2012 Engine

Engine Mechanical - 3.6L - Repair Instructions - On Vehicle - Acadia, Enclave And Traverse

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

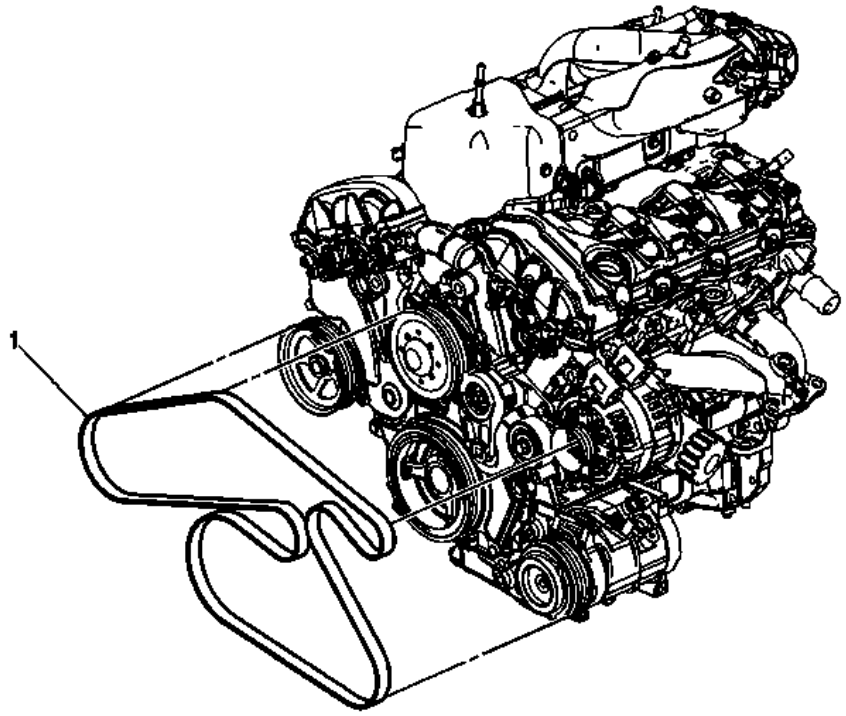

Fig. 1: Identifying Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Replacement

Callout	Component Name
	Preliminary Procedure **1. Remove the front wheelhouse liner. Refer to FRONT WHEELHOUSE FRONT LINER REPLACEMENT (ENCLAVE - ACADIA) or FRONT WHEELHOUSE FRONT LINER REPLACEMENT (TRAVERSE) or FRONT WHEELHOUSE REAR LINER REPLACEMENT (TRAVERSE) .** **2. Rotate the drive belt tensioner clockwise to release the drive belt tension.** **3. Slide the drive belt off of the belt idler pulley.** **4. Slowly release the drive belt tensioner.**
1	Drive Belt

DRIVE BELT TENSIONER REPLACEMENT

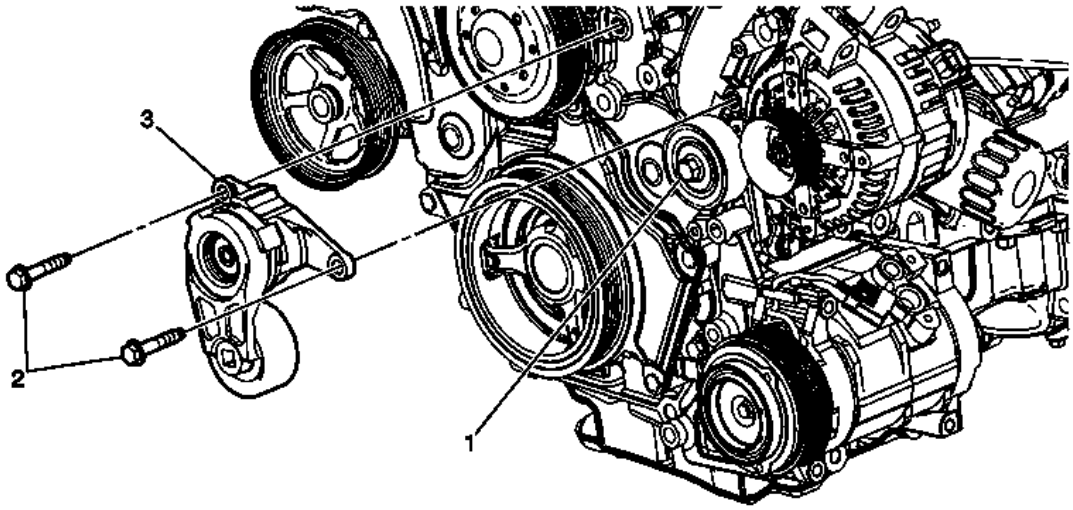

Fig. 2: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the right engine strut mount. Refer to **Engine Mount Strut Replacement - Right Side**. 2. Remove the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**. 3. Remove the drive belt. Refer to **Drive Belt Replacement**.	
1	Idler Pulley Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 50 N.m (37 lb ft)
2	Tensioner Bolt **Tighten** 25 N.m (18 lb ft)

3	Tensioner **TIP:** Remove wire harness retainer from tensioner.

DRIVE BELT IDLER PULLEY REPLACEMENT

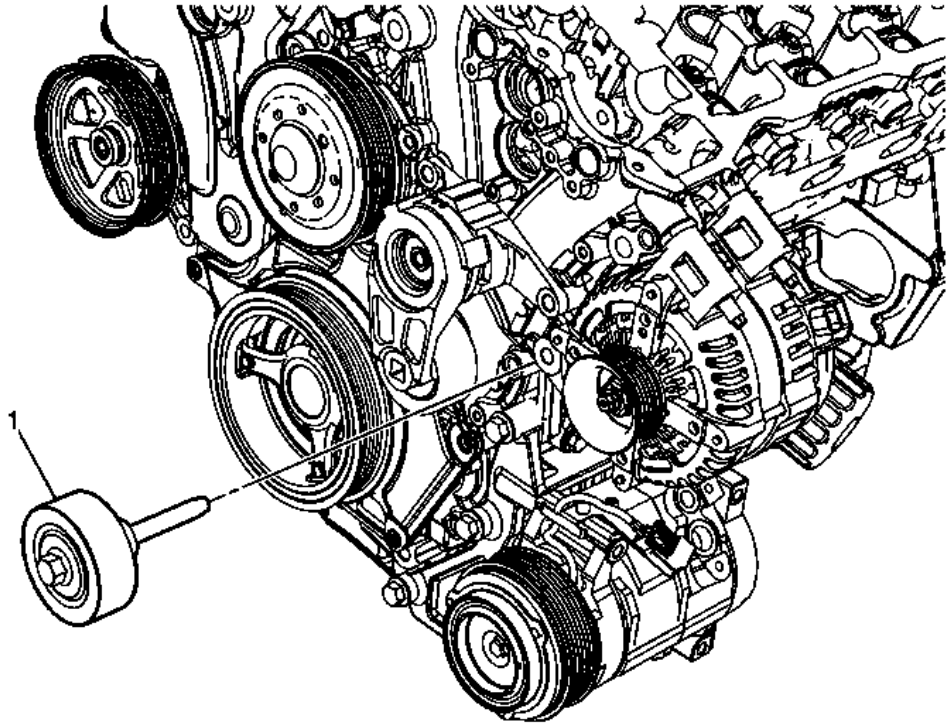

Fig. 3: Identifying Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the right engine strut mount. Refer to **Engine Mount Strut Replacement - Right Side**. 2. Remove the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**. 3. Remove the generator. Refer to **Generator Replacement** .	
1	Idler Pulley Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 50 N.m (37 lb ft)

ENGINE SUPPORT FIXTURE

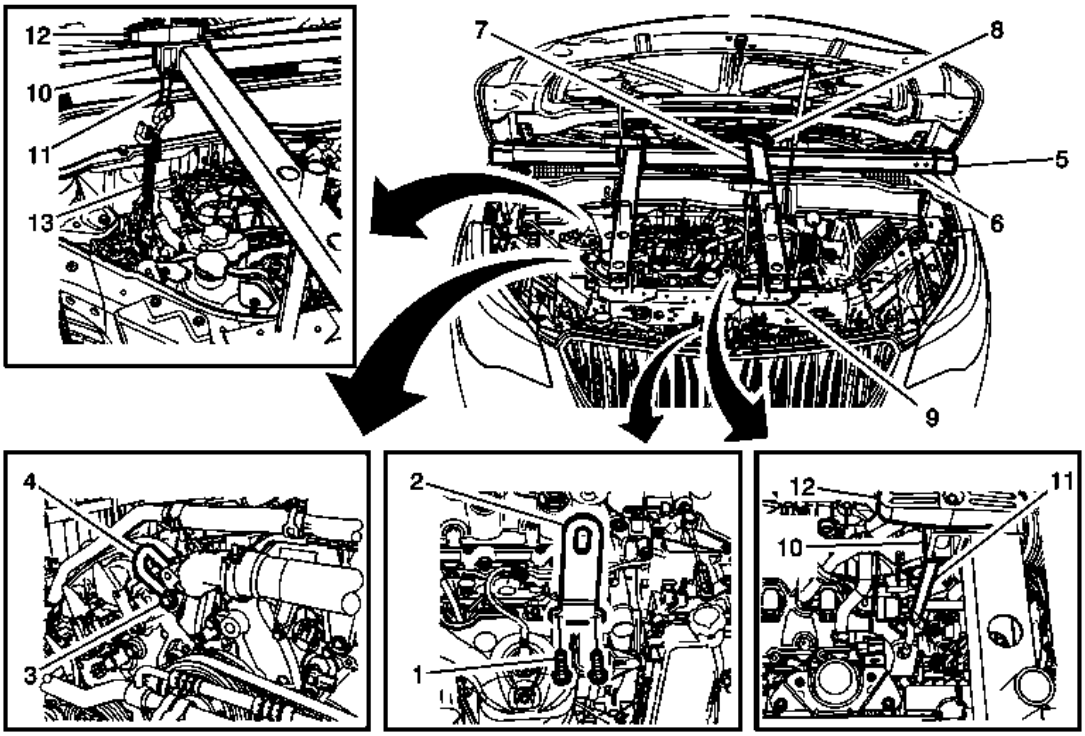

Fig. 4: Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name

Preliminary Procedures

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Remove the front compartment sight shields. Refer to **Front Compartment Sight Shields Replacement (Traverse)** , **Front Compartment Sight Shields Replacement (Acadia)** , **Front Compartment Sight Shields Replacement (Enclave)** .

Special Tools

- **EN-46114-1** Engine Lift Bracket
- **EN-36857** Engine Lift Bracket
- **EN-28467-301** Engine Support Fixture 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	Exhaust Manifold Bolt (Qty:2)
2	**EN-46114-1** Engine Lift Bracket **Procedure** If the engine is not equipped with engine lift bracket, install engine lift bracket as shown and use exhaust manifold bolts to retain.
3	Timing Cover Bolt
4	**EN-36857** Engine Lift Bracket **Procedure** Install engine lift bracket as shown and use timing cover bolt to retain.
5	**EN-28467-301** Engine Support Fixture Adapters (Qty:2) **NOTE:** **The rubber pads need to be removed to allow adapters to seat on fender rail.**
6	**J-284678-518** Main Support Beam **Procedure** Install main support beam through engine support fixture adapters.
7	**EN-28467-2A** Radiator Tube Shelf Assembly (Qty: 2) **Procedure** Place radiator shelf tube on top of main support beam.
8	**EN-28467-1A** Cross Bracket (Qty: 2) **Procedure** Tighten cross bracket to retain radiator tube shelf tube to main support beam.
9	**EN-28467-4A** Front Support Assembly (Qty: 2) **Procedure** Place front support assembly through radiator tube shelf and pin at proper height.
10	**J-28467-6A** Bracket Assembly (Qty: 2)
11	**EN-28467-8A** Hook Assembly (Qty: 2)
12	**EN-28467-34** Lift Hook Wing Nut and Washer (Qty: 2)
13	Hook and Chain **NOTE:** **Chain is used to provide extra length.**

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**.

2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
   - The hard rubber is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.
   - The rubber is split through the center of the engine mount.
   - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Front Mount Replacement**, , **Engine Rear Mount Replacement**, or **Transmission Mount Replacement - Left Side** .

ENGINE FRONT MOUNT REPLACEMENT

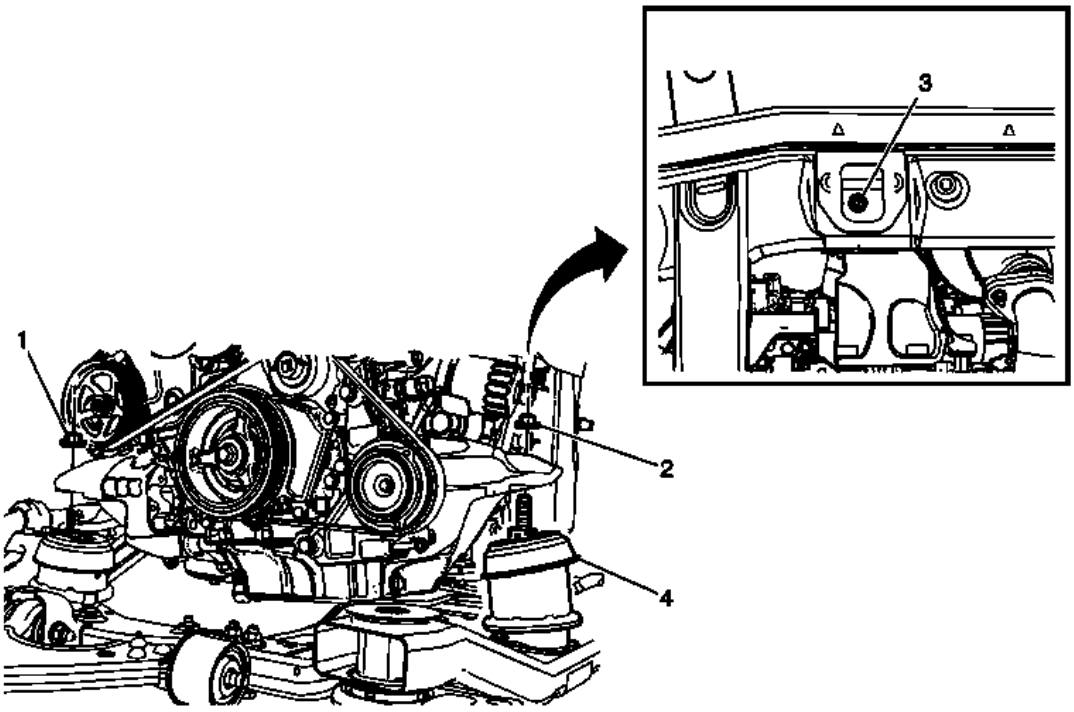

Fig. 5: Identifying Engine Front Mount Assembly
Courtesy of GENERAL MOTORS COMPANY

Engine Front Mount Replacement

Callout	Component Name
Preliminary Procedures 1. Support the engine. Refer to **Engine Support Fixture**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
	Rear Upper Engine Mount Nut

1	**CAUTION:** **Refer to Fastener Caution** **Procedure** 1. Remove and discard the rear engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. **Tighten** 60 N.m (44 lb ft)
2	Front Upper Engine Mount Nut **Procedure** 1. Remove and discard the front engine mount nut. 2. Disconnect the active engine mount vacuum line, if equipped. 3. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. **Tighten** 90 N.m (66 lb ft)
3	Front Lower Engine Mount Nut **Procedure** 1. Remove and discard the lower front engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. **Tighten** 75 N.m (55 lb ft)
4	Engine Mount **TIP:** To remove the engine mount, use the engine support fixture to raise engine.

ENGINE REAR MOUNT REPLACEMENT

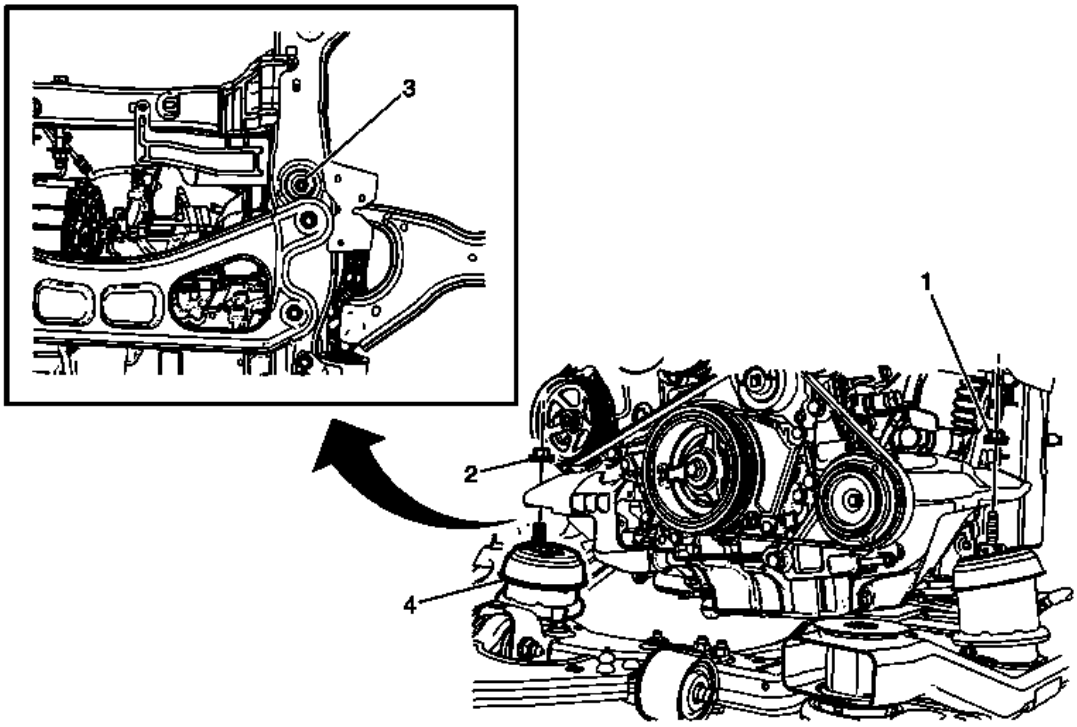

Fig. 6: Identifying Engine Rear Mount Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Engine Rear Mount Replacement

Callout	Component Name
Preliminary Procedures 1. Support the engine. Refer to **Engine Support Fixture**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Front Upper Engine Mount Nut **CAUTION:** **Refer to Fastener Caution** **Procedure** 1. Remove and discard the engine mount nut. 2. Disconnect the active engine mount vacuum line, if equipped. 3. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.

	Tighten 90 N.m (66 lb ft)
2	Rear Upper Engine Mount Nut **Procedure** 1. Remove and discard the engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. **Tighten** 60 N.m (44 lb ft)
3	Rear Lower Engine Mount Nut **Procedure** 1. Remove and discard the engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **TIP:** The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. **Tighten** 75 N.m (55 lb ft)
4	Engine Mount **TIP:** To remove the engine mount, use the engine support fixture to raise engine.

ENGINE FRONT MOUNT BRACKET REPLACEMENT

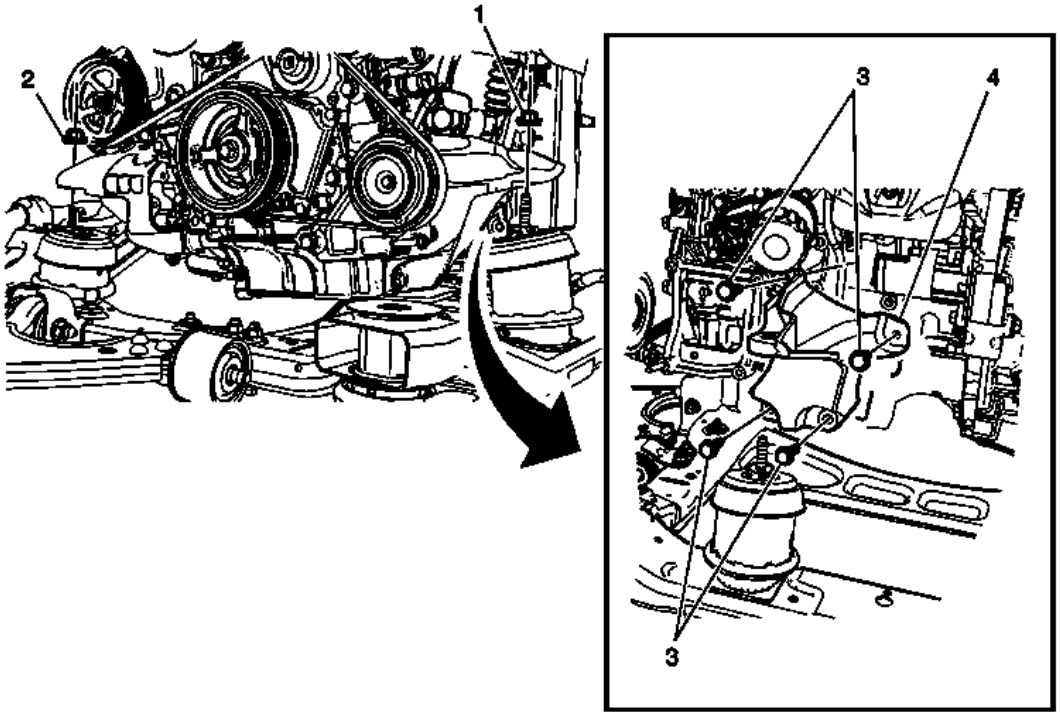

Fig. 7: Engine Front Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

Engine Front Mount Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the left side catalytic converter. Refer to **Catalytic Converter Replacement - Left Side** 2. Support the engine. Refer to **Engine Support Fixture**.	
1	Front Engine Mount Upper Nut **CAUTION:** **Refer to Fastener Caution** **Procedure** 1. Remove and discard front engine mount upper nut. 2. Allow adhesive on new engine mount nuts to cure for 24 hours after replacement. • Use engine support fixture to raise engine. • The engine mount nuts must be replaced once removed. **Tighten**

	90 N.m (66 lb ft)
2	Rear Engine Mount Upper Nut **Procedure** 1. Remove and discard rear engine mount upper nut. 2. Allow adhesive on new engine mount nuts to cure for 24 hours after replacement. • Use engine support fixture to raise engine. • The engine mount nuts must be replaced once removed. **Tighten** 60 N.m (44 lb ft)
3	Front Engine Mount Bracket Bolt **Tighten** 58 N.m (43 lb ft)
4	Front Engine Mount Bracket **TIP:** To remove engine mount bracket, use engine support fixture to raise engine.

ENGINE REAR MOUNT BRACKET REPLACEMENT (FRONT WHEEL DRIVE)

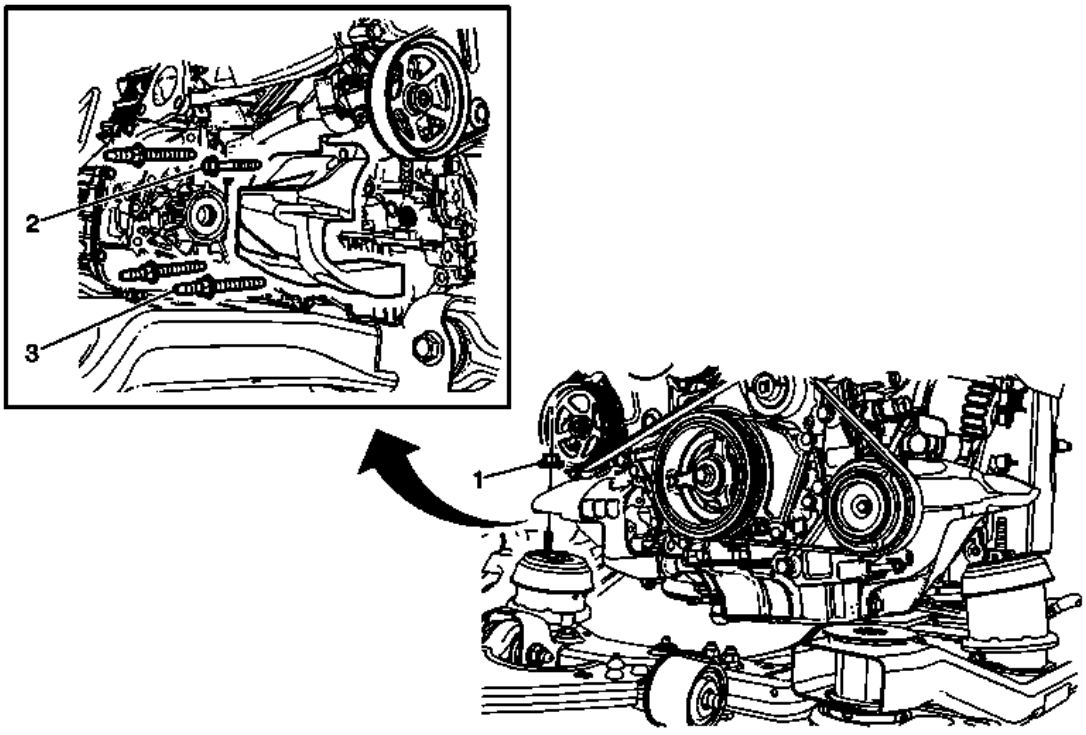

Fig. 8: Identifying Engine Rear Mount Bracket (Front Wheel Drive)
Courtesy of GENERAL MOTORS COMPANY

Engine Rear Mount Bracket Replacement (Front Wheel Drive)

Callout	Component Name
Preliminary Procedures 1. If equipped with FWD, remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** . 2. Support the engine. Refer to **Engine Support Fixture**. 3. Remove the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement** .	
1	Rear Engine Mount Upper Nut **CAUTION:** **Refer to Fastener Caution** **Procedure** 1. Remove and discard engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . • The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement. • Use engine support fixture to raise engine. **Tighten** 60 N.m (44 lb ft)
2	Rear Engine Mount Bracket Bolt **Tighten** 22 N.m (16 lb ft)
3	Rear Engine Mount Bracket Bolt **Tighten** 58 N.m (43 lb ft)

ENGINE REAR MOUNT BRACKET REPLACEMENT (ALL WHEEL DRIVE)

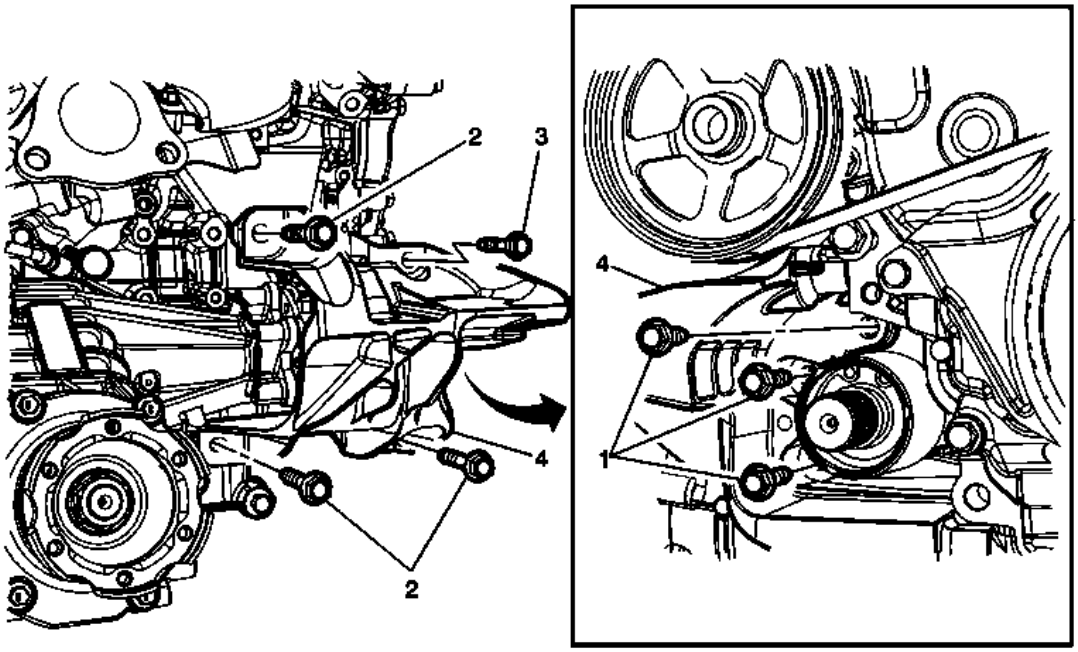

Fig. 9: Engine Mount Bracket & Components (All Wheel Drive)
Courtesy of GENERAL MOTORS COMPANY

Engine Rear Mount Bracket Replacement (All Wheel Drive)

Callout	Component Name
Preliminary Procedures 1. Remove the right front drive axle. Refer to **Front Wheel Drive Shaft Replacement** . 2. Remove the rear engine mount. Refer to **Engine Rear Mount Replacement**.	
1	Engine Mount Bracket to Transfer Case Retainer (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 22 N.m (16 lb ft)
2	Engine Mount Bracket to Engine Block (Qty: 3) **Tighten** 58 N.m (43 lb ft)
3	Engine Mount Bracket to Engine Block **Tighten** 22 N.m (16 lb ft)
4	Engine Mount Bracket

ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE

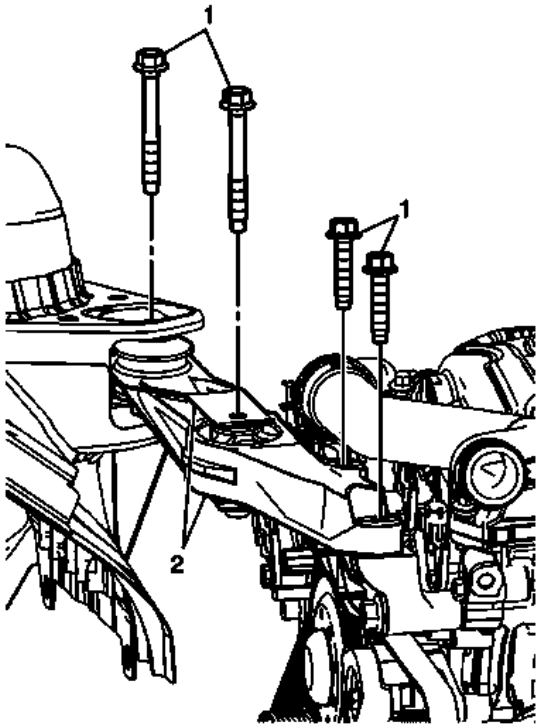

Fig. 10: View Of Right Side Engine Mount Strut
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Strut Replacement - Right Side

Callout	Component Name
Preliminary Procedure 1. Remove the radiator inlet hose from the water outlet tube. Refer to **Radiator Inlet Hose Replacement** . 2. Remove the underhood electrical center. Refer to **Underhood Electrical Center or Junction Block Replacement** . 3. Remove the wire harness retainer from the underhood electrical center bracket and reposition the harness. 4. Remove the underhood electrical center bracket bolts and bracket.	
1	Engine Mount Strut Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)

2	Engine Mount Strut

ENGINE MOUNT STRUT BRACKET REPLACEMENT - RIGHT SIDE

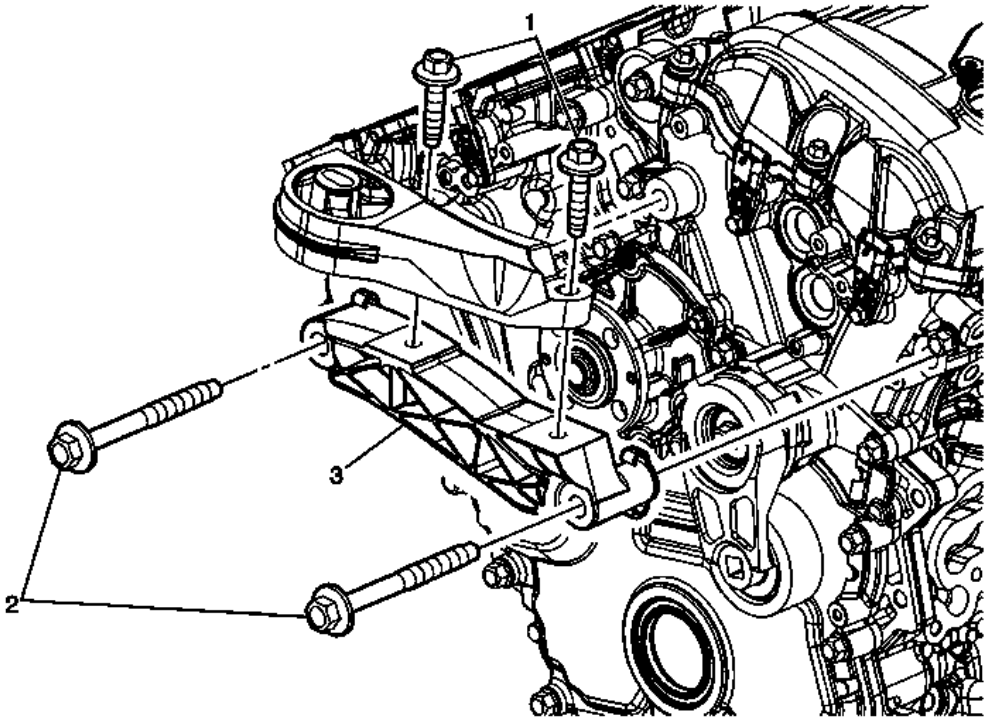

Fig. 11: Identifying Right Side Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Strut Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedure Remove the right engine mount strut mount. Refer to **Engine Mount Strut Replacement - Right Side**.	
1	Engine Mount Strut Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Engine Mount Strut Bracket Bolt **Tighten** 90 N.m (66 lb ft)
3	Engine Mount Strut Bracket

FUEL INJECTOR SIGHT SHIELD REPLACEMENT

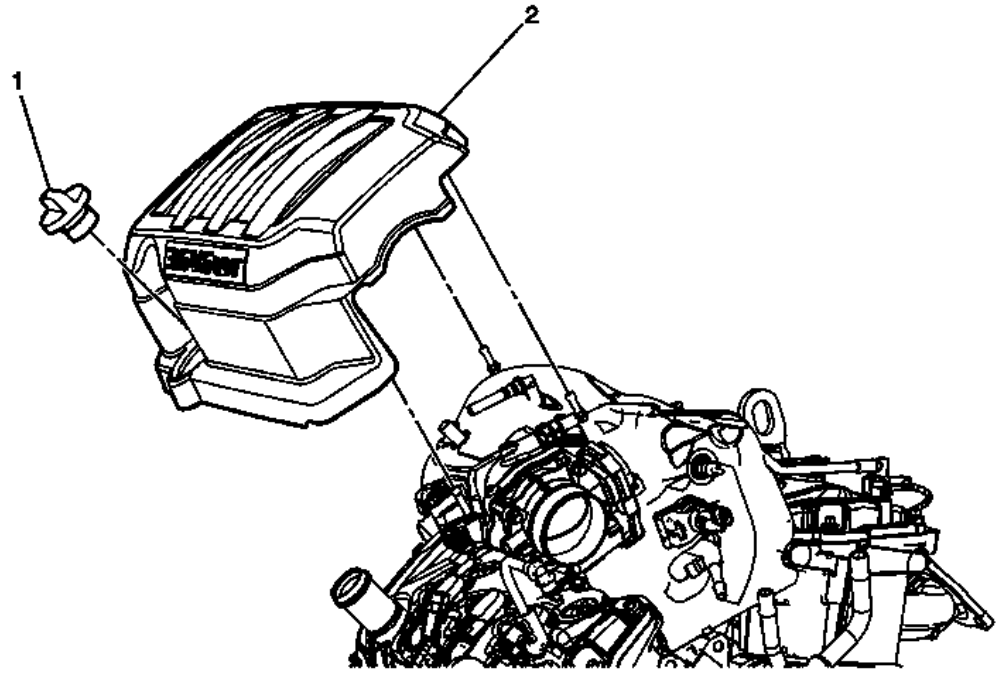

Fig. 12: View Of Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS COMPANY

Fuel Injector Sight Shield Replacement

Callout	Component Name
1	Oil Fill Cap
2	Fuel Injector Sight Shield **Procedure** Lift upward to remove sight shield from ballstuds.

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT

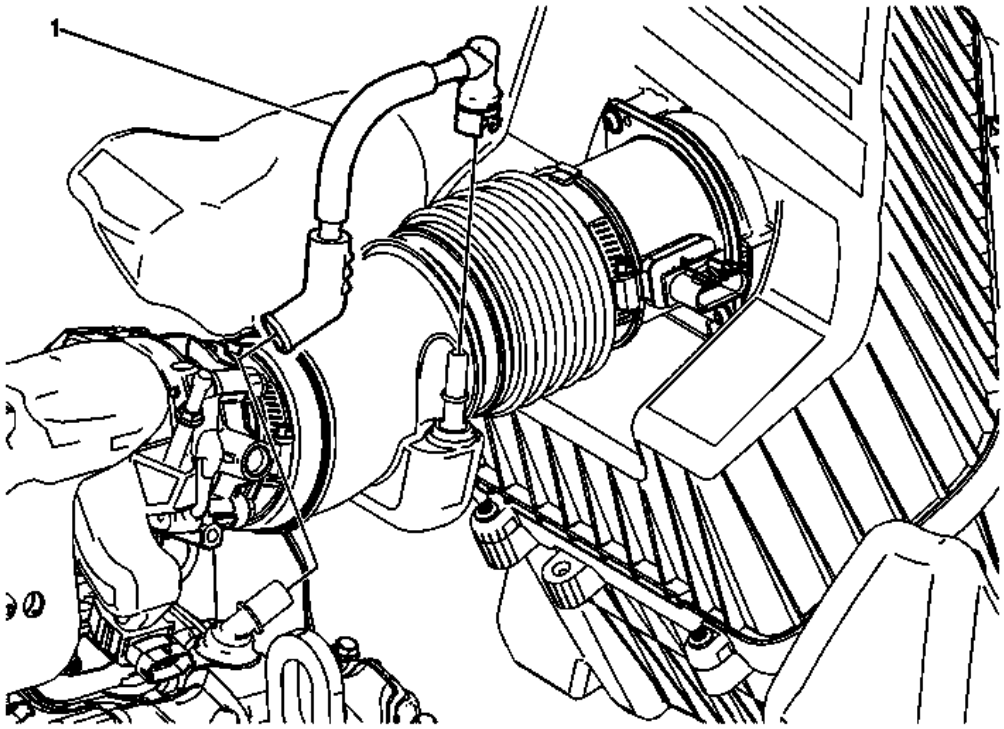

Fig. 13: Identifying Front Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Tube Replacement - Front

Callout	Component Name
Preliminary Procedure Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.	
1	Positive Crankcase Ventilation Tube **Procedure** Disconnect the PCV tube quick disconnect. Refer to **Plastic Collar Quick Connect Fitting Service** .

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - REAR

Removal Procedure

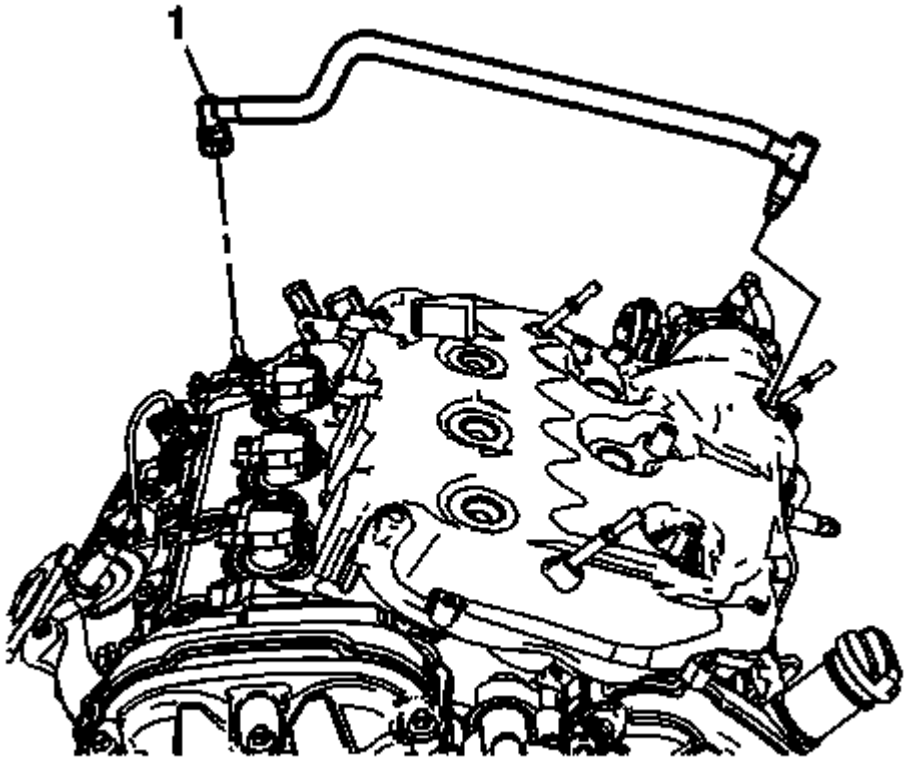

Fig. 14: View Of Rear Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Disconnect the positive crankcase ventilation (PCV) fresh air pipe (1) from the intake manifold.
3. Disconnect the PCV air pipe from the camshaft cover.

Installation Procedure

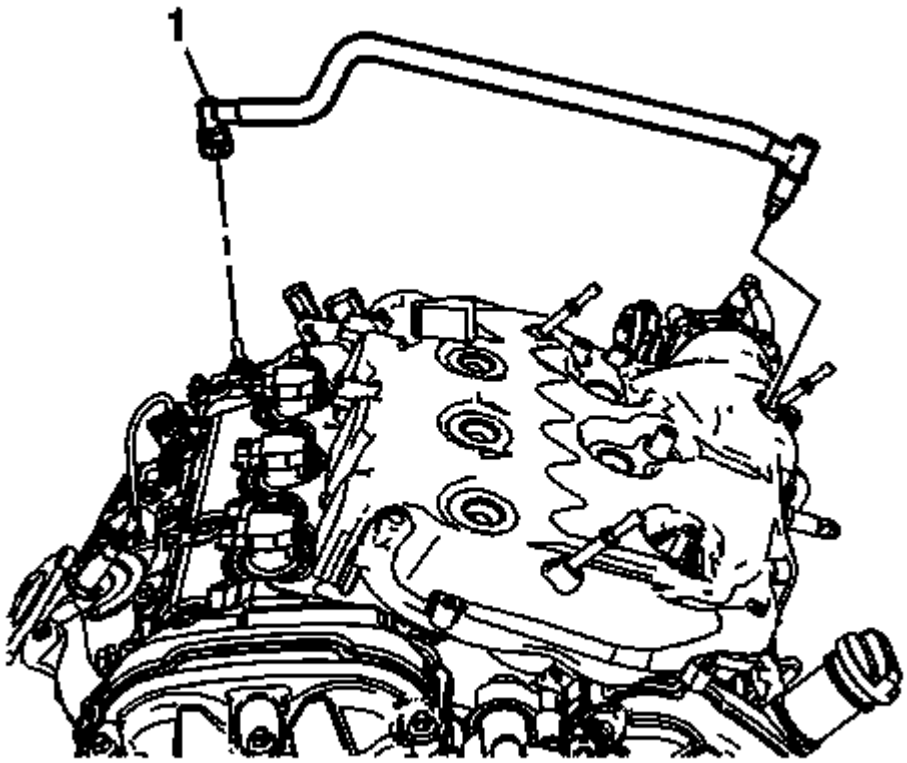

Fig. 15: View Of Rear Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

1. Connect the PCV air pipe (1) to the camshaft cover valve.
2. Connect the PCV air pipe to the intake manifold.
3. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Disconnect the brake booster vacuum hose from the intake manifold.
5. Remove the rear positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Tube Replacement - Rear**.

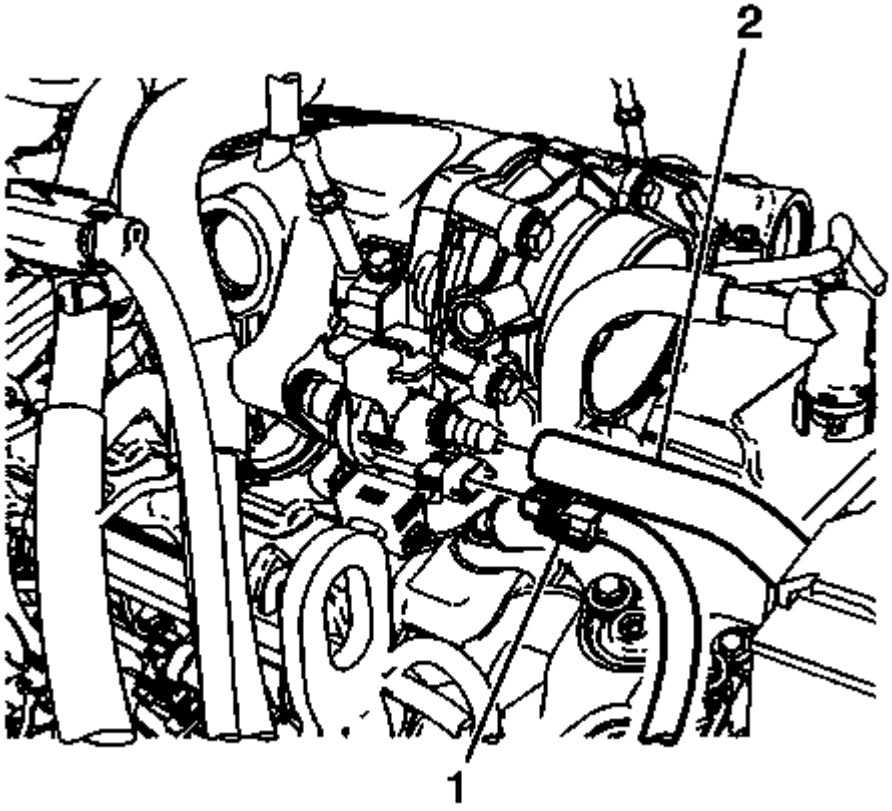

Fig. 16: Identifying Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the purge solenoid valve electrical connector (1).
7. Disconnect the purge line (2) from the purge solenoid valve.

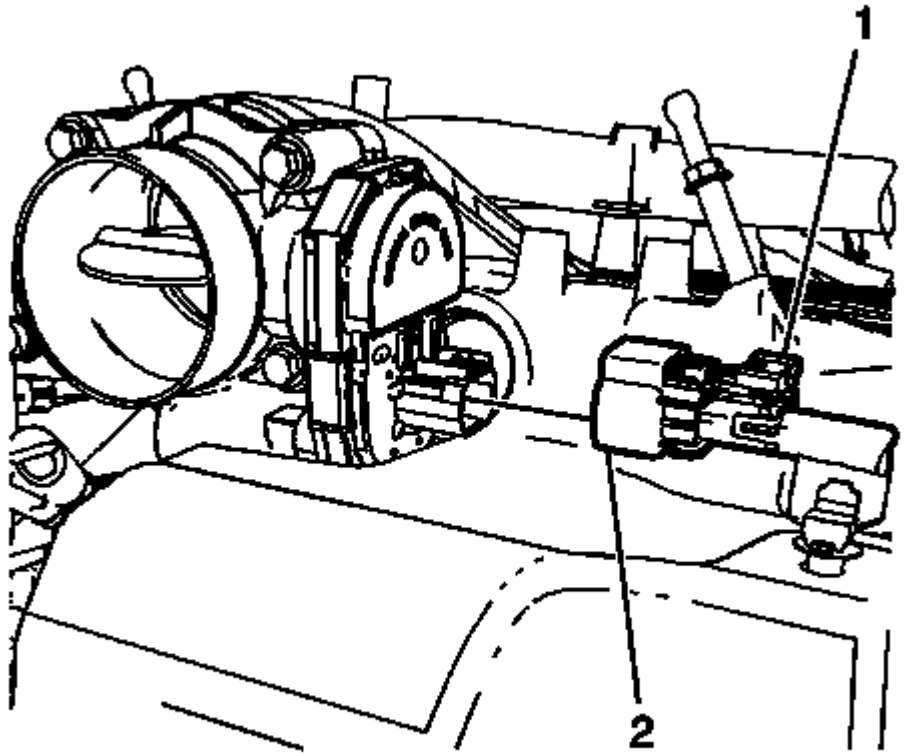

Fig. 17: Identifying Purge Solenoid Valve Electrical Connector Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Remove the electrical connector retainer (1).
9. Disconnect the throttle body electrical connector (2).
10. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .

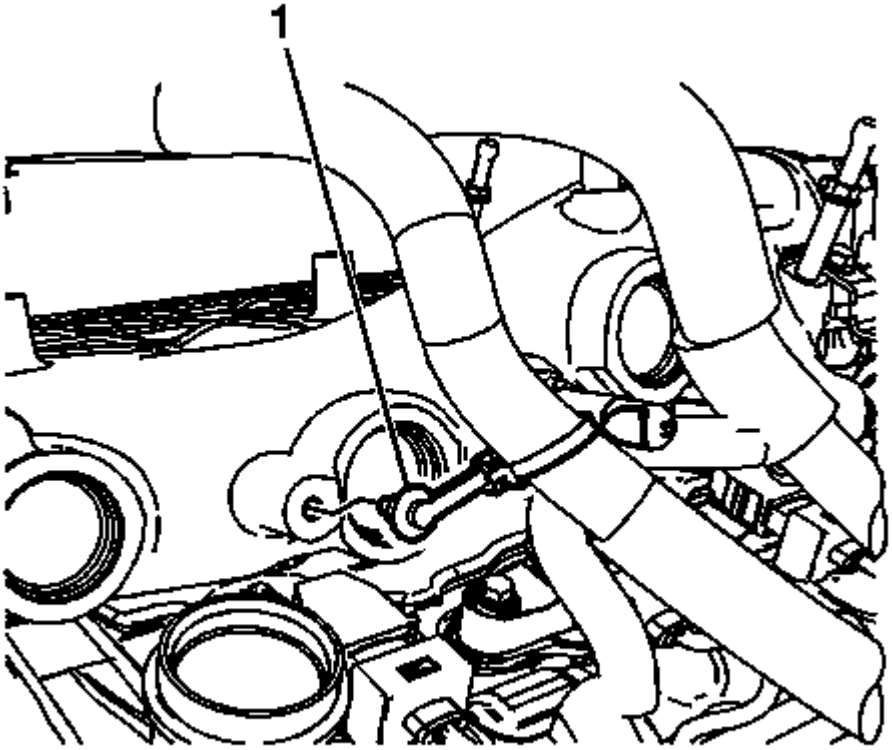

Fig. 18: Identifying Intake Manifold Wiring Harness Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

11. Remove the engine wiring harness retaining clip (1) from the side of the intake manifold.

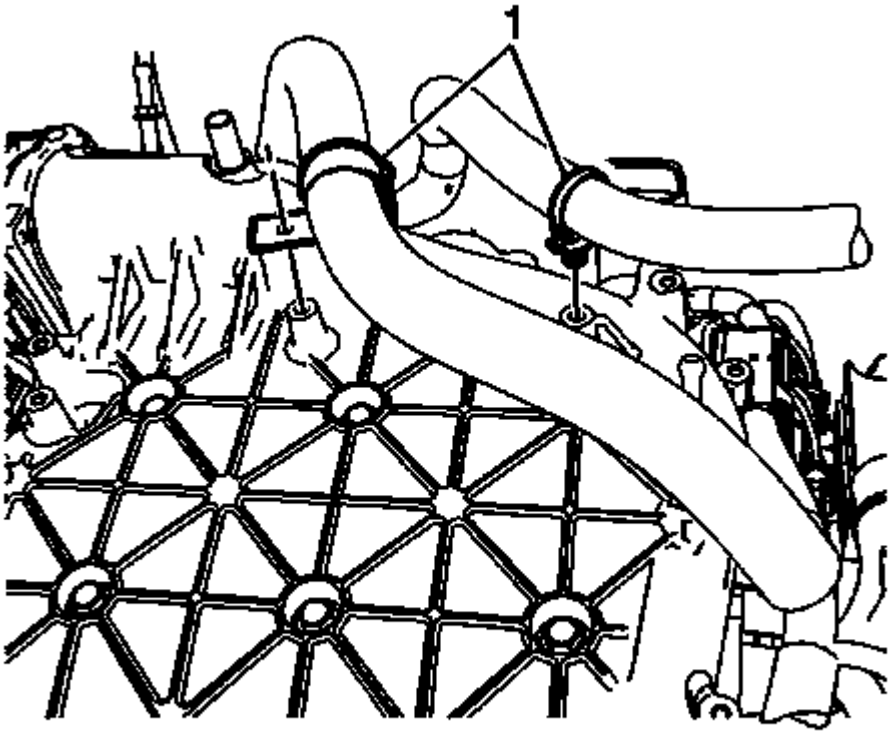

Fig. 19: View Of Wiring Harness Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the wiring harness retaining bolt.
13. Remove the engine wiring harness retaining clips (1) from the intake manifold.
14. Position the engine wiring harness aside.

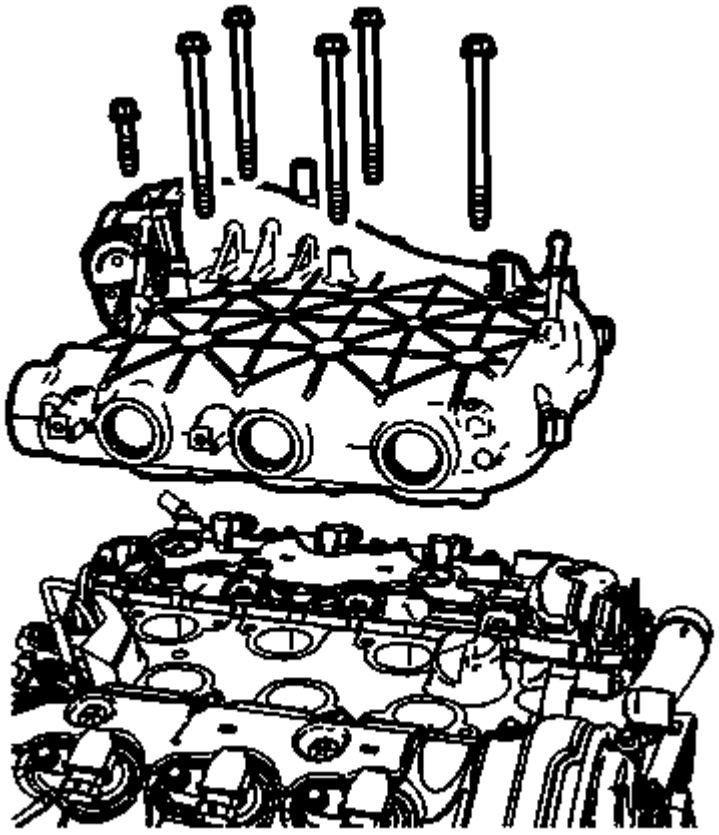

Fig. 20: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the intake manifold insulator.
16. Remove the intake manifold bolts.
17. Remove the intake manifold with the throttle body.
18. If the intake manifold is being replaced, disassemble the intake manifold. Refer to **Intake Manifold Disassemble** .
19. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

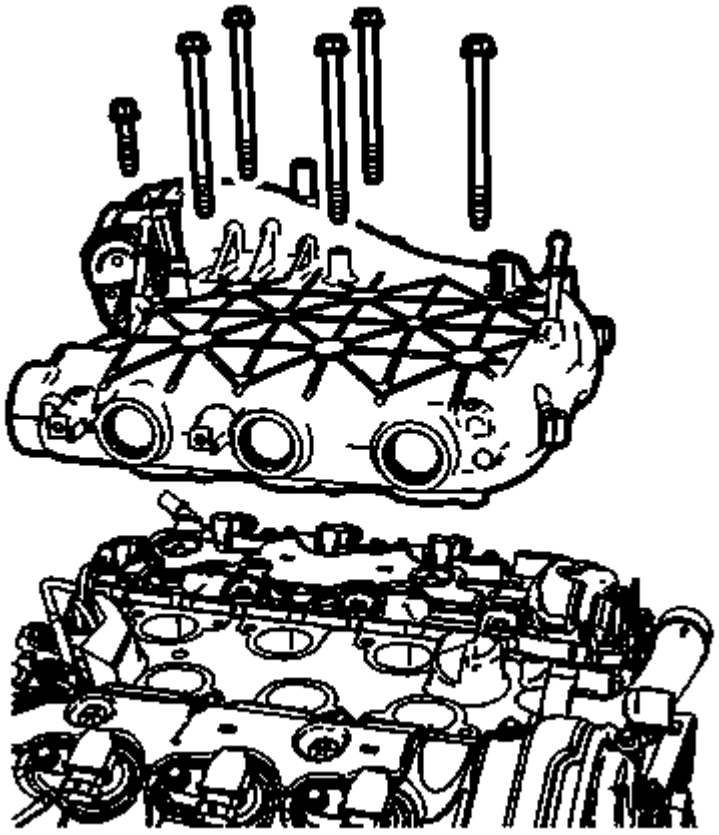

Fig. 21: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If the intake manifold is being replaced, assemble the intake manifold. Refer to **Intake Manifold Assemble** .
2. Install a NEW intake manifold gasket.
3. Install the intake manifold.

CAUTION: Refer to Fastener Caution

NOTE: Tighten the intake manifold bolts in an X pattern starting with the inside bolts and moving outward. .

4. Install the intake manifold bolts and tighten to 25 N.m (18 lb ft).

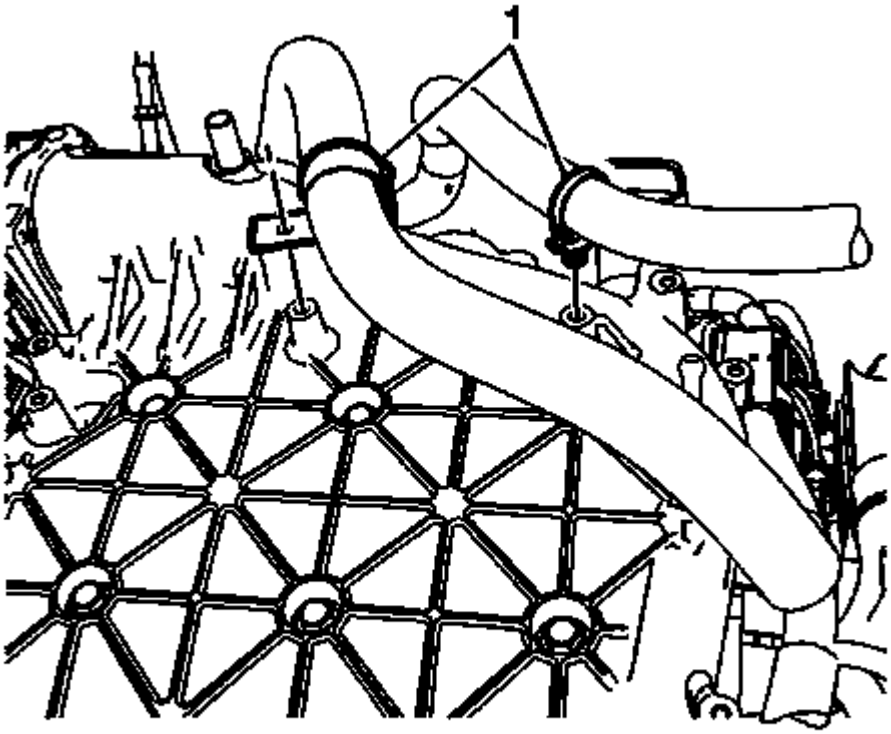

Fig. 22: View Of Wiring Harness Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Position the engine wiring harness in place.
6. Install the engine wiring harness retaining clips (1) to the intake manifold.

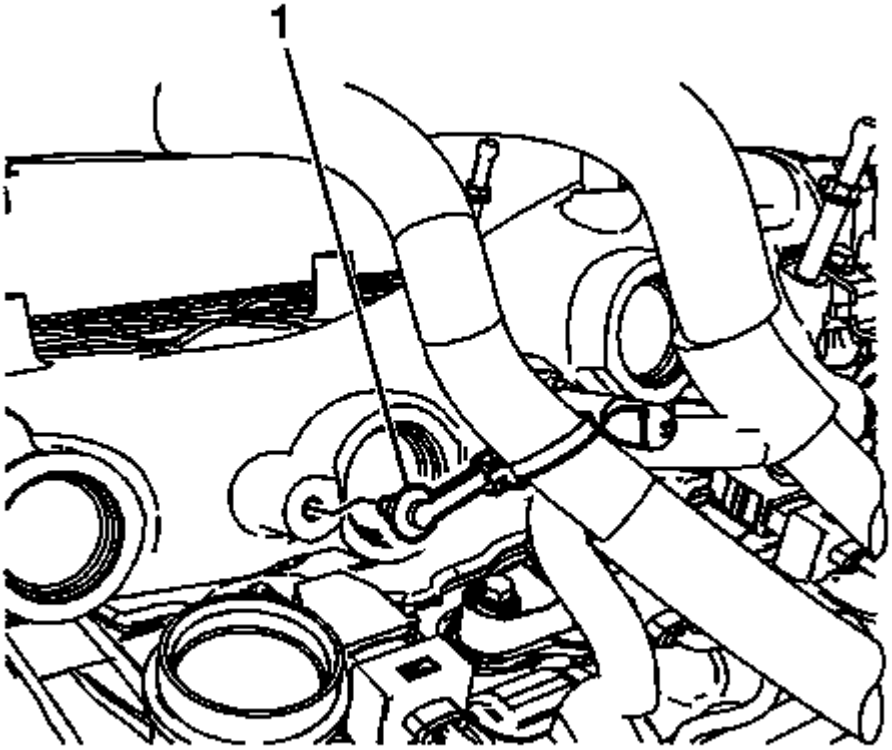

Fig. 23: Identifying Intake Manifold Wiring Harness Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

7. Install the engine wiring harness retaining clip (1) to the side of the intake manifold.

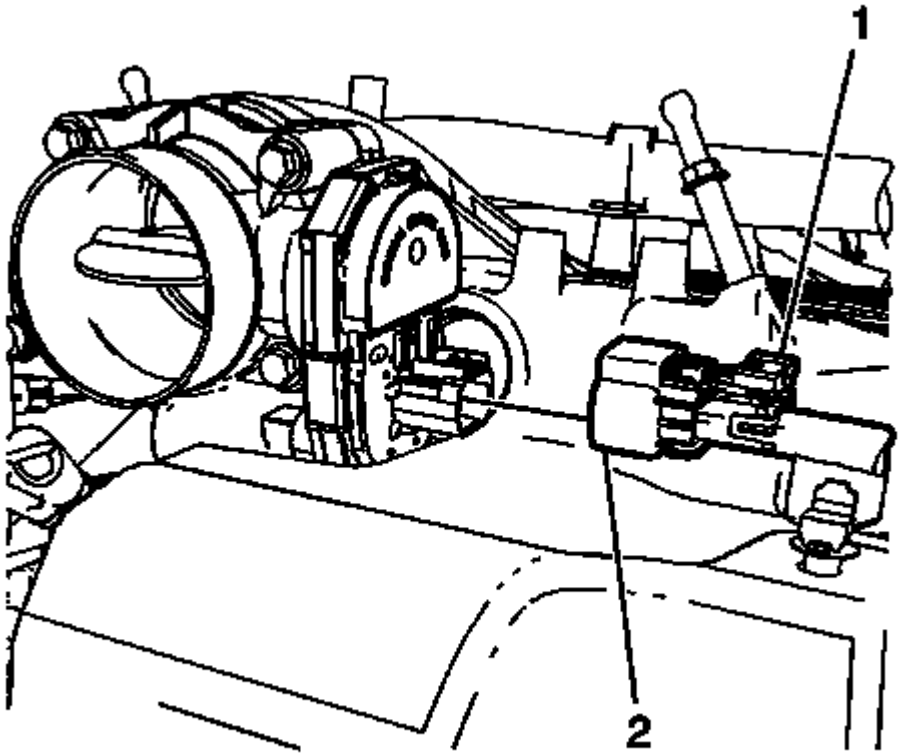

Fig. 24: Identifying Purge Solenoid Valve Electrical Connector Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .

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

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

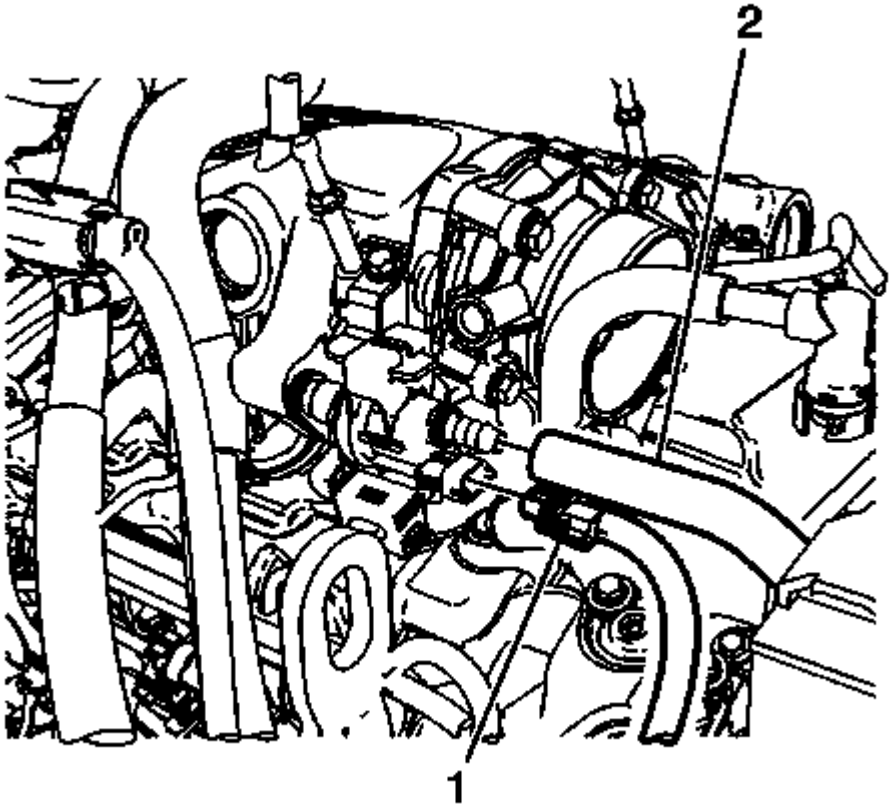

Fig. 25: Identifying Purge Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

11. Connect the purge line (2) to the purge solenoid valve.
12. Connect the purge solenoid valve electrical connector (1).
13. Install the rear positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Tube Replacement - Rear**.
14. Connect the brake booster vacuum hose to the intake manifold.
15. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
16. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

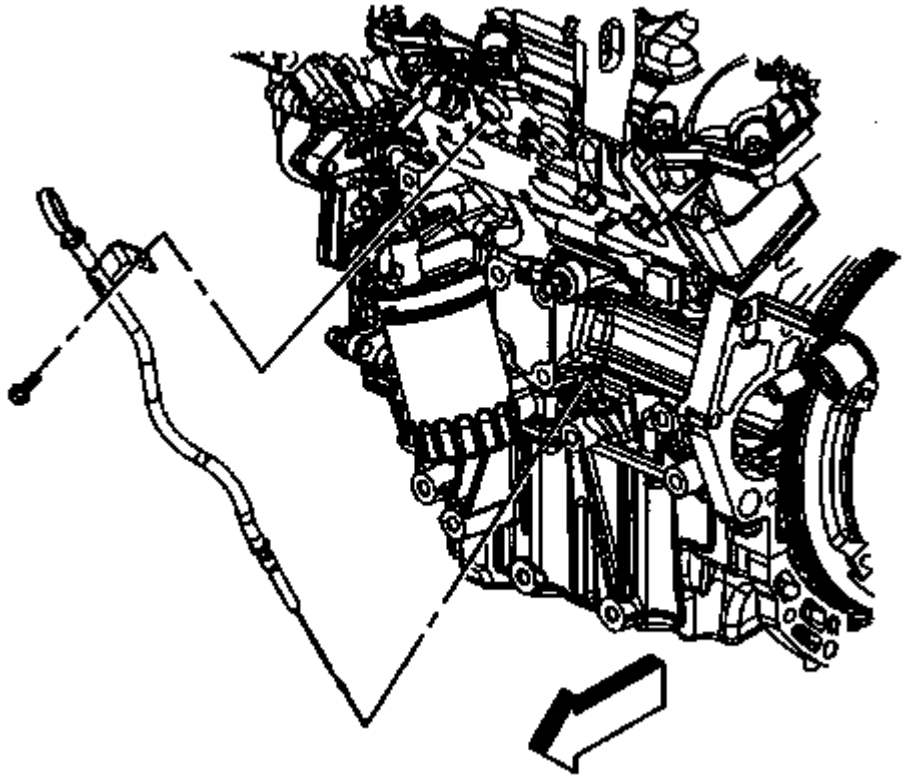

Fig. 26: Identifying Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the Fuel Injector Sight Shield. Refer to **Fuel Injector Sight Shield Replacement**
2. Remove the oil level indicator from the oil level indicator tube.
3. Remove the oil level indicator tube bolt.
4. Remove the oil level indicator tube up through the exhaust manifold.
5. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

Installation Procedure

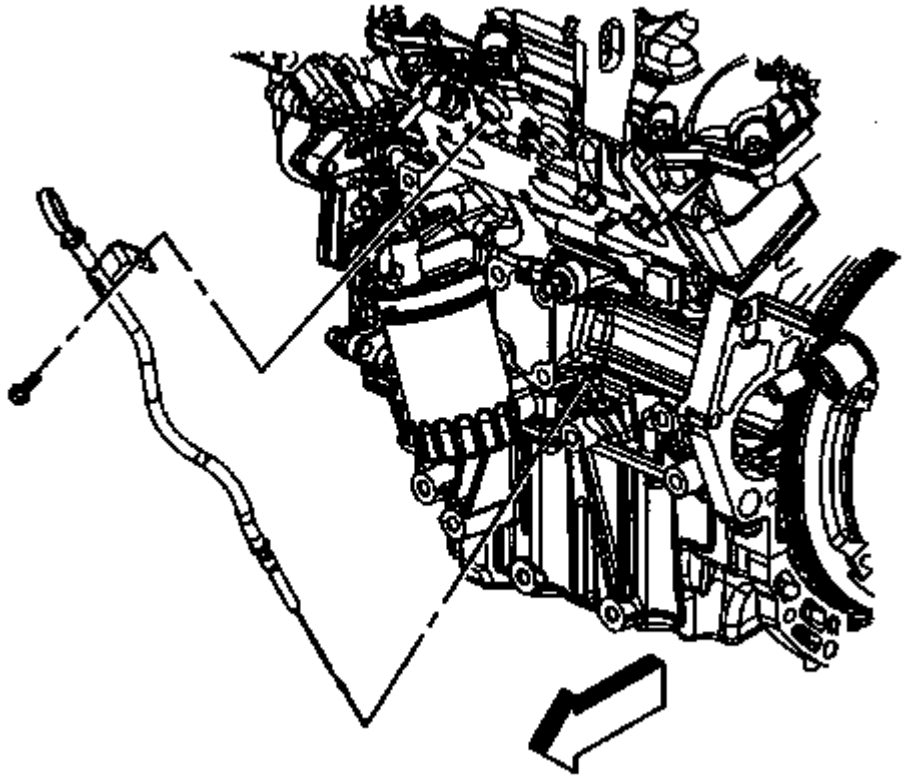

Fig. 27: Identifying Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install a new seal on the oil level indicator tube.
2. Install the oil level indicator tube.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bolt and tighten to 10 N.m (89 lb in).
4. Install the oil level indicator in the oil level indicator tube.
5. Install the Fuel Injector Sight Shield. Refer to **Fuel Injector Sight Shield Replacement**

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

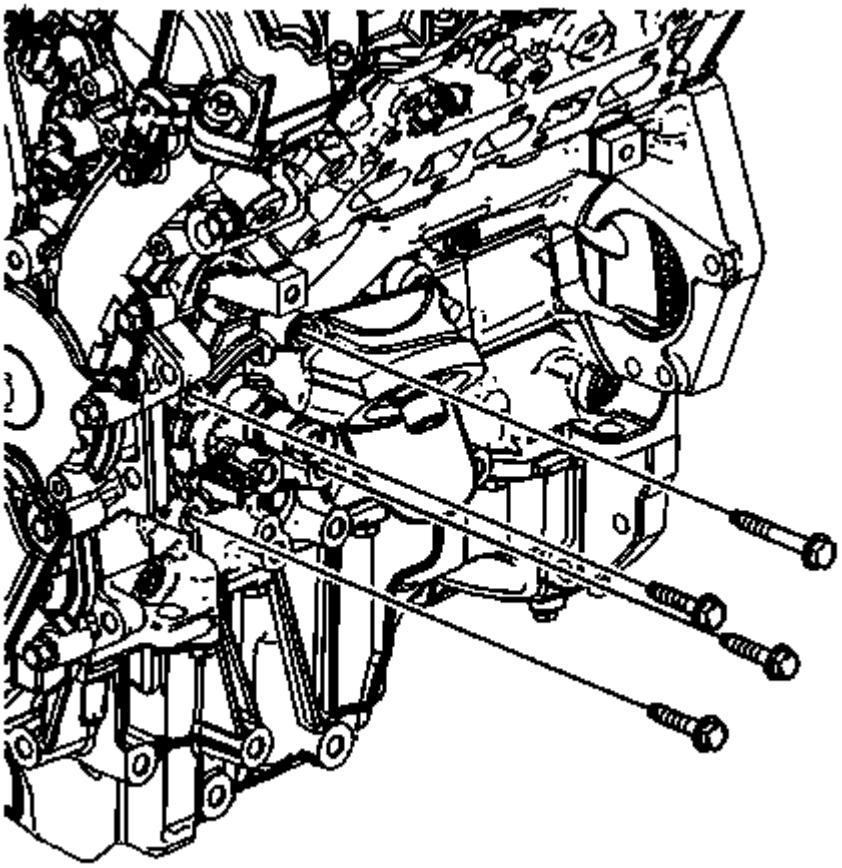

Fig. 28: Locating Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the generator. Refer to **Generator Replacement** .
2. Remove and properly dispose of the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
3. Disconnect the oil pressure sensor electrical connector.
4. Remove the oil filter adapter bolts from the engine block.

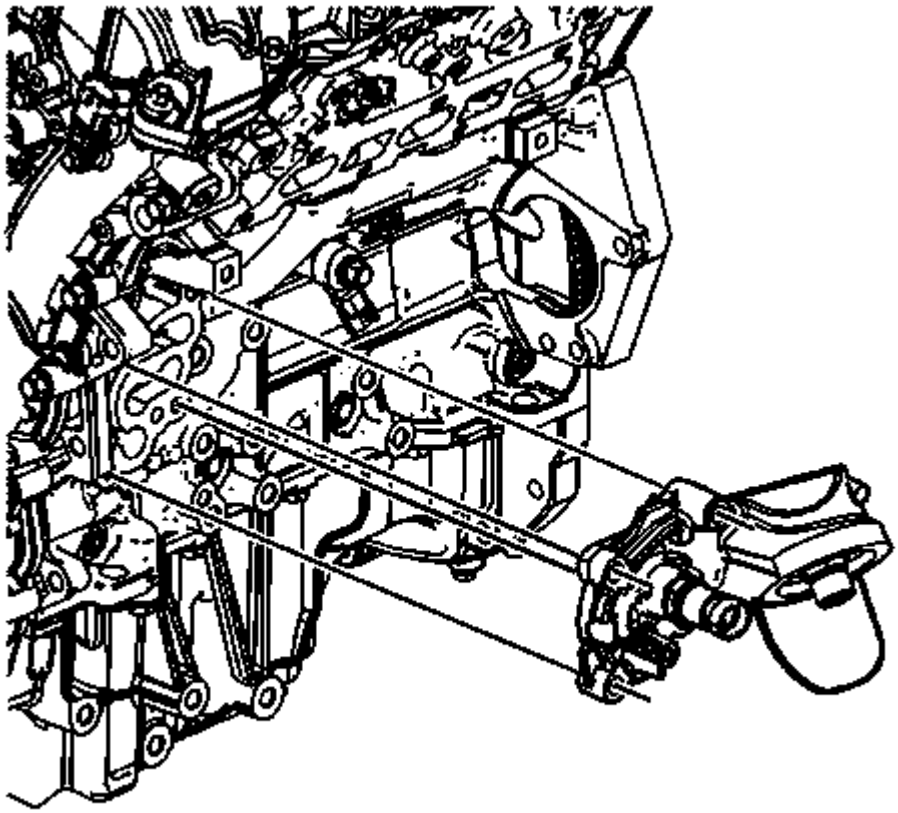

Fig. 29: Identifying Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil filter adapter.

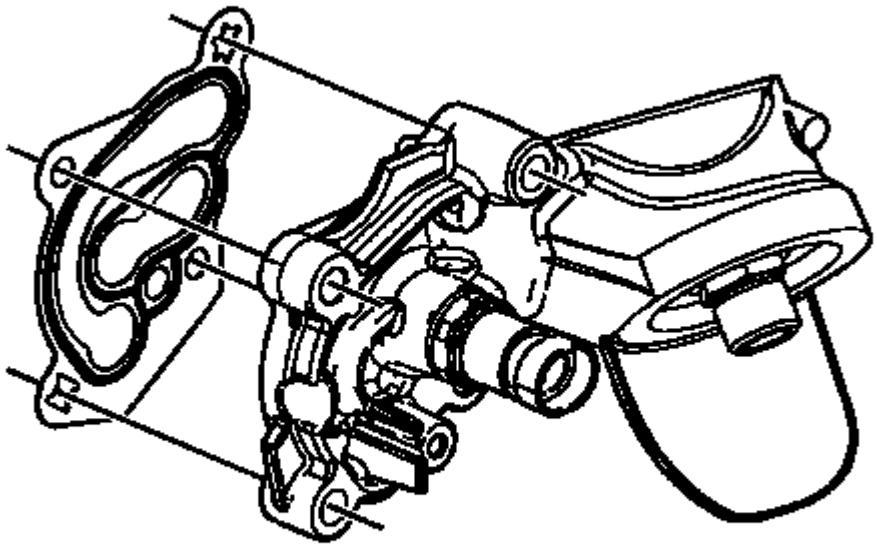

Fig. 30: View Of Oil Filter Adapter Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the oil filter adapter gasket.

Installation Procedure

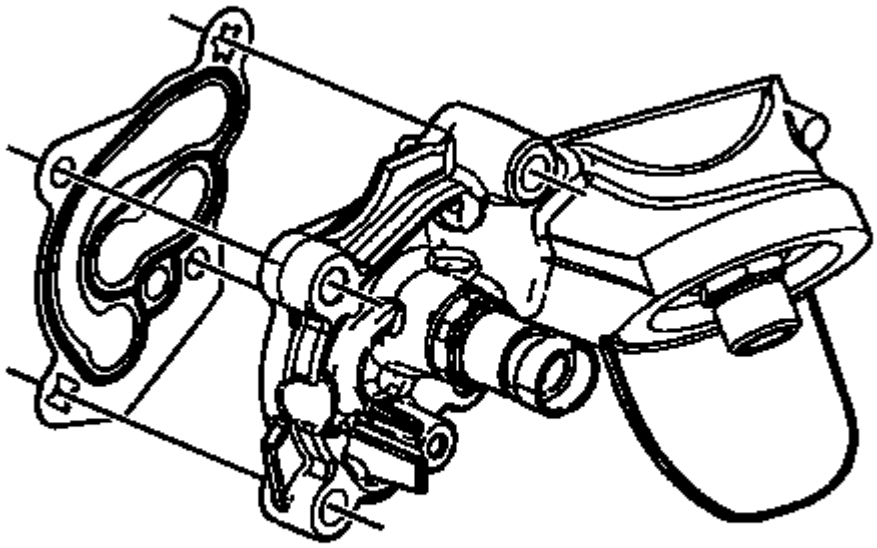

Fig. 31: View Of Oil Filter Adapter Gasket
Courtesy of GENERAL MOTORS COMPANY

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

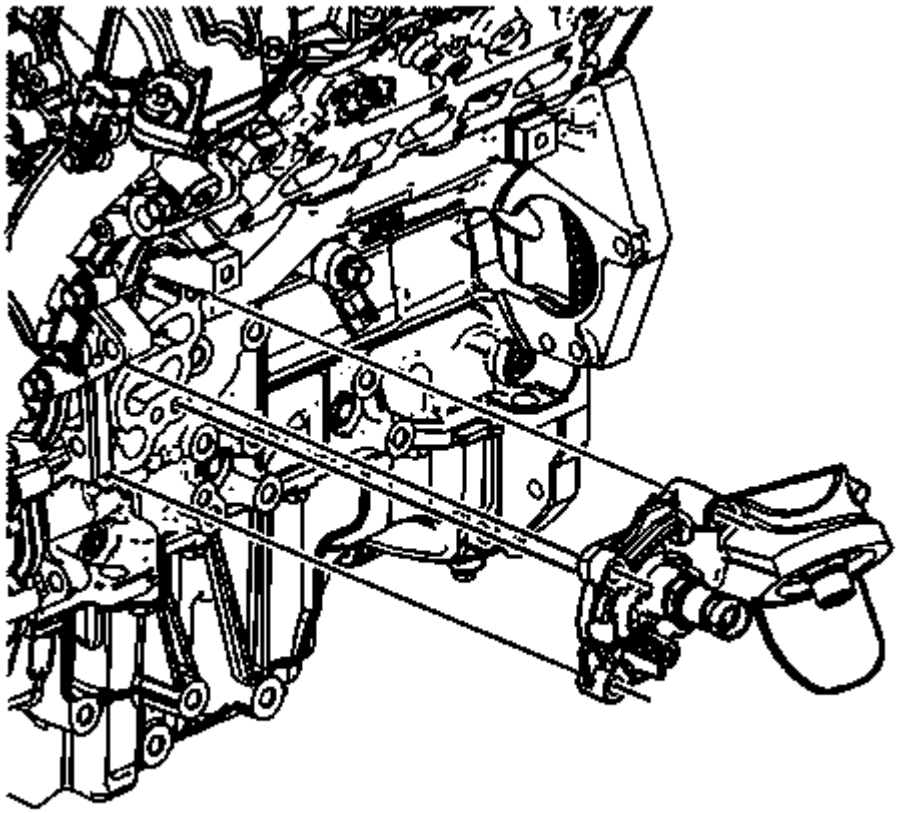

Fig. 32: Identifying Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

2. Place the oil filter adapter into position.

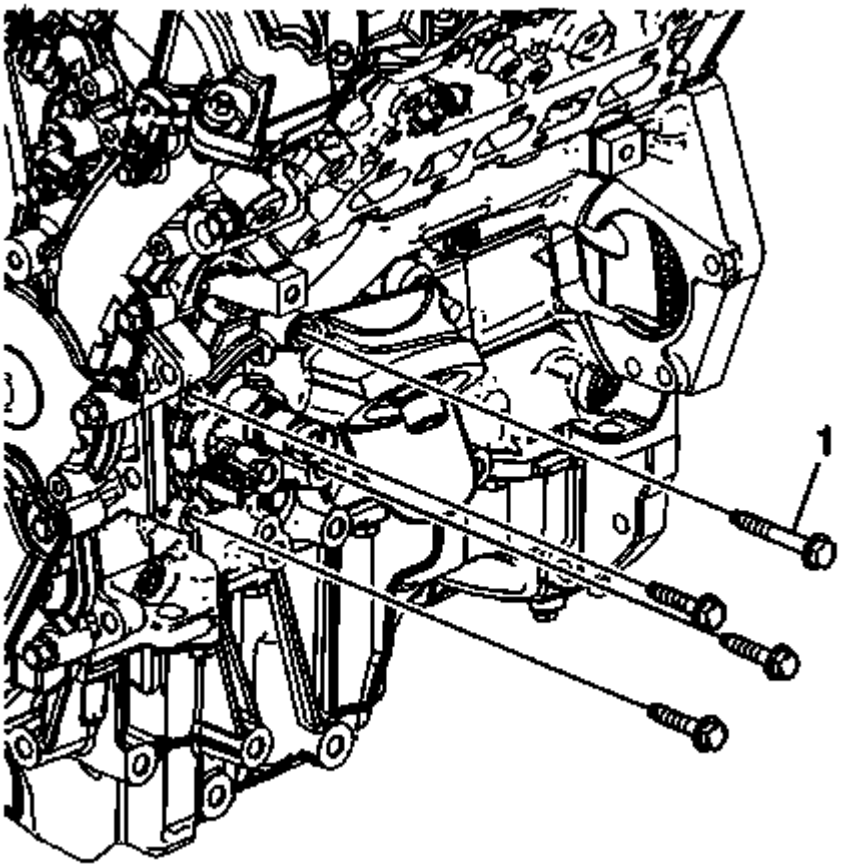

Fig. 33: Identifying Correct Position Of Longer Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the oil filter adapter bolts. Ensure the longer bolts (1) is installed in the upper rear position and tighten to 25 N.m (18 lb ft).
4. Install a NEW oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
5. Install the generator. Refer to **Generator Replacement** .

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN 46106** Flywheel Holding Tool
- **J 38416-2** Crankshaft Button
- **J 41816** Crankshaft Balancer Remover
- **J 41998-B** Crankshaft Balancer Installer

Removal Procedure

1. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the starter. Refer to **Starter Replacement** .

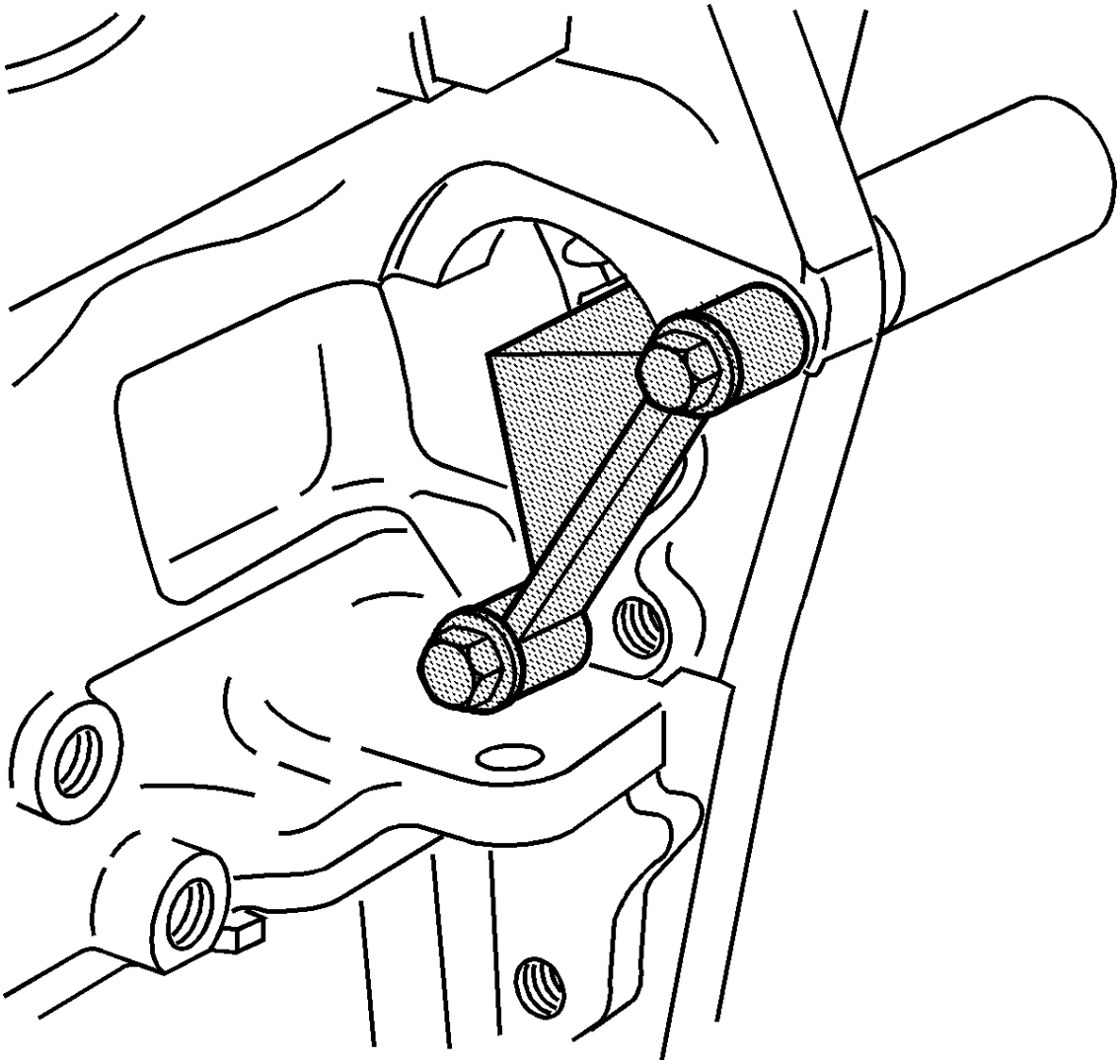

Fig. 34: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN 46106** flywheel holding tool through the starter mounting hole.

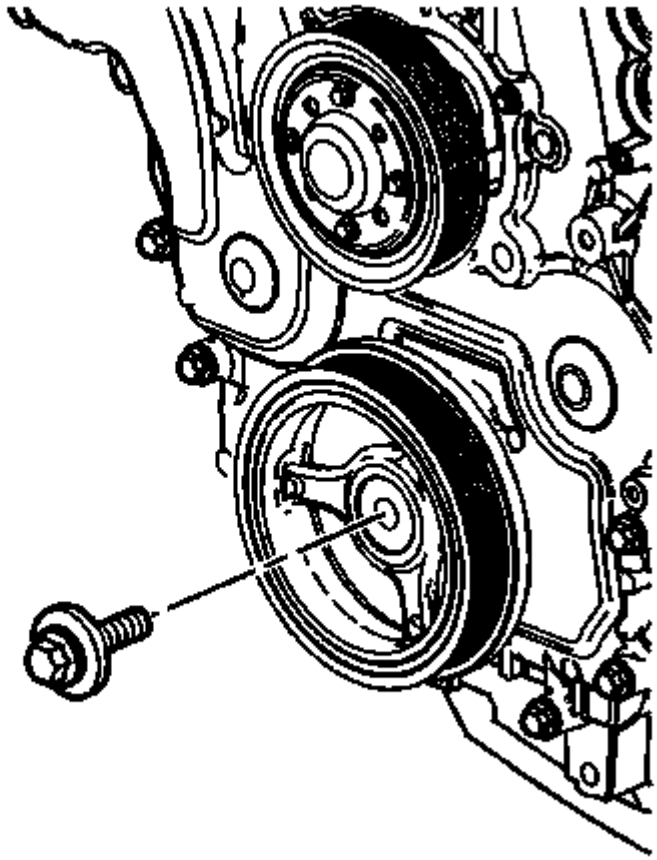

Fig. 35: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Support the right side of the frame with jackstands.
6. Remove the right side frame reinforcement bolts.
7. Loosen the right side frame bolts.
8. Lower the right side of the frame approximately 2 inches.
9. Remove the crankshaft balancer bolt. Discard the bolt.

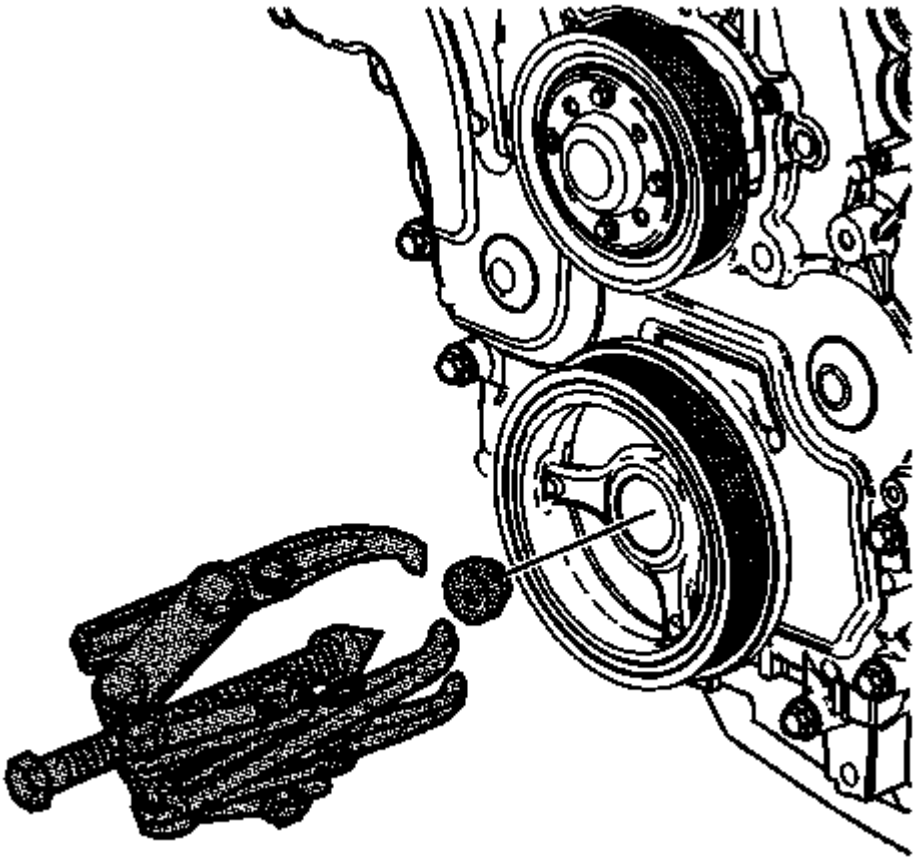

Fig. 36: View Of Crankshaft Balancer Remover Tool In Nose Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

10. Install the **J 38416-2** crankshaft button in the nose of the crankshaft.
11. Install the **J 41816** crankshaft balancer remover in order to remove the crankshaft balancer.
12. Tighten the center bolt of the **J 41816** crankshaft balancer remover in order to pull the crankshaft balancer off of the crankshaft.
13. Remove the **J 41816** crankshaft balancer remover from the crankshaft balancer.

Installation Procedure

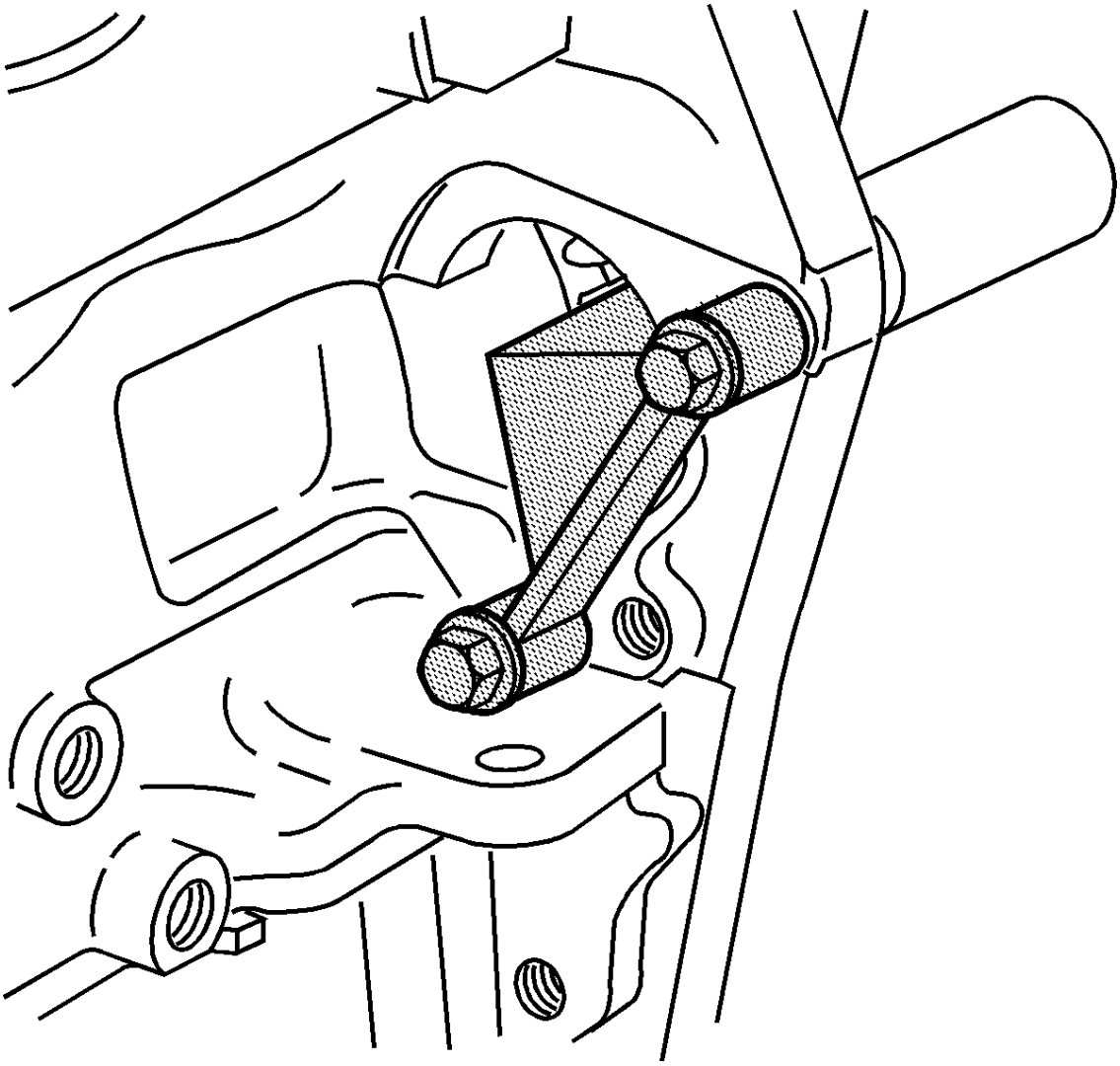

Fig. 37: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

1. The **EN 46106** flywheel holding tool must be installed onto the flywheel.
2. Use the **J 41998-B** crankshaft balancer installer , nut, bearing and washer to install the crankshaft balancer.

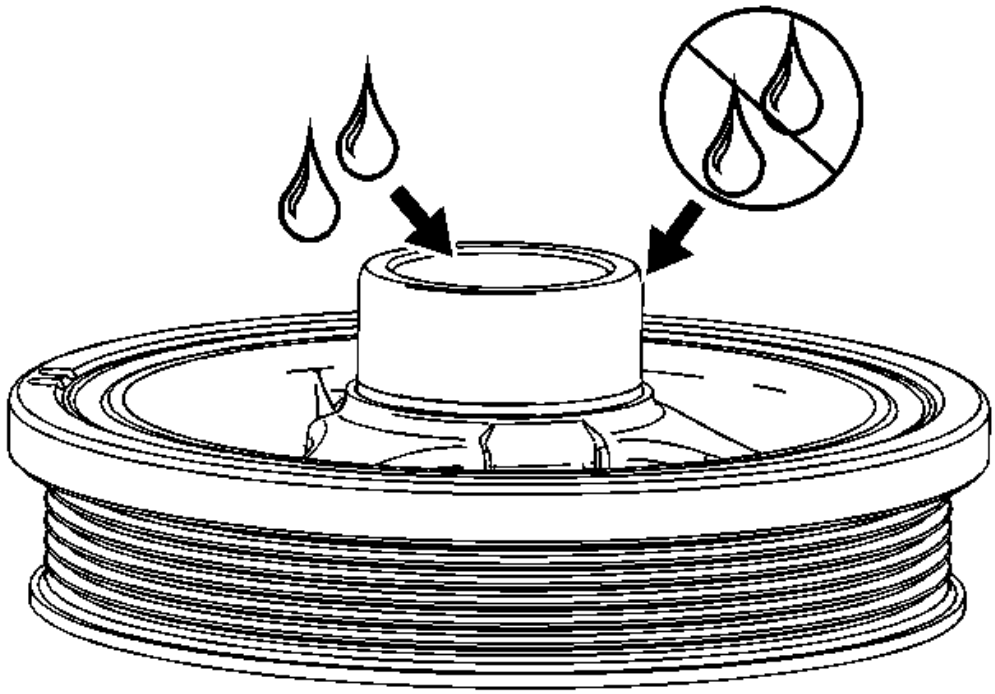

Fig. 38: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

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

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

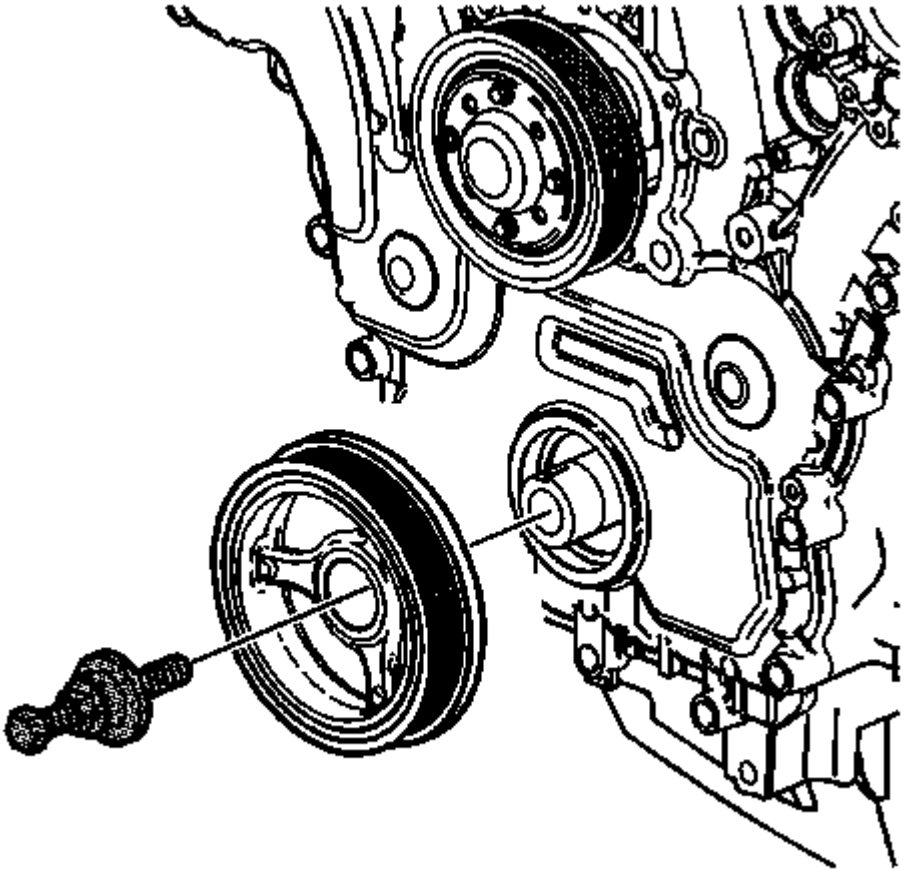

Fig. 39: View Of Crankshaft Balancer & Installation Tool
Courtesy of GENERAL MOTORS COMPANY

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

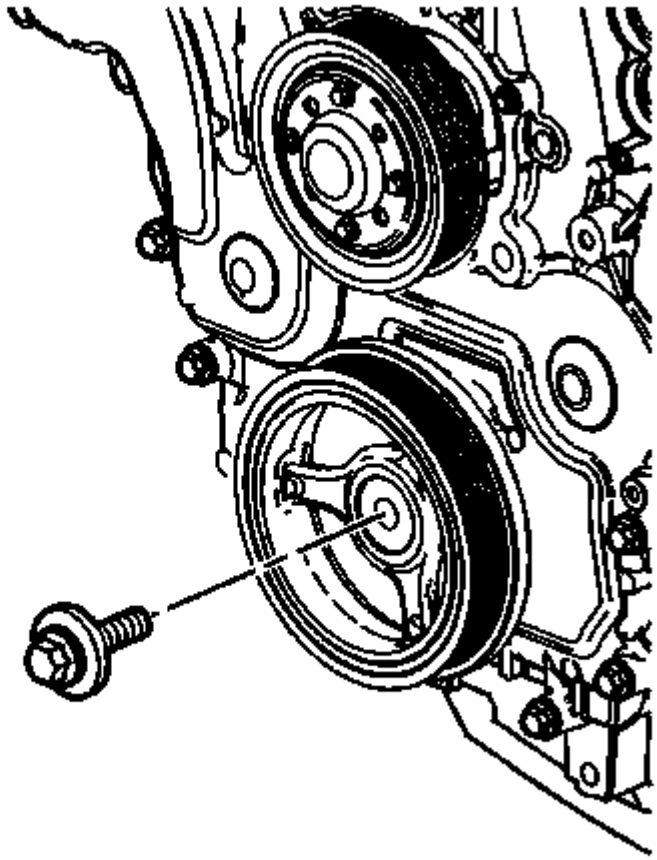

Fig. 40: Identifying Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

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

8. Install the NEW crankshaft balancer bolt.

CAUTION: Refer to Fastener Caution

9. Tighten the crankshaft balancer bolt.
   - Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft).
   - Tighten the crankshaft balancer bolt an additional 150 degrees using the **J 45059** angle meter.

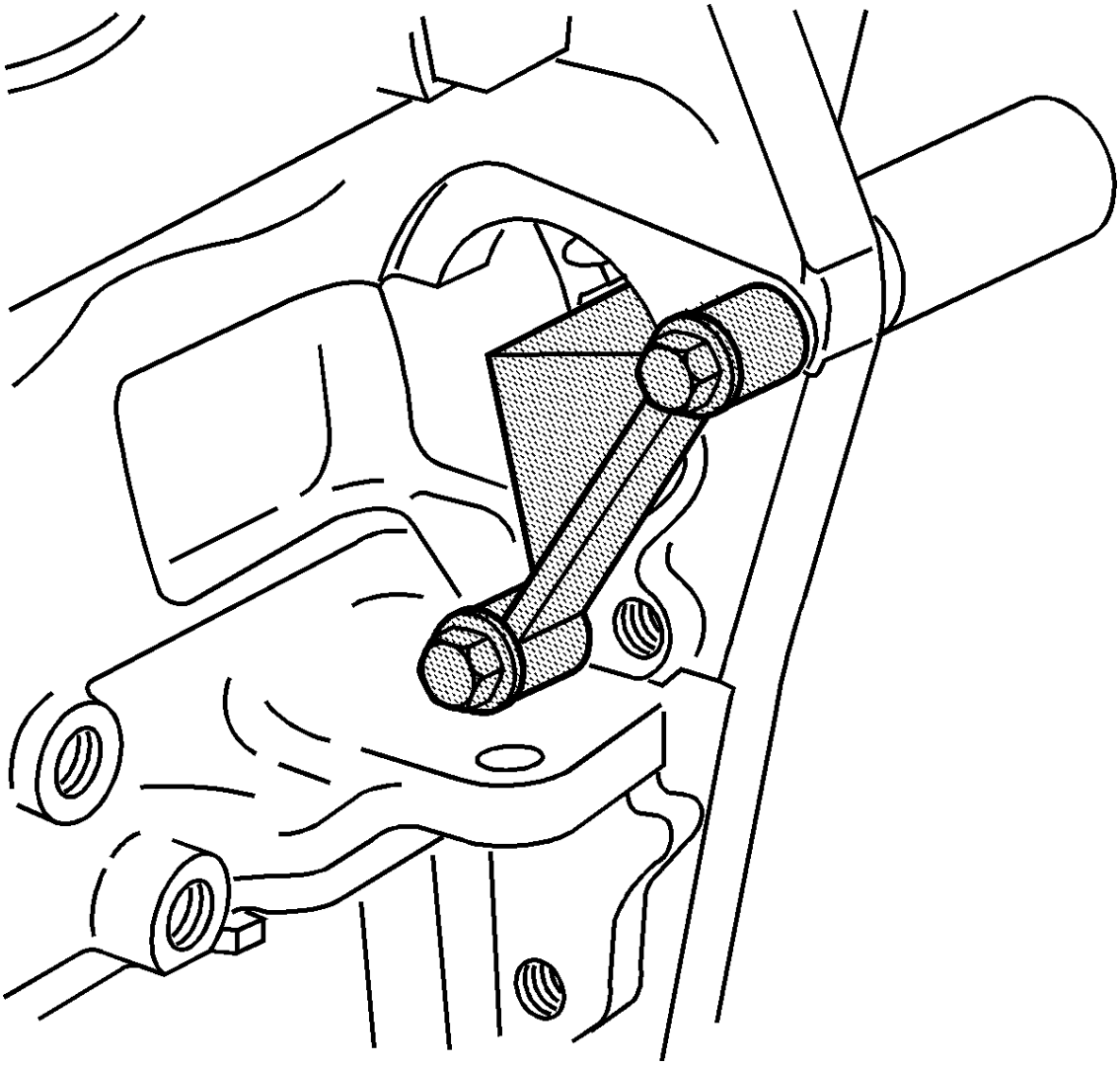

Fig. 41: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN 46106** flywheel holding tool.
11. Install the starter. Refer to **Starter Replacement** .
12. Using engine support fixture, raise the engine into position.
13. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
14. Install the drive belt. Refer to **Drive Belt Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

J 29184 Oil Seal Installer

Removal Procedure

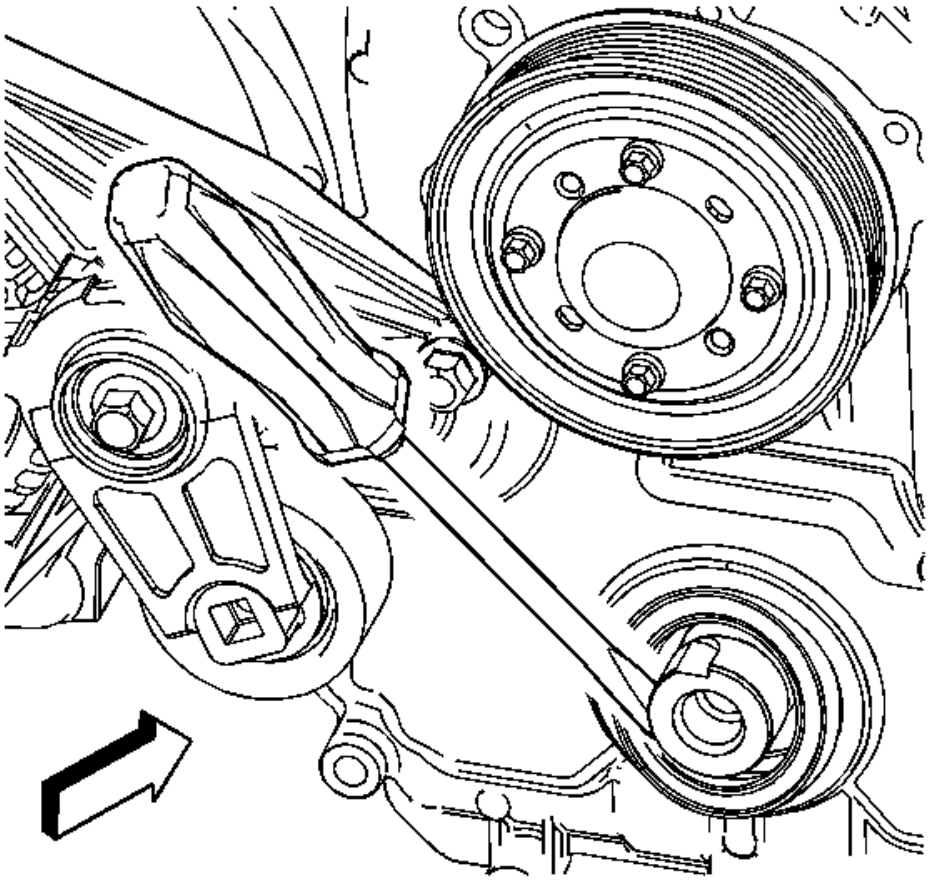

Fig. 42: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Use a flat-bladed tool in order to remove the crankshaft oil seal. Use care not to damage the engine front cover or the crankshaft.

Installation Procedure

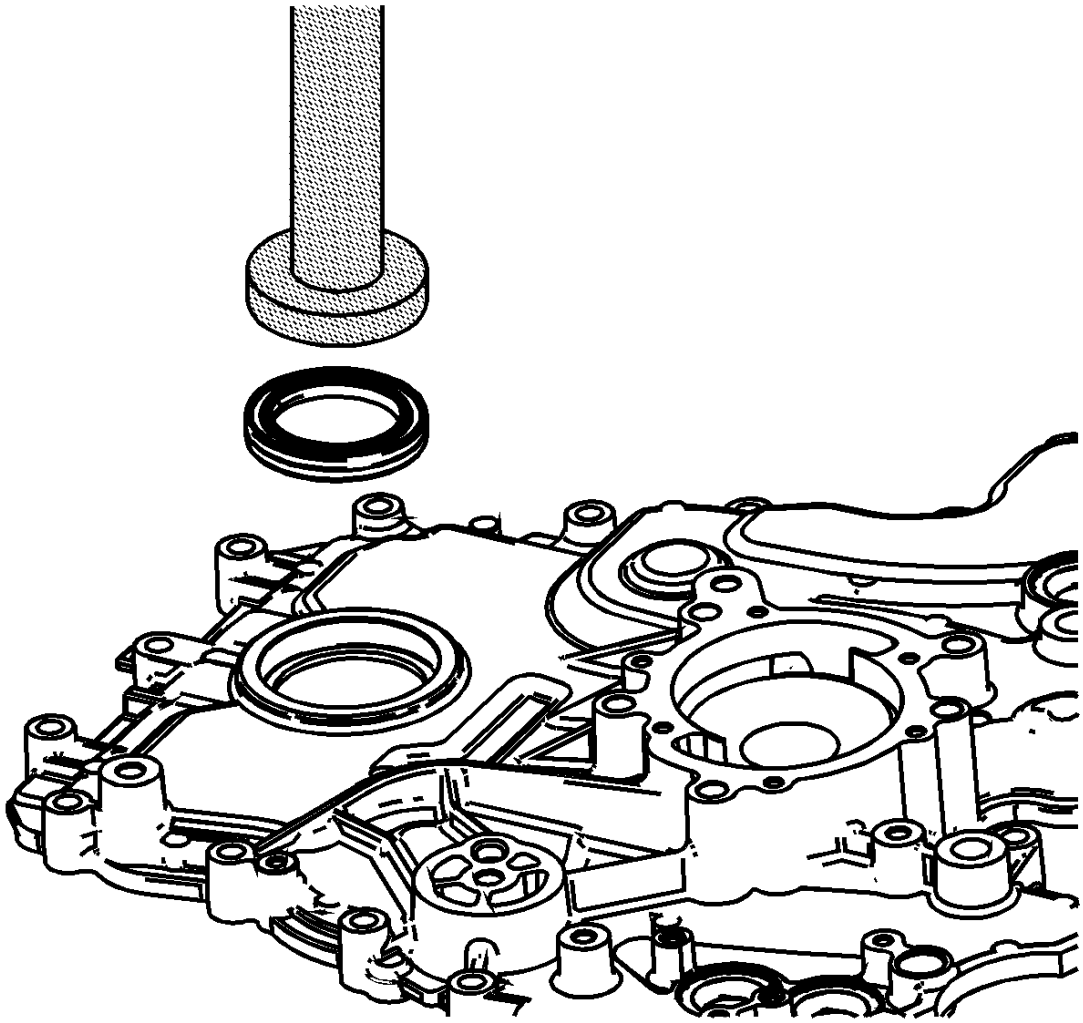

Fig. 43: View of Crankshaft Front Oil Seal Assembly
Courtesy of GENERAL MOTORS COMPANY

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

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

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

EN 46101 Spark Plug Tube Seal Guide

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left side ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .
3. Unclip and reposition the wire harness from the camshaft cover.
4. Remove the power steering reservoir bracket. Refer to **Power Steering Fluid Reservoir Bracket Replacement** .

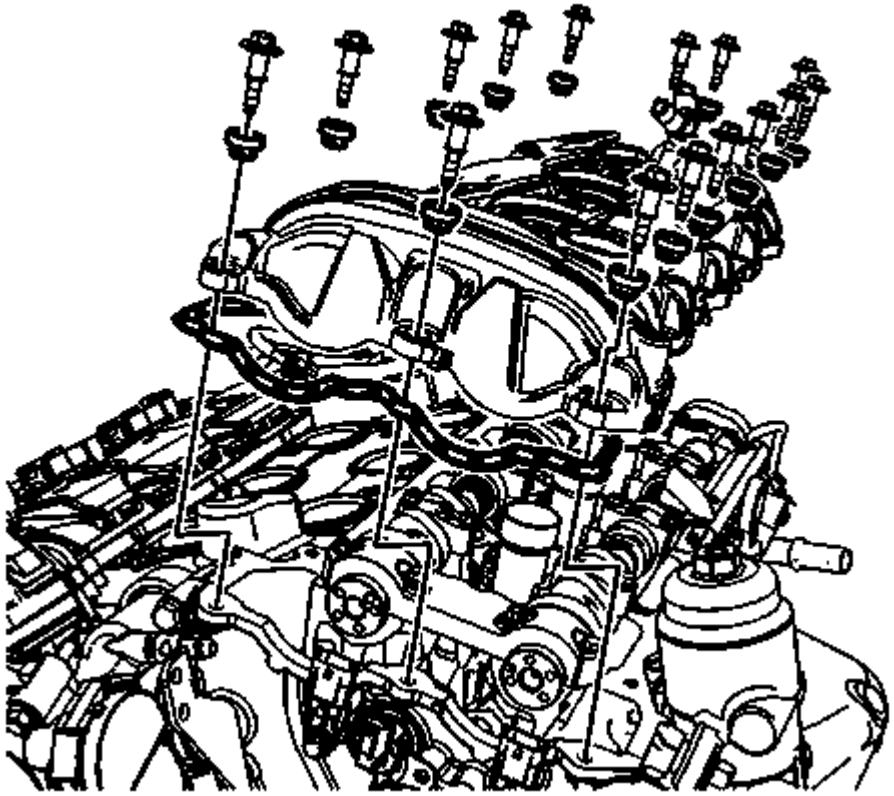

Fig. 44: Identifying Camshaft Cover Seal & Grommets
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left camshaft cover bolts.
6. Remove the left camshaft cover from the left cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LLT)** .

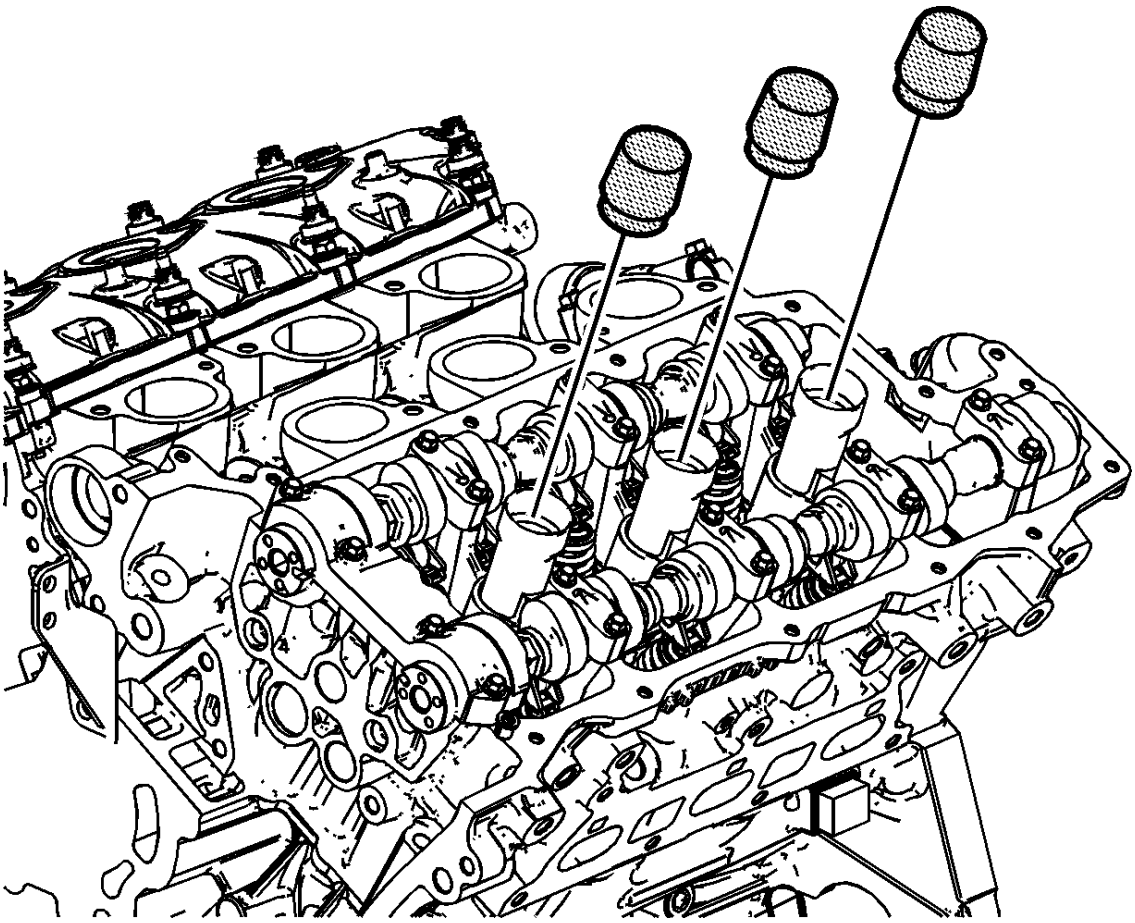

Fig. 45: View Of Spark Plug Tubes & Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN 46101** spark plug tube seal guide onto the spark plug tubes of the left cylinder head.

Installation Procedure

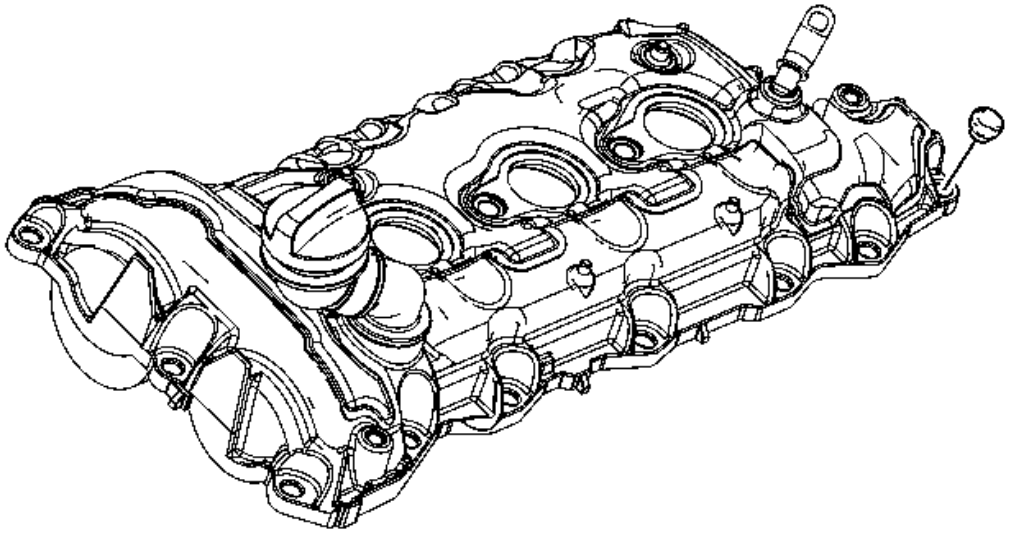

Fig. 46: View of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.
2. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.

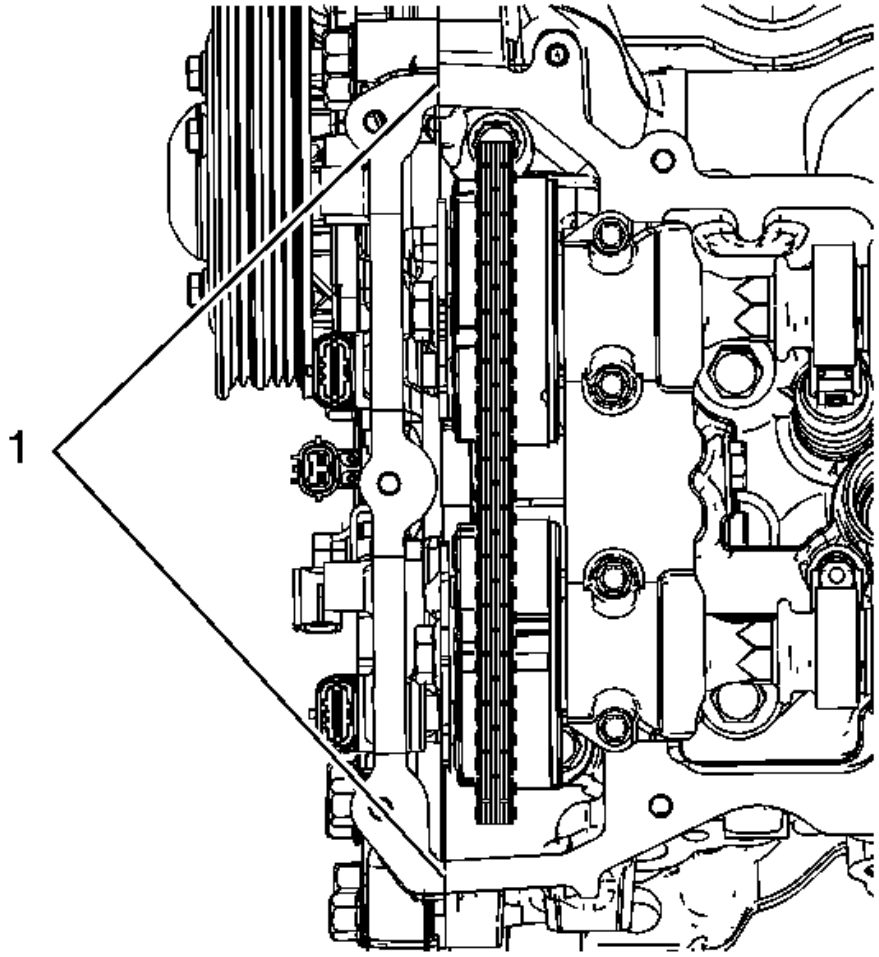

Fig. 47: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

3. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

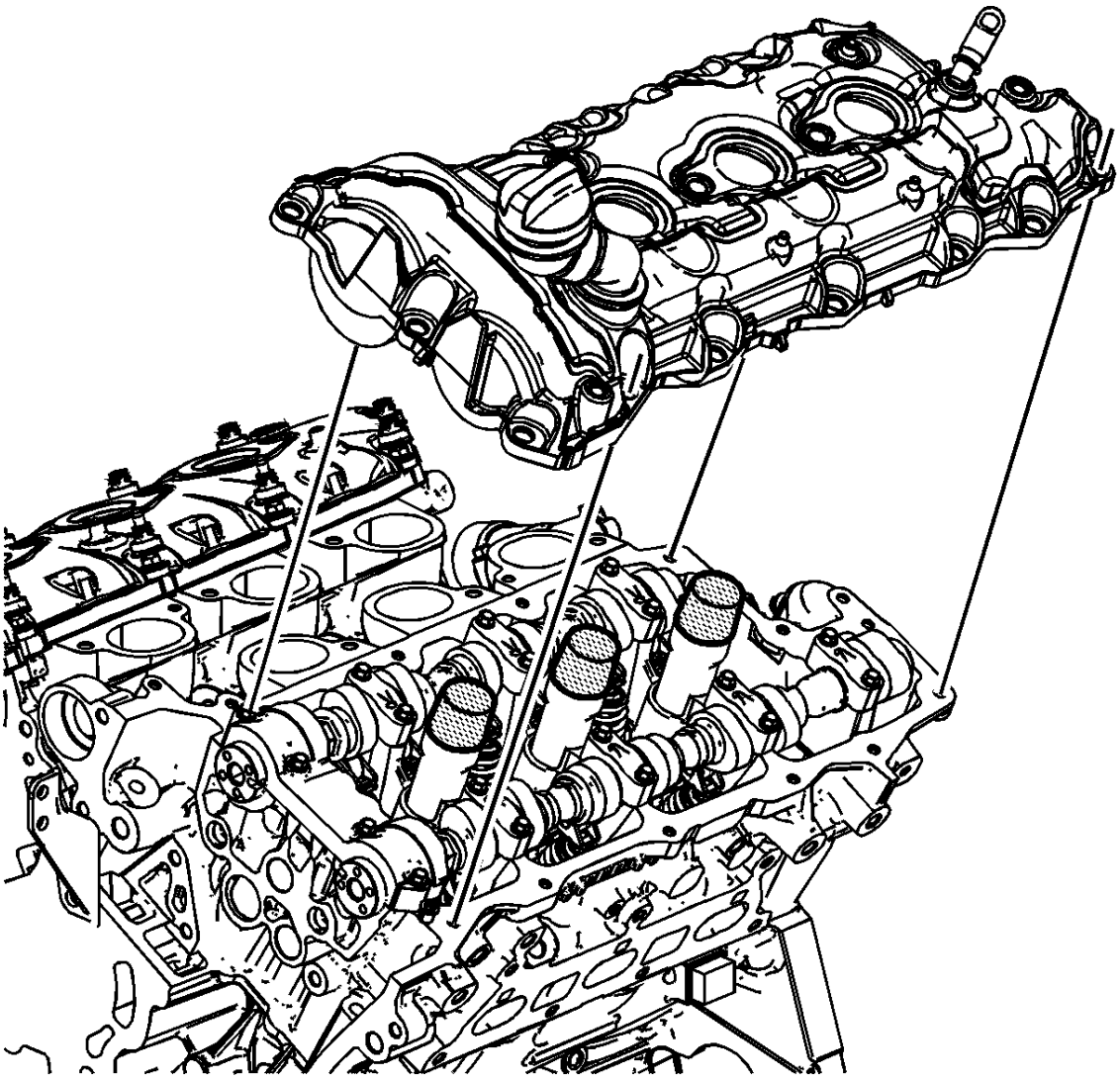

Fig. 48: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

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

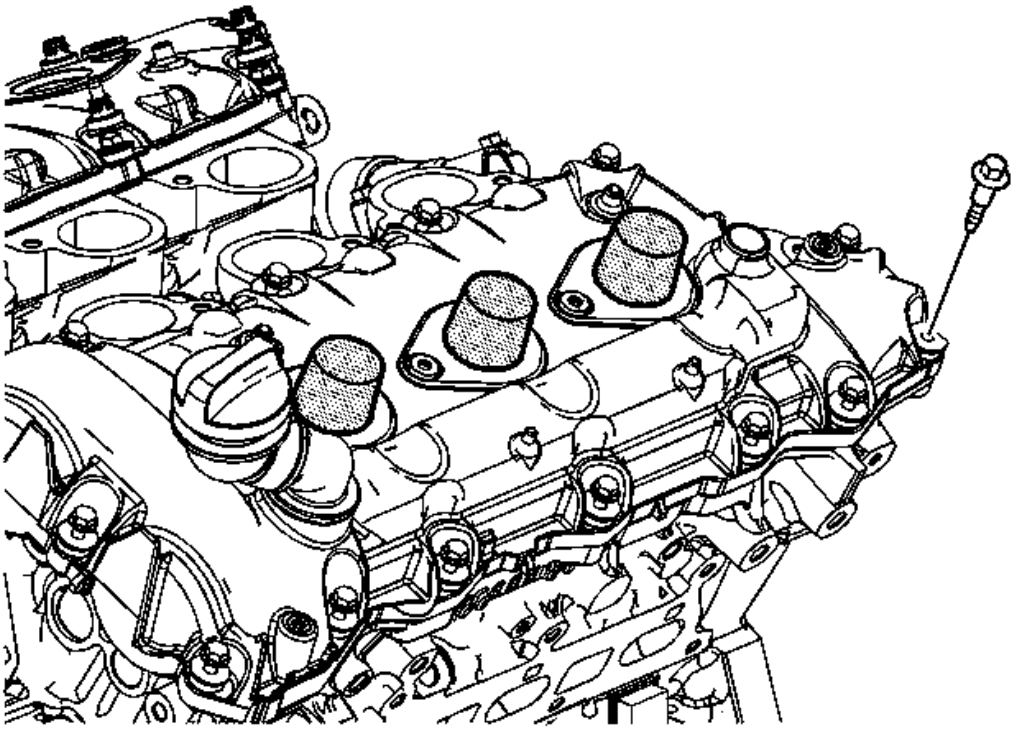

Fig. 49: View of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the left camshaft cover bolts.

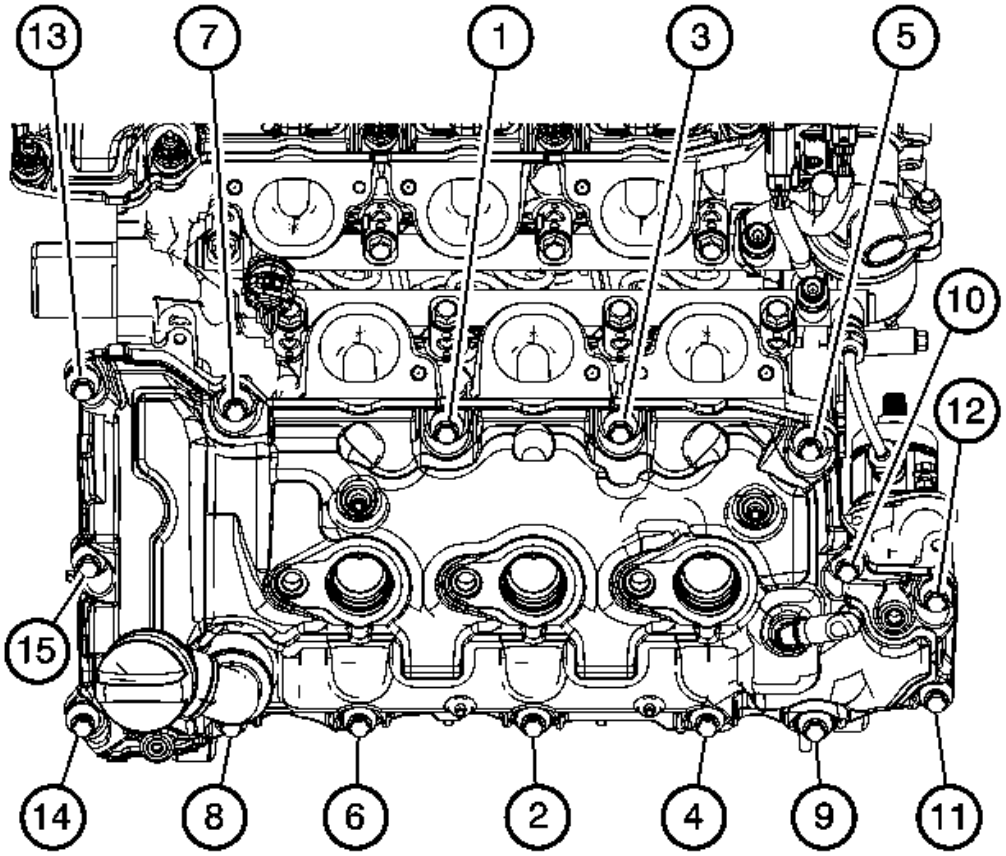

Fig. 50: Identifying Left Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the left camshaft cover bolts in sequence shown.

   Tighten

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

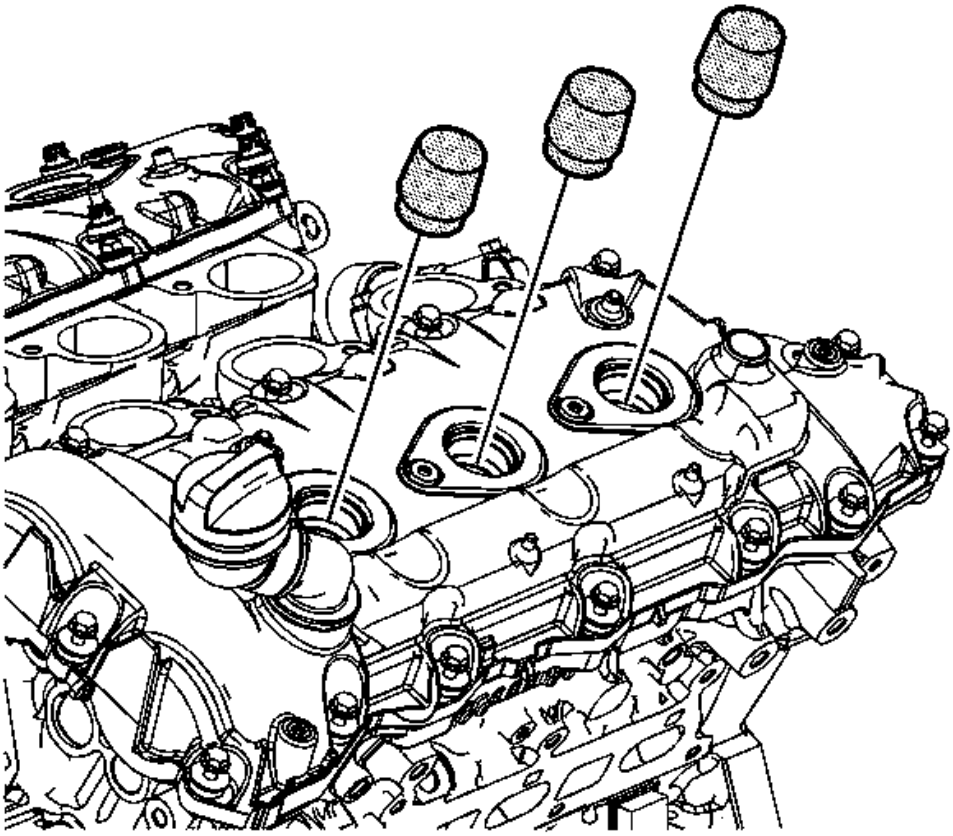

Fig. 51: View of Spark Plug Tubes & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN 46101** spark plug tube seal guide from the spark plug tubes of the left cylinder head.
8. Install the power steering reservoir bracket. Refer to **Power Steering Fluid Reservoir Bracket Replacement** .
9. Position the wire harness and clip to the camshaft cover.
10. Install the left side ignition coils. Refer to **Ignition Coil Replacement - Bank 2** .
11. Install the lower intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Special Tools

EN 46101 Spark Plug Tube Seal Guide

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the right bank spark plugs. Refer to **Spark Plug Replacement** .
3. Unbolt the power steering reservoir and position aside. Refer to **Power Steering Fluid Reservoir Replacement** .

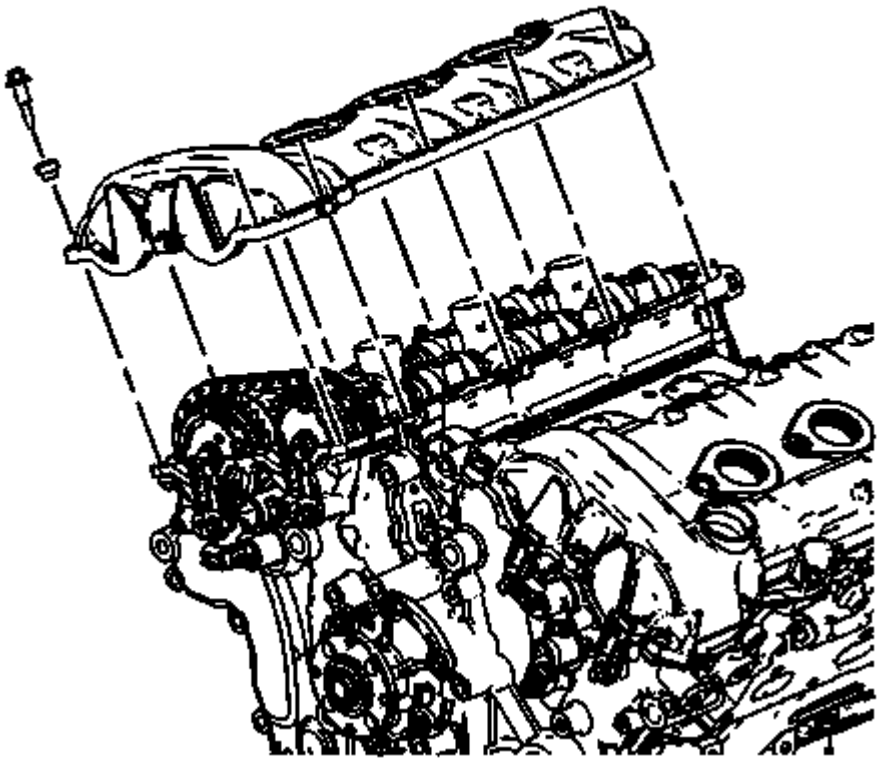

Fig. 52: Identifying Right Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right camshaft cover bolts.
5. Remove the right camshaft cover from the right cylinder head.
6. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LLT)** .

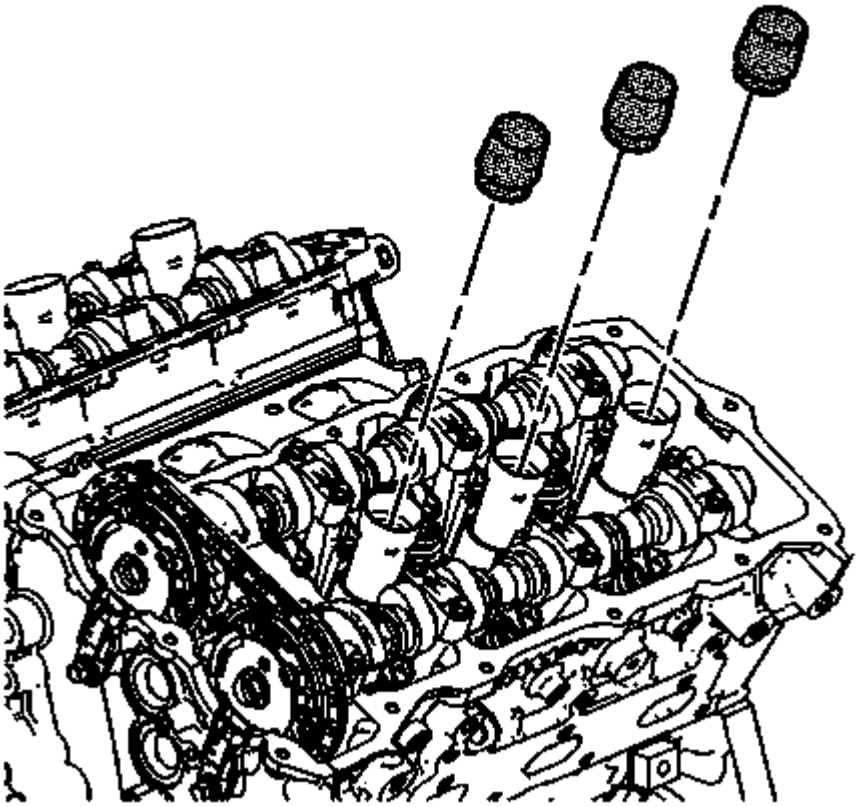

Fig. 53: Plugging Spark Plug Holes
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN 46101** spark plug tube seal guide onto the spark plug tubes of the right cylinder head.

Installation Procedure

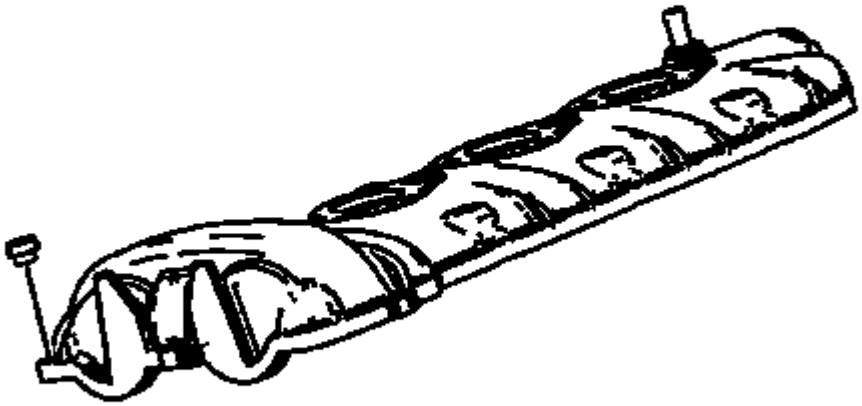

Fig. 54: Locating Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

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

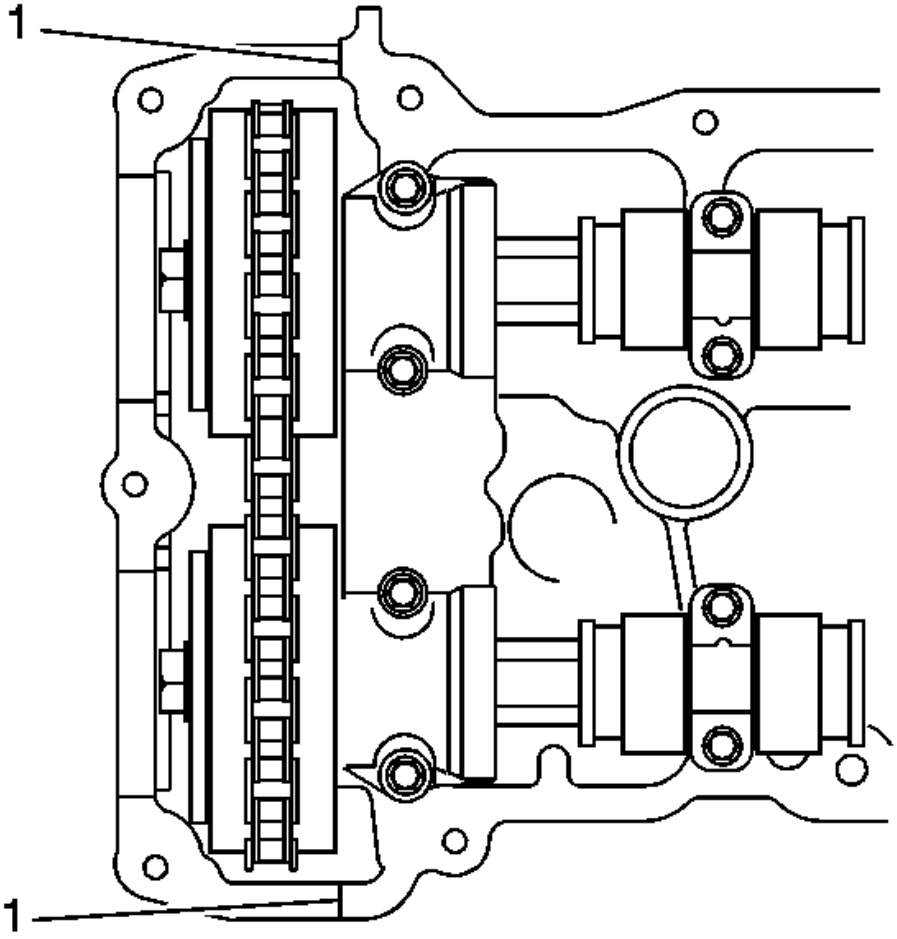

Fig. 55: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

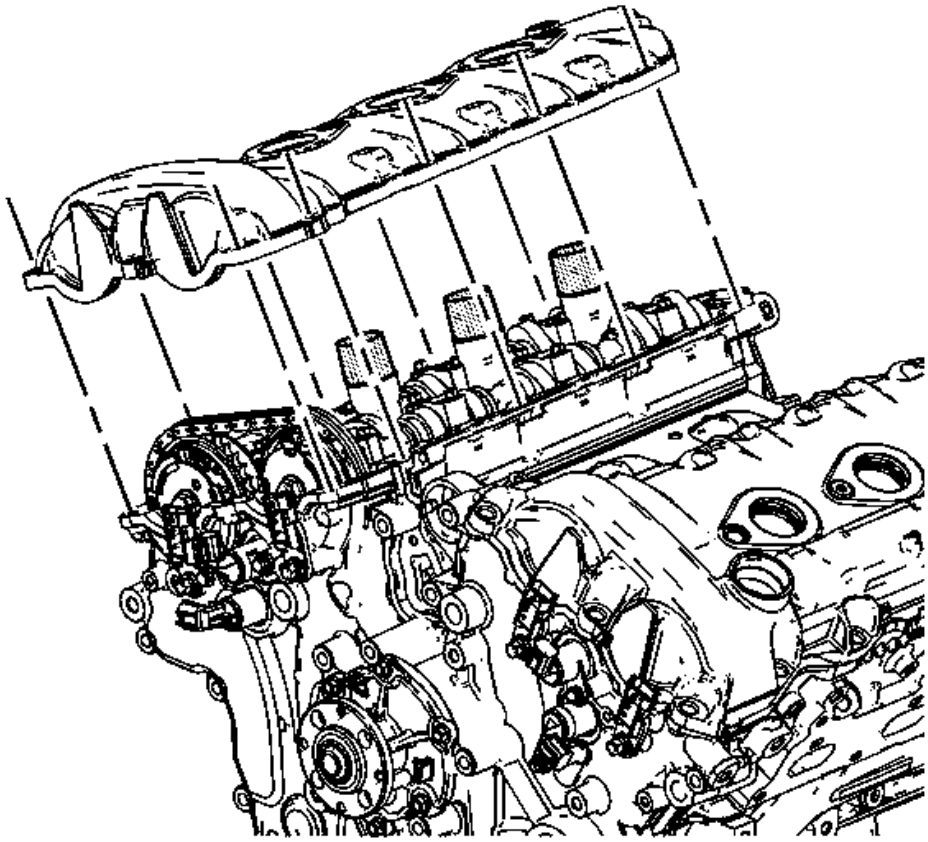

Fig. 56: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

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

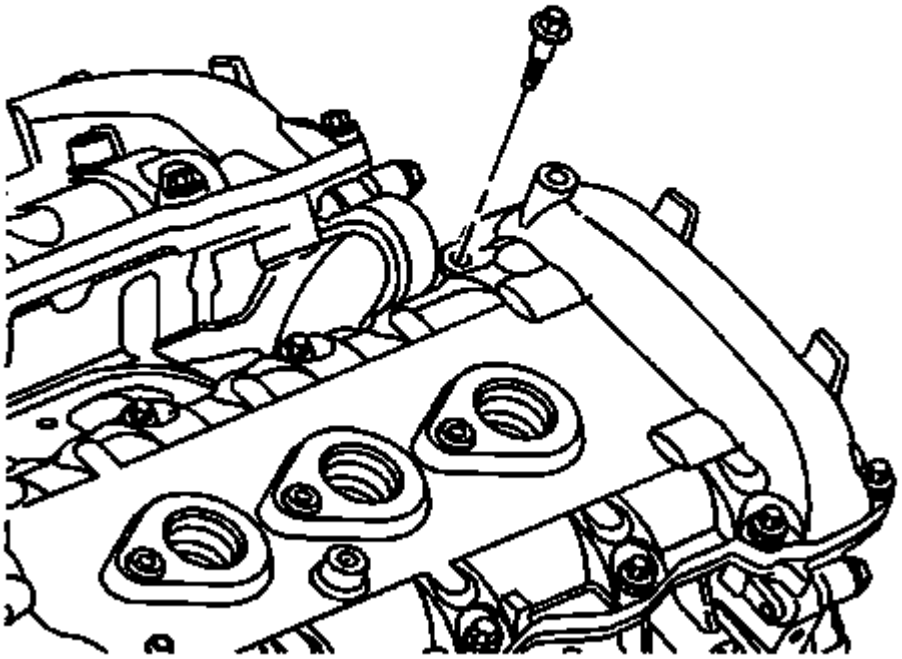

Fig. 57: Locating Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosely install the right camshaft cover bolts.

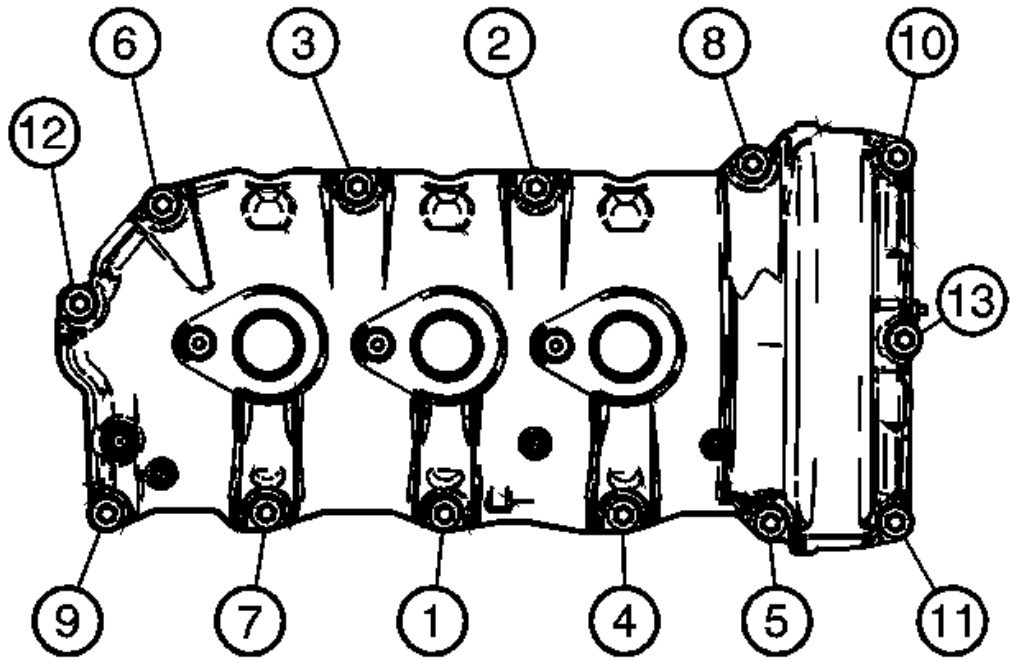

Fig. 58: Tightening Sequence for Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the right camshaft cover bolts in sequence.

   Tighten

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

6. Install the power steering reservoir. Refer to **Power Steering Fluid Reservoir Replacement** .

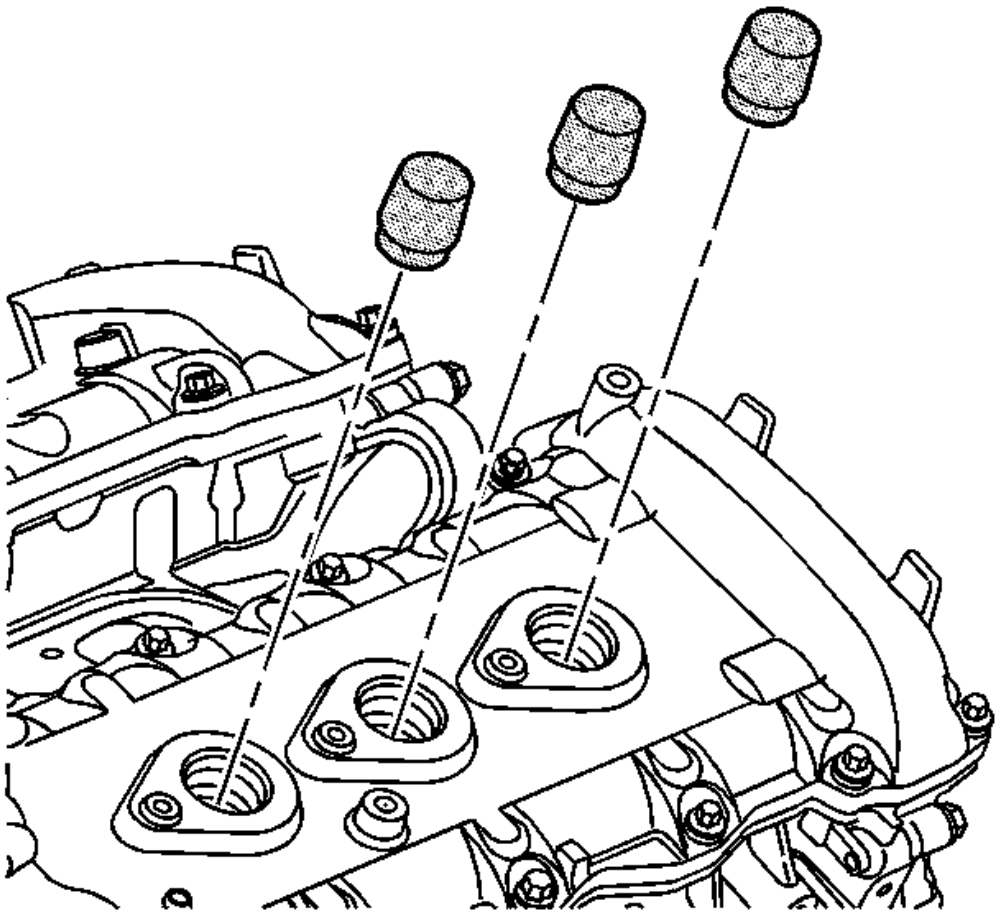

Fig. 59: Spark Plug Tube Seal Guides
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN 46101** spark plug tube seal guide from the spark plug tubes of the right cylinder head.
8. Install NEW spark plugs into the right cylinder head. Refer to **Spark Plug Replacement** .
9. Install the intake manifold. Refer to **Intake Manifold Replacement**.

ENGINE FRONT COVER REPLACEMENT

Special Tools

- **EN 46109** Guide Pin Set
- **EN-48383** Camshaft Retaining Tools
- **EN-48589** Crankshaft Rotational Socket
- **EN-46104** Water Pump Pulley Holding Tool

Removal Procedure

1. Remove the frame from the body with the engine and transmission. Refer to **Engine Replacement**.

   Follow steps 1-40 in the Engine Replacement Removal.

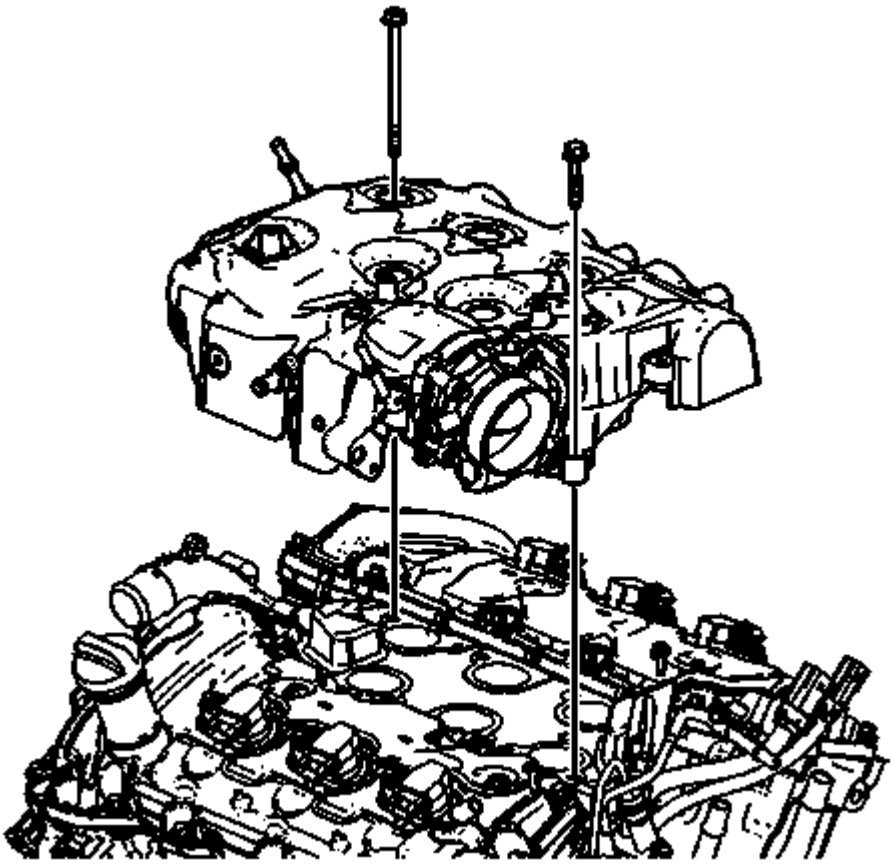

Fig. 60: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold. Refer to **Intake Manifold Removal** .

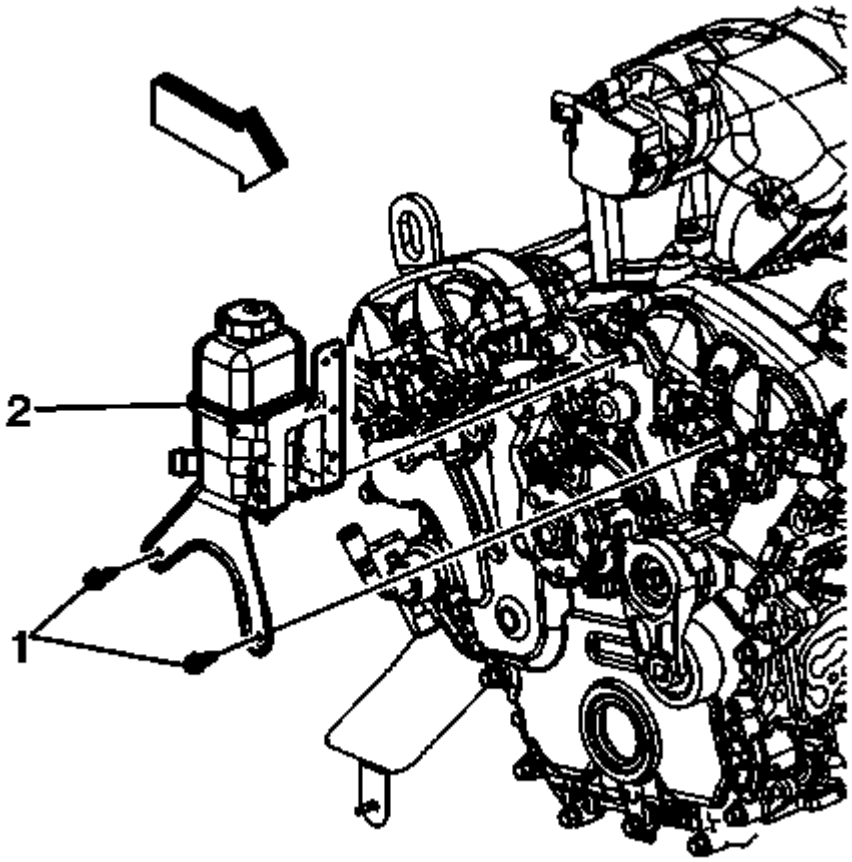

Fig. 61: Identifying Power Steering Fluid Reservoir Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is not necessary to remove the lines.

3. Remove the power steering reservoir bracket bolts and reposition.

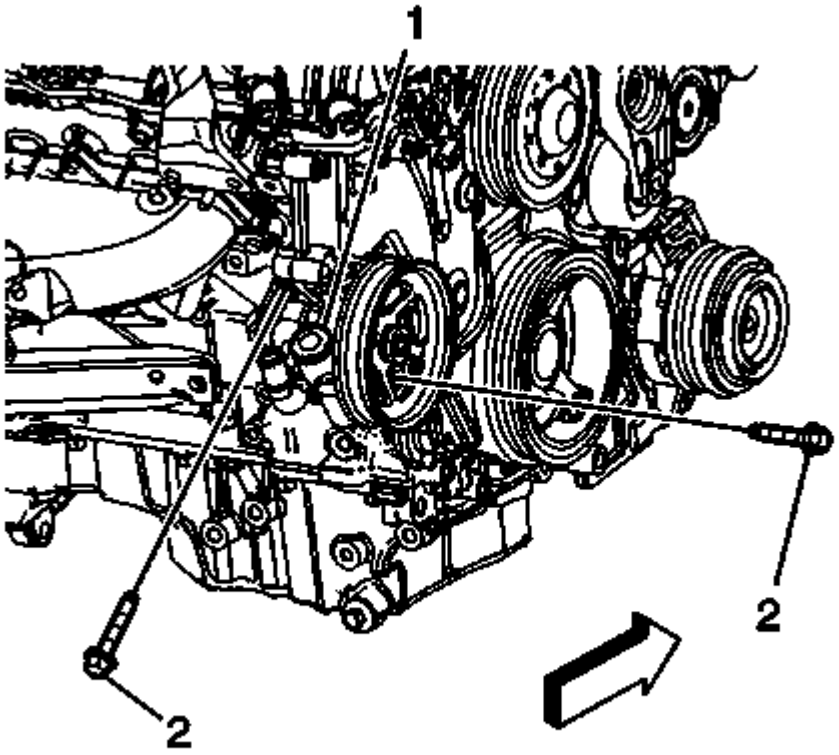

Fig. 62: View Of Power Steering Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is not necessary to remove the lines.

4. Remove the power steering pump bracket bolts and reposition.
5. Remove the left and right camshaft covers. Refer to **Camshaft Cover Removal - Left Side (LLT)** , and **Camshaft Cover Removal - Right Side** .
6. Remove the engine mount bracket bolts and bracket.

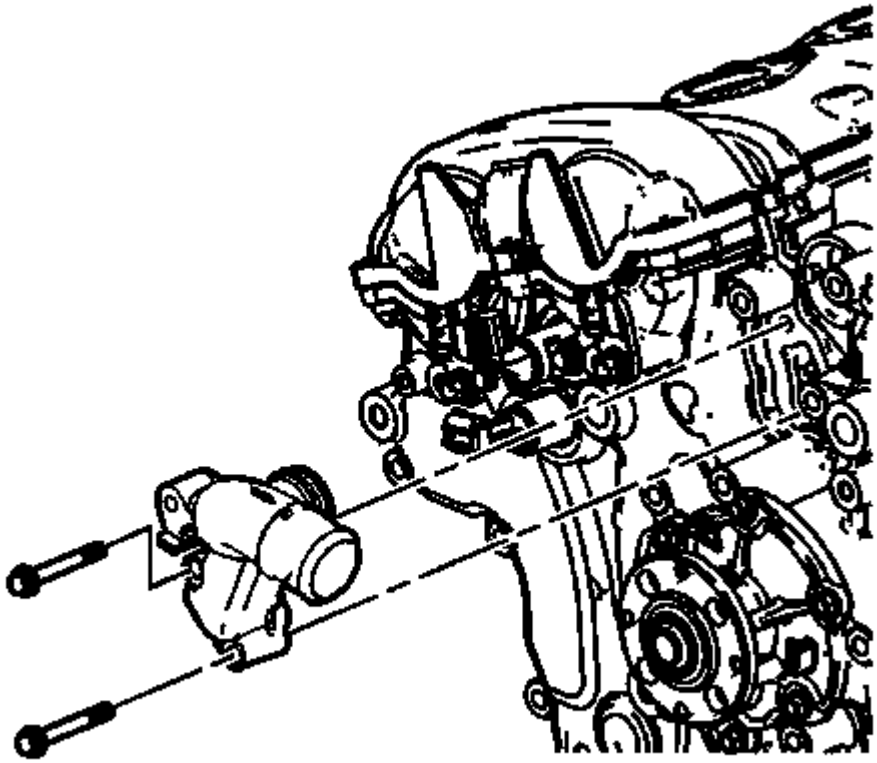

Fig. 63: Locating Water Outlet Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the water outlet housing assembly. Refer to **Water Outlet Removal** .

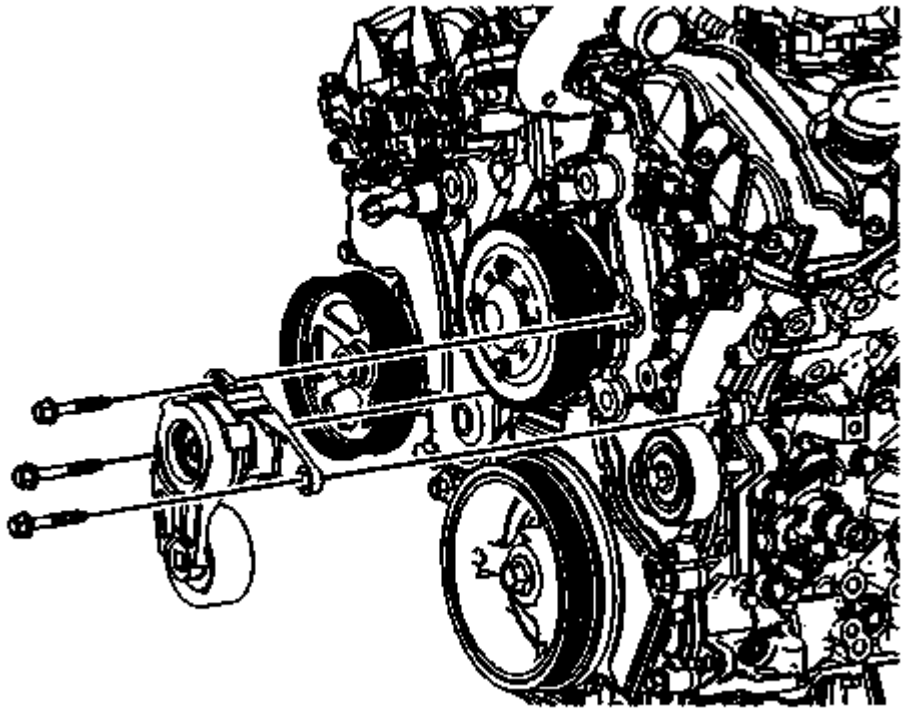

Fig. 64: Identifying Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the drive belt and drive belt tensioner. Refer to **Drive Belt Tensioner Removal** .

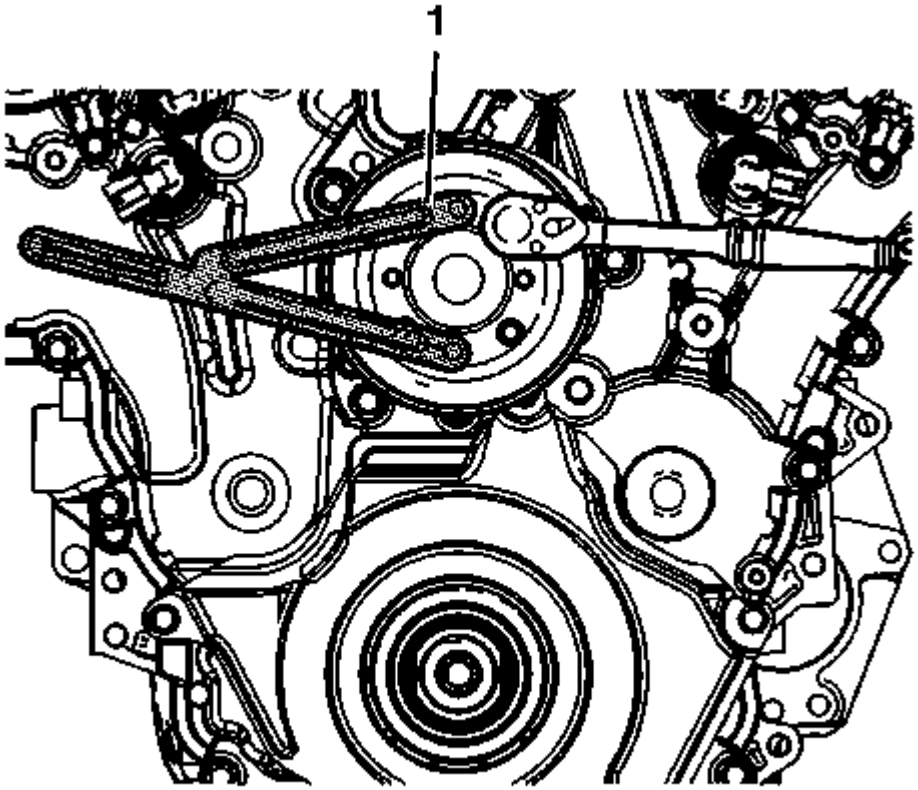

Fig. 65: Water Pump Pulley Holding Tool
Courtesy of GENERAL MOTORS COMPANY

9. Remove the water pump pulley using **EN-46104** Holding Tool and if necessary remove the water pump. Refer to **Water Pump Removal** .
10. Remove the oil filter.
11. Remove the starter heat shield.
12. Remove the starter electrical connections, starter bolts and starter.
13. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal** .

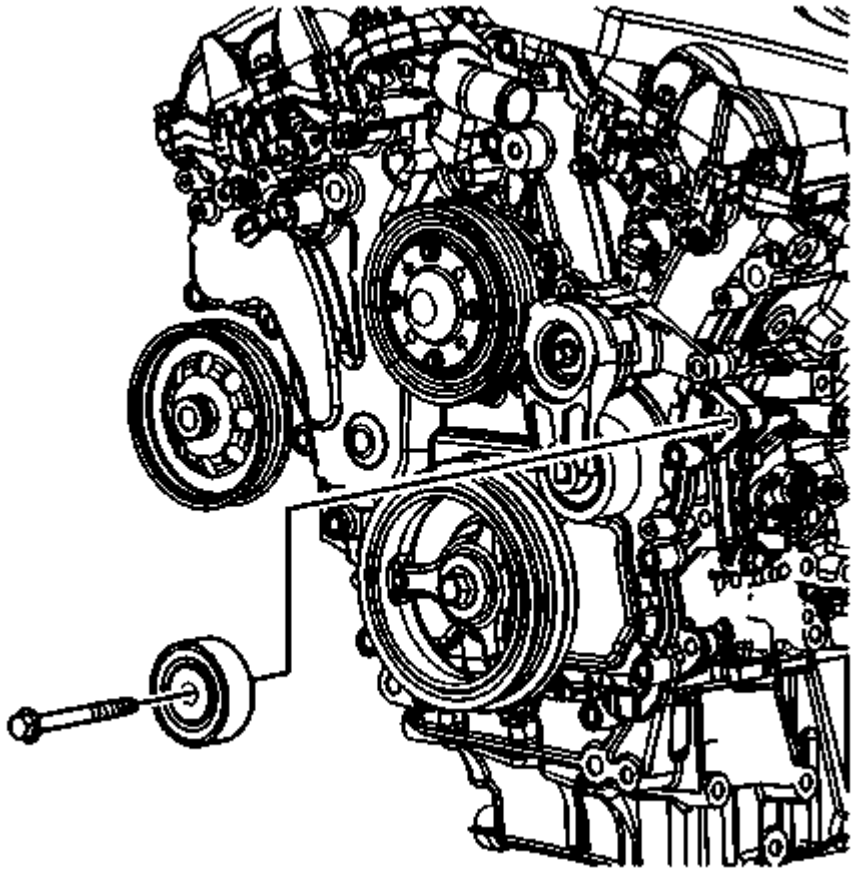

Fig. 66: Identifying Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Remove the drive belt idler bolt and idler. Refer to **Drive Belt Idler Pulley Removal**
15. Remove the generator.

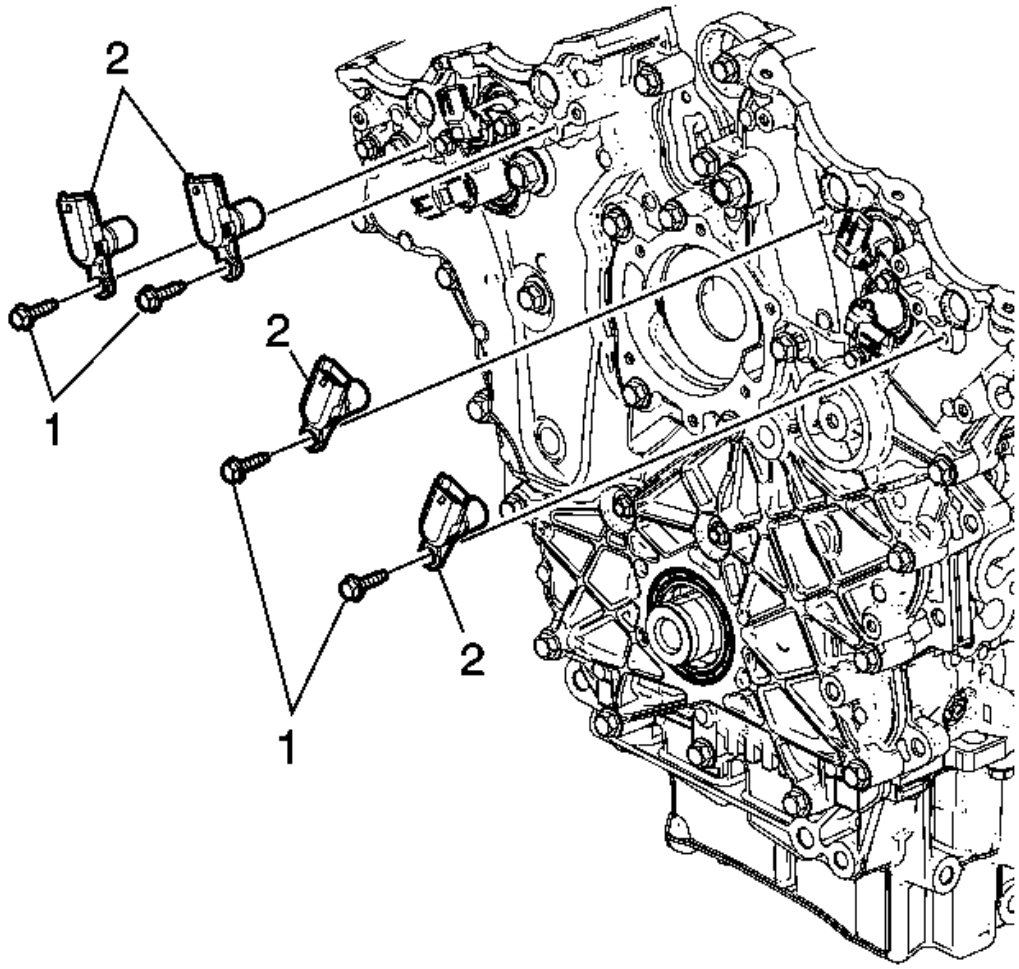

Fig. 67: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove camshaft position sensors (2) from the front cover.

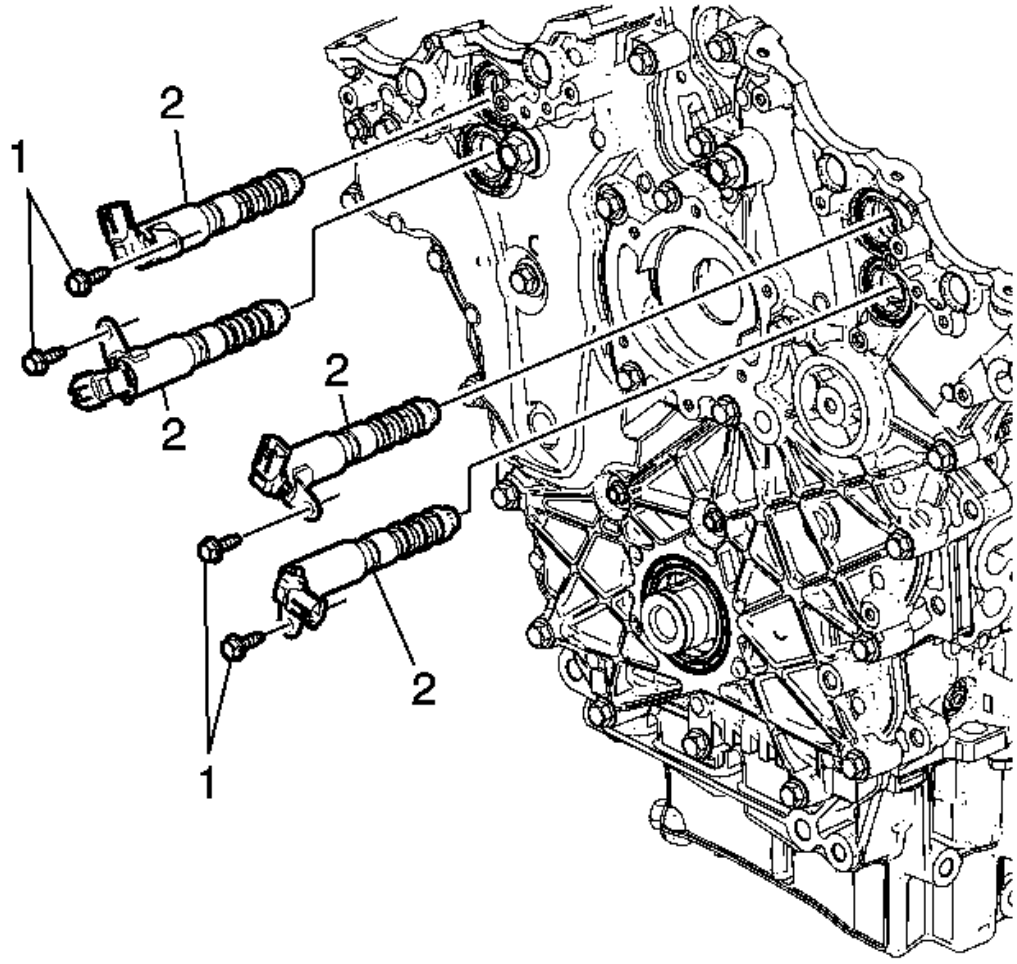

Fig. 68: Camshaft Position Actuator Valves & Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the camshaft position actuators from the front cover.

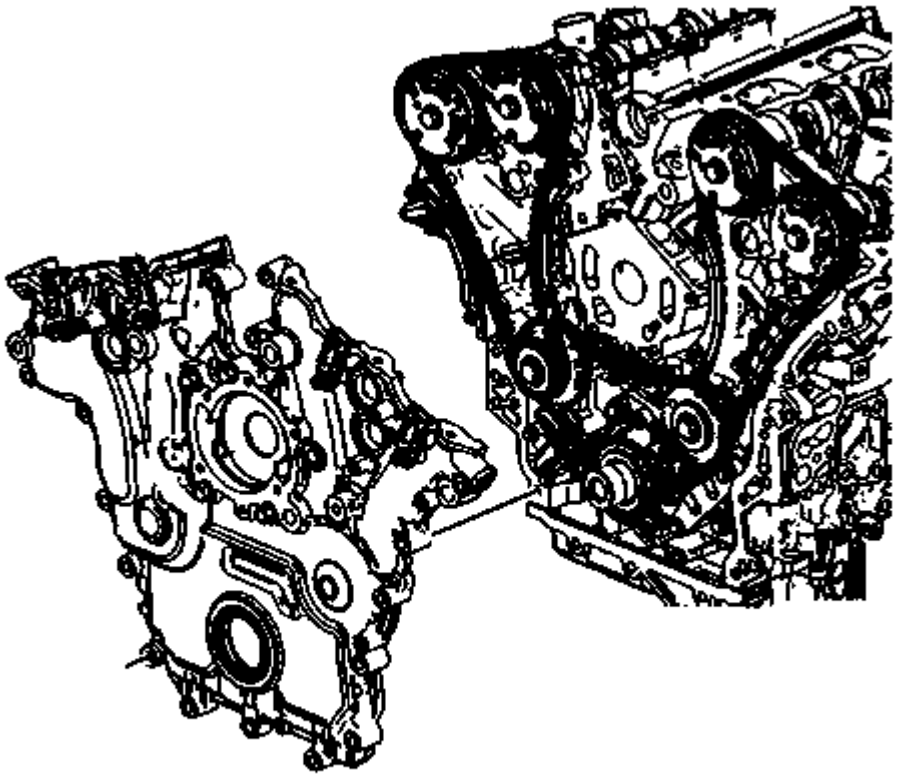

Fig. 69: Identifying Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: There are a total of 22 M8 bolts that must be removed and 3 optional M12 bolts that may need to be removed before the front cover will separate from the engine block.

18. Remove the engine front cover. **Engine Front Cover Removal** .

Installation Procedure

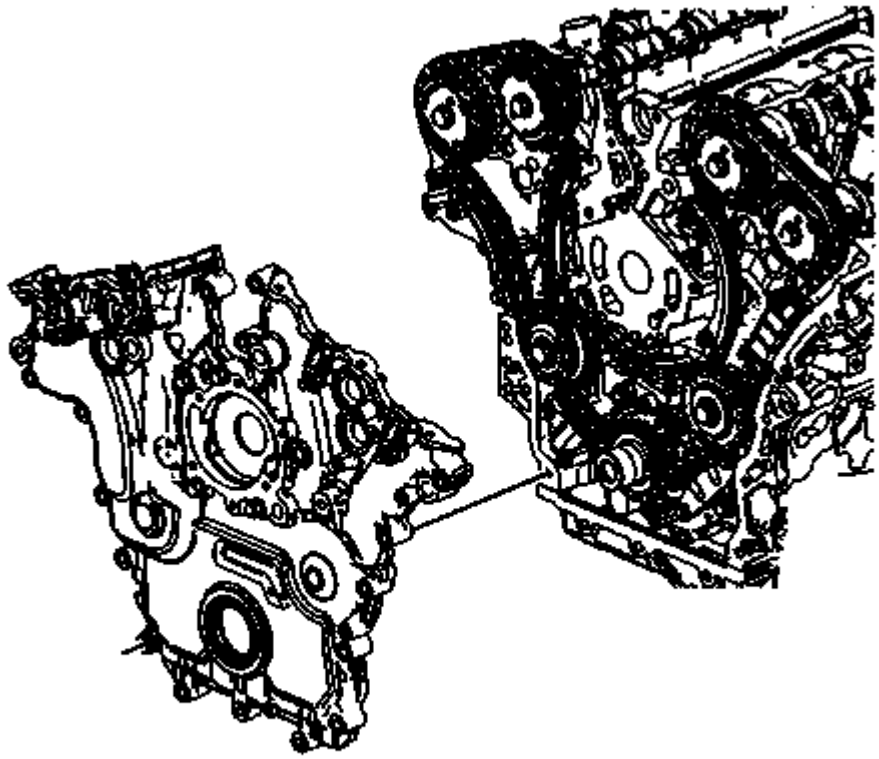

Fig. 70: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

1. Install front cover. Refer to **Engine Front Cover Installation** .

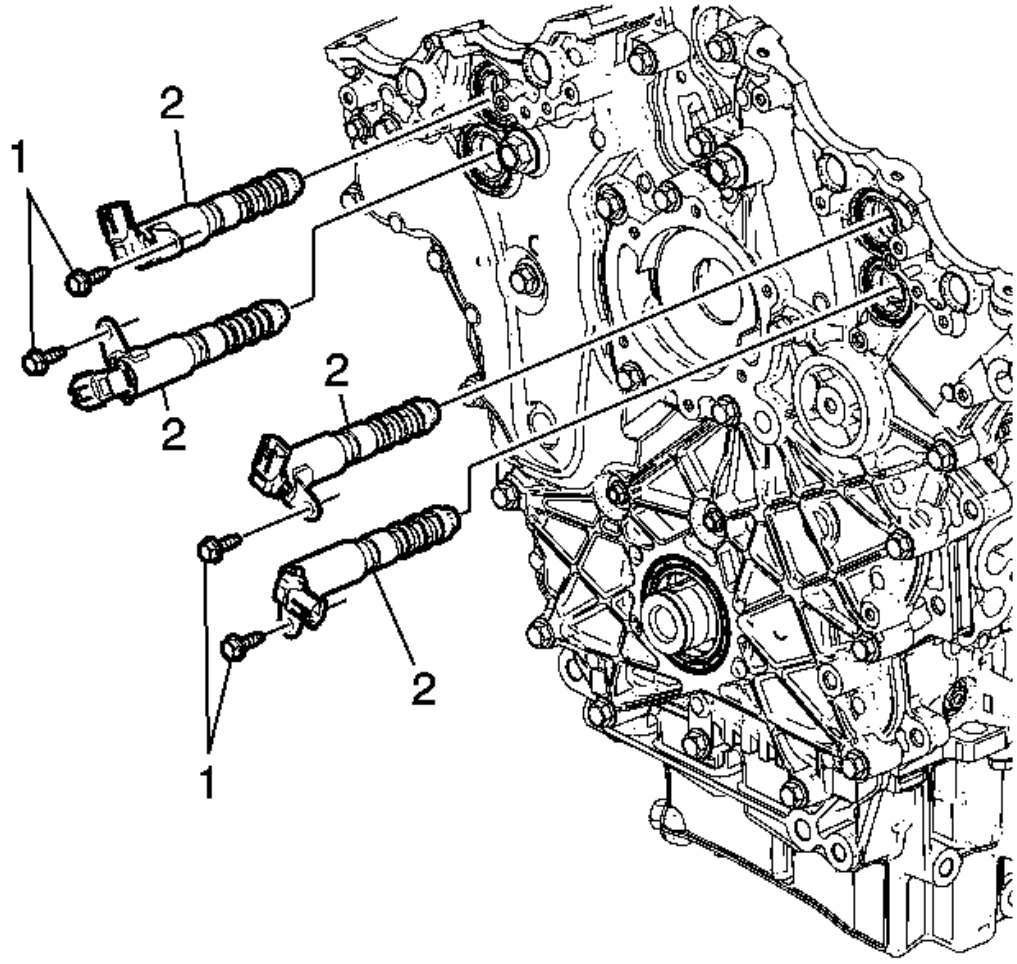

Fig. 71: Camshaft Position Actuator Valves & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the camshaft position actuators to the front cover.

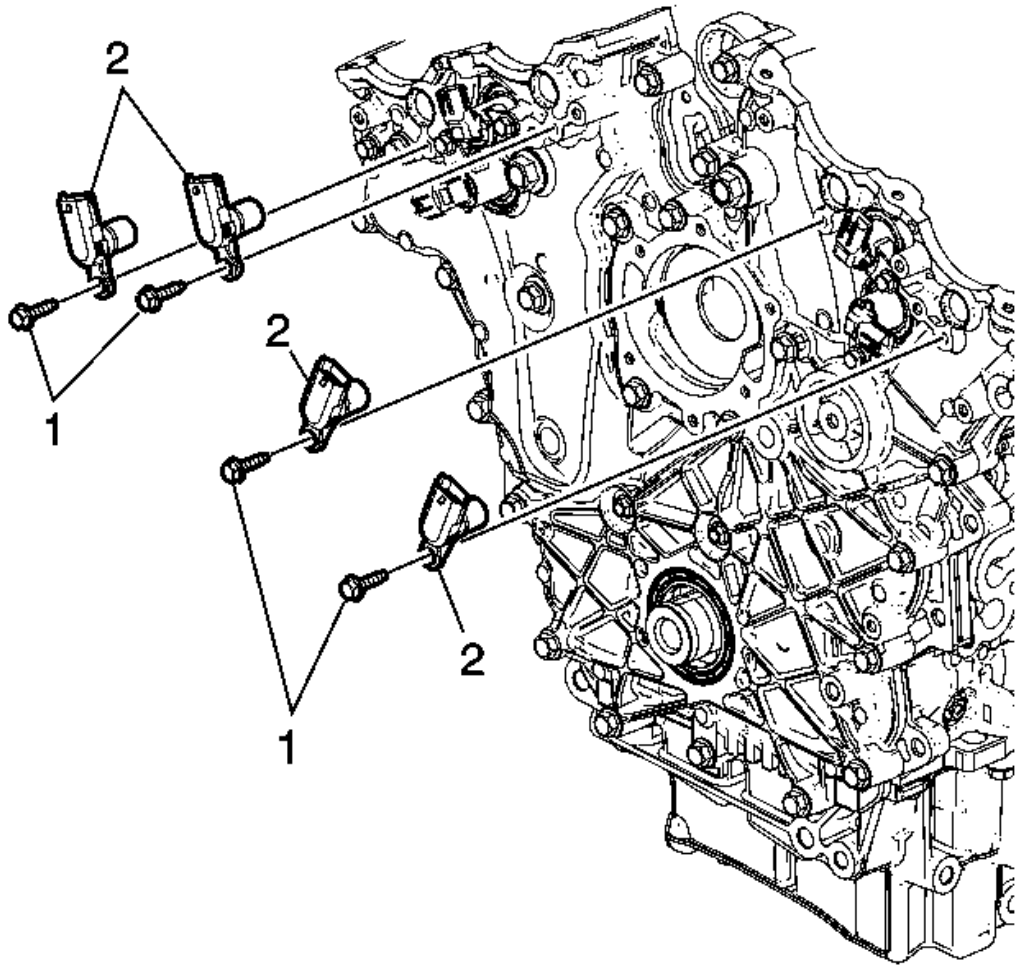

Fig. 72: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the camshaft position sensors (2) to the front cover.
4. Install the generator.

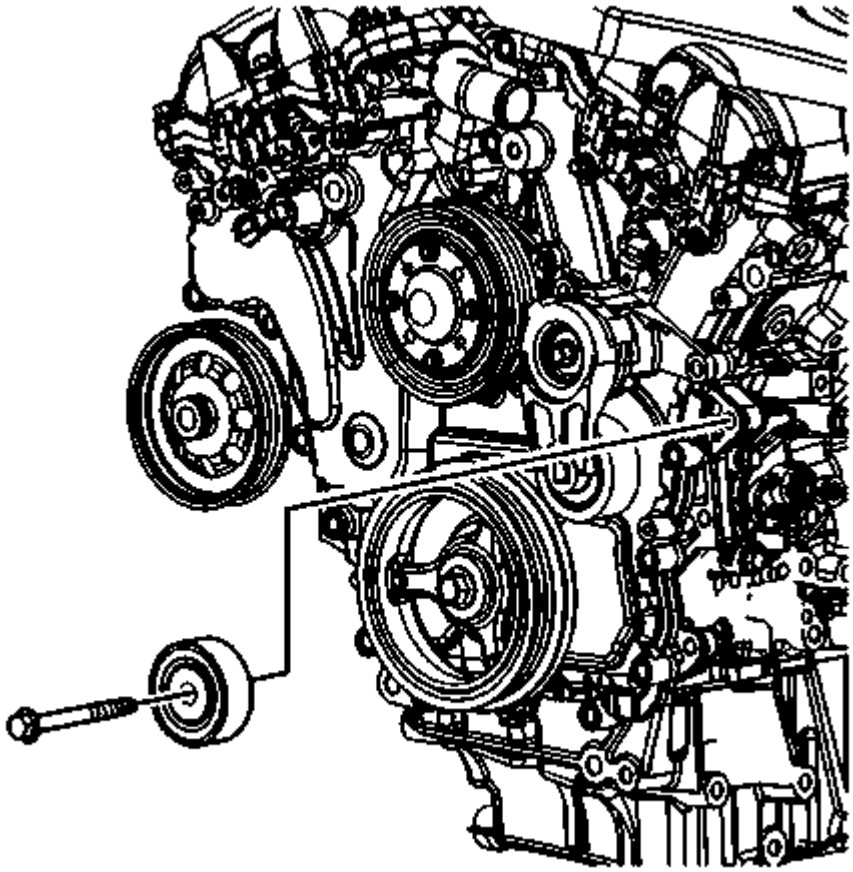

Fig. 73: Identifying Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the drive belt idler bolt and idler. Refer to **Drive Belt Idler Pulley Installation**
6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
7. Install the starter, starter bolts and starter electrical connections.
8. Install the starter heat shield.
9. Install the oil filter.

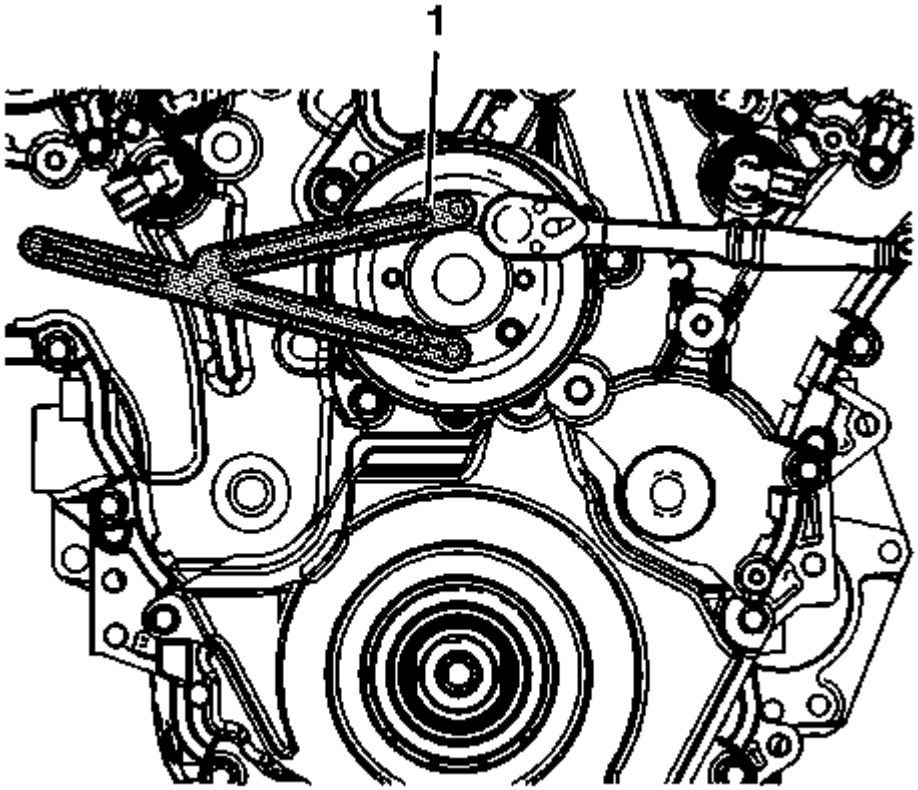

Fig. 74: Water Pump Pulley Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. If removed, install the water pump and the water pump pulley using **EN-46104** Holding Tool. Refer to **Water Pump Installation** .

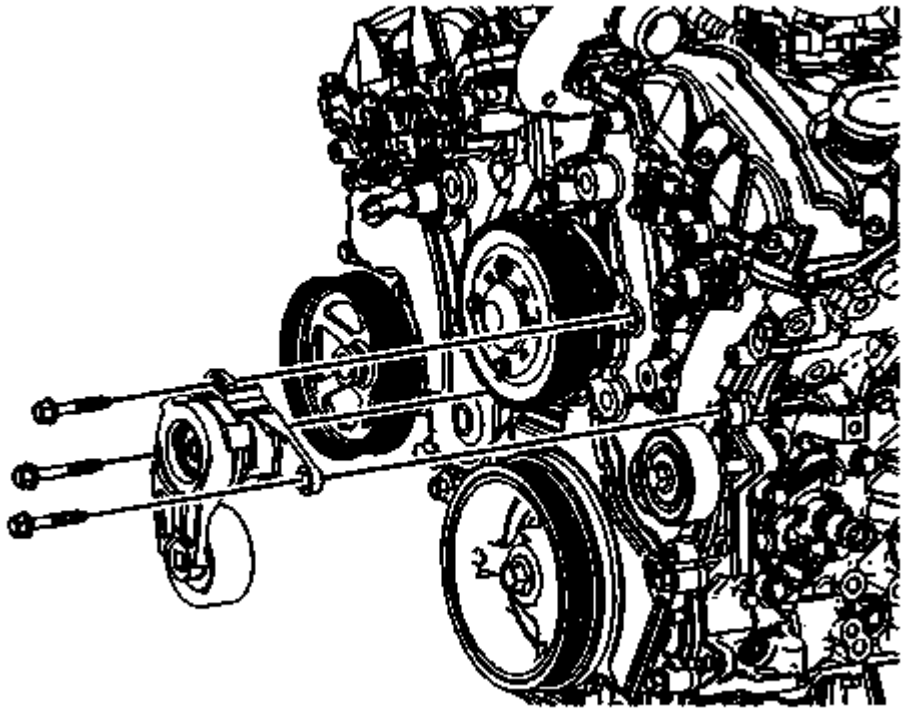

Fig. 75: Identifying Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Install the drive belt tensioner and drive belt. Refer to **Drive Belt Tensioner Installation** .

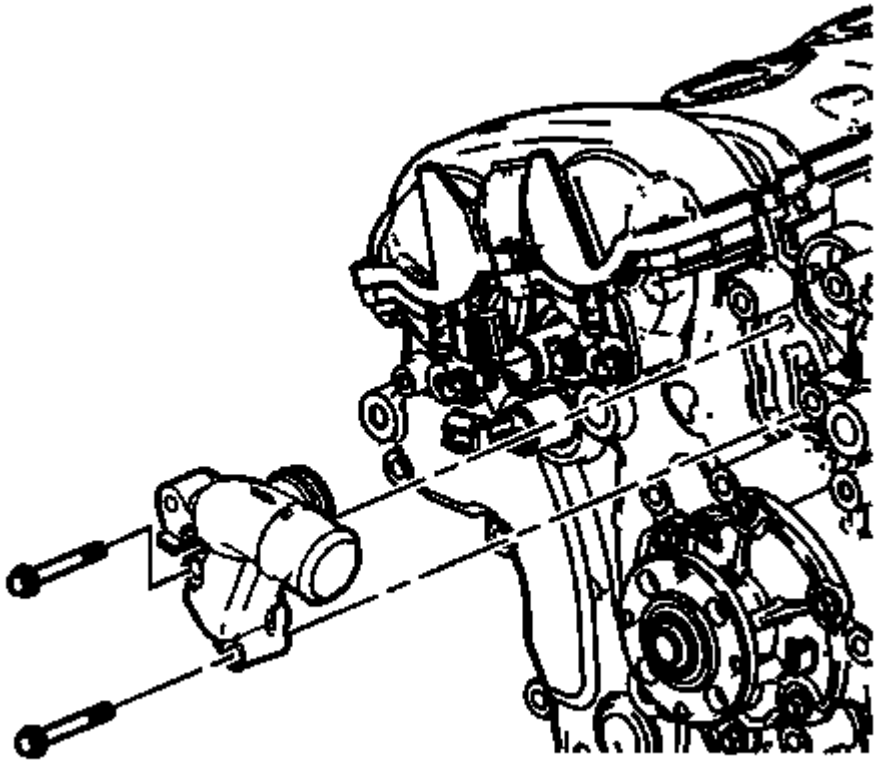

Fig. 76: Locating Water Outlet Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the water outlet housing assembly. Refer to **Water Outlet Installation** .
13. Install the engine mount bracket and bracket bolts.
14. Remove the left and right camshaft covers. Refer to **Camshaft Cover Installation - Left Side** , and **Camshaft Cover Installation - Right Side** .

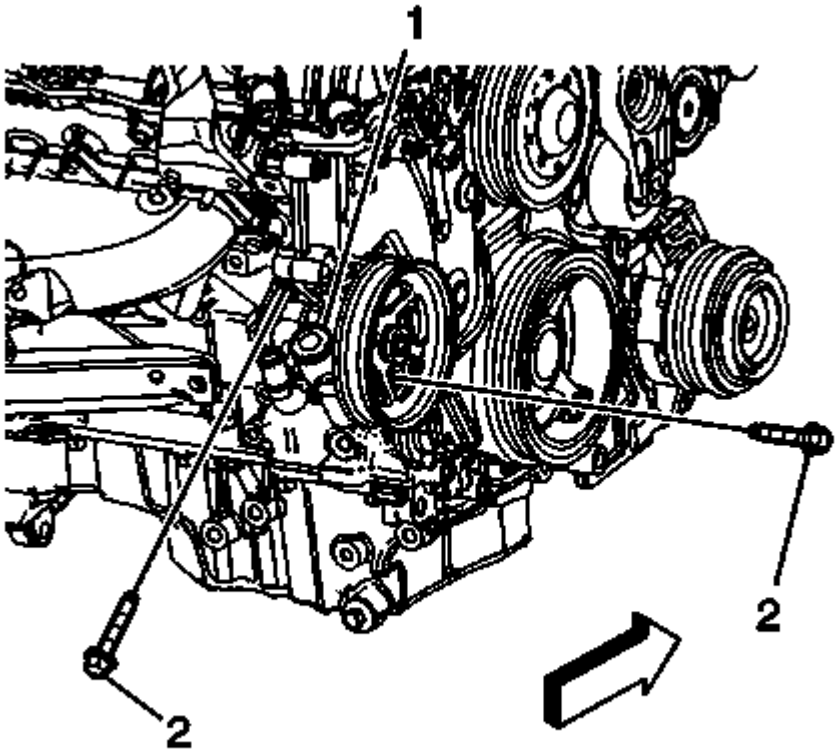

Fig. 77: View Of Power Steering Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

15. Reposition the power steering pump and install the bracket bolts. Tighten the bolts to 50 N.m (37 lb ft).

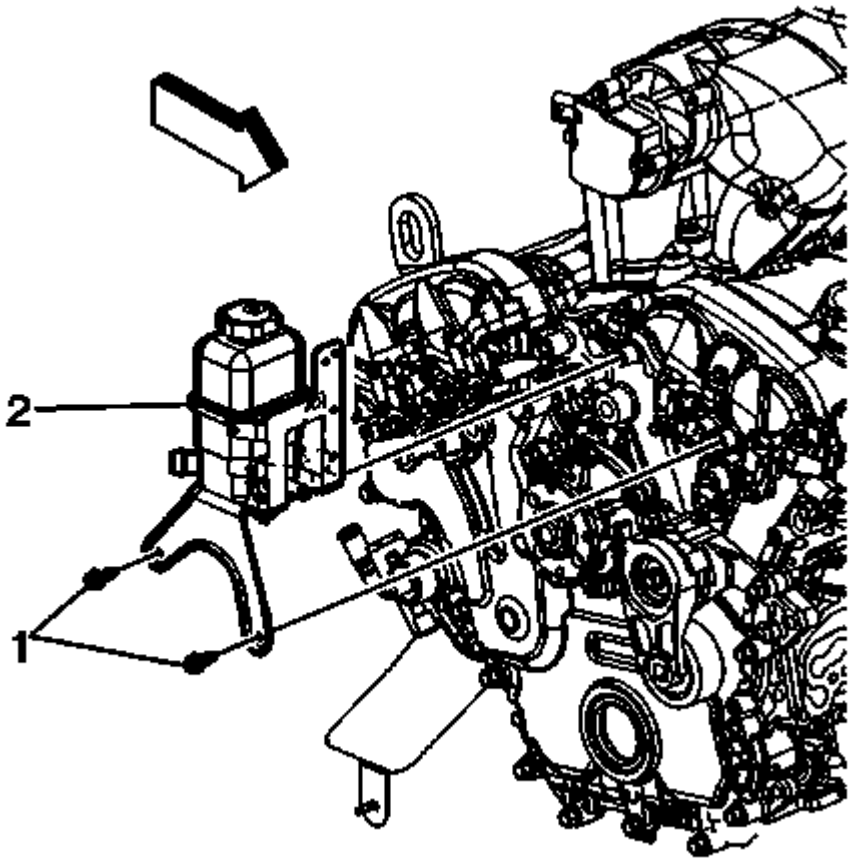

Fig. 78: Identifying Power Steering Fluid Reservoir Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install the power steering reservoir and install the bracket bolts. Tighten the bolts to 9 N.m (80 lb in).

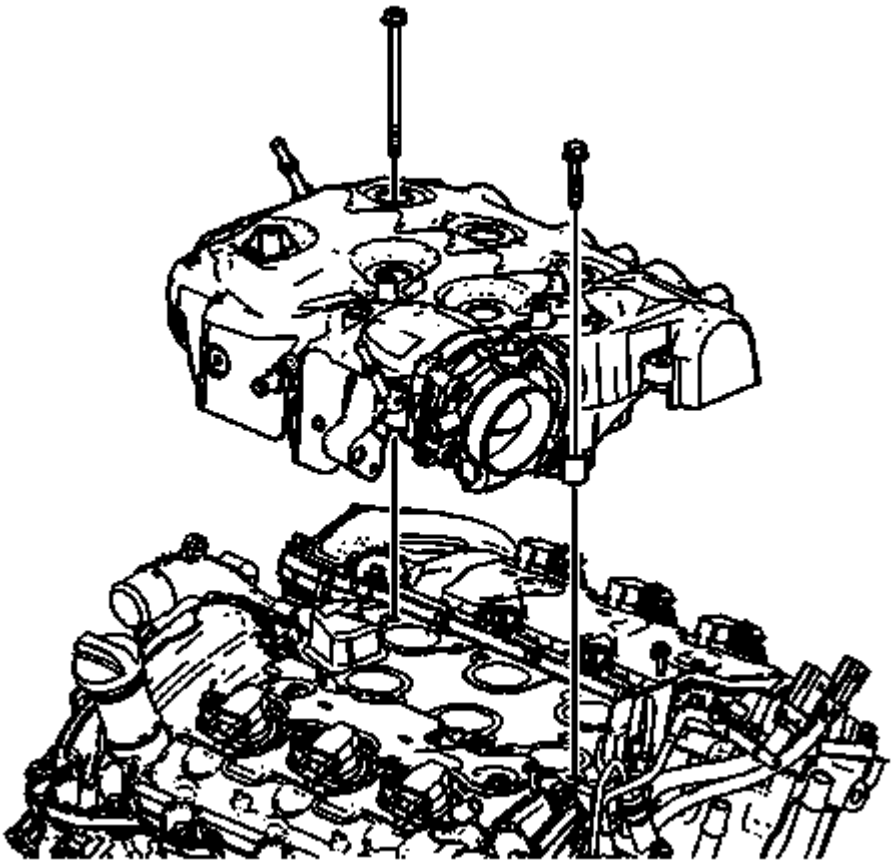

Fig. 79: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the intake manifold. Refer to **Intake Manifold Installation** .
18. Install the frame with the engine and transmission. Refer to **Engine Replacement**.

    Follow steps 16-49 in Engine Replacement Installation.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

Removal Procedure

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

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

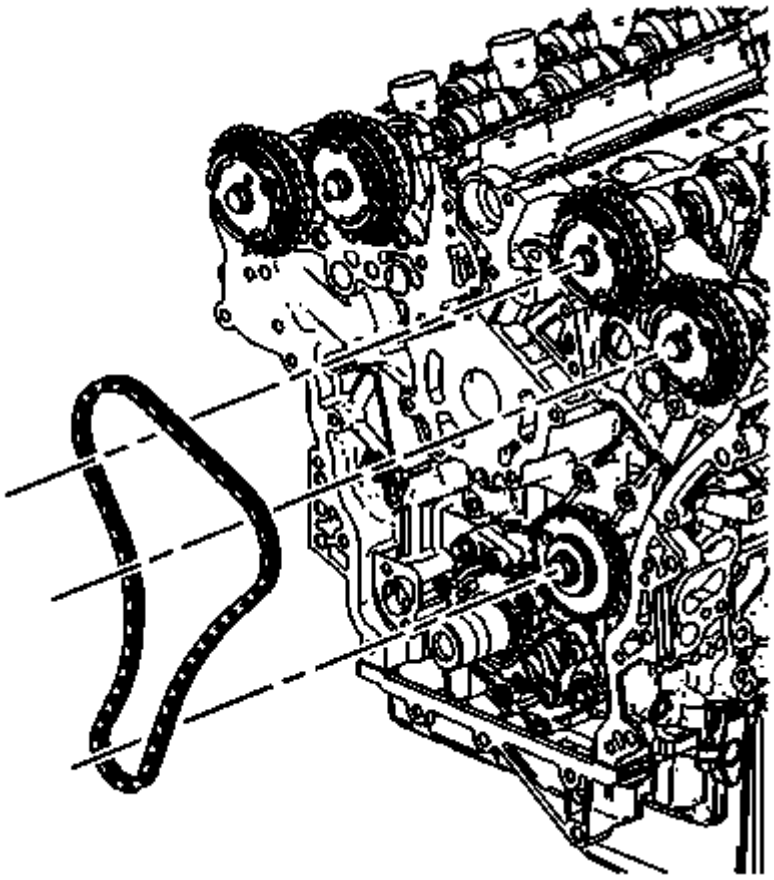

Fig. 80: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

14. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate**

Drive Chain Removal - Left Side .

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

Installation Procedure

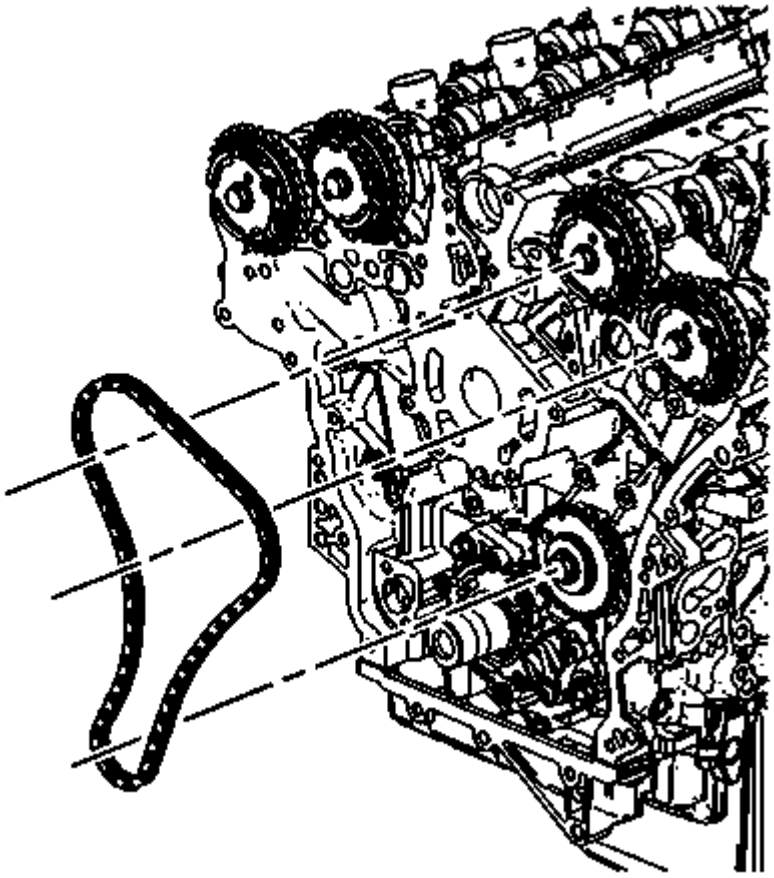

Fig. 81: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

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

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Removal Procedure

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

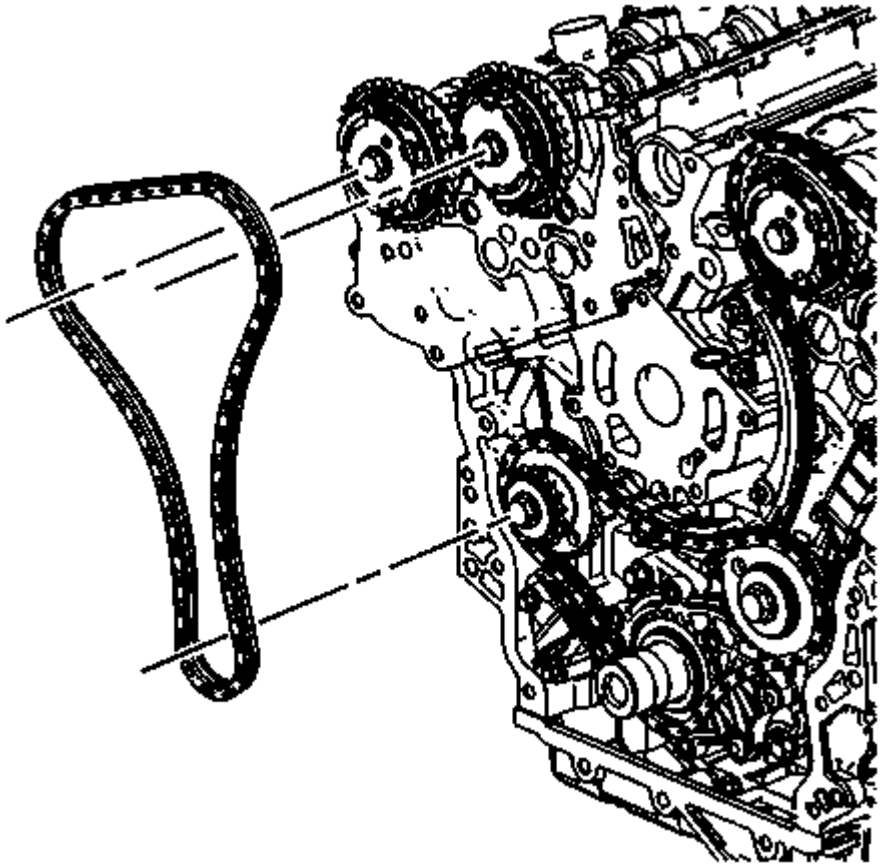

Fig. 82: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

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

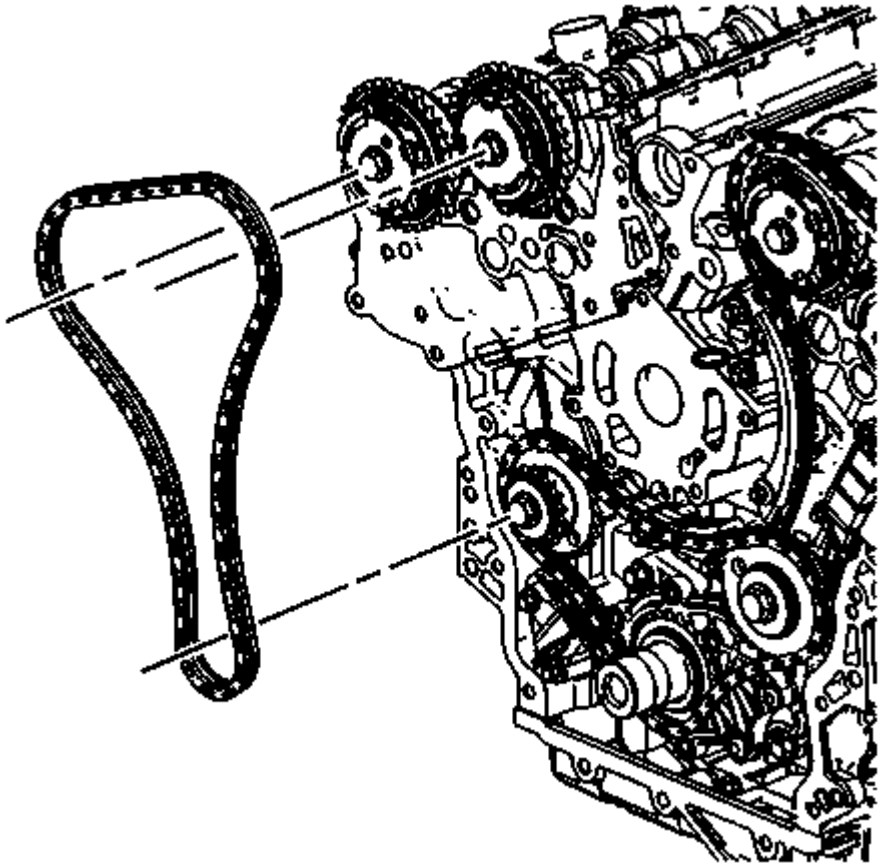

Fig. 83: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

2. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
3. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
4. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
5. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
6. Install the spark plugs. Refer to **Spark Plug Replacement** .
7. 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**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .

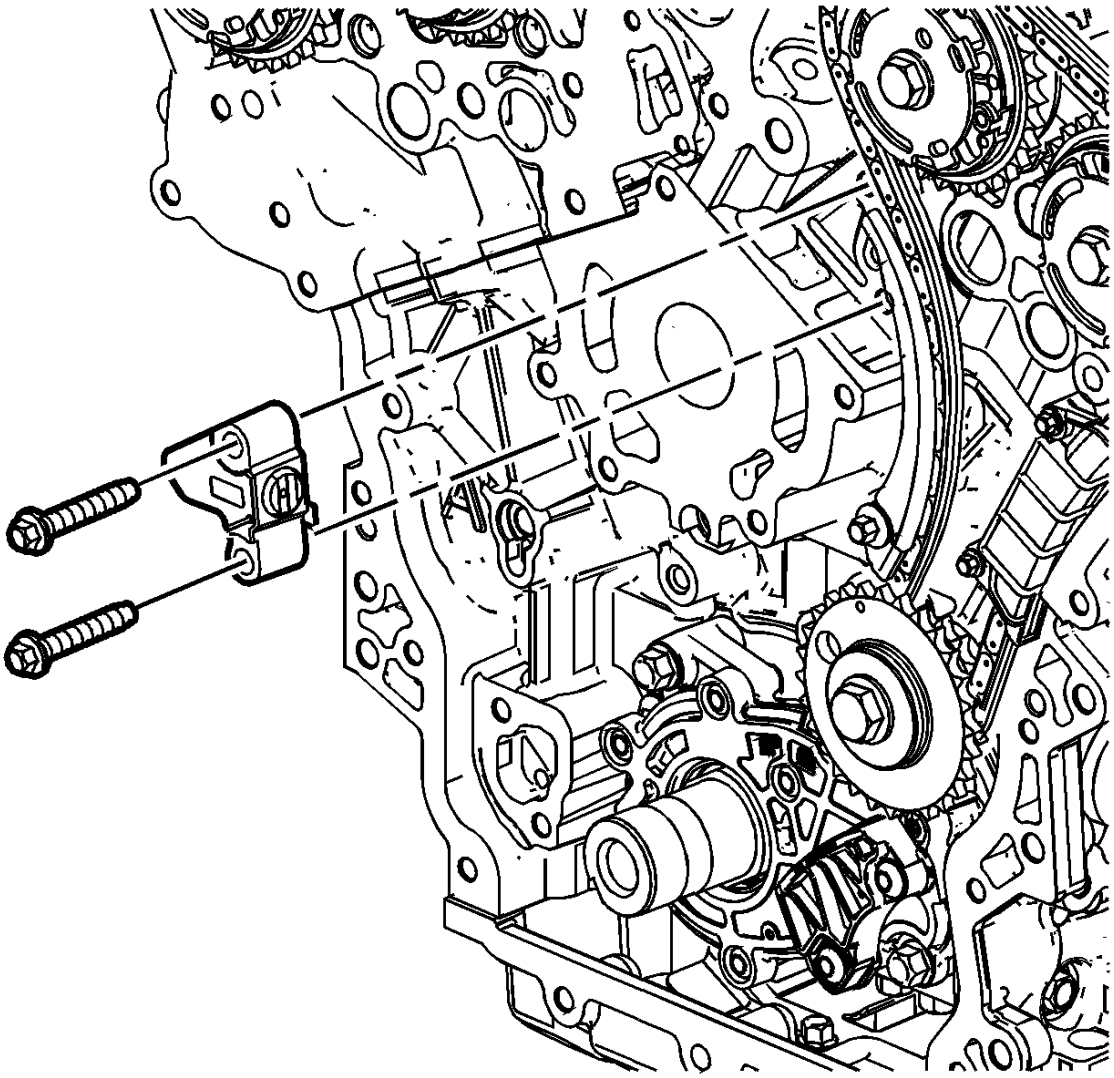

Fig. 84: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

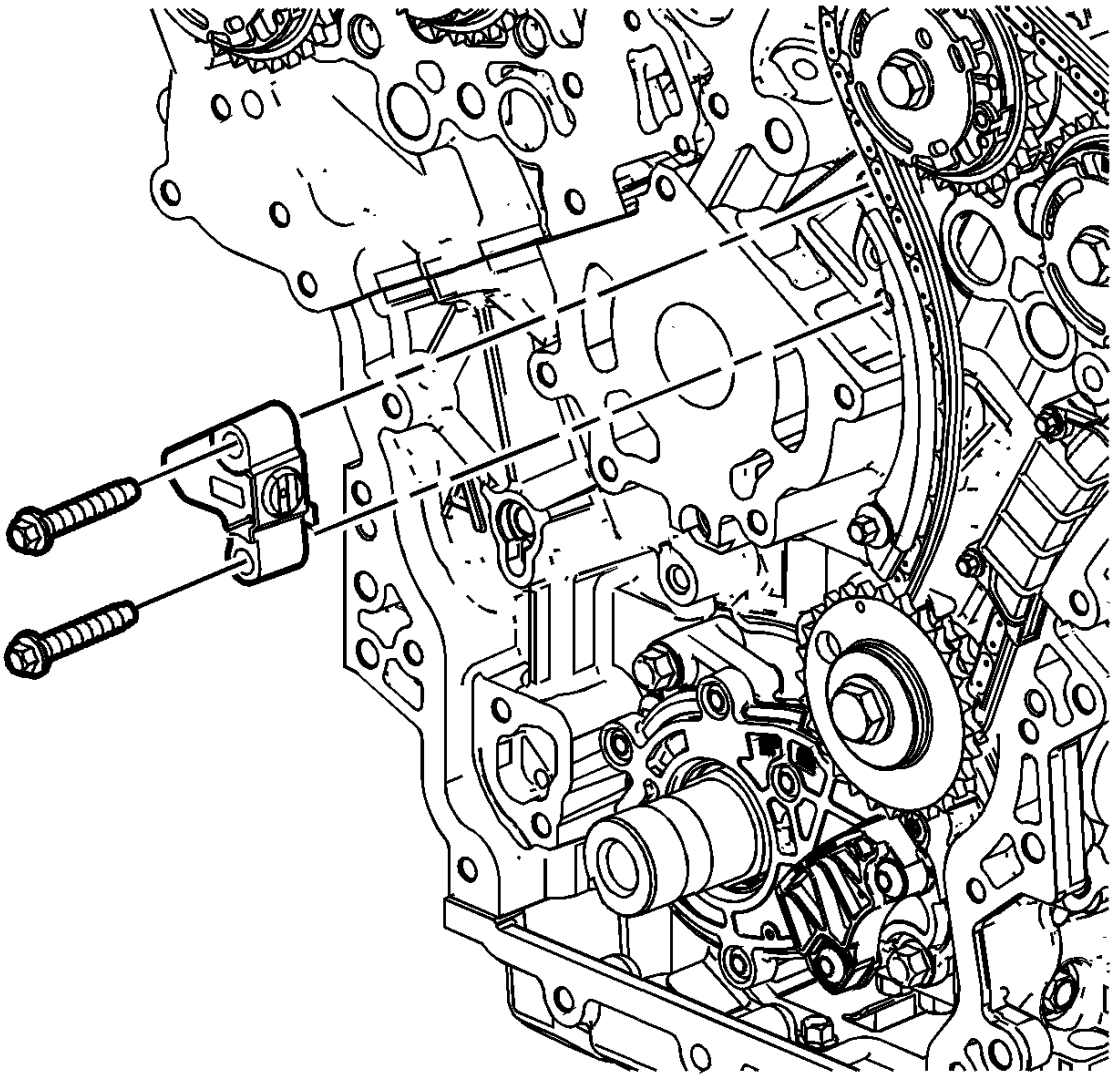

Fig. 85: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
2. Install the spark plugs. Refer to **Spark Plug Replacement** .
3. 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 spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .

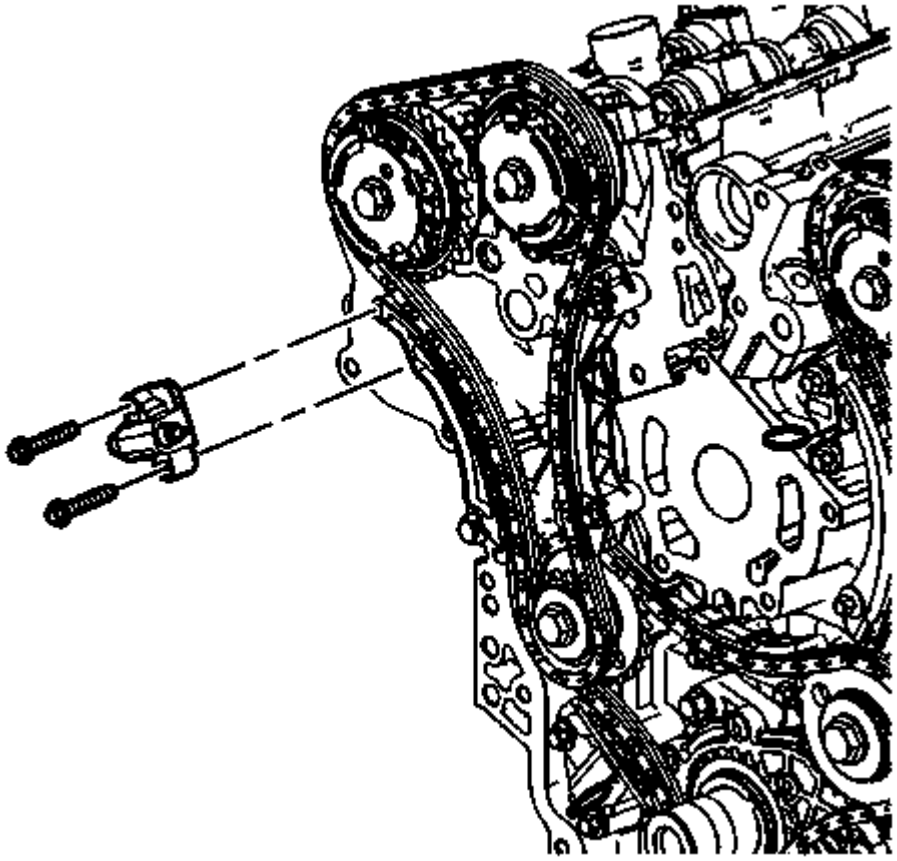

Fig. 86: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

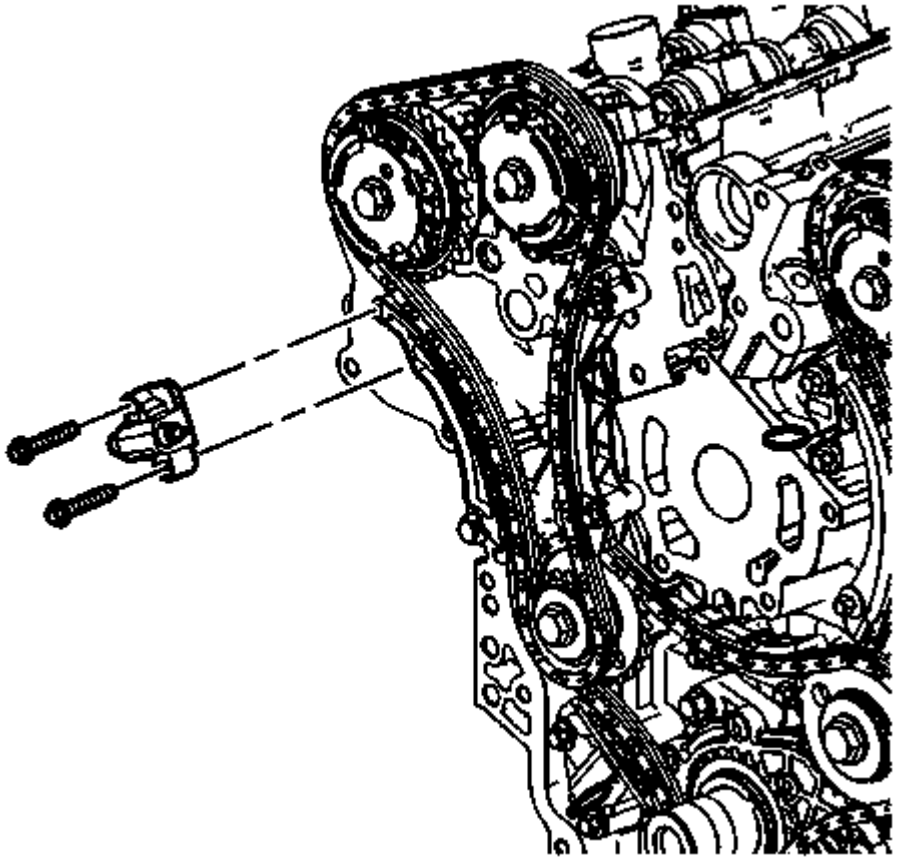

Fig. 87: View Of Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
2. Install the spark plugs. Refer to **Spark Plug Replacement** .
3. 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**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

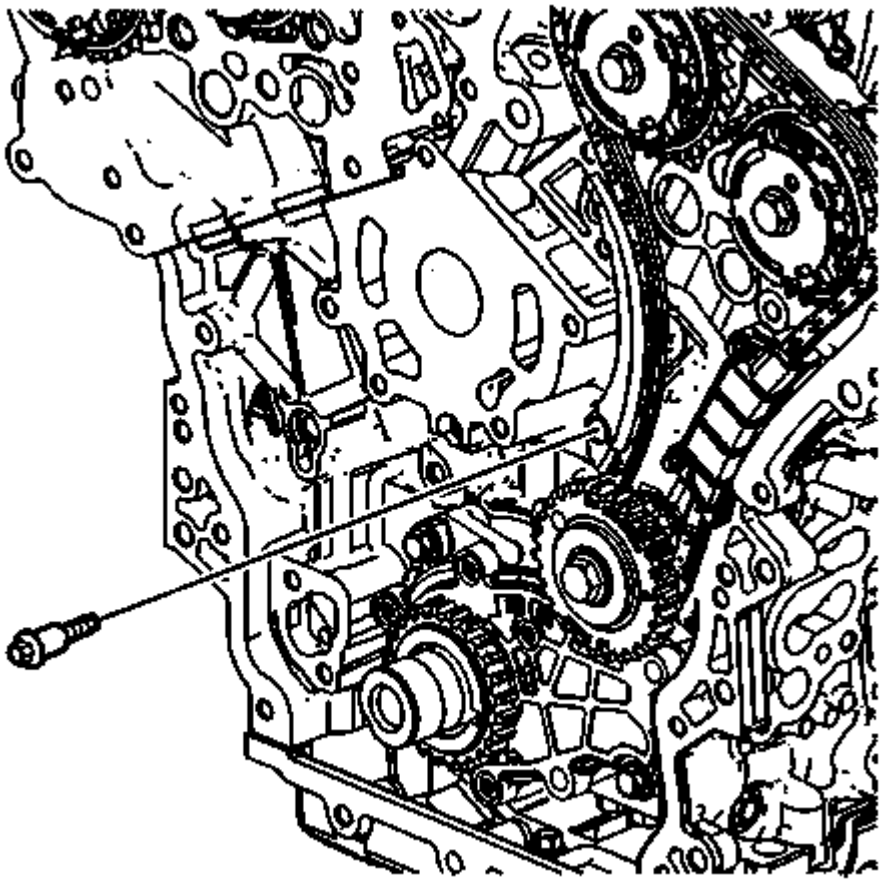

Fig. 88: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left secondary camshaft drive chain shoe bolt.

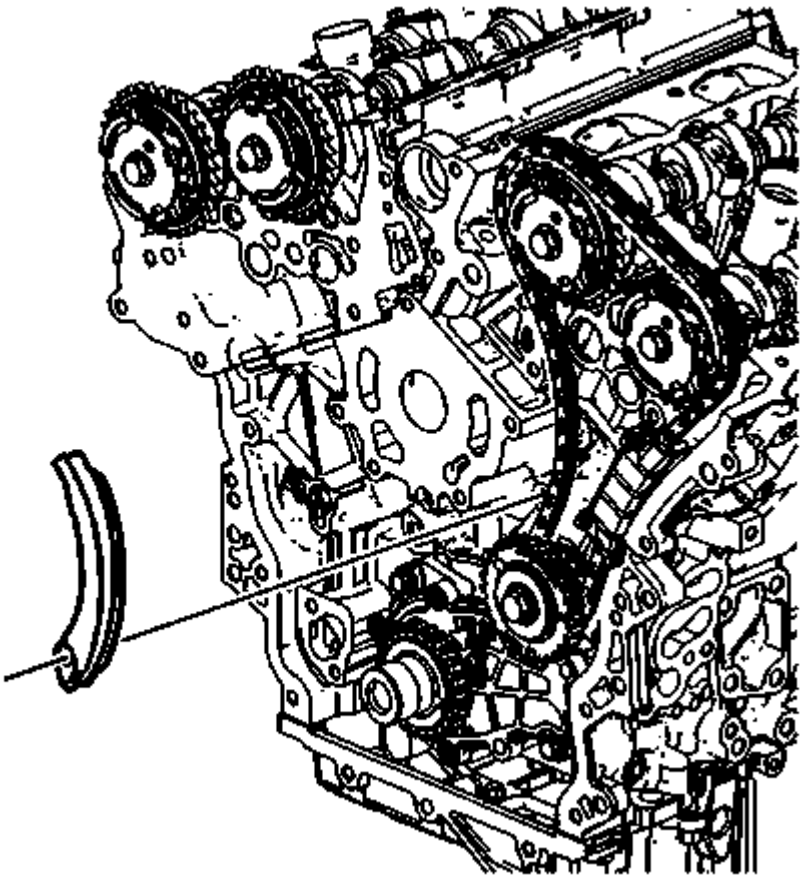

Fig. 89: View Of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left secondary camshaft drive chain shoe.

Installation Procedure

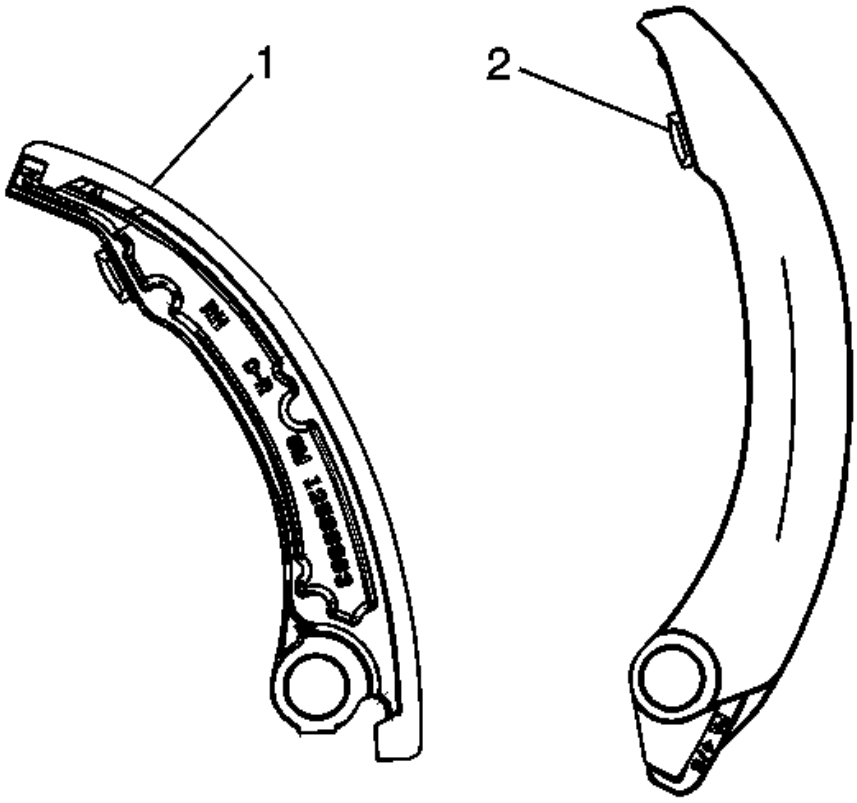

Fig. 90: Identifying Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left secondary camshaft drive chain shoe (2) is being installed.

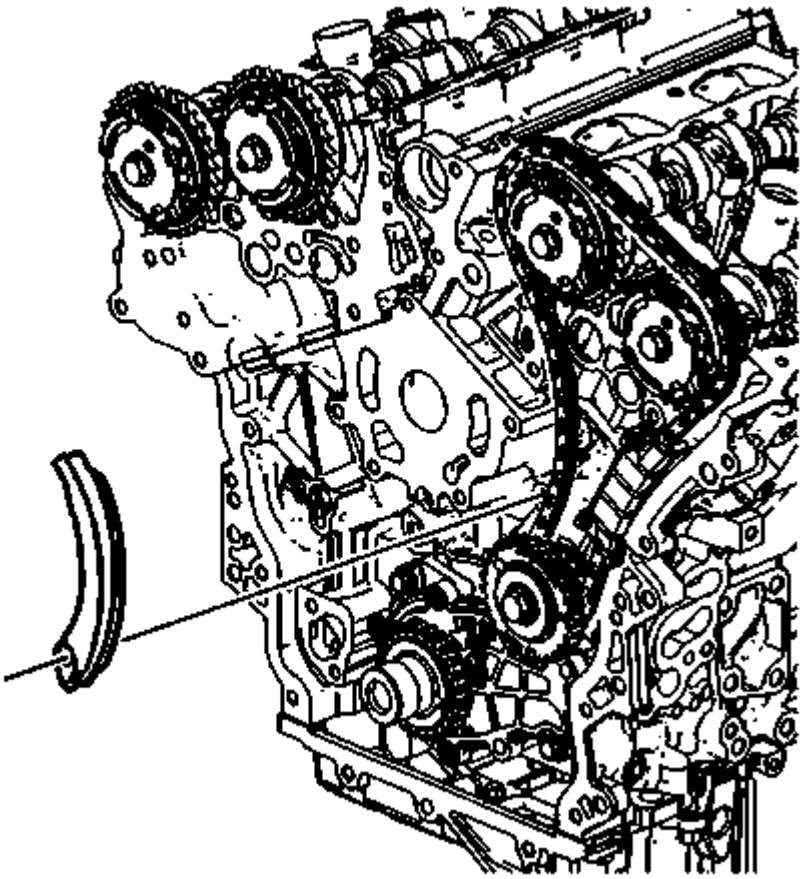

Fig. 91: View Of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

2. Position the left secondary camshaft drive chain shoe.

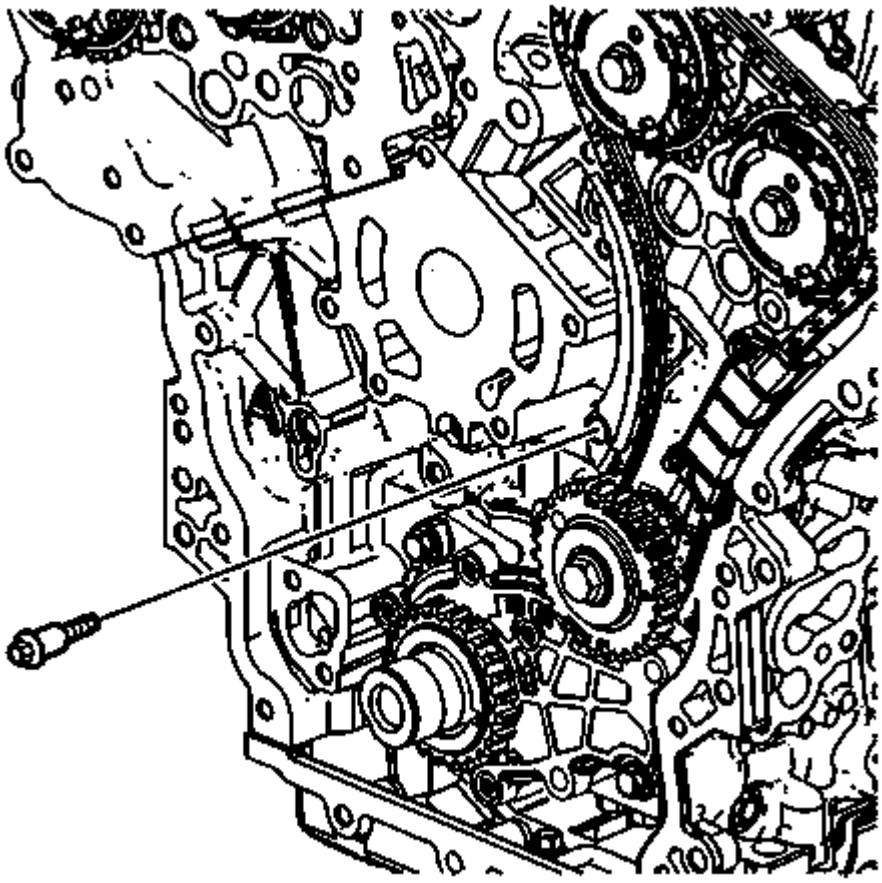

Fig. 92: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).
4. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
5. Install the spark plugs. Refer to **Spark Plug Replacement** .

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Removal Procedure

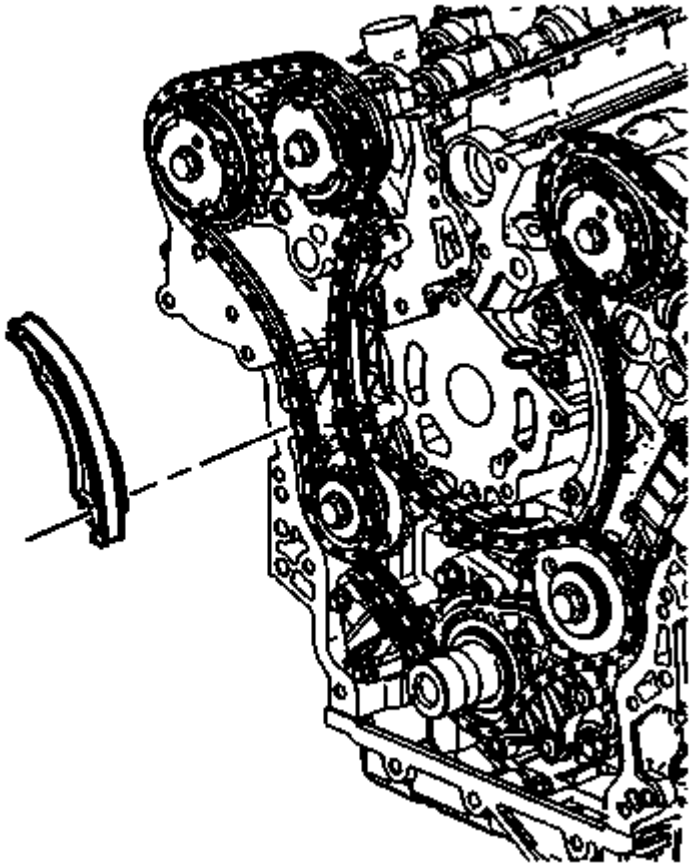

Fig. 93: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

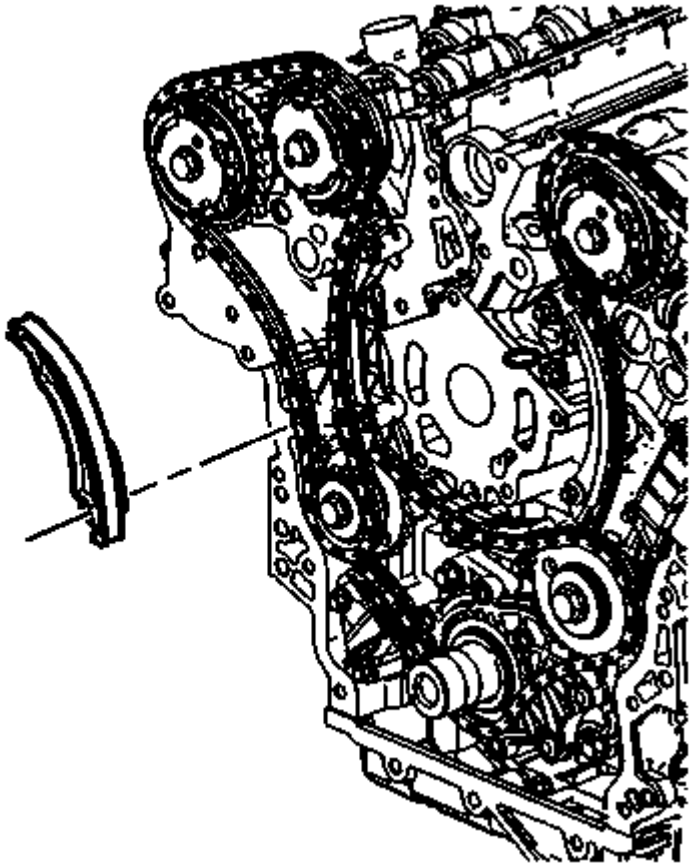

Fig. 94: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Install the spark plugs. Refer to **Spark Plug Replacement** .
4. 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 spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

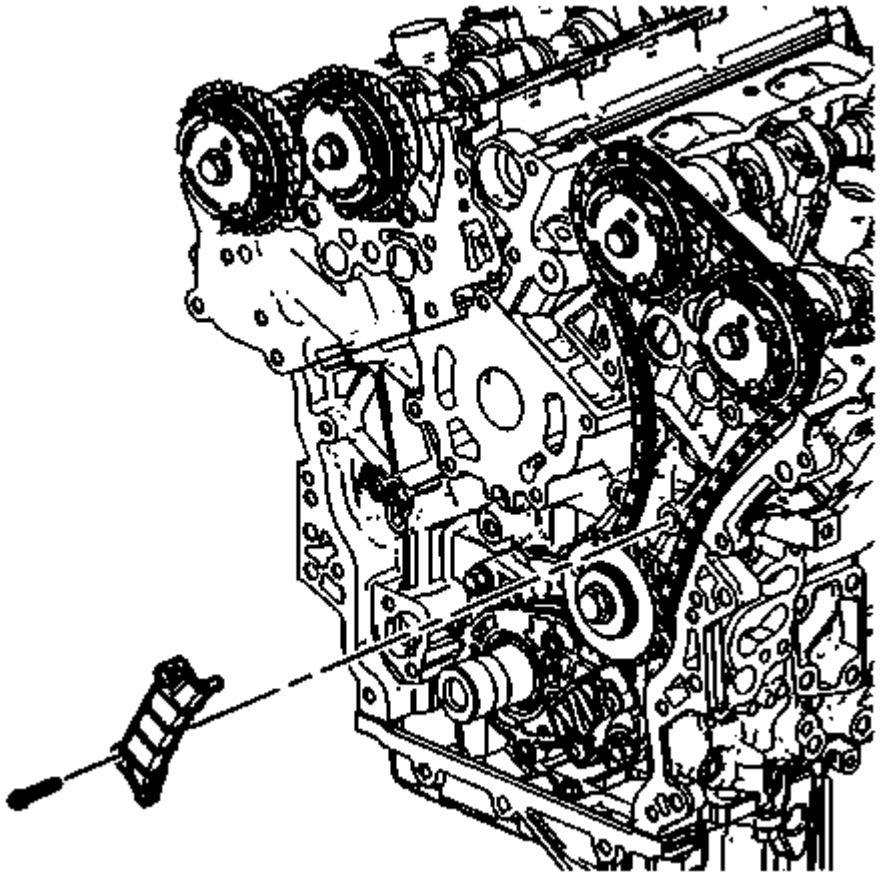

Fig. 95: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

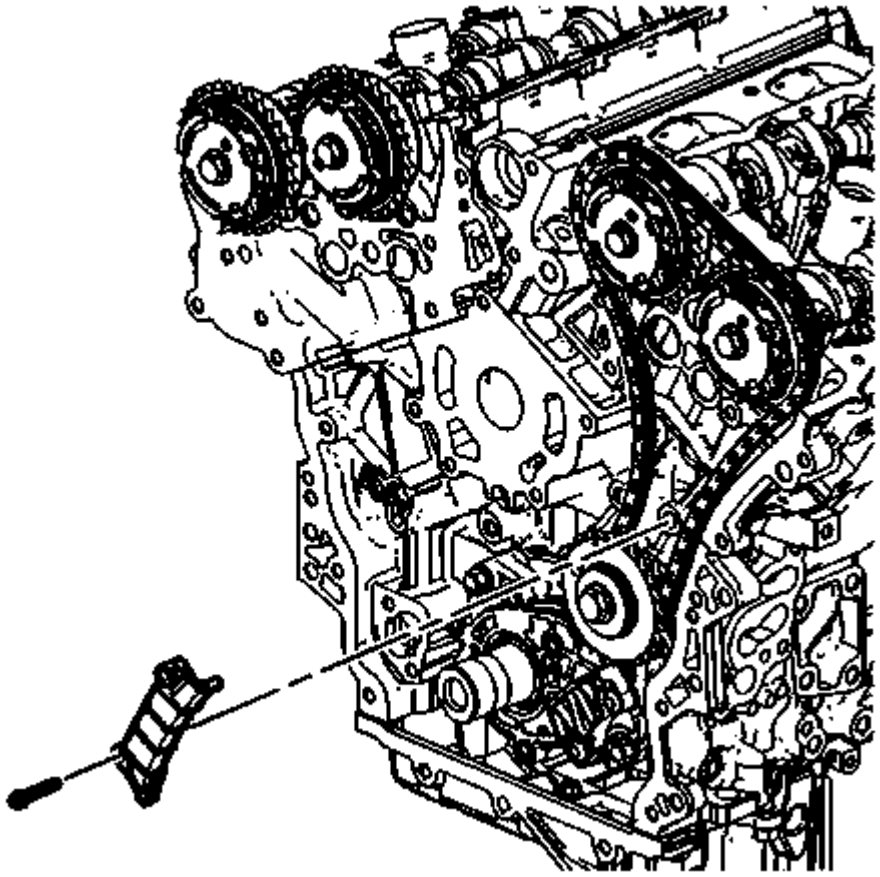

Fig. 96: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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 spark plugs. Refer to **Spark Plug Replacement** .
4. 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 spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

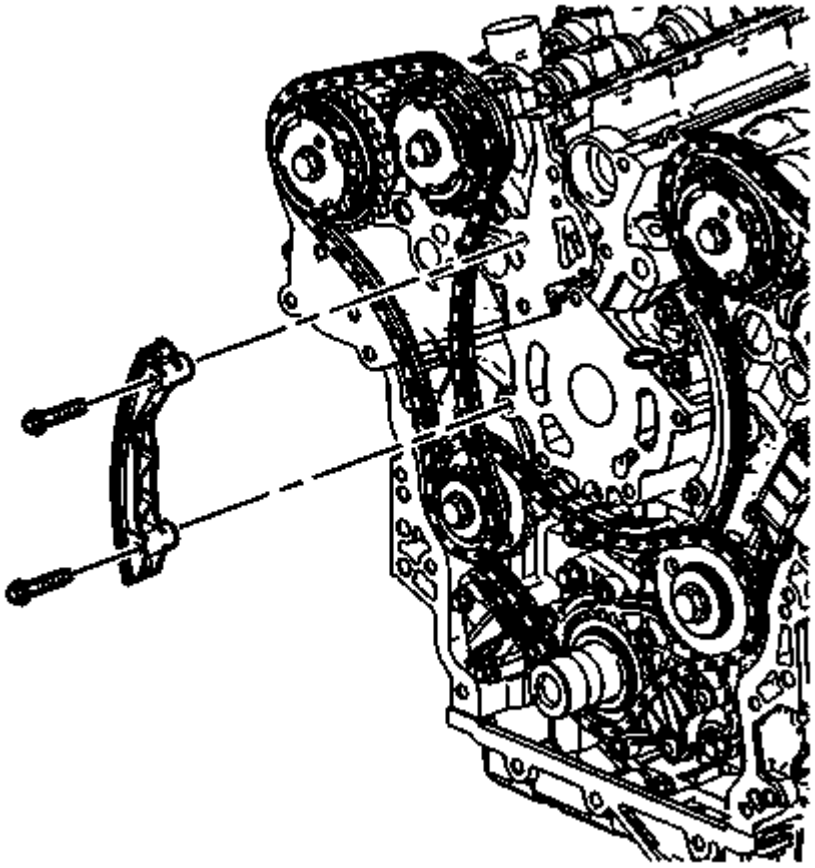

Fig. 97: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

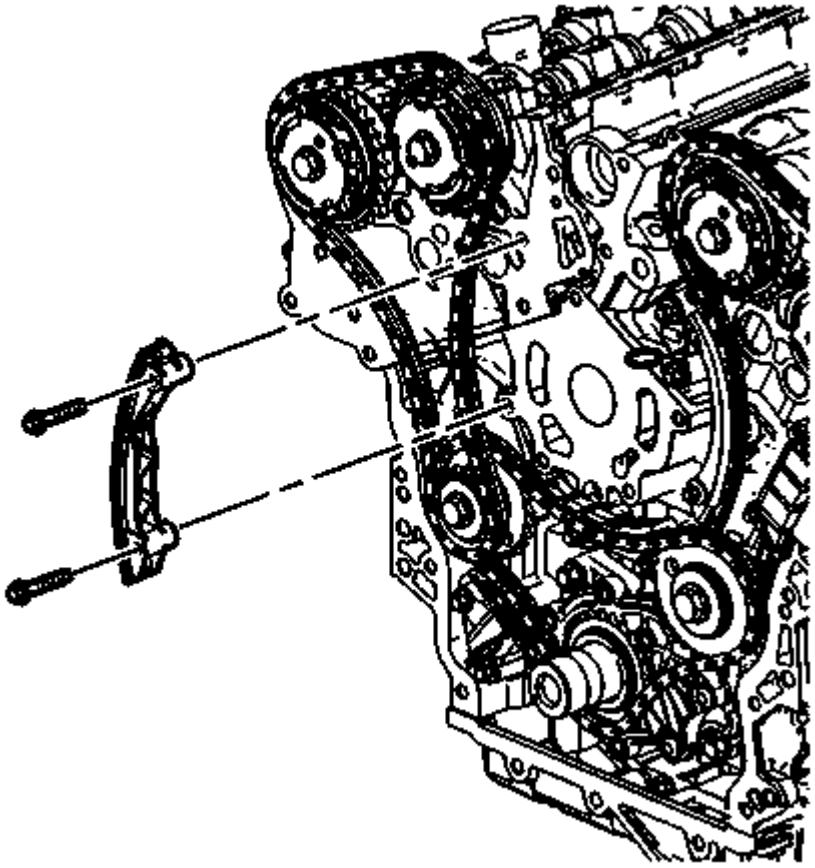

Fig. 98: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Special Tools

EN 46111 Crankshaft Rotation Socket

Removal Procedure

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

4. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
6. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .
7. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
8. Remove the primary camshaft drive chain upper guide. Refer to **Primary Timing Chain Guide Removal - Upper** .

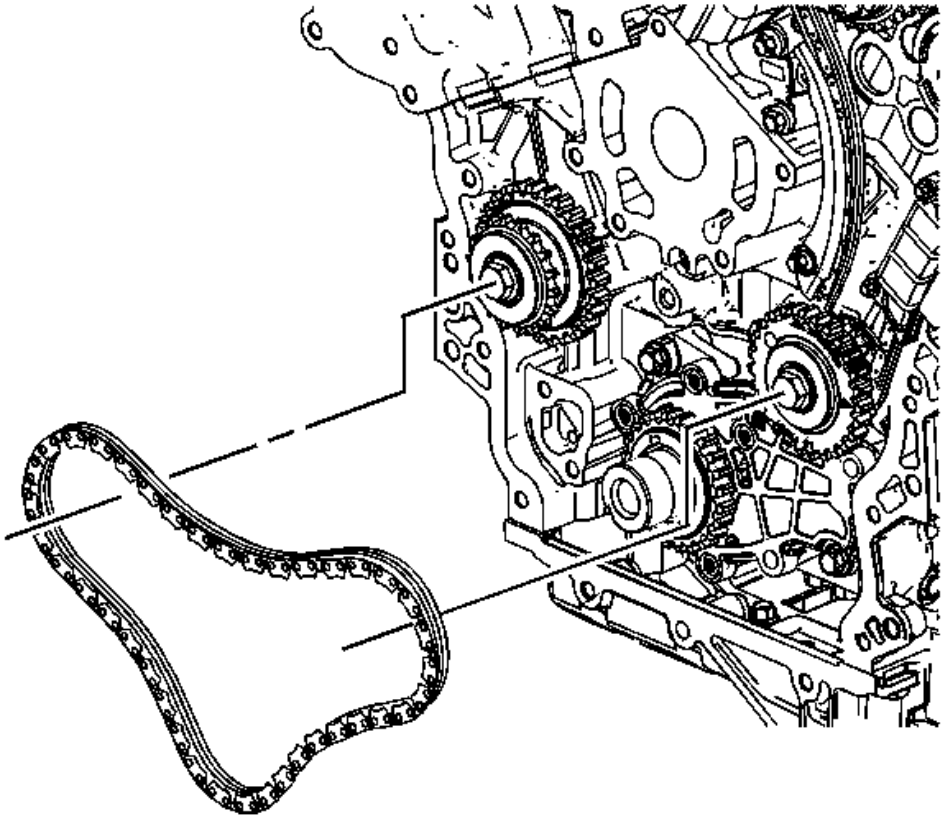

Fig. 99: Identifying Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

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

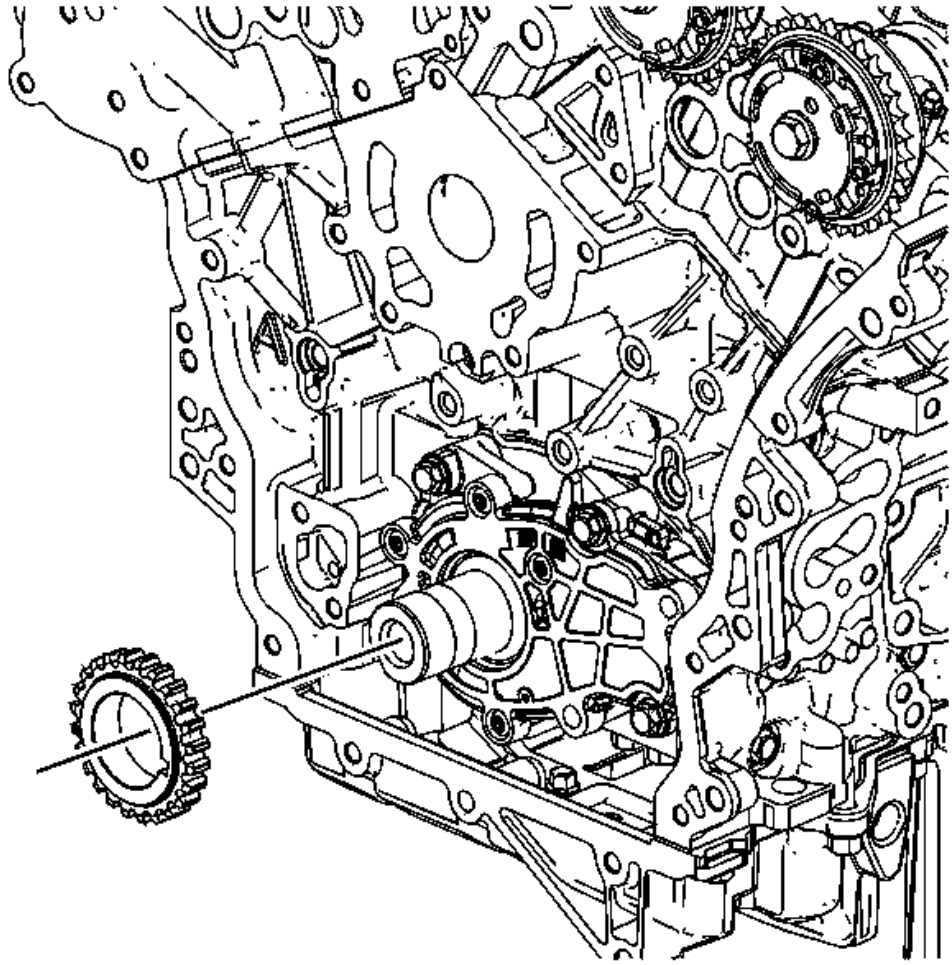

Fig. 100: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

10. Remove the crankshaft sprocket from the nose of the crankshaft.

Installation Procedure

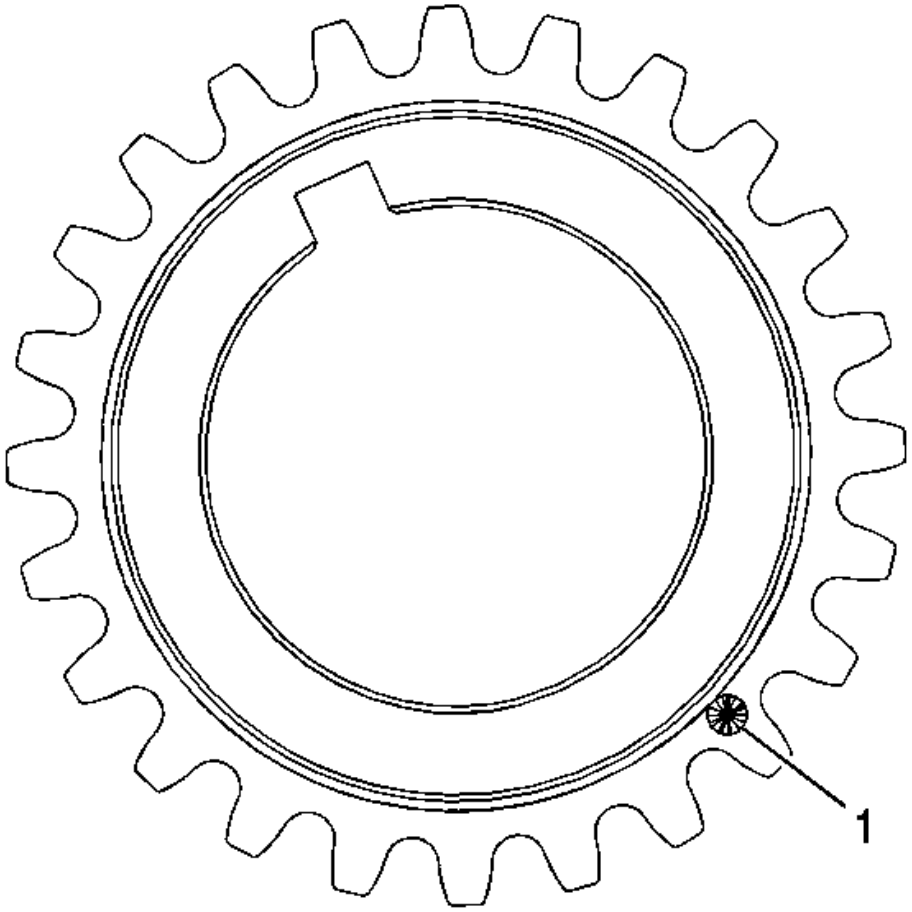

Fig. 101: Locating Timing Mark
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.

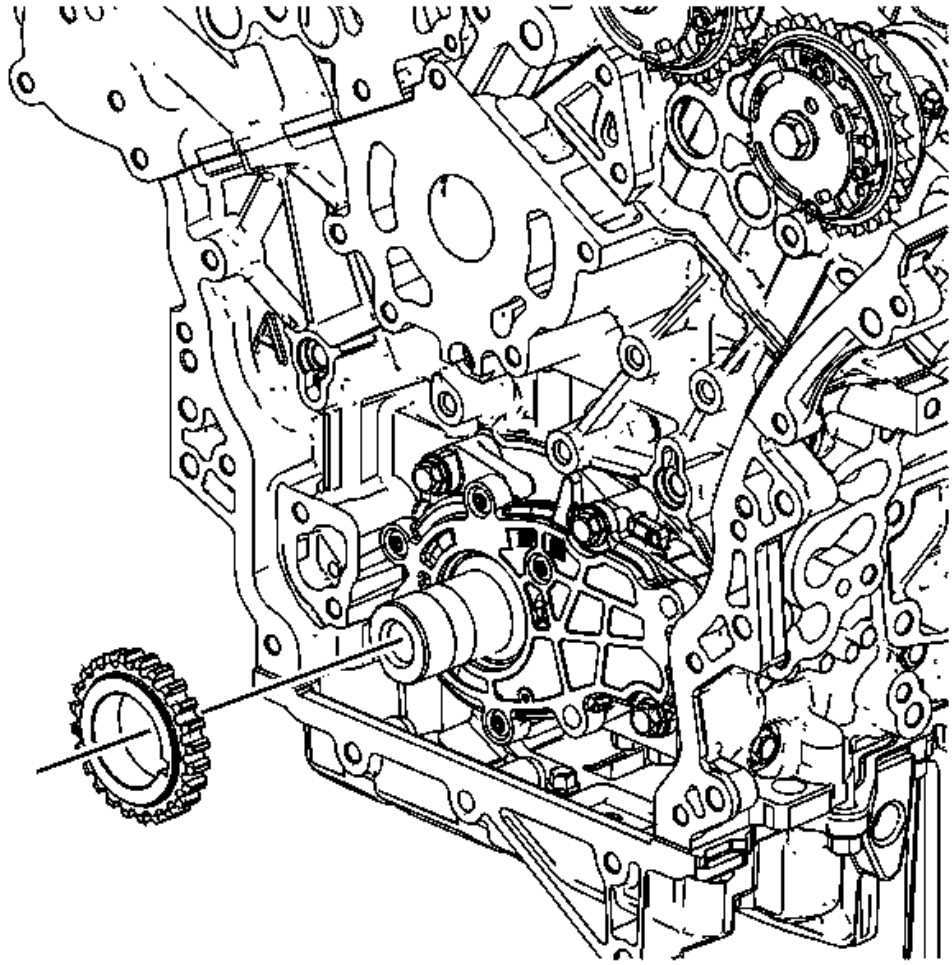

Fig. 102: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft sprocket on to the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.

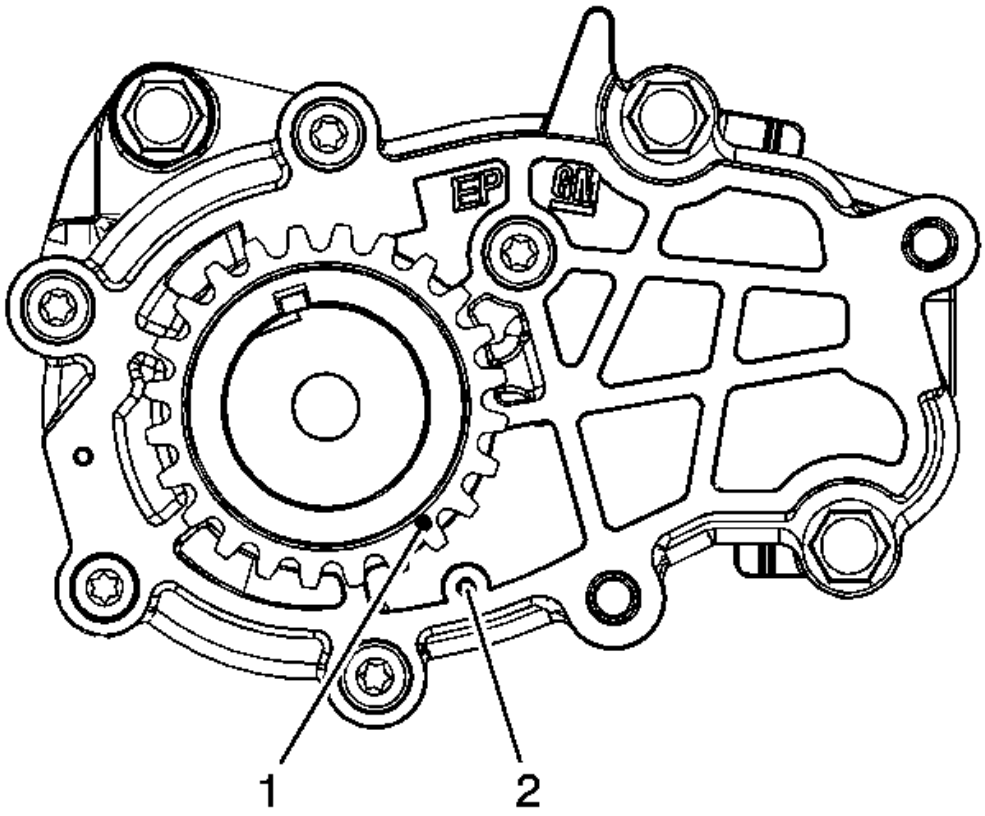

Fig. 103: View Of Timing Mark And Oil Pump Cover
Courtesy of GENERAL MOTORS COMPANY

5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN 46111** crankshaft rotation socket. Refer to **Timing Chain Alignment Diagram** - Stage One.

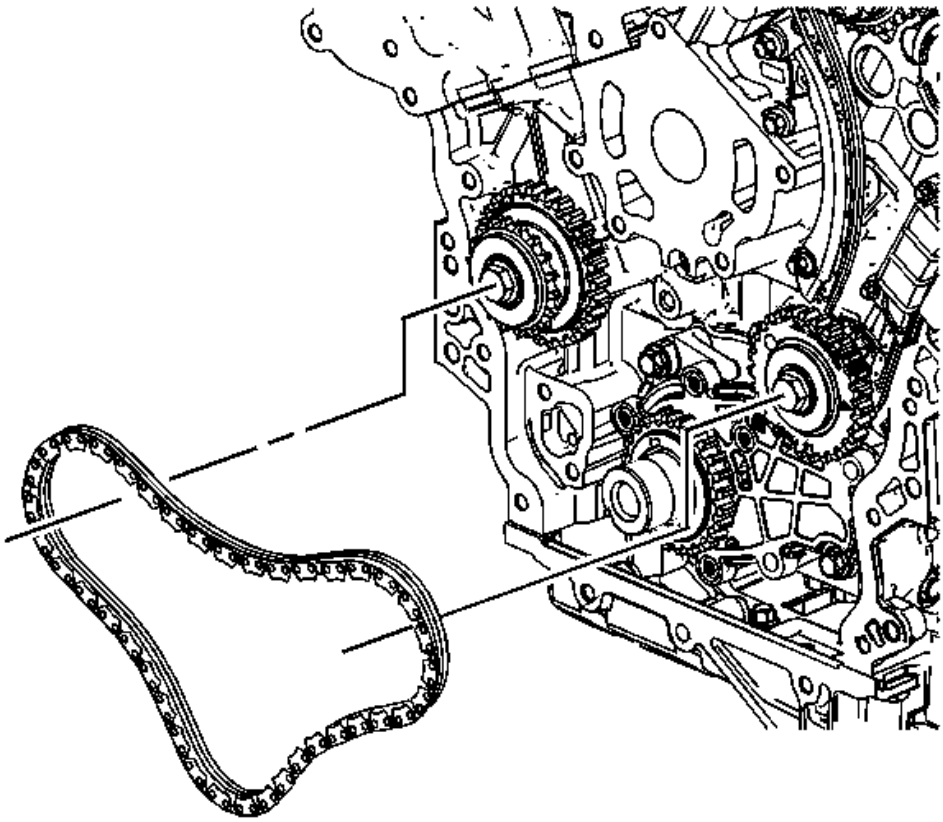

Fig. 104: Identifying Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

6. Install the primary camshaft timing chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
7. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
8. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
9. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
10. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
11. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
12. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .

13. Install the spark plugs. Refer to **Spark Plug Replacement** .
14. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

Removal Procedure

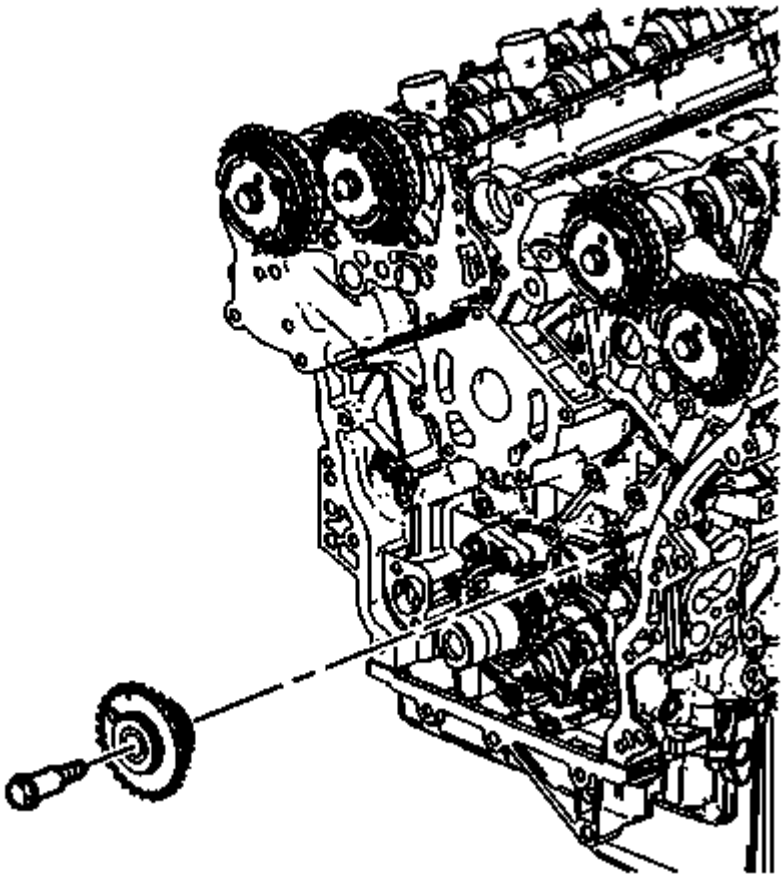

Fig. 105: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

Chain Tensioner Removal .

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

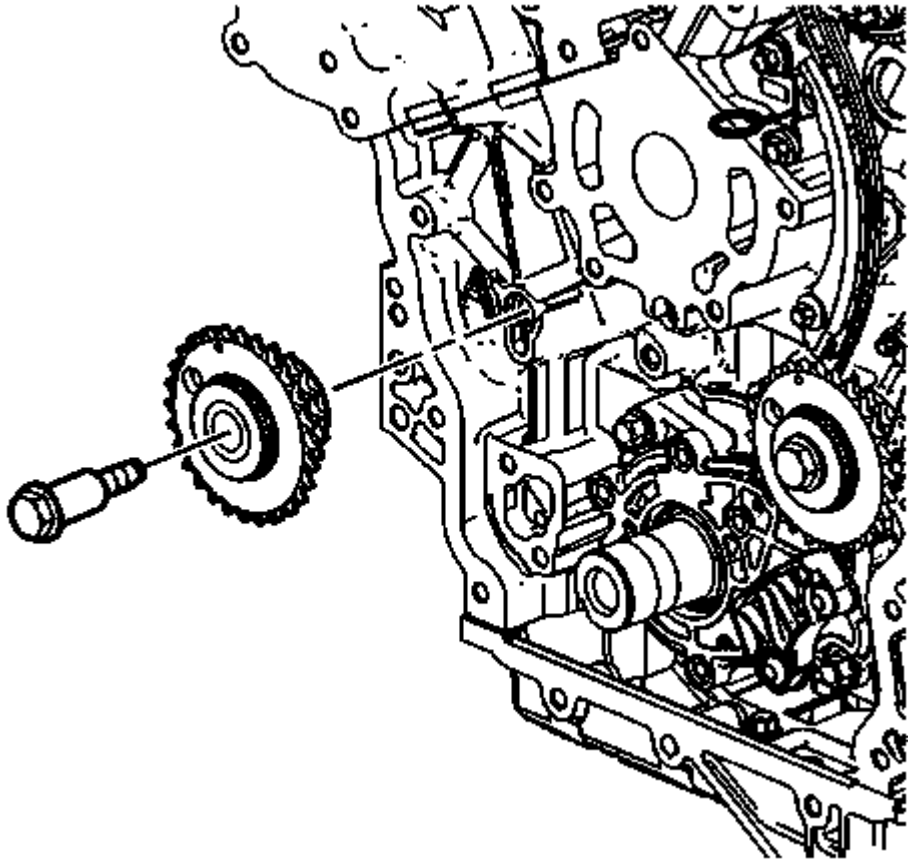

Fig. 106: View Of Right & Left Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS COMPANY

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

Sprocket Removal - Left Side .

Installation Procedure

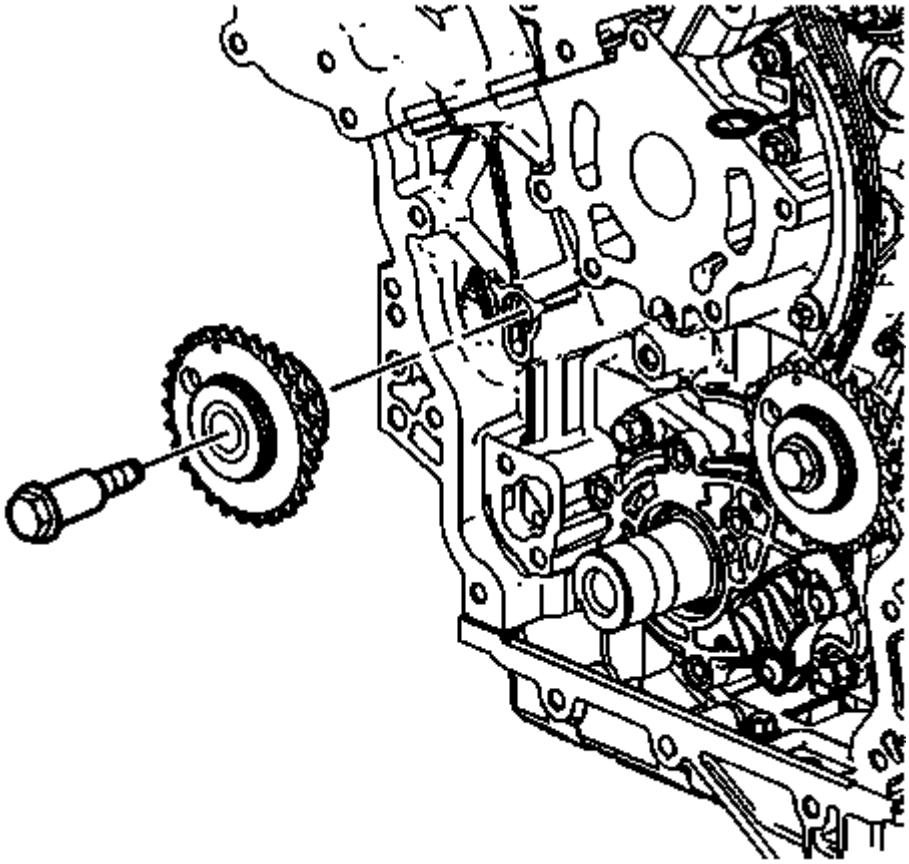

Fig. 107: View Of Right & Left Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS COMPANY

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

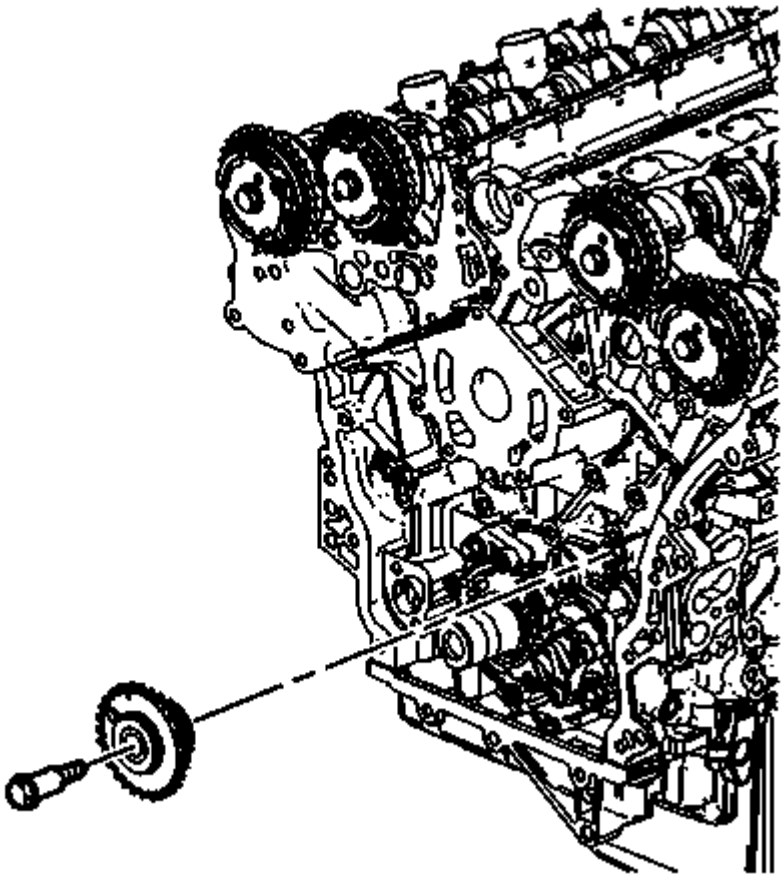

Fig. 108: View Of Left Camshaft Intermediate Drive Chain Idler Sprocket
Courtesy of GENERAL MOTORS COMPANY

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

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

Removal Procedure

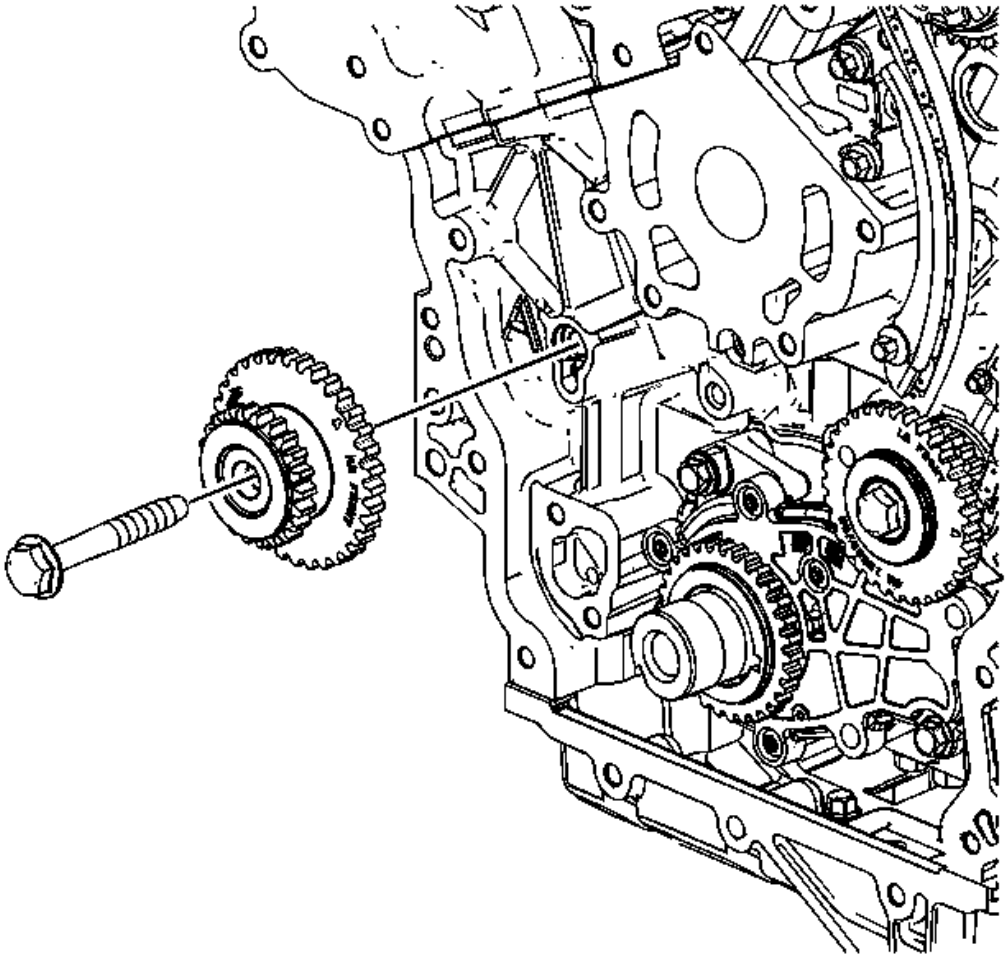

Fig. 109: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

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

Chain Tensioner Removal .

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

Installation Procedure

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

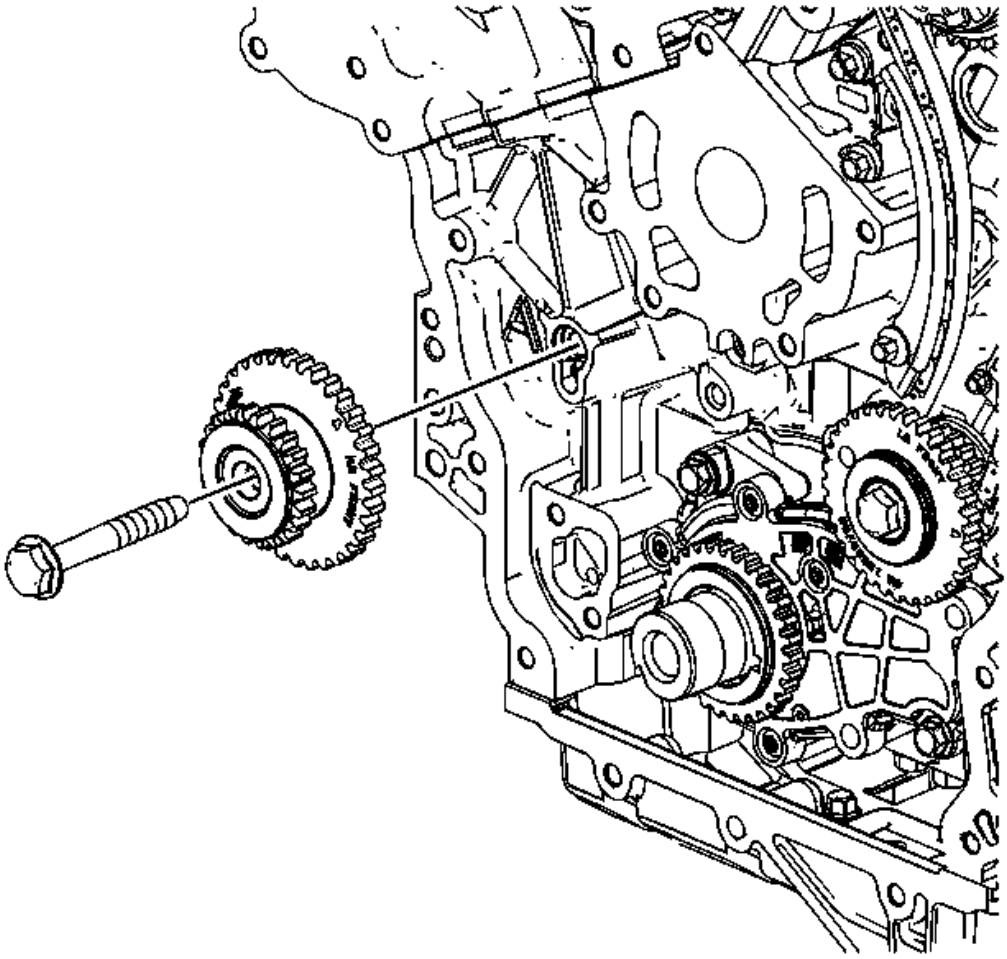

Fig. 110: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain**

Installation .

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

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

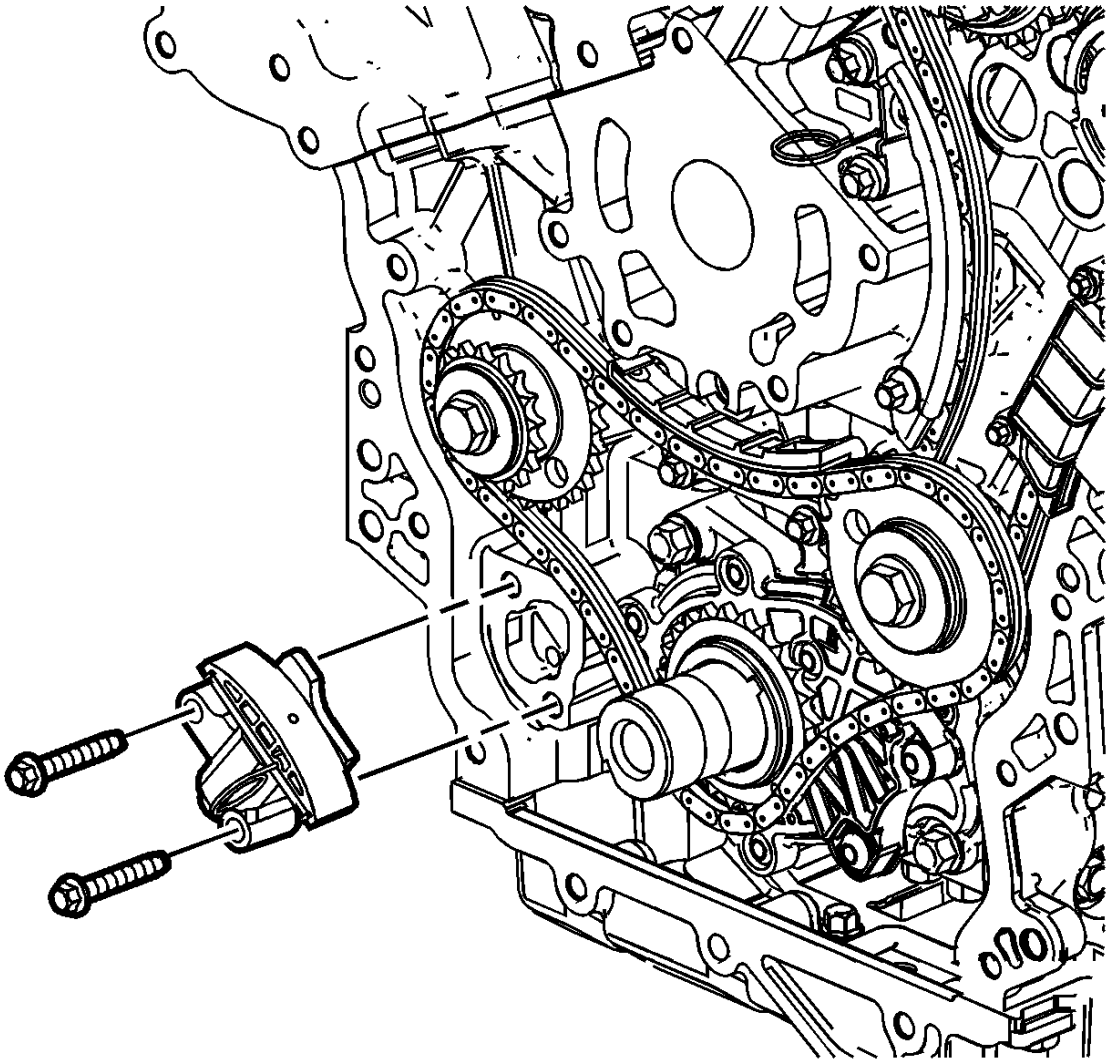

Fig. 111: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .

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.

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

Installation Procedure

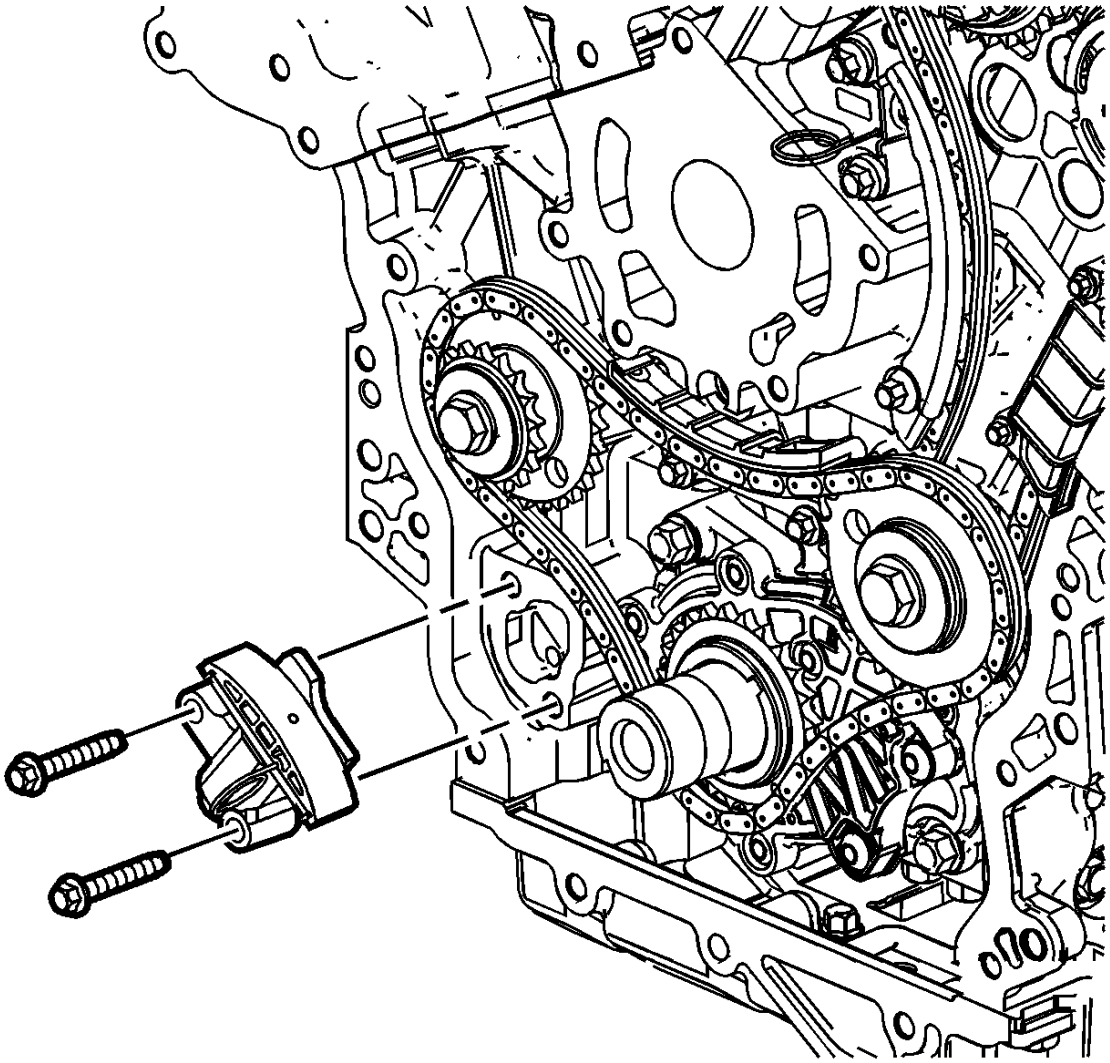

Fig. 112: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
2. Install the spark plugs. Refer to **Spark Plug Replacement** .
3. 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**.

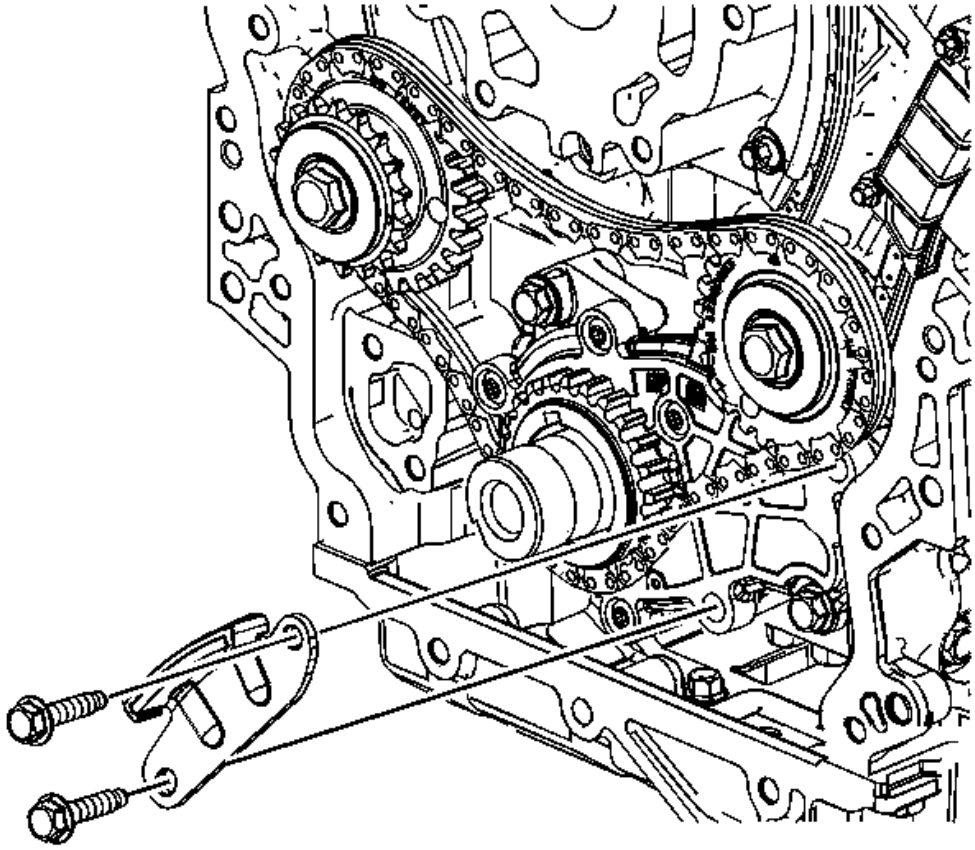

Fig. 113: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

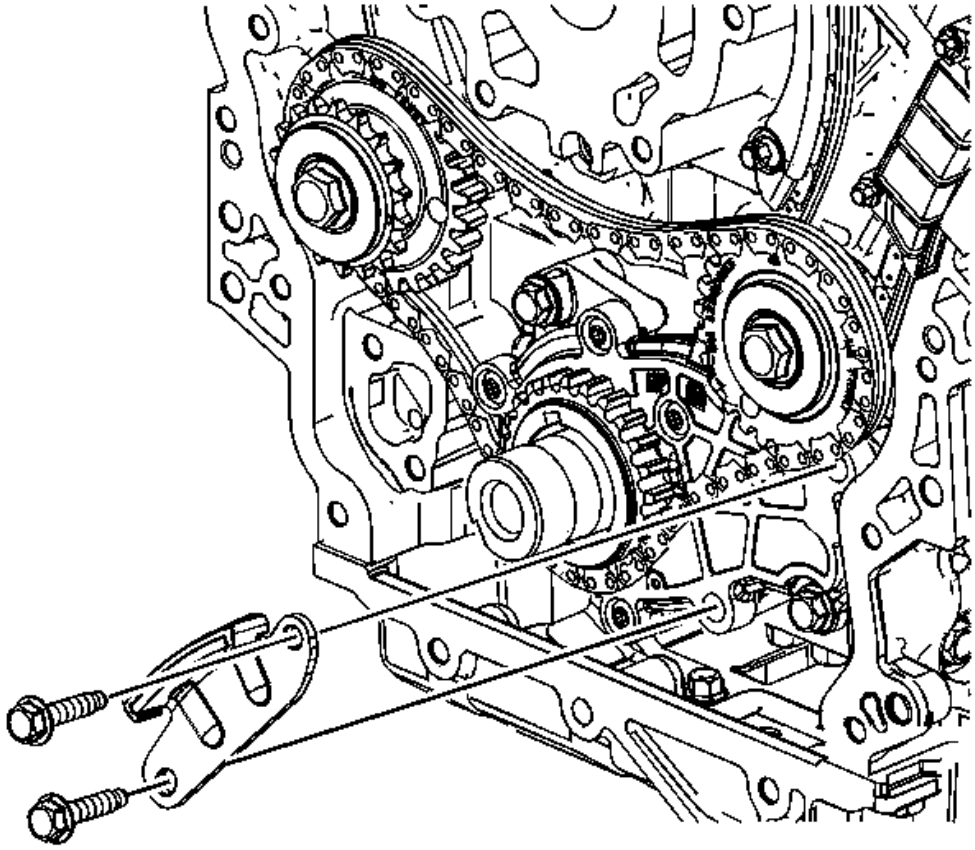

Fig. 114: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

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 25 N.m (18 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

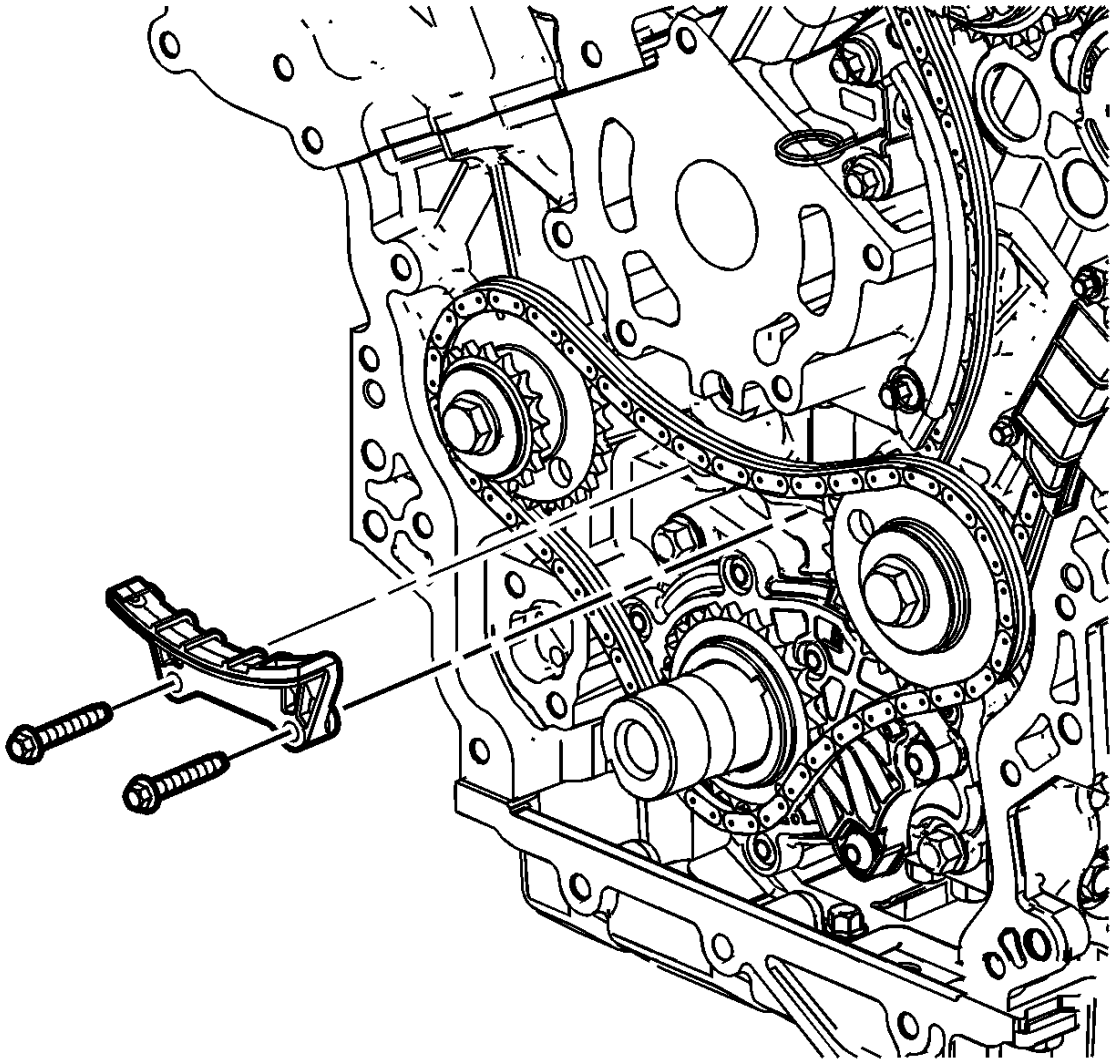

Fig. 115: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
4. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .

Installation Procedure

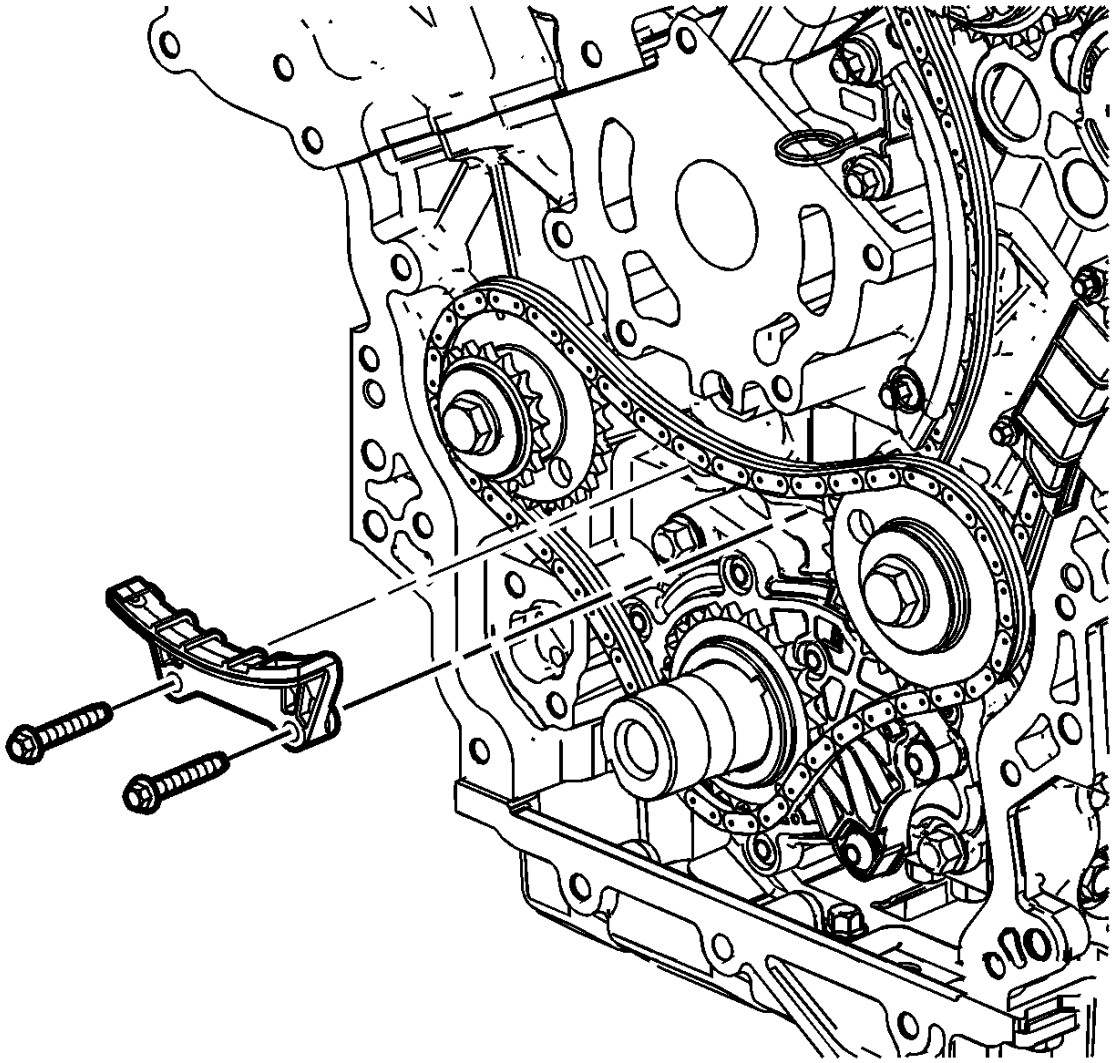

Fig. 116: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

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

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

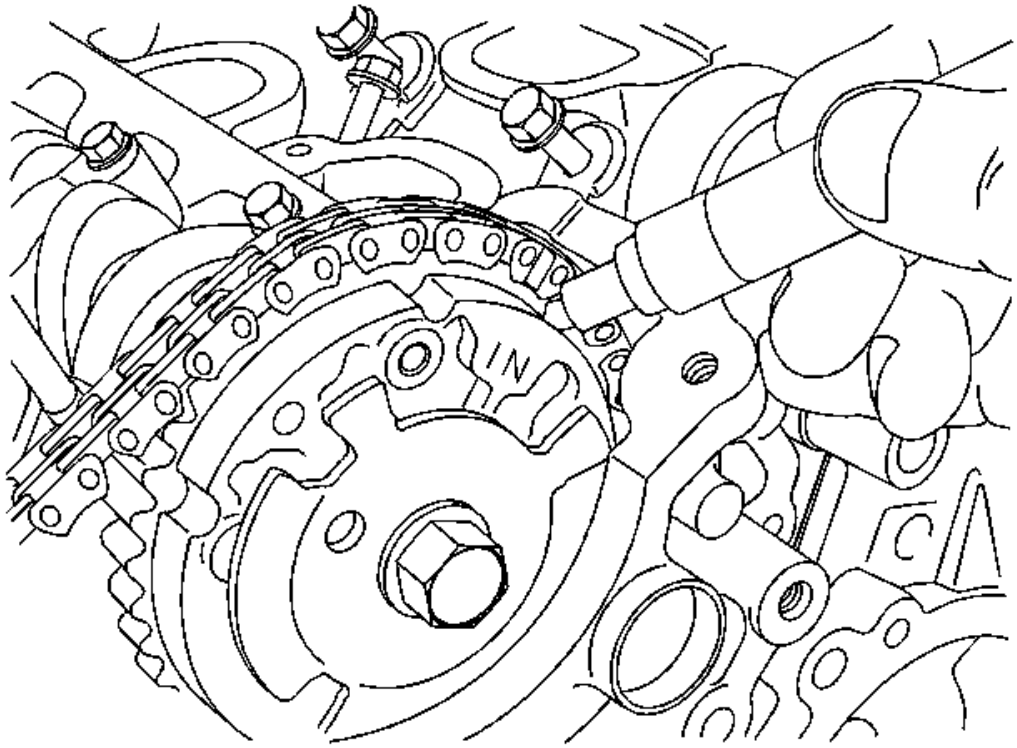

Fig. 117: Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS COMPANY

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.

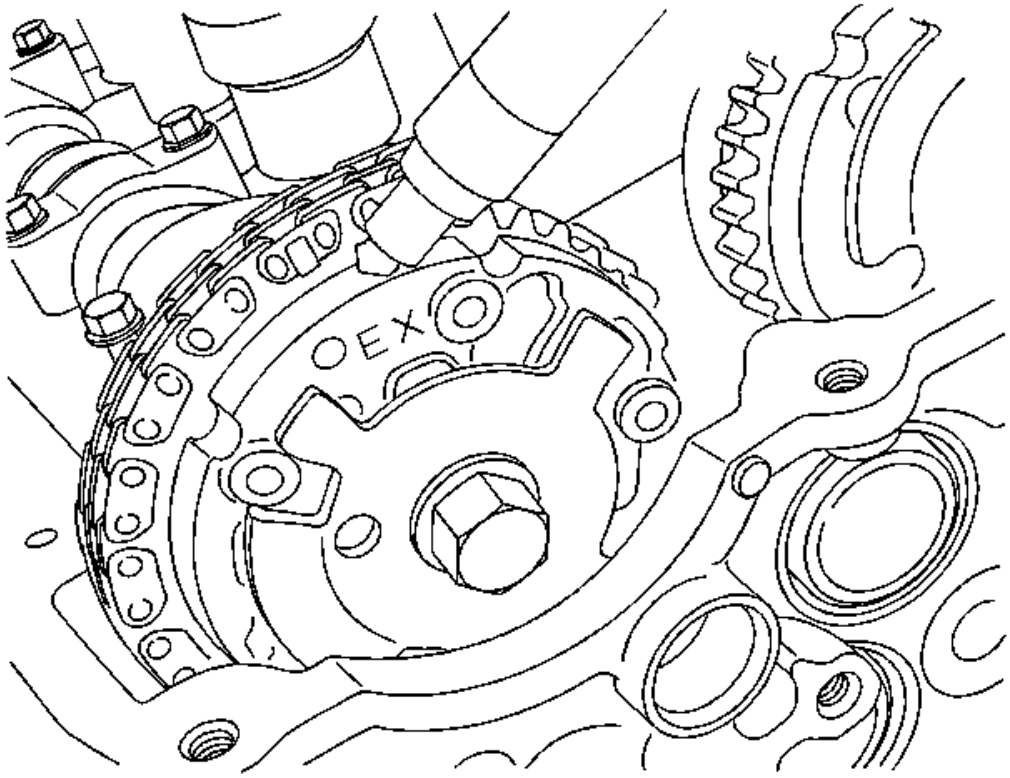

Fig. 118: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS COMPANY

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

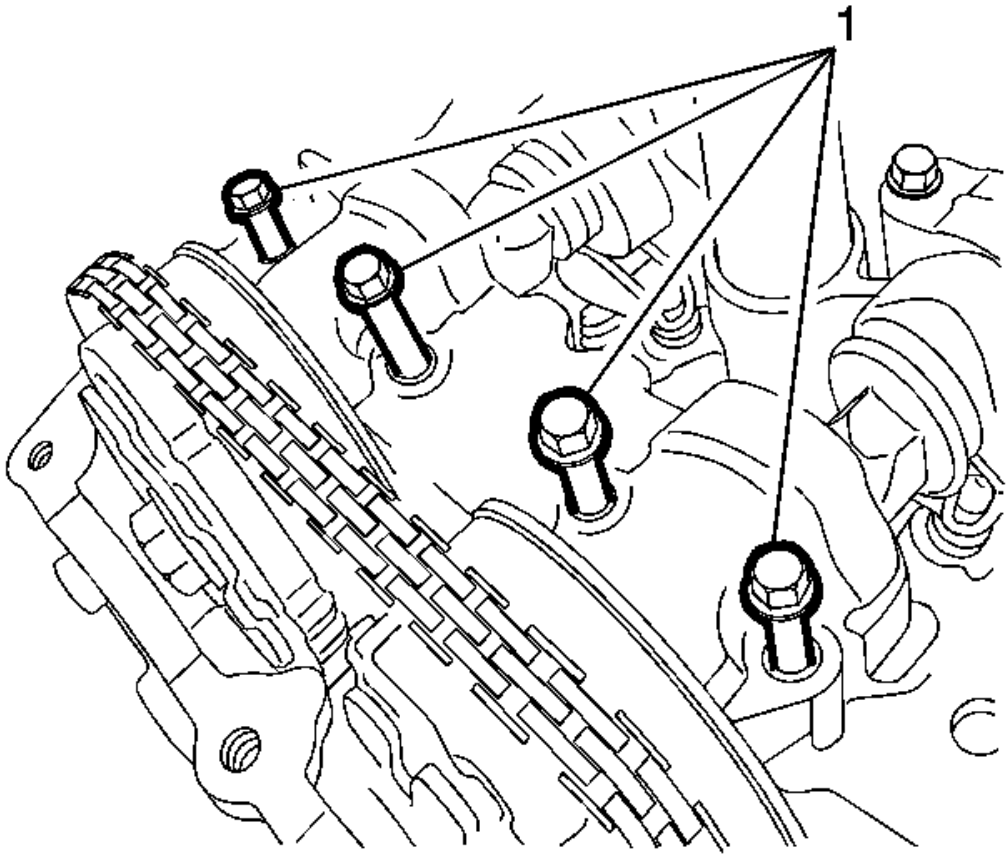

Fig. 119: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

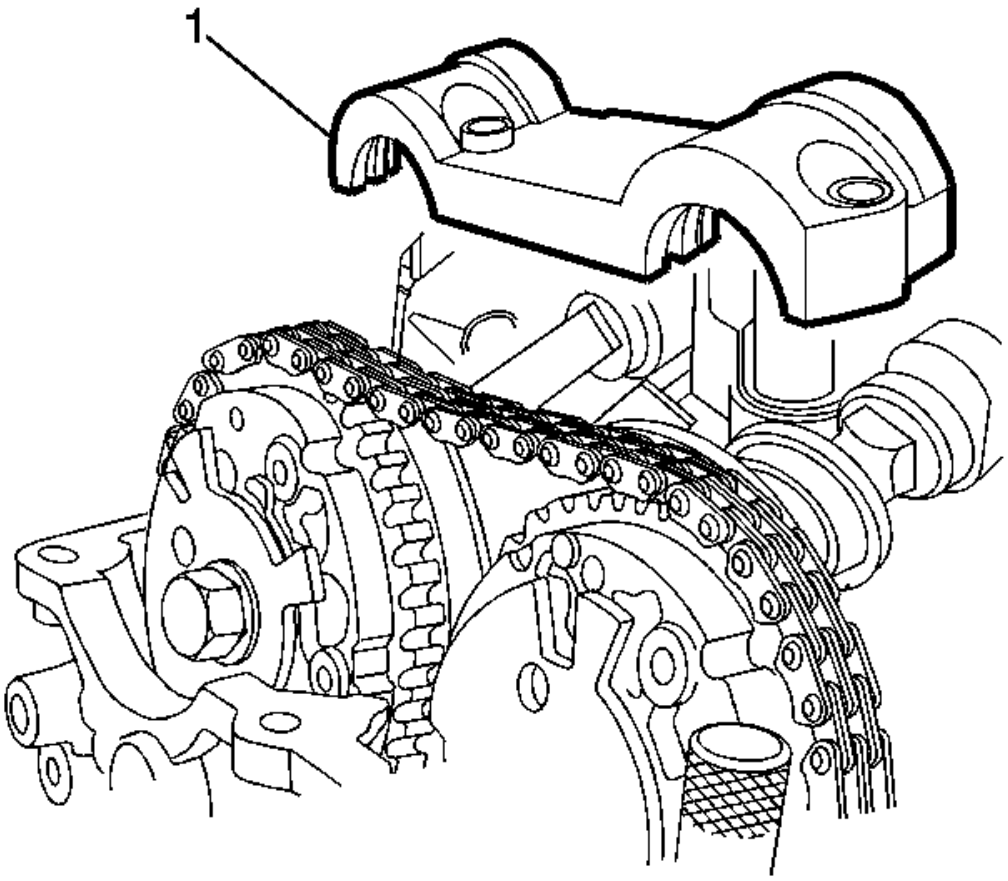

Fig. 120: View Of Camshaft Front Cap
Courtesy of GENERAL MOTORS COMPANY

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).

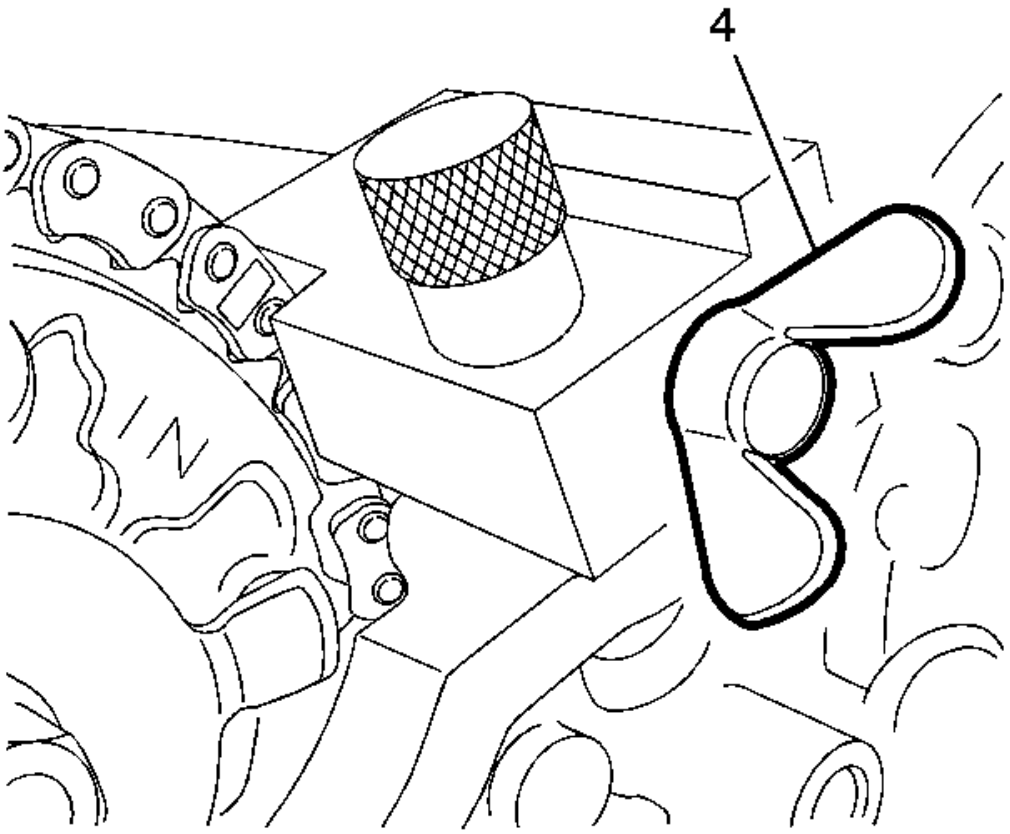

Fig. 121: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

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

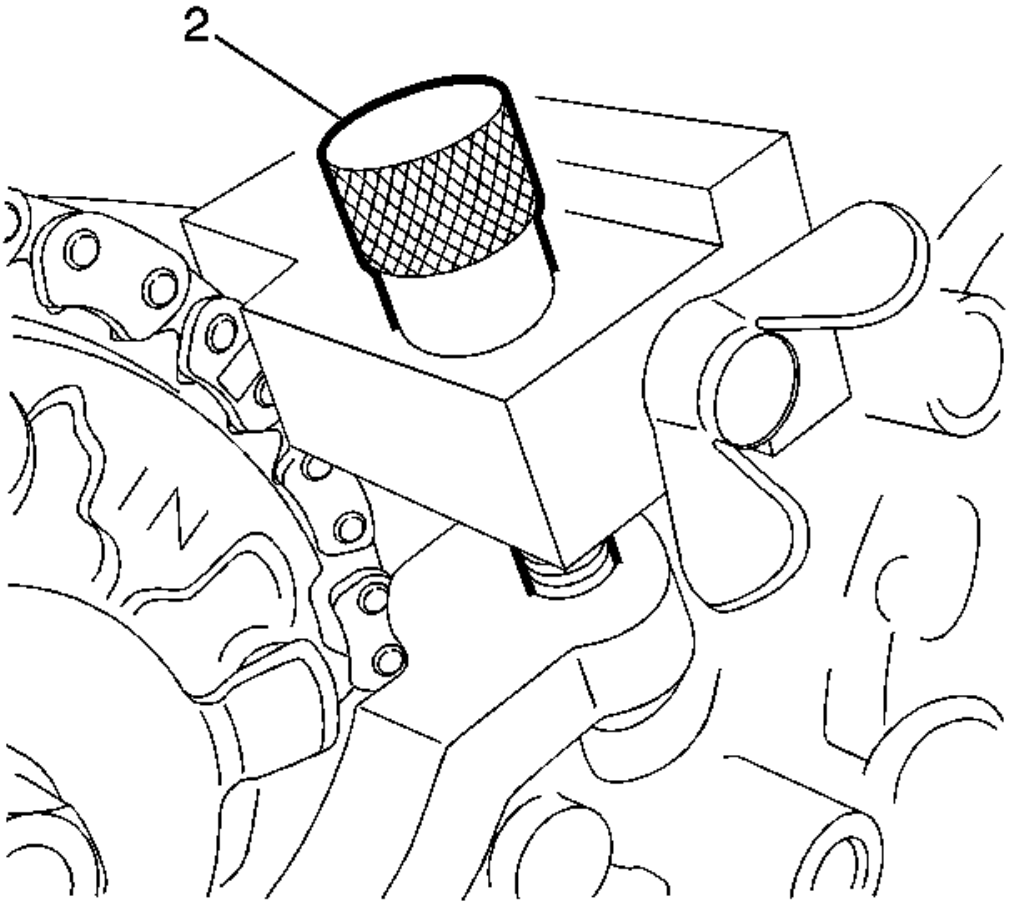

Fig. 122: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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.

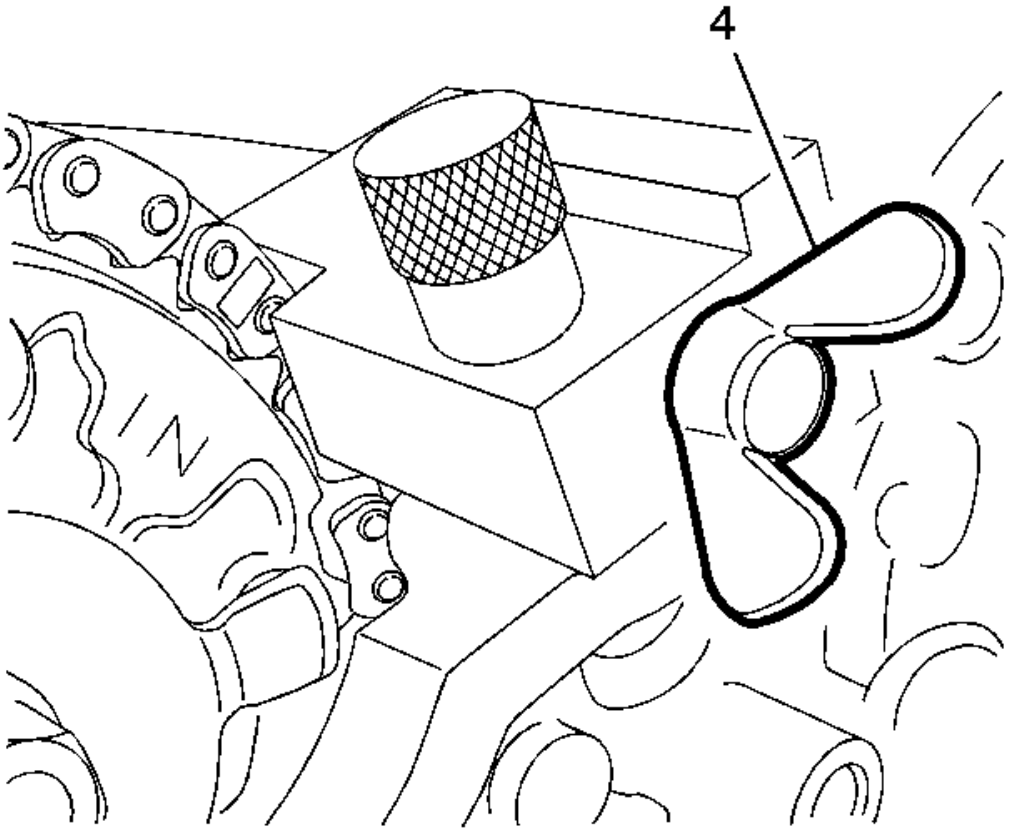

Fig. 123: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

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.

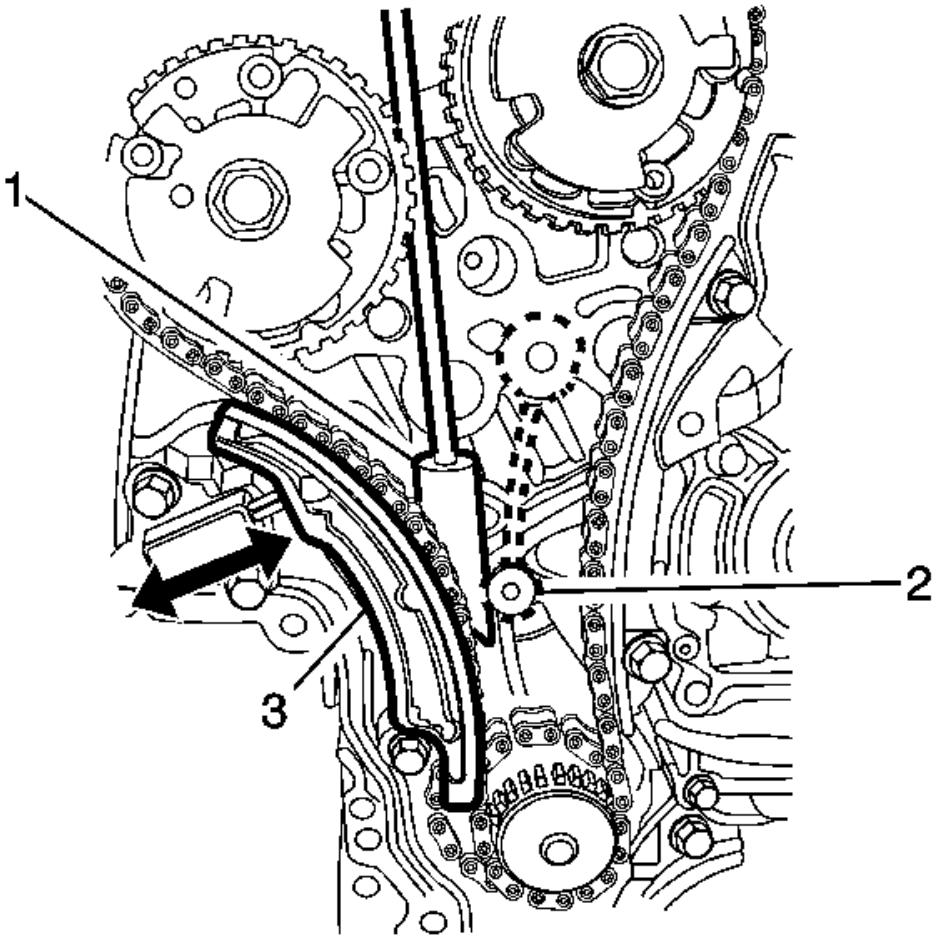

Fig. 124: Retainer Wedge
Courtesy of GENERAL MOTORS COMPANY

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.

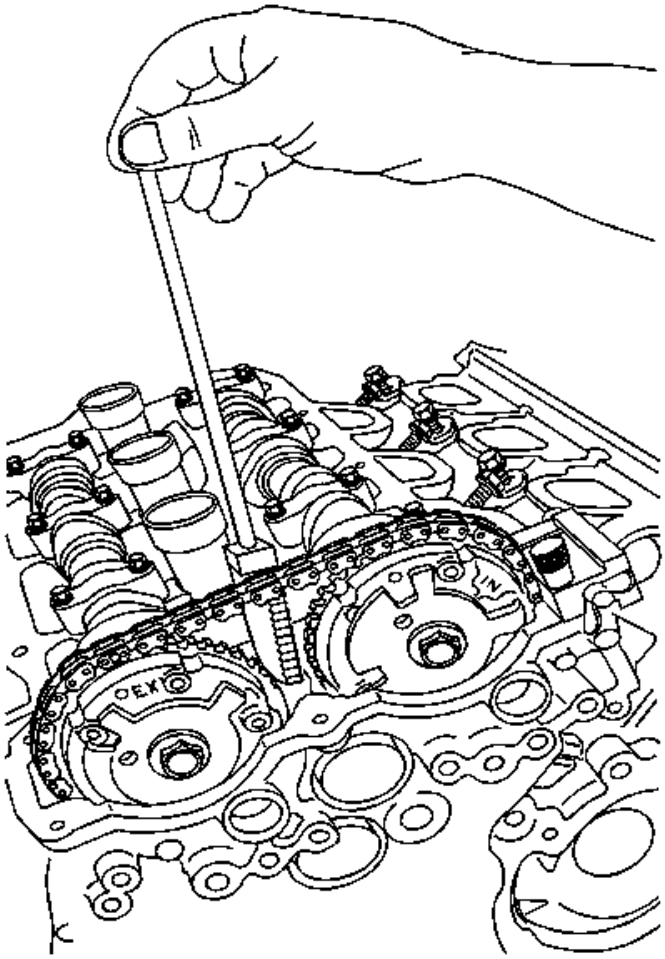

Fig. 125: Inserting Retainer
Courtesy of GENERAL MOTORS COMPANY

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.

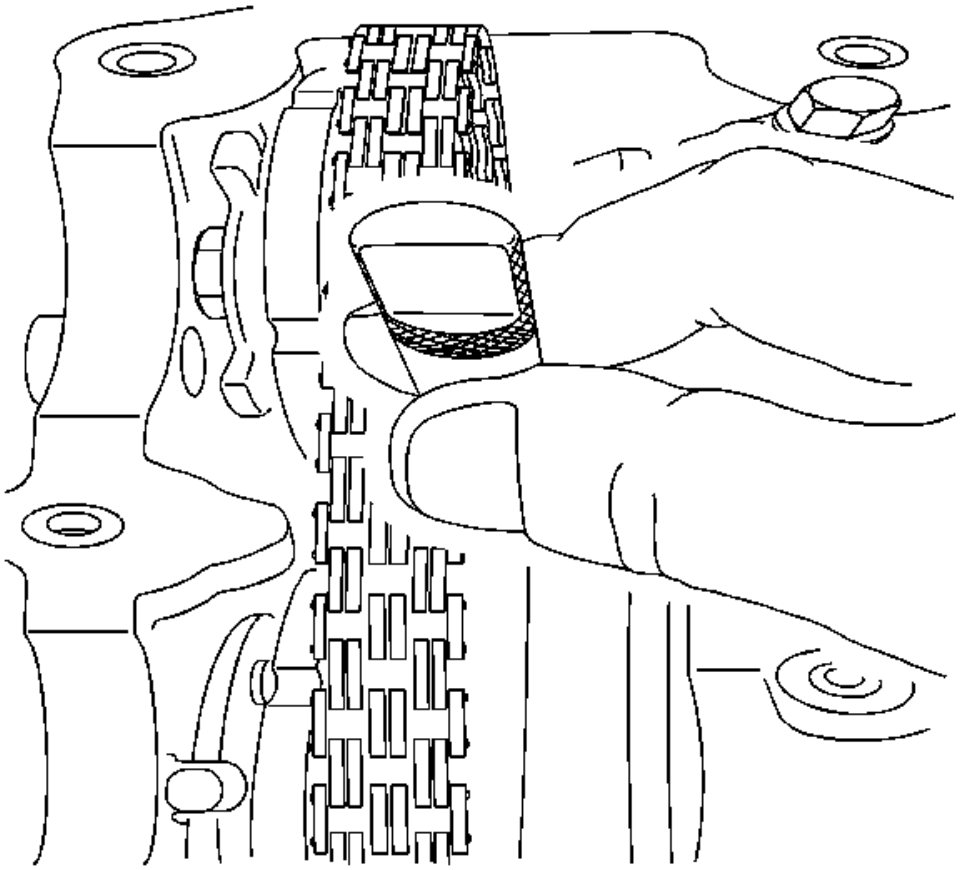

Fig. 126: Orienting Retainer Teeth
Courtesy of GENERAL MOTORS COMPANY

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.

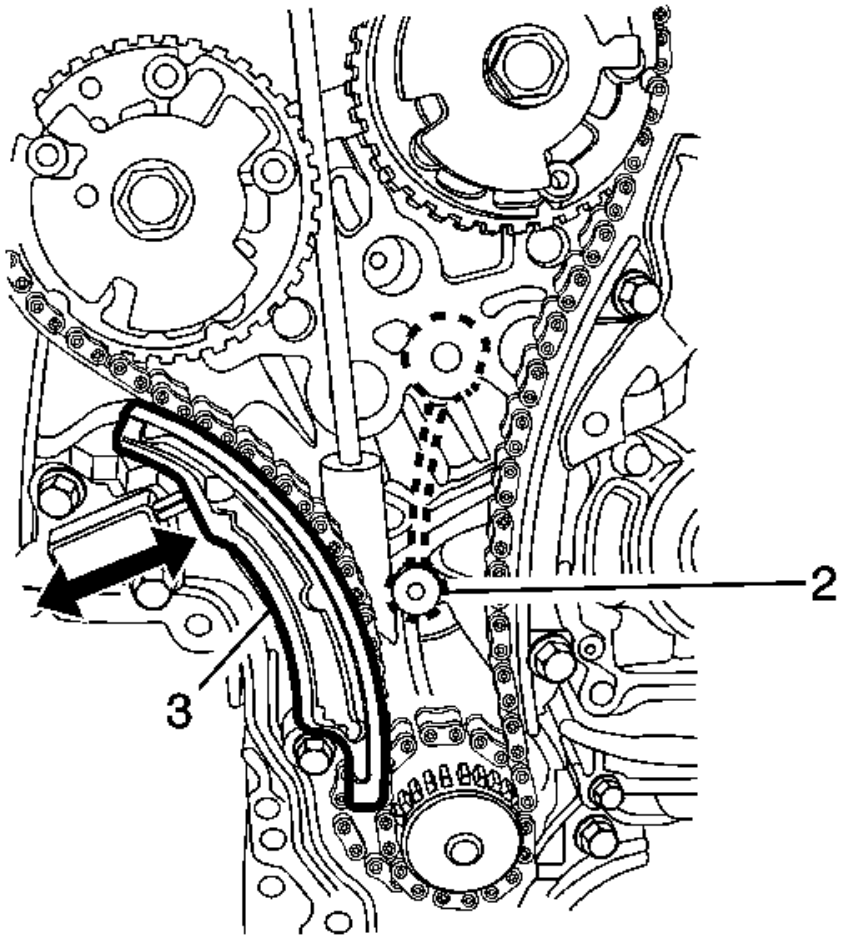

Fig. 127: Wedge, Timing Chain & Belt Casting
Courtesy of GENERAL MOTORS COMPANY

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).

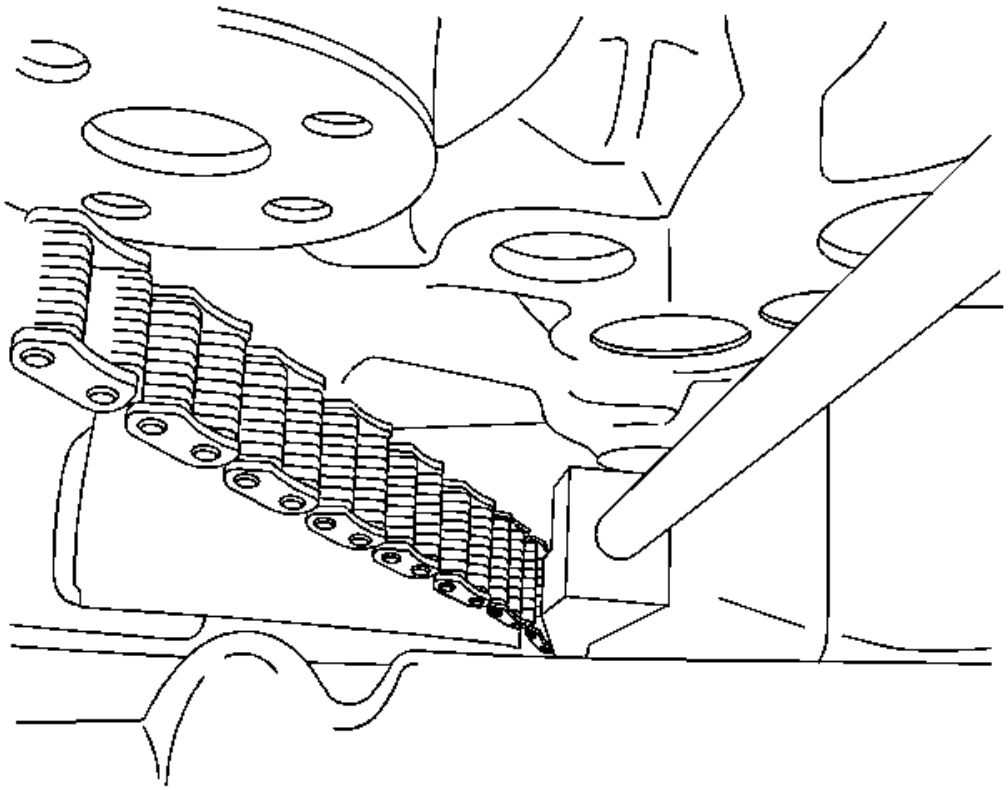

Fig. 128: Identifying Wedge Position
Courtesy of GENERAL MOTORS COMPANY

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.

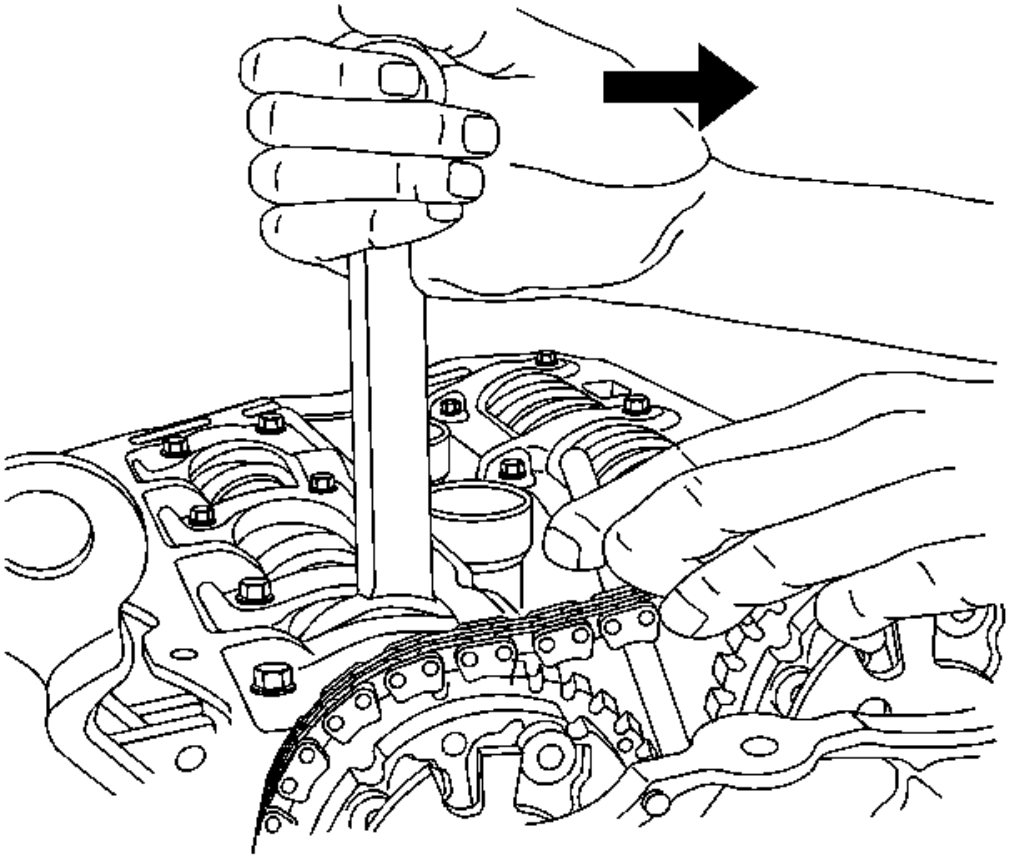

Fig. 129: Rotating Camshaft
Courtesy of GENERAL MOTORS COMPANY

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.

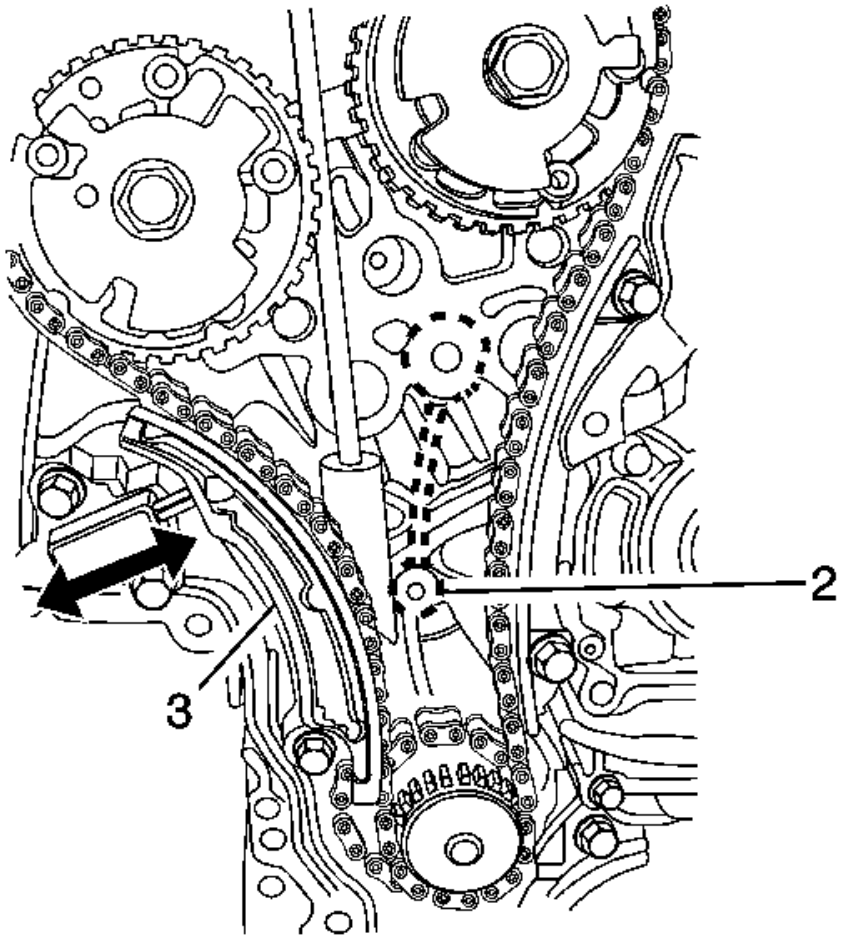

Fig. 130: Opening Gap Between Chain & Internal Rib In Front Cover
Courtesy of GENERAL MOTORS COMPANY

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.

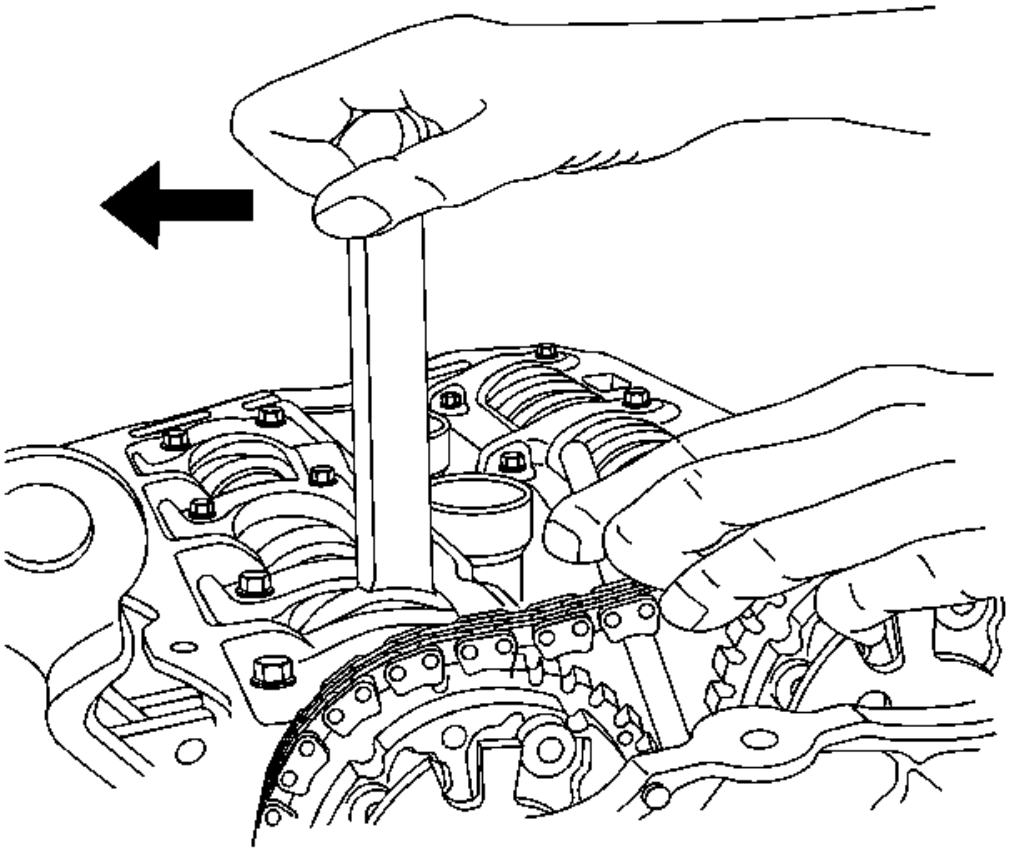

Fig. 131: Releasing Force On Wrench
Courtesy of GENERAL MOTORS COMPANY

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.

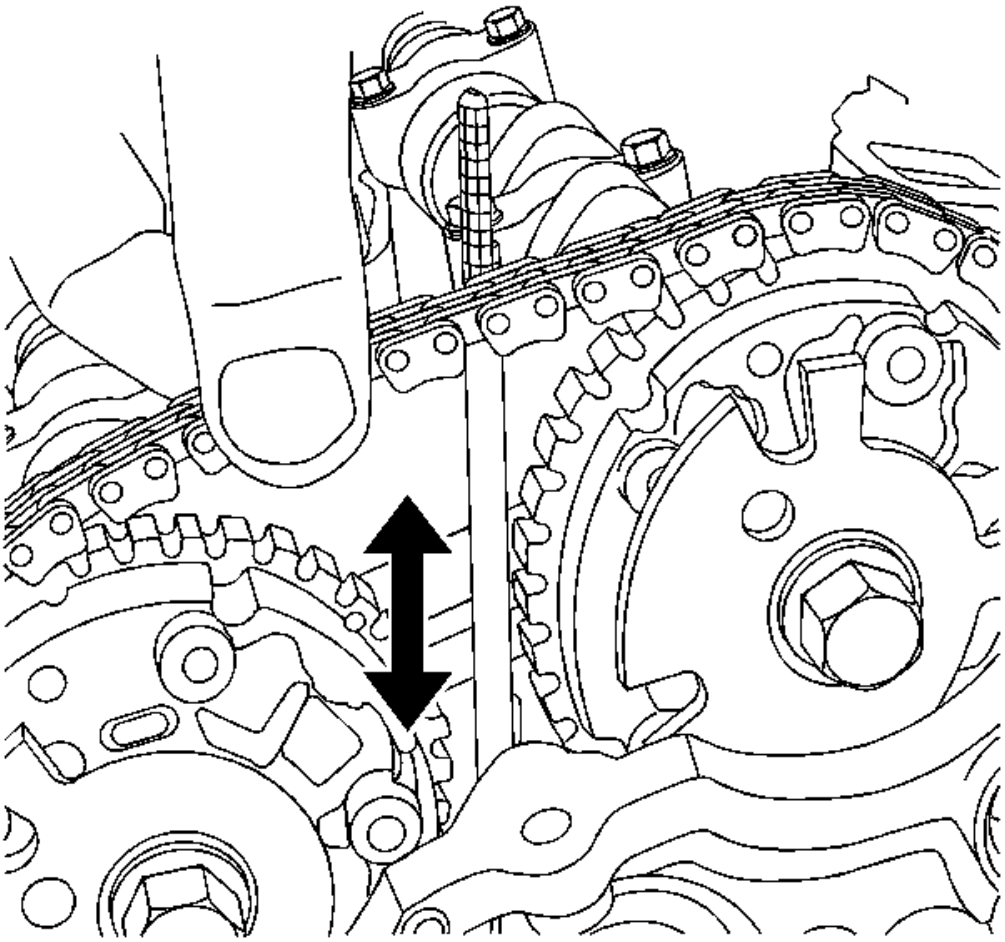

Fig. 132: Slack In Timing Drive Chain
Courtesy of GENERAL MOTORS COMPANY

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.

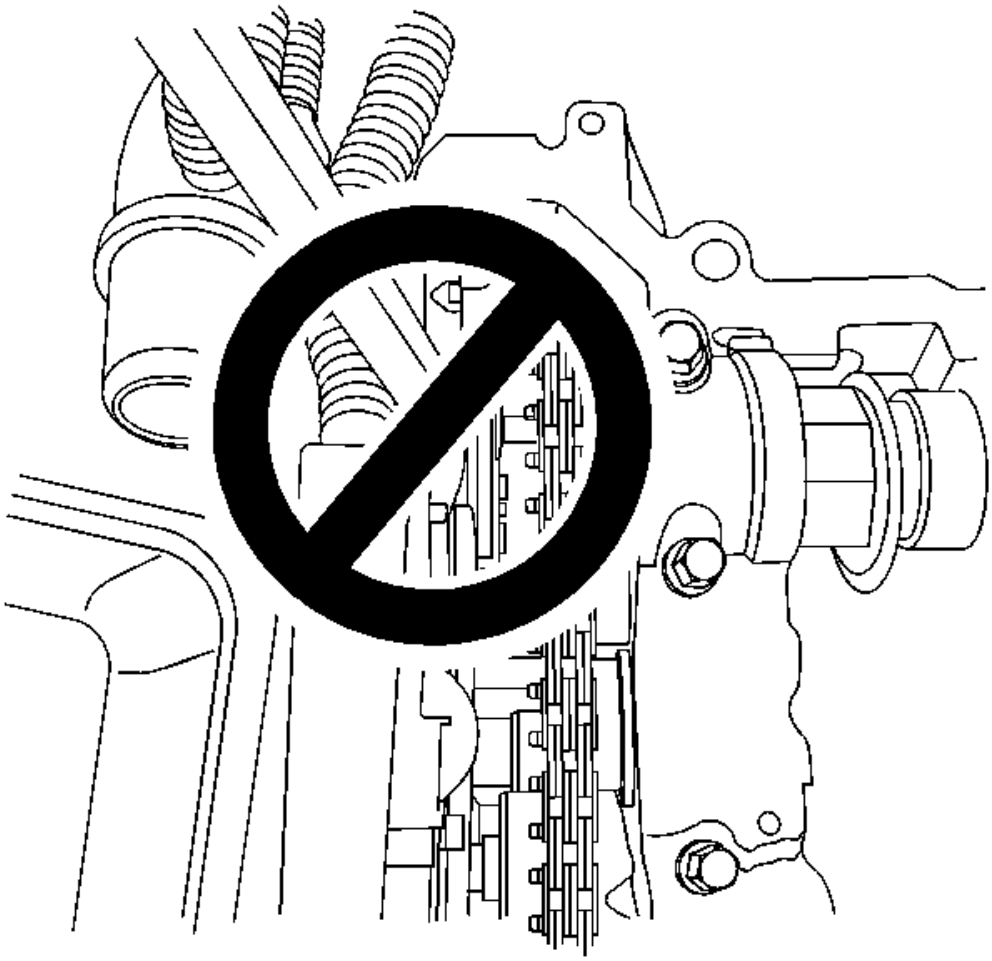

Fig. 133: Do Not Pry Warning
Courtesy of GENERAL MOTORS COMPANY

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

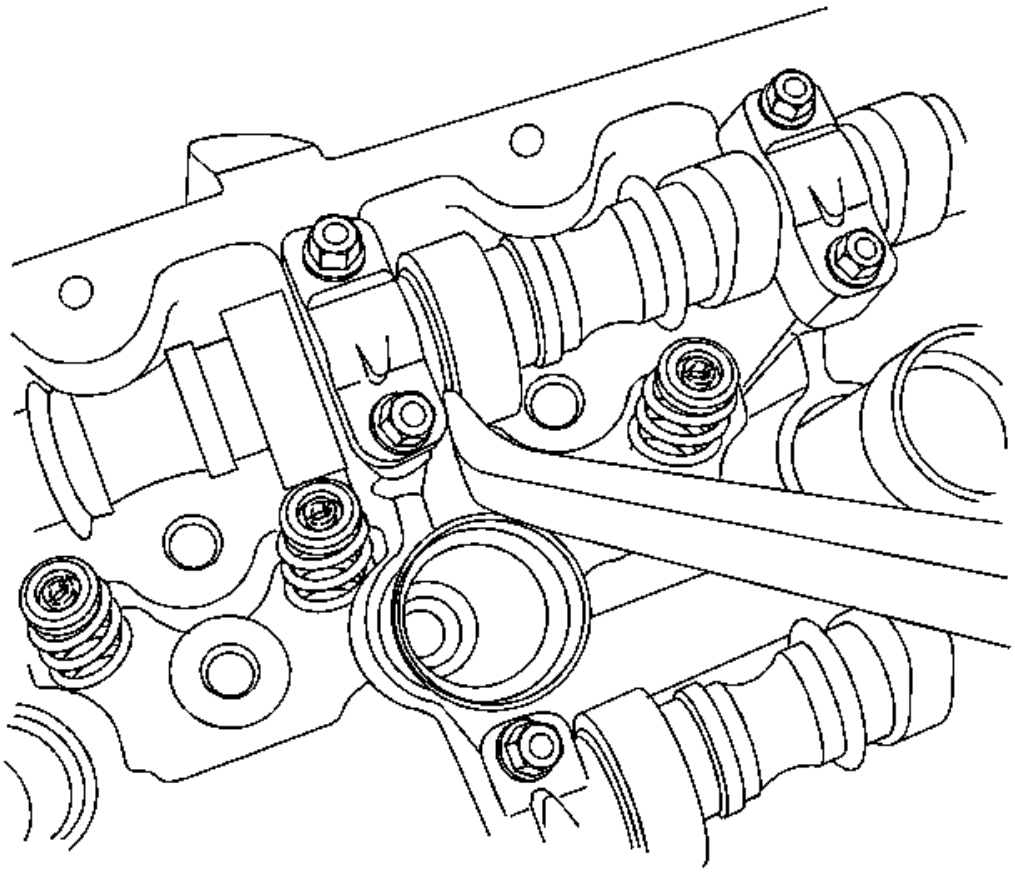

Fig. 134: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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.

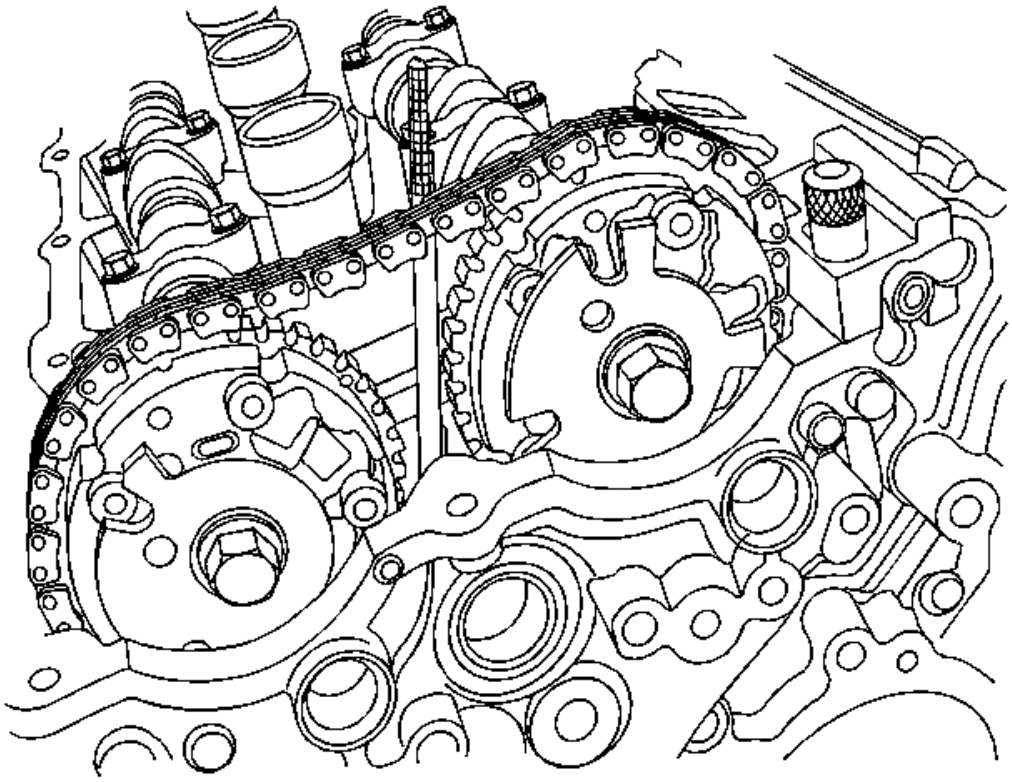

Fig. 135: Identifying Retainer Position
Courtesy of GENERAL MOTORS COMPANY

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).

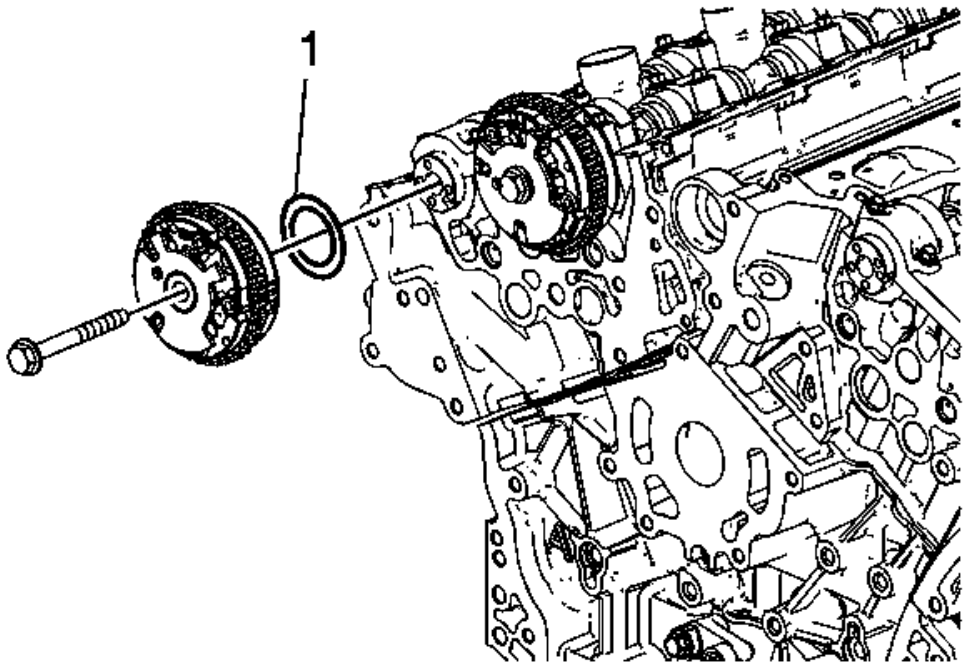

Fig. 136: Plastic Thrust Washers
Courtesy of GENERAL MOTORS COMPANY

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

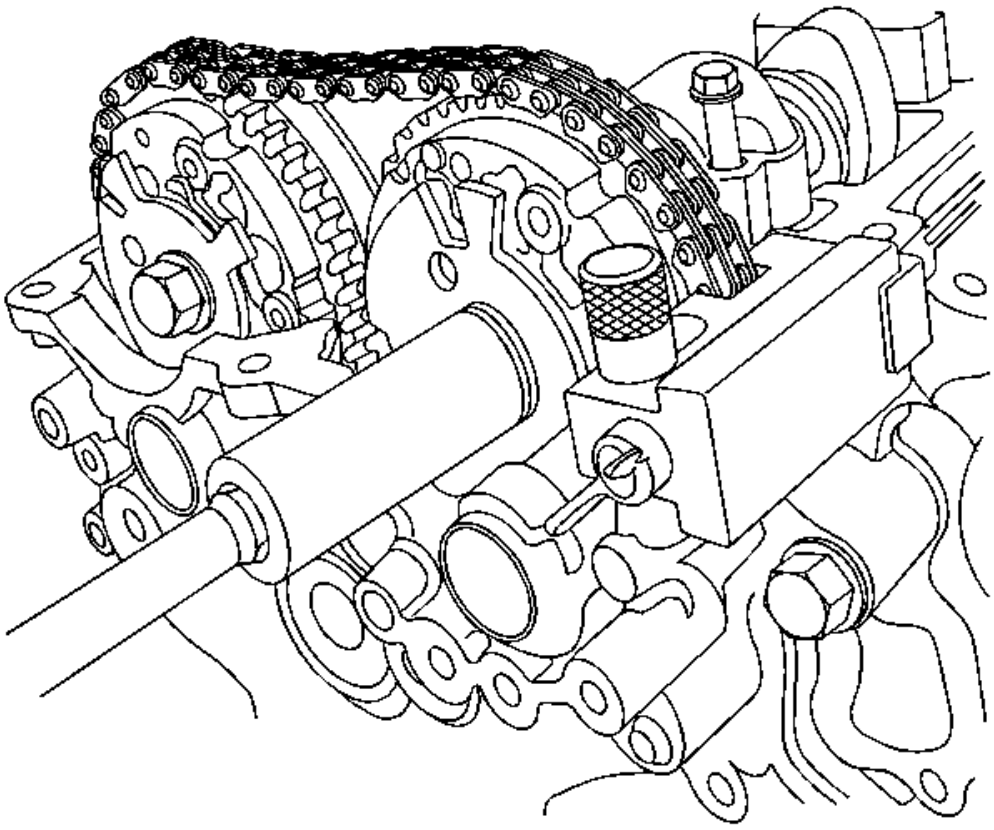

Fig. 137: View Of Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

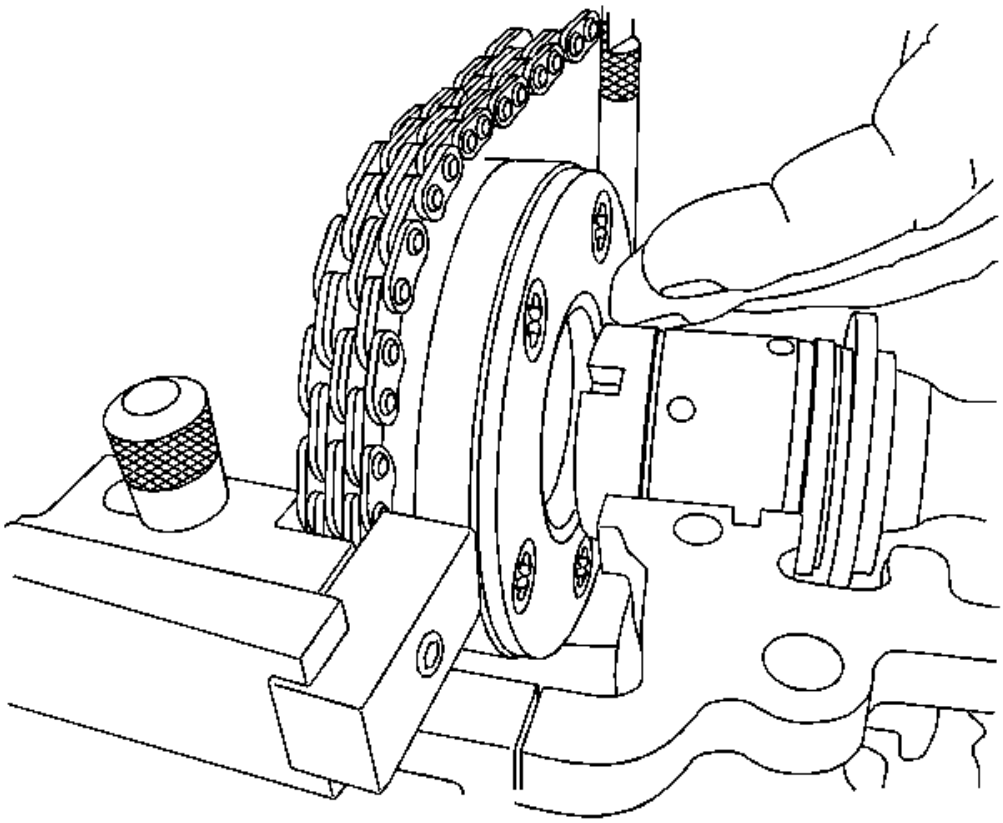

Fig. 138: Sliding Camshaft Position Actuator Off End Of Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

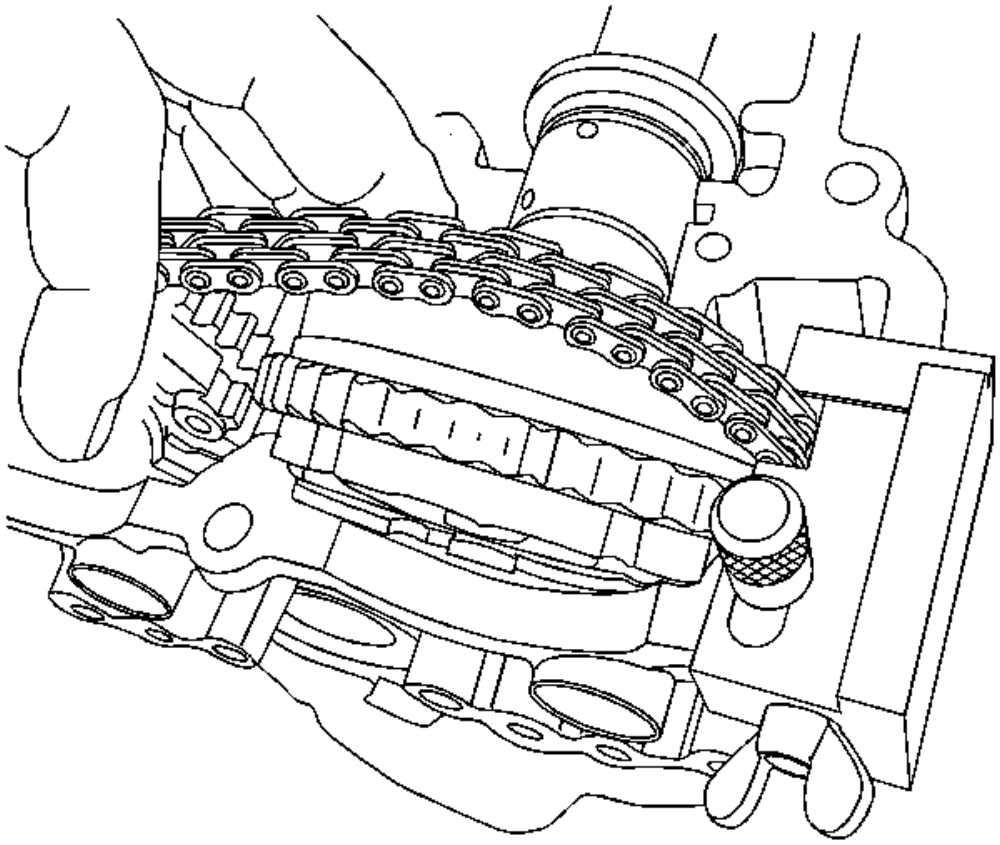

Fig. 139: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

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

Installation Procedure

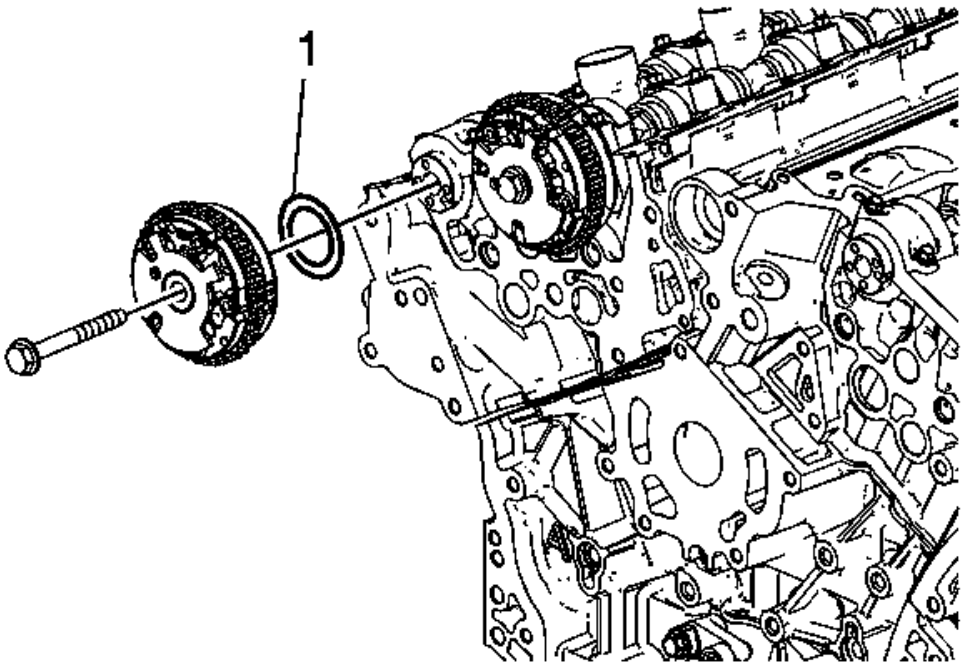

Fig. 140: Plastic Thrust Washers
Courtesy of GENERAL MOTORS COMPANY

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

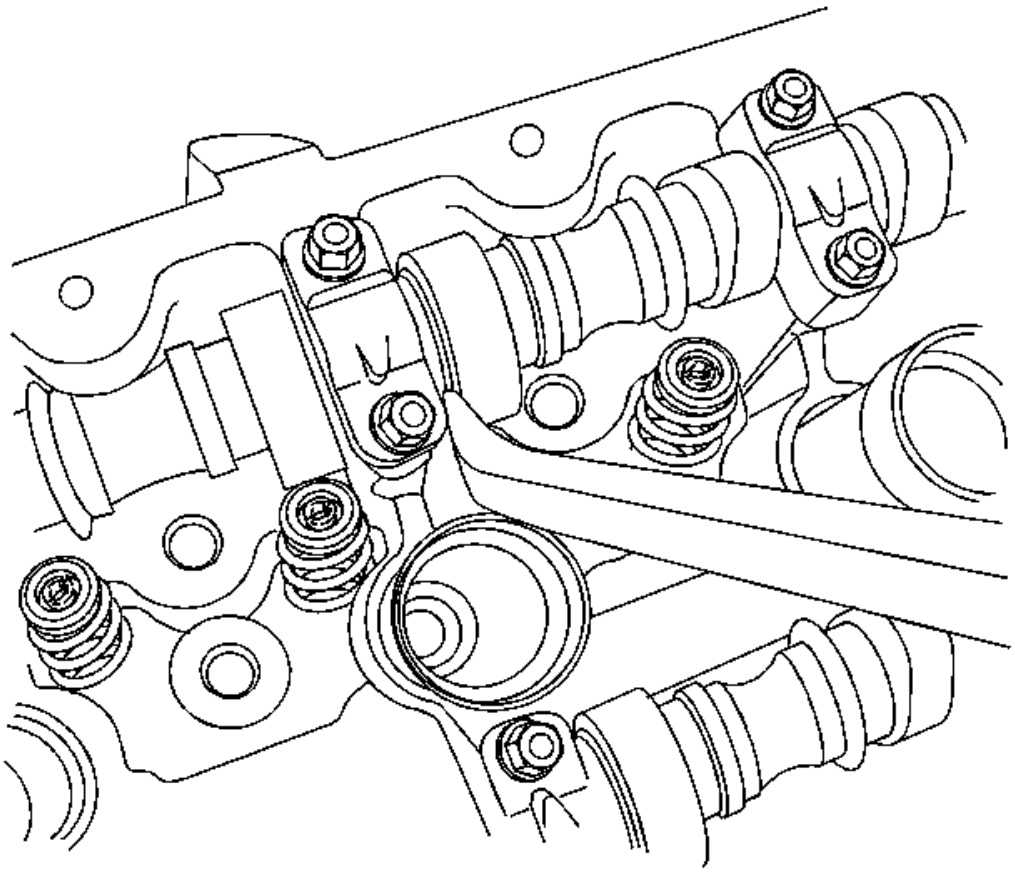

Fig. 141: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

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

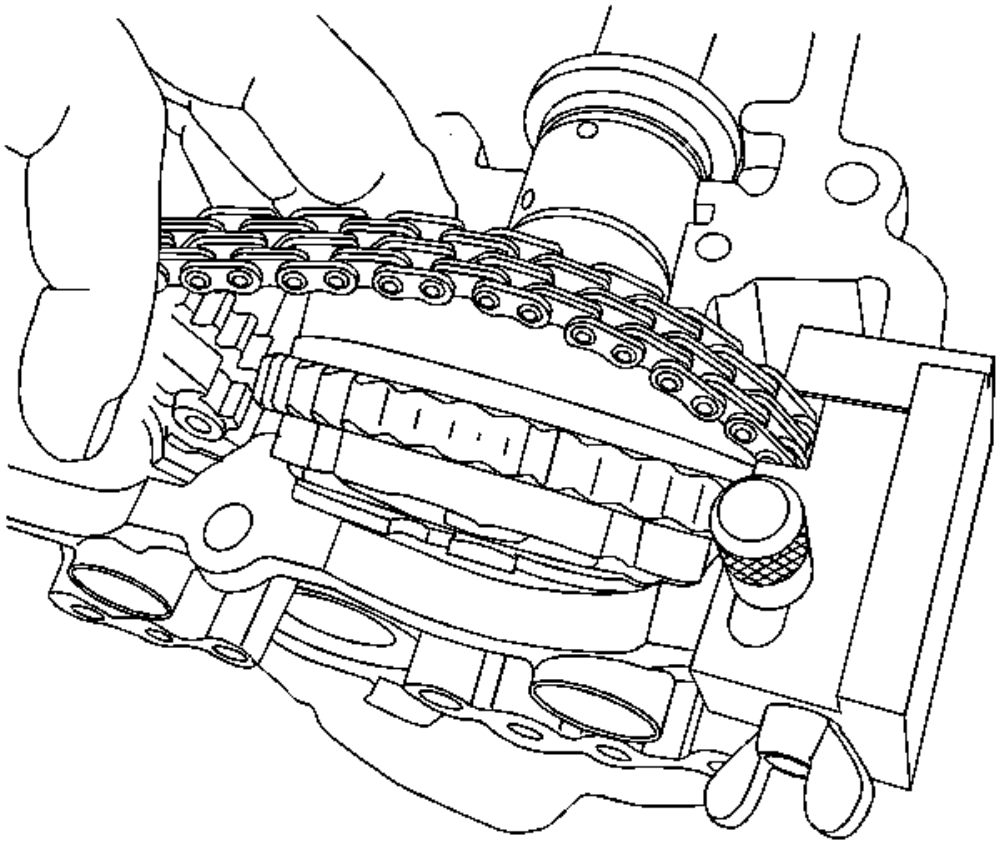

Fig. 142: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

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

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

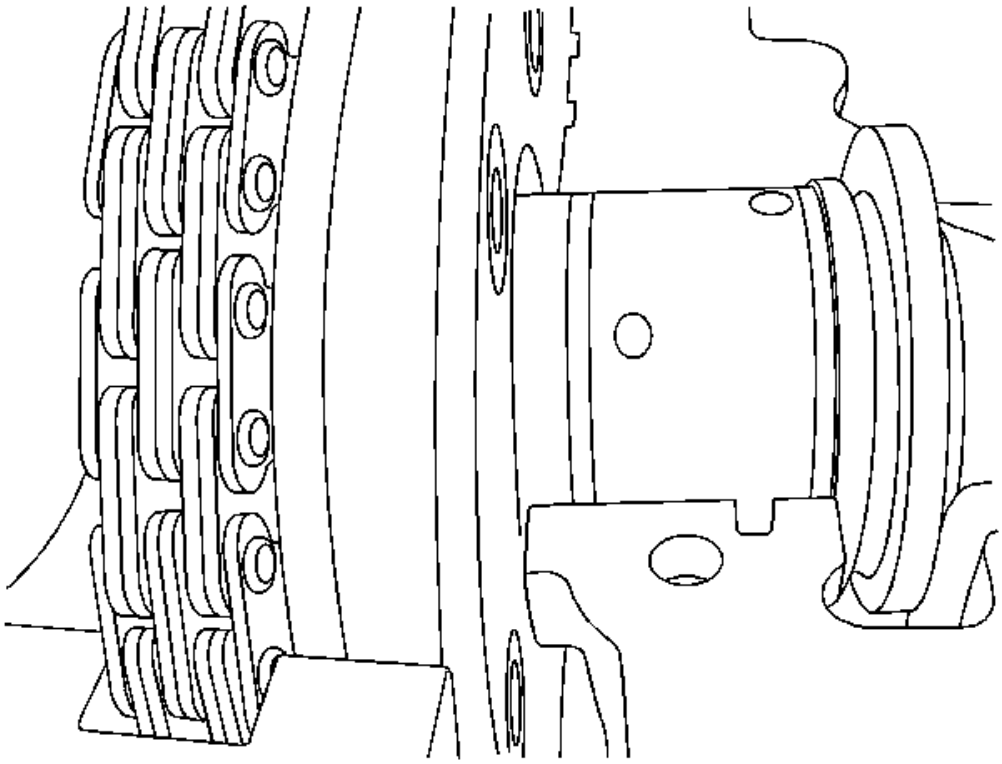

Fig. 143: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .

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

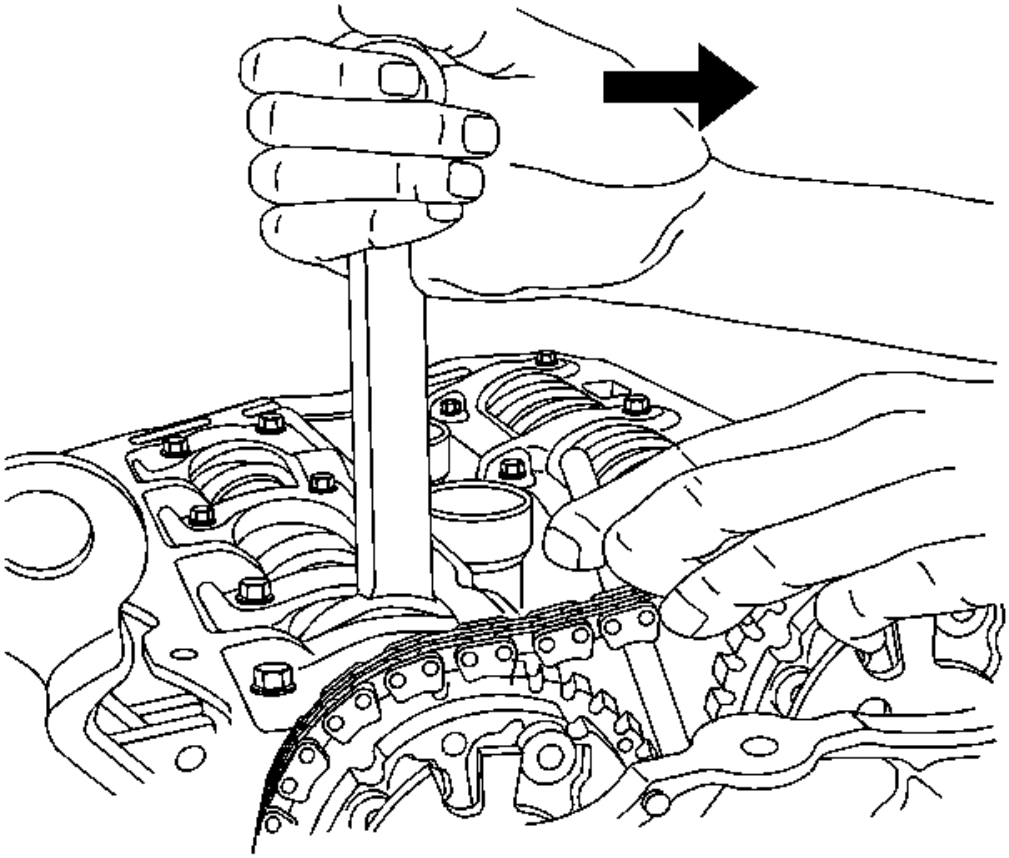

Fig. 144: Rotating Camshaft
Courtesy of GENERAL MOTORS COMPANY

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

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

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

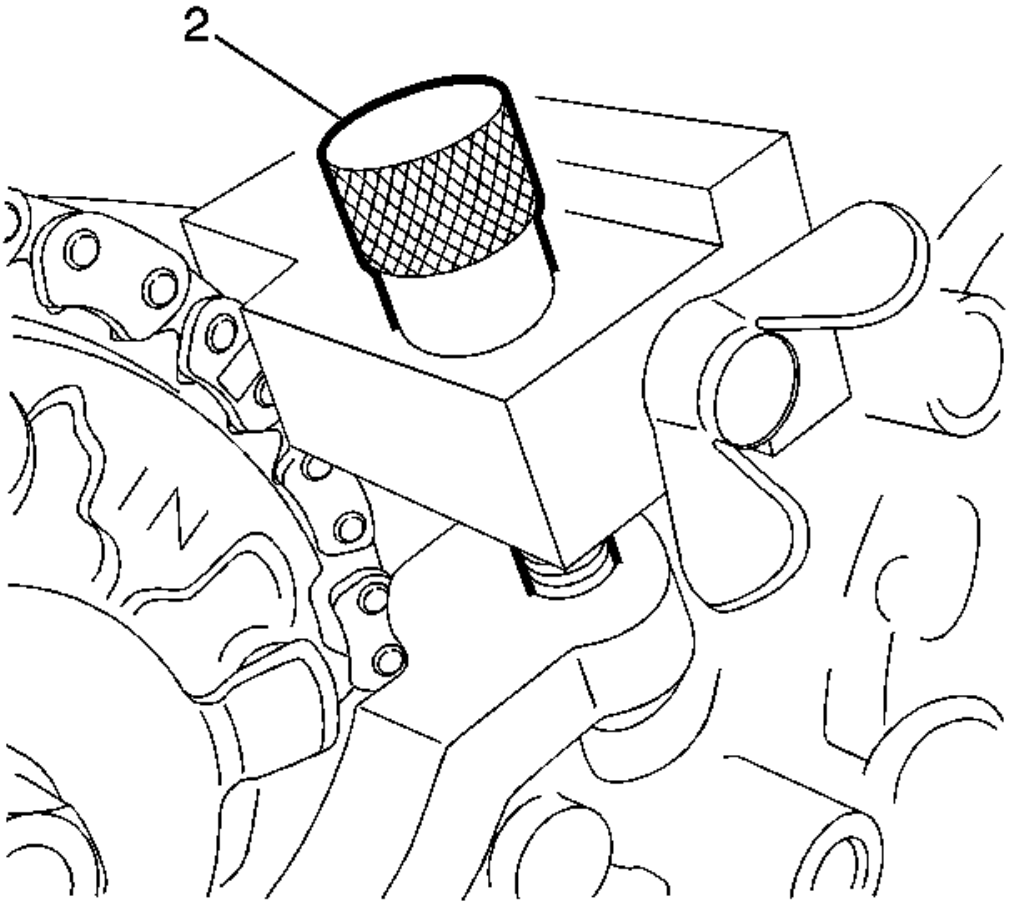

Fig. 145: View Of Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

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

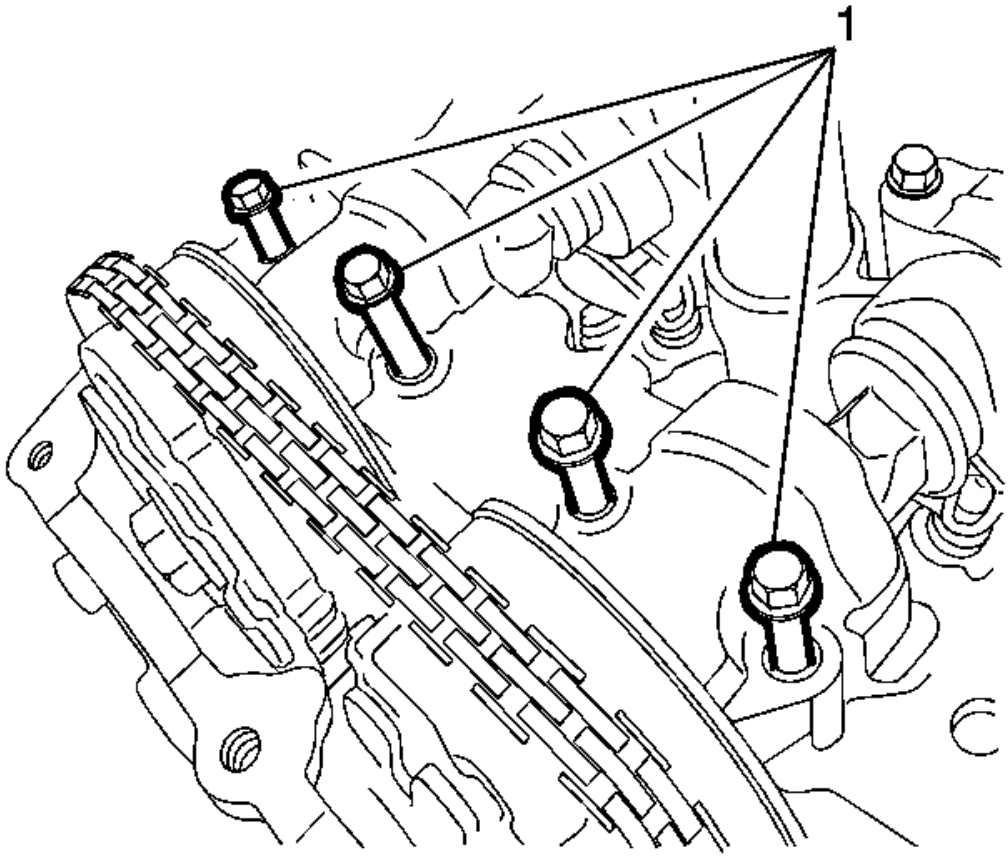

Fig. 146: Identifying Camshaft Front Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

Special Tools

EN-48313 Timing Chain Retention Tool

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

Removal Procedure

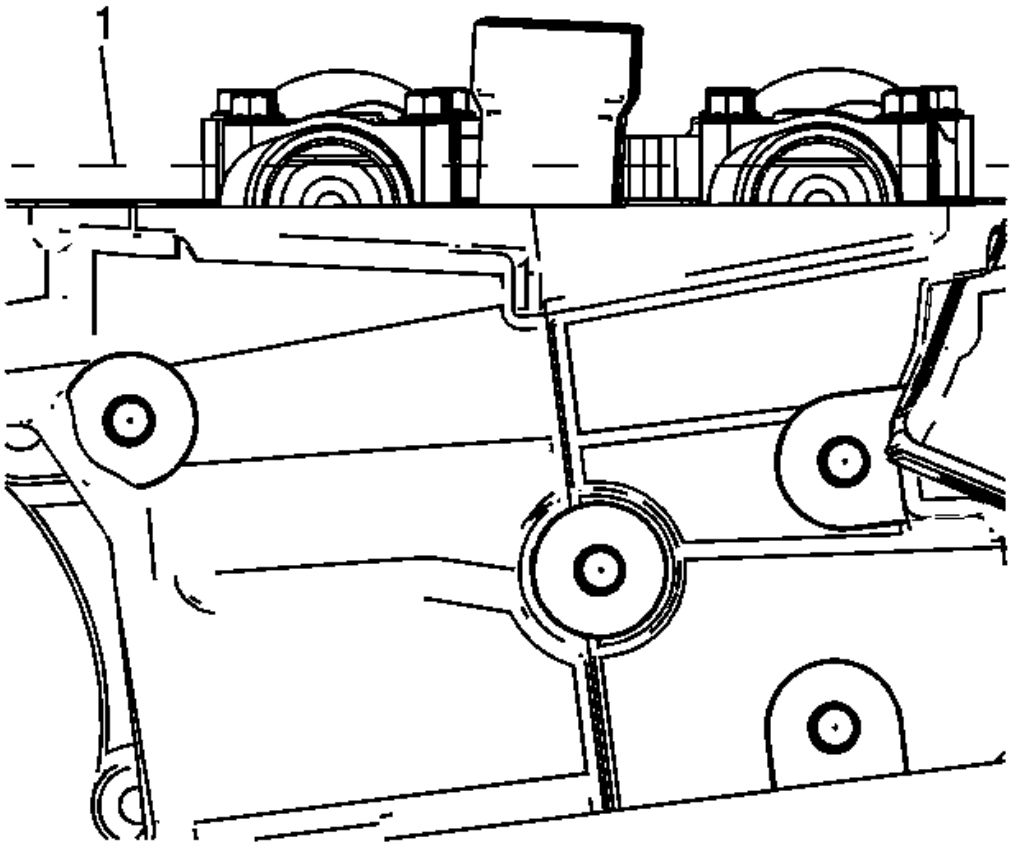

Fig. 147: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

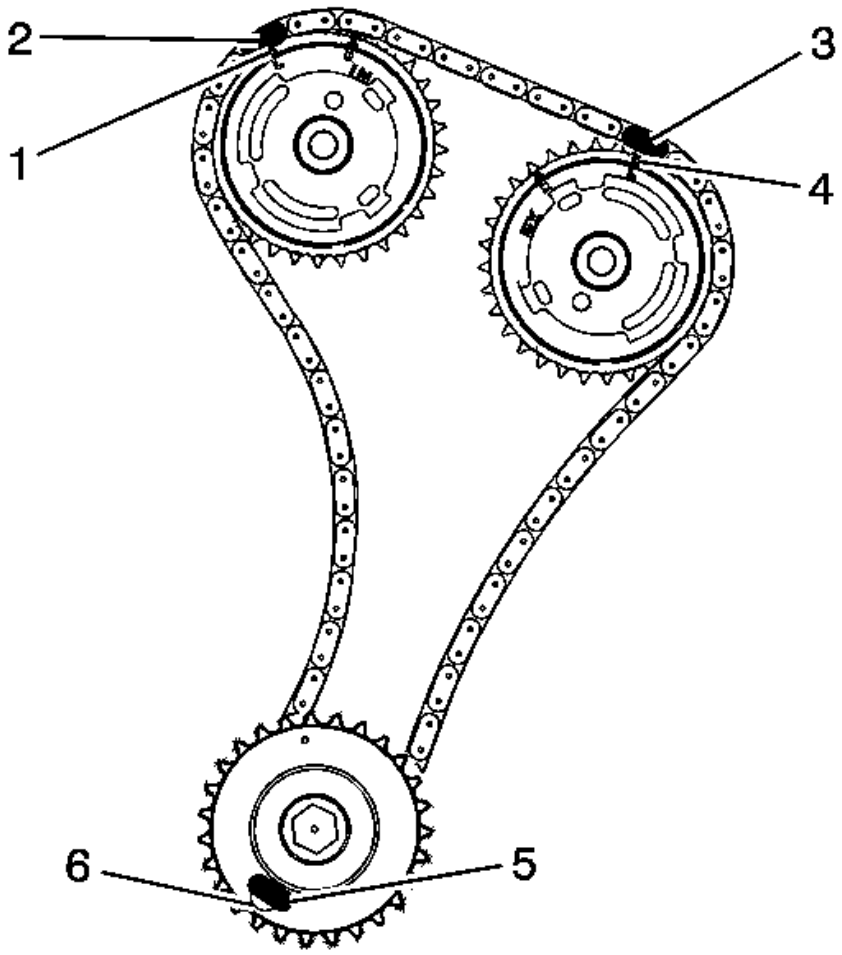

Fig. 148: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

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

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

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

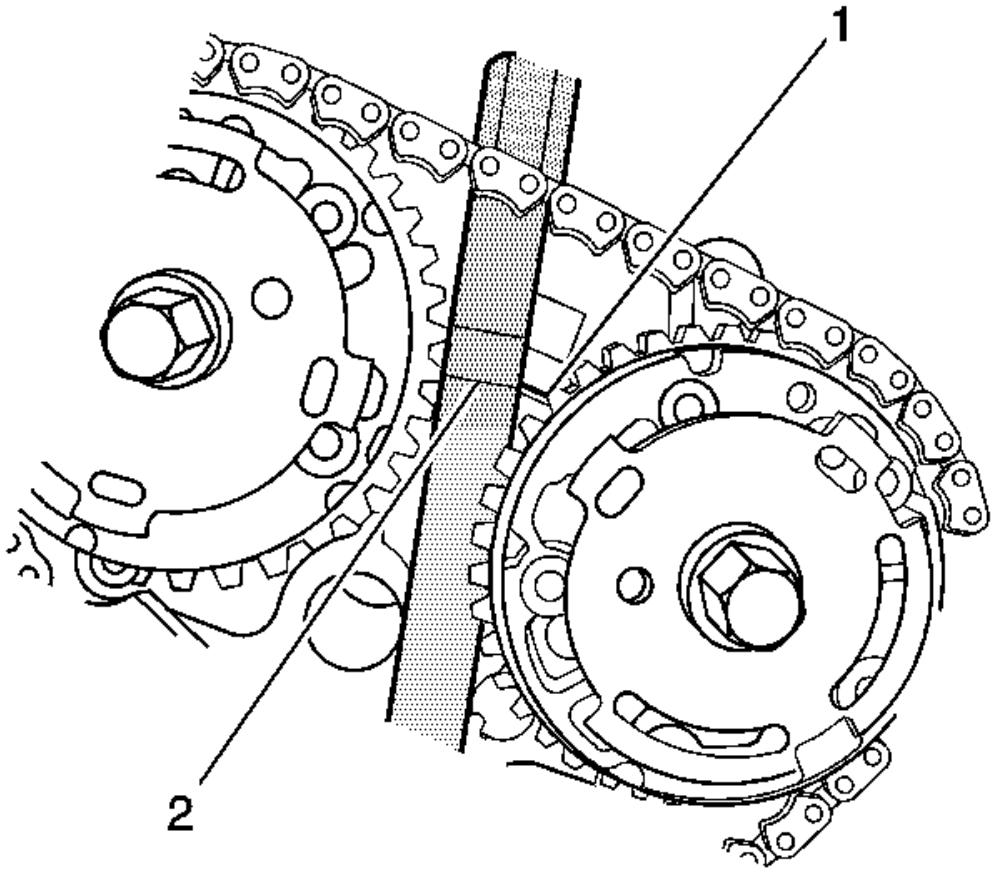

Fig. 149: Inserting Timing Chain Rentention Tool
Courtesy of GENERAL MOTORS COMPANY

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

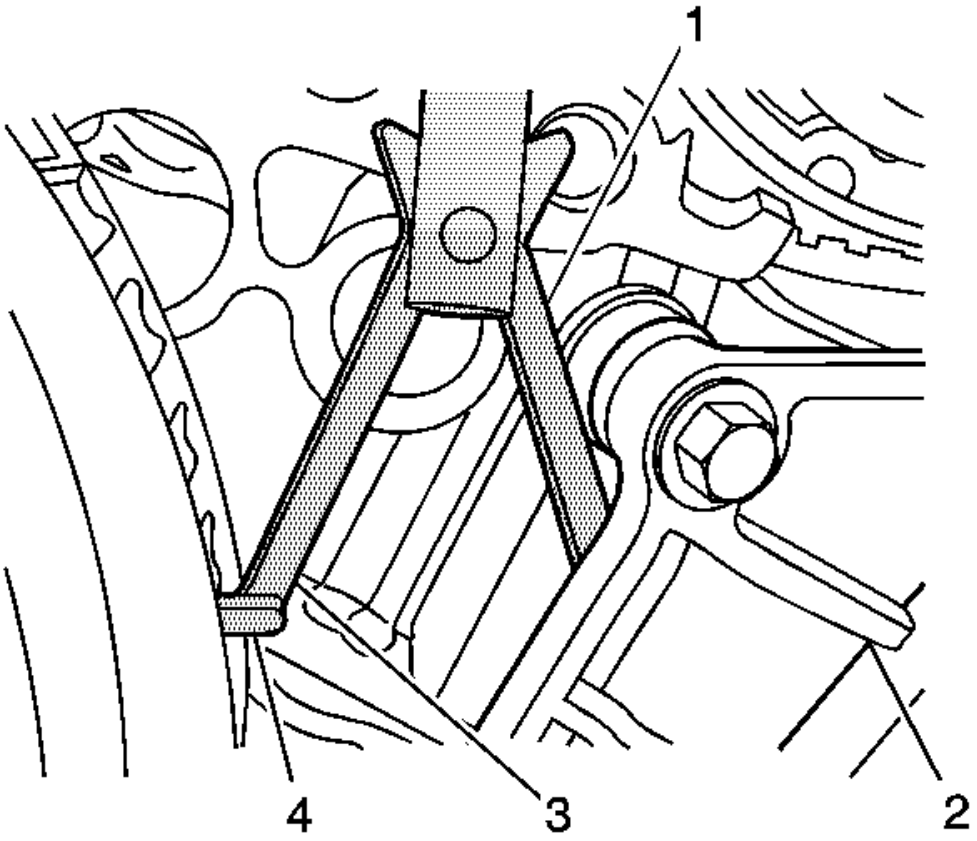

Fig. 150: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

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

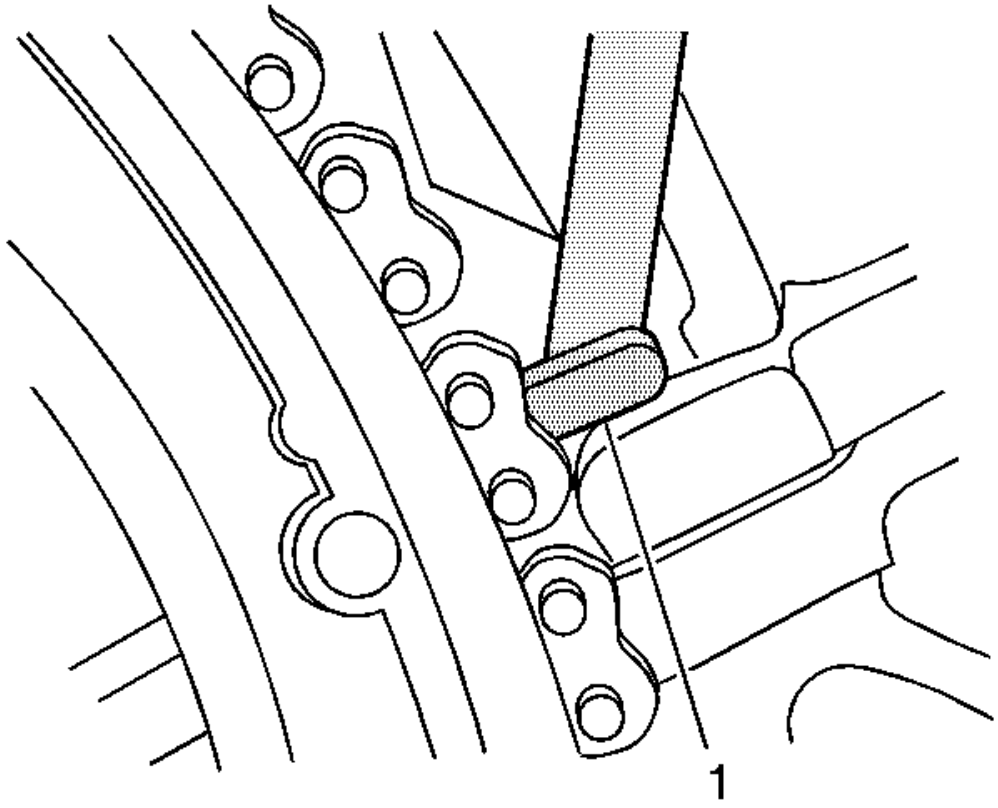

Fig. 151: Foot Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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.

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

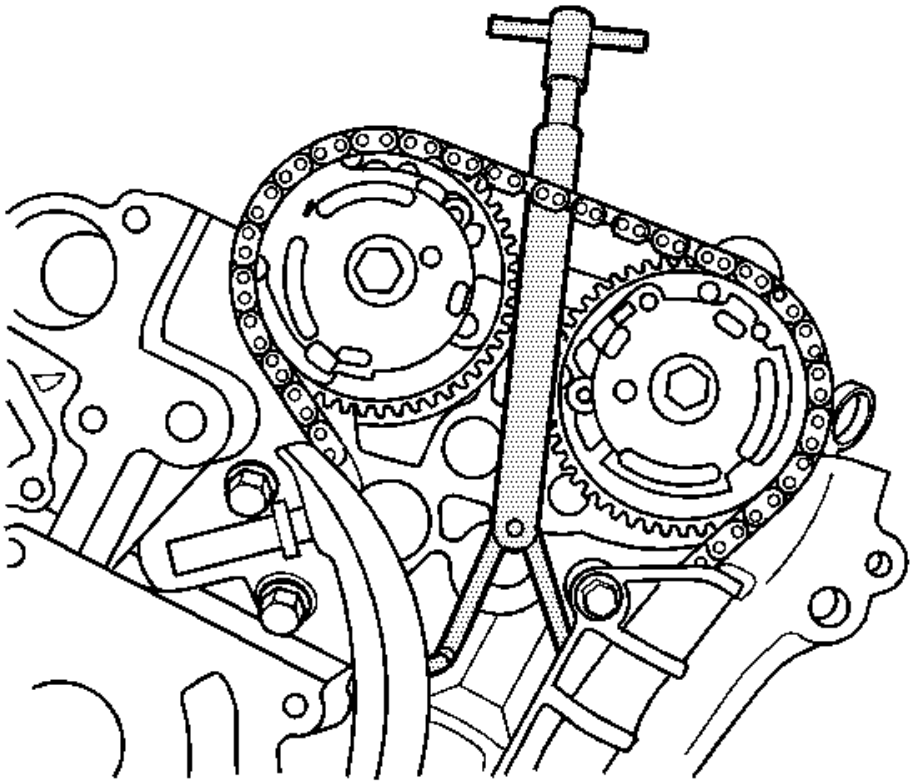

Fig. 152: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

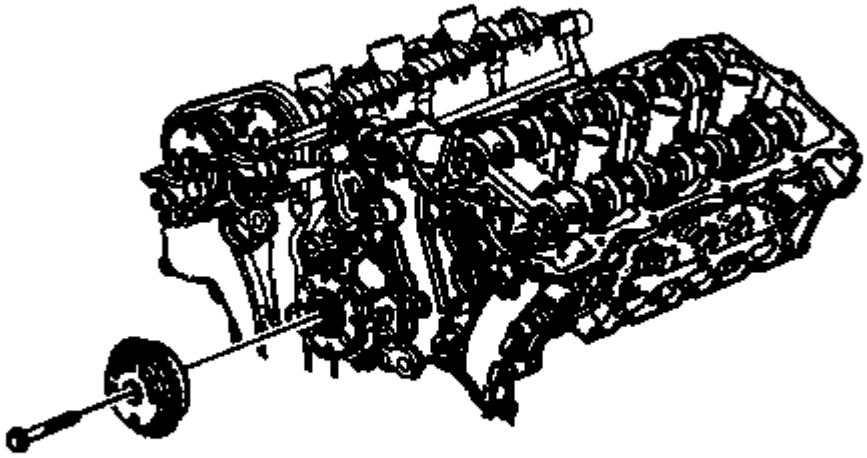

Fig. 153: View of Left Exhaust Camshaft Position Actuator And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

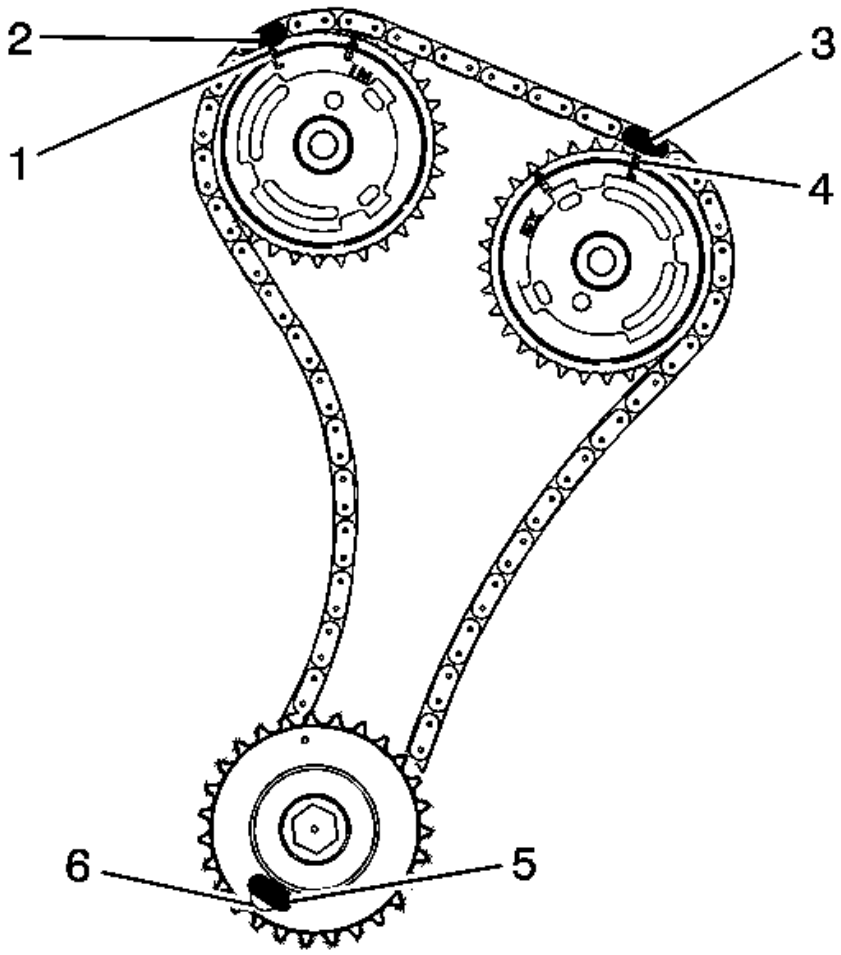

Fig. 154: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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.

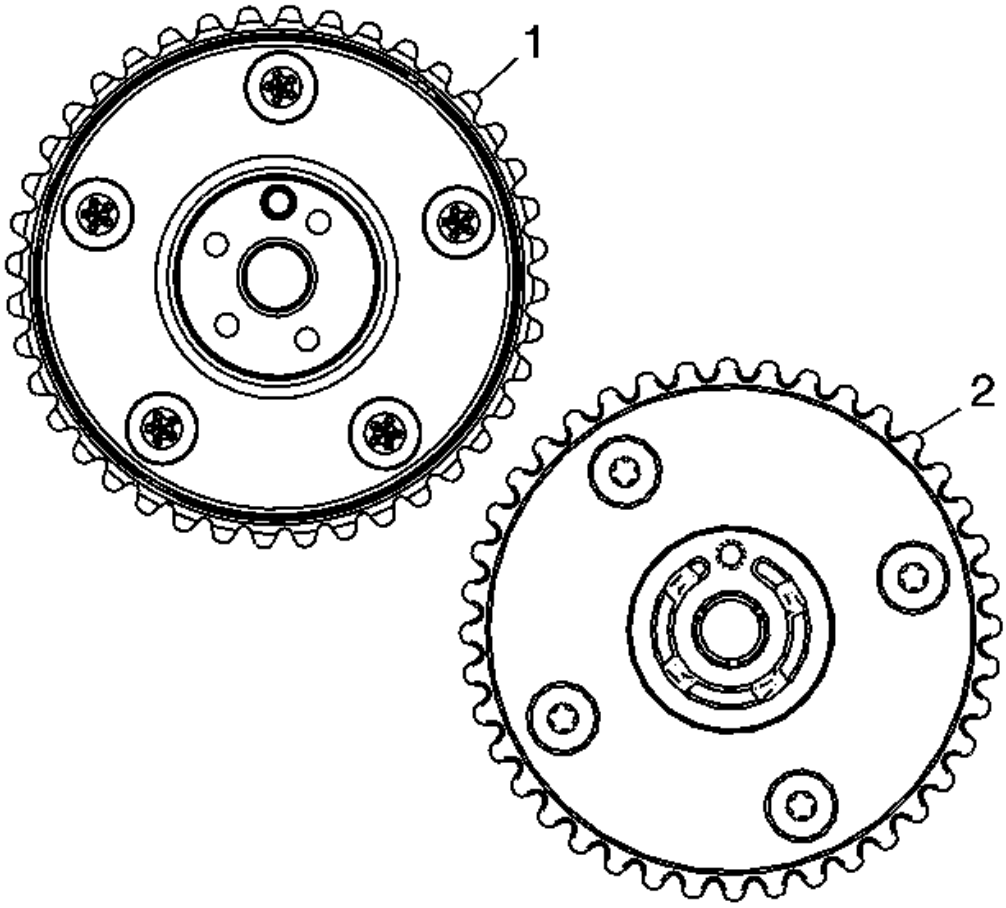

Fig. 155: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

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.

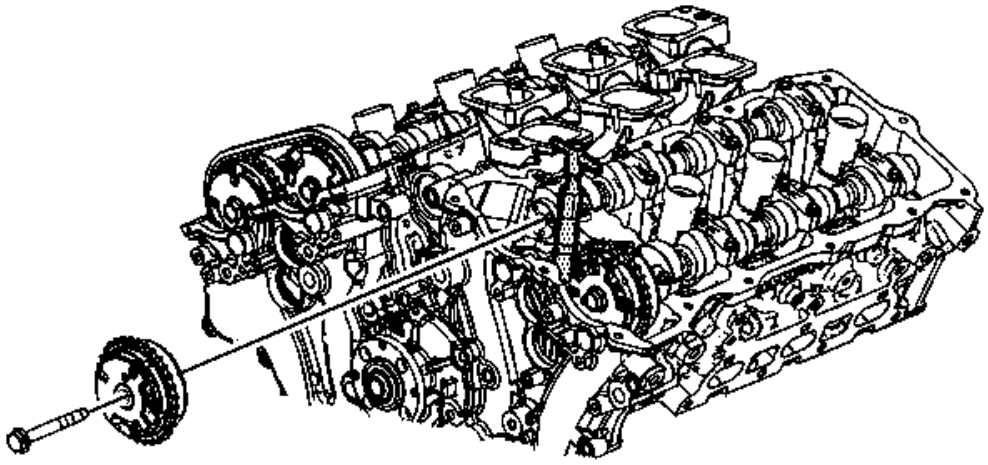

Fig. 156: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

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** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
11. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
12. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.

SETTING CAMSHAFT TIMING

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

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

CAMSHAFT REPLACEMENT - LEFT SIDE

Special Tools

- **EN-48589** Crankshaft Rotation Socket
- **EN-48383** Timing Chain Retention Tool

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

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the fuel pump from the cylinder head. Refer to **Fuel Pump Replacement (LLT)** .
3. Remove the left bank camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
4. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
5. Remove the camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** .
6. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2**.
7. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

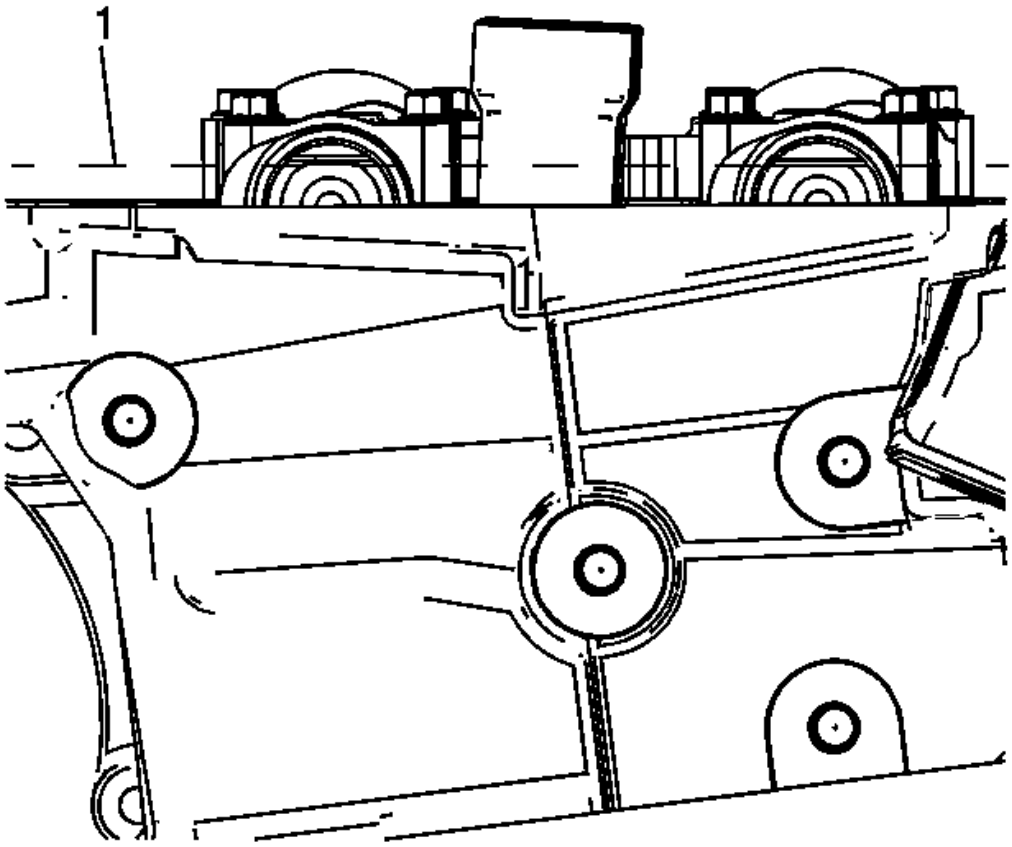

Fig. 157: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

8. Rotate the crankshaft with the **EN-48589** socket until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).

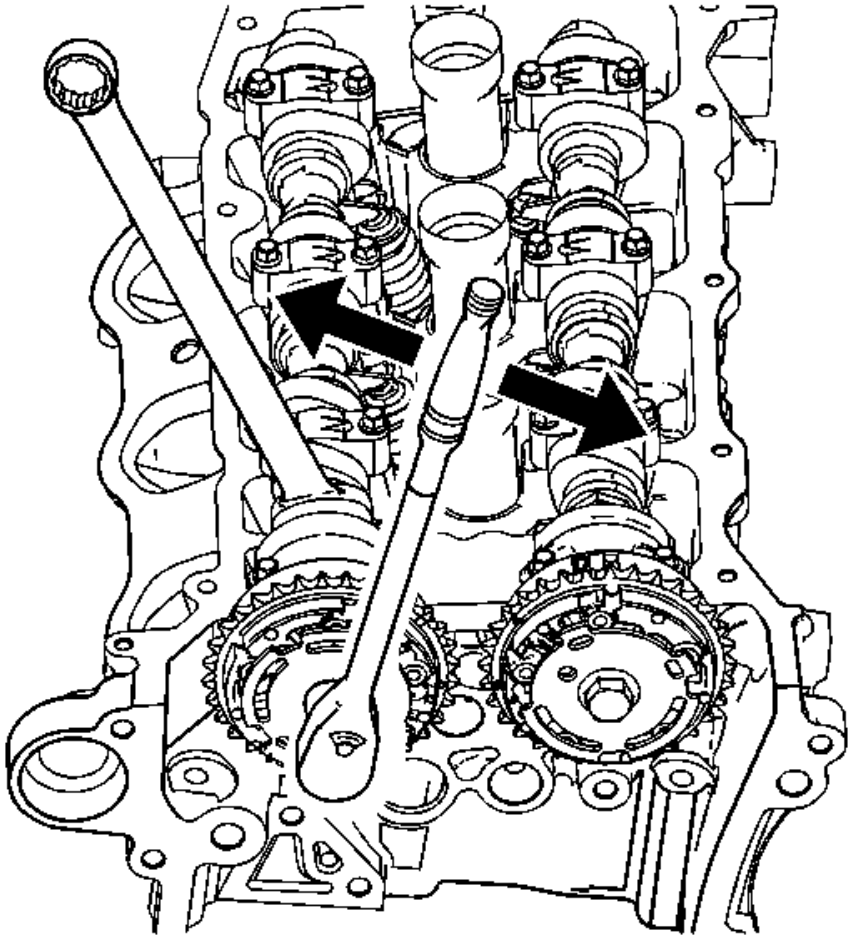

Fig. 158: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

NOTE:

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

9. Loosen the camshaft position actuator bolt.

NOTE: Ensure that the tips of the EN-48383 tool are fully engaged into the timing chain.

10. Install the **EN-48383** tool in order to retain the timing chain.

Firmly tighten the **EN-48383** tool nuts.

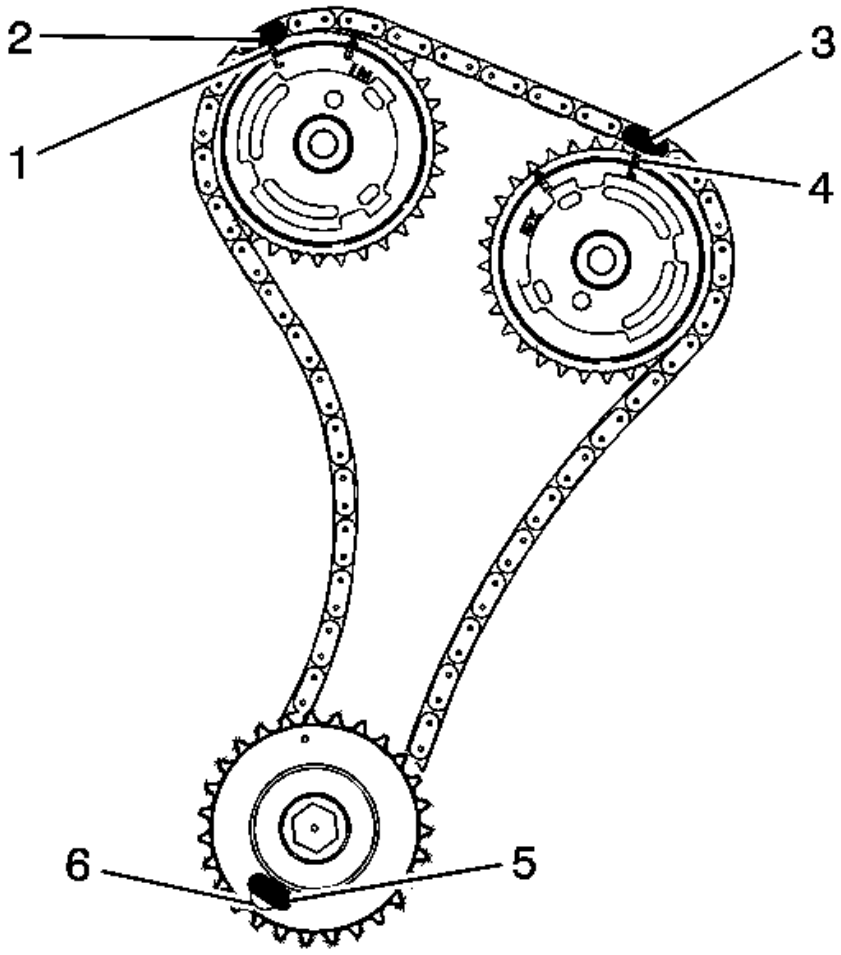

Fig. 159: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

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

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

Installation Procedure

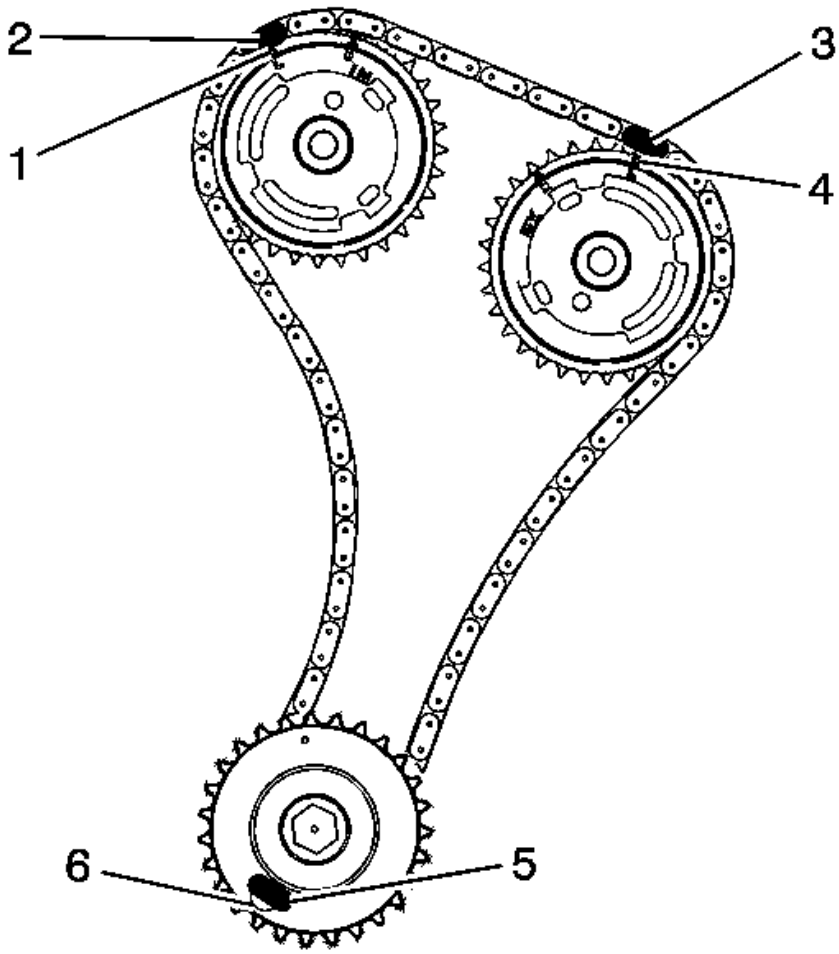

Fig. 160: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Left Side** .
3. Remove the **EN-48383** tool.

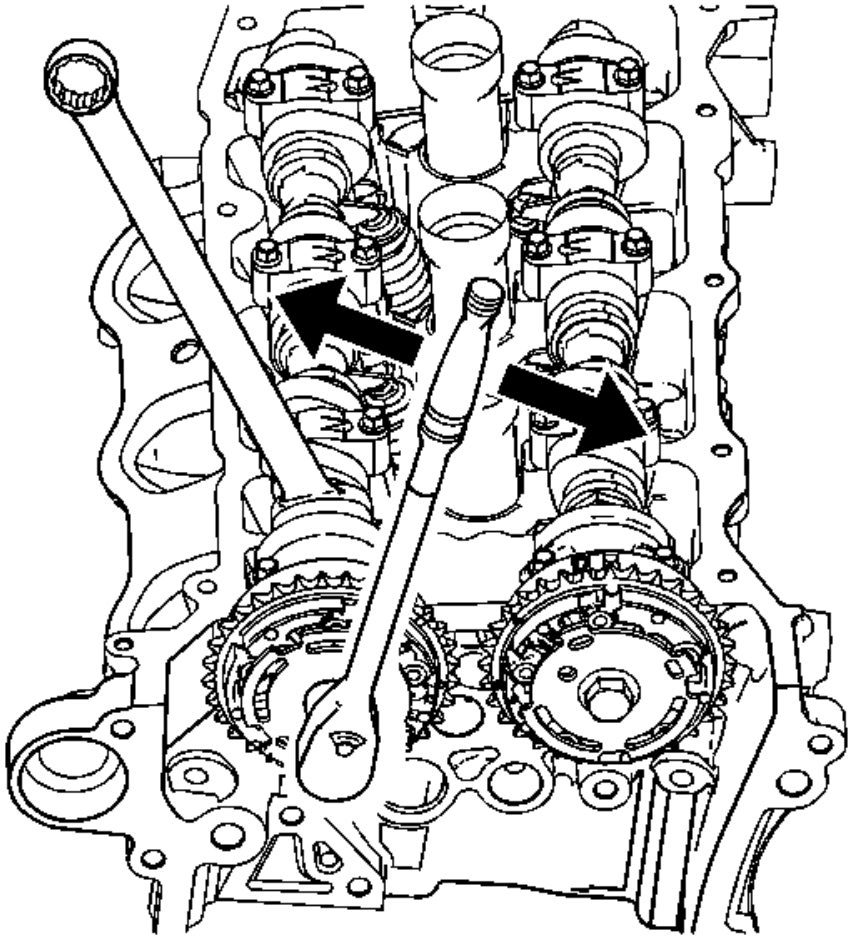

Fig. 161: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

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

4. Install and tighten the camshaft position actuators. Refer to **Camshaft Position Actuator Installation - Left Side Intake** , and **Camshaft Position Actuator Installation - Left Side Exhaust** .
5. Install the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** .
6. Install the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

9. Install the fuel pump to the cylinder head. Refer to **Fuel Pump Replacement (LLT)** .
10. Install the intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT REPLACEMENT - RIGHT SIDE

Special Tools

- **EN-48313** Timing Chain Retention Tool
- **EN 46111** Crankshaft Rotation Socket

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the intake camshaft position actuator solenoid. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
5. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

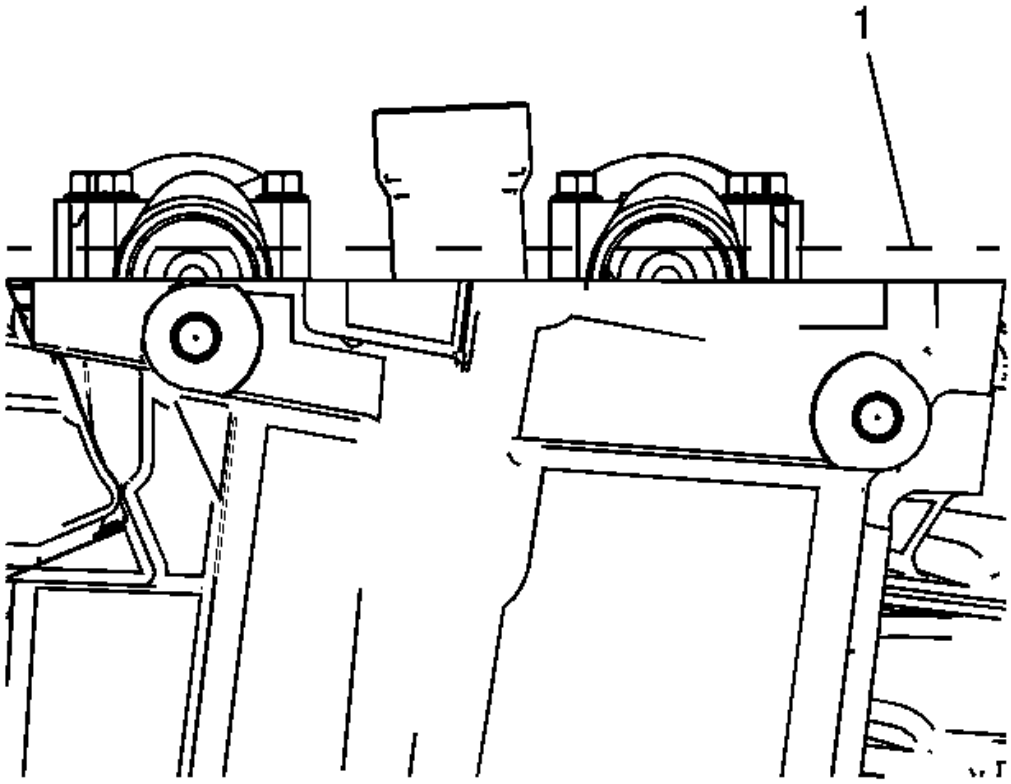

Fig. 162: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

6. Rotate the crankshaft with the **EN 46111** crankshaft rotation socket until the camshafts are in a neutral (low tension) position. The camshaft flats will be parallel with the camshaft cover rail (1).

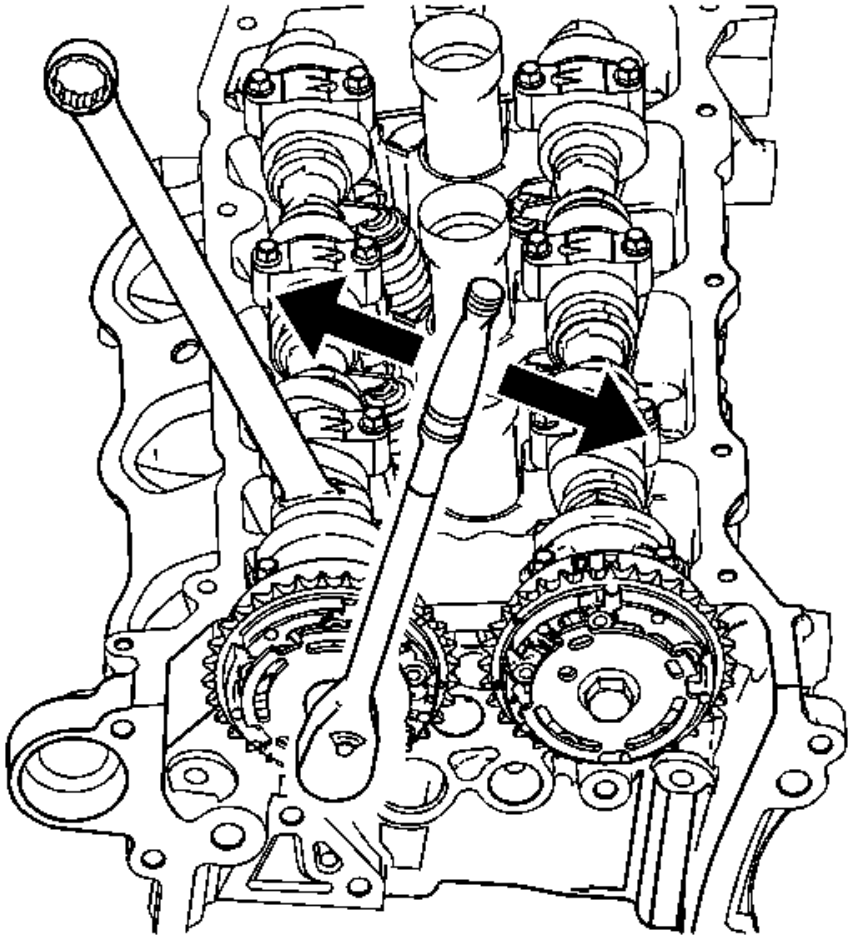

Fig. 163: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

NOTE:

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

7. Loosen the camshaft position actuator bolt.

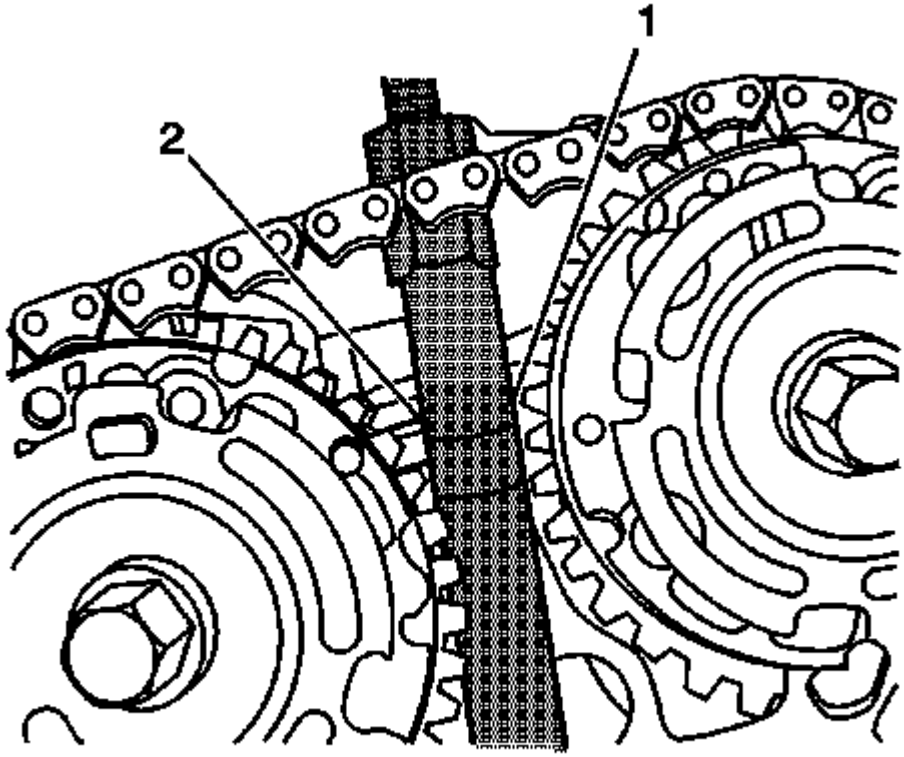

Fig. 164: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

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

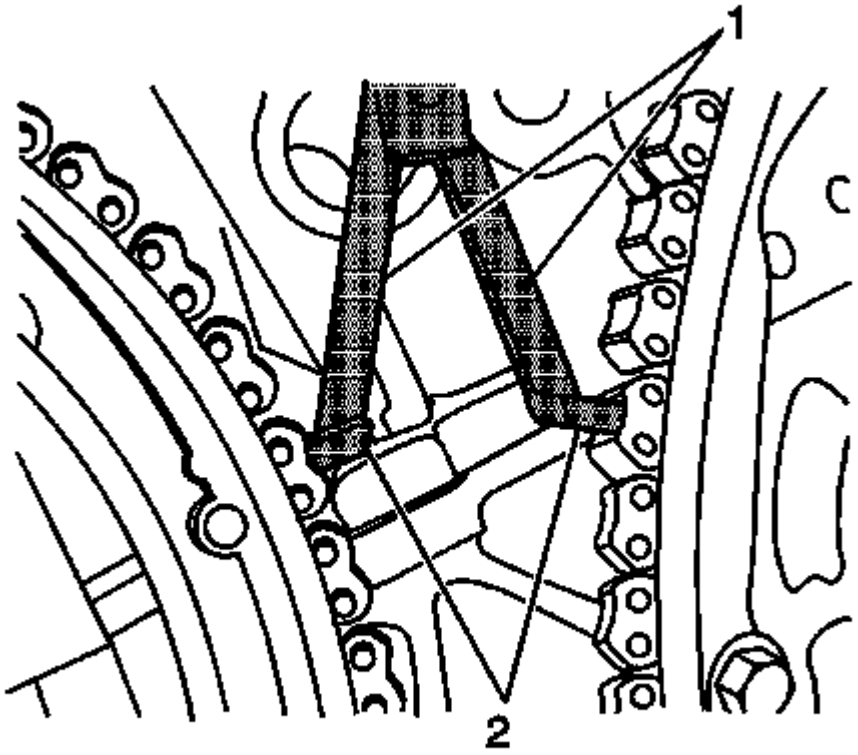

Fig. 165: View Of Feet, Legs of Special Tool & Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

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

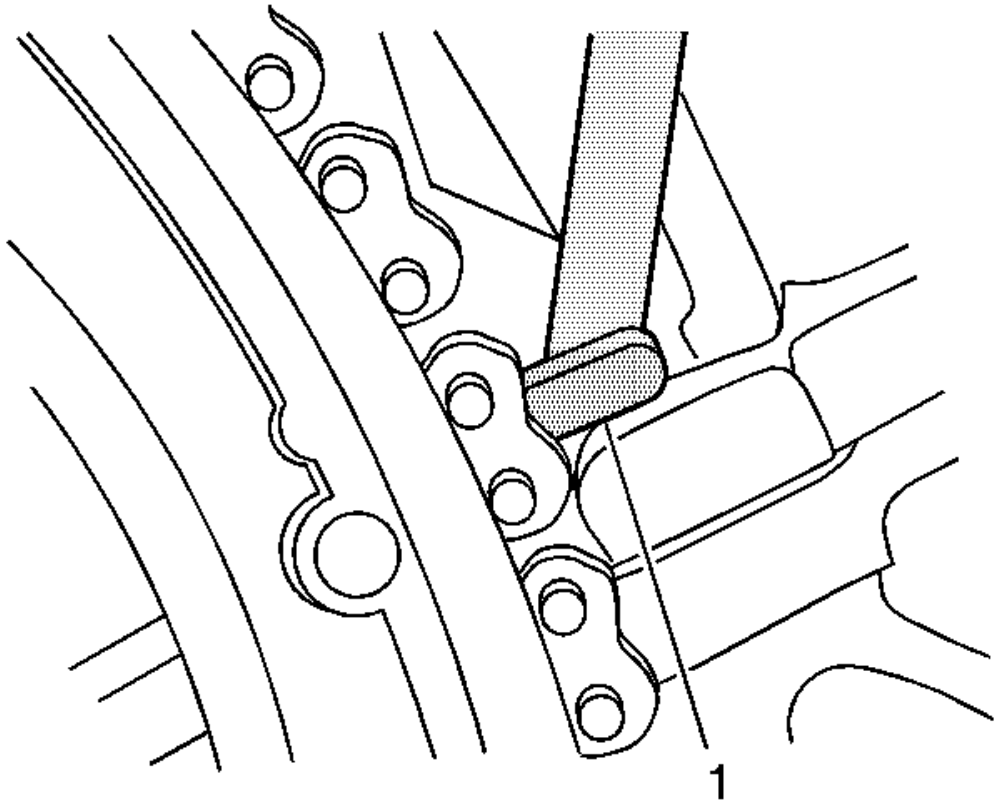

Fig. 166: Foot Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

13. Hand tighten the **EN-48313** timing chain retention tool.

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

14. Use an open end wrench on the hex cast into the body of the **EN-48313** timing chain retention tool and hand tighten the T-handle.

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

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

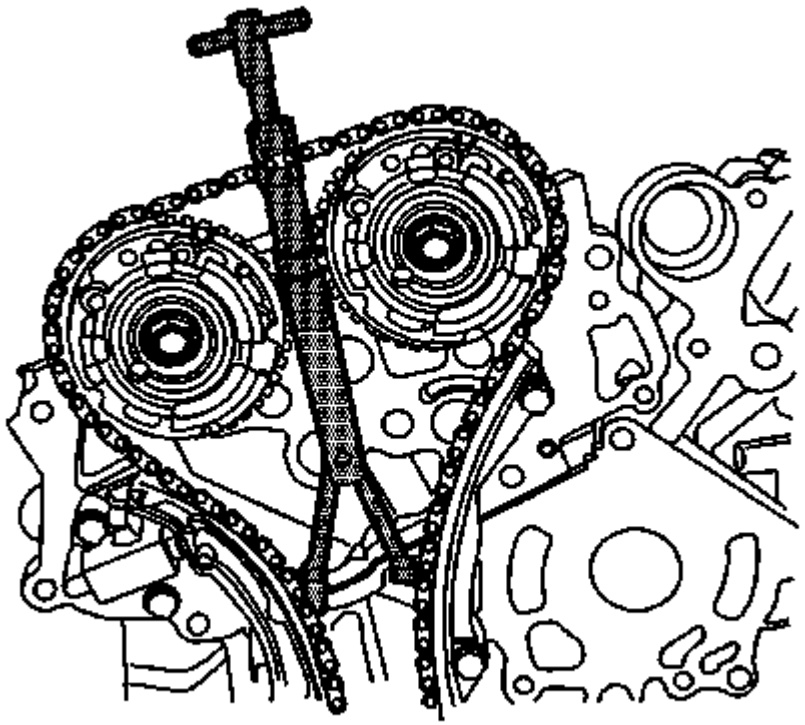

Fig. 167: Timing Chain Retention Tool Between Actuators
Courtesy of GENERAL MOTORS COMPANY

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

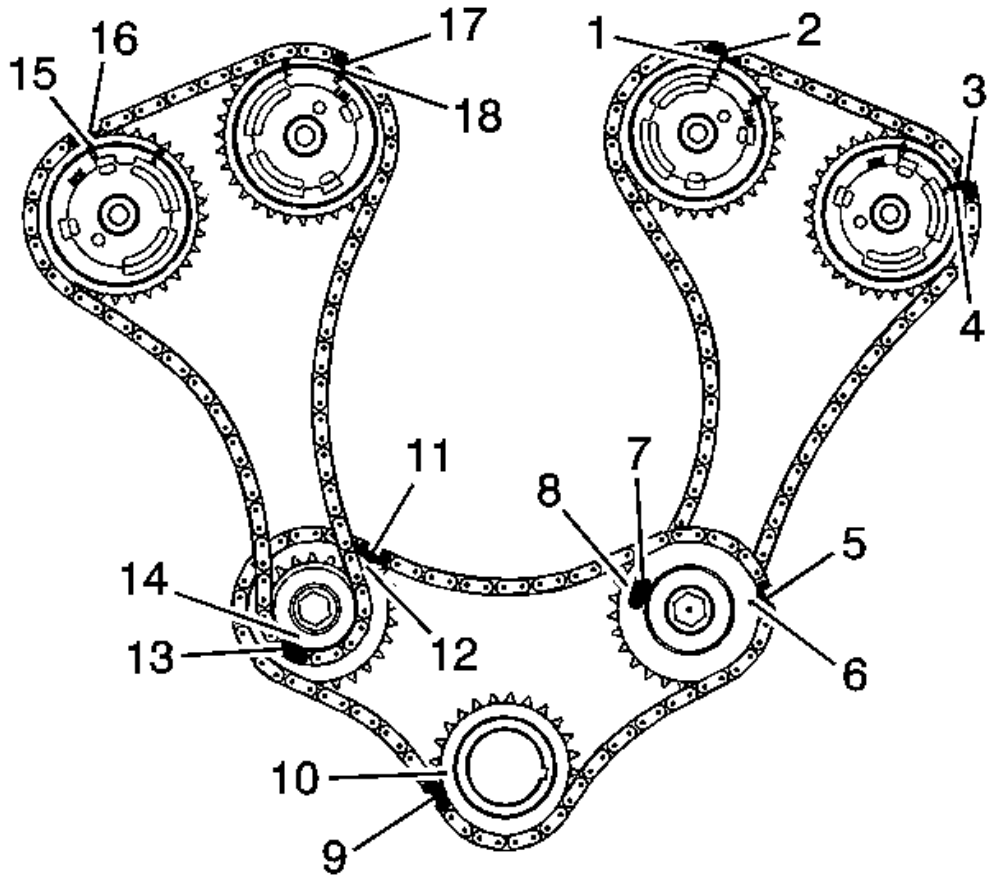

Fig. 168: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS COMPANY

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

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

Installation Procedure

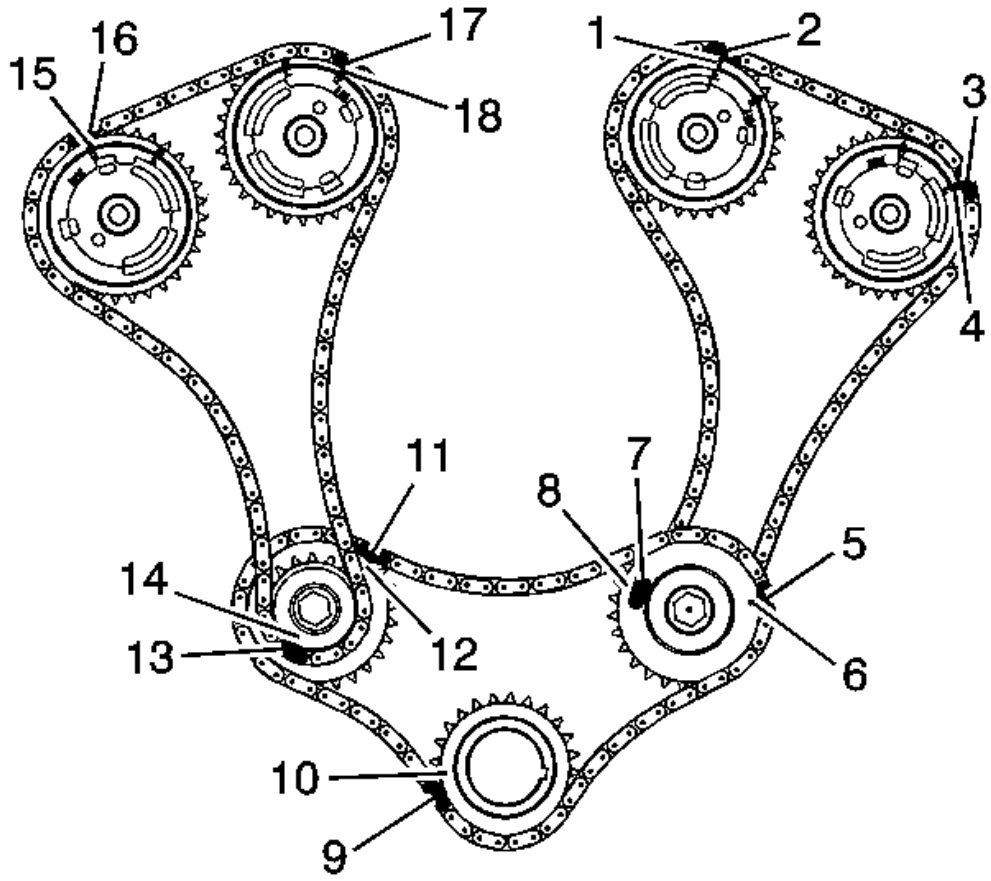

Fig. 169: Identifying Timing Chain Marks And Their Respective Locations On Gears, Sprockets And Actuators
Courtesy of GENERAL MOTORS COMPANY

NOTE:

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

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Right Side** .
3. Remove the **EN-48313** timing chain retention tool.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

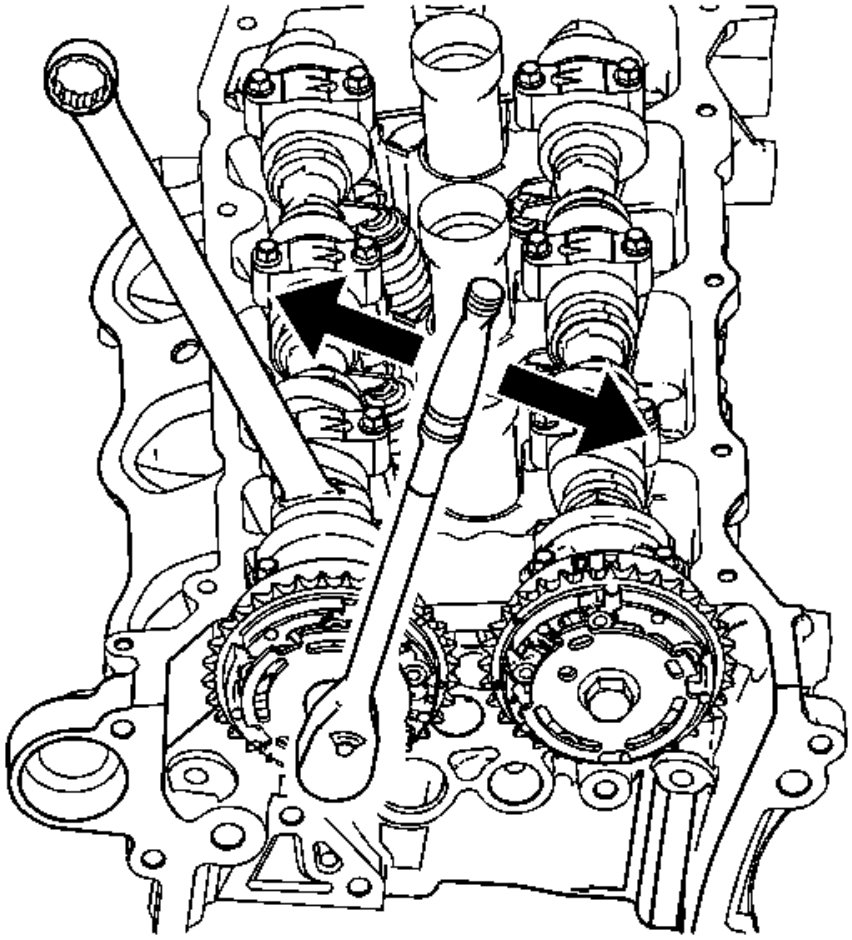

Fig. 170: Preventing Camshaft/Engine Rotation Using Open-End Wrench
Courtesy of GENERAL MOTORS COMPANY

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

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

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

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

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

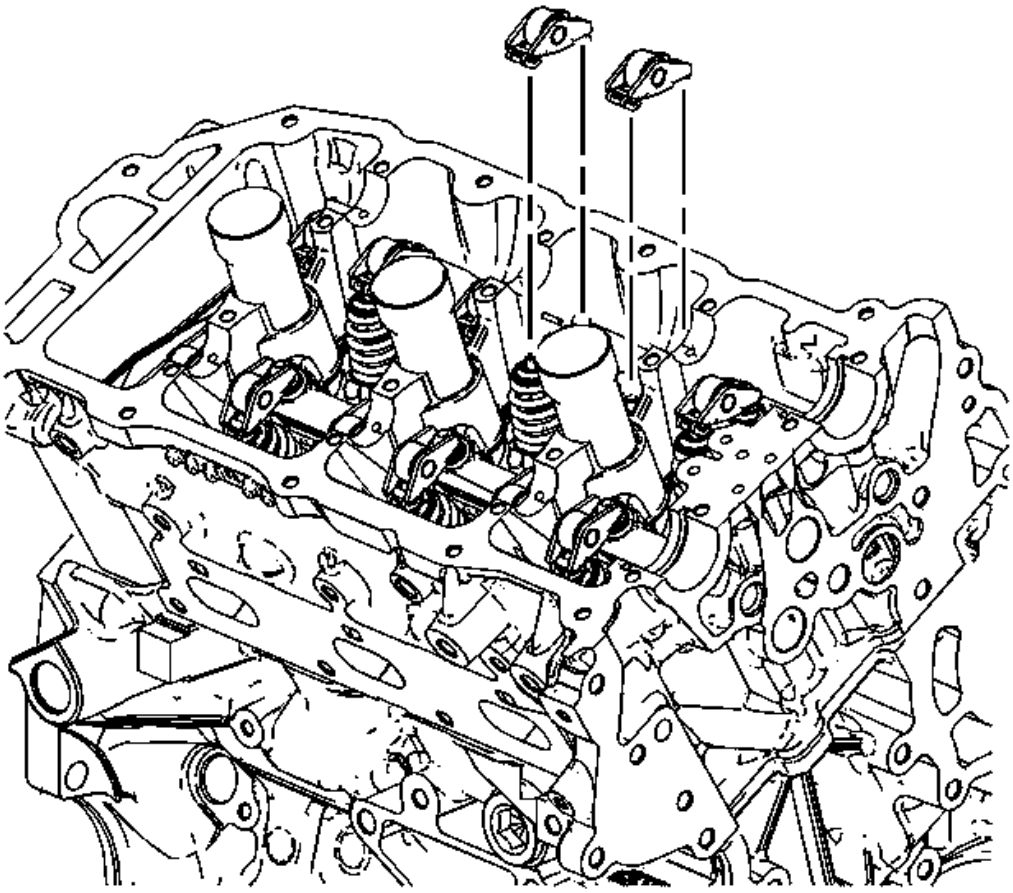

Fig. 171: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

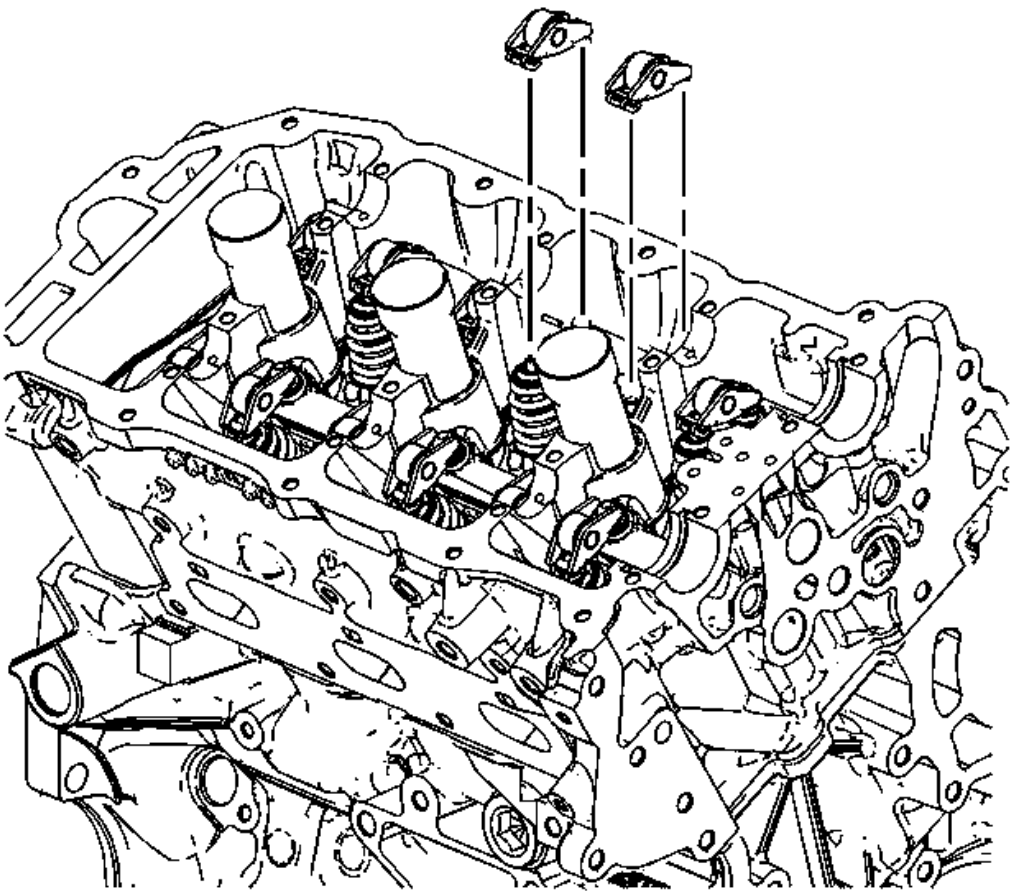

Fig. 172: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

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

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

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

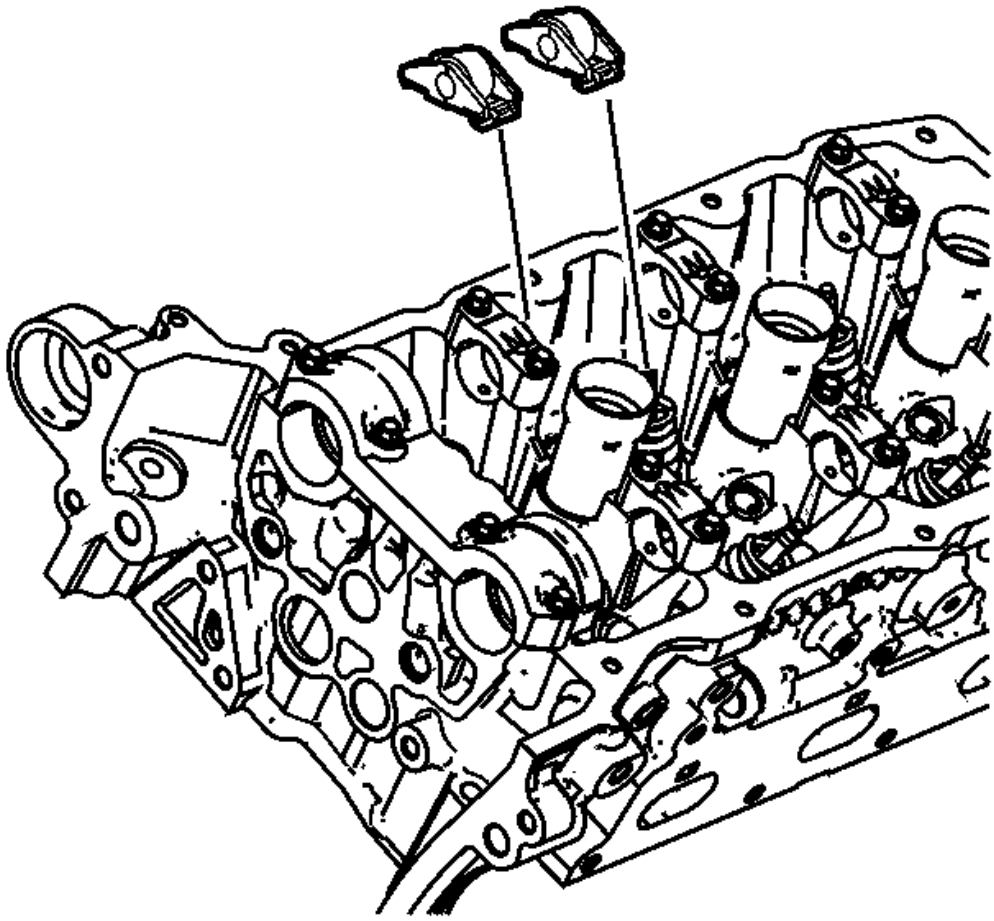

Fig. 173: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

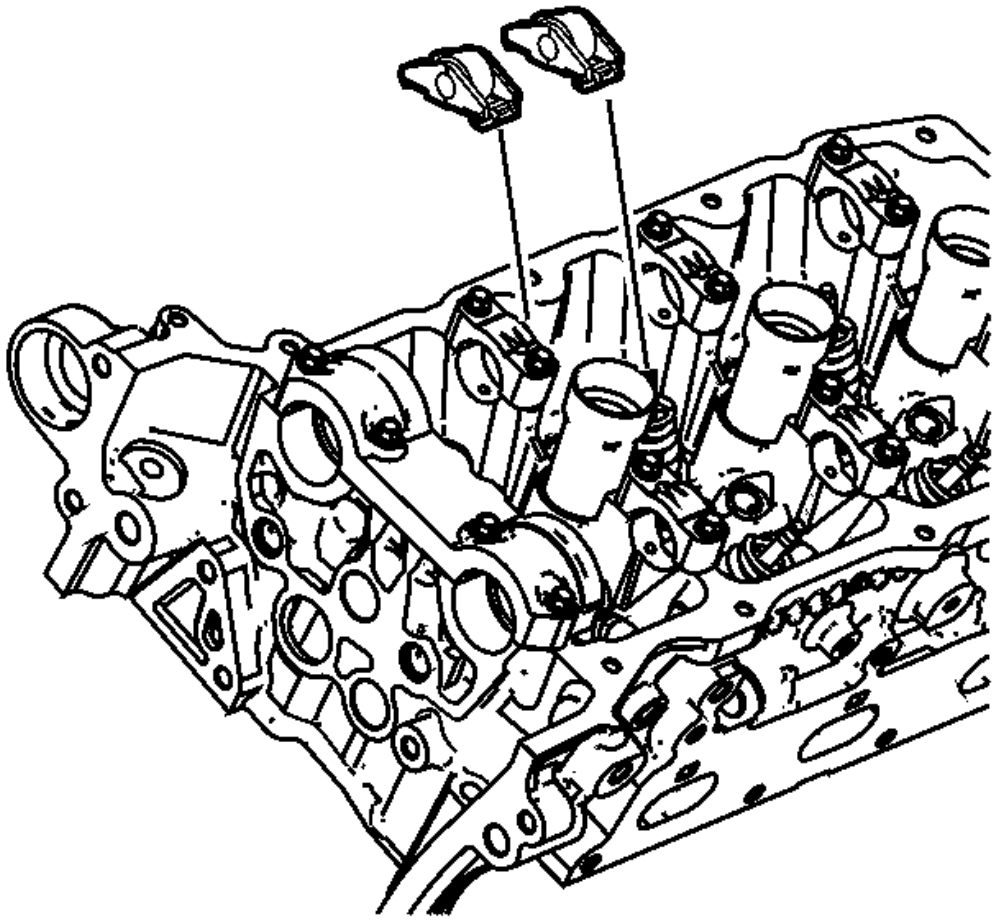

Fig. 174: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

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

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

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

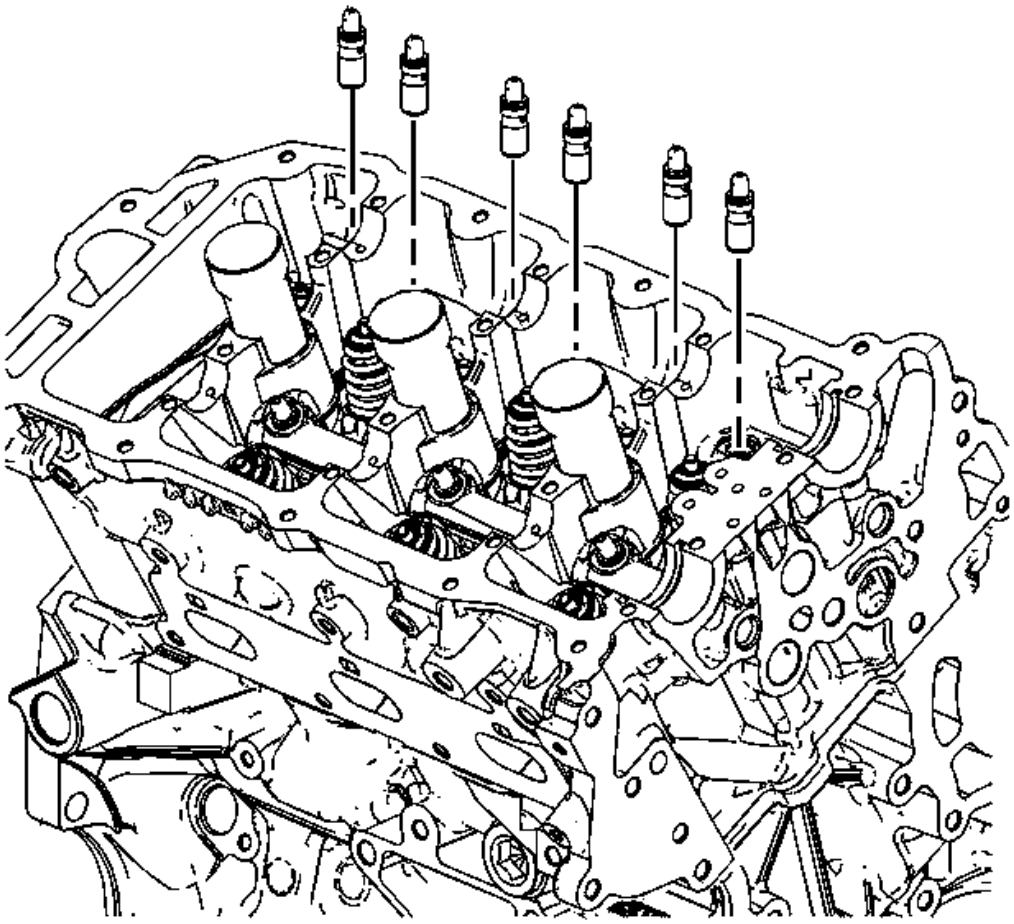

Fig. 175: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side (LLT)** .
4. Clean and inspect the camshaft(s), rocker arm(s) and lifter(s). 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

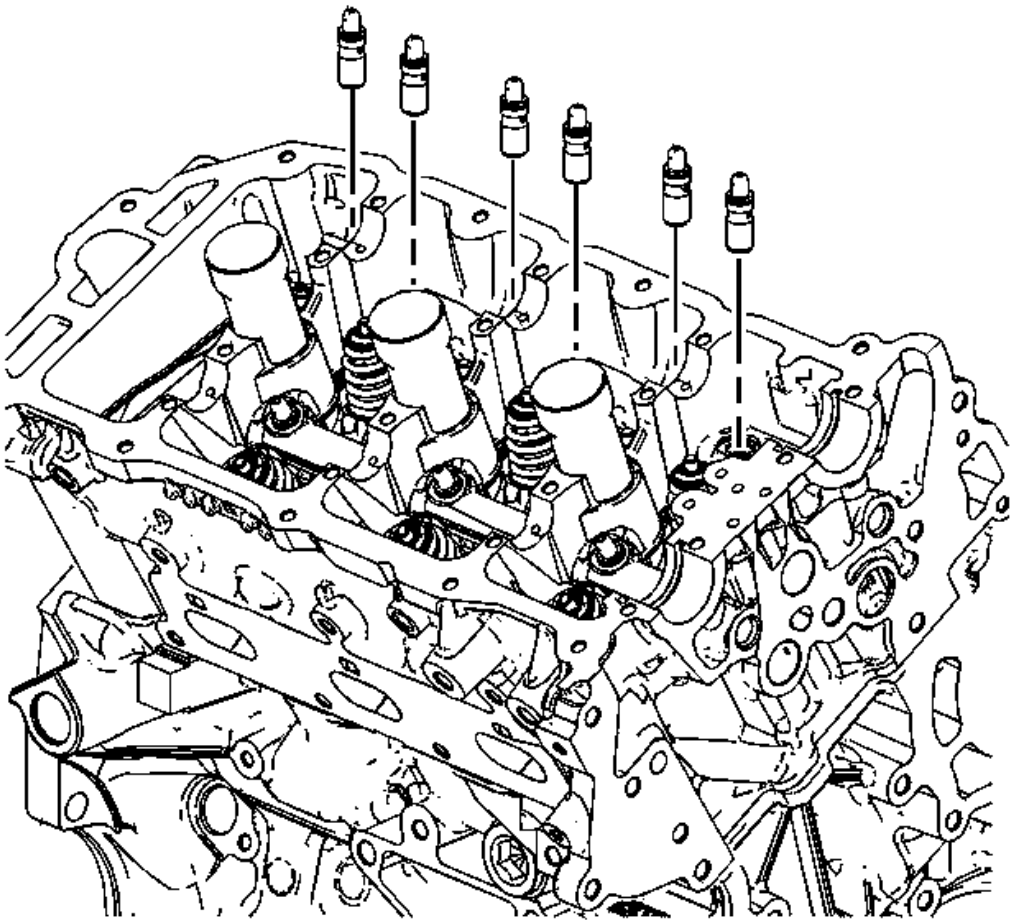

Fig. 176: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

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

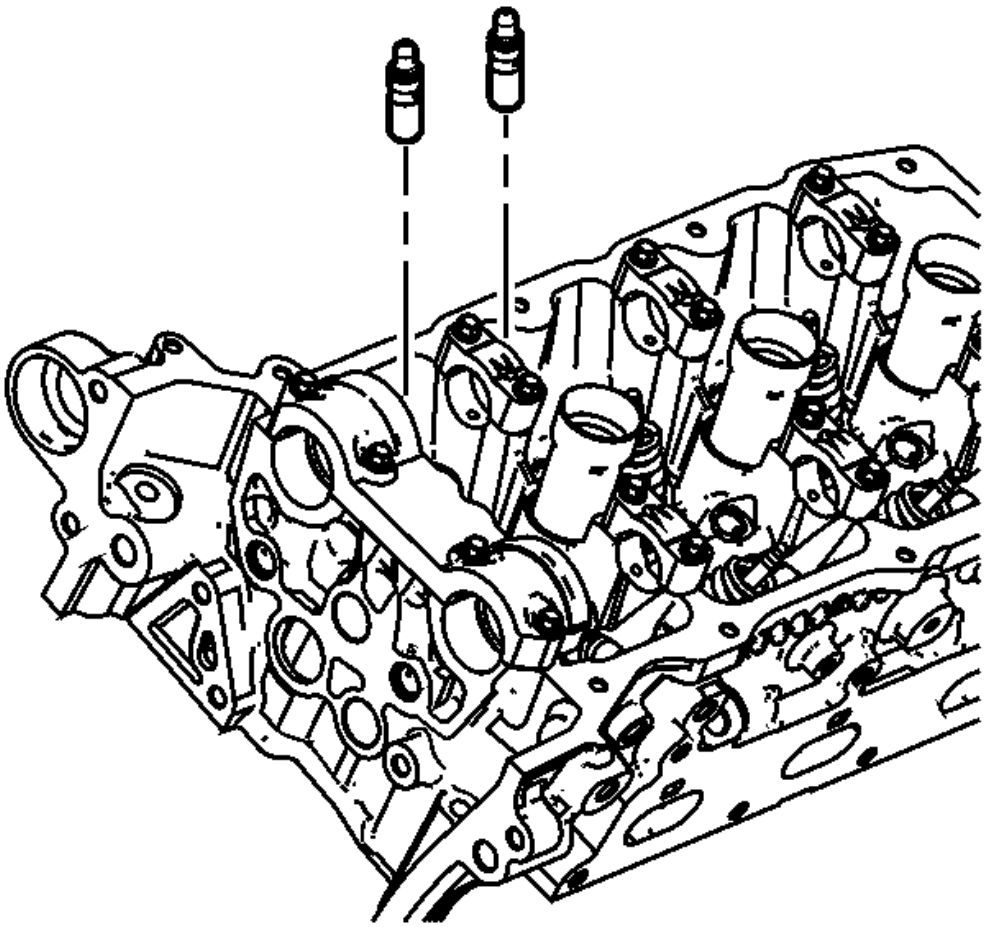

Fig. 177: View Of Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side (LLT)** .
4. Clean and inspect the camshaft(s), rocker arm(s) and lifter(s). 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

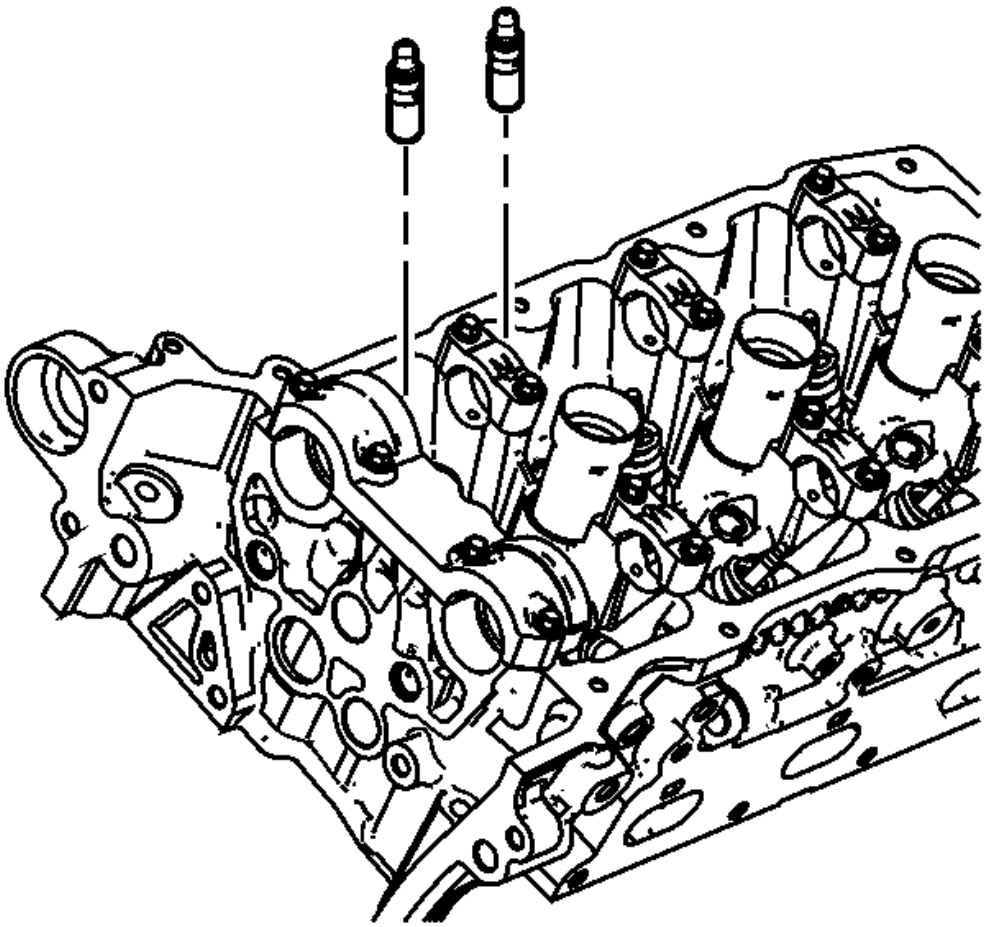

Fig. 178: View Of Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

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

Removal Procedure

1. Remove the starter motor. Refer to **Starter Replacement** .

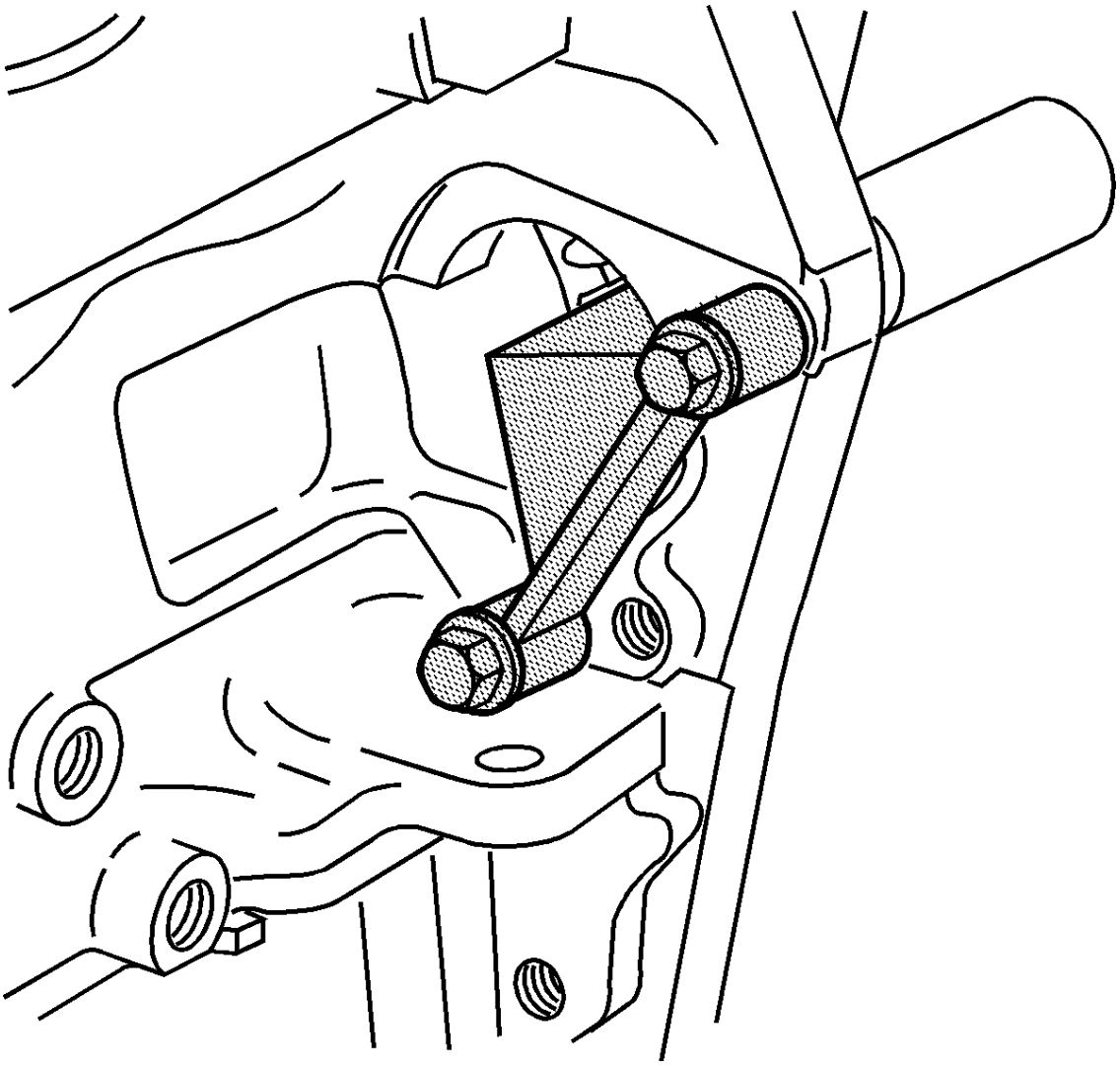

Fig. 179: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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

2. Install the **EN 46106** flywheel holding tool in order to prevent crankshaft rotation.
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Left Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Remove Rocker arm. refer to **Valve Rocker Arm Replacement - Left Side**
6. Install the **J 39313** spark plug port adapter to the applicable cylinder.
7. Connect the **J 39313** spark plug port adapter to a compressed air source.

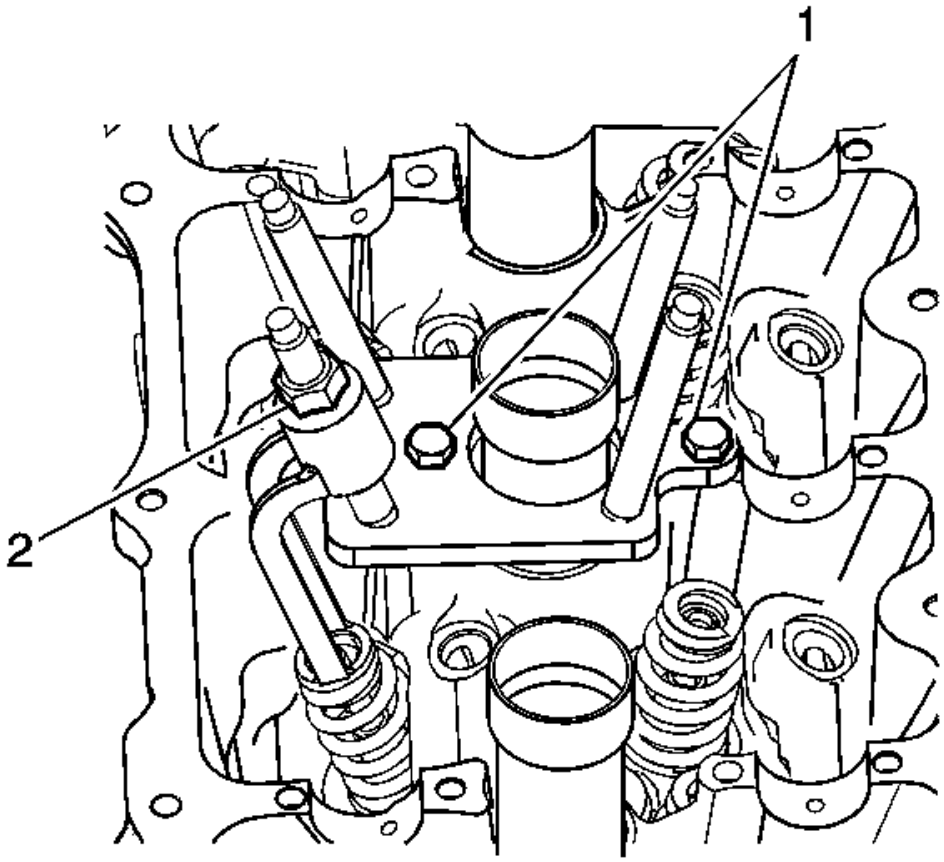

Fig. 180: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN 46110** on-vehicle valve spring compressor above the applicable cylinder as shown.
9. Tighten the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut (2).

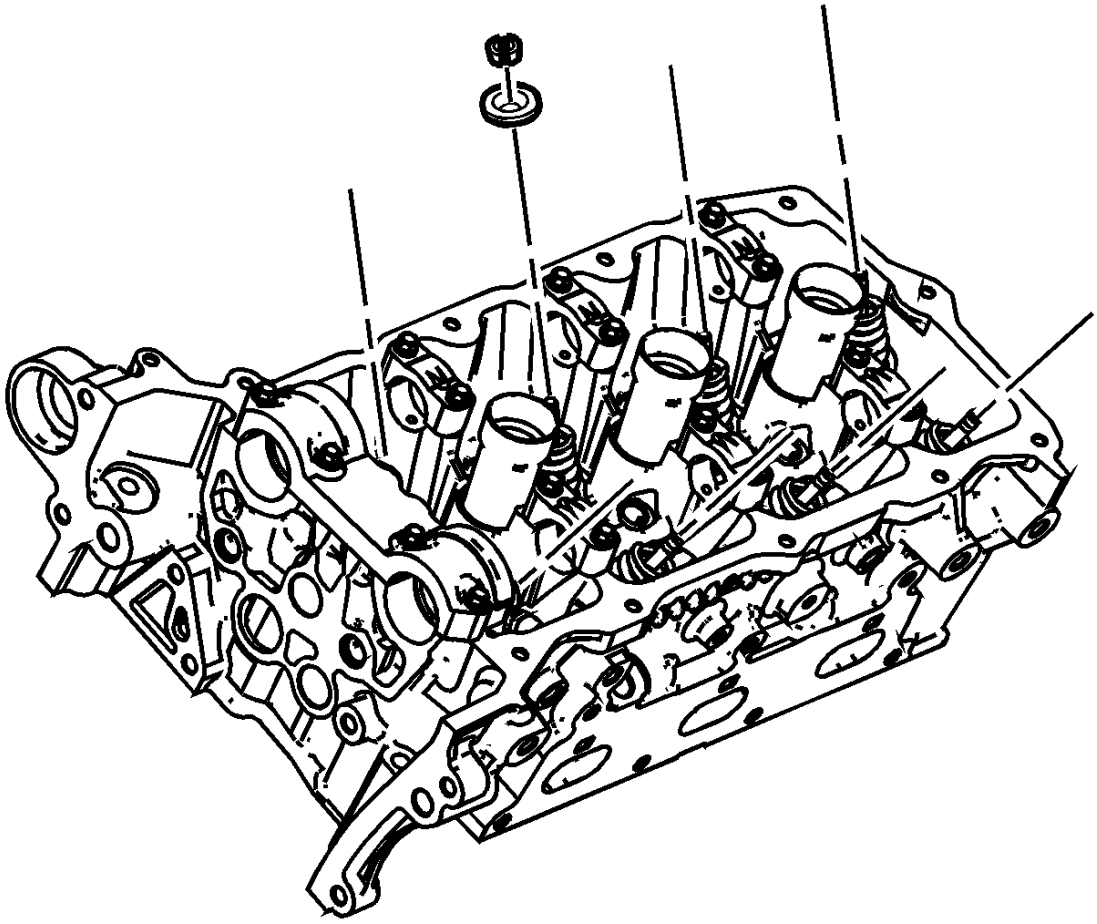

Fig. 181: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

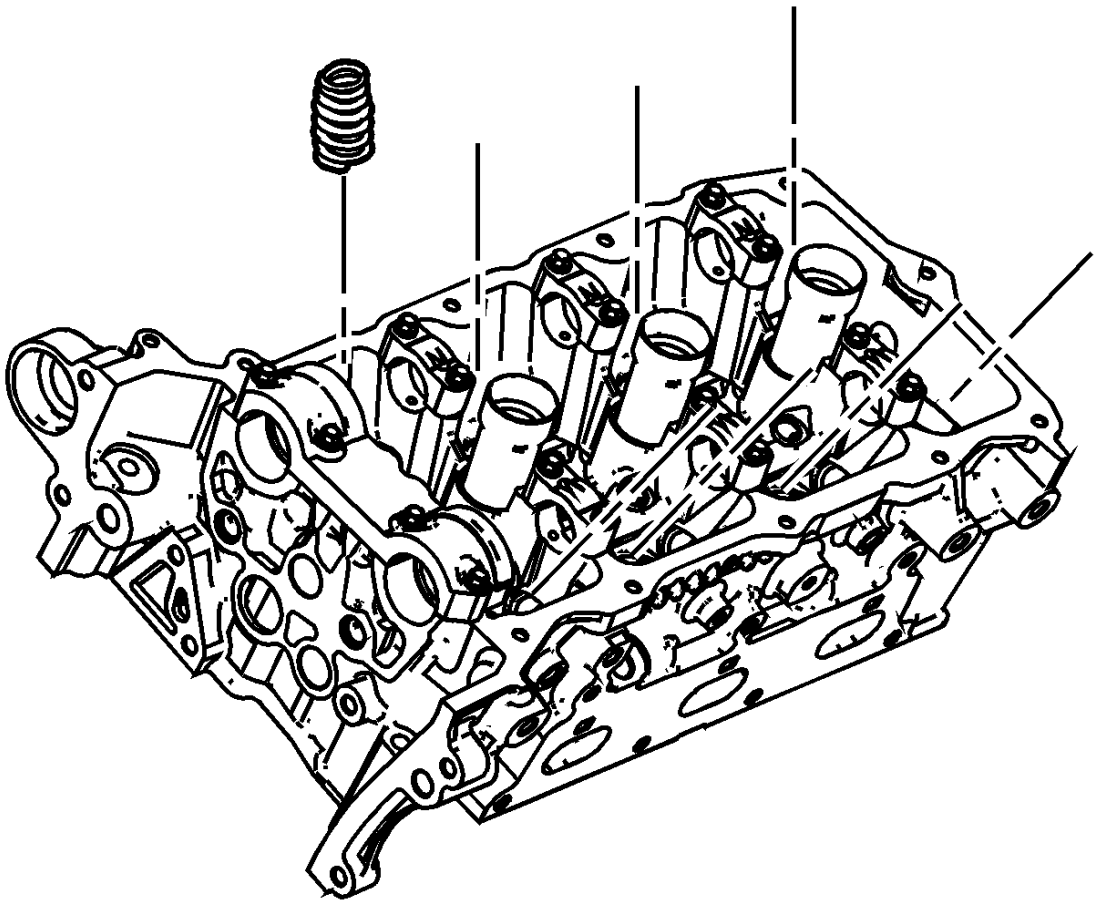

Fig. 182: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

13. Remove the valve spring.

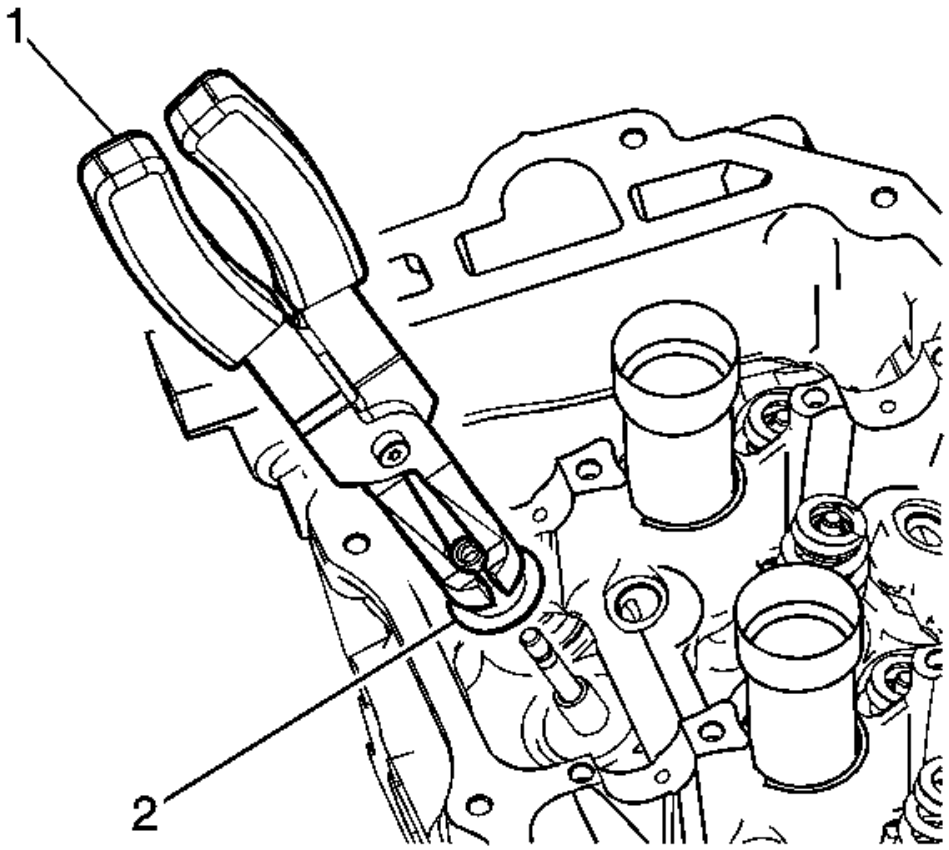

Fig. 183: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

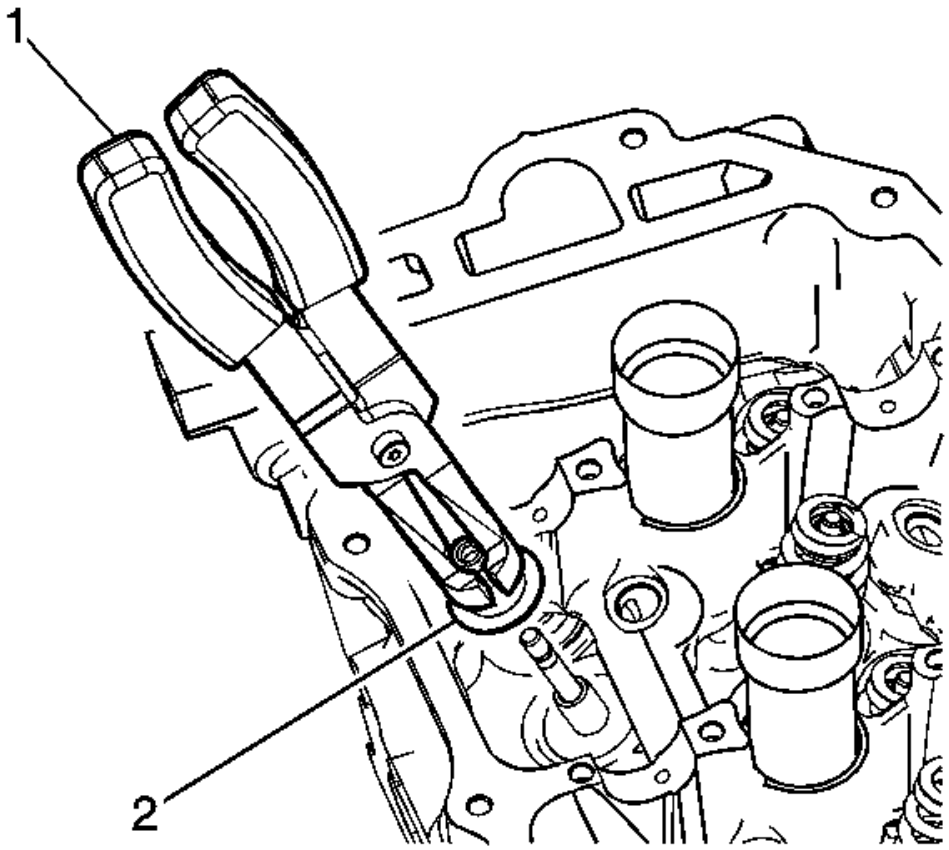

Fig. 184: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

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

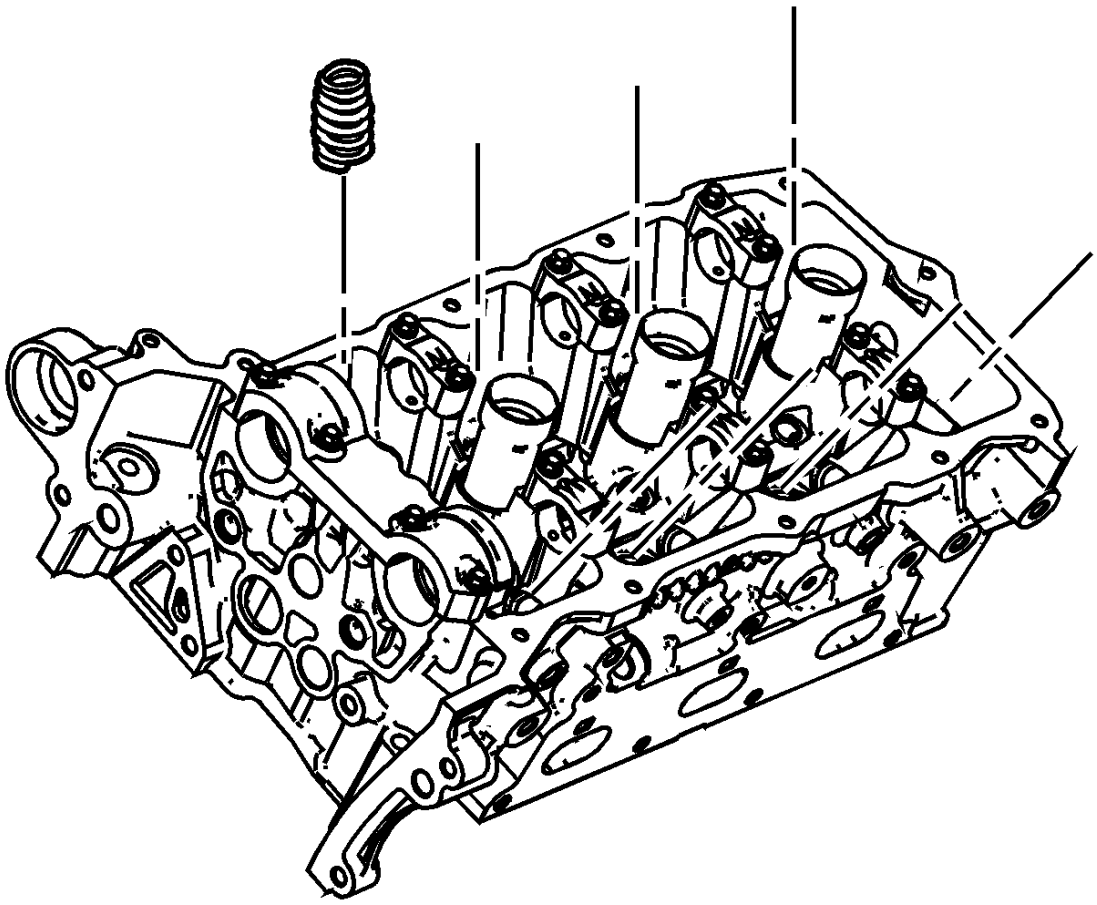

Fig. 185: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

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

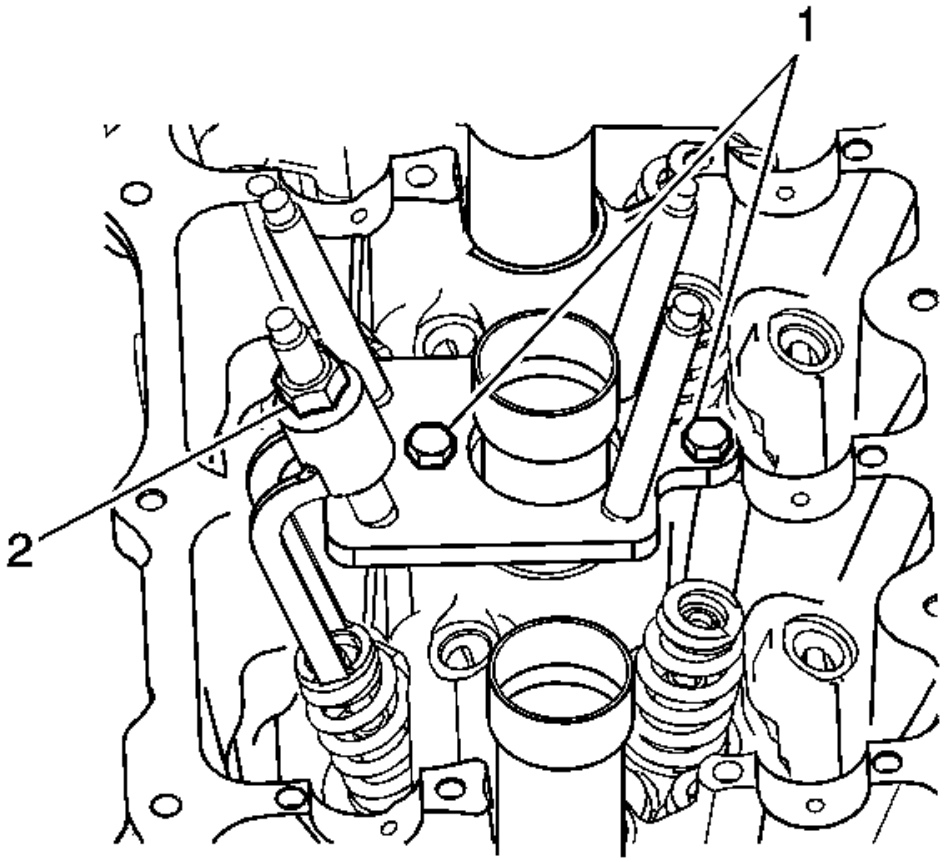

Fig. 186: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN 46110** on-vehicle valve spring compressor above the applicable valve spring as shown.

   Tighten the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut (2).

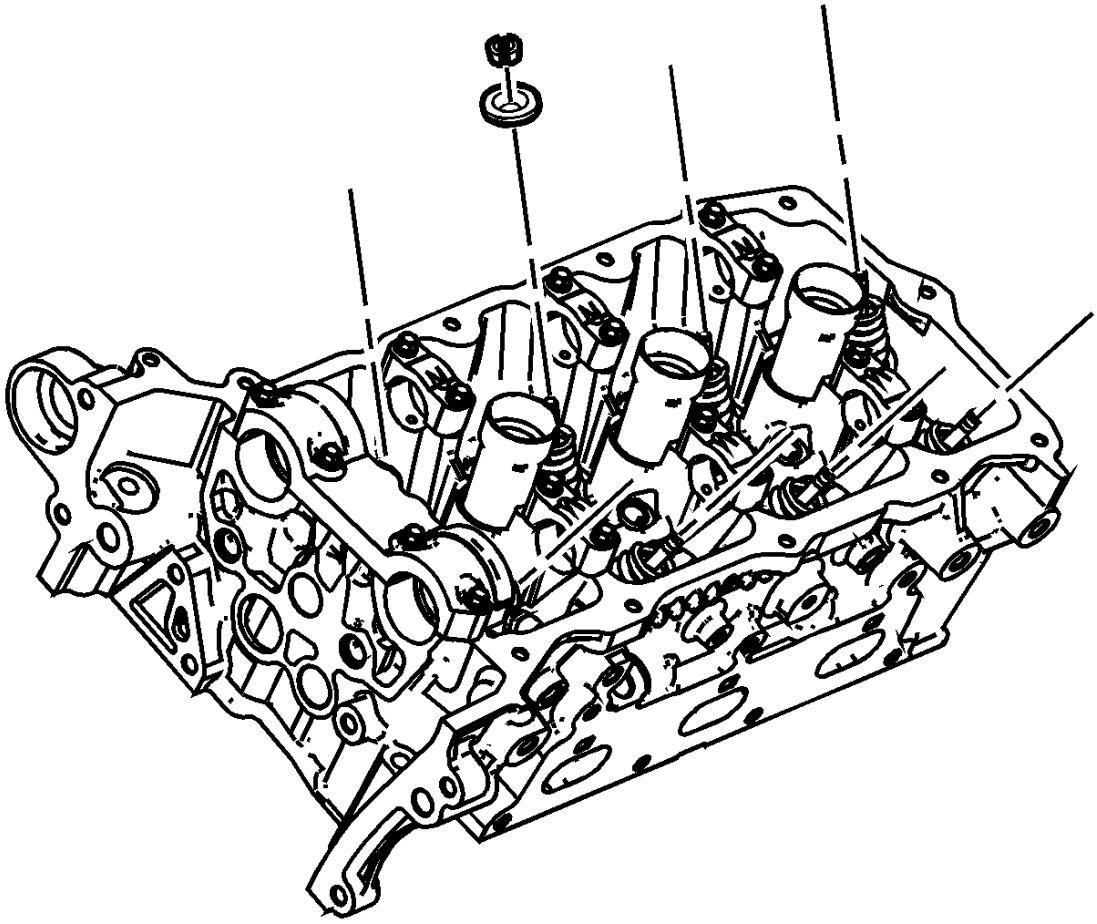

Fig. 187: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN 46110** on-vehicle valve spring compressor.
7. Disconnect the **J 39313** spark plug port adapter from the compressed air source.
8. Remove the **J 39313** spark plug port adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms and camshafts. Refer to **Camshaft Replacement - Left Side**.
11. Remove the **EN 46106** flywheel holding tool in order to prevent crankshaft rotation.
12. Install the starter motor. Refer to **Starter Replacement** .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

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

Removal Procedure

1. Remove the starter motor. Refer to **Starter Replacement** .

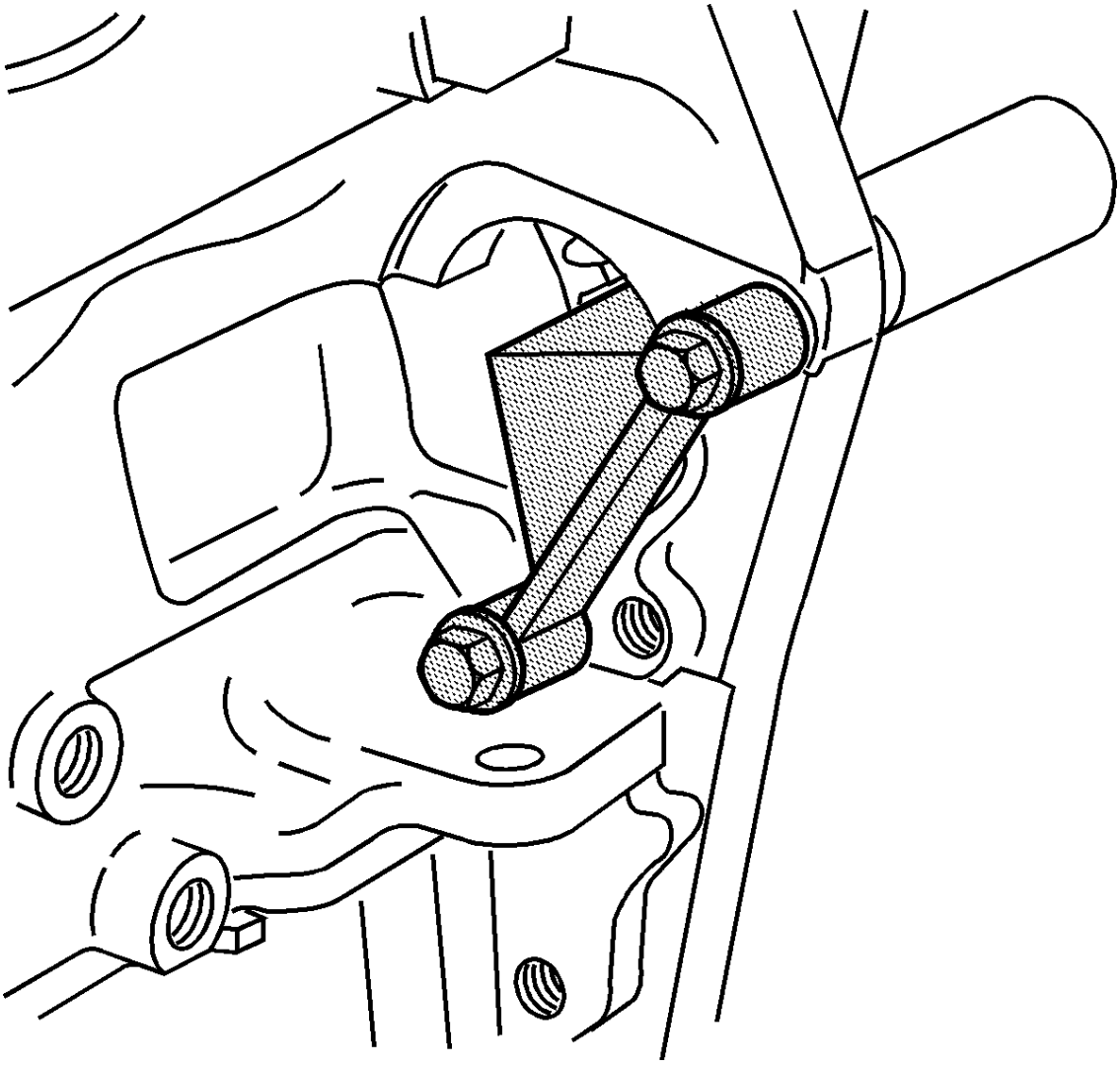

Fig. 188: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

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

2. Install the **EN 46106** flywheel holding tool in order to prevent crankshaft rotation.
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Right Side**, **Valve Rocker Arm Replacement - Right Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** spark plug port adapter to the applicable cylinder.
6. Connect the **J 39313** spark plug port adapter to a compressed air source.

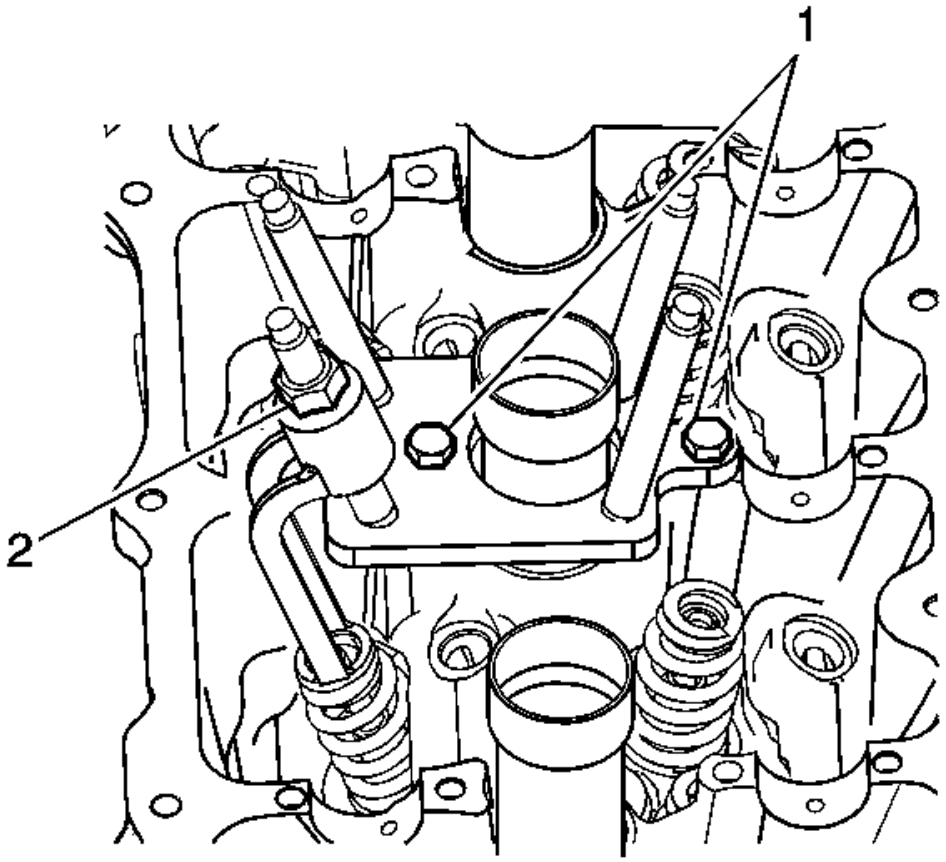

Fig. 189: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

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

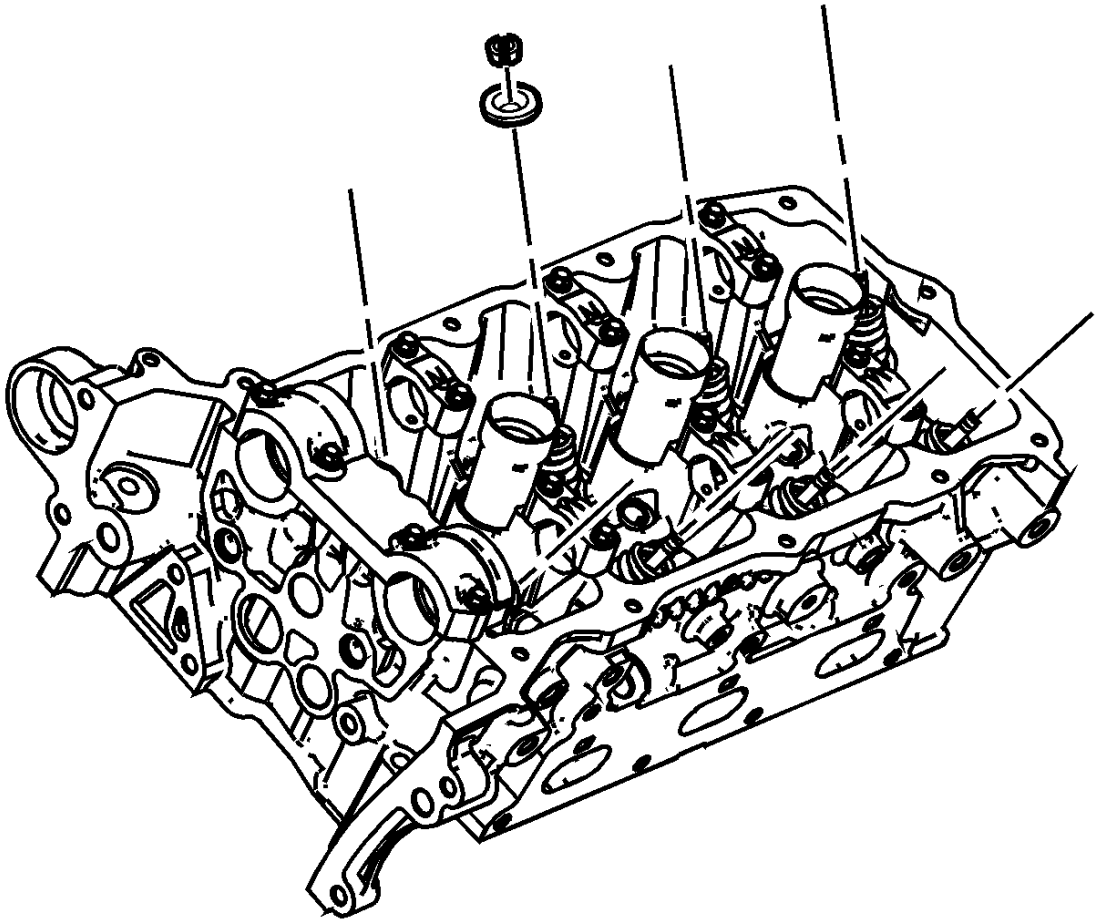

Fig. 190: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

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

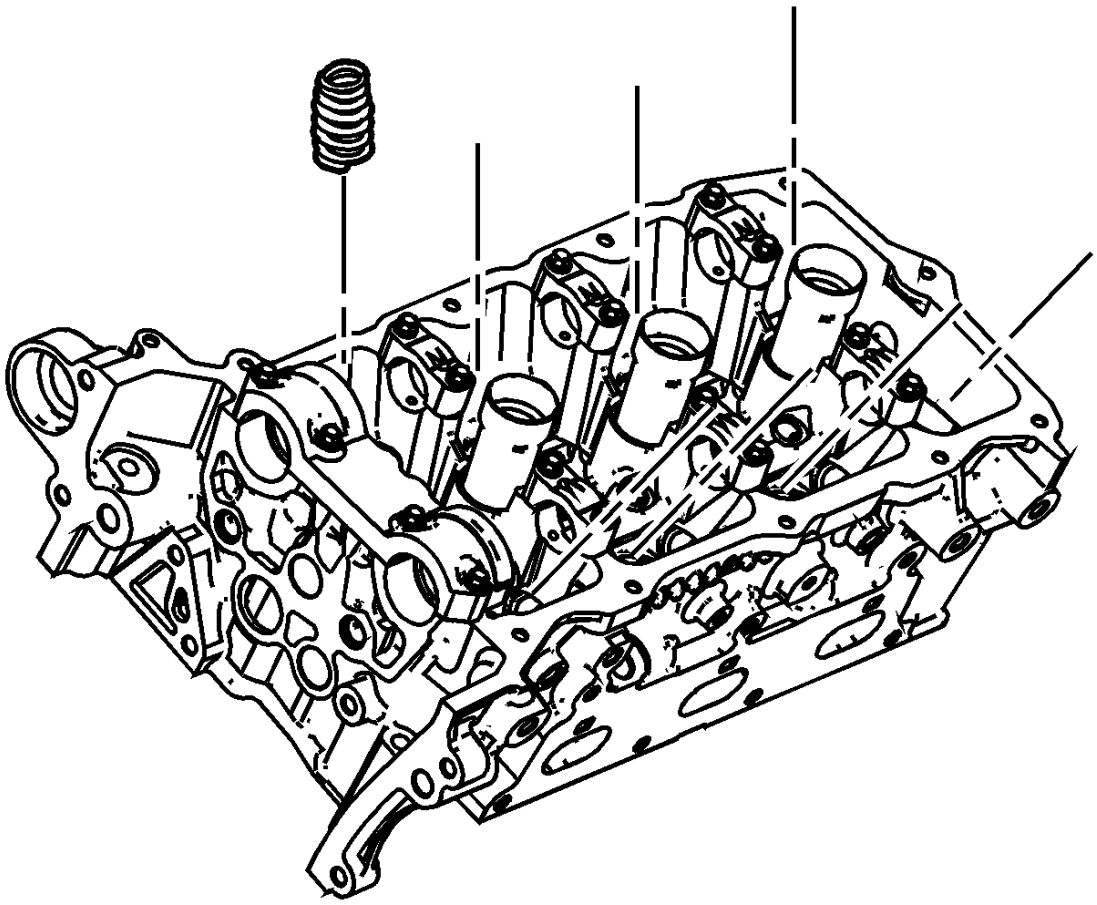

Fig. 191: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve springs.

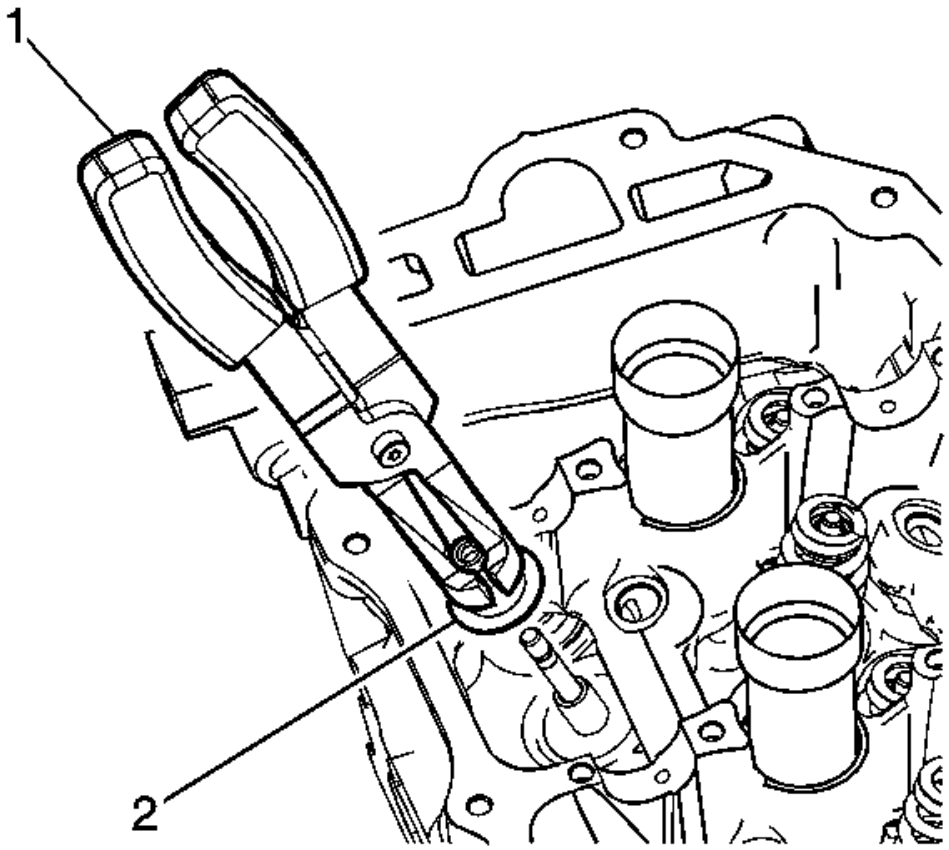

Fig. 192: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

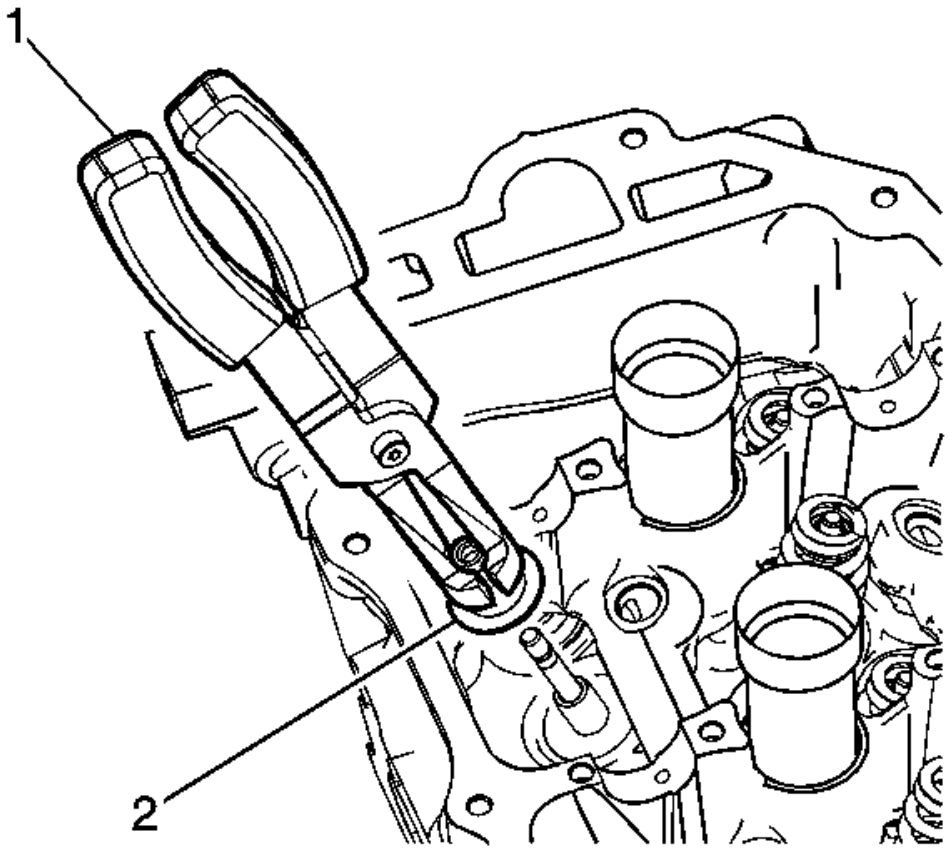

Fig. 193: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

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

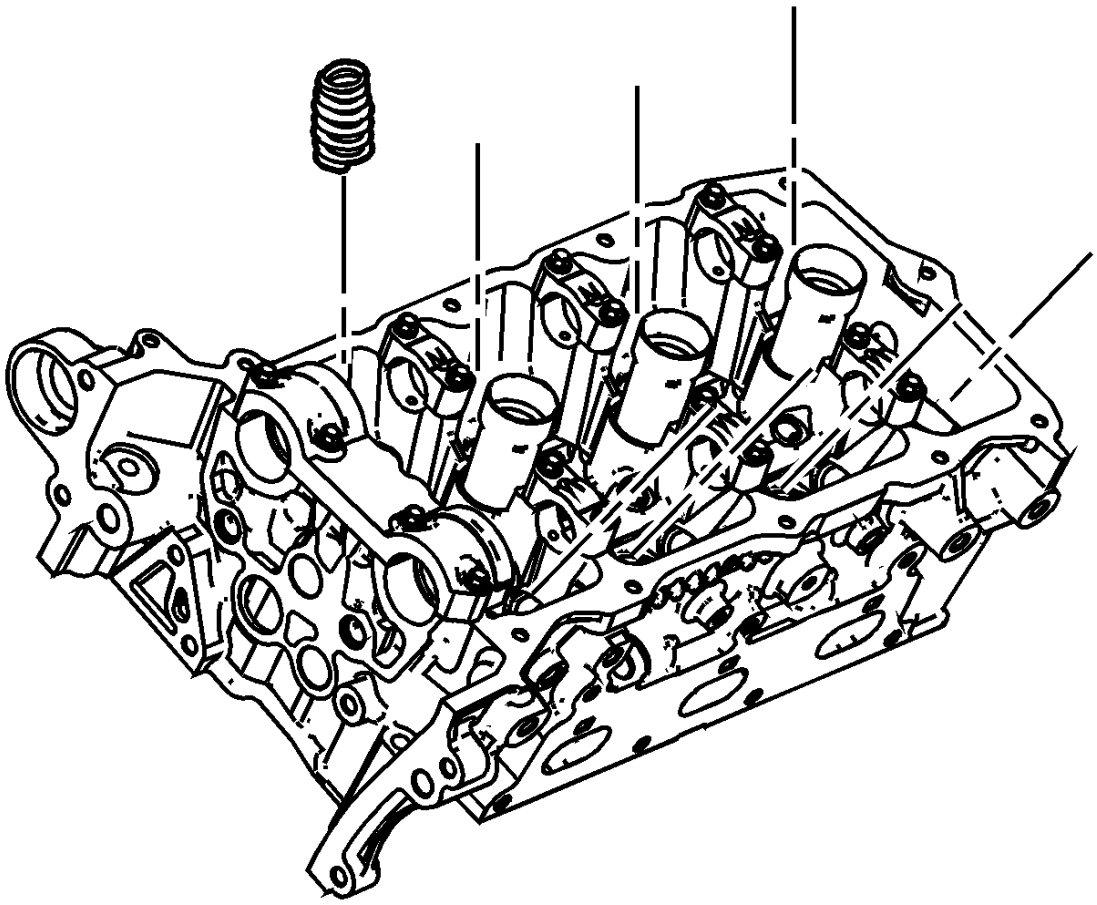

Fig. 194: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

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

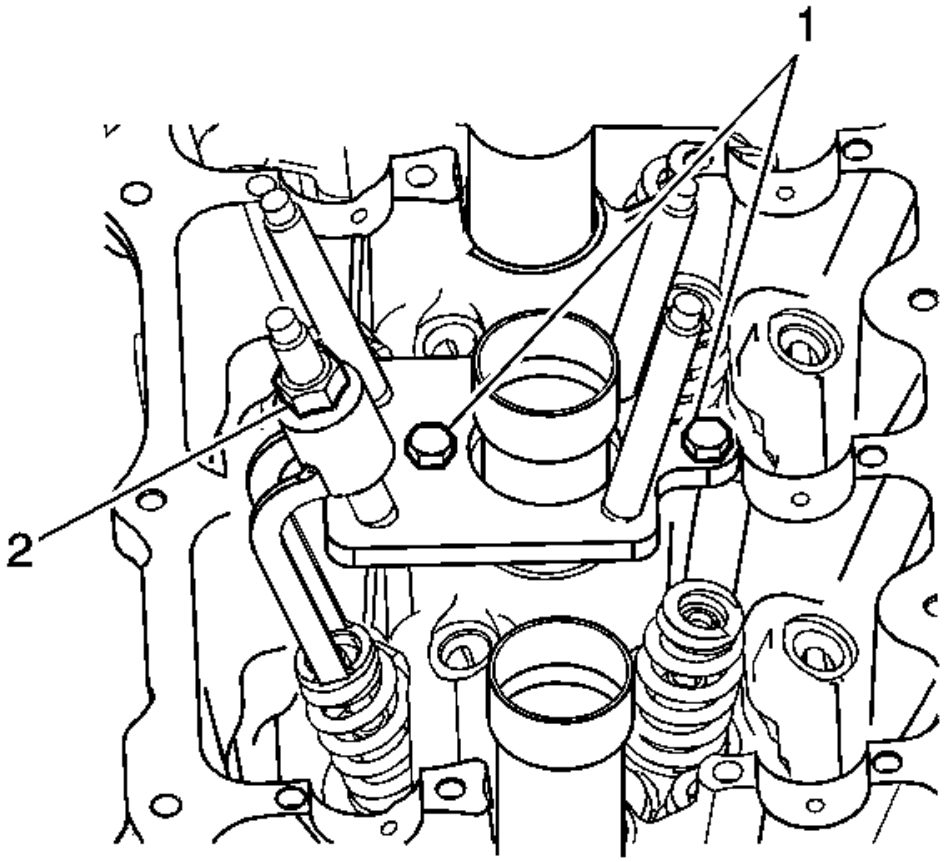

Fig. 195: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN 46110** on-vehicle valve spring compressor above the applicable valve spring as shown.

   Tighten the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut (2).

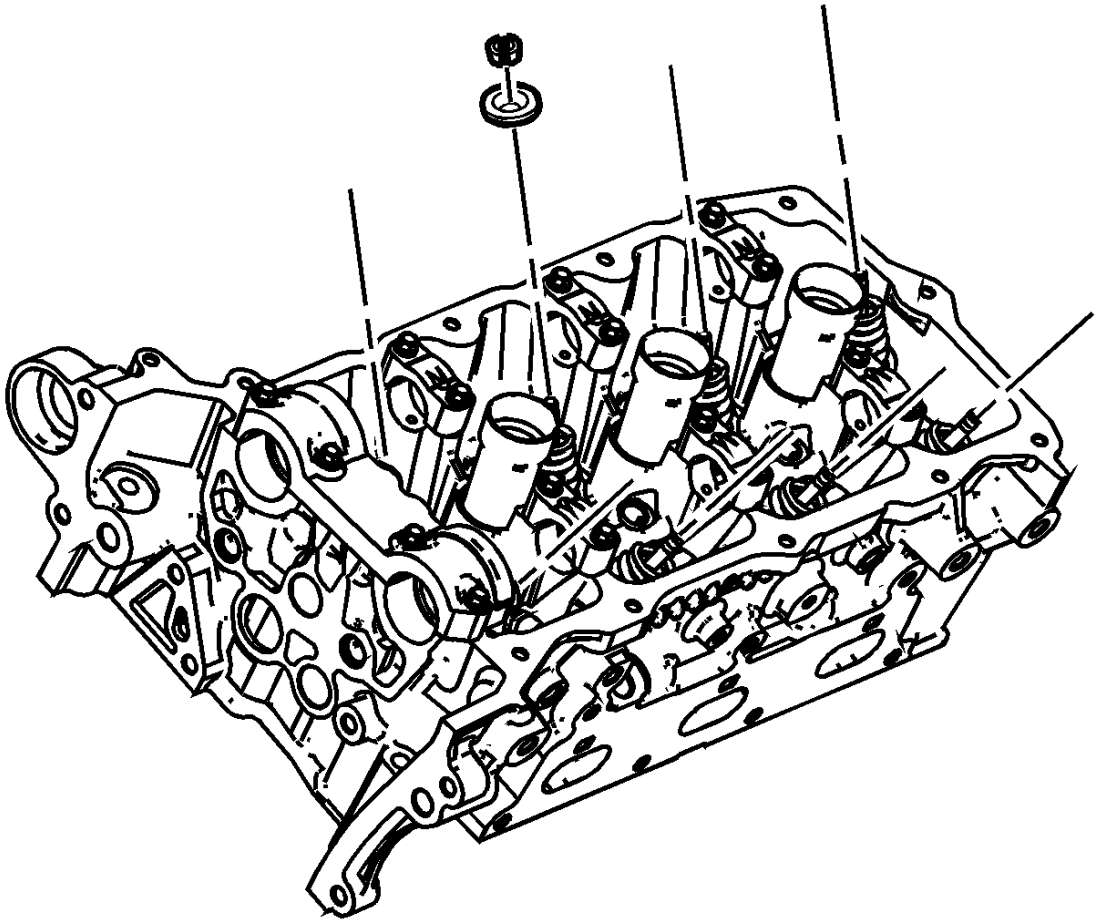

Fig. 196: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN 46110** on-vehicle valve spring compressor.
7. Disconnect the **J 39313** spark plug port adapter from the compressed air source.
8. Remove the **J 39313** spark plug port adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms and camshafts. Refer to **Camshaft Replacement - Right Side**.
11. Remove the **EN 46106** flywheel holding tool.
12. Install the starter motor. Refer to **Starter Replacement** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Removal Procedure

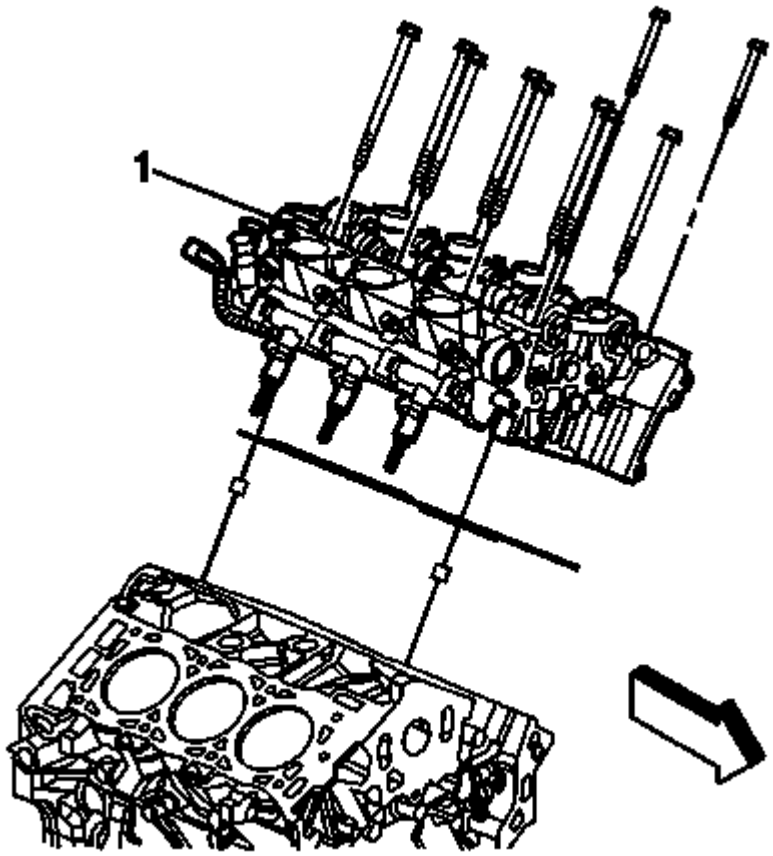

Fig. 197: Identifying Cylinder Head and Exhaust Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
2. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
3. Disconnect the coolant temperature sensor electrical connector.
4. Remove the catalytic converter from the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side** .
5. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
6. Remove the cylinder head (1) with the exhaust manifold. Refer to **Cylinder Head Removal - Left Side (LLT)** .

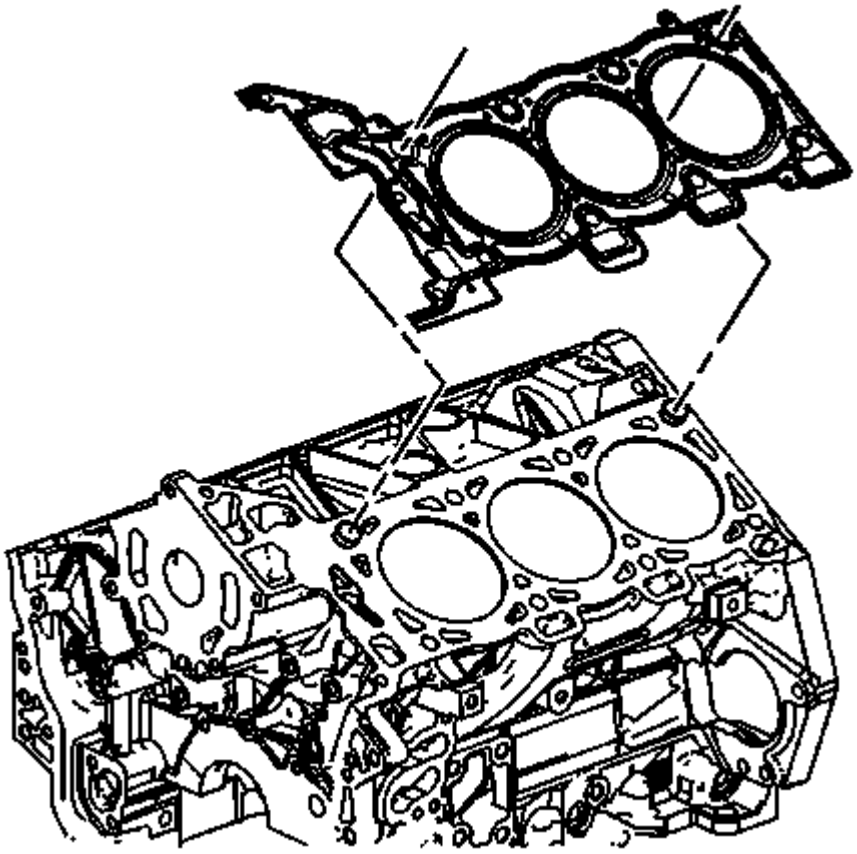

Fig. 198: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the cylinder head gasket.
8. 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** .
9. If necessary, perform the following steps:
    - Remove the exhaust manifold from the cylinder head. Refer to **Exhaust Manifold Removal - Left Side** .
    - Remove the camshaft. Refer to **Camshaft Removal - Left Side (LLT)** .
    - Disassemble the cylinder head. Refer to **Cylinder Head Disassemble** .
    - Remove the coolant sensor. Refer to **Engine Coolant Temperature Sensor Replacement** .

Installation Procedure

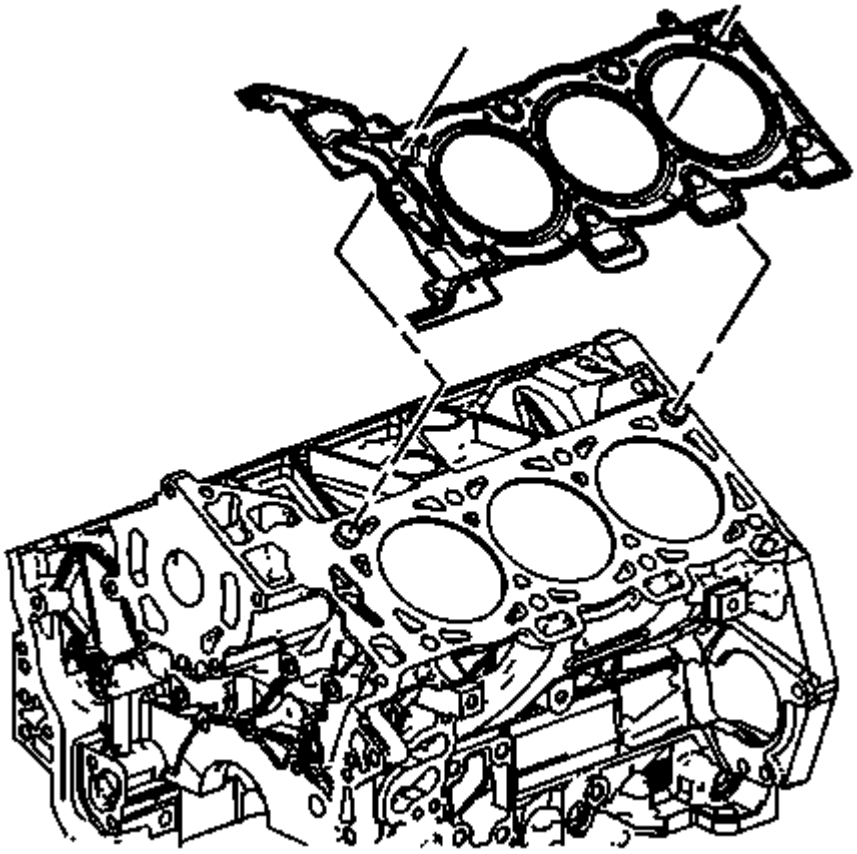

Fig. 199: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

1. If necessary, perform the following steps:
   - Install the coolant sensor. Refer to **Engine Coolant Temperature Sensor Replacement** .
   - Assemble the cylinder head. Refer to **Cylinder Head Assemble (LLT)** .
   - Install the camshaft. Refer to **Camshaft Installation - Left Side** .
   - Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Left Side** .
2. Install a NEW cylinder head gasket.

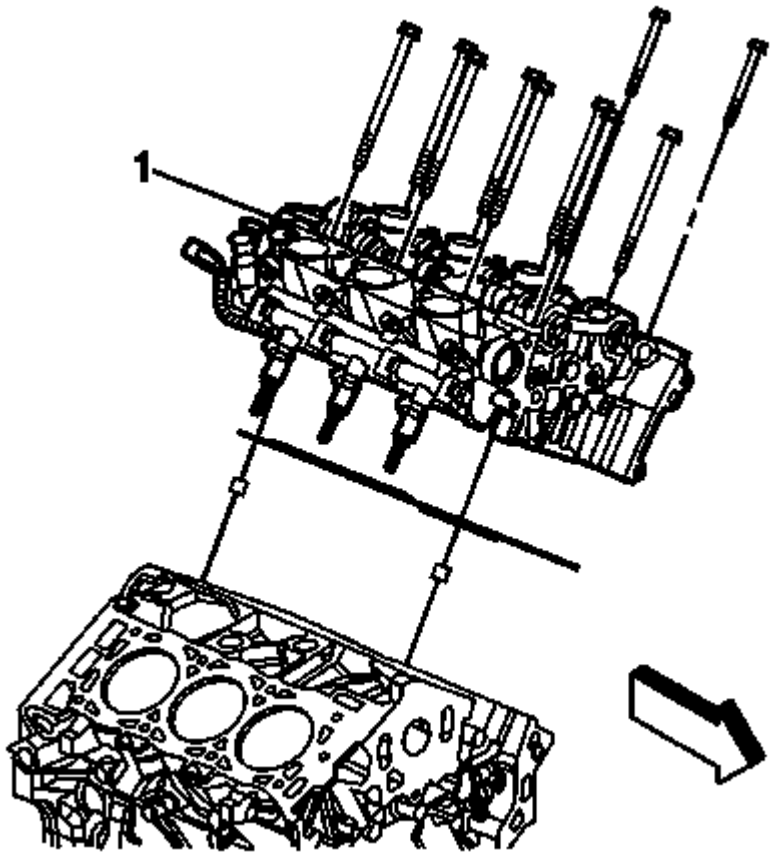

Fig. 200: Identifying Cylinder Head and Exhaust Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side** .
4. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
5. Install the catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side** .
6. Connect the wiring harness electrical connector located at the side of the cylinder head.
7. Install the coolant temperature sensor electrical connector.
8. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
9. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Remove the right side catalytic converter from the exhaust manifold. Refer to **Catalytic Converter Replacement - Right Side** .
3. Remove the ground wires from the cylinder head.
4. Disconnect and unclip the heated oxygen sensor (HO2) wiring harness.
5. Unbolt the power steering hose retainer.

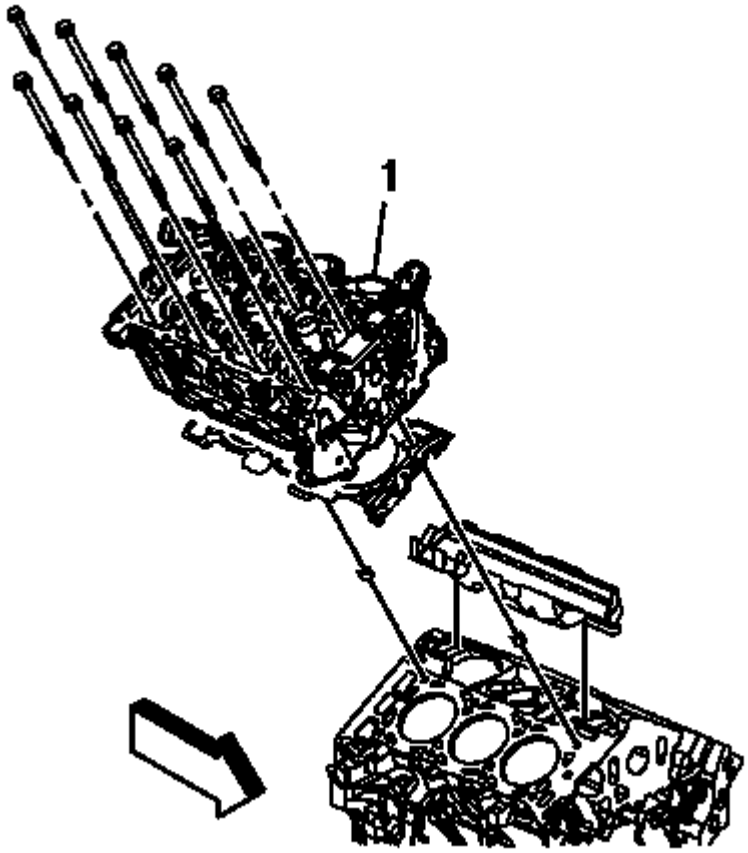

Fig. 201: Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

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

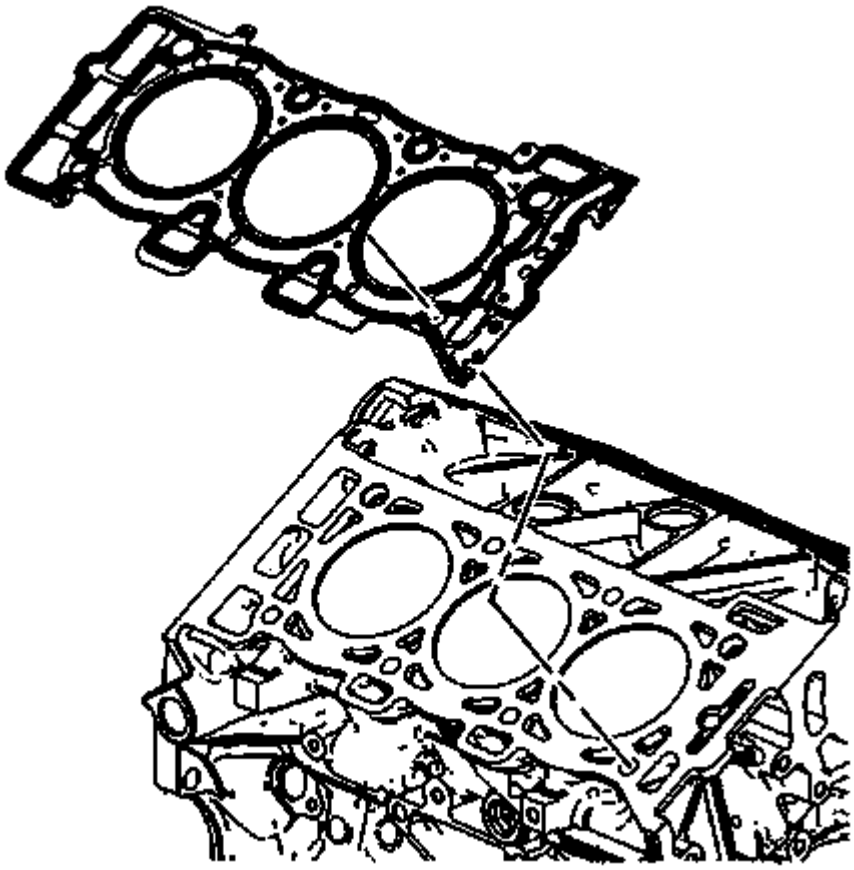

Fig. 202: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the cylinder head gasket.
8. 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** .
9. If necessary, perform the following steps:
    - Remove the exhaust manifold from the cylinder head. Refer to **Exhaust Manifold Removal - Right Side** .
    - Remove the camshaft. Refer to **Camshaft Removal - Right Side** .
    - Disassemble the cylinder head. Refer to **Cylinder Head Disassemble** .

Installation Procedure

1. If necessary, perform the following steps:
    - Assemble the cylinder head. Refer to **Cylinder Head Assemble (LLT)** .
    - Install the camshaft. Refer to **Camshaft Installation - Right Side** .
    - Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Right Side** .

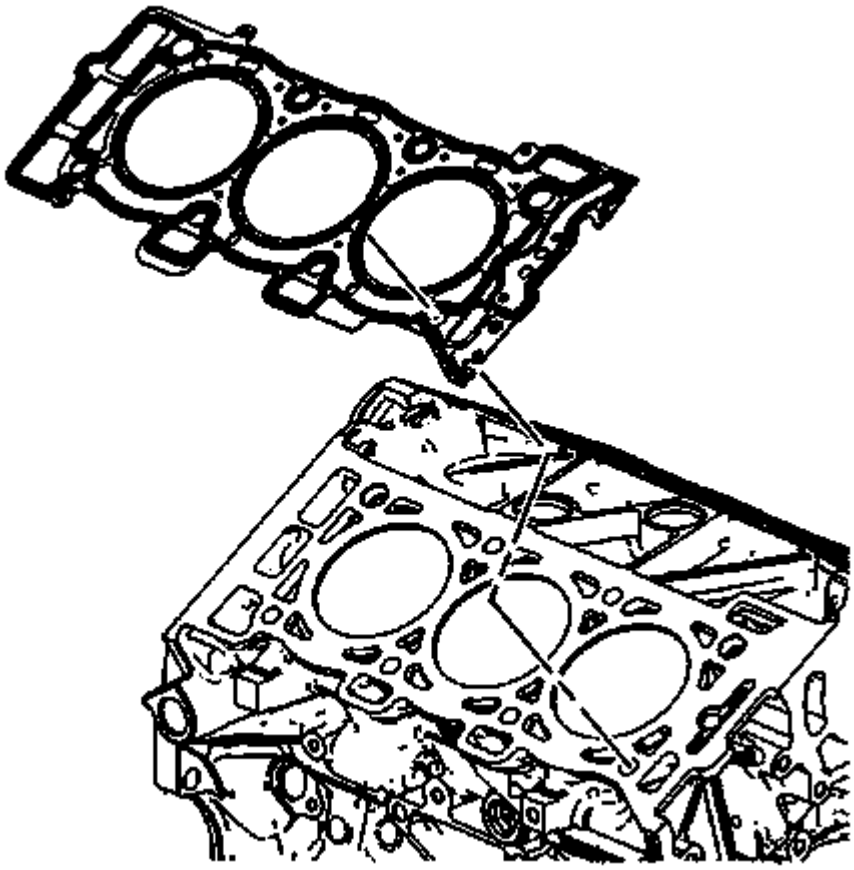

Fig. 203: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW cylinder head gasket.

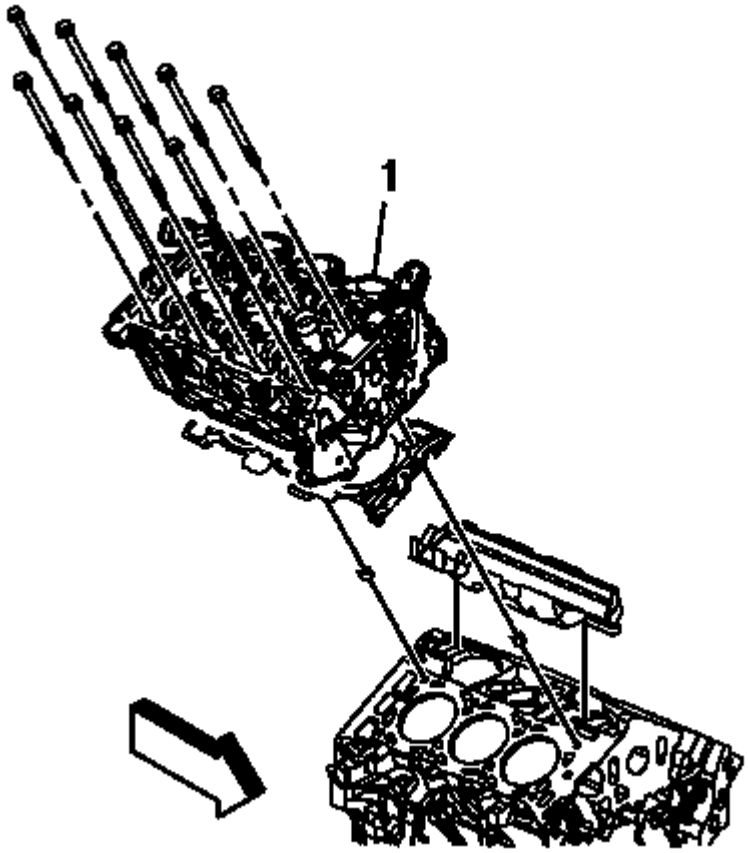

Fig. 204: Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

3. Install the cylinder head (1) with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Right Side** .
4. Install the power steering hose retainer.
5. Connect and clip the HO2 sensor wiring harness.
6. Install the ground wires to the cylinder head.
7. Install the right side catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Right Side** .
8. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

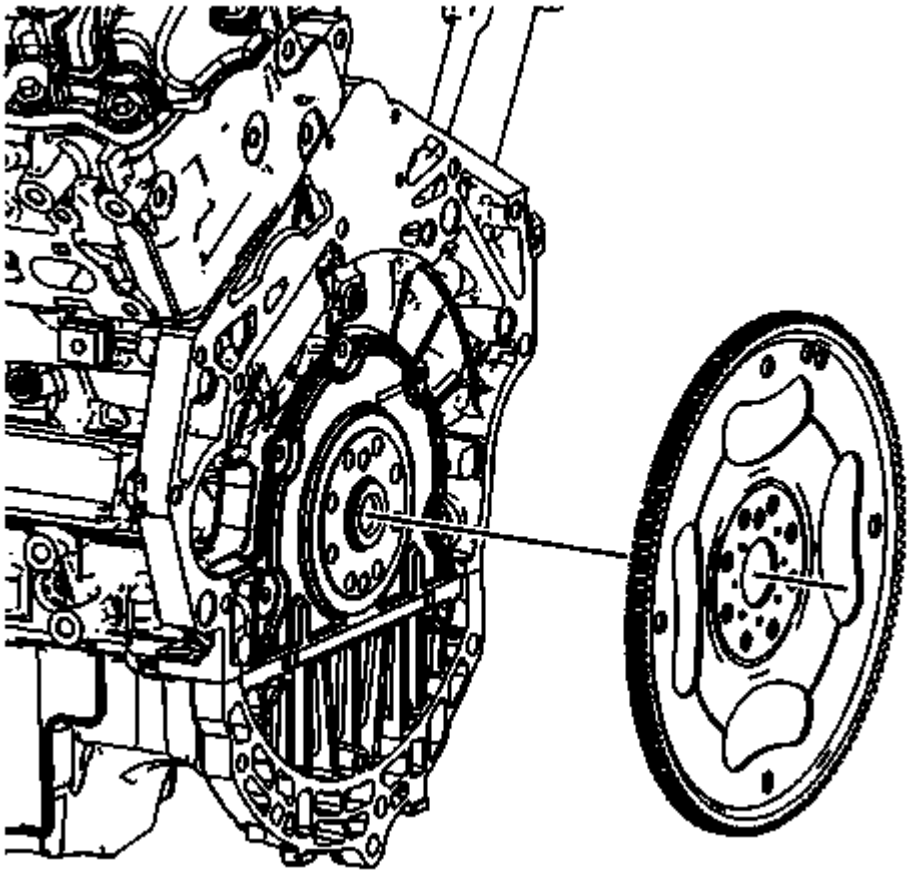

Fig. 205: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transmission. Refer to **Transmission Replacement (Front Wheel Drive)** , **Transmission Replacement (All Wheel Drive)** .
2. Remove the engine flywheel bolts and flywheel. Refer to **Engine Flywheel Removal** .
3. Clean and inspect the flywheel. Refer to **Engine Flywheel Cleaning and Inspection** , . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive. Refer to **Starter Replacement** .

Installation Procedure

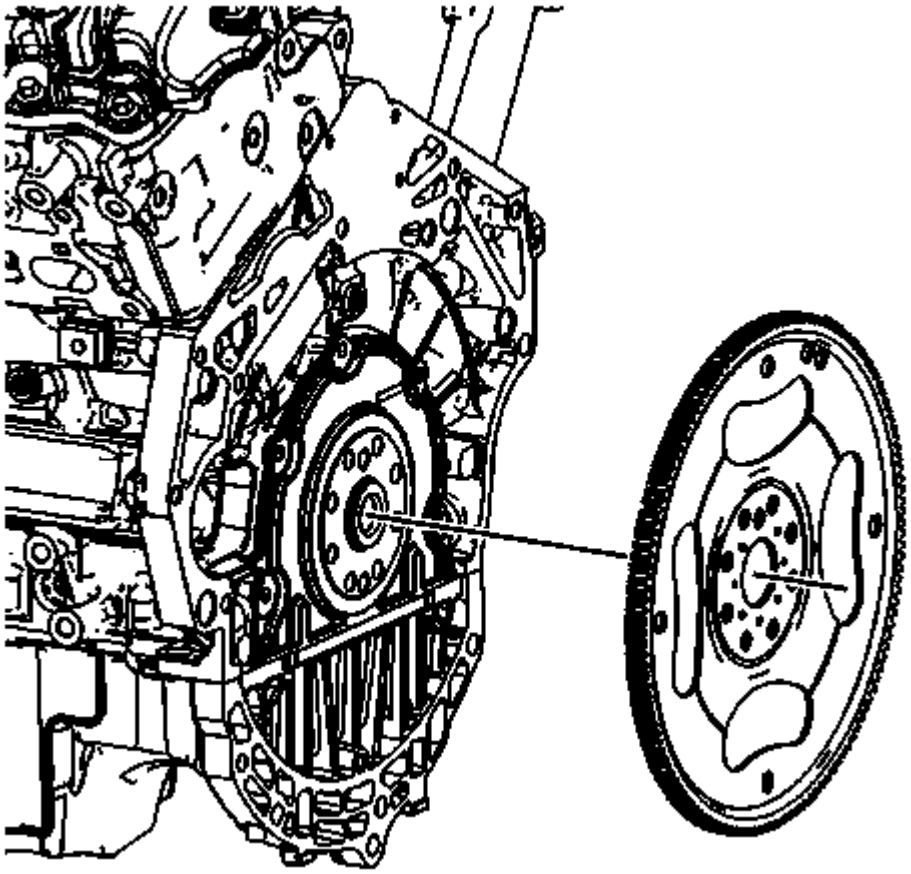

Fig. 206: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine flywheel and bolts. Refer to **Engine Flywheel Installation** .
2. Install the transmission. Refer to **Transmission Replacement (Front Wheel Drive)** , **Transmission Replacement (All Wheel Drive)** .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Removal Procedure

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

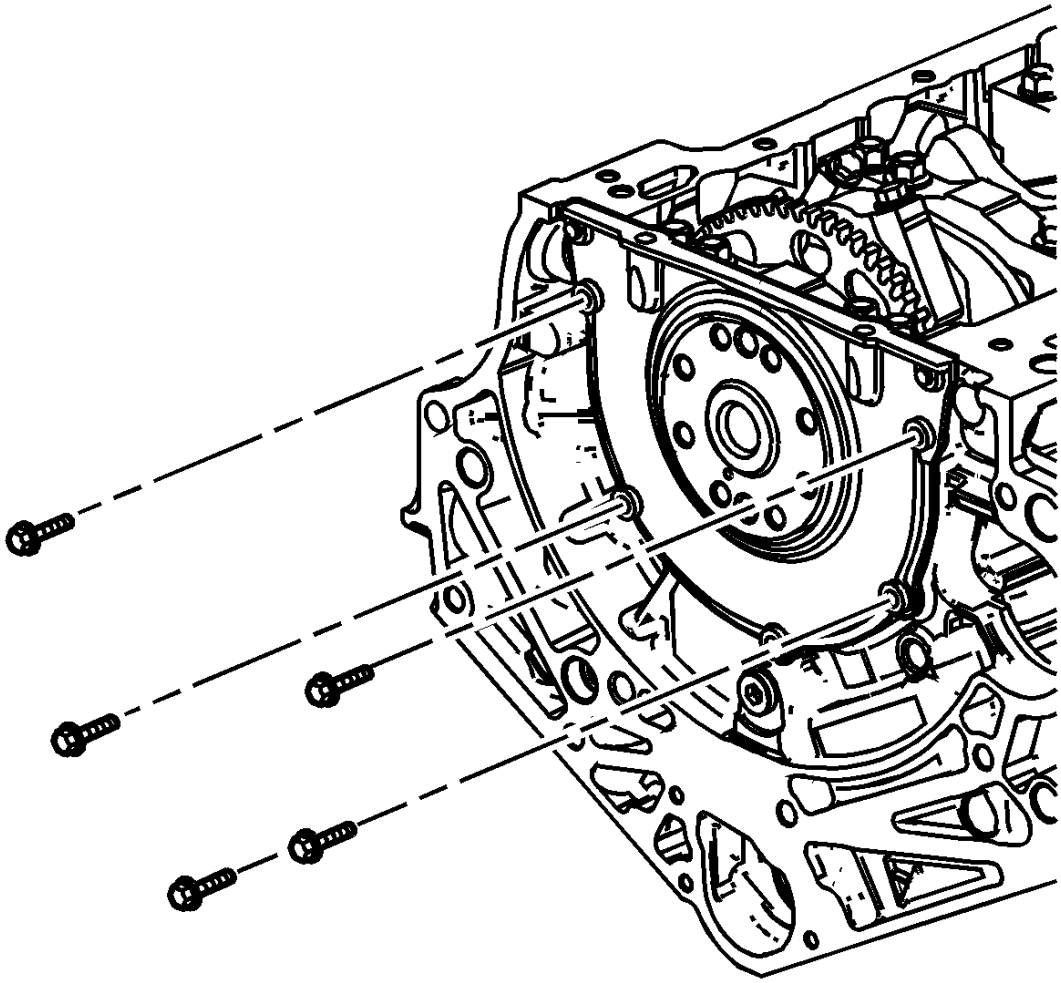

Fig. 207: Locating Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

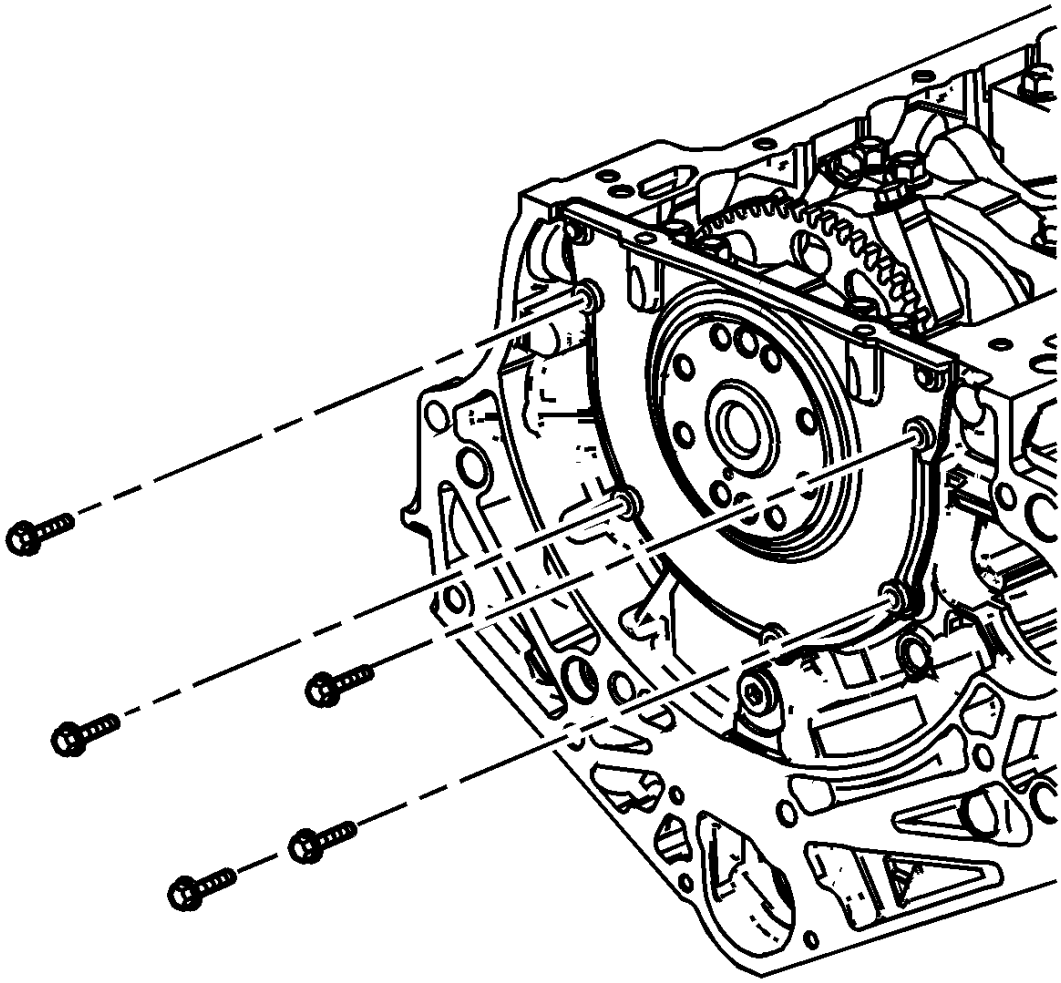

Fig. 208: Locating Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

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

OIL PUMP REPLACEMENT

Removal Procedure

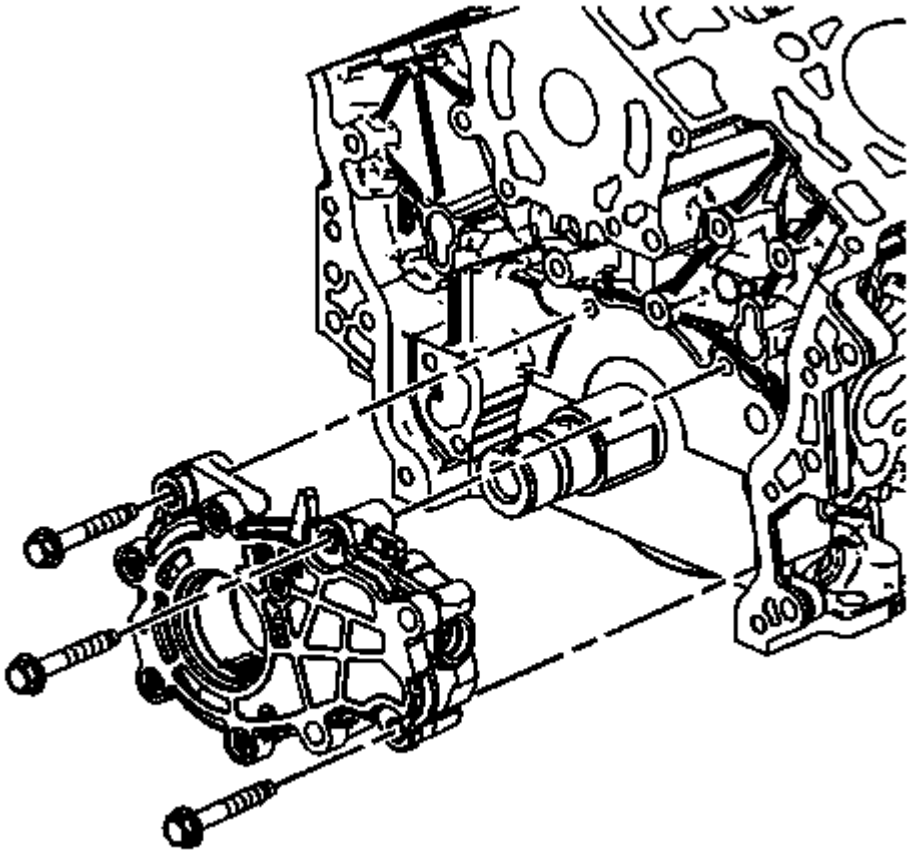

Fig. 209: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not remove the left bank idler sprocket.

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

Installation Procedure

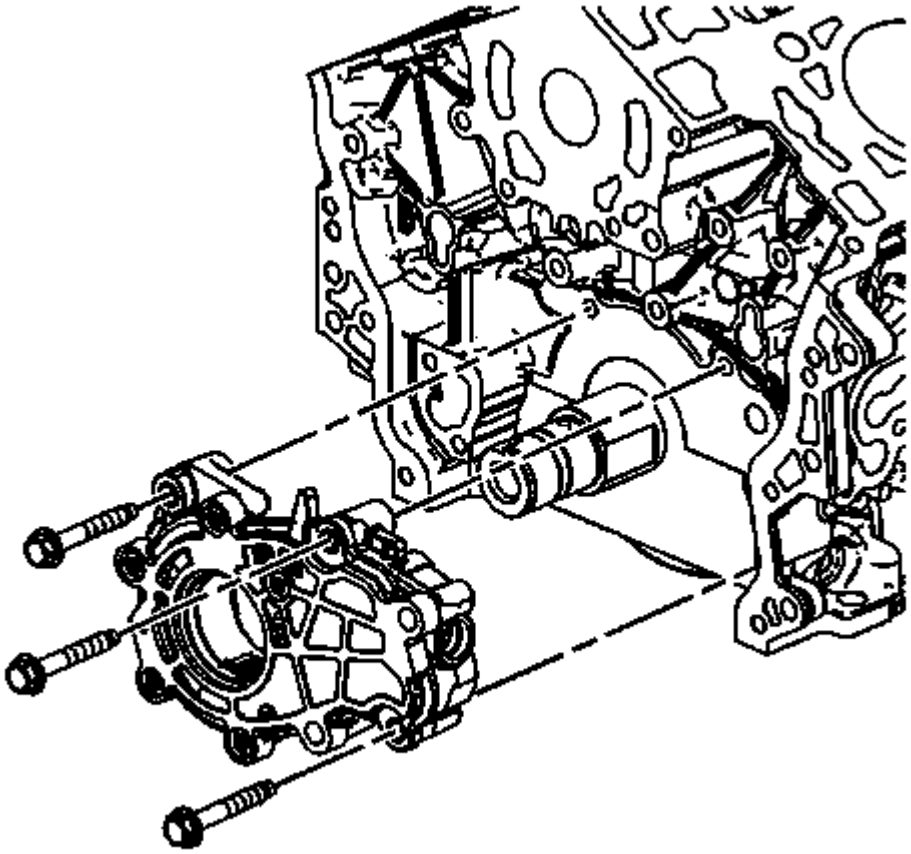

Fig. 210: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

OIL PAN REPLACEMENT

Special Tools

- **EN 46109** Guide Pin Set
- **J 39505** Torque Wrench Adapter

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement** .
3. Remove the engine. Refer to **Engine Replacement**.
4. Remove the engine front cover. Refer to **Engine Front Cover Removal** .

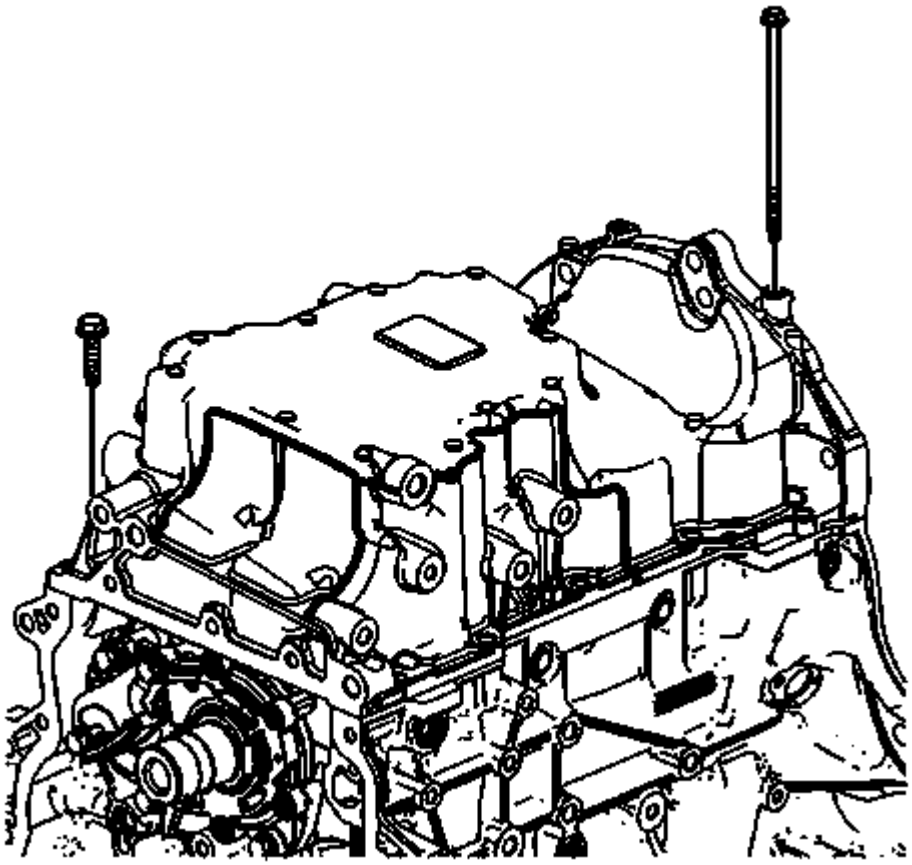

Fig. 211: Locating Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pan bolts.

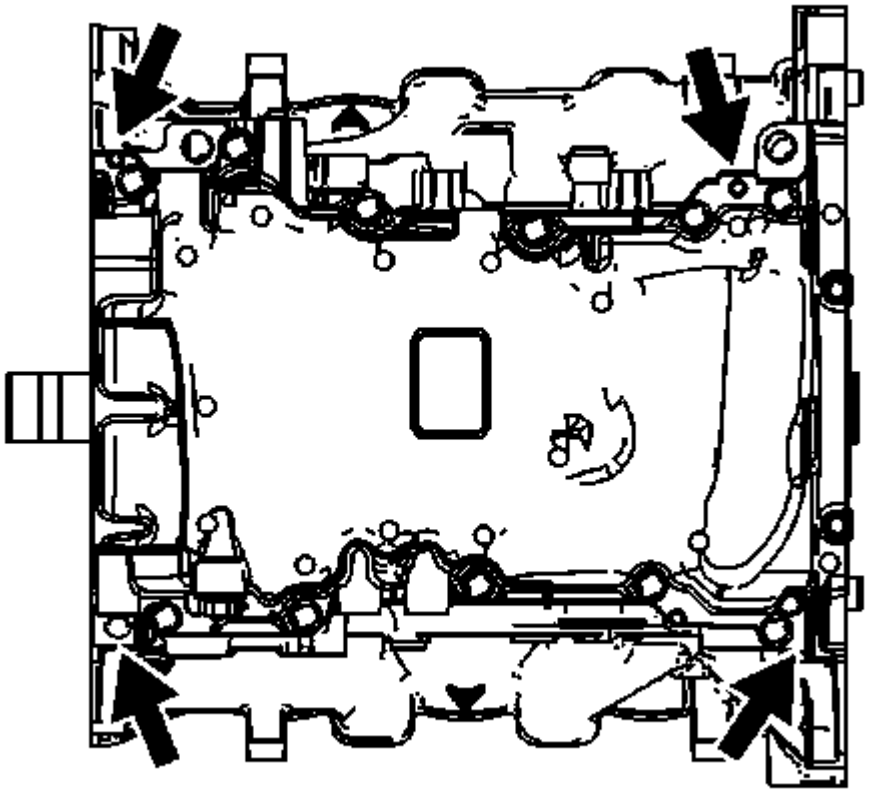

Fig. 212: Identifying Oil Pan RTV Sealant Pry Points
Courtesy of GENERAL MOTORS COMPANY

6. Using the pry points located at the edge of the oil pan separate the RTV sealant.

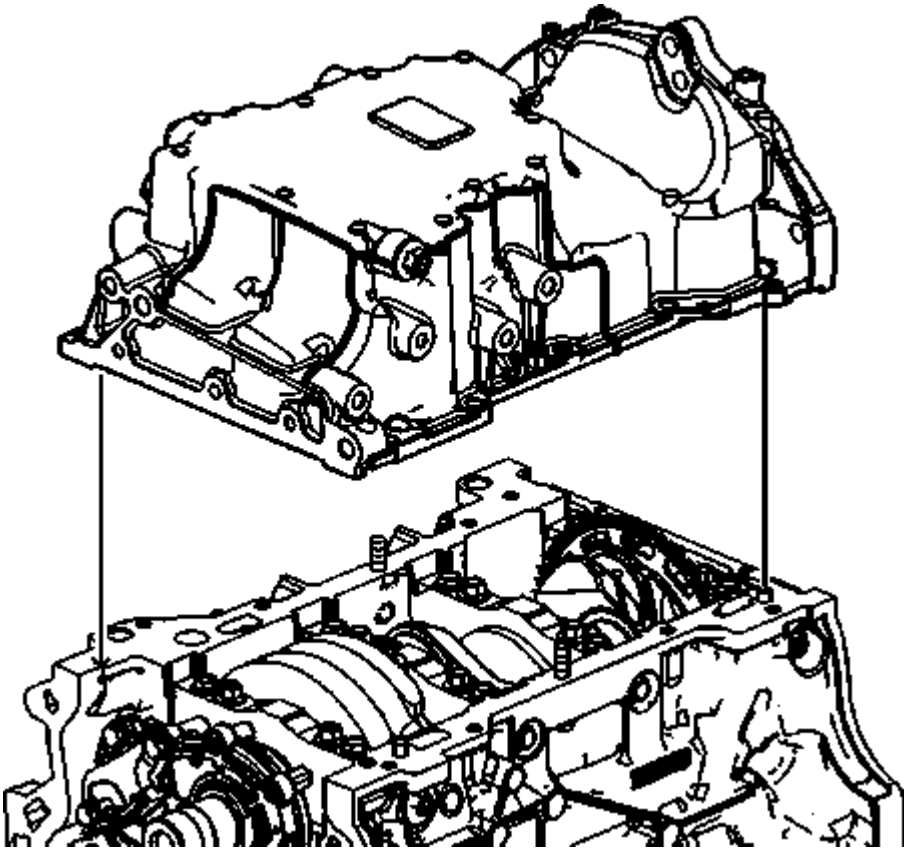

Fig. 213: View Of Oil Pan & Block
Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil pan from the block.
8. Clean the oil pan and the engine block gasket surface. Refer to **Oil Pan Cleaning and Inspection** .

Installation Procedure

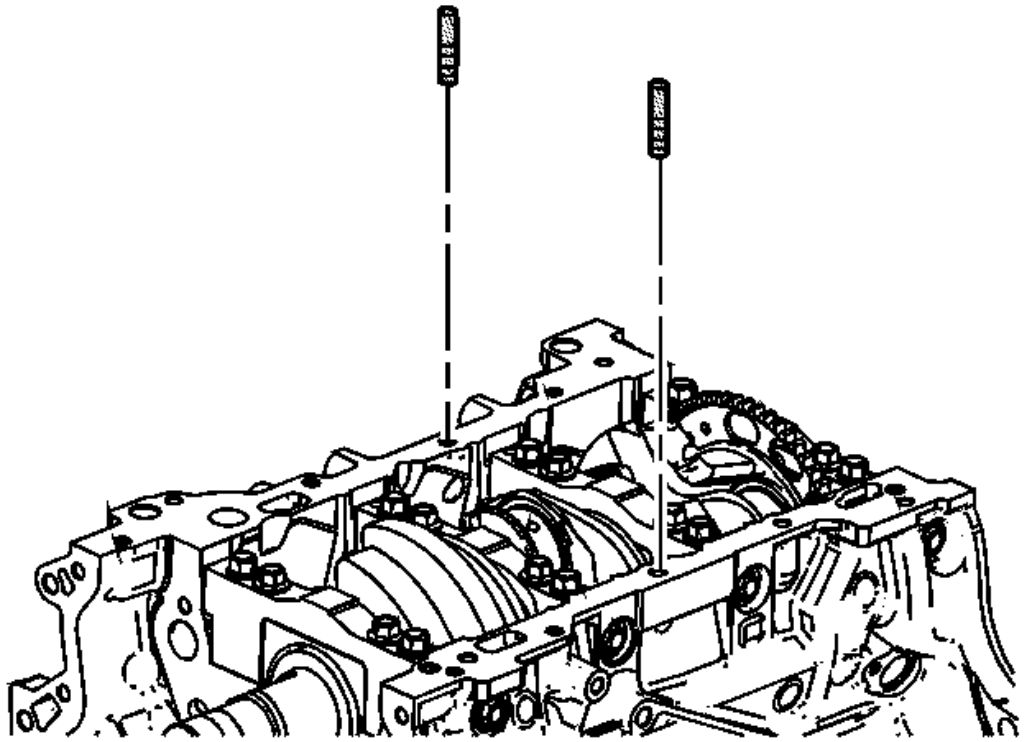

Fig. 214: View Of Guides
Courtesy of GENERAL MOTORS COMPANY

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

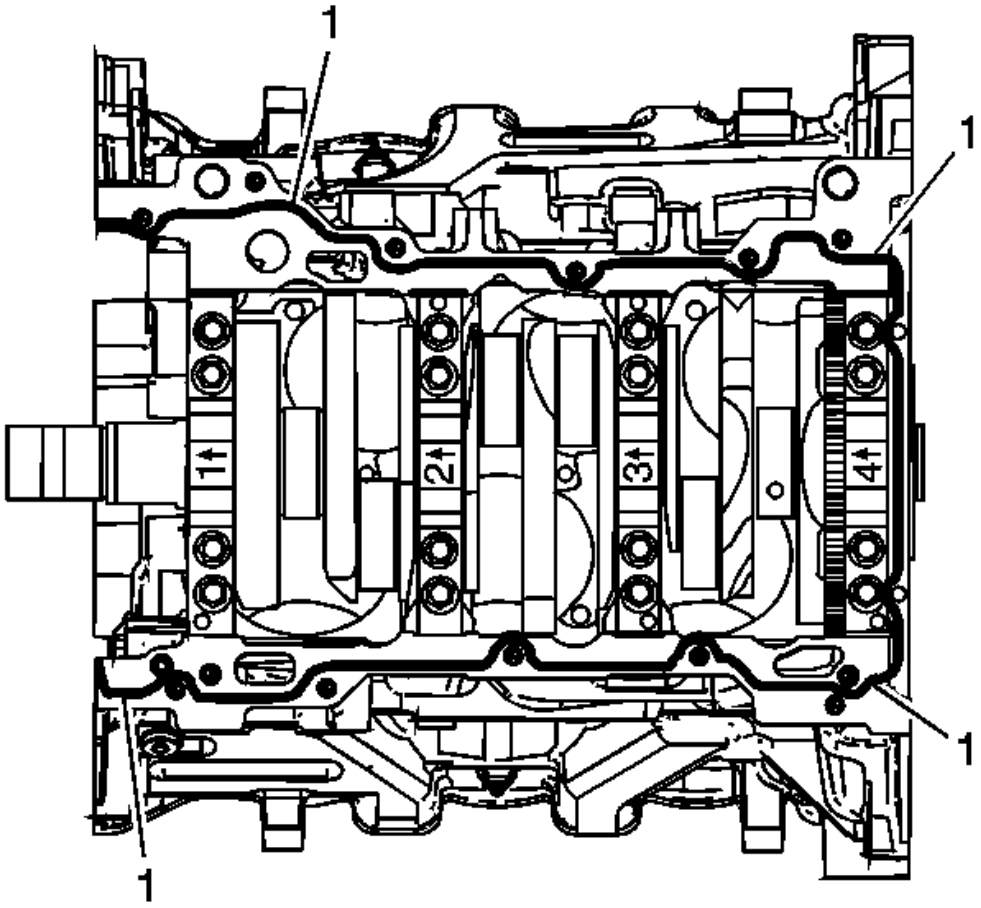

Fig. 215: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

2. Place a 3 mm (0.118 in) bead (1) of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the block pan rail and the crankshaft rear oil seal housing.

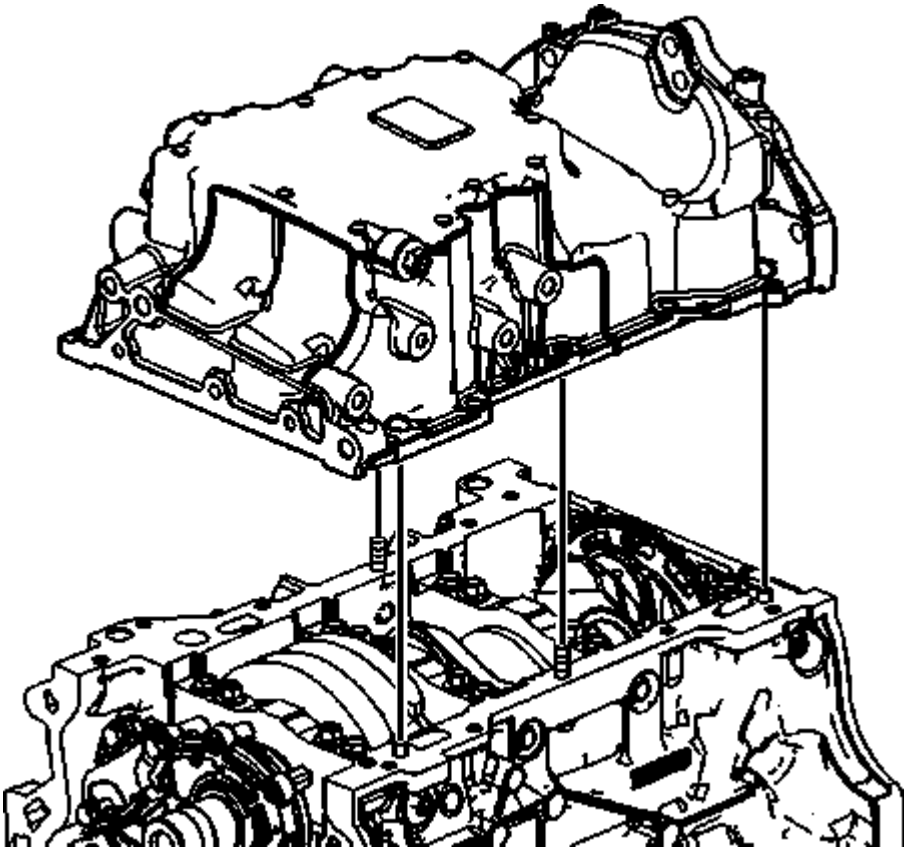

Fig. 216: Removing/Installing Oil Pan
Courtesy of GENERAL MOTORS COMPANY

3. Position the oil pan onto the block.

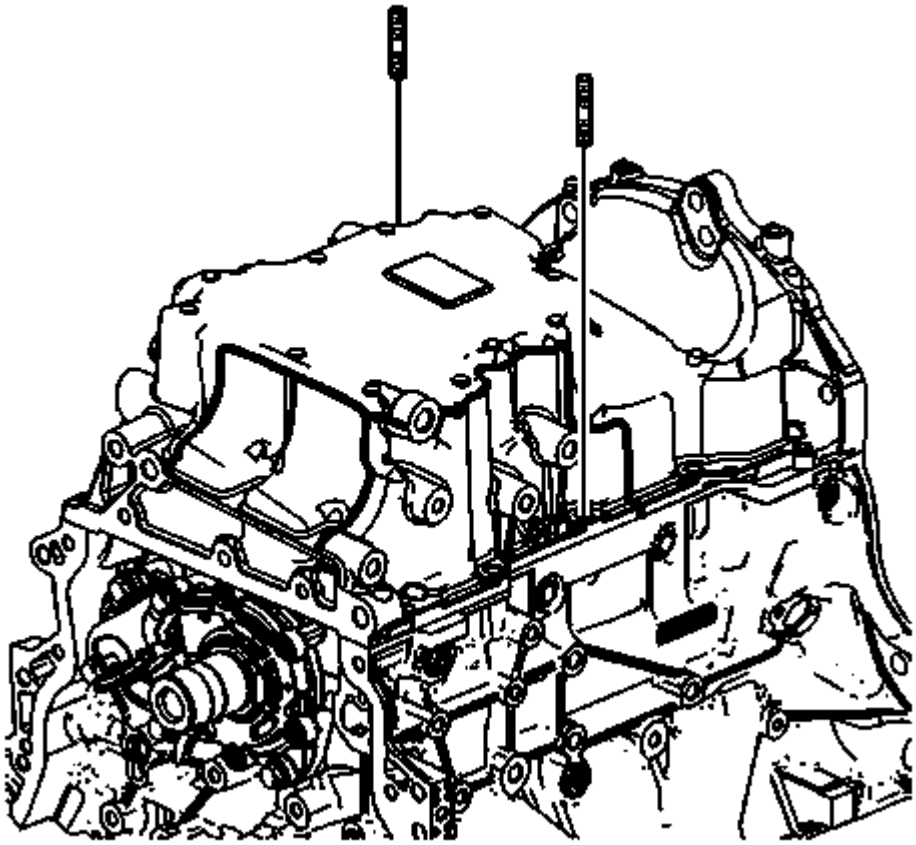

Fig. 217: View Of Engine Block Guides
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN 46109** guide pin set 8 mm (0.315 in) guides from the engine block.

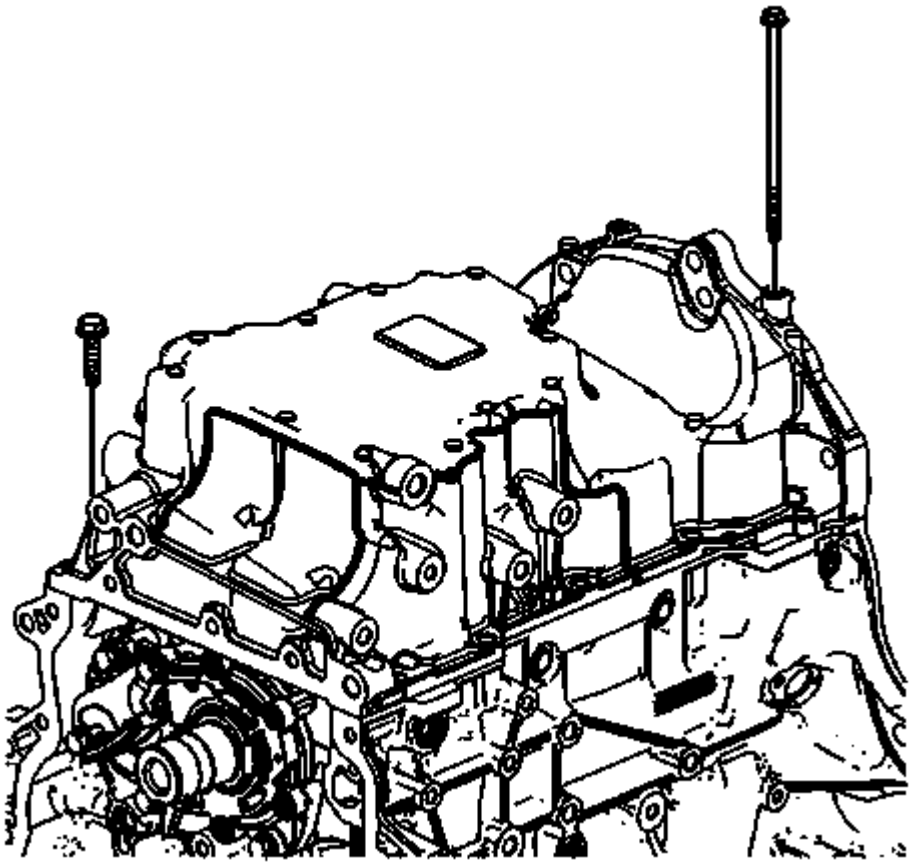

Fig. 218: Locating Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Loosely install the oil pan bolts.

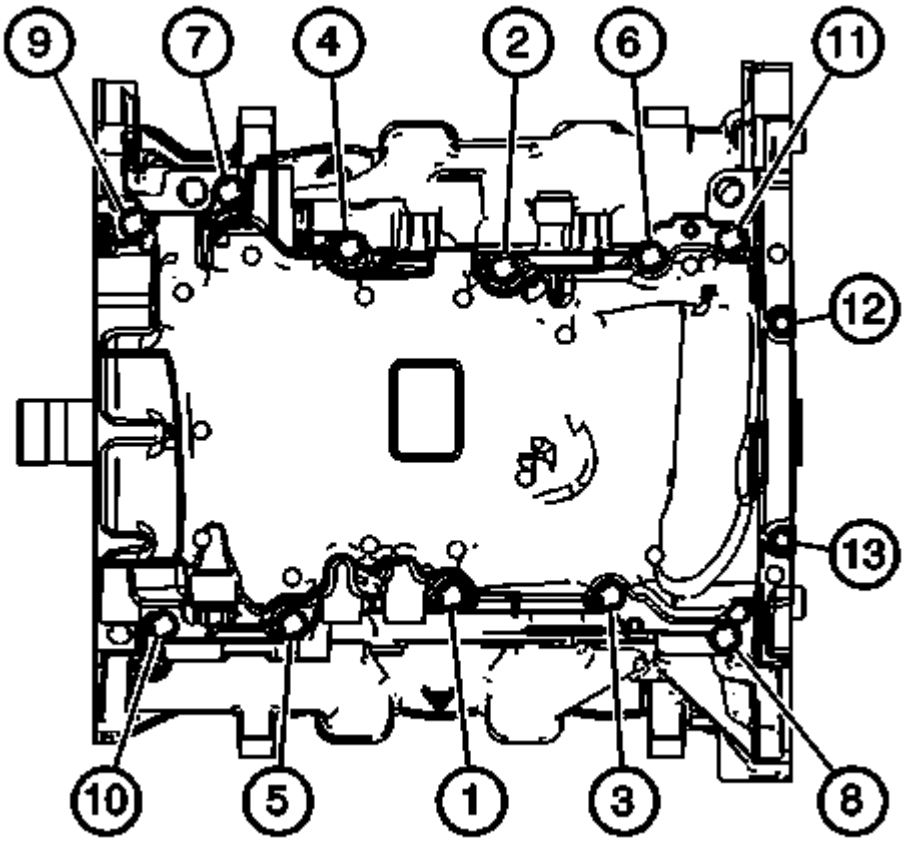

Fig. 219: Identifying Oil Pan Bolts - Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the oil pan bolts in sequence shown.

   Tighten

   1. Tighten the 8 mm bolts (1-11) to 25 N.m (18 lb ft).
   2. Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).
7. Install the engine front cover. Refer to **Engine Front Cover Installation** .
8. Install the engine. Refer to **Engine Replacement**.
9. Install the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement** .
10. Refill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Special Tools

J 41712 Oil Pressure Switch Socket

Removal Procedure

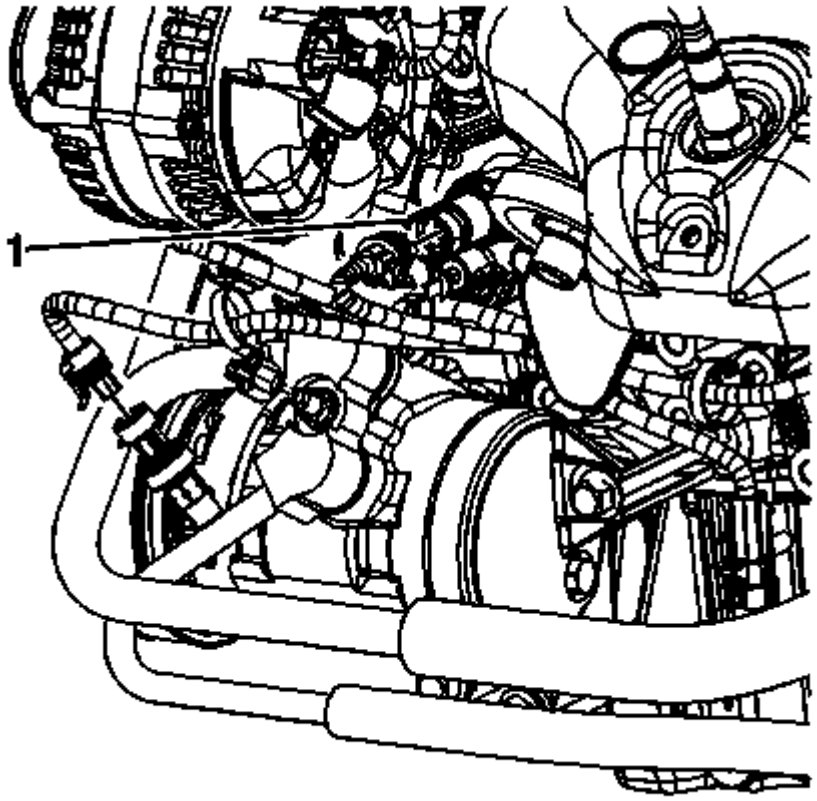

Fig. 220: Identifying Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Turn the ignition OFF.
2. Remove the generator. Refer to **GENERATOR REPLACEMENT** .
3. Disconnect the oil pressure sensor electrical connector.
4. Remove the oil pressure sensor (1).

Installation Procedure

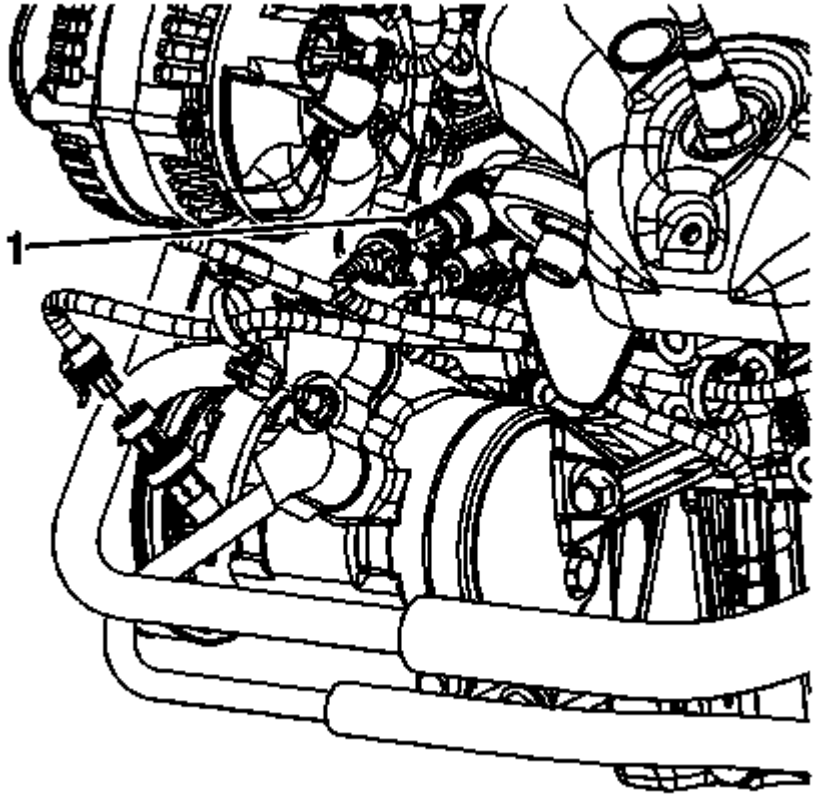

Fig. 221: Identifying Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil pressure sensor (1).

   Tighten

   Tighten the oil pressure sensor to 20 N.m (15 lb ft).

2. Connect the oil pressure sensor electrical connector.
3. Install the generator. Refer to **GENERATOR REPLACEMENT** .

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

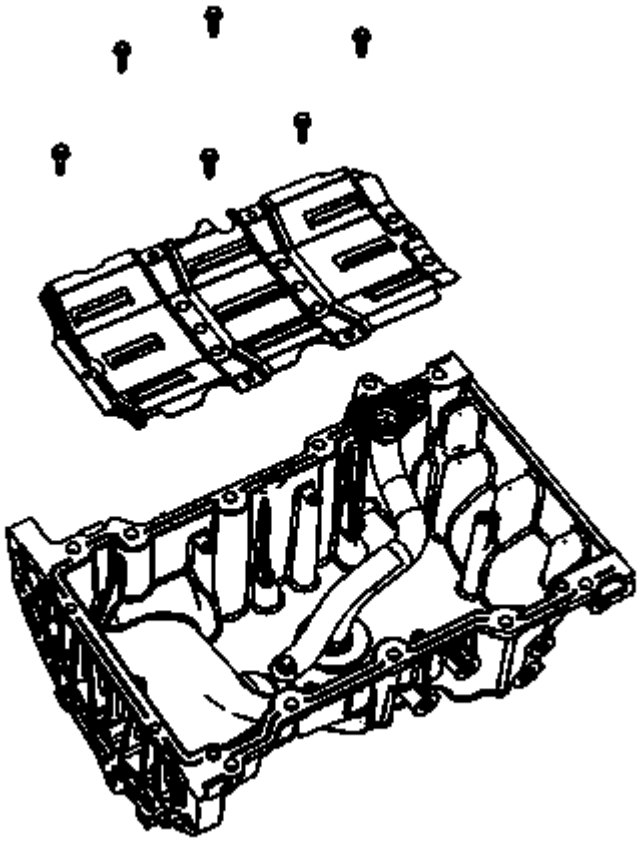

Fig. 222: Identifying Oil Pan Scraper Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.

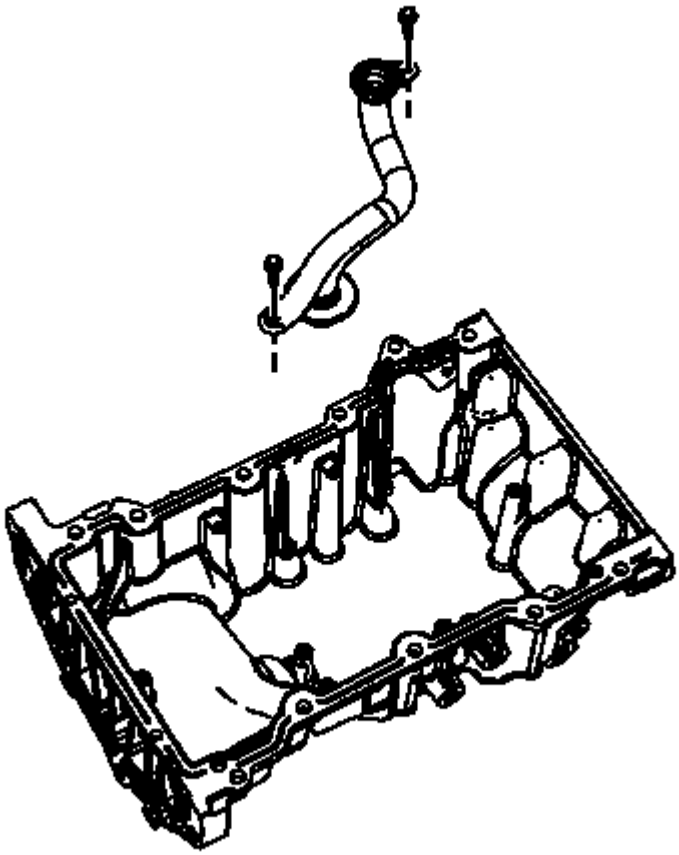

Fig. 223: View Of Oil Suction Pipe & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.

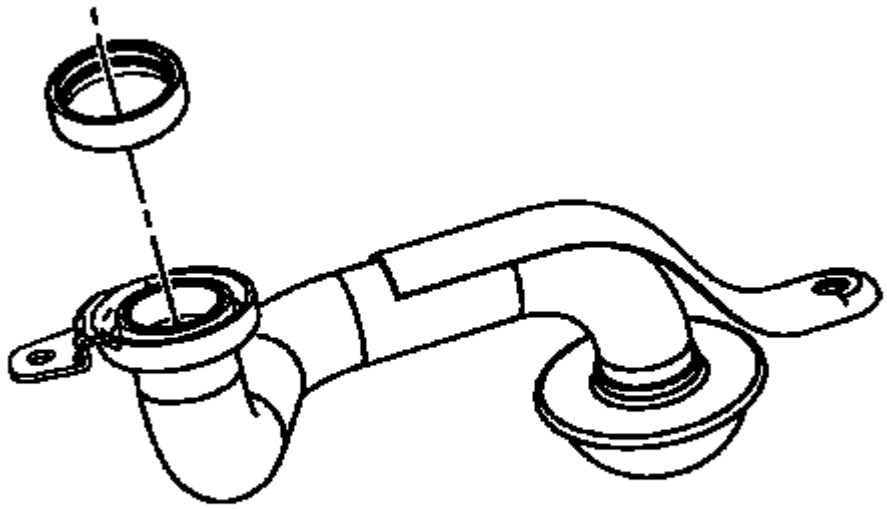

Fig. 224: Locating Oil Suction Tube Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

Installation Procedure

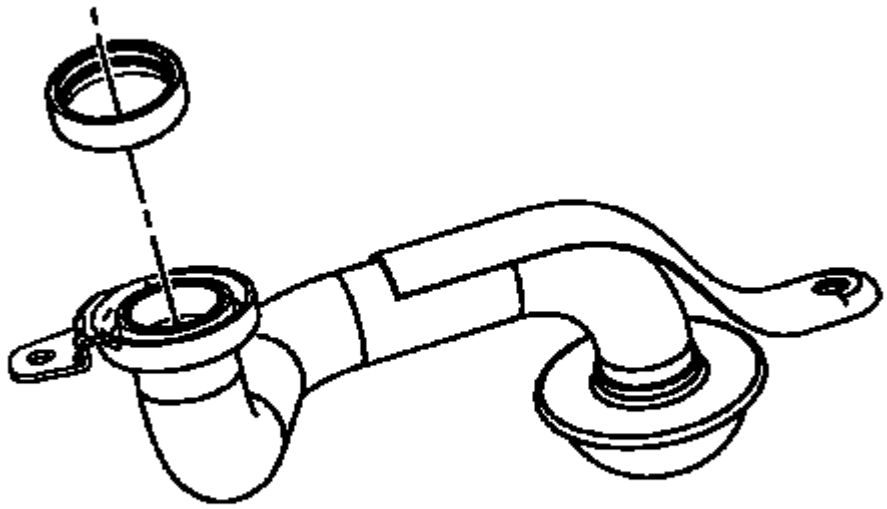

Fig. 225: Locating Oil Suction Tube Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW oil suction tube seal onto the oil suction tube. DO NOT reuse the old oil suction tube seal.

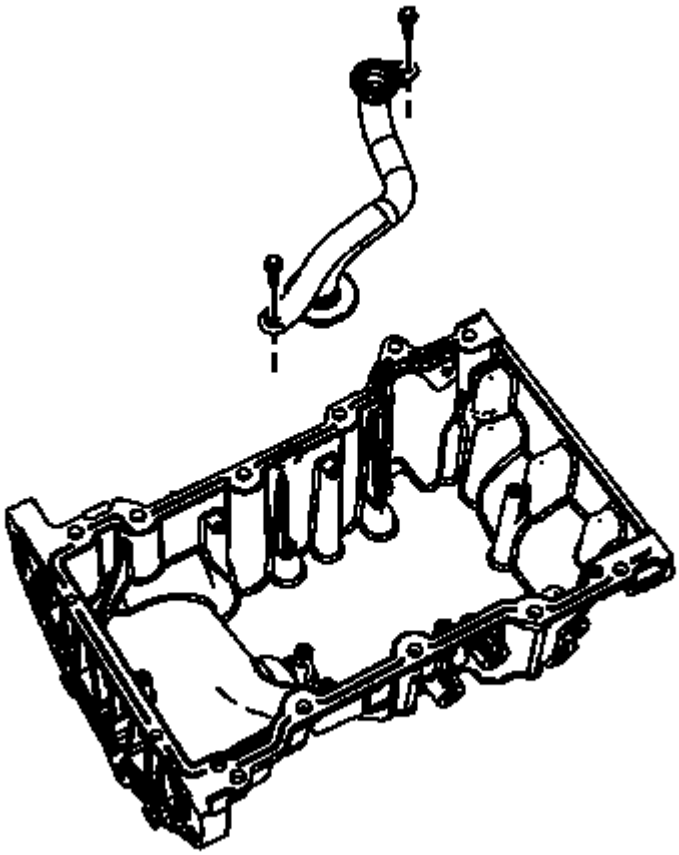

Fig. 226: View Of Oil Suction Pipe & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe.

CAUTION: Refer to Fastener Caution .

3. Install the oil suction pipe bolts.

Tighten

Tighten the oil suction pipe bolts to 10 N.m (89 lb in).

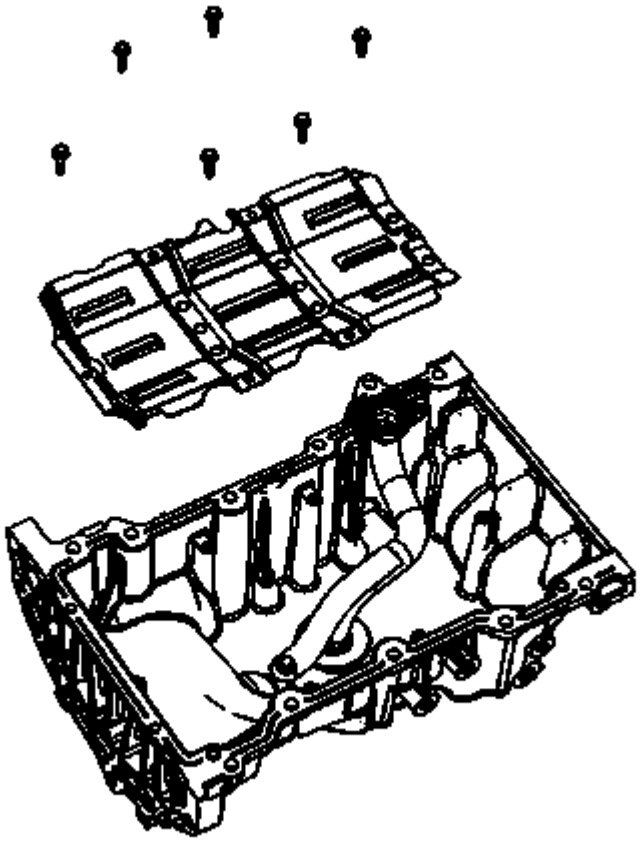

Fig. 227: Identifying Oil Pan Scraper Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pan scraper.
5. Install the oil pan scraper bolts.

Tighten

Tighten the oil pan scraper bolts to 10 N.m (89 lb in).

6. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

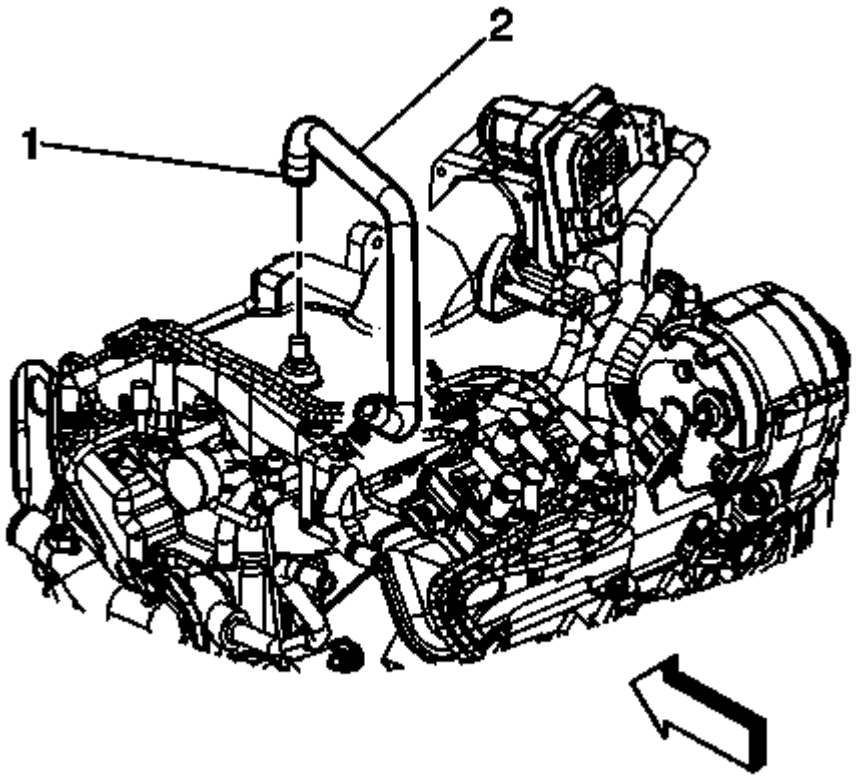

Fig. 228: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the brake booster vacuum hose (2) from the intake manifold.
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Discharge the fuel system. Refer to **Fuel Pressure Relief (Without CH-48027)** , **Fuel Pressure Relief (CH-48027)** , **Fuel Pressure Relief (High Side)** .

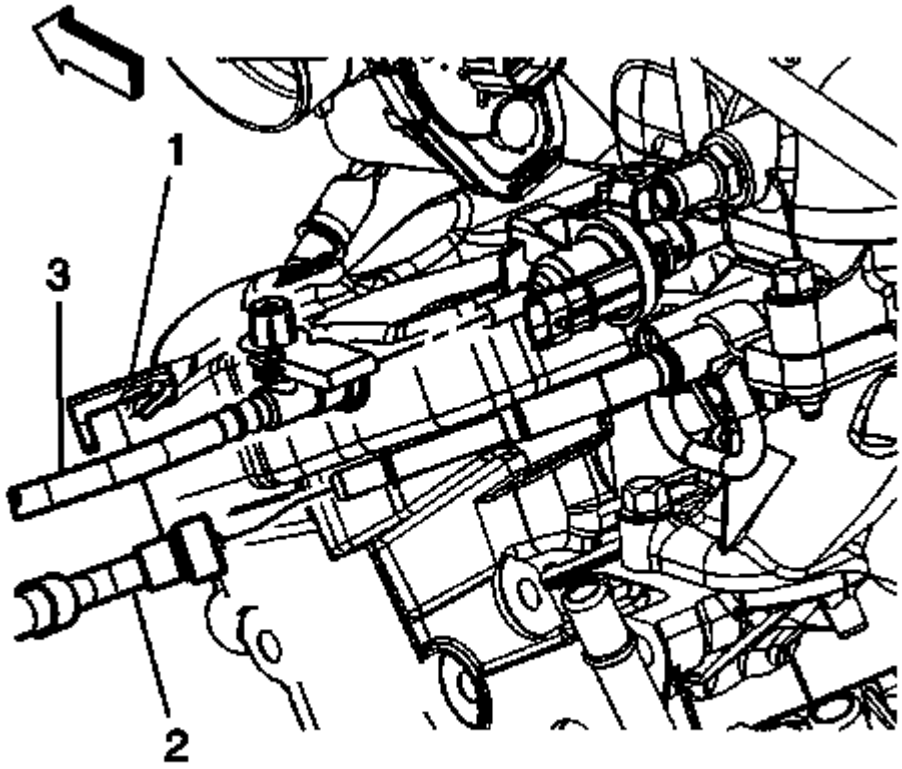

Fig. 229: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the evaporative emission (EVAP) hose/pipe (3) from the EVAP canister purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .

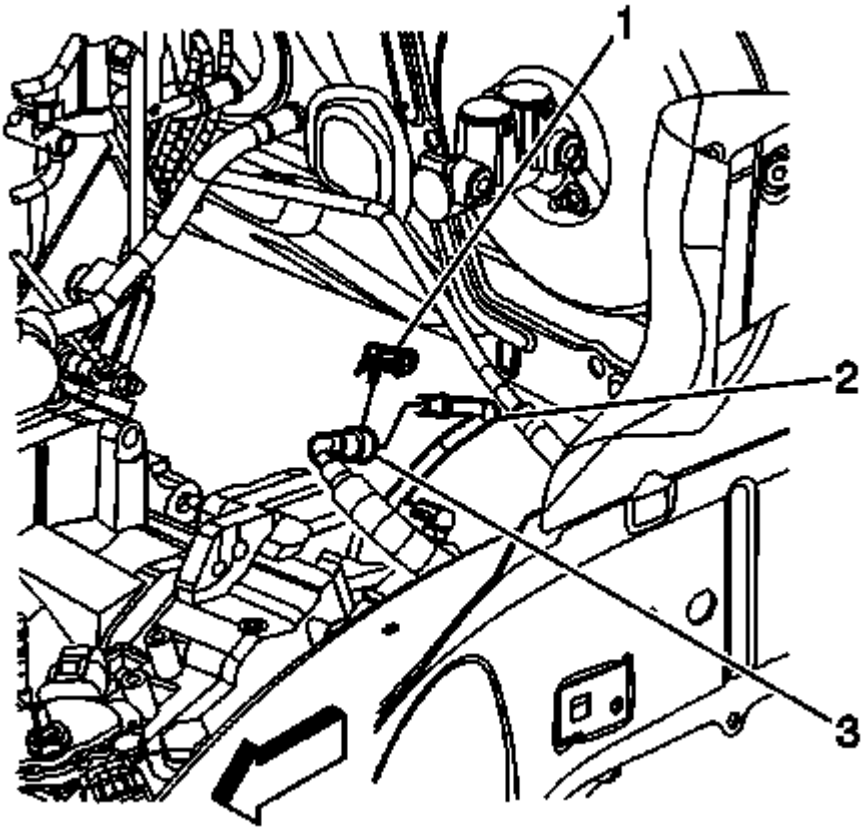

Fig. 230: Disconnecting/Connecting Engine Fuel Hose/Pipe At Chassis Fuel Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the engine fuel hose/pipe (3) from the chassis fuel hose/pipe (2). Refer to **Metal Collar Quick Connect Fitting Service** .
7. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .

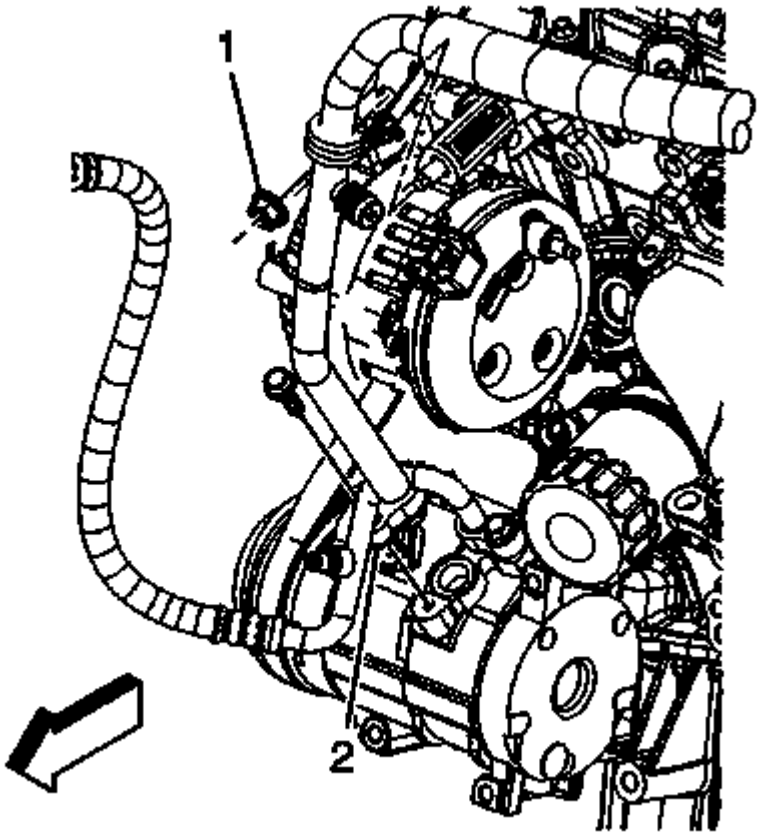

Fig. 231: Identifying Suction Hose Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

8. Remove the A/C compressor suction hose assembly (2) from the compressor. Cap or plug the hoses and compressor to prevent contamination. Refer to **Suction Hose Replacement** .

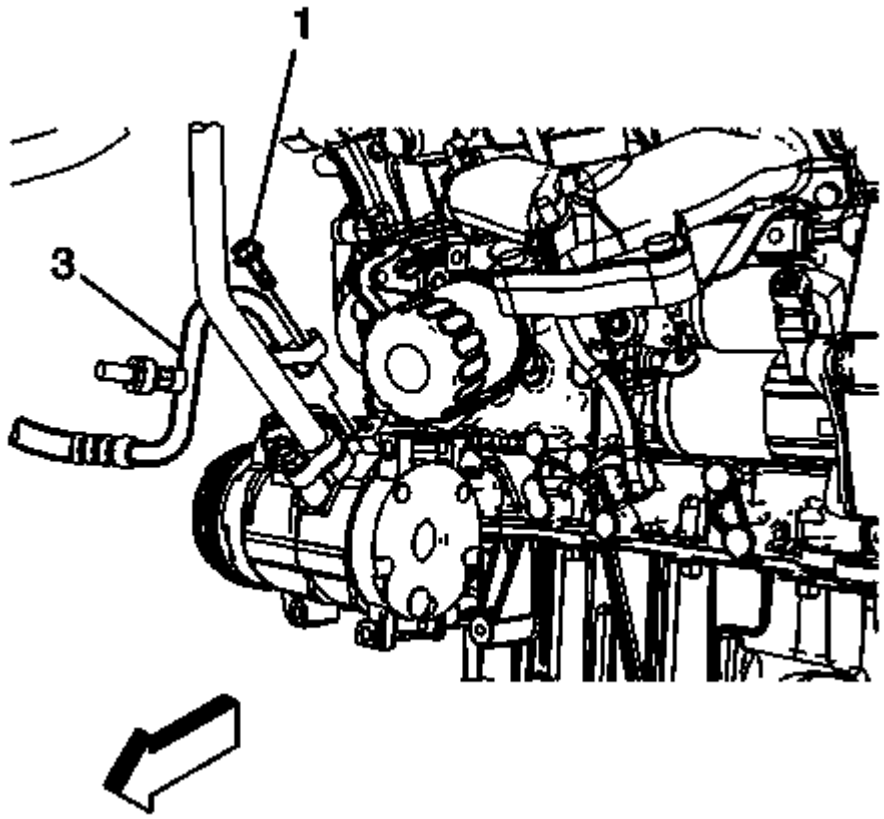

Fig. 232: Identifying A/C Compressor Discharge Line & Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the A/C compressor discharge hose assembly (3) from the compressor. Cap or plug the hoses and compressor to prevent contamination. Refer to **Discharge Hose Replacement** .
10. Drain the engine coolant from the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Vac N Fill)** .
11. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
12. Disconnect the inlet coolant heater hose from the engine. Refer to **Heater Inlet Hose Replacement** .
13. Disconnect the outlet coolant heater hose from the engine. Refer to **Heater Outlet Hose Replacement**
14. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement** .
15. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
16. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement** .
17. Remove the exhaust flexible pipe and secure the rear half of the exhaust system to the vehicle underbody. Refer to **Exhaust Flexible Pipe Replacement** .
18. Remove the front tires. Refer to **Tire and Wheel Removal and Installation** .

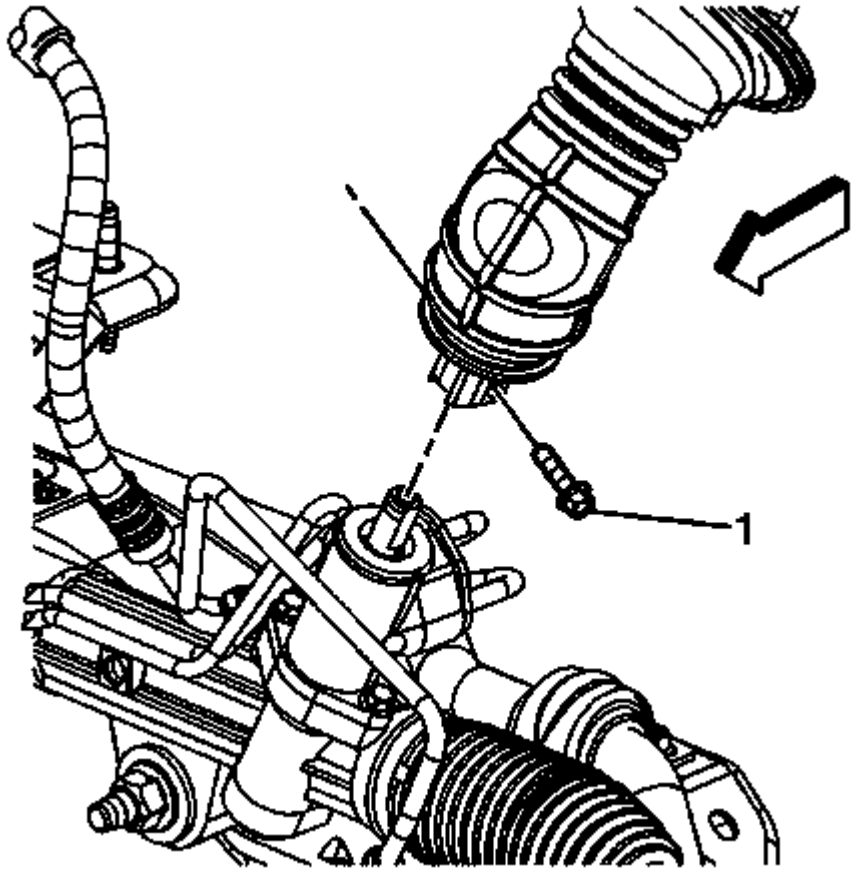

Fig. 233: Identifying Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

19. Remove the steering intermediate shaft pinch bolt (1) in order to disconnect the steering intermediate shaft from the steering gear.

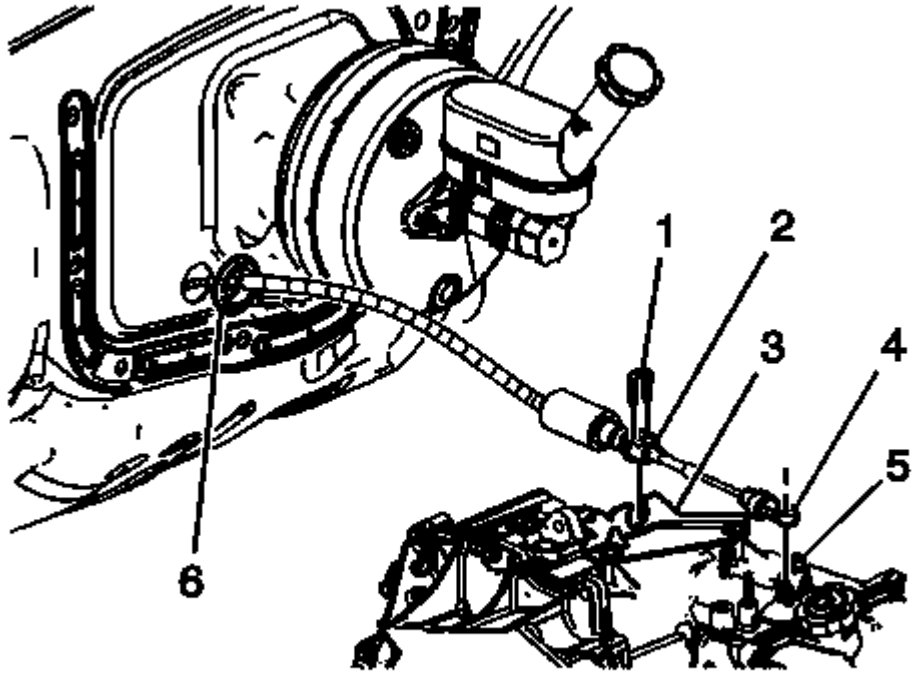

Fig. 234: View Of Range Selector Lever Cable Terminal & Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

20. Disconnect the transaxle shift cable (2). Refer to **Range Selector Lever Cable Replacement** .
21. Disconnect the transaxle cooler lines. Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .
22. Disconnect the negative battery extension cable. Refer to **Battery Negative Cable Extension Cable Replacement** .
23. Disconnect all engine electrical connectors.

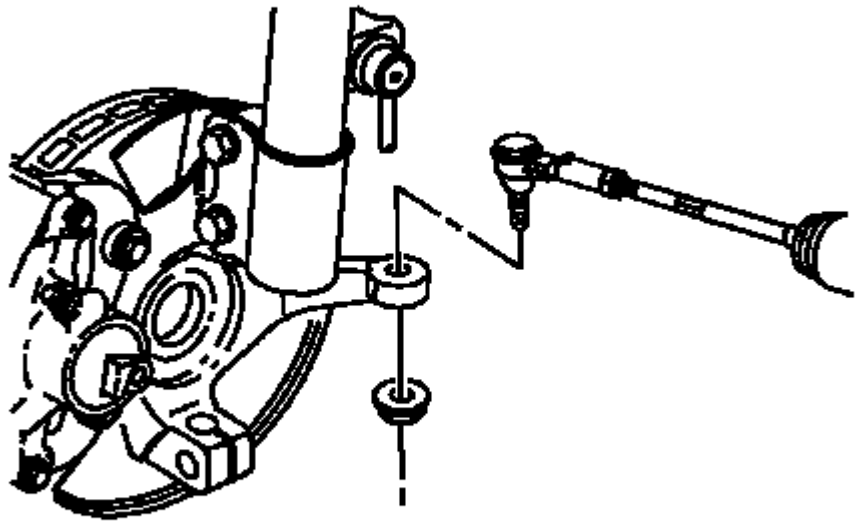

Fig. 235: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

24. Remove the right and left steering linkage outer tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .

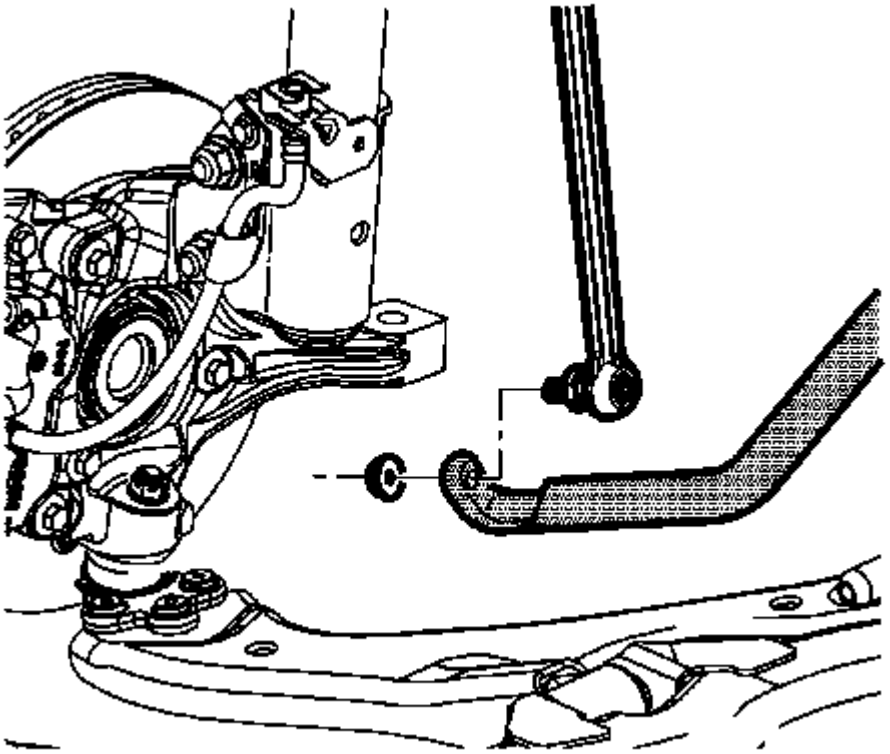

Fig. 236: View Of Stabilizer Shaft & Link
Courtesy of GENERAL MOTORS COMPANY

25. Remove the right and left stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .

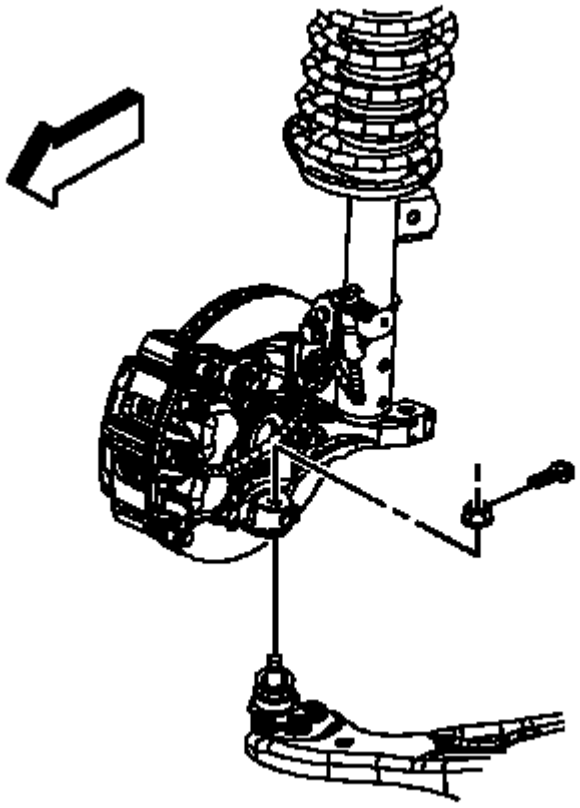

Fig. 237: View Of Lower Ball Joint At Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

26. Remove the right and left lower ball joints from the steering knuckles. Refer to **Lower Control Arm Replacement** .
27. Place a drain pan under the transaxle then separate the right and left front wheel drive shafts from the transaxle/transfer case. Refer to **Front Wheel Drive Shaft Replacement** .

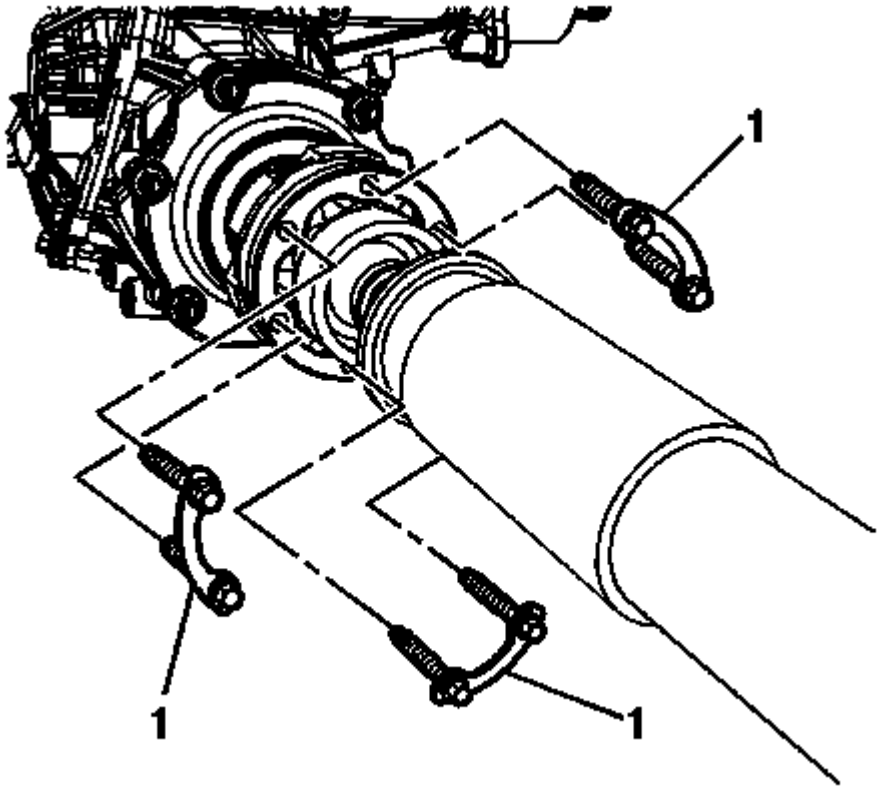

Fig. 238: View Of Propeller Shaft Bolts & Washers
Courtesy of GENERAL MOTORS COMPANY

28. On all wheel drive (AWD) models, remove the propeller shaft retaining bolts (1) in order to remove the shaft. Refer to **Propeller Shaft Replacement** .
29. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.

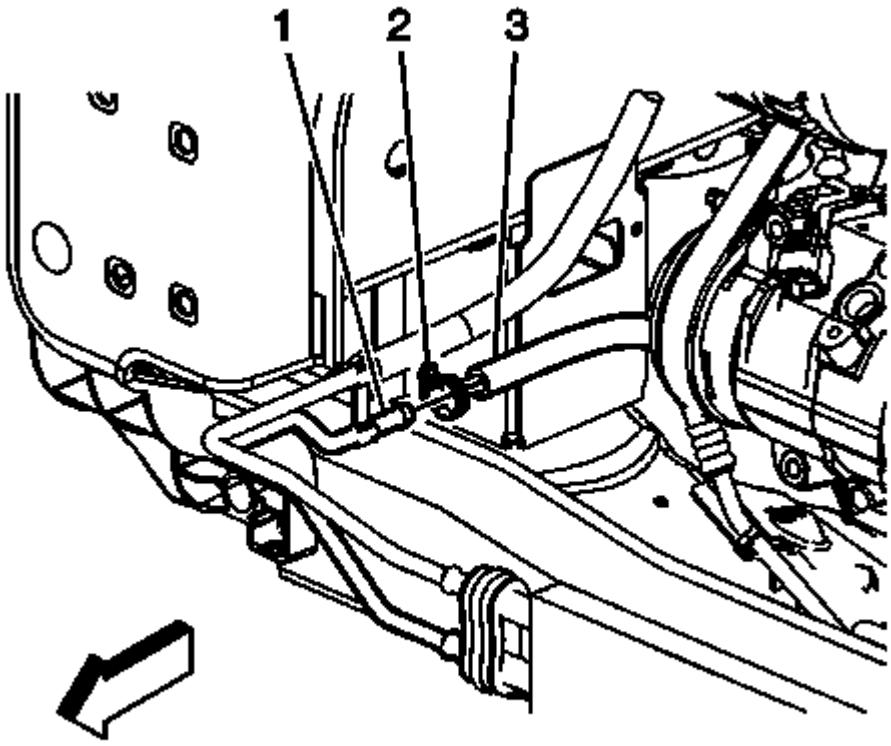

Fig. 239: Identifying Power Steering Fluid Cooler, Power Steering Cooler Pipe & Clamp
Courtesy of GENERAL MOTORS COMPANY

30. Disconnect the power steering hoses at the power steering fluid cooler (1). Refer to **Power Steering Cooler Pipe/Hose Replacement** .
31. Place a universal frame support fixture or jackstands under the frame.
32. Lower the vehicle until the frame contacts the frame support fixture or jackstands.

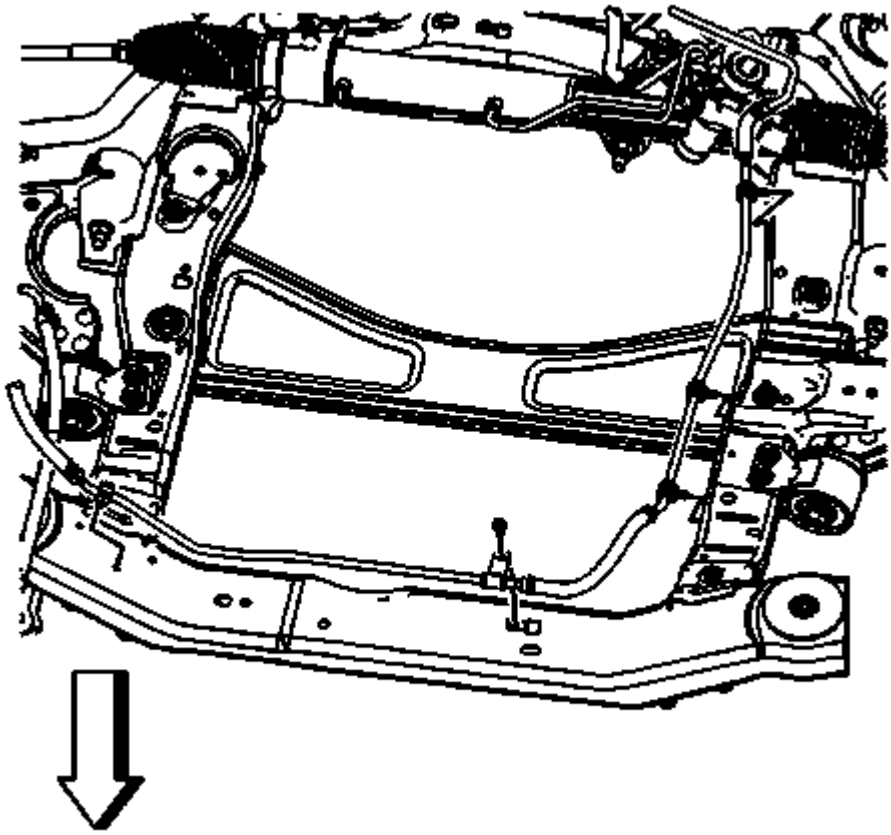

Fig. 240: Identifying Power Steering Cooler Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

33. Remove the subframe to body bracket bolts.

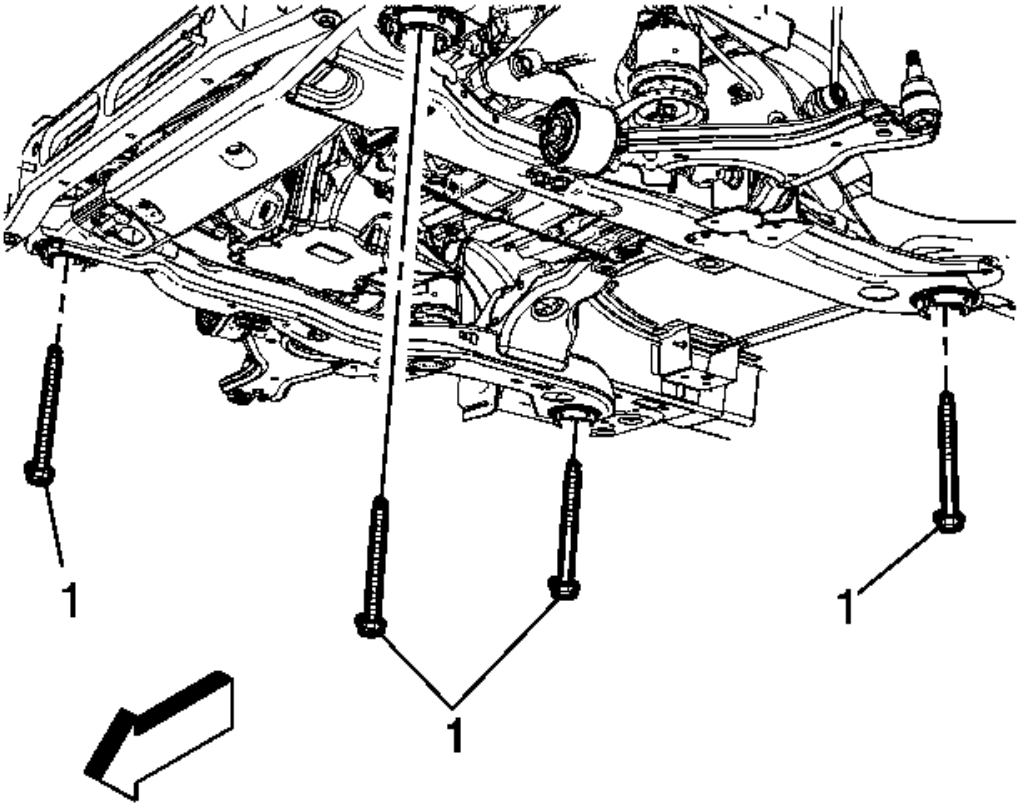

Fig. 241: Frame-To-Body Bolts
Courtesy of GENERAL MOTORS COMPANY

34. Remove the frame-to-body bolts (1).

IMPORTANT: Inspect for areas of body to powertrain contact or entanglement of wires and hoses while separating the vehicle body and powertrain.

35. Carefully raise the vehicle body up away from the powertrain.

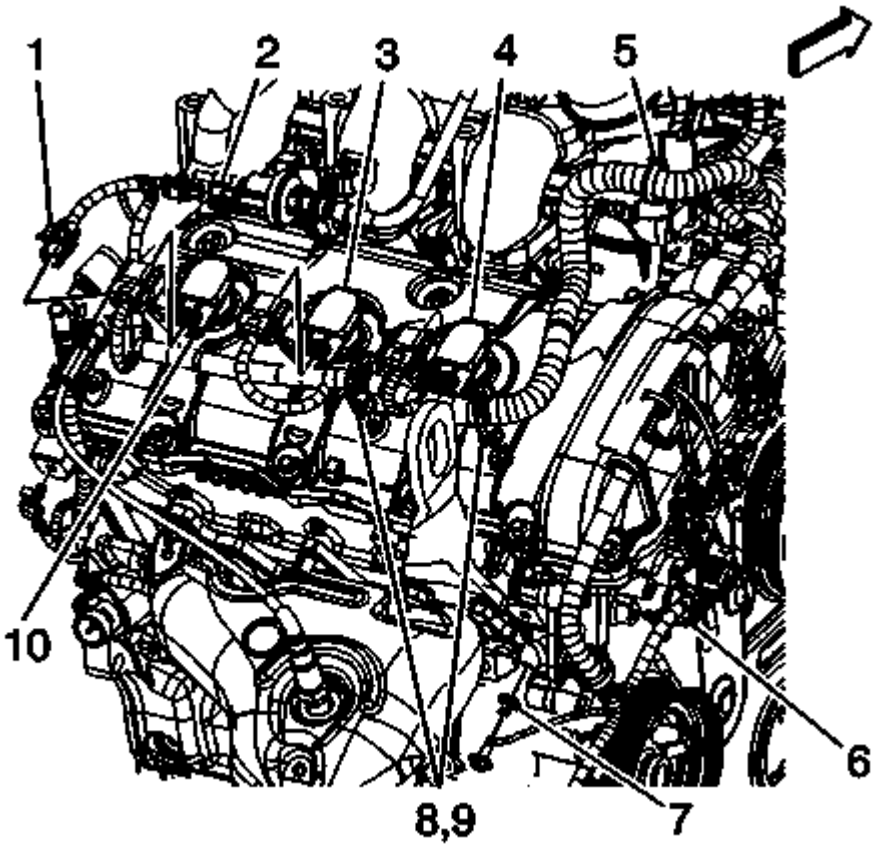

Fig. 242: Identifying Oxygen Sensor, EVAP Purge Solenoid, Ignition Coils & Retainers
Courtesy of GENERAL MOTORS COMPANY

36. Disconnect the engine electrical wiring harness from the following components:
    - Oxygen sensor (1)
    - EVAP purge solenoid (2)
    - Ignition coils (3, 4, 10)
    - Ground lead (7)
    - Remove wire harness from retainers (5, 6, 8, 9)

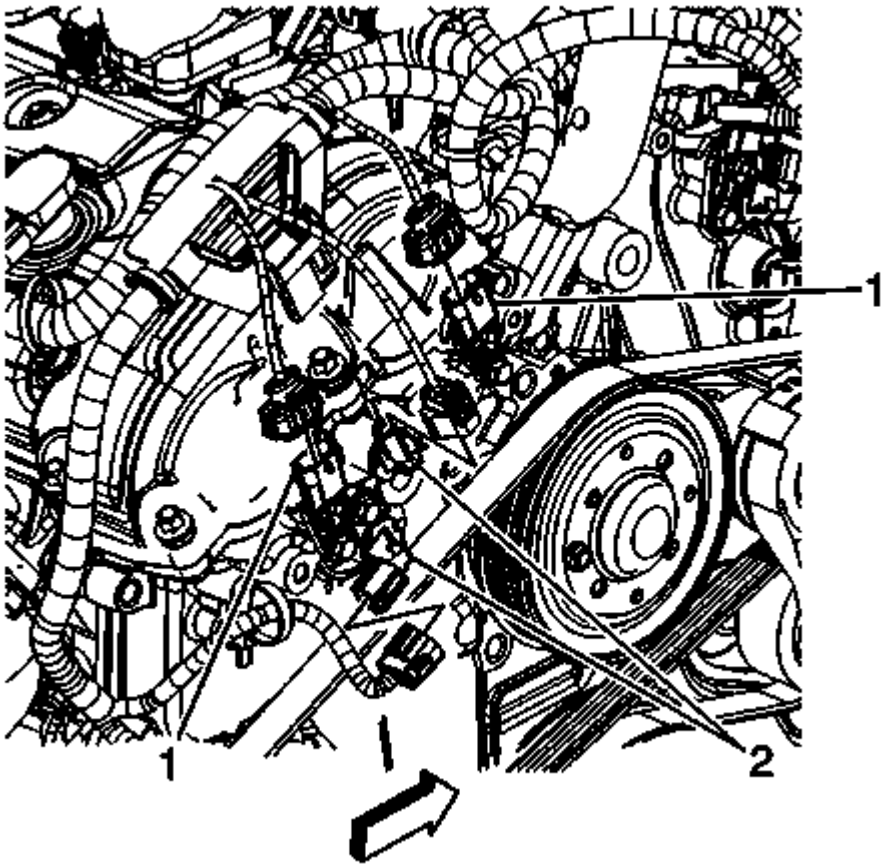

Fig. 243: View Of Camshaft Position Sensors & Actuators
Courtesy of GENERAL MOTORS COMPANY

37. Disconnect the left and right cylinder head engine electrical wiring harness from the following components:
    - Camshaft position sensors (1)
    - Camshaft position actuators (2)

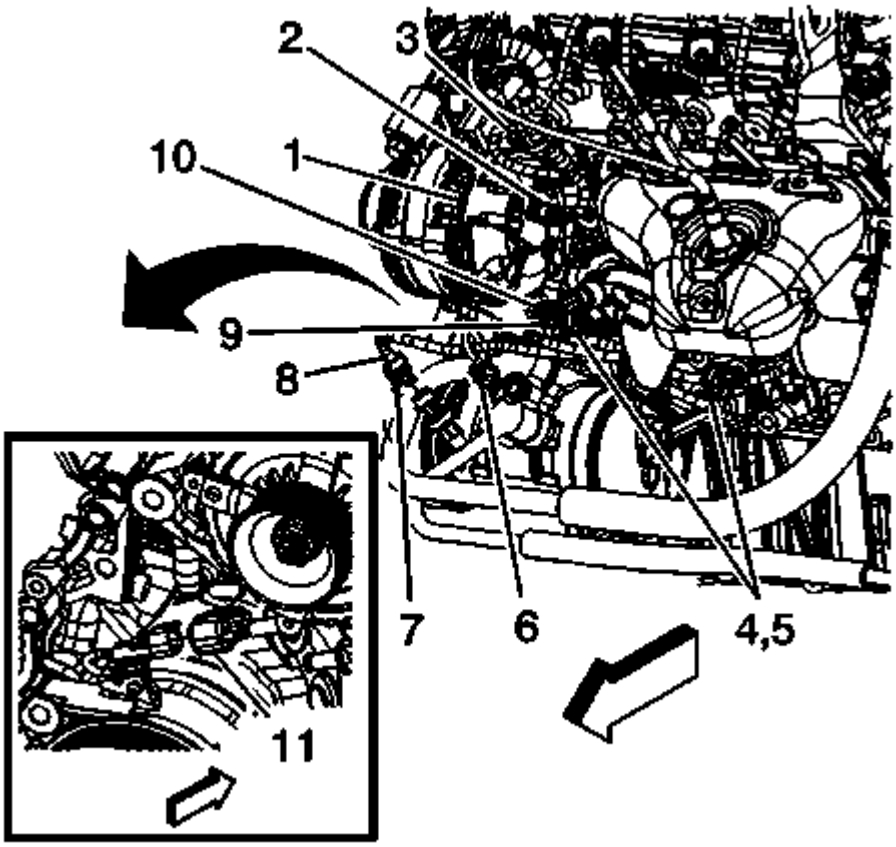

Fig. 244: Identifying Generator, A/C Compressor, Oil Pressure Switch & Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

38. Disconnect the engine electrical wiring harness from the following components:
    - Generator (1)
    - Retainer clips (2, 3, 4, 5, 6, 7, 9)
    - A/C compressor hose (8)
    - Oil pressure switch (10)
    - A/C compressor (8)

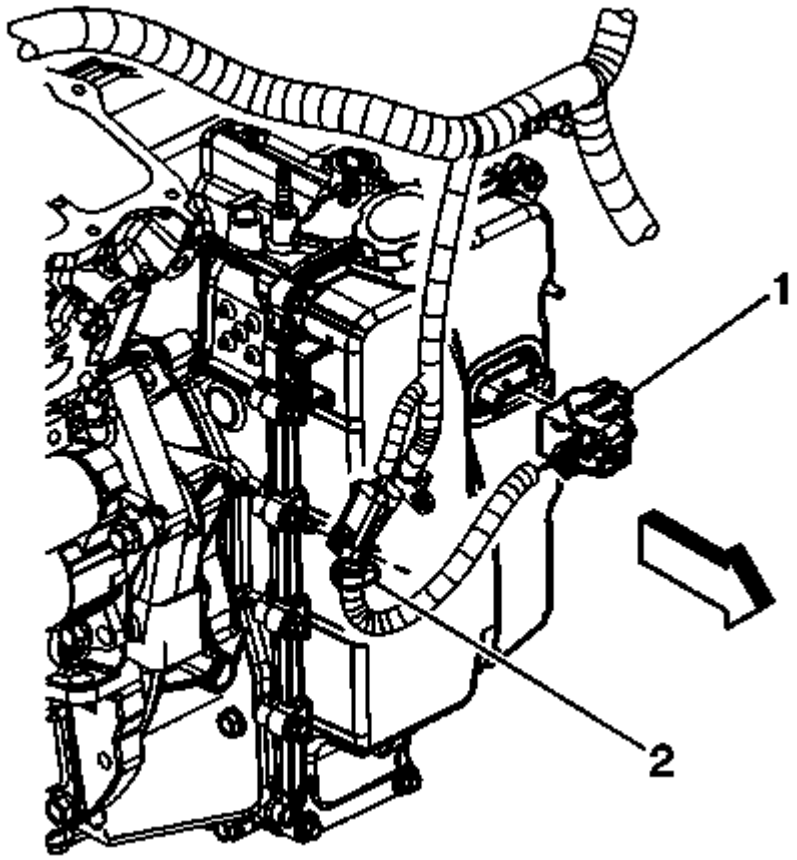

Fig. 245: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

39. Disconnect the engine electrical wiring harness from the following components:
    - Battery cable
    - Retainer clips (2)
    - Transmission module (1)
40. If equipped with an engine coolant heater, disconnect the coolant heater cord.
41. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement** .

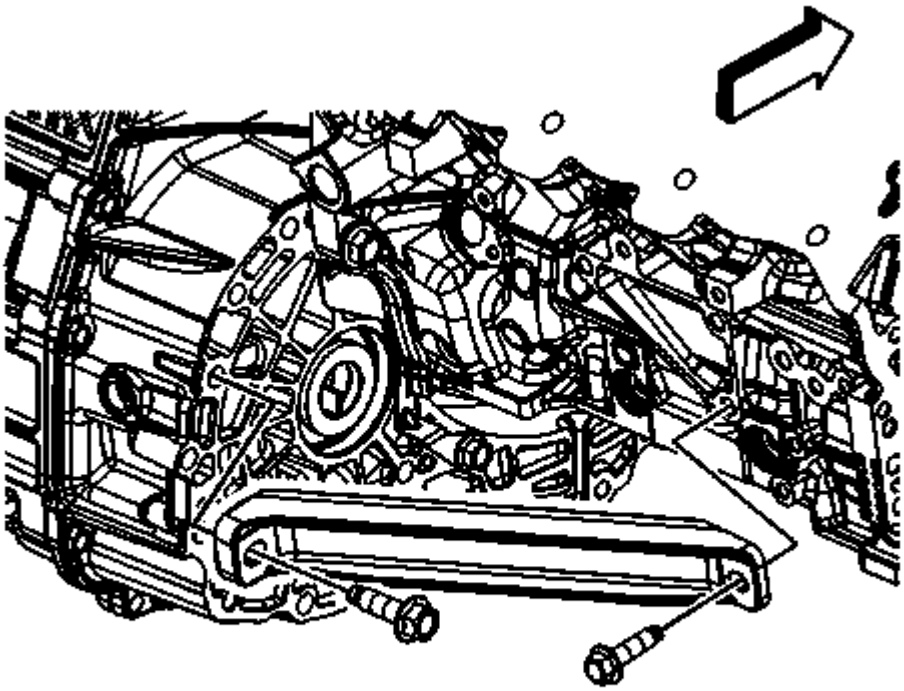

Fig. 246: Identifying Transmission Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

42. On FWD vehicles, remove the engine-to-transaxle brace bolts and brace.
43. On AWD vehicles, perform the following:
    1. Remove the front wheel drive intermediate shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .
    2. Remove the engine rear mount bracket. Refer to **Engine Rear Mount Bracket Replacement (Front Wheel Drive)**, **Engine Rear Mount Bracket Replacement (All Wheel Drive)**.
    3. Remove the transfer case. Refer to **Transfer Case Assembly Replacement** .

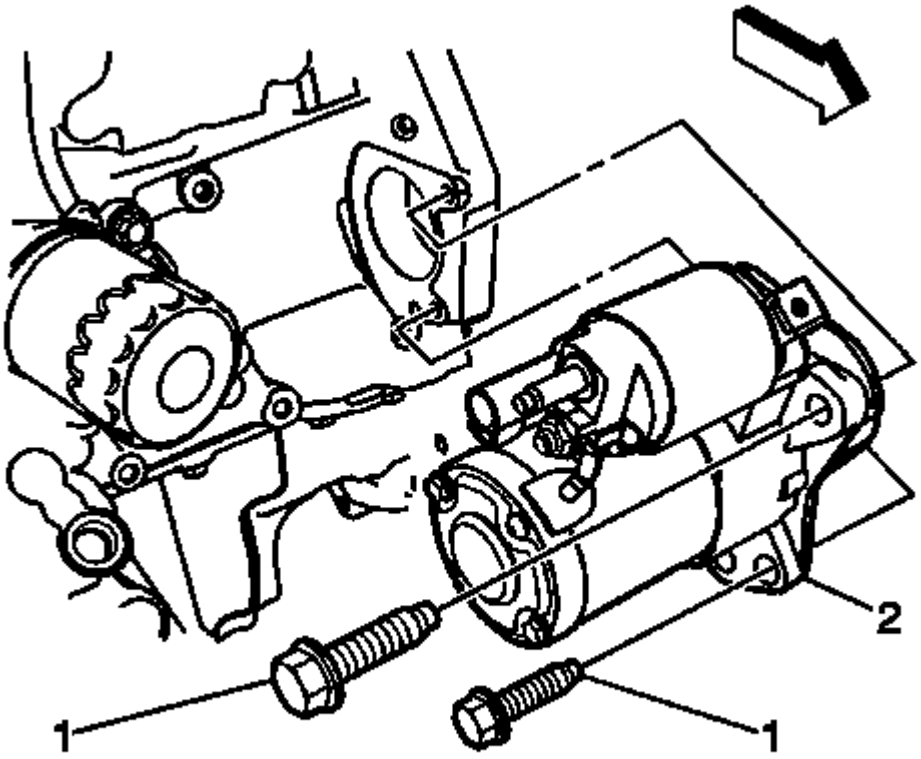

Fig. 247: Starter Motor & Bolts
Courtesy of GENERAL MOTORS COMPANY

44. Remove the starter motor (2). Refer to **Starter Replacement** .

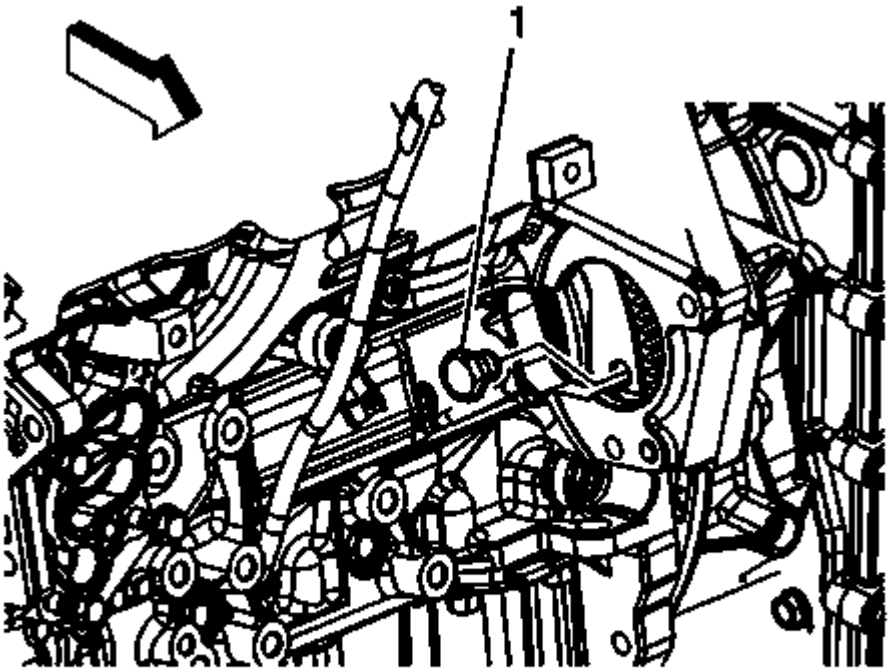

Fig. 248: View Of Torque Converter To Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

45. Remove the torque converter bolts (1).
46. Using a engine hoist and lift chain, support the engine weight.
47. Support the bellhousing of the transmission with a block of wood.

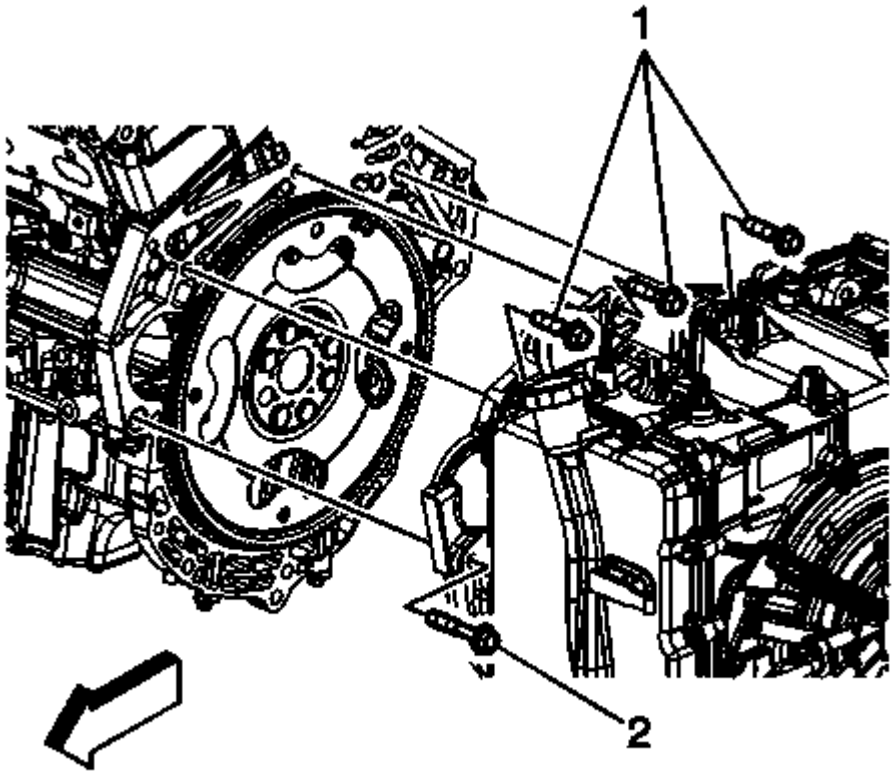

Fig. 249: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

48. Remove the automatic transaxle bolts (1, 2).
49. Remove the front and rear engine mount to mount bracket nuts.
50. Separate the automatic transaxle from the engine.

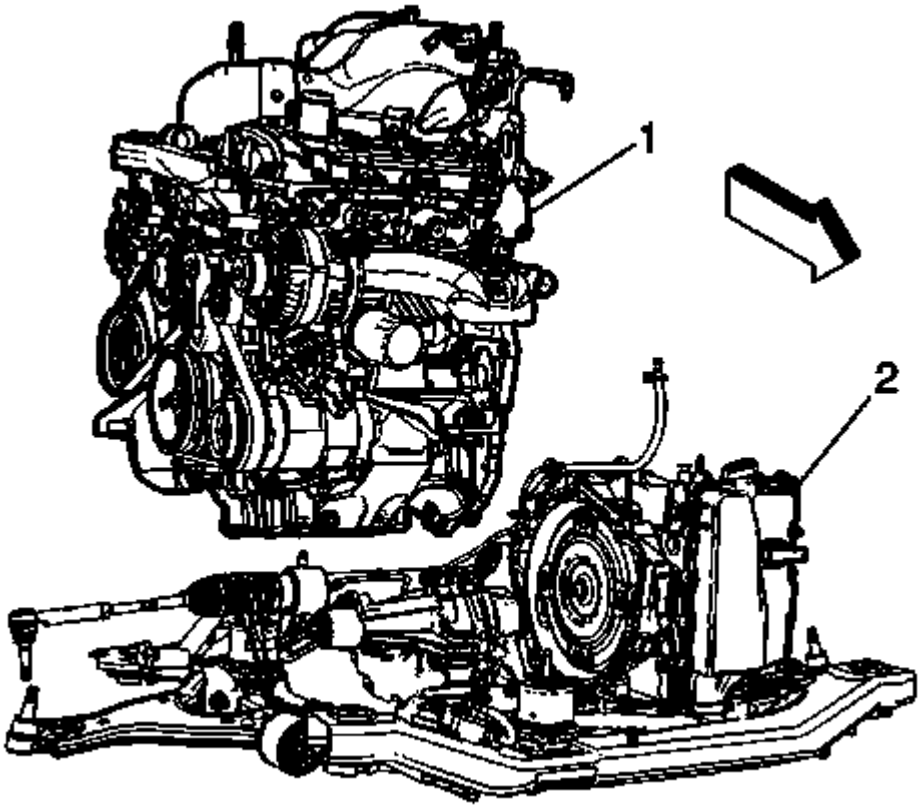

Fig. 250: Engine & Automatic Transaxle
Courtesy of GENERAL MOTORS COMPANY

51. Lift the engine (1) away from the frame and the automatic transaxle (2).
52. Secure the engine to an engine stand.
53. Remove any additional engine components as necessary. Refer to appropriate component sections in manual if needed.

Installation Procedure

1. Using a engine hoist and lift chain, remove the engine from the engine stand.

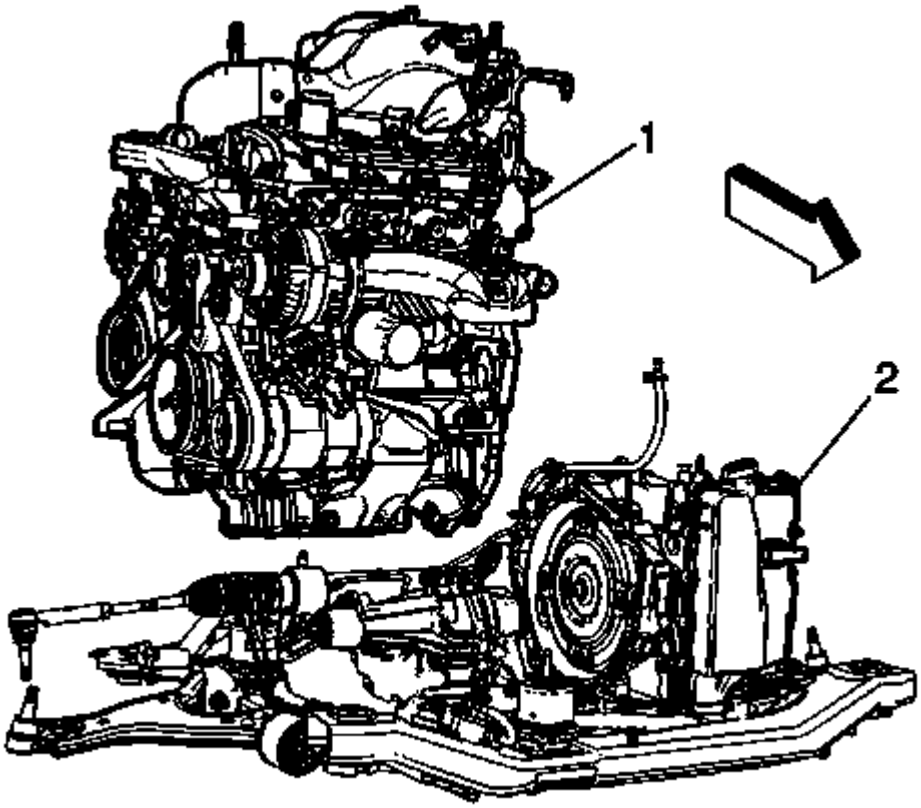

Fig. 251: Engine & Automatic Transaxle
Courtesy of GENERAL MOTORS COMPANY

2. Align the engine (1) to the frame and automatic transaxle (2).

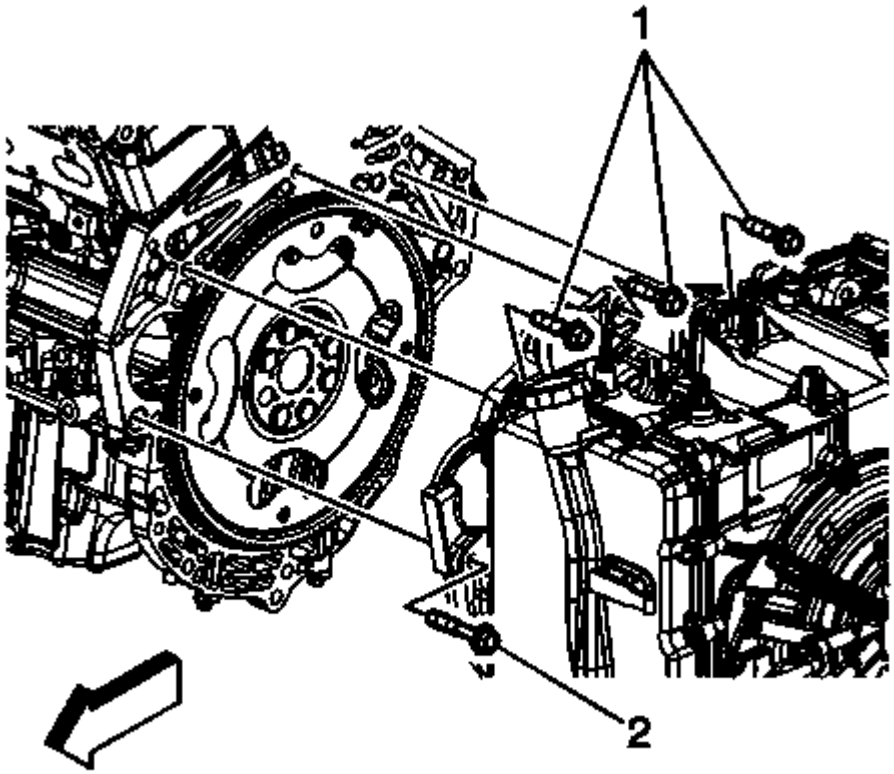

Fig. 252: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the automatic transaxle bolts (1, 2) and tighten to 75 N.m (55 lb ft).
4. Remove the engine hoist and lift chain.
5. Install the front and rear engine mount to bracket nuts, and tighten to 50 N.m (37 lb ft).

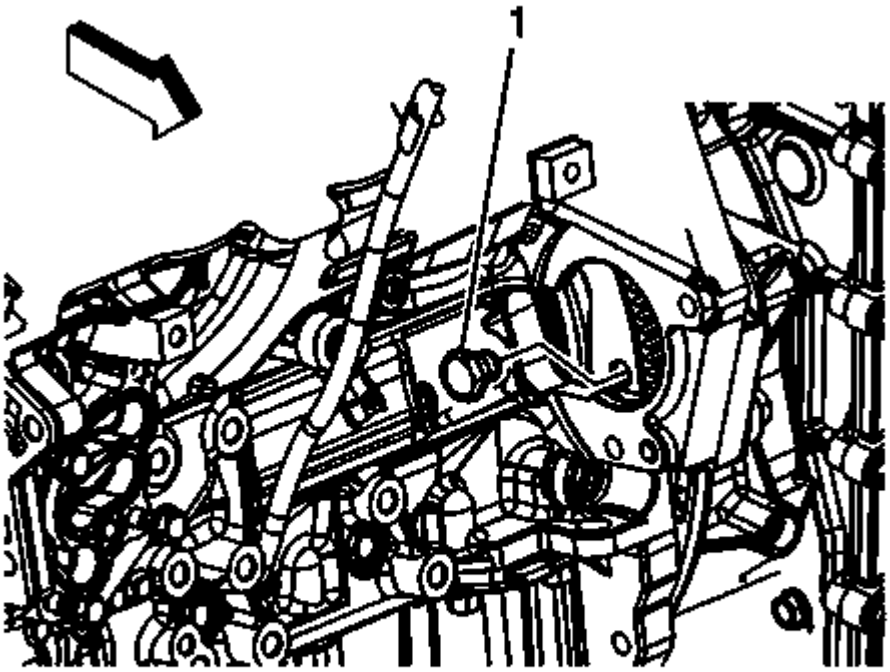

Fig. 253: View Of Torque Converter To Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the torque converter bolts (1) and tighten to 60 N.m (44 lb ft).

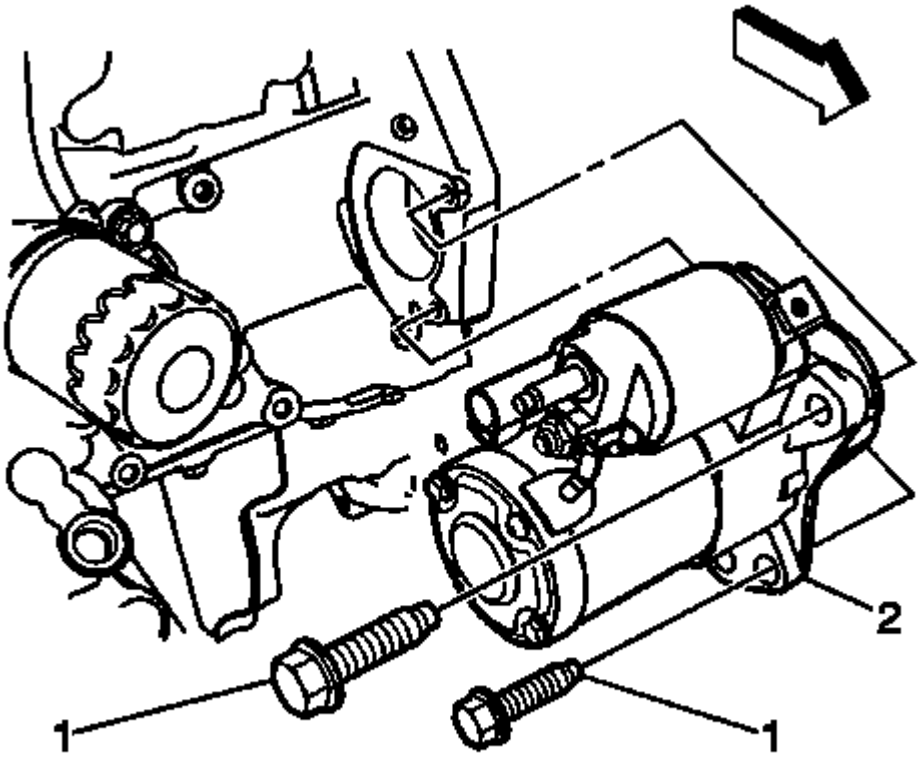

Fig. 254: Starter Motor & Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the starter motor (2). Refer to **Starter Replacement** .

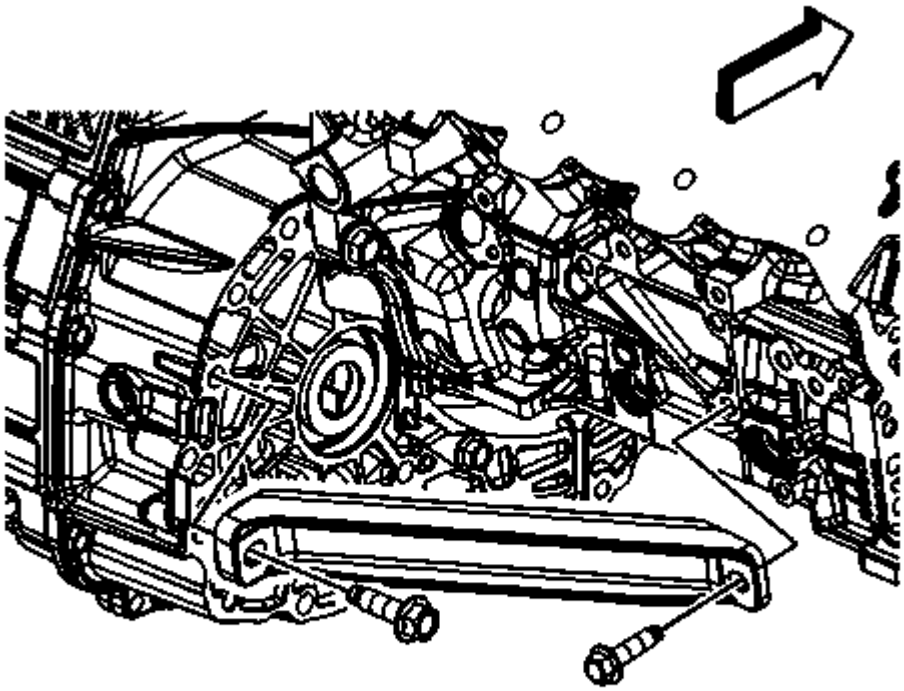

Fig. 255: Identifying Transmission Brace Bolts
Courtesy of GENERAL MOTORS COMPANY

8. On FWD vehicles, install the engine to transaxle brace and bolts and tighten to 50 N.m (37 lb ft).
9. On AWD vehicles, perform the following:
    1. Install the transfer case. Refer to **Transfer Case Assembly Replacement** .
    2. Install the engine rear mount bracket. Refer to **Engine Rear Mount Bracket Replacement (Front Wheel Drive)**, **Engine Rear Mount Bracket Replacement (All Wheel Drive)**.
    3. Install the front wheel drive intermediate shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .
10. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement** .
11. If equipped with an engine coolant heater, connect the coolant heater cord.

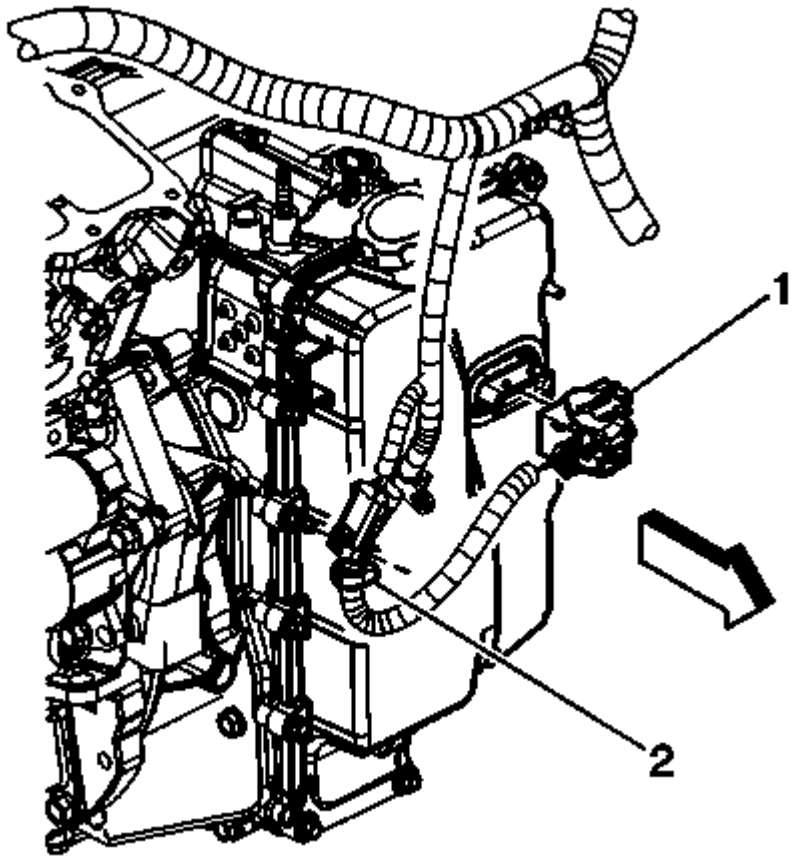

Fig. 256: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

12. Connect the engine electrical wiring harness to the following components:
    - Transmission module (1)
    - Retainer clips (2)
    - Battery cable
13. Install the battery cable to the cylinder head and tighten the bolt to 25 N.m (18 lb ft).

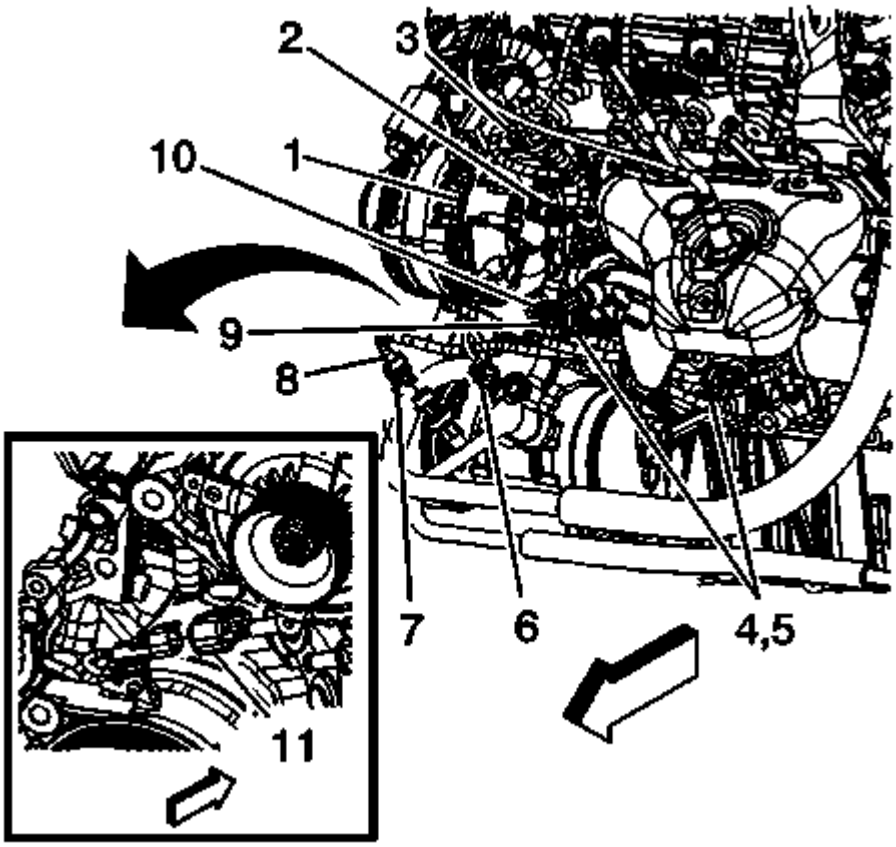

Fig. 257: Identifying Generator, A/C Compressor, Oil Pressure Switch & Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

14. Connect the engine electrical wiring harness to the following components:
    - A/C compressor (8)
    - Oil pressure switch (10)
    - A/C compressor hose (8)
    - Retainer clips (2, 3, 4, 5, 6, 7, 9)
15. Install the Generator terminal connector and nut (1) and tighten to 13 N.m (115 lb in).

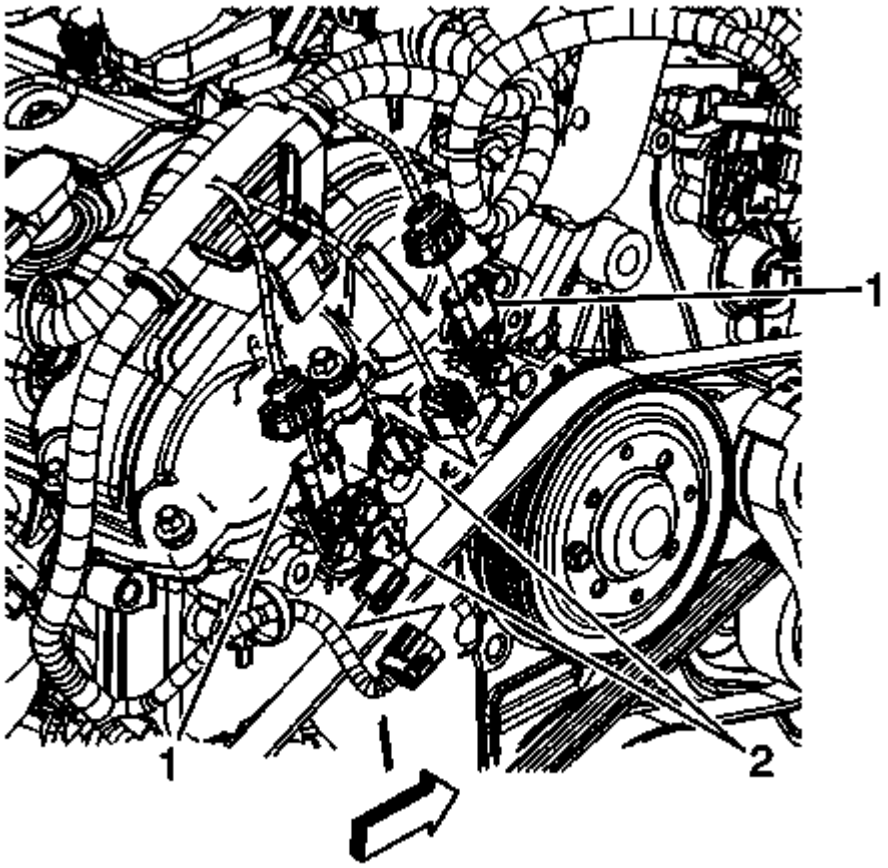

Fig. 258: View Of Camshaft Position Sensors & Actuators
Courtesy of GENERAL MOTORS COMPANY

16. Connect the left and right cylinder head engine electrical wiring harness to the following components:
    - Camshaft position actuators (2)
    - Camshaft position sensors (1)

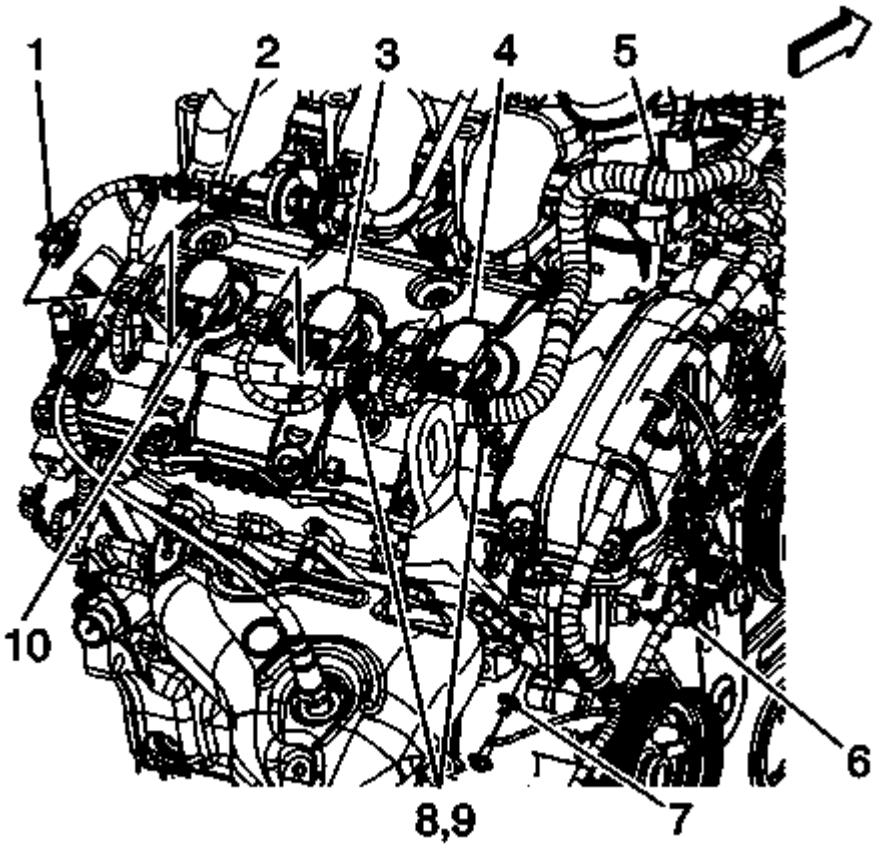

Fig. 259: Identifying Oxygen Sensor, EVAP Purge Solenoid, Ignition Coils & Retainers
Courtesy of GENERAL MOTORS COMPANY

17. Connect the engine electrical wiring harness to the following components:
    - Install wire harness to retainers (5, 6, 8, 9)
    - Ground lead (7)
    - Ignition coils (3, 4, 10)
    - EVAP purge solenoid (2)
    - Oxygen sensor (1)

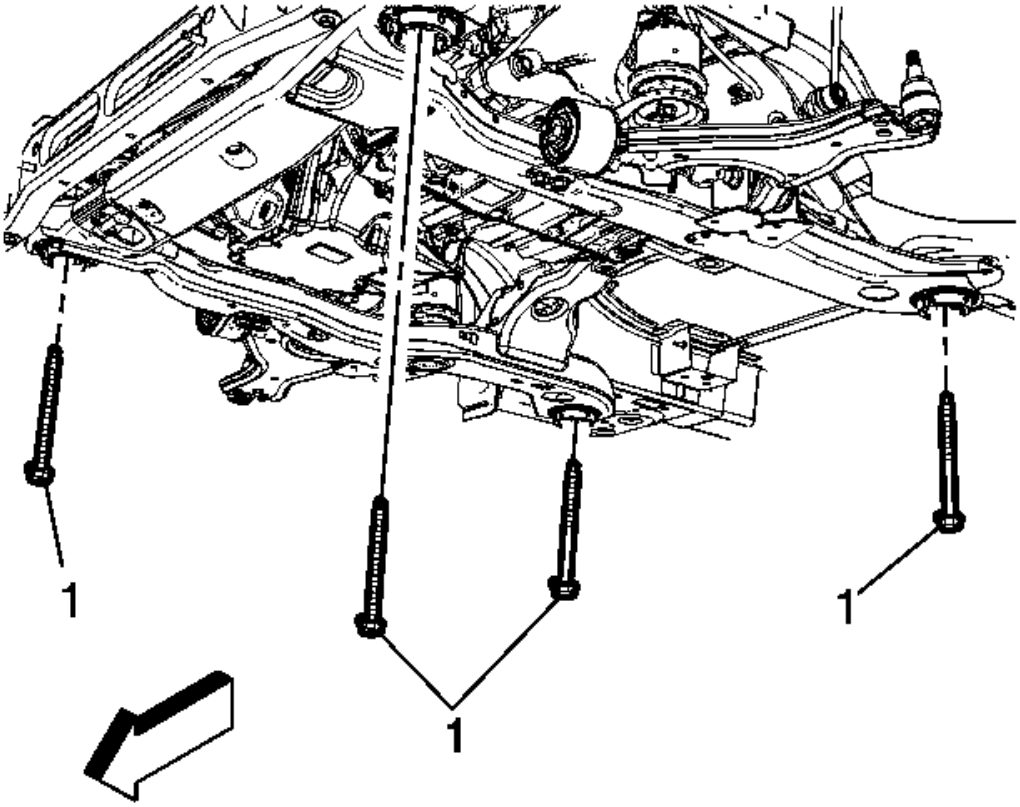

Fig. 260: Frame-To-Body Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the frame-to-body bolts (1) and tighten to 100 N.m (74 lb ft) + 90 degrees.

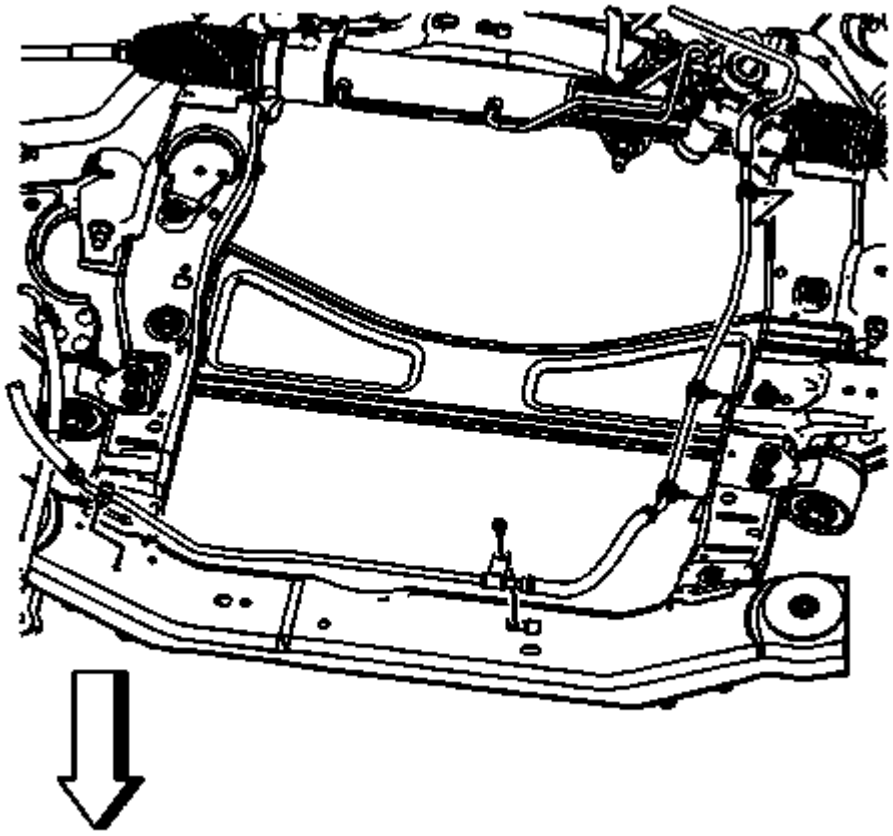

Fig. 261: Identifying Power Steering Cooler Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

19. Install the subframe to body bracket bolts and tighten to 60 N.m (44 lb ft).
20. Raise the vehicle and remove the support fixture or jackstands from under the vehicle.

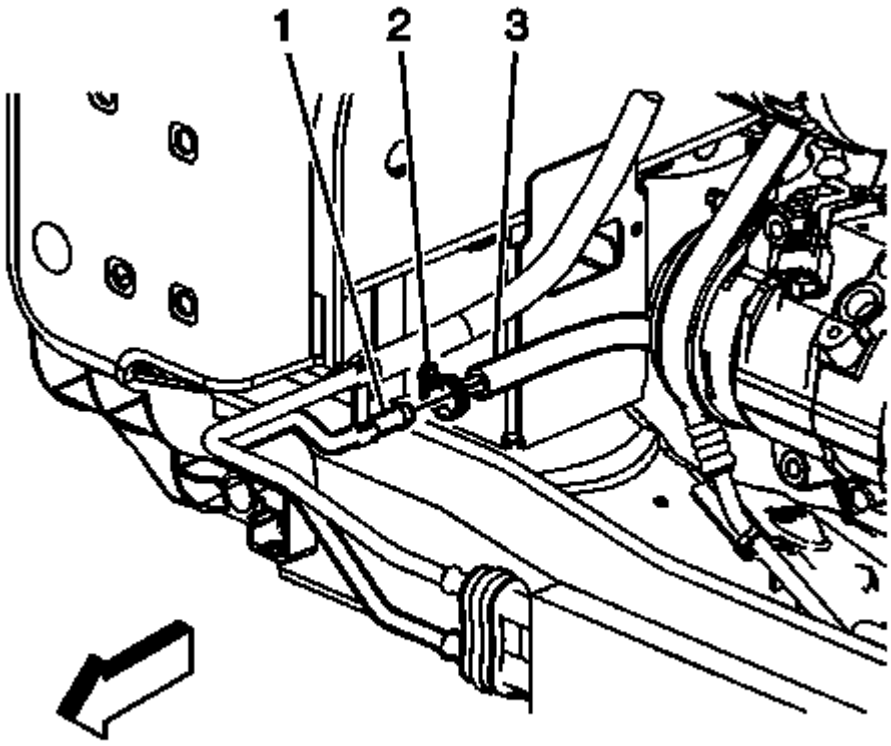

Fig. 262: Identifying Power Steering Fluid Cooler, Power Steering Cooler Pipe & Clamp
Courtesy of GENERAL MOTORS COMPANY

21. Connect the power steering hoses to the power steering fluid cooler (1). Refer to **Power Steering Cooler Pipe/Hose Replacement** .
22. Install the left transaxle mount bracket. Refer to **Transmission Mount Bracket Replacement - Left Side** .
23. Install the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
24. Raise the vehicle.

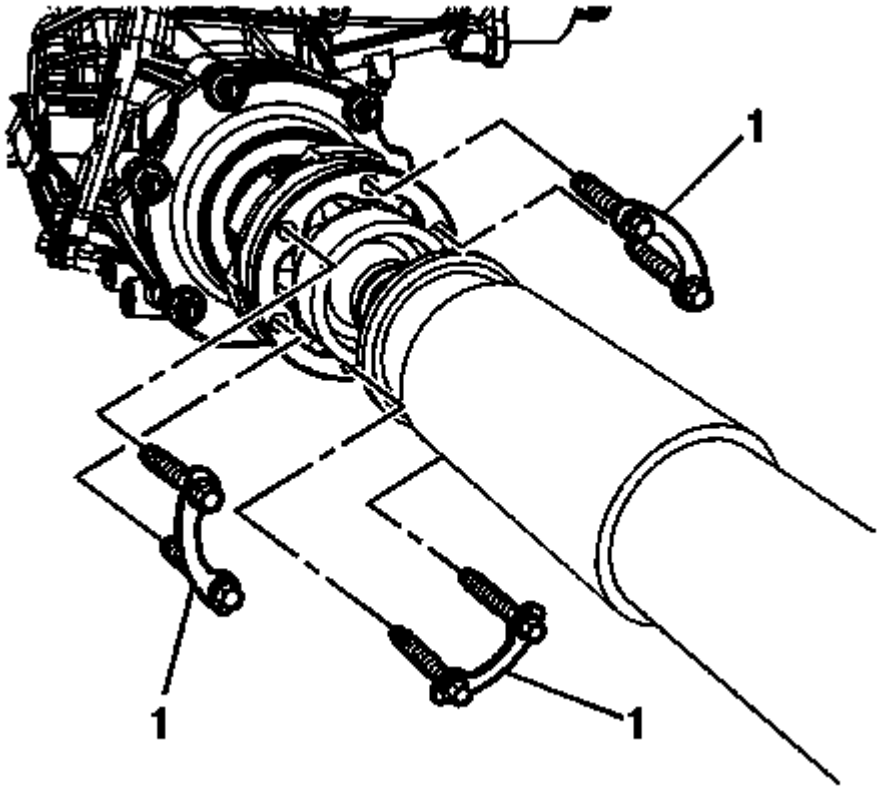

Fig. 263: View Of Propeller Shaft Bolts & Washers
Courtesy of GENERAL MOTORS COMPANY

25. On AWD models, install the propeller shaft and retainers (1). Refer to **Propeller Shaft Replacement** .
26. On FWD models, install the right and left front wheel drive shafts into the transaxle. Refer to **Front Wheel Drive Shaft Replacement** .

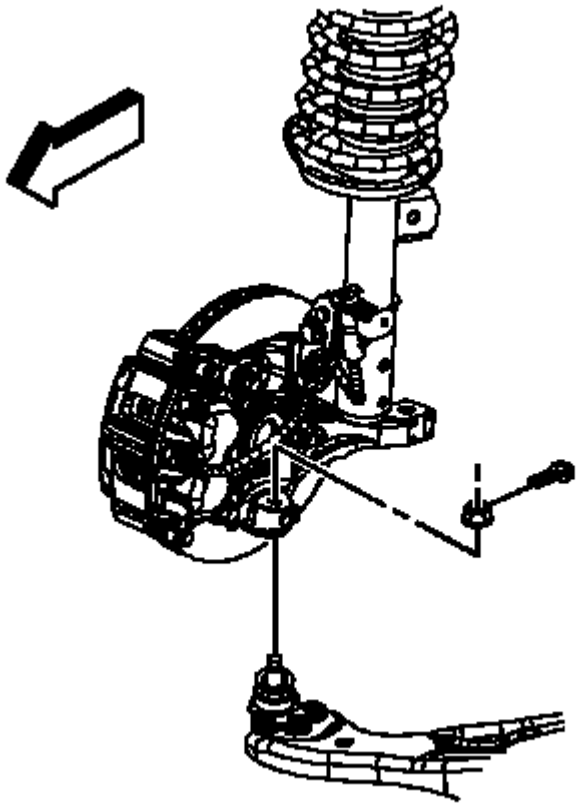

Fig. 264: View Of Lower Ball Joint At Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

27. On all models, install the right and left lower ball joints to the steering knuckles. Refer to **Lower Control Arm Replacement** .

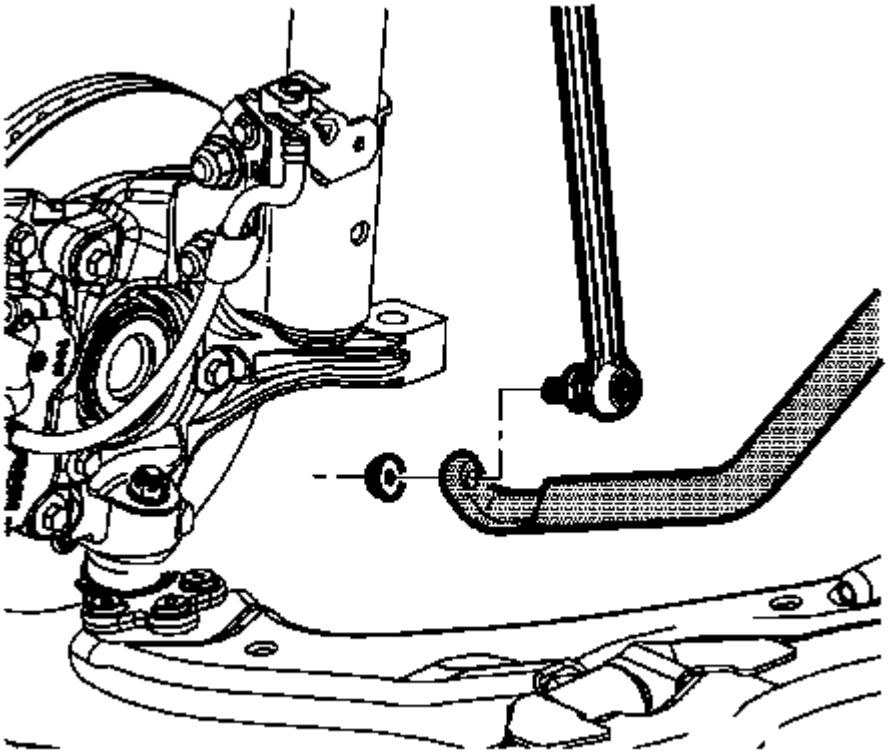

Fig. 265: View Of Stabilizer Shaft & Link
Courtesy of GENERAL MOTORS COMPANY

28. Install the right and left stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .

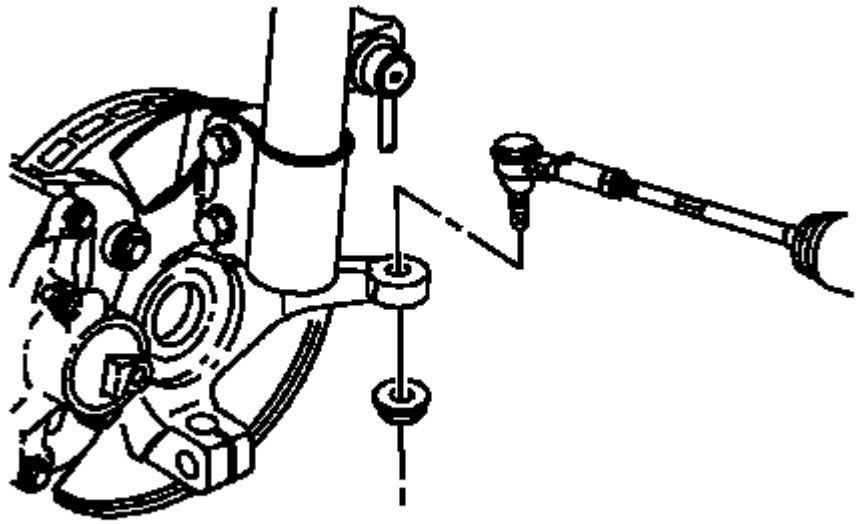

Fig. 266: View Of Tie Rod End To Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

29. Install the right and left steering linkage outer tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
30. Connect all engine electrical connectors.
31. Connect the negative battery extension cable. Refer to **Battery Negative Cable Extension Cable Replacement** .

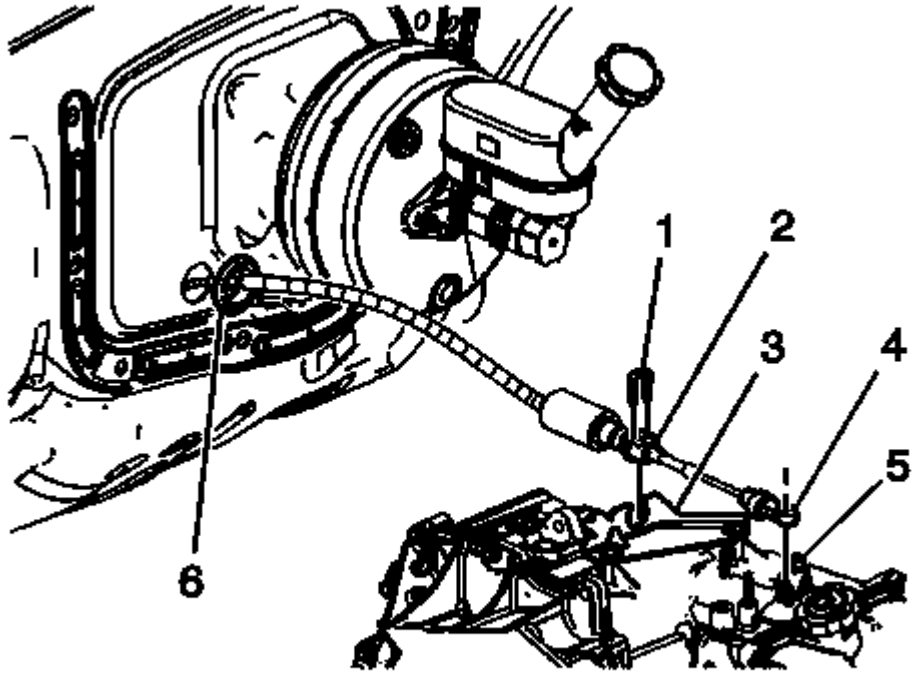

Fig. 267: View Of Range Selector Lever Cable Terminal & Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

32. Connect the transaxle shift cable (2). Refer to **Range Selector Lever Cable Replacement** .
33. Connect the transaxle cooler lines. Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .

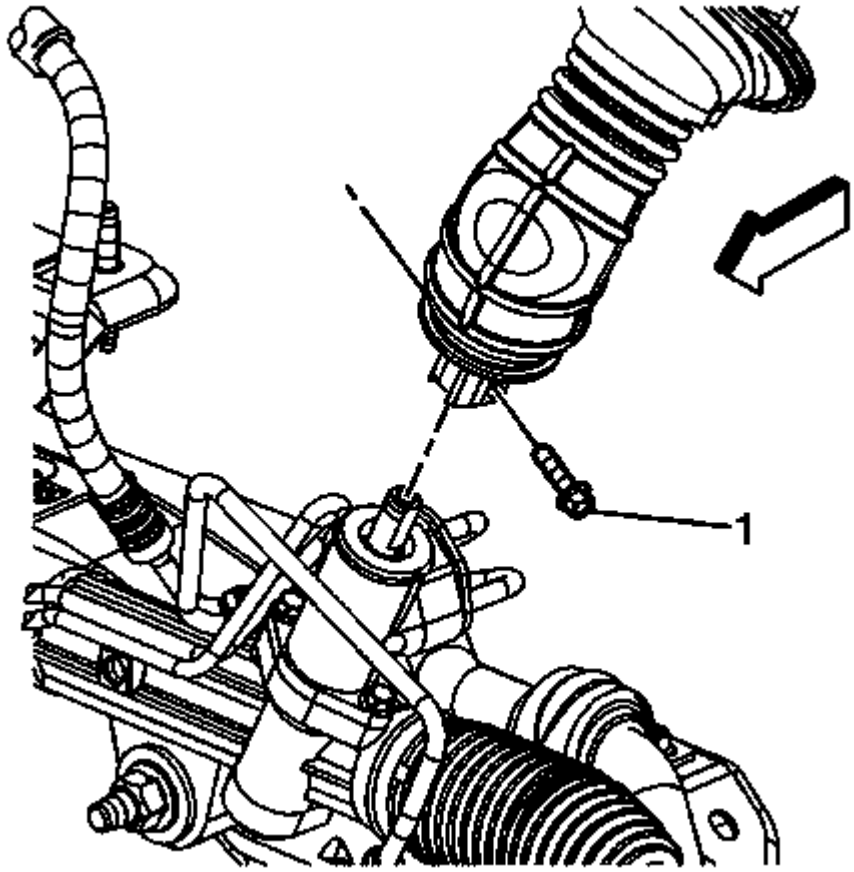

Fig. 268: Identifying Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

34. Connect the steering intermediate shaft to the steering gear and install the pinch bolt (1). Refer to **Intermediate Steering Shaft Replacement** .
35. Install the front tires. Refer to **Tire and Wheel Removal and Installation** .
36. Install the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement** .
37. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement** .
38. Lower the vehicle.
39. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement** .
40. Connect the outlet coolant heater hose to the engine. Refer to **Heater Outlet Hose Replacement**
41. Connect the inlet coolant heater hose to the engine. Refer to **Heater Inlet Hose Replacement** .
42. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement** .

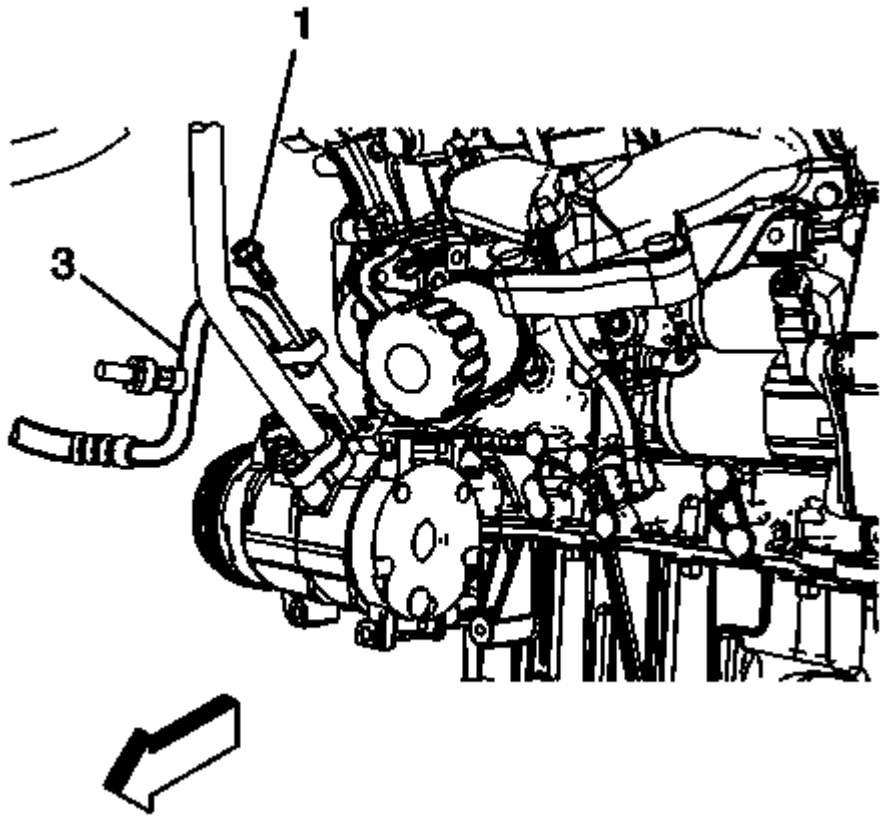

Fig. 269: Identifying A/C Compressor Discharge Line & Bolt
Courtesy of GENERAL MOTORS COMPANY

43. Install the A/C compressor discharge hose (3) assembly to the compressor. Refer to **Discharge Hose Replacement** .

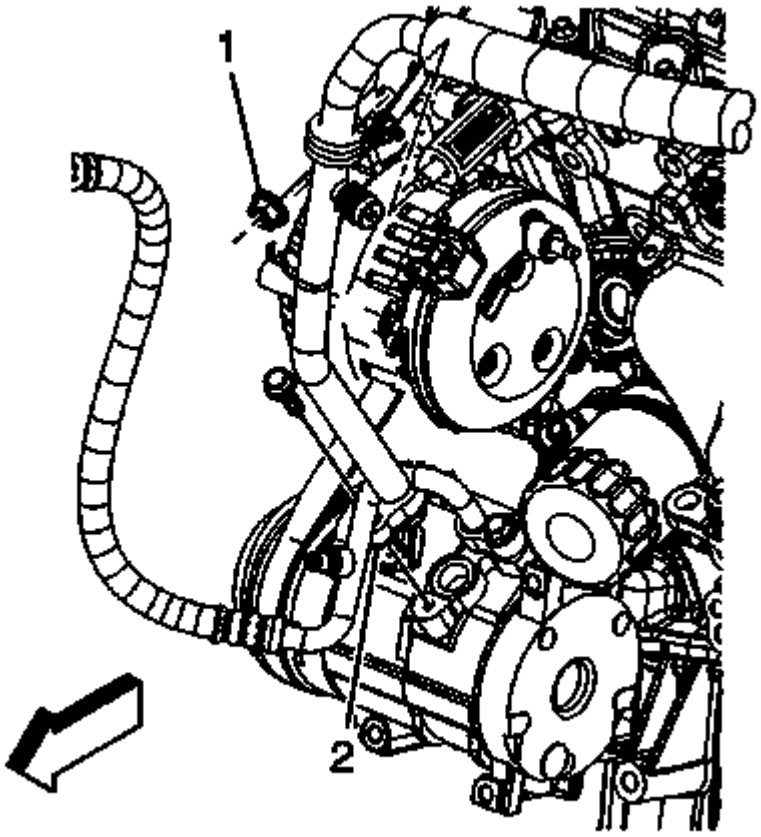

Fig. 270: Identifying Suction Hose Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

44. Install the A/C compressor suction hose assembly (2) to the compressor. Refer to **Suction Hose Replacement** .

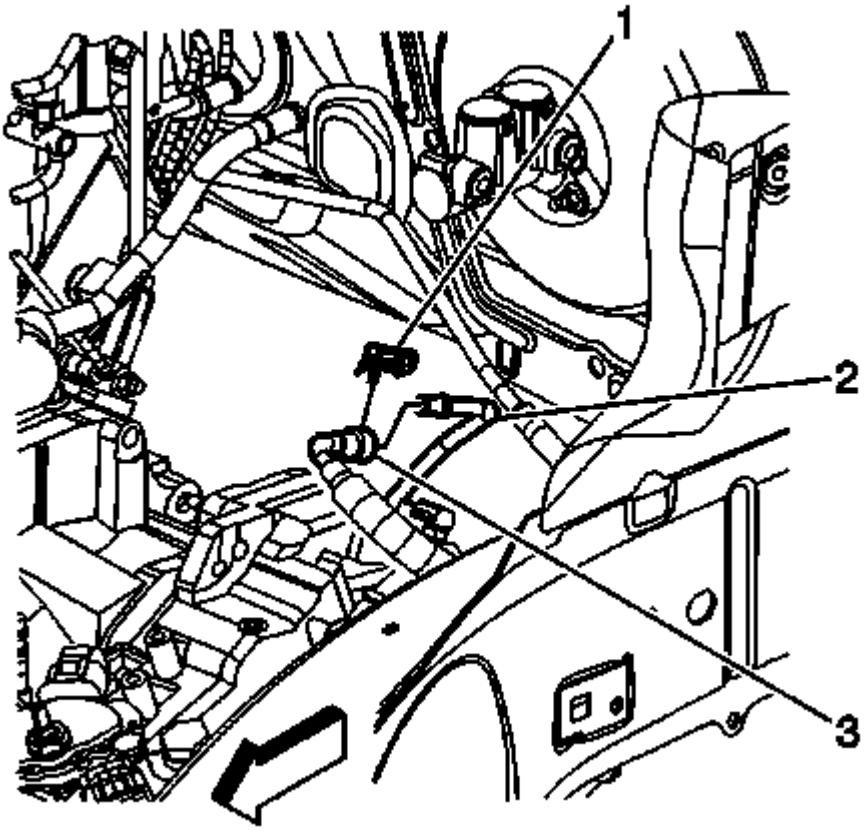

Fig. 271: Disconnecting/Connecting Engine Fuel Hose/Pipe At Chassis Fuel Hose/Pipe
Courtesy of GENERAL MOTORS COMPANY

45. Connect the engine fuel hose/pipe (3) to the chassis fuel hose/pipe (2). Refer to **Metal Collar Quick Connect Fitting Service** .

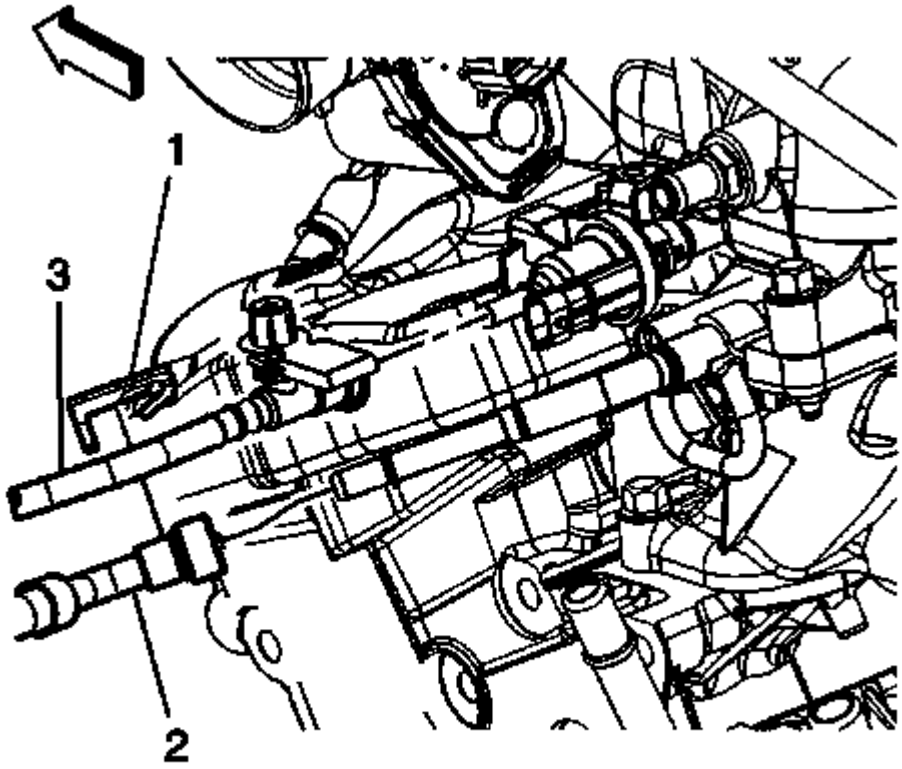

Fig. 272: View Of EVAP Pipe
Courtesy of GENERAL MOTORS COMPANY

46. Connect the EVAP hose/pipe (3) to the EVAP canister purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
47. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

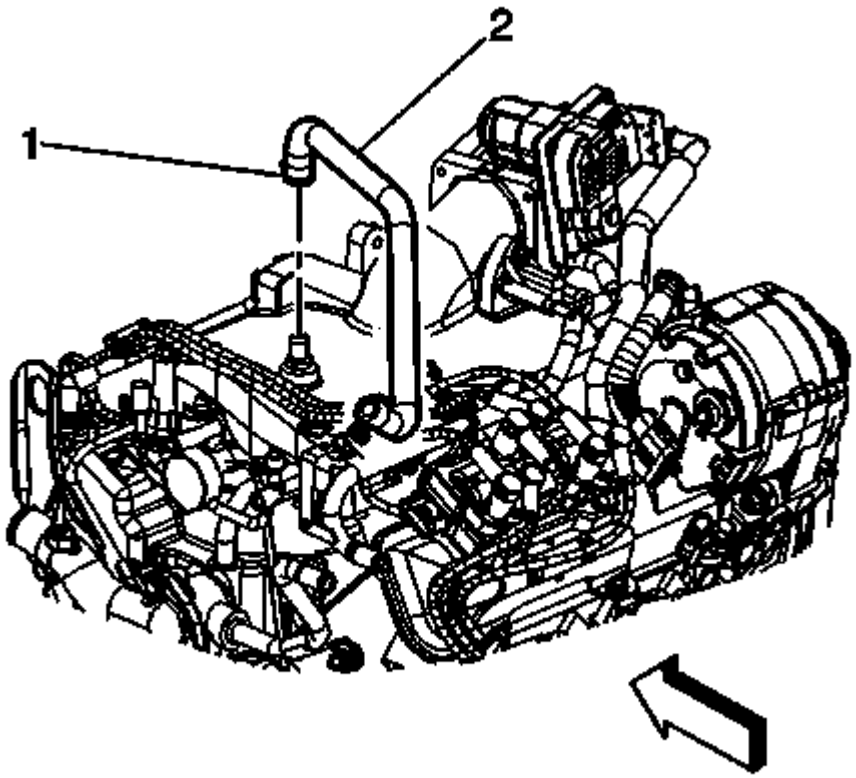

Fig. 273: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

48. Connect the brake booster vacuum hose (2) to the intake manifold.
49. Position the clamp (1) on the brake booster vacuum hose connection.
50. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
51. Fill the engine with engine oil. Refer to **Approximate Fluid Capacities** , , **Fluid and Lubricant Recommendations** , , and **Maintenance Schedule (North American Emissions)** .
52. Fill the engine with coolant. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (Vac N Fill)** .
53. Check the transaxle fluid level. Refer to **Adhesives, Fluids, Lubricants, and Sealers** , , **Transmission General Specifications** , , and **Approximate Fluid Capacities** .
54. Charge the AC system. Refer to **Refrigerant Recovery and Recharging** .
55. Add power steering fluid and bleed air from the power steering system. Refer to **Power Steering System Bleeding** .
56. Prime the fuel system.
    1. Cycle the ignition ON for 5 seconds then OFF for 10 seconds. Repeat cycling twice.
    2. Crank the engine until it starts. The maximum starter motor cranking time is 20 seconds.
    3. If the engine does not start, repeat the steps.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

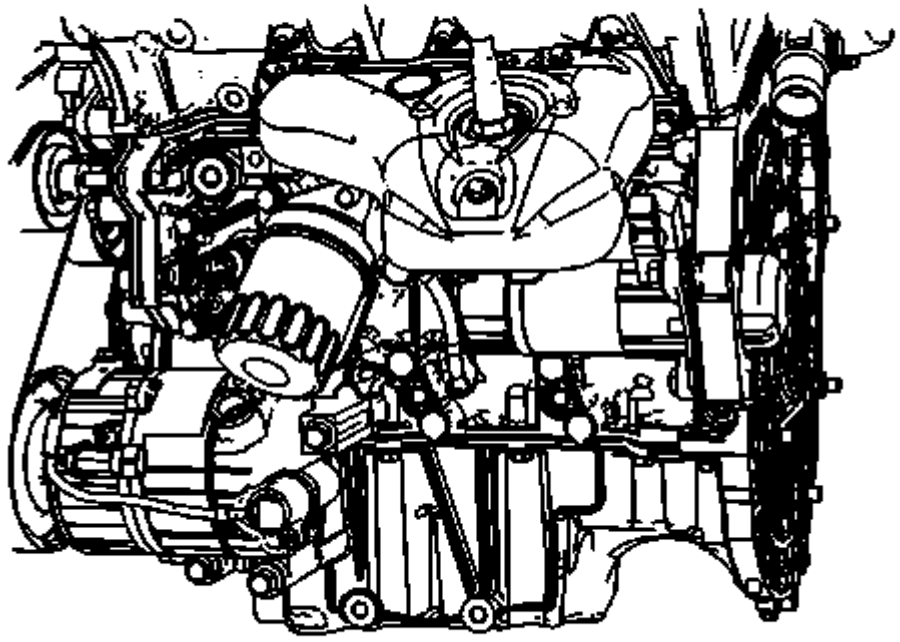

Fig. 274: View of Oil Filter
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Hot Exhaust System Warning .

1. Place the drain pan under the oil filter.
2. Loosen the oil filter. Allow the oil to drain completely.
3. Wrap the oil filter in a disposable towel or rag. Remove the oil filter, keep it upright until it is clear of the vehicle.
4. Thoroughly clean all oil spillage.
5. Lubricate the NEW oil filter gasket with clean engine oil and tighten the oil filter to 25 N.m (18 lb ft).

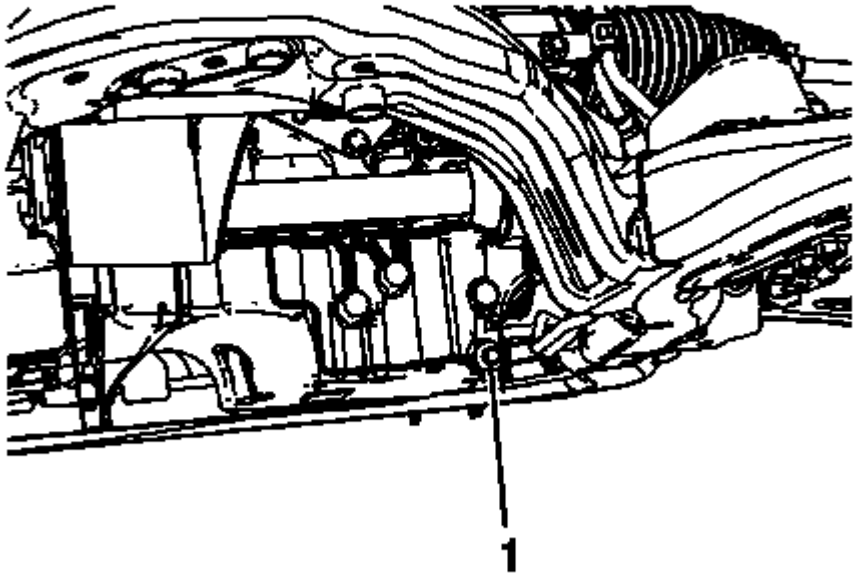

Fig. 275: Locating Oil Drain Plug
Courtesy of GENERAL MOTORS COMPANY

6. Place a drain pan under the oil pan drain plug.
7. Remove the oil pan drain plug (1). Allow the oil to drain completely.

Installation Procedure

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).
2. Clean the oil pan drain plug and oil filter areas from below.
3. Lower the vehicle.

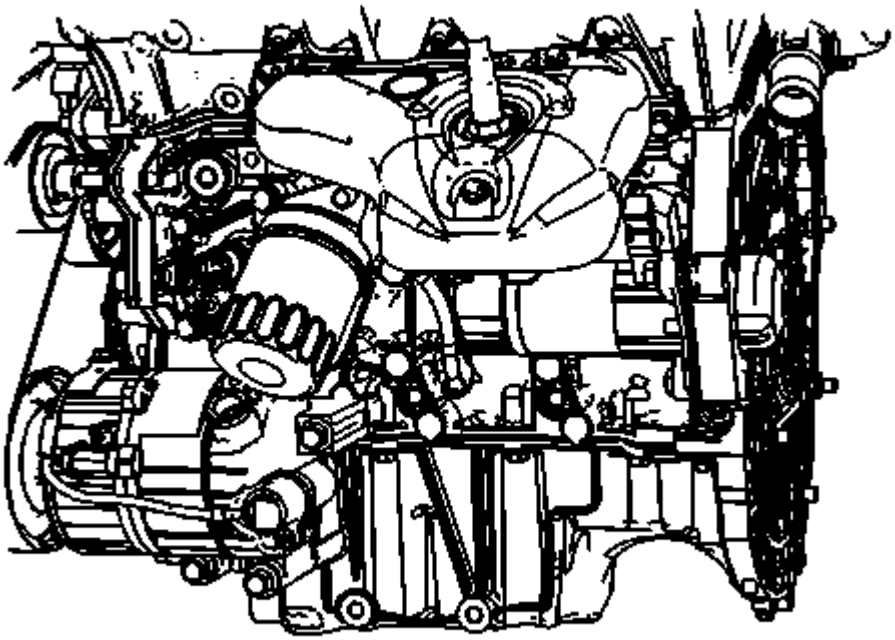

Fig. 276: View of Oil Filter
Courtesy of GENERAL MOTORS COMPANY

4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
5. Start the engine and inspect for leaks.

