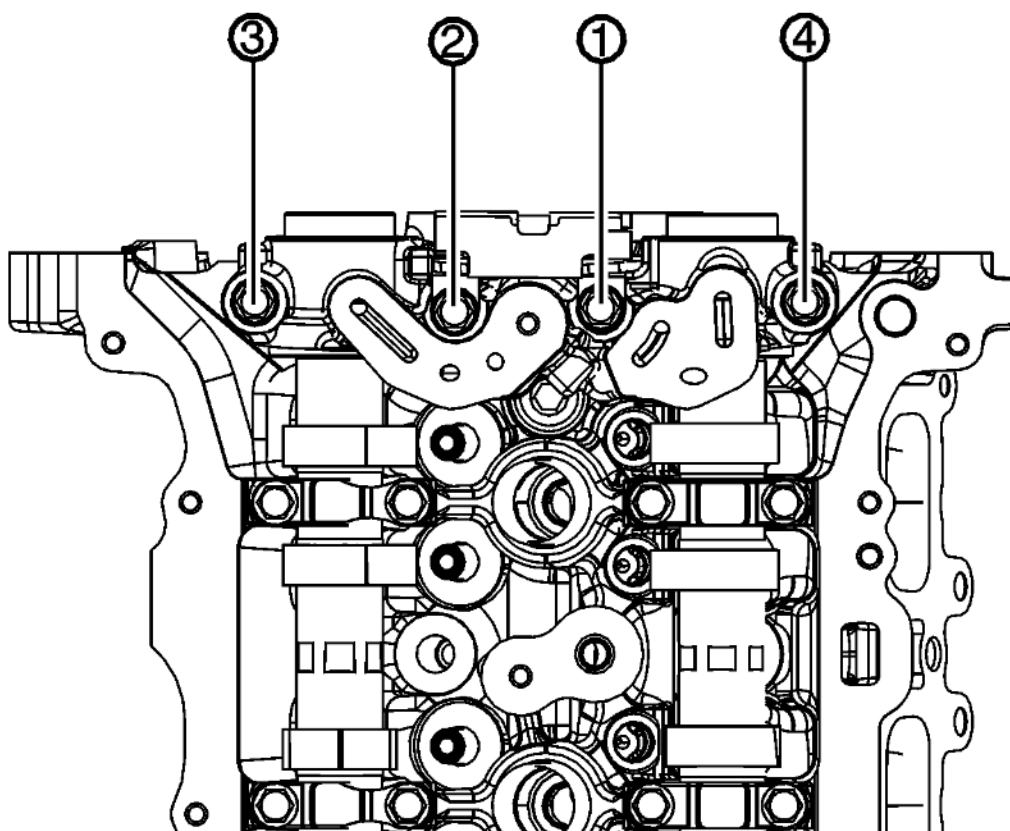


Fig. 175: Front Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

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

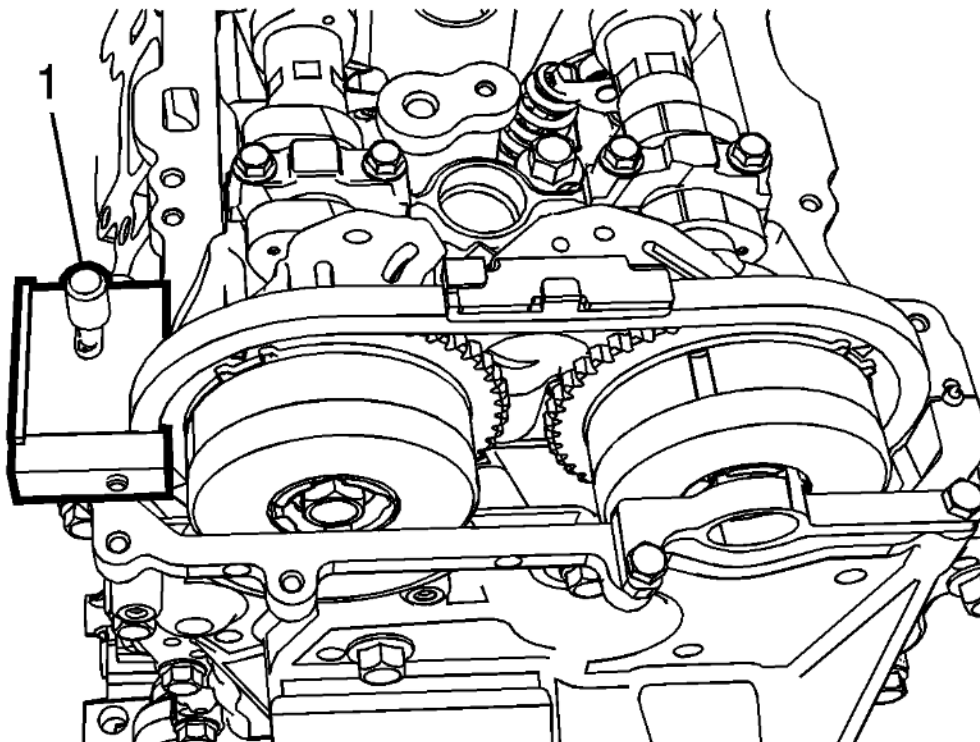


Fig. 176: Identifying EN-50656 Timing Chain Holding Tool
 Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**, **Camshaft Cover Replacement (LTG)**.
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.

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LCV), Camshaft Cover Replacement (LTG).

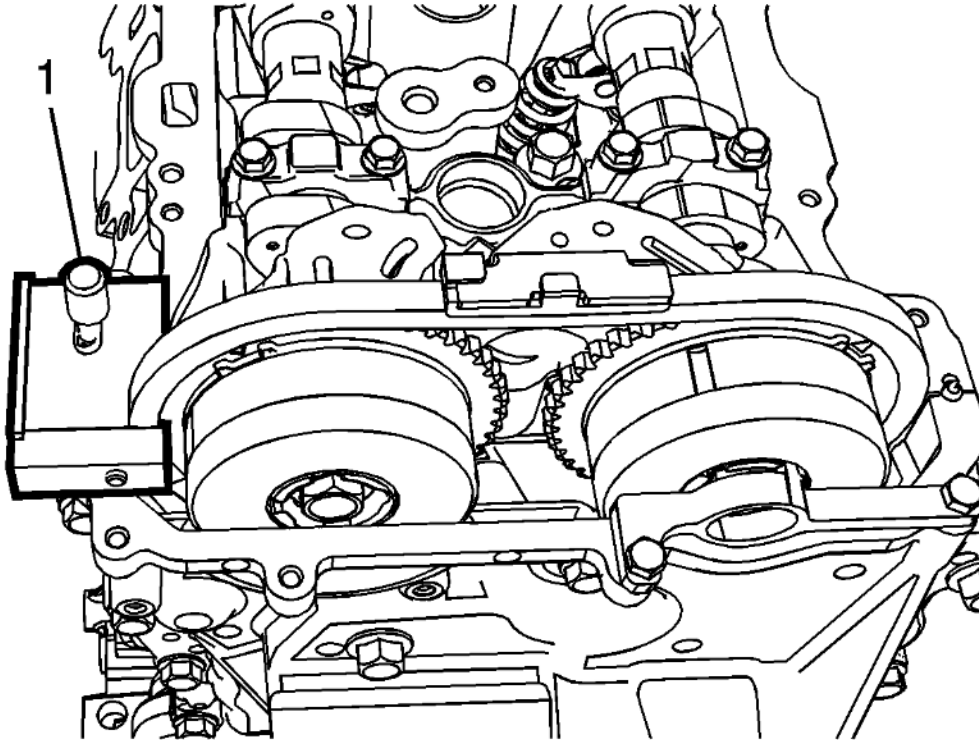


Fig. 177: Identifying EN-50656 Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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.

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

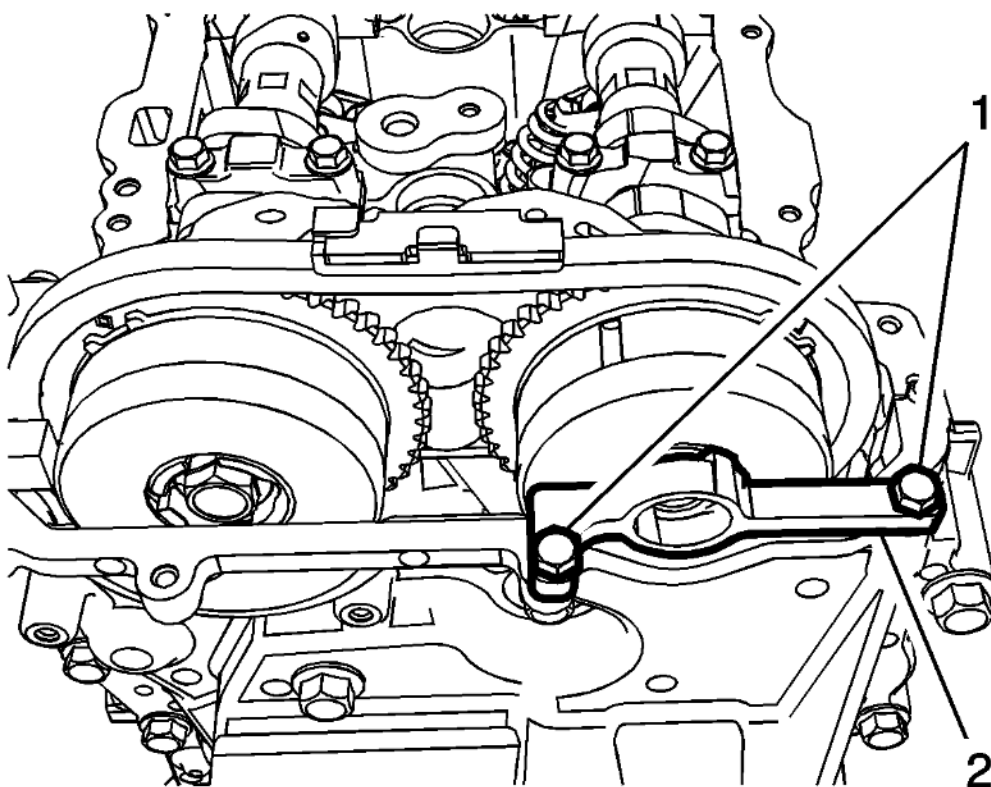


Fig. 178: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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).

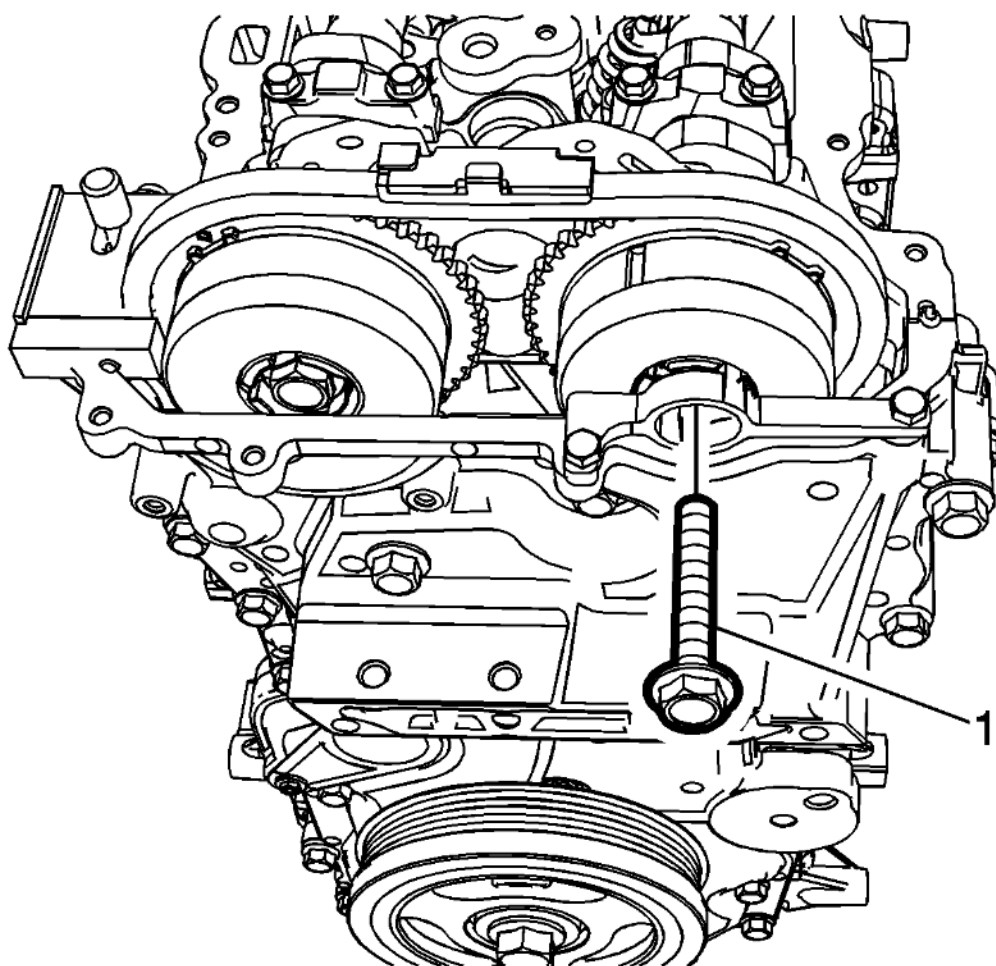


Fig. 179: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

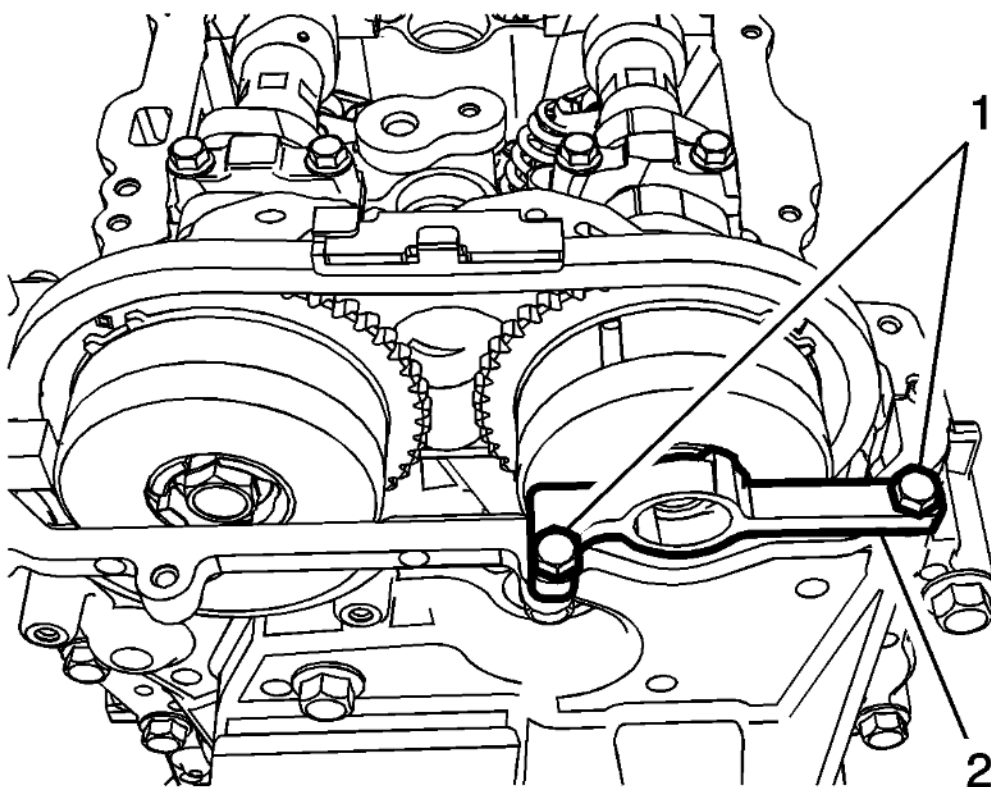


Fig. 180: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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

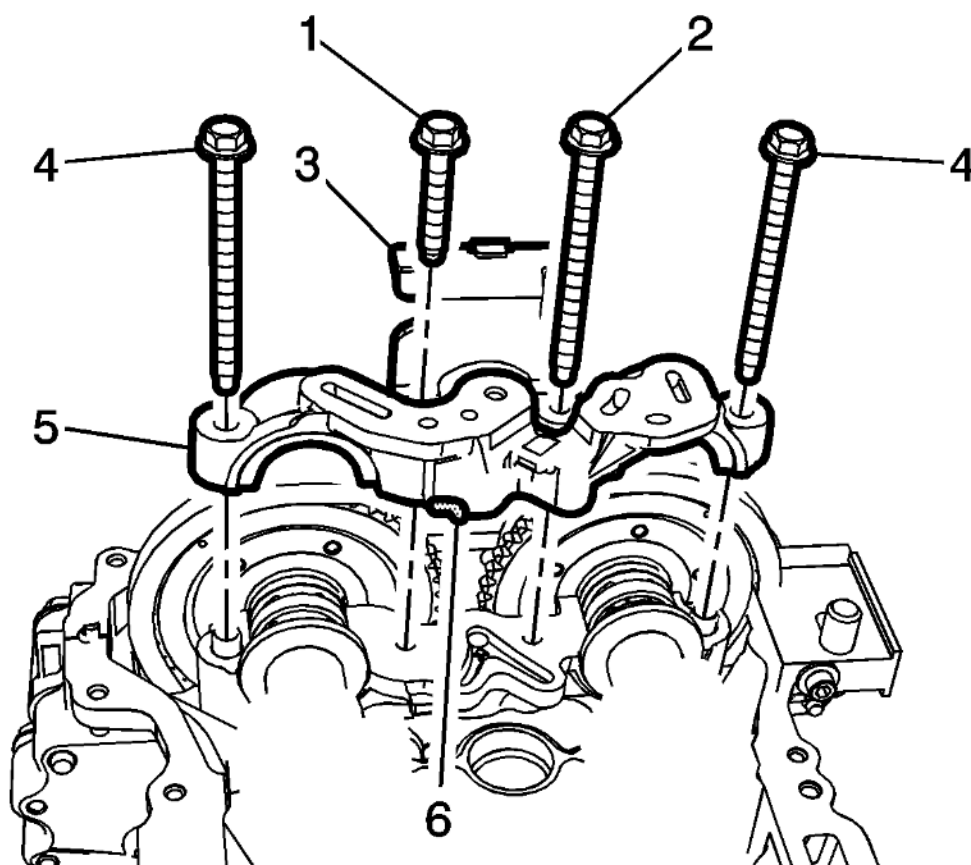


Fig. 181: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

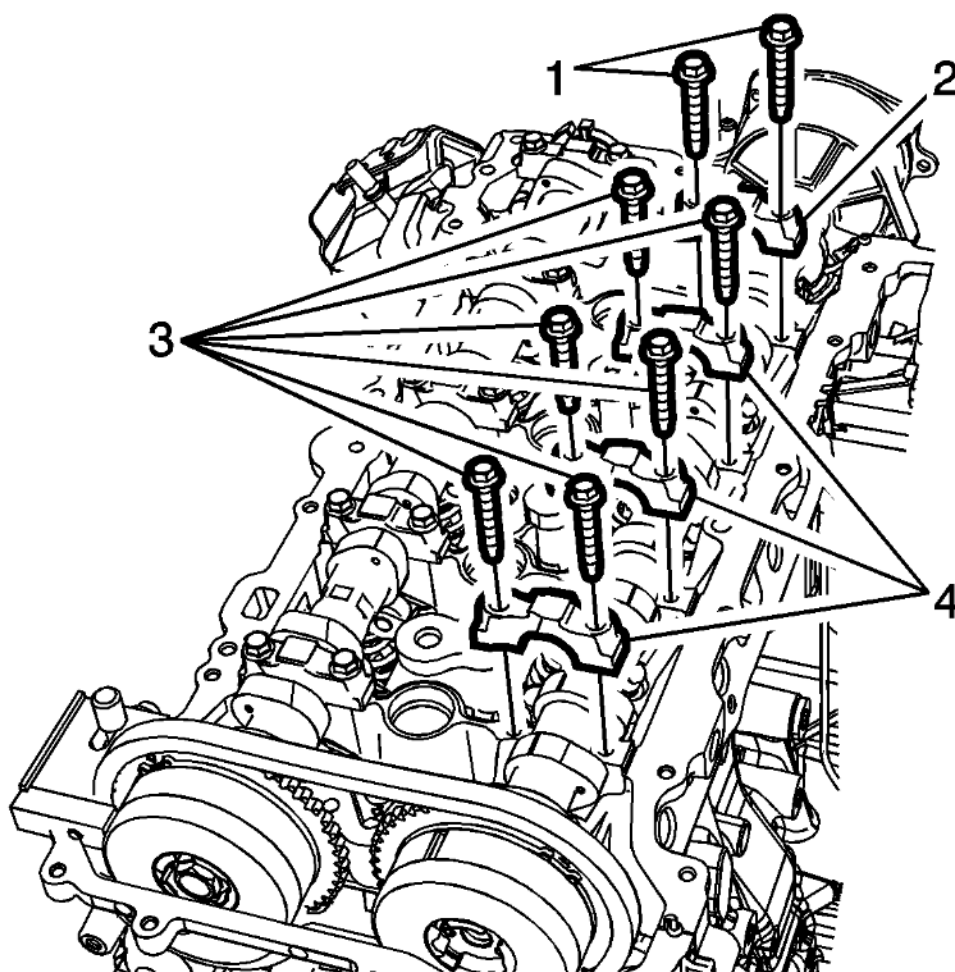


Fig. 182: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

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).

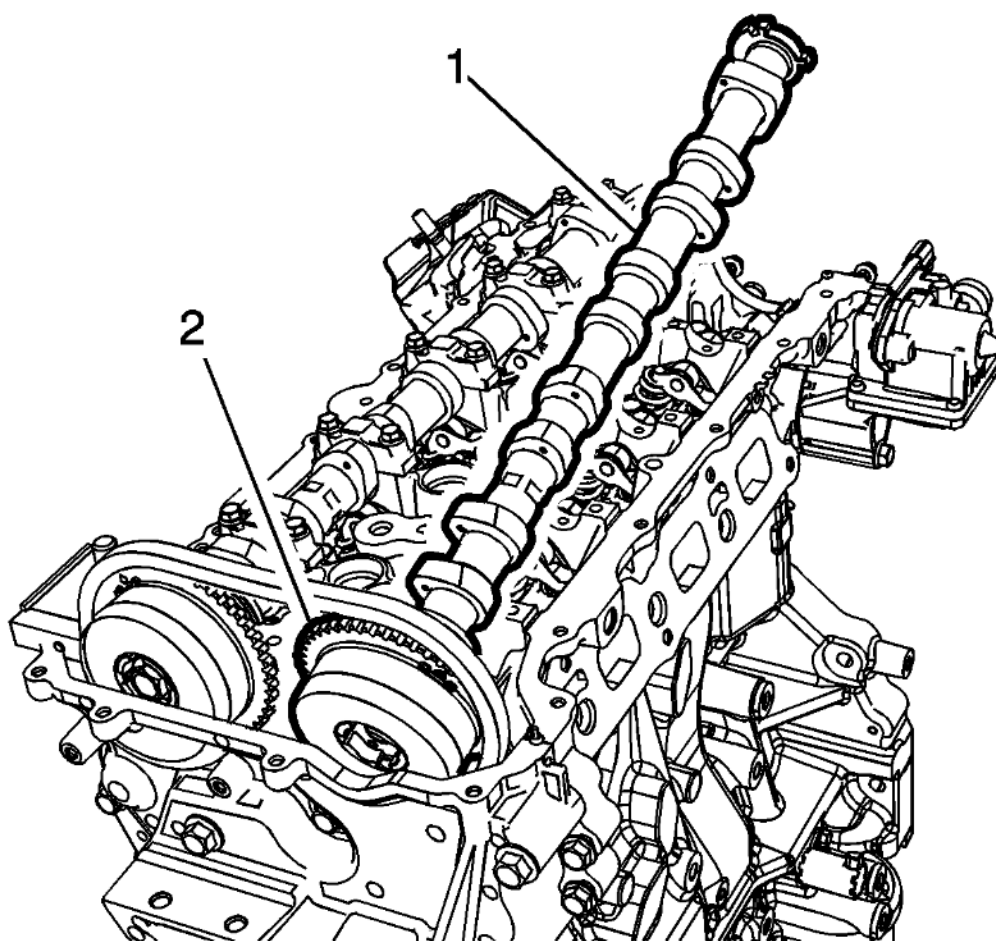


Fig. 183: Camshaft Assembly

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

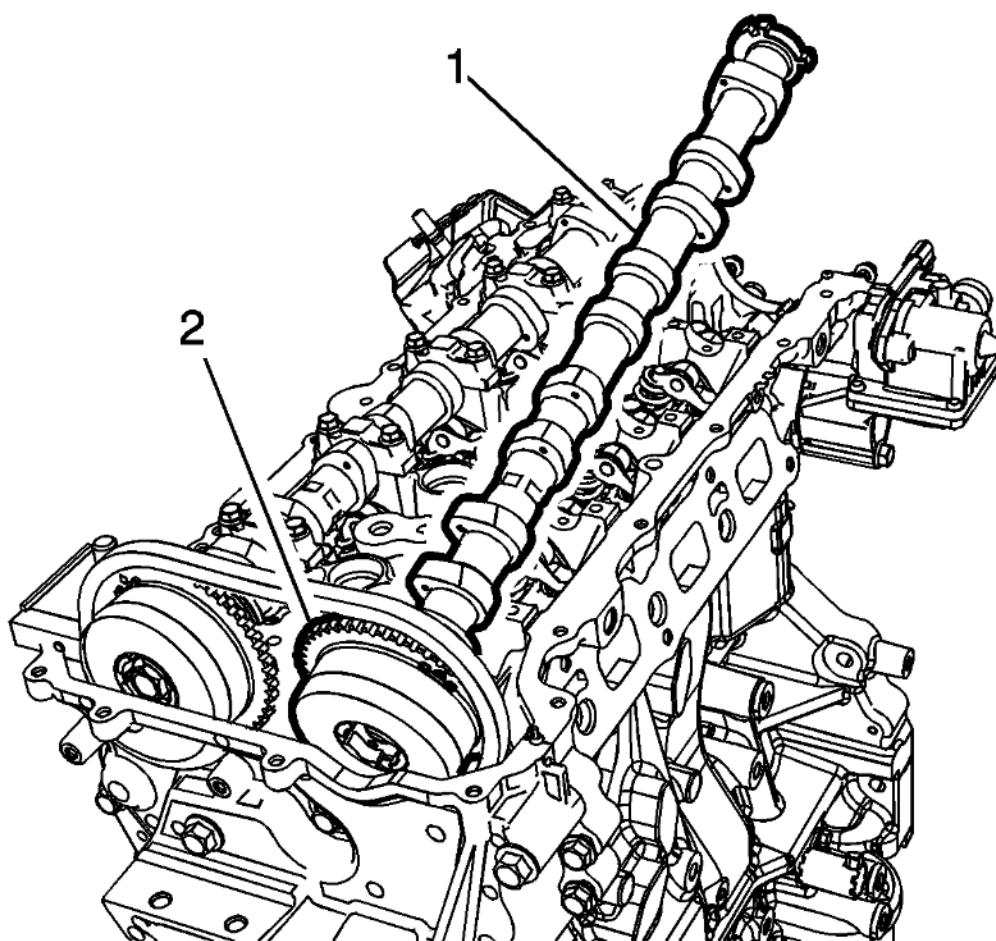


Fig. 184: Camshaft Assembly

Courtesy of GENERAL MOTORS COMPANY

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

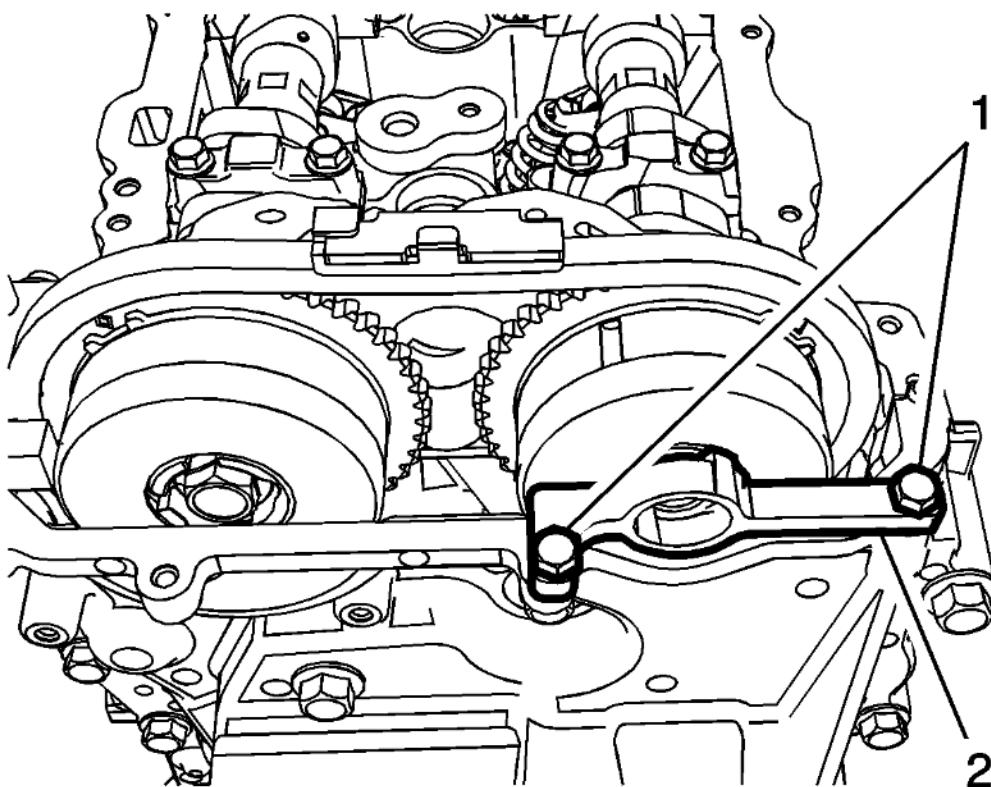


Fig. 185: Install Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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).

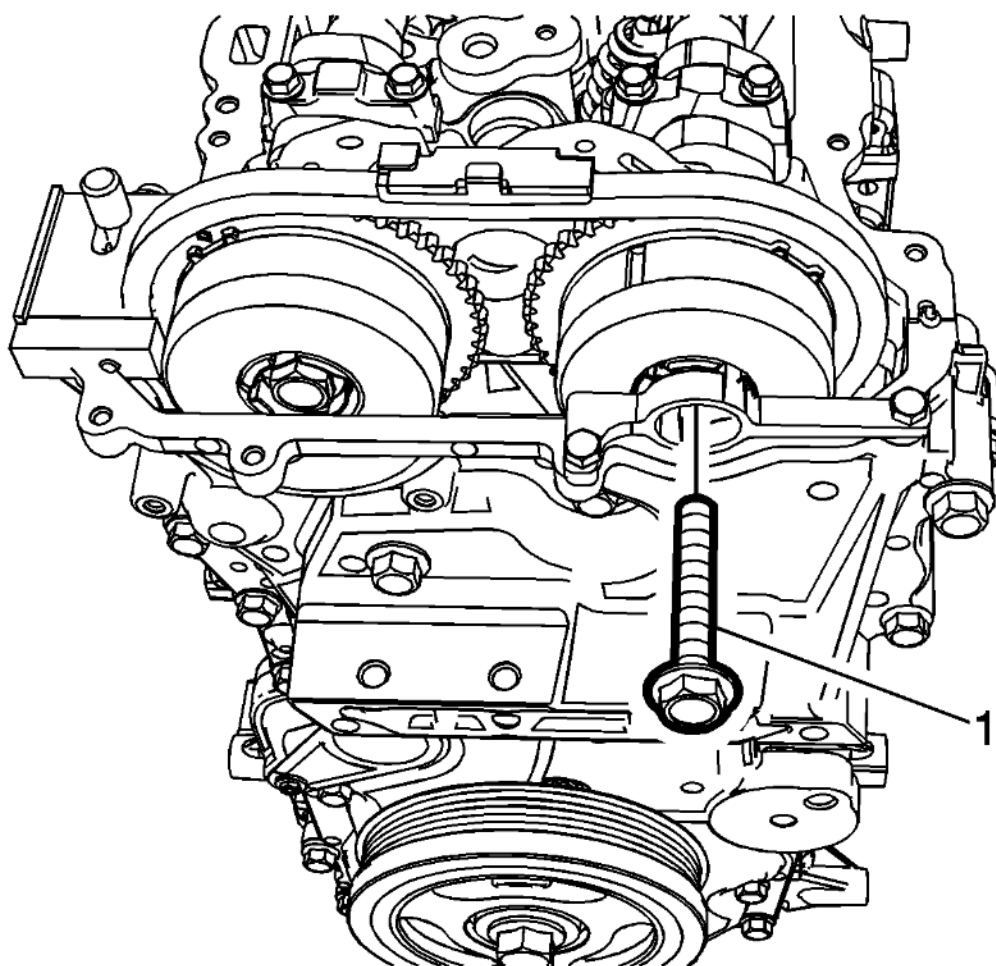


Fig. 186: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

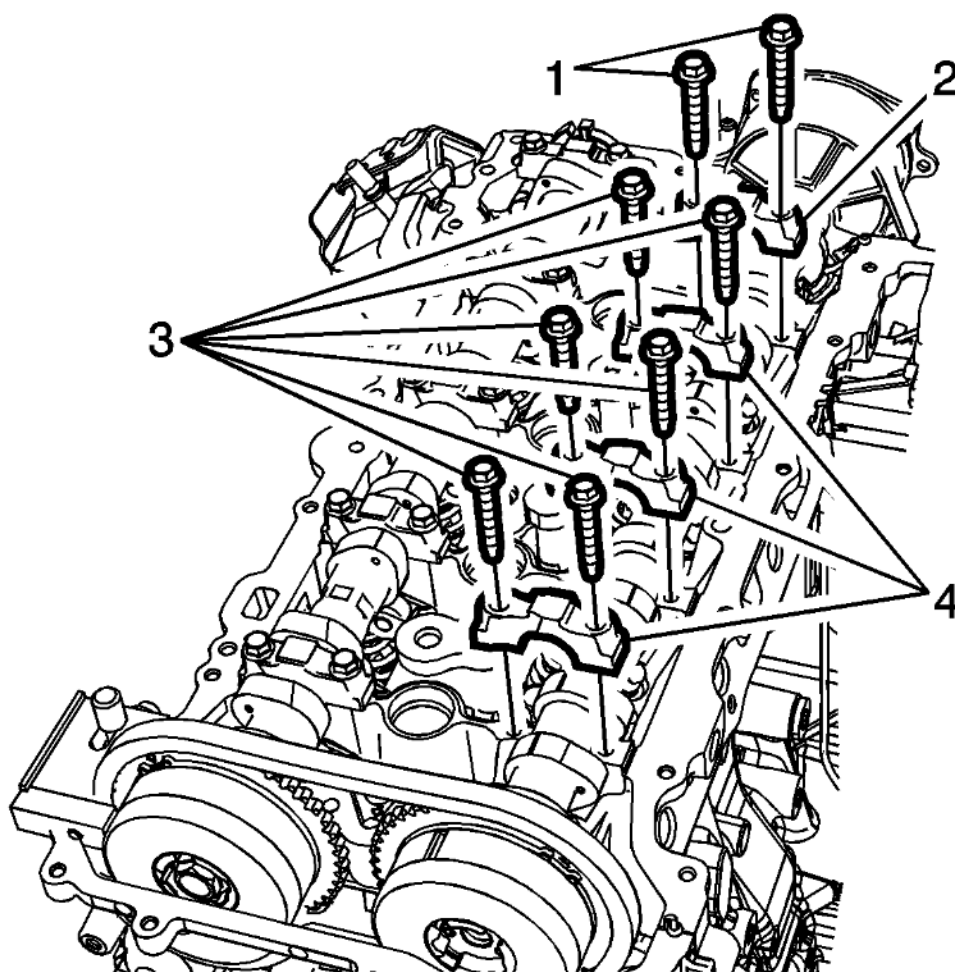


Fig. 187: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

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 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.

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).

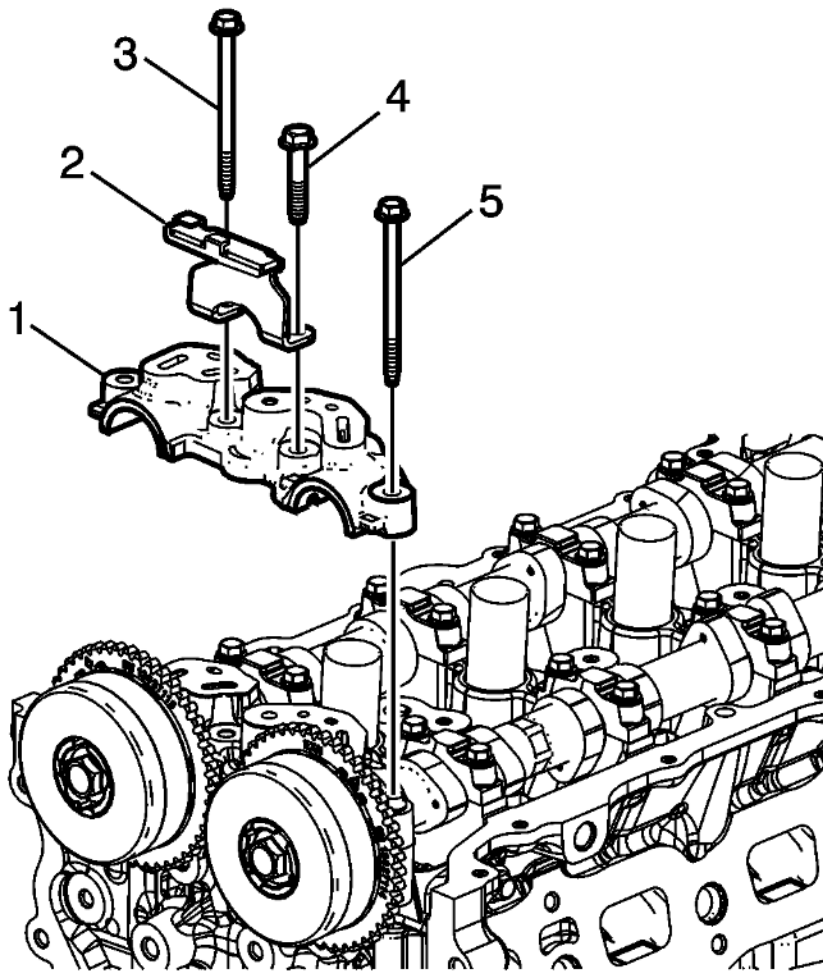


Fig. 188: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

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).

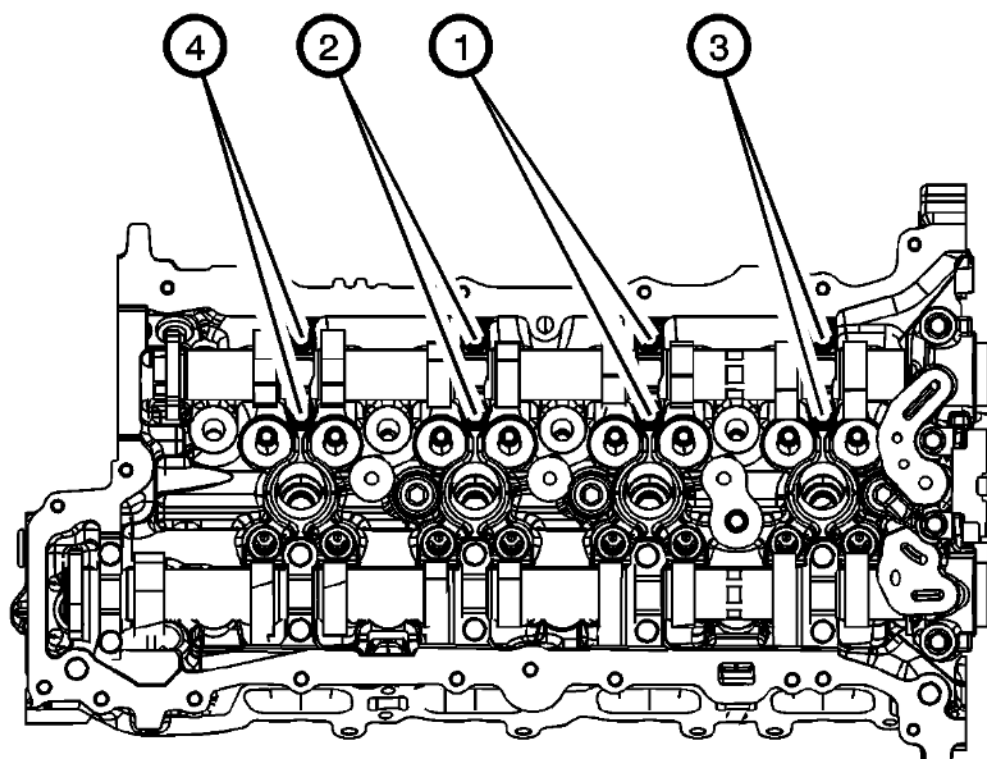


Fig. 189: Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

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. 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.

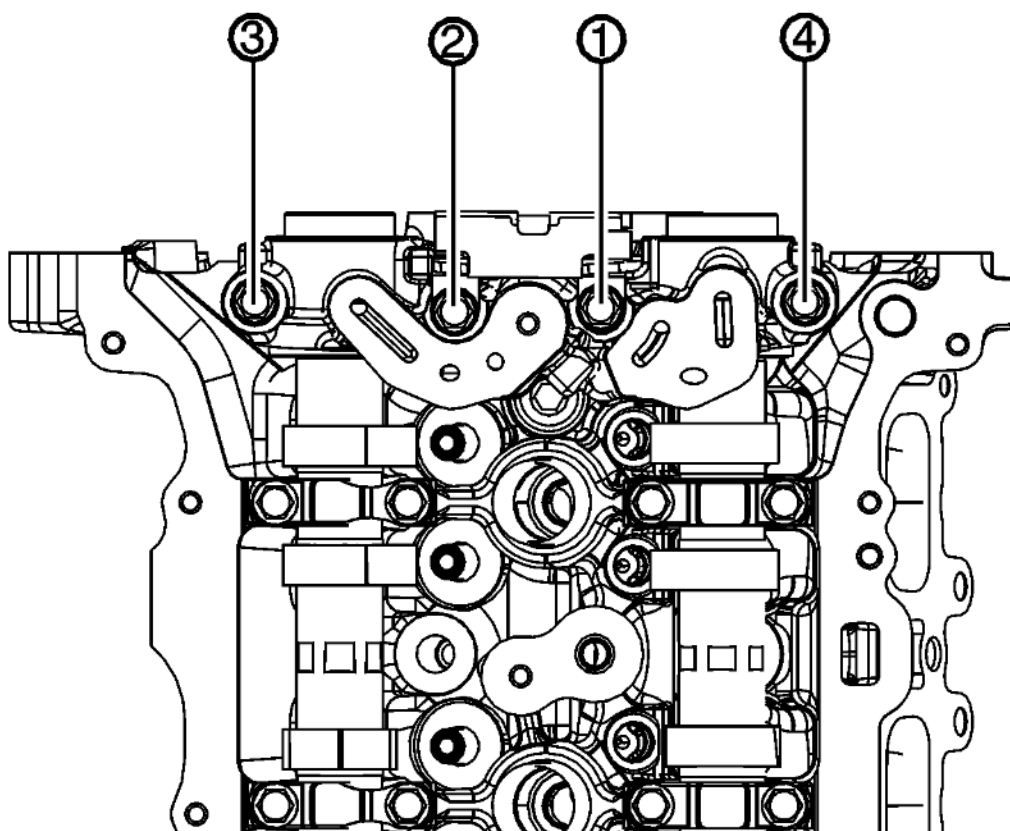


Fig. 190: Front Camshaft Cap Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

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

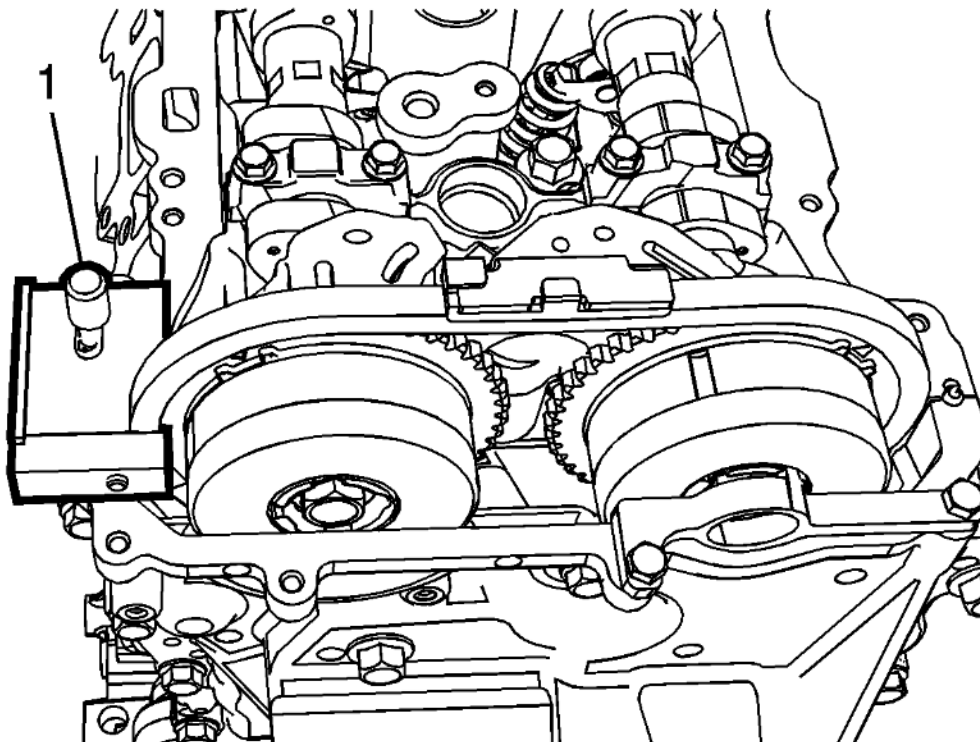


Fig. 191: Identifying EN-50656 Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT COVER HEAT SHIELD REPLACEMENT

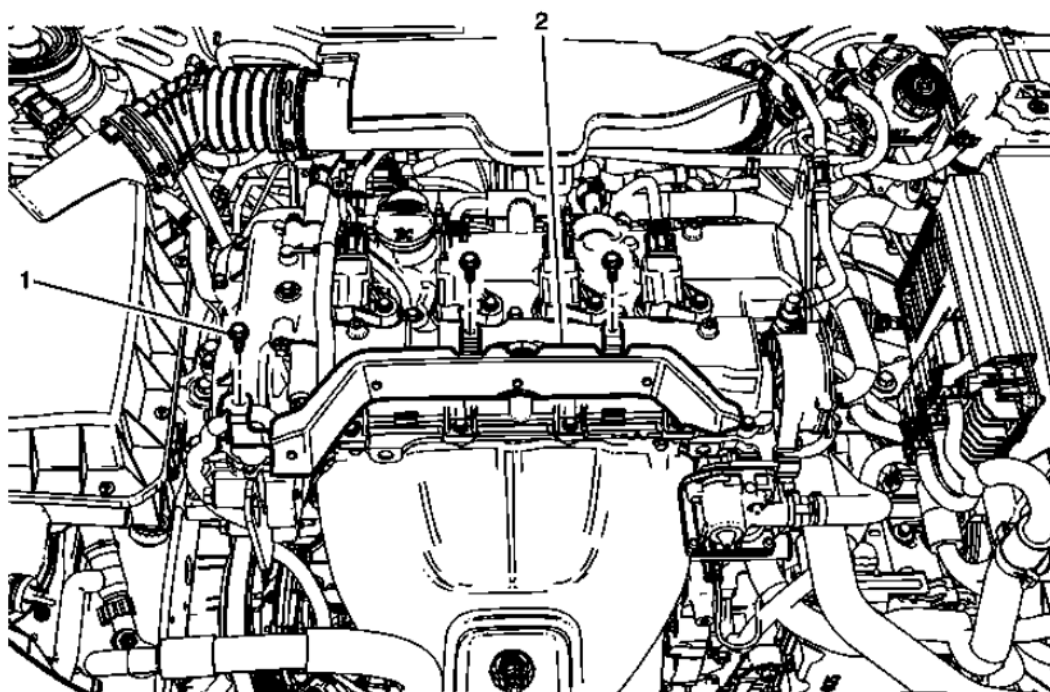


Fig. 192: Camshaft Cover Heat Shield
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Heat Shield Replacement

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LCV)</u> , <u>Intake Manifold Cover Replacement (LTG)</u> .	
1	Camshaft Heat Shield Cover Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
	Camshaft heat shield cover

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- EN-36017 Valve Guide Seal Remover
- EN-43649 Valve Spring Compressor
- EN-43649-10 Valve Spring Compressor Adaptor Set

- **EN-43653** Flywheel Holding Tool

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

Removal Procedure

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

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

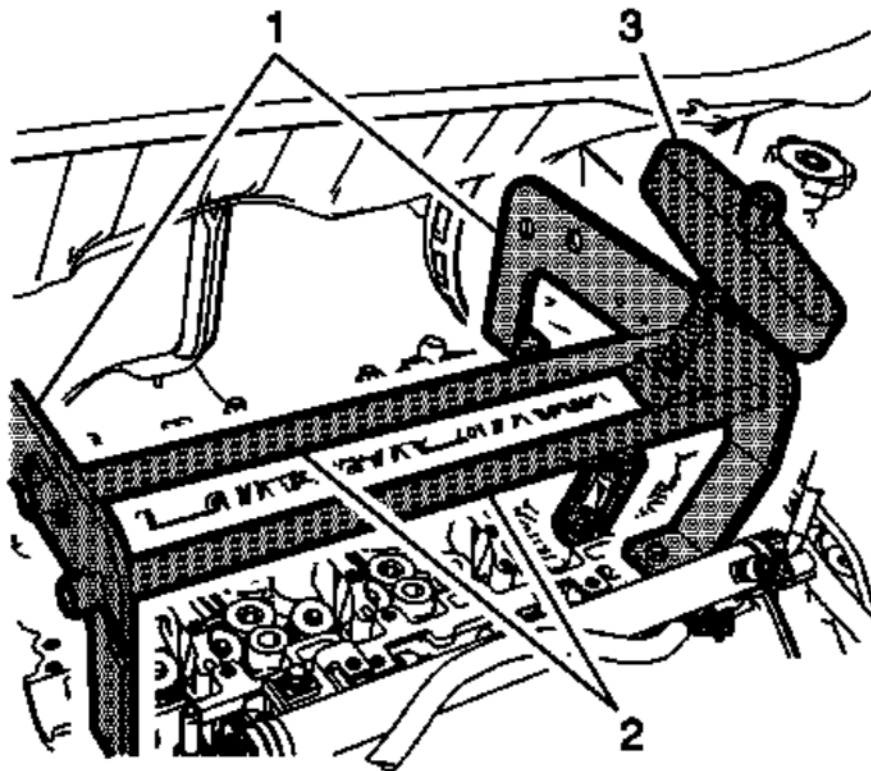


Fig. 193: View Of Valve Spring Compressor Adaptor Set
Courtesy of GENERAL MOTORS COMPANY

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

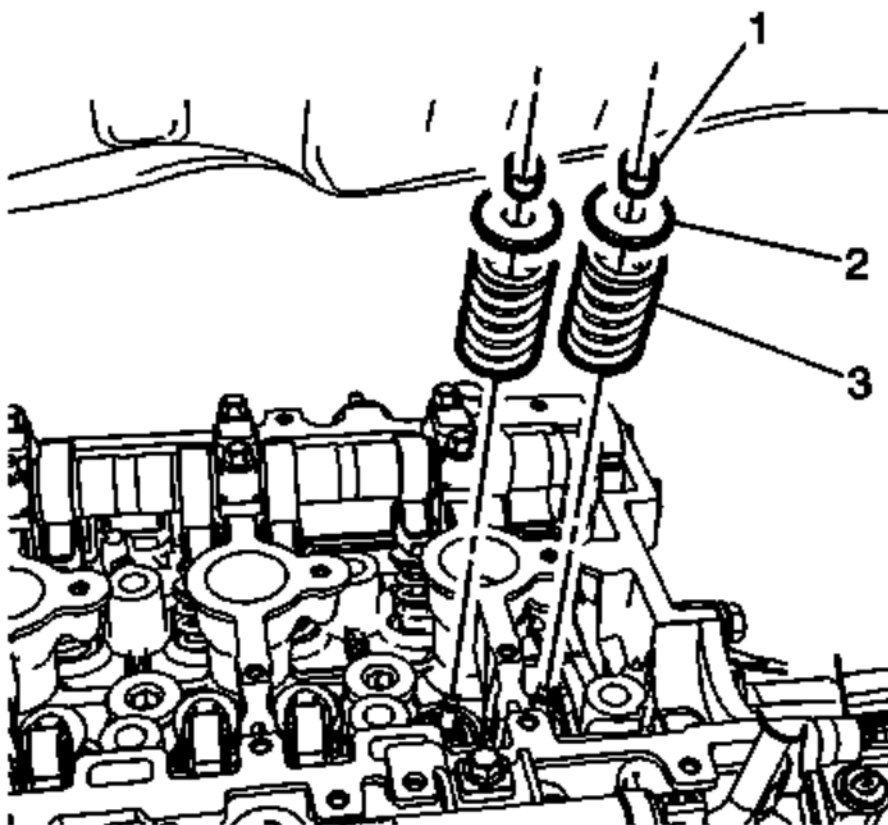


Fig. 194: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

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

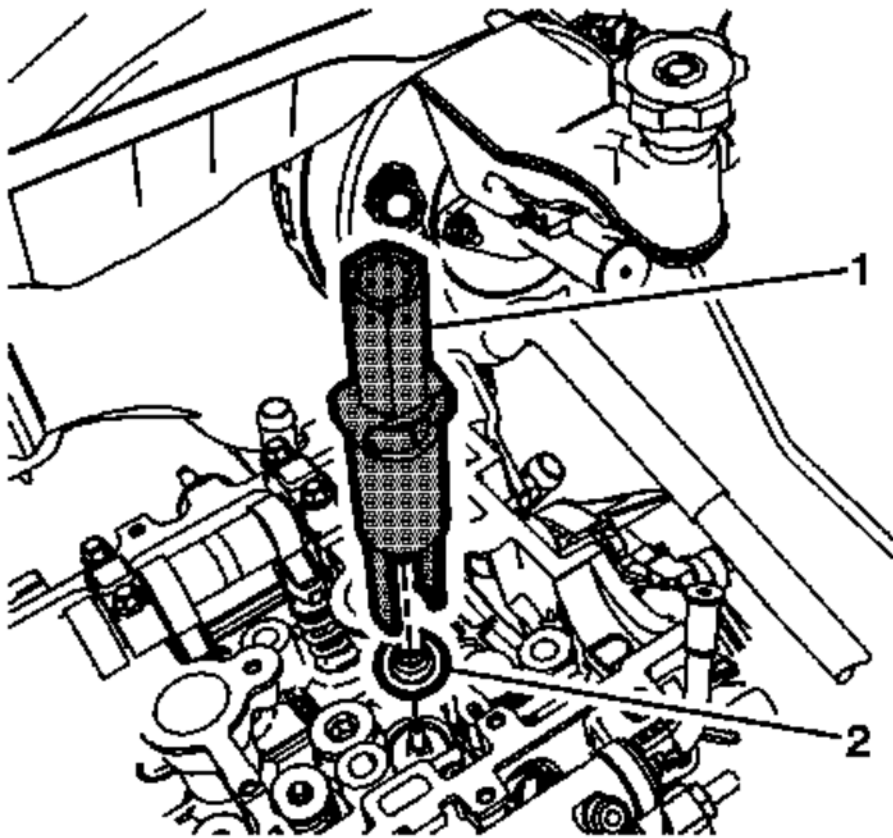


Fig. 195: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

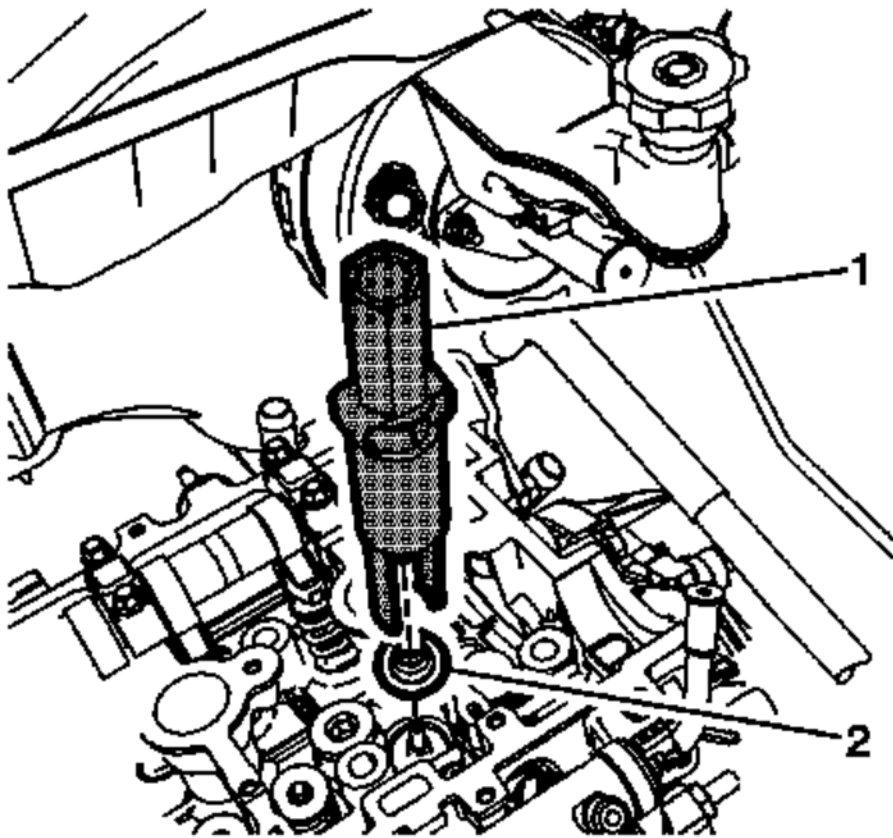


Fig. 196: View Of Valve Guide Seal Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

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

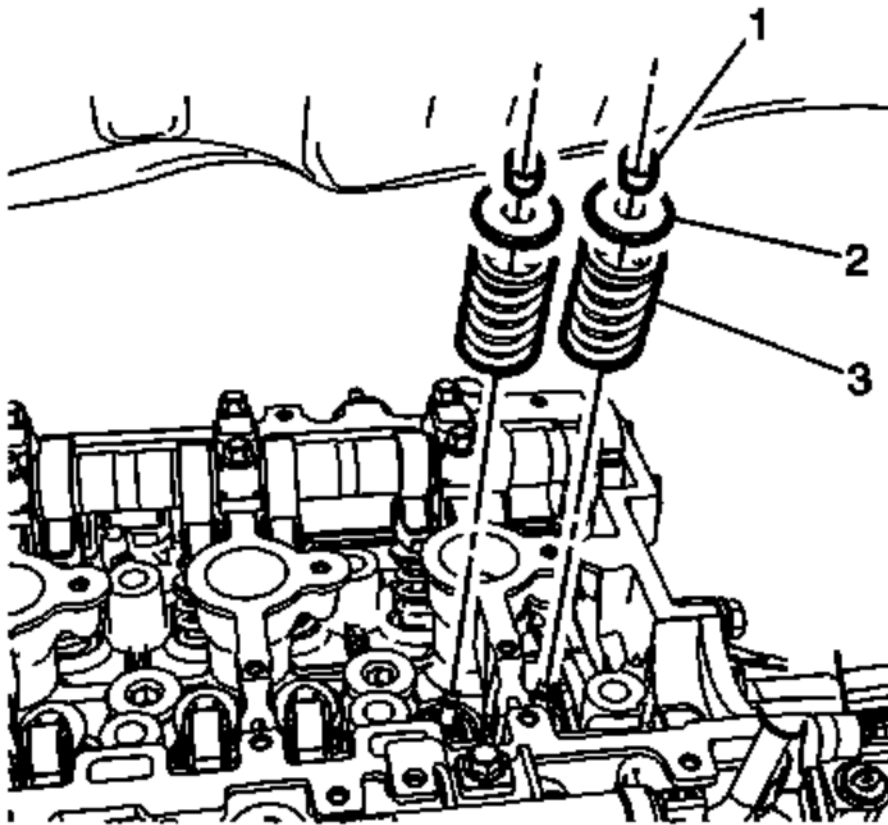


Fig. 197: View Of Valve Spring, Keepers & Retainer
Courtesy of GENERAL MOTORS COMPANY

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

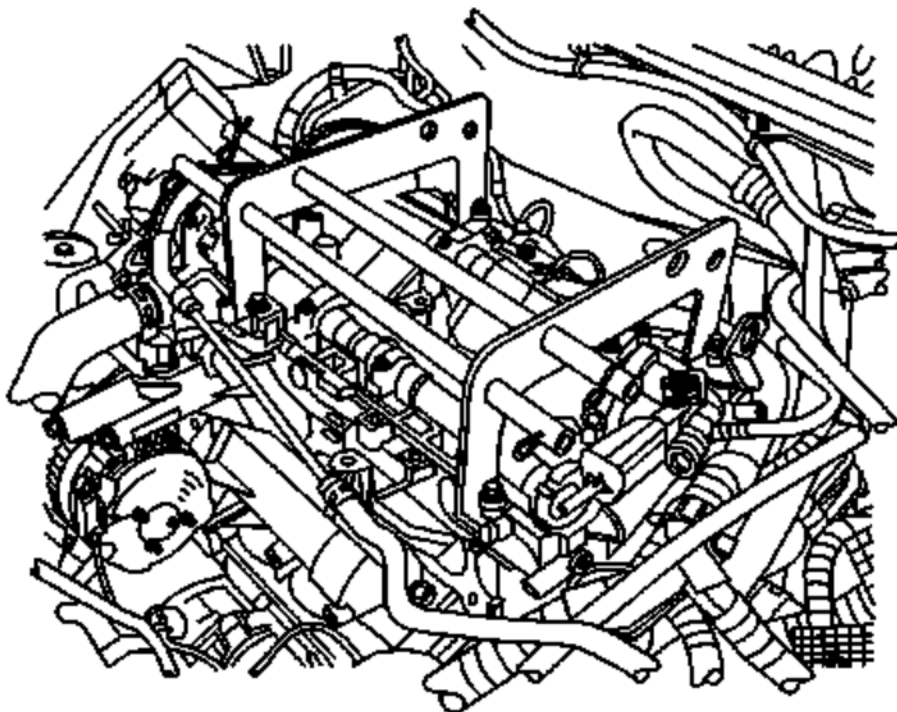


Fig. 198: Cylinder Head Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-43649** compressor and **EN-43649-10** adaptor set from the cylinder head.
7. Install the spark plugs. Refer to **Spark Plug Replacement** .
8. Install the camshaft. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.
9. Remove the **EN-43653** holding tool.
10. If equipped with an automatic transmission, install the starter. Refer to **Spark Plug Replacement** .

CYLINDER HEAD REPLACEMENT

Special Tools

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

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

Removal Procedure

1. Drain the coolant system. Refer to Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) .
2. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.
3. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LCV), Camshaft Cover Replacement (LTG).
4. Remove the intake manifold. Refer to Intake Manifold Replacement (LCV), Intake Manifold Replacement (LTG).
5. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LCV) , Exhaust Manifold Replacement (LTG) .
6. Remove the engine front cover. Refer to Engine Front Cover Replacement (LCV), Engine Front Cover Replacement (LTG).
7. Remove the camshaft position actuator and camshaft - Intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.

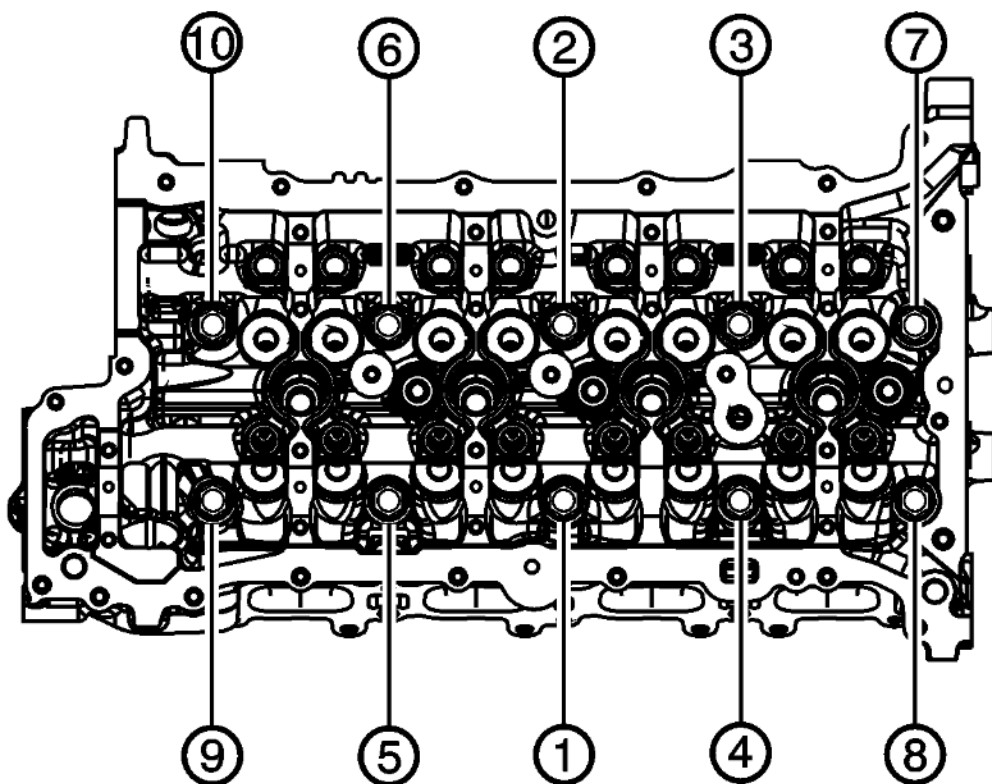


Fig. 199: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head to the block bolts in sequence.

Discard the bolts.

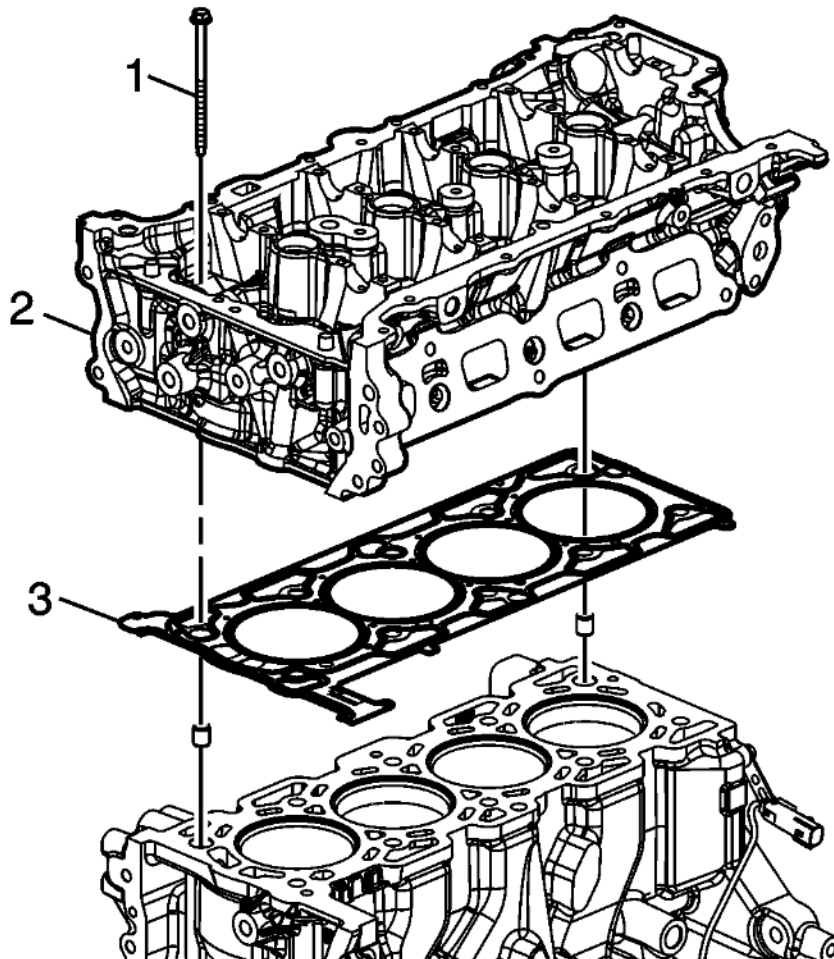


Fig. 200: Cylinder Head Gasket

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.

9. Remove the cylinder head (2).
10. Remove the cylinder head gasket (3).
11. Clean all of the gasket surfaces.
12. 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.

13. Clean the old sealer/lube and dirt from the bolt holes.
14. 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.

15. 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.
16. Remove any broken long cylinder head bolts using the **EN 38188** kit.
17. For cylinder head disassemble. Refer to Cylinder Head Disassemble .
18. 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 .

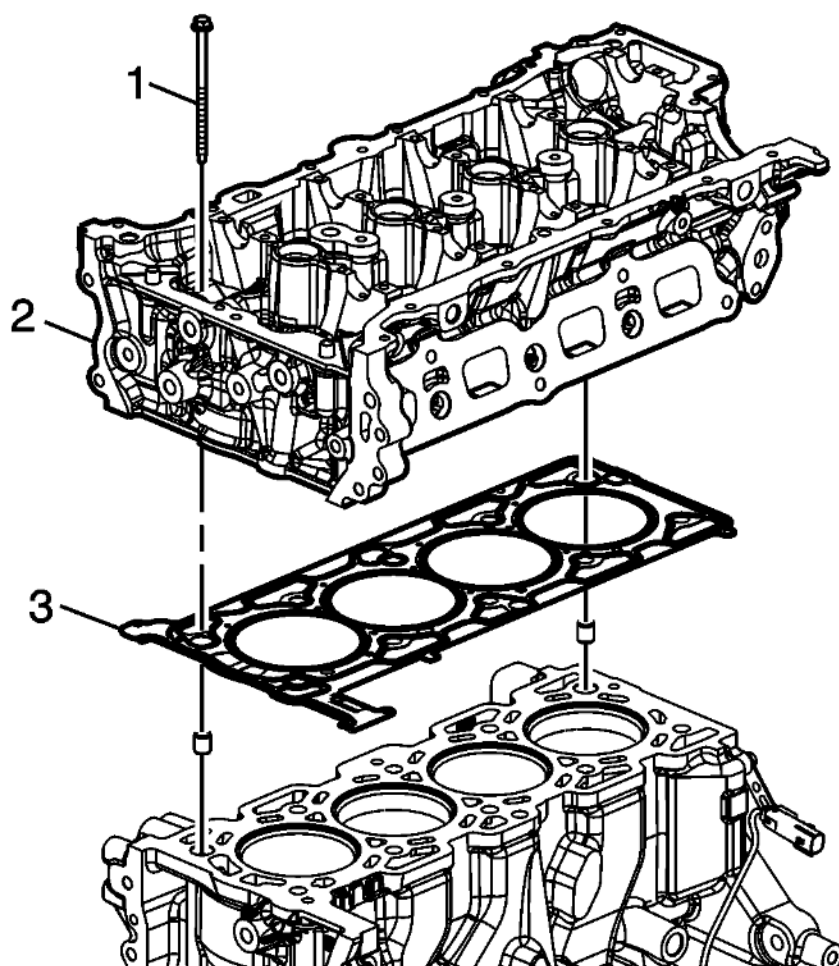


Fig. 201: Cylinder Head Gasket

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any sealing material.

2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

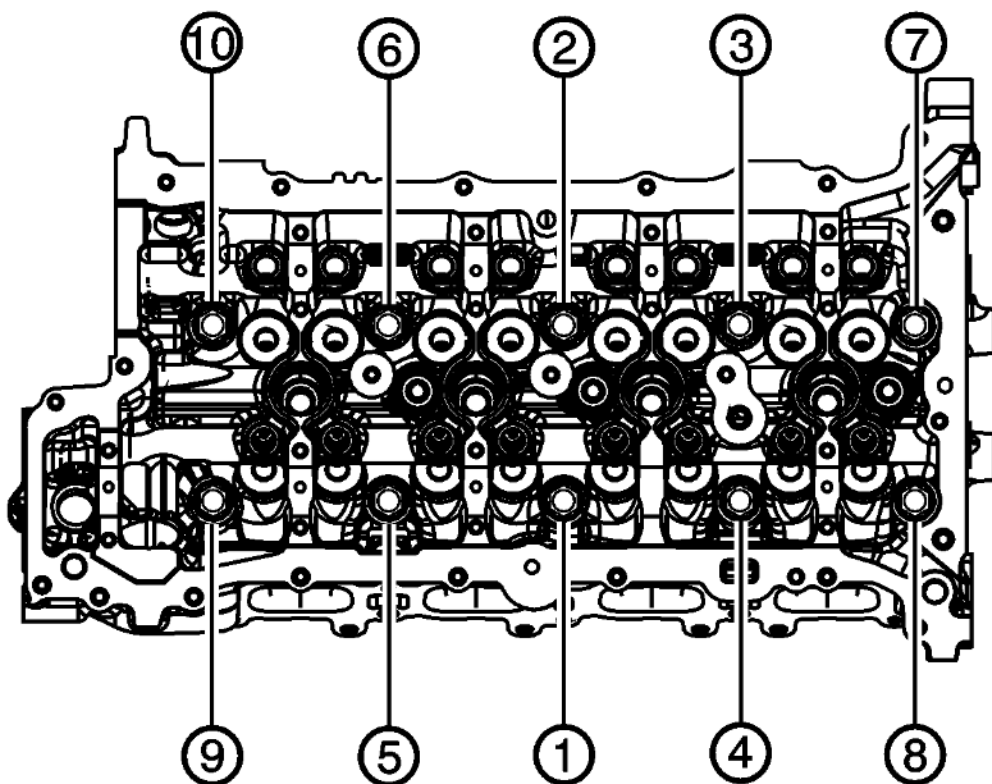


Fig. 202: Cylinder Head

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Always use NEW cylinder head bolts.

4. 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.
5. Install the camshaft position actuator and camshaft - Intake. Refer to Camshaft Position Actuator and Camshaft Replacement - Intake.
6. Install the engine front cover. Refer to Engine Front Cover Replacement (LCV), Engine Front Cover Replacement (LTG).
7. Install the exhaust manifold. Refer to Exhaust Manifold Replacement (LCV) , Exhaust Manifold Replacement (LTG) .

8. Install the intake manifold. Refer to **Intake Manifold Replacement (LCV)**, **Intake Manifold Replacement (LTG)**.
9. Install the camshaft cover. Refer to **Camshaft Cover Replacement (LCV)**, **Camshaft Cover Replacement (LTG)**.
10. Refill the engine with NEW oil. Refer to **Engine Oil and Oil Filter Replacement**.
11. Refill the coolant system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .

ENGINE OIL COOLER REPLACEMENT

Removal Procedure

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

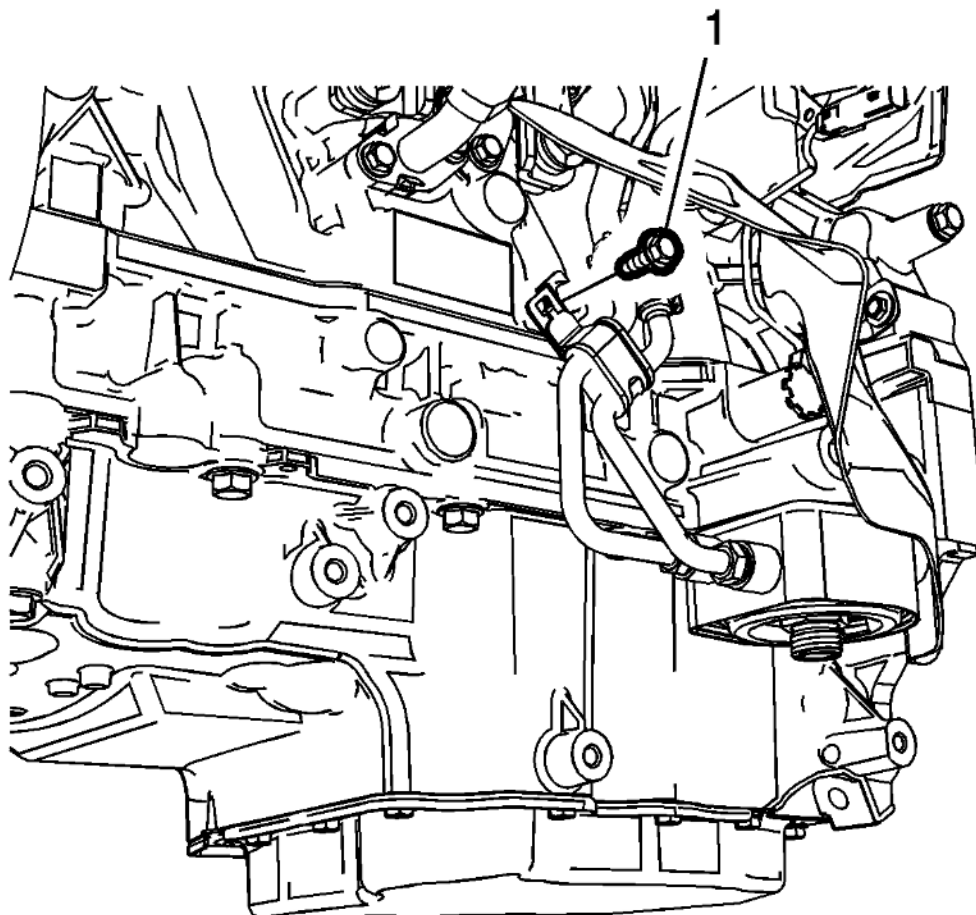


Fig. 203: Engine Oil Cooler Fastener
Courtesy of GENERAL MOTORS COMPANY

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

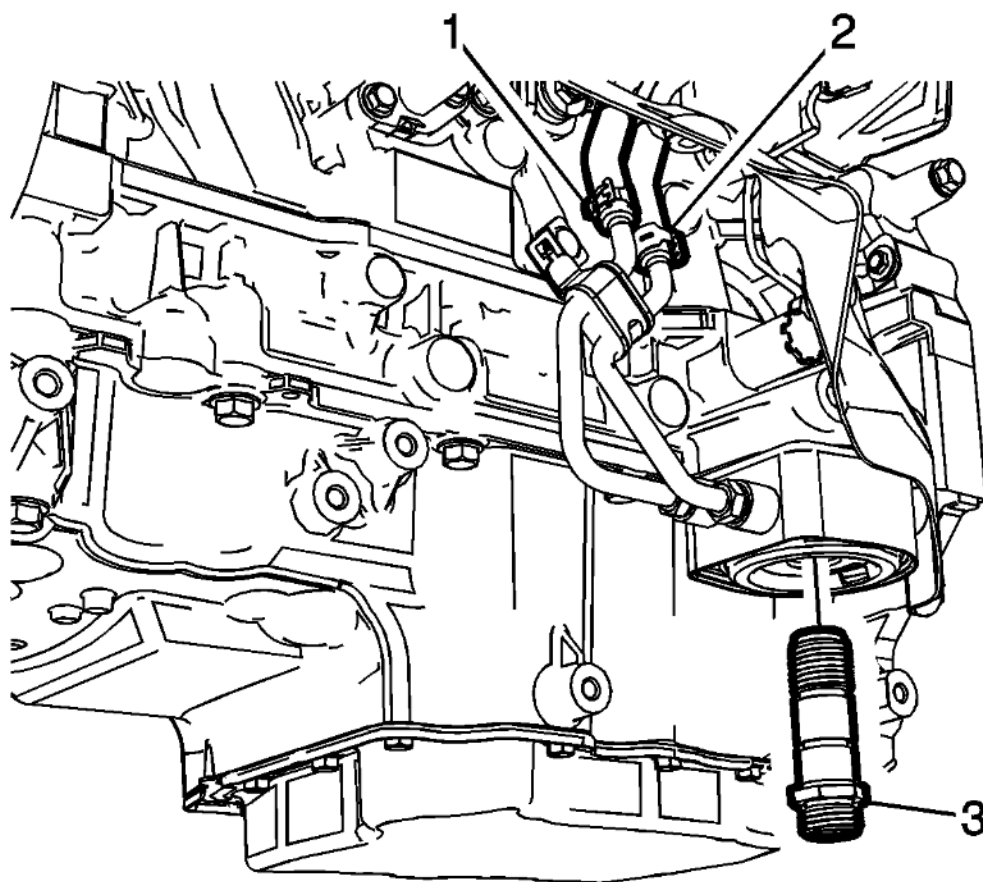


Fig. 204: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

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

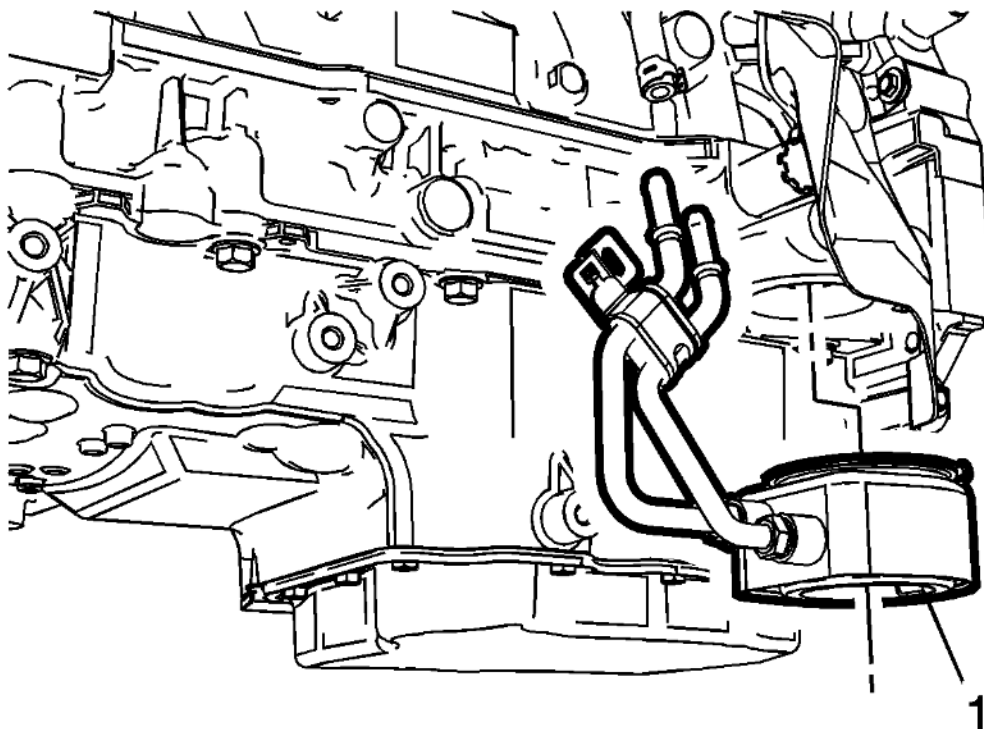


Fig. 205: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

NOTE: DISCARD the old engine oil cooler seal.

5. Remove the engine oil cooler (1).

Installation Procedure

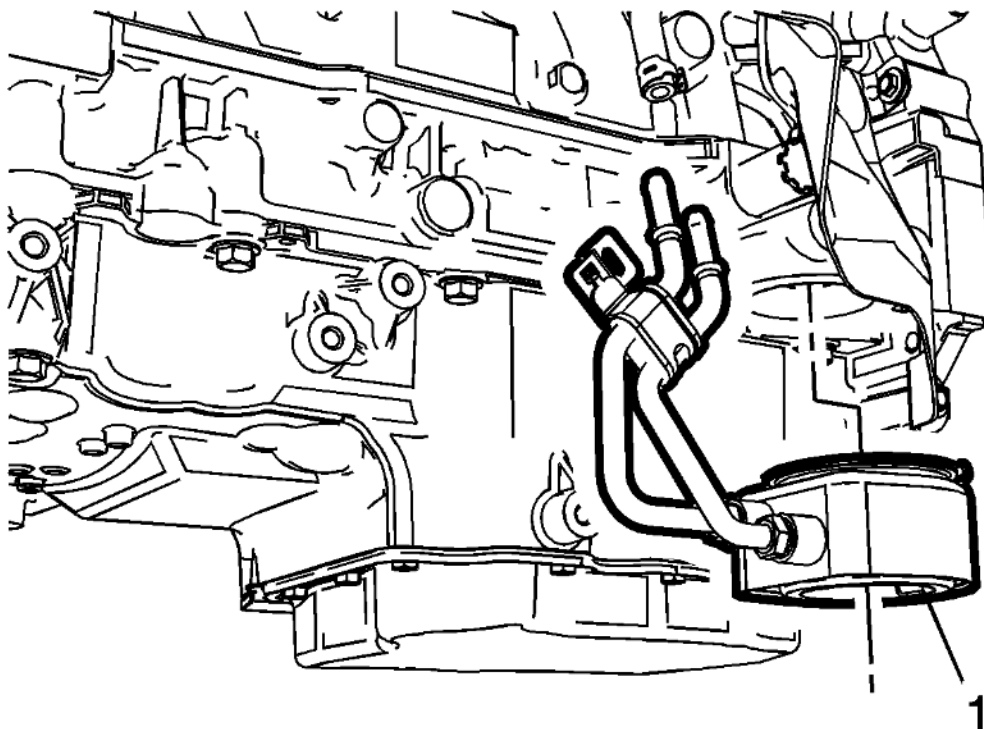


Fig. 206: Engine Oil Cooler

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).

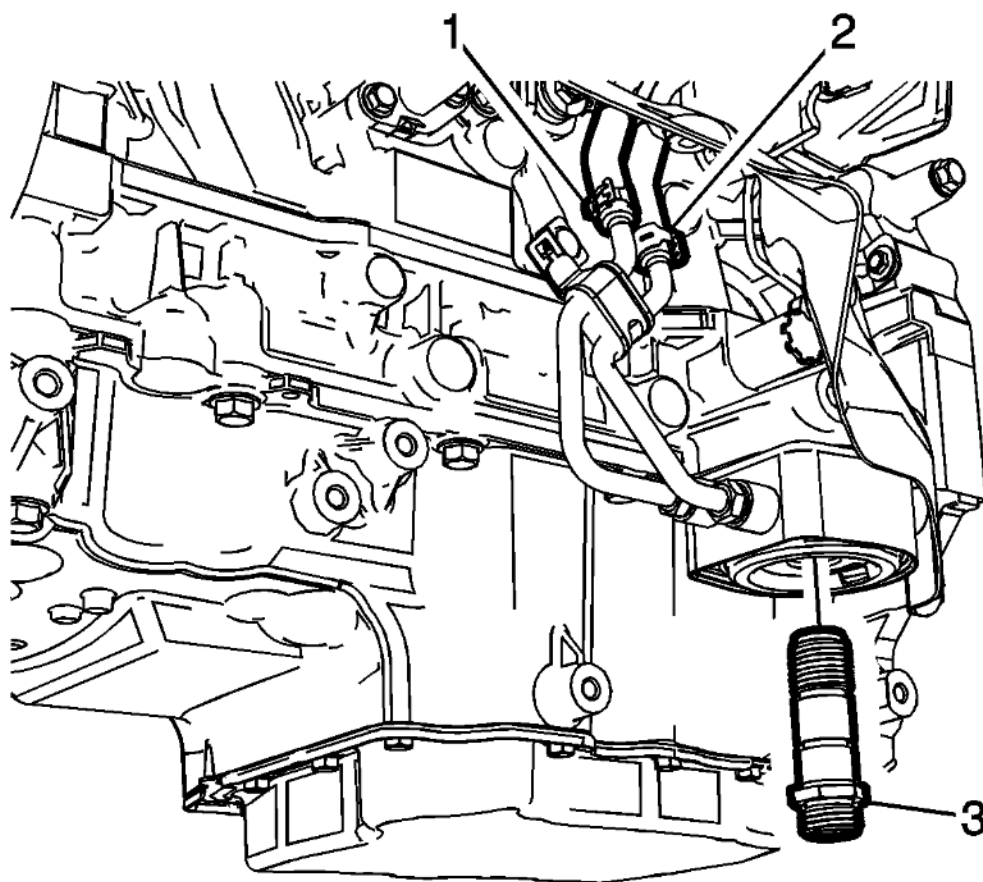


Fig. 207: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

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

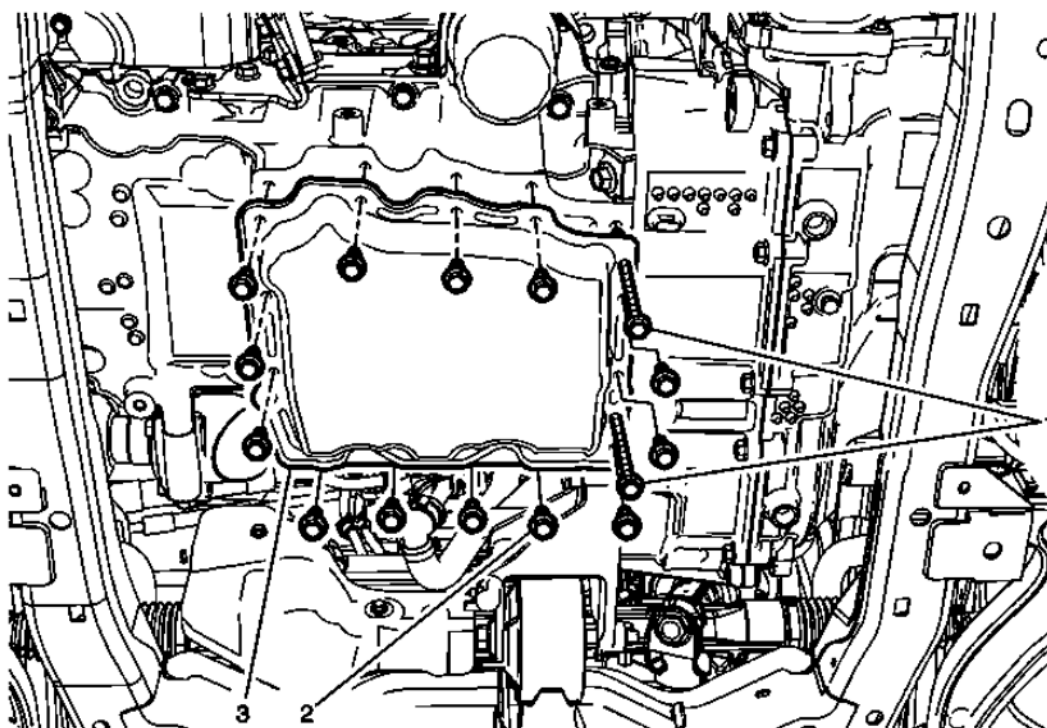


Fig. 208: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

Oil Pan Replacement

Callout	Component Name
Preliminary Procedures 1. Drain engine oil. Refer to <u>Engine Oil and Oil Filter Replacement</u> 2. Remove the exhaust front pipe. Refer to <u>Exhaust Front Pipe Replacement (LCV)</u> , <u>Exhaust Front Pipe Replacement (LTG)</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)
	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</u>

Sealers (LCV) , Adhesives, Fluids, Lubricants, and Sealers (LTG) .

3

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.
2. Disconnect the oil level sensor electrical connector.

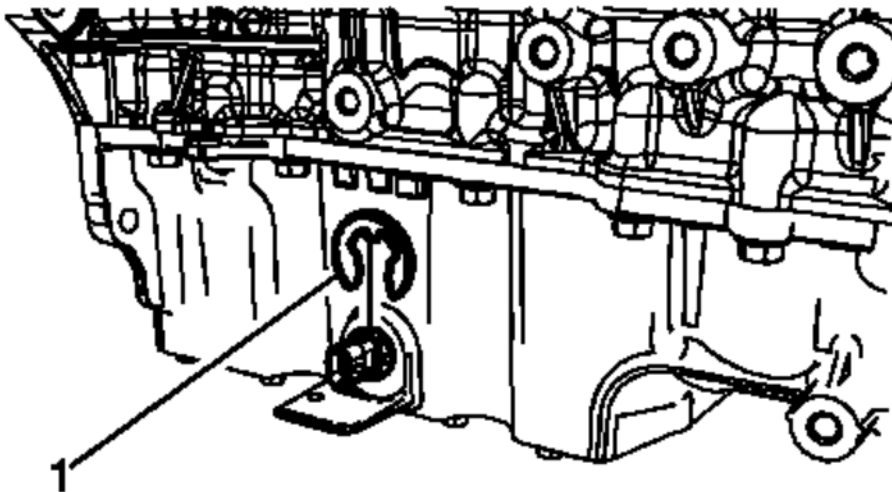


Fig. 209: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

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

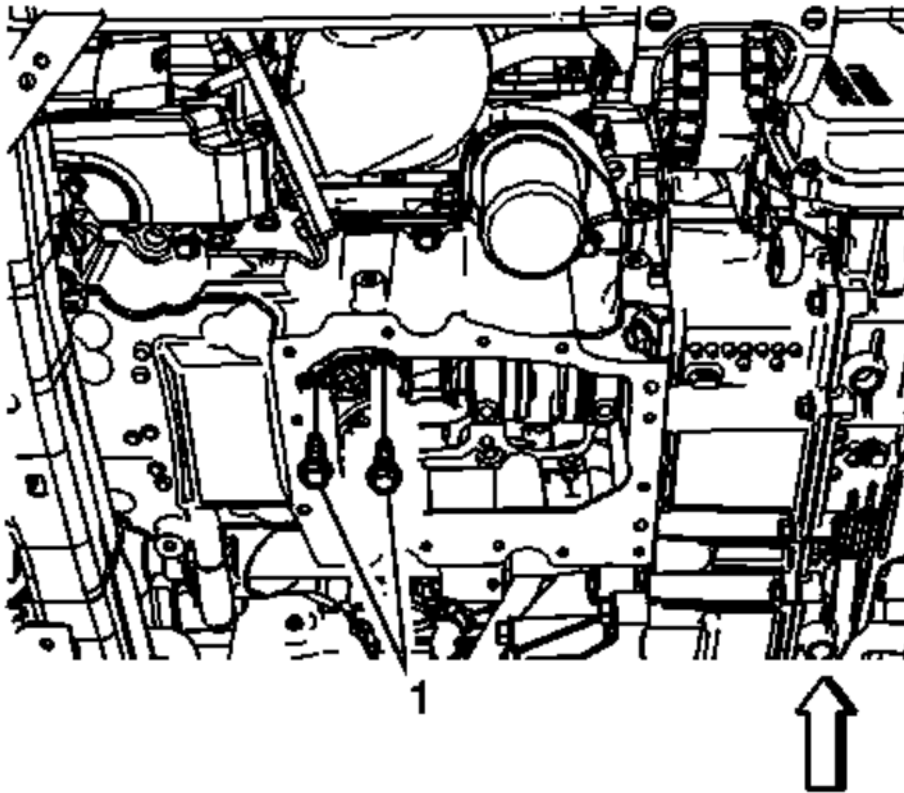


Fig. 210: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

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

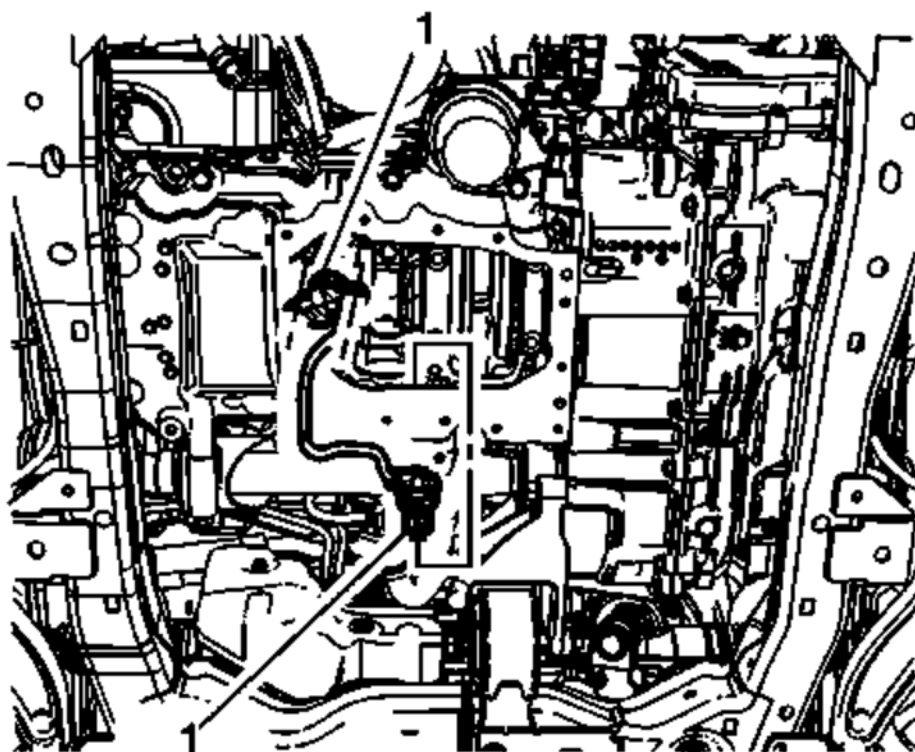


Fig. 211: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

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

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

Installation Procedure

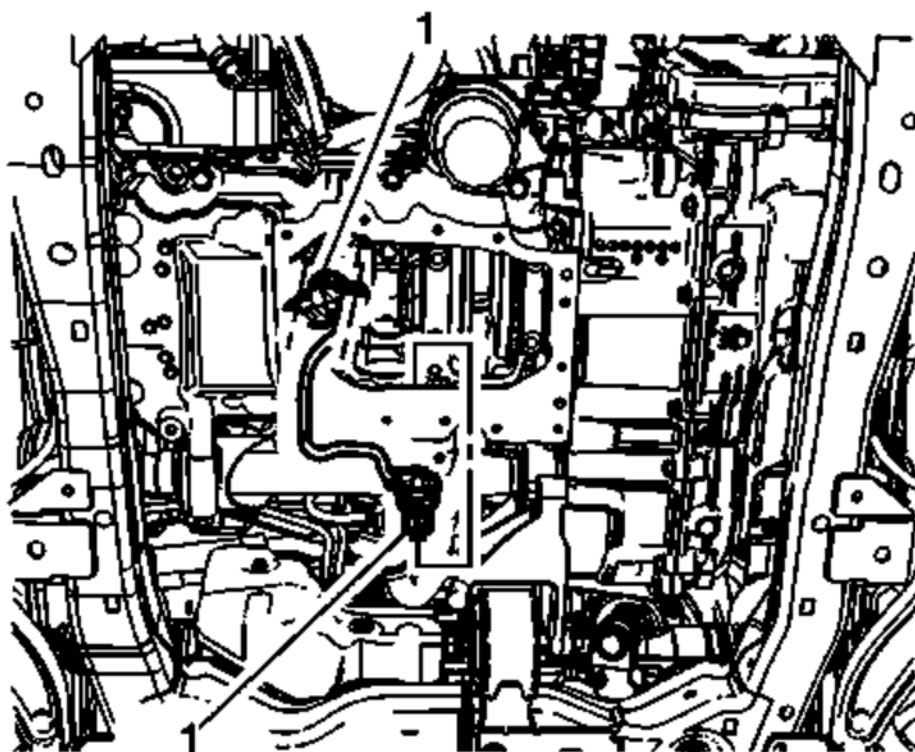


Fig. 212: O-ring Around Level Sensor
Courtesy of GENERAL MOTORS COMPANY

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

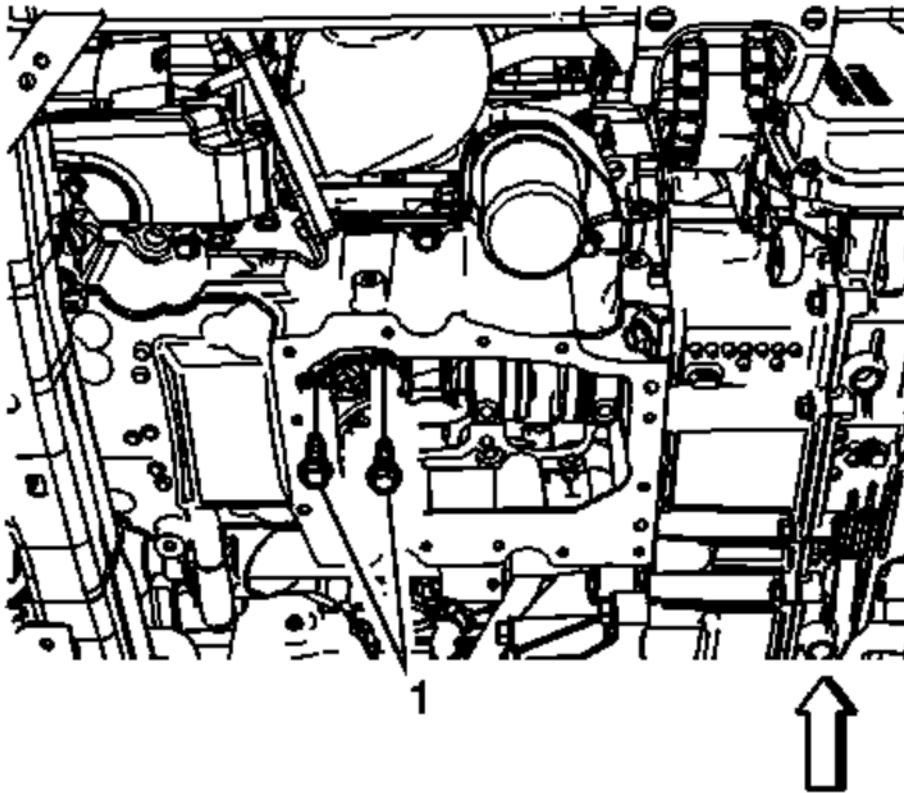


Fig. 213: Engine Oil Level Sensor Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

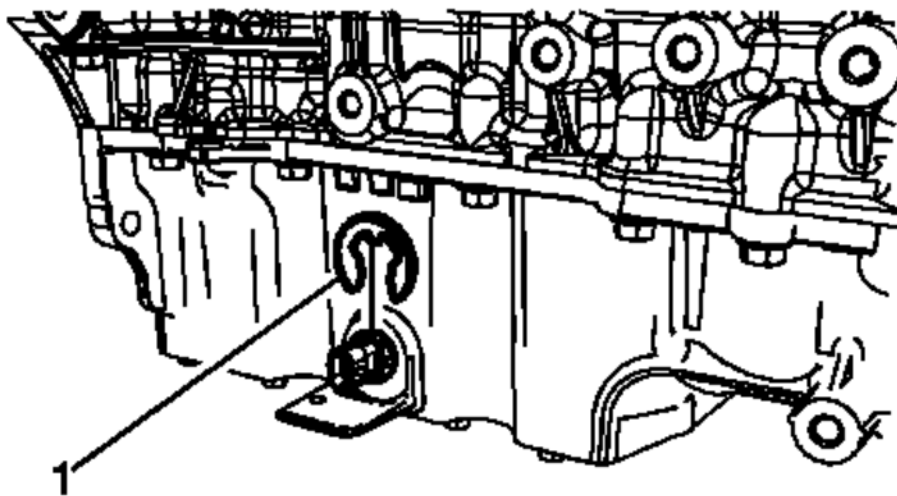


Fig. 214: Engine Oil Level Sensor C-clip
Courtesy of GENERAL MOTORS COMPANY

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

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

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

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

Removal Procedure

1. Remove the transmission. Refer to **Transmission Replacement** .

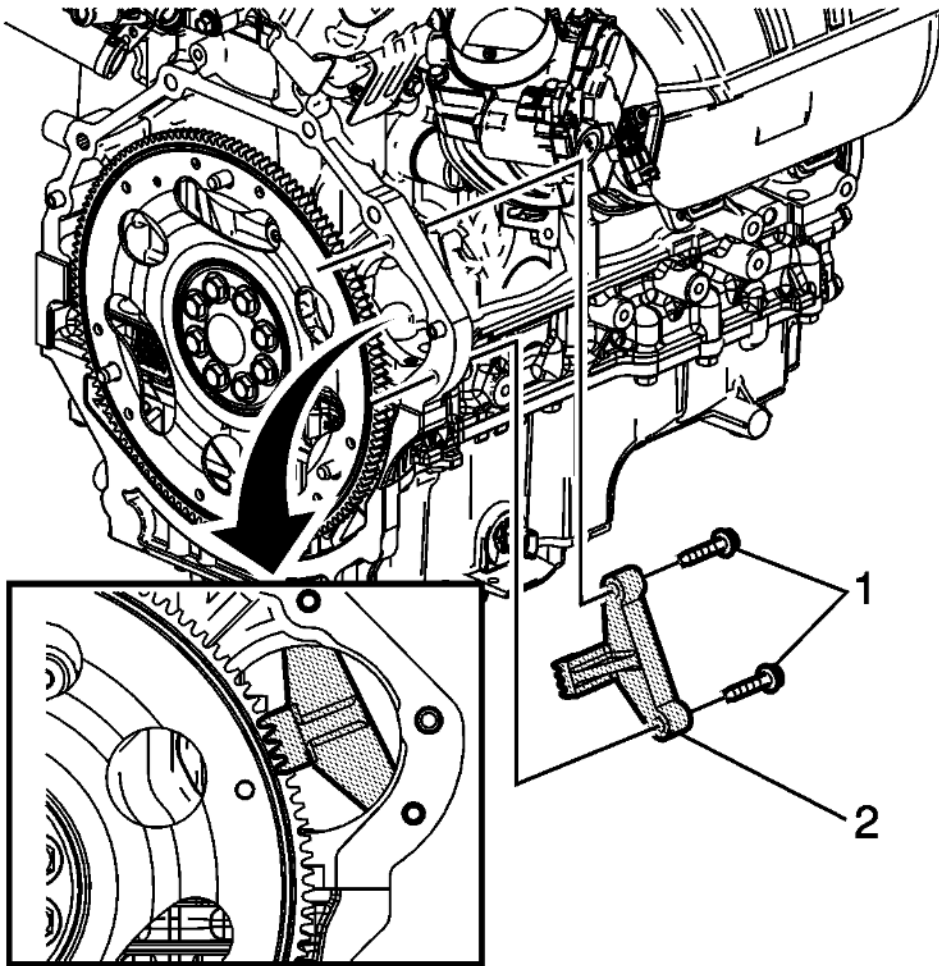


Fig. 215: Starter Motor Bolts

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.

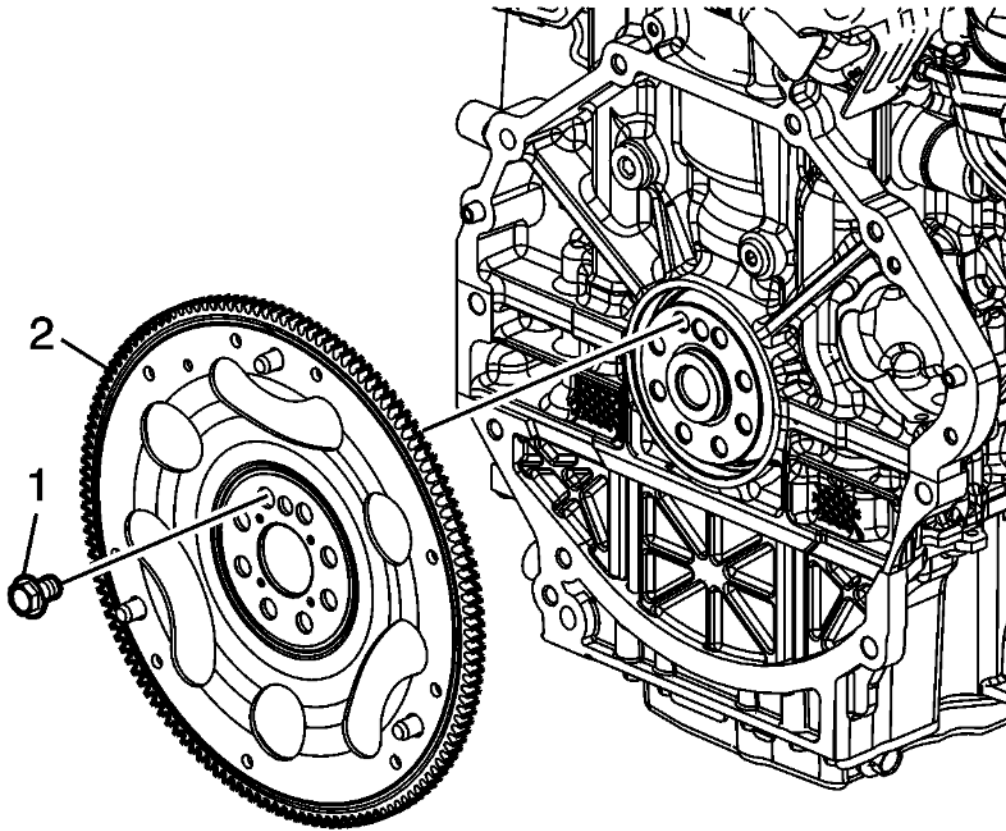


Fig. 216: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

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

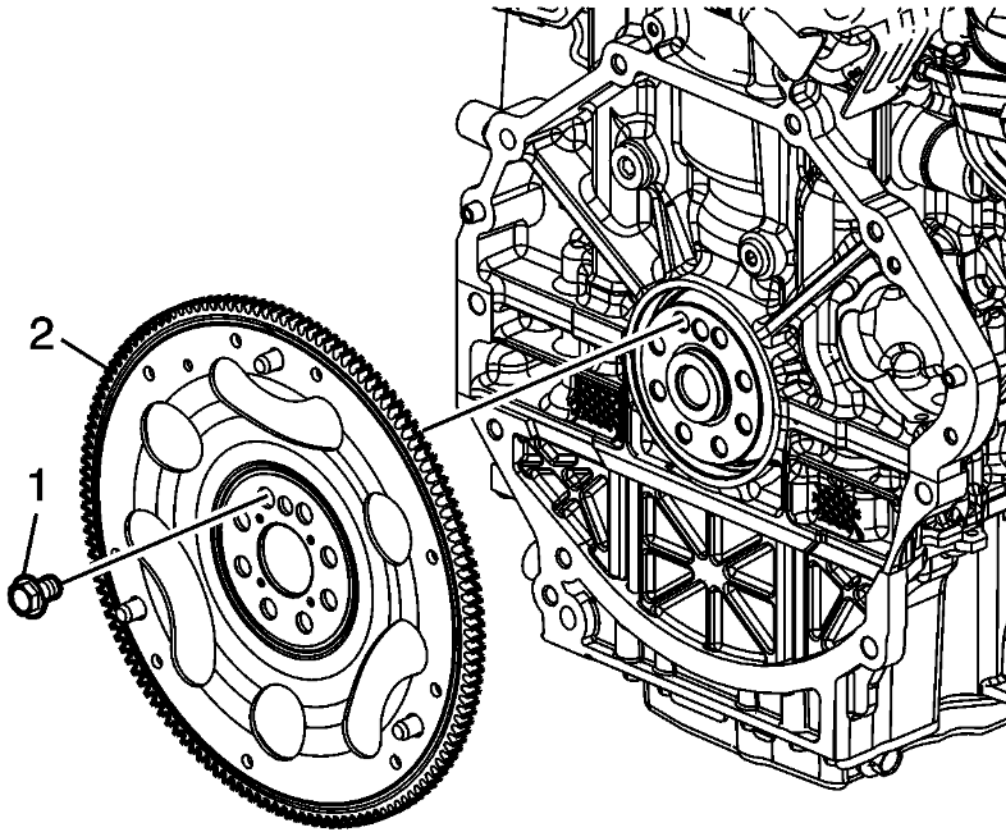


Fig. 217: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

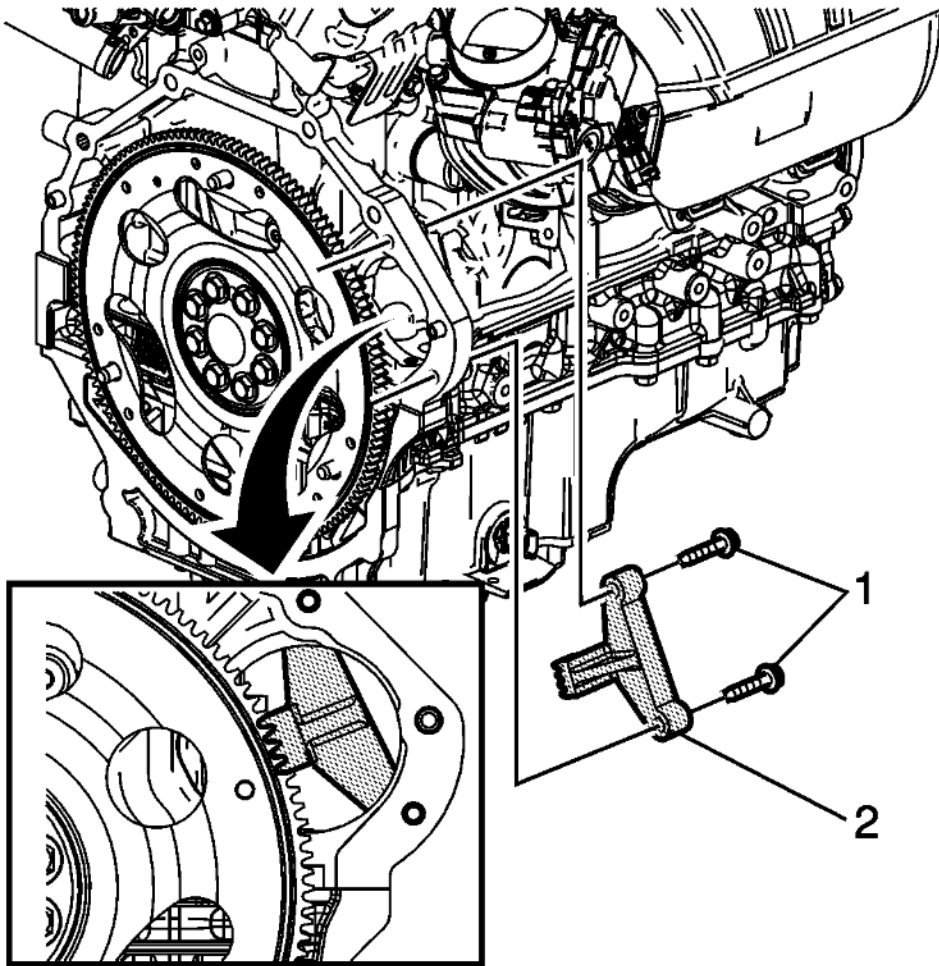


Fig. 218: Starter Motor Bolts

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.

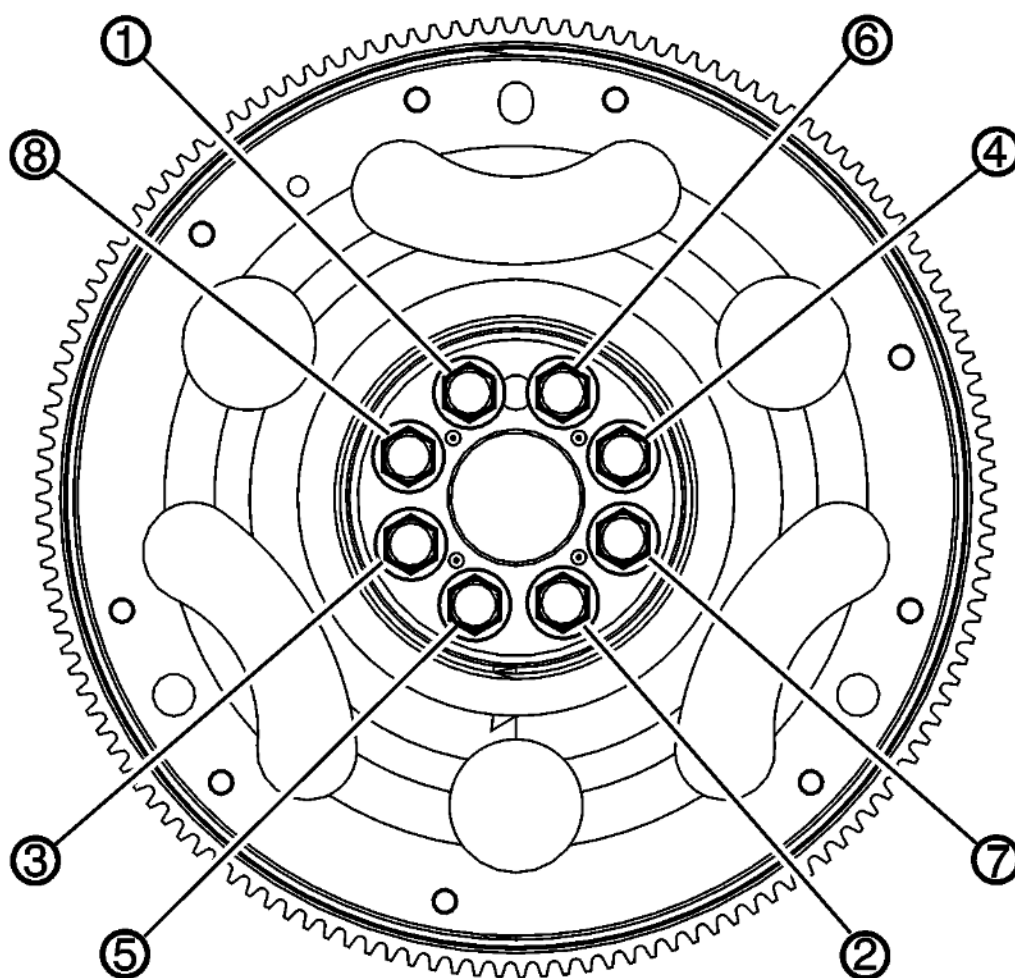


Fig. 219: Tightening Bolts First Pass In Sequence
 Courtesy of GENERAL MOTORS COMPANY

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** meter.
4. Remove **EN-50792** automatic flex plate holding tool.
5. Install the transmission. Refer to Transmission Replacement .

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

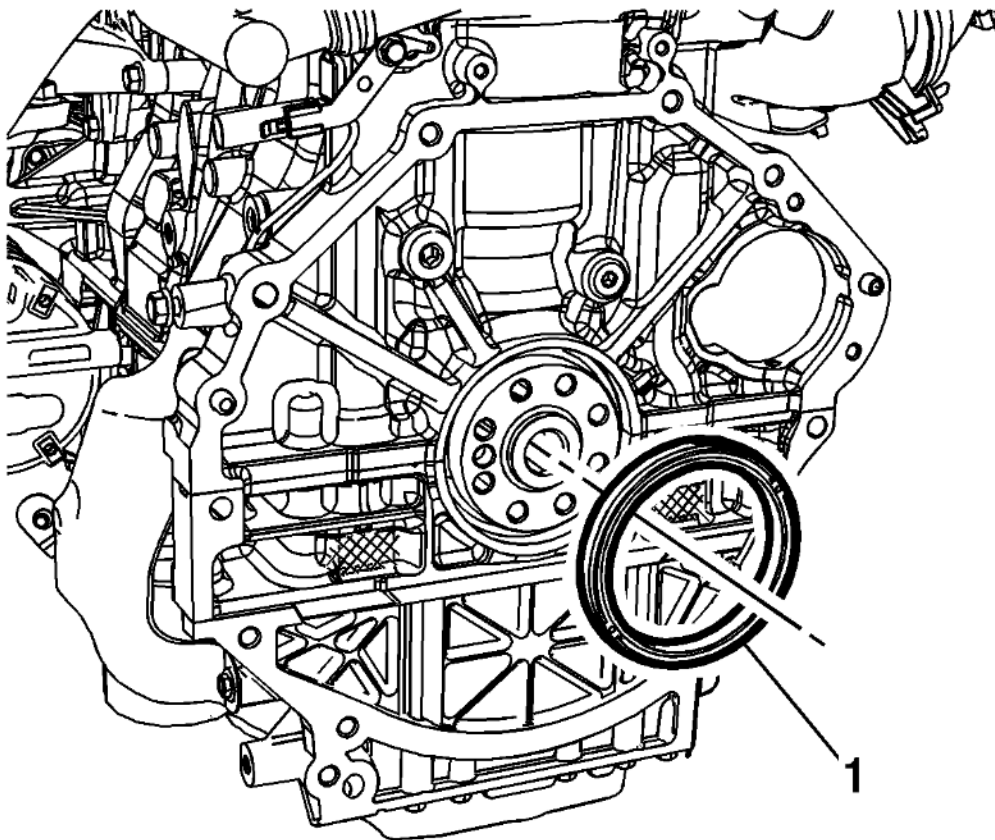


Fig. 220: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

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

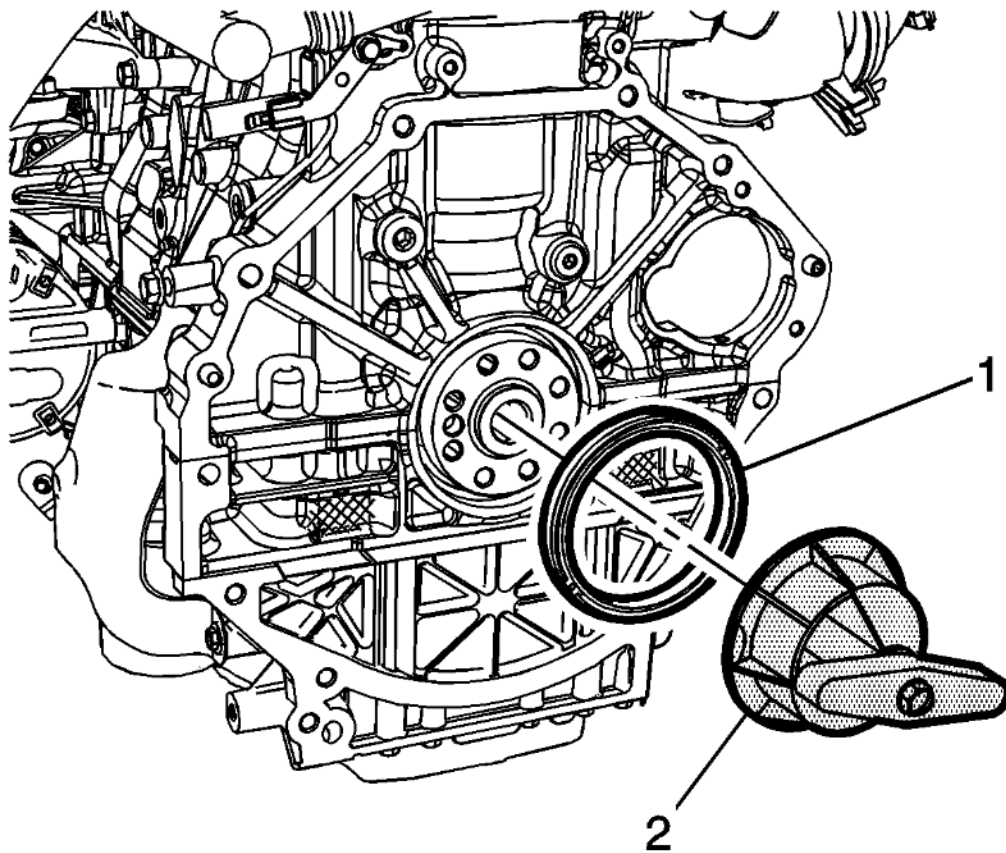


Fig. 221: Crankshaft Real Oil Seal
 Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-42067** 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 (LCV)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)**, **Cooling System Draining and Filling (Static Fill)**.
3. Evacuate the A/C system. Refer to **Refrigerant Recovery and Recharging**.
4. Remove the battery tray. Refer to **Battery Tray Replacement**.
5. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

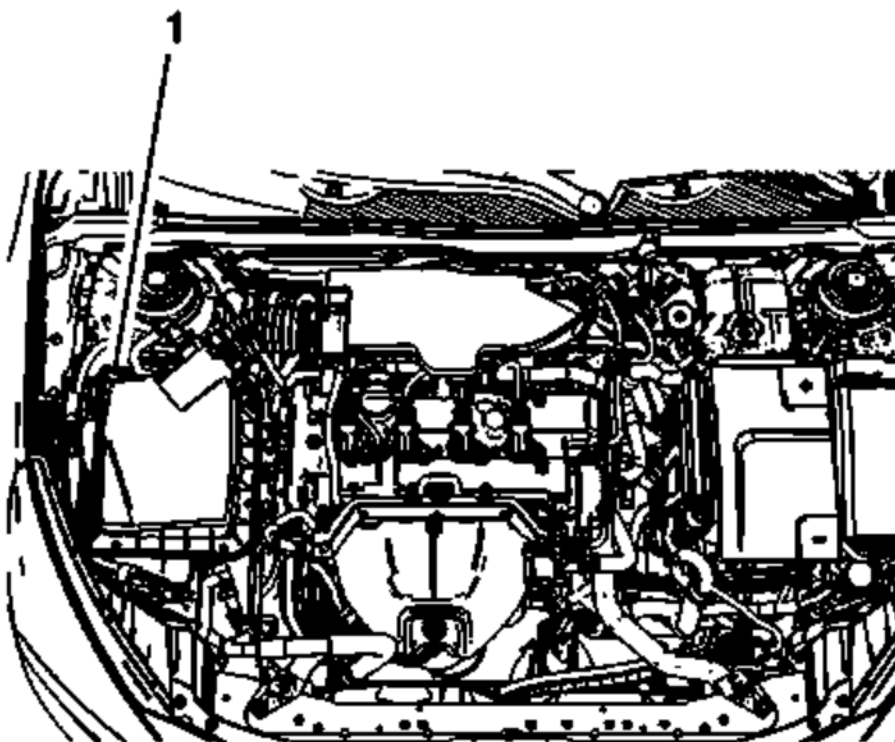


Fig. 222: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

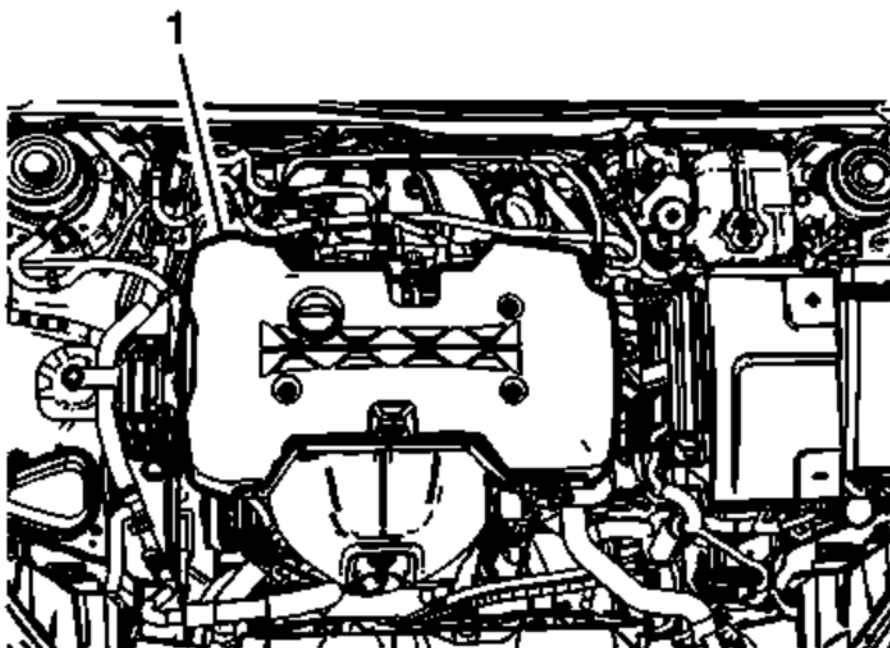


Fig. 223: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

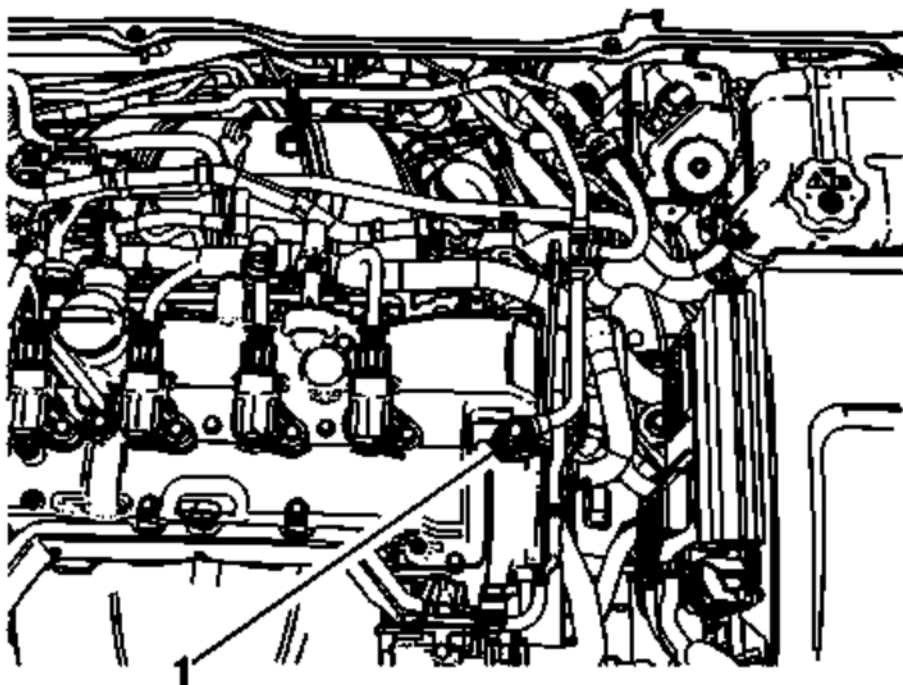


Fig. 224: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
10. Disconnect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

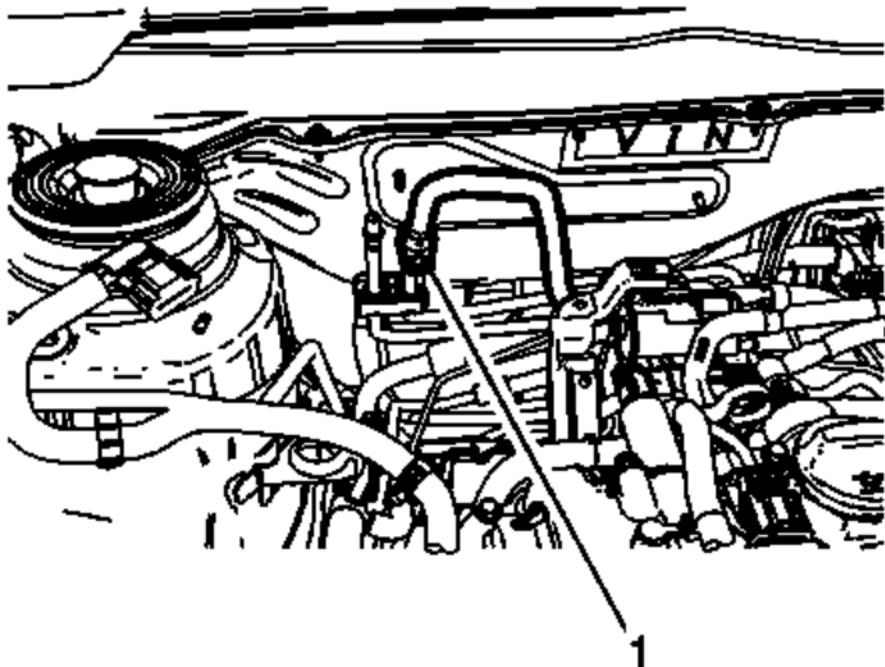


Fig. 225: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

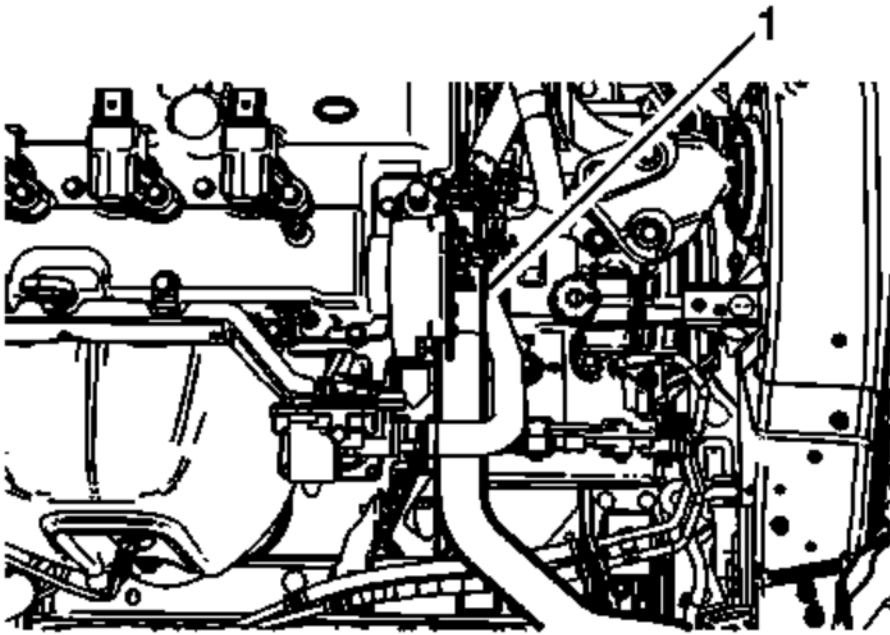


Fig. 226: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the radiator outlet hose (1). Refer to **Radiator Inlet Hose Replacement (LCV)** .

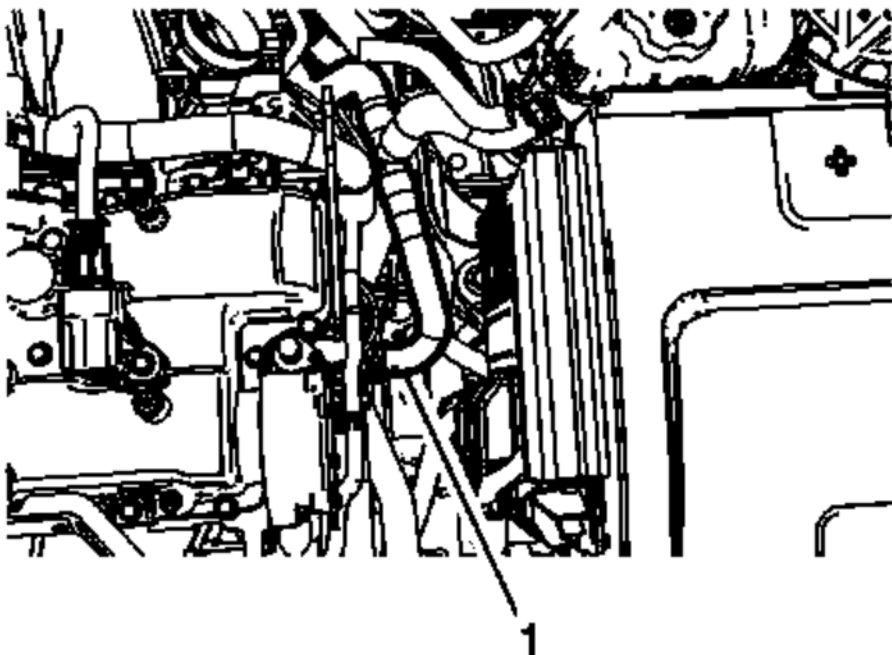


Fig. 227: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Remove the heater inlet hose (1). Refer to Heater Inlet Hose Replacement (LCV) .
14. Remove the heater outlet hose (2). Refer to Heater Outlet Hose Replacement (LCV) .

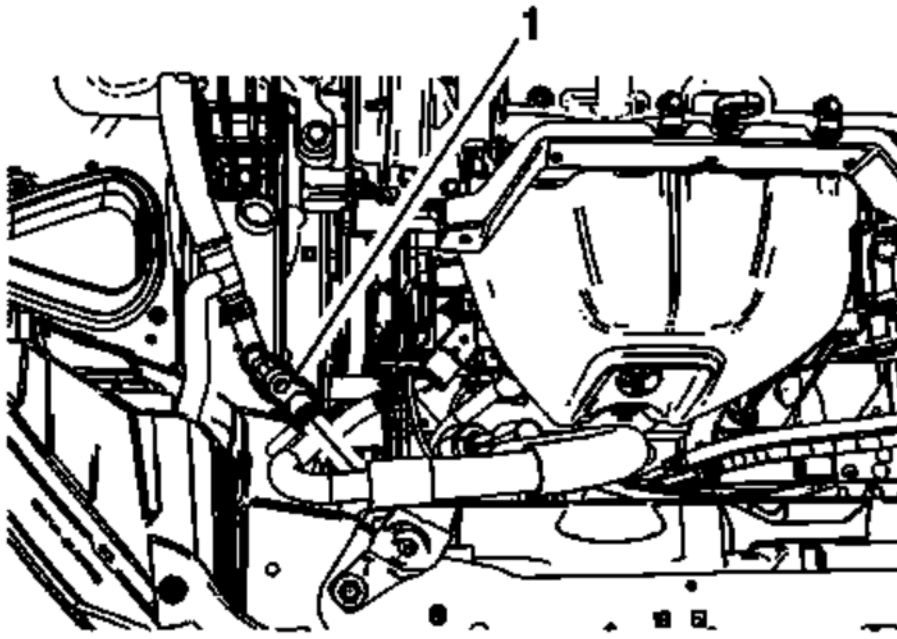


Fig. 228: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

15. Remove the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

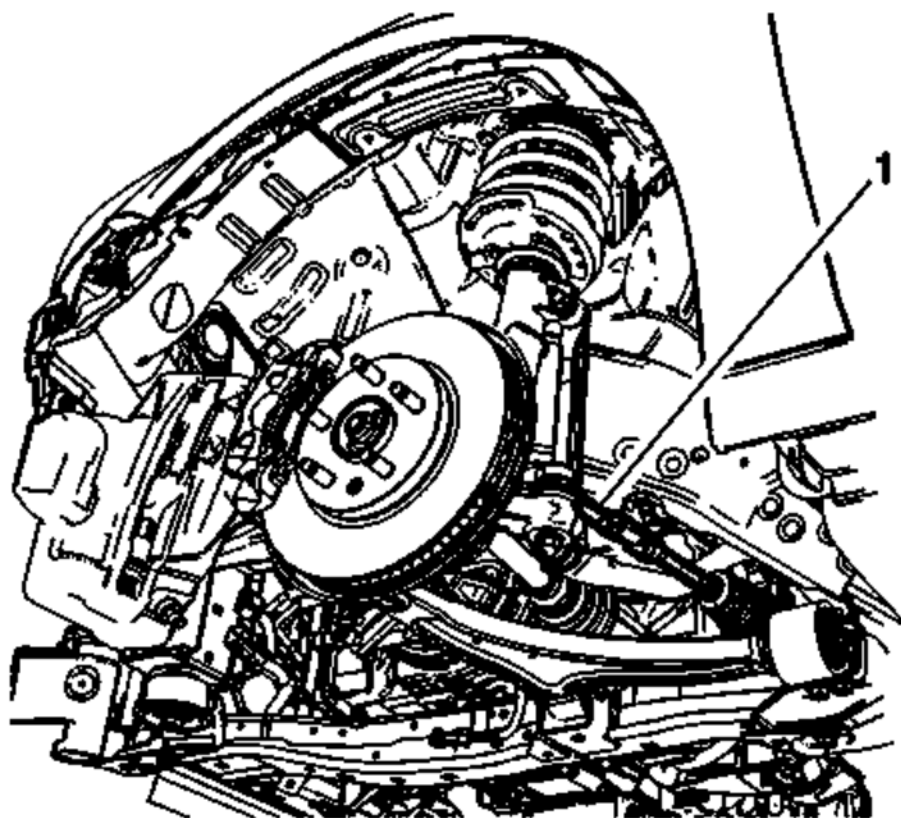


Fig. 229: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.

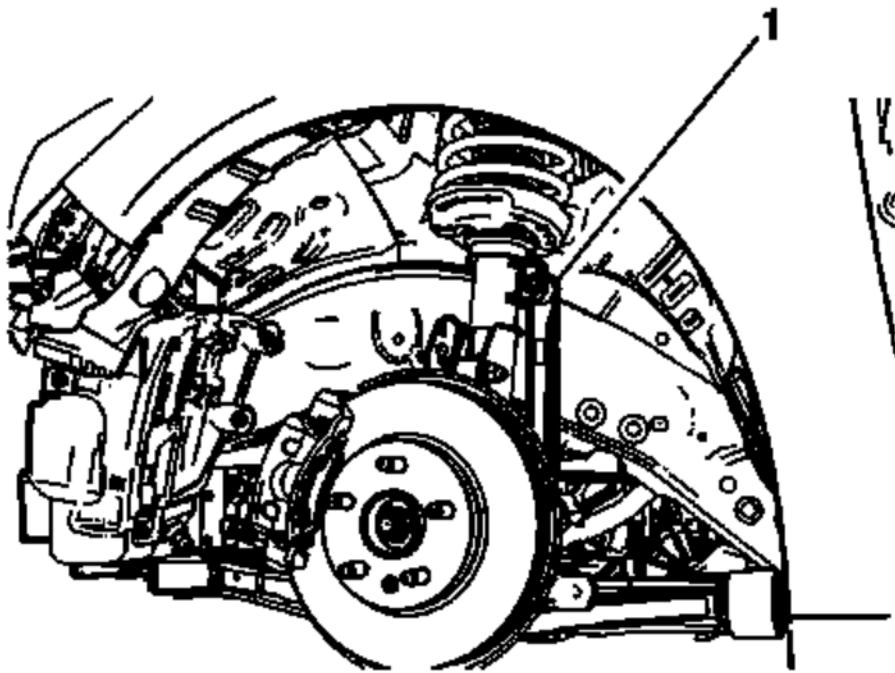


Fig. 230: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .
18. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
19. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LCV)** .
20. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement** .
21. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
22. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .

NOTE: **During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.**

23. Position an engine support table under the powertrain assembly.
24. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
25. With the table positioned, fully raise the table to contact with the powertrain assembly.

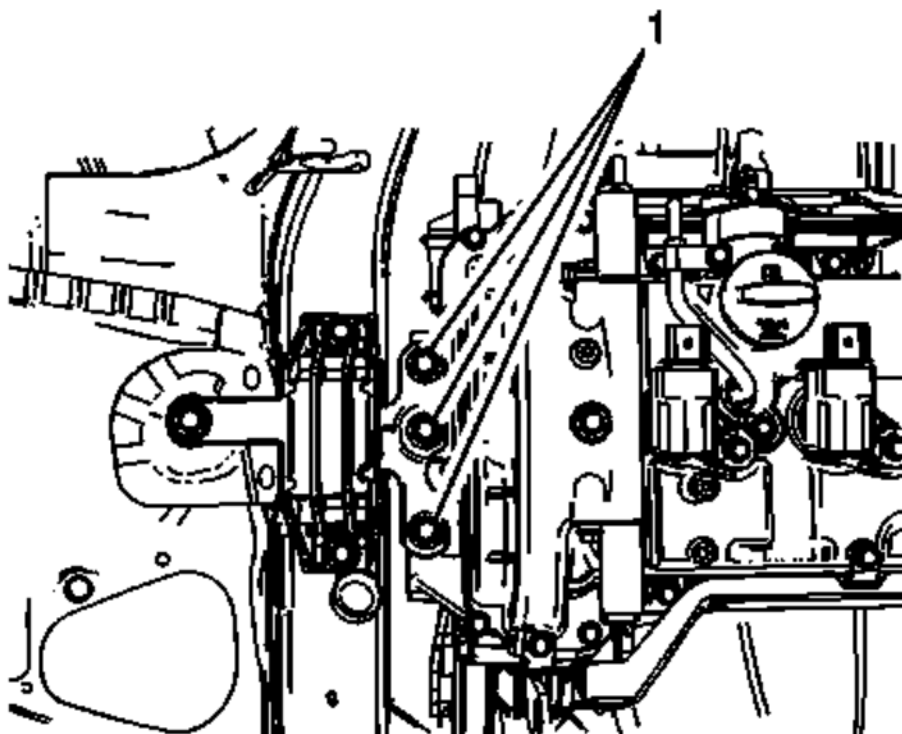


Fig. 231: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

26. Remove the engine mount (1). Refer to **Engine Mount Replacement (LCV)**.
27. Remove the transmission mount. Refer to **Transmission Mount Replacement - Left Side**.
28. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.
29. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
30. Separate the engine from the transaxle. Refer to **Transmission Replacement**.
31. Install the engine to a suitable engine stand.

Installation Procedure

1. Position the powertrain support table under the vehicle.
2. Raise the powertrain into position under the vehicle.
3. With the table positioned, if required, lower the vehicle over the powertrain.
4. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.
5. Lower the vehicle.
6. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side**.

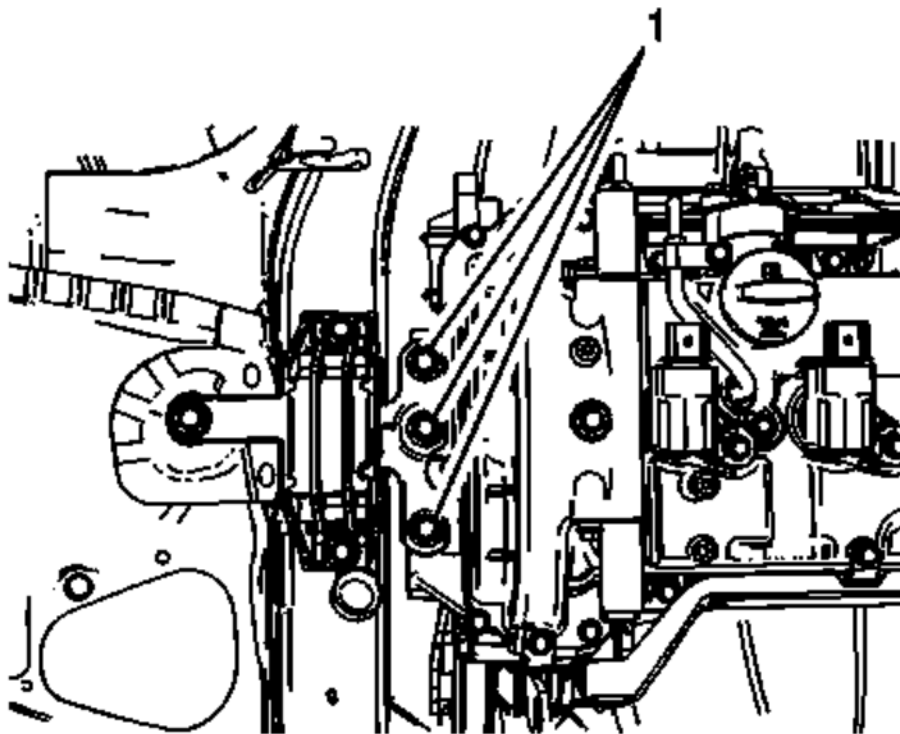


Fig. 232: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

7. Install the engine mount (1). Refer to **Engine Mount Replacement (LCV)**.
8. Install the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement**.
9. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side**.
10. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement**.
11. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LCV)**.
12. Connect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement**.

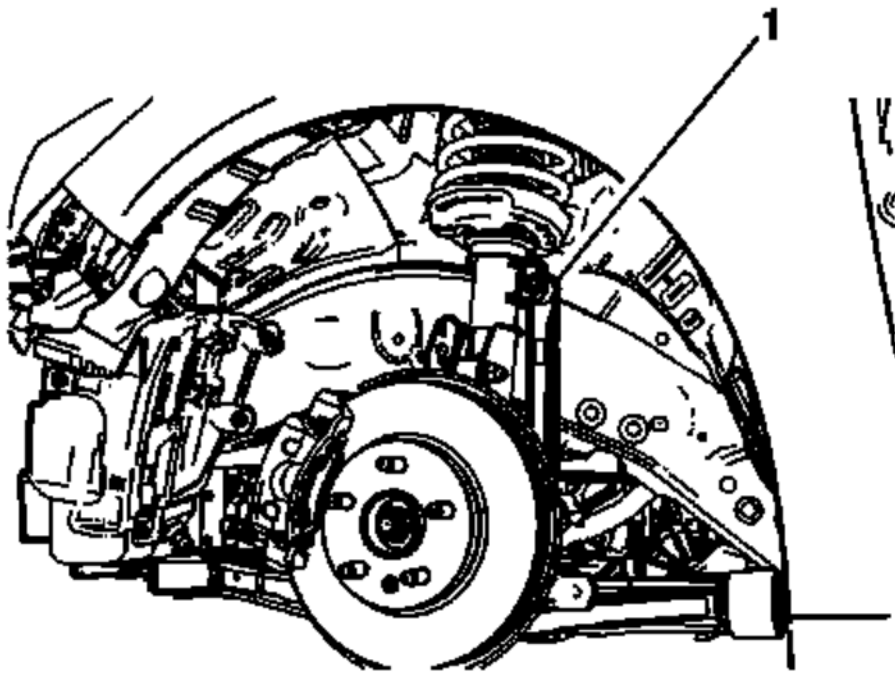


Fig. 233: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

13. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .

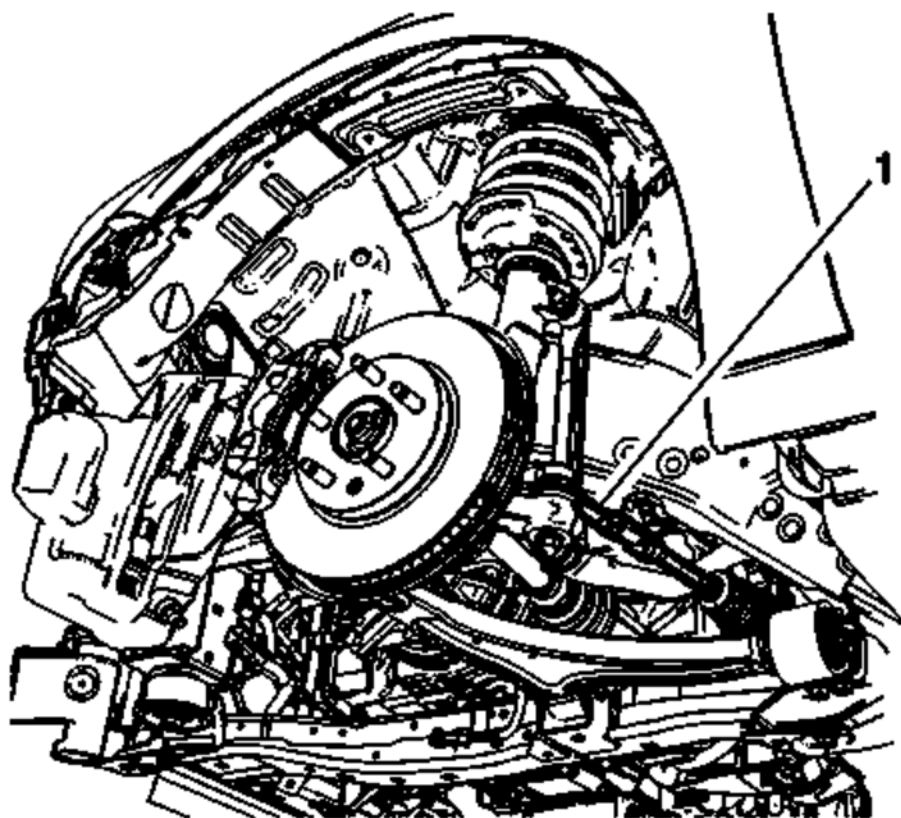


Fig. 234: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

14. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

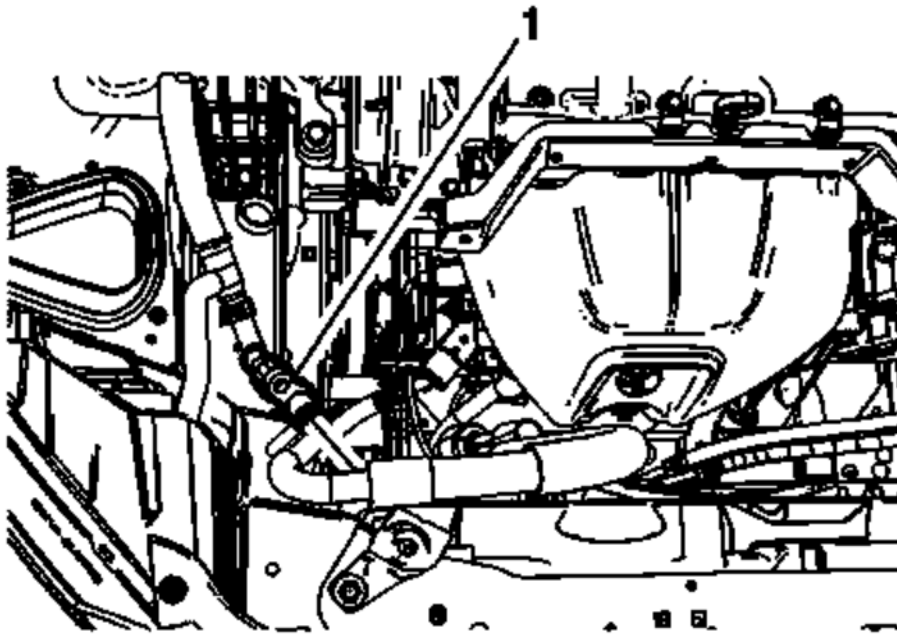


Fig. 235: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

15. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

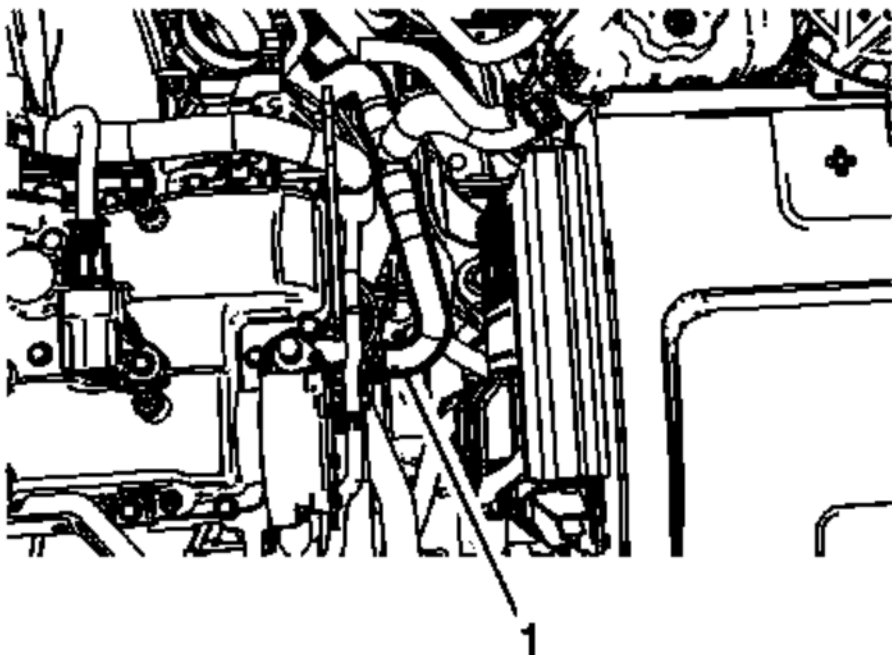


Fig. 236: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

16. Install the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LCV)** .
17. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LCV)** .

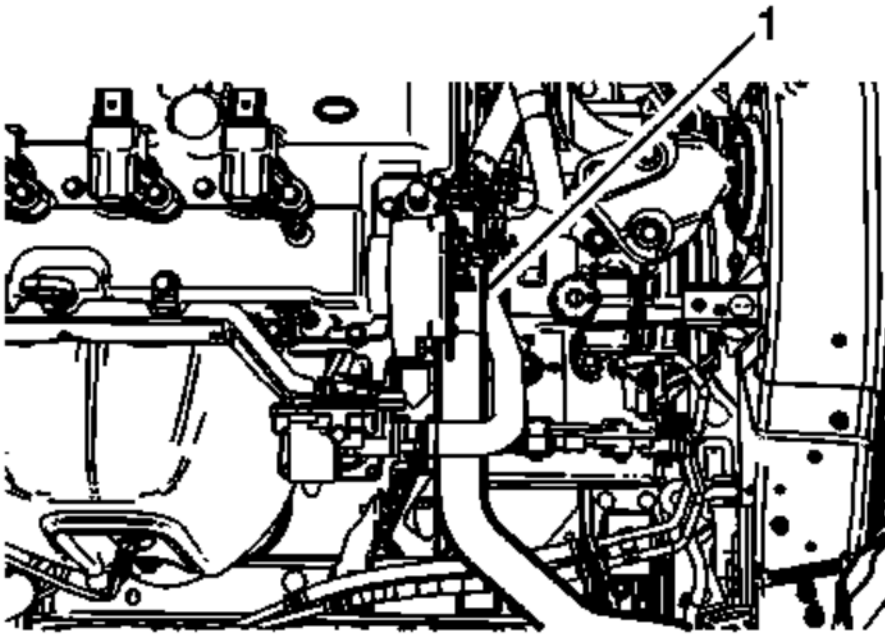


Fig. 237: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

18. Connect the radiator outlet hose (1). **Radiator Inlet Hose Replacement (LCV)** .

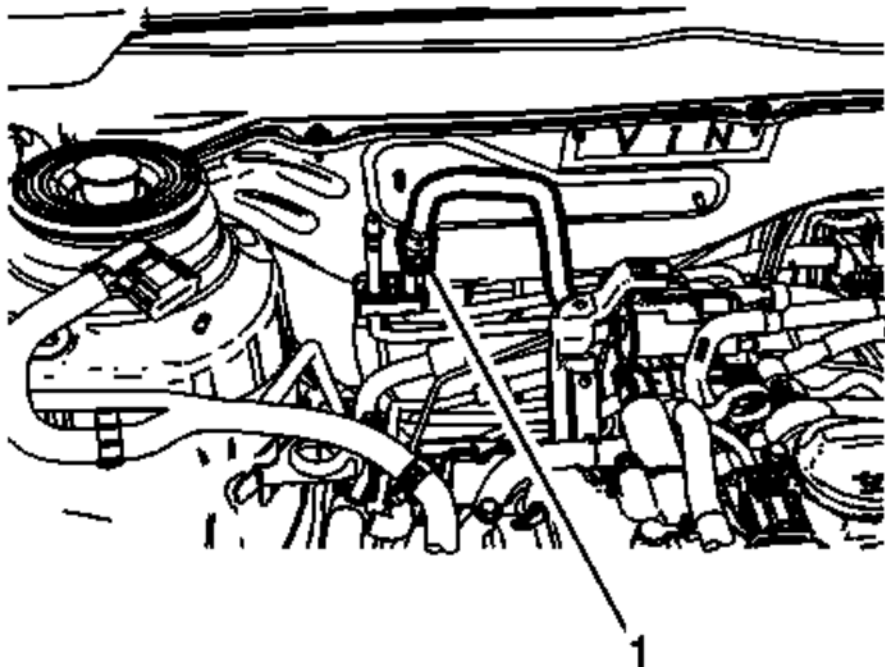


Fig. 238: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the EVAP hose (1). Refer to Plastic Collar Quick Connect Fitting Service .
20. Connect the fuel line (1). Refer to Metal Collar Quick Connect Fitting Service .

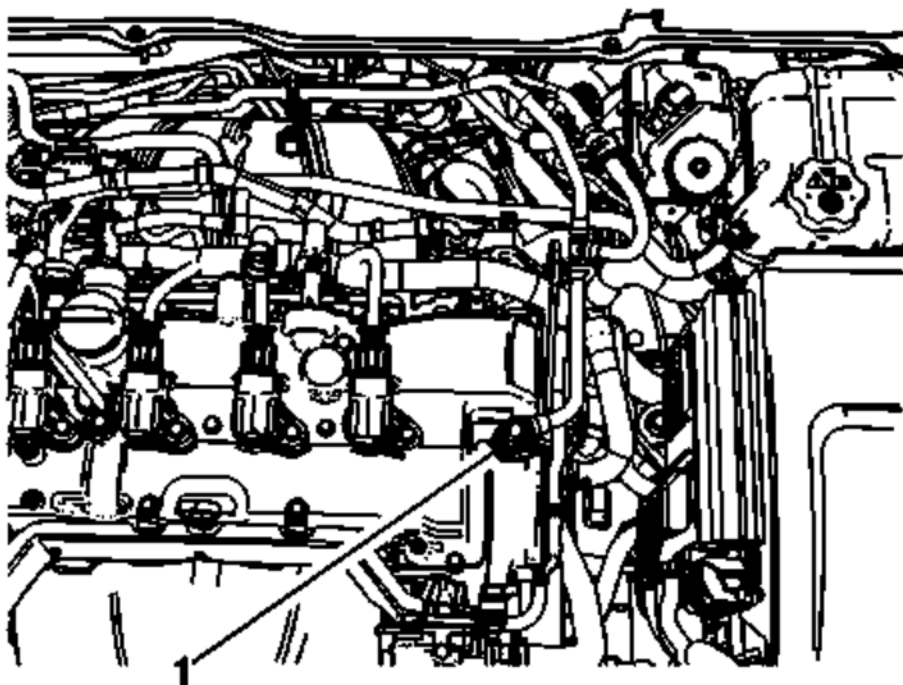


Fig. 239: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

21. Connect the vacuum hose (1). Refer to Plastic Collar Quick Connect Fitting Service .

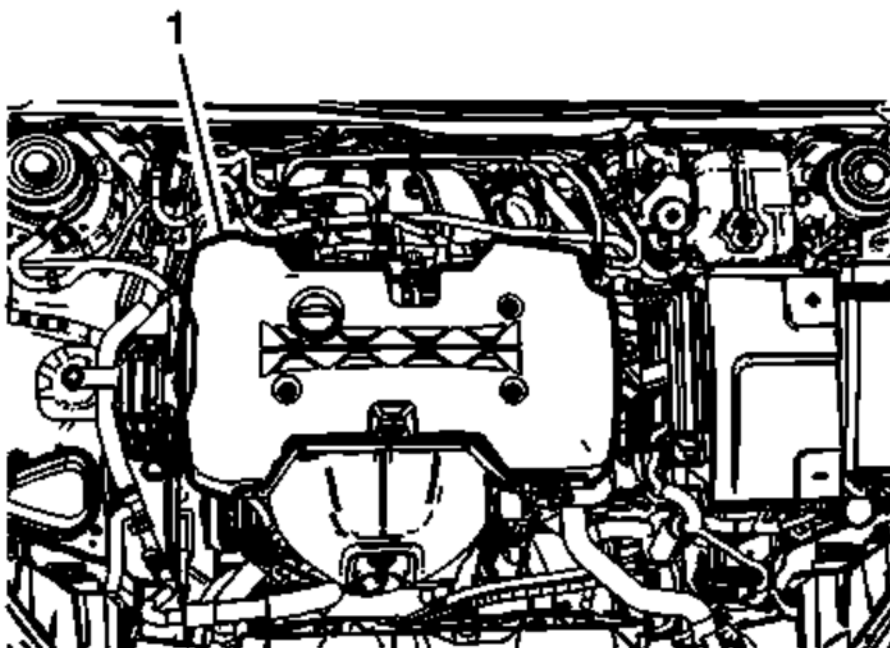


Fig. 240: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

22. Install the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement (LCV)**.
23. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LCV)**.

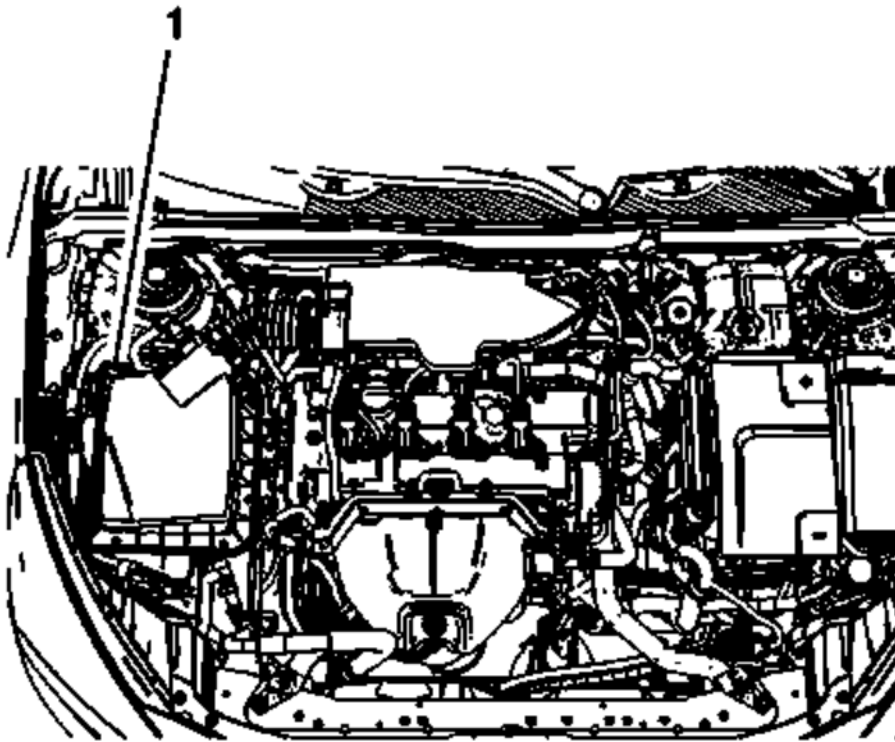


Fig. 241: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement (LCV)** .
25. Install the battery tray. Refer to **Battery Tray Replacement** .
26. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
27. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
28. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement** .
4. Evacuate the A/C system. Refer to **Refrigerant Recovery and Recharging** .

5. Remove the battery tray. Refer to **Battery Tray Replacement** .
6. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .

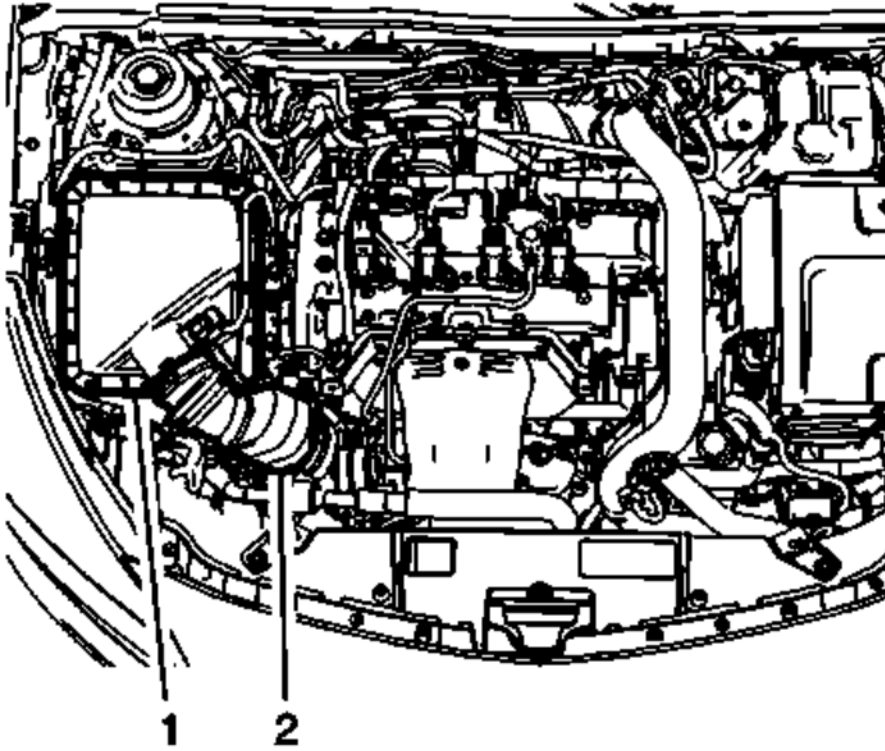


Fig. 242: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

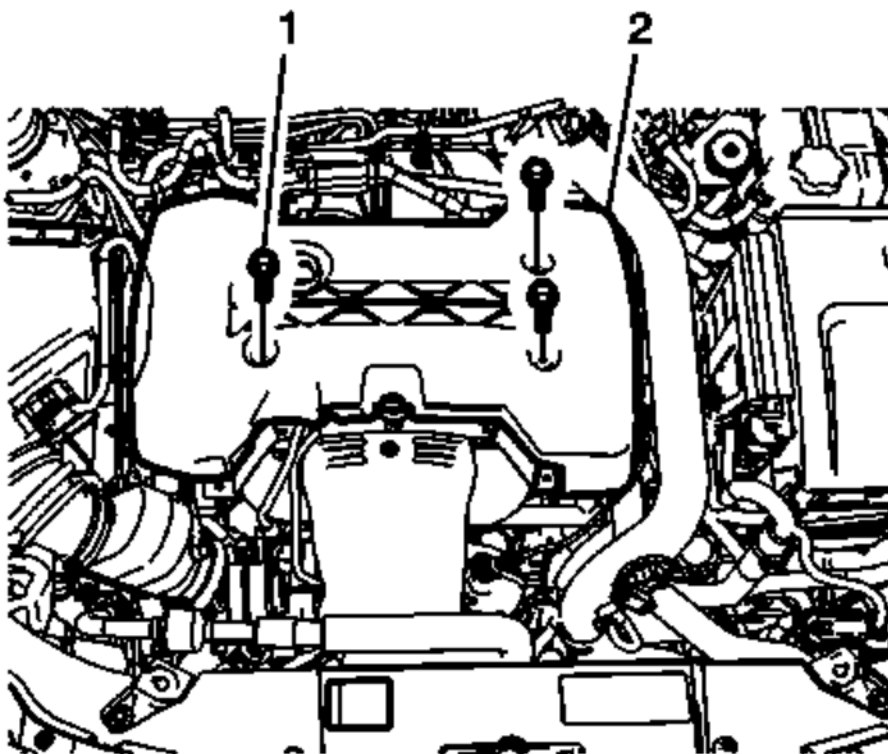


Fig. 243: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

9. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement (LTG)**.

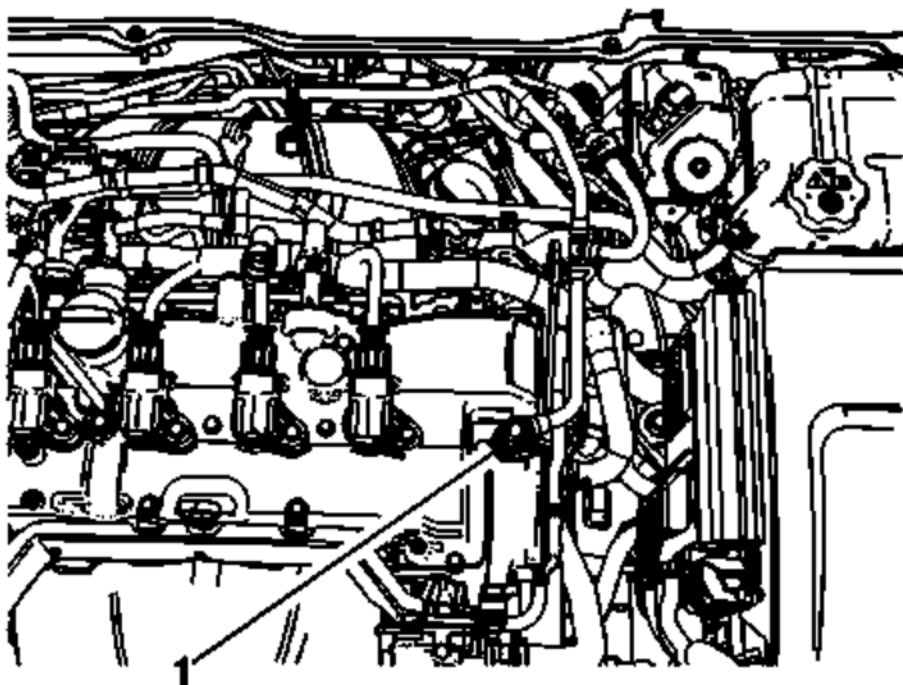


Fig. 244: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the vacuum hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
11. Disconnect the fuel line (1). Refer to **Metal Collar Quick Connect Fitting Service** .

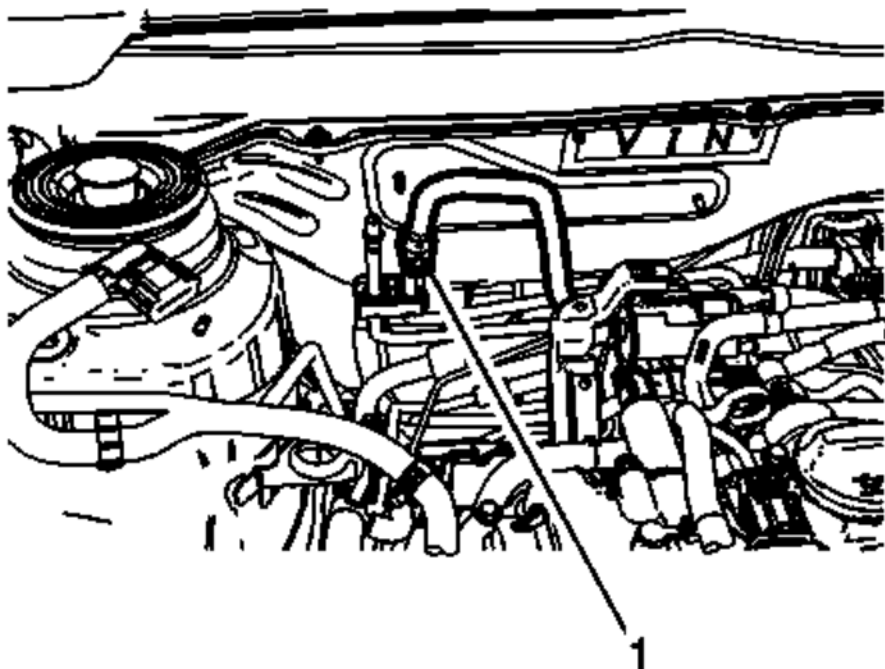


Fig. 245: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the EVAP hose (1). Refer to **Plastic Collar Quick Connect Fitting Service** .

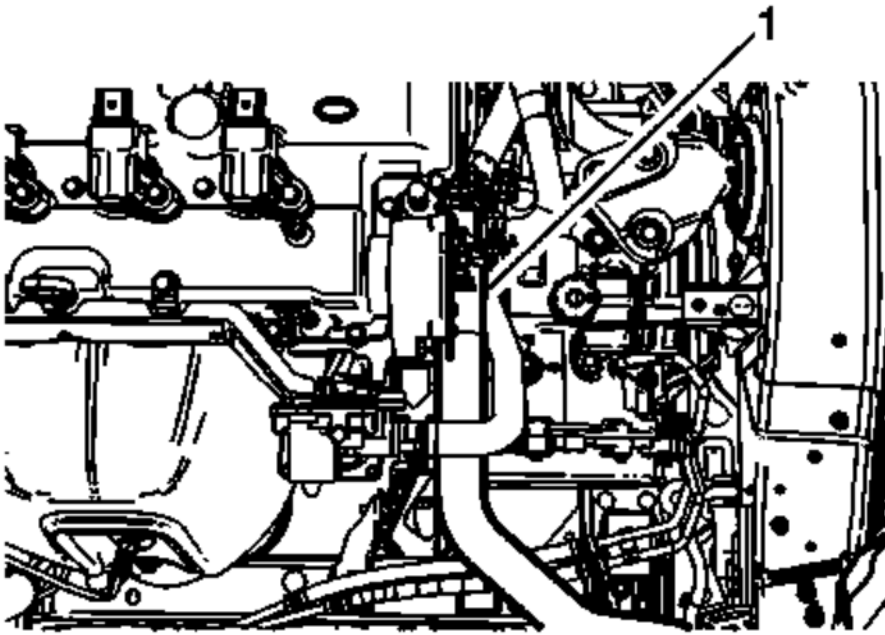


Fig. 246: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the radiator outlet hose (1). Refer to **Radiator Outlet Hose Replacement (LTG)** .

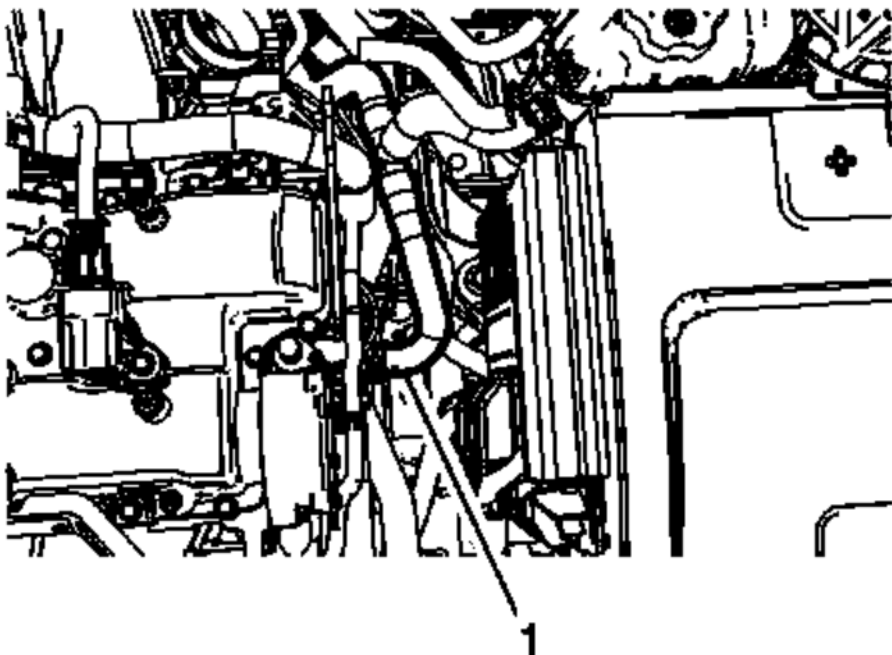


Fig. 247: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

14. Remove the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .
15. Remove the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .

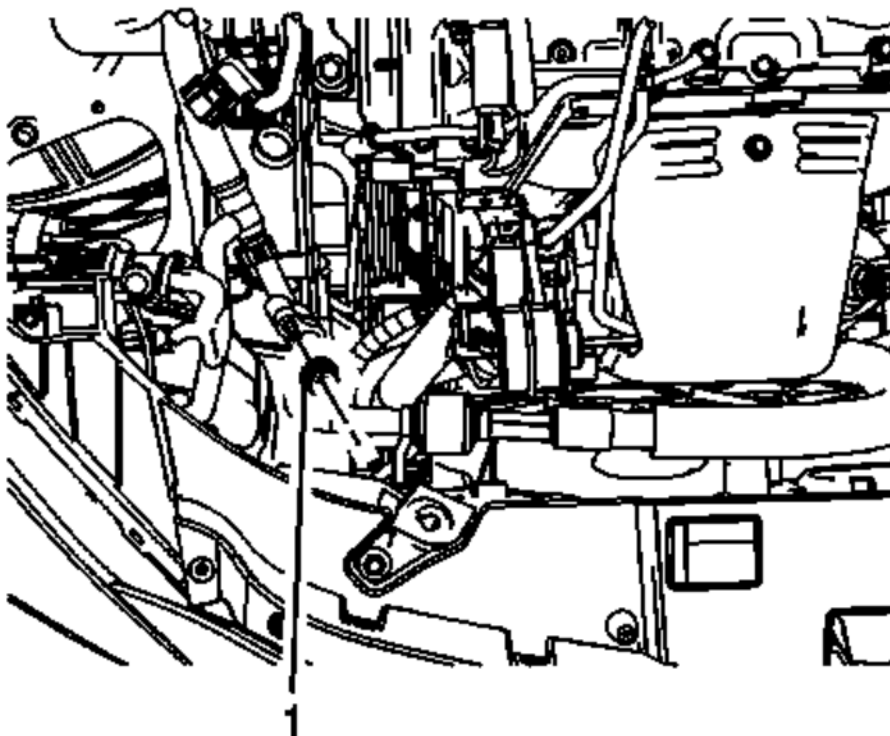


Fig. 248: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Remove the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

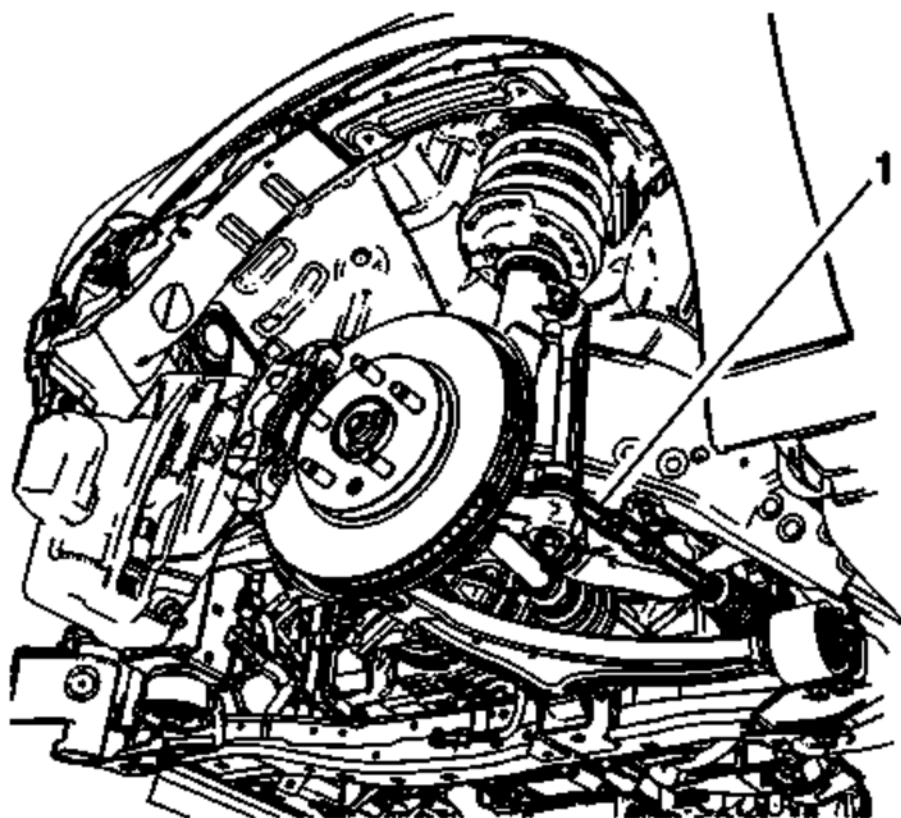


Fig. 249: Tie Rods And Steering Knuckles
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

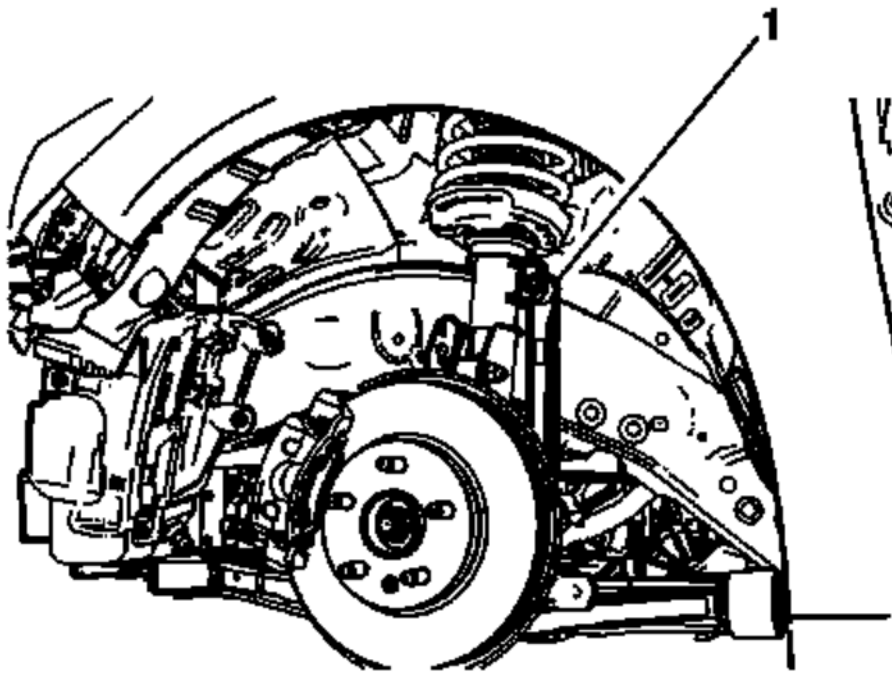


Fig. 250: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .
19. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
20. Remove the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)** .
21. Disconnect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement** .
22. Remove the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
23. Remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .

NOTE: During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
26. With the table positioned, fully raise the table to contact with the powertrain assembly.

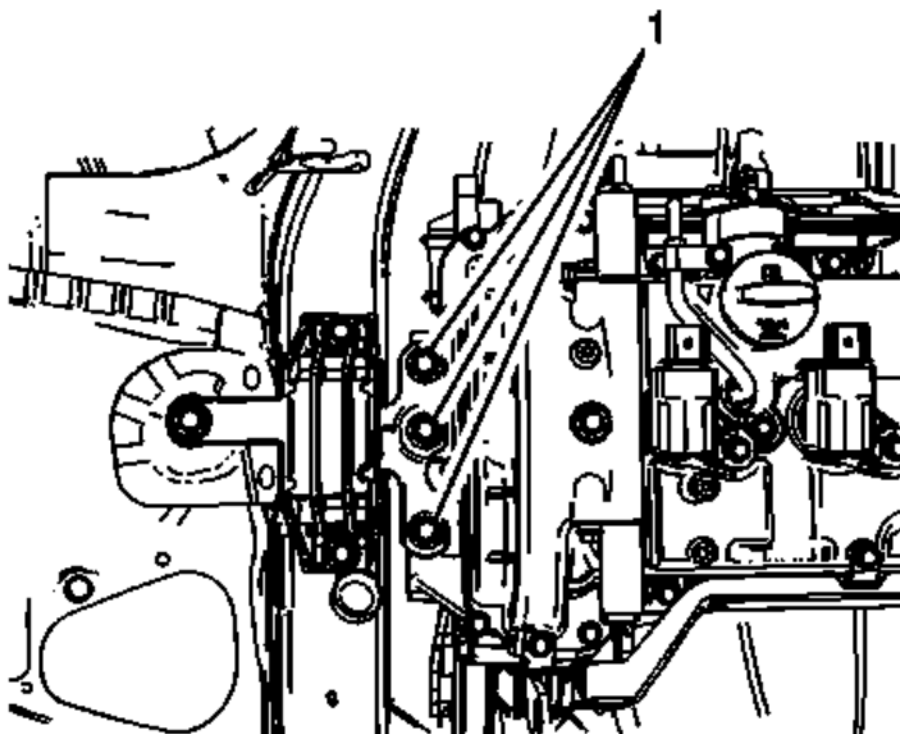


Fig. 251: Engine Mount

Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount (1). Refer to **Engine Mount Replacement (LTG)**.
28. Remove the transmission mount. Refer to **Transmission Mount Replacement - Left Side**.
29. Remove the frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. Refer to **Transmission Replacement**.
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine and transaxle back together. Refer to **Transmission Replacement**.
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the NEW frame to body bolts. Refer to **Drivetrain and Front Suspension Frame Replacement**.

6. Lower the vehicle.
7. Install the transmission mount. Refer to **Transmission Mount Replacement - Left Side** .

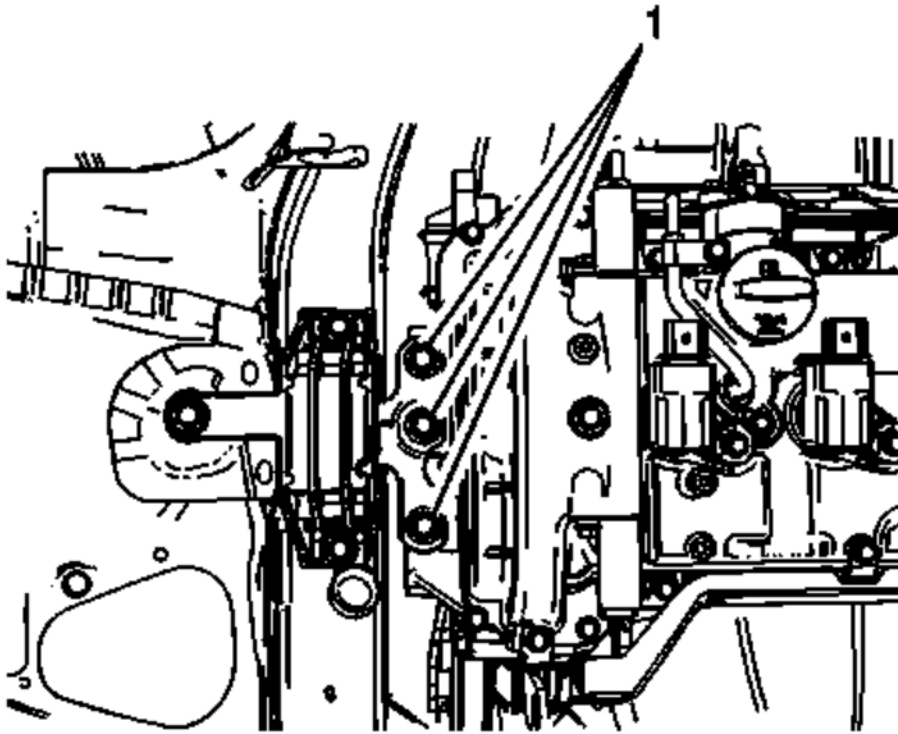


Fig. 252: Engine Mount
Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount (1). Refer to **Engine Mount Replacement (LTG)**.
9. Install the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .
10. Install the left wheel drive shaft. Refer to **Front Wheel Drive Shaft Replacement - Left Side** .
11. Connect the lower control arms from the steering knuckles. Refer to **Lower Control Arm Replacement** .
12. Install the exhaust system. Refer to **Exhaust Front Pipe Replacement (LTG)** .
13. Connect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .

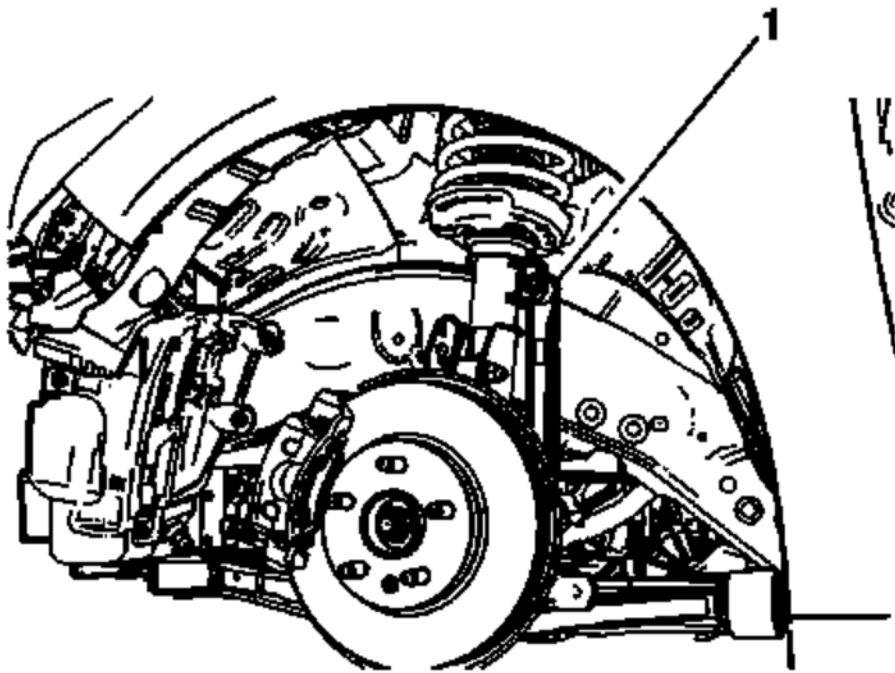


Fig. 253: Stabilizer Links

Courtesy of GENERAL MOTORS COMPANY

14. Connect the stabilizer links (1) from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .

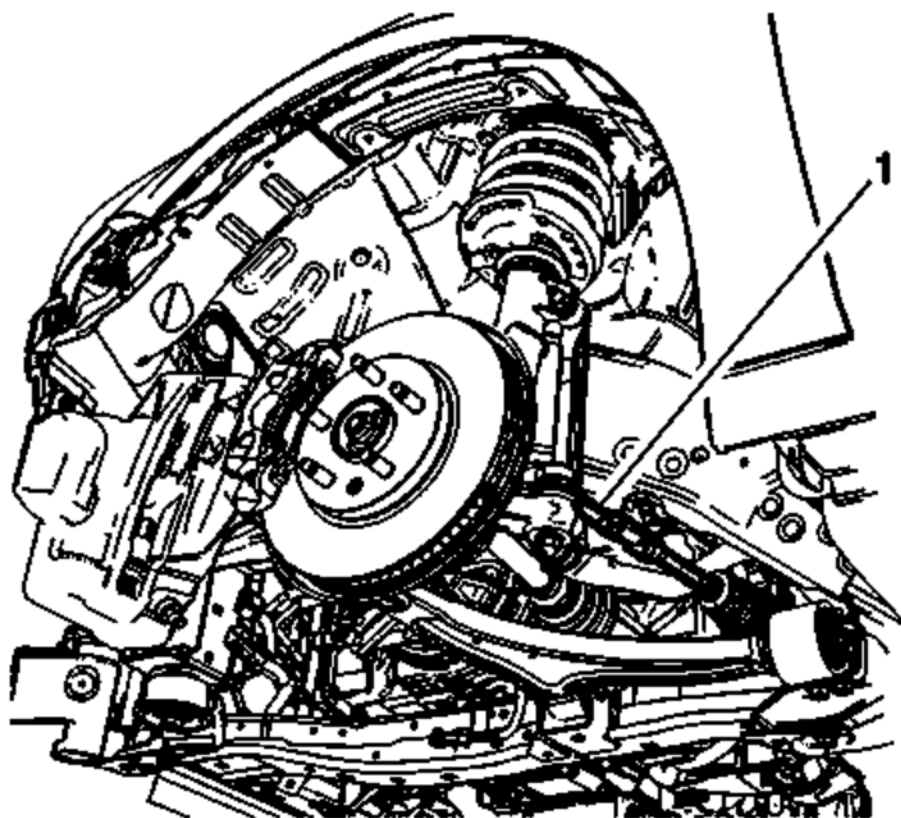


Fig. 254: Tie Rods And Steering Knuckles

Courtesy of GENERAL MOTORS COMPANY

15. Connect the tie rods (1) from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

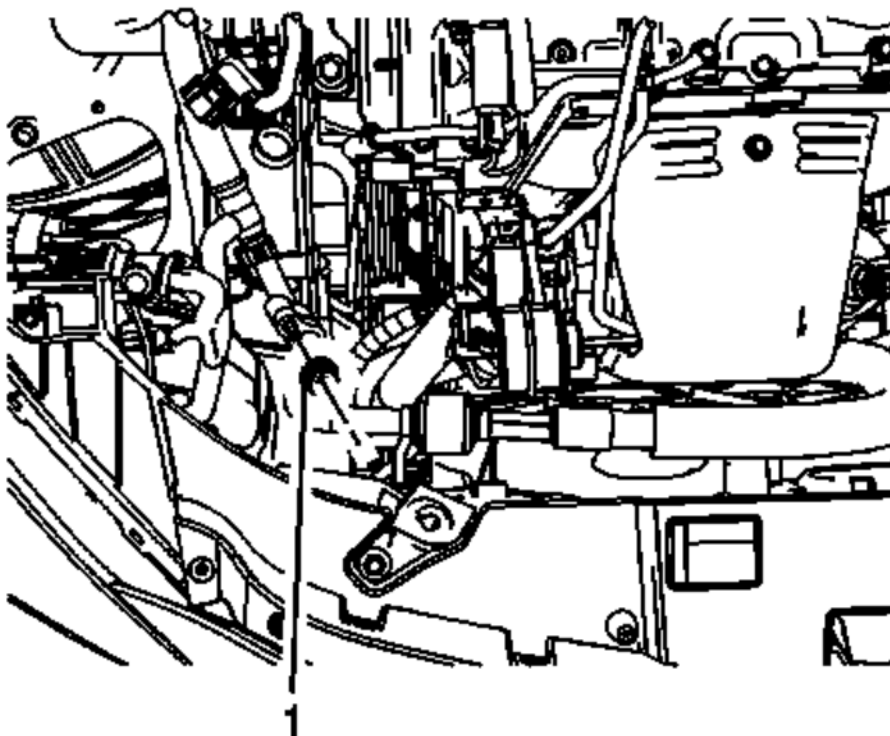


Fig. 255: Air Conditioning Compressor And Condenser Hose
Courtesy of GENERAL MOTORS COMPANY

16. Install the air conditioning compressor and condenser hose (1). Refer to **Air Conditioning Compressor and Condenser Hose Replacement** .

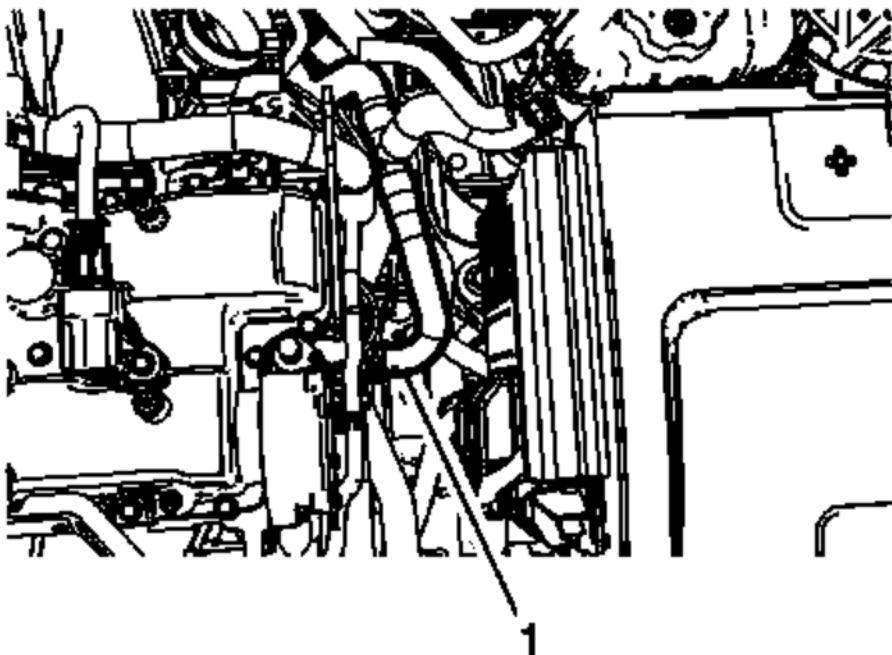


Fig. 256: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Install the heater outlet hose (2). Refer to **Heater Outlet Hose Replacement (LTG)** .
18. Install the heater inlet hose (1). Refer to **Heater Inlet Hose Replacement (LTG)** .

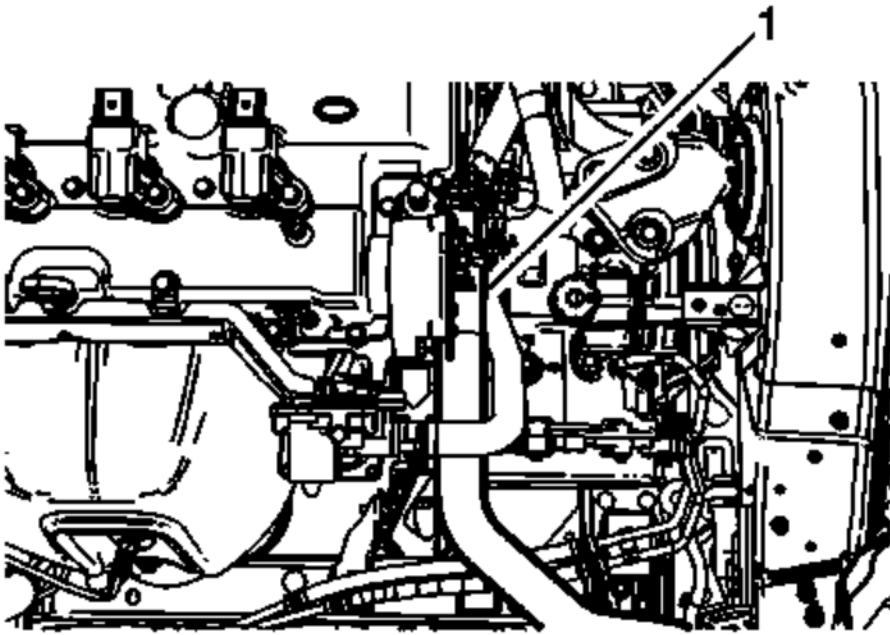


Fig. 257: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hosRadiator Outlet Hose Replacement (LTG) .

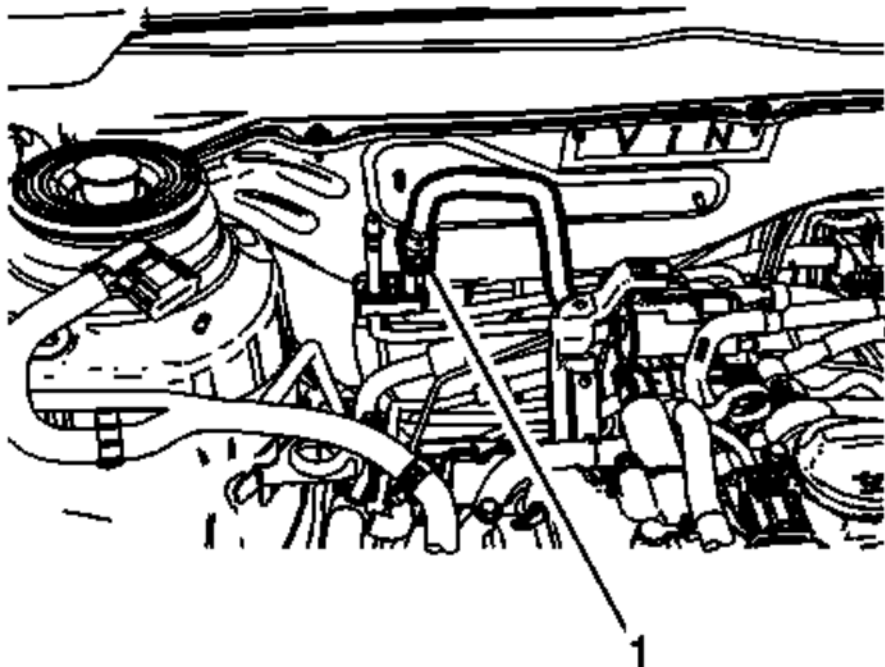


Fig. 258: EVAP Hose

Courtesy of GENERAL MOTORS COMPANY

20. Connect the EVAP hose (1). Refer to Plastic Collar Quick Connect Fitting Service .
21. Connect the fuel line (1). Refer to Metal Collar Quick Connect Fitting Service .

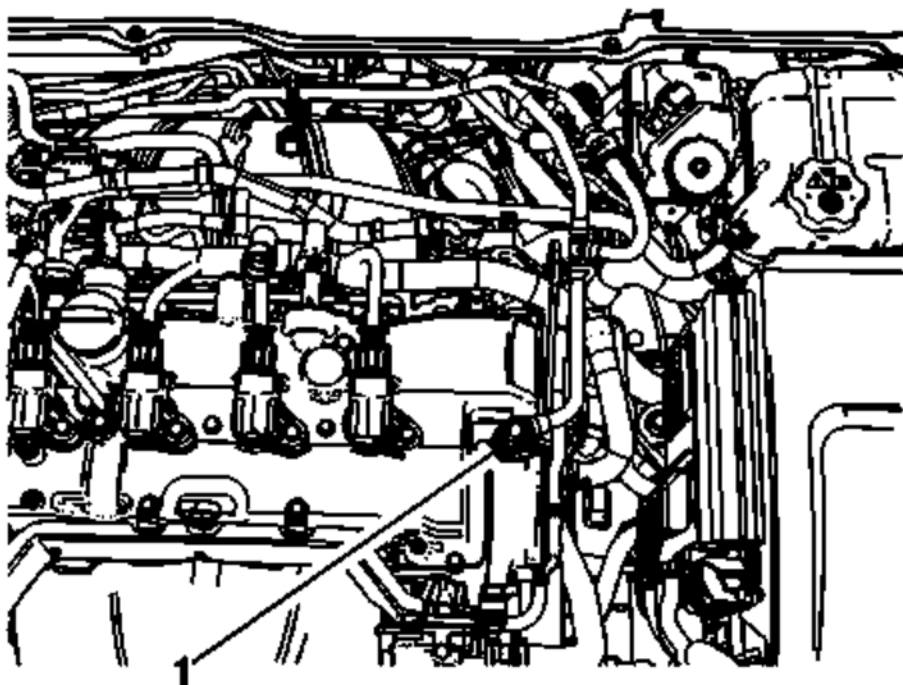


Fig. 259: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

22. Connect the vacuum hose (1). Refer to Plastic Collar Quick Connect Fitting Service .

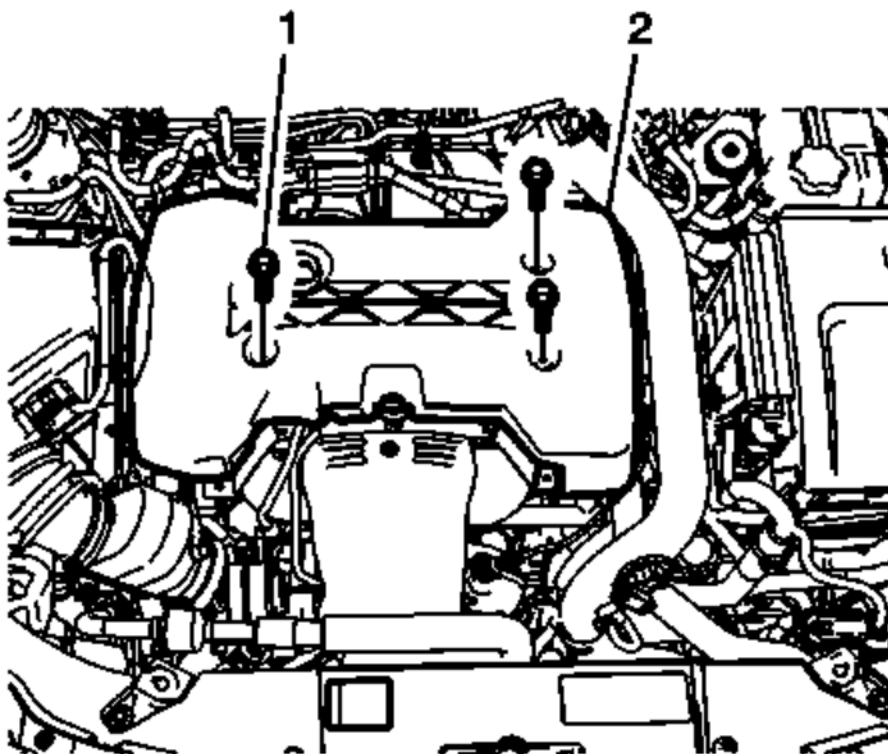


Fig. 260: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

23. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement (LTG)**.

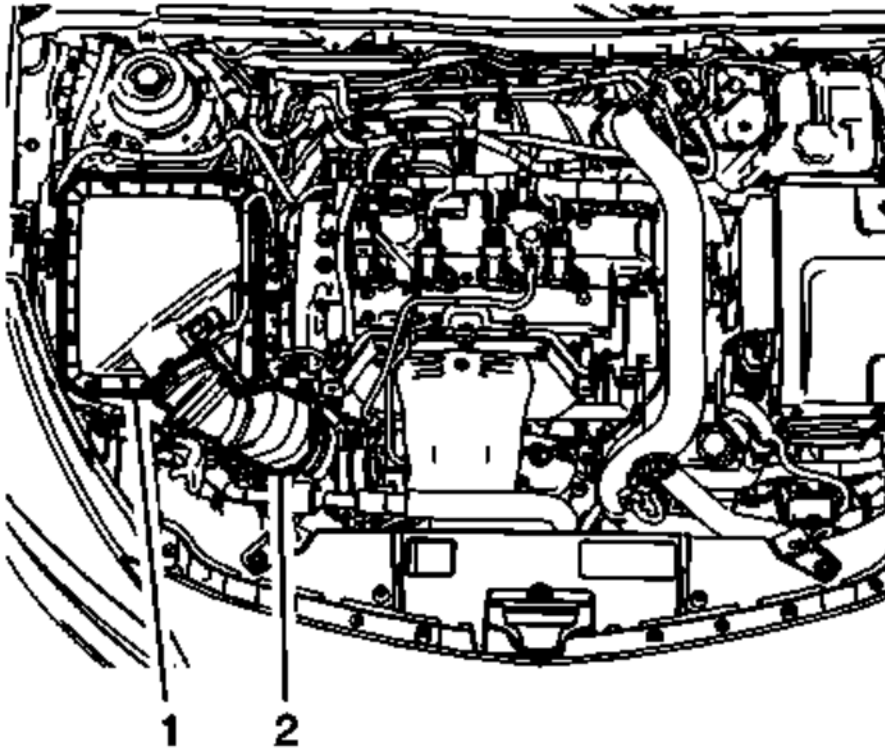


Fig. 261: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

24. Install the air cleaner assembly (1). Refer to **Air Cleaner Assembly Replacement (LTG)** .
25. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement (LTG)** .
26. Install the battery tray. Refer to **Battery Tray Replacement** .
27. Recharge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
29. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement** .
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

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.

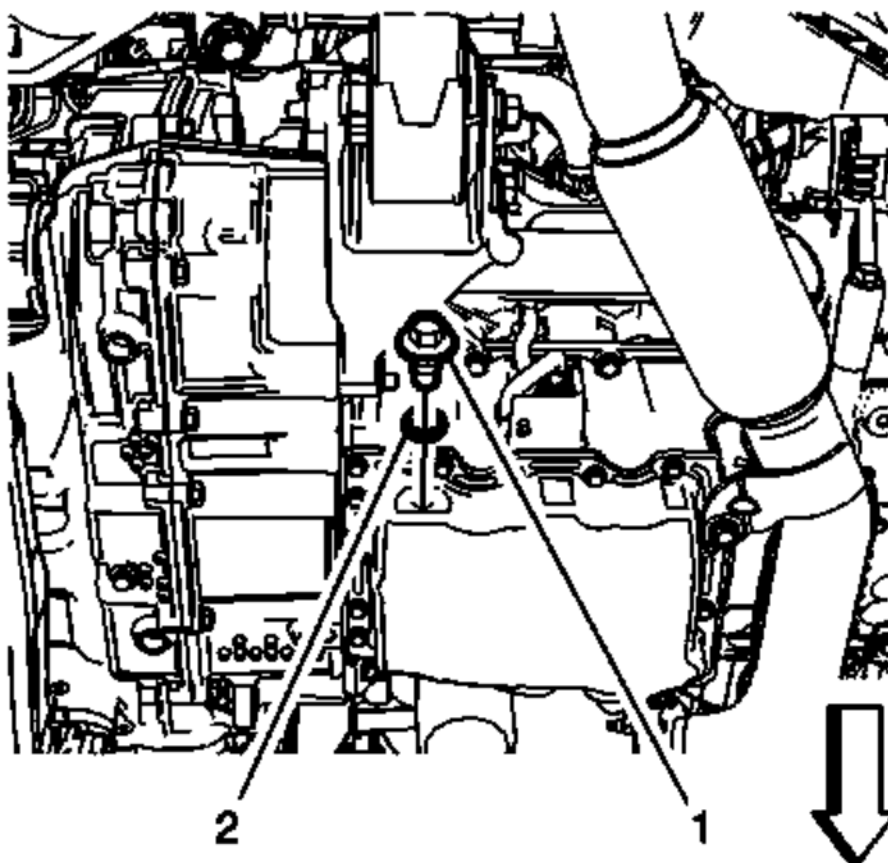


Fig. 262: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1).
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface (2), replace the oil pan drain plug sealing surface if necessary.

CAUTION: Refer to Component Fastener Tightening Caution .

7. Reinstall oil pan drain plug (1) and tighten to 25 (18 lb ft).

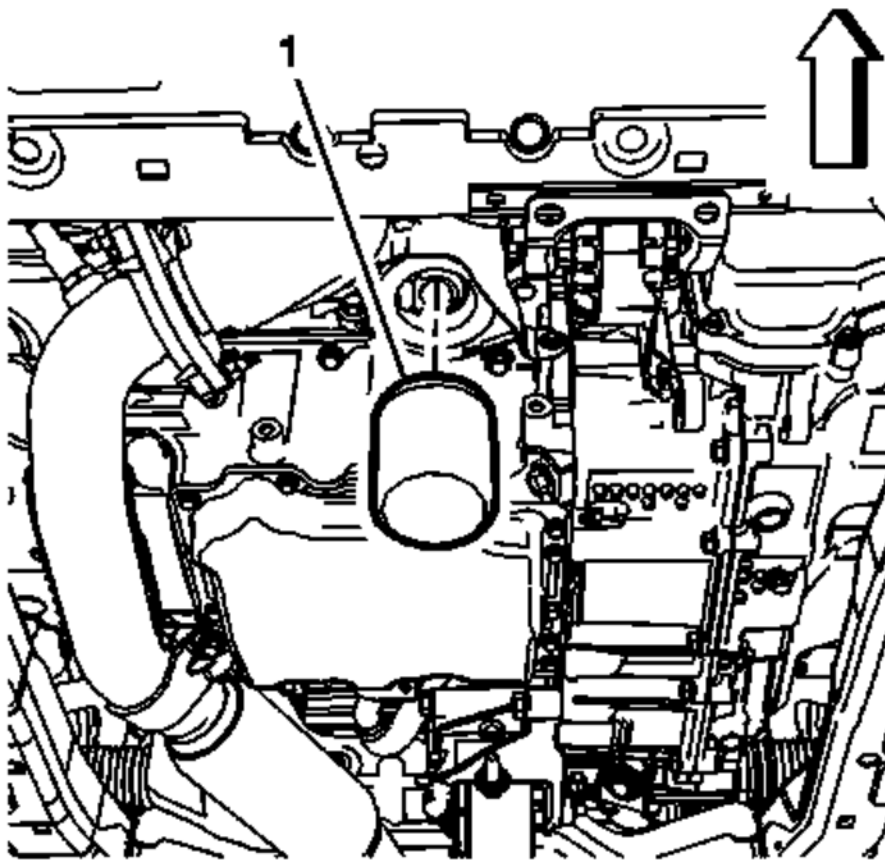


Fig. 263: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

8. Position a suitable drain pan under the oil filter.
9. Remove the oil filter (1).
10. 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

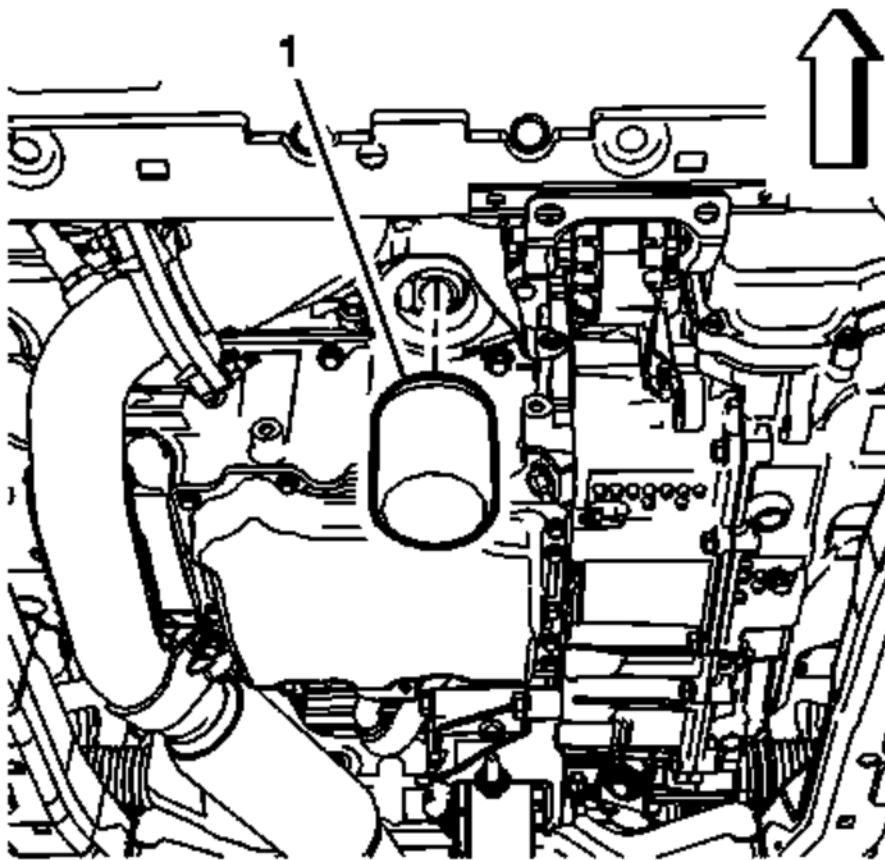


Fig. 264: Oil Filter

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.
5. Start the engine.
6. Inspect for oil leaks after engine start up.