

ENGINE

Engine Mechanical - 3.6L (LFX LF3) - Repair Instructions - On Vehicle - CTS Sedan

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT (LFX)

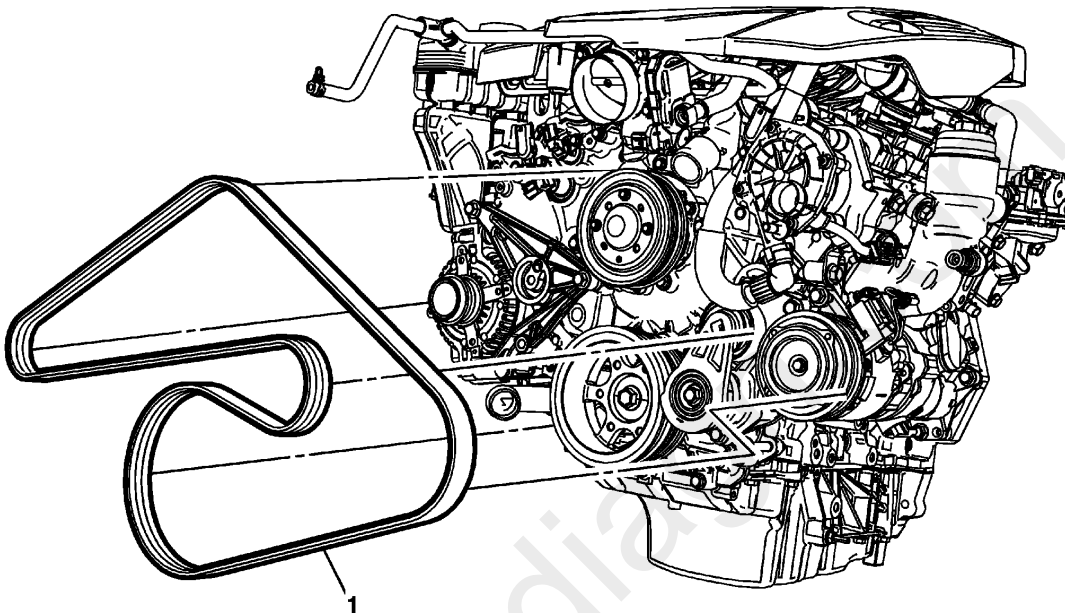


Fig. 1: Drive Belt Routing (LFX)

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> .	
1	Drive Belt Procedure 1. Rotate the drive belt tensioner counter clockwise to release the drive belt tension. 2. Slide the drive belt off of the water pump pulley. 3. Slowly release the drive belt tensioner.

DRIVE BELT REPLACEMENT (LF3)

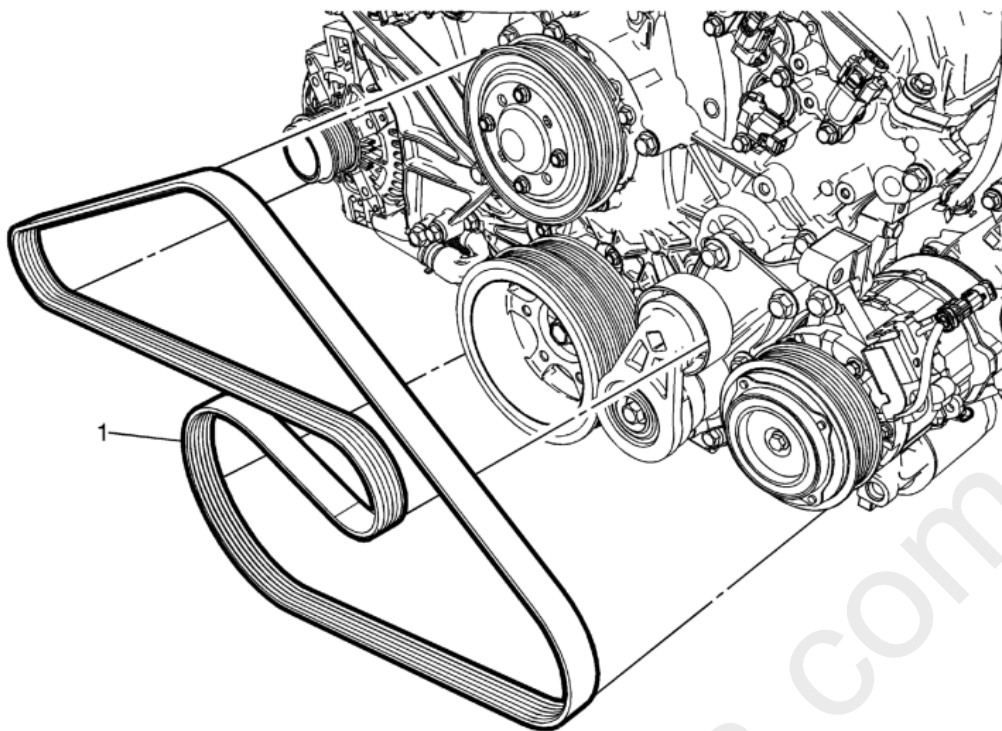


Fig. 2: Drive Belt Routing (LF3)

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement (LF3)

Callout	Component Name
Preliminary Procedures	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u>	
1	Drive Belt Procedure 1. Rotate the drive belt tensioner clockwise to release the drive belt tension. 2. Slide the drive belt off of the belt idler pulley. 3. Slowly release the drive belt tensioner.

DRIVE BELT TENSIONER REPLACEMENT (LFX)

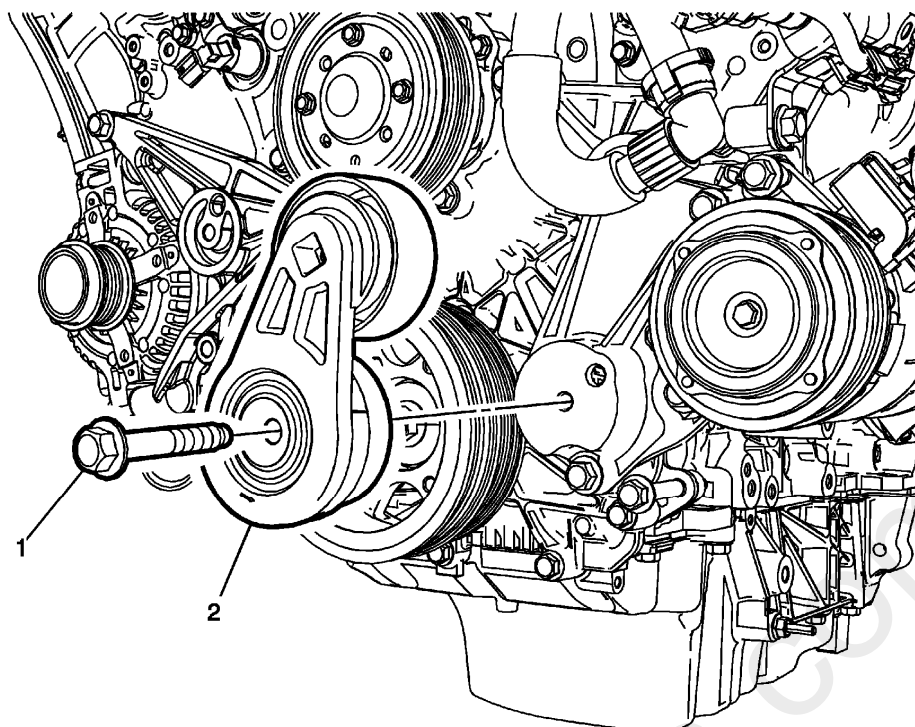


Fig. 3: Drive Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement (LFX)

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

DRIVE BELT TENSIONER REPLACEMENT (LF3)

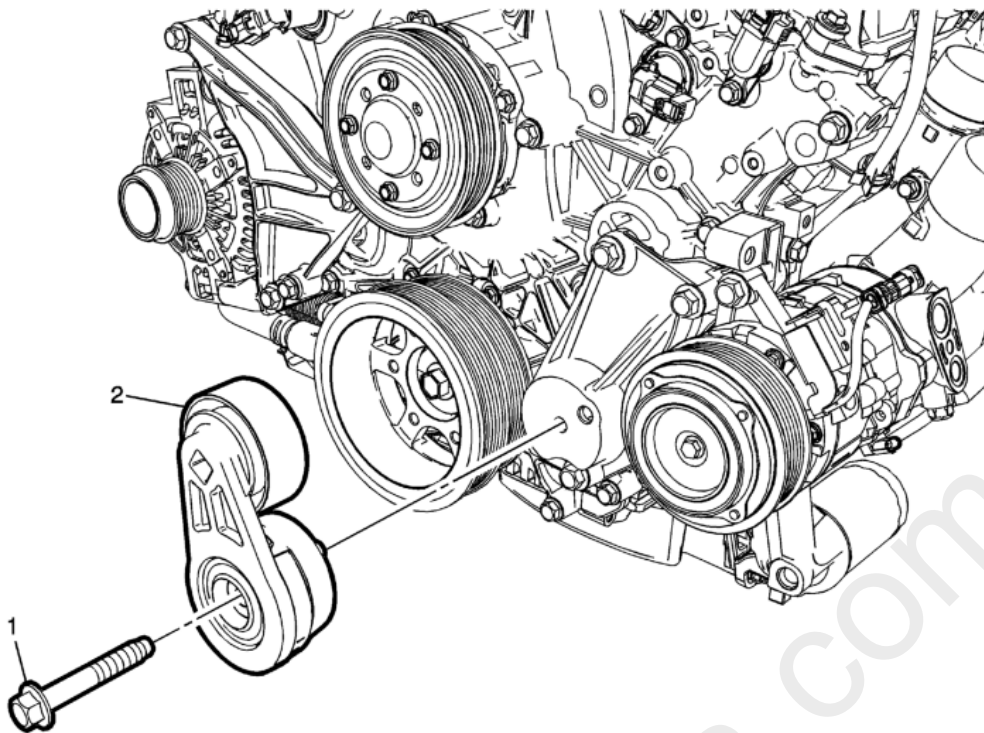


Fig. 4: Drive Belt Tensioner (LF3)

Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to <u>Drive Belt Replacement (LF3)</u> .	
1	Drive Belt Tensioner Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Drive Belt Tensioner

GENERATOR AND DRIVE BELT TENSIONER BRACKET REPLACEMENT

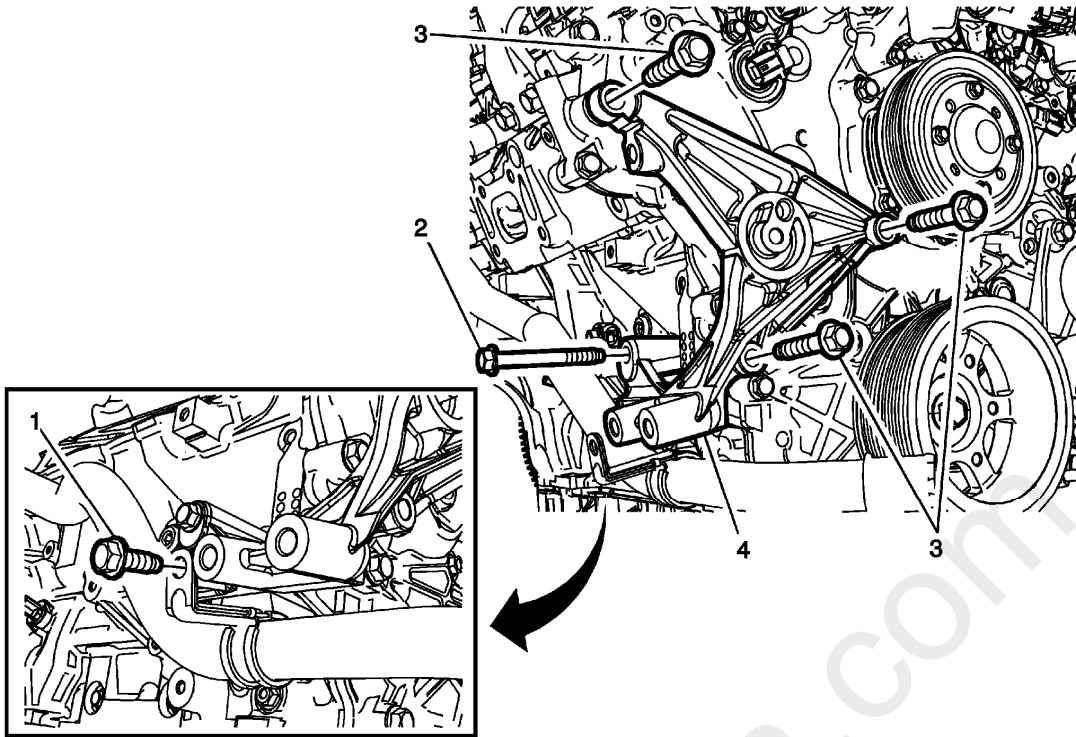


Fig. 5: Generator and Drive Belt Tensioner Bracket
 Courtesy of GENERAL MOTORS COMPANY

Generator and Drive Belt Tensioner Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the generator. Refer to <u>Generator Replacement (LFX)</u> , <u>Generator Replacement (LTG)</u> , <u>Generator Replacement (LF3)</u> .	
1	Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Position the coolant hose clamp clear of the generator and drive belt tensioner bracket. Tighten 22 N.m (16 lb ft)
2	Fastener Tighten 50 (37 lb ft)
3	Fastener (QTY:3) Tighten 50 (37 lb ft)
4	Generator and Drive Belt Tensioner Bracket.

CHARGE AIR COOLER COVER REPLACEMENT

Removal Procedure

1. Remove the supercharger water manifold. Refer to [Supercharger Water Manifold Replacement](#) .

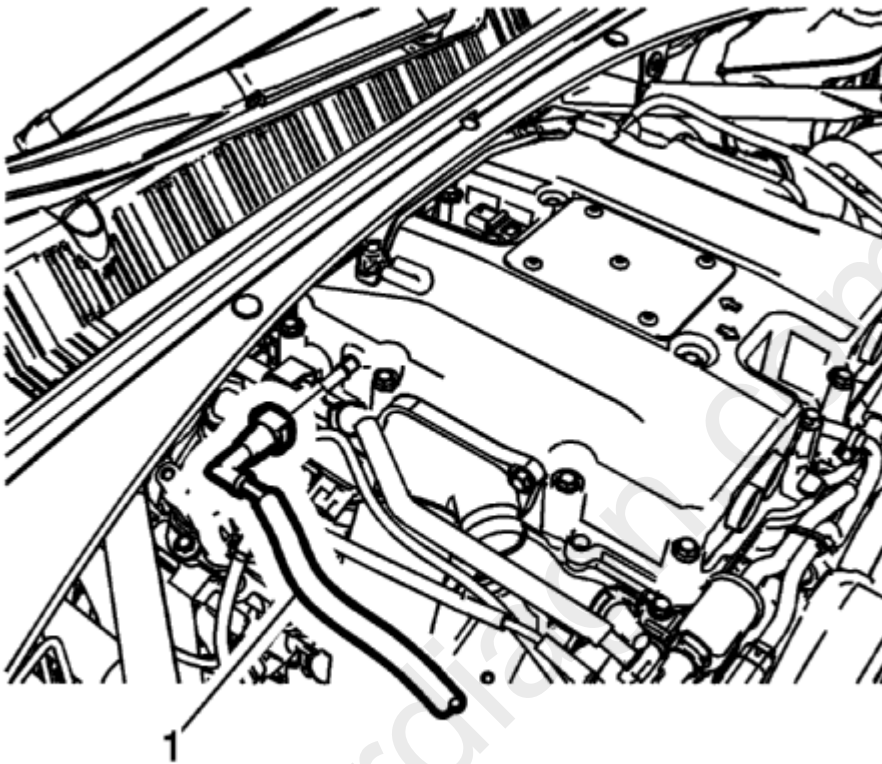


Fig. 6: Vacuum Line

Courtesy of GENERAL MOTORS COMPANY

2. Disconnect vacuum line (1). Refer to [Plastic Collar Quick Connect Fitting Service](#) .

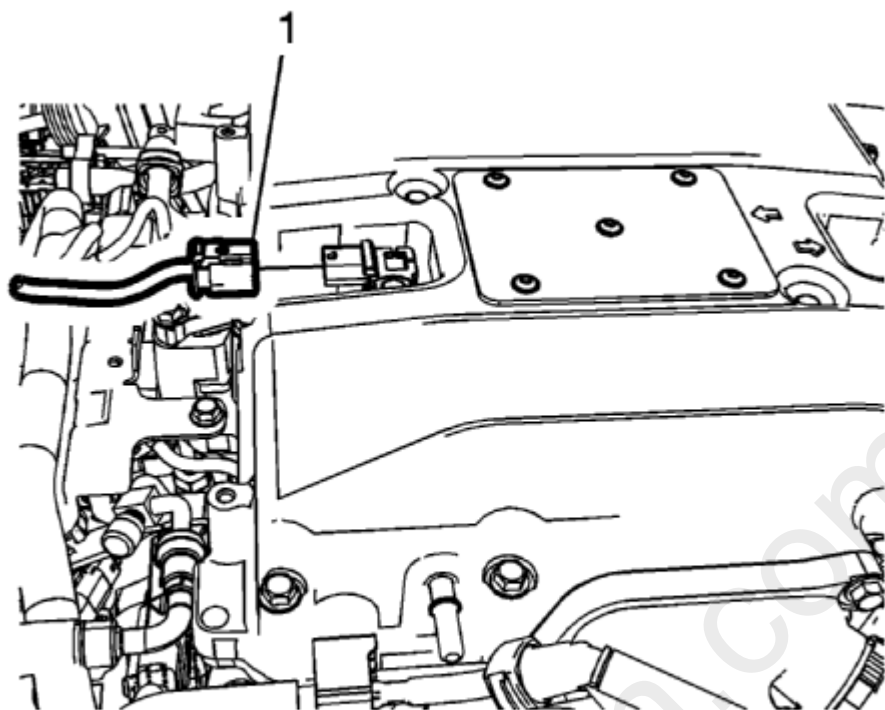


Fig. 7: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect electrical connector (1)

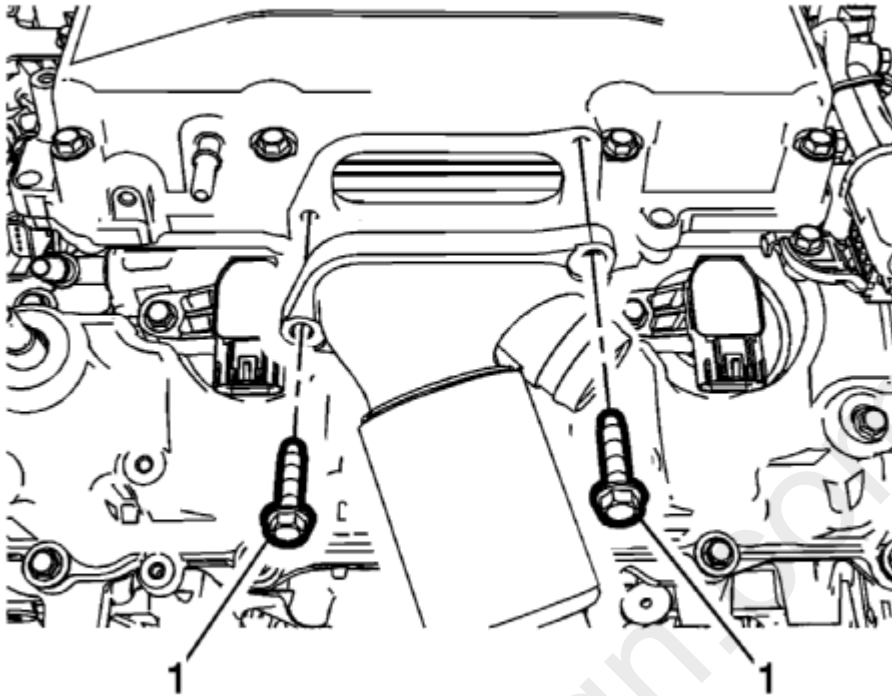


Fig. 8: Charge Air Cooler Inlet Air Tube Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left charge air cooler inlet air tube bolts (1) and position tube aside. Refer to **Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3)** .

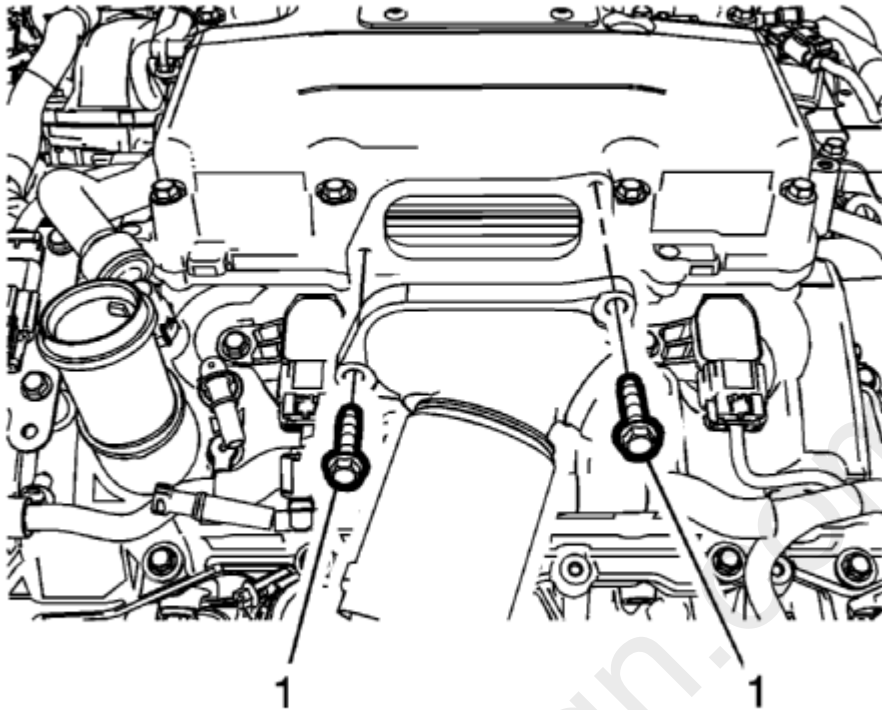


Fig. 9: Charge Air Cooler Inlet Air Tube Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right charge air cooler inlet air tube bolts (1) and position tube aside. Refer to **Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)** .

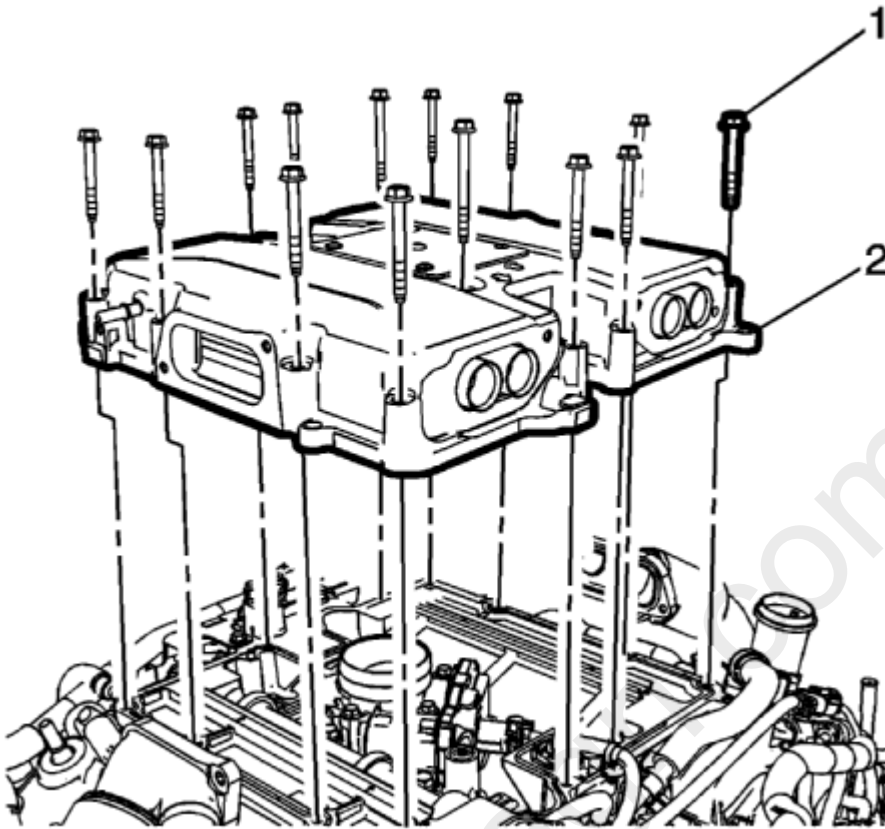


Fig. 10: Charge Air Cooler Cover
Courtesy of GENERAL MOTORS COMPANY

6. Remove the charge air cooler bolts (1) and the charge air cooler cover (2).

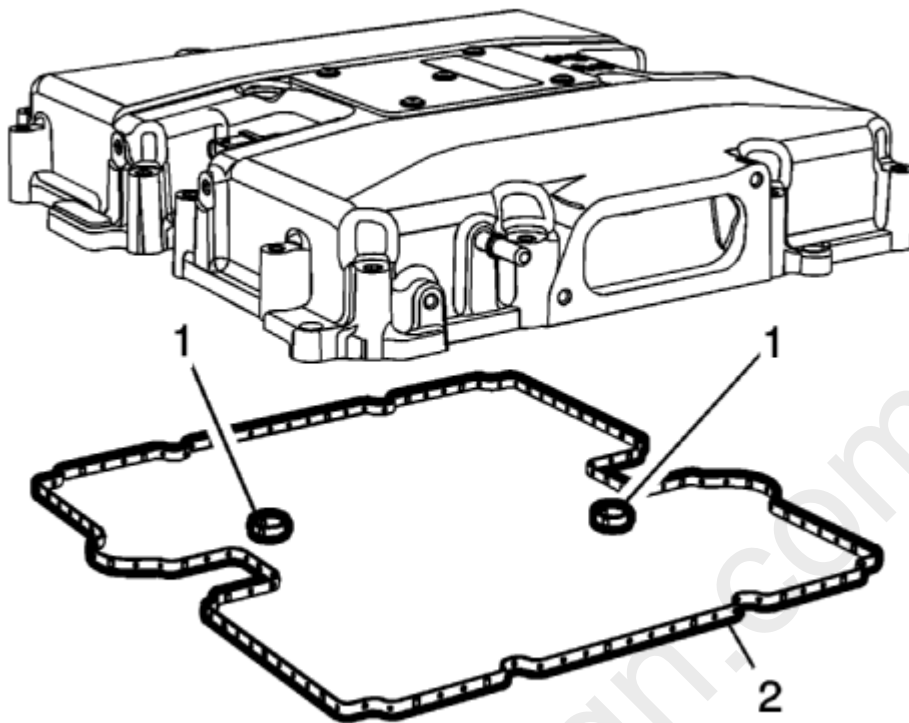


Fig. 11: Charge Air Cooler Gaskets
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the gaskets (1 and 2).

Installation Procedure

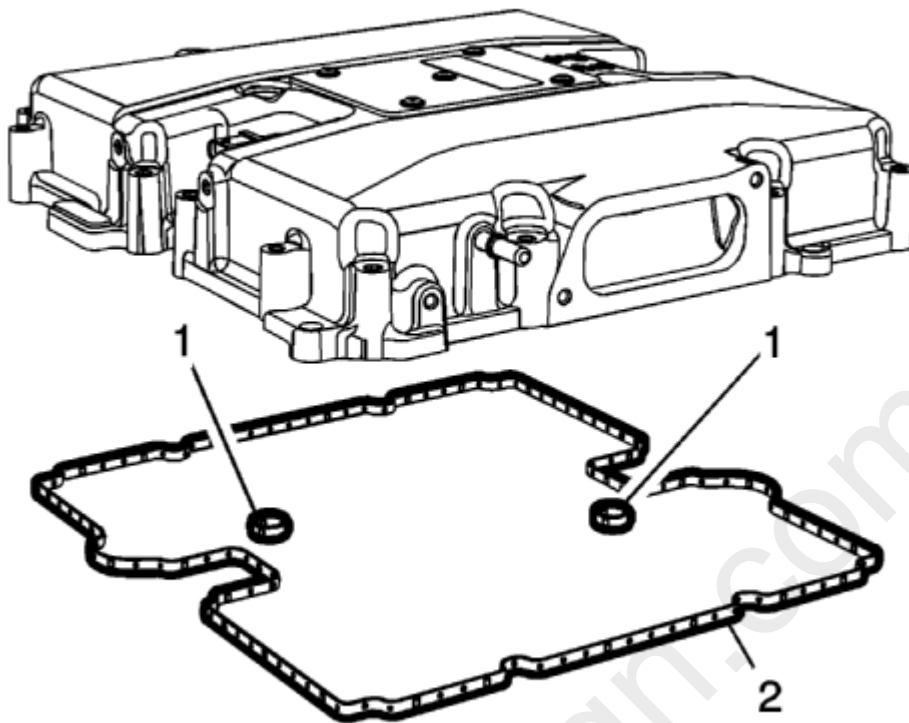


Fig. 12: Charge Air Cooler Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW gaskets (1 and 2) on the charge air cooler cover.

CAUTION: Refer to Fastener Caution .

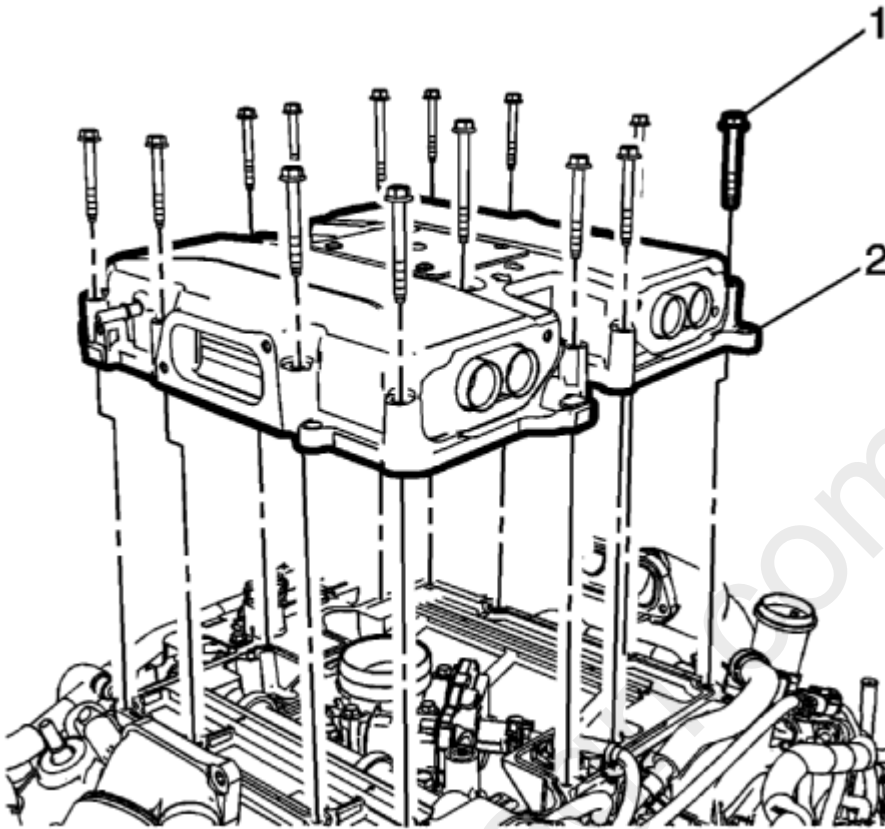


Fig. 13: Charge Air Cooler Cover
Courtesy of GENERAL MOTORS COMPANY

2. Install the charge air cooler cover (2) and the charge air cooler bolts (1). Hand tighten the bolts.

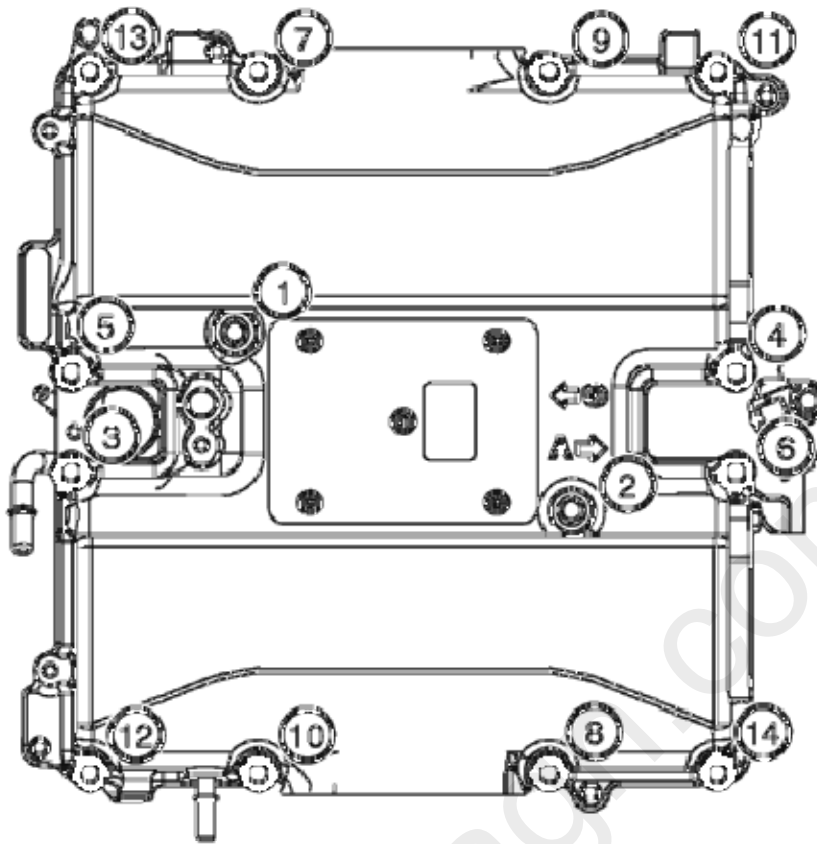


Fig. 14: Charge Air Cooler Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Tighten the charge air cooler bolts in the sequence shown.

3. Tighten the charge air cooler bolts (1) to 10 (89 lb in).

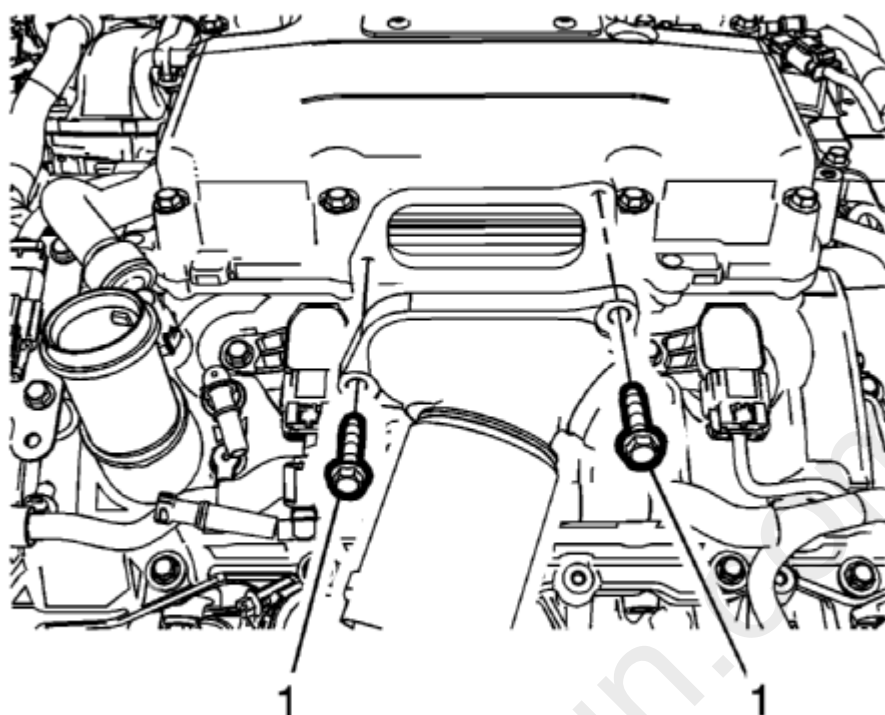


Fig. 15: Charge Air Cooler Inlet Air Tube Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Position the right charge air cooler inlet air tube and install the bolts (1). Refer to **Charge Air Cooler Inlet Pipe Replacement - Right Side (LF3)** .

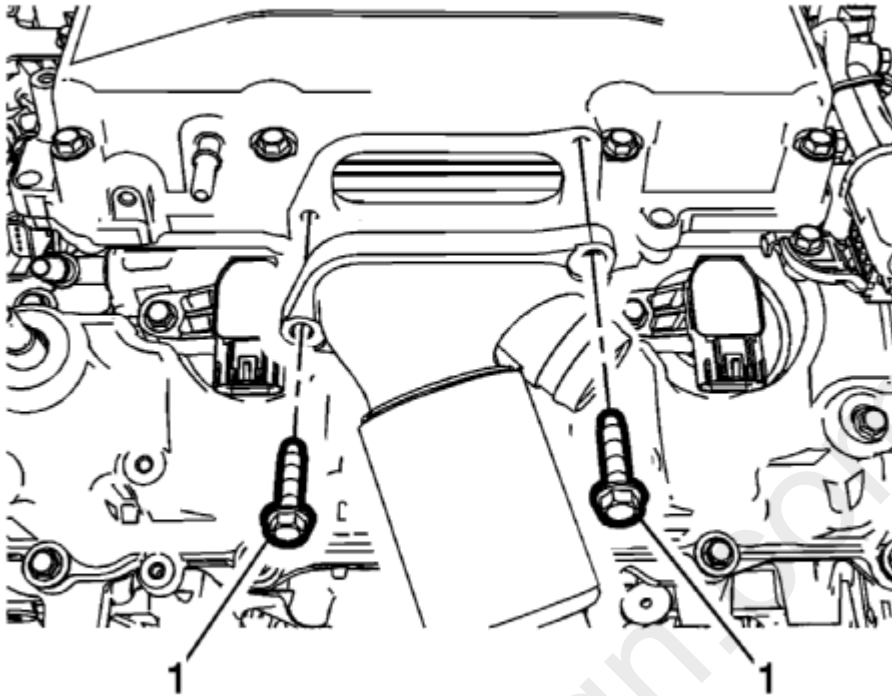


Fig. 16: Charge Air Cooler Inlet Air Tube Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Position the left charge air cooler inlet air tube and install the bolts (1). Refer to **Charge Air Cooler Inlet Pipe Replacement - Left Side (LF3)** .

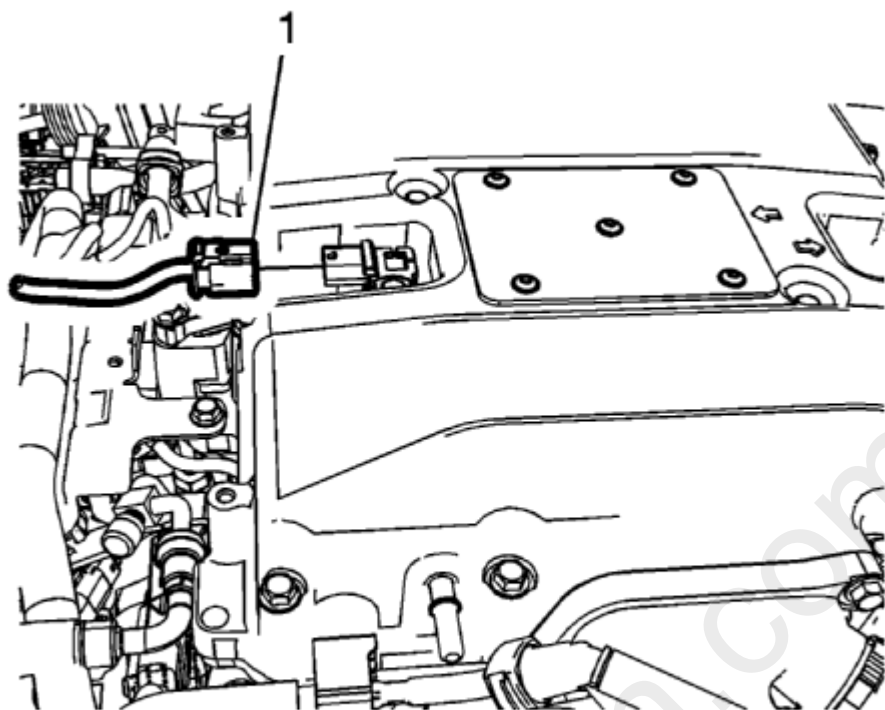


Fig. 17: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

6. Connect electrical connector (1)

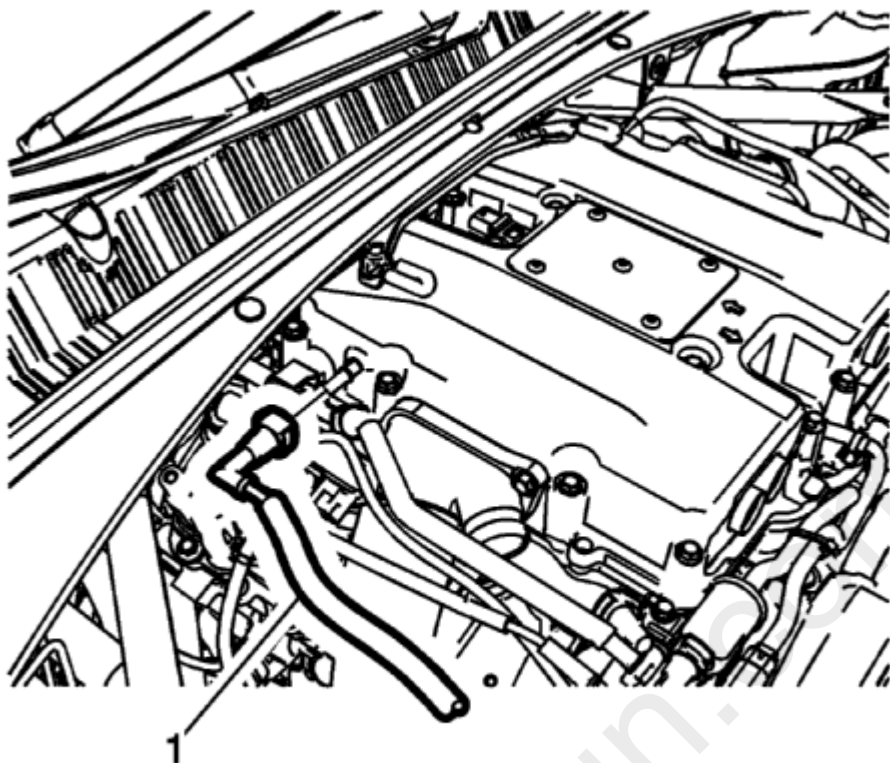


Fig. 18: Vacuum Line

Courtesy of GENERAL MOTORS COMPANY

7. Connect vacuum line (1). Refer to **Plastic Collar Quick Connect Fitting Service** .
8. Install the supercharger water manifold. Refer to **Supercharger Water Manifold Replacement** .

ENGINE SUPPORT FIXTURE

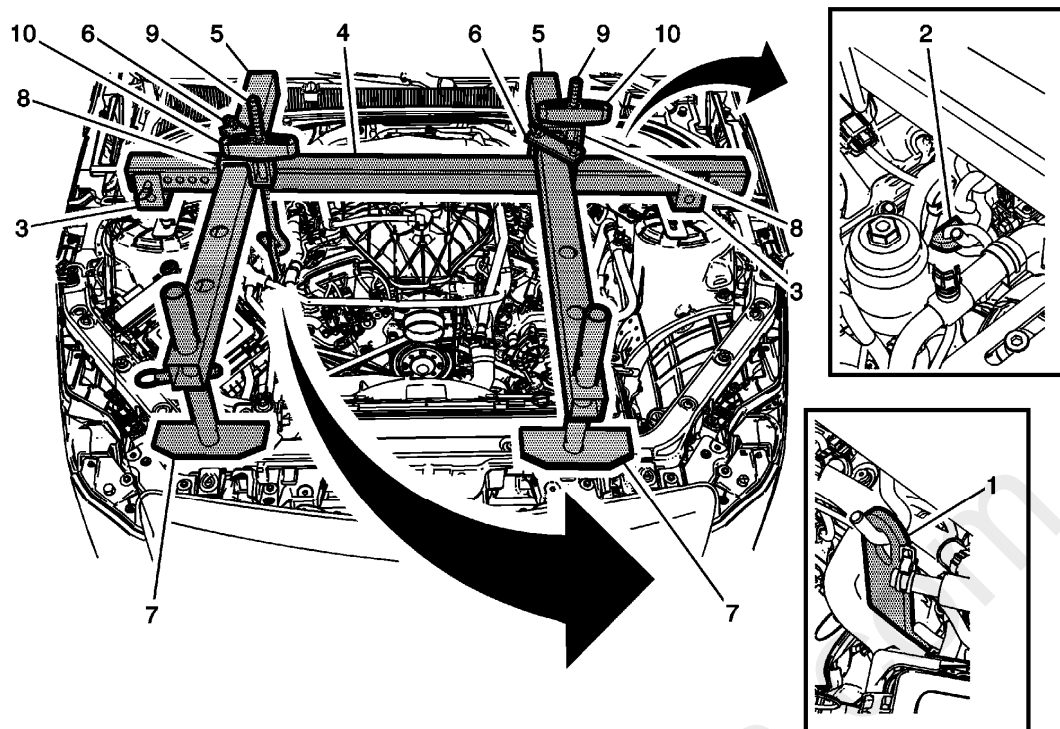


Fig. 19: Engine Support Fixture
 Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedures	
1.	Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> .
2.	Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .
3.	Remove the radiator surge tank. Refer to <u>Radiator Surge Tank Replacement (LTG)</u> , <u>Radiator Surge Tank Replacement (LFX, LF3)</u> .
4.	Remove the secondary air injection pump inlet hose, if equipped. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u> .
Special Tools	
• EN-36857 Engine Lift Bracket • EN-46114 Engine Lift Bracket • EN-28467-550 Engine Support Beam Adapters • J-284678-518 Main Support Beam • EN-28467-2A Radiator Tube Shelf Assembly • EN-28467-1A Cross Bracket	

- **EN-28467-4A** Front Support Assembly
- **J-28467-6A** Bracket Assembly
- **EN-28467-8A** Hook Assembly
- **EN-28467-34** Lift Hook Wing Nut and Washer

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

1	EN-36857 Engine Lift Bracket Procedure Place engine lift bracket on cylinder head and install two bolts to retain lift bracket.
2	EN-36857 Engine Lift Bracket Procedure Remove exhaust nut and place engine lift bracket on stud and replace nut to retain lift bracket.
3	EN-28467-550 Engine Support Beam Adapters (Qty:2) Procedure Place engine support beam adapters on the strut towers as shown.
4	J-284678-518 Main Support Beam Procedure Install main support beam through engine support beam adapters and pin in place.
5	EN-28467-2A Radiator Tube Shelf Assembly (Qty: 2) Procedure Place radiator shelf tubes on top of main support beam.
6	EN-28467-1A Cross Bracket (Qty: 2) Procedure Loosely install cross bracket to retain radiator shelf tube to main support beam. Tighten cross bracket after front support assembly is in place.
7	EN-28467-4A Front Support Assembly (Qty: 2) Procedure Place front support assembly through radiator tube shelf and pin at proper height.
8	J-28467-6A Bracket Assembly (Qty: 2)
9	EN-28467-8A Hook Assembly (Qty: 2)
10	EN-28467-34 Lift Hook Wing Nut and Washer (Qty: 2)

ENGINE MOUNT INSPECTION

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

1. Install the engine support fixture. Refer to **Engine Support Fixture**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.

- The rubber is split through the center of the engine mount.
 - The GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Engine Mount Replacement - Left Side (LFX)**, **Engine Mount Replacement - Left Side (LF3)**, or **Engine Mount Replacement - Right Side (LFX)**, **Engine Mount Replacement - Right Side (LF3)**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE (LFX)

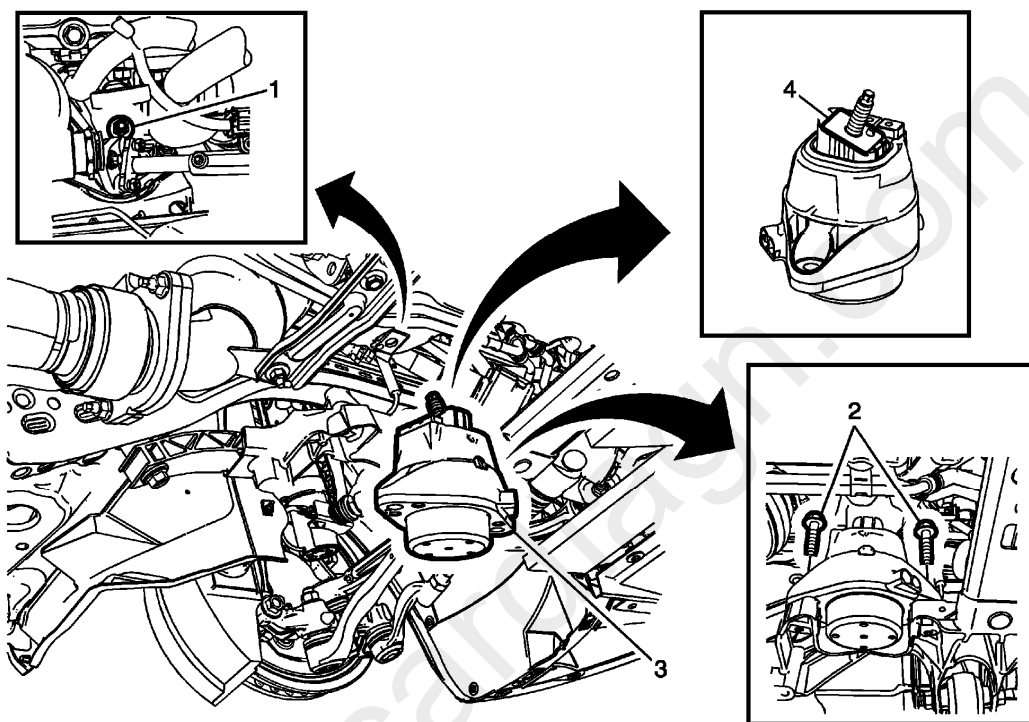


Fig. 20: Engine Mount - Left Side (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Left Side (LFX)

Callout	Component Name
Preliminary Procedures	
1.	Install the engine support fixture. Refer to <u>Engine Support Fixture</u> .
2.	Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .
3.	Remove the front engine compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> .
4.	Remove the left frame brace.
5.	Disconnect the engine mount vacuum hose.

1	Engine Mount Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

ENGINE MOUNT REPLACEMENT - LEFT SIDE (LF3)

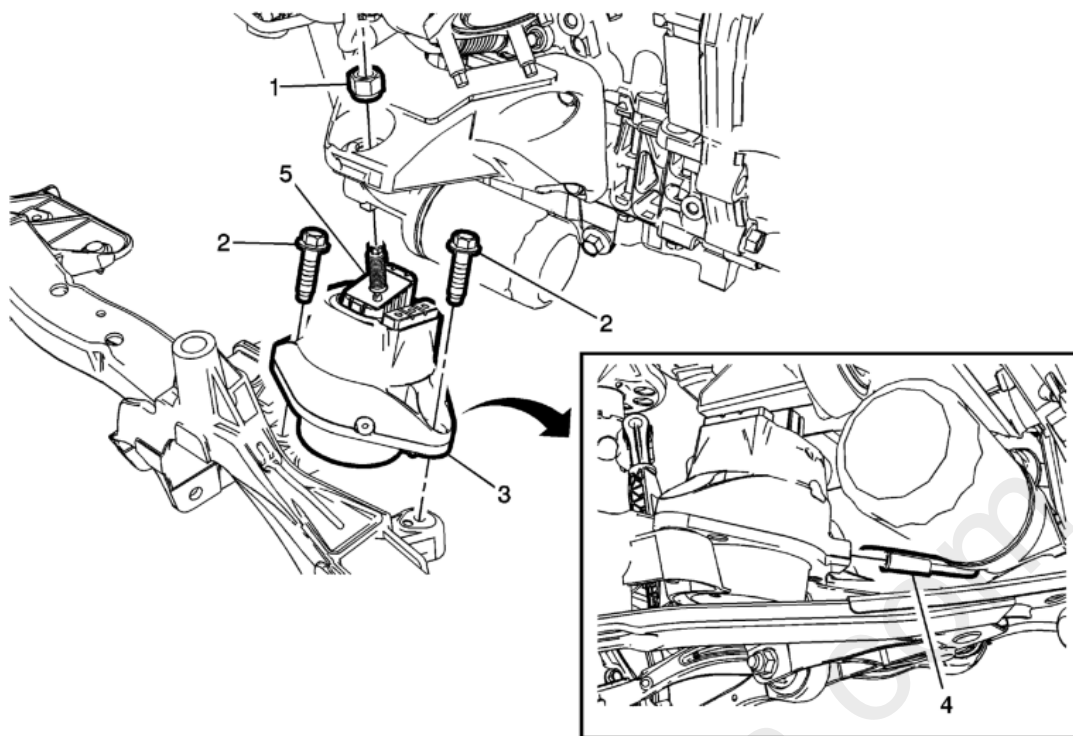


Fig. 21: Engine Mount - Left Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u>, <u>Front Compartment Lower Noise Shield Replacement (RWD)</u>. 4. Remove the left frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u>.	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
	Engine Mount Fastener (Qty: 2)

2	Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Engine Mount Vacuum Line
5	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (LFX)

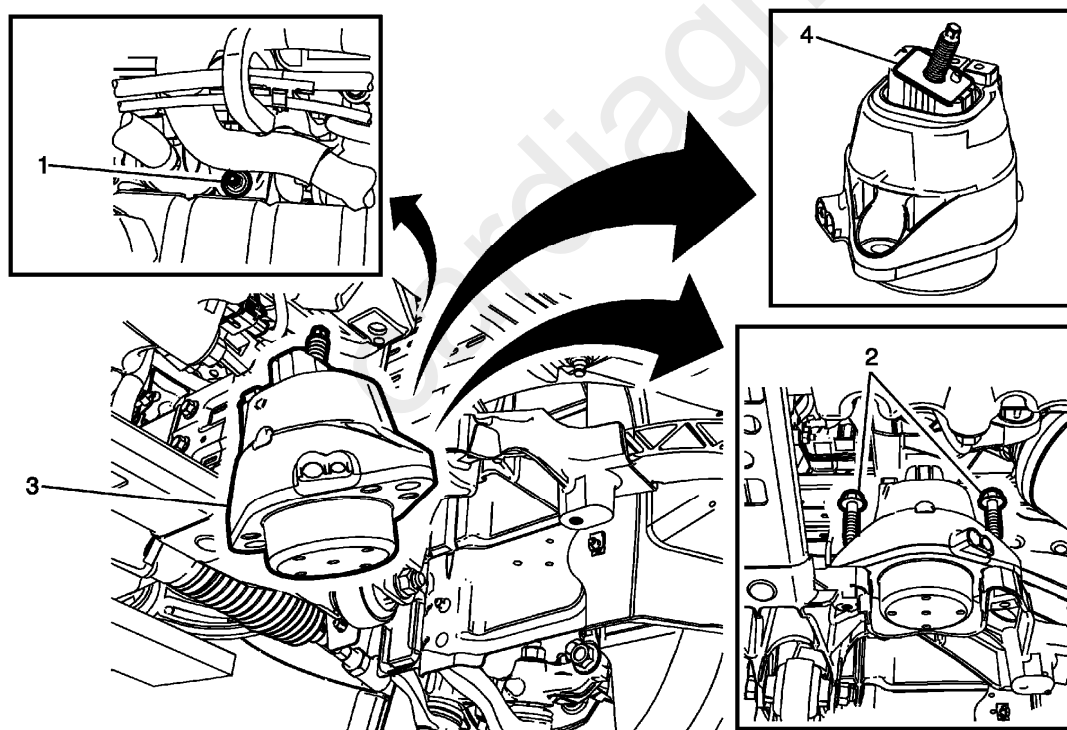


Fig. 22: Engine Mount - Right Side (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Right Side (LFX)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the engine compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the right frame brace. 5. Disconnect the engine mount vacuum hose.	
1	Engine Mount Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE (LF3)

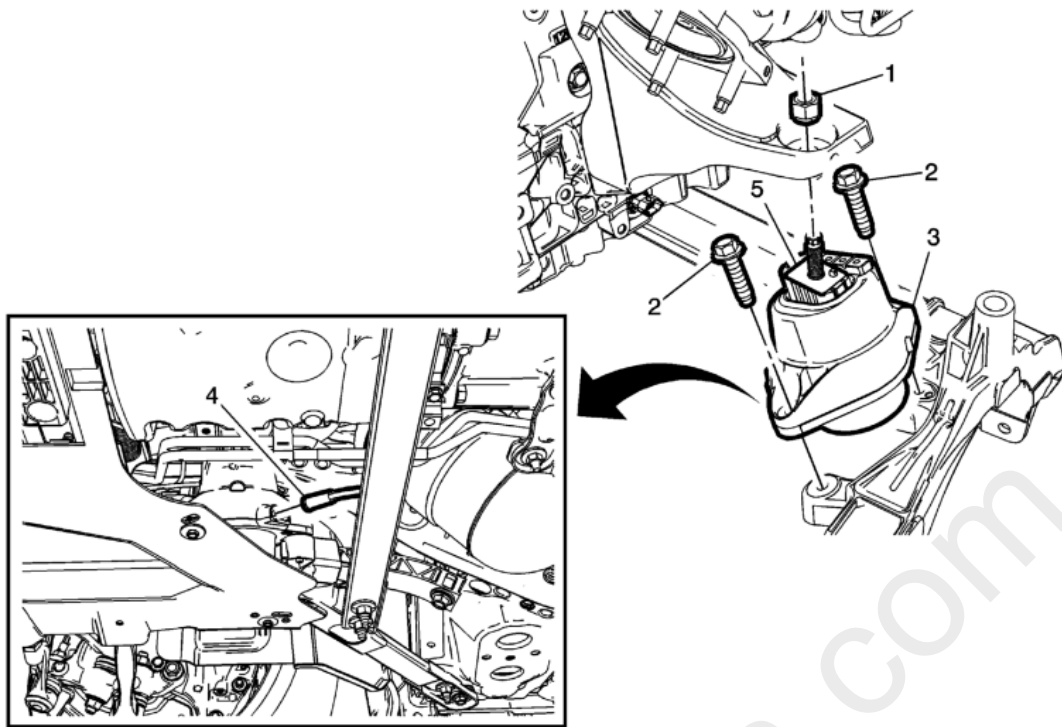


Fig. 23: Engine Mount - Right Side (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u>, <u>Front Compartment Lower Noise Shield Replacement (RWD)</u>. 4. Remove the right frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u>.	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
	Engine Mount Fastener (Qty: 2)

2	Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Engine Mount Vacuum Line
5	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

ENGINE MOUNT VACUUM VALVE REPLACEMENT (LFX)

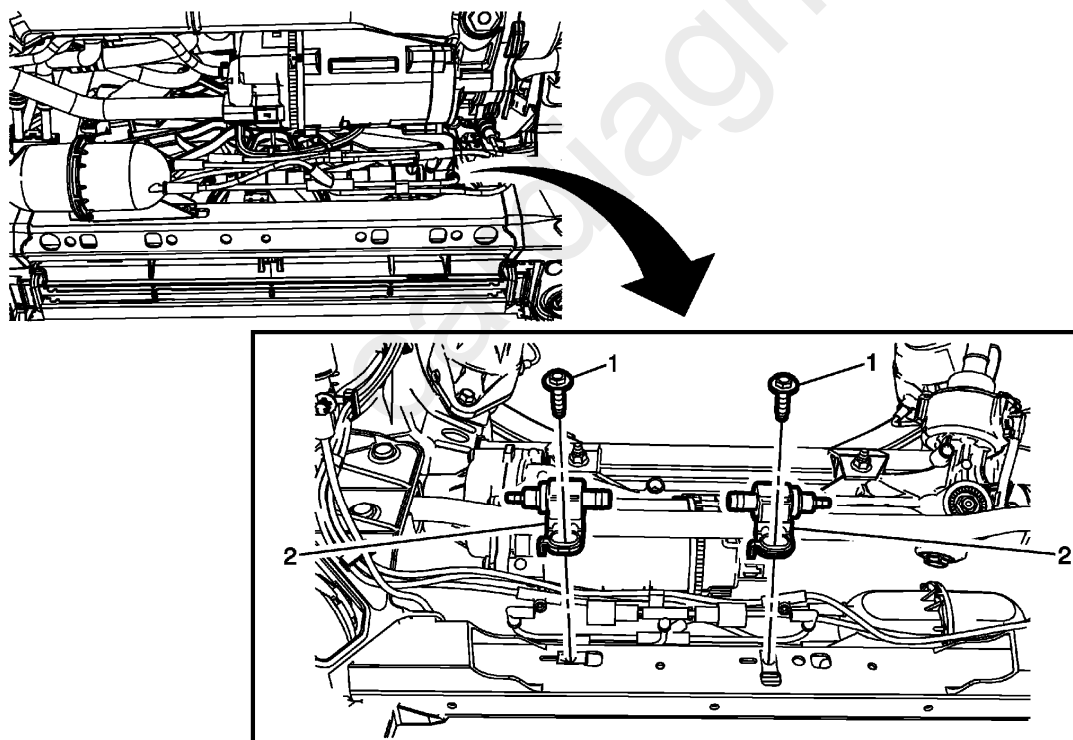


Fig. 24: Engine Mount Vacuum Valve (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Valve Replacement (LFX)

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

ENGINE MOUNT VACUUM VALVE REPLACEMENT (LF3)

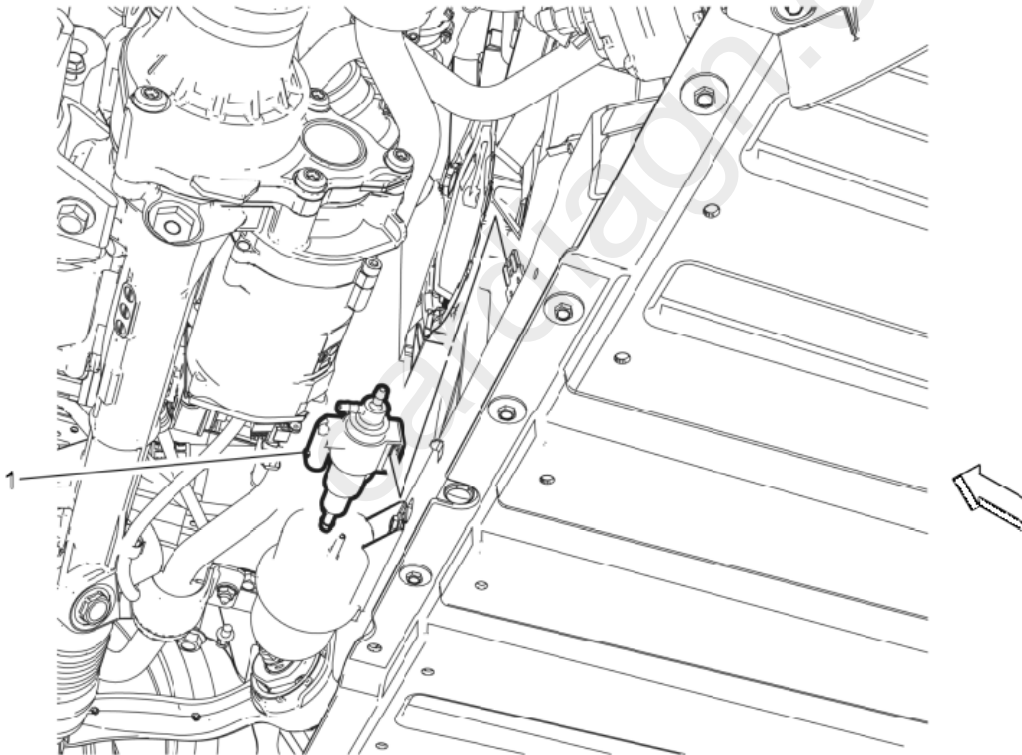


Fig. 25: Engine Mount Vacuum Valve (LF3)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Valve Replacement (LF3)

Callout	Component Name
Preliminary Procedure	

Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .

1	Engine Mount Vacuum Valve Procedure 1. Disconnect the vacuum lines from the engine mount vacuum valve. 2. Detach the engine mount vacuum valve from the retaining bracket.
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ENGINE MOUNT VACUUM FILTER REPLACEMENT

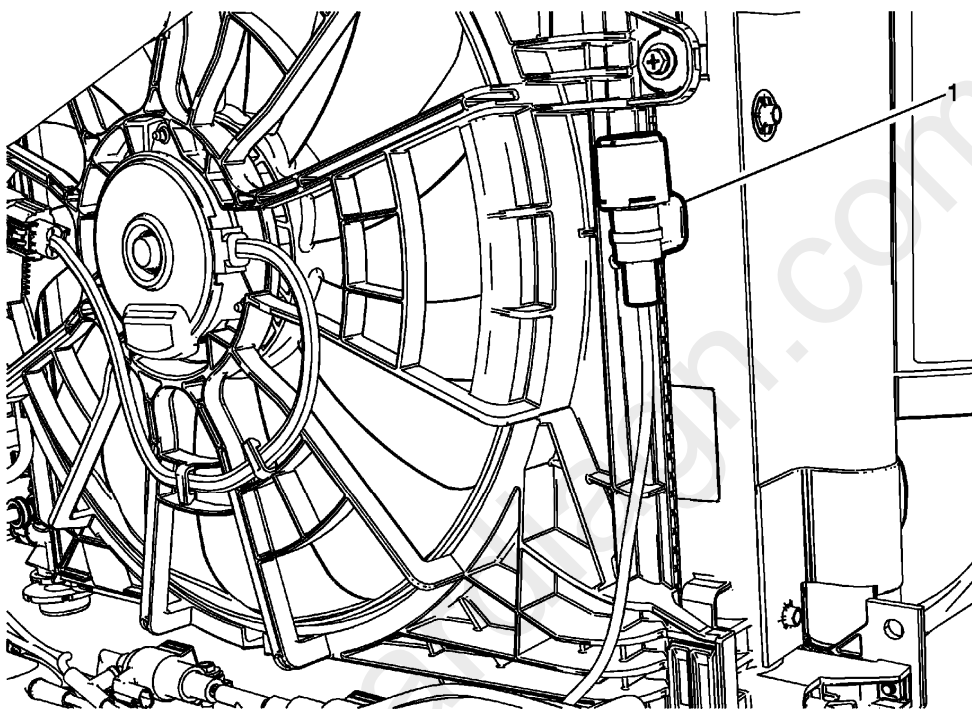


Fig. 26: Engine Mount Vacuum Filter
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Filter Replacement

Callout	Component Name
Preliminary Procedure Remove the charge air cooler air tube, LTG only. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement</u> .	
1	Engine Mount Vacuum Filter NOTE: Disconnect the engine mount vacuum hose before removing the filter.

ENGINE MOUNT VACUUM TANK REPLACEMENT

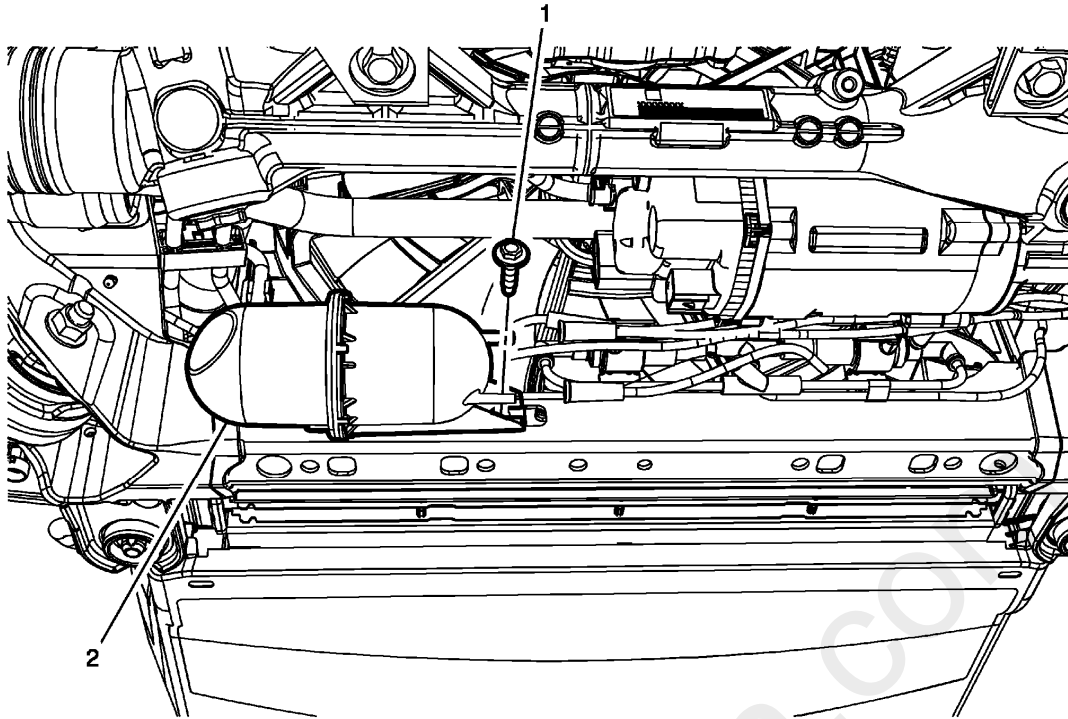


Fig. 27: Engine Mount Vacuum Tank
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Tank Replacement

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

ENGINE MOUNT VACUUM HOSE REPLACEMENT (LF3)

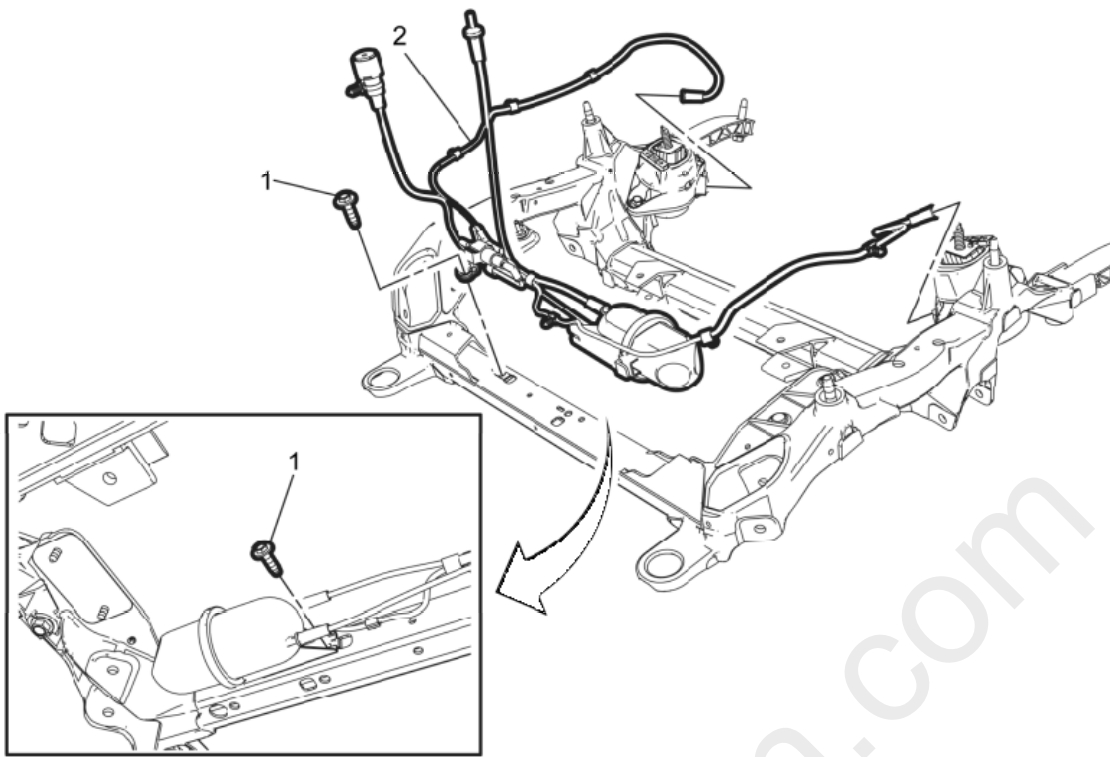


Fig. 28: Engine Mount Vacuum Hose (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Hose Replacement (LF3)

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

2. Disconnect the engine mount vacuum hoses from the engine mounts.
3. Disconnect the vacuum filter from the vacuum hose assembly.
4. Remove the engine mount vacuum hose assembly from the frame.

ENGINE MOUNT VACUUM HOSE REPLACEMENT (LFX)

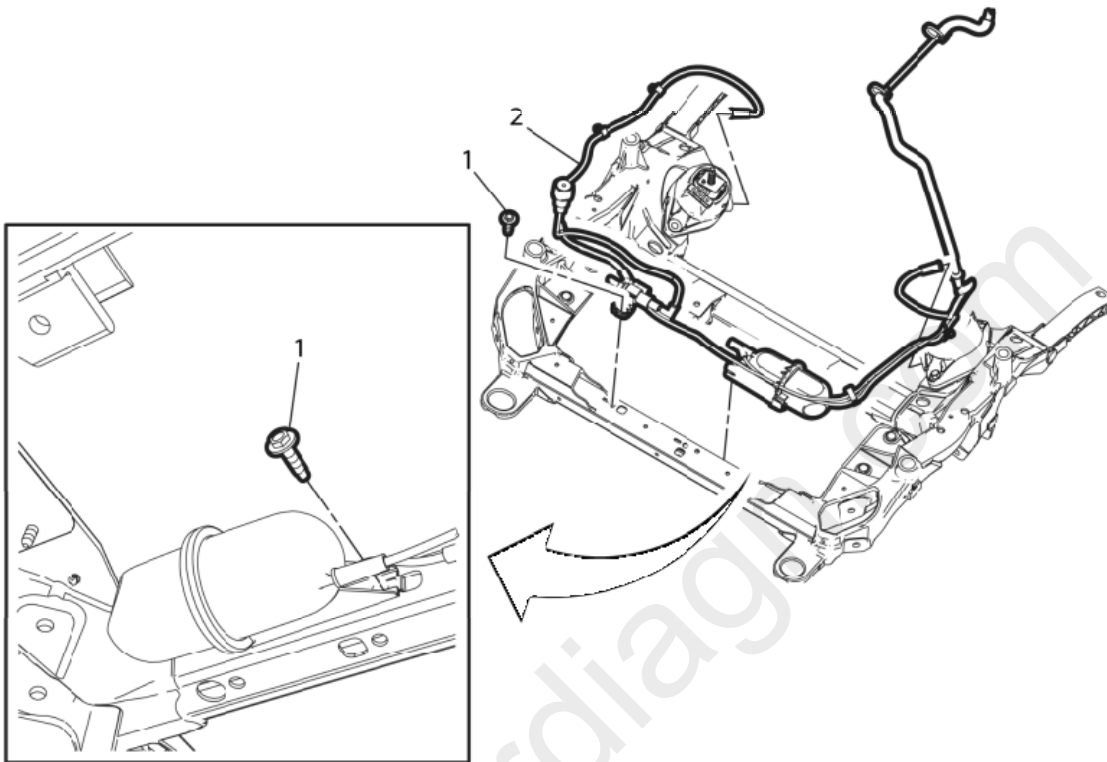


Fig. 29: Engine Mount Vacuum Hose (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Vacuum Hose Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Remove the drivetrain and front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Vacuum Hose Fasteners (Qty: 2)
	CAUTION: Refer to <u>Fastener Caution</u> .
	NOTE: Disconnect the vacuum lines from the components.
	Tighten

	9 (80 lb in)
	Engine Mount Vacuum Hose
2	Procedure 1. Disconnect the engine mount vacuum hose retainers at the frame. 2. Disconnect the engine mount vacuum hoses from the engine mounts. 3. Disconnect the vacuum filter from the vacuum hose assembly. 4. Remove the engine mount vacuum hose assembly from the frame.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE (LFX)

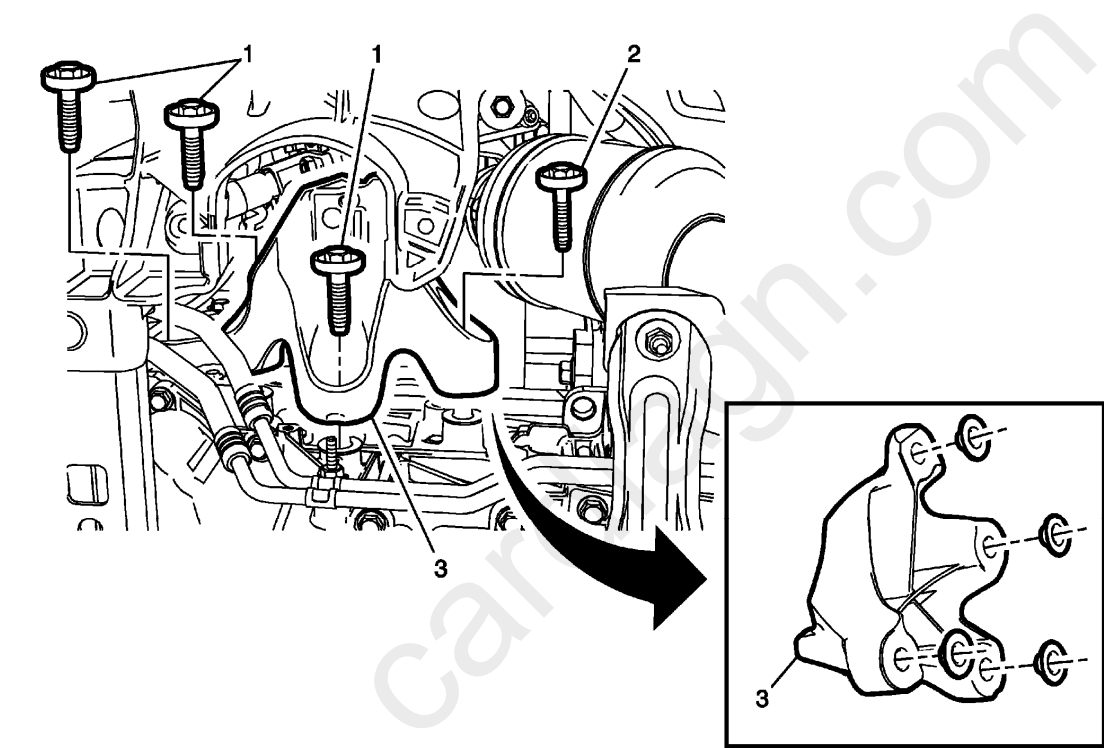


Fig. 30: Engine Mount Bracket - Left Side (LFX)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Left Side (LFX)

Callout	Component Name
Preliminary Procedures	
Remove the left engine mount. Refer to <u>Engine Mount Replacement - Left Side (LFX)</u> .	
1	Engine Mount Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 60 (44 lb ft)
2	Engine Mount Bracket Fastener Tighten 38 (28 lb ft) for vehicles equipped with AWD Tighten 22 (16 lb ft) for vehicles equipped with RWD
3	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE (LF3)

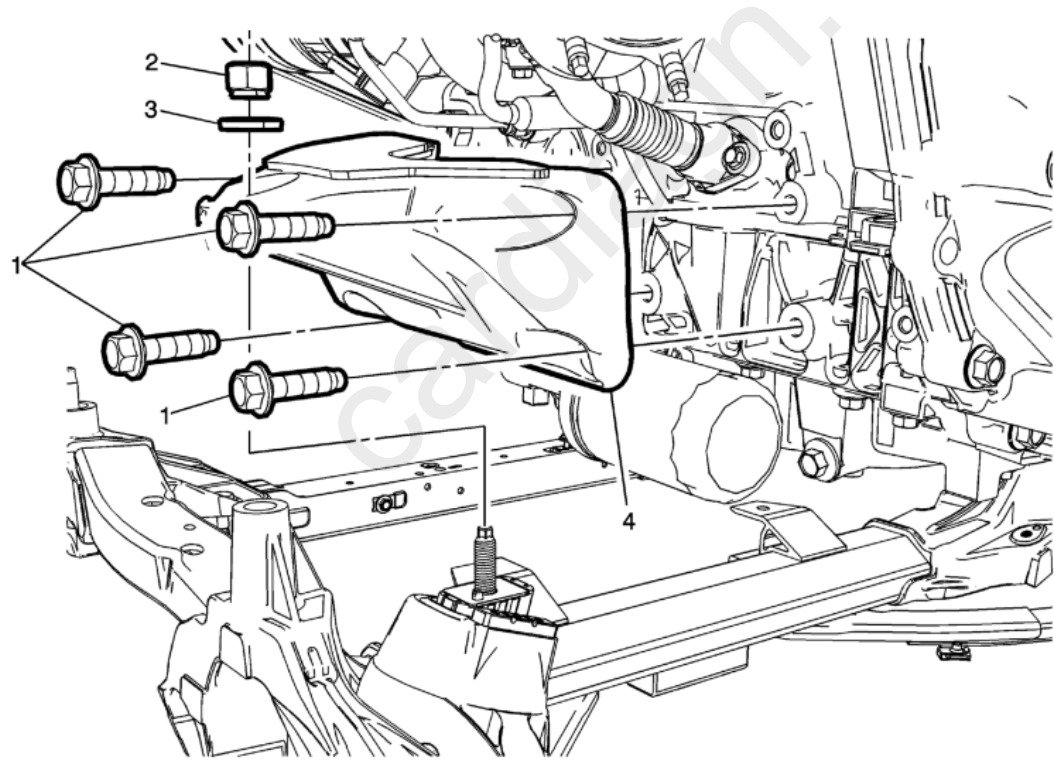


Fig. 31: Engine Mount Bracket - Left Side (LF3)
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Left Side (LF3)

Callout	Component Name

Preliminary Procedures

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
3. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .
4. Remove the left frame brace from the front suspension cradle. Refer to **Drivetrain and Front Suspension Cradle Replacement** .

1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Engine Mount Fastener Tighten 70 N.m (52 lb ft)
3	Washer
4	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (LFX)

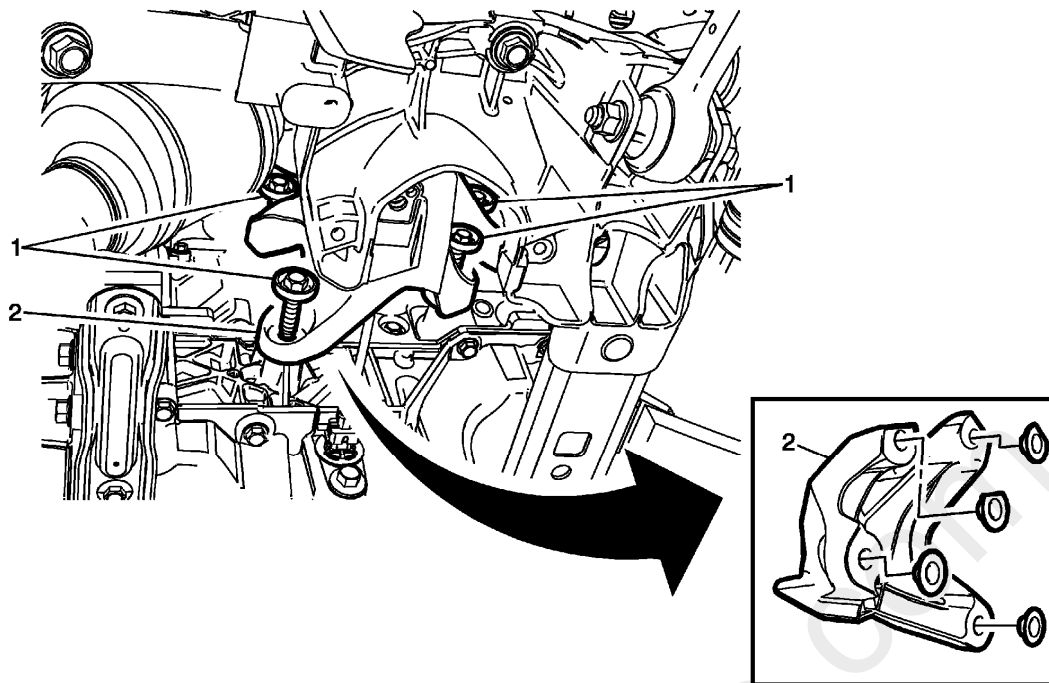


Fig. 32: Engine Mount Bracket - Right Side (LFX)
 Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Right Side (LFX)

Callout	Component Name
Preliminary Procedures	
Remove the right engine mount. Refer to <u>Engine Mount Replacement - Right Side (LFX)</u> .	
1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 60 (44 lb ft)
2	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE (LF3)

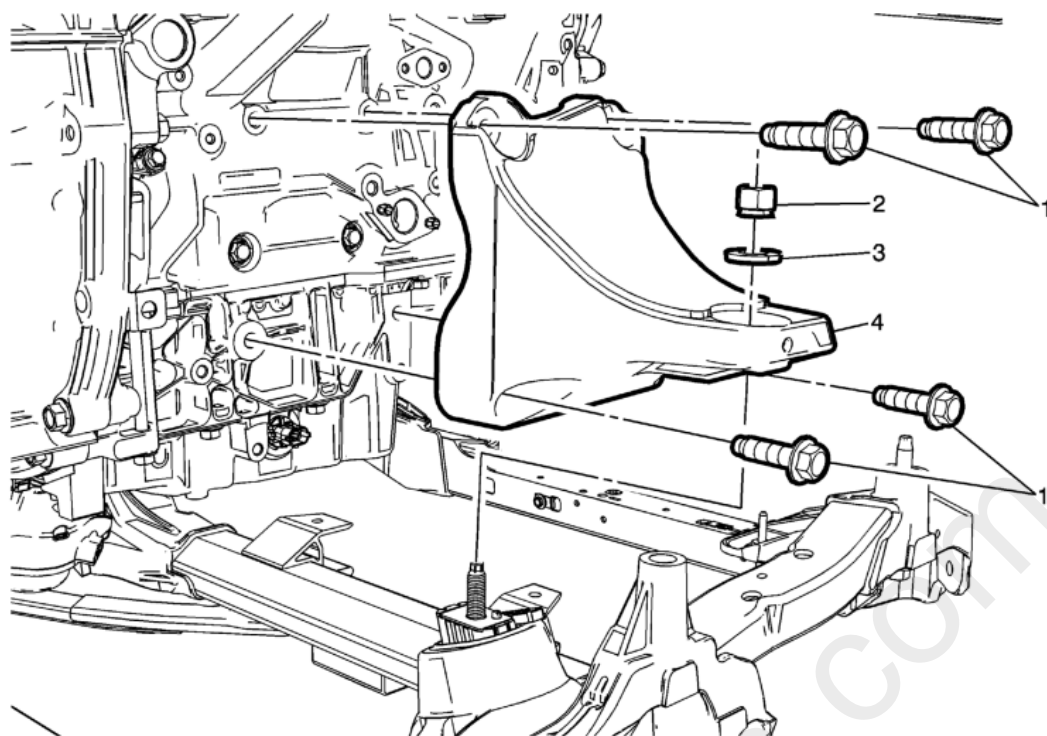


Fig. 33: Engine Mount Bracket - Right Side (LF3)

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u>, <u>Front Compartment Lower Noise Shield Replacement (RWD)</u>. 4. Remove the right frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u>.	
1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Engine Mount Fastener Tighten 70 N.m (52 lb ft)

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

INTAKE MANIFOLD COVER REPLACEMENT (LFX)

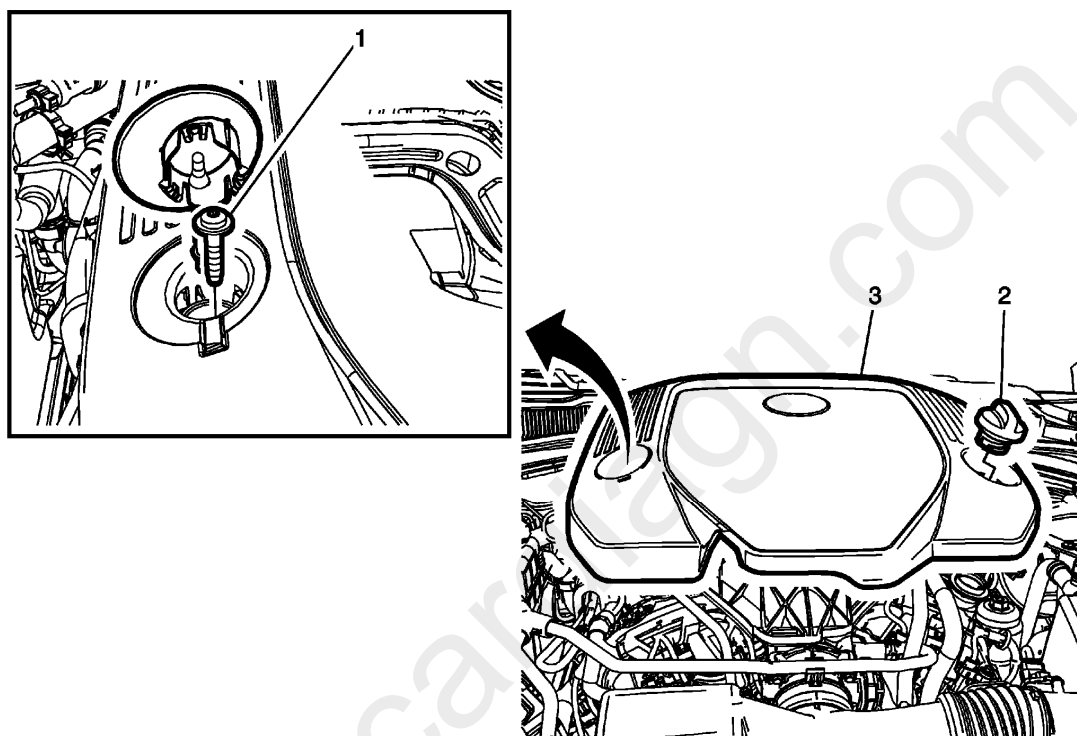


Fig. 34: Intake Manifold Cover (LFX)
Courtesy of GENERAL MOTORS COMPANY

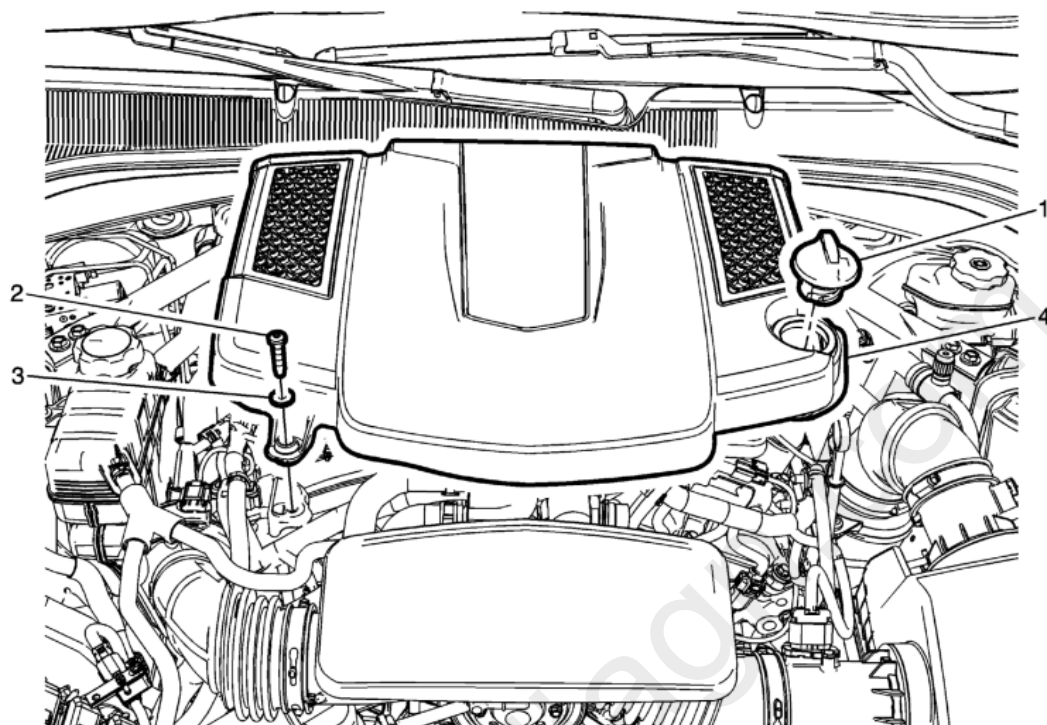
Intake Manifold Cover Replacement (LFX)

Callout	Component Name
1	Intake Manifold Cover Fastener Procedure Flip open the access cover. Tighten 9 N.m (80 lb in)
2	Oil Cap Procedure Remove the oil cap before removing the intake manifold cover.
	Intake Manifold Cover

3

Procedure

Pull the intake manifold cover upward to remove.

INTAKE MANIFOLD COVER REPLACEMENT (LF3)**Fig. 35: Intake Manifold Cover (LF3)**

Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Cover Replacement (LF3)

Callout	Component Name
1	Oil Cap Procedure Remove the oil cap before removing the intake manifold cover.
2	Intake Manifold Cover Fastener Tighten 9 N.m (80 lb in)
3	Washer
4	Intake Manifold Cover Procedure Pull the intake manifold cover upward to remove.

INTAKE MANIFOLD INSULATOR REPLACEMENT

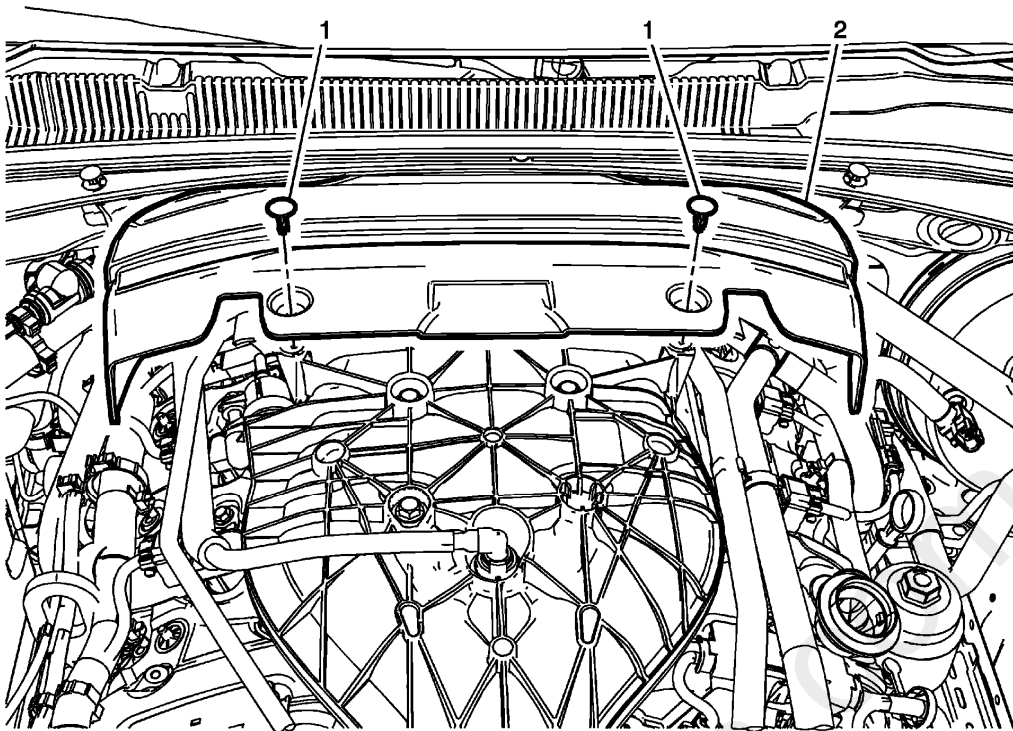


Fig. 36: Intake Manifold Insulator
 Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Insulator Replacement

Callout	Component Name
Preliminary Procedure	
Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Intake Manifold Insulator Retainers (Qty;2)
2	Intake Manifold Insulator

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LFX (DIRTY AIR))

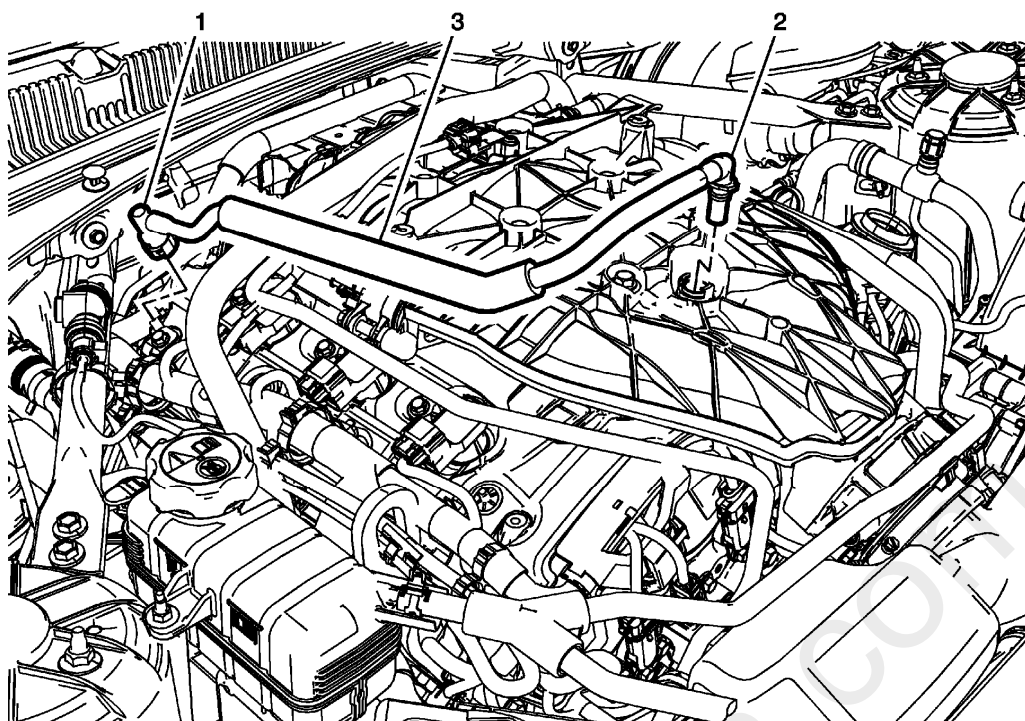


Fig. 37: Positive Crankcase Ventilation Hose/Pipe/Tube (LFX - Dirty Air)
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFX (Dirty Air))

Callout	Component Name
Preliminary Procedure Remove the intake manifold insulator. Refer to <u>Intake Manifold Insulator Replacement..</u>	
1	PCV Pipe Fitting Procedure Disconnect the pipe at right side camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	PCV Pipe Fitting Procedure Turn the PCV air tube connector 90 degrees to detach the connector from the intake manifold
3	PCV Pipe

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LFX (CLEAN AIR))

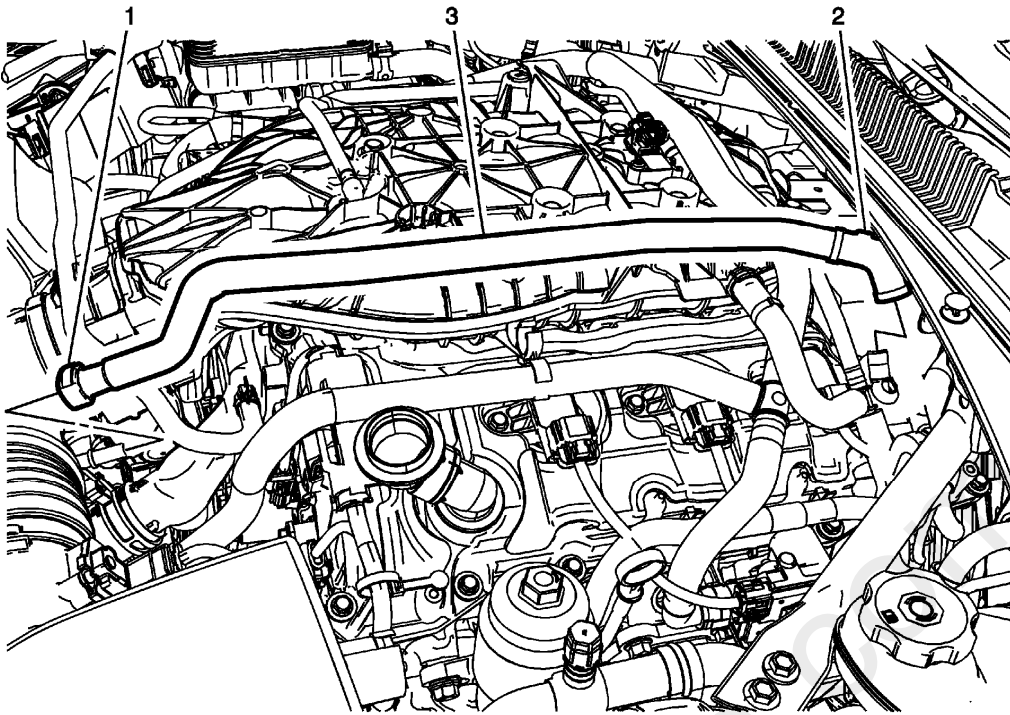


Fig. 38: Positive Crankcase Ventilation Hose/Pipe/Tube (LFX - Clean Air)
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFX (Clean Air))

Callout	Component Name
Preliminary Procedure Remove the intake manifold insulator. Refer to <u>Intake Manifold Insulator Replacement..</u>	
1	PCV Pipe Fitting Procedure Disconnect the pipe from the air cleaner outlet duct. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	PCV Pipe Fitting Procedure Disconnect the pipe from the left side valve cover.
3	PCV Pipe

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LF3 (FRONT))

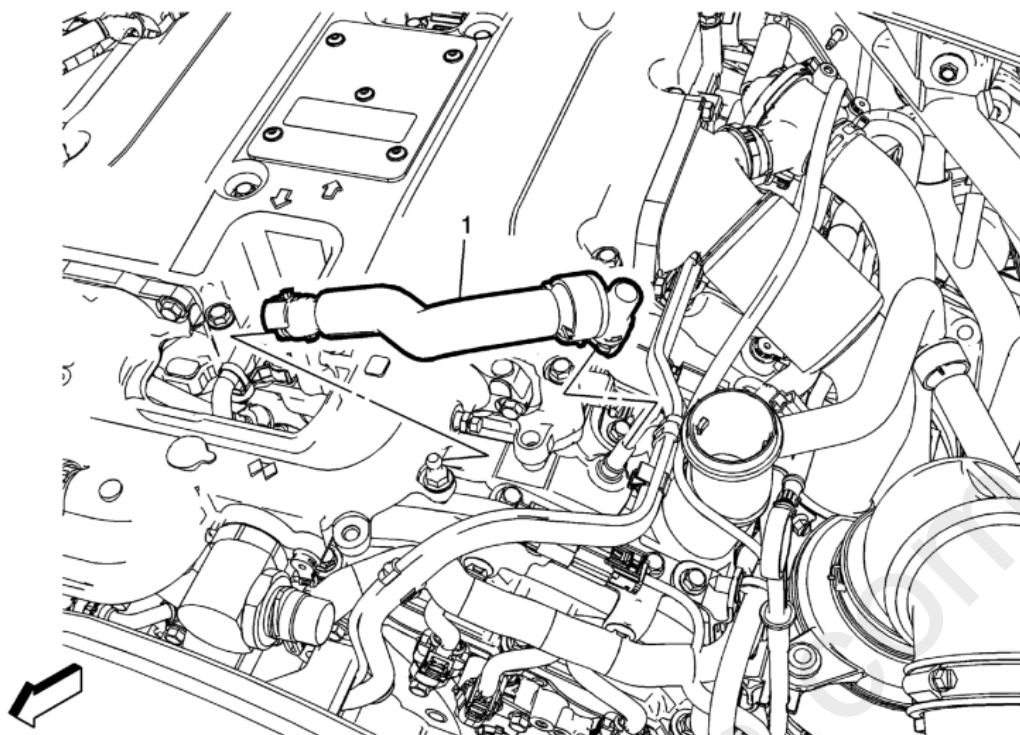


Fig. 39: Positive Crankcase Ventilation Hose/Pipe/Tube (LF3 (Front))
 Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Front))

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Positive Crankcase Ventilation Tube Procedure Disconnect the PCV tube from the intake manifold and the camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LF3 (REAR))

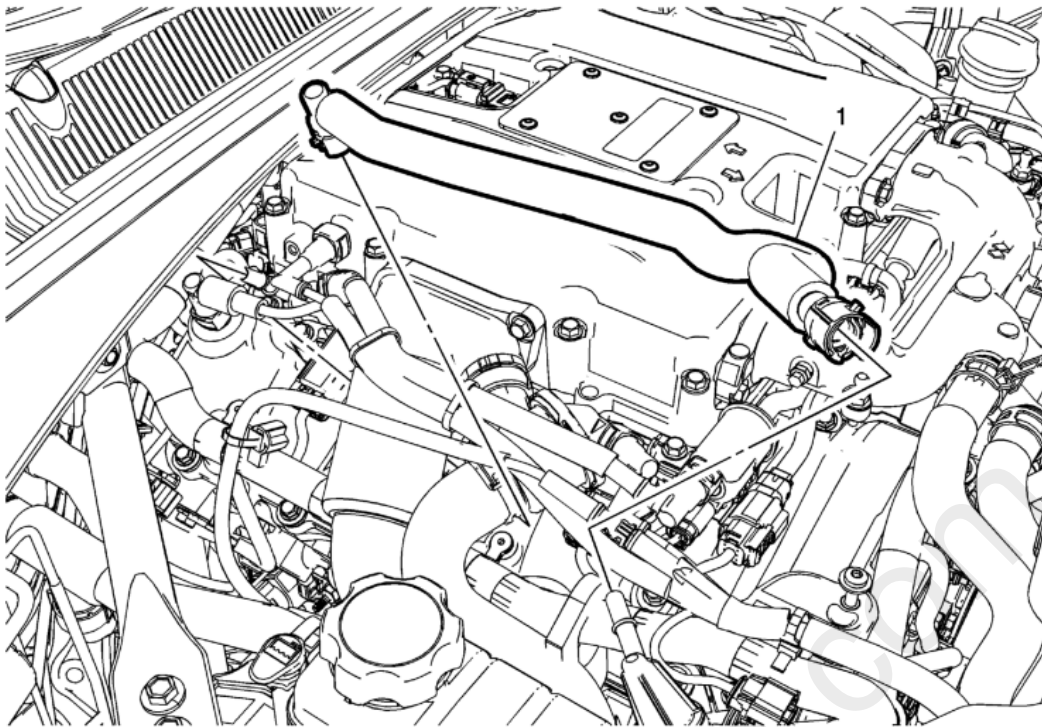


Fig. 40: Positive Crankcase Ventilation Hose/Pipe/Tube (LF3 (Rear))
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Rear))

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Positive Crankcase Ventilation Tube Procedure Disconnect the PCV tube from the intake manifold and the camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

TURBOCHARGER REPLACEMENT (BANK 2)

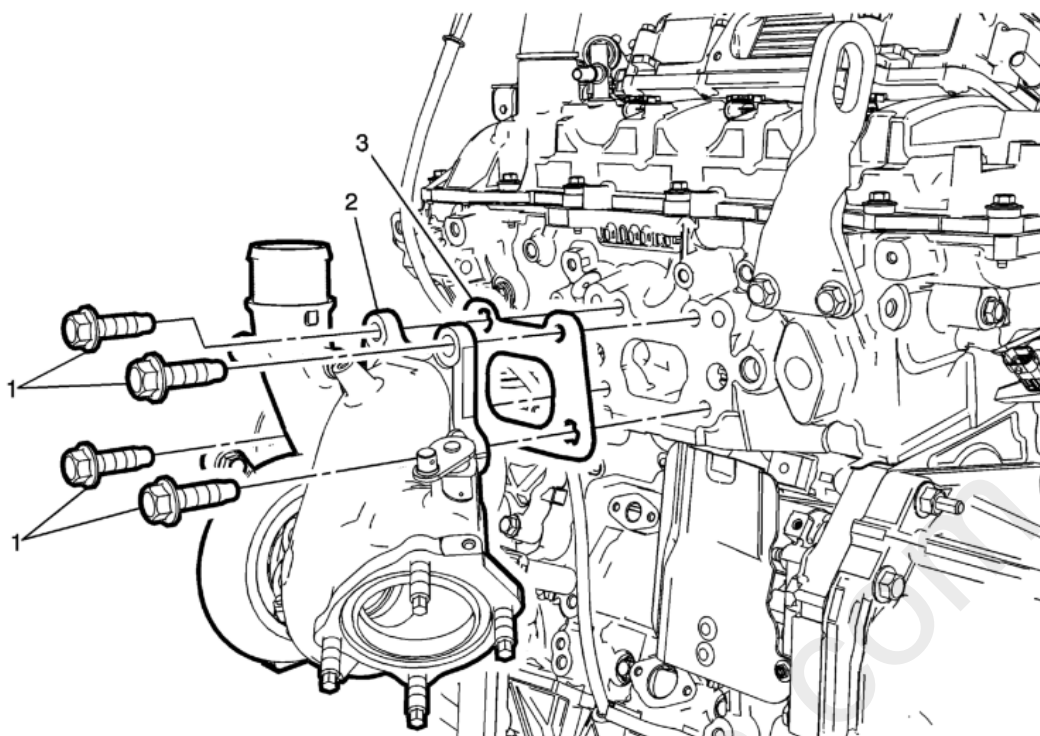


Fig. 41: Turbocharger (Bank 2)

Courtesy of GENERAL MOTORS COMPANY

Turbocharger Replacement (Bank 2)

Callout	Component Name
Preliminary Procedures	
1.	Remove the three-way catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side (LFX)</u> , <u>Catalytic Converter Replacement - Left Side (LF3)</u> .
2.	Remove the turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Left Side</u> .
3.	Remove the turbocharger air inlet adaptor. Refer to <u>Turbocharger Air Inlet Adapter Replacement - Bank 2</u> .
4.	Remove the charge air cooler inlet hose . Refer to <u>Charge Air Cooler Inlet Air Hose Replacement - Left Side (LF3)</u> .
5.	Disconnect the front turbocharger coolant feed pipe and return pipe from the turbocharger. Refer to <u>Turbocharger Coolant Feed Pipe Replacement (LTG)</u> , <u>Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 2)</u> , <u>Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 1)</u> , and <u>Turbocharger Coolant Return Pipe Replacement (LTG)</u> , <u>Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 2)</u> , <u>Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 1)</u> .
6.	Disconnect the front turbocharger oil feed pipe and return pipe from the turbocharger. Refer to <u>Turbocharger Oil Feed Pipe Replacement (Bank 1)</u> , <u>Turbocharger Oil Feed Pipe Replacement (Bank 2)</u> , and <u>Turbocharger Oil Return Pipe Replacement (Bank 1)</u> .

Turbocharger Oil Return Pipe Replacement (Bank 2).

1	Turbocharger bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Turbocharger
3	NOTE: Discard and replace with NEW gasket. Gasket

TURBOCHARGER REPLACEMENT (BANK 1)

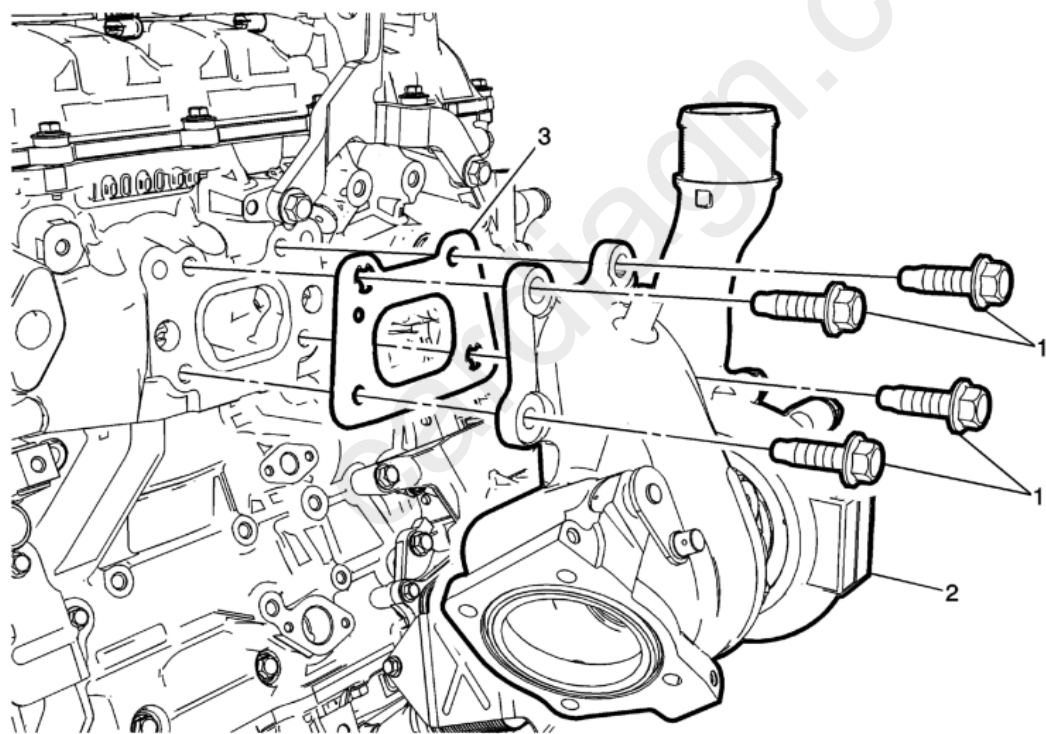


Fig. 42: Turbocharger (Bank 1)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Replacement (Bank 1)

Callout	Component Name
Preliminary Procedures	

1. Remove the rear three-way catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LFX)** , **Catalytic Converter Replacement - Left Side (LF3)** .
2. Remove the right turbocharger wastegate actuator. Refer to **Turbocharger Wastegate Actuator Replacement - Right Side** .
3. Remove the right turbocharger air inlet adaptor. Refer to **Turbocharger Air Inlet Adapter Replacement - Bank 1** .
4. Remove the right charge air cooler inlet hose . Refer to **Charge Air Cooler Inlet Air Hose Replacement - Left Side (LF3)** .
5. Disconnect the front turbocharger coolant feed pipe and return pipe from the turbocharger. Refer to **Turbocharger Coolant Feed Pipe Replacement (LTG)** , **Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 2)** , **Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 1)** , and **Turbocharger Coolant Return Pipe Replacement (LTG)** , **Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 2)** , **Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 1)** .
6. Disconnect the front turbocharger oil feed pipe and return pipe from the turbocharger. Refer to **Turbocharger Oil Feed Pipe Replacement (Bank 1)**, **Turbocharger Oil Feed Pipe Replacement (Bank 2)**, and **Turbocharger Oil Return Pipe Replacement (Bank 1)**, **Turbocharger Oil Return Pipe Replacement (Bank 2)**.

1	Turbocharger bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Turbocharger
3	NOTE: Discard and replace with NEW gasket. Gasket

TURBOCHARGER OIL RETURN PIPE REPLACEMENT (BANK 1)

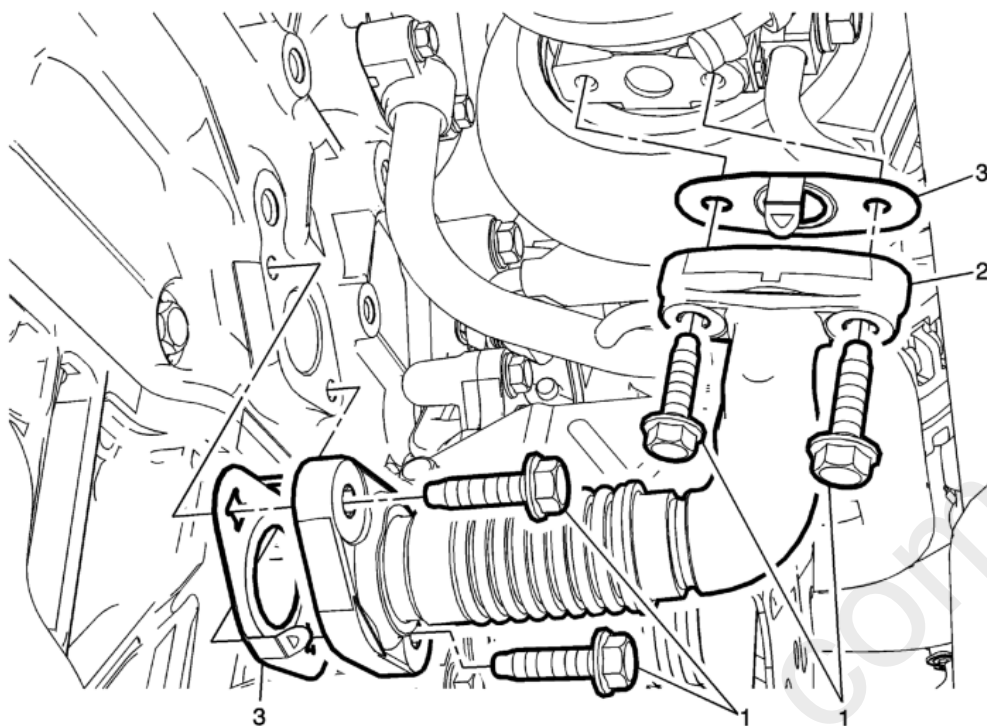


Fig. 43: Turbocharger Oil Return Pipe (Bank 1)
 Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement (Bank 1)

Callout	Component Name
Preliminary Procedures Remove the turbocharger heat shield bank 1. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> .	
1	Turbocharger Oil Return Pipe Bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe
3	Gaskets NOTE: Discard and replace with NEW gaskets.

TURBOCHARGER OIL RETURN PIPE REPLACEMENT (BANK 2)

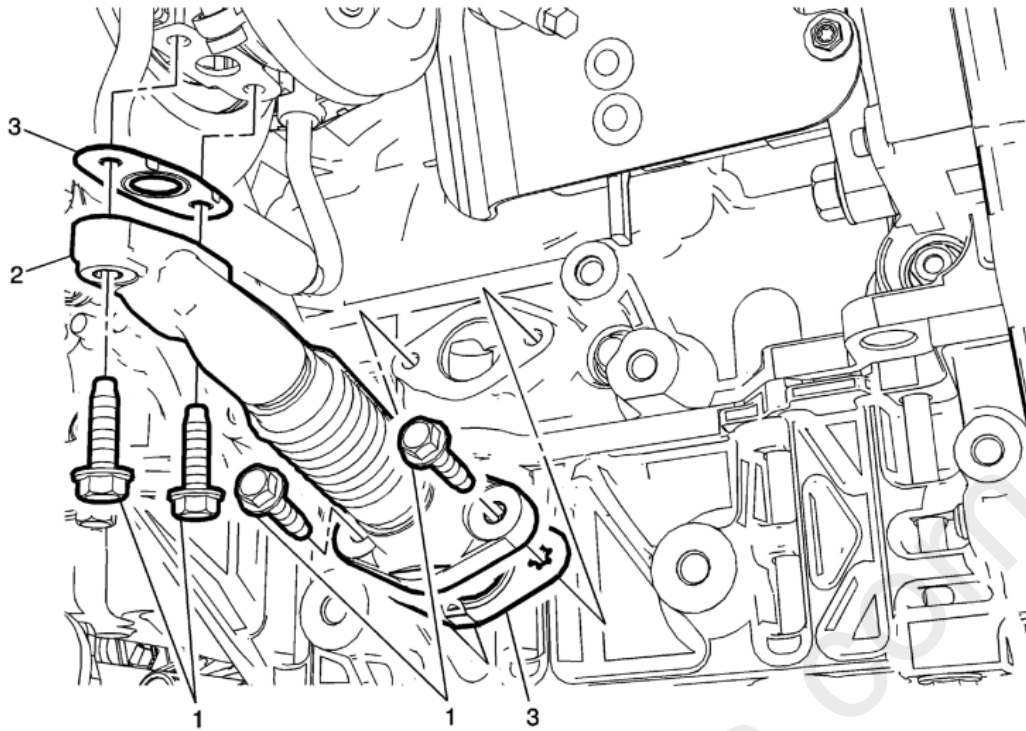


Fig. 44: Turbocharger Oil Return Pipe (Bank 2)
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Return Pipe Replacement (Bank 2)

Callout	Component Name
Preliminary Procedures Remove the turbocharger heat shield bank 2. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> .	
1	Turbocharger Oil Return Pipe Bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe
3	Gaskets NOTE: Discard and replace with NEW gaskets.

TURBOCHARGER OIL FEED PIPE REPLACEMENT (BANK 1)

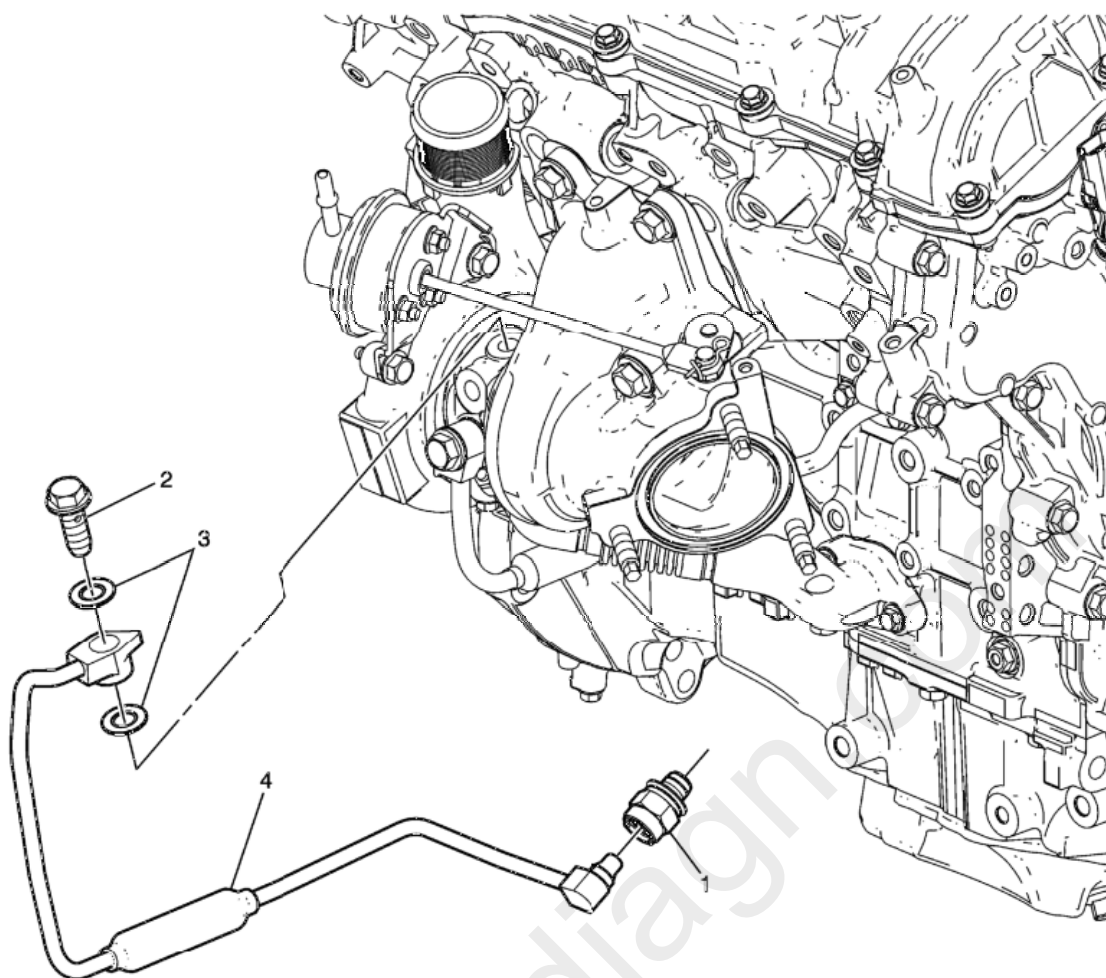


Fig. 45: Turbocharger Oil Feed Pipe (Bank 1)
 Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedures	
1. Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> . 2. Remove the right turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Right Side</u> .	
1	Turbocharger Oil Feed Pipe Fitting NOTE: Install NEW fitting. It is not reusable
	Turbocharger Oil Feed Pipe Bolt CAUTION:

2	Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
3	Turbocharger Oil Feed Pipe Gaskets NOTE: Install NEW gaskets. They are not reusable.
4	Turbocharger Oil Feed Pipe

TURBOCHARGER OIL FEED PIPE REPLACEMENT (BANK 2)

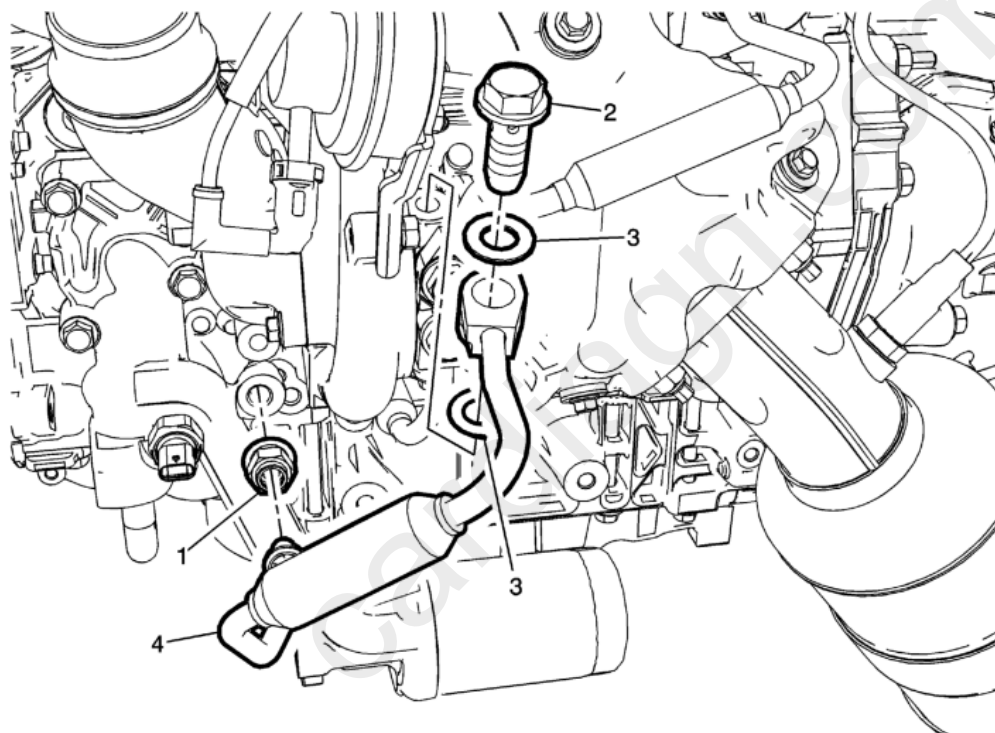


Fig. 46: Turbocharger Oil Feed Pipe (Bank 2)
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedures	
1.	Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> .
2.	Remove the left turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Left Side</u> .

1	Turbocharger Oil Feed Pipe Fitting NOTE: Install NEW fitting. It is not reusable
2	Turbocharger Oil Feed Pipe Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
3	Turbocharger Oil Feed Pipe Gaskets NOTE: Install NEW gaskets. They are not reusable.
4	Turbocharger Oil Feed Pipe

INTAKE MANIFOLD REPLACEMENT (LFX)

Removal Procedure

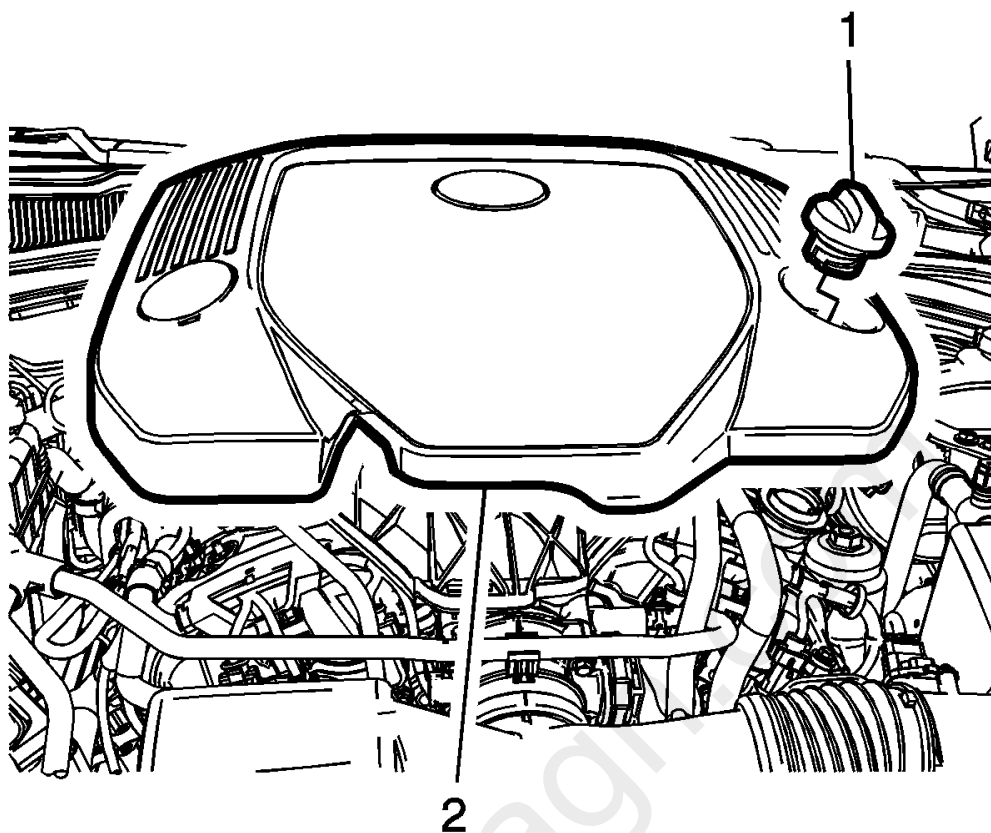


Fig. 47: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

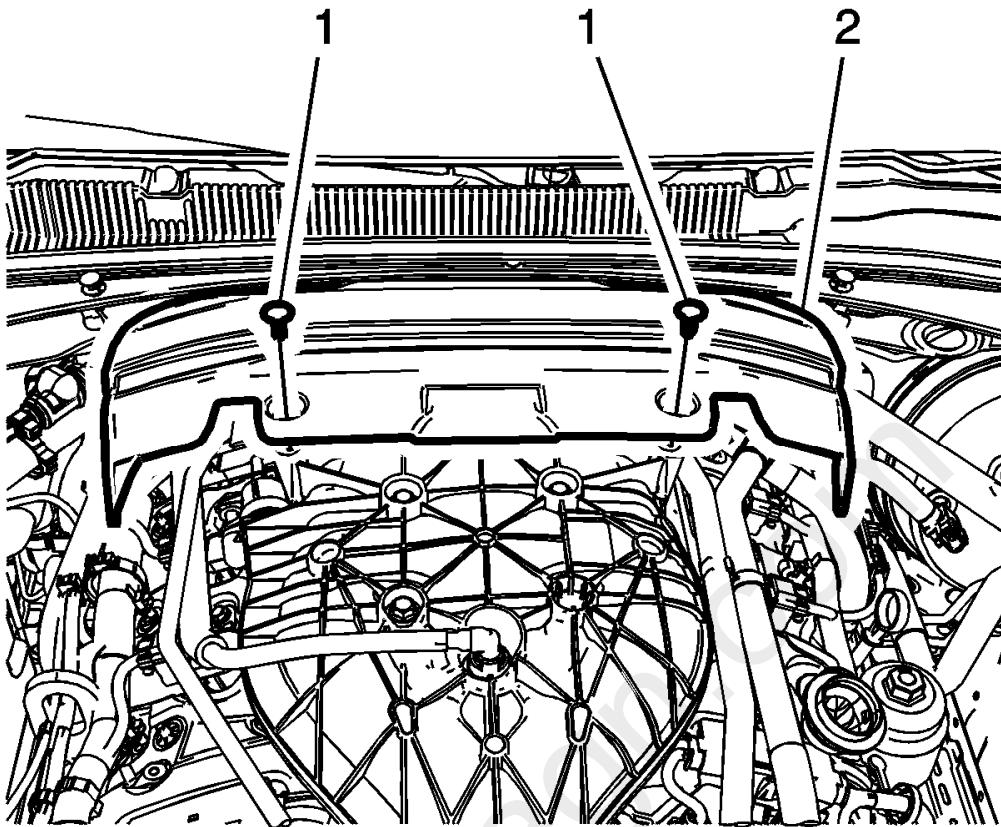


Fig. 48: Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold insulator (2). Refer to **Intake Manifold Insulator Replacement**.
3. Remove the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LFX)** .

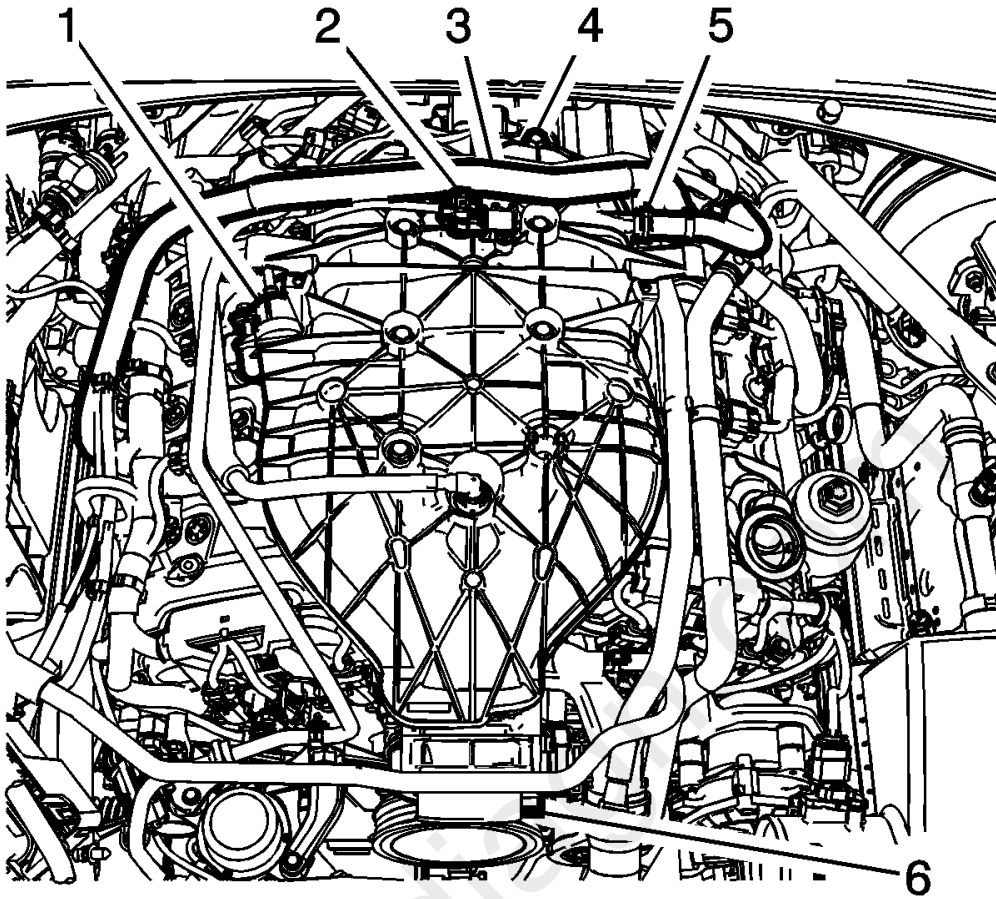


Fig. 49: Identifying Vacuum Hoses
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the brake booster vacuum hose (5) from the intake manifold.
5. Disconnect the MAP sensor connector (2).
6. Disconnect and reposition the secondary air injection hose (3), if equipped.
7. Remove the fuel pipe shield (4). Refer to **Fuel Pipe Shield Replacement (LFX)** .
8. Disconnect the EVAP solenoid (1) connector and hose.
9. Disconnect the throttle body connector (6).

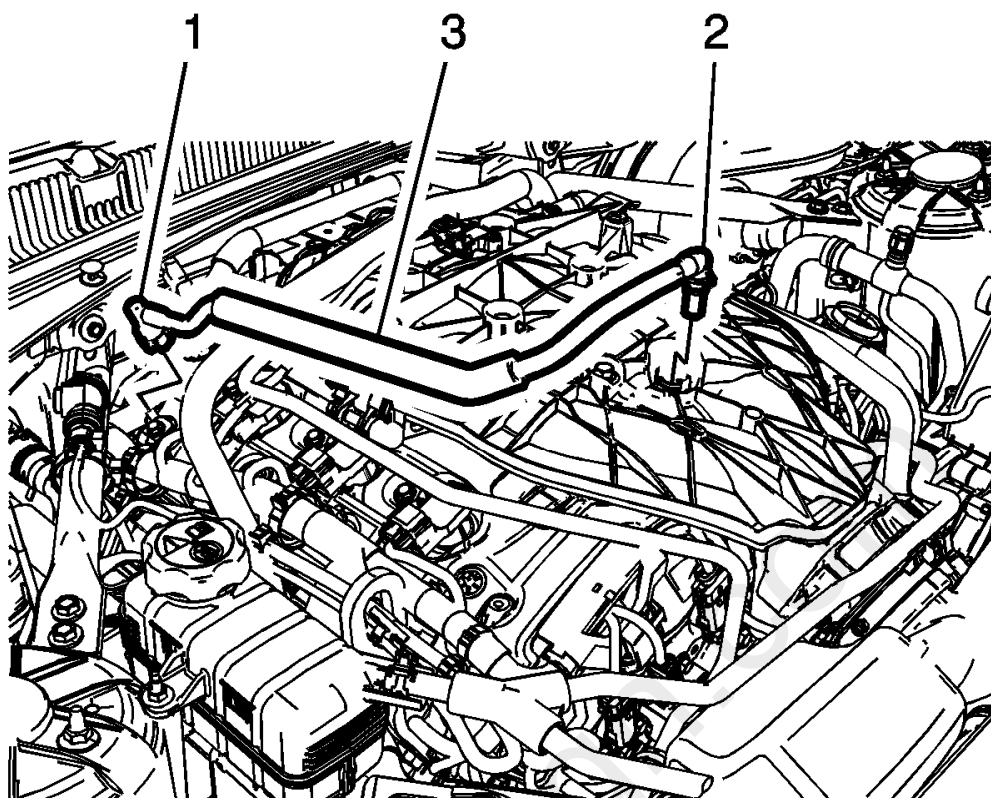


Fig. 50: PCV Dirty Air Hose
Courtesy of GENERAL MOTORS COMPANY

10. Remove the PCV dirty air hose (3).

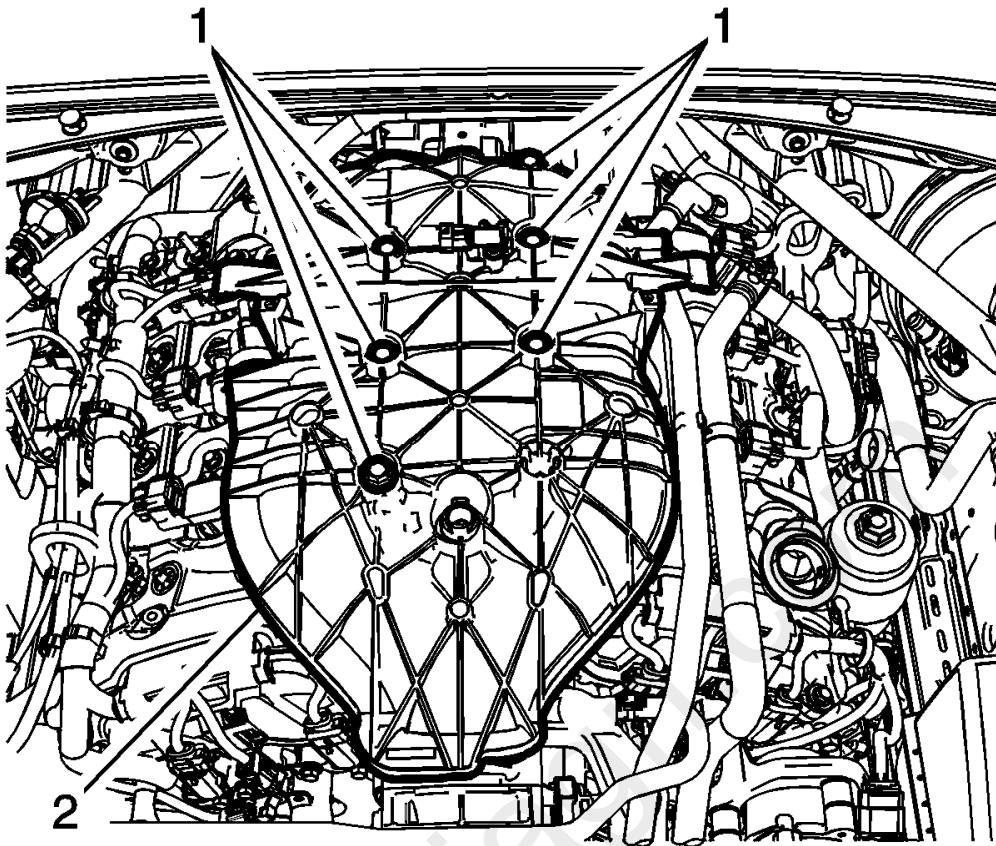


Fig. 51: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold bolts (1).
12. Remove the intake manifold (2).

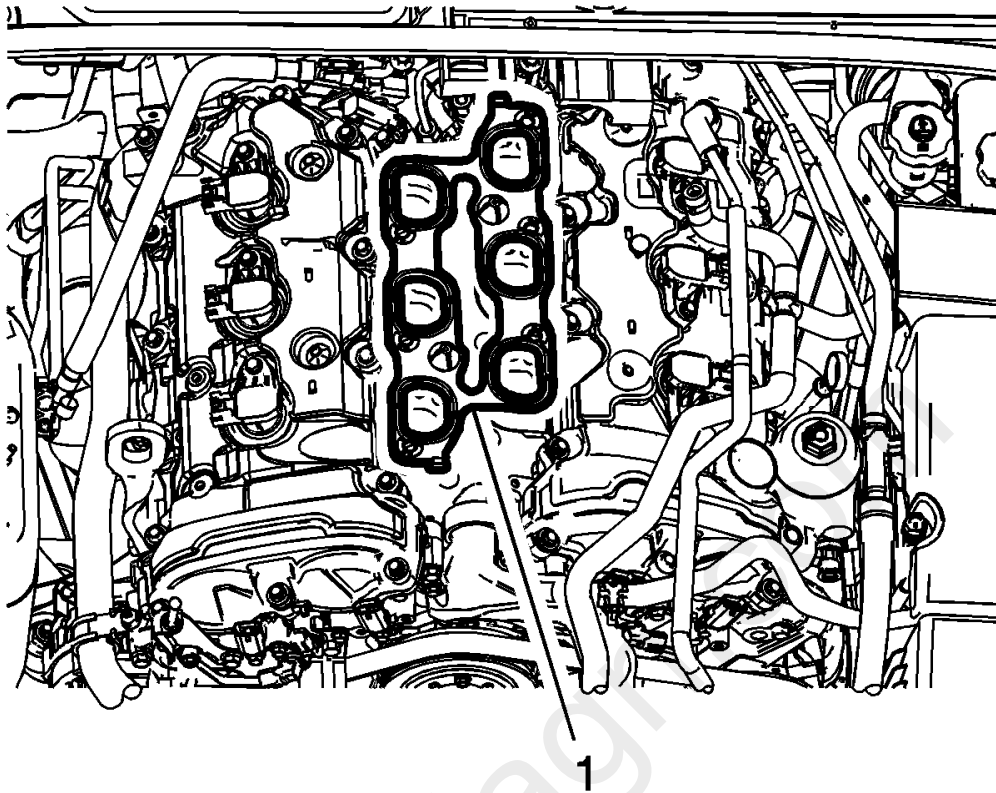


Fig. 52: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

13. Remove and discard the intake manifold gasket (1).
14. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection (LFX)** .
15. If necessary, disassemble the intake manifold. Refer to **Intake Manifold Disassemble (LFX)** .

Installation Procedure

1. If disassembled, assemble the intake manifold. Refer to **Intake Manifold Assemble (LFX)** .

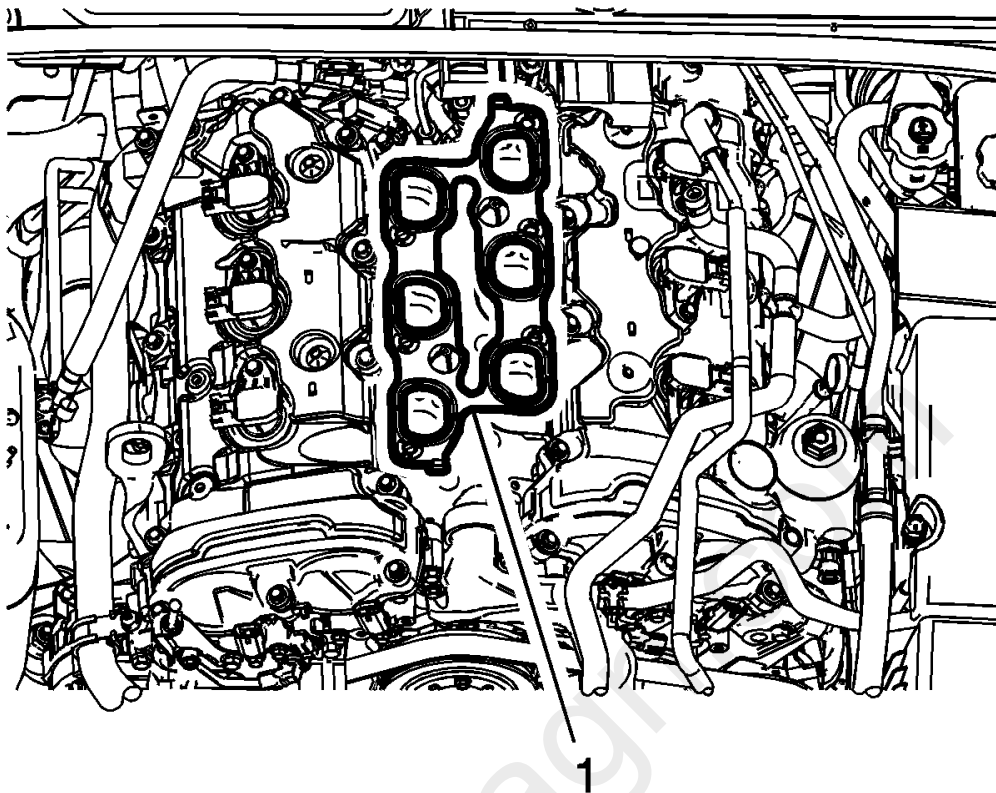


Fig. 53: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

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

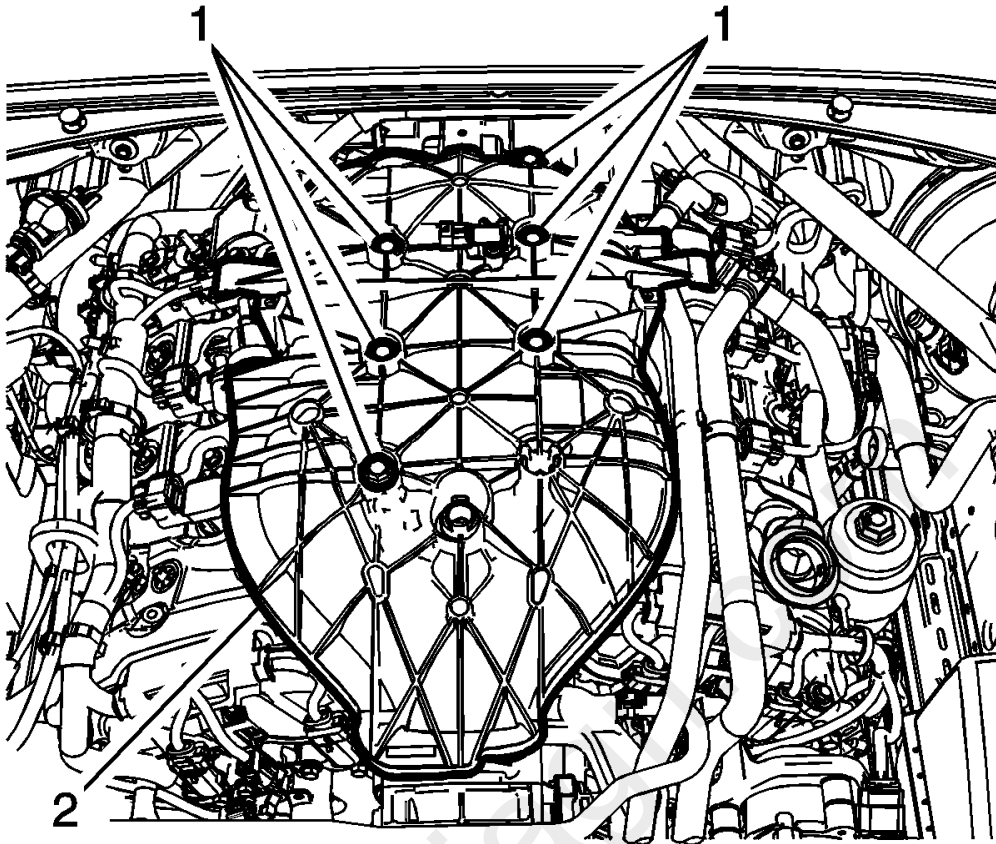


Fig. 54: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

3. Install the intake manifold (2).
4. install the intake manifold fastener (1) and finger tighten.

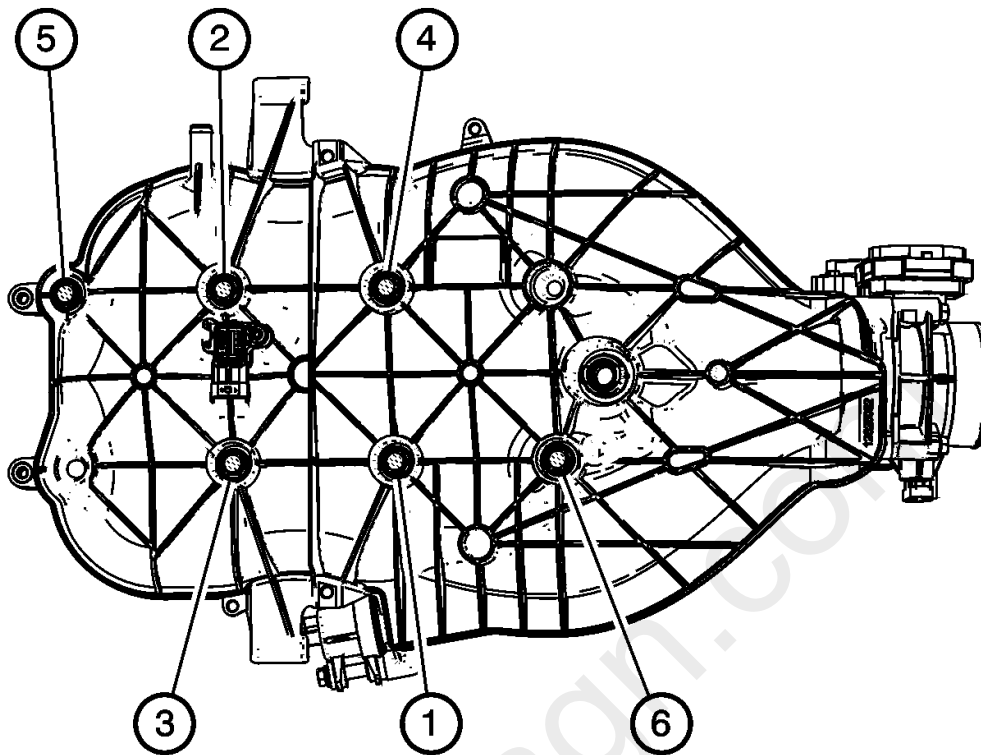


Fig. 55: Identifying Intake Manifold Bolts Tighten Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the intake manifold bolts in the sequence shown.

Tighten

- First pass tighten the intake manifold to 25 N.m (18 lb ft).
- Final pass tighten the intake manifold to 25 N.m (18 lb ft).

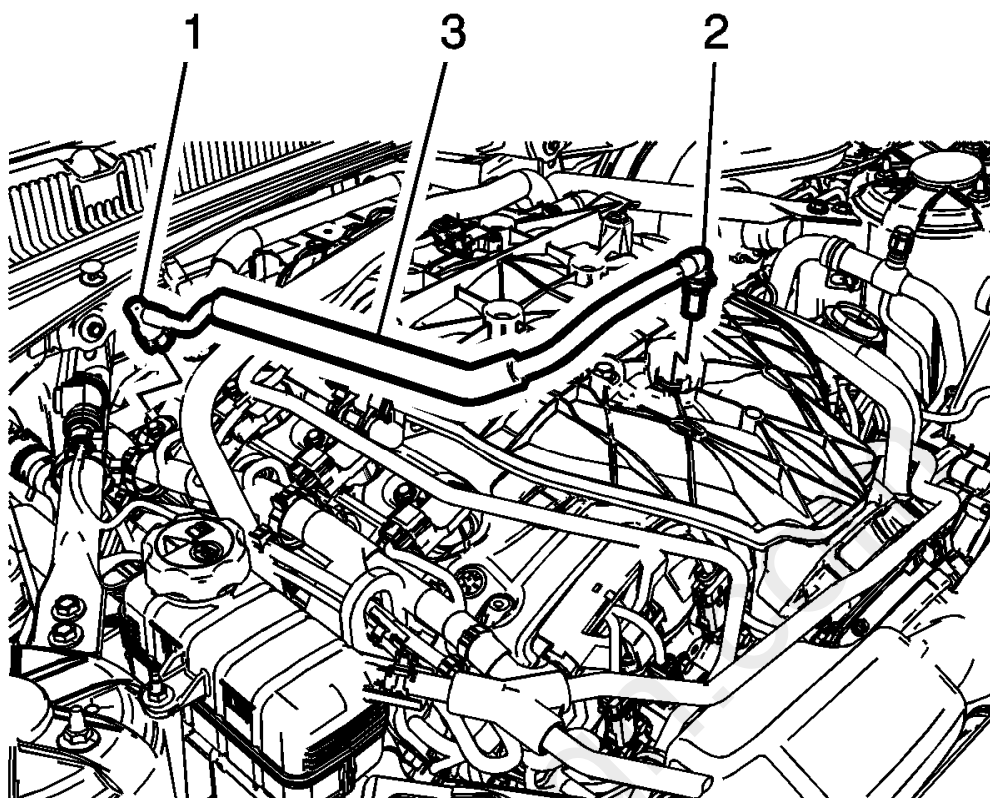


Fig. 56: PCV Dirty Air Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install the PCV dirty air hose (3).

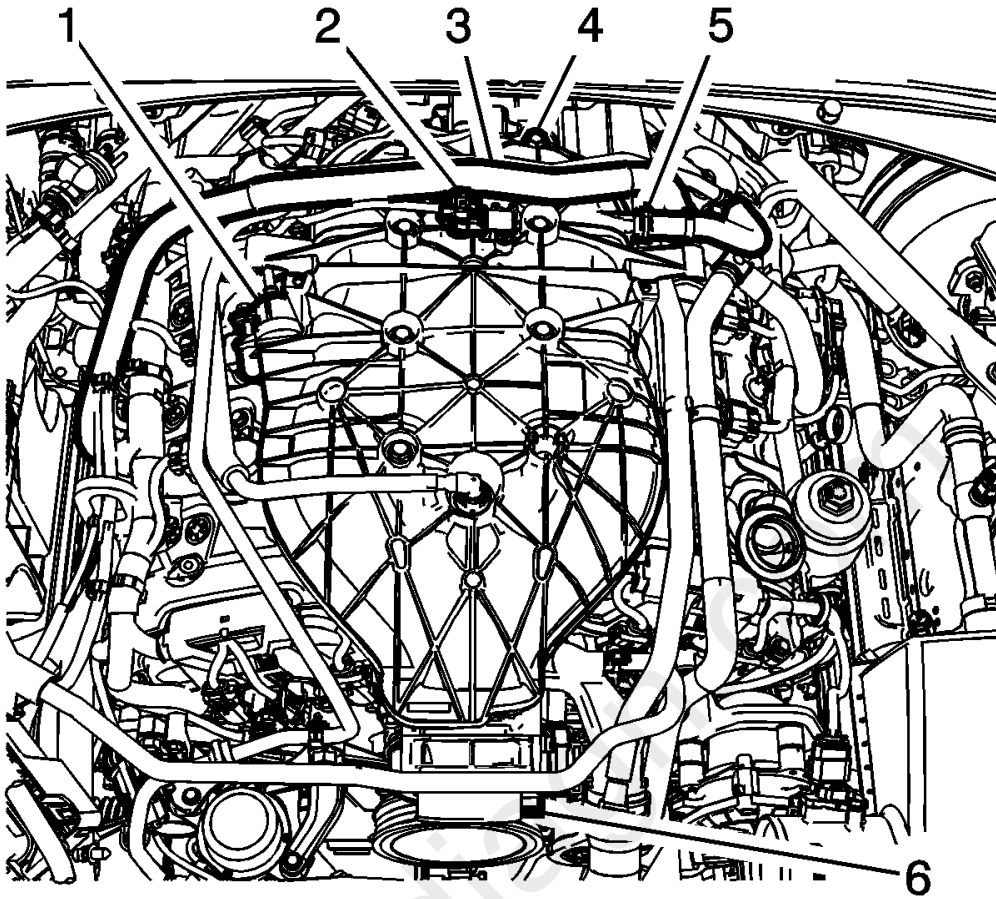


Fig. 57: Identifying Vacuum Hoses
Courtesy of GENERAL MOTORS COMPANY

7. Connect the brake booster vacuum hose (5) to the intake manifold.
8. Connect the MAP sensor connector (2).
9. Connect the secondary air injection hose (3), if equipped.
10. Install the fuel pipe shield (4). Refer to **Fuel Pipe Shield Replacement (LFX)** .
11. Disconnect the EVAP solenoid (1) connector and hose.
12. Disconnect the throttle body connector (6).
13. Install the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (LFX)** .

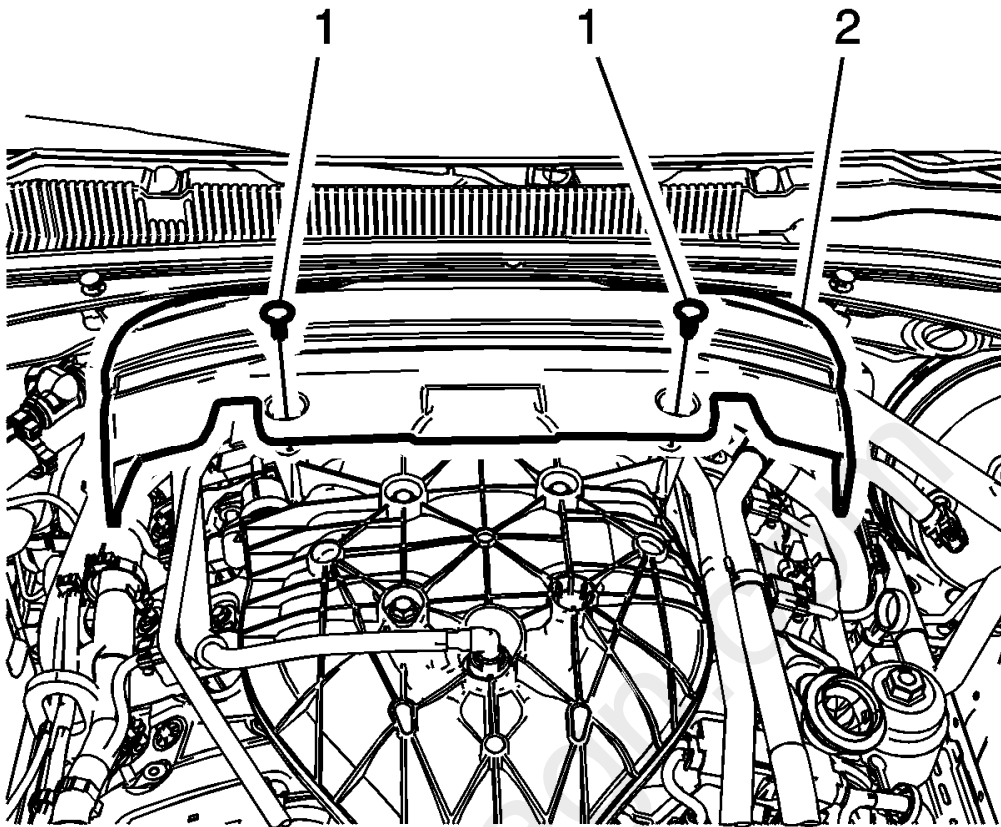


Fig. 58: Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

14. Install the intake manifold insulator (2). Refer to **Intake Manifold Insulator Replacement**.

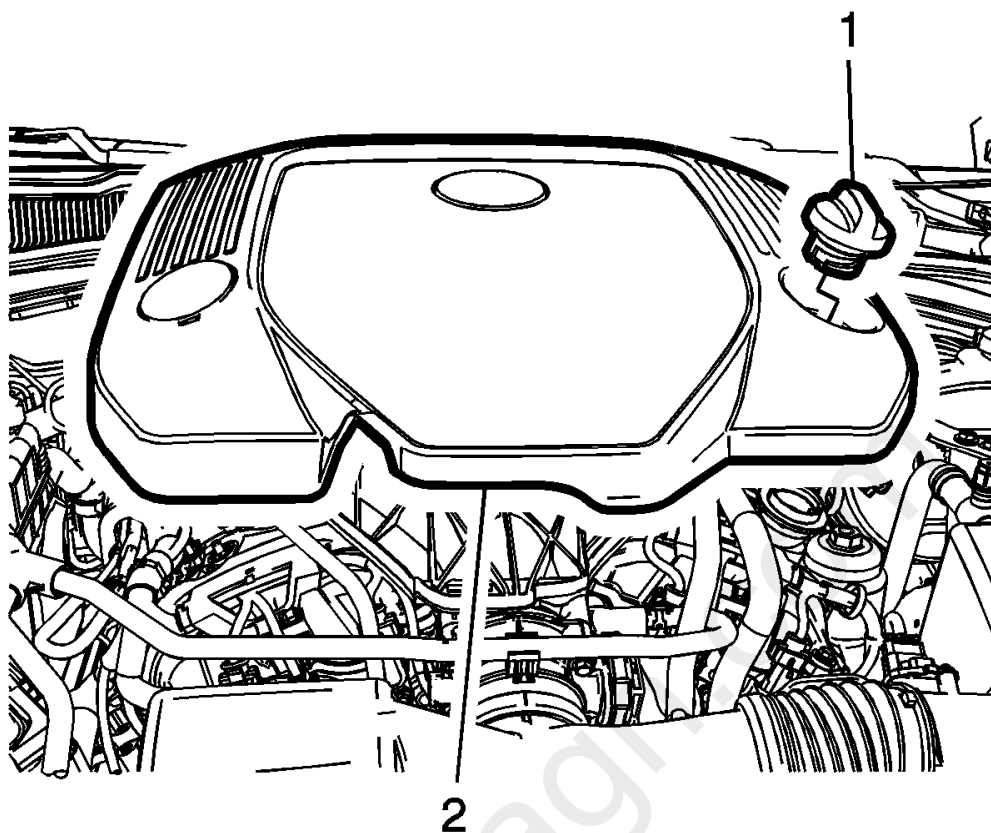


Fig. 59: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

INTAKE MANIFOLD REPLACEMENT (LF3)

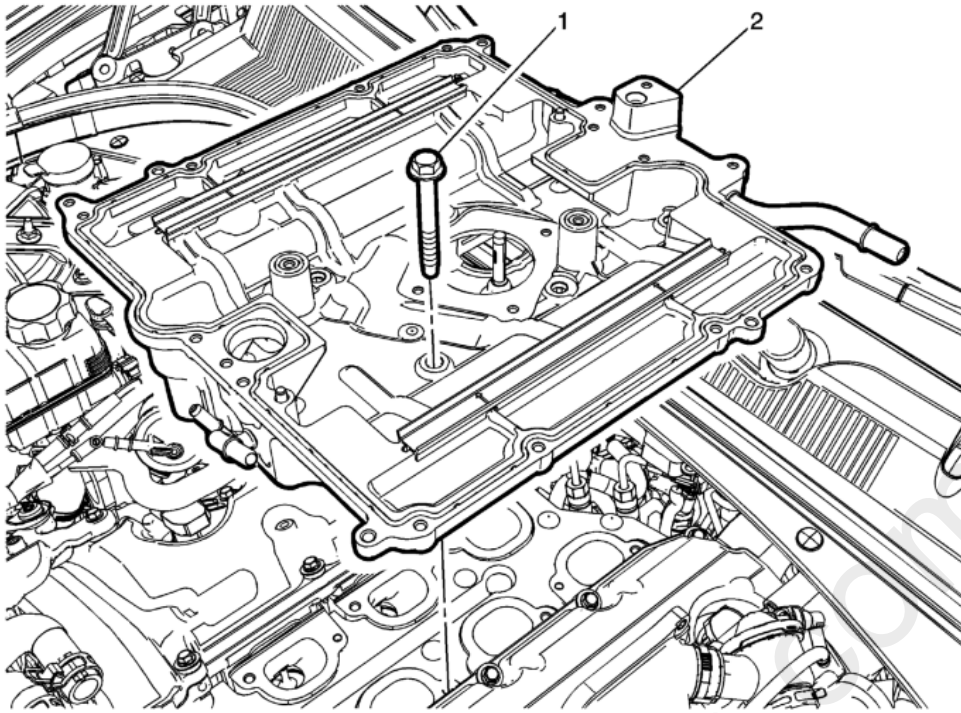


Fig. 60: Intake Manifold (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the charge air cooler cover. Refer to <u>Charge Air Cooler Cover Replacement</u>. 2. Disconnect and reposition the vacuum supply and PCV tubes and lines. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Intake Manifold Bolts: (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Intake Manifold

ENGINE OIL LEVEL INDICATOR TUBE REPLACEMENT (LFX)

Removal Procedure

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

2. Unclip and reposition the main harness and the lower harness away from the oil level indicator tube.

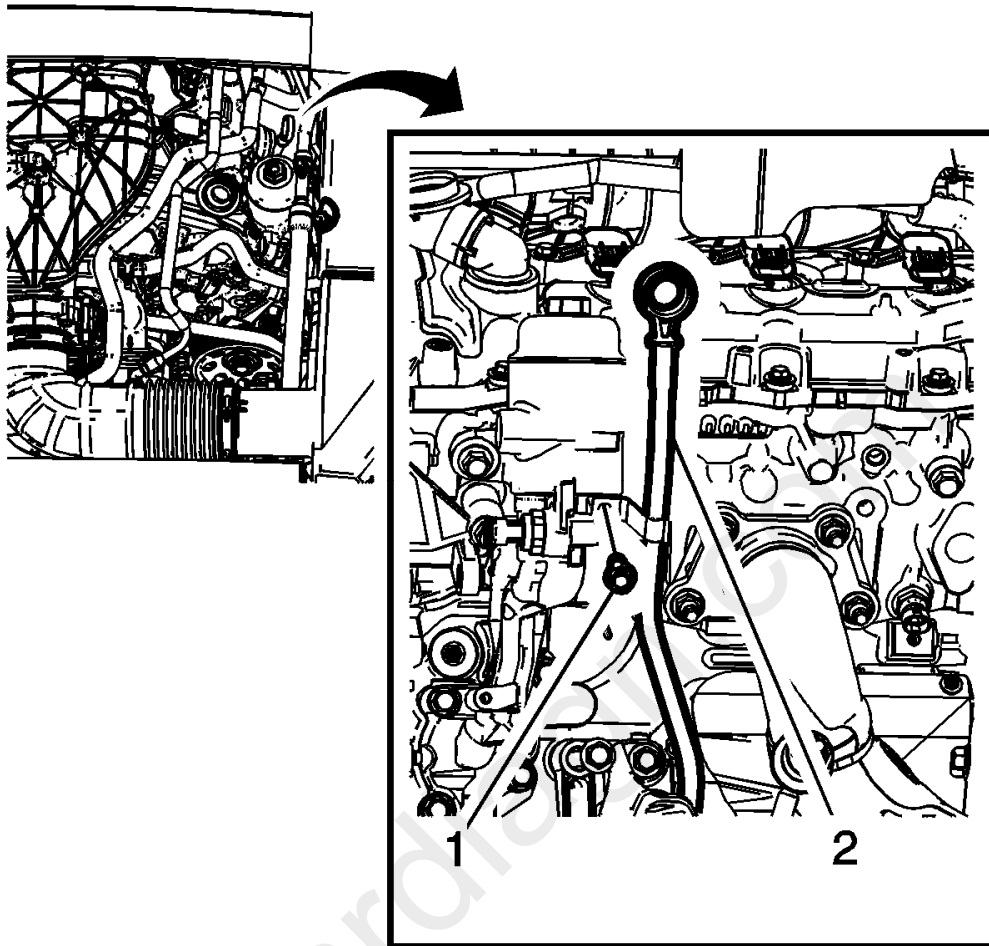


Fig. 61: Indicator Tube & Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil level indicator tube bracket bolt (1).
4. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.

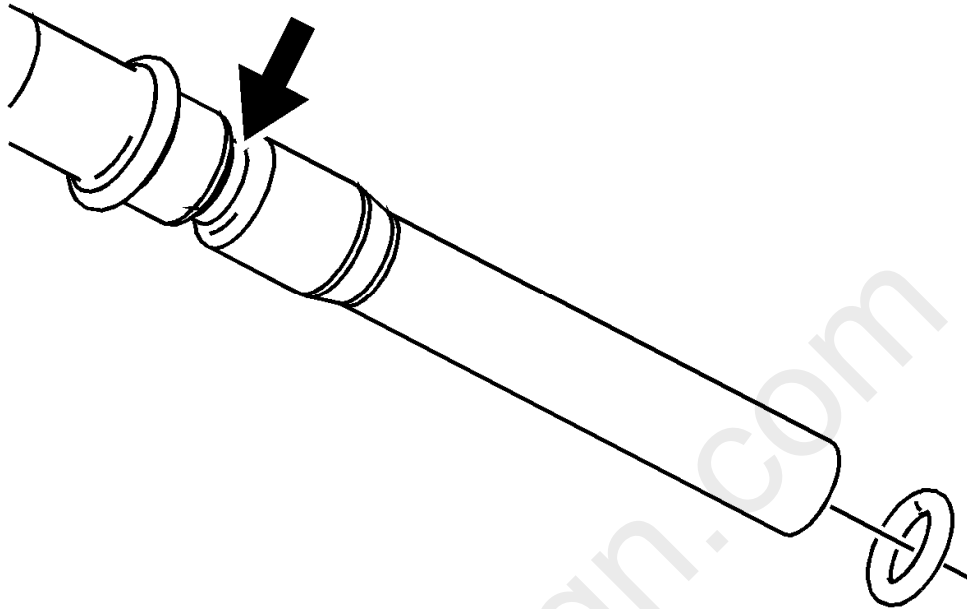


Fig. 62: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

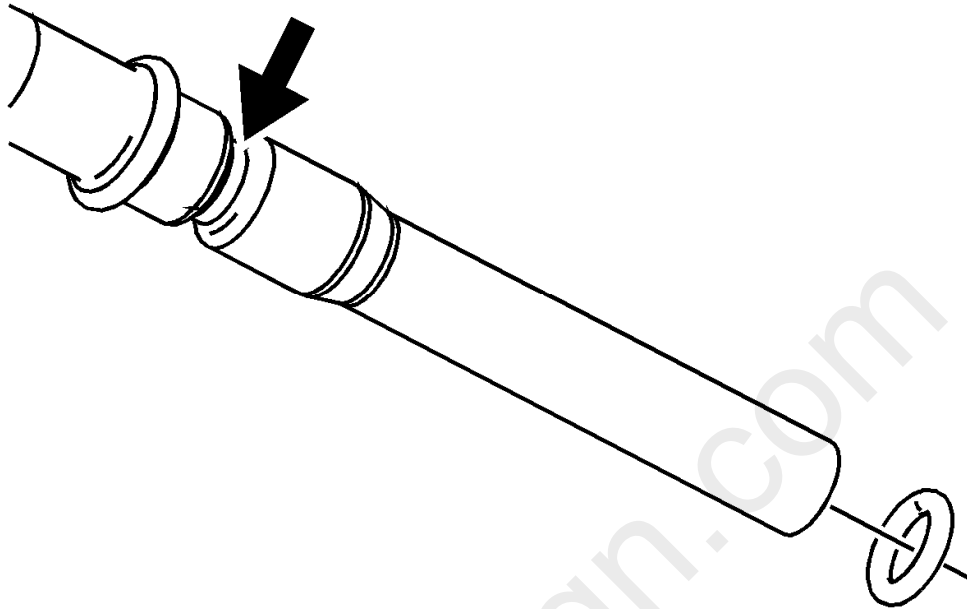


Fig. 63: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

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

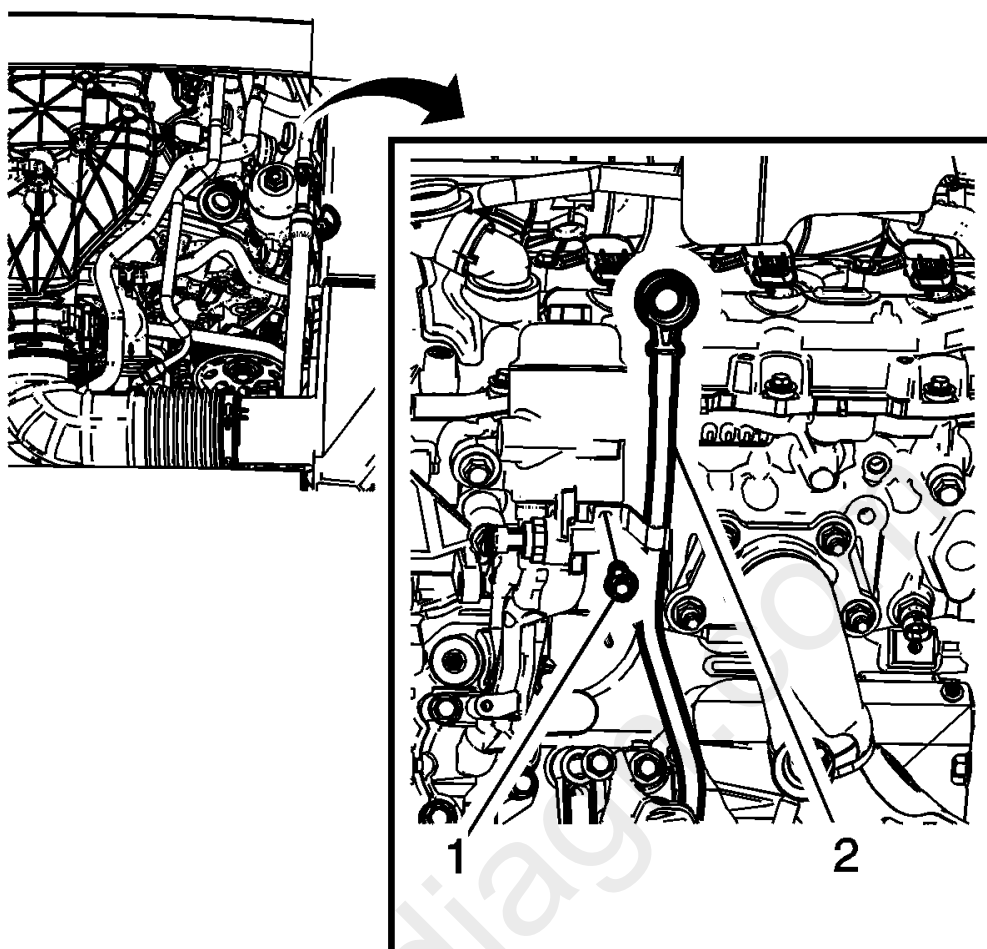


Fig. 64: Indicator Tube & Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Position the oil level indicator and tube (2) by sliding the tube down and in to the approximate location of the lower crankcase hole.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Guide the lower portion of the oil level indicator tube into the lower crankcase hole and seat the oil level indicator tube in place
5. lower the vehicle.

CAUTION: Refer to Fastener Caution .

6. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).
7. Position and clip the main harness and the lower harness to the oil level indicator tube.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)**.

ENGINE OIL LEVEL INDICATOR TUBE REPLACEMENT (LF3)

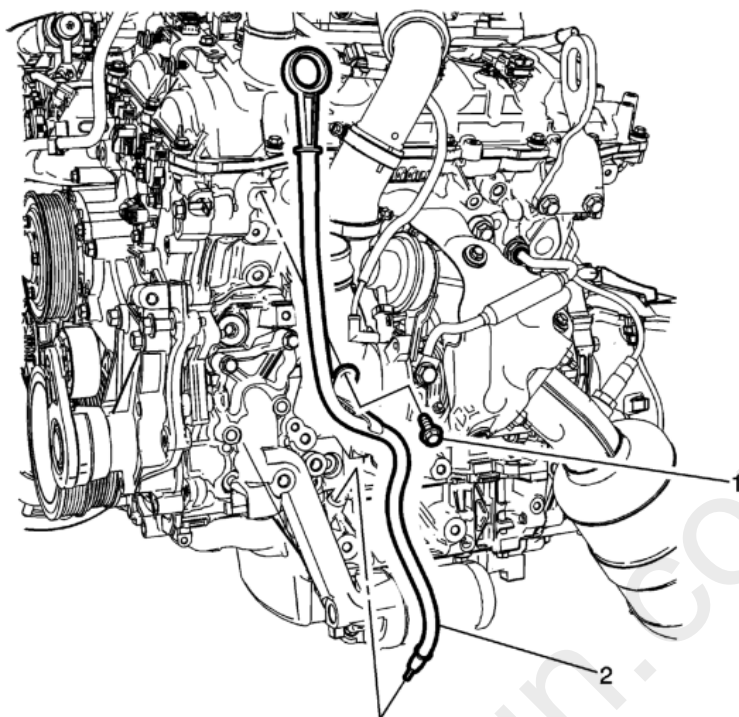


Fig. 65: Oil Level Indicator Tube (LF3)
Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator Tube Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u> .	
1	Oil Level Indicator Tube Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (7 lb ft)
2	Oil Level Indicator Tube NOTE: Ensure that the oil level indicator tube is fully seated prior to tightening the fastener.

ENGINE OIL FILTER ADAPTER REPLACEMENT (LF3)

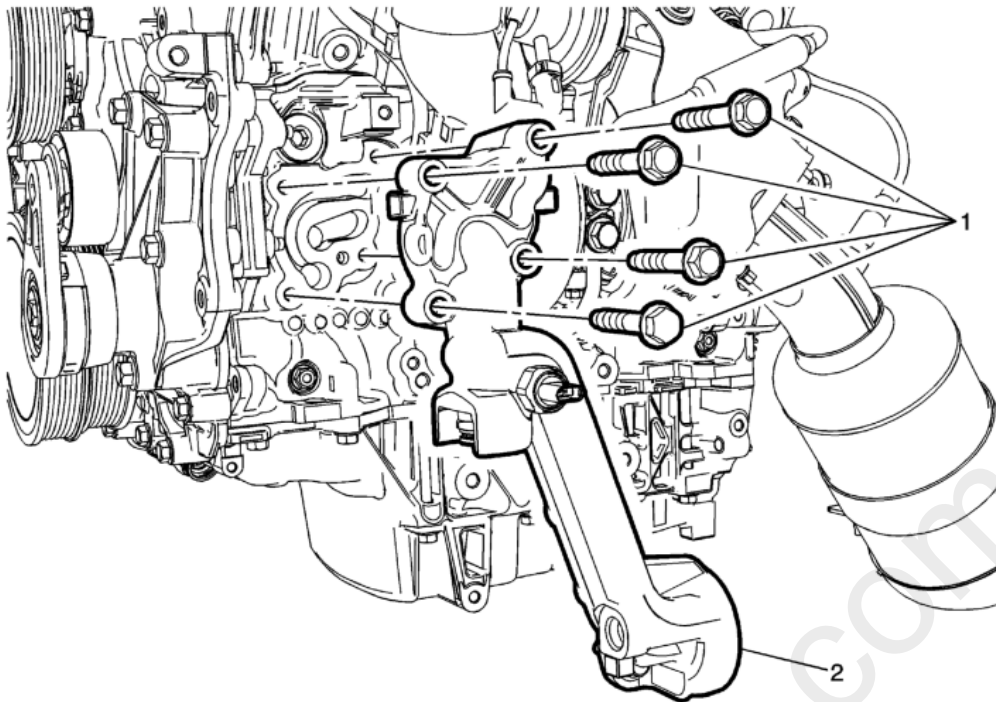


Fig. 66: Engine Oil Filter Adapter (LF3)
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Adapter Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove left turbocharger oil feed pipe. Refer to <u>Turbocharger Oil Feed Pipe Replacement (Bank 1), Turbocharger Oil Feed Pipe Replacement (Bank 2)</u>. 2. Disconnect the engine oil cooler outlet pipe. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper), Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u>.	
1	Oil Filter Adapter Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Oil Filter Adapter Procedure 1. Disconnect the engine oil pressure sensor electrical connector.

2. Transfer components as necessary.
3. Replace oil filter adapter gasket with NEW gasket.

ENGINE OIL FILTER ADAPTER REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Remove the engine compartment lower noise shield. Refer to Front Compartment Lower Noise Shield Replacement (AWD) , Front Compartment Lower Noise Shield Replacement (RWD) .

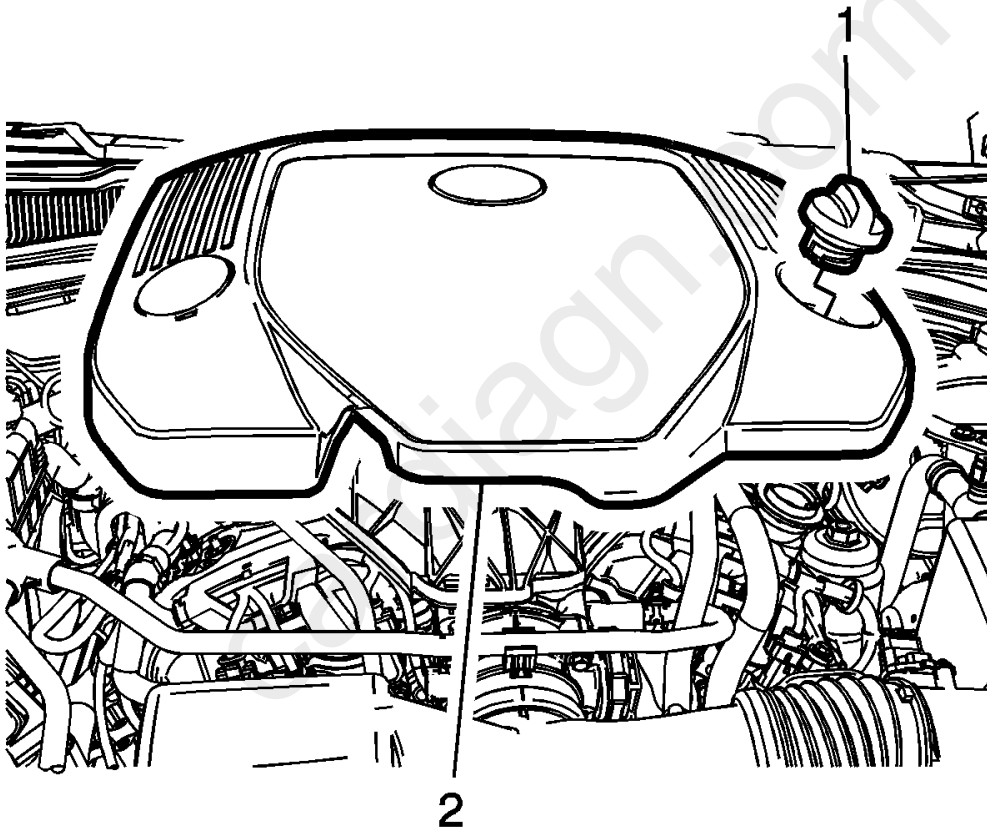


Fig. 67: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

3. Remove the intake manifold cover (2). Refer to Intake Manifold Cover Replacement (LFX).
4. Remove the oil filter and allow to drain. Refer to Engine Oil and Oil Filter Replacement (LFX).
5. Install the oil filter.

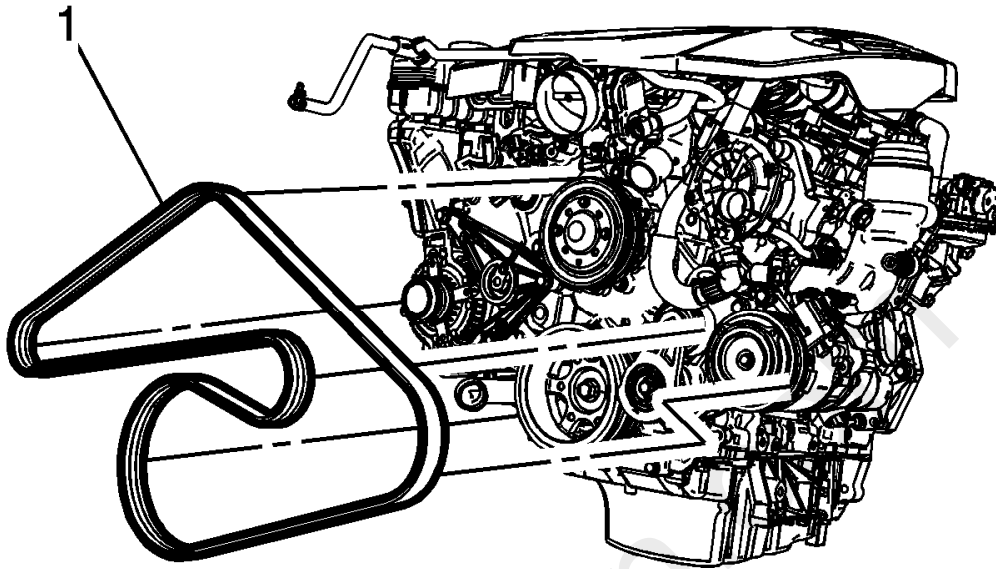


Fig. 68: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

6. Remove the drive belt (1). Refer to **Drive Belt Replacement (LFX)**.

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

7. Remove the A/C compressor bolts and reposition the A/C compressor in order to gain access to the oil filter adapter fasteners. Refer to **Air Conditioning Compressor Replacement (LFX)**.
8. Disconnect the oil pressure sensor electrical connector.

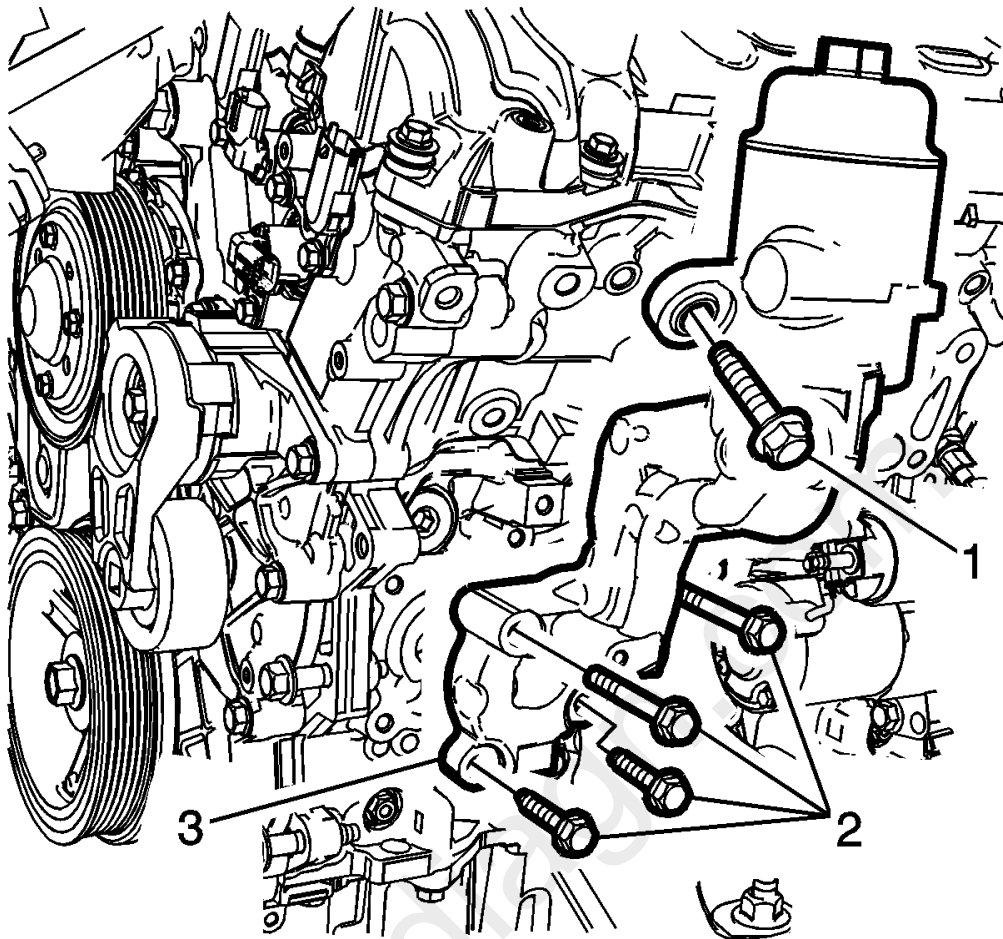


Fig. 69: Oil Filter Adapter & Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Place a drain pan under the vehicle.
10. Remove the oil filter adapter bolts (1 and 2).
11. Remove the oil filter adapter (3).
12. Remove and discard the oil filter adapter gasket.

Installation Procedure

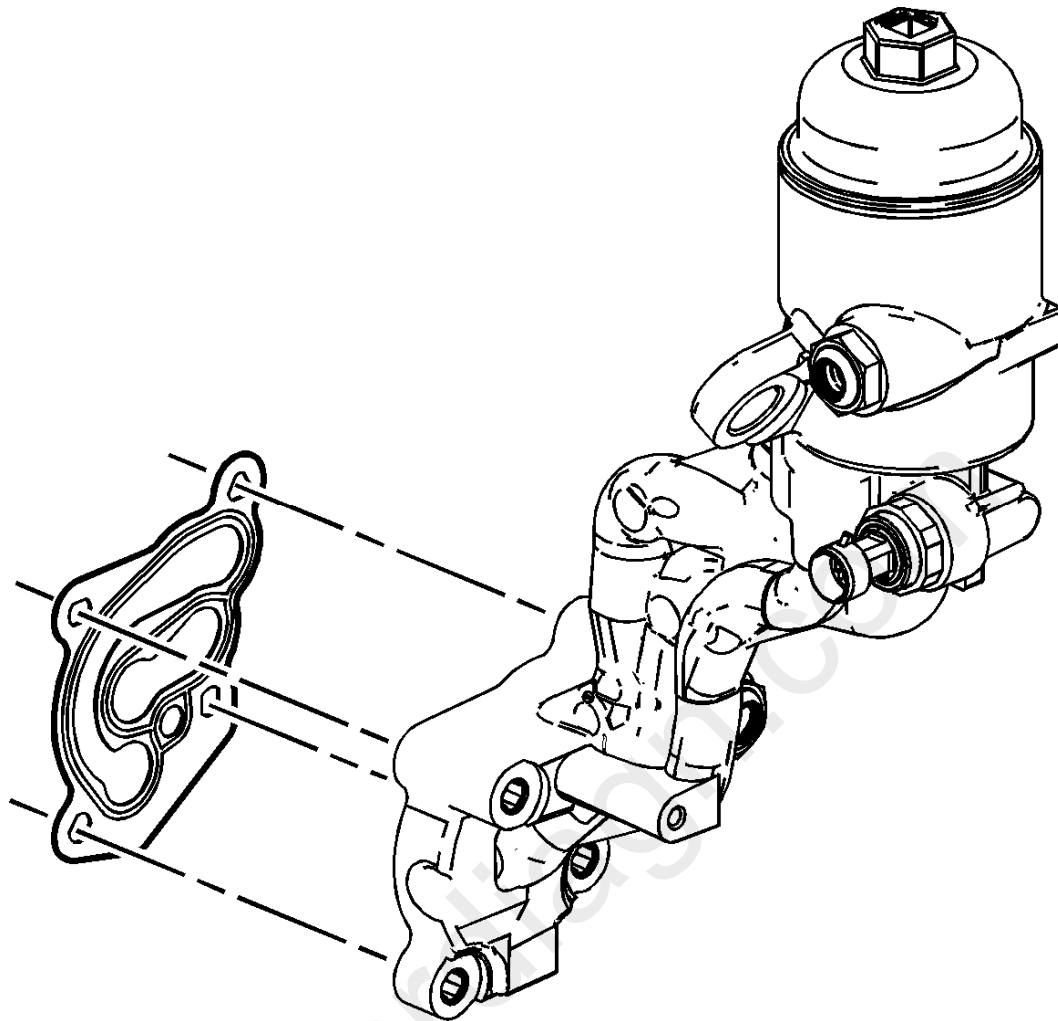


Fig. 70: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.

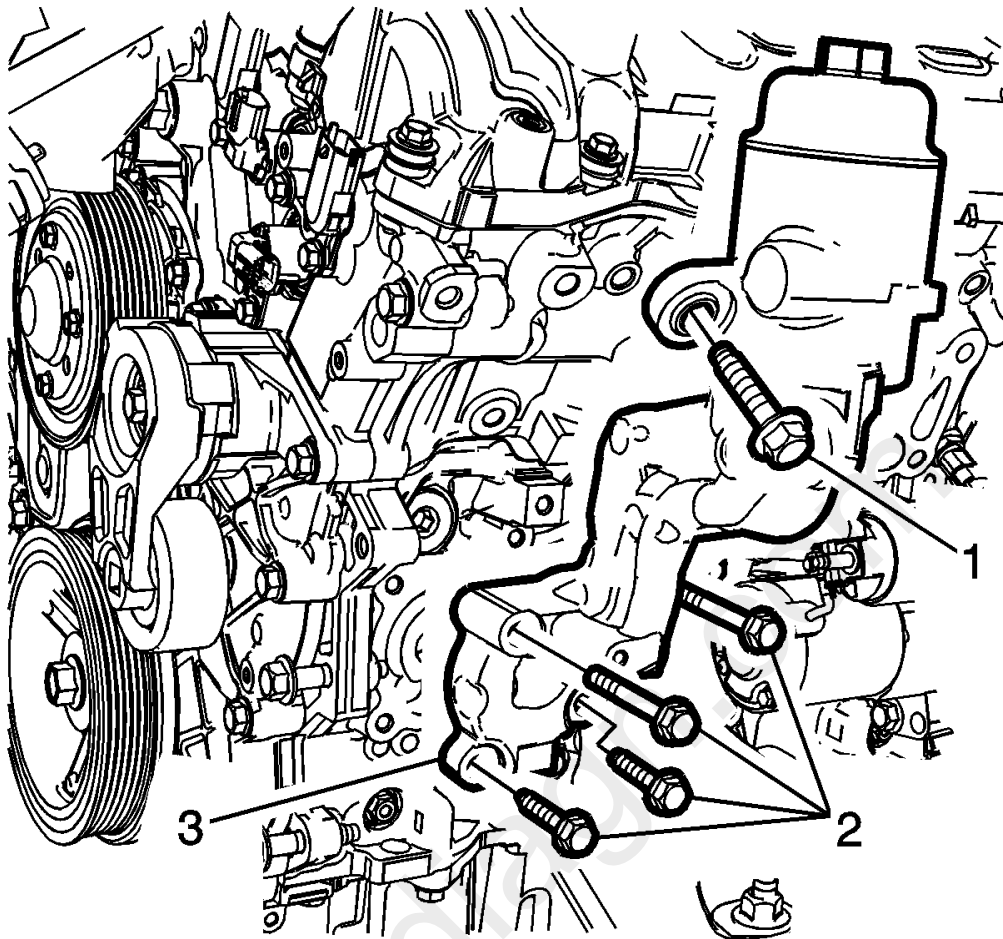


Fig. 71: Oil Filter Adapter & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil filter adapter (3).
3. Install the oil filter adapter bolts (1, 2) into the oil filter adapter and hand tighten.

CAUTION: Refer to Fastener Caution .

4. Tighten the oil filter adapter bolts (2) to 25 N.m (18 lb ft).
5. Tighten the oil filter adapter bolt (1) to 58 N.m (43 lb ft).
6. Connect the oil pressure sensor electrical connector.
7. Install the A/C compressor with the A/C pipes to the engine. Refer to **Air Conditioning Compressor Replacement (LFX)** .

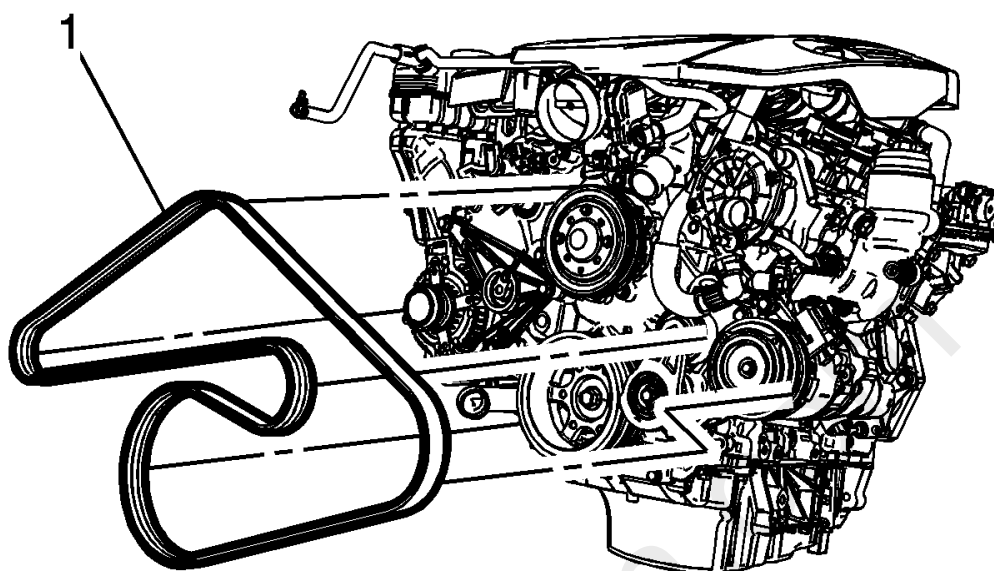


Fig. 72: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

8. Install the drive belt. Refer to **Drive Belt Replacement (LFX)**.

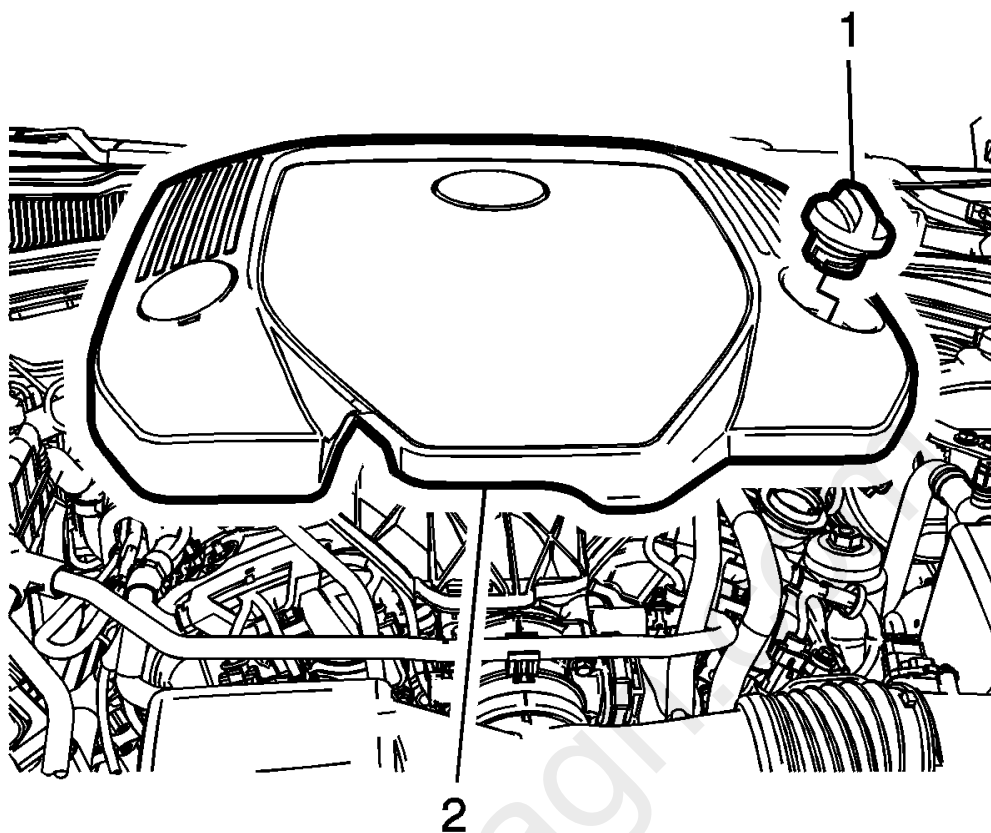


Fig. 73: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

9. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement (LFX)**.
10. Install the engine compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .
11. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Check and add engine oil as necessary.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- EN-38416-2 Crankshaft Button
- EN-41816 Crankshaft Balancer Remover
- EN-41998-B Crankshaft Balancer Installer
- EN-45059 Angle Meter

- **EN-46106** Flywheel Holding Tool

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

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement (LFX)**, **Drive Belt Replacement (LF3)**.
2. Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LTG with V03)** , **Engine Coolant Fan Shroud Replacement (LFX)** , **Engine Coolant Fan Shroud Replacement (LTG without V03)** , **Engine Coolant Fan Shroud Replacement (LF3)** .
3. Remove the starter. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .

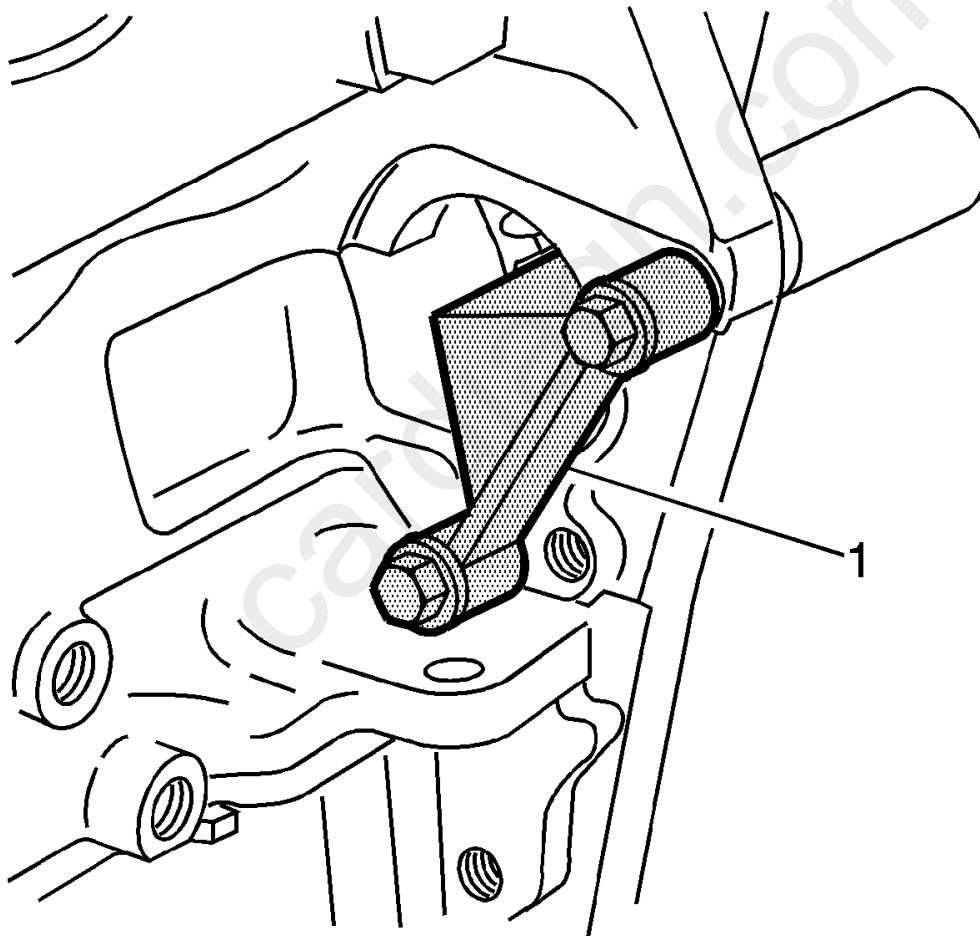


Fig. 74: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46106** tool (1) through the starter mounting hole.

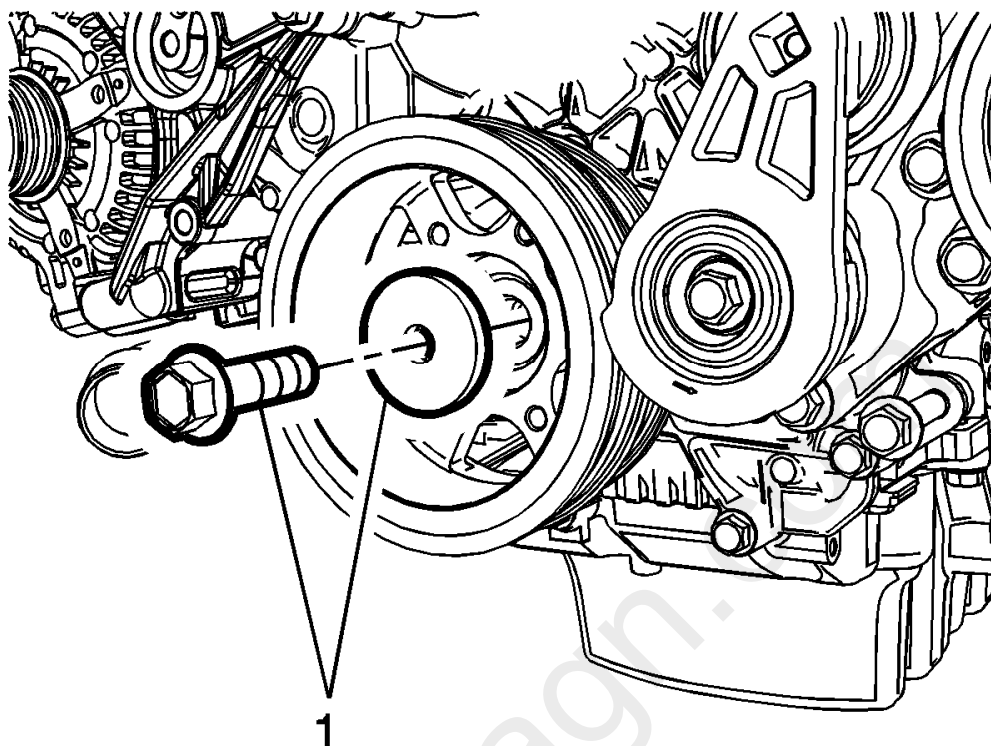


Fig. 75: Crankshaft Balancer Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the crankshaft balancer bolt and washer (1). Discard the bolt.

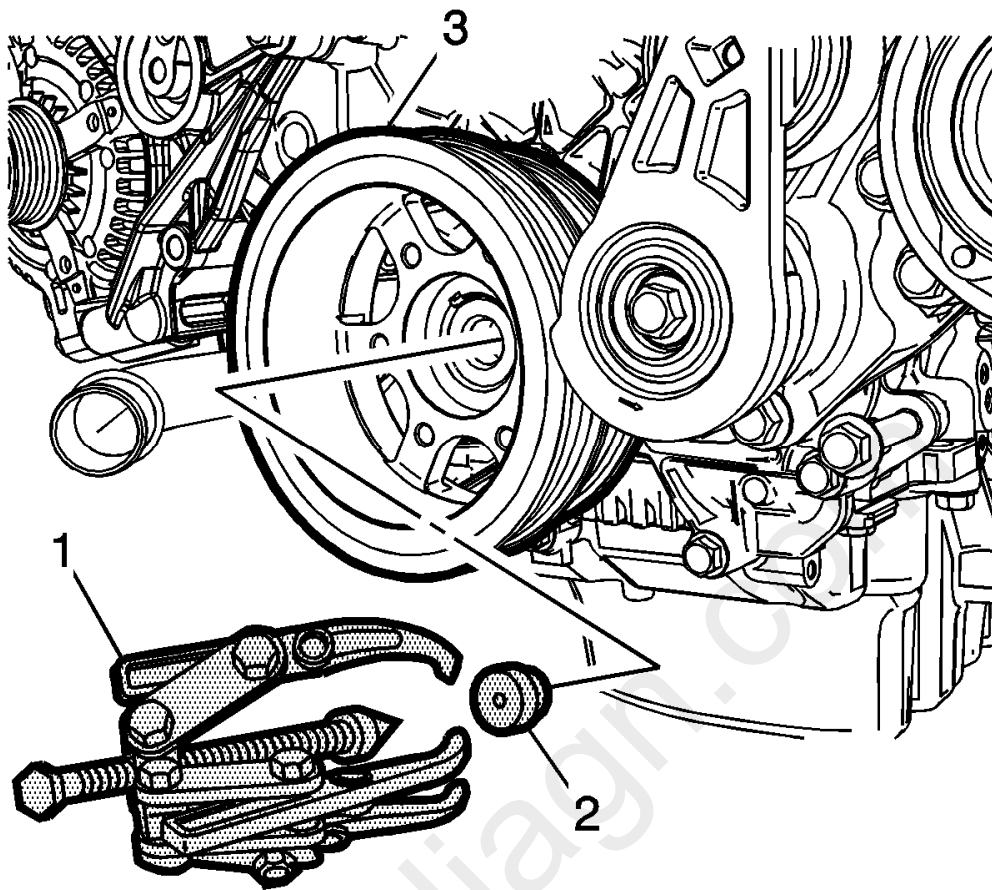


Fig. 76: Crankshaft Balancer Remover
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-38416-2** button (2) in the nose of the crankshaft.
7. Install the **EN-41816** remover (1) in order to remove the crankshaft balancer (3).
8. Tighten the center bolt of the **EN-41816** remover (1) in order to pull the crankshaft balancer off of the crankshaft.
9. Remove the **EN-41816** remover and **EN-38416-2** button from the crankshaft balancer.

Installation Procedure

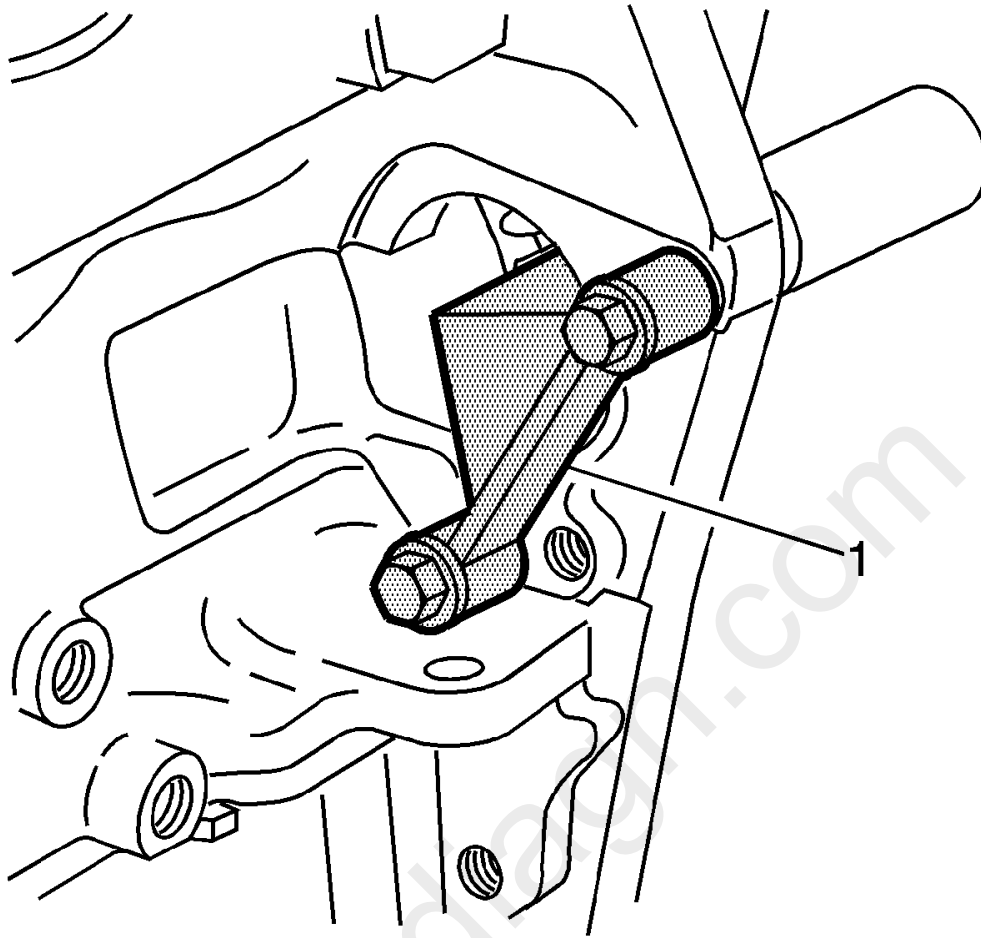


Fig. 77: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

1. The **EN-46106** tool (1) must be installed onto the flywheel.

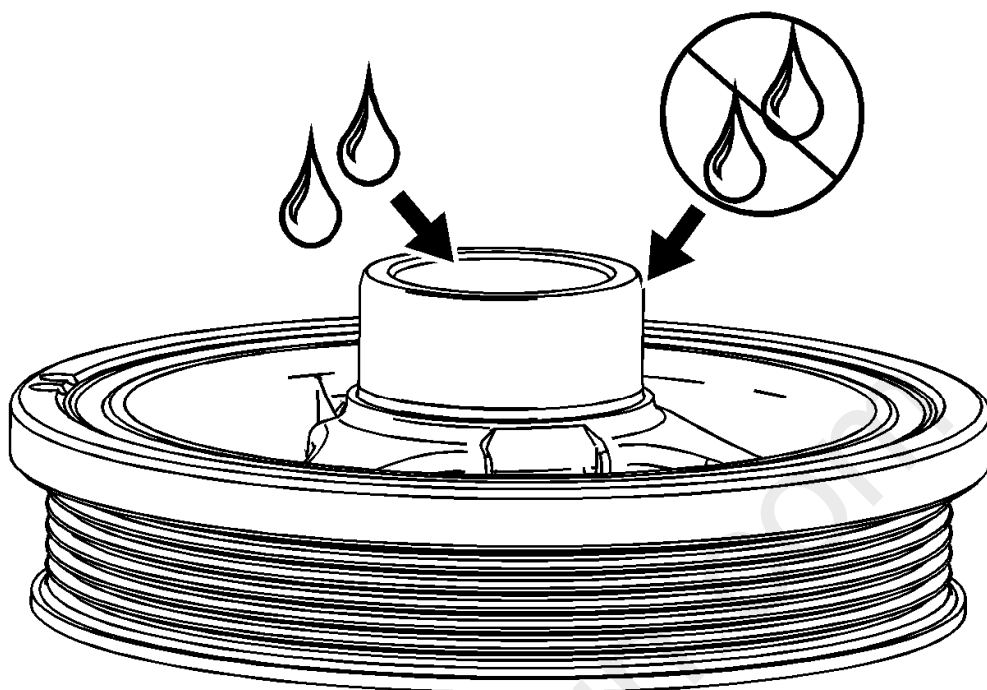


Fig. 78: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

2. Apply lubricant to the inside of the crankshaft balancer hub bore.

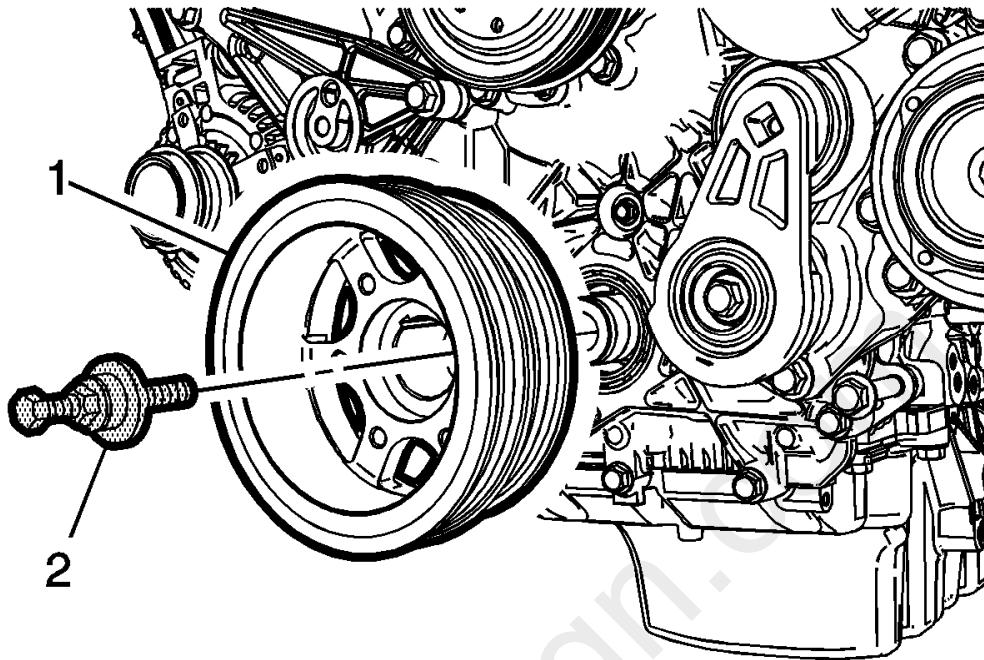


Fig. 79: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

3. Place the crankshaft balancer (1) in position on the crankshaft.
4. Thread the **EN-41998-B** installer (2) in the crankshaft. Ensure you engage at least 10 threads of the **EN-41998-B** installer before pressing the crankshaft balancer in place.
5. Push the crankshaft balancer into position by tightening the nut on the **EN-41998-B** installer until the large washer bottoms out on the crankshaft end.
6. Remove the **EN-41998-B** installer.

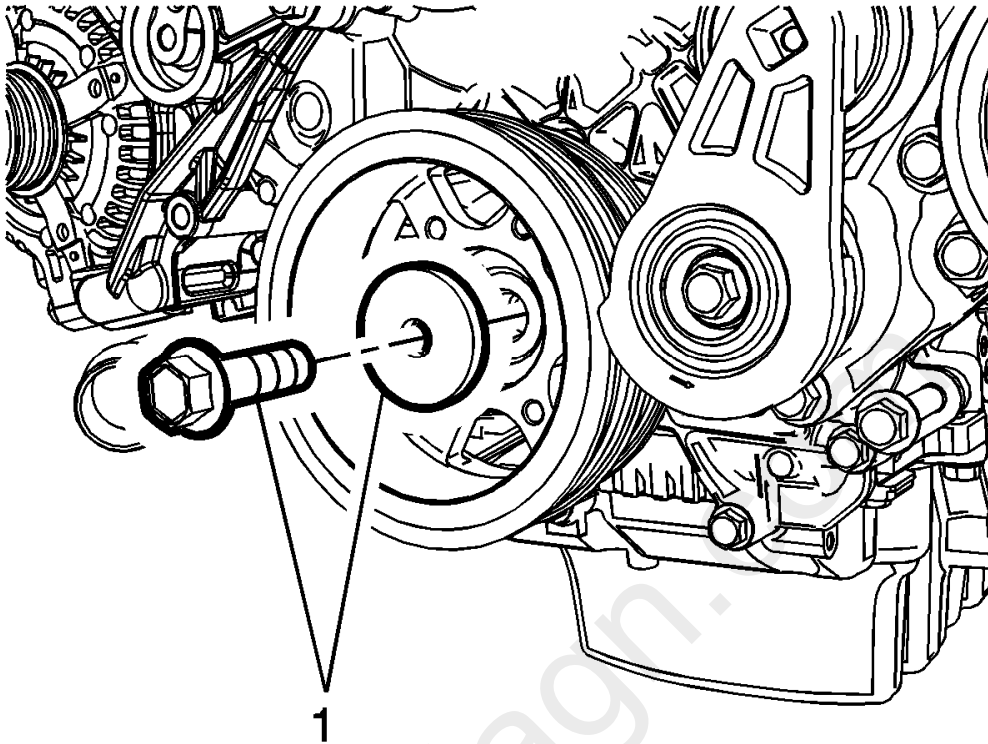


Fig. 80: Crankshaft Balancer Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Always install a new crankshaft balancer retaining bolt (1) and washer.

7. Install the NEW crankshaft balancer bolt (1).

CAUTION: Refer to Fastener Caution .

8. Tighten the crankshaft balancer bolt to 100 (74 lb ft) and an additional 150 degrees using the EN-45059 meter.

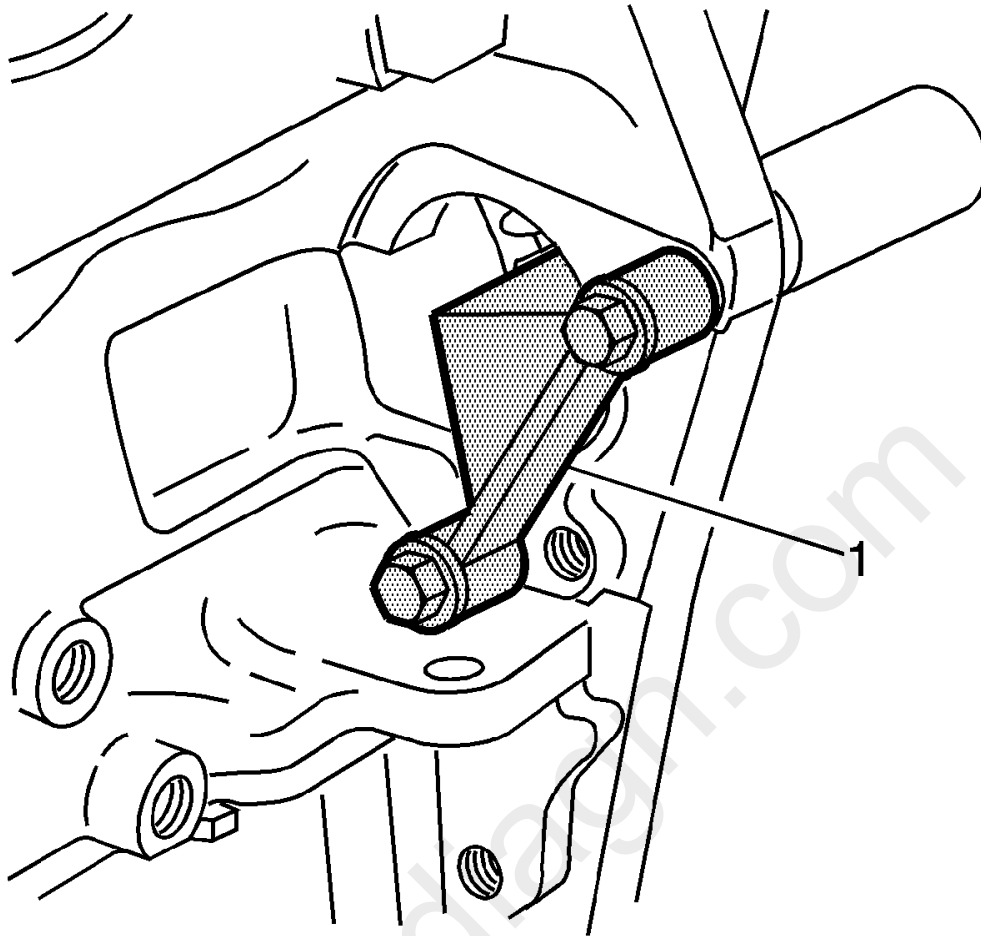


Fig. 81: Flywheel Holding Tool

Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46106** tool (1) .
10. Install the starter. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .
11. Install the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LTG with V03)** , **Engine Coolant Fan Shroud Replacement (LFX)** , **Engine Coolant Fan Shroud Replacement (LTG without V03)** , **Engine Coolant Fan Shroud Replacement (LF3)** .
12. Install the drive belt. Refer to **Drive Belt Replacement (LFX)**, **Drive Belt Replacement (LF3)**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-29184 Oil Seal Installer

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

Removal Procedure

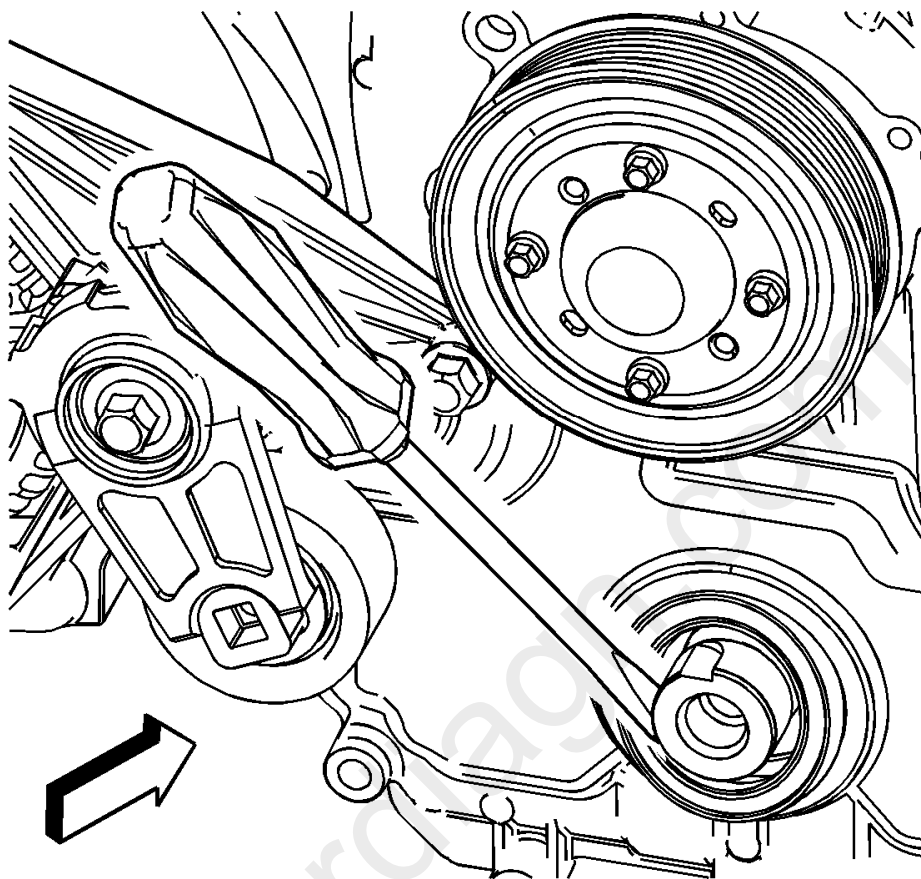


Fig. 82: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the crankshaft front oil seal using a suitable flat blade tool.

Installation Procedure

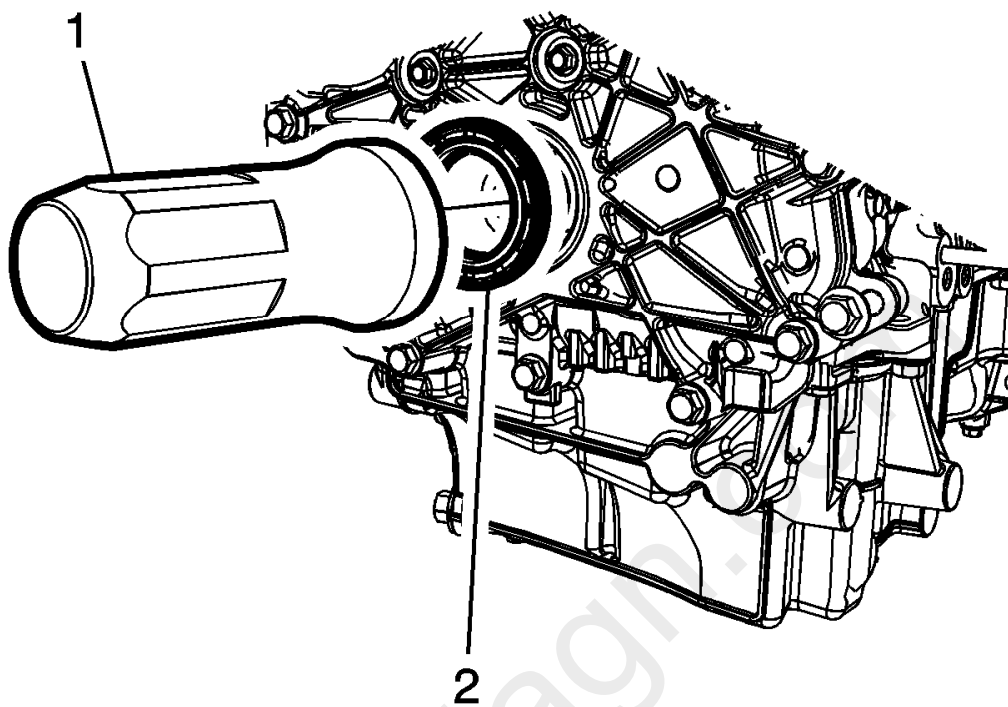


Fig. 83: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

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

1. Use the **EN-29184** installer (1) or equivalent to install the crankshaft front oil seal (2).
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

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

Removal Procedure

1. Remove the left diagonal brace. Refer to Front End Sheet Metal Diagonal Brace Replacement - Left Side.
2. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LFX), Fuel Pipe Shield Replacement (LF3).

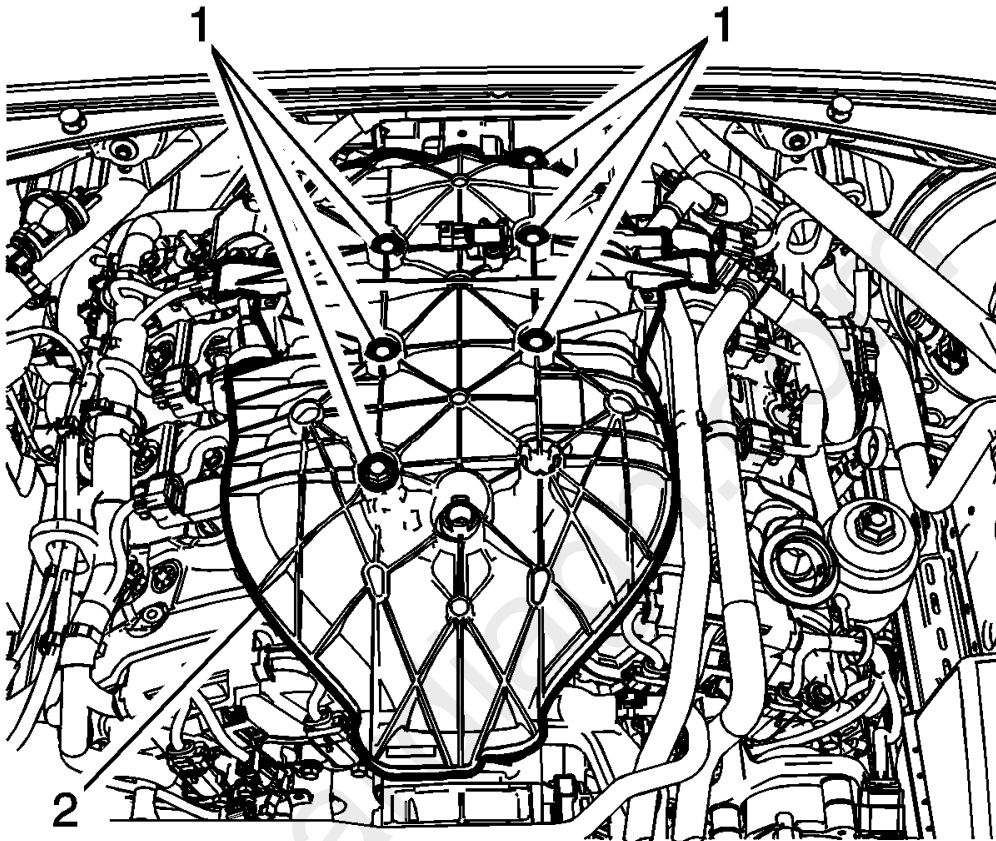


Fig. 84: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

3. Remove the intake manifold (2). Refer to Intake Manifold Replacement (LFX), Intake Manifold Replacement (LF3).

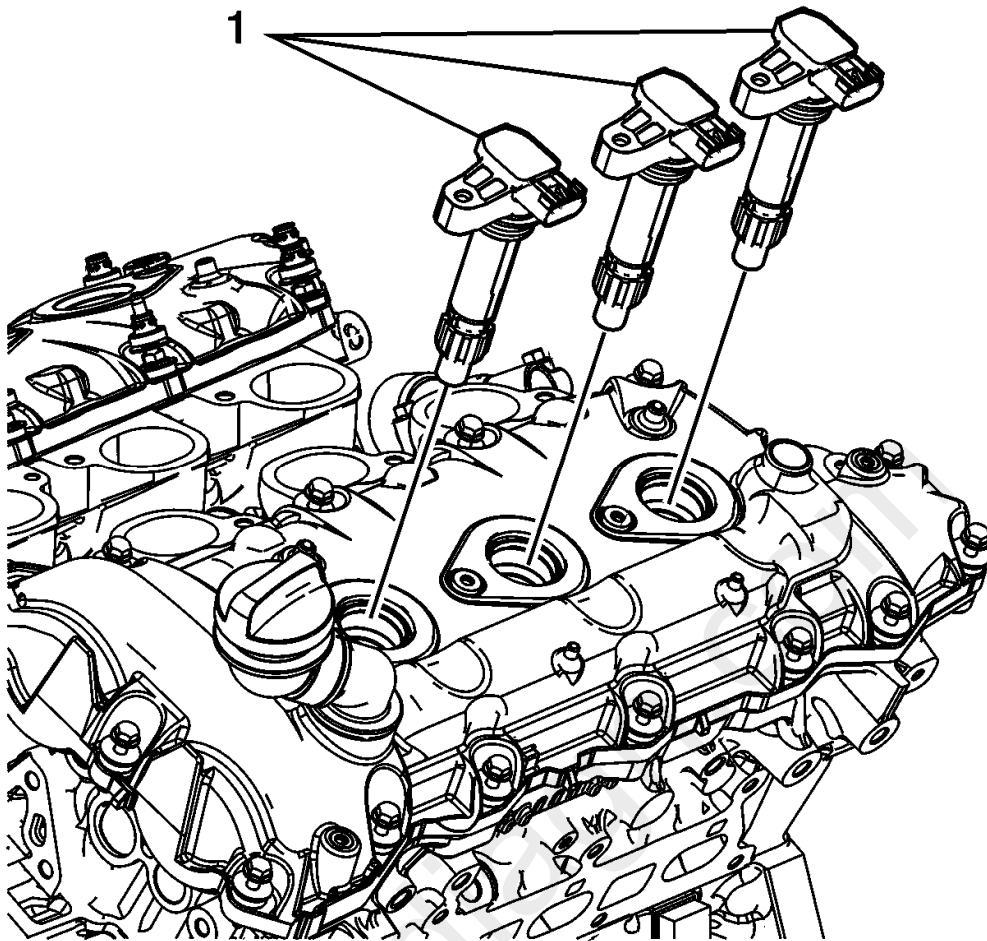


Fig. 85: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 2 (LFX)** , **Ignition Coil Replacement - Bank 2 (LF3)** .
5. Disconnect and remove the engine harness from the camshaft cover.

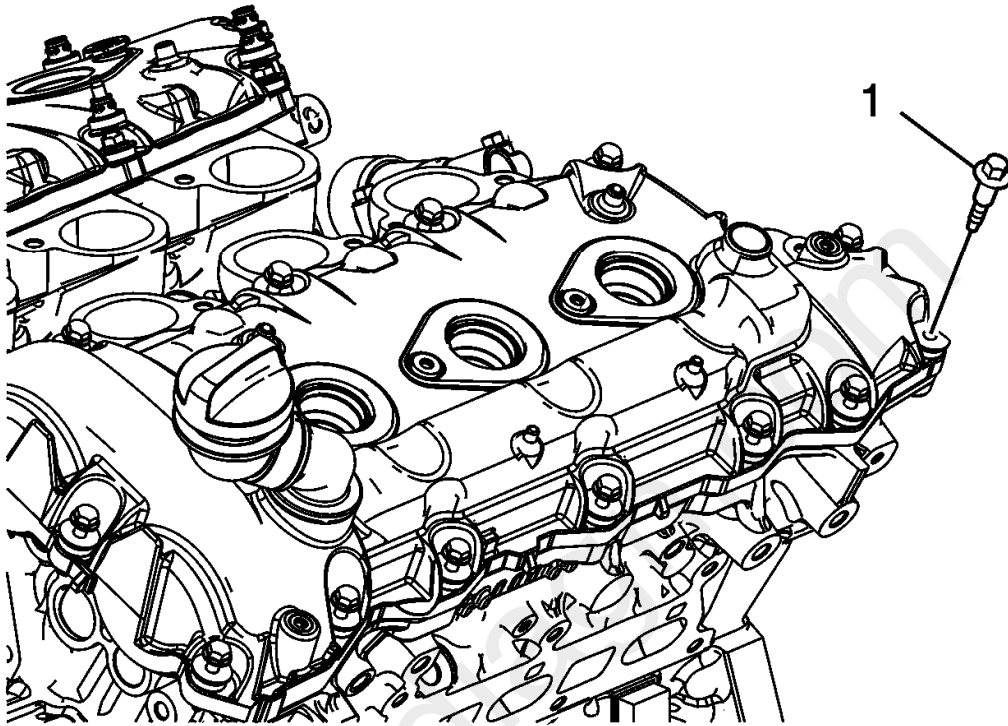


Fig. 86: View of Camshaft Cover and Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the left camshaft cover bolts.

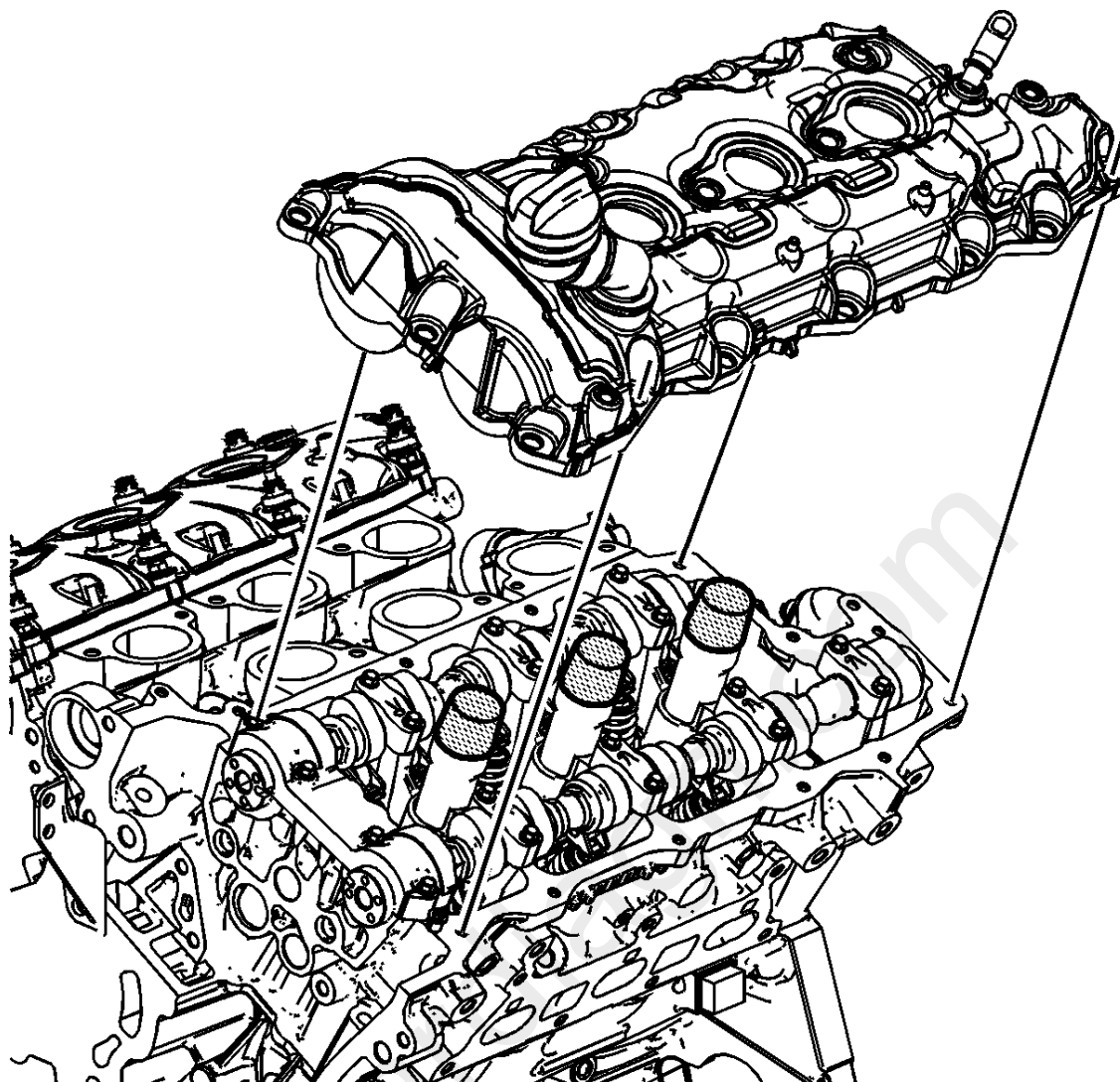


Fig. 87: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Remove the left camshaft cover from the left cylinder head.
8. Install the **EN-46101** guide onto the spark plug tubes of the left cylinder head.
9. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LF3)** , **Camshaft Cover Cleaning and Inspection (LFX)**

Installation Procedure

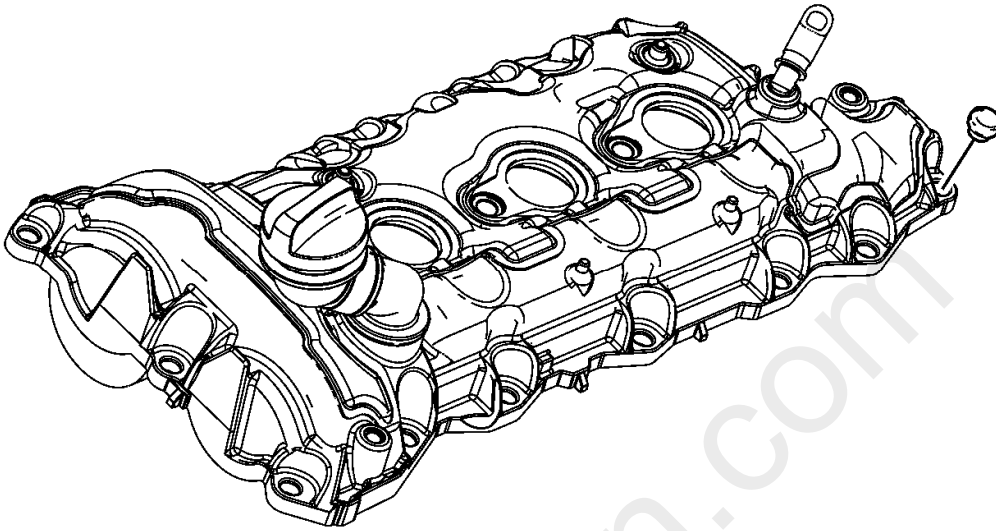


Fig. 88: View of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

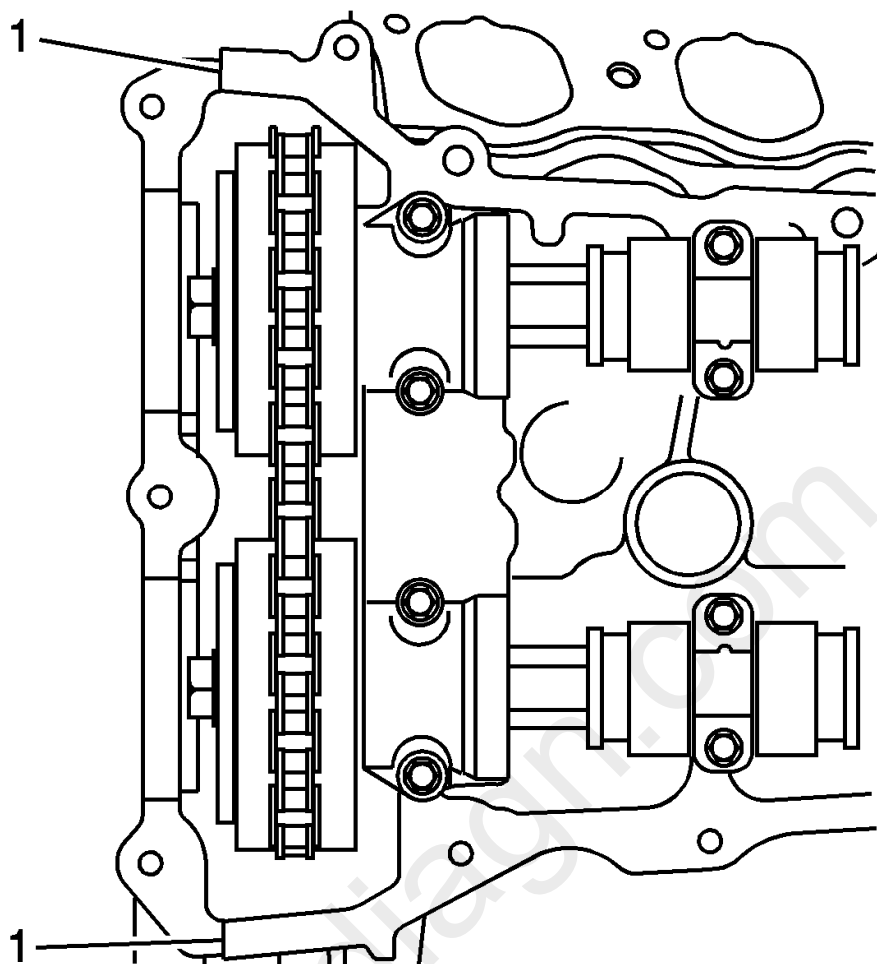


Fig. 89: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1).

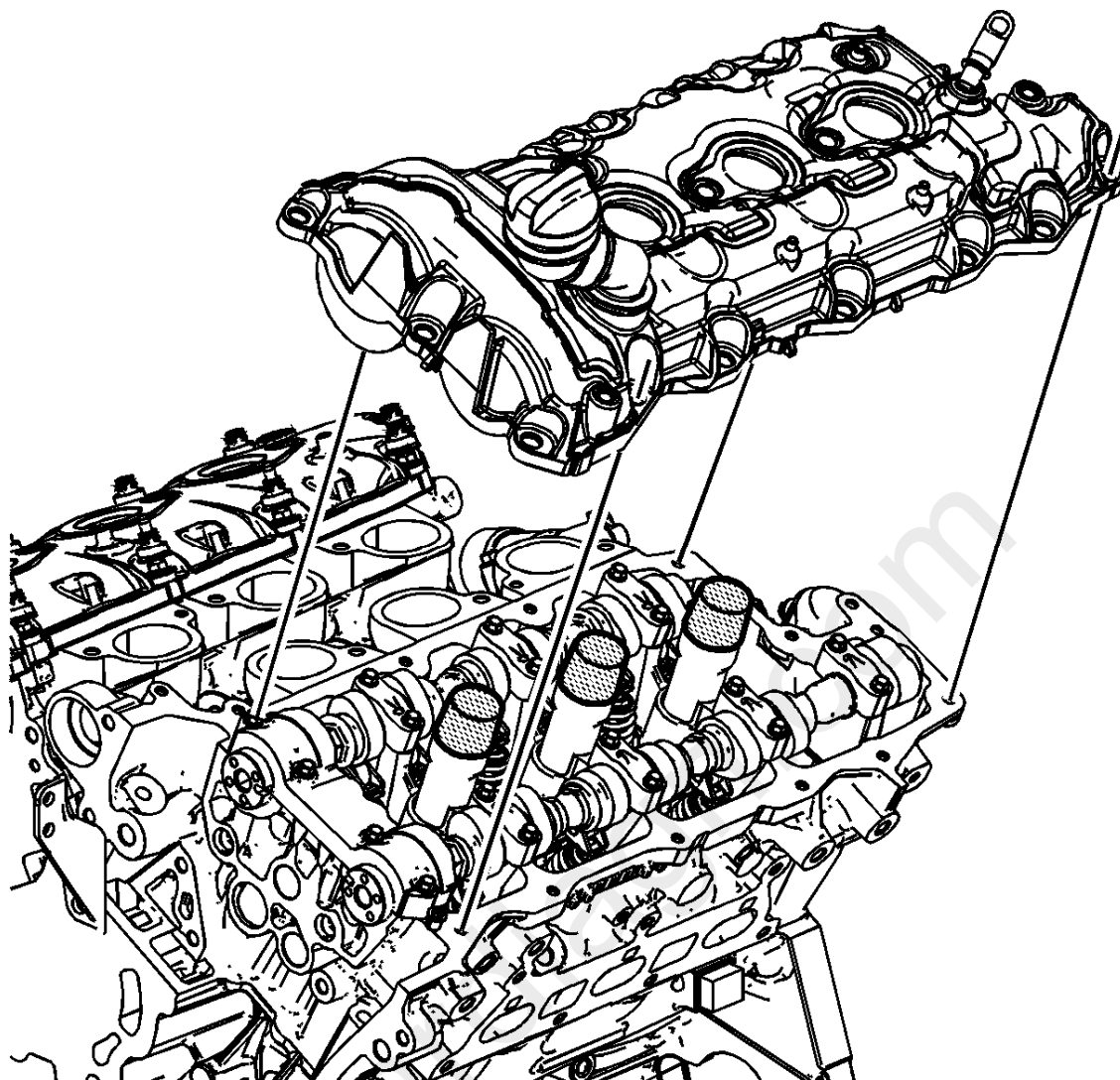


Fig. 90: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

3. Place the left camshaft cover into position onto the left cylinder head.

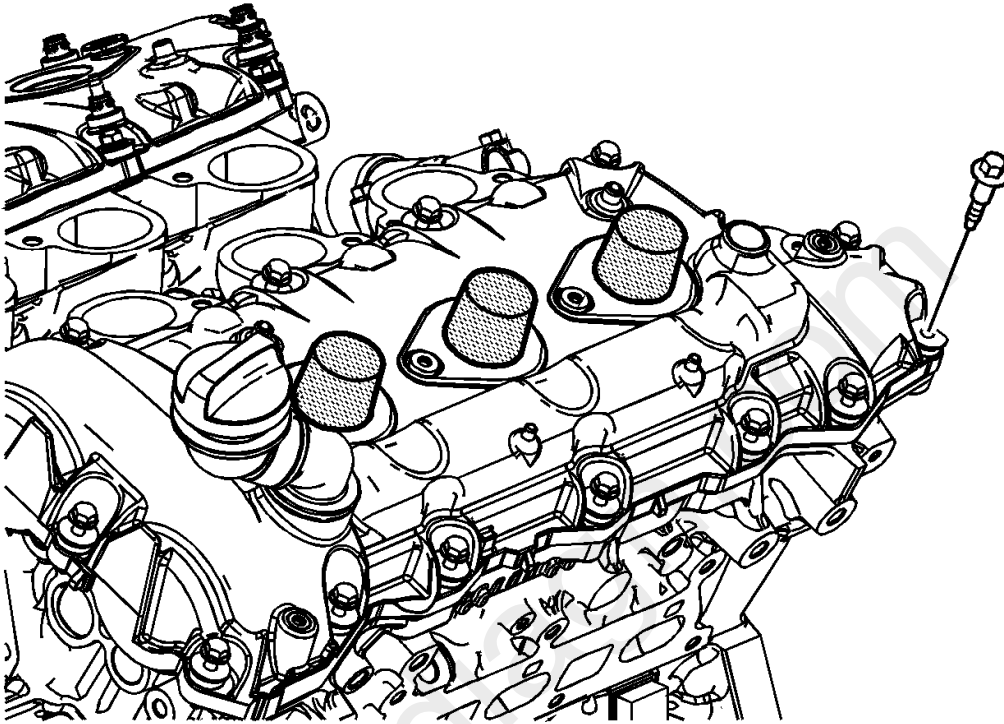


Fig. 91: View of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Loosely install the left camshaft cover bolts.

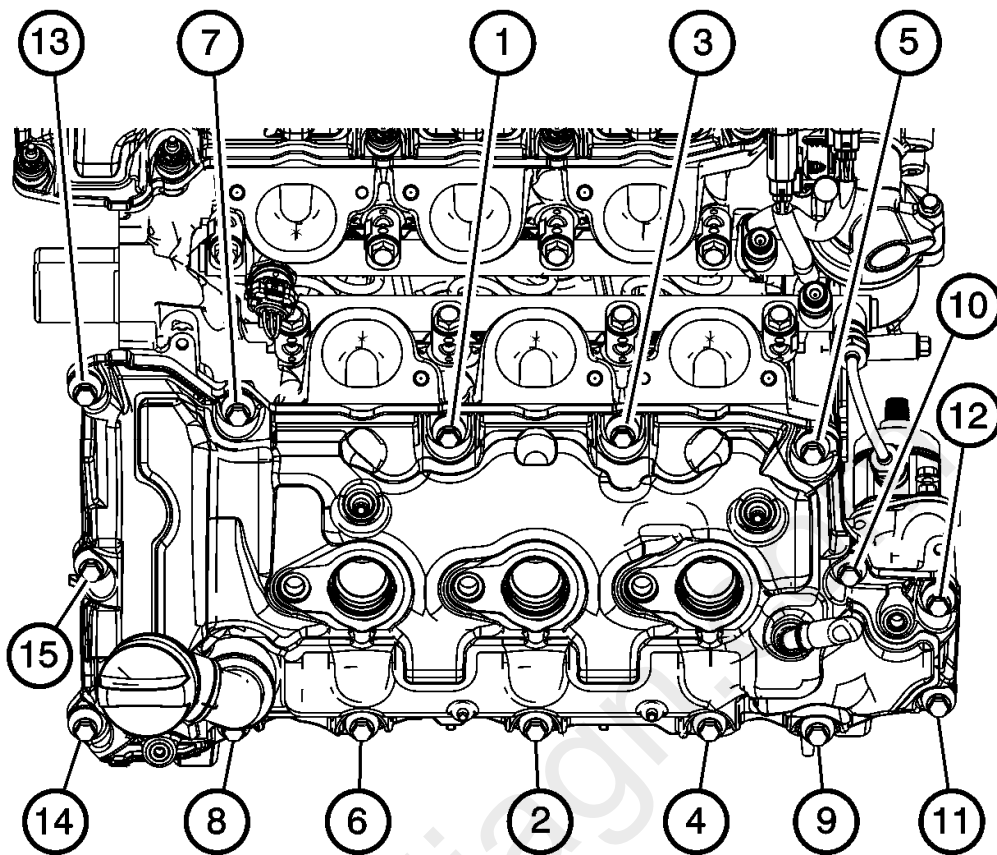


Fig. 92: Identifying Left Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the left camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).

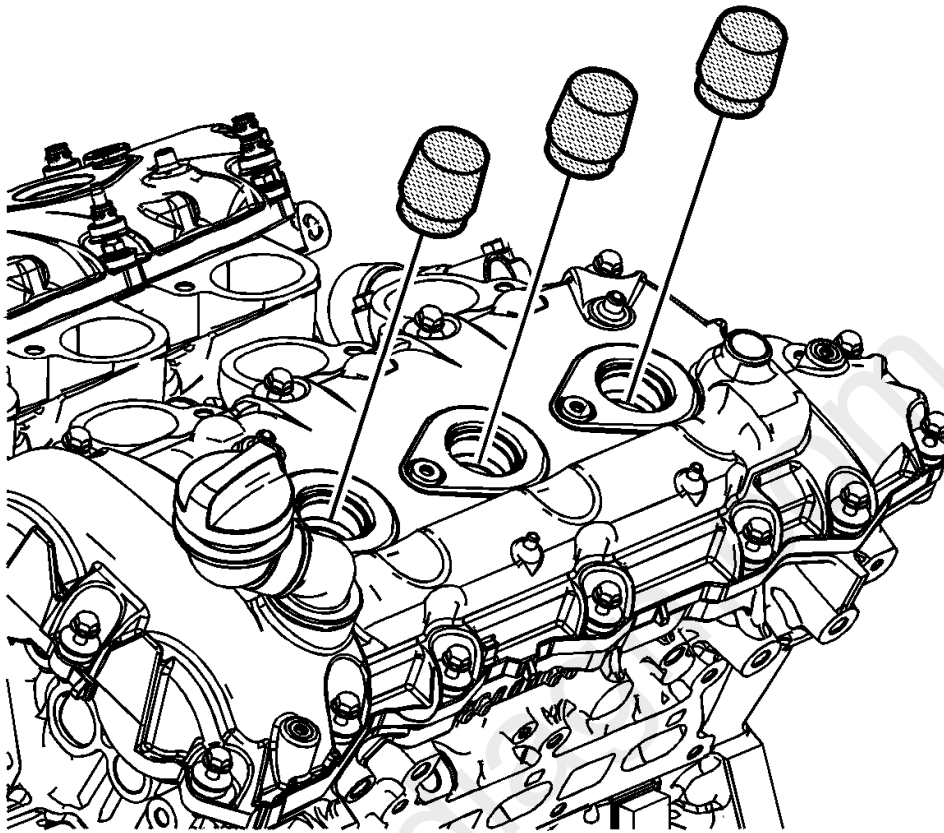


Fig. 93: View of Spark Plug Tubes & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-46101** guide from the spark plug tubes of the left cylinder head.
7. Connect and install the engine harness to the camshaft cover.

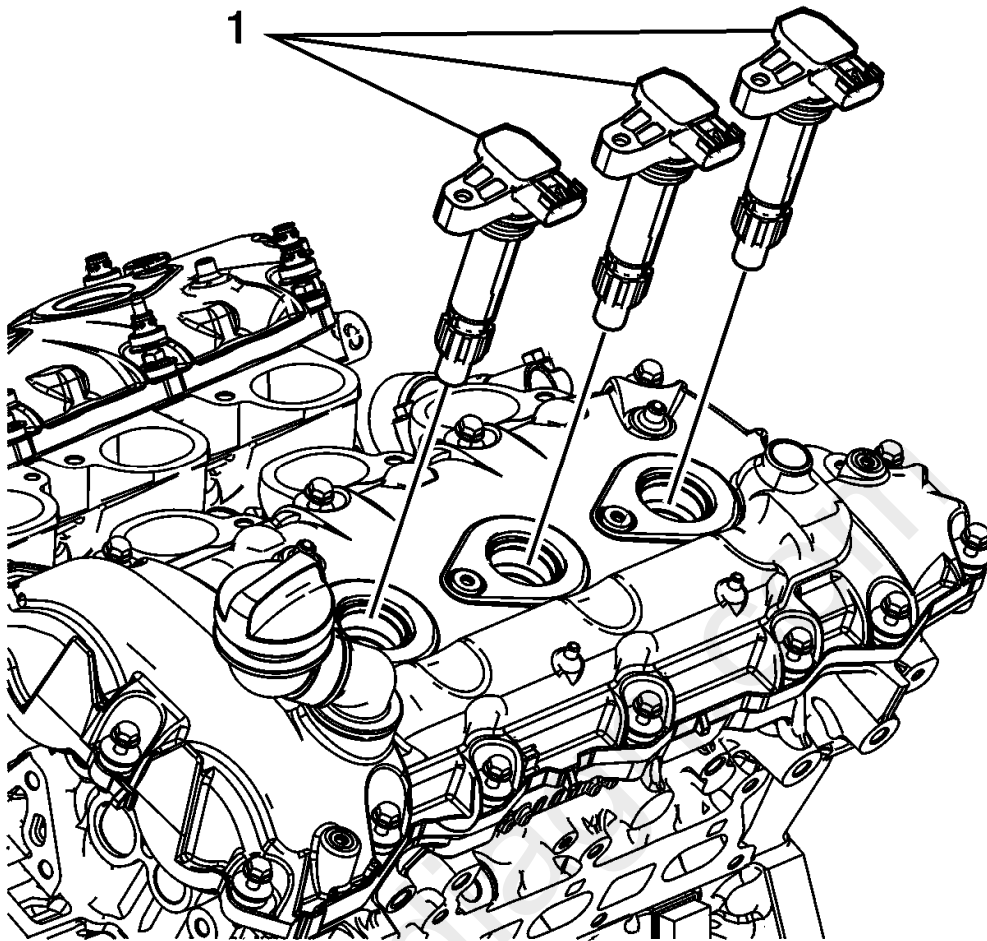


Fig. 94: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

8. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 2 (LFX)** , **Ignition Coil Replacement - Bank 2 (LF3)** .

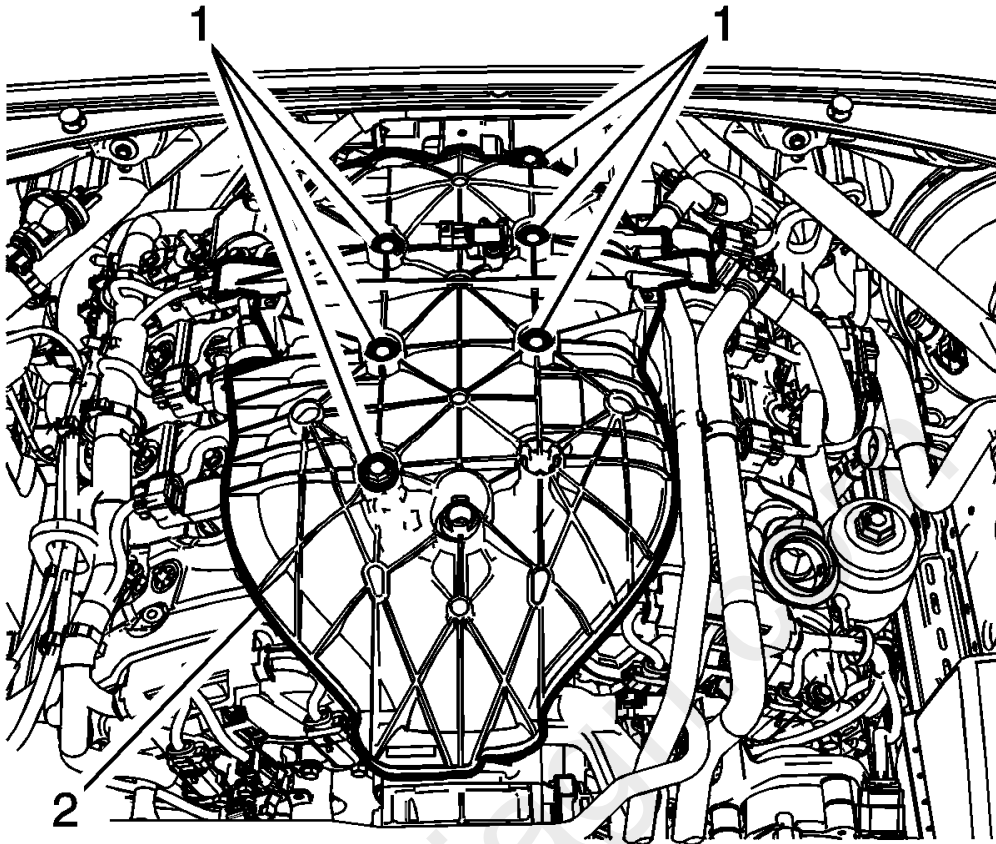


Fig. 95: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

9. Install the intake manifold (2). Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LFX)** , **Fuel Pipe Shield Replacement (LF3)** .
11. Install the left diagonal brace. Refer to **Front End Sheet Metal Diagonal Brace Replacement - Left Side** .

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

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

Removal Procedure

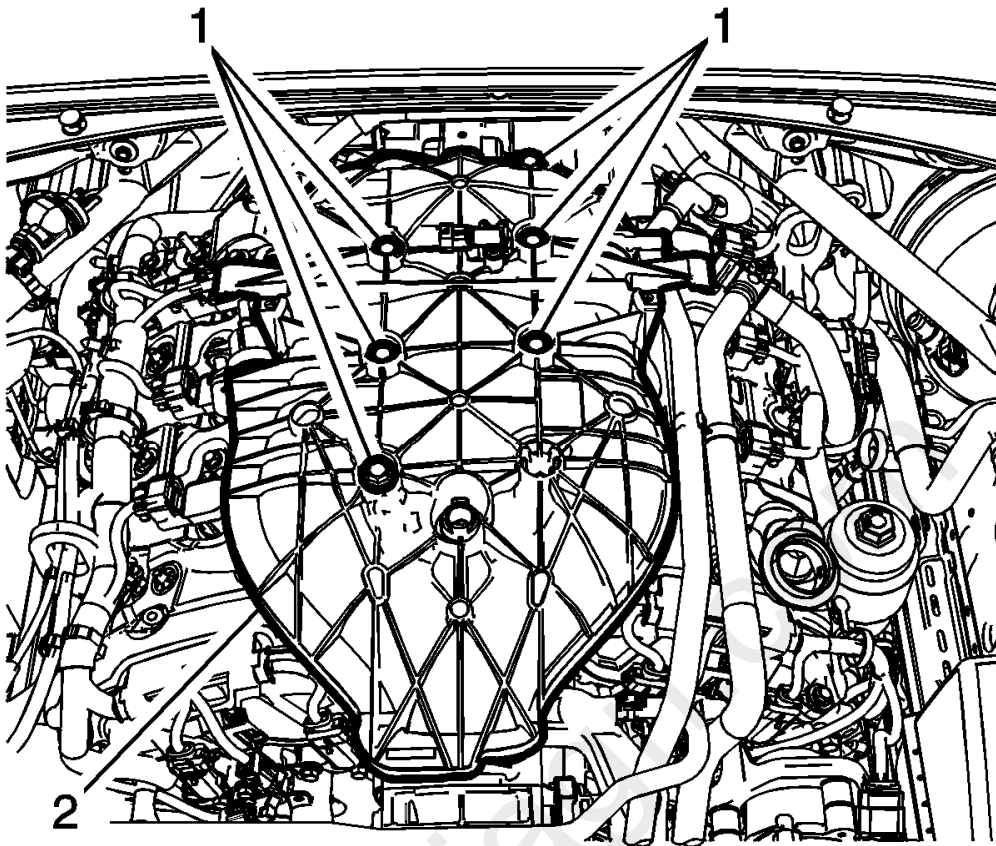


Fig. 96: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold (2). Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.

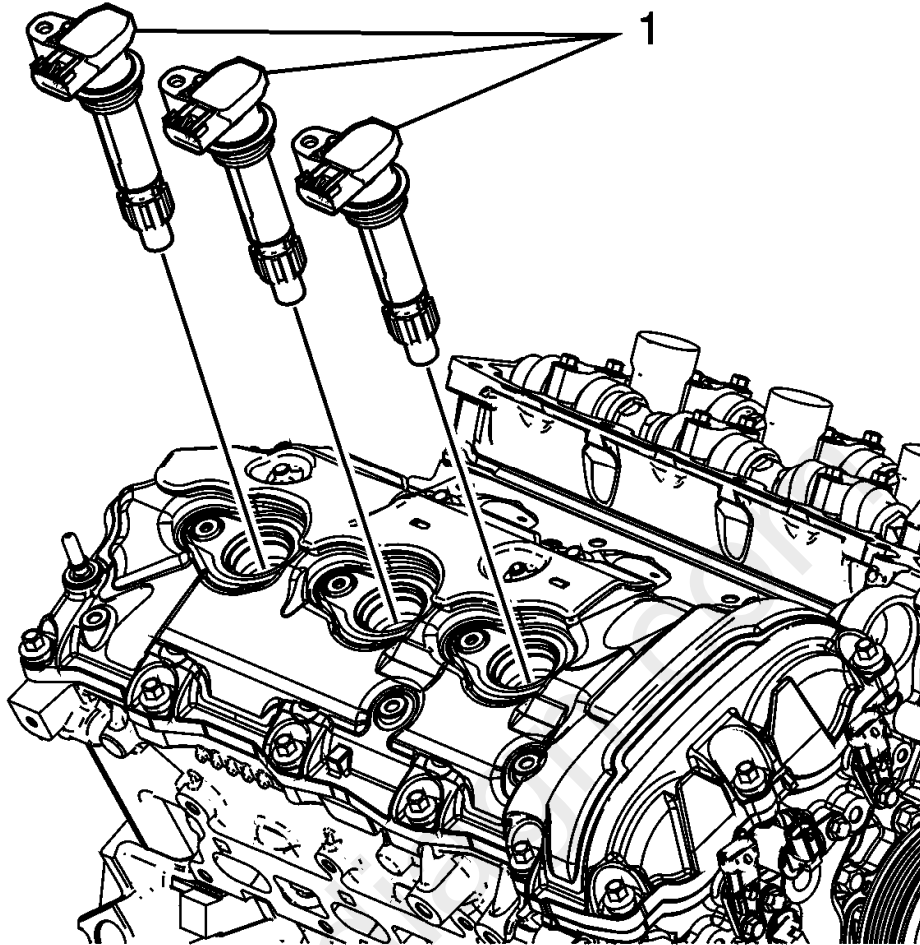


Fig. 97: View Of Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils. Refer to **Ignition Coil Replacement - Bank 1 (LFX)** , **Ignition Coil Replacement - Bank 1 (LF3)**
3. Remove the plenum front panel. Refer to **Plenum Front Panel Replacement** .
4. Remove the right diagonal brace. Refer to **Front End Sheet Metal Diagonal Brace Replacement - Right Side** .
5. Disconnect and remove the engine harness from the camshaft cover.

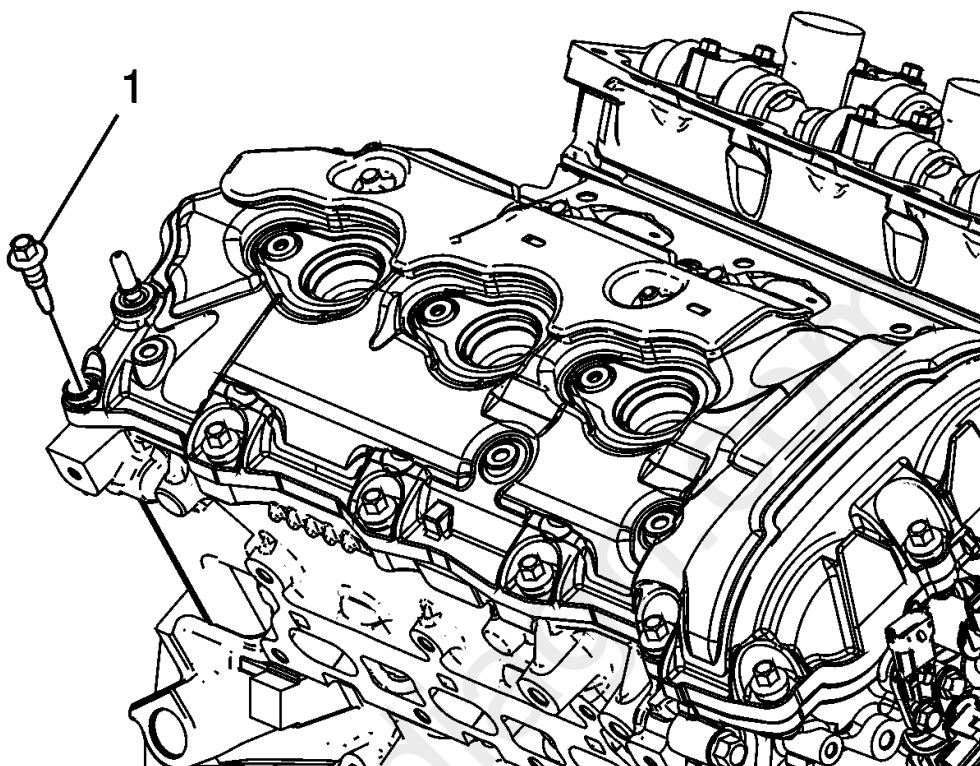


Fig. 98: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the right camshaft cover bolts.

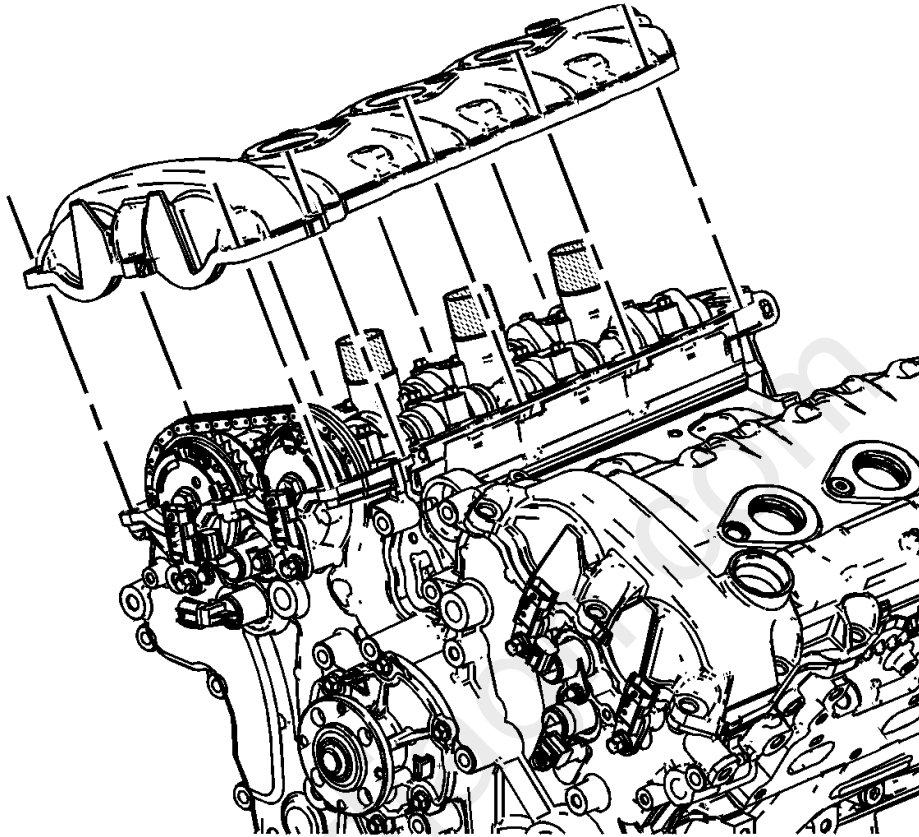


Fig. 99: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

7. Remove the right camshaft cover from the right cylinder head.
8. Install the **EN-46101** guide onto the spark plug tubes of the right cylinder head.
9. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LF3)** , **Camshaft Cover Cleaning and Inspection (LFX)**

Installation Procedure

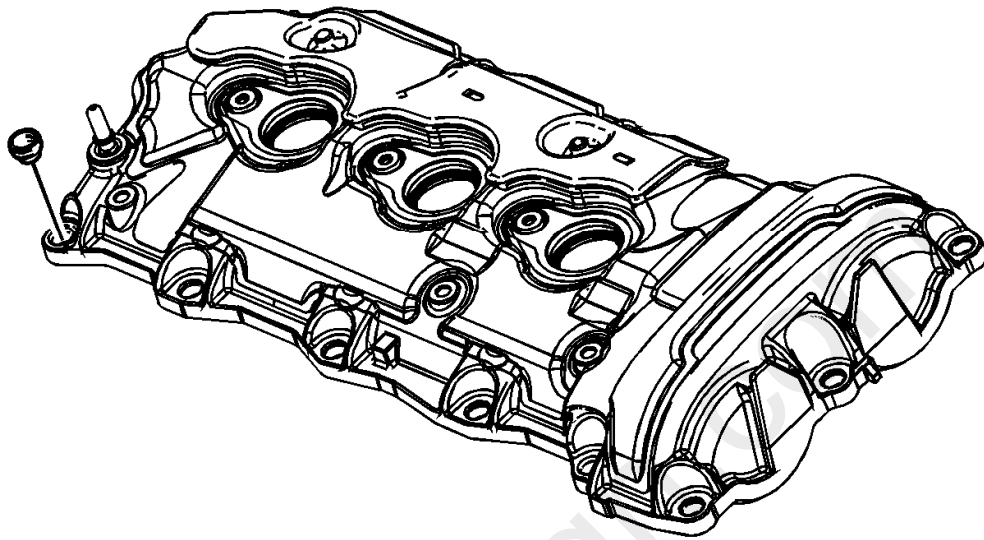


Fig. 100: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

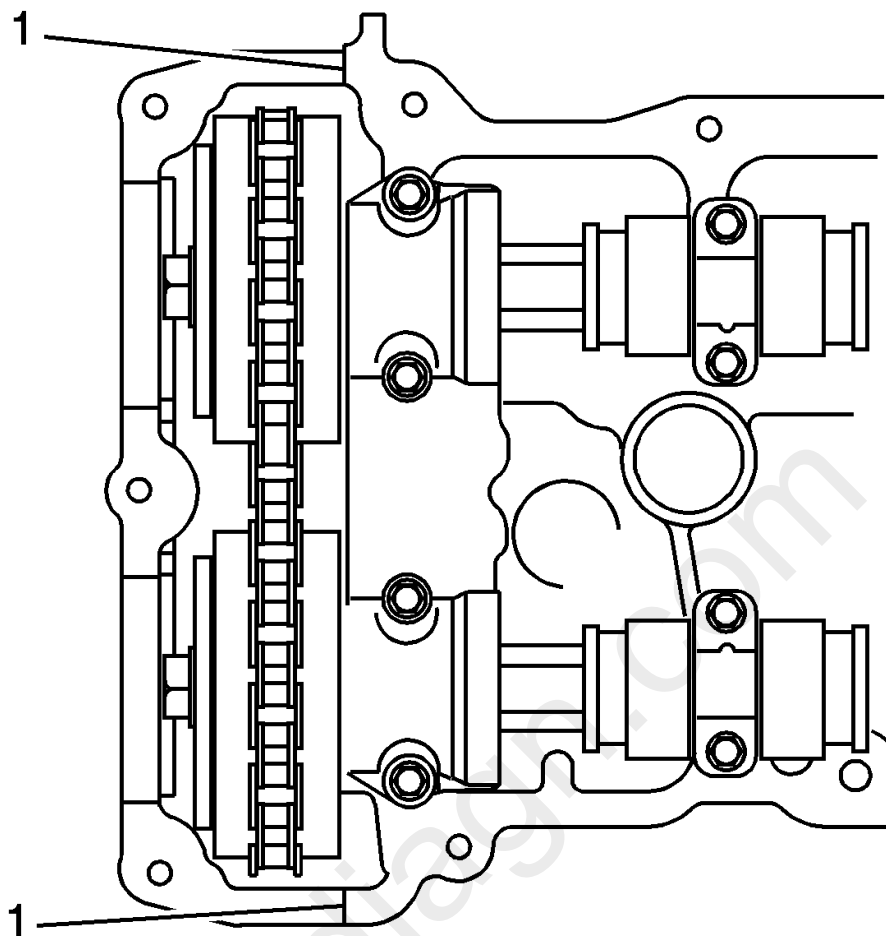


Fig. 101: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1).

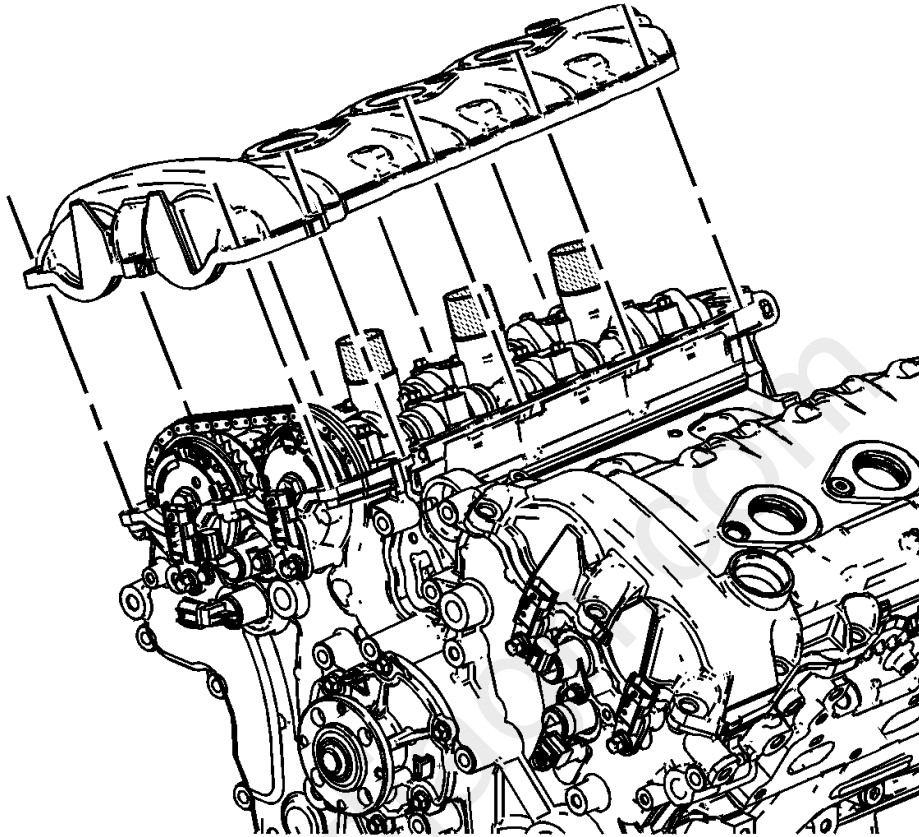


Fig. 102: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Place the right camshaft cover into position onto the right cylinder head.

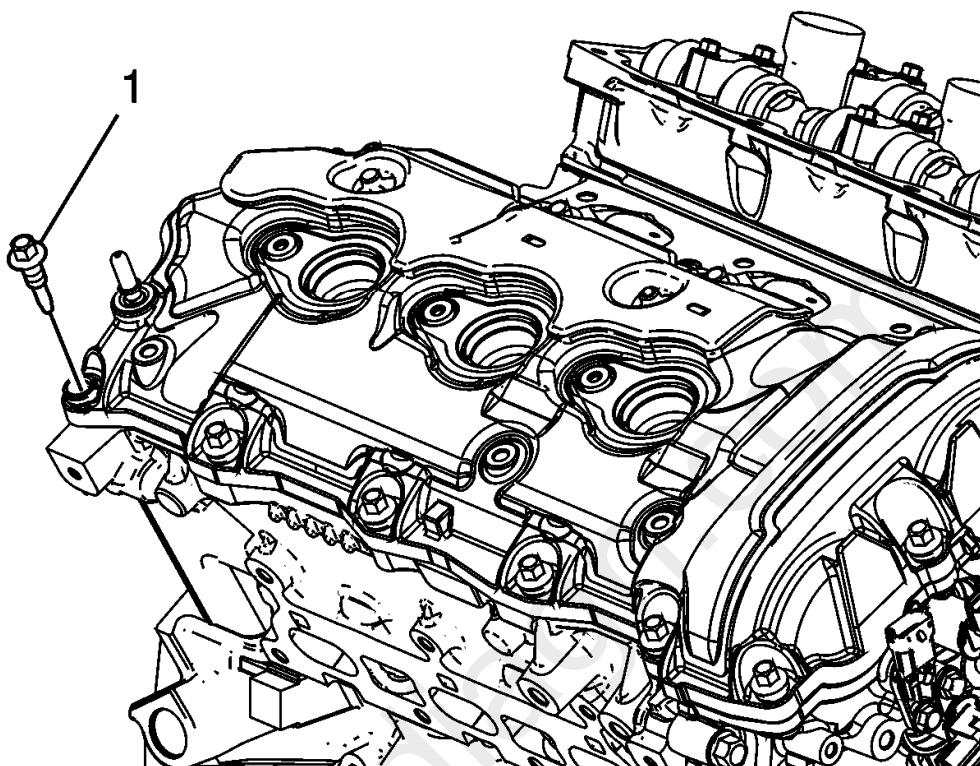


Fig. 103: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

4. Loosely install the right camshaft cover bolts.

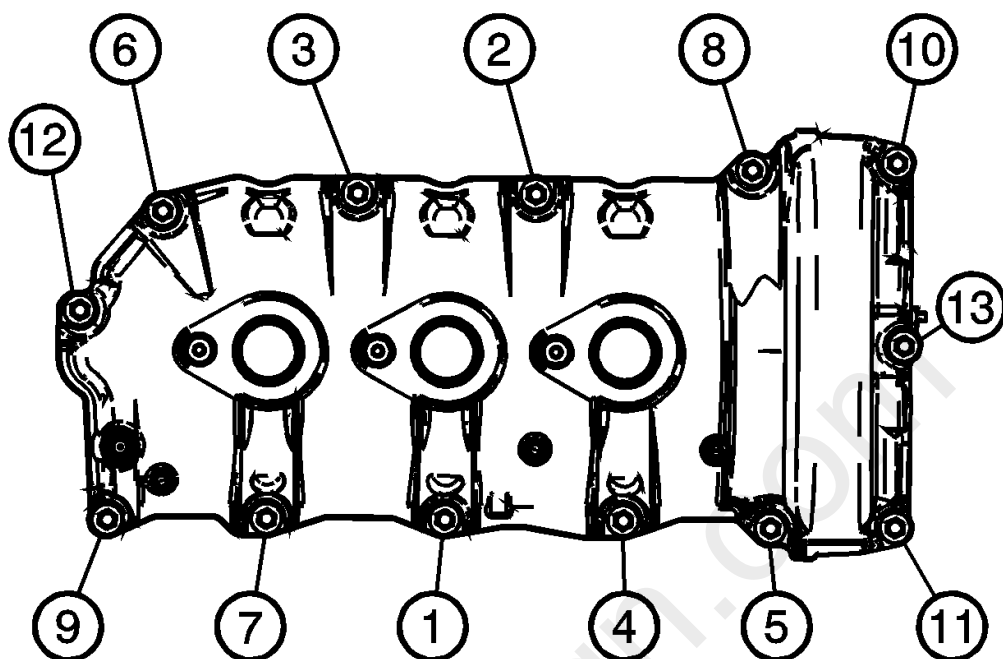


Fig. 104: Tightening Sequence for Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the right camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).

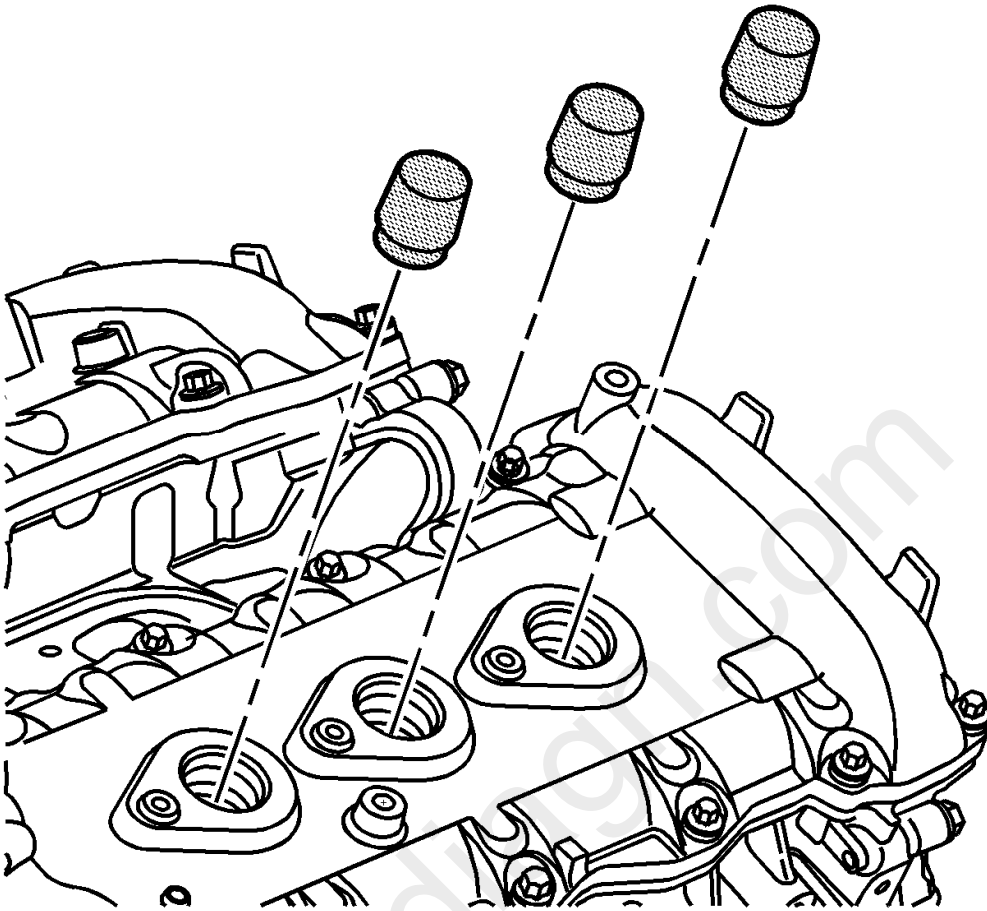


Fig. 105: Identifying Special Tool - EN 46101
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-46101** guide from the spark plug tubes of the right cylinder head.
7. Connect and install the engine harness to the camshaft cover.
8. Install the right diagonal brace. Refer to **Front End Sheet Metal Diagonal Brace Replacement - Right Side** .
9. Install the plenum front panel. Refer to **Plenum Front Panel Replacement** .

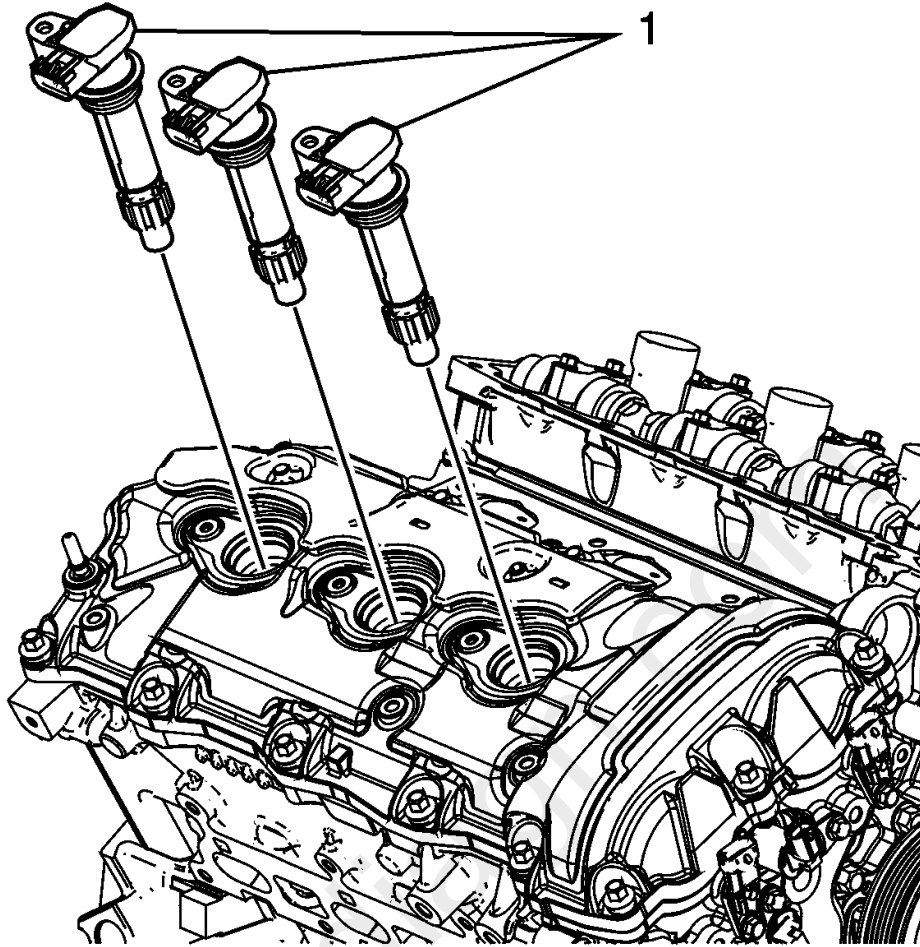


Fig. 106: View Of Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

10. Install the ignition coils. Refer to **Ignition Coil Replacement - Bank 1 (LFX)** , **Ignition Coil Replacement - Bank 1 (LF3)**

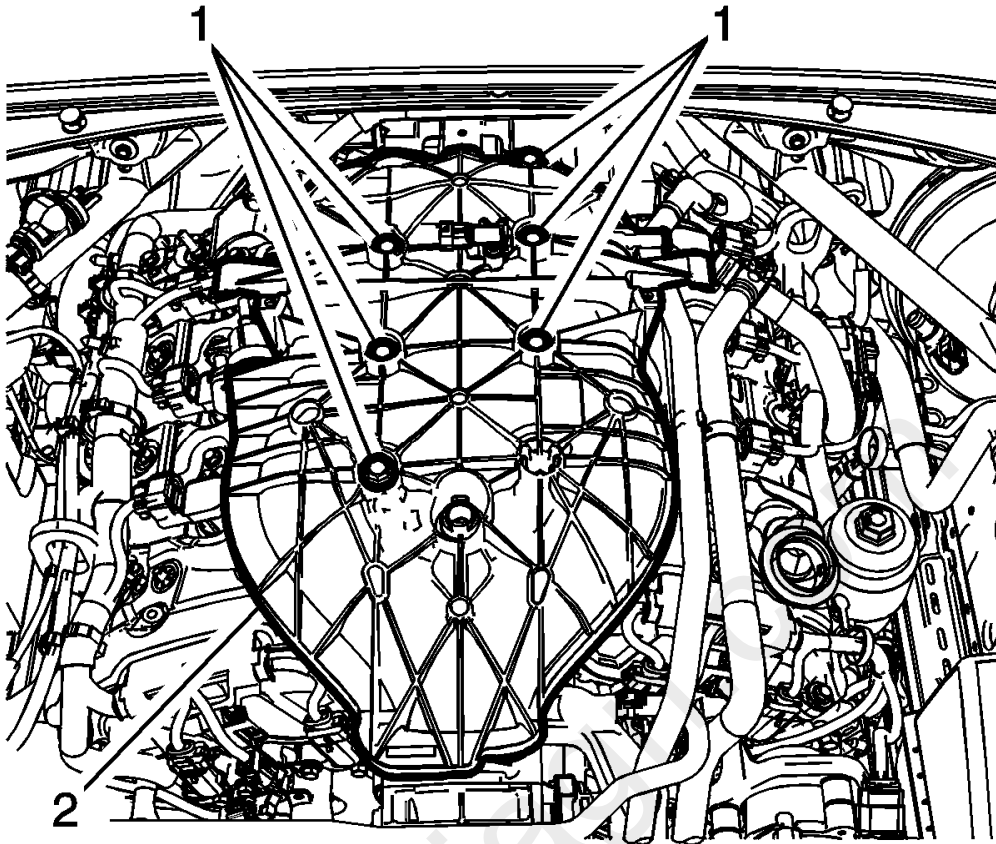


Fig. 107: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

11. Install the intake manifold (2). Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.

ENGINE FRONT COVER REPLACEMENT

Special Tools

EN-46109 Engine Front Cover Installation Guide Pins

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

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFX)** , **Air Cleaner Assembly Replacement (LF3)** .
2. Remove the water pump pulley. Refer to **Water Pump Replacement (LFX, LF3)** , **Water Pump**

Replacement (LTG) .

3. Remove the intake manifold. Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.
4. If equipped, remove the secondary air injection pump. Refer to **Secondary Air Injection Pump Replacement** .
5. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.
6. Drain the engine coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .
7. Remove the water outlet with the radiator hose and reposition aside. Refer to **Water Outlet Replacement (LFX)** , **Water Outlet Replacement (LF3)** , **Water Outlet Replacement (LTG)** .
8. Remove the generator and drive belt tensioner bracket . Refer to **Generator and Drive Belt Tensioner Bracket Replacement**
9. Remove the air conditioner compressor bracket . Refer to **Air Conditioning Compressor Bracket Replacement (LFX)** , **Air Conditioning Compressor Bracket Replacement (LF3)** .
10. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

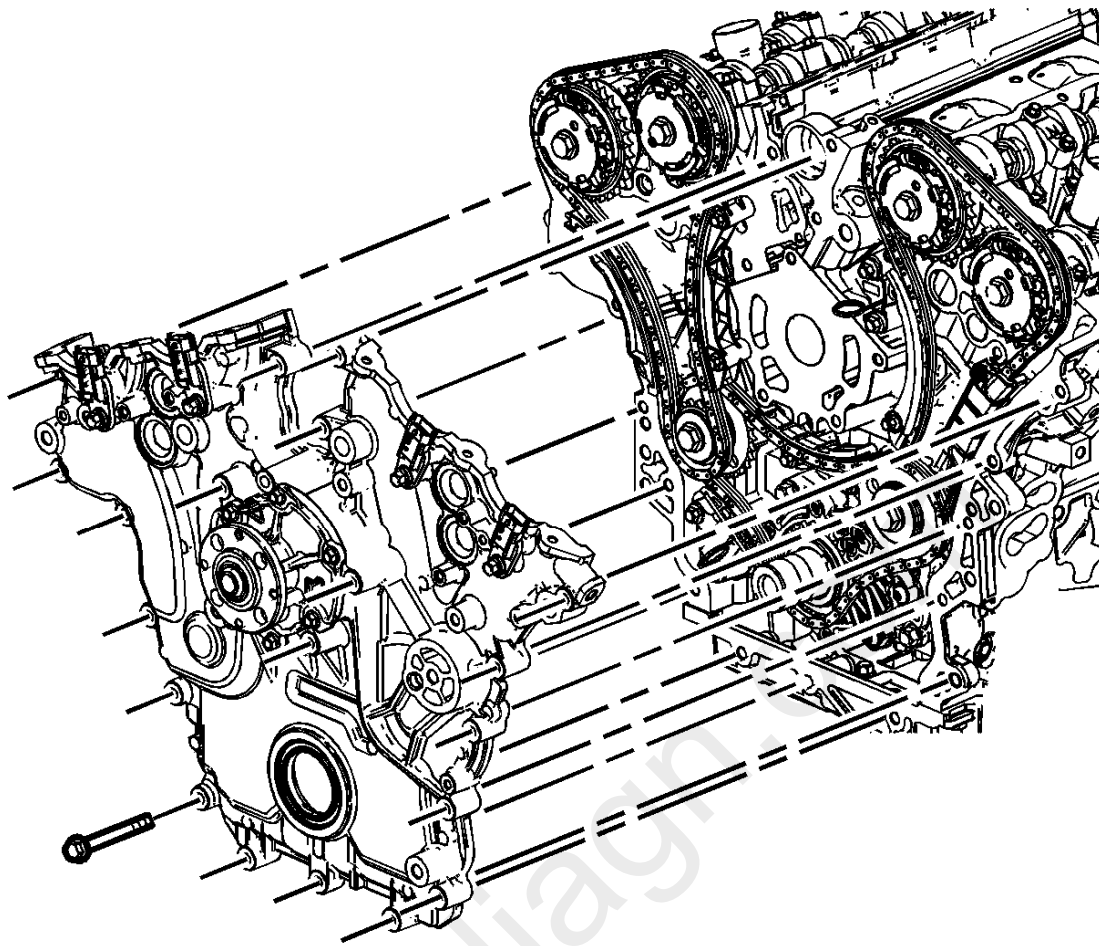


Fig. 108: Engine Front Cover

Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

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

Inspection .

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

Installation Procedure

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

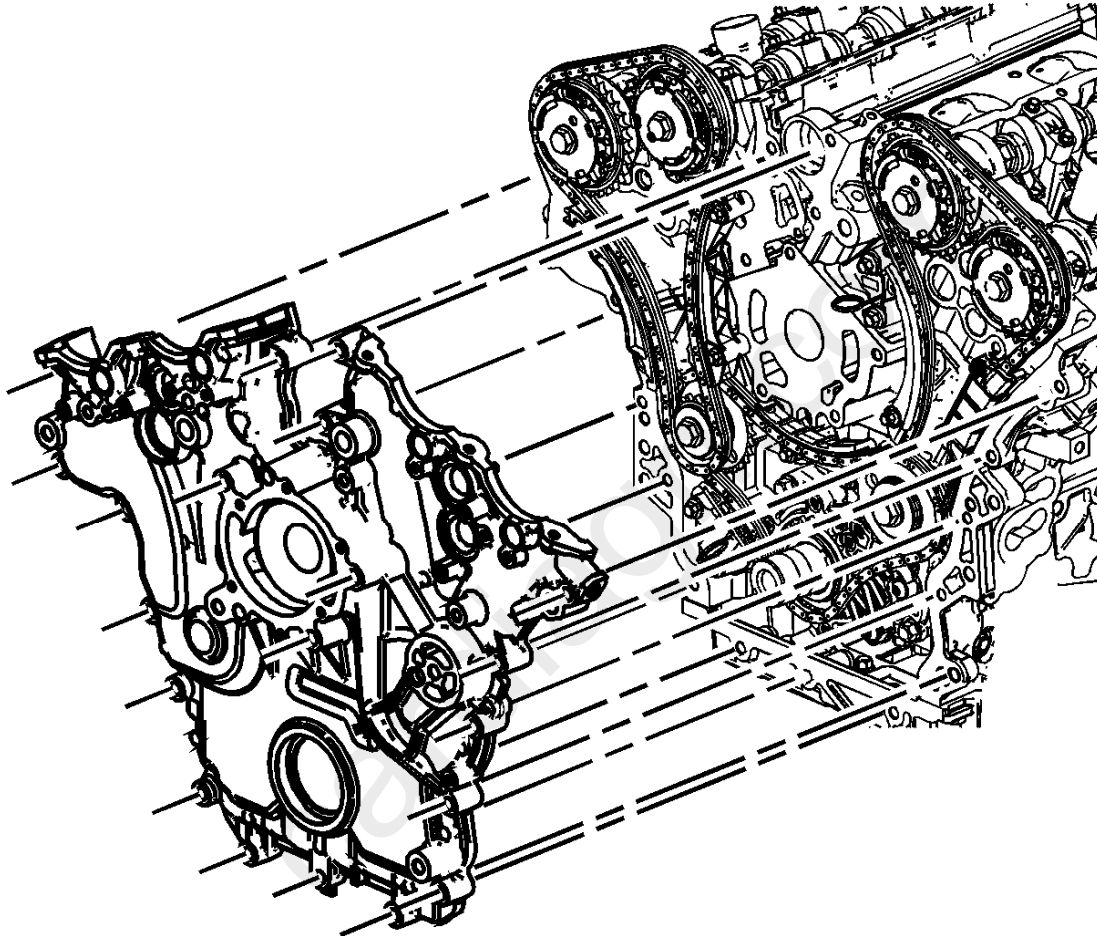


Fig. 109: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

2. Use the EN-46109 pins in order to install the engine front cover. Refer to **Engine Front Cover Installation .**
3. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement.**
4. Install the water outlet with radiator hose. Refer to **Water Outlet Replacement (LFX) , Water Outlet Replacement (LF3) , Water Outlet Replacement (LTG) .**

5. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.
6. Install the air conditioner compressor bracket . Refer to **Air Conditioning Compressor Bracket Replacement (LFX)** , **Air Conditioning Compressor Bracket Replacement (LF3)** .
7. Install the generator and drive belt tensioner bracket . Refer to **Generator and Drive Belt Tensioner Bracket Replacement**
8. If equipped, install the secondary air injection pump. Refer to **Secondary Air Injection Pump Replacement** .
9. Install the intake manifold. Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.
10. Install the water pump pulley. Refer to **Water Pump Replacement (LFX, LF3)** , **Water Pump Replacement (LTG)** .
11. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFX)** , **Air Cleaner Assembly Replacement (LF3)** .
12. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain components. Refer to Camshaft Timing Chain Components Installation .
2. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

Removal Procedure

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

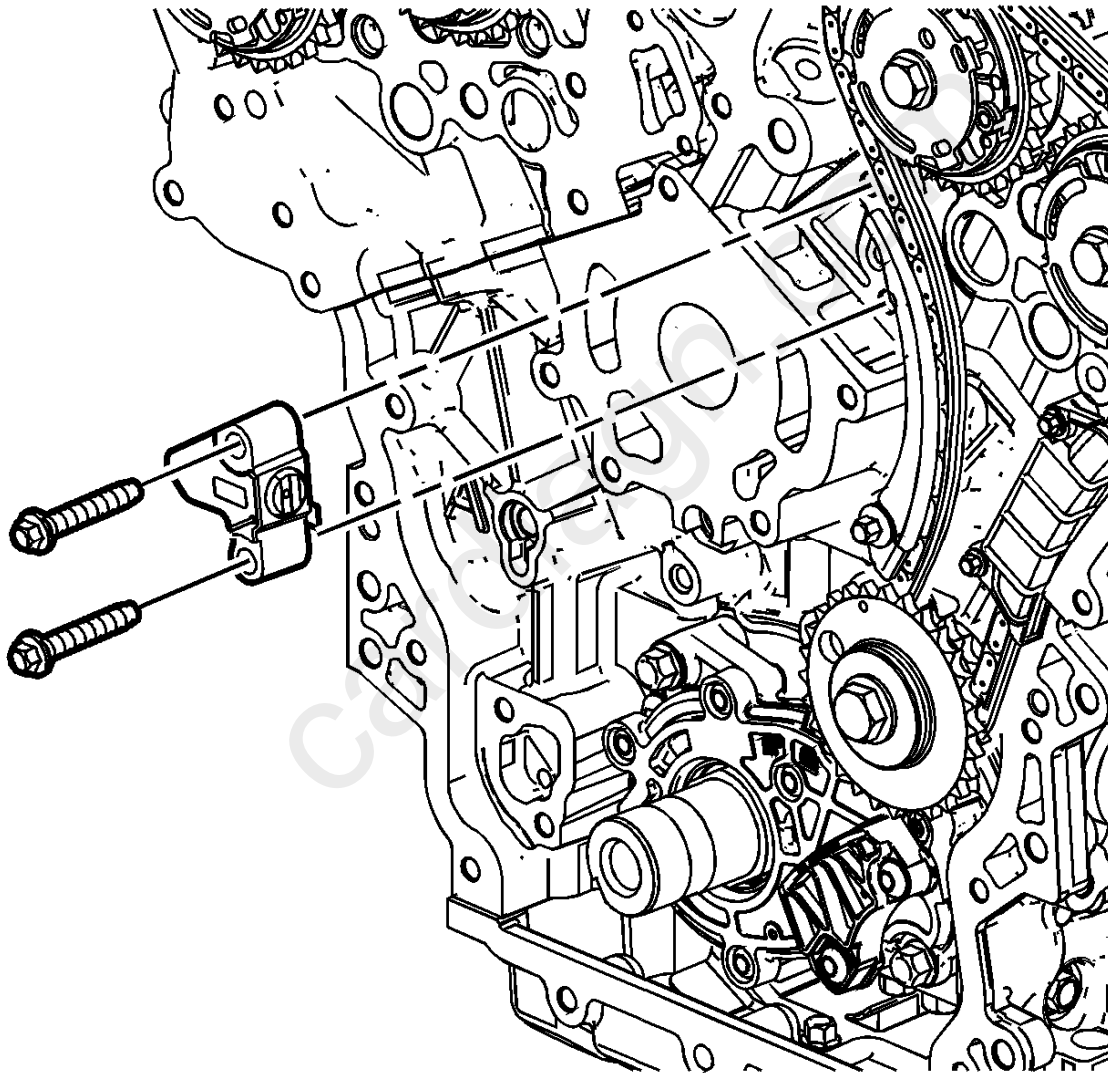


Fig. 110: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to Secondary Timing Chain Tensioner Removal - Left Side .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive

Components Cleaning and Inspection .

Installation Procedure

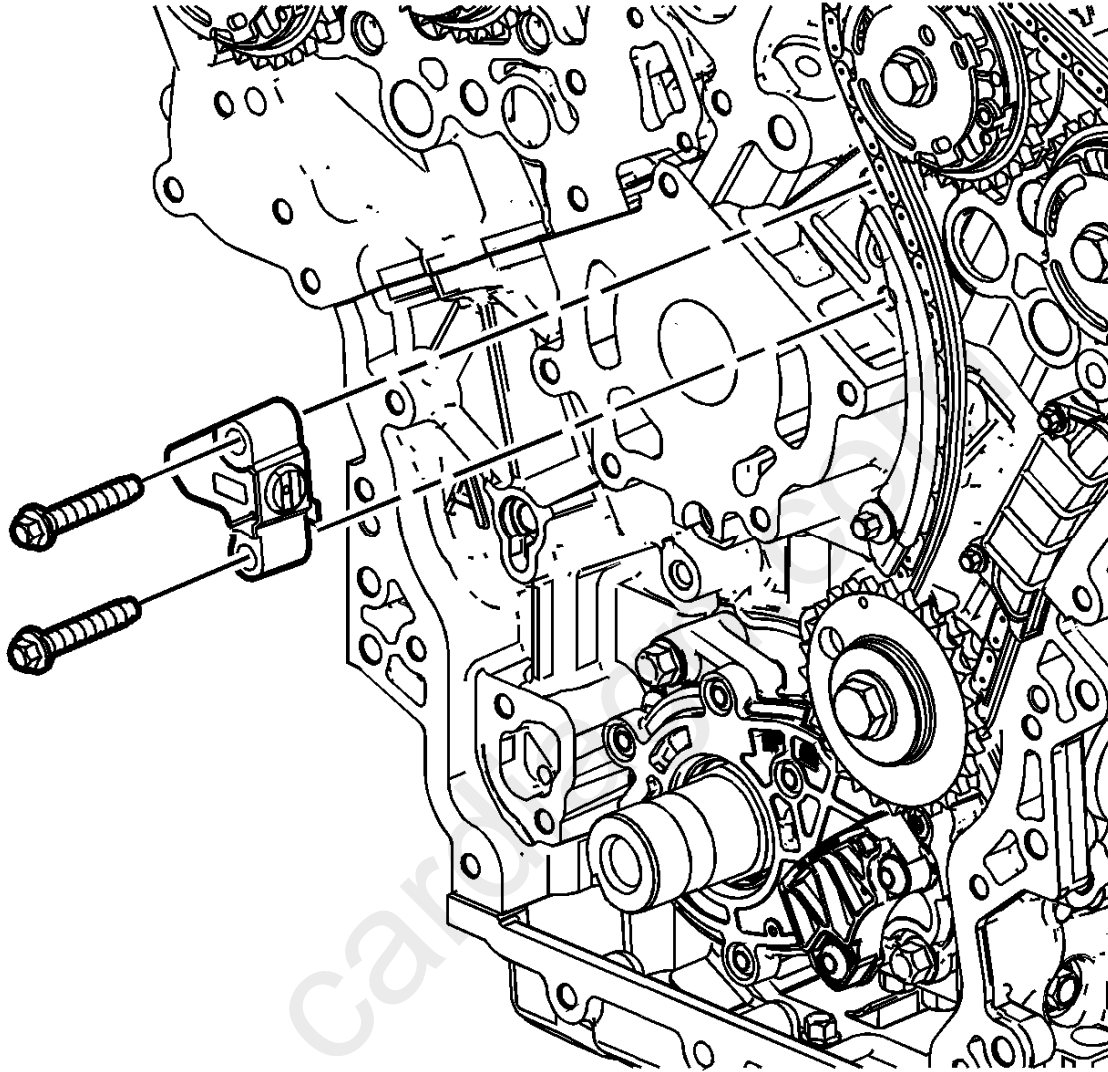


Fig. 111: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

Removal Procedure

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

2. Remove the right side secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

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

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

Removal Procedure

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

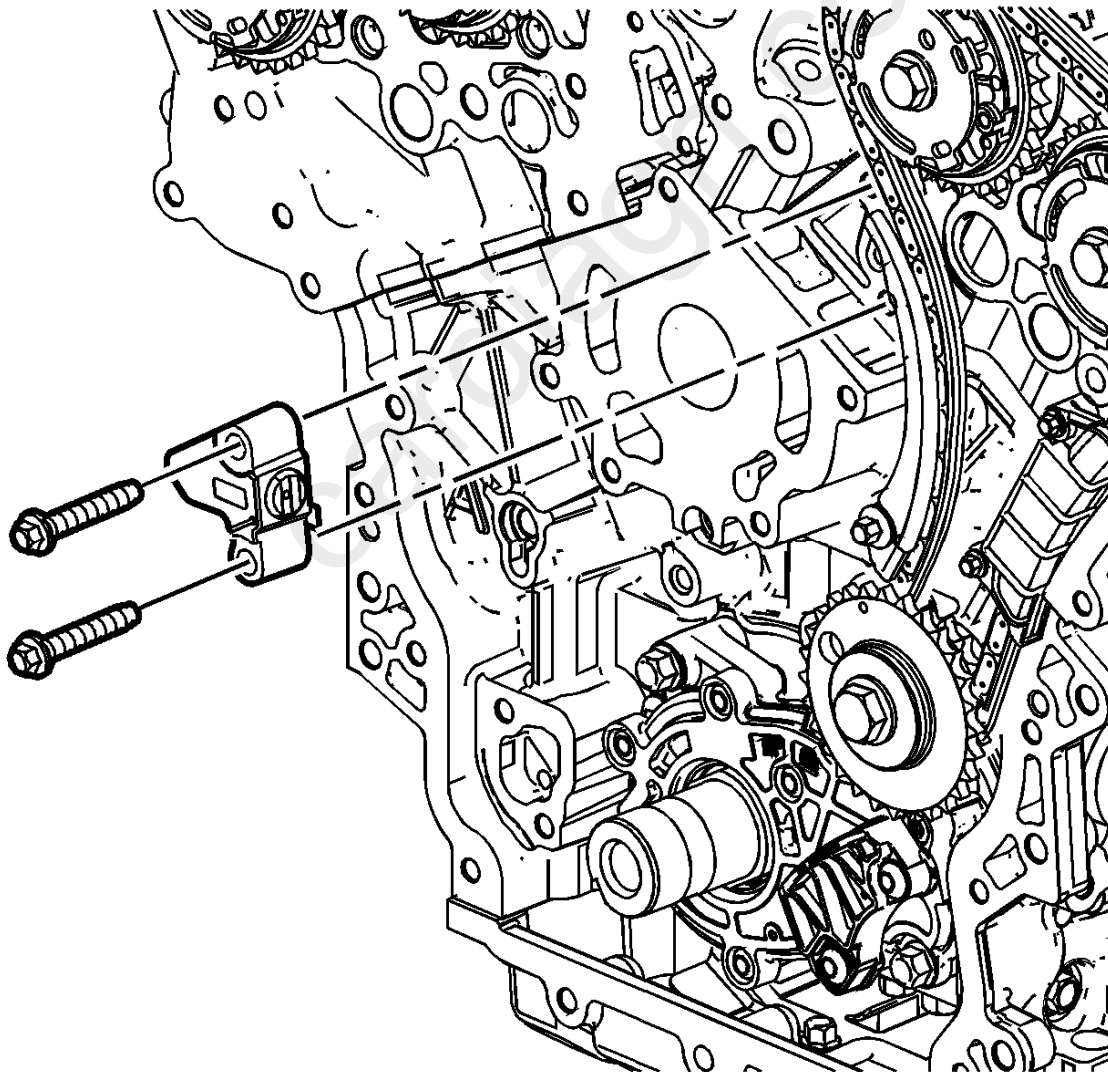


Fig. 112: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

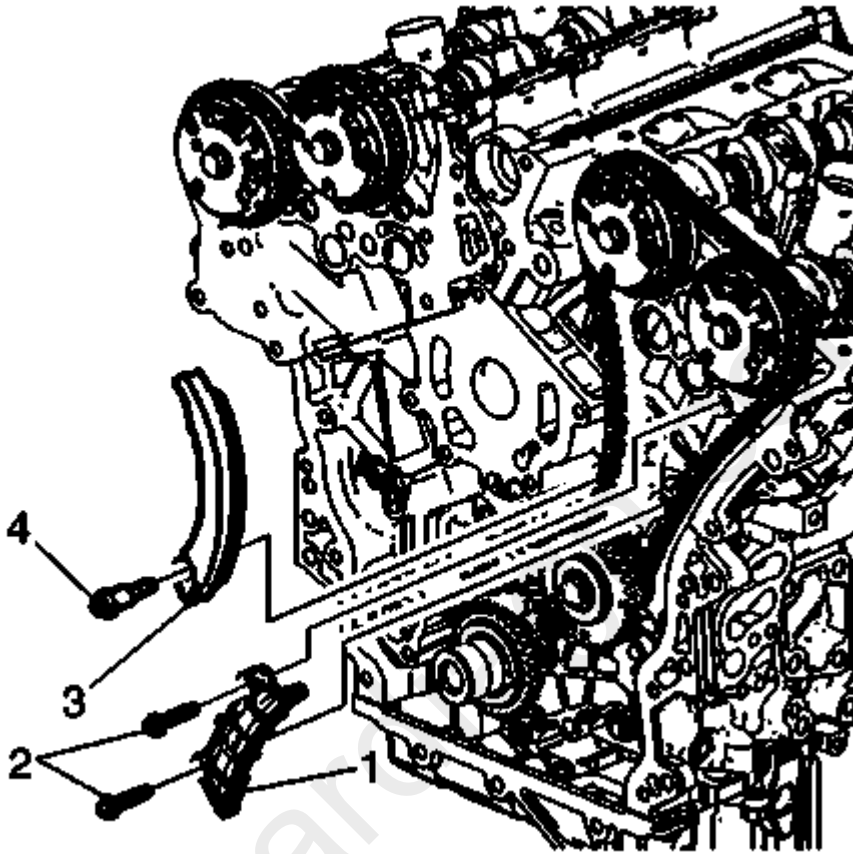


Fig. 113: Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left secondary camshaft drive chain guide bolts (2).
4. Remove the left secondary camshaft drive chain guide (1).
5. Remove the left secondary camshaft drive chain bolt (4) and shoe (3) .

Installation Procedure

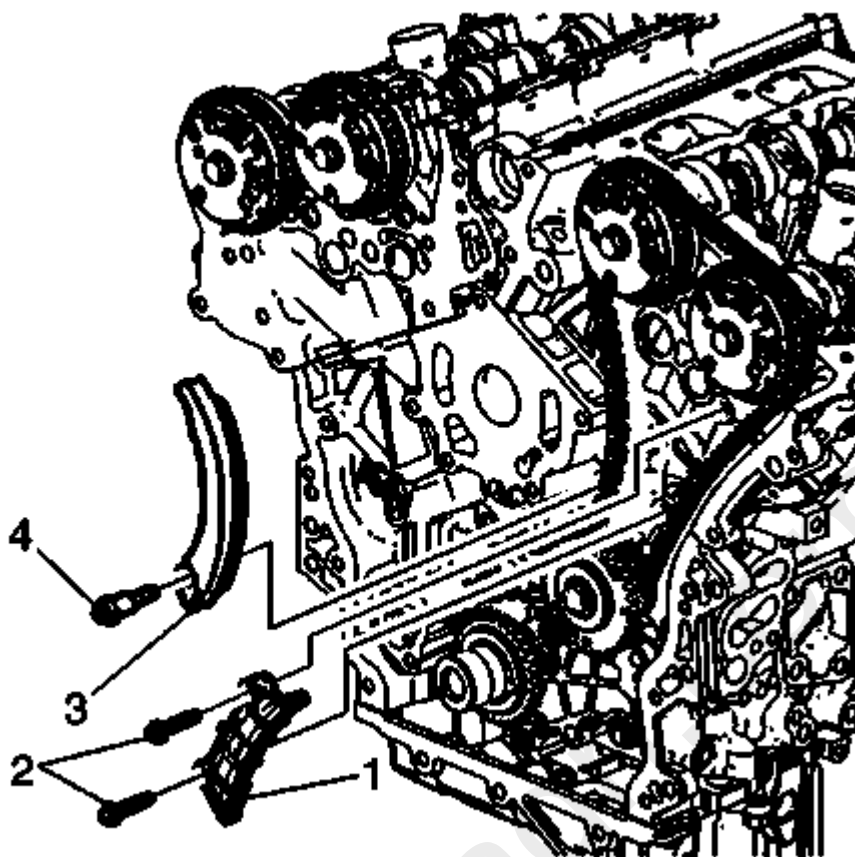


Fig. 114: Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Install the left secondary camshaft drive chain guide shoe (3) and bolt (4), and chain guide (1) and guide bolt (2). Refer to **Camshaft Timing Chain Components Installation** .

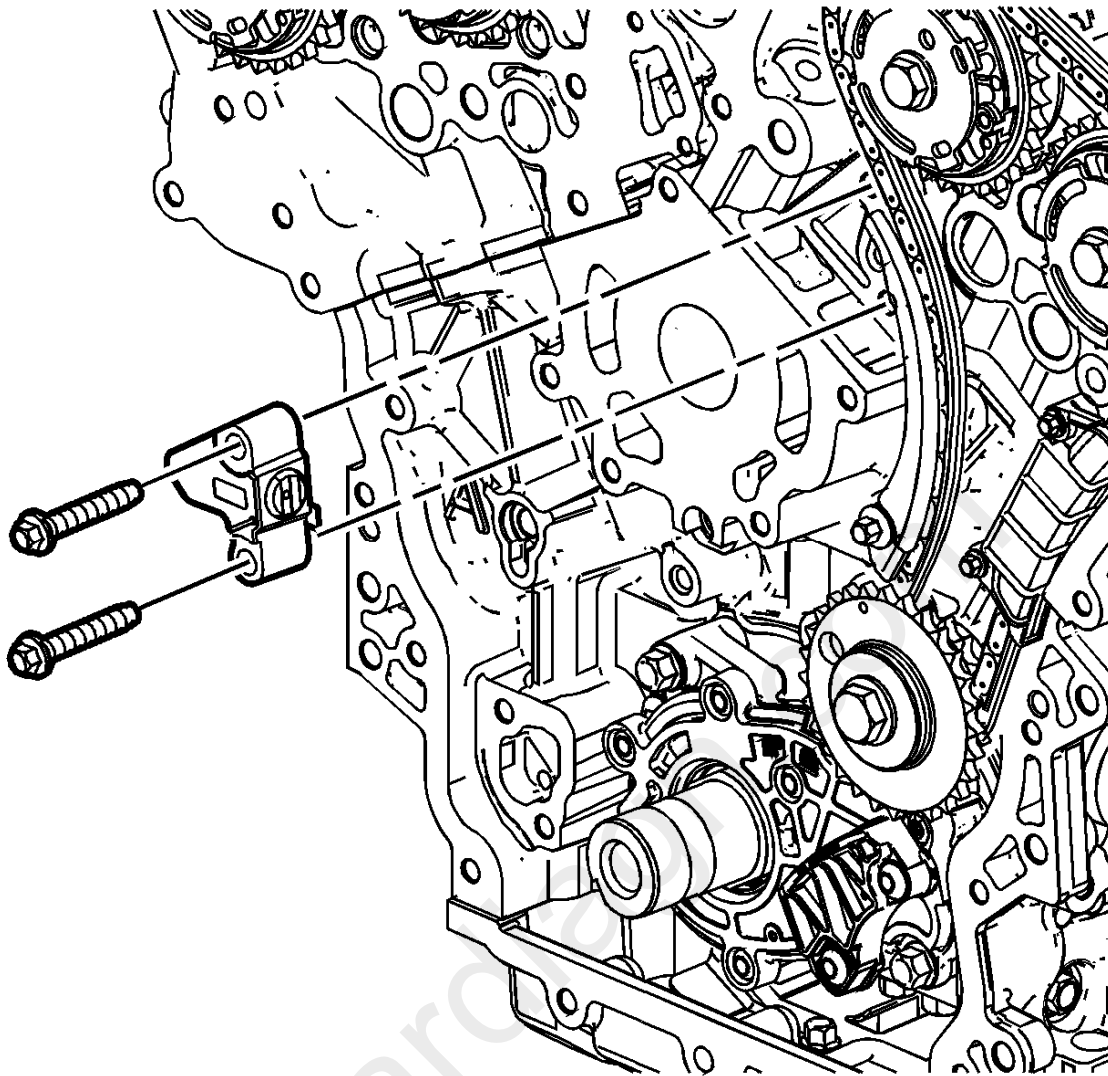


Fig. 115: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Removal Procedure

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

4. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

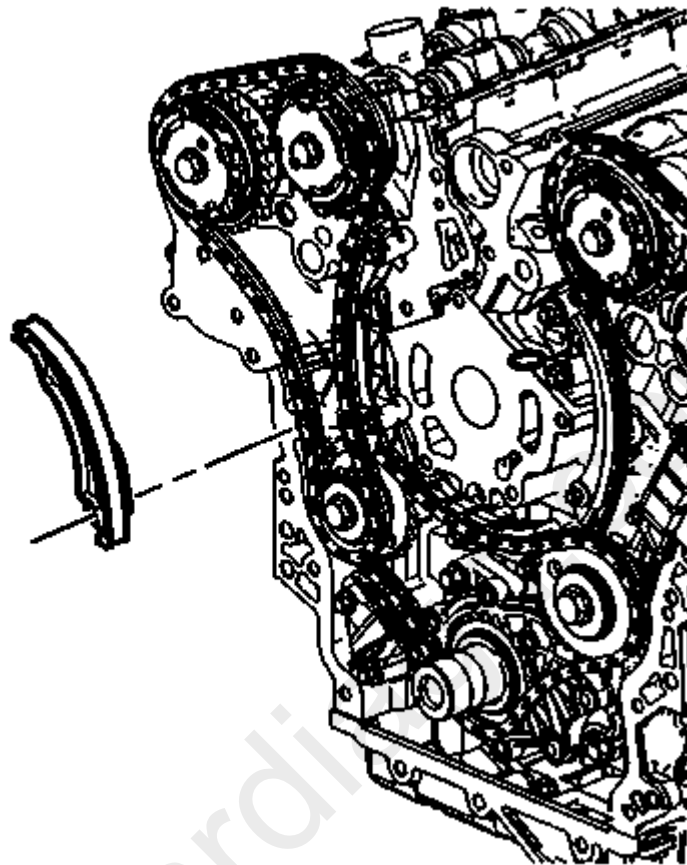


Fig. 116: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

Removal Procedure

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

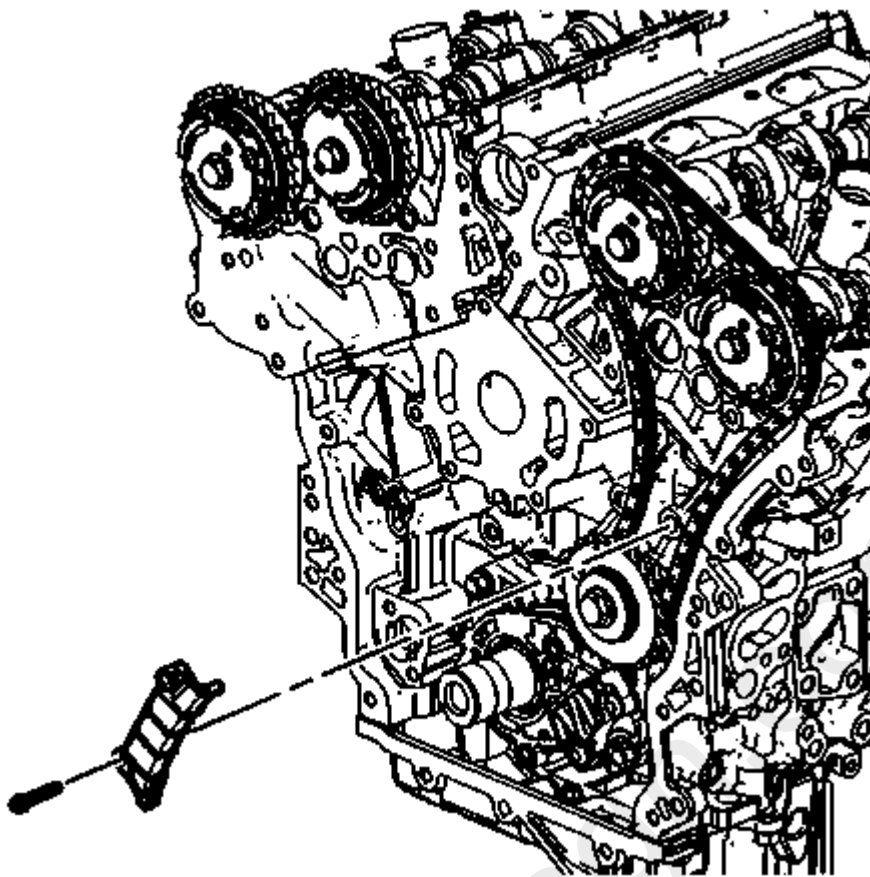


Fig. 117: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

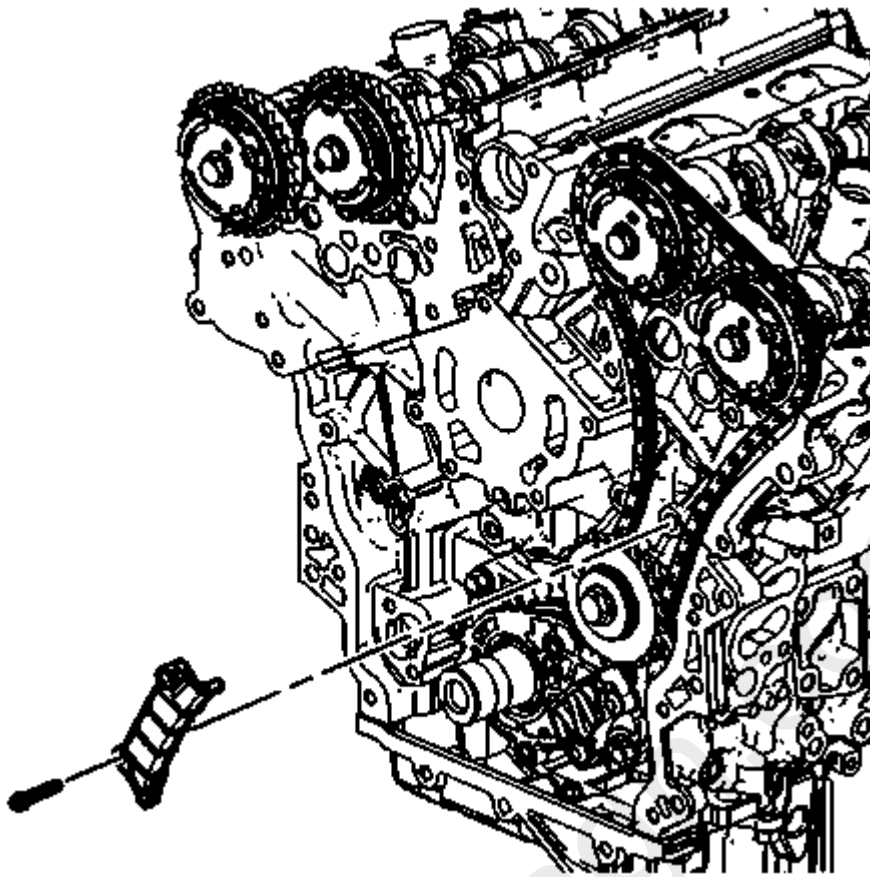


Fig. 118: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

Removal Procedure

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

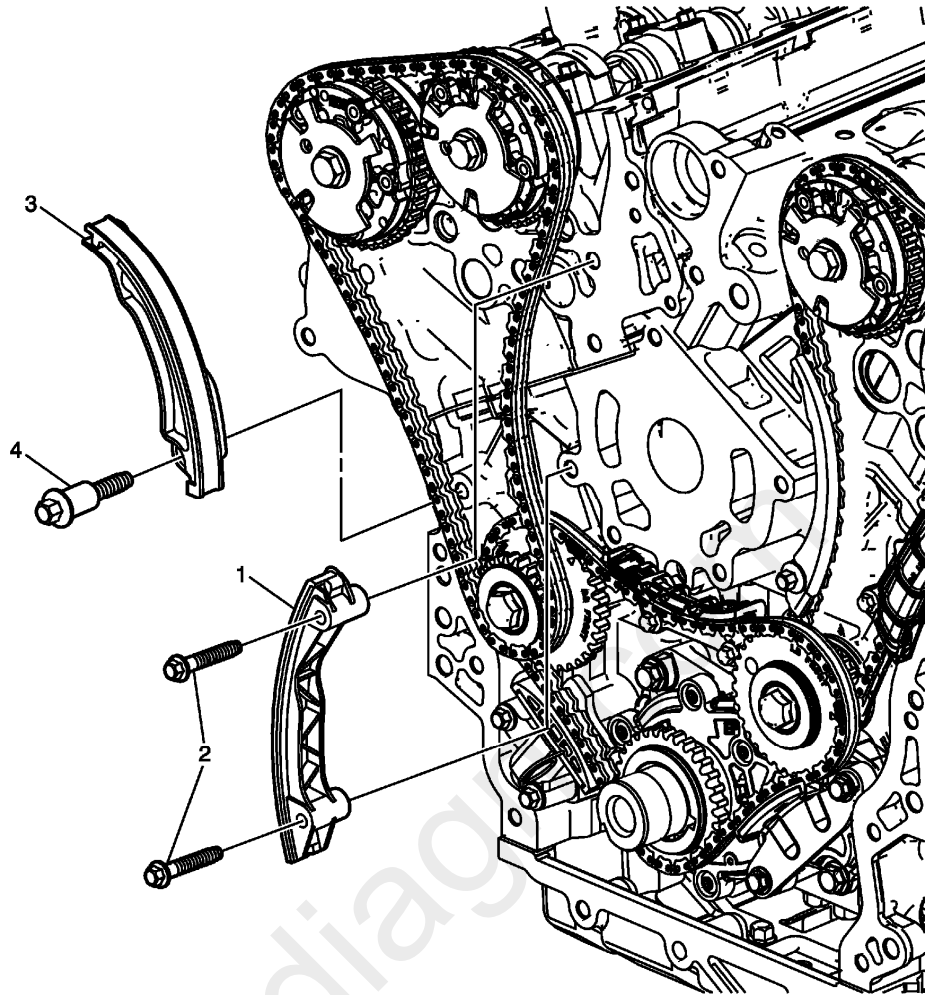


Fig. 119: Secondary Camshaft Drive Chain Guide and Shoe - Right Side
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right side secondary camshaft drive chain shoe (3) and guide (1). Refer to **Camshaft Timing Chain Components Removal** .
4. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

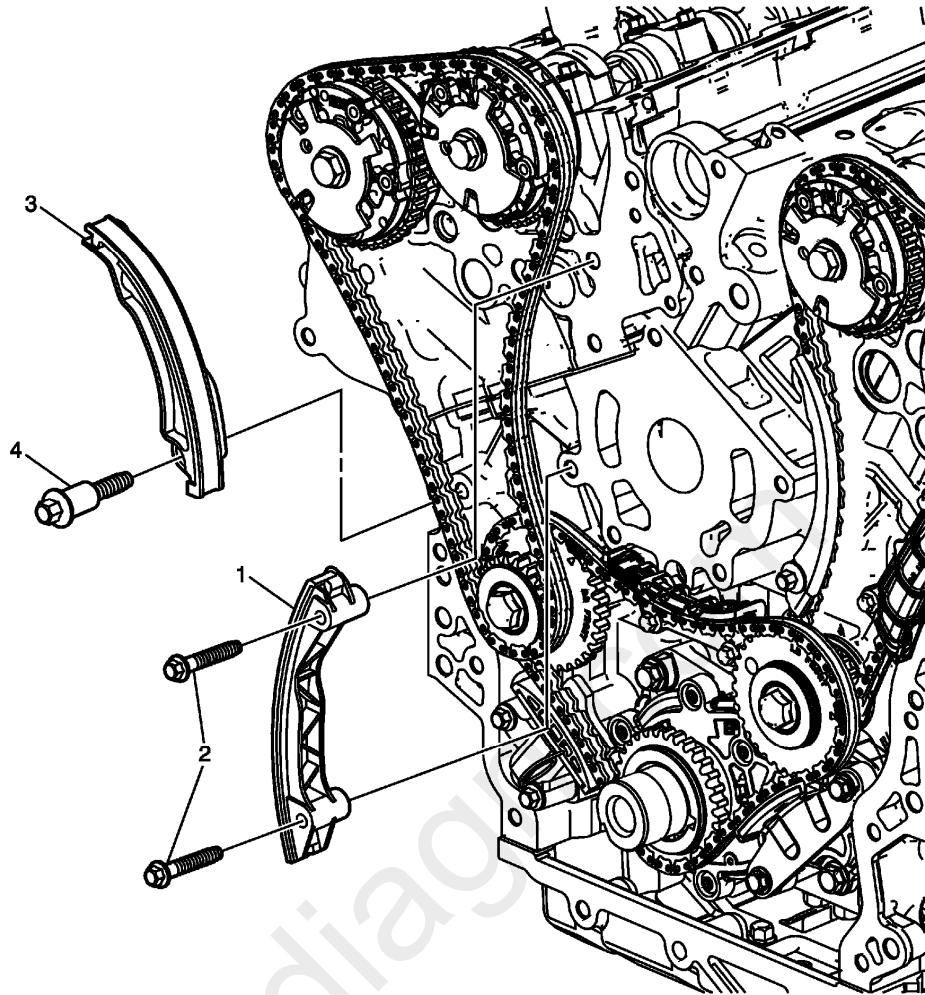


Fig. 120: Secondary Camshaft Drive Chain Guide and Shoe - Right Side
Courtesy of GENERAL MOTORS COMPANY

1. Install the right side secondary camshaft drive chain shoe (3) and guide (1). Refer to **Camshaft Timing Chain Components Installation** .
2. Install the right side secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Removal**.
3. Remove the primary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Removal**.
4. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection**.

Installation Procedure

1. Install the primary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Installation**.
2. Install the right side secondary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Installation**.
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal**.

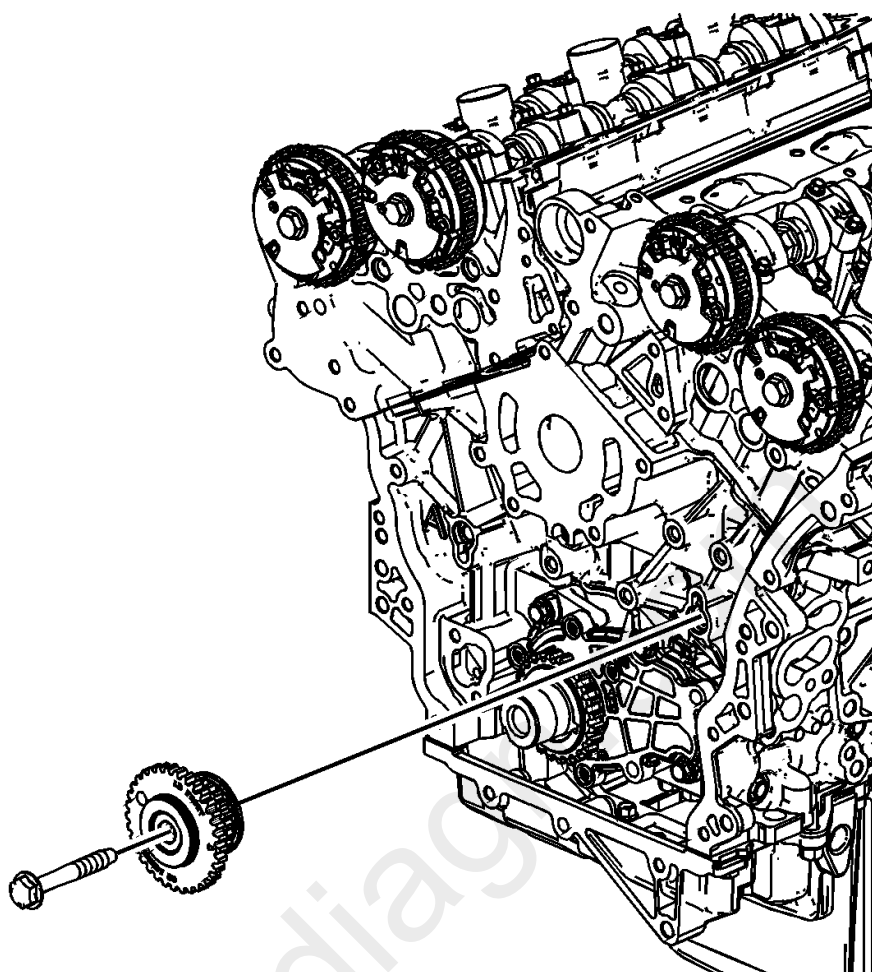


Fig. 121: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

Installation Procedure

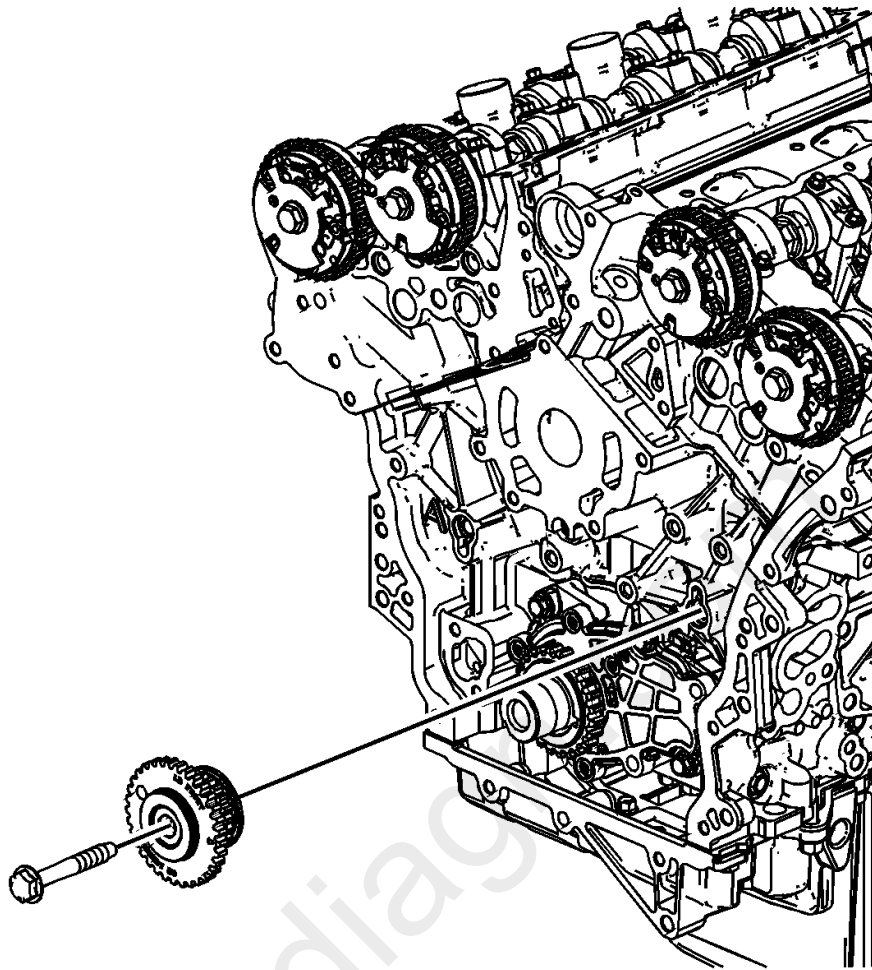


Fig. 122: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal** .

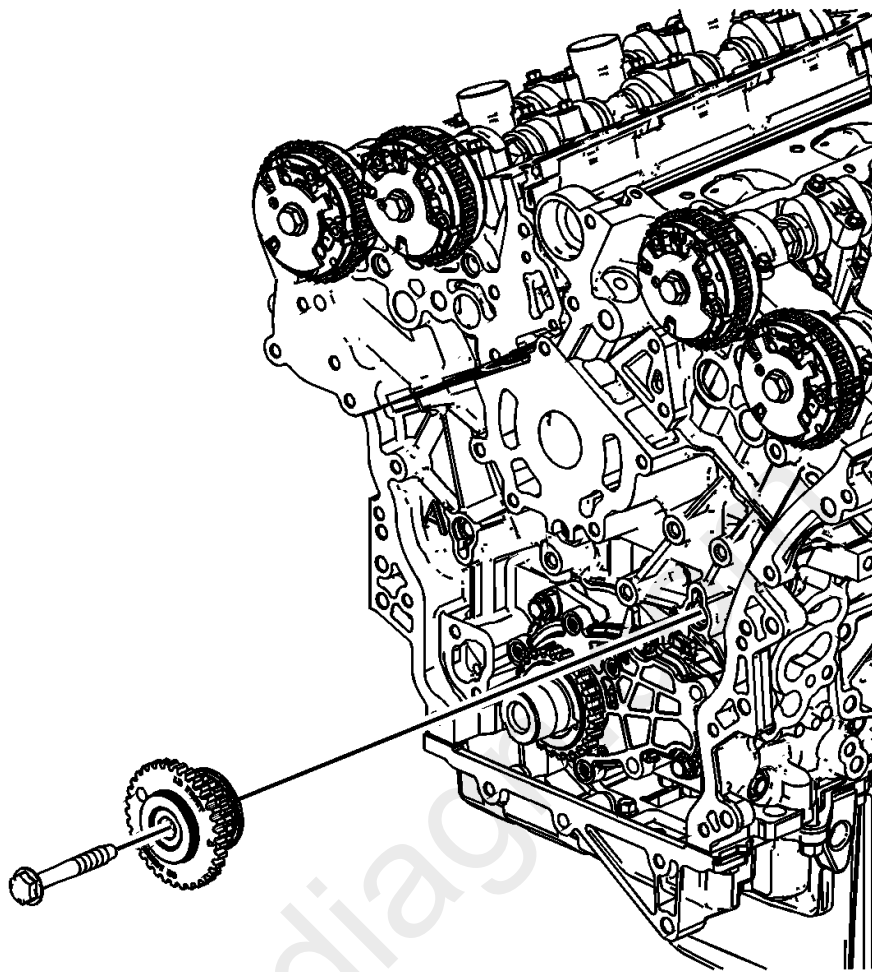


Fig. 123: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

Installation Procedure

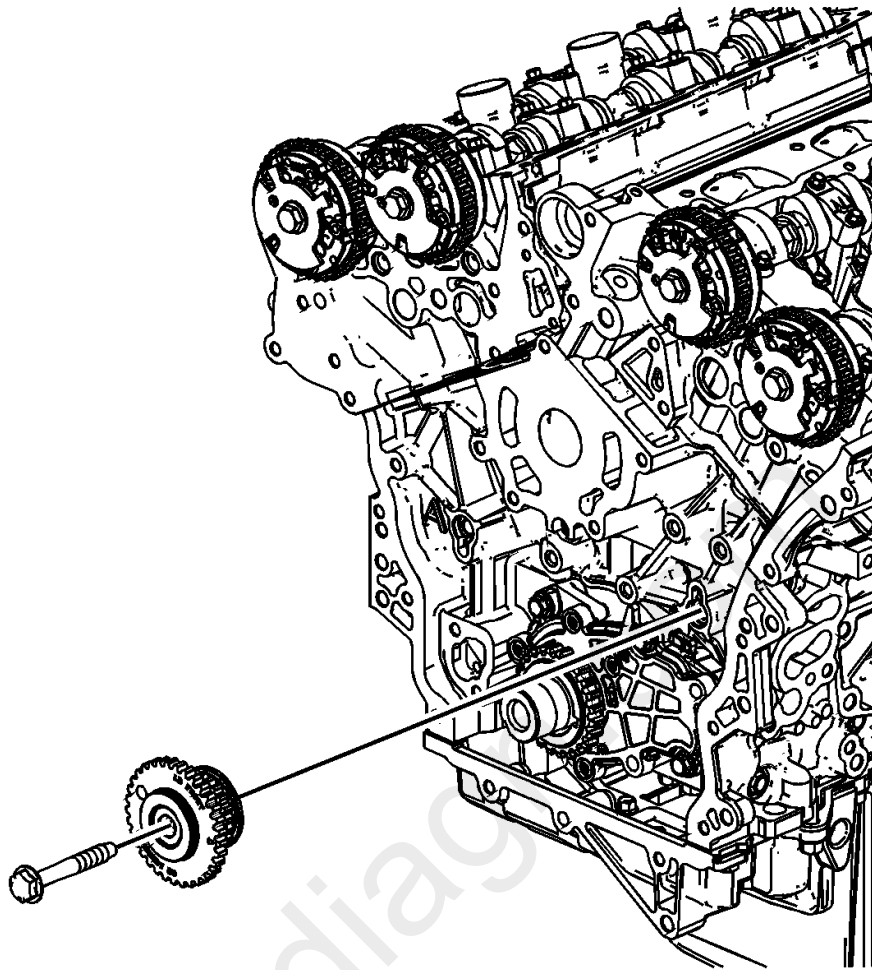


Fig. 124: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

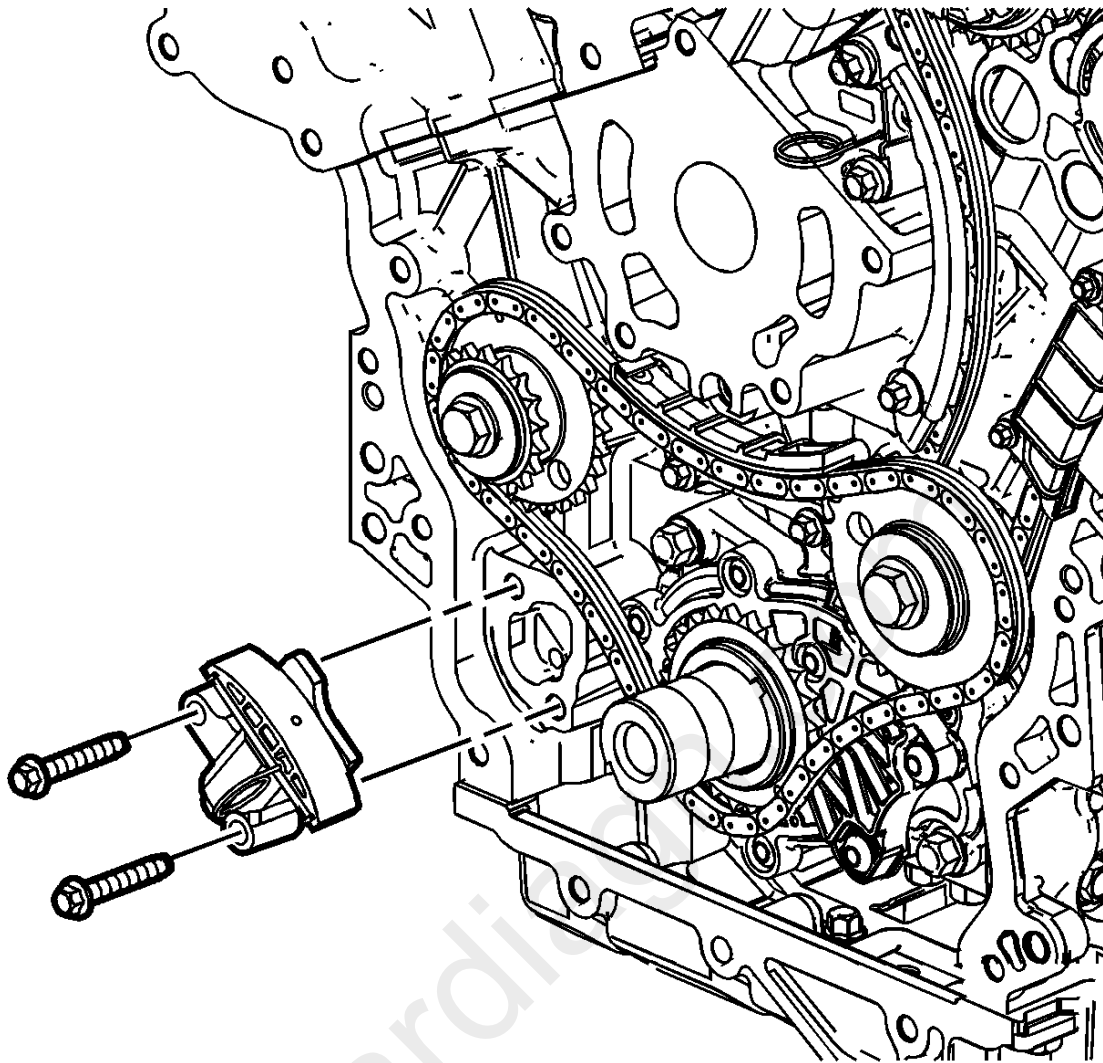


Fig. 125: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Installation Procedure

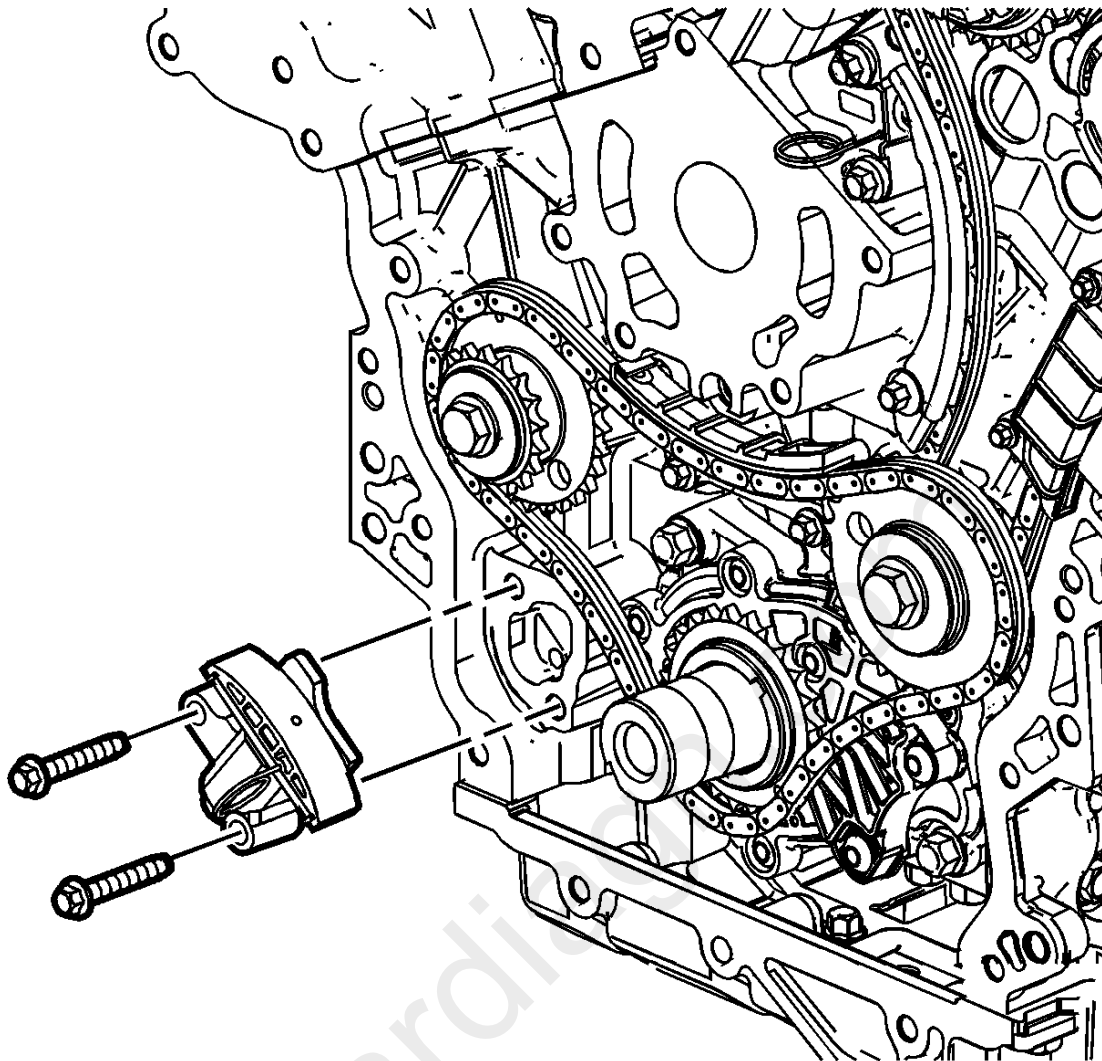


Fig. 126: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

Removal Procedure

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

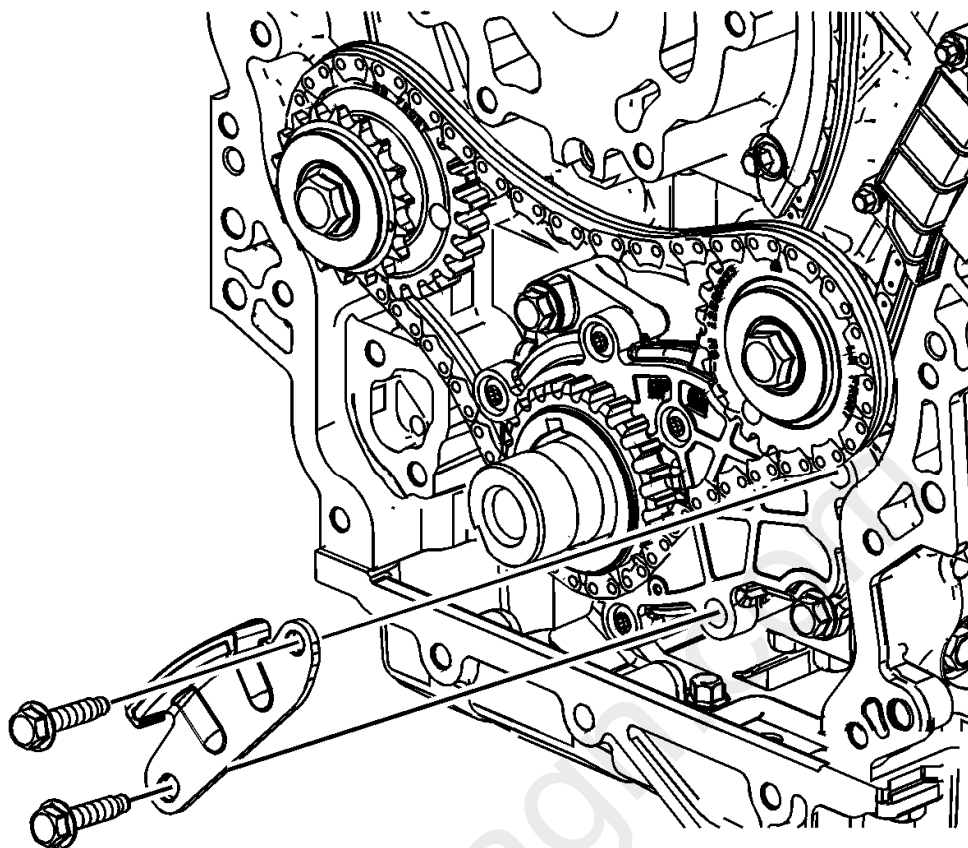


Fig. 127: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

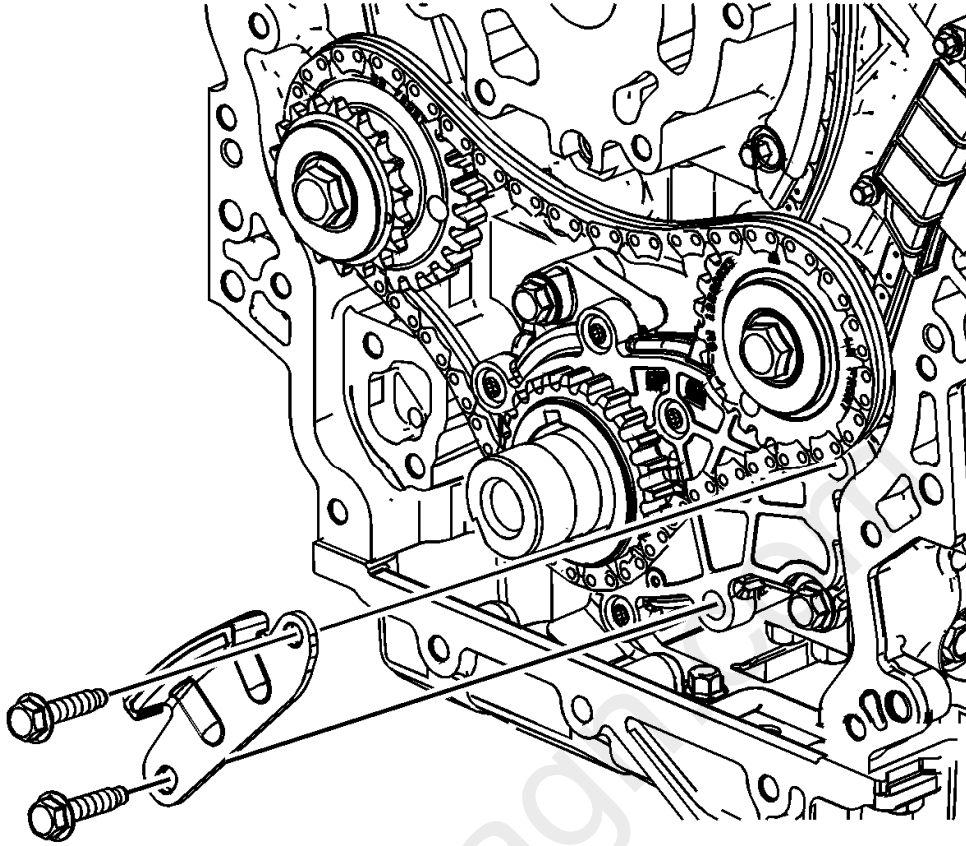


Fig. 128: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

Removal Procedure

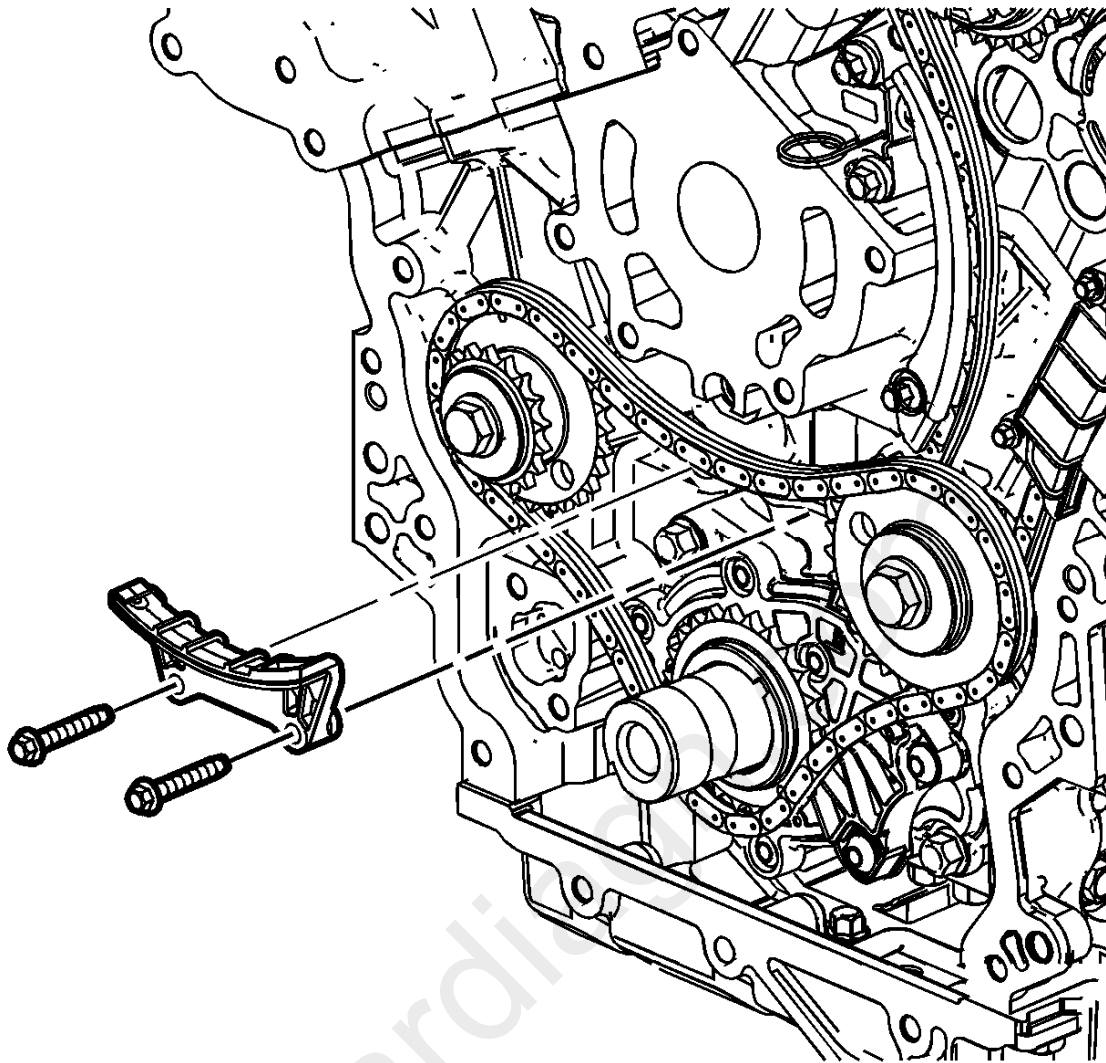


Fig. 129: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

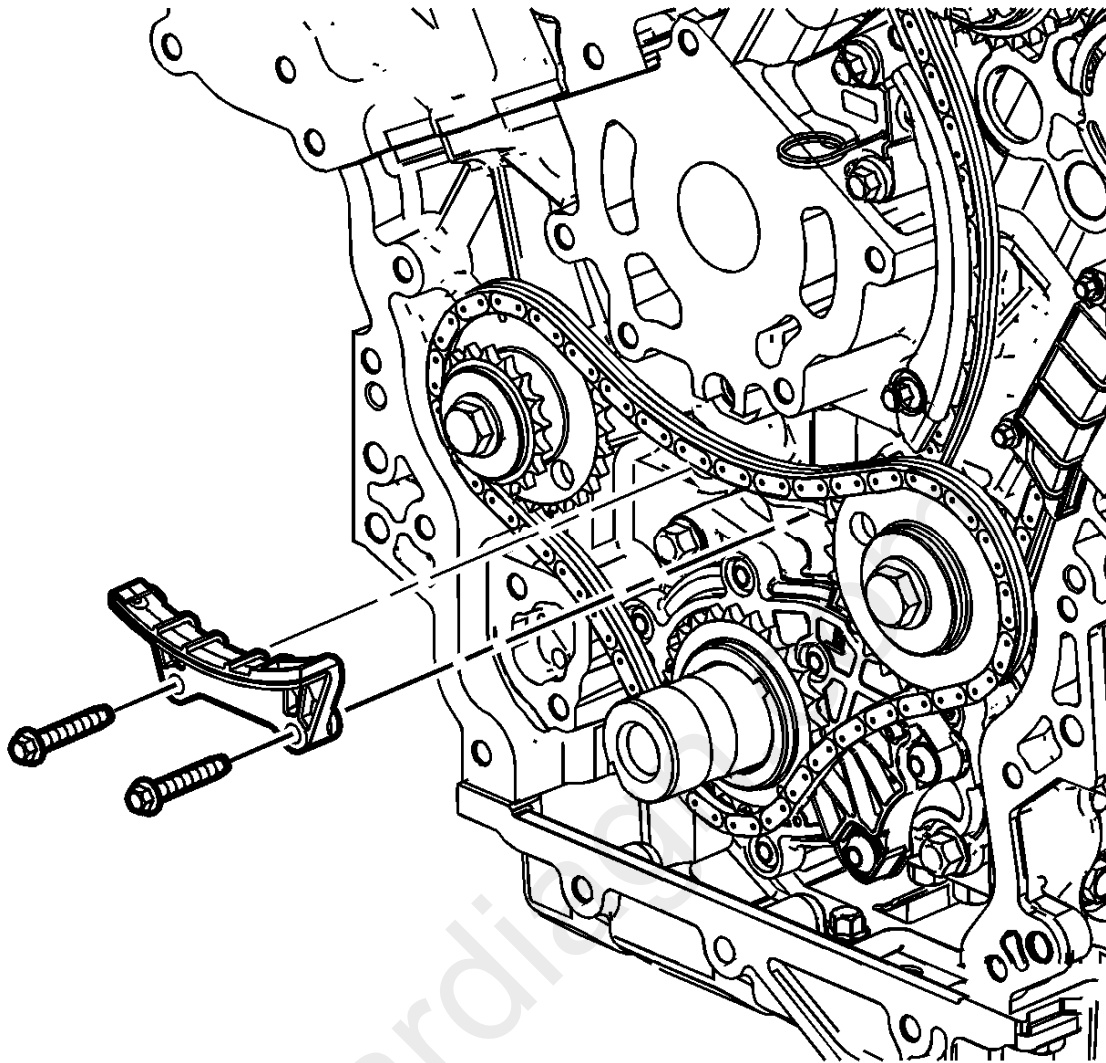


Fig. 130: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

Special Tools

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

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

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side.**
2. Remove the camshaft position actuator solenoid valve solenoid - intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake (LF3)** .
3. Remove the intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake (LFX)** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake (LF3)** .
4. Remove the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust (LFX)** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust (LF3)** .
5. Remove the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust (LF3)** .
6. Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on "base circle" and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.

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

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

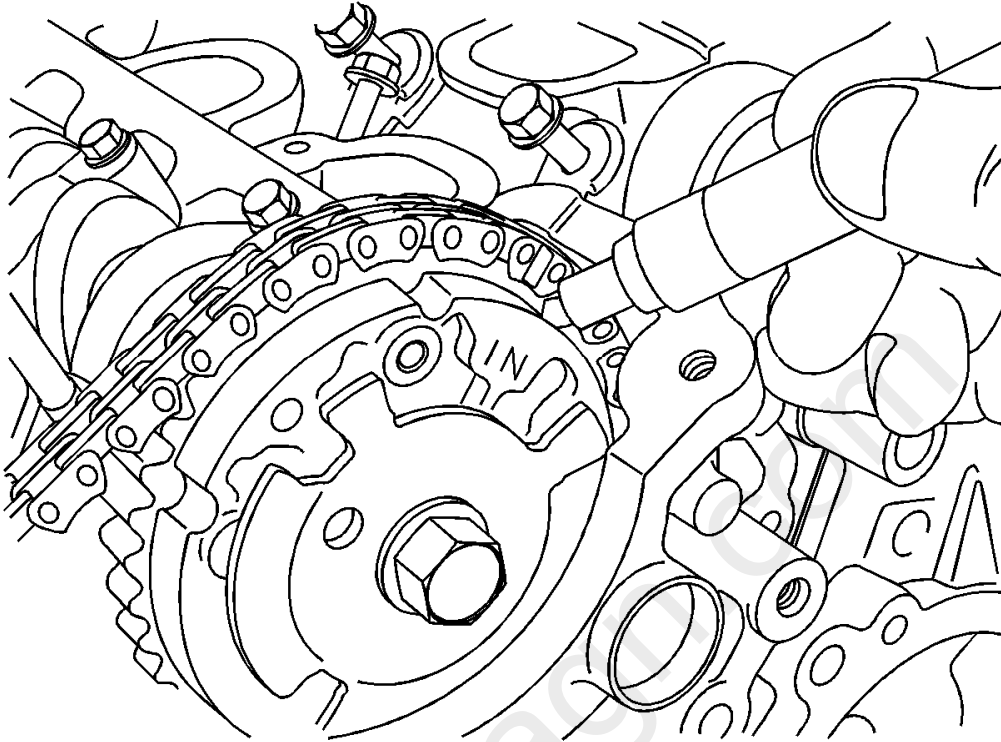


Fig. 131: Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS COMPANY

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

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

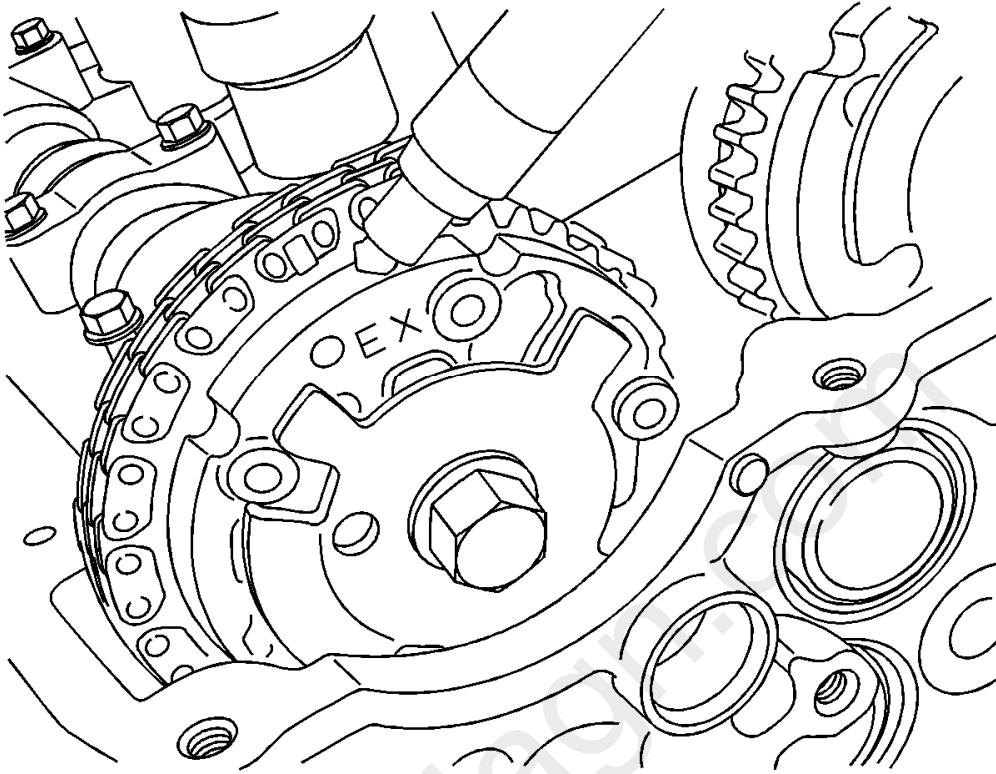


Fig. 132: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS COMPANY

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

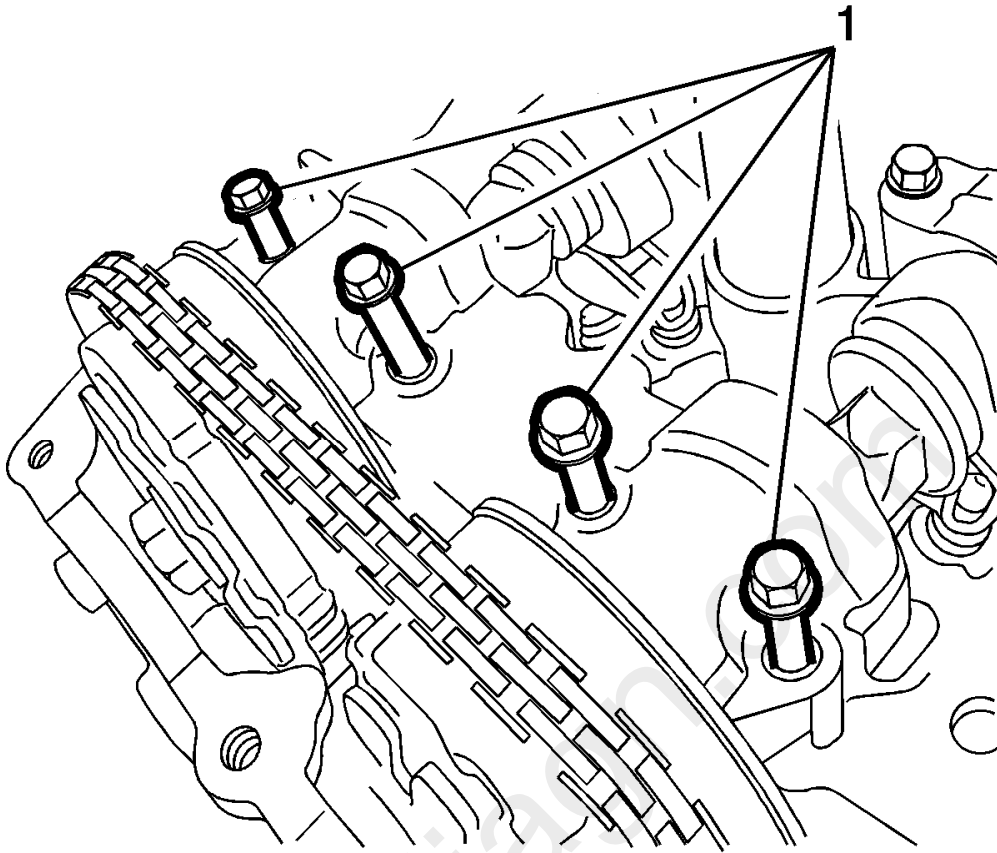


Fig. 133: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

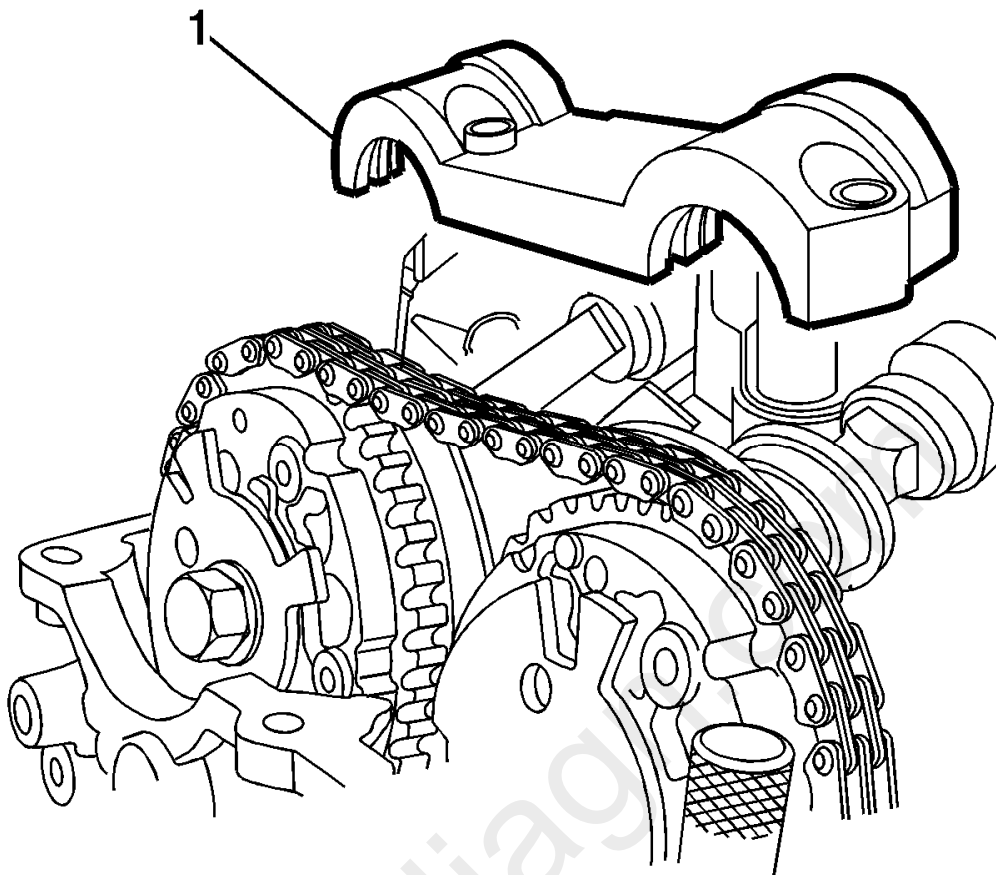


Fig. 134: View Of Camshaft Front Cap
Courtesy of GENERAL MOTORS COMPANY

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

11. Remove the camshaft front cap (1).

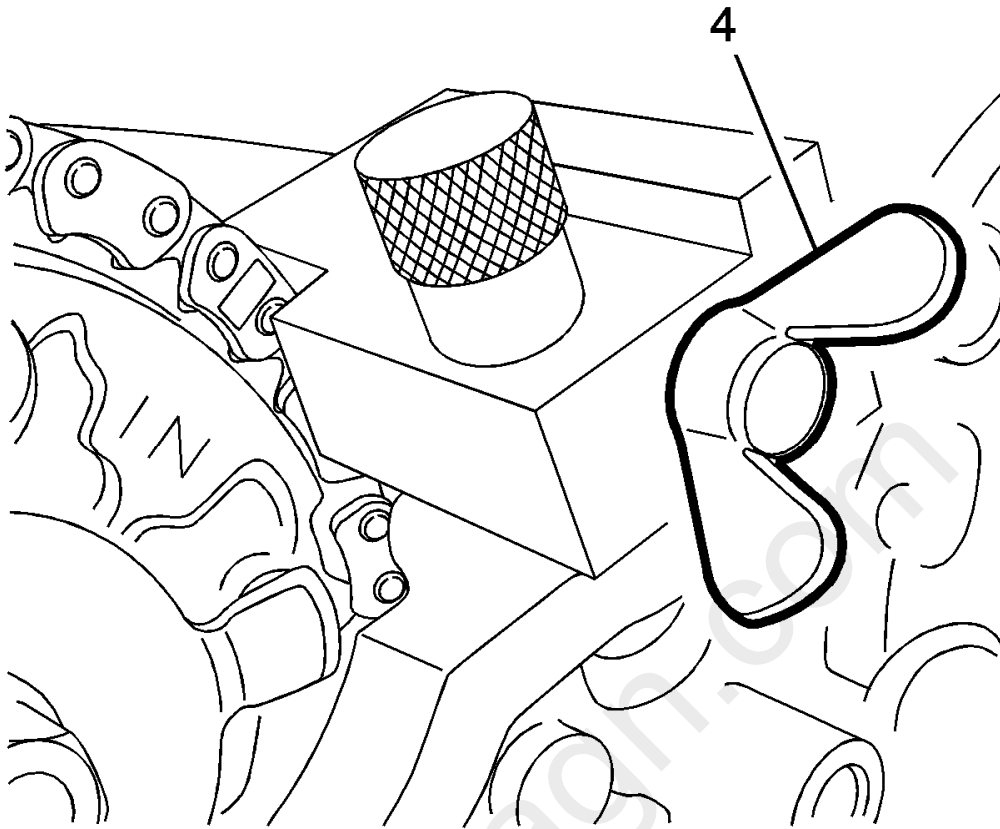


Fig. 135: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

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

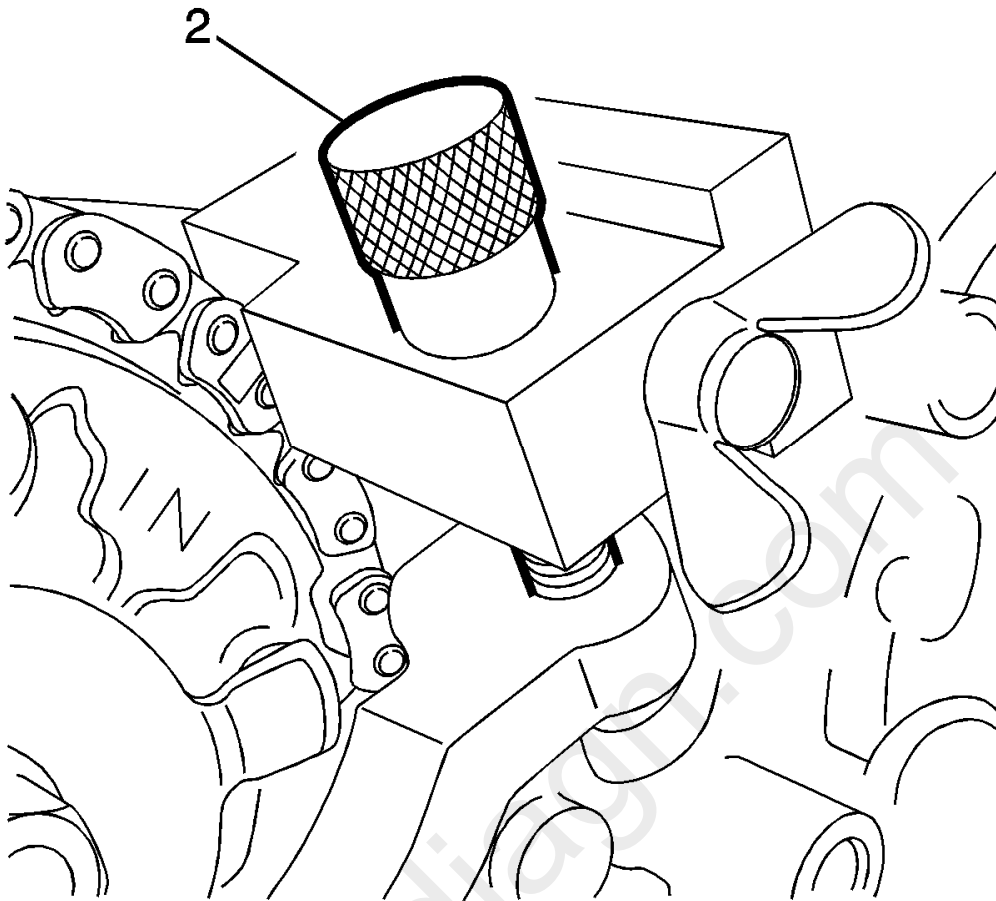


Fig. 136: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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

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

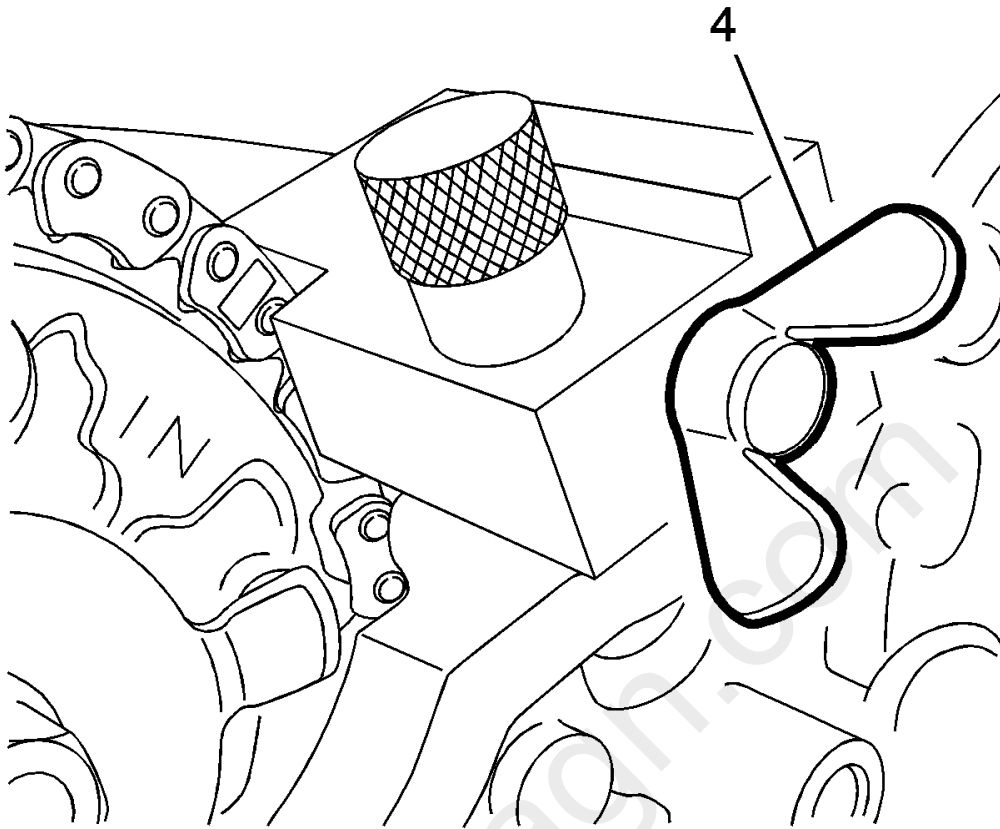


Fig. 137: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

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

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

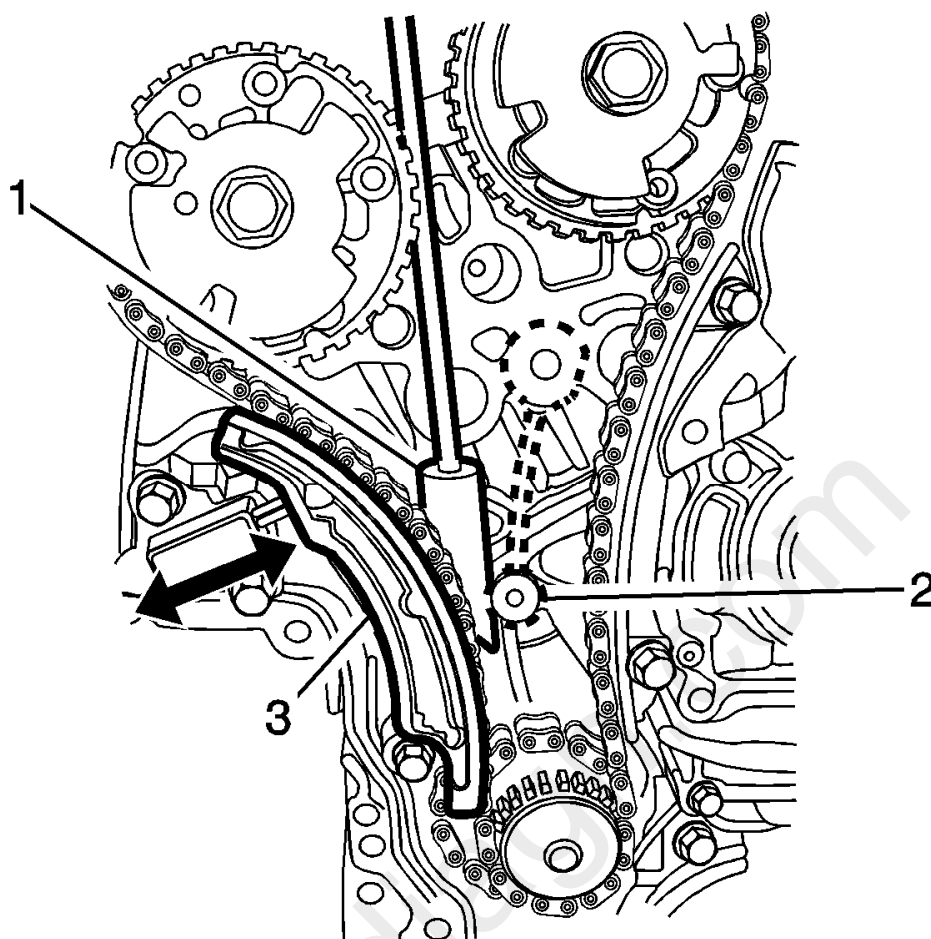


Fig. 138: Retainer Wedge

Courtesy of GENERAL MOTORS COMPANY

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

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

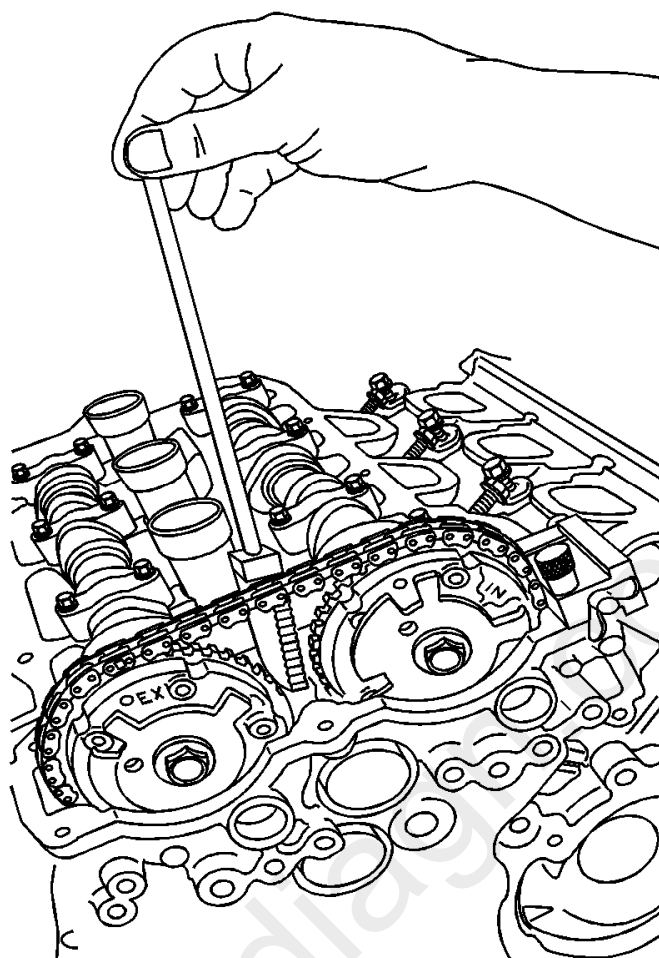


Fig. 139: Inserting Retainer

Courtesy of GENERAL MOTORS COMPANY

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

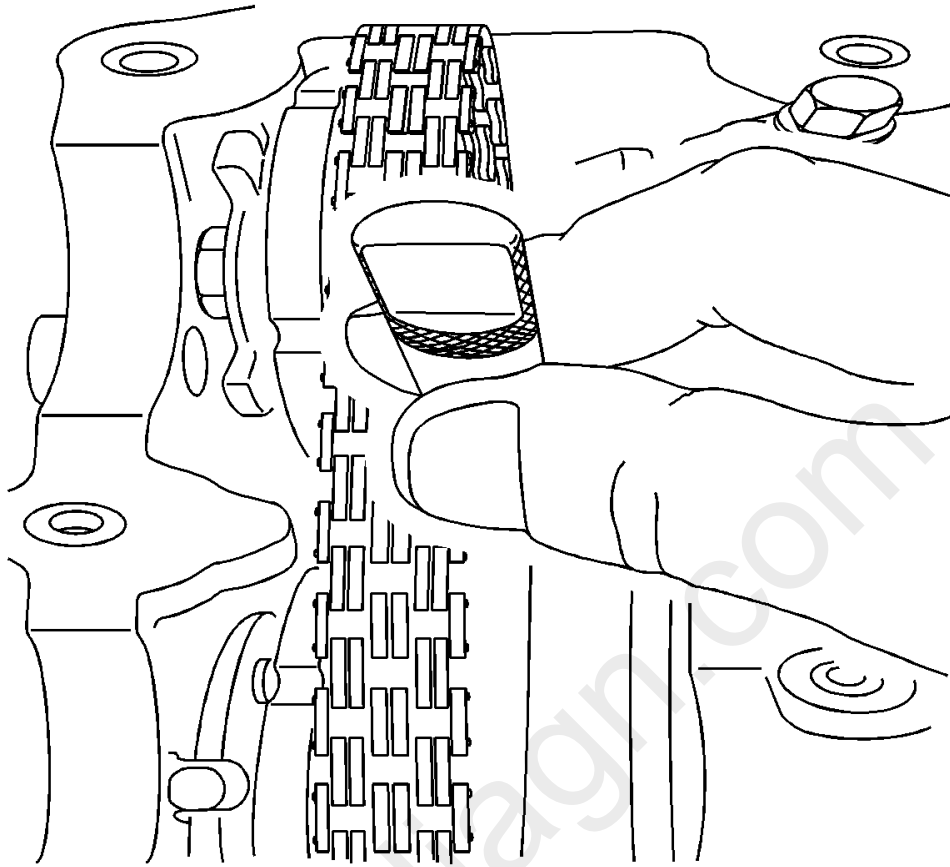


Fig. 140: Orienting Retainer Teeth
Courtesy of GENERAL MOTORS COMPANY

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

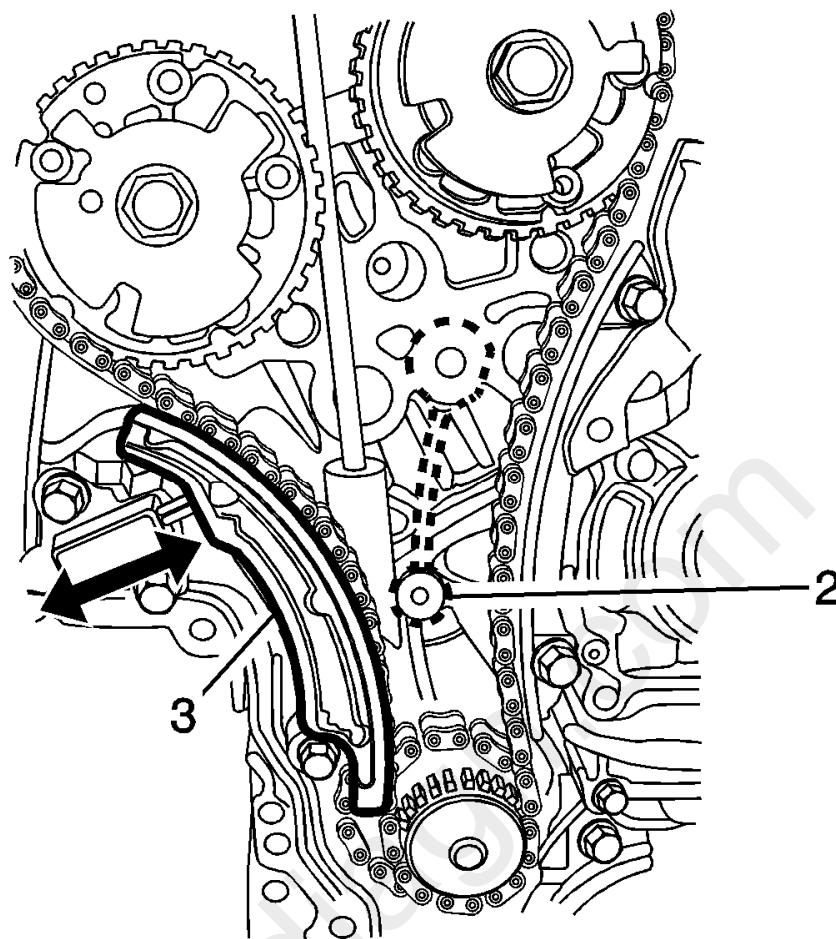


Fig. 141: Wedge, Timing Chain And Belt Casting
Courtesy of GENERAL MOTORS COMPANY

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

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

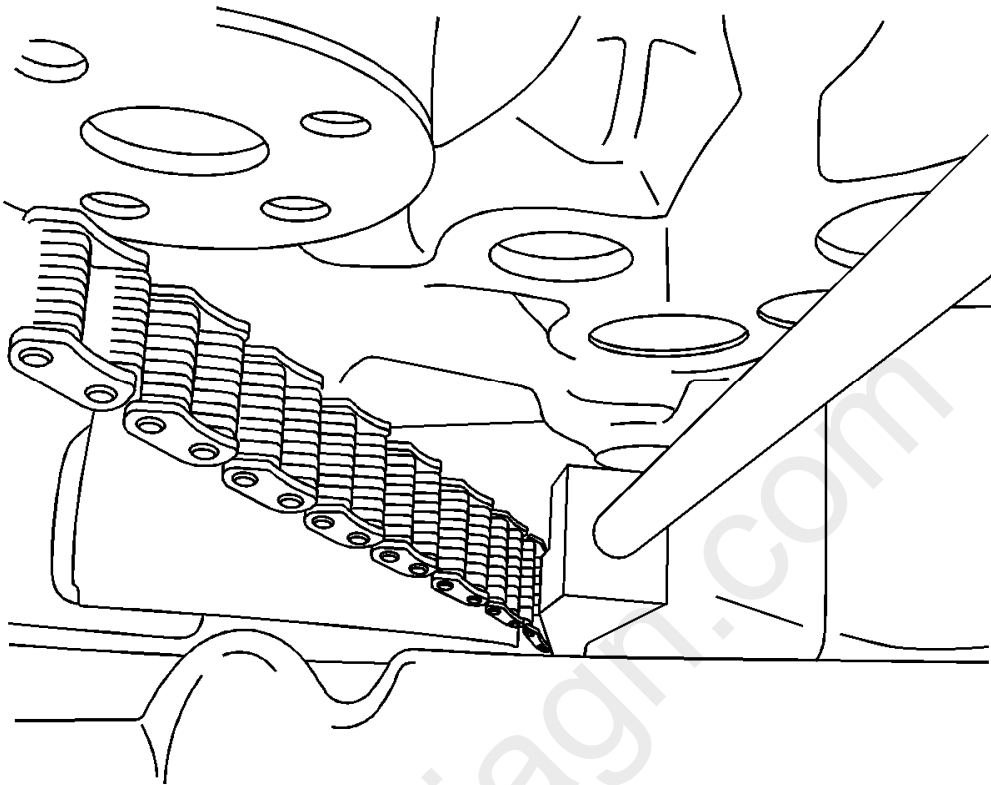


Fig. 142: Positioning Wedge

Courtesy of GENERAL MOTORS COMPANY

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

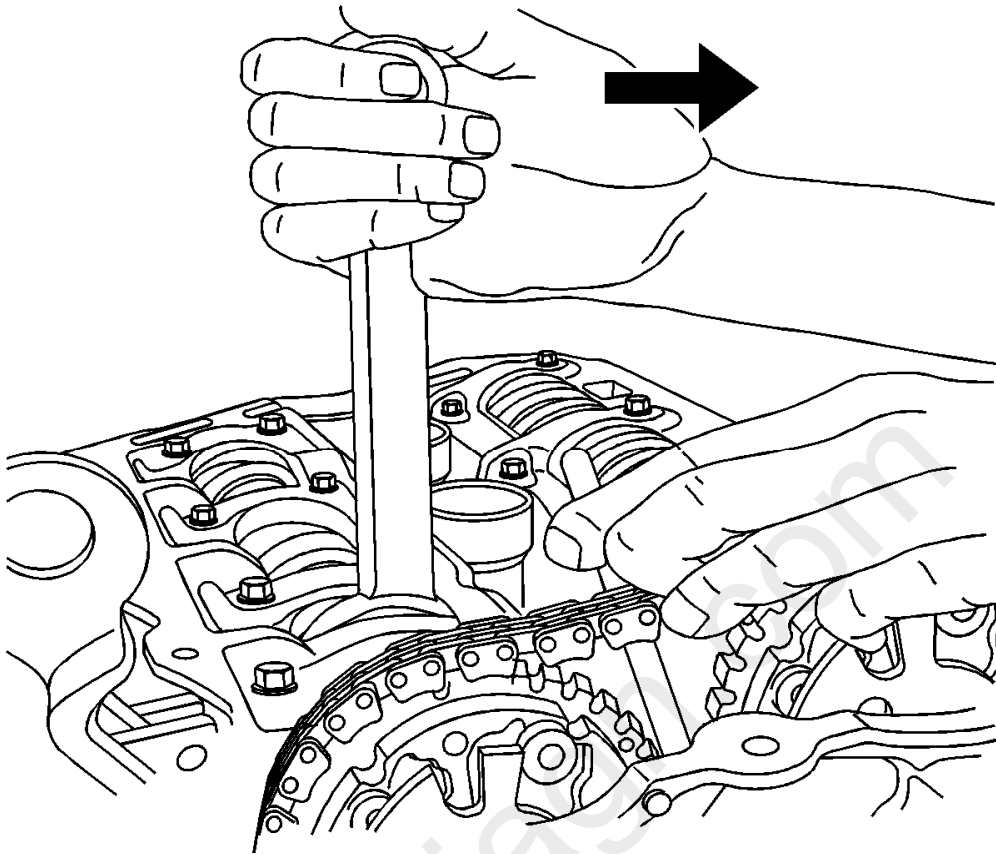


Fig. 143: Rotating Camshaft

Courtesy of GENERAL MOTORS COMPANY

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

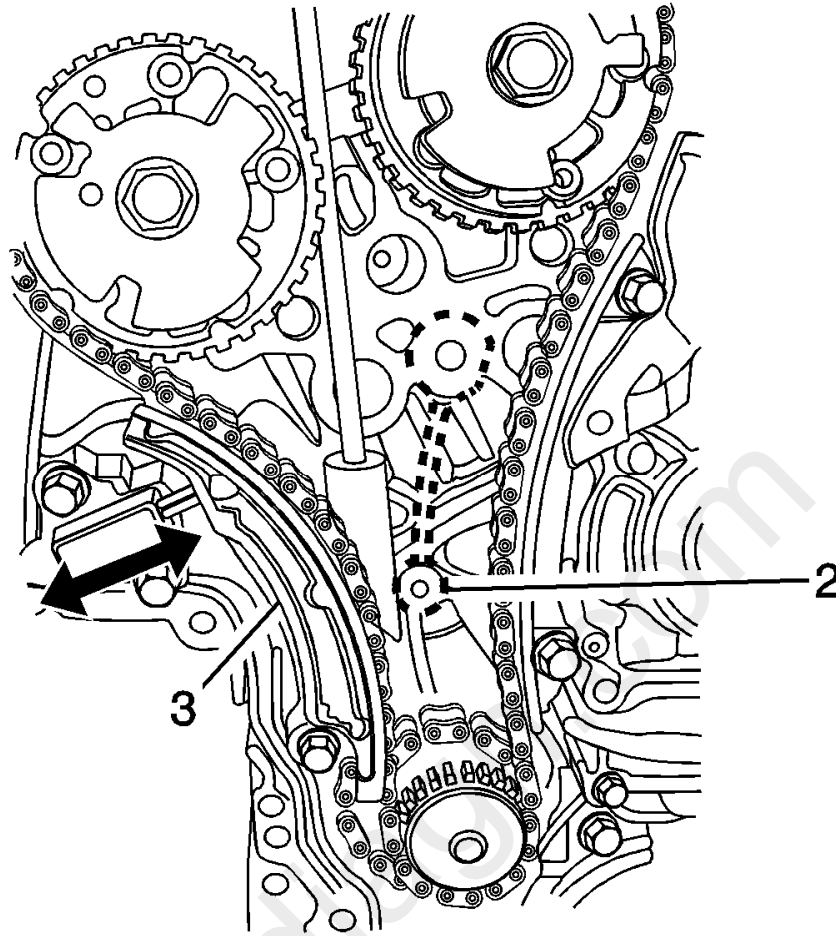


Fig. 144: Opening Gap Between Chain & Internal Rib In Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

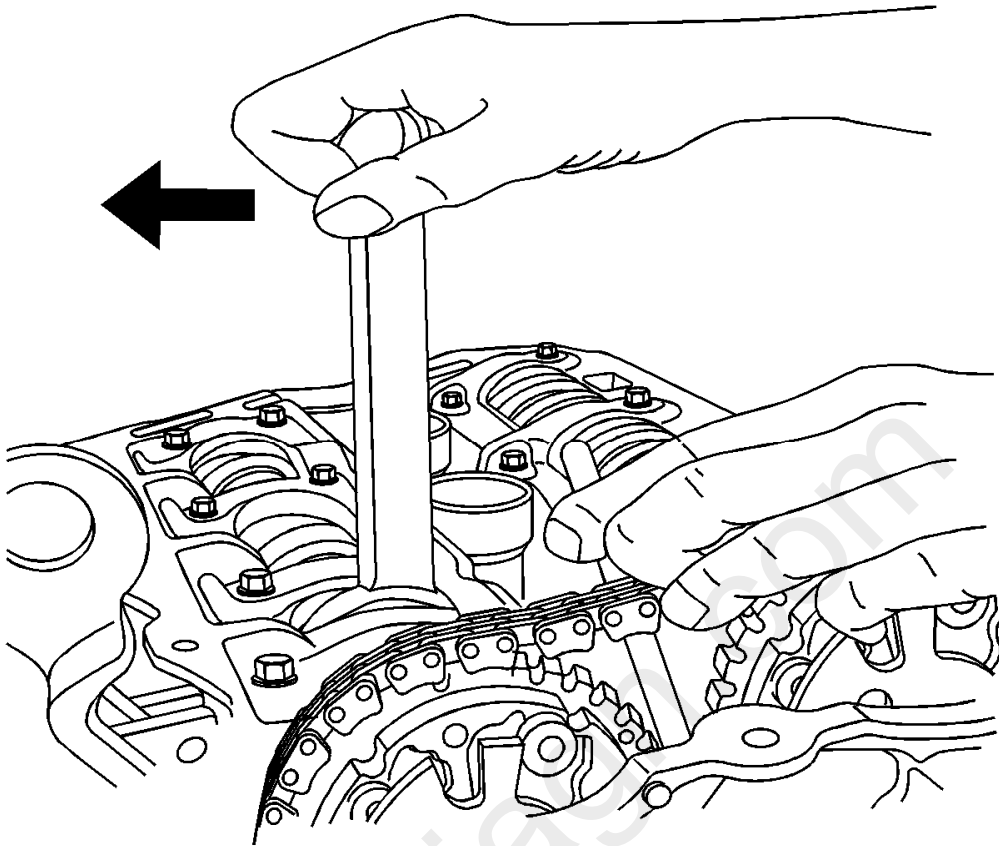


Fig. 145: Releasing Force On Wrench
Courtesy of GENERAL MOTORS COMPANY

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

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

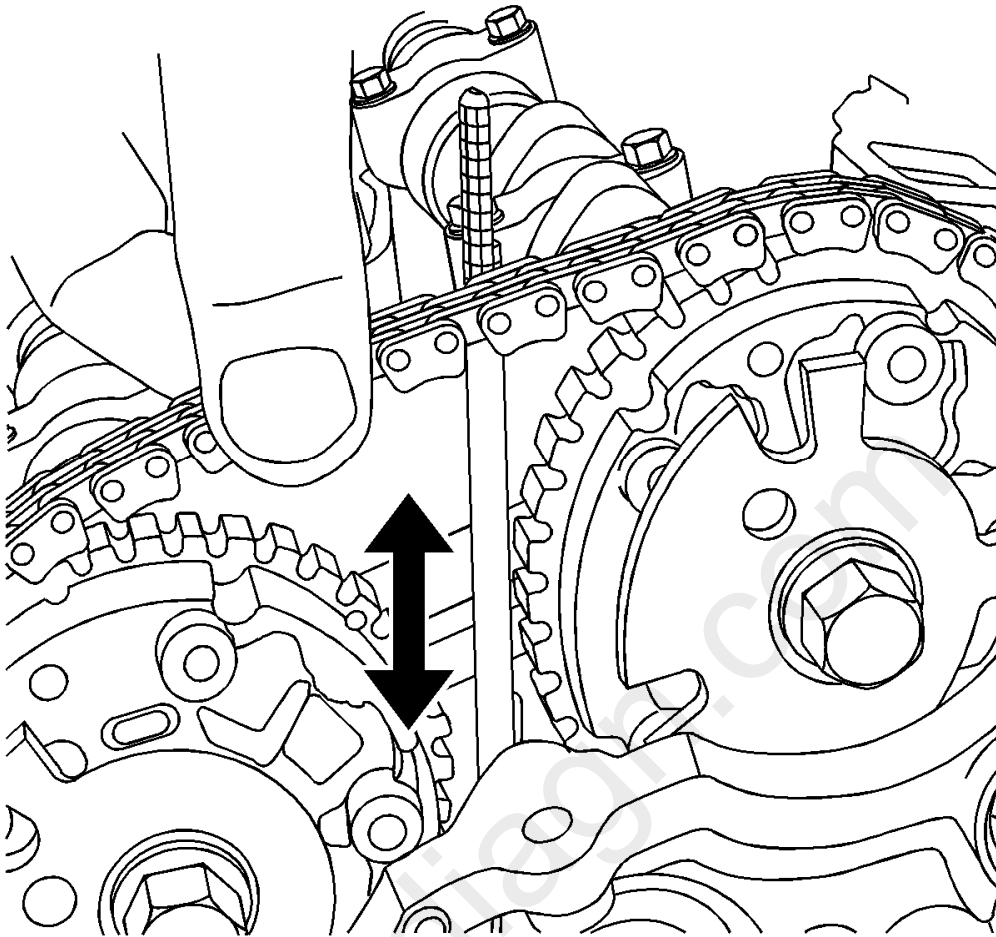


Fig. 146: Slack In Timing Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

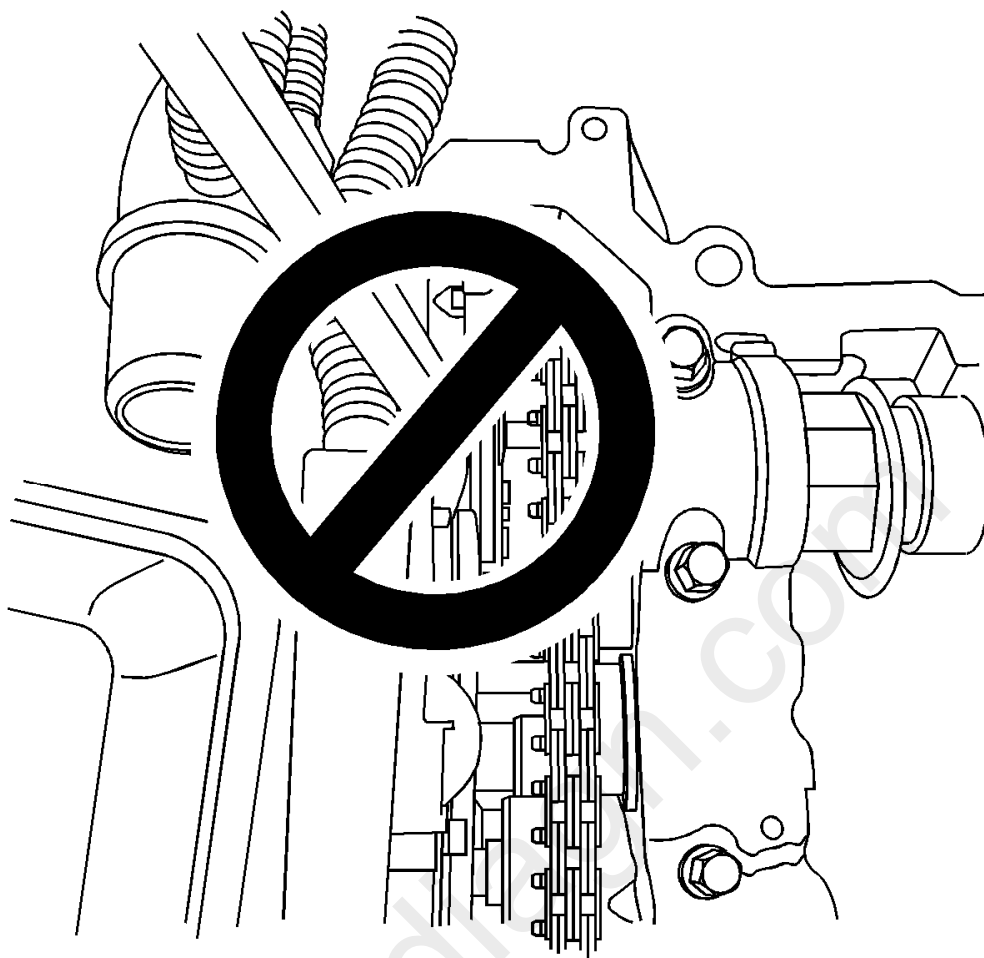


Fig. 147: Do Not Pry Warning
Courtesy of GENERAL MOTORS COMPANY

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

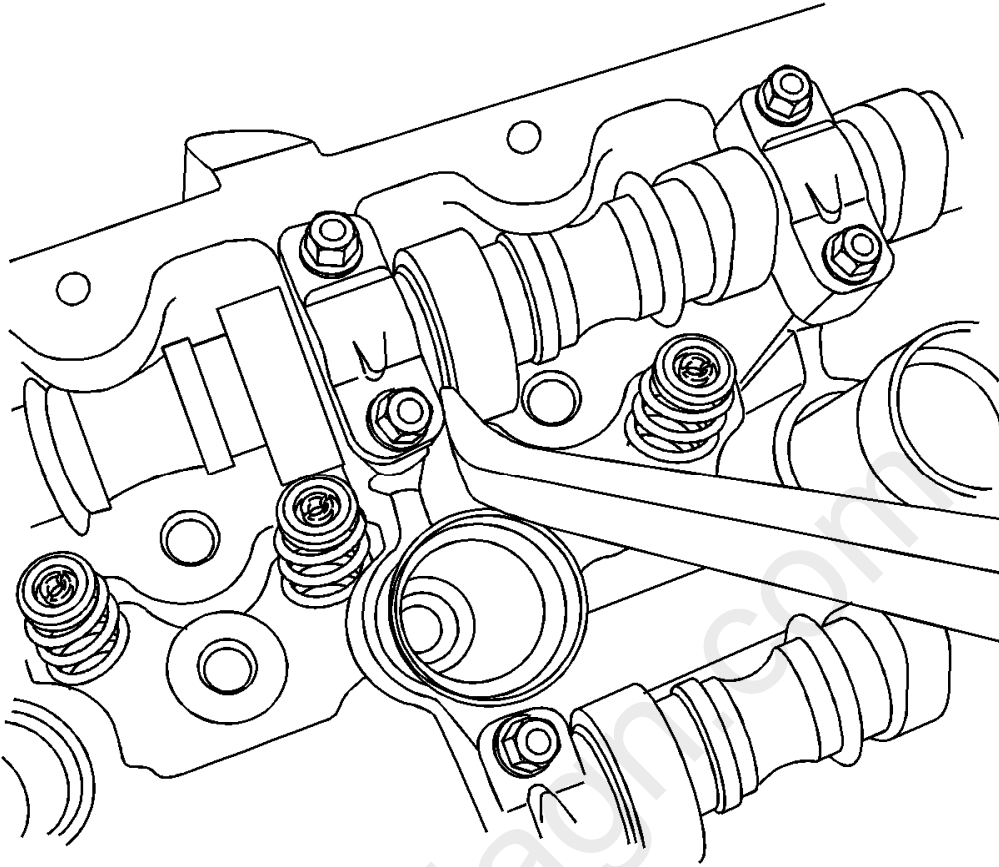


Fig. 148: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

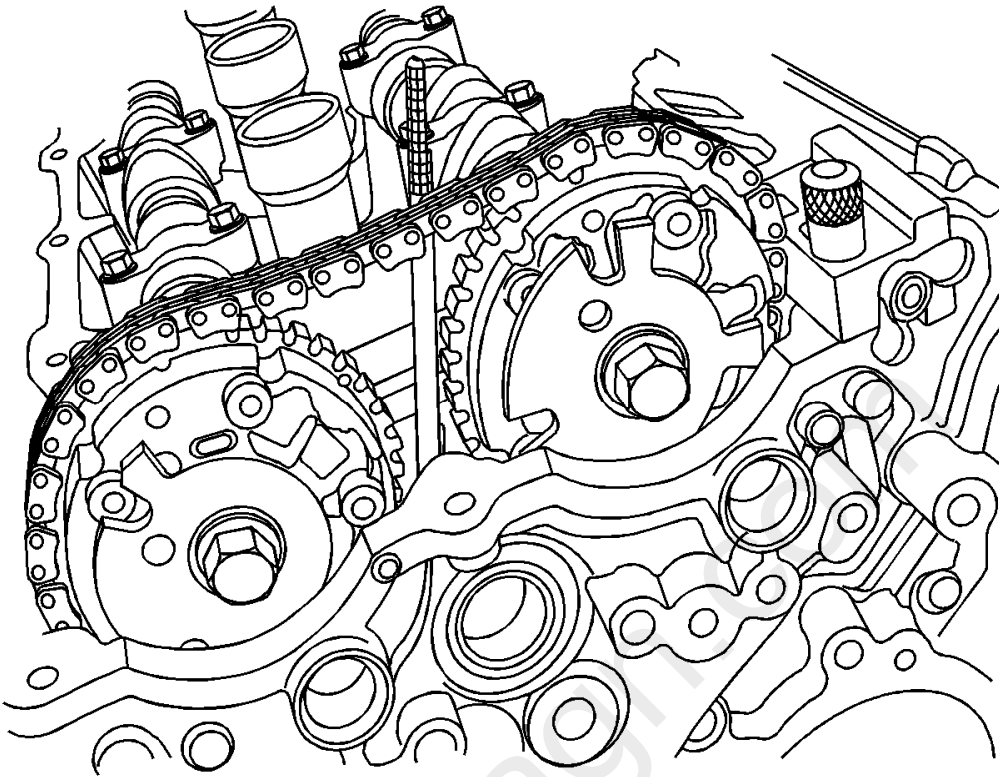


Fig. 149: Retainer Position

Courtesy of GENERAL MOTORS COMPANY

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

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

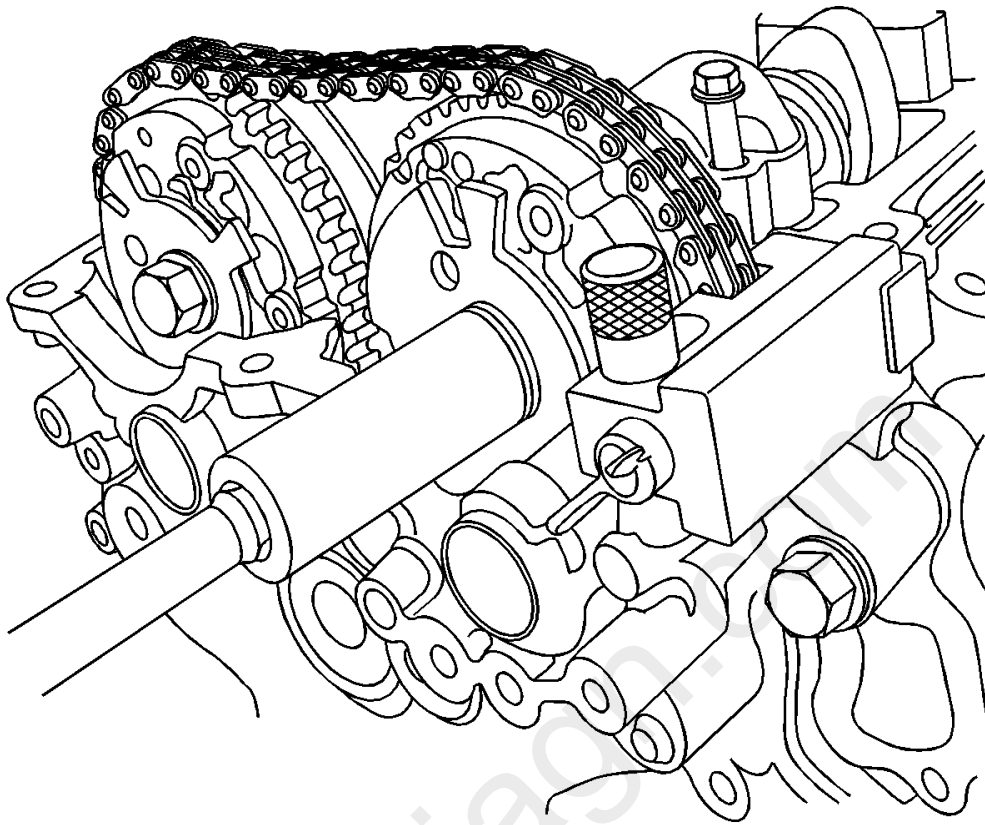


Fig. 150: View Of Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

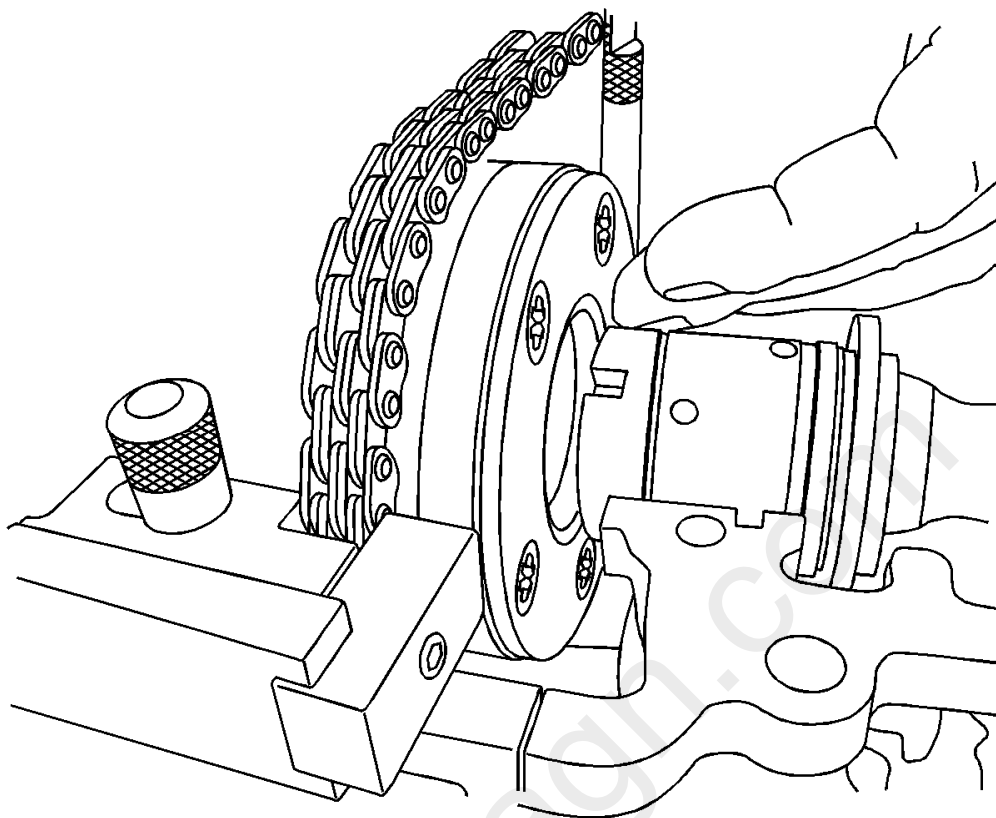


Fig. 151: Sliding Camshaft Position Actuator Off End Of Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

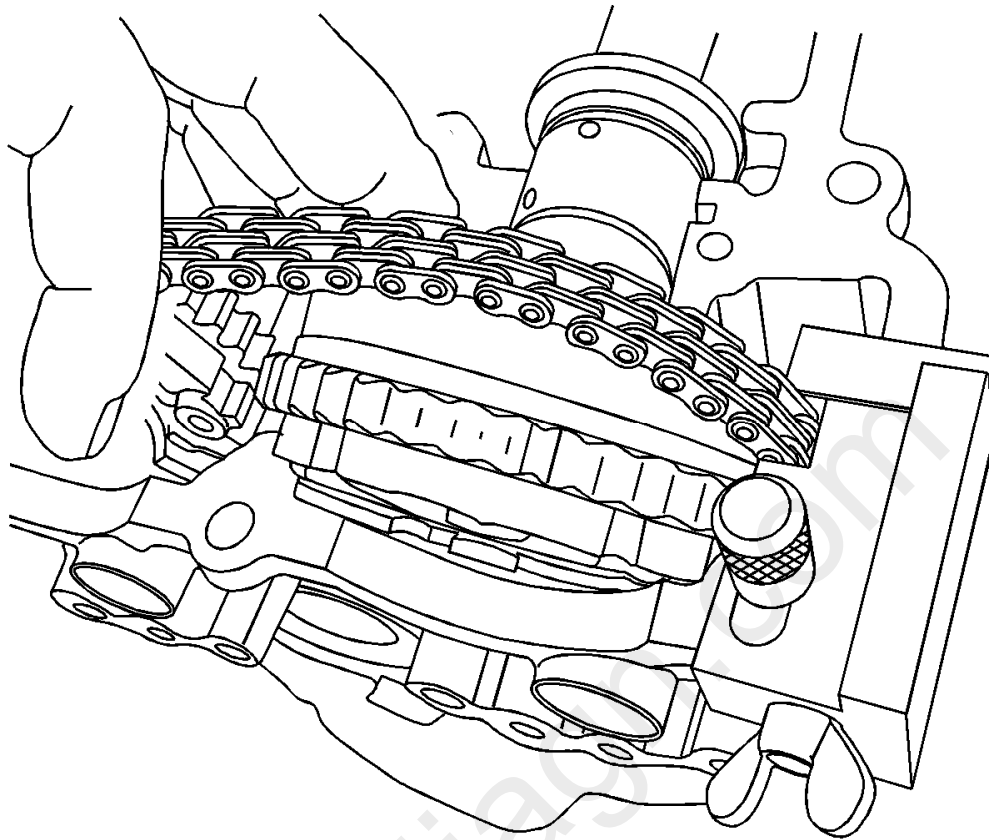


Fig. 152: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Installation Procedure

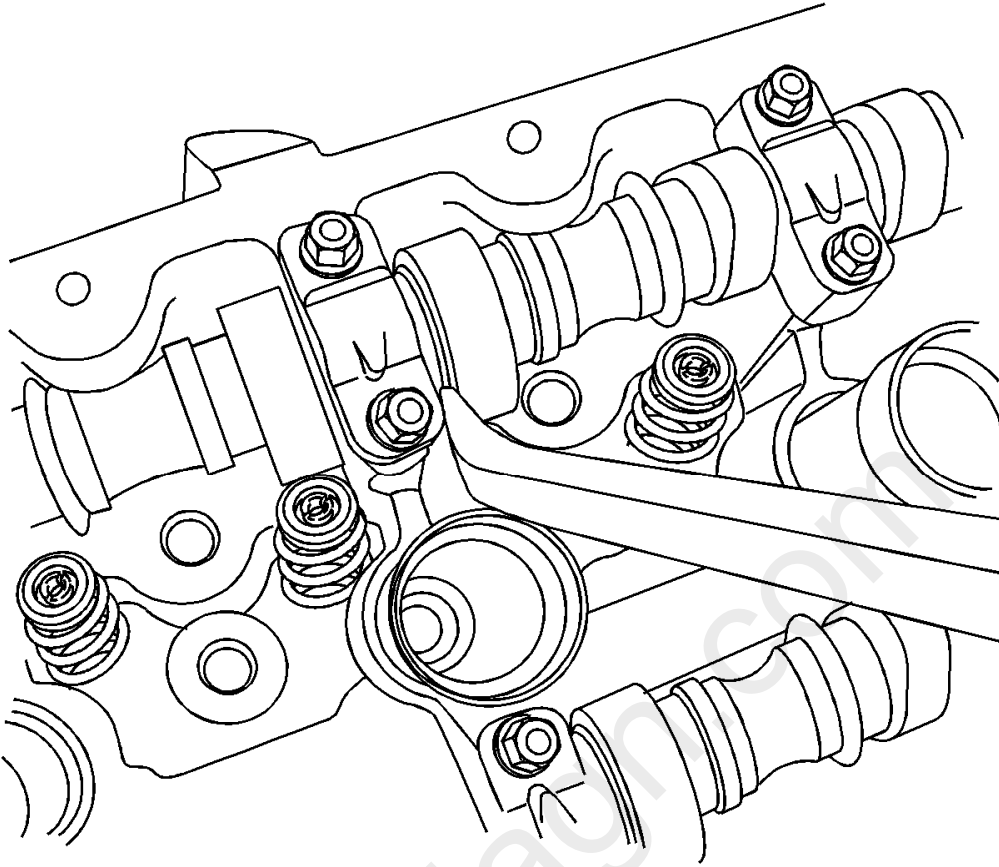


Fig. 153: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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

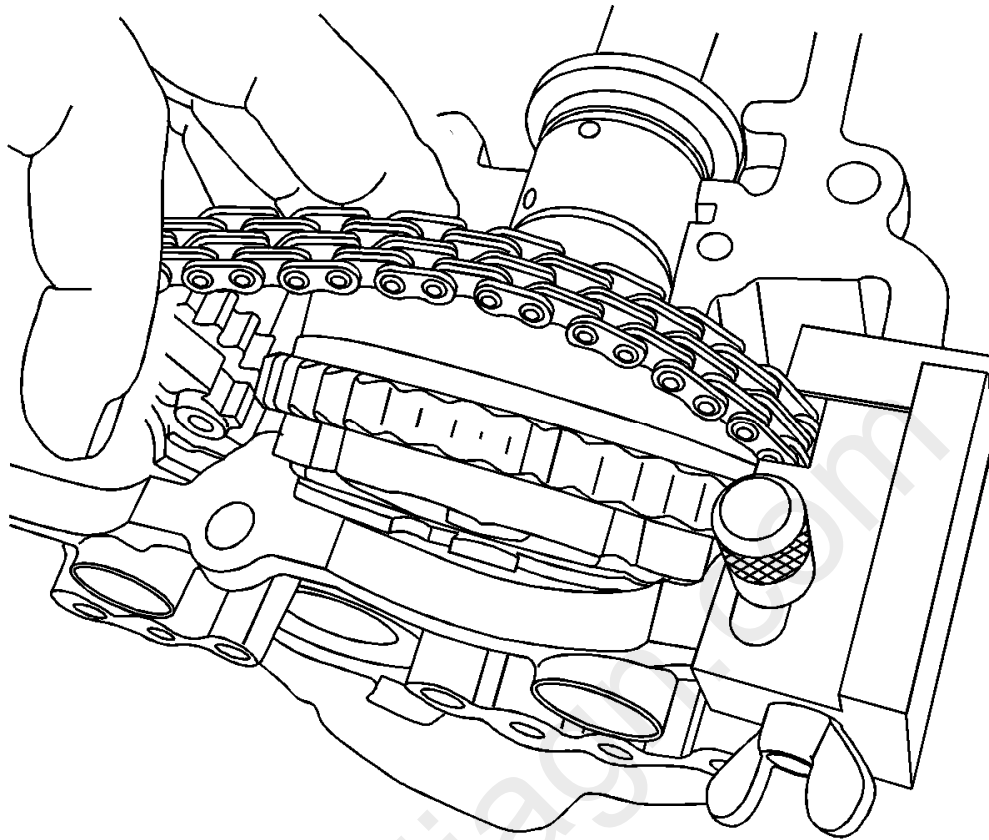


Fig. 154: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

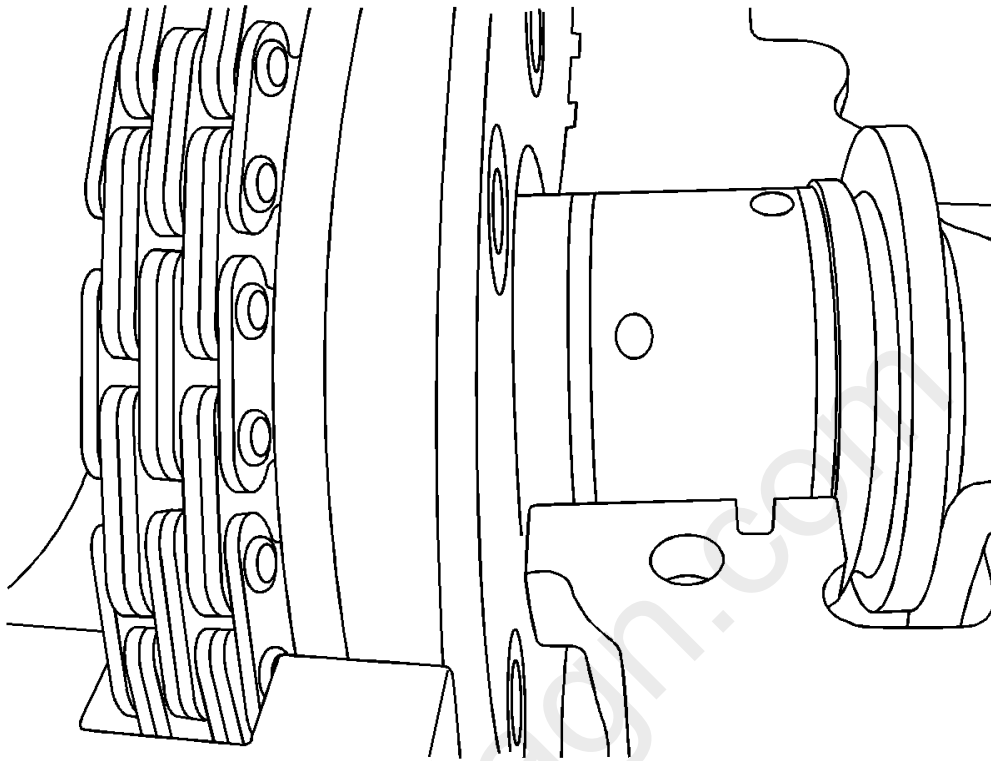


Fig. 155: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

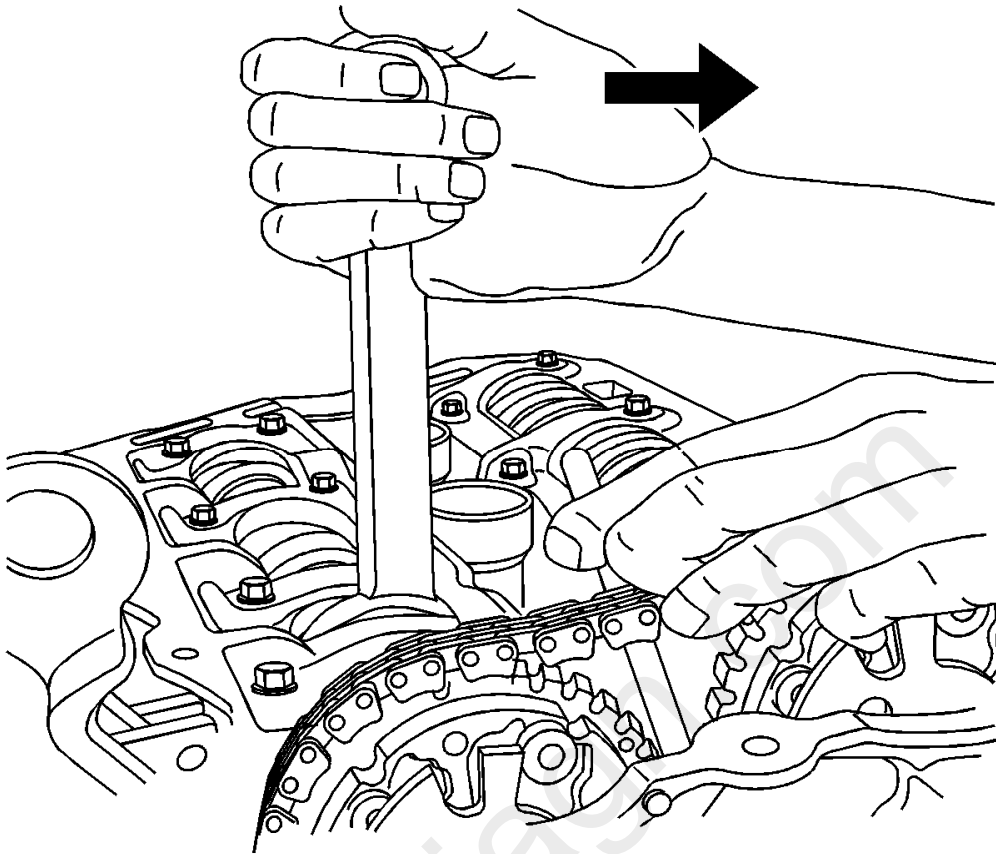


Fig. 156: Rotating Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

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

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

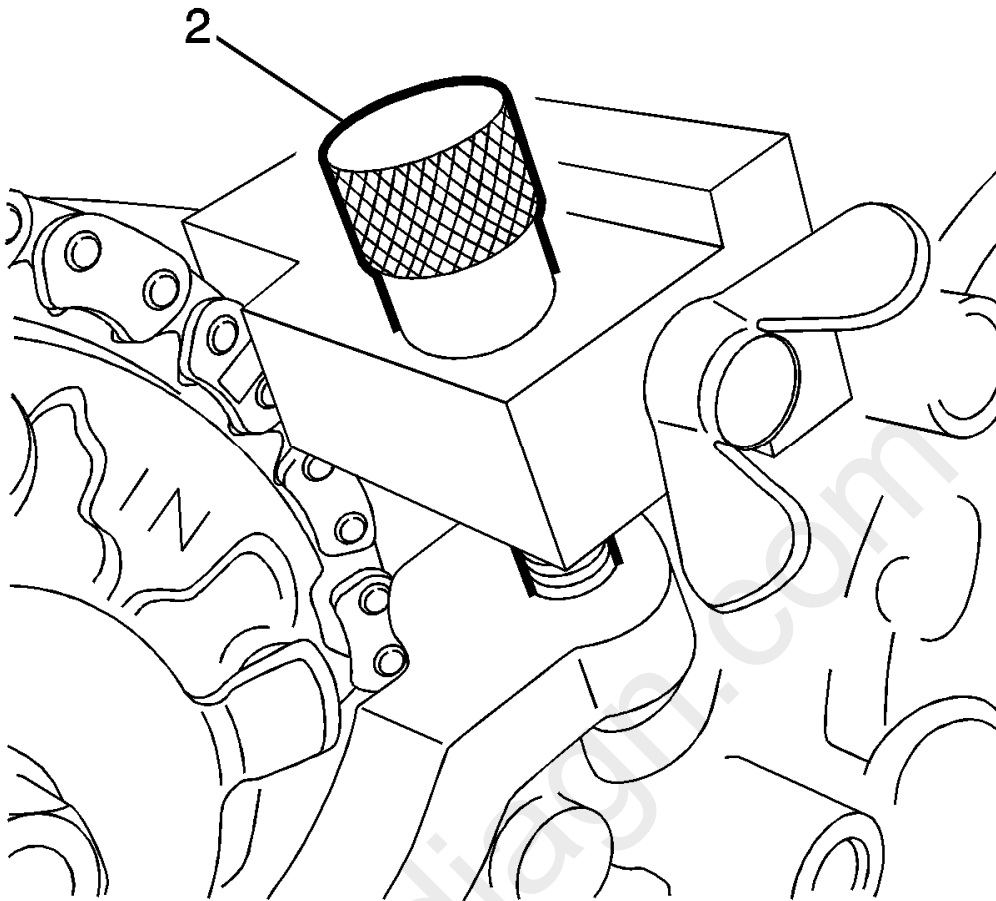


Fig. 157: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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

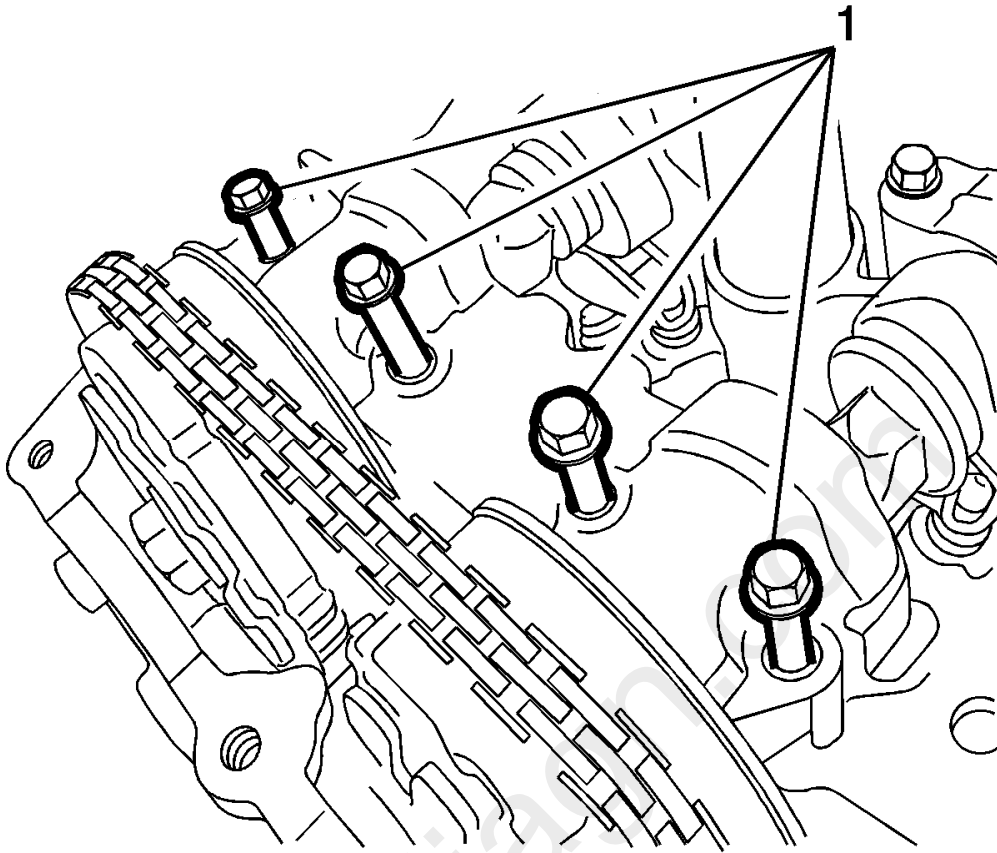


Fig. 158: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install camshaft front cap and bolts (1).
13. Tighten the camshaft front cap outer bolts to 10 N.m (89 lb in).
14. Tighten the camshaft front cap inner bolts to 10 N.m (89 lb in).
15. Install the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust (LF3)** .
16. Install the camshaft position actuator solenoid valve solenoid-intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake (LF3)** .
17. Install the intake camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake (LFX)** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake (LF3)** .
18. Install the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust (LFX)** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust (LF3)** .

19. Install the camshaft cover. Refer to Camshaft Cover Replacement - Right Side.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

Special Tools

EN-48313 Timing Chain Retention Tool

For equivalent regional tools, refer to Special Tools .

Removal Procedure

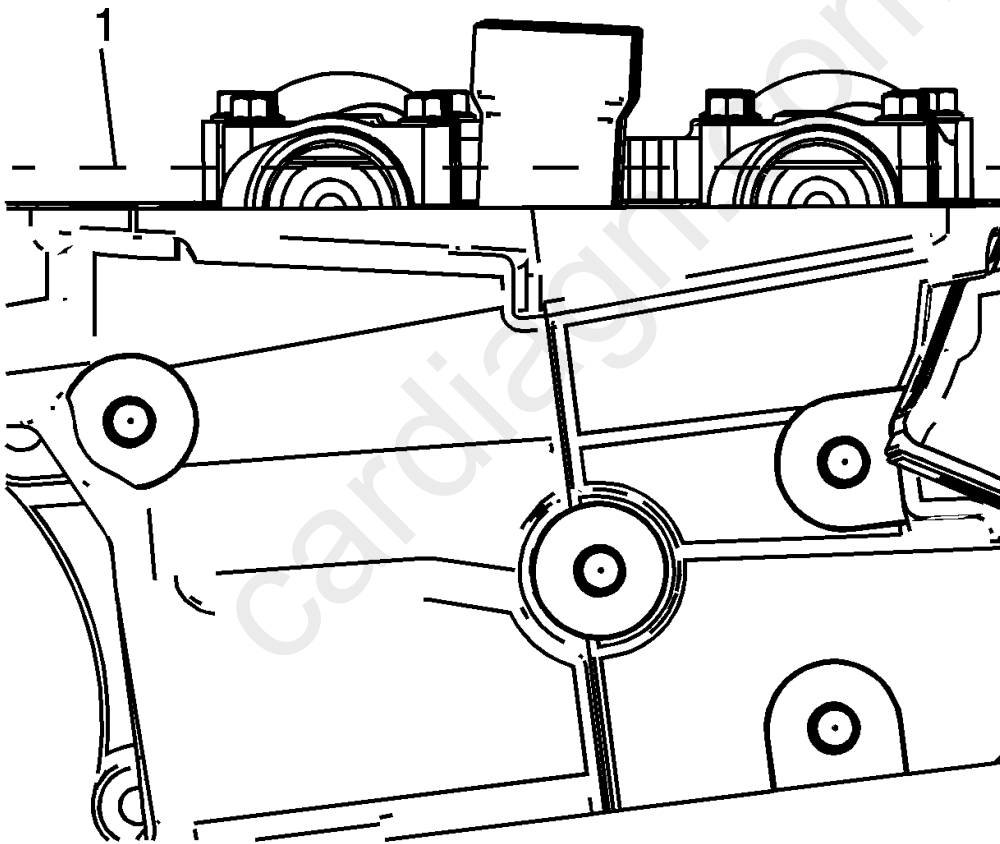


Fig. 159: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft cover. Refer to Camshaft Cover Replacement - Left Side.
2. Remove the left intake and exhaust camshaft position sensors. Refer to Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake (LFX) , Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake (LF3) , and Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust

(LFX) , Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust (LF3) .

3. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (LFX) , Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (LF3) , and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (LFX) , Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (LF3) .**

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

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

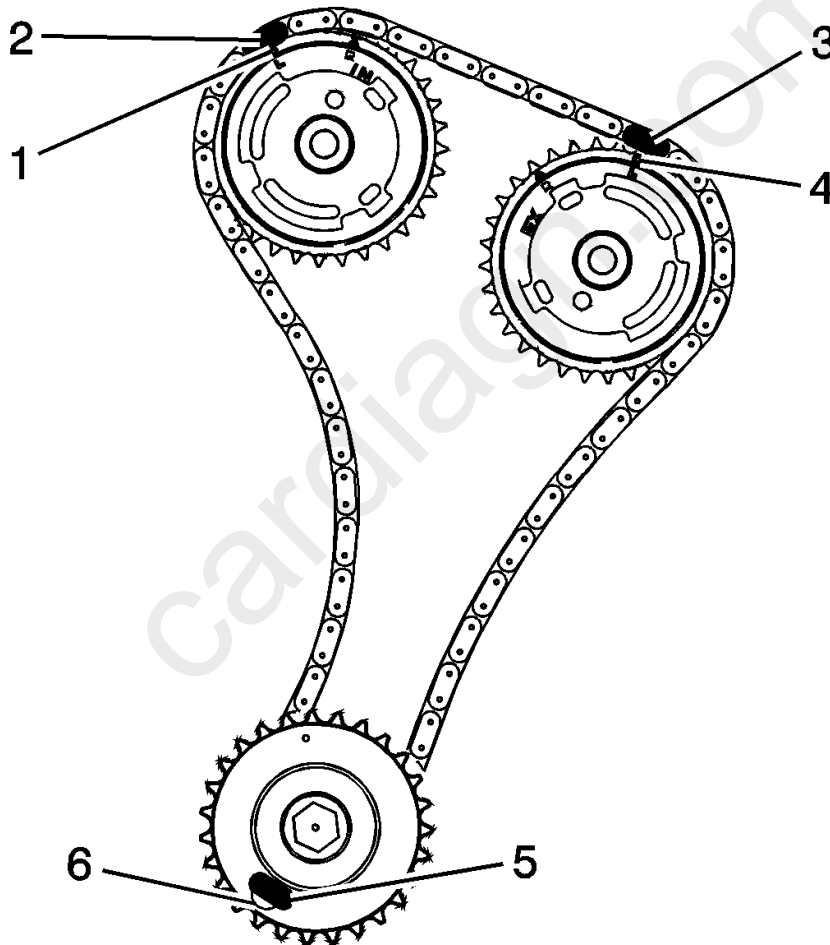


Fig. 160: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

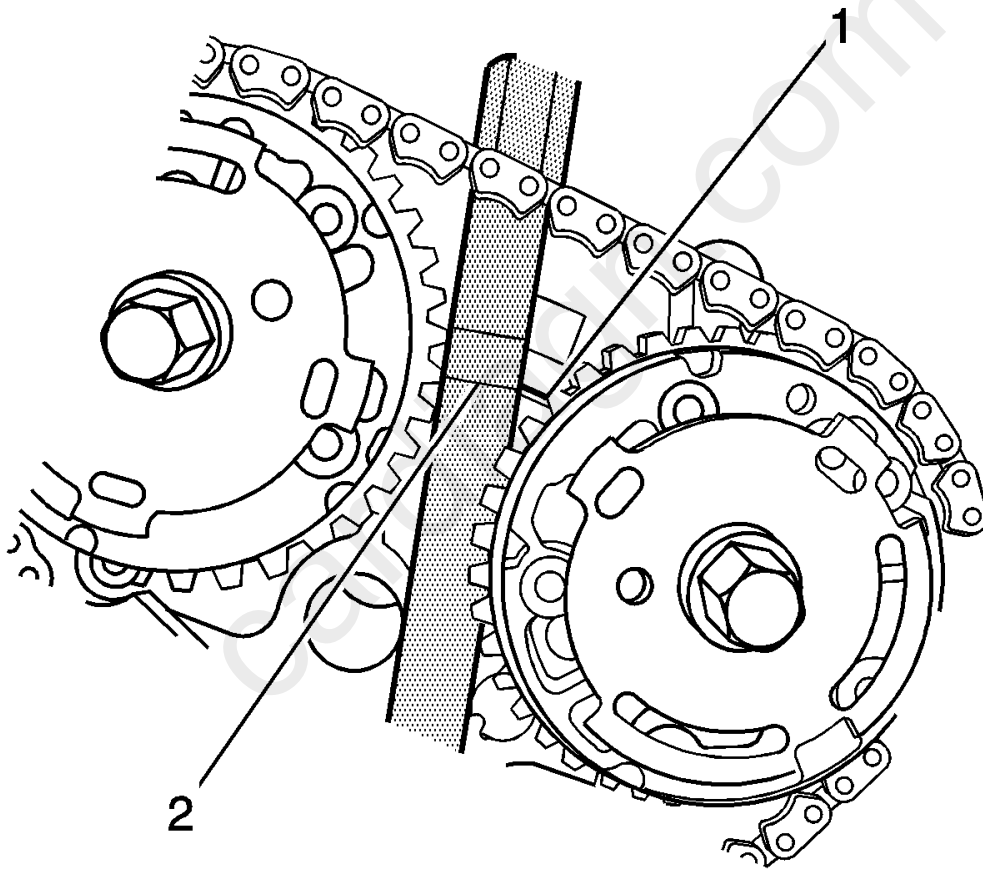


Fig. 161: Inserting Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

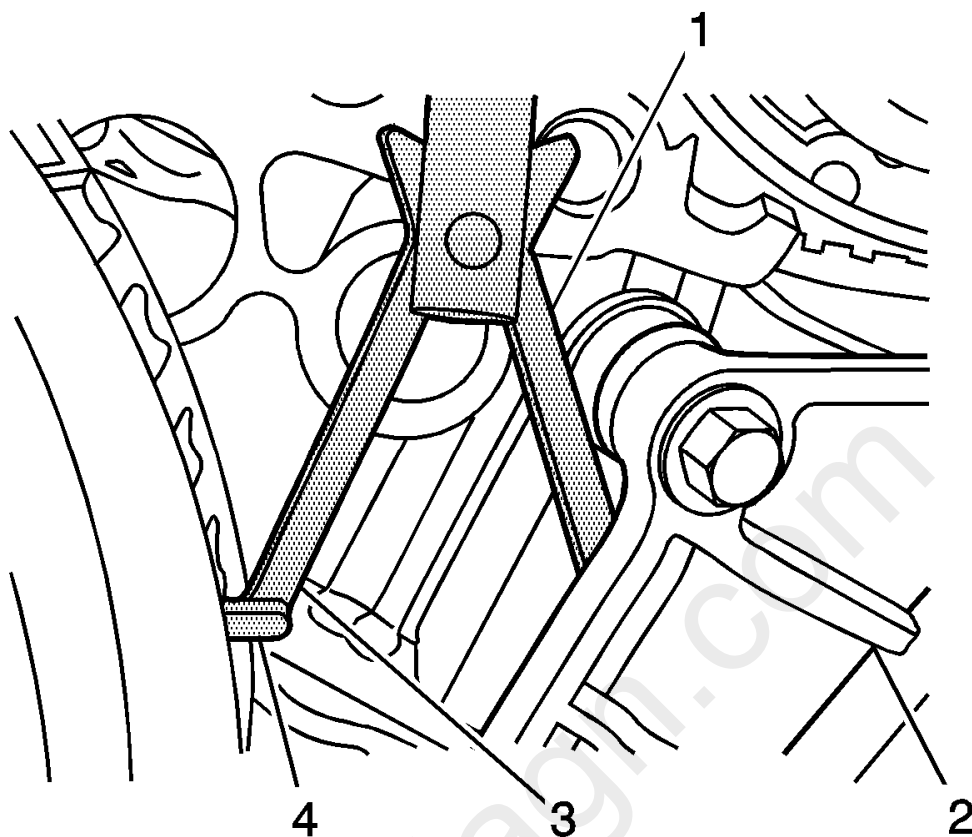


Fig. 162: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

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

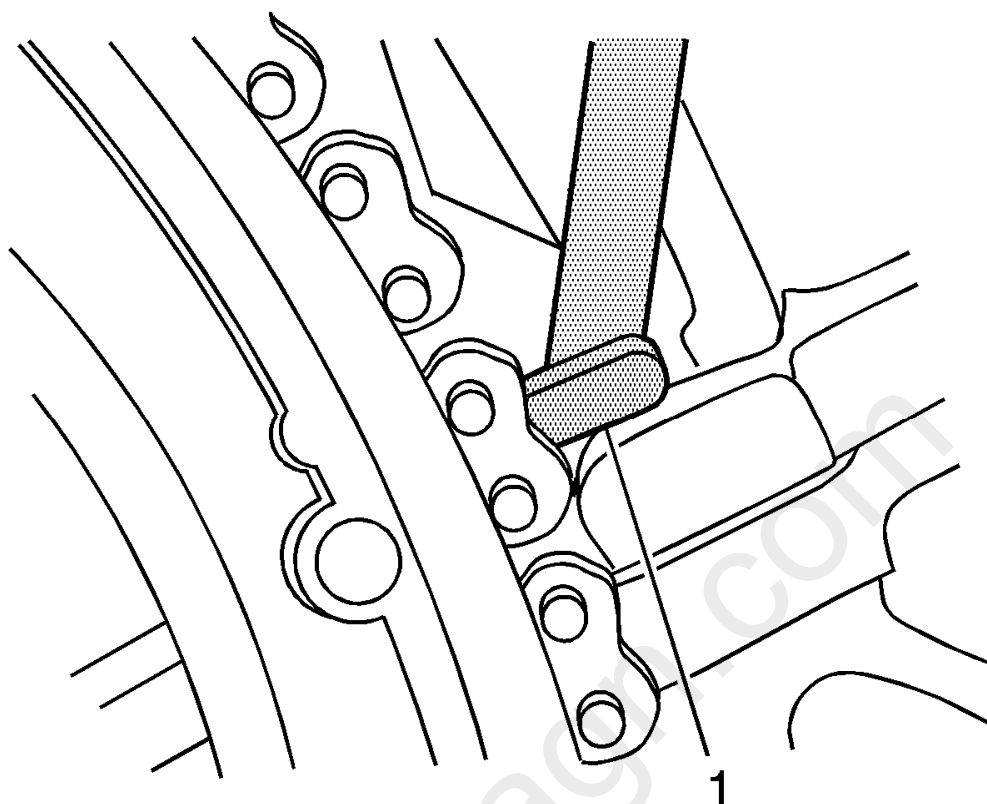


Fig. 163: Foot of Timing Chain Retention Tool EN-48313
Courtesy of GENERAL MOTORS COMPANY

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

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

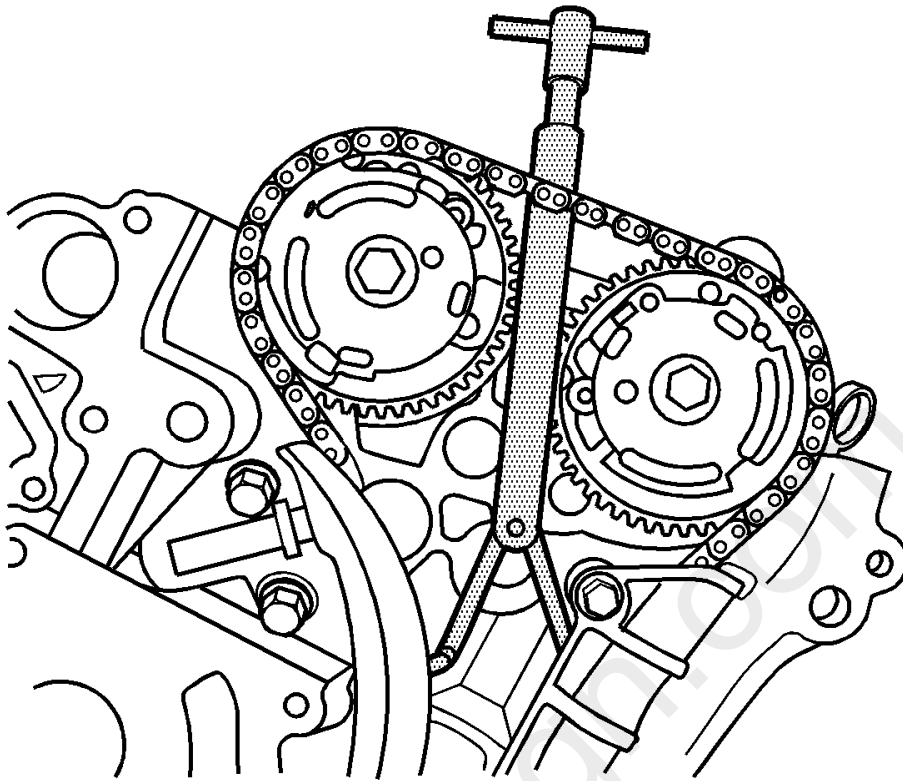


Fig. 164: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

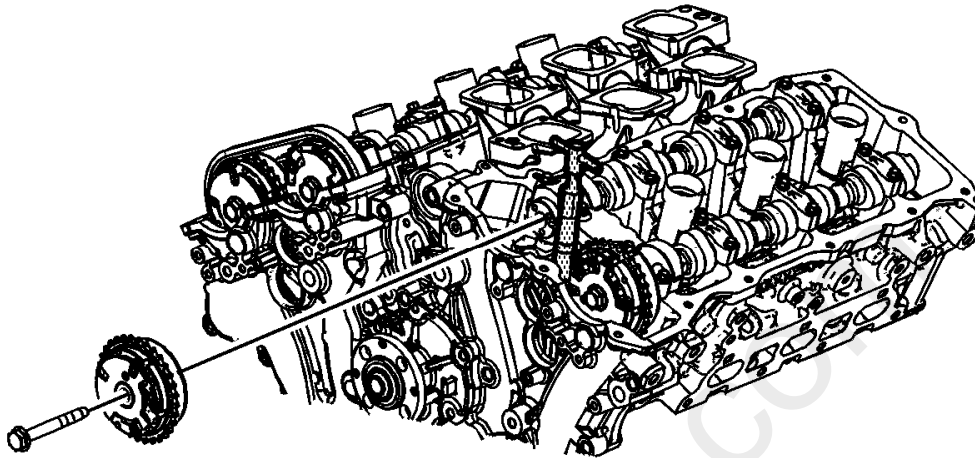


Fig. 165: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

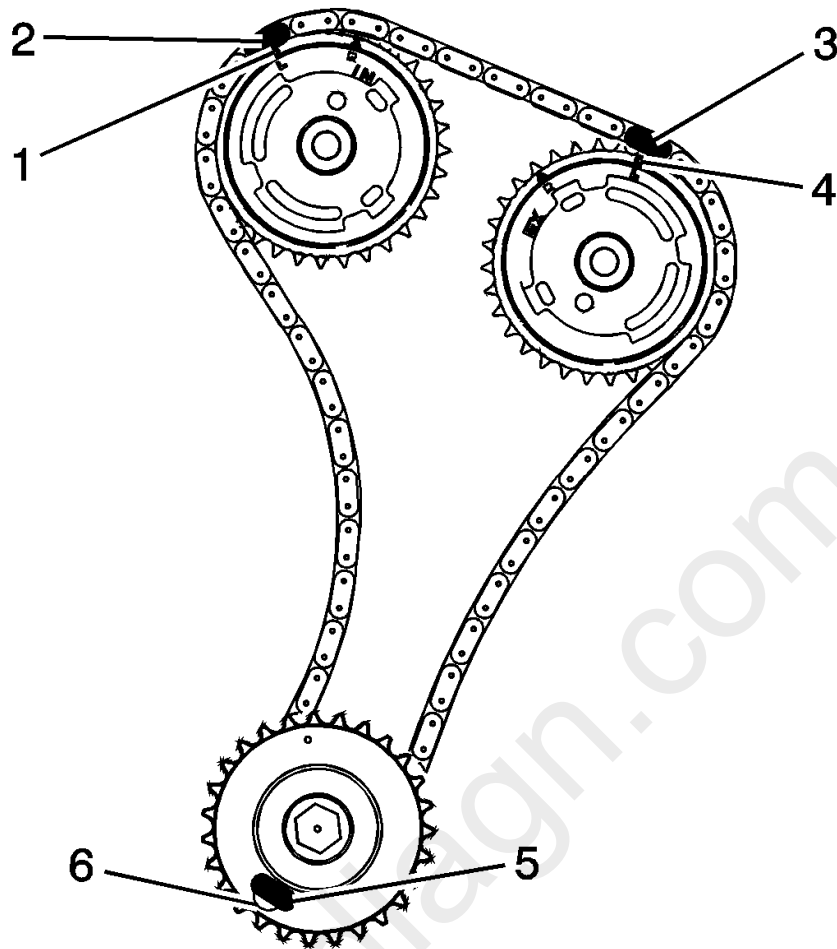


Fig. 166: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

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

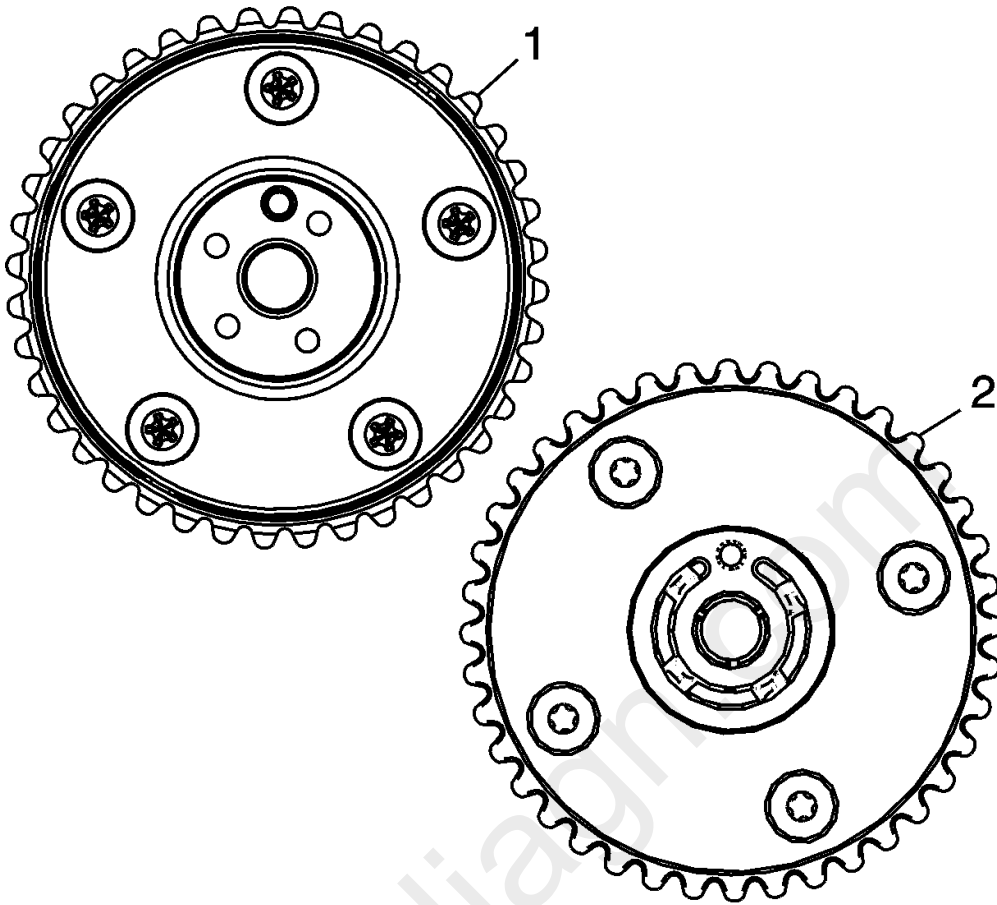


Fig. 167: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- The camshaft position actuator will vary depending on application.
- Camshaft thrust washers must only be installed on applications that had thrust washers present during removal of the camshaft position actuators. Do not install washers on applications if they are not already present.

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

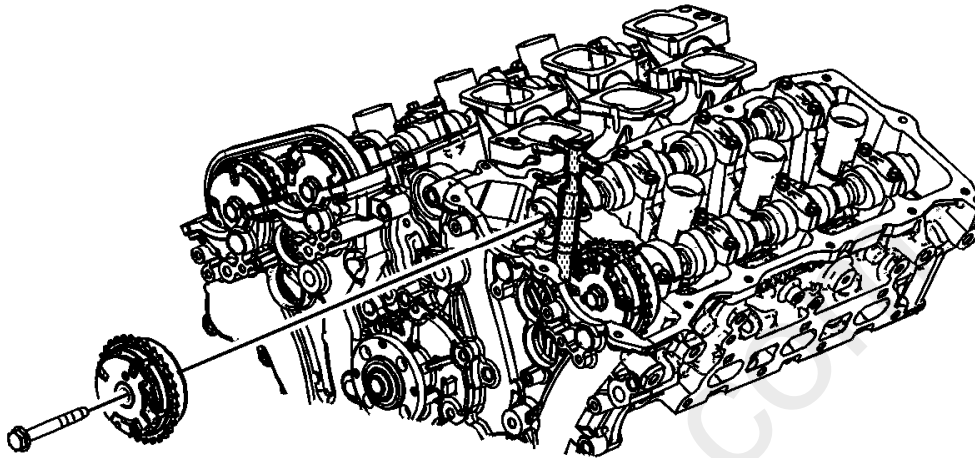


Fig. 168: View Of Exhaust Camshaft Position Actuator Bolt
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
8. If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
9. If both the exhaust and intake has been replaced, then tighten bolt to 58 N.m (43 lb ft).
10. Install the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake (LF3)** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (LFX)** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust (LF3)** .
11. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake (LFX)** , **Camshaft Position Sensor Replacement - Bank 2**

(Left Side) Intake (LF3) , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust (LFX)** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust (LF3)** .

12. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement (LFX)**, **Intake Manifold Replacement (LF3)**.

SETTING CAMSHAFT TIMING

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

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

CAMSHAFT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the fuel pump. Refer to **Fuel Pump Replacement (LFX)** , **Fuel Pump Replacement (LF3)** .
2. Remove the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 2**.

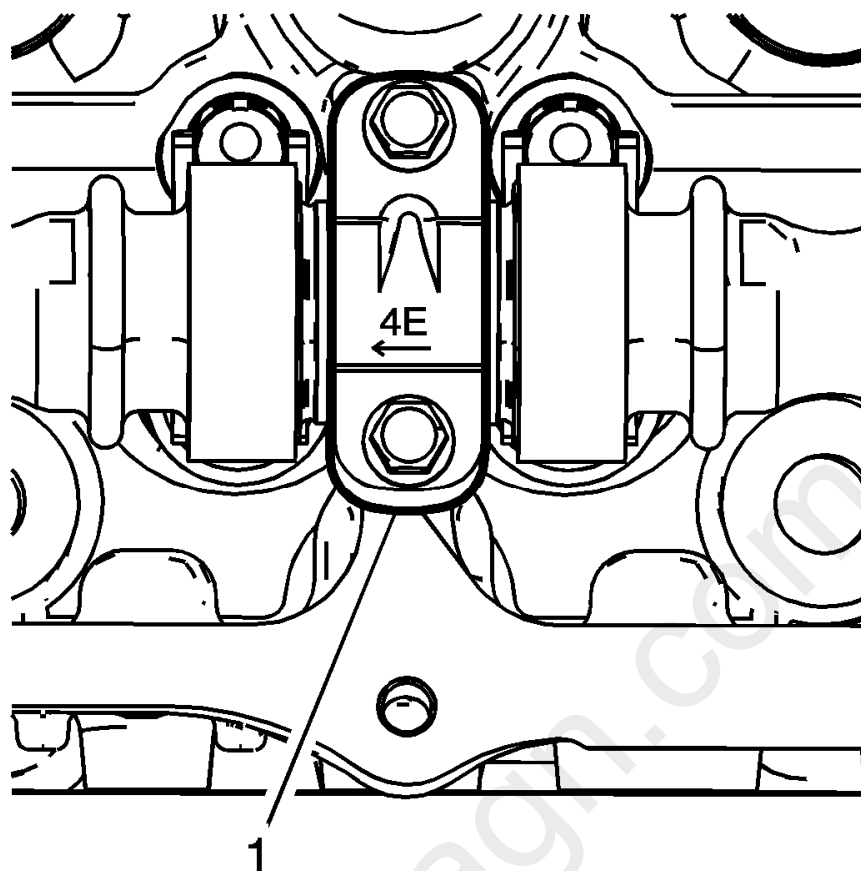


Fig. 169: Bearing Caps

Courtesy of GENERAL MOTORS COMPANY

3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

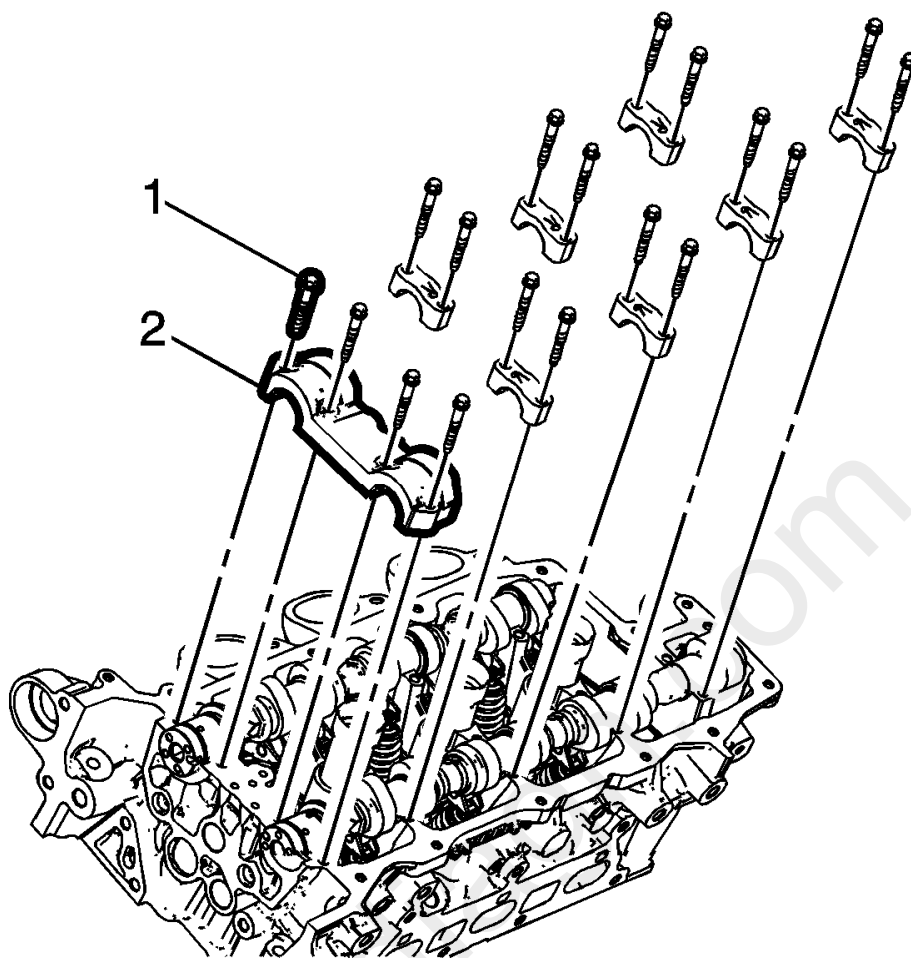


Fig. 170: Bearing Cap Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft bearing cap bolts (1).
5. Remove the camshaft bearing caps (2).

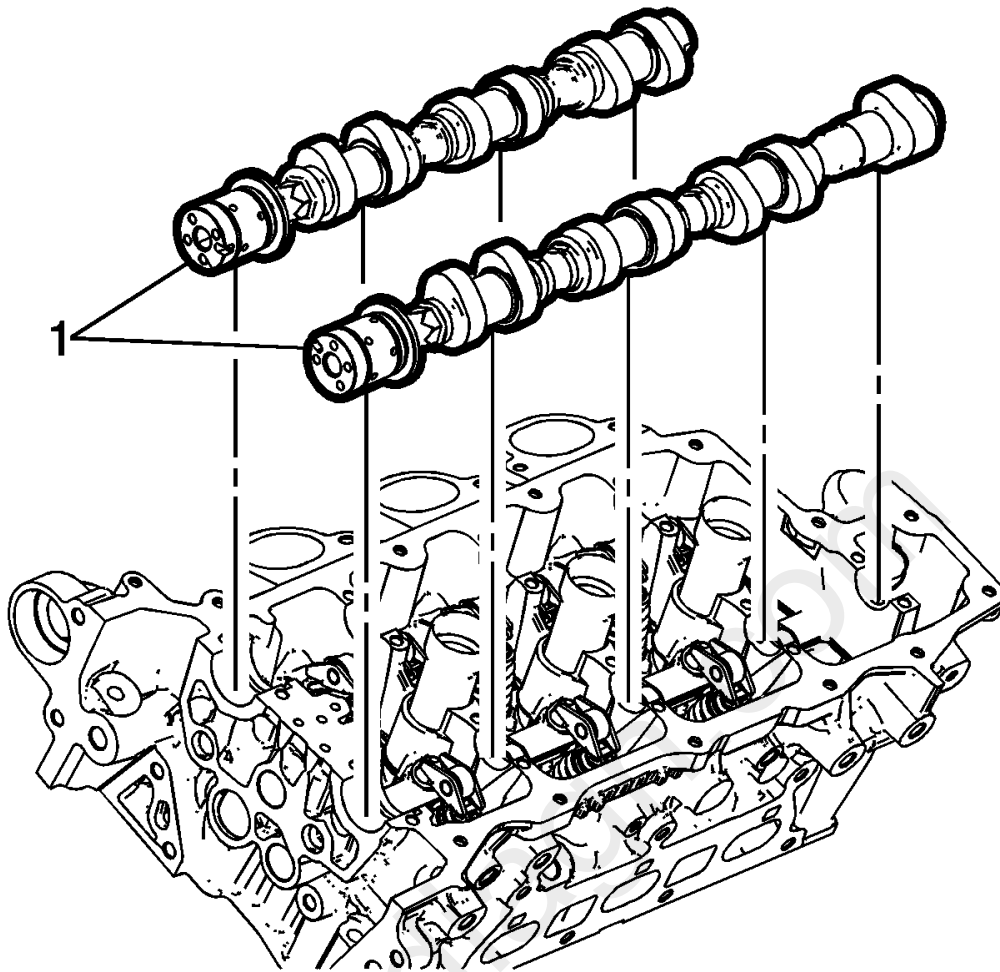


Fig. 171: Camshafts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the camshafts upon removal to ensure installation is in the correct position.

6. Remove the camshafts (1).

Installation Procedure

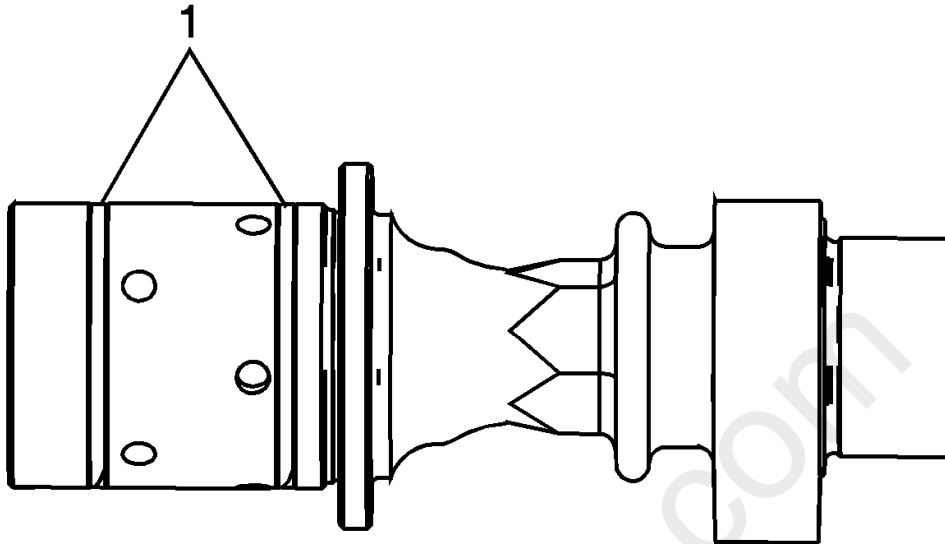


Fig. 172: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

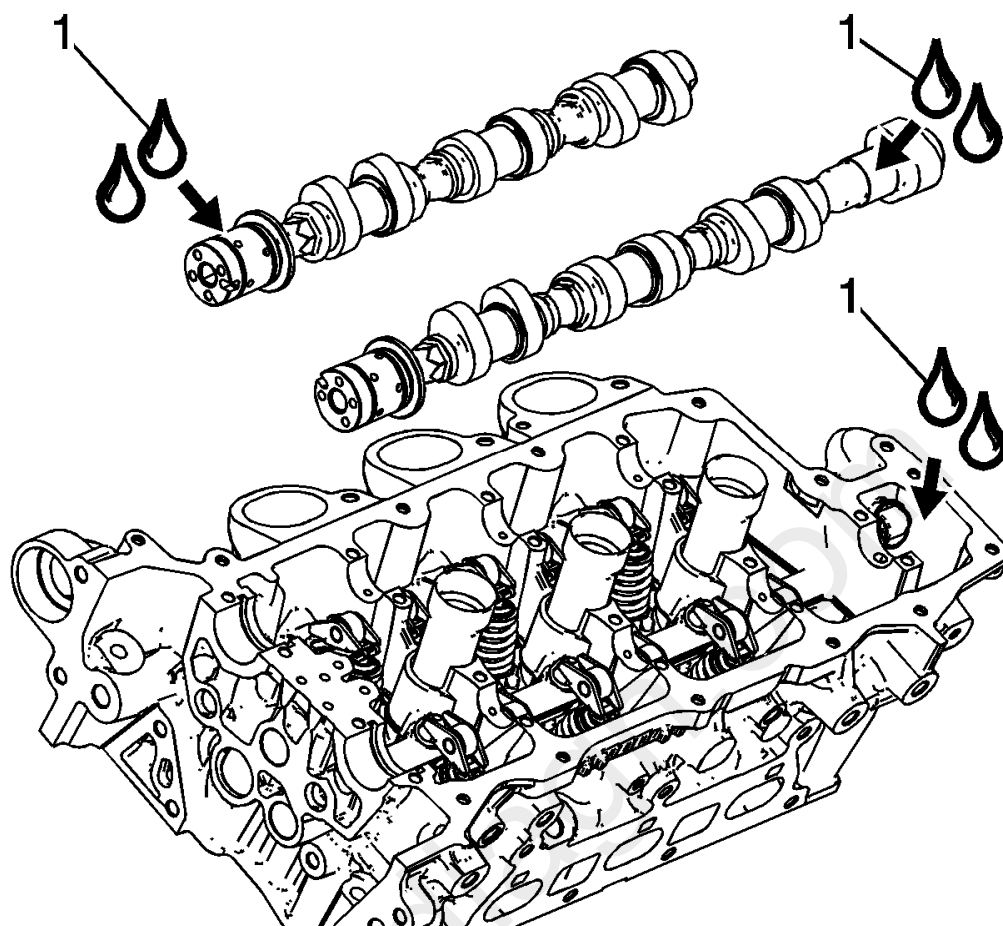


Fig. 173: Camshaft Journal Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the left cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

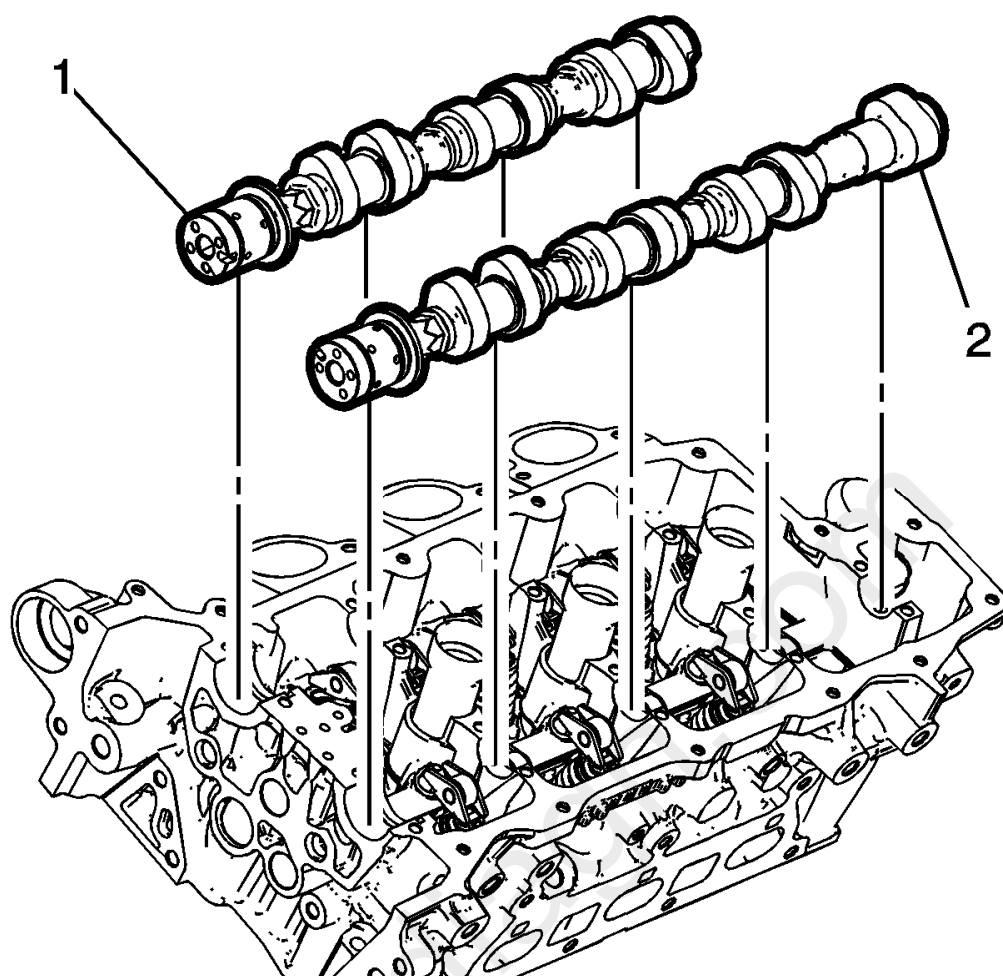


Fig. 174: Camshaft Intake And Exhaust Positioning Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake (1) and left exhaust (2) camshafts in position in the left cylinder head.

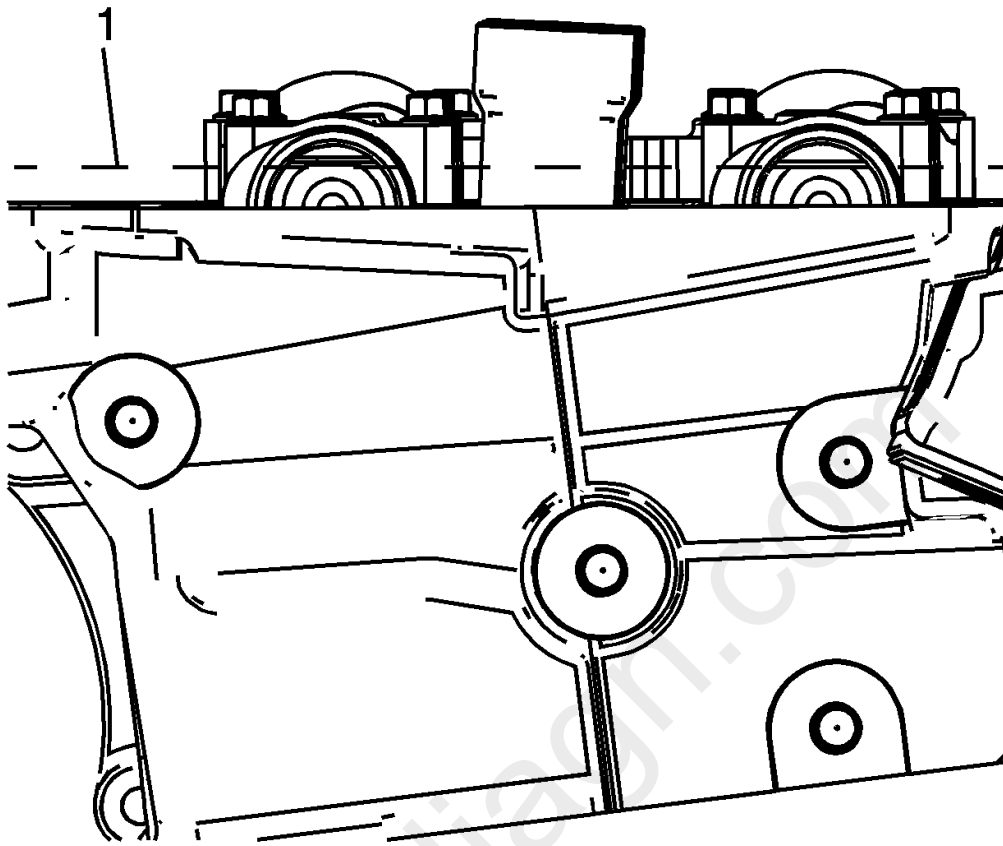


Fig. 175: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

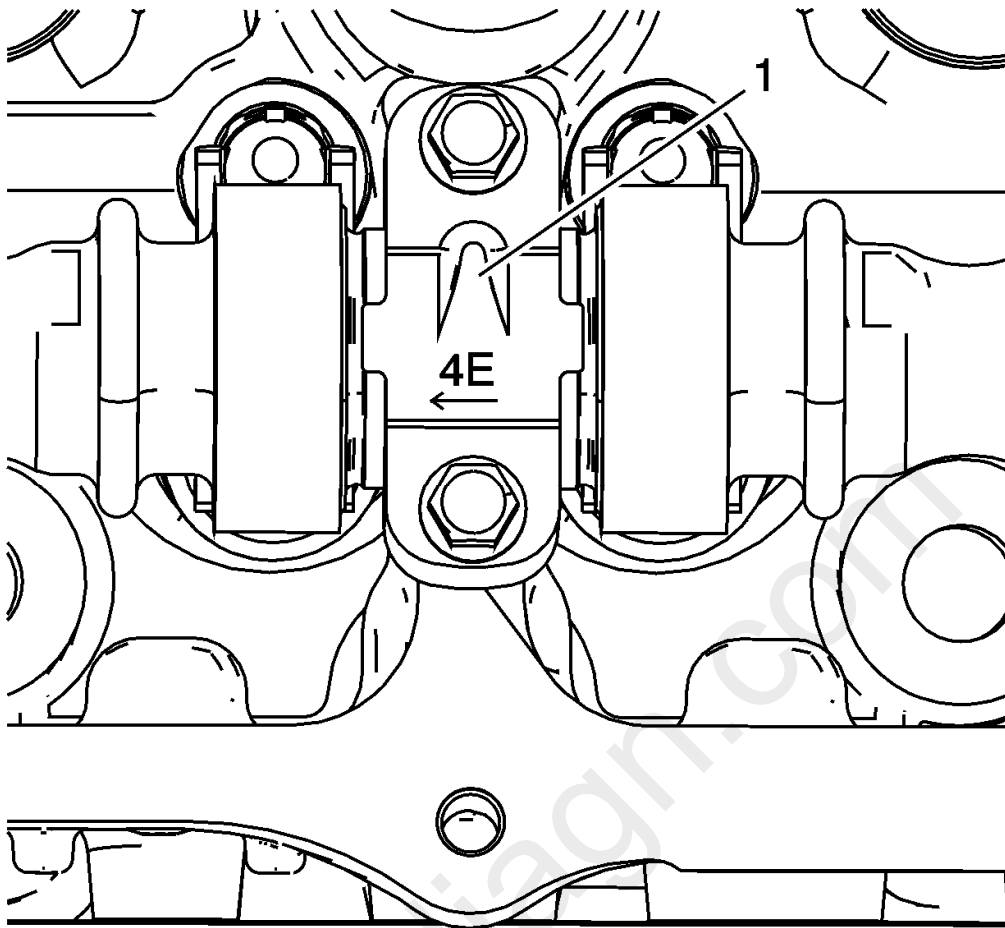


Fig. 176: Left Cylinder Head Camshaft Bearing Cap Markings
 Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

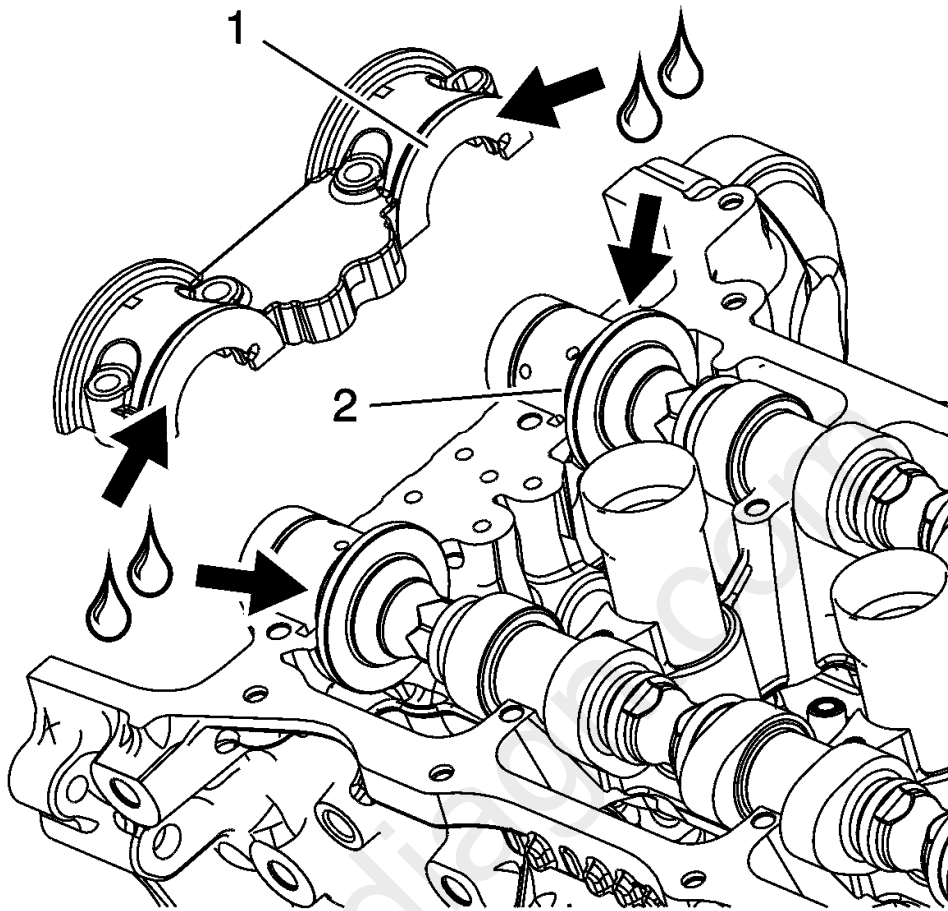


Fig. 177: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

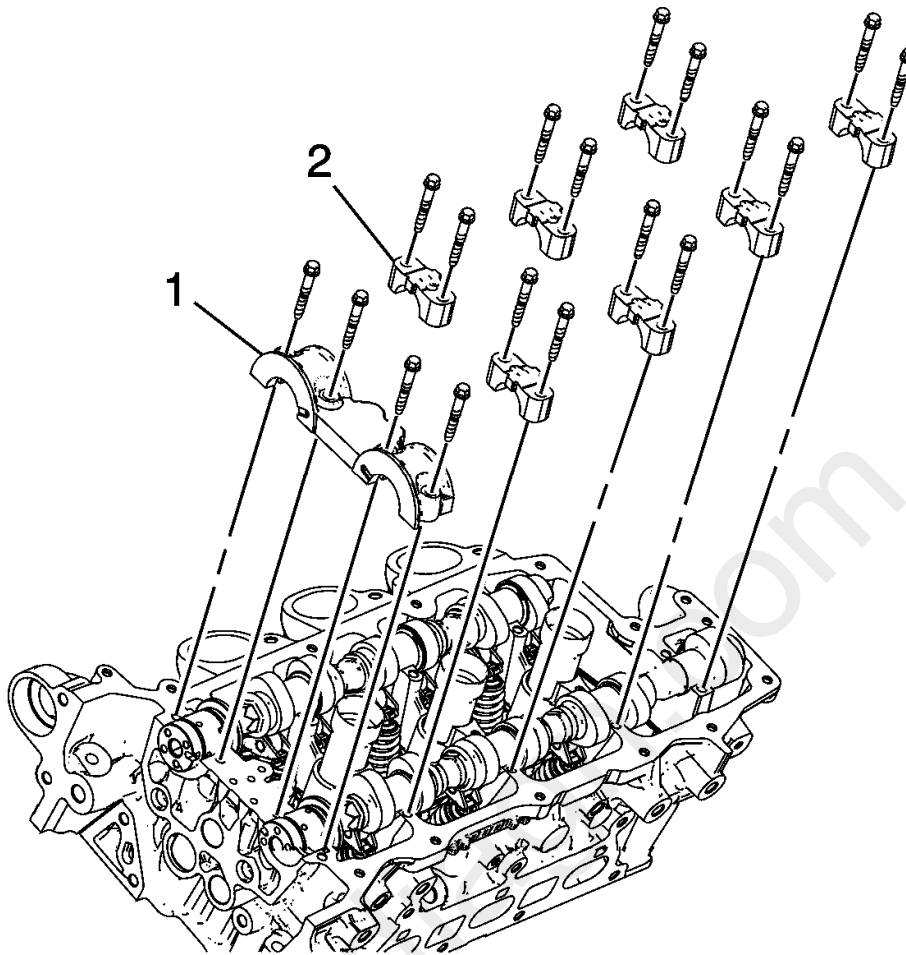


Fig. 178: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

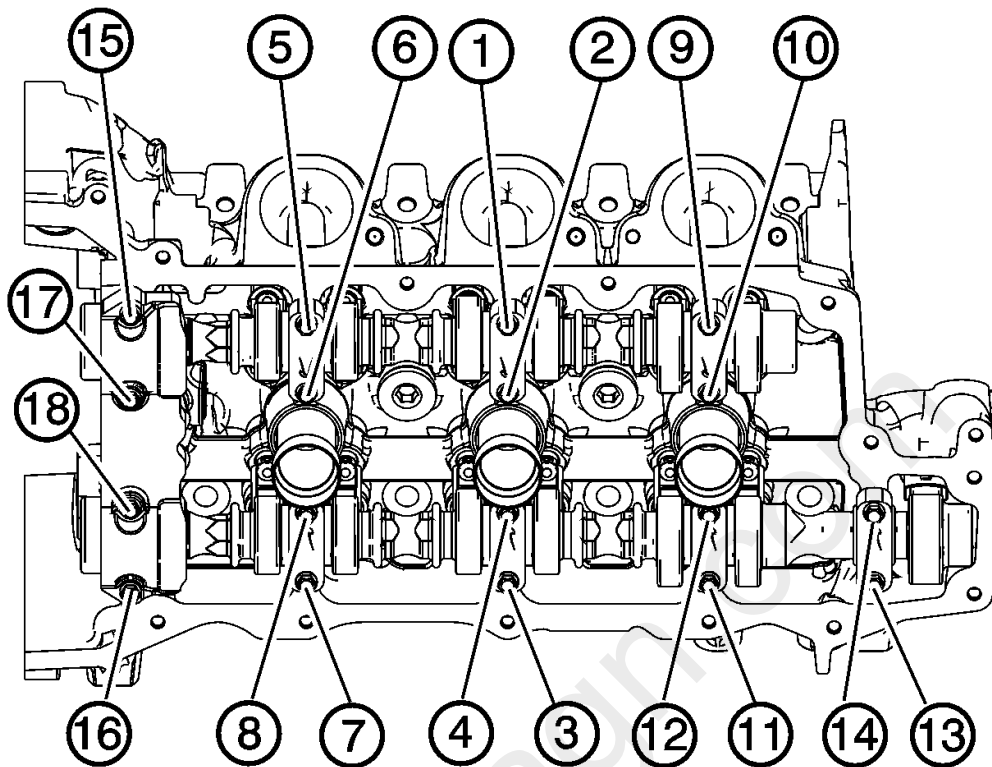


Fig. 179: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 2.
15. Install the fuel pump. Refer to Fuel Pump Replacement (LFX) , Fuel Pump Replacement (LF3) .

CAMSHAFT REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 .

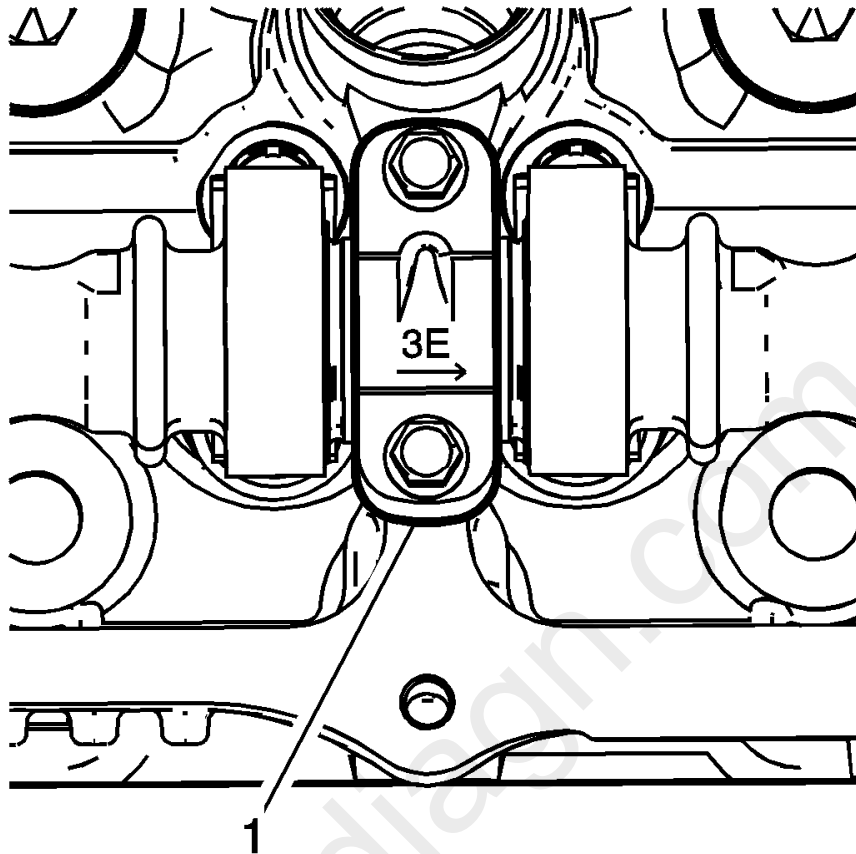


Fig. 180: Bearing Cap Markings

Courtesy of GENERAL MOTORS COMPANY

2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

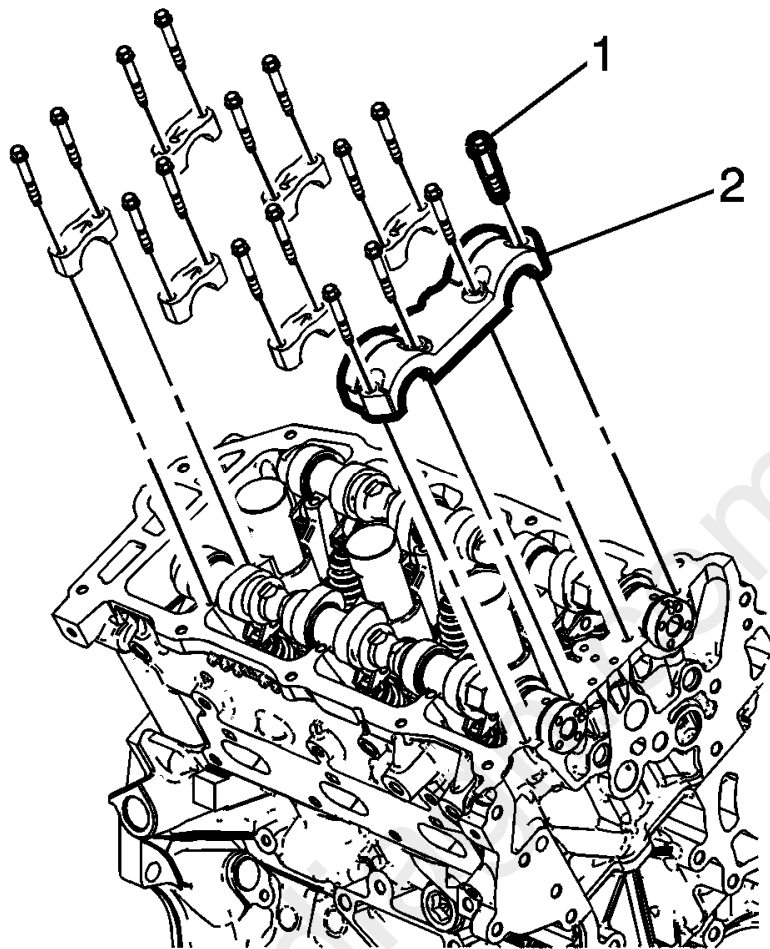


Fig. 181: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).

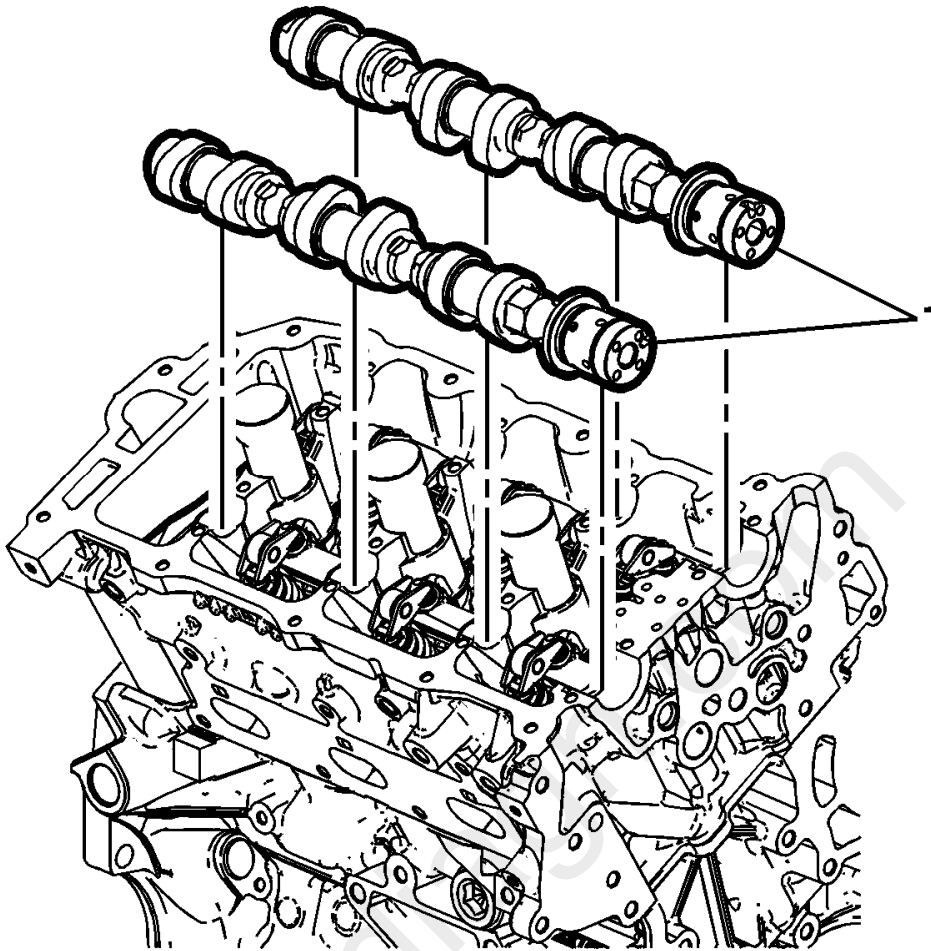


Fig. 182: Camshafts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

5. Remove the camshafts (1).

Installation Procedure

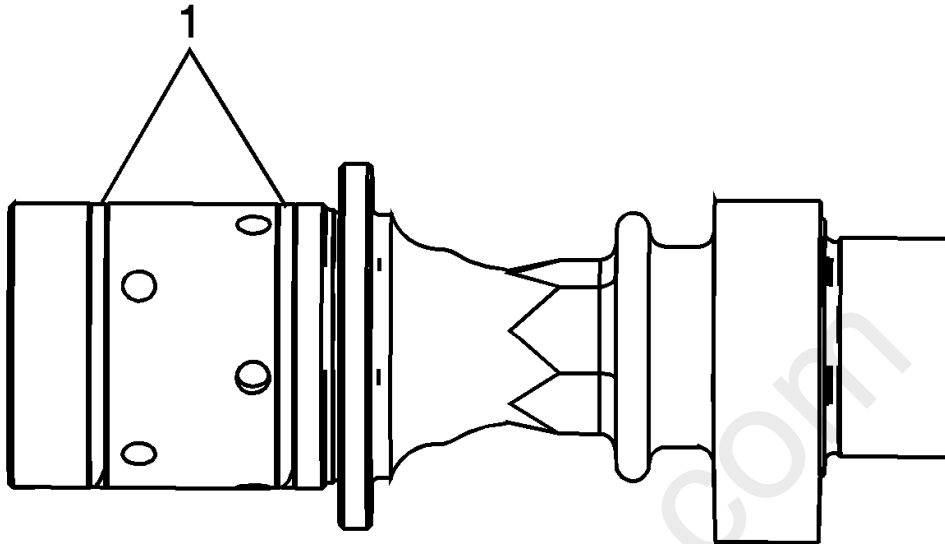


Fig. 183: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

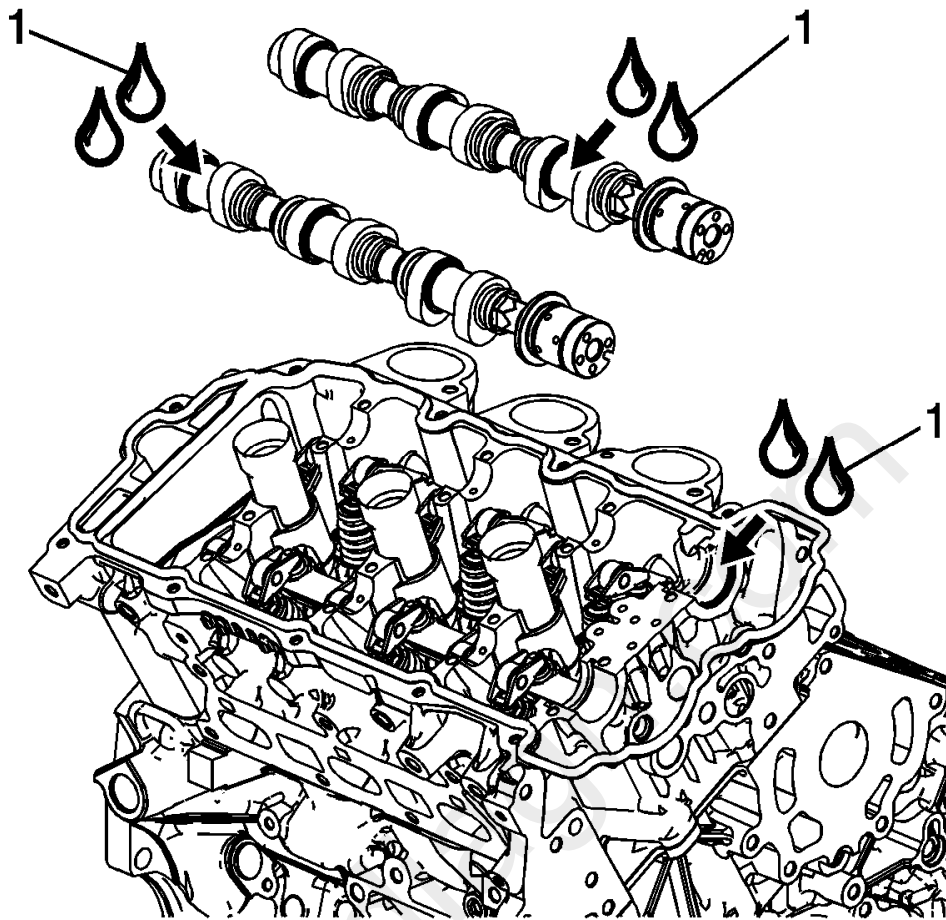


Fig. 184: Right Cylinder Head Camshaft Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

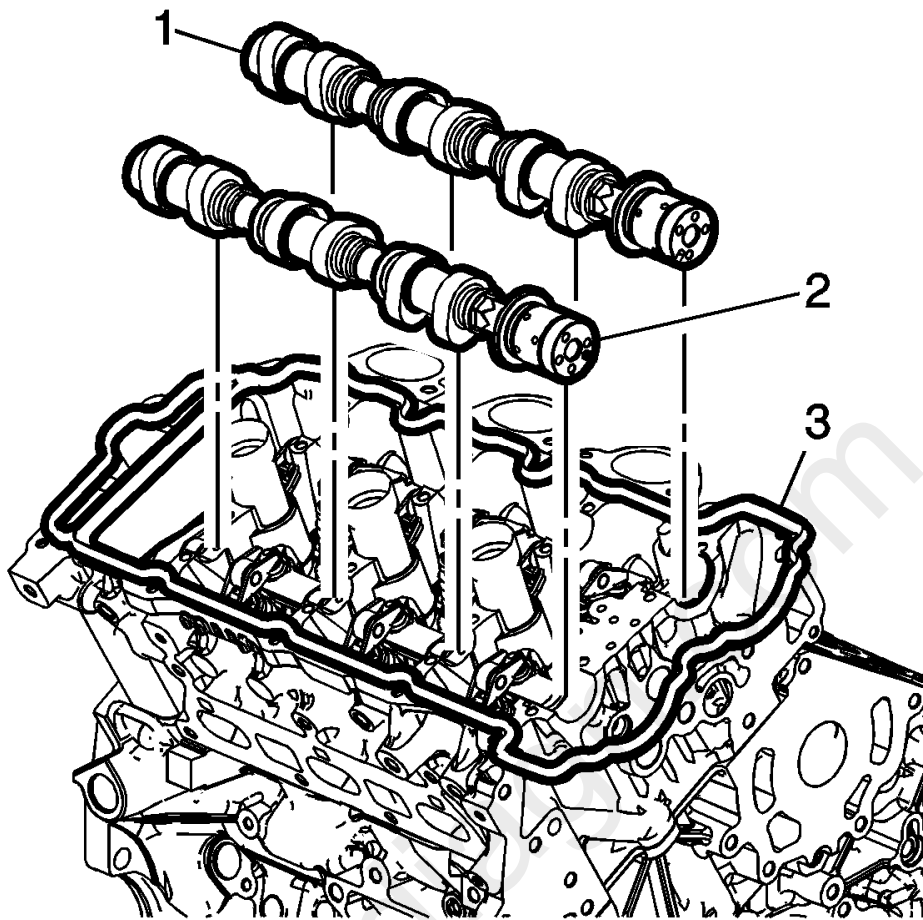


Fig. 185: Right Cylinder Head Camshaft Intake And Exhaust Positioning Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).

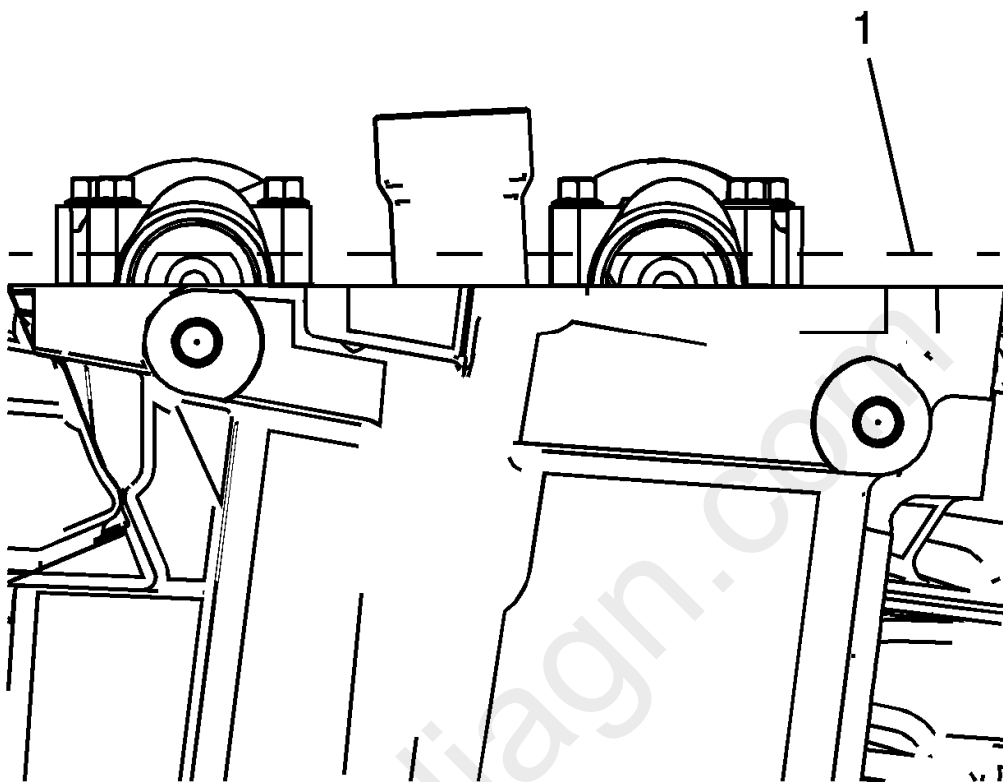


Fig. 186: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

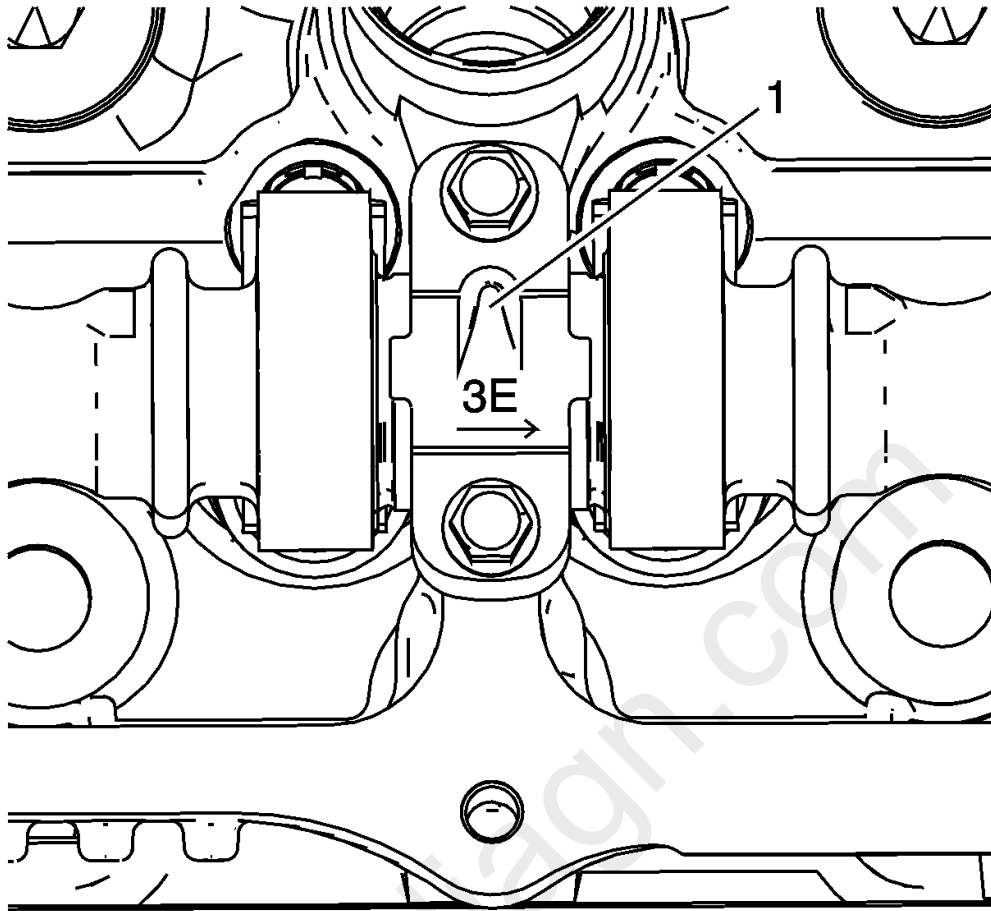


Fig. 187: Right Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature (1) must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

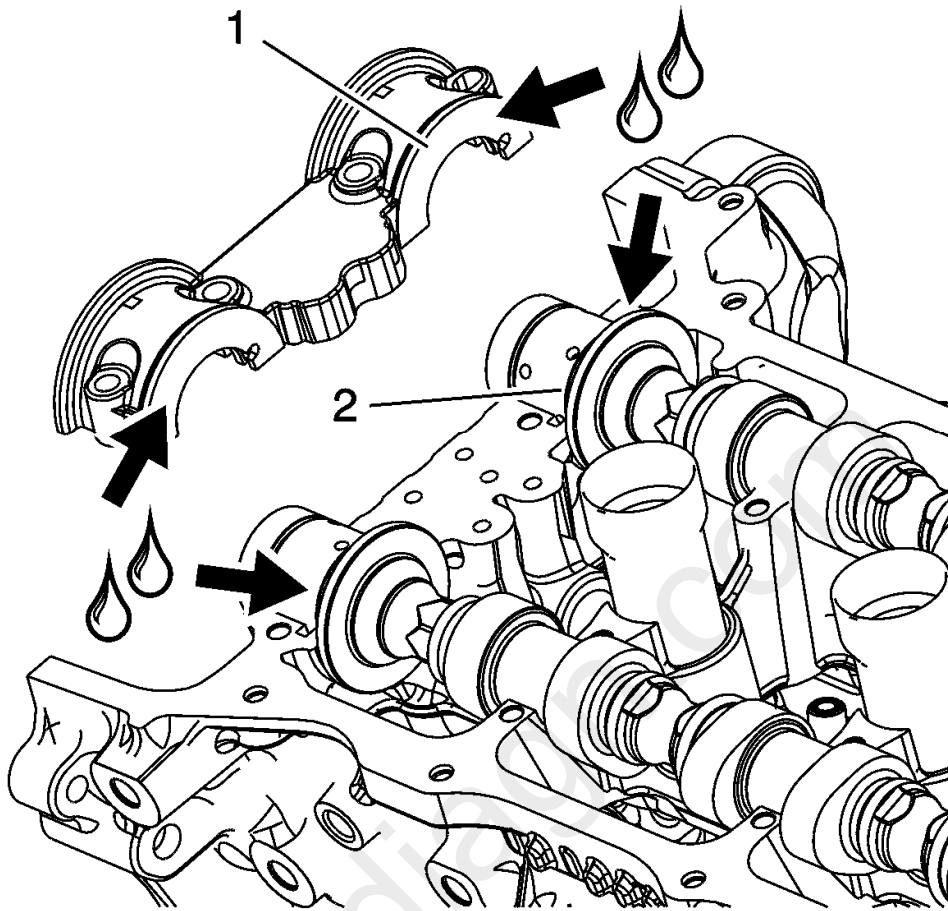


Fig. 188: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

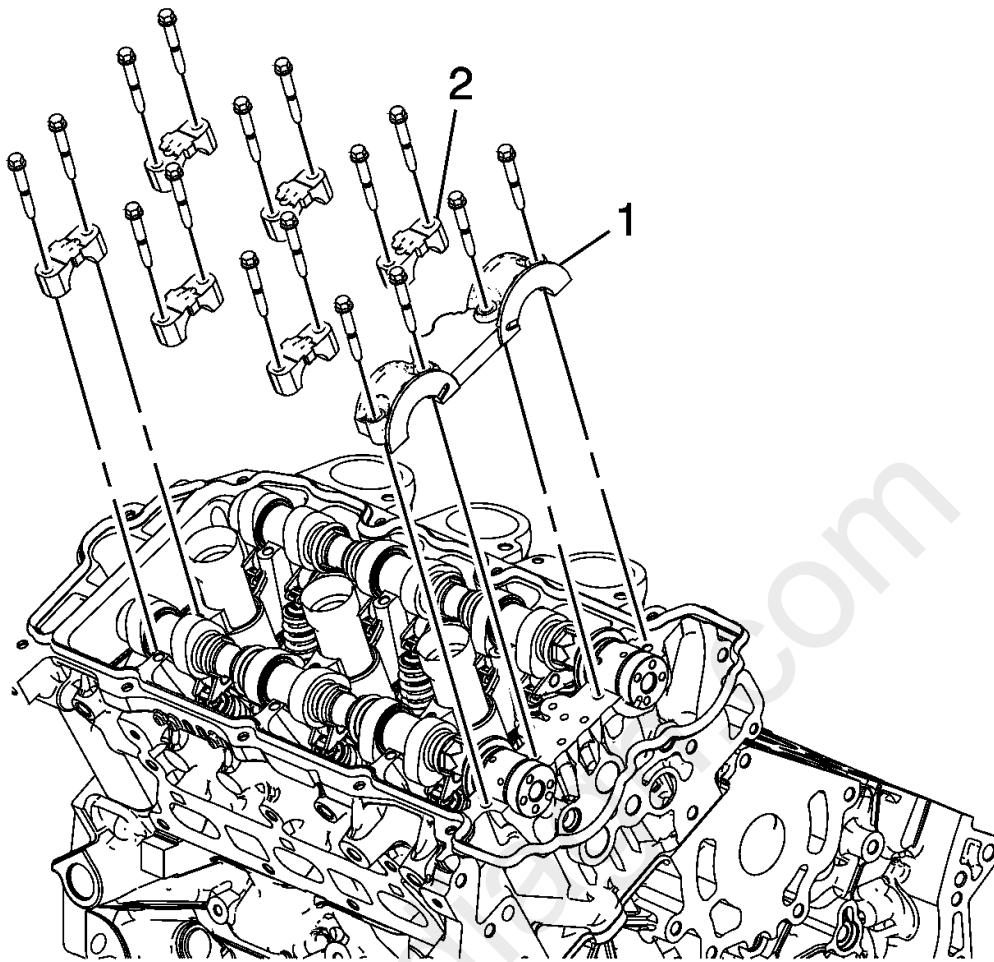


Fig. 189: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

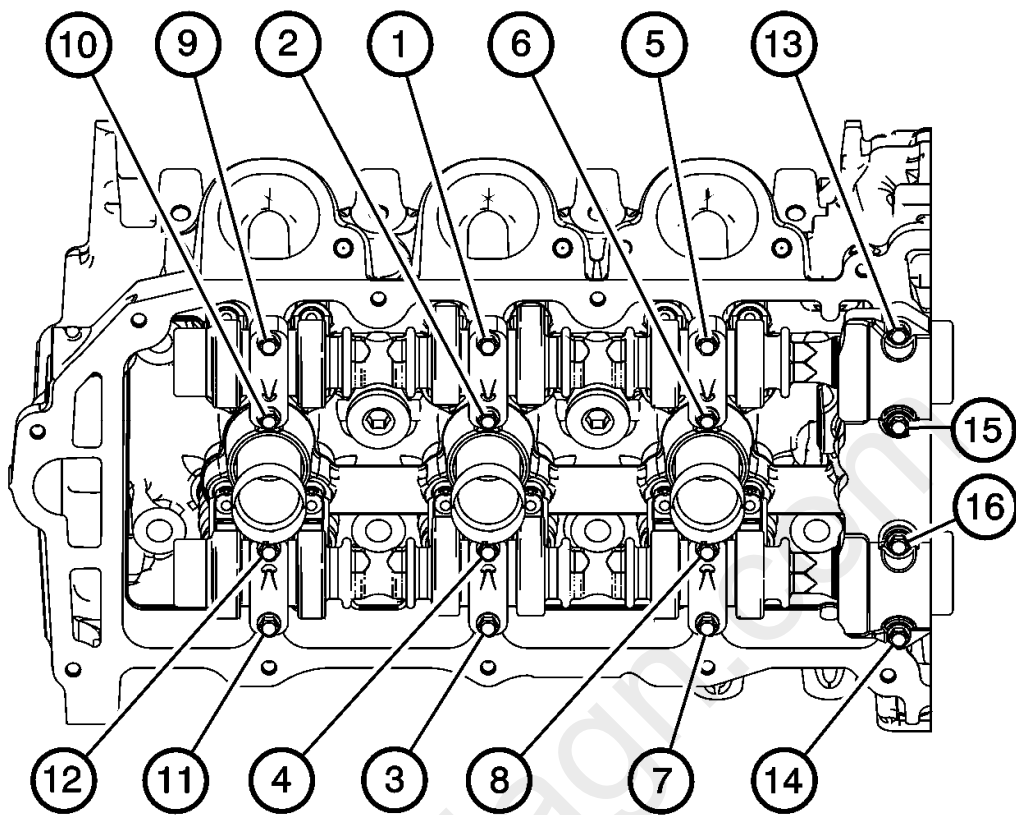


Fig. 190: Camshaft Bearing Cap Bolts Tighten Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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.

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to Camshaft Position Actuator Replacement - Bank 1 .

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

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

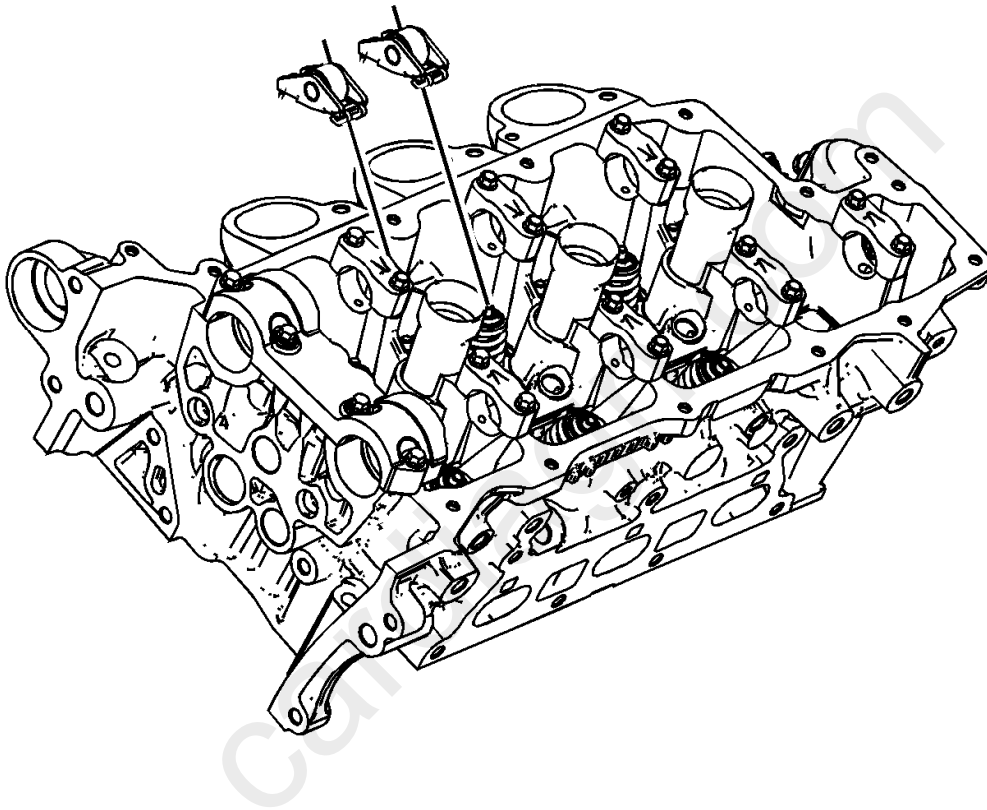


Fig. 191: View Of Valve Rocker Arm - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to Camshaft Cleaning and Inspection , and Valve Rocker Arm Cleaning and Inspection .
4. Clean and inspect the valve lifters and replace as necessary. Refer to Valve Lifter Cleaning and Inspection

Installation Procedure

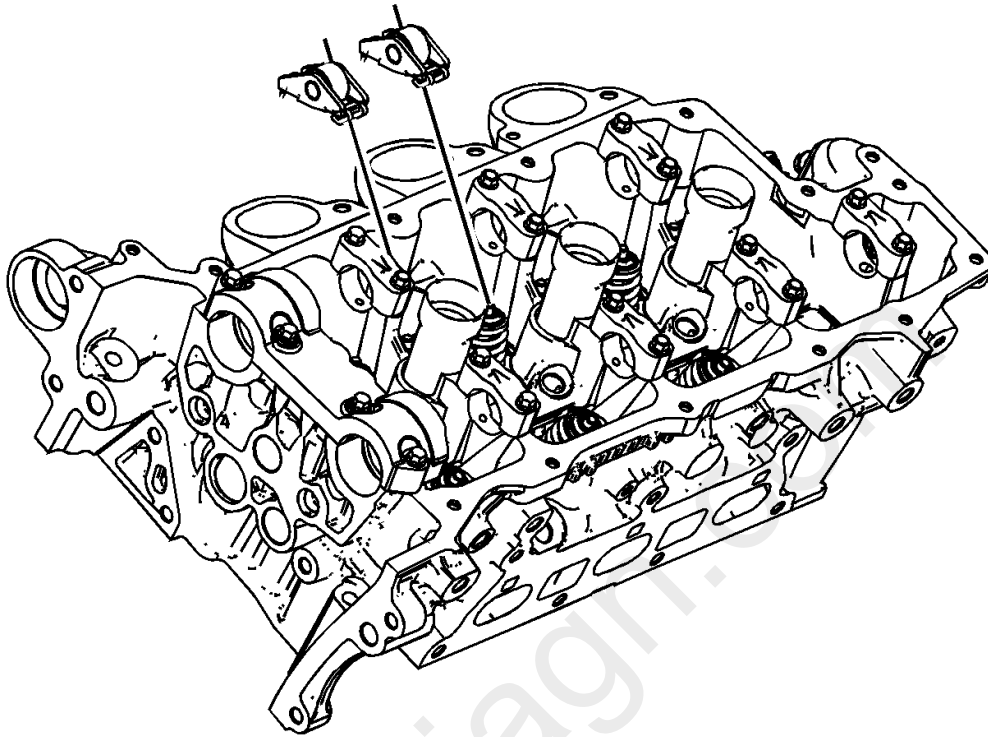


Fig. 192: View Of Valve Rocker Arm - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

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

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

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

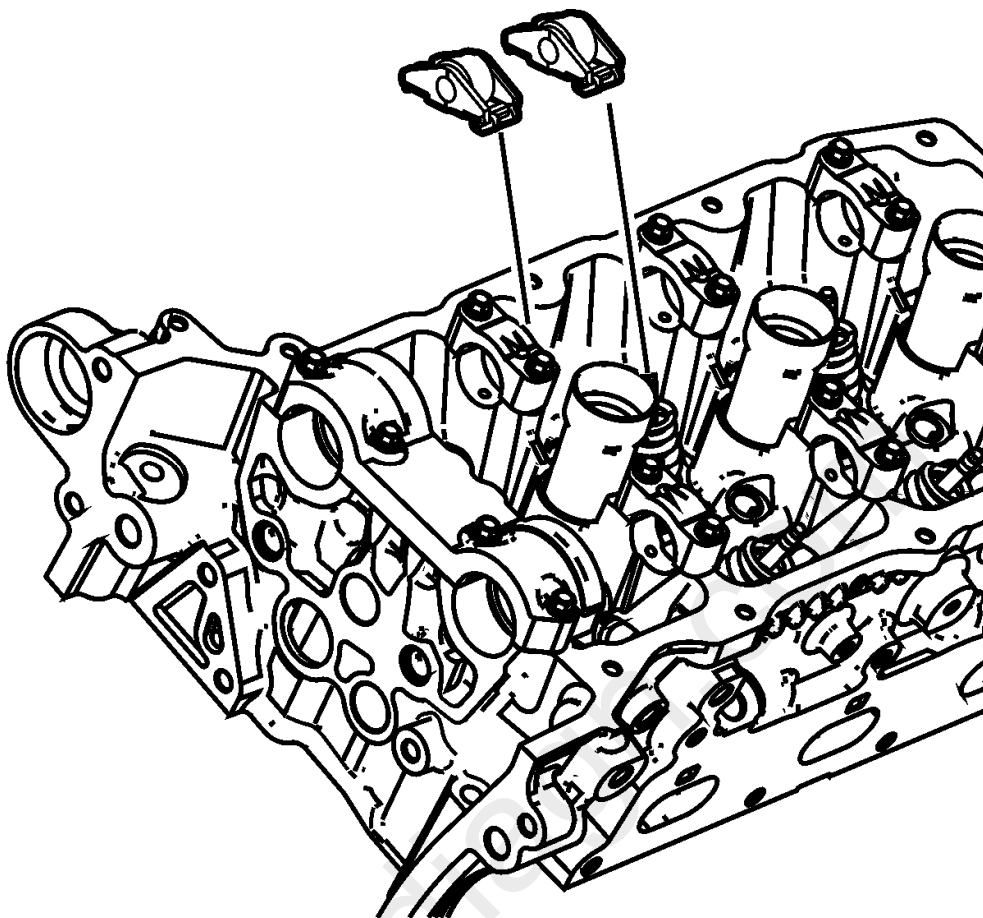


Fig. 193: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Rocker Arm Cleaning and Inspection** .
4. Clean and inspect the valve lifters and replace as necessary. Refer to **Valve Lifter Cleaning and Inspection**

Installation Procedure

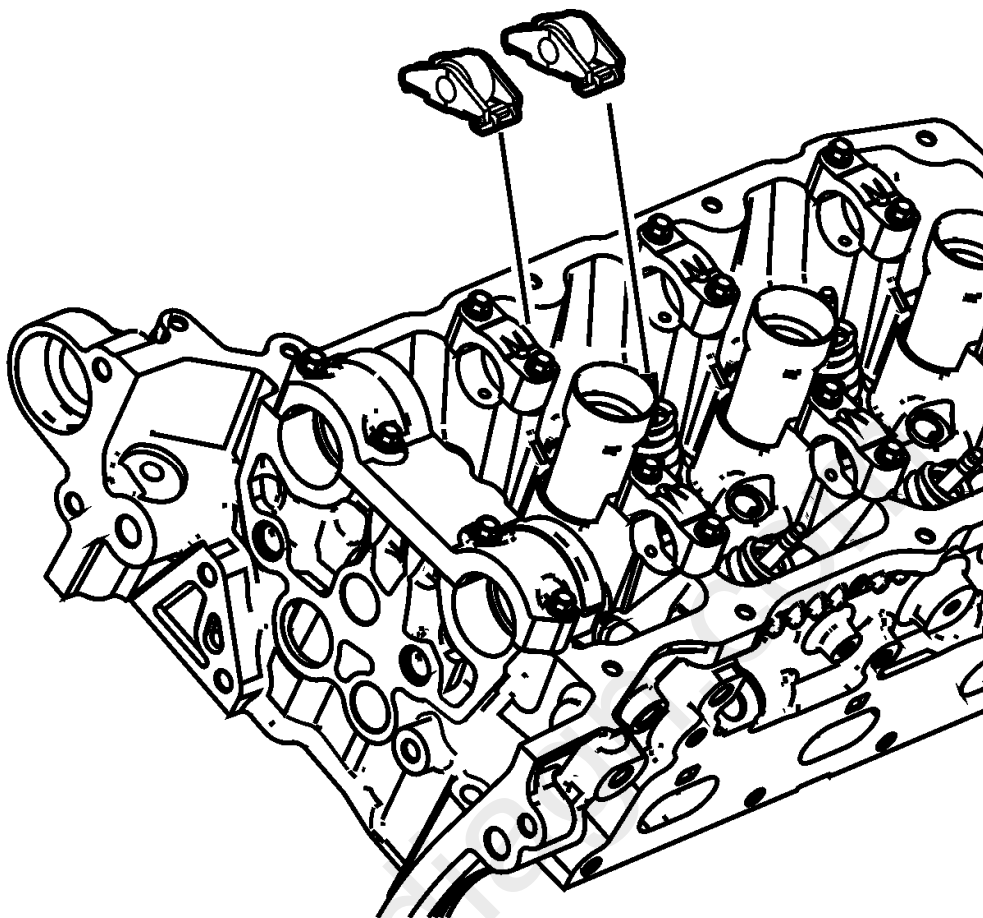


Fig. 194: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

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

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

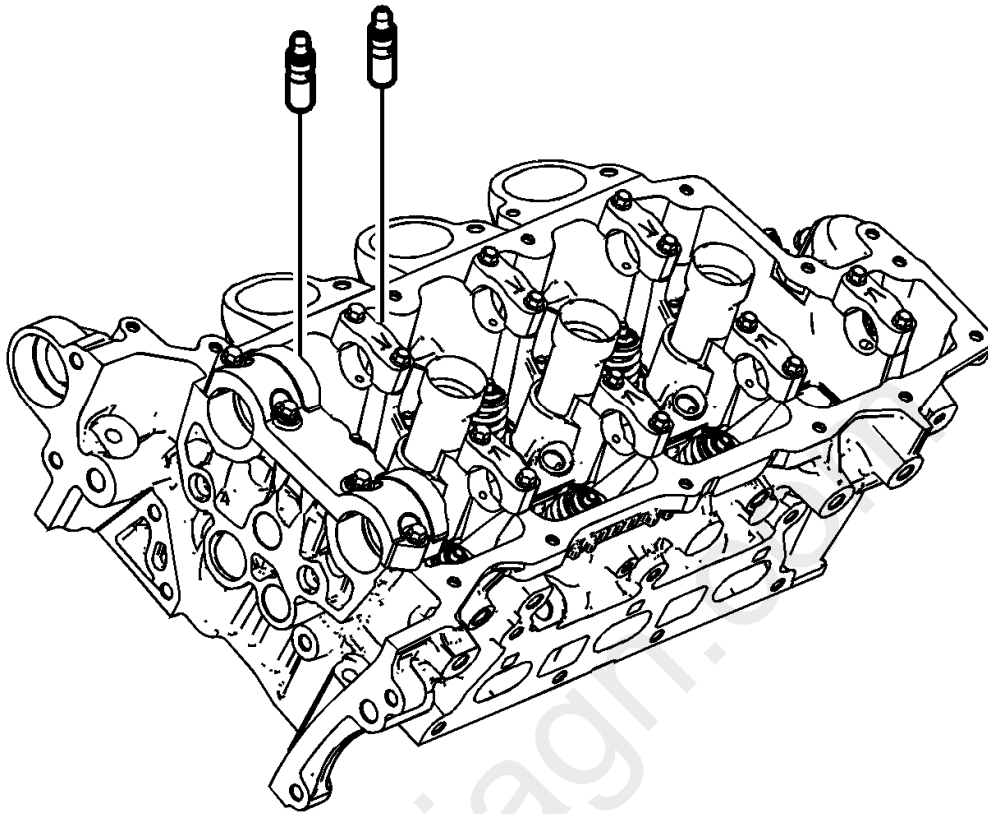


Fig. 195: Valve Lifter Removal - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

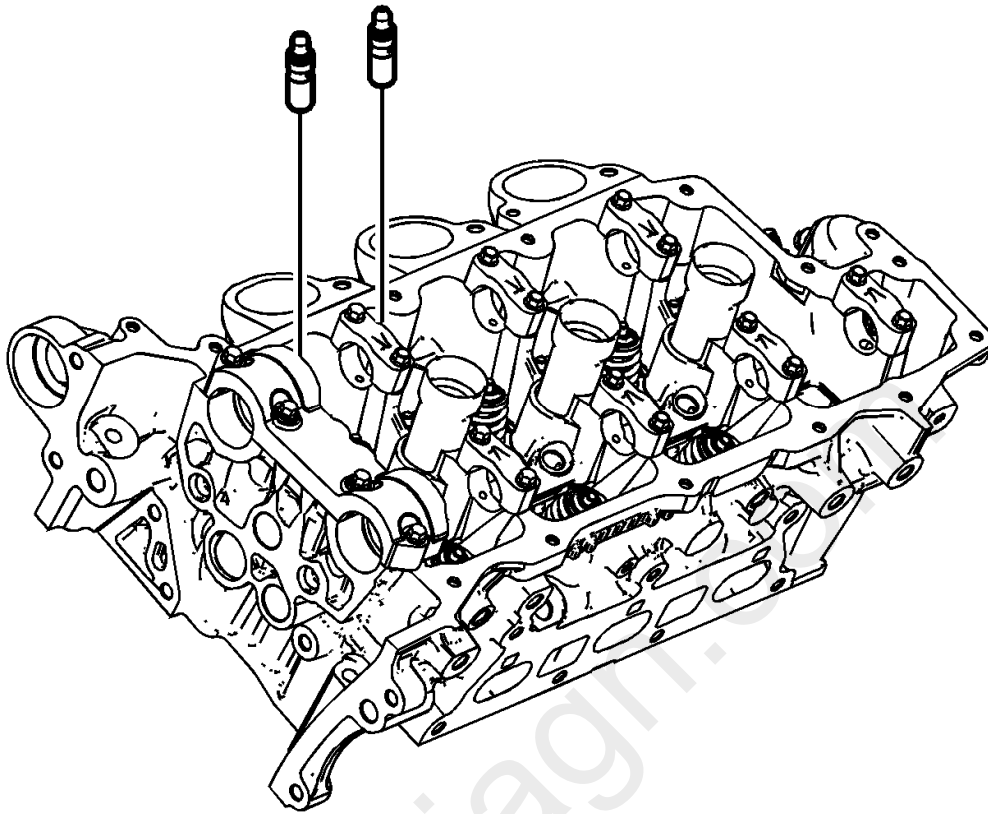


Fig. 196: Valve Lifter Removal - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

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

VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

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

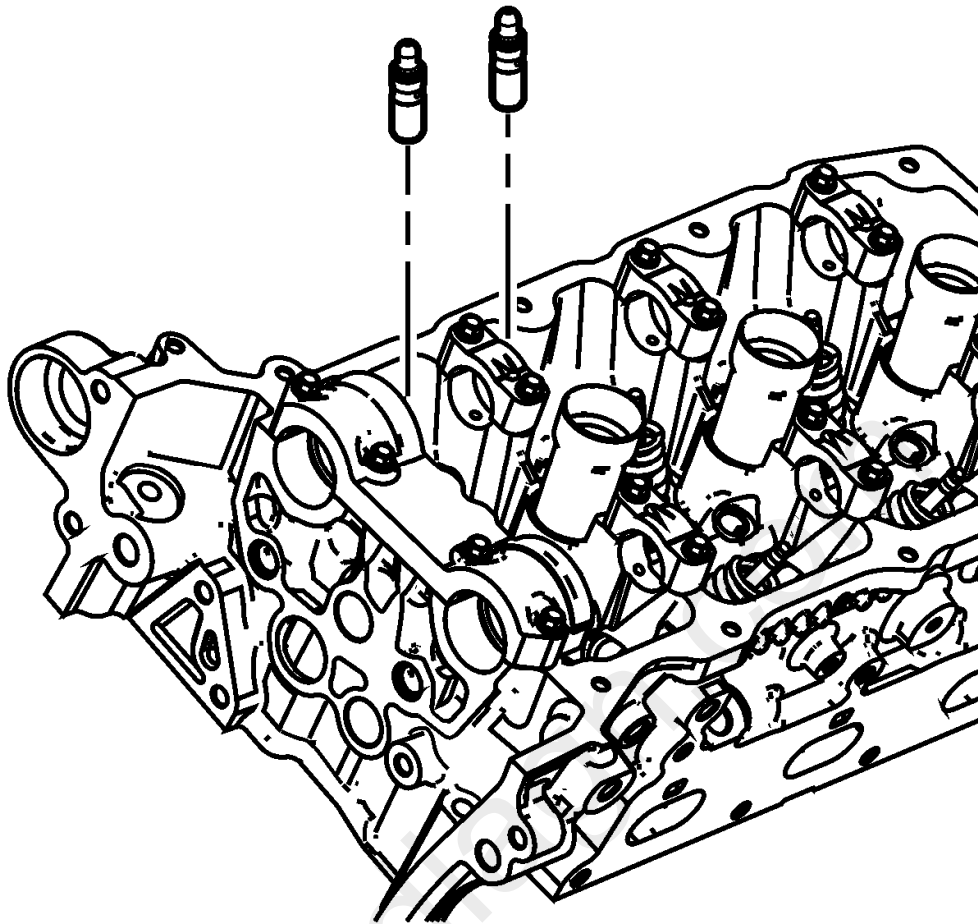


Fig. 197: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

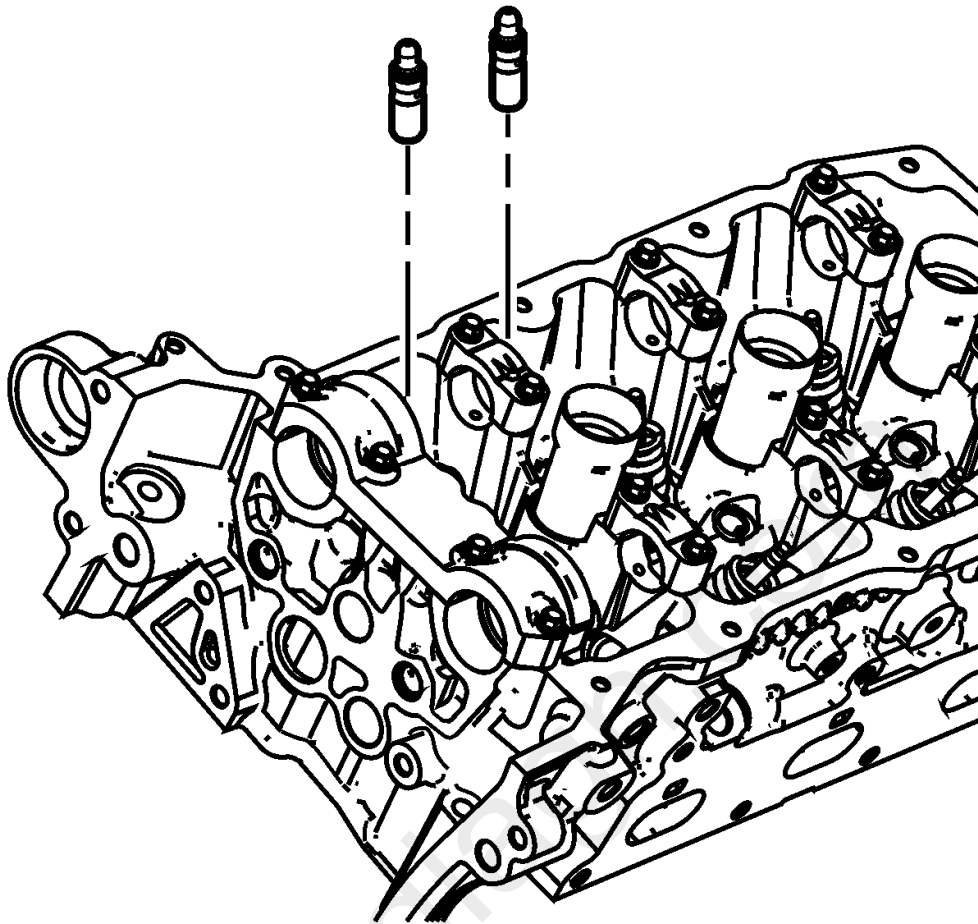


Fig. 198: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

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

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

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

Removal Procedure

NOTE: This procedure is not used in Brazil.

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
2. Remove the starter motor. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .

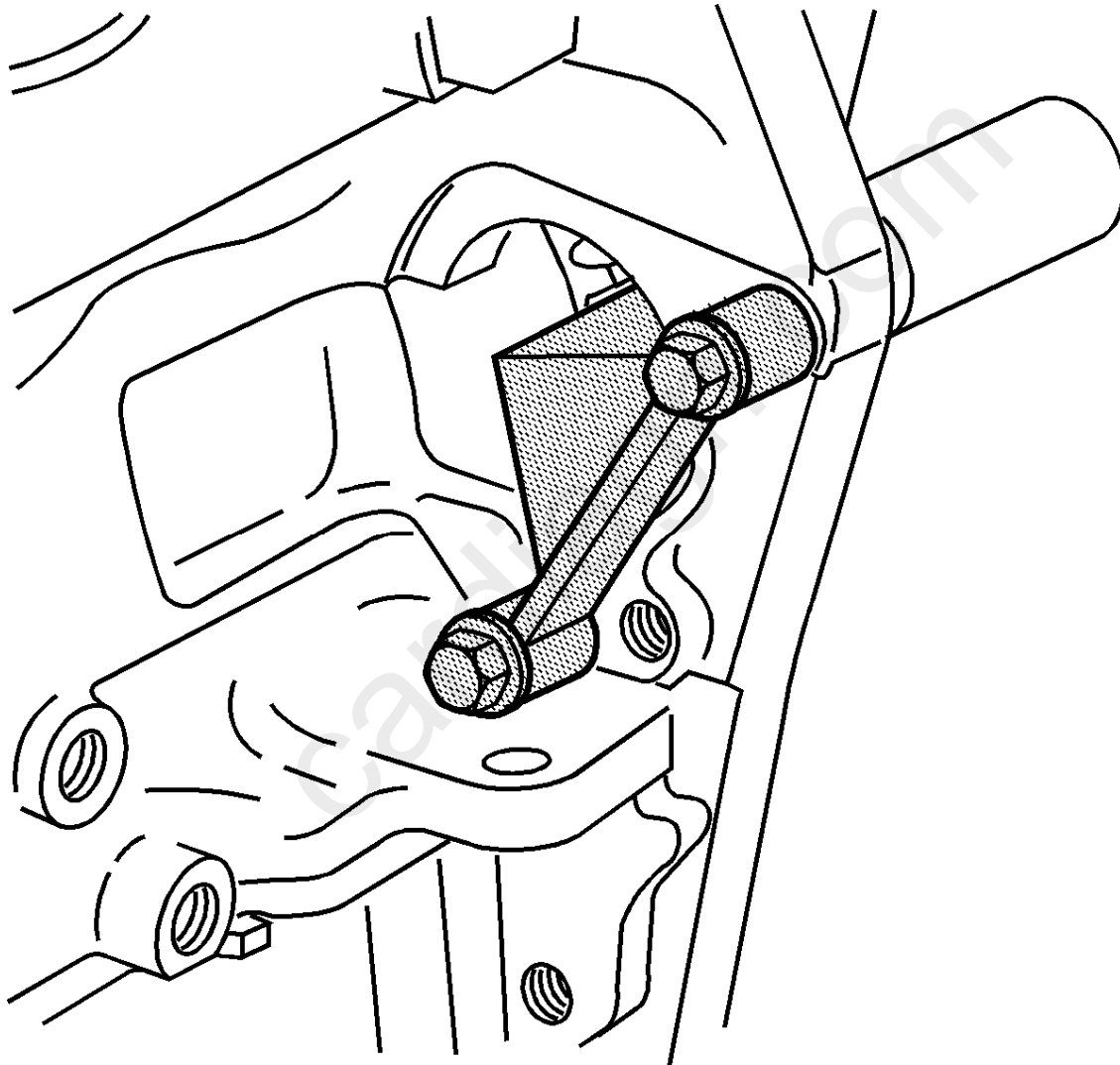


Fig. 199: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

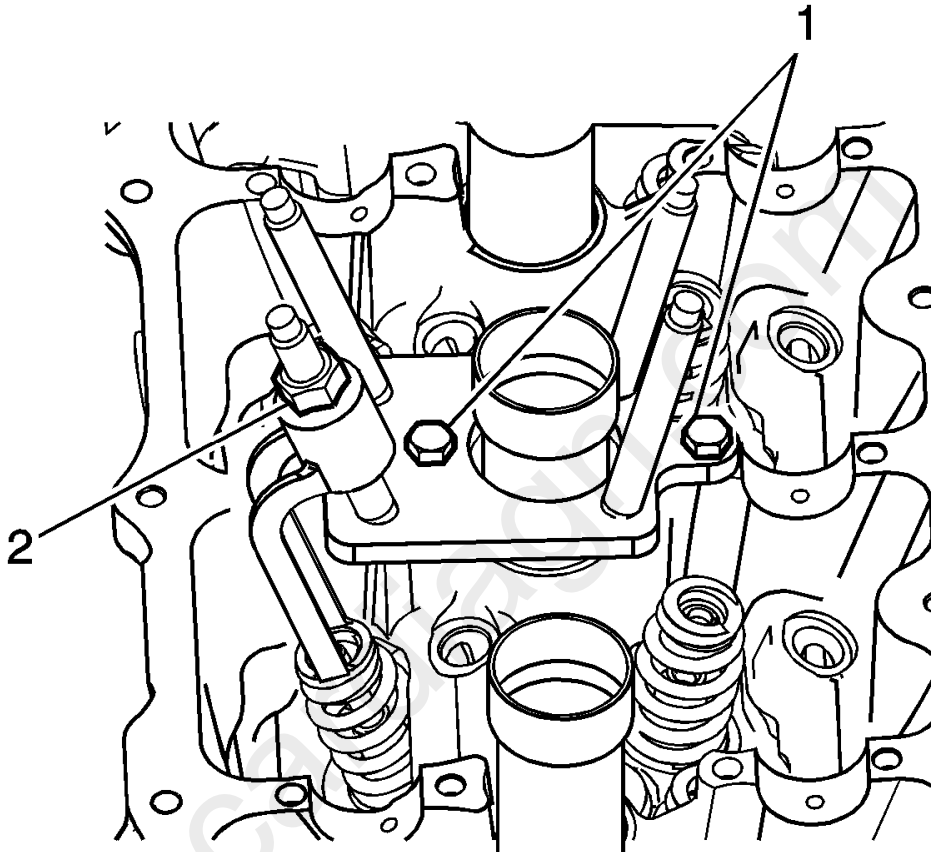


Fig. 200: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

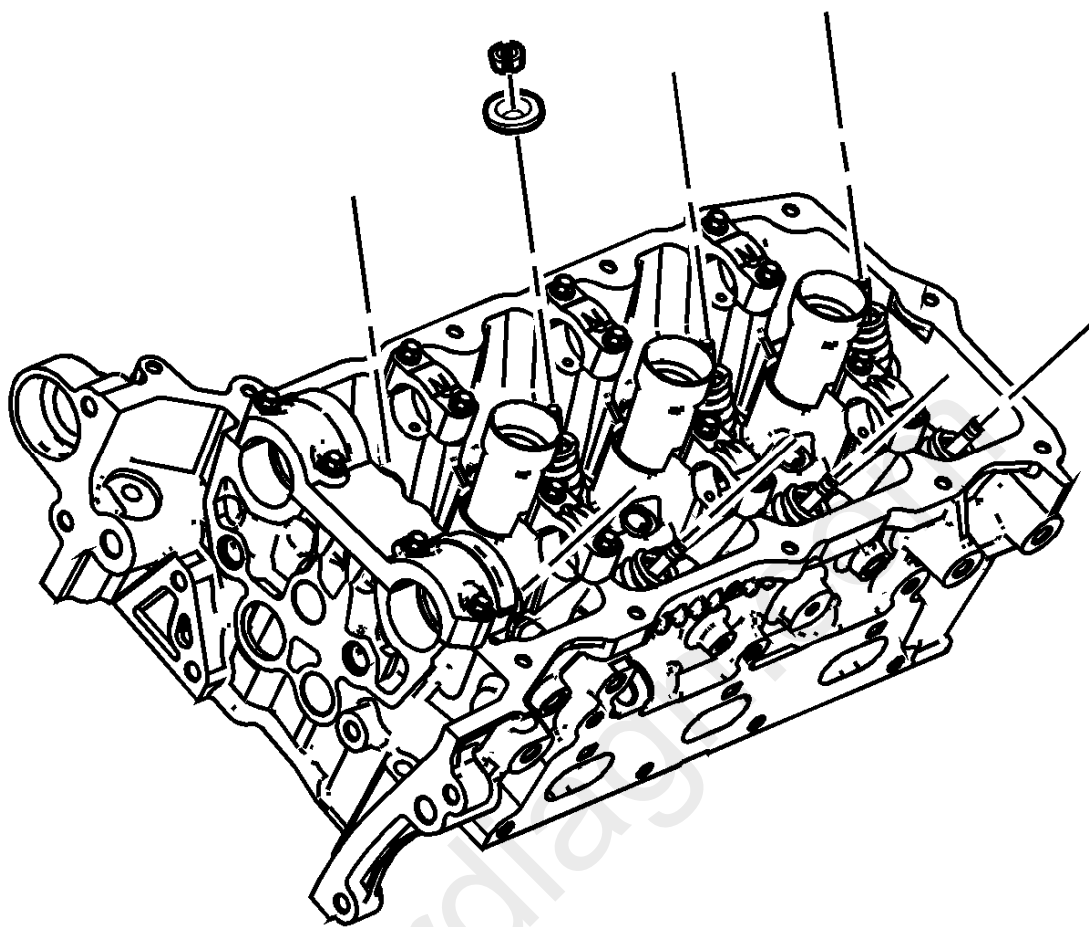


Fig. 201: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

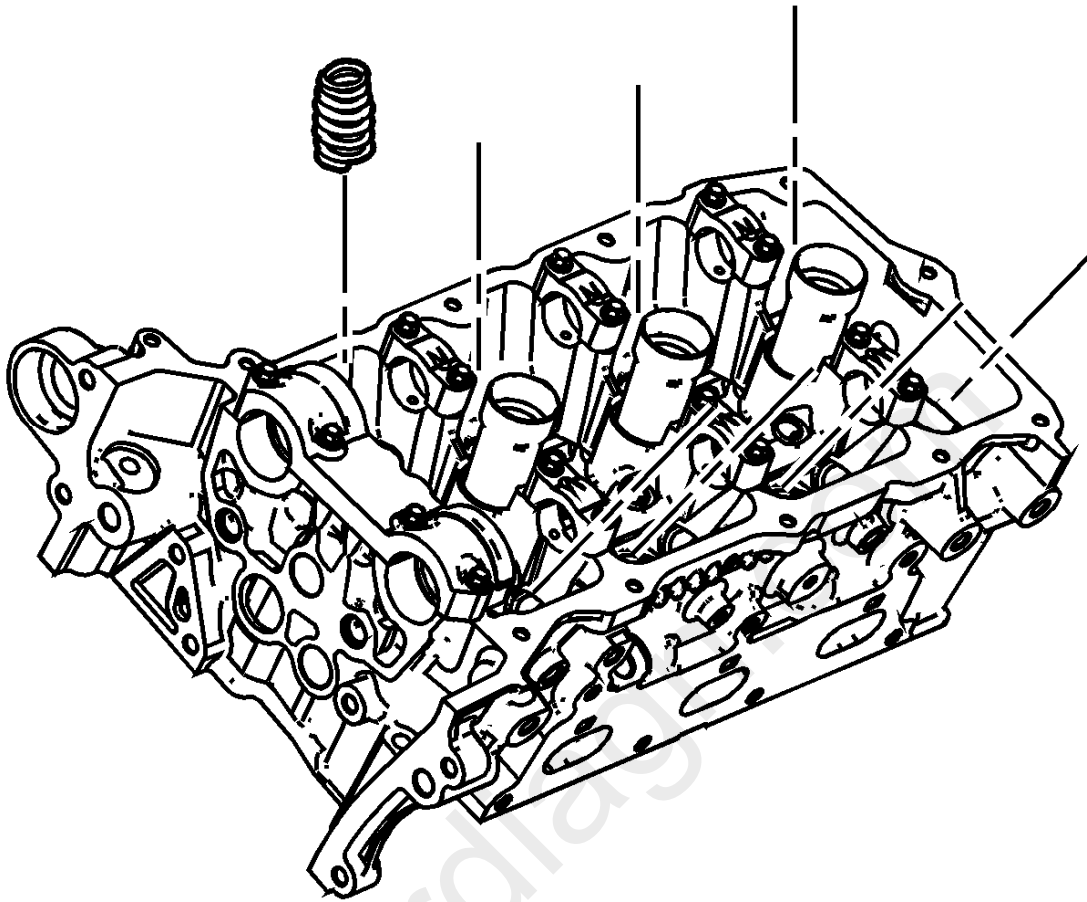


Fig. 202: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

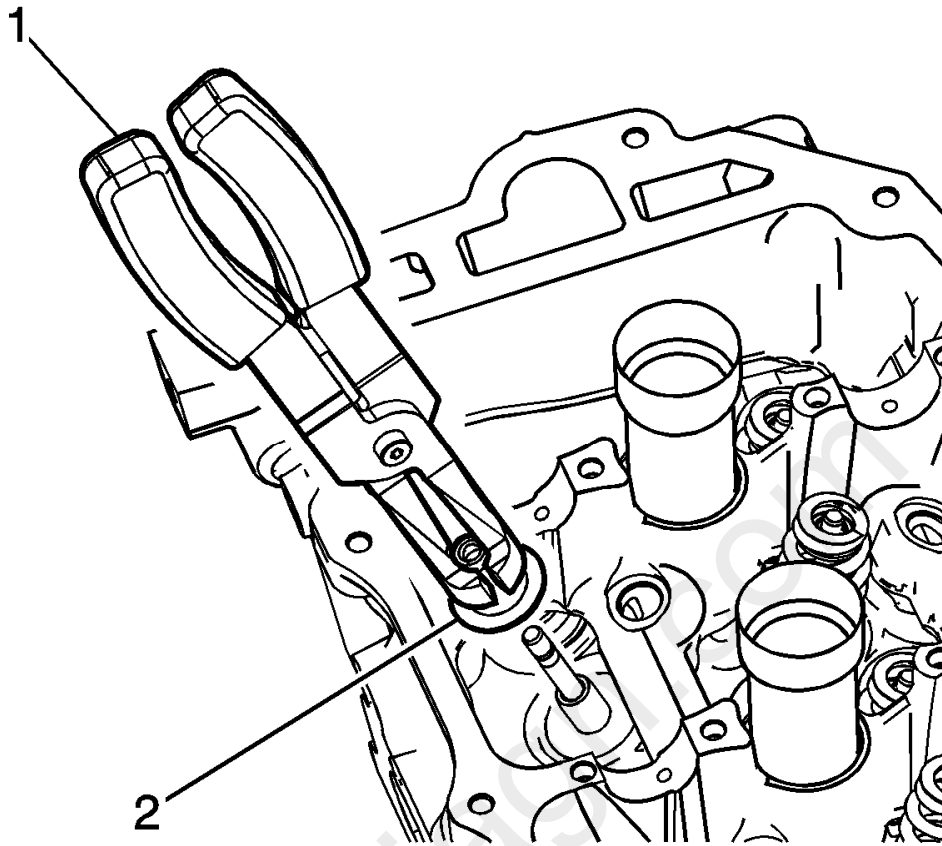


Fig. 203: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

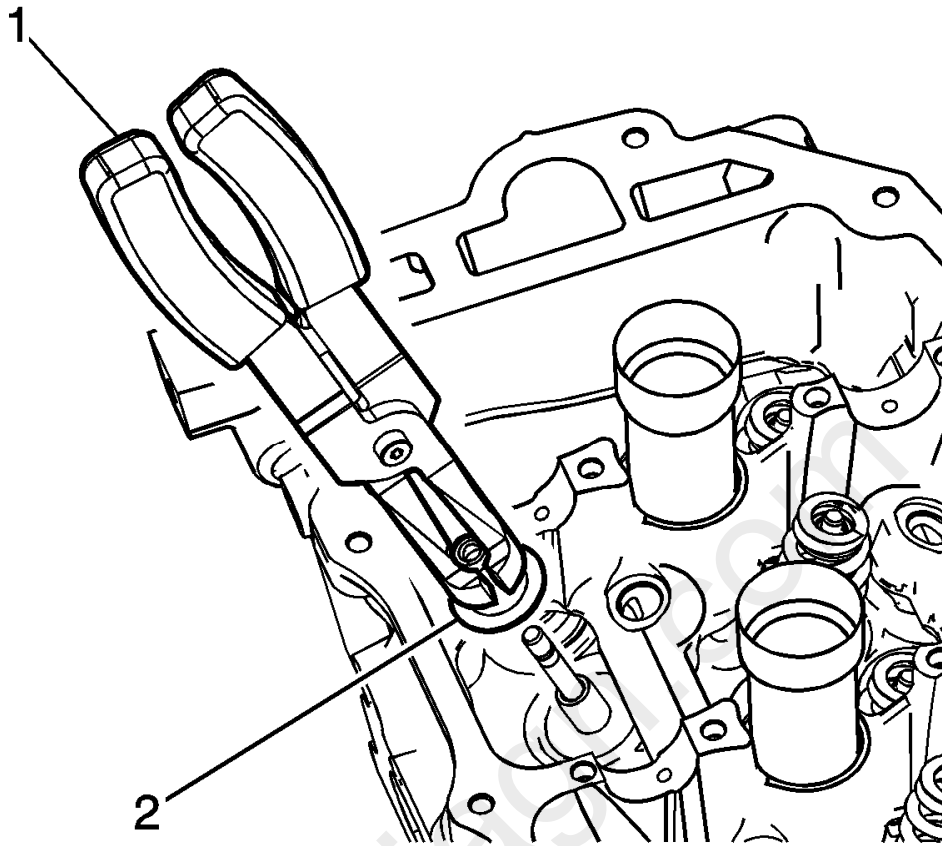


Fig. 204: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seal (2).

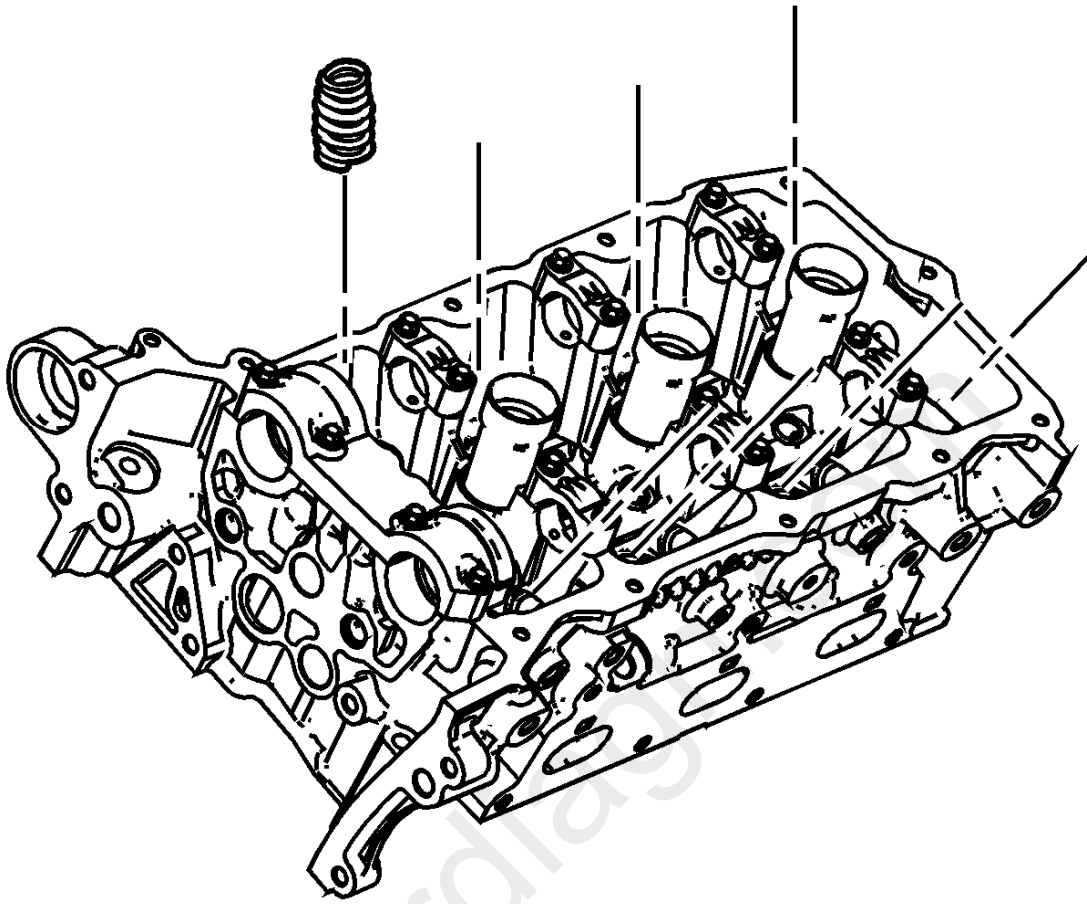


Fig. 205: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

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

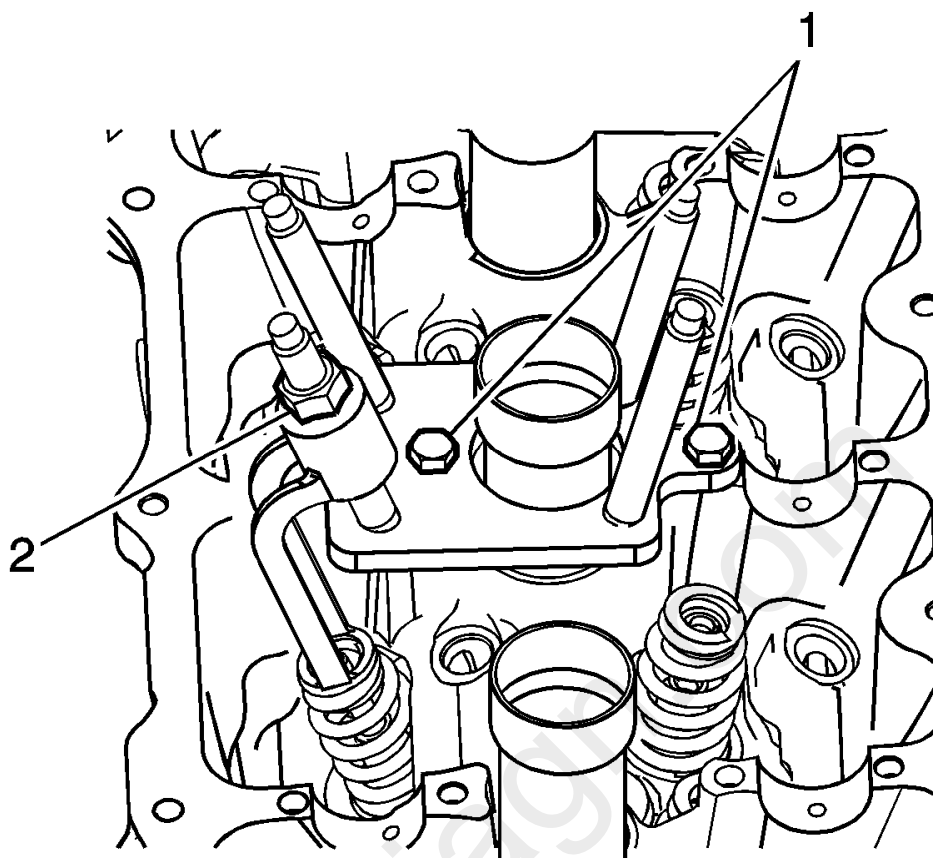


Fig. 206: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.
Tighten the **EN-46110** compressor nut (2).

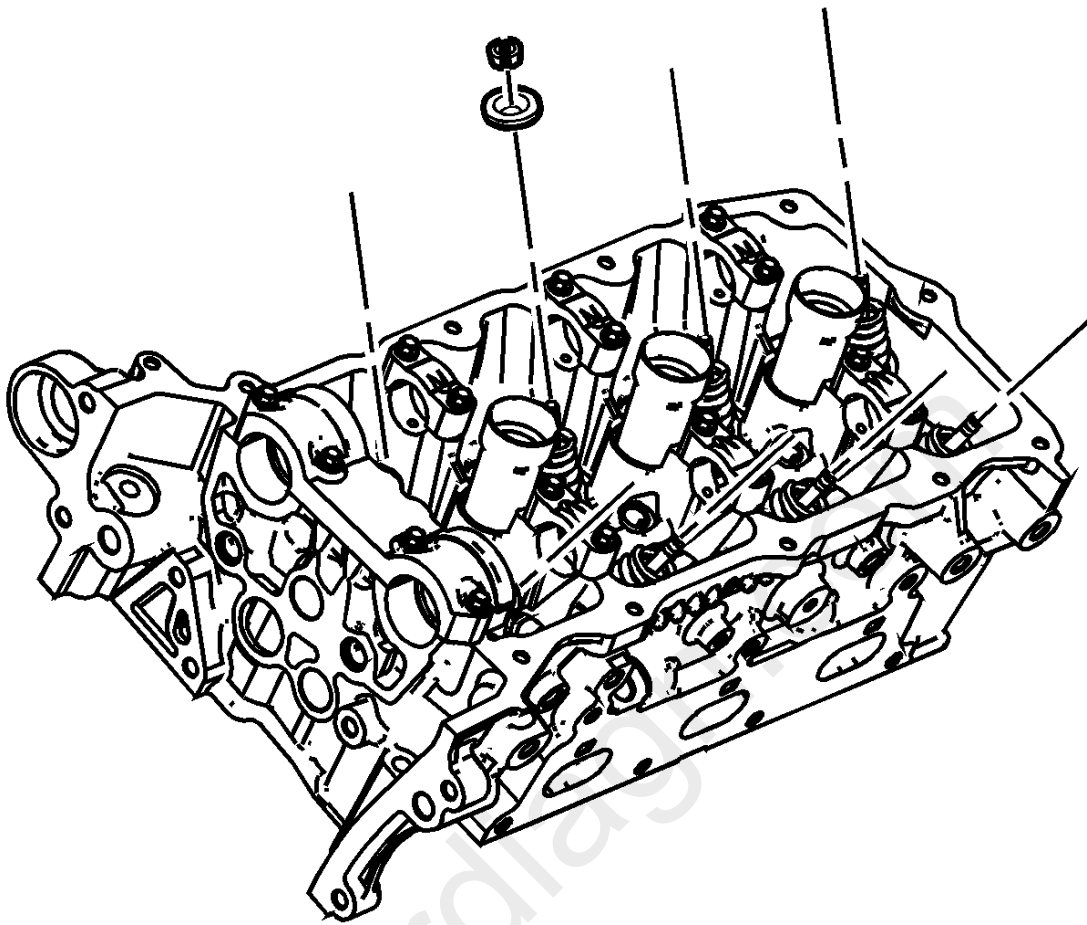


Fig. 207: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .
10. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
11. Remove the **EN-46106** tool in order to prevent crankshaft rotation.
12. Install the starter motor. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

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

Removal Procedure

NOTE: **This procedure is not used in Brazil.**

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.
2. Remove the starter motor. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .

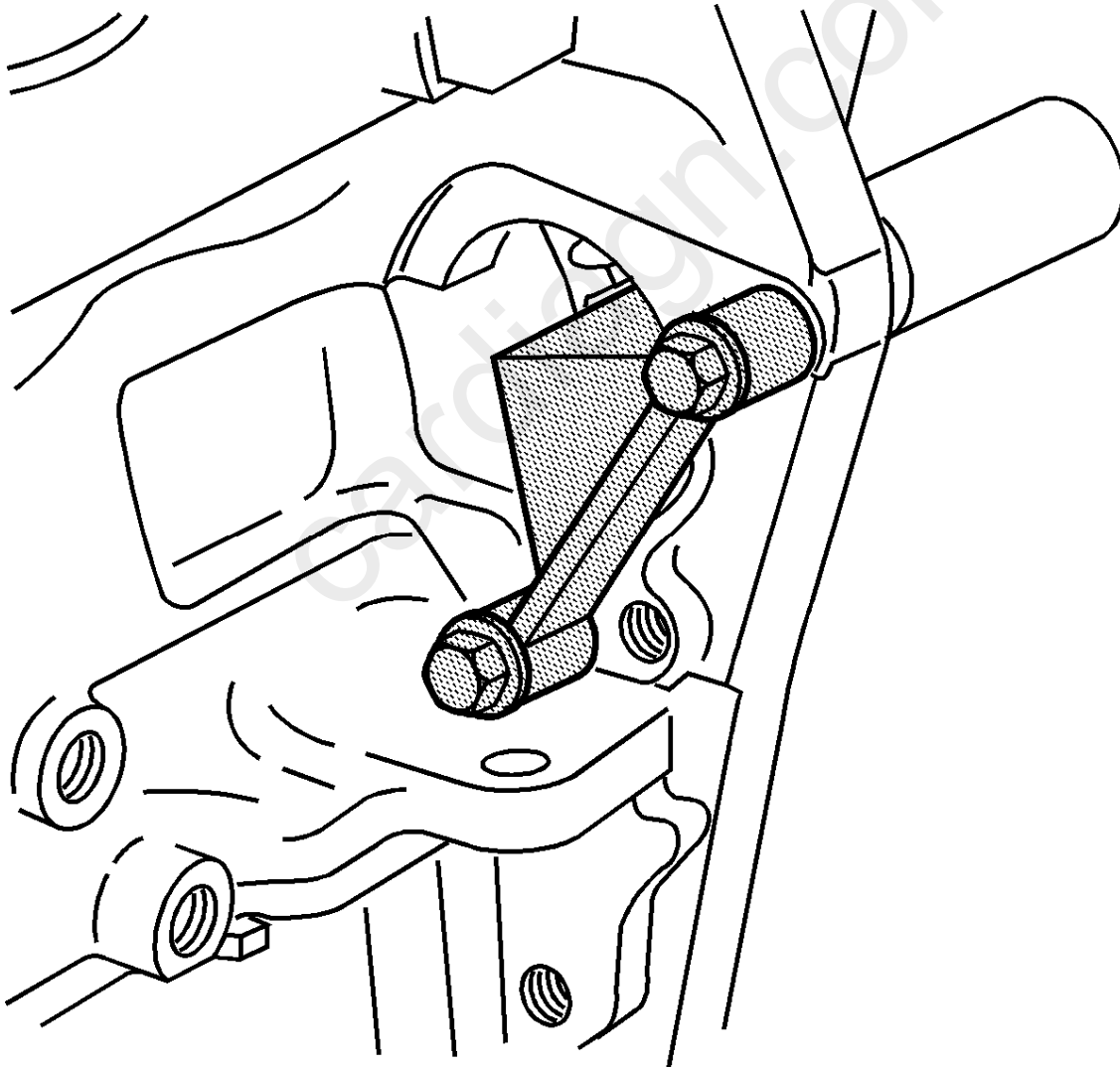


Fig. 208: Identifying Special Tool - EN 46106

Courtesy of GENERAL MOTORS COMPANY

NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

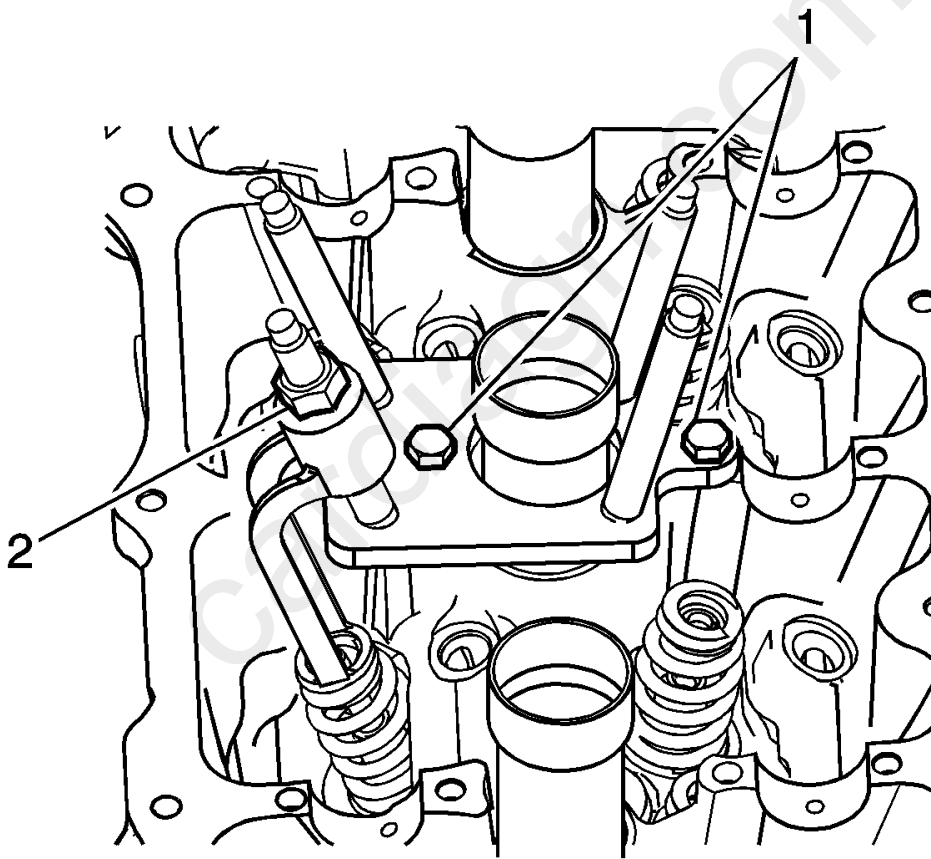


Fig. 209: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

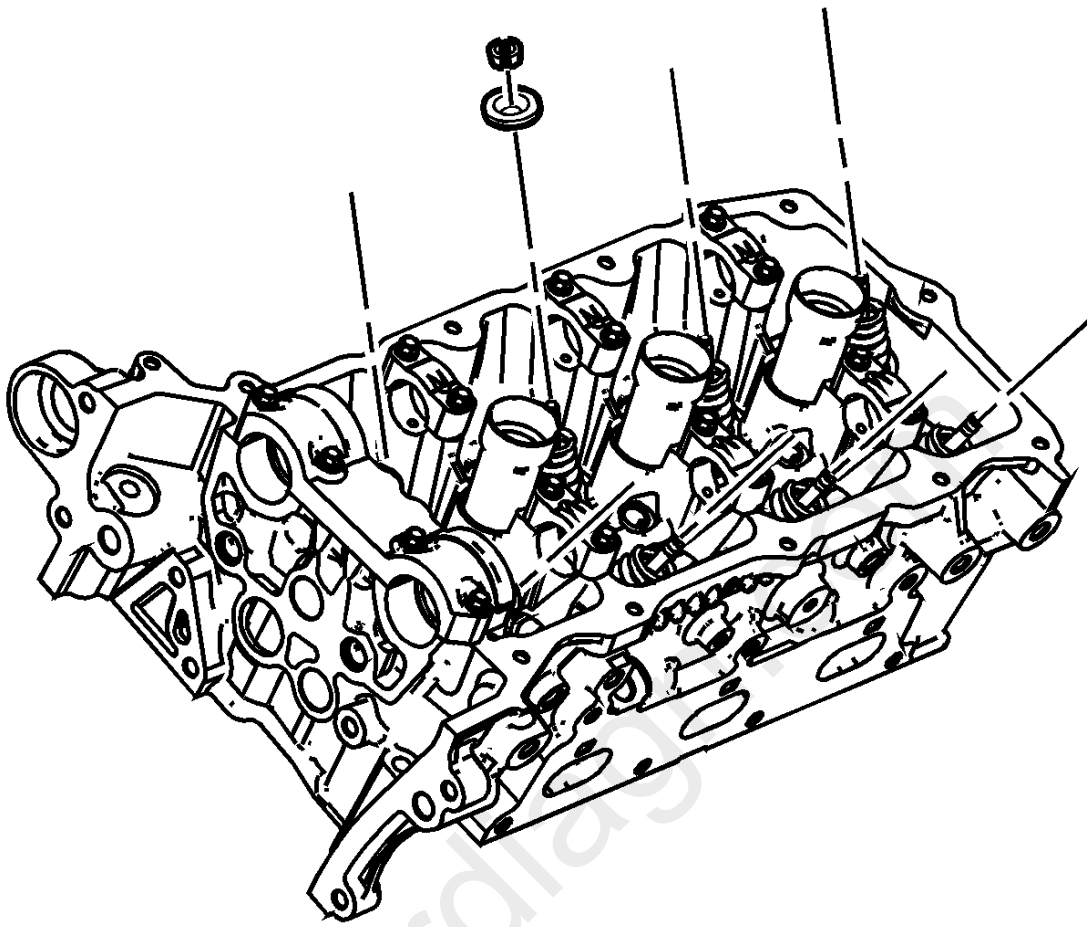


Fig. 210: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

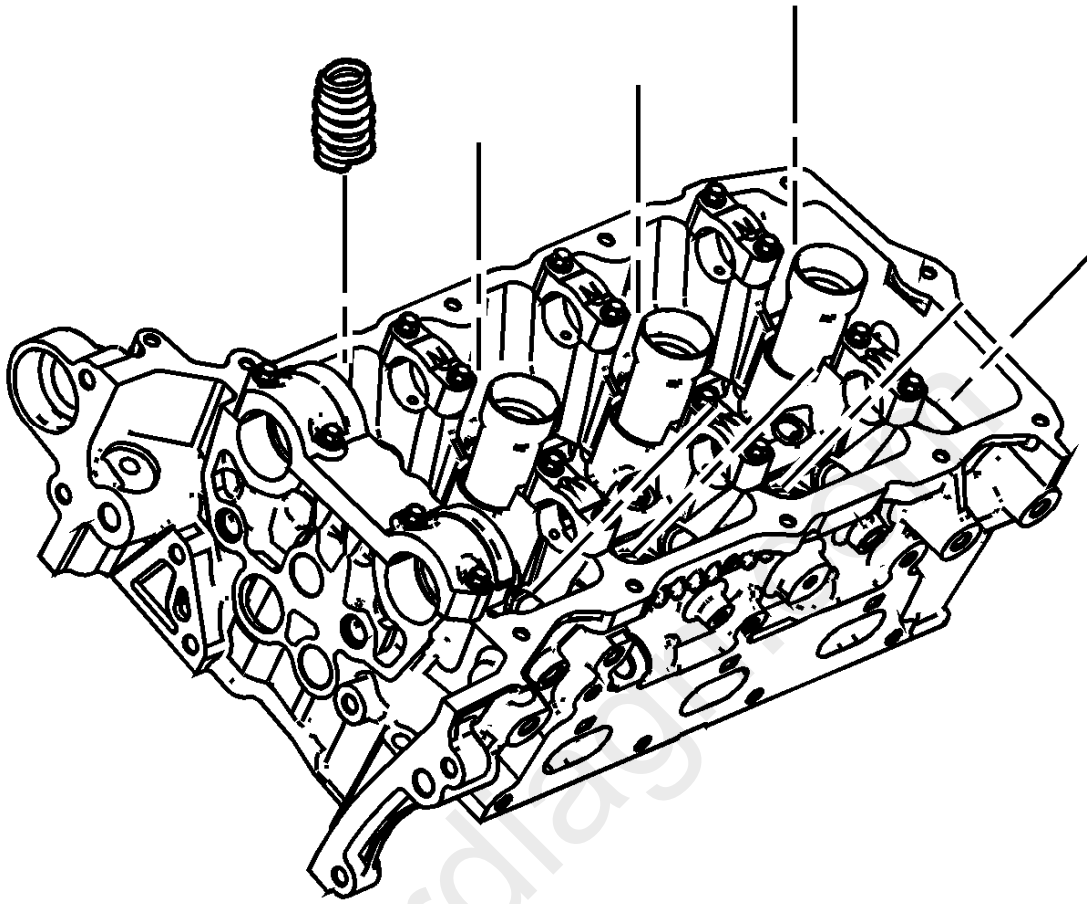


Fig. 211: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

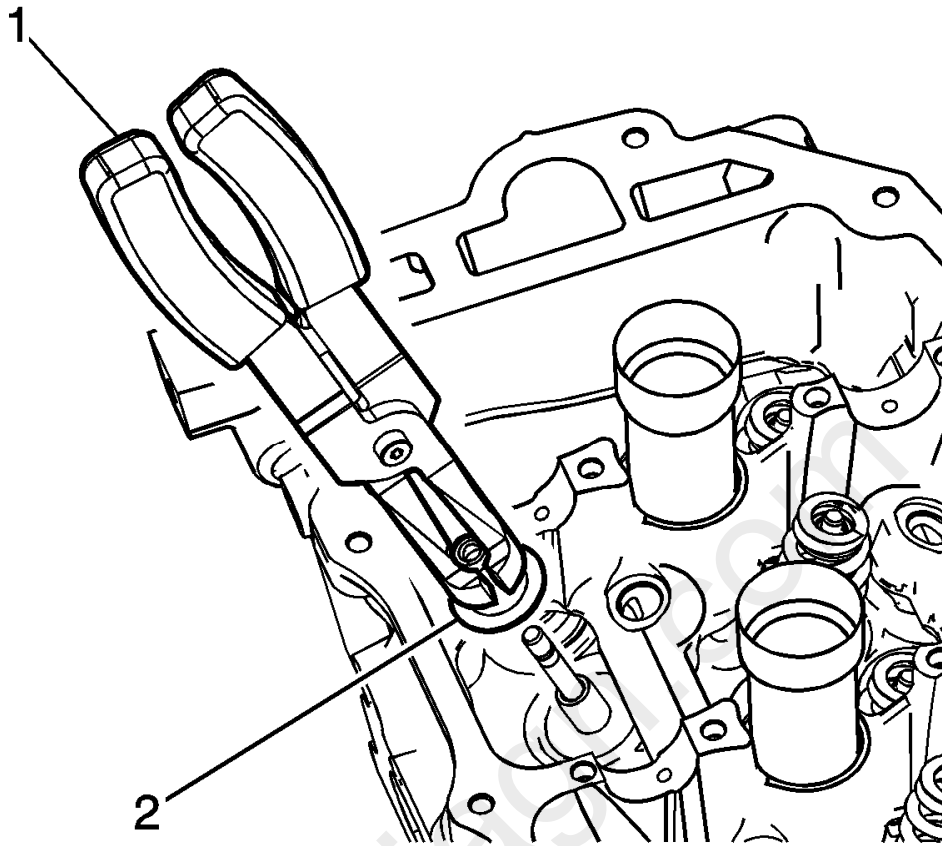


Fig. 212: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

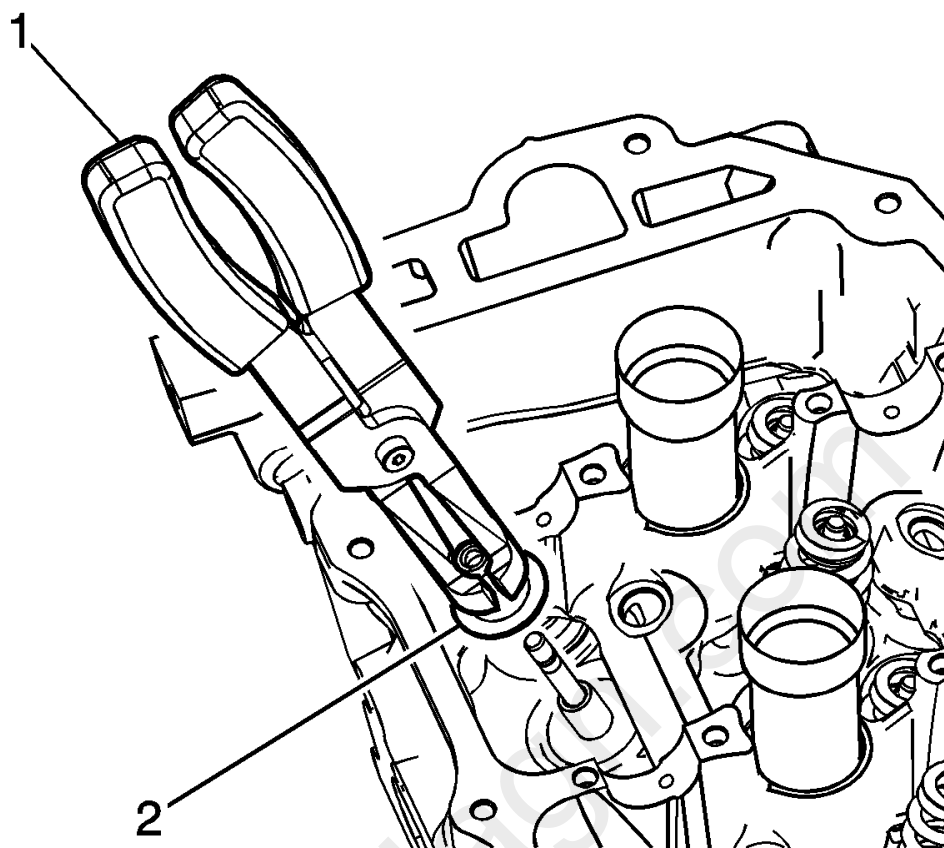


Fig. 213: Identifying Special Tool - EN-46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seals (2).

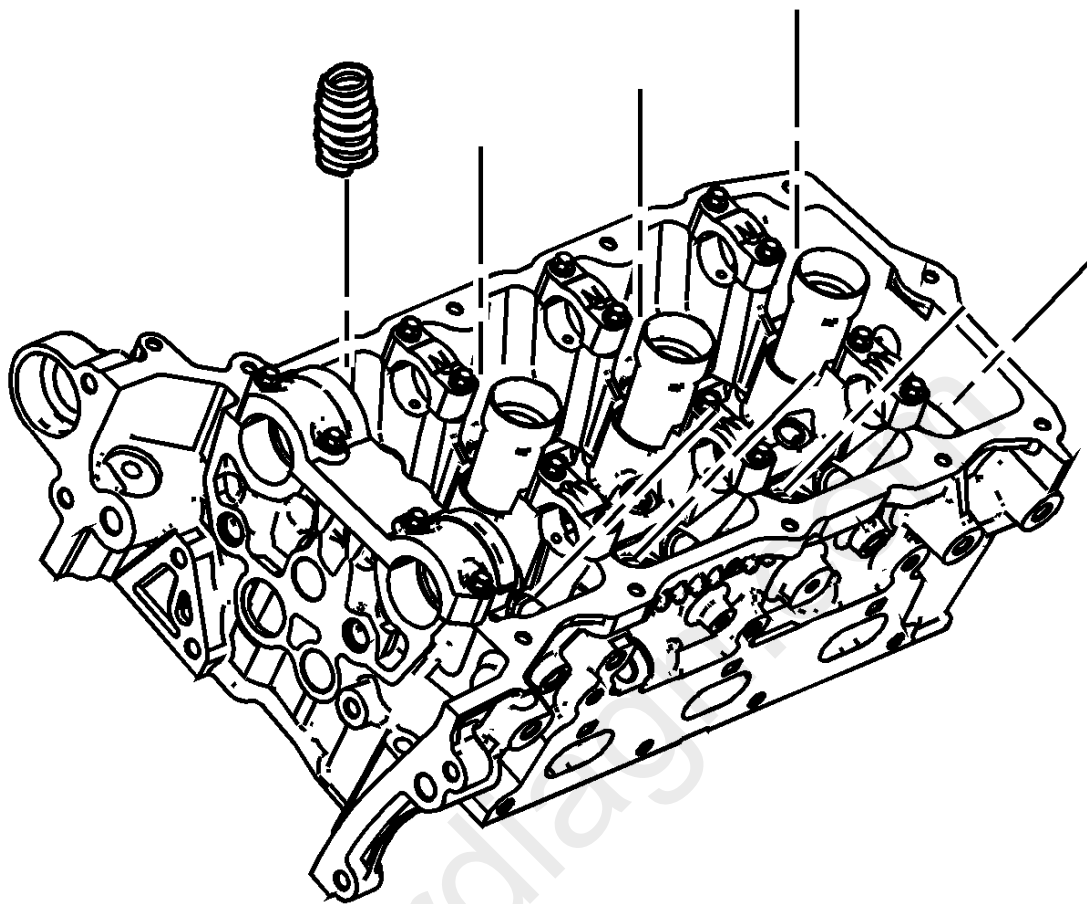


Fig. 214: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

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

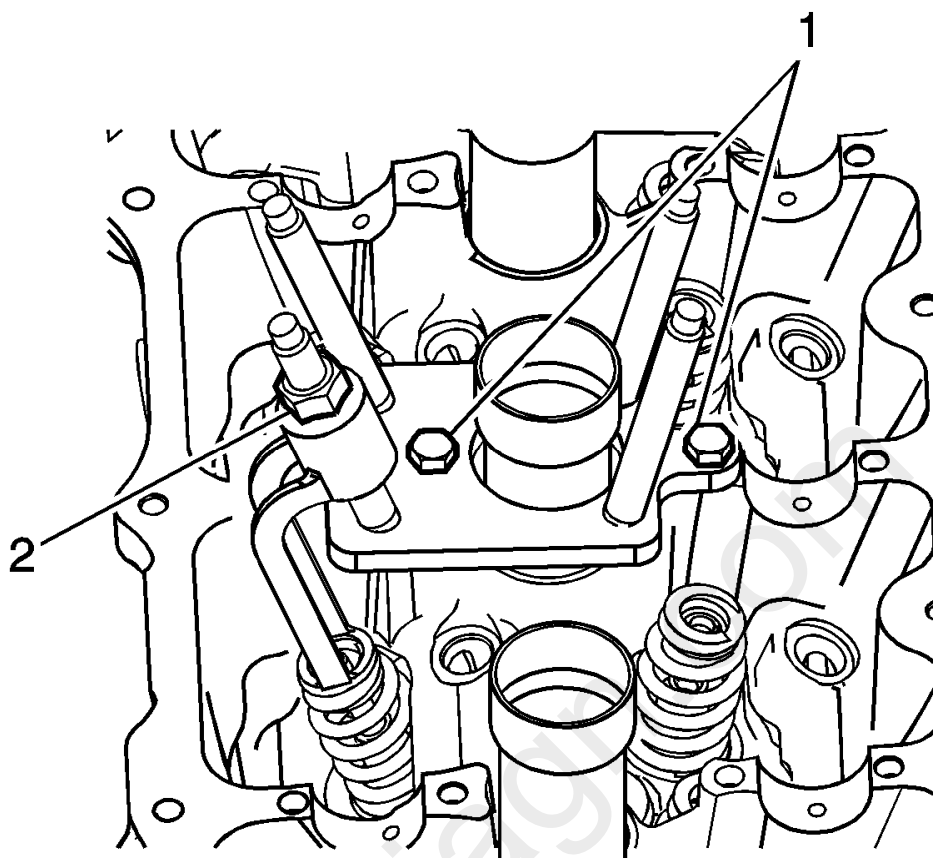


Fig. 215: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.
Tighten the **EN-46110** compressor nut (2).

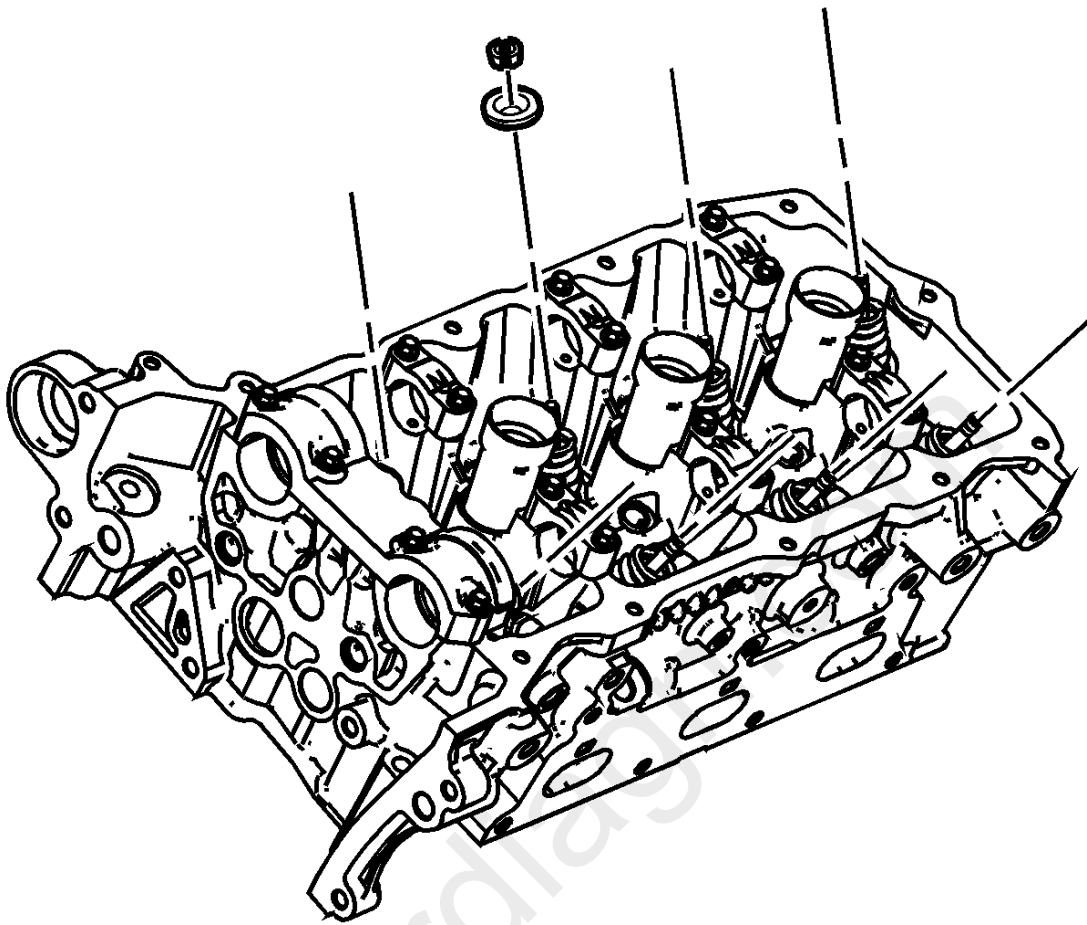


Fig. 216: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement (LFX)** , **Spark Plug Replacement (LF3)** .
10. Install the rocker arms . Refer to **Valve Rocker Arm Replacement - Right Side**.
11. Remove the **EN-46106** tool.
12. Install the starter motor. Refer to **Starter Replacement (LFX)** , **Starter Replacement (LTG)** , **Starter Replacement (LF3)** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

EN-45059 Angle Meter

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

Removal Procedure

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
2. Remove the fuel pump. Refer to **Fuel Pump Replacement (LFX)** , **Fuel Pump Replacement (LF3)** .
3. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LFX)** , **Catalytic Converter Replacement - Left Side (LF3)** .
4. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LFX)**, **Oil Level Indicator Tube Replacement (LF3)**.
5. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement (LF3)**, **Oil Filter Adapter Replacement (LFX)**.
6. Remove the secondary air injection pump, if equipped. Refer to **Secondary Air Injection Pump Replacement** .

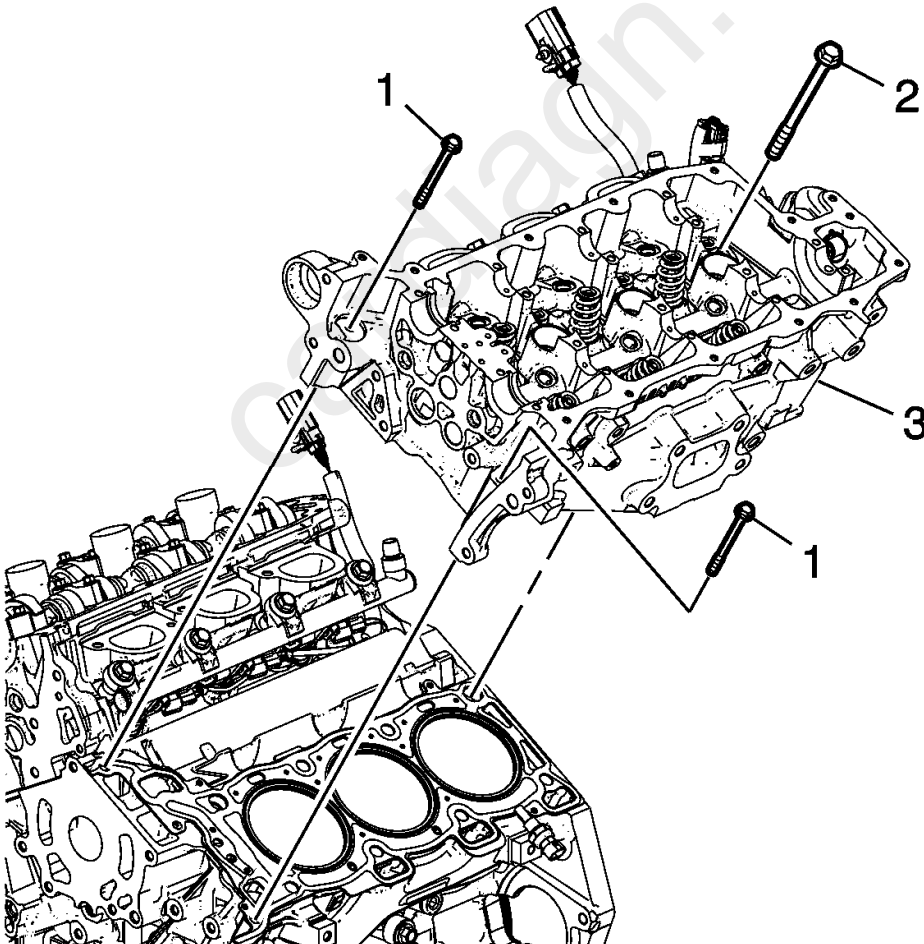


Fig. 217: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 front M8 left cylinder head bolts (1).
8. Remove the left cylinder head bolts (2).
9. Remove the left cylinder head (3).
10. Remove the ground wire bolt and ground wire.
11. Disconnect and reposition harness as necessary.

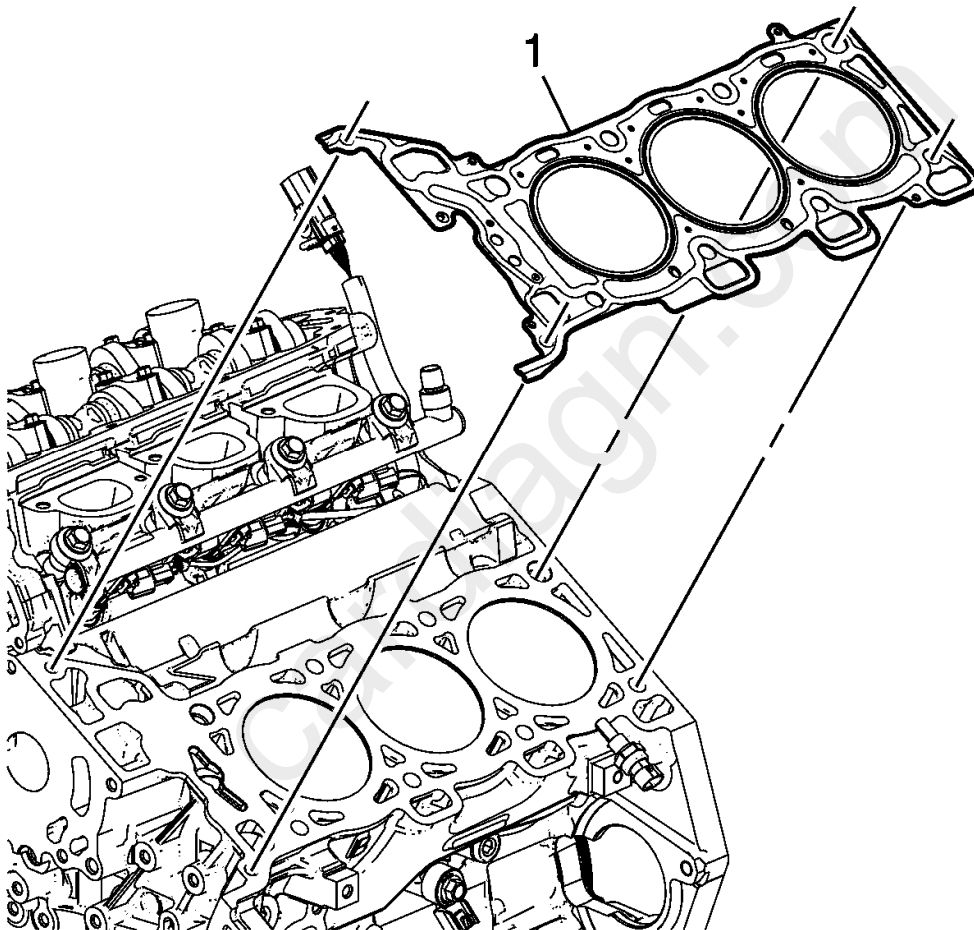


Fig. 218: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

12. Remove and discard the left cylinder head gasket (1).
13. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** , and **Engine Block Cleaning and Inspection** .
14. Disassemble the cylinder head as necessary. Refer to **Cylinder Head Disassemble** .

Installation Procedure

1. Assemble the cylinder head as necessary. Refer to Cylinder Head Assemble .

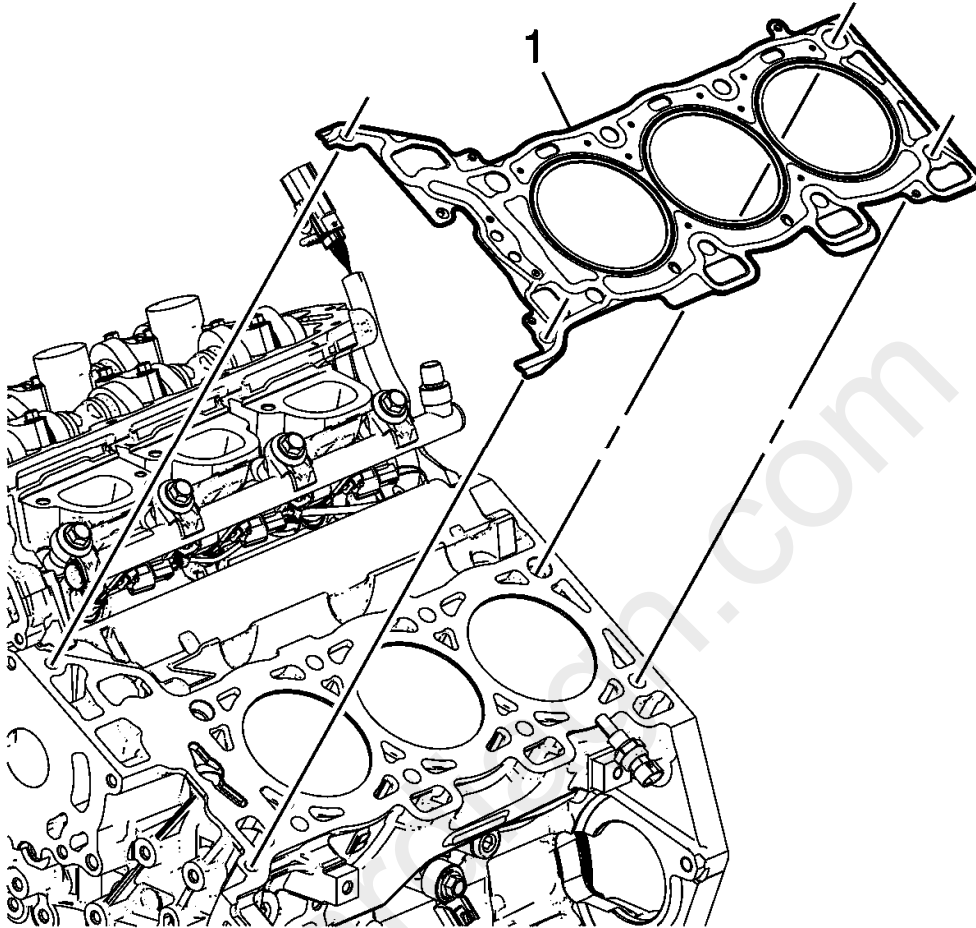


Fig. 219: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

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

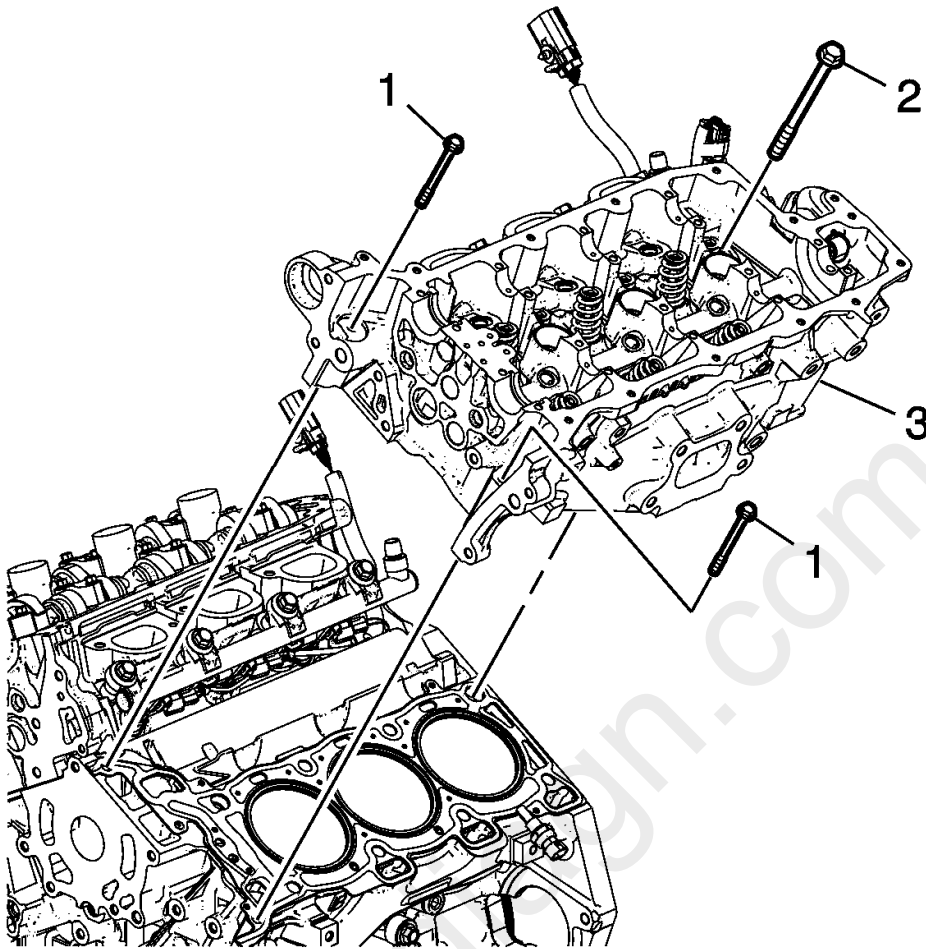


Fig. 220: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

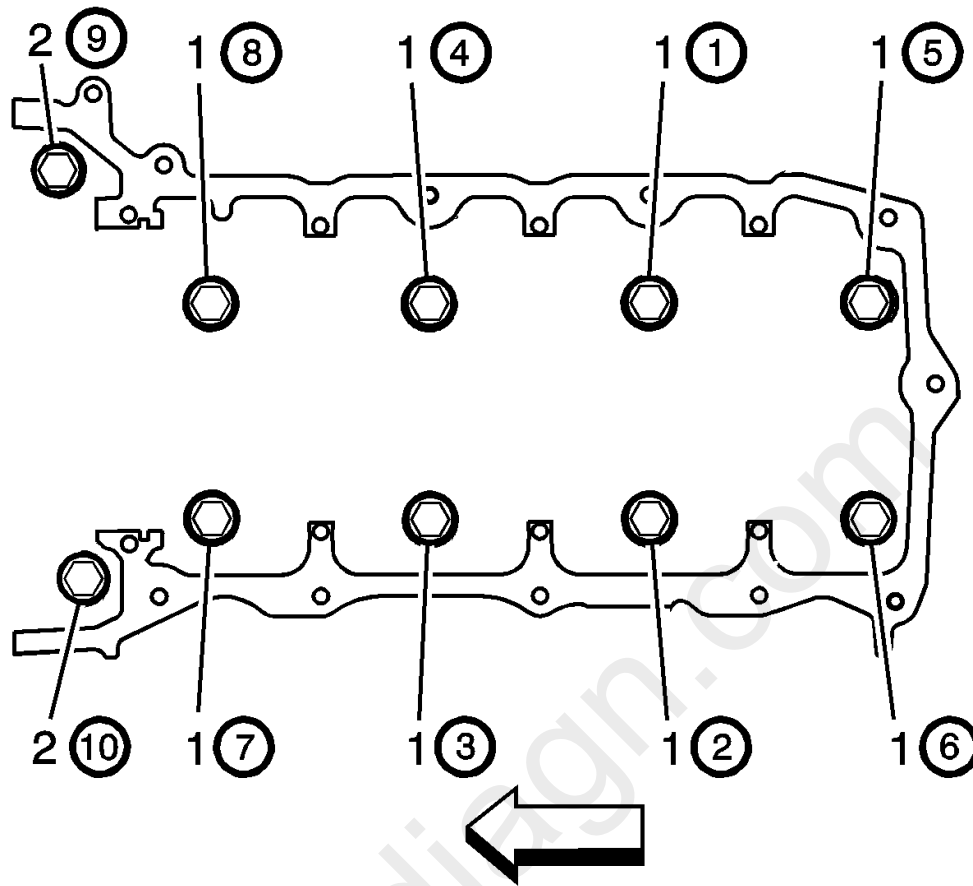


Fig. 221: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE:

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

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

EN-45059 meter.

8. Install the secondary air injection pump, if equipped. Refer to **Secondary Air Injection Pump Replacement** .
9. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LFX)**, **Oil Level Indicator Tube Replacement (LF3)**.
10. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement (LF3)**, **Oil Filter Adapter Replacement (LFX)**.
11. Install the fuel pump. Refer to **Fuel Pump Replacement (LFX)** , **Fuel Pump Replacement (LF3)** .
12. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LFX)** , **Catalytic Converter Replacement - Left Side (LF3)** .
13. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

EN-45059 Angle Meter

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

Removal Procedure

1. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Remove the catalytic converter . Refer to **Catalytic Converter Replacement - Right Side (LFX)** , **Catalytic Converter Replacement - Right Side (LF3)** .

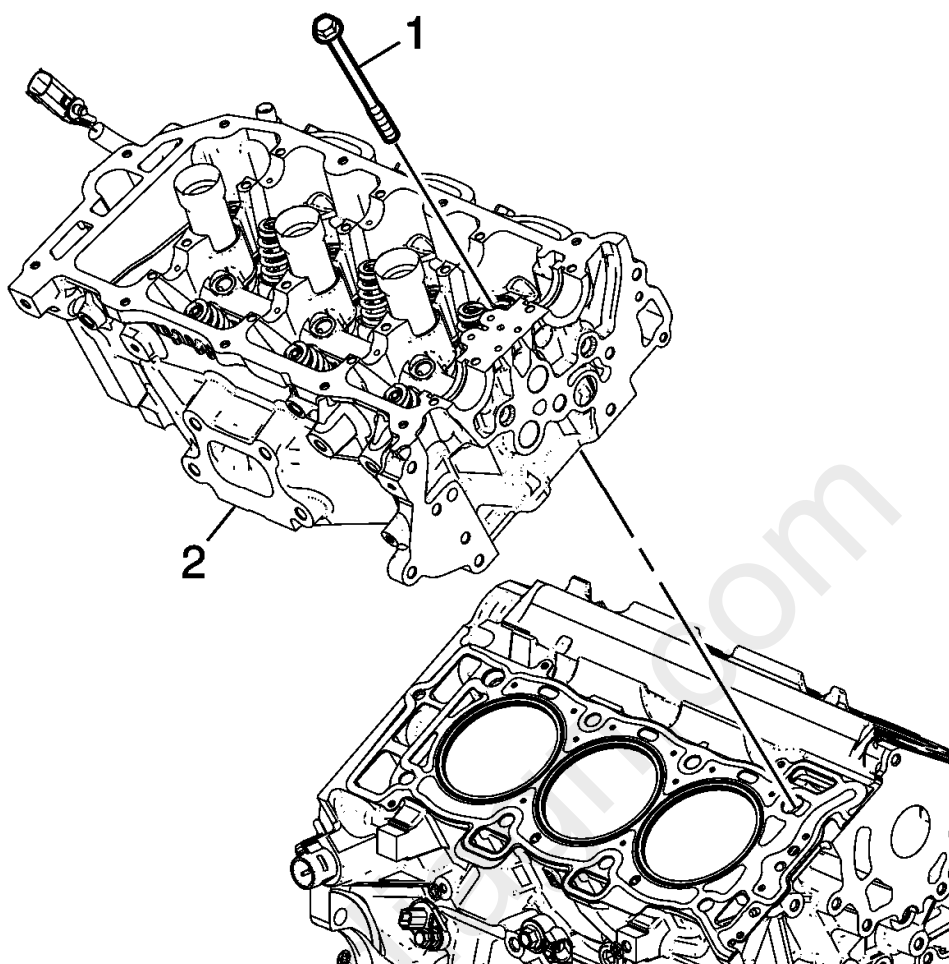


Fig. 222: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right cylinder head bolts (1).
4. Remove the right cylinder head (2).
5. Remove Ground wire and harness and position aside.

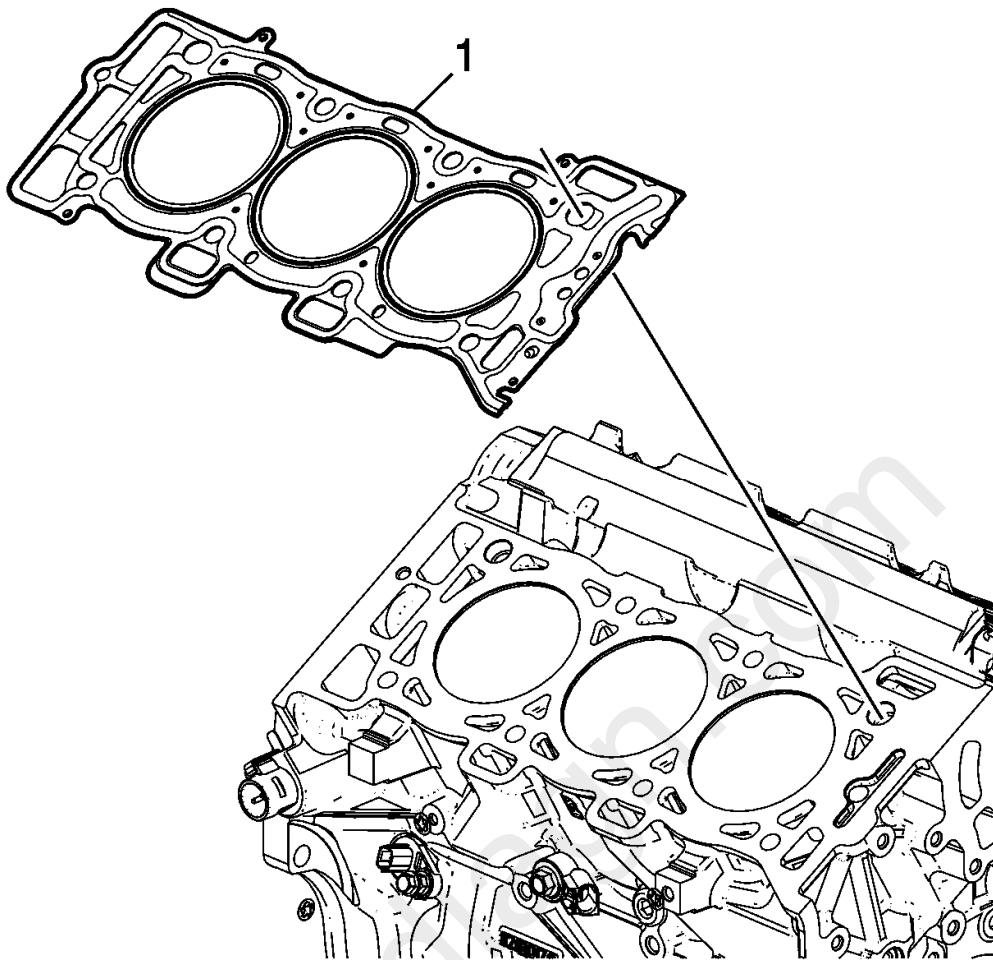


Fig. 223: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the cylinder head gasket (1).
7. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** , and **Engine Block Cleaning and Inspection** .
8. Disassemble the cylinder head as necessary. Refer to **Cylinder Head Disassemble** .

Installation Procedure

1. Assemble the cylinder head as necessary. Refer to **Cylinder Head Assemble** .

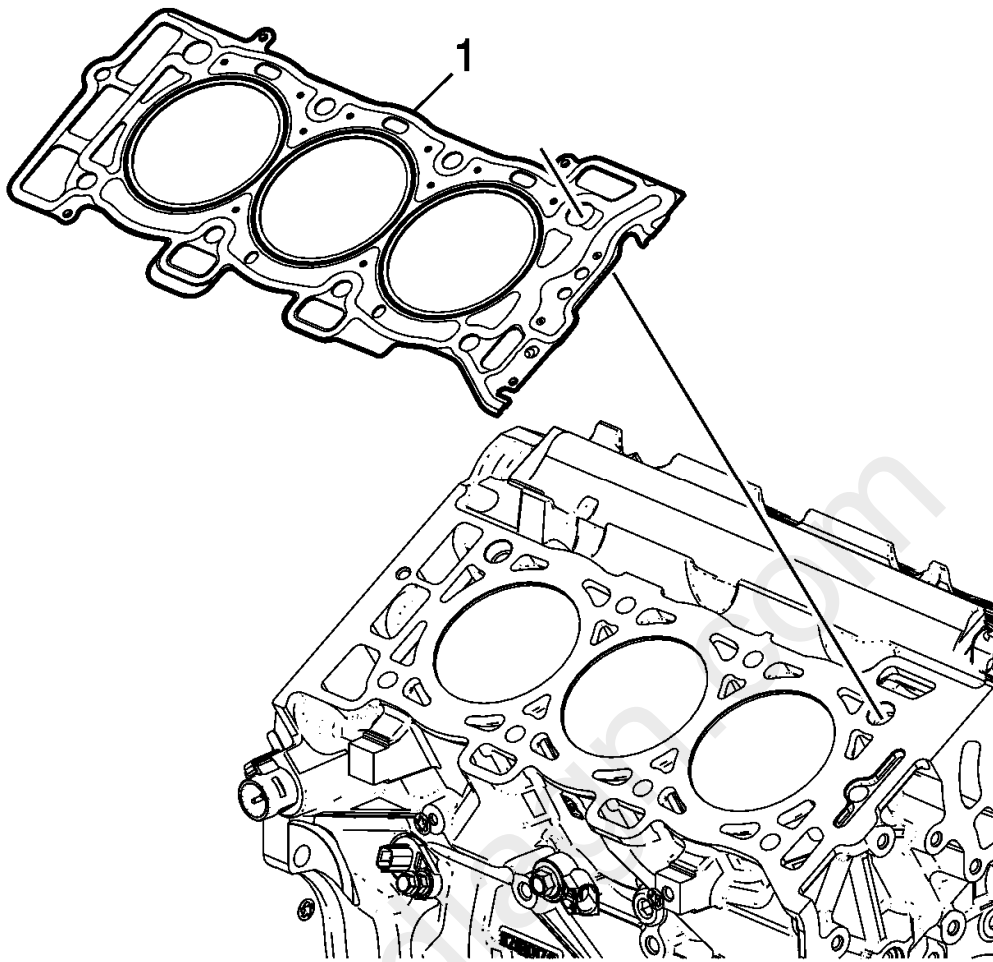


Fig. 224: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

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

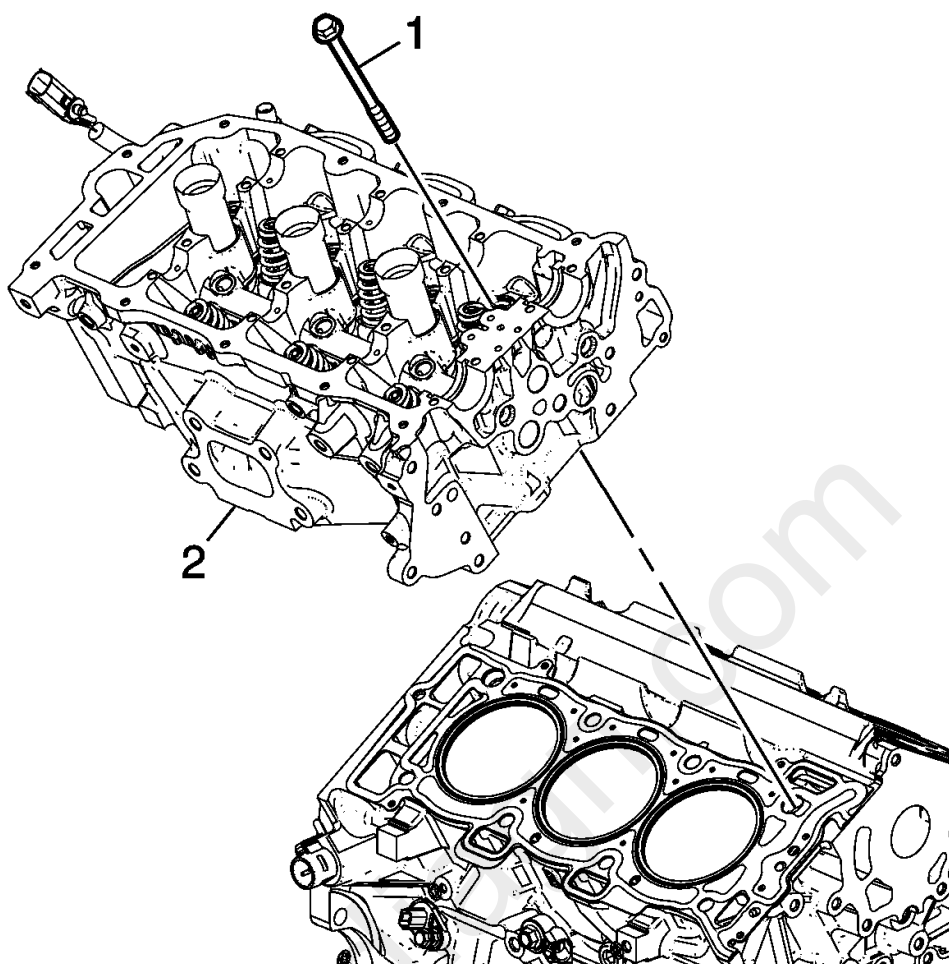


Fig. 225: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

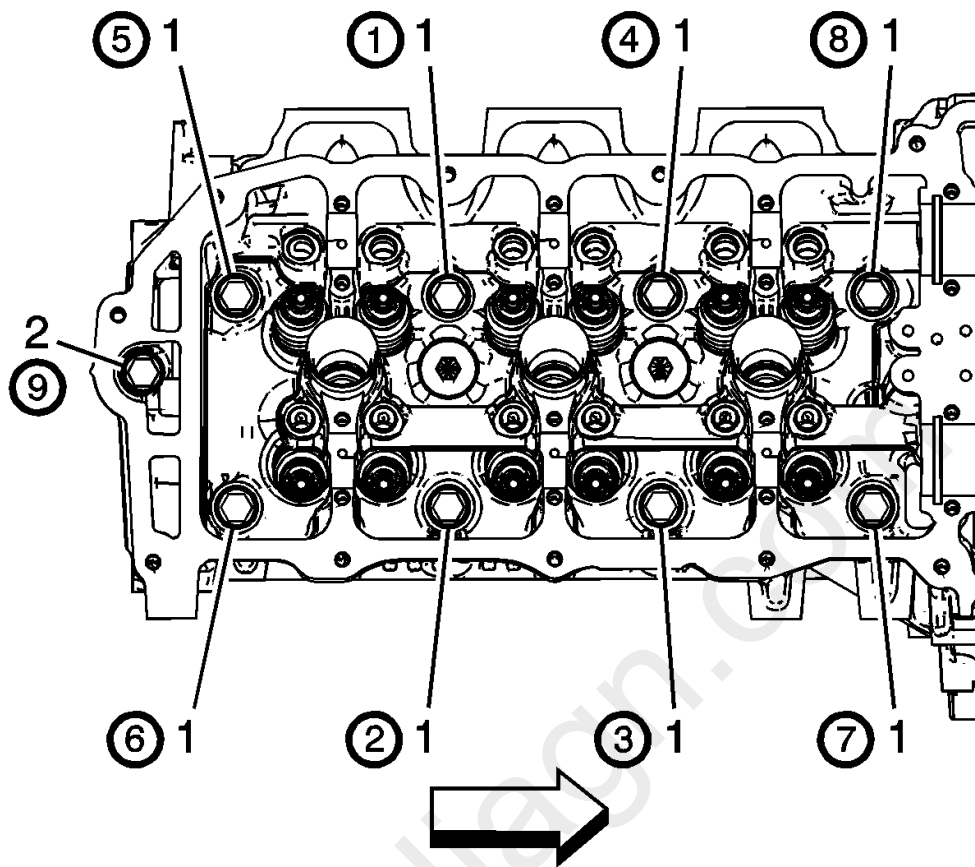


Fig. 226: Identifying M11 Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE:

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

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

meter.

8. Install the catalytic converter . Refer to Catalytic Converter Replacement - Right Side (LFX) , Catalytic Converter Replacement - Right Side (LF3) .
9. Install the right bank secondary timing chain. Refer to Secondary Camshaft Intermediate Drive Chain Replacement - Right Side.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

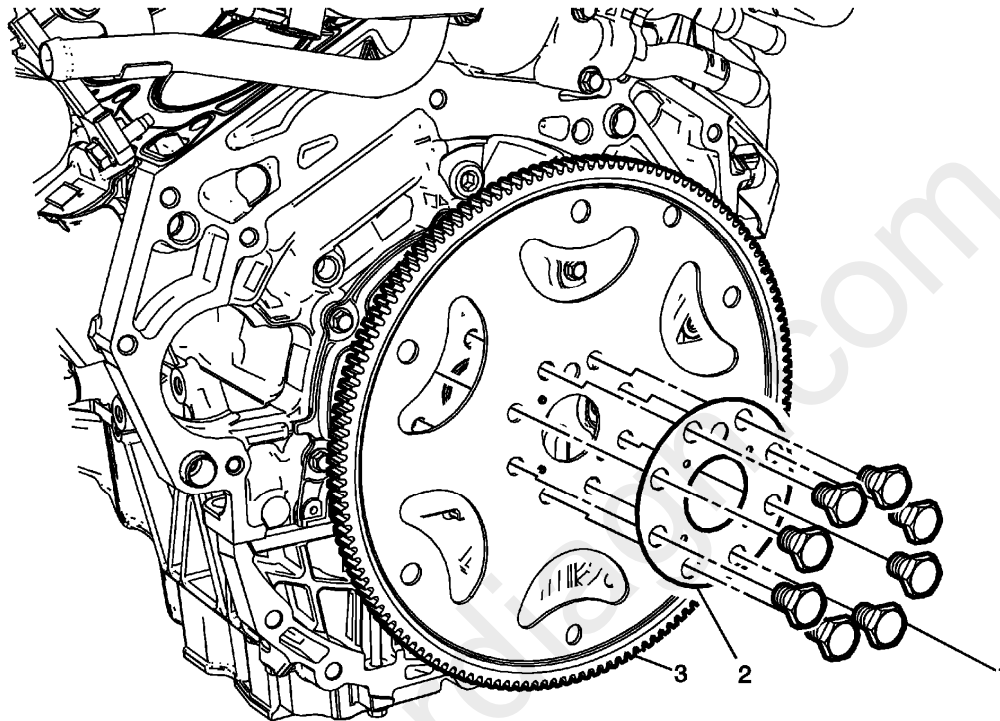


Fig. 227: Automatic Transmission Flex Plate & Components
Courtesy of GENERAL MOTORS COMPANY

Automatic Transmission Flex Plate Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to <u>Transmission Replacement (LTG)</u> , <u>Transmission Replacement (LFX)</u> .	
Special Tools • EN 45059 Angle Meter • EN 46106 Flywheel Holding Tool	
For equivalent regional tools. Refer to <u>Special Tools</u> .	
	Automatic Transmission Flex Plate Fastener (Qty: 8)

	CAUTION: Refer to <u>Fastener Caution</u> .
1	Procedure New bolts must be used whenever removing the automatic transmission flex plate. Tighten 30 (22 lb ft) plus 45 degrees
2	Automatic Transmission Flex Plate Spacer
3	Automatic Transmission Flex Plate Procedure Clean and inspect the automatic transmission flex plate. Refer to <u>Automatic Transmission Flex Plate Cleaning and Inspection</u> .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Special Tools

- **EN-42183** Handle
- **EN-46109** Guide Pin Set
- **EN-47839** Crankshaft Rear Oil Seal Installation Tool

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

Removal Procedure

1. Remove the engine. Refer to **Engine Replacement (LFX)**, **Engine Replacement (LF3)**.
2. Remove the flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
3. Remove the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.

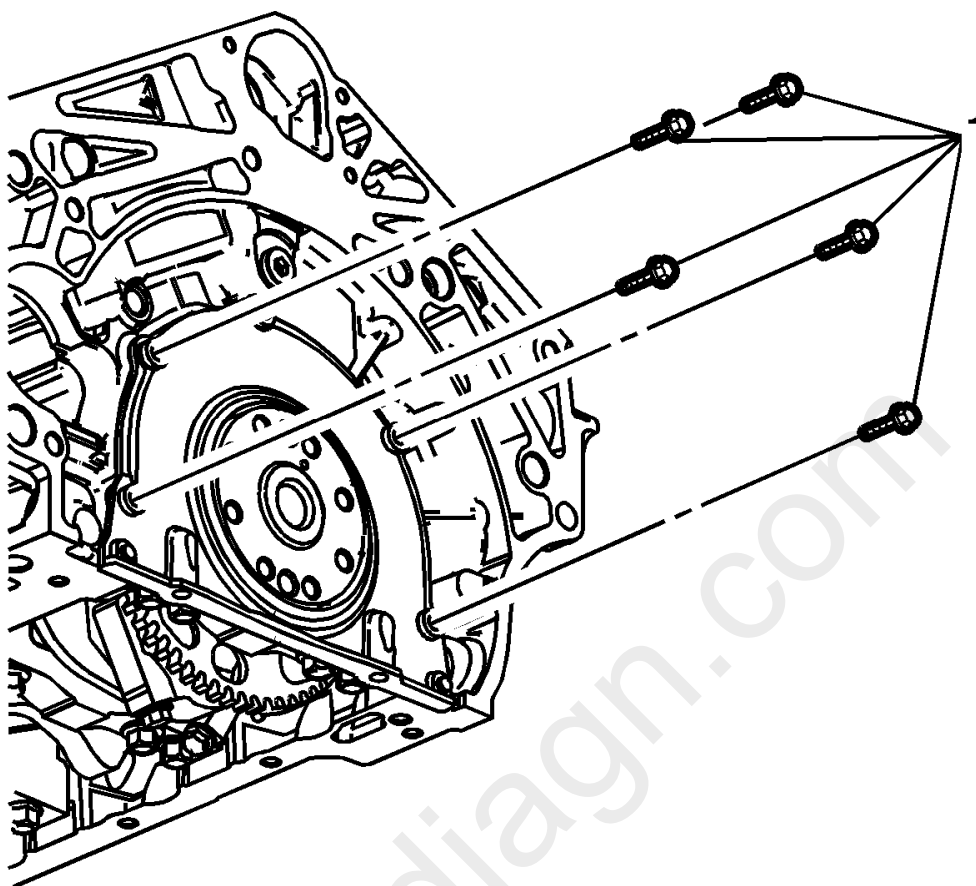


Fig. 228: Crankshaft Rear Oil Seal & Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft rear oil seal and housing bolts (1).

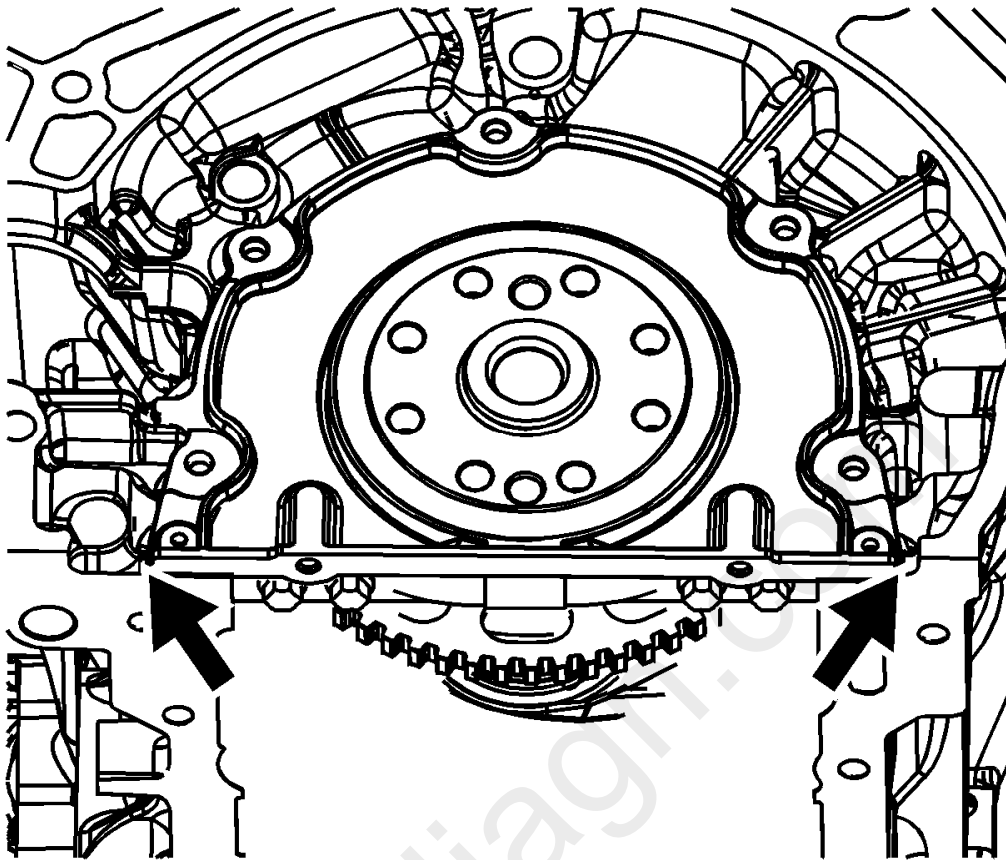


Fig. 229: Crankshaft Rear Oil Seal Housing Pry Points
Courtesy of GENERAL MOTORS COMPANY

5. Use the pry points located at the edge of the crankshaft rear oil seal housing to separate the RTV sealant.

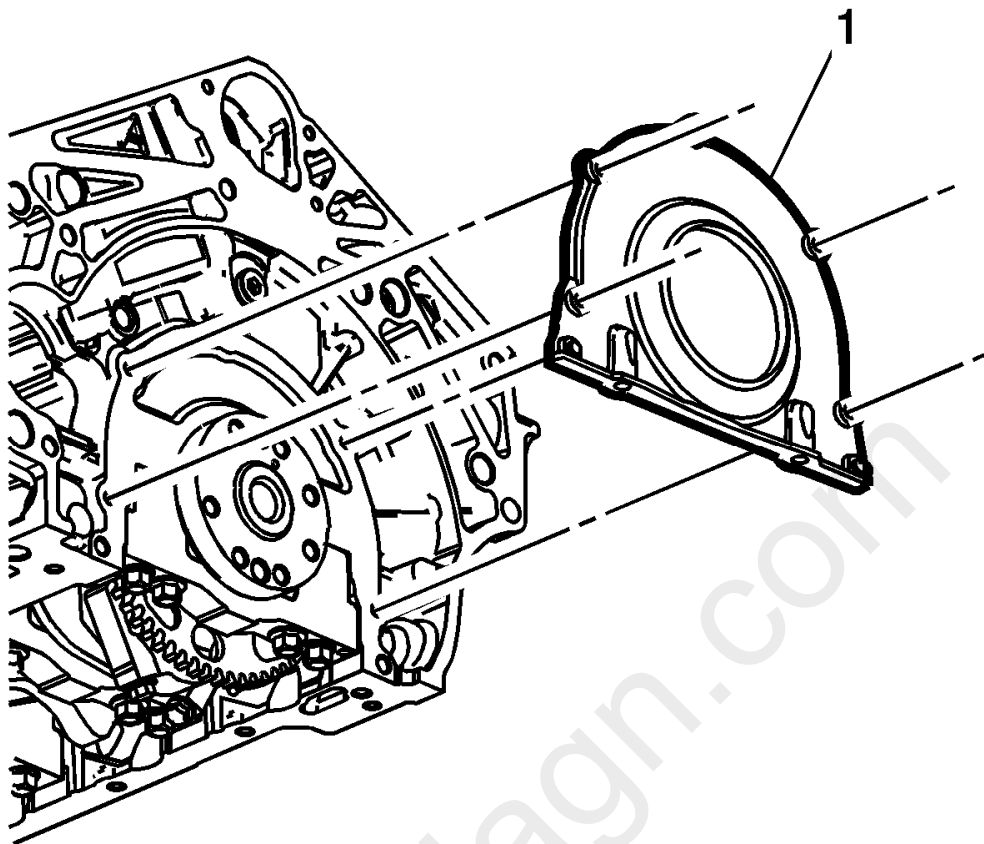


Fig. 230: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the crankshaft rear oil seal and housing (1). Refer to **Crankshaft Rear Oil Seal and Housing Removal** .

Installation Procedure

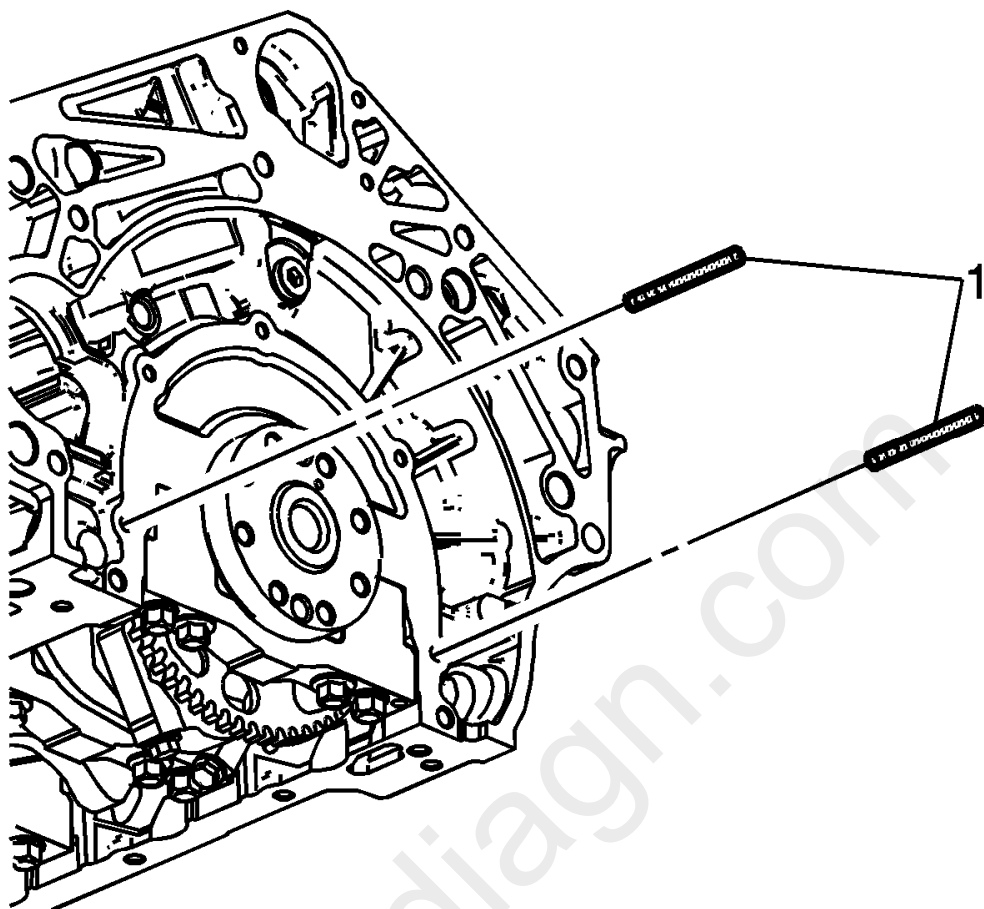


Fig. 231: Guide Pin Set

Courtesy of GENERAL MOTORS COMPANY

1. Install the 6 mm (0.236 in) guides from the EN-46109 pin set into the 2 crankshaft rear oil seal housing corner bolt holes of the engine block

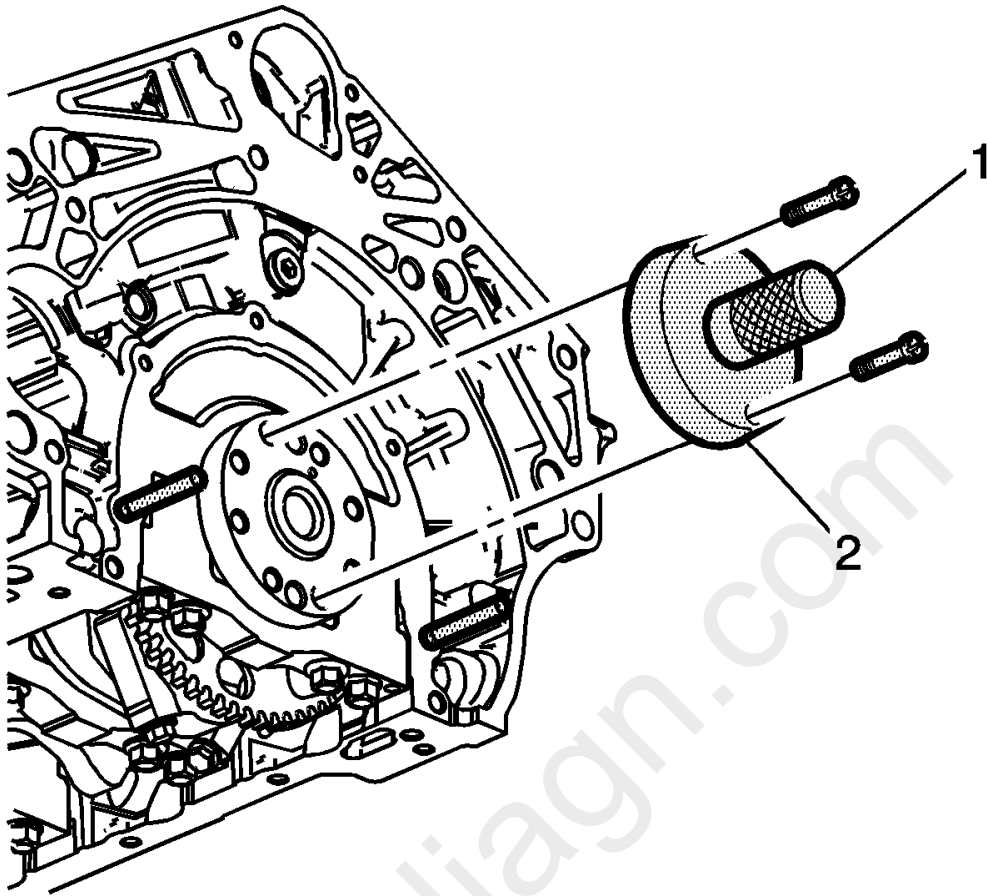


Fig. 232: Crankshaft Rear Oil Seal Installation Tool & Handle
Courtesy of GENERAL MOTORS COMPANY

2. Install the EN-47839 tool with the EN-42183 handle (1, 2) onto the rear of the crankshaft flange.

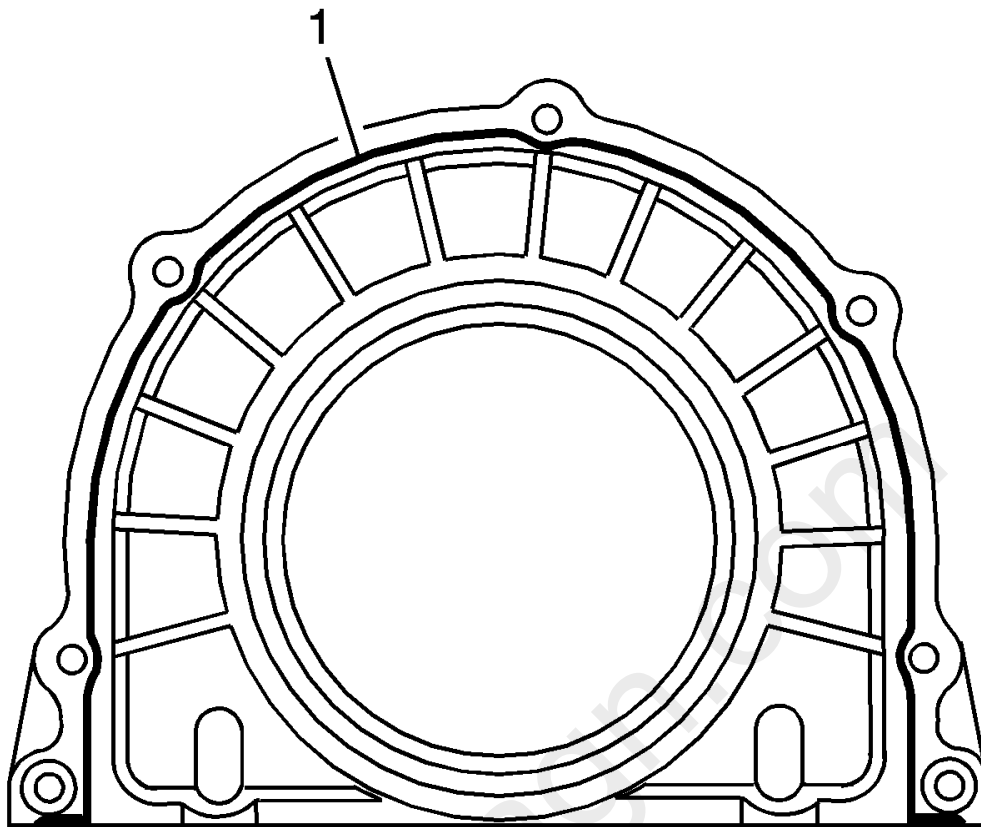


Fig. 233: RTV Sealant On Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead of RTV sealant (1) to the NEW crankshaft rear oil seal housing as shown (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** , for recommended sealant.

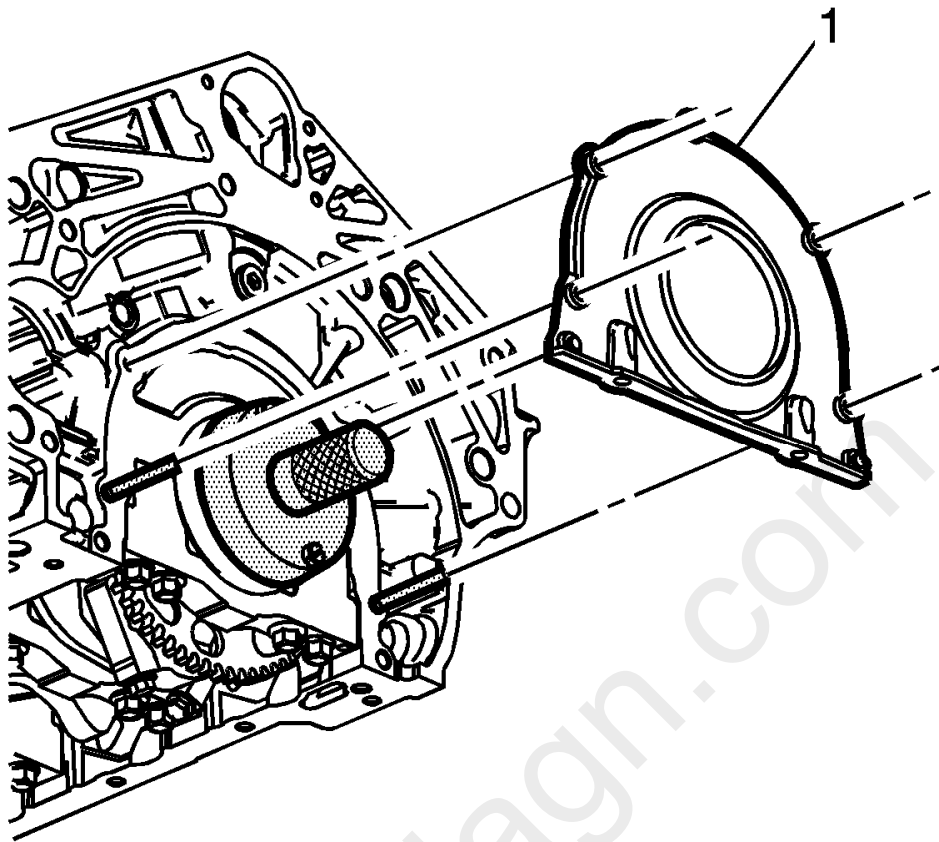


Fig. 234: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.

4. Install the crankshaft rear oil seal housing (1) to the engine block.

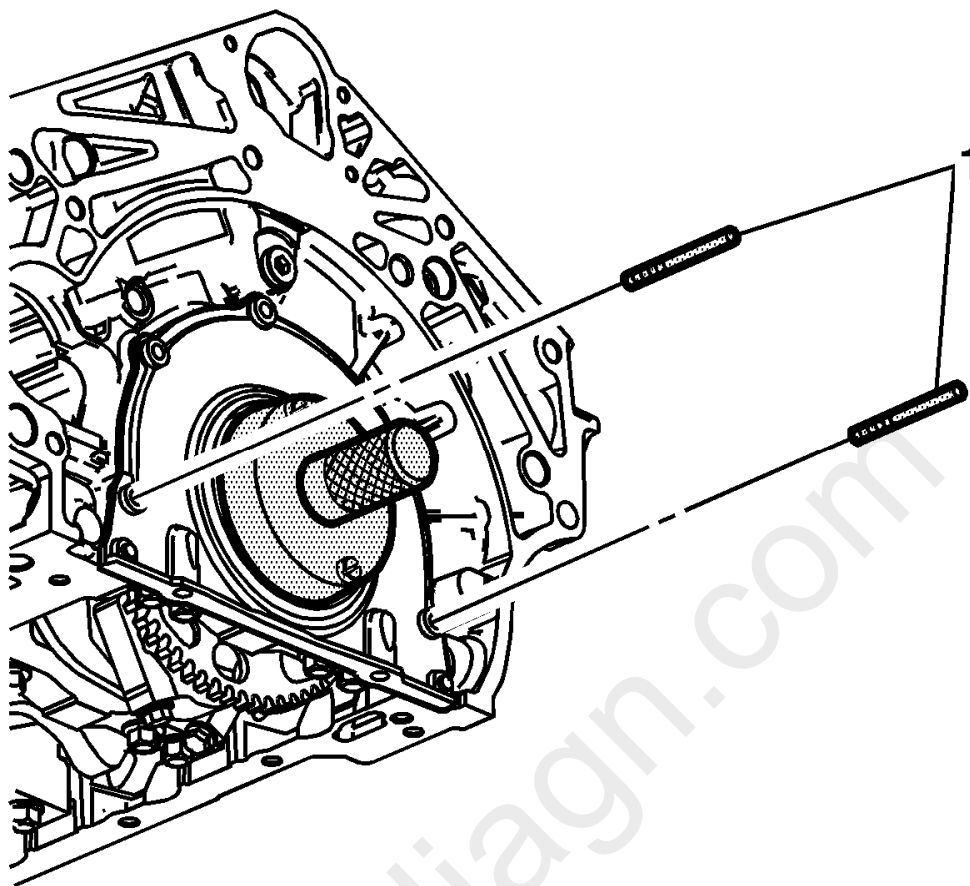


Fig. 235: Guide Pin Set

Courtesy of GENERAL MOTORS COMPANY

5. Remove the EN-46109 pin set 6 mm (0.236 in) guides (1) from the engine block.

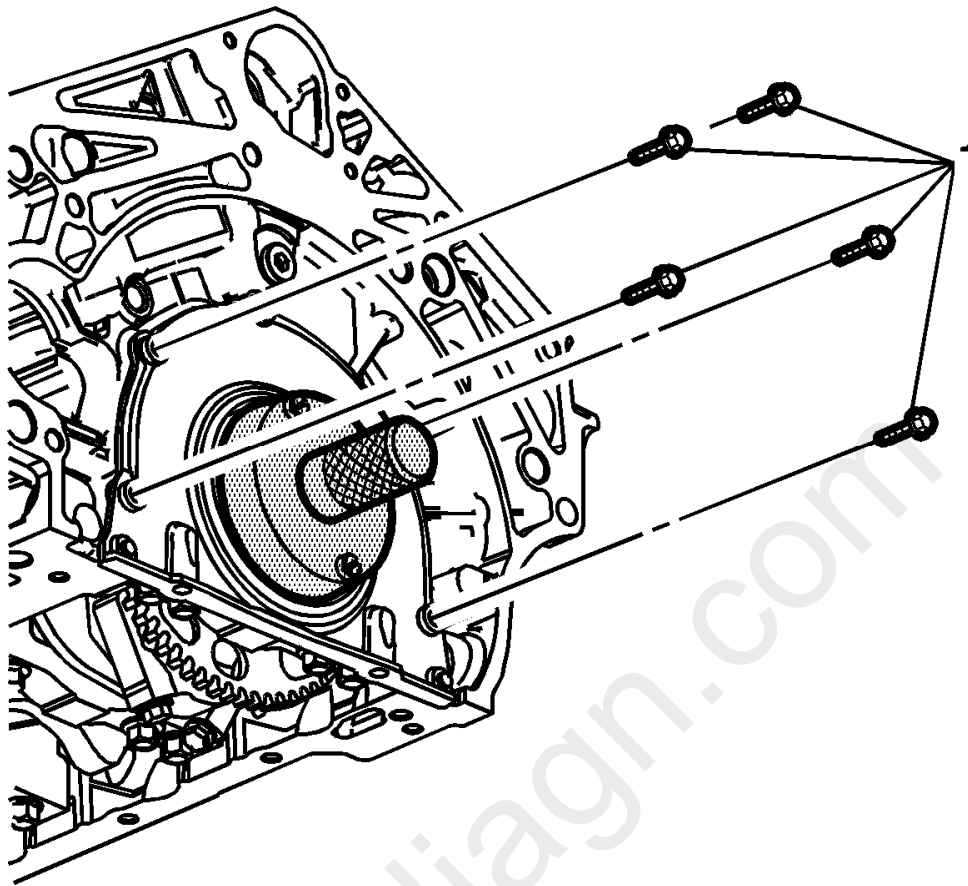


Fig. 236: Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the crankshaft rear oil seal housing bolts (1).

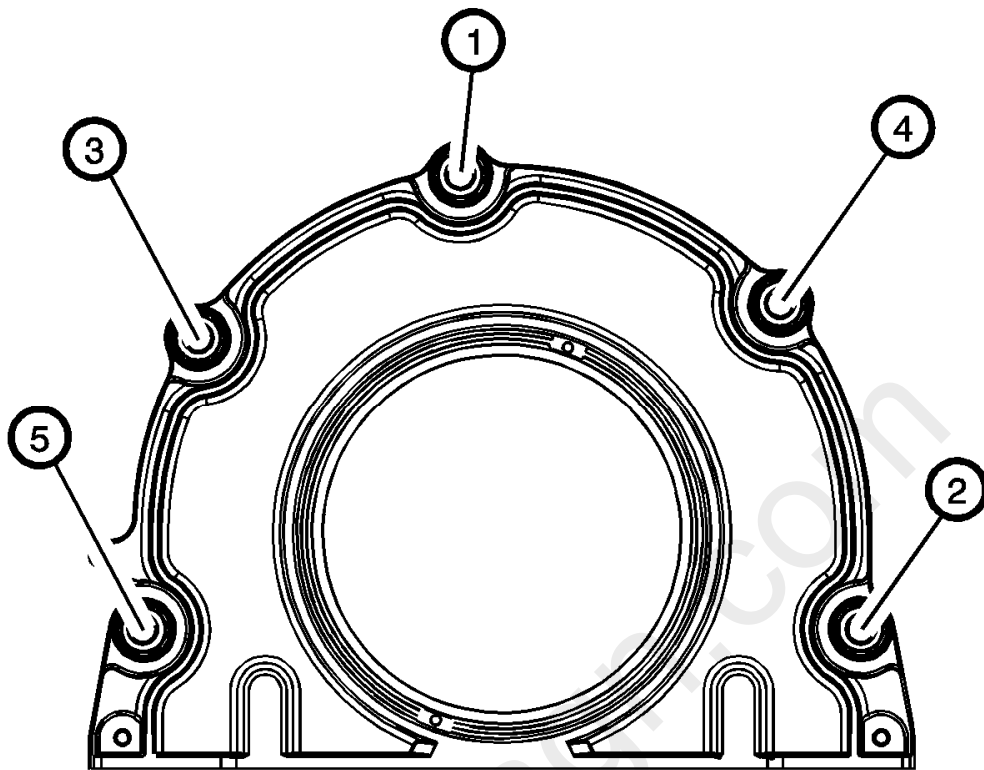


Fig. 237: Crankshaft Rear Oil Seal Housing Bolt Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the crankshaft rear oil seal housing bolts in sequence and tighten to 10 N.m (89 lb in).

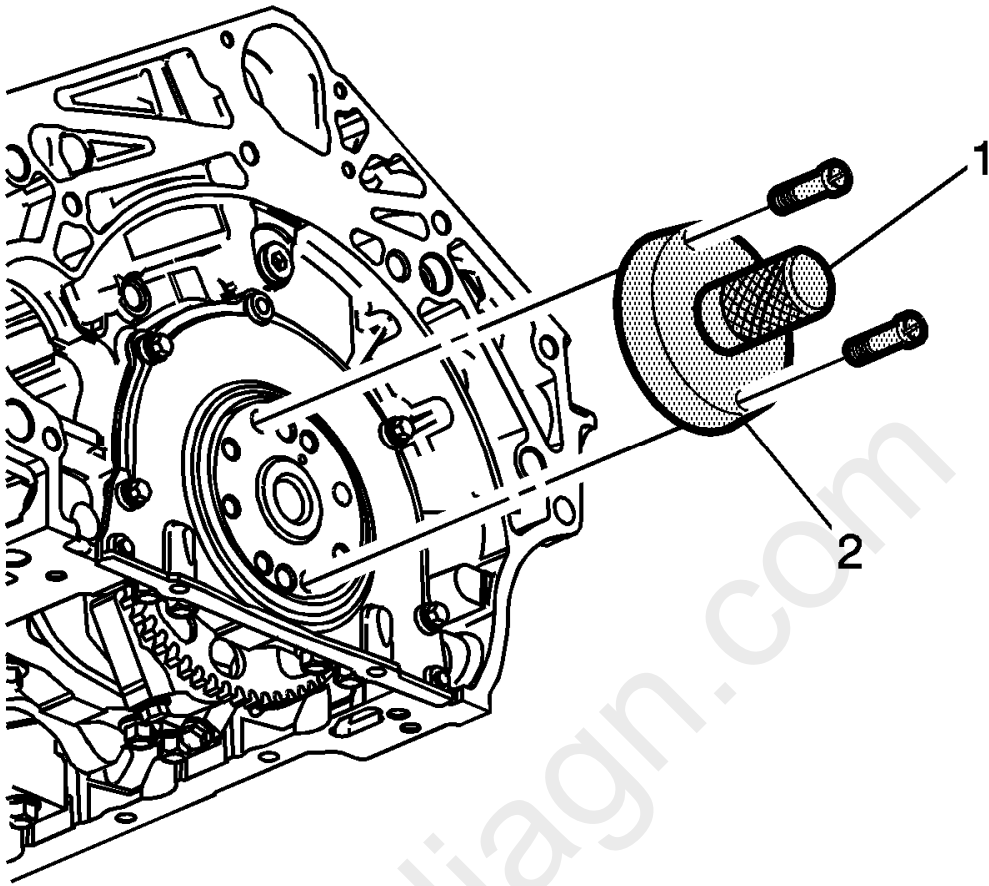


Fig. 238: Crankshaft Rear Oil Seal Installation Tool & Handle
Courtesy of GENERAL MOTORS COMPANY

8. Remove the EN-47839 tool and EN-42183 handle (1, 2) from the crankshaft flange.
9. Install the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.
10. Install the flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
11. Install the engine. Refer to **Engine Replacement (LFX)**, **Engine Replacement (LF3)**.

ENGINE OIL COOLER REPLACEMENT

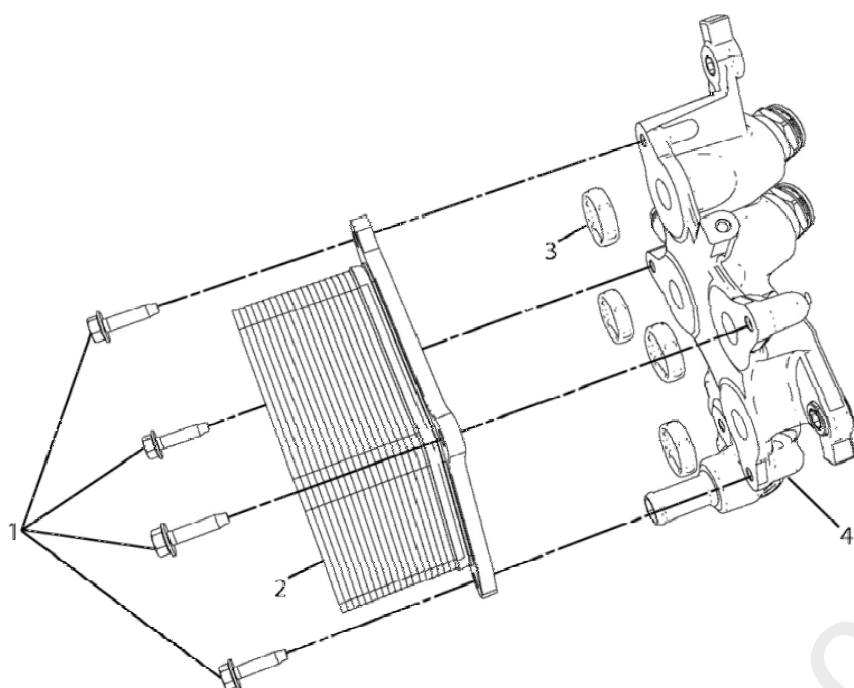


Fig. 239: Engine Oil Cooler
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Replacement

Callout	Component Name
Preliminary Procedures Remove the engine oil cooler shield. Refer to Engine Oil Cooler Shield Replacement .	
1	Engine Oil Cooler Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 10 (89 lb in)
2	Engine Oil Cooler
3	Engine Oil Cooler Seals Procedure Inspect the oil cooler and oil cooler adapter for proper mating prior to reinstalling the NEW seals. NOTE: Install new oil cooler seals whenever the oil cooler and adapter are separated.
4	Oil Cooler Adapter

ENGINE OIL COOLER INLET AND OUTLET HOSE REPLACEMENT (UPPER)

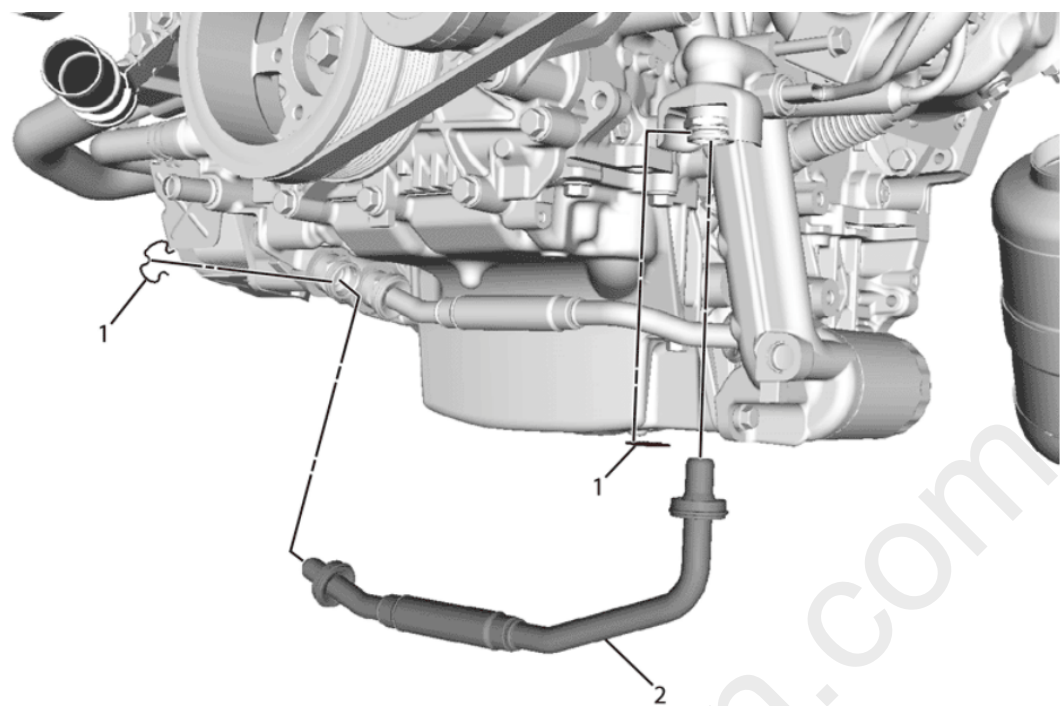


Fig. 240: Engine Oil Cooler Inlet and Outlet Hose (Upper)
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)

Callout	Component Name
Preliminary Procedure	
1. Drain the engine oil. Refer to <u>Engine Oil and Oil Filter Replacement (LFX)</u> , <u>Engine Oil and Oil Filter Replacement (LF3)</u> .	
2. Remove the electric belt drive rack and pinion steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (RWD)</u> .	
1	Engine Oil Cooler Hose Retainers
2	Engine Oil Cooler Upper Hose Procedure
	NOTE: Cap the open ends of the hose to prevent dirt from entering the hose assembly. Remove the hose assembly from bottom of vehicle.

ENGINE OIL COOLER INLET AND OUTLET HOSE REPLACEMENT (LOWER)

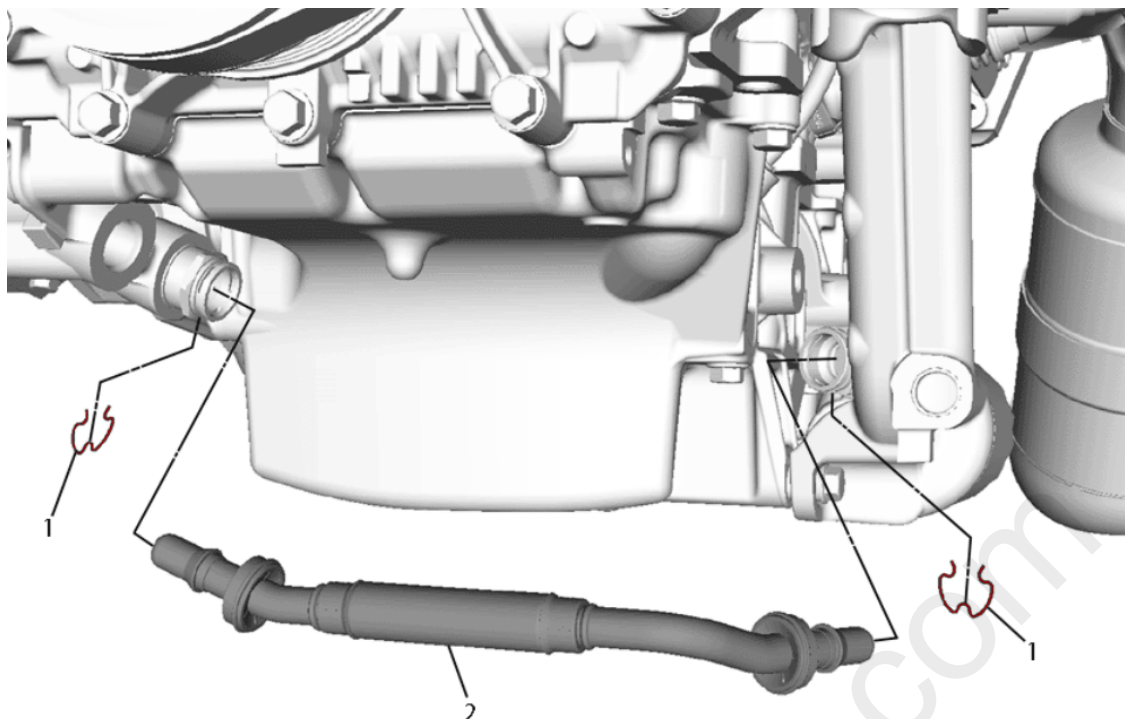


Fig. 241: Engine Oil Cooler Inlet and Outlet Hose (Lower)
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)

Callout	Component Name
Preliminary Procedure	
1. Drain the engine oil. Refer to <u>Engine Oil and Oil Filter Replacement (LFX), Engine Oil and Oil Filter Replacement (LF3)</u> . 2. Remove the electric belt drive rack and pinion steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (RWD)</u> .	
1	Engine Oil Cooler Hose Retainers
2	Engine Oil Cooler Lower Hose Procedure NOTE: Cap the open ends of the hose to prevent dirt from entering the hose assembly. Remove the hose assembly from bottom of vehicle.

ENGINE OIL COOLER INLET HOSE CONNECTOR FITTING REPLACEMENT (UPPER)

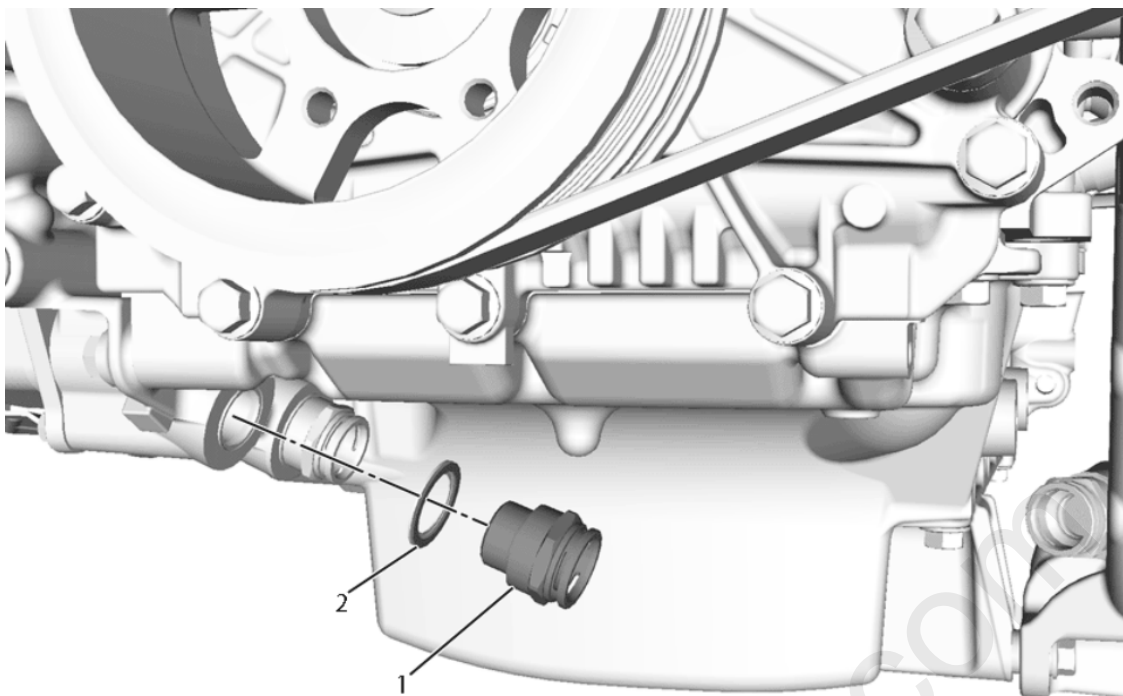


Fig. 242: Engine Oil Cooler Inlet Hose Connector Fitting (Upper)
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Inlet Hose Connector Fitting Replacement (Upper)

Callout	Component Name
Preliminary Procedure Disconnect the engine oil cooler inlet hose. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u> , <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u> .	
1	Engine Oil Cooler Inlet Hose Fitting Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 35 (26 lb ft)
2	Inlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.

ENGINE OIL COOLER OUTLET HOSE CONNECTOR FITTING REPLACEMENT (LOWER)

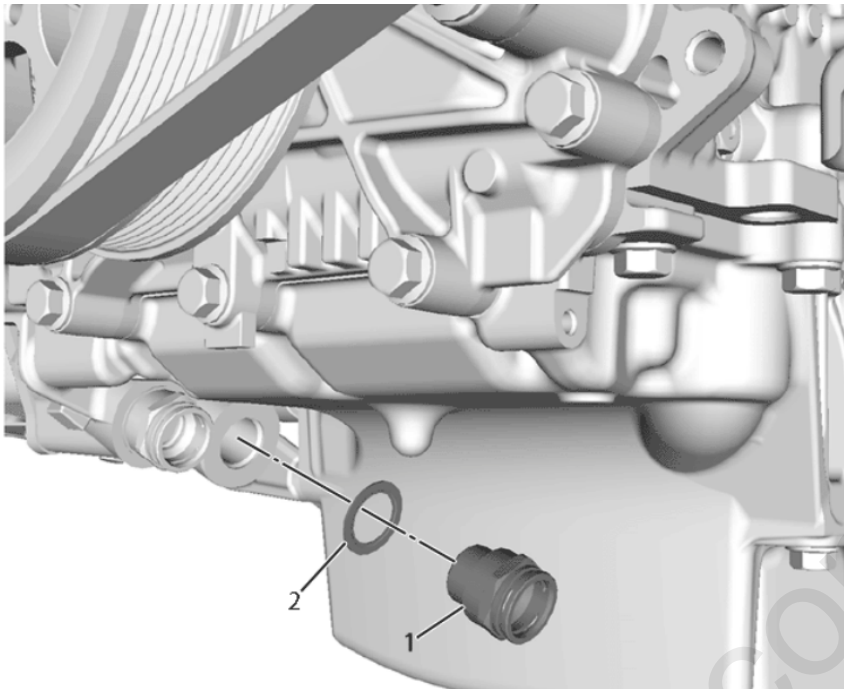


Fig. 243: Engine Oil Cooler Outlet Hose Connector Fitting (Lower)
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Outlet Hose Connector Fitting Replacement (Lower)

Callout	Component Name
Preliminary Procedure Disconnect the engine oil cooler outlet hose. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u> , <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u> .	
1	Engine Oil Cooler outlet Hose Fitting Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 35 (26 lb ft)
2	Outlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.

ENGINE OIL COOLER ADAPTER REPLACEMENT

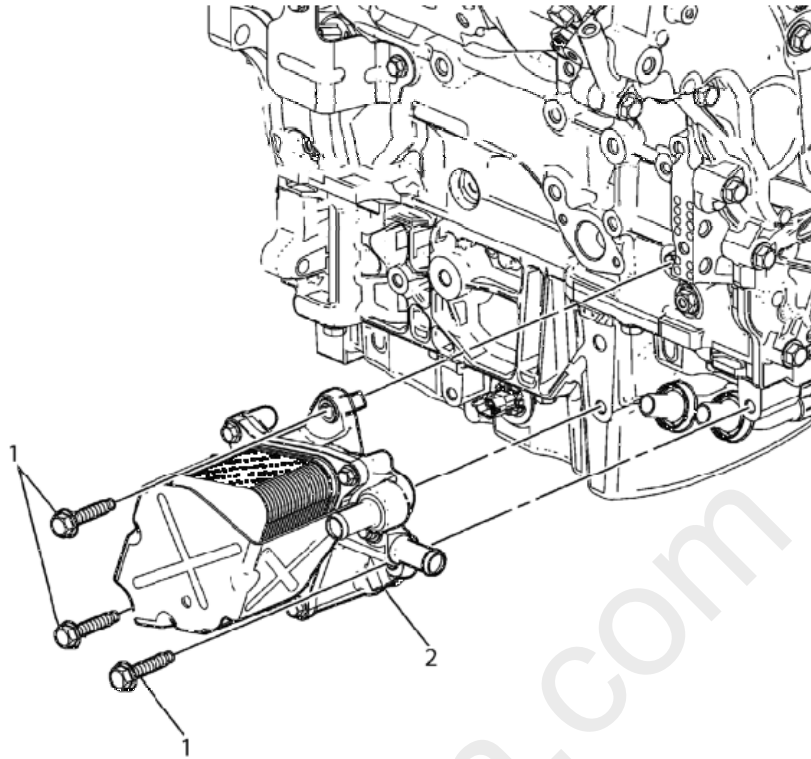


Fig. 244: Engine Oil Cooler Adapter
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Adapter Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the turbocharger coolant hose from the oil cooler adapter. Refer to <u>Turbocharger Coolant Hoses/Pipes Replacement</u> . 2. Remove the radiator outlet hose from the oil cooler adapter. Refer to <u>Radiator Outlet Hose Replacement (LTG with V03)</u> , <u>Radiator Outlet Hose Replacement (LFX)</u> , <u>Radiator Outlet Hose Replacement (LTG without V03)</u> , <u>Radiator Outlet Hose Replacement (LF3)</u> . 3. Remove the engine oil cooler inlet and outlet hoses. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u>, <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u>.	
1	Oil Cooler Adapter Assembly Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
	Engine Oil Cooler Adapter Assembly

	Procedure
2	1. Remove the oil cooler adapter assembly from the engine block. 2. Transfer components as necessary.

OIL PUMP REPLACEMENT

Removal Procedure

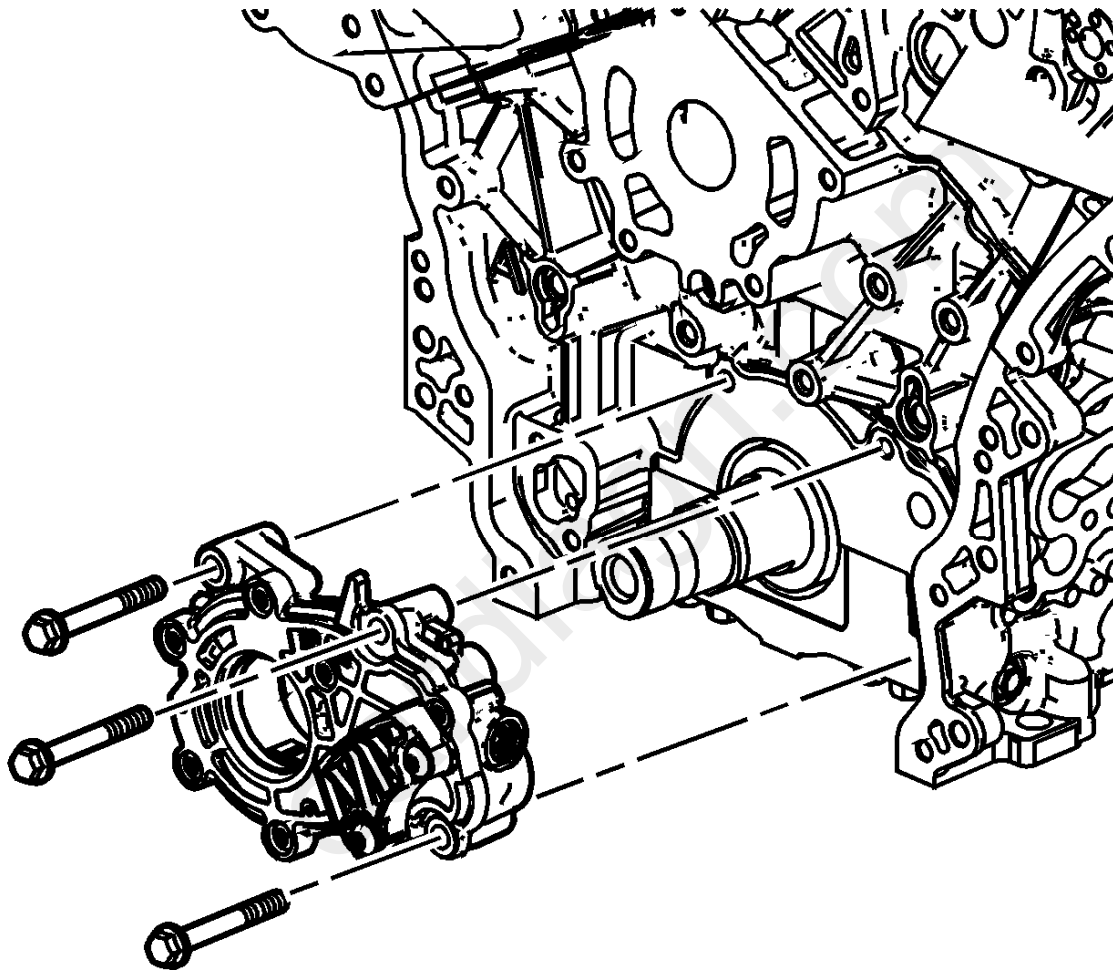


Fig. 245: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove the left bank idler sprocket.

1. Remove the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

2. Remove the crankshaft sprocket. Refer to Crankshaft Sprocket Removal .
3. Remove the oil pump bolts and the oil pump.

Installation Procedure

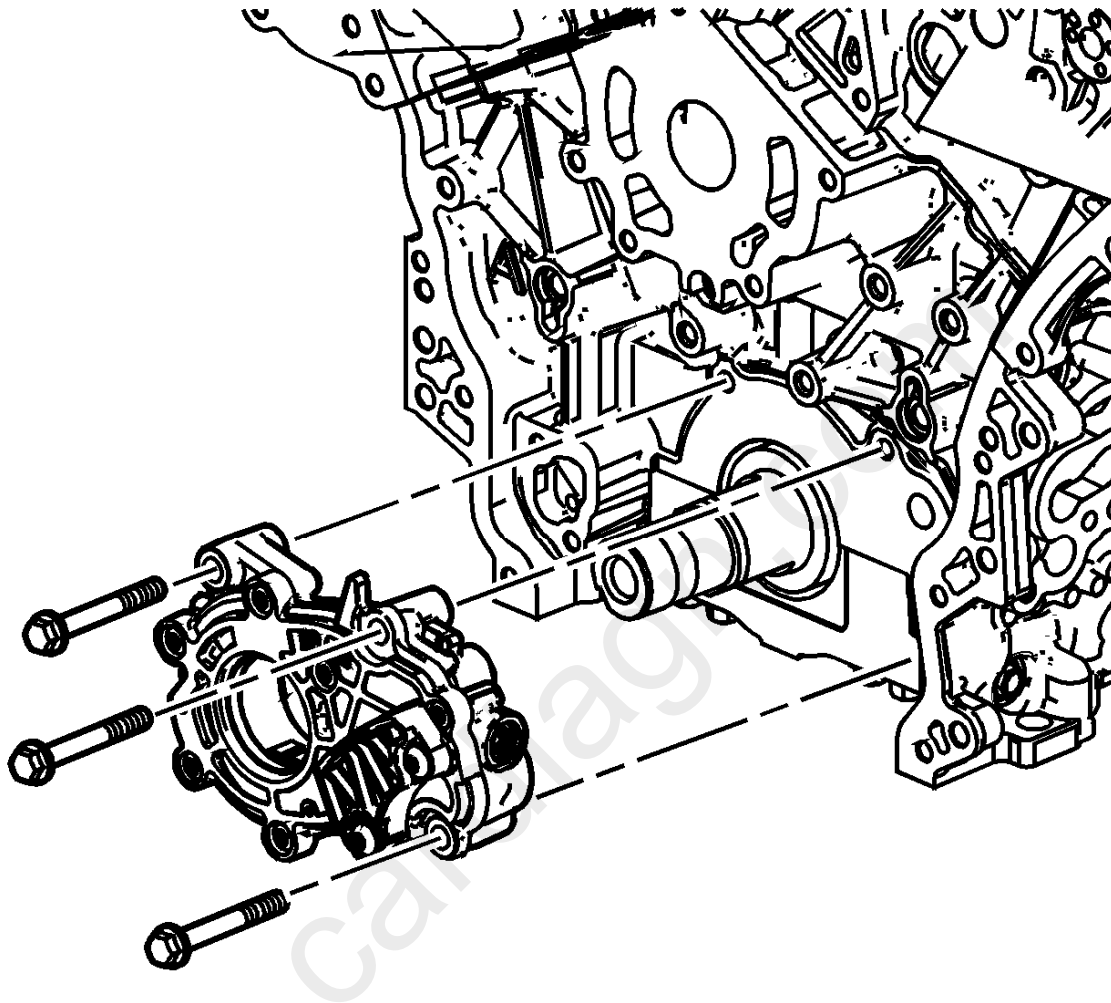


Fig. 246: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

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

OIL PAN REPLACEMENT (LFX)

Special Tools

EN 46109 Guide Pin Set.

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement (LFX).
2. Remove the engine front cover. Refer to Engine Front Cover Replacement.
3. Remove the oil level indicator tube. Refer to Oil Level Indicator Tube Replacement (LFX).
4. Remove the drivetrain and front suspension frame . Refer to Drivetrain and Front Suspension Frame Removal and Installation .
5. If equipped with AWD remove the front differential carrier. Refer to Front Differential Carrier Assembly Replacement .
6. Remove the engine mount bracket-to-oil pan bolts. Refer to Engine Mount Bracket Replacement - Right Side (LFX) and Engine Mount Bracket Replacement - Left Side (LFX).

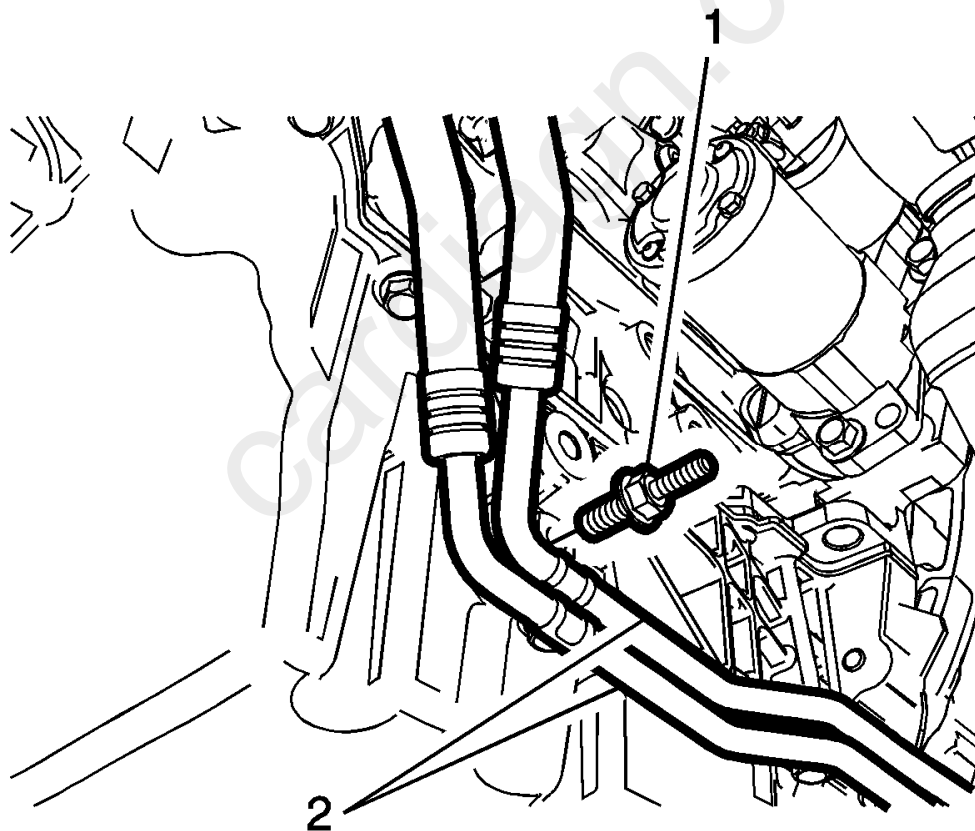


Fig. 247: Automatic Transmission Lines
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fastener (1) retaining the transmission lines (2) to the oil pan.
8. Position the transmission lines out of the way.
9. Disconnect the oil level sensor.

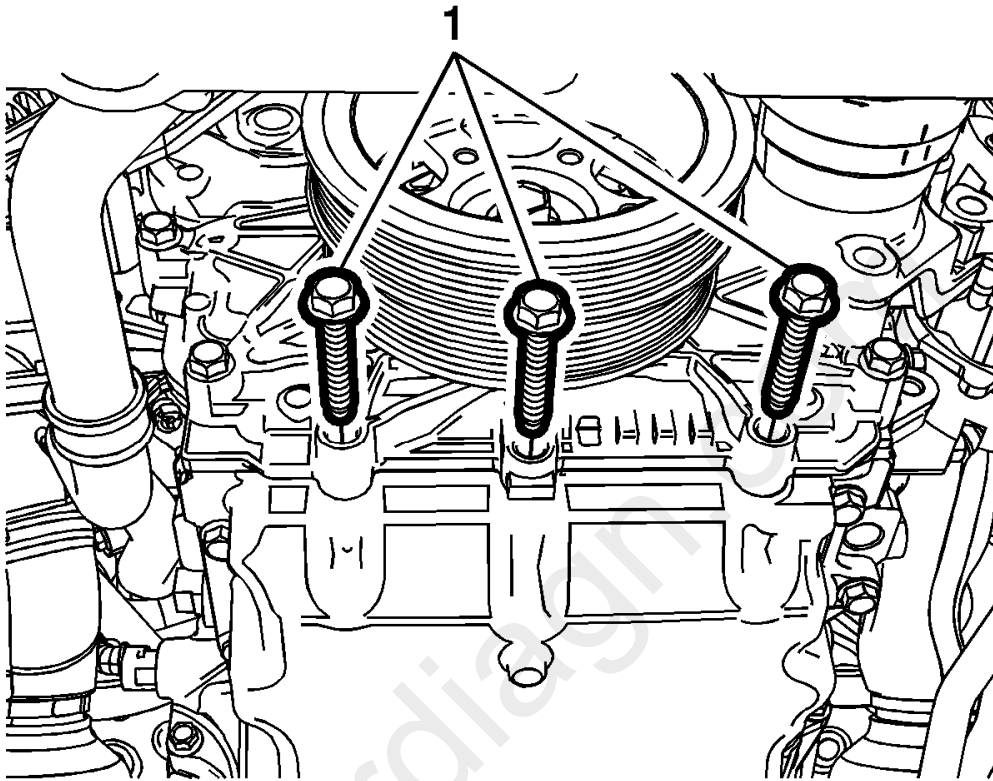


Fig. 248: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the front cover bolts (1).

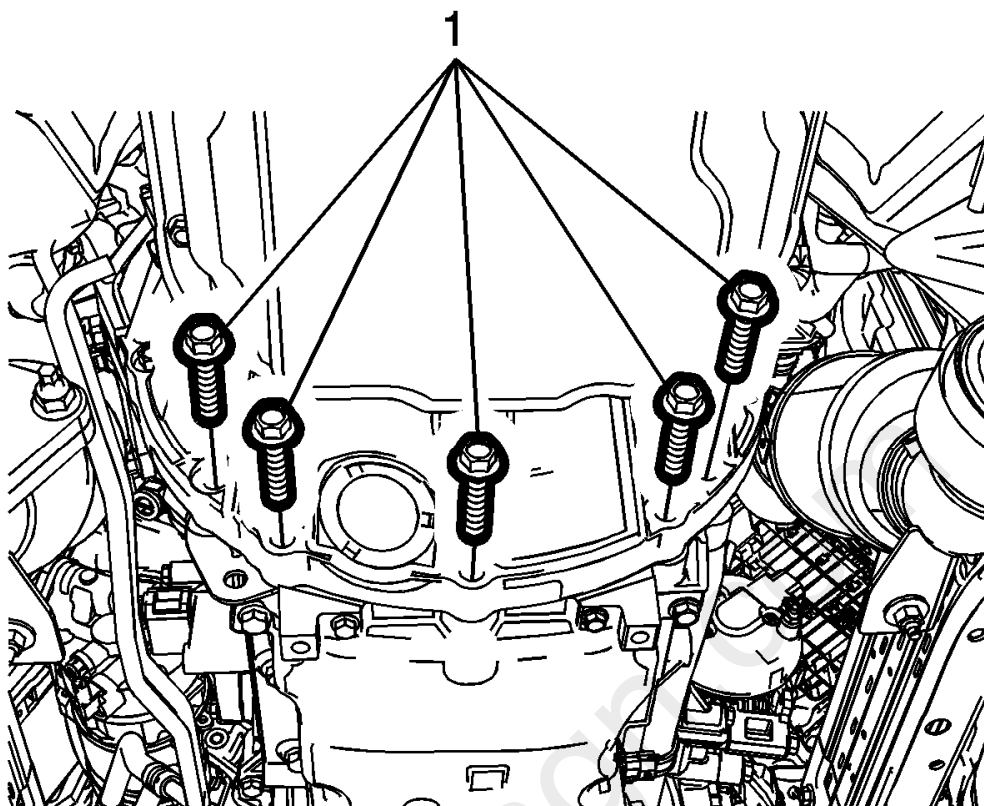


Fig. 249: Transmission To Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the transmission to oil pan bolts (1).

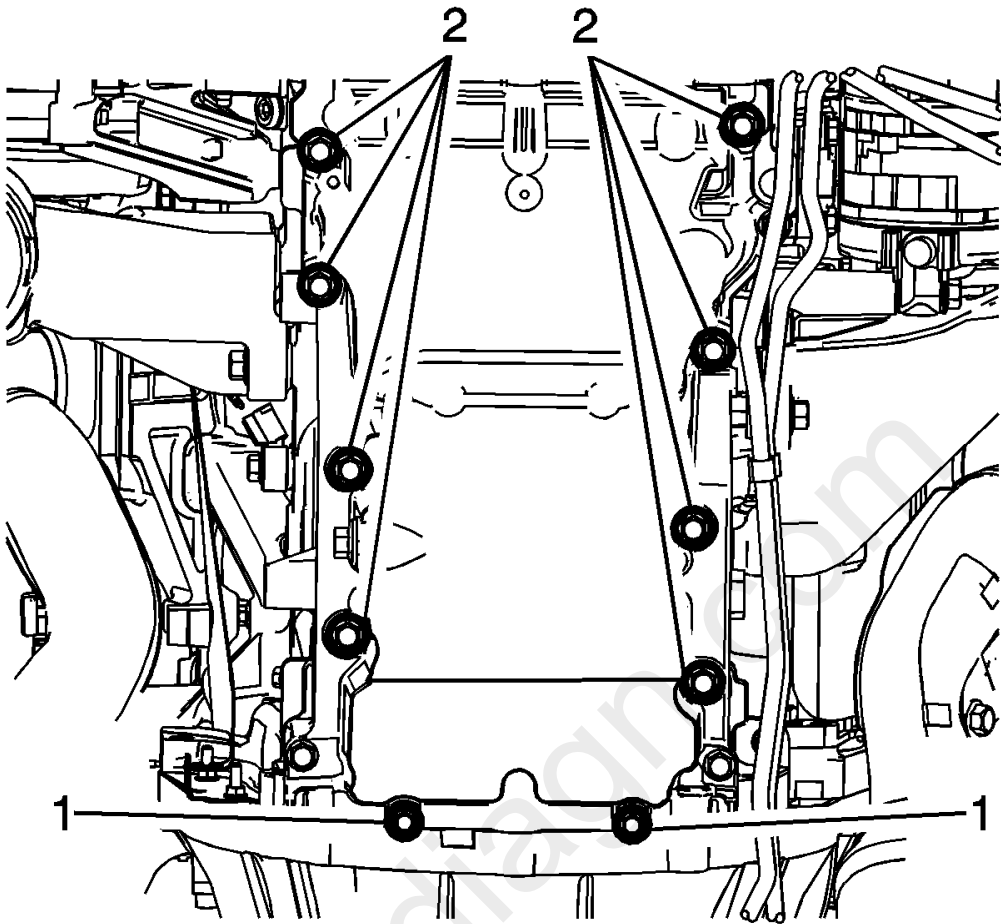


Fig. 250: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil pan bolts (1) and (2).

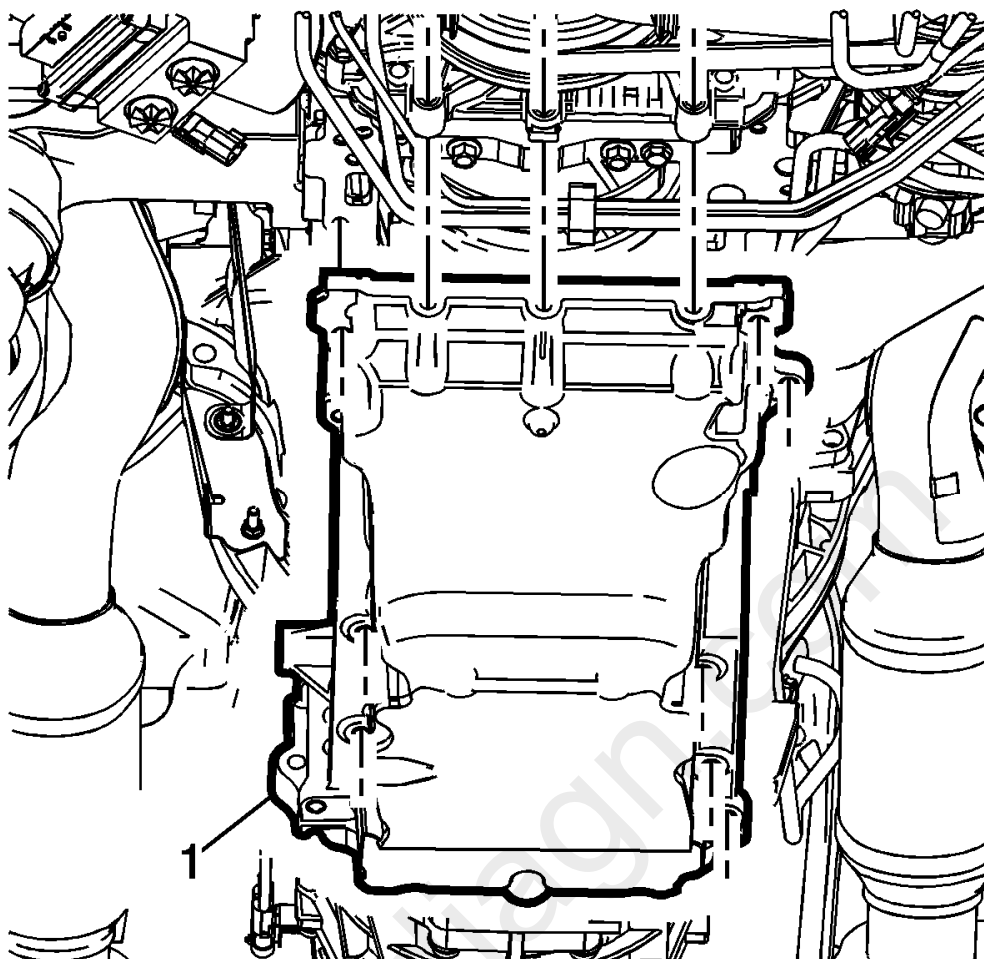


Fig. 251: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

13. Remove the oil pan (1).
14. If necessary, disassemble the oil pan. Refer to **Oil Pan Disassemble (LFX-RWD)** , **Oil Pan Disassemble (LFX-AWD)** .
15. Clean and inspect the oil pan. Refer to **Oil Pan Cleaning and Inspection (LFX-RWD)** , **Oil Pan Cleaning and Inspection (LFX-AWD)**

Installation Procedure

1. If the oil pan was disassembled, assemble the oil pan. Refer to **Oil Pan Assemble (LFX-RWD)** , **Oil Pan Assemble (LFX-AWD)** .

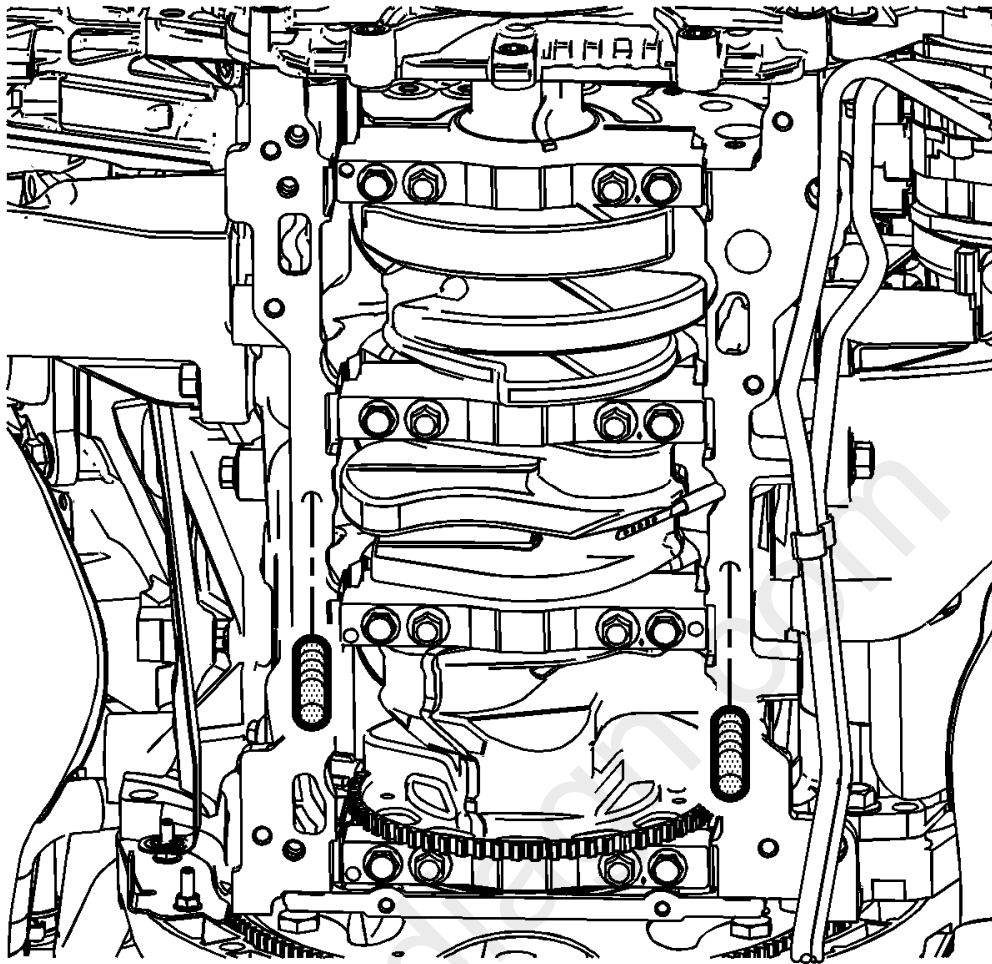


Fig. 252: EN 46109 Guides
Courtesy of GENERAL MOTORS COMPANY

2. Install the 8 mm (0.315 in) guides from the EN 46109 set into the center oil pan rail bolt hole on each side of the engine block.

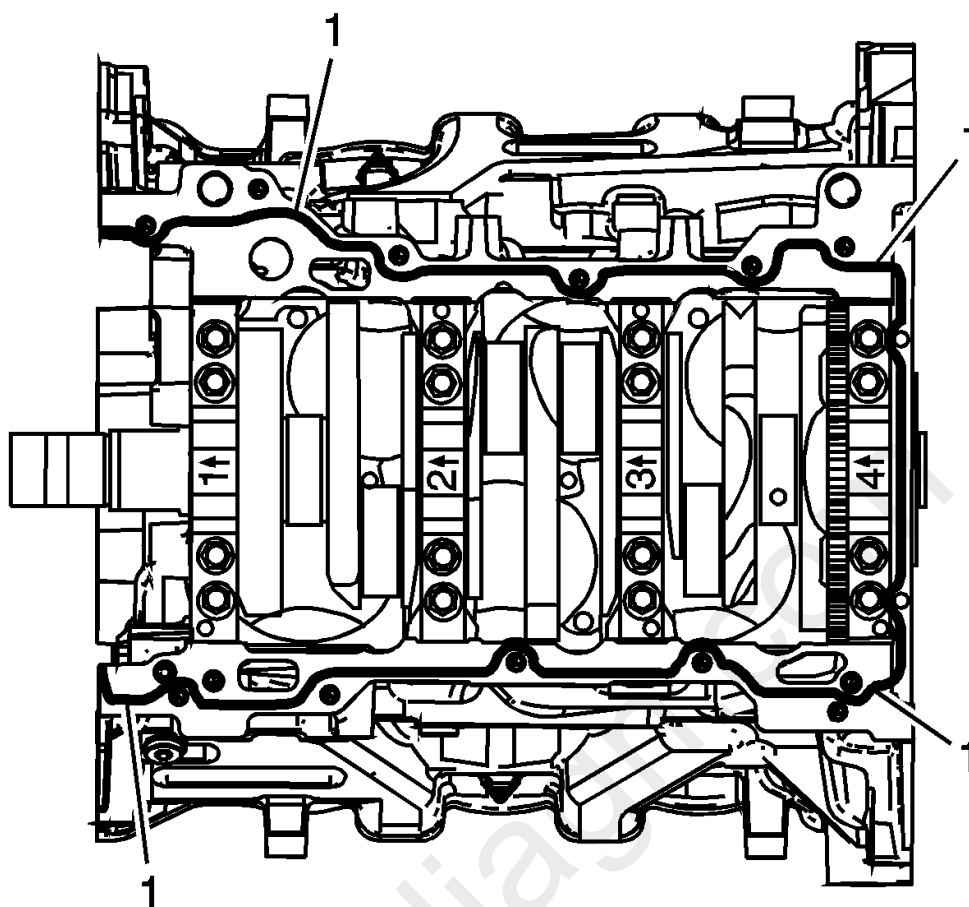


Fig. 253: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead of RTV sealant, on the block pan rail and the crankshaft rear oil seal housing (1).

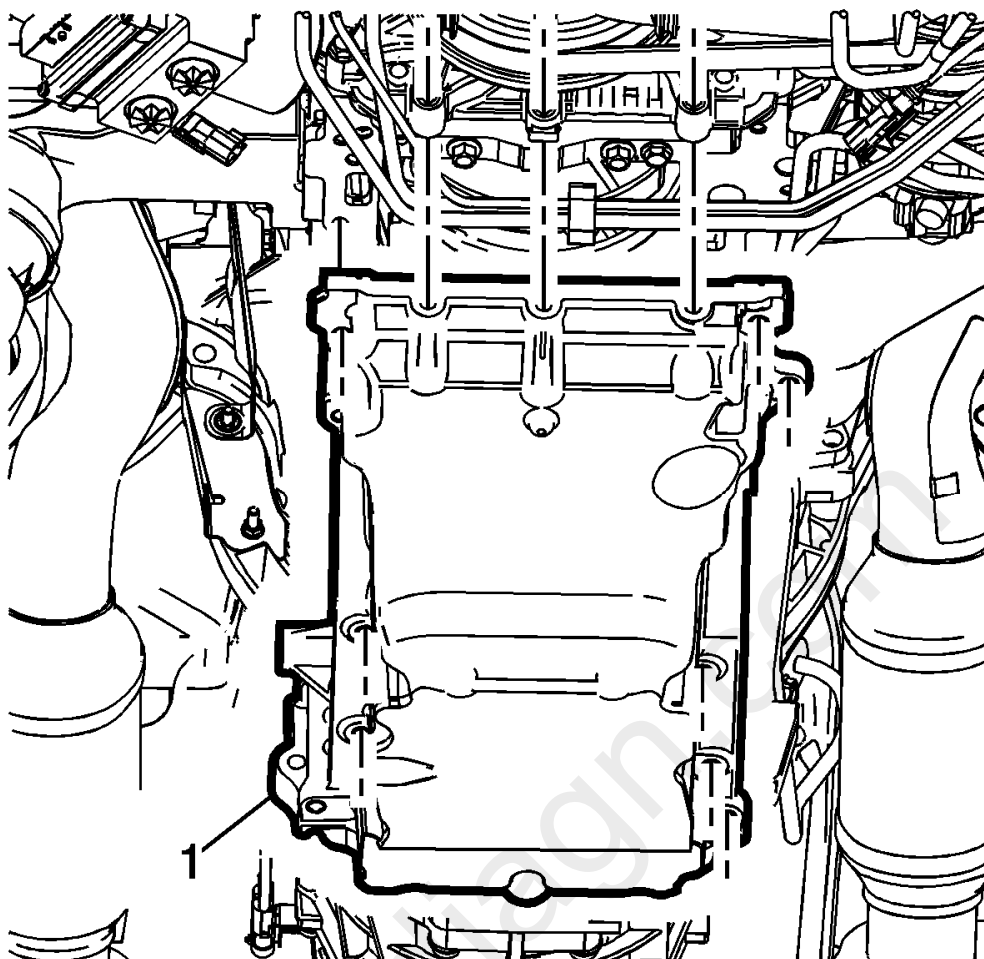


Fig. 254: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

4. Install oil pan (1)
5. Remove the EN 46109 set 8 mm (0.315 in) guides from the engine block.

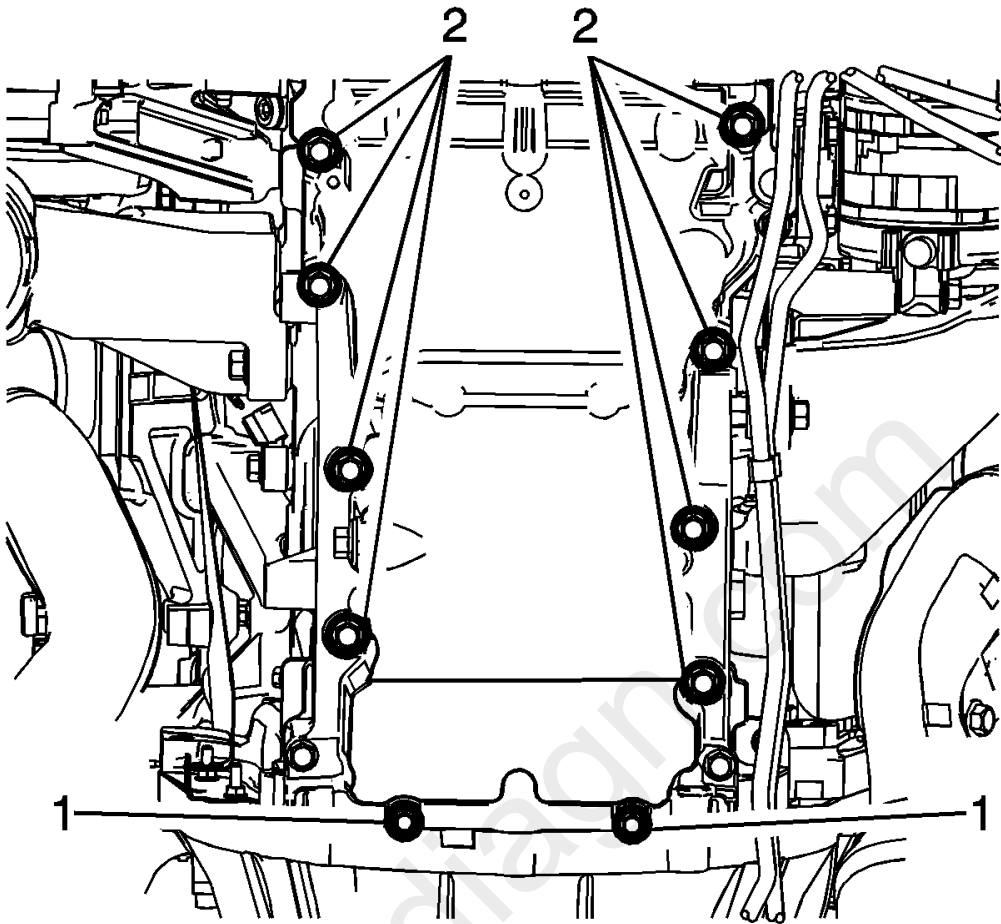


Fig. 255: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Loosely install the oil pan bolts (1) and (2).

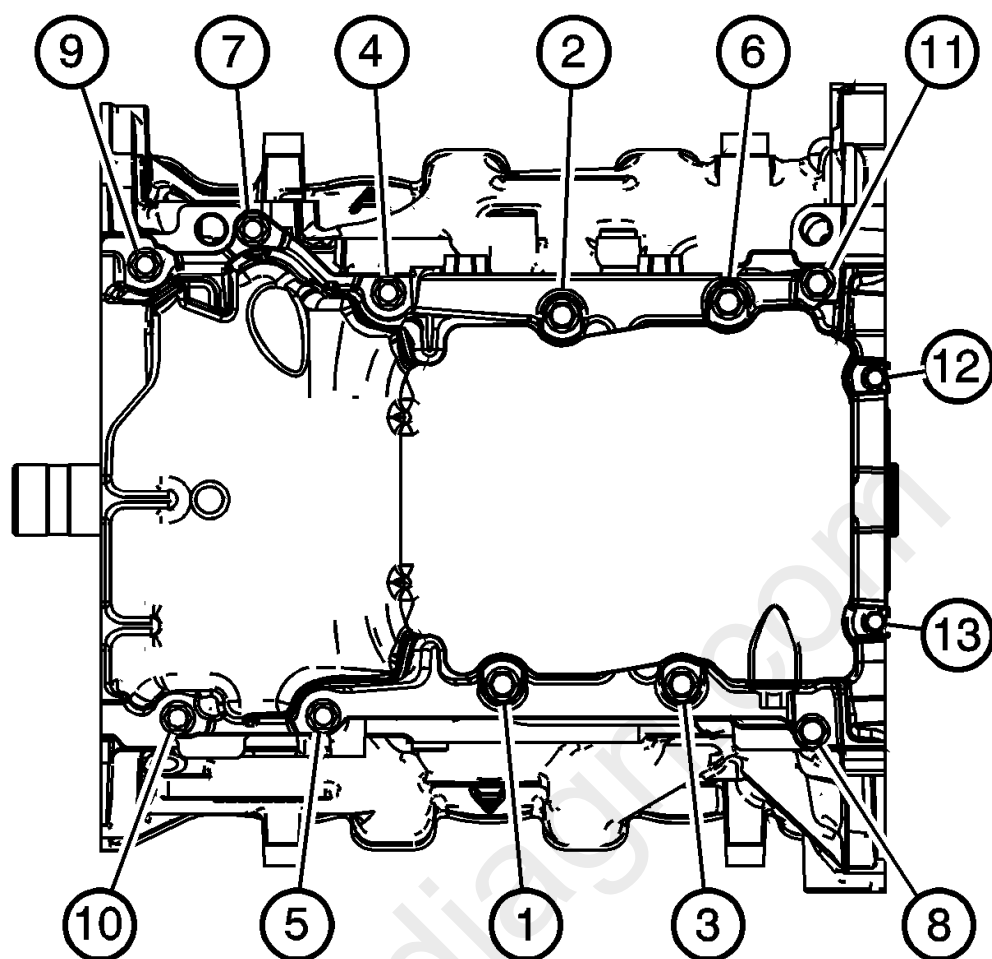


Fig. 256: View Of Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the oil pan bolts in sequence shown.
 - Tighten the 8 mm bolts (1-11) to 25 N.m (18 lb ft).
 - Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).

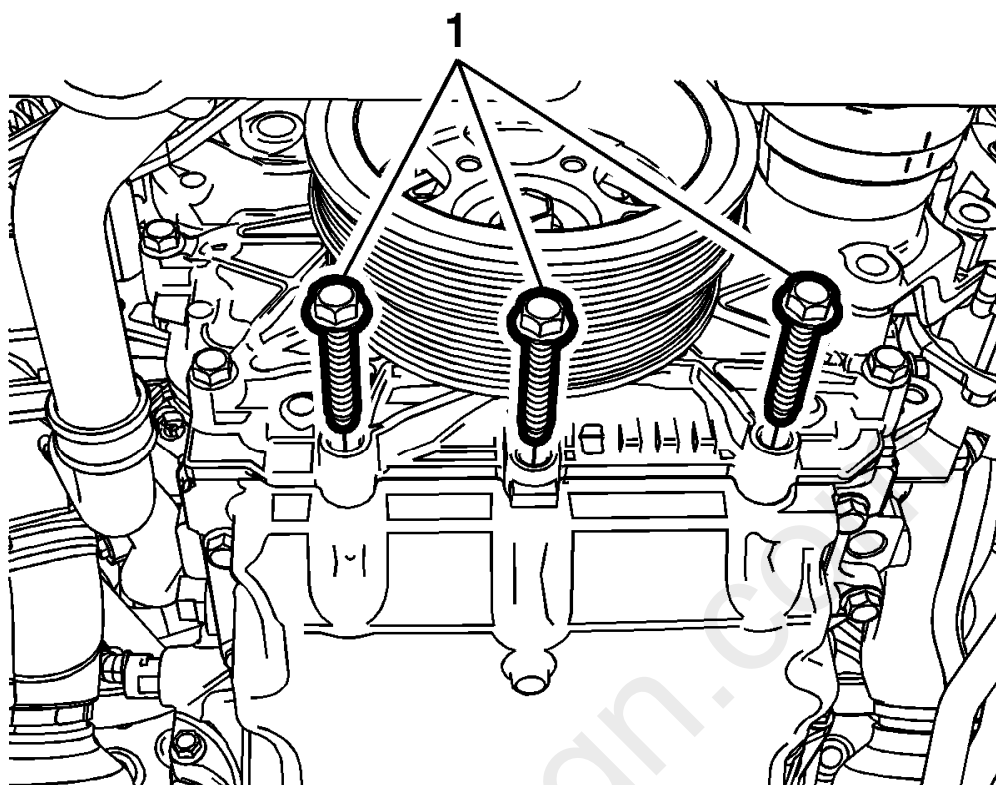


Fig. 257: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install NEW front cover bolts (1) and tighten the bolts to 20 N.m (14 lb ft) plus 60°.

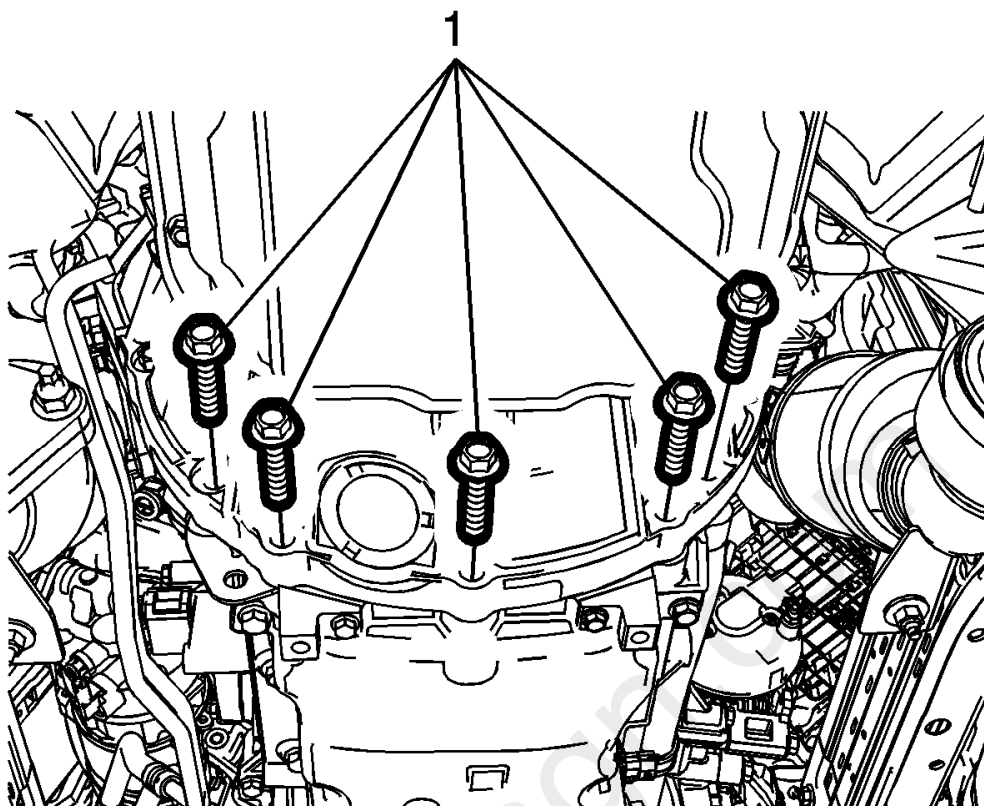


Fig. 258: Transmission To Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the transmission to oil pan bolts (1) and tighten the bolts to 50 N.m (37 lb ft).
10. Connect the oil level sensor.

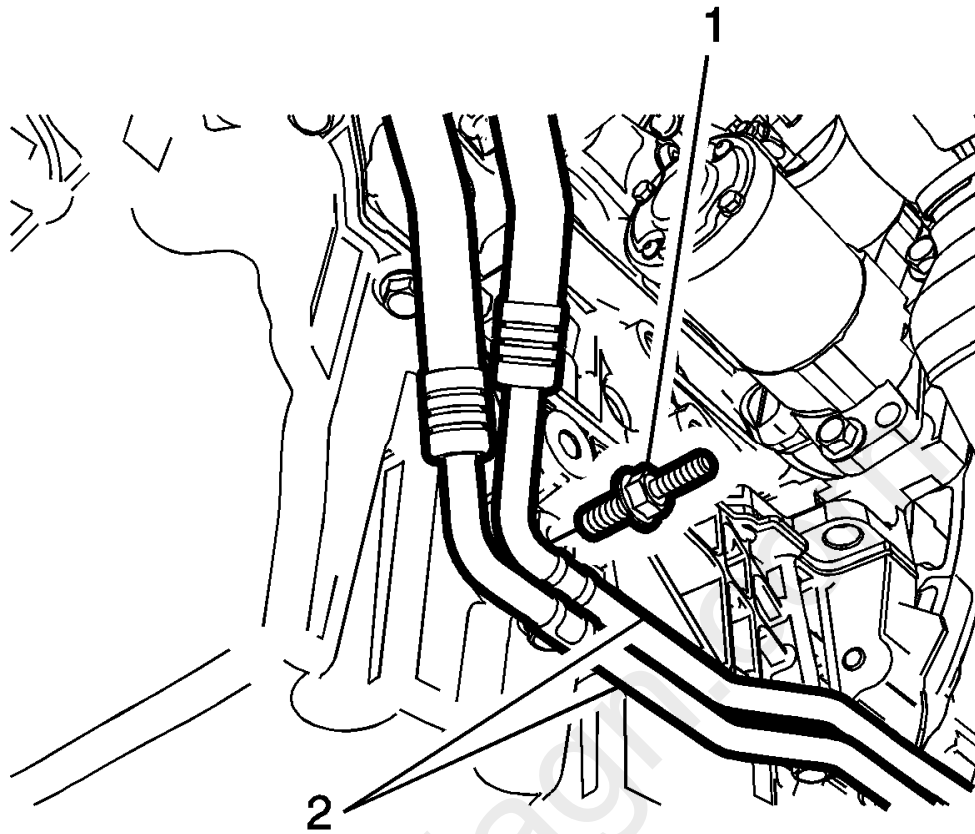


Fig. 259: Automatic Transmission Lines
Courtesy of GENERAL MOTORS COMPANY

11. Reposition the transmission lines to the oil pan (2).
12. Install the fastener (1) retaining the transmission lines (2) to the oil pan and tighten the fastener to 22 N.m (16 lb ft).
13. Install the engine mount bracket-to-oil pan bolts. Refer to **Engine Mount Bracket Replacement - Right Side (LFX)** and **Engine Mount Bracket Replacement - Left Side (LFX)**.
14. If equipped with AWD Install the front differential carrier. Refer to **Front Differential Carrier Assembly Replacement**.
15. Install the drivetrain and front suspension frame. Refer to **Drivetrain and Front Suspension Frame Removal and Installation**.
16. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LFX)**.
17. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
18. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement (LFX)**.

OIL PAN REPLACEMENT (LF3)

Special Tools

EN-46109 Guide Pin Set

For equivalent regional tools, refer to Special Tools .

Removal Procedure

1. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement (LF3).
2. Unplug the engine oil level switch.
3. Remove the front cover. Refer to Engine Front Cover Replacement.
4. Remove the oil level indicator tube. Refer to Oil Level Indicator Tube Replacement (LF3).
5. Remove the drivetrain front cradle. Refer to Drivetrain and Front Suspension Cradle Replacement .
6. Remove the engine mount brackets. Refer to Engine Mount Bracket Replacement - Left Side (LF3), and Engine Mount Bracket Replacement - Right Side (LF3).
7. Remove the engine oil cooler adapter assembly. Refer to Engine Oil Cooler Adapter Replacement.

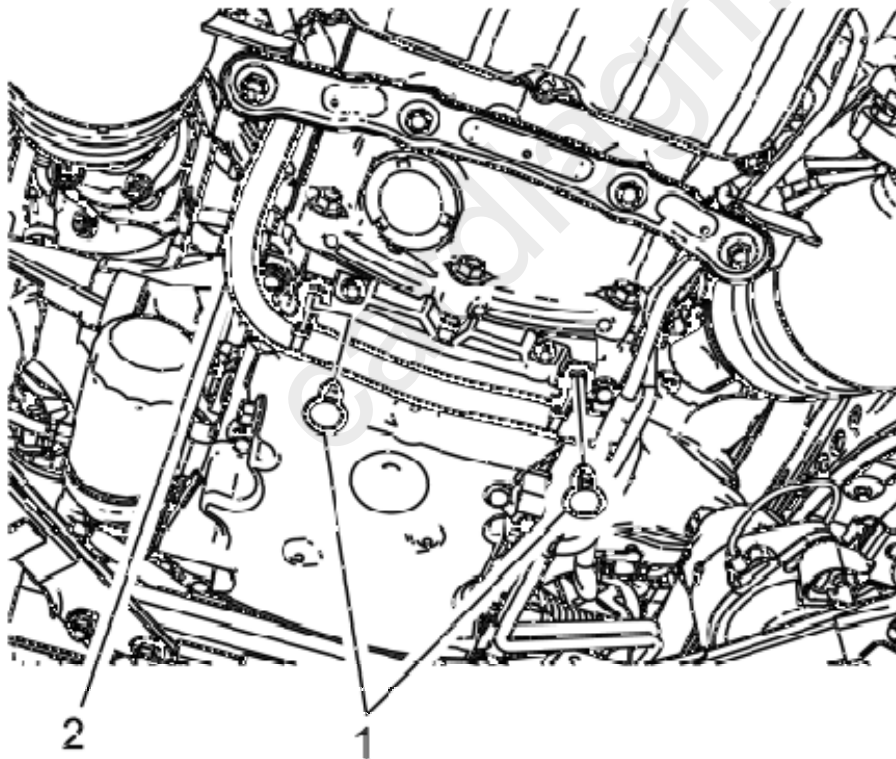


Fig. 260: Electrical Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove the electrical wiring harness retainers (1) then reposition the wiring harness away from the

engine oil pan.

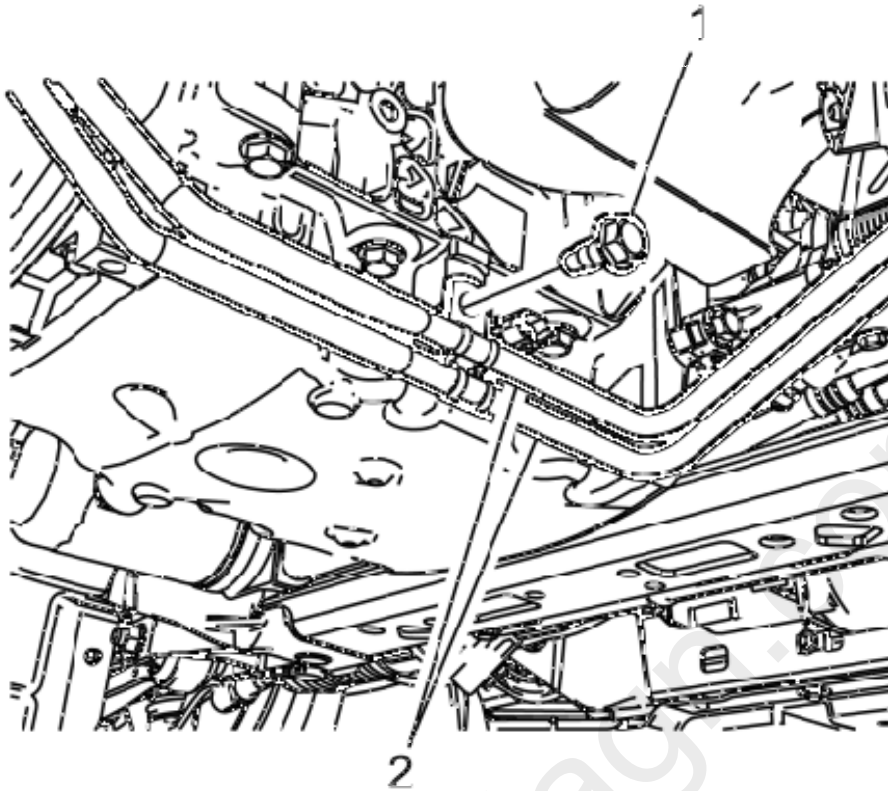


Fig. 261: Transmission Cooler Lines
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bolt (1) from the transmission cooler line retainer then reposition the cooler lines (2) to allow engine oil pan removal.

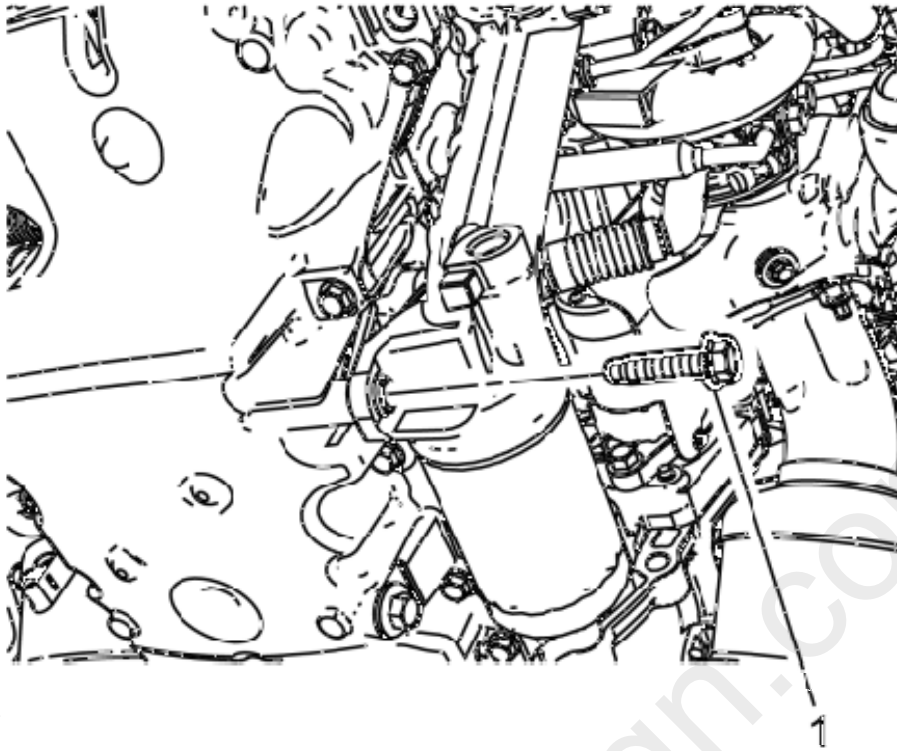


Fig. 262: Engine Oil Filter Adapter Lower Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the lower bolt (1) from the oil filter adapter.

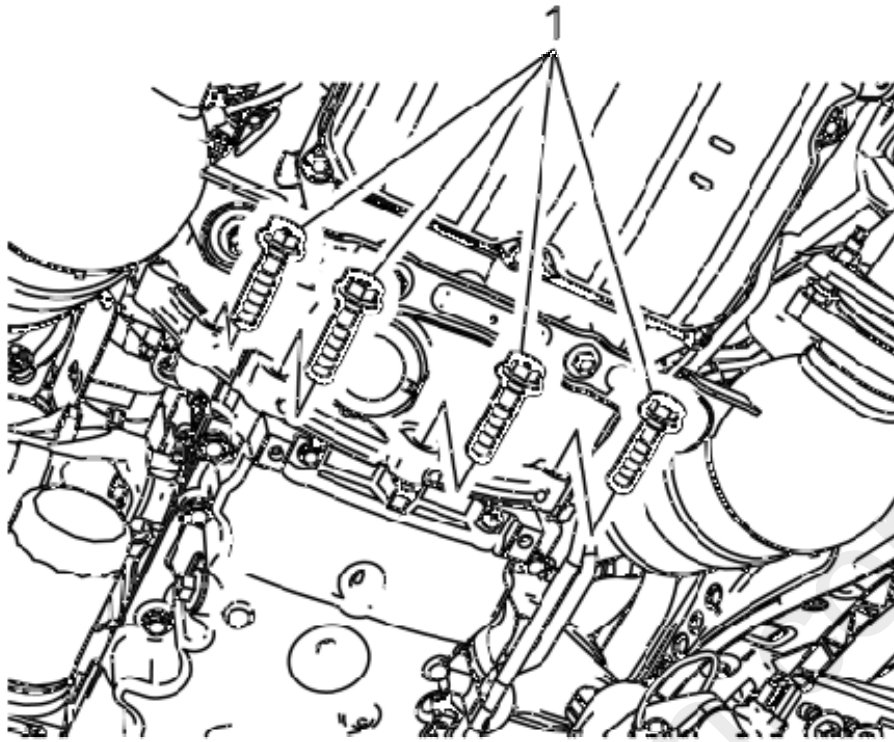


Fig. 263: Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the oil pan to transmission bolts (1).

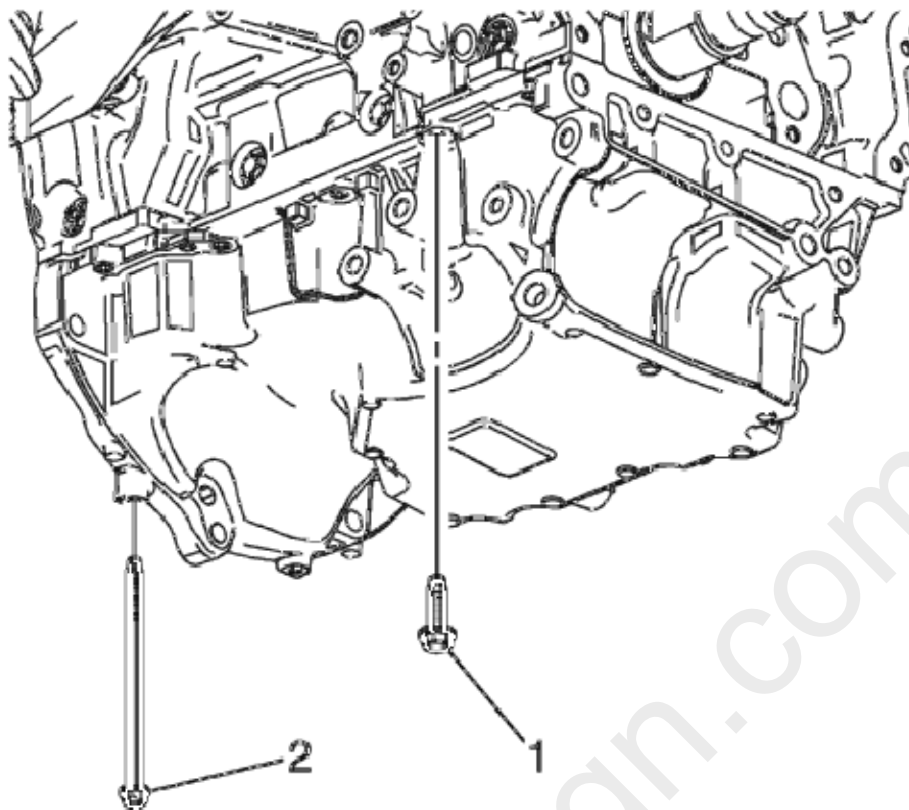


Fig. 264: Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

12. Remove the oil pan bolts (1) and (2).

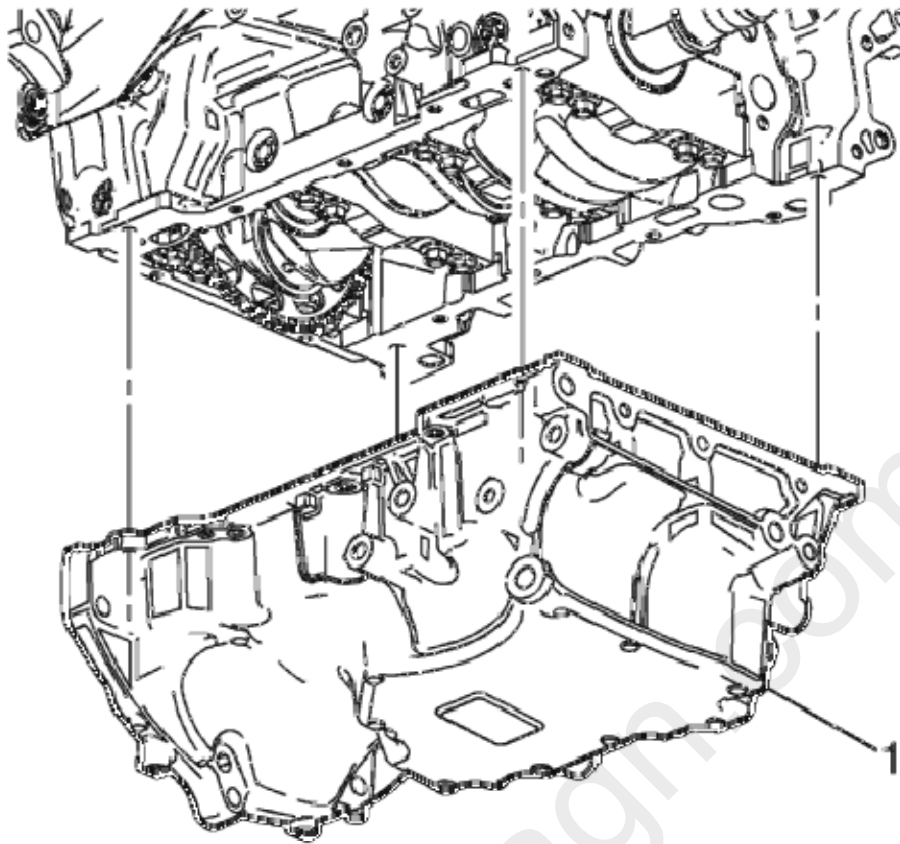


Fig. 265: Engine Oil Pan

Courtesy of GENERAL MOTORS COMPANY

13. Remove the oil pan.
14. Clean the oil pan and engine block gasket sealing surface. Refer to **Oil Pan Cleaning and Inspection (LF3)**.
15. Disassemble the oil pan as necessary. Refer to **Oil Pan Assemble (LF3)**.

Installation Procedure

1. Assemble the oil pan as necessary. Refer to **Oil Pan Assemble (LF3)**.

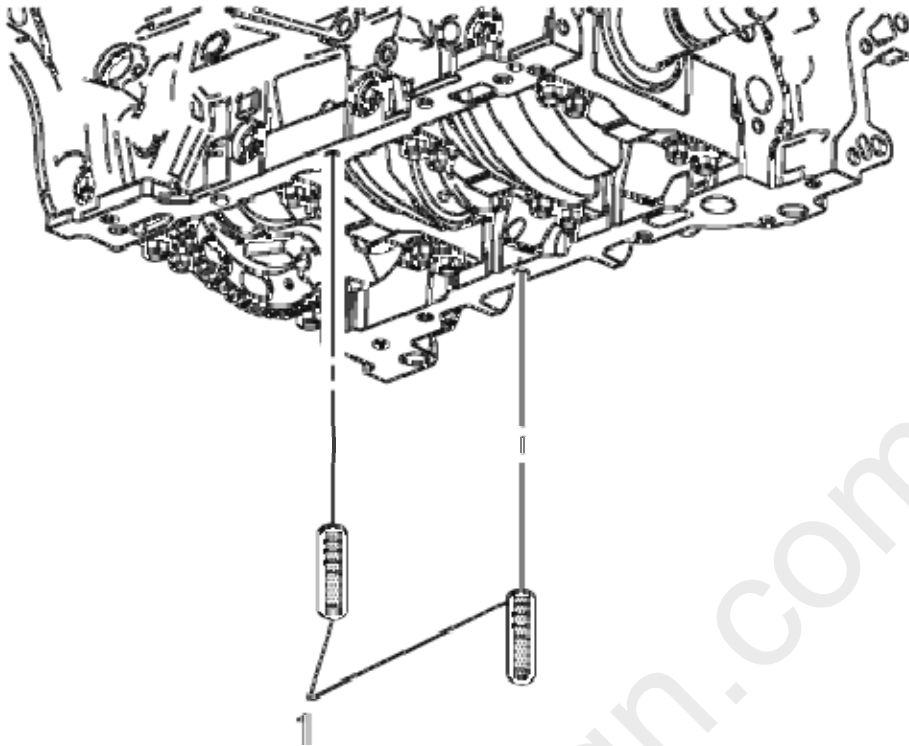


Fig. 266: Oil Pan Guides

Courtesy of GENERAL MOTORS COMPANY

2. Install the 8 mm (0.315 in) guides (1) from the **EN-46109** set into the center oil pan rail bolt hole on each side of the engine block.

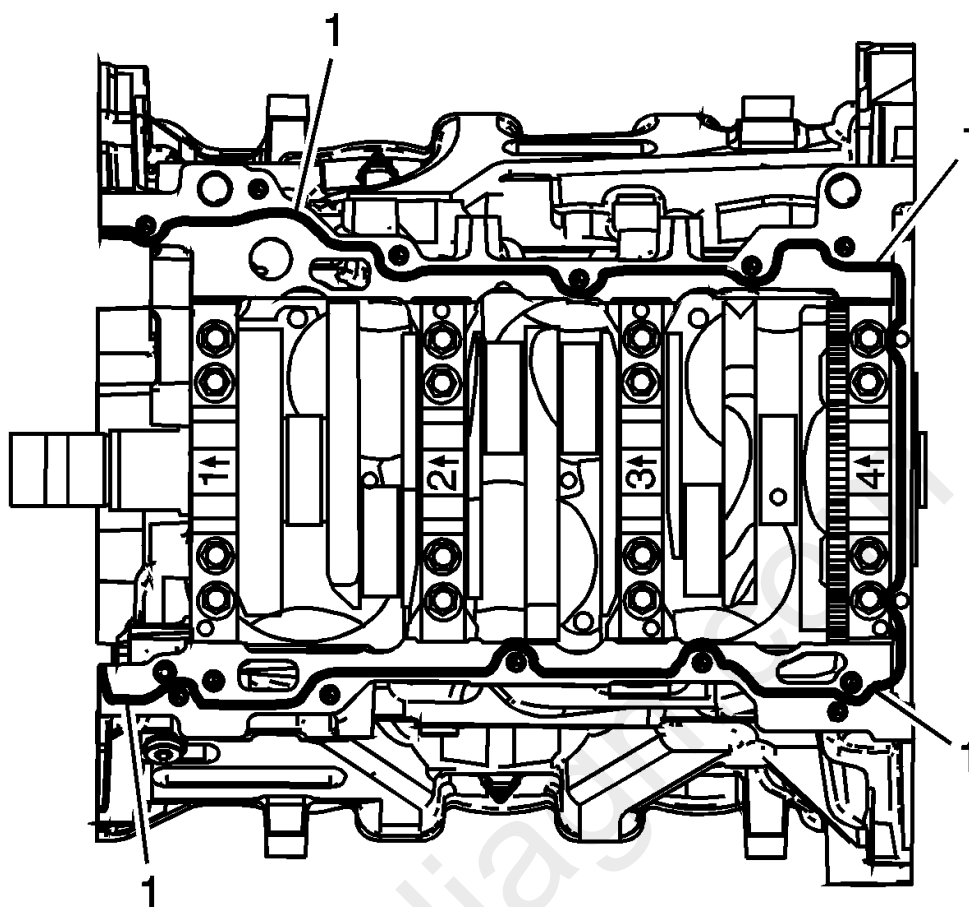


Fig. 267: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

3. Apply a 3 mm (0.118 in) bead (1) of RTV sealant on the block pan rail and the crankshaft rear oil seal housing. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

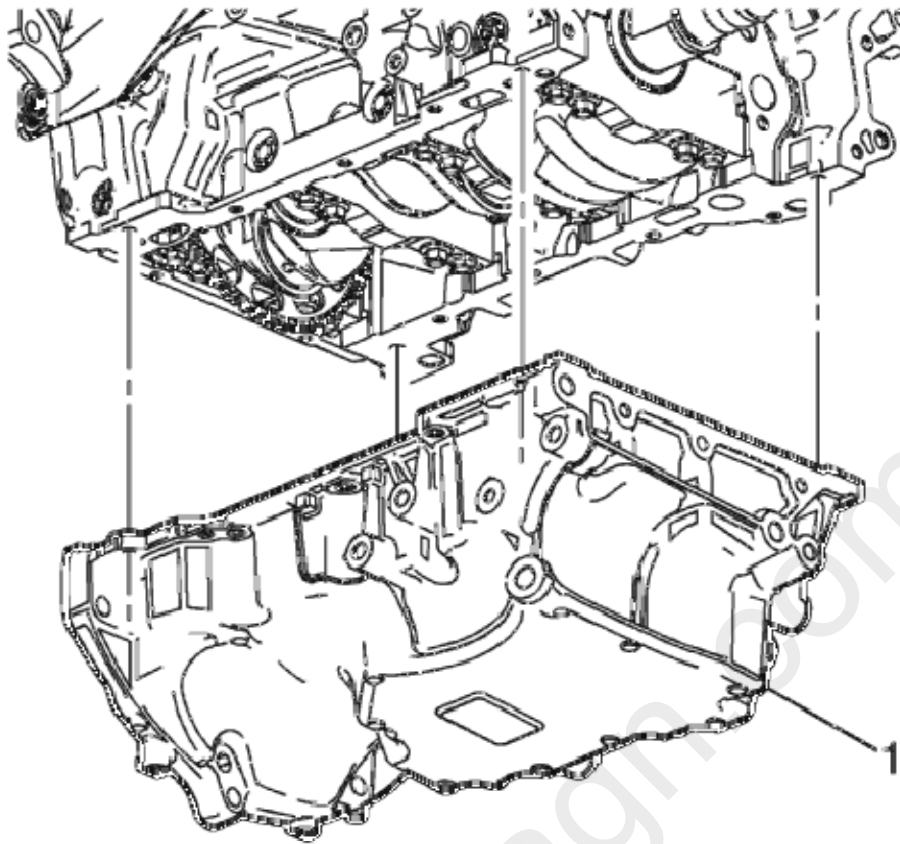


Fig. 268: Oil Pan

Courtesy of GENERAL MOTORS COMPANY

4. Position the oil pan (1) onto the block.

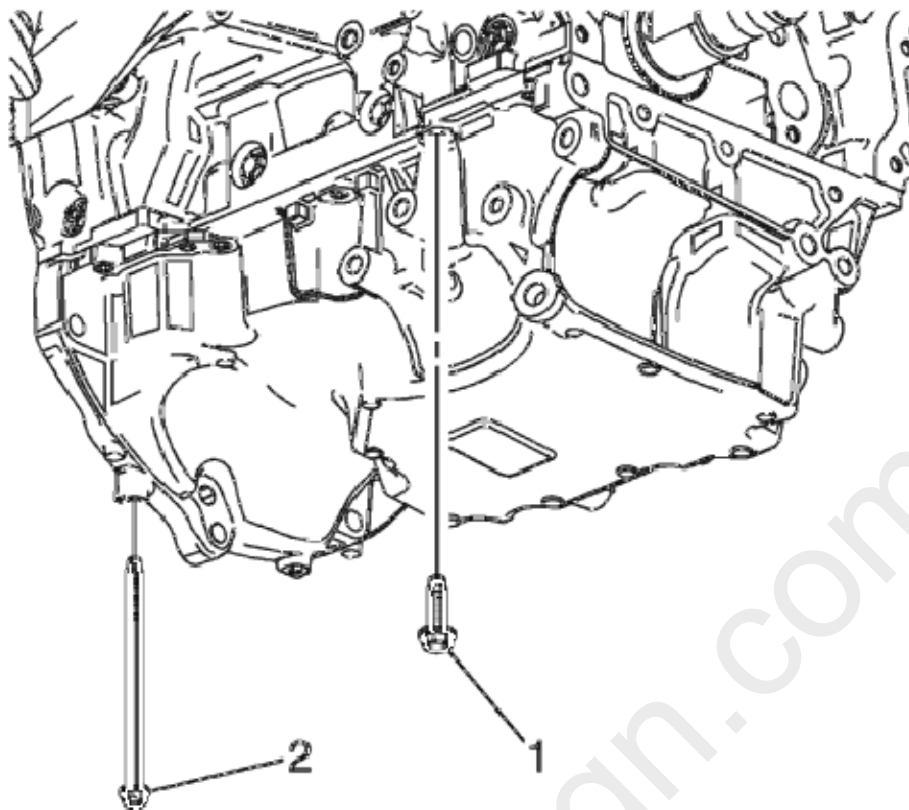


Fig. 269: Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the oil pan bolts (1 and 2).

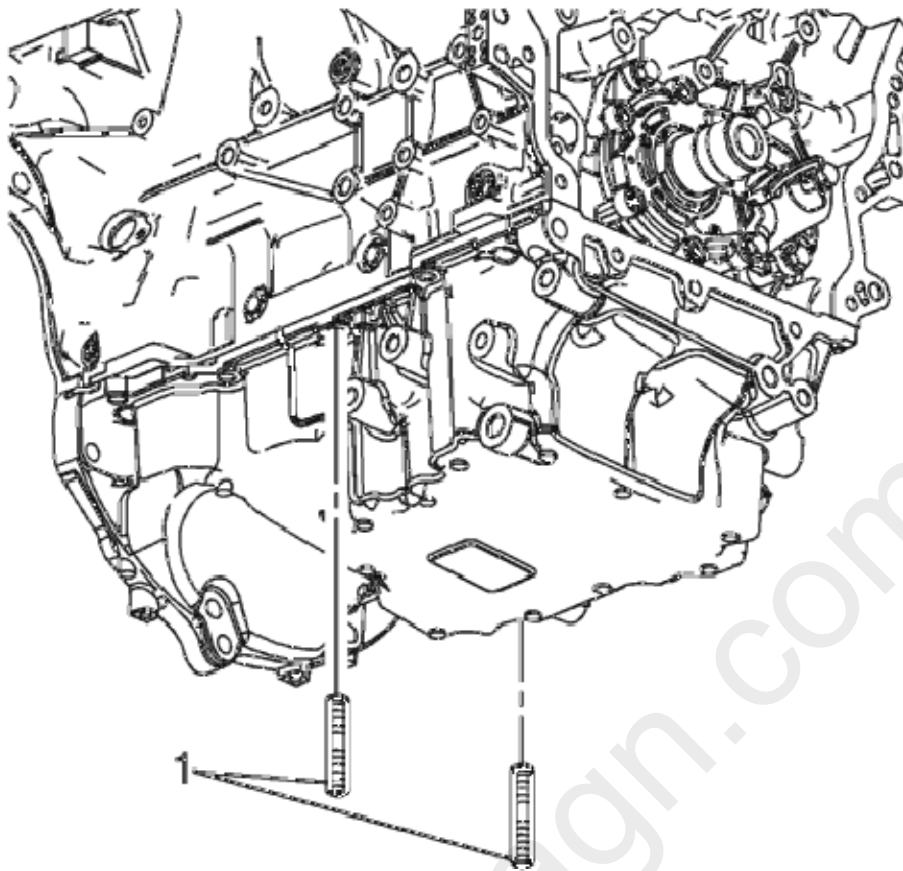


Fig. 270: Oil Pan Guides

Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-46109** set 8 mm (0.315 in) guides (1) from the engine block then install the remaining bolts.

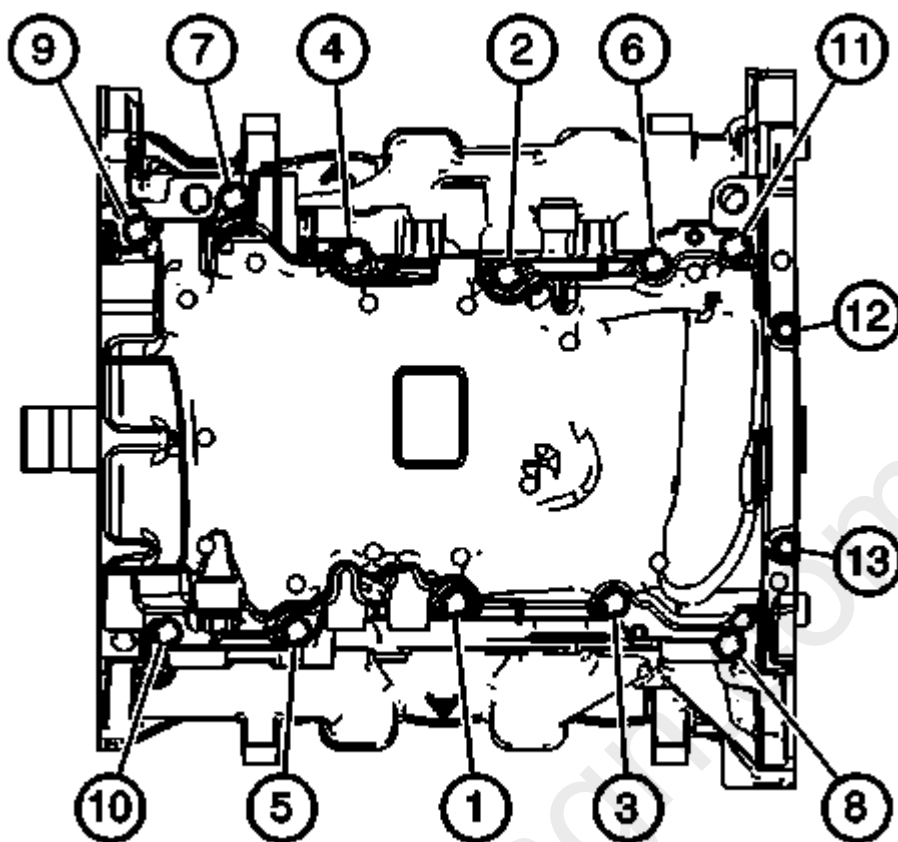


Fig. 271: Identifying Oil Pan Bolts - Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the oil pan bolts in sequence.
 1. The 8 mm bolts (1-11) to 25 (18 lb ft).
 2. The 6 mm bolts (12, 13) to 10 (89 lb in).

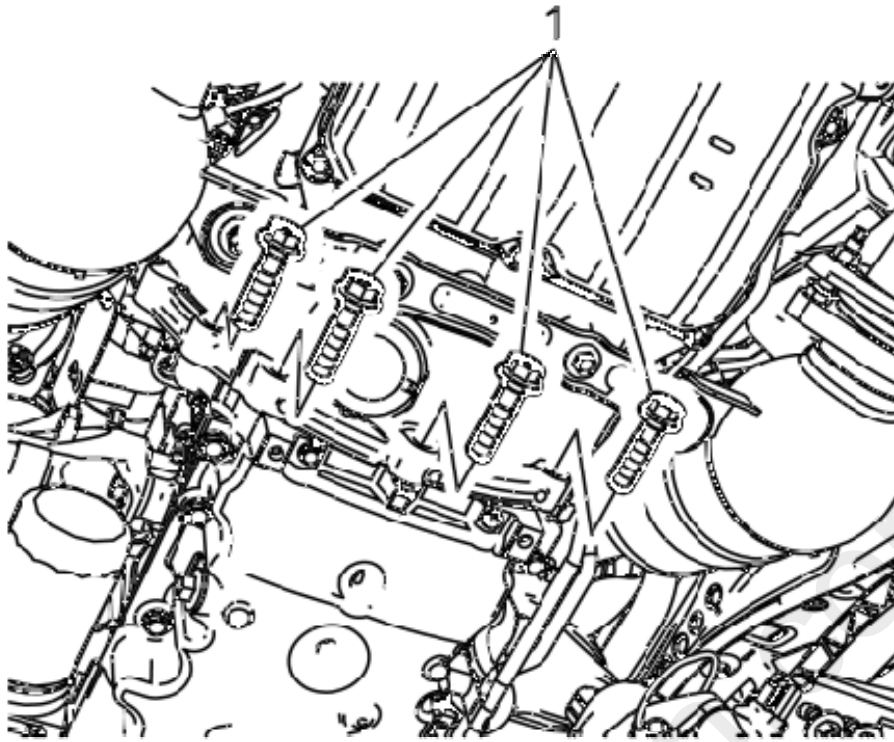


Fig. 272: Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Hand start the oil pan to transmission bolts and tighten to 75 (55 lb ft).
9. Install the engine mount brackets. Refer to , **Engine Mount Bracket Replacement - Left Side (LF3)**, and **Engine Mount Bracket Replacement - Right Side (LF3)**.

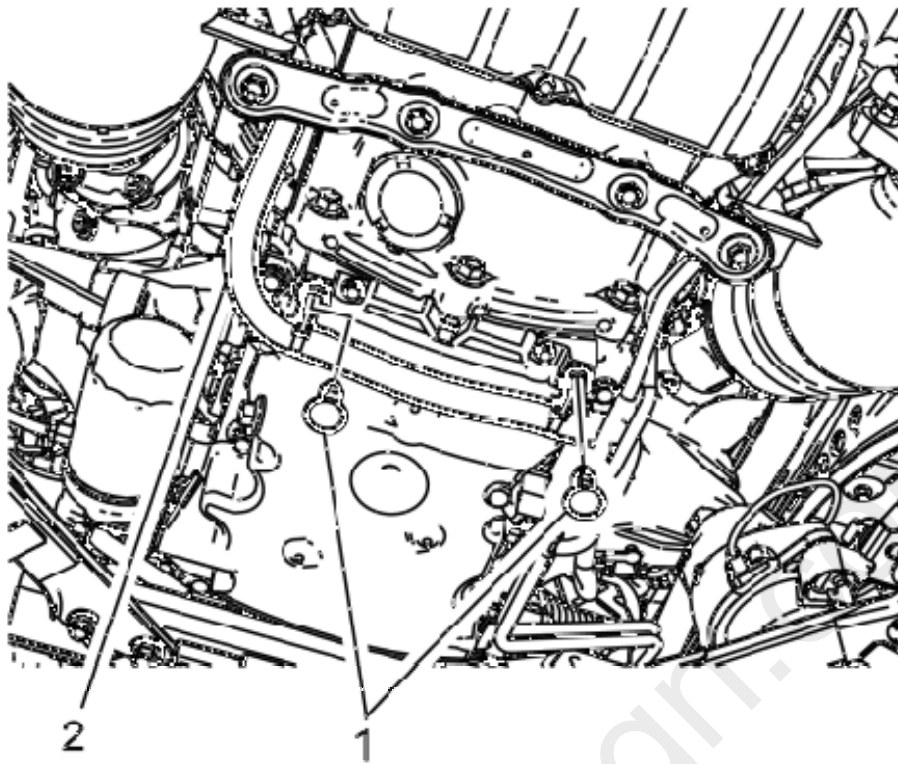


Fig. 273: Electrical Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Reposition the wiring harness and install the electrical wiring harness retainers (1) to secure the harness to the engine oil pan.
11. Install the engine oil cooler and adapter assembly. Refer to **Engine Oil Cooler Adapter Replacement**.

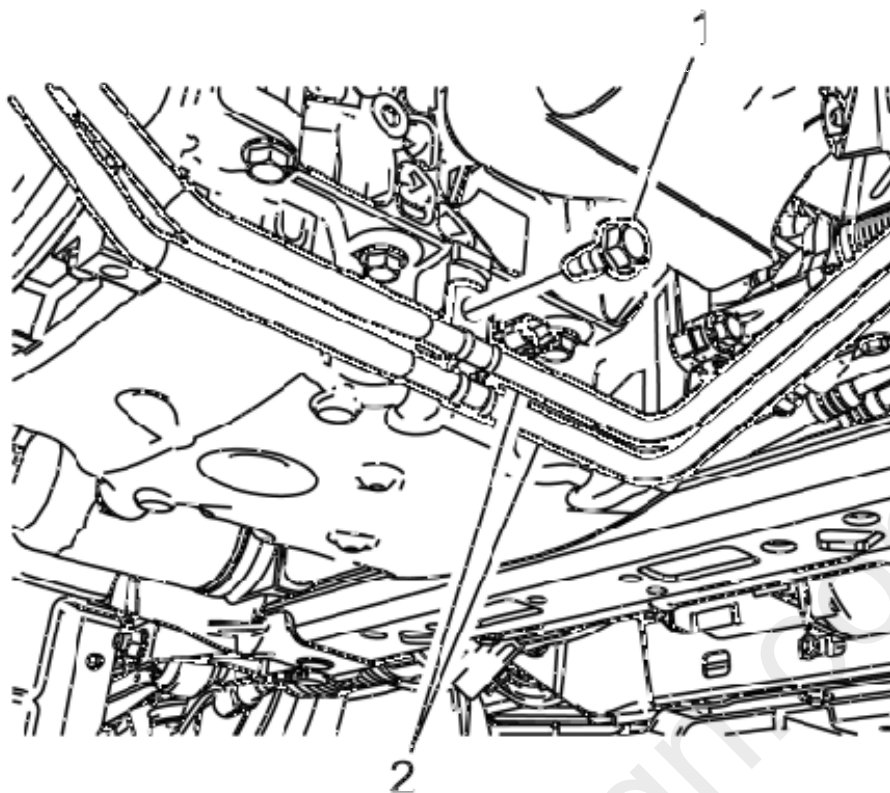


Fig. 274: Transmission Cooler Lines

Courtesy of GENERAL MOTORS COMPANY

12. Reposition the transmission cooler lines (2) then install the bolt (1) into the transmission cooler line retainer. Tighten to 25 (18 lb ft).

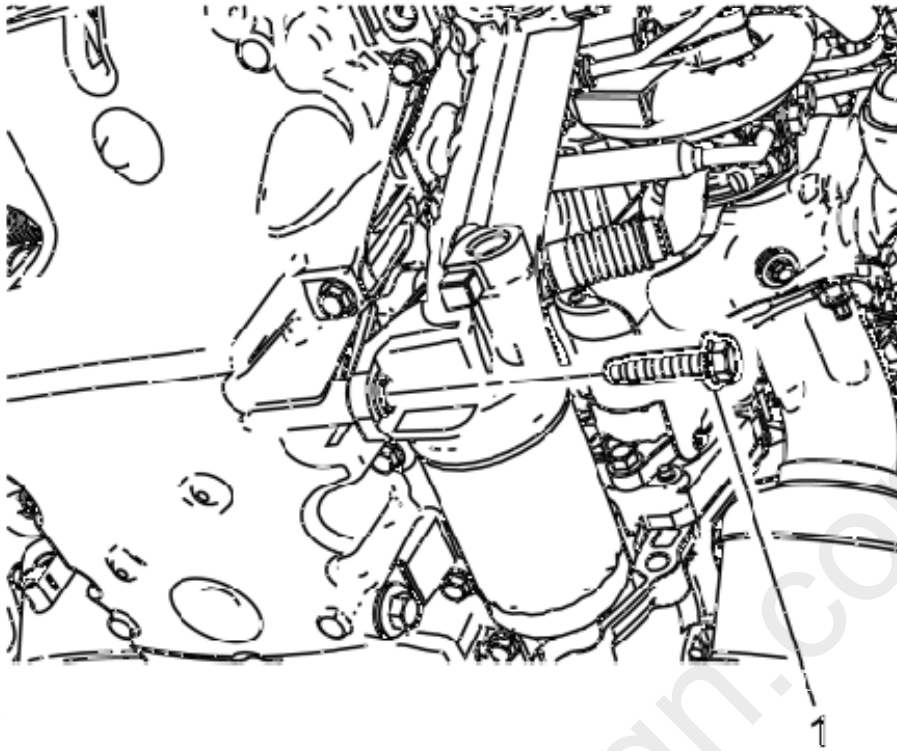


Fig. 275: Engine Oil Filter Adapter Lower Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the oil filter adapter lower bolt (1) and tighten to 25 (18 lb ft).
14. Install the drivetrain front cradle. Refer to **Drivetrain and Front Suspension Cradle Replacement** .
15. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement (LF3)**.
16. Plug in the engine oil level switch.
17. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
18. Refill the engine oil. Refer to **Engine Oil and Oil Filter Replacement (LF3)**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (LFX)

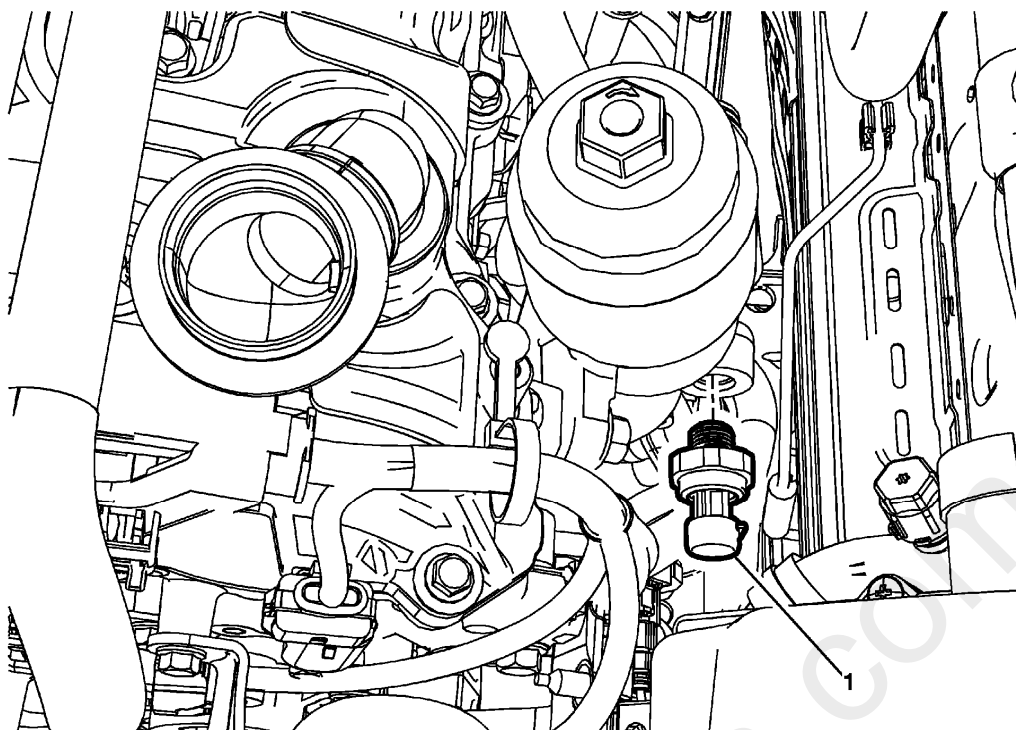


Fig. 276: Engine Oil Pressure Sensor and/or Switch
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Sensor and/or Switch Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LFX)</u> .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the oil pressure sensor electrical connector. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to <u>Special Tools</u> .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (LF3)

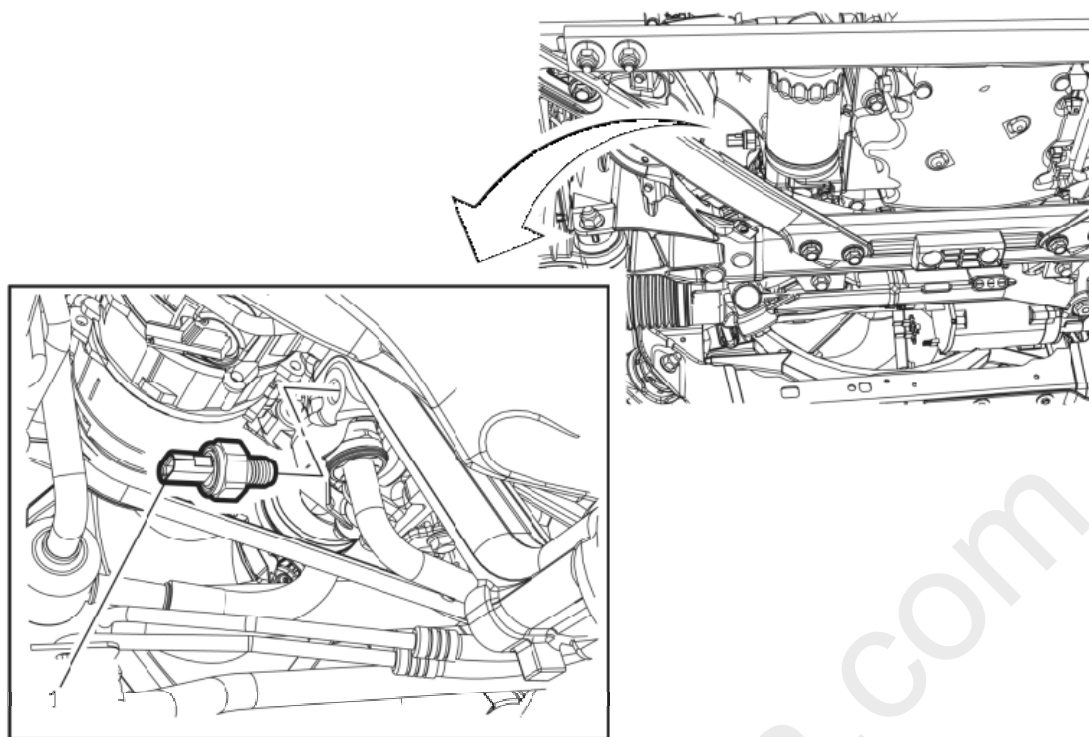


Fig. 277: Engine Oil Pressure Sensor and/or Switch (LF3)
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Sensor and/or Switch Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the oil pressure sensor electrical connector. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to <u>Special Tools</u> .

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.

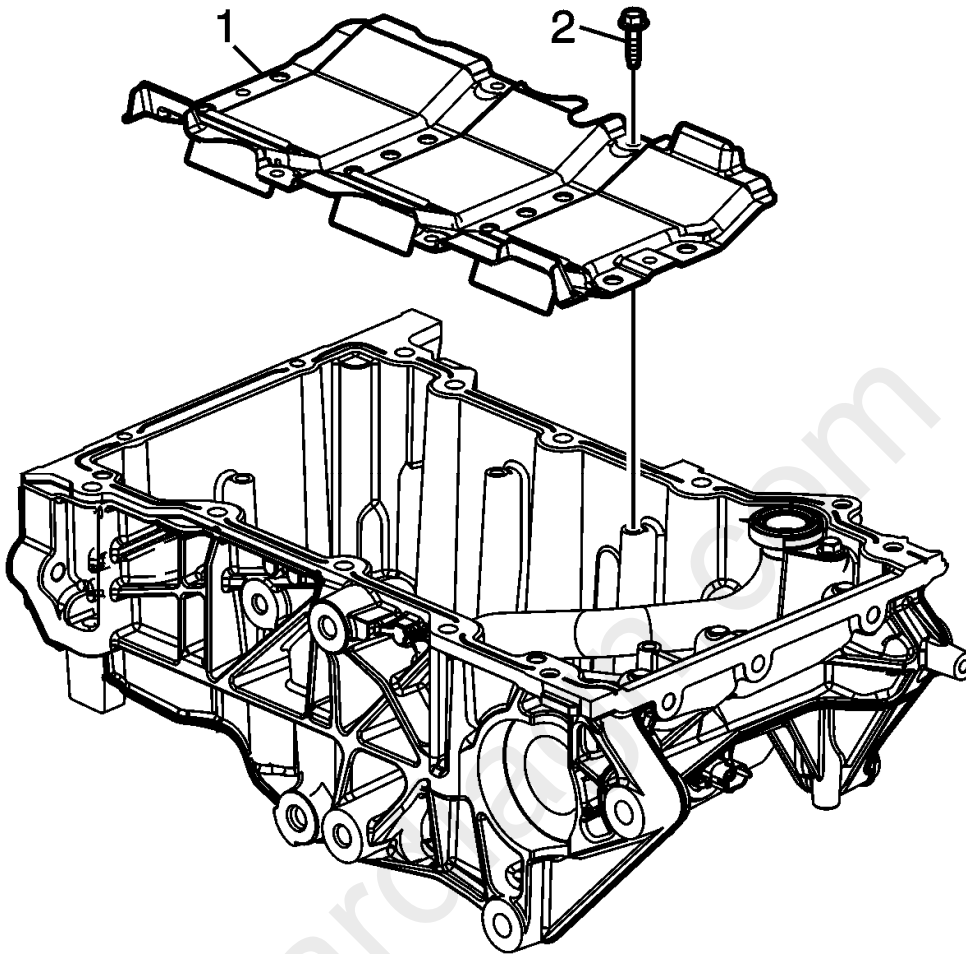


Fig. 278: Oil Pan Scraper
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts (2).
3. Remove the oil pan scraper (1).

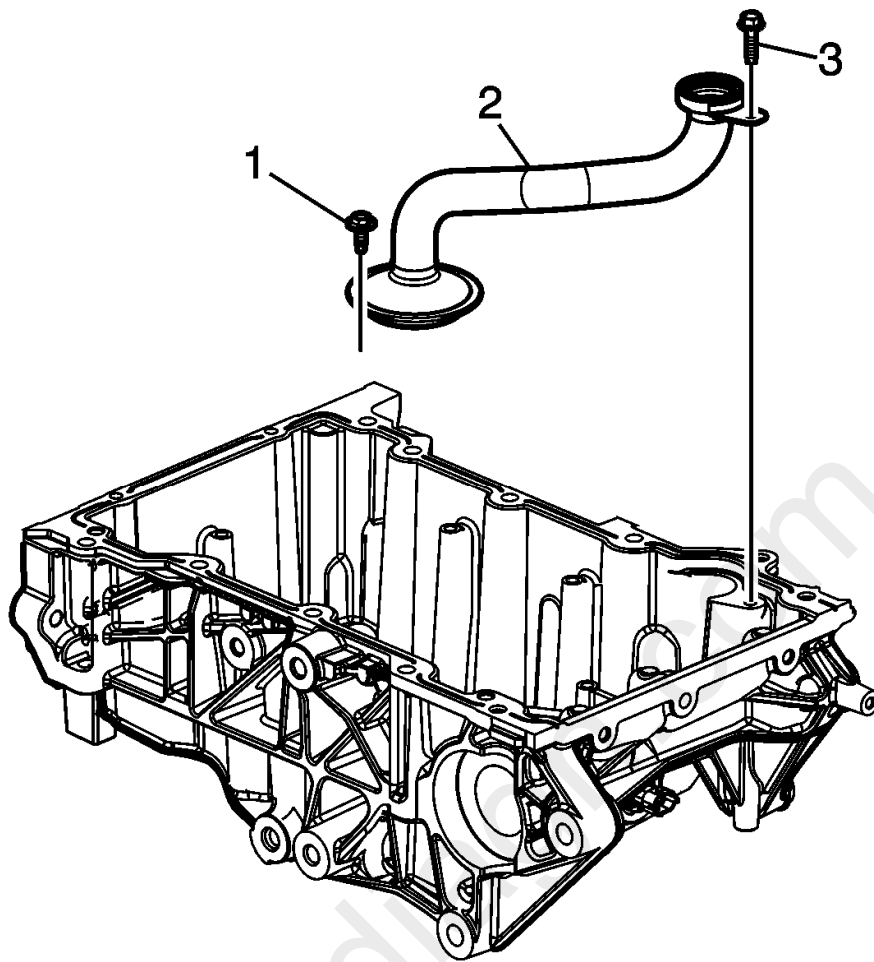


Fig. 279: Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolts (3).
5. Remove the oil suction pipe (2).
6. Remove the oil suction pipe retaining bolts (1).

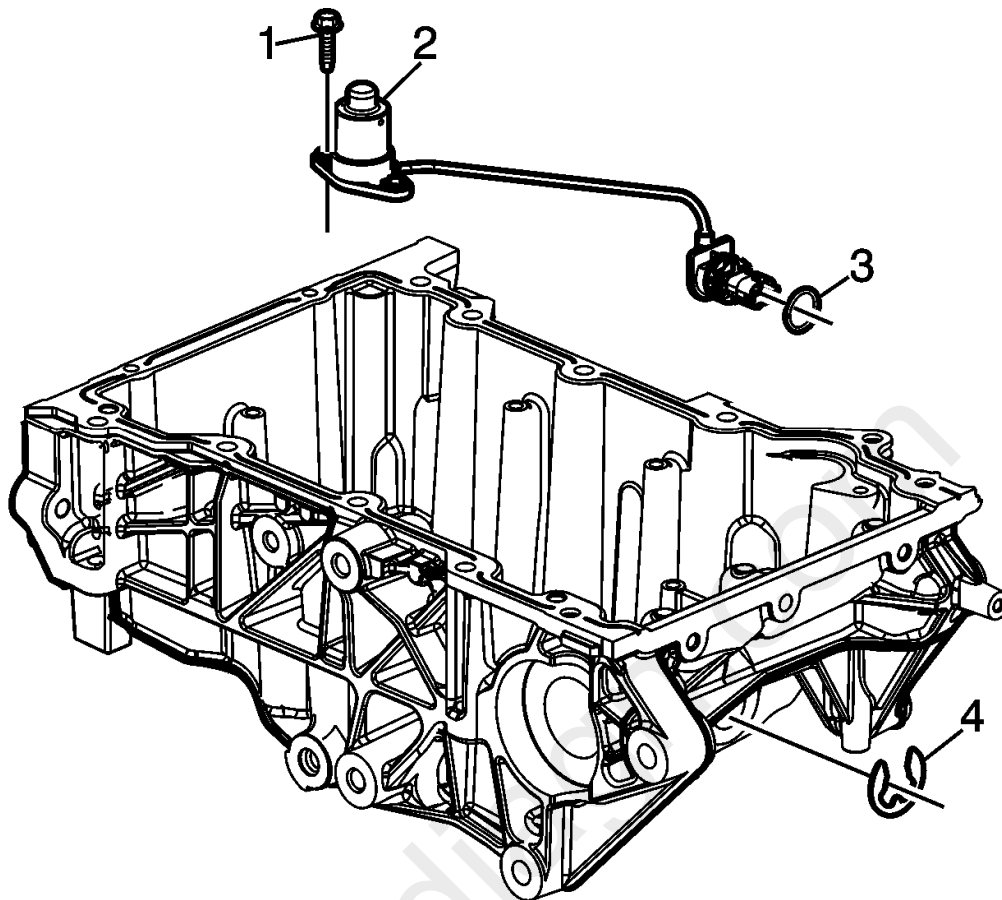


Fig. 280: Engine Oil Level Switch
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine oil level switch clip (4).
8. Remove the engine oil level switch bolts (1).
9. Remove the engine oil level switch (2).
10. Remove the engine oil level switch seal (3).

Installation Procedure

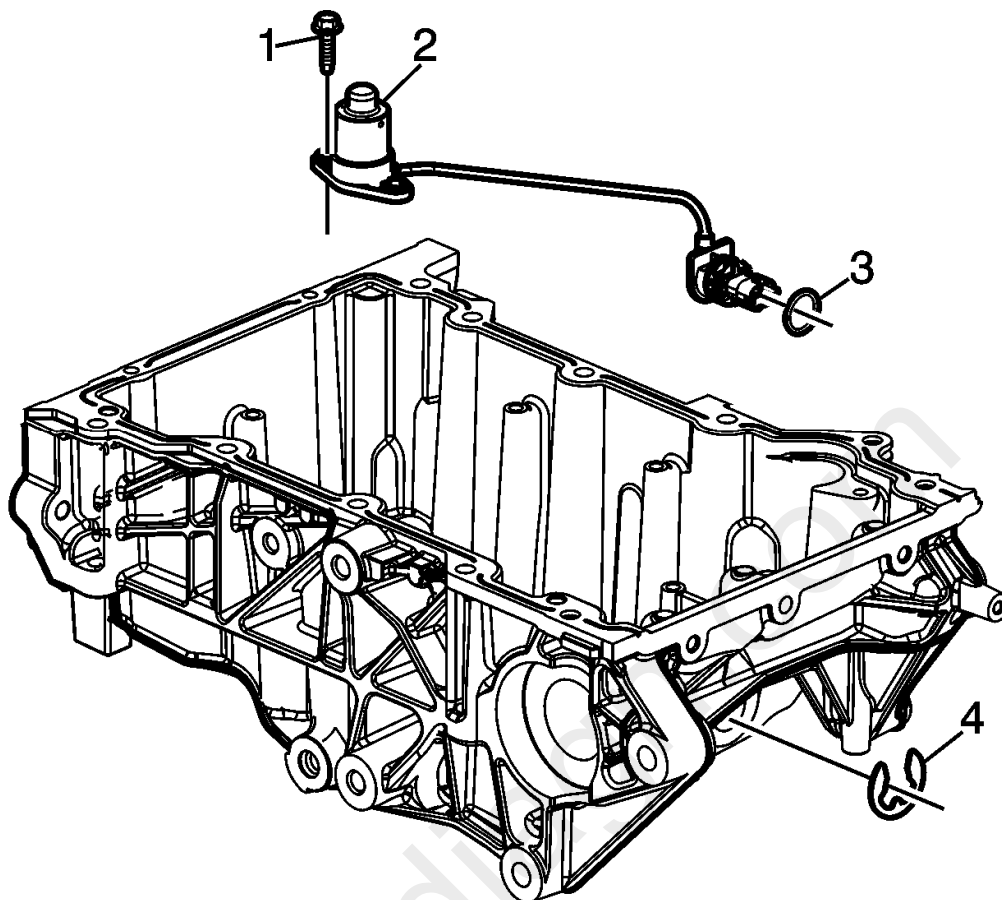


Fig. 281: Engine Oil Level Switch
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the NEW engine oil level switch seal (3).
2. Install the engine oil level switch (2).
3. Install the engine oil level switch bolts (1) and tighten to 10 (89 lb in).
4. Install NEW engine oil level switch clip (4).

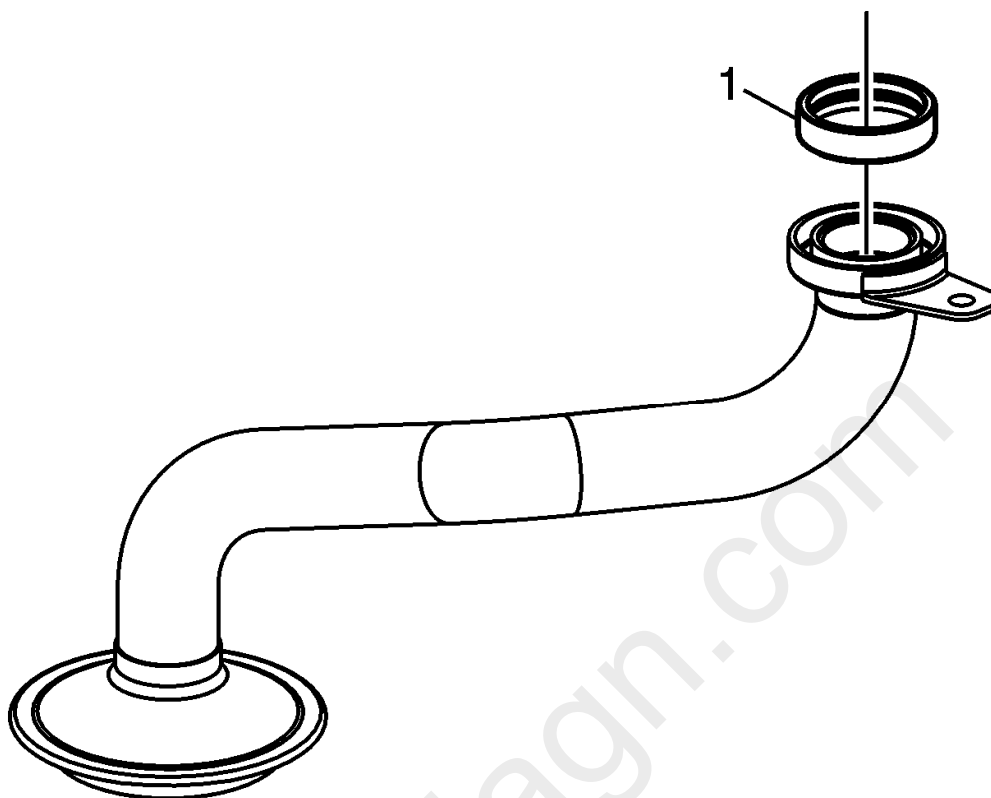


Fig. 282: Oil Suction Pipe Seal

Courtesy of GENERAL MOTORS COMPANY

5. inspect the oil suction pipe seal (1) and replace if damaged.

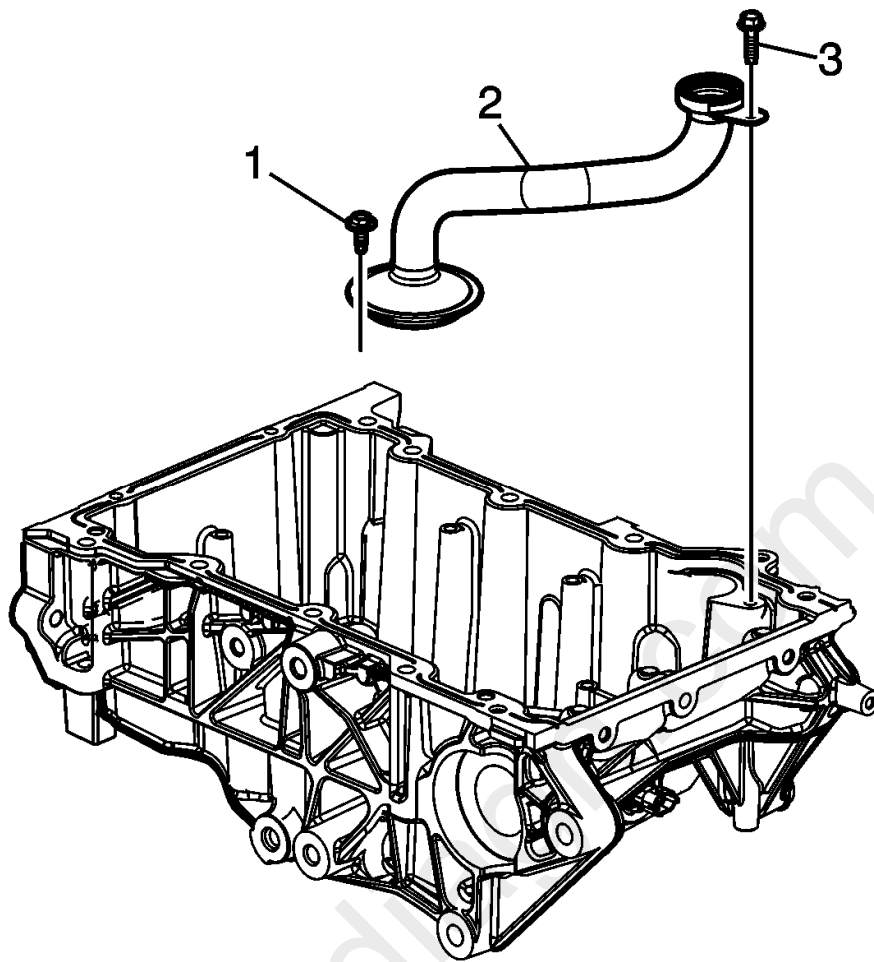


Fig. 283: Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Install the oil suction pipe (2).
7. Install the oil suction pipe retaining bolts (1) and tighten to 10 (89 lb in).
8. Install the oil suction pipe bolts (3) and tighten to 10 (89 lb in).

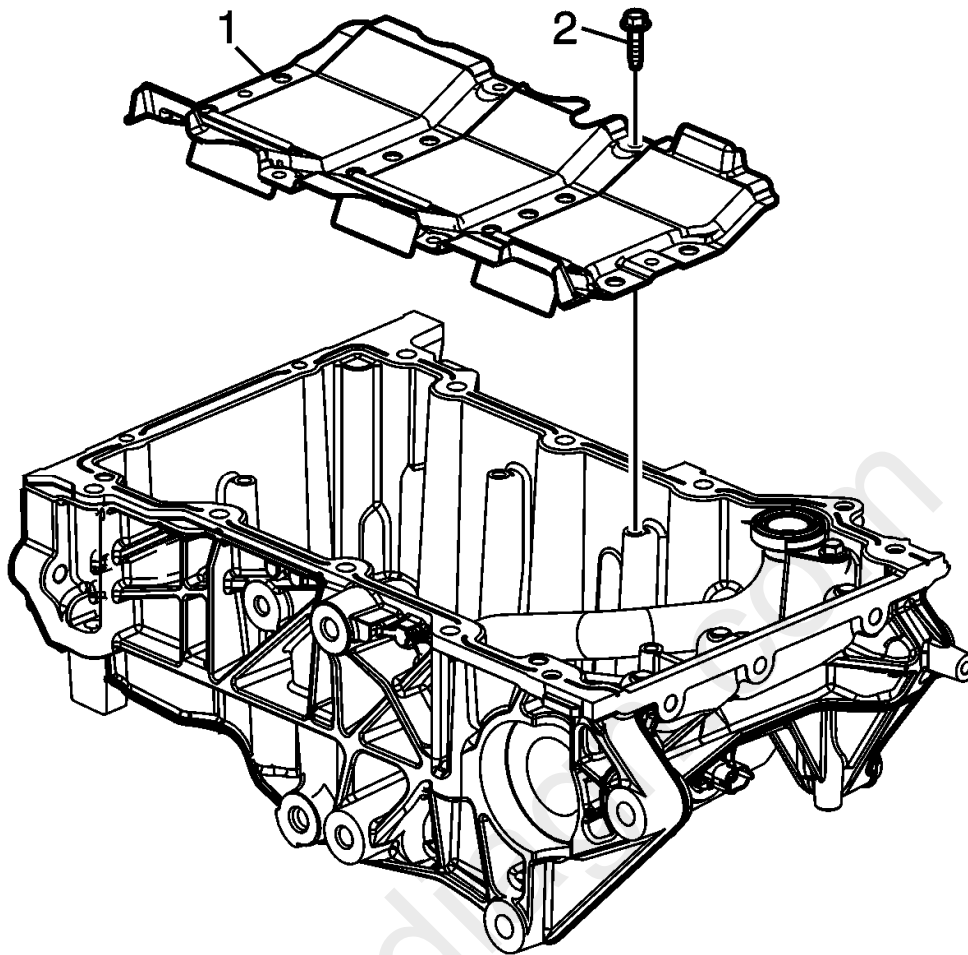


Fig. 284: Oil Pan Scraper

Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pan scraper (1).
10. Install the oil pan scraper bolts (2) and tighten to 10 (89 lb in).
11. Install the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.

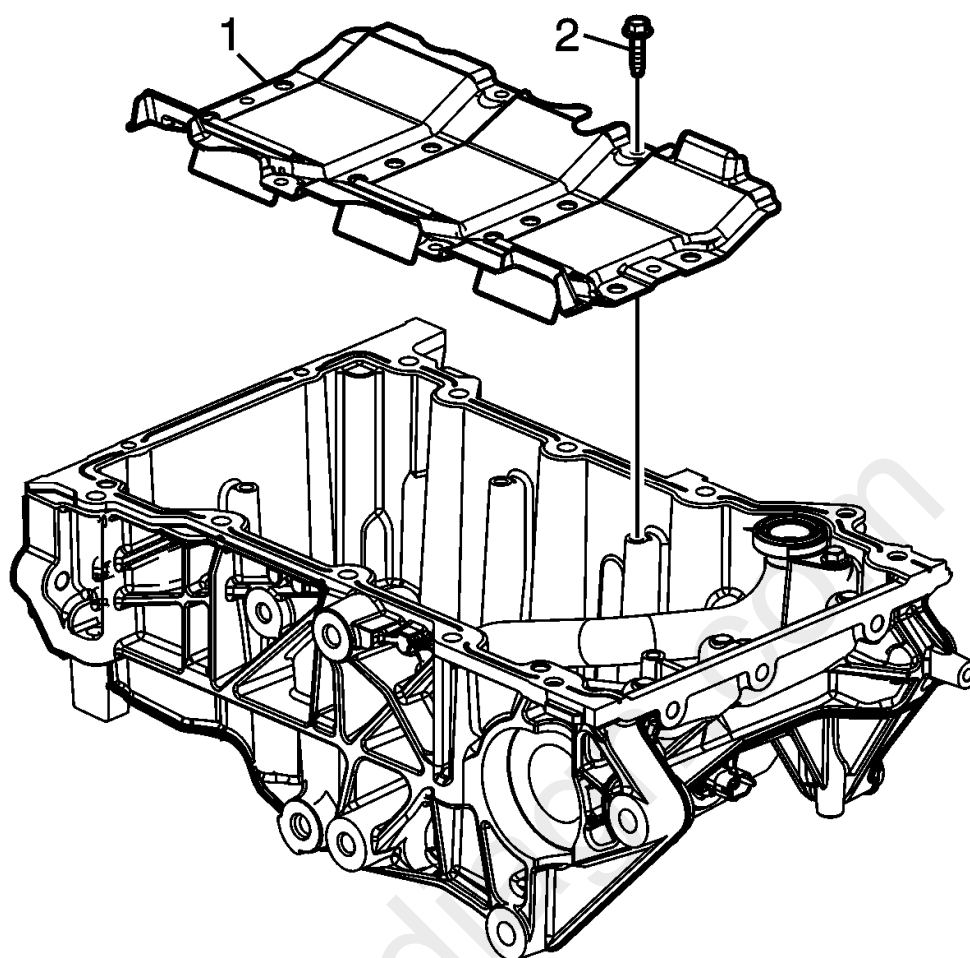


Fig. 285: Oil Pan Scraper

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts (2).
3. Remove the oil pan scraper (1).

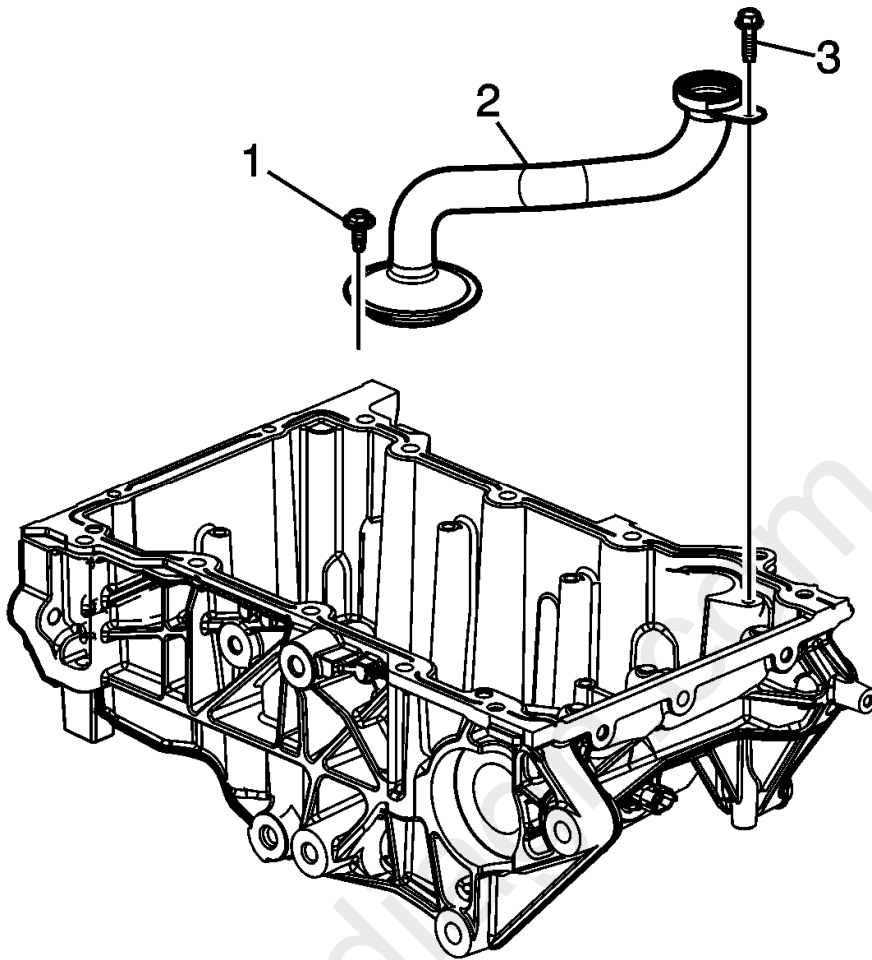


Fig. 286: Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolts (3).
5. Remove the oil suction pipe (2).
6. Remove the oil suction pipe retaining bolts (1).

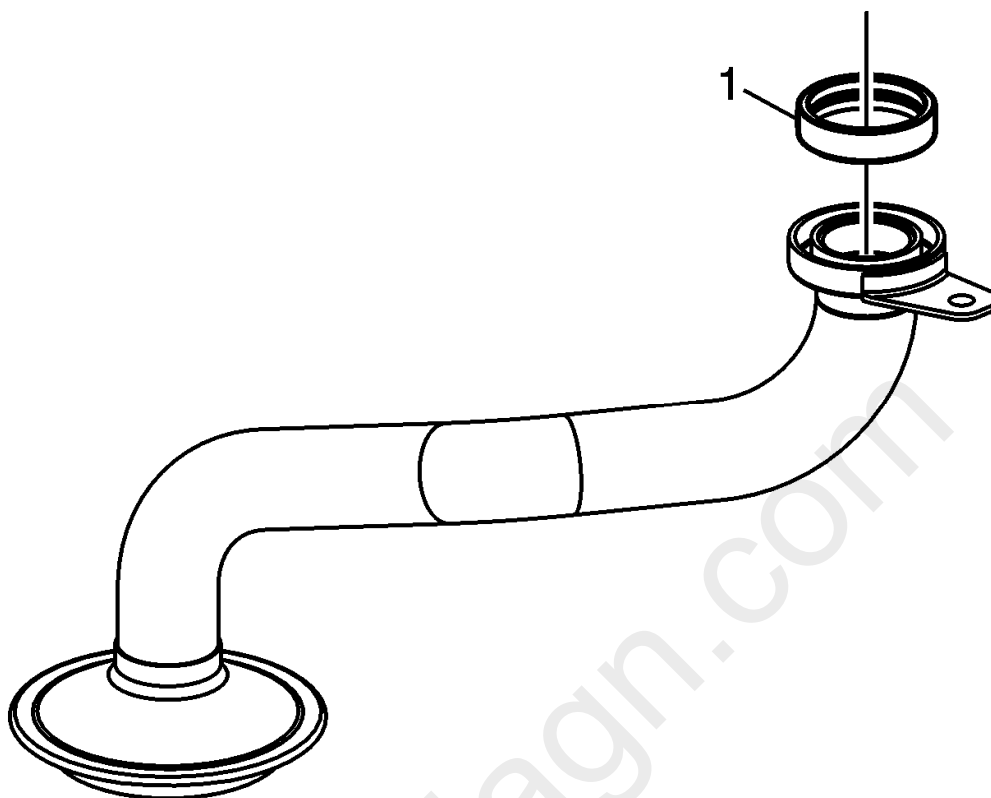


Fig. 287: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the oil suction pipe seal (1).

Installation Procedure

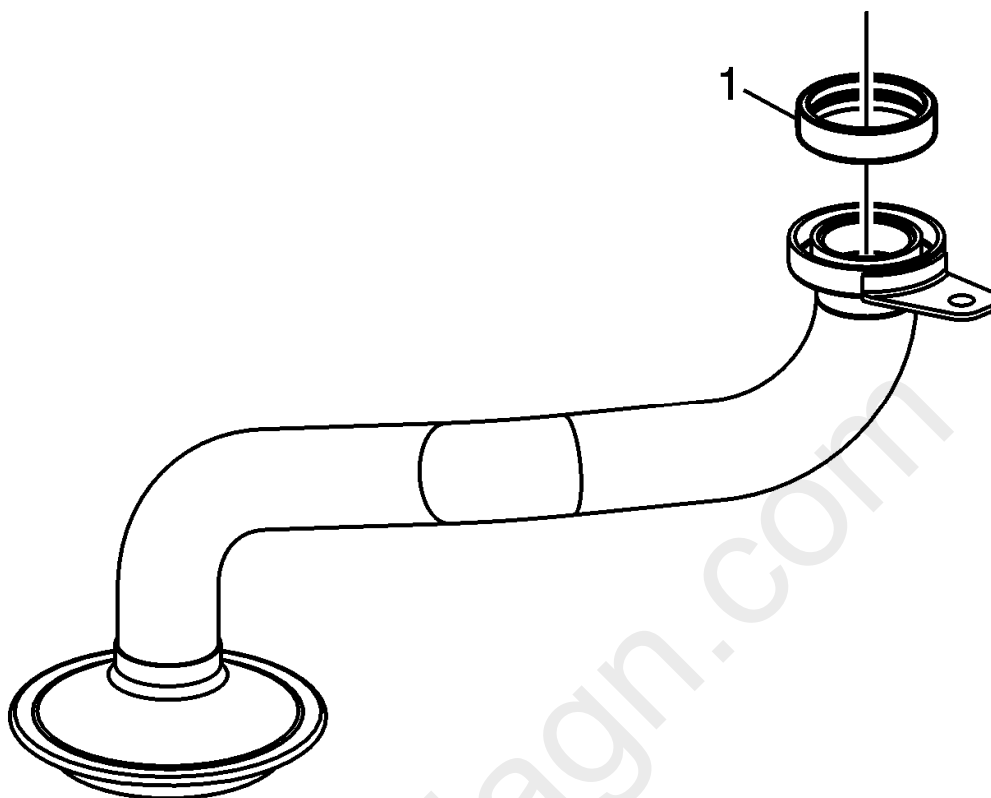


Fig. 288: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW oil suction pipe seal (1).

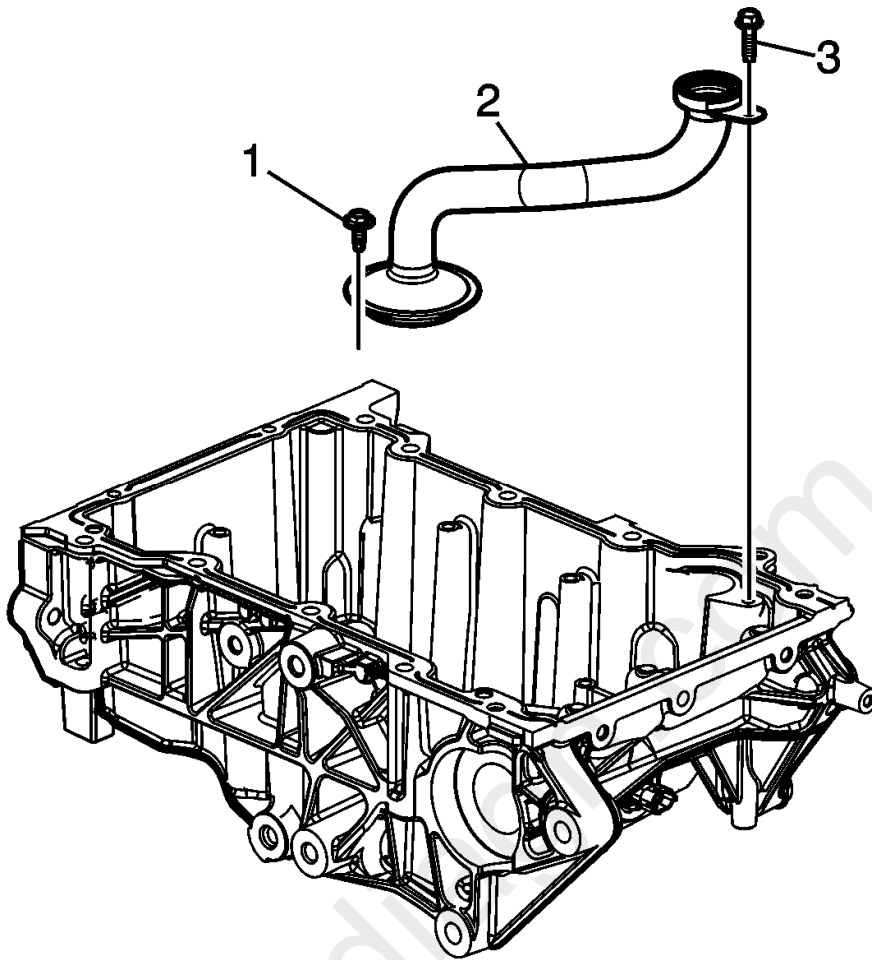


Fig. 289: Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe (2).

CAUTION: Refer to Fastener Caution .

3. Install the oil suction pipe retaining bolts (1) and tighten to 10 N.m (89 lb in).
4. Install the oil suction pipe bolts (3) and tighten to 10 N.m (89 lb in).

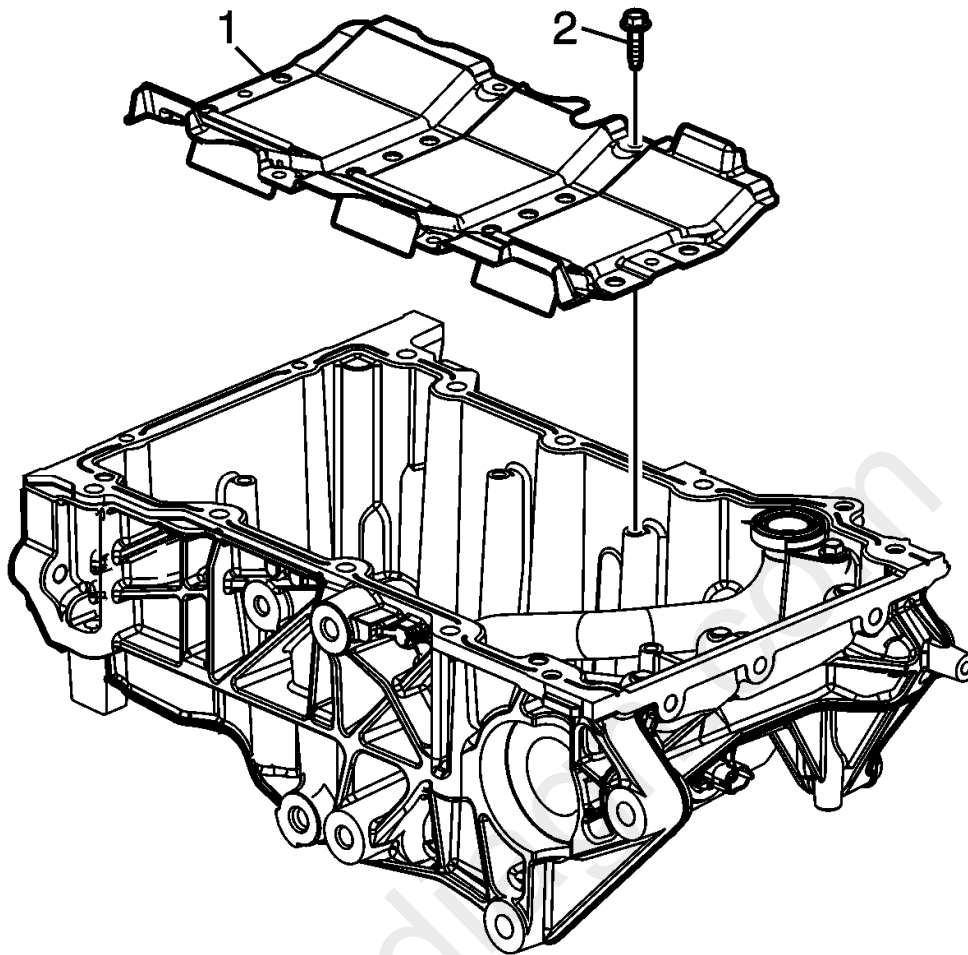


Fig. 290: Oil Pan Scraper

Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan scraper (1).
6. Install the oil pan scraper bolts (2) and tighten to 10 N.m (89 lb in).
7. Install the oil pan. Refer to **Oil Pan Replacement (LFX)**, **Oil Pan Replacement (LF3)**.

ENGINE OIL COOLER SHIELD REPLACEMENT

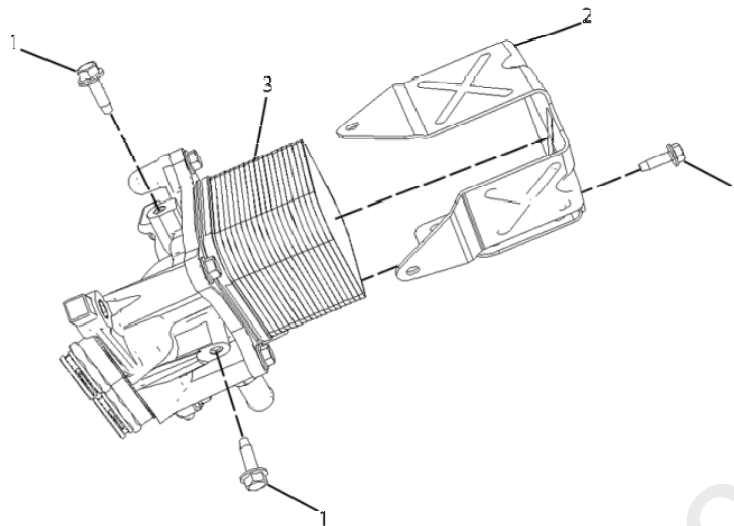


Fig. 291: Engine Oil Cooler Shield
 Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Shield Replacement

Callout	Component Name
Preliminary Procedures	
Remove the engine oil cooler adapter assembly. Refer to <u>Engine Oil Cooler Adapter Replacement</u> .	
1	Engine Oil Cooler Shield Bolts (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Engine Oil Cooler Shield
3	Engine Oil Cooler and Adapter Assembly

ENGINE REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging (R-134a)** , **Refrigerant**

Recovery and Recharging (R-1234yf) .

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

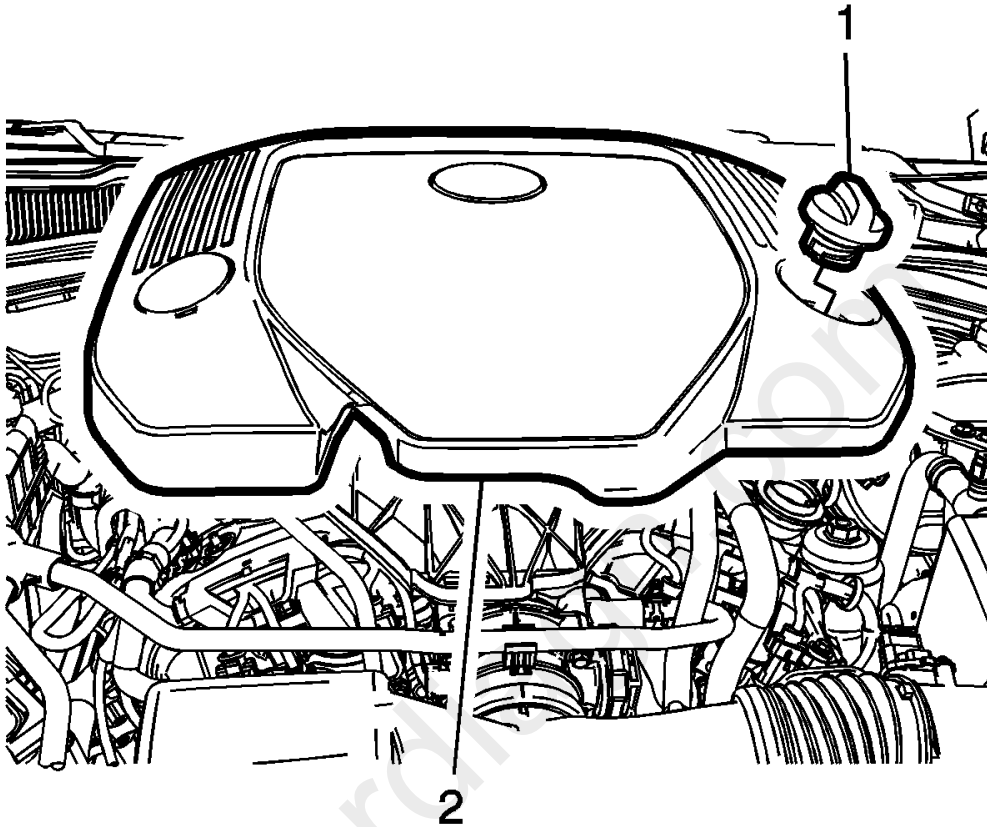


Fig. 292: Intake Manifold Cover

Courtesy of GENERAL MOTORS COMPANY

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

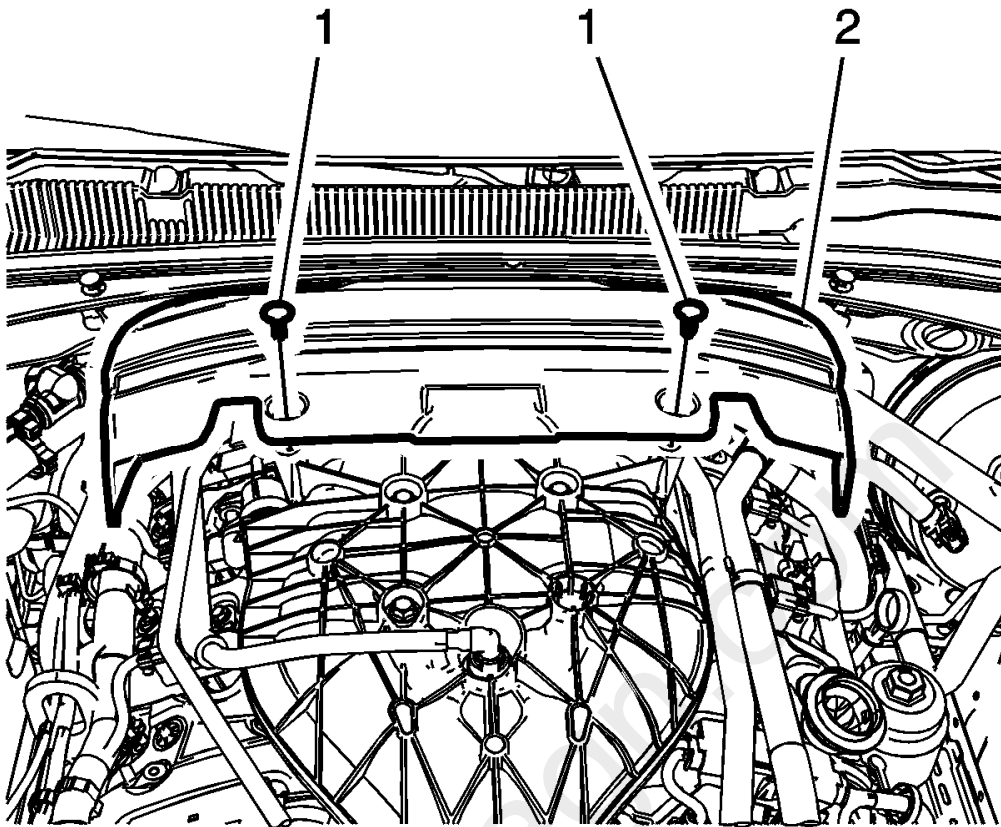


Fig. 293: Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intake manifold insulator (2). Refer to **Intake Manifold Insulator Replacement**.

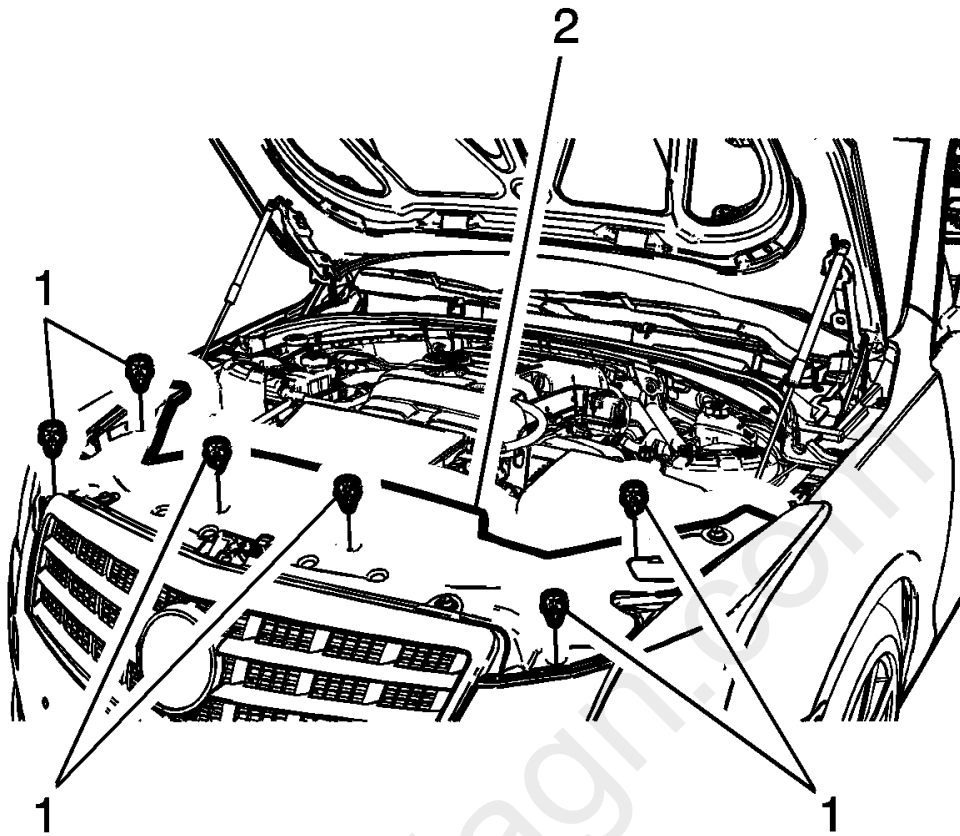


Fig. 294: Front Compartment Front Side Shield
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front compartment front side shield (2). Refer to **Front Compartment Front Sight Shield Replacement** .
7. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFX)** .

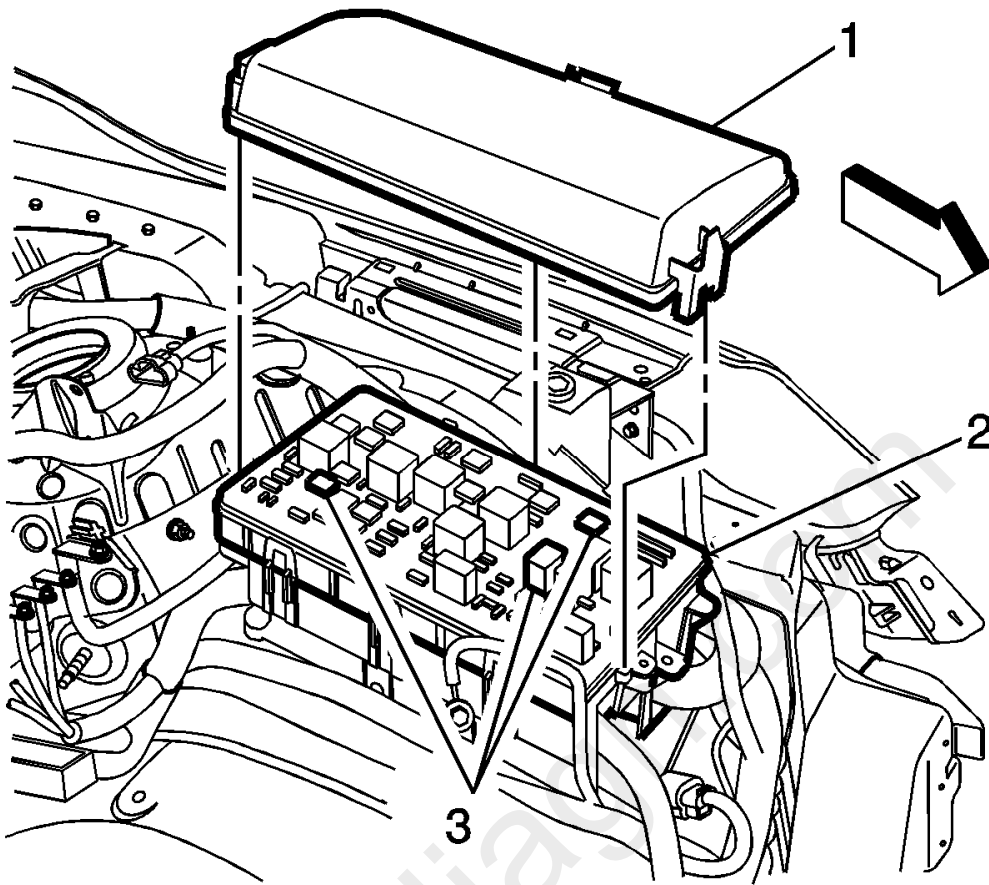


Fig. 295: Front Compartment Fuse Block
Courtesy of GENERAL MOTORS COMPANY

8. Remove the front compartment fuse block (2). Refer to **Front Compartment Fuse Block Housing Replacement** .

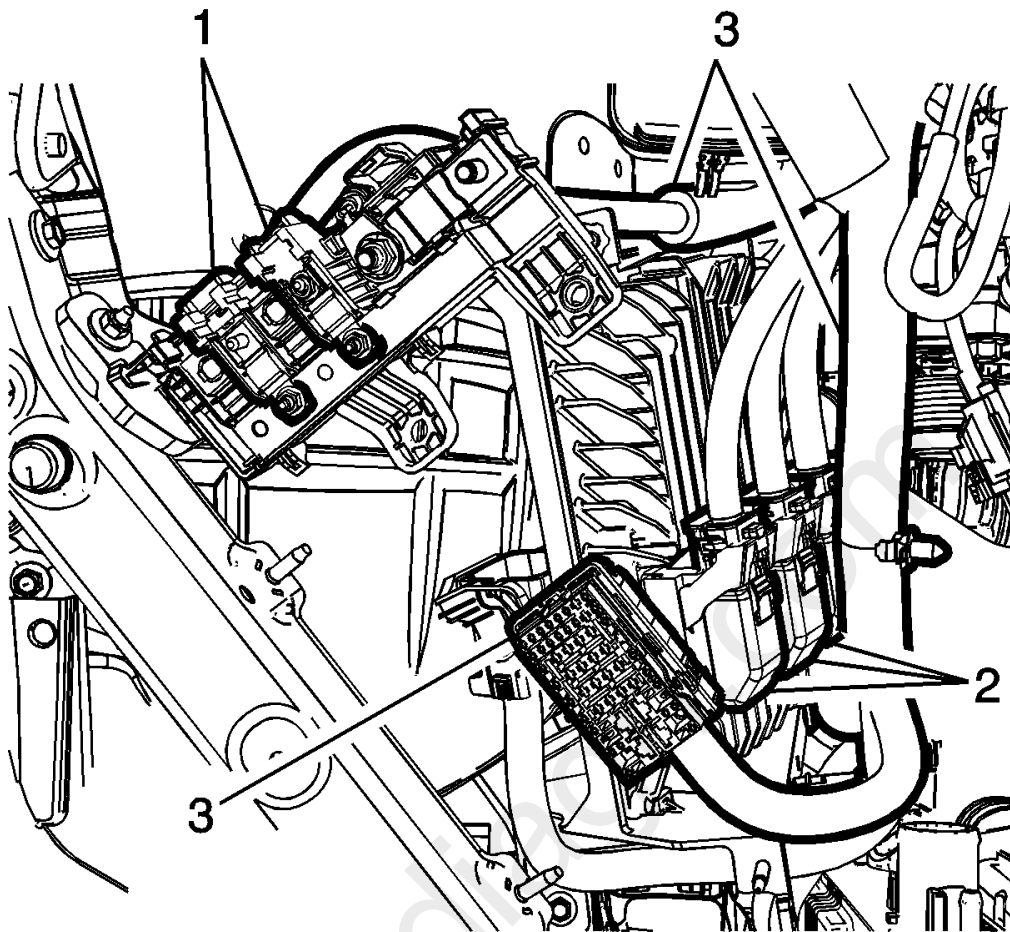


Fig. 296: Battery Terminals, ECM Connectors And Engine Harness
Courtesy of GENERAL MOTORS COMPANY

9. Remove the battery terminals (1) from the jump start post junction block.
10. Disconnect the ECM connectors (2).
11. Reposition the engine harness (3) on the engine.

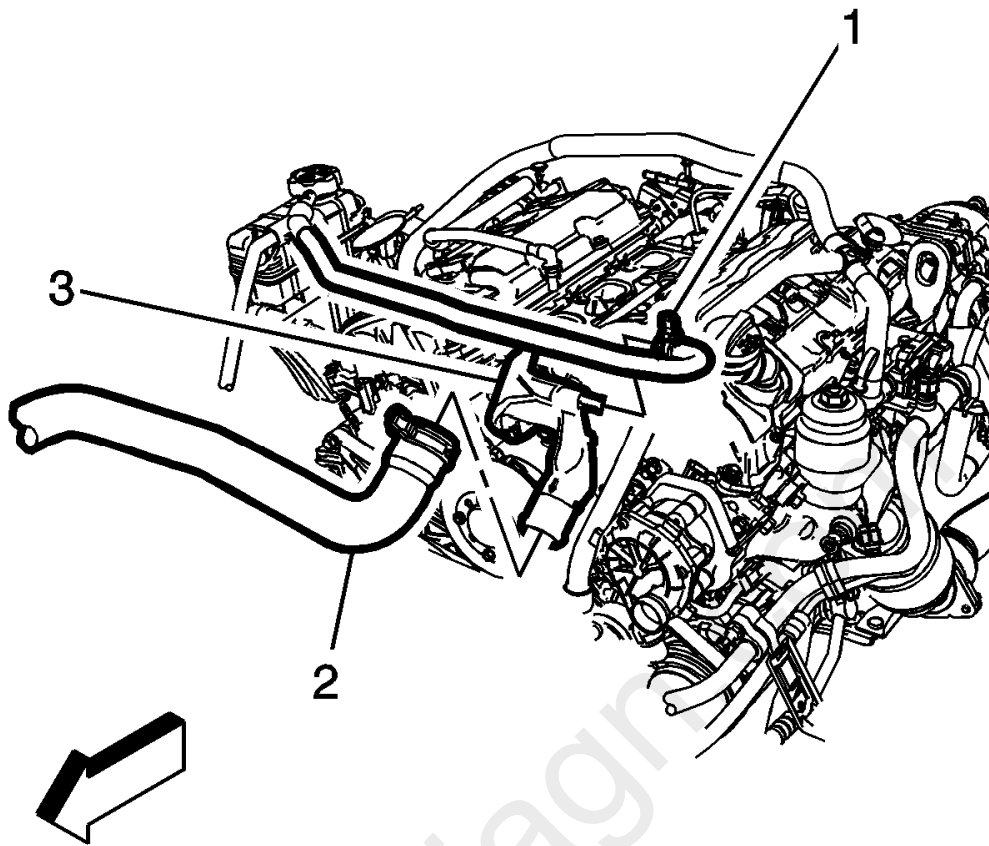


Fig. 297: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the radiator inlet hose (2) from the water outlet.
13. Disconnect the coolant air bleed hose (1) from the water outlet and position aside.

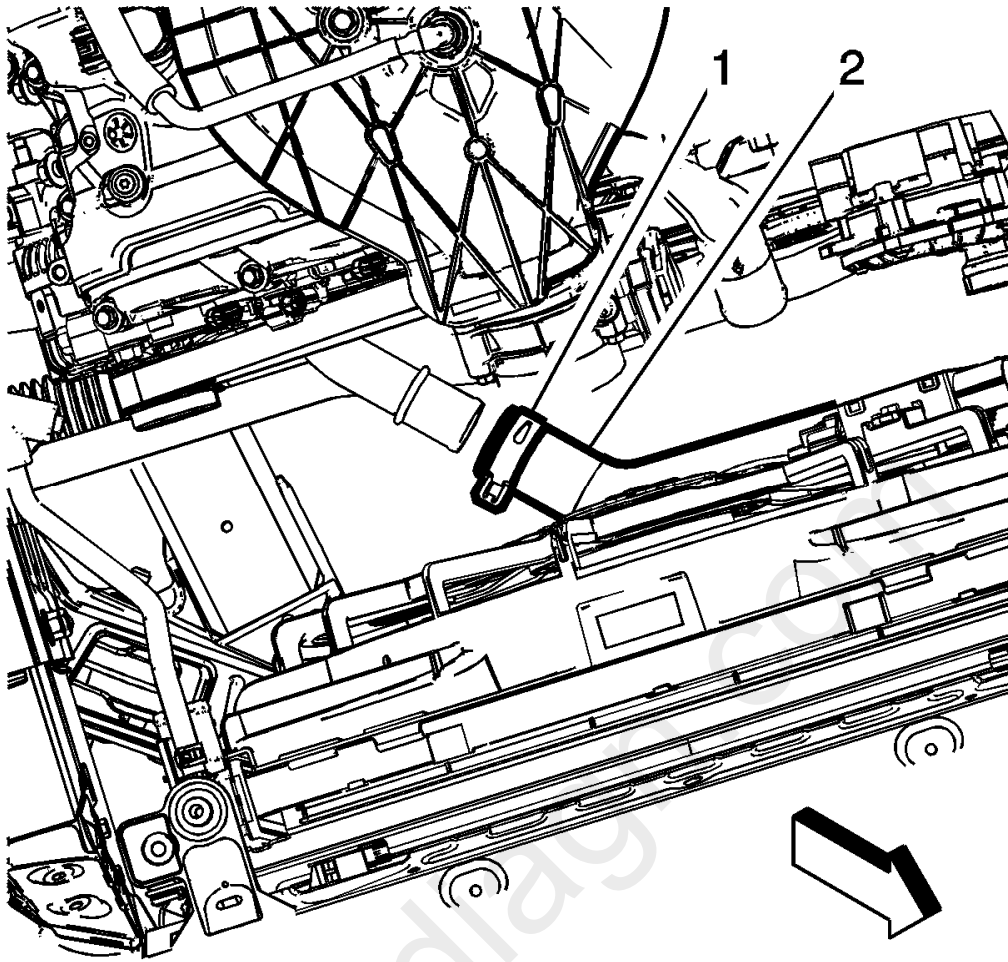


Fig. 298: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the radiator outlet hose (2) from the engine.

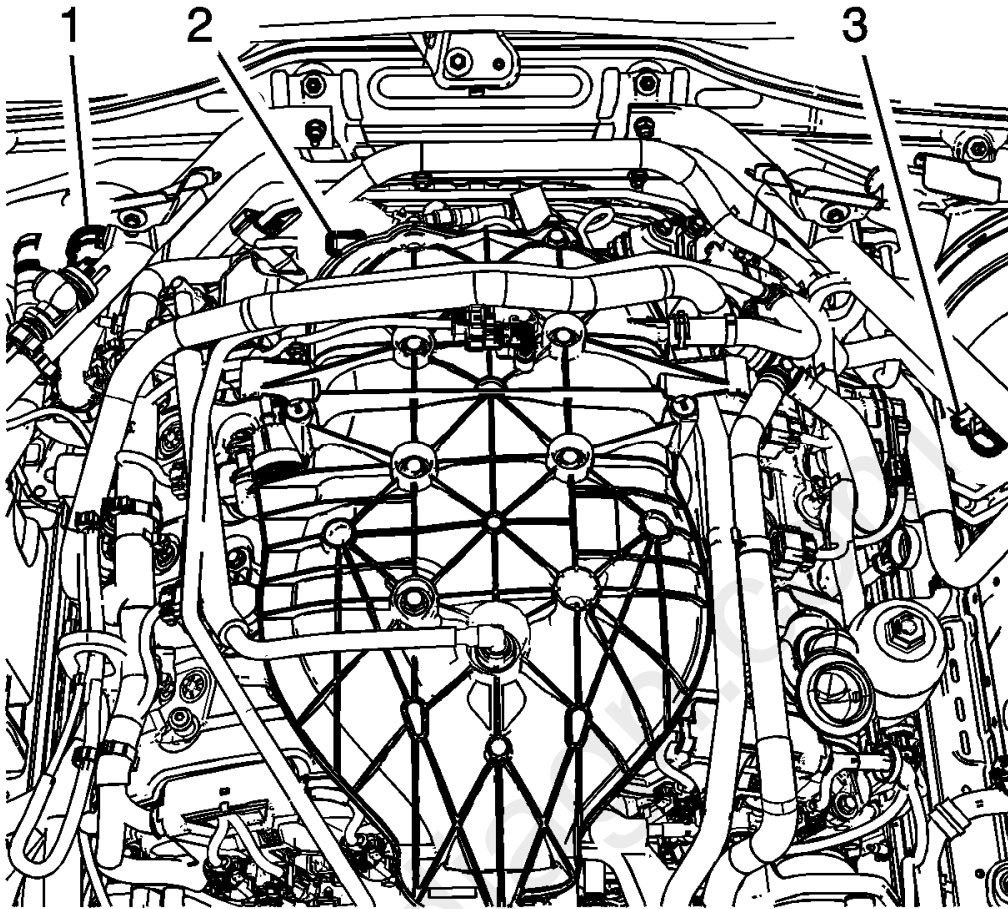


Fig. 299: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

15. Disconnect the heater inlet hose (1) from the heater core tube.
16. Disconnect the heater outlet hose from the heater core tube.
17. Disconnect the heater outlet to surge tank hose.
18. Disconnect the fuel line (2) from the fuel pump.
19. Disconnect the evaporative emission purge solenoid hose.
20. Remove the vacuum booster check valve (3) from the vacuum booster.
21. Using mechanics wire, support the radiator assembly to the vehicle body.
22. Disconnect the A/C lines from the condenser. Position the lines aside.
23. Disconnect and reposition harnesses as necessary.
24. Disconnect the transmission fluid cooler lines from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX MGG)** .

25. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
26. Remove the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .
27. Remove the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .
28. Disconnect the A/C lines from the compressor. Position the lines aside.

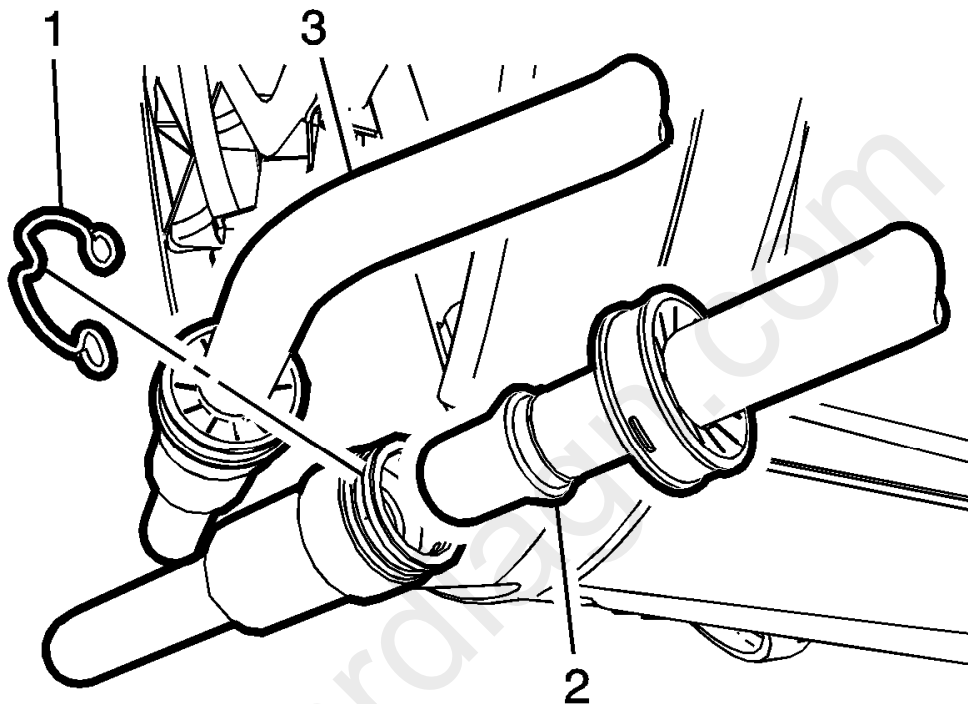


Fig. 300: Oil Cooler Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

29. If equipped with an external engine oil cooler, disconnect the oil cooler inlet (2) and oil cooler outlet (3) hoses from the engine oil cooler.

NOTE: The engine, transmission and if equipped with AWD, the transfer case is removed as an assembly from the vehicle. The following two steps will prepare the transmission and if equipped with AWD, the transfer case for removal of the assembly.

30. Prepare the transmission for removal. Refer to **Transmission Replacement (LFX)** .
31. If equipped with AWD, prepare the transfer case for removal. Refer to **Transfer Case Assembly Replacement** .
32. Remove the catalytic converter(s). Refer to **Catalytic Converter Replacement - Left Side (LFX)** and **Catalytic Converter Replacement - Right Side (LFX)** .

NOTE: Removing the powertrain assembly from the vehicle could cause an unstable balance condition with the vehicle body on the vehicle hoist. Securing the vehicle body to the hoist is necessary.

33. Secure the vehicle body to the vehicle hoist using suitable straps or binders.

NOTE: The powertrain assembly will be removed from vehicle on the drivetrain and front suspension frame. In the next step, only perform the necessary procedures required to remove the powertrain assembly.

34. Remove the drivetrain and front suspension cradle with the powertrain attached. Refer to **Drivetrain and Front Suspension Cradle Replacement** .
35. Lower the powertrain onto a suitable support table.
36. Secure the powertrain to the support table using straps and binders.
37. With the aid of an assistant, carefully raise the body from the frame.
38. Ensure when raising the body the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Oil cooler lines
39. Separate the engine from the transmission. Refer to **Transmission Replacement (LFX)** .
40. Disconnect electrical connectors as necessary.

Installation Procedure

1. Install the engine to the transmission. Refer to **Transmission Replacement (LFX)** .
2. Place the powertrain and frame assembly on the engine support table.
3. Secure the powertrain to the support table using straps and binders.
4. With the aid of an assistant, carefully lower the body onto the powertrain assembly.
5. Ensure when lowering the body the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Oil cooler lines
6. Install the drivetrain and front suspension cradle with the powertrain attached. Refer to **Drivetrain and**

Front Suspension Cradle Replacement .

7. Remove the engine support table.
8. Install the catalytic converter(s). Refer to **Catalytic Converter Replacement - Left Side (LFX)** and **Catalytic Converter Replacement - Right Side (LFX)** .
9. If equipped with AWD, complete installation of the transfer case. Refer to **Transfer Case Assembly Replacement** .
10. Complete installation of the transmission. Refer to **Transmission Replacement (LFX)** .

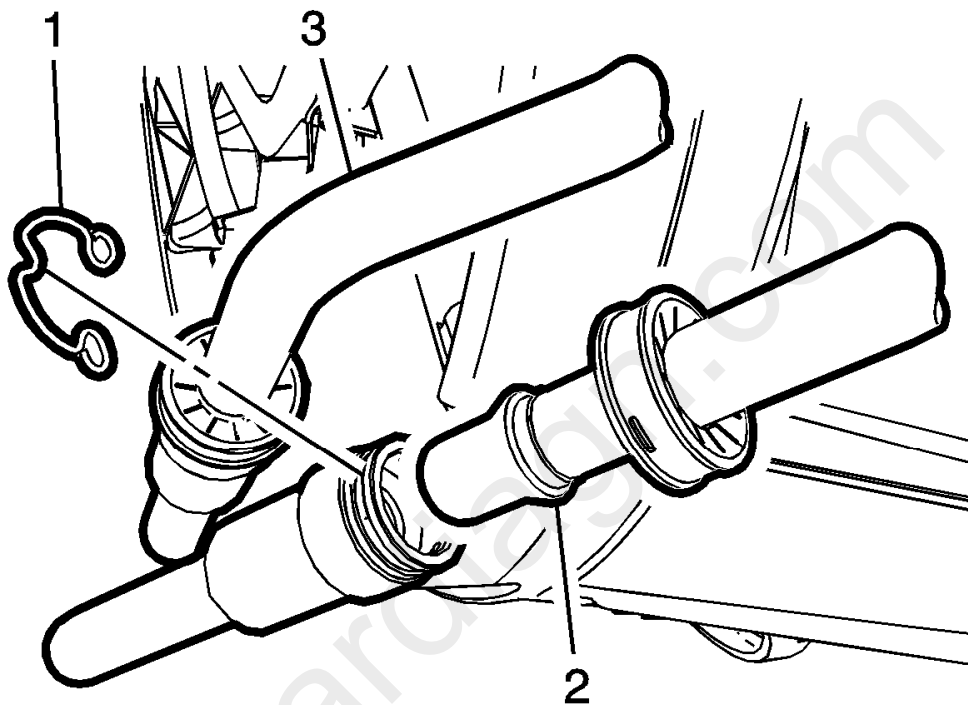


Fig. 301: Oil Cooler Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

11. If equipped with an external engine oil cooler, connect the oil cooler inlet (2) and oil cooler outlet (3) hoses to the engine oil cooler.
12. Connect the A/C lines to the compressor.
13. Install the transmission fluid cooler lines to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA with V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX, LTG MYA without V03)** , **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LFX MGG)** .

14. Install the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .
15. Install the front compartment lower noise shield. Refer to **Front Compartment Lower Noise Shield Replacement (AWD)** , **Front Compartment Lower Noise Shield Replacement (RWD)** .
16. Lower the vehicle.

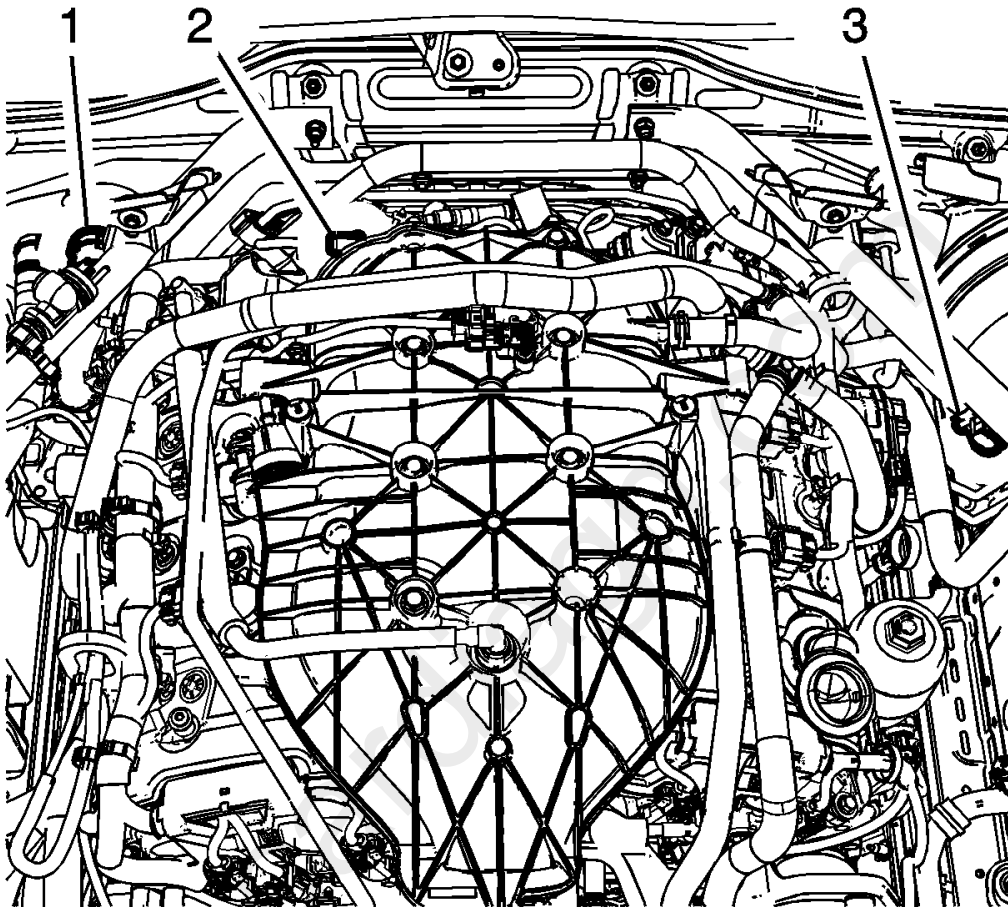


Fig. 302: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

17. Connect the heater inlet hose (1) to the heater core tube.
18. Connect the heater outlet hose to the heater core tube.
19. Connect the heater outlet to surge tank hose.
20. Connect the fuel line (2) to the fuel pump.
21. Install the vacuum booster check valve (3) to the vacuum booster.
22. Connect the evaporative emission purge solenoid hose.
23. Remove mechanics wire that supported the radiator assembly to the vehicle body.
24. Connect the A/C lines from the condenser.

25. Reposition and connect harnesses as necessary.

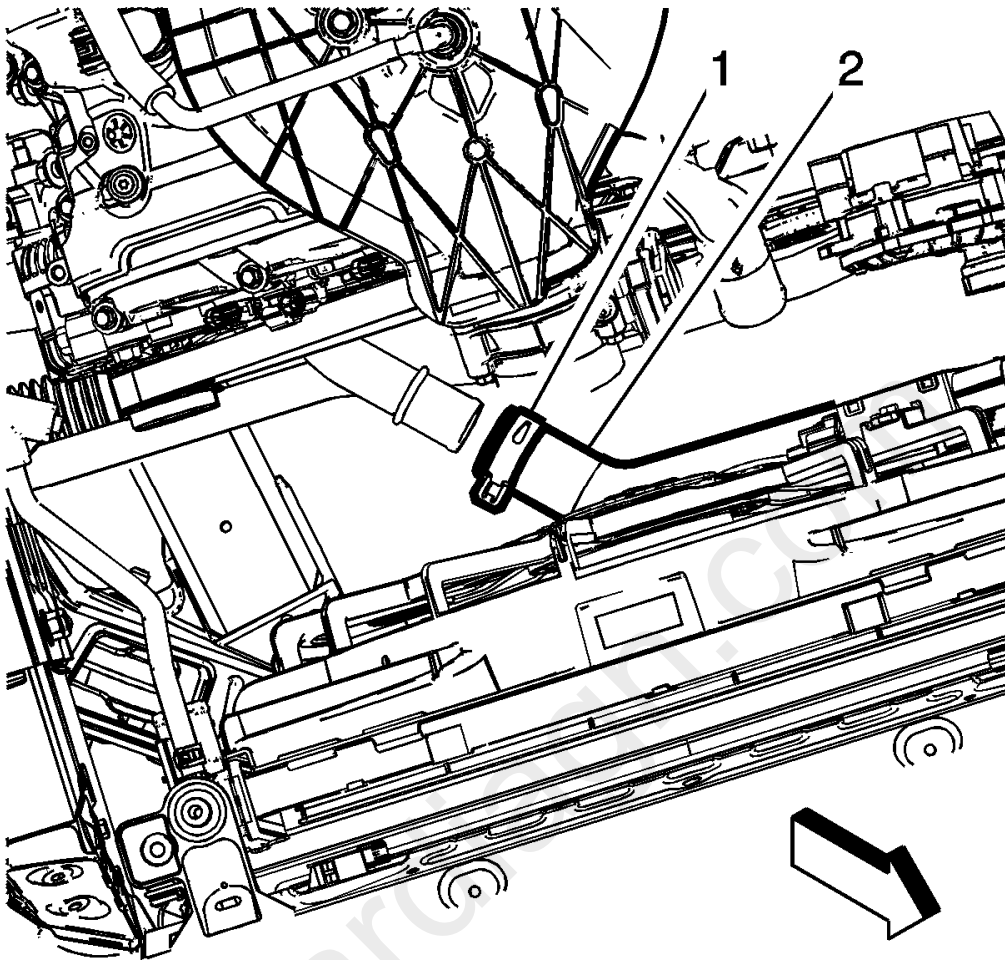


Fig. 303: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

26. Connect the radiator outlet hose (2) to the engine.

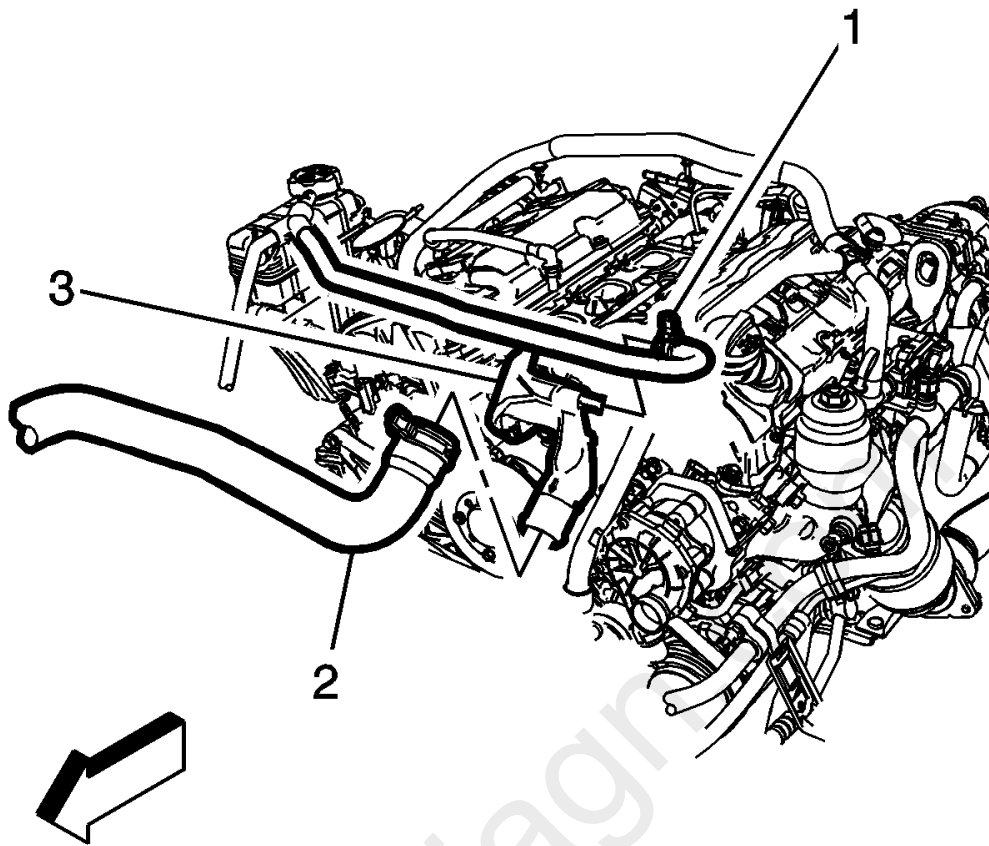


Fig. 304: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

27. Connect the radiator inlet hose (2) to the water outlet.
28. Connect the coolant air bleed hose (1) to the water outlet.

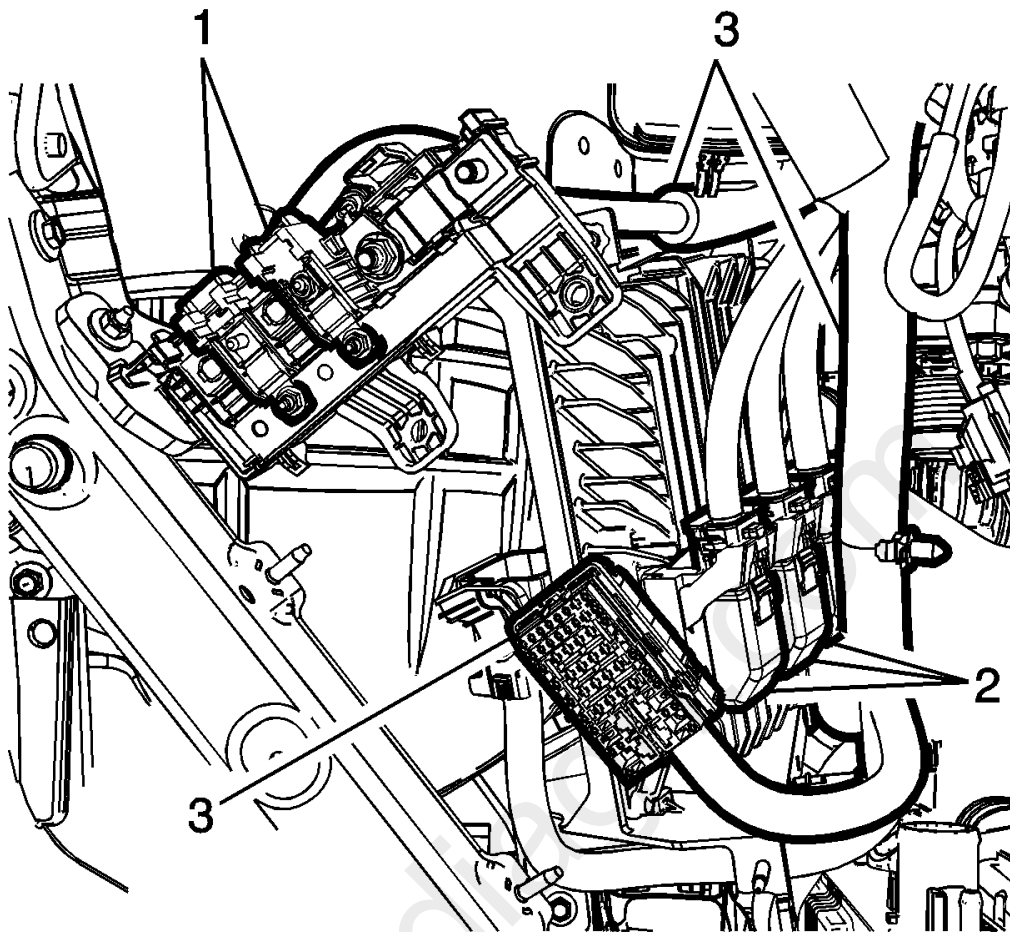


Fig. 305: Battery Terminals, ECM Connectors And Engine Harness
Courtesy of GENERAL MOTORS COMPANY

29. Install the battery terminals (1) to the jump start post junction block.
30. Connect the ECM connectors (2).

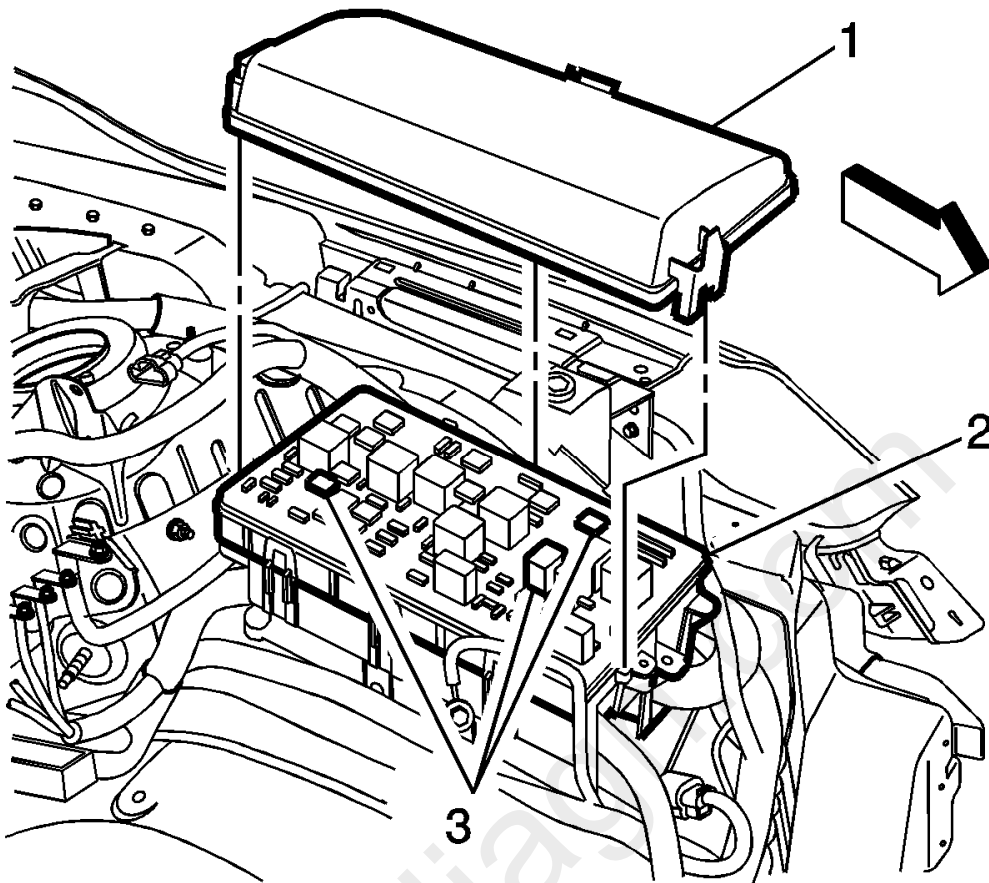


Fig. 306: Front Compartment Fuse Block
Courtesy of GENERAL MOTORS COMPANY

31. Install the front compartment fuse block (2). Refer to **Front Compartment Fuse Block Housing Replacement** .

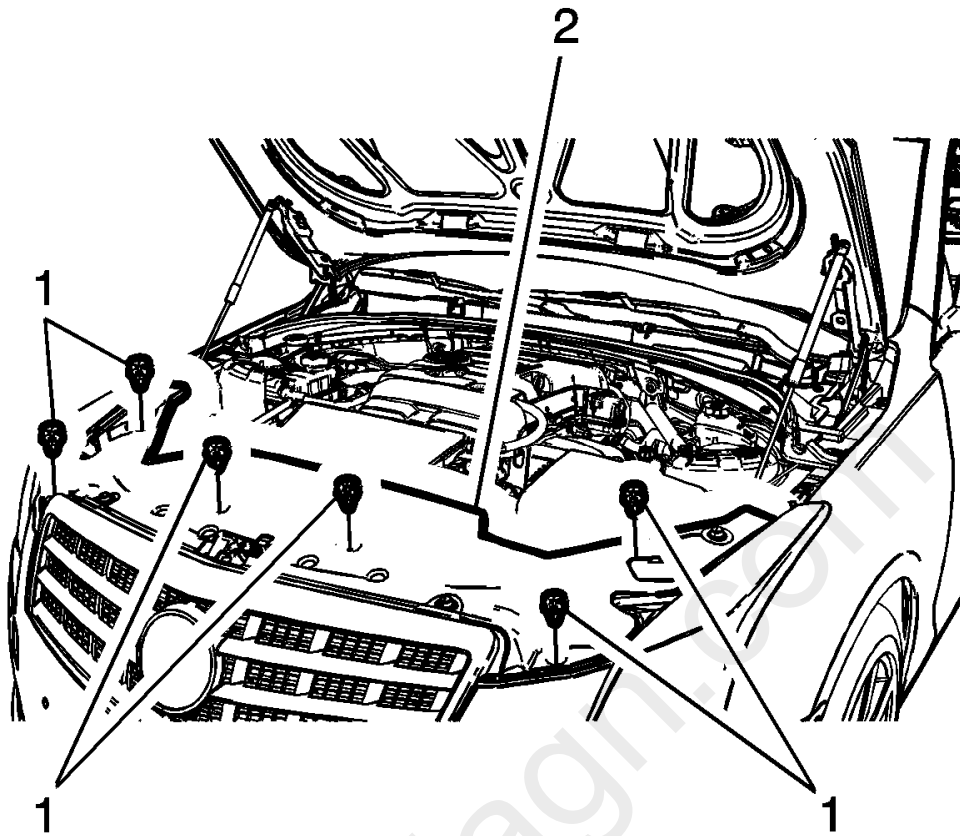


Fig. 307: Front Compartment Front Side Shield
Courtesy of GENERAL MOTORS COMPANY

32. Install the front compartment front side shield (2). Refer to **Front Compartment Front Sight Shield Replacement** .
33. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LFX)** .

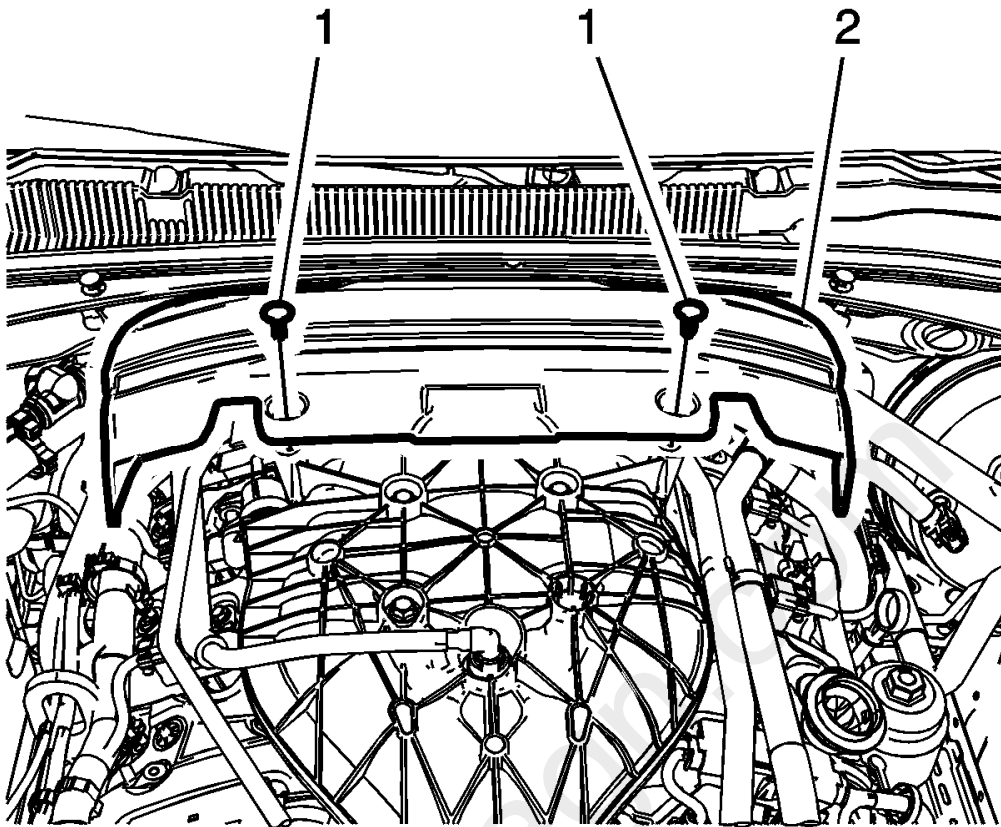


Fig. 308: Intake Manifold Insulator
Courtesy of GENERAL MOTORS COMPANY

34. Install the intake manifold insulator (2). Refer to **Intake Manifold Insulator Replacement**.

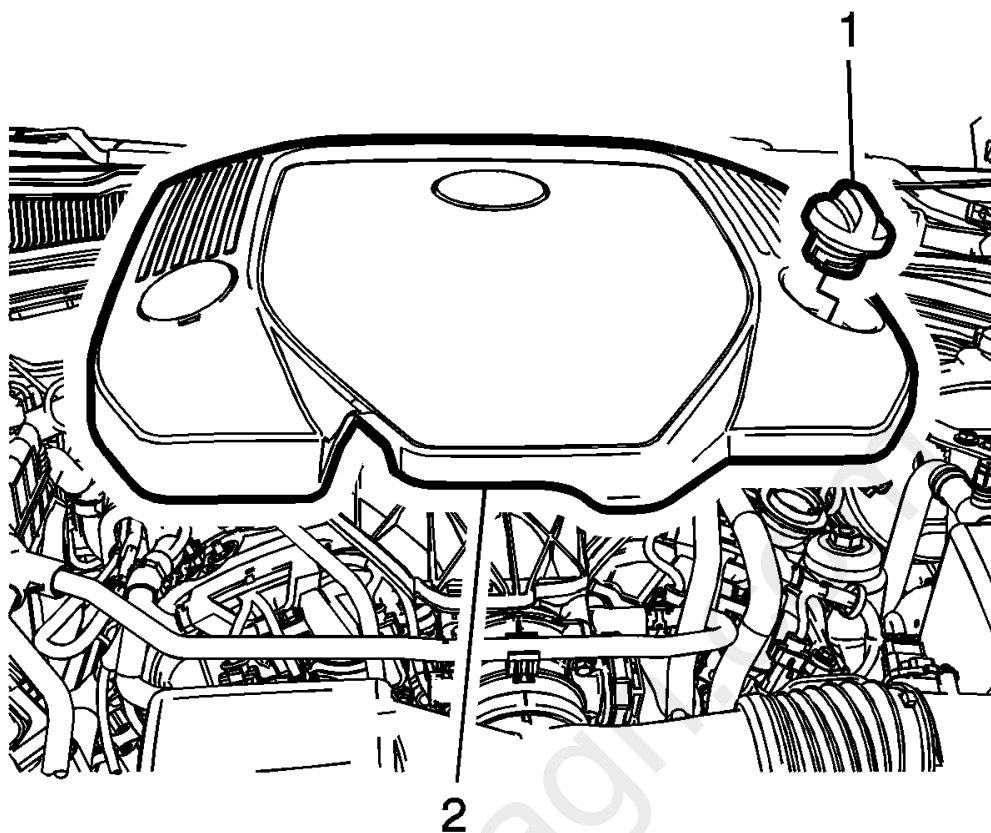


Fig. 309: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

35. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement (LFX)**.
36. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
37. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE 47716)** .

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

38. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to **Engine Prelubing** .
39. Charge the A/C system. Refer to **Refrigerant Recovery and Recharging (R-134a)** , **Refrigerant Recovery and Recharging (R-1234yf)** .
40. Perform the throttle learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn** .

ENGINE REPLACEMENT (LF3)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging (R-134a)** , **Refrigerant Recovery and Recharging (R-1234yf)** .
3. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .
4. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LF3)** .
5. Disconnect the charge air coolant hose from the supercharger water manifold. Refer to **Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)** .
6. Disconnect the charge air coolant hose - engine to radiator from the supercharger water manifold. Refer to **Charge Air Cooler Coolant Hose Replacement - Engine to Radiator** .
7. Disconnect the radiator surge tank hose from the water outlet and position aside. Refer to **Radiator Surge Tank Inlet Hose Replacement (LF3)** .
8. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LF3)** .
9. Remove the front compartment fuse block. Refer to **Front Compartment Fuse Block Housing Replacement** .

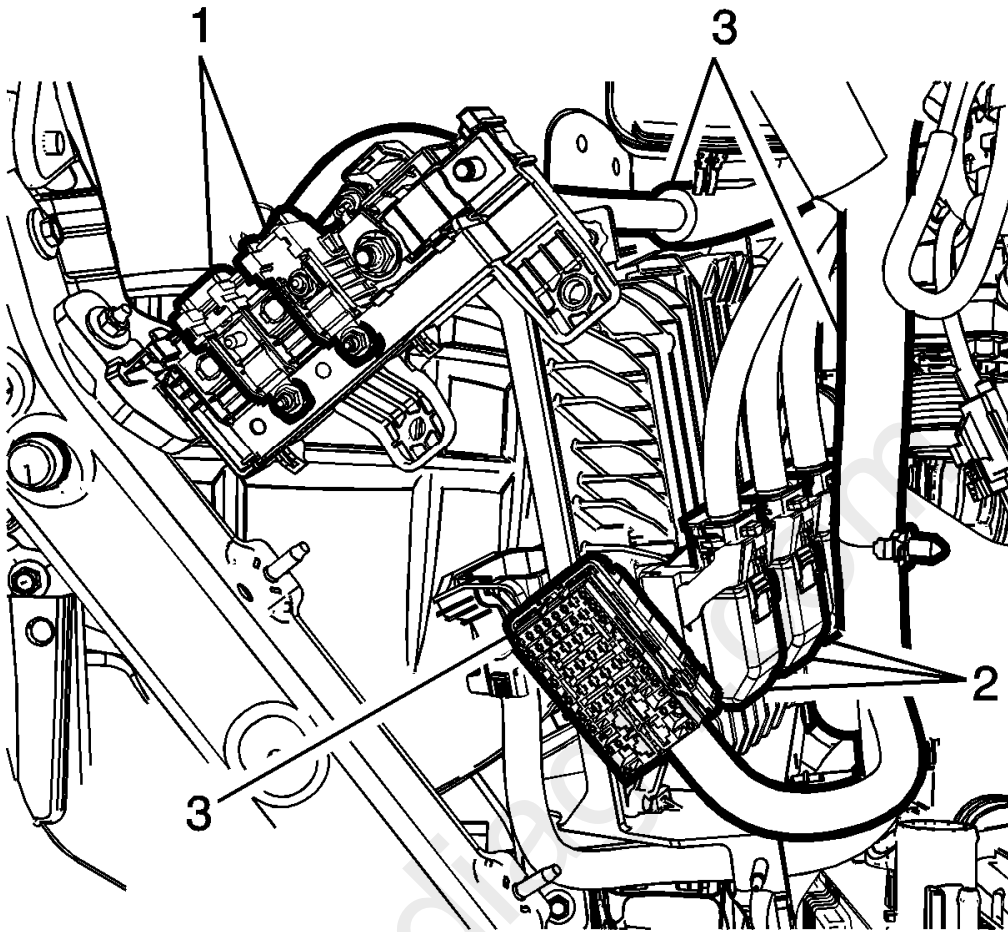


Fig. 310: Battery Terminals, ECM Connectors And Engine Harness
Courtesy of GENERAL MOTORS COMPANY

10. Remove the battery terminals (1) from the jump start post junction block.
11. Disconnect the ECM connectors (2).
12. Reposition the engine harness (3) on the engine.
13. Disconnect the heater inlet hose from the heater core tube.
14. Disconnect the heater outlet hose from the heater core tube.
15. Disconnect the heater outlet to surge tank hose.

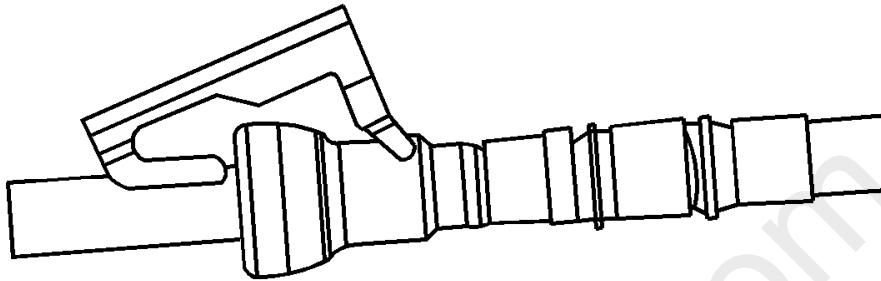


Fig. 311: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the fuel feed line quick connect from the fuel feed pipe. Refer to **Metal Collar Quick Connect Fitting Service** .
17. Disconnect the evaporative emission purge solenoid hose.

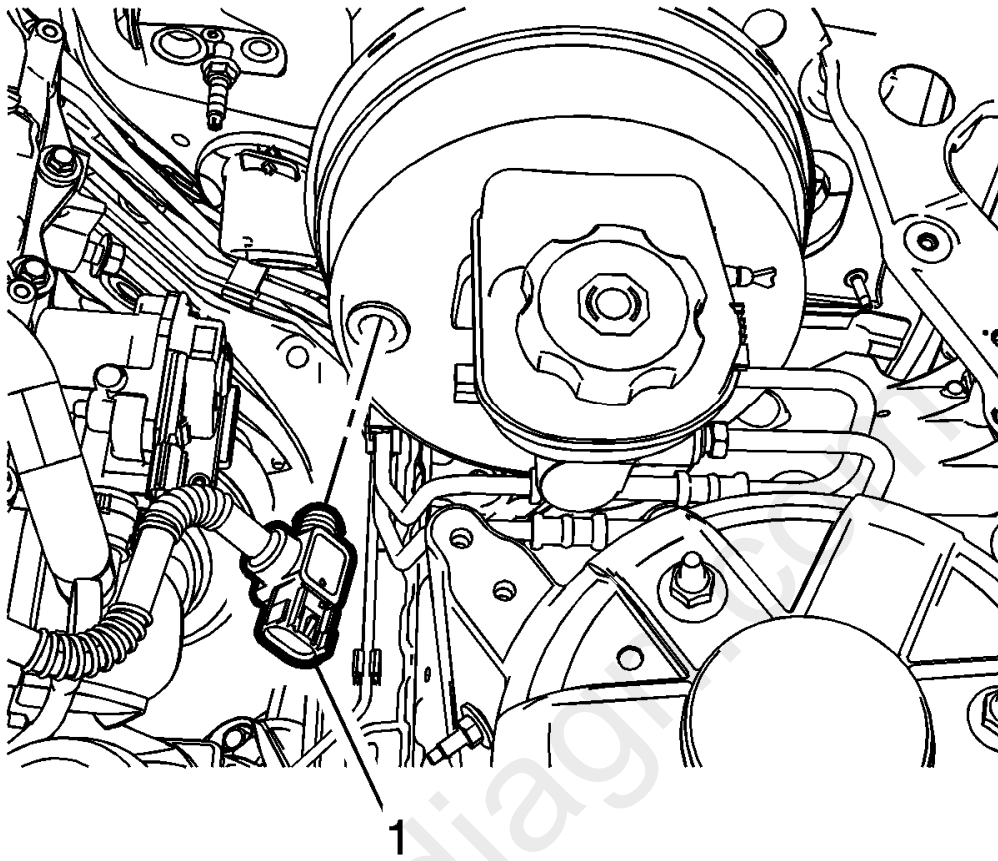


Fig. 312: Brake Vacuum Booster Check Valve
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect the vacuum booster check valve (1) from the vacuum booster.
19. Using mechanics wire, support the radiator assembly to the vehicle body.
20. Disconnect the A/C lines from the condenser. Position the lines aside.
21. Disconnect and reposition harnesses as necessary.
22. Disconnect the transmission fluid cooler lines from the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LF3 with MGG and V03)** .
23. Remove the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .
24. Disconnect the A/C lines from the compressor. Position the lines aside.

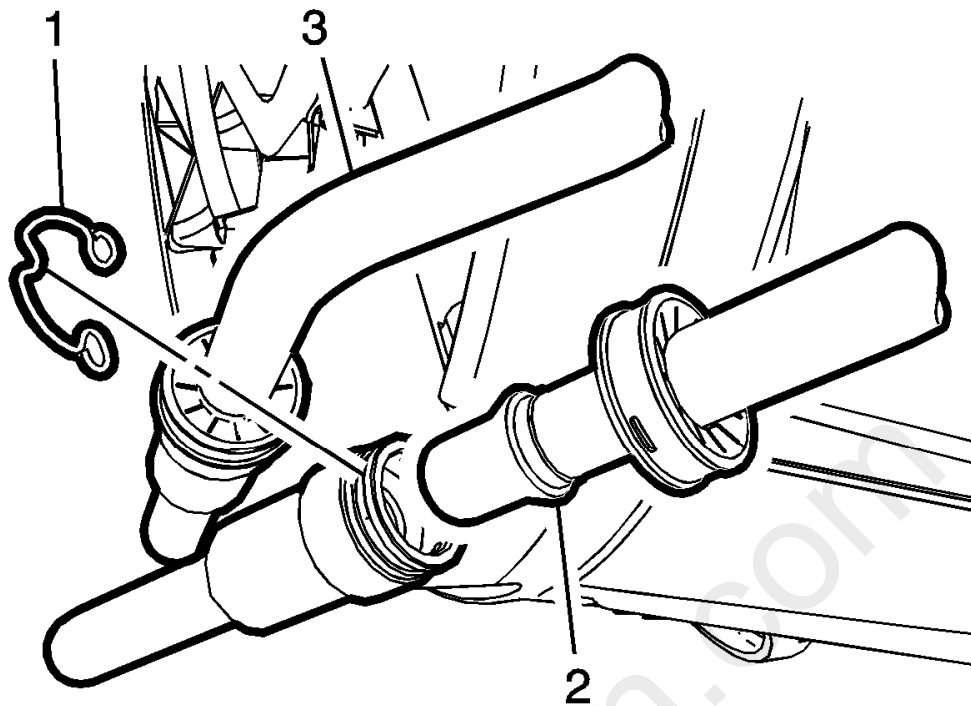


Fig. 313: Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

25. If equipped with an external engine oil cooler, disconnect the oil cooler inlet (2) and oil cooler outlet (3) hoses from the engine oil cooler.

NOTE: The engine, transmission and if equipped with AWD, the transfer case is removed as an assembly from the vehicle. The following two steps will prepare the transmission and if equipped with AWD, the transfer case for removal of the assembly.

26. Prepare the transmission for removal.
27. If equipped with AWD, prepare the transfer case for removal. Refer to **Transfer Case Assembly Replacement**.
28. Remove the catalytic converter(s). Refer to **Catalytic Converter Replacement - Left Side (LF3)**, and **Catalytic Converter Replacement - Right Side (LF3)**.

NOTE: Removing the powertrain assembly from the vehicle could cause an

unstable balance condition with the vehicle body on the vehicle hoist. Securing the vehicle body to the hoist is necessary.

29. Secure the vehicle body to the vehicle hoist using suitable straps or binders.

NOTE: **The powertrain assembly will be removed from vehicle on the drivetrain and front suspension frame. In the next step, only perform the necessary procedures required to remove the powertrain assembly.**

30. Remove the drivetrain and front suspension cradle with the powertrain attached. Refer to **Drivetrain and Front Suspension Cradle Replacement** .
31. Lower the powertrain onto a suitable support table.
32. Secure the powertrain to the support table using straps and binders.
33. With the aid of an assistant, carefully raise the body from the frame.
34. Ensure when raising the body the following items are clear from the frame:
- Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Oil cooler lines
35. Separate the engine from the transmission.
36. Disconnect electrical connectors as necessary.

Installation Procedure

1. Install the engine to the transmission.
2. Place the powertrain and frame assembly on the engine support table.
3. Secure the powertrain to the support table using straps and binders.
4. With the aid of an assistant, carefully lower the body onto the powertrain assembly.
5. Ensure when lowering the body the following items are clear from the frame:
- Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Oil cooler lines
6. Install the drivetrain and front suspension cradle with the powertrain attached. Refer to **Drivetrain and Front Suspension Cradle Replacement** .
7. Remove the engine support table.
8. Install the catalytic converter(s). Refer to **Catalytic Converter Replacement - Left Side (LF3)** , and **Catalytic Converter Replacement - Right Side (LF3)** .
9. If equipped with AWD, complete installation of the transfer case. Refer to **Transfer Case Assembly Replacement** .
10. Complete installation of the transmission.

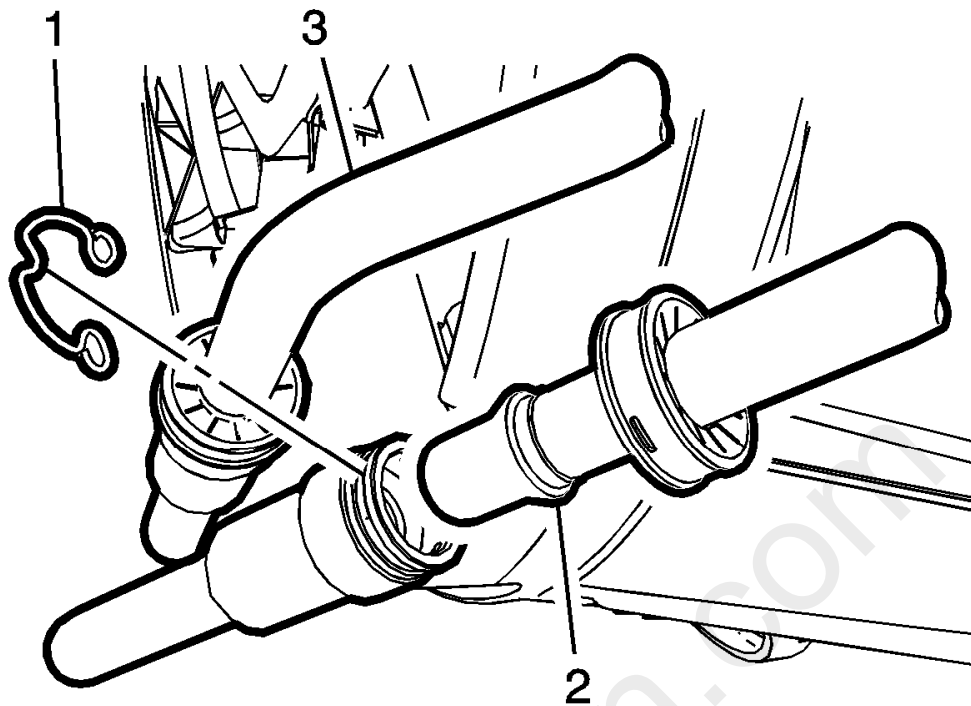


Fig. 314: Oil Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

11. If equipped with an external engine oil cooler, connect the oil cooler inlet (2) and oil cooler outlet (3) hoses to the engine oil cooler.
12. Connect the A/C lines to the compressor.
13. Install the transmission fluid cooler lines to the radiator. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (LF3 with MGG and V03)** .
14. Install the engine lower front splash shield. Refer to **Engine Lower Front Splash Shield Replacement** .
15. Lower the vehicle.
16. Connect the heater inlet hose to the heater core tube.
17. Connect the heater outlet hose to the heater core tube.
18. Connect the heater outlet to surge tank hose.

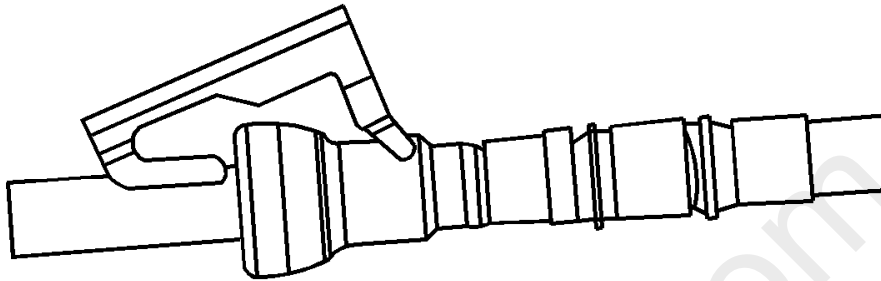


Fig. 315: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

19. Connect the fuel feed line quick connect to the fuel feed pipe. Refer to **Metal Collar Quick Connect Fitting Service** .

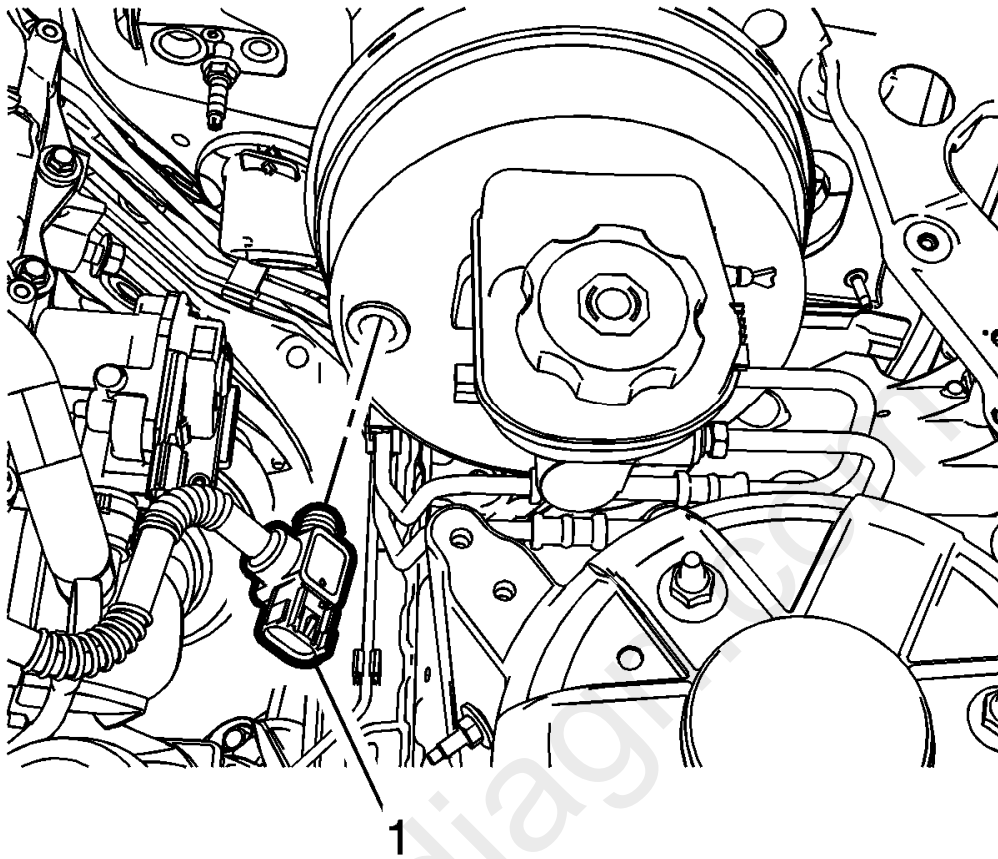


Fig. 316: Brake Vacuum Booster Check Valve
Courtesy of GENERAL MOTORS COMPANY

20. Connect the vacuum booster check valve (1) to the vacuum booster.
21. Connect the evaporative emission purge solenoid hose.
22. Remove mechanics wire that supported the radiator assembly to the vehicle body.
23. Connect the A/C lines from the condenser.
24. Reposition and connect harnesses as necessary.
25. Connect the heater outlet to surge tank hose.
26. Connect the heater outlet hose to the heater core tube.
27. Connect the heater inlet hose to the heater core tube.

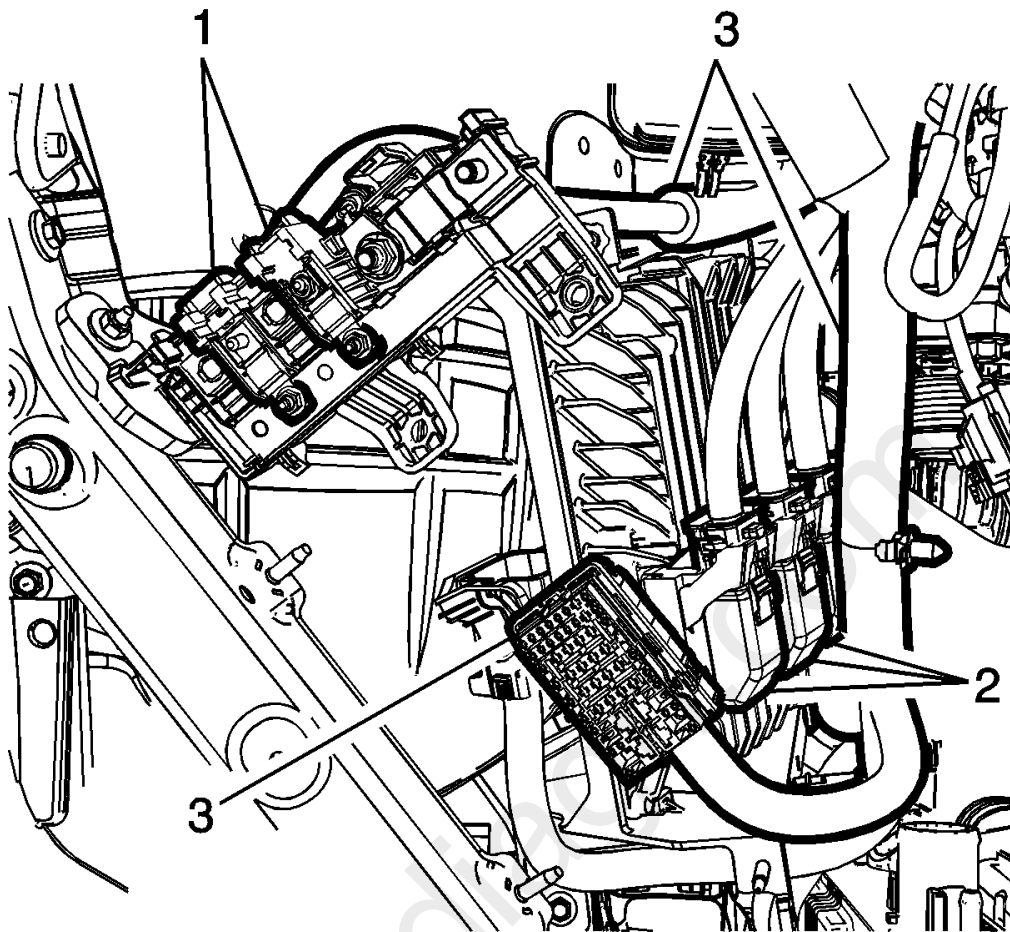


Fig. 317: Battery Terminals, ECM Connectors And Engine Harness
 Courtesy of GENERAL MOTORS COMPANY

28. Install the battery terminals (1) to the jump start post junction block.
29. Connect the ECM connectors (2).
30. Install the front compartment fuse block. Refer to **Front Compartment Fuse Block Housing Replacement** .
31. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement (LF3)** .
32. Connect the radiator surge tank hose to the water outlet. Refer to **Radiator Surge Tank Inlet Hose Replacement (LF3)** .
33. Connect the charge air coolant hose - engine to radiator to the supercharger water manifold. Refer to **Charge Air Cooler Coolant Hose Replacement - Engine to Radiator** .
34. Connect the charge air coolant hose to the supercharger water manifold. Refer to **Charge Air Cooler Coolant Hose Replacement (Pump to Engine LF3)** .
35. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LF3)** .
36. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LF3)** .
37. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

38. Fill the cooling system. Refer to Cooling System Draining and Filling (Static Fill) , Cooling System Draining and Filling (GE 47716) .

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

39. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to Engine Prelubing .
40. Charge the A/C system. Refer to Refrigerant Recovery and Recharging (R-134a) , Refrigerant Recovery and Recharging (R-1234yf) .
41. Perform the throttle learn procedure. Refer to Q38 Throttle Body: Throttle/Idle Learn .

ENGINE OIL AND OIL FILTER REPLACEMENT (LFX)

Removal Procedure

1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement (LFX).
2. Place a drain pan underneath the oil filter.

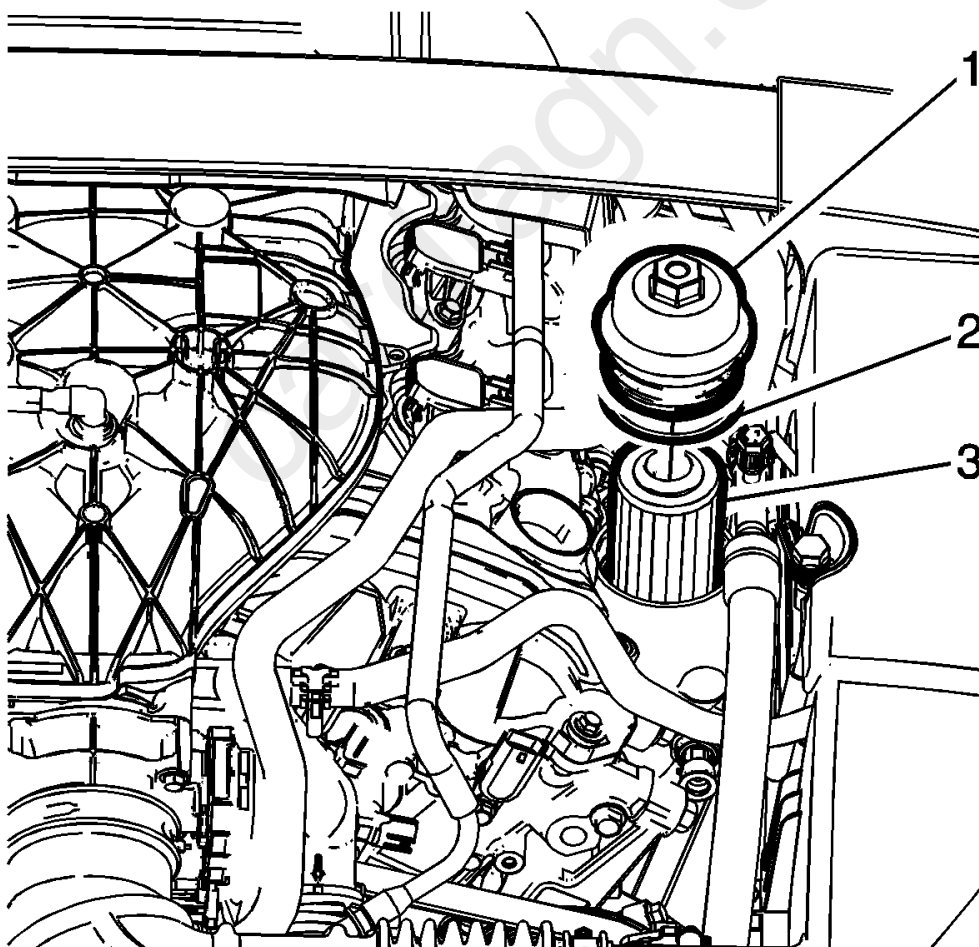


Fig. 318: Oil Cap & Seal

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil filter cap (1) and seal (2).
4. Remove and properly dispose of the oil filter insert (3).
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

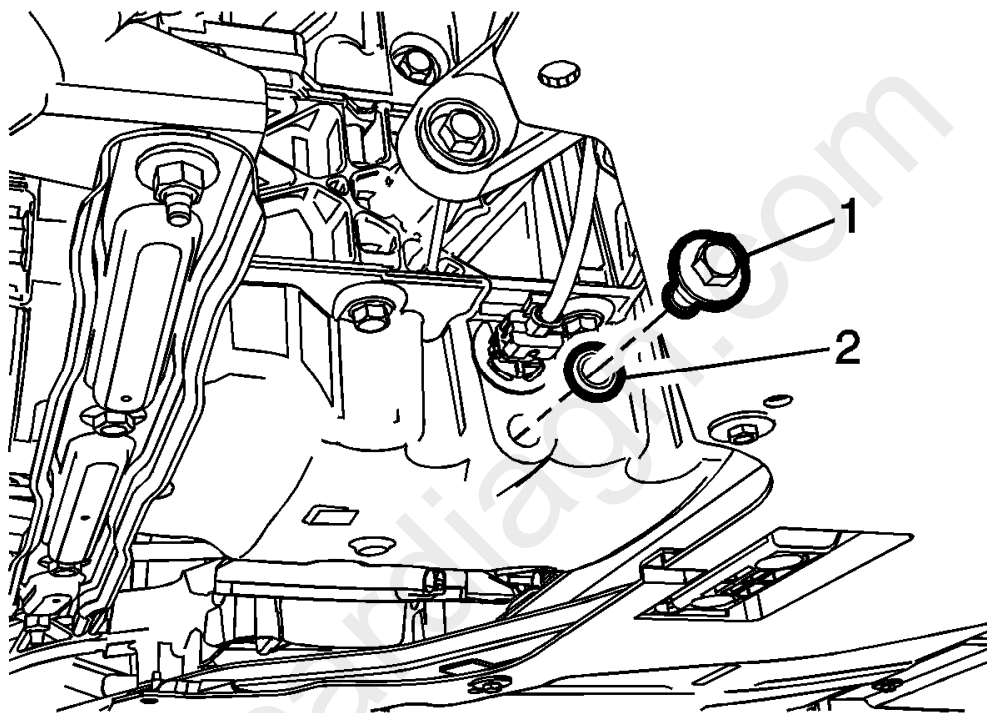


Fig. 319: Engine Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

6. Place a suitable drain pan below the oil pan drain plug.
7. Remove the oil pan drain plug (1) and seal (2).
8. Allow the oil to drain completely.

Installation Procedure

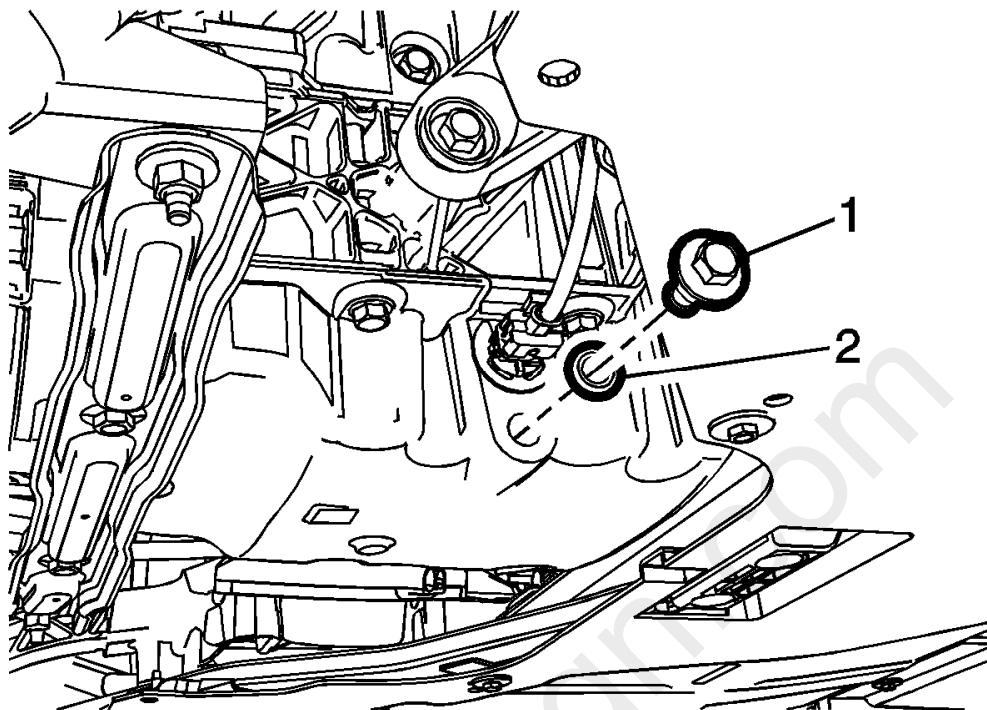


Fig. 320: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Component Fastener Tightening Caution .

NOTE: **Inspect the oil drain plug seal for damage, replace if necessary.**

1. Install seal (2) and oil pan drain plug (1) and tighten to 25 N.m (18 lb ft).
2. Remove the drain pan.
3. Lower the vehicle.

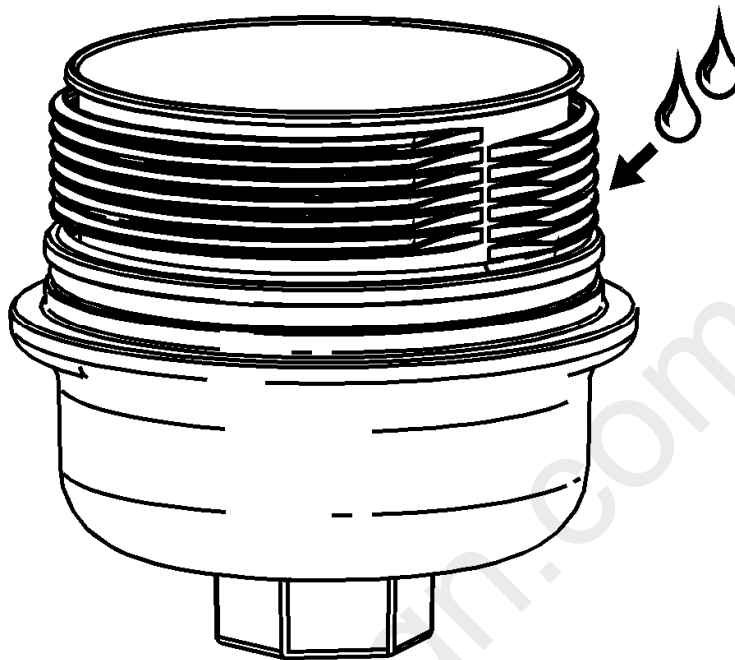


Fig. 321: Lubricating Threads Of Oil Filter Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

4. Lubricate the oil filter cap threads with clean engine oil.

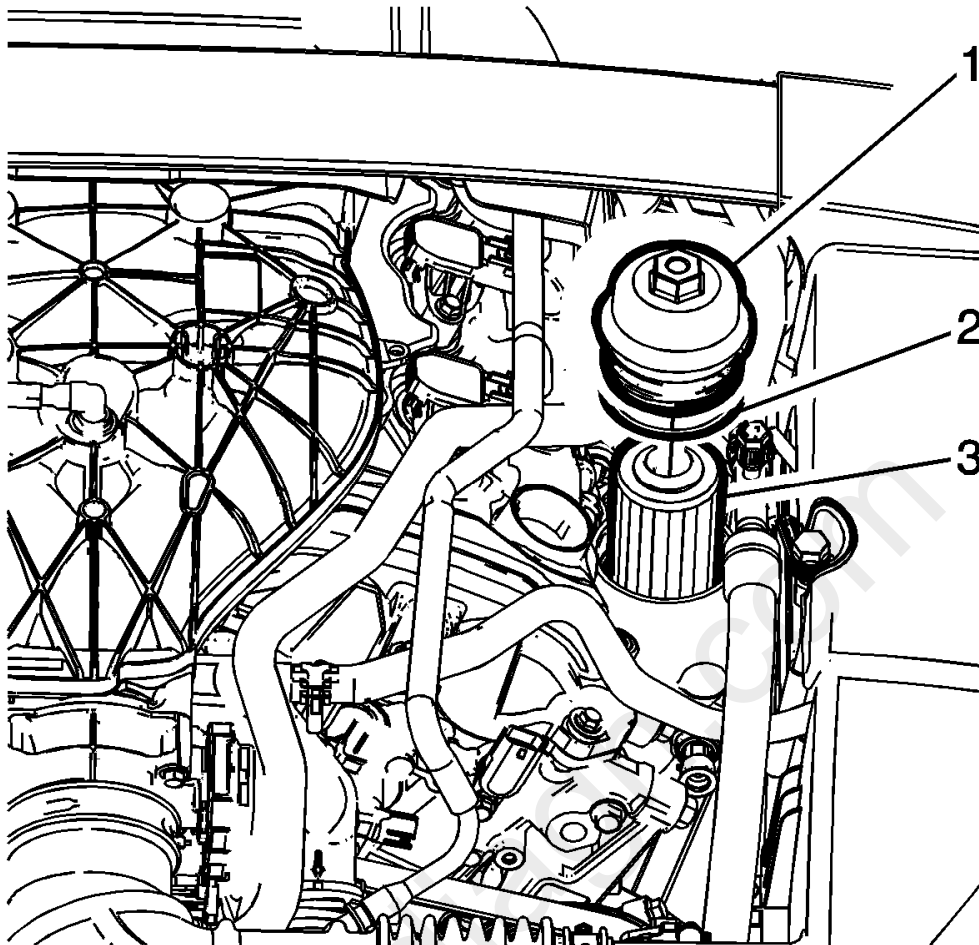


Fig. 322: Oil Cap & Seal

Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW oil filter (3).

CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

NOTE: Inspect the oil filter seal for damage, replace if necessary.

6. Install seal (2) and tighten the oil filter cap (1) to 25 N.m (18 lb ft).
7. Fill the engine with the appropriate oil type and quantity. Refer to **Fluid and Lubricant Recommendations**.
8. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement (LFX)**.
9. Reset the oil life. Refer to **GM Oil Life System Resetting**

ENGINE OIL AND OIL FILTER REPLACEMENT (LF3)

Removal Procedure

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

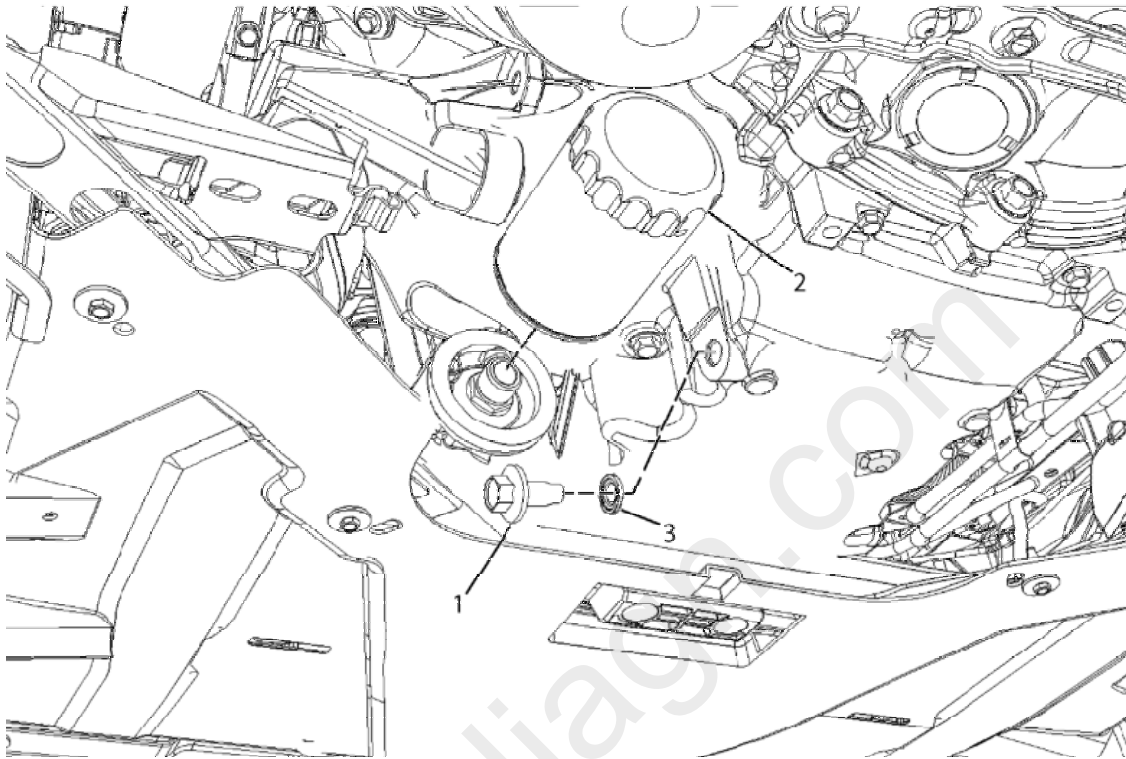


Fig. 323: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

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

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

NOTE: Clean and inspect the oil pan drain plug seal (3), replace if necessary.

4. Install the oil pan drain plug and tighten to 25 (18 lb ft).

WARNING: Refer to **Hot Exhaust System Warning** .

5. Place the drain pan under the oil filter (2).
6. Remove the oil filter. Allow the oil to drain completely.

Installation Procedure

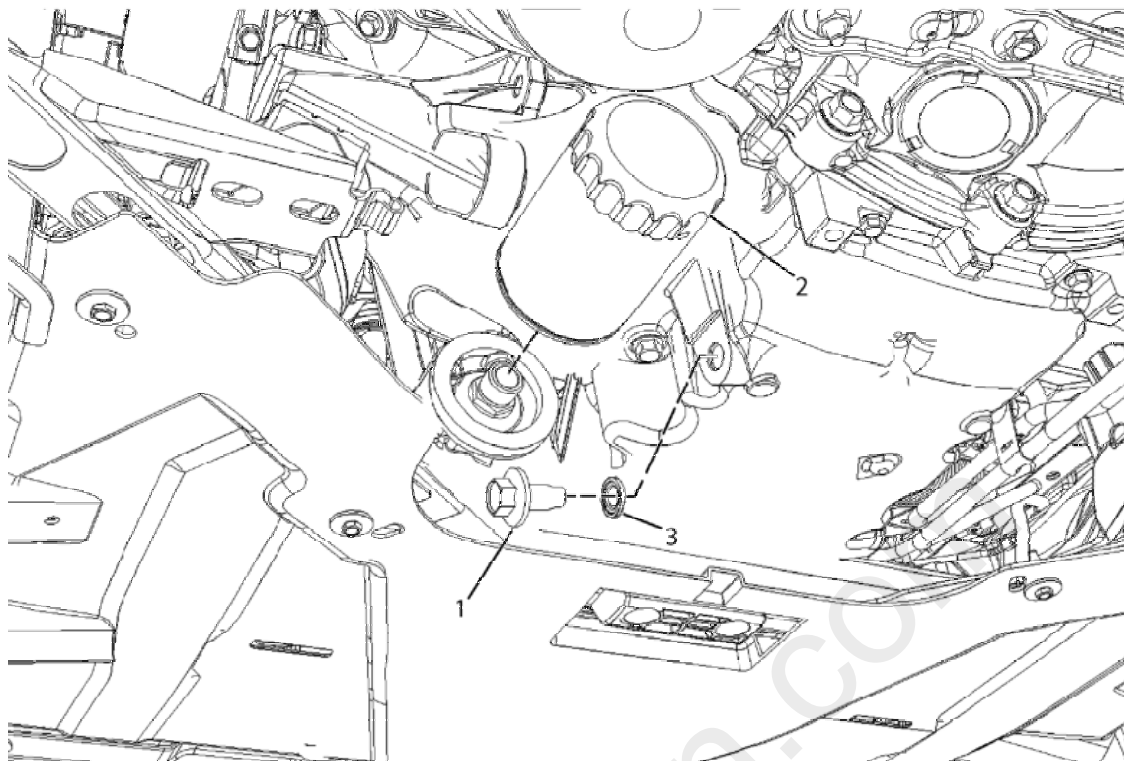


Fig. 324: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Tighten the oil filter (2) to 25 (18 lb ft).
3. Lower the vehicle.
4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
5. Start the engine and inspect for leaks.
6. Reset the oil life monitor. Refer to **GM Oil Life System Resetting** .

Drive Belt Replacement (LFX)

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LFX)</u> .	
1	Drive Belt
	Procedure
	1. Rotate the drive belt tensioner counter clockwise to release the drive belt tension.
	2. Slide the drive belt off of the water pump pulley.
	3. Slowly release the drive belt tensioner.

Drive Belt Replacement (LF3)

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Callout	Component Name
Preliminary Procedures	
Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u>	
1	Drive Belt Procedure 1. Rotate the drive belt tensioner clockwise to release the drive belt tension. 2. Slide the drive belt off of the belt idler pulley. 3. Slowly release the drive belt tensioner.

Drive Belt Tensioner Replacement (LFX)

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

Drive Belt Tensioner Replacement (LF3)

Callout	Component Name
Preliminary Procedure	
Remove the drive belt. Refer to <u>Drive Belt Replacement (LF3)</u> .	
1	Drive Belt Tensioner Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Drive Belt Tensioner

Generator and Drive Belt Tensioner Bracket Replacement

Callout	Component Name
Preliminary Procedure	
Remove the generator. Refer to <u>Generator Replacement (LFX)</u> , <u>Generator Replacement (LTG)</u> , <u>Generator Replacement (LF3)</u> .	

1	Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Position the coolant hose clamp clear of the generator and drive belt tensioner bracket. Tighten 22 N.m (16 lb ft)
2	Fastener Tighten 50 (37 lb ft)
3	Fastener (QTY:3) Tighten 50 (37 lb ft)
4	Generator and Drive Belt Tensioner Bracket.

Engine Support Fixture

Callout	Component Name
Preliminary Procedures 1. Remove the front compartment front sight shield. Refer to <u>Front Compartment Front Sight Shield Replacement</u> . 2. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX), Intake Manifold Cover Replacement (LF3)</u>. 3. Remove the radiator surge tank. Refer to <u>Radiator Surge Tank Replacement (LTG)</u> , <u>Radiator Surge Tank Replacement (LFX, LF3)</u> . 4. Remove the secondary air injection pump inlet hose, if equipped. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u> .	
Special Tools • EN-36857 Engine Lift Bracket • EN-46114 Engine Lift Bracket • EN-28467-550 Engine Support Beam Adapters • J-284678-518 Main Support Beam • EN-28467-2A Radiator Tube Shelf Assembly • EN-28467-1A Cross Bracket • EN-28467-4A Front Support Assembly • J-28467-6A Bracket Assembly • EN-28467-8A Hook Assembly • EN-28467-34 Lift Hook Wing Nut and Washer	

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

1	EN-36857 Engine Lift Bracket Procedure Place engine lift bracket on cylinder head and install two bolts to retain lift bracket.
2	EN-36857 Engine Lift Bracket Procedure Remove exhaust nut and place engine lift bracket on stud and replace nut to retain lift bracket.
3	EN-28467-550 Engine Support Beam Adapters (Qty:2) Procedure Place engine support beam adapters on the strut towers as shown.
4	J-284678-518 Main Support Beam Procedure Install main support beam through engine support beam adapters and pin in place.
5	EN-28467-2A Radiator Tube Shelf Assembly (Qty: 2) Procedure Place radiator shelf tubes on top of main support beam.
6	EN-28467-1A Cross Bracket (Qty: 2) Procedure Loosely install cross bracket to retain radiator shelf tube to main support beam. Tighten cross bracket after front support assembly is in place.
7	EN-28467-4A Front Support Assembly (Qty: 2) Procedure Place front support assembly through radiator tube shelf and pin at proper height.
8	J-28467-6A Bracket Assembly (Qty: 2)
9	EN-28467-8A Hook Assembly (Qty: 2)
10	EN-28467-34 Lift Hook Wing Nut and Washer (Qty: 2)

Engine Mount Replacement - Left Side (LFX)

Callout	Component Name
Preliminary Procedures	
1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the front engine compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the left frame brace. 5. Disconnect the engine mount vacuum hose.	
	Engine Mount Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

1	Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

Engine Mount Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the left frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
	Engine Mount Fastener (Qty: 2)

2	Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Engine Mount Vacuum Line
5	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.

Engine Mount Replacement - Right Side (LFX)

Callout	Component Name
Preliminary Procedures	
1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the engine compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the right frame brace. 5. Disconnect the engine mount vacuum hose.	
1	Engine Mount Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.

4	Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount. Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.
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Engine Mount Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>. 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>. 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the right frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure Working under the hood, remove the engine mount upper fastener. Tighten 70 N.m (52 lb ft)
2	Engine Mount Fastener (Qty: 2) Tighten 58 N.m (43 lb ft)
3	Engine Mount Procedure Using the engine support fixture, raise the engine enough to remove the engine mount.
4	Engine Mount Vacuum Line
Phenolic Spacer CAUTION: Phenolic spacer must be present to prevent galvanic/corrosive reaction and/or excessive temperature conduction between engine mount bracket and engine mount.	

5	Replace mount if phenolic spacer is missing or damaged. Failure to ensure phenolic spacer is intact and not damaged can lead to premature failure of engine mount and/or engine mount bracket. Procedure Inspect the engine mount to ensure the phenolic spacer is in place and not damaged.
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Engine Mount Vacuum Valve Replacement (LFX)

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

Engine Mount Vacuum Valve Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> .	
1	Engine Mount Vacuum Valve Procedure 1. Disconnect the vacuum lines from the engine mount vacuum valve. 2. Detach the engine mount vacuum valve from the retaining bracket.

Engine Mount Vacuum Filter Replacement

Callout	Component Name
Preliminary Procedure Remove the charge air cooler air tube, LTG only. Refer to <u>Charge Air Cooler Outlet Air Tube Replacement</u> .	
1	Engine Mount Vacuum Filter NOTE:

Disconnect the engine mount vacuum hose before removing the filter.

Engine Mount Vacuum Tank Replacement

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

Engine Mount Vacuum Hose Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the drivetrain and front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Vacuum Hose Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Disconnect the vacuum lines from the components. Tighten 9 (80 lb in)
2	Engine Mount Vacuum Hose Procedure 1. Disconnect the engine mount vacuum hose retainers at the frame. 2. Disconnect the engine mount vacuum hoses from the engine mounts. 3. Disconnect the vacuum filter from the vacuum hose assembly. 4. Remove the engine mount vacuum hose assembly from the frame.

Engine Mount Vacuum Hose Replacement (LFX)

Callout	Component Name
Preliminary Procedure Remove the drivetrain and front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Vacuum Hose Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . NOTE: Disconnect the vacuum lines from the components. Tighten 9 (80 lb in)
2	Engine Mount Vacuum Hose Procedure 1. Disconnect the engine mount vacuum hose retainers at the frame. 2. Disconnect the engine mount vacuum hoses from the engine mounts. 3. Disconnect the vacuum filter from the vacuum hose assembly. 4. Remove the engine mount vacuum hose assembly from the frame.

Engine Mount Bracket Replacement - Left Side (LFX)

Callout	Component Name
Preliminary Procedures Remove the left engine mount. Refer to <u>Engine Mount Replacement - Left Side (LFX)</u> .	
1	Engine Mount Bracket Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 60 (44 lb ft)
2	Engine Mount Bracket Fastener Tighten 38 (28 lb ft) for vehicles equipped with AWD Tighten 22 (16 lb ft) for vehicles equipped with RWD
	Engine Mount Bracket

3	NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.
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Engine Mount Bracket Replacement - Left Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the left frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Engine Mount Fastener Tighten 70 N.m (52 lb ft)
3	Washer
4	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

Engine Mount Bracket Replacement - Right Side (LFX)

Callout	Component Name
Preliminary Procedures Remove the right engine mount. Refer to <u>Engine Mount Replacement - Right Side (LFX)</u> .	
1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 60 (44 lb ft)
2	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

Engine Mount Bracket Replacement - Right Side (LF3)

Callout	Component Name
Preliminary Procedures 1. Install the engine support fixture. Refer to <u>Engine Support Fixture</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> . 4. Remove the right frame brace from the front suspension cradle. Refer to <u>Drivetrain and Front Suspension Cradle Replacement</u> .	
1	Engine Mount Bracket Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 N.m (43 lb ft)
2	Engine Mount Fastener Tighten 70 N.m (52 lb ft)
3	Washer
4	Engine Mount Bracket NOTE: Engine mount brackets are magnesium. To prevent galvanic corrosion, the bracket includes pressed on spacers on the back side. Even though it is highly unlikely, the pressed on spacers may loosen and fall off during engine mount bracket removal. Ensure the spacers are in place before reinstalling an existing bracket.

Intake Manifold Cover Replacement (LFX)

Callout	Component Name
	Intake Manifold Cover Fastener

1	Procedure Flip open the access cover. Tighten 9 N.m (80 lb in)
2	Oil Cap Procedure Remove the oil cap before removing the intake manifold cover.
3	Intake Manifold Cover Procedure Pull the intake manifold cover upward to remove.

Intake Manifold Cover Replacement (LF3)

Callout	Component Name
1	Oil Cap Procedure Remove the oil cap before removing the intake manifold cover.
2	Intake Manifold Cover Fastener Tighten 9 N.m (80 lb in)
3	Washer
4	Intake Manifold Cover Procedure Pull the intake manifold cover upward to remove.

Intake Manifold Insulator Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LFX)</u> , <u>Intake Manifold Cover Replacement (LF3)</u> .	
1	Intake Manifold Insulator Retainers (Qty;2)
2	Intake Manifold Insulator

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFX (Dirty Air))

Callout	Component Name
Preliminary Procedure Remove the intake manifold insulator. Refer to <u>Intake Manifold Insulator Replacement..</u>	
1	PCV Pipe Fitting Procedure Disconnect the pipe at right side camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	PCV Pipe Fitting Procedure Turn the PCV air tube connector 90 degrees to detach the connector from the intake manifold
3	PCV Pipe

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFX (Clean Air))

Callout	Component Name
Preliminary Procedure Remove the intake manifold insulator. Refer to <u>Intake Manifold Insulator Replacement..</u>	
1	PCV Pipe Fitting Procedure Disconnect the pipe from the air cleaner outlet duct. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
2	PCV Pipe Fitting Procedure Disconnect the pipe from the left side valve cover.
3	PCV Pipe

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Front))

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3).</u>	
1	Positive Crankcase Ventilation Tube Procedure Disconnect the PCV tube from the intake manifold and the camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LF3 (Rear))

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement (LF3).</u>	
1	Positive Crankcase Ventilation Tube Procedure Disconnect the PCV tube from the intake manifold and the camshaft cover. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .

Turbocharger Replacement (Bank 2)

Callout	Component Name
Preliminary Procedures 1. Remove the three-way catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side (LFX)</u> , <u>Catalytic Converter Replacement - Left Side (LF3)</u> . 2. Remove the turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Left Side</u> . 3. Remove the turbocharger air inlet adaptor. Refer to <u>Turbocharger Air Inlet Adapter Replacement - Bank 2</u> . 4. Remove the charge air cooler inlet hose . Refer to <u>Charge Air Cooler Inlet Air Hose Replacement - Left Side (LF3)</u> . 5. Disconnect the front turbocharger coolant feed pipe and return pipe from the turbocharger. Refer to	

Turbocharger Coolant Feed Pipe Replacement (LTG) , Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 2) , Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 1) , and Turbocharger Coolant Return Pipe Replacement (LTG) , Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 2) , Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 1) .

6. Disconnect the front turbocharger oil feed pipe and return pipe from the turbocharger. Refer to **Turbocharger Oil Feed Pipe Replacement (Bank 1), Turbocharger Oil Feed Pipe Replacement (Bank 2), and Turbocharger Oil Return Pipe Replacement (Bank 1), Turbocharger Oil Return Pipe Replacement (Bank 2).**

1	Turbocharger bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Turbocharger
3	NOTE: Discard and replace with NEW gasket. Gasket

Turbocharger Replacement (Bank 1)

Callout	Component Name
Preliminary Procedures	
1.	Remove the rear three-way catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side (LFX) , Catalytic Converter Replacement - Left Side (LF3) .</u>
2.	Remove the right turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Right Side .</u>
3.	Remove the right turbocharger air inlet adaptor. Refer to <u>Turbocharger Air Inlet Adapter Replacement - Bank 1 .</u>
4.	Remove the right charge air cooler inlet hose . Refer to <u>Charge Air Cooler Inlet Air Hose Replacement - Left Side (LF3) .</u>
5.	Disconnect the front turbocharger coolant feed pipe and return pipe from the turbocharger. Refer to <u>Turbocharger Coolant Feed Pipe Replacement (LTG) , Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 2) , Turbocharger Coolant Feed Pipe Replacement (LF3 - Bank 1) , and Turbocharger Coolant Return Pipe Replacement (LTG) , Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 2) , Turbocharger Coolant Return Pipe Replacement (LF3 - Bank 1) .</u>
6.	Disconnect the front turbocharger oil feed pipe and return pipe from the turbocharger. Refer to <u>Turbocharger Oil Feed Pipe Replacement (Bank 1), Turbocharger Oil Feed Pipe Replacement (Bank 2), and Turbocharger Oil Return Pipe Replacement (Bank 1),</u>

Turbocharger Oil Return Pipe Replacement (Bank 2).

1	Turbocharger bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 58 (43 lb ft)
2	Turbocharger
3	NOTE: Discard and replace with NEW gasket. Gasket

Turbocharger Oil Return Pipe Replacement (Bank 1)

Callout	Component Name
Preliminary Procedures Remove the turbocharger heat shield bank 1. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> .	
1	Turbocharger Oil Return Pipe Bolts CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe
3	Gaskets NOTE: Discard and replace with NEW gaskets.

Turbocharger Oil Return Pipe Replacement (Bank 2)

Callout	Component Name
Preliminary Procedures Remove the turbocharger heat shield bank 2. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> .	
1	Turbocharger Oil Return Pipe Bolts CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (89 lb in)
2	Turbocharger Oil Return Pipe
3	Gaskets NOTE: Discard and replace with NEW gaskets.

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Callout	Component Name
Preliminary Procedures	
1. Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> . 2. Remove the right turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Right Side</u> .	
1	Turbocharger Oil Feed Pipe Fitting NOTE: Install NEW fitting. It is not reusable
2	Turbocharger Oil Feed Pipe Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
3	Turbocharger Oil Feed Pipe Gaskets NOTE: Install NEW gaskets. They are not reusable.
4	Turbocharger Oil Feed Pipe

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Callout	Component Name
Preliminary Procedures	
1. Remove the turbocharger heat shield. Refer to <u>Turbocharger Heat Shield Replacement (LF3 Bank 1)</u> , <u>Turbocharger Heat Shield Replacement (LF3 Bank 2)</u> . 2. Remove the left turbocharger wastegate actuator. Refer to <u>Turbocharger Wastegate Actuator Replacement - Left Side</u> .	

1	Turbocharger Oil Feed Pipe Fitting NOTE: Install NEW fitting. It is not reusable
2	Turbocharger Oil Feed Pipe Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 35 (26 lb ft)
3	Turbocharger Oil Feed Pipe Gaskets NOTE: Install NEW gaskets. They are not reusable.
4	Turbocharger Oil Feed Pipe

Intake Manifold Replacement (LF3)

Callout	Component Name
Preliminary Procedures 1. Remove the charge air cooler cover. Refer to <u>Charge Air Cooler Cover Replacement</u> . 2. Disconnect and reposition the vacuum supply and PCV tubes and lines. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Intake Manifold Bolts: (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Intake Manifold

Oil Level Indicator Tube Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement (LF3)</u> .	
1	Oil Level Indicator Tube Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten 10 (7 lb ft)
2	Oil Level Indicator Tube NOTE: Ensure that the oil level indicator tube is fully seated prior to tightening the fastener.

Oil Filter Adapter Replacement (LF3)

Callout	Component Name
Preliminary Procedures - Remove left turbocharger oil feed pipe. Refer to <u>Turbocharger Oil Feed Pipe Replacement (Bank 1)</u>, <u>Turbocharger Oil Feed Pipe Replacement (Bank 2)</u>. - Disconnect the engine oil cooler outlet pipe. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u>, <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u>.	
1	Oil Filter Adapter Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Oil Filter Adapter Procedure - Disconnect the engine oil pressure sensor electrical connector. - Transfer components as necessary. - Replace oil filter adapter gasket with NEW gasket.

Automatic Transmission Flex Plate Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to <u>Transmission Replacement (LTG)</u> , <u>Transmission Replacement (LFX)</u> .	
Special Tools - EN 45059 Angle Meter - EN 46106 Flywheel Holding Tool	

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

1	Automatic Transmission Flex Plate Fastener (Qty: 8) CAUTION: Refer to <u>Fastener Caution</u> . Procedure New bolts must be used whenever removing the automatic transmission flex plate. Tighten 30 (22 lb ft) plus 45 degrees
2	Automatic Transmission Flex Plate Spacer
3	Automatic Transmission Flex Plate Procedure Clean and inspect the automatic transmission flex plate. Refer to <u>Automatic Transmission Flex Plate Cleaning and Inspection</u> .

Engine Oil Cooler Replacement

Callout	Component Name
Preliminary Procedures Remove the engine oil cooler shield. Refer to <u>Engine Oil Cooler Shield Replacement</u> .	
1	Engine Oil Cooler Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Engine Oil Cooler
3	Engine Oil Cooler Seals Procedure Inspect the oil cooler and oil cooler adapter for proper mating prior to reinstalling the NEW seals. NOTE: Install new oil cooler seals whenever the oil cooler and adapter are separated.
4	Oil Cooler Adapter

Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)

Callout	Component Name
Preliminary Procedure 1. Drain the engine oil. Refer to <u>Engine Oil and Oil Filter Replacement (LFX)</u> , <u>Engine Oil and Oil</u>	

Filter Replacement (LF3).

2. Remove the electric belt drive rack and pinion steering gear. Refer to **Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD)** , **Electric Belt Drive Rack and Pinion Steering Gear Replacement (RWD)** .

1	Engine Oil Cooler Hose Retainers
2	Engine Oil Cooler Upper Hose Procedure NOTE: Cap the open ends of the hose to prevent dirt from entering the hose assembly. Remove the hose assembly from bottom of vehicle.

Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)

Callout	Component Name
Preliminary Procedure 1. Drain the engine oil. Refer to <u>Engine Oil and Oil Filter Replacement (LFX)</u>, <u>Engine Oil and Oil Filter Replacement (LF3)</u>. 2. Remove the electric belt drive rack and pinion steering gear. Refer to <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (AWD)</u> , <u>Electric Belt Drive Rack and Pinion Steering Gear Replacement (RWD)</u> .	
1	Engine Oil Cooler Hose Retainers
2	Engine Oil Cooler Lower Hose Procedure NOTE: Cap the open ends of the hose to prevent dirt from entering the hose assembly. Remove the hose assembly from bottom of vehicle.

Engine Oil Cooler Inlet Hose Connector Fitting Replacement (Upper)

Callout	Component Name
Preliminary Procedure Disconnect the engine oil cooler inlet hose. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u> , <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u> .	
1	Engine Oil Cooler Inlet Hose Fitting Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> .

	Tighten 35 (26 lb ft)
2	Inlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.

Engine Oil Cooler Outlet Hose Connector Fitting Replacement (Lower)

Callout	Component Name
Preliminary Procedure Disconnect the engine oil cooler outlet hose. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u> , <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u> .	
1	Engine Oil Cooler outlet Hose Fitting Fastener CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Tighten 35 (26 lb ft)
2	Outlet Hose Fitting Seal Ring NOTE: Replace the seal whenever fitting is removed.

Engine Oil Cooler Adapter Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the turbocharger coolant hose from the oil cooler adapter. Refer to <u>Turbocharger Coolant Hoses/Pipes Replacement</u> . 2. Remove the radiator outlet hose from the oil cooler adapter. Refer to <u>Radiator Outlet Hose Replacement (LTG with V03)</u> , <u>Radiator Outlet Hose Replacement (LFX)</u> , <u>Radiator Outlet Hose Replacement (LTG without V03)</u> , <u>Radiator Outlet Hose Replacement (LF3)</u> . 3. Remove the engine oil cooler inlet and outlet hoses. Refer to <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Upper)</u>, <u>Engine Oil Cooler Inlet and Outlet Hose Replacement (Lower)</u>.	
1	Oil Cooler Adapter Assembly Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)

2	Engine Oil Cooler Adapter Assembly Procedure 1. Remove the oil cooler adapter assembly from the engine block. 2. Transfer components as necessary.
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Engine Oil Pressure Sensor and/or Switch Replacement (LFX)

Callout	Component Name
Preliminary Procedure Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement (LFX)</u> .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the oil pressure sensor electrical connector. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to <u>Special Tools</u> .

Engine Oil Pressure Sensor and/or Switch Replacement (LF3)

Callout	Component Name
Preliminary Procedure Remove the front compartment lower noise shield. Refer to <u>Front Compartment Lower Noise Shield Replacement (AWD)</u> , <u>Front Compartment Lower Noise Shield Replacement (RWD)</u> .	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the oil pressure sensor electrical connector. Tighten 20 N.m (15 lb ft) Special Tools EN-41712 Oil Pressure Switch Socket For equivalent regional tools, refer to <u>Special Tools</u> .

Engine Oil Cooler Shield Replacement

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Callout	Component Name
Preliminary Procedures	
Remove the engine oil cooler adapter assembly. Refer to <u>Engine Oil Cooler Adapter Replacement</u> .	
1	Engine Oil Cooler Shield Bolts (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 (89 lb in)
2	Engine Oil Cooler Shield
3	Engine Oil Cooler and Adapter Assembly