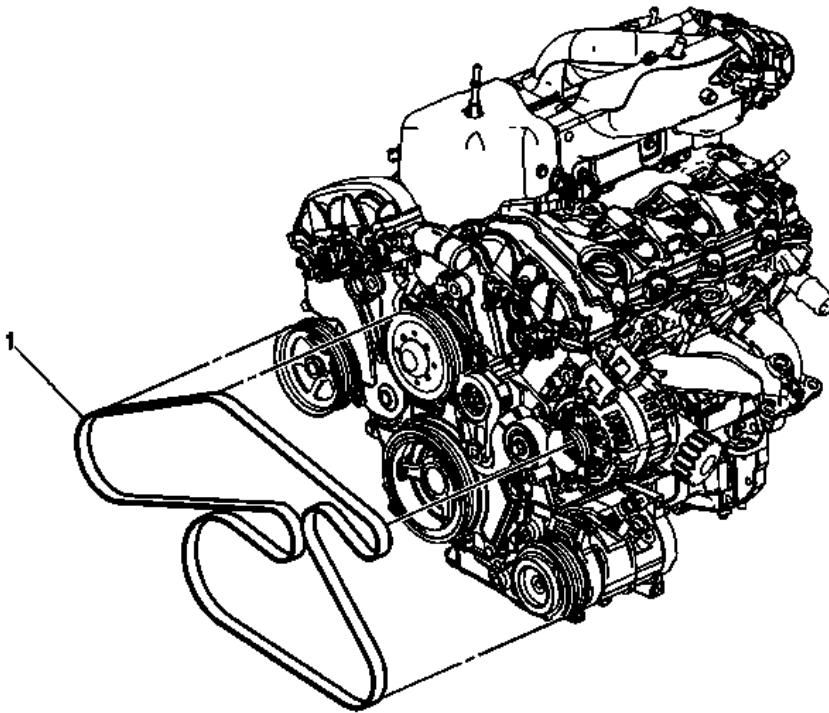


## 2014 ENGINE

## Engine Mechanical - 3.6L (LLT) - Repair Instructions - On Vehicle - Acadia, Enclave And Traverse

## REPAIR INSTRUCTIONS - ON VEHICLE

## DRIVE BELT REPLACEMENT

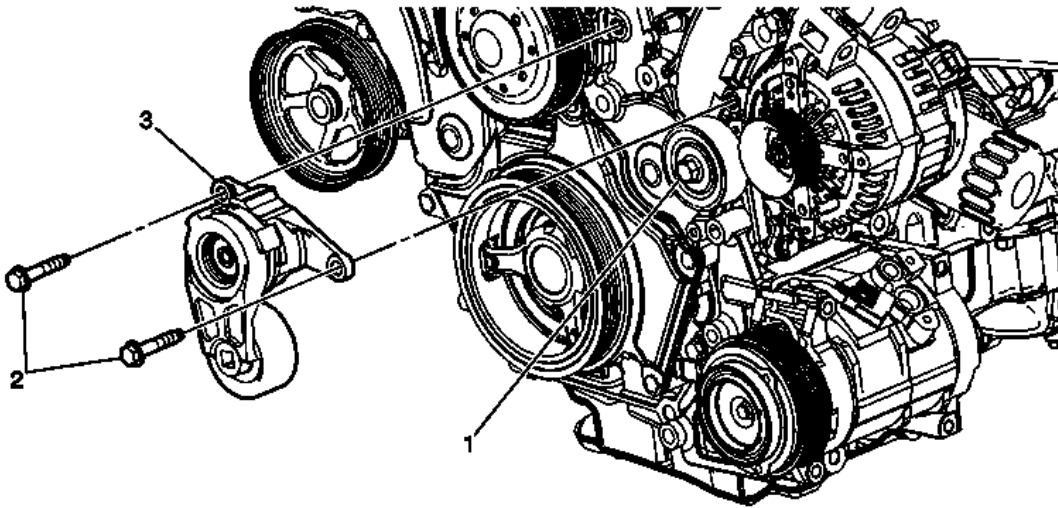


**Fig. 1: Identifying Drive Belt Routing**  
Courtesy of GENERAL MOTORS COMPANY

## Drive Belt Replacement

Callout	Component Name
<b>Preliminary Procedure</b>	
<ol style="list-style-type: none"><li>1. Remove the front wheelhouse liner. Refer to <b><u>Front Wheelhouse Front Liner Replacement (Acadia, Enclave, Traverse)</u></b>.</li><li>2. Rotate the drive belt tensioner clockwise to release the drive belt tension.</li><li>3. Slide the drive belt off of the belt idler pulley.</li><li>4. Slowly release the drive belt tensioner.</li></ol>	
1	Drive Belt

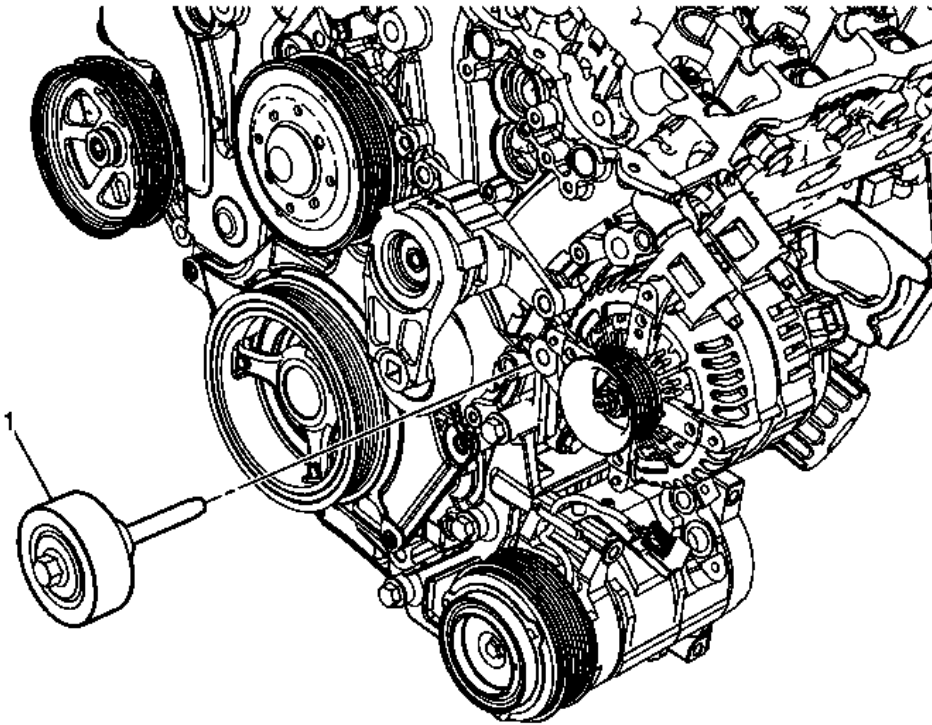
## DRIVE BELT TENSIONER REPLACEMENT



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

### Drive Belt Tensioner Replacement

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

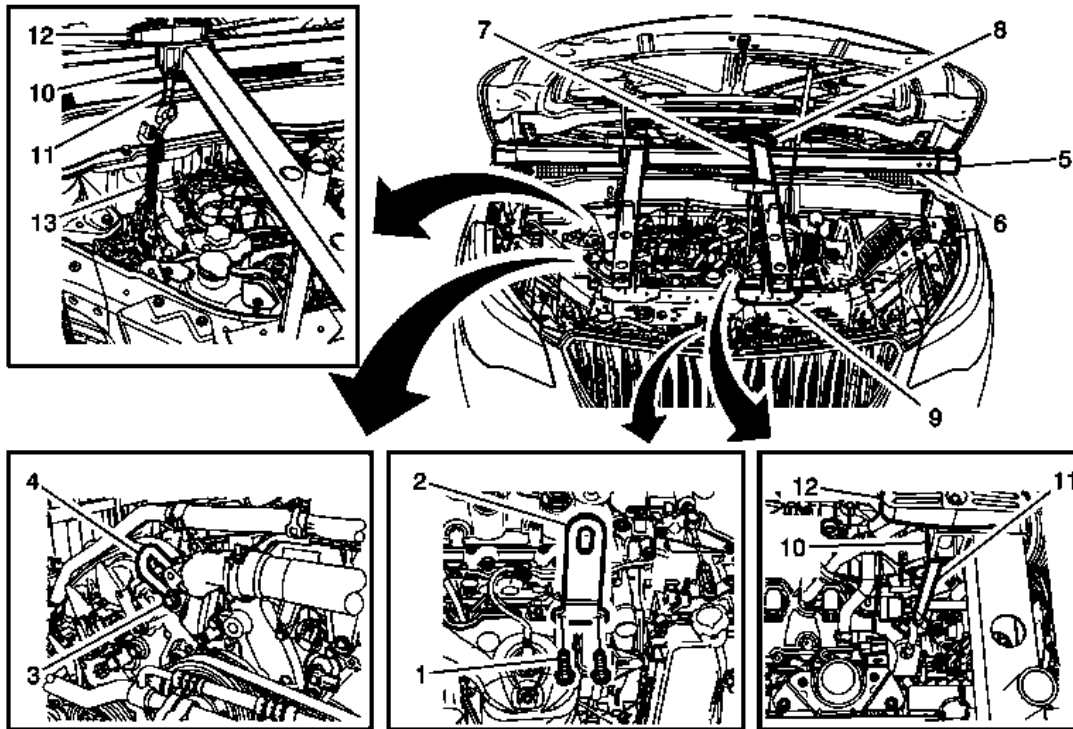
**DRIVE BELT IDLER PULLEY REPLACEMENT****Fig. 3: Identifying Drive Belt Idler Pulley**

Courtesy of GENERAL MOTORS COMPANY

**Drive Belt Idler Pulley Replacement**

Callout	Component Name
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Remove the right engine strut mount. Refer to <u>Engine Mount Strut Replacement - Right Side</u>.</li> <li>2. Remove the right engine mount strut bracket. Refer to <u>Engine Mount Strut Bracket Replacement - Right Side</u>.</li> <li>3. Remove the generator. Refer to <u>Generator Replacement</u>.</li> </ol>	
1	Idler Pulley Bolt  <b>CAUTION:</b> Refer to <u>Fastener Caution</u> .  <b>Tighten</b> 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
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Remove the fuel injector sight shield. Refer to <b>Fuel Injector Sight Shield Replacement</b>.</li> <li>2. Remove the front compartment sight shields. Refer to <b>Front Compartment Front Sight Shield Replacement (Enclave)</b>, <b>Front Compartment Front Sight Shield Replacement (Traverse)</b>, <b>Front Compartment Front Sight Shield Replacement (Acadia)</b>.</li> </ol>	
<b>Special Tools</b>	
<ul style="list-style-type: none"> <li>• EN-46114-1 Engine Lift Bracket</li> <li>• EN-36857 Engine Lift Bracket</li> <li>• EN-28467-301 Engine Support Fixture Adapters</li> <li>• J-284678-518 Main Support Beam</li> <li>• EN-28467-2A Radiator Tube Shelf Assembly</li> <li>• EN-28467-1A Cross Bracket</li> <li>• EN-28467-4A Front Support Assembly</li> <li>• J-28467-6A Bracket Assembly</li> <li>• EN-28467-8A Hook Assembly</li> </ul>	



## 2014 Chevrolet Traverse LTZ

2014 ENGINE Engine Mechanical - 3.6L (LLT) - Repair Instructions - On Vehicle - Acadia, Enclave And Traverse

- **EN-28467-34** Lift Hook Wing Nut and Washer

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

1	Exhaust Manifold Bolt (Qty:2)
2	<b>EN-46114-1</b> Engine Lift Bracket <b>Procedure</b> 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	<b>EN-36857</b> Engine Lift Bracket <b>Procedure</b> Install engine lift bracket as shown and use timing cover bolt to retain.
5	<b>EN-28467-301</b> Engine Support Fixture Adapters (Qty:2)  <b>NOTE:</b> <b>The rubber pads need to be removed to allow adapters to seat on fender rail.</b>
6	<b>J-284678-518</b> Main Support Beam <b>Procedure</b> Install main support beam through engine support fixture adapters.
7	<b>EN-28467-2A</b> Radiator Tube Shelf Assembly (Qty: 2) <b>Procedure</b> Place radiator shelf tube on top of main support beam.
8	<b>EN-28467-1A</b> Cross Bracket (Qty: 2) <b>Procedure</b> Tighten cross bracket to retain radiator tube shelf tube to main support beam.
9	<b>EN-28467-4A</b> Front Support Assembly (Qty: 2) <b>Procedure</b> Place front support assembly through radiator tube shelf and pin at proper height.
10	<b>J-28467-6A</b> Bracket Assembly (Qty: 2)
11	<b>EN-28467-8A</b> Hook Assembly (Qty: 2)
12	<b>EN-28467-34</b> Lift Hook Wing Nut and Washer (Qty: 2)
13	Hook and Chain  <b>NOTE:</b> <b>Chain is used to provide extra length.</b>

### ENGINE MOUNT INSPECTION

1. Install the engine support fixture. Refer to **Engine Support Fixture**.

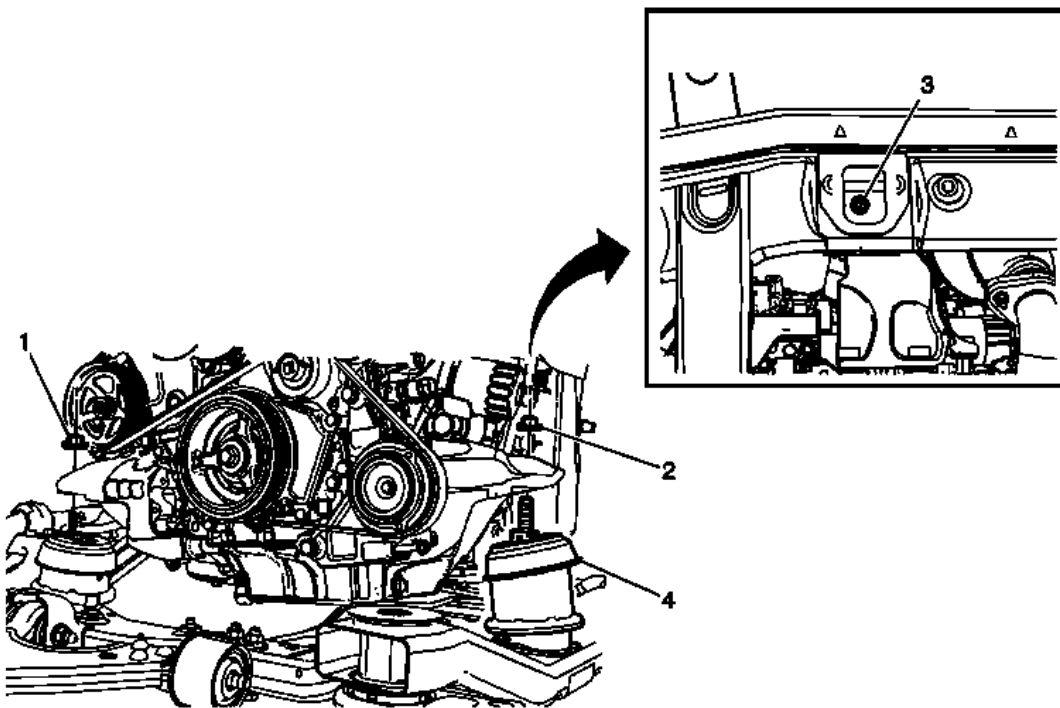
**IMPORTANT:** Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

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

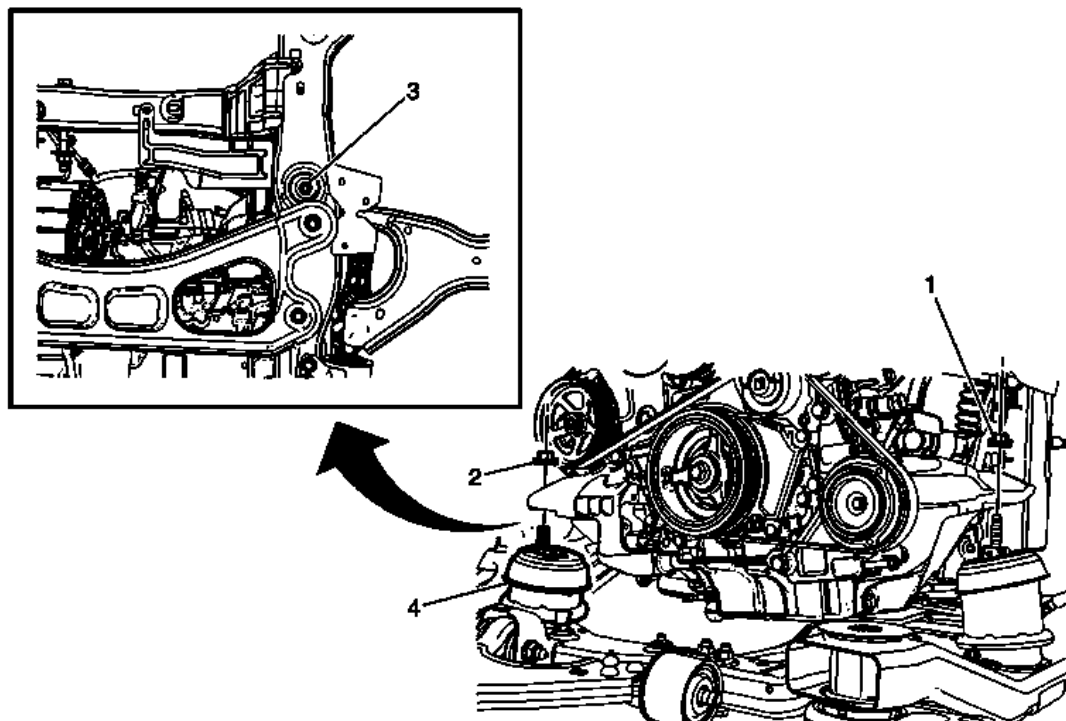
### Engine Front Mount Replacement

Callout	Component Name
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Support the engine. Refer to <b><u>Engine Support Fixture</u></b>.</li> <li>2. Raise and support the vehicle. Refer to <b><u>Lifting and Jacking the Vehicle</u></b> .</li> </ol>	
	Rear Upper Engine Mount Nut
	<b>CAUTION:</b>

1	<p>Refer to <b><u>Fastener Caution</u></b></p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the rear engine mount nut.</li> <li>2. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>• The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</li> <li>• Use engine support fixture to raise engine.</li> </ul> <p><b>Tighten</b> 60 N.m (44 lb ft)</p>
2	<p>Front Upper Engine Mount Nut</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the front engine mount nut.</li> <li>2. Disconnect the active engine mount vacuum line, if equipped.</li> <li>3. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>• The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</li> <li>• Use engine support fixture to raise engine.</li> </ul> <p><b>Tighten</b> 90 N.m (66 lb ft)</p>
3	<p>Front Lower Engine Mount Nut</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the lower front engine mount nut.</li> <li>2. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>TIP:</b> The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</p>

	<b>Tighten</b> 75 N.m (55 lb ft)
4	Engine Mount

## ENGINE REAR MOUNT REPLACEMENT



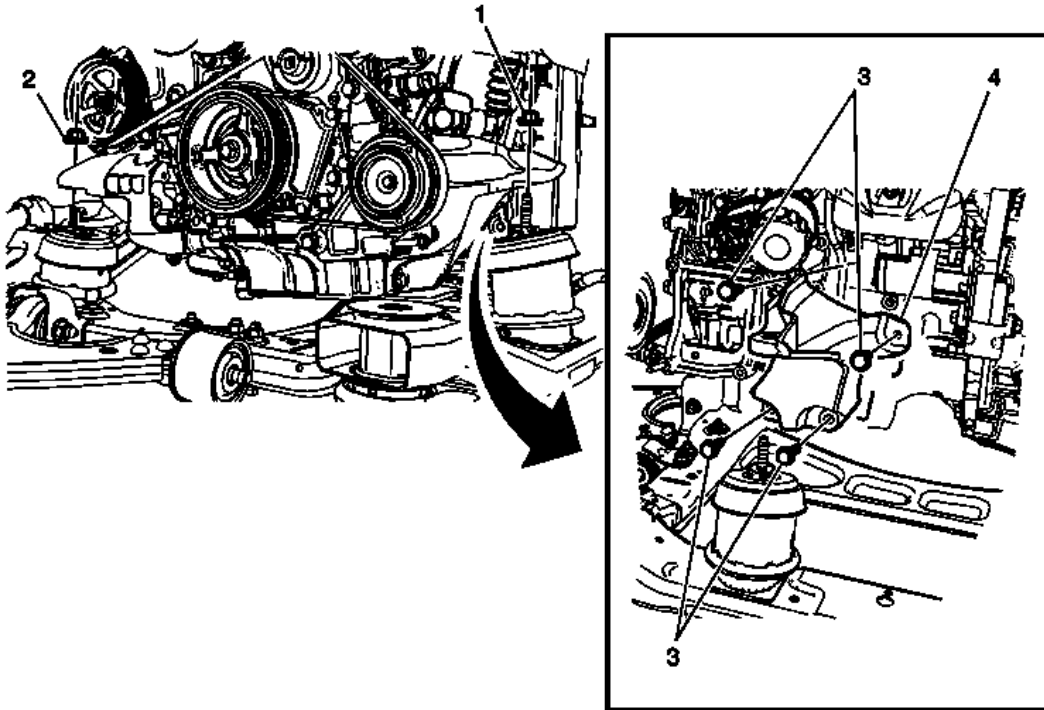
**Fig. 6: Identifying Engine Rear Mount Assembly Components**  
Courtesy of GENERAL MOTORS COMPANY

### Engine Rear Mount Replacement

Callout	Component Name
<b>Preliminary Procedures</b> <ol style="list-style-type: none"> <li>1. Support the engine. Refer to <u>Engine Support Fixture</u>.</li> <li>2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u>.</li> </ol> <p><b>NOTE:</b> The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</p>	
	Front Upper Engine Mount Nut  <b>CAUTION:</b> Refer to <u>Fastener Caution</u>

1	<p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the engine mount nut.</li> <li>2. Disconnect the active engine mount vacuum line, if equipped.</li> <li>3. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>Tighten</b> 90 N.m (66 lb ft)</p>
2	<p>Rear Upper Engine Mount Nut</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the engine mount nut.</li> <li>2. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>Tighten</b> 60 N.m (44 lb ft)</p>
3	<p>Rear Lower Engine Mount Nut</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard the engine mount nut.</li> <li>2. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .</li> </ol> <p><b>Tighten</b> 75 N.m (55 lb ft)</p>
4	<p>Engine Mount</p> <p><b>NOTE:</b> To remove the engine mount, use the engine support fixture to raise engine.</p>

## ENGINE FRONT MOUNT BRACKET REPLACEMENT



**Fig. 7: Identifying Engine Front Mount Assembly Components**  
Courtesy of GENERAL MOTORS COMPANY

### Engine Front Mount Bracket Replacement

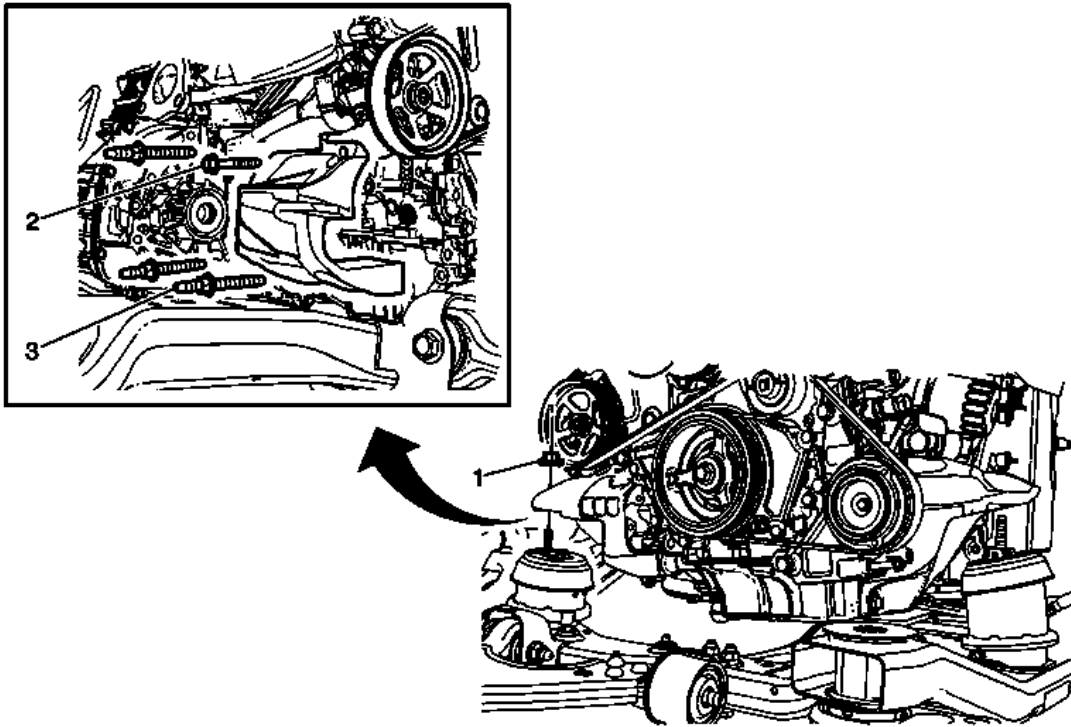
Callout	Component Name
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Remove the left side catalytic converter. Refer to <u>Catalytic Converter Replacement - Left Side</u></li> <li>2. Support the engine. Refer to <u>Engine Support Fixture</u>.</li> </ol>	
	<p>Front Engine Mount Upper Nut</p> <p><b>CAUTION:</b> Refer to <u>Fastener Caution</u></p> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Remove and discard front engine mount upper nut.</li> <li>2. Apply threadlocker to the engine mount threads. Refer to <u>Adhesives, Fluids, Lubricants and Sealers</u>.</li> </ol> <p><b>NOTE:</b></p> <ul style="list-style-type: none"> <li>• The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</li> <li>• Use engine support fixture to raise engine.</li> </ul>

## 2014 Chevrolet Traverse LTZ

2014 ENGINE Engine Mechanical - 3.6L (LLT) - Repair Instructions - On Vehicle - Acadia, Enclave And Traverse

	<b>Tighten</b> 90 N.m (66 lb ft)
2	<p>Rear Engine Mount Upper Nut</p> <p><b>Procedure</b></p> <ol style="list-style-type: none"><li>1. Remove and discard rear engine mount upper nut.</li><li>2. Apply threadlocker to the engine mount threads.</li></ol> <p><b>NOTE:</b></p> <ul style="list-style-type: none"><li>• The engine mount nuts must be replaced once removed. Allow adhesive on new engine mounts nuts to cure for 24 hours after replacement.</li><li>• Use engine support fixture to raise engine.</li></ul> <p><b>Tighten</b> 60 N.m (44 lb ft)</p>
3	<p>Front Engine Mount Bracket Bolt</p> <p><b>Tighten</b> 58 N.m (43 lb ft)</p>
4	<p>Front Engine Mount Bracket</p> <p><b>NOTE:</b> To remove engine mount bracket, use engine support fixture to raise engine.</p>

### ENGINE REAR MOUNT BRACKET REPLACEMENT (FRONT WHEEL DRIVE)



**Fig. 8: Identifying Engine Rear Mount Bracket**  
 Courtesy of GENERAL MOTORS COMPANY

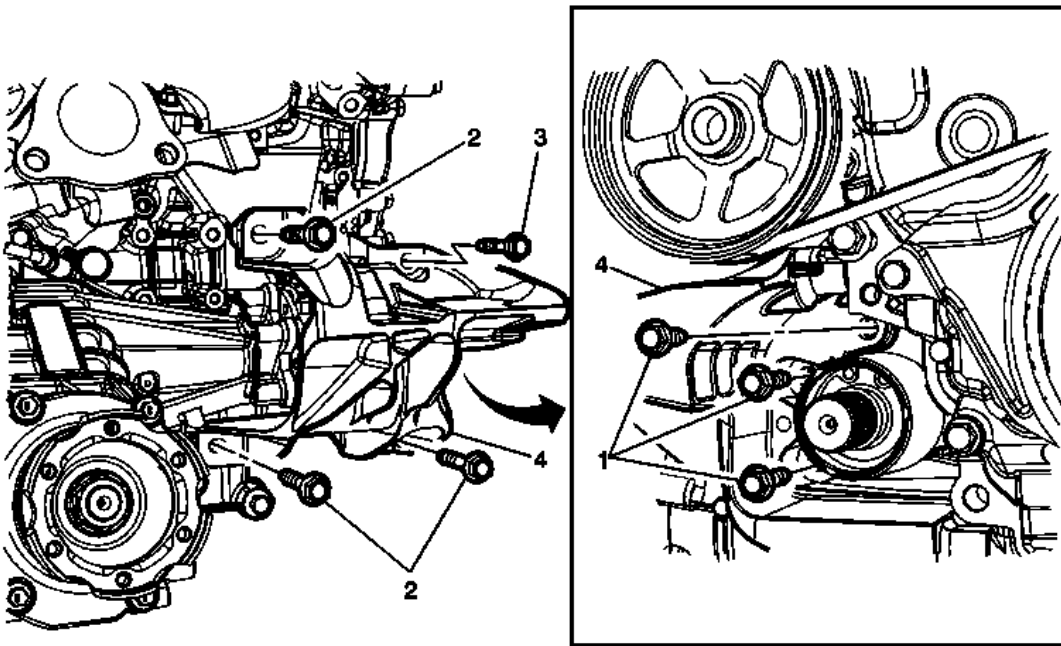
### Engine Rear Mount Bracket Replacement (Front Wheel Drive)

Callout	Component Name
<b>Preliminary Procedures</b>	
1. If equipped with FWD, remove the intermediate drive shaft. Refer to <b><u>Front Wheel Drive Intermediate Shaft Replacement</u></b> . 2. Support the engine. Refer to <b><u>Engine Support Fixture</u></b> . 3. Remove the exhaust flexible pipe. Refer to <b><u>Exhaust Flexible Pipe Replacement</u></b> .	
1	Rear Engine Mount Upper Nut  <b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b>  <b>Procedure</b>  1. Remove and discard engine mount nut. 2. Apply threadlocker to the engine mount threads. Refer to <b><u>Adhesives, Fluids, Lubricants and Sealers</u></b> .  <b>NOTE:</b> <ul style="list-style-type: none"> <li>• The engine mount nuts must be replaced once removed. Allow adhesive on new</li> </ul>



	<p>engine mounts nuts to cure for 24 hours after replacement.</p> <ul style="list-style-type: none"> <li>• Use engine support fixture to raise engine.</li> </ul> <p><b>Tighten</b> 60 N.m (44 lb ft)</p>
2	<p>Rear Engine Mount Bracket Bolt</p> <p><b>Tighten</b> 22 N.m (16 lb ft)</p>
3	<p>Rear Engine Mount Bracket Bolt</p> <p><b>Tighten</b> 58 N.m (43 lb ft)</p>

## ENGINE REAR MOUNT BRACKET REPLACEMENT (ALL WHEEL DRIVE)



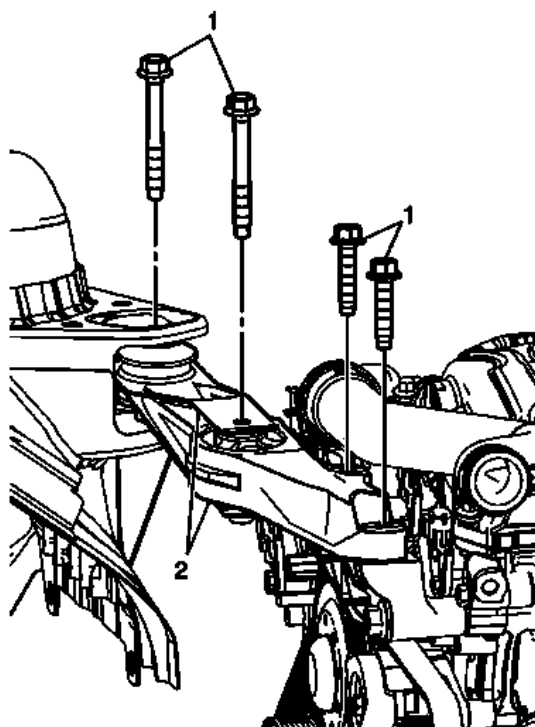
**Fig. 9: Mount Bracket (All Wheel Drive)**  
Courtesy of GENERAL MOTORS COMPANY

### Engine Rear Mount Bracket Replacement (All Wheel Drive)

Callout	Component Name
<b>Preliminary Procedures</b>	
1.	Remove the right front drive axle. Refer to <b>Front Wheel Drive Shaft Replacement</b> .
2.	Remove the rear engine mount. Refer to <b>Engine Rear Mount Replacement</b> .

1	<p>Engine Mount Bracket to Transfer Case Retainer (Qty: 3)</p> <p><b>CAUTION:</b> Refer to <u>Fastener Caution</u> .</p> <p><b>Tighten</b> 22 N.m (16 lb ft)</p>
2	<p>Engine Mount Bracket to Engine Block (Qty: 3)</p> <p><b>Tighten</b> 58 N.m (43 lb ft)</p>
3	<p>Engine Mount Bracket to Engine Block</p> <p><b>Tighten</b> 22 N.m (16 lb ft)</p>
4	Engine Mount Bracket

## ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE



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

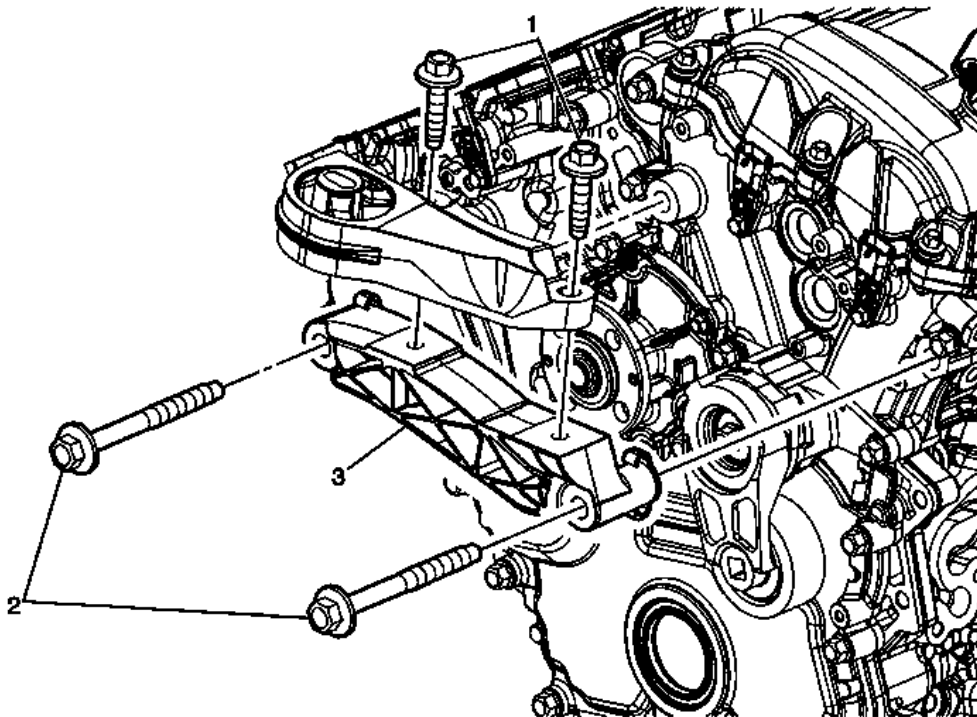
### Engine Mount Strut Replacement - Right Side

Callout	Component Name
<b>Preliminary Procedure</b>	

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	<p>Engine Mount Strut Bolt</p> <p><b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b> .</p> <p><b>Tighten</b> 58 N.m (43 lb ft)</p>
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

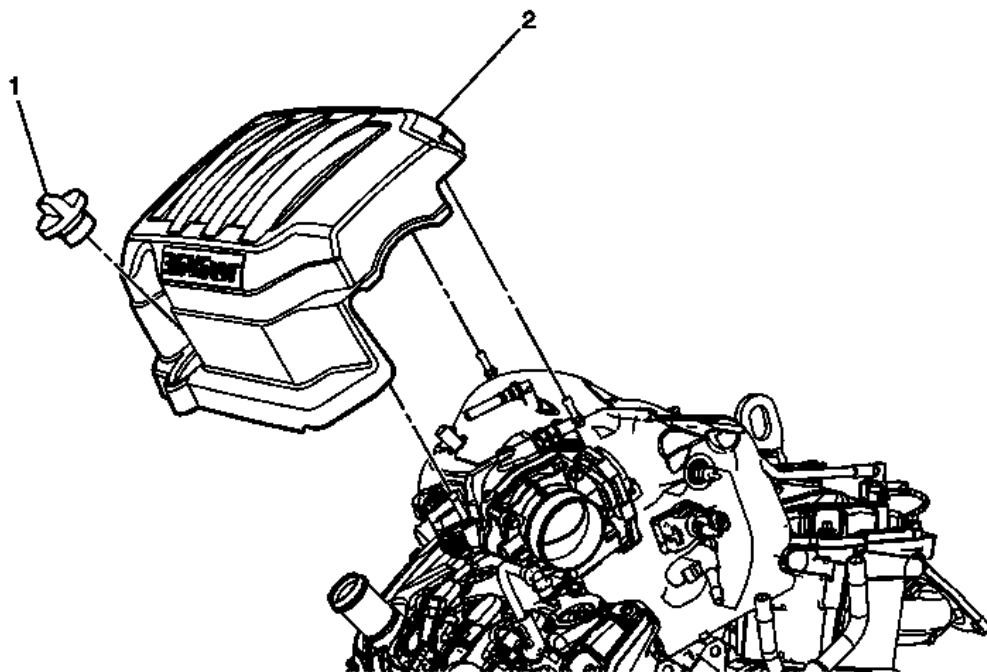
#### Engine Mount Strut Bracket Replacement - Right Side

Callout	Component Name
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**Preliminary Procedure**

Remove the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side.**

1	Engine Mount Strut Bolt  <b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b>  <b>Tighten</b> 58 N.m (43 lb ft)
2	Engine Mount Strut Bracket Bolt <b>Tighten</b> 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

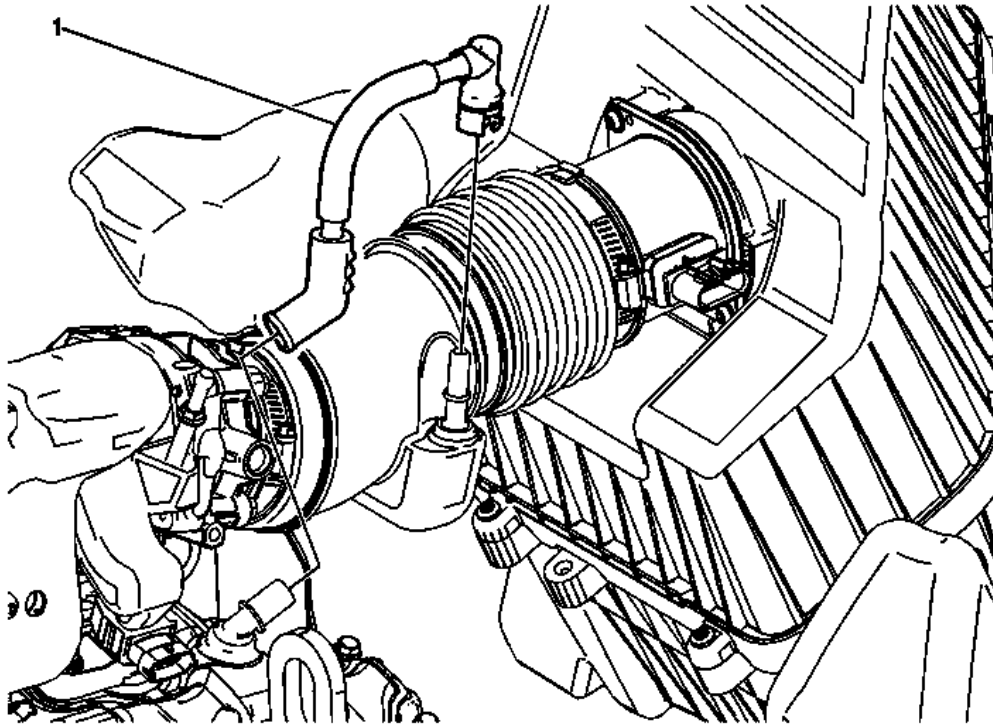
**Fuel Injector Sight Shield Replacement**

Callout	Component Name
1	Oil Fill Cap
	Fuel Injector Sight Shield

2

**Procedure**

Lift upward to remove sight shield from ballstuds.

**POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT**

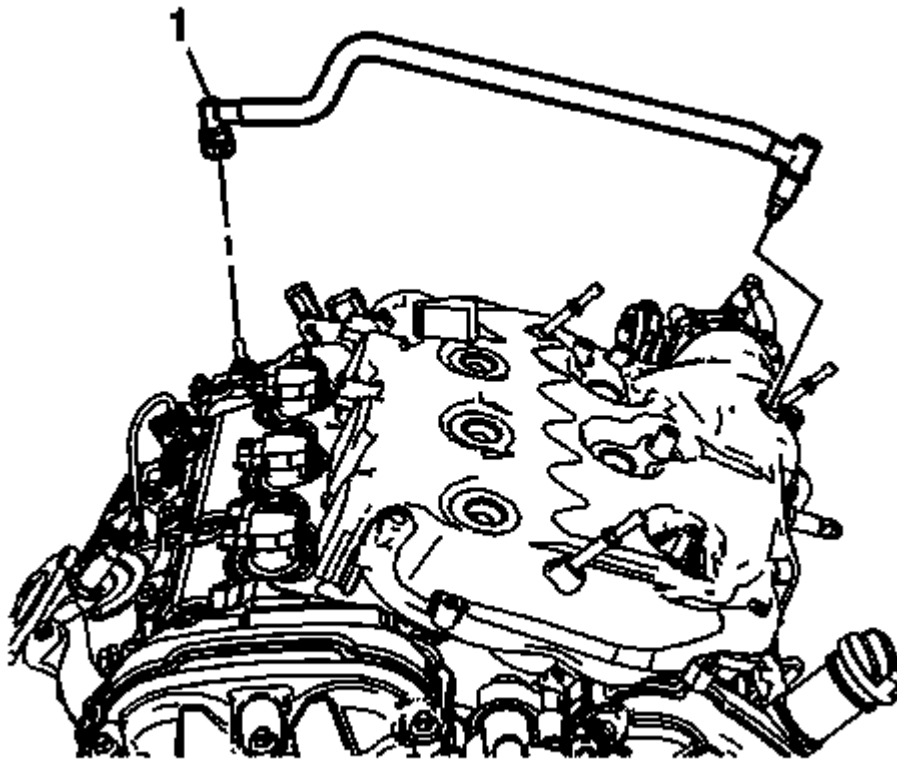
**Fig. 13: Identifying Front Positive Crankcase Ventilation Tube**  
Courtesy of GENERAL MOTORS COMPANY

**Positive Crankcase Ventilation Tube Replacement - Front**

Callout	Component Name
<b>Preliminary Procedure</b> Remove the fuel injector sight shield. Refer to <b><u>Fuel Injector Sight Shield Replacement</u></b> .	
1	Positive Crankcase Ventilation Tube <b>Procedure</b> Disconnect the PCV tube quick disconnect. Refer to <b><u>Plastic Collar Quick Connect Fitting Service</u></b> .  <b>NOTE:</b> <b>DISCARD</b> the PCV tube and install a <b>NEW</b> PCV tube.

**POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - REAR****Removal Procedure**

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

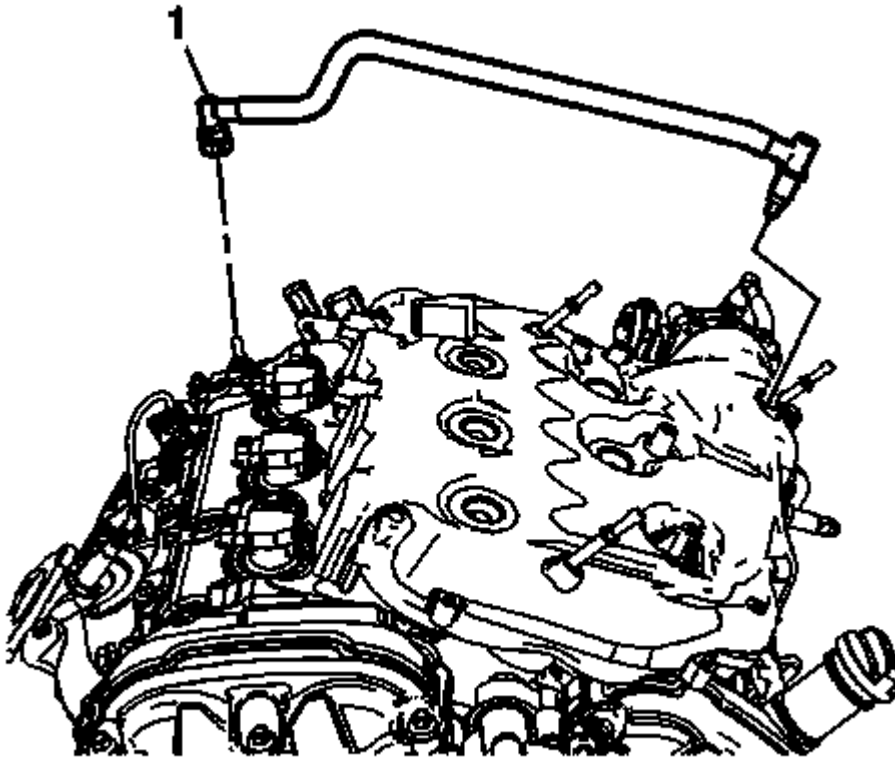


**Fig. 14: View Of Rear Positive Crankcase Ventilation Tube**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Connect the PCV air pipe (1) to the camshaft cover valve.



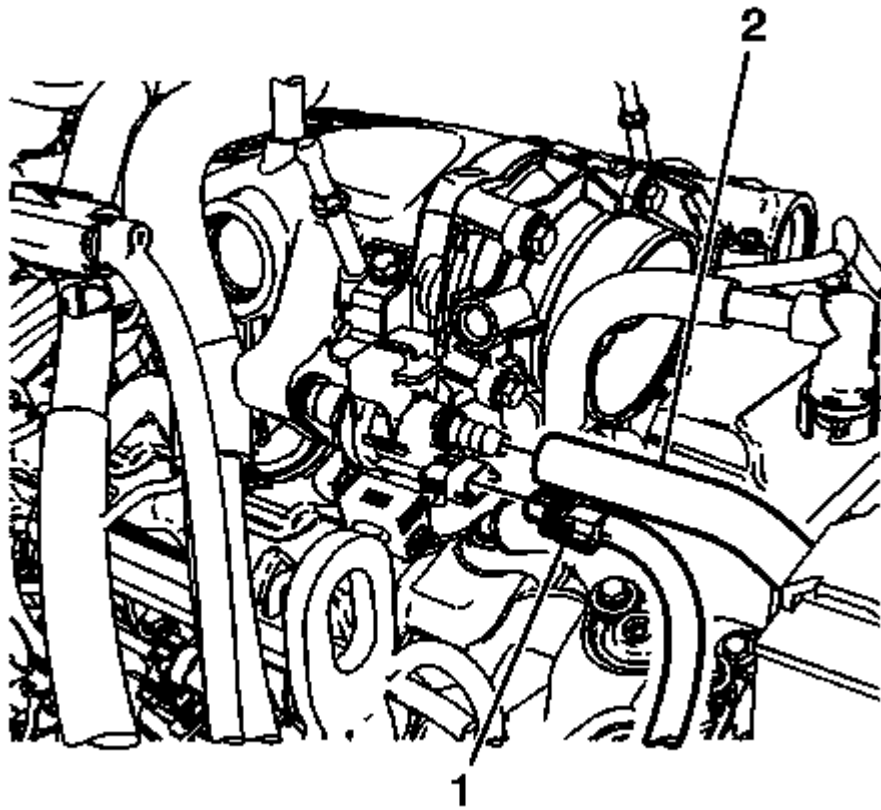
**Fig. 15: View Of Rear Positive Crankcase Ventilation Tube**  
Courtesy of GENERAL MOTORS COMPANY

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**

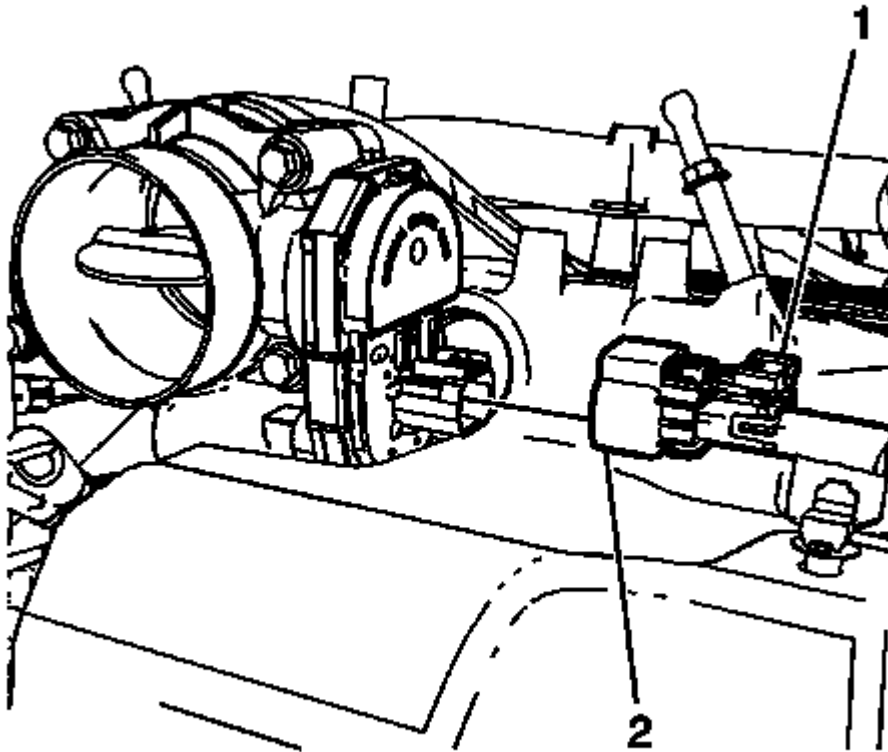
1. Turn the ignition OFF.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
4. Disconnect the brake booster vacuum hose from the intake manifold.
5. Remove the rear positive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



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

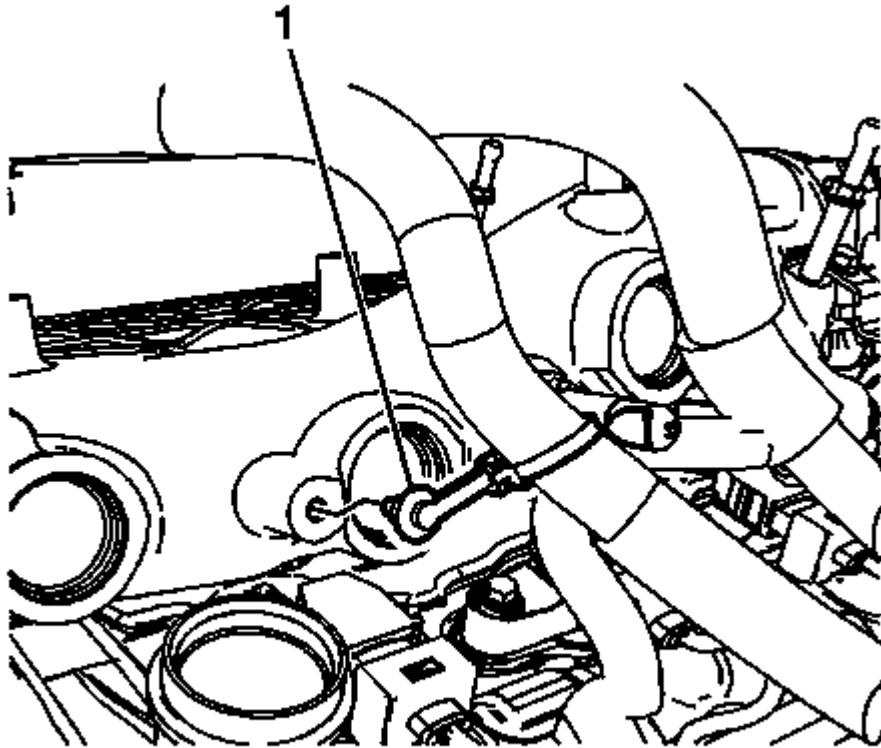
7. Disconnect the purge line (2) from the purge solenoid valve.
8. Remove the electrical connector retainer (1).





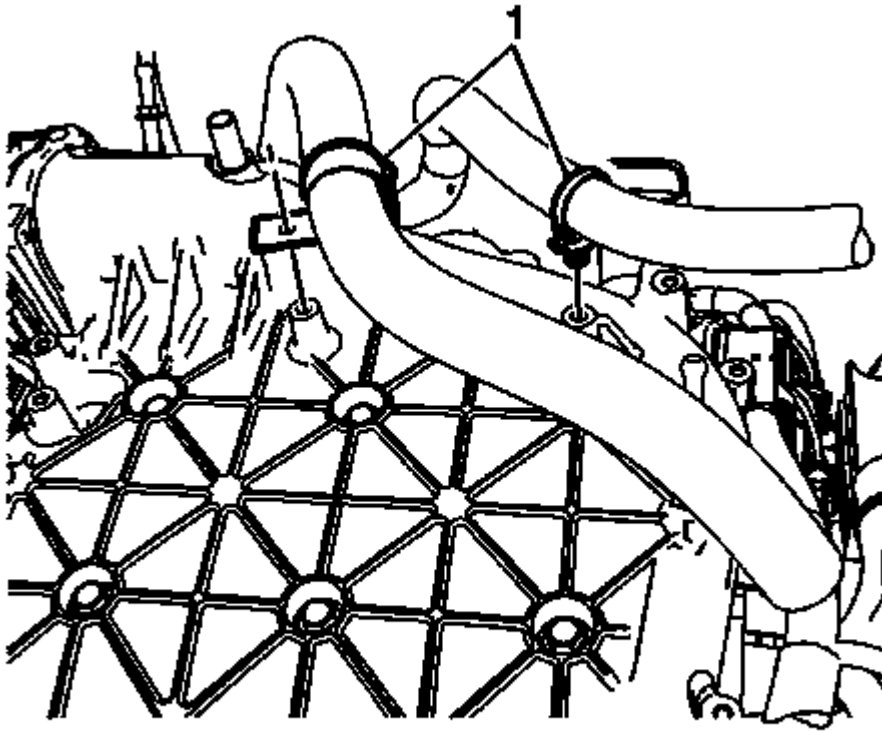
**Fig. 17: Identifying Purge Solenoid Valve Electrical Connector Retainer**  
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the throttle body electrical connector (2).
10. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .
11. Remove the engine wiring harness retaining clip (1) from the side of the intake manifold.



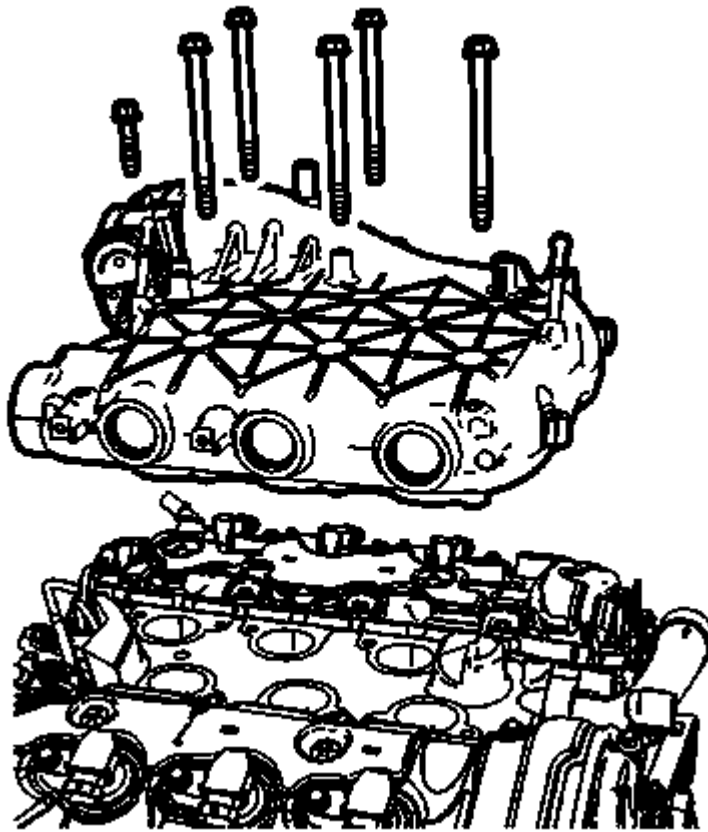
**Fig. 18: Identifying Intake Manifold Wiring Harness Retaining Clip**  
Courtesy of GENERAL MOTORS COMPANY

12. Remove the wiring harness retaining bolt.



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

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

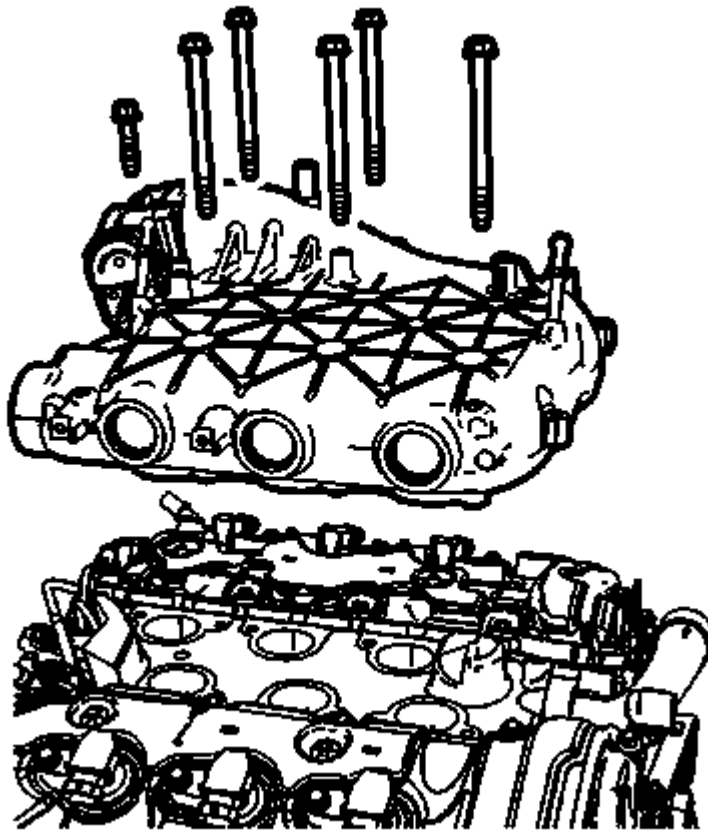


**Fig. 20: View Of Intake Manifold & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. If the intake manifold is being replaced, assemble the intake manifold. Refer to **Intake Manifold Assemble** .



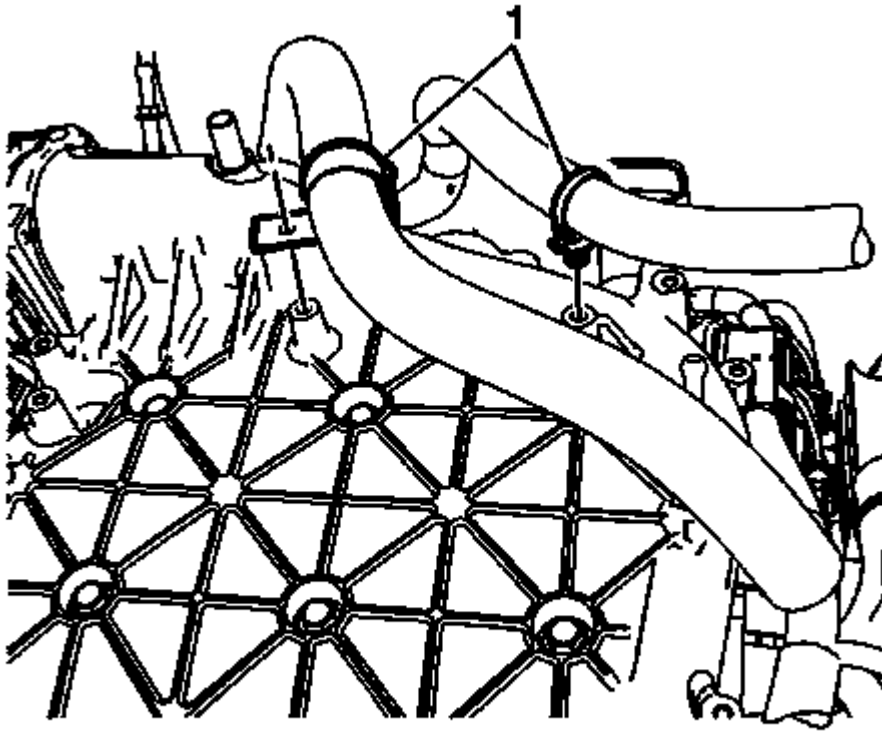
**Fig. 21: View Of Intake Manifold & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW intake manifold gasket.
3. Install the intake manifold.
4. Install the intake manifold bolts and tighten to 25 N.m (18 lb ft).

**CAUTION:** Refer to Fastener Caution

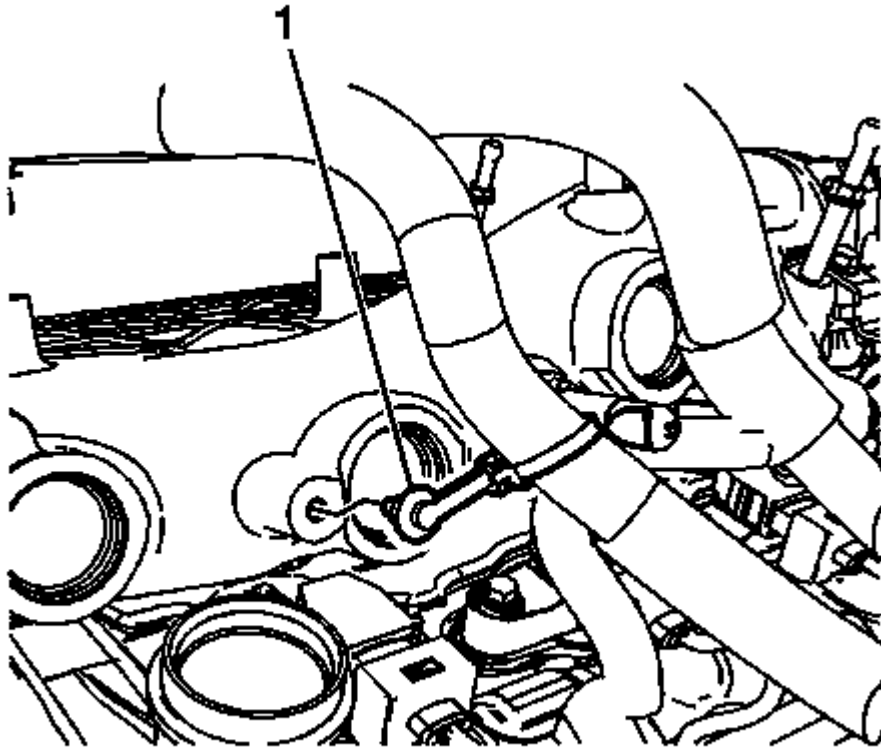
**NOTE:** Tighten the intake manifold bolts in an X pattern starting with the inside bolts and moving outward..

5. Position the engine wiring harness in place.



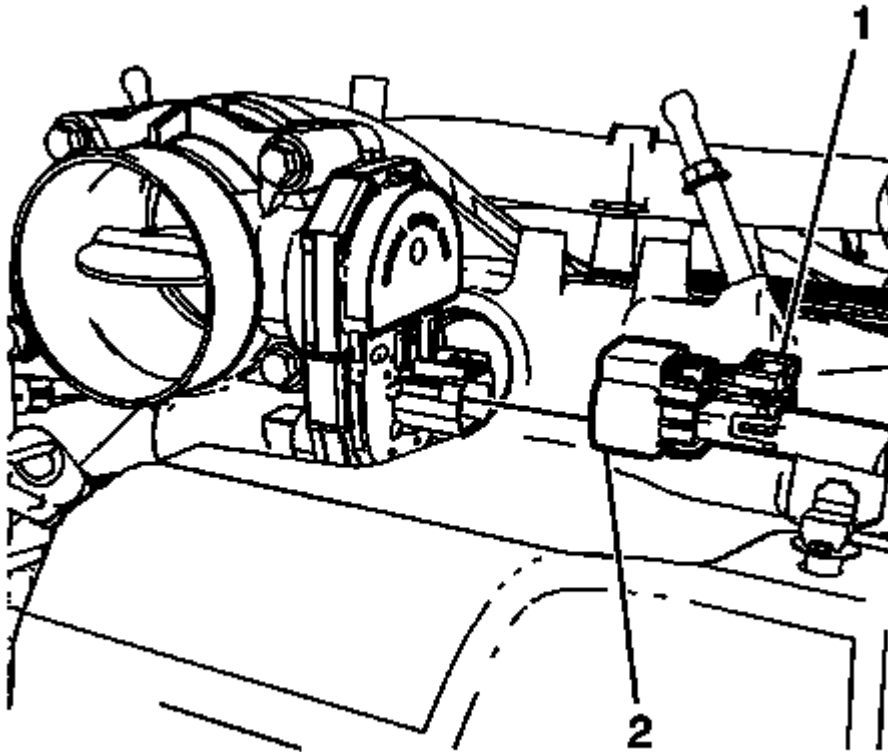
**Fig. 22: View Of Wiring Harness Retaining Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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



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

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



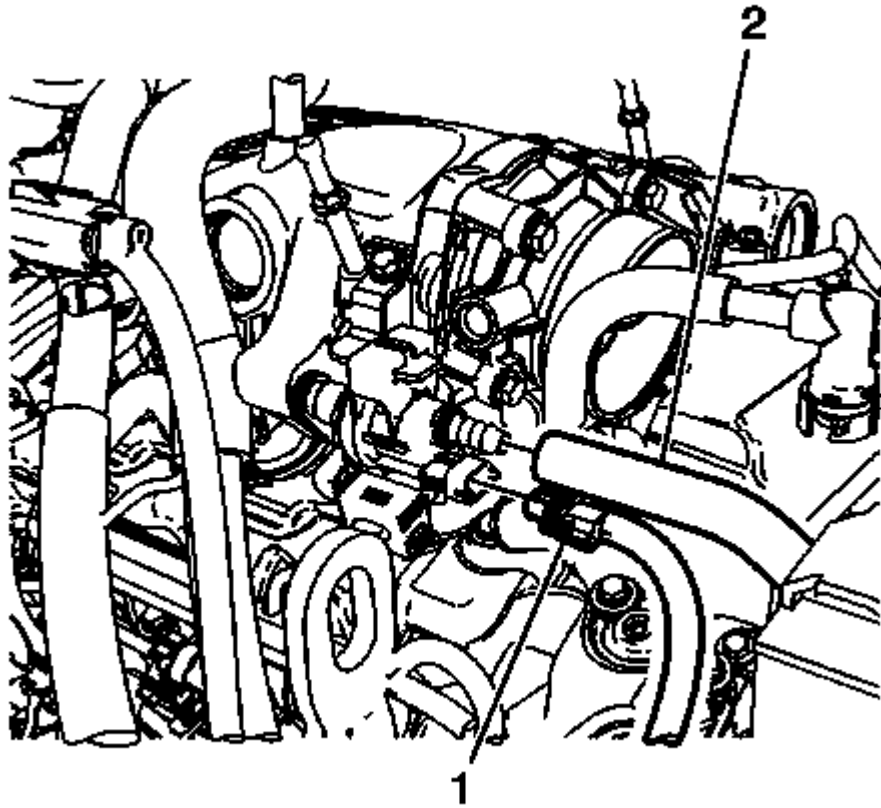
**Fig. 24: Identifying Purge Solenoid Valve Electrical Connector Retainer**  
 Courtesy of GENERAL MOTORS COMPANY

9. Connect the electrical connector (2) to the throttle body.

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

10. Install the electrical connector retainer (1).
11. Connect the purge line (2) to the purge solenoid valve.





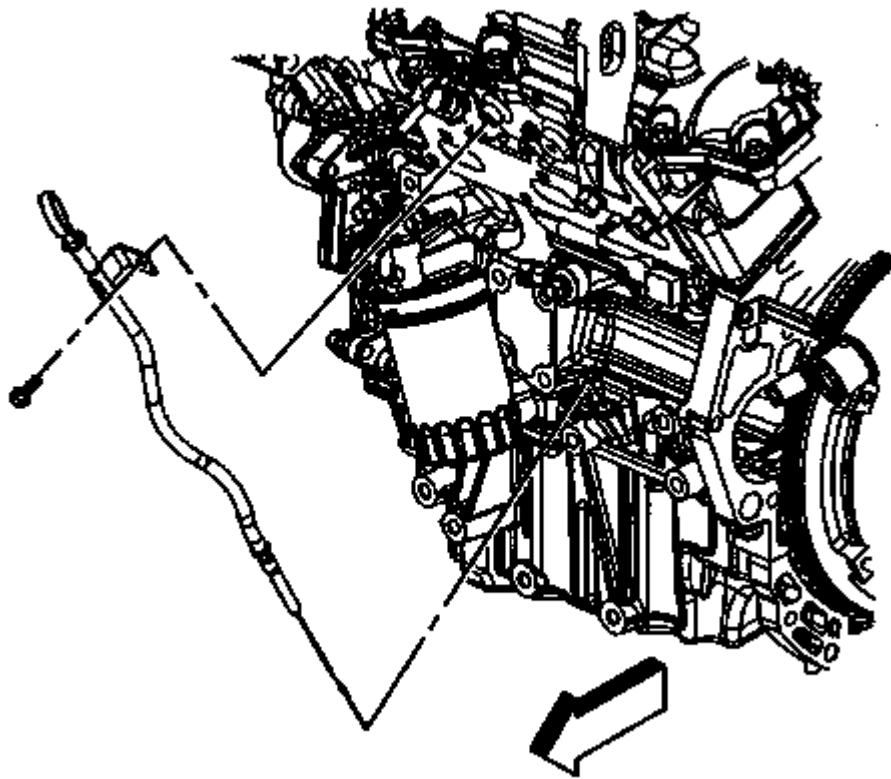
**Fig. 25: Identifying Purge Solenoid Valve Electrical Connector**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Remove the Fuel Injector Sight Shield. Refer to **Fuel Injector Sight Shield Replacement**

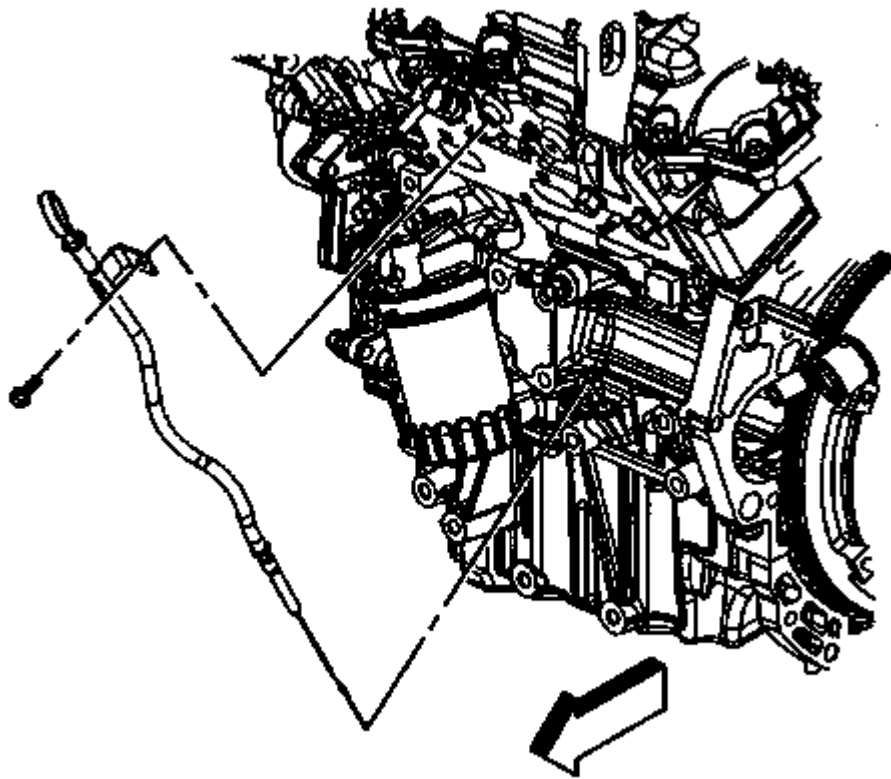


**Fig. 26: Identifying Oil Level Indicator Tube & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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**

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



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

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

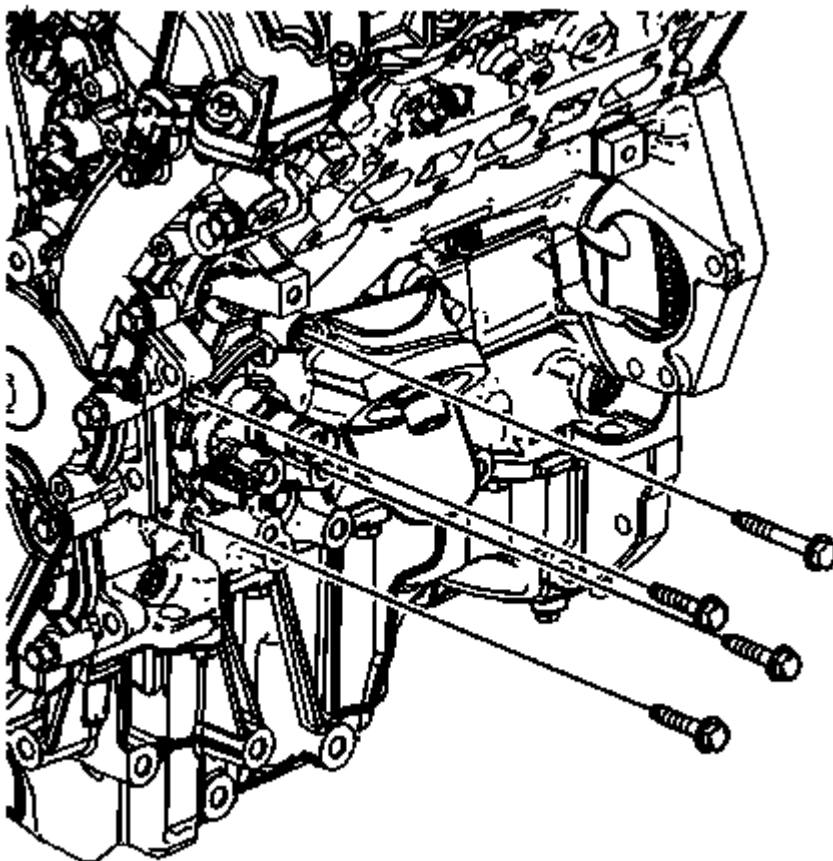
**CAUTION: Refer to Fastener Caution .**

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**

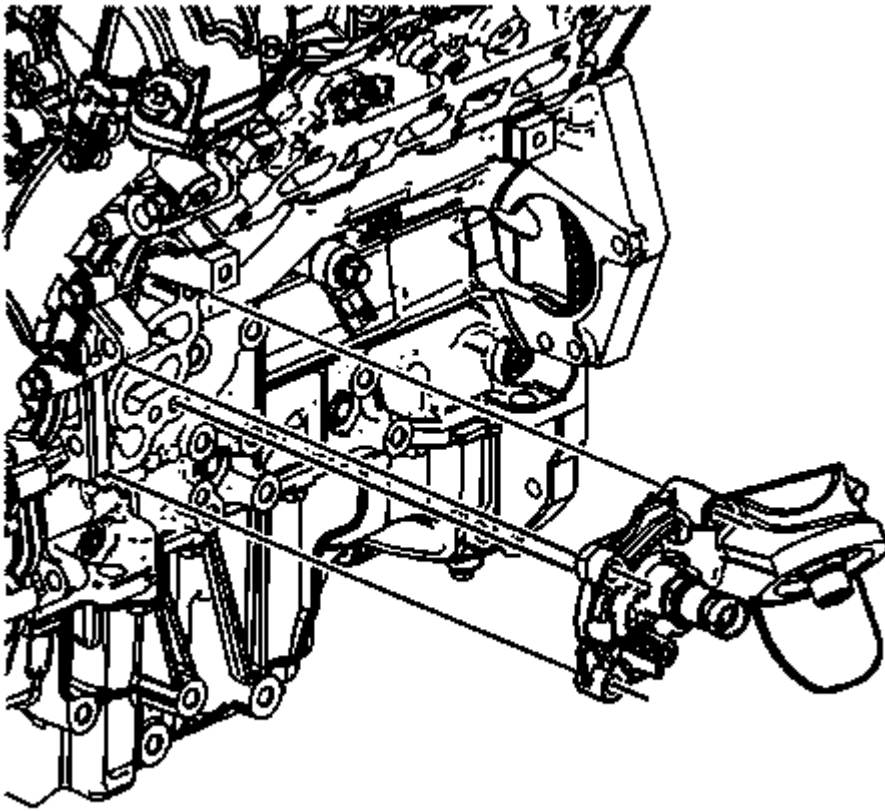
### **Removal Procedure**

1. Remove the generator. Refer to **Generator Replacement** .



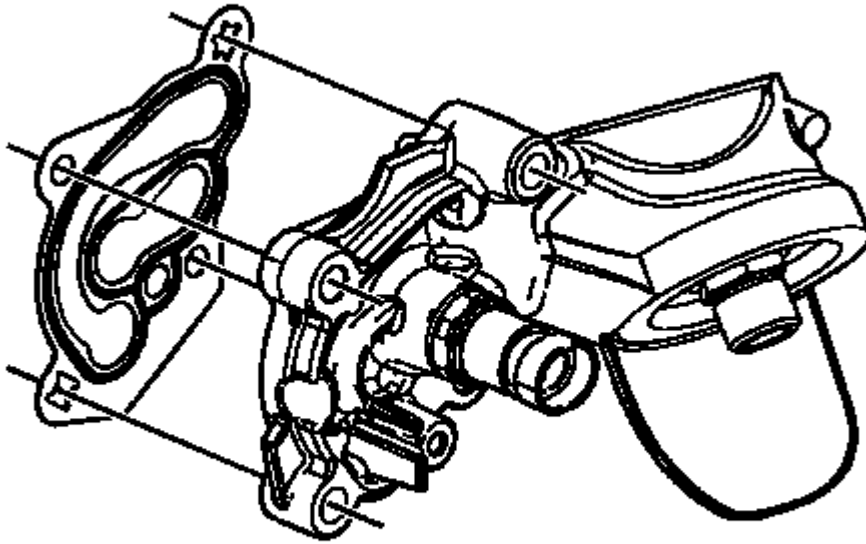
**Fig. 28: Locating Oil Filter Adapter Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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.
5. Remove the oil filter adapter.



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

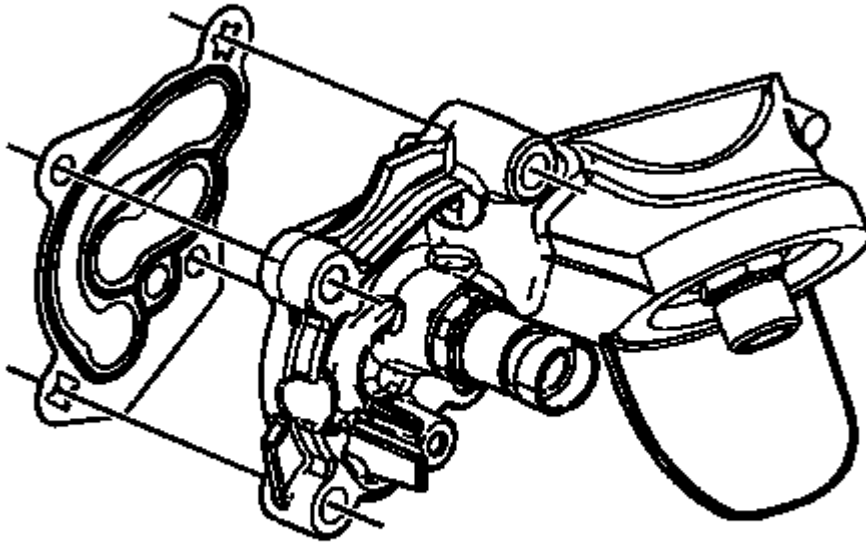
6. Remove and discard the oil filter adapter gasket.



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

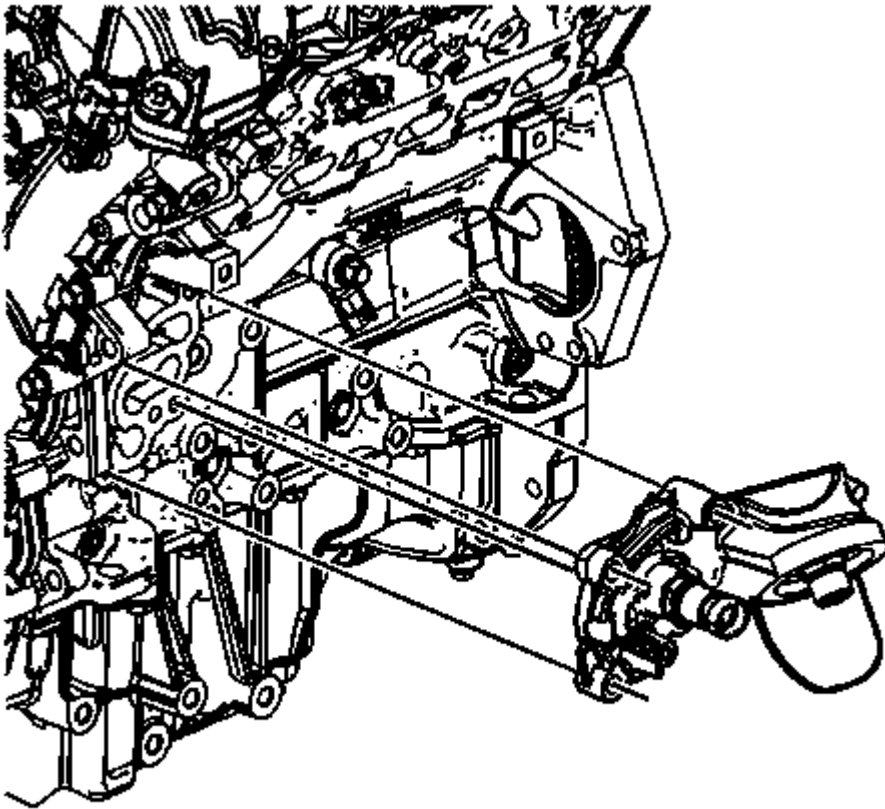
**Installation Procedure**

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



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

2. Place the oil filter adapter into position.

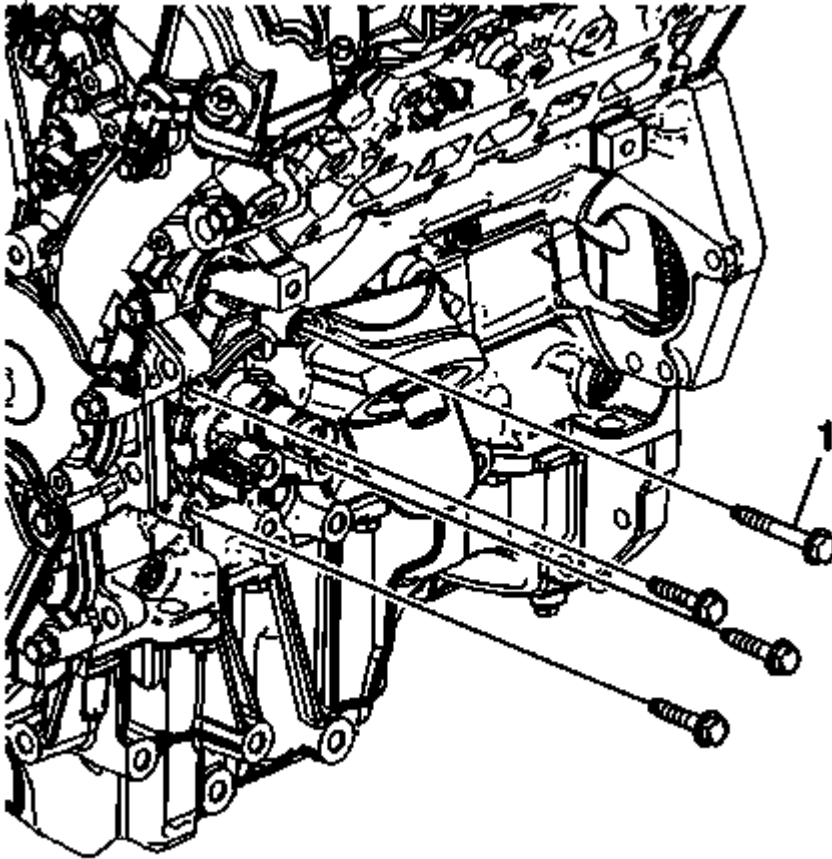


**Fig. 32: Identifying Oil Filter Adapter**

Courtesy of GENERAL MOTORS COMPANY

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).





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

**CAUTION:** Refer to Fastener Caution .

4. Install a NEW oil filter. Refer to Engine Oil and Oil Filter Replacement.
5. Install the generator. Refer to Generator Replacement .

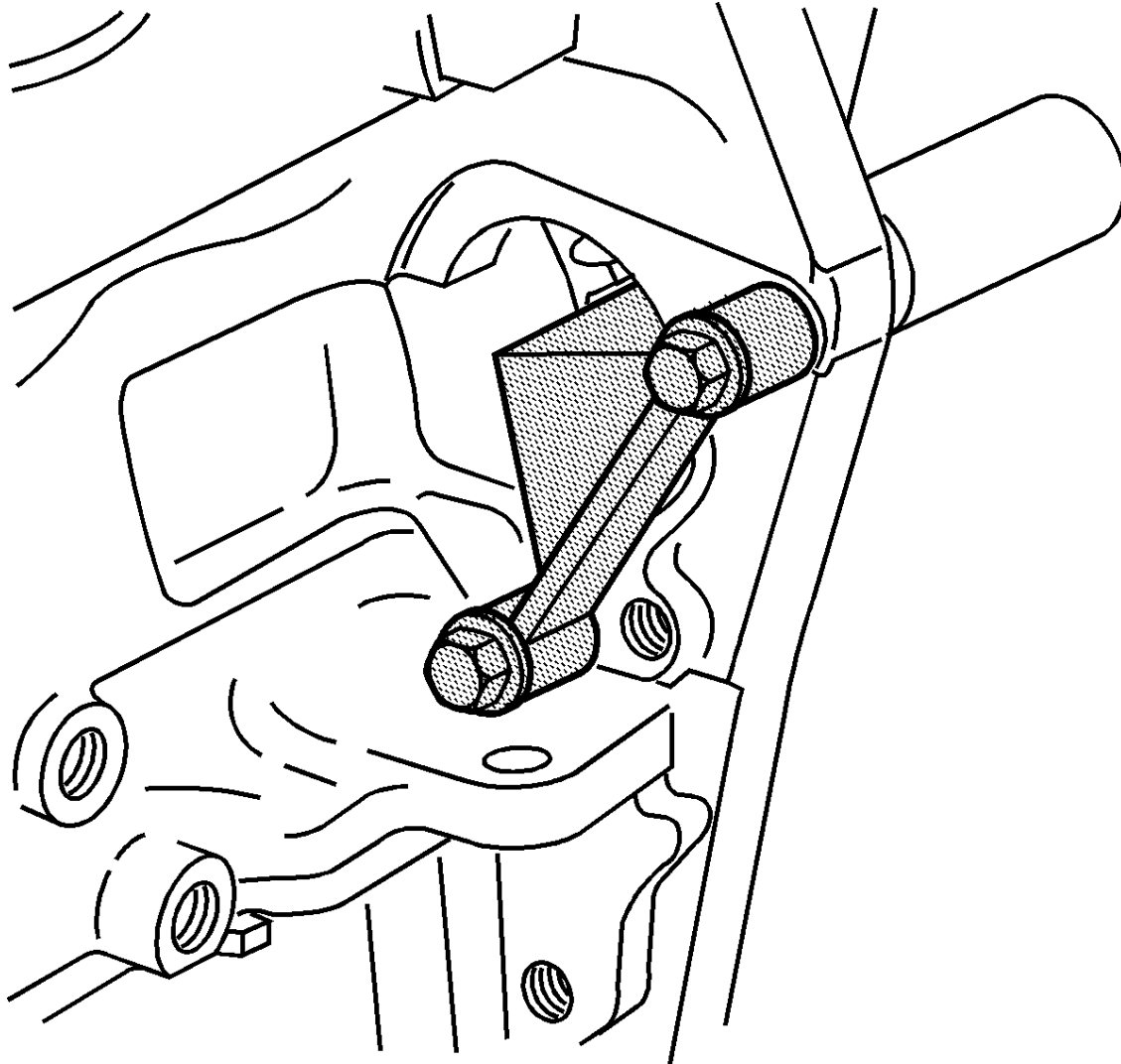
## **CRANKSHAFT BALANCER REPLACEMENT**

### **Special Tools**

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

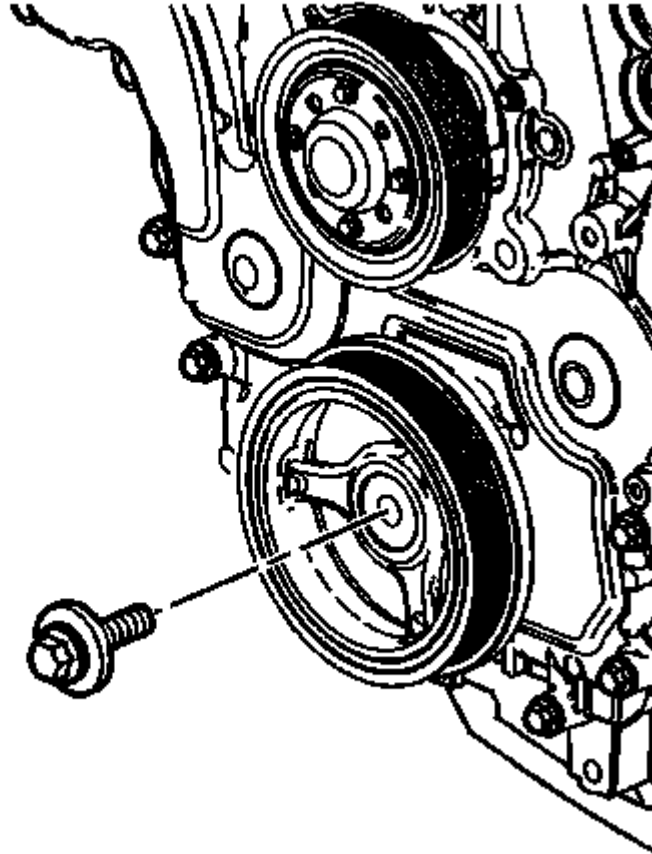
### **Removal Procedure**

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



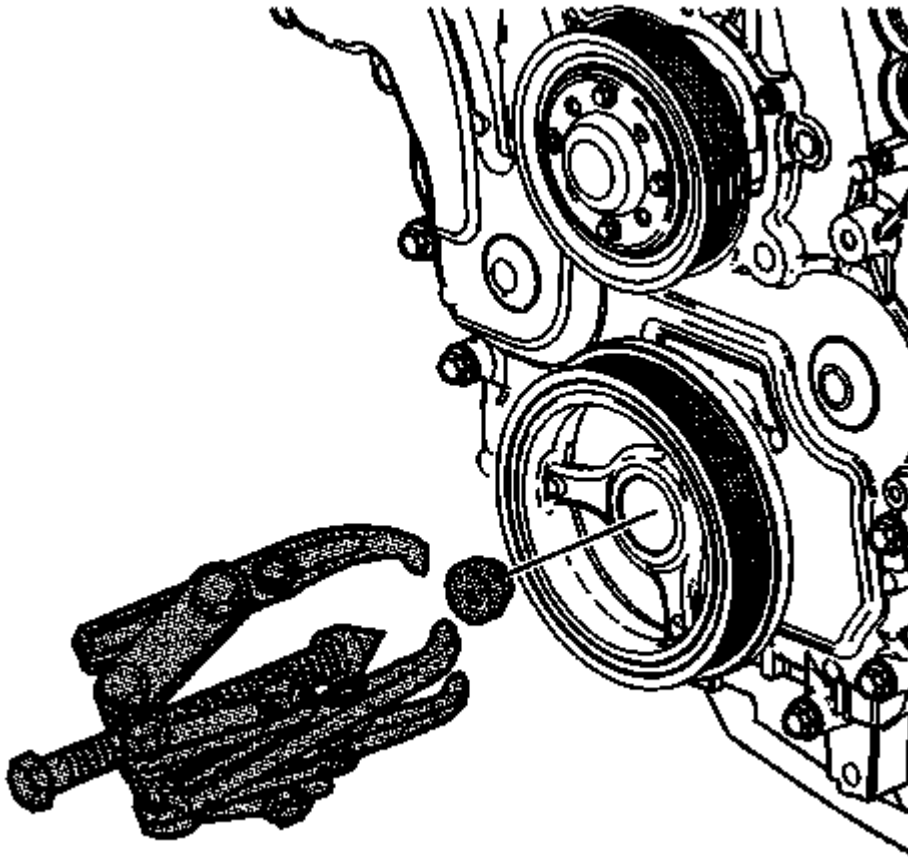
**Fig. 34: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine support fixture. Refer to **Engine Support Fixture**.
6. Remove the frame-to-body bolts. Refer to steps 18-24 of the removal of **Drivetrain and Front Suspension Frame Replacement**.
7. Use the engine support fixture, to lower the right side of the frame approximately 2 inches.
8. Remove the crankshaft balancer bolt. Discard the bolt.



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

9. Install the **J 38416-2** crankshaft button in the nose of the crankshaft.

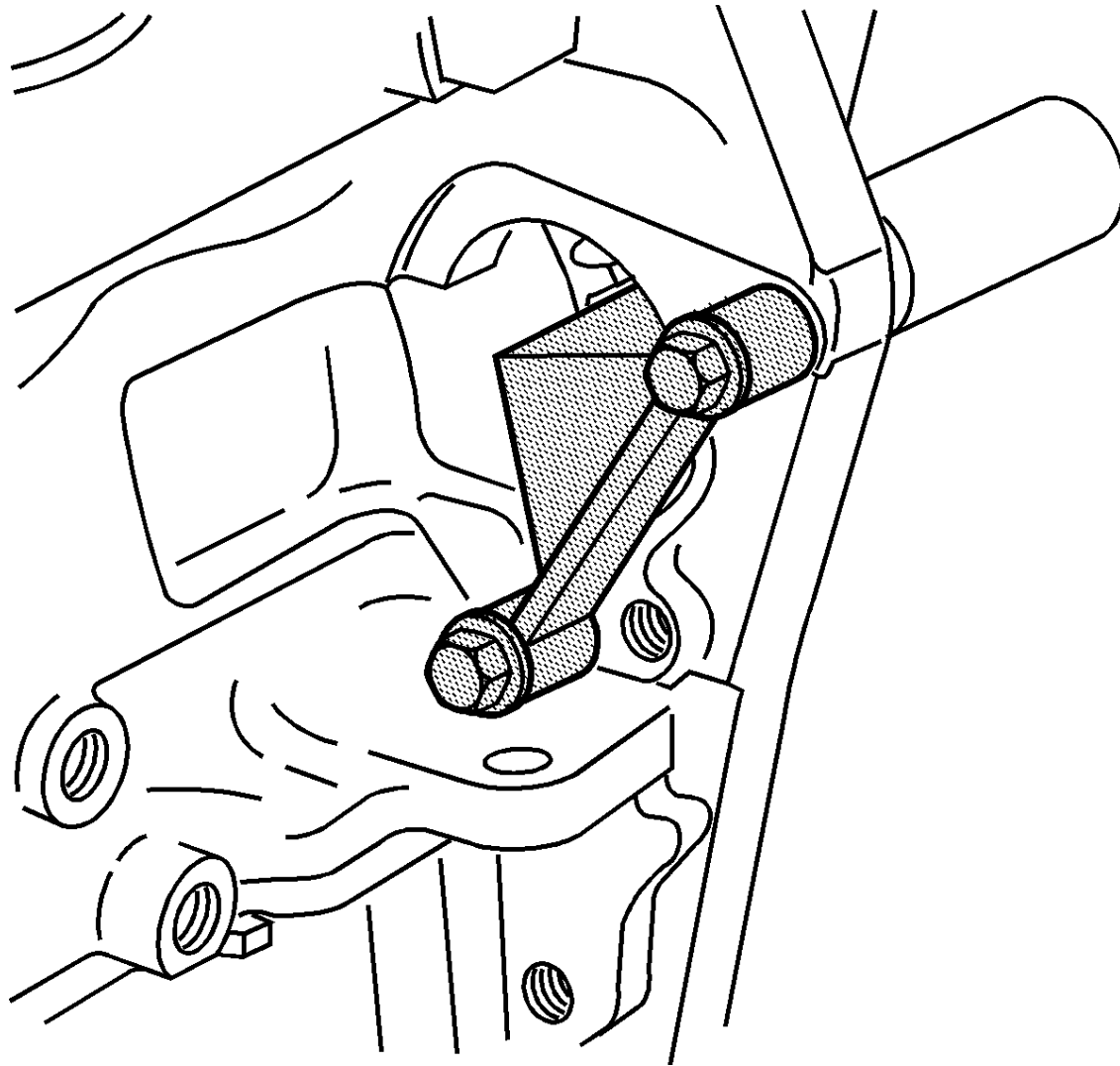


**Fig. 36: View Of J 38416-2 In Nose Of Crankshaft**  
**Courtesy of GENERAL MOTORS COMPANY**

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

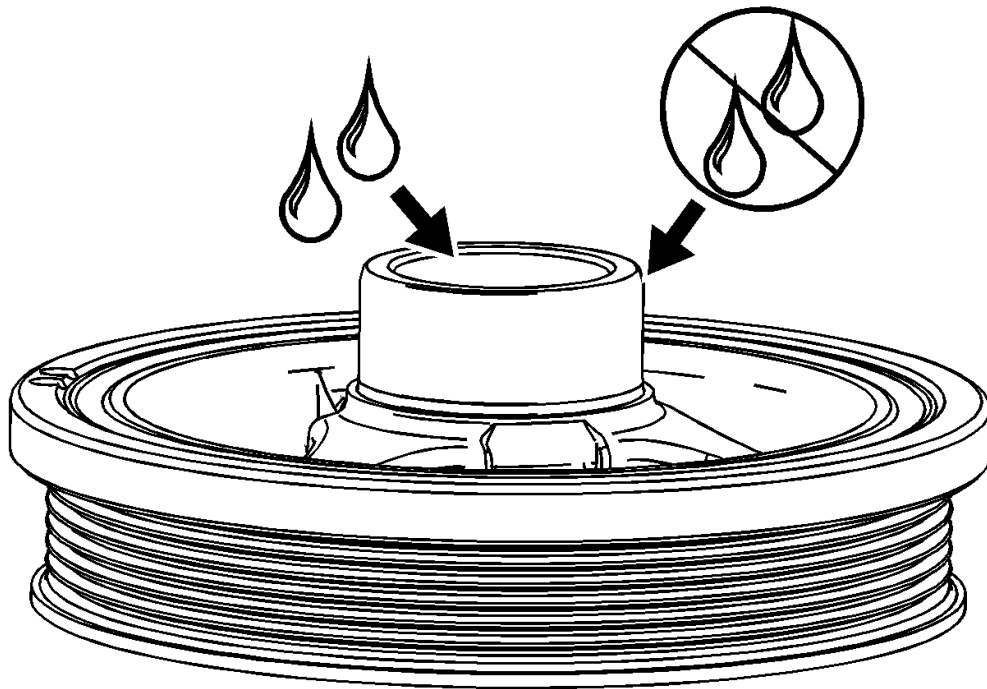
#### **Installation Procedure**

1. The **EN 46106** flywheel holding tool must be installed onto the flywheel.



**Fig. 37: Identifying Special Tool - EN 46106**  
**Courtesy of GENERAL MOTORS COMPANY**

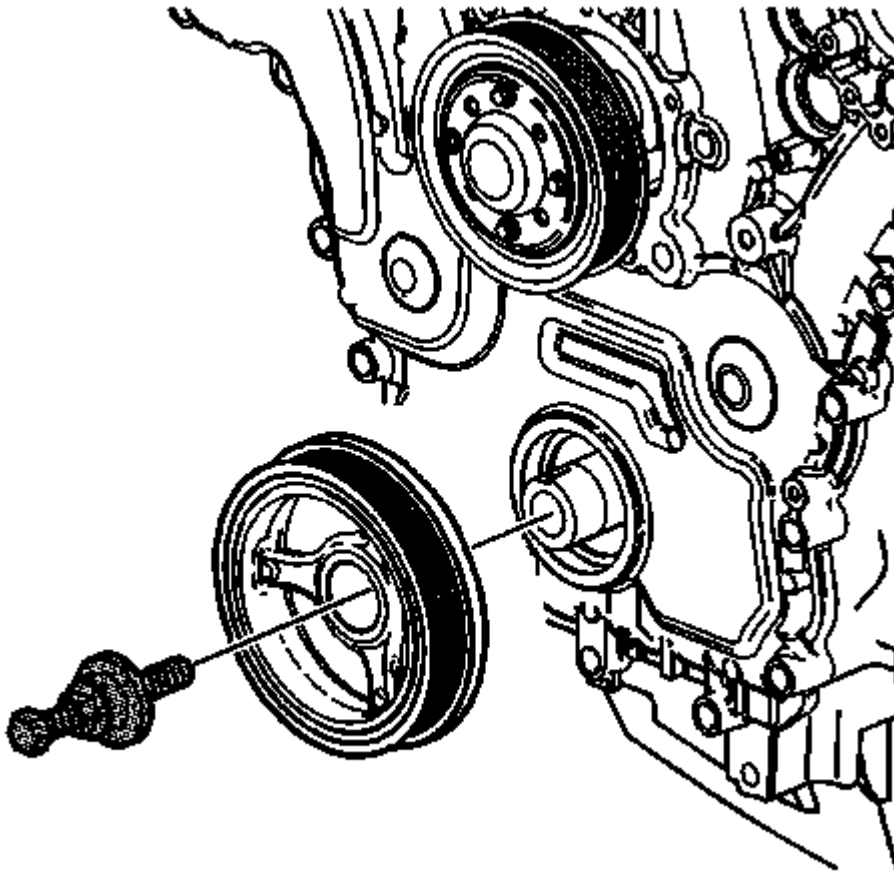
2. Use the **J 41998-B** crankshaft balancer installer, nut, bearing and washer to install the crankshaft balancer.
3. Apply lubricant to the inside of the crankshaft balancer hub bore.



**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.

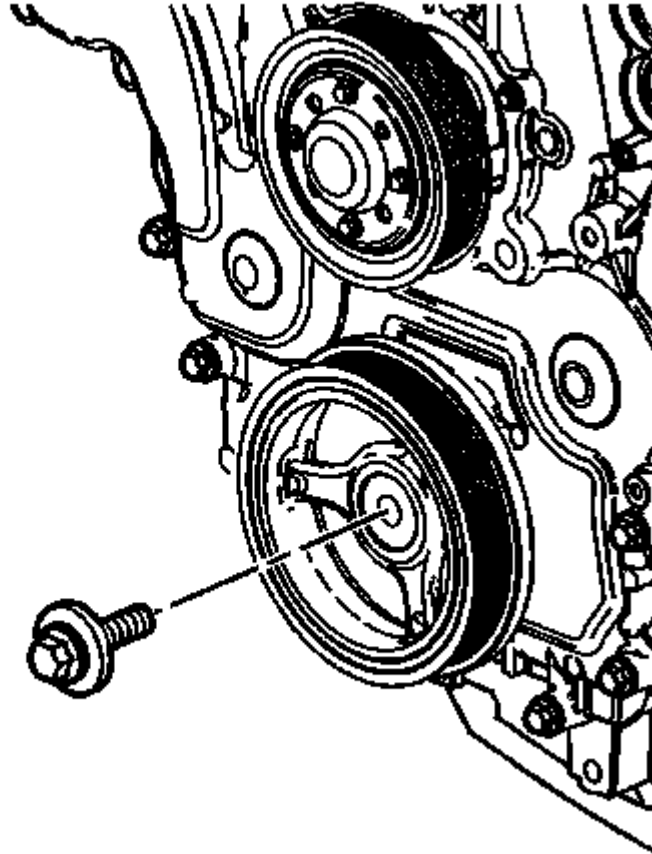
4. Place the crankshaft balancer in position on the crankshaft.



**Fig. 39: View Of Crankshaft Balancer & Installation Tool J 41998-B**  
**Courtesy of GENERAL MOTORS COMPANY**

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.
8. Install the NEW crankshaft balancer bolt.

**CAUTION:** This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.



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

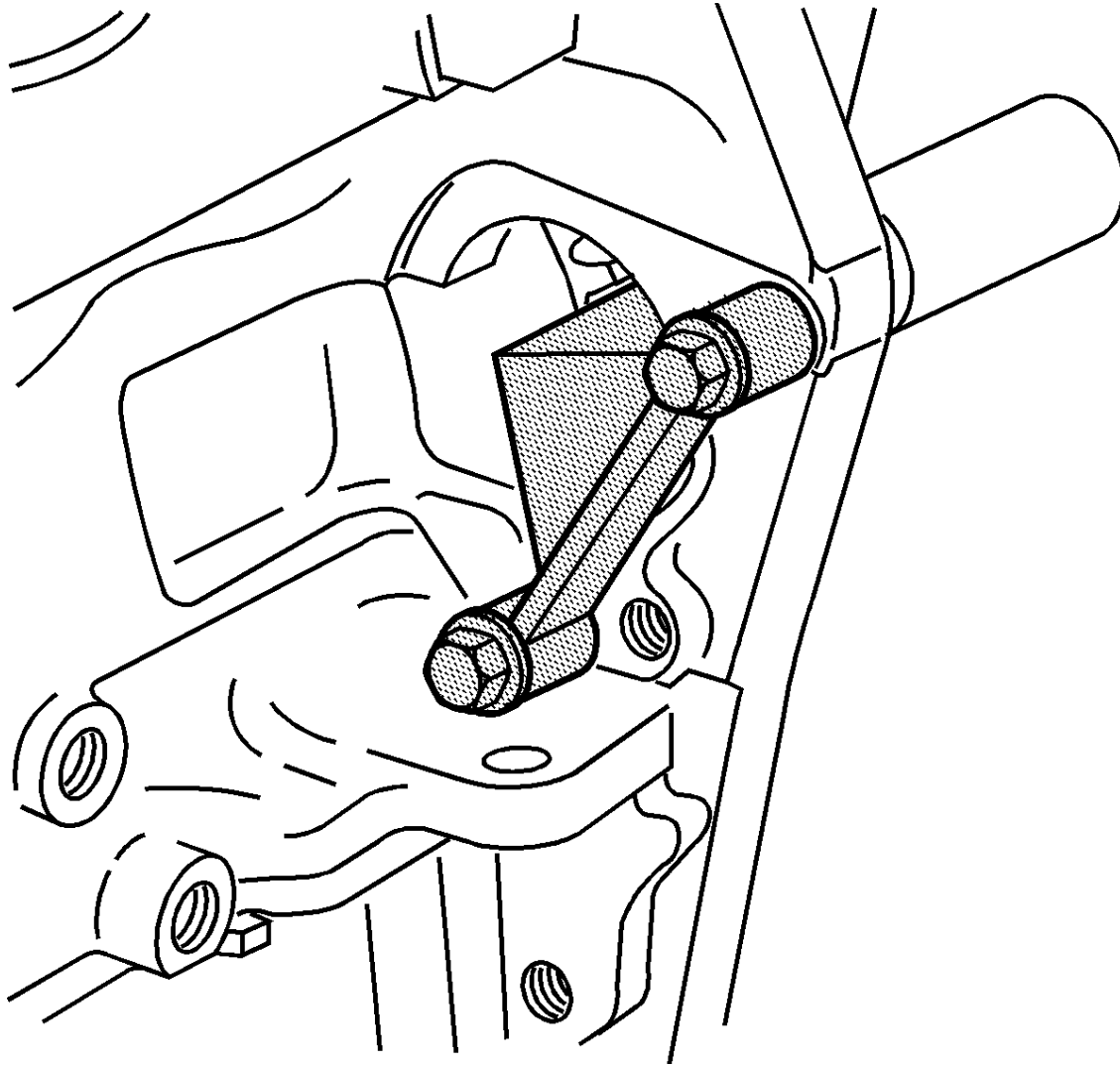
**NOTE:** Always install a new crankshaft balancer retaining bolt and washer.

9. Tighten the crankshaft balancer bolt.

**CAUTION:** Refer to Fastener Caution

- Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft).
  - Tighten the crankshaft balancer bolt an additional 150° using the **J 45059** angle meter.
10. Remove the **EN 46106** flywheel holding tool.





**Fig. 41: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS COMPANY

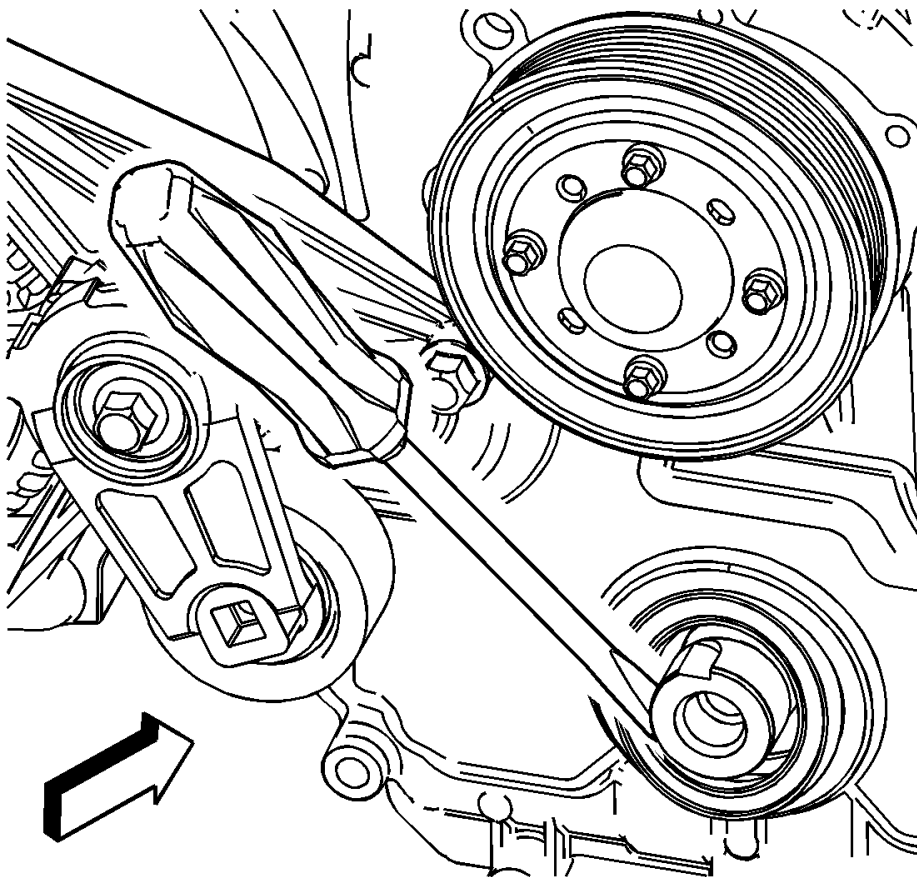
11. Install the starter. Refer to **Starter Replacement** .
12. Using engine support fixture, raise the engine into position.
13. Install NEW frame-to-body bolts. Refer to steps 1-10 of the install of **Drivetrain and Front Suspension Frame Replacement** .

**NOTE:**        **Front end alignment not required due to frame only being lowered and reinstalled.**

14. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side**.
15. Remove the engine support fixture.
16. Install the drive belt. Refer to **Drive Belt Replacement**.

**CRANKSHAFT FRONT OIL SEAL REPLACEMENT****Special Tools****J 29184** Oil Seal Installer**Removal Procedure**

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

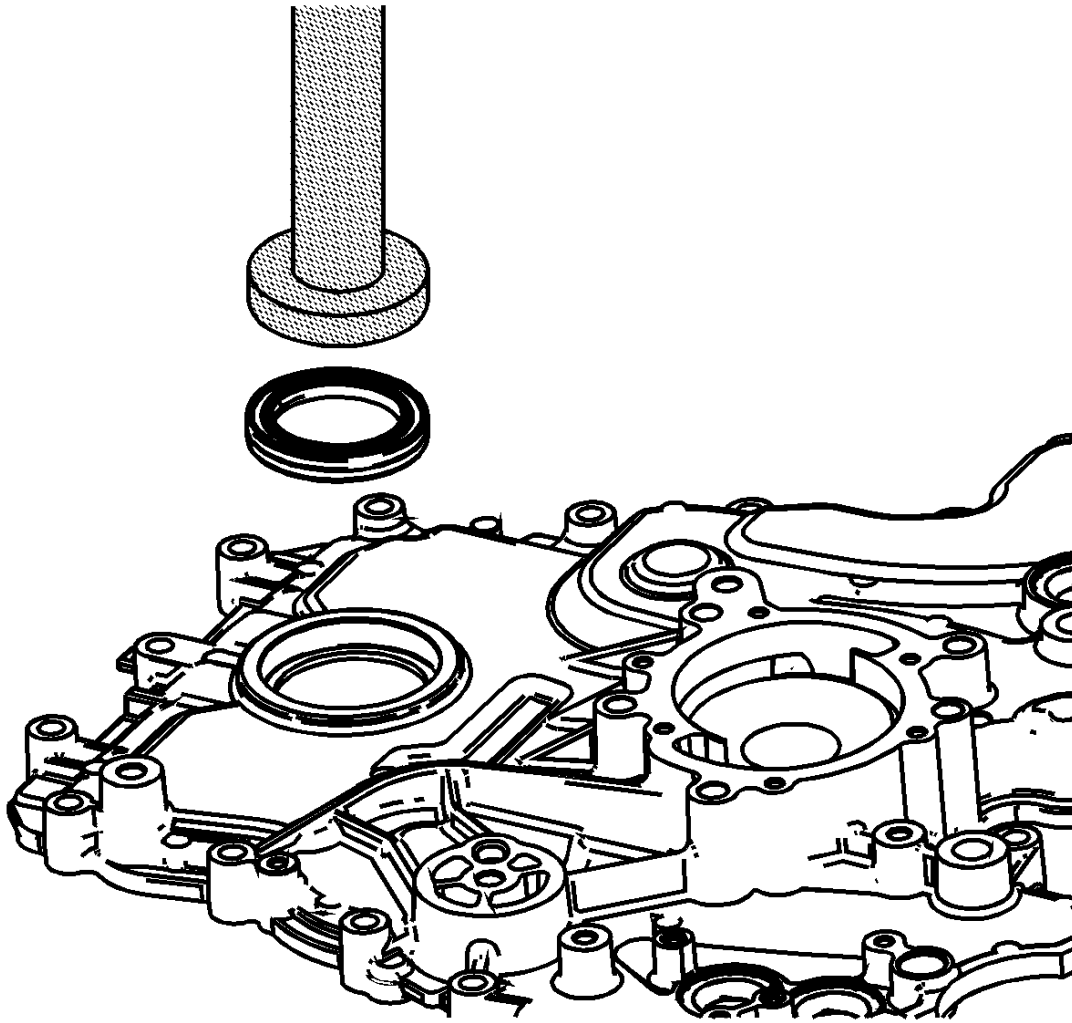


**Fig. 42: Removing Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Use the **J 29184** oil seal installer or equivalent to install the crankshaft front oil seal.



**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.

2. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

## CAMSHAFT COVER REPLACEMENT - LEFT SIDE

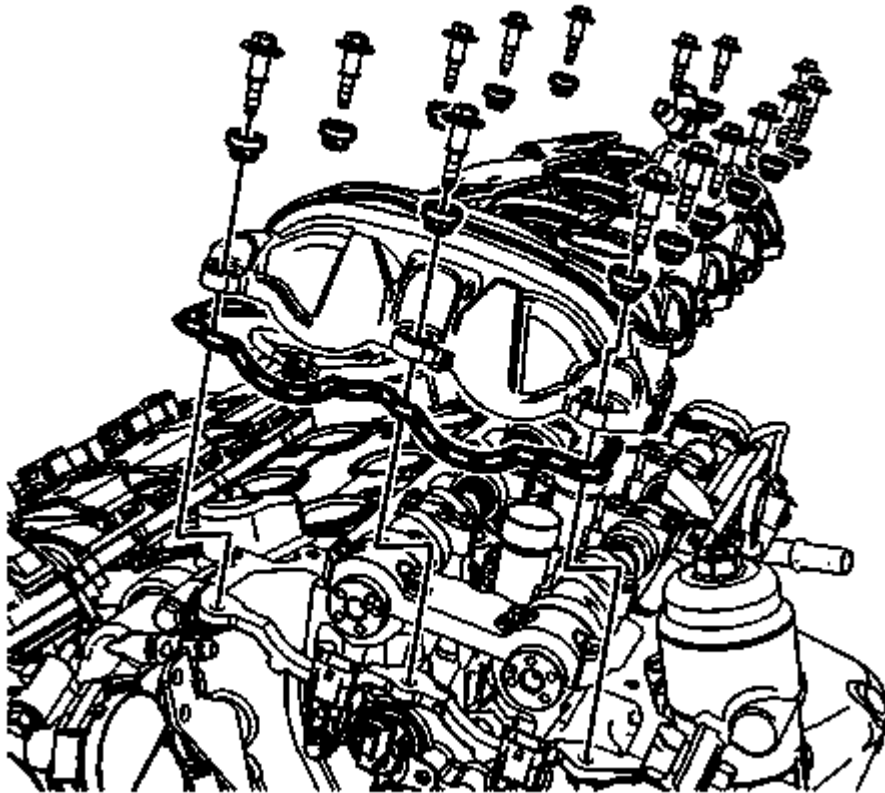
### Special Tools

EN 46101 Spark Plug Tube Seal Guide

### Removal Procedure

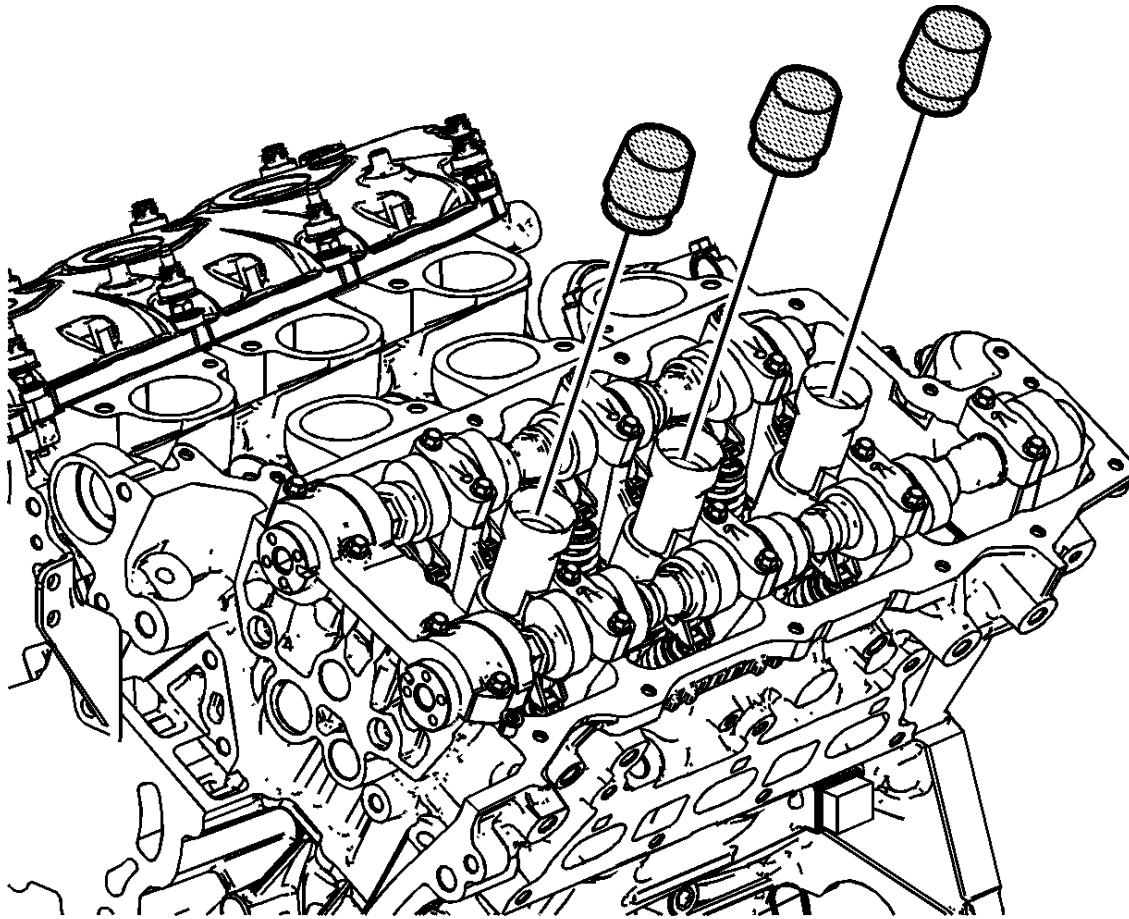
1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).

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** .
5. Remove the left camshaft cover bolts.



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

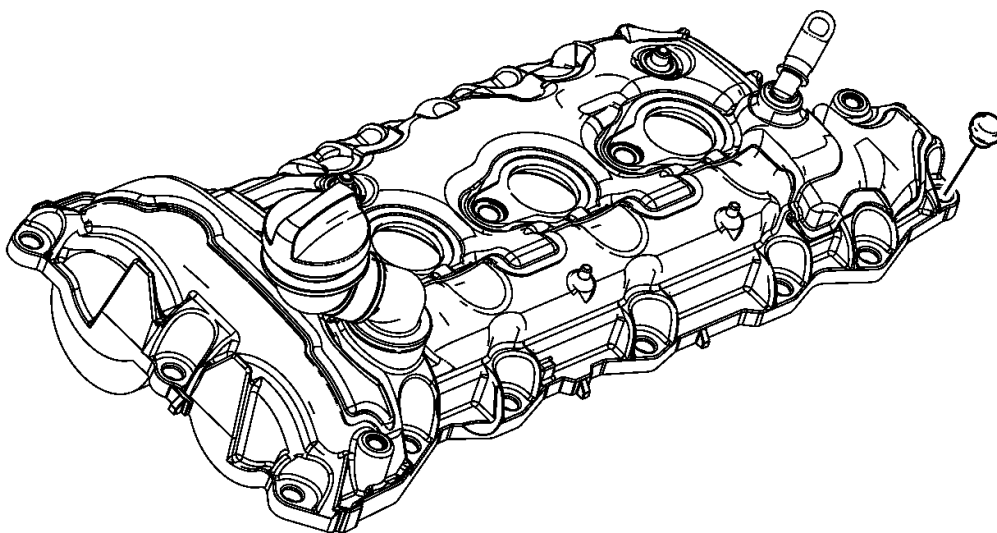
6. Remove the left camshaft cover from the left cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .
8. Install the **EN 46101** spark plug tube seal guide onto the spark plug tubes of the left cylinder head.



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

#### **Installation Procedure**

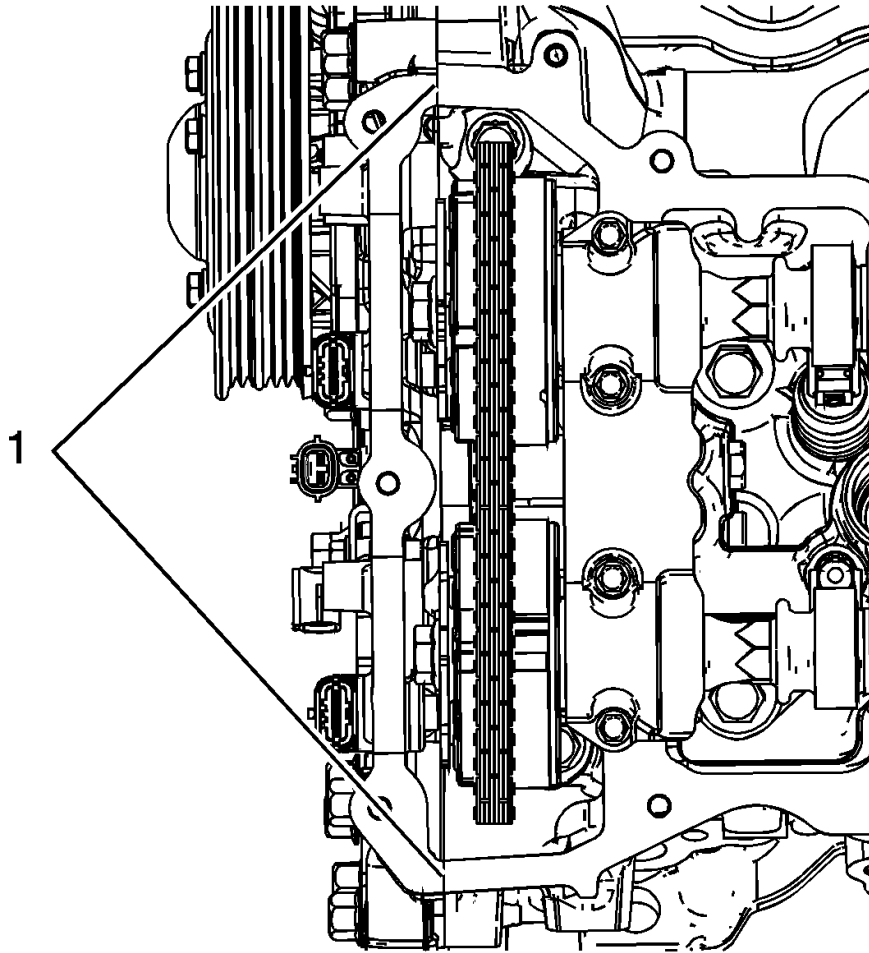
1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.



**Fig. 46: View of Camshaft Cover**

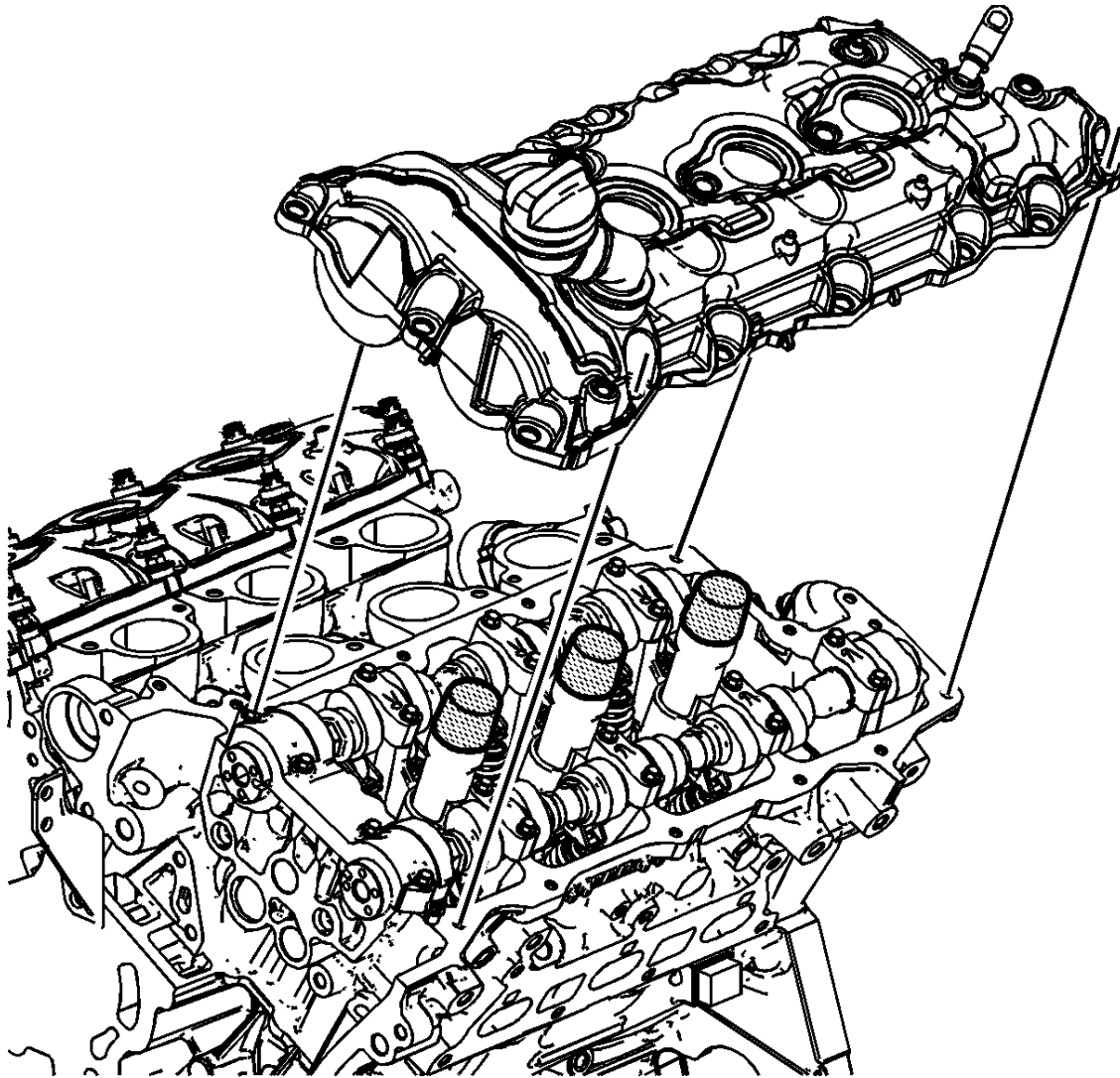
**Courtesy of GENERAL MOTORS COMPANY**

2. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.
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. 47: Locating Engine Front Cover Split Lines**  
Courtesy of GENERAL MOTORS COMPANY

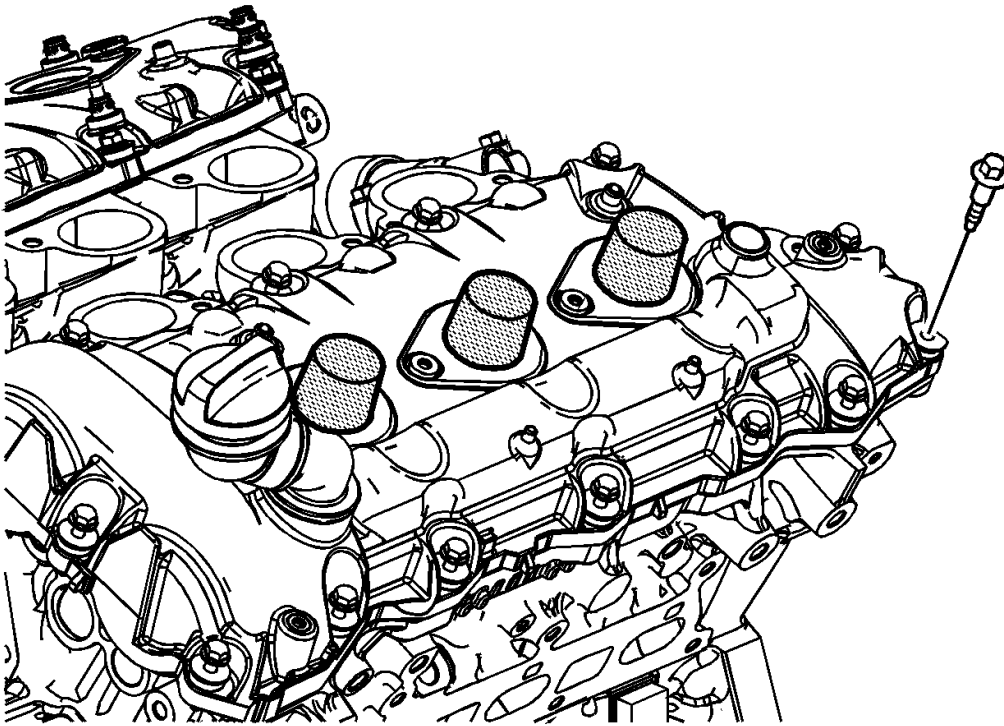
4. Place the left camshaft cover into position onto the left cylinder head.



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

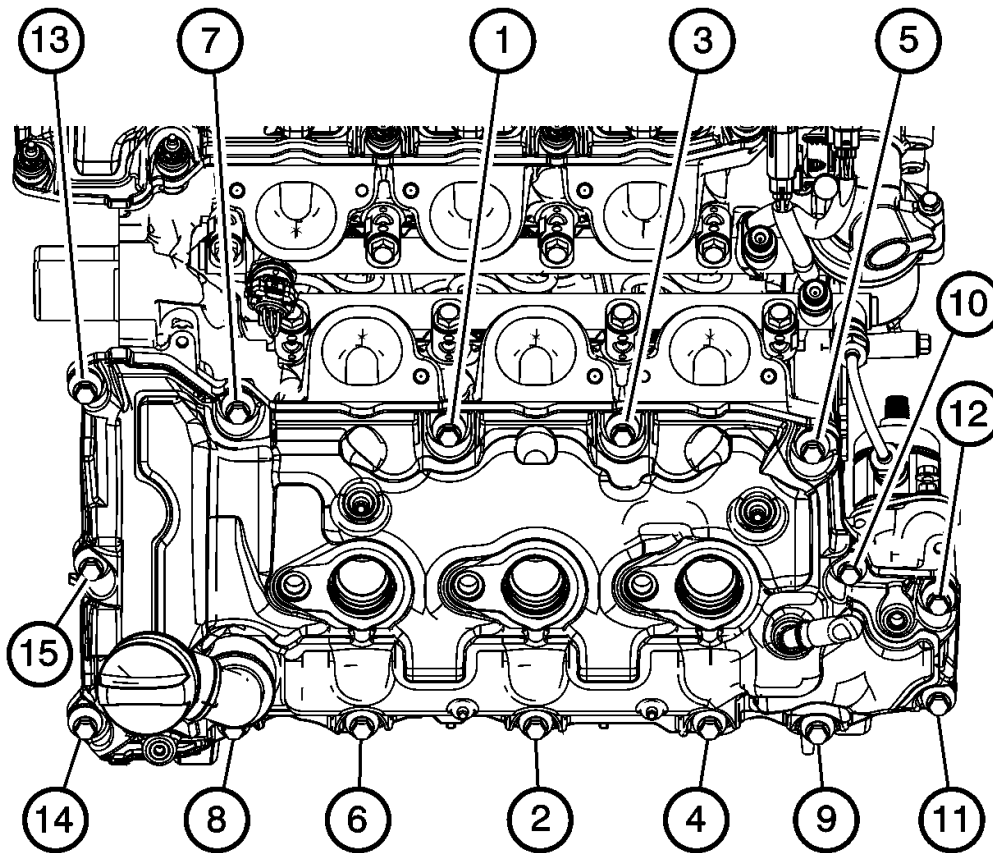
5. Loosely install the left camshaft cover bolts.





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

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



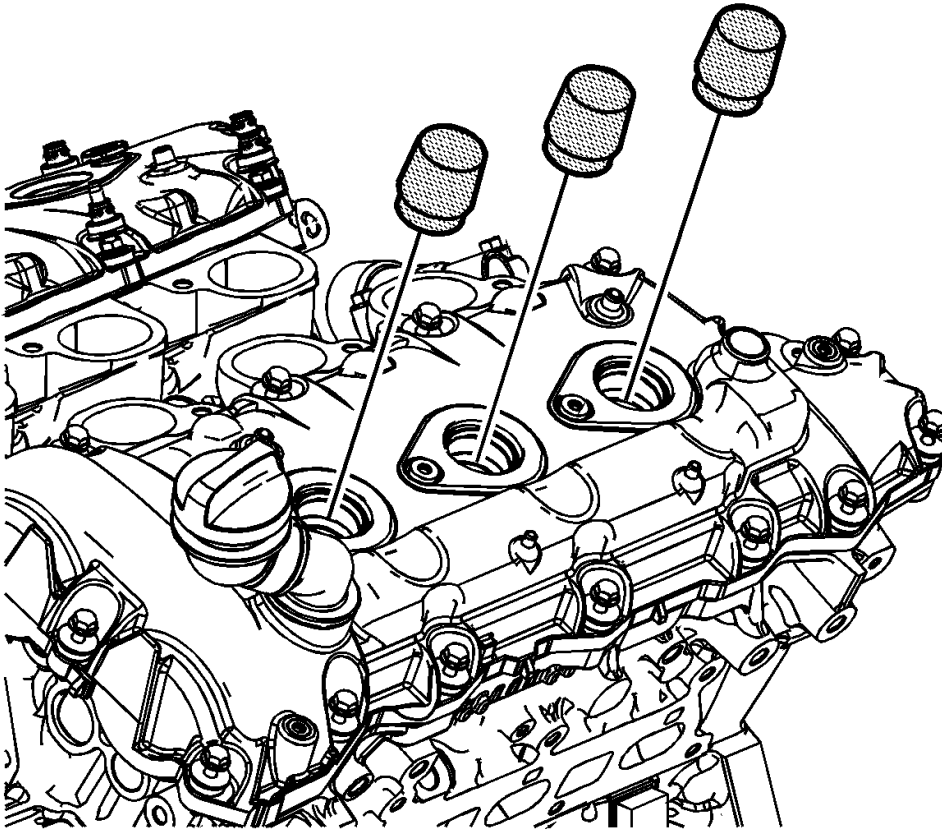
**Fig. 50: Identifying Left Camshaft Cover Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

### Tighten

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

7. Remove the **EN 46101** spark plug tube seal guide from the spark plug tubes of the left cylinder head.



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

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**

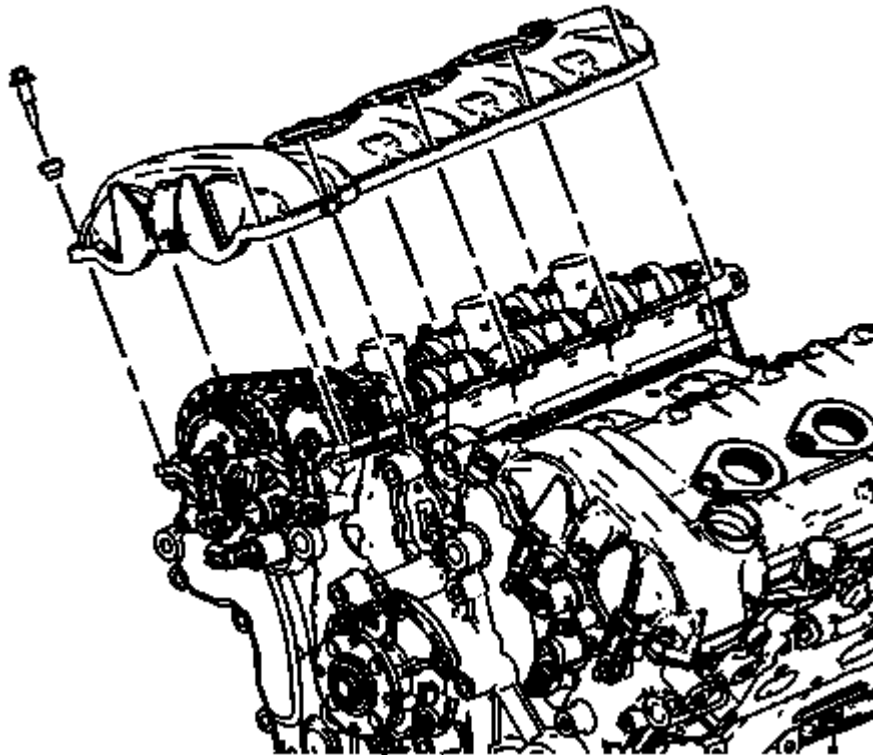
### **Special Tools**

**EN 46101** Spark Plug Tube Seal Guide

### **Removal Procedure**

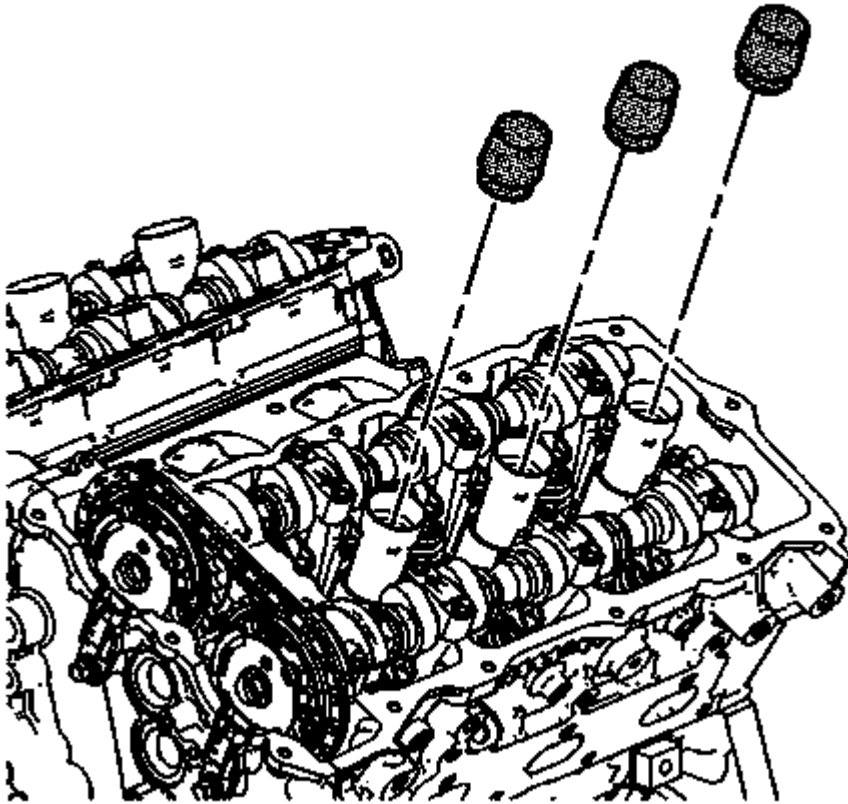
1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.

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** .
4. Remove the right camshaft cover bolts.



**Fig. 52: Removing & Installing Camshaft Cover**  
Courtesy of GENERAL MOTORS COMPANY

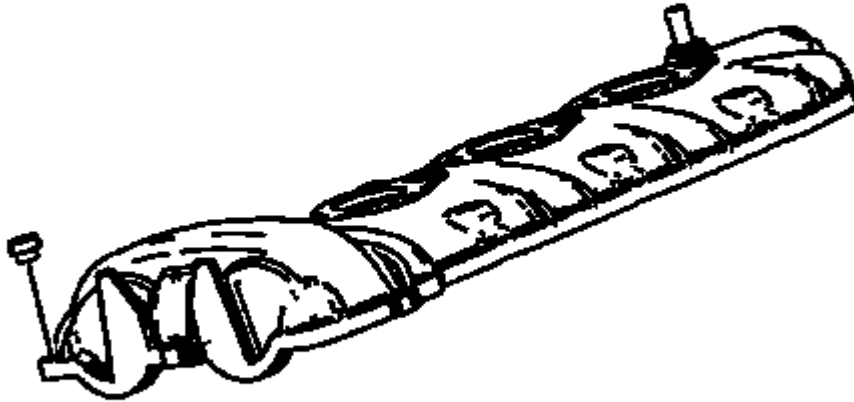
5. Remove the right camshaft cover from the right cylinder head.
6. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection** .
7. Install the **EN 46101** spark plug tube seal guide onto the spark plug tubes of the right cylinder head.



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

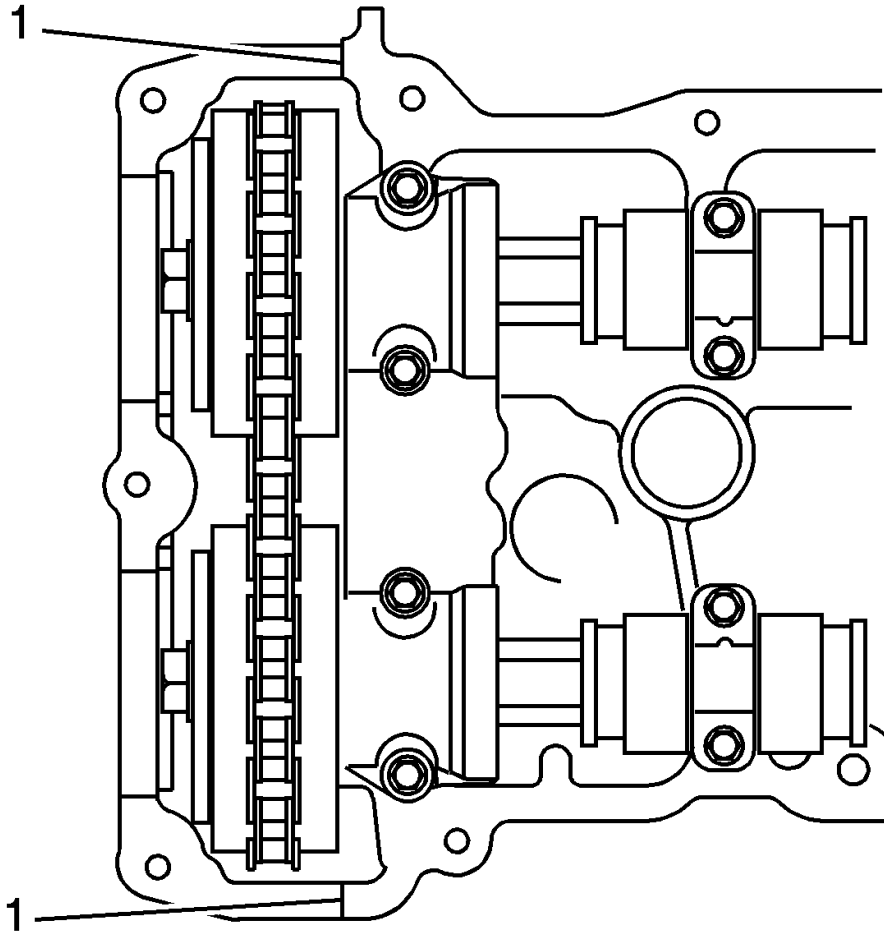
**Installation Procedure**

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



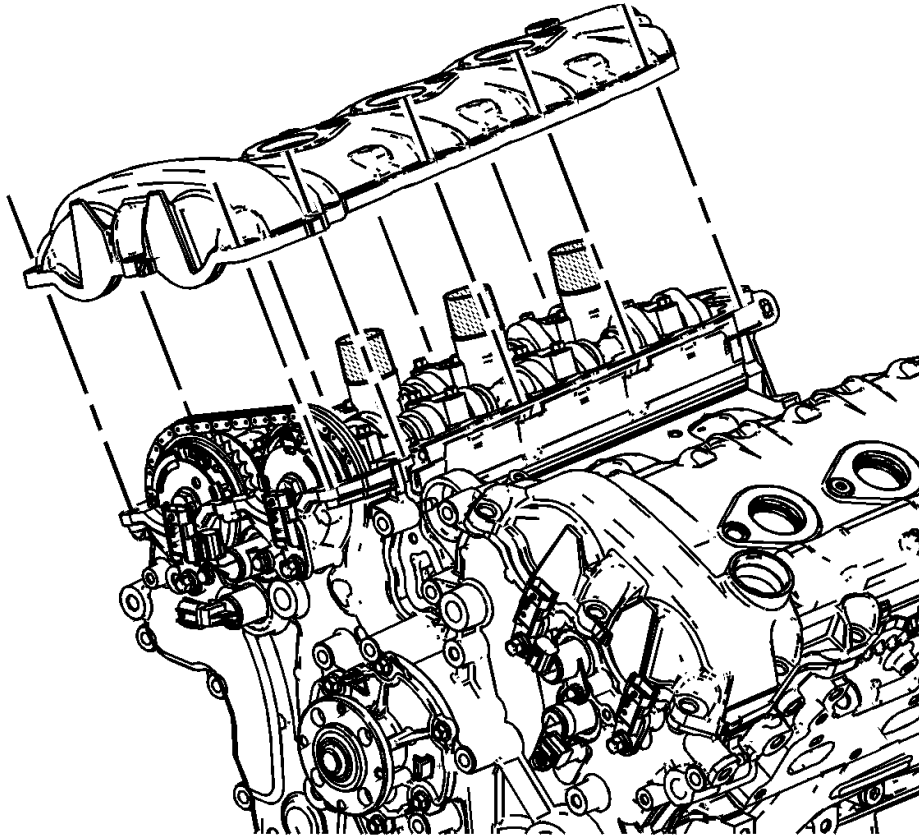
**Fig. 54: Locating Camshaft Cover Bolt Grommets**  
Courtesy of GENERAL MOTORS COMPANY

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

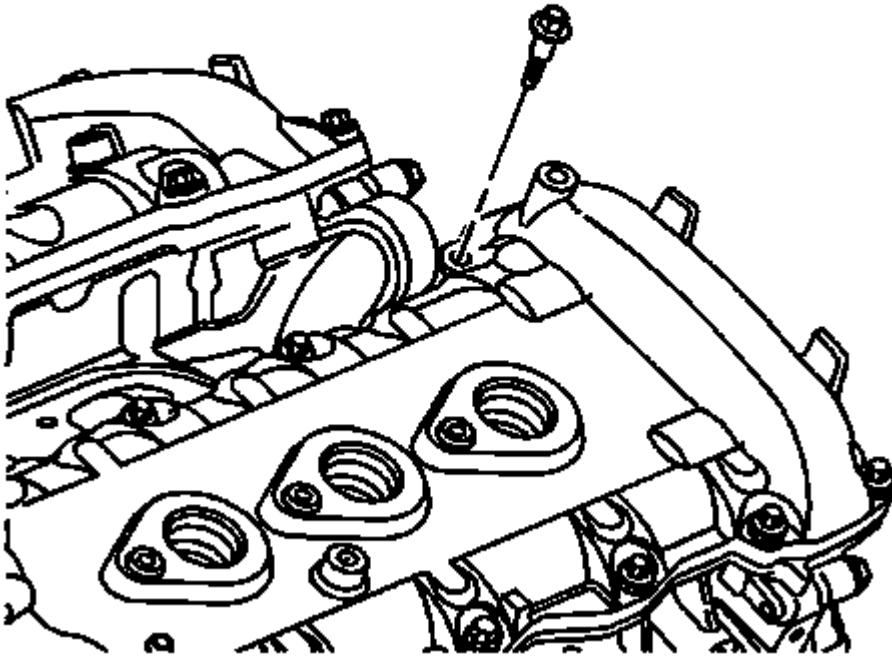
3. Place the right camshaft cover into position onto the right cylinder head.



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

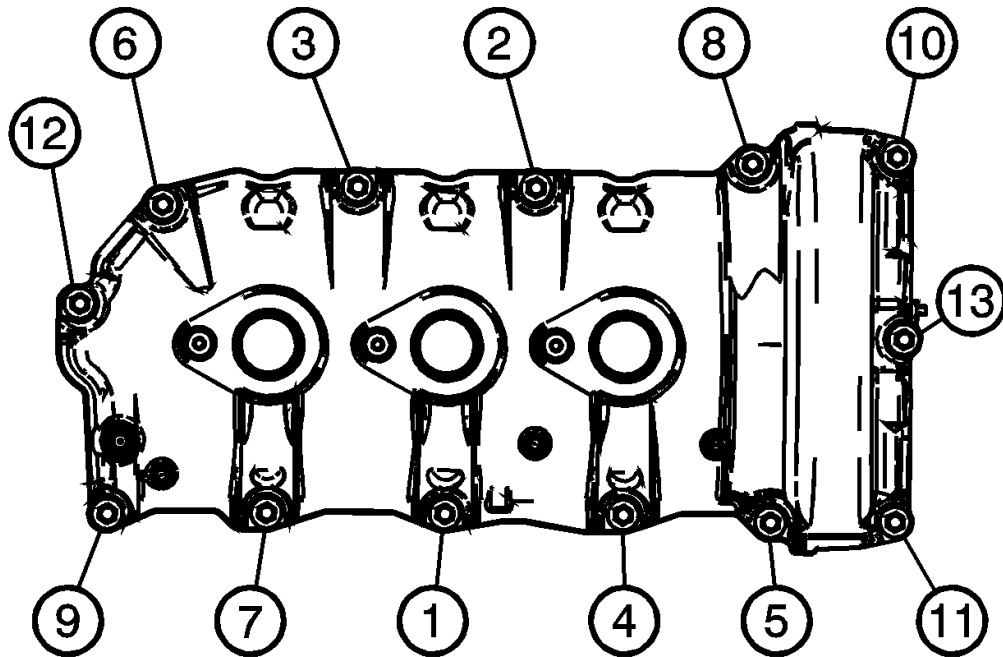
4. Loosely install the right camshaft cover bolts.





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

5. Tighten the right camshaft cover bolts in sequence.



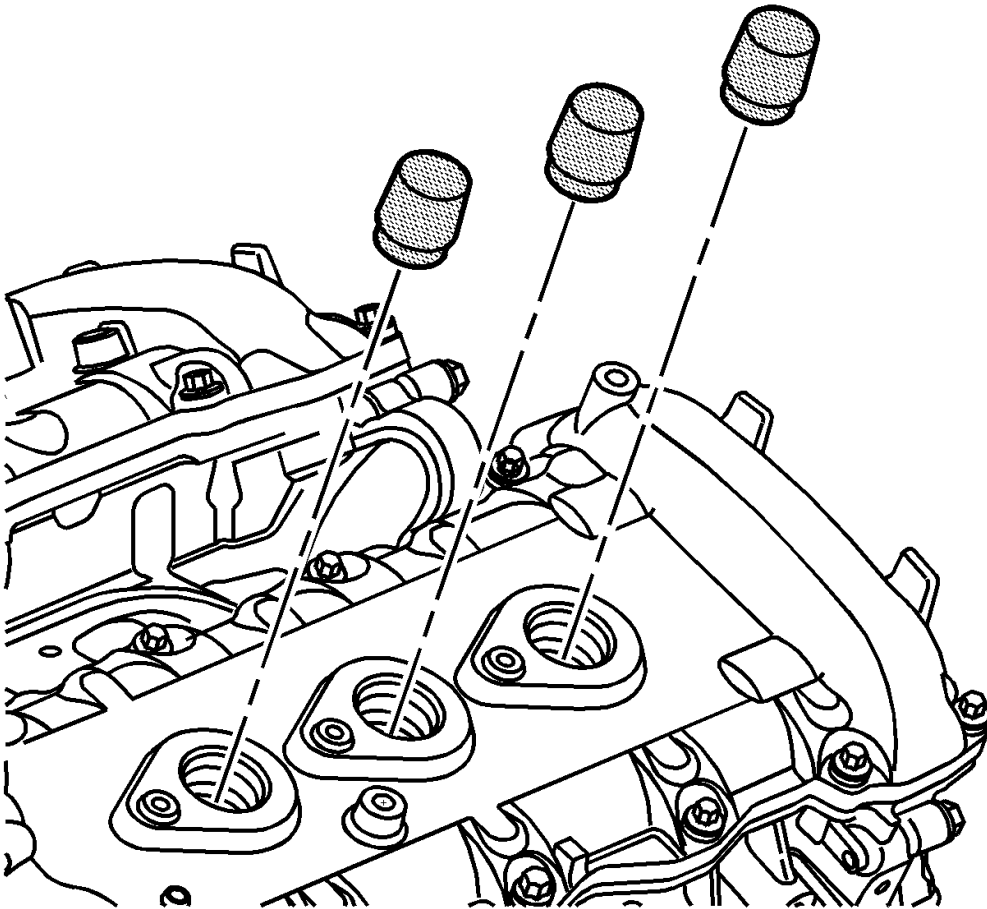
**Fig. 58: Tightening Sequence for Right Camshaft Cover Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

### Tighten

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

6. Install the power steering reservoir. Refer to Power Steering Fluid Reservoir Replacement .
7. Remove the **EN 46101** spark plug tube seal guide from the spark plug tubes of the right cylinder head.



**Fig. 59: Identifying Special Tool - EN 46101**  
Courtesy of GENERAL MOTORS COMPANY

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**

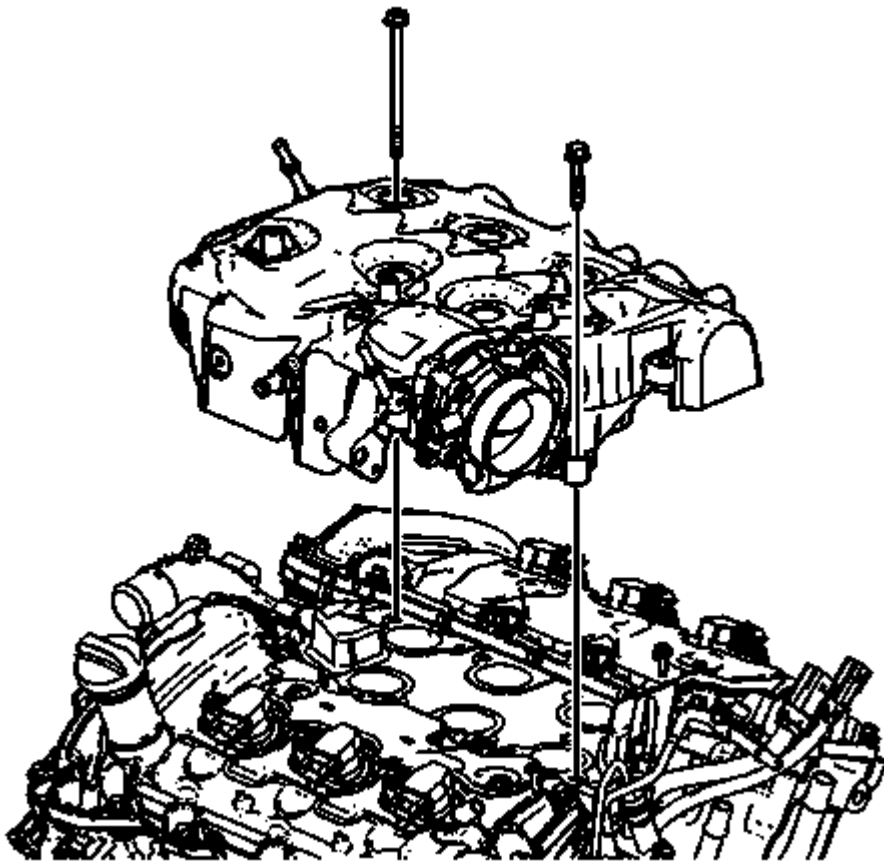
- **EN 46109** Guide Pin Set
- **EN-48383** Camshaft Retaining Tools
- **EN-48589** Crankshaft Rotational Socket
- **EN-46104** Water Pump Pulley Holding Tool

### **Removal Procedure**

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

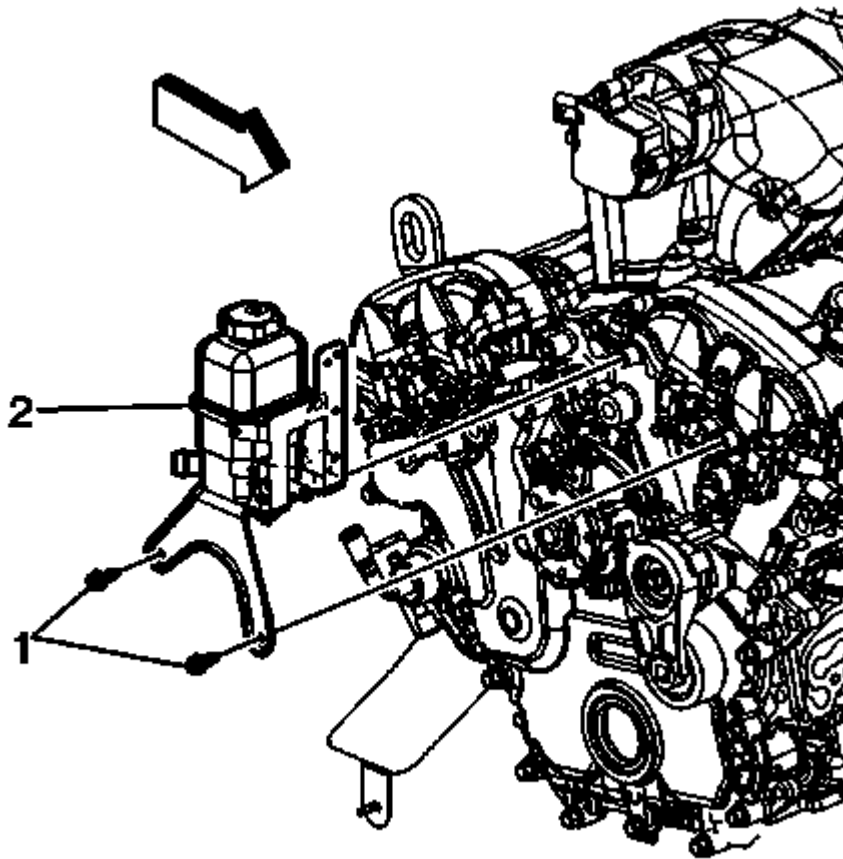
Follow steps 1-39 in the Engine Replacement Removal.

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



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

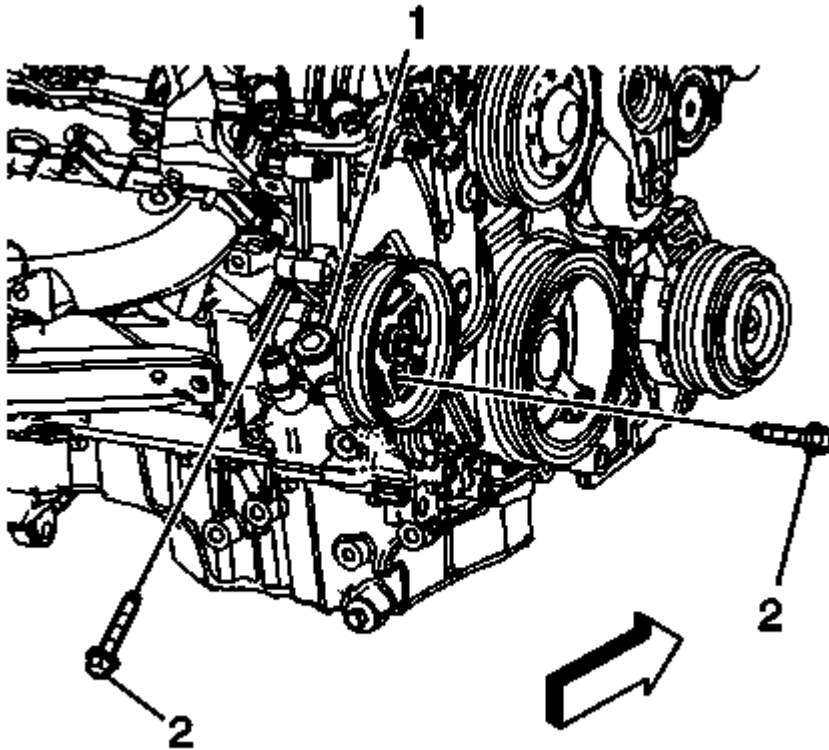
3. Remove the power steering reservoir bracket bolts and reposition.



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

**NOTE:** It is not necessary to remove the lines.

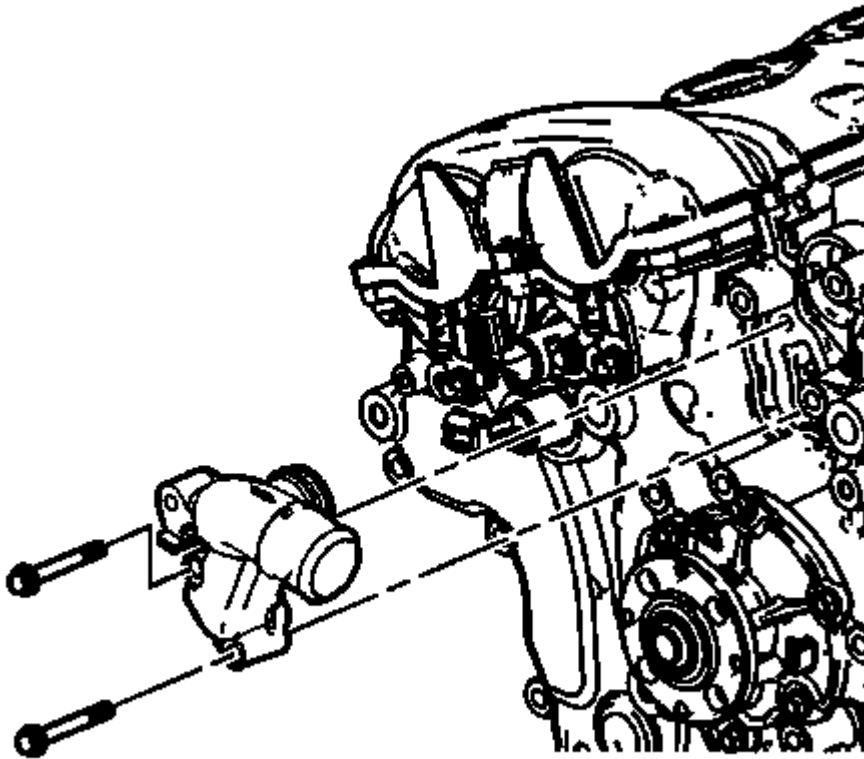
4. Remove the power steering pump bracket bolts and reposition.



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

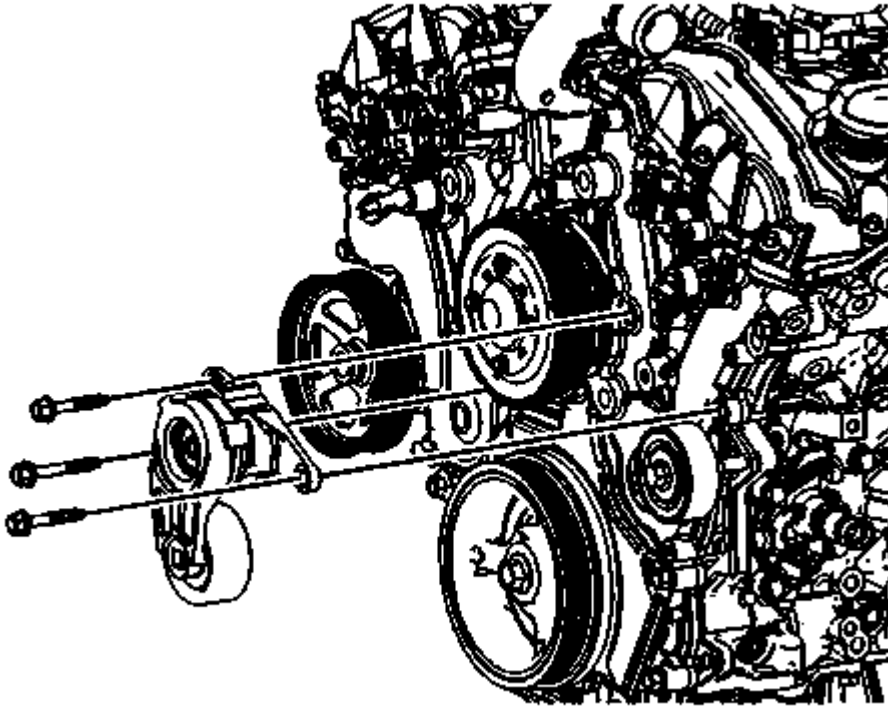
**NOTE:** It is not necessary to remove the lines.

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



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

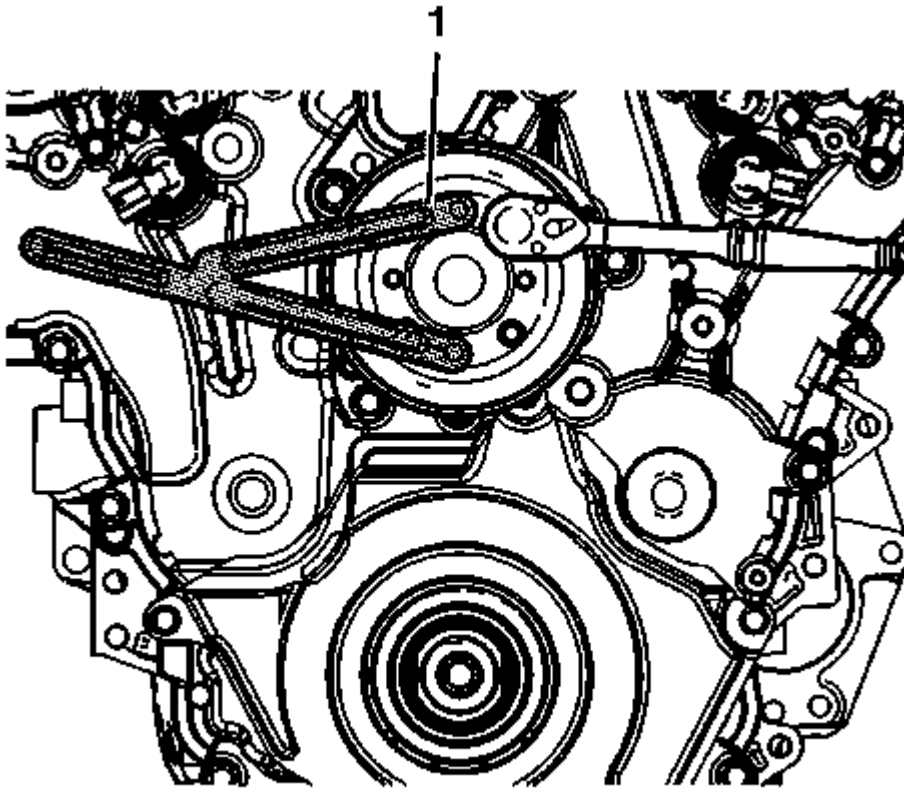
8. Remove the drive belt and drive belt tensioner. Refer to **Drive Belt Tensioner Removal** .



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

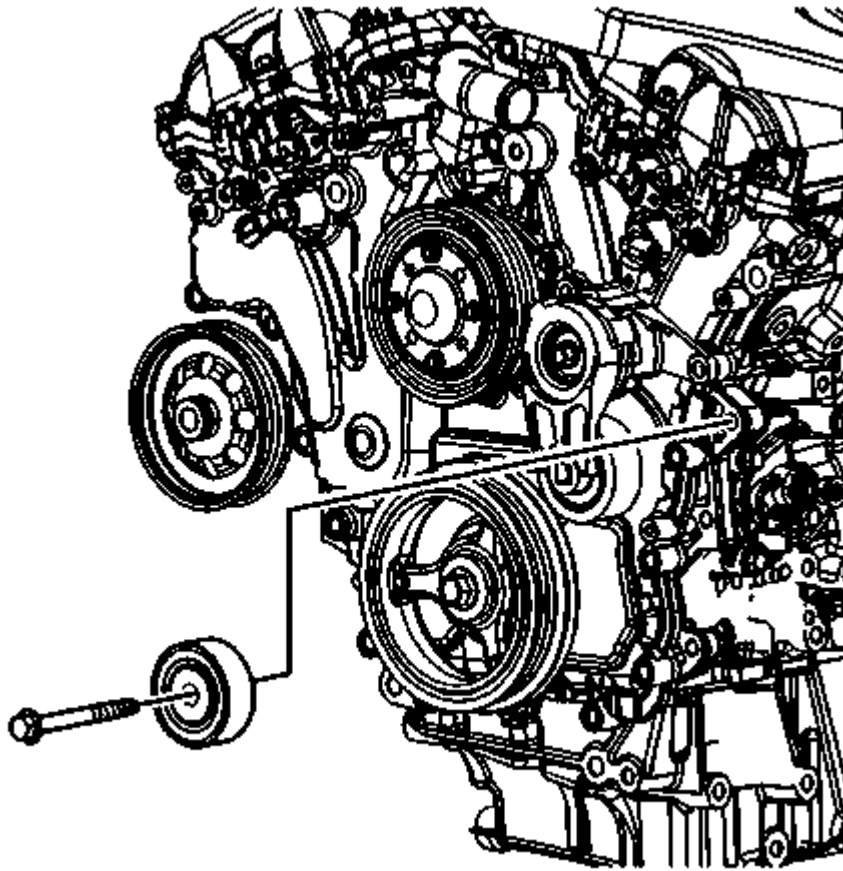
9. Remove the water pump pulley using EN-46104 Holding Tool and if necessary remove the water pump. Refer to **Water Pump Removal** .





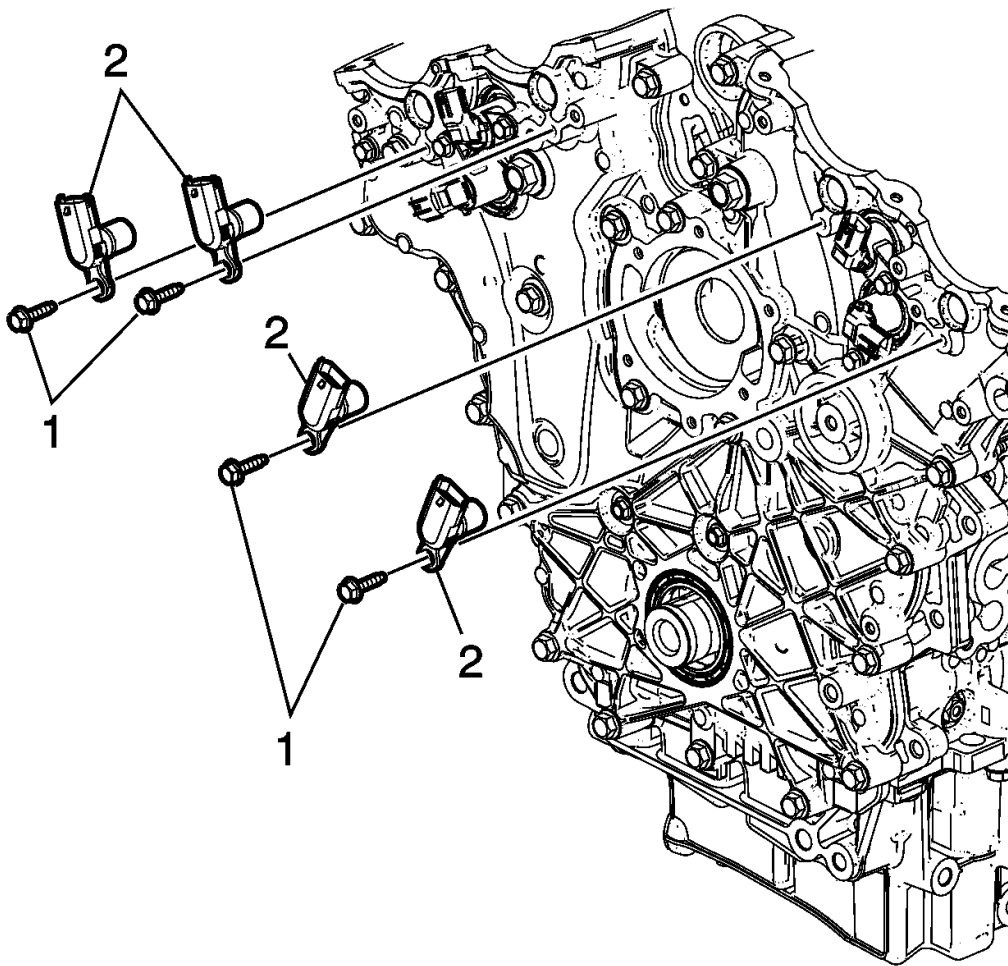
**Fig. 65: Identifying Special Tool - EN 46104**  
**Courtesy of GENERAL MOTORS COMPANY**

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



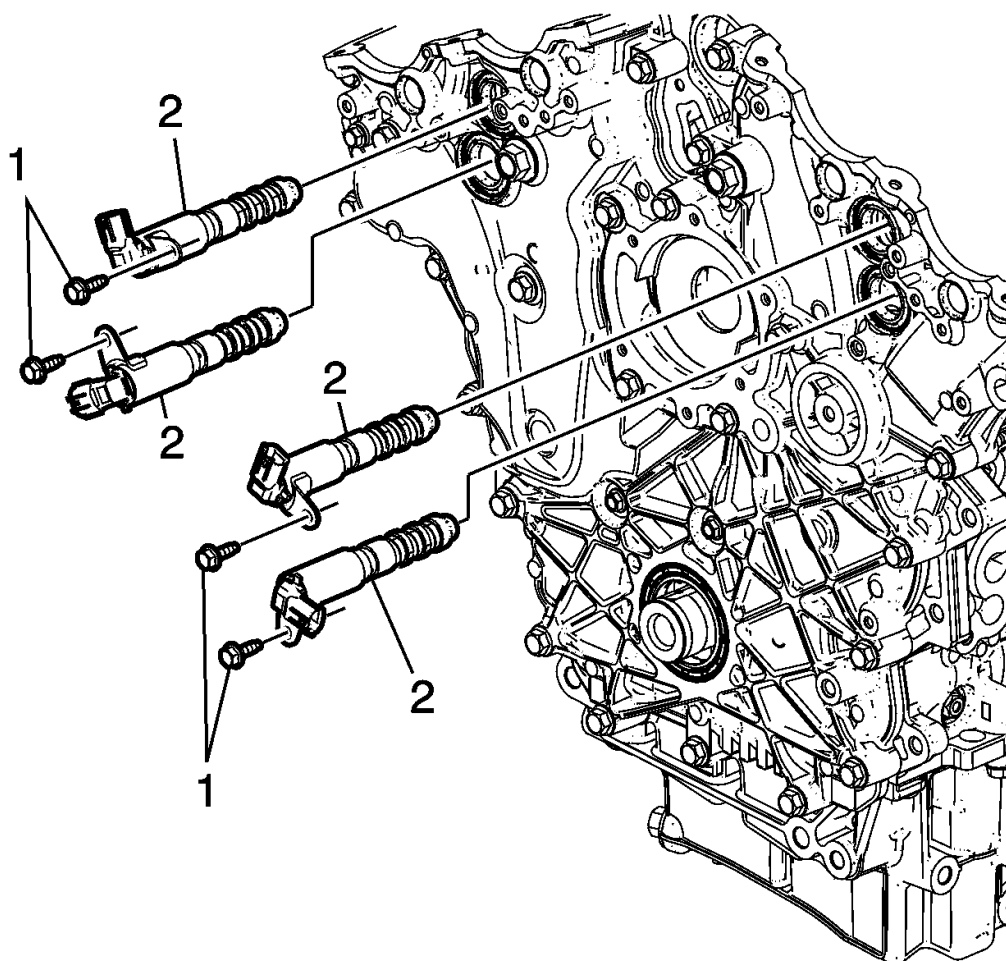
**Fig. 66: Identifying Drive Belt Idler Pulley & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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



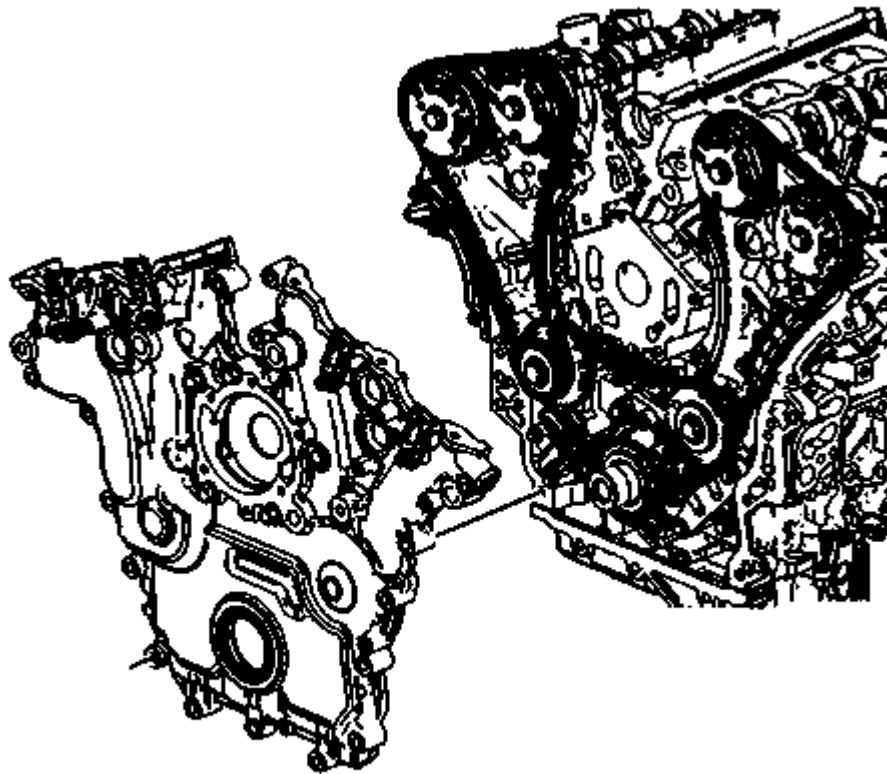
**Fig. 67: Placing Camshaft Position Sensors**  
**Courtesy of GENERAL MOTORS COMPANY**

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



**Fig. 68: Placing Camshaft Position Actuator Valves**  
Courtesy of GENERAL MOTORS COMPANY

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

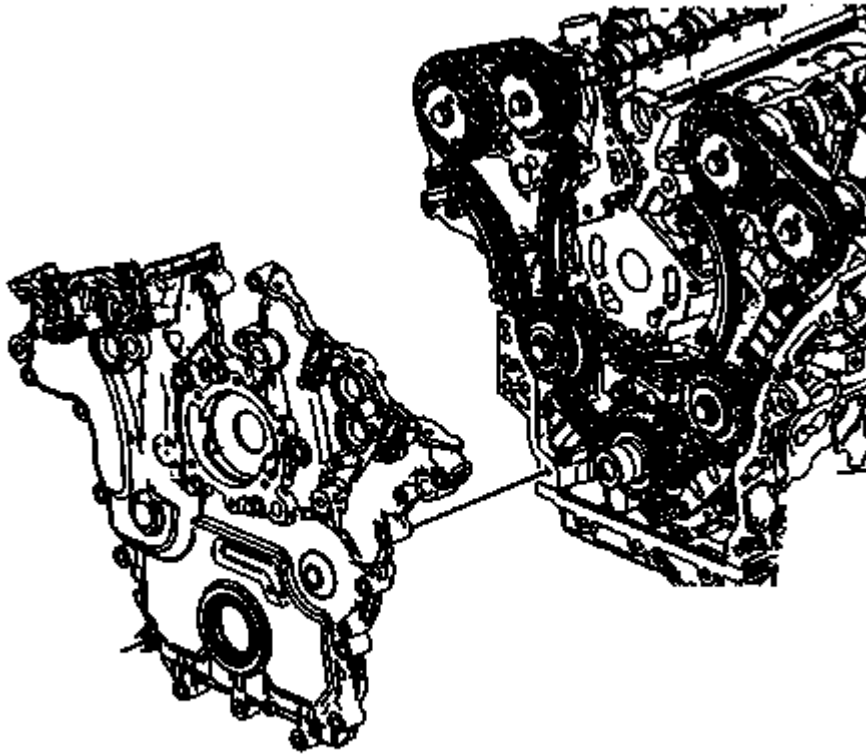


**Fig. 69: Removing/Installing Engine Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

**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.

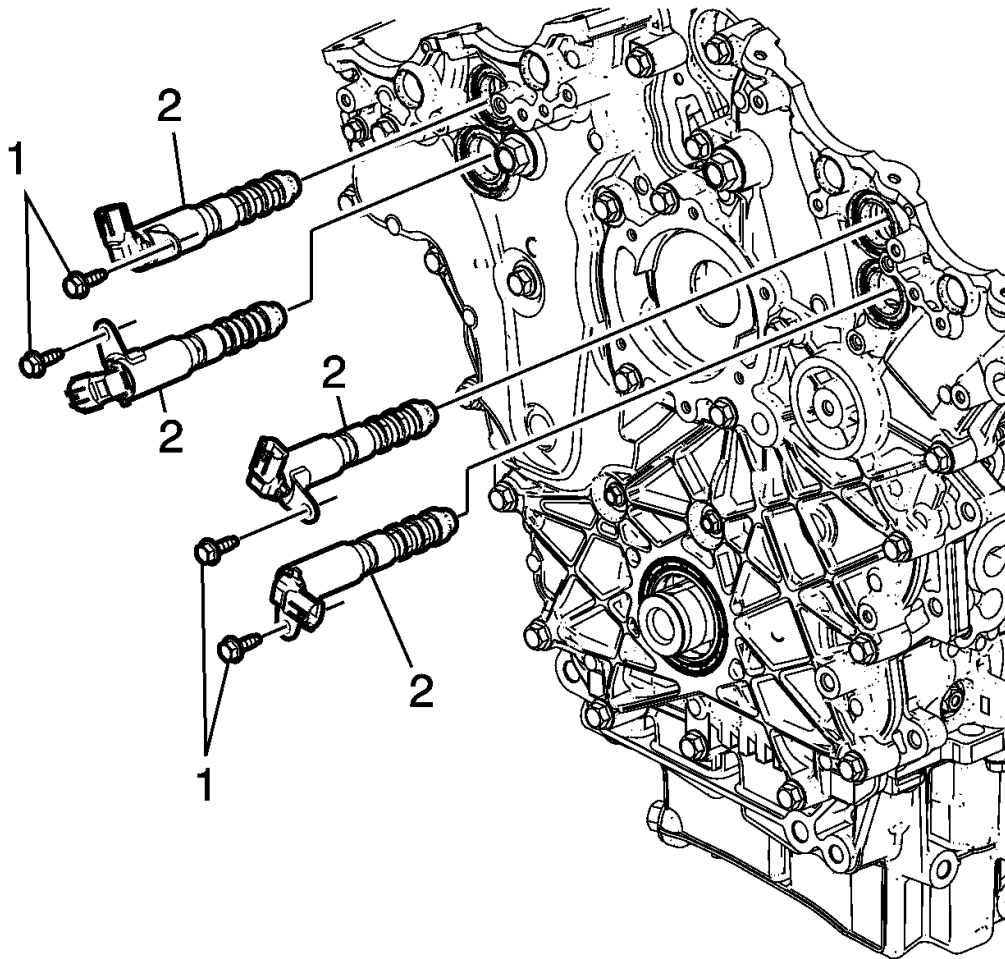
#### Installation Procedure

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



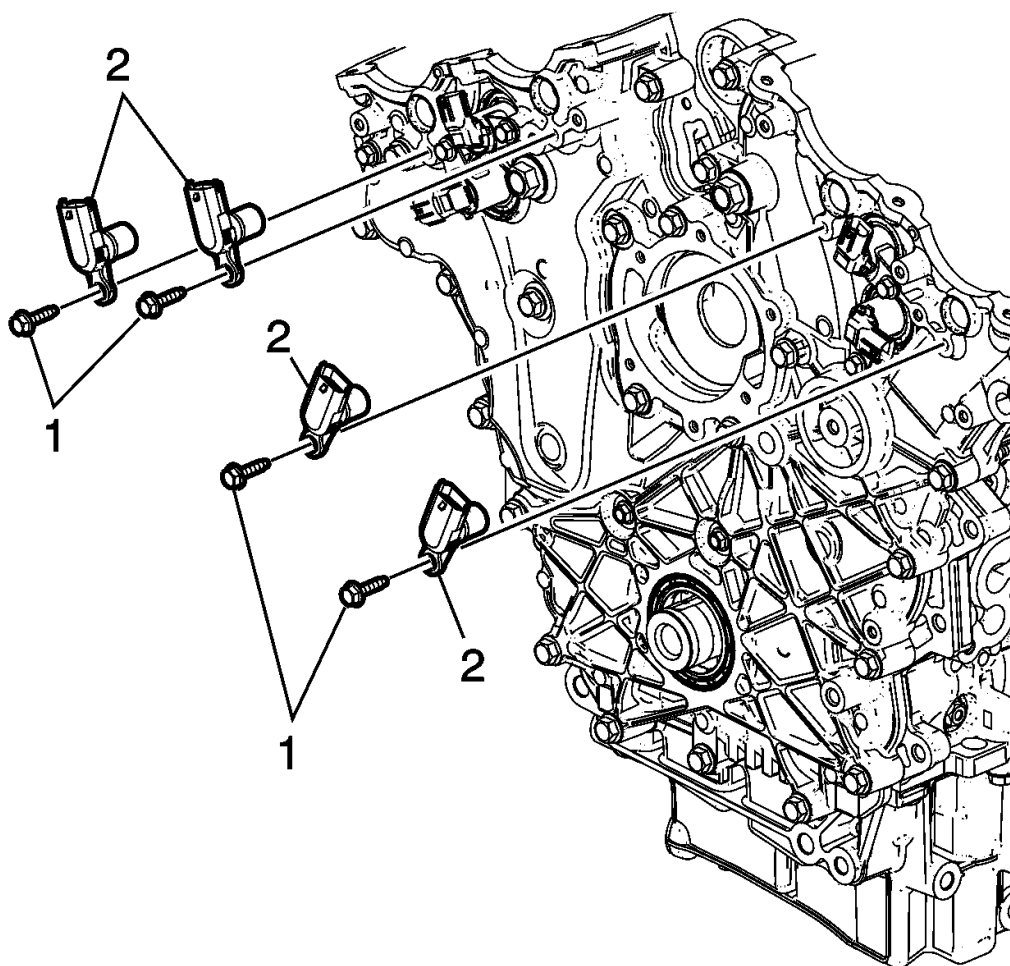
**Fig. 70: View Of Engine Front Cover**  
**Courtesy of GENERAL MOTORS COMPANY**

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



**Fig. 71: Placing Camshaft Position Actuator Valves**  
**Courtesy of GENERAL MOTORS COMPANY**

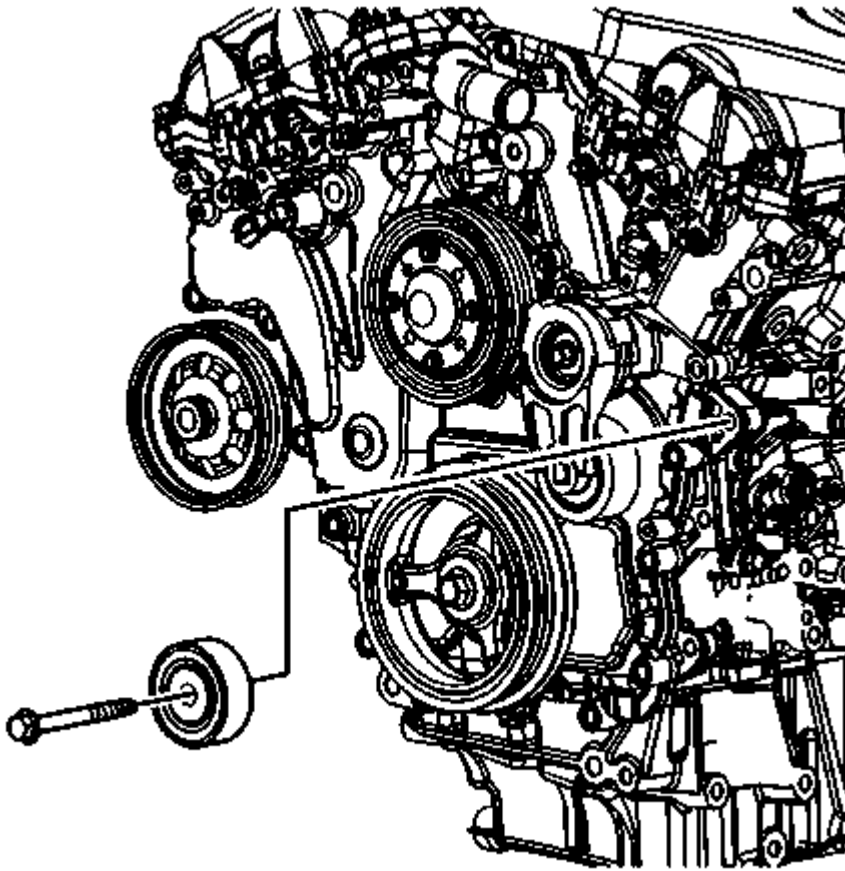
3. Install the camshaft position sensors (2) to the front cover.



**Fig. 72: Placing Camshaft Position Sensors**  
Courtesy of GENERAL MOTORS COMPANY

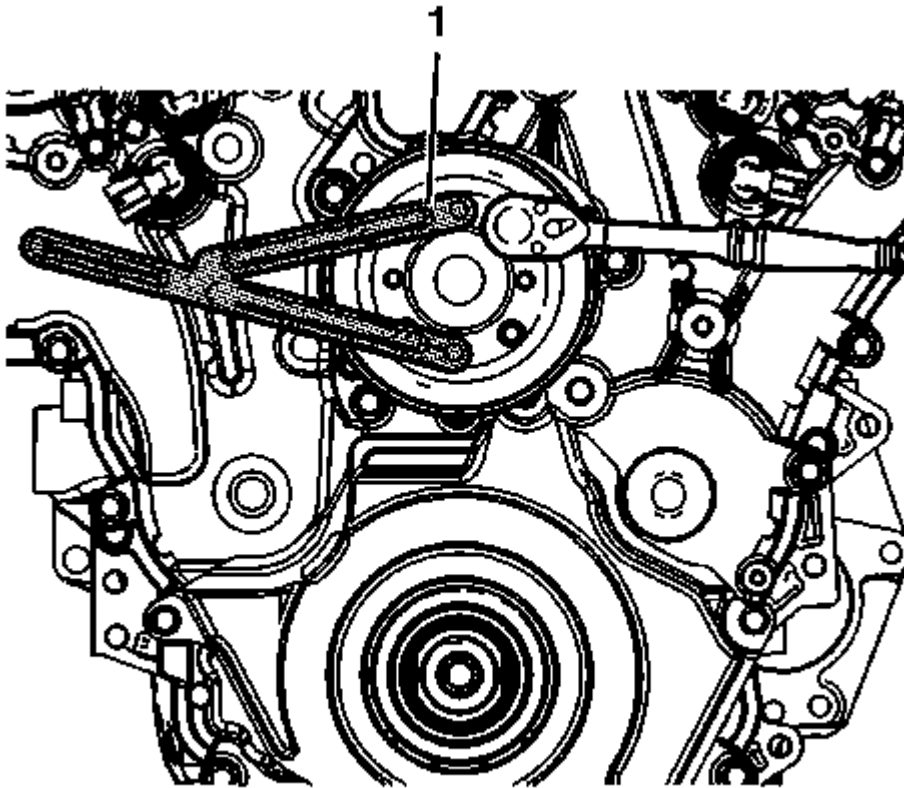
4. Install the generator.
5. Install the drive belt idler bolt and idler. Refer to **Drive Belt Idler Pulley Installation**





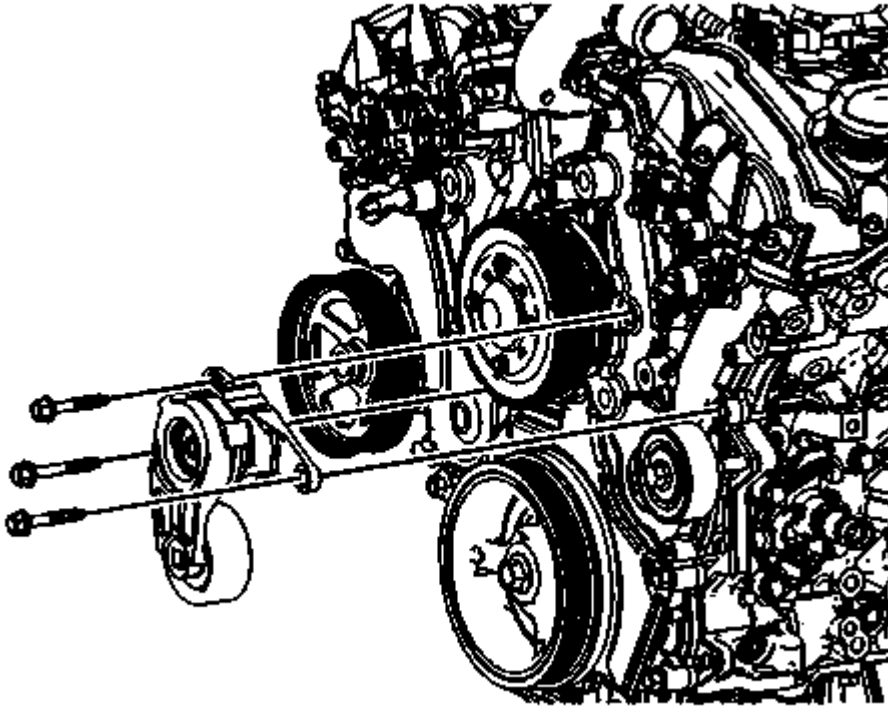
**Fig. 73: Identifying Drive Belt Idler Pulley & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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



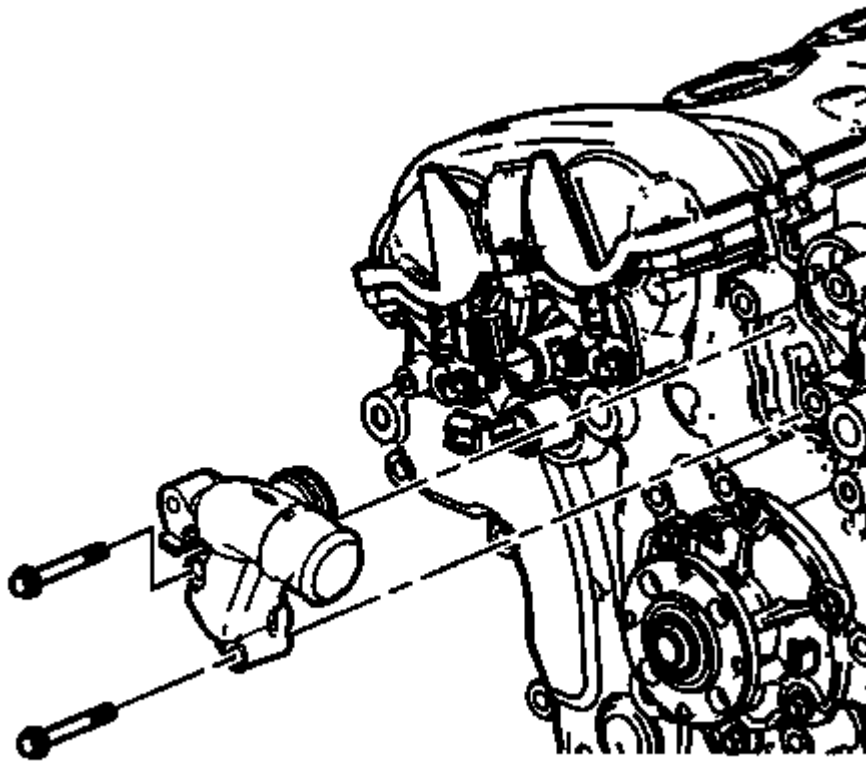
**Fig. 74: Identifying Special Tool - EN 46104**  
Courtesy of GENERAL MOTORS COMPANY

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



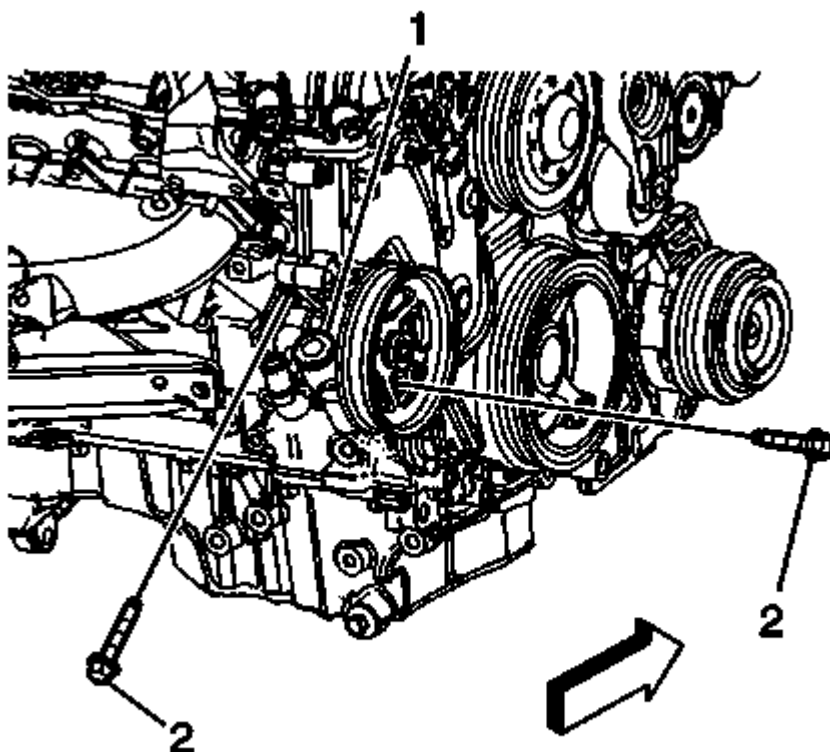
**Fig. 75: Identifying Drive Belt Tensioner Bracket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

12. Install the water outlet housing assembly. Refer to **Water Outlet Installation** .



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

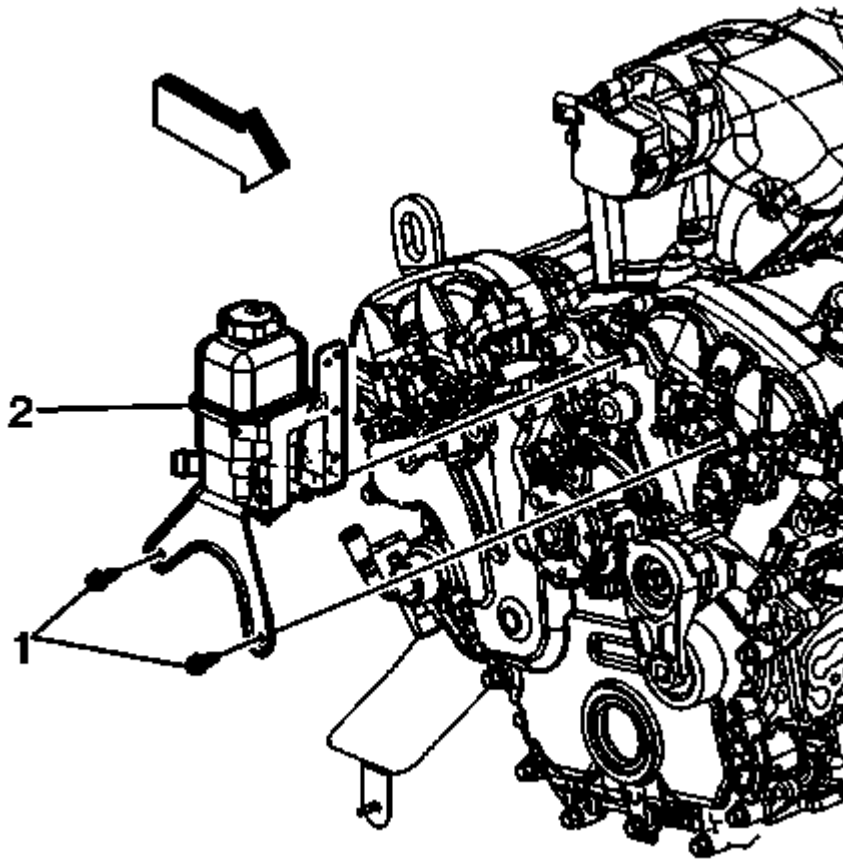
13. Install the engine mount bracket and bracket bolts.
14. Install the left and right camshaft covers. Refer to **Camshaft Cover Installation - Left Side** and **Camshaft Cover Installation - Right Side**.
15. Reposition the power steering pump and install the bracket bolts. Tighten the bolts to 50 N.m (37 lb ft).



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

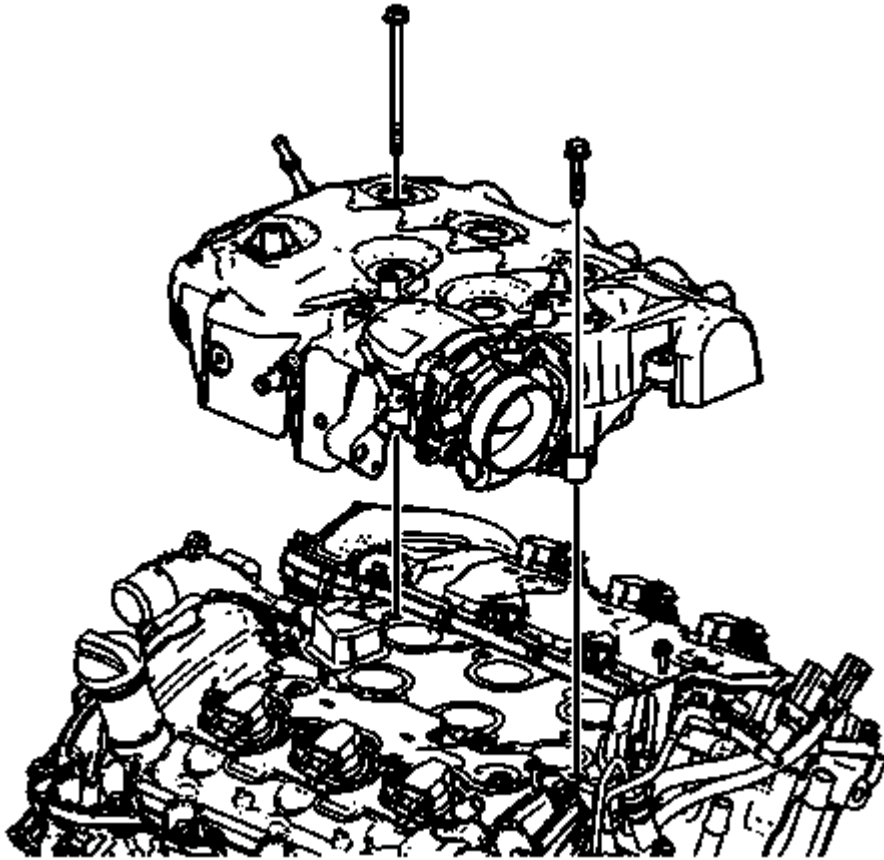
**CAUTION:** Refer to Fastener Caution .

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



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

17. Install the intake manifold. Refer to **Intake Manifold Installation** .



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

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

### **Installation Procedure**

1. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation**.

2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

**SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE****Removal Procedure**

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

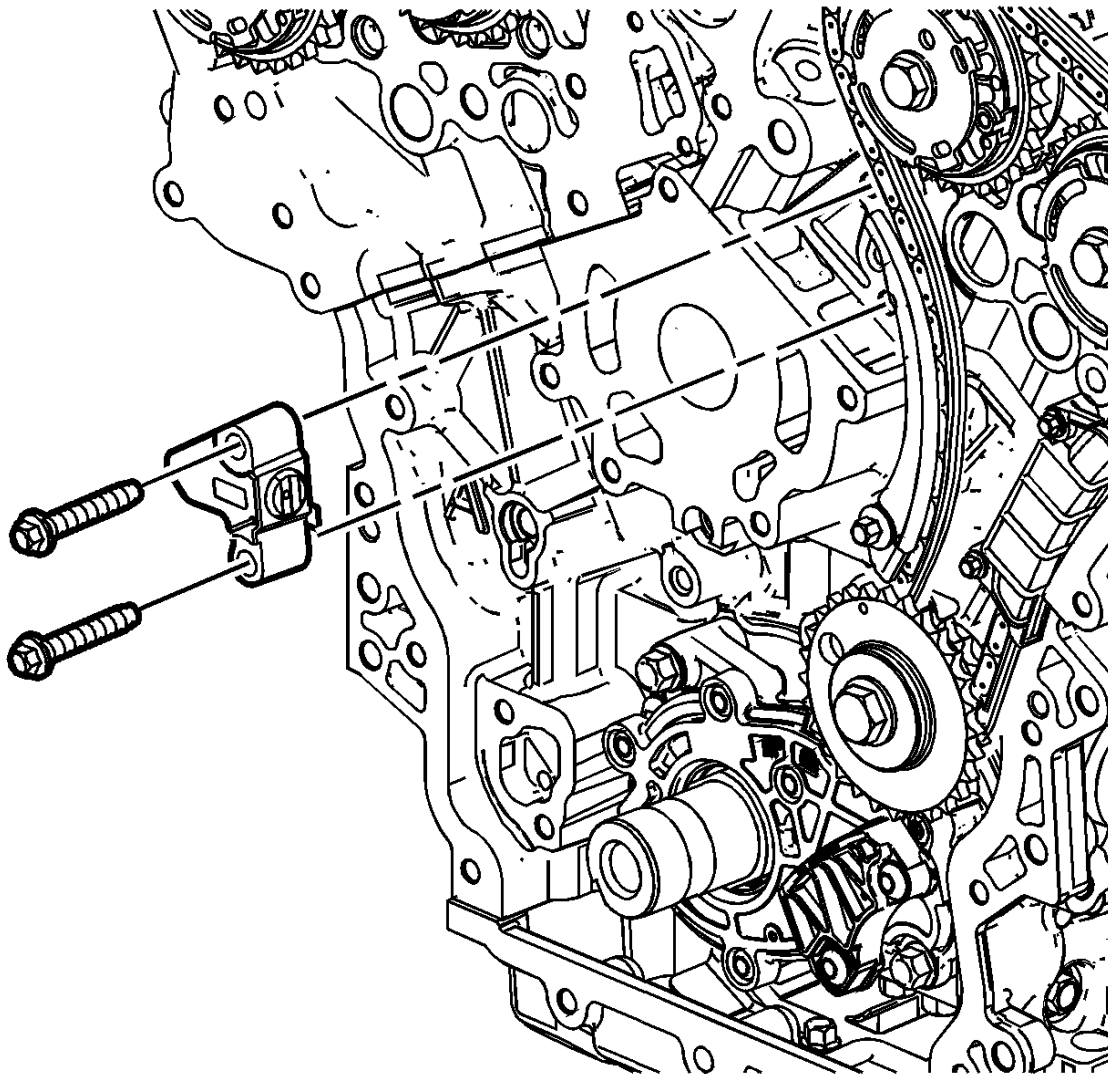
**Installation Procedure**

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

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

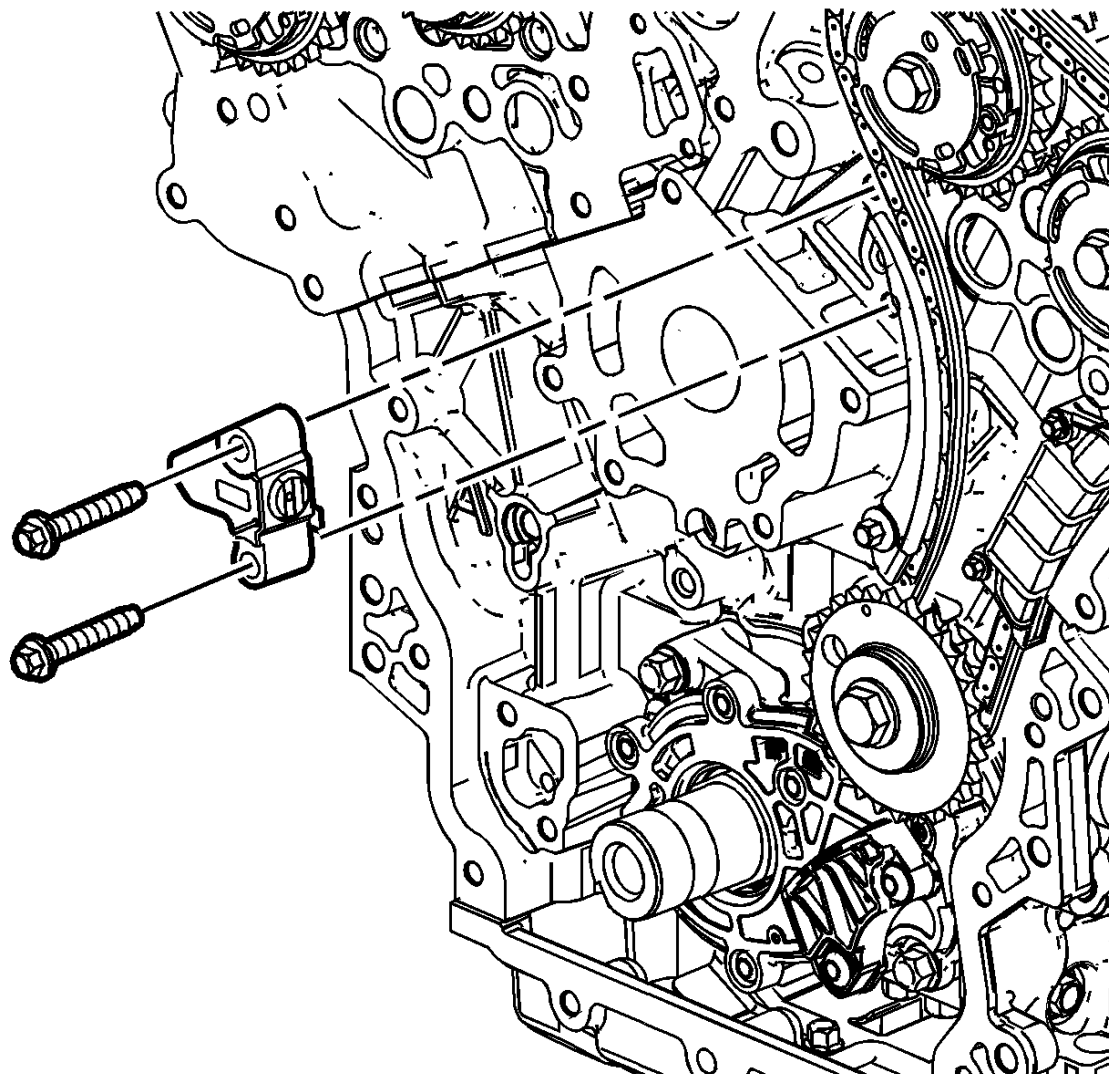




**Fig. 80: Location Of Left Bank Secondary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

#### Installation Procedure

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .



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

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**

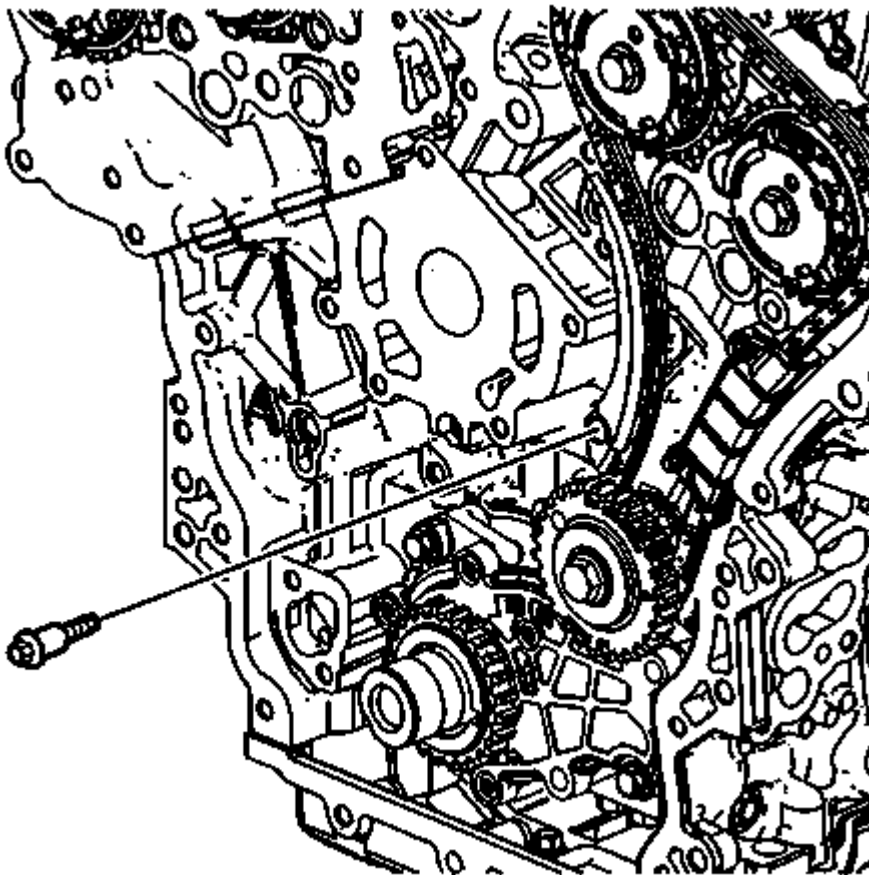
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft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

**Installation Procedure**

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

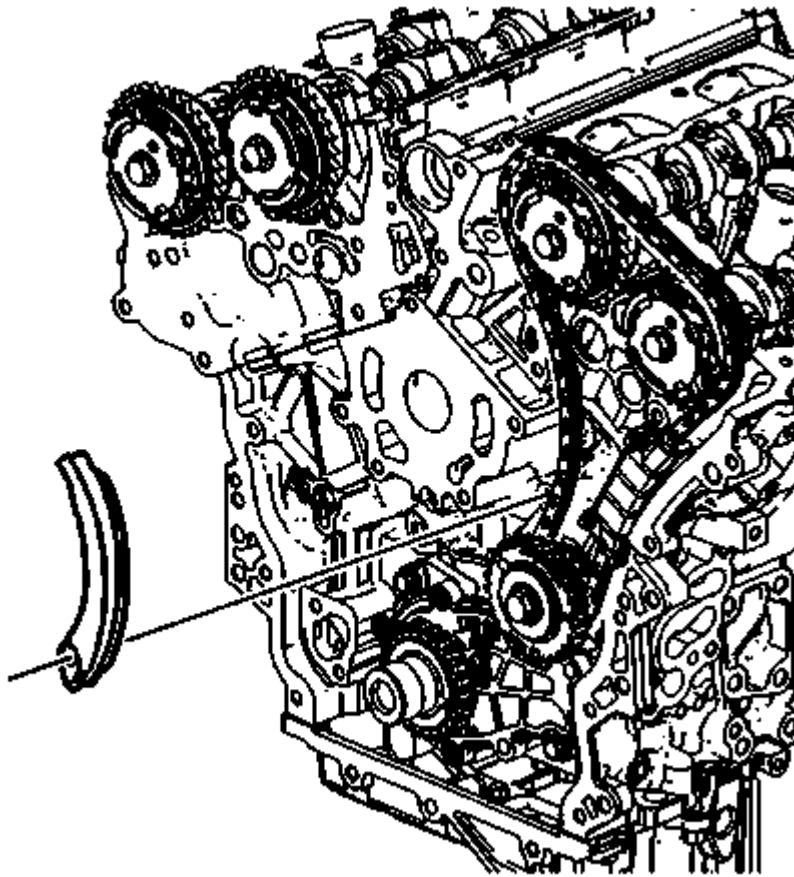
**SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE****Removal Procedure**

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
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** .
4. Remove the left secondary camshaft drive chain shoe bolt.



**Fig. 82: Identifying Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS COMPANY

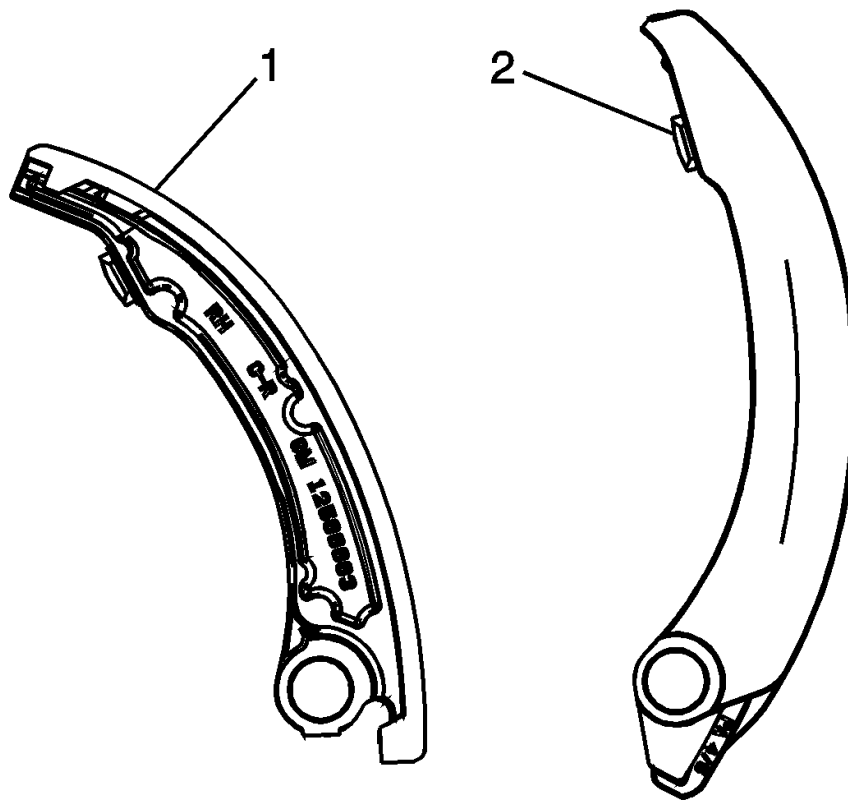
5. Remove the left secondary camshaft drive chain shoe.



**Fig. 83: View Of Left Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

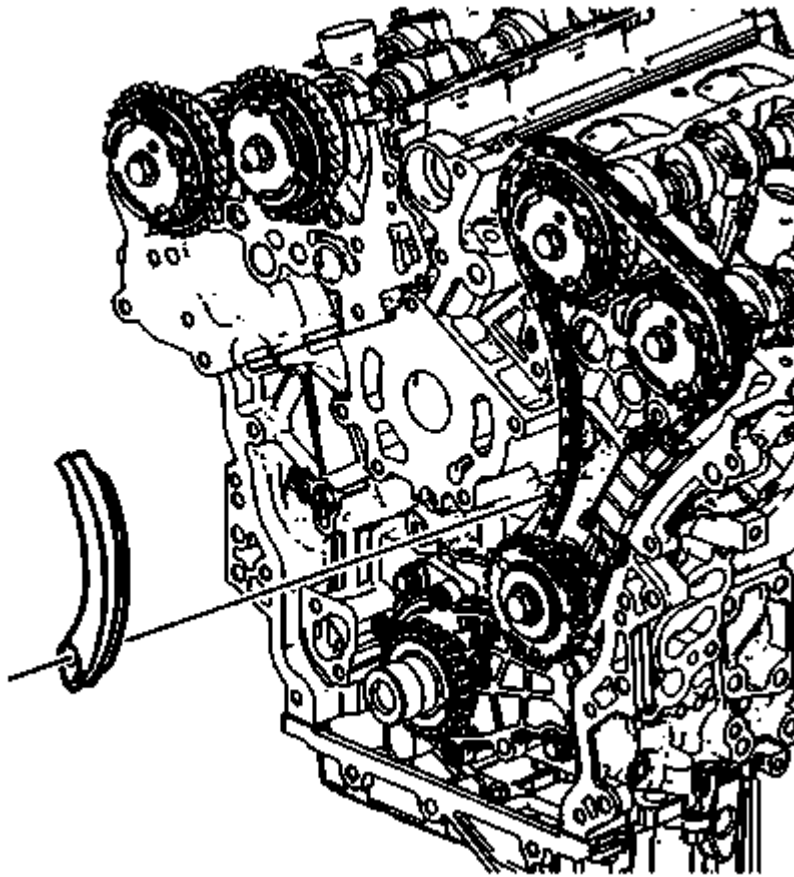
#### **Installation Procedure**

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



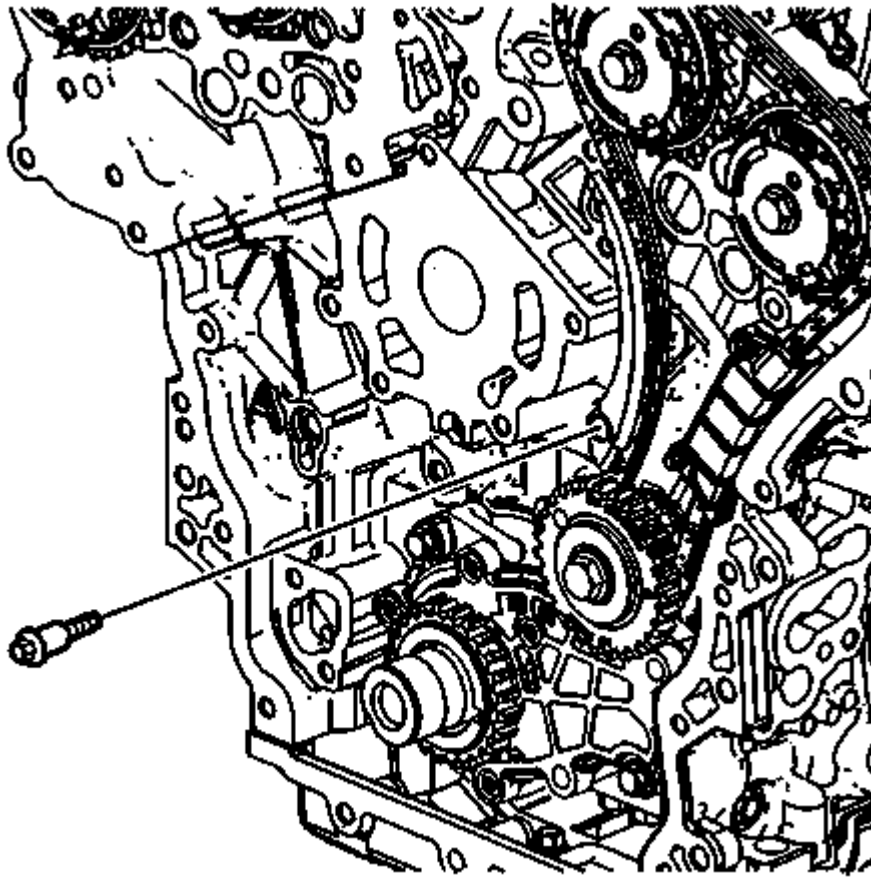
**Fig. 84: Identifying Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

2. Position the left secondary camshaft drive chain shoe.



**Fig. 85: View Of Left Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).



**Fig. 86: Identifying Secondary Camshaft Drive Chain Shoe Bolt**  
Courtesy of GENERAL MOTORS COMPANY

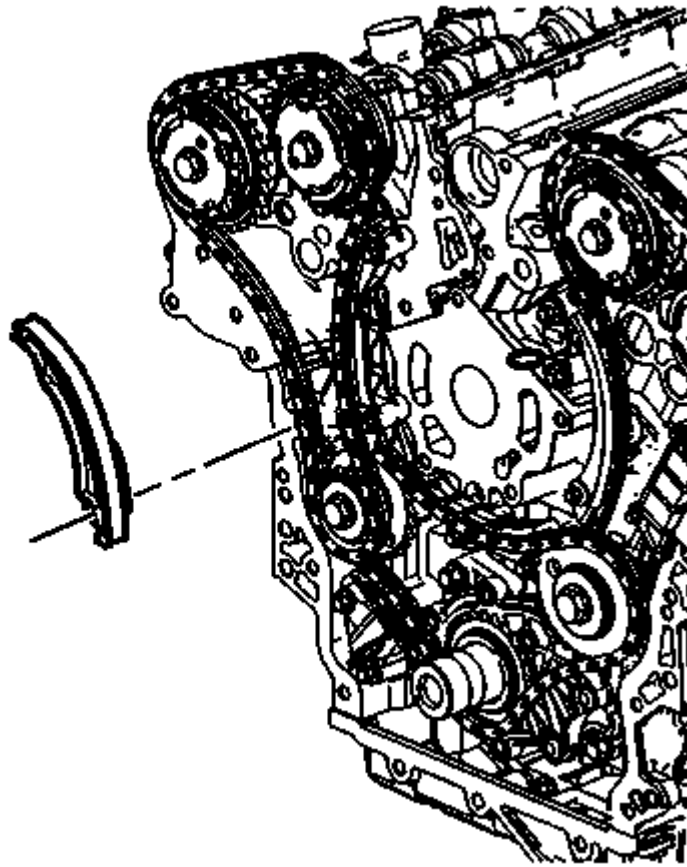
**CAUTION:** Refer to Fastener Caution .

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**

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



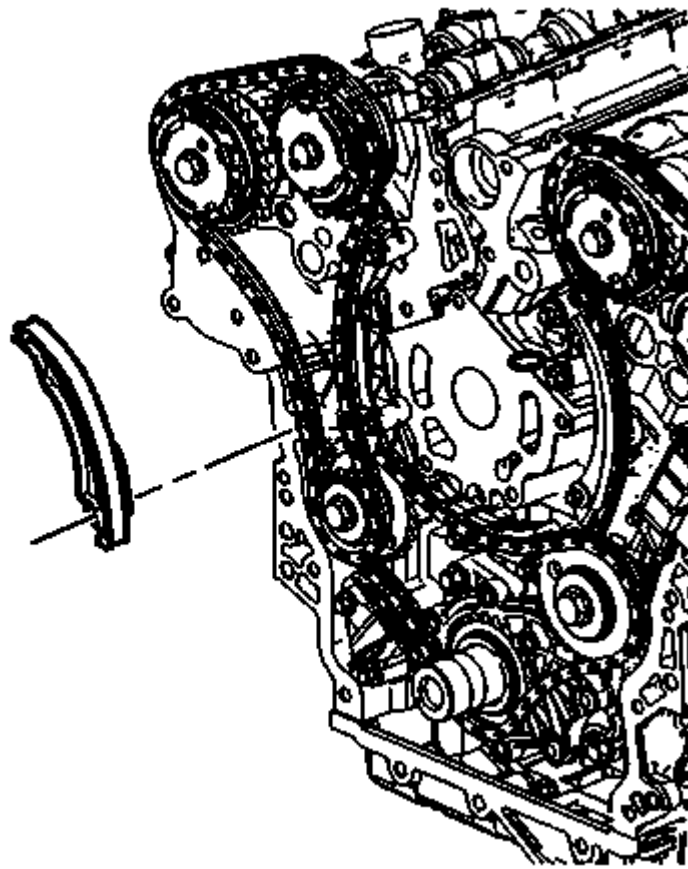
**Fig. 87: View Of Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .





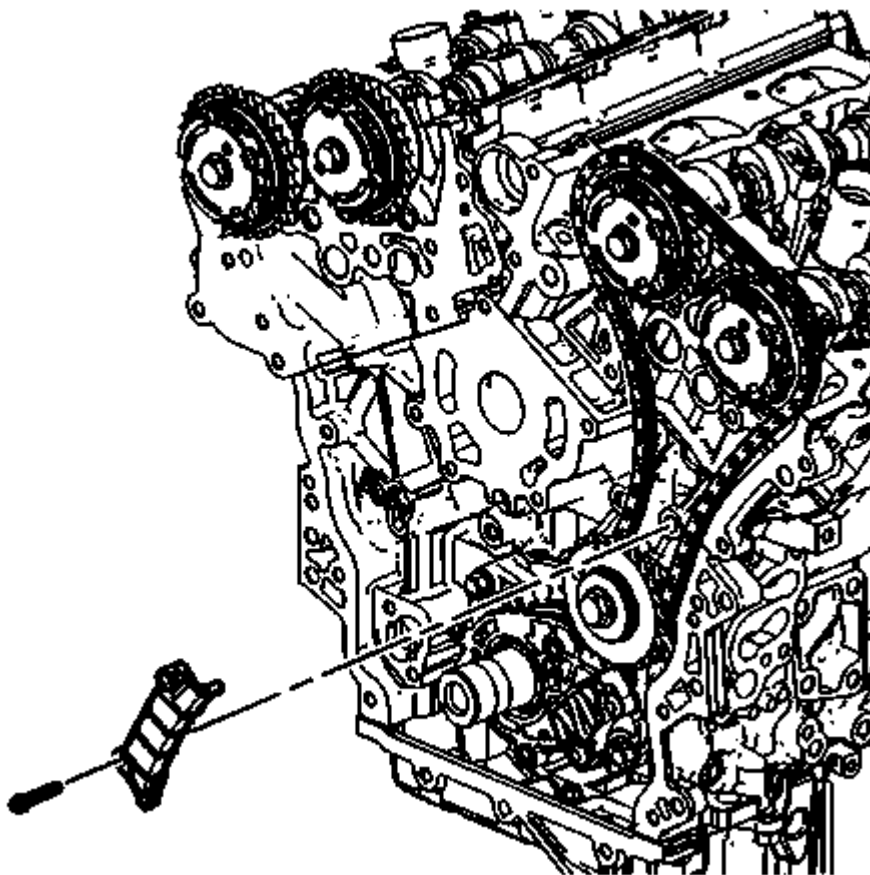
**Fig. 88: View Of Right Secondary Camshaft Drive Chain Shoe**  
Courtesy of GENERAL MOTORS COMPANY

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**

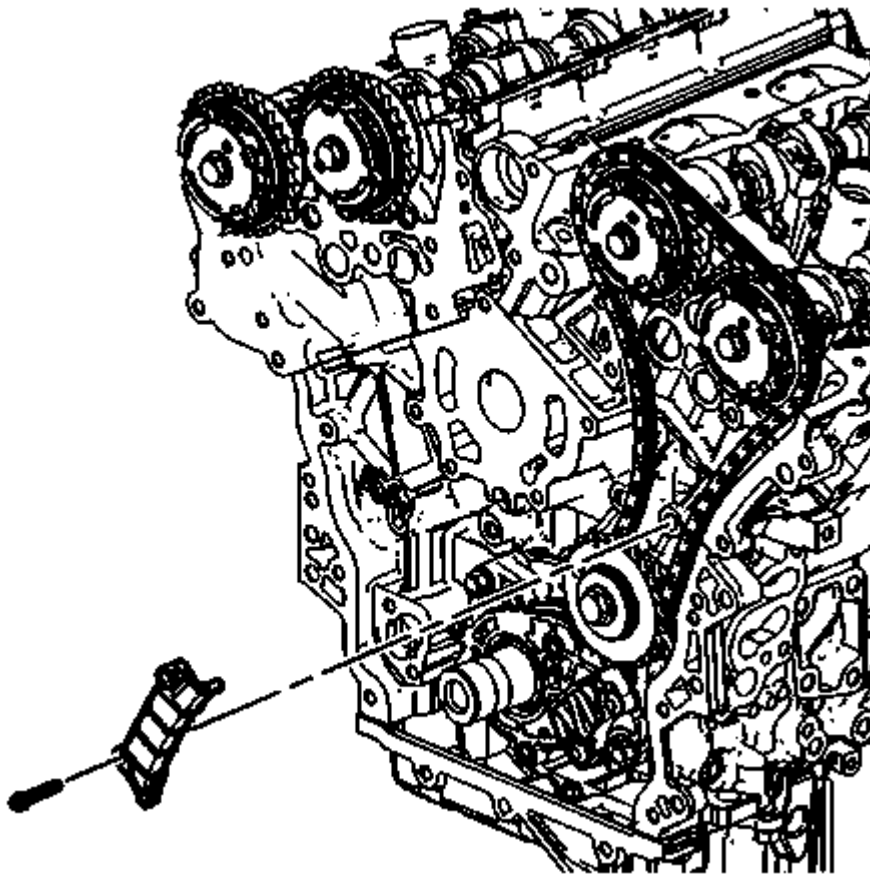
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement**.
3. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal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



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

#### Installation Procedure

1. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .



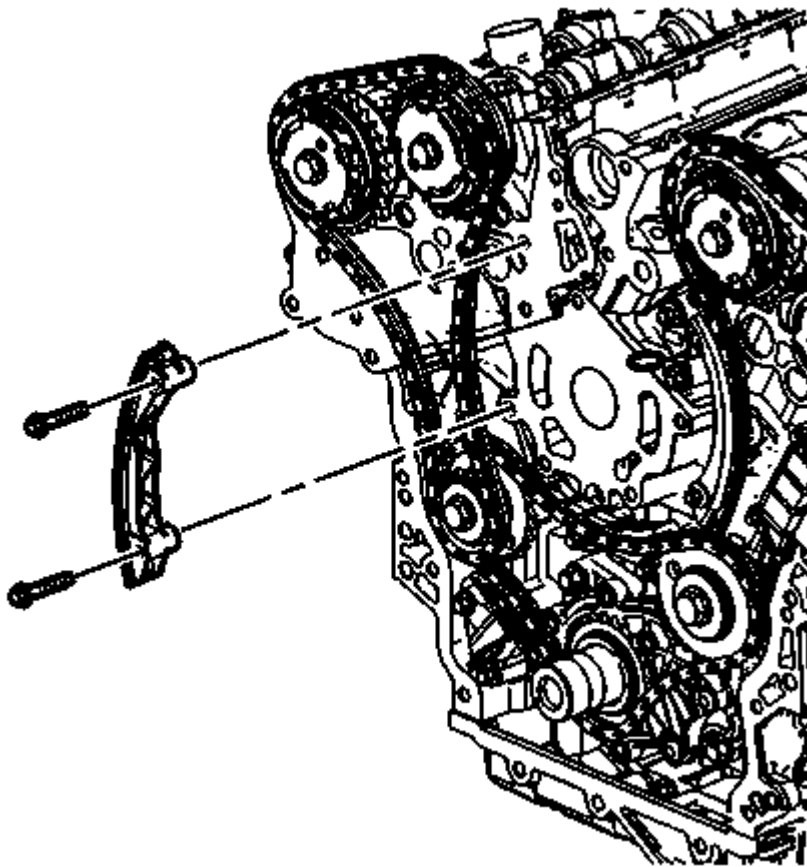
**Fig. 90: View Of Left Bank Secondary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

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

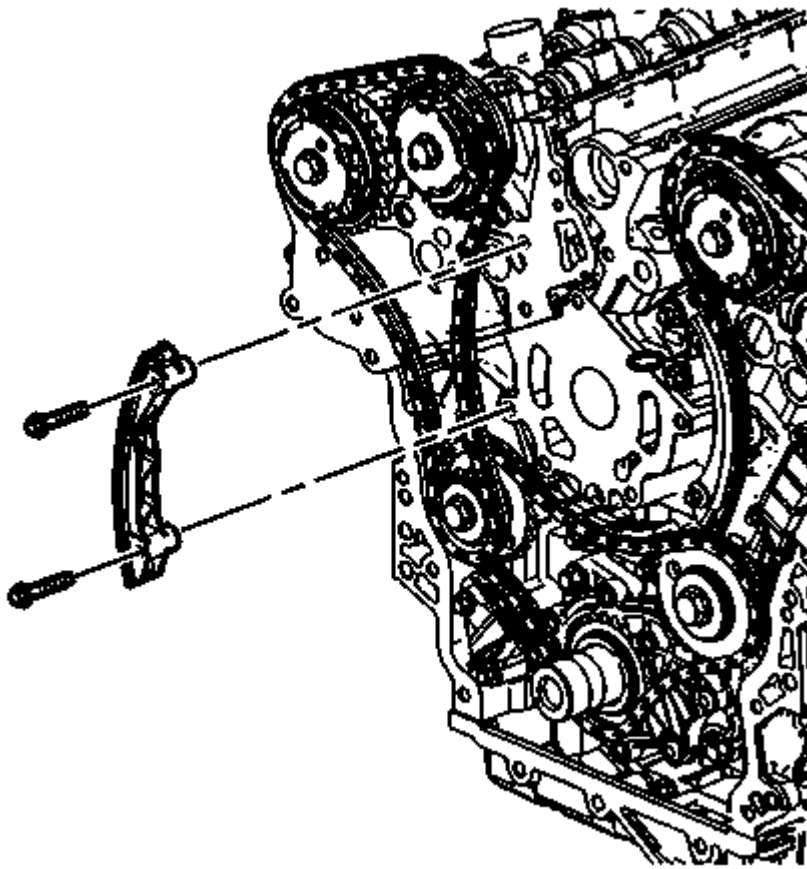
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal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



**Fig. 91: View Of Right Secondary Camshaft Drive Chain Guide & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**Installation Procedure**

1. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .



**Fig. 92: View Of Right Secondary Camshaft Drive Chain Guide & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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**

### **Removal Procedure**

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

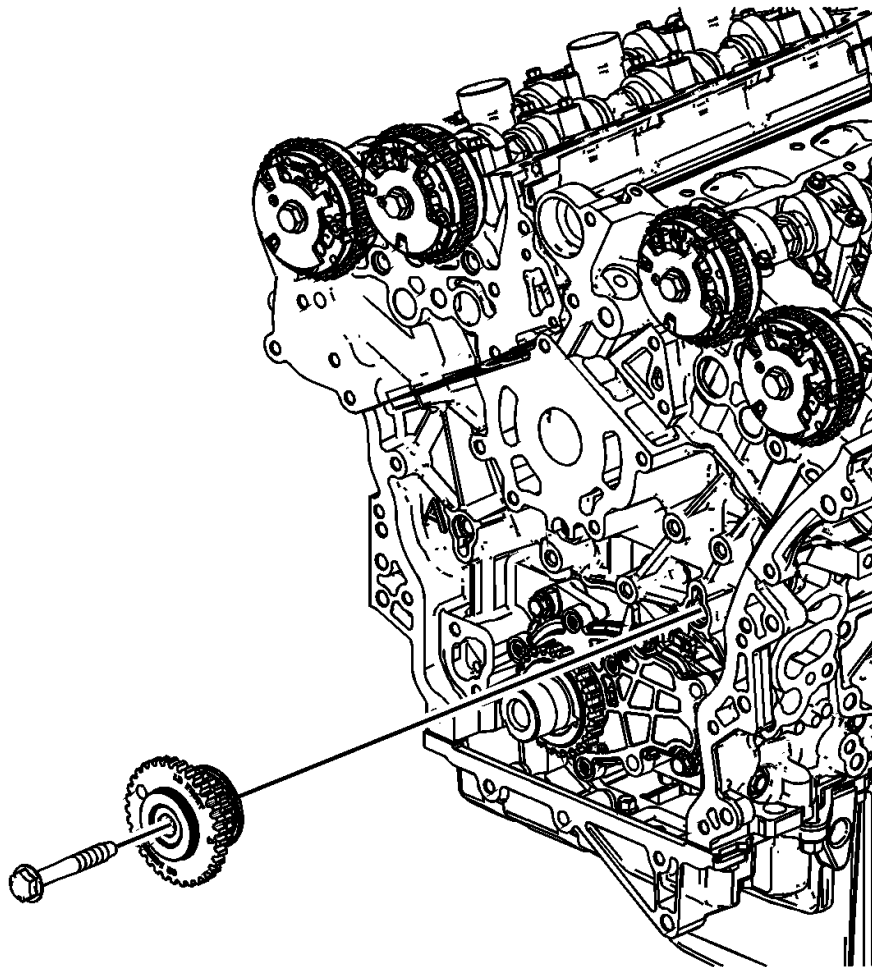
### **Installation Procedure**

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

## **TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE**

### **Removal Procedure**

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

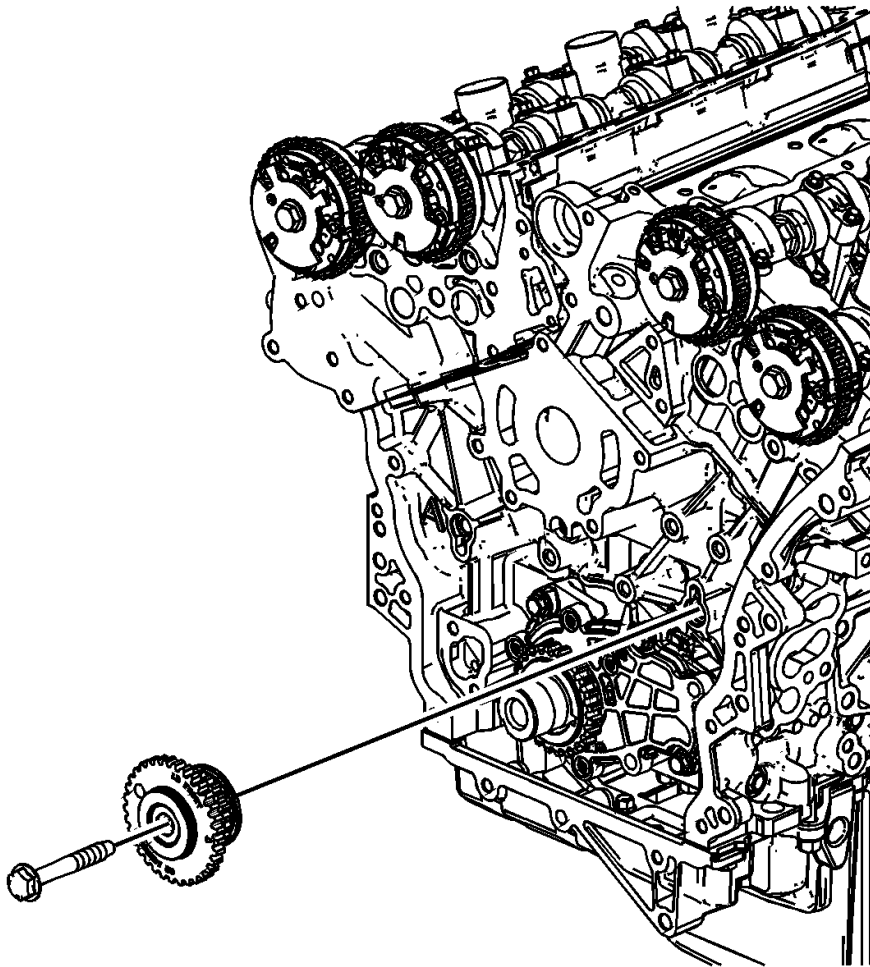


**Fig. 93: View Of Camshaft Intermediate Drive Chain Idler & Bolt**

Courtesy of GENERAL MOTORS COMPANY

#### Installation Procedure

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .



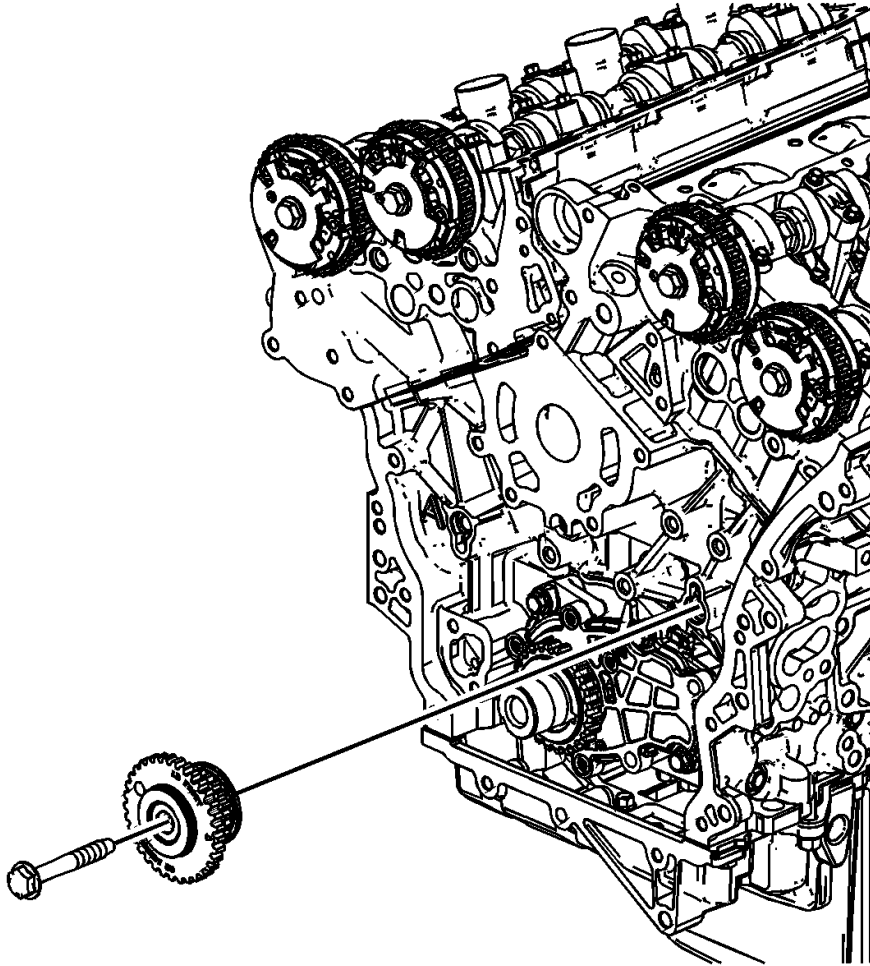
**Fig. 94: View Of Camshaft Intermediate Drive Chain Idler & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement** .

#### **TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE**

#### Removal Procedure

1. Remove spark plugs. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal** .
4. Remove the right intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

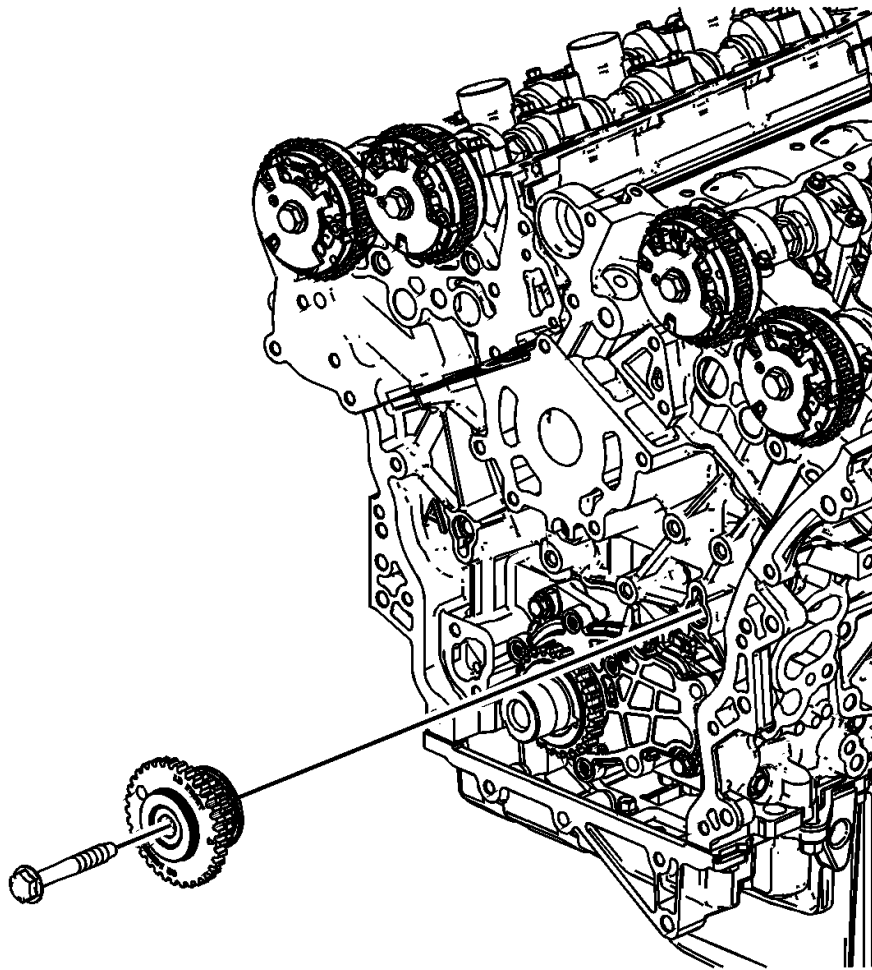


**Fig. 95: View Of Camshaft Intermediate Drive Chain Idler & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

#### **Installation Procedure**

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .





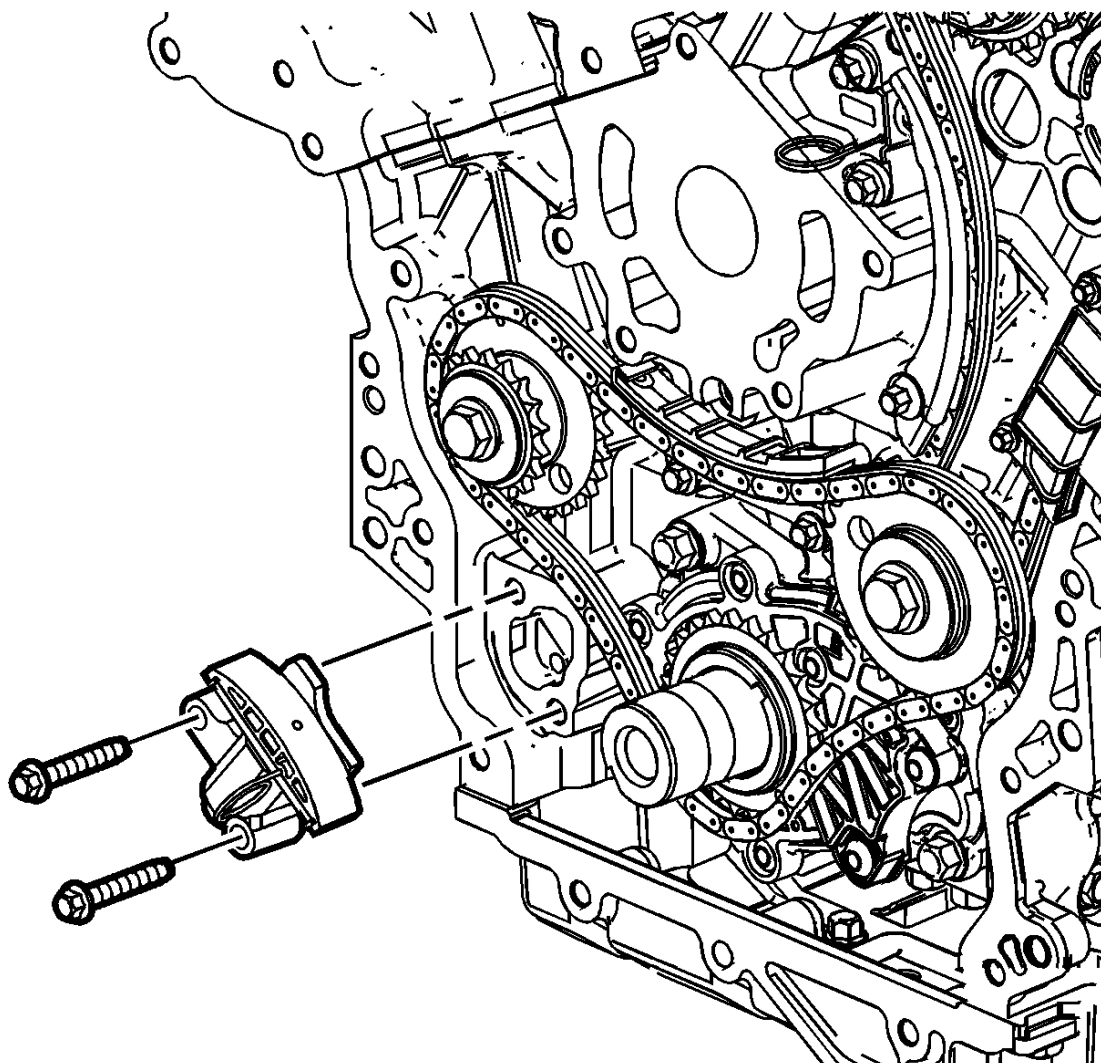
**Fig. 96: View Of Camshaft Intermediate Drive Chain Idler & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement** .

## **PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT**

### **Removal Procedure**

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



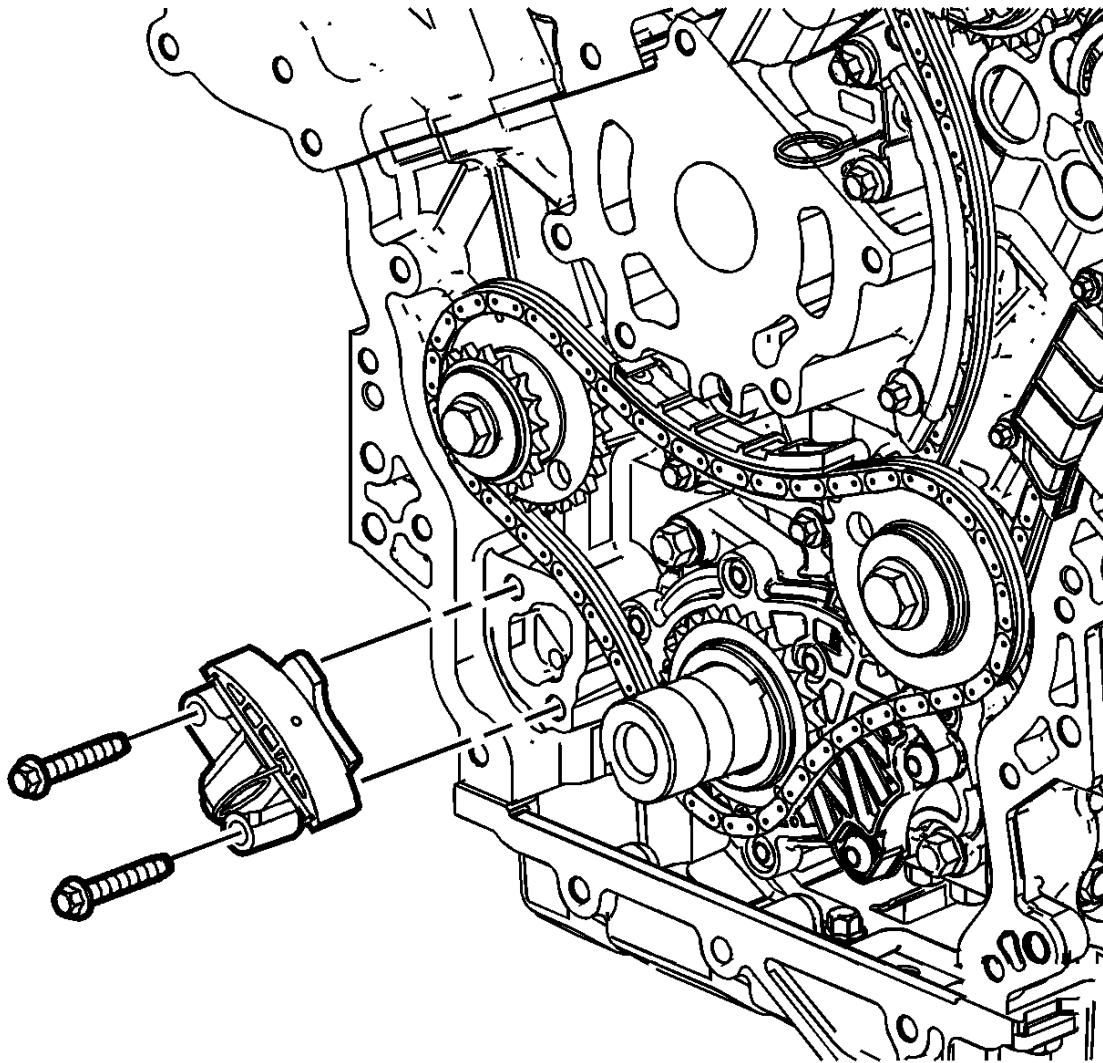
**Fig. 97: View Of Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .

**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.

#### Installation Procedure

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



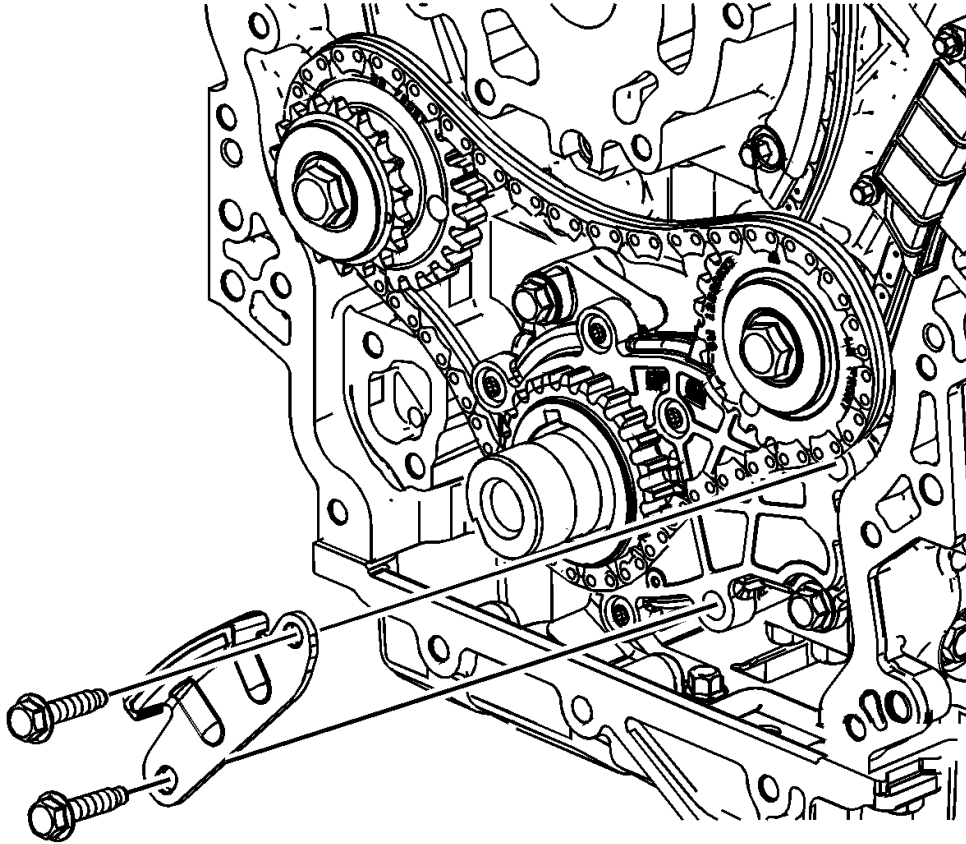
**Fig. 98: View Of Primary Camshaft Drive Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

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

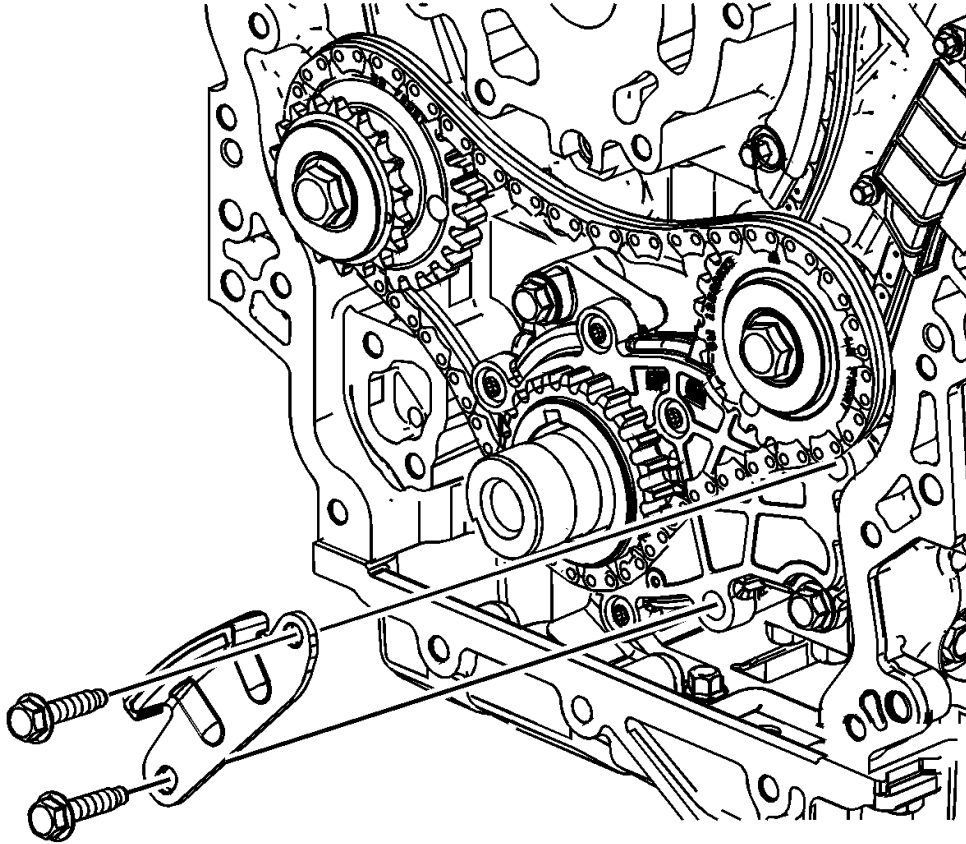


**Fig. 99: View Of Primary Camshaft Drive Chain Lower Guide Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove the primary camshaft drive chain lower guide.

#### **Installation Procedure**

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



**Fig. 100: View Of Primary Camshaft Drive Chain Lower Guide Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the primary camshaft drive chain lower guide bolts and tighten to 25 N.m (18 lb ft).

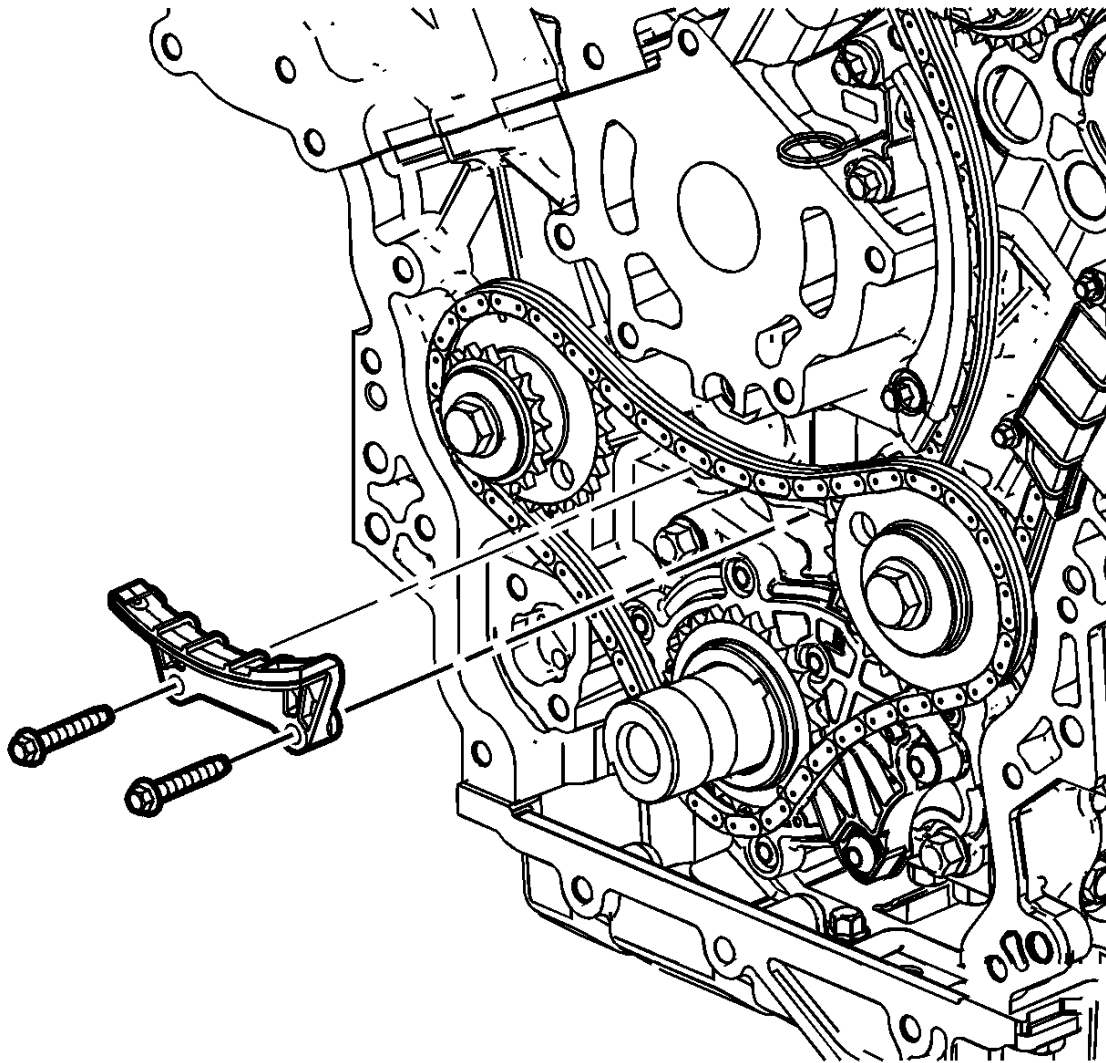
**CAUTION:** Refer to **Fastener Caution** .

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**

1. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .

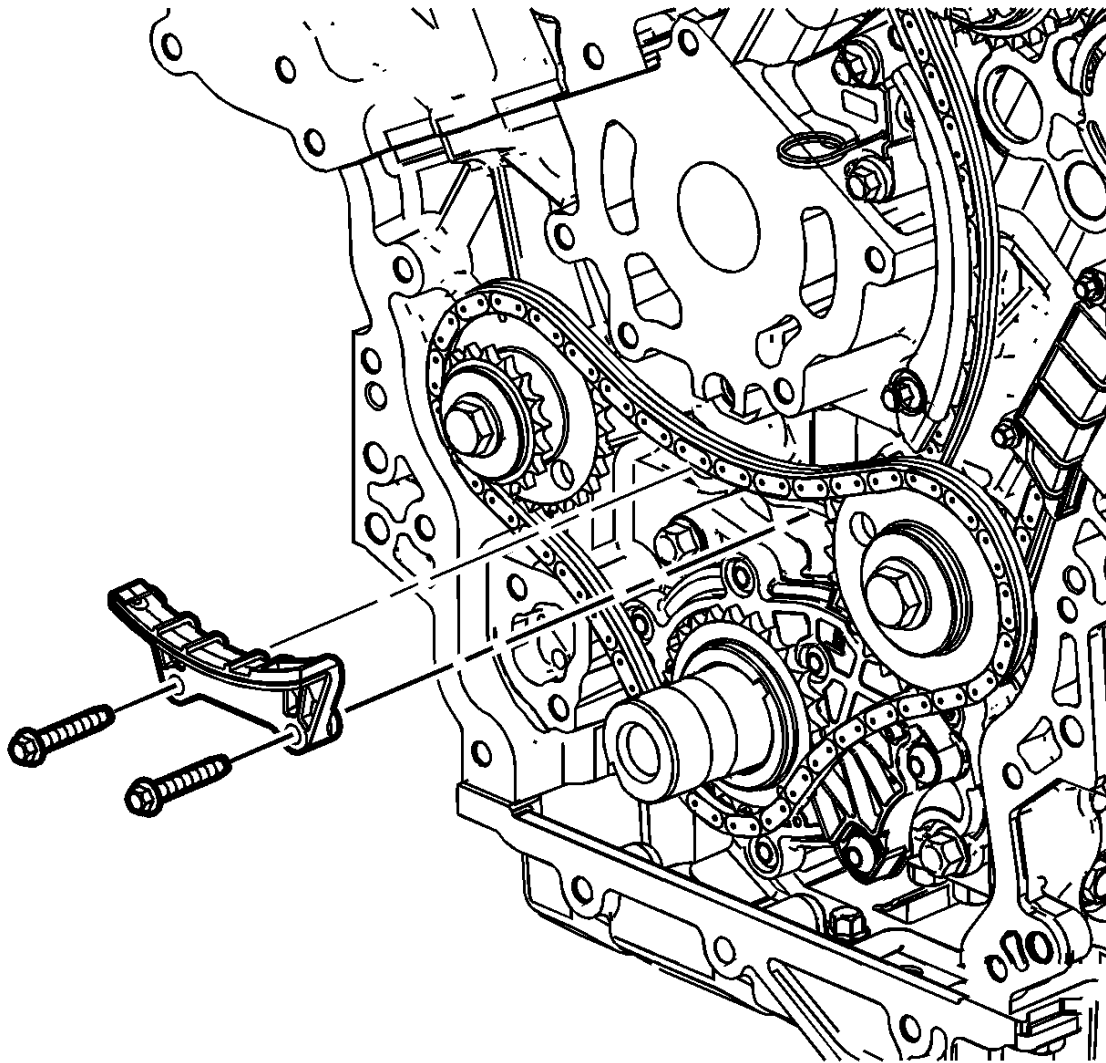


**Fig. 101: View Of Upper Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper**.



**Fig. 102: View Of Upper Primary Camshaft Drive Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

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** .

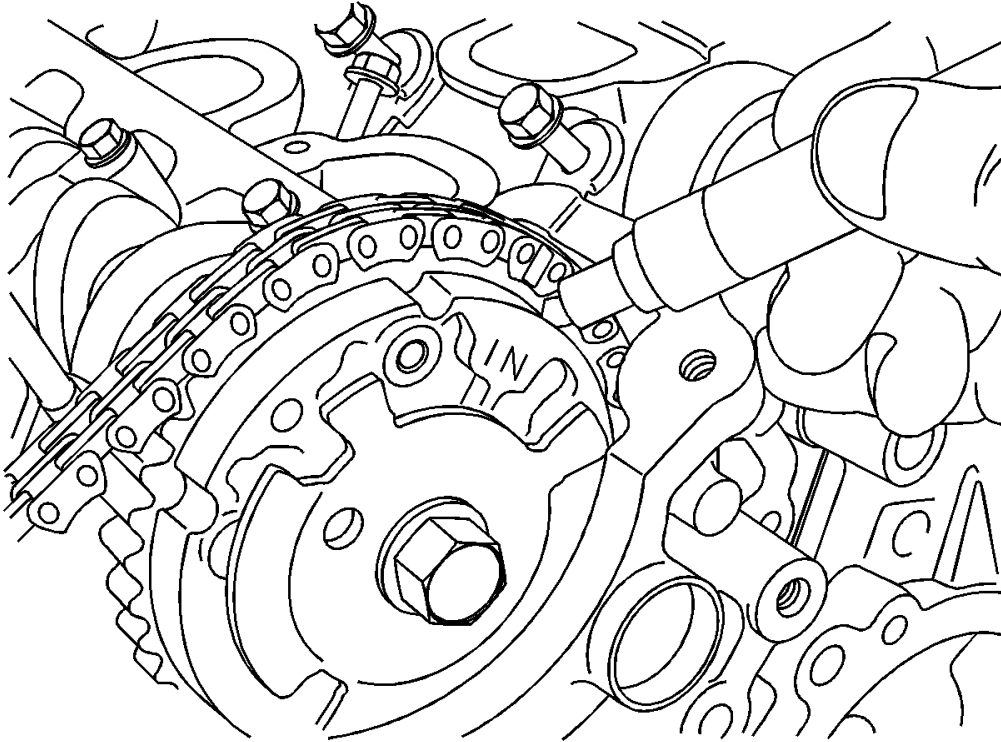
**Removal Procedure**

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.
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.

**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.**

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

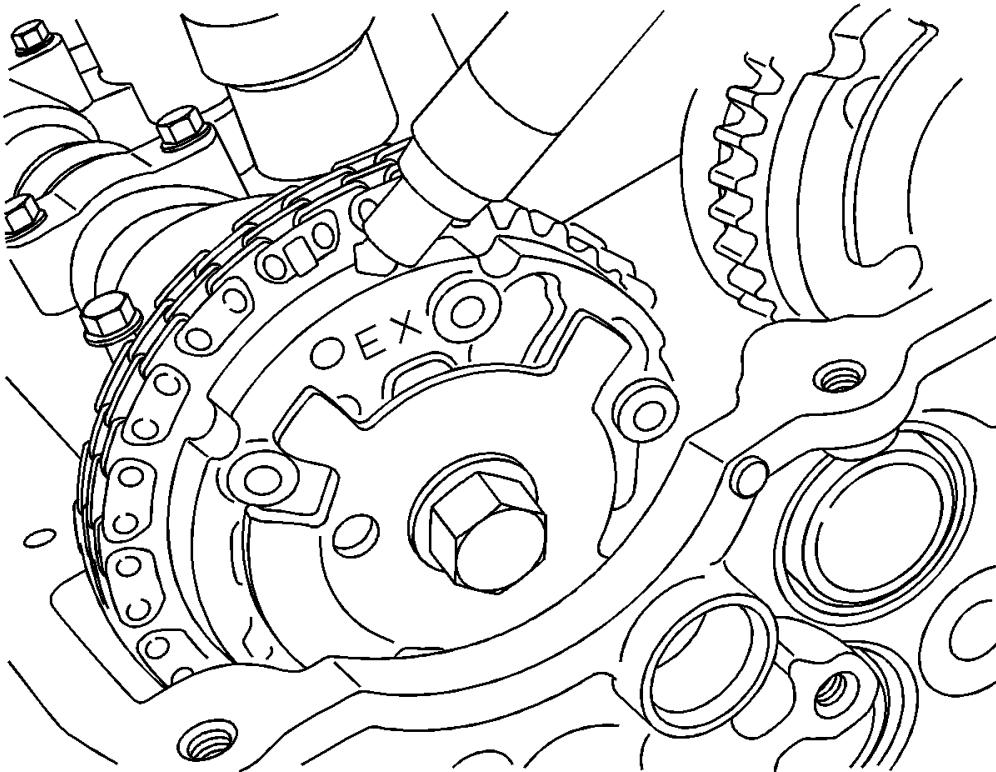




**Fig. 103: Marking Position Of Chain To Camshaft Position Actuator - Intake**  
Courtesy of GENERAL MOTORS COMPANY

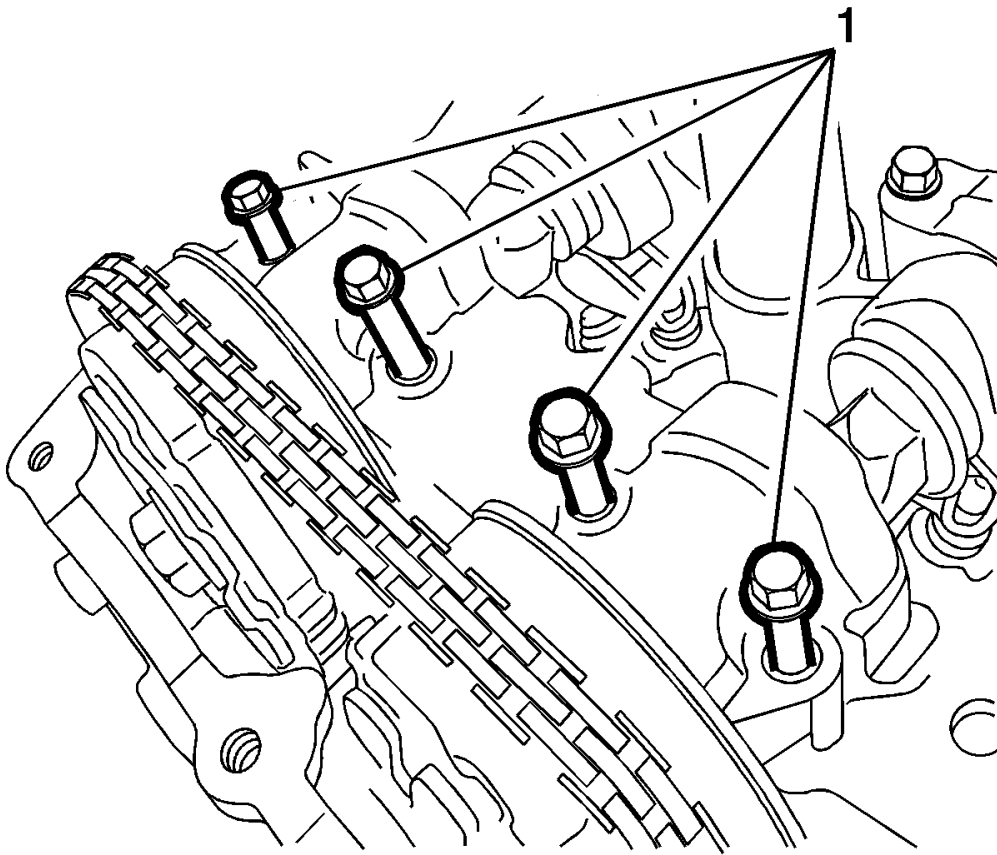
**NOTE:** Be certain to clearly mark the position of the chain to the camshaft position actuator(s). Though the engine does not need to be set to a specific timing mark before starting the procedure, the relationship of the chain to the actuator(s) is critical and must be reestablished on assembly.

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



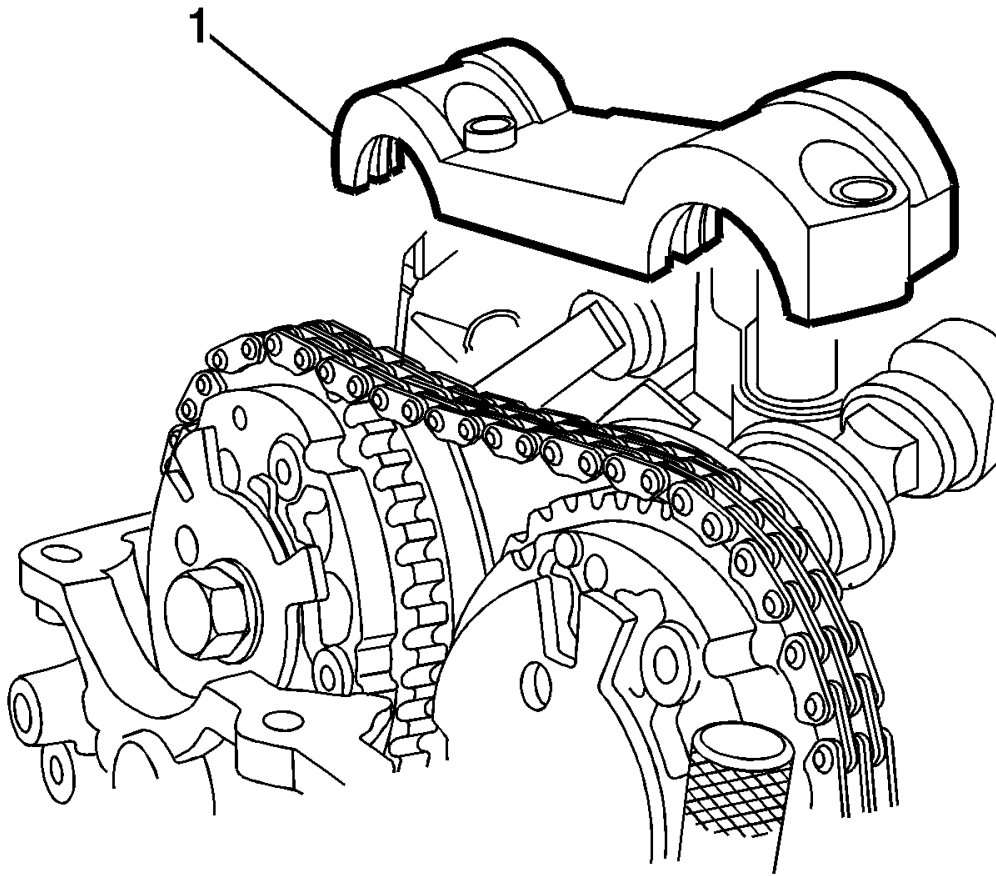
**Fig. 104: Marking Position Of Chain To Camshaft Position Actuator - Exhaust**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).



**Fig. 105: Identifying Camshaft Front Cap & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

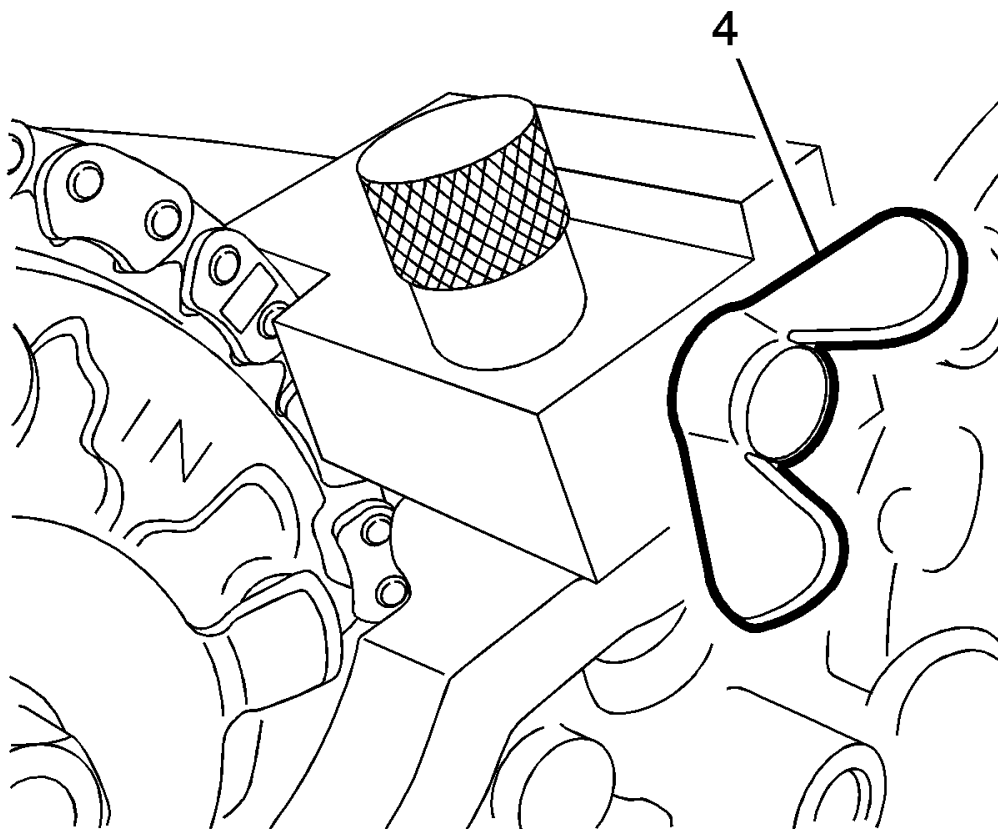
11. Remove the camshaft front cap (1).



**Fig. 106: 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.

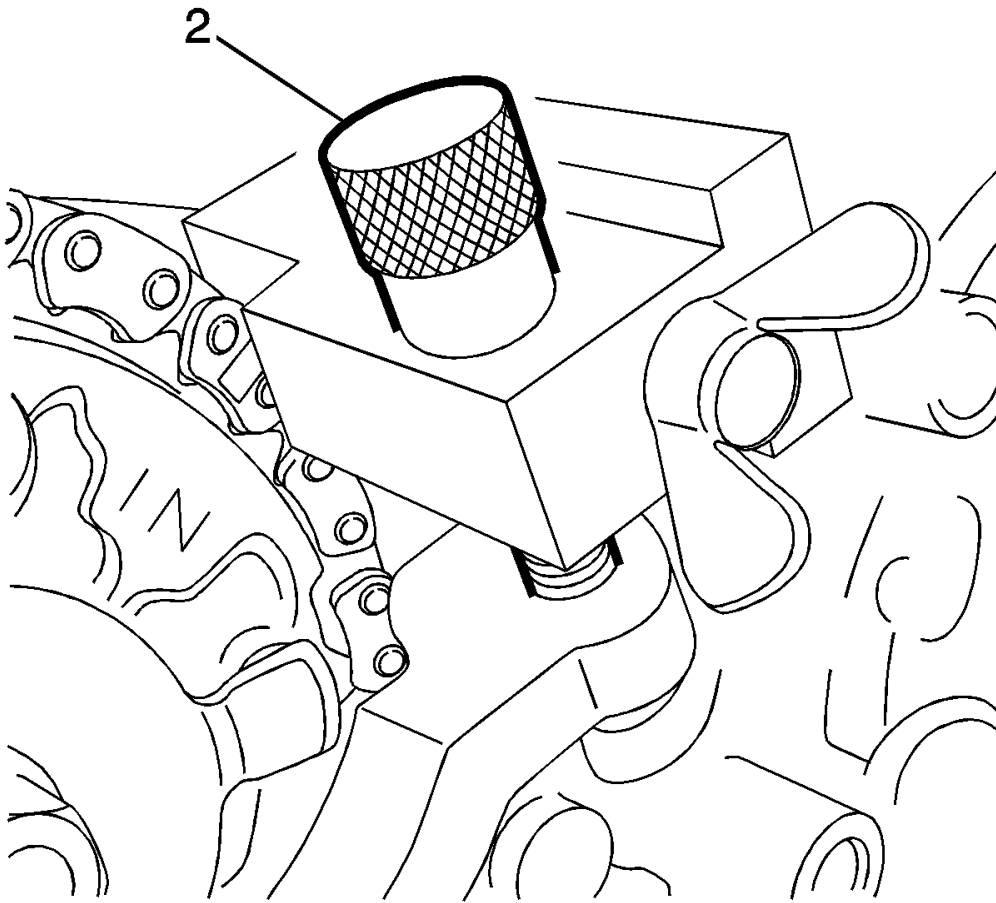
12. Loosen wingnut (4) to open the clamping area of EN49982-1 retainer.



**Fig. 107: Retainer Wingnut**

Courtesy of GENERAL MOTORS COMPANY

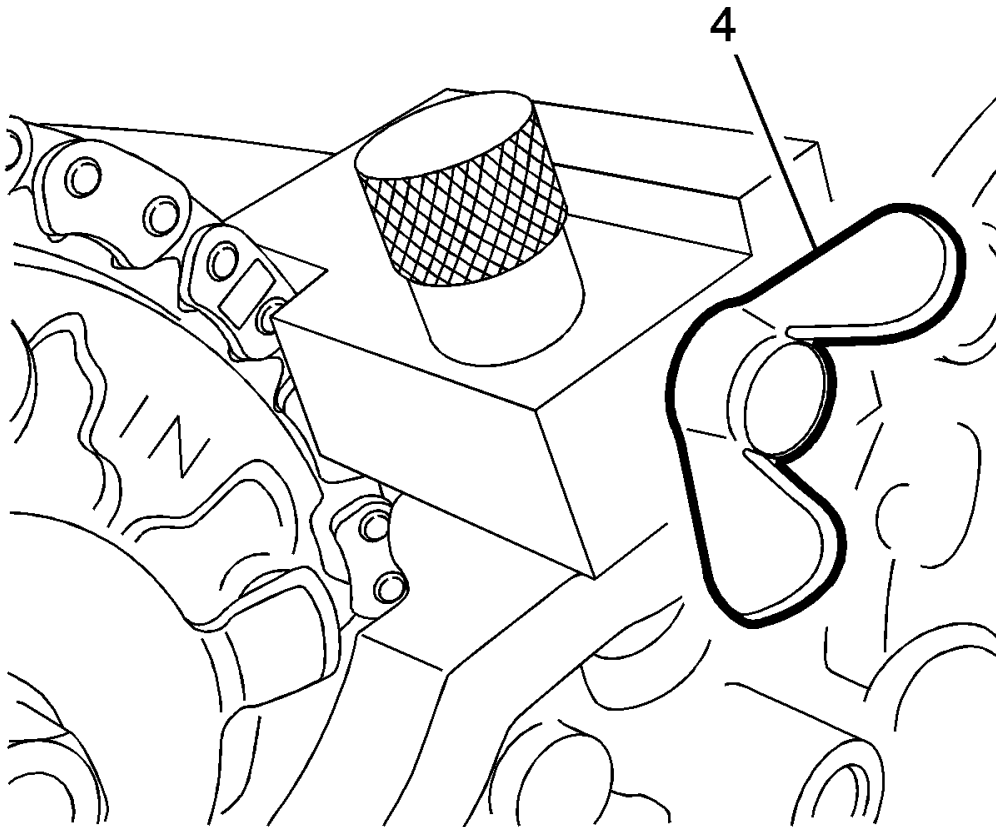
13. Install EN49982-1 retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the EN49982-1 retainer finger-tight.



**Fig. 108: 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.

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

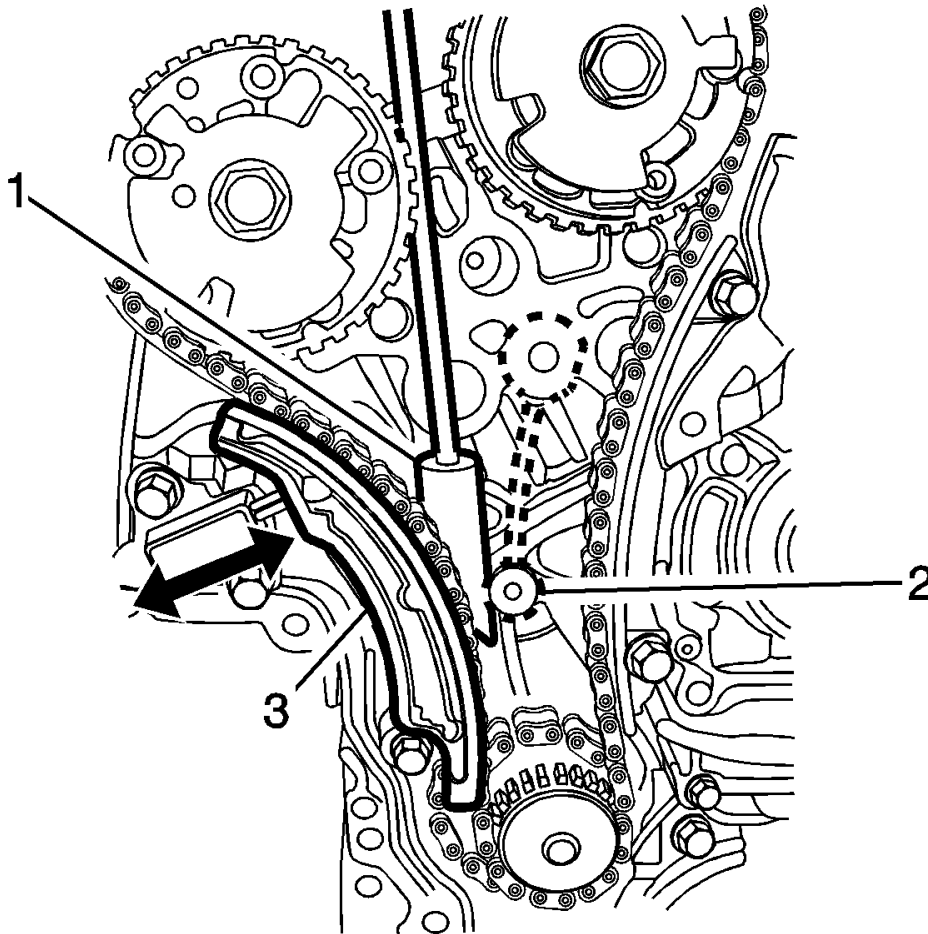


**Fig. 109: Retainer Wingnut**

Courtesy of GENERAL MOTORS COMPANY

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

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.



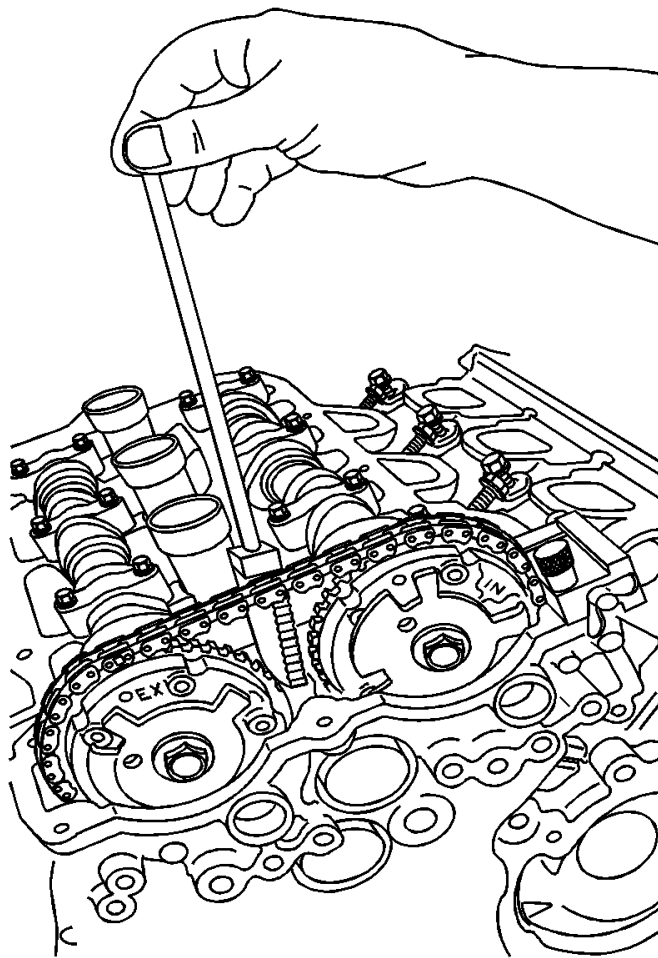
**Fig. 110: Retainer Wedge**

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.

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.

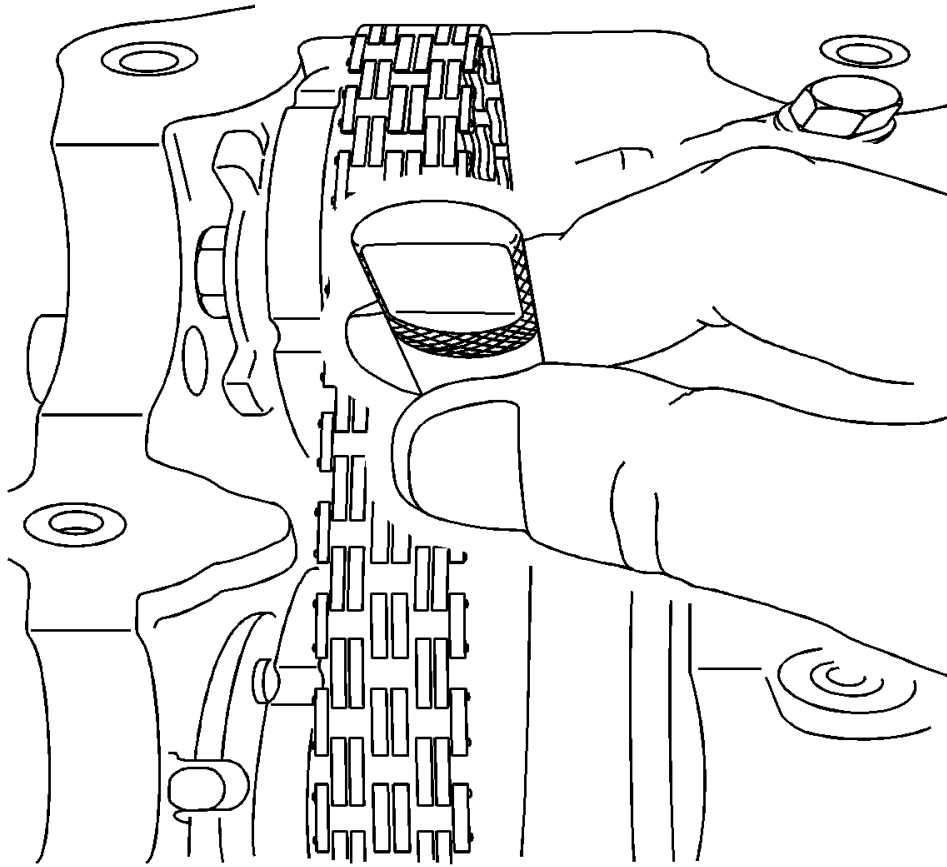




**Fig. 111: Inserting Retainer**

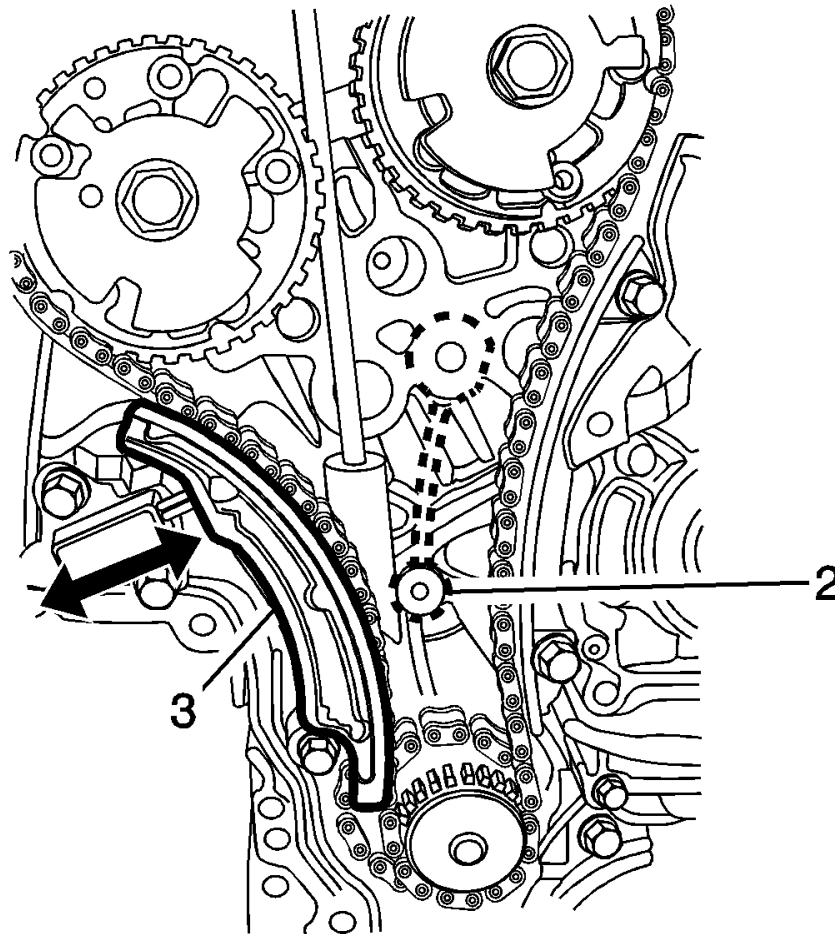
Courtesy of GENERAL MOTORS COMPANY

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. 112: Orienting Retainer Teeth**  
Courtesy of GENERAL MOTORS COMPANY

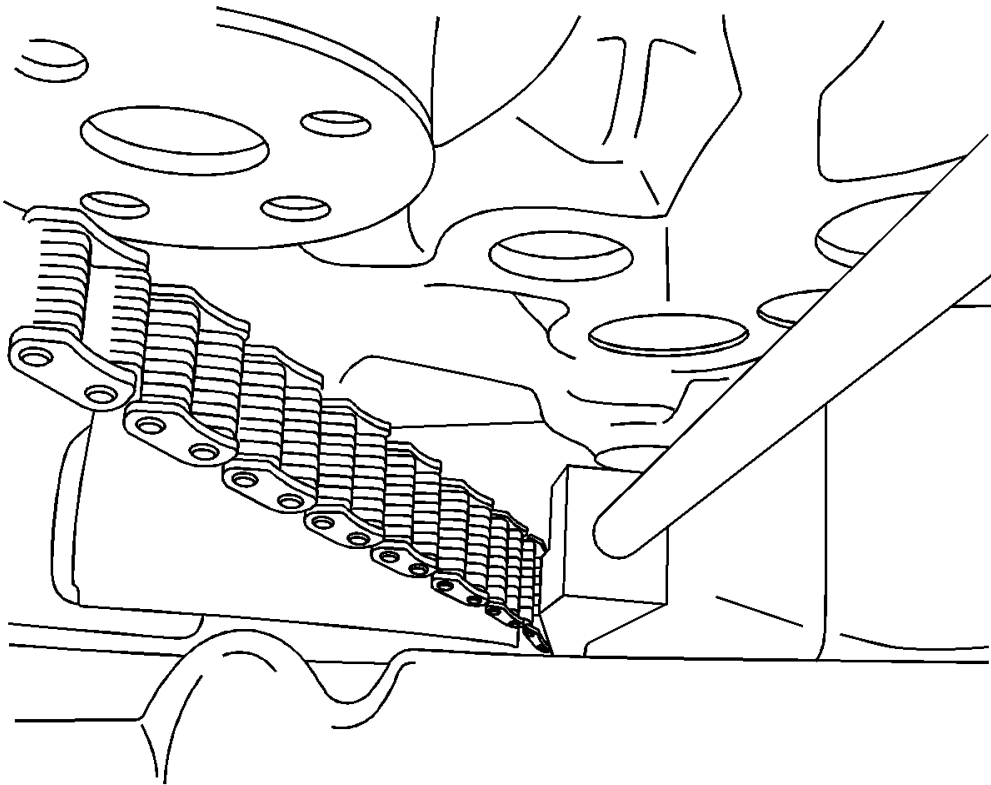
18. Drop the wedge down until it begins to engage the timing chain and the belt casting (2).



**Fig. 113: Wedge, Timing Chain And Belt Casting**  
Courtesy of GENERAL MOTORS COMPANY

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

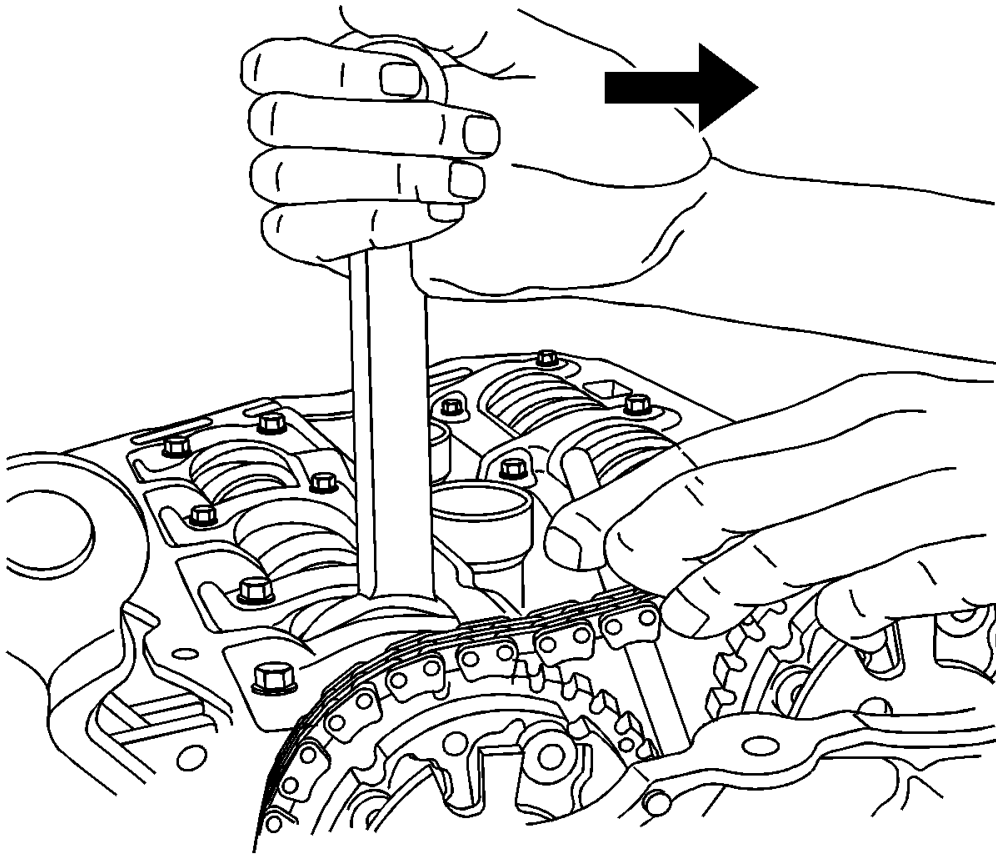
19. If possible shine a strong light down from above, between the camshaft position actuators and see the wedge in overall position as shown in the above graphic.



**Fig. 114: Positioning Wedge**

Courtesy of GENERAL MOTORS COMPANY

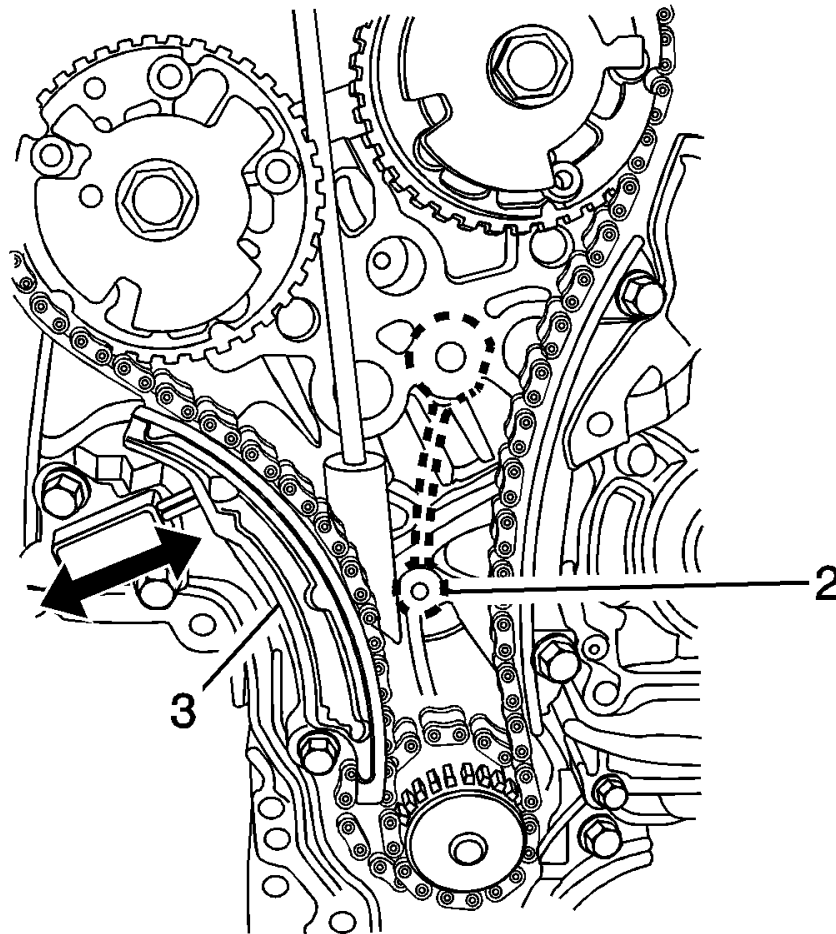
20. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the **EN49982-2** retainer.



**Fig. 115: Rotating Camshaft**

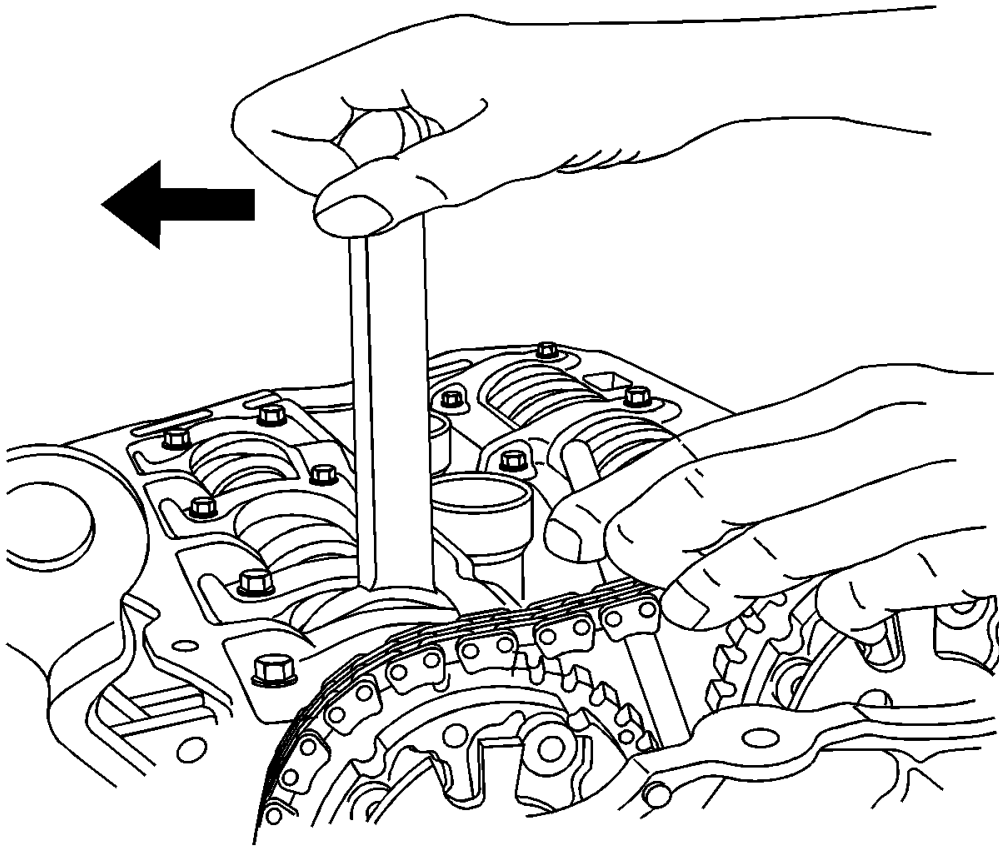
Courtesy of GENERAL MOTORS COMPANY

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

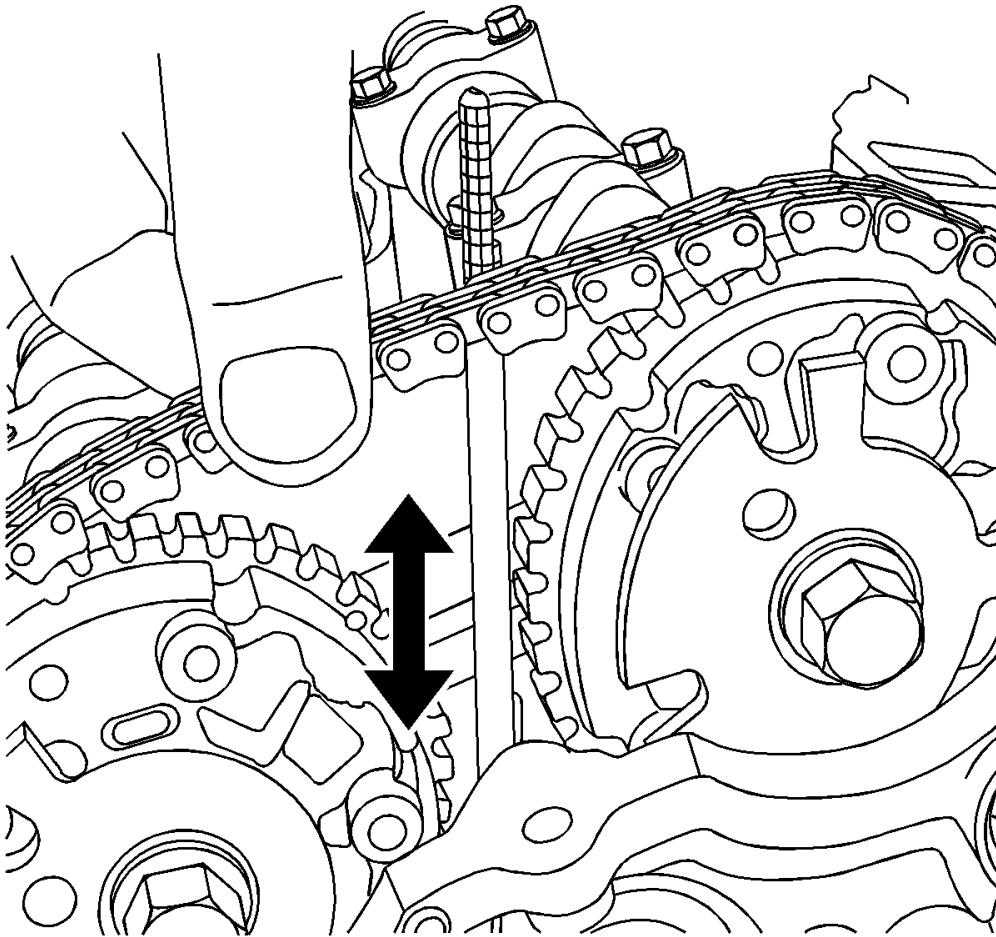
22. Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of **EN49982-2** retainer. You should be able to lightly tug on the **EN49982-2** retainer and it should stay in position. Repeat steps 20 and 21 if necessary to re-insert the **EN49982-2**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



**Fig. 117: 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.

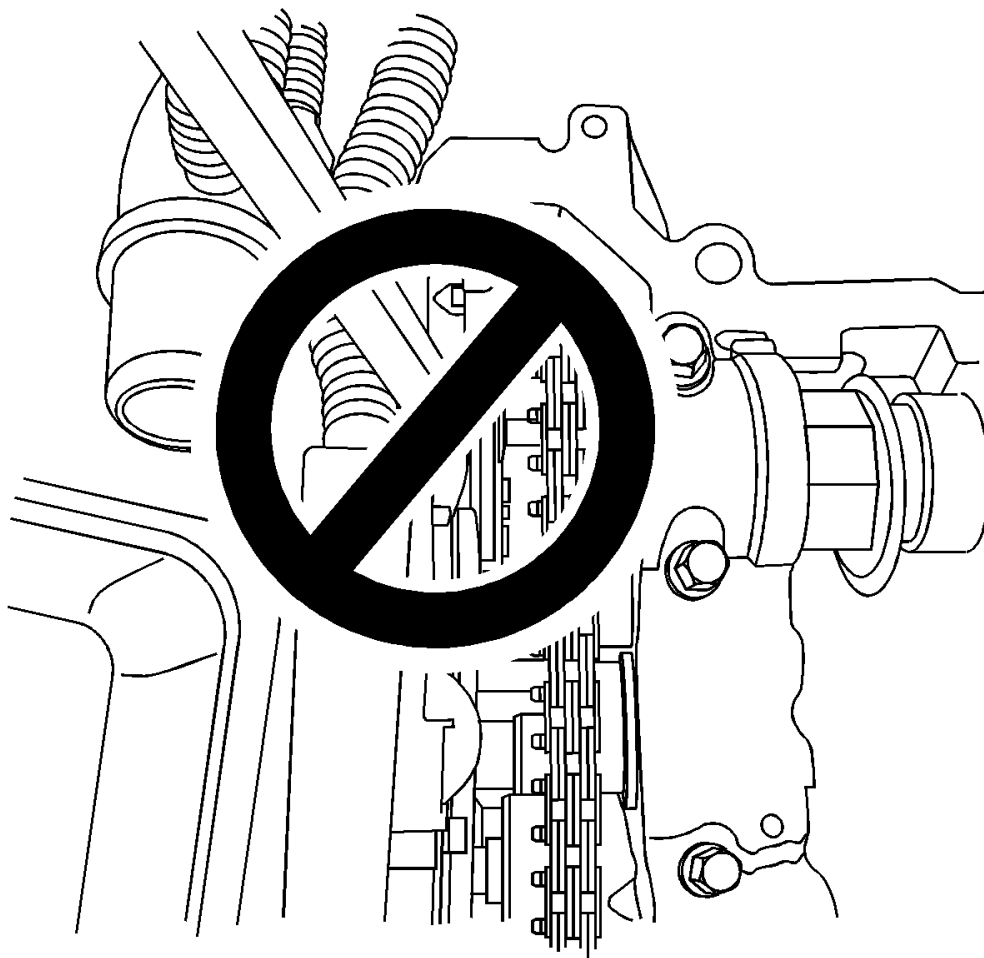
23. With EN49982-2 retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown.



**Fig. 118: Slack In Timing Drive Chain**  
**Courtesy of GENERAL MOTORS COMPANY**

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

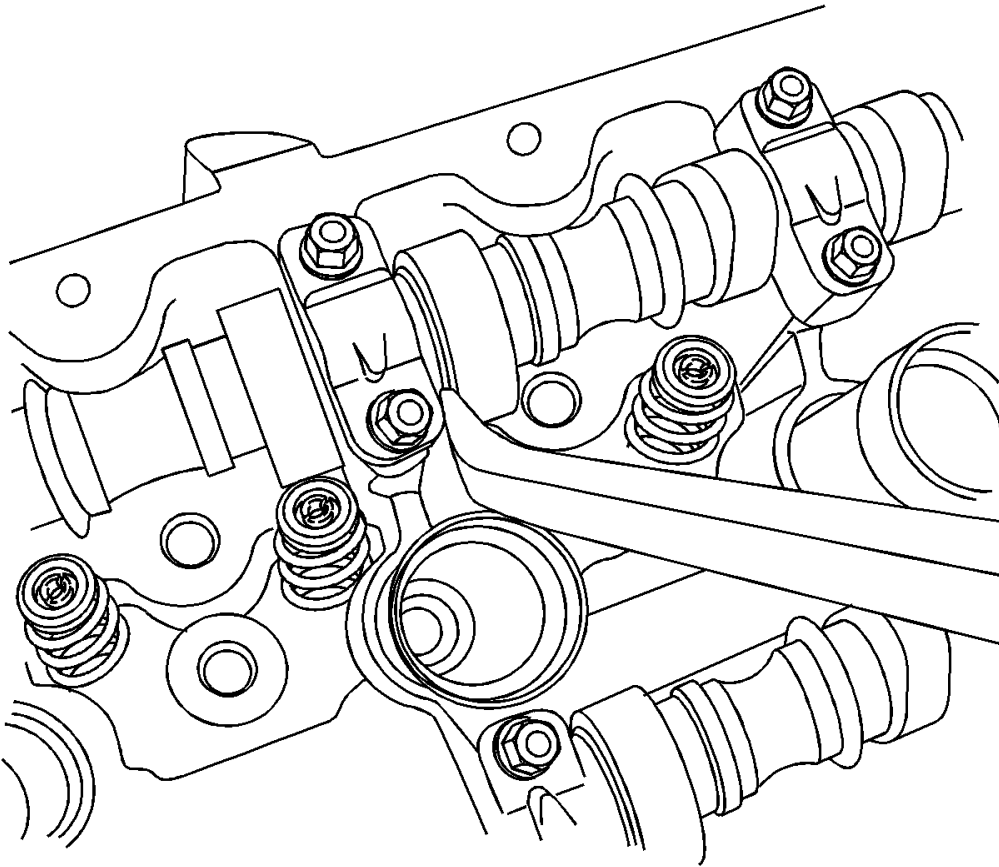




**Fig. 119: Do Not Pry Warning**

**Courtesy of GENERAL MOTORS COMPANY**

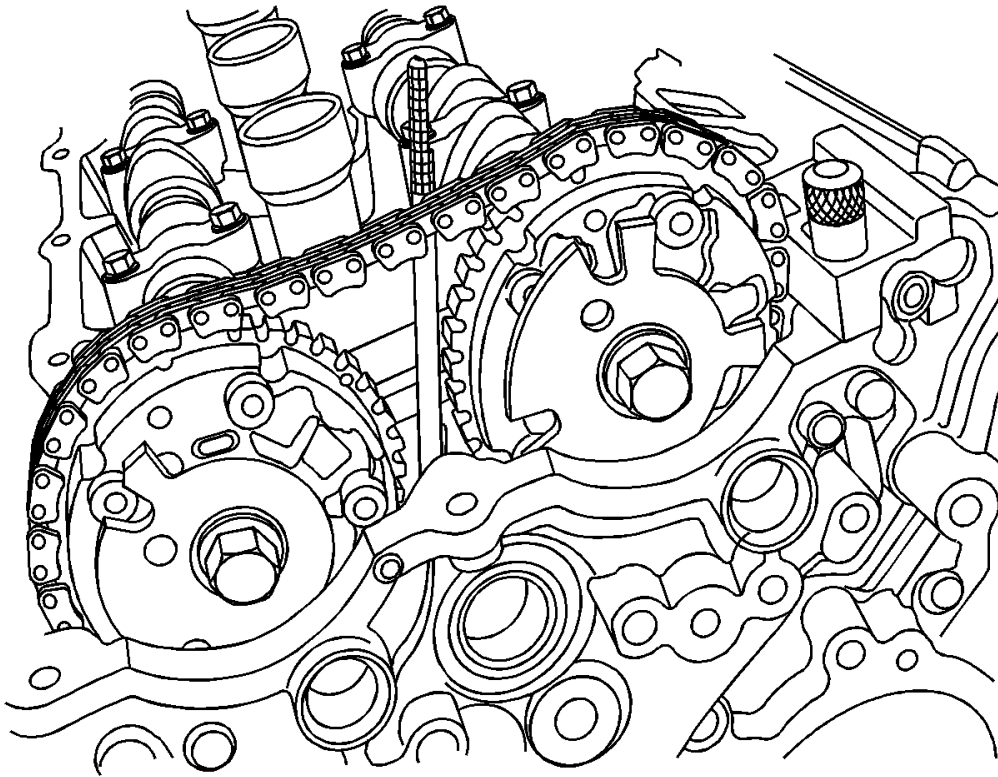
25. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine.



**Fig. 120: 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.

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).

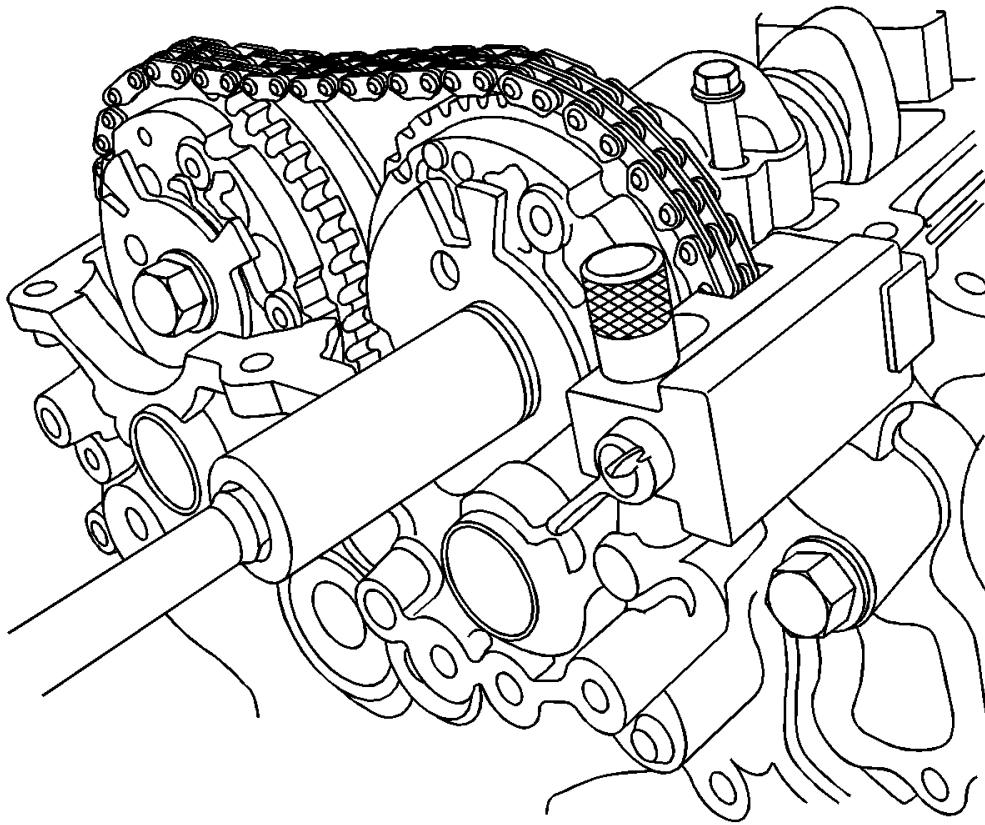


**Fig. 121: Retainer Position**

Courtesy of GENERAL MOTORS COMPANY

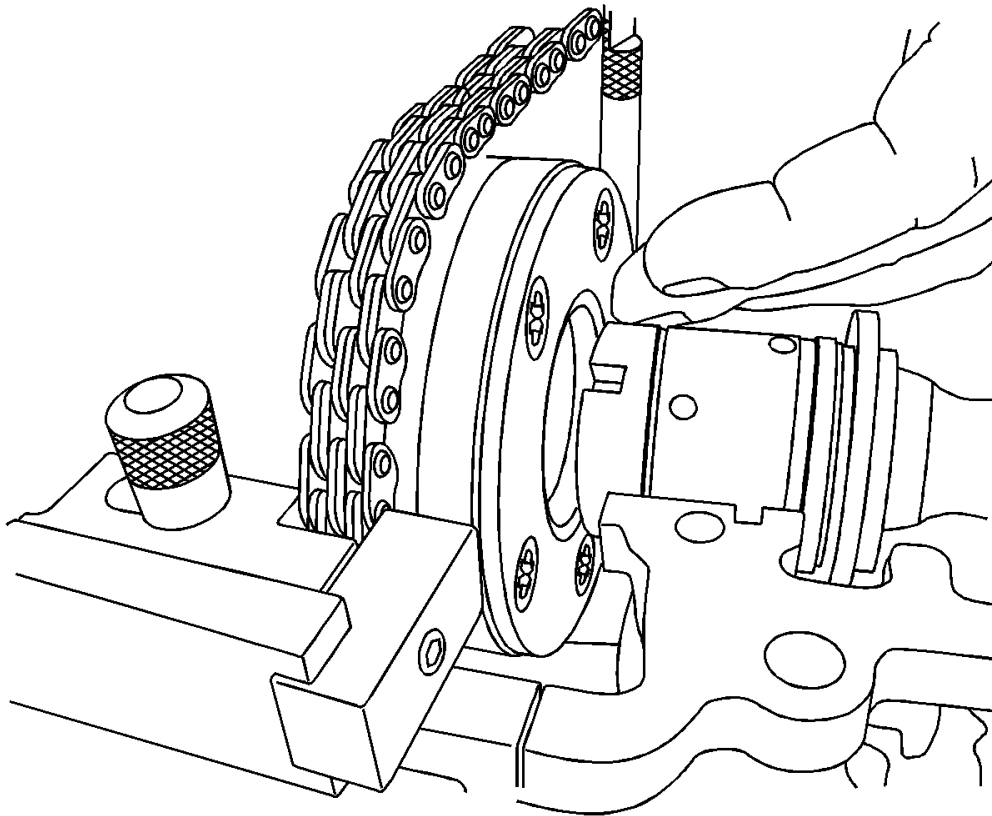
**NOTE:** Do not move or disturb the EN49982 retainer components after their installation or the timing chains may be lost inside the front cover.

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



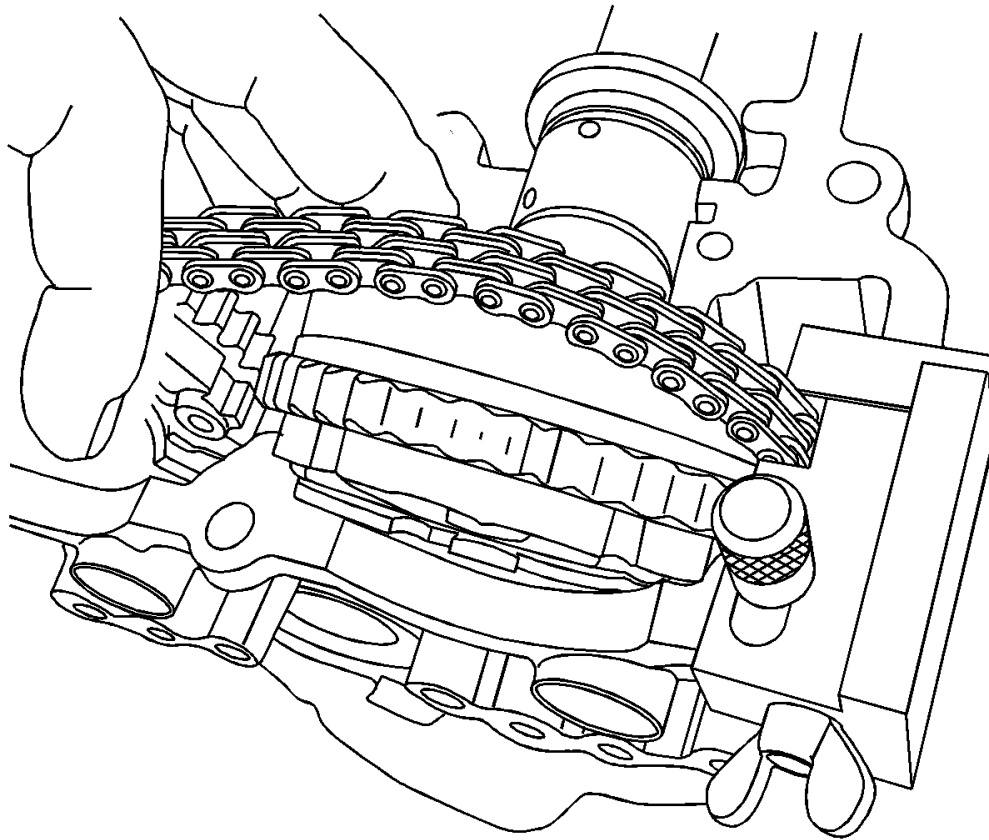
**Fig. 122: View Of Intake Camshaft Position Actuator**  
**Courtesy of GENERAL MOTORS COMPANY**

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



**Fig. 123: Sliding Camshaft Position Actuator Off End Of Intake Camshaft**  
Courtesy of GENERAL MOTORS COMPANY

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



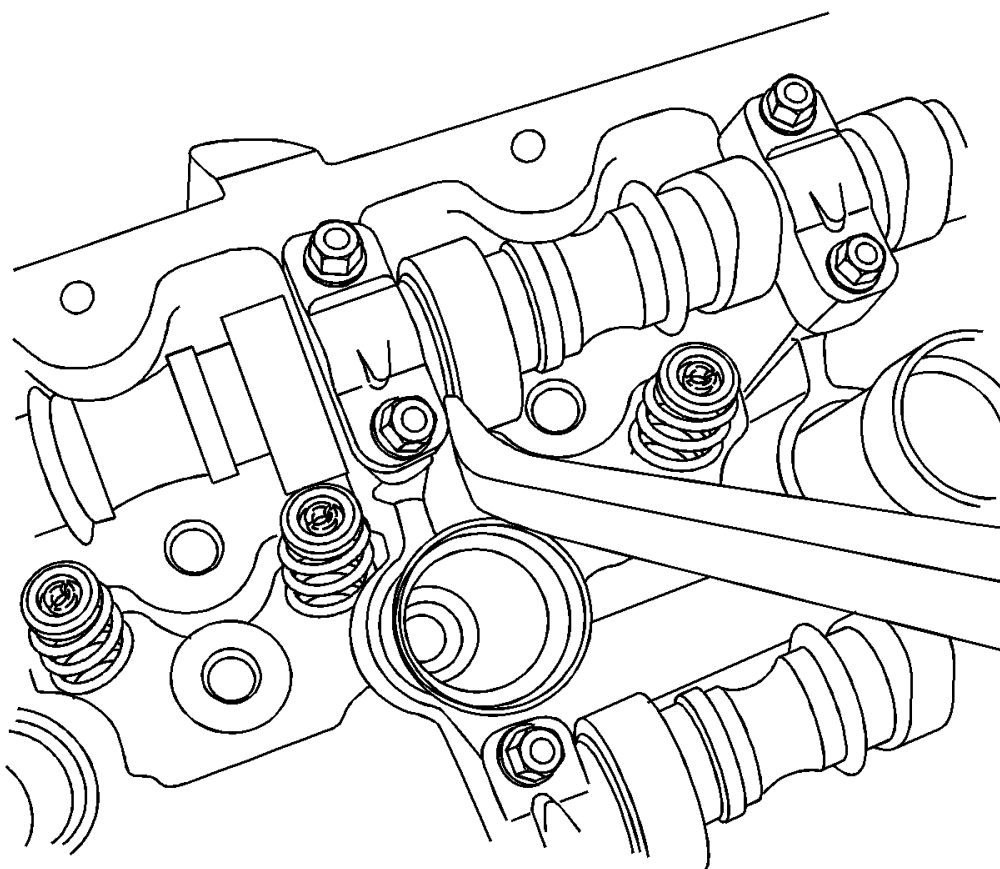
**Fig. 124: Tilting Camshaft Position Actuator Forward**  
Courtesy of GENERAL MOTORS COMPANY

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

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

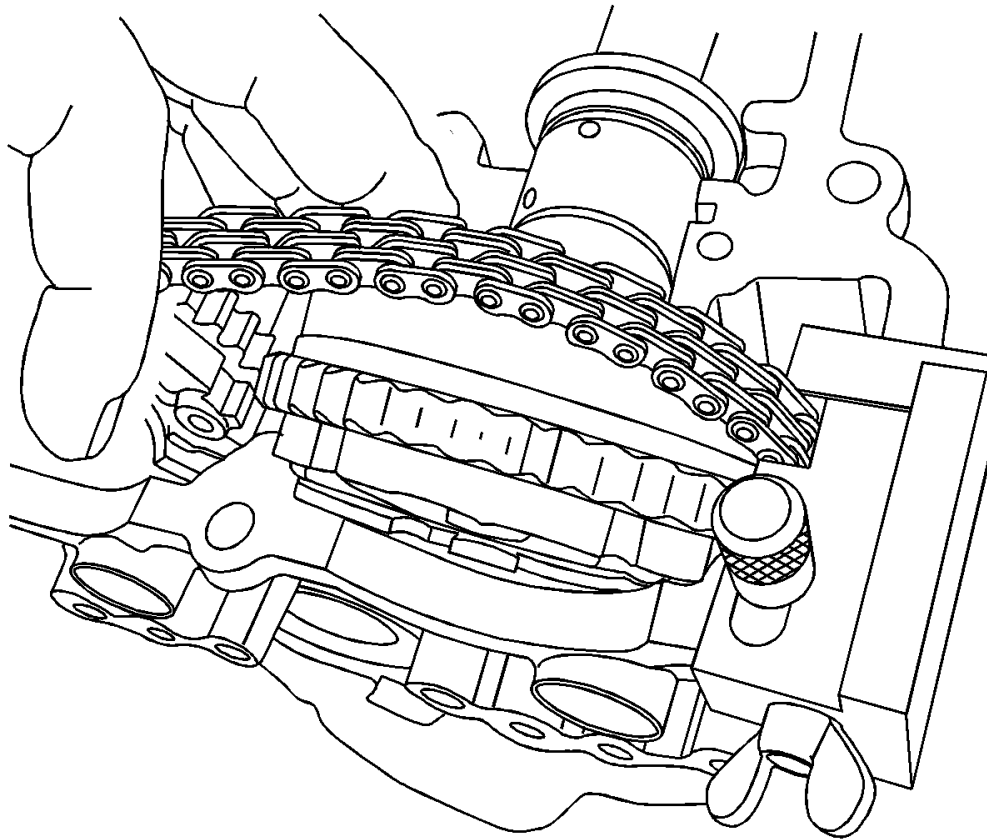
#### **Installation Procedure**

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



**Fig. 125: Prying Camshaft Forward**  
**Courtesy of GENERAL MOTORS COMPANY**

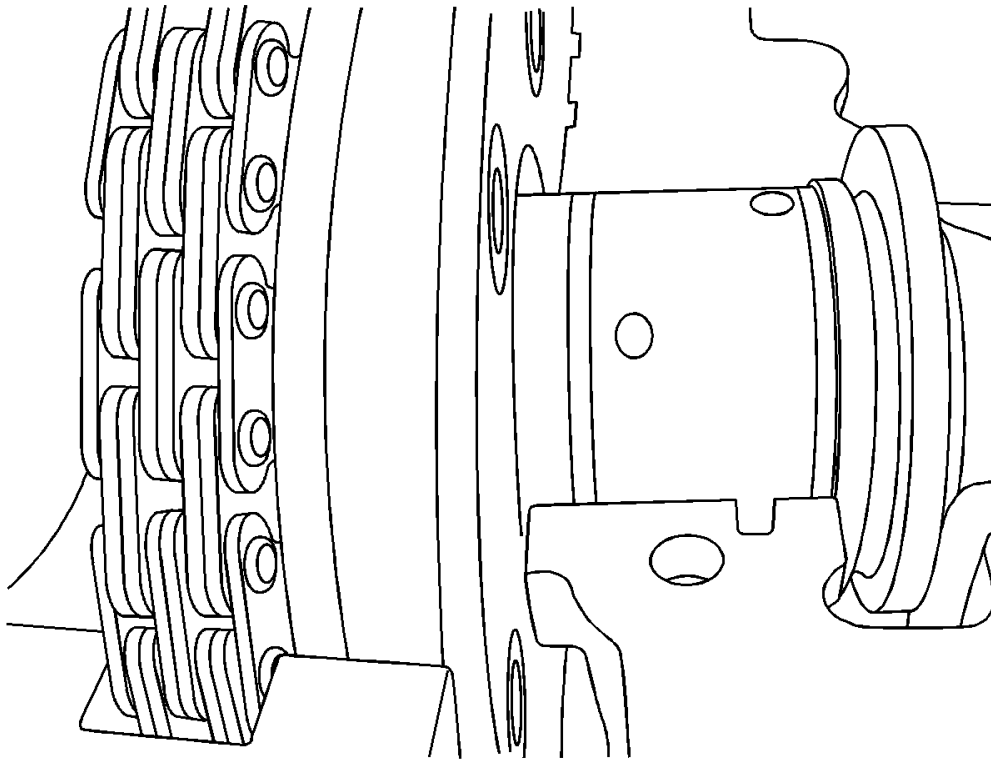
2. Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator.



**Fig. 126: Tilting Camshaft Position Actuator Forward**  
Courtesy of GENERAL MOTORS COMPANY

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



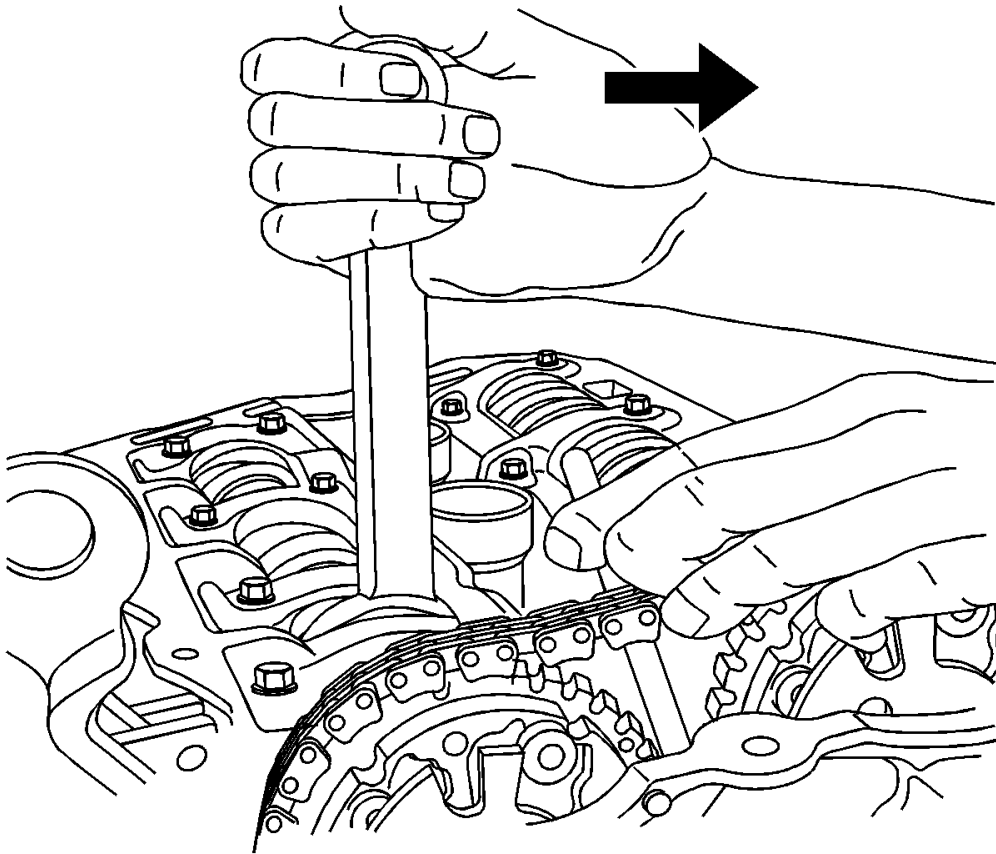


**Fig. 127: Fitting Camshaft Position Actuator**  
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake camshaft position actuator retaining bolt and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.

**CAUTION: Refer to Fastener Caution .**

5. Install the exhaust camshaft position actuator retaining bolt and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
6. Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.
7. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the **EN49982-2** retainer.



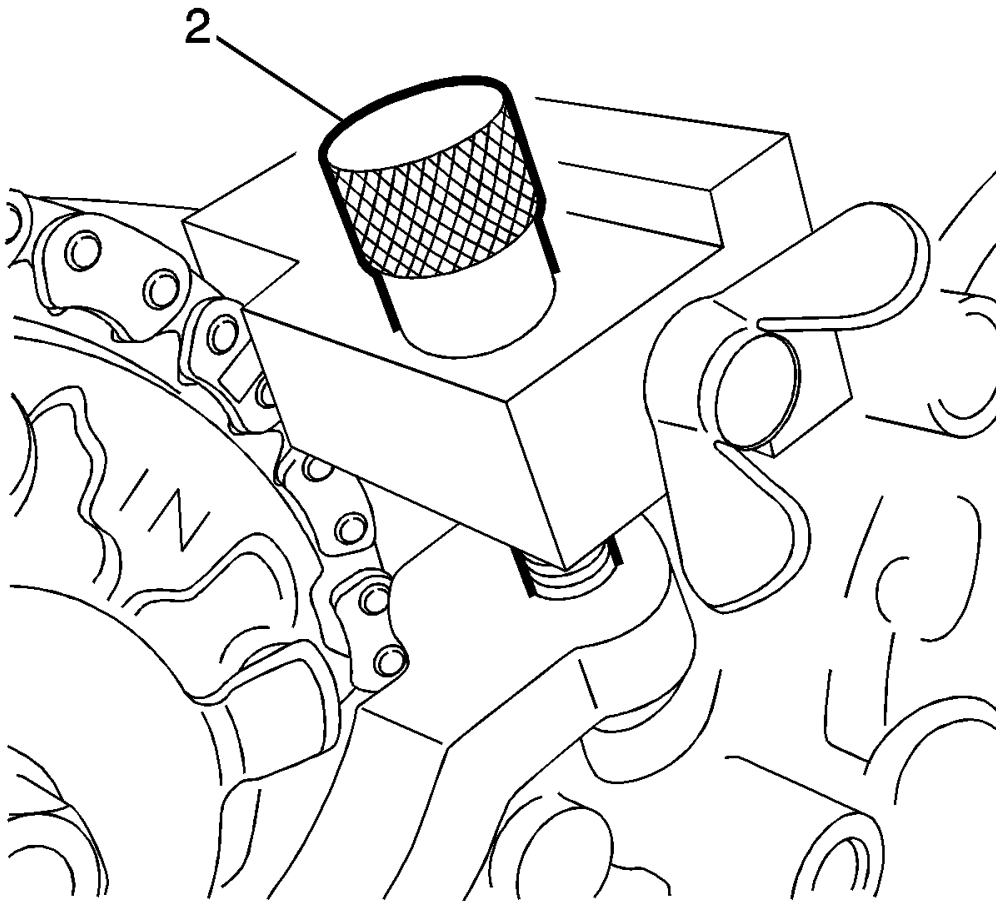
**Fig. 128: Rotating Camshaft**

Courtesy of GENERAL MOTORS COMPANY

8. Remove EN49982-2 retainer.
9. Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.
10. Torque one or both camshaft position actuator retaining bolts to 58 N.m (43 lb ft).

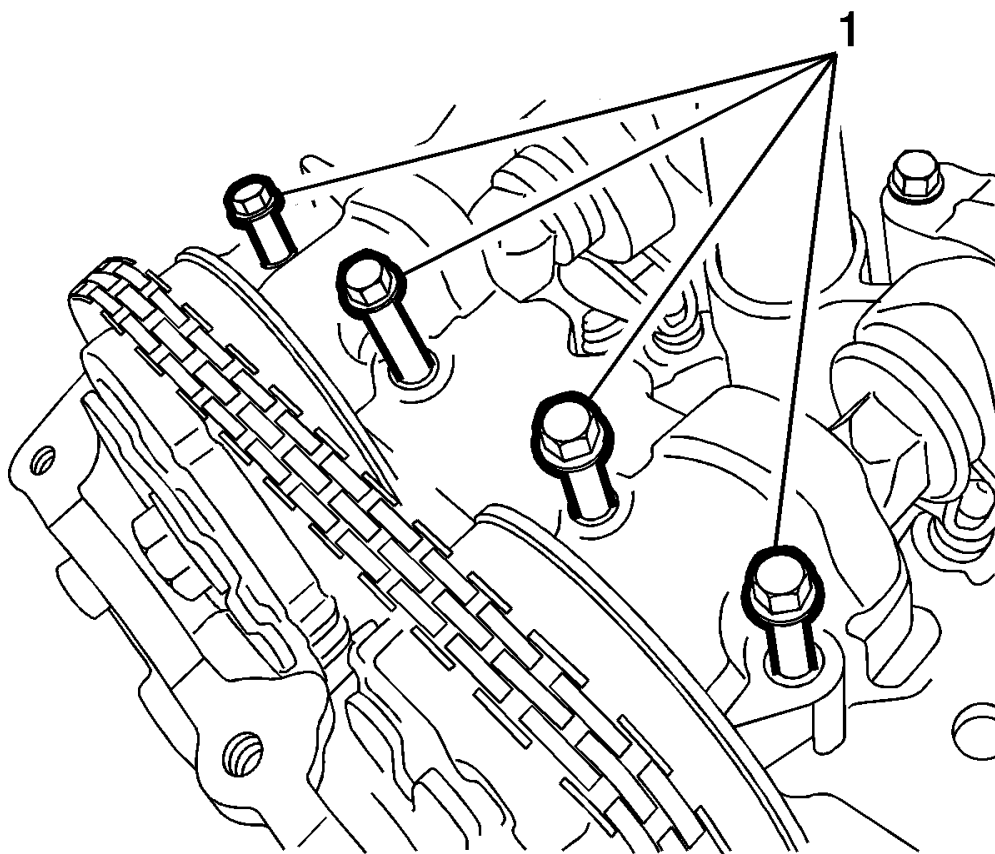
**NOTE:** Double-check the marks on the camshaft position actuators and chains to ensure they are correct.

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



**Fig. 129: View Of Retainer Thumbscrew**  
Courtesy of GENERAL MOTORS COMPANY

12. Install camshaft front cap and bolts (1).



**Fig. 130: Identifying Camshaft Front Cap & Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

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

## **CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2**

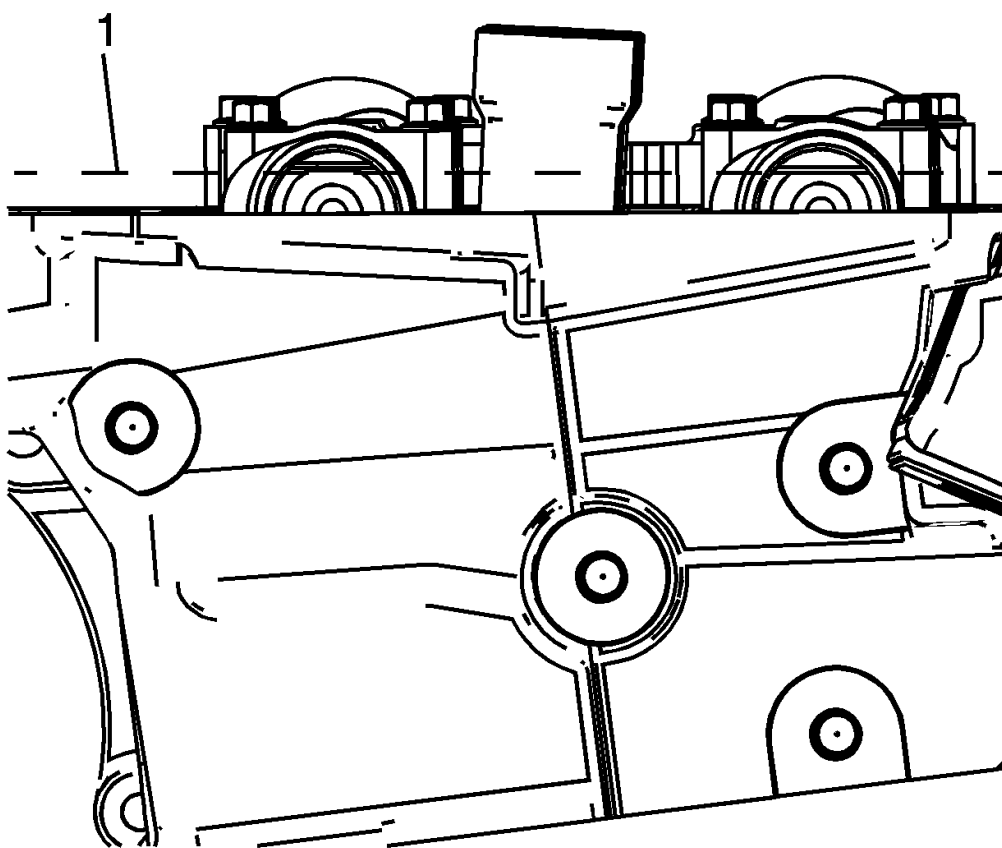
### **Special Tools**

**EN-48313 Timing Chain Retention Tool**

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

**Removal Procedure**

1. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.

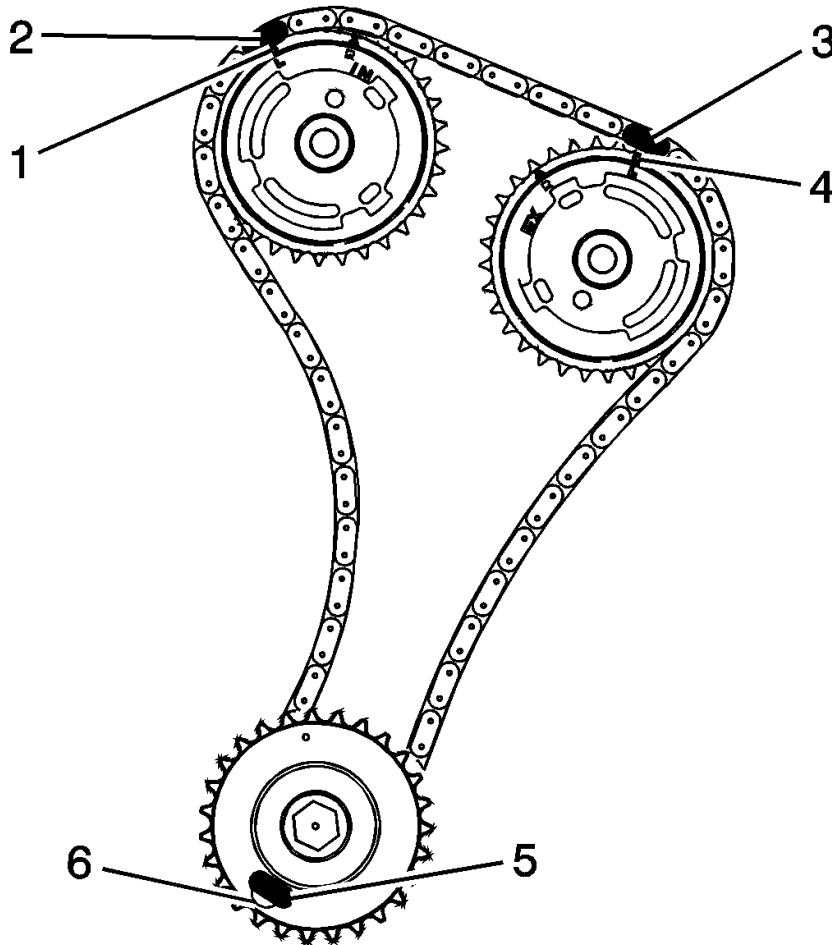


**Fig. 131: View Of Camshaft Flats Parallel With Camshaft Cover Rail**  
Courtesy of GENERAL MOTORS COMPANY

2. 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** .
3. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
4. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).

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

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



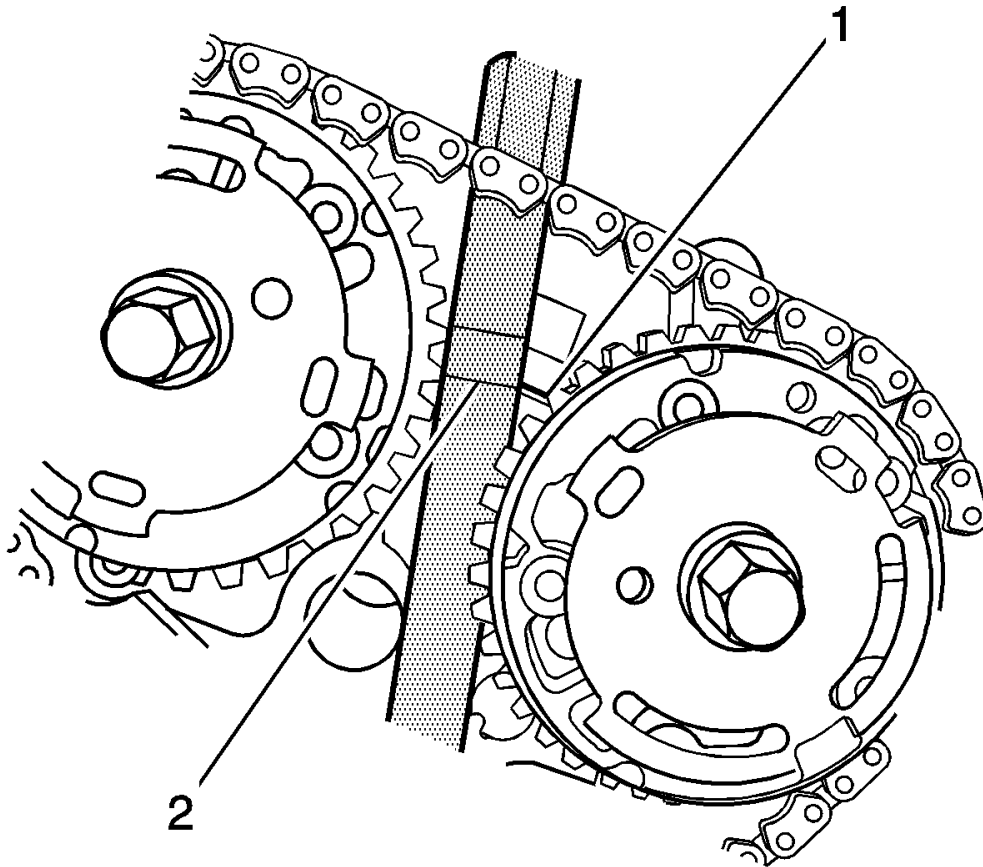
**Fig. 132: Locating Left Secondary Camshaft Drive Chain Timing Marks**  
Courtesy of GENERAL MOTORS COMPANY

**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 (3) and the adjacent tooth on the intake camshaft position actuator (4).
7. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

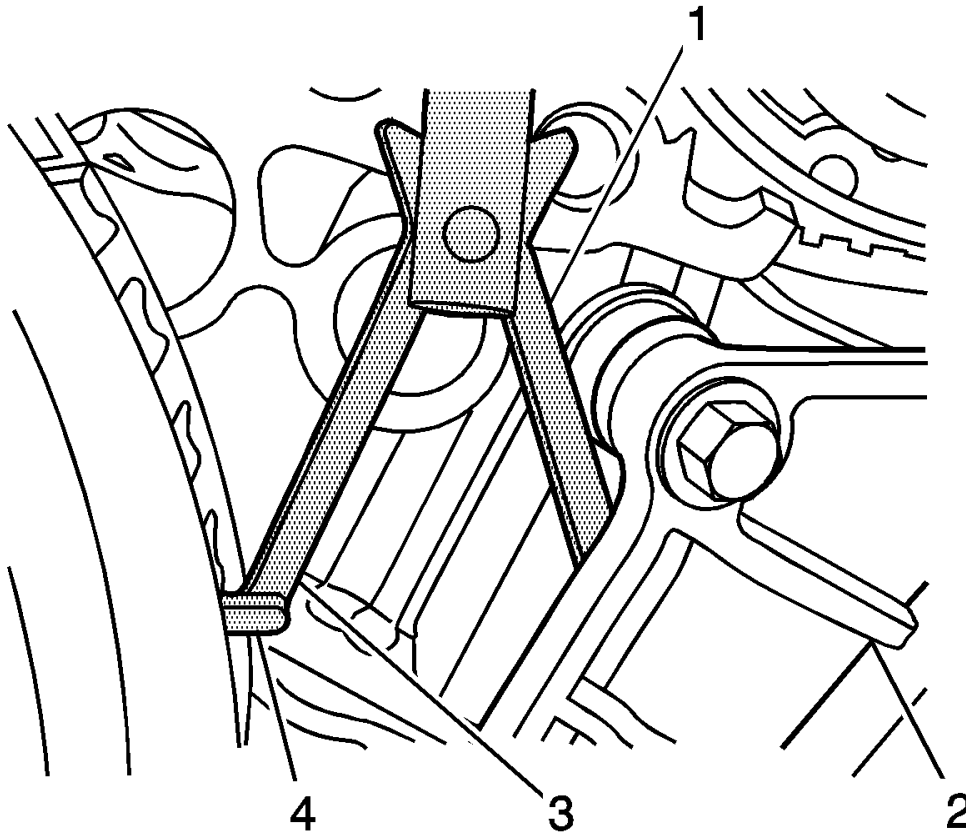
**CAUTION:** Refer to Torque Reaction Against Timing Drive Chain Caution .

8. Unscrew the **EN-48313** tool so that the legs of the tool are retracted.



**Fig. 133: Inserting Timing Chain Retention Tool**  
 Courtesy of GENERAL MOTORS COMPANY

9. Insert the **EN-48313** tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.
10. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.

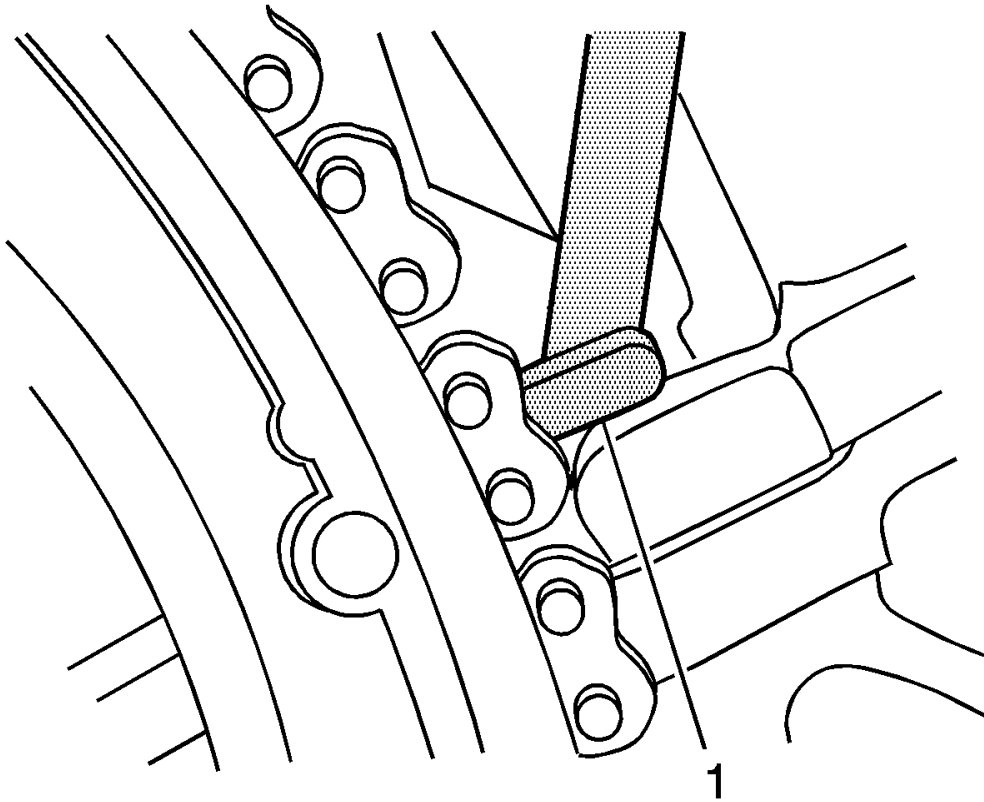


**Fig. 134: View Of Feet, Legs & Timing Chain Guide**  
Courtesy of GENERAL MOTORS COMPANY

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

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

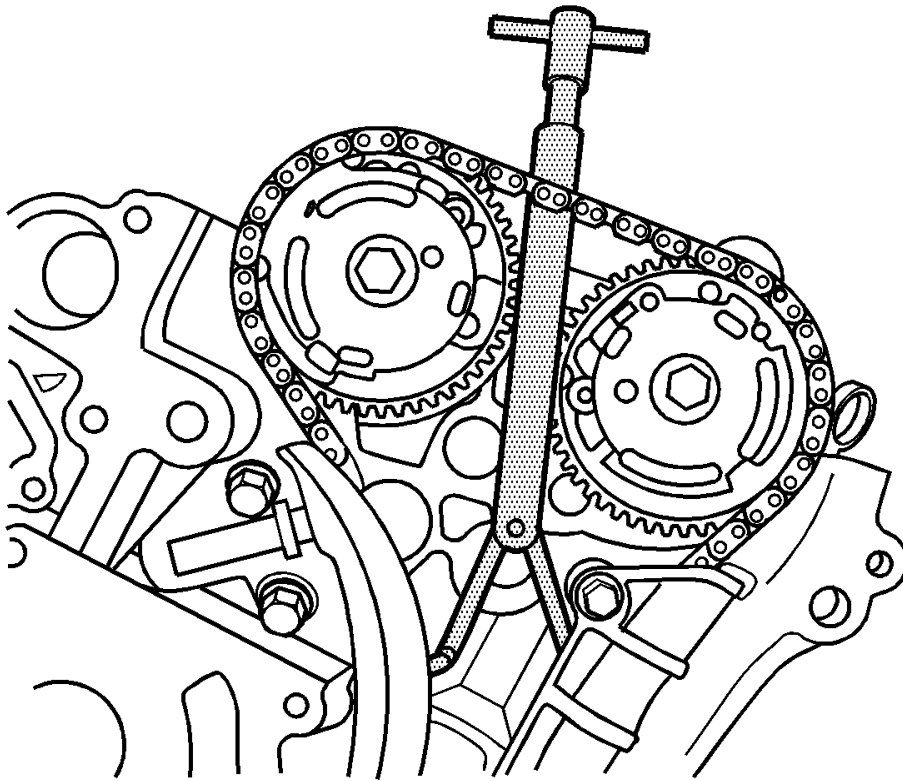




**Fig. 135: Foot of Timing Chain Retention Tool EN-48313**  
Courtesy of GENERAL MOTORS COMPANY

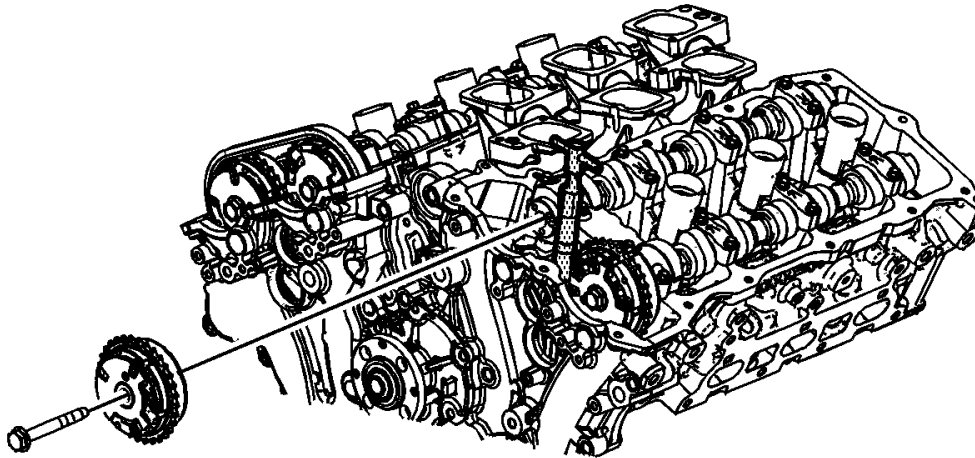
**NOTE:** Ensure that the foot (1) of the EN-48313 tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313 tool.

15. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.
16. The EN-48313 tool is now properly installed to hold the timing chain in position.



**Fig. 136: Timing Chain Retention Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

17. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.

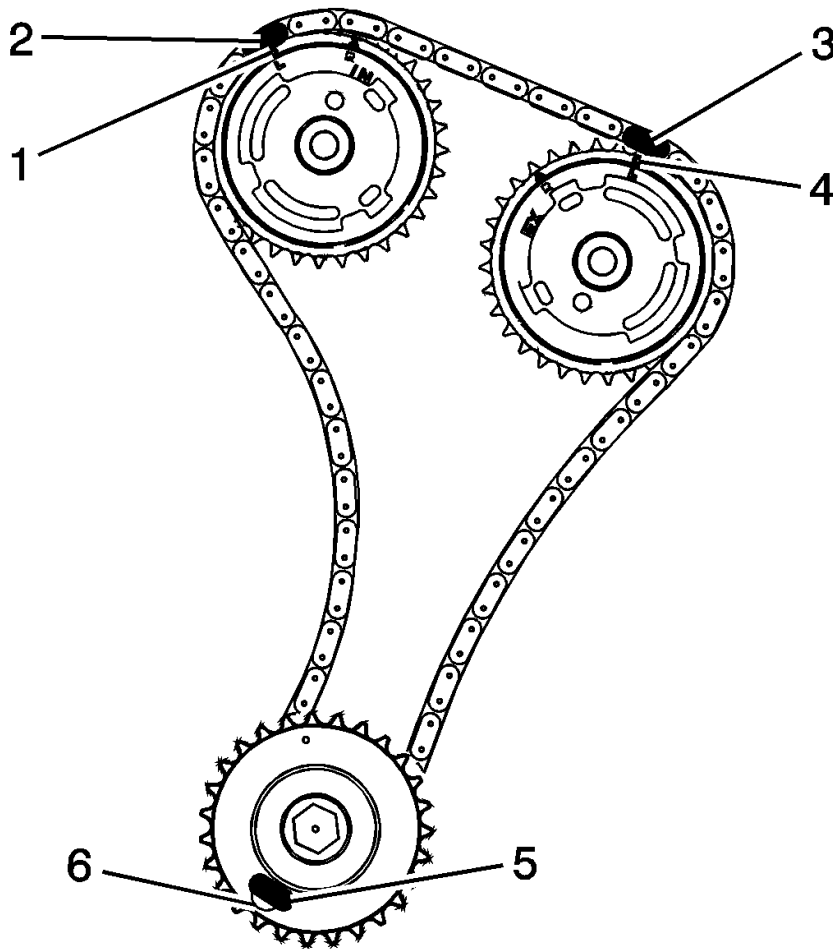


**Fig. 137: View Of Exhaust Camshaft Position Actuator Bolt**  
Courtesy of GENERAL MOTORS COMPANY

18. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
19. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
20. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313** tool once the actuators have been removed.
21. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
22. Remove the camshaft thrust washer.

#### **Installation Procedure**

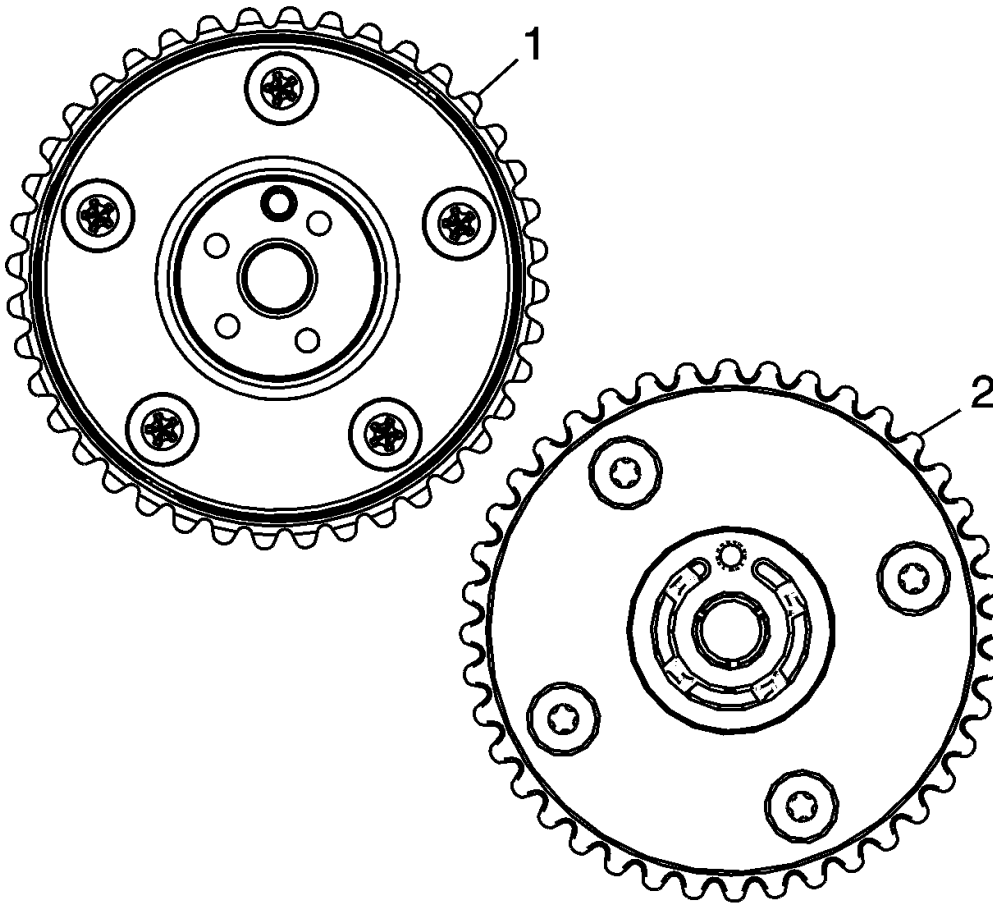
1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.



**Fig. 138: 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.

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.
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).

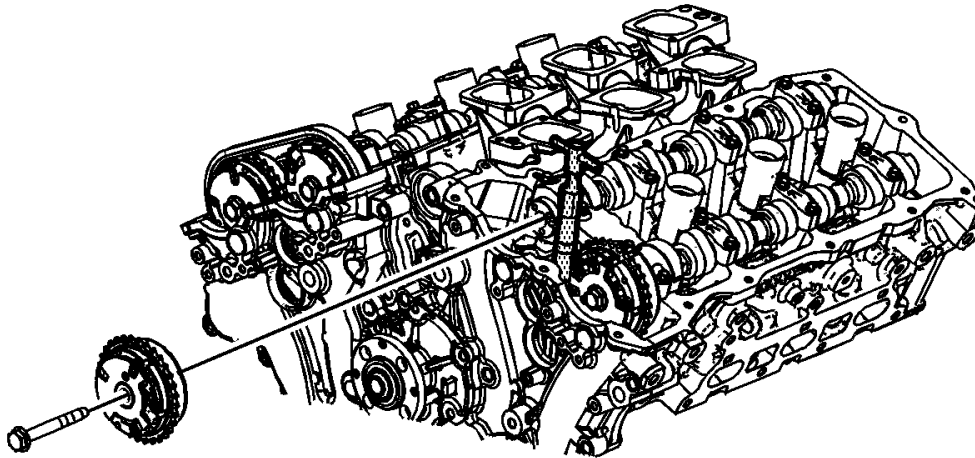


**Fig. 139: Identifying Camshaft Position Actuators**  
 Courtesy of GENERAL MOTORS COMPANY

**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.

6. Install the thrust washer, if applicable.
7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).



**Fig. 140: View Of Exhaust Camshaft Position Actuator Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

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

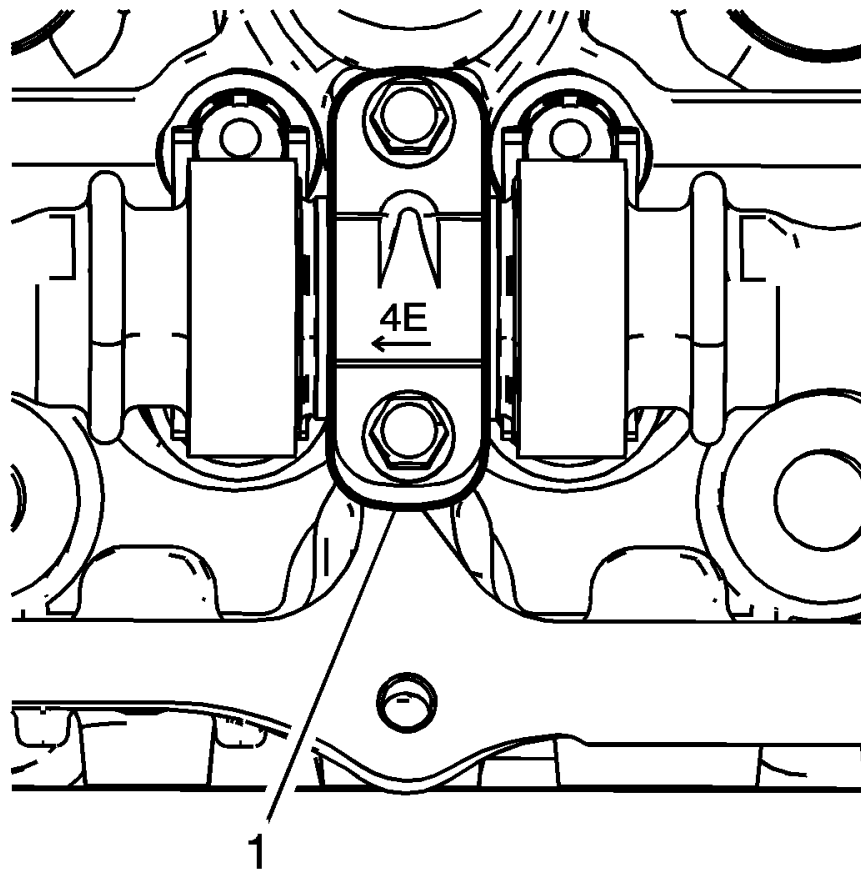
**IMPORTANT:** Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing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

### Removal Procedure

1. Remove the fuel pump. Refer to **Fuel Pump Replacement (LLT)** .
2. Remove the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 2**.
3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:

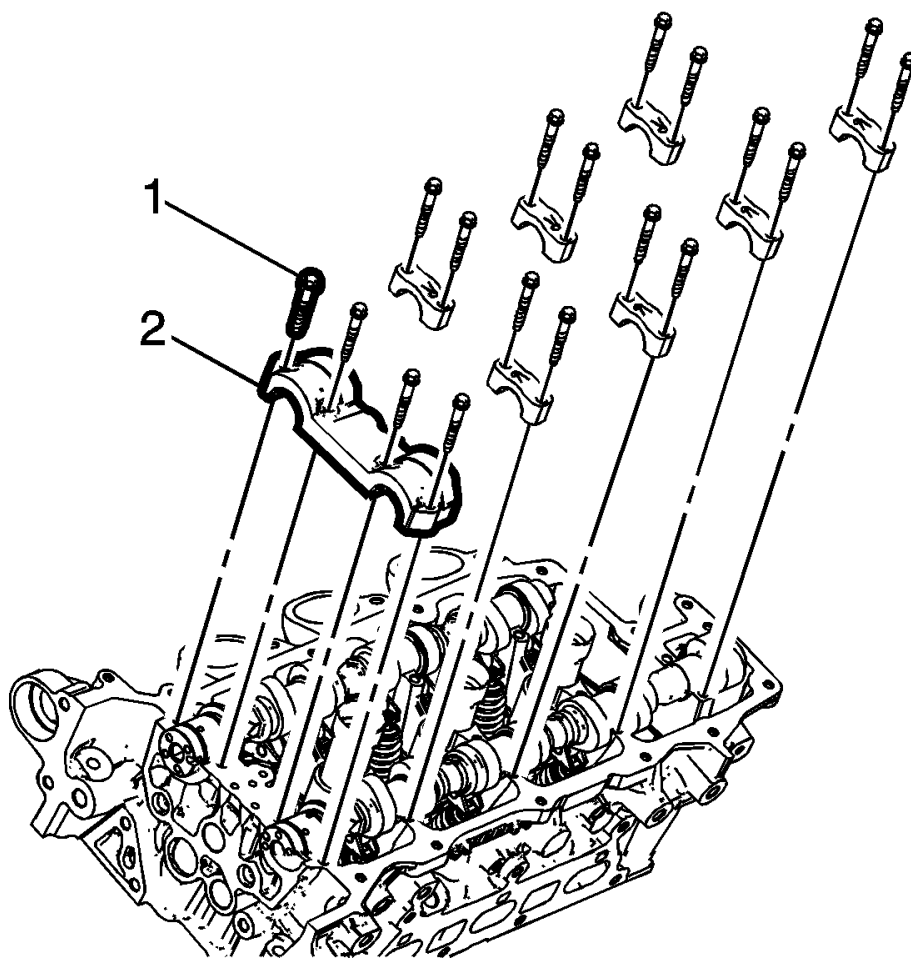


**Fig. 141: Bearing Caps**

Courtesy of GENERAL MOTORS COMPANY

- The raised feature must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number indicates the journal position from the front of the engine.
4. Remove the camshaft bearing cap bolts (1).

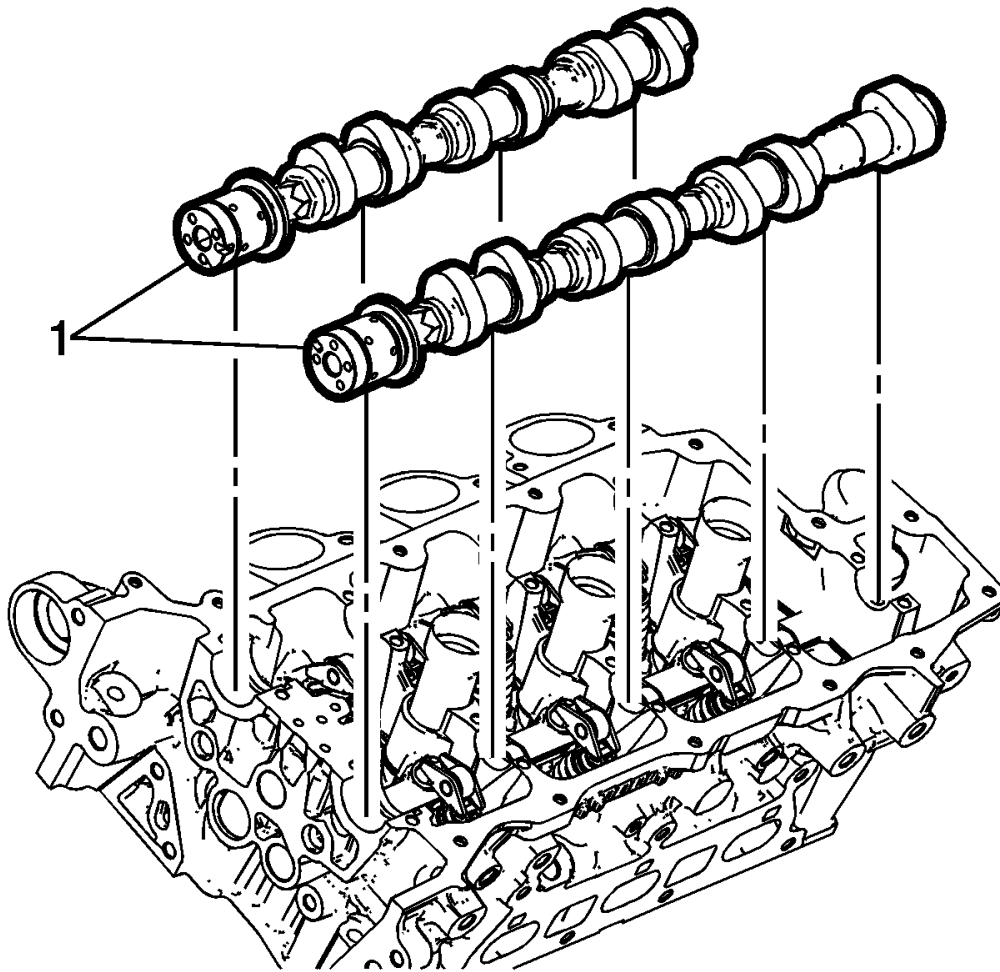




**Fig. 142: Bearing Cap Bolts**

Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft bearing caps (2).
6. Remove the camshafts (1).



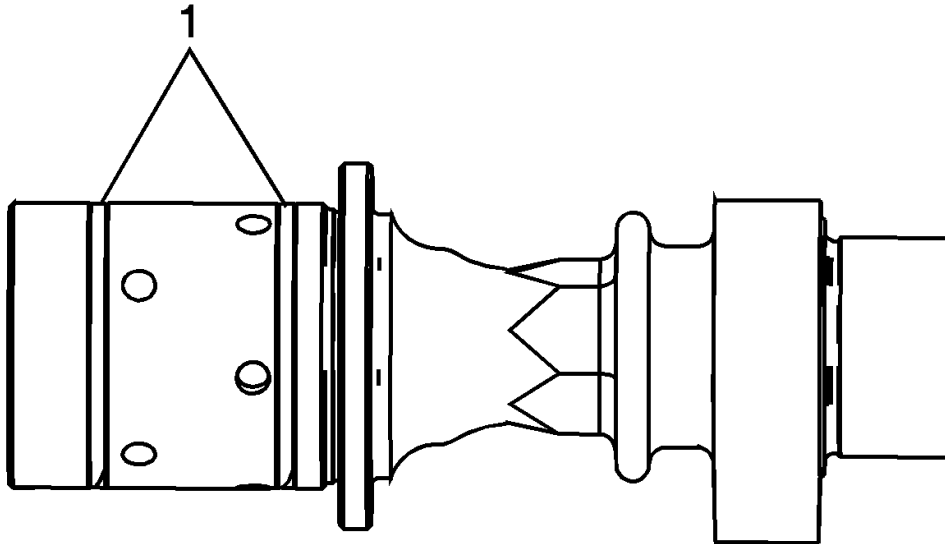
**Fig. 143: Camshafts**

Courtesy of GENERAL MOTORS COMPANY

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

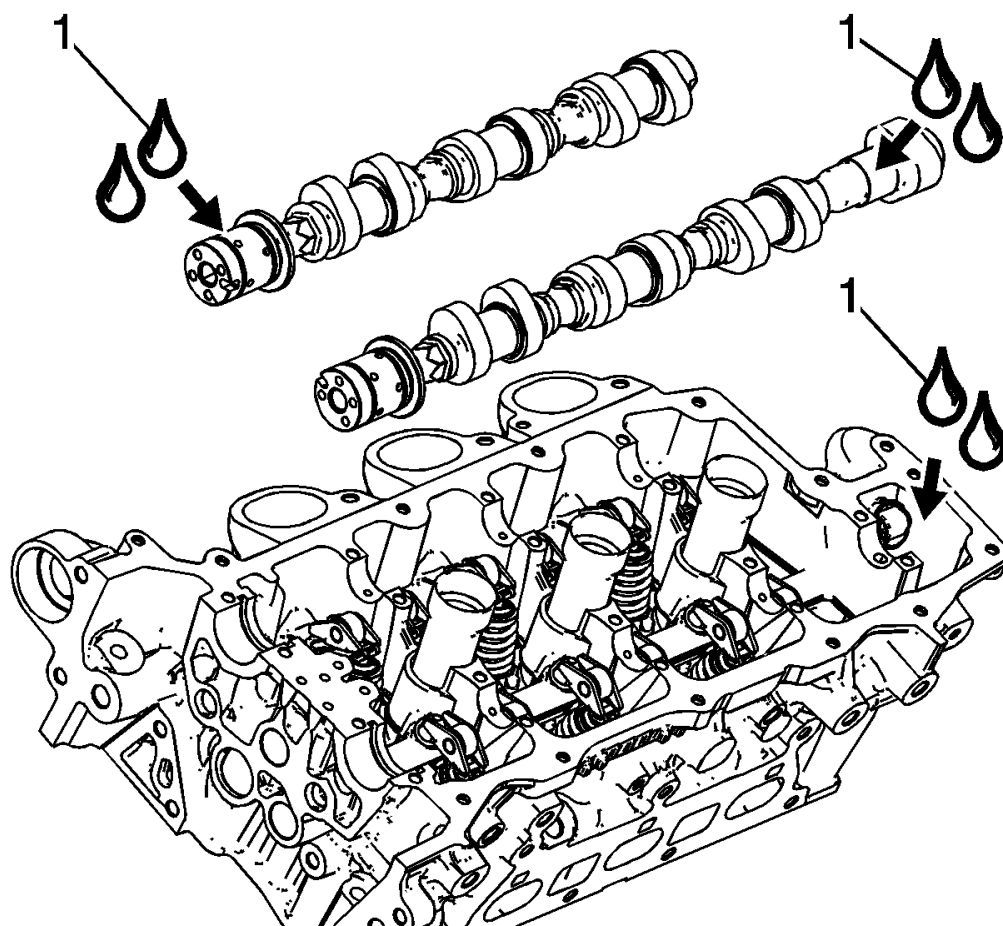
#### Installation Procedure

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



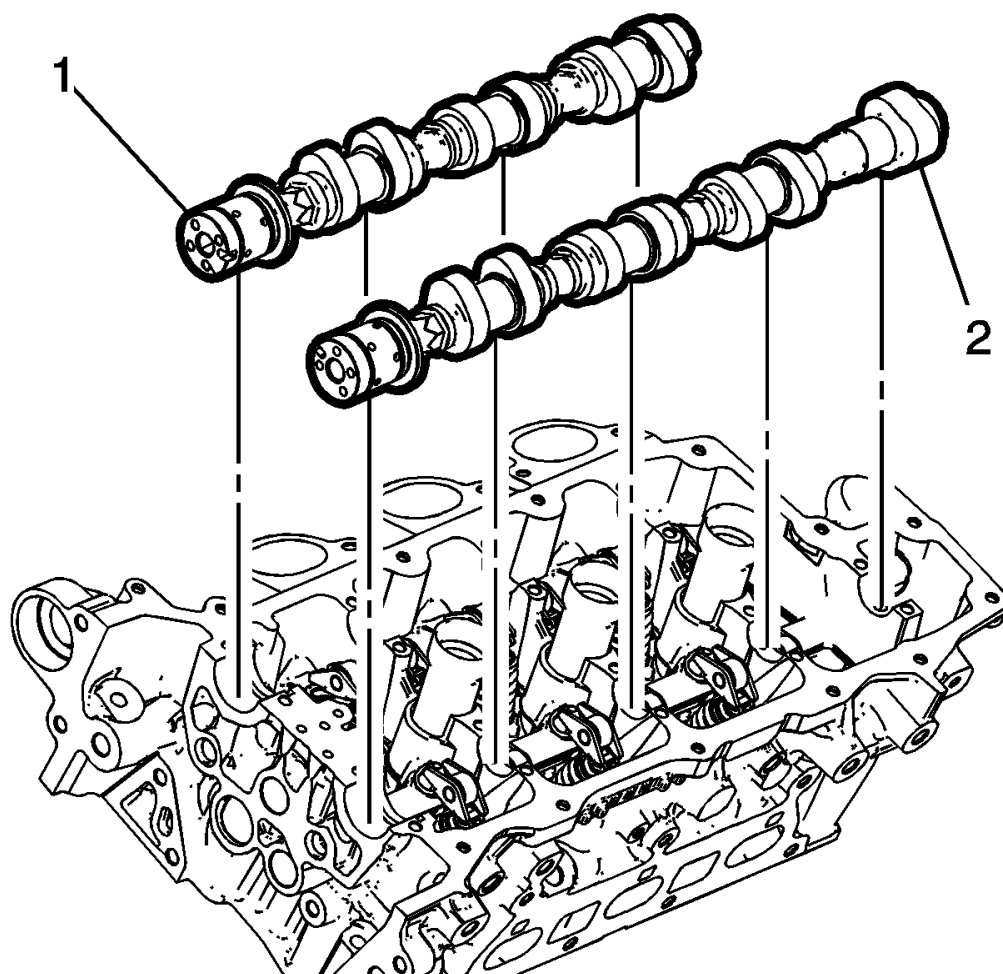
**Fig. 144: Locating Camshaft Sealing Rings In Camshaft Grooves**  
Courtesy of GENERAL MOTORS COMPANY

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



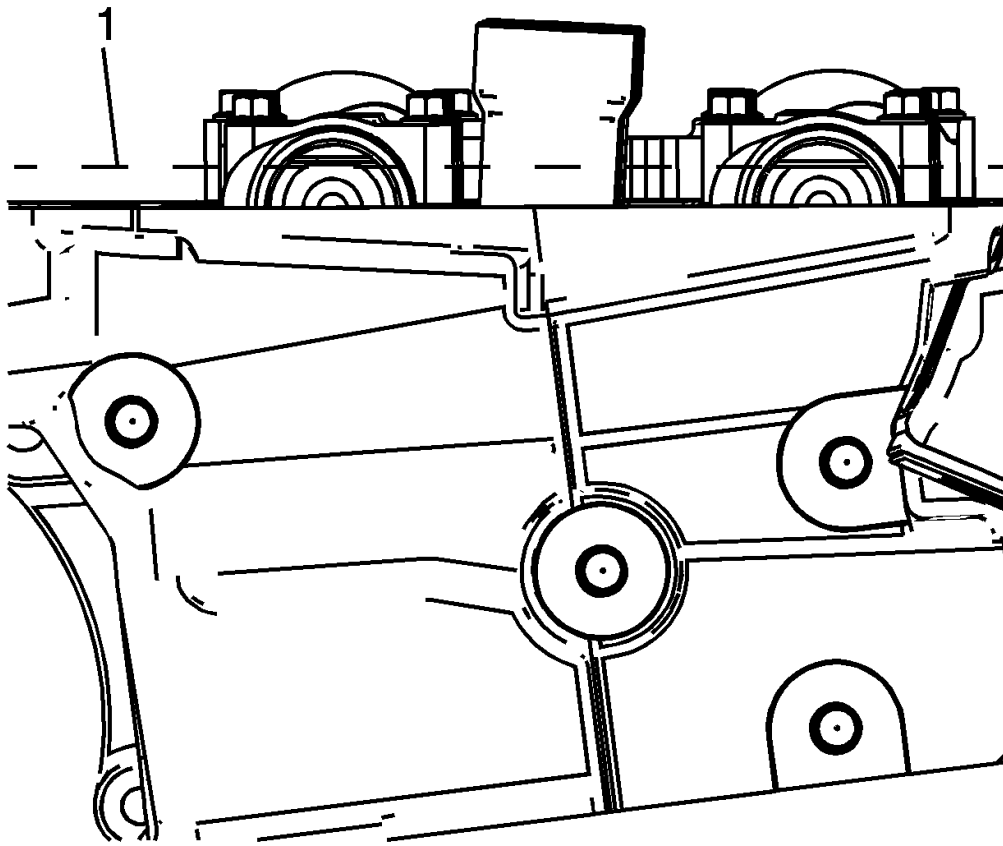
**Fig. 145: Camshaft Journal Lubrication Points**  
Courtesy of GENERAL MOTORS COMPANY

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



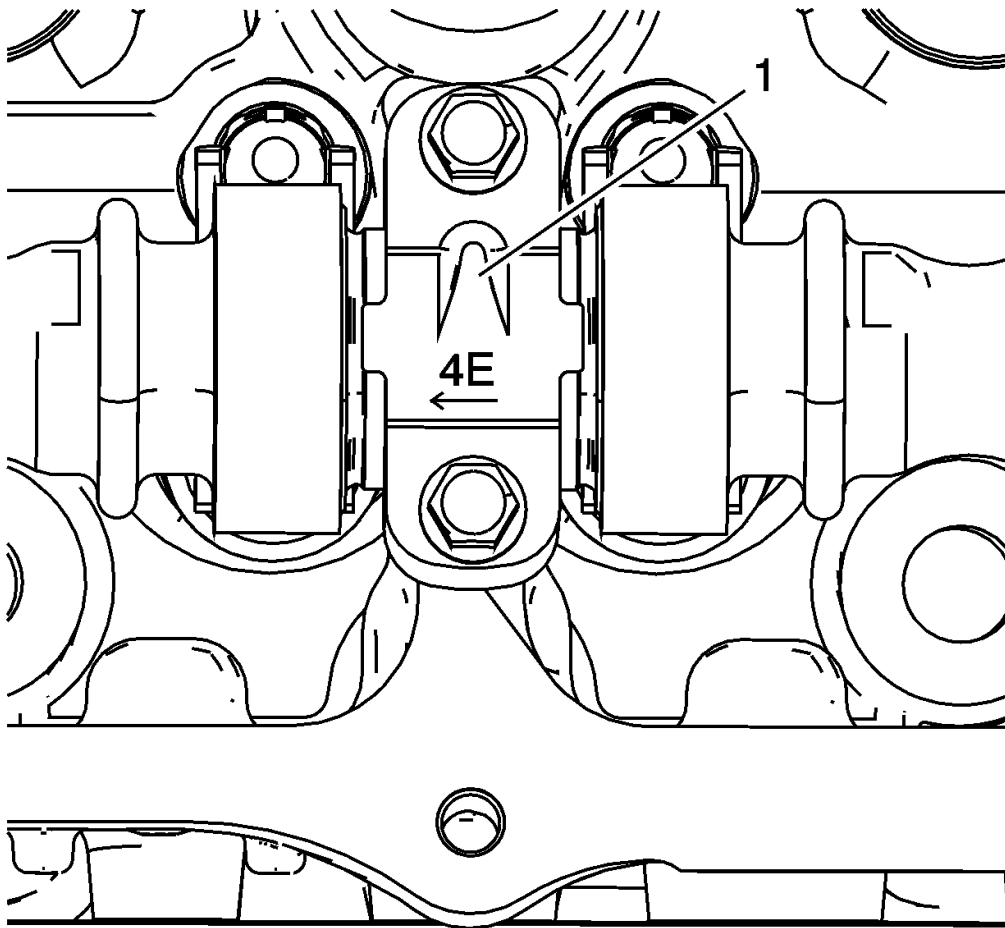
**Fig. 146: Camshaft Intake And Exhaust Positioning Points**  
Courtesy of GENERAL MOTORS COMPANY

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



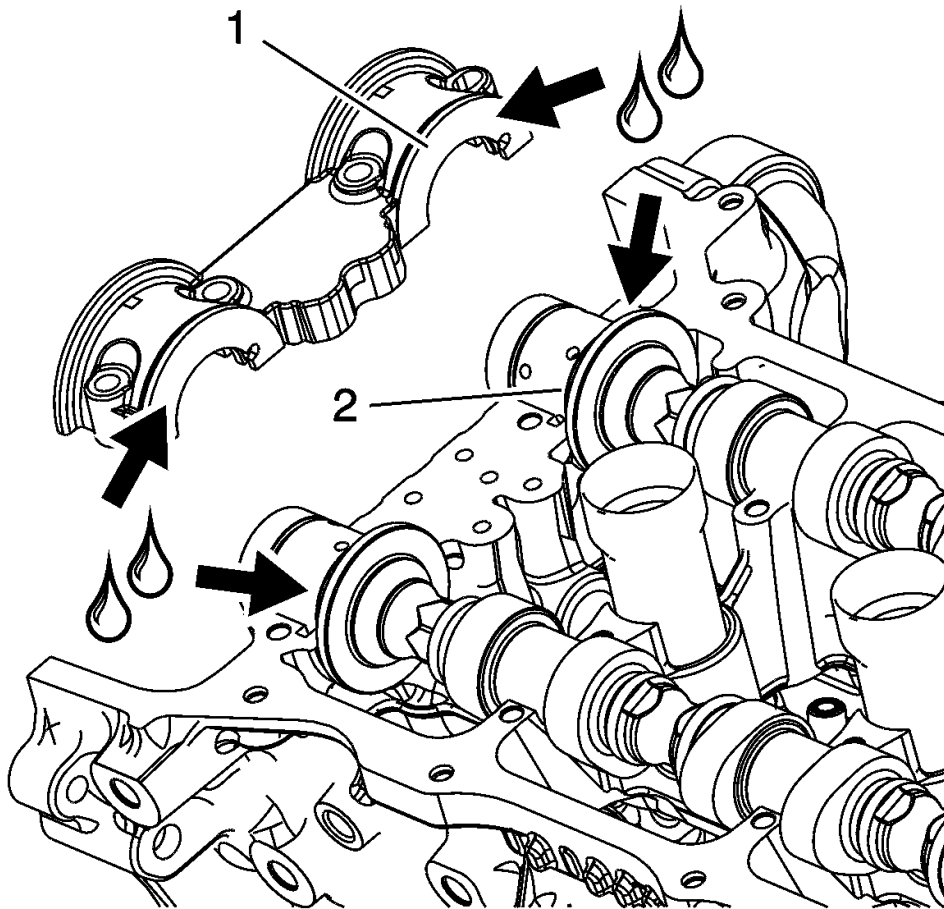
**Fig. 147: View Of Camshaft Flats Parallel With Camshaft Cover Rail**  
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:



**Fig. 148: Left Cylinder Head Camshaft Bearing Cap Markings**  
 Courtesy of GENERAL MOTORS COMPANY

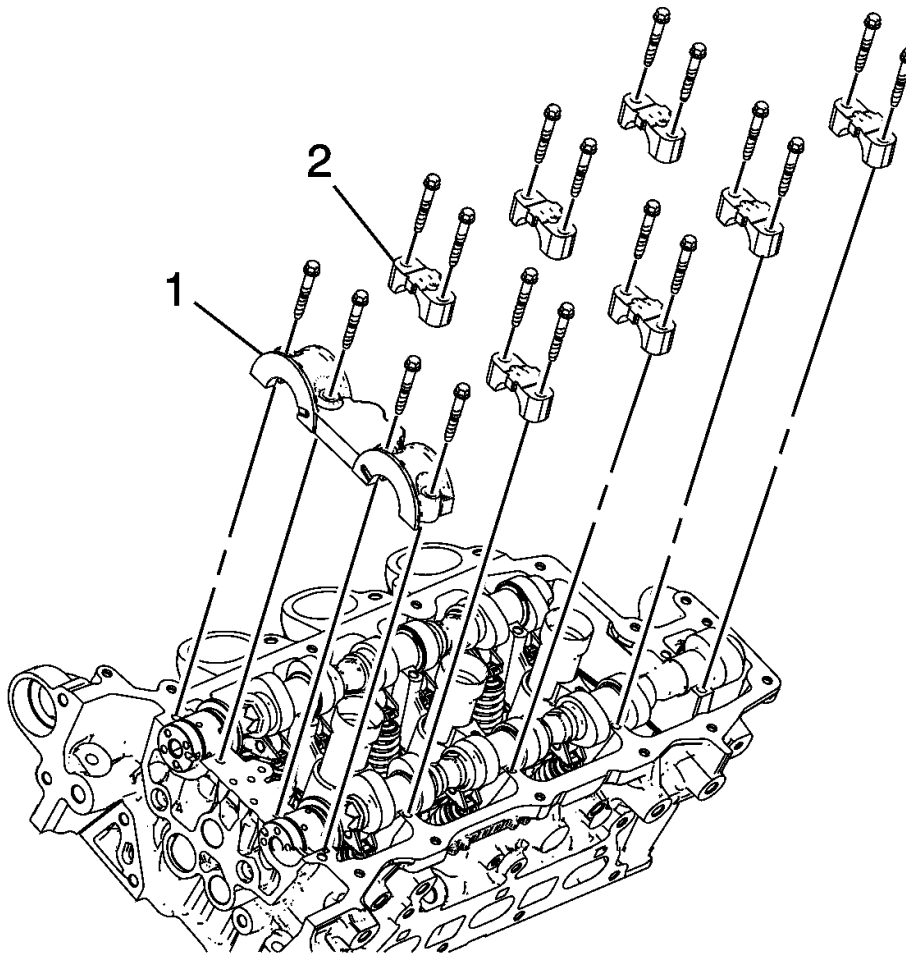
- The raised feature (1) must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.
  7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.



**Fig. 149: Camshaft Bearing Cap And Camshaft Thrust Surface**  
Courtesy of GENERAL MOTORS COMPANY

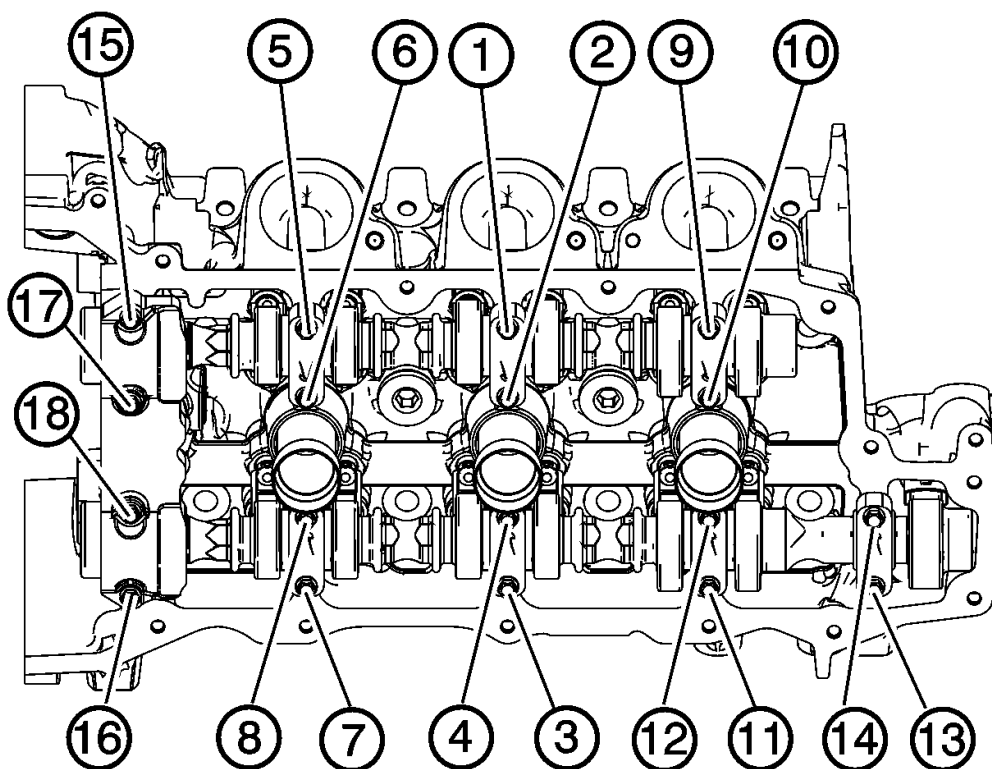
8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.





**Fig. 150: Camshaft Bearing Caps And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).



**Fig. 151: Identifying Camshaft Bearing Cap Bolt Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

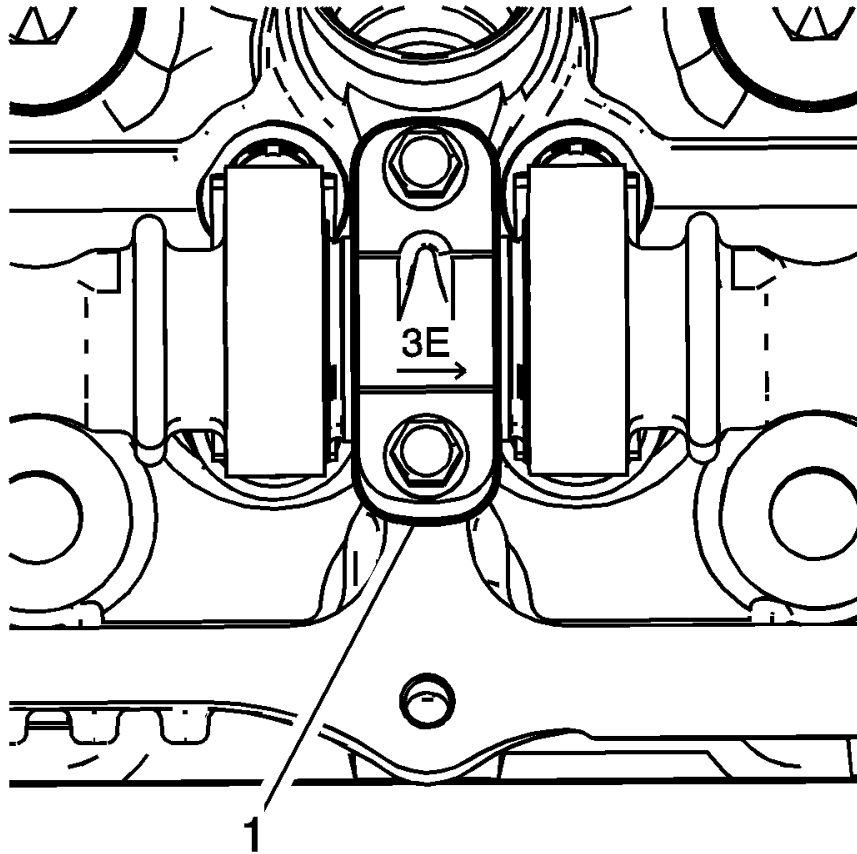
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to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

## CAMSHAFT REPLACEMENT - RIGHT SIDE

### Removal Procedure

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

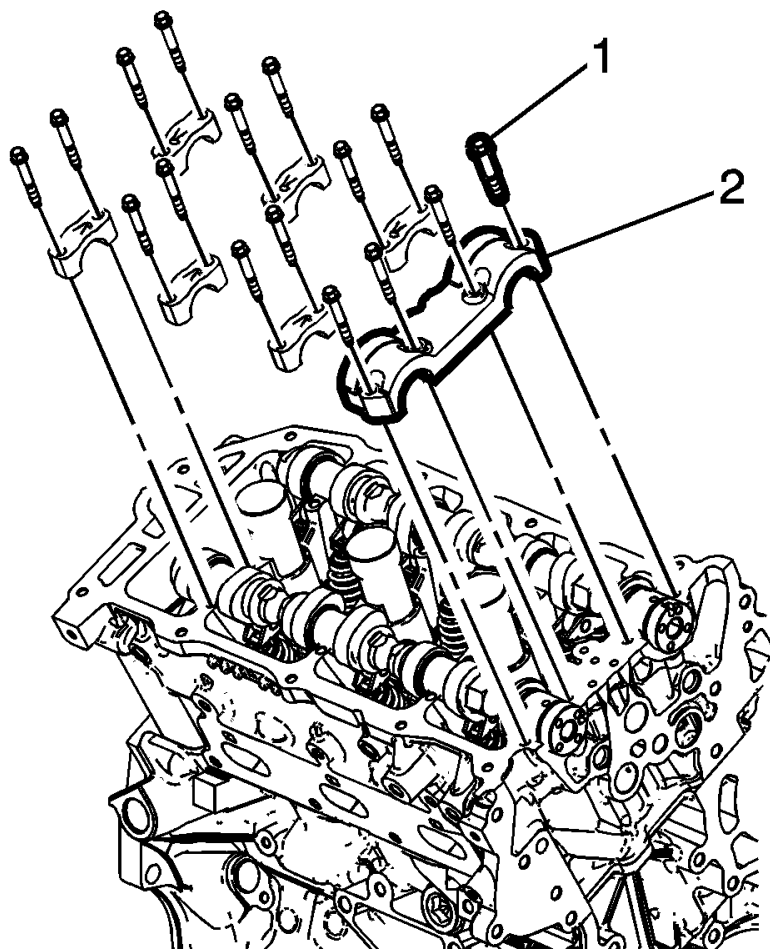
2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:



**Fig. 152: Bearing Cap Markings**

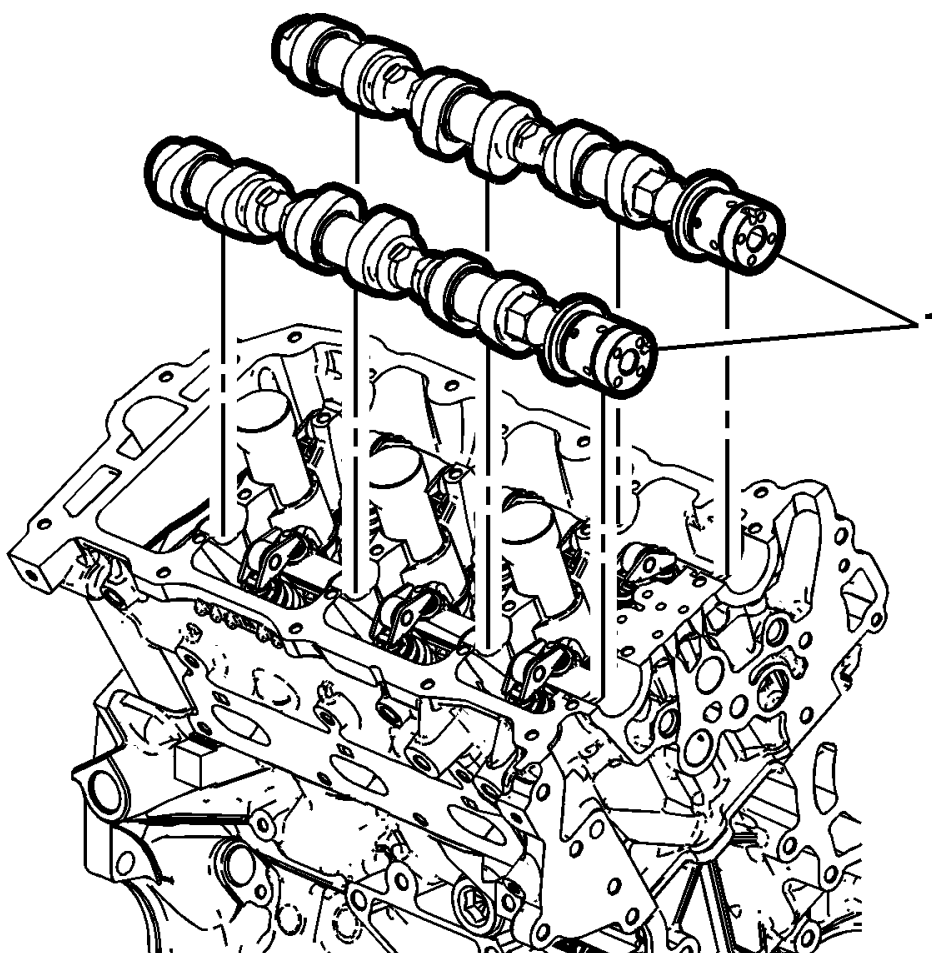
Courtesy of GENERAL MOTORS COMPANY

- The raised feature must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number indicates the journal position from the front of the engine.
3. Remove the camshaft bearing cap bolts (1).



**Fig. 153: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

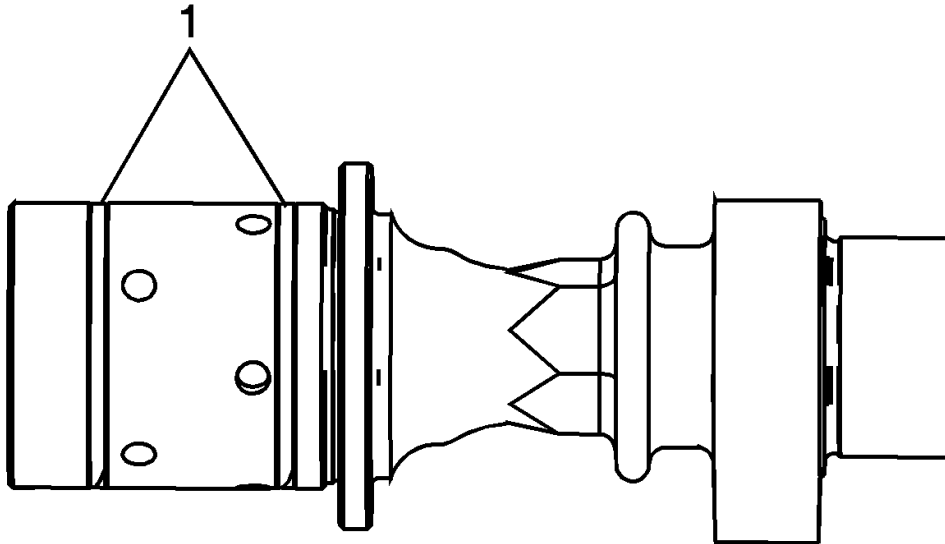


**Fig. 154: Camshafts**

Courtesy of GENERAL MOTORS COMPANY

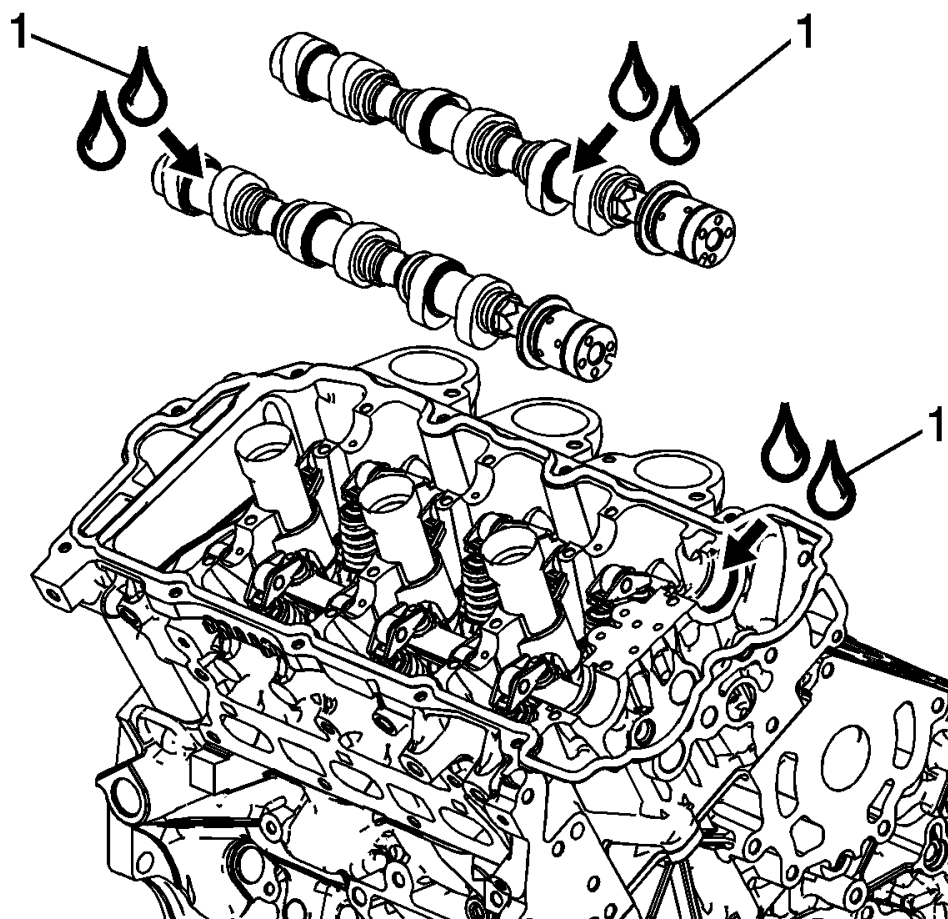
**IMPORTANT:** Mark the camshafts upon removal to ensure installation is in the correct position.

#### Installation Procedure



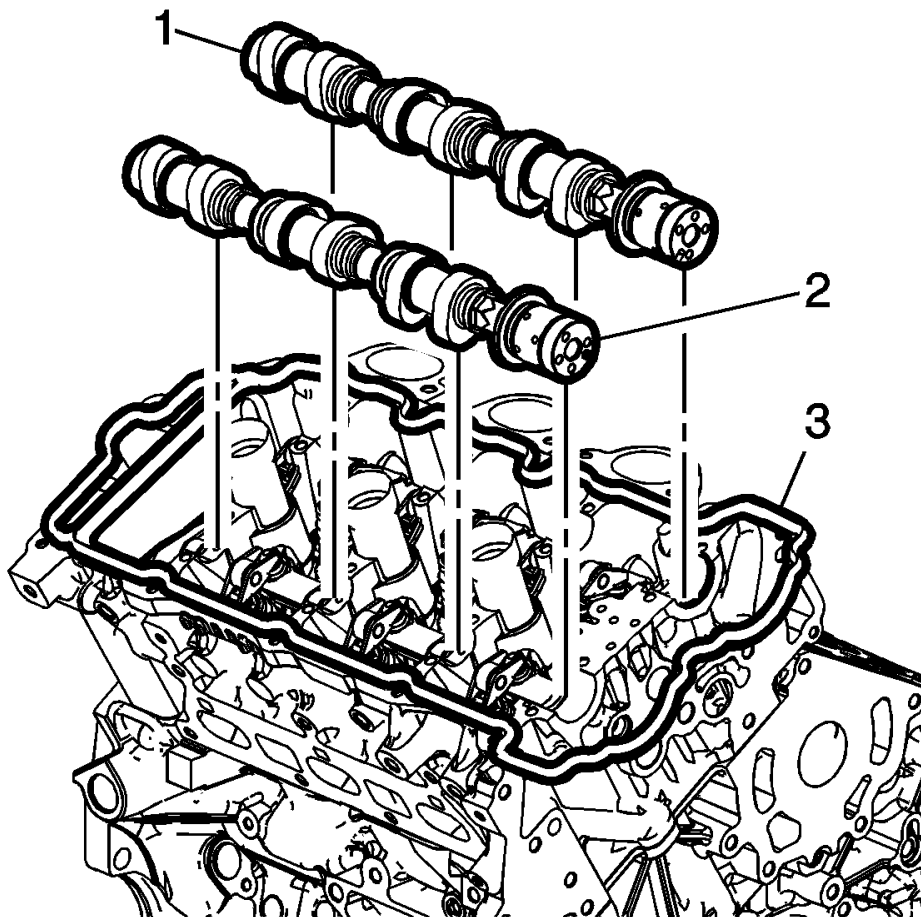
**Fig. 155: Locating Camshaft Sealing Rings In Camshaft Grooves**  
 Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.
2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.



**Fig. 156: Right Cylinder Head Camshaft Lubrication Points**  
Courtesy of GENERAL MOTORS COMPANY

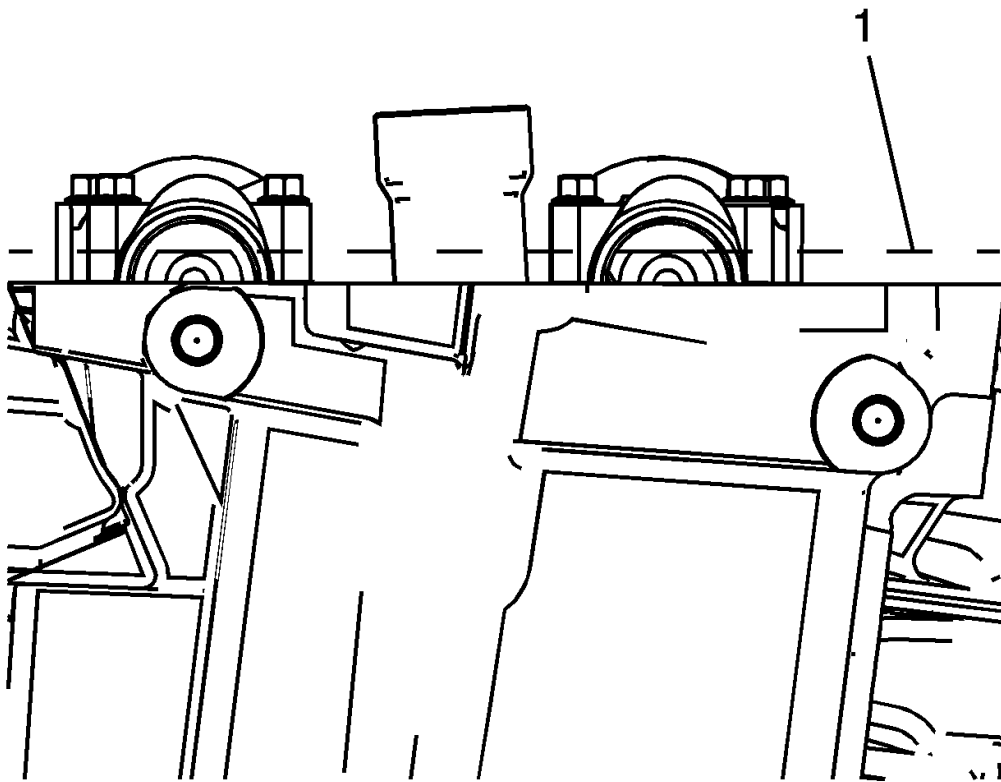
3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).



**Fig. 157: Right Cylinder Head Camshaft Intake And Exhaust Positioning Points**  
Courtesy of GENERAL MOTORS COMPANY

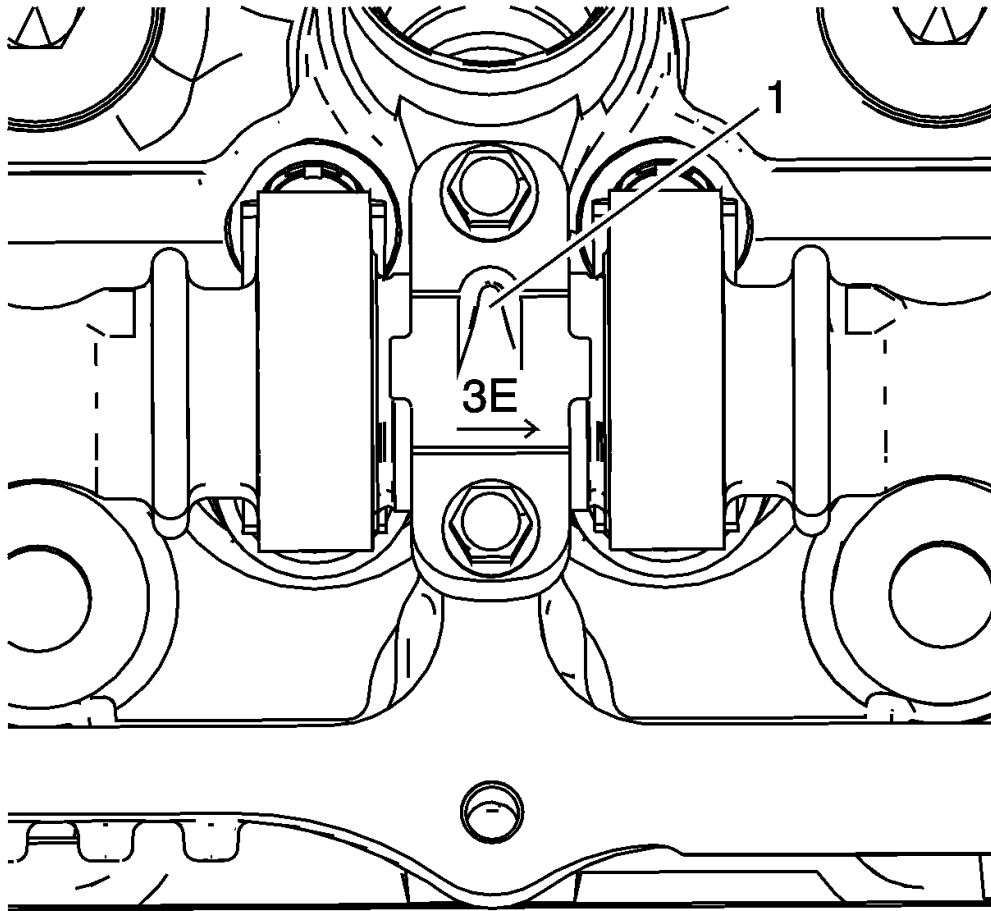
4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.





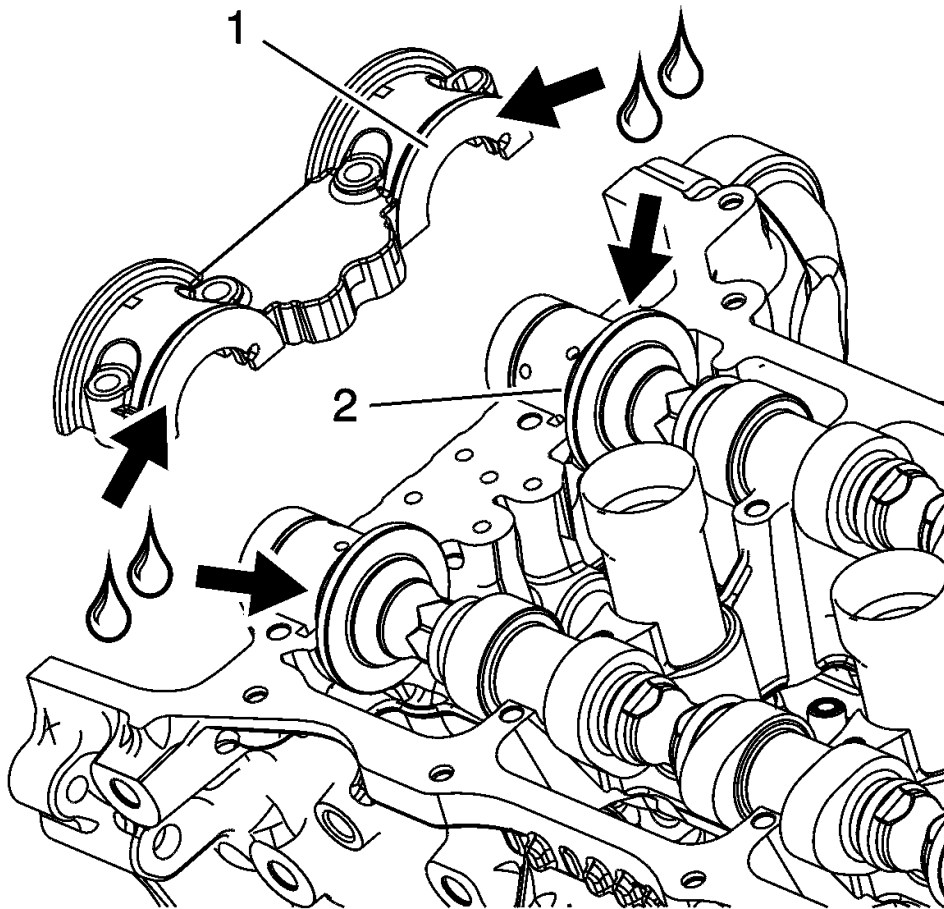
**Fig. 158: Identifying Camshaft Neutral (Low Tension) Position**  
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:



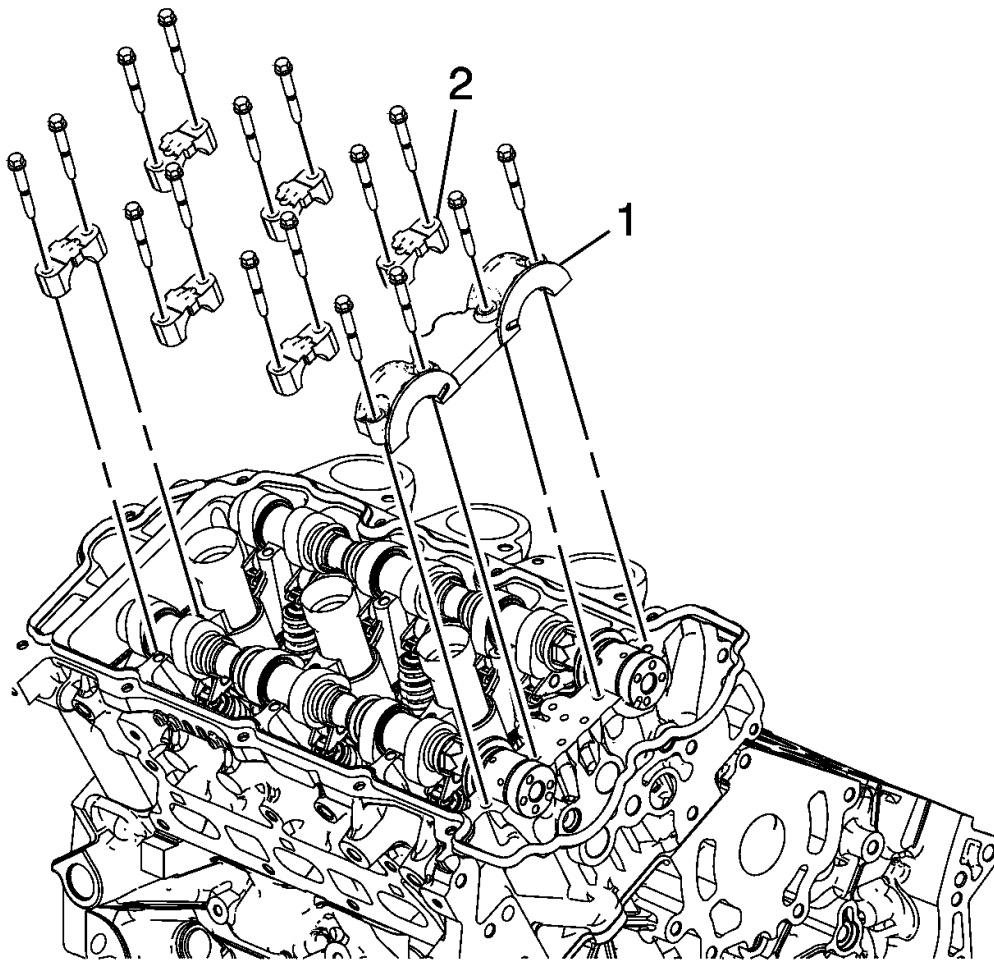
**Fig. 159: Right Cylinder Head Camshaft Bearing Cap Markings**  
 Courtesy of GENERAL MOTORS COMPANY

- The raised feature (1) must always be oriented toward the center of the cylinder head.
  - The I indicates the intake camshaft.
  - The E indicates the exhaust camshaft.
  - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.
  7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.



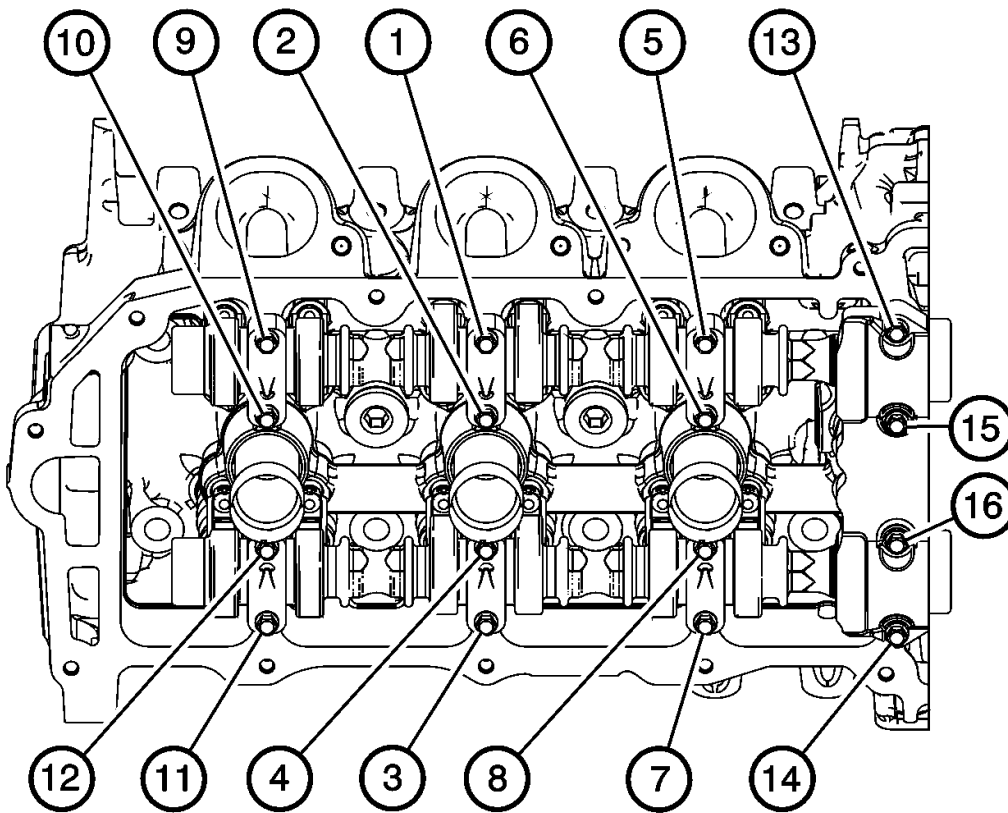
**Fig. 160: Camshaft Bearing Cap And Camshaft Thrust Surface**  
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.



**Fig. 161: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.
11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).



**Fig. 162: Camshaft Bearing Cap Bolts Tighten Sequence**  
Courtesy of GENERAL MOTORS COMPANY

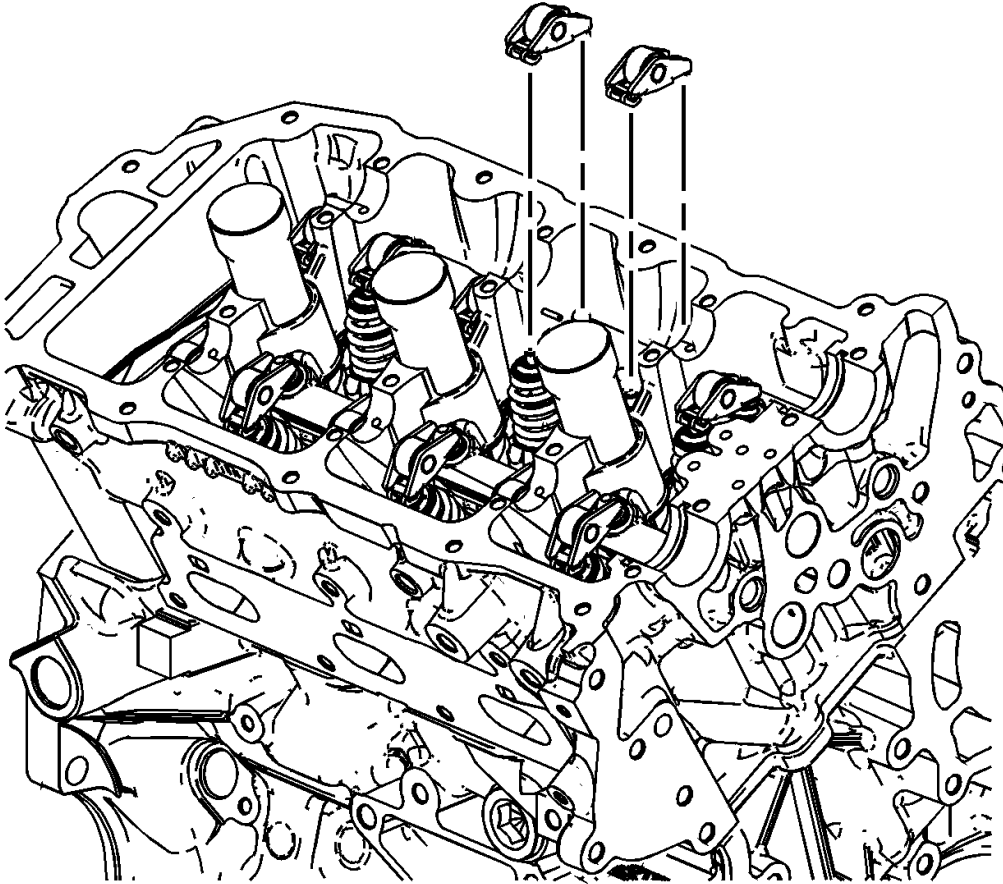
**CAUTION:** Refer to Fastener Caution .

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

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

**VALVE ROCKER ARM REPLACEMENT - LEFT SIDE****Removal Procedure**

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

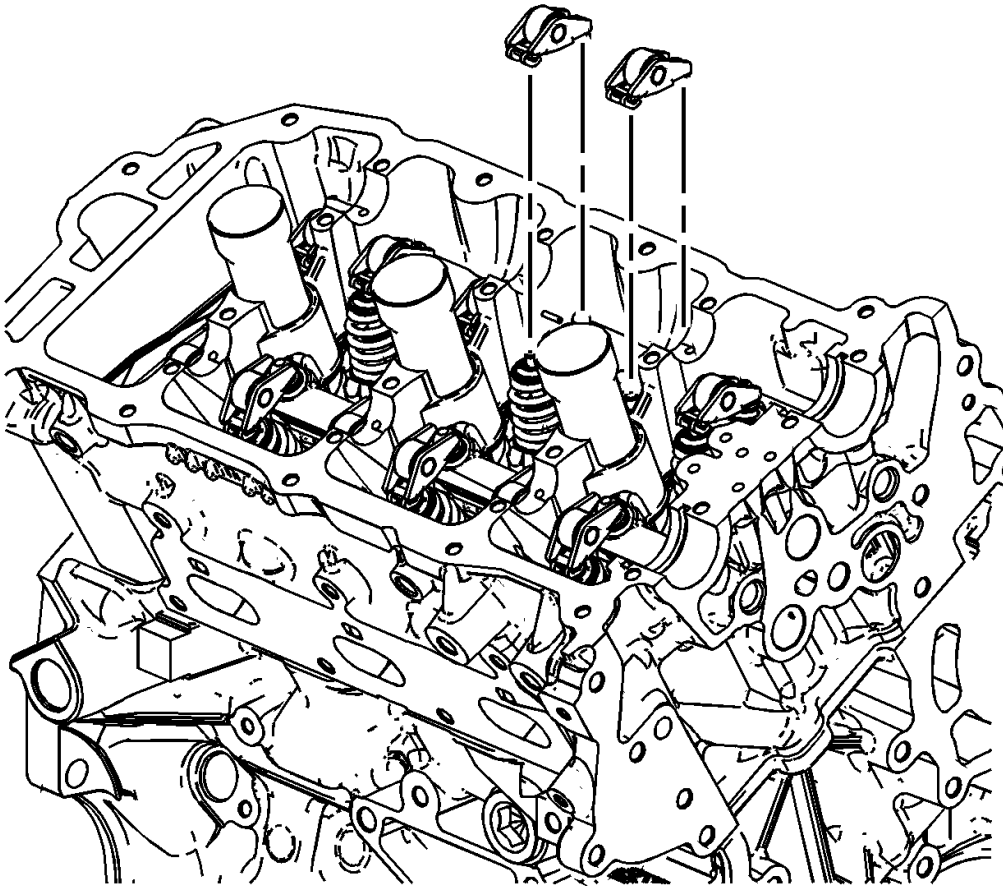


**Fig. 163: Identifying Valve Rocker Arms**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Left Side**.



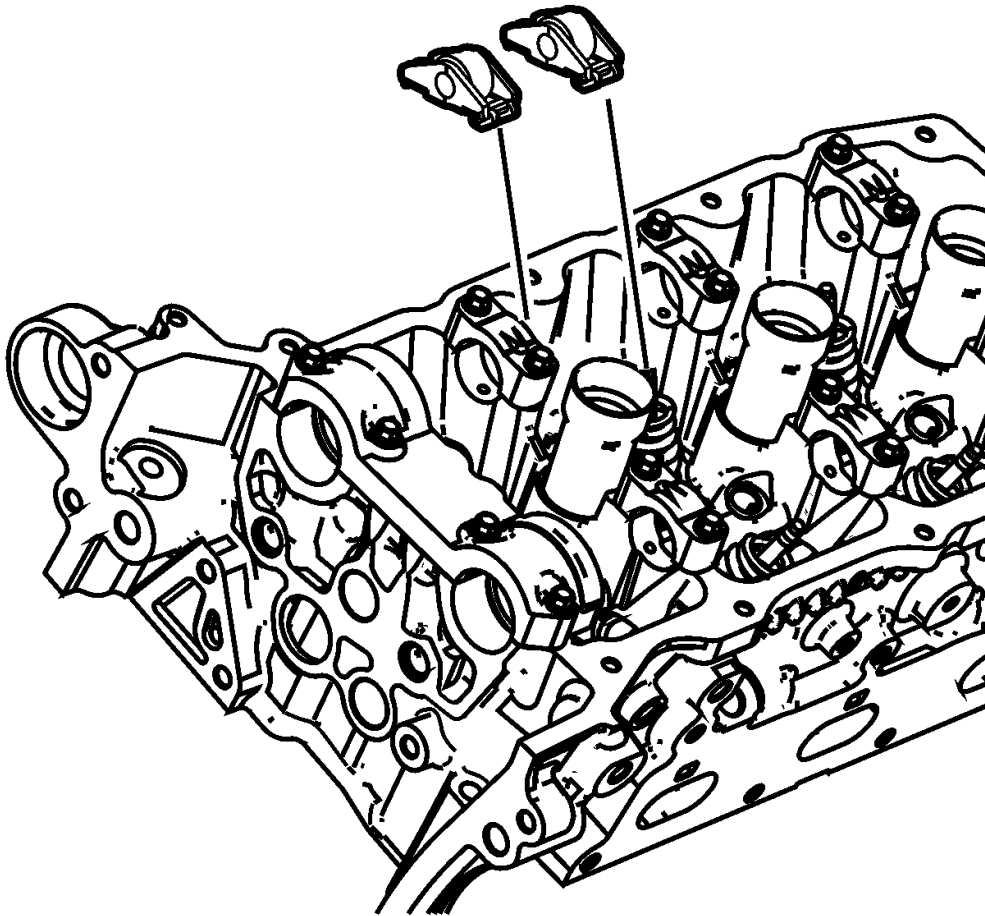
**Fig. 164: Identifying Valve Rocker Arms**  
Courtesy of GENERAL MOTORS COMPANY

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**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side**.



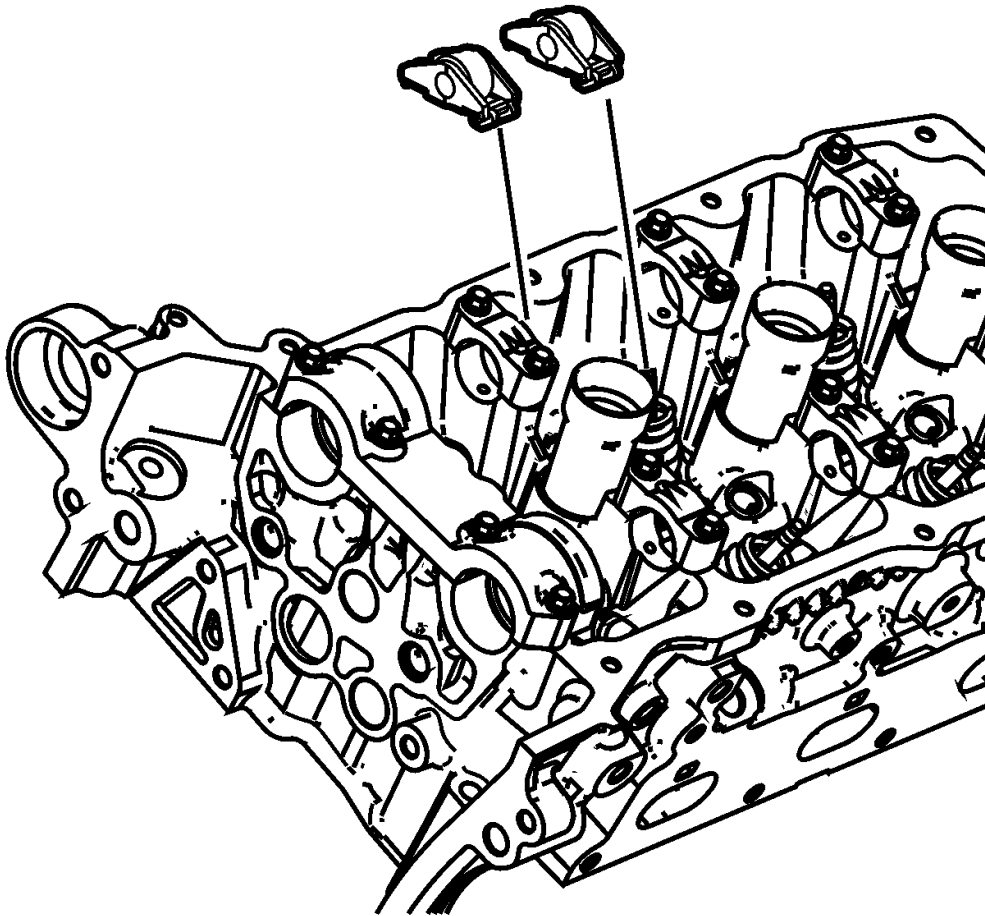
**Fig. 165: View Of Valve Rocker Arm**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the rocker arms.





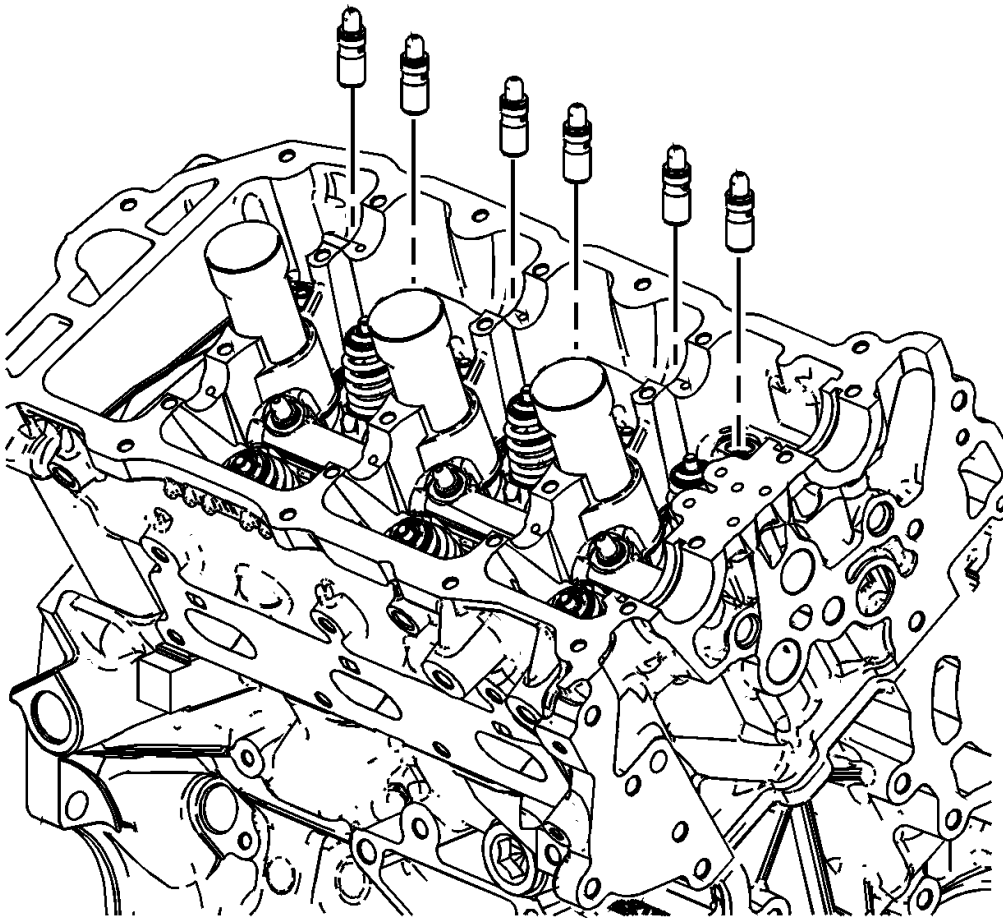
**Fig. 166: View Of Valve Rocker Arm**  
Courtesy of GENERAL MOTORS COMPANY

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 .
3. Remove the lifters. Refer to Valve Lifter Removal - Left Side .



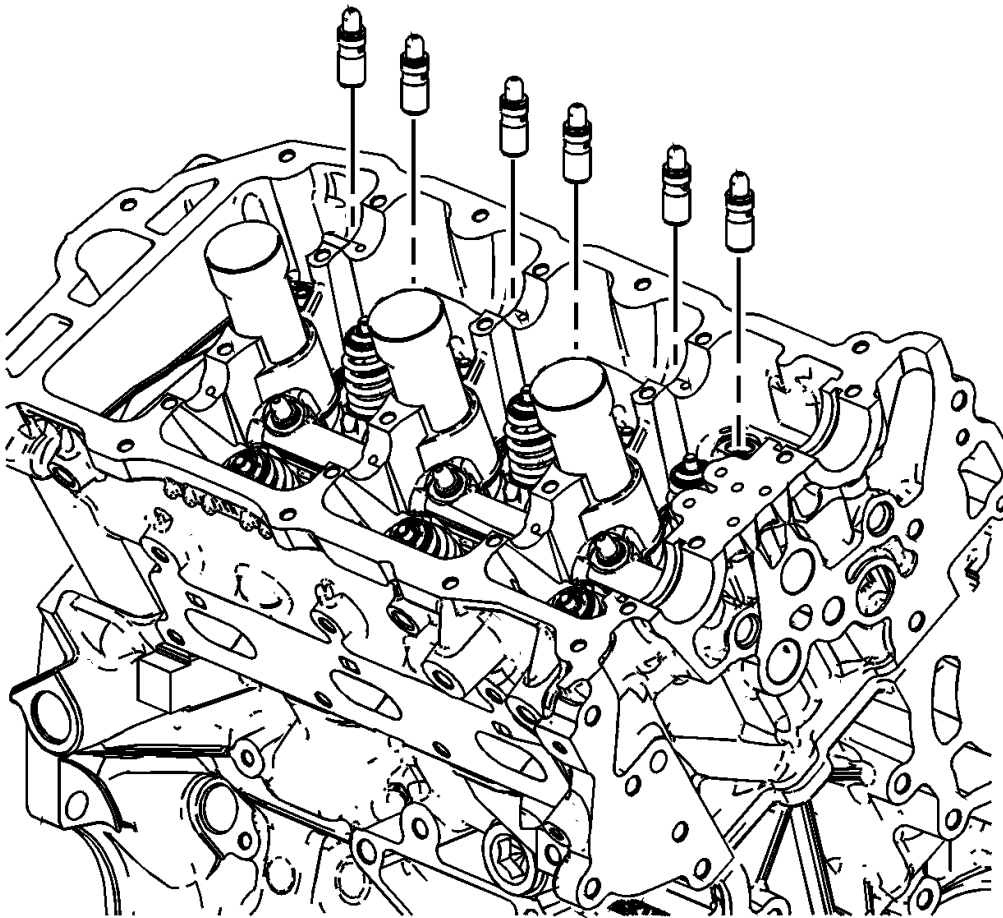
**Fig. 167: Identifying Stationary Hydraulic Lash Adjuster (SHLA)**

Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the lifters. Refer to **Valve Lifter Installation - Left Side** .



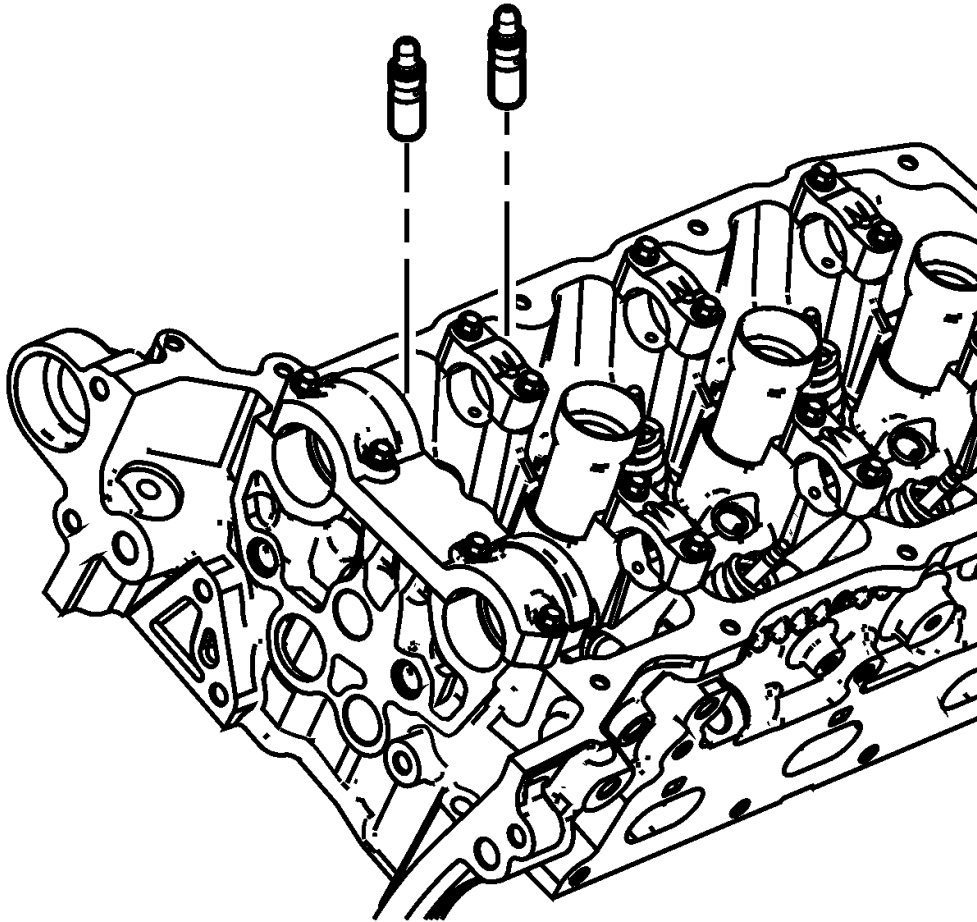
**Fig. 168: Identifying Stationary Hydraulic Lash Adjuster (SHLA)**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Left Side** .
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** .
3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side** .

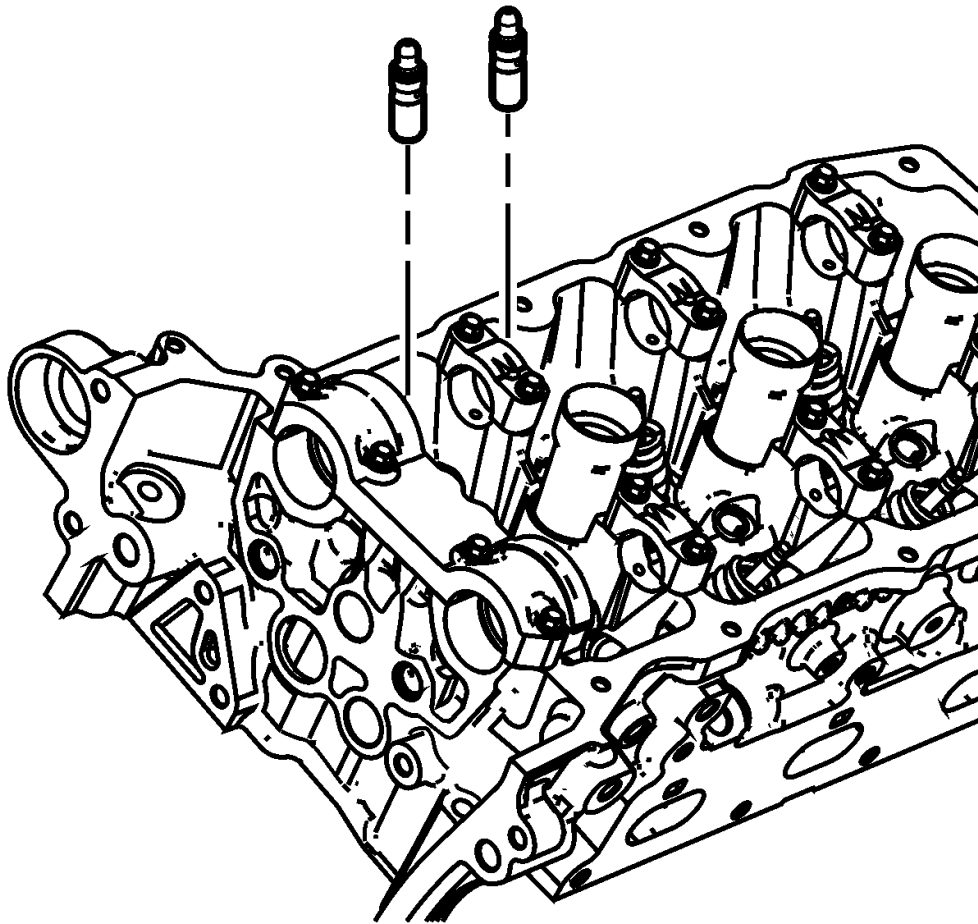


**Fig. 169: View Of Stationary Hydraulic Lash Adjuster (SHLAs)**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the lifters. Refer to Valve Lifter Installation - Right Side .



**Fig. 170: View Of Stationary Hydraulic Lash Adjuster (SHLAs)**  
Courtesy of GENERAL MOTORS COMPANY

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**.

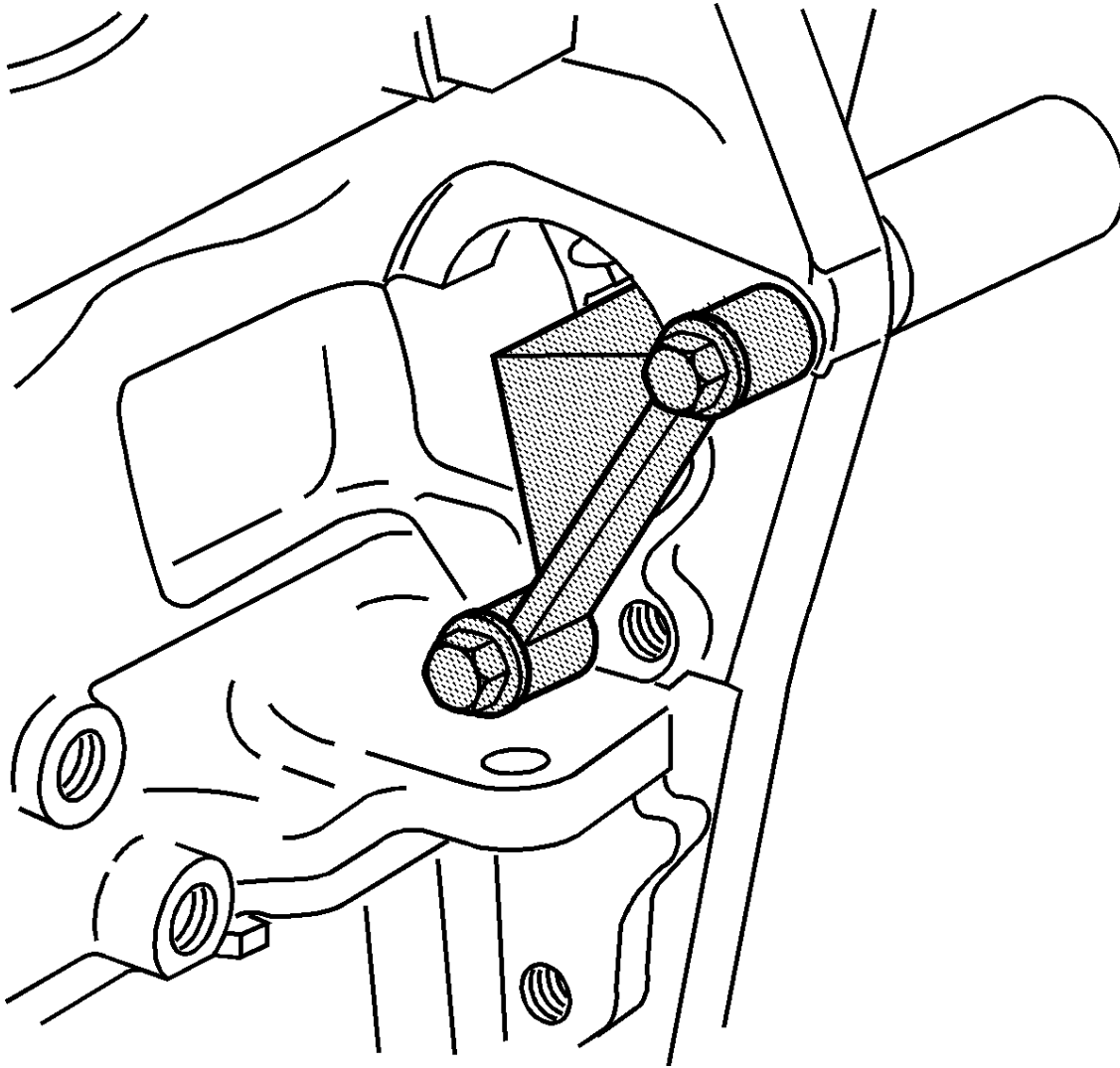
## **VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE**

### **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** .
2. Install the **EN 46106** flywheel holding tool in order to prevent crankshaft rotation.

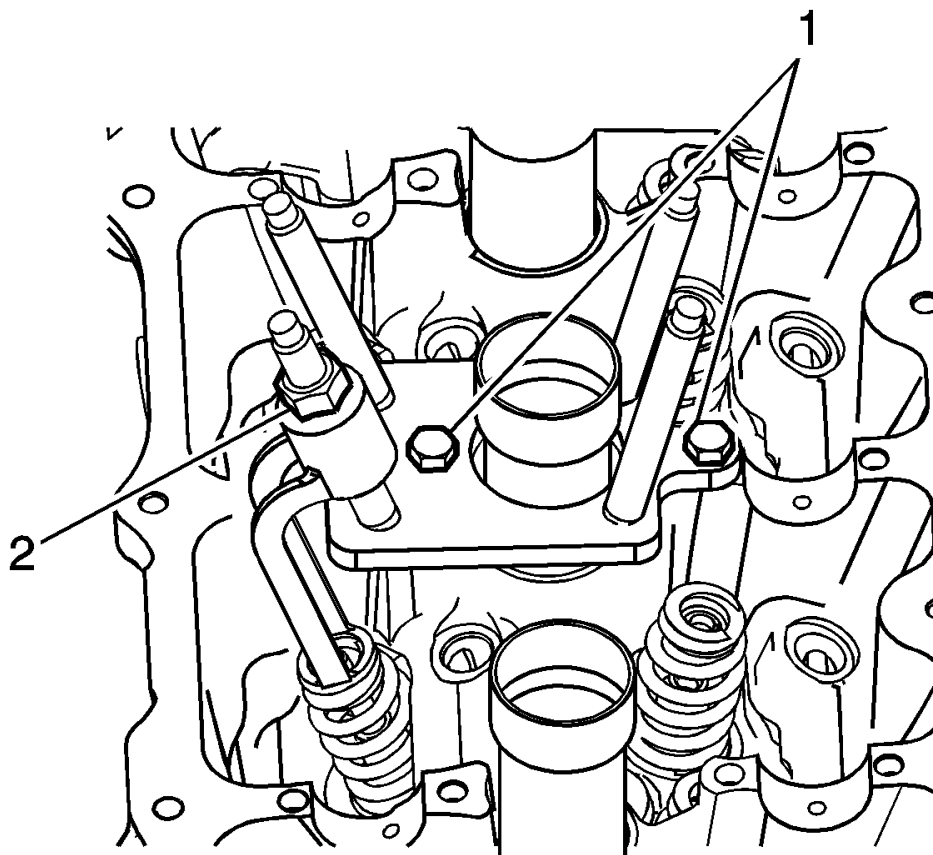


**Fig. 171: Identifying Special Tool - EN 46106**  
Courtesy of GENERAL MOTORS COMPANY

**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.

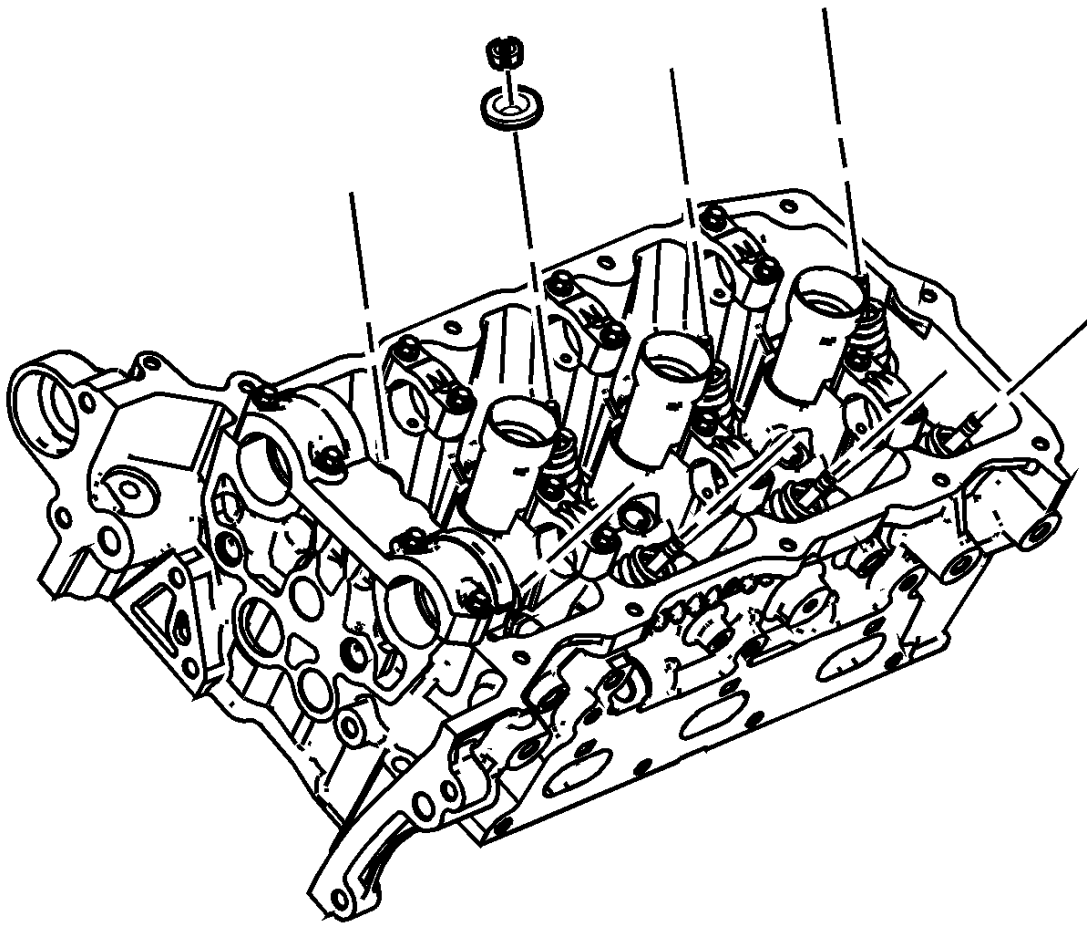
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Left Side**.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Remove Rocker arm. refer to **Valve Rocker Arm Replacement - Left Side**
6. Install the **J 39313** spark plug port adapter to the applicable cylinder.
7. Connect the **J 39313** spark plug port adapter to a compressed air source.

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



**Fig. 172: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS COMPANY

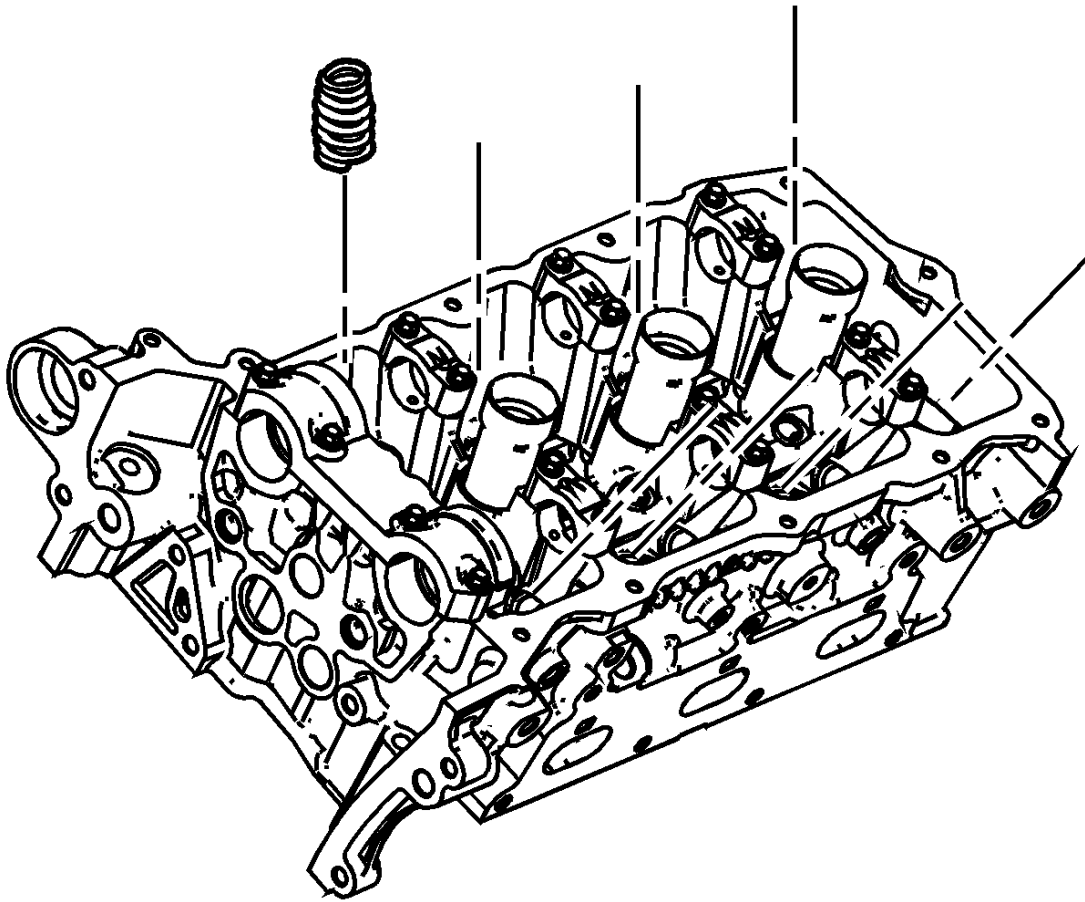
9. Tighten the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut (2).
10. Remove the valve keepers.



**Fig. 173: View Of Valve Spring Keepers**  
Courtesy of GENERAL MOTORS COMPANY

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

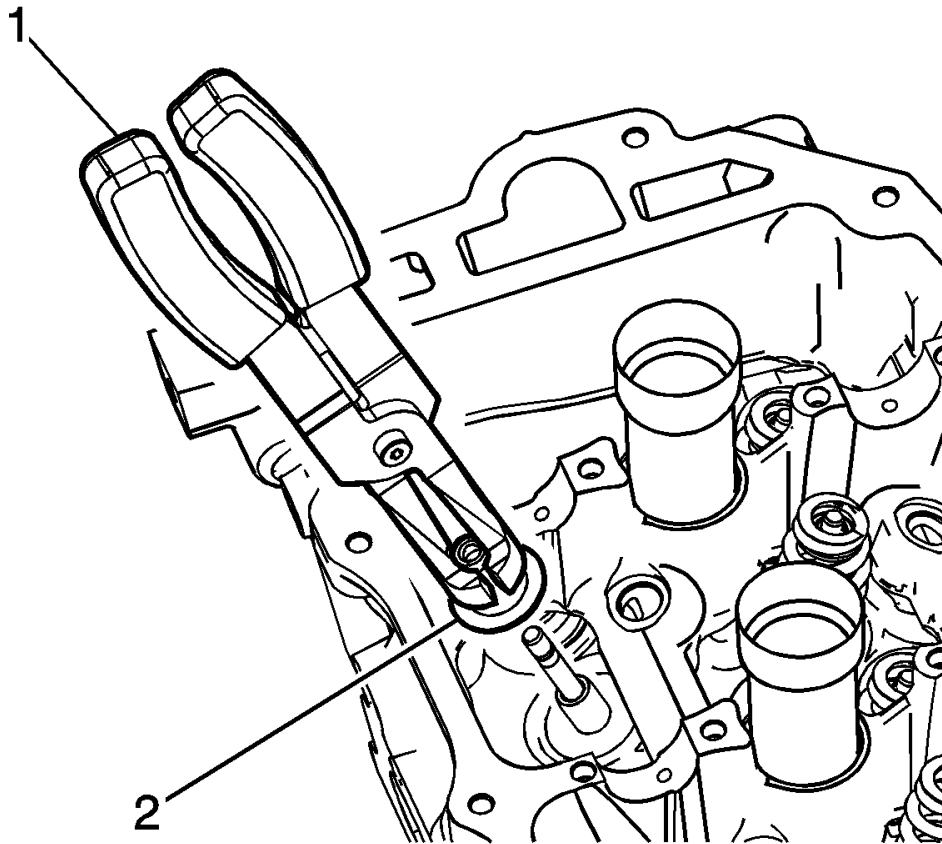




**Fig. 174: View Of Valve Spring**

Courtesy of GENERAL MOTORS COMPANY

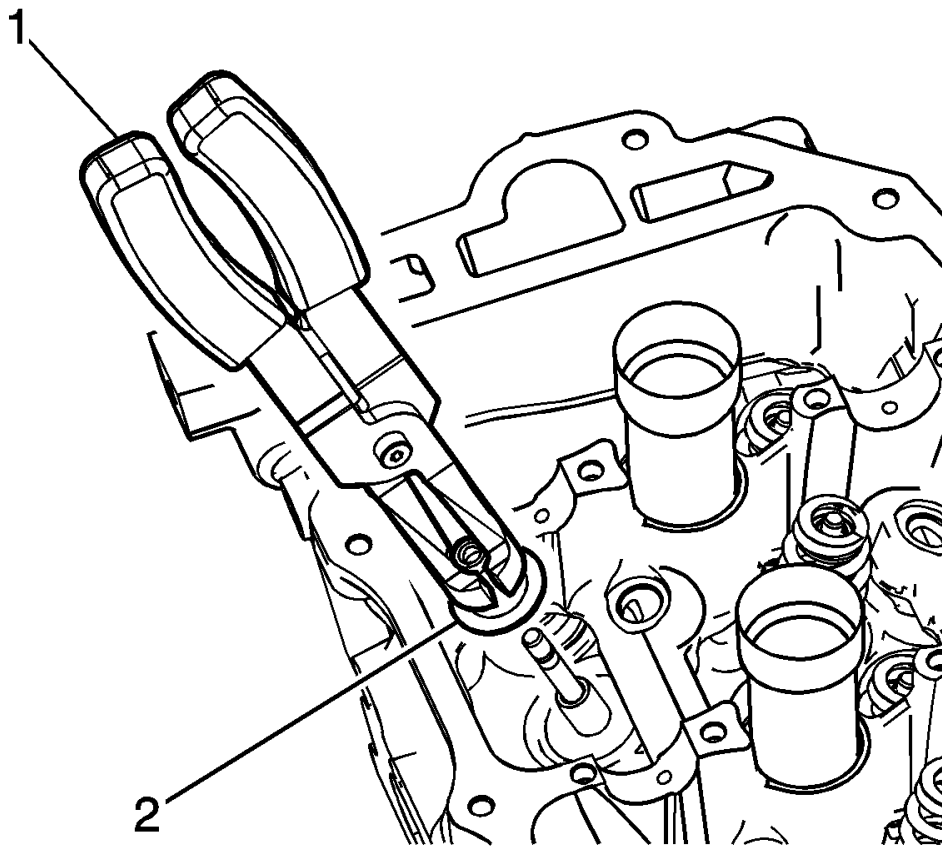
14. Use the **EN 46116** valve stem seal remover/installer (1) in order to remove the valve stem seal (2).



**Fig. 175: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

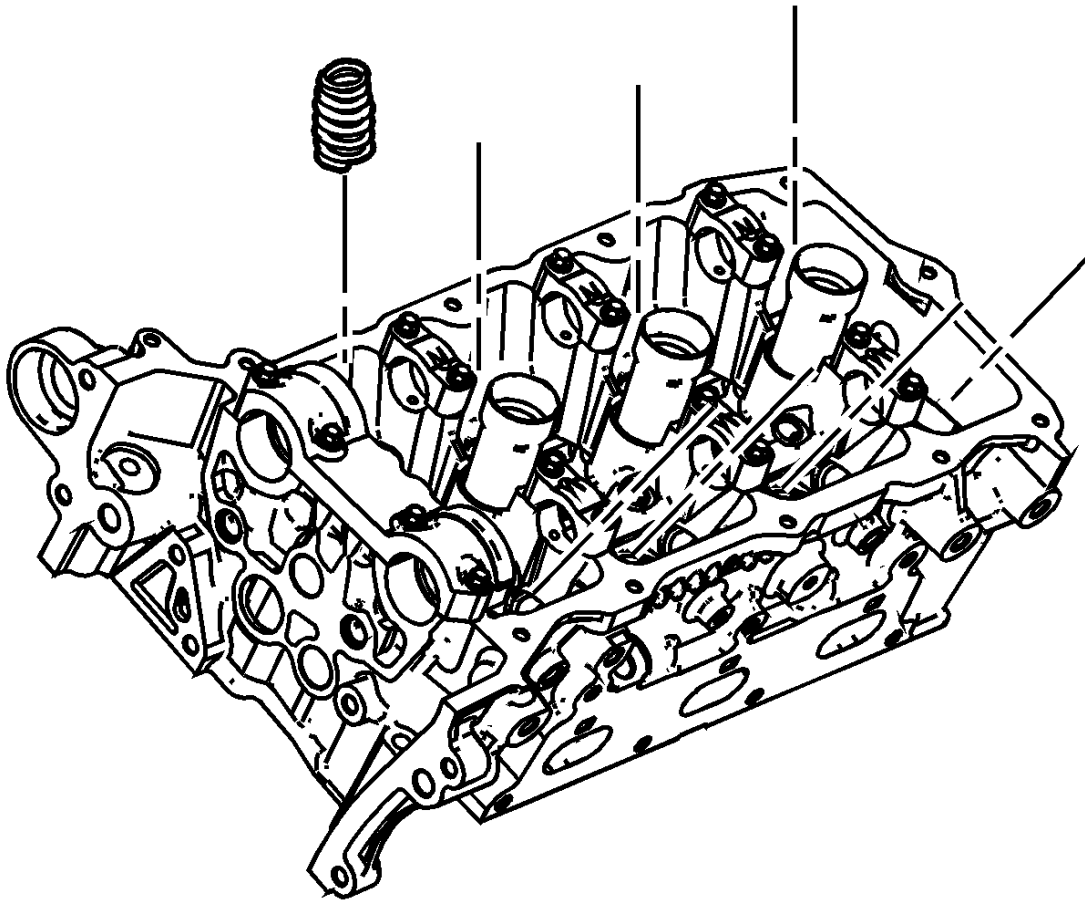
#### **Installation Procedure**

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



**Fig. 176: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the valve spring.

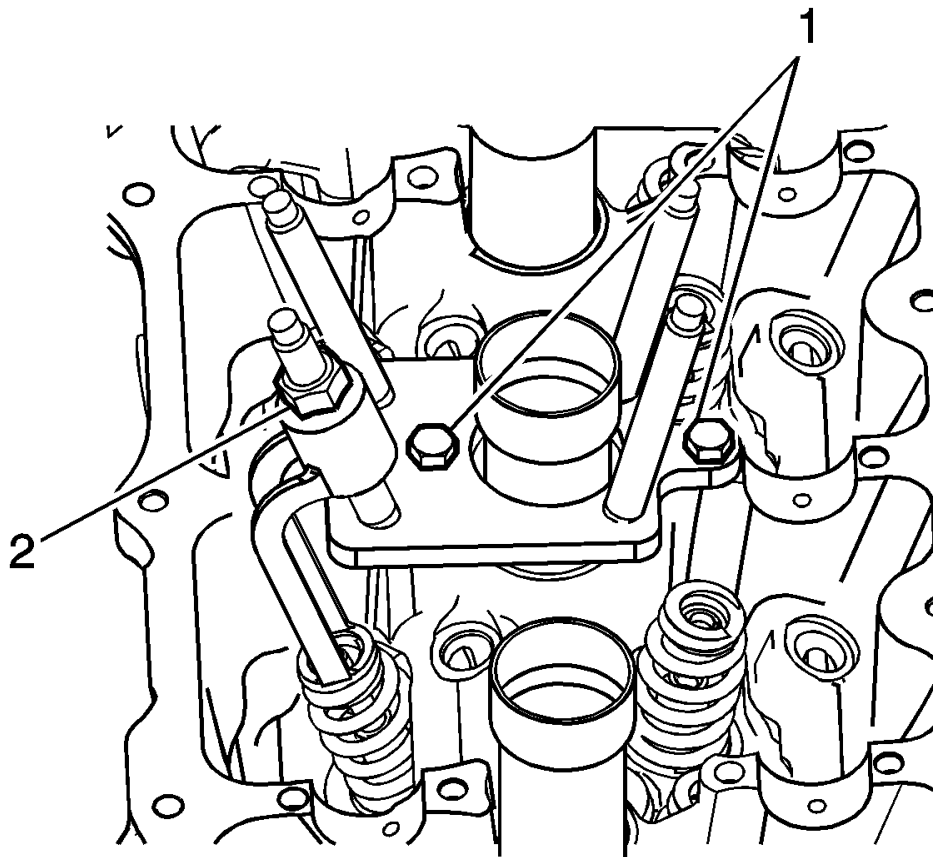


**Fig. 177: View Of Valve Spring**

Courtesy of GENERAL MOTORS COMPANY

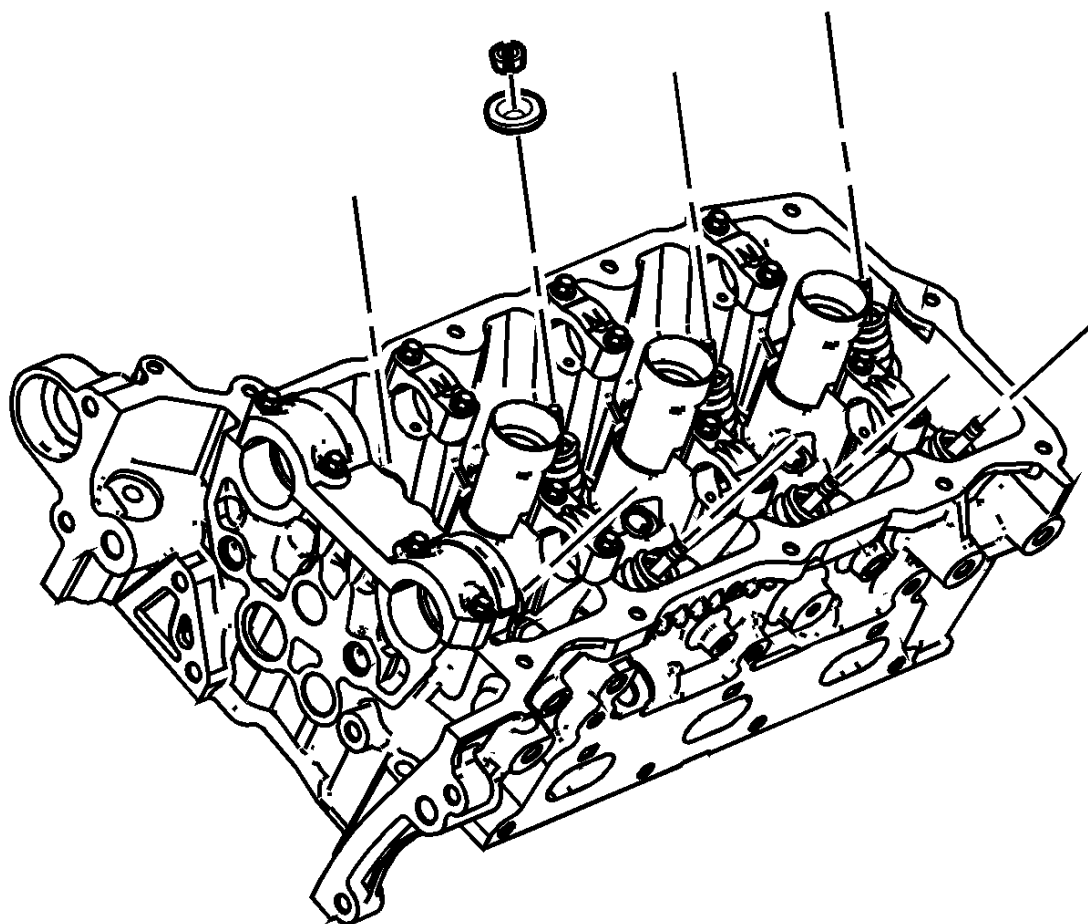
3. Install the valve spring retainer.
4. Install the **EN 46110** on-vehicle valve spring compressor above the applicable valve spring as shown.

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



**Fig. 178: View Of Installed Valve Spring Compressor Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

5. Install the valve spring keepers.



**Fig. 179: View Of Valve Spring Keepers**  
Courtesy of GENERAL MOTORS COMPANY

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

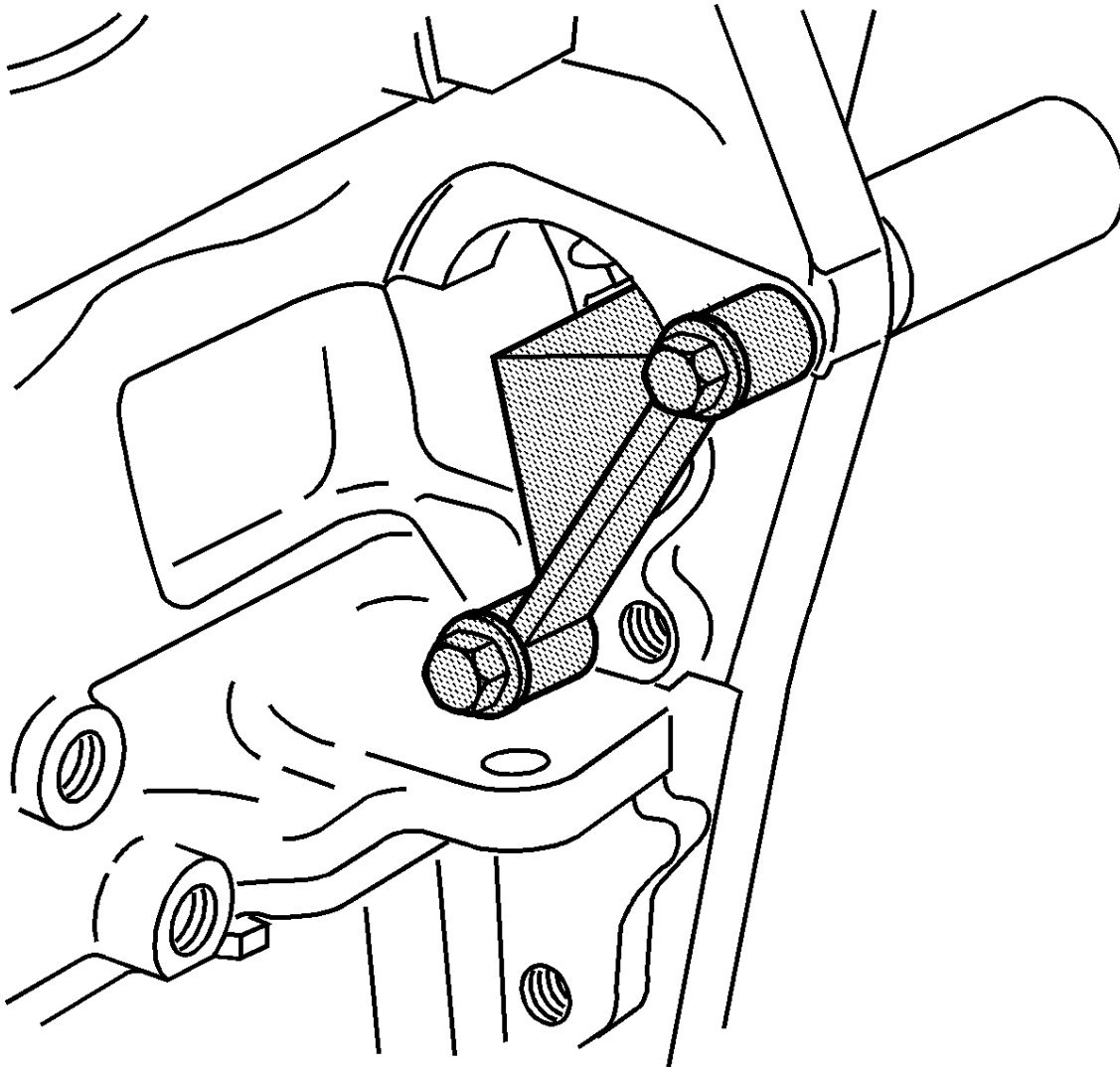
### Special Tools

- **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**

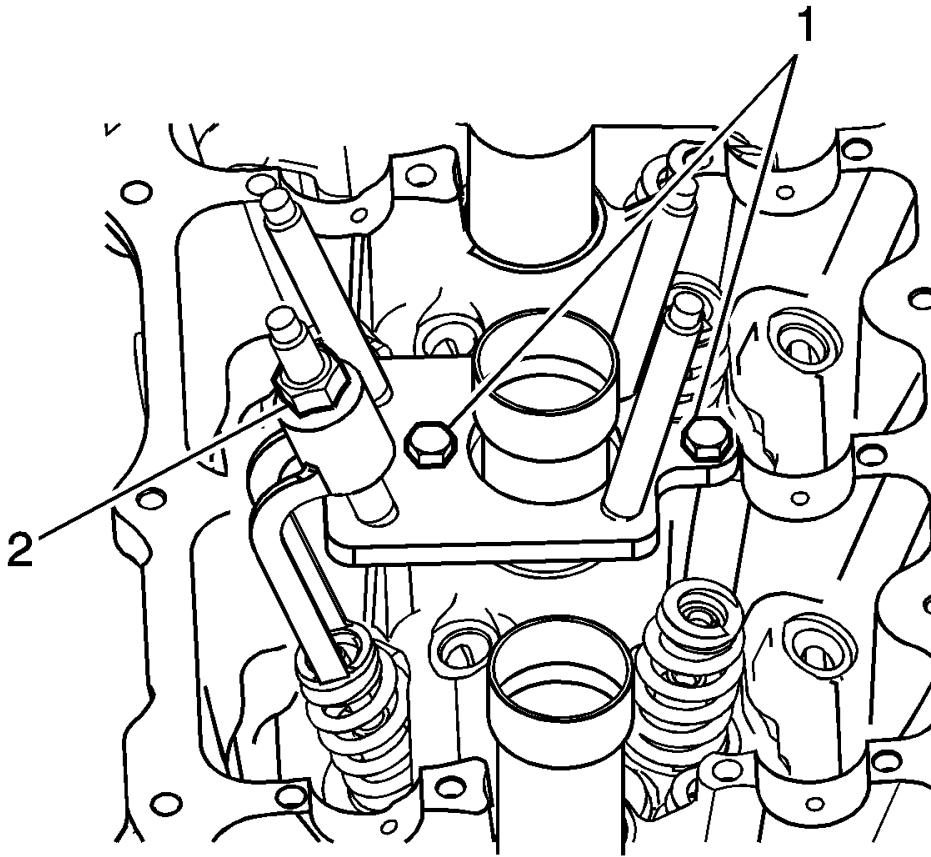
1. Remove the starter motor. Refer to **Starter Replacement** .
2. Install the **EN 46106** flywheel holding tool in order to prevent crankshaft rotation.



**Fig. 180: Identifying Special Tool - EN 46106**  
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.

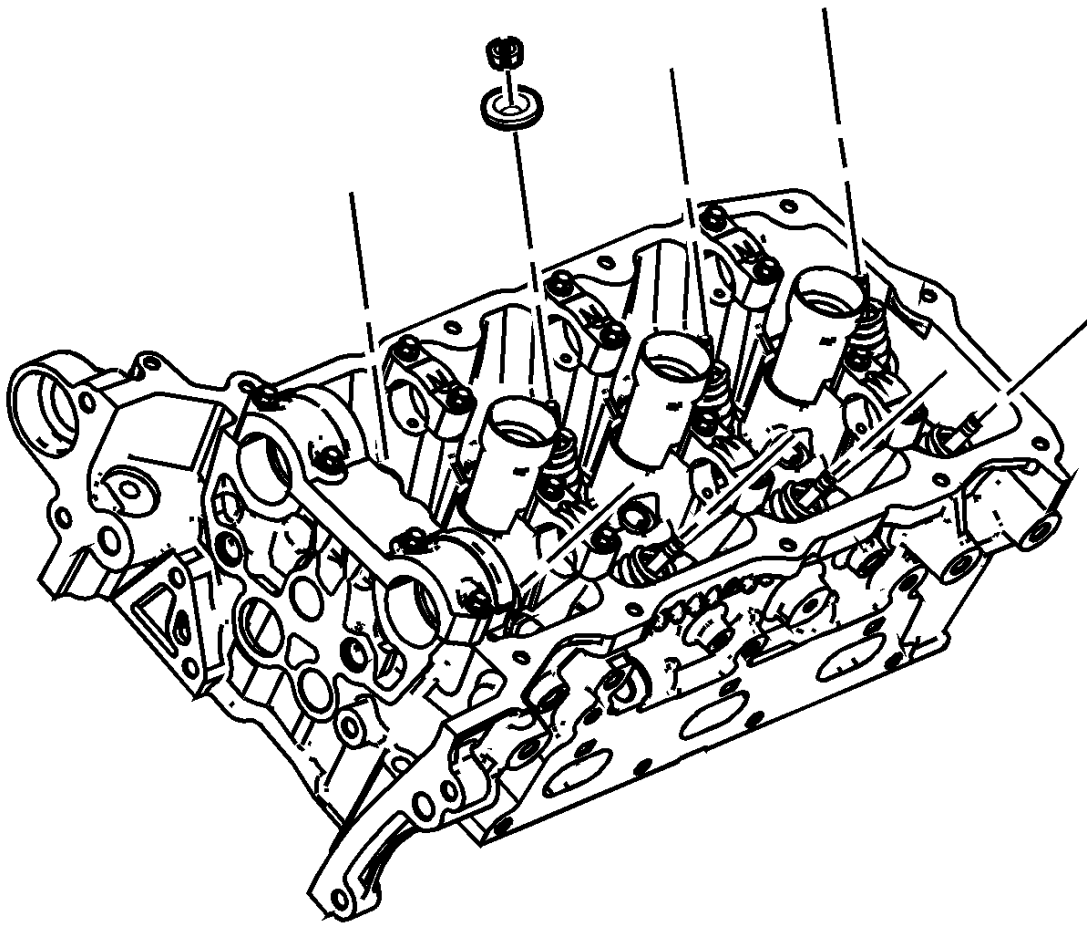
3. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Right Side, Valve Rocker Arm Replacement - Right Side.**
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement**.
5. Install the **J 39313** spark plug port adapter to the applicable cylinder.
6. Connect the **J 39313** spark plug port adapter to a compressed air source.
7. Install the **EN 46110** on-vehicle valve spring compressor above the applicable cylinder as shown.



**Fig. 181: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS COMPANY

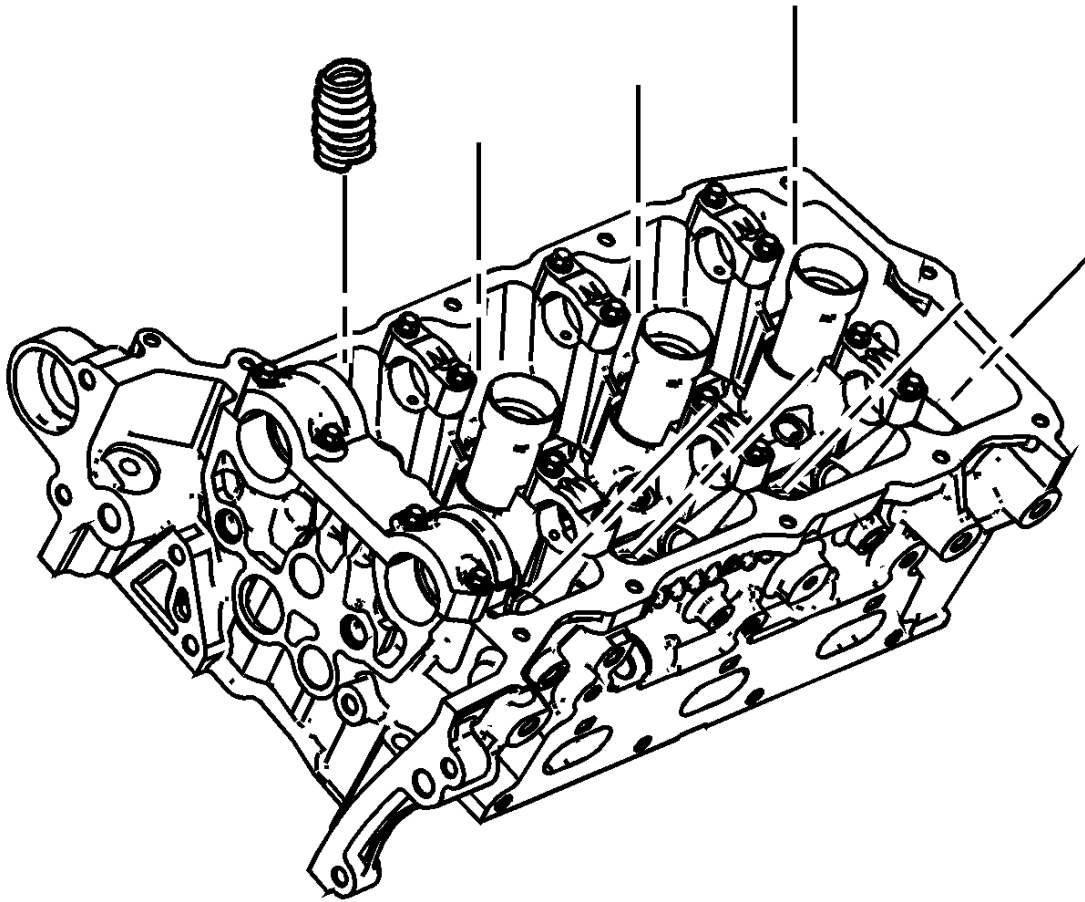
8. Tighten the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut (2).
9. Remove the valve keepers.





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

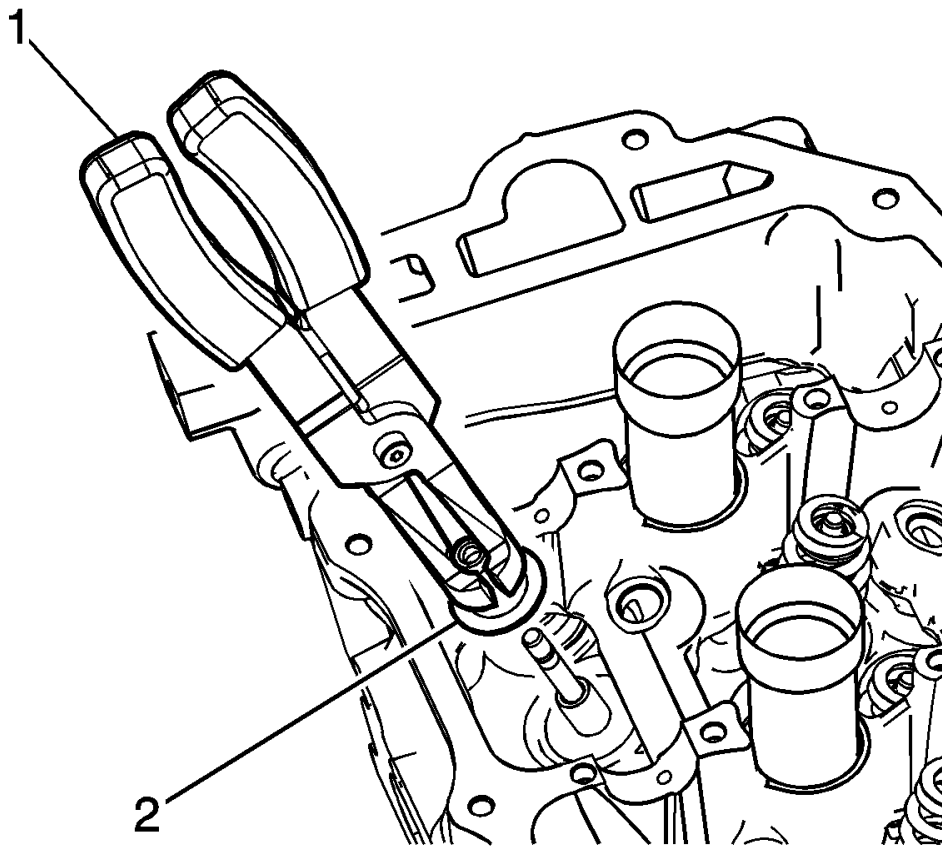
10. Loosen the **EN 46110** on-vehicle valve spring compressor valve spring compressor nut.
11. Remove the valve spring retainer.
12. Remove the valve springs.



**Fig. 183: View Of Valve Spring**

Courtesy of GENERAL MOTORS COMPANY

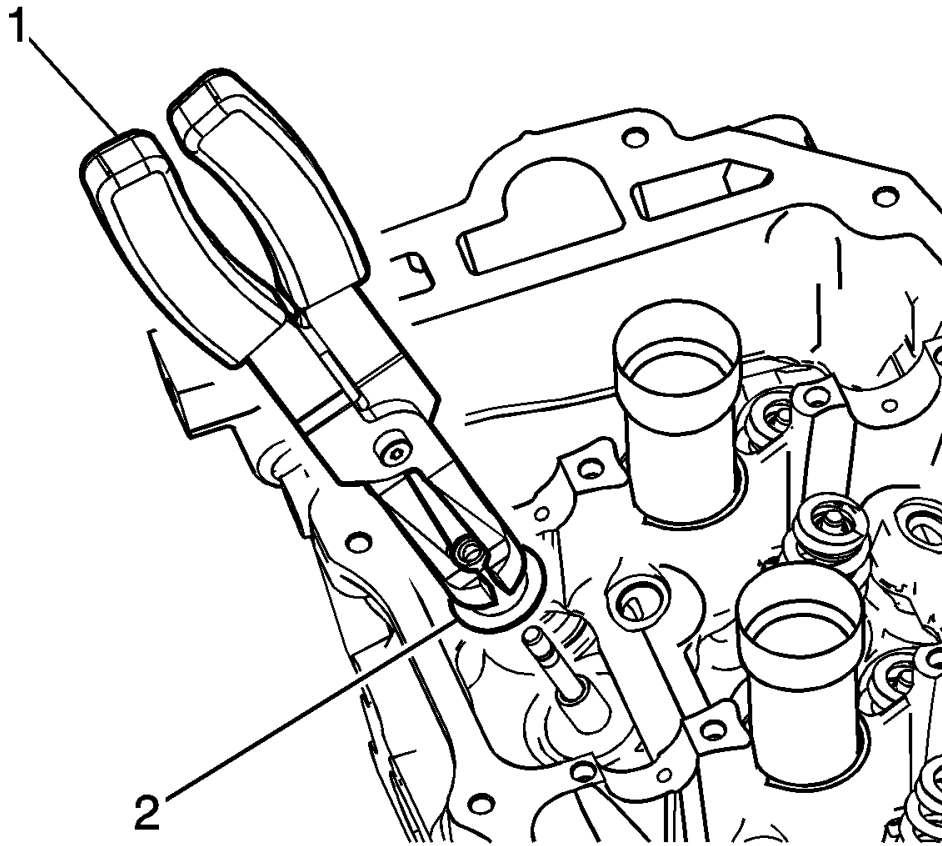
13. Use the **EN 46116** valve stem seal remover/installer (1) in order to remove the valve stem seal (2).



**Fig. 184: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
Courtesy of GENERAL MOTORS COMPANY

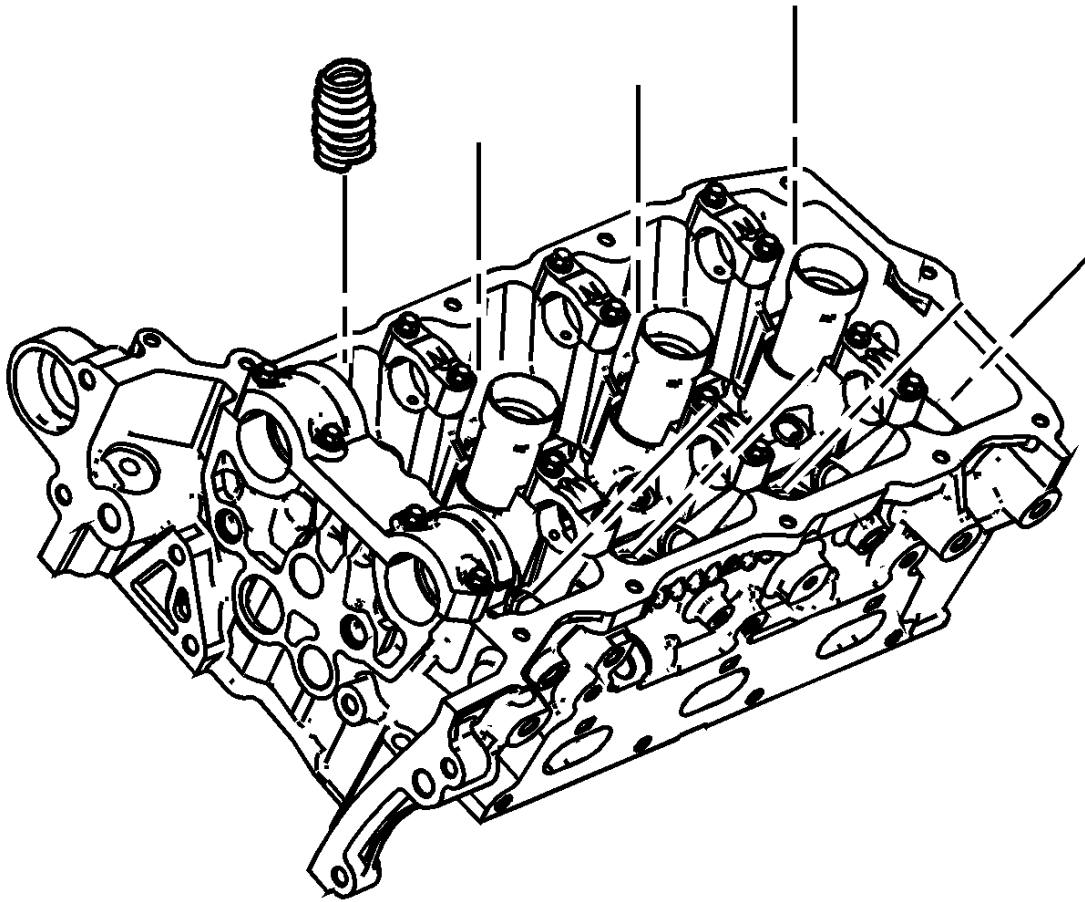
#### **Installation Procedure**

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



**Fig. 185: Identifying Special Tool - EN-46116 & Valve Stem Seal**  
**Courtesy of GENERAL MOTORS COMPANY**

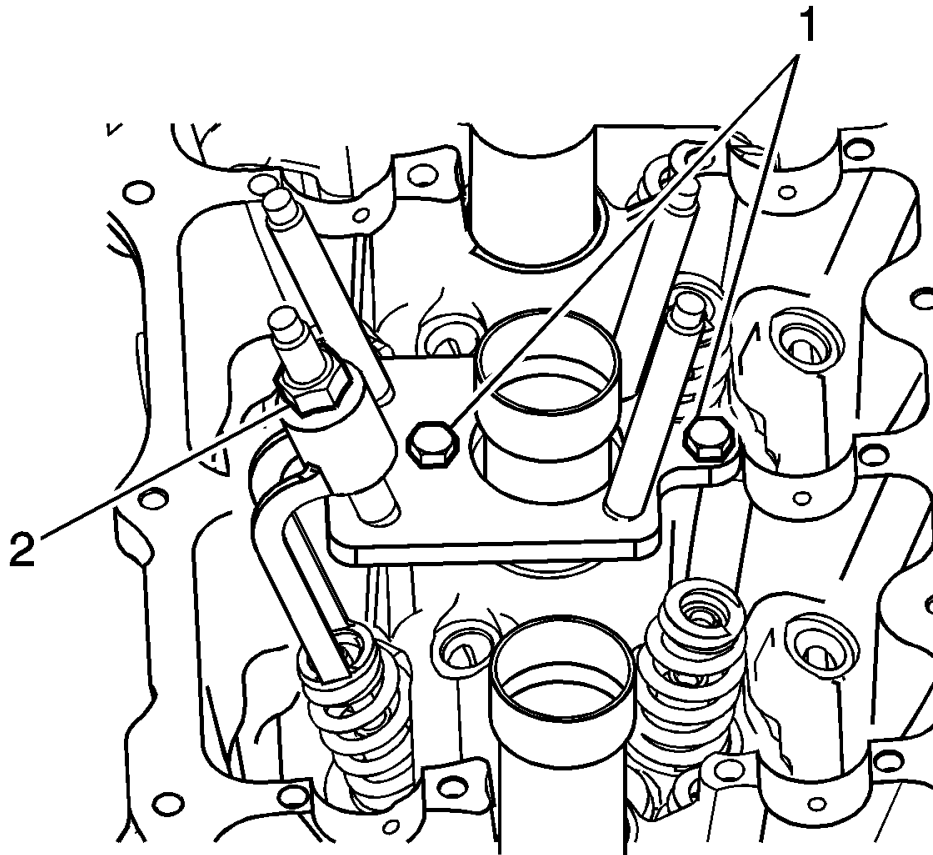
2. Install the valve spring.



**Fig. 186: View Of Valve Spring**

Courtesy of GENERAL MOTORS COMPANY

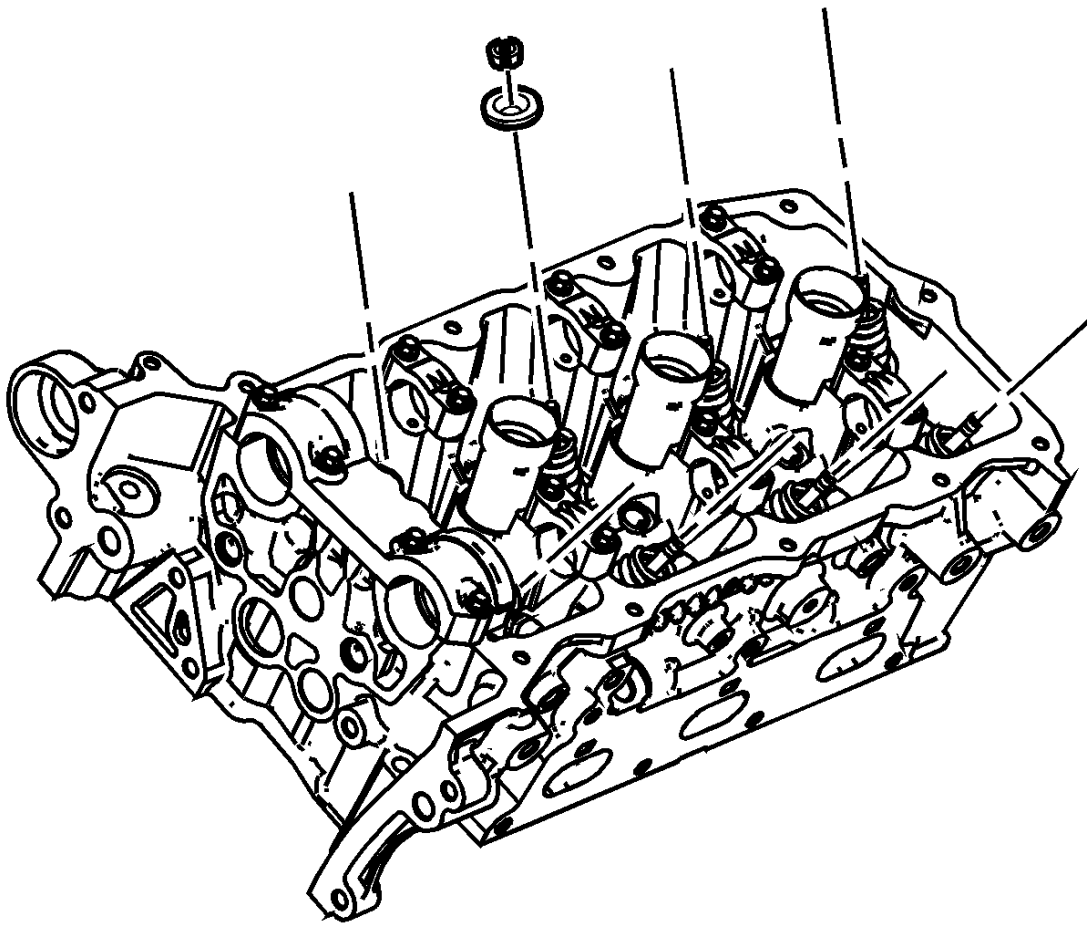
3. Install the valve spring retainer.
4. Install the **EN 46110** on-vehicle valve spring compressor above the applicable valve spring as shown.



**Fig. 187: View Of Installed Valve Spring Compressor Tool**  
Courtesy of GENERAL MOTORS COMPANY

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

5. Install the valve spring keepers.



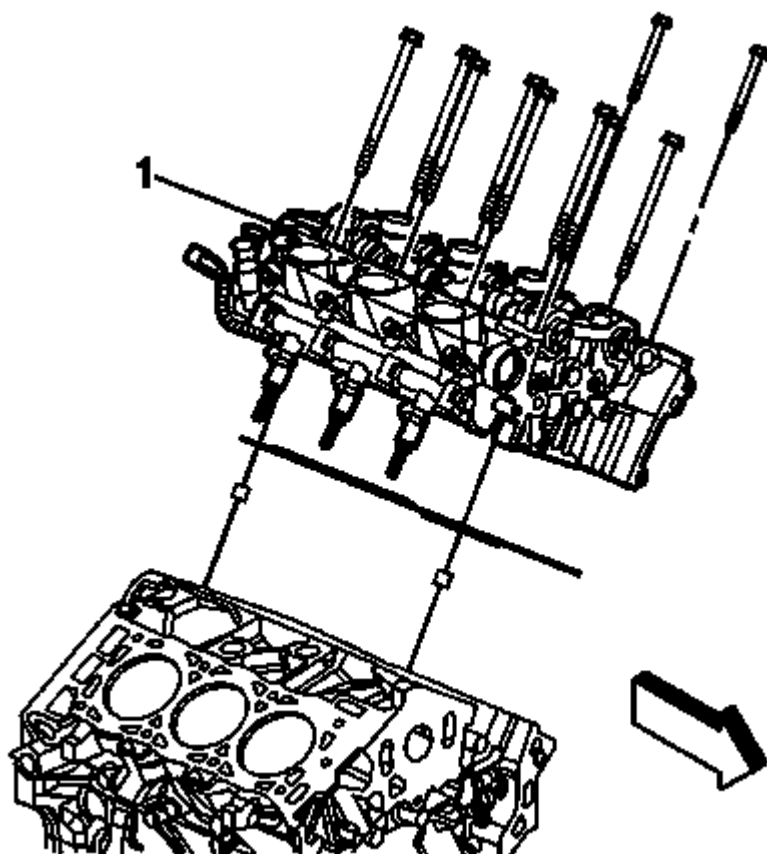
**Fig. 188: View Of Valve Spring Keepers**  
Courtesy of GENERAL MOTORS COMPANY

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

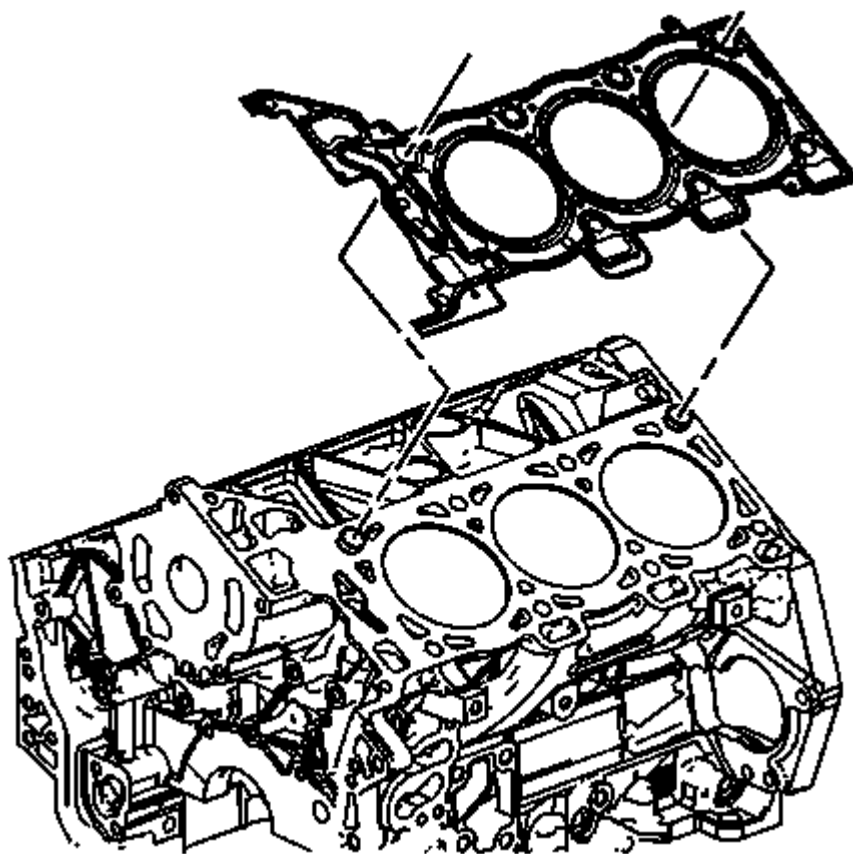
1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain**

**Replacement - Left Side.**

**Fig. 189: Identifying Cylinder Head and Exhaust Manifold Assembly**  
Courtesy of GENERAL MOTORS COMPANY

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 .**
7. Remove and discard the cylinder head gasket.



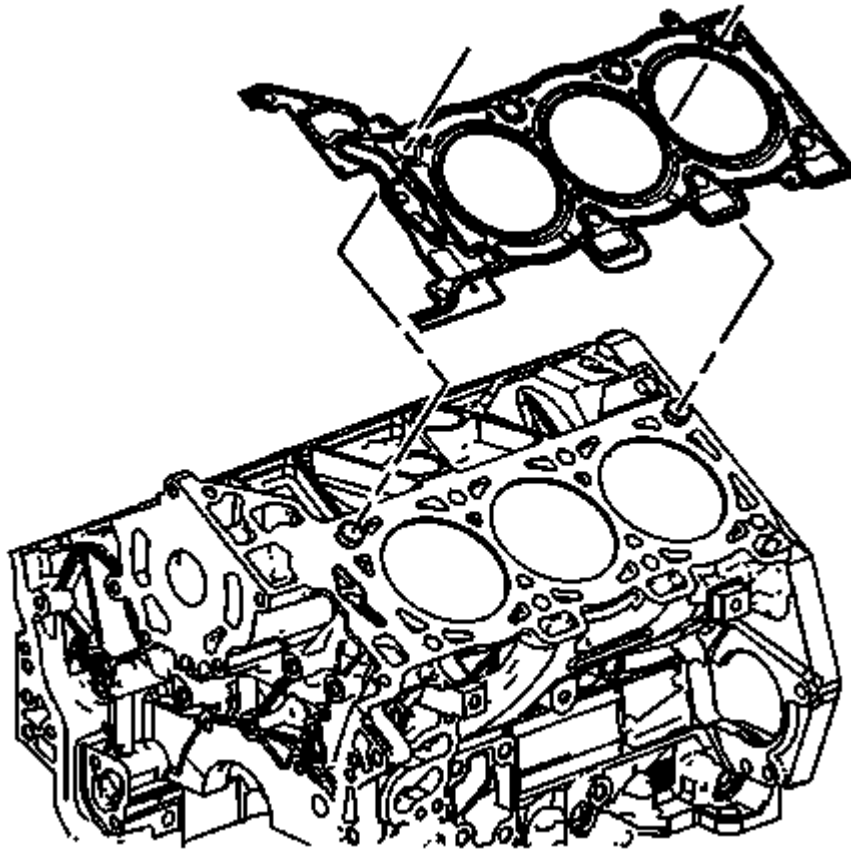


**Fig. 190: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS COMPANY

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** .
  - Disassemble the cylinder head. Refer to **Cylinder Head Disassemble** .
  - Remove the coolant sensor. Refer to **Engine Coolant Temperature Sensor Replacement** .

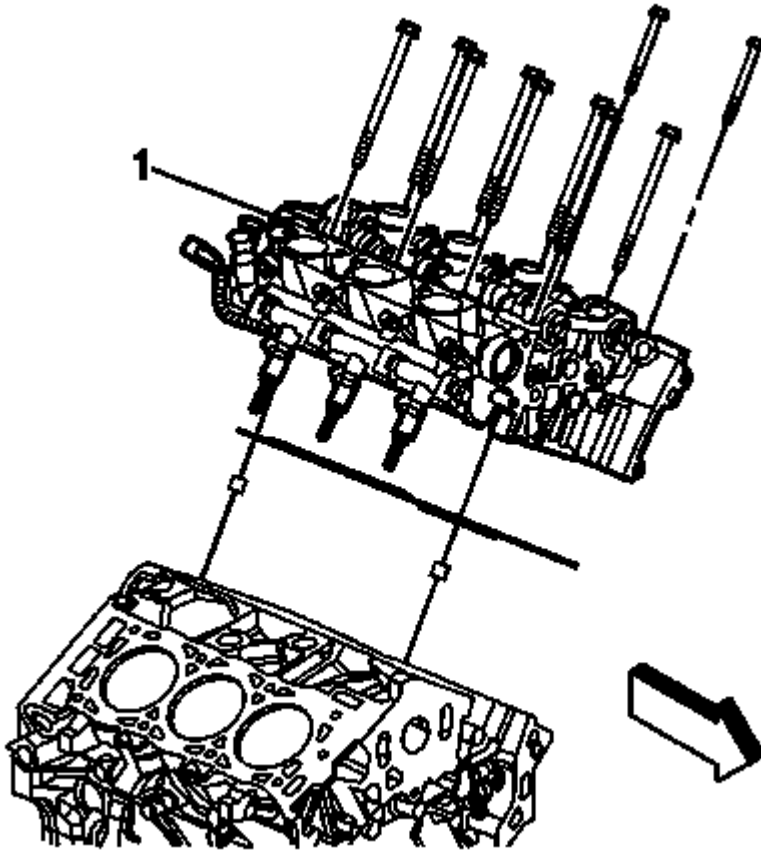
#### Installation Procedure

1. If necessary, perform the following steps:



**Fig. 191: View Of Left Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS COMPANY

- Install the coolant sensor. Refer to **Engine Coolant Temperature Sensor Replacement** .
  - Assemble the cylinder head. Refer to **Cylinder Head Assemble** .
  - 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.
  3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side** .



**Fig. 192: Identifying Cylinder Head and Exhaust Manifold Assembly**  
Courtesy of GENERAL MOTORS COMPANY

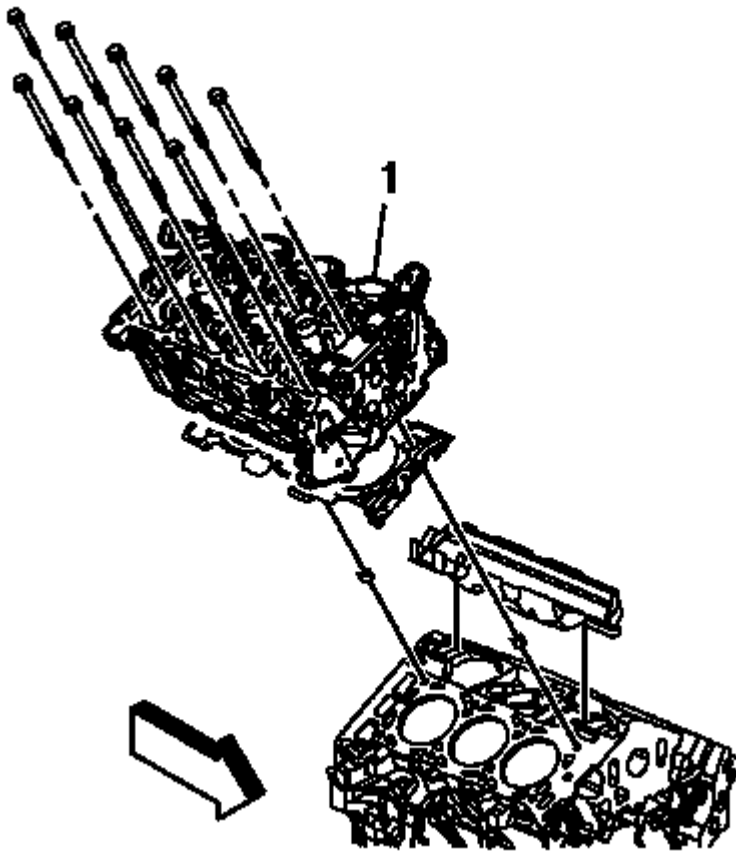
4. Install the camshaft position actuator solenoid valve. Refer to Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake and Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust.
5. Install the catalytic converter to the exhaust 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

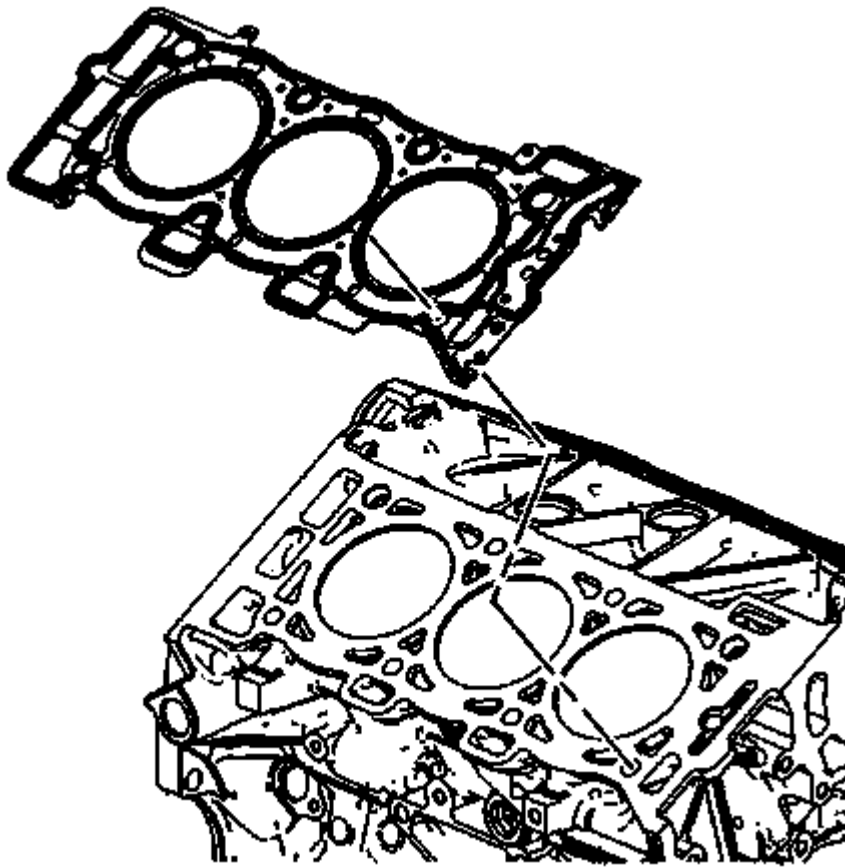
1. Remove the right bank secondary timing chain. Refer to Secondary Camshaft Intermediate Drive Chain Replacement - Right Side.

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



**Fig. 193: Removing/Installing Cylinder Head Exhaust Manifold**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard the cylinder head gasket.

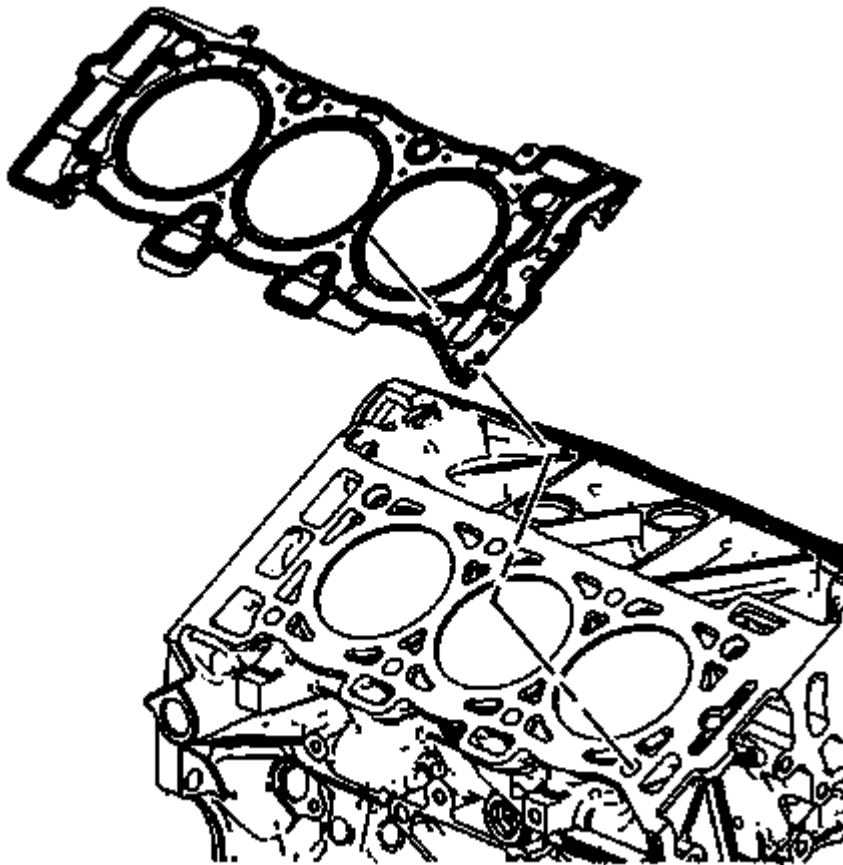


**Fig. 194: View Of Right Cylinder Head Gasket**  
Courtesy of GENERAL MOTORS COMPANY

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** .

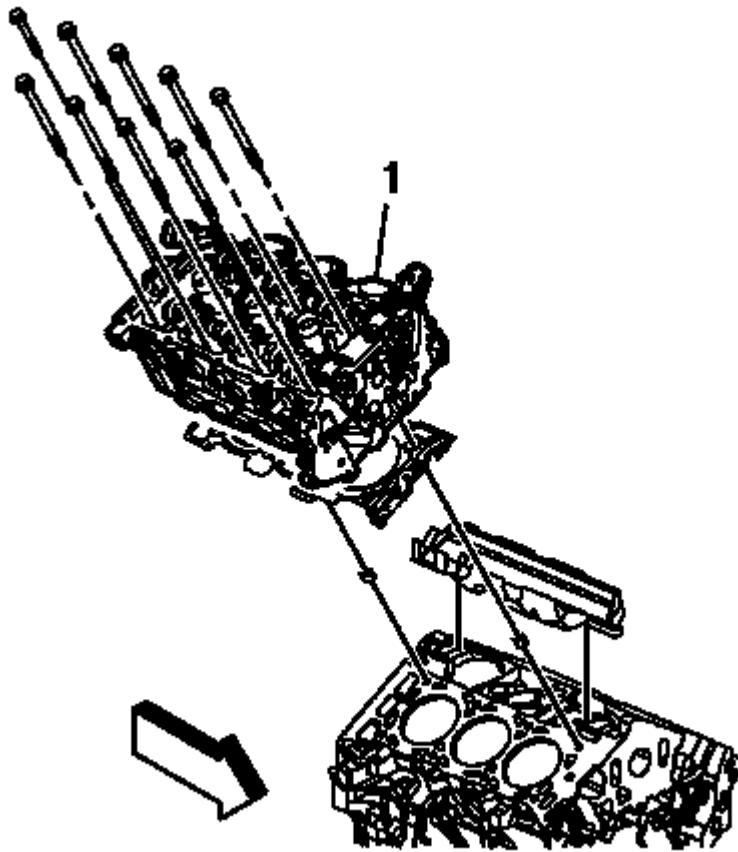
#### **Installation Procedure**

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



**Fig. 195: View Of Right Cylinder Head Gasket**  
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** .



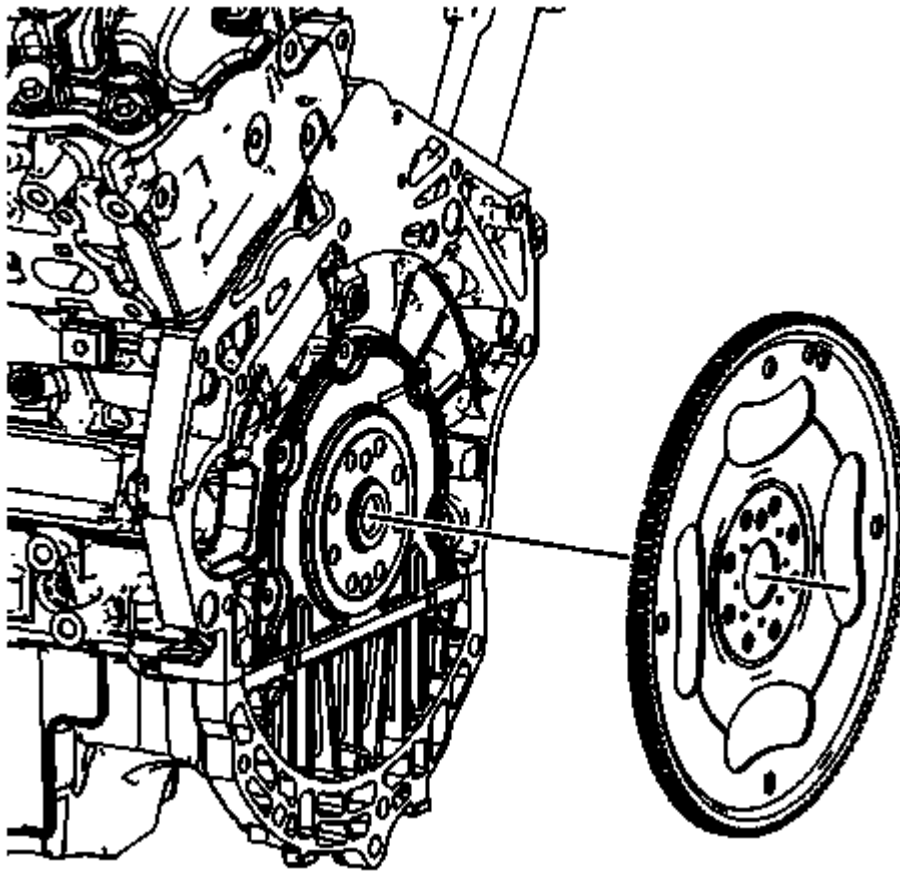
**Fig. 196: Removing/Installing Cylinder Head Exhaust Manifold**  
Courtesy of GENERAL MOTORS COMPANY

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**.

## **AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT**

### **Removal Procedure**

1. Remove the transmission. Refer to **Transmission Replacement (All Wheel Drive)**, **Transmission Replacement (Front Wheel Drive)**.



**Fig. 197: View Of Engine Flywheel**

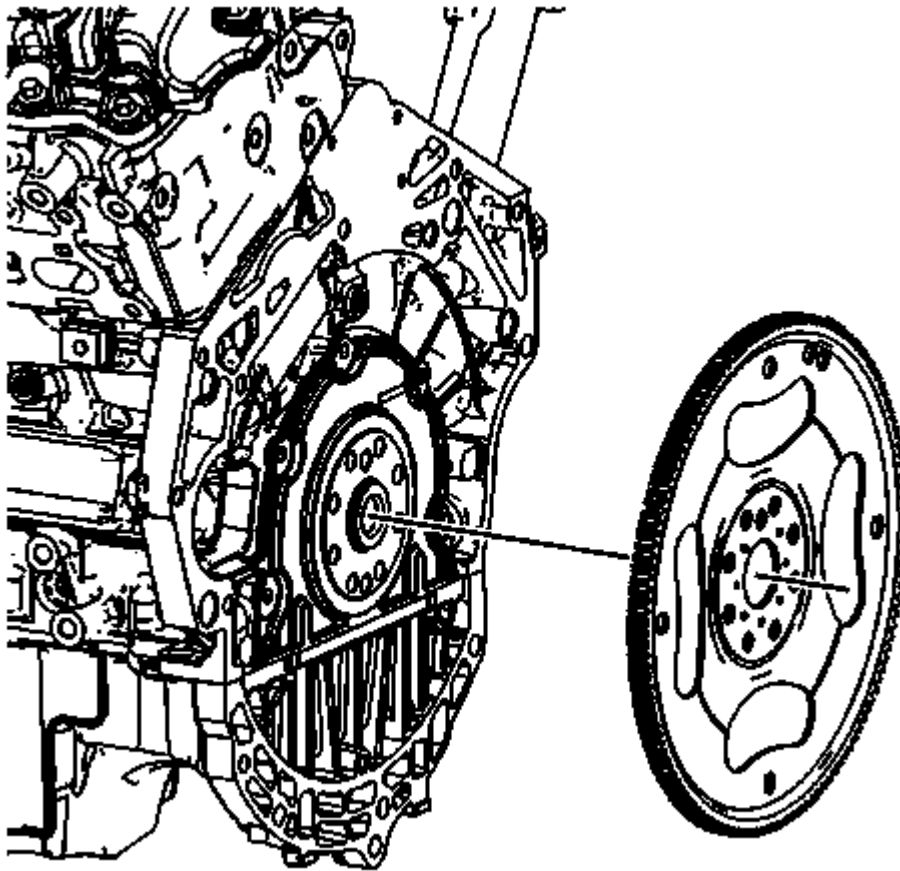
Courtesy of GENERAL MOTORS COMPANY

2. Remove the automatic flex plate bolts and flex plate. Refer to **Automatic Transmission Flex Plate Removal** .
3. Clean and inspect the flex plate. Refer to **Automatic Transmission Flex Plate Cleaning and Inspection** . If the flex plate 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**

1. Install the automatic flex plate and flex plate bolts. Refer to **Automatic Transmission Flex Plate Installation** .





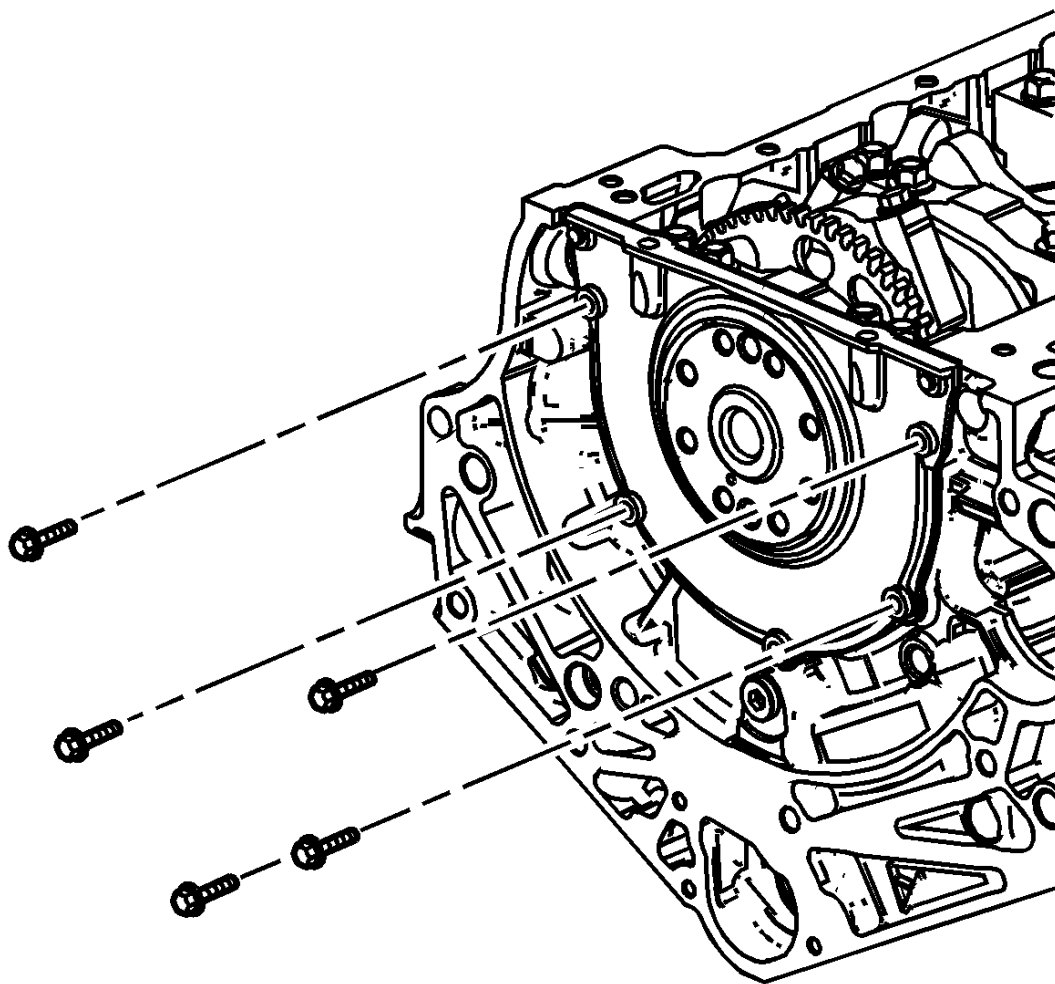
**Fig. 198: View Of Engine Flywheel**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the transmission. Refer to **Transmission Replacement (All Wheel Drive)** , **Transmission Replacement (Front Wheel Drive)** .

## **CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT**

### **Removal Procedure**

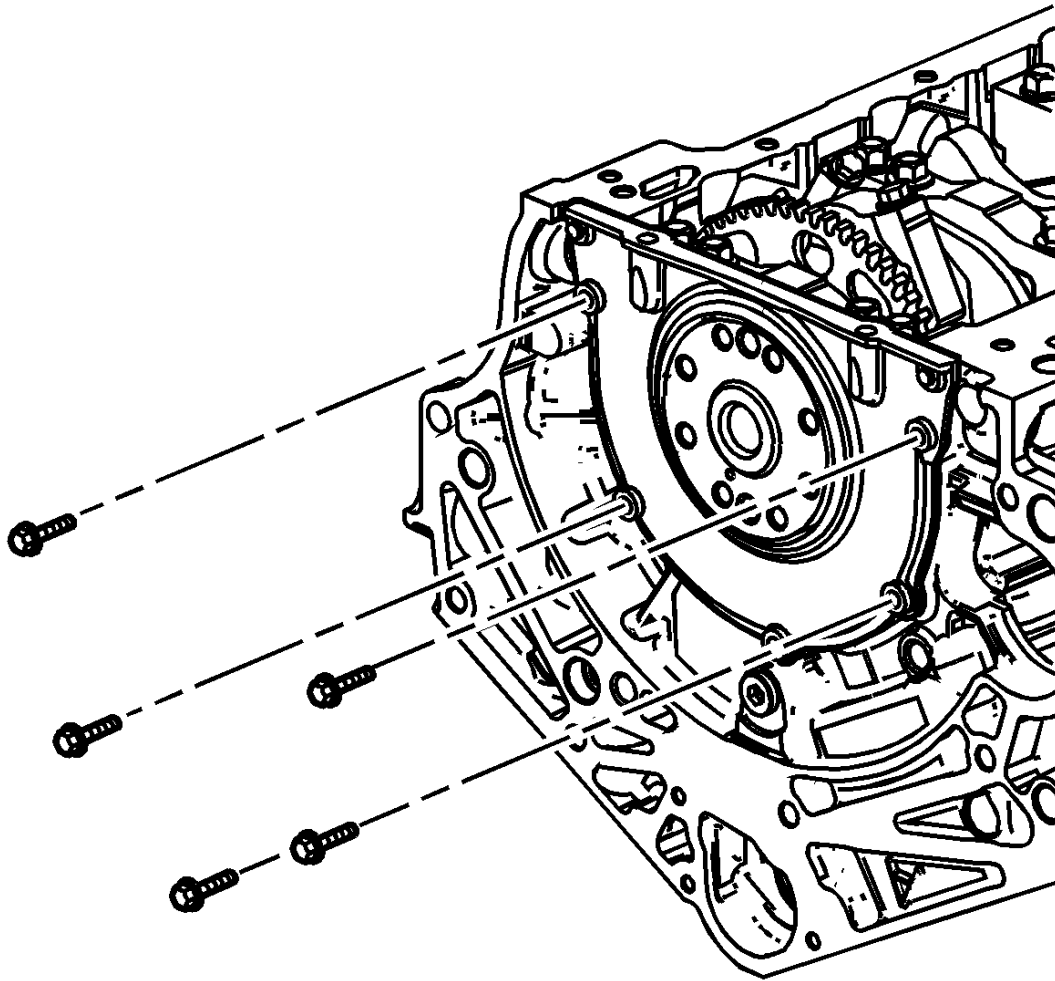
1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
3. Remove the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Removal** .



**Fig. 199: Locating Crankshaft Rear Oil Seal Housing Bolts**  
Courtesy of GENERAL MOTORS COMPANY

#### Installation Procedure

1. Install the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Installation** .



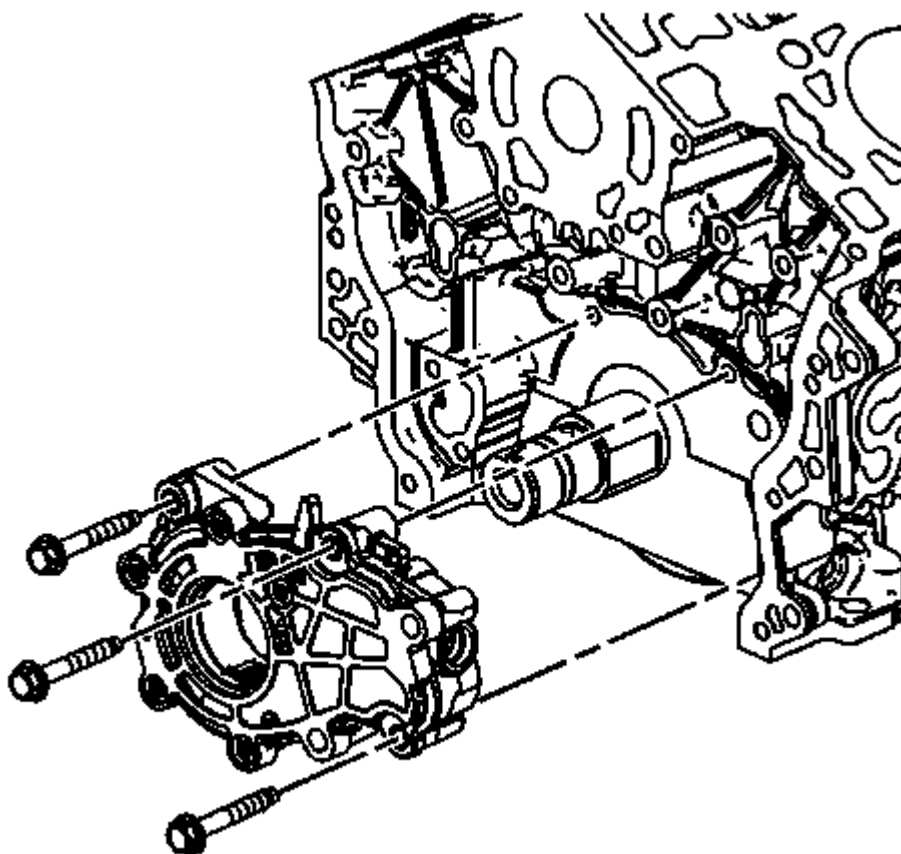
**Fig. 200: Locating Crankshaft Rear Oil Seal Housing Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
3. Install the oil pan. Refer to **Oil Pan Replacement**.

## **OIL PUMP REPLACEMENT**

### **Removal Procedure**

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



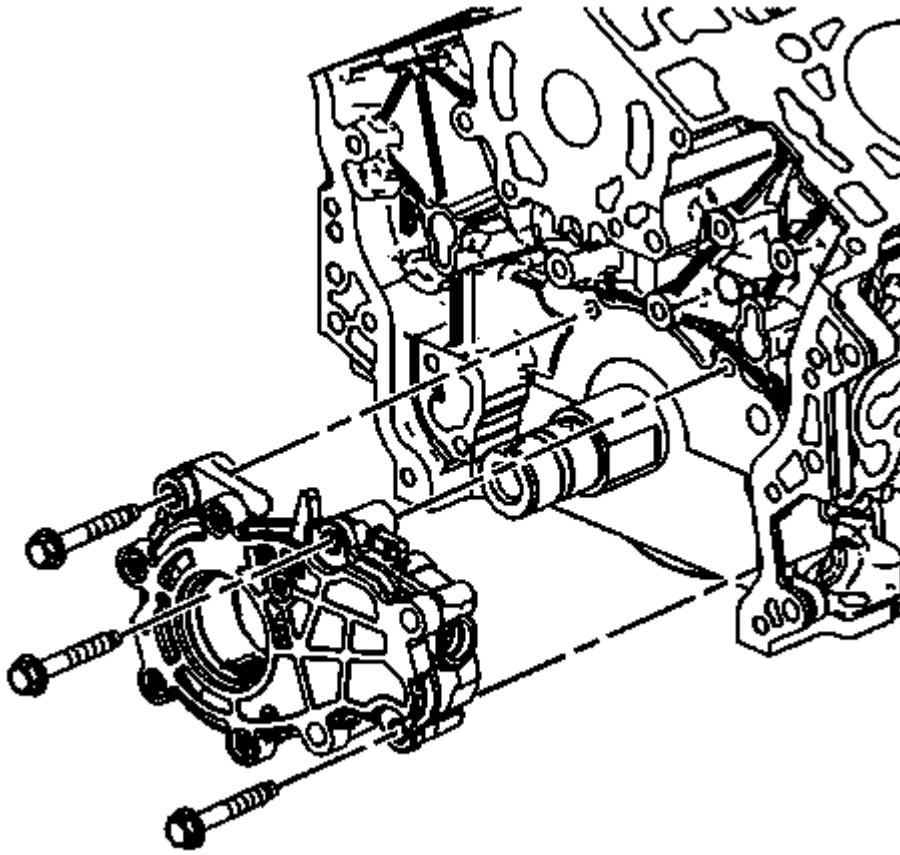
**Fig. 201: Identifying Oil Pump & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**IMPORTANT:** Do not remove the left bank idler sprocket.

2. Remove the oil pump bolts and the oil pump. Refer to [Oil Pump Removal](#) .

**Installation Procedure**

1. Install the oil pump. Refer to [Oil Pump Installation](#) .



**Fig. 202: Identifying Oil Pump & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

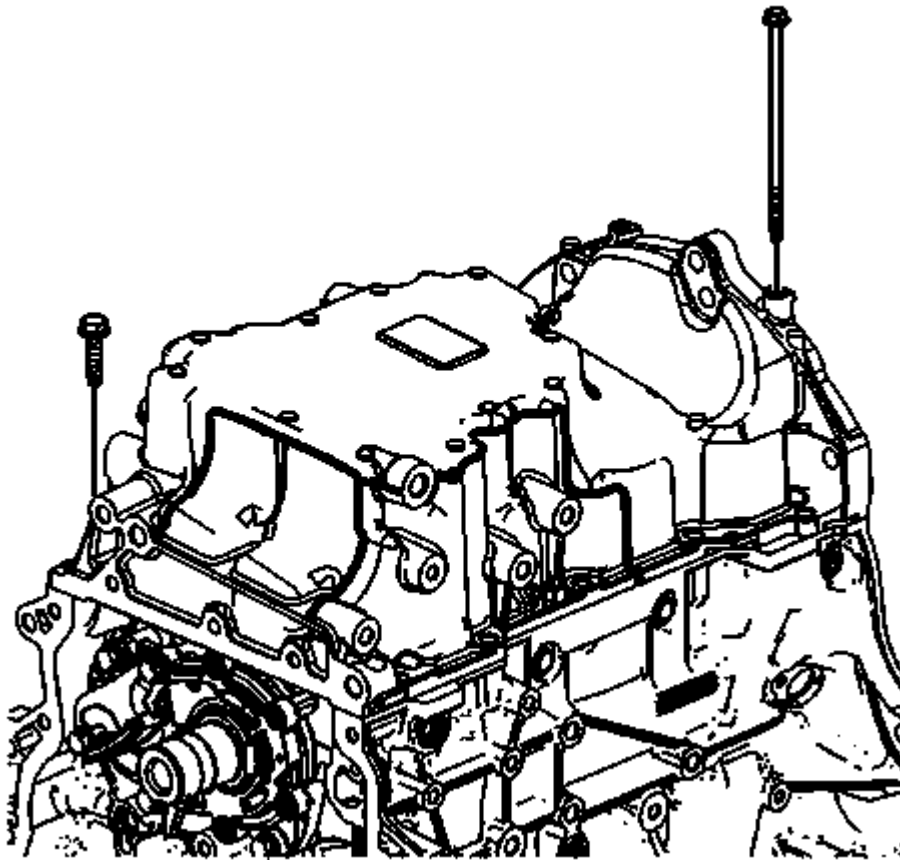
## **OIL PAN REPLACEMENT**

### **Special Tools**

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

### **Removal Procedure**

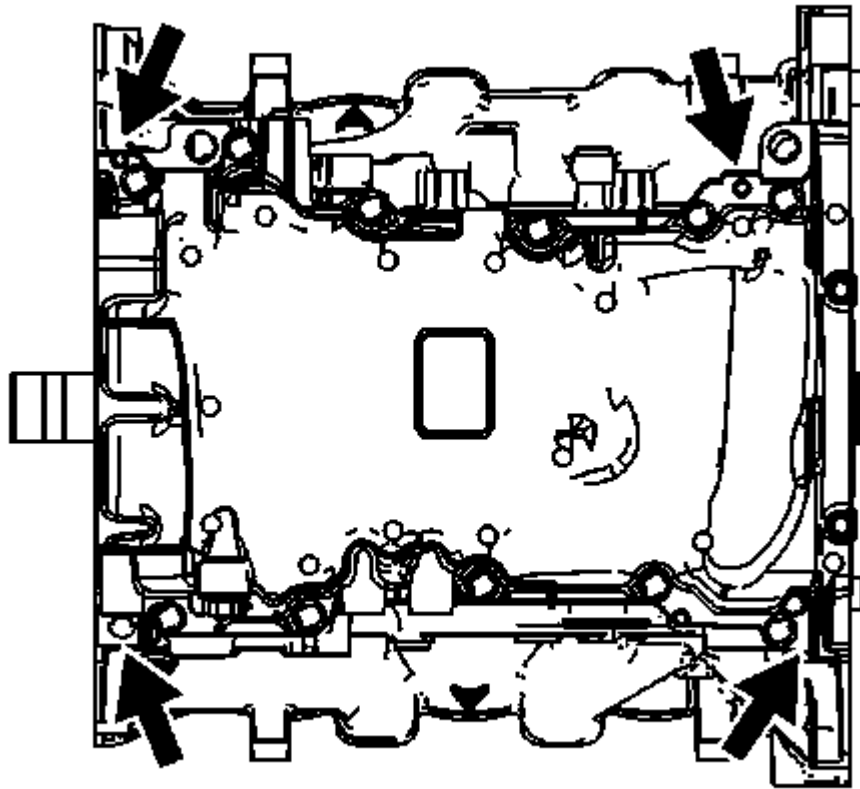
1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement**.
3. Remove the engine. Refer to **Engine Replacement**.
4. Remove the engine front cover. Refer to **Engine Front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



**Fig. 203: Locating Oil Pan Bolts**

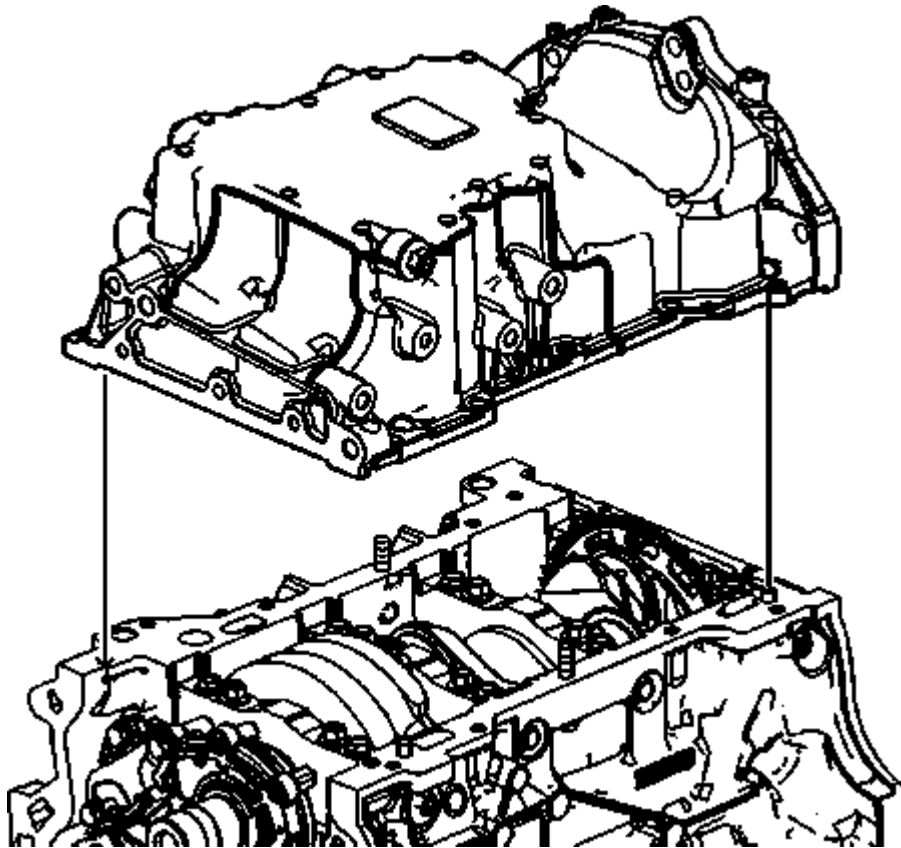
Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 204: Identifying Oil Pan RTV Sealant Pry Points**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil pan from the block.



**Fig. 205: View Of Oil Pan & Block**

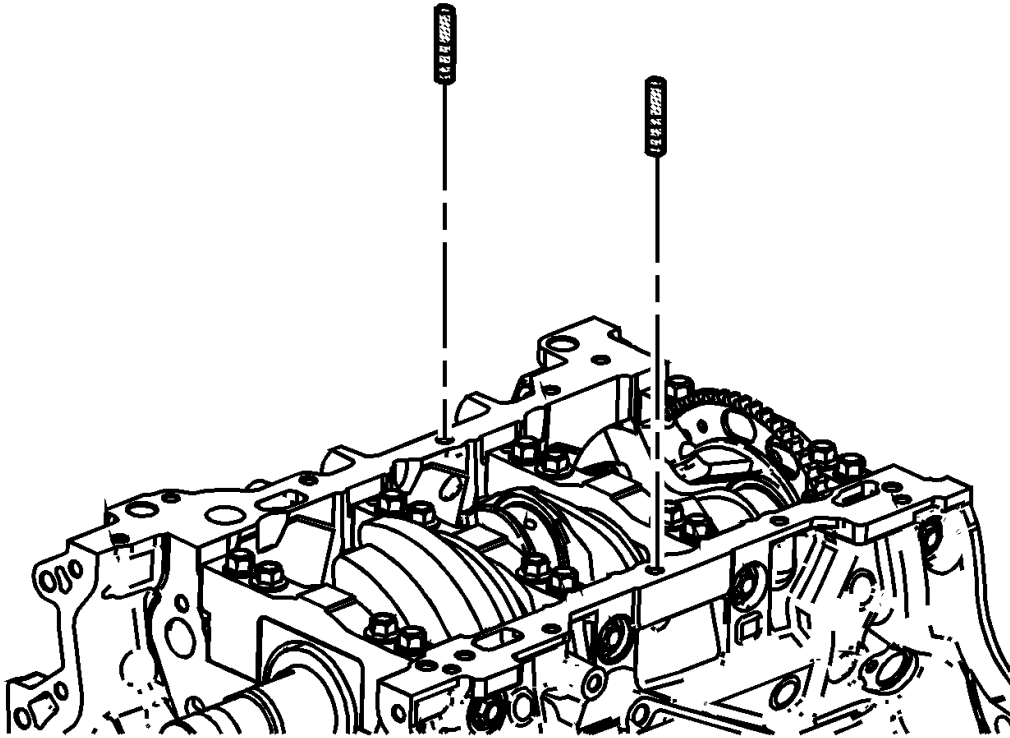
Courtesy of GENERAL MOTORS COMPANY

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

#### **Installation Procedure**

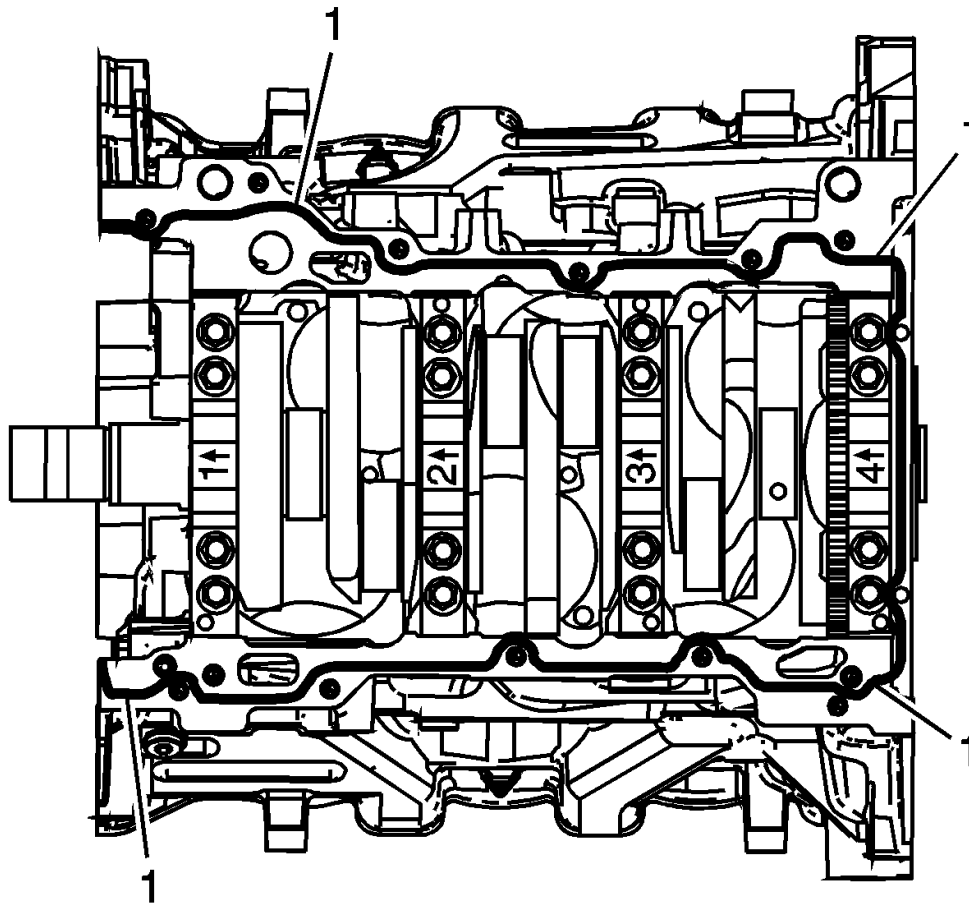
1. Install the 8 mm (0.315 in) guides from the **EN 46109** guide pin set into the center oil pan rail bolt hole on each side of the engine block.





**Fig. 206: Identifying Special Tool - EN 46109 Guides**  
**Courtesy of GENERAL MOTORS COMPANY**

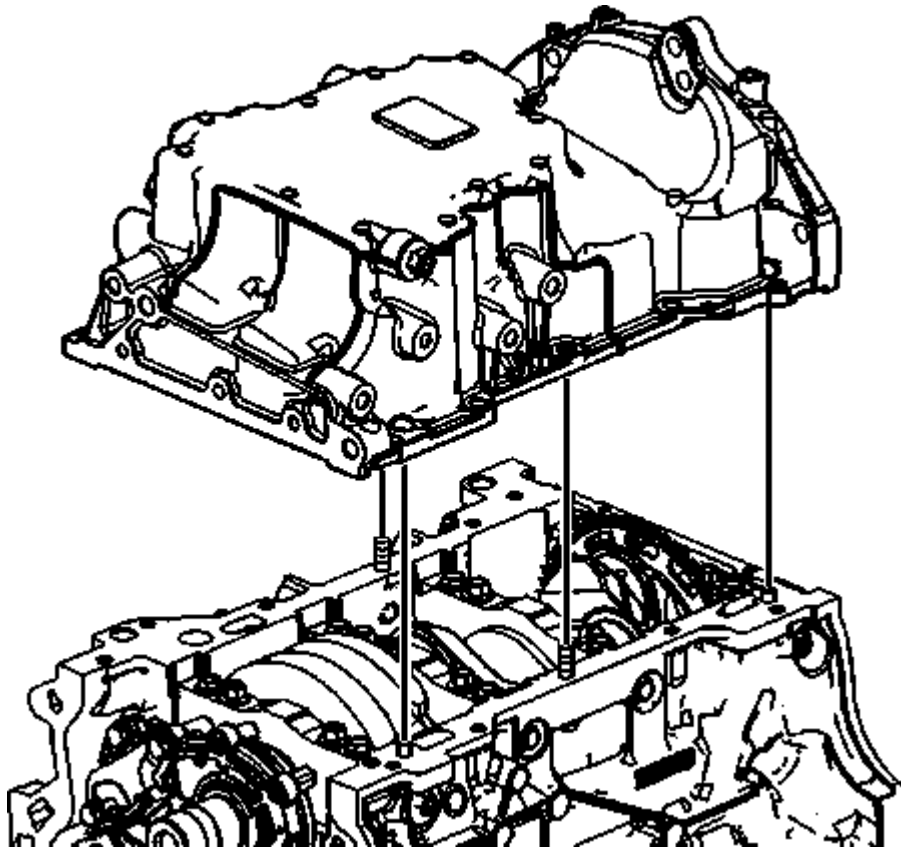
2. Place a 3 mm (0.118 in) bead (1) of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the block pan rail and the crankshaft rear oil seal housing.



**Fig. 207: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing**

Courtesy of GENERAL MOTORS COMPANY

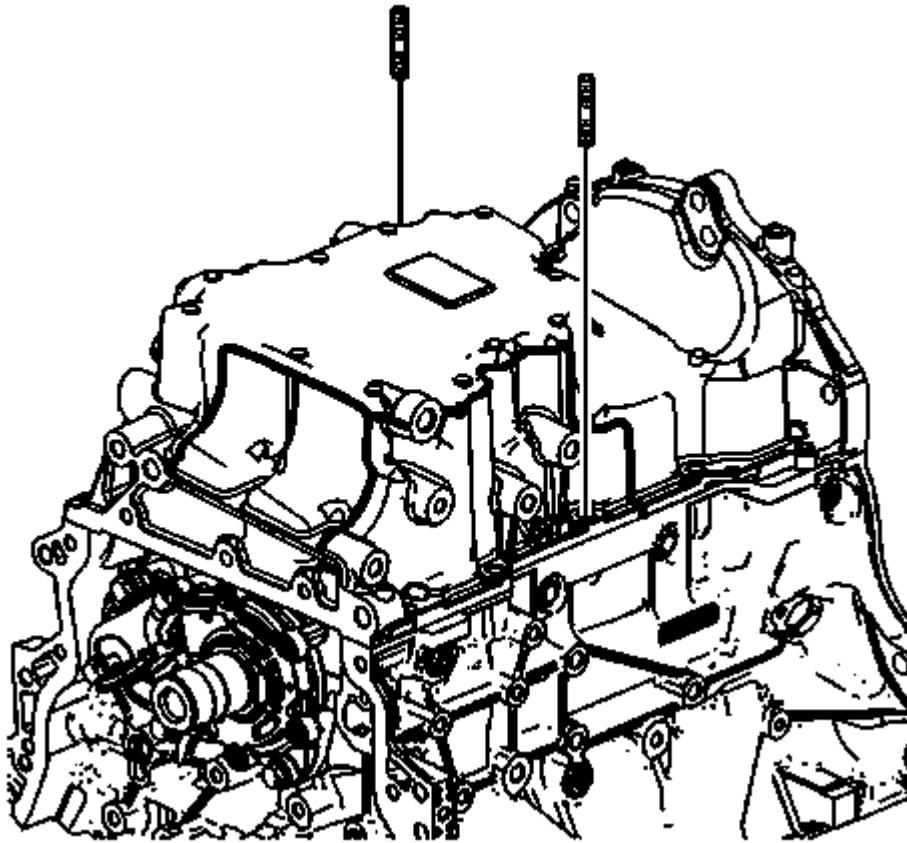
3. Position the oil pan onto the block.



**Fig. 208: Removing/Installing Oil Pan**

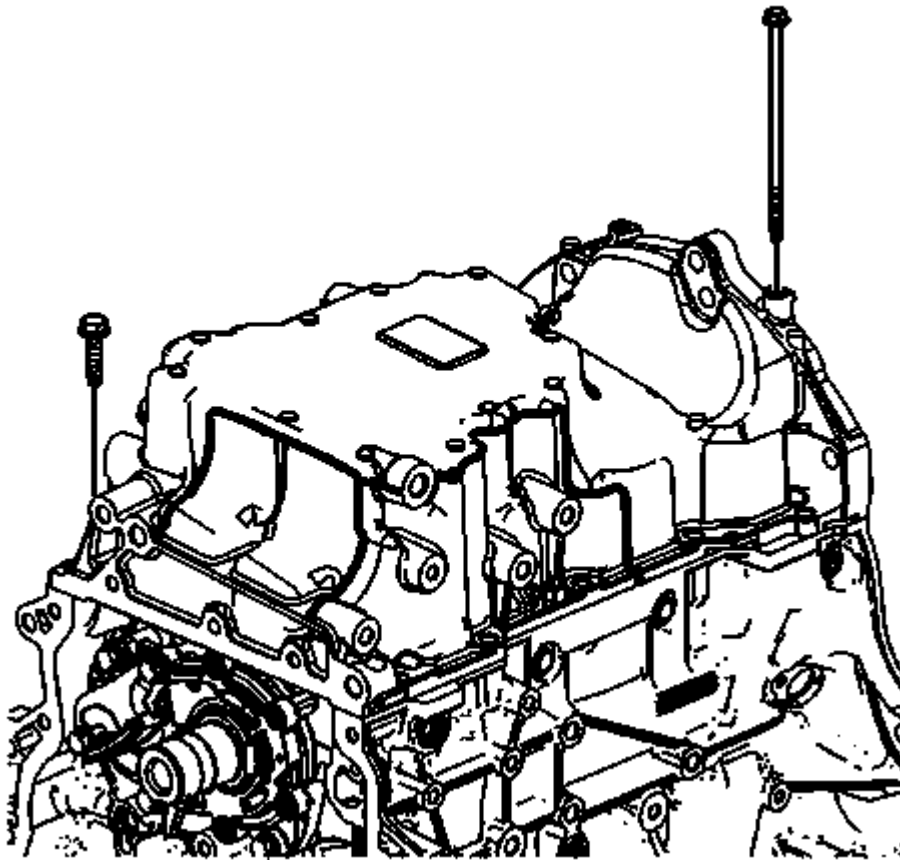
Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 209: Identifying Special Tools - EN 46109**  
**Courtesy of GENERAL MOTORS COMPANY**

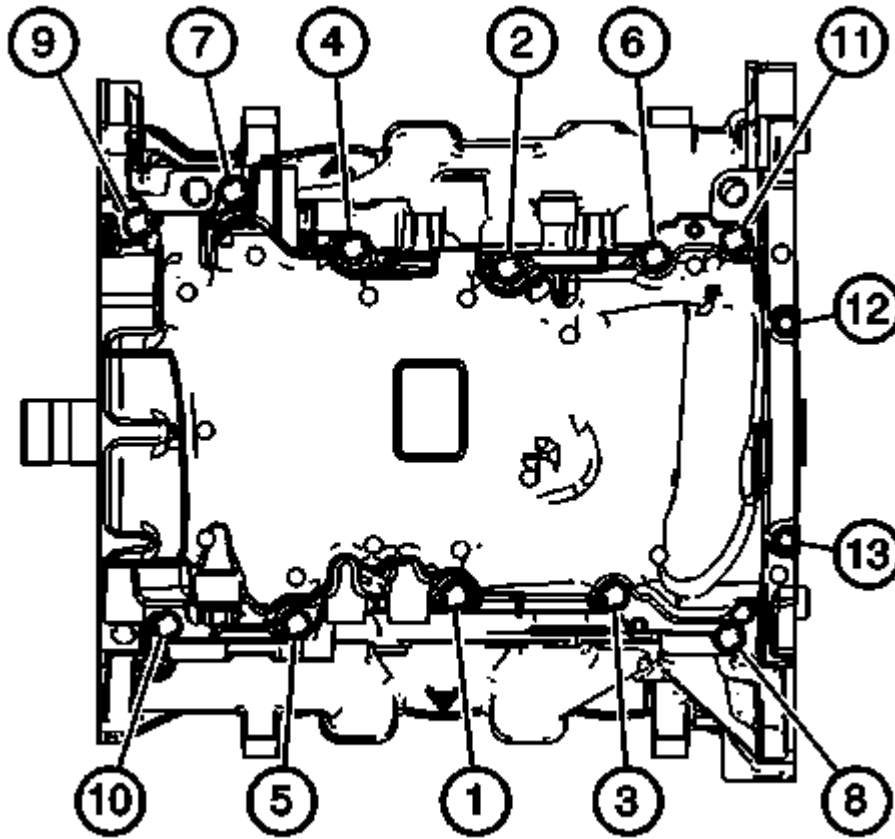
5. Loosely install the oil pan bolts.



**Fig. 210: Locating Oil Pan Bolts**

Courtesy of GENERAL MOTORS COMPANY

6. Tighten the oil pan bolts in sequence shown.



**Fig. 211: Identifying Oil Pan Bolts - Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

### 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.

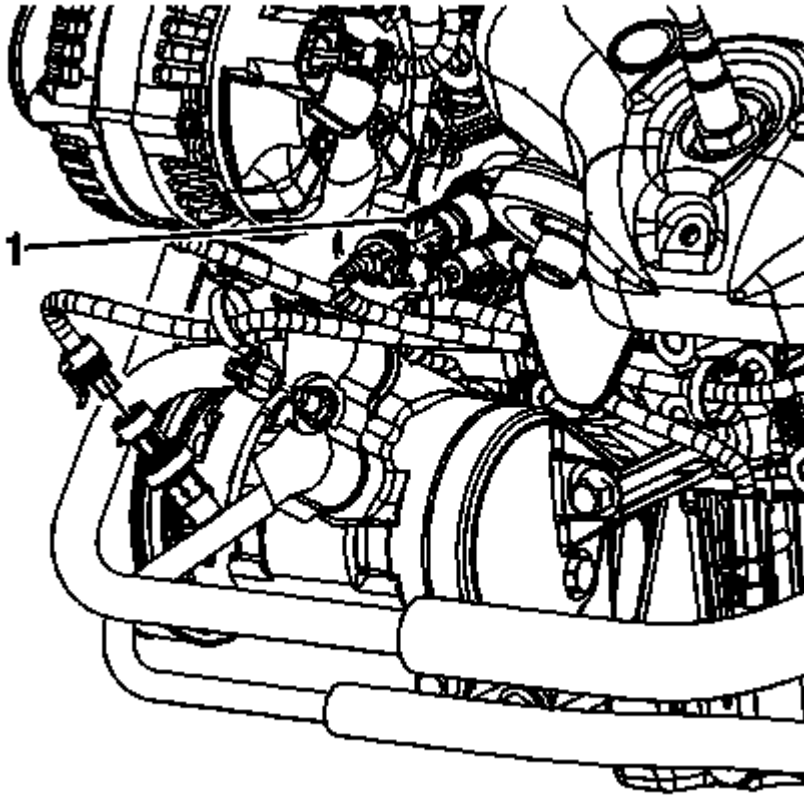
### ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

#### Special Tools

**J 41712** Oil Pressure Switch Socket

**Removal Procedure**

1. Turn the ignition OFF.

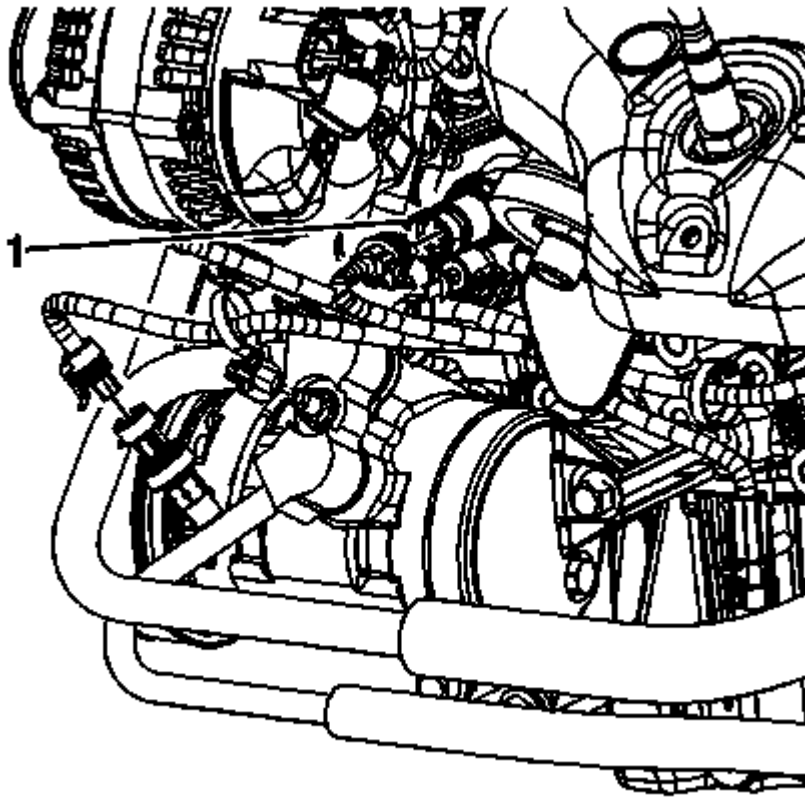


**Fig. 212: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS COMPANY

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**

1. Install the oil pressure sensor (1).



**Fig. 213: Identifying Oil Pressure Sensor**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

### **Tighten**

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

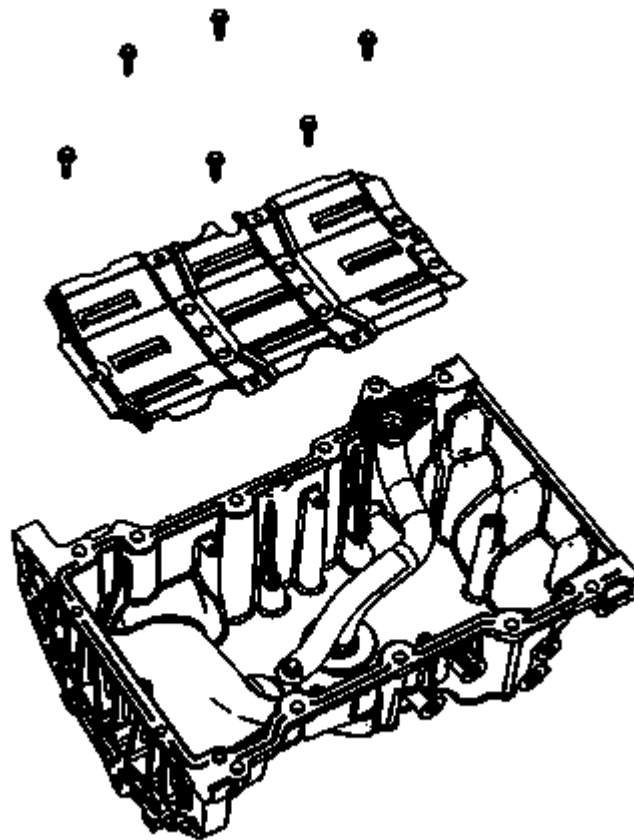
2. Connect the oil pressure sensor electrical connector.
3. Install the generator. Refer to Generator Replacement .

## **OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT**

### **Removal Procedure**

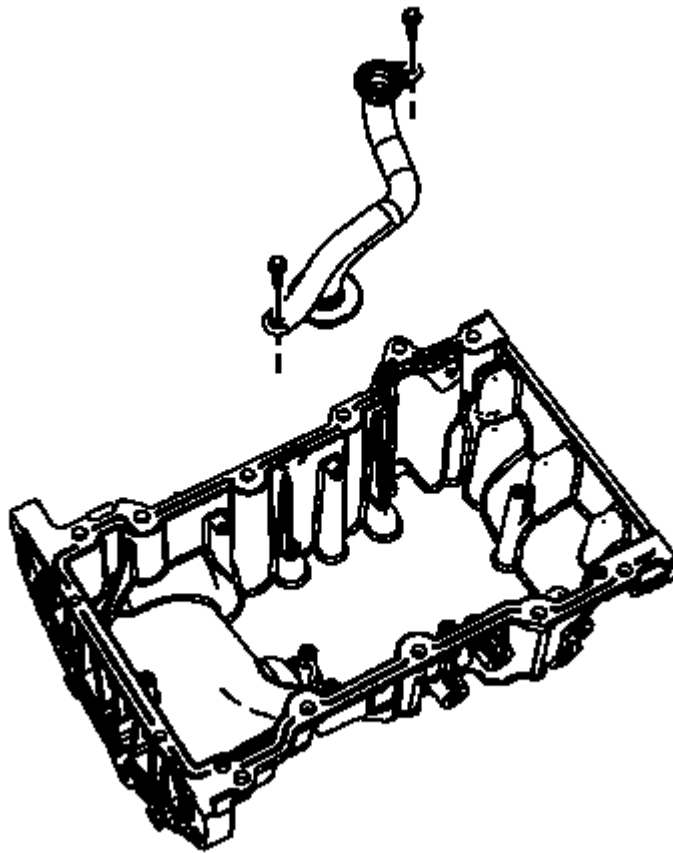
1. Remove the oil pan. Refer to Oil Pan Replacement.





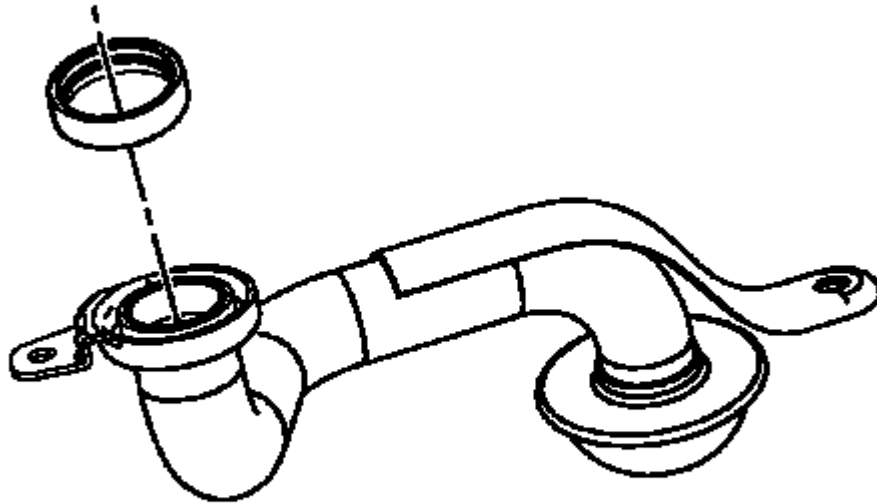
**Fig. 214: Identifying Oil Pan Scraper Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.
4. Remove the oil suction pipe bolts.



**Fig. 215: View Of Oil Suction Pipe & Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

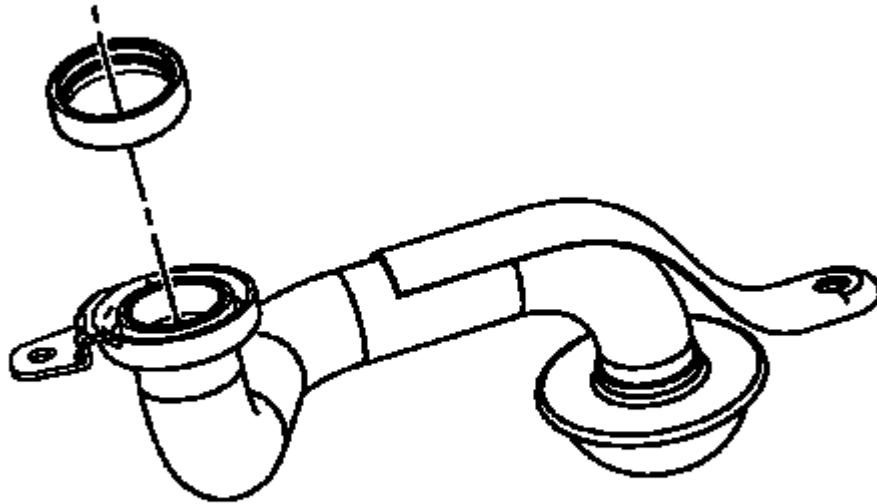
5. Remove the oil suction pipe.
6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.



**Fig. 216: Locating Oil Suction Tube Seal**  
Courtesy of GENERAL MOTORS COMPANY

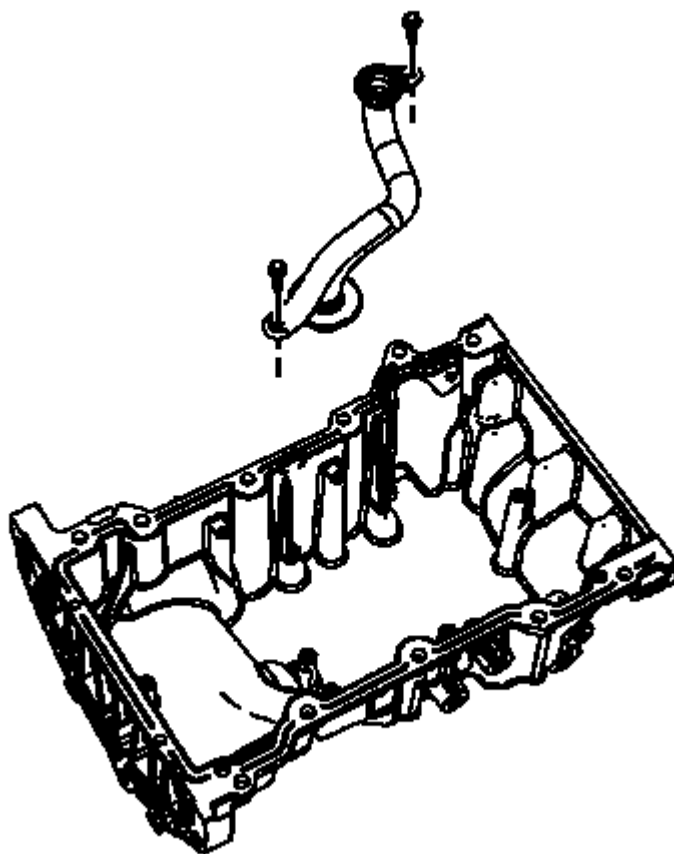
#### **Installation Procedure**

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



**Fig. 217: Locating Oil Suction Tube Seal**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe.



**Fig. 218: View Of Oil Suction Pipe & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

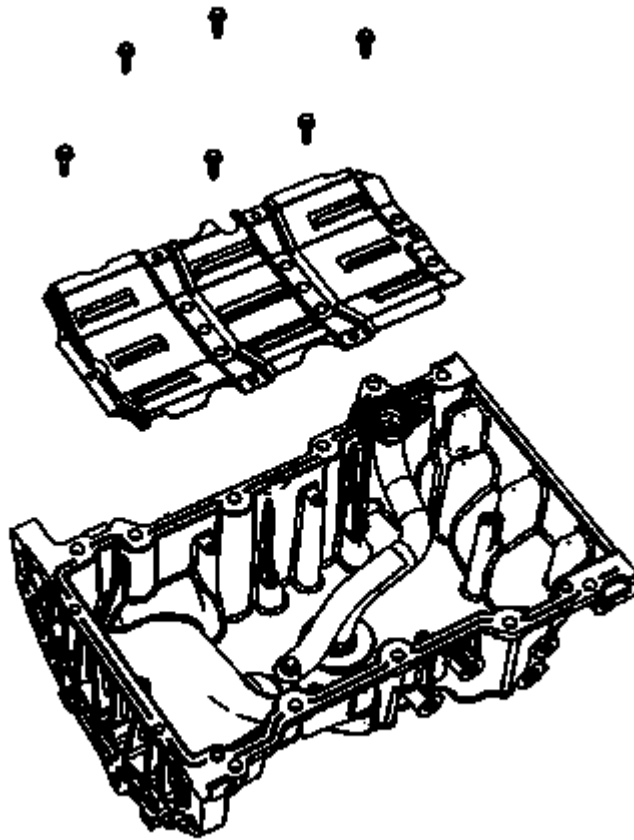
3. Install the oil suction pipe bolts.

**CAUTION: Refer to Fastener Caution .**

### **Tighten**

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

4. Install the oil pan scraper.



**Fig. 219: Identifying Oil Pan Scraper Bolts**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan scraper bolts.

#### **Tighten**

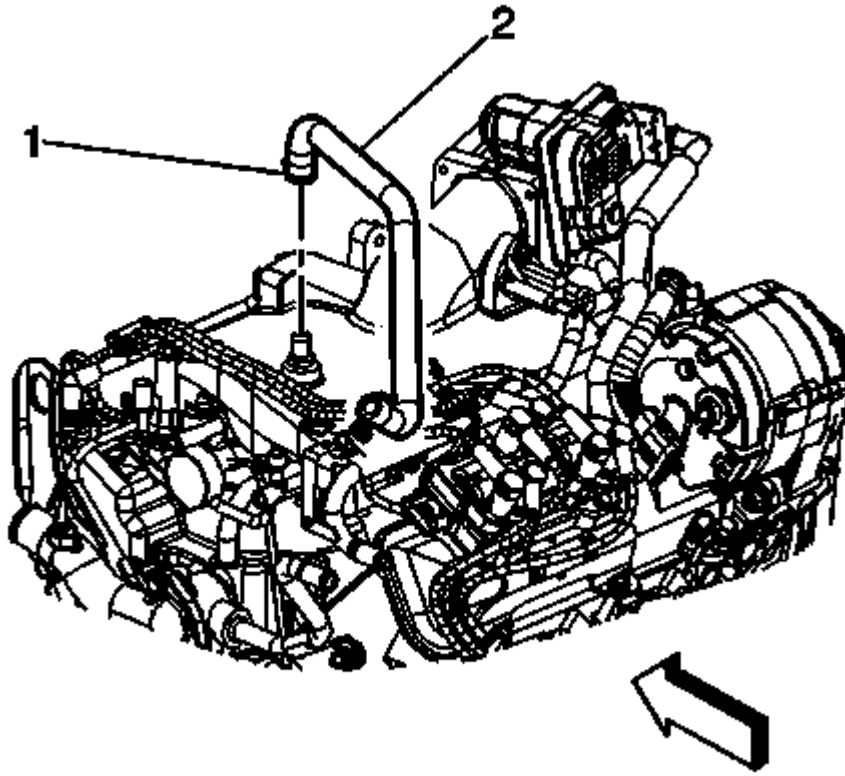
Tighten the oil pan scraper bolts to 10 N.m (89 lb in).

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

## **ENGINE REPLACEMENT**

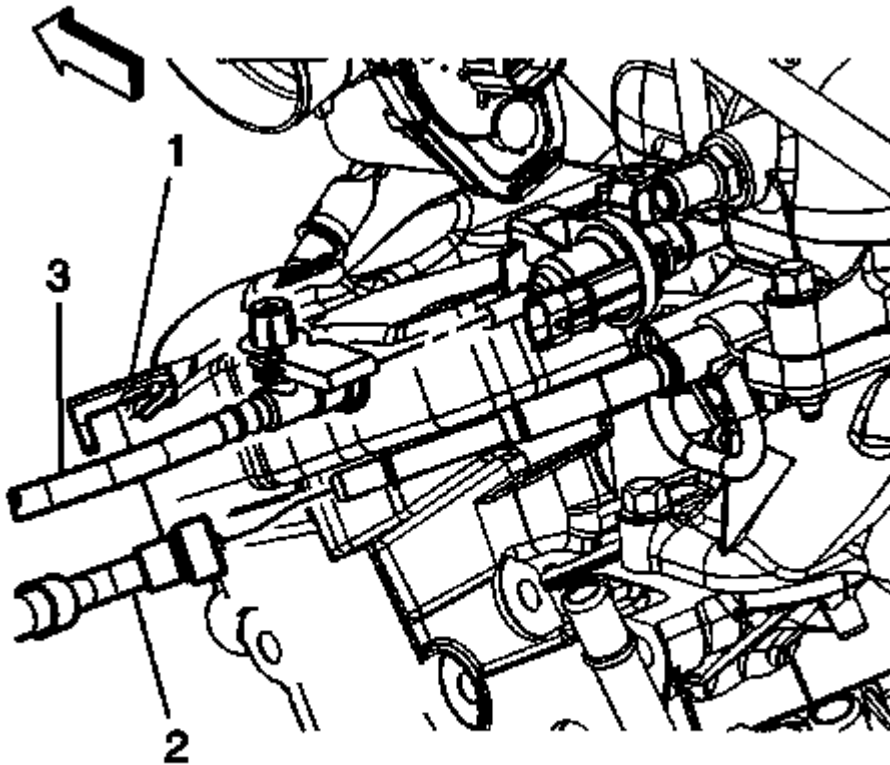
### **Removal Procedure**

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
2. Disconnect the brake booster vacuum hose (2) from the intake manifold.



**Fig. 220: View Of Brake Booster Vacuum Hose**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Discharge the fuel system. Refer to **Fuel Pressure Relief (CH-48027)** , **Fuel Pressure Relief (Without CH-48027)** , **Fuel Pressure Relief (High Side)** .
5. Disconnect the evaporative emission (EVAP) hose/pipe (3) from the EVAP canister purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .

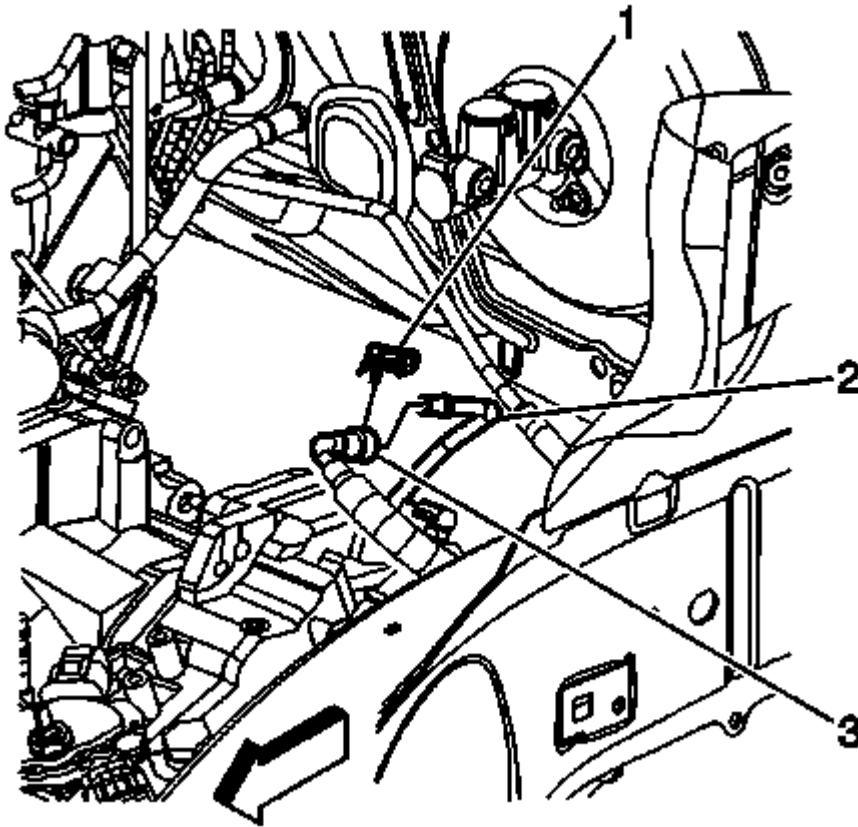


**Fig. 221: View Of EVAP Pipe**

Courtesy of GENERAL MOTORS COMPANY

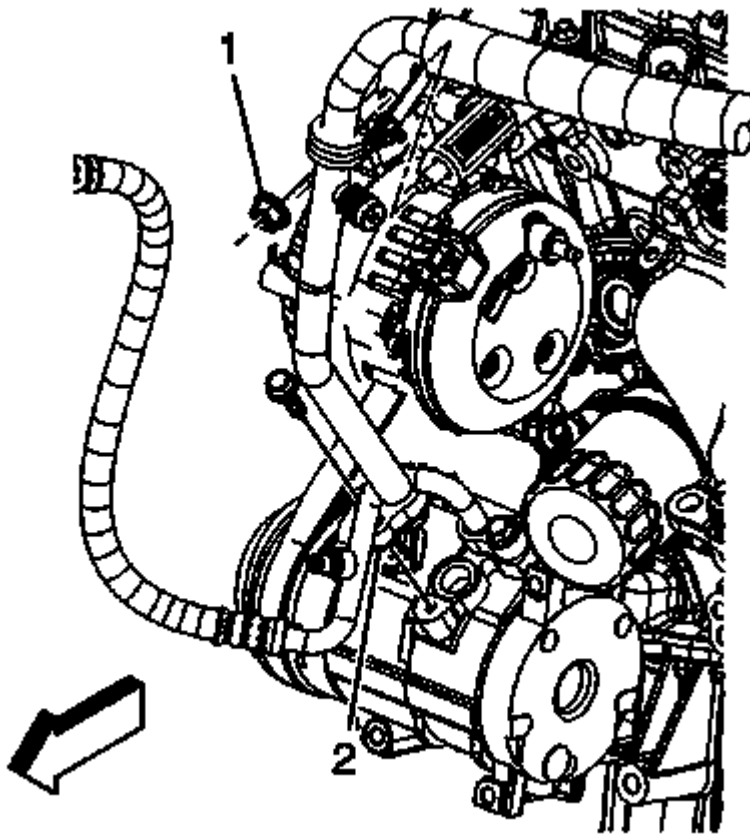
6. Disconnect the engine fuel hose/pipe (3) from the chassis fuel hose/pipe (2). Refer to **Metal Collar Quick Connect Fitting Service** .





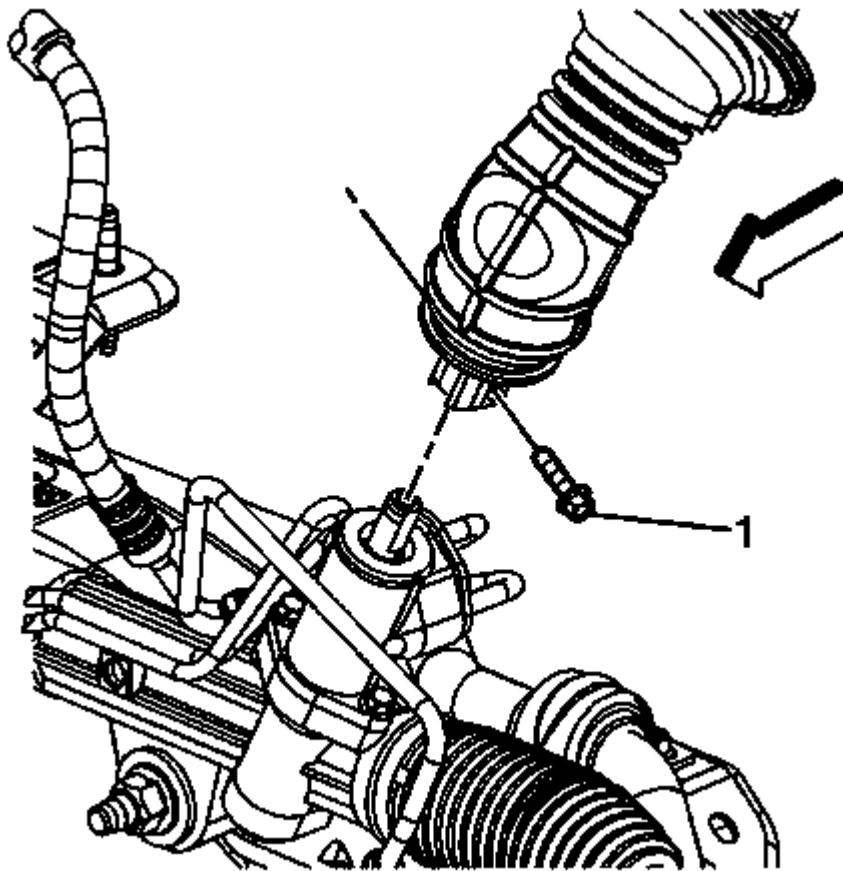
**Fig. 222: Disconnecting/Connecting Engine Fuel Hose/Pipe At Chassis Fuel Hose/Pipe**  
Courtesy of GENERAL MOTORS COMPANY

7. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
8. Remove the A/C compressor hose assembly (2) from the compressor. Cap or plug the hoses and compressor to prevent contamination. Refer to **Air Conditioning Compressor Hose Replacement** .



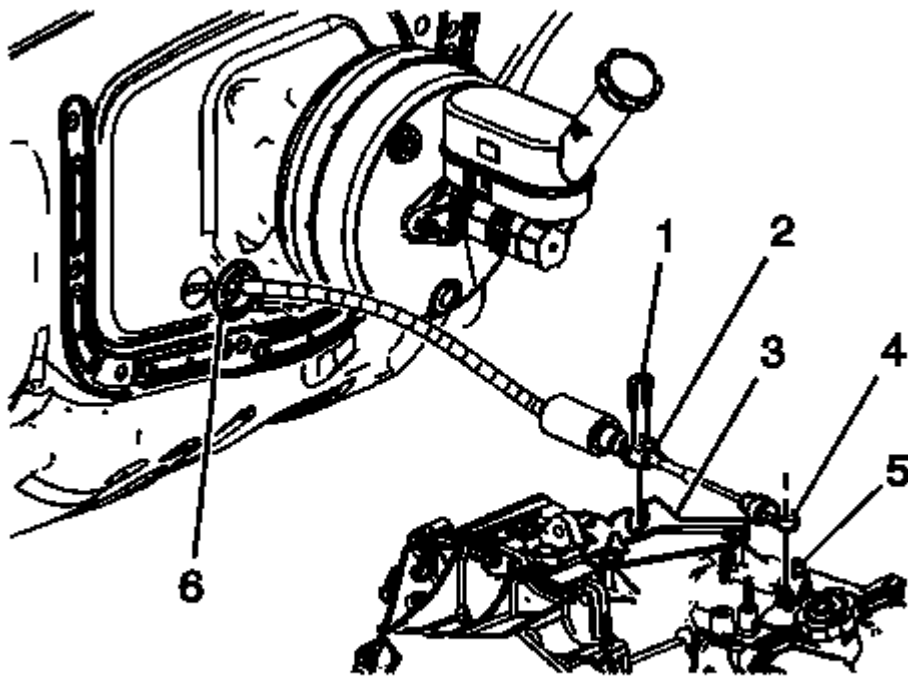
**Fig. 223: Identifying Suction Hose Bracket Nut**  
Courtesy of GENERAL MOTORS COMPANY

9. 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) .
10. Remove the coolant recovery reservoir. Refer to Coolant Recovery Reservoir Replacement .
11. Disconnect the inlet coolant heater hose from the engine. Refer to Heater Inlet Hose Replacement .
12. Disconnect the outlet coolant heater hose from the engine. Refer to Heater Outlet Hose Replacement
13. Remove the radiator inlet hose. Refer to Radiator Inlet Hose Replacement .
14. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
15. Remove the radiator outlet hose. Refer to Radiator Outlet Hose Replacement .
16. Remove the exhaust flexible pipe and secure the rear half of the exhaust system to the vehicle underbody. Refer to Exhaust Flexible Pipe Replacement .
17. Remove the front tires. Refer to Tire and Wheel Removal and Installation .
18. Remove the steering intermediate shaft pinch bolt (1) in order to disconnect the steering intermediate shaft from the steering gear.



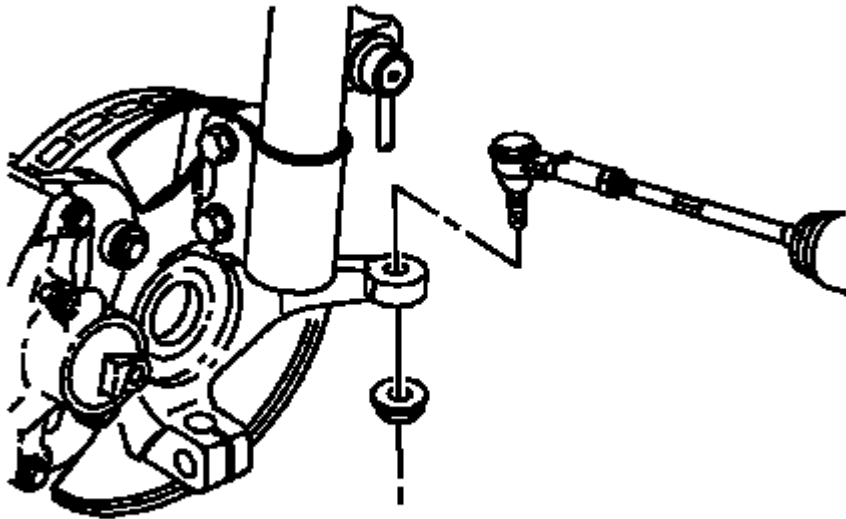
**Fig. 224: Identifying Intermediate Steering Shaft Bolt**  
Courtesy of GENERAL MOTORS COMPANY

19. Disconnect the transaxle shift cable (2). Refer to **Range Selector Lever Cable Replacement** .



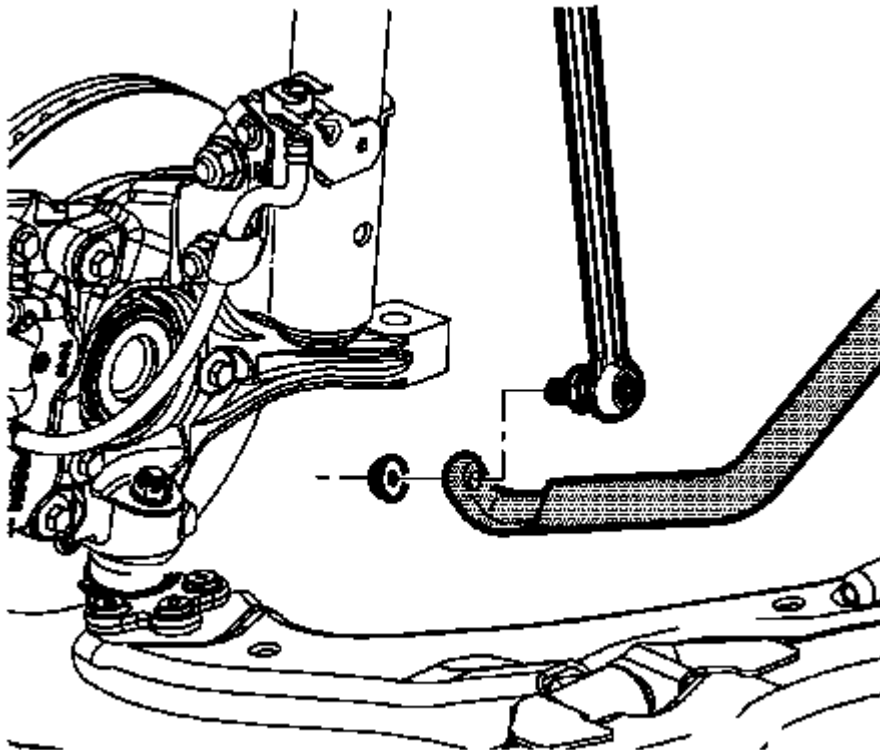
**Fig. 225: View Of Range Selector Lever Cable Terminal & Manual Shift Lever Pin**  
 Courtesy of GENERAL MOTORS COMPANY

20. Disconnect the transaxle cooler lines. Refer to **Fluid Cooler Inlet Hose Replacement** and **Fluid Cooler Outlet Hose Replacement** .
21. Disconnect the negative battery extension cable. Refer to **Battery Negative Cable Extension Cable Replacement** .
22. Disconnect all engine electrical connectors.
23. Remove the right and left steering linkage outer tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .



**Fig. 226: View Of Tie Rod End To Steering Knuckle**  
Courtesy of GENERAL MOTORS COMPANY

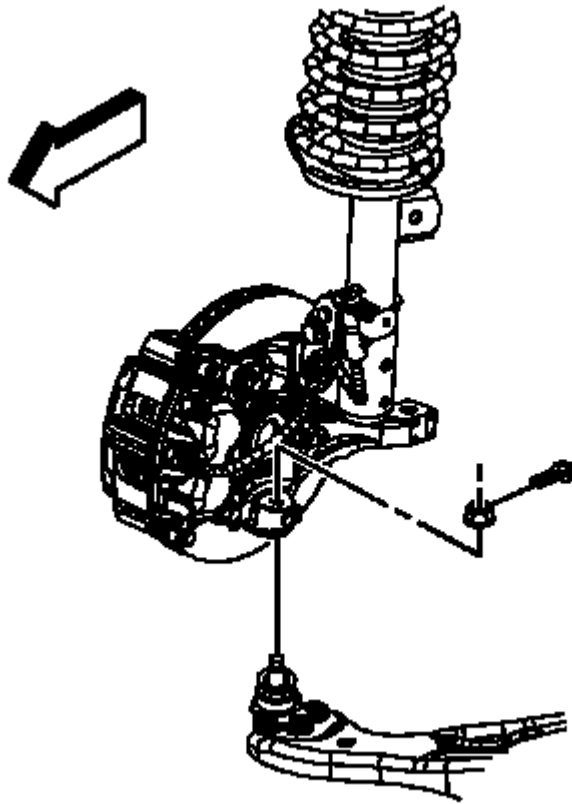
24. Remove the right and left stabilizer shaft links from the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .



**Fig. 227: View Of Stabilizer Shaft & Link**

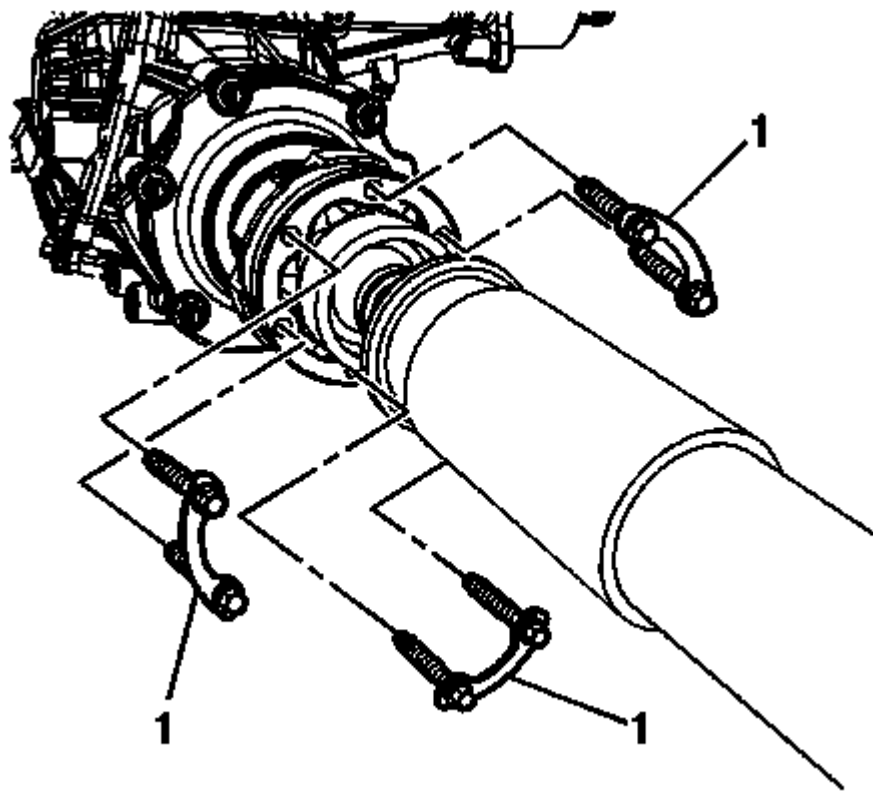
Courtesy of GENERAL MOTORS COMPANY

25. Remove the right and left lower ball joints from the steering knuckles. Refer to **Lower Control Arm Replacement** .



**Fig. 228: View Of Lower Ball Joint At Steering Knuckle**  
Courtesy of GENERAL MOTORS COMPANY

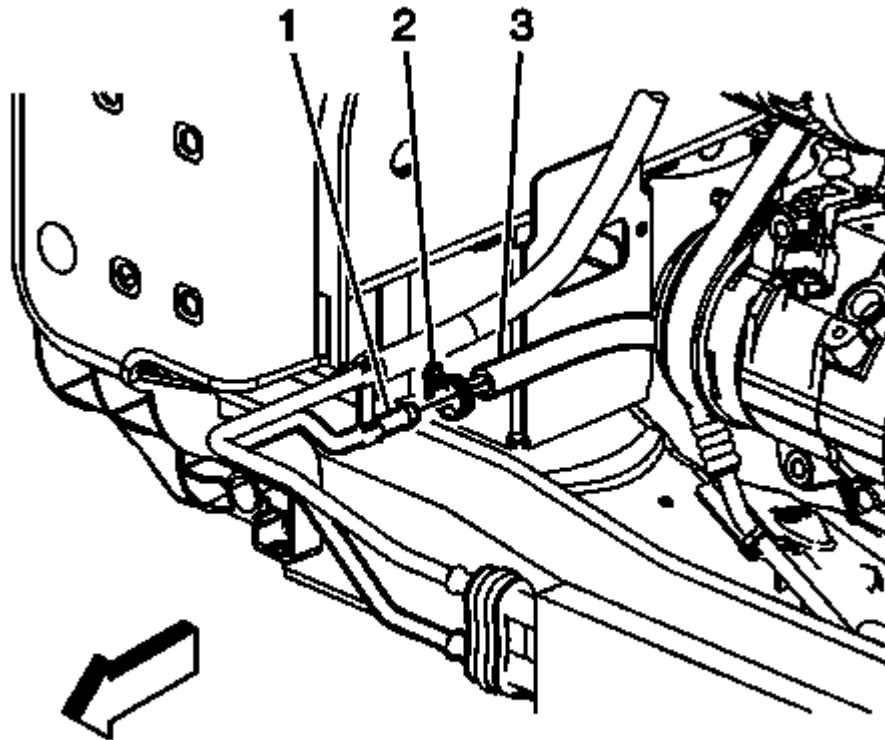
26. Place a drain pan under the transaxle then separate the right and left front wheel drive shafts from the transaxle/transfer case. Refer to **Front Wheel Drive Shaft Replacement** .
27. On all wheel drive (AWD) models, remove the propeller shaft retaining bolts (1) in order to remove the shaft. Refer to **Propeller Shaft Replacement** .



**Fig. 229: View Of Propeller Shaft Bolts & Washers**  
Courtesy of GENERAL MOTORS COMPANY

28. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
29. Disconnect the power steering hoses at the power steering fluid cooler (1). Refer to **Power Steering Cooler Pipe/Hose Replacement**.



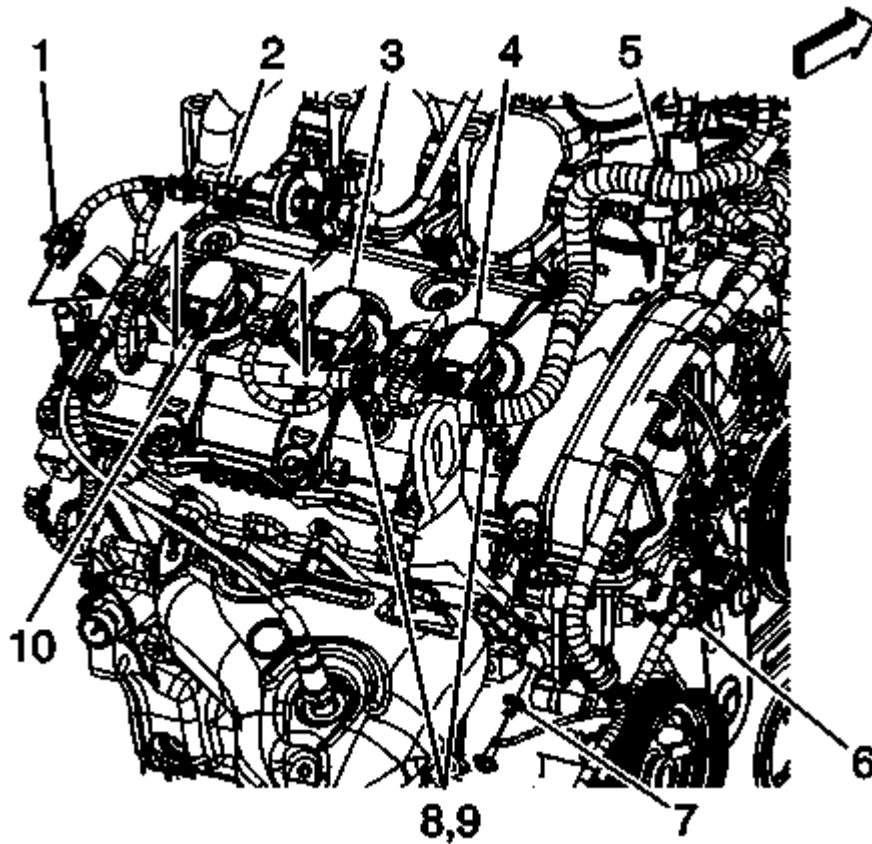


**Fig. 230: Identifying Power Steering Fluid Cooler, Power Steering Cooler Pipe & Clamp**  
 Courtesy of GENERAL MOTORS COMPANY

30. Place a universal frame support fixture or jackstands under the frame.
31. Lower the vehicle until the frame contacts the frame support fixture or jackstands.
32. Remove the frame-to-body bolts. Refer to steps 18-24 of the removal of **Drivetrain and Front Suspension Frame Replacement** .
33. Carefully raise the vehicle body up away from the powertrain.

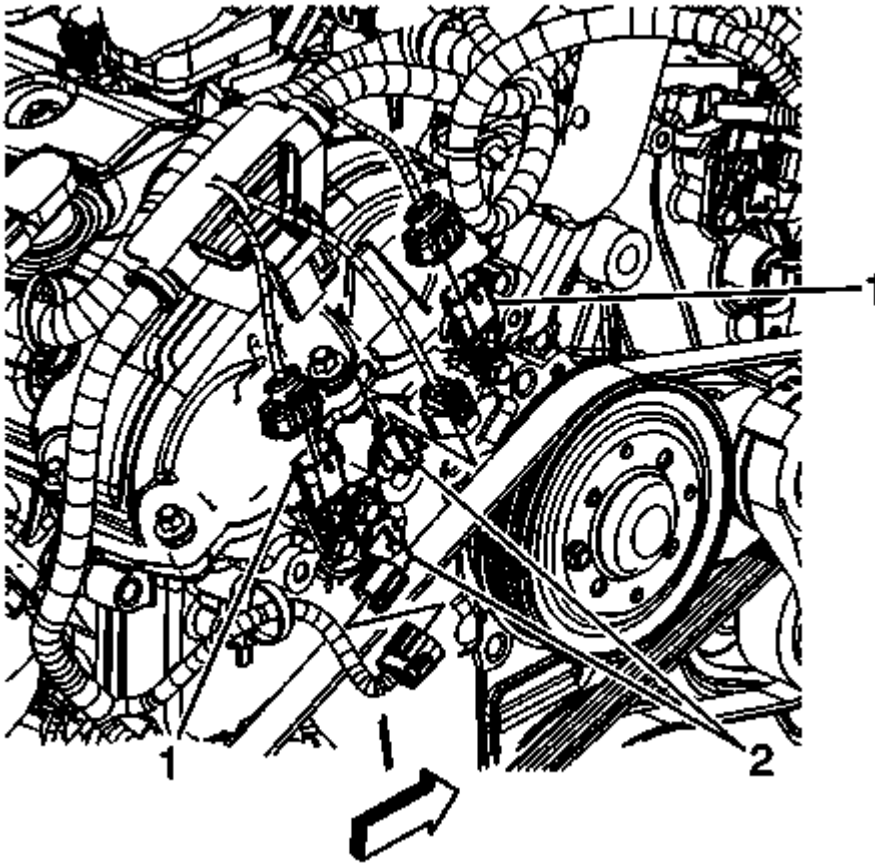
**IMPORTANT: Inspect for areas of body to powertrain contact or entanglement of wires and hoses while separating the vehicle body and powertrain.**

34. Disconnect the engine electrical wiring harness from the following components:



**Fig. 231: Identifying Oxygen Sensor, EVAP Purge Solenoid, Ignition Coils And Retainers**  
 Courtesy of GENERAL MOTORS COMPANY

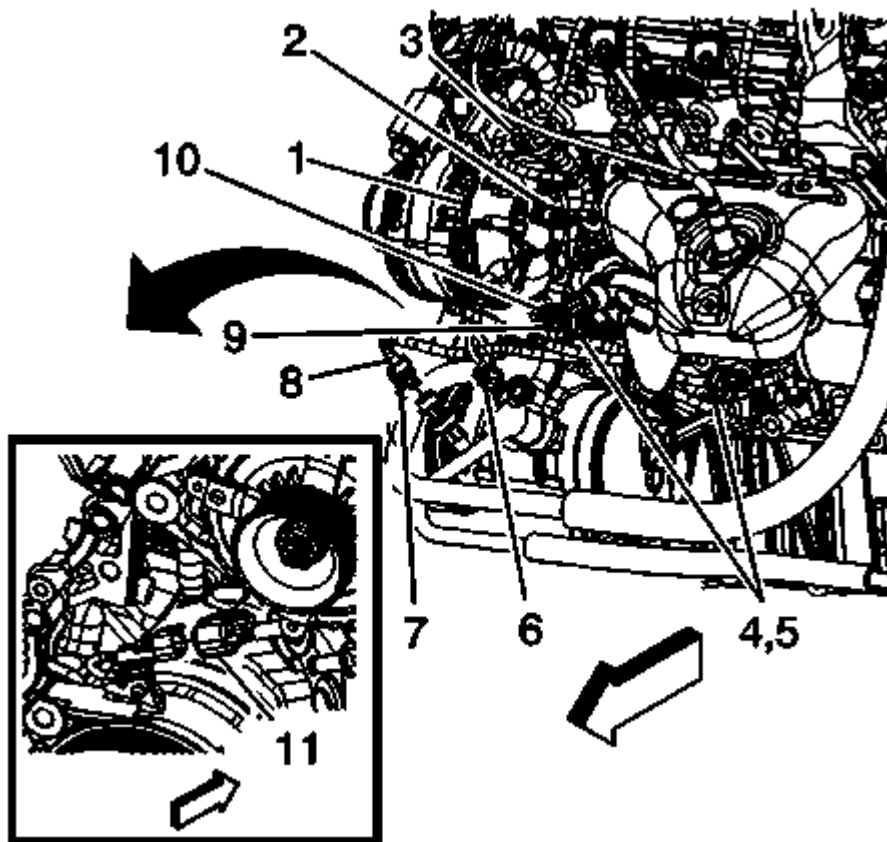
- Oxygen sensor (1)
  - EVAP purge solenoid (2)
  - Ignition coils (3, 4, 10)
  - Ground lead (7)
  - Remove wire harness from retainers (5, 6, 8, 9)
35. Disconnect the left and right cylinder head engine electrical wiring harness from the following components:



**Fig. 232: View Of Camshaft Position Sensors & Actuators**  
**Courtesy of GENERAL MOTORS COMPANY**

- Camshaft position sensors (1)
- Camshaft position actuators (2)

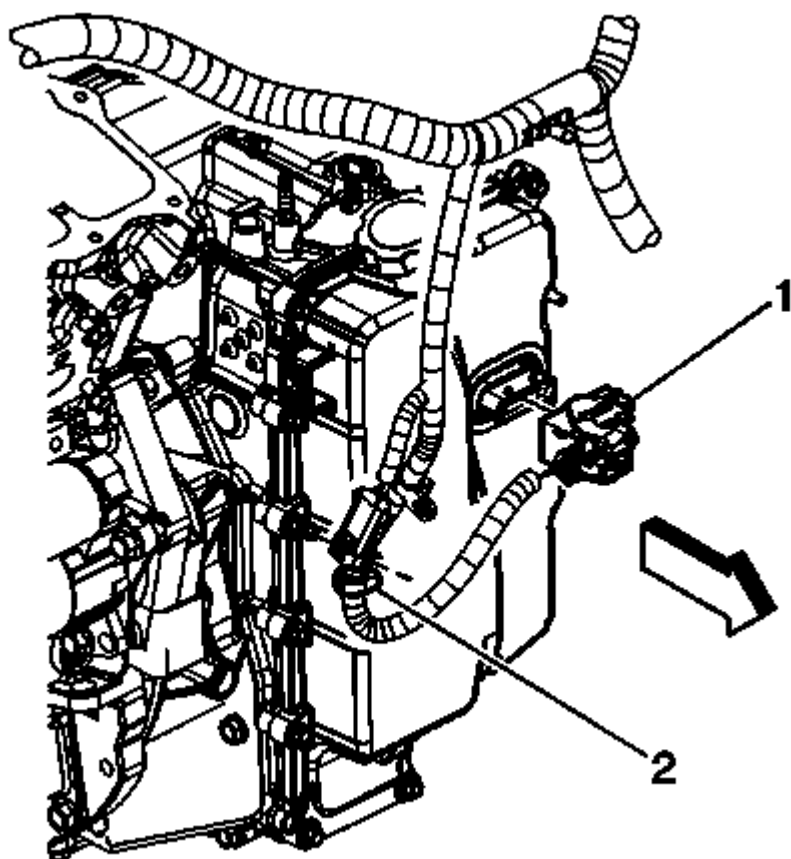
36. Disconnect the engine electrical wiring harness from the following components:



**Fig. 233: Identifying Generator, A/C Compressor, Oil Pressure Switch & Retainer Clips**  
 Courtesy of GENERAL MOTORS COMPANY

- Generator (1)
- Retainer clips (2, 3, 4, 5, 6, 7, 9)
- A/C compressor hose (8)
- Oil pressure switch (10)
- A/C compressor (8)

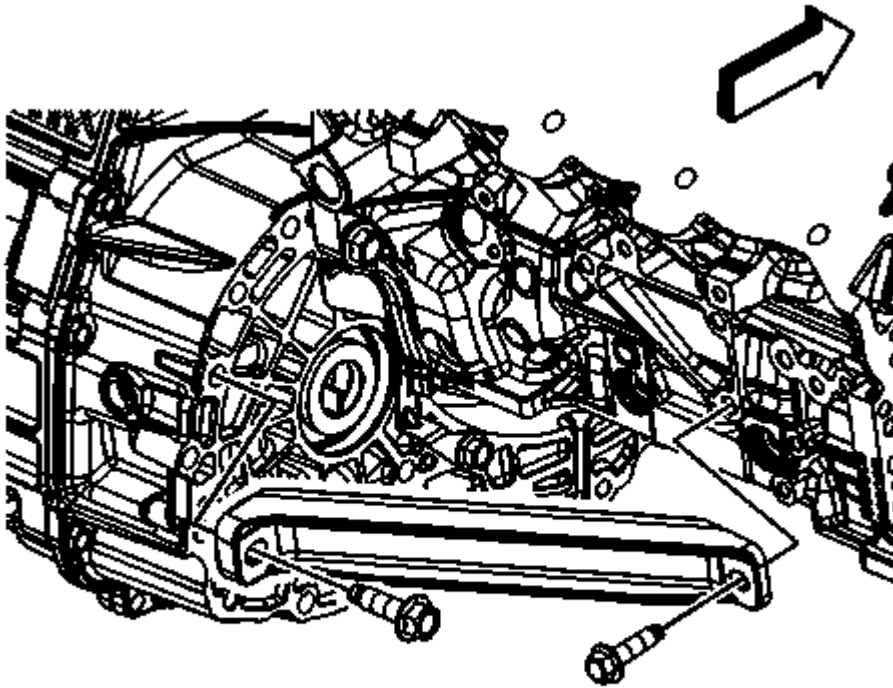
37. Disconnect the engine electrical wiring harness from the following components:



**Fig. 234: Identifying Wire Harness Retainer & TCM Electrical Connector**  
 Courtesy of GENERAL MOTORS COMPANY

- Battery cable
- Retainer clips (2)
- Transmission module (1)

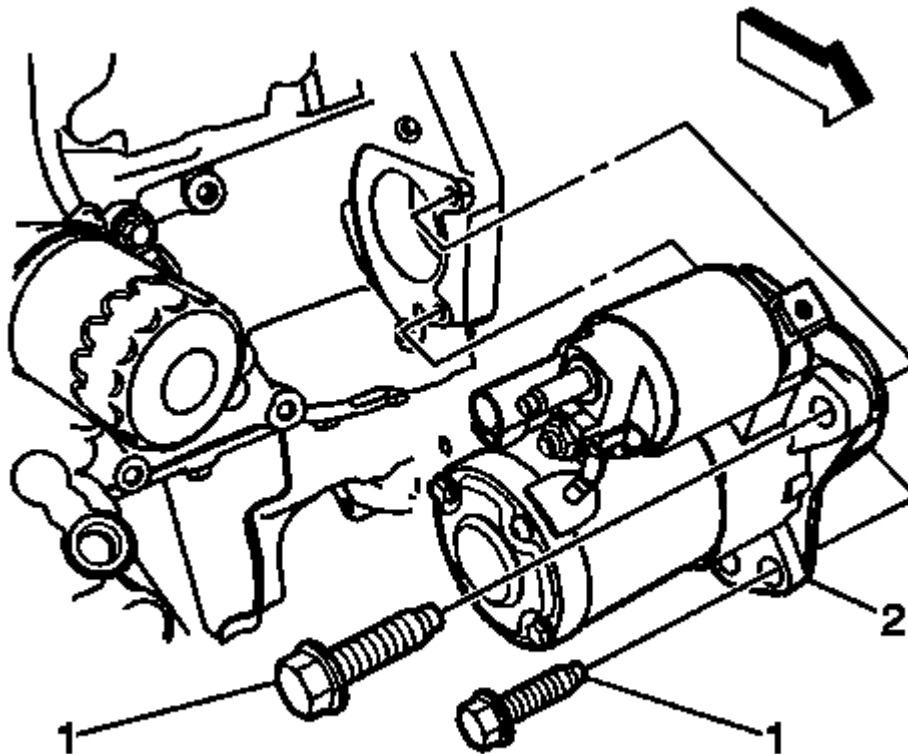
38. If equipped with an engine coolant heater, disconnect the coolant heater cord.
39. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.
40. On FWD vehicles, remove the engine-to-transaxle brace bolts and brace.



**Fig. 235: Identifying Transmission Brace Bolts**

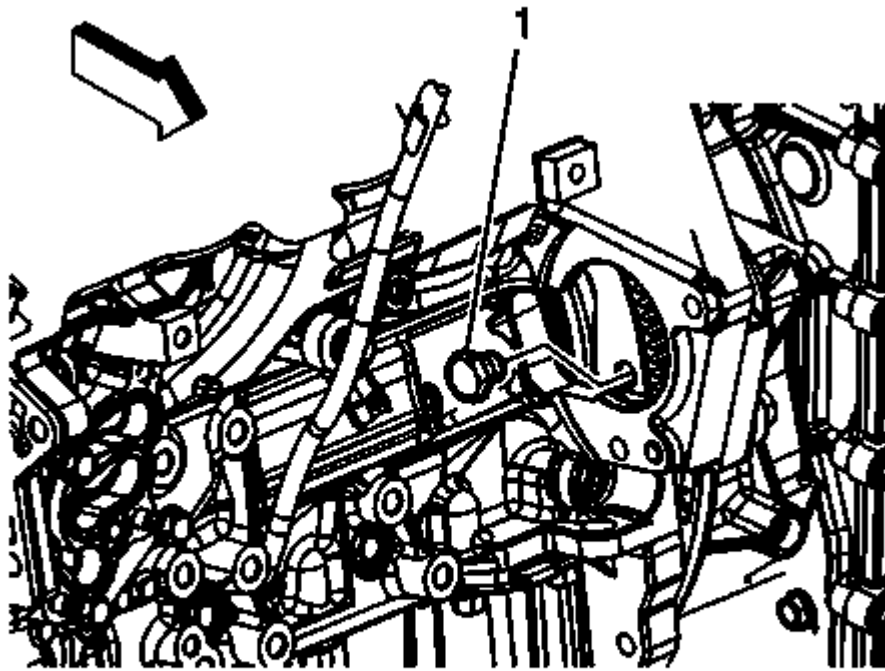
Courtesy of GENERAL MOTORS COMPANY

41. On AWD vehicles, perform the following:
  1. Remove the engine rear mount bracket. Refer to **Engine Rear Mount Bracket Replacement (Front Wheel Drive)**, **Engine Rear Mount Bracket Replacement (All Wheel Drive)**.
  2. Remove the transfer case. Refer to **Transfer Case Assembly Replacement** .
42. Remove the starter motor (2). Refer to **Starter Replacement** .



**Fig. 236: Starter Motor And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

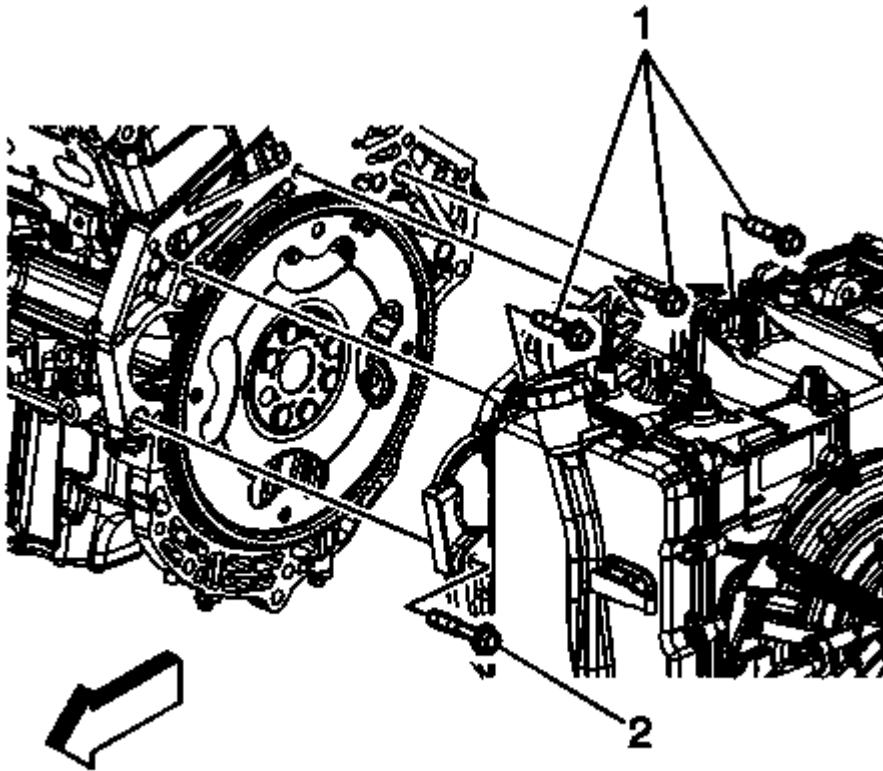
43. Remove the torque converter bolts (1).



**Fig. 237: View Of Torque Converter To Flywheel Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

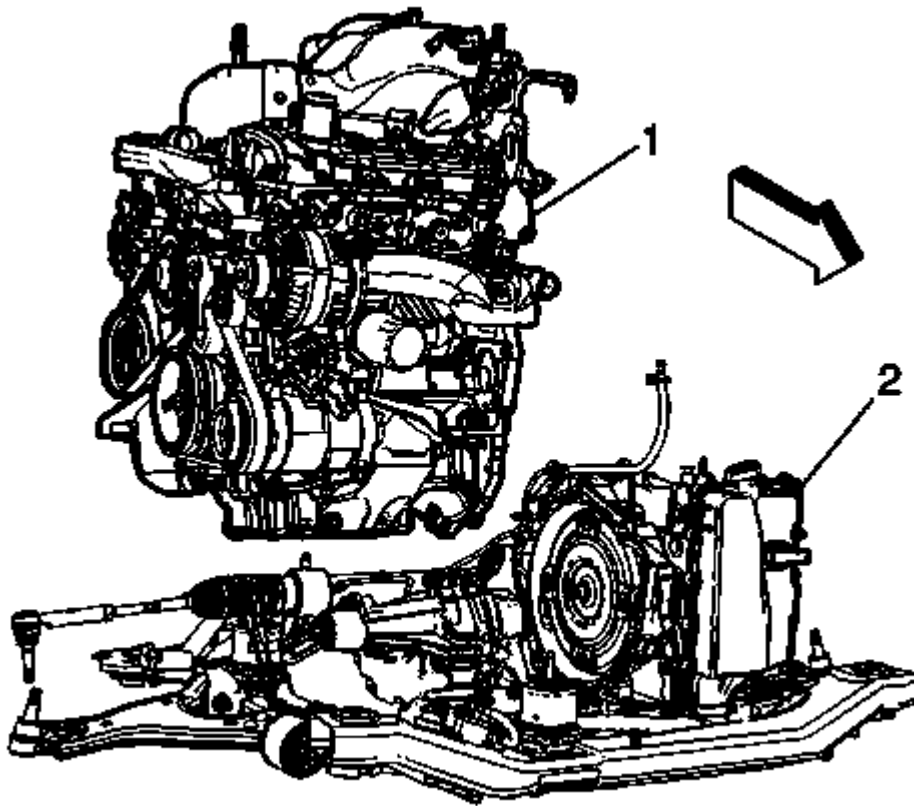
44. Using a engine hoist and lift chain, support the engine weight.
45. Support the bellhousing of the transmission with a block of wood.
46. Remove the automatic transaxle bolts (1, 2).





**Fig. 238: Identifying Upper Transmission To Engine Bolts**  
Courtesy of GENERAL MOTORS COMPANY

47. Remove the front and rear engine mount to mount bracket nuts.
48. Separate the automatic transaxle from the engine.
49. Lift the engine (1) away from the frame and the automatic transaxle (2).

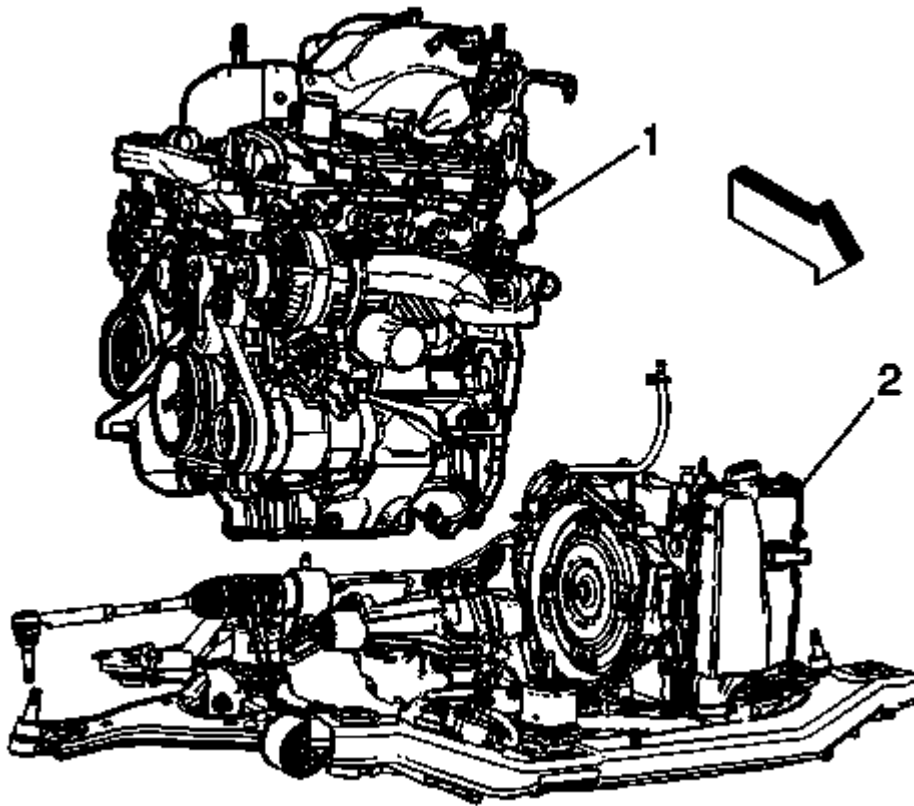


**Fig. 239: Engine And Automatic Transaxle**  
**Courtesy of GENERAL MOTORS COMPANY**

50. Secure the engine to an engine stand.
51. Remove any additional engine components as necessary. Refer to appropriate component sections in manual if needed.

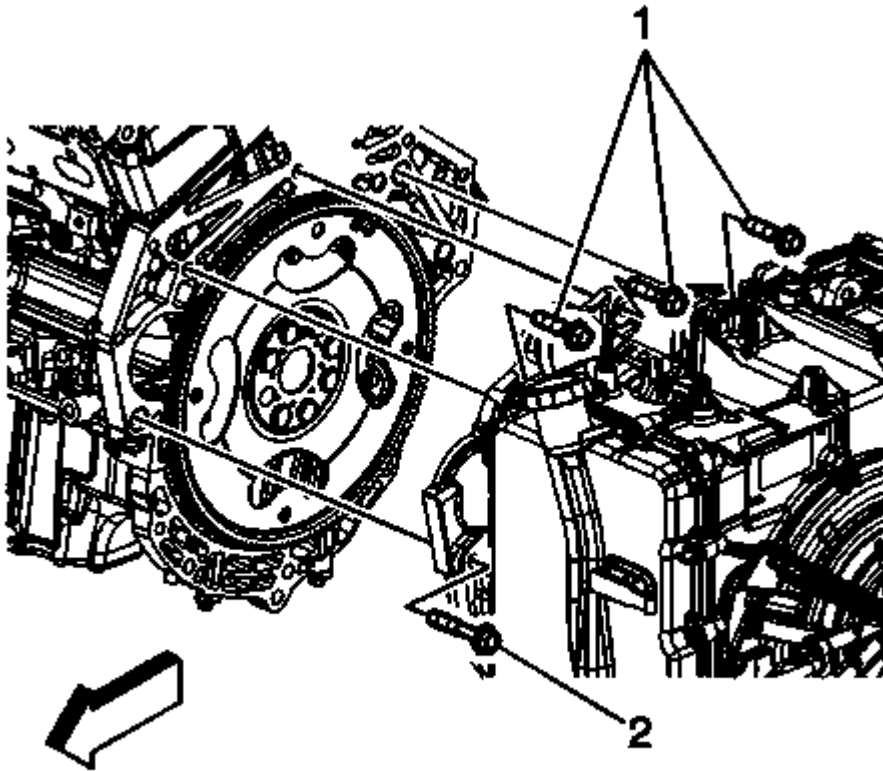
#### **Installation Procedure**

1. Using a engine hoist and lift chain, remove the engine from the engine stand.
2. Align the engine (1) to the frame and automatic transaxle (2).



**Fig. 240: Engine And Automatic Transaxle**  
Courtesy of GENERAL MOTORS COMPANY

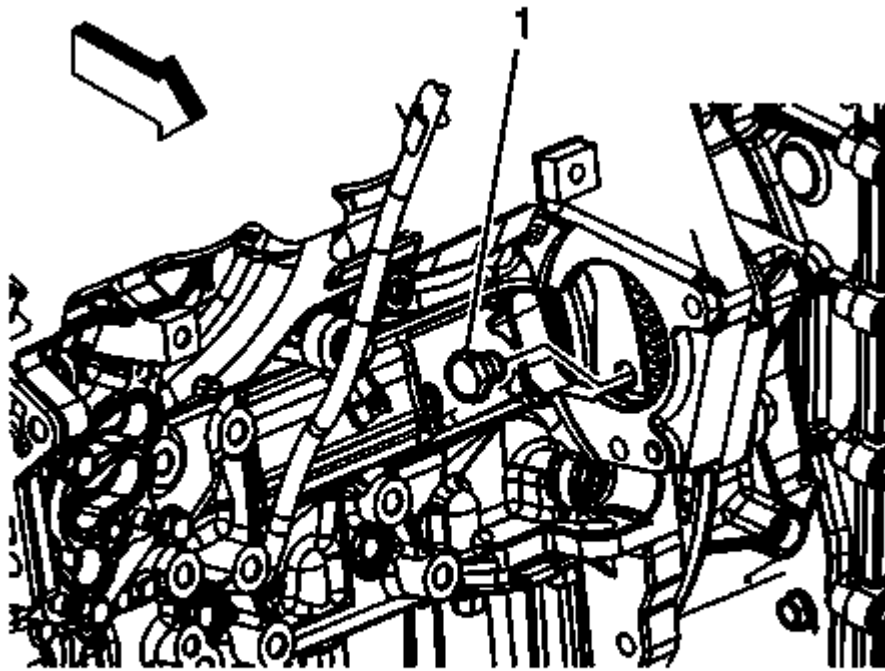
3. Install the automatic transaxle bolts (1, 2) and tighten to 75 N.m (55 lb ft).



**Fig. 241: Identifying Upper Transmission To Engine Bolts**  
Courtesy of GENERAL MOTORS COMPANY

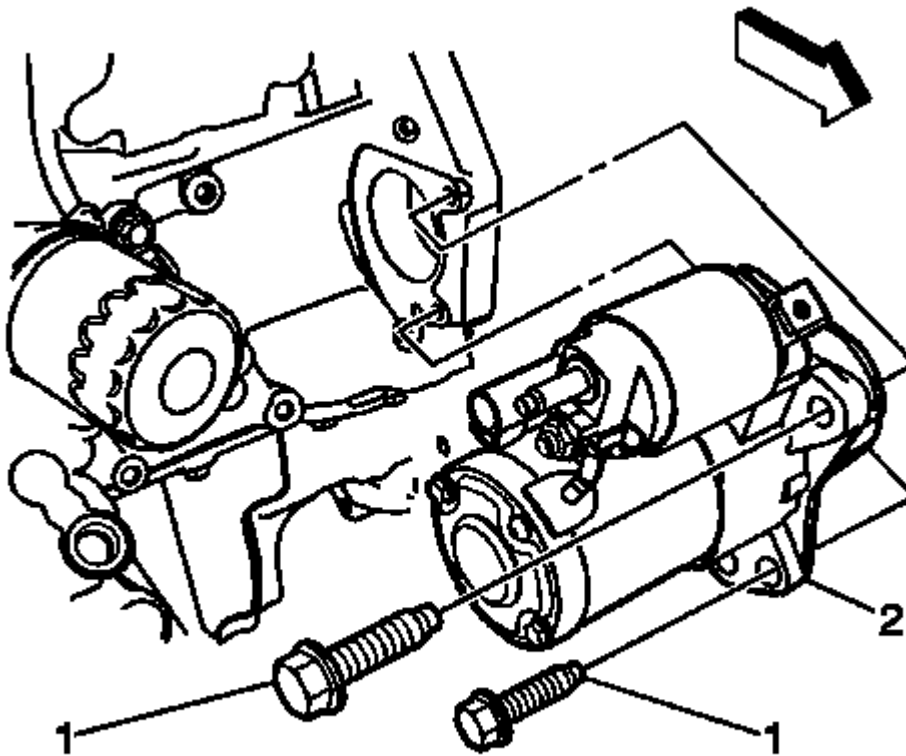
**CAUTION:** Refer to Fastener Caution .

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



**Fig. 242: View Of Torque Converter To Flywheel Bolts**  
Courtesy of GENERAL MOTORS COMPANY

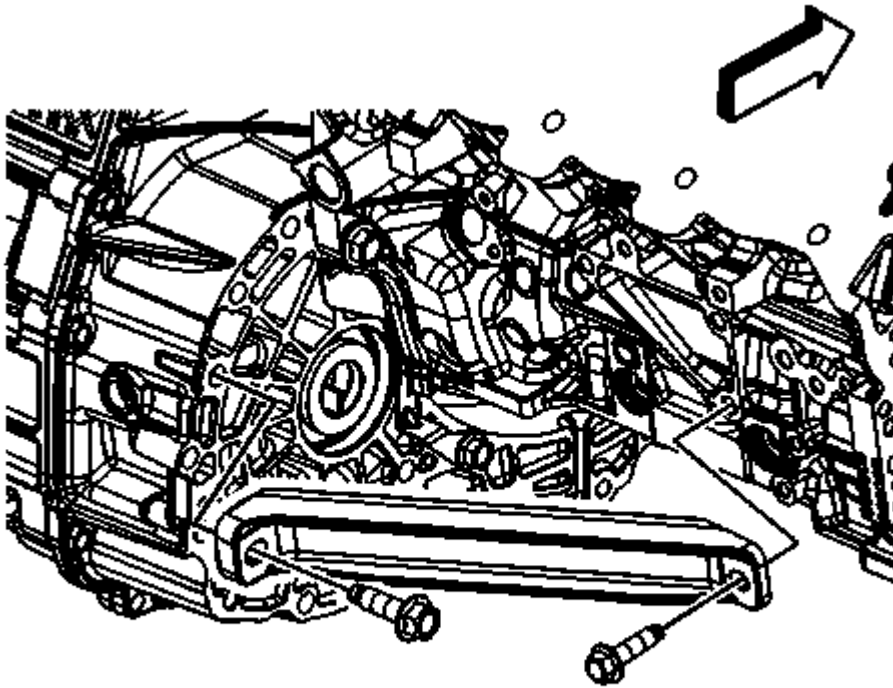
7. Install the starter motor (2). Refer to **Starter Replacement** .



**Fig. 243: Starter Motor And Bolts**

Courtesy of GENERAL MOTORS COMPANY

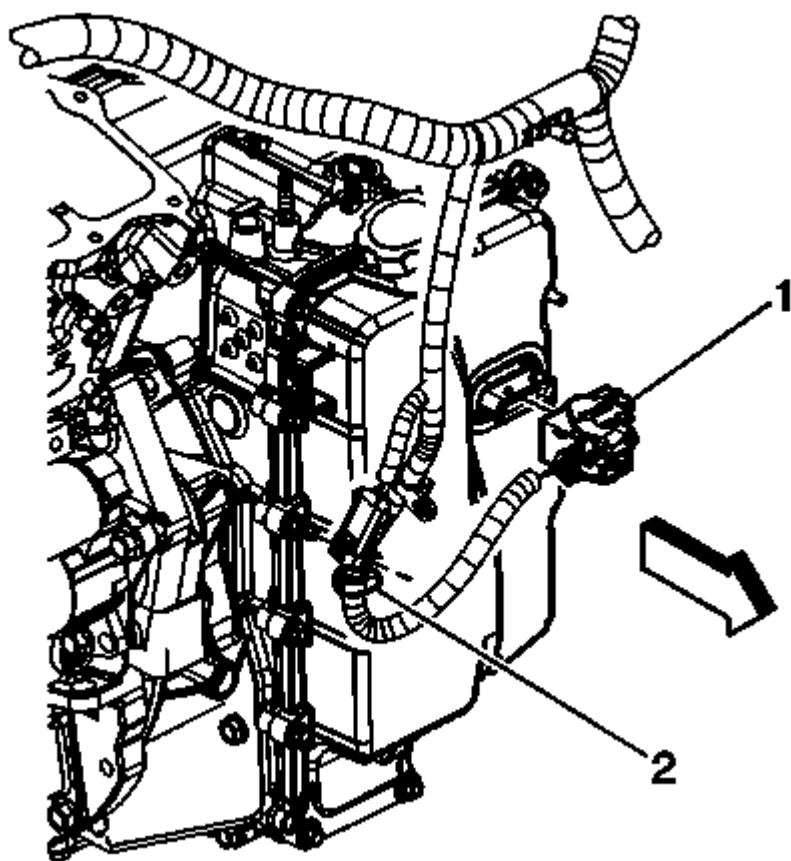
8. On FWD vehicles, install the engine to transaxle brace and bolts and tighten to 50 N.m (37 lb ft).



**Fig. 244: Identifying Transmission Brace Bolts**

Courtesy of GENERAL MOTORS COMPANY

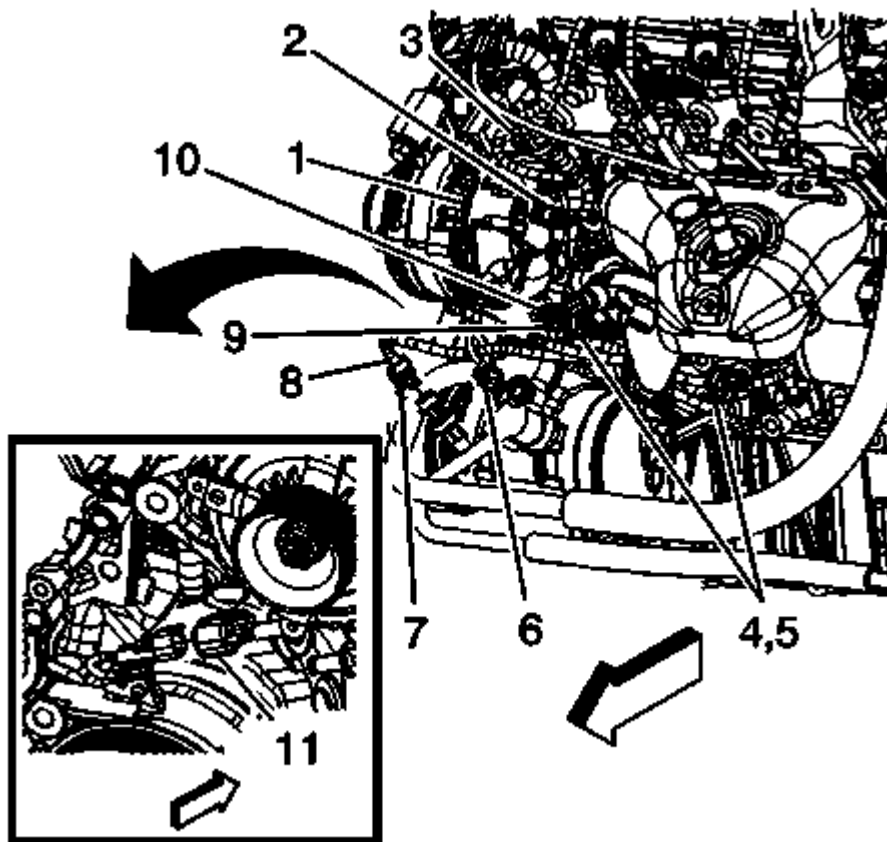
9. On AWD vehicles, perform the following:
  1. Install the transfer case. Refer to **Transfer Case Assembly Replacement** .
  2. Install the engine rear mount bracket. Refer to **Engine Rear Mount Bracket Replacement (Front Wheel Drive)**, **Engine Rear Mount Bracket Replacement (All Wheel Drive)**.
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.
12. Connect the engine electrical wiring harness to the following components:



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

- 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).
  14. Connect the engine electrical wiring harness to the following components:

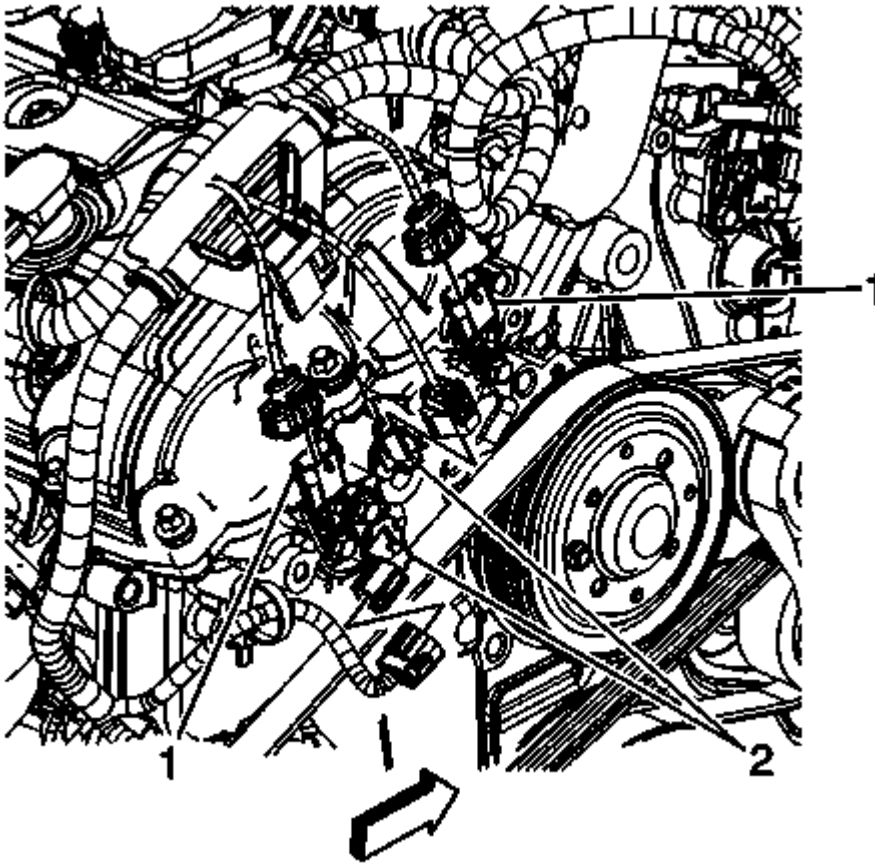




**Fig. 246: Identifying Generator, A/C Compressor, Oil Pressure Switch & Retainer Clips**  
 Courtesy of GENERAL MOTORS COMPANY

- A/C compressor (8)
- Oil pressure switch (10)
- A/C compressor hose (8)
- Retainer clips (2, 3, 4, 5, 6, 7, 9)

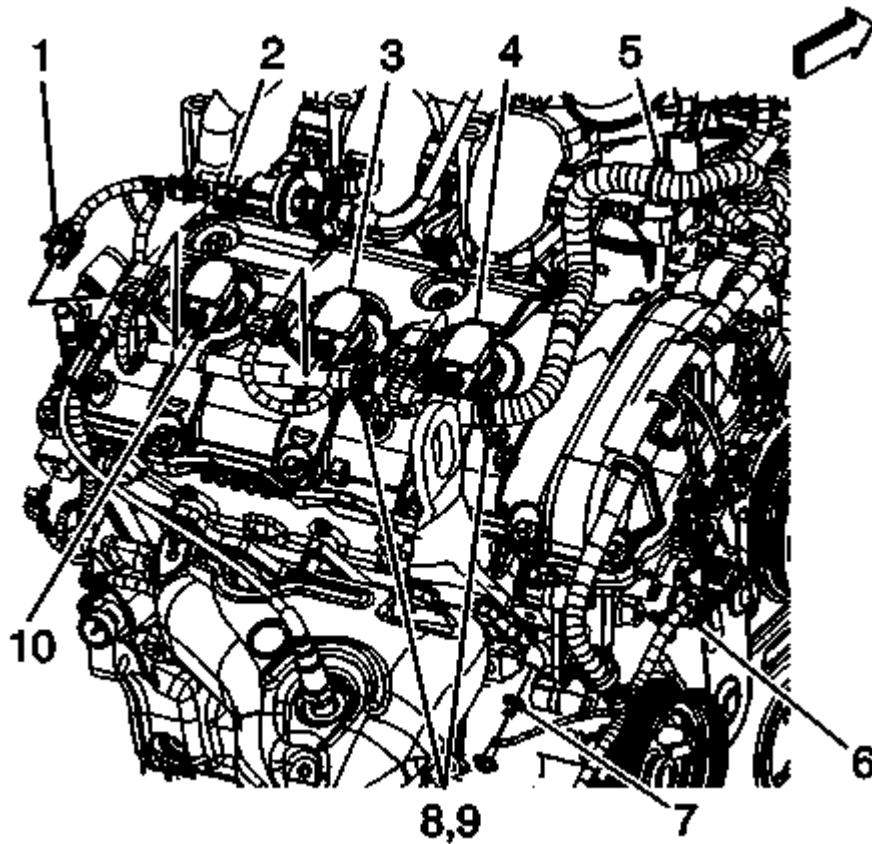
15. Install the Generator terminal connector and nut (1) and tighten to 13 N.m (115 lb in).
16. Connect the left and right cylinder head engine electrical wiring harness to the following components:



**Fig. 247: View Of Camshaft Position Sensors & Actuators**  
**Courtesy of GENERAL MOTORS COMPANY**

- Camshaft position actuators (2)
- Camshaft position sensors (1)

17. Connect the engine electrical wiring harness to the following components:

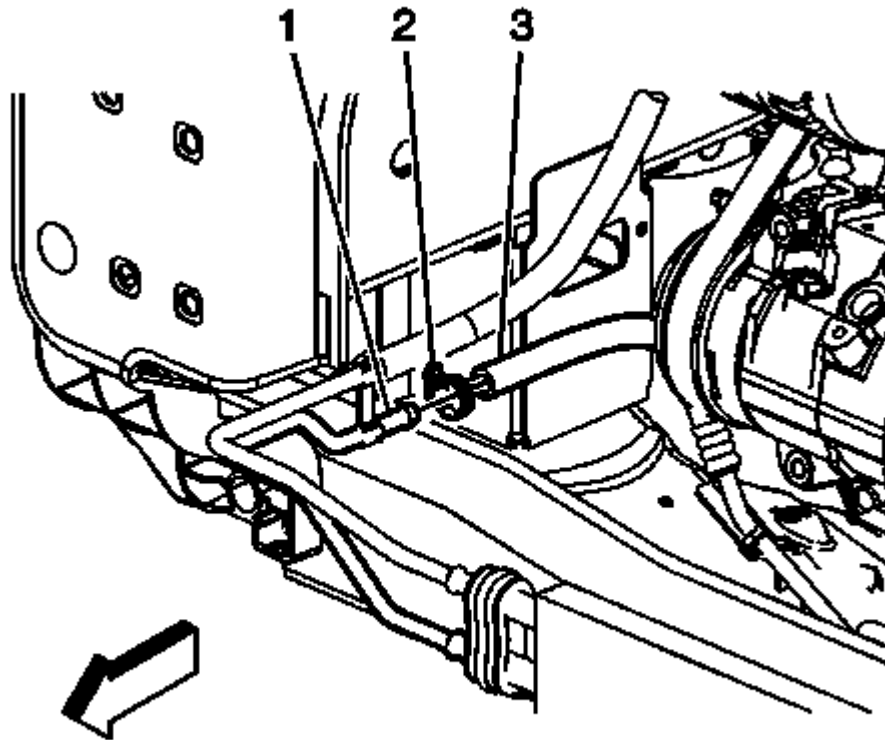


**Fig. 248: Identifying Oxygen Sensor, EVAP Purge Solenoid, Ignition Coils & Retainers**  
 Courtesy of GENERAL MOTORS COMPANY

- Install wire harness to retainers (5, 6, 8, 9)
  - Ground lead (7)
  - Ignition coils (3, 4, 10)
  - EVAP purge solenoid (2)
  - Oxygen sensor (1)
18. Install NEW frame-to-body bolts. Refer to steps 1-10 of the install of **Drivetrain and Front Suspension Frame Replacement** .

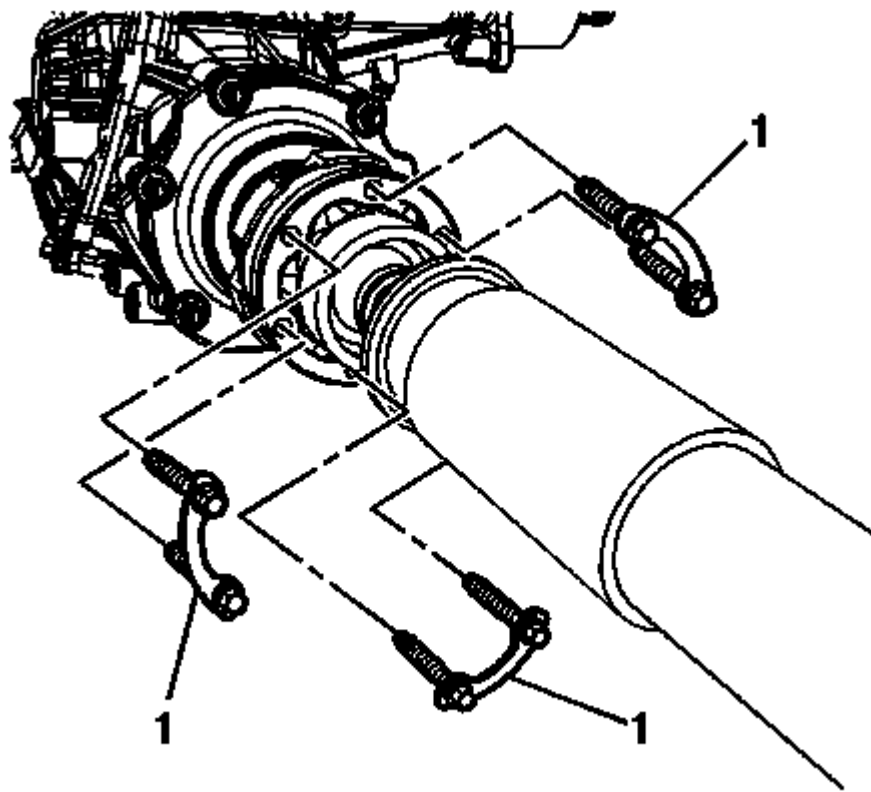
**NOTE:**      **Front end alignment not required due to frame only being lowered and reinstalled.**

19. Raise the vehicle and remove the support fixture or jackstands from under the vehicle.
20. Connect the power steering hoses to the power steering fluid cooler (1). Refer to **Power Steering Cooler Pipe/Hose Replacement** .



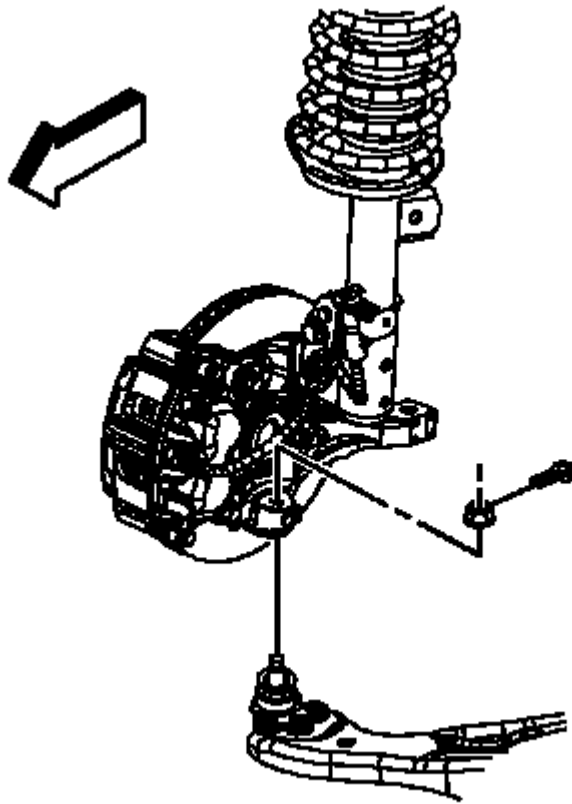
**Fig. 249: Identifying Power Steering Fluid Cooler, Power Steering Cooler Pipe & Clamp**  
Courtesy of GENERAL MOTORS COMPANY

21. Install the left transaxle mount bracket. Refer to **Transmission Mount Bracket Replacement - Left Side**.
22. Install the engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side**.
23. Raise the vehicle.
24. On AWD models, install the propeller shaft and retainers (1). Refer to **Propeller Shaft Replacement**.



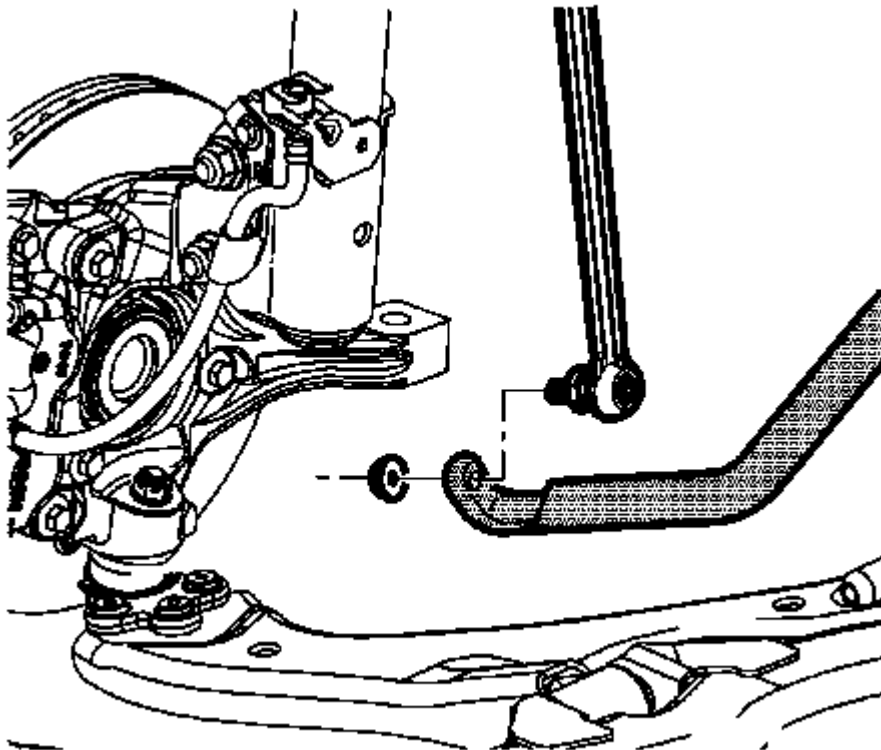
**Fig. 250: View Of Propeller Shaft Bolts & Washers**  
 Courtesy of GENERAL MOTORS COMPANY

25. On FWD models, install the right and left front wheel drive shafts into the transaxle. Refer to **Front Wheel Drive Shaft Replacement** .
26. On all models, install the right and left lower ball joints to the steering knuckles. Refer to **Lower Control Arm Replacement** .



**Fig. 251: View Of Lower Ball Joint At Steering Knuckle**  
Courtesy of GENERAL MOTORS COMPANY

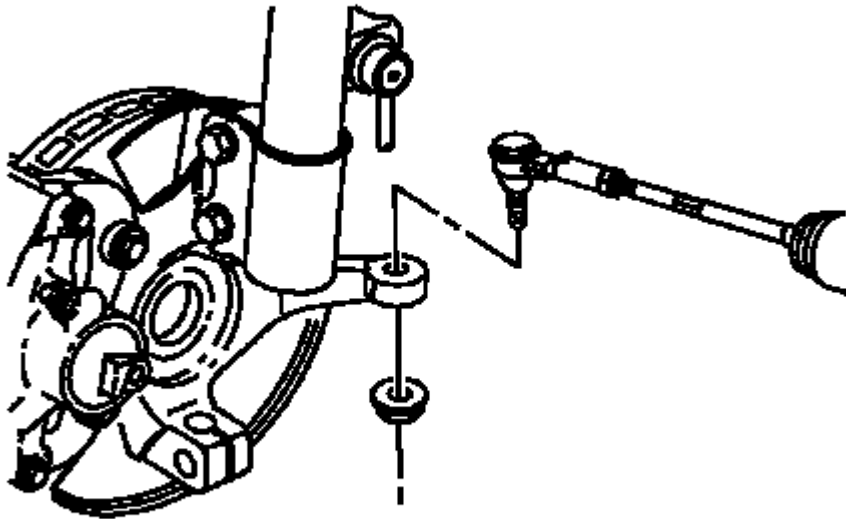
27. Install the right and left stabilizer shaft links to the stabilizer shaft. Refer to **Stabilizer Shaft Link Replacement** .



**Fig. 252: View Of Stabilizer Shaft & Link**

Courtesy of GENERAL MOTORS COMPANY

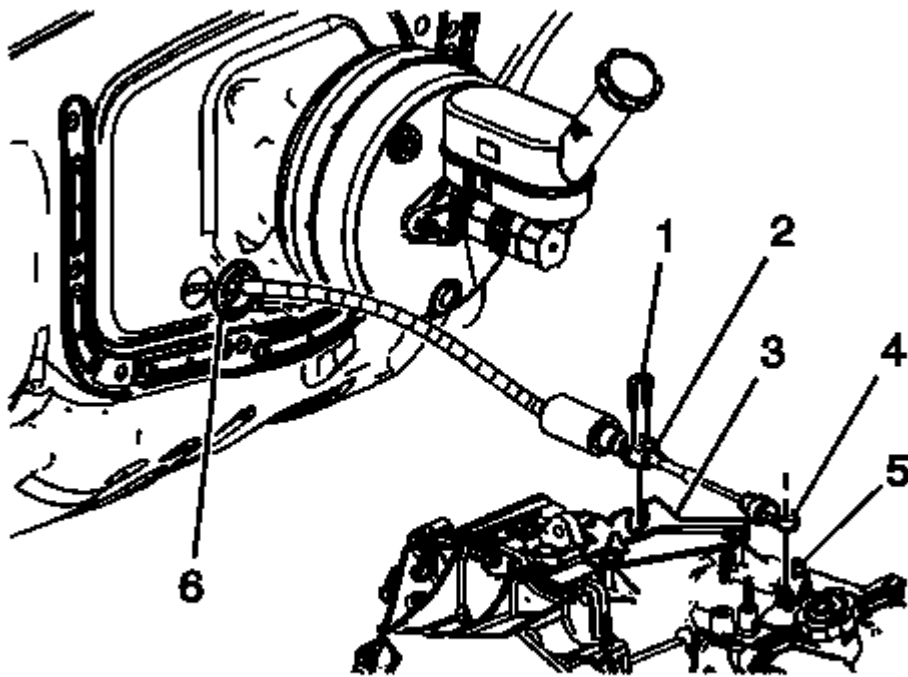
28. Install the right and left steering linkage outer tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .



**Fig. 253: View Of Tie Rod End To Steering Knuckle**  
Courtesy of GENERAL MOTORS COMPANY

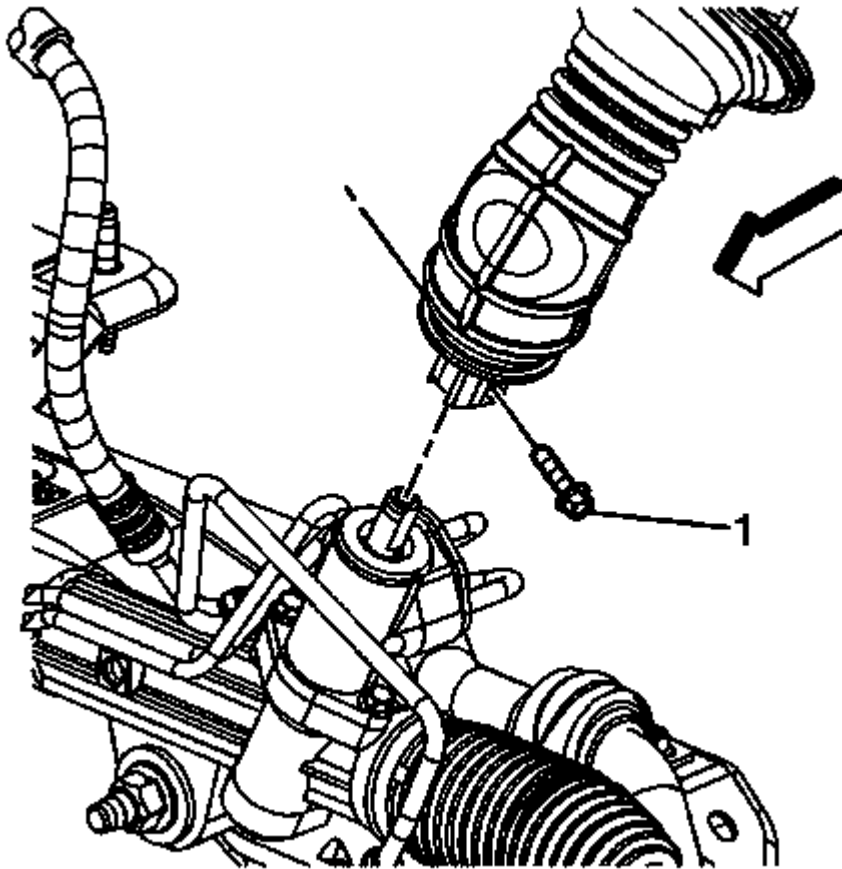
29. Connect all engine electrical connectors.
30. Connect the negative battery extension cable. Refer to **Battery Negative Cable Extension Cable Replacement** .
31. Connect the transaxle shift cable (2). Refer to **Range Selector Lever Cable Replacement** .





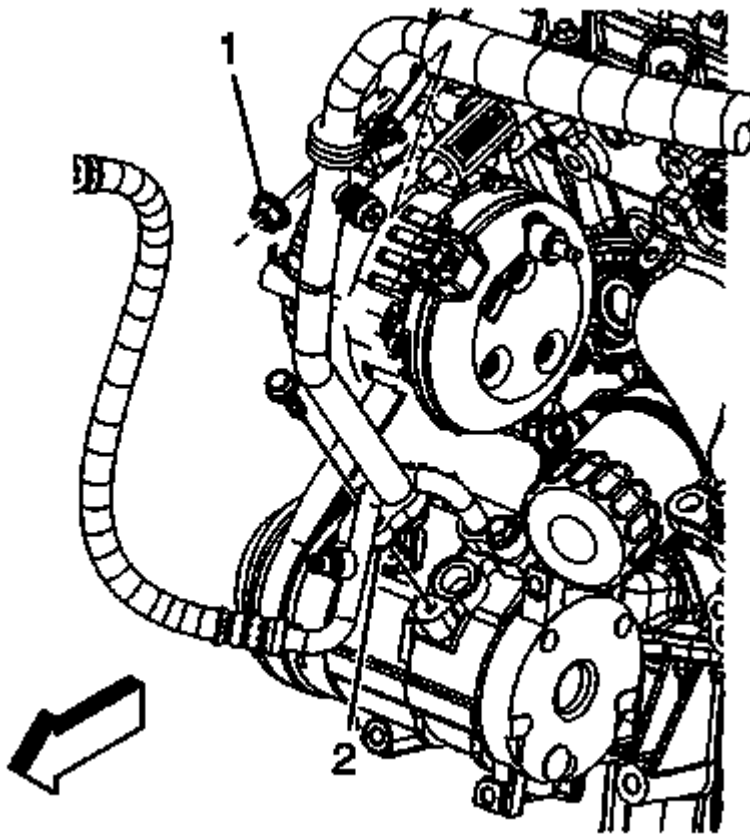
**Fig. 254: View Of Range Selector Lever Cable Terminal & Manual Shift Lever Pin**  
Courtesy of GENERAL MOTORS COMPANY

32. Connect the transaxle cooler lines. Refer to **Fluid Cooler Inlet Hose Replacement** and **Fluid Cooler Outlet Hose Replacement** .
33. Connect the steering intermediate shaft to the steering gear and install the pinch bolt (1). Refer to **Intermediate Steering Shaft Replacement** .



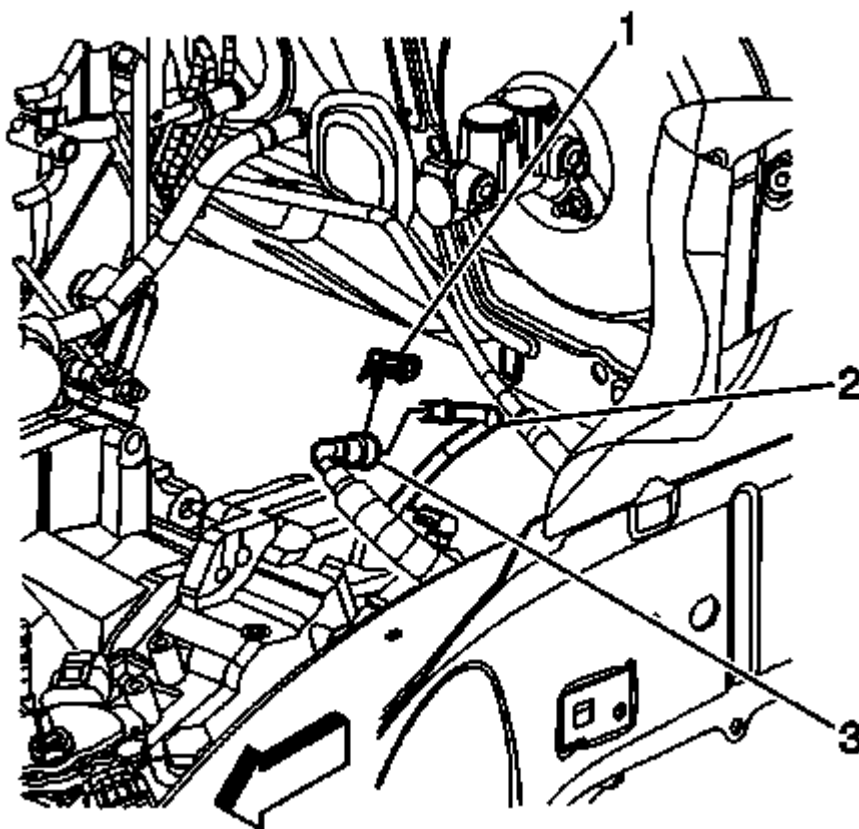
**Fig. 255: Identifying Intermediate Steering Shaft Bolt**  
Courtesy of GENERAL MOTORS COMPANY

34. Install the front tires. Refer to **Tire and Wheel Removal and Installation** .
35. Install the exhaust flexible pipe. Refer to **Exhaust Flexible Pipe Replacement** .
36. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement** .
37. Lower the vehicle.
38. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement** .
39. Connect the outlet coolant heater hose to the engine. Refer to **Heater Outlet Hose Replacement** .
40. Connect the inlet coolant heater hose to the engine. Refer to **Heater Inlet Hose Replacement** .
41. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement** .
42. Install the A/C compressor hose assembly (2) to the compressor. Refer to **Air Conditioning Compressor Hose Replacement** .



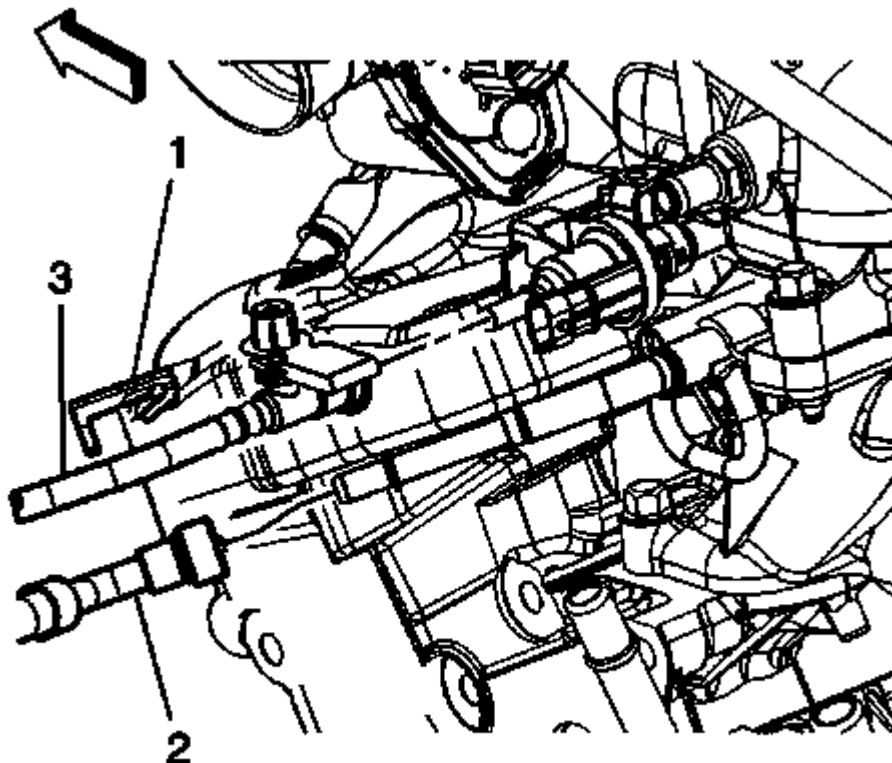
**Fig. 256: Identifying Suction Hose Bracket Nut**  
Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 257: Disconnecting/Connecting Engine Fuel Hose/Pipe At Chassis Fuel Hose/Pipe**  
Courtesy of GENERAL MOTORS COMPANY

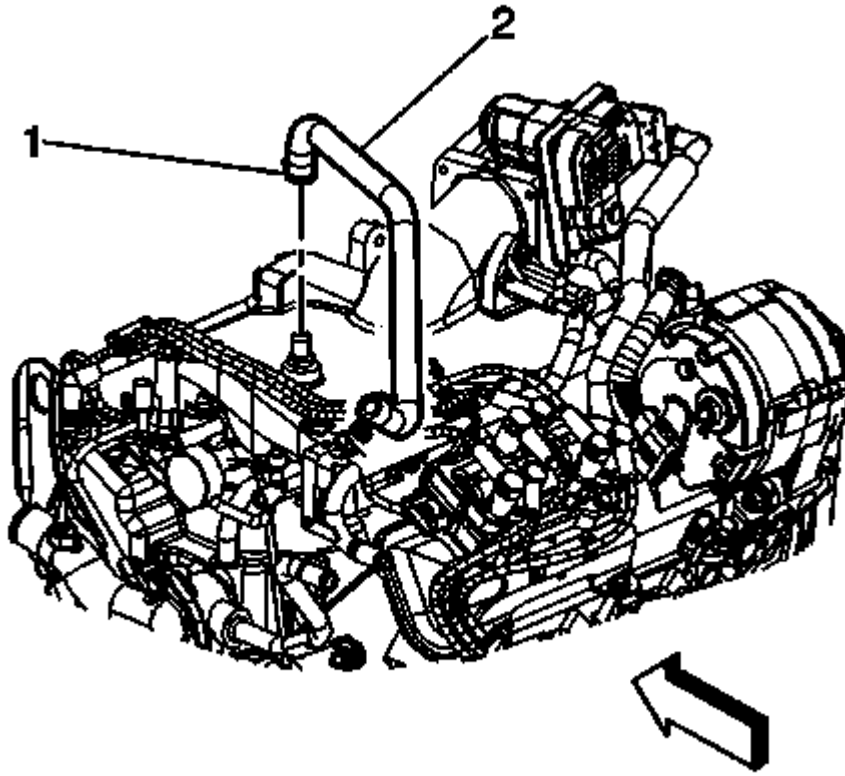
44. Connect the EVAP hose/pipe (3) to the EVAP canister purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service** .



**Fig. 258: View Of EVAP Pipe**

Courtesy of GENERAL MOTORS COMPANY

45. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
46. Connect the brake booster vacuum hose (2) to the intake manifold.



**Fig. 259: View Of Brake Booster Vacuum Hose**  
Courtesy of GENERAL MOTORS COMPANY

47. Position the clamp (1) on the brake booster vacuum hose connection.
48. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
49. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to **Engine Prelubing**.

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

50. If prelubing has not been performed, fill the engine with engine oil. Refer to **Approximate Fluid Capacities**, **Fluid and Lubricant Recommendations** and **Maintenance Schedule (North American Emissions)**.
51. Fill the engine with coolant. Refer to **Cooling System Draining and Filling (Static Fill)**, **Cooling System Draining and Filling (Vac N Fill)**.
52. Check the transaxle fluid level. Refer to **Adhesives, Fluids, Lubricants and Sealers**, **Transmission General Specifications** and **Approximate Fluid Capacities**.
53. Charge the AC system. Refer to **Refrigerant Recovery and Recharging**.
54. Add power steering fluid and bleed air from the power steering system. Refer to **Power Steering System Bleeding**.

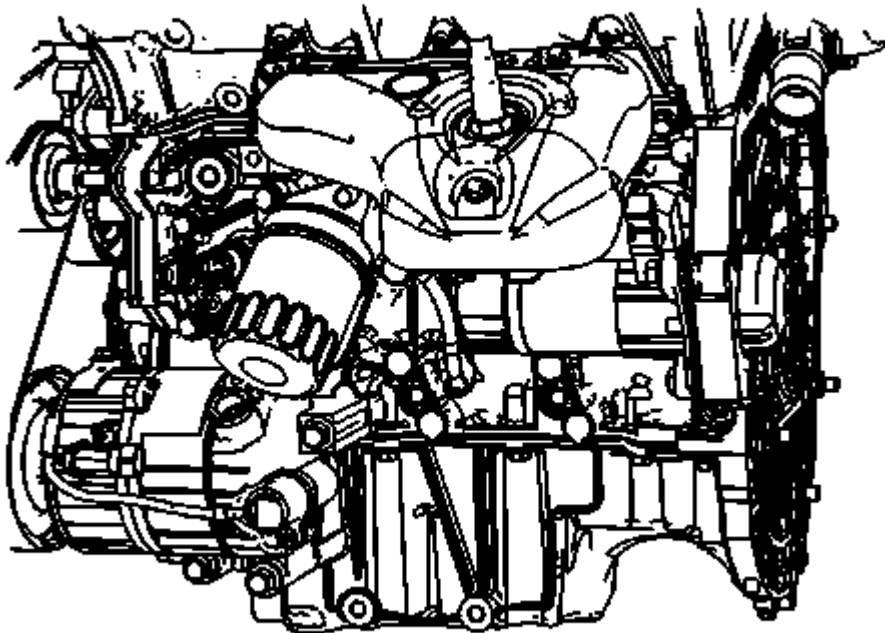
55. Prime the fuel system.

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

1. Place the drain pan under the oil filter.



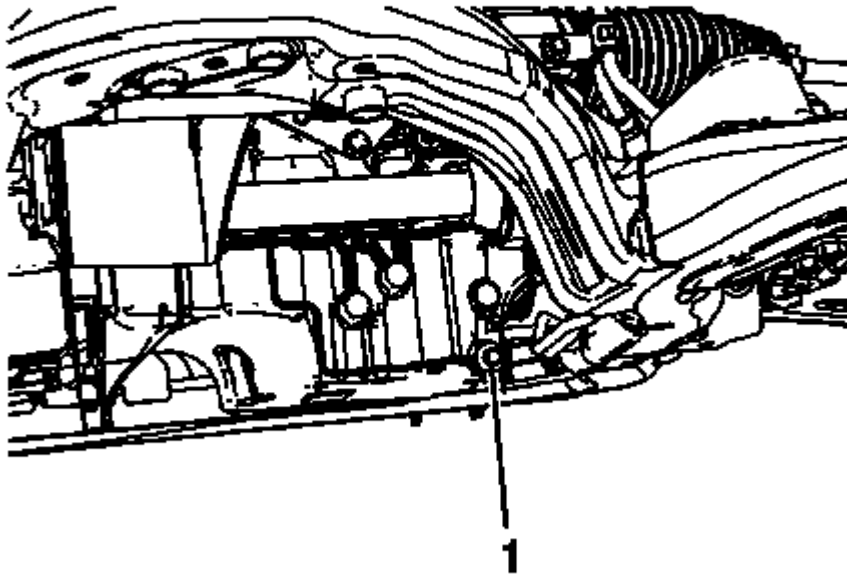
**Fig. 260: View of Oil Filter**

Courtesy of GENERAL MOTORS COMPANY

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

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).
6. Place a drain pan under the oil pan drain plug.



**Fig. 261: Locating Oil Drain Plug**  
Courtesy of GENERAL MOTORS COMPANY

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

#### **Installation Procedure**

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

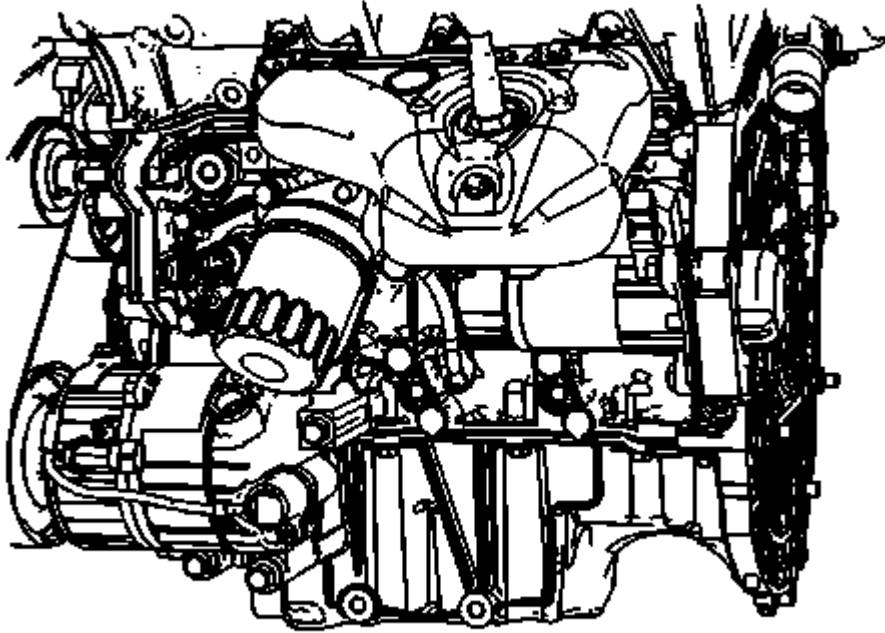
**CAUTION: Refer to Fastener Caution .**

**NOTE:        Clean and inspect the oil pan drain plug seal, replace parts as necessary.**

2. Clean the oil pan drain plug and oil filter areas from below.
3. Lower the vehicle.



4. Refill the engine oil. Refer to **Approximate Fluid Capacities** .



**Fig. 262: View of Oil Filter**

Courtesy of GENERAL MOTORS COMPANY

5. Start the engine and inspect for leaks.