

**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

**2012 ENGINE****Engine Mechanical - 1.8L (LUW) - Cruze****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****Fastener Tightening Specifications**

Application	Specification	
	Metric	English
AC Compressor and Condenser Hose Nut	19	14 lb ft
AC Compressor Bolt	22	16 lb ft
AC Evaporator Hose Assembly Nut	19	14 lb ft
Air Intake Hose Clamps	3.5	31 lb in
Automatic Transmission Flex Plate Bolt	60 (2)	44 lb ft (2)
Camshaft Adjuster Bolt		
• First Pass	50 (1)	37 lb ft (1)
• Second Pass	150 degrees	
• Final Pass	15 degrees	
Camshaft Adjuster Closure Plug	30	22 lb ft
Camshaft Bearing Cap Bolt	8	71 lb in
Camshaft Closure Bolt	30	22 lb ft
Camshaft Cover Bolt	8	71 lb in
Camshaft Position Actuator Solenoid Valve Bolt	6	53 lb in
Camshaft Position Sensor Bolt	6	53 lb in
Cold Start Rail Bolt	4	35 lb in
Connecting Rod Bearing Cap Bolt		
• First Pass	35 (1)	26 lb ft (1)
• Second Pass	45 degrees	
• Final Pass	15 degrees	
Coolant Pipe Pump Module Bolt	8	71 lb in
Coolant Pipe Thermostat Housing Bolt	8	71 lb in
Crankshaft Balancer Bolt		
• First Pass	95 (1)	70 lb ft (1)
• Second Pass	45 degrees	
• Final Pass	15 degrees	
Crankshaft Bearing Cap Bolt		
• First Pass	50 (1)	37 lb ft (1)

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

• Second Pass	45 degrees	
• Final Pass	15 degrees	
Crankshaft Position Sensor Bolt	5	44 lb in
Cylinder Head Bolt		
• First Pass	25 (1)	18 lb ft (1)
• Second Pass	90 degrees	
• Third Pass	90 degrees	
• Fourth Pass	90 degrees	
• Final Pass	45 degrees	
Drive Belt Tensioner Bolt	55	41 lb ft
Engine Coolant Pipe Bolts	9	80 lb in
Engine Coolant Thermostat	8	71 lb in
Engine Coolant Thermostat Housing	8	71 lb in
Engine Coolant Thermostat Housing Coolant Pipe Bolt	8	71 lb in
Engine Flywheel Bolt - Transmission D16/D20/F17		
• First Pass	35 (1)	26 lb ft (1)
• Second Pass	30 degrees	
• Final Pass	15 degrees	
Engine Flywheel Bolt - Transmission M32		
• First Pass	60 (1)	44 lb ft (1)
• Second Pass	45 degrees	
• Final Pass	15 degrees	
Engine Front Cover (Oil Pump Housing)	20	15 lb ft
Engine Lift Front Bracket	25	18 lb ft
Engine Mount Bolt	62	46 lb ft
Engine Mount Bolt to Engine Mount Bracket - M10		
• First Pass	50 (1)	37 lb ft (1)
• Second Pass	60 degrees	
• Final Pass	75 degrees	
Engine Mount Bracket Bolt to Engine Mount		
• First Pass	50 (1)	37 lb ft (1)
• Second Pass	60 degrees	
• Final Pass	75 degrees	
Engine Mount Bracket to Engine Block/Cylinder Head		
• First Pass	60 (1)	46 lb ft (1)

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

• Second Pass	45 degrees	
• Final Pass	60 degrees	
Engine Mount Nut	62	46 lb ft
Engine Oil Cooler Bolts	8	71 lb ft
Engine Oil Cooler Housing Bolt	25	18 lb ft
Engine Oil Cooler Inlet Pipe Bolt	8	71 lb in
Engine Oil Cooler Outlet Pipe Bolt	8	71 lb in
Engine Oil Level Indicator Bolt	10	89 lb in
Engine Oil Pressure Indicator Switch	20	15 lb ft
Engine Support Fixture (Front) Bolt	65	48 lb ft
Engine Support Fixture (Rear Left Side) Bolt	65	48 lb ft
Engine Support Fixture (Rear Right Side) Bolt	65	48 lb ft
Evaporative Emission Canister Purge Solenoid Valve Bracket Bolt	7	62 lb in
Exhaust Manifold Bracket Bolt	20	15 lb ft
Exhaust Manifold Nut	20 (1)	15 lb ft (1)
Front Compartment Fuse Block Bolt	22	16 lb ft
Front Exhaust Pipe Bolt	20	15 lb ft
Generator Bolt	35	26 lb ft
Heat Shield Exhaust Manifold Bolt	8	71 lb in
Heated Oxygen Sensor	42	31 lb ft
Ignition Module Bolt	8	71 lb in
Intake Manifold Absolute Pressure Sensor Bolt	6	53 lb in
Intake Manifold Bolt	20	15 lb ft
Intake Manifold Bracket Bolt	8	71 lb in
Intake Manifold Bracket to Engine Block Bolt	8	71 lb in
Intake Manifold Grommet Bolt	7	62 lb in
Knock Sensor Bolt	20	15 lb ft
Multiport Fuel Injection Fuel Rail Bolt	7	62 lb in
Oil Filter Cap	25	18 lb ft
Oil Flow Check Valve Bore Plug	21	15 lb ft
Oil Level Indicator Tube Bolt	15	11 lb ft
Oil Pan Baffle Bolt	10	89 lb in
Oil Pan Bolt	10	89 lb in
Oil Pan Drain Plug	14	124 lb in
Oil Pan Transmission Housing Bolt M10	40	30 lb ft
Oil Pan Transmission Housing Bolt M12	60	44 lb ft
Oil Pressure Measurement Closure Bolt Cylinder Head	15	11 lb ft
Oil Pressure Relief Valve Closure Bolt	21	15 lb ft

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

Oil Pressure Switch	20	15 lb ft
Oil Pump Cover Bolt	8	71 lb in
Power Steering Fluid Reservoir Bolt	9	80 lb in
Spark Plugs	25	18 lb ft
Throttle Body Bolt	8	71 lb in
Timing Belt Idler Pulley Bolt		
• First Pass	20 (1)	15 lb ft (1)
• Second Pass	120 degrees	
• Final Pass	15 degrees	
Timing Belt Lower Front Cover Bolt	6	53 lb in
Timing Belt Rear Cover Bolt	6 (2)	53 lb in (2)
Timing Belt Tensioner Bolt		
• First Pass	20 (1)	15 lb ft (1)
• Second Pass	120 degrees	
• Final Pass	15 degrees	
Timing Belt Upper Front Cover Bolt	6	53 lb in
Transmission to Cylinder Block Bolt	75	55 lb ft
Transmission to Oil Pan Bolt	50	37 lb ft
Water Pump Bolt	8	71 lb in
Water Pump Pulley Bolt	20 (2)	15 lb ft (2)
Wiring Harness Ground Nut	9	80 lb in

1 = Use NEW fastener

2 = Recut threads and insert NEW bolts with screw locking compound.

For screw locking compound, refer to electronic parts catalogue.

### ENGINE MECHANICAL SPECIFICATIONS

#### Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
• Engine Type	4-Cylinder Inline	
• Valves	16	
• Displacement	1.796 l	109.59 cu in
• Bore	80.5 mm	3.169 in
• Bore Distance	86 mm	3.386 in
• Stroke	88.2 mm	3.472 in
• Compression Ratio	10.5:1	



## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

<ul style="list-style-type: none"> <li>Maximum Power / Engine Speed kW/RPM - Gasoline</li> <li>Maximum Power / Engine Speed kW/RPM - E85 Ethanol</li> </ul>	103 KW/6300 106 KW/6300	
<ul style="list-style-type: none"> <li>Maximum Torque / Engine Speed - Gasoline Y/RPM/lb ft/RPM</li> <li>Maximum Torque / Engine Speed - E85 Ethanol Y/RPM/lb ft/RPM</li> </ul>	170 N.m/ 3800 183 N.m/ 3800	125 lb ft/3800 135 lb ft/3800
<ul style="list-style-type: none"> <li>Idle Speed RPM</li> </ul>	700-780	
<ul style="list-style-type: none"> <li>Overspeed RPM</li> </ul>	6500	
<ul style="list-style-type: none"> <li>Firing Order</li> </ul>	1-3-4-2	
<ul style="list-style-type: none"> <li>Engine Length - RFB to Front of Poly V Belt</li> </ul>	513 mm	20 in
<ul style="list-style-type: none"> <li>Engine Height - Crank Center to Top</li> </ul>	420 mm	17 in
<ul style="list-style-type: none"> <li>Engine Weight - MT Version</li> </ul>	120.5 kg	266 lb
<b>Block</b>		
<ul style="list-style-type: none"> <li>Cylinder Block Height</li> </ul>	198.5 mm	8 in
<ul style="list-style-type: none"> <li>Cylinder Bore Diameter - Standard Size Guiding Value 00</li> </ul>	80.492-80.508 mm	3.169-3.1694 in
<ul style="list-style-type: none"> <li>Cylinder Bore Diameter - Standard Size Guiding Value 05</li> </ul>	80.542-80.558 mm	3.171-3.1716 in
<ul style="list-style-type: none"> <li>Cylinder Bore Diameter - Oversize Guiding Value 00+05</li> </ul>	80.992-81.008 mm	3.188-3.1893 in
<b>Crankshaft</b>		
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 1-5 Diameter - Standard Size (brown/green)</li> </ul>	54.980-54.997 mm	2.165-2.166 in
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 1-5 Diameter - Undersize 0.25 (brown/green)</li> </ul>	54.730-54.747 mm	2.155-2.156 in
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 1-5 Diameter - Undersize 0.50 (brown/green)</li> </ul>	54.482-54.495 mm	2.145-2.146 in
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 3 Width - Standard Size</li> </ul>	26.000-26.052 mm	1.024-1.026 in
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 3 Width - Undersize 0.25</li> </ul>	26.200-26.252 mm	1.032-1.034 in
<ul style="list-style-type: none"> <li>Crankshaft Main Bearing Journal 3 Width - Undersize 0.50</li> </ul>	26.400-26.452 mm	1.040-1.042 in
<ul style="list-style-type: none"> <li>Con-Rod Bearing Journal - Standard Size</li> </ul>	42.971-42.987 mm	1.692-1.693 in
<ul style="list-style-type: none"> <li>Con-Rod Bearing Journal - Undersize 0.25 (blue)</li> </ul>	42.721-42.737 mm	1.682-1.683 in

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

• Con-Rod Bearing Journal - Undersize 0.50 (white)	42.471-42.487 mm	1.672-1.673 in
• Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Standard Size (brown)	1.987-1.993 mm	0.0783-0.0785 in
• Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Standard Size (green)	1.993-1.999 mm	0.0785-0.0787 in
• Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Undersize 0.25 (brown/blue)	2.112-2.118 mm	0.0832-0.0834 in
• Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Undersize 0.25 (green/blue)	2.118-2.124 mm	0.0834-0.0836 in
• Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Undersize 0.50 (brown/blue)	2.237-2.243 mm	0.0842-0.0844 in
Crankshaft Main Bearing 1-5 - Bearing Shell Thickness - Undersize 0.50 (green/blue)	2.243-2.249 mm	0.0884-0.0886 in
Crankshaft Bearing Allowable Clearance	0.005-0.059 mm	0.0002-0.0024 in
Crankshaft Bearing Allowable End Clearance	0.100-0.202 mm	0.004-0.008 in
Crankshaft Main Bearing 3 Width - Standard Size	25.85-25.90 mm	1.018-1.020 in
Crankshaft Main Bearing 3 Width - Undersize 0.25	26.05-26.10 mm	1.026-1.028 in
Crankshaft Main Bearing 3 Width - Undersize 0.50	26.25-26.30 mm	1.034-1.036 in
Con-Rod Bearing Shell Thickness - Standard Size	1.485-1.497 mm	0.0585-0.0590 in
Con-Rod Bearing Shell Thickness - Undersize 0.25	1.610-1.622 mm	0.0634-0.0639 in
Con-Rod Bearing Shell Thickness - Undersize 0.50	1.735-1.747 mm	0.0684-0.0688 in
Con-Rod Bearing Allowable Clearance	0.019-0.071 mm	0.0007-0.0028 in
Pistons and Pins		
• Piston Diameter - Standard Size Guiding Value 00	80.455-80.465 mm	3.1676-3.1680 in
• Piston Diameter - Standard Size Guiding Value 00	80-505-80.51 mm	3.1695-3.1697 in
• Piston Diameter - Oversize Guiding Value 00+05	80.955-80.965 mm	3.1872-3.1876 in
• Piston Clearance	0.027-0.053 mm	0.0011-0.0021 in
• Pin Diameter	19 mm	0.785 in
• Pin Longitude	49.84 mm	1.962 in
• Pin to Piston Clearance	0.020-0.060 mm	0.0008-0.0024 in
• Pin to Con-Rod Clearance	0.015-0.021 mm	0.0006-0.0009 in
Piston Rings		
• Piston Ring Thickness - First Compression Ring	1.170-1.190 mm	0.0461-0.0469 in
• Piston Ring Thickness - Second Compression	1.170-1.190 mm	0.0461-0.0469 in

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

Ring		
• Piston Ring Thickness - Oil Control Ring	1.900-1.980 mm	0.0749-0.0780 in
• Piston Ring End Gap - First Compression Ring	0.20-0.40 mm	0.0079-0.0158 in
• Piston Ring End Gap - Second Compression Ring	0.40-0.60 mm	0.0158-0.0237 in
• Piston Ring End Gap - Oil Control Ring	0.25-0.75 mm	0.0098-0.0295 in
• Piston Ring to Groove Clearance - First Compression Ring	0.040-0.080 mm	0.0016-0.0032 in
• Piston Ring to groove Clearance - Second Compression Ring	0.030-0.070 mm	0.0012-0.0028 in
• Piston Ring to Groove Clearance - Oil Control Ring	0.030-0.130 mm	0.0012-0.051 in
Cylinder Head		
• Surface Flatness - Block Deck - Longitude	0.05 mm	0.00197 in
	If the deck surface is out of specification, replace the cylinder head. Do not machine the cylinder head.	
• Surface Flatness - Block Deck - Transverse	0.03 mm	0.00118 in
	If the deck surface is out of specification, replace the cylinder head. Do not machine the cylinder head.	
Valve Seat Width - Intake	1.0-1.4 mm	0.040-0.056 in
Valve Seat Width - Exhaust	1.4-1.8 mm	0.056-0.071 in
Valve Seat Angle	45 degrees (- 0.25 degrees)	
Valve Seat Angle Adjustment - Upper	30 degrees (+/- 0.5 degrees)	
Valve Seat Angle Adjustment - Lower	60 degrees (+/- 0.5 degrees)	
Valve Guide Bore Norm Size	5.000-5.016 mm	0.1969-0.1975 in
Valve Guide Bore Oversize 0.075	5.075-5.091 mm	0.1999-0.2005 in
Valve Guide Bore Oversize 0.150	5.150-5.166 mm	0.2028-0.2034 in
Valve Guide Assembly Height	10.70-11.00 mm	0.422-0.434 in
Valve Guide Longitude	36.70-37.30 mm	1.445-1.468 in
Valve Assembly Height - Intake	36.33 mm	1.430 in
Valve Assembly Height - Exhaust	36.33 mm	1.430 in
Camshaft		
• Cam Stroke Intake	10 mm	0.394 in
• Cam Stroke Exhaust	9 mm	0.354 in
Valve System		
• Valves Norm Longitude - Intake	101.10-101.30 mm	3.980-3.988 in
• Valves Norm Longitude - Exhaust	100.40-100.60 mm	3.953-3.961 in

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

• Valves Oversize Longitude 0.075 - Intake	100.70-100.90 mm	3.965-3.972 in
• Valves Oversize Longitude 0.075 - Exhaust	100.00-100.20 mm	3.937-3.945 in
• Valves - Valve Stem Norm Diameter - Intake	4.965-4.980 mm	0.1955-0.1961 in
• Valves - Valve Stem Norm Diameter - Exhaust	4.950-4.965 mm	0.1949-0.1955 in
• Valves - Valve Stem Oversize Diameter 0.075 - Intake	5.040-5.055 mm	0.1985-0.1991 in
• Valves - Valve Stem Oversize Diameter 0.075 - Exhaust	5.025-5.050 mm	0.1979-0.1989 in
• Valves - Valve Stem to Guide Clearance - Intake	0.020-0.051 mm	0.0008-0.0021 in
• Valves - Valve Stem to Guide Clearance - Exhaust	0.035-0.066 mm	0.0014-0.0026 in
• Valves - Valve Stem allowable Run-Out	0.05 mm	0.0019 in
• Valves - Valve Disk Diameter - Intake	31.1-31.3 mm	1.225-1.233 in
• Valves - Valve Disk Diameter - Exhaust	27.4-27.6 mm	1.079-1.087 in
• Valves - Valve Seat Angle on Valve Disk	90°40' (+/-15')	
• Valve Springs Longitude	42 mm	1.65 in
• Valve Springs Longitude Under Load - Open	35.0 mm	1.38 in
• Valve Springs Longitude Under Load - Close	25.0 mm	0.98 in
Engine Oil		
• Viscosity	SAE 0-W30, 0-W40, 5-W30 and 5-W40	
• Quality	Dexos 1	
Quantity		
• Oil Change Incl. Filter	4.5 l	4.76 quarts
• Oil Consumption Liter/1 000 km (1.057 quarts/621 miles)	max. 0.6 l	max. 0.634 quarts
Cooling System		
• Coolant Specification	Refer to Electronic Parts Catalog	
• Water Pump Design	Rotary Pump	
• Cooling System Capacity	5, 6 l	5.92 quarts
• Flow (Engine Outlet 6000 min <sup>-1</sup> , Thermostat Fully Open)	160 l/min	42.27 US gal/min
• Flow (Radiator 6000 min <sup>-1</sup> , Thermostat Fully Open)	165 l/min	174.4 quarts/min
• Thermostat Opening - Electrical	90°C	194°F

**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

- Thermostat Opening - Thermic

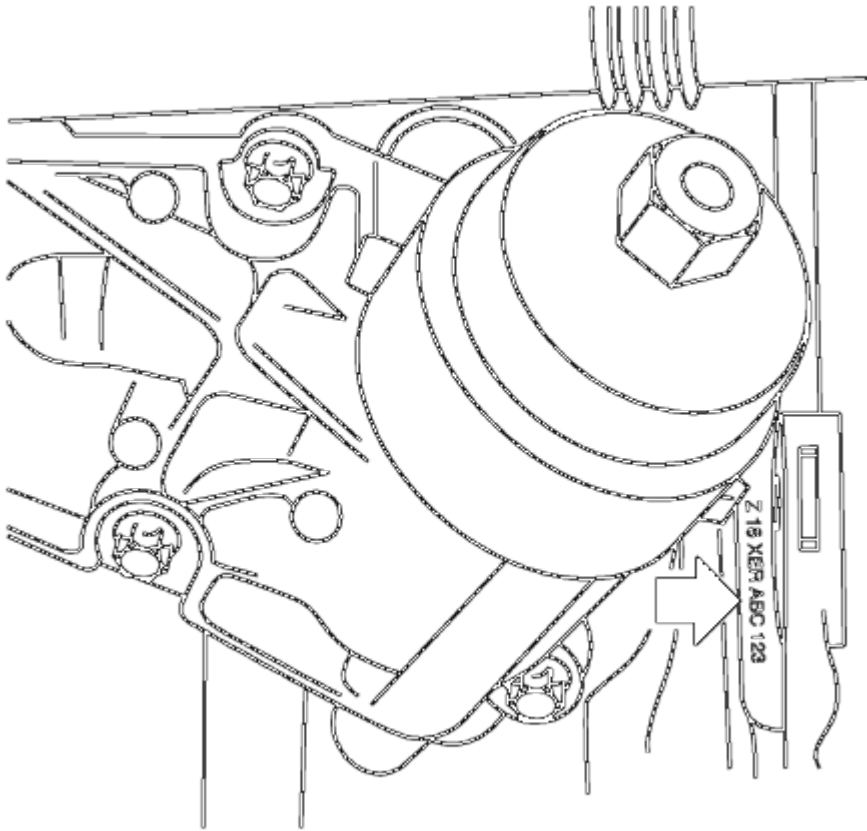
105°C

221°F

**ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS****Adhesives, Fluids, Lubricants, and Sealers**

Application	Type of Material	GM Part Number	
		United States	Canada
Bolt Connections	Screw Locking Compound	12345382	10953489
Camshaft Bearings	Dexos1 Engine Oil	19293000	19286321
Camshaft Front Oil Seal	Sealant	1052943	10953491
Camshafts	Dexos1 Engine Oil	19293000	19286321
Crankshaft Bearing Lubricant	Dexos1 Engine Oil	19293000	19286321
Engine Block Oil Gallery Plugs	Sealant	1052943	10953491
Engine Oil	Dexos1 Engine Oil	19293000	19286321
Intake and Exhaust Valves	Dexos1 Engine Oil	19293000	19286321
Oil Pan	Sealant	12378521	88901148
Oxygen Sensor	Assembly Paste - White	88862477	88862478
Oxygen Sensor Threads	Anti-seize	12397953	NA
Rear Crankshaft Main Bearing Cap	Sealant	12378521	88901148
Rear Crankshaft Oil Seal	Dexos1 Engine Oil	19293000	19286321
Rod Bearing - Rod Pins of Crankshaft	Dexos1 Engine Oil	19293000	19286321
Seal Rings	Silicone Grease - White	12345579	10953481
Turbo Heat Shield Fastener	Lubricant	12345996	10953501
Water Pump Bearing	Sealant	1052943	10953491

**COMPONENT LOCATOR****ENGINE IDENTIFICATION**



**Fig. 1: Engine Identification Code On Cylinder Block**  
Courtesy of GENERAL MOTORS COMPANY

**IMPORTANT:** When a short block engine is installed, the engine number must be marked on the cylinder block before installing the engine.

The engine identification code is embossed on the flattened area of the cylinder block, arrow, at the transmission side.

## DIAGNOSTIC INFORMATION AND PROCEDURES

### SYMPTOMS - ENGINE MECHANICAL

#### Strategy Based Diagnostics

Perform the **Diagnostic System Check - Vehicle**.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

**Visual/Physical Inspection**

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

**Intermittent**

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

**Symptom List**

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Coolant in Engine Oil**
- **Engine Compression Test**
- **Cylinder Leakage Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Crankcase Ventilation System Inspection/Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

## OIL PRESSURE DIAGNOSIS AND TESTING

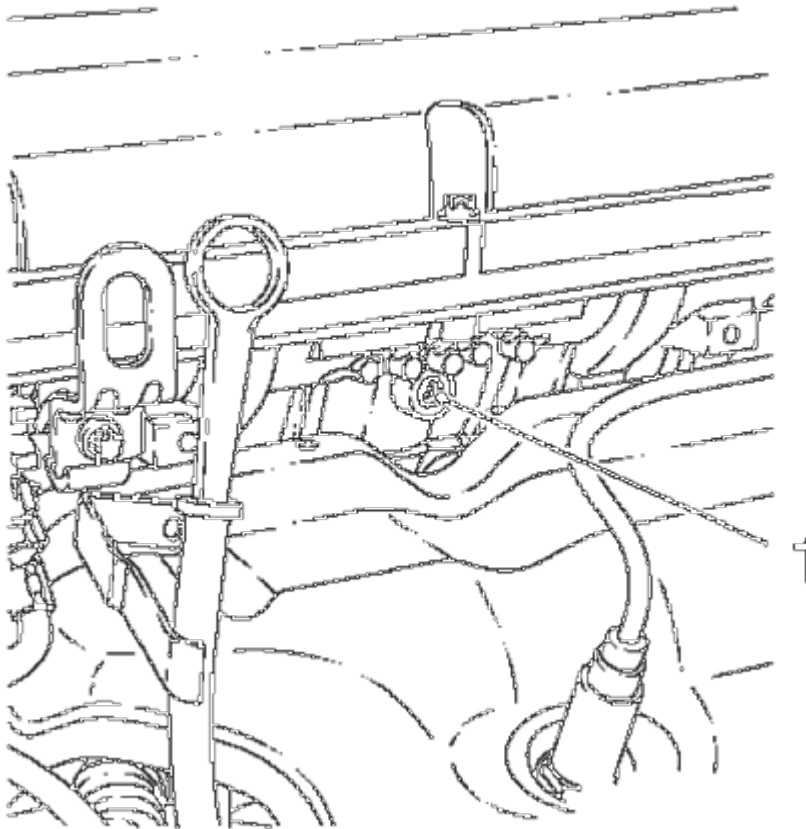
### Special Tools

- **EN-498-B** Oil Pressure Gauge
- **EN-232** Adapter Oil Pressure Check

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

### Removal Procedure

1. If necessary, remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUJ)** , **Exhaust Manifold Heat Shield Replacement (LUW)** .



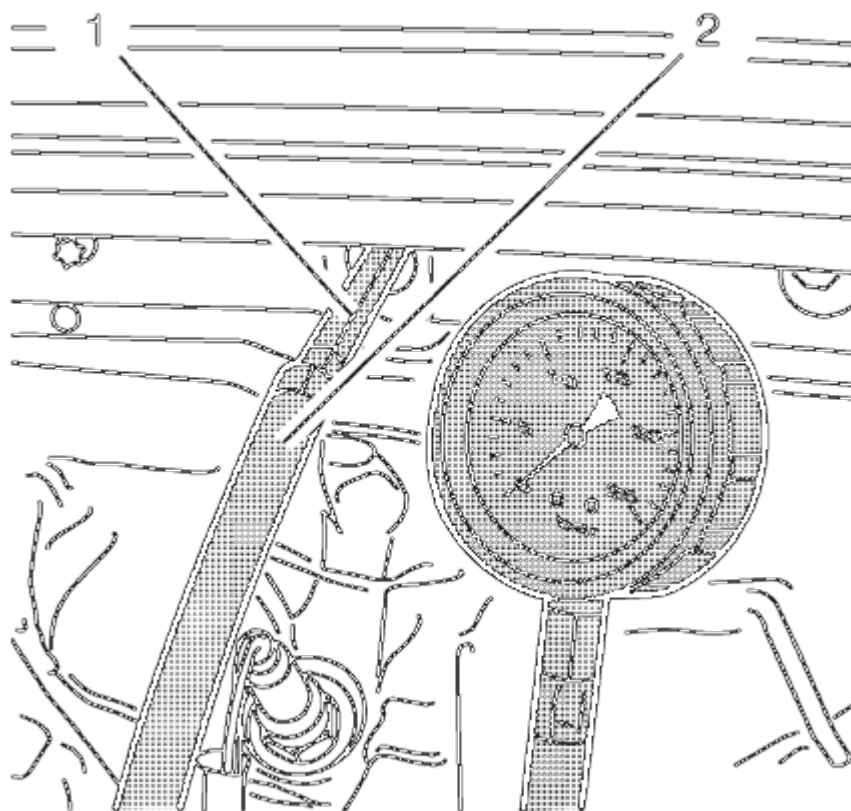
**Fig. 2: Closure Bolt**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the closure bolt (1).
3. Clean the thread.

### Measurement Procedure





**Fig. 3: Oil Pressure Test Gauge**

Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-498-B** gauge (2).
2. Install the **EN-232** adapter (1).
3. Start the engine.
4. Check oil pressure.

At idling speed, the oil pressure must be at least 130 kPa (18.85 psi) and the oil temperature must be 80°C (170°F) or more.

#### Installation Procedure

1. Switch off the engine.
2. Remove the **EN-232** adapter.
3. Remove the **EN-498-B** gauge.
4. Install new closure bolt in the cylinder head.

**CAUTION:** Refer to Fastener Caution .

**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

5. Tighten the closure bolt to 15 N.m (11 lb ft).
6. If necessary, install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUJ)** , **Exhaust Manifold Heat Shield Replacement (LUW)** .
7. Check the engine oil level.

**OIL LEAK DIAGNOSIS****Oil Leak Diagnosis**

Step	Action	Yes	No
DEFINITION: You can repair most fluid leaks by first, visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the leak and the cause of the leak.			
1	<ol style="list-style-type: none"> <li>1. Operate the vehicle until it reaches normal operating temperature. Refer to <b><u>Engine Mechanical Specifications</u></b>.</li> <li>2. Park the vehicle on a level surface over a large sheet of paper or other clean surface.</li> <li>3. Wait 15 minutes.</li> <li>4. Inspect for drippings.</li> </ol>		
	Are drippings present?	Go to <b>Step 2</b>	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 3</b>
3	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> <li>• Cracked or damaged components</li> </ul> </li> </ol>		
	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 4</b>
4	<ol style="list-style-type: none"> <li>1. Completely clean the entire engine and surrounding components.</li> <li>2. Operate the vehicle for several miles at normal operating temperature and at varying speeds.</li> <li>3. Park the vehicle on a level surface over a large sheet of paper or other clean surface.</li> <li>4. Wait 15 minutes.</li> <li>5. Identify the type of fluid and the approximate location of the leak.</li> </ol>		

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 5</b>
5	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> <li>• Cracked or damaged components</li> </ul> </li> </ol>		
	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 6</b>
6	<ol style="list-style-type: none"> <li>1. Completely clean the entire engine and surrounding components.</li> <li>2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area.</li> <li>3. Operate the vehicle for several miles at normal operating temperature and at varying speeds.</li> <li>4. Identify the type of fluid and the approximate location of the leak from the discolorations in the powder surface.</li> </ol>		
	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 7</b>
7	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> <li>• Cracked or damaged components</li> </ul> </li> </ol>		
	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 8</b>
8	<p>Identify the type of fluid and the approximate location of the leak.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 9</b>
9	<ol style="list-style-type: none"> <li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>• Sealing surfaces</li> <li>• Fittings</li> </ul> </li> </ol>		

**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	<ul style="list-style-type: none"> <li>• Cracked or damaged components</li> </ul>		
	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	System OK
10	<p>1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas:</p> <ul style="list-style-type: none"> <li>• Higher than recommended fluid levels</li> <li>• Higher than recommended fluid pressures</li> <li>• Plugged or malfunctioning fluid filters or pressure bypass valves</li> <li>• Plugged or malfunctioning engine ventilation system</li> <li>• Improperly tightened or damaged fasteners</li> <li>• Cracked or porous components</li> <li>• Improper sealants or gaskets, where required</li> <li>• Improper sealant or gasket installation</li> <li>• Damaged or worn gaskets or seals</li> <li>• Damaged or worn sealing surfaces</li> </ul> <p>2. Inspect the engine for customer modifications.</p>		
	Is there mechanical damage or customer modifications to the engine?	Go to <b>Step 11</b>	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to <b>Step 1</b>	-

**OIL CONSUMPTION DIAGNOSIS**

Excessive oil consumption, not due to leaks, is the use of 0.6 L (0.14 gallon) engine oil within 1000 kilometers (622 miles). The causes of excessive oil consumption include the following conditions:

- External oil leaks

Tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted.

### COOLANT IN COMBUSTION CHAMBER

#### Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage.	
<ol style="list-style-type: none"><li>1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <b><u>Engine Will Not Crank - Crankshaft Will Not Rotate</u></b>.</li><li>2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.</li><li>3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.</li><li>4. Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <b><u>Engine Compression Test</u></b>.</li></ol>	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <b><u>Cylinder Head Cleaning and Inspection</u></b> , and <b><u>Cylinder Head Replacement</u></b> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <b><u>Cylinder Head Replacement</u></b> .
Cracked cylinder head	Replace the cylinder head and gasket. <b><u>Cylinder Head Replacement</u></b>
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components as required.

### COOLANT IN ENGINE OIL

#### Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to	

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.

1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed.**
2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.
3. Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test.**

Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <b><u>Cylinder Head Replacement.</u></b>
Warped cylinder head	Replace the cylinder head and gasket. Refer to <b><u>Cylinder Head Replacement.</u></b>
Cracked cylinder head	Replace the cylinder head and gasket. <b><u>Cylinder Head Replacement</u></b>
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components as required.

### ENGINE NOISE UNDER LOAD

#### Engine Noise Under Load

Cause	Correction
Low oil pressure	<ol style="list-style-type: none"><li>1. Perform an oil pressure test. Refer to <b><u>Oil Pressure Diagnosis and Testing.</u></b></li><li>2. Repair or replace as required.</li></ol>
Detonation or spark knock	Verify the correct operation of the ignition. Refer to <b><u>Symptoms - Engine Controls .</u></b>
Loose torque converter bolts	<ol style="list-style-type: none"><li>1. Inspect the torque converter bolts and flywheel.</li><li>2. Repair as required.</li></ol>
Cracked flywheel- automatic transmission	<ol style="list-style-type: none"><li>1. Inspect the flywheel bolts and flywheel.</li><li>2. Repair as required.</li></ol>
Excessive connecting rod bearing clearance	Inspect the following components and repair as required: <ul style="list-style-type: none"><li>• The connecting rod bearings</li><li>• The connecting rods</li><li>• The crankshaft</li></ul>
Excessive crankshaft bearing clearance	Inspect the following components and repair as required:

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

- The crankshaft bearings
- The crankshaft journals
- The cylinder block crankshaft bearing bore

### ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

#### Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	<ol style="list-style-type: none"><li>1. Drain the oil.</li><li>2. Install the correct viscosity oil.</li></ol>
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	<ol style="list-style-type: none"><li>1. Inspect the thrust bearing and crankshaft.</li><li>2. Repair or replace as required.</li></ol>
Damaged or faulty oil filter by-pass valve	<ol style="list-style-type: none"><li>1. Inspect the oil filter by-pass valve for proper operation.</li><li>2. Repair or replace as required.</li></ol>
Malfunctioning camshaft position actuators - improper oil viscosity or contamination. The result is camshaft actuator locking pin does not lock	<ol style="list-style-type: none"><li>1. Verify correct engine oil viscosity by changing the engine oil and filter. Reevaluate the concern.</li><li>2. Isolate the noise to a specific camshaft position actuator.</li><li>3. Replace the camshaft actuator, oil and filter.</li></ol>

### BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

#### Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine revolutions per minute (RPM) variations and lead to a misfire diagnostic trouble code (DTC). A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire	Repair or replace the flywheel and/or balancer as required.

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

condition.	
<p>Restricted exhaust system</p> <p>A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.</p>	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
<p>Improperly installed or damaged manifold absolute pressure (MAP) sensor</p> <p>The sealing grommet of the MAP sensor should not be torn or damaged.</p>	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
<p>Worn or loose rocker arms</p> <p>The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.</p>	Replace the valve rocker arms as required.
<p>Stuck valves</p> <p>Carbon buildup on the valve stem can cause the valve not to close properly.</p>	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
<p>Excessive oil pressure</p> <p>A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.</p>	<ul style="list-style-type: none"> <li>• Perform an oil pressure test. Refer to <b><u>Oil Pressure Diagnosis and Testing</u></b>.</li> <li>• Repair or replace the oil pump as required.</li> </ul>
<p>Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages</p> <p>Coolant consumption may or may not cause the engine to overheat.</p>	<ul style="list-style-type: none"> <li>• Inspect for spark plugs saturated by coolant.</li> <li>• Inspect the cylinder heads, engine block, and/or head gaskets.</li> <li>• Repair or replace as required.</li> </ul>
<p>Worn piston rings</p> <p>Oil consumption may or may not cause the engine to misfire.</p>	<ul style="list-style-type: none"> <li>• Inspect the spark plugs for oil deposits.</li> <li>• Inspect the cylinders for a loss of compression. Refer to <b><u>Engine Compression Test</u></b>.</li> <li>• Perform cylinder leak down and compression testing to identify the cause.</li> <li>• Repair or replace as required.</li> </ul>
<p>A damaged crankshaft reluctor wheel</p> <p>A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and</p>	Replace the sensor and/or crankshaft as required.



## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

location of the damage.

- Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position.
- Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set.
- Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a DTC P0300 or P0336.

### BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

#### Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine revolutions per minute (RPM) variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"><li>• Inspect the spark plugs for oil deposits.</li><li>• Inspect the cylinders for a loss of compression. Refer to <b><u>Engine Compression Test</u></b>.</li><li>• Perform cylinder leak down and compression testing to determine the cause.</li><li>• Repair or replace as required.</li></ul>

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft, and create a diagnostic trouble code (DTC) without an actual misfire condition.	Replace the crankshaft and bearings as required.
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### BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

#### Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Sticking lifters	Replace as required.

### BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

#### Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gasket and/or cracking, or other damage to the cylinder head and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"><li>Inspect for spark plugs saturated by coolant.</li><li>Perform a cylinder leak down test.</li><li>Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket.</li><li>Repair or replace as required.</li></ul>

### BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

#### Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides, and/or valve stem oil seals	<ul style="list-style-type: none"><li>Inspect the spark plugs for oil deposits.</li><li>Repair or replace as required.</li></ul>
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"><li>Inspect the spark plugs for oil deposits.</li><li>Inspect the cylinders for a loss of compression. Refer to <b><u>Engine Compression Test</u></b>.</li></ul>

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

- Perform cylinder leak down and compression testing to determine the cause.
- Repair or replace as required.

### UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

#### Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"><li>• Perform an oil pressure test. Refer to <b><u>Oil Pressure Diagnosis and Testing</u></b>.</li><li>• Repair or replace as required.</li></ul>
Loose and/or worn valve rocker arm attachments	<ul style="list-style-type: none"><li>• Inspect the valve rocker arm stud, nut, or bolt.</li><li>• Repair or replace as required.</li></ul>
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace as required: <ul style="list-style-type: none"><li>• The valve rocker arm</li><li>• The valve lifter</li><li>• The oil filter bypass valve</li><li>• The oil pump and pump screen</li><li>• The engine block oil galleries</li></ul>
Broken valve spring	Replace the valve spring.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing belt and/or damaged sprocket teeth	Replace the timing belt and sprockets.
Worn, damaged, or faulty timing belt tensioners	Replace tensioners
Worn engine camshaft lobes	<ul style="list-style-type: none"><li>• Inspect the engine camshaft lobes.</li><li>• Replace the camshaft and valve lifters as required.</li></ul>
Worn valve guides or valve stems	Inspect the following components, and repair as required: <ul style="list-style-type: none"><li>• The valves</li><li>• The valve guides</li></ul>
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair as required: <ul style="list-style-type: none"><li>• The valves</li><li>• The valve guides</li></ul>

## LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

### Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> <li>Perform an oil pressure test. Refer to <b><u>Oil Pressure Diagnosis and Testing</u></b>.</li> <li>Repair or replace damaged components as required.</li> </ul>
Worn accessory drive components- abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	<ol style="list-style-type: none"> <li>Inspect the accessory drive system.</li> <li>Repair or replace as required.</li> </ol>
Loose or damaged crankshaft balancer	<ol style="list-style-type: none"> <li>Inspect the crankshaft balancer.</li> <li>Repair or replace as required.</li> </ol>
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <b><u>Symptoms - Engine Controls</u></b> .
Loose torque converter bolts	<ol style="list-style-type: none"> <li>Inspect the torque converter bolts and flywheel.</li> <li>Repair or replace as required.</li> </ol>
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	<ol style="list-style-type: none"> <li>Inspect the oil pan.</li> <li>Inspect the oil pump screen.</li> <li>Repair or replace as required.</li> </ol>
Oil pump screen loose, damaged or restricted	<ol style="list-style-type: none"> <li>Inspect the oil pump screen.</li> <li>Repair or replace as required.</li> </ol>
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"> <li>Inspect the piston and cylinder bore.</li> <li>Repair as required.</li> </ol>
Excessive piston pin-to-bore clearance	<ol style="list-style-type: none"> <li>Inspect the piston, piston pin, and the connecting rod.</li> <li>Repair or replace as required.</li> </ol>
Excessive connecting rod bearing clearance	<p>Inspect the following components and repair as required:</p> <ul style="list-style-type: none"> <li>The connecting rod bearings</li> <li>The connecting rods</li> <li>The crankshaft</li> <li>The crankshaft journals</li> </ul>
Excessive crankshaft bearing clearance	Inspect the following components and repair as required:

**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	<ul style="list-style-type: none"> <li>• The crankshaft bearings</li> <li>• The crankshaft journals</li> </ul>
<p>Incorrect piston, piston pin, and connecting rod installation</p> <p>Pistons must be installed with the mark, or dimple, on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.</p>	<ol style="list-style-type: none"> <li>1. Verify the pistons, piston pins and connecting rods are installed correctly.</li> <li>2. Repair as required.</li> </ol>

**ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE****Engine Will Not Crank - Crankshaft Will Not Rotate**

<b>Cause</b>	<b>Correction</b>
Seized accessory drive system component	<ol style="list-style-type: none"> <li>1. Remove accessory drive belts.</li> <li>2. Rotate crankshaft by hand at the balancer or flywheel location.</li> </ol>
<p>Hydraulically locked cylinder</p> <ul style="list-style-type: none"> <li>• Coolant/antifreeze in cylinder</li> <li>• Oil in cylinder</li> <li>• Fuel in cylinder</li> </ul>	<ol style="list-style-type: none"> <li>1. Remove spark plugs and check for fluid.</li> <li>2. Inspect for broken head gasket.</li> <li>3. Inspect for cracked engine block or cylinder head.</li> <li>4. Inspect for a sticking fuel injector.</li> <li>5. Inspect for cracked cylinder wall.</li> </ol>
Seized automatic transmission torque converter	<ol style="list-style-type: none"> <li>1. Remove the torque converter bolts.</li> <li>2. Rotate crankshaft by hand at the balancer or flywheel location.</li> </ol>
Seized manual transmission	<ol style="list-style-type: none"> <li>1. Disengage the clutch.</li> <li>2. Rotate crankshaft by hand at the balancer or flywheel location.</li> </ol>
Broken timing chain and/or gears	<ul style="list-style-type: none"> <li>• Inspect timing chain and gears.</li> <li>• Repair as required.</li> </ul>
Seized balance shaft	<ul style="list-style-type: none"> <li>• Inspect balance shaft.</li> <li>• Repair as required.</li> </ul>
<p>Material in cylinder</p> <ul style="list-style-type: none"> <li>• Broken valve</li> <li>• Piston material</li> <li>• Foreign material</li> <li>• Cracked cylinder wall</li> </ul>	<ul style="list-style-type: none"> <li>• Inspect cylinder for damaged components and/or foreign materials.</li> <li>• Inspect for fallen cylinder wall.</li> <li>• Repair or replace as required.</li> </ul>
Seized crankshaft or connecting rod bearings	

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	<ul style="list-style-type: none"><li>• Inspect crankshaft and connecting rod bearings.</li><li>• Inspect for fallen cylinder wall.</li><li>• Repair as required.</li></ul>
Bent or broken connecting rod	<ul style="list-style-type: none"><li>• Inspect connecting rods.</li><li>• Repair as required.</li></ul>
Broken crankshaft	<ul style="list-style-type: none"><li>• Inspect crankshaft.</li><li>• Repair as required.</li></ul>

### ENGINE COMPRESSION TEST

#### Removal Procedure

1. Remove the throttle body. Refer to [Throttle Body Assembly Replacement](#) .
2. Remove the spark plugs. Refer to [Spark Plug Replacement](#) .
3. Remove the relay holder cover.
4. Remove the fuel pump relay.

#### Measurement Procedure

Check Compression for all cylinders:

**NOTE:**        **Engine revs at least 300/min.**

1. Start the engine (approx. 4 seconds).
2. Compare the compression values.

Maximum pressure differential 100 kPa (14.5 psi)

#### Installation Procedure

1. Install the fuel pump relay.
  - Place into the socket.
  - Ensure the plug contacts are sound.
2. Install the relay carrier cover.
3. Install the spark plugs. Refer to [Spark Plug Replacement](#) .
4. Install the throttle body. Refer to [Throttle Body Assembly Replacement](#) .

### DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

#### Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**2**

The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

**3**

The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

**4**

Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

**6**

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

**10**

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

**12**

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

## 14

This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

## 15

This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

## 16

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

## 17

This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

## 19

Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

### Drive Belt Chirping, Squeal, and Whine Diagnosis

Step	Action	Yes	No
<b>CAUTION:</b> Refer to <b><u>Belt Dressing Caution</u></b> .			
<b>DEFINITION:</b> The following items are indications of chirping: <ul style="list-style-type: none"> <li>• A high pitched noise that is heard once per revolution of the drive belt or a pulley.</li> <li>• Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.</li> </ul>			
<b>DEFINITION:</b> The following items are indications of drive belt squeal:			



**2012 Chevrolet Cruze LS**

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

- A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.
- The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to <b>Step 2</b>	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to <b>Step 3</b>	Go to Diagnostic Aids above.
3	1. Remove the drive belt.  If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed.  2. Operate the engine for no longer than 30-40 seconds.  3. Repeat this test if necessary by removing the remaining belt(s).  Does the chirping, squeal or whine noise still exist?	Go to <b><u>Symptoms - Engine Mechanical</u></b>	Go to <b>Step 4</b>
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to <b>Step 5</b>	Go to <b>Step 6</b>
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to <b>Step 20</b>	Go to <b>Step 6</b>
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to <b>Step 7</b>	Go to <b>Step 8</b>
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to <b>Step 20</b>	Go to <b>Step 8</b>

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to <b>Step 9</b>	Go to <b>Step 10</b>
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to <b>Step 20</b>	Go to <b>Step 10</b>
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to <b>Step 11</b>	Go to <b>Step 12</b>
11	<p><b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b> .</p> <p>1. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications</u></b>. 2. Replace any improper or missing fasteners.</p> <p>Did you complete the repair?</p>	Go to <b>Step 20</b>	Go to <b>Step 12</b>
12	Inspect for a bent pulley. Did you find the condition?	Go to <b>Step 18</b>	Go to <b>Step 19</b>
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to <b>Step 20</b>	Go to <b>Step 14</b>
14	Test the drive belt tensioner for proper operation. Refer to <b><u>Drive Belt Tensioner Diagnosis</u></b> . Did you find and correct the condition?	Go to <b>Step 20</b>	Go to <b>Step 15</b>
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to <b>Step 20</b>	Go to <b>Step 16</b>
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to <b>Step 20</b>	Go to <b>Step 17</b>
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to <b>Step 20</b>	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to <b>Step 20</b>	Go to <b>Step 19</b>
19	Replace the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . Did you complete the repair?	Go to <b>Step 20</b>	Go to Diagnostic Aids above.
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 3</b>

### DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Afinacion de Motor y Diagnostico, OBDII, VW, Audi

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Page 30

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**Diagnostic Aids**

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**2**

This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

**3**

This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

**4**

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plies of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

**5**

Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

**9**

Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

11

This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12

Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

**Drive Belt Rumbling and Vibration Diagnosis**

Step	Action	Yes	No
<b>CAUTION:</b> Refer to <u><b>Belt Dressing Caution</b></u> .			
<b>DEFINITION:</b> The following items are indications of drive belt rumbling: <ul style="list-style-type: none"> <li>• A low pitch tapping, knocking, or thumping noise heard at or just above idle.</li> <li>• Heard once per revolution of the drive belt or a pulley.</li> <li>• Rumbling may be caused from: <ul style="list-style-type: none"> <li>○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove</li> <li>○ The separation of the drive belt</li> <li>○ A damaged drive belt</li> <li>○ A worn drive belt idler pulley</li> </ul> </li> </ul>			
<b>DEFINITION:</b> The following items are indications of drive belt vibration: <ul style="list-style-type: none"> <li>• The vibration is engine-speed related.</li> <li>• The vibration may be sensitive to accessory load.</li> </ul>			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to <b>Step 2</b>	Go to <u><b>Symptoms - Engine Mechanical</b></u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to <b>Step 3</b>	Go to Diagnostic Aids above.
	1. Remove the drive belt.  If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a		

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

3	<p>belt is removed.</p> <ol style="list-style-type: none"> <li>2. Operate the engine for no longer than 30-40 seconds.</li> <li>3. Repeat this test if necessary by removing the remaining belt(s).</li> </ol> <p>Does the rumbling or vibration still exist?</p>	<p>Go to <b>Symptoms - Engine Mechanical</b></p>	<p>Go to <b>Step 4</b></p>
4	<p>Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up.</p> <p>Did you find any of these conditions?</p>	<p>Go to <b>Step 7</b></p>	<p>Go to <b>Step 5</b></p>
5	<p>Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves.</p> <p>Did you find severe pilling?</p>	<p>Go to <b>Step 6</b></p>	<p>Go to <b>Step 7</b></p>
6	<ol style="list-style-type: none"> <li>1. Clean the drive belt pulleys using a suitable wire brush.</li> <li>2. Reinstall the drive belts. Refer to <b><u>Drive Belt Replacement</u></b>.</li> </ol> <p>Did you correct the condition?</p>	<p>Go to <b>Step 8</b></p>	<p>Go to <b>Step 7</b></p>
7	<p>Install a new drive belt. Refer to <b><u>Drive Belt Replacement</u></b>.</p> <p>Did you complete the replacement?</p>	<p>Go to <b>Step 8</b></p>	<p>Go to <b>Step 9</b></p>
8	<p>Operate the system in order to verify the repair.</p> <p>Did you correct the condition?</p>	<p>System OK</p>	<p>Go to <b>Step 9</b></p>
9	<p>Inspect for improper, loose or missing fasteners.</p> <p>Did you find any of these conditions?</p>	<p>Go to <b>Step 10</b></p>	<p>Go to <b>Step 11</b></p>
10	<p><b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b></p> <ol style="list-style-type: none"> <li>1. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications</u></b>.</li> <li>2. Replace improper or missing fasteners.</li> </ol> <p>Did you complete the repair?</p>	<p>Go to <b>Step 13</b></p>	<p>Go to <b>Step 11</b></p>
11	<p>Inspect for a bent water pump shaft. Refer to <b><u>Water Pump Replacement (LUW)</u></b> , <b><u>Water Pump Replacement (LUJ)</u></b> .</p> <p>Did you find and correct the condition?</p>	<p>Go to <b>Step 13</b></p>	<p>Go to <b>Step 12</b></p>
12	<p>Inspect for bent or cracked brackets.</p>		

## 2012 Chevrolet Cruze LS

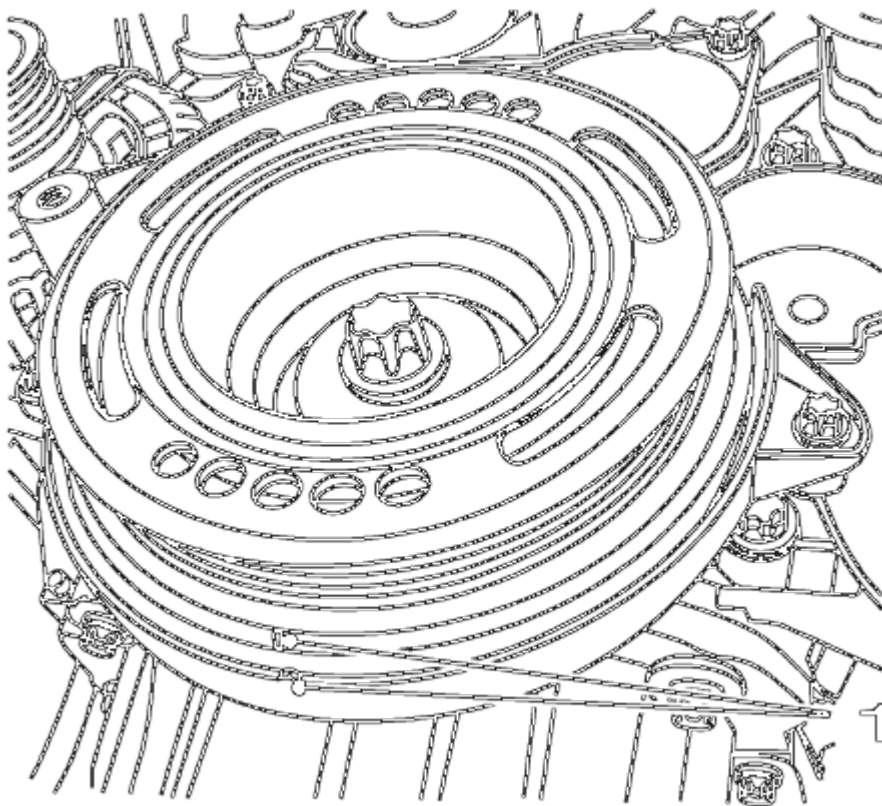
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	Did you find and correct the condition?	Go to <b>Step 13</b>	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 3</b>

### CYLINDER LEAKAGE TEST

#### Removal Procedure

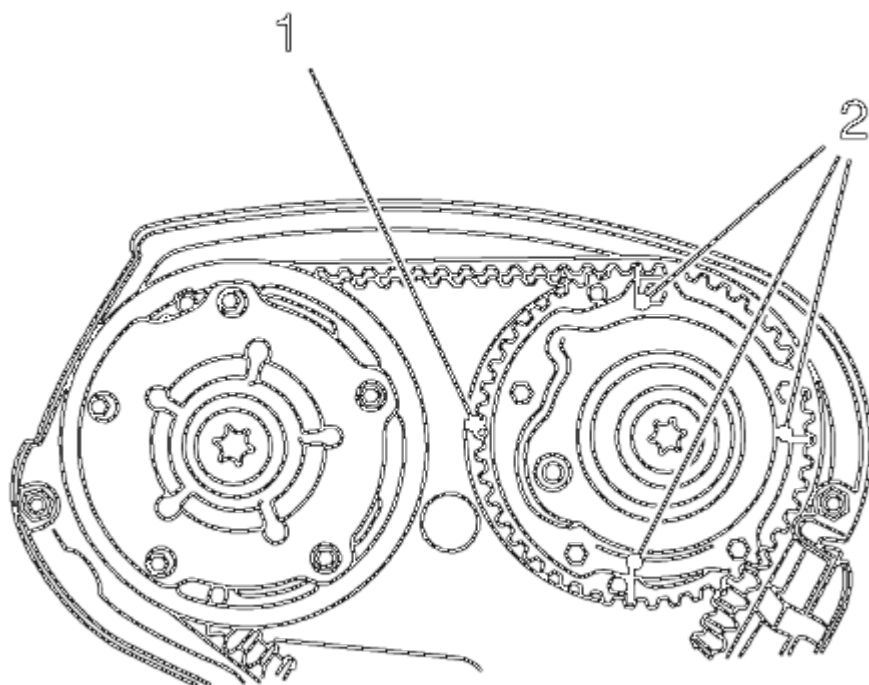
1. Open the hood.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement**
4. Lower the vehicle.
5. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal**.
6. Remove the spark plugs. Refer to **Spark Plug Replacement** .
7. Detach the engine wiring harness from intake manifold, cylinder head cover and engine wiring harness bracket.
8. Remove the coolant expansion tank closure cap.
9. Remove the oil dipstick.



**Fig. 4: Crankshaft TDC Position**

**Courtesy of GENERAL MOTORS COMPANY**

10. Set up the crankshaft.
11. Move the crankshaft in the direction of the engine rotation to the first cylinder TDC position (mark 1).



**Fig. 5: Guidance Marks**

Courtesy of GENERAL MOTORS COMPANY

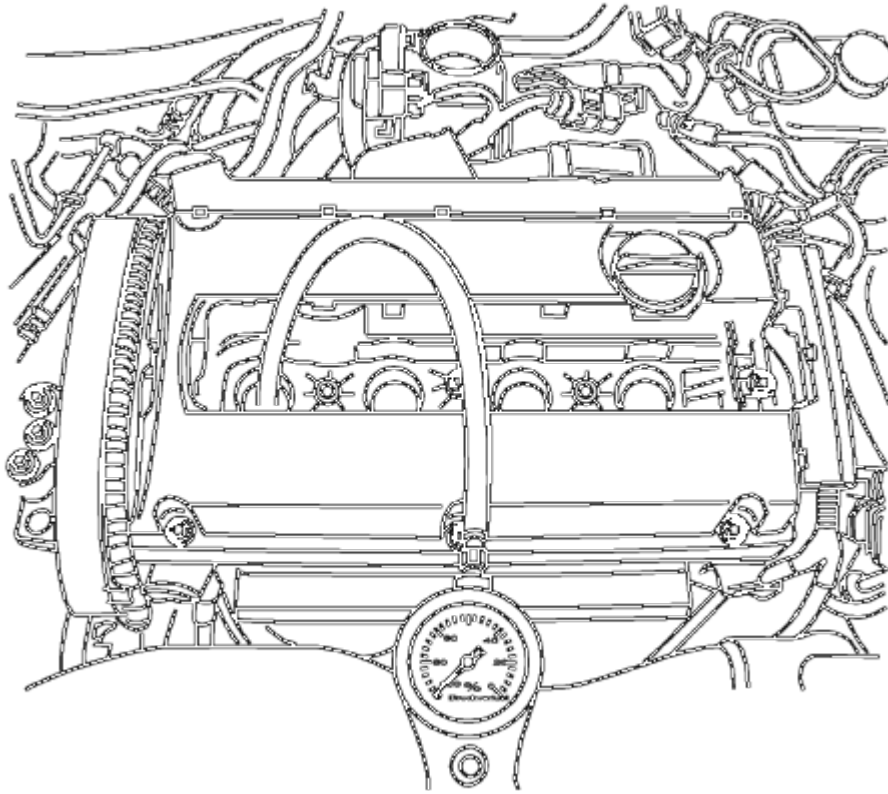
12. Apply guidance marks.
13. Attach 3 markings (2) as an aid to one of the camshaft adjusters, each one offset by 90° to the marking applied (1).

#### Test Procedure

**NOTE:** Follow manufacturer instructions.

1. Calibrate the pressure loss tester and connect to the compressed air system.





**Fig. 6: Pressure Loss Tester**

Courtesy of GENERAL MOTORS COMPANY

2. Install the pressure loss tester.

**NOTE:        Wheels must be in contact with the ground.**

- Engage first gear and apply the parking brake.
- Install the connecting piece into the spark plug thread of cylinder number 1.
- Apply compressed air to cylinder number 1.

3. Inspect for Pressure Loss

- Take pressure loss reading.
  - The maximum permissible pressure differential between cylinders is approximately 10 percent.
  - Maximum pressure loss of a cylinder is 25 percent.
- Take note of any visible escape of compressed air.

Intake manifold, exhaust manifold, crankcase

- Take note of any bubble formation in the coolant compensation tank.
4. Perform pressure loss test by analogy on cylinders 3, 4 and 2.

**Installation Procedure**

1. Remove the pressure loss tester.
2. Remove the connection piece from the spark plug thread.
3. Put the vehicle in neutral.
4. Insert the oil dipstick.
5. Install the coolant expansion tank closure cap.
6. Install the spark plugs. Refer to **Spark Plug Replacement** .
7. Install the engine wiring harness to the intake manifold.
8. Install the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Installation**.
9. Raise and support the vehicle.
10. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement**
11. Lower the vehicle.
12. Close the hood.

**CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS****Results of Incorrect Operation**

A plugged positive crankcase ventilation (PCV) orifice or hose may cause the following conditions:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Oil in the throttle body
- Sludge in the engine

**Functional Check**

With these systems, any blow-by in excess of the system capacity, from a badly worn engine, sustained heavy load, etc., is exhausted into the throttle body and is drawn into the engine.

Proper operation of the crankcase ventilation system depends upon a sealed engine. If oil slugging or dilution is noted and the crankcase ventilation system is functioning properly, check the engine for a possible cause. Correct any problems.

If an engine is idling rough, inspect for a clogged PCV orifice, a dirty vent filter, air cleaner element, or plugged hose. Replace as required. Use the following procedure:

1. Remove the PCV hose from the cylinder head cover.

2. Operate the engine at idle.
3. Place your thumb over the end of the hose in order to check for a vacuum. If there is no vacuum at the hose, inspect for the following items:
  - Plugged hoses
  - The manifold port
4. Turn OFF the engine.
5. Inspect the PCV orifice in the cylinder head cover for debris or blockage.

## **DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS**

### **Diagnostic Aids**

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

### **Test Description**

The numbers below refer to the step numbers on the diagnostic table.

#### **2**

This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

#### **4**

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

5

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6

Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14

The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15

This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

#### Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
<b>CAUTION:</b> <b>Refer to <u>Belt Dressing Caution</u> .</b>			
<b>DEFINITION:</b> The drive belt falls off the pulleys or may not ride correctly on the pulleys. <b>DEFINITION:</b> Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to <b>Step 2</b>	Go to <b><u>Symptoms - Engine Mechanical</u></b>
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect		

## 2012 Chevrolet Cruze LS

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	for a damaged drive belt. Did you find the condition?	Go to <b>Step 3</b>	Go to <b>Step 4</b>
3	Install a new drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . Does the drive belt continue to fall off?	Go to <b>Step 4</b>	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 5</b>
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 6</b>
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 7</b>
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to <b>Step 8</b>	Go to <b>Step 9</b>
8	<b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b>  1. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications</u></b> . 2. Replace improper or missing fasteners.  Does the drive belt continue to fall off?	Go to <b>Step 9</b>	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <b><u>Drive Belt Tensioner Diagnosis</u></b> . Does the drive belt tensioner operate correctly?	Go to <b>Step 11</b>	Go to <b>Step 10</b>
10	Replace the drive belt tensioner. Refer to <b><u>Drive Belt Tensioner Replacement</u></b> . Does the drive belt continue to fall off?	Go to <b>Step 11</b>	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 2</b>
13	Inspect the drive belt for the proper installation. Refer to <b><u>Drive Belt Replacement</u></b> . Did you find this condition?	Go to <b>Step 16</b>	Go to <b>Step 14</b>
14	Inspect for the proper drive belt. Did you find this condition?	Go to <b>Step 16</b>	Go to <b>Step 15</b>
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to <b>Step 17</b>	Go to Diagnostic Aids above.
16	Replace the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> . Did you complete the replacement?	Go to <b>Step 17</b>	-

17

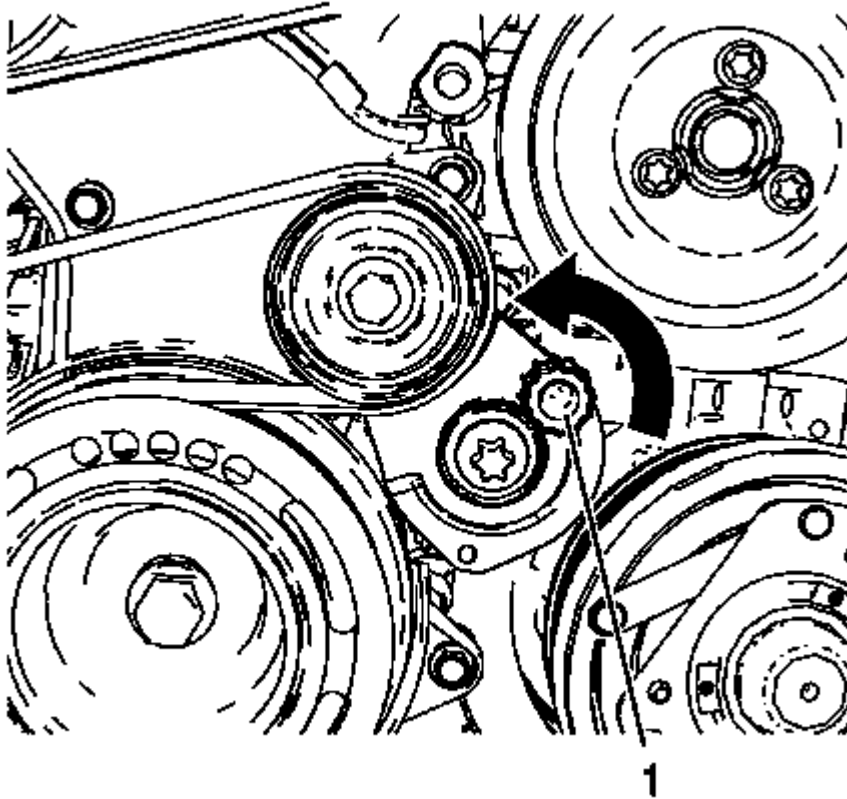
Operate the system in order to verify the repair.  
Did you correct the condition?

System OK

-

## DRIVE BELT TENSIONER DIAGNOSIS

Diagnosis consists of a function check on the automatic belt tensioner and a visual check on the belt and the components linked to the belt.



**Fig. 7: Drive Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

- Apply tension to the belt tensioner via the cast projection (1) in the direction of the arrow, counterclockwise, and allow to slide back slowly.
- The tensioner must slide back to the initial position.

## DUAL MASS FLYWHEEL DIAGNOSIS

Check for Thermal Overload

**NOTE:** These quick information shall help to carry out a correct diagnosis in case of a customer complaint.

Through friction of clutch plate on the friction surface of the dual mass flywheel temperatures up to 200 °C can arise during normal driving. At sliding clutch or through operating errors much higher temperatures can arise. These temperatures must not cause mandatory a reduced lifetime of the dual mass flywheel.

**Possible indications for a high thermal load are:**

- Tarnish (bluish) as well as local hotspots on friction surface
- Tarnish (bluish) near of mounting area and riveting area of clutch

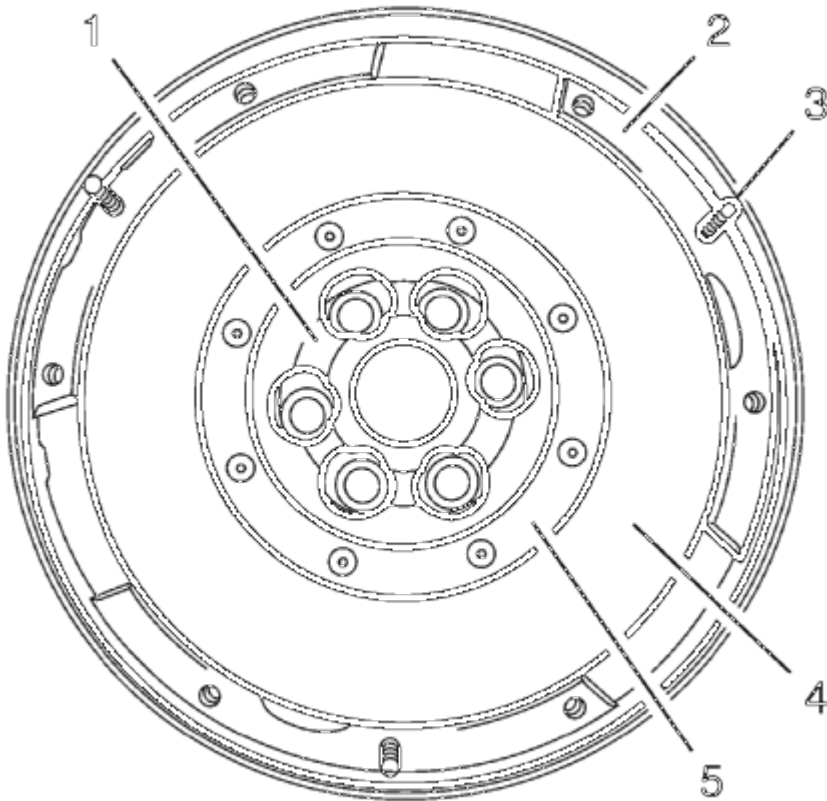
If all other checkable features are well, the dual mass flywheel can stay in the vehicle.

**Possible indications for a too high thermal load are:**

- Cracks
- Fusion zones on friction surface (material smear)
- Scores in friction surface (for example through clutch lining riveting at destroyed or worn clutch plate)
- Tarnish (bluish) which reaches up to bearing area of dual mass flywheel
- Bluish discoloration of locating pins (3 locating pins in outer zone of dual mass flywheel)

In these cases the dual mass flywheel has to be replaced.

**Overview Dual Mass Flywheel**

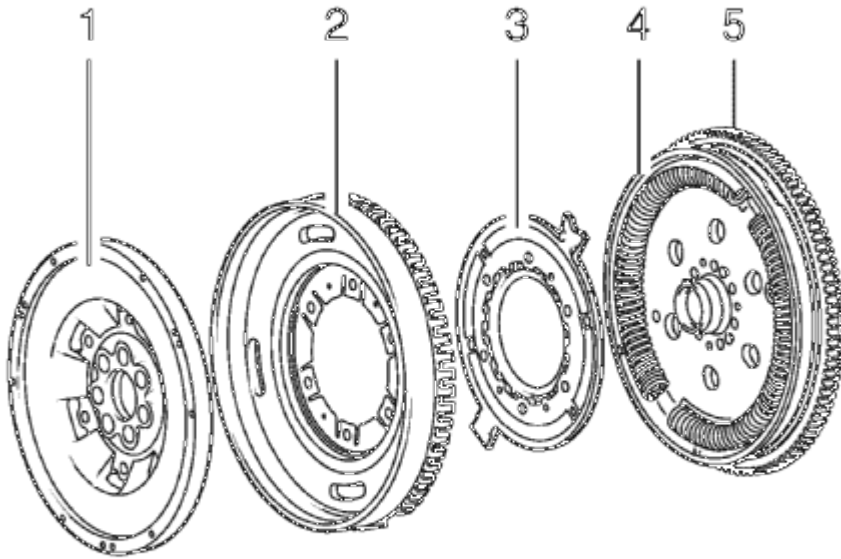
**Fig. 8: Dual Mass Flywheel**

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Bearing Area
2	Mounting Area Pressure Plate
3	Locating Pins
4	Friction Surface
5	Riveting Area

**Exploded View Dual Mass Flywheel with Additional Mass**





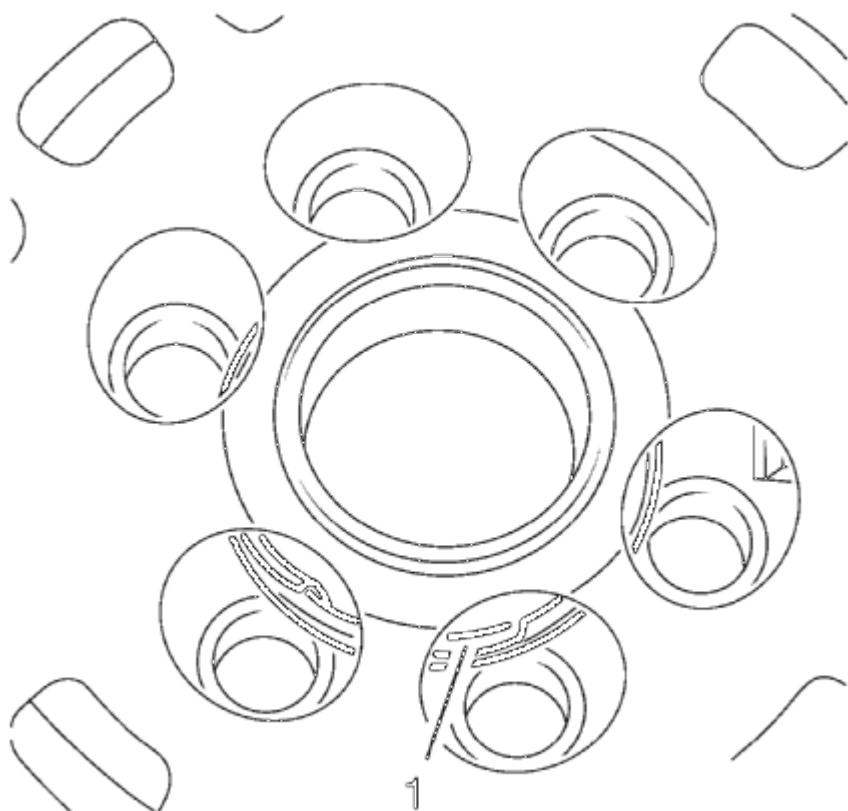
**Fig. 9: Dual Mass Flywheel With Additional Mass**  
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Secondary Flywheel Mass
2	Additional Mass, Coupled with Cover and Pulse-Generator Ring
3	Flange
4	Primary Flywheel Mass with Bowed Springs and Plain Bearing/Bearing Bolt
5	Toothed Ring

#### Check for Damaged Components

All following checking procedures have to be carried out at installed dual mass flywheel. For visual check at vehicle very bright light and a additional bright and small pocket lamp is necessary. Damages like grease on primary flywheel and loose ore missing balance weights cannot be checked at installed condition. During visual check material alteration can be stated which eliminate a further operating suitability.

For comparison different damages at dual mass flywheel with the corresponding further procedure are presented here.



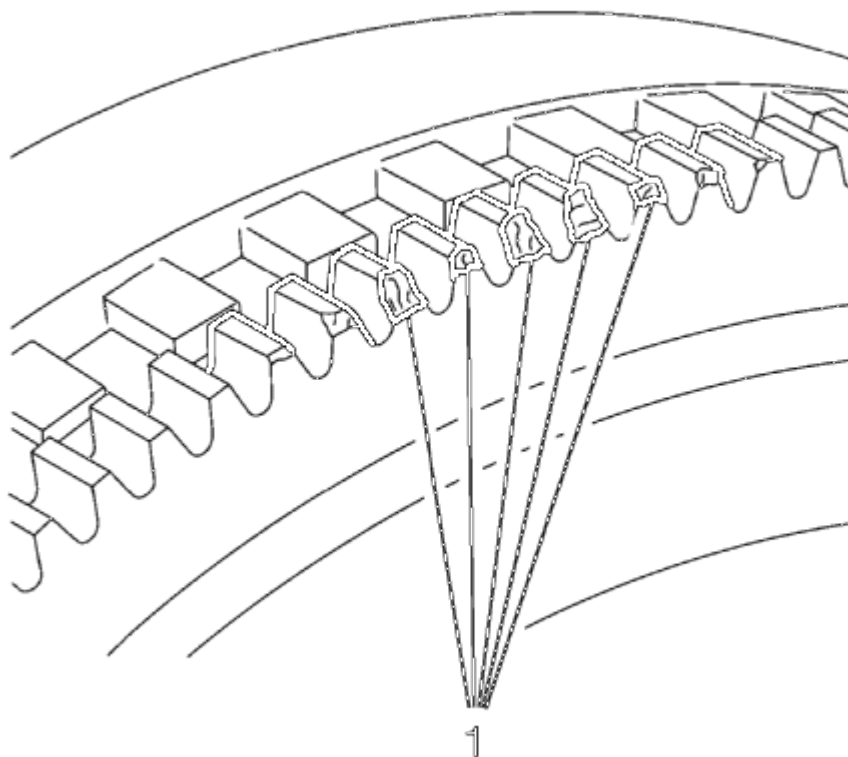
**Fig. 10: Plain Bearing**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** In case of mechanical damages at plain bearing the dual mass flywheel has to be replaced.

1. Inspect plain bearing (1) for damages.

Dependent of the manufacturer damages can be detected through ventilation openings of secondary flywheel. Parts of the bearing (1) are detached or lie loose around the bearing bolt.



**Fig. 11: Toothed Ring**

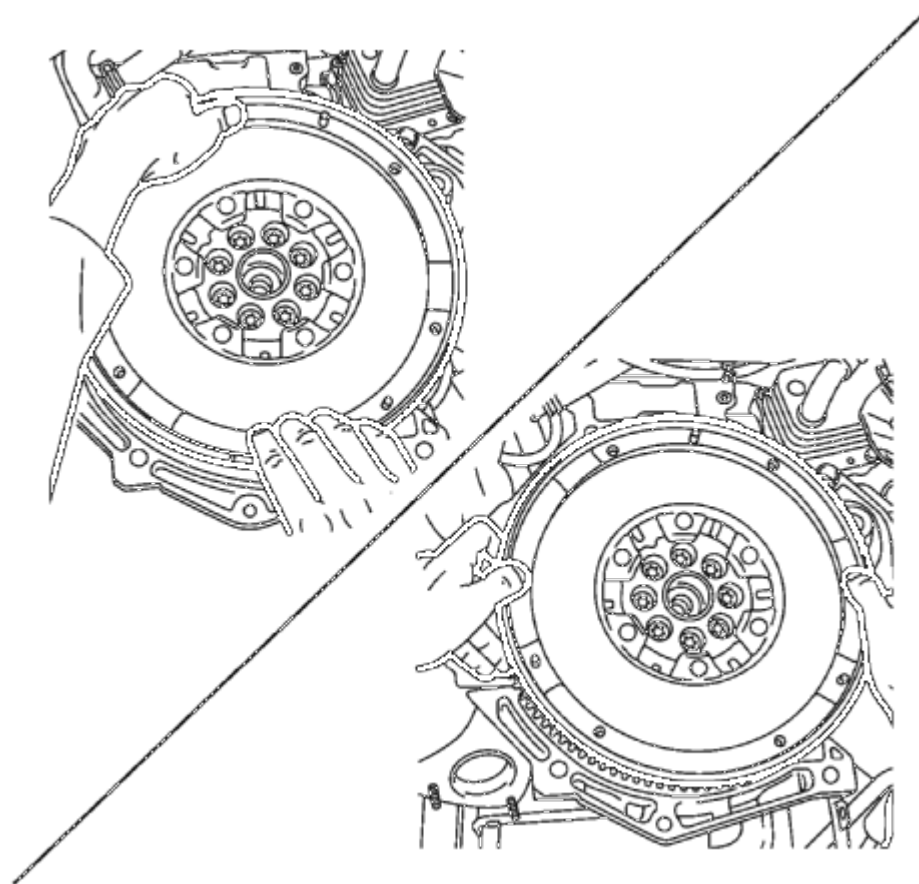
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Light abrasion on frontal areas of teeth is allowed. If problems occur during starting the engine the dual mass flywheel has to be replaced.

2. Inspect toothed ring (1) for damages.

The toothed ring is needed to start the engine. Through a lot of starting procedures and/or an incorrect engaging starter signs of abrasion can occur on teeth of the toothed ring. The profile of damages can reach from only low signs of abrasion up to heavy material removal. The installation of a pulse-generator ring depends on the manufacturer.

The image shows signs of abrasion and mechanical damages at toothed ring (1), they occur through abrasion due to a lot of starting procedures. In this case the dual mass flywheel has to be replaced.

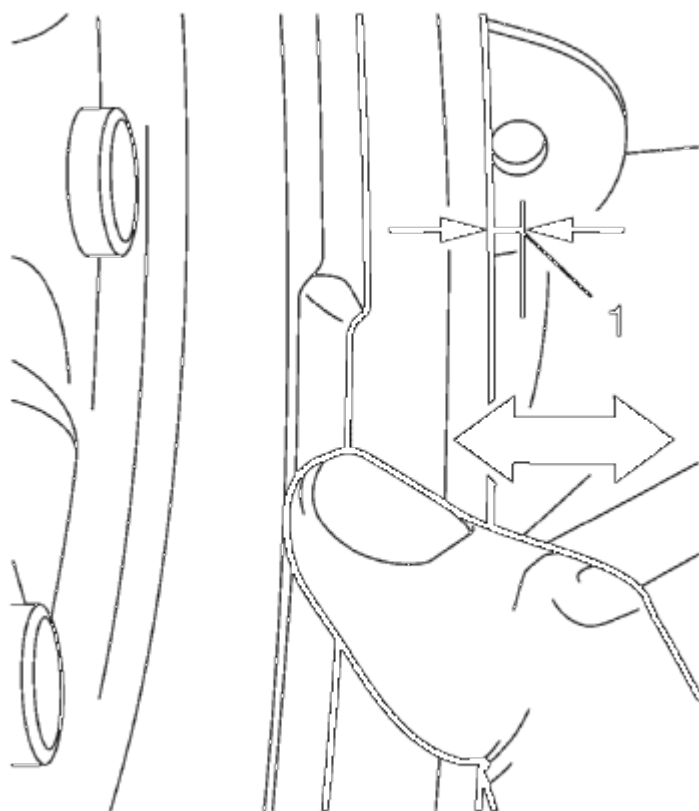
**Fig. 12: Inspecting Tilt Clearance**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The check must be carried out only by hand without any tools.

3. Inspect tilt clearance.

At dual mass flywheel the additional-mass ring looms over the gap between primary and secondary flywheel. It is not possible to carry out just a visual check.



**Fig. 13: Tilt Clearance Height**

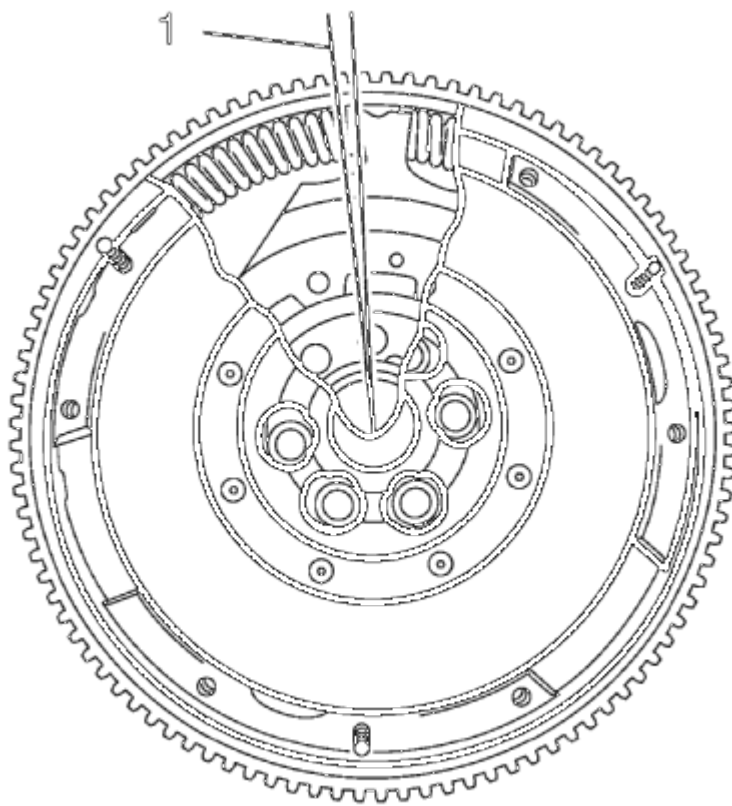
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** An absolute clear measurement is not possible with this check due to the different applied forces of the several workshop employees during the check.

4. Embrace dual mass flywheel and apply thumbs onto the outer radius of secondary flywheel.
5. Apply pressure onto the secondary flywheel alternating on upper, lower, left and right side

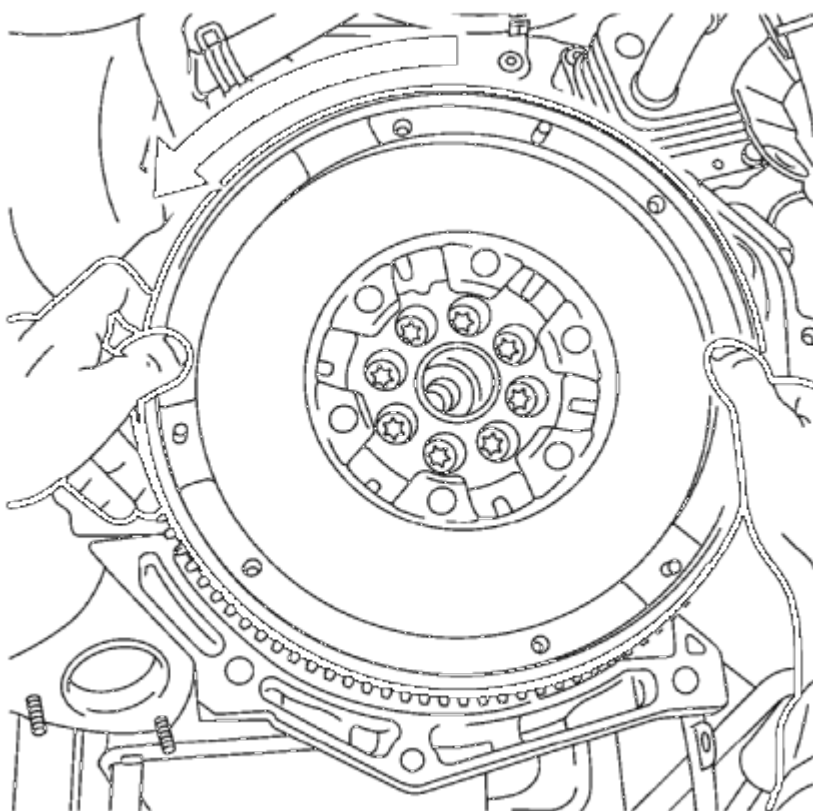
During the tilt clearance check a functional metal rattling noise may occur.

If tilt clearance is higher than 3 mm (MUST be measured, DO NOT make an estimation) (1) the dual mass flywheel has to be replaced.

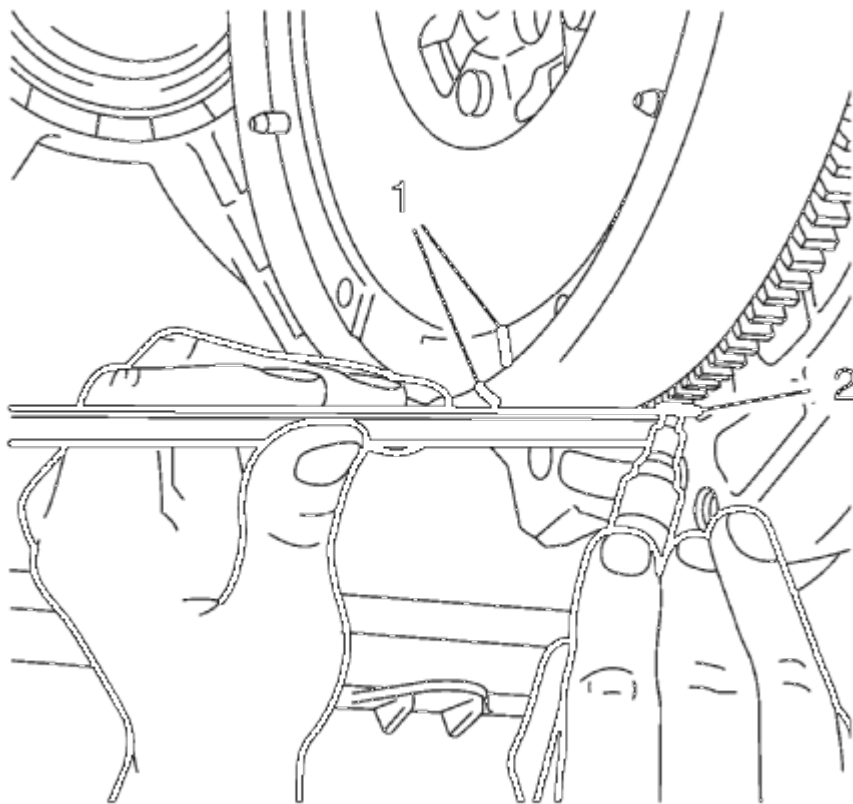


**Fig. 14: Tilt Clearance Angle**

Courtesy of GENERAL MOTORS COMPANY

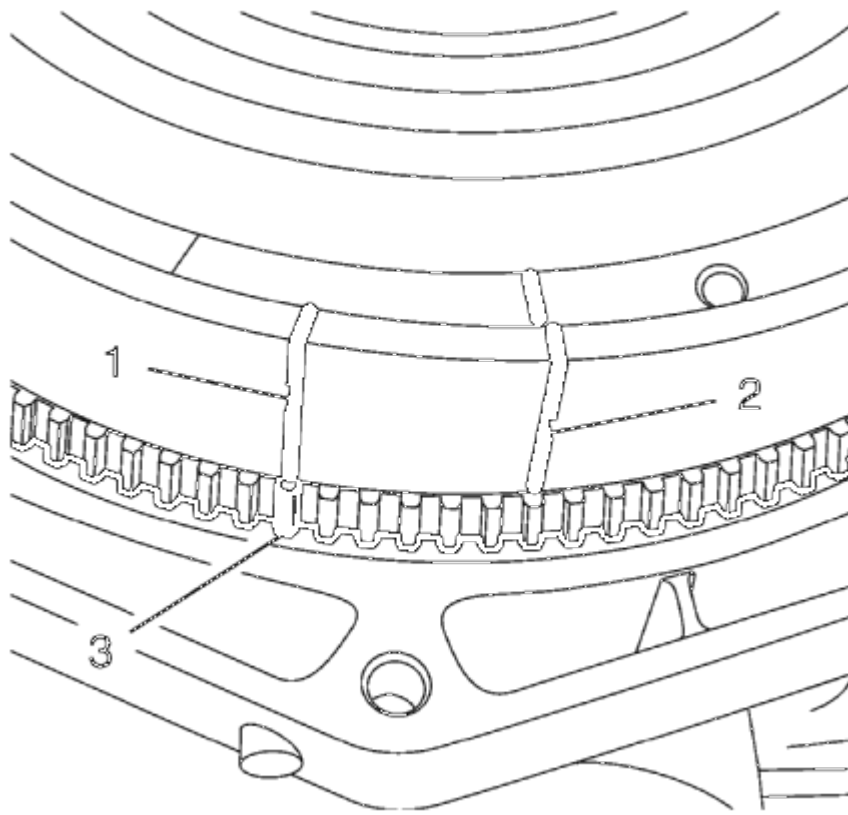


**Fig. 15: Rotating Secondary Flywheel Anticlockwise**  
**Courtesy of GENERAL MOTORS COMPANY**



**Fig. 16: Releasing Secondary Flywheel**  
Courtesy of GENERAL MOTORS COMPANY





**Fig. 17: Mark On Flywheel And Toothed Ring For Starter**  
**Courtesy of GENERAL MOTORS COMPANY**

6. Inspect clearance angle (1).

Before the inspection of the clearance angle the dual mass flywheel should be rotated several times clockwise and anticlockwise to receive a feeling for the resistance of the springs. In addition unusual loud clicking noise or possible rattle, crunch, grinding noise can be sounded out during rotating the dual mass flywheel.

If the rotation of the flywheel is impossible the flywheel is defective and has to be replaced.

The clearance angle is the angle (1) about the secondary and the primary flywheel can be turned light against each other. Thereby the flange wings are moved in the duct of the bowed springs without adjoining the bowed springs. Dictated by functional factors the clearance angle is up to 8 teeth.

Is the secondary flywheel rotated beyond this point the bowed springs in the duct are moved to spring arrestor in the primary flywheel/cover. Now the both spring are tensioned.

- Rotate secondary flywheel anticlockwise (arrow) until the elastic counterforce (spring force) is clear noticeable.
- Release secondary flywheel slowly until the bowed springs are relaxed, so no counterforce acts

onto the springs.

- Mark position with a vertical line by a white pencil on secondary flywheel (1) and on toothed ring for starter (2).
- Rotate secondary flywheel clockwise until the elastic counterforce is clear noticeable.
- Release secondary flywheel slowly until the bowed springs are relaxed.
- Apply new marking on secondary flywheel (1) on the height of the marking on the toothed ring for starter (3).
- Count amount of teeth on toothed ring for starter from marked tooth up to the height of the first marking on secondary flywheel (2). Dictated by functional factors up to 8 teeth are allowed.

7. ALWAYS replace the engine flywheel if following conditions are given:

- The difference exceeds the amount of 8 teeth.
- The dual mass flywheel cannot be rotated.
- During rotating the dual mass flywheel a hard metallic arrestor is audible or noticeable.

## REPAIR INSTRUCTIONS - ON VEHICLE

### DRIVE BELT REPLACEMENT

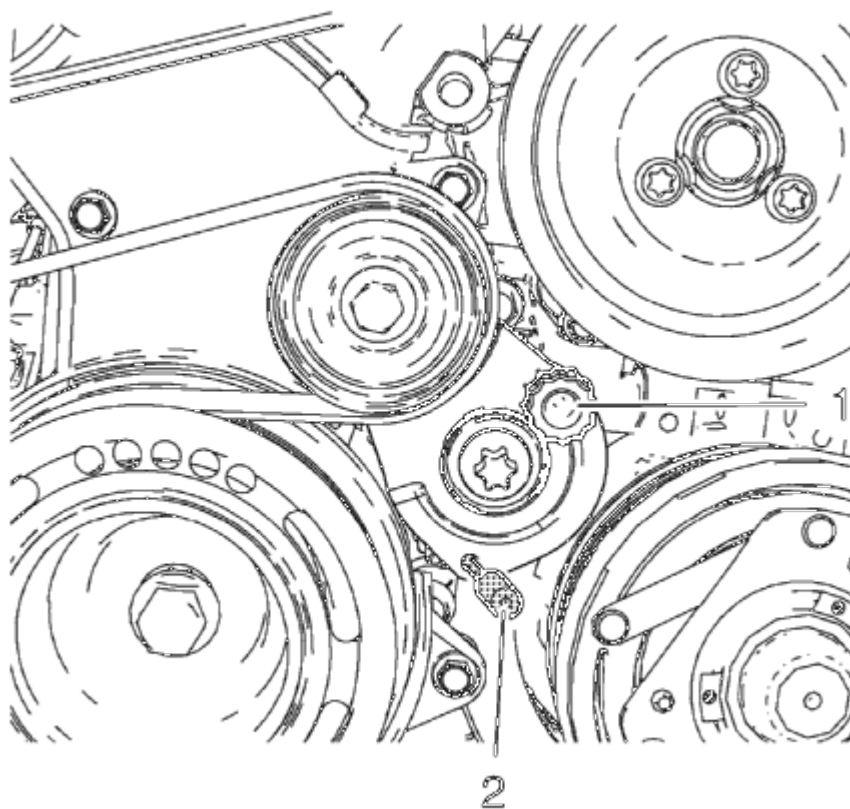
#### Special Tools

**EN 6349** Locking Pin

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

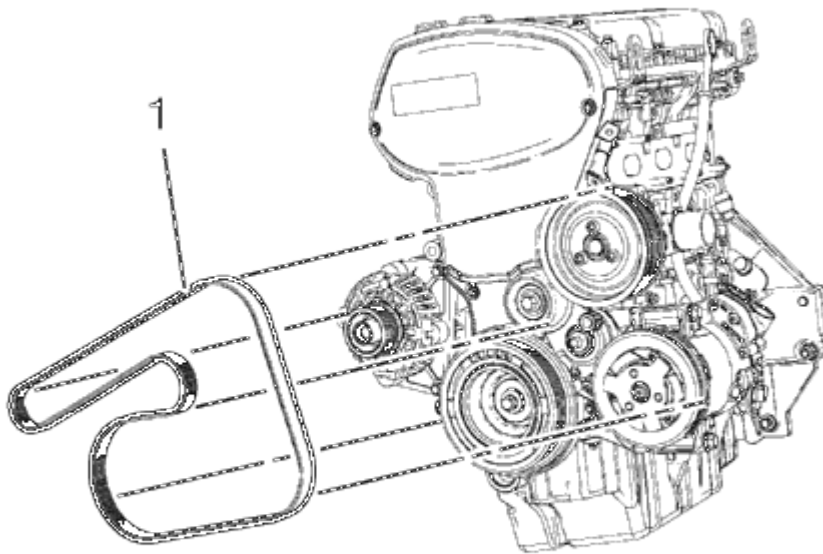
#### Removal Procedure

1. Open the hood.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .



**Fig. 18: Drive Belt Tensioner And Special Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

4. Release tension to the drive belt tensioner by rotating counterclockwise (1) and lock with **EN 6349** pin (2).

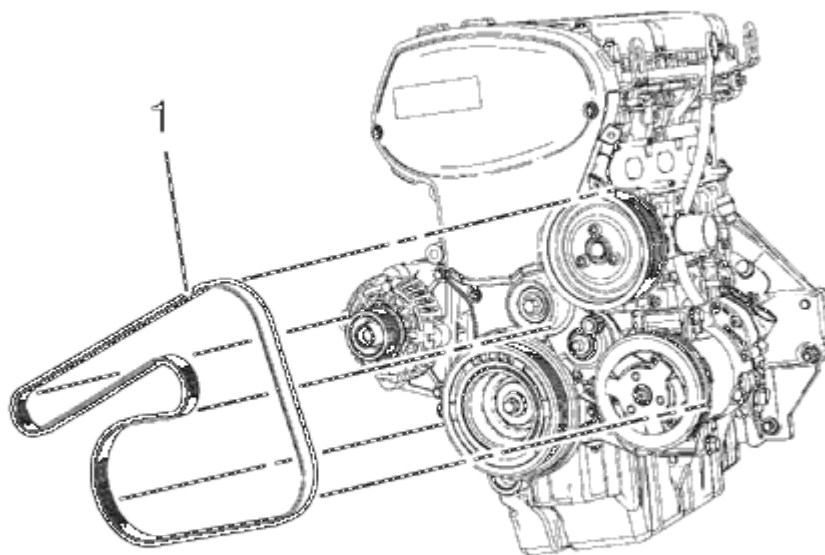


**Fig. 19: Drive Belt Routing**

**Courtesy of GENERAL MOTORS COMPANY**

5. Remove the drive belt (1).

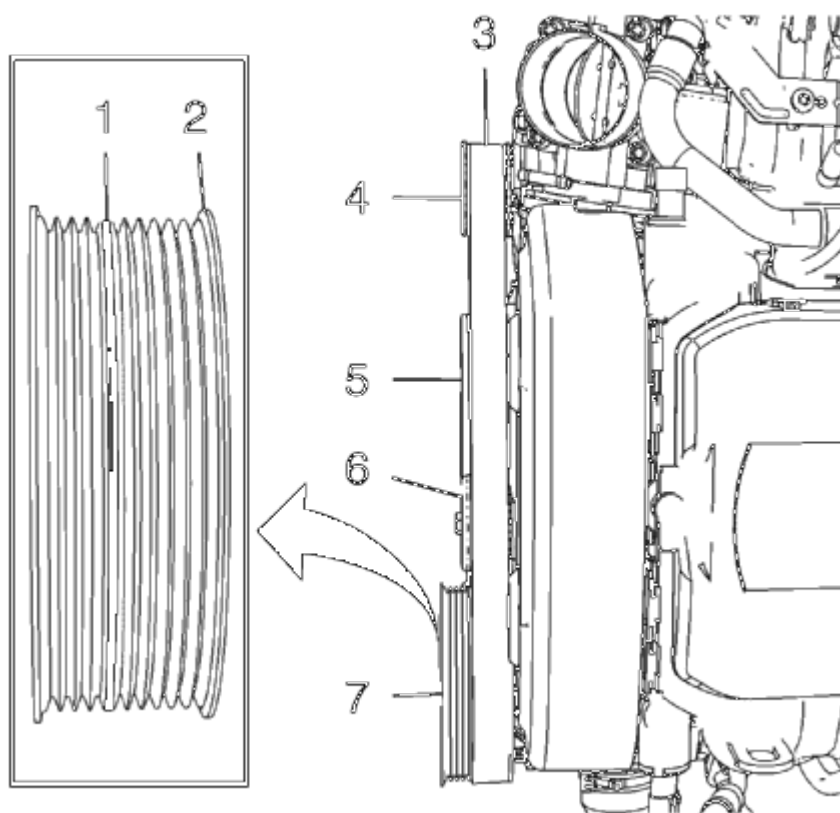
**Installation Procedure**



**Fig. 20: Drive Belt Routing**

**Courtesy of GENERAL MOTORS COMPANY**

1. Install the drive belt (1).

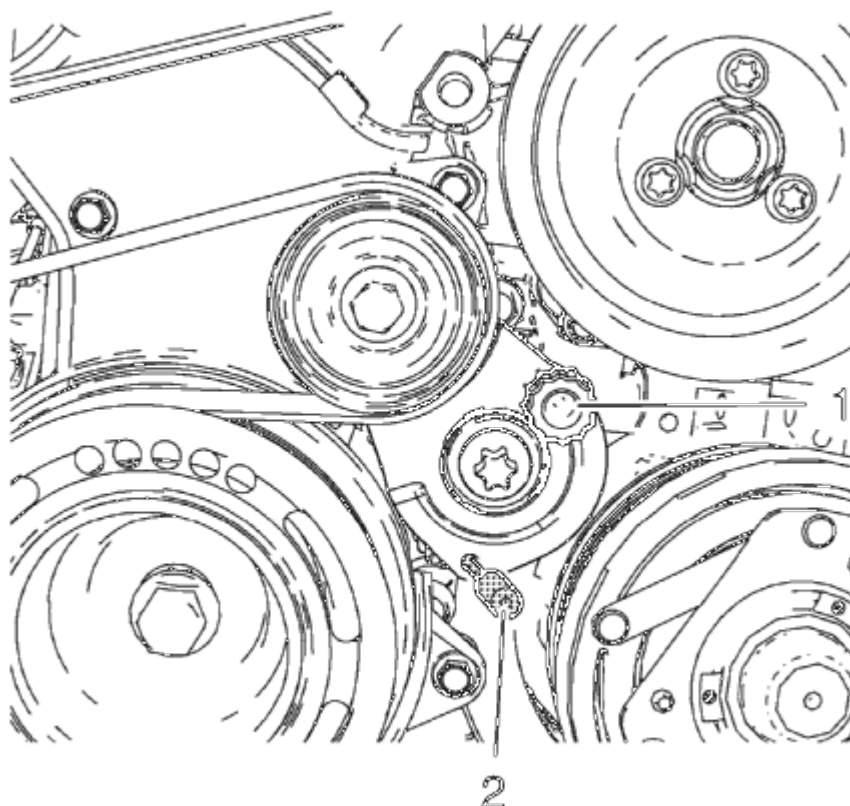


**Fig. 21: Checking Drive Belt Position**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Ensure that the drive belt is aligned on the generator pulley (4), crankshaft balancer (5), drive belt tensioner (6) water pump pulley (7), and A/C compressor. The drive belt must lie on the water pump pulley between the flange (1) and (2).

2. Check the position of the drive belt (3).



**Fig. 22: Drive Belt Tensioner And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

3. Release tension to the tensioner by rotating counterclockwise (1).

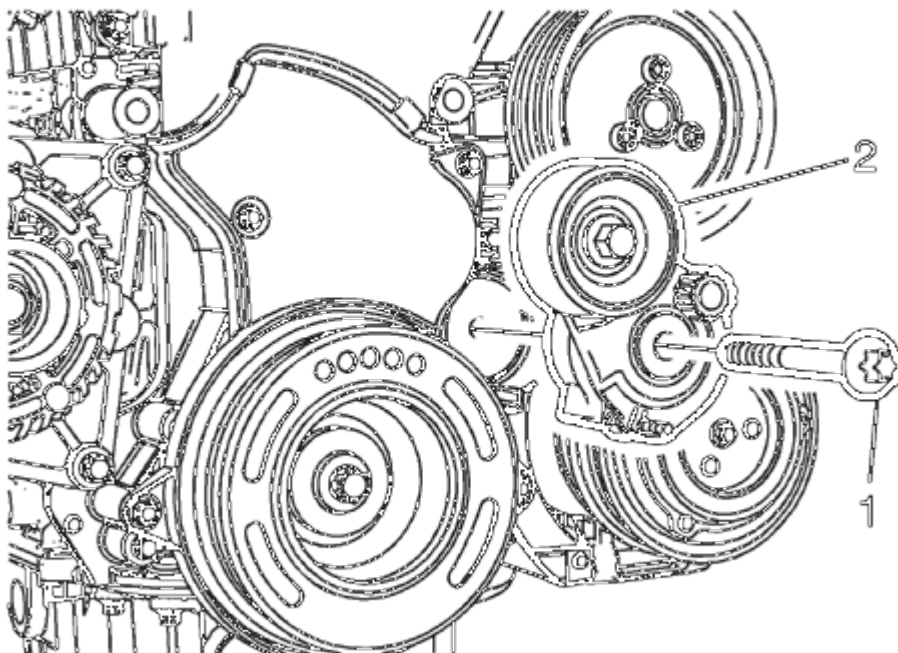
**NOTE:** Allow tensioner to slide back slowly.

4. Remove EN 6349 pin (2).
5. Apply tension to the tensioner clockwise (1).
6. Install the right front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement.
7. Lower the vehicle.
8. Close the hood.

## DRIVE BELT TENSIONER REPLACEMENT

### Removal Procedure

1. Remove the generator and air conditioning compressor belt. Refer to Drive Belt Replacement.



**Fig. 23: Drive Belt Tensioner Bolt**

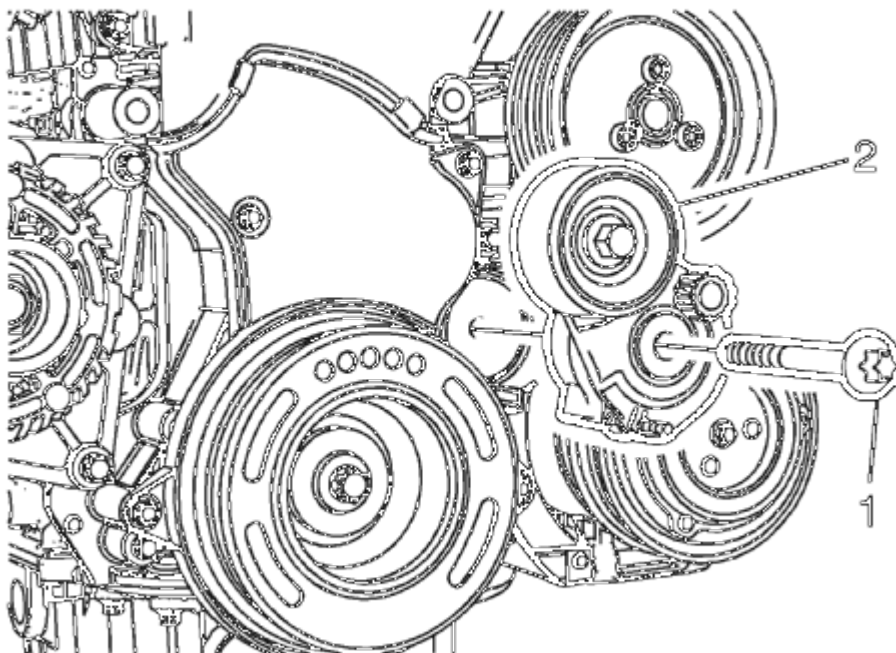
Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt tensioner bolt (1).
3. Remove the drive belt tensioner (2).

#### **Installation Procedure**

1. Clean the drive belt tensioner thread.





**Fig. 24: Drive Belt Tensioner Bolt**

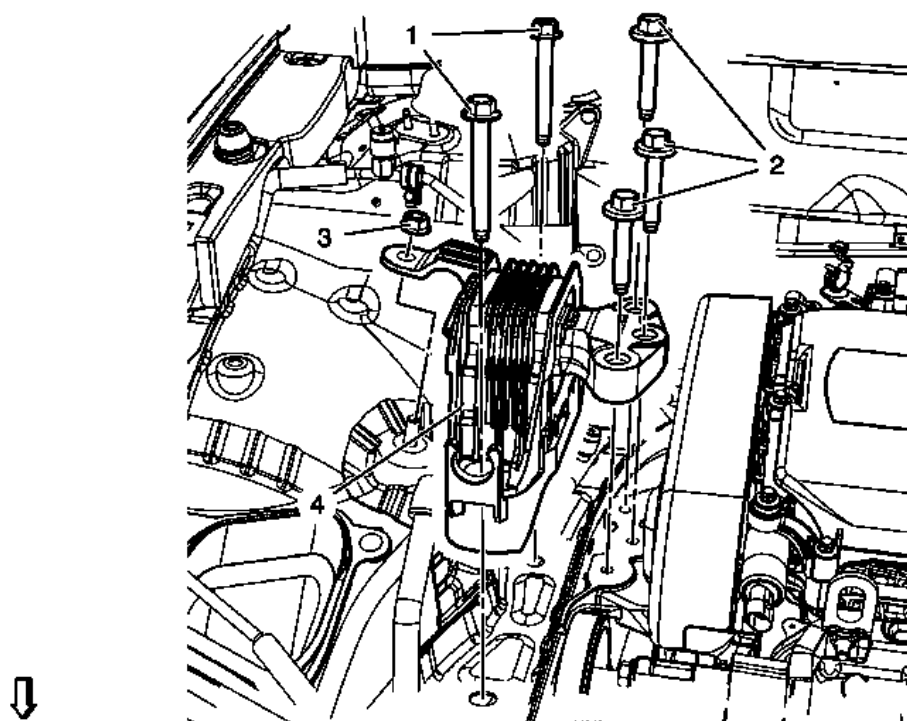
Courtesy of GENERAL MOTORS COMPANY

2. Install drive belt tensioner (2).

**CAUTION:** Refer to Fastener Caution .

3. Install the drive belt tensioner bolt (1) and tighten to 55 N.m (41 lb ft).
4. Install the generator and air conditioning compressor belt. Refer to Drive Belt Replacement.

## ENGINE MOUNT REPLACEMENT

**Fig. 25: Engine Mount And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**Engine Mount Replacement**

Callout	Component Name
<b>Preliminary Procedures</b> <ol style="list-style-type: none"> <li>1. Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a> .</li> <li>2. Support the engine. Install a suitable engine lifting device. Install a suitable cable at the 3 engine lift brackets and at the engine lifting device.</li> </ol>	
1	Engine Mount Bolt (Qty: 2)  <b>CAUTION:</b> Refer to <a href="#">Fastener Caution</a> .  <b>Tighten</b> 62 N.m (46 lb ft)
2	Engine Mount Bracket Bolt (Qty: 3)  <b>CAUTION:</b> Refer to <a href="#">Torque-to-Yield Fastener Caution</a> .

## 2012 Chevrolet Cruze LS

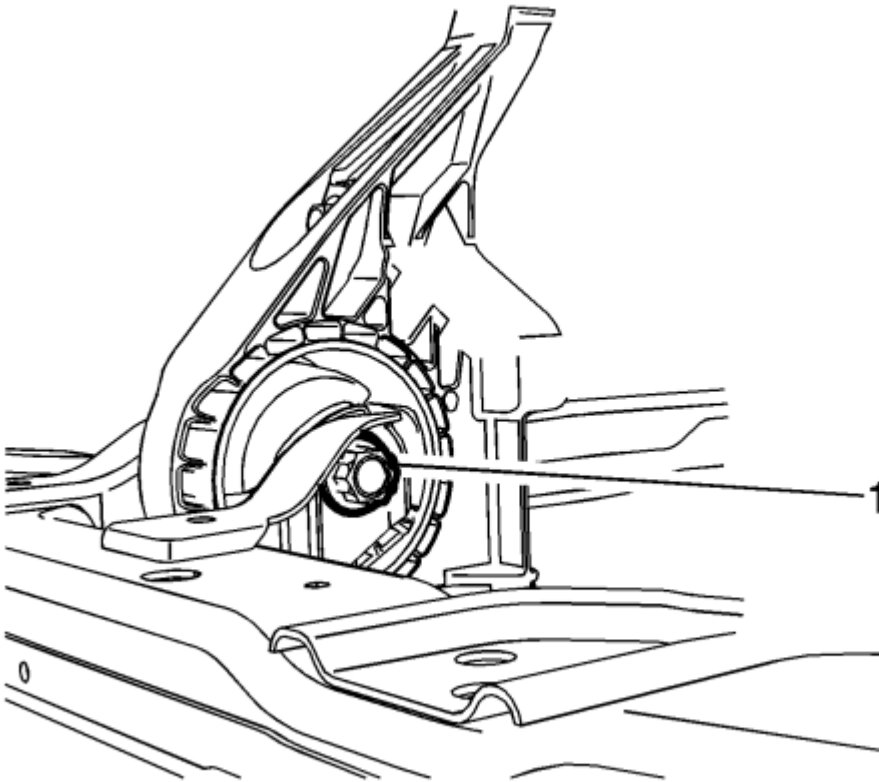
2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	<b>Procedure</b> Install NEW bolts, do NOT reuse old bolts <b>Tighten</b> 50 N.m + 60°-75° (37 lb ft + 60°-75°)
3	Engine Mount Nut <b>Tighten</b> 62 N.m (46 lb ft)
4	Engine Mount

### POWERTRAIN MOUNT BALANCING

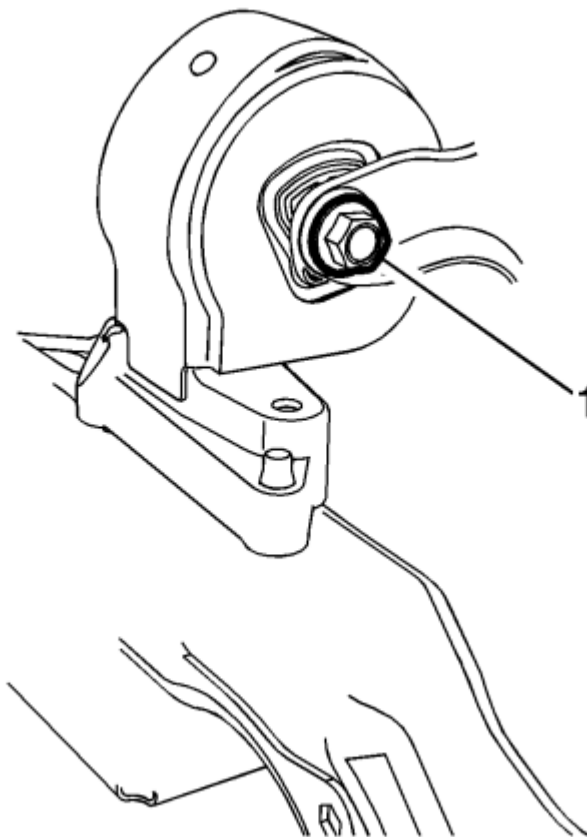
**NOTE:** Follow the balance procedure steps listed below when no starting point has been established such as in a collision repair.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



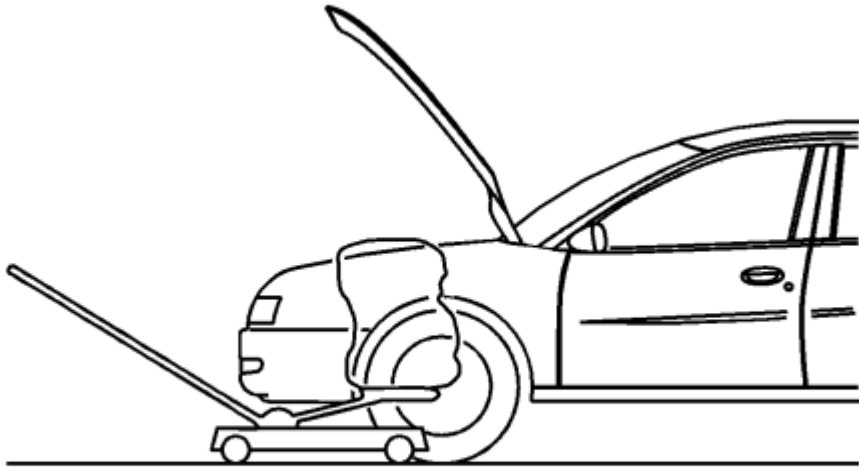
**Fig. 26: Front Transaxle Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1) until it is finger tight.



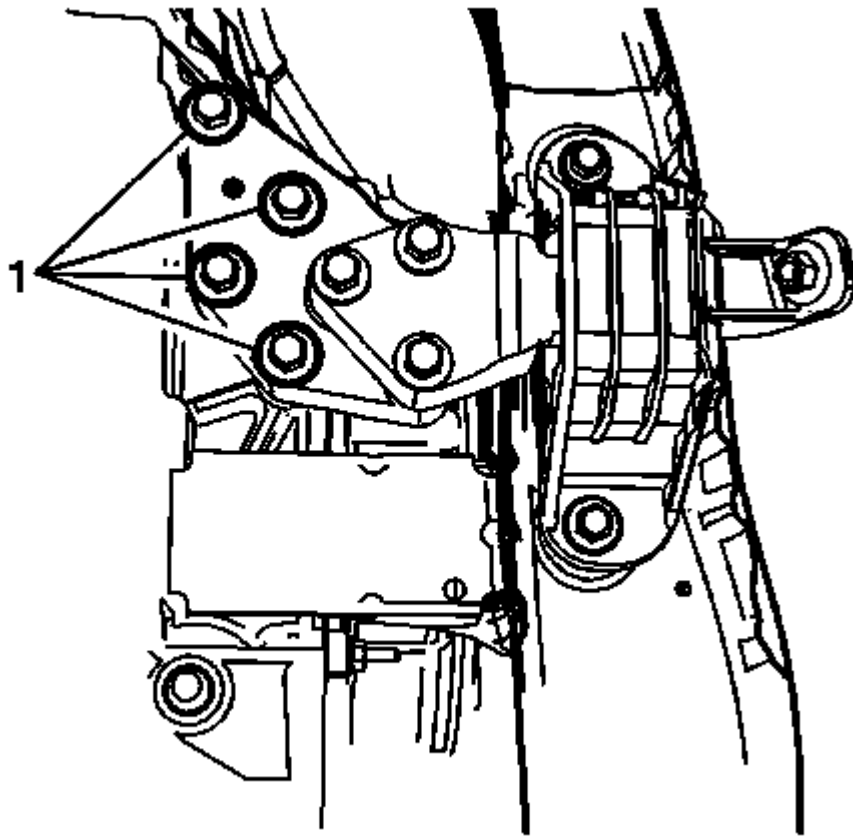
**Fig. 27: Rear Transaxle Mount And Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount (1) through bolt until it is finger tight.
4. Lower the vehicle.



**Fig. 28: Supporting Engine/Transmission With Hydraulic Floor Jack**  
Courtesy of GENERAL MOTORS COMPANY

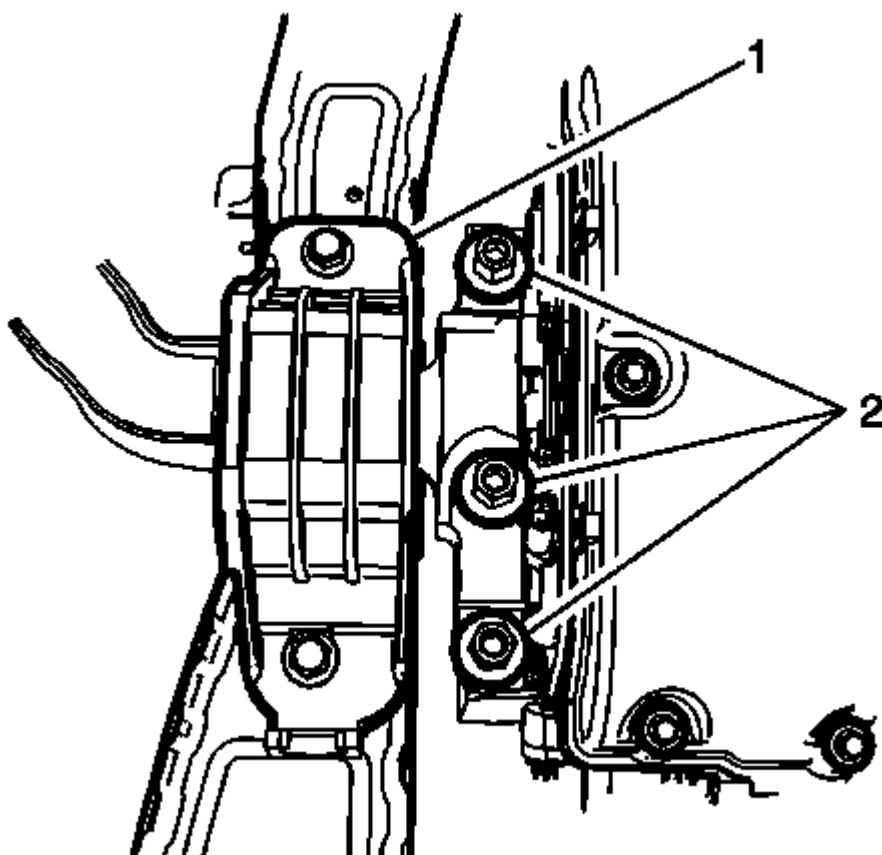
5. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.



**Fig. 29: Transaxle Bolts**

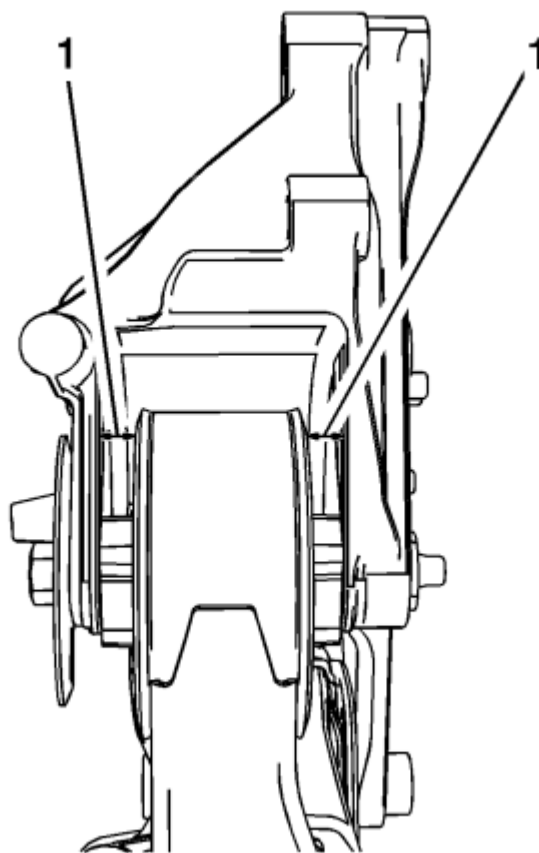
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the transaxle adapter to transaxle bolts (1).



**Fig. 30: Engine Mount And Bracket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

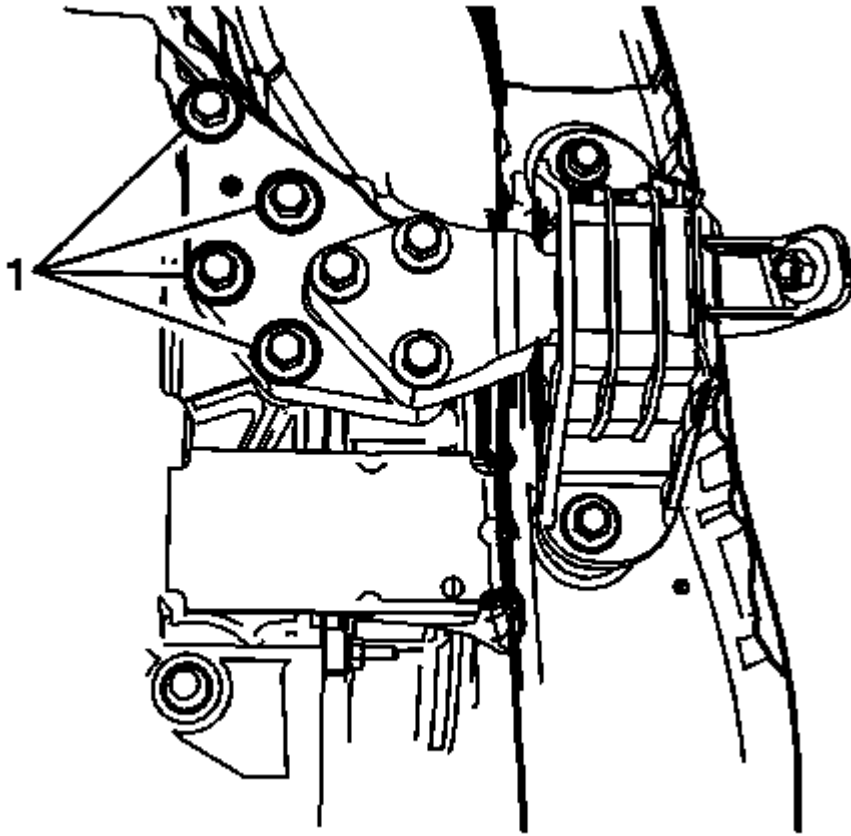
7. Loosen the engine mount (1) to bracket bolts (2).
8. Lower the floor jacks in order to allow a 1/4 inch (6 mm) gap between the upper engine mount and engine mount bracket, and also between the transmission and left transmission mount.



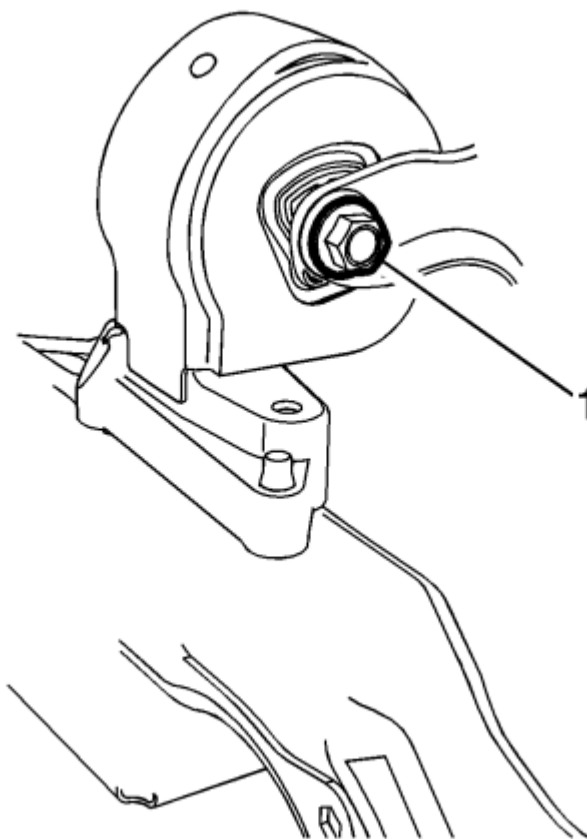
**Fig. 31: Front And Rear Powertrain Mounts**  
**Courtesy of GENERAL MOTORS COMPANY**

9. Check that the front and rear mounts are centered (1) in the mount brackets, adjust if necessary.
10. Tighten the left hand (transaxle side) mount bolts, starting with the bolt nearest to the center of the mount. See the appropriate transmission mount replacement procedure for the fastener tightening specifications.



**Fig. 32: Transaxle Bolts****Courtesy of GENERAL MOTORS COMPANY**

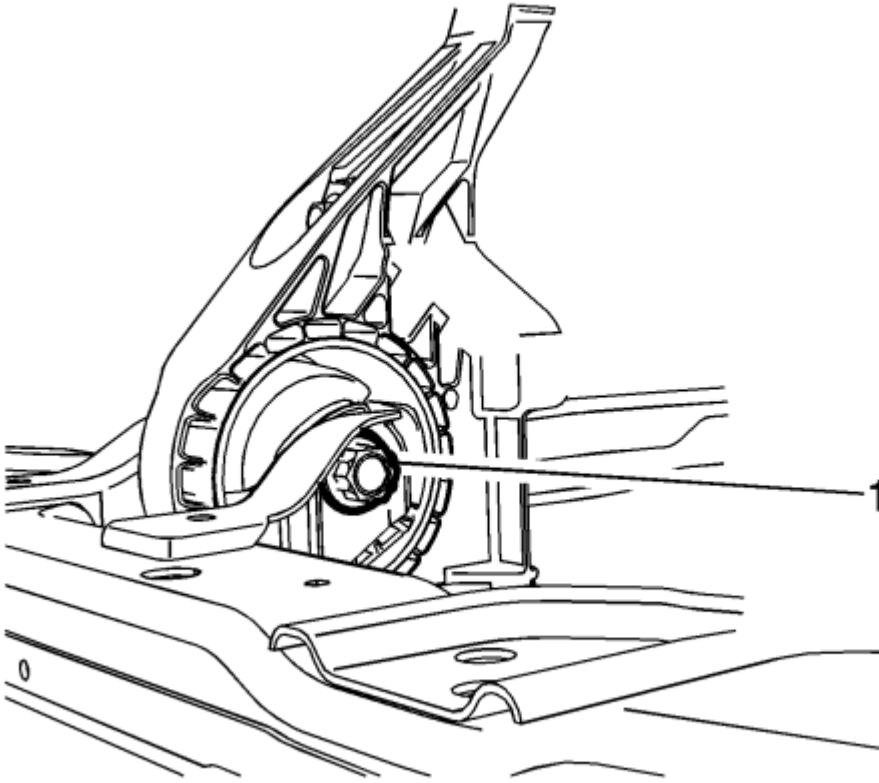
11. Tighten the right hand (engine side) mount bolts (1), starting with the bolt nearest to the center of the mount. See the appropriate engine mount replacement procedure for the fastener tightening specifications.
12. Remove the floor jacks from under the oil pan and transmission.
13. Raise the vehicle.
14. Shake the powertrain from front to rear and allow the powertrain to settle.



**Fig. 33: Rear Transaxle Mount And Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** It is essential that the lower mount through bolts should be as close to centered as possible in the oversized mount insert holes before tightening to specification.

15. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.



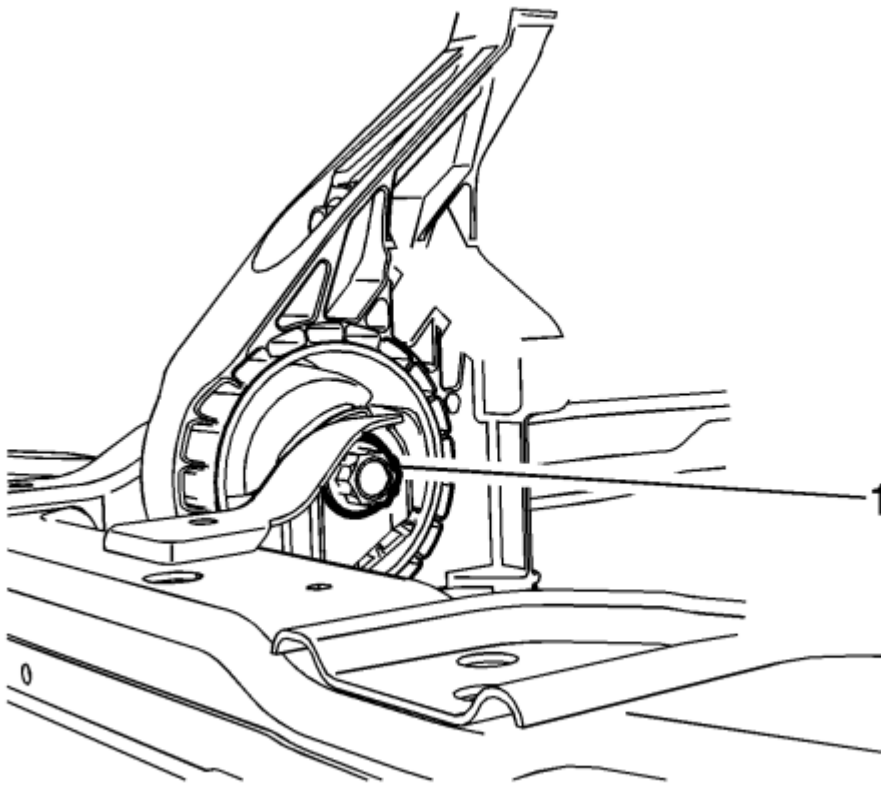
**Fig. 34: Front Transaxle Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

16. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
17. Lower the vehicle.

#### **POWERTRAIN MOUNT BALANCING - LOWER**

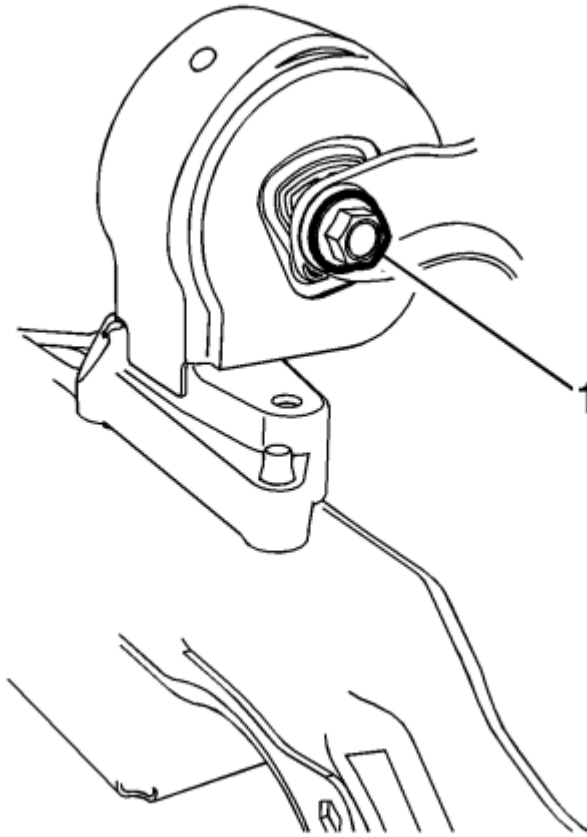
**NOTE:** Follow the balance procedure steps listed below when front or rear mounts through bolts are loosened or removed during a repair procedure.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



**Fig. 35: Front Transaxle Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the front transaxle mount through bolt (1).

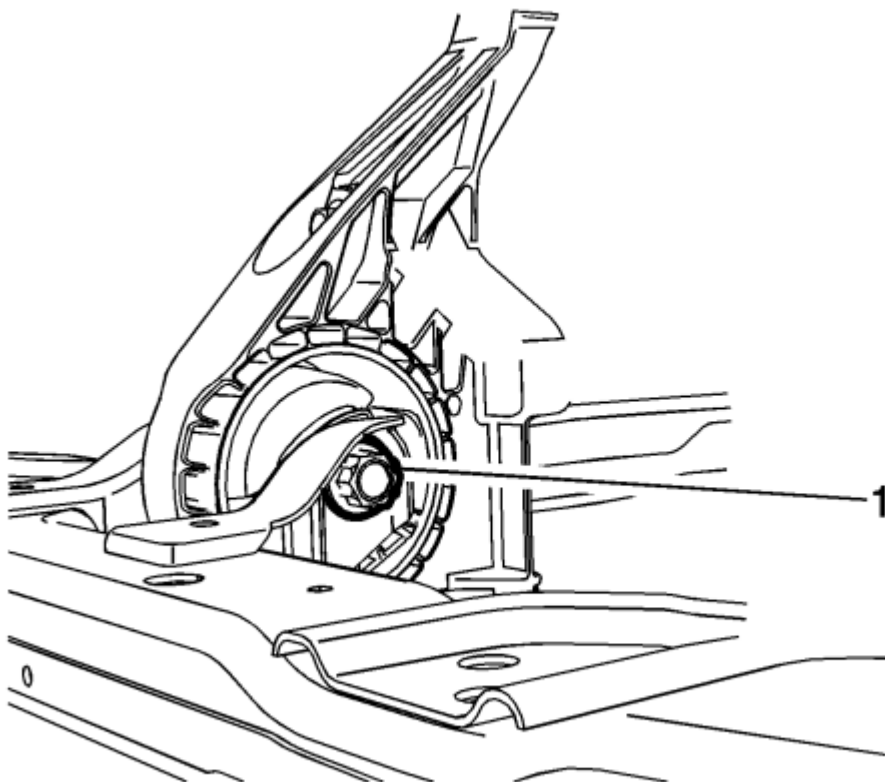


**Fig. 36: Rear Transaxle Mount And Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the rear transaxle mount through bolt (1).
4. Shake the powertrain from front to rear and allow the powertrain to settle.

**NOTE:** It is essential that the through bolts are as close to centered as possible in the oversized mount insert holes before tightening to specification.

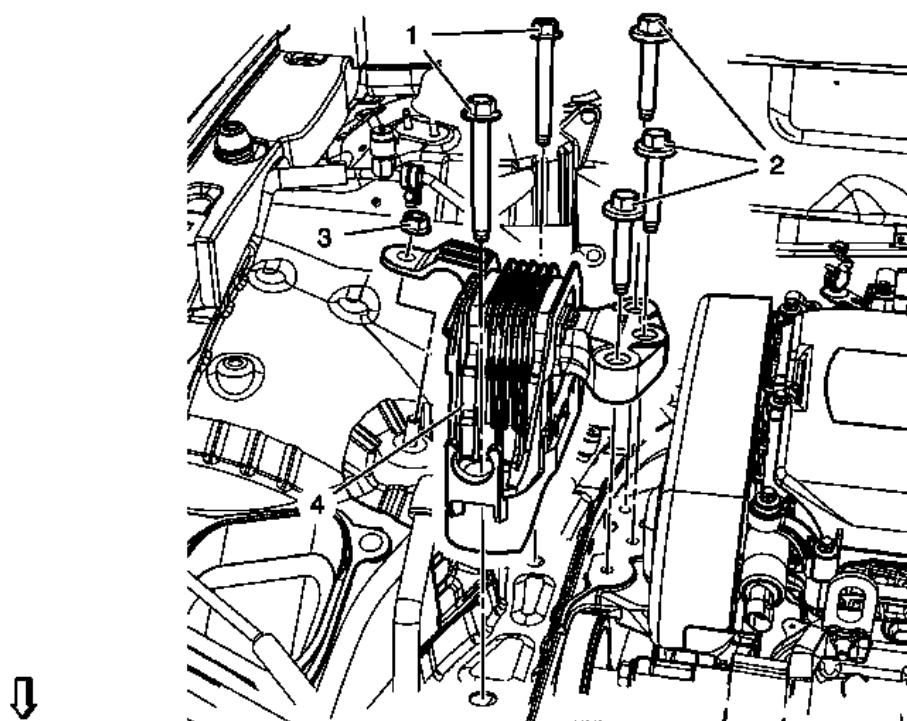
5. Tighten the rear transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.



**Fig. 37: Front Transaxle Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the front transaxle mount through bolt (1). See the appropriate transmission mount replacement procedure for the fastener tightening specifications.
7. Lower the vehicle.

#### **ENGINE MOUNT REPLACEMENT - RIGHT SIDE**

**Fig. 38: Engine Mount And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**Engine Mount Replacement - Right Side**

Callout	Component Name
<b>Preliminary Procedures</b> <ol style="list-style-type: none"> <li>1. Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a> .</li> <li>2. Support the engine. Install a suitable engine lifting device. Install a suitable cable at the 3 engine lift brackets and at the engine lifting device.</li> </ol>	
1	Engine Mount Bolt (Qty: 2)  <b>CAUTION:</b> Refer to <a href="#">Fastener Caution</a> .  <b>Tighten</b> 62 N.m (46 lb ft)
2	Engine Mount Bracket Bolt (Qty: 3)  <b>CAUTION:</b> Refer to <a href="#">Torque-to-Yield Fastener Caution</a> .

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

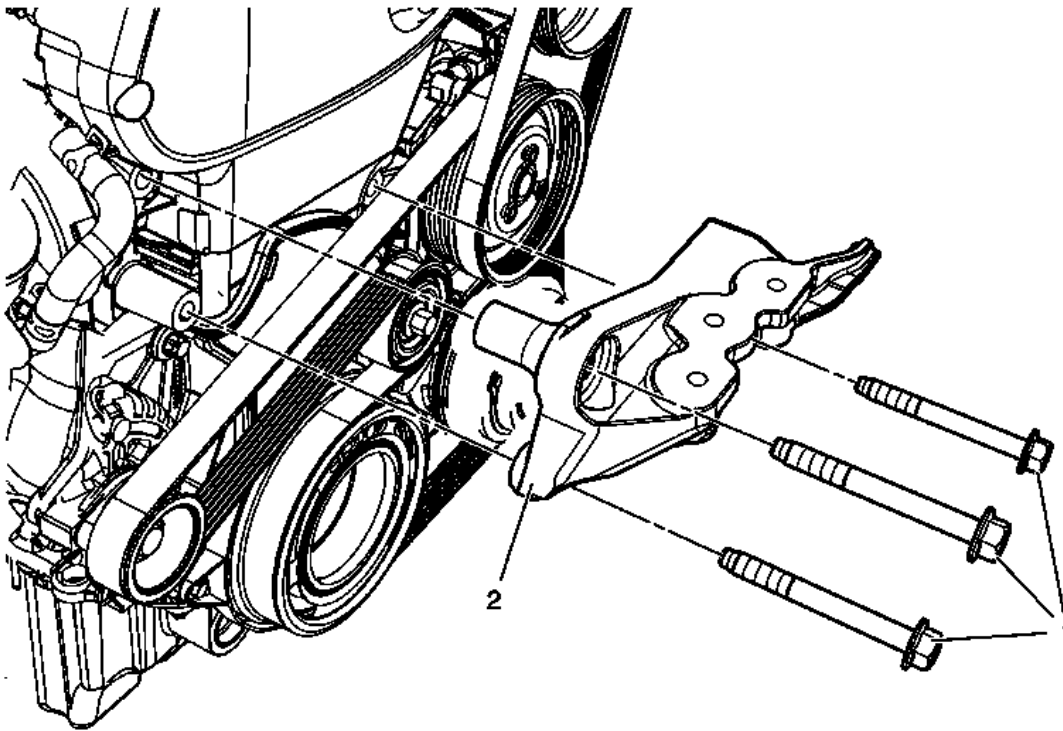
	<b>Procedure</b> Use NEW bolts, do NOT reuse old bolts. <b>Tighten</b> 50 N.m + 60°-75° (37 lb ft + 60°-75°)
3	Engine Mount Nut <b>Tighten</b> 62 N.m (46 lb ft)
4	Engine Mount

### ENGINE MOUNT INSPECTION

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
  - The hard rubber is covered with heat check cracks.
  - The rubber is separated from the metal plate of the engine mount.
  - The rubber is split through the center of the engine mount.
4. For engine mount replacement, refer to **Engine Mount Replacement - Right Side**.
5. For rear transmission mount replacement, refer to the following:
  - Automatic transmission, refer to **Transmission Rear Mount Replacement (Electronic Power Steering)** .
  - Manual transmission, refer to **Transmission Rear Mount Replacement** .
6. For left transmission mount replacement, refer to the following:
  - Automatic transmission, refer to **Transmission Mount Replacement - Left Side** .
  - Manual transmission, refer to **Transmission Mount Bracket Replacement - Left Side** .

### ENGINE MOUNT BRACKET REPLACEMENT



**Fig. 39: Engine Mount Bracket**

Courtesy of GENERAL MOTORS COMPANY

**Engine Mount Bracket Replacement**

Callout	Component Name
<b>Preliminary Procedures</b>	
Remove the engine mount. Refer to <u>Engine Mount Replacement</u> .	
1	Engine Mount Bracket Bolt (Qty: 3)  <b>CAUTION:</b> Refer to <u>Fastener Caution</u> .  <b>Tighten</b> 60 N.m (45 lb ft) + 45-60°
2	Engine Mount Bracket

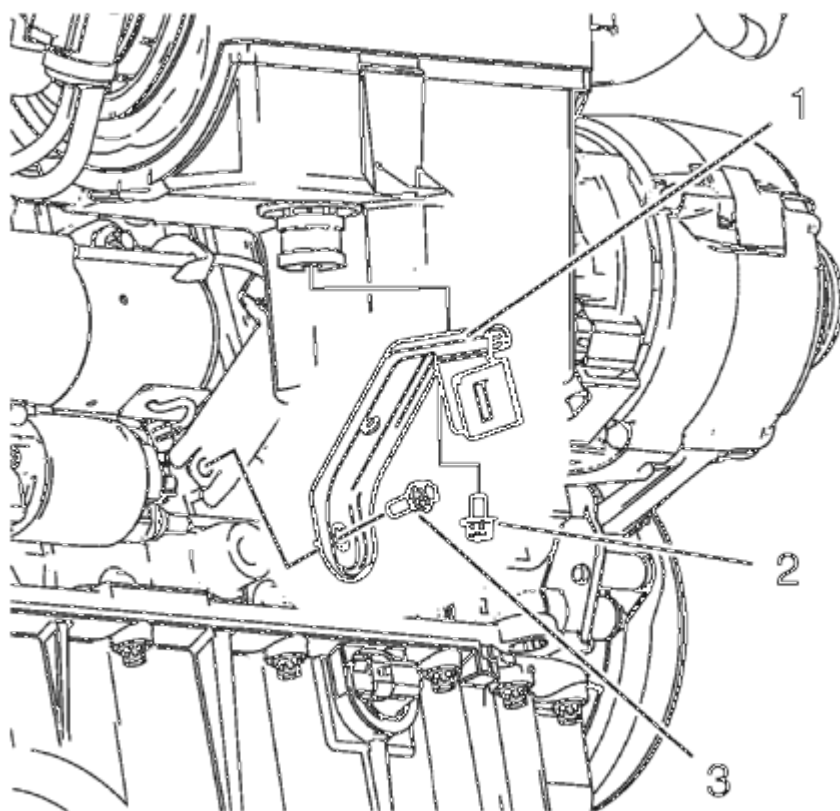
**INTAKE MANIFOLD REPLACEMENT****Removal Procedure****WARNING:** Refer to Gasoline/Gasoline Vapors Warning .

**WARNING:** Refer to Safety Goggles and Fuel Warning .

**WARNING:** In order to reduce the risk of fire and personal injury observe the following items:

- Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes
- Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.
- Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.
- Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)

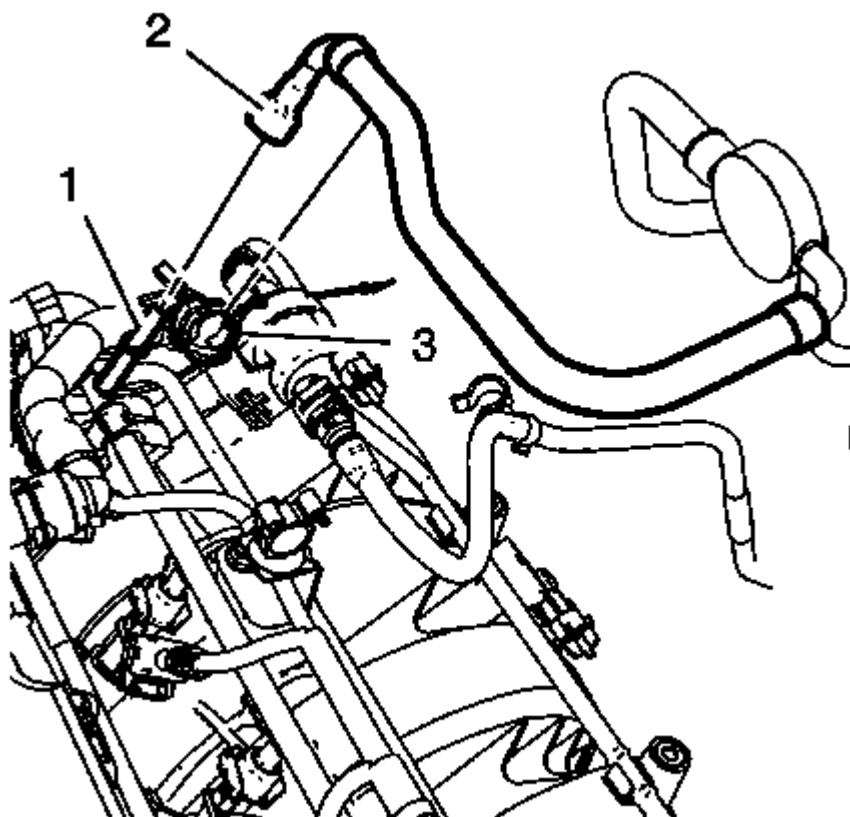
1. Open the hood.
2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .
3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
4. Place a drain pan underneath the vehicle.



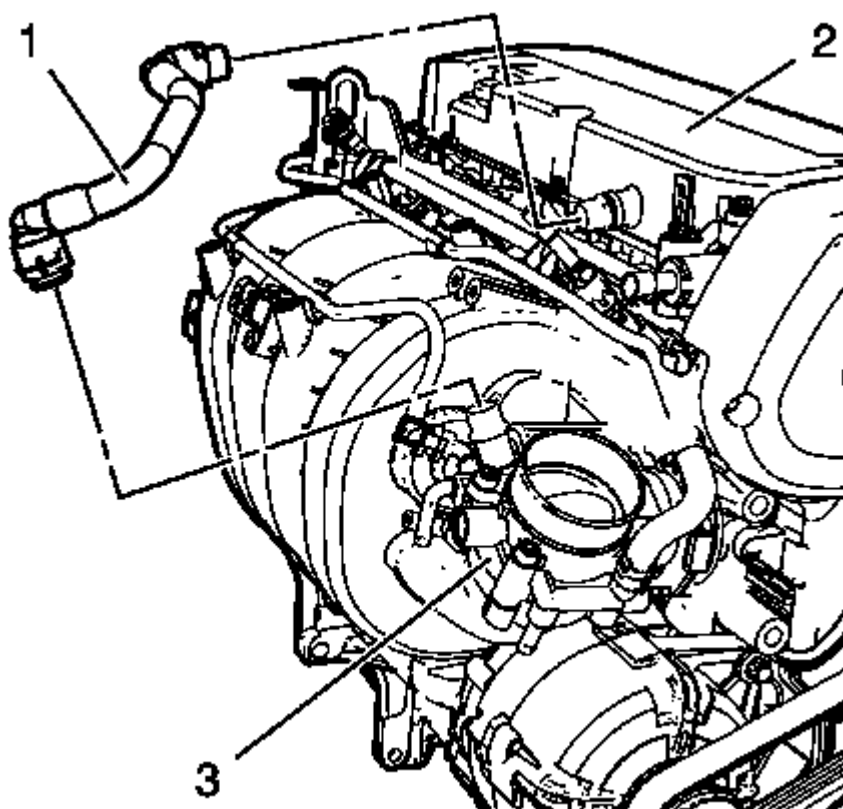
**Fig. 40: Intake Manifold Brace And Bolts**

Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 intake manifold brace bolts (2, 3).
6. Remove and disconnect the wiring harness plug from the heated oxygen sensor 1.
7. Remove the intake manifold brace (1).
8. Remove the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**

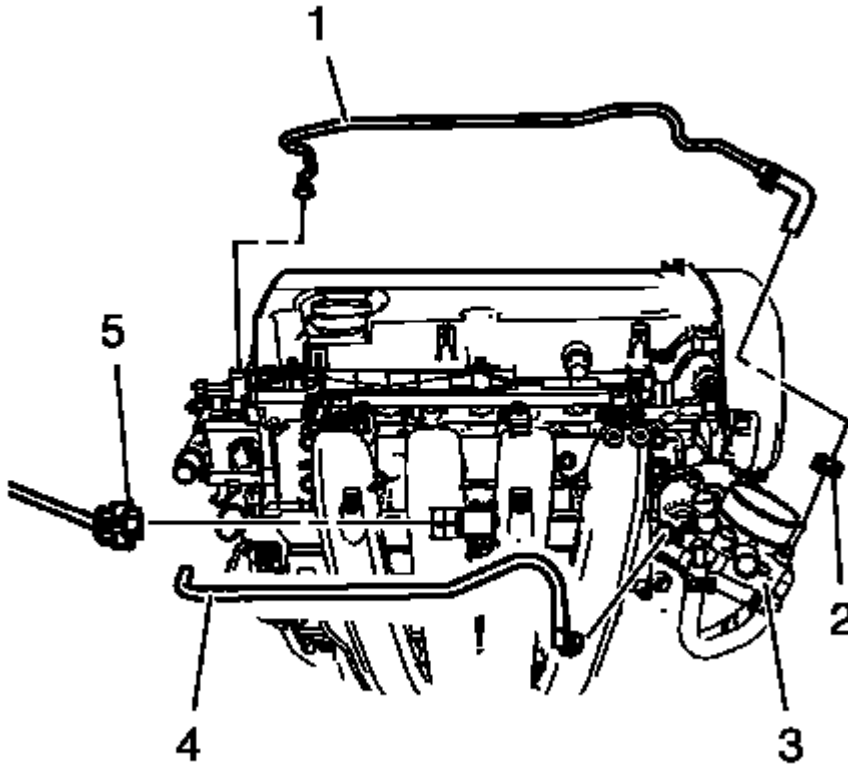
**Fig. 41: Fuel Feed Pipe****Courtesy of GENERAL MOTORS COMPANY**

9. Unclip the fuel feed pipe (2) from the fuel feed pipe clip (3).
10. Release the fuel feed pipe (2) from the multiport fuel injection fuel rail (1) and remove the fuel feed pipe.
11. Close the fuel feed pipe with a suitable cap.



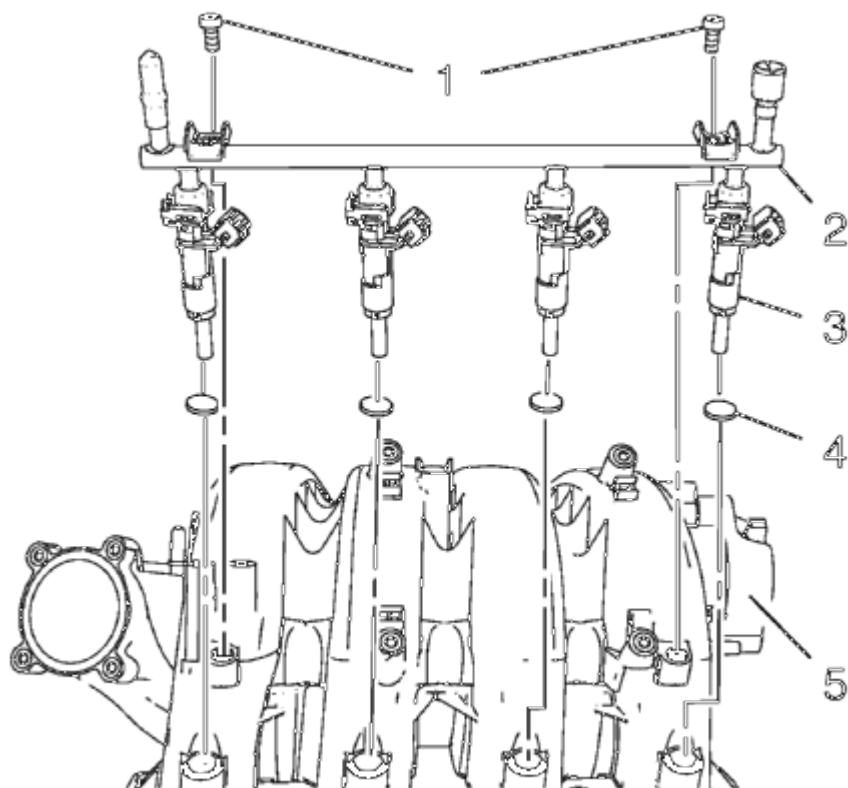
**Fig. 42: Throttle Body And Positive Crankcase Ventilation Tube**  
Courtesy of GENERAL MOTORS COMPANY

12. Remove the positive crankcase ventilation tube (1) from throttle body (3) and the camshaft cover (2).
13. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.



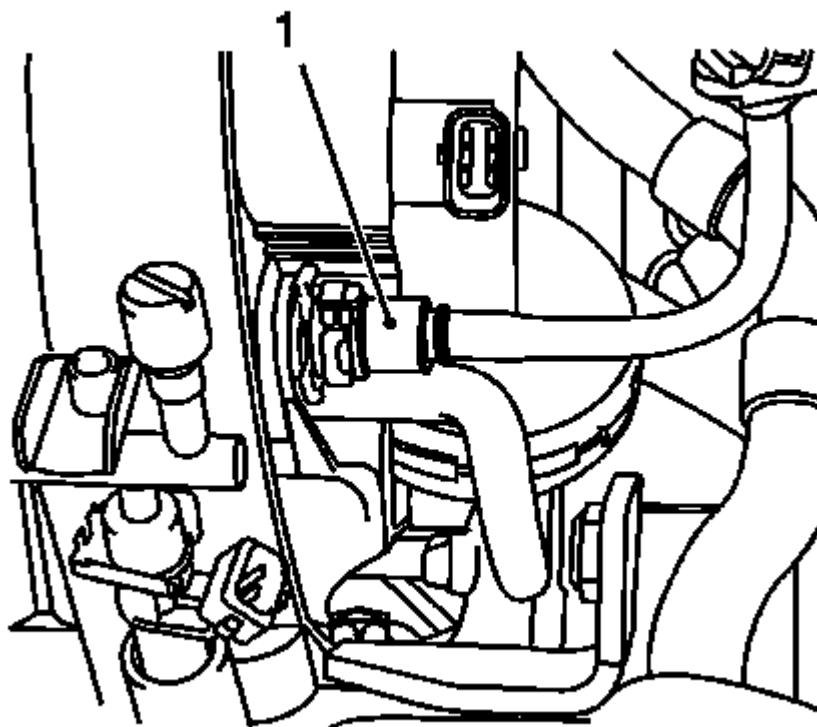
**Fig. 43: Throttle Body, Throttle Body Heater Inlet Hose And Throttle Body Heater Outlet Hose**  
 Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the manifold absolute pressure sensor wiring harness plug (5).
15. Remove the clamp (2) and remove the throttle body heater inlet hose (1) from throttle body (3).
16. Disconnect the throttle body heater outlet hose (4) from the throttle body (3).
17. Remove the engine management wiring harness and the fuel injectors wiring harness.



**Fig. 44: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

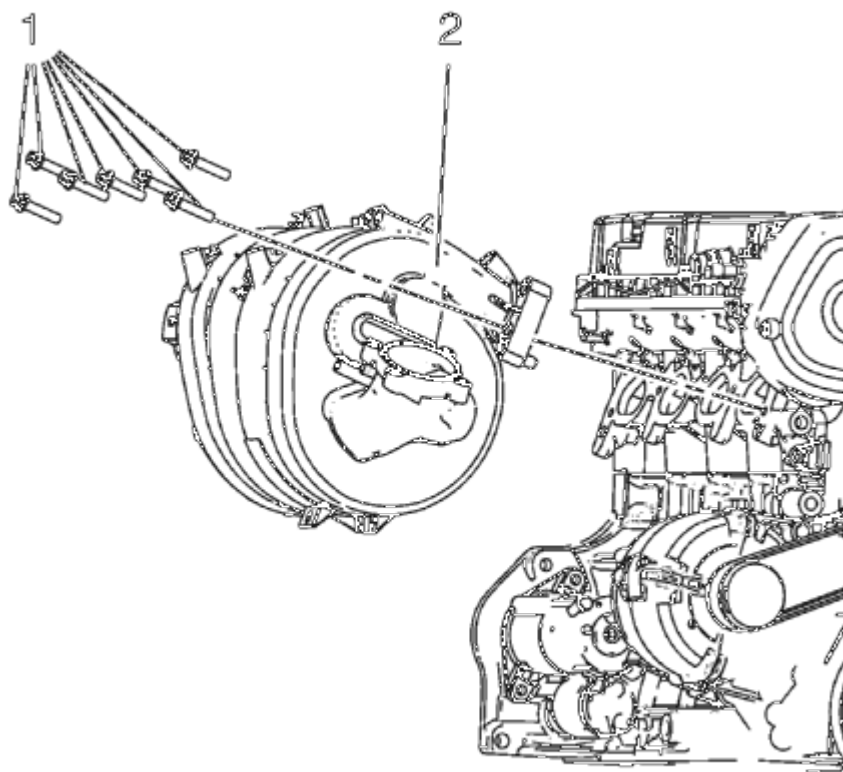
18. Remove the 2 multiport fuel injection fuel rail bolts (1).
19. Remove the multiport fuel injection fuel rail (2) and the fuel injectors (3) from the intake manifold (5).
20. Remove the 4 multiport fuel injector seals (4).



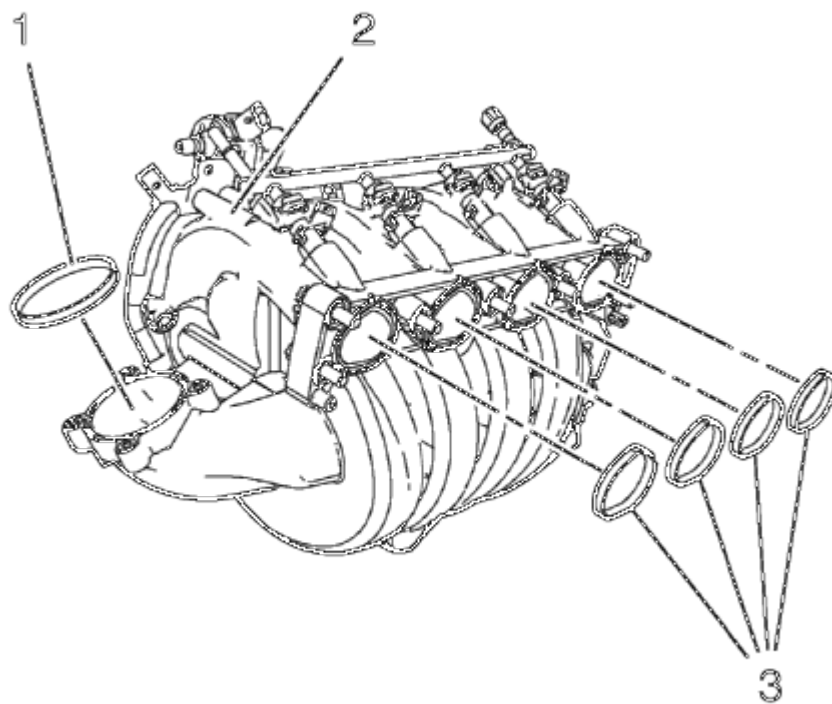
**Fig. 45: Brake Servo Vacuum Line**  
Courtesy of GENERAL MOTORS COMPANY

21. Disconnect the booster vacuum pipe (1) from the intake manifold.



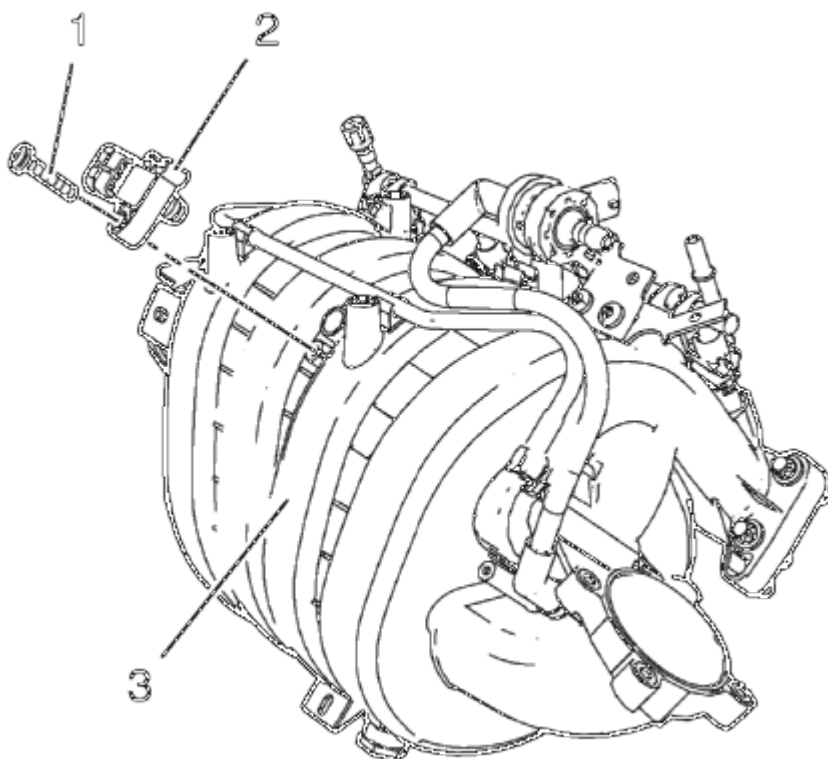
**Fig. 46: Intake Manifold And Bolts****Courtesy of GENERAL MOTORS COMPANY**

22. Remove the 7 intake manifold bolts (1).
23. Remove the intake manifold (2).



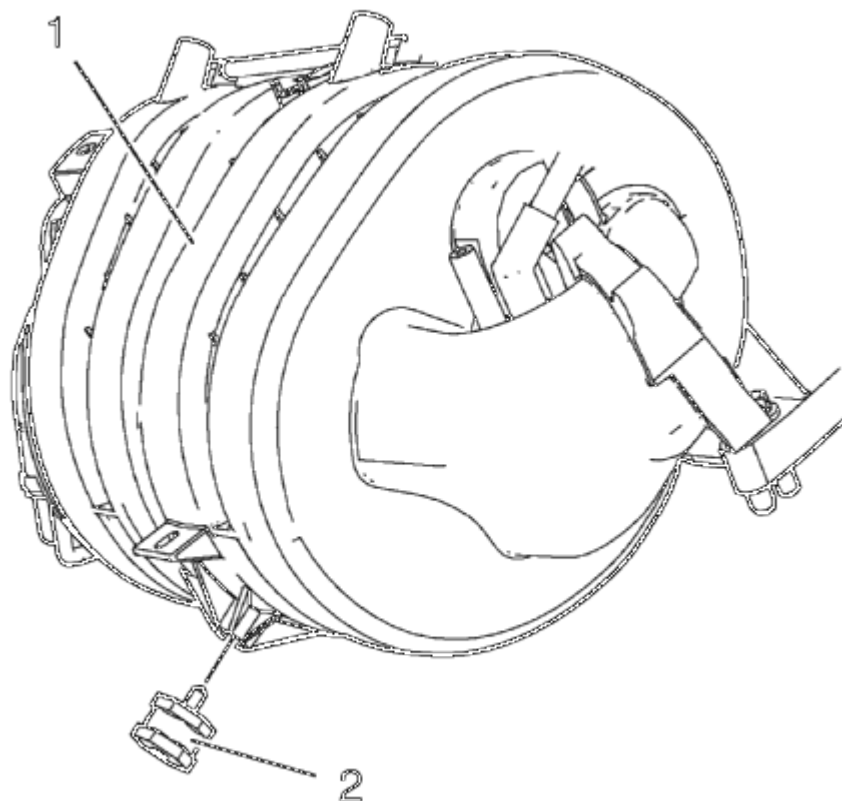
**Fig. 47: Intake Manifold, Intake Manifold Seal And Throttle Body Seal**  
Courtesy of GENERAL MOTORS COMPANY

24. Remove the intake manifold gaskets (1, 3) from the intake manifold (2).



**Fig. 48: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

25. Remove the manifold absolute pressure sensor bolt (1).
26. Remove the manifold absolute pressure sensor (2) from the intake manifold (3).



**Fig. 49: Intake Manifold And Mount**  
Courtesy of GENERAL MOTORS COMPANY

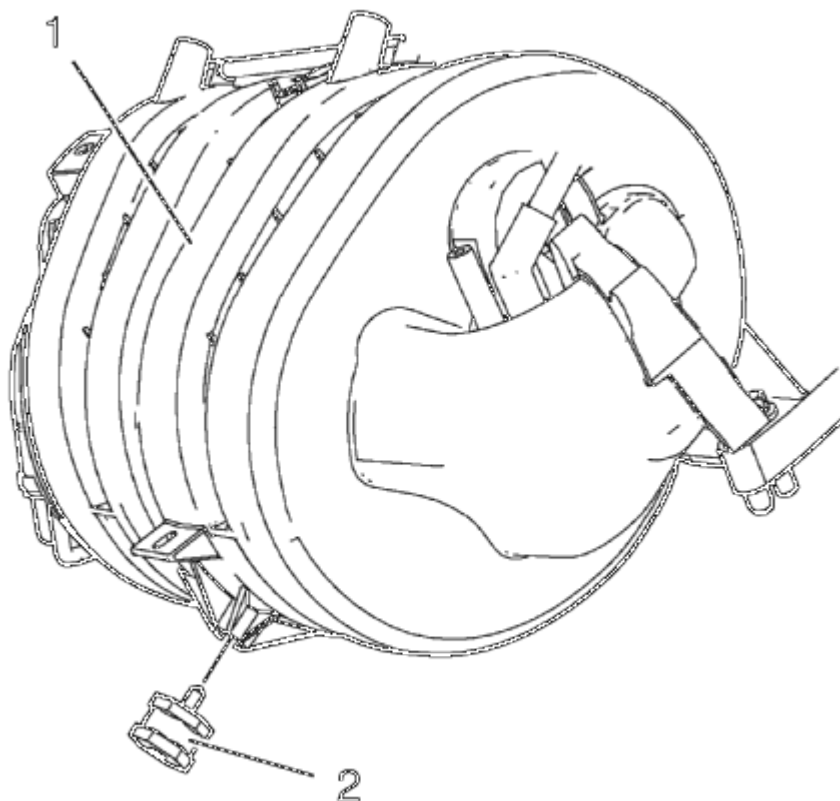
27. Remove the rubber bracket (2) from intake manifold (1).

#### **Cleaning and Inspection Procedure**

Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection**.

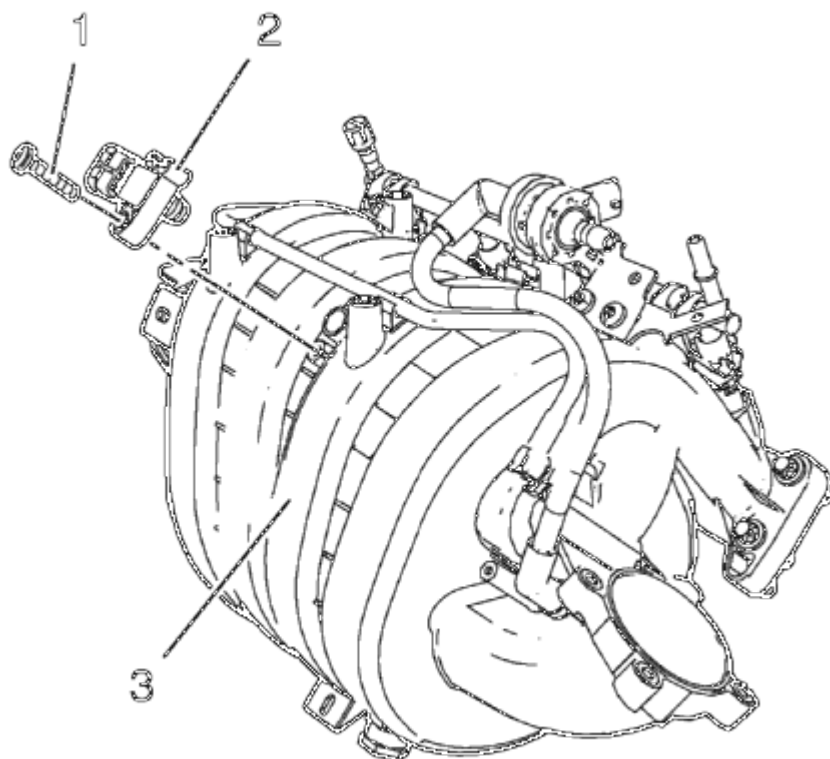
#### **Installation Procedure**

1. Clean the sealing surfaces.



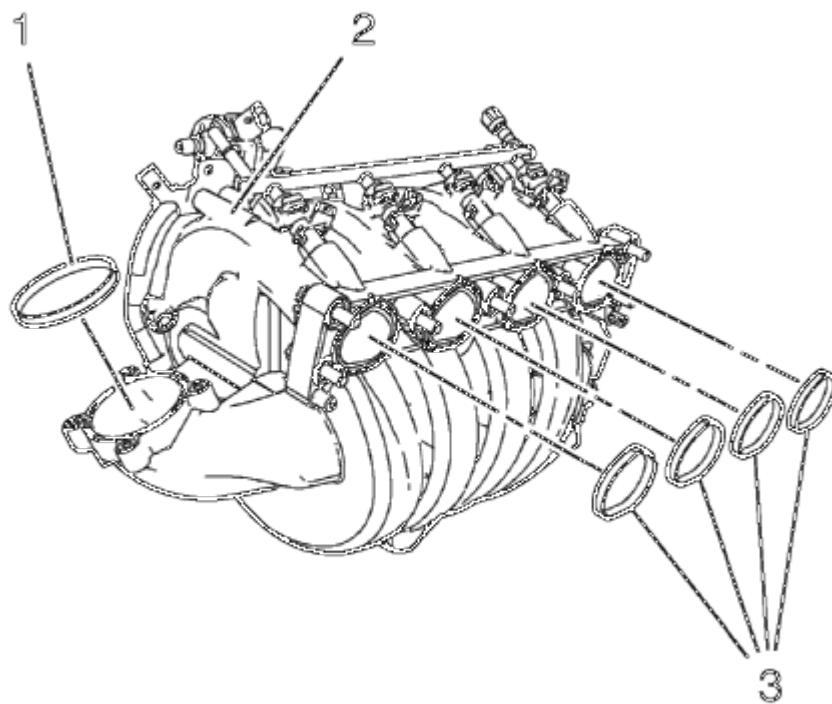
**Fig. 50: Intake Manifold And Mount**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the rubber bracket (2) to intake manifold (1).



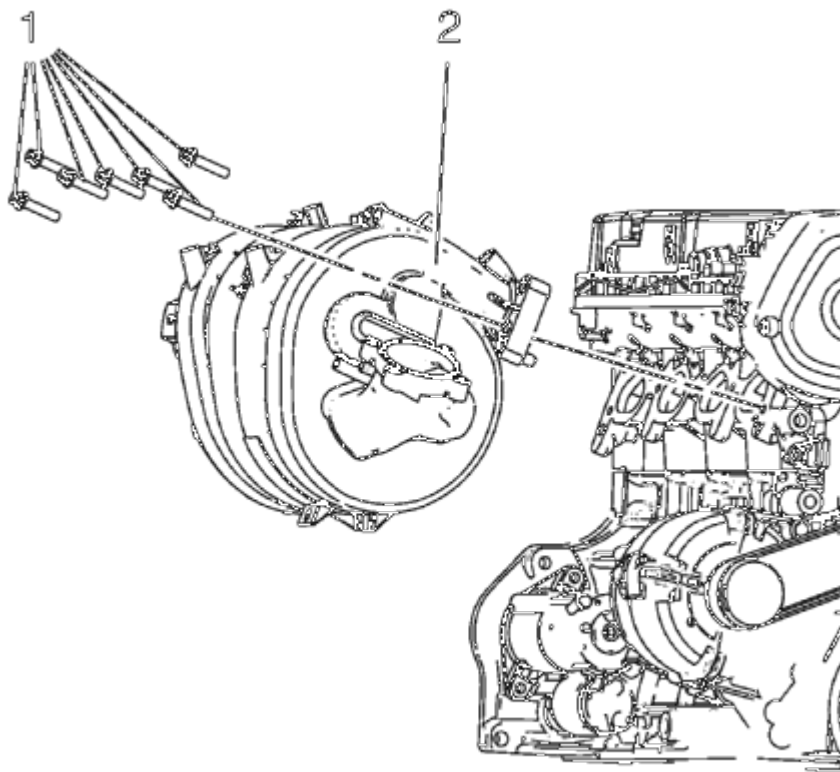
**Fig. 51: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the manifold absolute pressure sensor (2) to the intake manifold (3).
4. Install the manifold absolute pressure sensor bolt (1) and tighten to 6 N.m (53 lb in).



**Fig. 52: Intake Manifold, Intake Manifold Seal And Throttle Body Seal**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the NEW gaskets (1, 3) to the intake manifold (2).



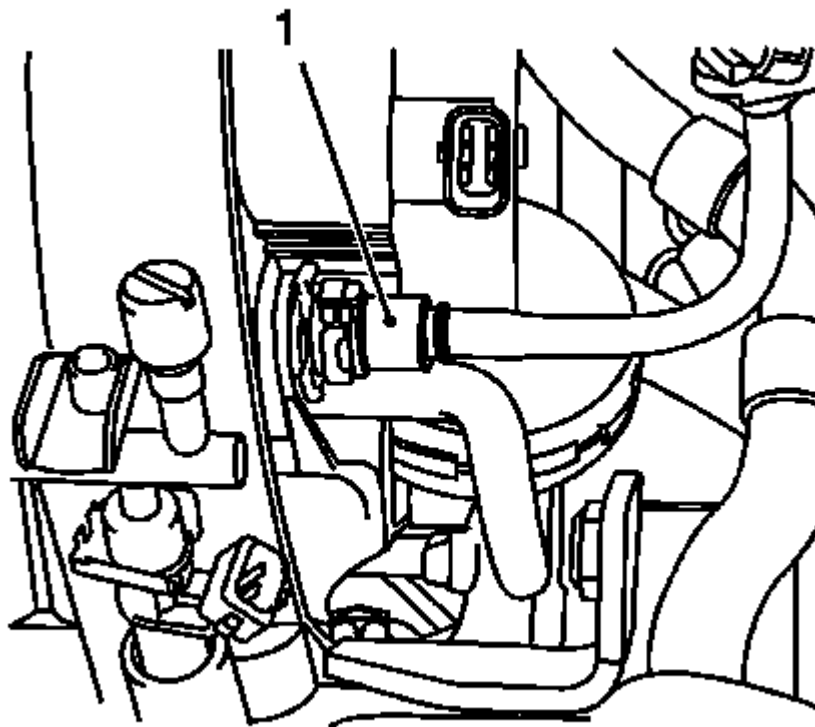
**Fig. 53: Intake Manifold And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

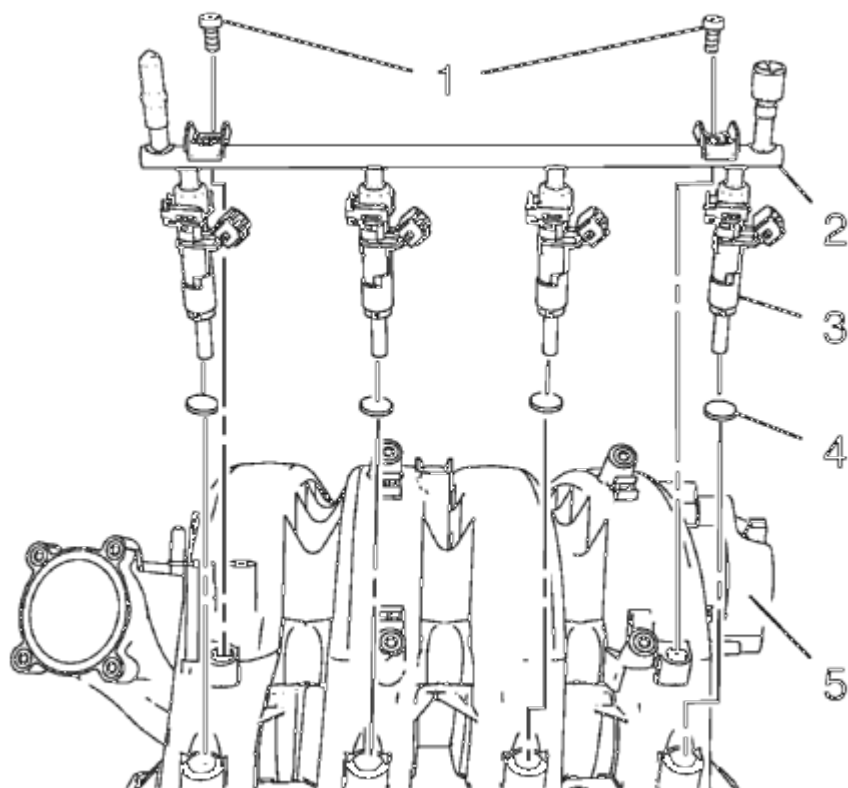
6. Install the intake manifold (2) and the 7 intake manifold bolts (1) and tighten to 20 N.m (15 lb ft).





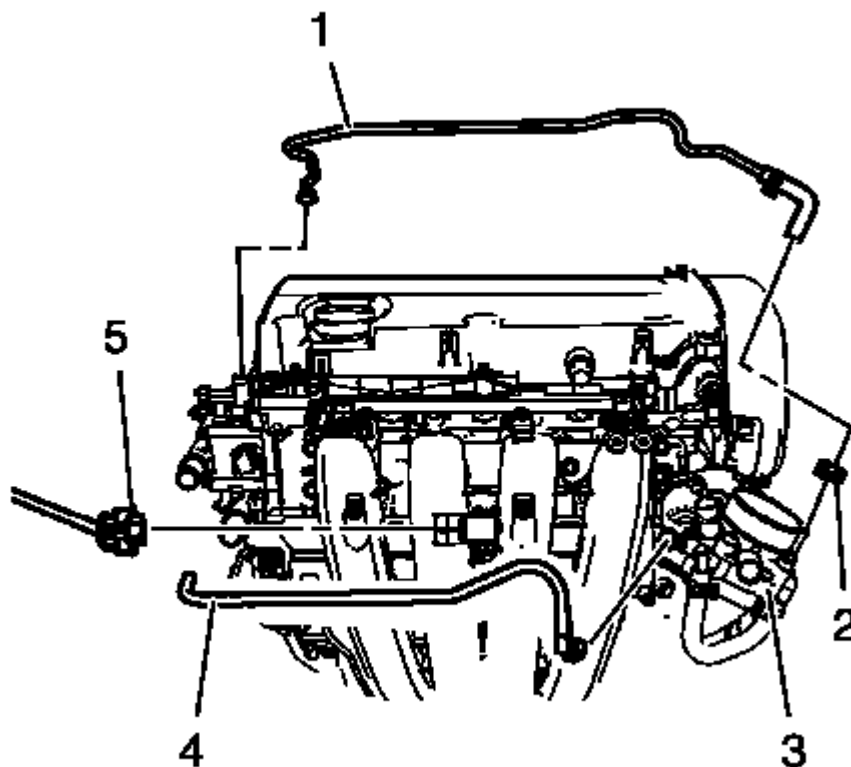
**Fig. 54: Brake Servo Vacuum Line**  
Courtesy of GENERAL MOTORS COMPANY

7. Connect the booster vacuum pipe (1) to the intake manifold.



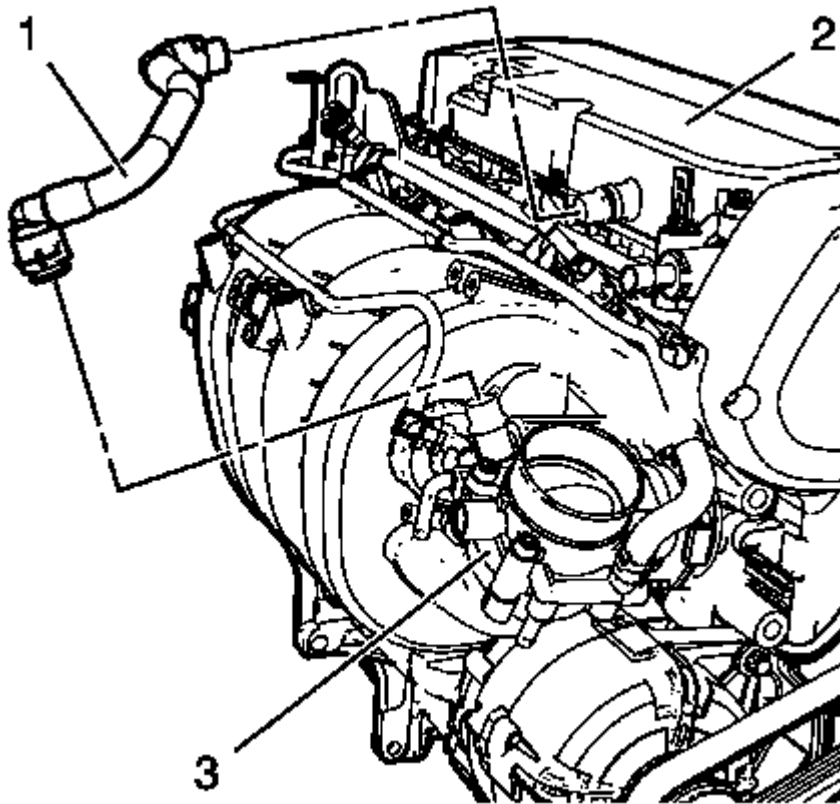
**Fig. 55: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

8. Install the 4 multiport fuel injector seals (4).
9. Install the multiport fuel injection fuel rail (2) and the fuel injectors (3) to the intake manifold (5).
10. Install the 2 multiport fuel injection fuel rail bolts (1) and tighten to 8 N.m (71 lb in).



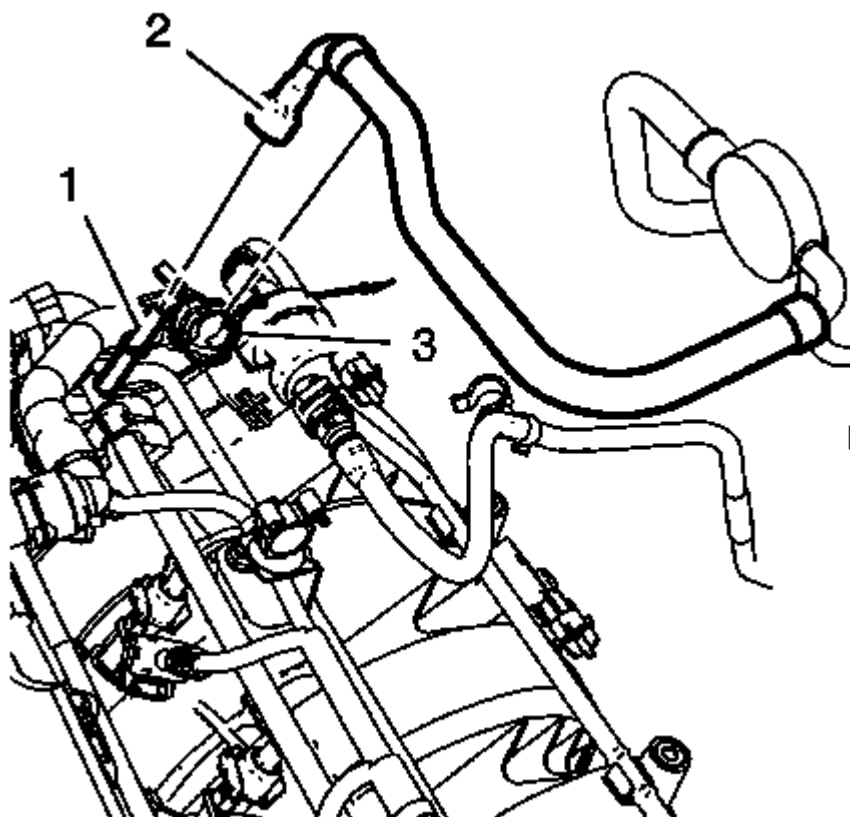
**Fig. 56: Throttle Body, Throttle Body Heater Inlet Hose And Throttle Body Heater Outlet Hose**  
Courtesy of GENERAL MOTORS COMPANY

11. Connect the throttle body heater outlet hose (4) to the throttle body (3).
12. Install the throttle body heater inlet hose (1) to the throttle body (3) and install the clamp (2).
13. Connect the manifold absolute pressure sensor wiring harness plug (5).
14. Install the engine management wiring harness and the fuel injectors wiring harness.



**Fig. 57: Throttle Body And Positive Crankcase Ventilation Tube**  
 Courtesy of GENERAL MOTORS COMPANY

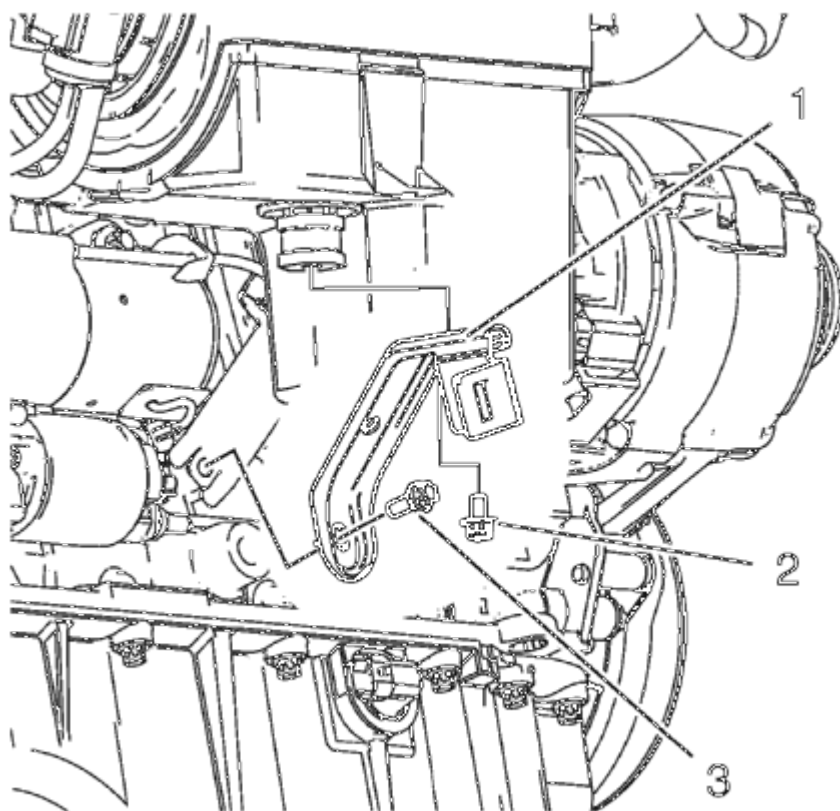
15. Install the positive crankcase ventilation tube (1) the to throttle body (3) and to the camshaft cover (2).
16. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement** .
17. Install the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**



**Fig. 58: Fuel Feed Pipe**

**Courtesy of GENERAL MOTORS COMPANY**

18. Remove the cap from fuel feed pipe (2).
19. Install the fuel feed pipe (2) to the multiport fuel injection fuel rail (1).
20. Clip the fuel feed pipe (2) to the fuel feed pipe clip (3).



**Fig. 59: Intake Manifold Brace And Bolts**

Courtesy of GENERAL MOTORS COMPANY

21. Install the intake manifold brace (1).
22. Install and connect the wiring harness plug to the heated oxygen sensor 1.
23. Install the 2 intake manifold brace bolts (2, 3) and tighten to 8 N.m (71 lb in).
24. Lower the vehicle.
25. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
26. Close the hood.

## TIMING BELT REPLACEMENT

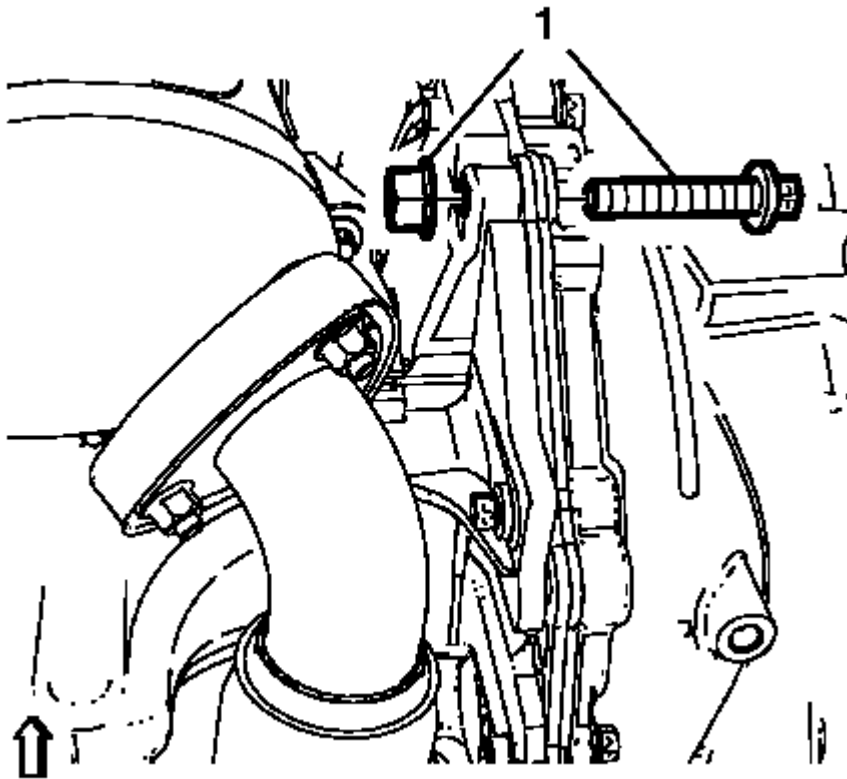
### Special Tools

- **EN-6333** Timing Belt Tensioner Locking Pin
- **EN-6340** Camshaft Locking Tool
- **EN-6625** Crankshaft Locking Device
- **EN-45059** Anglemeter

For equivalent regional tools, refer to [Special Tools](#).

**Removal Procedure**

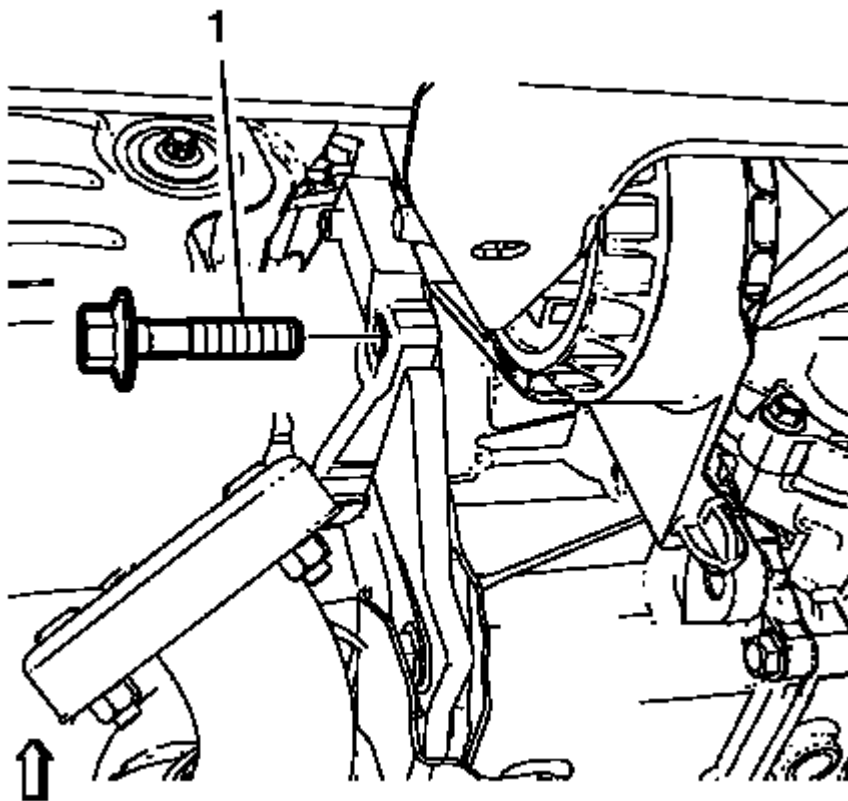
1. Open the hood.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal** .
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
6. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** .
7. Remove the front compartment insulator. Refer to **Front Compartment Insulator Replacement** .
8. Set the engine to top dead center (TDC).
9. For vehicle with manual transmission: Remove the transmission front mount. Refer to **Transmission Front Mount Replacement** .



**Fig. 60: Connection Bolt**

Courtesy of GENERAL MOTORS COMPANY

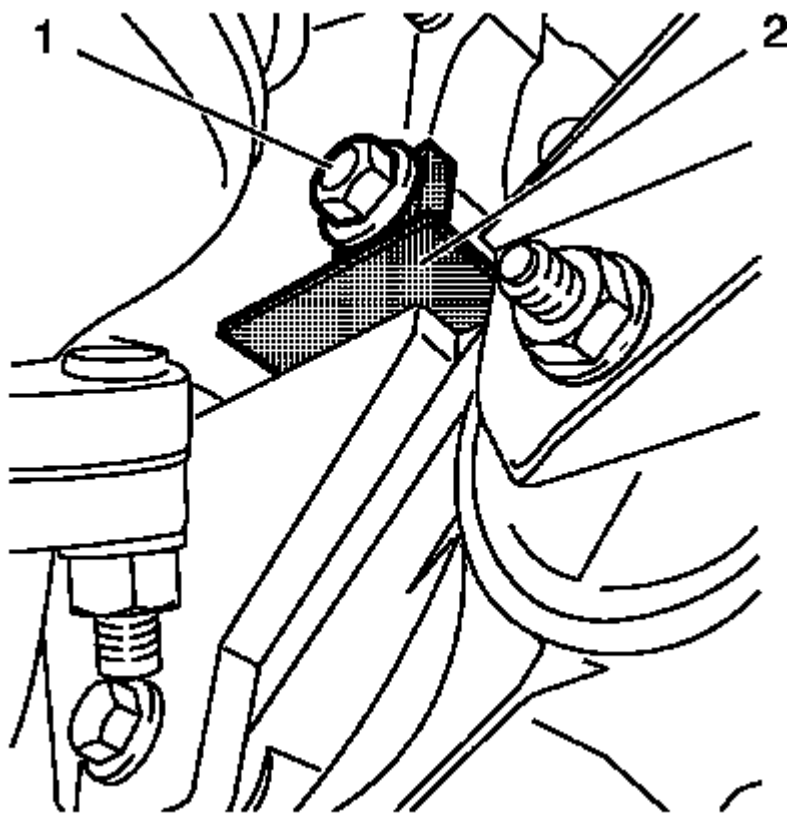
10. For vehicle with manual transmission: Remove the bolted connection (1).



**Fig. 61: Automatic Transmission Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

11. For vehicle with automatic transmission: Remove the bolt (1).

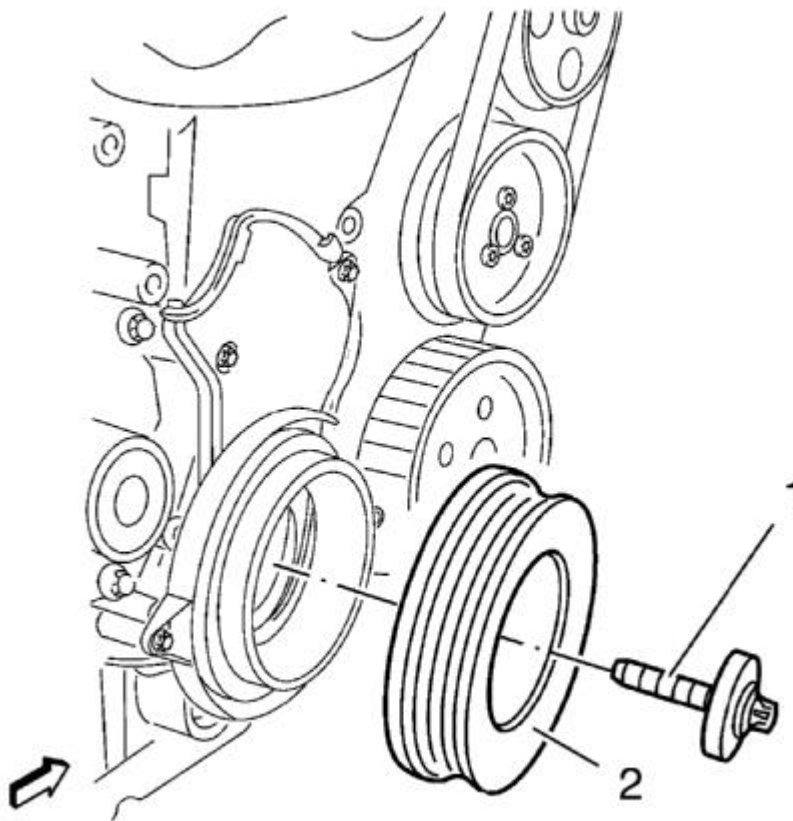




**Fig. 62: Locking Device And Bolt**

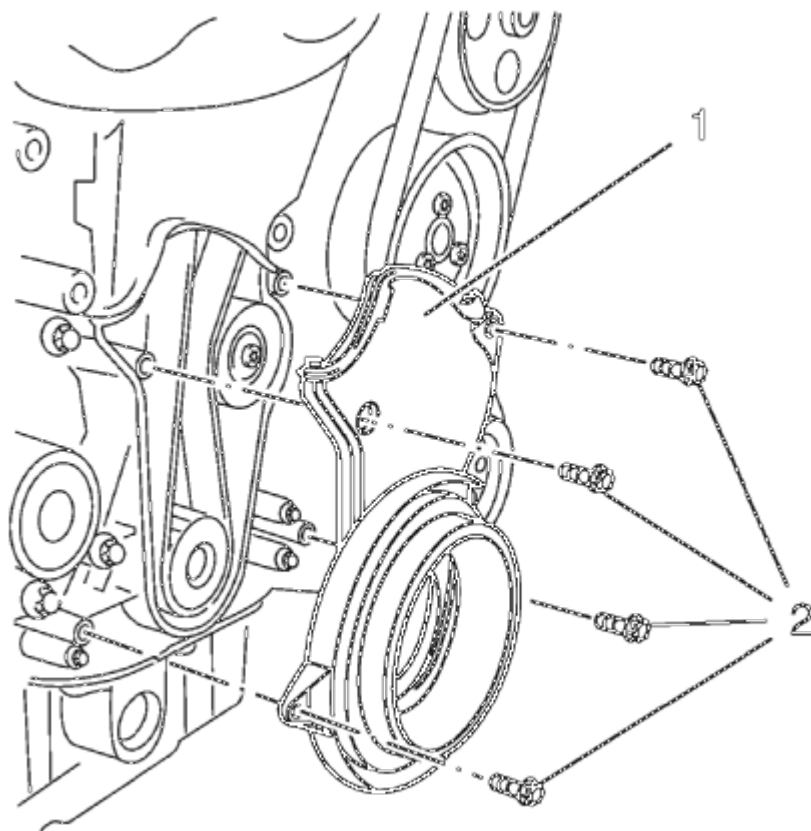
Courtesy of GENERAL MOTORS COMPANY

12. Install **EN-6625** locking device (2) to block the crankshaft.
13. Install the bolt or bolted connection (1).



**Fig. 63: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

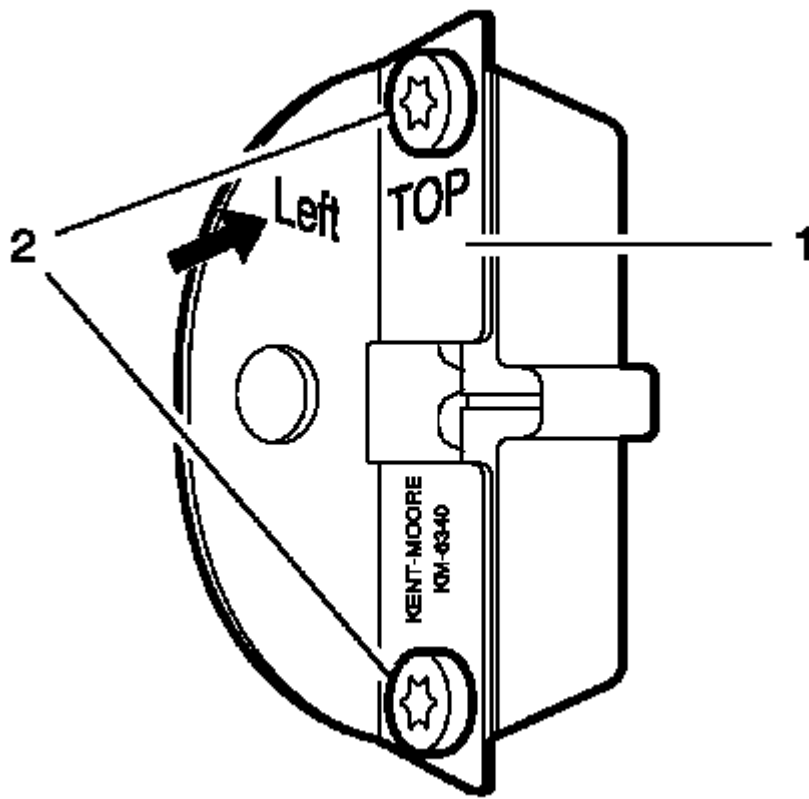
14. Remove and DISCARD the crankshaft balancer bolt (1).



**Fig. 64: Timing Belt Lower Front Cover**

Courtesy of GENERAL MOTORS COMPANY

15. Remove the 4 lower timing belt cover bolts (2).
16. Remove the lower timing belt cover (1).
17. Lower the vehicle.

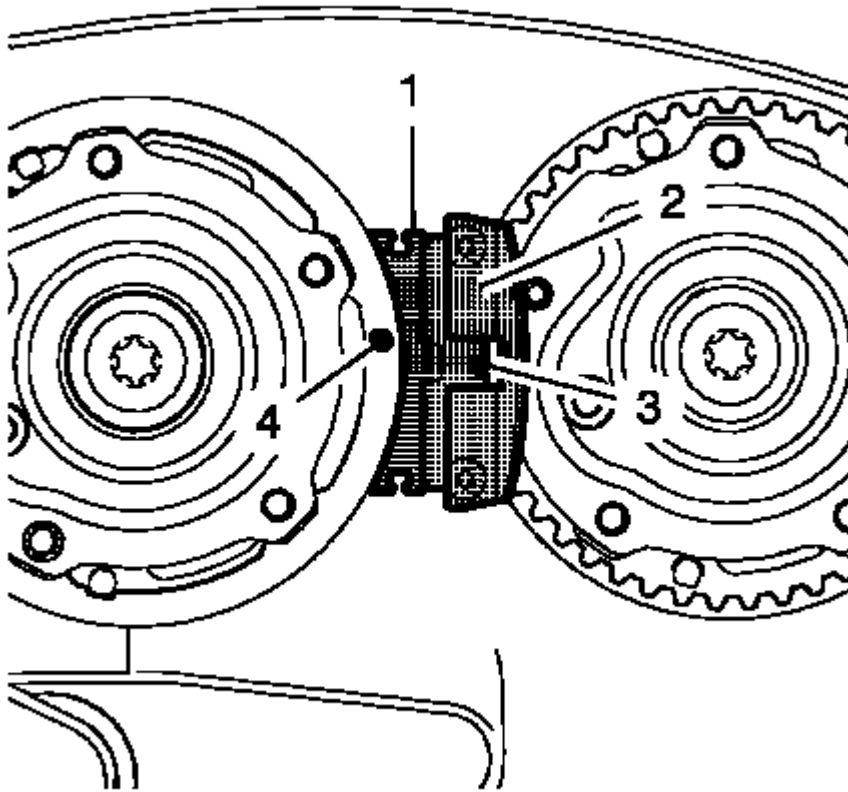


**Fig. 65: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The left half of the EN-6340 locking tool can be recognized by the lettering "left", arrow, on the tool.

18. Prepare the left half of the EN-6340 locking tool.
  1. Remove the 2 bolts (2)
  2. Remove the front panel (1) from the EN-6340 locking tool - left.



**Fig. 66: Camshaft Adjuster Locking Tool**  
Courtesy of GENERAL MOTORS COMPANY

19. Install the **EN-6340** locking tool into the camshaft adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340-left during this process but must be somewhat above as shown.

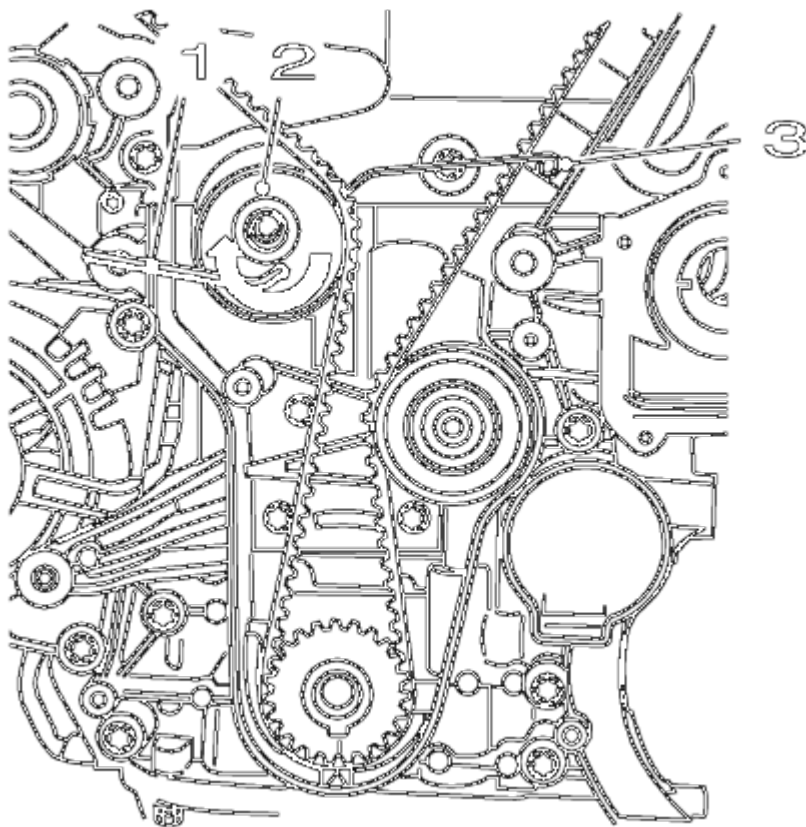
1. Install the **EN-6340** locking tool - left (1) in the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340-right.

2. Install **EN-6340** locking tool - right (2) in the camshaft adjusters as shown.

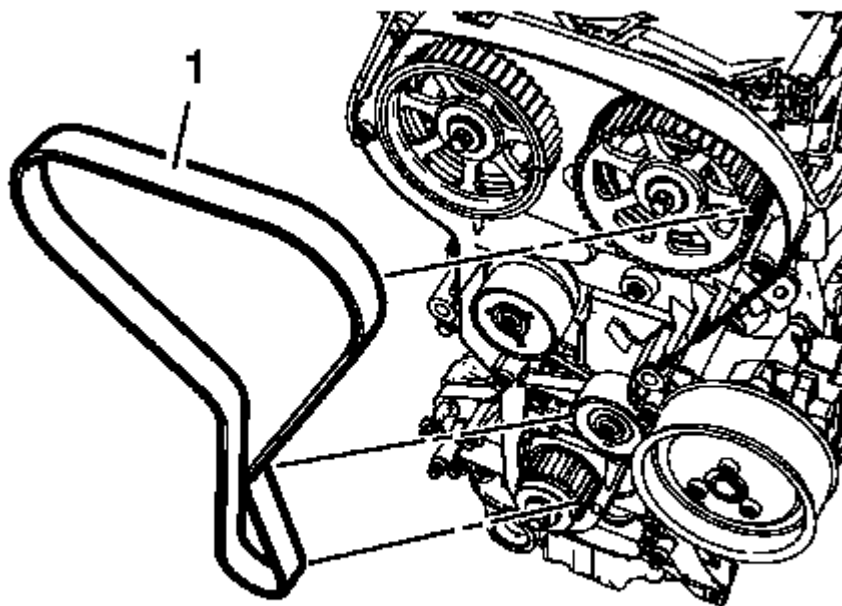
20. Remove **EN-6340** locking tool.

21. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



**Fig. 67: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

22. Apply tension to the drive belt tensioner (2) in the direction of the arrow, using an allen key (1).
23. Install the **EN-6333** locking pin (3).
24. Remove the timing belt idler pulley. Refer to **Timing Belt Idler Pulley Replacement**.

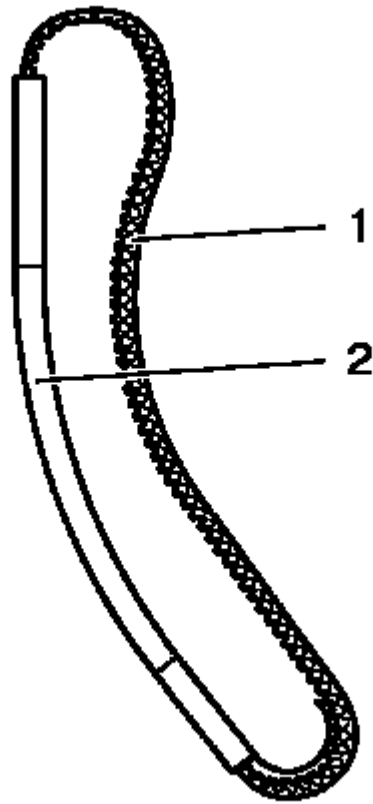


**Fig. 68: Drive Belt Routing**

Courtesy of GENERAL MOTORS COMPANY

25. Remove the timing belt (1).

#### Installation Procedure



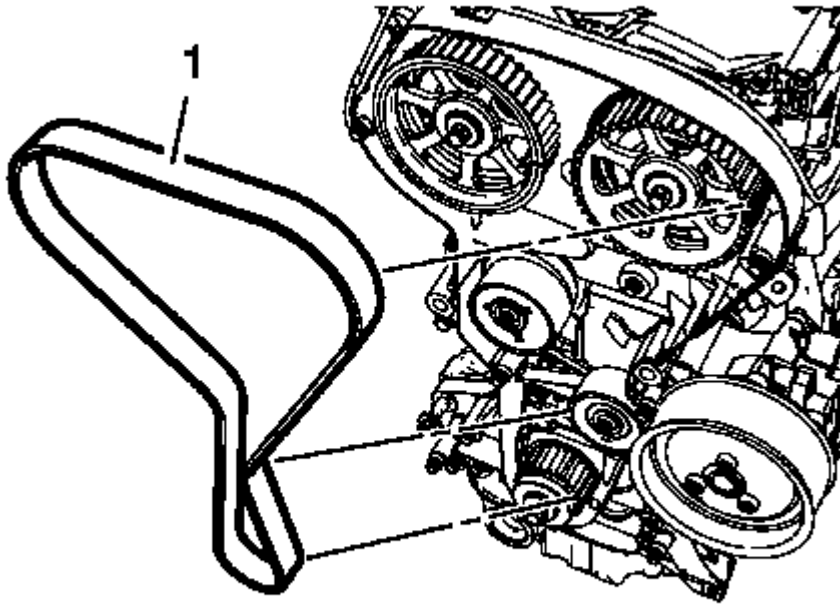
**Fig. 69: Timing Belt And Assembly Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Threading the timing belt through the engine mount bracket is only permissible in conjunction with the assembly tool supplied with NEW timing belts or otherwise it is possible to damage the toothed belt at this stage by kinking it.

**NOTE:** If the toothed belt has been used, observe the direction of rotation.

1. Install the timing belt (1) in the enclosed assembly tool (2).
2. Guide the timing belt through the engine mount bracket with the assembly tool.
3. Remove the assembly tool.

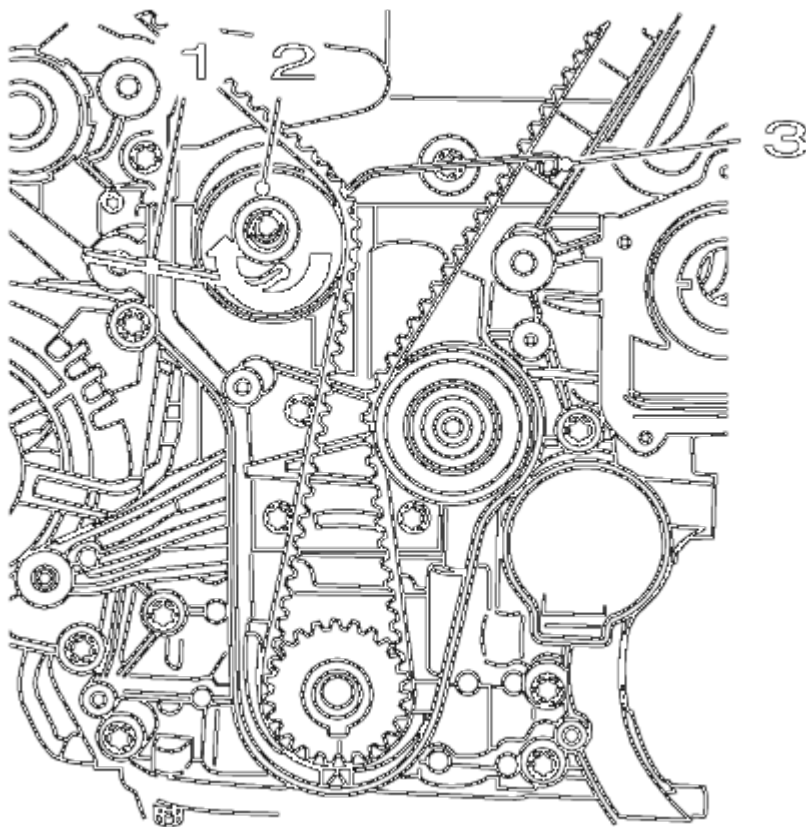




**Fig. 70: Drive Belt Routing**

Courtesy of GENERAL MOTORS COMPANY

4. Install the timing belt (1).
5. Guide the timing belt past the tensioner and place it on the crankshaft sprocket wheel.
6. Place the timing belt on the exhaust and intake camshaft position actuator adjusters.
7. Raise and support the vehicle.
8. Install the timing belt idler pulley. Refer to **Timing Belt Idler Pulley Replacement**.

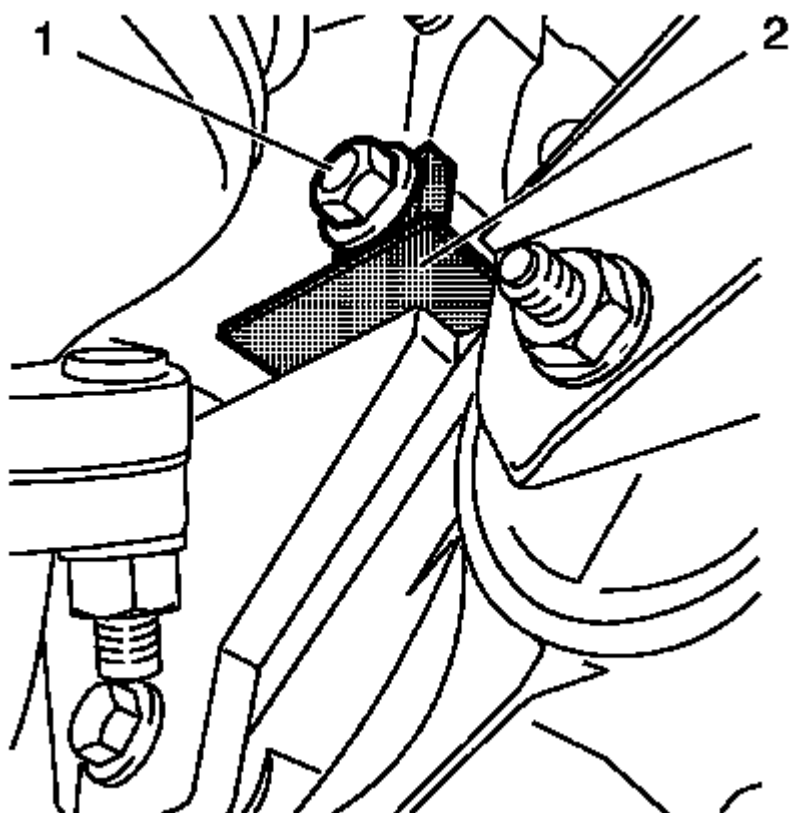


**Fig. 71: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

9. Apply tension to the drive belt tensioner (2) in the direction of the arrow, using an allen key (1).
10. Remove the **EN-6333** locking pin (3).

**NOTE:**        **The timing belt tensioner moves automatically to the correct position.**

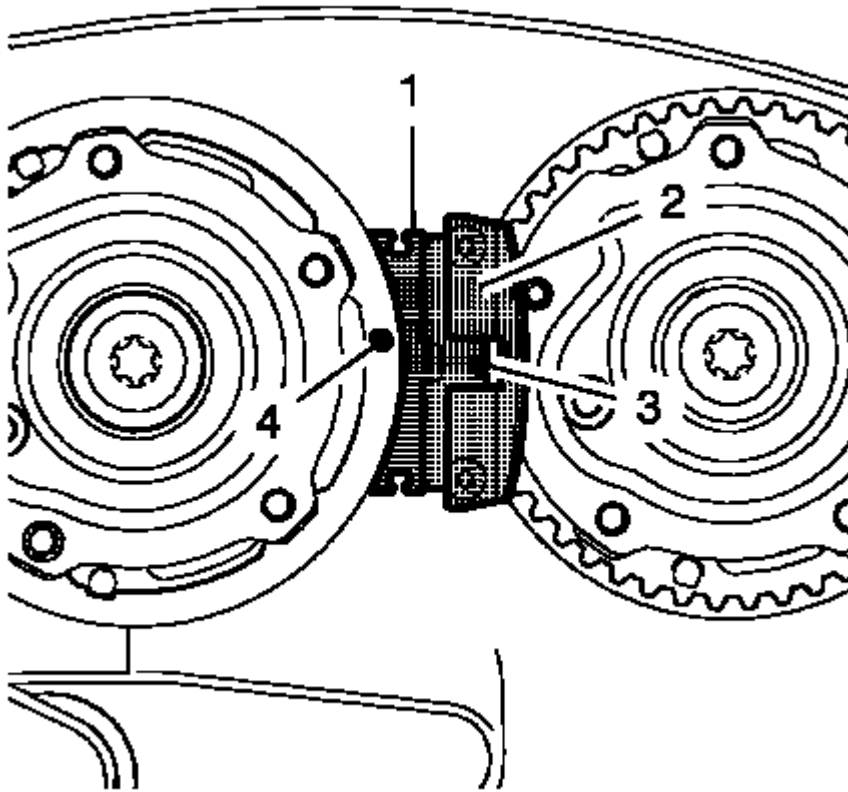
11. Release tension on timing belt tensioner.



**Fig. 72: Locking Device And Bolt**

Courtesy of GENERAL MOTORS COMPANY

12. Remove bolt or bolted connection (1).
13. Remove **EN-6625** locking device (2).
14. Lower the vehicle.
15. Remove the **EN-6340** locking tool.



**Fig. 73: Camshaft Adjuster Locking Tool**  
Courtesy of GENERAL MOTORS COMPANY

16. Check the timing

**NOTE:** Note the marking at the camshaft sprockets.

1. Turn the crankshaft 720° in the direction of engine rotation by the crankshaft balancer bolt.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340-left during this process but must be somewhat above as shown.

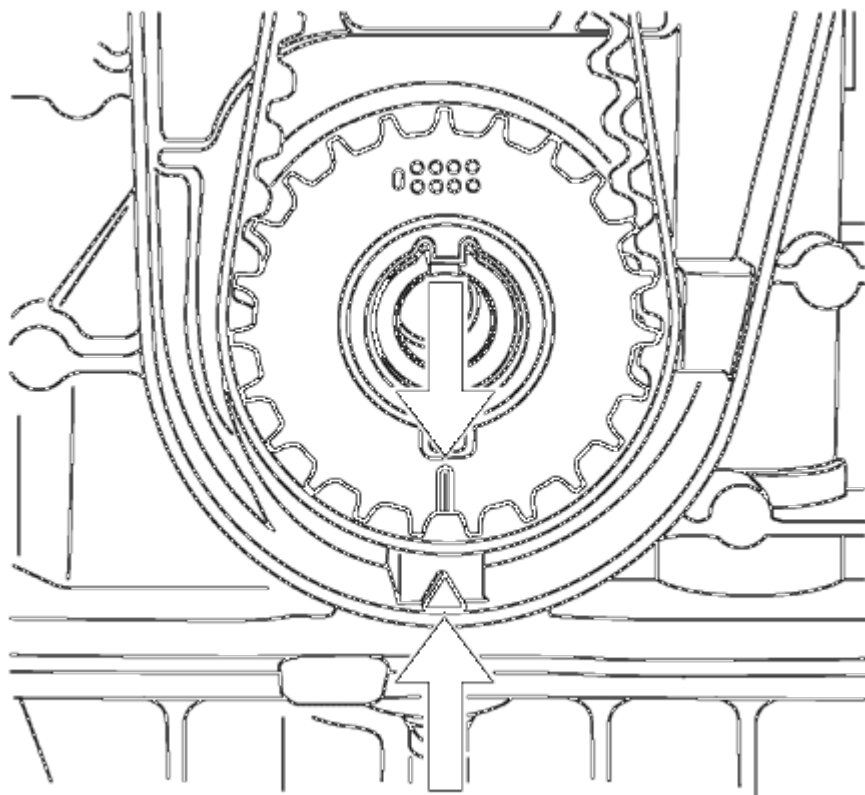
2. Install EN-6340-left locking tool (1) into the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340-right.

3. Install EN-6340-right locking tool (2) into the camshaft adjusters as shown.

17. Remove the EN-6340 locking tool.

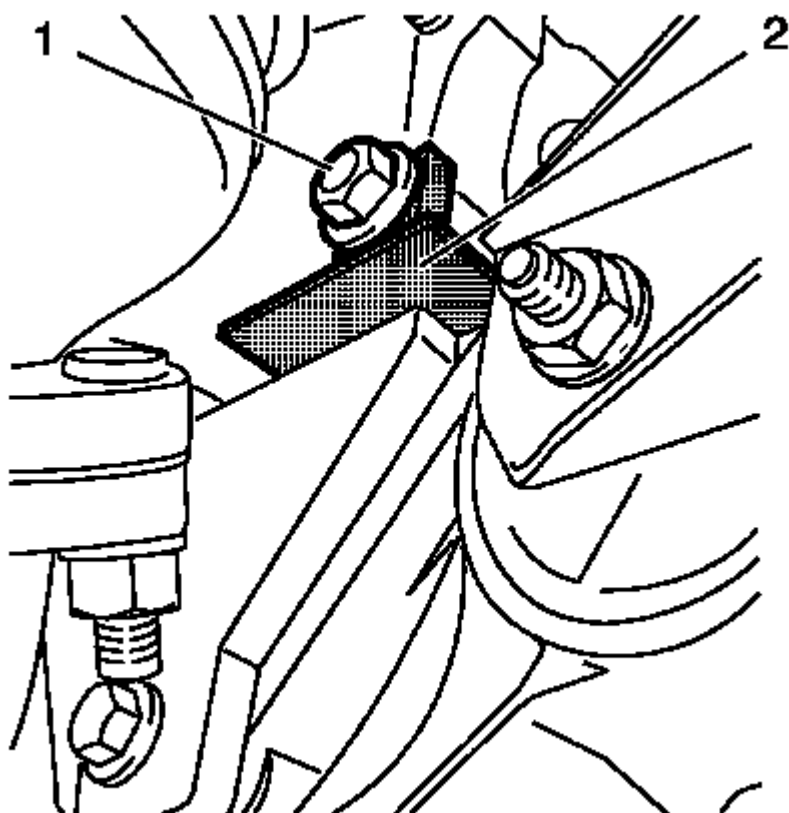
18. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.



**Fig. 74: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The timing belt drive gear and oil pump housing must align.

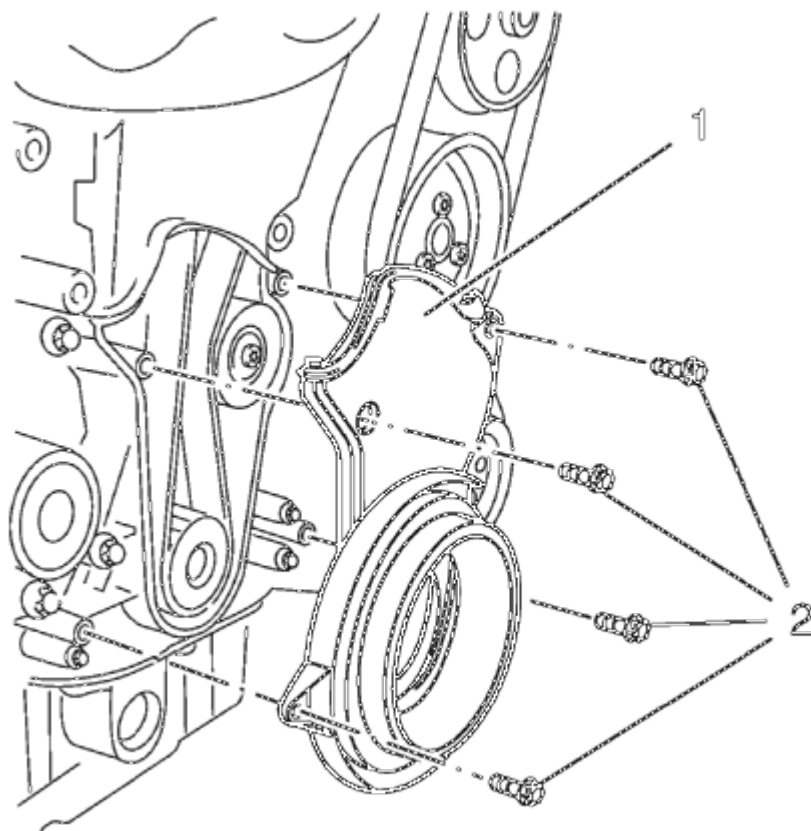
19. Control the crankshaft balancer position.



**Fig. 75: Locking Device And Bolt**

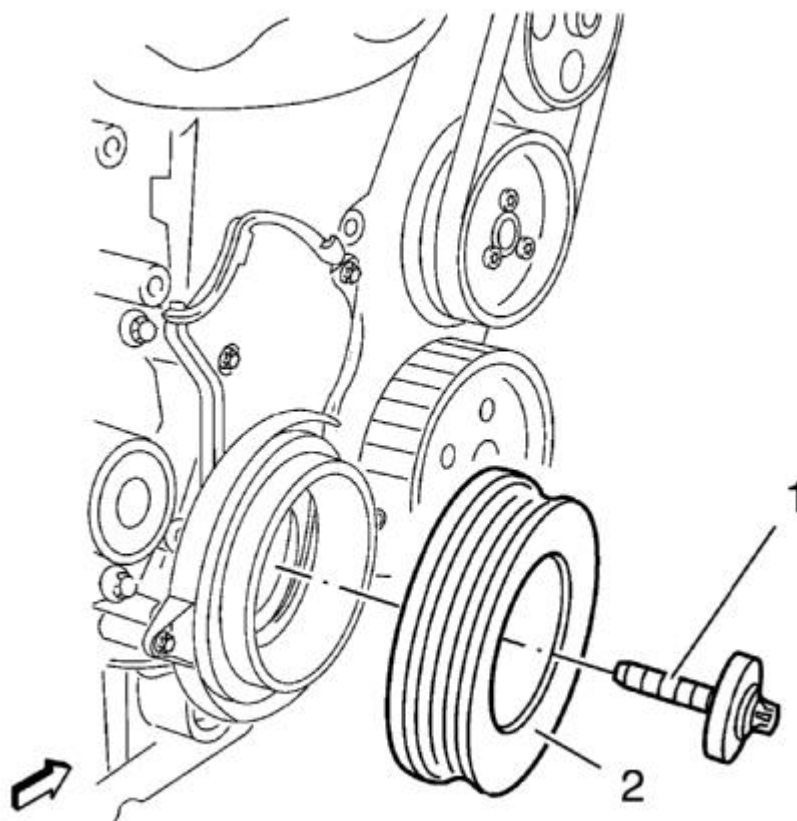
Courtesy of GENERAL MOTORS COMPANY

20. Install **EN-6625** locking device (2) to block the crankshaft.
21. Install the bolt or bolted connection (1).



**Fig. 76: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

22. Install the lower timing belt cover (1).
23. Install the 4 lower timing belt cover bolts (2) and tighten to 6 N.m (53 lb in).



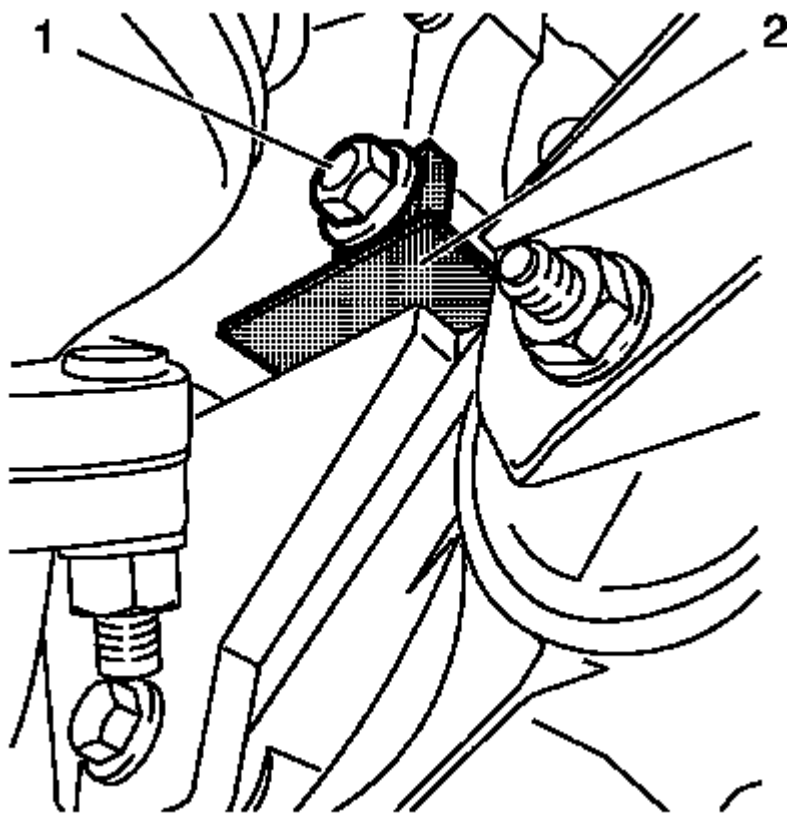
**Fig. 77: Crankshaft Balancer And Bolt**

Courtesy of GENERAL MOTORS COMPANY

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

24. Install the crankshaft balancer (2).
25. Install a NEW crankshaft balancer bolt (1) and tighten in 3 passes using the **EN-45059** meter :
  1. First pass to 95 N.m (70 lb ft)
  2. Second pass to 45°
  3. Third pass to 15°

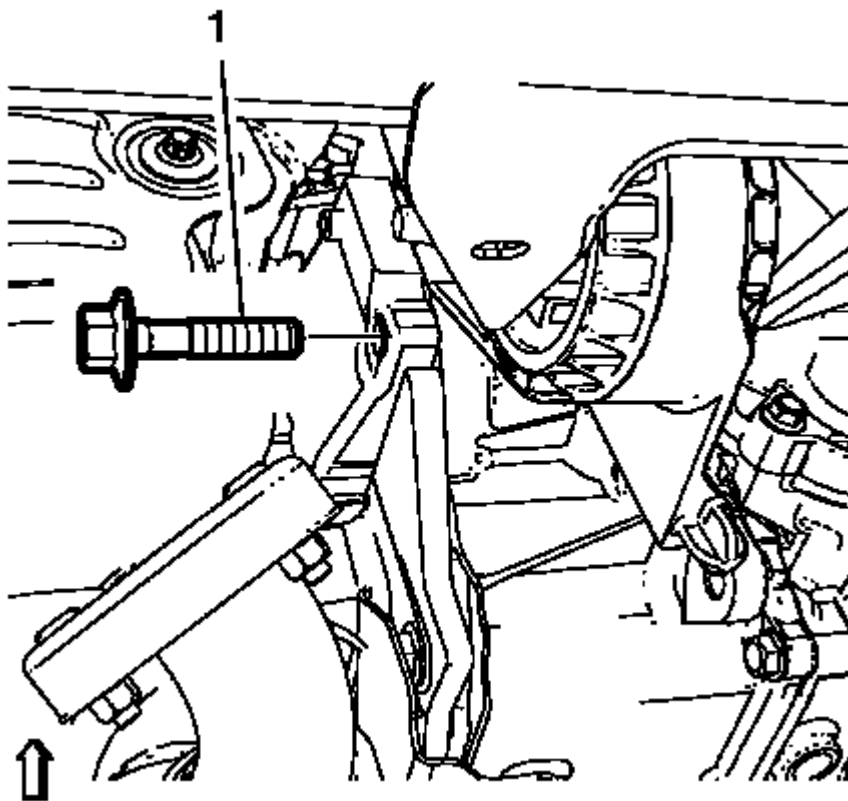




**Fig. 78: Locking Device And Bolt**

Courtesy of GENERAL MOTORS COMPANY

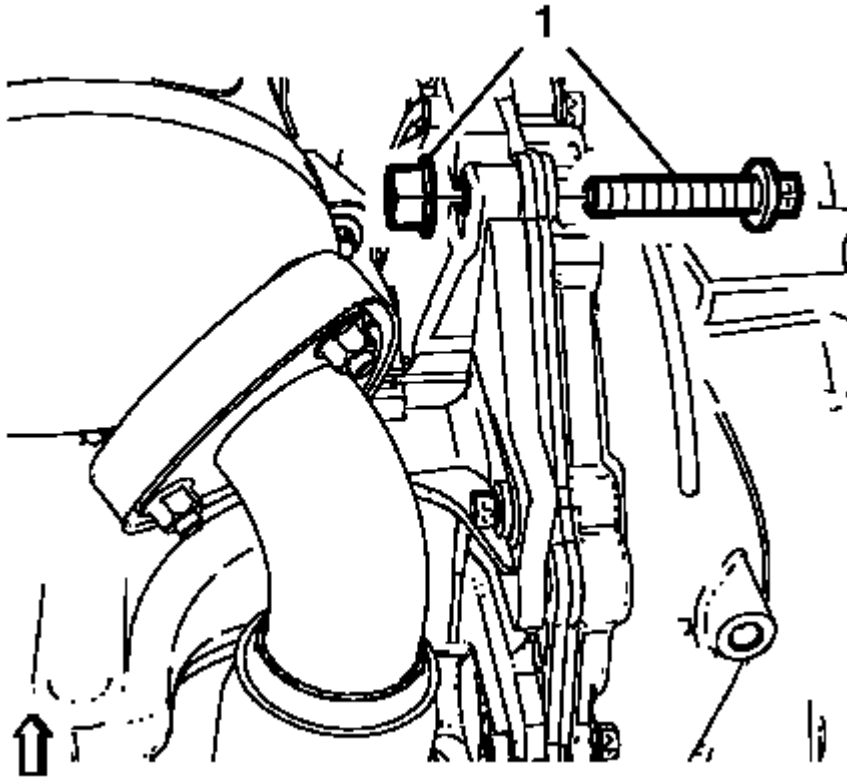
26. Remove bolt or bolted connection (1).
27. Remove **EN-6625** locking device (2).



**Fig. 79: Automatic Transmission Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

28. For vehicle with automatic transmission: Install the bolt (1) and tighten to 45 N.m (33 lb ft).



**Fig. 80: Connection Bolt**

Courtesy of GENERAL MOTORS COMPANY

29. For vehicle with manual transmission: Install the bolt (1) and tighten to 40 N.m (32 lb ft).
30. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
31. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement**.
32. Lower the vehicle.
33. Remove the **EN-6340** locking tool.
34. Install the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Installation**.
35. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
36. Close the hood.

## TIMING BELT IDLER PULLEY REPLACEMENT

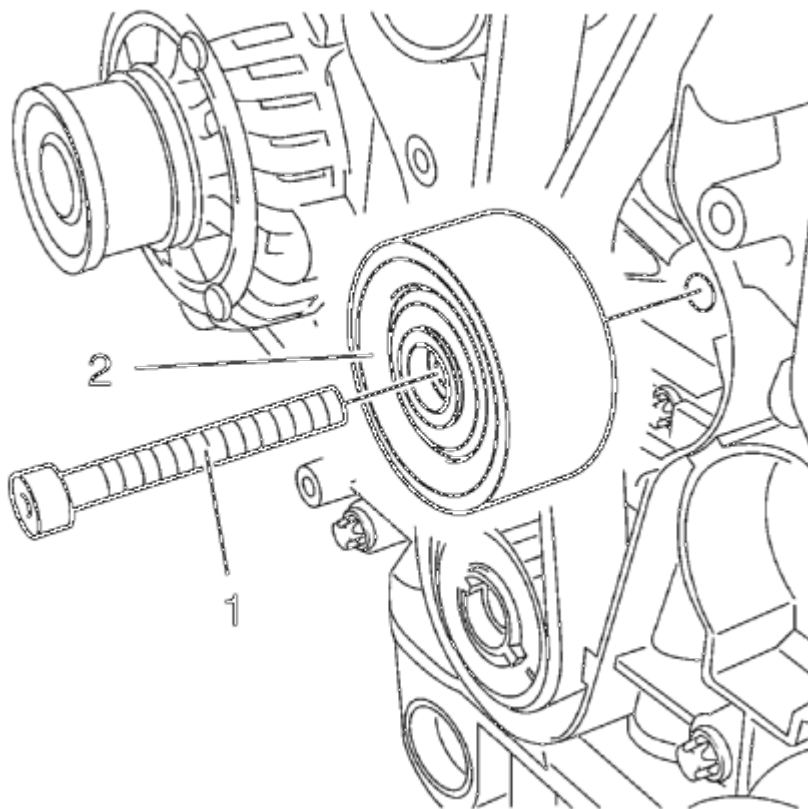
### Special Tools

**EN-45059** Angle Meter

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

### Removal Procedure

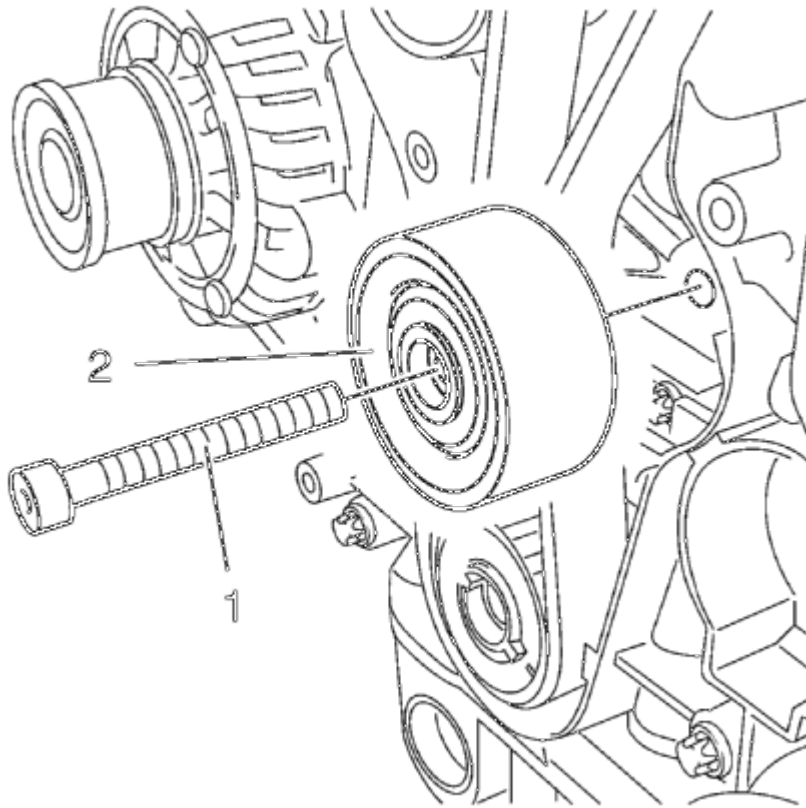
1. Remove the timing belt. Refer to **Timing Belt Replacement**.



**Fig. 81: Timing Belt Idler Pulley Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the timing belt idler pulley bolt (2).
3. Remove the timing belt idler pulley (1).

#### **Installation Procedure**



**Fig. 82: Timing Belt Idler Pulley Bolt**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

1. Install the timing belt idler pulley (1) and tighten the NEW bolt (2) in three passes use the **EN-45059** meter :
  1. First pass tighten to 20 N.m (15 lb ft).
  2. Second pass to 120 degrees.
  3. Final pass to 15 degrees.
2. Install the timing belt. Refer to Timing Belt Replacement.

## **TIMING BELT TENSIONER REPLACEMENT**

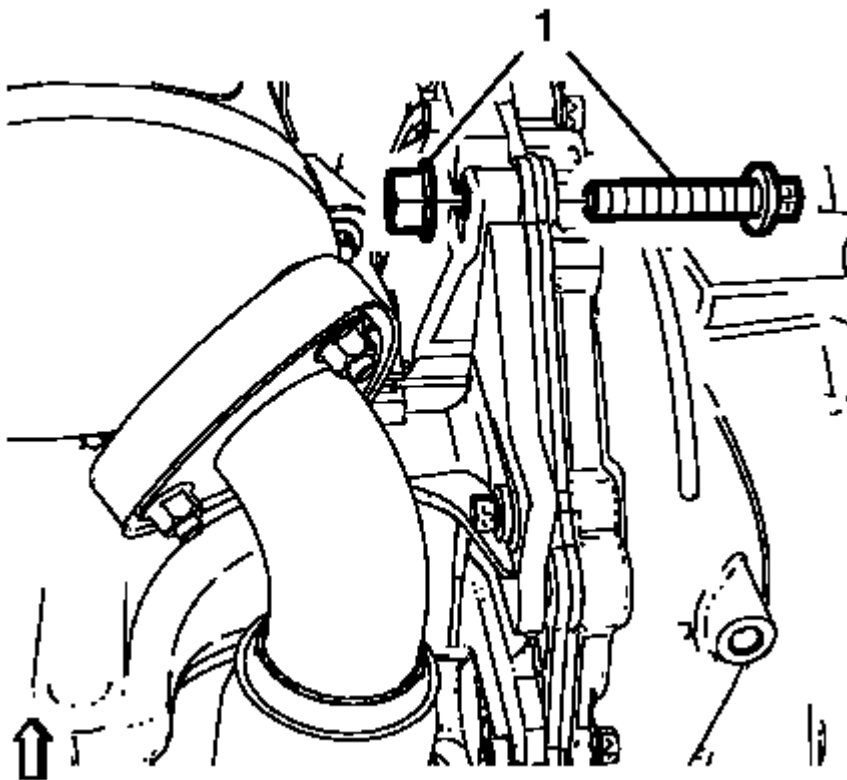
### **Special Tools**

- **EN-6333** Timing Belt Tensioner Locking Pin
- **EN-6340** Camshaft Locking Tool
- **EN-6625** Crankshaft Locking Device
- **EN-45059** Torque Angle Sensor Kit

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

#### **Removal Procedure**

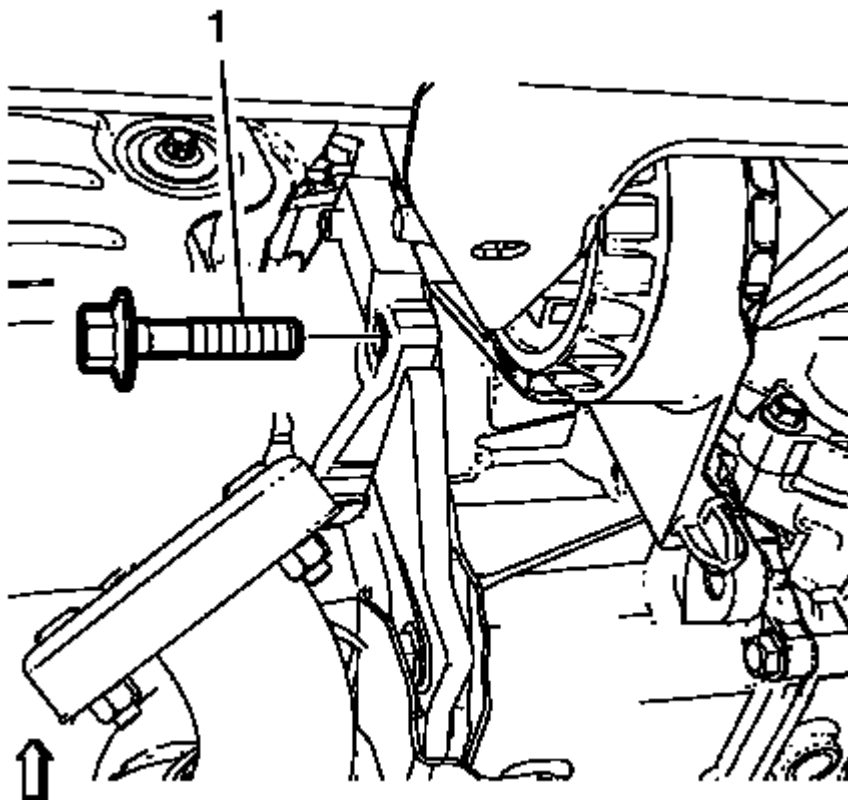
1. Open the hood.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
6. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
7. Remove the front compartment insulator. Refer to **Front Compartment Insulator Replacement** .
8. Set the engine to top dead center (TDC).
9. For vehicle with manual transmission: Remove the transmission front mount. Refer to **Transmission Front Mount Replacement** .



**Fig. 83: Connection Bolt**

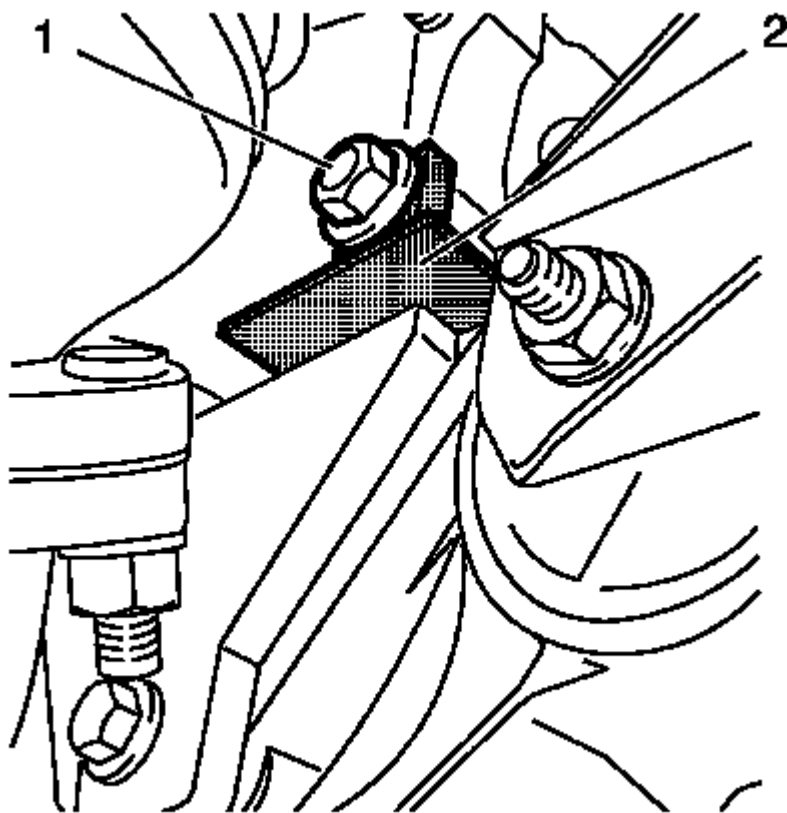
Courtesy of GENERAL MOTORS COMPANY

10. For vehicle with manual transmission: Remove the bolted connection (1).

**Fig. 84: Automatic Transmission Bracket Bolt**

Courtesy of GENERAL MOTORS COMPANY

11. For vehicle with automatic transmission: Remove the bolt (1).

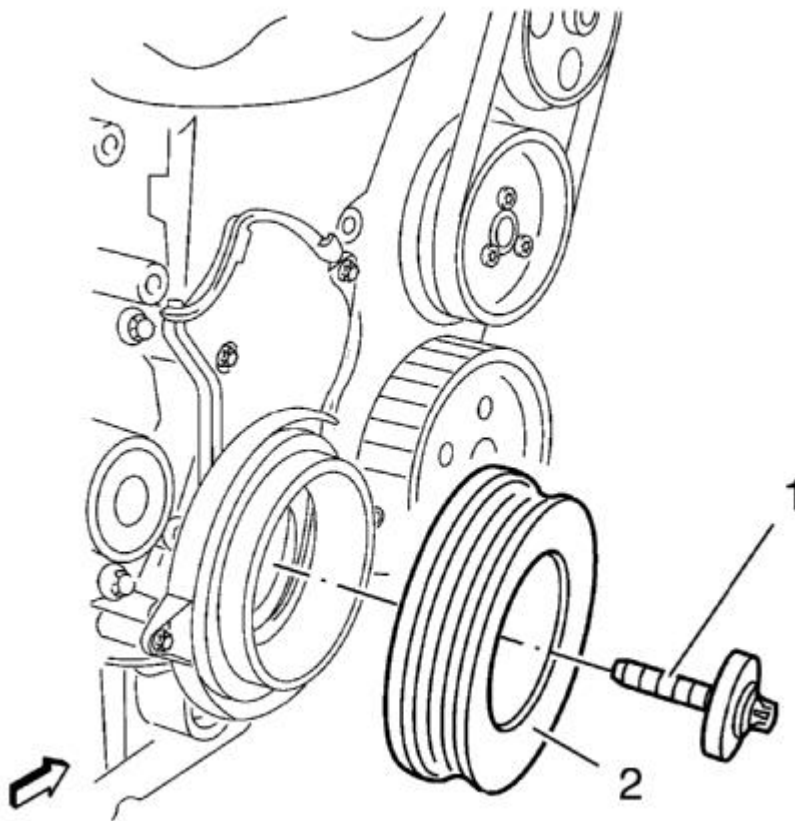


**Fig. 85: Locking Device And Bolt**

Courtesy of GENERAL MOTORS COMPANY

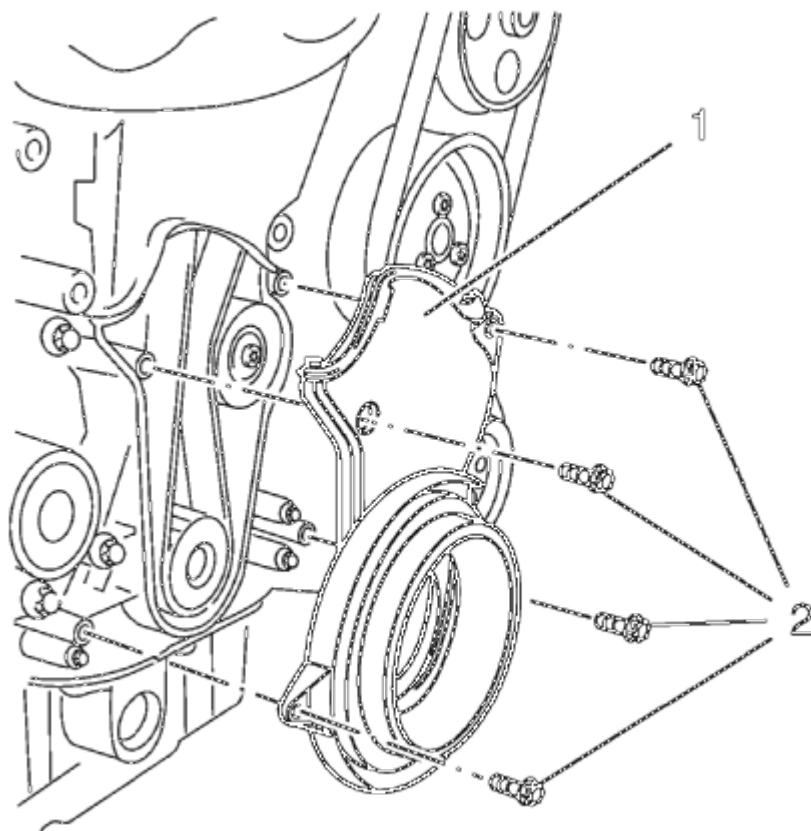
12. Install **EN-6625** locking device (2) to block the crankshaft.
13. Install the bolt or bolted connection (1).





**Fig. 86: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

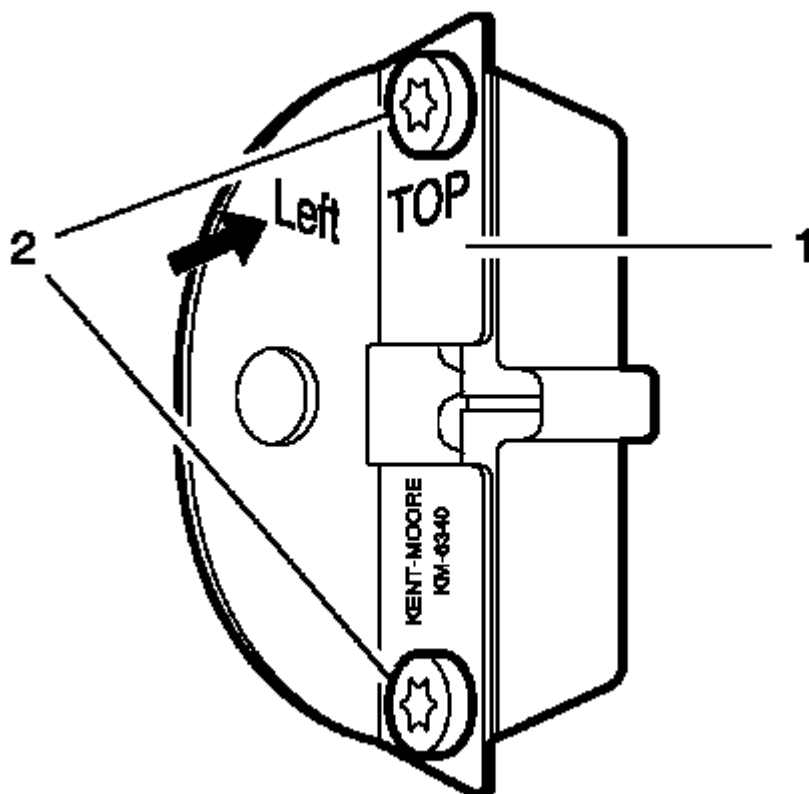
14. Remove and DISCARD the crankshaft balancer bolt (1).



**Fig. 87: Timing Belt Lower Front Cover**

Courtesy of GENERAL MOTORS COMPANY

15. Remove the 4 lower timing belt cover bolts (2).
16. Remove the lower timing belt cover (1).
17. Lower the vehicle.

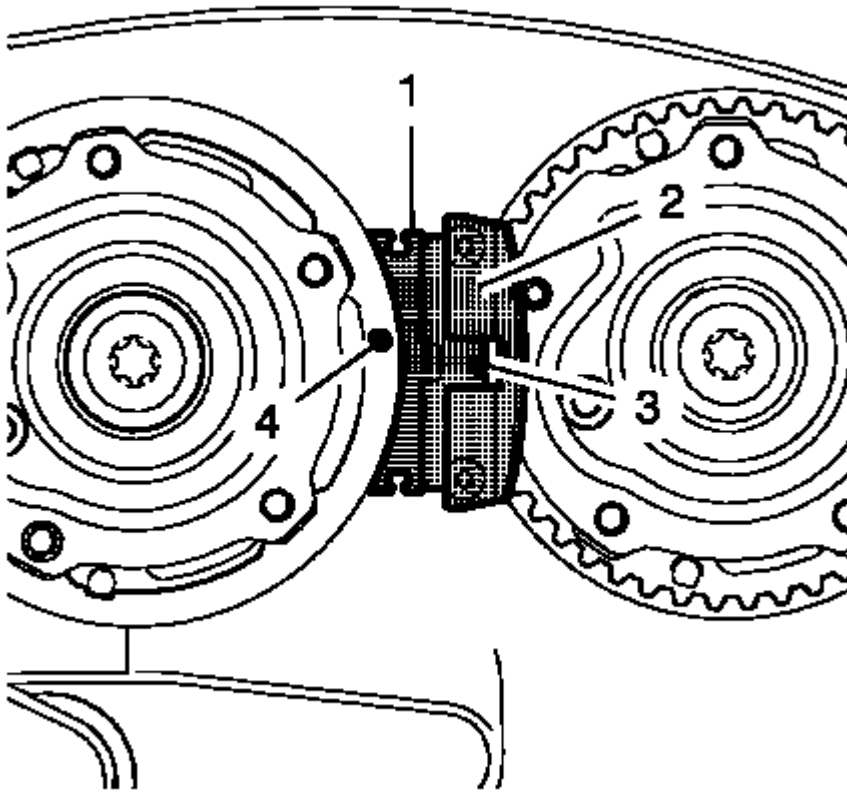


**Fig. 88: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The left half of the EN-6340 locking tool can be recognized by the lettering "left", arrow, on the tool.

18. Prepare the left half of the EN-6340 locking tool.
  1. Remove the 2 bolts (2)
  2. Remove the front panel (1) from the EN-6340 locking tool - left.



**Fig. 89: Camshaft Adjuster Locking Tool**  
Courtesy of GENERAL MOTORS COMPANY

19. Install the **EN-6340** locking tool into the camshaft adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340-left during this process but must be somewhat above as shown.

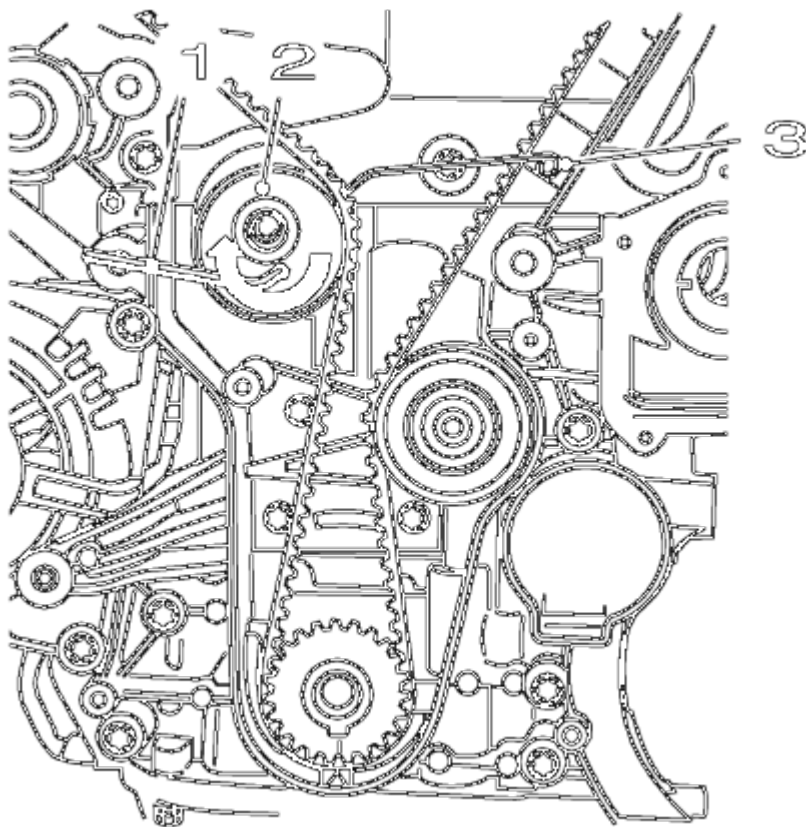
1. Install the **EN-6340** locking tool - left (1) in the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340-right.

2. Install **EN-6340** locking tool - right (2) in the camshaft adjusters as shown.

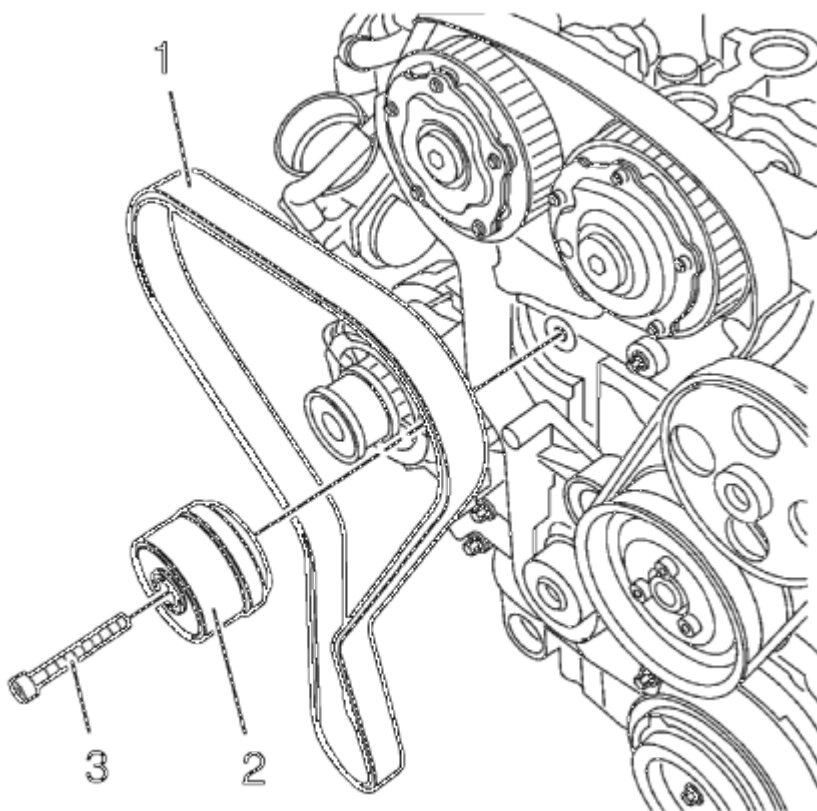
20. Remove **EN-6340** locking tool.

21. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



**Fig. 90: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

22. Apply tension to the drive belt tensioner (2) in the direction of the arrow, using an allen key (1).
23. Install the **EN-6333** locking pin (3).
24. Lower the vehicle.
25. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement**.
26. Remove the timing belt center front cover. Refer to **Timing Belt Center Front Cover Removal**.



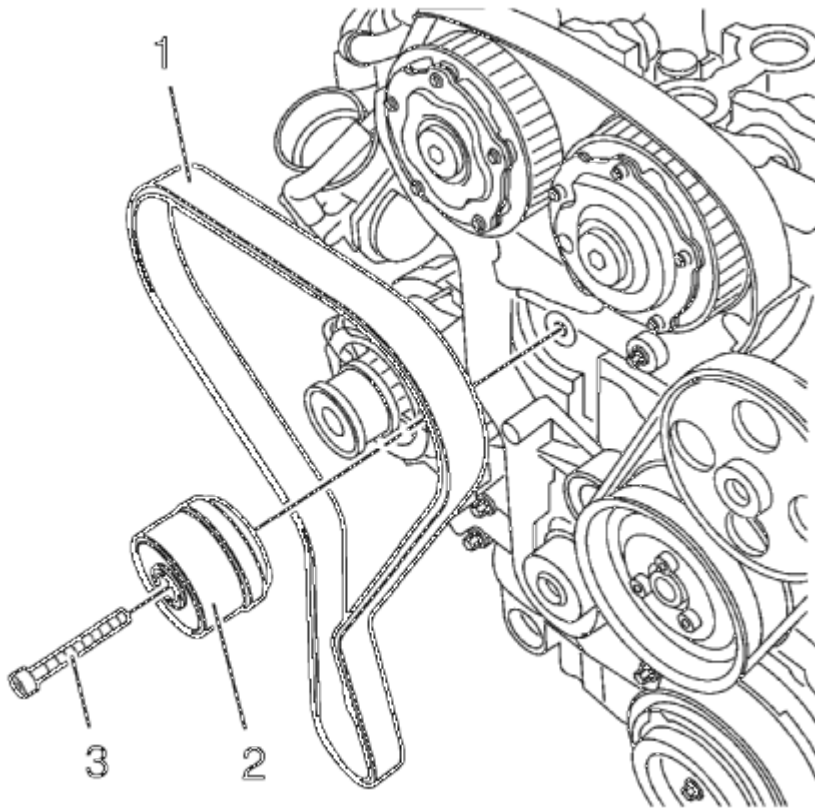
**Fig. 91: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Note the direction of the belt, if the timing belt will be reused.

27. Remove the timing belt (1).
28. Remove and DISCARD the timing belt tensioner bolt (3).
29. Remove the timing belt tensioner (2).

#### Installation Procedure

1. Re-cut the timing belt tensioner thread.



**Fig. 92: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

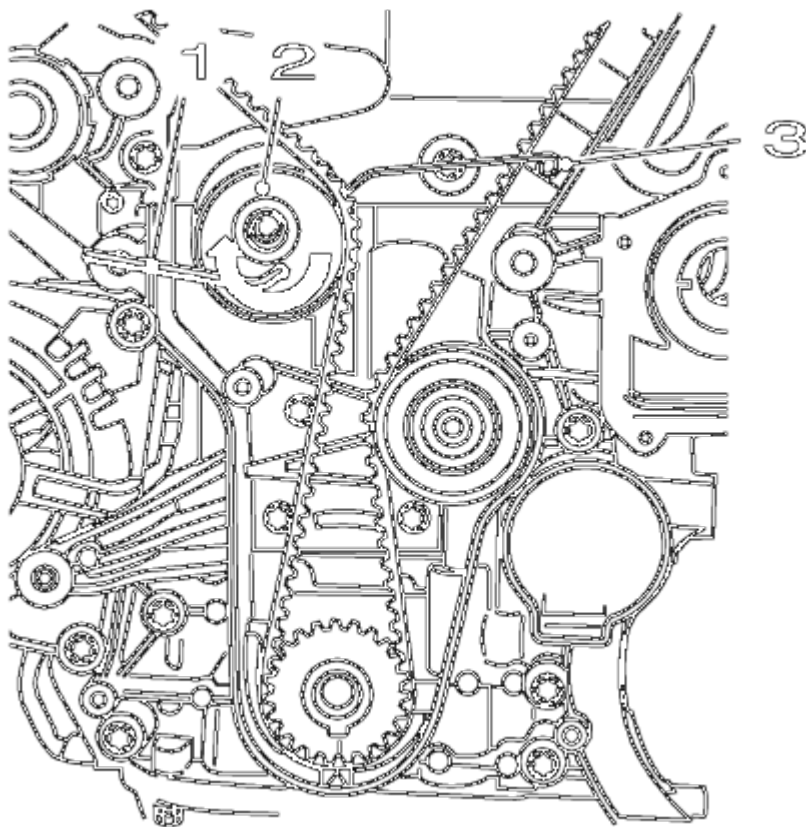
2. Install the timing belt tensioner (2).

**NOTE:** Service may offer bolts that are not microencapsulated. If this is the case apply thread lock agent to the bolt.

3. If fastener is microencapsulated, install a NEW timing belt tensioner bolt (3). DO NOT reuse the old bolt.

**CAUTION:** Refer to Fastener Caution .

4. Tighten the timing belt tensioner bolt to 20 N.m (15 lb ft).
5. Install the timing belt (1).
6. Guide the timing belt past the tensioner and place it on the crankshaft sprocket wheel.
7. Place the timing belt on the exhaust and intake camshaft position actuator adjusters.
8. Install the engine mount bracket. Refer to Engine Mount Bracket Replacement.
9. Install the timing belt center front cover. Refer to Timing Belt Center Front Cover Installation.
10. Raise the vehicle.



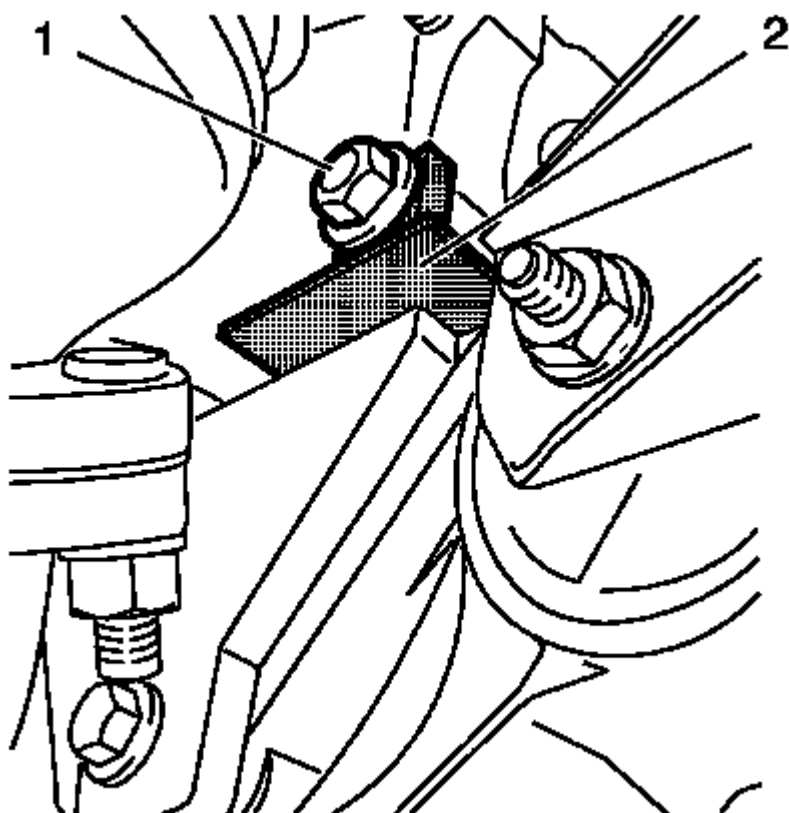
**Fig. 93: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

11. Apply tension to the drive belt tensioner (2) in the direction of the arrow, using an allen key (1).
12. Remove the **EN-6333** locking pin (3).

**NOTE:**        **The timing belt tensioner moves automatically to the correct position.**

13. Release tension on timing belt tensioner.

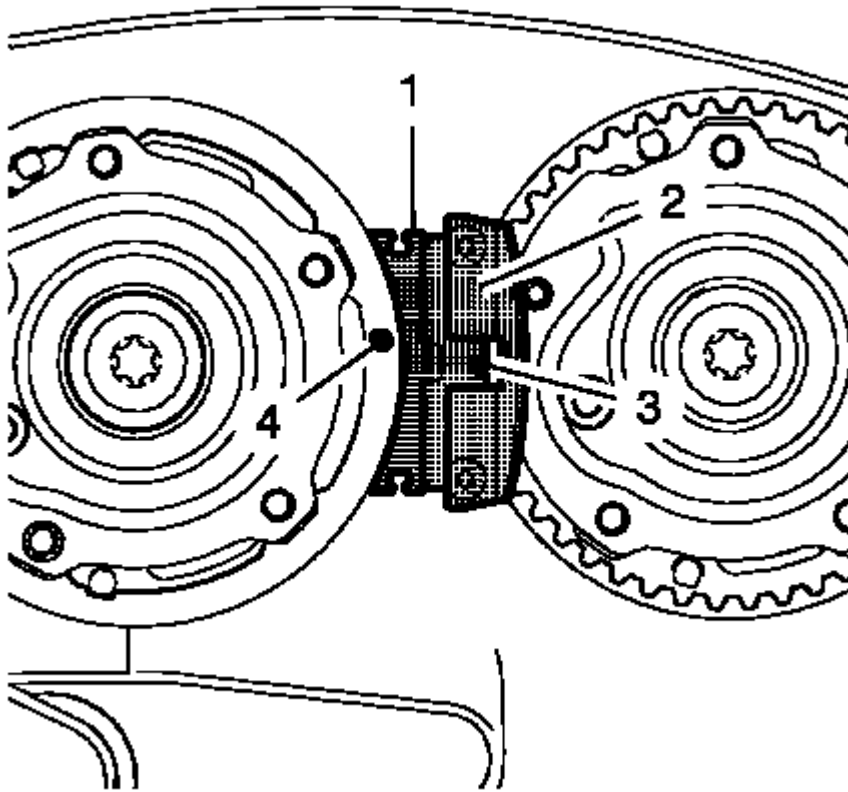




**Fig. 94: Locking Device And Bolt**

Courtesy of GENERAL MOTORS COMPANY

14. Remove bolt or bolted connection (1).
15. Remove **EN-6625** locking device (2).
16. Lower the vehicle.
17. Remove the **EN-6340** locking tool.



**Fig. 95: Camshaft Adjuster Locking Tool**  
Courtesy of GENERAL MOTORS COMPANY

18. Check the timing

**NOTE:** Note the marking at the camshaft sprockets.

1. Turn the crankshaft 720° in the direction of engine rotation by the crankshaft balancer bolt.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340-left during this process but must be somewhat above as shown.

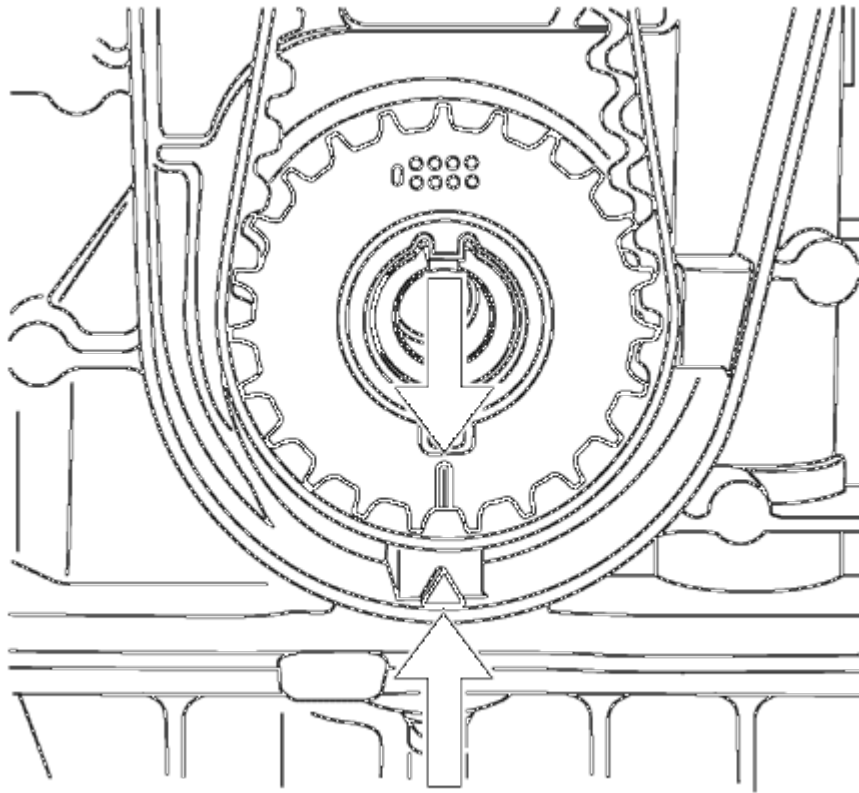
2. Install EN-6340-left locking tool (1) into the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340-right.

3. Install EN-6340-right locking tool (2) into the camshaft adjusters as shown.

19. Remove the EN-6340 locking tool.

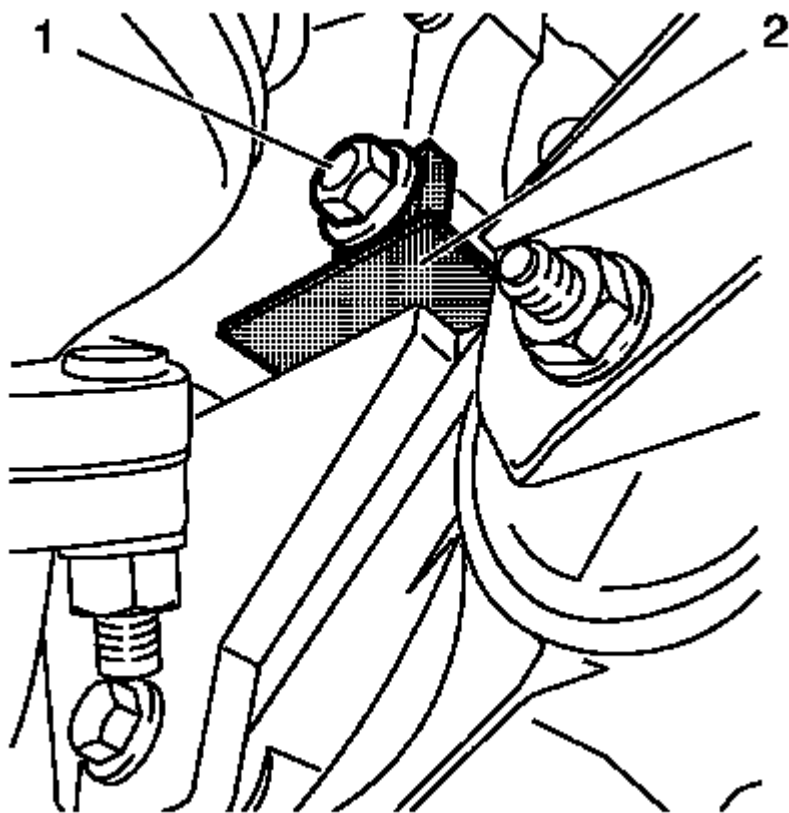
20. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.



**Fig. 96: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The timing belt drive gear and oil pump housing must align.

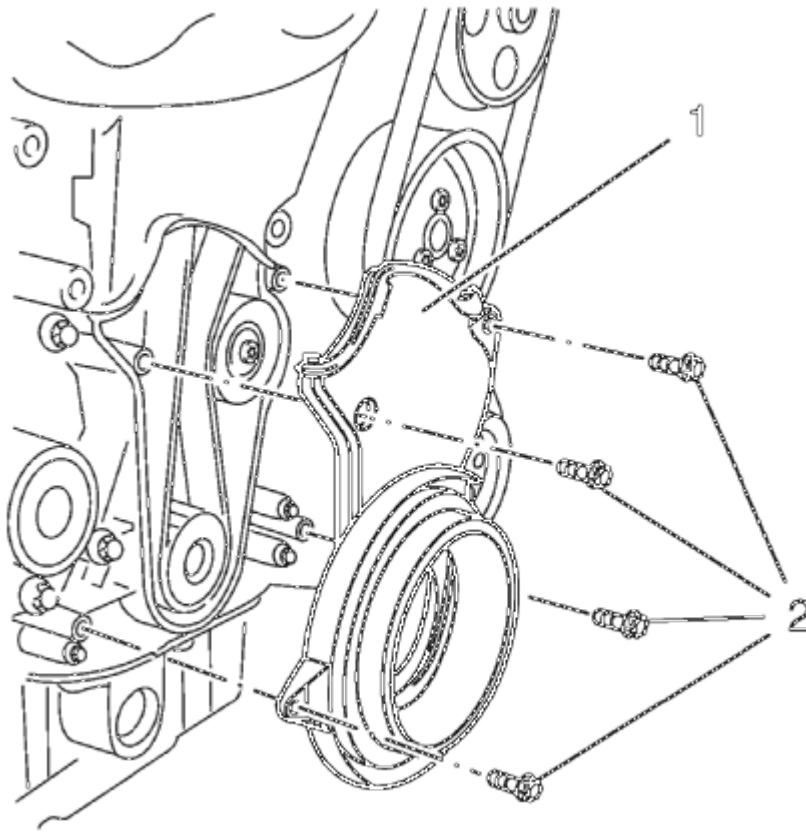
21. Control the crankshaft balancer position.



**Fig. 97: Locking Device And Bolt**

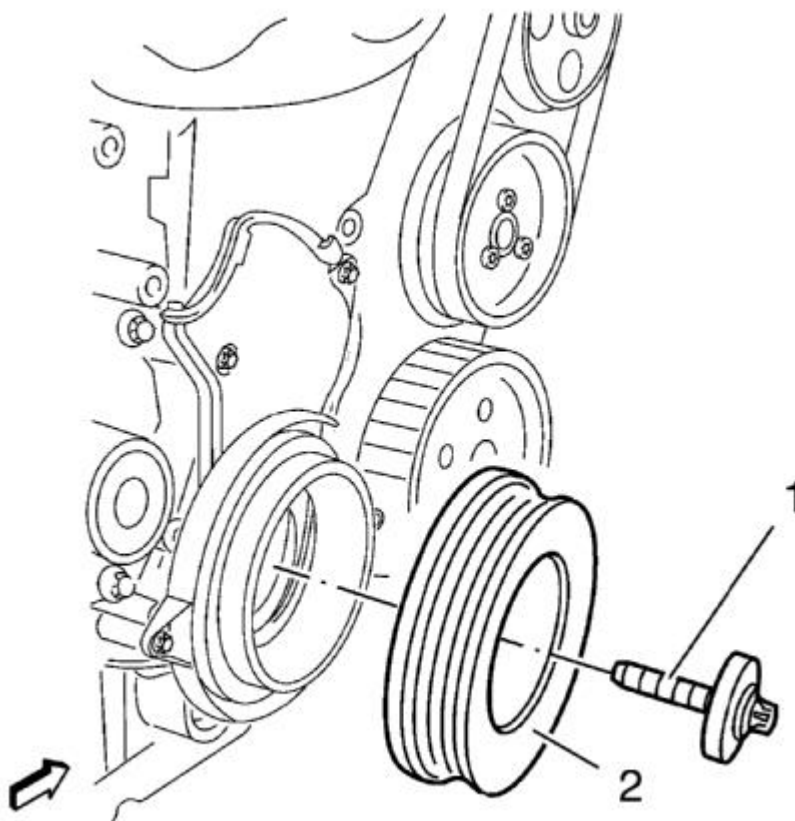
**Courtesy of GENERAL MOTORS COMPANY**

22. Install **EN-6625** locking device (2) to block the crankshaft.
23. Install the bolt or bolted connection (1).



**Fig. 98: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

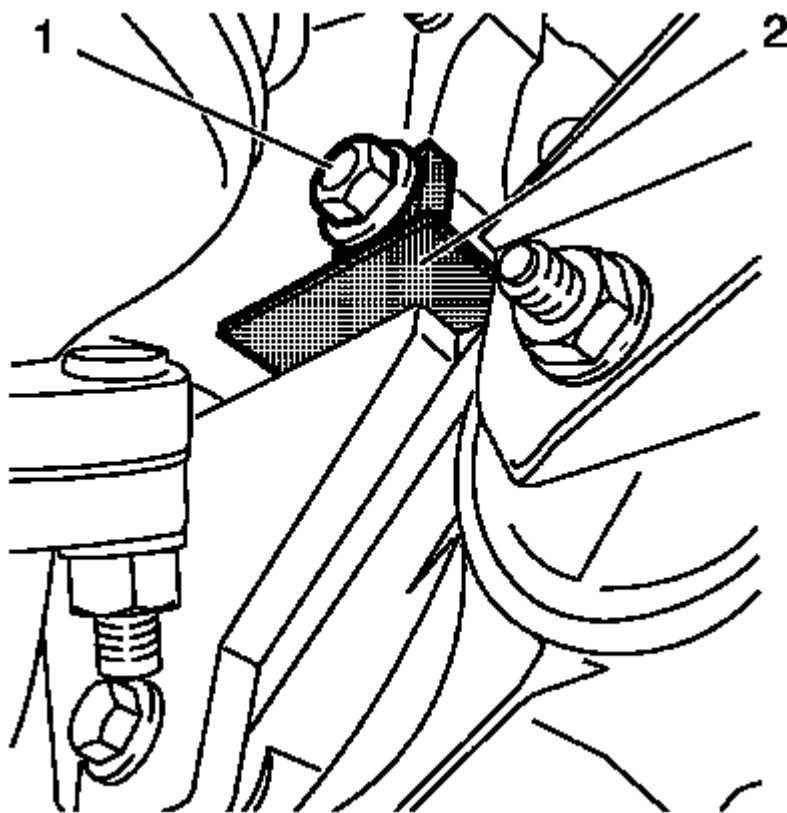
24. Install the lower timing belt cover (1).
25. Install the 4 lower timing belt cover bolts (2) and tighten to 6 N.m (53 lb in).



**Fig. 99: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

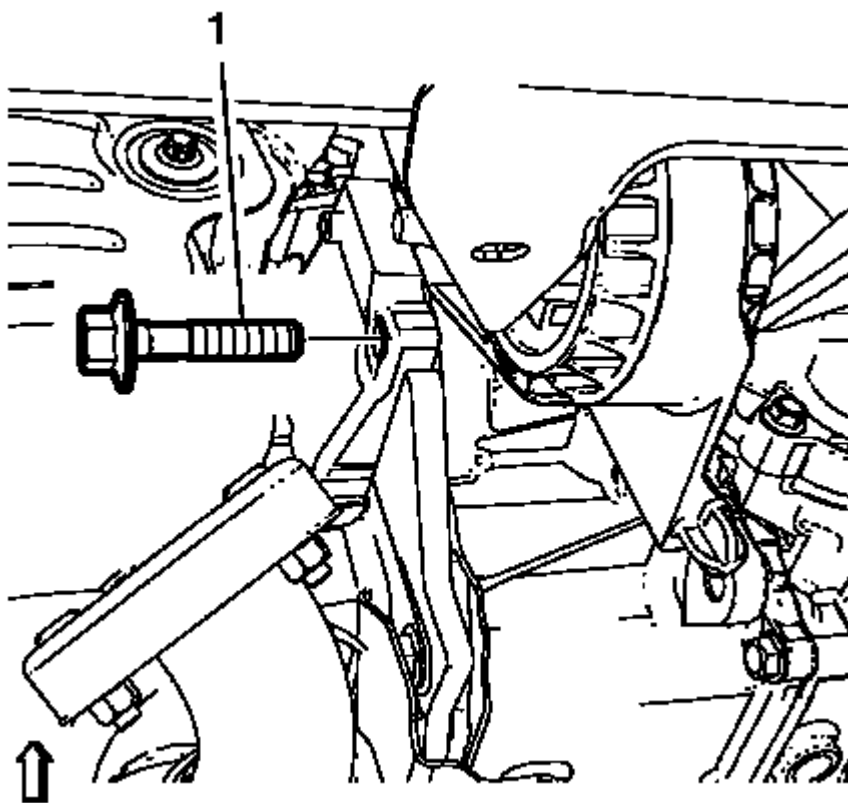
**CAUTION:** Refer to Torque-to-Yield Fastener Caution in the Preface section.

26. Install the crankshaft balancer (2).
27. Install a NEW crankshaft balancer bolt (1) and tighten in 3 passes using the **EN-45059** sensor kit :
  1. First pass to 95 N.m (70 lb ft).
  2. Second pass to 45°.
  3. Third pass to 15°.



**Fig. 100: Locking Device And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

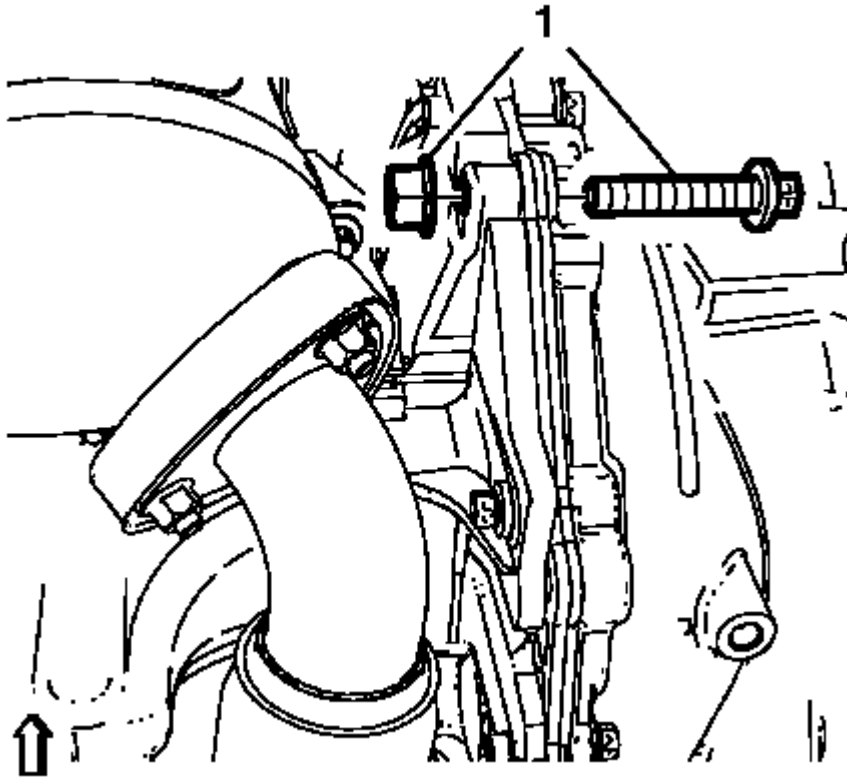
28. Remove bolt or bolted connection (1).
29. Remove **EN-6625** locking device (2).



**Fig. 101: Automatic Transmission Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

30. For vehicle with automatic transmission: Install the bolt (1) and tighten to 45 N.m (33 lb ft).



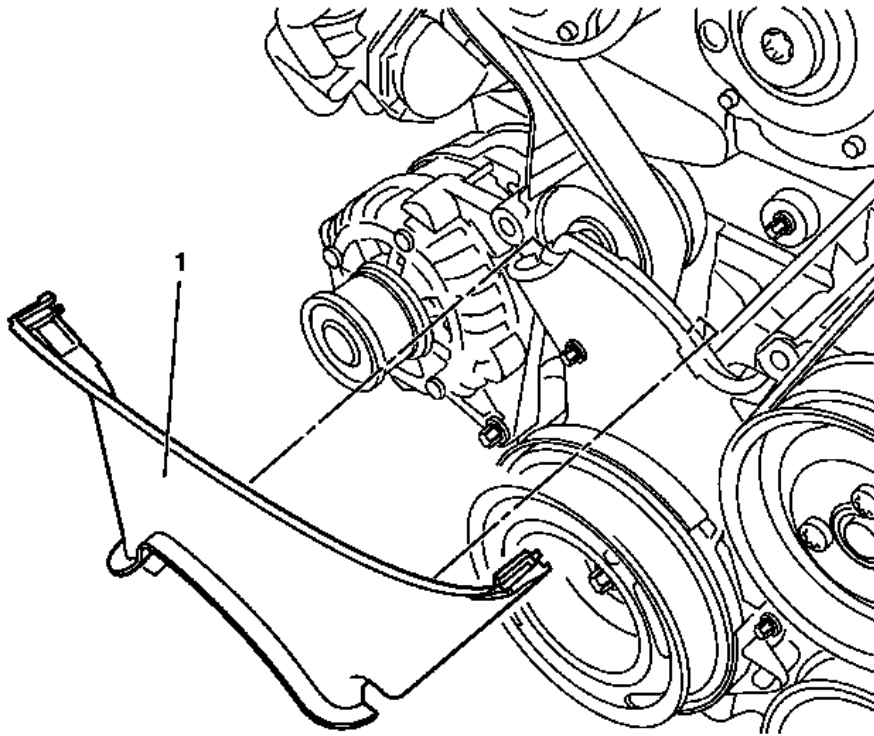


**Fig. 102: Connection Bolt**

Courtesy of GENERAL MOTORS COMPANY

31. For vehicle with manual transmission: Install the bolted connection (1) and tighten to 40 N.m (32 lb ft).
32. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
33. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement**.
34. Lower the vehicle.
35. Remove the **EN-6340** locking tool.
36. Install the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Installation**.
37. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
38. Close the hood.

## TIMING BELT CENTER FRONT COVER REPLACEMENT

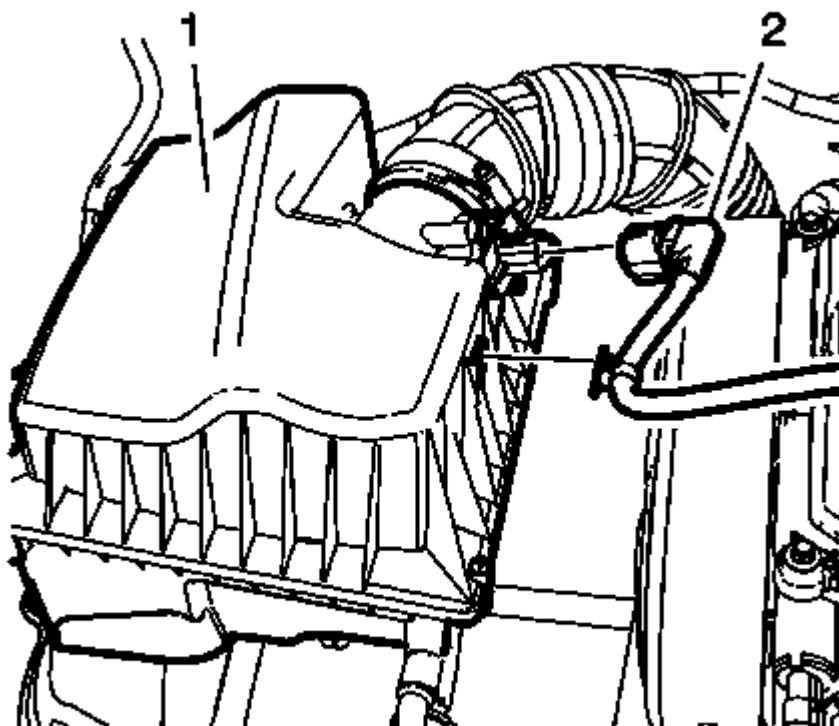
**Fig. 103: Timing Belt Center Front Cover**

Courtesy of GENERAL MOTORS COMPANY

**Timing Belt Center Front Cover Replacement**

Callout	Component Name
<b>Preliminary Procedure</b>	
1. Remove the timing belt upper front cover. Refer to <b><u>Timing Belt Upper Front Cover Replacement</u></b> .	
2. Remove the engine mount bracket. Refer to <b><u>Engine Mount Bracket Replacement</u></b> .	
1	Timing Belt Center Front Cover

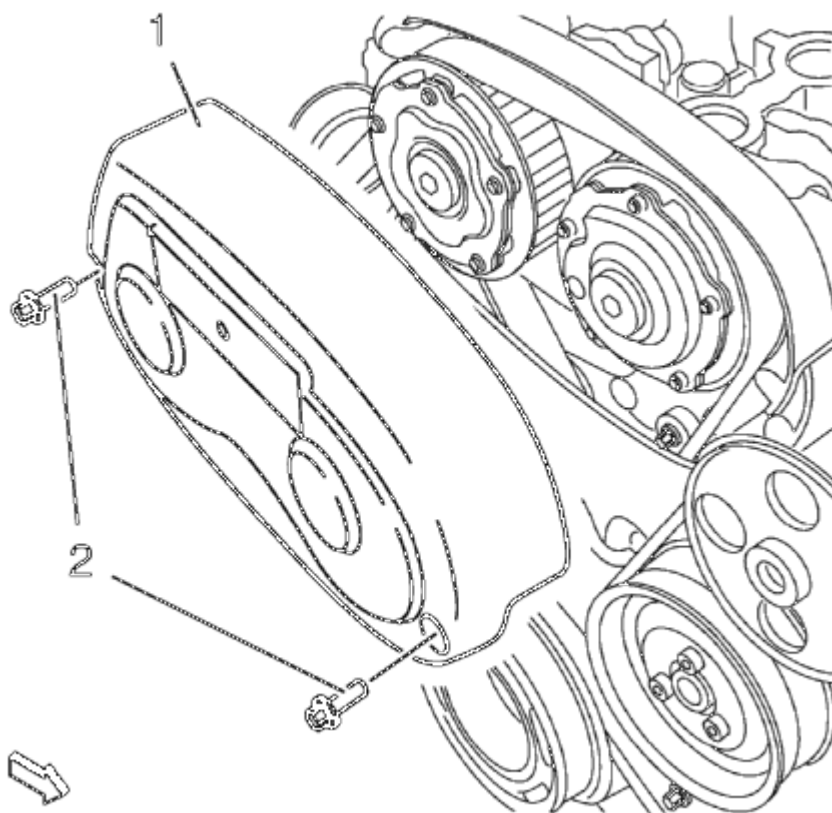
**TIMING BELT UPPER FRONT COVER REPLACEMENT****Removal Procedure**



**Fig. 104: Air Cleaner**

Courtesy of GENERAL MOTORS COMPANY

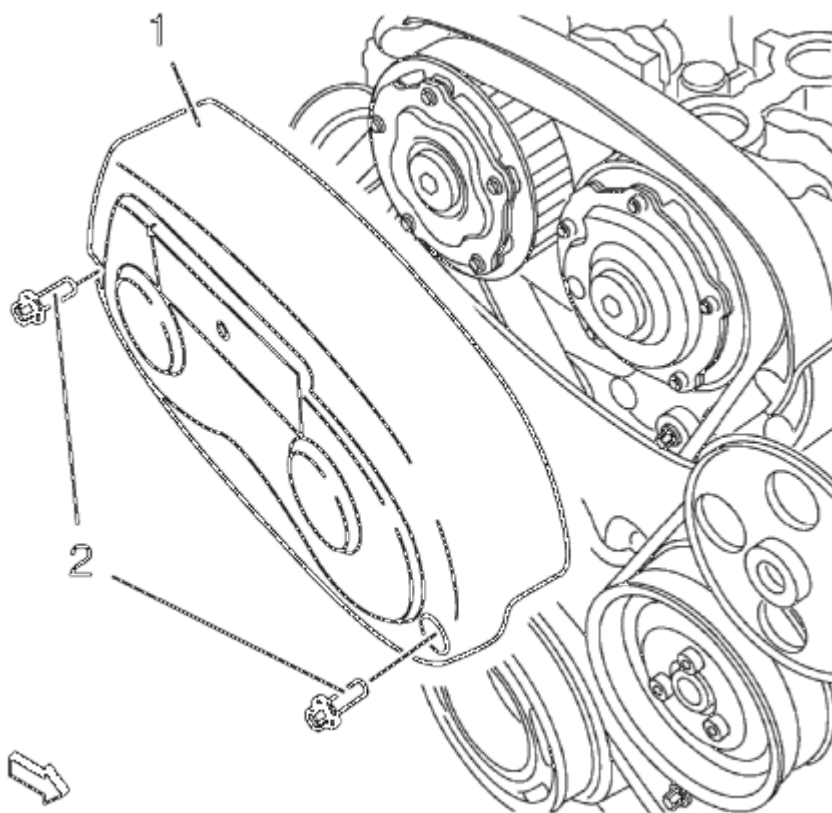
1. Disconnect the wiring harness plug (2).
2. Unclip the wiring harness from the air cleaner (1).



**Fig. 105: Timing Belt Upper Front Cover**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove the 2 timing belt upper front cover bolts (2).
4. Remove the timing belt upper front cover (1).

#### **Installation Procedure**

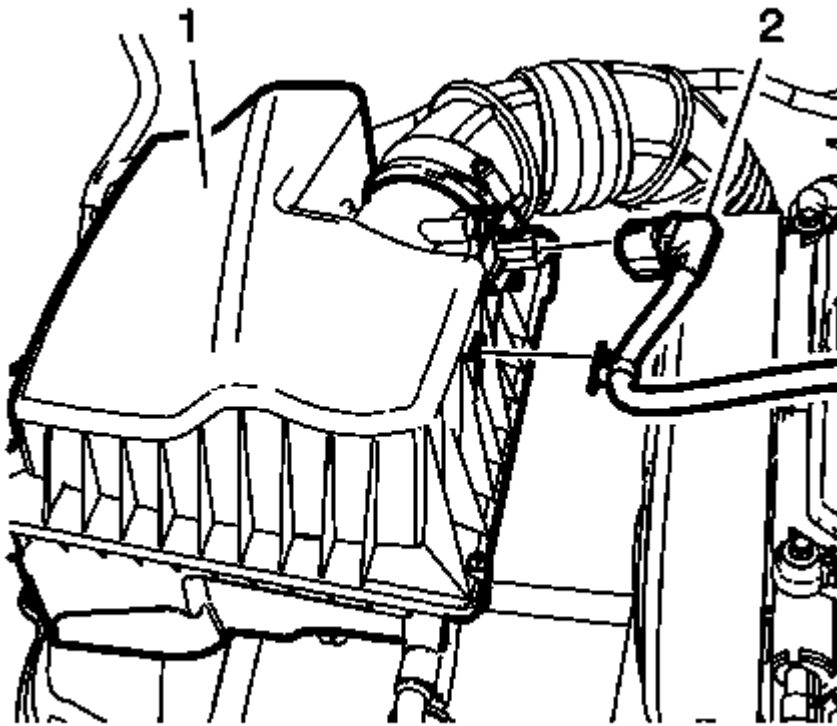


**Fig. 106: Timing Belt Upper Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the timing belt upper front cover (1).

**CAUTION:** Refer to Fastener Caution .

2. Install the 2 timing belt upper front cover bolts (2) and tighten to 6 N.m (53 lb in).

**Fig. 107: Air Cleaner**

Courtesy of GENERAL MOTORS COMPANY

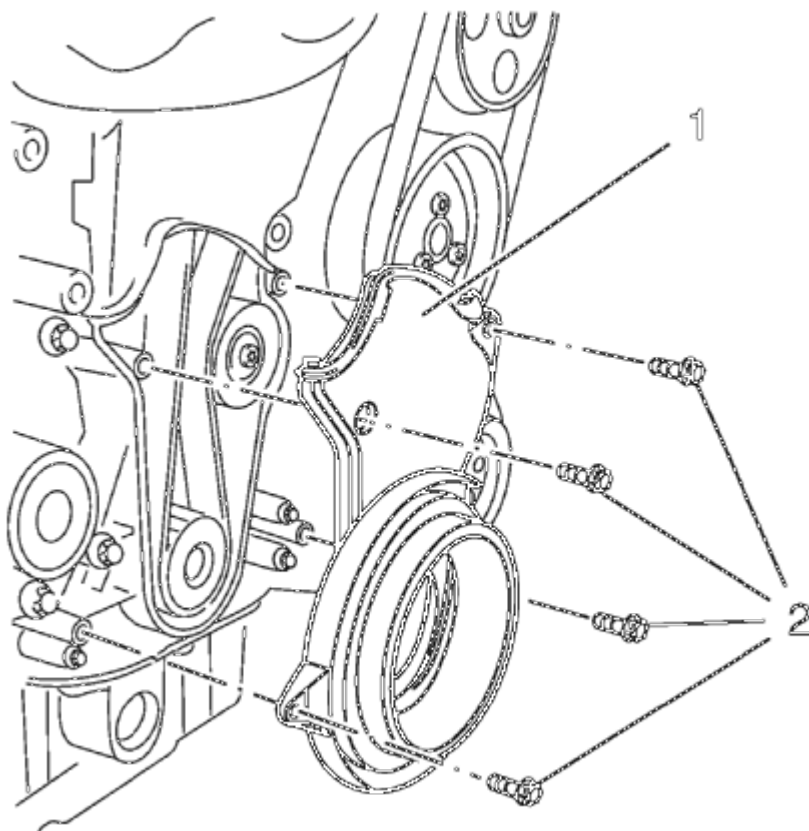
3. Connect the wiring harness plug (2).
4. Clip in the wiring harness to the air cleaner (1).

## **TIMING BELT LOWER FRONT COVER REPLACEMENT**

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

### **Removal Procedure**

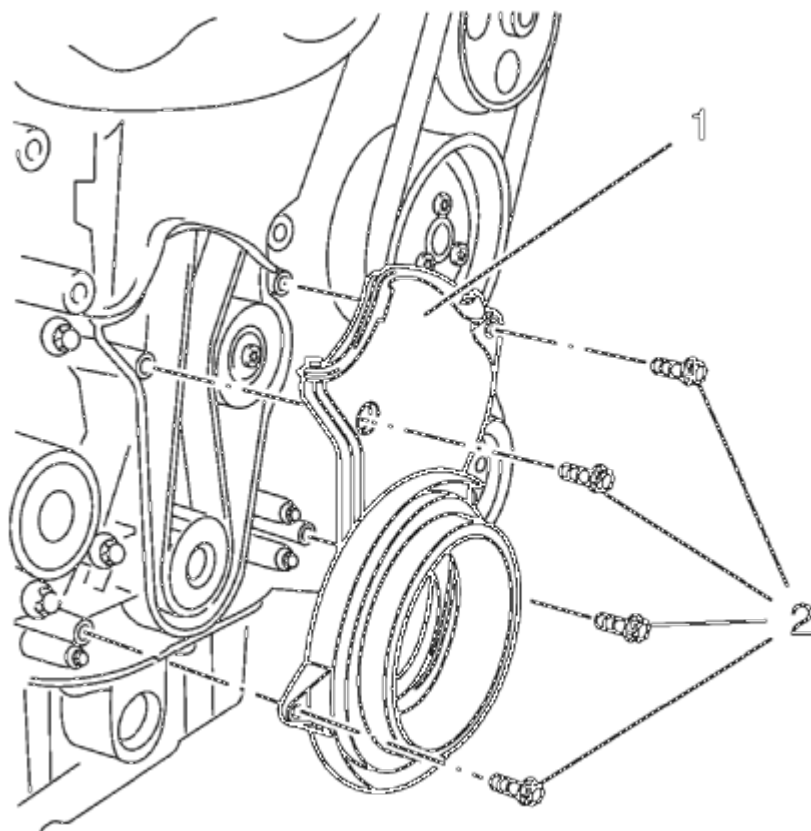
1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.



**Fig. 108: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 4 lower timing belt cover bolts (2).
4. Remove the lower timing belt cover (1).

#### Installation Procedure



**Fig. 109: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

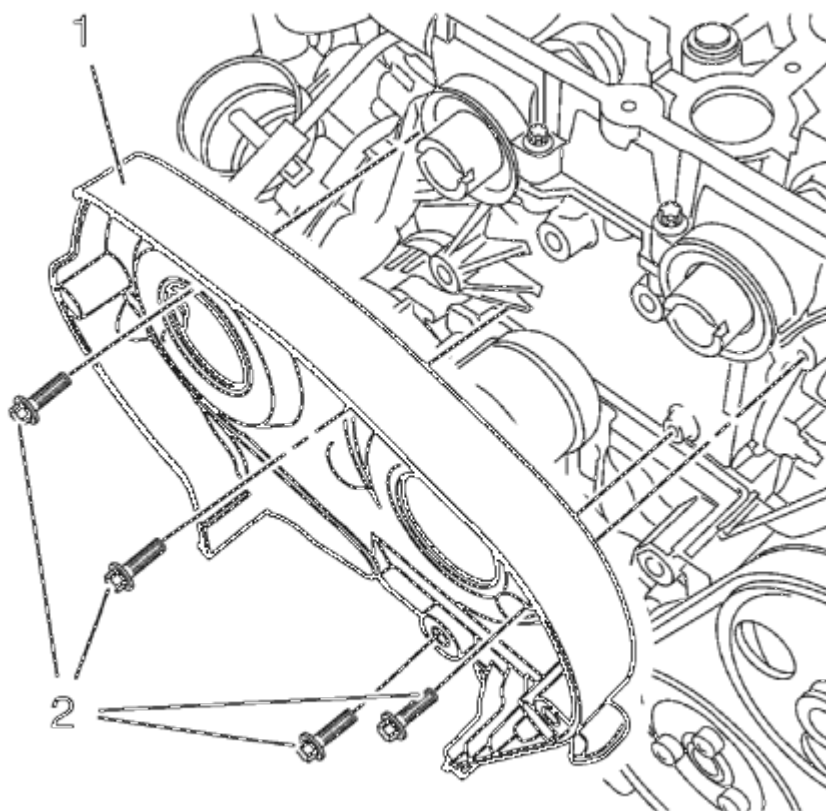
1. Install the lower timing belt cover (1).
2. Install the 4 lower timing belt cover bolts (2) and tighten to 6 N.m (53 lb in).
3. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.
4. Lower the vehicle.

## TIMING BELT REAR COVER REPLACEMENT

### Removal Procedure

1. Remove the camshaft position actuator adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.
2. Remove the timing belt tensioner. Refer to **Timing Belt Tensioner Replacement**.





**Fig. 110: Timing Belt Rear Cover And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

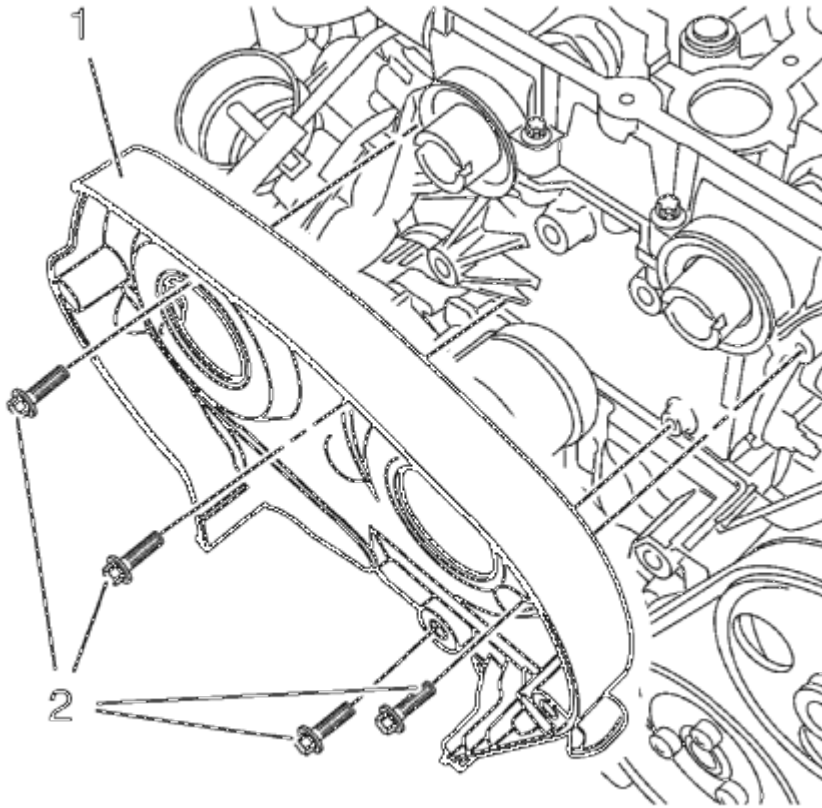
3. Remove and DISCARD the 4 timing belt rear cover bolts (2).

**NOTE:** Oil can escape. Use a cloth, rag or paper to take the oil drain away from all timing components.

4. Remove the timing belt rear cover (1).

#### **Installation Procedure**

1. Re-cut the 4 timing belt rear cover threads.



**Fig. 111: Timing Belt Rear Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the cover is contaminated with oil. You have to clean it close.

2. Install the timing belt rear cover (1).

**CAUTION:** Refer to Fastener Caution .

**NOTE:** Service may offer bolts that are not microencapsulated. If this is the case apply thread lock agent to the bolt. If fastener is microencapsulated, install a NEW 4 timing belt rear cover bolts. DO NOT reuse the old bolt.

3. Install the 4 NEW timing belt rear cover bolts (2) and tighten to 6 N.m (53 lb in).
4. Install the timing belt tensioner. Refer to Timing Belt Tensioner Replacement.
5. Install the camshaft position actuator adjuster. Refer to Camshaft Position Actuator Adjuster Replacement.

## VALVE LIFTER REPLACEMENT

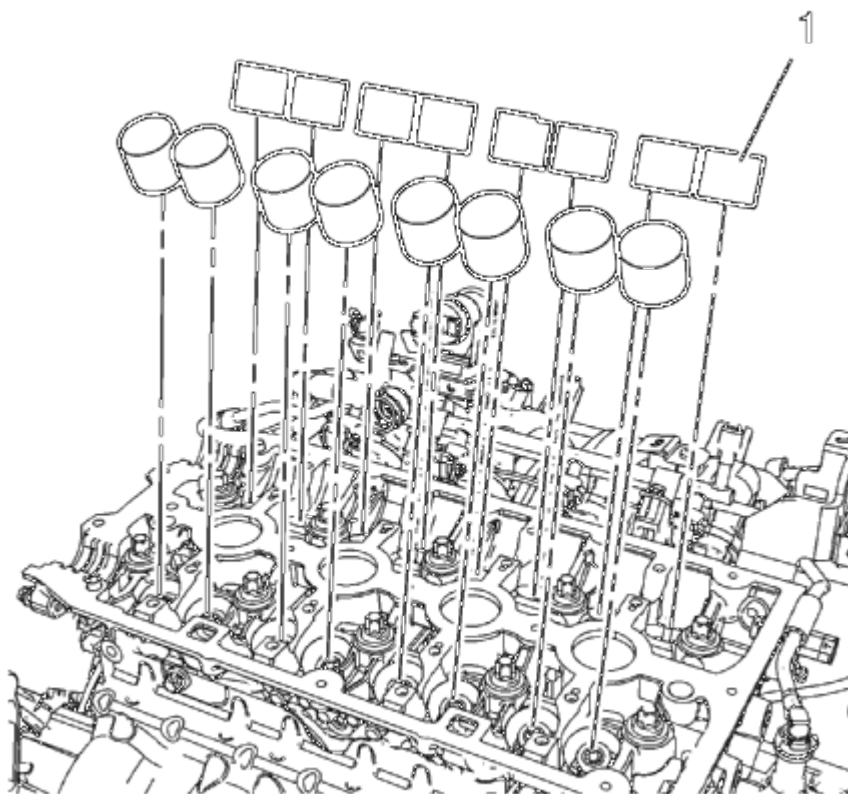
## Special Tools

### EN-845 Suction Device

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

## Removal Procedure

1. Remove the camshafts. Refer to **Camshaft Replacement**.



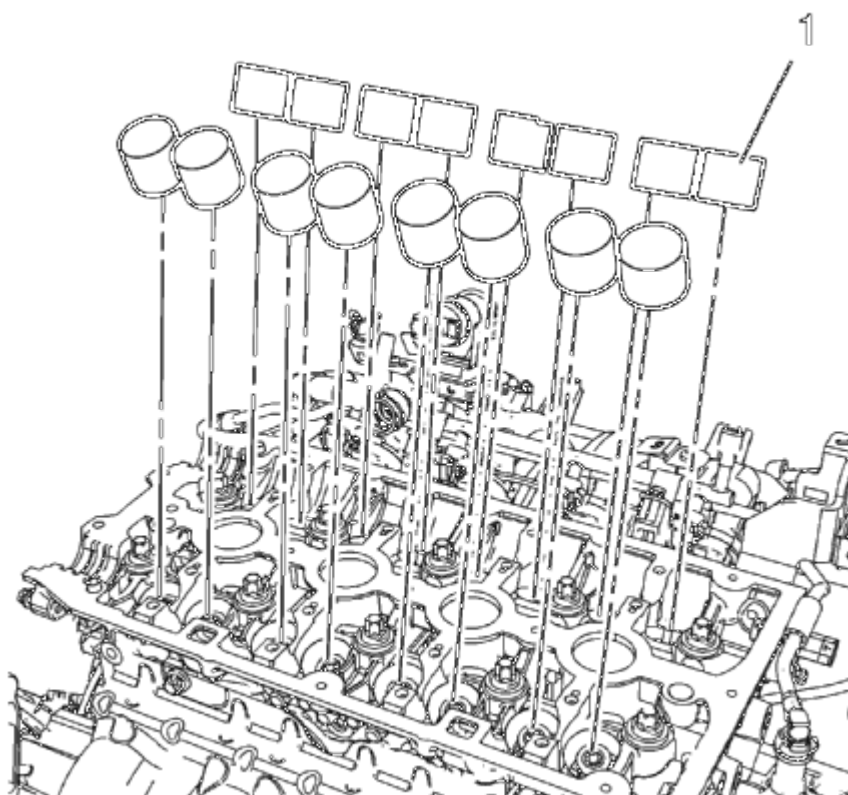
**Fig. 112: Valve Lifters**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mark the assignments.

2. Remove the 16 valve lifters (1), using the **EN-845** suction device.

## Installation Procedure



**Fig. 113: Valve Lifters**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Observe the correct assignment.

**NOTE:** Coat the sliding surfaces with **NEW** engine oil.

1. Install the 16 valve lifters (1), using the **EN-845** suction device.
2. Install the camshafts. Refer to **Camshaft Replacement**.

## CYLINDER HEAD REPLACEMENT

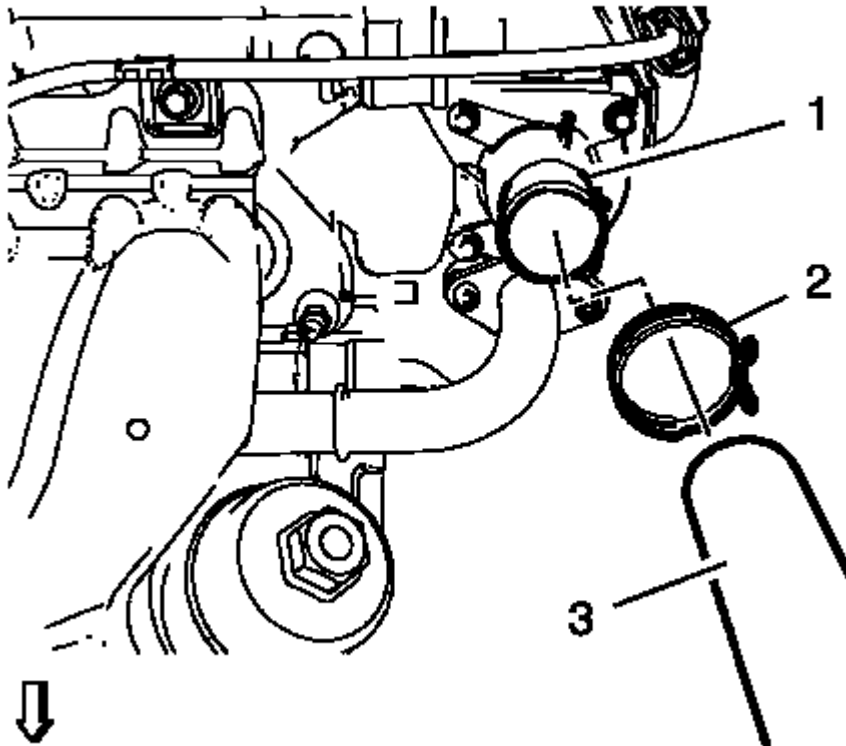
### Special Tools

- **EN-6333** Timing Belt Tensioner Locking Pin
- **EN-6340** Camshaft Adjuster Locking Tool
- **EN-6625** Crankshaft Locking Device
- **EN-6628-A** Camshaft Locking Tool
- **EN-45059** Angle Meter

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

### Removal Procedure

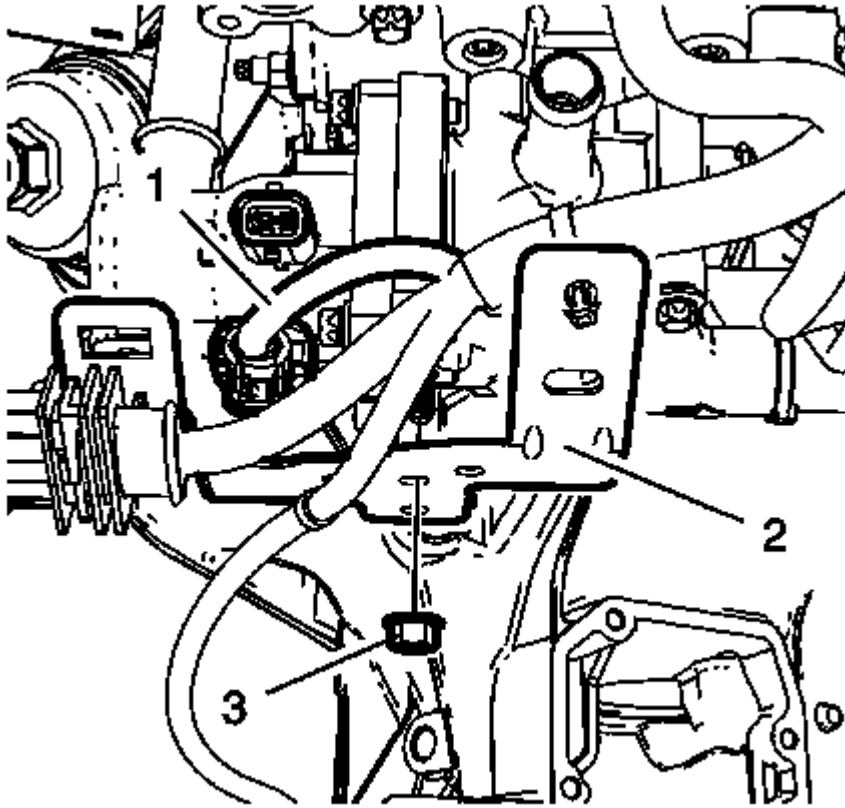
1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE-47716 Fill)**, **Cooling System Draining and Filling (Static Fill)**.
5. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
6. Remove the intake manifold. Refer to **Intake Manifold Replacement**.



**Fig. 114: Radiator Inlet Hose And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

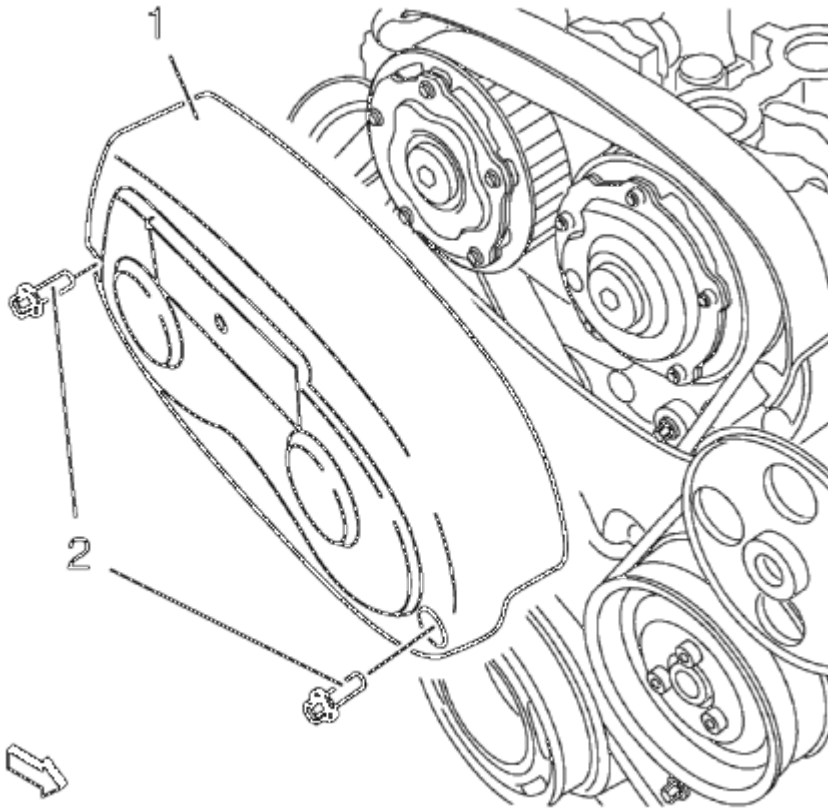
7. Loosen the radiator inlet hose clamp (2).
8. Remove the radiator inlet hose (3) from the engine coolant thermostat (1).
9. Remove the heater outlet hose from the engine coolant thermostat housing. Refer to **Heater Outlet Hose Replacement (LUJ)**, **Heater Outlet Hose Replacement (LUW)**.

10. Remove the heater inlet hose from the engine coolant thermostat housing. Refer to **Heater Inlet Hose Replacement (LUJ)** , **Heater Inlet Hose Replacement (LUW)** .



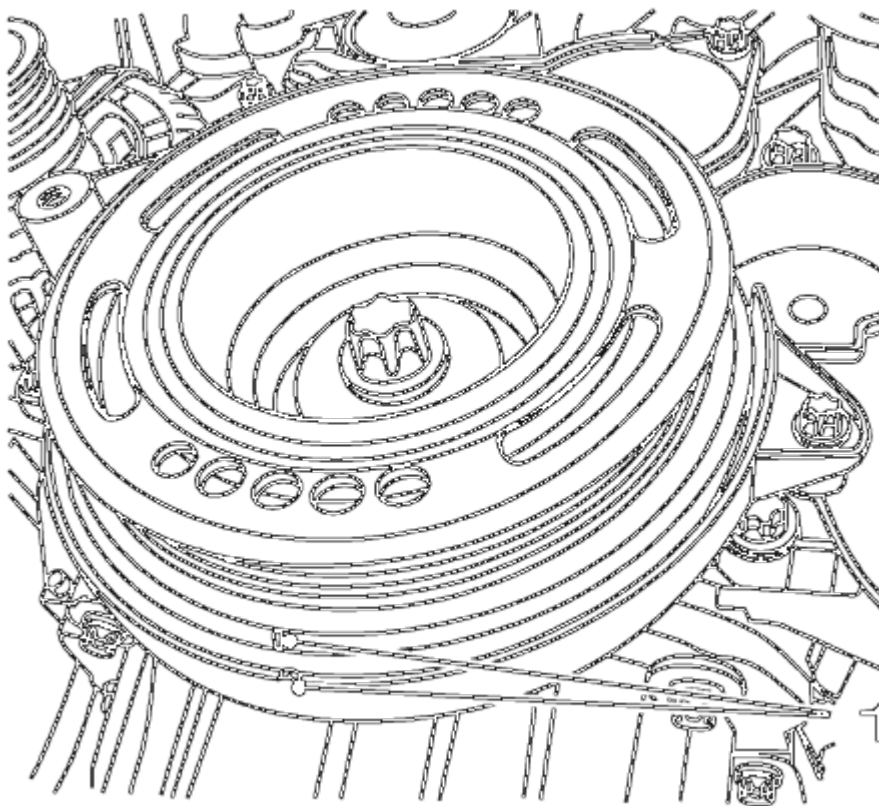
**Fig. 115: Thermostat Housing Bracket, Bolts And Wiring Harness**  
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the thermostat wiring harness plug (1).
12. Remove the thermostat housing bracket nut (3).
13. Hang the thermostat housing bracket (2) with attached wiring harness aside.
14. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement (LUW)** .



**Fig. 116: Timing Belt Upper Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

15. Remove the 2 timing belt upper front cover bolts (2).
16. Remove the timing belt upper front cover (1).
17. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
18. Remove the 2 camshaft position sensor. Refer to **Camshaft Position Sensor Replacement**.
19. Remove the 2 camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Replacement**.
20. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

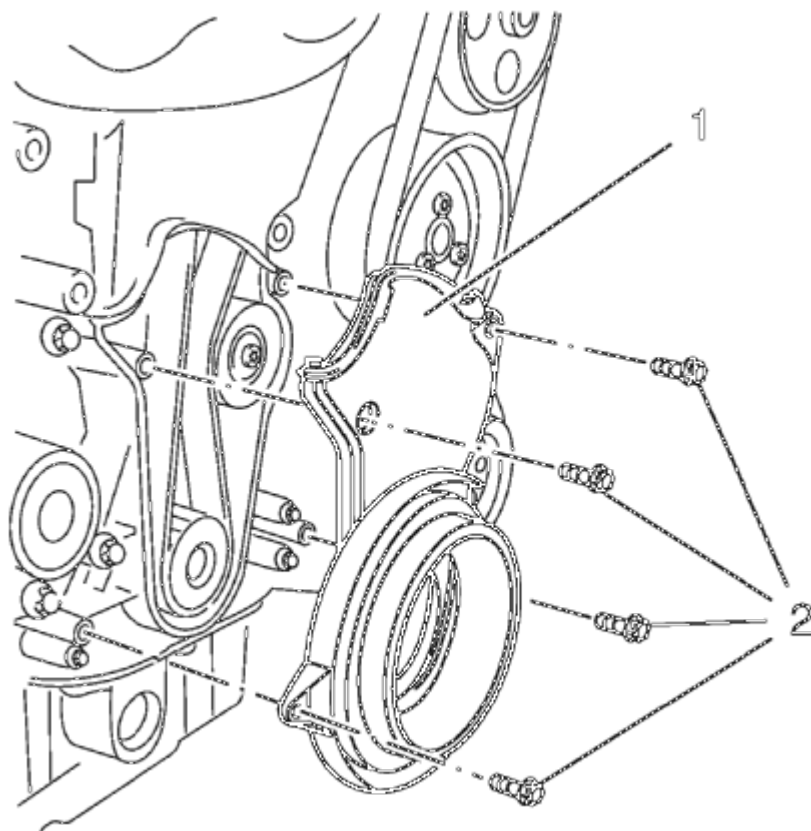


**Fig. 117: Crankshaft TDC Position**

Courtesy of GENERAL MOTORS COMPANY

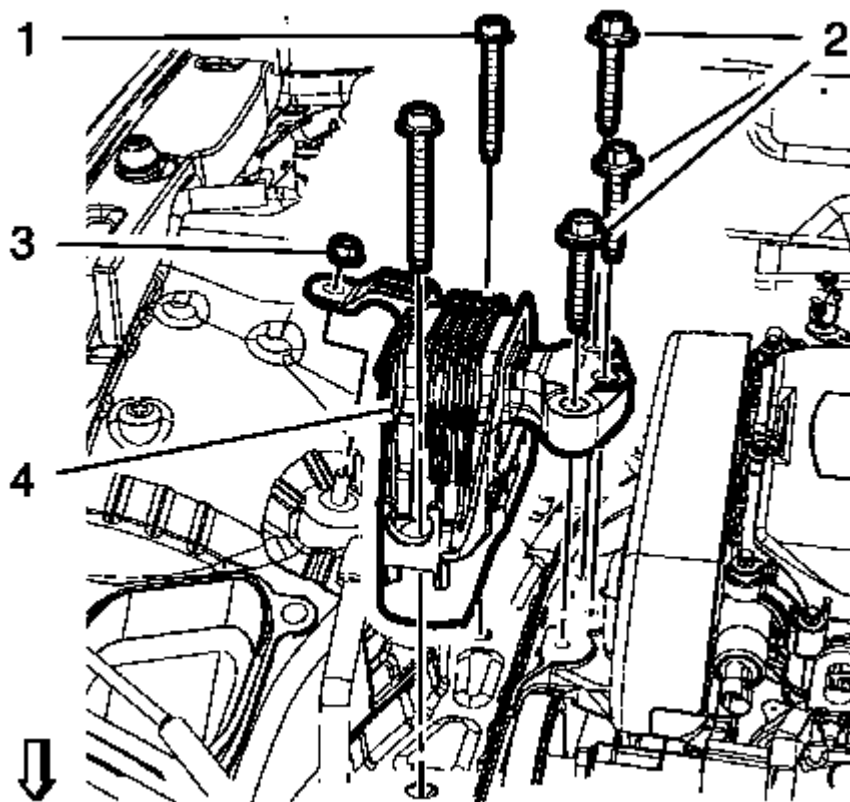
21. Set the crankshaft balancer in direction of engine rotation until the markings (1) line up with the cylinder 1 at TDC.
22. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.





**Fig. 118: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

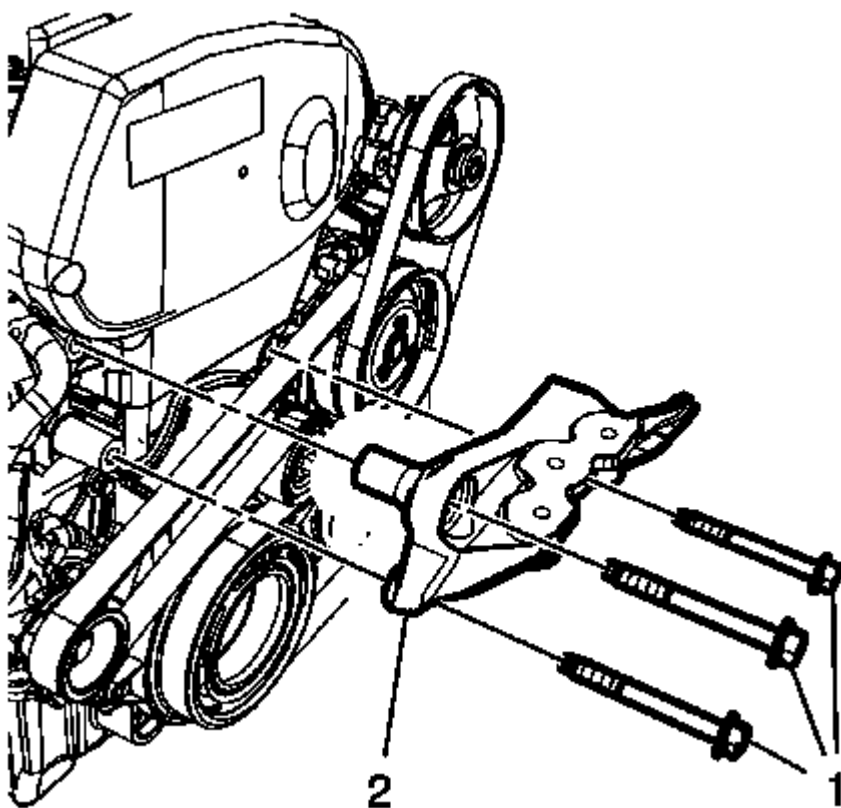
23. Remove the 4 lower timing belt cover bolts (2).
24. Remove the lower timing belt cover (1).
25. Lower the vehicle.
26. Support the engine under the oil pan.



**Fig. 119: Engine Mount And Bolts**

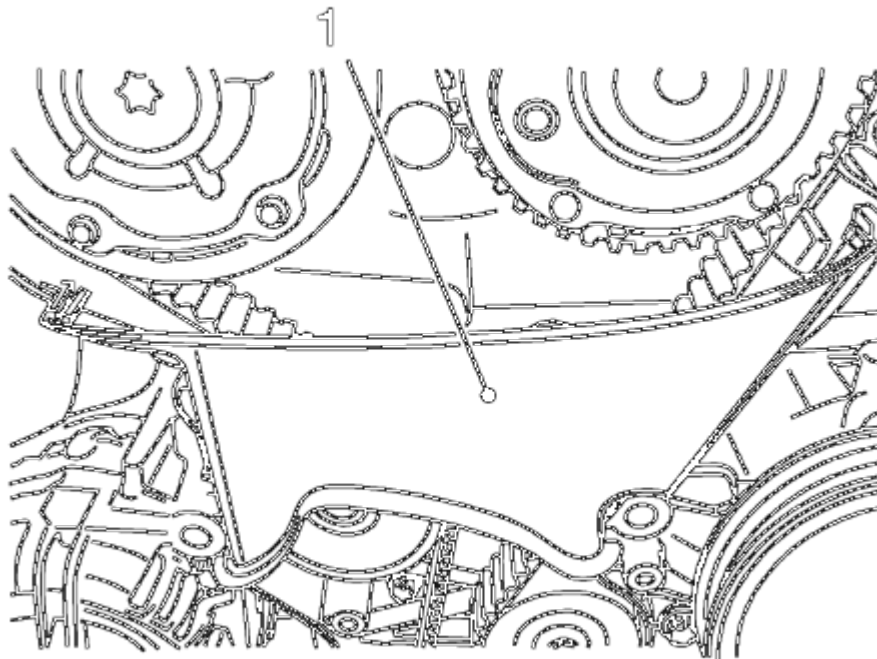
Courtesy of GENERAL MOTORS COMPANY

27. Remove the engine mount nut (3).
28. Remove the 5 engine mount bolts (1, 2).
29. Remove the engine mount (4).



**Fig. 120: Engine Mount Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

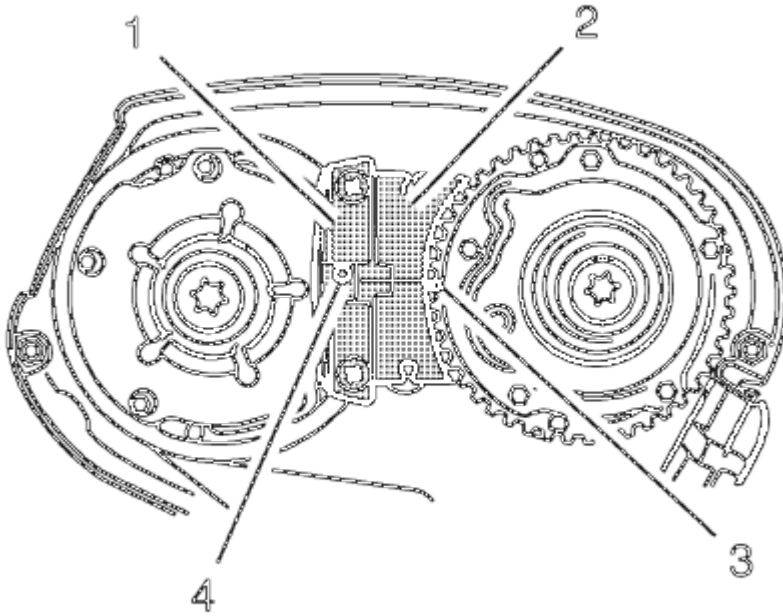
30. Remove the 3 engine mount bracket bolts (1).
31. Remove the engine mount bracket (2).



**Fig. 121: Toothed Belt Cover**

Courtesy of GENERAL MOTORS COMPANY

32. Remove the center front timing belt cover from the rear timing belt cover at 2 locations.
33. Remove the center front timing belt cover (1).



**Fig. 122: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

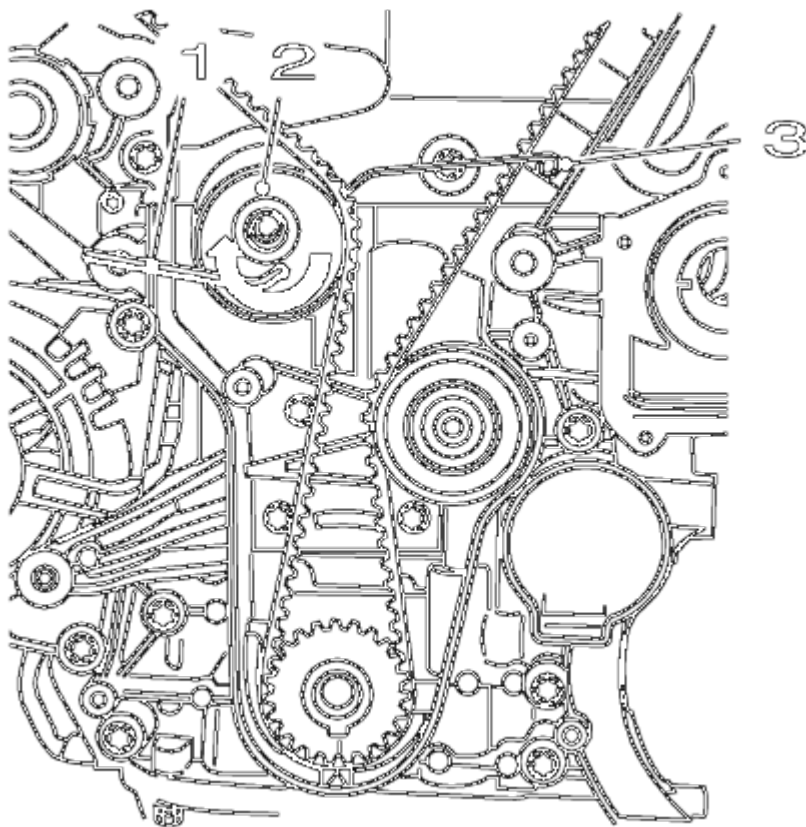
34. Install the **EN-6340** locking tool into the camshaft adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340 locking tool - left during this process but must be somewhat above as shown.

- Install the **EN-6340** locking tool - left (1) in the camshaft adjusters as shown.

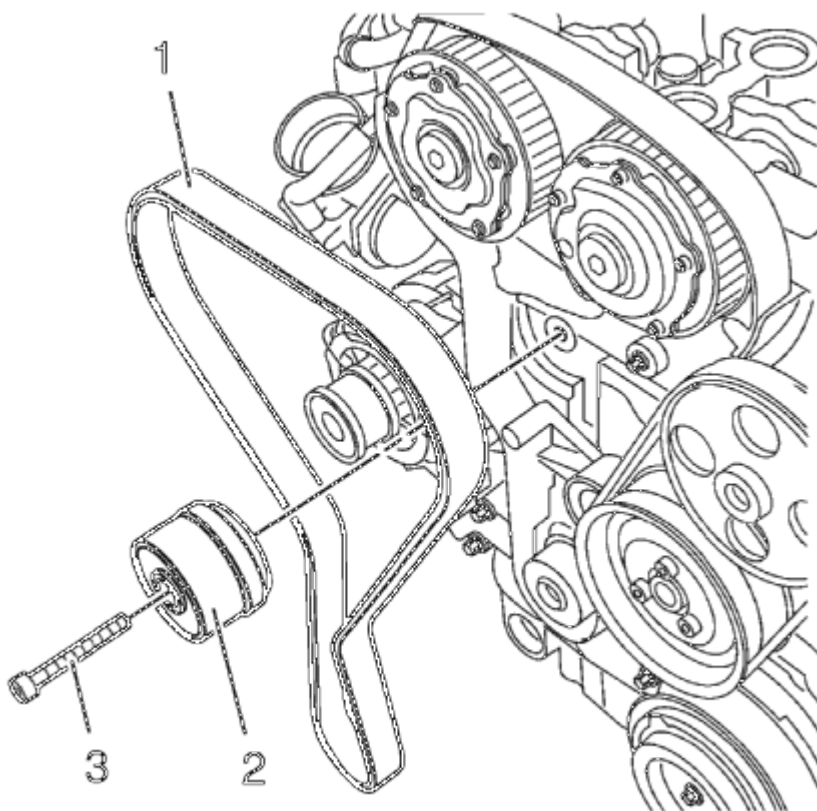
**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right.

- Install **EN-6340** locking tool - right (2) in the camshaft adjusters as shown.



**Fig. 123: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

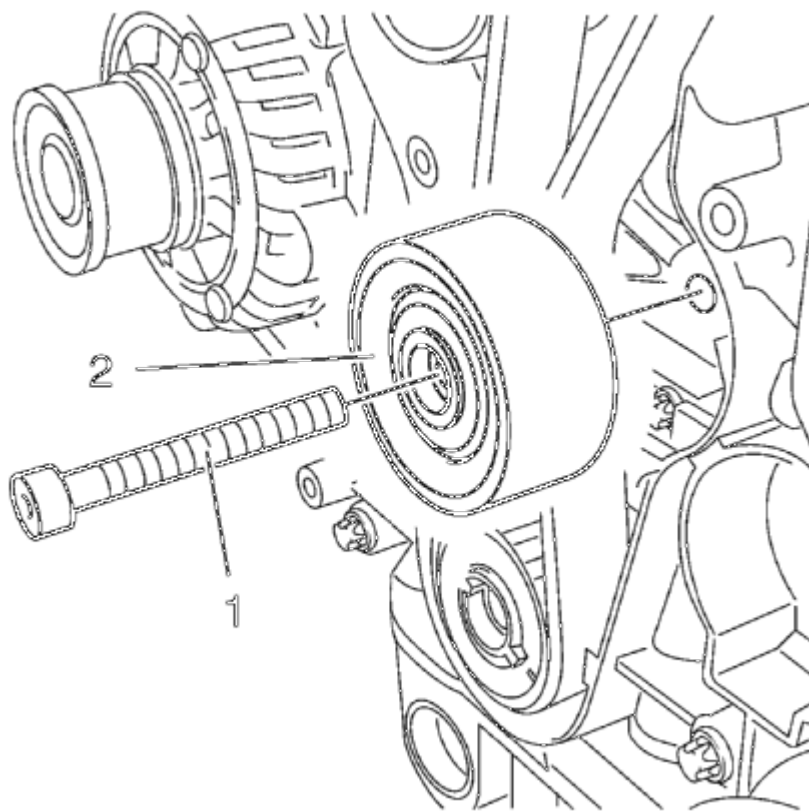
35. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an allen key (1).
36. Install the **EN-6333** pin (3).



**Fig. 124: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Note the direction of the belt, if the timing belt will be reused.**

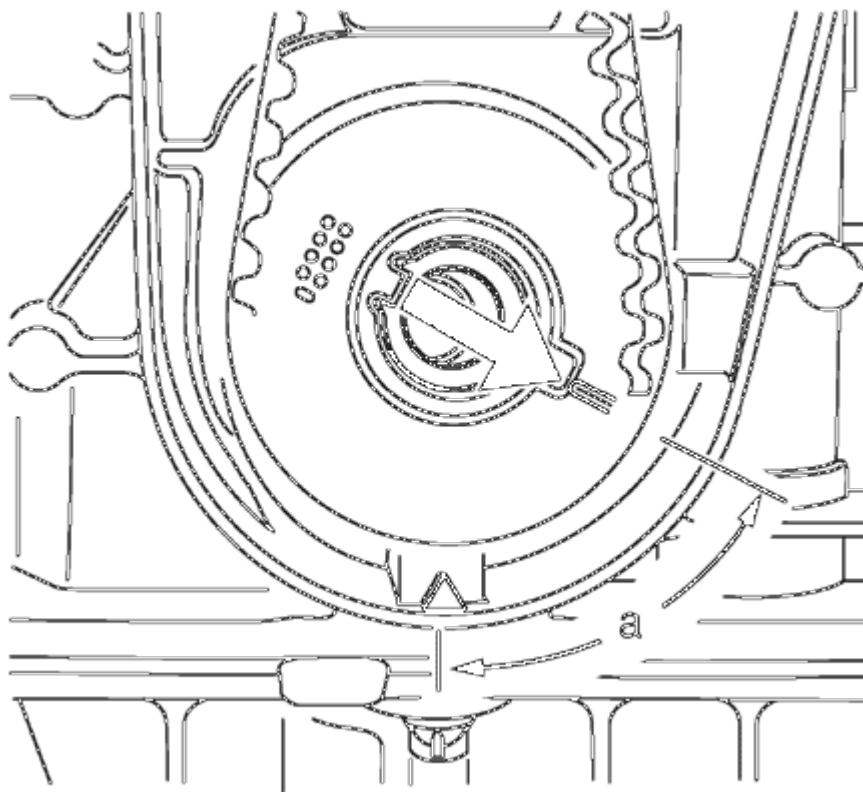
37. Remove the timing belt (1).
38. Remove and DISCARD the timing belt tensioner bolt (3).
39. Remove the timing belt tensioner (2).
40. Raise the vehicle.



**Fig. 125: Timing Belt Idler Pulley Bolt**  
Courtesy of GENERAL MOTORS COMPANY

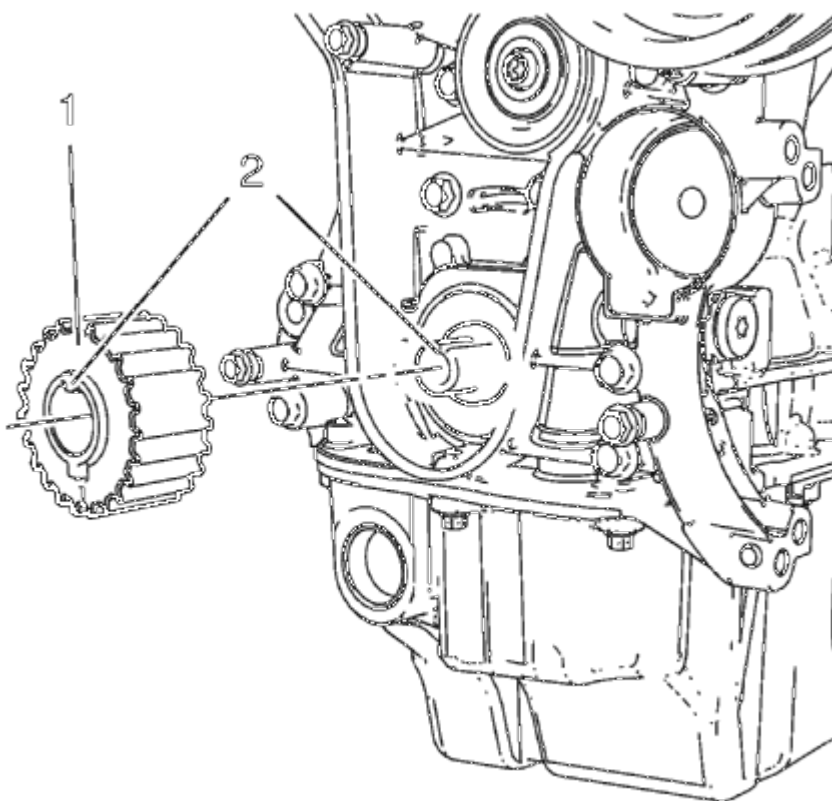
41. Remove the timing belt idler pulley bolt (1).
42. Remove the timing belt idler pulley (2).
43. Remove the **EN-6625** locking device.





**Fig. 126: Turning Crankshaft Against Direction Of Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

44. Set the crankshaft in direction of engine rotation to 60 degrees (a) before TDC. Use the **EN-45059** meter and the crankshaft balancer bolt.

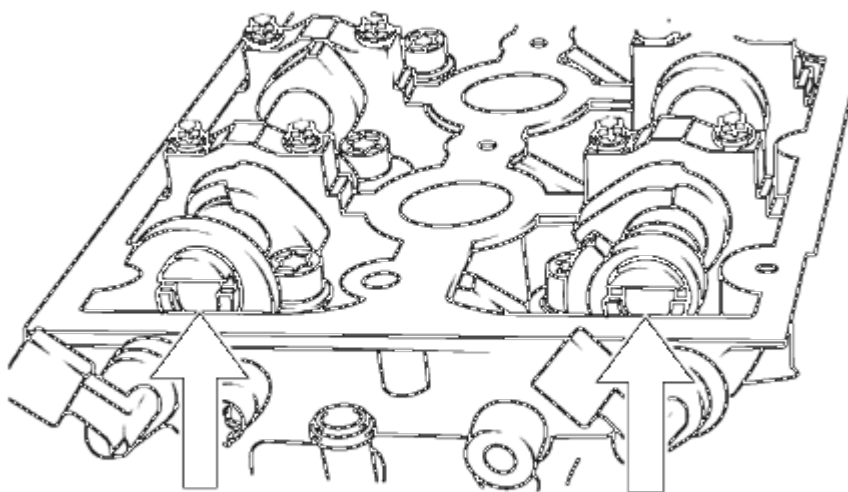


**Fig. 127: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Some engine oil will run out of the camshaft and the camshaft position actuator adjuster. That is the reason for the removal of the whole timing assembly.

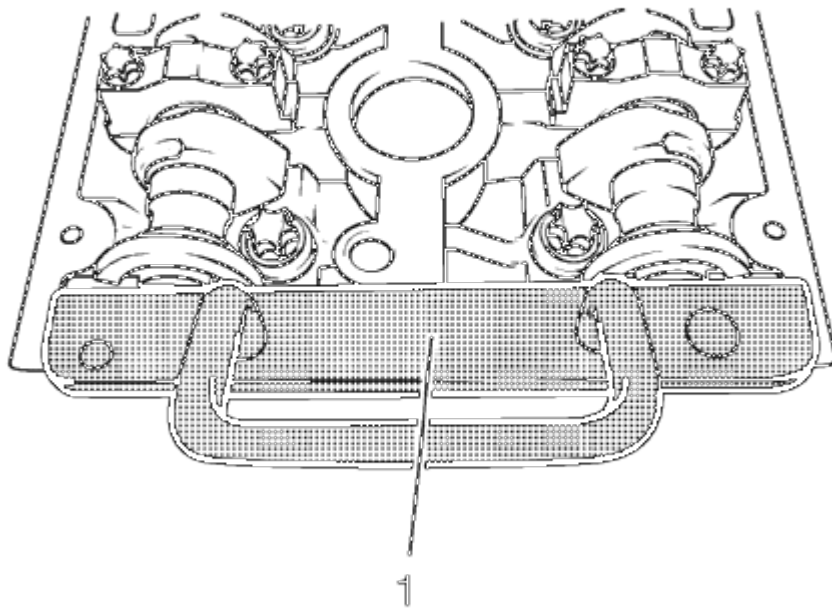
45. Remove the crankshaft sprocket (1).
46. Lower the vehicle.
47. Remove the **EN-6340** locking tool.



**Fig. 128: Aligning Camshafts Horizontally**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Note the arrows.**

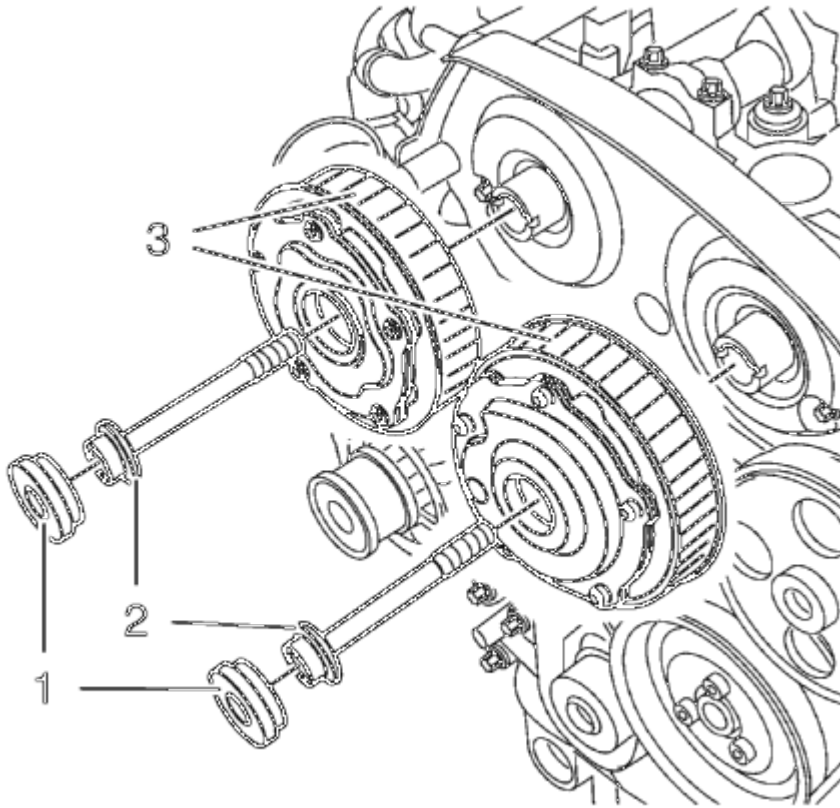
48. Turn the camshaft by the camshaft position actuator adjuster until the groove on the end of the camshafts is horizontal.



**Fig. 129: Locking Tool**

**Courtesy of GENERAL MOTORS COMPANY**

49. Install the **EN-6628-A** locking tool (1).
50. Place a collecting basin underneath the vehicle.



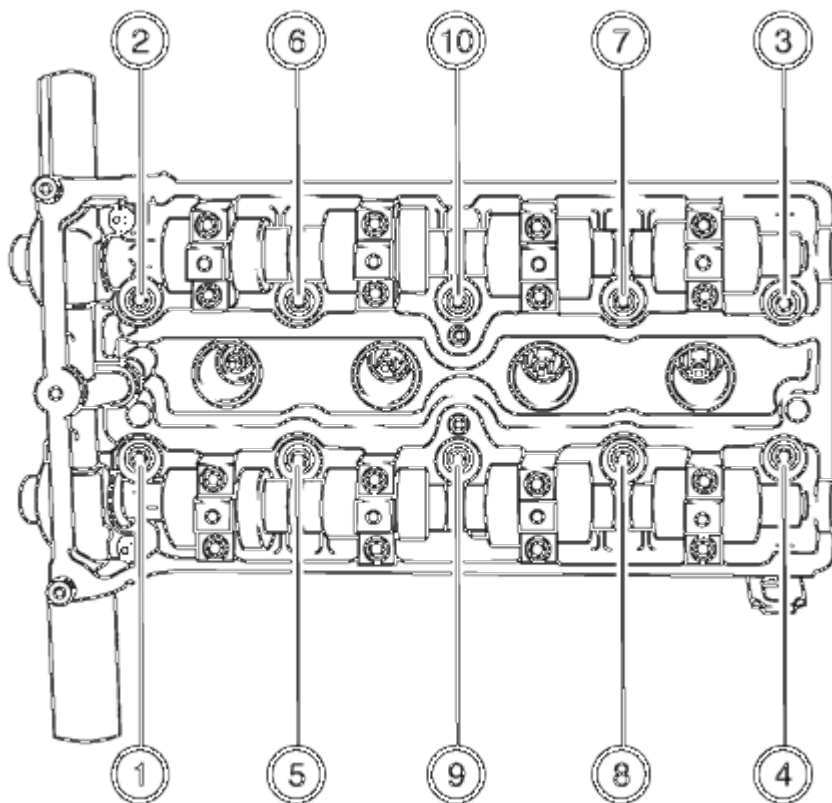
**Fig. 130: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

51. Remove the camshaft position actuator adjuster closure bolt (1) of the intake camshaft position actuator adjuster and the exhaust camshaft position actuator adjuster (3).

**NOTE:** A second technician is required.

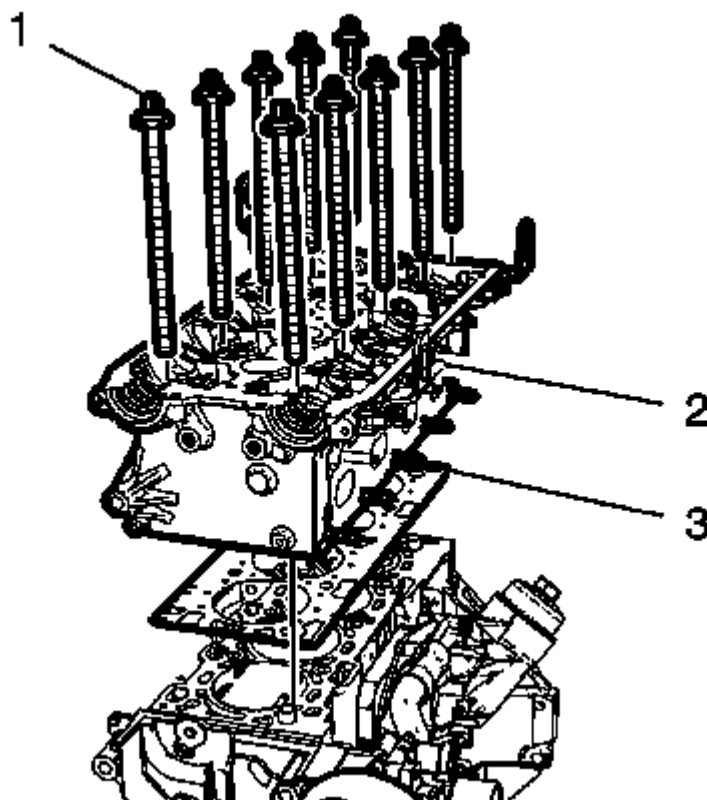
**NOTE:** Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The usage of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.

52. Remove and DISCARD the intake camshaft position actuator adjuster bolt and/or the exhaust camshaft position actuator adjuster bolt (2).
53. Remove the intake camshaft position actuator adjuster and the exhaust camshaft position actuator adjuster (3).
54. Remove the timing belt rear cover. Refer to **Timing Belt Rear Cover Removal**.



**Fig. 131: Cylinder Head Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

55. Loosen the 10 cylinder head bolts in sequence as shown.
1. Loosen the 10 bolts 90 degrees.
  2. Loosen the 10 bolts 180 degrees.



**Fig. 132: Cylinder Head And Bolts**

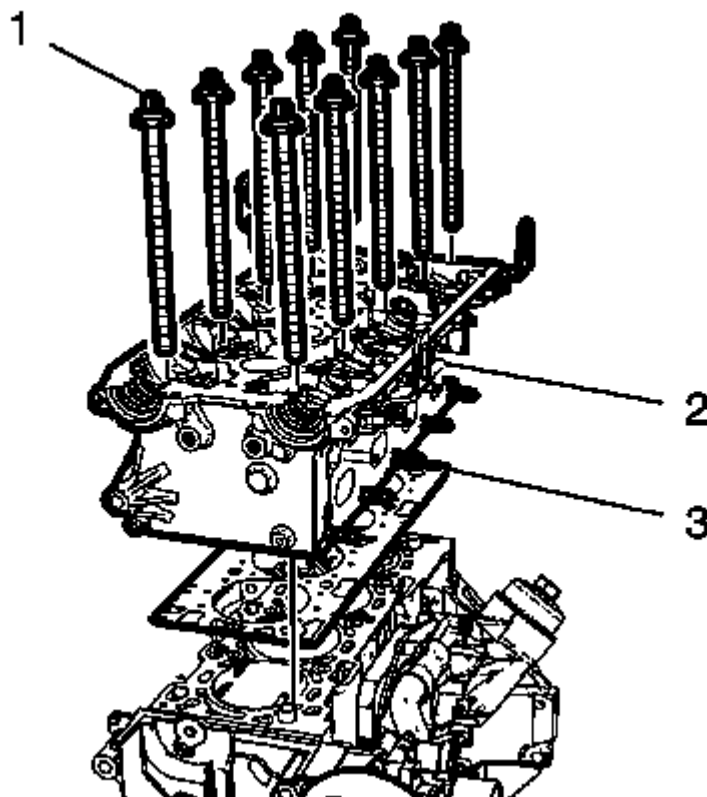
Courtesy of GENERAL MOTORS COMPANY

56. Remove and DISCARD the 10 cylinder head bolts (1).
57. Remove the cylinder head (2).
58. Remove and DISCARD the cylinder head gasket (3).
59. In case of re-use, then clean and inspect the cylinder head. Refer to Cylinder Head Cleaning and Inspection.
60. Remove the thermostat housing. Refer to Engine Coolant Thermostat Housing Removal.
61. Remove the camshafts. Refer to Camshaft Removal.
62. Remove the valve lifter. Refer to Valve Lifter Removal.
63. Disassemble the cylinder head. Refer to Cylinder Head Disassemble.

#### Installation Procedure

1. Assemble the cylinder head. Refer to Cylinder Head Assemble.
2. Install the valve lifter. Refer to Valve Lifter Installation.
3. Install the camshafts. Refer to Camshaft Installation.
4. Install the thermostat housing. Refer to Engine Coolant Thermostat Housing Installation.
5. Clean the sealing surfaces.

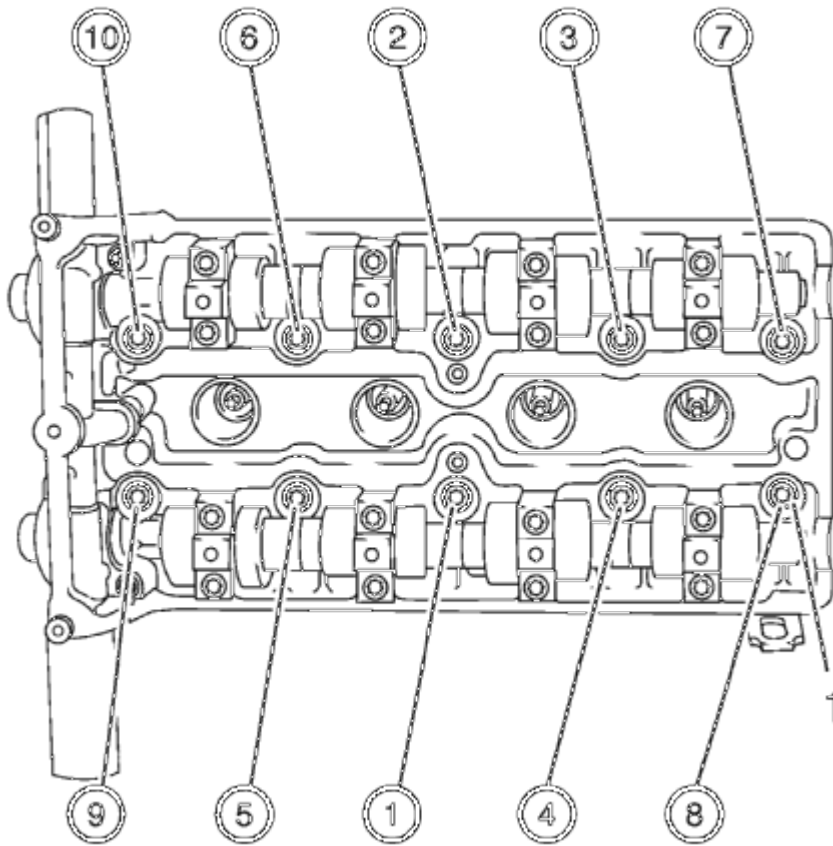
6. Inspect for plane surface.
  - Cylinder block, cylinder head
  - Straight-edge, feeler gauge



**Fig. 133: Cylinder Head And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

7. Install a NEW cylinder head gasket (3).
8. Install the cylinder head (2).



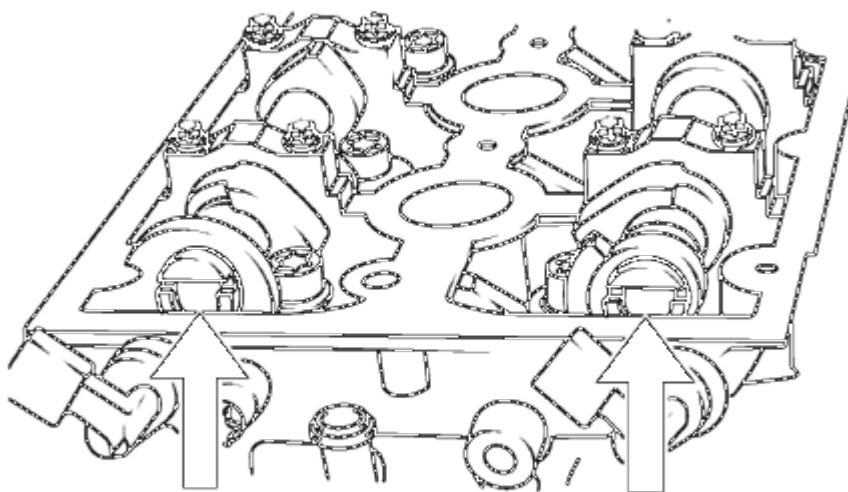


**Fig. 134: Cylinder Head Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

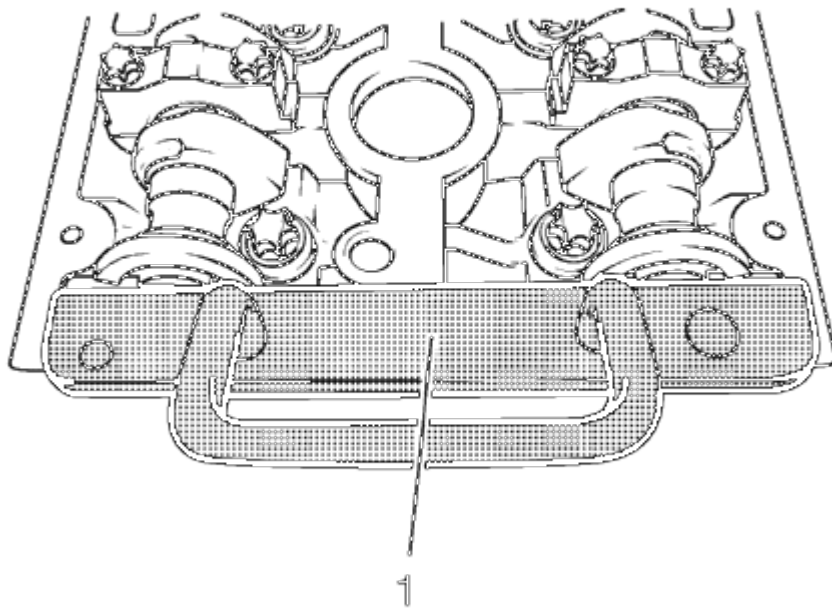
9. Install 10 NEW cylinder head bolts (1).
10. Tighten the bolts as shown in sequence in 5 passes, using the **EN-45059** meter :
  1. First pass to 25 (18 lb ft)
  2. Second pass to 90 degrees
  3. Third pass to 90 degrees
  4. Fourth pass to 90 degrees
  5. Final pass to 45 degrees
11. Install the timing belt rear cover. Refer to Timing Belt Rear Cover Installation.



**Fig. 135: Aligning Camshafts Horizontally**

**Courtesy of GENERAL MOTORS COMPANY**

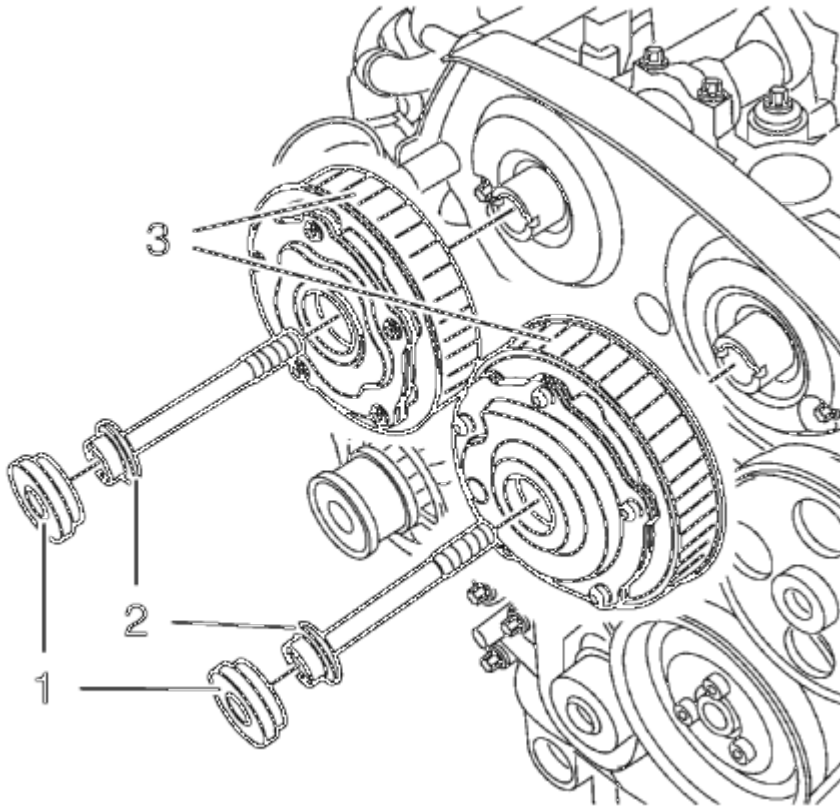
12. Align the camshafts horizontally by the hexagon arrows, until the **EN-6628-A** locking tool can be inserted in both camshafts.



**Fig. 136: Locking Tool**

**Courtesy of GENERAL MOTORS COMPANY**

13. Insert the **EN-6628-A** locking tool (1) into the camshafts.

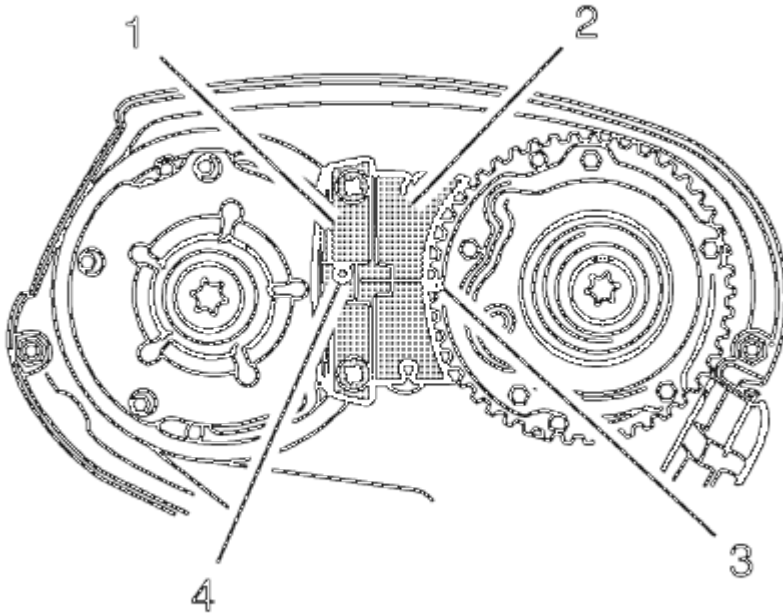


**Fig. 137: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the cover is contaminated with oil, you have to clean it close.

**NOTE:** A second person is required. Counterhold against the hexagon of corresponding camshaft with an open-ended wrench.

14. Install intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).
15. Install a NEW intake camshaft position actuator adjuster bolt and/or a NEW exhaust camshaft position actuator adjuster bolt (2).



**Fig. 138: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

16. Install the **EN-6340** locking tool into the camshaft position actuator adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft position actuator adjuster does not correspond to the groove of EN-6340 locking tool - left during this process but must be somewhat above as shown.

1. Install the **EN-6340** locking tool - left (1) in the camshaft position actuator adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft position actuator adjuster must correspond to the groove on EN-6340 locking tool - right.

2. Install the **EN-6340** locking tool - right (2) in the camshaft position actuator adjusters as shown.

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

**NOTE:** If the cover is contaminated with oil, you have to clean it close.

**NOTE:** A second technician is required.

**NOTE:** Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The Use of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.

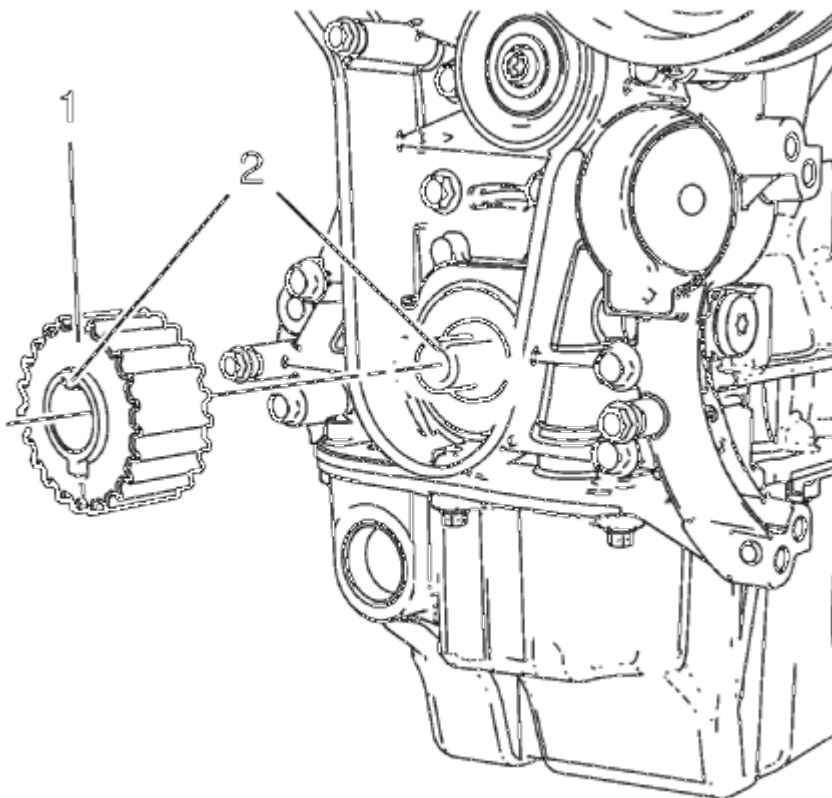
17. Tighten the camshaft position actuator adjuster bolts (2) in three passes use the **EN-45059** meter :

Hold at the appropriate camshaft hexagon.

1. First pass tighten to 50 (37 lb ft).
2. Second pass to 150 degrees.
3. Final pass to 15 degrees.

**NOTE:** Check the closure bolt seal ring.

18. Install the 2 camshaft position actuator adjuster closure plugs (1) and tighten to 30 (22 lb ft).  
19. Remove the **EN-6628-A** locking tool.

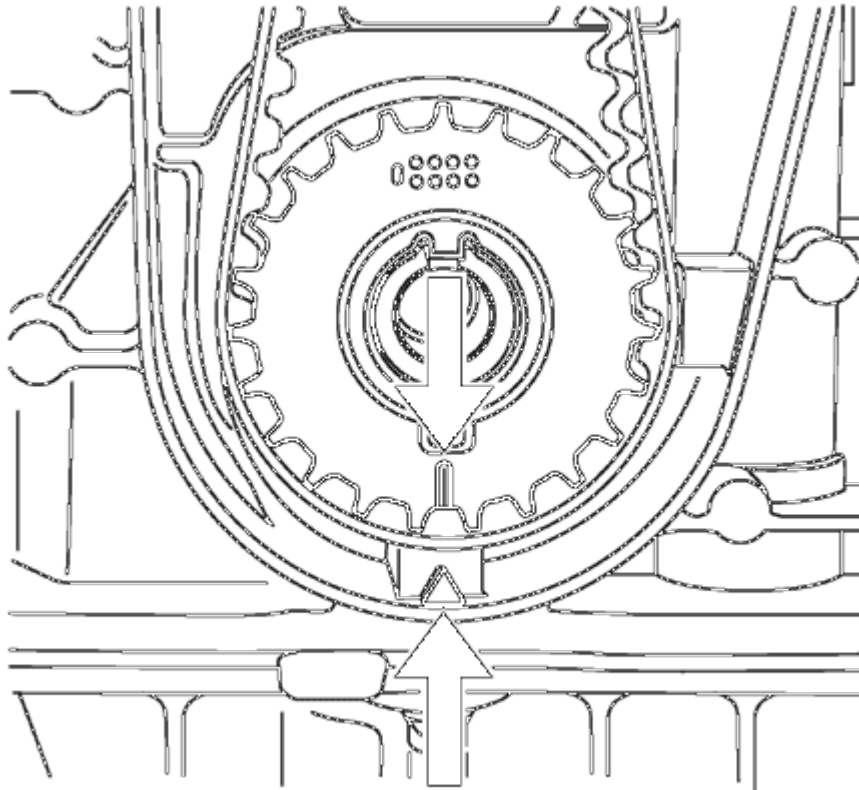


**Fig. 139: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When installing the crankshaft sprocket, the cam and the groove must align (2).

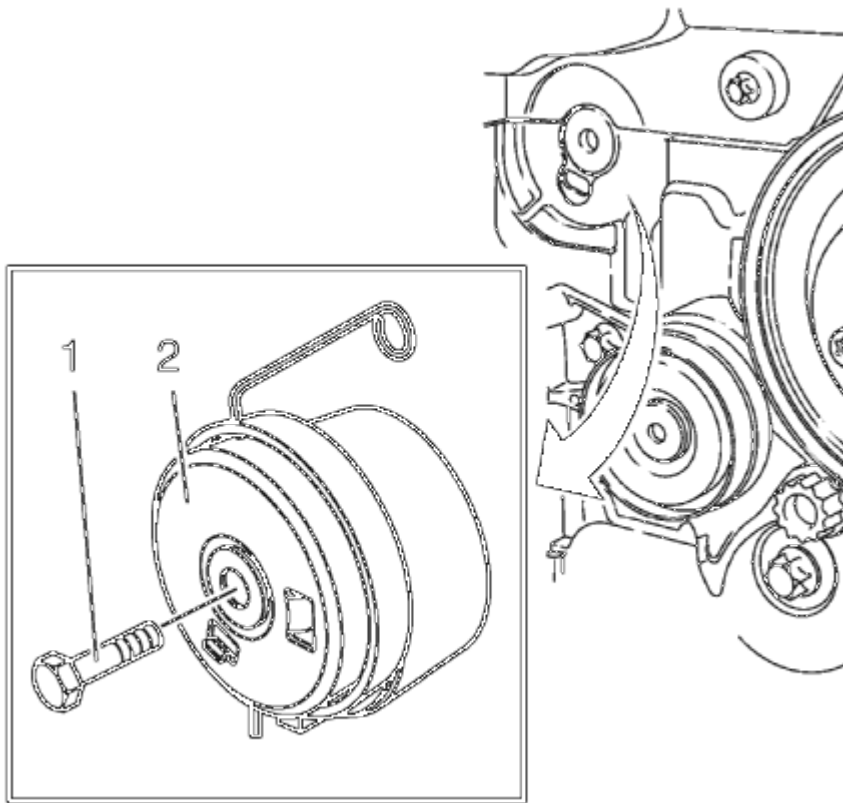
20. Install the crankshaft sprocket (1).

**Fig. 140: Aligning Timing Belt Drive Gear And Oil Pump Housing**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The crankshaft sprocket and oil pump housing must align.

21. Set the crankshaft in the direction of engine rotation to TDC. Use the crankshaft balancer bolt.



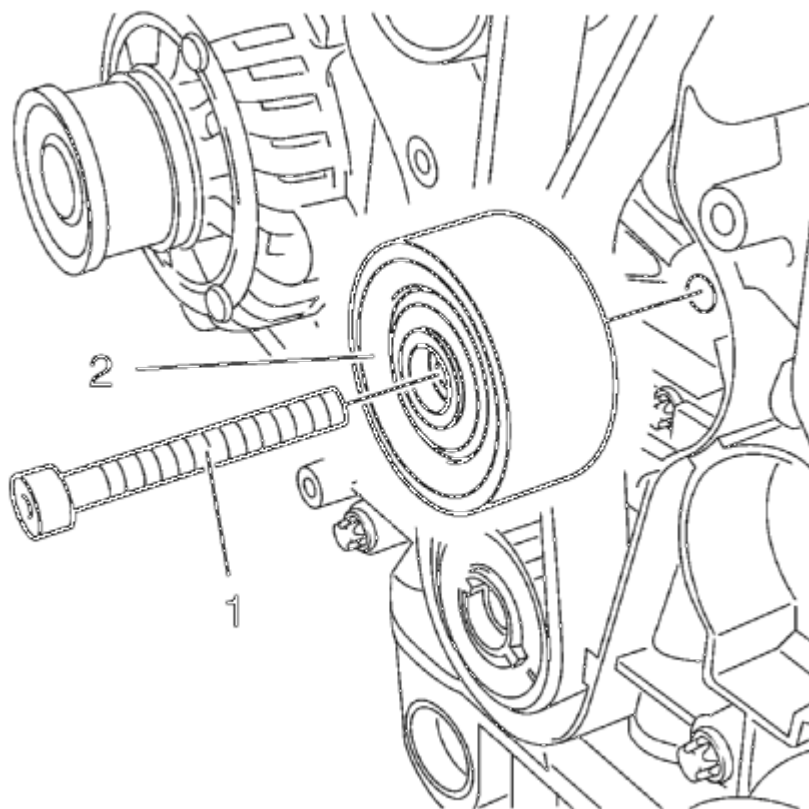
**Fig. 141: Timing Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

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

22. Install the timing belt tensioner (2) and tighten the NEW timing belt tensioner bolt (1) in three passes use the **EN-45059** meter :
1. First pass tighten to 20 (15 lb ft).
  2. Second pass to 120 degrees.
  3. Third pass to 15 degrees.



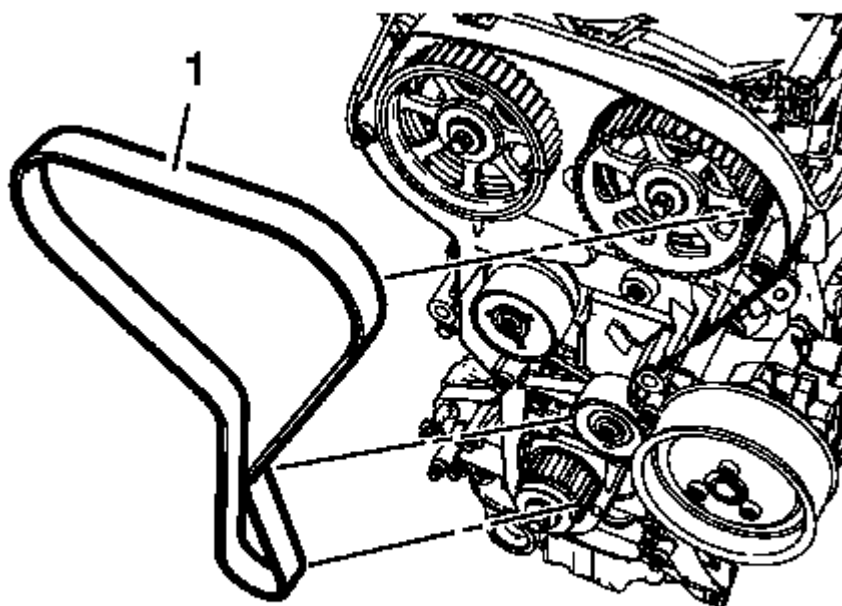


**Fig. 142: Timing Belt Idler Pulley Bolt**

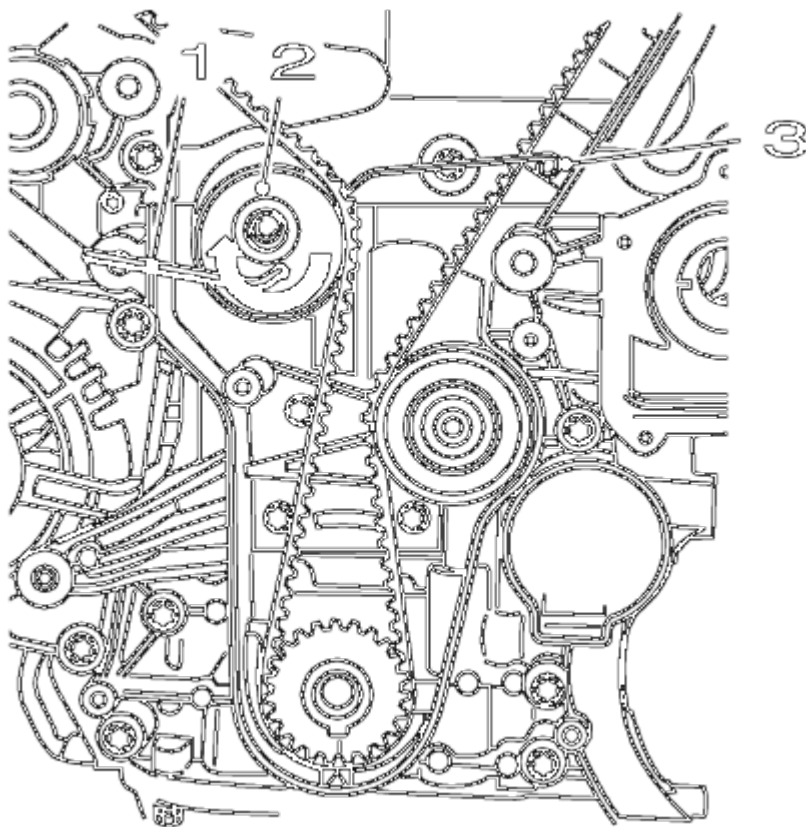
Courtesy of GENERAL MOTORS COMPANY

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

23. Install the timing belt idler pulley (2) and tighten the NEW bolt (1) in three passes use the **EN-45059** meter :
1. First pass tighten to 20 (15 lb ft).
  2. Second pass to 120 degrees.
  3. Third pass to 15 degrees.

**Fig. 143: Drive Belt Routing****Courtesy of GENERAL MOTORS COMPANY**

24. Install the timing belt (1).
25. Guide the timing belt past the tensioner and place it on the crankshaft sprocket wheel.
26. Place the timing belt on the exhaust and intake camshaft position actuator adjusters.

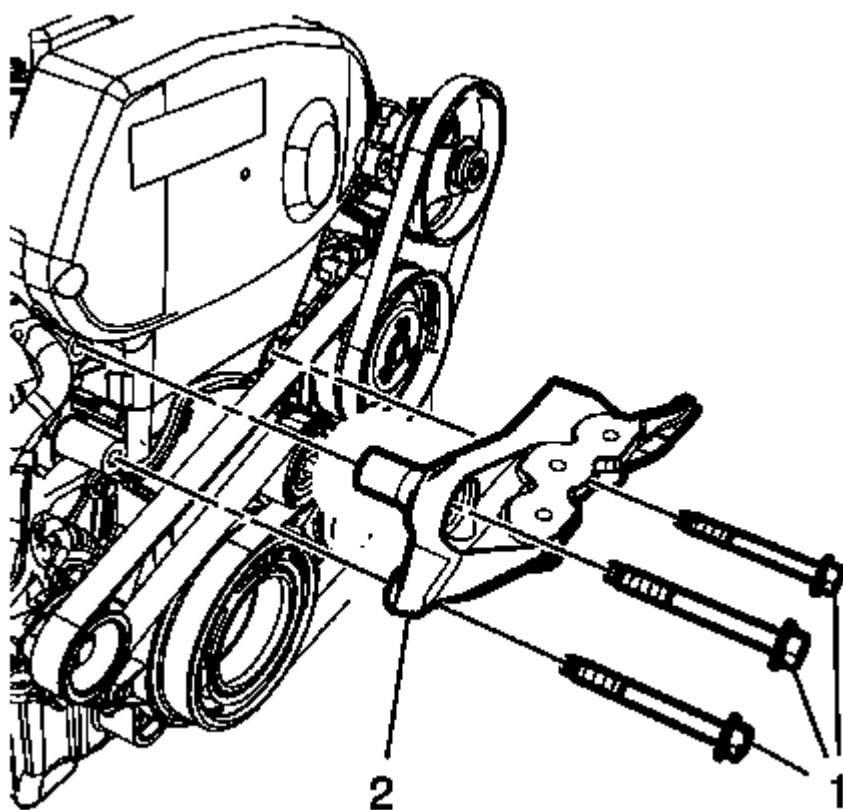


**Fig. 144: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

27. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an allen key (1).
28. Remove the EN-6333 pin (3).

**NOTE:** The timing belt tensioner moves automatically to the correct position.

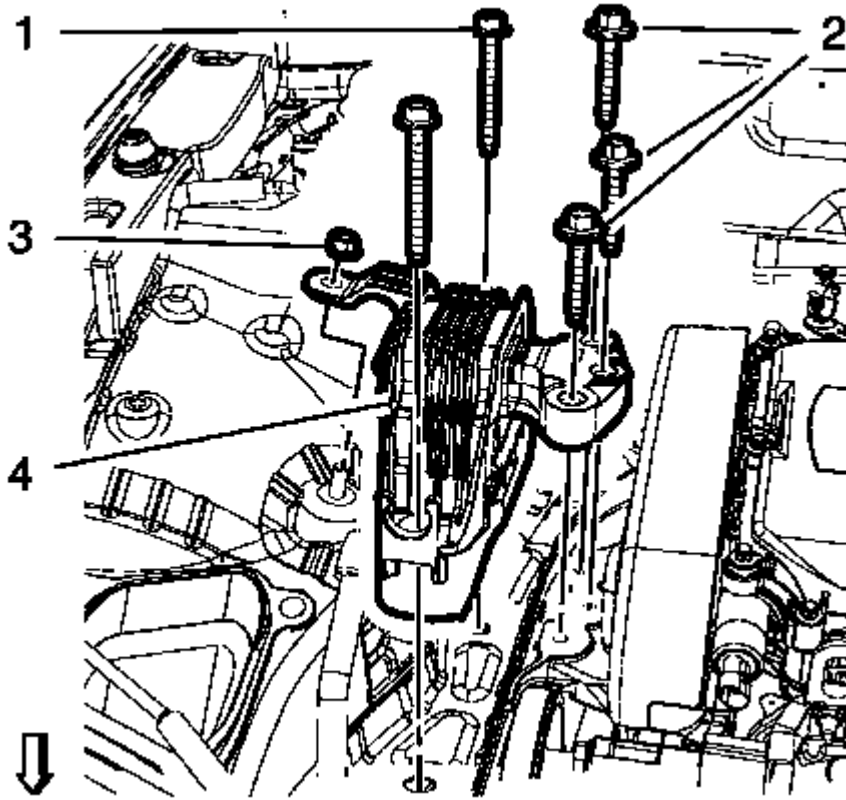
29. Release tension on timing belt tensioner.
30. Lower the vehicle.



**Fig. 145: Engine Mount Bracket And Bolts**

Courtesy of GENERAL MOTORS COMPANY

31. Install the engine mount bracket (2).
32. Install the 3 engine mount bracket bolts (1) tighten to 62 (46 lb ft).



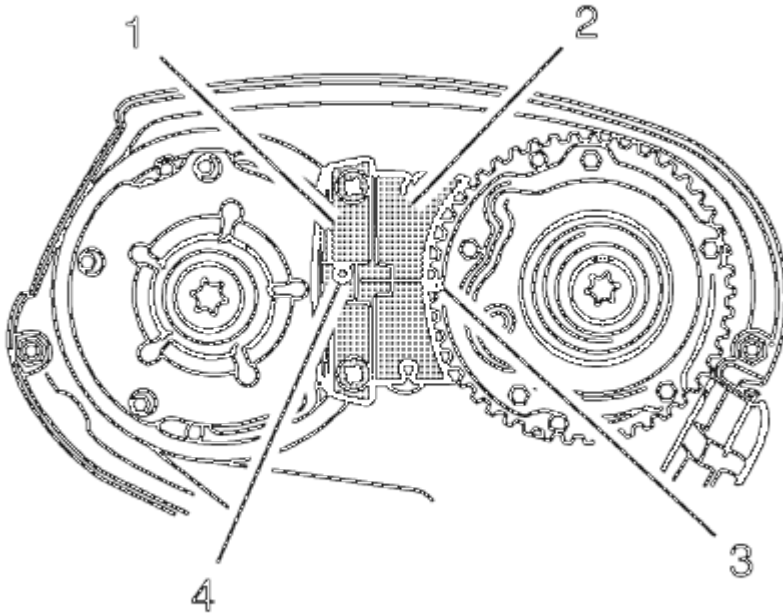
**Fig. 146: Engine Mount And Bolts**

Courtesy of GENERAL MOTORS COMPANY

33. Install the engine mount (4).
34. Install the 2 engine mount bolts (1) and tighten to 62 (46 lb ft).

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

35. Install the 3 engine mount bolts (2) and tighten in three passes use the **EN-45059** meter.
  1. First pass tighten to 50 (37 lb ft).
  2. Second pass to 60 degrees.
  3. Third pass to 15 degrees.
36. Unsupport the engine.
37. Remove **EN-6340** locking tool.



**Fig. 147: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

38. Check the timing

**NOTE:** Note the marking at the camshaft sprockets.

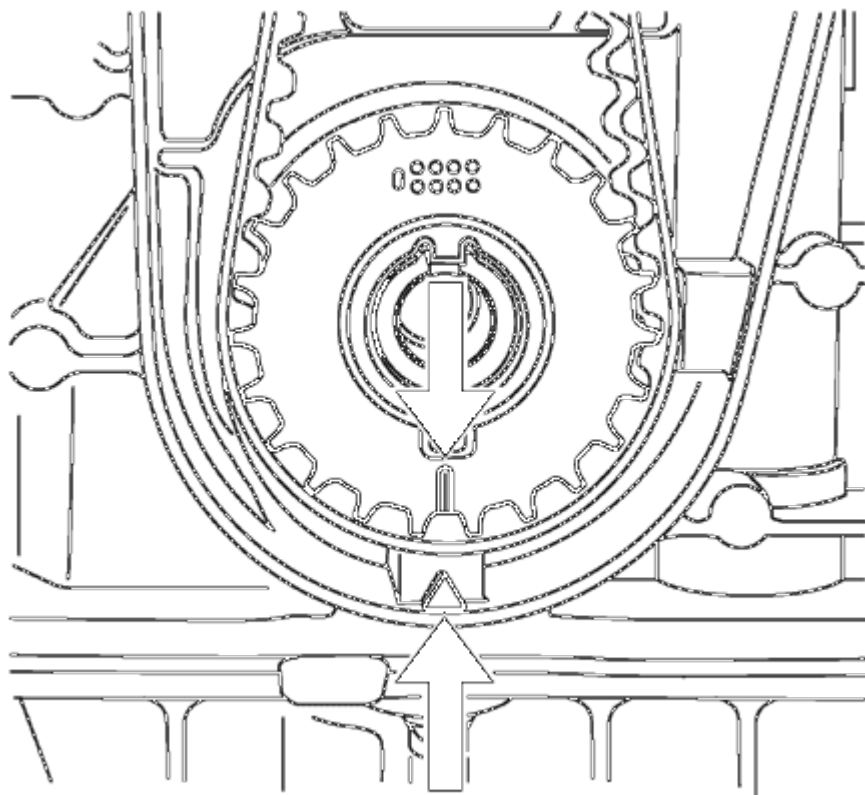
- Turn the crankshaft 720 degrees in the direction of engine rotation by the bolt on the crankshaft balancer.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340 locking tool - left during this process but must be somewhat above as shown.

- Install EN-6340 locking tool - left (1) into the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right.

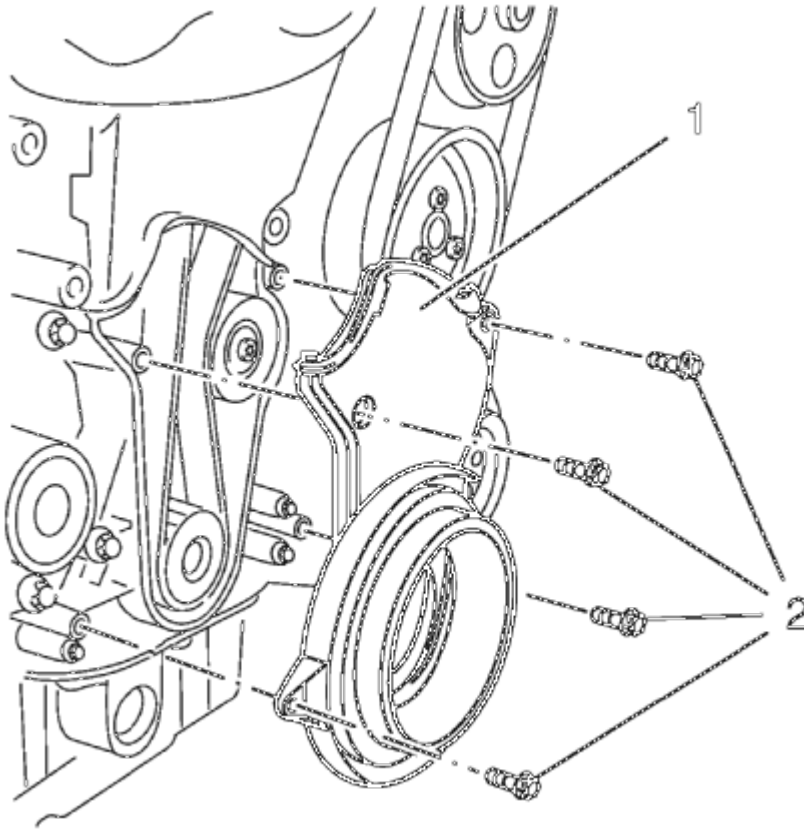
- Install EN-6340 locking tool - right (2) into the camshaft adjusters as shown.
- Raise the vehicle.



**Fig. 148: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The crankshaft sprocket and oil pump housing must align.

39. Check the crankshaft position.



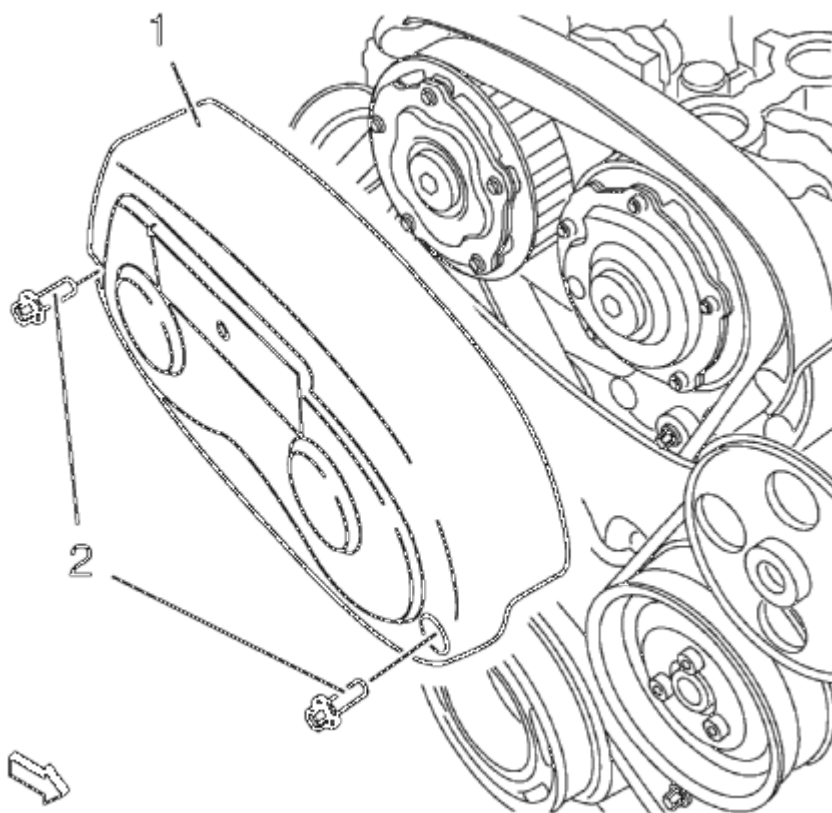
**Fig. 149: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

40. Install the lower timing belt cover (1).

**CAUTION: Refer to Fastener Caution .**

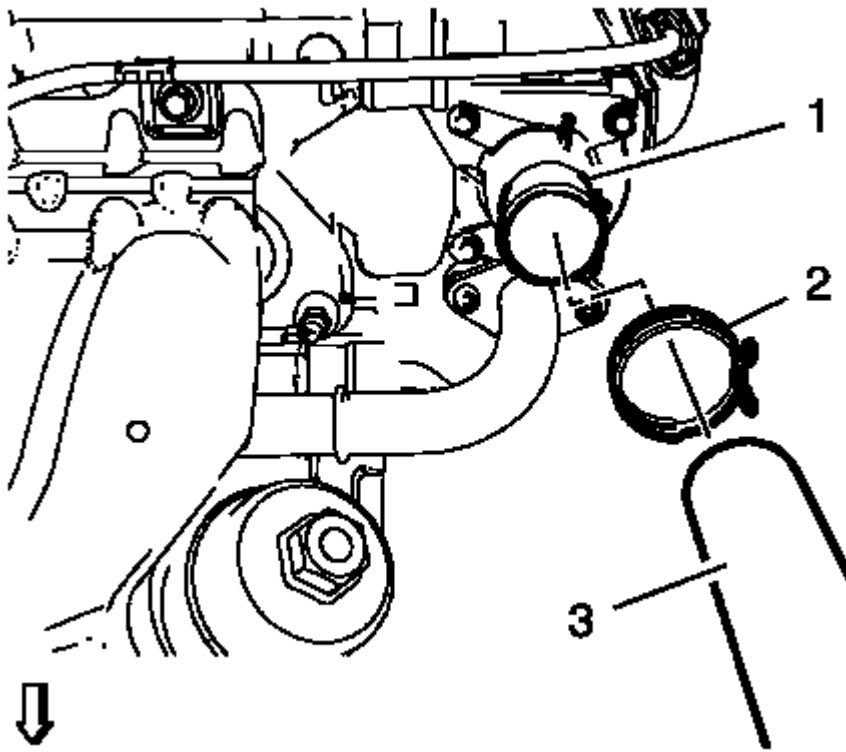
41. Install the 4 lower timing belt cover bolts (2) and tighten to 6 (53 lb in).
42. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.
43. Lower the vehicle.
44. Remove the **EN-6340** locking tool.
45. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Replacement**.
46. Install the 2 camshaft position sensors. Refer to **Camshaft Position Sensor Replacement** .
47. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.





**Fig. 150: Timing Belt Upper Front Cover**  
 Courtesy of GENERAL MOTORS COMPANY

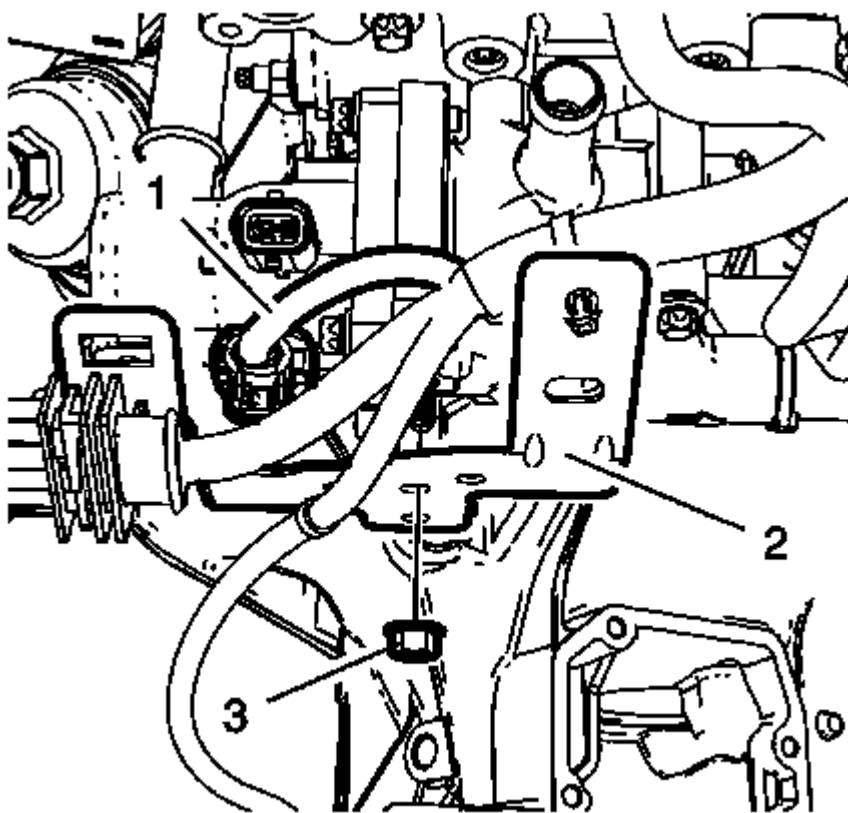
48. Install the timing belt upper front cover (1).
49. Install the 2 timing belt upper front cover bolts (2) and tighten to 6 (53 lb in).
50. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LUW)** .



**Fig. 151: Radiator Inlet Hose And Clamp**

Courtesy of GENERAL MOTORS COMPANY

51. Install the radiator inlet hose (3) with the radiator inlet hose clamp (2) to the engine coolant thermostat (1).
52. Install the heater inlet hose to the engine coolant thermostat housing. Refer to **Heater Inlet Hose Replacement (LUJ)** , **Heater Inlet Hose Replacement (LUW)** .
53. Install the heater outlet hose to the engine coolant thermostat housing. Refer to **Heater Outlet Hose Replacement (LUJ)** , **Heater Outlet Hose Replacement (LUW)** .



**Fig. 152: Thermostat Housing Bracket, Bolts And Wiring Harness**  
Courtesy of GENERAL MOTORS COMPANY

54. Install the engine coolant thermostat housing bracket (2).
55. Install the engine coolant thermostat housing bracket nut (3) and tighten to 6 (53 lb in).
56. Connect the thermostat wiring harness plug (1).
57. Install the intake manifold. Refer to **Intake Manifold Replacement**.
58. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
59. Fill engine oil. Refer to **Engine Mechanical Specifications**.
60. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.
61. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE-47716 Fill)**, **Cooling System Draining and Filling (Static Fill)**.

## OIL PAN REPLACEMENT

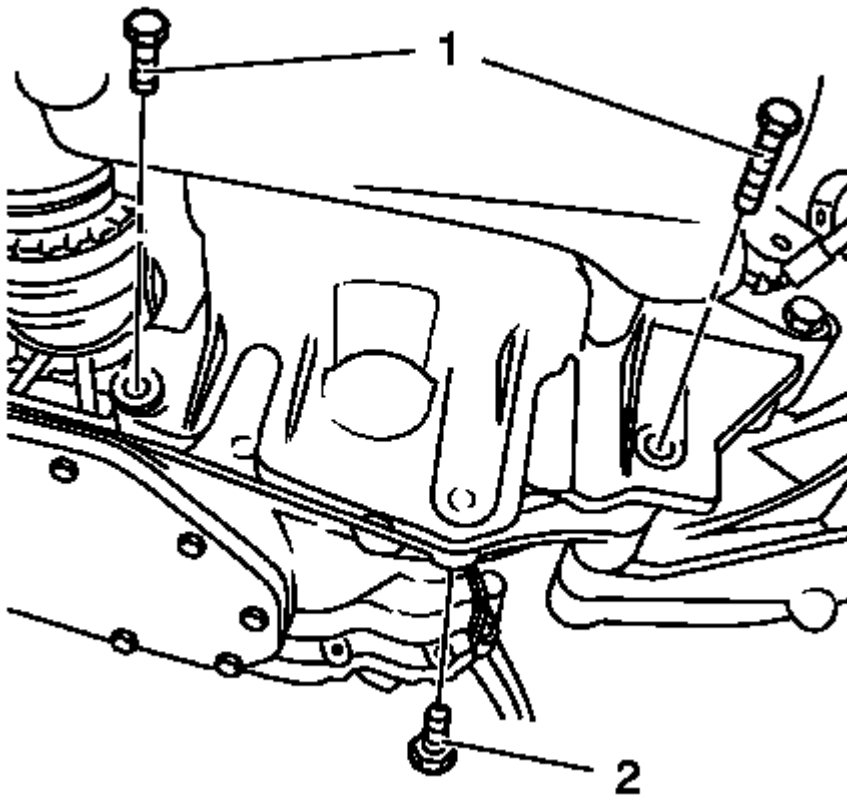
### Removal Procedure

1. Open the hood.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
3. Place collecting basin underneath.

4. Remove the oil drain bolt.
5. Collect the engine oil.

**CAUTION:** Refer to Fastener Caution .

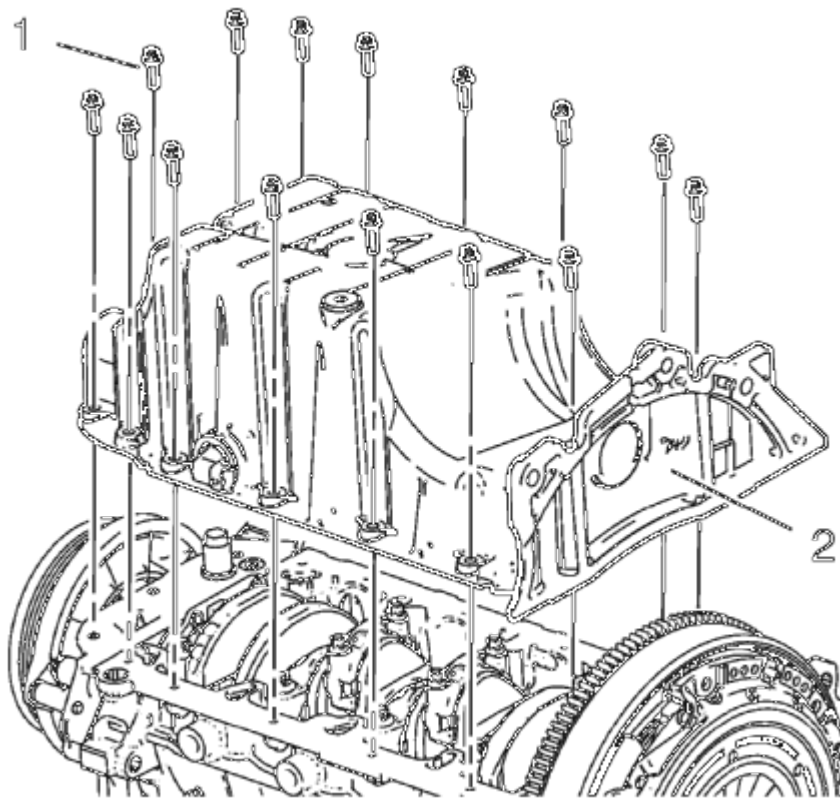
6. Install the NEW seal ring and the oil drain bolt, tighten to 14 N.m (124 lb in).
7. Lower the vehicle.
8. Remove the oil level indicator tube. Refer to Oil Level Indicator Tube Replacement.
9. Raise the vehicle.
10. Remove the right front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement .
11. Remove the engine oil heater. Refer to Engine Oil Heater Replacement.
12. Remove the exhaust front pipe. Refer to Exhaust Front Pipe Replacement .



**Fig. 153: Oil Pan Bolts**

Courtesy of GENERAL MOTORS COMPANY

13. Remove the 3 oil pan bolts (1, 2) from the transmission.

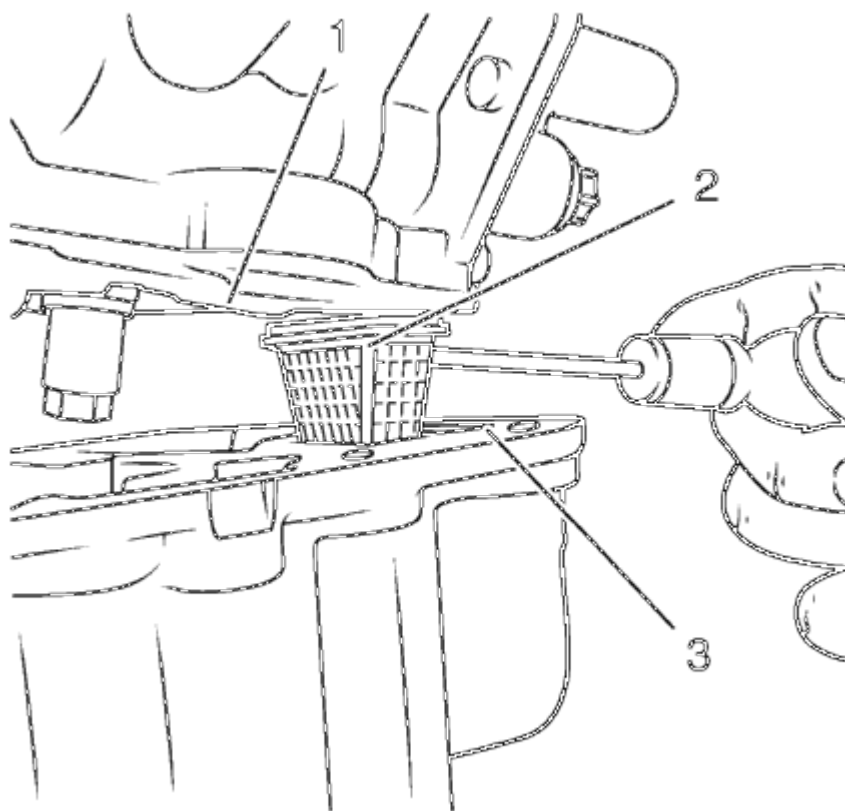


**Fig. 154: Oil Pan And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Remove the oil pan evenly all the way around with a suitable tool.

14. Remove the 15 oil pan bolts (1) and remove the oil pan (2).



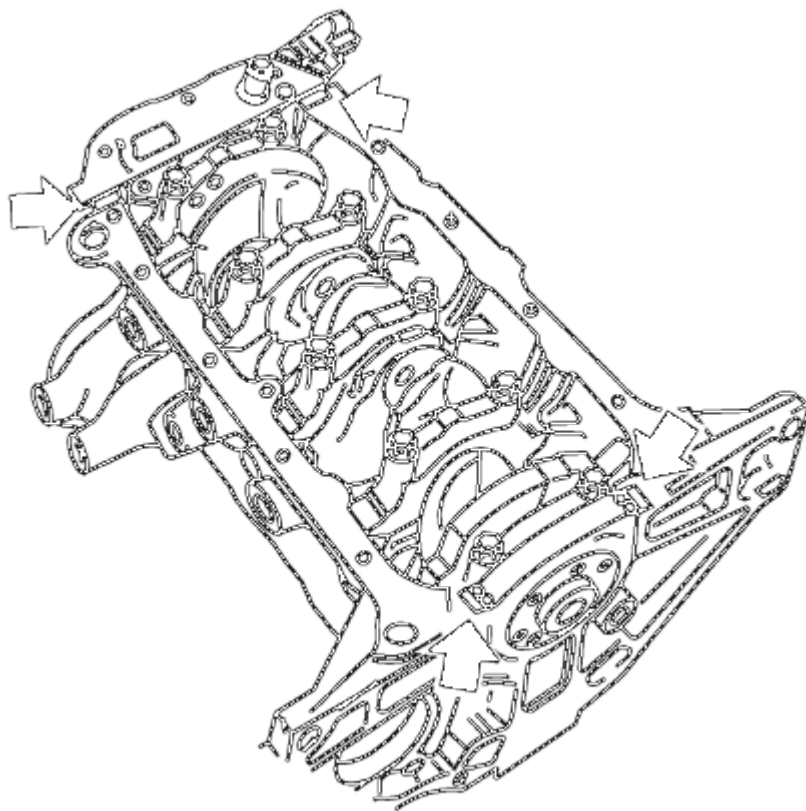
**Fig. 155: Protecting Oil Screen From Damage**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Use a screwdriver or another suitable tool.

15. To prevent damage to the oil screen, ensure that the oil screen (2) remains in the oil pan (3). If the oil screen gets caught on the cylinder block (1), push it into the oil pan.
16. Remove the oil pan.

#### Installation Procedure

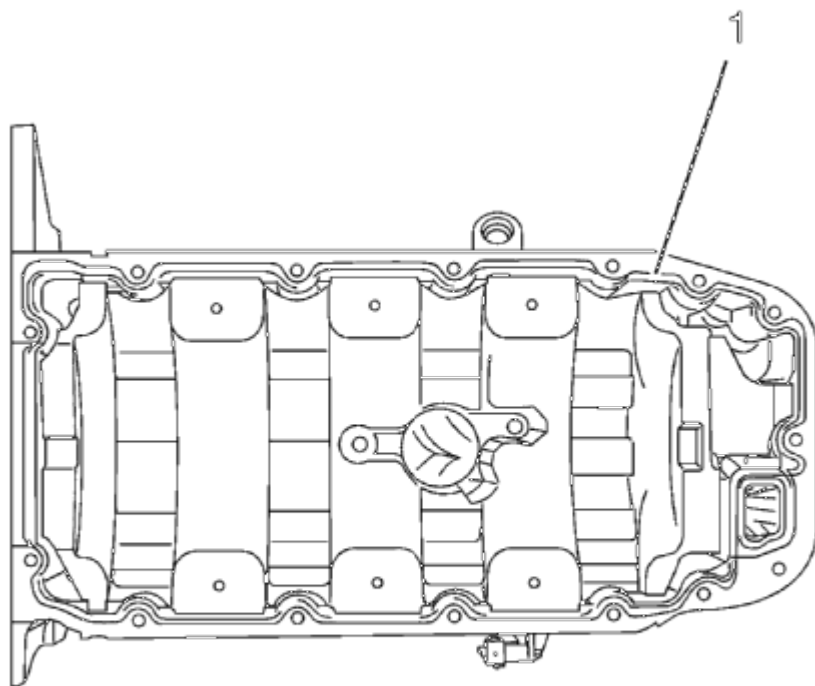
1. Clean the sealing surfaces.



**Fig. 156: Joints For Sealant Application**

Courtesy of GENERAL MOTORS COMPANY

2. Apply an approximately 3.5 mm (0.14 in) thick bead of oil pan sealant to the joints (arrows).

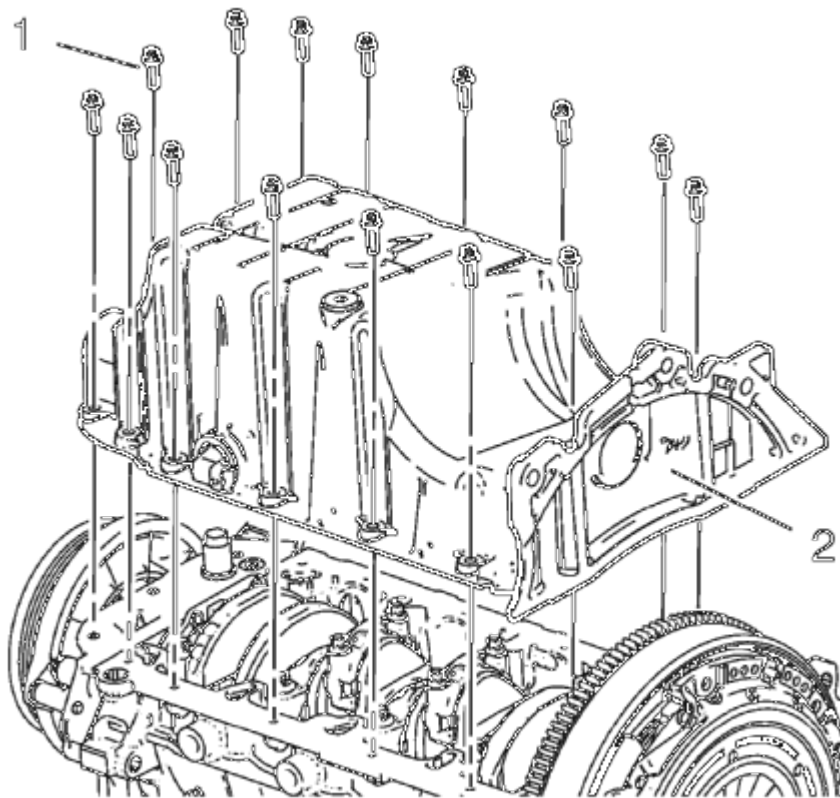
**Fig. 157: Sealant Application Area**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The assembly time including torque check must take no longer than 10 minutes.

3. Apply an approximately 3.5 mm (0.14 in) thick bead of oil pan sealant (1) as illustrated.



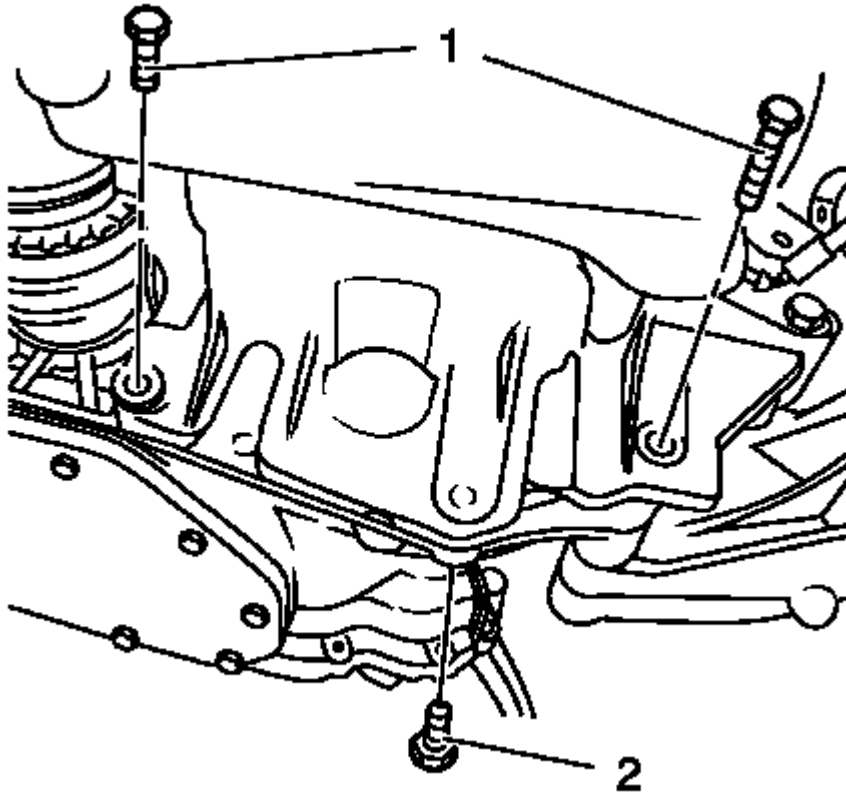


**Fig. 158: Oil Pan And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

4. Install the 15 oil pan bolts (1) to the oil pan (2) and tighten to 10 N.m (89 lb in).



**Fig. 159: Oil Pan Bolts**

Courtesy of GENERAL MOTORS COMPANY

5. Install the 3 oil pan bolts (1, 2) to the transmission and tighten to 40 N.m (30 lb ft).
6. Install the exhaust front pipe. Refer to [Exhaust Front Pipe Replacement](#) .
7. Install the engine oil heater. Refer to [Engine Oil Heater Replacement](#).
8. Install the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .
9. Lower the vehicle.
10. Install the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).

**NOTE:**        **Inspect the engine oil level and correct if necessary.**

11. Refill the collected engine oil.
12. Close the hood.

## AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

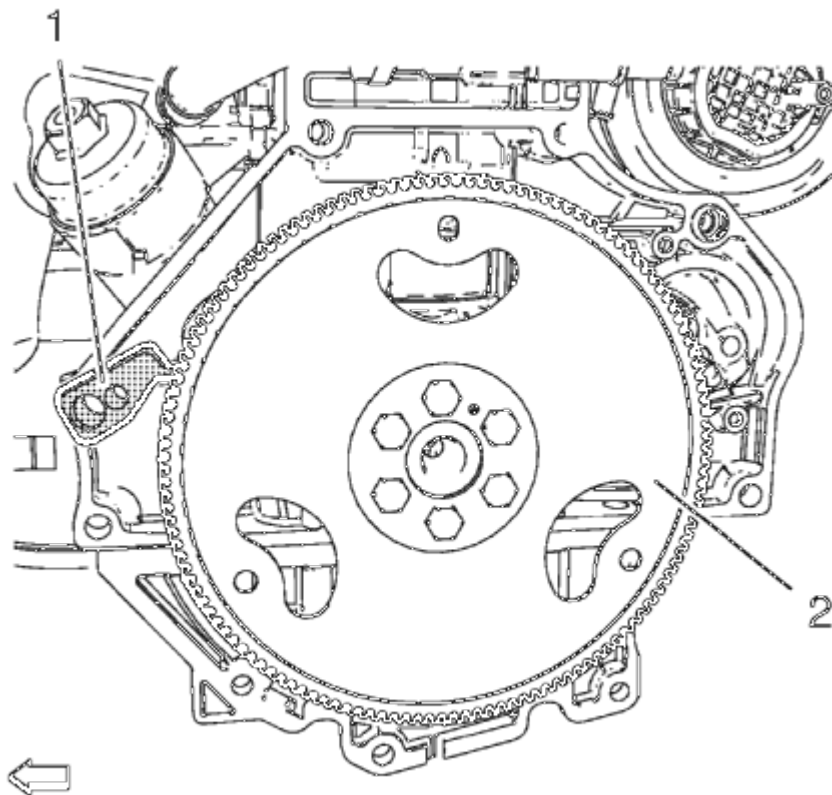
### Special Tools

**EN-652** Automatic Transmission Flex Plate Holder

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

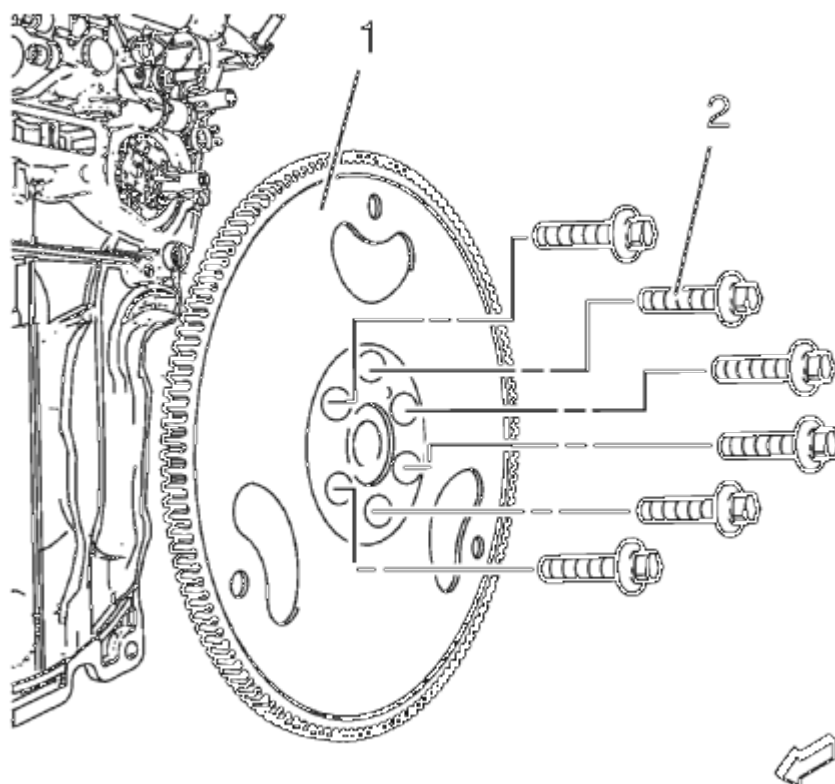
**Removal Procedure**

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



**Fig. 160: Automatic Transmission Flex Plate And Holder**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-652** holder (1) to hold the automatic transmission flex plate (2).
3. Loosen the 6 automatic transmission flex plate bolts.
4. Remove the **EN-652** holder (1).

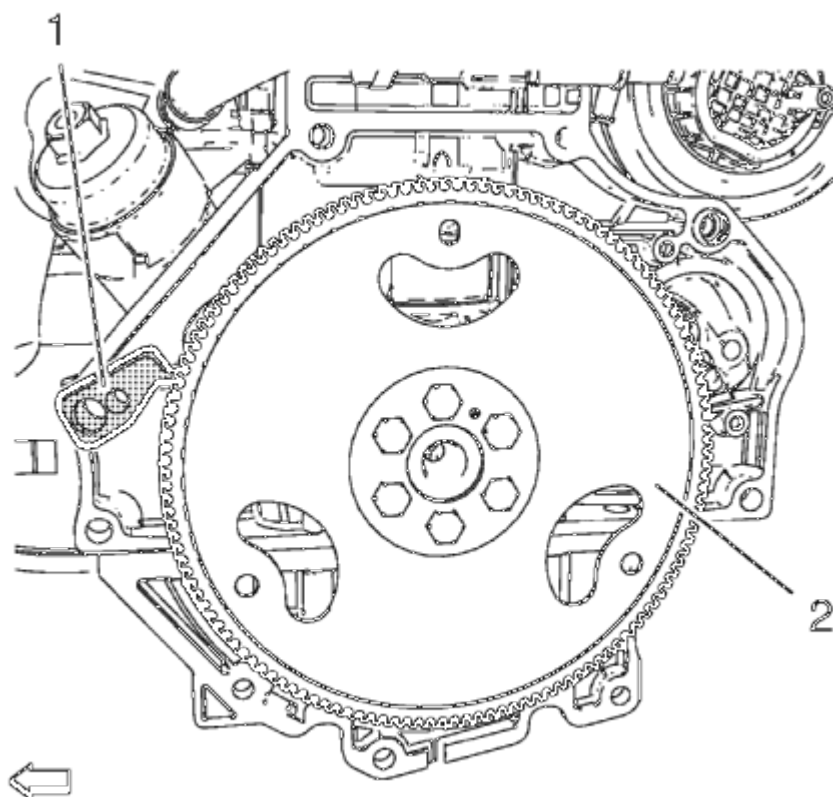


**Fig. 161: Automatic Transmission Flex Plate And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 6 automatic transmission flex plate bolts (2).
6. Remove the automatic transmission flex plate (1).

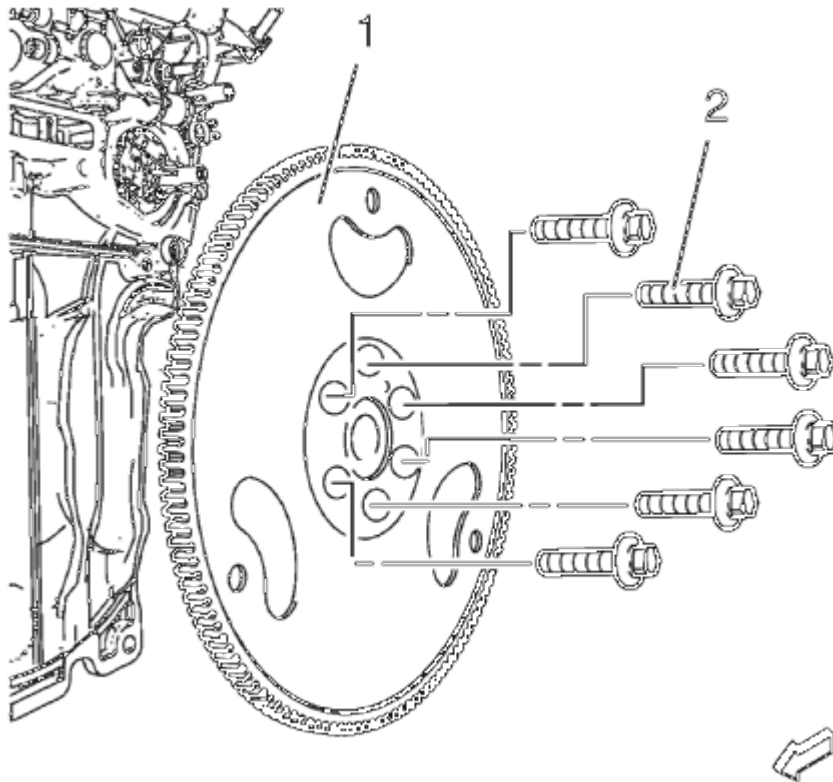
#### **Installation Procedure**

1. Clean the automatic transmission flex plate bolt threads.



**Fig. 162: Automatic Transmission Flex Plate And Holder**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the automatic transmission flex plate (2) and the **EN-652** holder to hold the automatic transmission flex plate (2).



**Fig. 163: Automatic Transmission Flex Plate And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

3. Install the 6 NEW automatic transmission flex plate bolts (2) and tighten the bolts to 60 N.m (44 lb ft)  $\pm$  5°.
4. Remove the **EN-652** holder.
5. Install the automatic transmission. Refer to Transmission Replacement .

## ENGINE FLYWHEEL REPLACEMENT (MANUAL TRANSMISSION)

### Removal Procedure

1. Remove the manual transmission. Refer to Transmission Replacement .
2. Remove the clutch pressure and driven plate. Refer to Clutch Pressure and Driven Plate Replacement

**(1.4L LUJ) , Clutch Pressure and Driven Plate Replacement (1.8L LUW) .**

3. Remove the engine flywheel. Refer to **Engine Flywheel Removal**.

**Installation Procedure**

1. Install the engine flywheel. Refer to **Engine Flywheel Installation**
2. Install the clutch pressure and driven plate. Refer to **Clutch Pressure and Driven Plate Replacement (1.4L LUJ) , Clutch Pressure and Driven Plate Replacement (1.8L LUW) .**
3. Install the manual transmission. Refer to **Transmission Replacement** .

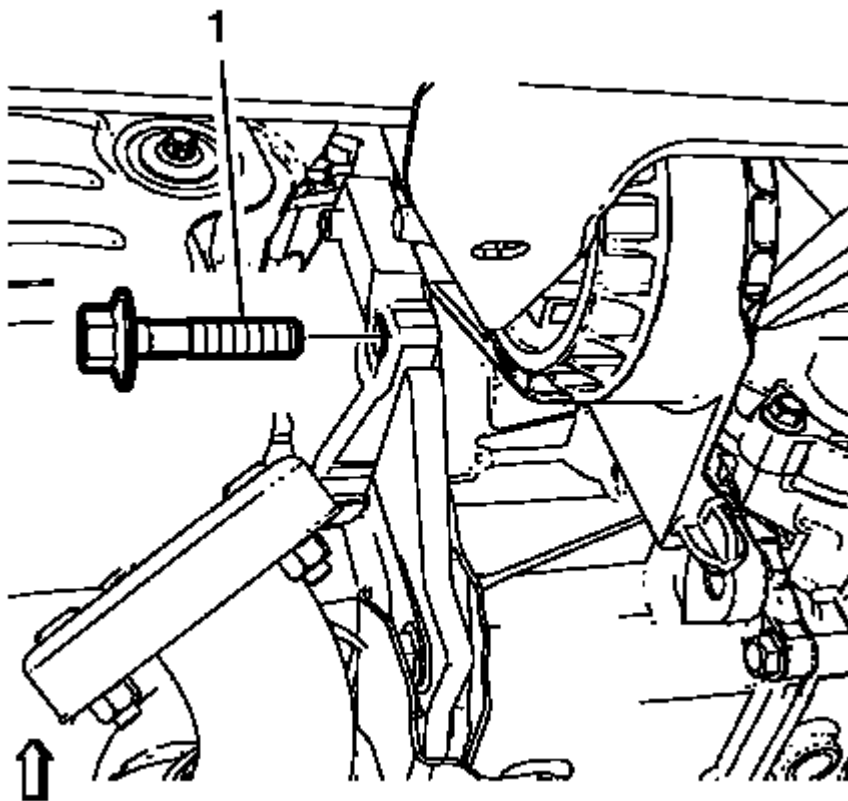
**CRANKSHAFT BALANCER REPLACEMENT (AUTOMATIC TRANSMISSION)****Special Tools**

- **EN-6625** Crankshaft Locking Device
- **EN-45059** Angle Meter

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

**Removal Procedure**

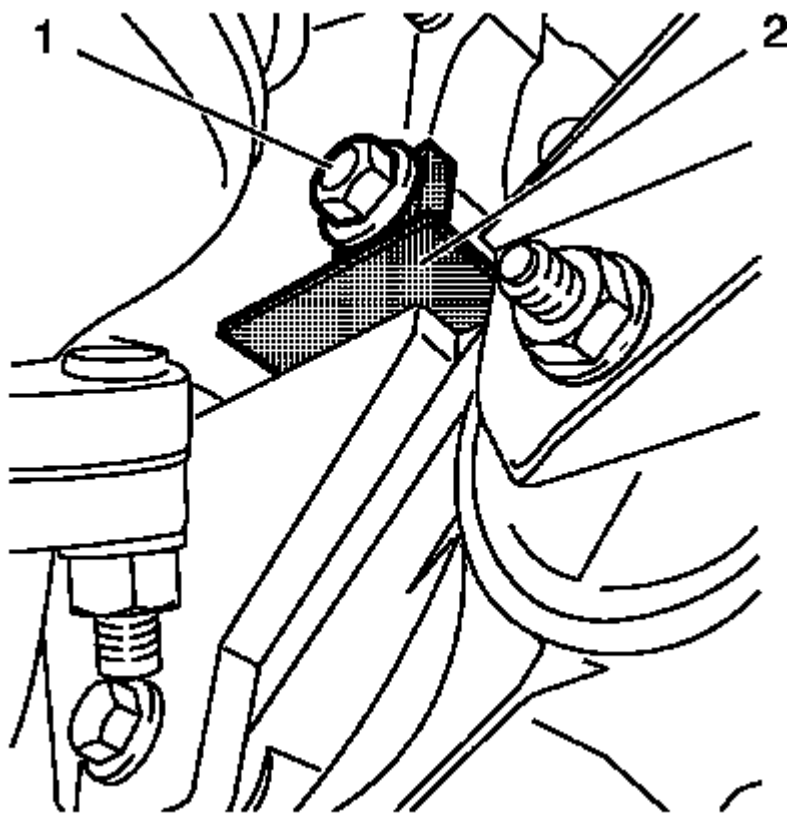
1. Open the hood.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
4. Remove the drive belt. Refer to **Drive Belt Replacement**.



**Fig. 164: Automatic Transmission Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

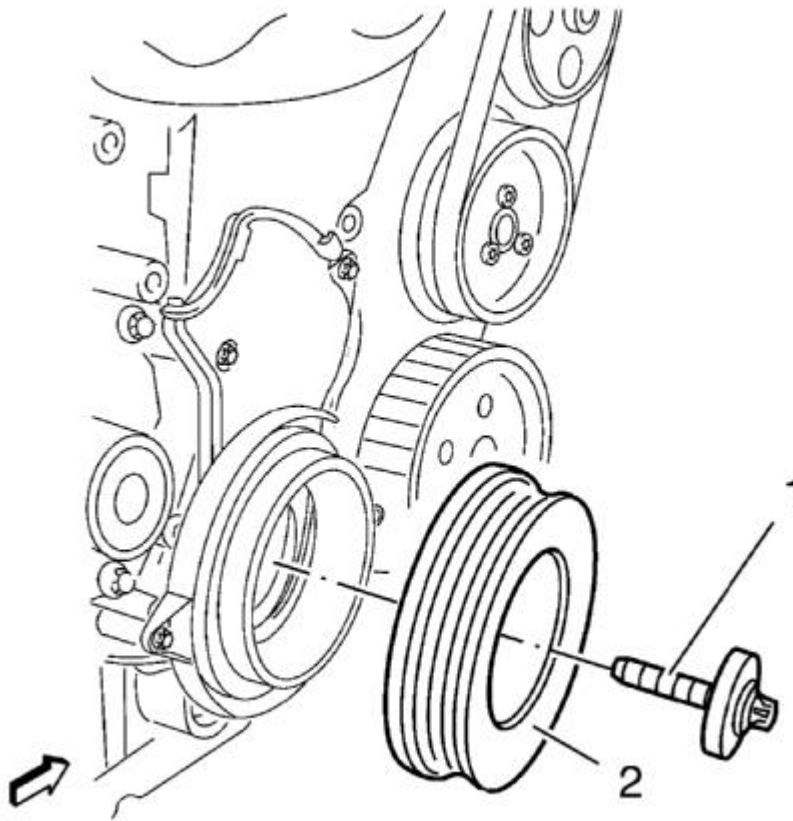
5. Remove the bolt (1).





**Fig. 165: Locking Device And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

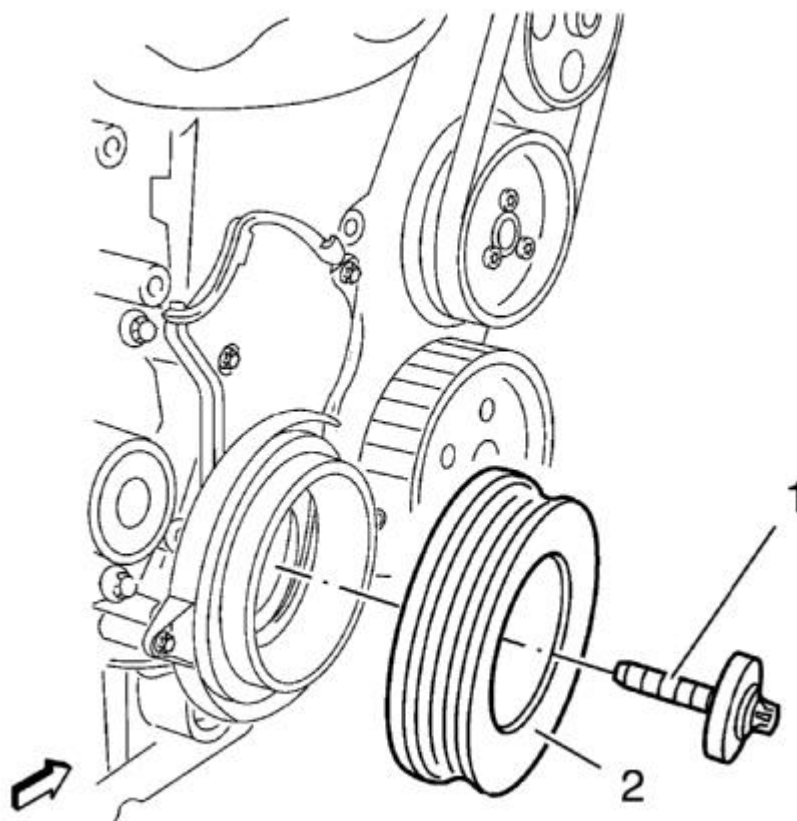
6. Install the **EN-6625** locking device (2) to lock the crankshaft.
7. Install the bolt (1).



**Fig. 166: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD the crankshaft balancer bolt (1).
9. Remove the crankshaft balancer (2).

#### Installation Procedure



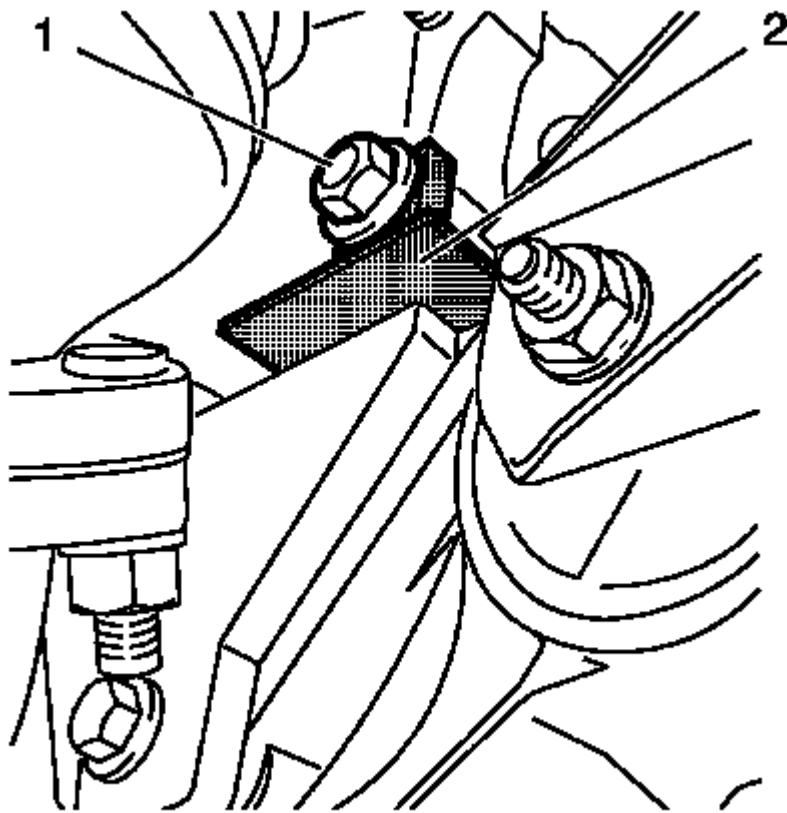
**Fig. 167: Crankshaft Balancer And Bolt**  
 Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft balancer (2).

**CAUTION: Refer to Fastener Caution .**

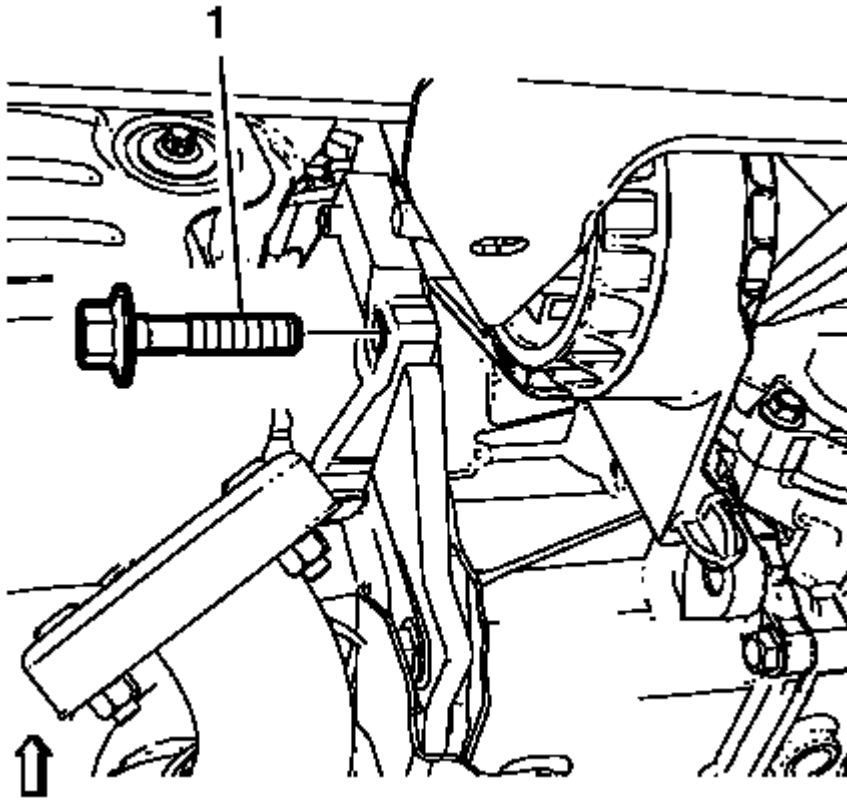
**CAUTION: Refer to Torque-to-Yield Fastener Caution .**

2. Install a NEW crankshaft balancer bolt (1) and tighten in 3 passes using the **EN-45059** meter :
  1. First pass to 95 N.m (70 lb ft).
  2. Second pass to 45°.
  3. Third pass to 15°.



**Fig. 168: Locking Device And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the bolt (1).
4. Remove **EN-6625** locking device (2) to unlock the crankshaft.



**Fig. 169: Automatic Transmission Bracket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the bolt (1) and tighten to 45 N.m (33 lb ft).
6. Install the drive belt. Refer to **Drive Belt Replacement**.
7. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement**.
8. Lower the vehicle.
9. Close the hood.

## CRANKSHAFT BALANCER REPLACEMENT (MANUAL TRANSMISSION)

### Special Tools

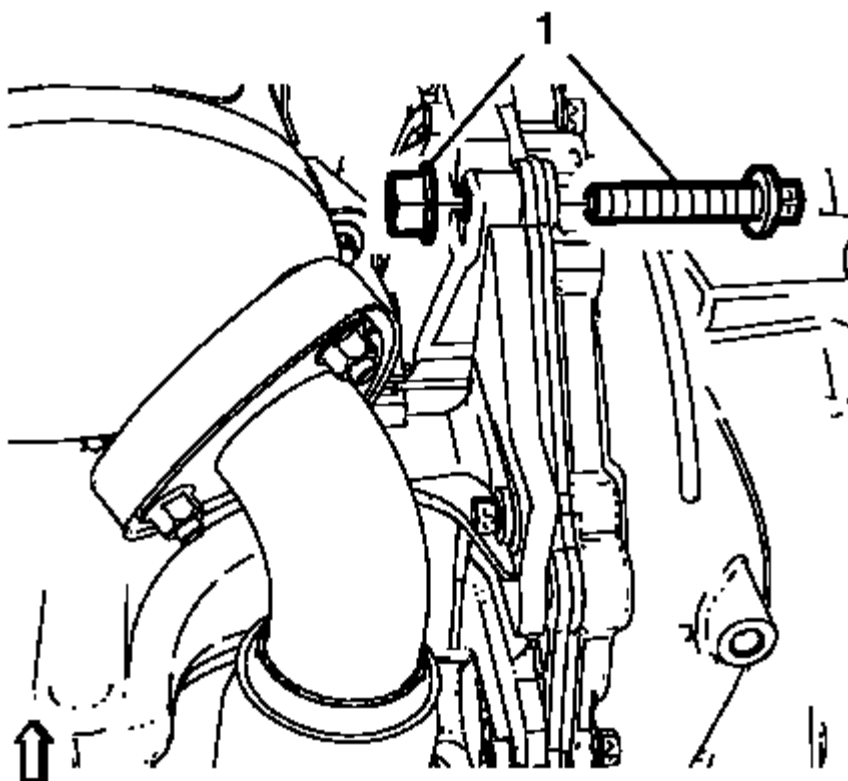
- **EN-6625** Crankshaft Locking Device
- **EN-45059** Angle Meter

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

### Removal Procedure

1. Open the hood.

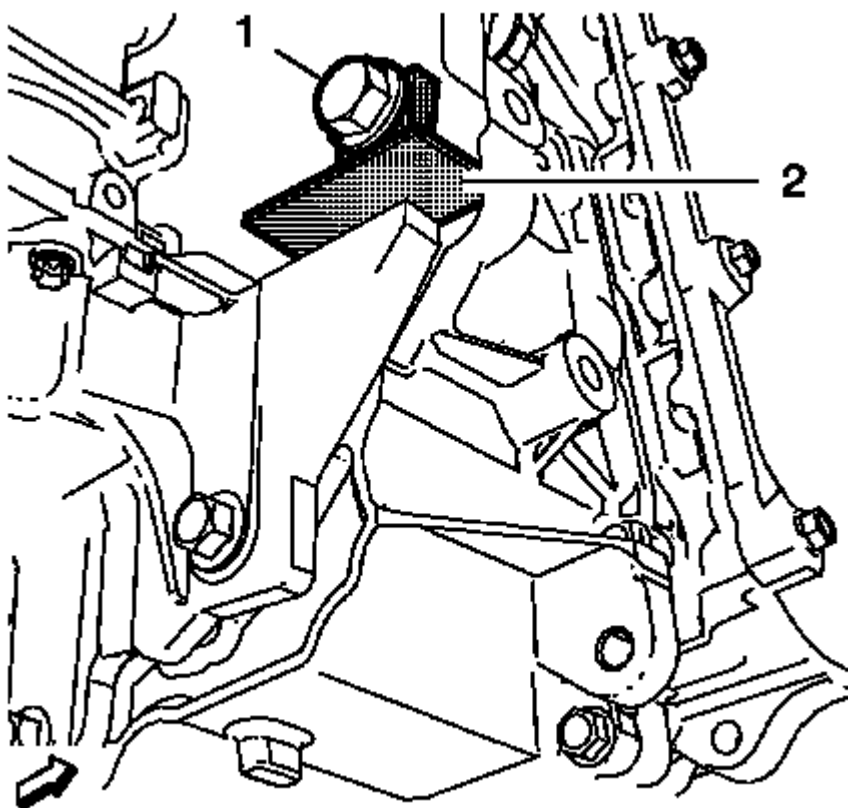
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
4. Remove the drive belt. Refer to **Drive Belt Replacement**.
5. Remove the transmission front mount. Refer to **Transmission Front Mount Replacement** .



**Fig. 170: Connection Bolt**

Courtesy of GENERAL MOTORS COMPANY

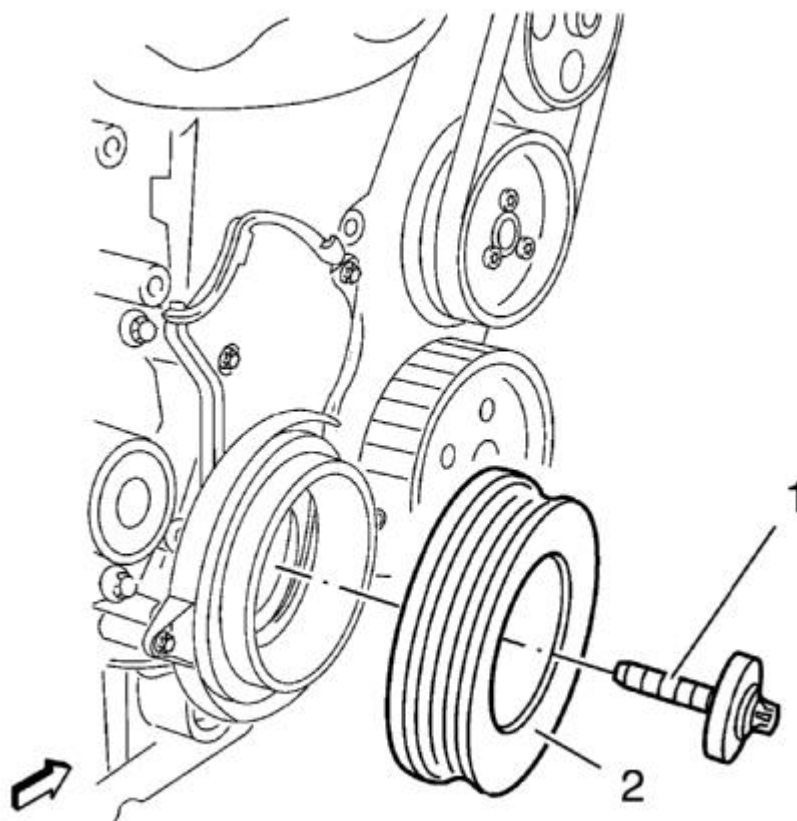
6. Remove the bolted connection (1).



**Fig. 171: Locking Device**

Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-6625** locking device (2) to lock the crankshaft.
8. Install the bolted connection (1).

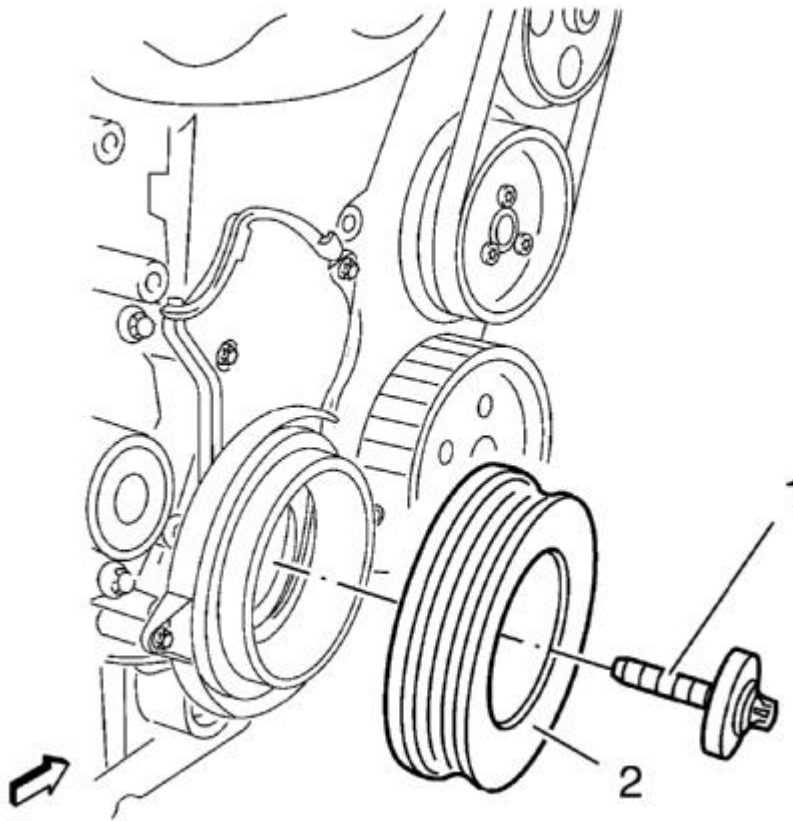


**Fig. 172: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

9. Remove and DISCARD the crankshaft balancer bolt (1).
10. Remove the crankshaft balancer (2).

#### Installation Procedure





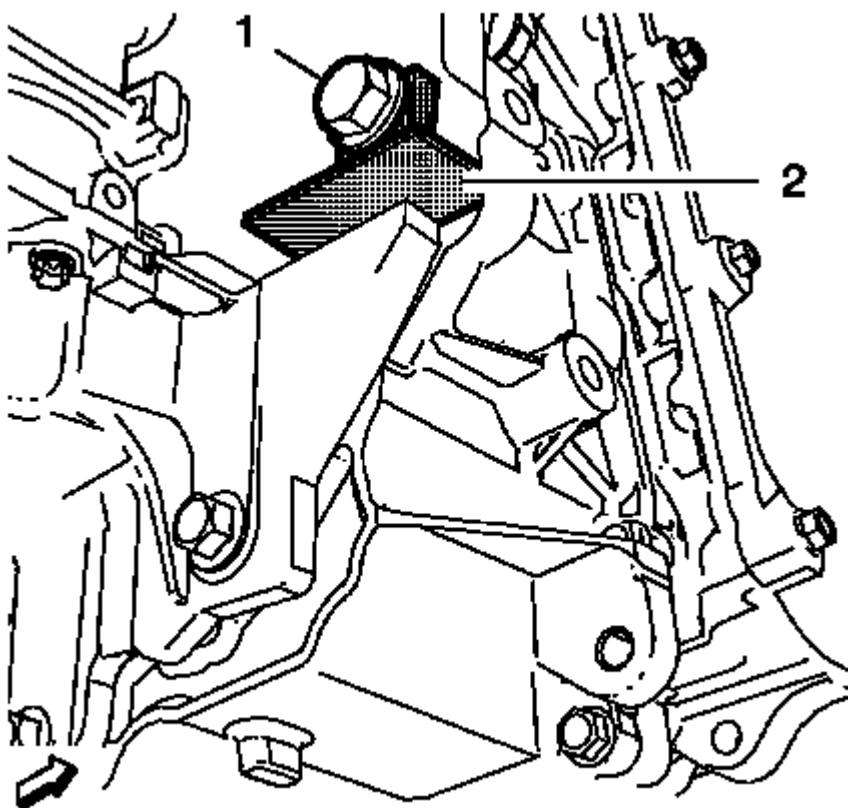
**Fig. 173: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft balancer (2).

**CAUTION: Refer to Fastener Caution .**

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

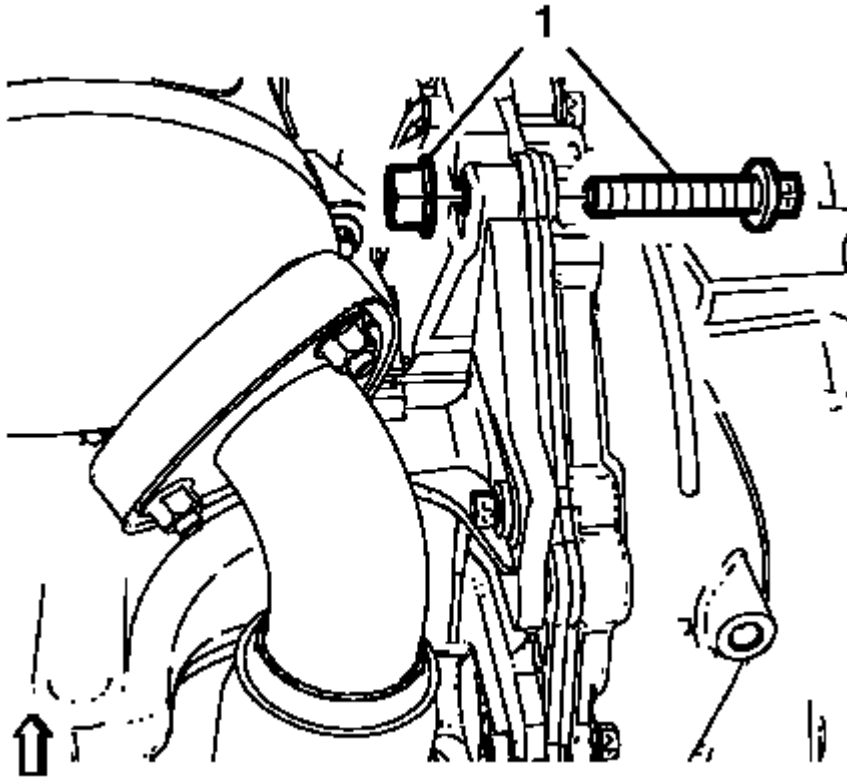
2. Install a NEW crankshaft balancer bolt (1) and tighten in 3 passes using the **EN-45059** meter :
  1. First pass to 95 N.m (70 lb ft).
  2. Second pass to 45°.
  3. Third pass to 15°.



**Fig. 174: Locking Device**

Courtesy of GENERAL MOTORS COMPANY

3. Remove the bolted connection (1).
4. Remove **EN-6625** locking device (2) to unlock the crankshaft.



**Fig. 175: Connection Bolt**

Courtesy of GENERAL MOTORS COMPANY

5. Install the bolted connection (1) and tighten to 40 N.m (30 lb ft).
6. Install the transmission front mount. Refer to **Transmission Front Mount Replacement** .
7. Install the drive belt. Refer to **Drive Belt Replacement**.
8. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement** .
9. Lower the vehicle.
10. Close the hood.

## CRANKSHAFT FRONT OIL SEAL REPLACEMENT

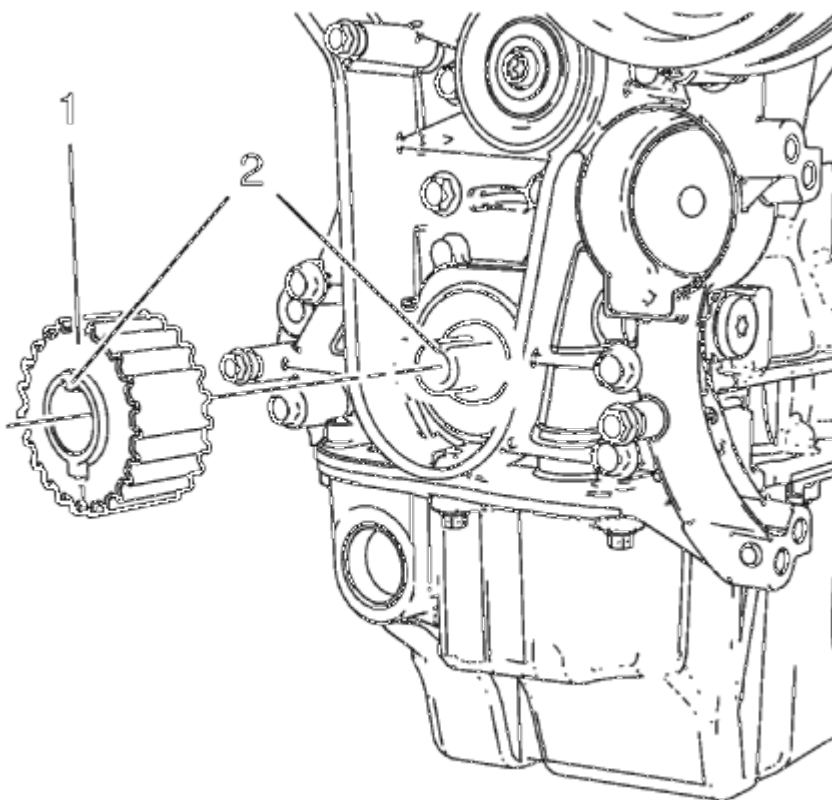
### Special Tools

- EN-6351 Mounting Sleeves
- EN-45000 Remover

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

### Removal Procedure

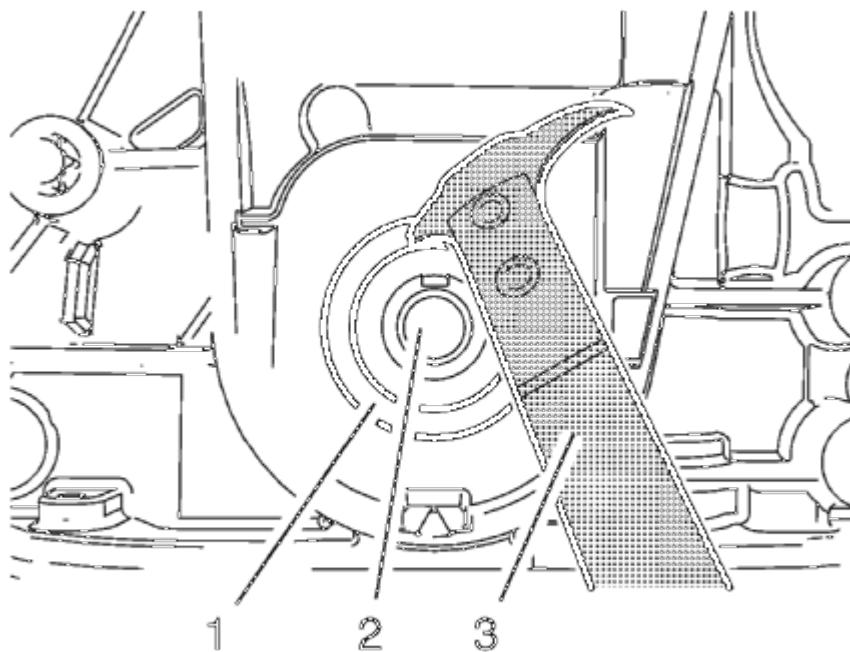
1. Replace the timing belt. Refer to **Timing Belt Replacement**.



**Fig. 176: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the crankshaft sprocket (1).

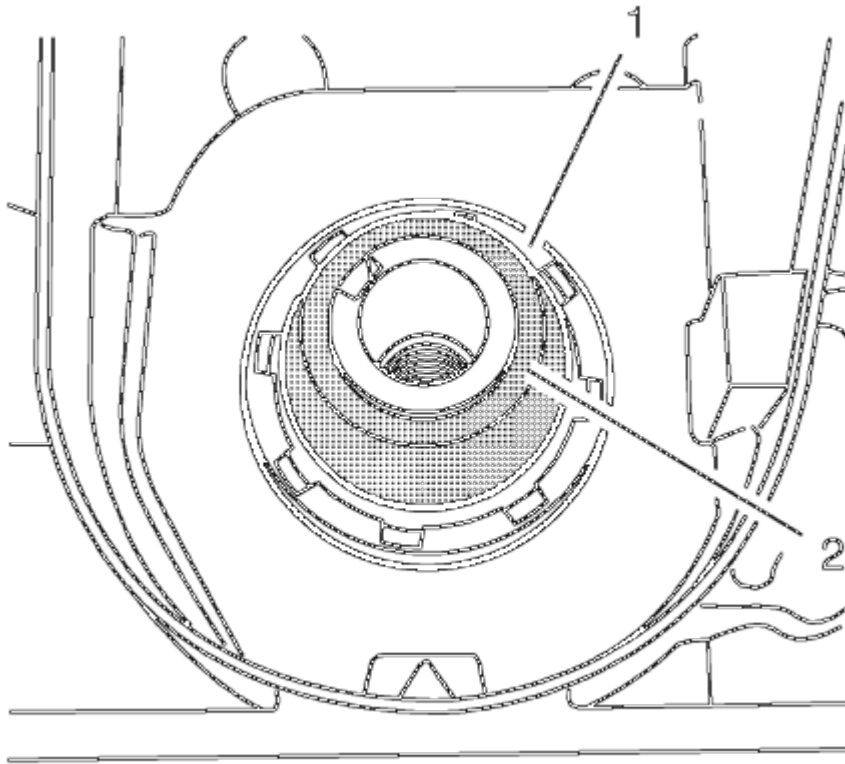


**Fig. 177: Crankshaft Front Oil Seal Removal Tool**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Clean the crankshaft sealing surface with a clean, lint-free towel. Inspect lead-in edge of crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove burrs/sharp edges with crocus cloth before proceeding.

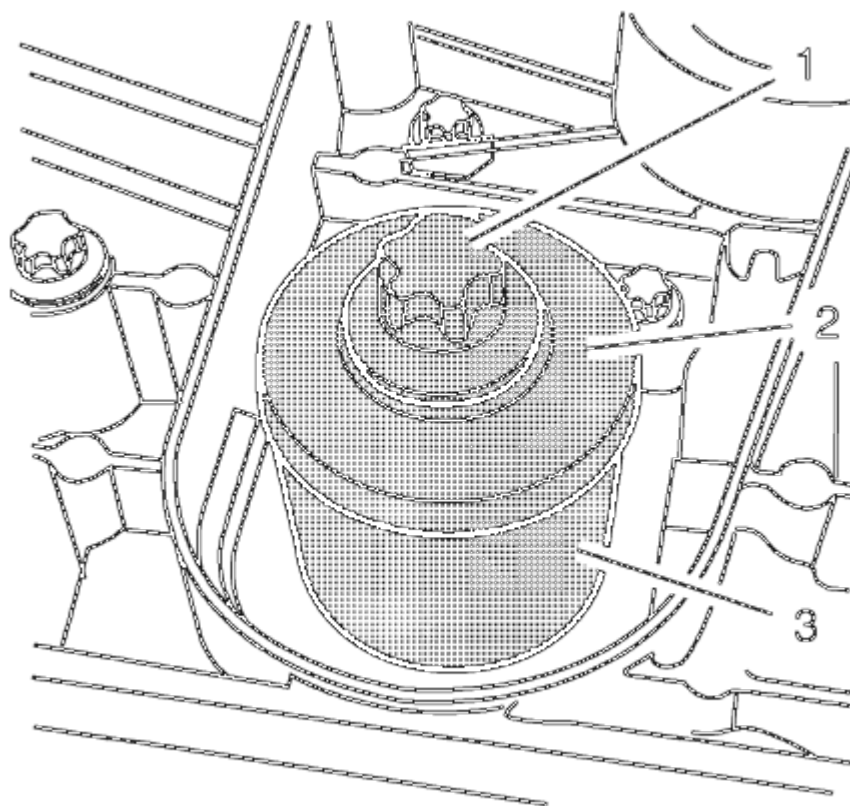
3. Using the **EN-45000** remover (3), remove the crankshaft front oil seal (1) from the crankshaft (2).

#### Installation Procedure



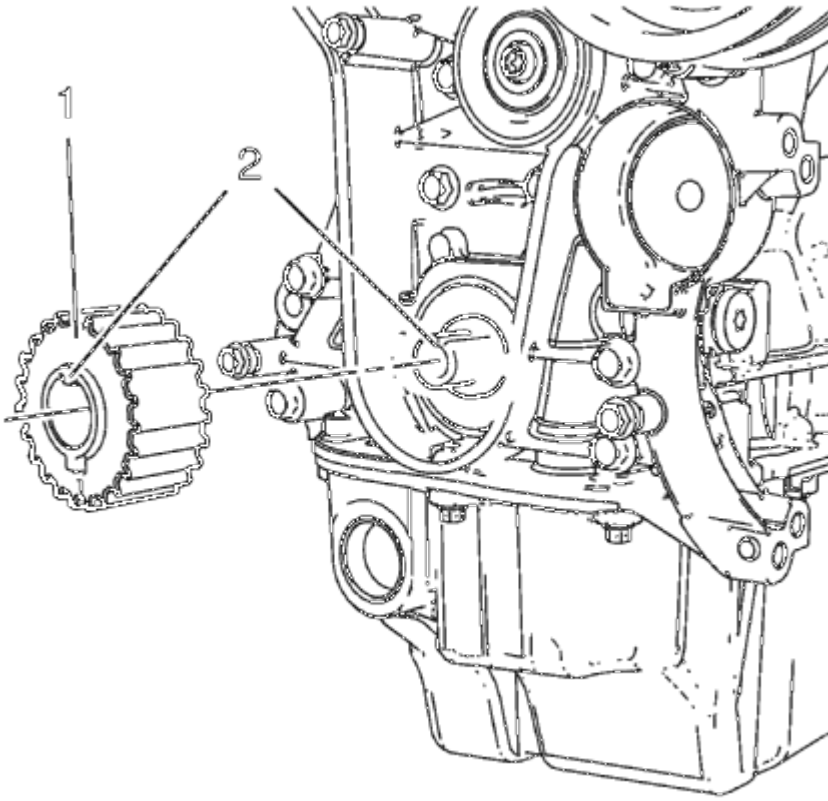
**Fig. 178: Crankshaft And Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing surfaces.
2. Slide the **EN-6351** mounting sleeves (2) protective sleeve onto the crankshaft journal.
3. Slide the crankshaft front oil seal (1) over the protective sleeve on the crankshaft journal.



**Fig. 179: Crankshaft Drive Gear Bolt, Washer And Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the protective sleeve, and using the **EN-6351** mounting sleeves (3), press the seal ring into the pump housing.
5. Use the crankshaft drive gear bolt (1) and washer (2) to press in the crankshaft front oil seal.

**Fig. 180: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When installing the crankshaft sprocket, the cam and the groove must align (2).

6. Install the crankshaft sprocket (1).
7. Install the timing belt. Refer to **Timing Belt Replacement**.

## CRANKSHAFT REAR OIL SEAL REPLACEMENT

### Special Tools

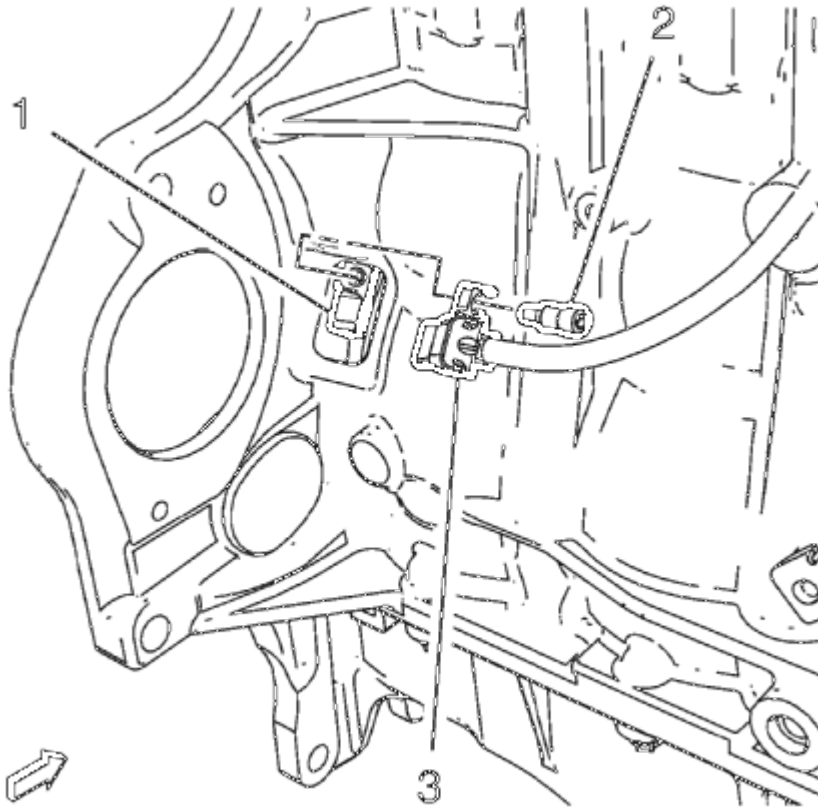
- **EN-235-D** Installer Kit
- **EN-328-B** Pin Remover
- **EN-658-1** Installer
- **EN-6624** Remover

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

### Removal Procedure

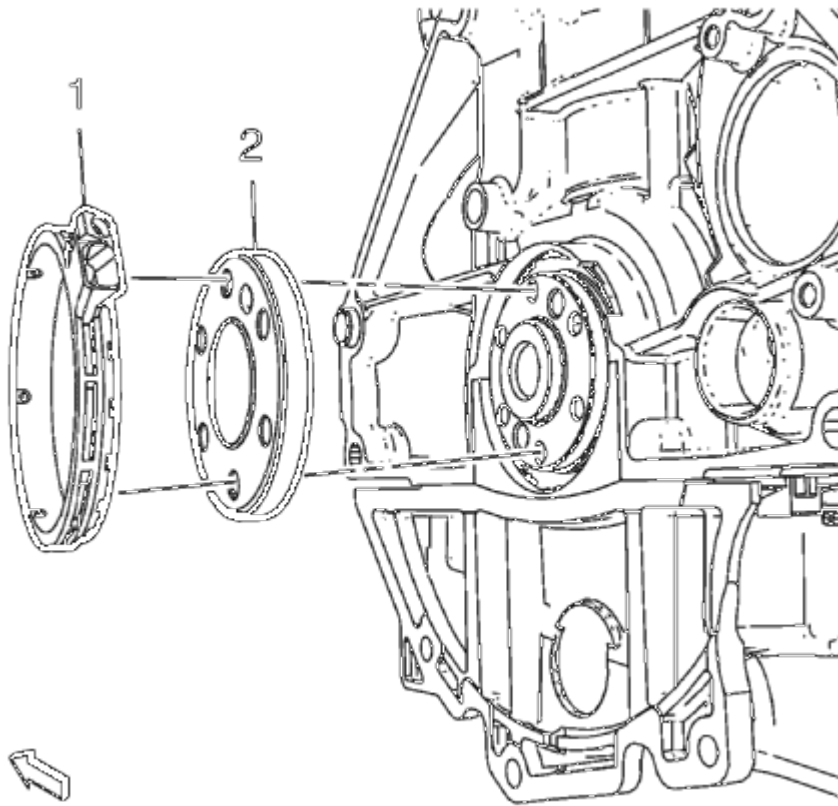


1. For vehicle with automatic transmission: remove the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. For vehicle with manual transmission: remove the engine flywheel. Refer to **Engine Flywheel Replacement (Manual Transmission)**.
3. Place the collecting basin underneath.



**Fig. 181: Crankshaft Position Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

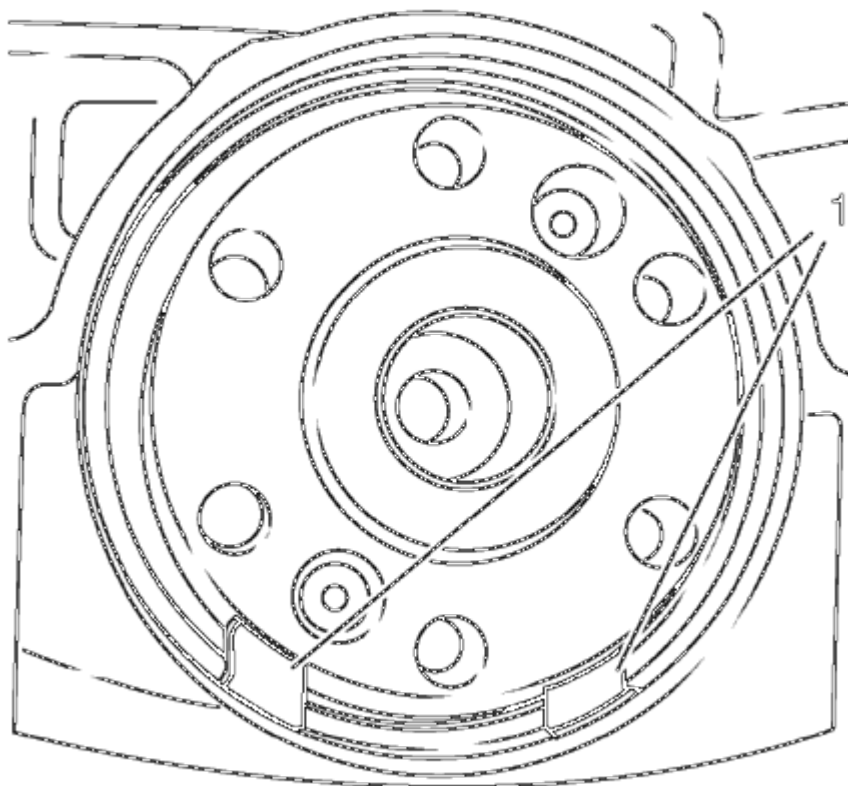
4. Remove the crankshaft position sensor bolt (2).
5. Remove the crankshaft position sensor (3) from the crankshaft rear oil seal housing (1).



**Fig. 182: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Do not allow the crankshaft encoder wheel to come into contact with external magnetic fields or sharp metal objects. Do not drop the crankshaft encoder wheel. Do not damage the rubberized encoder track. Failure to follow these precautions may cause damage to the component.

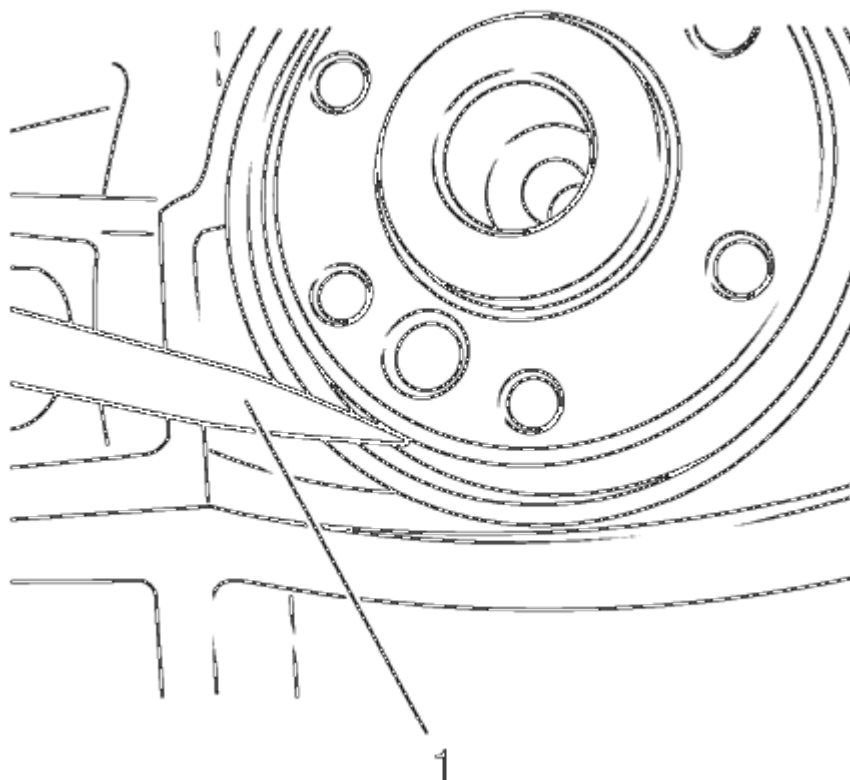
6. Remove the crankshaft rear oil seal housing (1).
7. Remove the crankshaft position sensor reluctor ring (2).



**Fig. 183: Holes At 5 O'clock And 7 O'clock Positions**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The diameter of the hole must not exceed 2 mm (0.0787 in). If the diameter of the hole exceeds 2 mm (0.0787 in), the bolt of EN-6624 remover will not be able to grip.

8. Only make a hole at the 5 o'clock and 7 o'clock positions (1), these are the only positions where is a cavity behind the seal ring.



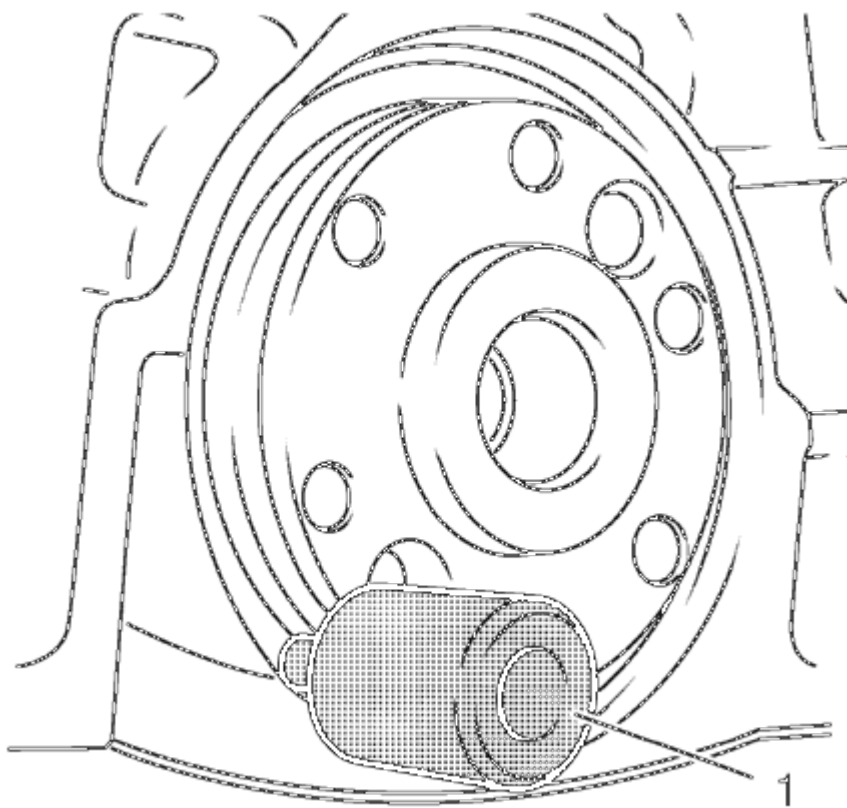
**Fig. 184: Scribe Tool**

Courtesy of GENERAL MOTORS COMPANY

9. Using a suitable tool, such as a scribe (1), make a hole in the crankshaft rear oil seal.

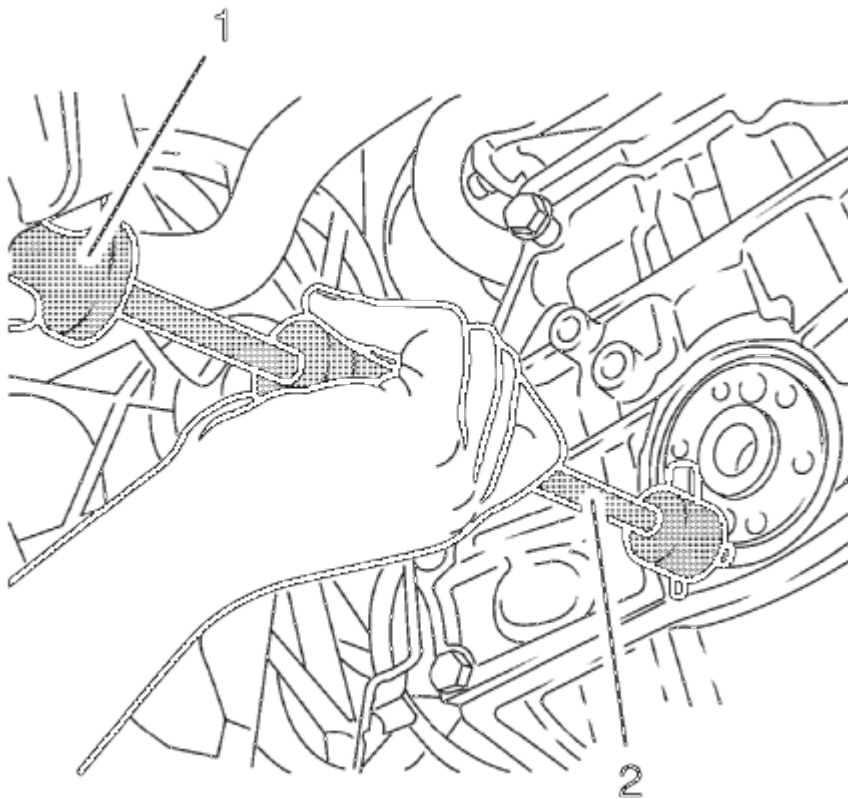
Position the scribe (1) at the outer edge of the crankshaft rear oil seal.

10. Remove the seal ring.



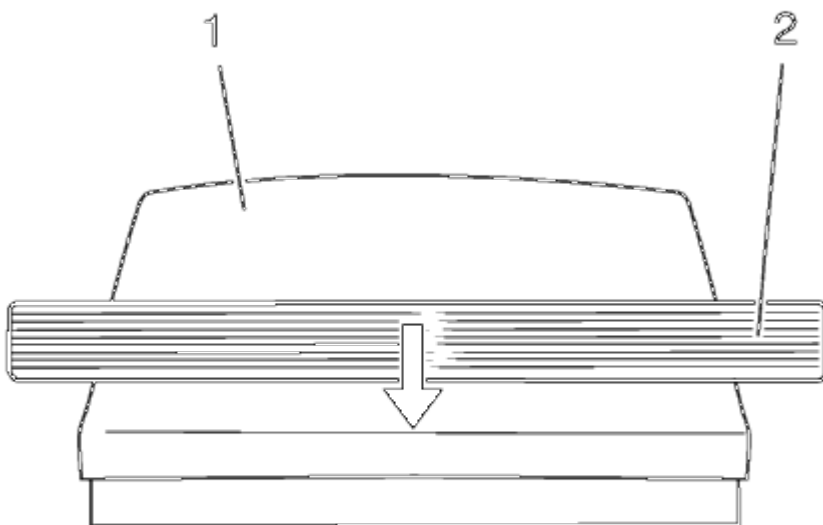
**Fig. 185: crankshaft Rear Oil Seal Removal Tool**  
Courtesy of GENERAL MOTORS COMPANY

11. Install **EN-6624** remover (1) to the crankshaft rear oil seal and tighten the bolt.

**Fig. 186: Special Removal Tools****Courtesy of GENERAL MOTORS COMPANY**

12. Install the **EN-328-B** remover (1) to **EN-6624** remover (2) and remove the crankshaft rear oil seal.

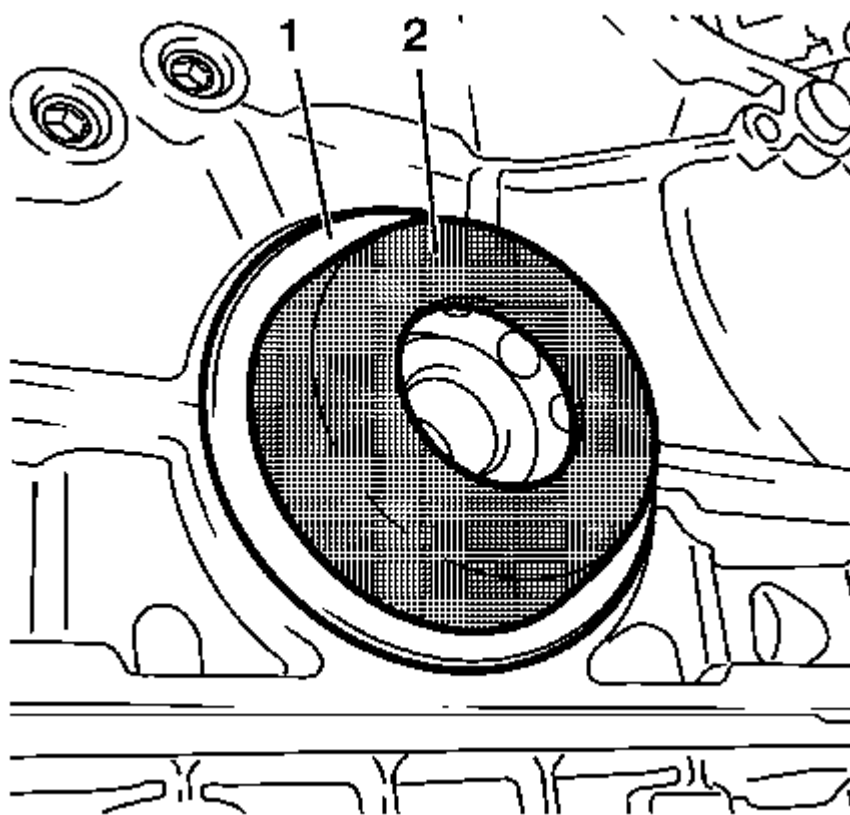
**Installation Procedure**



**Fig. 187: Crankshaft Rear Oil Seal**

Courtesy of GENERAL MOTORS COMPANY

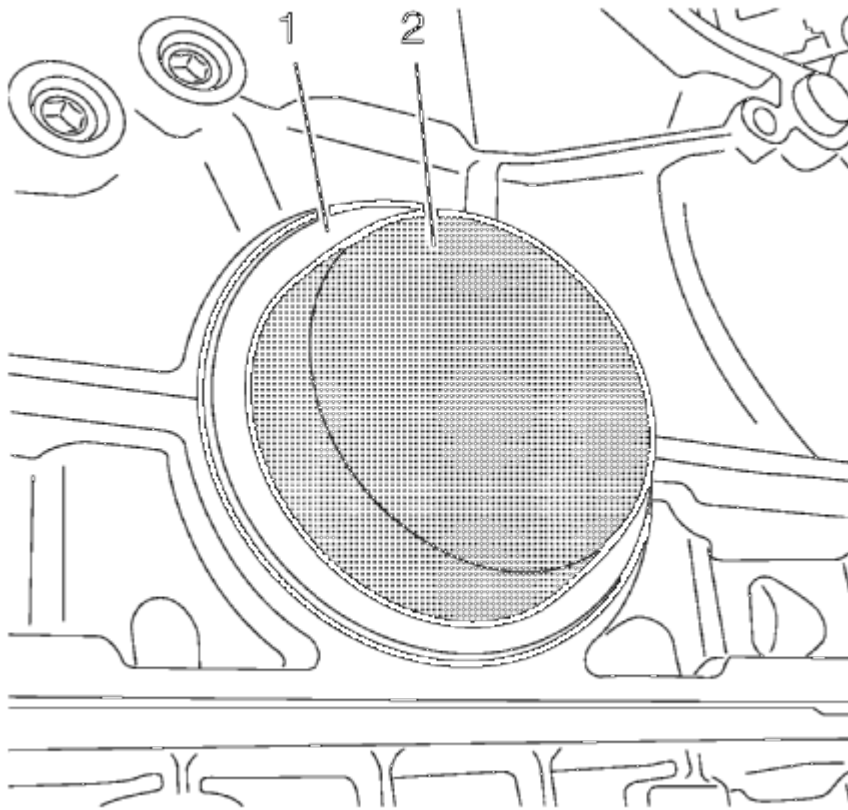
1. Slide the crankshaft rear oil seal (2) across the **EN-235-6** installer (1) contained in **EN-235-D** kit.



**Fig. 188: Crankshaft Rear Oil Seal And Installer**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the crankshaft rear oil seal (1) with **EN-235-6** installer (2) to the crankshaft.

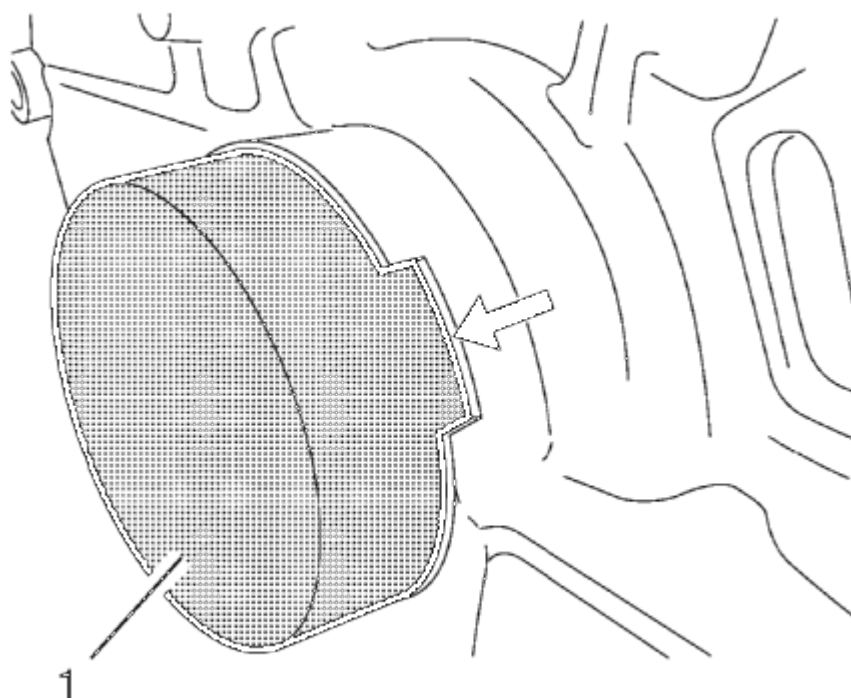




**Fig. 189: Oil Seal Installer**

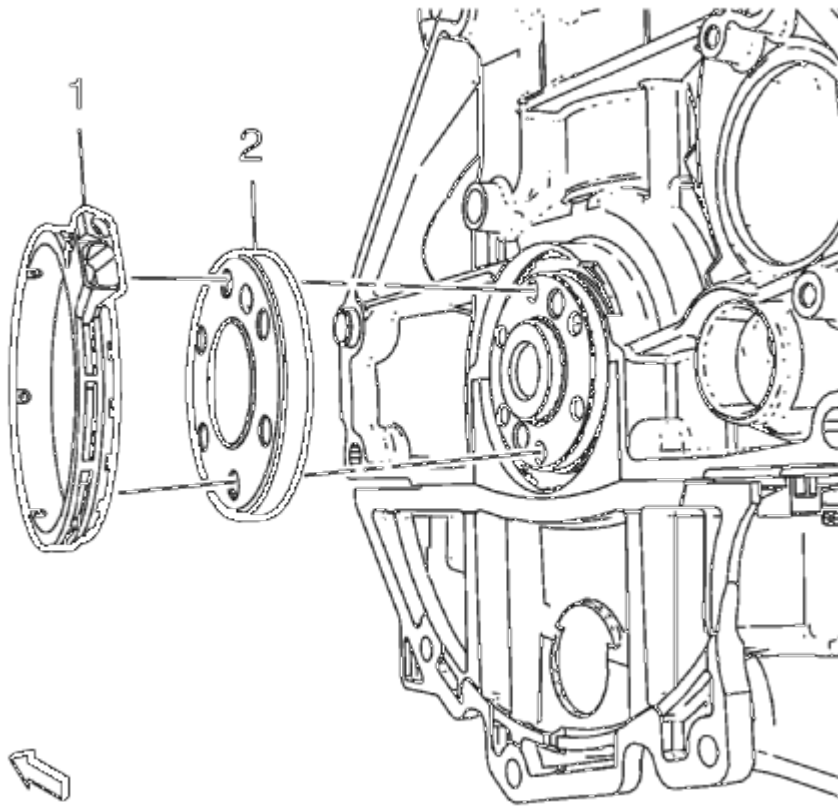
Courtesy of GENERAL MOTORS COMPANY

3. Use **EN-658-1** installer (2) to strike the crankshaft rear oil seal (1)



**Fig. 190: Check Crankshaft Rear Oil Seal For Proper Seat**  
Courtesy of GENERAL MOTORS COMPANY

4. Check the crankshaft rear oil seal for proper seat, the **EN-658-1** installer (1) must be flush with the cylinder block at the position (arrow).

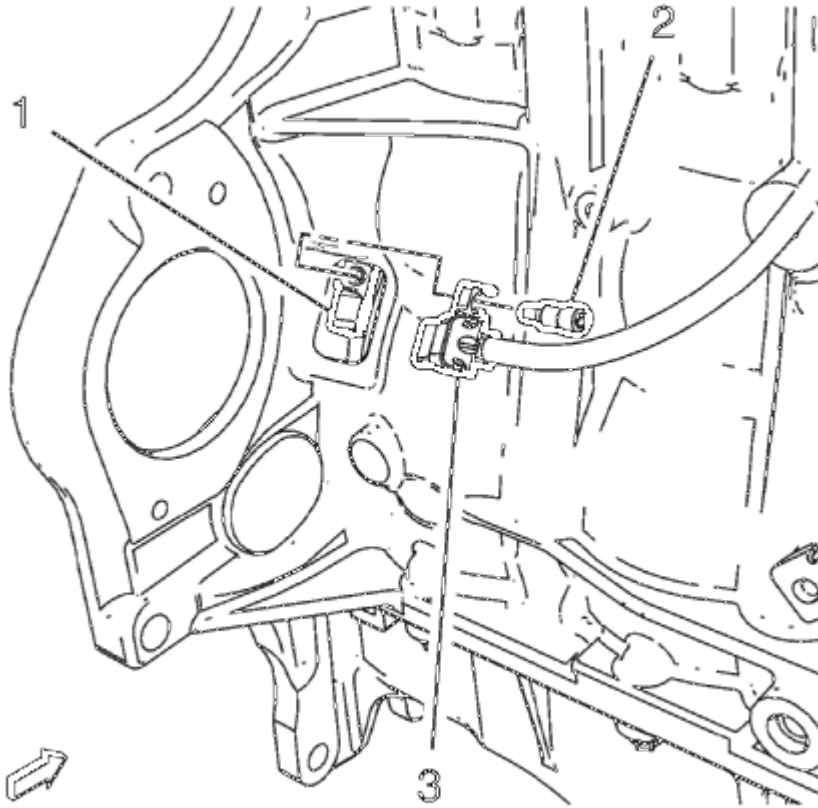


**Fig. 191: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the crankshaft position sensor reluctor ring (2).

**CAUTION:** Do not allow the crankshaft encoder wheel to come into contact with external magnetic fields or sharp metal objects. Do not drop the crankshaft encoder wheel. Do not damage the rubberized encoder track. Failure to follow these precautions may cause damage to the component.

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



**Fig. 192: Crankshaft Position Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the crankshaft position sensor (3) to the crankshaft rear oil seal housing (1).

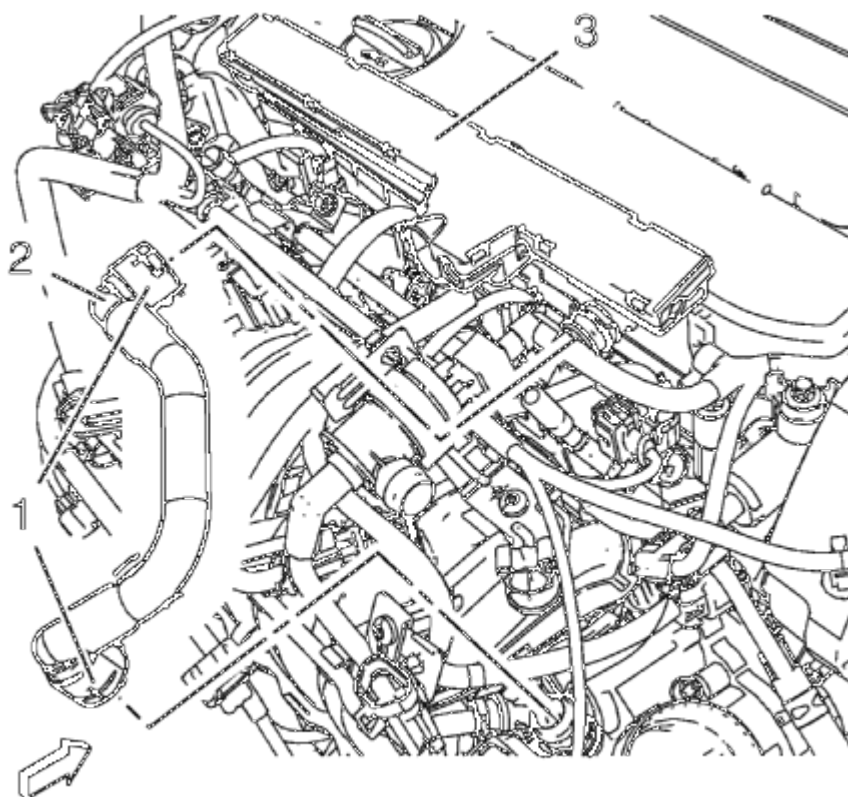
**CAUTION: Refer to Fastener Caution .**

8. Install the crankshaft position sensor bolt (2) and tighten to 4.5 N.m (40 lb in).
9. Remove the collecting basin.
10. For vehicle with manual transmission: install the engine flywheel. Refer to **Engine Flywheel Replacement (Manual Transmission)**.
11. For vehicle with automatic transmission: install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

## POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

### Removal Procedure

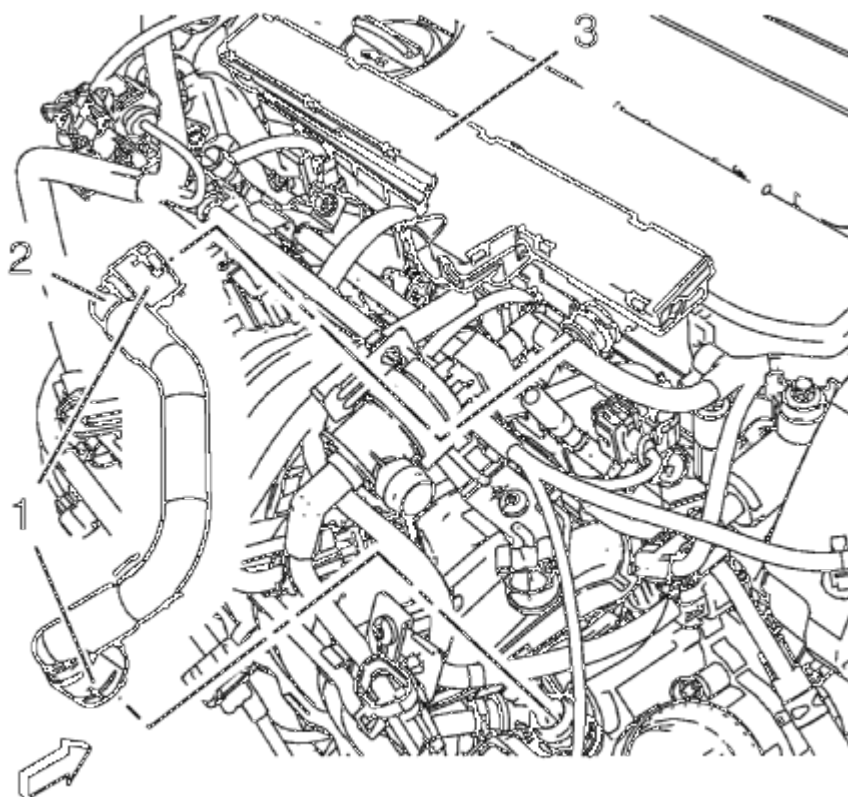
1. Open the hood.



**Fig. 193: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide**  
Courtesy of GENERAL MOTORS COMPANY

2. Unclip the ECM wiring harness guide (3) from the cylinder head cover.
3. Disconnect the 2 positive crankcase ventilation tube connectors (1).
4. Remove the positive crankcase ventilation tube (2).

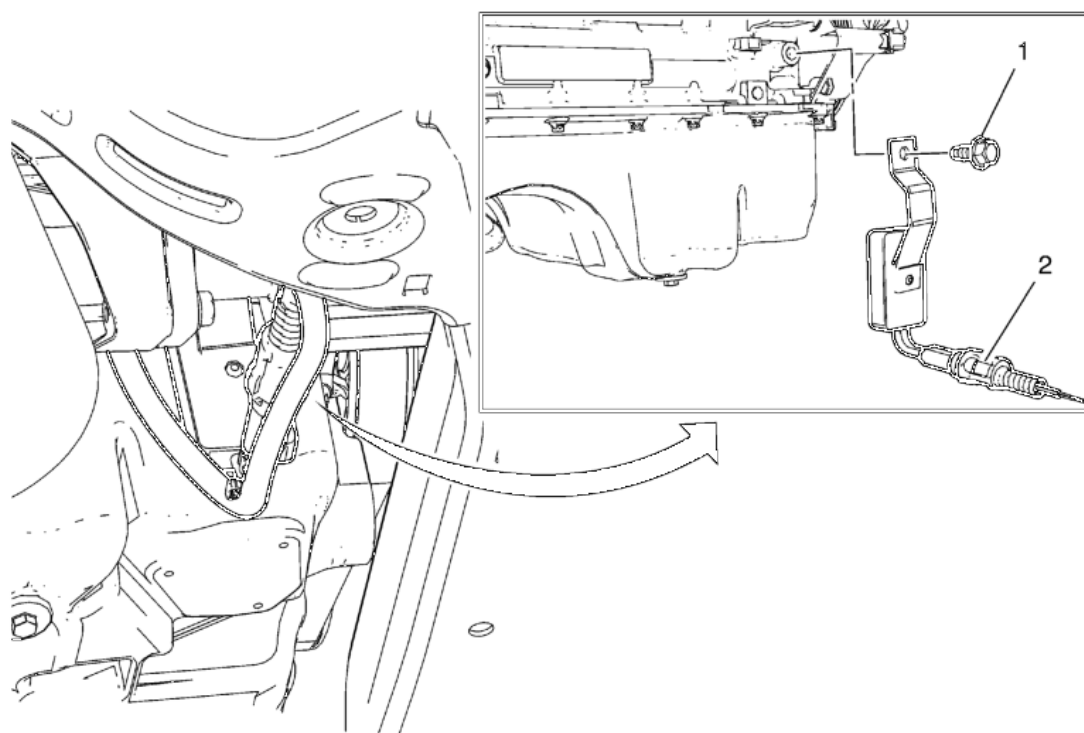
#### **Installation Procedure**



**Fig. 194: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the positive crankcase ventilation tube (2).
2. Connect the 2 positive crankcase ventilation tube connectors (1).
3. Clip in the ECM wiring harness guide (3) to the cylinder head cover.
4. Close the hood.

## **ENGINE OIL HEATER REPLACEMENT**

**Fig. 195: Engine Oil Heater And Bolt**

Courtesy of GENERAL MOTORS COMPANY

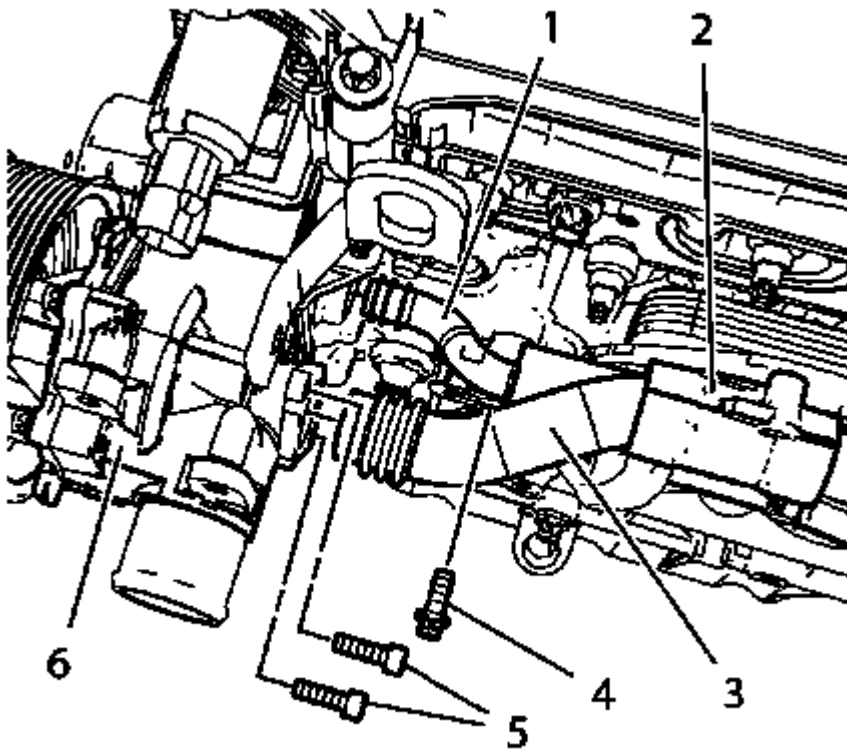
**Engine Oil Heater Replacement**

Callout	Component Name
<b>WARNING:</b> While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.	
<b>Preliminary Procedures</b> Disconnect the battery negative cable. Refer to <b><u>Battery Negative Cable Disconnection and Connection</u></b> .	
1	Engine Oil Heater Bolt  <b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b> .  <b>Tighten</b> 40 N.m (30 lb ft)
2	Engine Oil Heater <b>Procedure</b> Disconnect the wiring harness plug.

**ENGINE FRONT COVER WITH OIL PUMP REPLACEMENT**

## Removal Procedure

1. Open the hood.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement (LUW)** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE-47716 Fill)** , **Cooling System Draining and Filling (Static Fill)** .
5. Remove the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (LUJ)** , **Air Conditioning Compressor Replacement (LUW)** .
6. Remove the generator. Refer to **Generator Replacement (LUJ)** , **Generator Replacement (LUW)** .
7. Remove the timing belt rear cover. Refer to **Timing Belt Rear Cover Replacement** .
8. Remove the oil pan. Refer to **Oil Pan Replacement** .
9. Remove the radiator outlet hose from the water pump. Refer to **Radiator Outlet Hose Replacement (LUW)** , **Radiator Outlet Hose Replacement (LUJ)** .

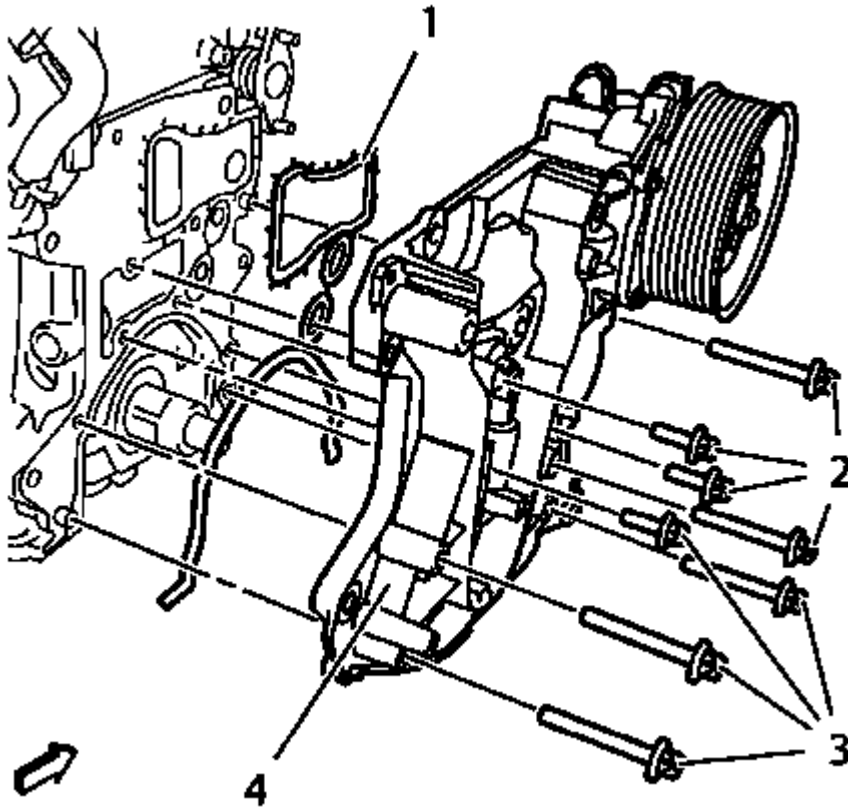


**Fig. 196: Engine Oil Cooler Outlet Pipe And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove the engine oil cooler inlet pipe bolt (4).



11. Push the engine oil cooler inlet pipe (1) into the engine oil cooler housing (2).
12. Remove the 2 engine oil cooler outlet pipe bolts (5) from the water pump.
13. Push the engine oil cooler outlet pipe (3) into the engine oil cooler housing (2).

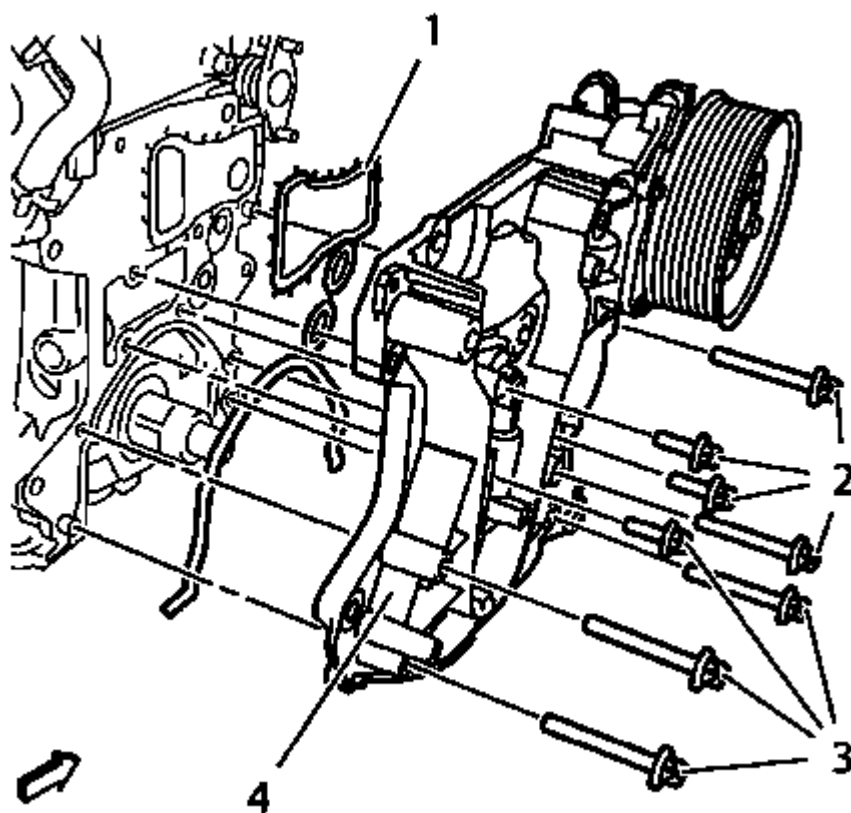


**Fig. 197: Engine Front Cover, Seal And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

14. Remove the 8 engine front cover bolts (2, 3).
15. Remove the engine front cover (4).
16. Remove the engine front cover seal (1).

#### Installation Procedure

1. Clean sealing surface.

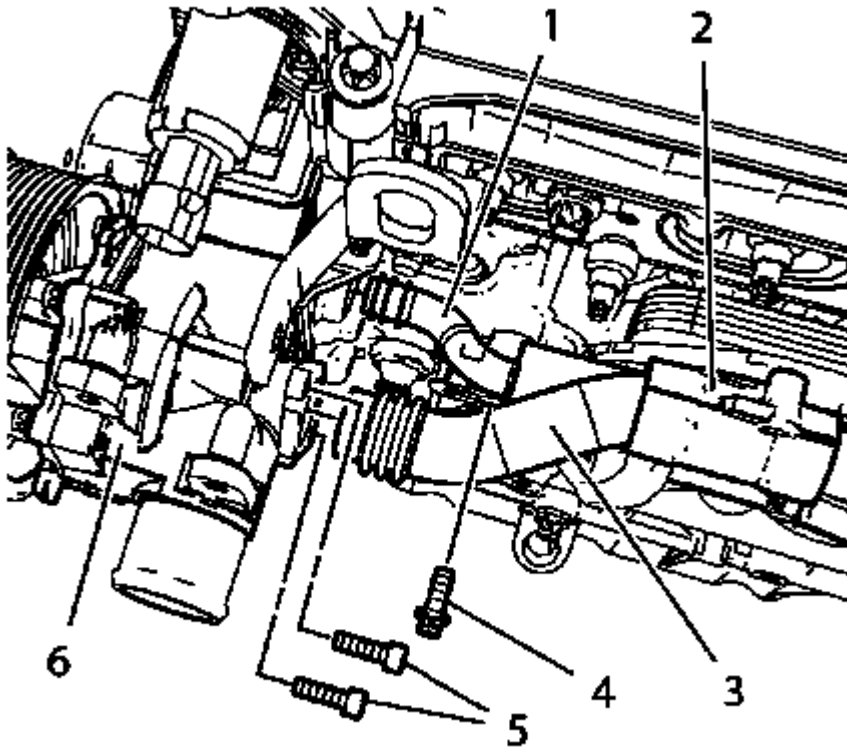


**Fig. 198: Engine Front Cover, Seal And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW engine front cover seal (1).
3. Install the engine front cover (4).

**CAUTION:** Refer to Fastener Caution .

4. Install the 8 engine front cover bolts (2, 3) and tighten to 20 N.m (15 lb ft).

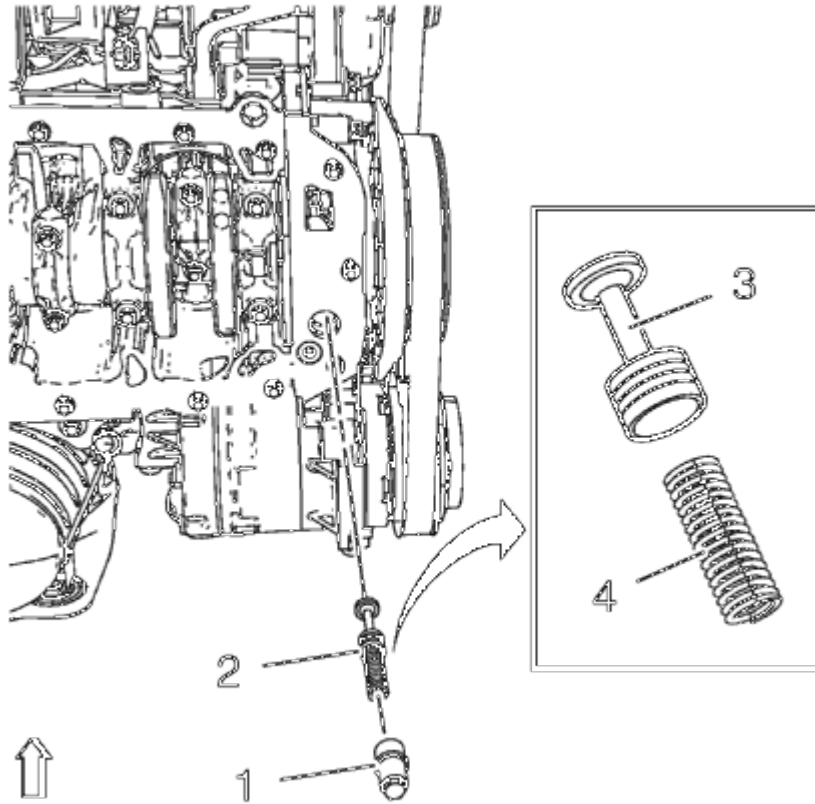


**Fig. 199: Engine Oil Cooler Outlet Pipe And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

5. Push the engine oil cooler outlet pipe (3) to the water pump (6).
6. Install the engine oil cooler outlet pipe bolts (5) and tighten to 8 N.m (71 lb in).
7. Push the engine oil cooler inlet pipe (1) into the water pump (6).
8. Install the engine oil cooler inlet pipe bolt (4) and tighten to 8 N.m (71 lb in).
9. Install the radiator outlet hose to the water pump. Refer to **Radiator Outlet Hose Replacement (LUW)** , **Radiator Outlet Hose Replacement (LUJ)** .
10. Install the oil pan. Refer to **Oil Pan Replacement**.
11. Install the timing belt rear cover. Refer to **Timing Belt Rear Cover Replacement**.
12. Install the generator. Refer to **Generator Replacement (LUJ)** , **Generator Replacement (LUW)** .
13. Install the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (LUJ)** , **Air Conditioning Compressor Replacement (LUW)** .
14. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LUW)** .
15. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE-47716 Fill)** , **Cooling System Draining and Filling (Static Fill)** .
17. Close the hood.

**OIL PRESSURE RELIEF VALVE REPLACEMENT****Removal Procedure**

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



**Fig. 200: Oil Pressure Relief Valve Assembly**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pressure relief valve closure bolt (1).
3. Remove the oil pressure relief valve assembly (2).
4. Remove the piston (3) and the spring (4).

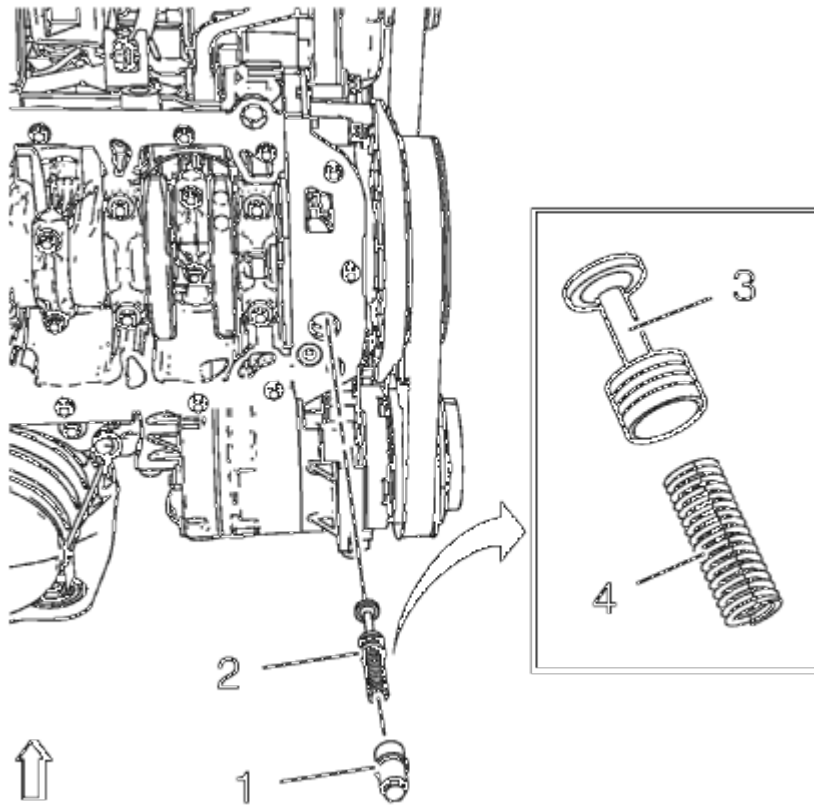
**WARNING:** Bodily injury may occur if the cleaning solvent is inhaled or exposed to the skin.

**WARNING:** To avoid eye injury, use approved safety lenses, goggles, or face shield when using buffing and cleaning equipment.

5. Clean the parts.

6. Inspect the parts.
7. Clean the thread.

#### Installation Procedure



**Fig. 201: Oil Pressure Relief Valve Assembly**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the piston (3) and the spring (4).
2. Install the oil pressure relief valve assembly (2).

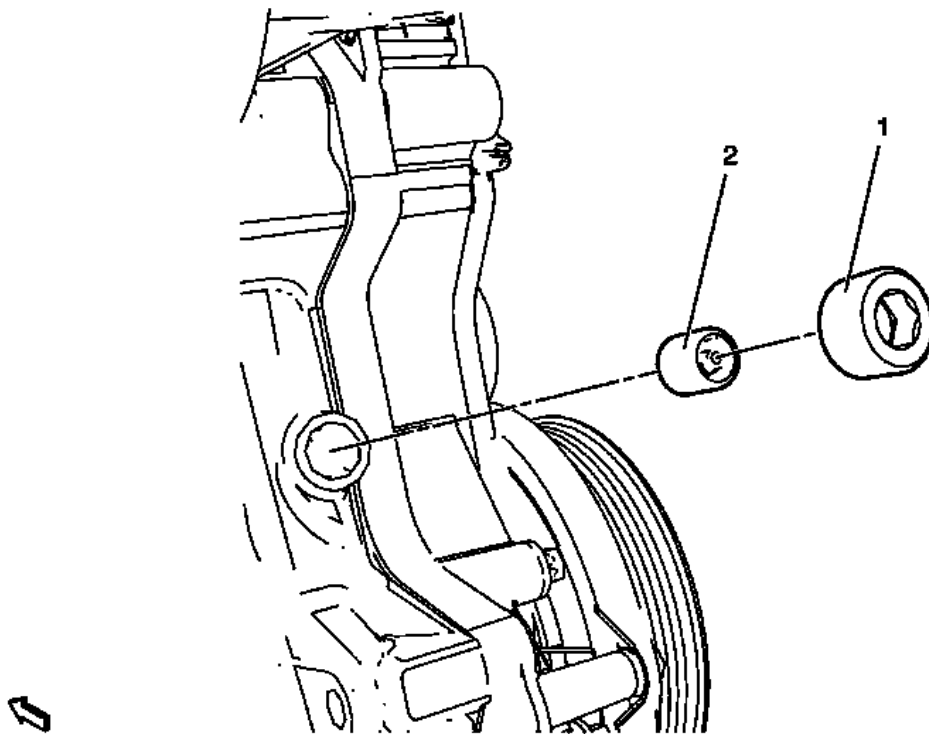
**CAUTION: Refer to Fastener Caution .**

3. Install the oil pressure relief valve closure bolt (1) and tighten to 21 N.m (16 lb ft).
4. Install the oil pan. Refer to Oil Pan Replacement.

#### ENGINE OIL COOLER HOUSING REPLACEMENT

Refer to Engine Oil Cooler Replacement (LUW) , Engine Oil Cooler Replacement (LUJ) , it is the same procedure.

## OIL FLOW CHECK VALVE REPLACEMENT



**Fig. 202: Oil Flow Check Valve**  
 Courtesy of GENERAL MOTORS COMPANY

## Oil Flow Check Valve Replacement

Callout	Component Name
<b>Preliminary Procedure</b> Remove the generator. Refer to <b><u>Generator Replacement (LUJ)</u></b> , <b><u>Generator Replacement (LUW)</u></b> .	
1	Oil Flow Check Valve Bore Plug  <b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b> .  <b>Tighten</b> 21 N.m (16 lb ft)
2	Oil Flow Check Valve

## OIL LEVEL INDICATOR TUBE REPLACEMENT

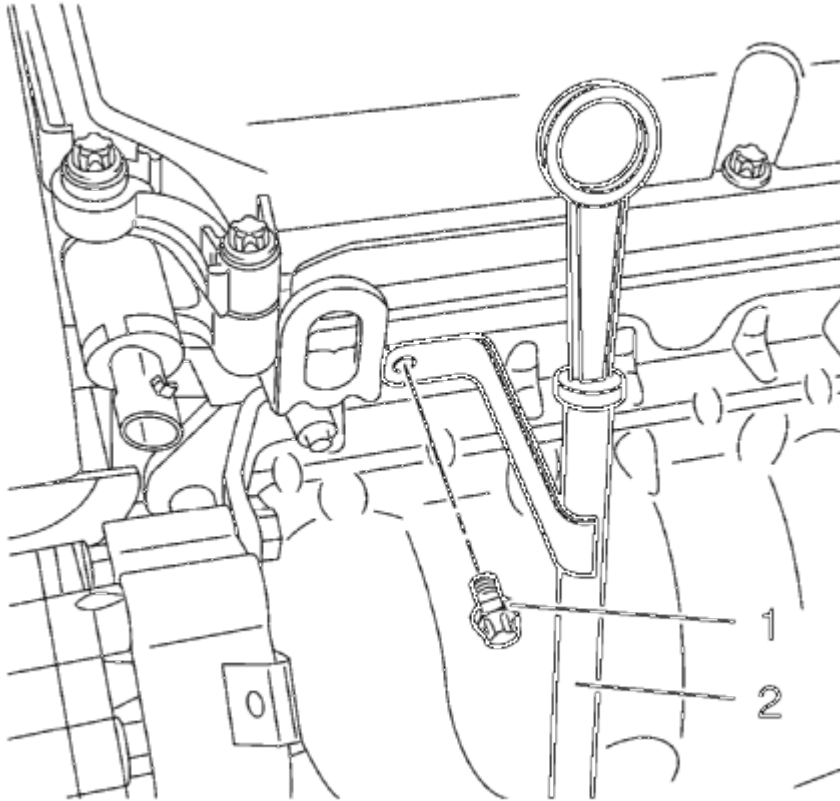
## Removal Procedure

1. Open the hood.

2. Remove the oil dipstick.

**NOTE:** If the engine oil level is at maximum, some oil may emerge when drawing out the oil dipstick guide tube.

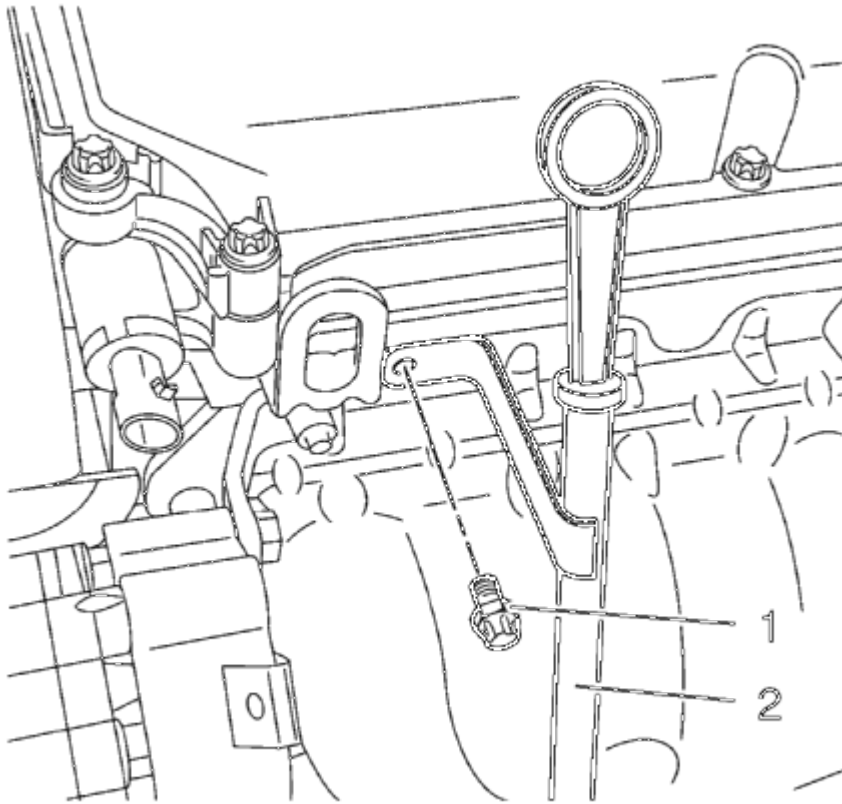
3. Place collecting basin underneath.



**Fig. 203: Oil Level Indicator Tube And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil level indicator tube bolt (1).
5. Remove the oil level indicator tube (2) and the oil level indicator seal.

#### Installation Procedure



**Fig. 204: Oil Level Indicator Tube And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil level indicator tube (2).
2. Install a NEW oil level indicator tube gasket.

**CAUTION:** Refer to Fastener Caution .

3. Install the oil level indicator tube bolt (1) and tighten to 15 N.m (11 lb ft).
4. Install the oil dipstick.
5. Close the hood.

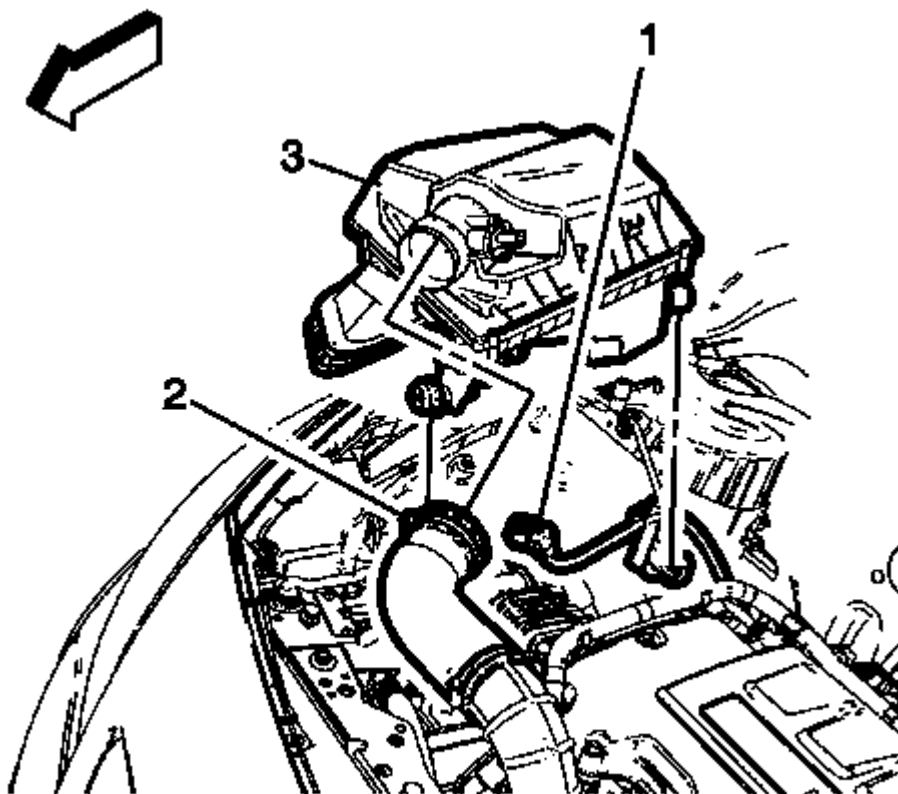
## ENGINE REPLACEMENT

### Removal Procedure

1. Disconnect the negative battery cable from the battery. Refer to Battery Negative Cable Disconnection and Connection .
2. Drain the engine cooling system. Refer to Cooling System Draining and Filling (GE-47716 Fill) , Cooling System Draining and Filling (Static Fill) .

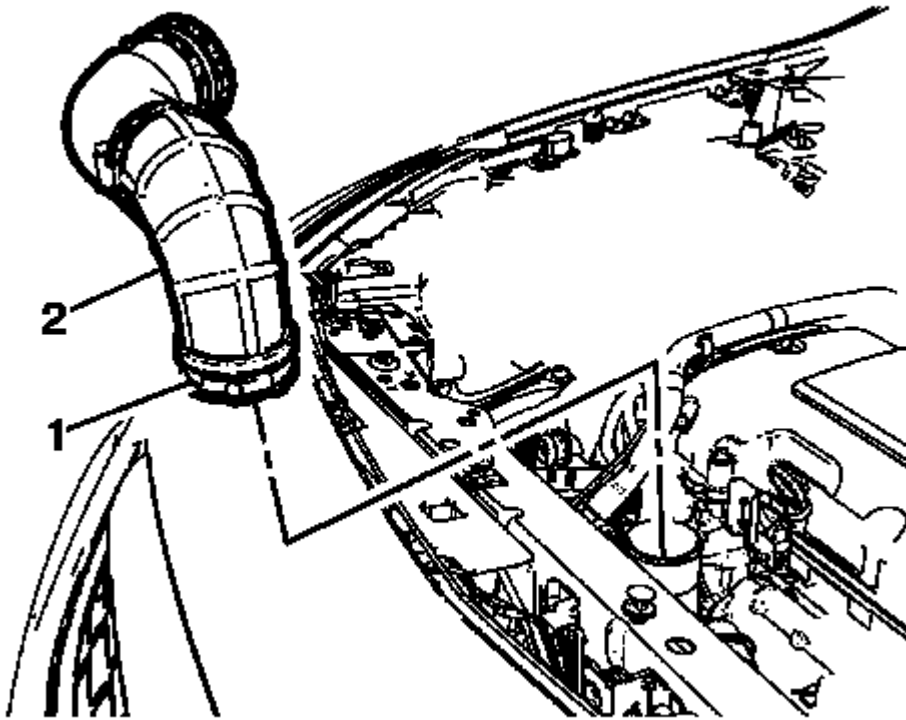


3. Recover the air conditioning refrigerant. Refer to **Refrigerant Recovery and Recharging** .



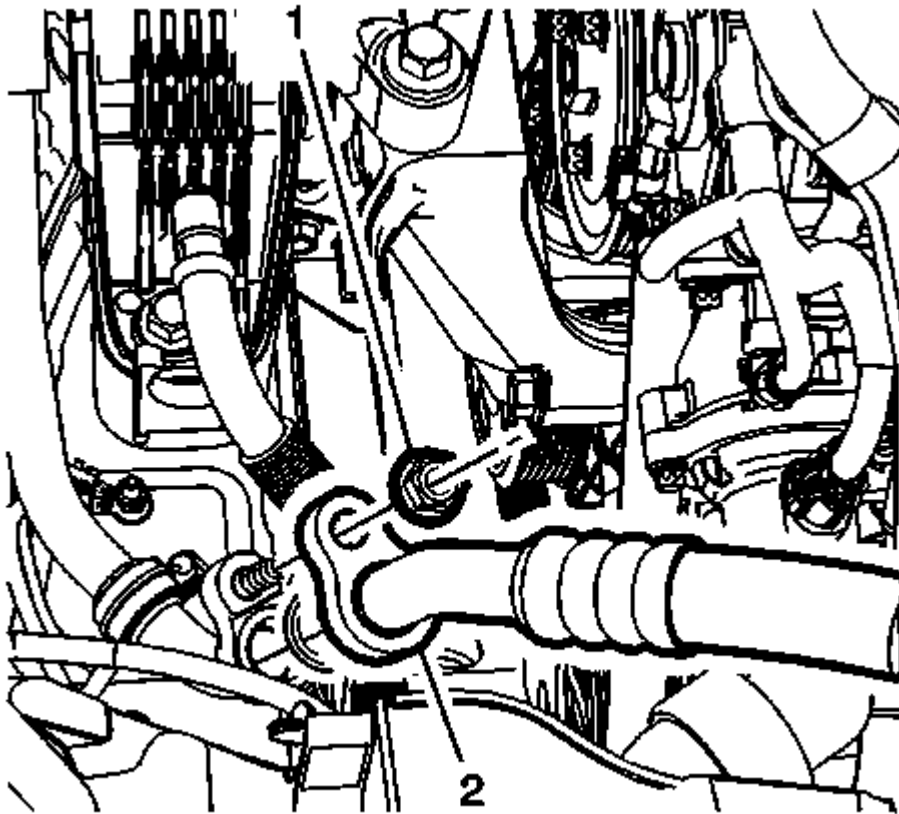
**Fig. 205: Air Cleaner Assembly, Electrical Connector And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector (1).
5. Loosen the clamp (2) and remove air cleaner from air cleaner assembly (3).



**Fig. 206: Air Cleaner Outlet Duct And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

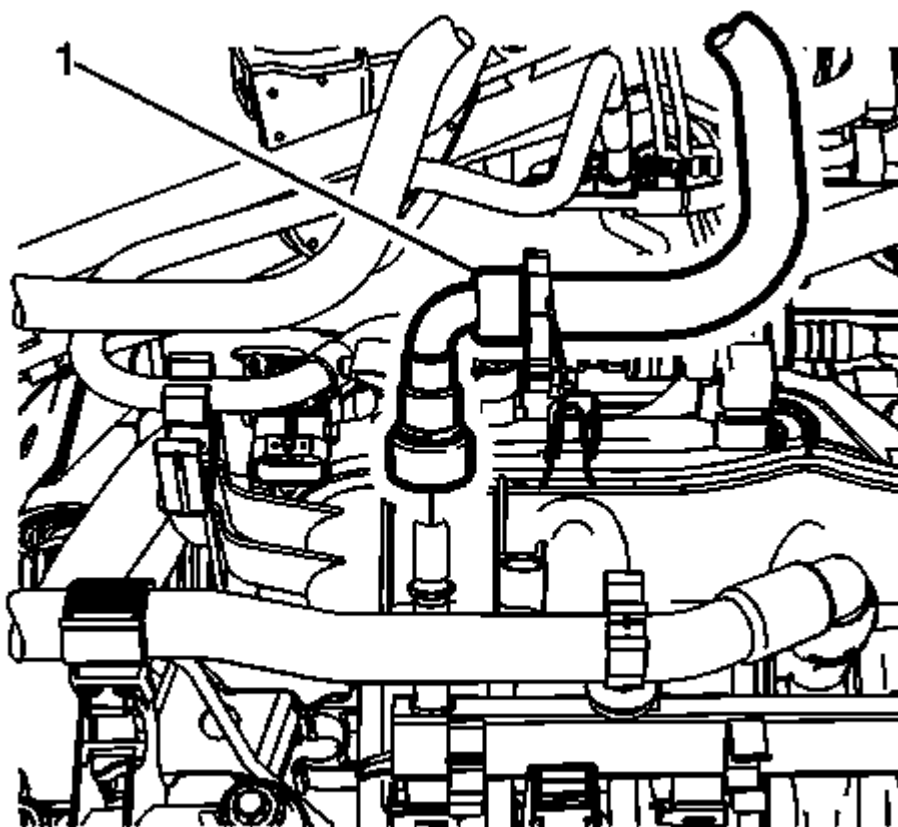
6. Loosen the clamp (1) and remove the outlet duct (2).
7. Remove the charge air cooler inlet air hose. Refer to **Charge Air Cooler Inlet Air Hose Replacement** .
8. Remove the charge air cooler outlet air hose. Refer to **Charge Air Cooler Outlet Air Hose Replacement (Manual Transmission)** , **Charge Air Cooler Outlet Air Hose Replacement (Automatic Transmission)** .



**Fig. 207: Refrigerant Hose And Nut**

Courtesy of GENERAL MOTORS COMPANY

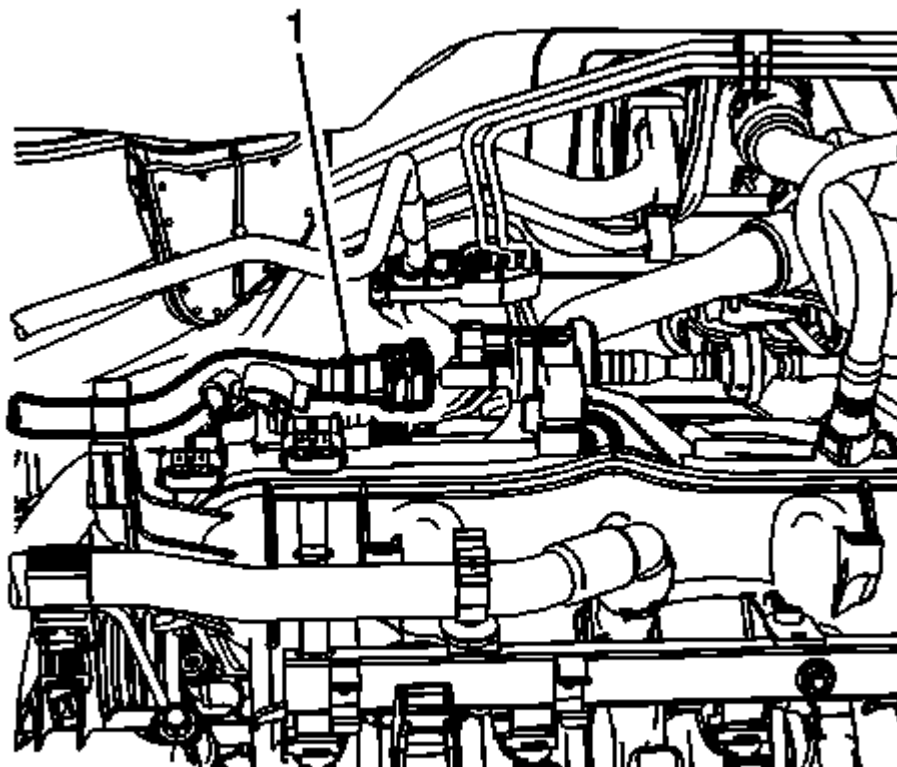
9. Remove refrigerant hose nut (1) from refrigerant hose (2).



**Fig. 208: Fuel Feed Pipe**

Courtesy of GENERAL MOTORS COMPANY

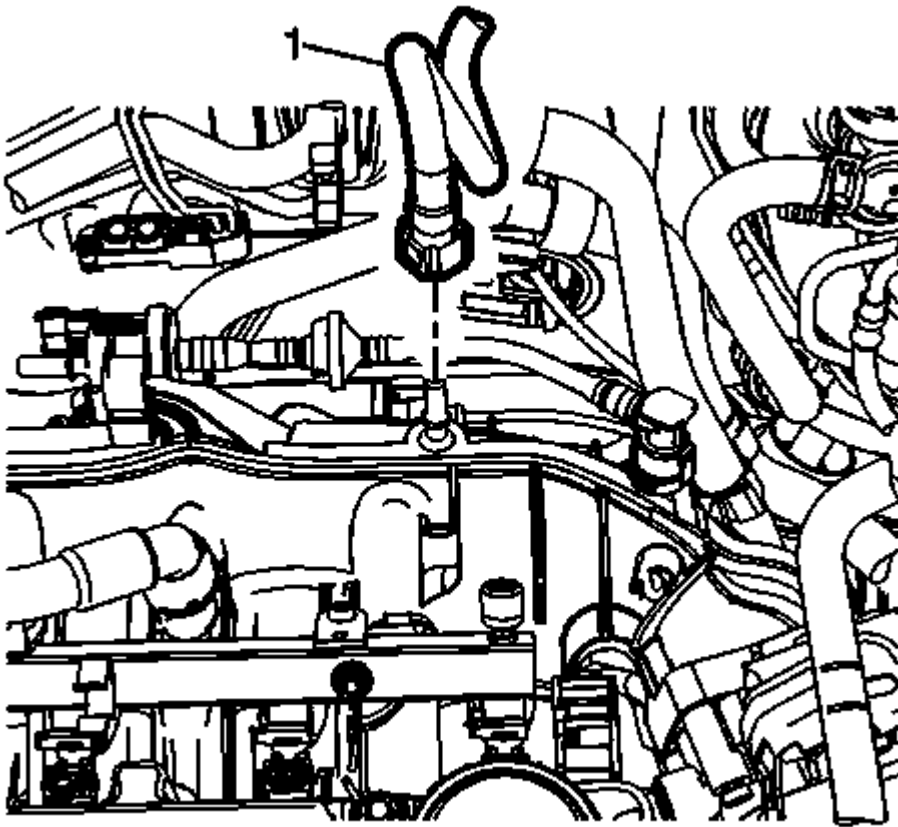
10. Disconnect the fuel feed line (1) and reposition away from the engine. Refer to **Fuel Pressure Relief** .



**Fig. 209: Fuel Ventilation Pipe**

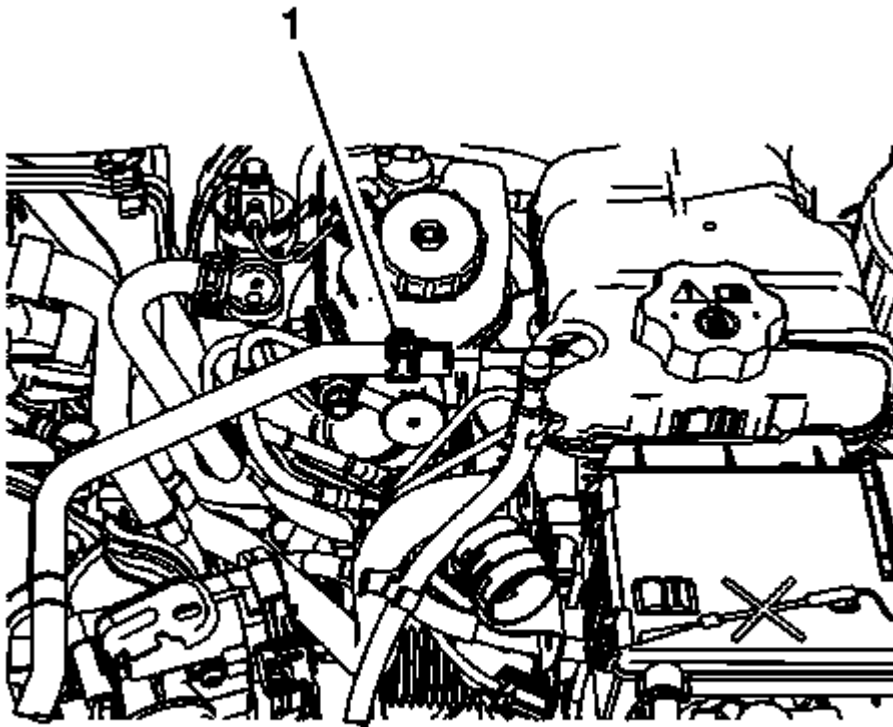
Courtesy of GENERAL MOTORS COMPANY

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



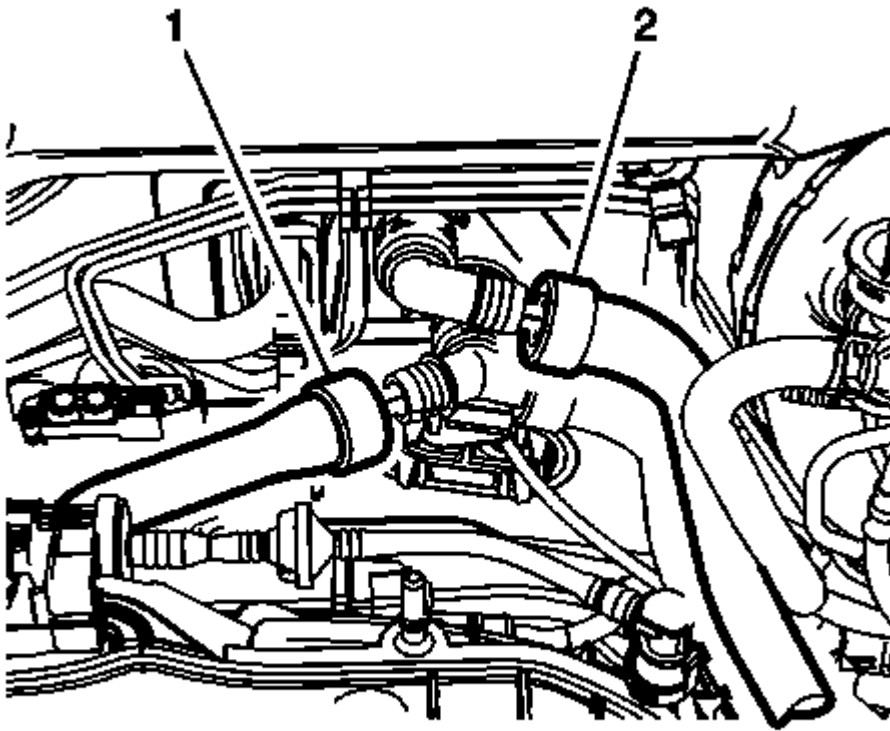
**Fig. 210: Brake Booster Vacuum Pipe**  
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the power brake booster vacuum pipe (1).



**Fig. 211: Radiator Surge Tank Outlet Hose Clamp**  
Courtesy of GENERAL MOTORS COMPANY

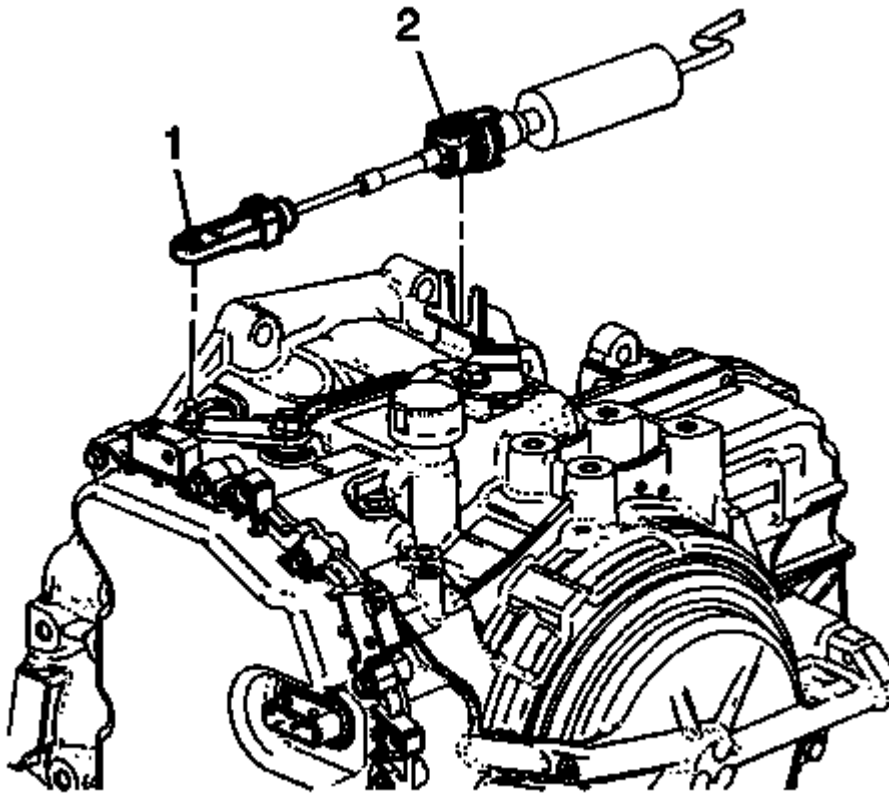
13. Reposition the hose clamp (1) and remove the radiator surge tank outlet hose.



**Fig. 212: Heater Core Inlet And Outlet Hoses**  
Courtesy of GENERAL MOTORS COMPANY

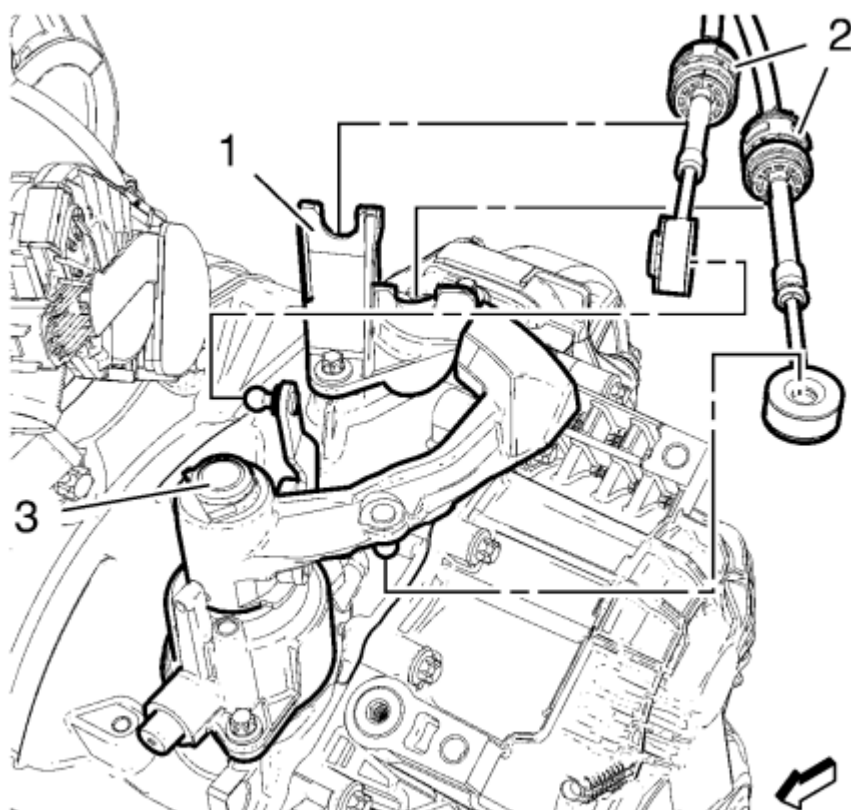
14. Disconnect inlet (2) and outlet (1) heater core hoses.





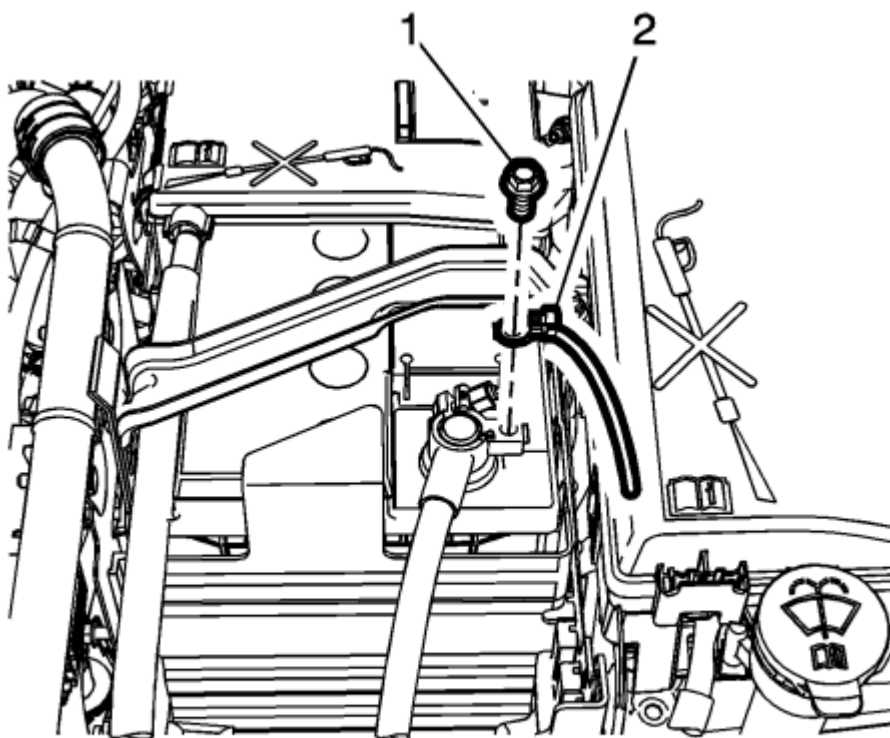
**Fig. 213: Transmission Range Selector Lever And Cable Connection**  
Courtesy of GENERAL MOTORS COMPANY

15. On vehicles equipped with a automatic transmission, disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.
16. On vehicles equipped with a automatic transmission, press the locking tabs inward in order to release the transmission range selector lever cable (2) from the cable bracket.



**Fig. 214: Selector Lever Cable, Bracket And Transmission Control Housing**  
Courtesy of GENERAL MOTORS COMPANY

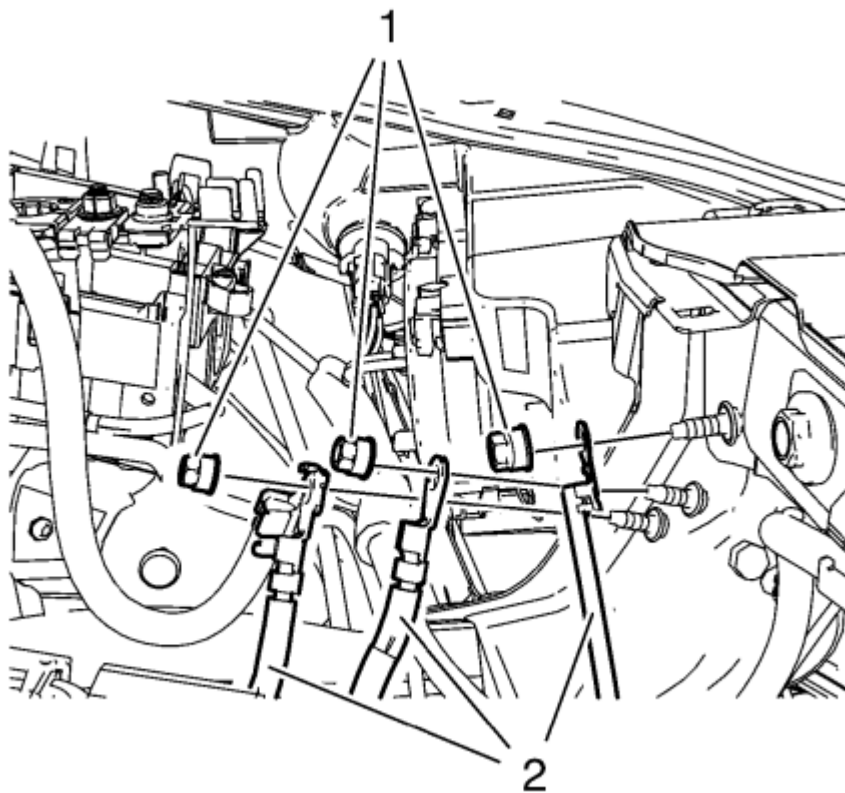
17. On vehicles equipped with a manual transmission, using a suitable pry tool, disconnect the shift lever cables (2) from the shift levers (3)
18. On vehicles equipped with a manual transmission, remove the shift lever cables (2) from the cable bracket (1).



**Fig. 215: Ground Strap And Bolt**

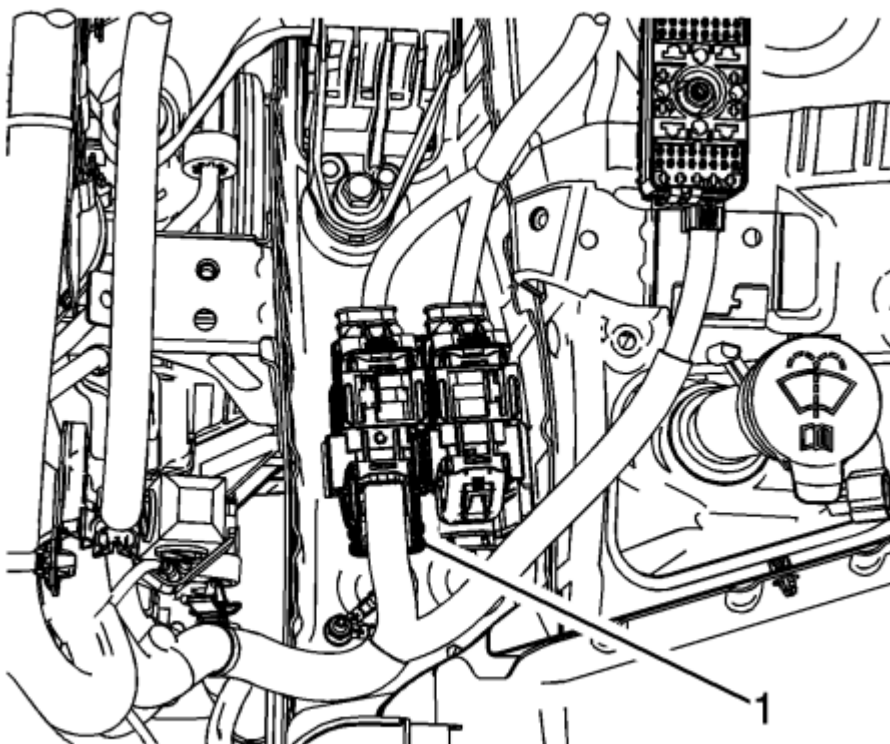
Courtesy of GENERAL MOTORS COMPANY

19. Remove the ground strap bolt (1) from the battery cable and reposition the strap (2) a side.
20. Remove the battery tray. Refer to **Battery Tray Replacement** .



**Fig. 216: Wiring Harnesses And Ground Nuts**  
Courtesy of GENERAL MOTORS COMPANY

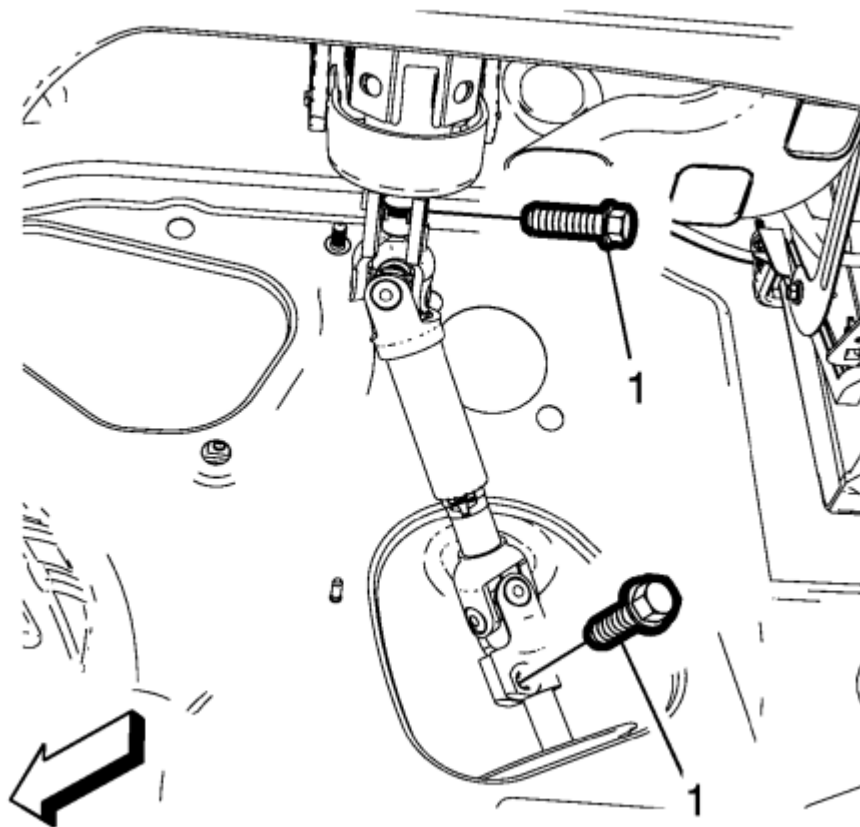
21. Remove the ground nuts (1) and put the wiring harness (2) aside.
22. Disconnect the electrical connectors from the engine control module (ECM). Refer to **Engine Control Module Replacement** .
23. Disconnect the wiring harness from the accessory wiring junction block.



**Fig. 217: Junction Connector**

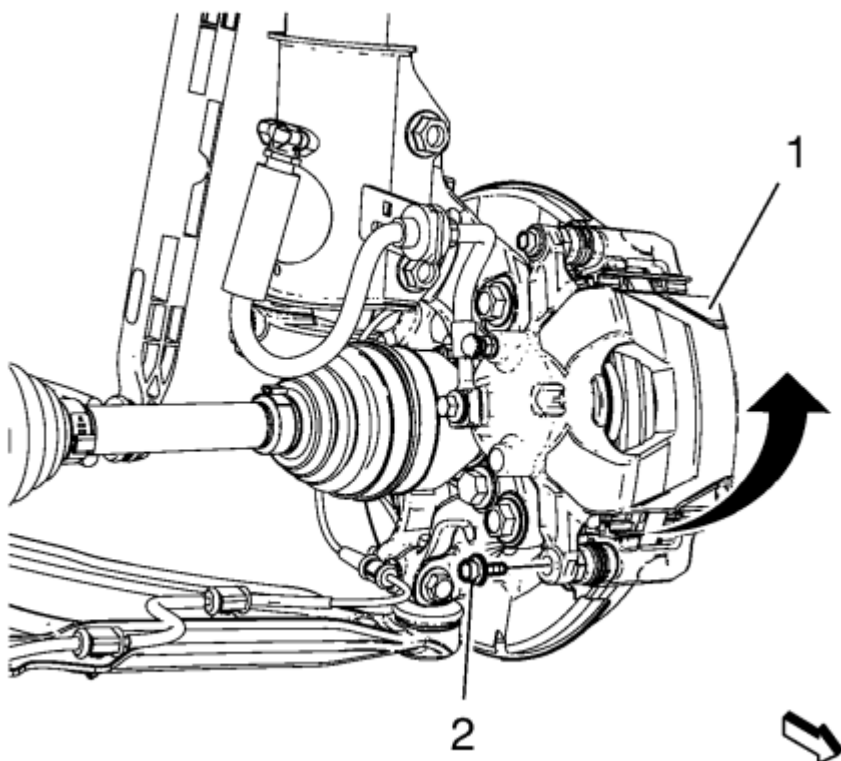
**Courtesy of GENERAL MOTORS COMPANY**

24. Disconnect the wiring harness from the junction connector (1).
25. Place the ECM, transmission and the accessory wiring junction block wiring harnesses on the top of engine assembly.
26. Install the engine support fixture.



**Fig. 218: Lower Steering Intermediate Shaft Bolt**  
Courtesy of GENERAL MOTORS COMPANY

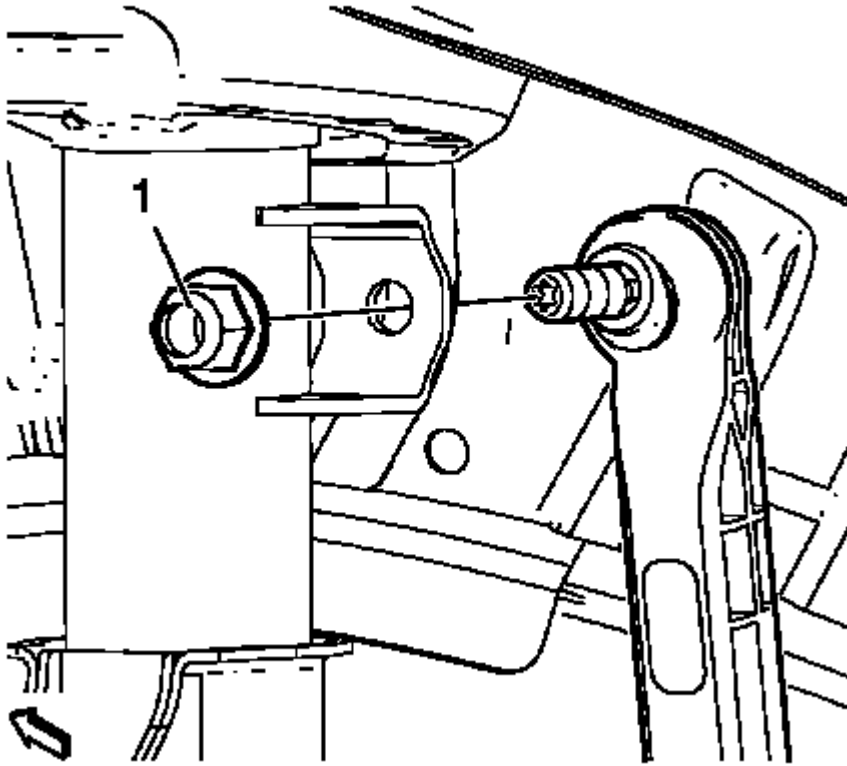
27. Remove and DISCARD the lower steering intermediate shaft bolt (1).



**Fig. 219: Brake Caliper And Brake Caliper Guide Pin Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do Not disconnect the brake hoses from the calipers.

28. Remove the front brake calipers (1) and caliper bolts (2) from the caliper brackets, and then suspend the calipers with mechanics wire to the body.
29. Remove the exhaust system. Refer to Exhaust System Replacement .

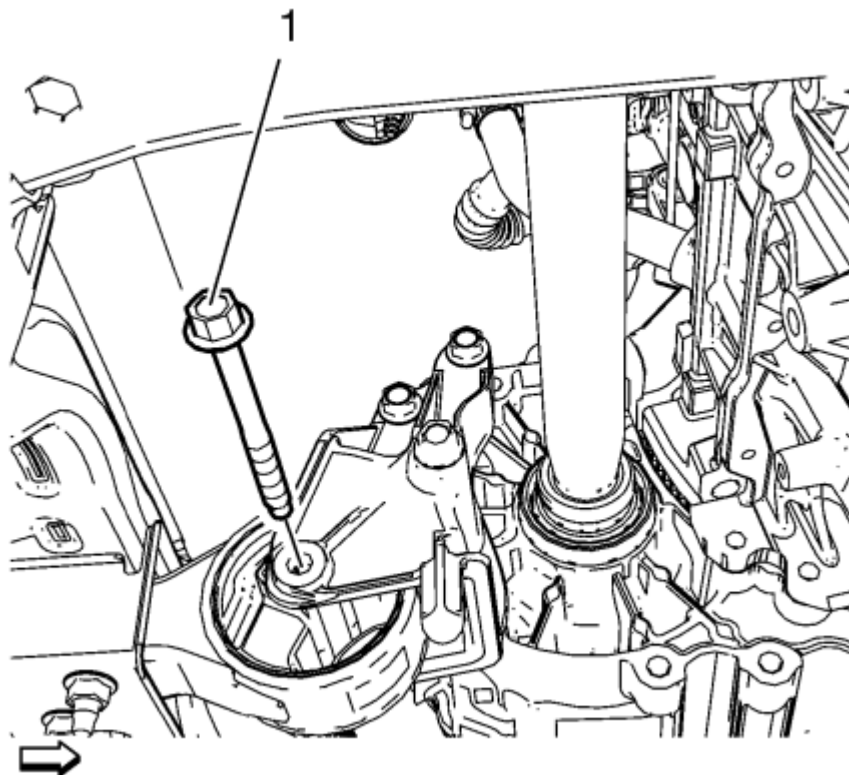


**Fig. 220: Stabilizer Link Nut**

Courtesy of GENERAL MOTORS COMPANY

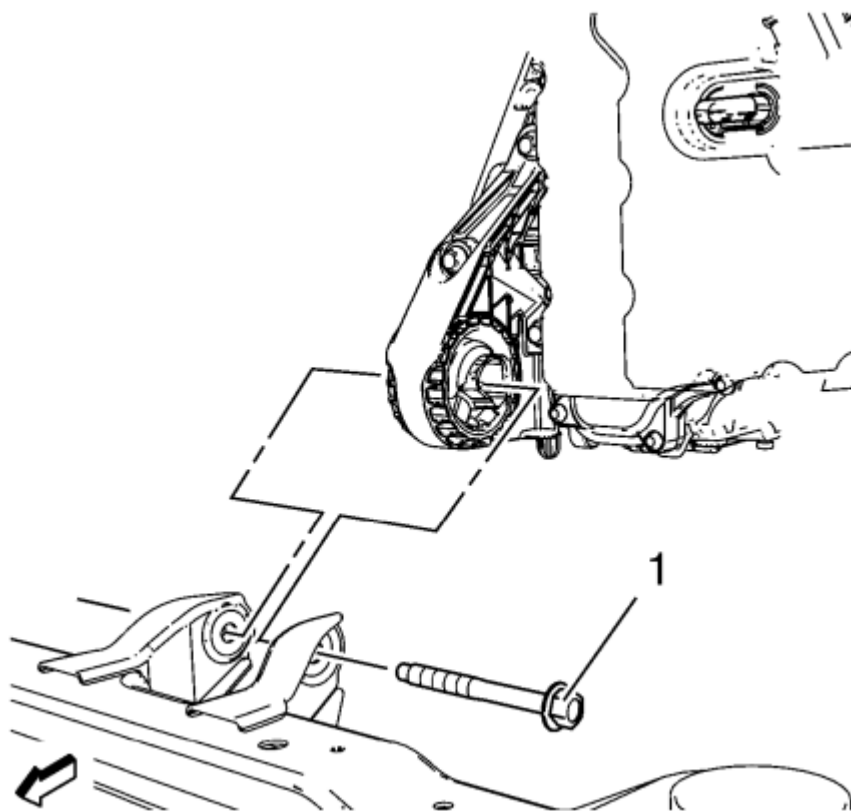
30. Remove and DISCARD the stabilizer link nut (1) from the strut assemblies. Refer to **Stabilizer Shaft Link Replacement** .
31. Disconnect the right wheel drive shaft from the intermediate shaft.
32. Disconnect the front steering knuckles from the strut assemblies. Refer to **Steering Knuckle Replacement** .
33. Disconnect the electronic power steering connectors from the electronic power steering assembly. Refer to **FEP Connectors (Steering Gear)** .





**Fig. 221: Transmission Bracket Mount To Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

34. Remove the rear transmission mount bracket to rear mount through bolt (1).

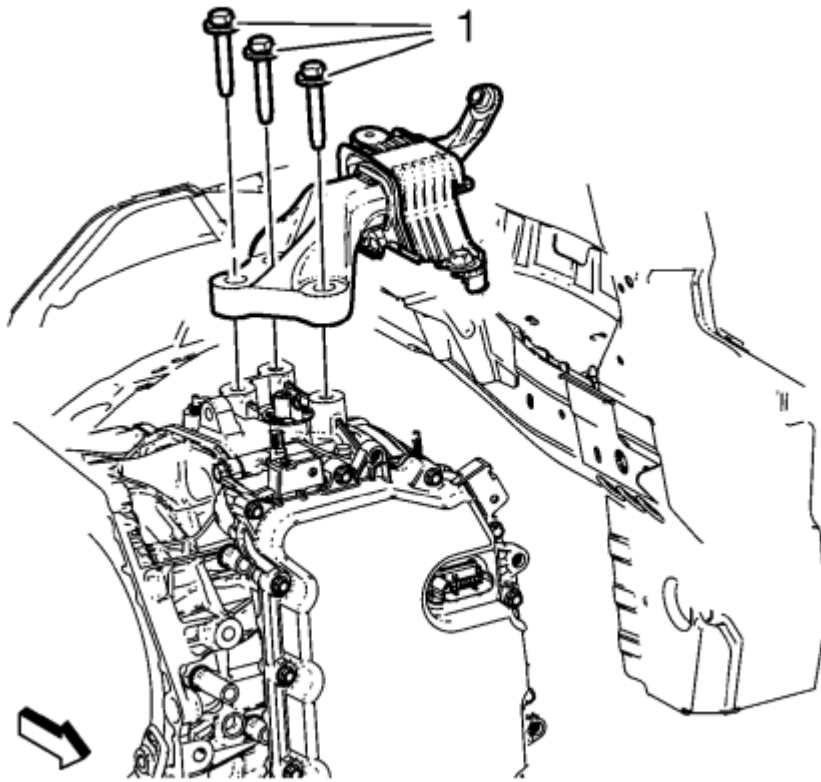


**Fig. 222: Front Transmission Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

35. Remove the transmission front mount through bolt (1).
36. Using suitable straps or chains, secure the front of vehicle to the hoist arms.

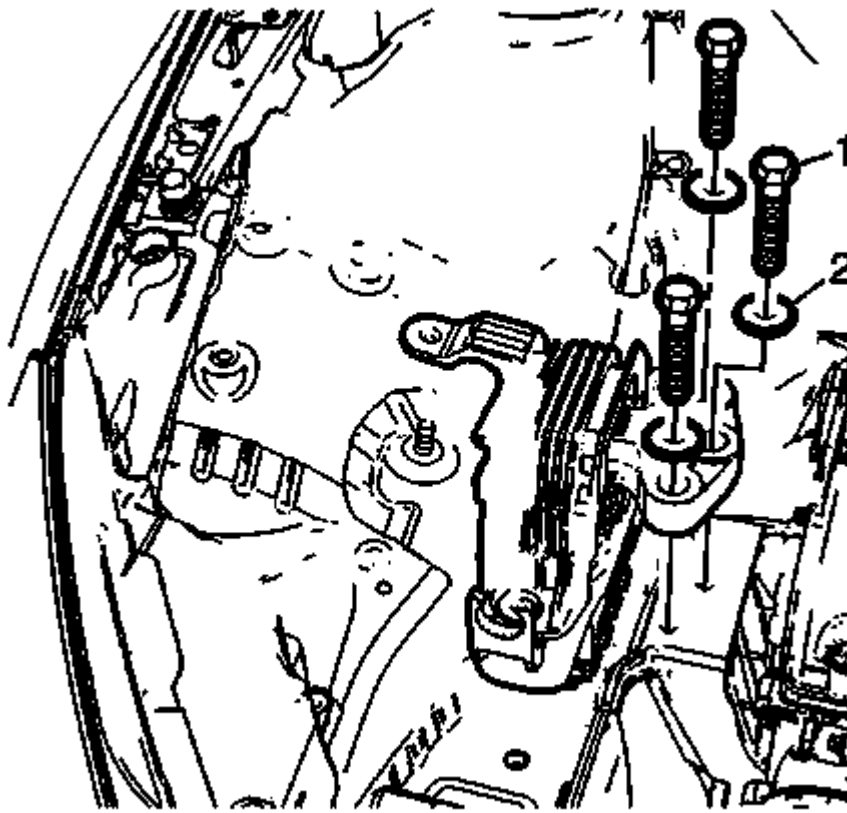
**NOTE:** Use the engine support fixture to slightly raise the powertrain assembly to aid in the removal of the engine and transmission mount bolts.

37. Use the engine support fixture to slightly raise the powertrain assembly to aid in the removal of the engine and transmission mount bolts.



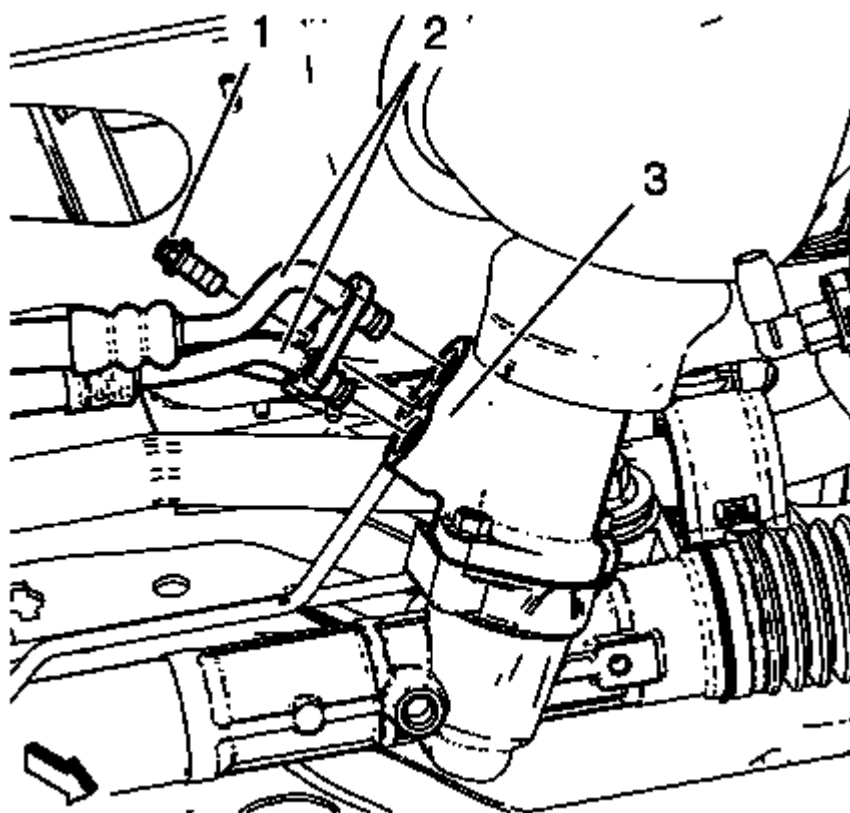
**Fig. 223: Automatic Transmission Mount Bracket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

38. Remove and DISCARD the left transmission mount to bracket bolts (1).



**Fig. 224: Engine Mount Bracket Bolts And Washers**  
Courtesy of GENERAL MOTORS COMPANY

39. Remove the engine mount to engine mount bracket bolts (1) and the washers (2).
40. Using a suitable engine support table, lower the vehicle until the drivetrain and front suspension frame contacts the engine support table.
41. Position blocks of wood below the oil pan and transmission to stabilize the powertrain on the support table.
42. Using the engine support fixture, lower the powertrain down until it is resting on the engine support table.



**Fig. 225: Power Steering Gear, Inlet And Outlet Hose And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

43. Remove the power steering gear inlet and outlet hose bolts (1). Remove the inlet and outlet hose (2) from the steering gear (3).
44. Remove the engine support fixture.
45. Remove the drivetrain and front suspension frame reinforcements from the rear of the frame.
46. Remove the front drivetrain and front suspension frame retaining bolts.
47. Slowly and carefully raise the vehicle, ensure the engine, transmission, radiator assembly and drivetrain suspension frame are free from wiring, hoses and other engine compartment components.
48. Separate the transmission from the engine assembly.
49. Disconnect engine coolant hoses as necessary.
50. Disconnect electrical connectors as necessary.
51. Transfer components as necessary.

#### Installation Procedure

1. Position the engine to the transmission assembly.
2. Position the engine, transmission, radiator assembly and drivetrain suspension frame under the vehicle.
3. Slowly and carefully lower the vehicle, ensure the engine, transmission, radiator assembly and drivetrain

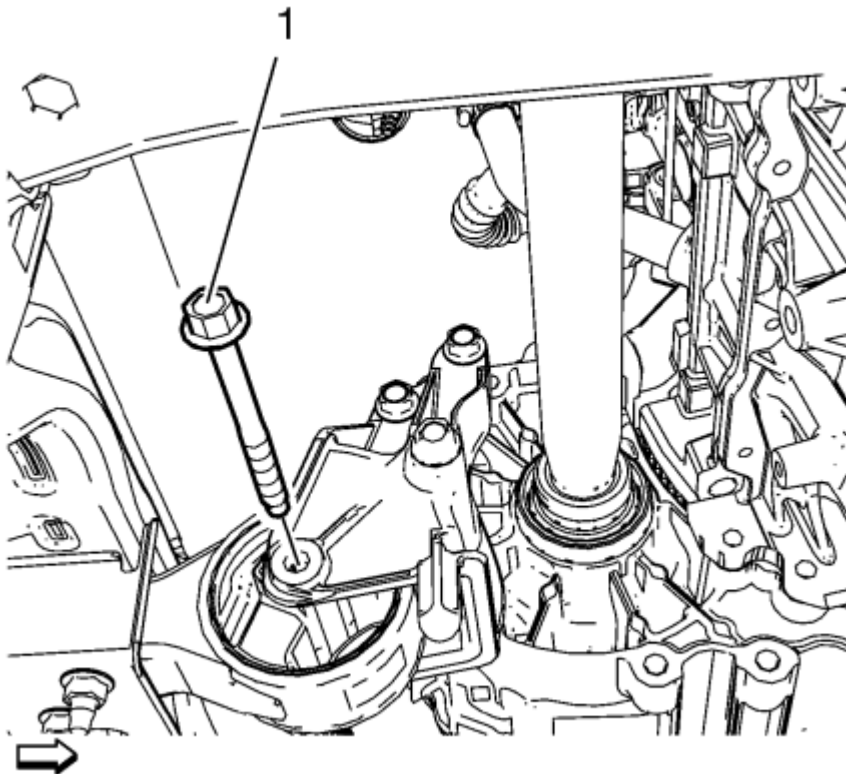
suspension frame are free from wiring, hoses and other engine compartment components.

**CAUTION:** Refer to Fastener Caution .

4. Install the four front drivetrain and front suspension frame retaining bolts, then tighten to the fasteners to 160 N.m (118 lb ft).
5. Install the drivetrain and front suspension frame reinforcements to the rear of the frame, then tighten the reinforcement fasteners to 22 N.m (16 lb ft).

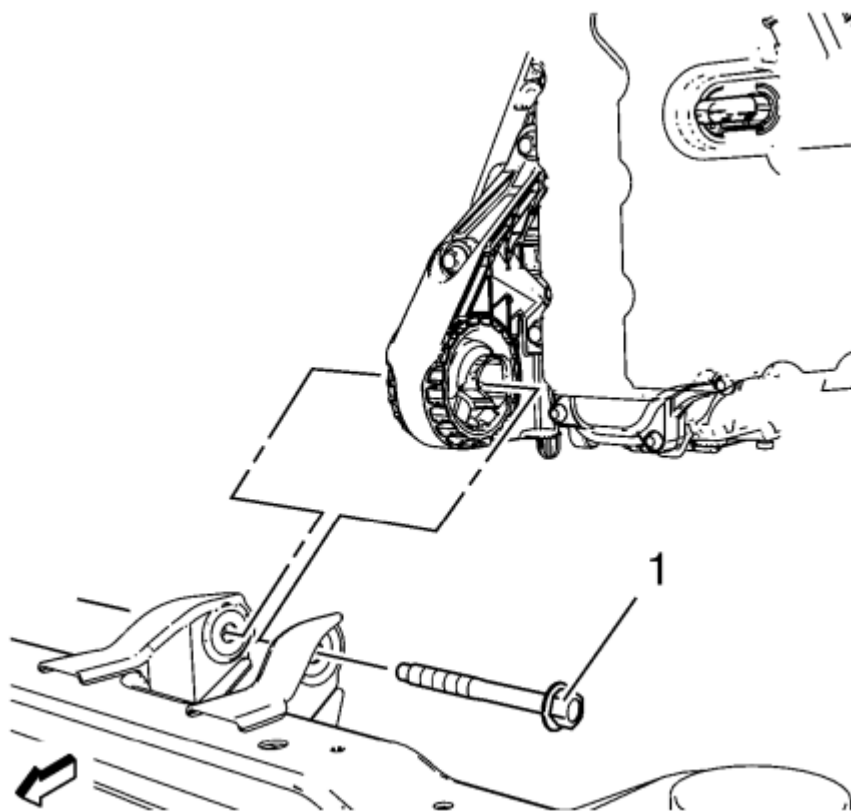
**NOTE:** Use the engine support fixture to slightly raise the powertrain assembly to aid in the installation of the engine and transmission mount bolts.

6. Install the engine support fixture. Refer to Engine Support Fixture .



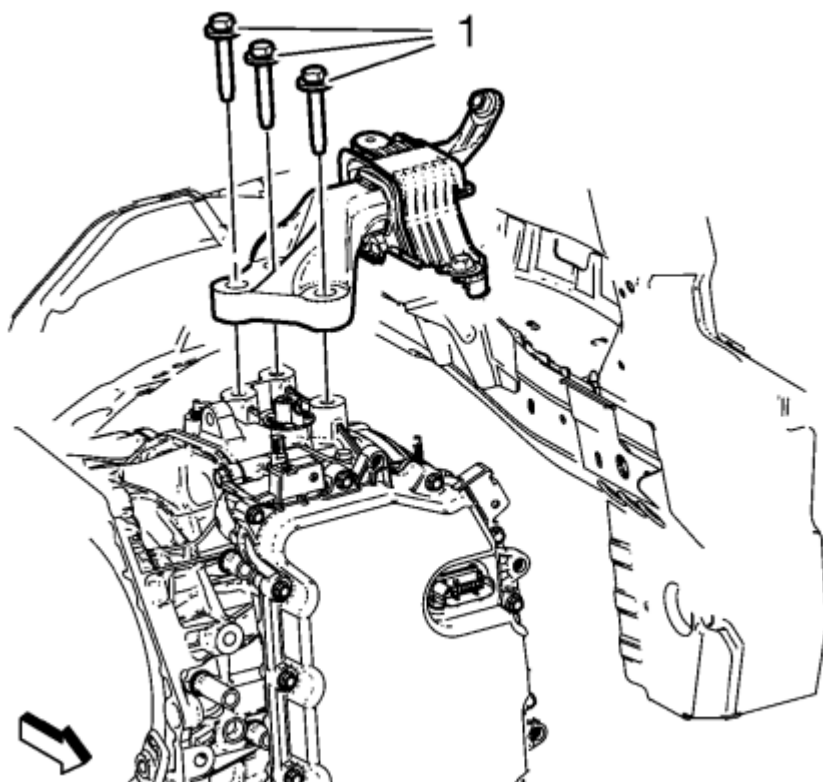
**Fig. 226: Transmission Bracket Mount To Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the transmission bracket mount to mount through bolt (1) and tighten to 100 N.m (74 lb ft).



**Fig. 227: Front Transmission Mount Through Bolt**  
Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission mount through bolt (1) and tighten to 58 N.m (43 lb ft).
9. Install the engine mount. Refer to **Engine Mount Replacement - Right Side** .

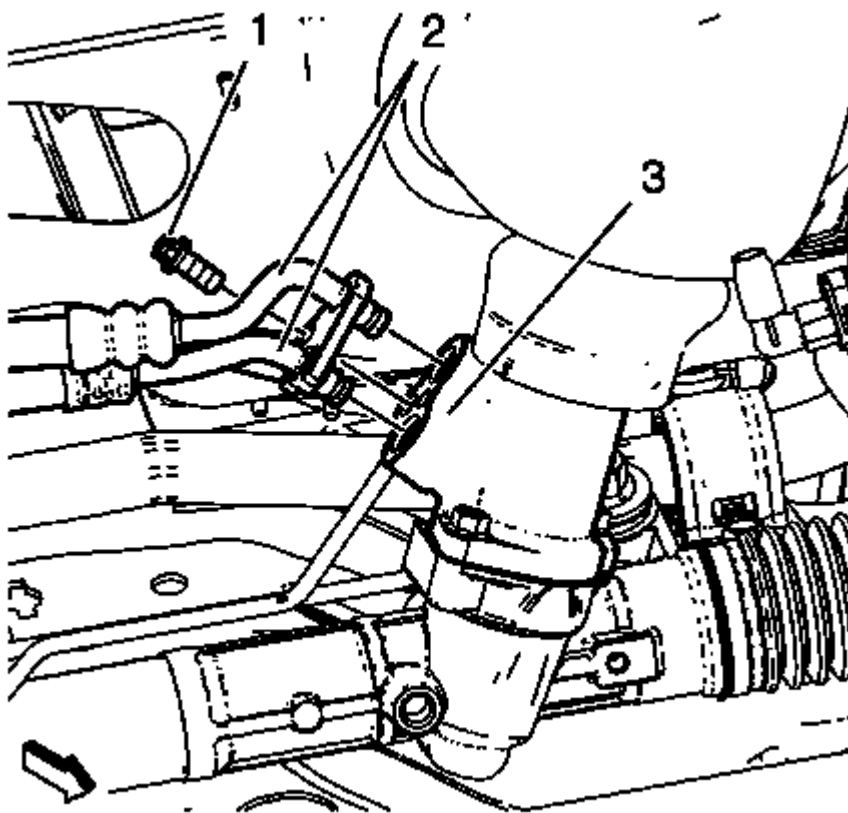


**Fig. 228: Automatic Transmission Mount Bracket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Refer to Torque-to-Yield Fastener Warning .

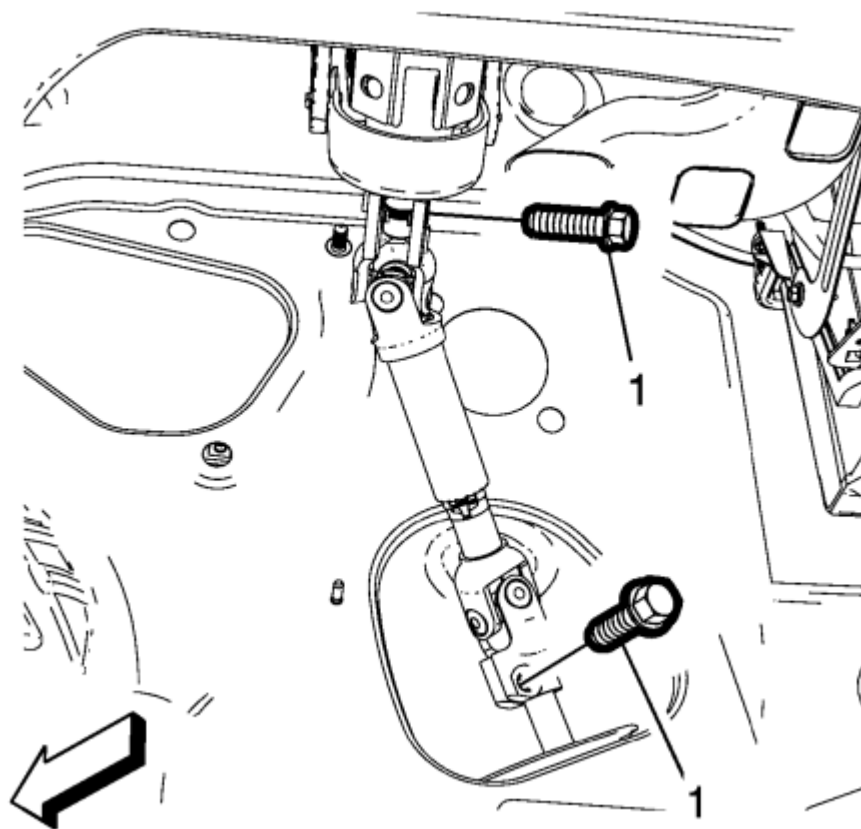
10. Install the NEW left transmission mount to transmission bolts (1) and tighten to 50 N.m (37 lb ft) plus 60-75 degrees.





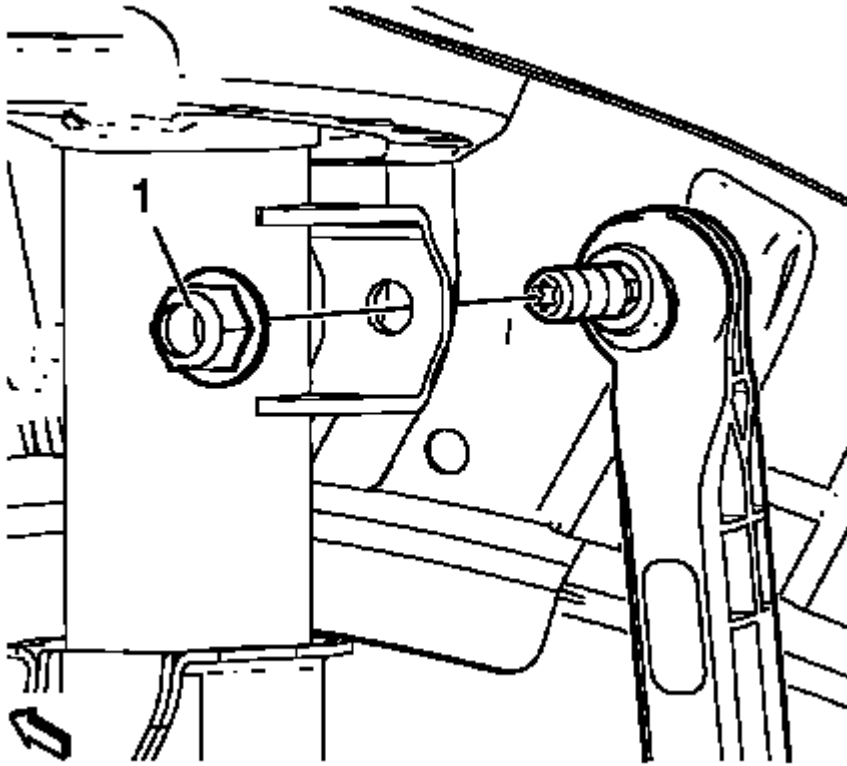
**Fig. 229: Power Steering Gear, Inlet And Outlet Hose And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

11. Install the inlet and outlet hose (2) to the steering gear (3).
12. Install power steering gear inlet and outlet hose bolts (1) and tighten to 11 N.m (97 lb in).



**Fig. 230: Lower Steering Intermediate Shaft Bolt**  
Courtesy of GENERAL MOTORS COMPANY

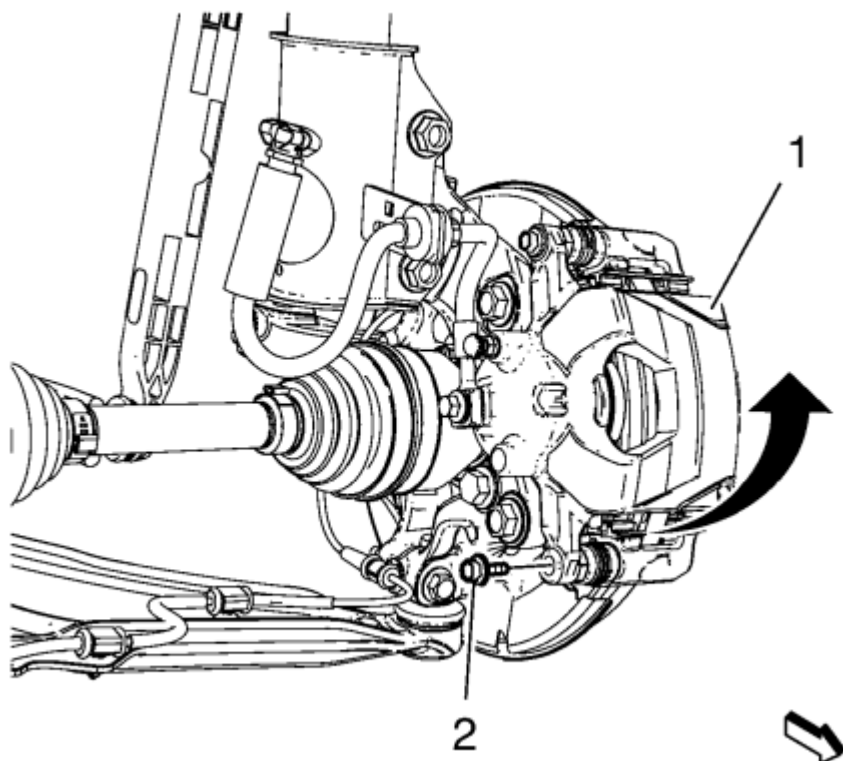
13. Instal NEW the lower steering intermediate shaft (1) bolt and tighten to 34 N.m (25 lb ft).
14. Connect the front steering knuckles to the strut assemblies. Refer to **Steering Knuckle Replacement** .



**Fig. 231: Stabilizer Link Nut**

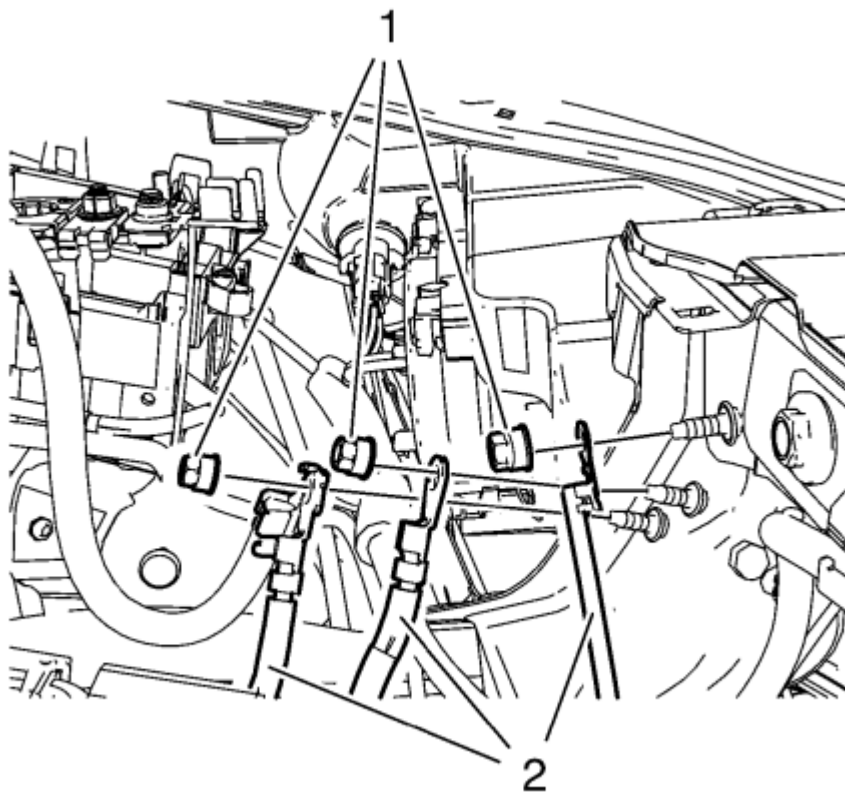
Courtesy of GENERAL MOTORS COMPANY

15. Install NEW the stabilizer link nut (1) to the strut assemblies. Refer to **Stabilizer Shaft Link Replacement** .
16. Connect the right wheel drive shaft from the intermediate shaft.



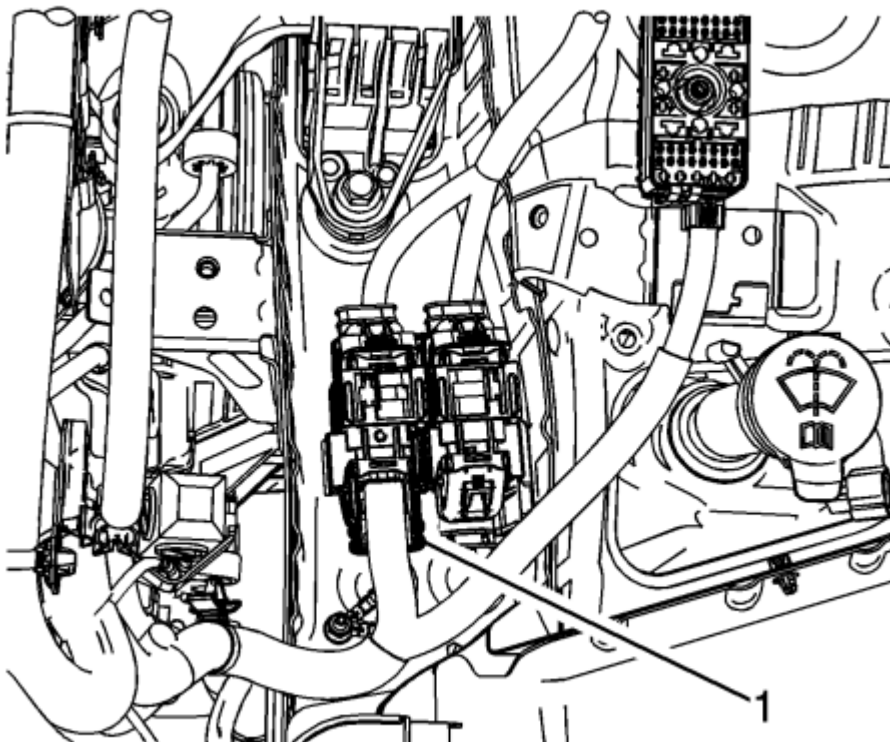
**Fig. 232: Brake Caliper And Brake Caliper Guide Pin Bolt**  
Courtesy of GENERAL MOTORS COMPANY

17. Install the front brake caliper (1) and tighten the brake caliper guide pin bolt (2) to 28 N.m (21 lb ft).
18. Install the exhaust system. Refer to **Exhaust System Replacement** .
19. Connect the wheel speed connectors to the steering knuckles.
20. Remove the engine support fixture.
21. Connect the wiring connectors and ground strap to the transmission.
22. Connect the wiring harness to the accessory wiring junction block.
23. Connect the electrical connectors to the ECM. Refer to **Engine Control Module Replacement** .



**Fig. 233: Wiring Harnesses And Ground Nuts**  
**Courtesy of GENERAL MOTORS COMPANY**

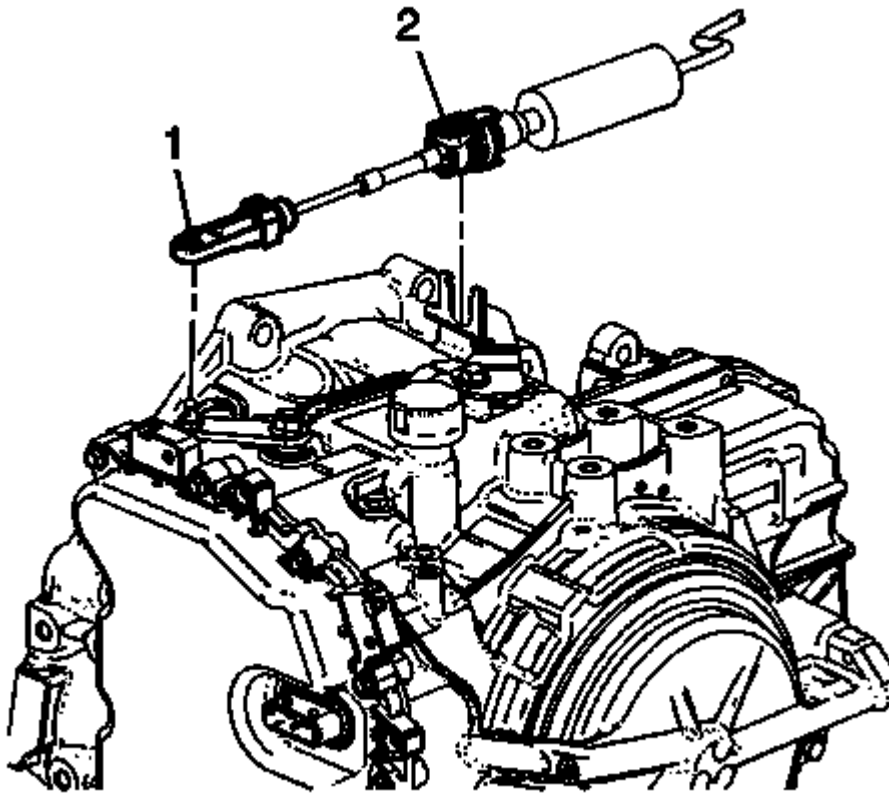
24. Install the wiring harnesses (2).
25. Install the ground nuts (1) and tighten to 9 N.m (80 lb in).



**Fig. 234: Junction Connector**

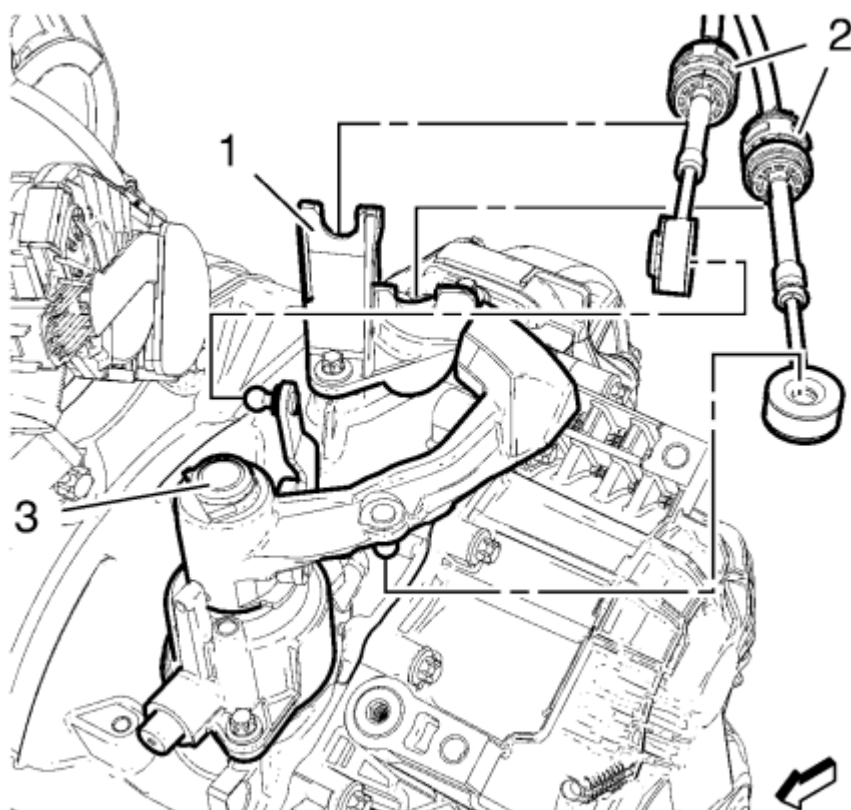
Courtesy of GENERAL MOTORS COMPANY

26. Connect the wiring harness plugs (1).



**Fig. 235: Transmission Range Selector Lever And Cable Connection**  
Courtesy of GENERAL MOTORS COMPANY

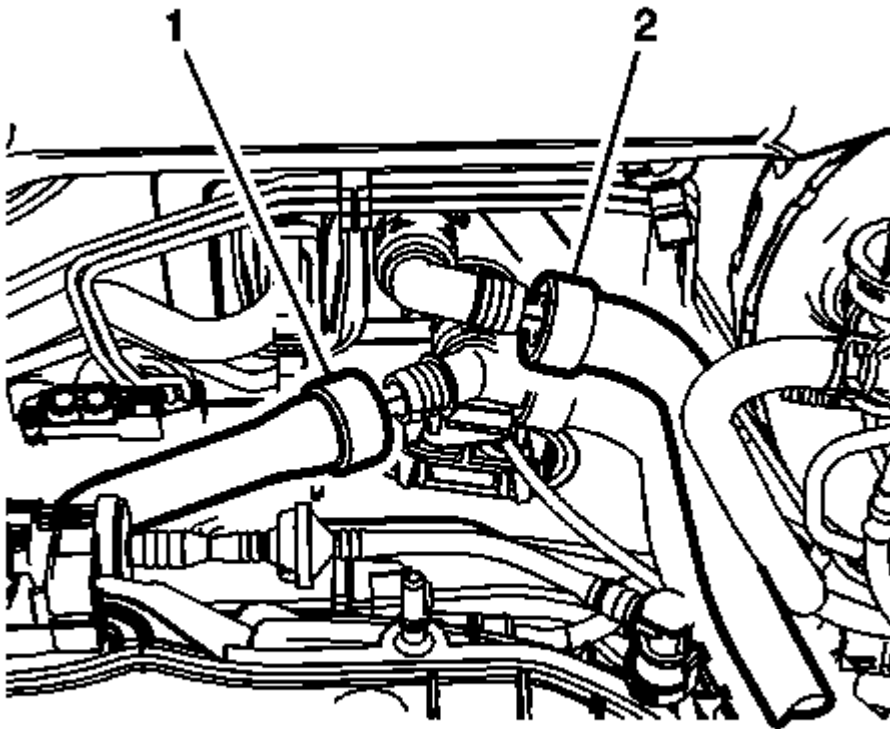
27. On vehicles equipped with a automatic transmission, connect the transmission range selector lever cable terminal (1) to the transmission manual shift lever pin.
28. On vehicles equipped with a automatic transmission, press the locking tabs outward in order to lock the transmission range selector lever cable (2) to the cable bracket.



**Fig. 236: Selector Lever Cable, Bracket And Transmission Control Housing**  
Courtesy of GENERAL MOTORS COMPANY

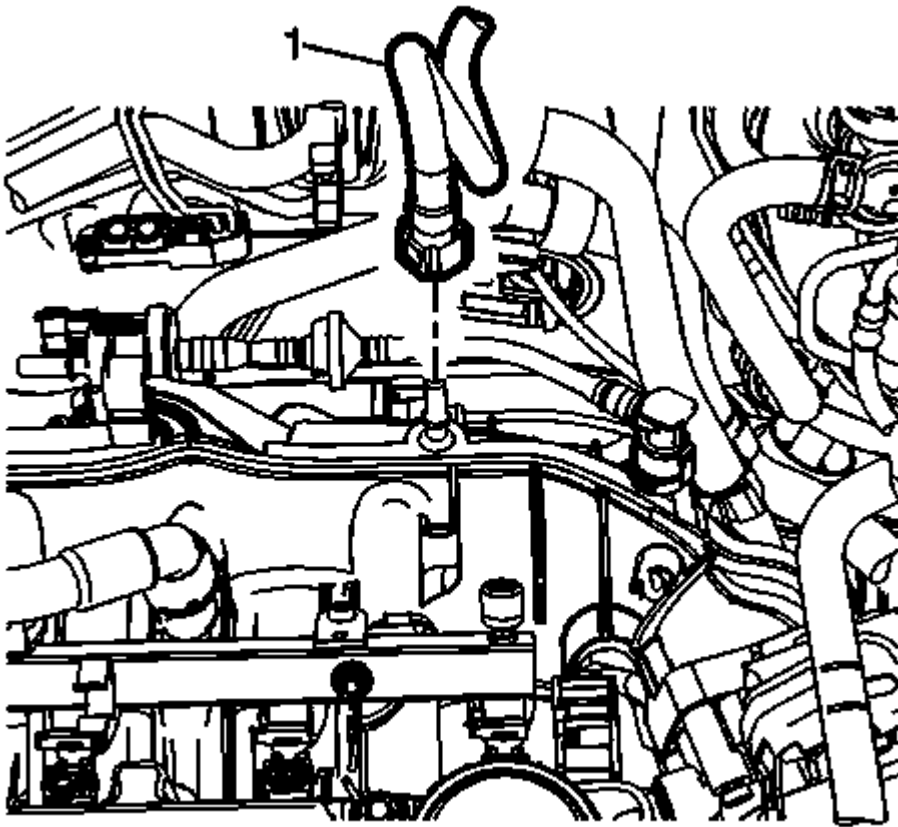
29. On vehicles equipped with a manual transmission, connect the shift lever cables (2) to the shift levers (3)
30. On vehicles equipped with a manual transmission, install the shift lever cables (2) to the cable bracket (1).
31. Install the battery tray. Refer to **Battery Tray Replacement** .





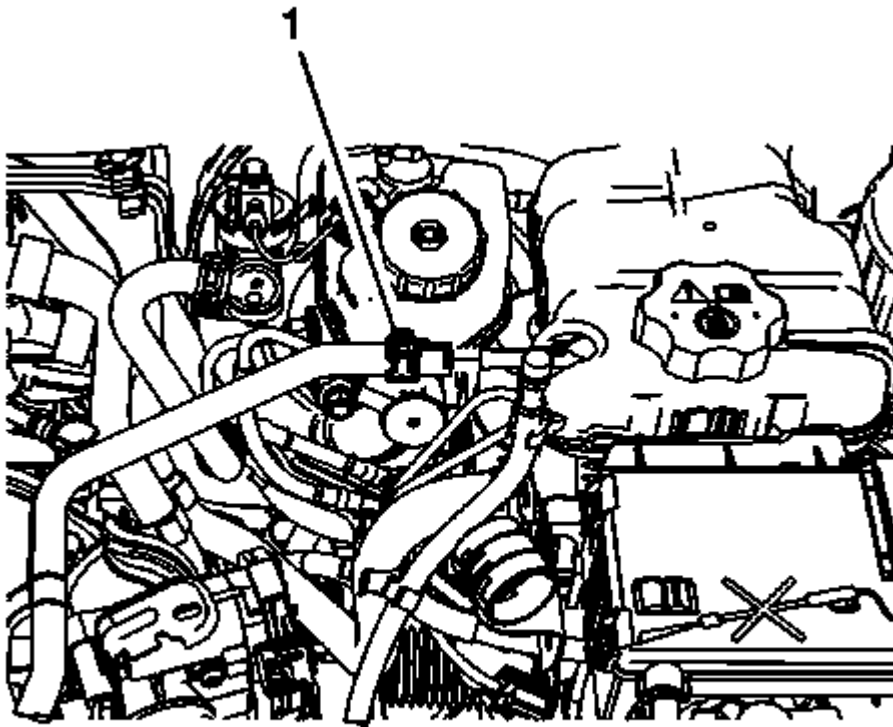
**Fig. 237: Heater Core Inlet And Outlet Hoses**  
Courtesy of GENERAL MOTORS COMPANY

32. Connect inlet (2) and outlet (1) heater core hoses.



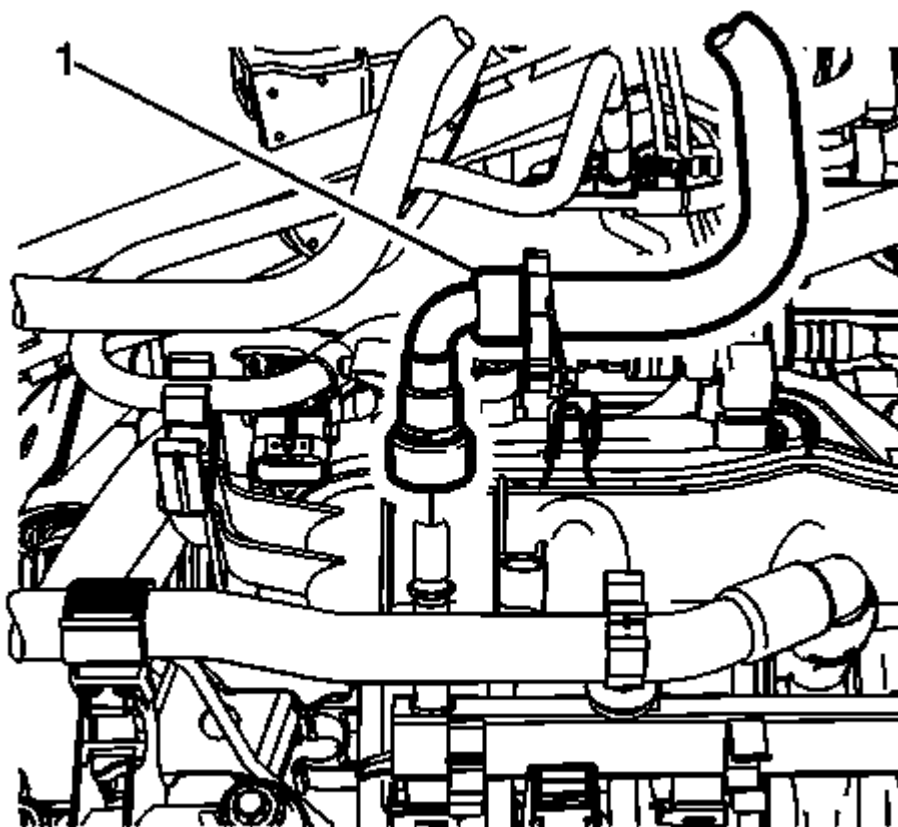
**Fig. 238: Brake Booster Vacuum Pipe**  
Courtesy of GENERAL MOTORS COMPANY

33. Connect the power brake booster vacuum pipe (1).



**Fig. 239: Radiator Surge Tank Outlet Hose Clamp**  
Courtesy of GENERAL MOTORS COMPANY

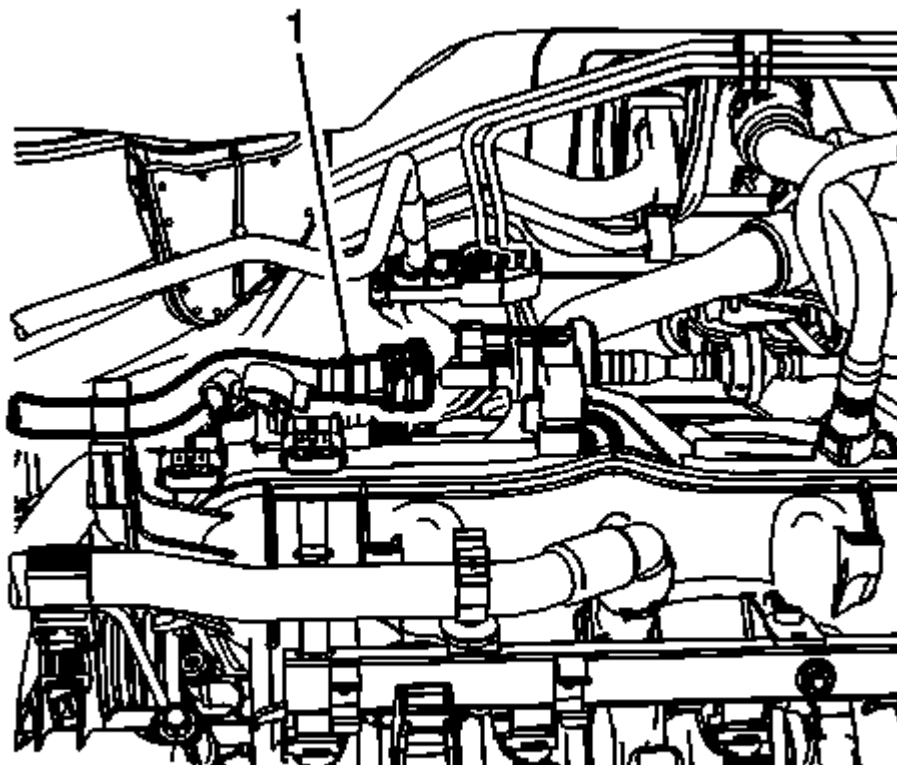
34. Connect the coolant hose and reposition the clamp (1).



**Fig. 240: Fuel Feed Pipe**

Courtesy of GENERAL MOTORS COMPANY

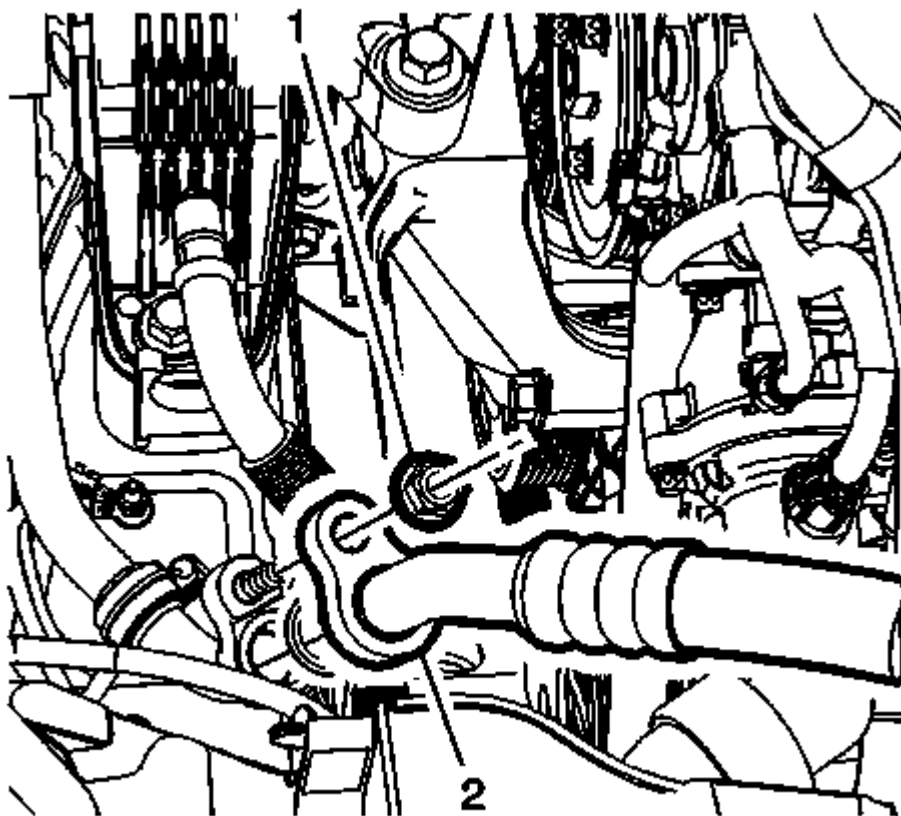
35. Connect the fuel feed line (1) and reposition away from the engine. Refer to **Fuel Pressure Relief** .



**Fig. 241: Fuel Ventilation Pipe**

Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 242: Refrigerant Hose And Nut**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Use NEW O-ring seals. Refer to **Air Conditioning O-Ring Seal Replacement** .

37. Install refrigerant hose (2) and tighten the nut (1) to 19 N.m (14 lb ft).
38. Install the charge air cooler inlet air hose. Refer to **Charge Air Cooler Inlet Air Hose Replacement** .
39. Install the charge air cooler outlet air hose. Refer to **Charge Air Cooler Outlet Air Hose Replacement (Manual Transmission)** , **Charge Air Cooler Outlet Air Hose Replacement (Automatic Transmission)** .
40. Connect engine coolant hoses as necessary.
41. Connect electrical connectors as necessary.
42. Install the front fascia.
43. Install the front wheelhouse front liners.
44. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
45. Fill the engine cooling system. Refer to **Cooling System Draining and Filling (GE-47716 Fill)** , **Cooling System Draining and Filling (Static Fill)** .
46. Charge the air conditioning system. Refer to **Refrigerant Recovery and Recharging** .

47. Check engine oil level. Refer to **Engine Oil and Oil Filter Replacement** .
48. Connect the negative battery cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .

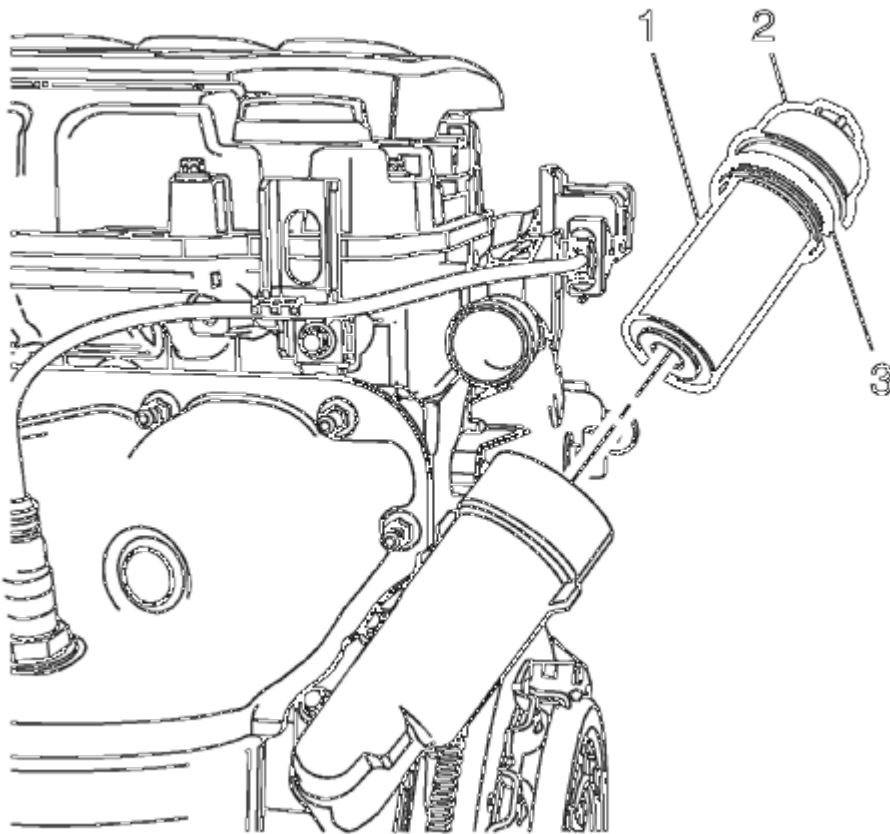
## ENGINE OIL AND OIL FILTER REPLACEMENT

### Removal Procedure

1. Open hood.
2. Place a drain pan below the vehicle.

**CAUTION:** To prevent damage to oil filter cap ensure proper tool is used. Do not use an open end wrench which may cause damage to filter cap.

3. Using a 24mm socket or closed end wrench loosen oil filter cap. Unscrew filter cap 3 turns and let oil filter and cap assembly drain in housing for 30 seconds.



**Fig. 243: Engine Oil Filter Cap, Cap Seal Ring And Oil Filter Element**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Use care when removing engine oil filter cap and filter to minimize fluid spillage. If fluid spillage occurs it must be cleaned with appropriate cleaner.

**NOTE:** Inspect oil filter cap for any cracks or damage. If oil filter cap is damaged it must be replaced.

4. Remove the engine oil filter cap (2) with the engine oil filter cap seal ring (3) and the oil filter element (1).
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Remove the oil pan drain plug and allow the oil to drain into the drain pan.

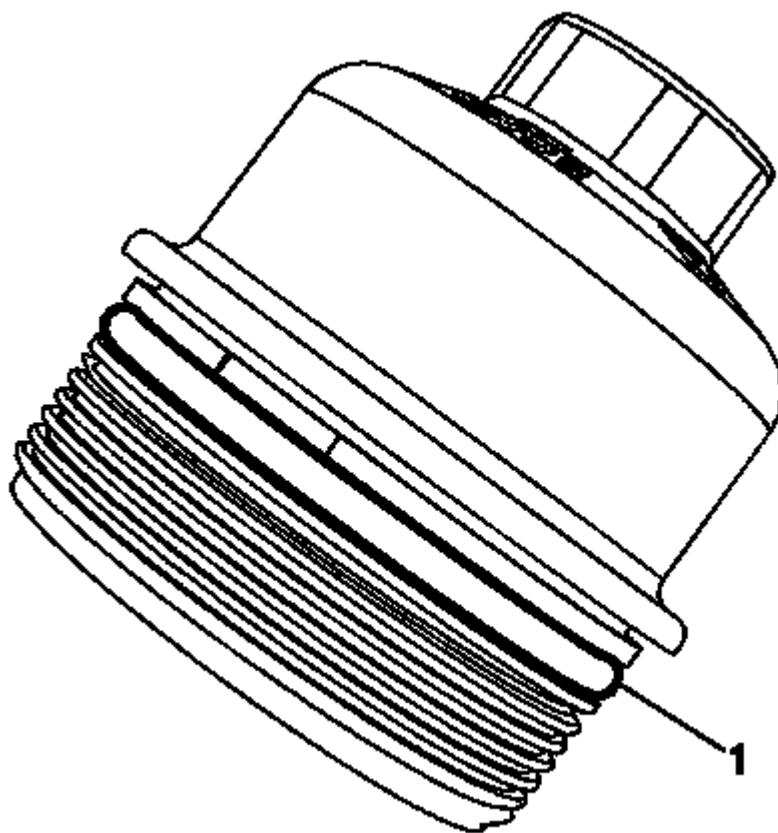
**Installation Procedure**

1. Clean the oil pan drain plug thread in the oil pan.
2. Install a NEW seal ring to the oil pan drain plug.

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

3. Install the oil pan drain plug and tighten to 14 N.m (10 lb ft).
4. Lower the vehicle.



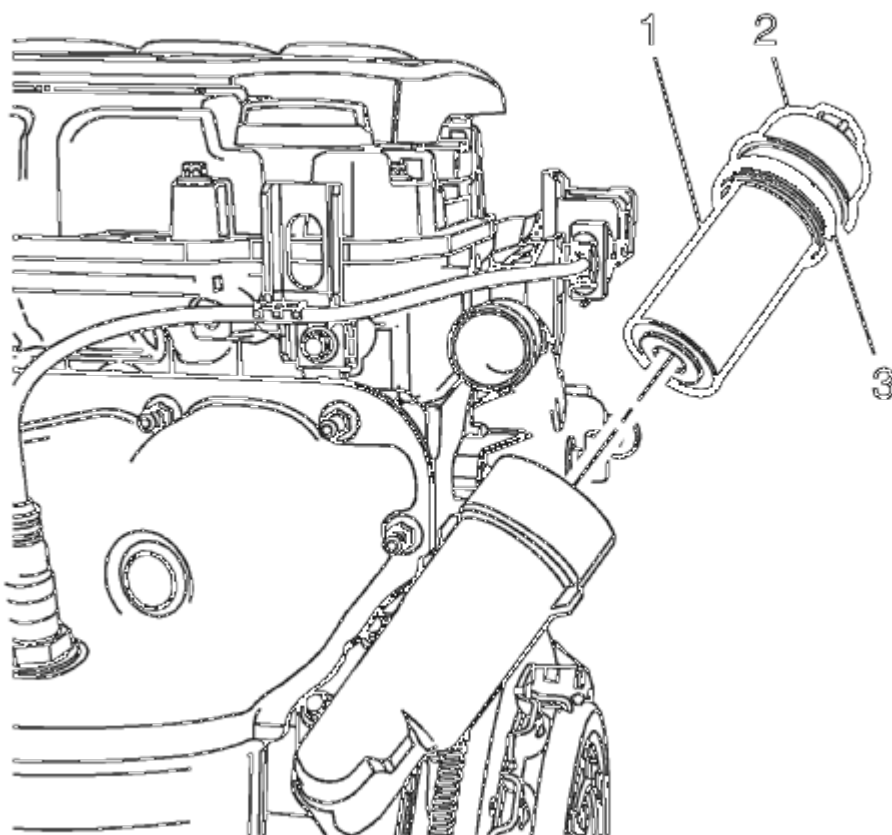


**Fig. 244: Oil Filter Cap Seal Ring**

Courtesy of GENERAL MOTORS COMPANY

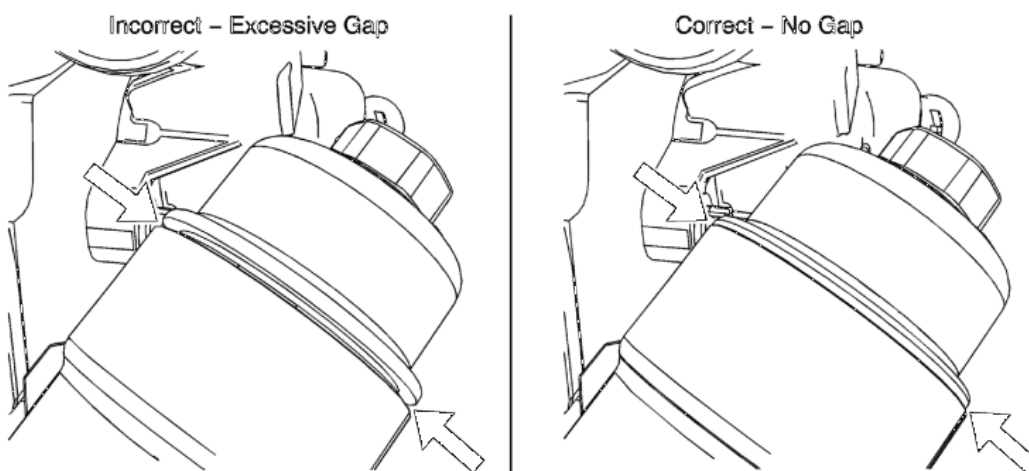
**NOTE:** Clean oil filter cap and lubricate the NEW oil filter cap seal ring with clean engine oil. Ensure oil filter cap seal ring is in proper position as shown.

5. Install a NEW oil filter cap seal ring (1).



**Fig. 245: Engine Oil Filter Cap, Cap Seal Ring And Oil Filter Element**  
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil filter cap (2) with NEW engine oil filter cap seal ring (3) and NEW oil filter element (1) hand tight.



**Fig. 246: Oil Filter Cap Seal Ring**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Ensure oil filter cap is completely seated on oil filter housing. If not completely seated an oil leak may occur.

**CAUTION:** Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

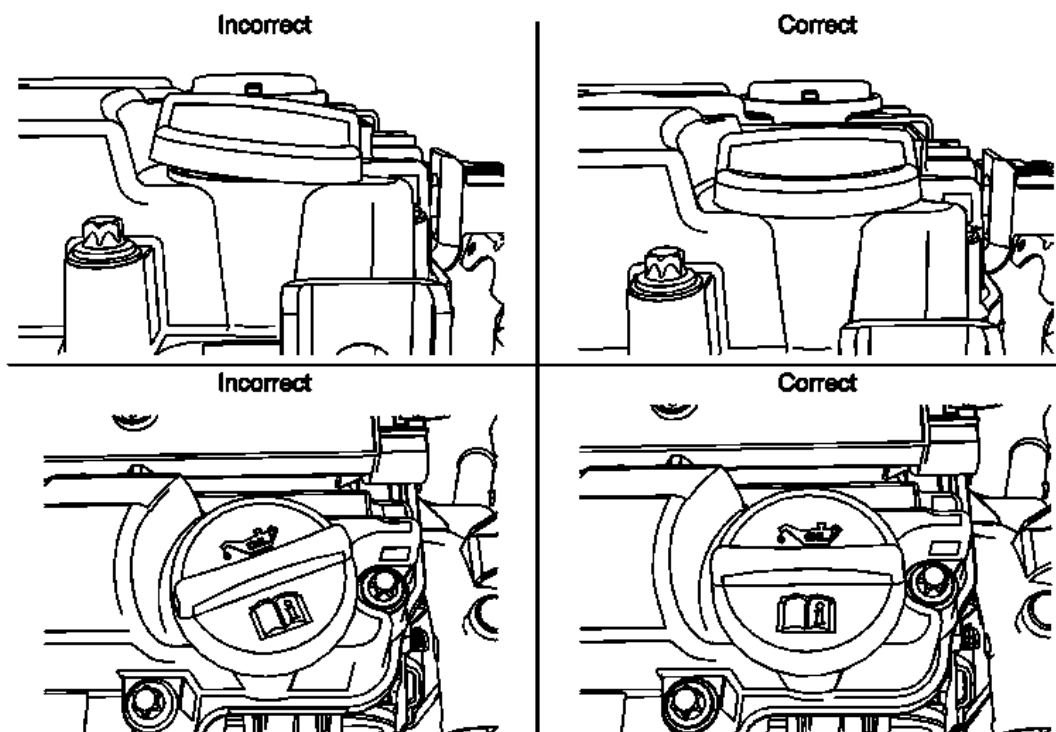
7. Using a 24mm socket or closed end wrench tighten the engine oil filter cap to 25 N.m (18 lb ft).

**CAUTION:** Using engine oils of any viscosity other than those viscosities recommended could result in engine damage.

**NOTE:** Do not overfill the engine with engine oil.

**NOTE:** Anytime engine oil is added (top off or oil changes) ensure all engine surfaces are completely free of residual oil. If there is oil on any engine surface clean as necessary.

8. Fill engine with NEW oil using Dexos™1 5W-30 specification.

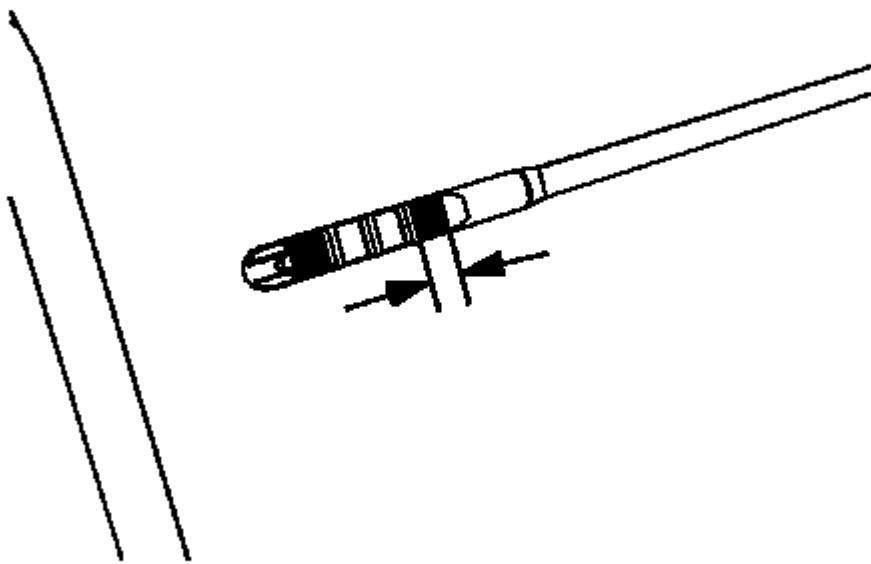


**Fig. 247: Proper Oil Filler Cap Seating**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Oil fill cap must be properly seated and tightened during installation.

9. Install oil fill cap.
10. Start the engine and allow it to run until the oil pressure control indicator goes off. Inspect for any oil leaks around the drain plug, oil filter and oil fill cap.



**Fig. 248: Engine Oil Level Indicator**  
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the engine oil level. The oil level should be in the cross-hatched section of the oil level indicator as shown.
12. Close hood.
13. Reset the engine oil life system monitor.

## **CAMSHAFT SEAL REPLACEMENT**

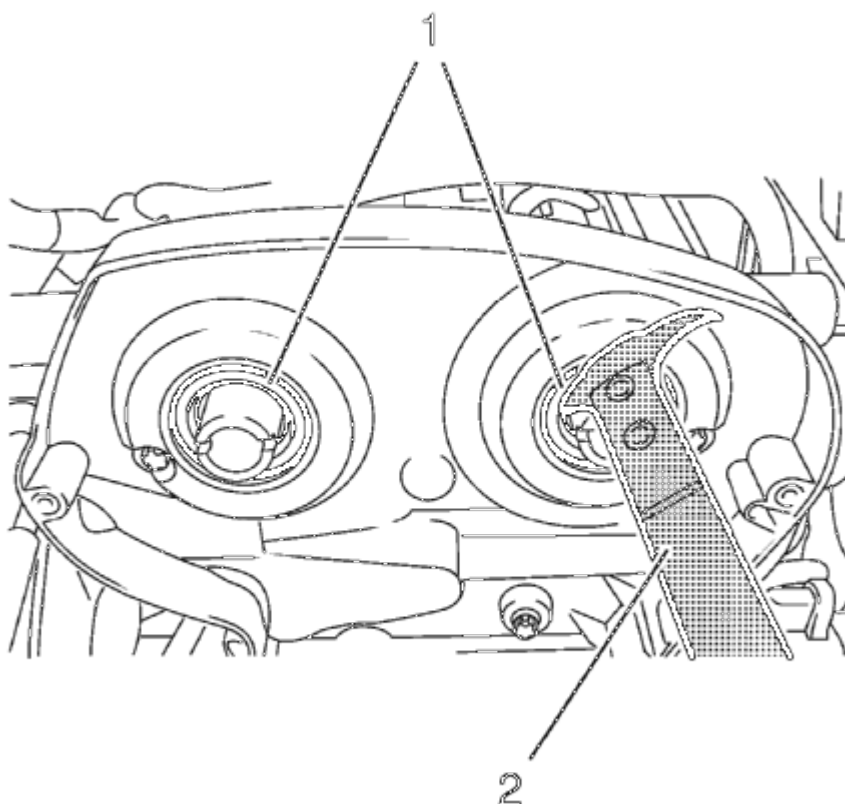
### **Special Tools**

- **EN-422** Installer
- **EN-45000** Remover

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

### Removal Procedure

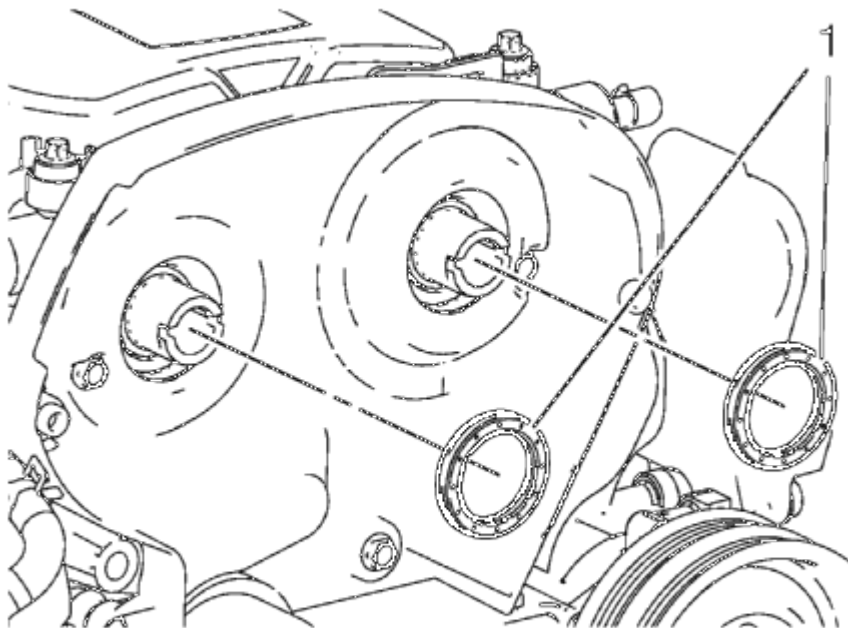
1. Remove the camshaft position actuator adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.



**Fig. 249: Camshaft Front Oil Seals And Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not damage the sealing surfaces.

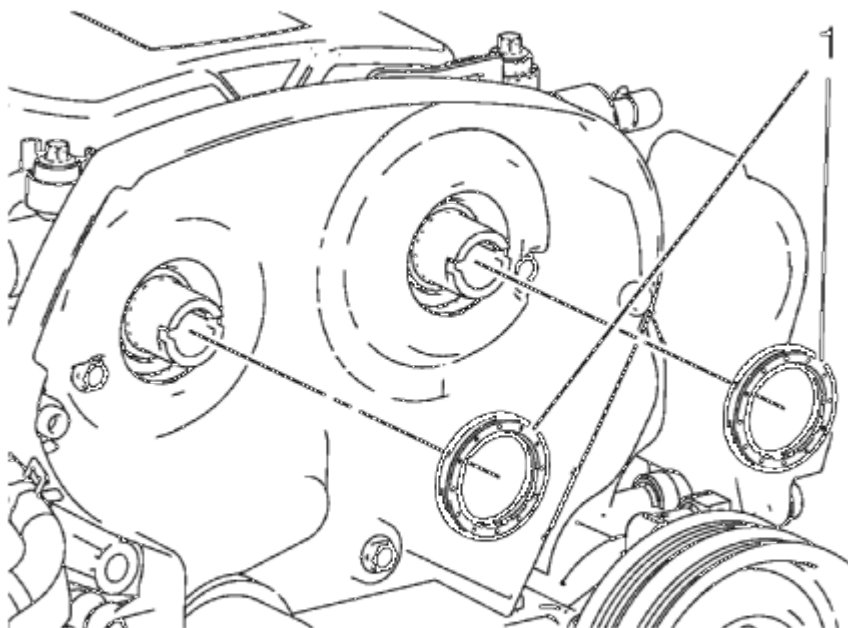
2. Use the **EN-45000** remover to loosen the camshaft front oil seals (1).



**Fig. 250: Camshaft Front Oil Seals**  
Courtesy of GENERAL MOTORS COMPANY

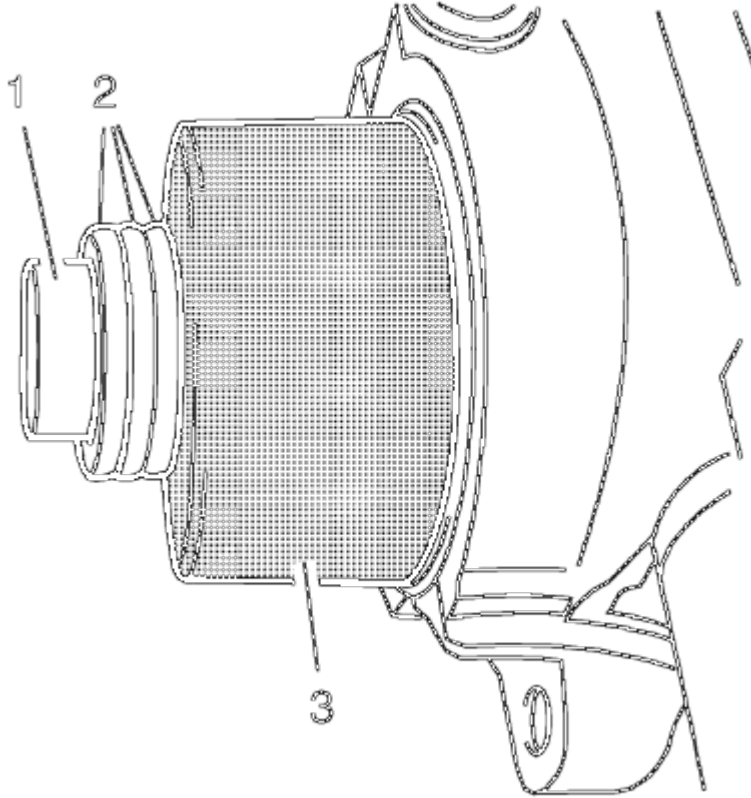
3. Remove the camshaft front oil seals (1).

#### Installation Procedure



**Fig. 251: Camshaft Front Oil Seals**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Insert 2 NEW camshaft front oil seals (1).



**Fig. 252: Camshaft Sprocket Bolt, Shims And Tool**  
 Courtesy of GENERAL MOTORS COMPANY

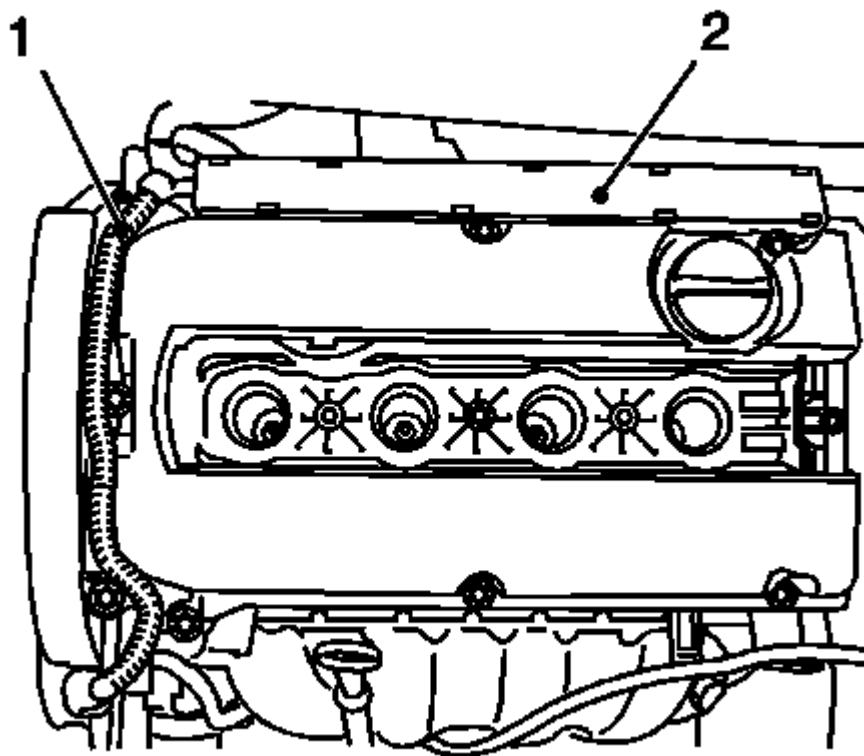
2. Tighten the seal ring with **EN-422** installer (3) on the camshaft until this is in contact with the cylinder head.
3. To install, use camshaft sprocket bolt (1) in conjunction with shims (2) with a total thickness of approximately 10 mm (0.393 in).
4. Install the camshaft position actuator adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.

## CAMSHAFT COVER REPLACEMENT

### Removal Procedure

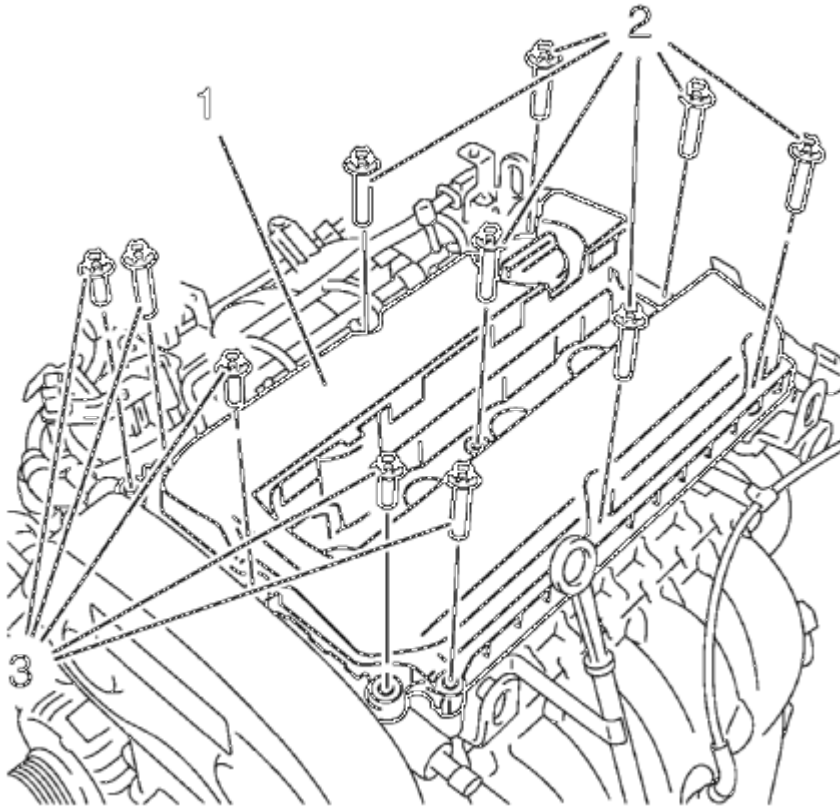
1. Open the hood.
2. Remove the ignition coil. Refer to **Ignition Coil Replacement** .





**Fig. 253: Wiring Harness Guide And Cylinder Head Cover**  
Courtesy of GENERAL MOTORS COMPANY

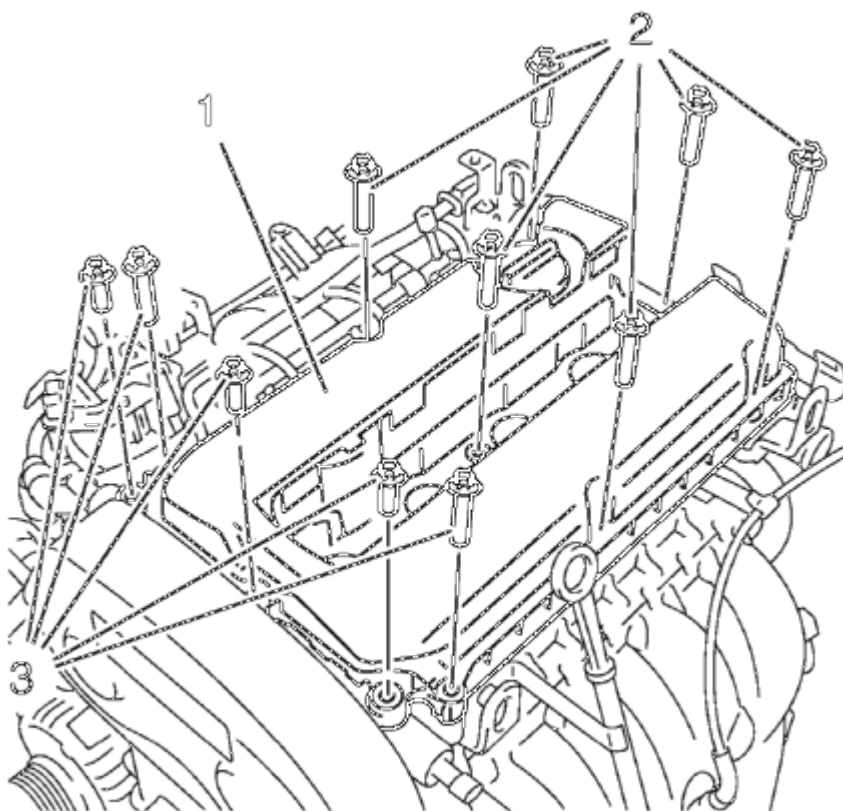
3. Unclip the ECM wiring harness guide (1) from the cylinder head cover.
4. Disconnect the wiring guide (2).
5. Remove the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.



**Fig. 254: Camshaft Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 11 bolts (2, 3).
7. Remove the camshaft cover (1).

#### Installation Procedure



**Fig. 255: Camshaft Cover And Bolts**

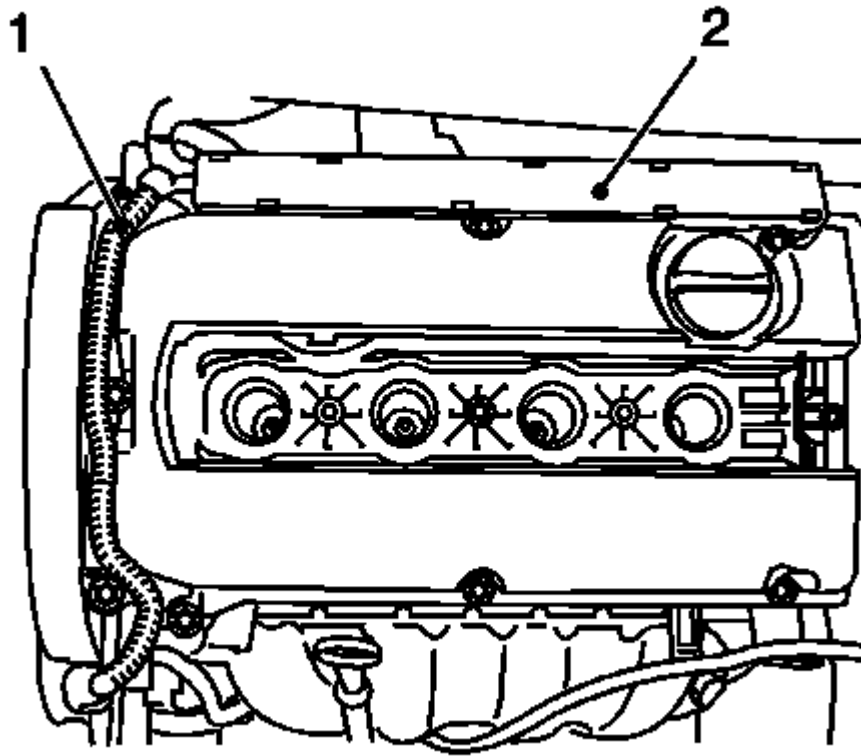
Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft cover (1).

Insert a NEW gasket in the cylinder head cover.

**CAUTION: Refer to Fastener Caution .**

2. Install the 11 bolts (2, 3) and tighten to 8 N.m (71 lb in).
3. Install the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.



**Fig. 256: Wiring Harness Guide And Cylinder Head Cover**  
Courtesy of GENERAL MOTORS COMPANY

4. Clip in the ECM wiring harness guide (1) to the cylinder head cover.
5. Connect the wiring guide (2).
6. Install the ignition coil. Refer to **Ignition Coil Replacement** .
7. Close the hood.

## CAMSHAFT POSITION ACTUATOR ADJUSTER REPLACEMENT

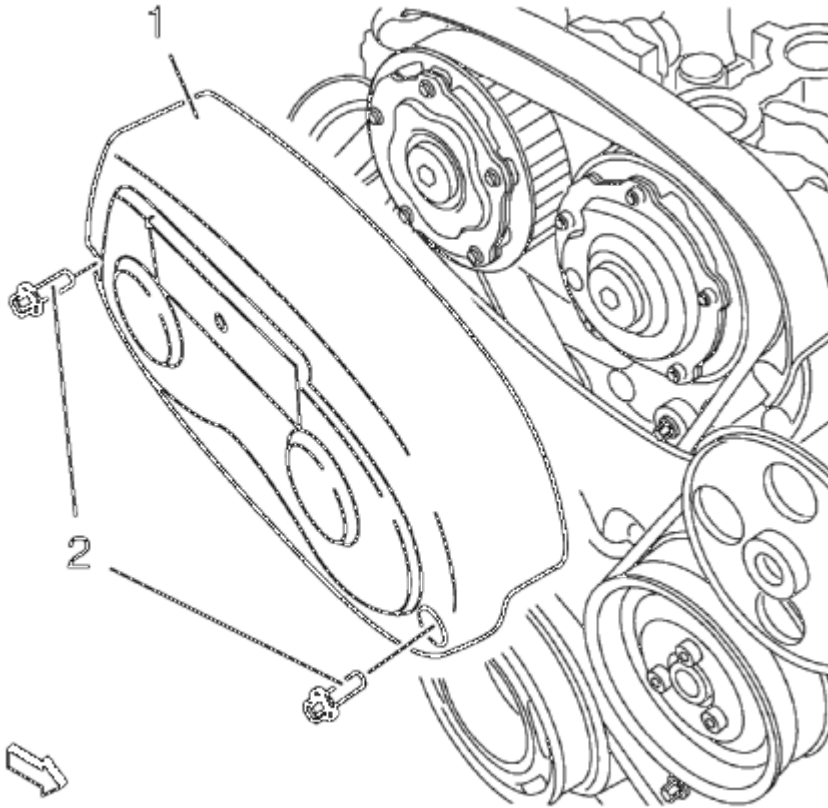
### Special Tools

- **EN-6340** Camshaft Adjuster Locking Tool
- **EN-6333** Timing Belt Tensioner Locking Pin
- **EN-6625** Crankshaft Locking Device
- **EN-6628-A** Camshaft Locking Tool
- **EN-45059** Angle Meter

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

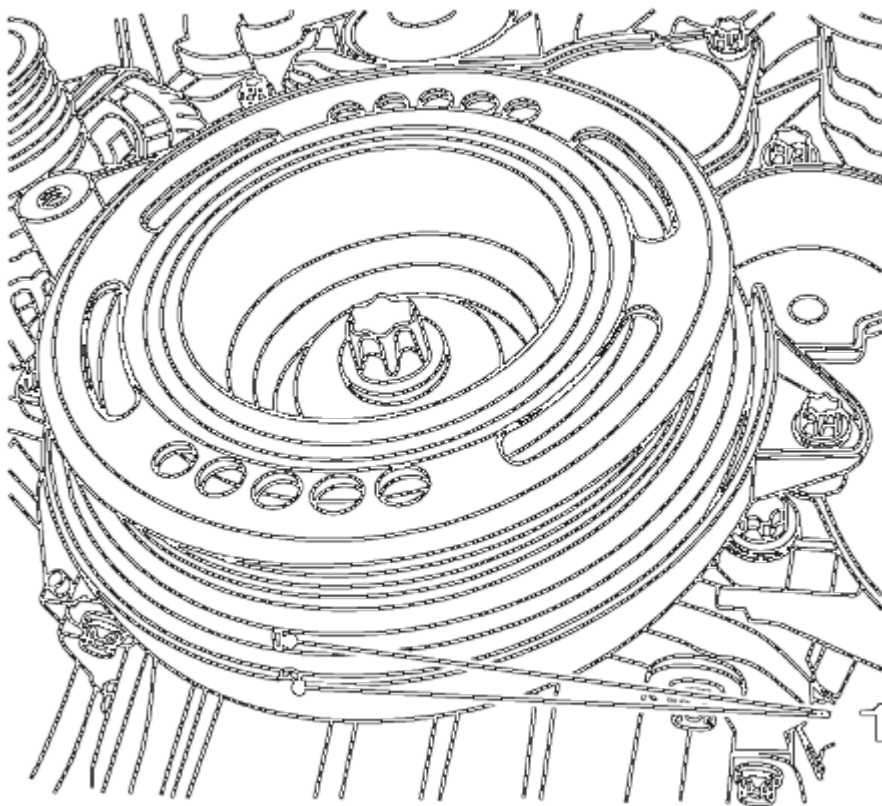
**Removal Procedure**

1. Remove the air cleaner housing. Refer to **Air Cleaner Assembly Replacement**.



**Fig. 257: Timing Belt Upper Front Cover**  
**Courtesy of GENERAL MOTORS COMPANY**

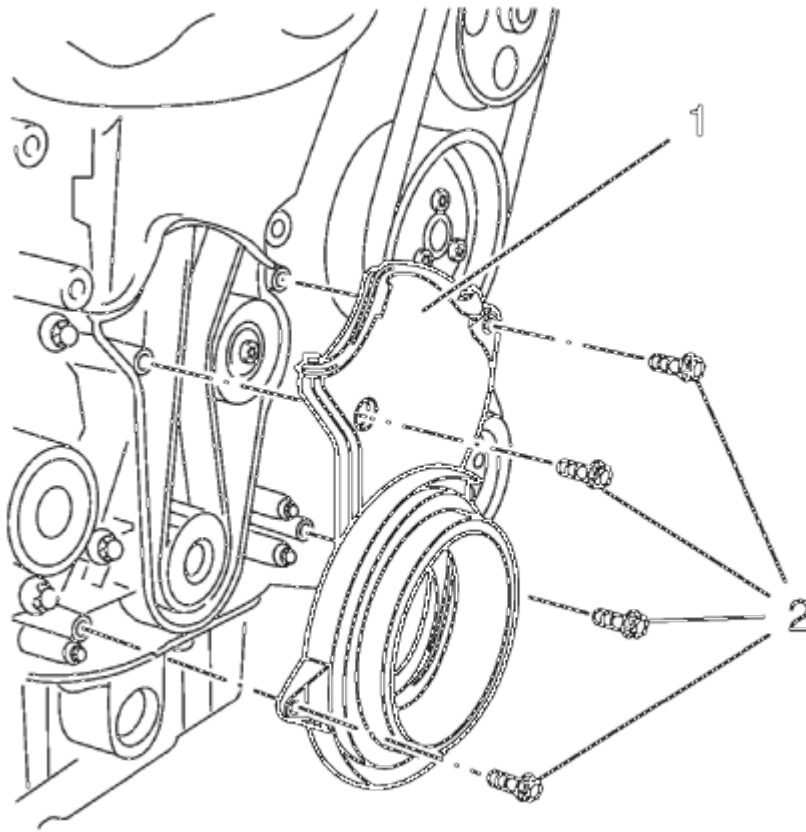
2. Remove the 2 timing belt upper front cover bolts (2).
3. Remove the timing belt upper front cover (1).
4. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
5. Remove the 2 camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Replacement**.
6. Remove the drive belt. Refer to **Drive Belt Replacement**.
7. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.



**Fig. 258: Crankshaft TDC Position**

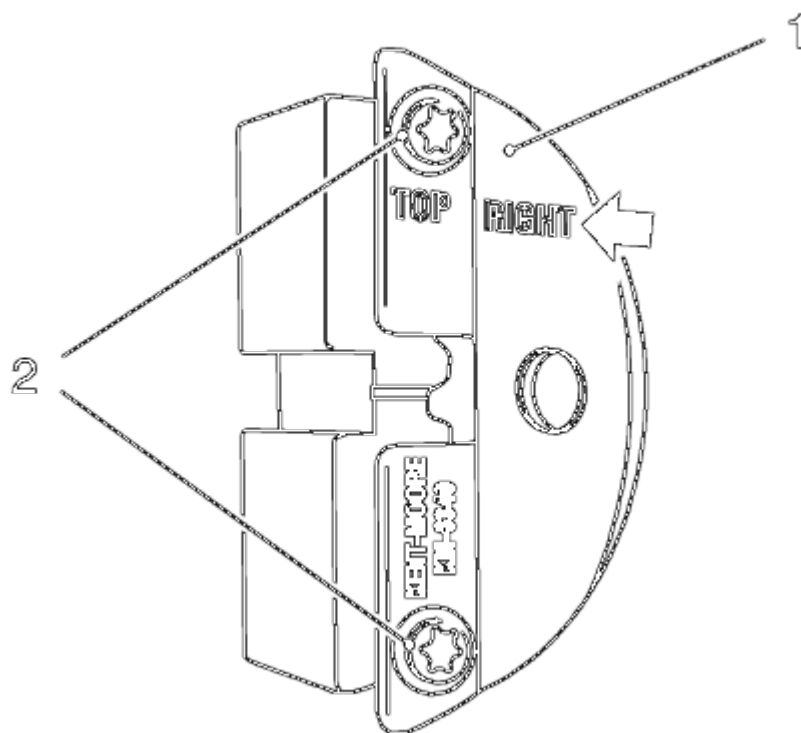
Courtesy of GENERAL MOTORS COMPANY

8. Set the crankshaft balancer in direction of engine rotation until the markings (1) line up with the cylinder 1 at TDC.
9. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.
10. Remove the **EN-6625** locking device.



**Fig. 259: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 4 lower timing belt cover bolts (2).
12. Remove the lower timing belt cover (1).
13. Lower the vehicle.



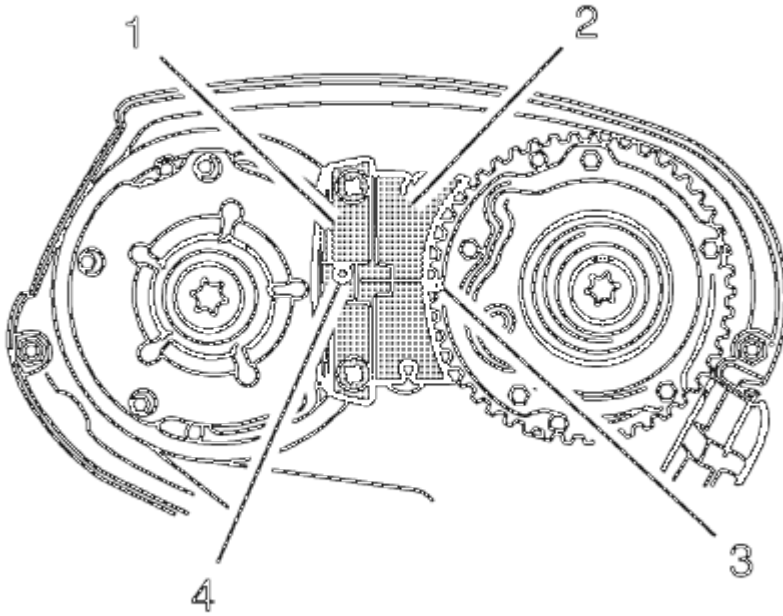
**Fig. 260: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering "right", arrow, on the tool.

14. Prepare the right half of the EN-6340 locking tool.
  1. Remove the 2 bolts (2).
  2. Remove the front panel (1) from the EN-6340 locking tool - right.





**Fig. 261: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

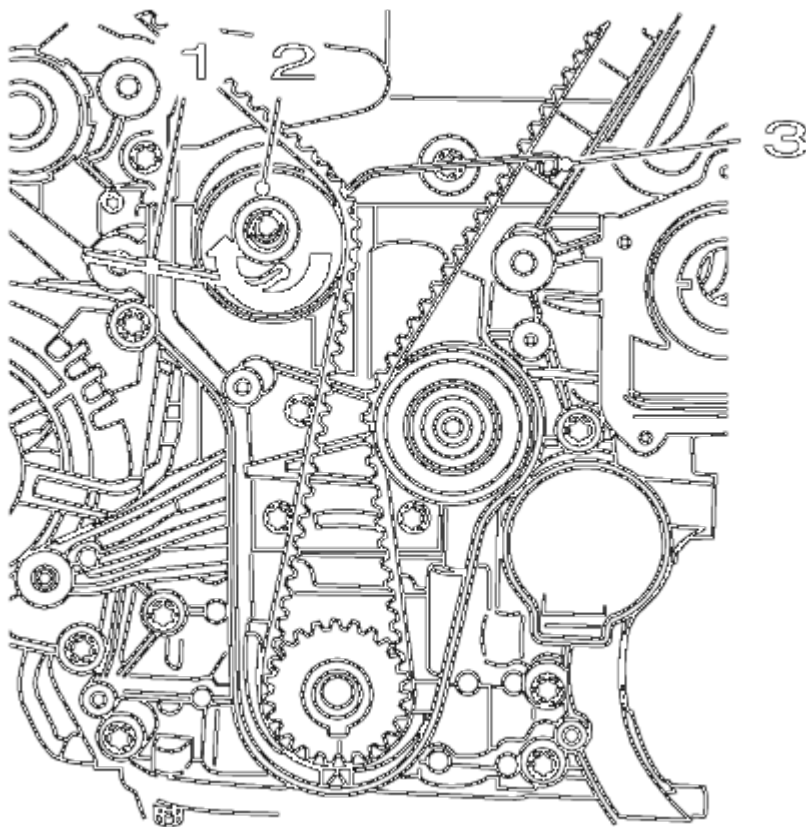
15. Install the **EN-6340** locking tool into the camshaft adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340 locking tool - left during this process but must be somewhat above as shown.

- Install the **EN-6340** locking tool - left (1) into the camshaft adjusters as shown.

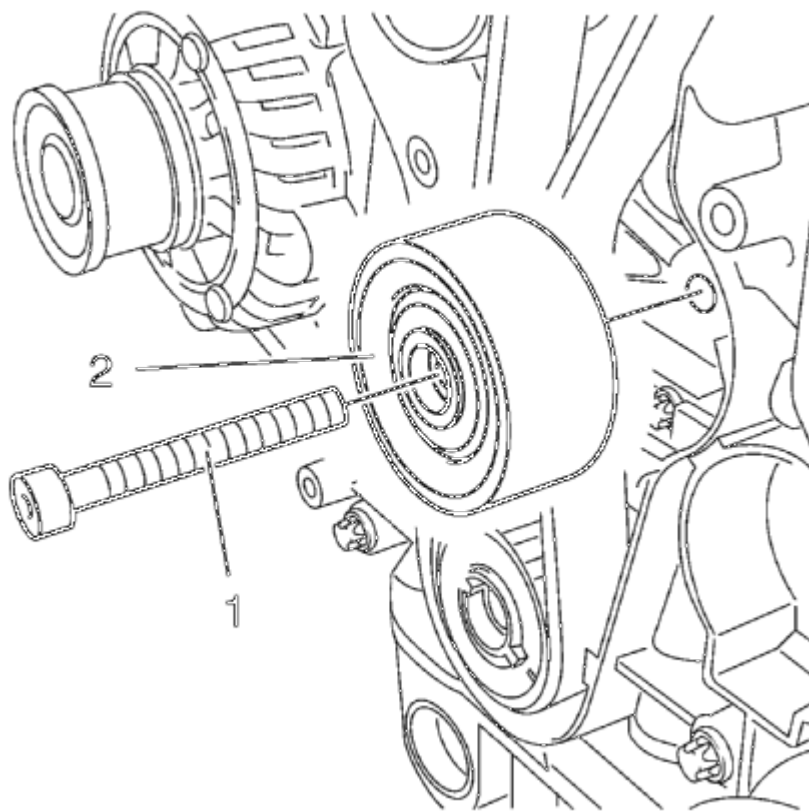
**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right.

- Install **EN-6340** locking tool - right (2) into the camshaft adjusters as shown.



**Fig. 262: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

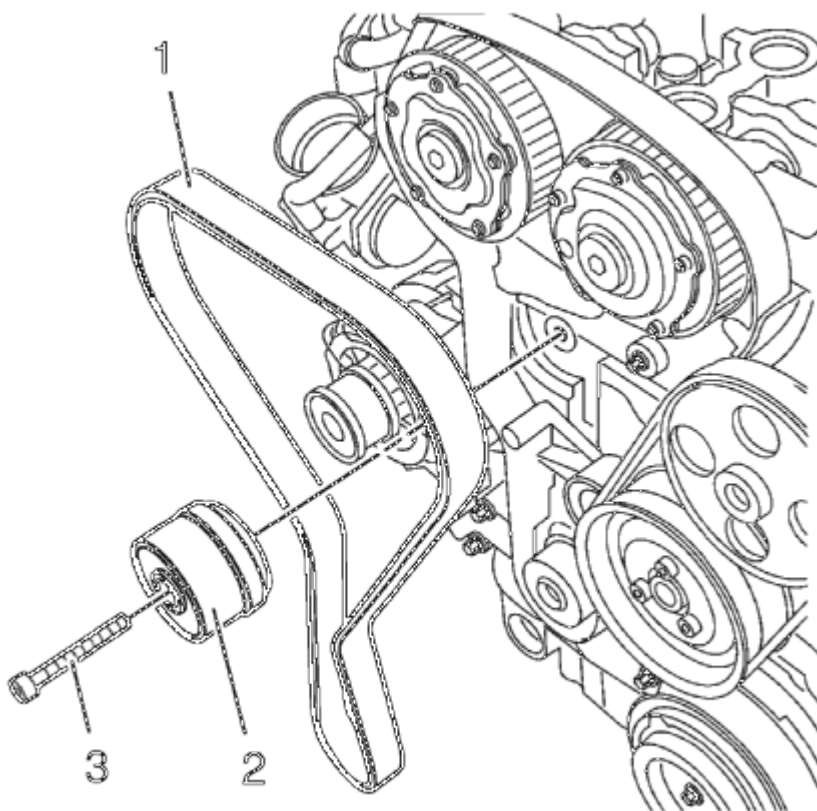
16. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an allen key (1).
17. Install the **EN-6333** pin (3).



**Fig. 263: Timing Belt Idler Pulley Bolt**

**Courtesy of GENERAL MOTORS COMPANY**

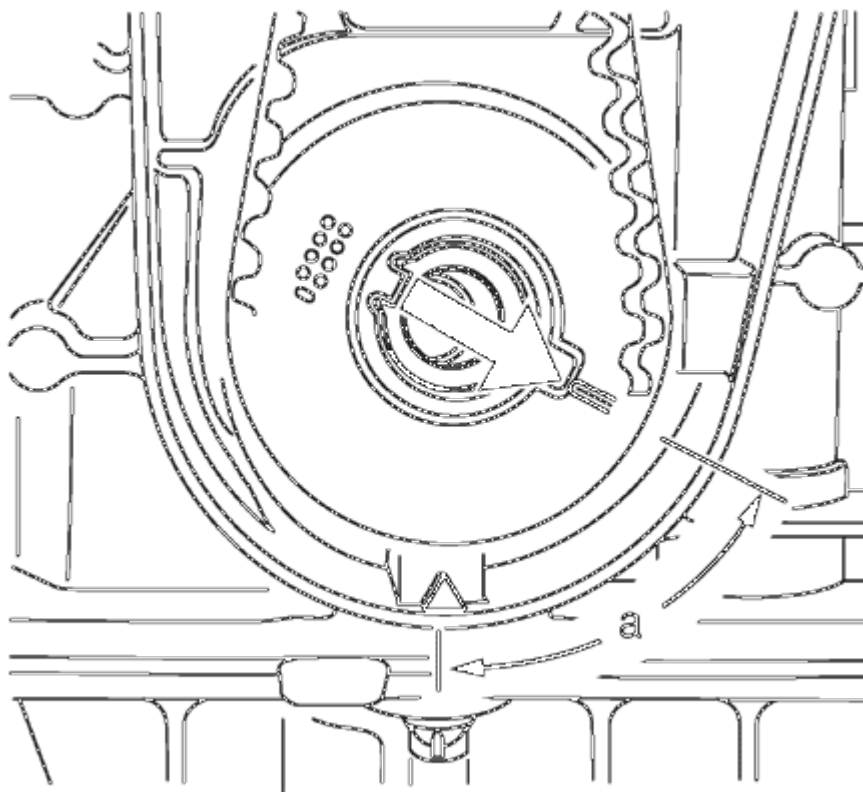
18. Remove and DISCARD the timing belt idler pulley bolt (1).
19. Remove the timing belt idler pulley (2).



**Fig. 264: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

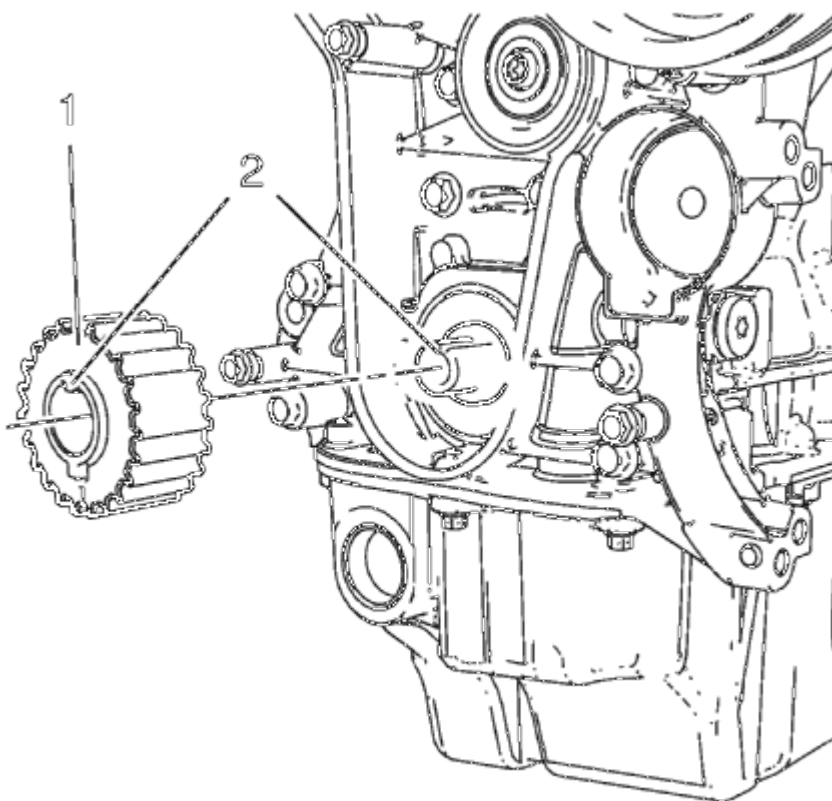
**NOTE:**        **Note the direction of the belt, if the timing belt will be reused.**

20. Remove the timing belt (1).
21. Remove and DISCARD the timing belt tensioner bolt (3).
22. Remove the timing belt tensioner (2).



**Fig. 265: Turning Crankshaft Against Direction Of Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

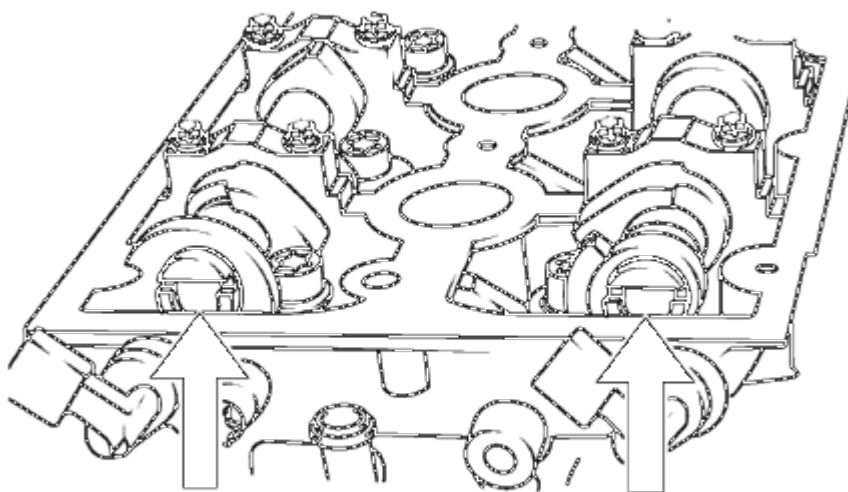
23. Set the crankshaft in direction of engine rotation to 60 degrees (a) before TDC. Use the **EN-45059** meter and the crankshaft balancer bolt.

**Fig. 266: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Some engine oil will run out of the camshaft and the camshaft position actuator adjuster. That is the reason for the removal of the whole timing assembly.

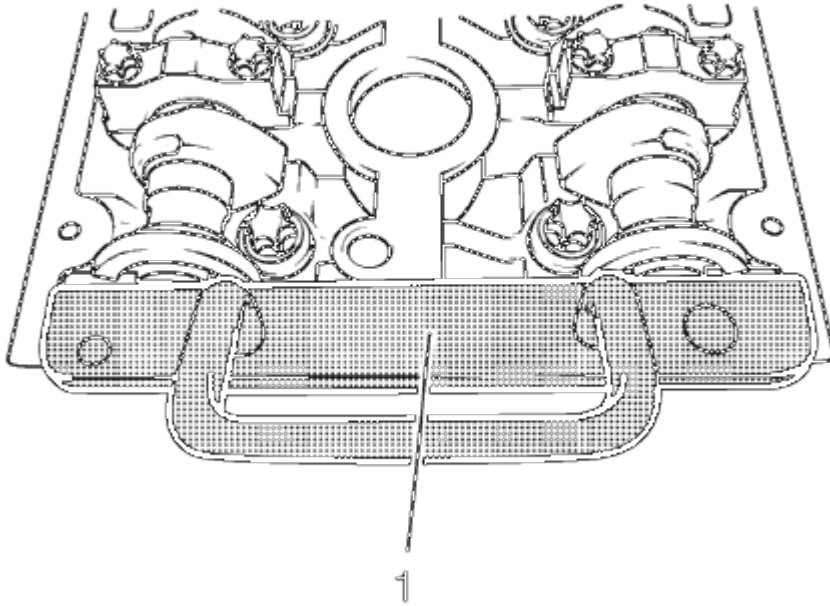
24. Remove the crankshaft sprocket (1).
25. Lower the vehicle.



**Fig. 267: Aligning Camshafts Horizontally**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Note the arrows.**

26. Turn the camshaft by the hexagon until the groove on the end of the camshafts is horizontal.

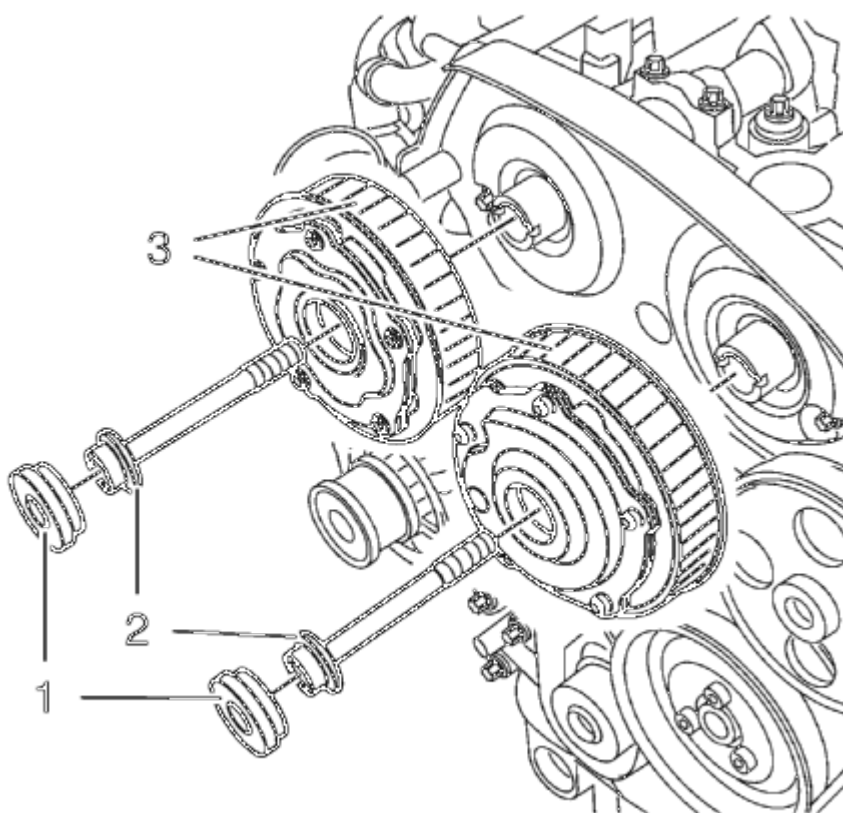


**Fig. 268: Locking Tool**

**Courtesy of GENERAL MOTORS COMPANY**

27. Install the **EN-6628-A** locking tool (1).
28. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
29. Place a collecting basin underneath the vehicle.





**Fig. 269: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

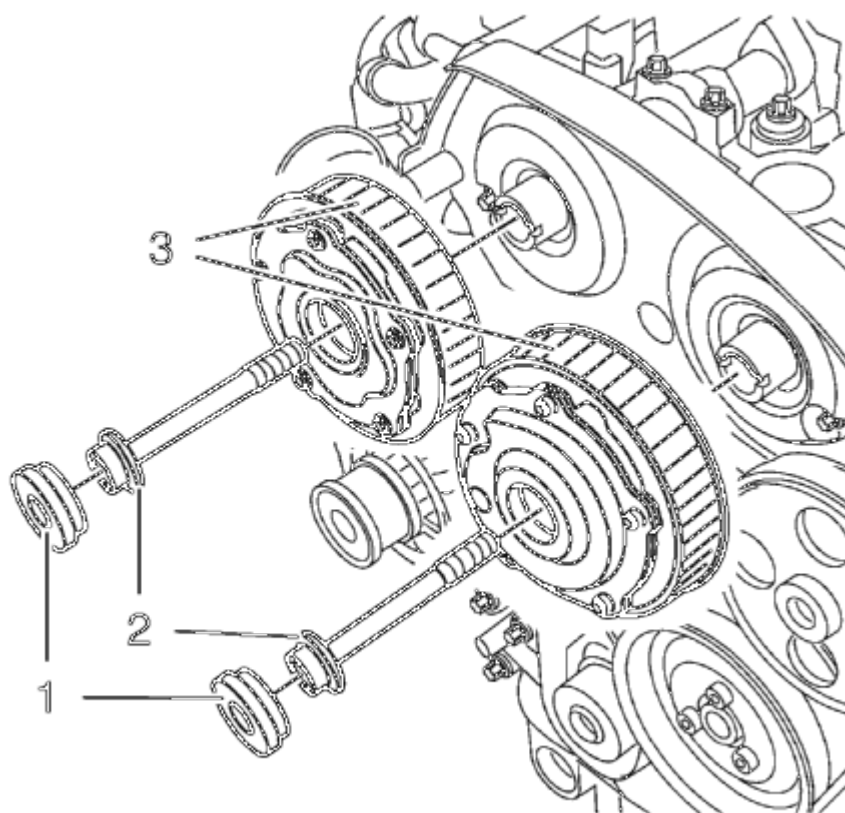
30. Remove the camshaft position actuator adjuster closure bolt (1) of the intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).

**NOTE:** A second technician is required.

**NOTE:** Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The usage of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.

31. Remove and DISCARD the intake camshaft position actuator adjuster bolt and/or the exhaust camshaft position actuator adjuster bolt (2).
32. Remove the intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).

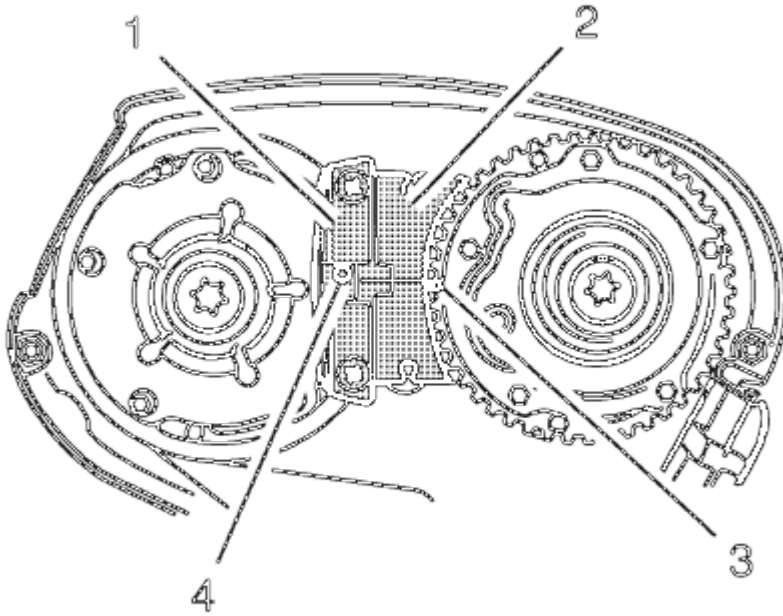
#### Installation Procedure



**Fig. 270: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the cover is contaminated with oil, you have to clean it close.

1. Install intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).
2. Install a NEW intake camshaft position actuator adjuster bolt and/or a NEW exhaust camshaft position actuator adjuster bolt (2). DO NOT tighten the bolts yet.



**Fig. 271: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

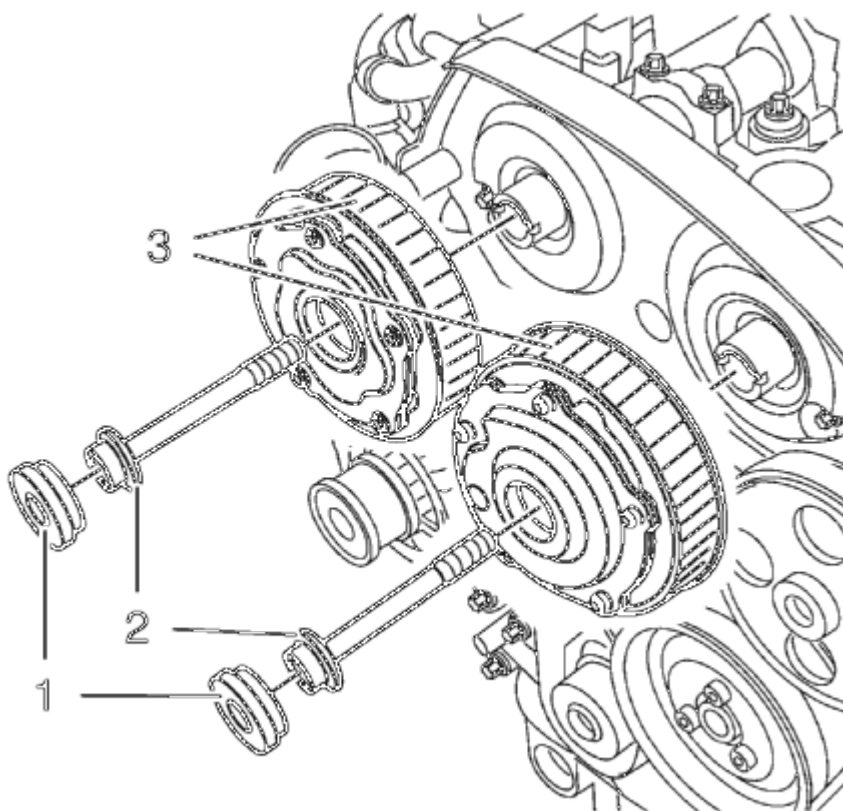
3. Install the **EN-6340** locking tool into the camshaft position actuator adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft position actuator adjuster does not correspond to the groove of EN-6340-left locking tool - left during this process but must be somewhat above as shown.

1. Install the **EN-6340-left** locking tool (1) in the camshaft position actuator adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft position actuator adjuster must correspond to the groove on EN-6340-left locking tool - right.

2. Install the **EN-6340-right** locking tool (2) in the camshaft position actuator adjusters as shown.



**Fig. 272: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

**NOTE:** A second technician is required.

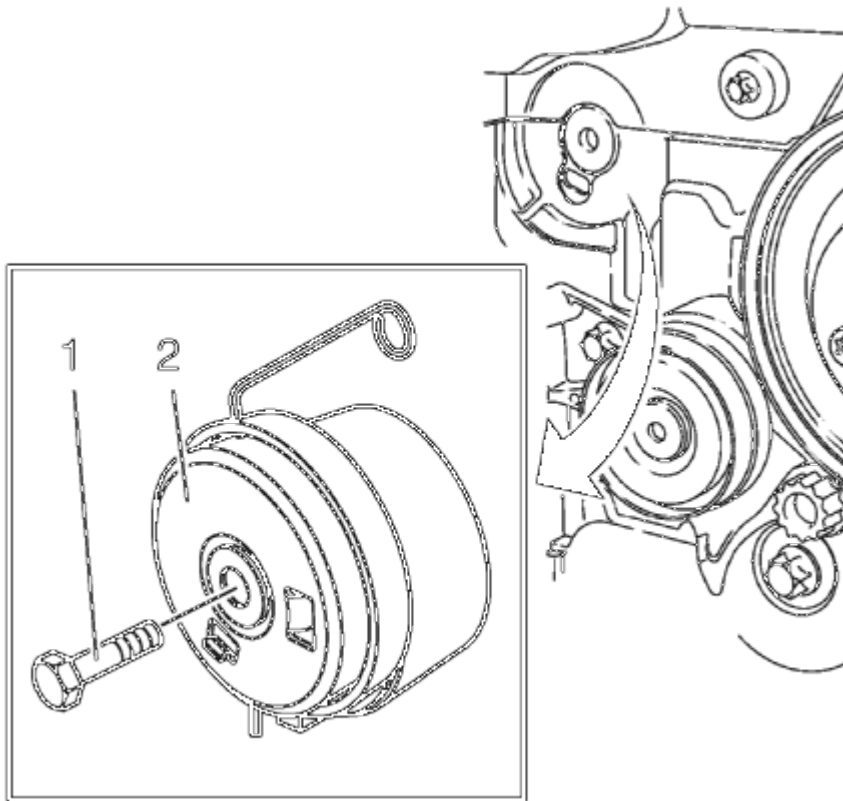
**NOTE:** Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The usage of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.

4. Tighten the camshaft position actuator adjuster bolts (2) in three passes use the **EN-45059** meter :
  1. First pass tighten to 50 N.m (37 lb ft).
  2. Second pass to 150 degrees.

3. Final pass to 15 degrees.

**NOTE:** Check the closure bolt seal ring.

5. Install the 2 camshaft position actuator adjuster closure plugs (1) and tighten to 30 N.m (22 lb ft).
6. Remove the **EN-6628-A** locking tool.
7. Raise the vehicle.

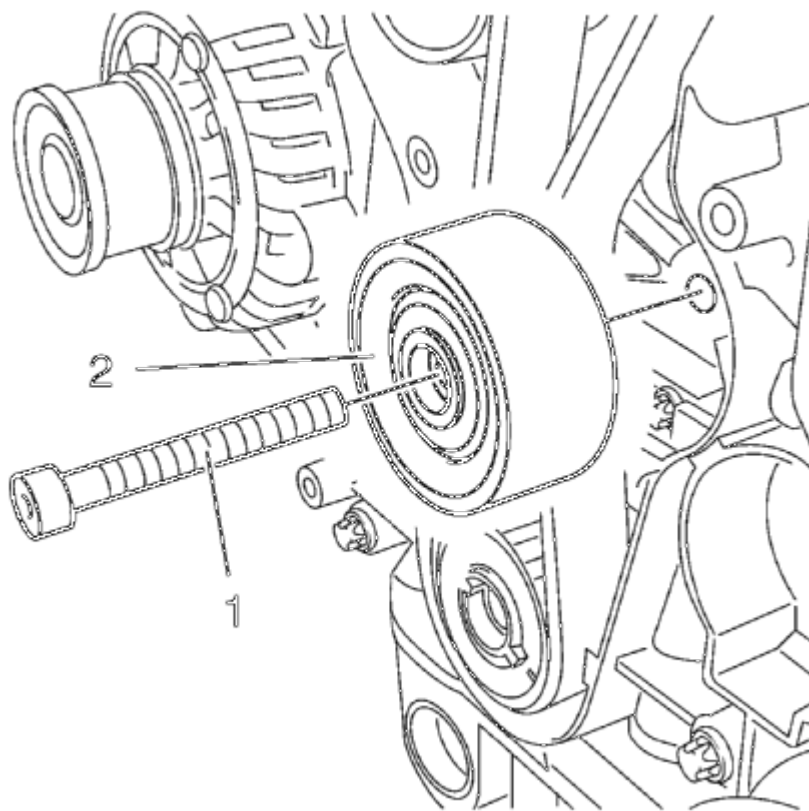


**Fig. 273: Timing Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

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

8. Install the timing belt tensioner (2) and tighten the NEW timing belt tensioner bolt (1) in three passes use the **EN-45059** meter :
  1. First pass tighten to 20 N.m (15 lb ft).
  2. Second pass to 120 degrees.
  3. Final pass to 15 degrees.

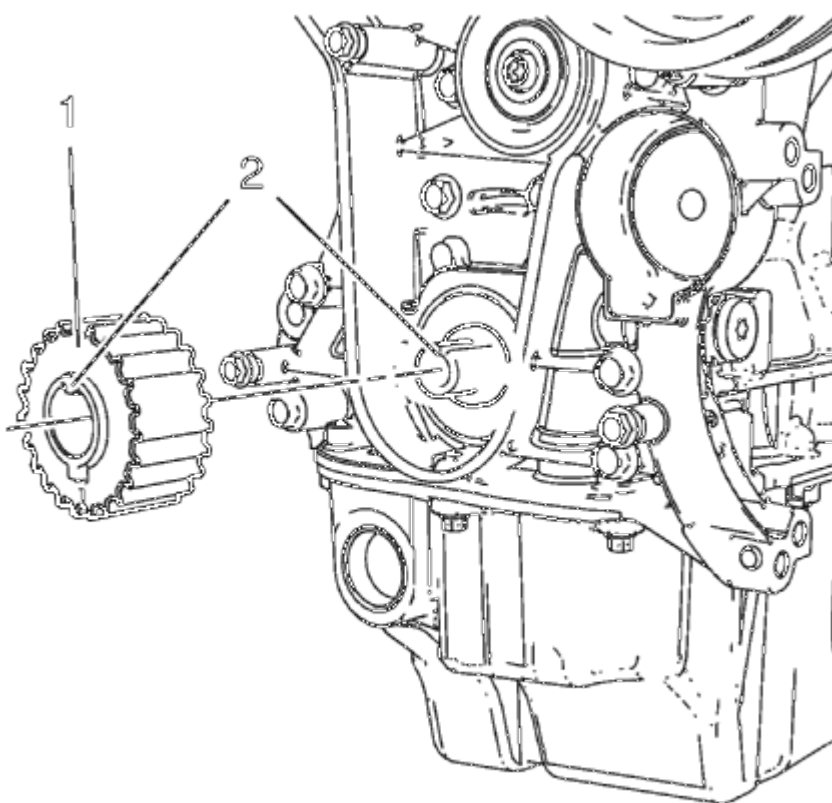


**Fig. 274: Timing Belt Idler Pulley Bolt**

Courtesy of GENERAL MOTORS COMPANY

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

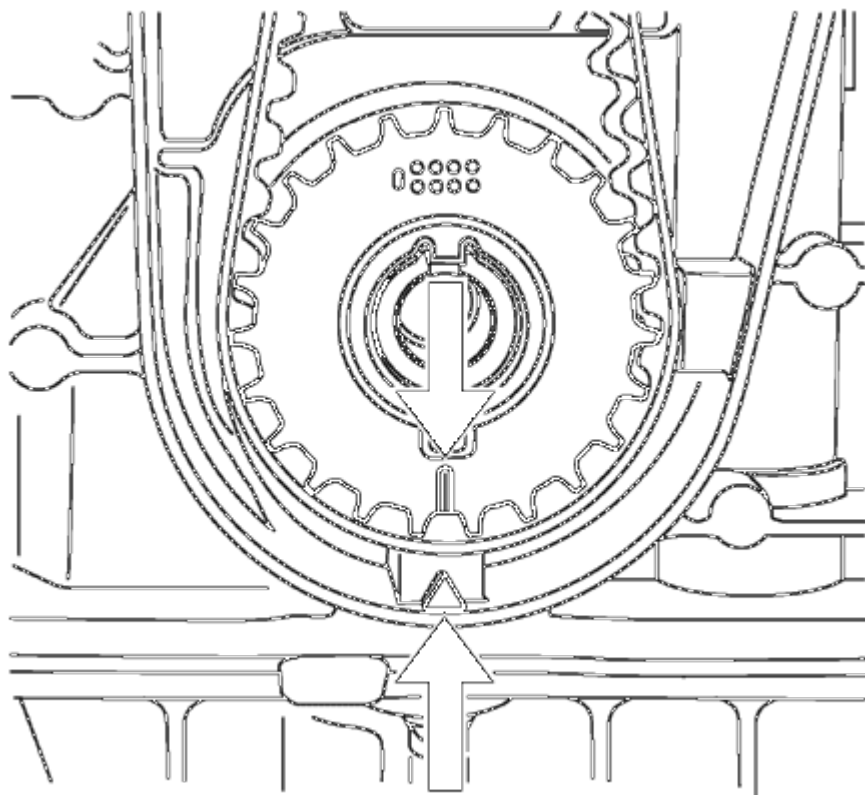
9. Install the timing belt idler pulley (2) and tighten the NEW bolt (1) in three passes use the **EN-45059** meter :
  1. First pass tighten to 20 N.m (15 lb ft).
  2. Second pass to 120 degrees.
  3. Final pass to 15 degrees.

**Fig. 275: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When installing the crankshaft sprocket, the cam and the groove must align (2).

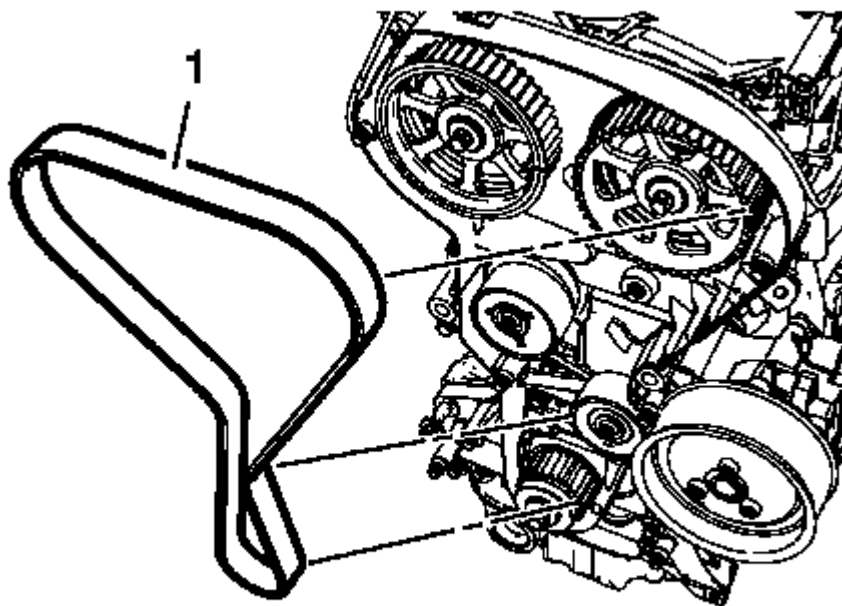
10. Install the crankshaft sprocket (1).



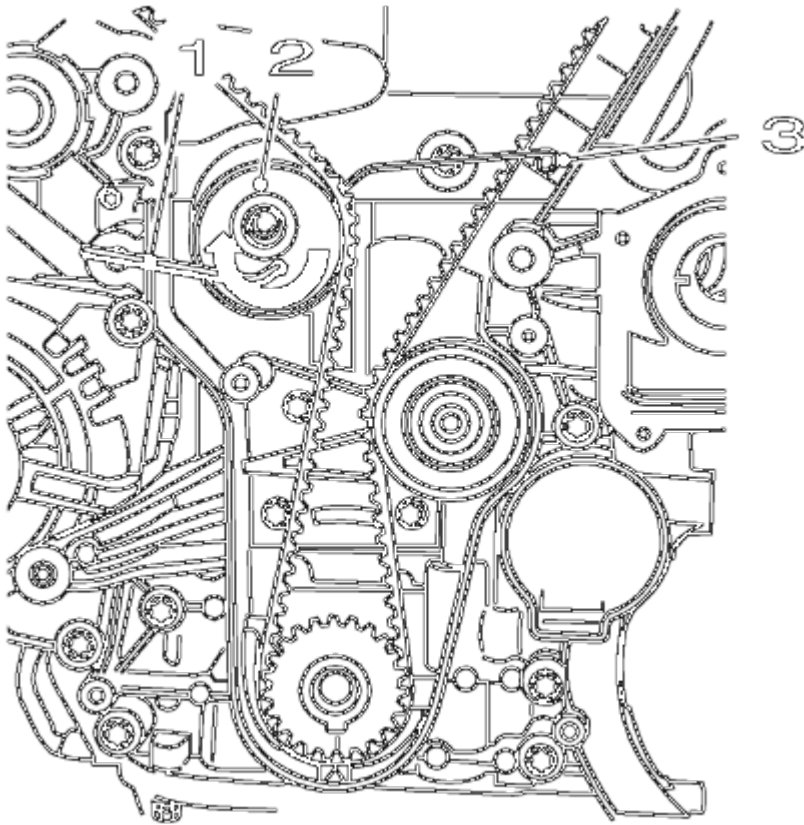
**Fig. 276: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

11. Set the crankshaft in the direction of engine rotation to TDC. Use the crankshaft balancer bolt.



**Fig. 277: Drive Belt Routing****Courtesy of GENERAL MOTORS COMPANY**

12. Install the timing belt (1).
13. Guide the timing belt past the tensioner and place it on the crankshaft sprocket wheel.
14. Place the timing belt on the exhaust and intake camshaft position actuator adjusters.



**Fig. 278: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

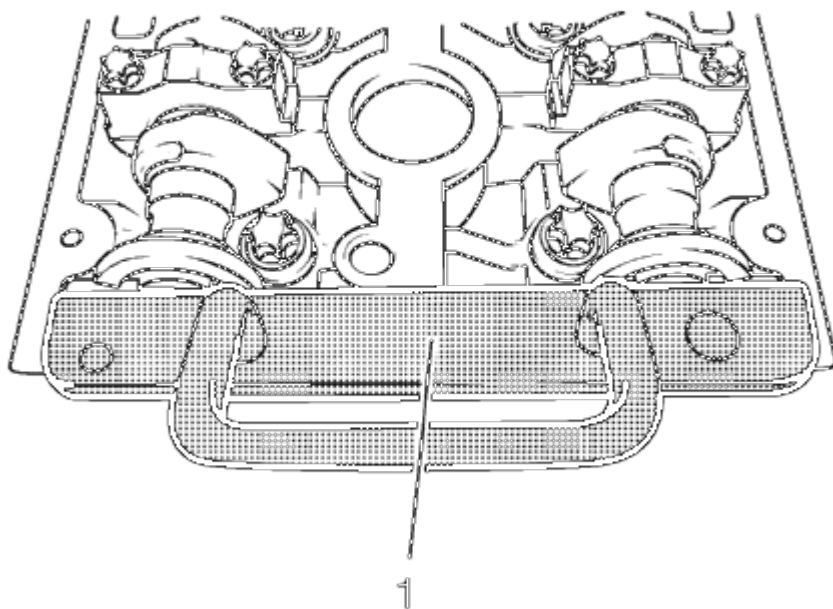
15. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an allen key (1).
16. Remove the **EN-6333** pin (3).

**NOTE:** The timing belt tensioner moves automatically to the correct position.

17. Release tension on timing belt tensioner.
18. Check position of the camshaft and camshaft position actuator adjuster.
  1. Turn crankshaft 720 degrees in the direction of engine rotation by the crankshaft balancer bolt.

**NOTE:** Note marking, camshaft position actuator adjuster.

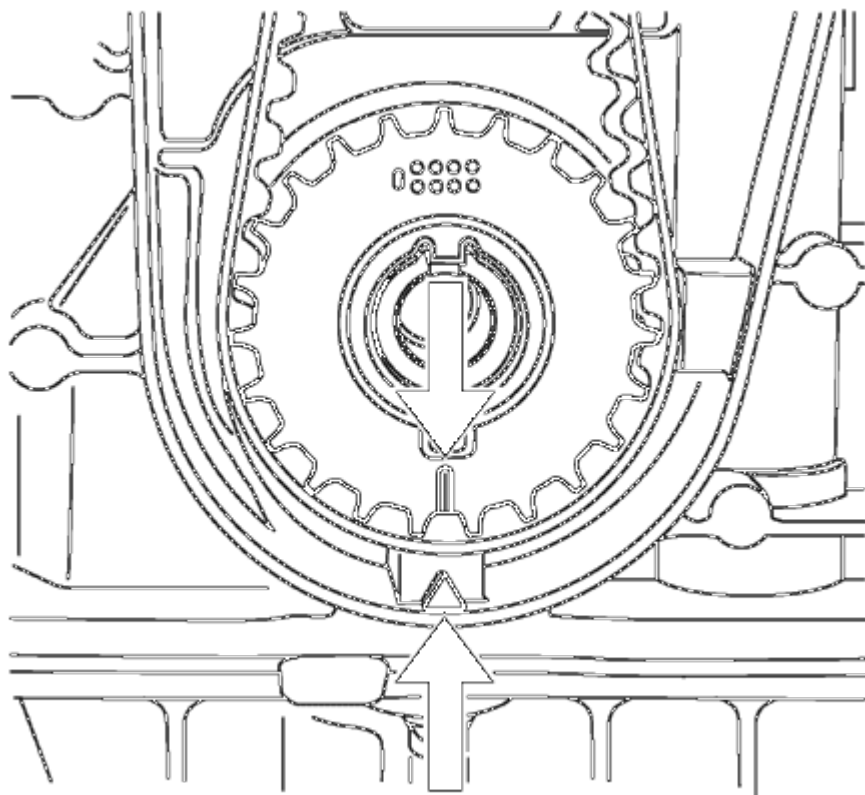
2. Insert **EN-6340** locking tool into camshaft position actuator adjuster.



**Fig. 279: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

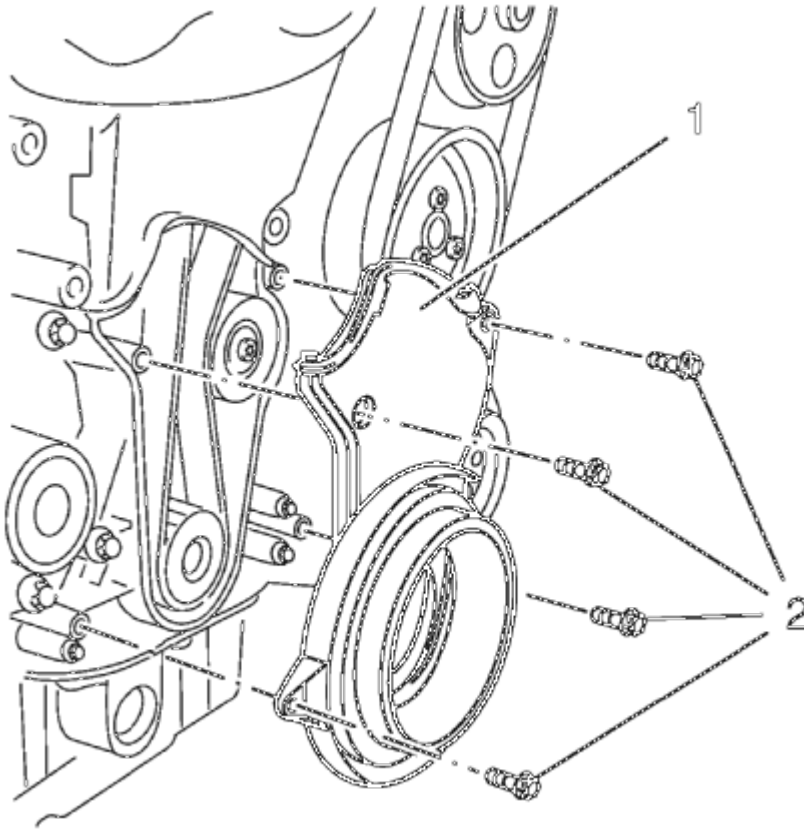
19. Insert the **EN-6628-A** locking tool (1) into the camshafts.
20. Align camshafts by hexagon until **EN-6628-A** locking tool can be inserted in both camshafts.



**Fig. 280: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

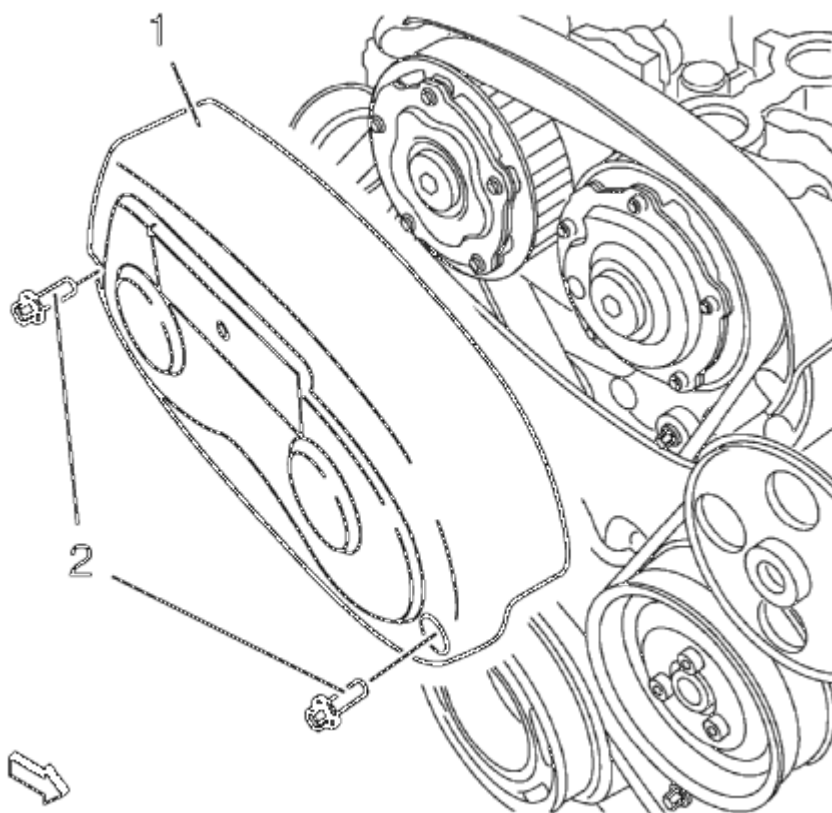
**NOTE:** The crankshaft sprocket and oil pump housing must align.

21. Check the crankshaft position.
22. Remove the **EN-6628-A** locking tool.



**Fig. 281: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

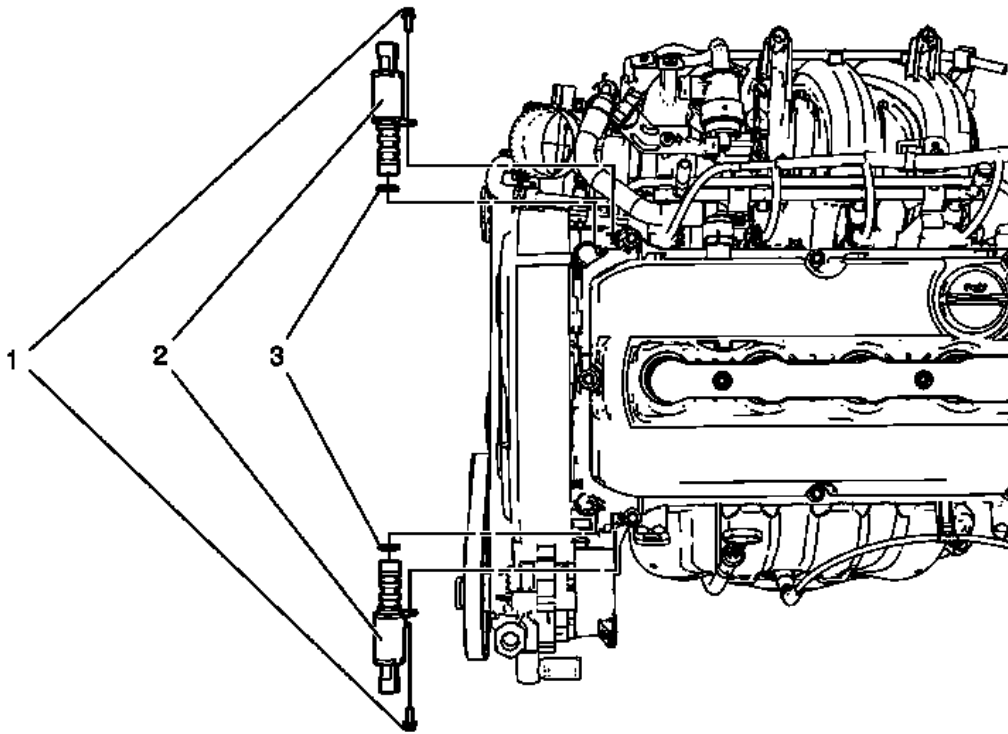
23. Install the lower front timing belt cover (1) and tighten the 4 bolts (2) to 6 N.m (53 lb in).
24. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (Manual Transmission)**, **Crankshaft Balancer Replacement (Automatic Transmission)**.
25. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
26. Install the drive belt. Refer to **Drive Belt Replacement**.
27. Lower the vehicle.
28. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Replacement**.
29. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.



**Fig. 282: Timing Belt Upper Front Cover**  
 Courtesy of GENERAL MOTORS COMPANY

30. Install the timing belt upper front cover (1).
31. Install the 2 timing belt upper front cover bolts (2) and tighten to 6 N.m (53 lb in).
32. Install the air cleaner housing. Refer to **Air Cleaner Assembly Replacement** .

#### **CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT**



**Fig. 283: Camshaft Position Actuator Solenoid Valve**  
 Courtesy of GENERAL MOTORS COMPANY

### Camshaft Position Actuator Solenoid Valve Replacement

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Bolt (Qty: 2)  <b>CAUTION:</b> Refer to <u>Fastener Caution</u> .  <b>Tighten</b> 6 N.m (53 lb in)
2	Camshaft Position Actuator Solenoid Valve (Qty: 2)
3	Camshaft Position Actuator Solenoid Valve Seal (Qty: 2) <b>TIP:</b> Coat the camshaft position actuator solenoid valve seals with NEW engine oil.

## CAMSHAFT REPLACEMENT

### Special Tools

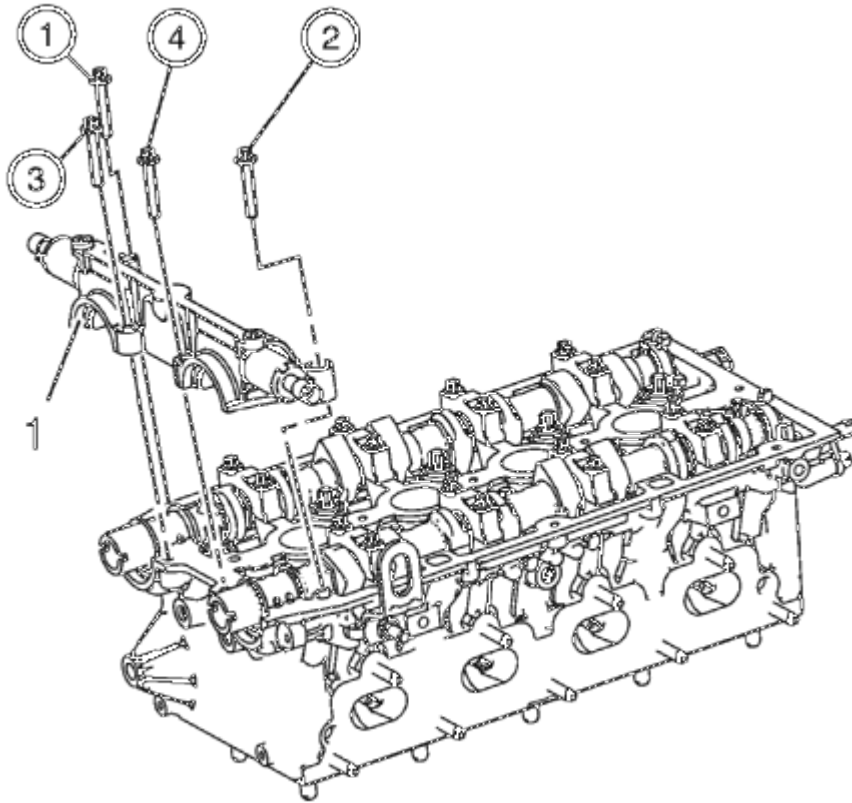
- EN-422 Installer
- EN-6628-A Locking Tool

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

### Removal Procedure

1. Remove the camshaft adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.
2. Remove the rear timing belt cover. Refer to **Timing Belt Rear Cover Replacement**.
3. Remove intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement**.
4. Remove exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement**.
5. Remove **EN-6628-A** locking tool.

Counterhold at hexagon of camshaft.



**Fig. 284: Camshaft Bearing Cap And Camshaft Bearing Cap Bolts Removal Sequence**  
Courtesy of GENERAL MOTORS COMPANY

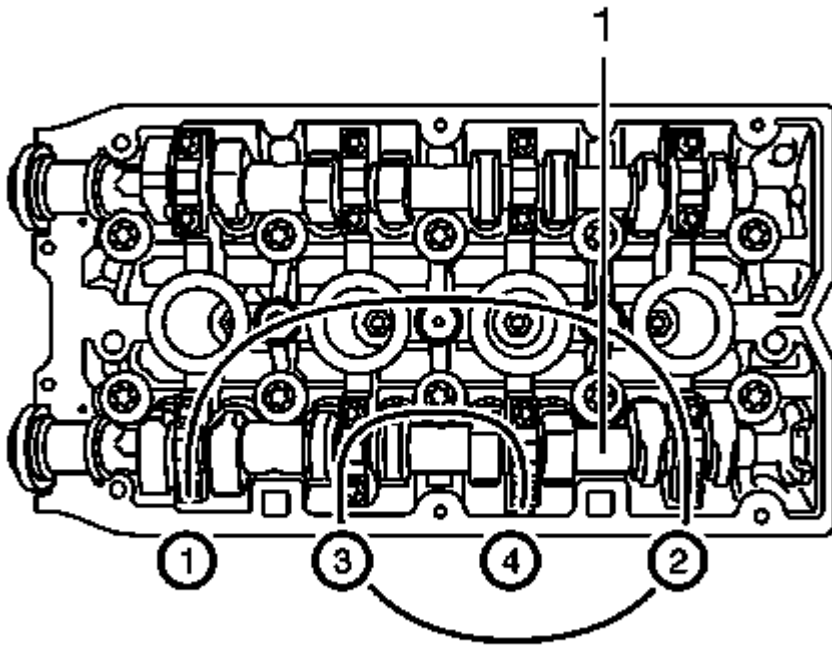
**NOTE:** Note removal sequence 1-4.

6. Remove the 4 camshaft bearing cap bolts.

**NOTE:** Release the bearing support by striking it gently with a plastic hammer.



7. Remove the first camshaft bearing cap (1).

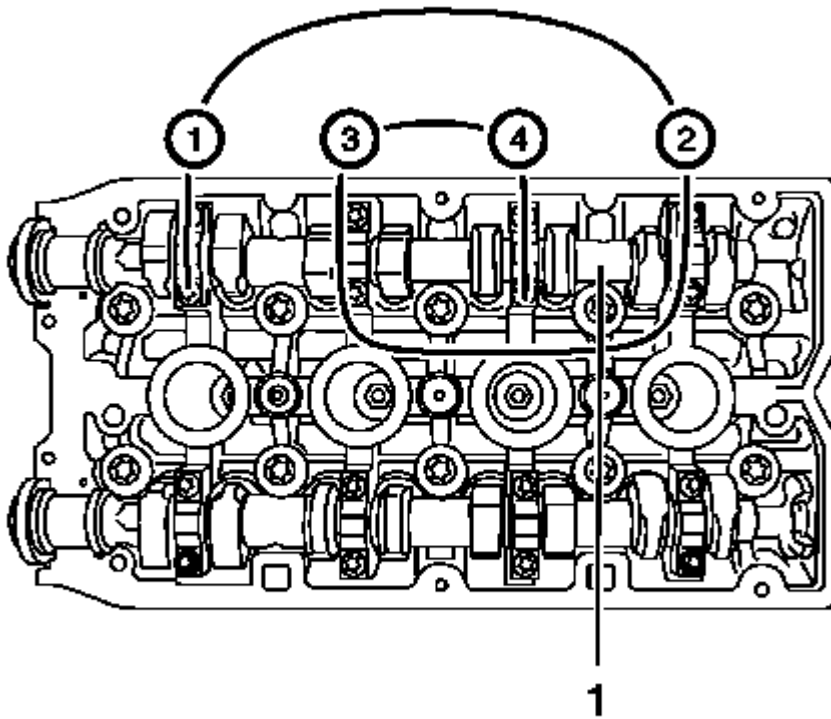


**Fig. 285: Exhaust Camshaft Bearing Cap Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

8. Loosen the 8 exhaust camshaft bearing cap bolts working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
9. Remove the 8 exhaust camshaft bearing cap bolts.

**NOTE:** Mark camshaft bearing caps before removal.

10. Remove the 4 exhaust camshaft bearing caps Numbers 6-9 from the cylinder head.
11. Remove the exhaust camshaft (1).



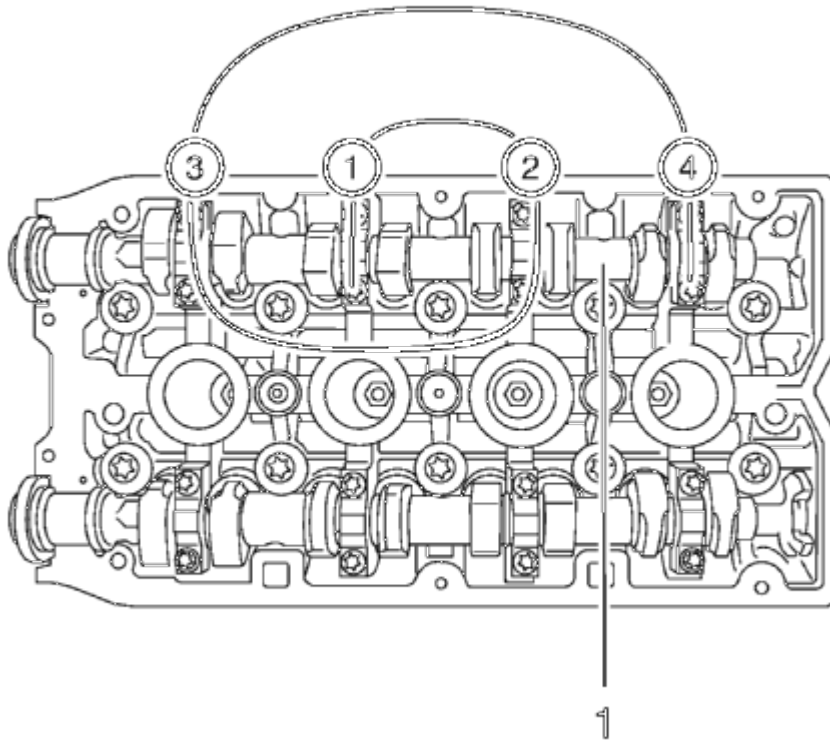
**Fig. 286: Intake Camshaft Bearing Cap Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

12. Loosen the 8 intake camshaft bearing cap bolts working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
13. Remove the 8 intake camshaft bearing cap bolts.

**NOTE:** Mark camshaft bearing caps before removal.

14. Remove the 4 intake camshaft bearing caps Numbers 2-5 from the cylinder head.
15. Remove the intake camshaft (1).
16. Detach the seal rings from the camshafts.

#### Installation Procedure



**Fig. 287: Intake Camshaft Bearing Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate with clean engine oil.

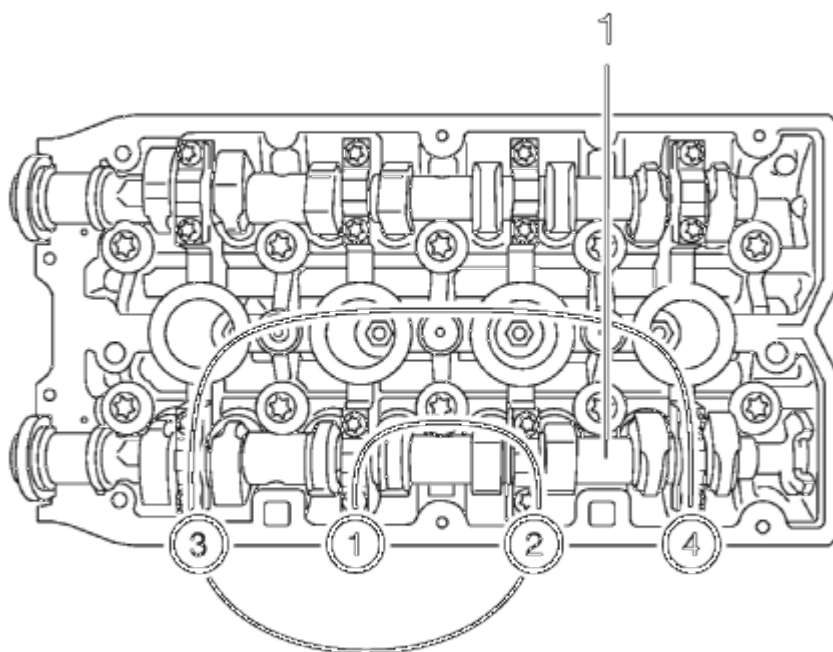
1. Install the intake camshaft (1).

**NOTE:** Note the identification marking on the camshaft bearing cover.

2. Install the 4 intake camshaft bearing cover Numbers 2-5.

**CAUTION:** Refer to Fastener Caution .

3. Install the 8 intake camshaft bearing cover bolts and tighten in a spiral from the inside to the outside to 8 N.m (71 lb in).



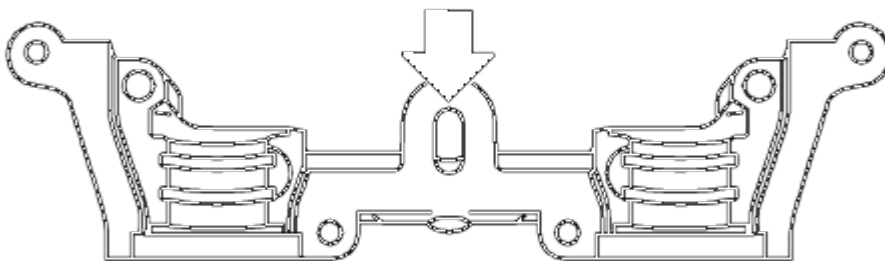
**Fig. 288: Exhaust Camshaft Bearing Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate with clean engine oil.

4. Install the exhaust camshaft (1).

**NOTE:** Note the identification marking on the camshaft bearing cover.

5. Install the 4 exhaust camshaft bearing cover Numbers 6-9.
6. Install the 8 exhaust camshaft bearing cover bolts and tighten in a spiral from the inside to the outside to 8 N.m (71 lb in).



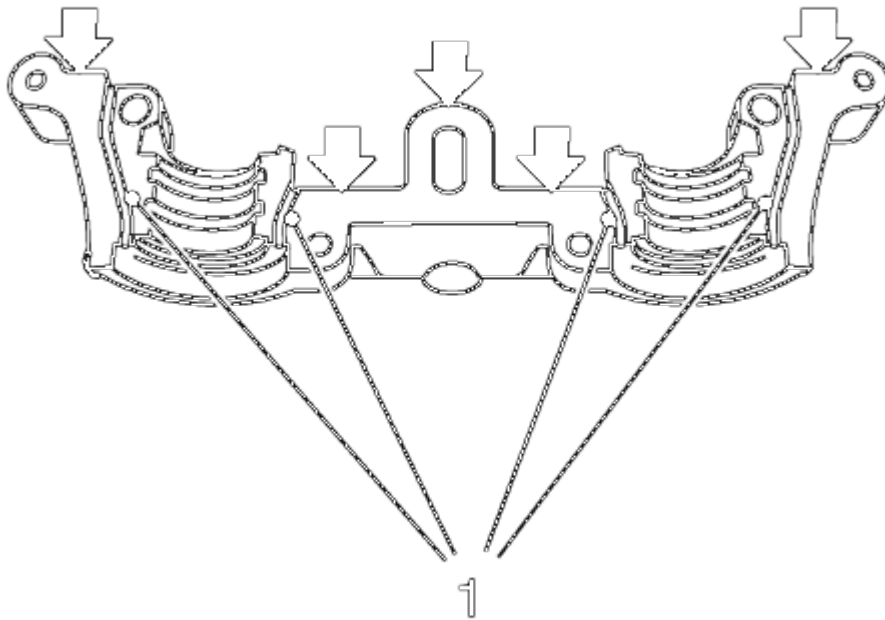
**Fig. 289: Oil Duct**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Sealing surfaces must be free from oil and grease.**

7. Clean sealing surfaces of the first camshaft bearing support and the cylinder head with a suitable tool.

Clean oil duct from any sealant residue.

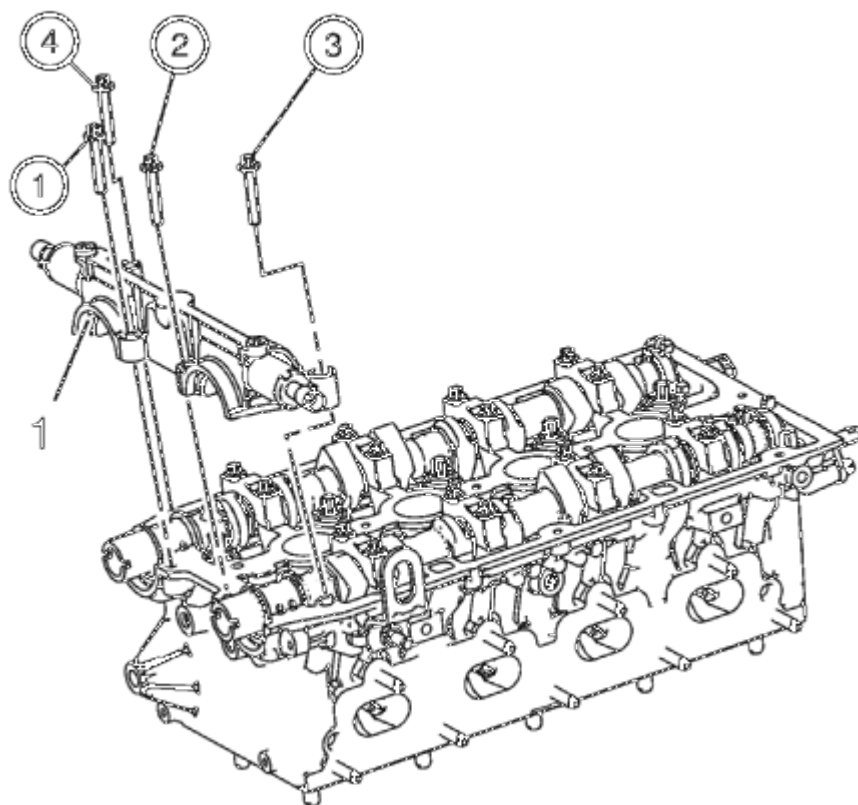
**Fig. 290: Sealing Surfaces And Grooves**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- Sealing surfaces must be free from oil and grease.
- It is essential to ensure that no sealant is applied outside the marked sealing areas.
- The grooves adjacent to the sealing surfaces must remain free from sealant.

8. Apply surface sealant to sealing surfaces (1) of the first camshaft bearing cap thinly and evenly.
9. Position the first camshaft bearing cap on the cylinder block and tighten the bolts approximately to 2 N.m (18 lb in).



**Fig. 291: Camshaft Bearing Cap**

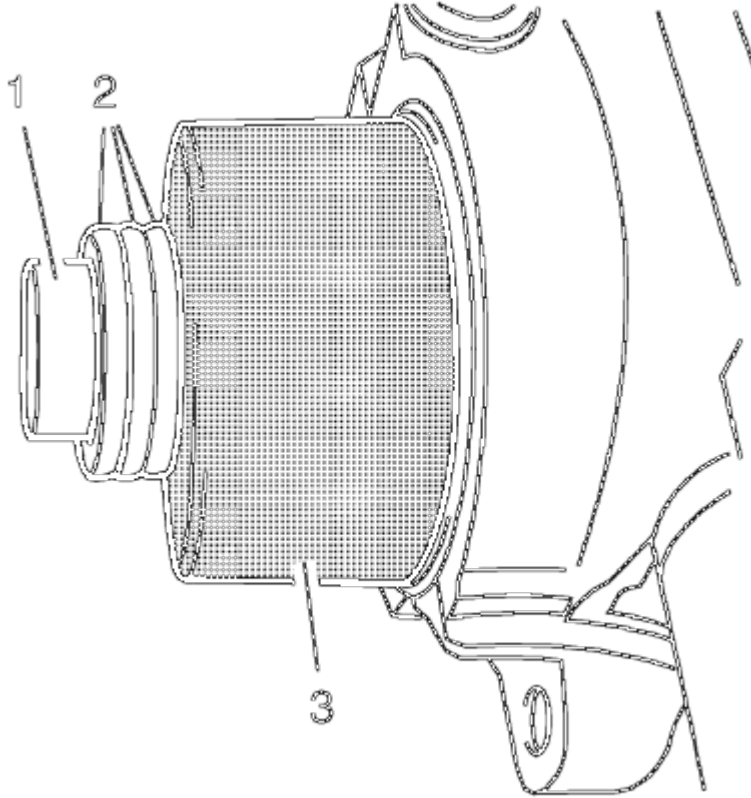
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** No sealant may reach the camshafts.

10. Install the first camshaft bearing cap (1).

**NOTE:** Note installation sequence 1-4.

11. Install the first camshaft bearing cap bolts and tighten to 8 N.m (71 lb in).



**Fig. 292: Camshaft Sprocket Bolt, Shims And Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

12. Install 2 NEW sealing rings to the camshafts.
13. Tighten the seal ring with **EN-422** installer (3) on the camshaft until this is in contact with the cylinder head.
14. To install, use camshaft sprocket bolt (1) in conjunction with shims (2) with a total thickness of approximately 10 mm (0.394 in).
15. Remove the **EN-422** installer (3).
16. Turn the intake camshaft against the direction of engine rotation.
17. Install **EN-6628-A** locking tool.
18. Turn the exhaust camshaft in the direction of rotation of the engine.
19. Install **EN-6628-A** locking tool.
20. Install exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .
21. Install intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement** .
22. Install the rear timing belt cover. Refer to **Timing Belt Rear Cover Replacement**.
23. Install the camshaft adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.

## VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT



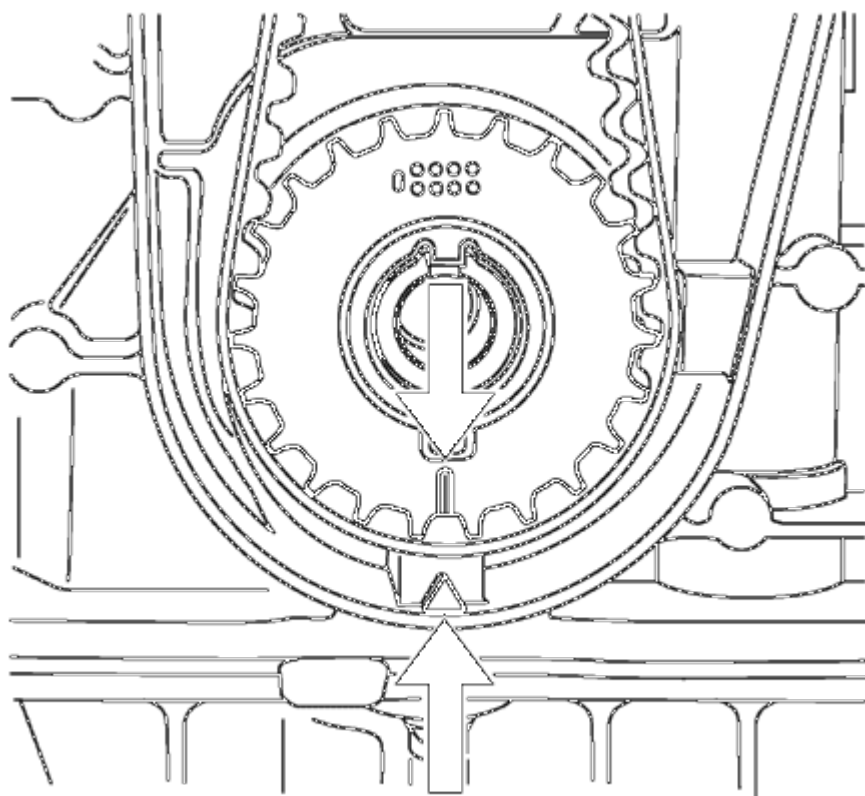
## Special Tools

- **207649** Rod Hairpin Clips
- **547324** Flange Screws
- **EN-840** Pliers / Remover
- **EN-958** Installer
- **EN-45059** Angle Meter
- **EN-50717** Kit
- **J-43649-2** Rods

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

## Removal Procedure

1. Remove the spark plugs. Refer to **Spark Plug Replacement**.
2. Remove the camshaft position actuator adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.
3. Remove both camshafts. Refer to **Camshaft Replacement**.
4. Remove the valve lifter. Refer to **Valve Lifter Replacement**.



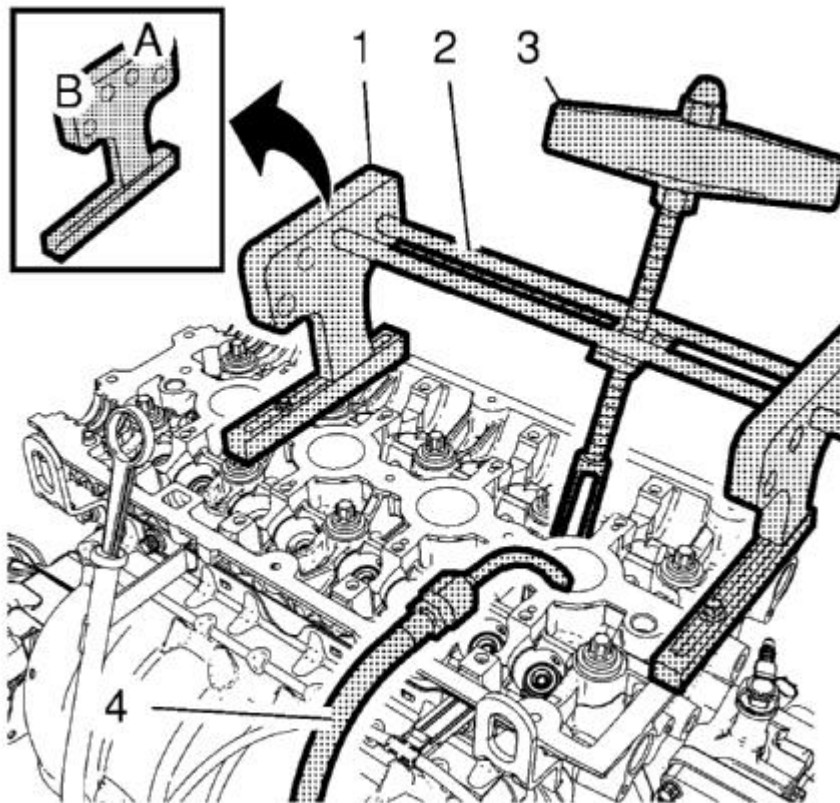
**Fig. 293: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

5. For cylinder 1 and 4 set the crankshaft to TDC marking, cylinder number 1. Use the crankshaft balancer bolt.
6. For cylinder 2 and 3, set the crankshaft BDC (180 degrees from TDC marking). Use the crankshaft balancer bolt.

**NOTE:**        **Wheels must contact the ground.**

7. Shift to 1. gear (MT) or park position (AT) and apply the park brake.

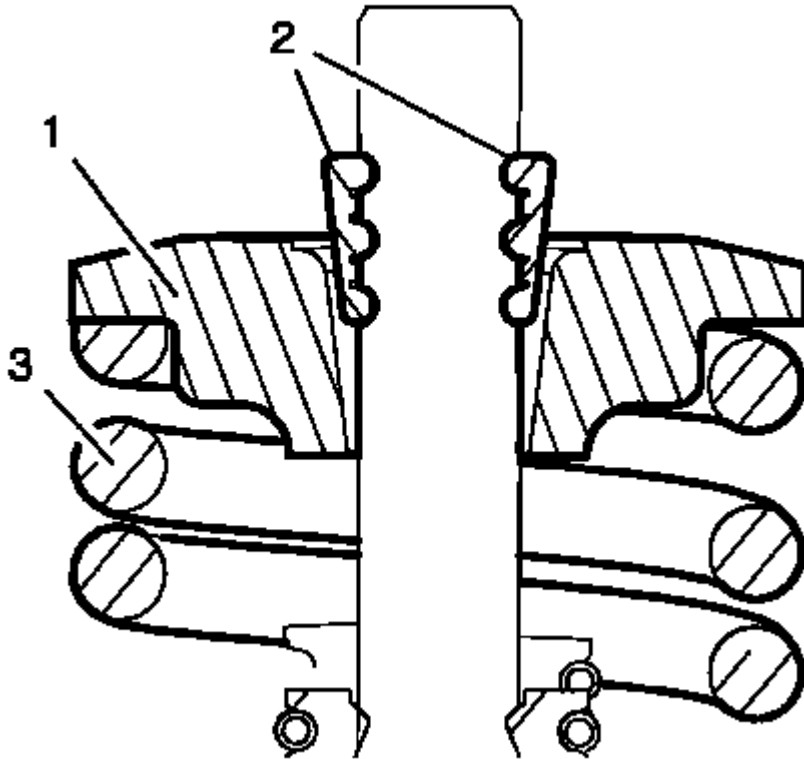
#### Valve Stem Oil Seal Removal



**Fig. 294: Special Tools**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the 2 **EN-50717-1** stands (1) to the cylinder head and fix them with the **547324** screws.
2. Install the 2 **J-43649-2** rods (2) and the **EN-51717-2** compressor (3) to the B-side of the **EN-50717-1** stands. Secure the rods with the **207649** clips then.
3. Install an suitable air pressure adapter (4) to the spark plug hole.

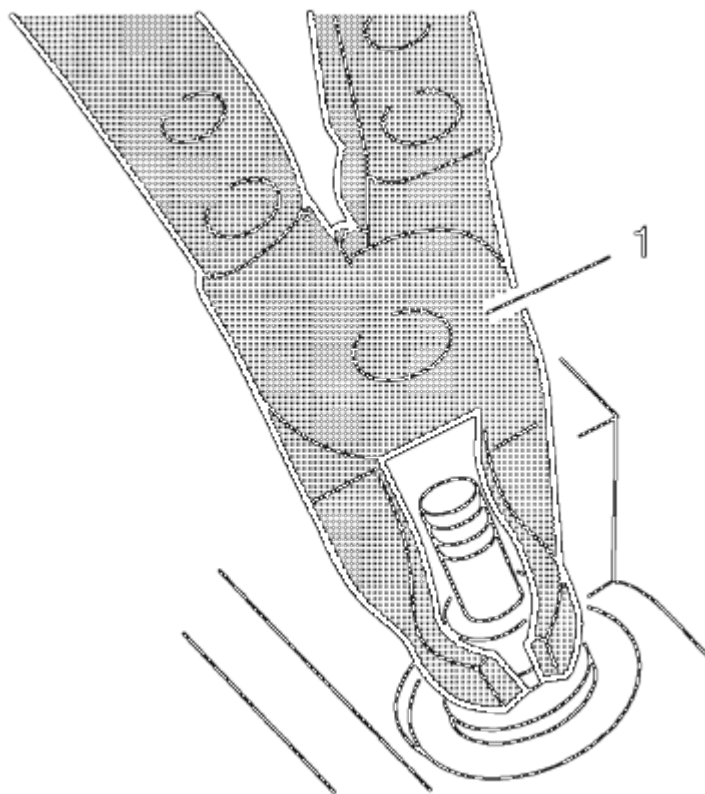
4. Apply air pressure to the corresponding cylinder.
5. Position the **EN-51717-2** compressor (3) so that its adapter proper contacts the valve spring retainer and pretension the compressor.



**Fig. 295: Valve Spring Retainer And Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.

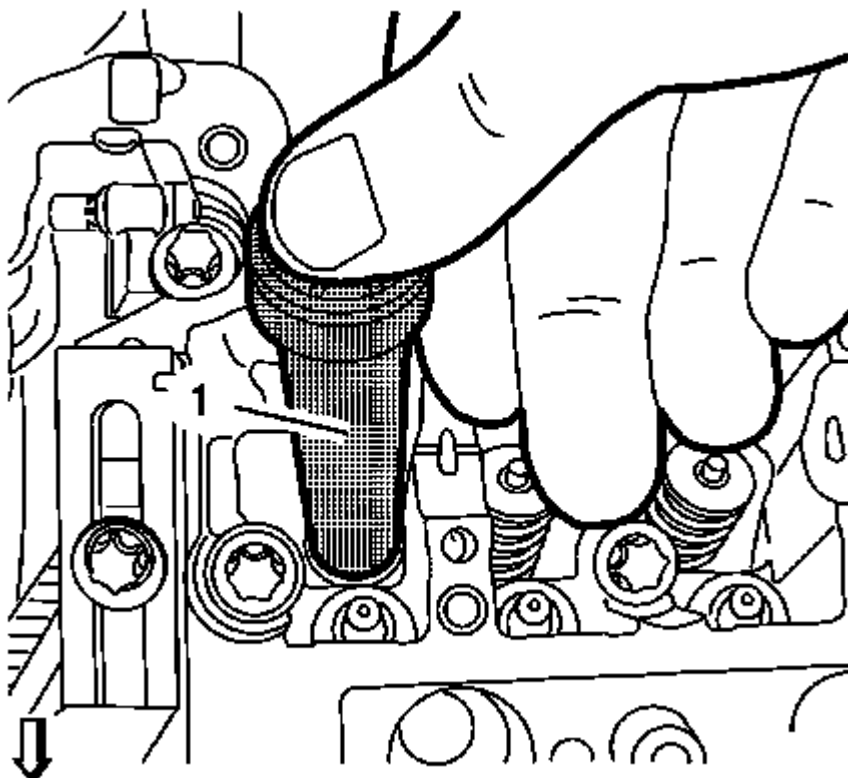
6. Apply pressure to the **EN-50717-2** compressor to push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension. Carefully remove the valve keys then.
7. Release the tension from the **EN-50717-2** compressor.
8. Remove the valve spring retainer (1) and the valve spring (3).



**Fig. 296: Valve Stem Seal Removal Tool**  
Courtesy of GENERAL MOTORS COMPANY

9. Remove and DISCARD the valve stem oil seal, using the **EN-840** pliers (1).

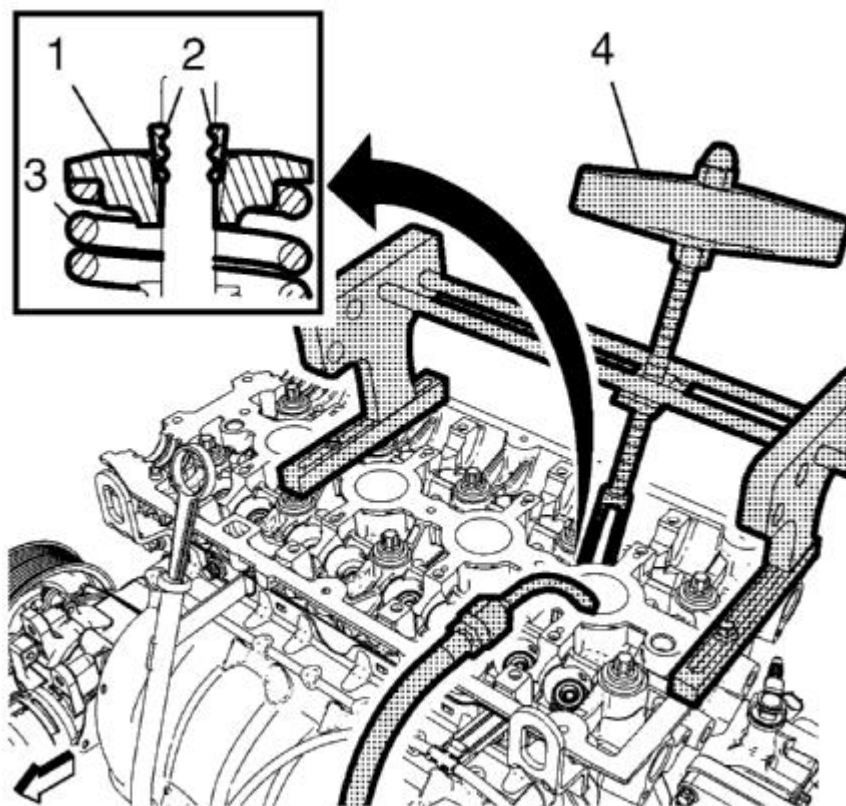
#### Valve Stem Oil Seal Installation



**Fig. 297: Intake Valve Stem Oil Seal Installation Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate the **NEW** valve stem oil seal with clean engine oil.

1. Install the NEW valve stem oil seal, using the **EN-958** installer (1).
2. Loosely install the valve spring and the valve spring retainer.



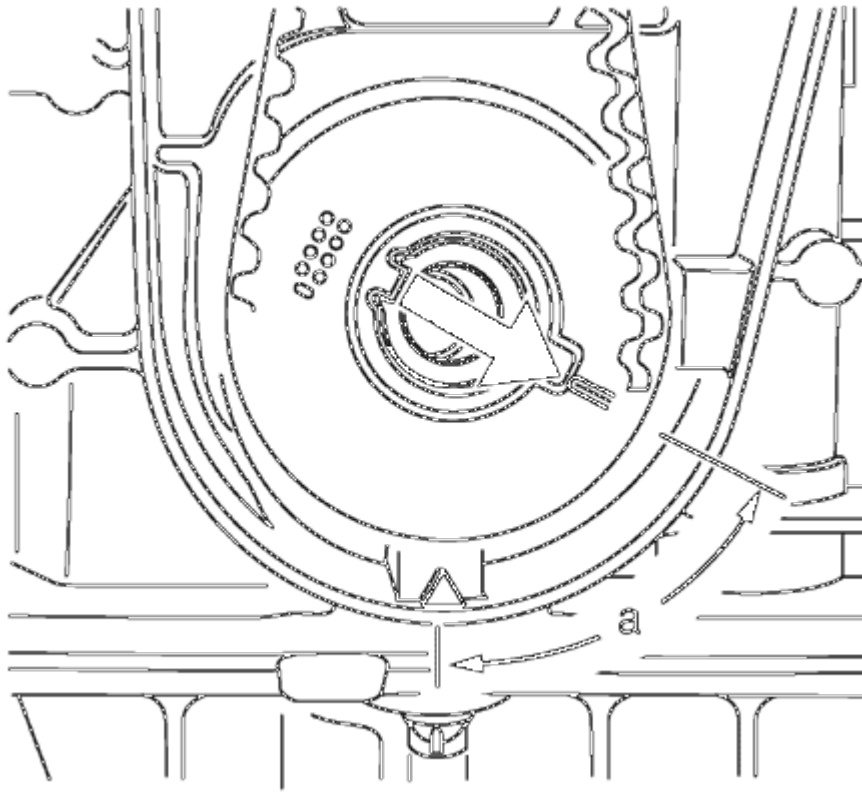
**Fig. 298: Valve Spring Compressor**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** The valve stem keys must correctly seat in the valve spring cap.  
Engine damage may occur by not installing properly.

3. Using the **EN-51717-2** compressor (4), push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) can be inserted. Carefully insert the valve keys then, so that they are properly installed to the valve stem grooves.
4. Carefully release the tension from the **EN-50717-2** compressor.
5. Inspect the valve keys and valve spring retainer for proper seat.
6. Repeat the procedure with the remaining valves and cylinders. Transfer the **EN-50717-1** stands and the **EN-51717-2** compressor as needed.
7. Take care that air pressure is always applied to the combustion chamber of the treated cylinder.

#### Installation Procedure



**Fig. 299: Turning Crankshaft Against Direction Of Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

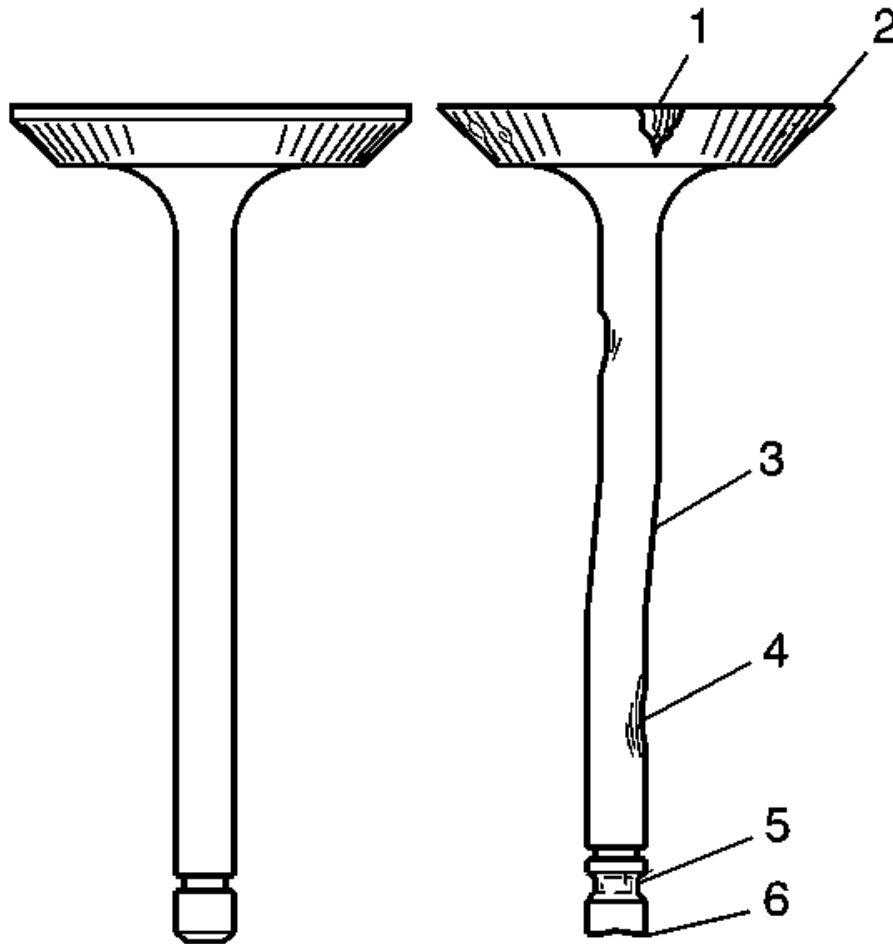
1. Set the crankshaft in direction of engine rotation to 60 degrees (a) before TDC. Use the **EN-45059** meter and the crankshaft balancer bolt.
2. Install the valve lifter. Refer to **Valve Lifter Replacement**.
3. Install both camshafts. Refer to **Camshaft Replacement**.
4. Install the camshaft position actuator adjuster. Refer to **Camshaft Position Actuator Adjuster Replacement**.
5. Install the spark plugs. Refer to **Spark Plug Replacement**.

## VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING

### Valve Cleaning Procedure

1. Use soft bristle wire brush to clean any carbon build-up from the valve head. DO NOT use a wire brush on any part of the valve stem. The valve stem is chrome plated to provide enhanced wear characteristics. Wire brushing the stem could remove the chrome plating.
2. Thoroughly clean the valve with solvent and wipe dry.

### Valve Visual Inspection Procedure



**Fig. 300: Inspection Points For Valve Damage**  
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the valve for damage from the head to tip for the following conditions:
  - Pitting in the valve seat area (1)
  - Lack of valve margin (2)
  - Bending in the valve stem (3)
  - Pitting or excessive wear in the stem (4)
  - Worn valve key grooves (5)
  - Worn valve tip (6)
2. Replace the valve if any of these conditions exist.

#### Valve Measurement and Reconditioning Overview

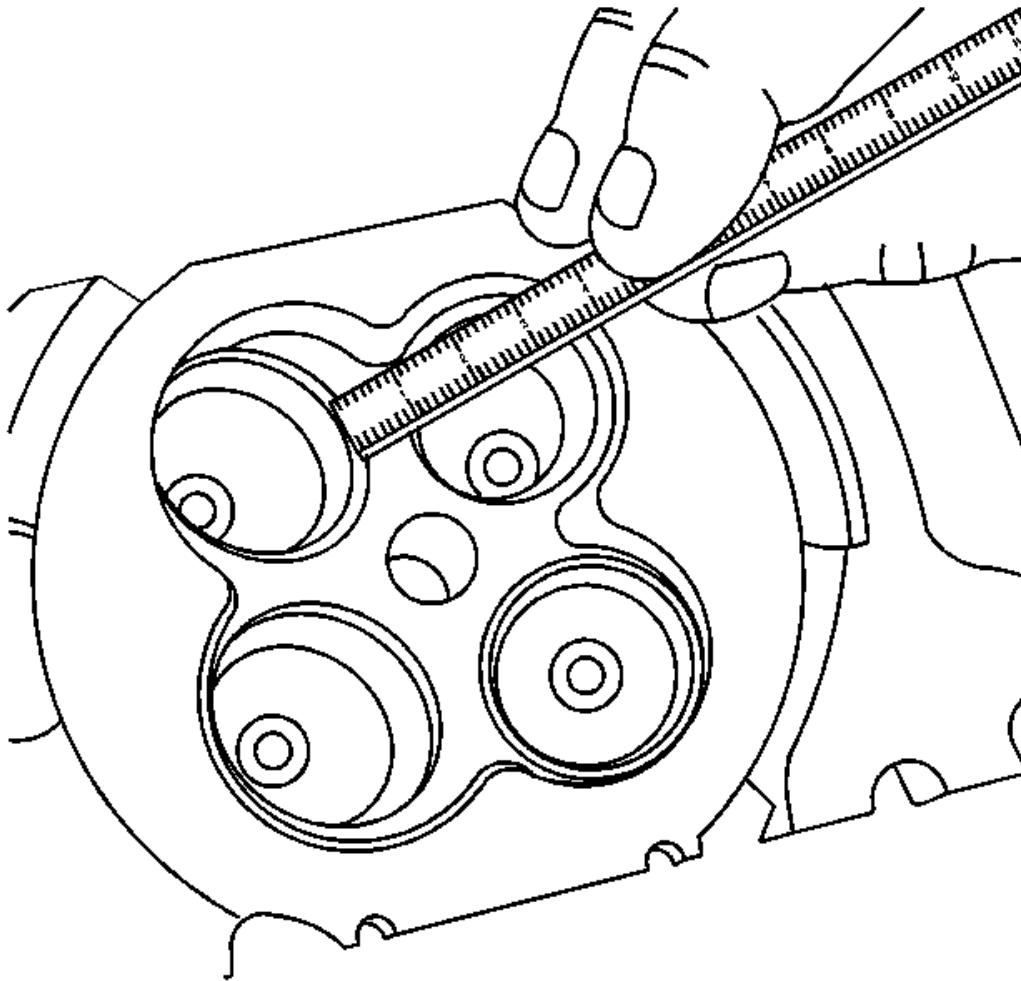
**NOTE:** • Proper valve service is critical to engine performance. Therefore, all



detailed measurement procedures must be followed to identify components that are out of specification.

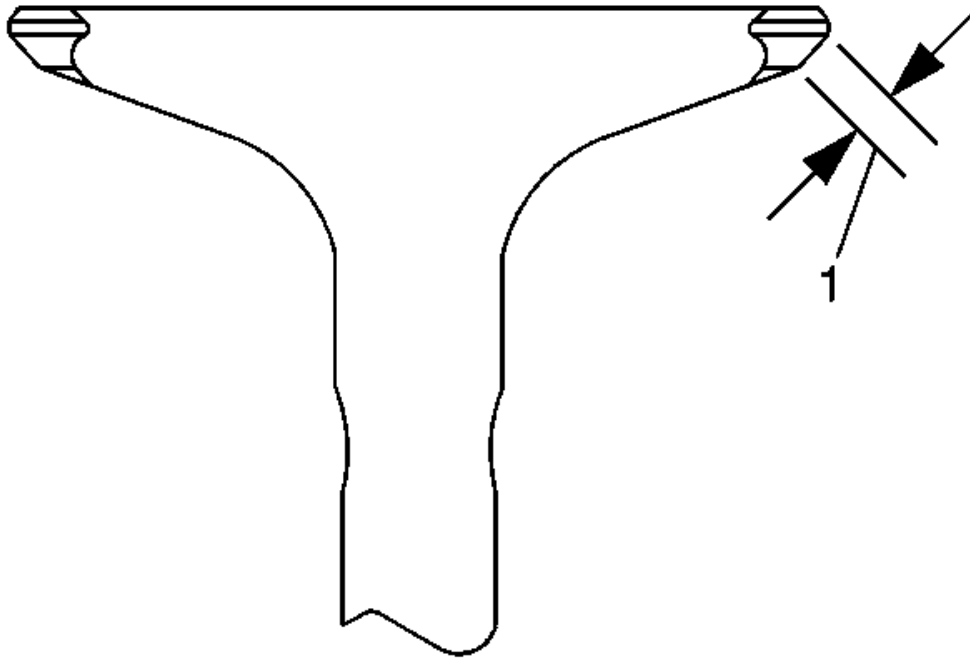
- If the measurement procedures reveal that the valve or valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning.

#### Valve Seat Width Measurement Procedure



**Fig. 301: Checking Valve Seat Width**  
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.



**Fig. 302: Measuring Seat Width On Valve Face**  
Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width on the valve face (1) using a proper scale.

**NOTE:** The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter (margin) of the valve. If the contact area is too close to the margins, the seat must be reconditioned to move the contact area away from the margin.

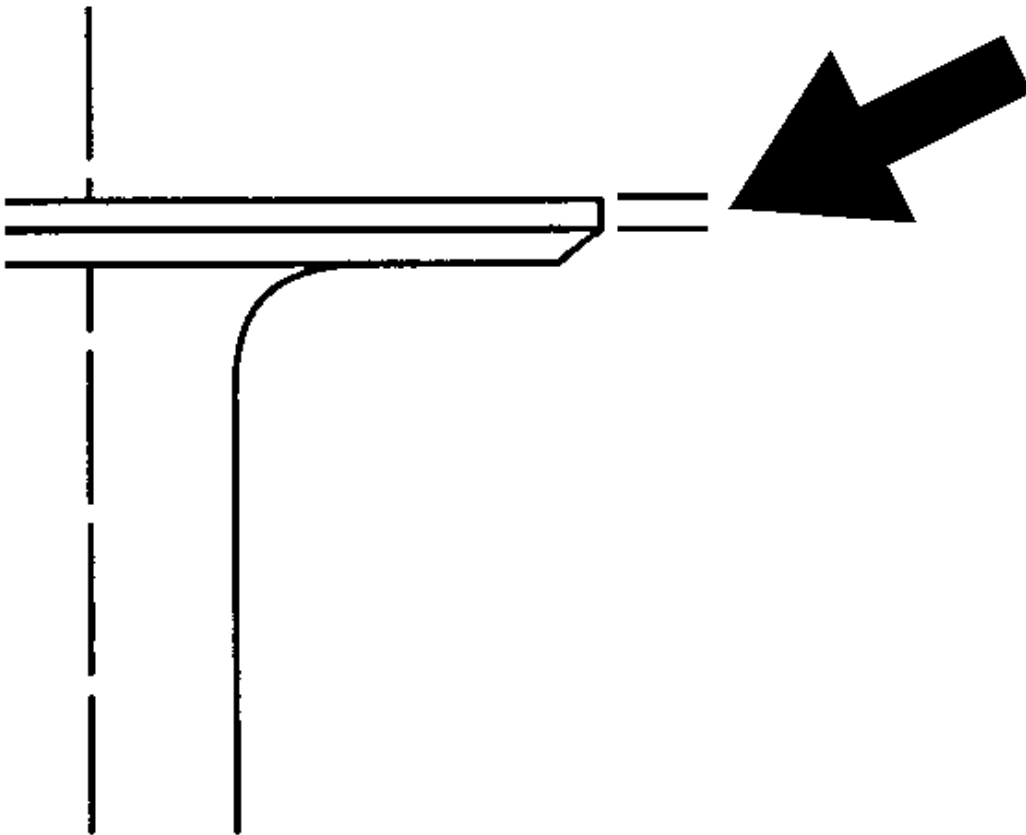
3. Compare your measurements with the specifications, refer to **Engine Mechanical Specifications**.
4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must grind the valve seat using the Valve and Seat Reconditioning Procedure to bring the width back into specification. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

**Valve Seat Roundness Measurement Procedure**

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.

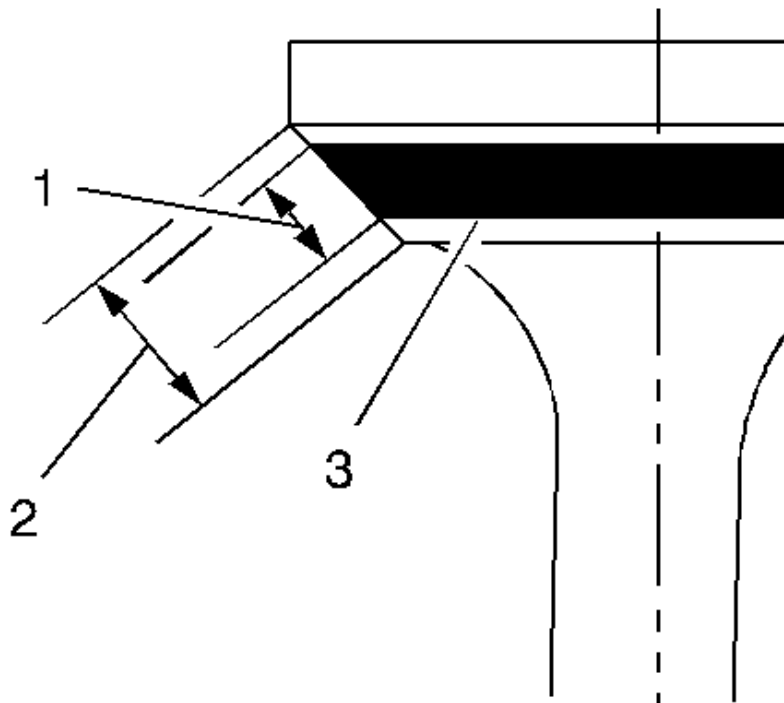
**CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.**

2. Compare your measurements with the specifications, refer to **Engine Mechanical Specifications**.
3. If the valve seat exceeds the roundness specification, you must grind the valve and valve seat using the Valve and Seat Reconditioning Procedure.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

**Valve Margin Measurement Procedure**

**Fig. 303: Valve Margin Measurement****Courtesy of GENERAL MOTORS COMPANY**

1. Measure the valve margin using an appropriate scale.
2. Reference the specifications in this section for minimum valve margin and compare them to your measurements.
3. If the valve margins are beyond specification, replace the valves.
4. If the valve margins are within specification and do not require refacing, test the valve for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

**Valve-to-Seat Concentricity Measurement Procedure****Fig. 304: Valve Contact Face Measurements****Courtesy of GENERAL MOTORS COMPANY**

**NOTE:**

- **Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.**
- **You must measure the valve face and the valve seat to ensure proper valve sealing.**

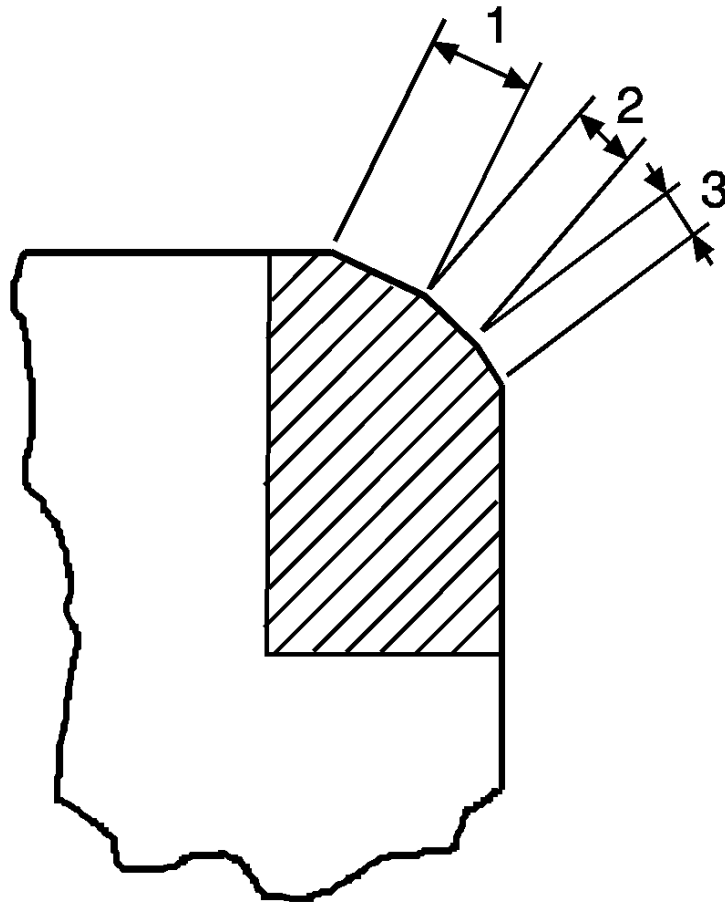
1. Coat the valve face lightly with blue dye (3).
2. Install the valve in the cylinder head.
3. Turn the valve against the seat with enough pressure to wear off the dye.
4. Remove the valve from the cylinder head.
5. Inspect the valve face.
  - If the valve face is concentric, providing a proper seal, with the valve stem, a continuous mark will be made around the entire face (1).

**NOTE:**

**The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin, of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.**

- If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be refaced or replaced and the seat must be reconditioned using the Valve and Seat Reconditioning Procedure.

**Valve and Seat Reconditioning Procedure**



**Fig. 305: Valve Seat Proper Angles**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the build up of carbon on the seats.
- It is necessary to reface the valve if seat reconditioning is required unless a new valve is used.

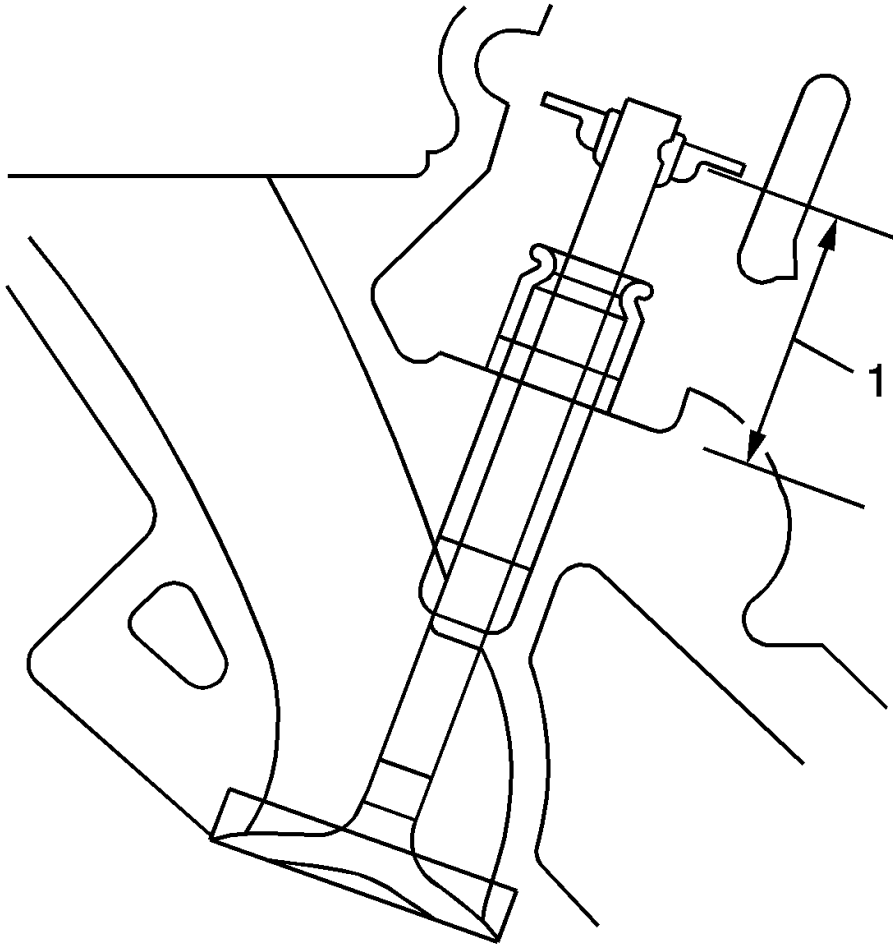
1. Grind the valve seats (2) to the proper angle specification, refer to **Engine Mechanical Specifications**.
2. Using the proper angle specification, refer to **Engine Mechanical Specifications**, grind, relieve, the valve seats (1) to correctly position the valve seating surface (2) to the valve.
3. Using the proper angle specification listed in engine mechanical specifications, refer to **Engine Mechanical Specifications**, grind, undercut, the valve seats (3) to narrow the valve seat widths to the specifications, refer to **Engine Mechanical Specifications**.

4. If the original valve is being used, grind the valve to the specifications, refer to **Engine Mechanical Specifications**. Measure the valve margin again after grinding using the Valve Margin Measurement Procedure. Replace the valve if the margin is out of specification. New valves do not require grinding.
5. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
6. Install the valve in the cylinder head.
  - If you are using refaced valves, lap the valves into the seats with a fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that minimal lapping is required. Excessive lapping will groove the valve face and prevent a good seat when hot.

**NOTE:**      **Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.**

- If you are using new valves, do not lap the valves under any condition.
7. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using the Valve Stem Height Measurement Procedure.
  8. If the valve stem height is acceptable, test the seats for concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

#### Valve Stem Height Measurement Procedure



**Fig. 306: Measuring Valve Stem Height**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve into the valve guide.
2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.
5. Measure the distance (1) between the cylinder head to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications**.
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.

**CAUTION: DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing**



**premature wear and possible engine damage.**

**CAUTION: DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.**

7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

## **VALVE SPRING INSPECTION AND MEASUREMENT**

### **Special Tool**

**GE-22738-B** Valve Spring Tester

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

### **Inspection Procedure**

1. Clean the valve springs in solvent.

**WARNING: Wear safety glasses in order to avoid eye damage.**

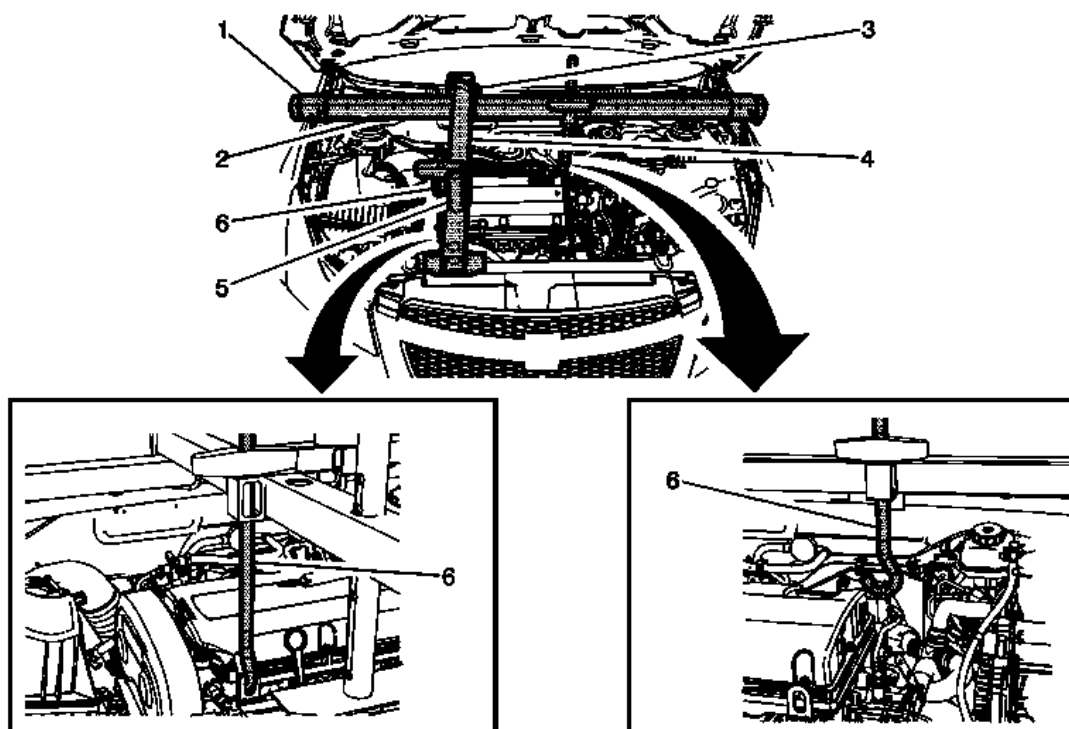
2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

### **Measurement Procedure**

1. Measure the tension of the valve spring using the **GE-22738-B** tester. Refer to **Engine Mechanical Specifications**.
2. If low valve spring load is found, replace the valve springs. **DO NOT** use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

## **REPAIR INSTRUCTIONS - OFF VEHICLE**

### **ENGINE SUPPORT FIXTURE**

**Fig. 307: Engine Support Fixture**

Courtesy of GENERAL MOTORS COMPANY

**Engine Support Fixture**

Callout	Component Name
<b>Preliminary Procedure</b> Remove the Front Fender Shipping Cover. Refer to <b>Front Fender Shipping Cover Replacement</b> .	
<b>Special Tools</b> <ul style="list-style-type: none"> <li>• J-43405 Engine Support Fixture Adapter</li> <li>• J-28467-518 Main Support Beam</li> <li>• J-28467-1A Cross Bracket</li> <li>• J-28467-5A Strut Tower Support Assembly</li> <li>• J-28467-2A Radiator Tube Shelf Assembly</li> <li>• J-36857 Engine Lift Bracket</li> <li>• J-28467-8A Hook Assembly</li> </ul>	
For equivalent regional tools, refer to <b>Special Tools</b> .	
1	Engine Support Fixture Adapter Leg (Qty: 2) <b>Procedure</b> Install the bracket to fender frame. Do not install on top of fender lip.

## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

2	Main Support Beam
3	Cross Bracket
4	Strut Tower Support Assembly <b>Procedure</b> Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly
6	Hook Assembly <b>Procedure</b> Use a grade 10.9 bolt to install the engine lift bracket. <b>TIP:</b> If the engine is not equipped with engine lift bracket, install J-36857 in place.

### TIMING BELT INSPECTION

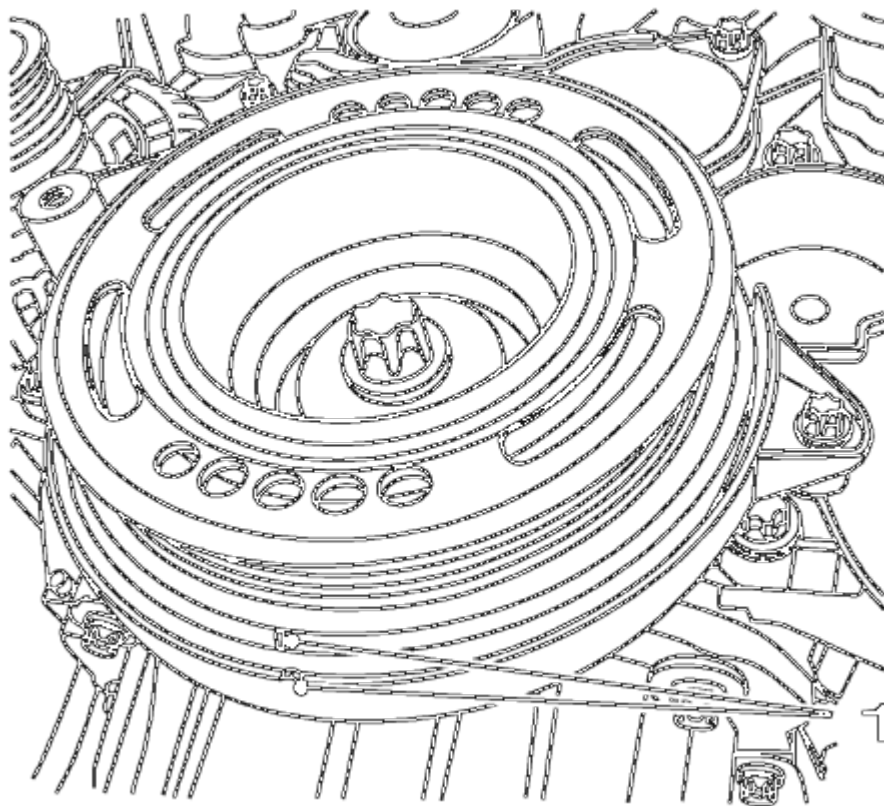
#### Special Tools

- **EN-6340** Locking Tool
- **EN-6628-A** Locking Tool

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

#### Removal Procedure

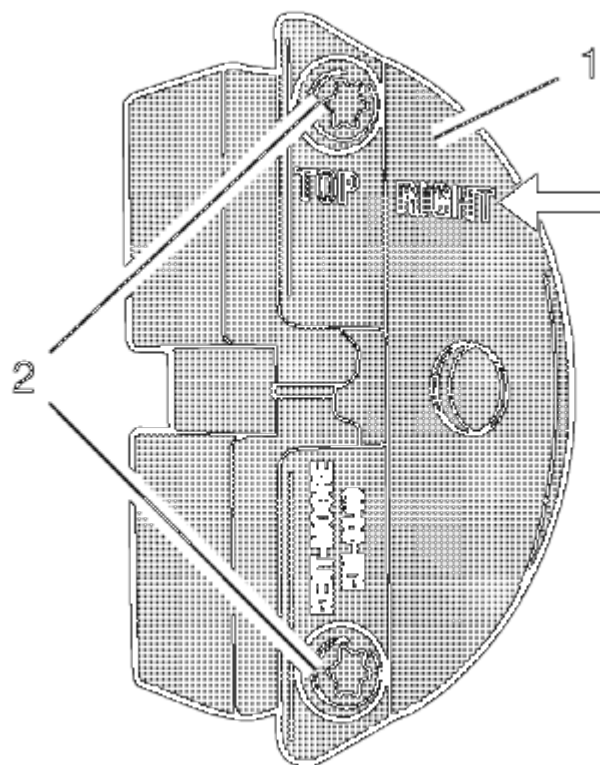
1. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal**.



**Fig. 308: Crankshaft TDC Position**

Courtesy of GENERAL MOTORS COMPANY

2. Set the crankshaft balancer in the direction of the engine rotation to "1st cylinder TDC" (mark 1).
3. Remove the camshaft cover. Refer to **Camshaft Cover Removal**.

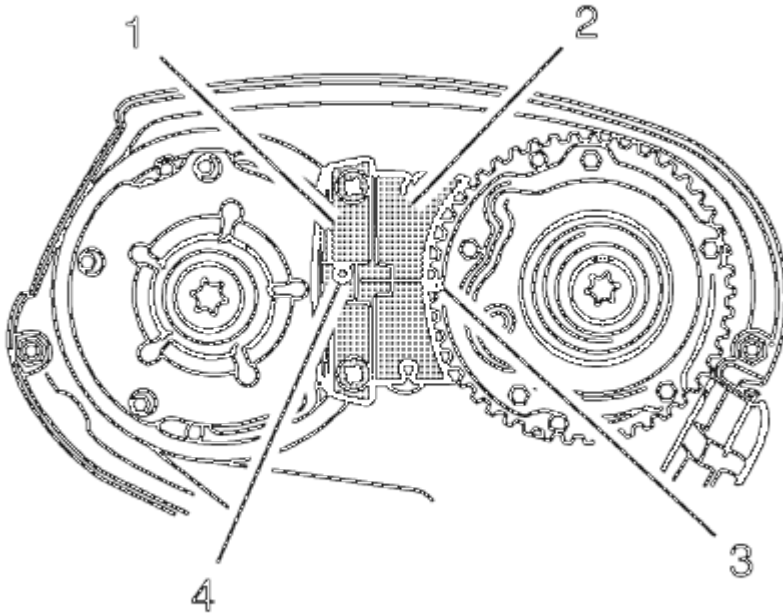


**Fig. 309: Front Panel And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering "right", arrow, on the tool.

4. Prepare the right half of the **EN-6340** locking tool.
  1. Remove the 2 bolts (2).
  2. Remove the front panel (1) from the **EN-6340** locking tool -right.

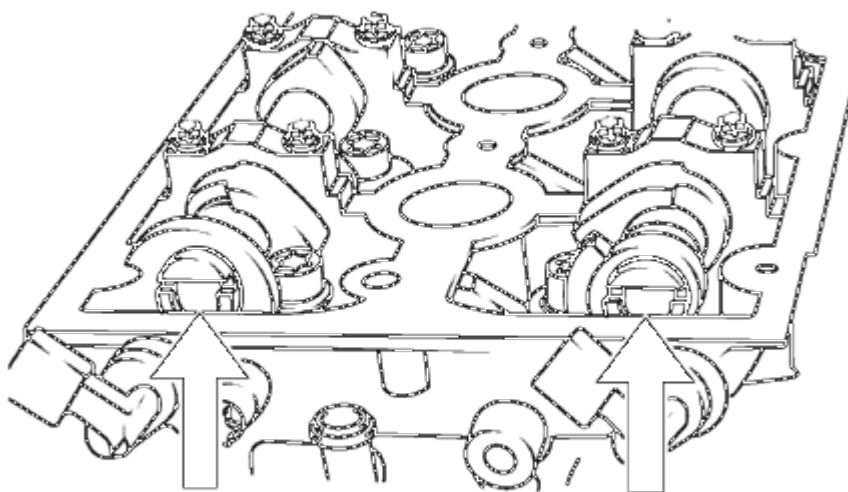


**Fig. 310: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- The spot type marking (4) on the intake camshaft position actuator adjuster does not correspond to the groove of the EN-6340 locking tool - left (1) during this process, but must be somewhat above.
- The spot type marking (3) on the exhaust camshaft position actuator adjuster must correspond to the groove on EN-6340 locking tool - right (2).

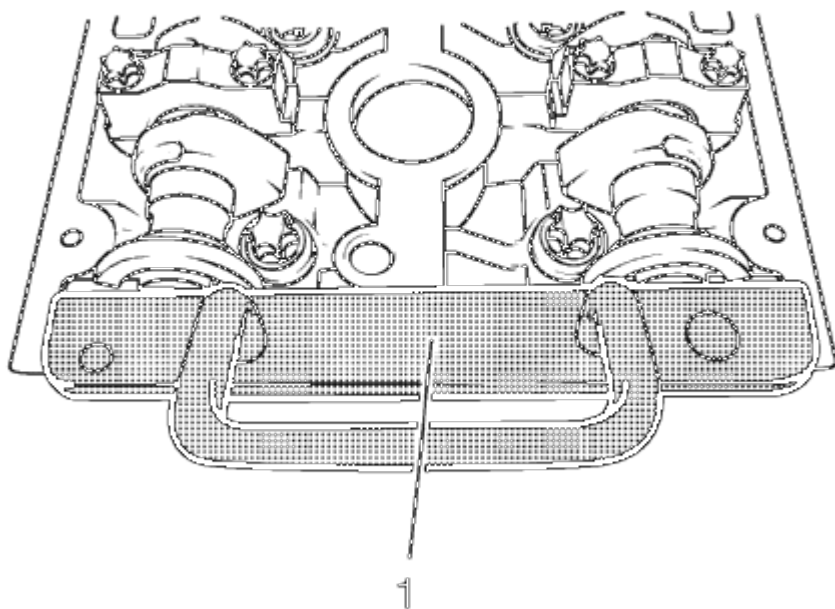
5. Insert the **EN-6340** locking tool - left (1) and the **EN-6340** locking tool - right (2) in the camshaft position actuator adjuster.



**Fig. 311: Aligning Camshafts Horizontally**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the EN-6628-A locking tool cannot be inserted, the timing must be set.

6. Align the camshafts horizontally by the hexagon (arrows) until the **EN-6628-A** locking tool can be inserted in both camshafts.



**Fig. 312: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

7. Insert the **EN-6628-A** locking tool (1) into the camshafts.

#### Installation Procedure

1. Remove the **EN-6628-A** locking tool.
2. Remove the **EN-6340** locking tool.
3. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
4. Install the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Installation**.

#### TIMING BELT ADJUSTMENT

##### Special Tools

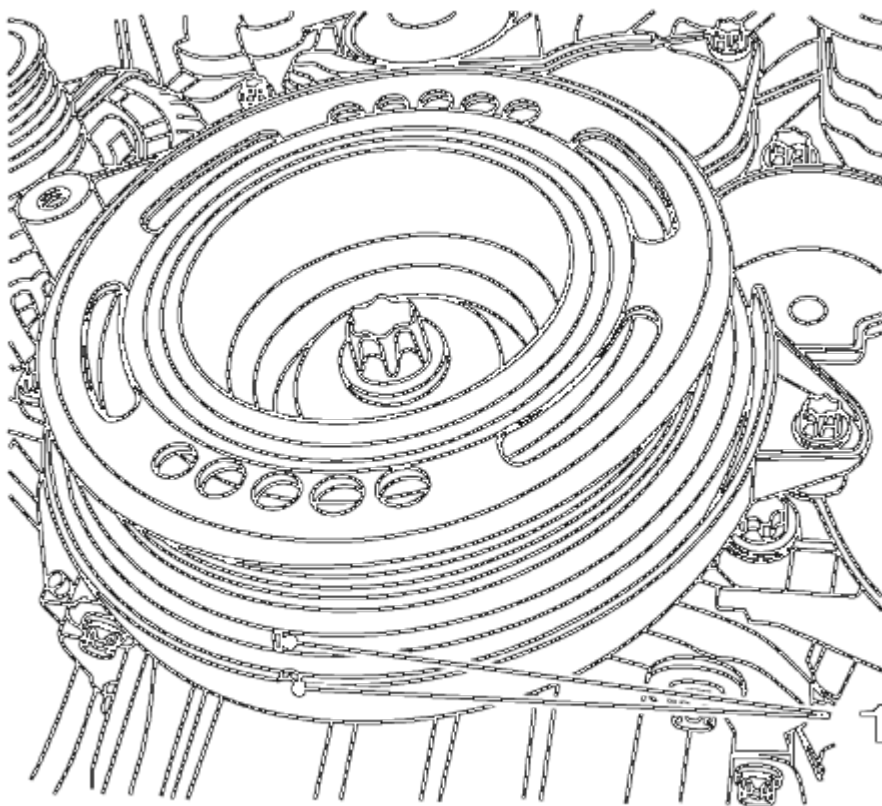
- **EN-652** Flywheel Holder
- **EN-6333** Locking Pin
- **EN-6340** Locking Tool
- **EN-6628-A** Locking Tool
- **EN-45059** Torque Angle Sensor Kit



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

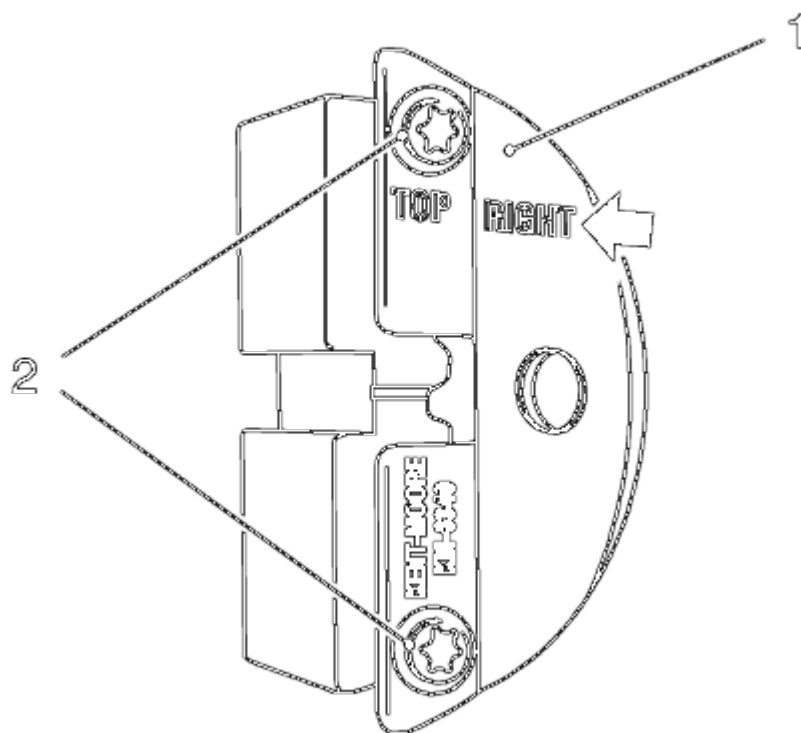
### Removal Procedure

1. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal**.



**Fig. 313: Crankshaft TDC Position**  
Courtesy of GENERAL MOTORS COMPANY

2. Set the crankshaft balancer in the direction of the engine rotation to "1st cylinder TDC" (mark 1).
3. Remove the camshaft cover. Refer to **Camshaft Cover Removal**.

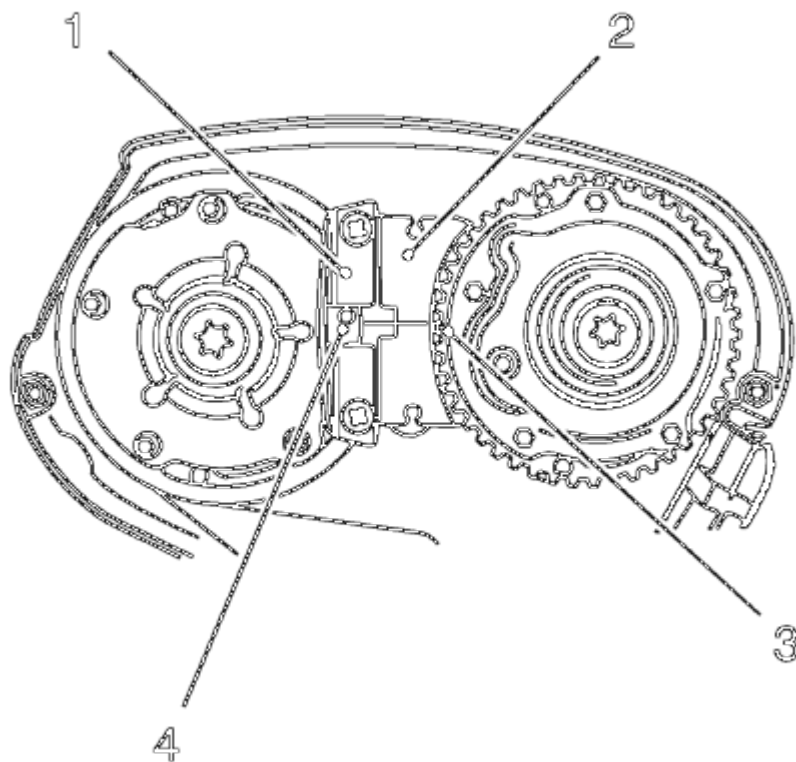


**Fig. 314: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering "right", arrow, on the tool.

4. Prepare the right half of the EN-6340 locking tool.
  1. Remove the 2 bolts (2).
  2. Remove the front panel (1) from the EN-6340 locking tool - right.



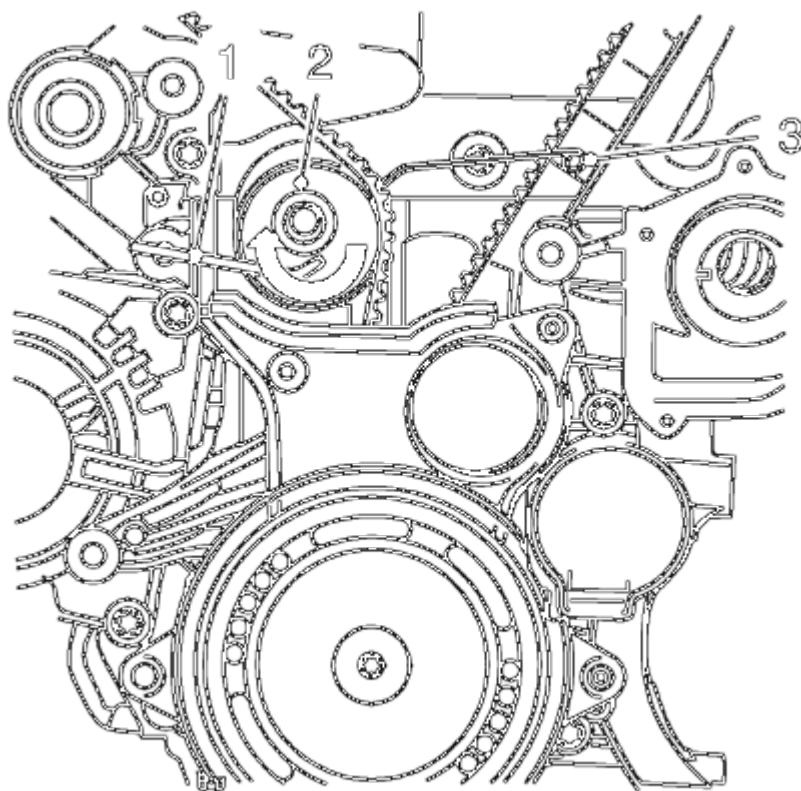
**Fig. 315: Camshaft Holder And Markings**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- The spot type marking (4) on the intake camshaft position actuator adjuster does not correspond to the groove of the EN-6340 locking tool - left (1) during this process, but must be somewhat above.
- The spot type marking (3) on the exhaust camshaft position actuator adjuster must correspond to the groove on EN-6340 locking tool - right (2).

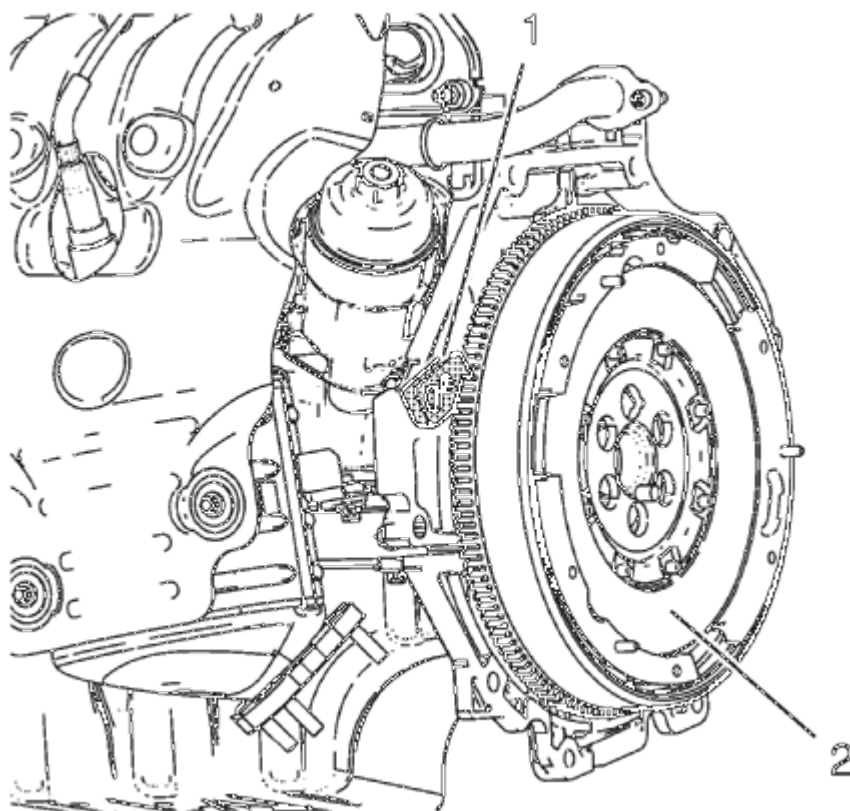
5. Insert the **EN-6340** locking tool - left (1) and the **EN-6340** locking tool - right (2) in the camshaft position actuator adjuster.



**Fig. 316: Tooth Belt Tensioner**

**Courtesy of GENERAL MOTORS COMPANY**

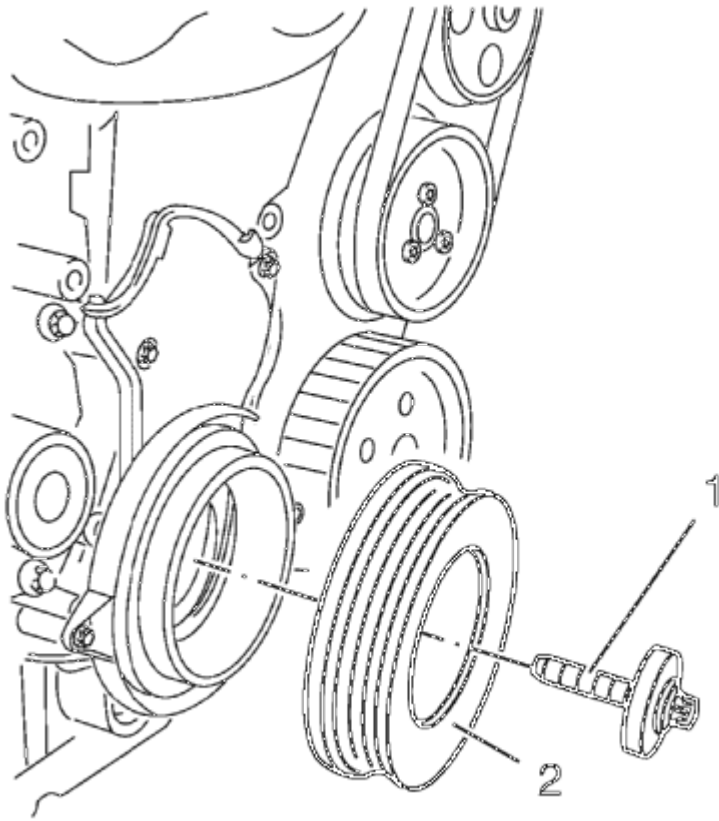
6. Install the **EN-6333** locking pin (1), apply tension to the timing belt tension roller (2) in the direction of the arrow. Install the **EN-6333** locking pin (3).
7. Mark timing belt in direction of rotation.



**Fig. 317: Flywheel And Flywheel Holder**

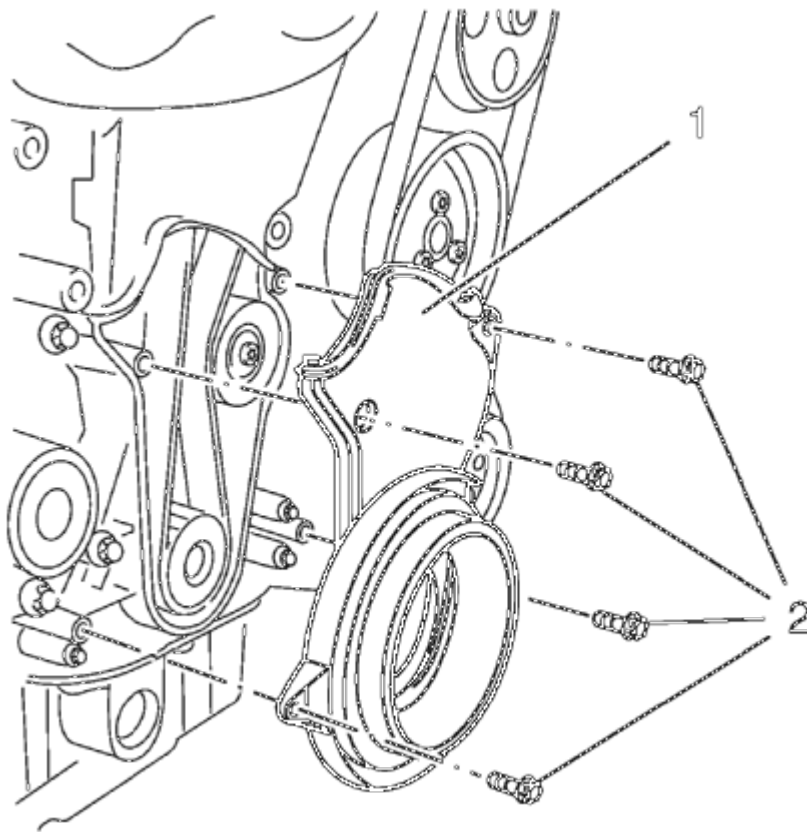
**Courtesy of GENERAL MOTORS COMPANY**

8. Install the **EN-652** flywheel holder (1), lock the flywheel (2) (or automatic transmission flex respectively) via the starter ring gear.



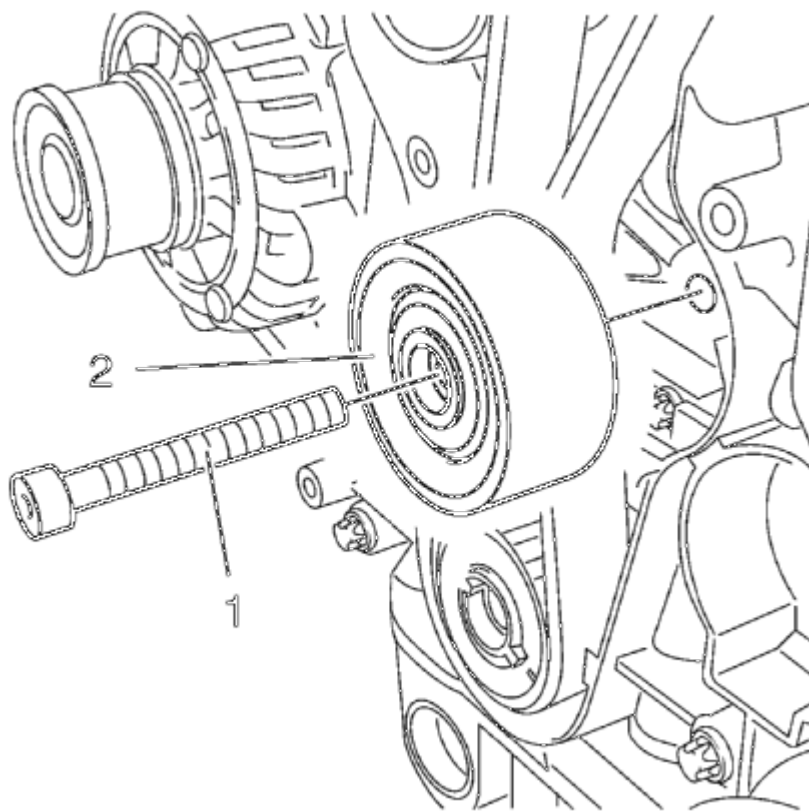
**Fig. 318: Crankshaft Balancer And Bolt**  
 Courtesy of GENERAL MOTORS COMPANY

9. Remove and DISCARD the crankshaft balancer bolt (1).
10. Remove the crankshaft balancer (2).



**Fig. 319: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 4 timing belt lower front cover bolts (2).
12. Remove the timing belt lower front cover (1).

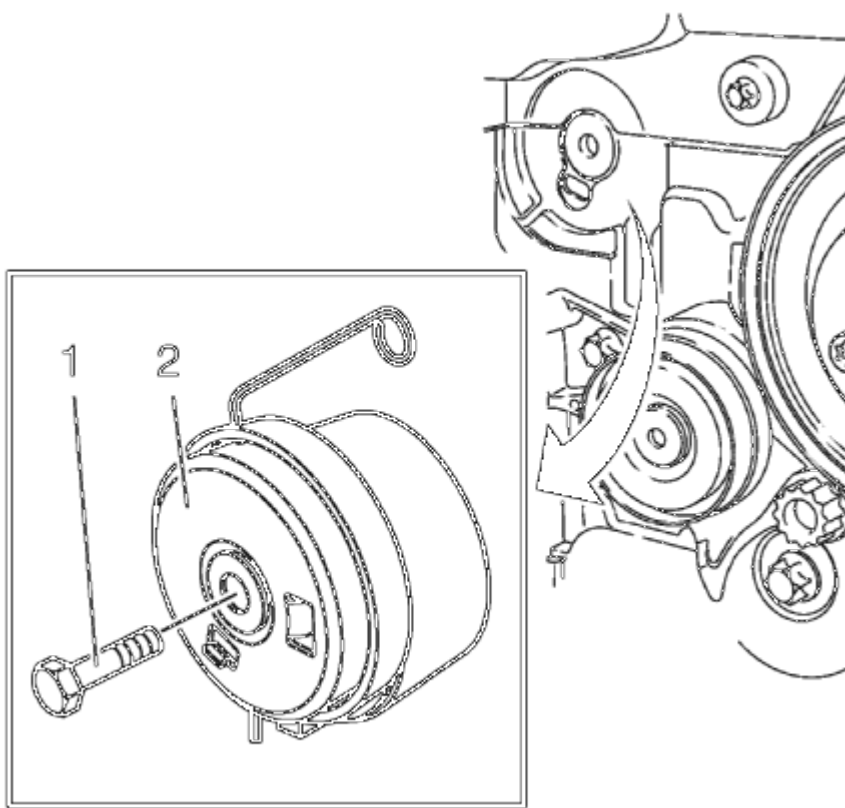


**Fig. 320: Timing Belt Idler Pulley Bolt**

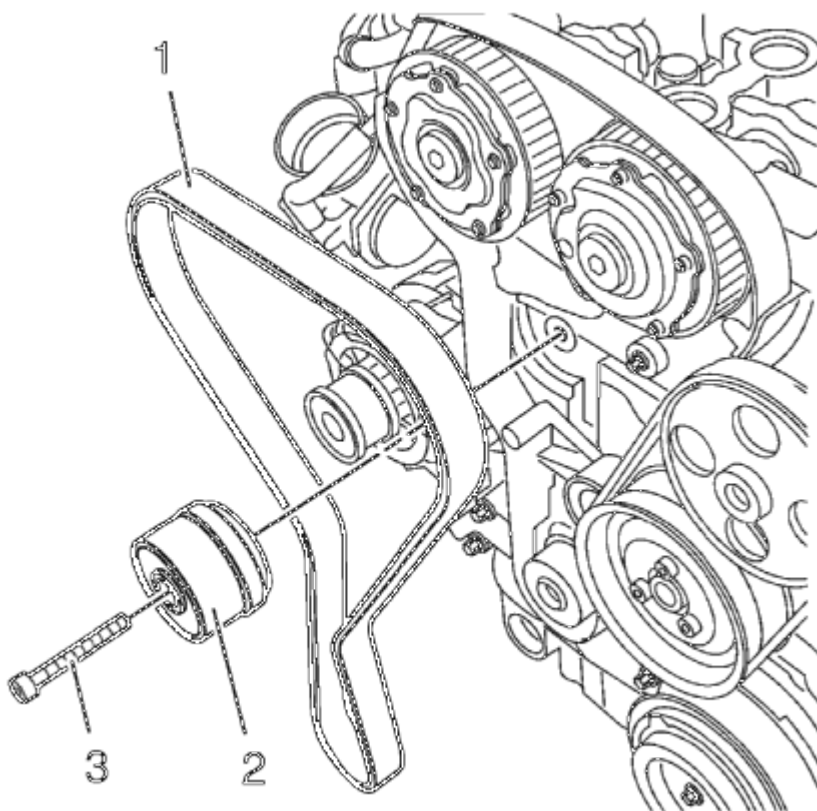
**Courtesy of GENERAL MOTORS COMPANY**

13. Remove the timing belt idler pulley bolt (1).
14. Remove the timing belt idler pulley (2).



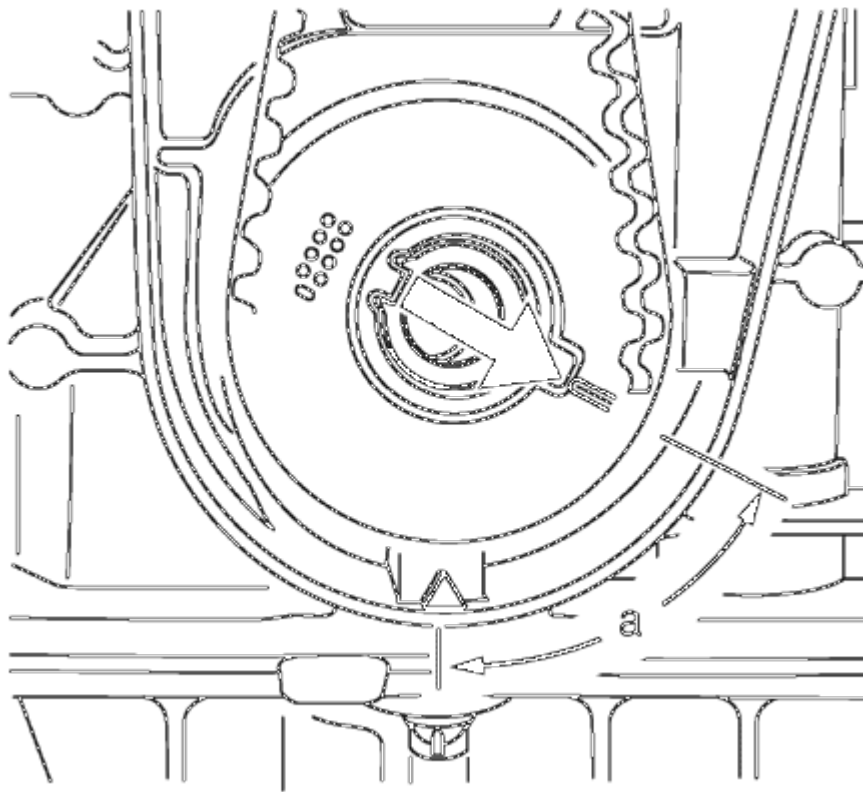
**Fig. 321: Timing Belt Tensioner****Courtesy of GENERAL MOTORS COMPANY**

15. Remove the tensioner bolt (1).
16. Remove the timing belt tensioner (2).



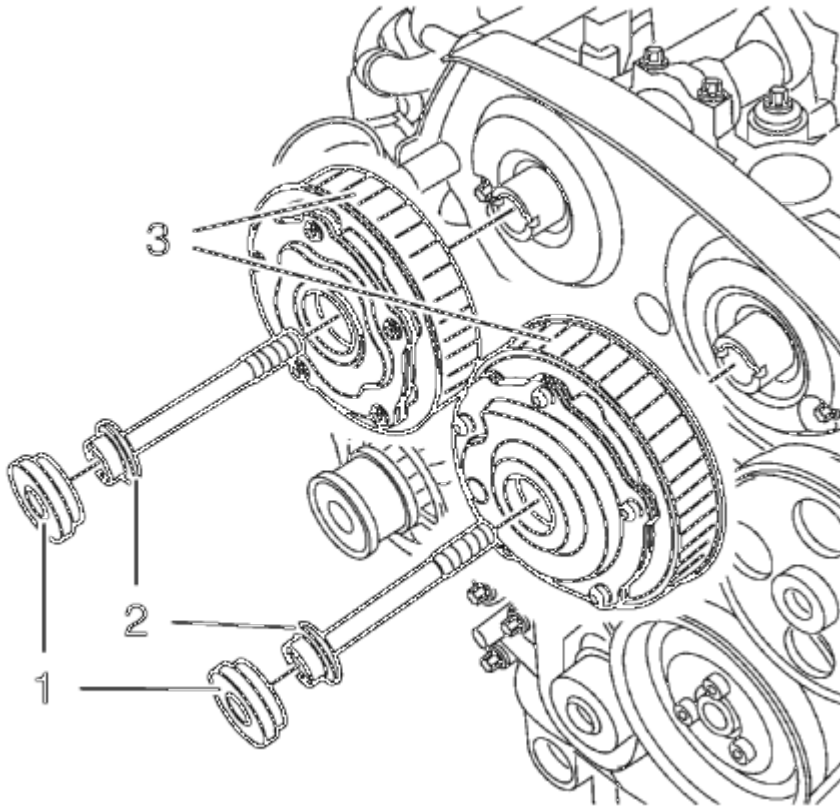
**Fig. 322: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

17. Remove the timing belt (1).
18. Stop the timing belt tensioner (2).
19. Remove the **EN-652** flywheel holder to unlock the crankshaft.



**Fig. 323: Turning Crankshaft Against Direction Of Engine Rotation**  
Courtesy of GENERAL MOTORS COMPANY

20. Turn the crankshaft 60° (A) against the direction of engine rotation.



**Fig. 324: Camshaft Position Actuator Adjuster Closure Bolt**  
 Courtesy of GENERAL MOTORS COMPANY

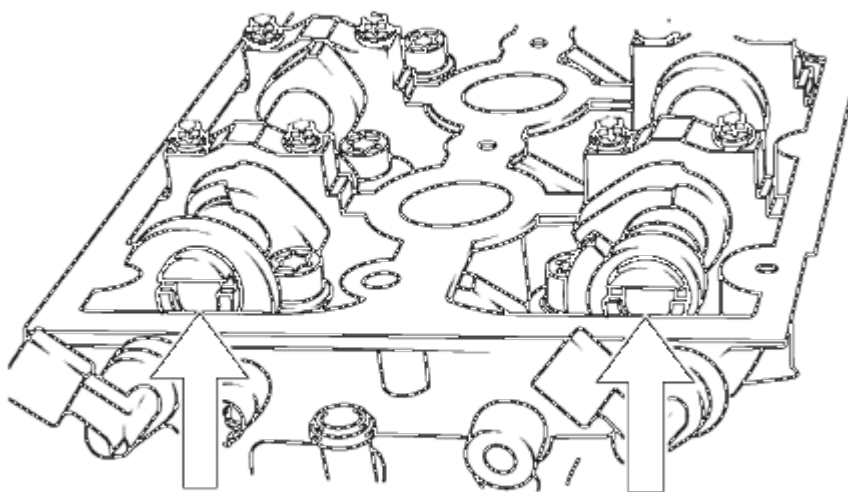
21. Remove the 2 camshaft position actuator adjuster closure bolts (1).

**NOTE:**      **A second technician is required.**

22. Loosen the camshaft position actuator adjuster bolts (2).

Hold at the appropriate camshaft hexagon.

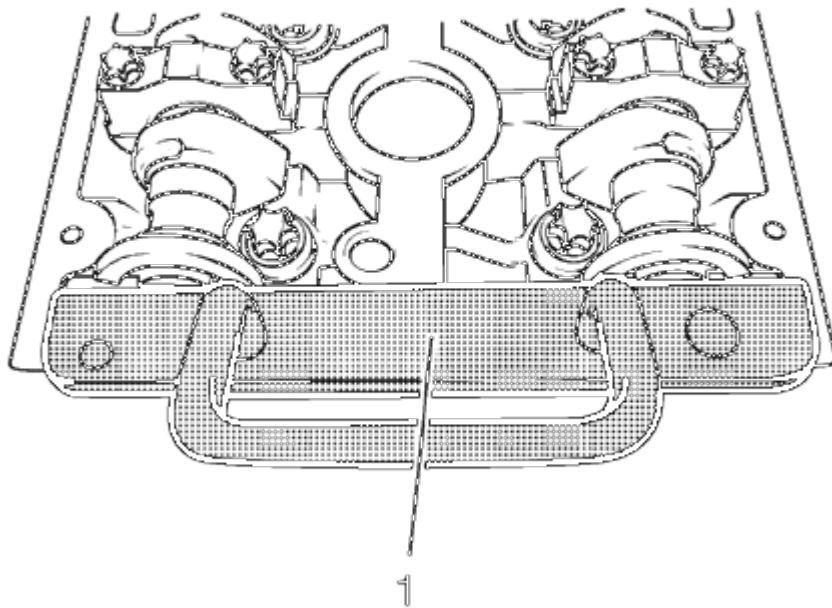
23. Remove and DISCARD the camshaft position actuator adjuster bolts (2) and the camshaft position actuator adjuster (3).



**Fig. 325: Aligning Camshafts Horizontally**

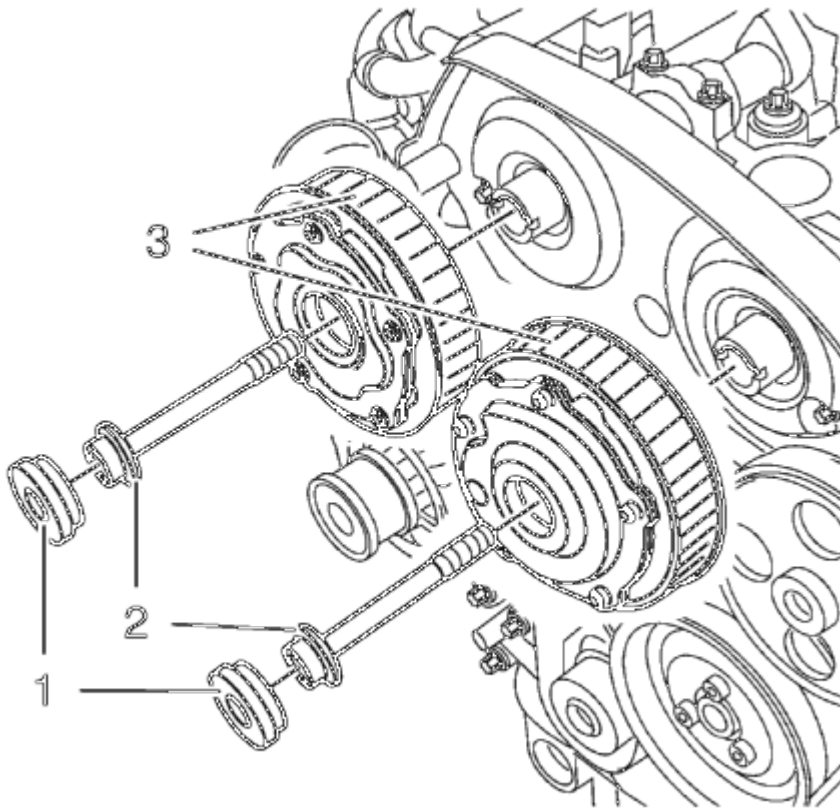
Courtesy of GENERAL MOTORS COMPANY

24. Align the camshafts horizontally by the hexagon arrows, until the **EN-6628-A** locking tool can be inserted in both camshafts.

**Fig. 326: Locking Tool****Courtesy of GENERAL MOTORS COMPANY**

25. Insert the **EN-6628-A** locking tool (1) into the camshafts.

**Installation Procedure**



**Fig. 327: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not tighten the camshaft adjuster bolts.

1. Install the camshaft position actuator adjuster (3).
2. Install NEW camshaft position actuator adjuster bolts (2).

**CAUTION:** Refer to Fastener Caution .

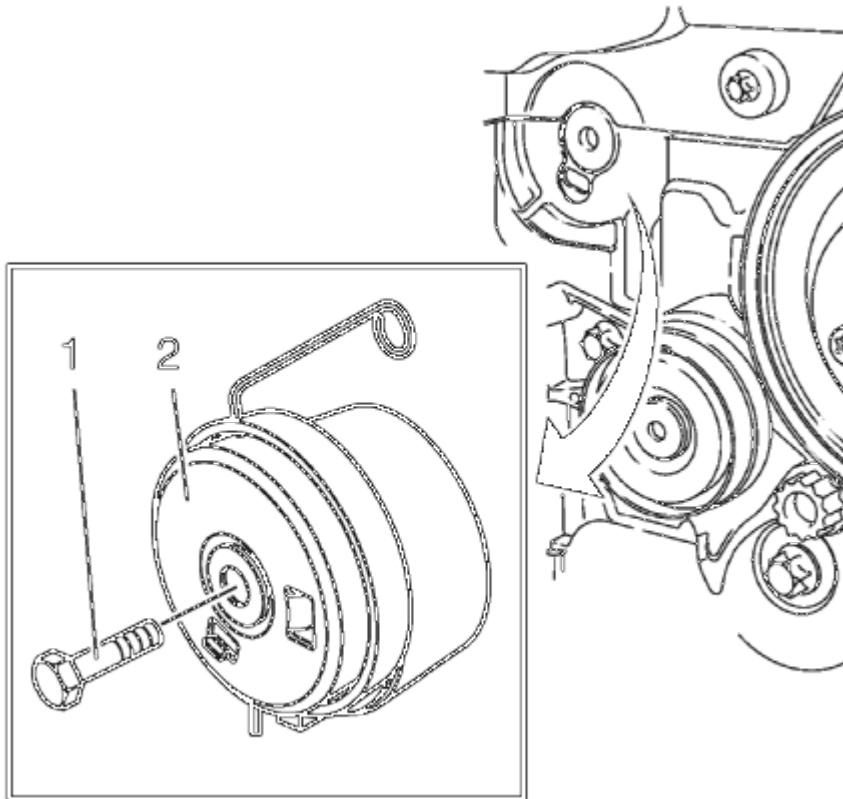
**CAUTION:** Refer to Torque-to-Yield Fastener Caution .

**NOTE:** A second technician is required.

3. Tighten the camshaft position actuator adjuster bolts (2) in three passes:

Hold at the appropriate camshaft hexagon.

1. First pass tighten to 65 N.m (48 lb ft).
2. Second pass to 120°.
3. Third pass to 15°.
4. Replace the camshaft position actuator adjuster seal rings.
5. Install the 2 camshaft position actuator adjuster closure plugs (1) and tighten to 30 N.m (22 lb ft).
6. Remove the **EN-6628-A** locking tool.

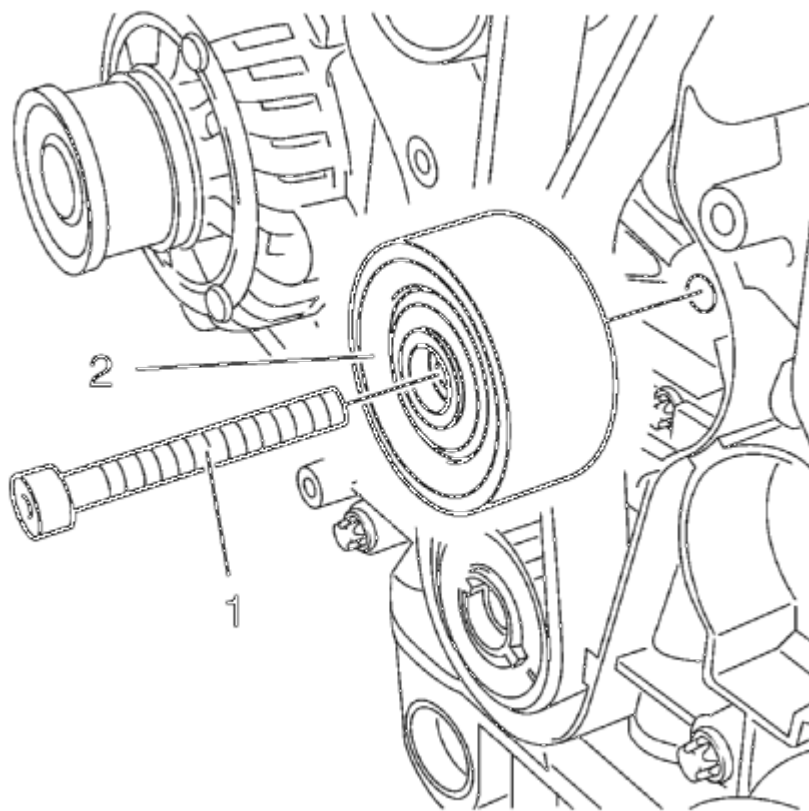


**Fig. 328: Timing Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

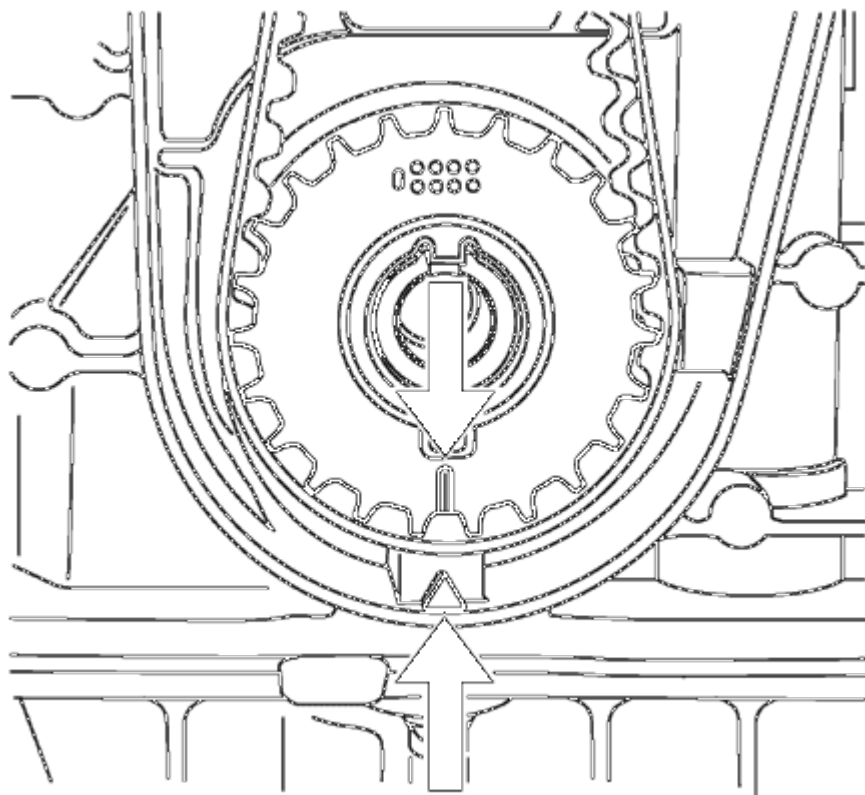
7. Clean the timing belt tensioner thread.
8. Install the timing belt tensioner (2) and tighten the NEW timing belt tensioner bolt (1) to 20 N.m (15 lb ft).
9. Clean the timing belt idler pulley thread.





**Fig. 329: Timing Belt Idler Pulley Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

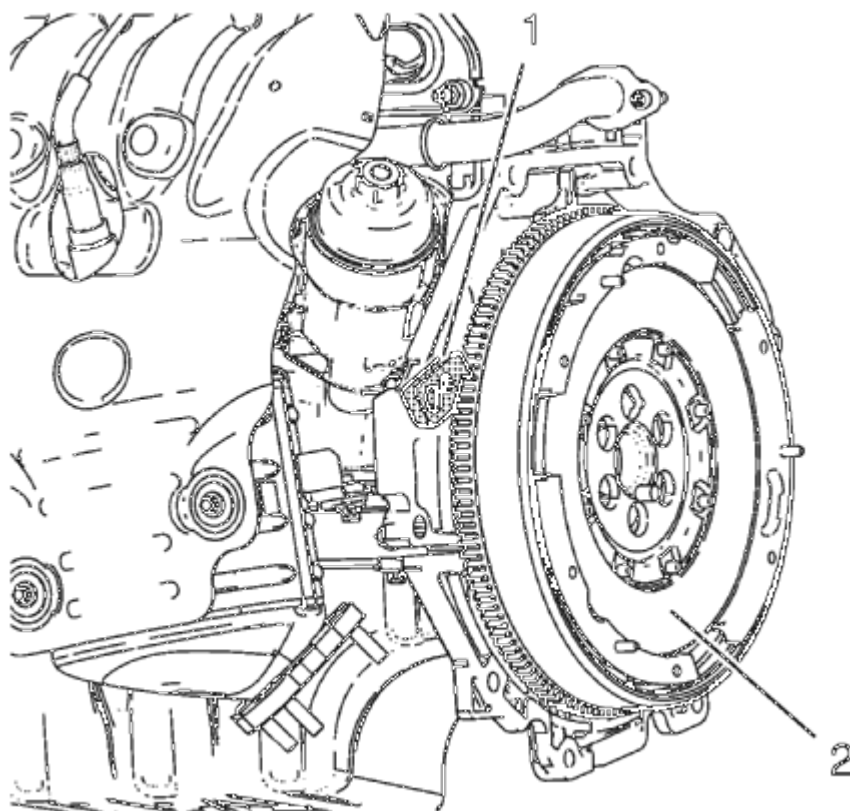
10. Install the timing belt idler pulley (2) and tighten the NEW bolt (1) to 25 N.m (18 lb ft).



**Fig. 330: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The timing belt drive gear and oil pump housing must align.

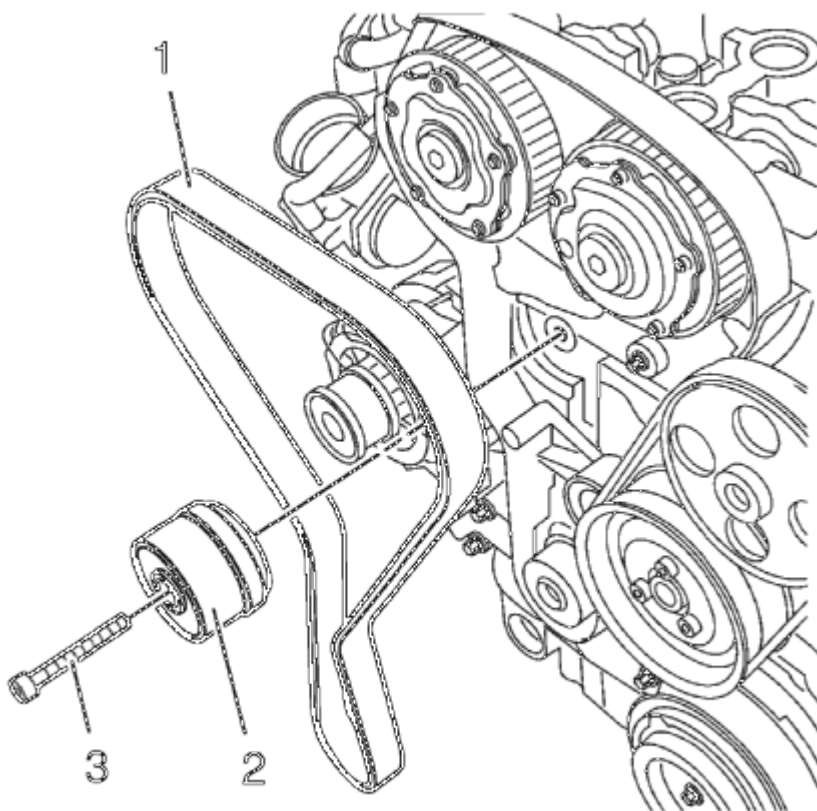
11. Turn the crankshaft in the direction of engine rotation, by the crankshaft balancer bolt, to cylinder 1 TDC of combustion stroke.



**Fig. 331: Flywheel And Flywheel Holder**

**Courtesy of GENERAL MOTORS COMPANY**

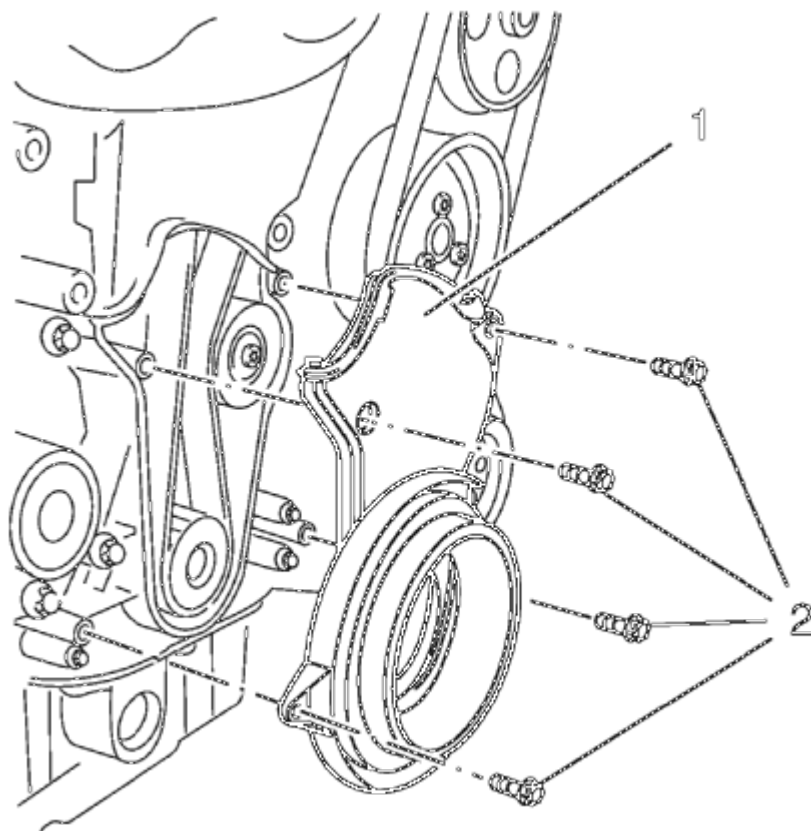
12. Install the **EN-652** flywheel holder (1), lock the flywheel (2) (or automatic transmission flex respectively) via the starter ring gear.



**Fig. 332: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

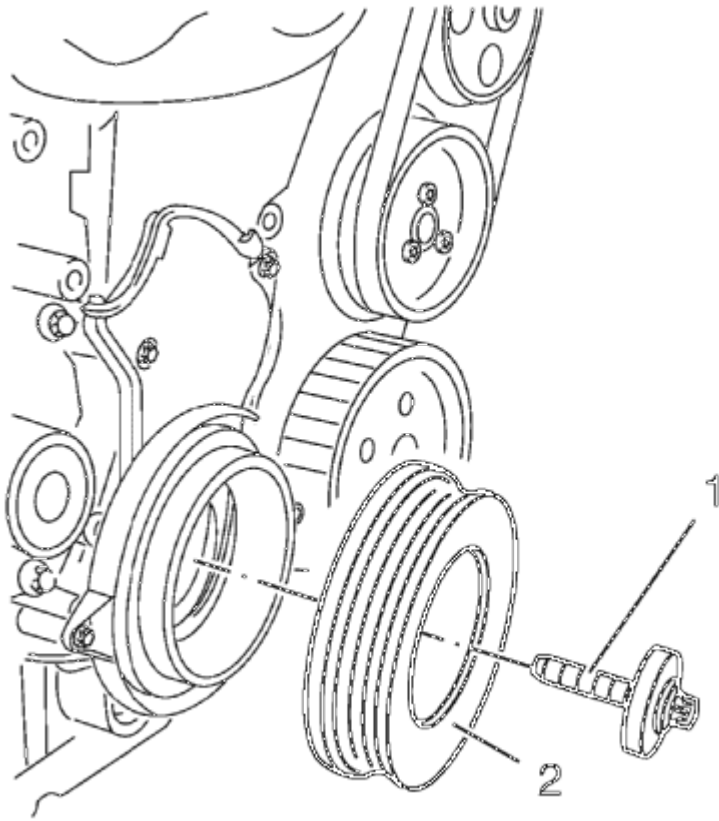
**NOTE:**        **Observe direction of rotation.**

13. Insert the timing belt (1).
14. Apply preliminary tension clockwise to the timing belt tensioner roller.
15. Remove the **EN-6333** locking pin.
16. Release the tension on the timing belt tensioner.



**Fig. 333: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

17. Install the lower front timing belt cover (1) and tighten the 4 bolts (2) to 6 N.m (53 lb in).

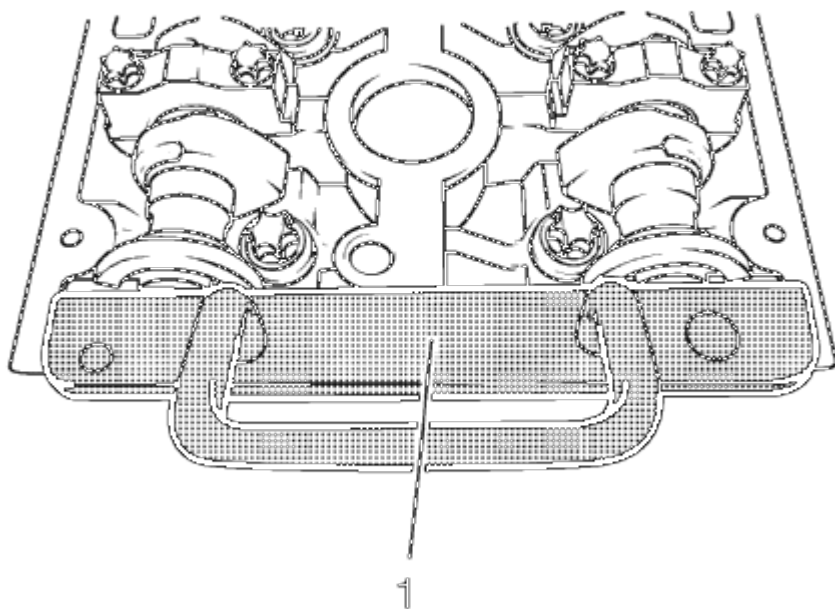


**Fig. 334: Crankshaft Balancer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

18. Install the crankshaft balancer (2) and NEW bolt (1) and tighten in 3 passes using the **EN-45059** sensor kit :
  1. First pass to 95 N.m (70 lb ft).
  2. Second pass to 45°.
  3. Third pass to 15°.
19. Remove the **EN-652** flywheel holder to unlock the crankshaft.
20. Remove the **EN-6340** locking tool.
21. Check position of the camshaft position actuator adjuster.
  1. Turn crankshaft 720° in the direction of engine rotation by the crankshaft balancer bolt.

**NOTE:**      **Note marking, camshaft position actuator adjuster.**

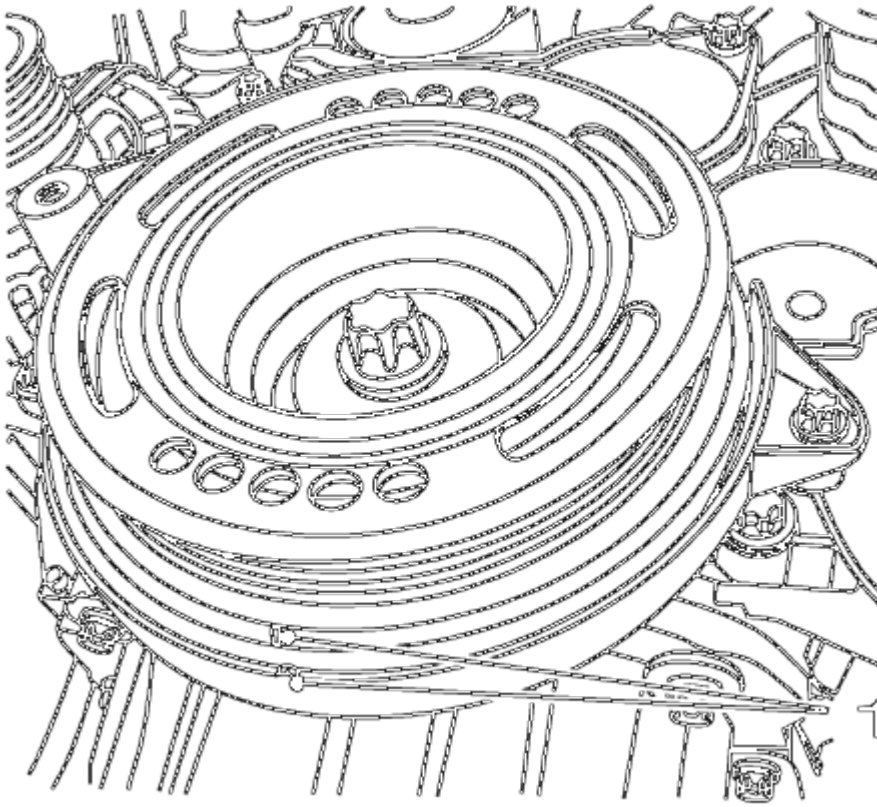
2. Insert **EN-6340** locking tool into camshaft timing gears.



**Fig. 335: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

22. Insert the **EN-6628-A** locking tool (1) into the camshafts.
23. Align camshafts by hexagon until **EN-6628-A** locking tool can be inserted in both camshafts.



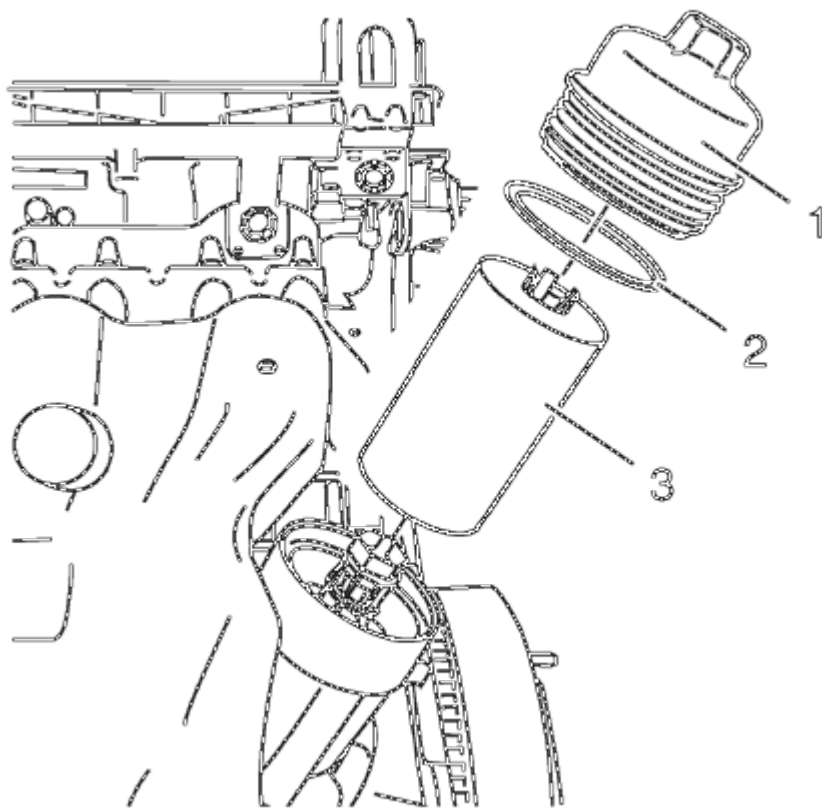
**Fig. 336: Crankshaft TDC Position**

Courtesy of GENERAL MOTORS COMPANY

24. Check the crankshaft position.
25. Marking on crankshaft balancer must align with marking on timing belt lower cover, see mark (1).
26. Remove the **EN-6628-A** locking tool.
27. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
28. Install the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Installation**.

## **DRAINING FLUIDS AND OIL FILTER REMOVAL**





**Fig. 337: Oil Filter Cap, Oil Filter Seal And Oil Filter Insert**  
Courtesy of GENERAL MOTORS COMPANY

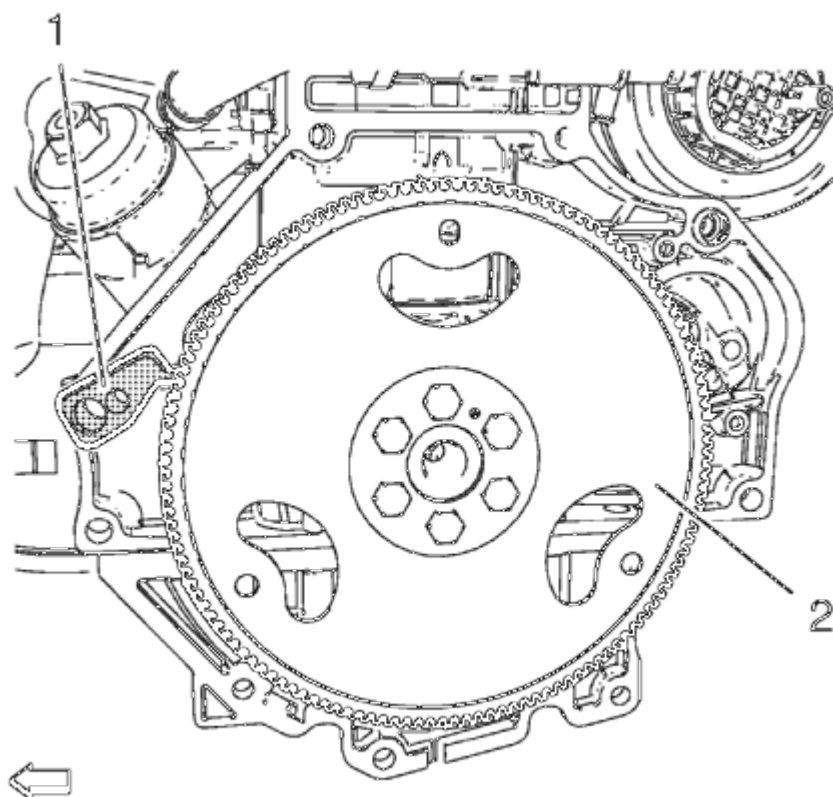
1. Place a drip pan underneath.
2. Remove the oil filter cap (1).
3. Remove the oil filter cap seal (2).
4. Remove and properly dispose of the oil filter insert (3).
5. Re-install the oil filter cap.
6. Remove the oil drain bolt.
7. Drain the engine oil into the drip pan.

## AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

### Special Tools

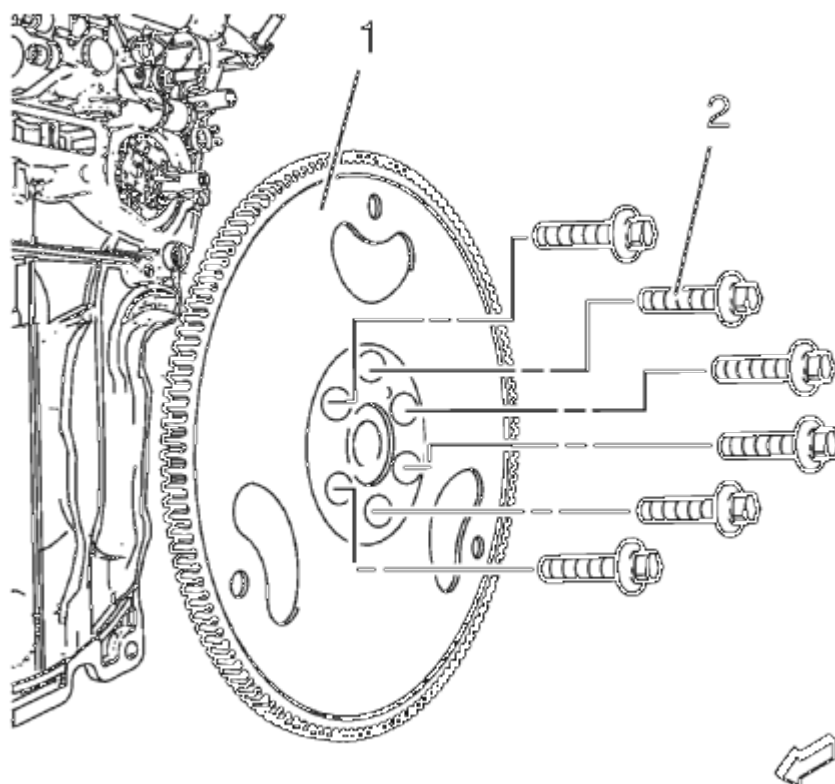
**EN-652** Automatic Transmission Flex Plate Holder

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



**Fig. 338: Automatic Transmission Flex Plate And Holder**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-652** holder (1) to hold the automatic transmission flex plate (2).
2. Loosen the 6 automatic transmission flex plate bolts.
3. Remove the **EN-652** holder (1).



**Fig. 339: Automatic Transmission Flex Plate And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

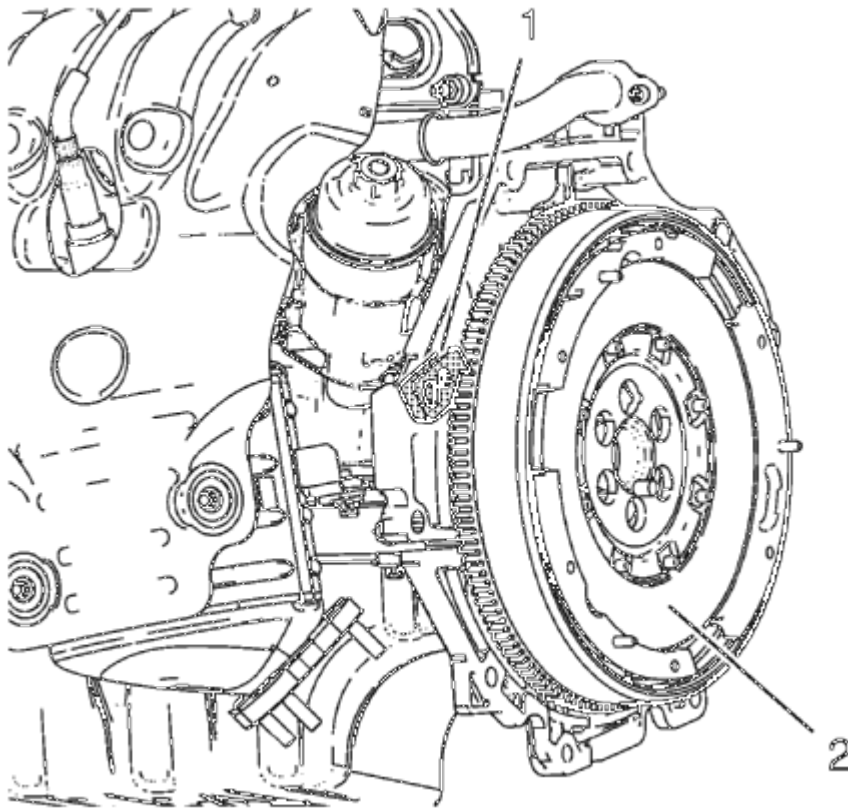
4. Remove the 6 automatic transmission flex plate bolts (2).
5. Remove the automatic transmission flex plate (1).

## ENGINE FLYWHEEL REMOVAL

### Special Tools

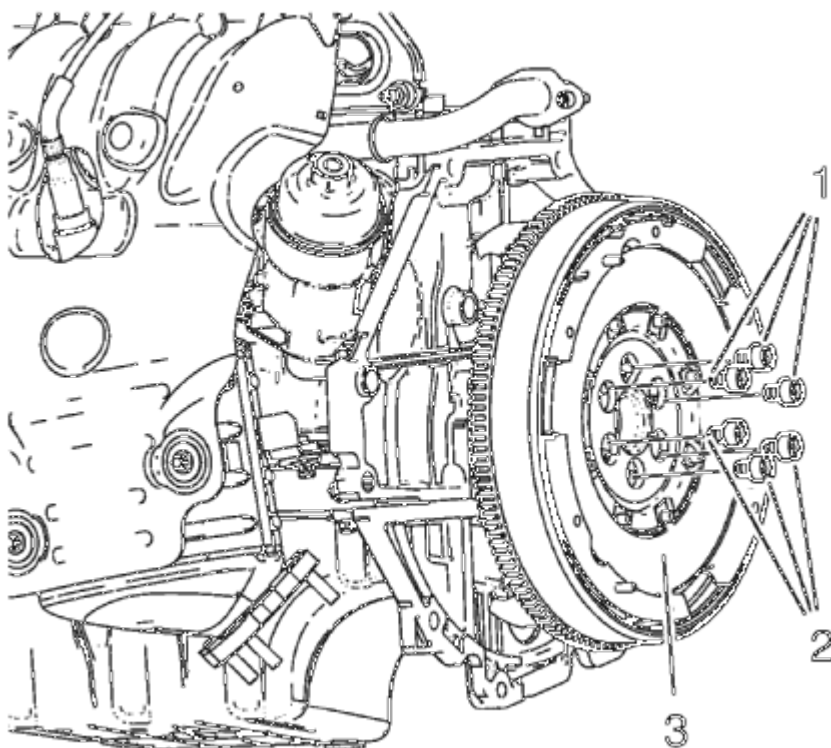
**EN-652** Flywheel Holder

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



**Fig. 340: Flywheel And Flywheel Holder**  
Courtesy of GENERAL MOTORS COMPANY

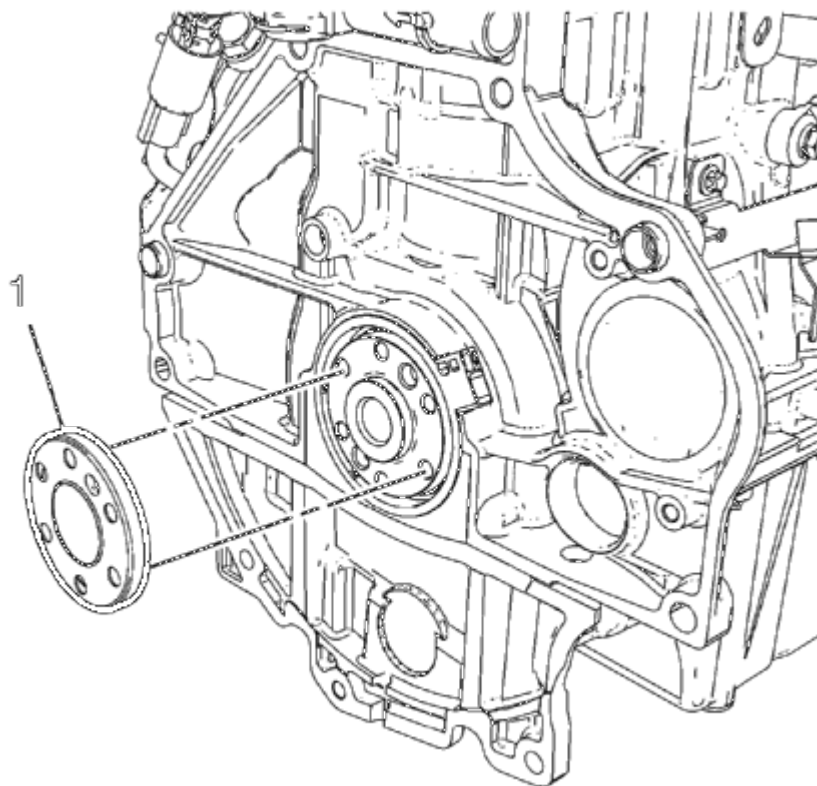
1. Install the **EN-652** holder (1), lock the flywheel via the starter ring gear.
2. Loosen the 6 flywheel bolts.
3. Remove the **EN-652** holder (1).



**Fig. 341: Flywheel And Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

4. Remove and DISCARD the 6 flywheel bolts (1, 2).
5. Remove the flywheel (3).



**Fig. 342: Crankshaft Position Reluctor Ring**  
Courtesy of GENERAL MOTORS COMPANY

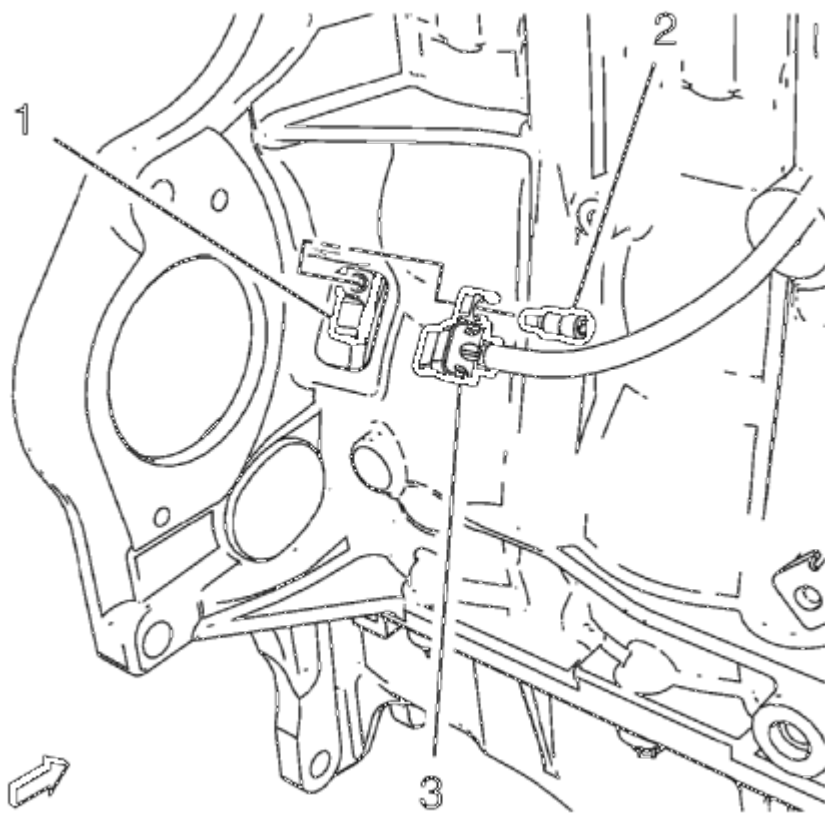
6. Remove the crankshaft position reluctor ring (1).

## CRANKSHAFT REAR OIL SEAL REMOVAL

### Special Tools

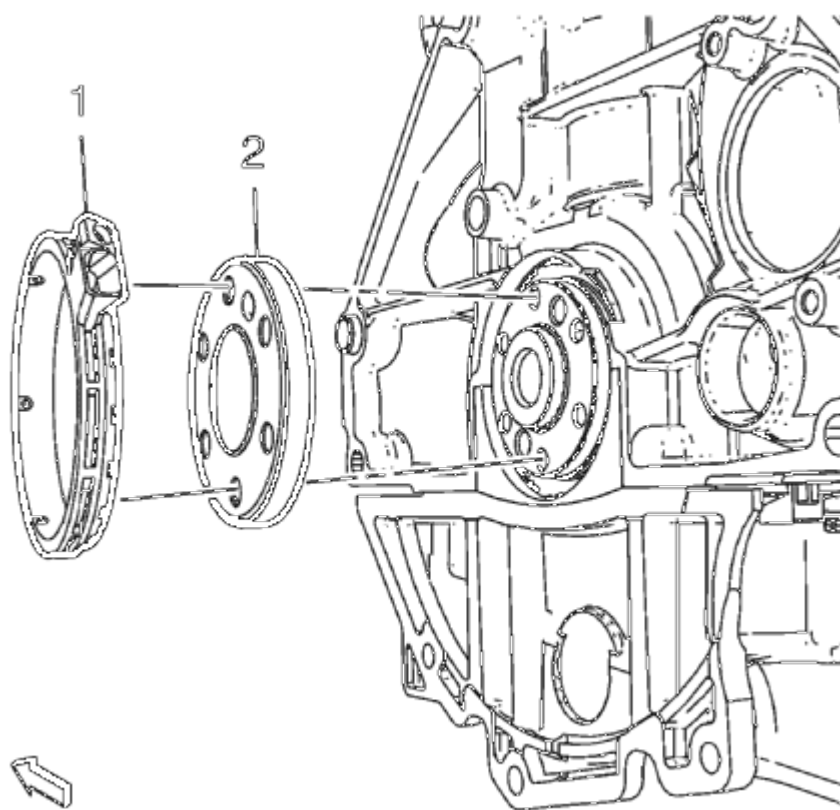
- EN-328-B Pin Remover
- EN-6624 Remover

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



**Fig. 343: Crankshaft Position Sensor And Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the crankshaft position sensor bolt (2).
2. Remove the crankshaft position sensor (3) from the crankshaft rear oil seal housing (1).

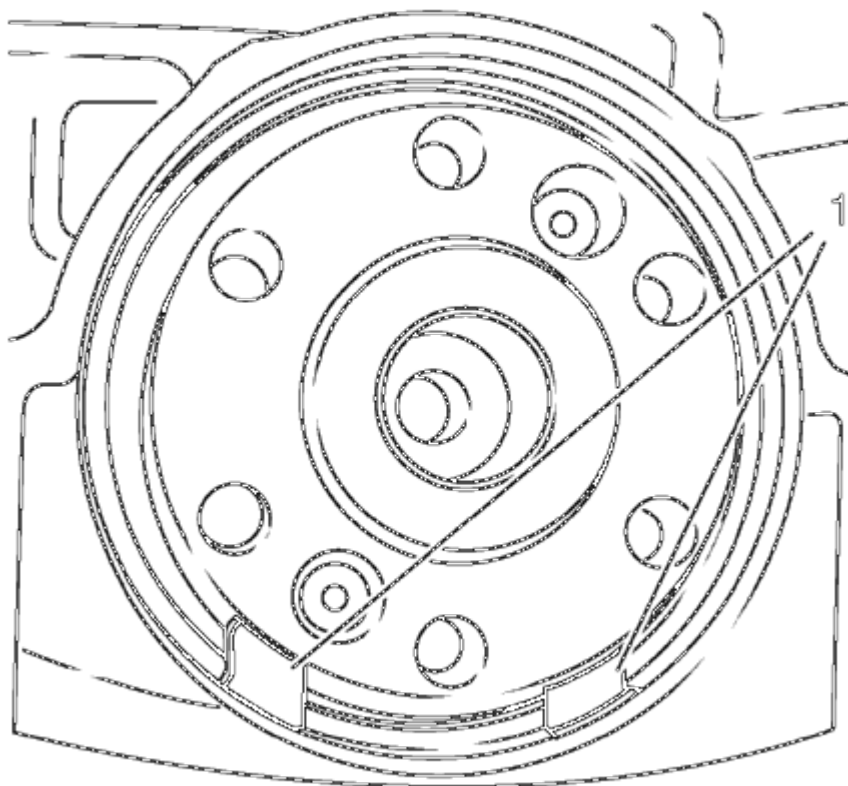


**Fig. 344: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Do not allow the crankshaft encoder wheel to come into contact with external magnetic fields or sharp metal objects. Do not drop the crankshaft encoder wheel. Do not damage the rubberized encoder track. Failure to follow these precautions may cause damage to the component.

3. Remove the crankshaft rear oil seal housing (1).
4. Remove the crankshaft position sensor reluctor ring (2).

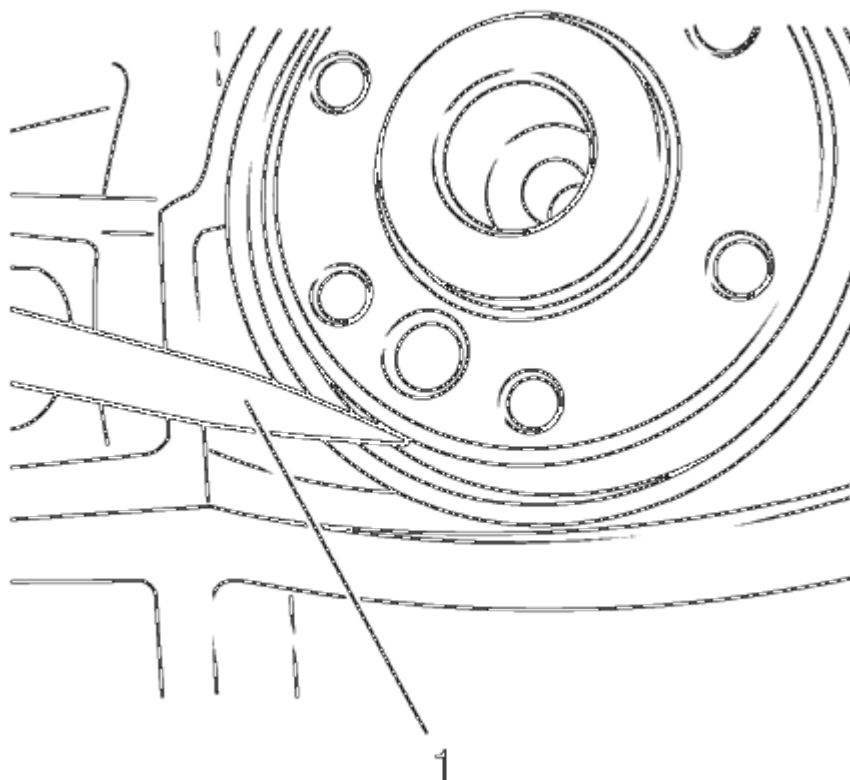




**Fig. 345: Holes At 5 O'clock And 7 O'clock Positions**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The diameter of the hole must not exceed 2 mm (0.0787 in). If the diameter of the hole exceeds 2 mm (0.0787 in), the bolt of EN-6624 remover will not be able to grip.

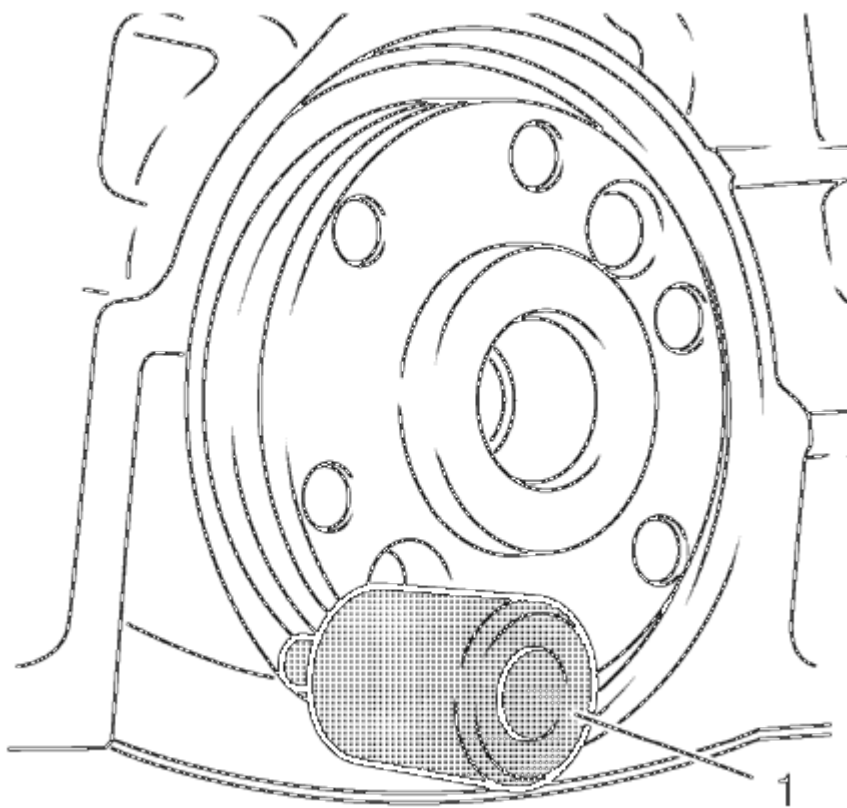
5. Only make a hole at the 5 o'clock and 7 o'clock positions (1), these are the only positions where is a cavity behind the seal ring.

**Fig. 346: Scribe Tool****Courtesy of GENERAL MOTORS COMPANY**

6. Using a suitable tool, such as a scribe (1), make a hole in the crankshaft rear oil seal.

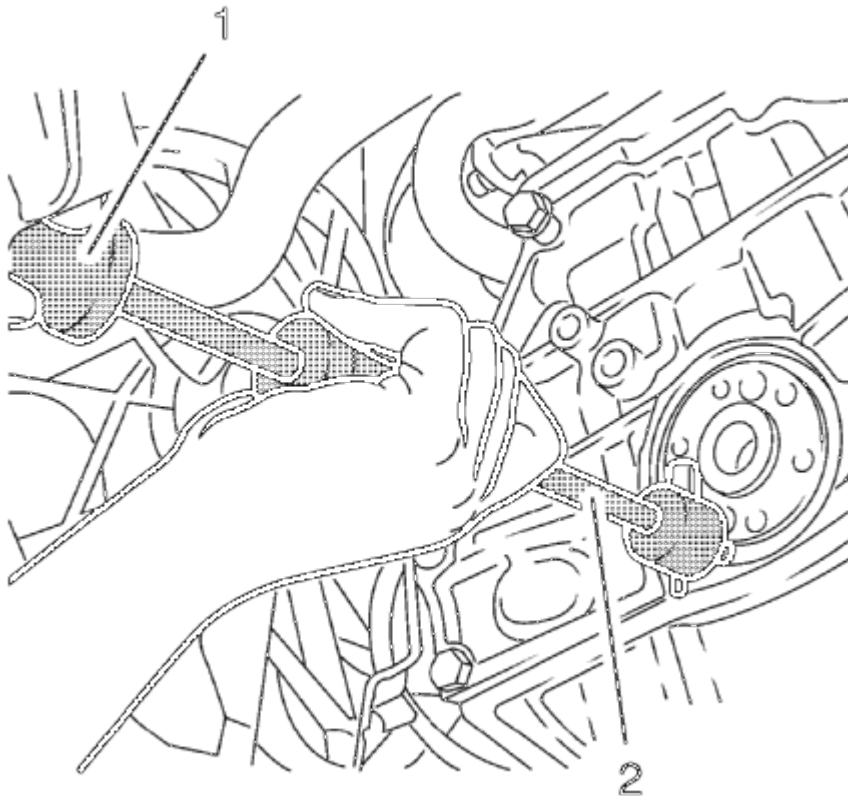
Position the scribe (1) at the outer edge of the crankshaft rear oil seal.

7. Remove the seal ring.



**Fig. 347: crankshaft Rear Oil Seal Removal Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

8. Install **EN-6624** remover (1) to the crankshaft rear oil seal and tighten the bolt.

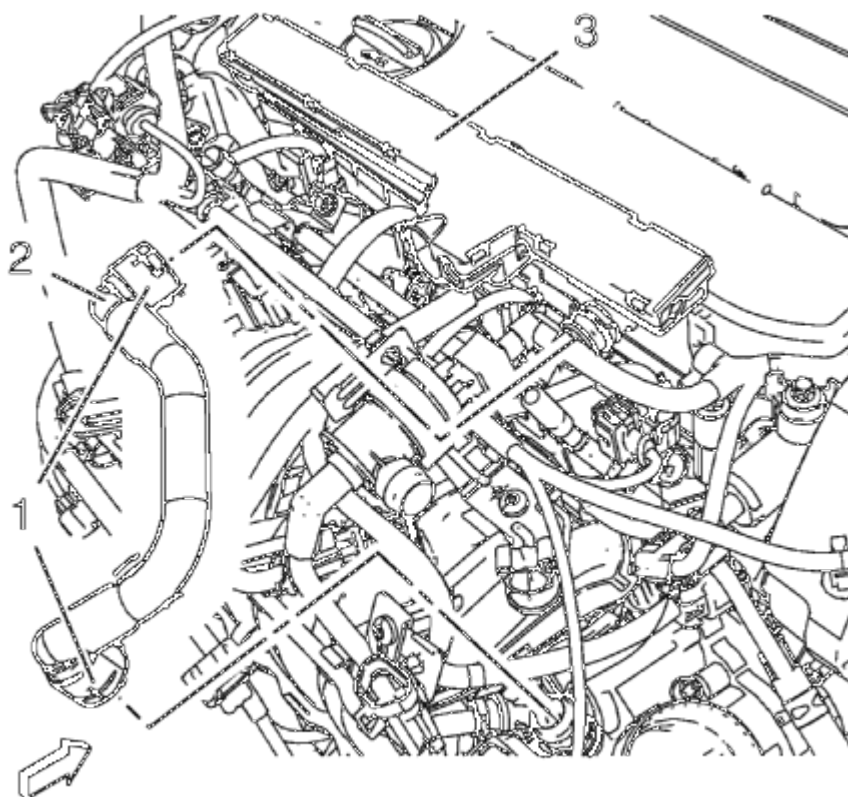


**Fig. 348: Special Removal Tools**

Courtesy of GENERAL MOTORS COMPANY

9. Install the **EN-328-B** remover (1) to **EN-6624** remover (2) and remove the crankshaft rear oil seal.

#### **POSITIVE CRANKCASE VENTILATION PIPE REMOVAL**



**Fig. 349: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide**  
Courtesy of GENERAL MOTORS COMPANY

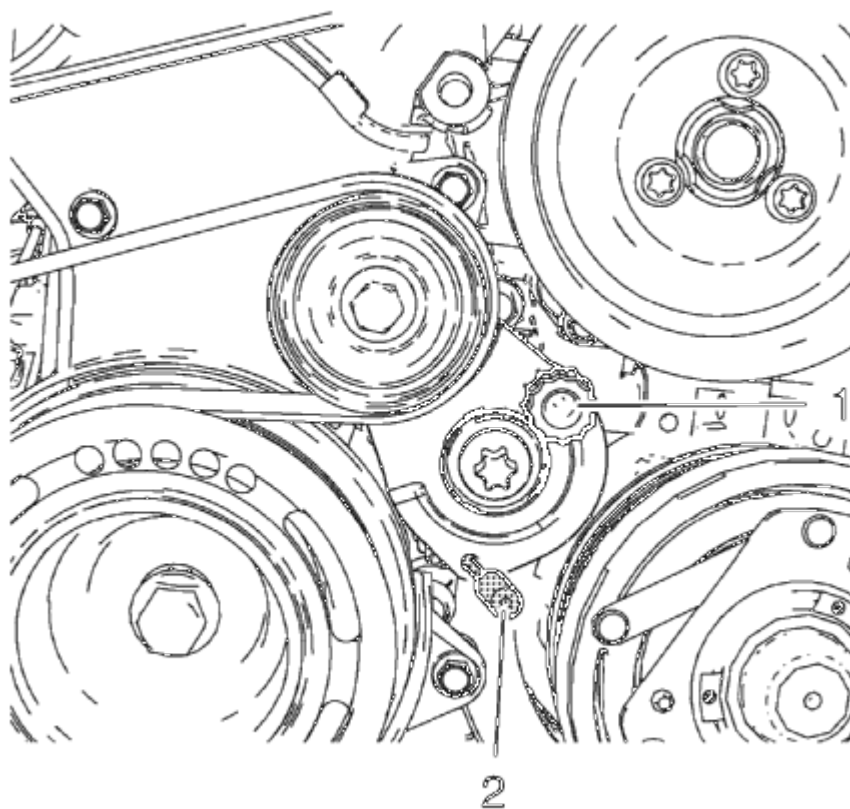
1. Unclip the ECM wiring harness guide (3) from the cylinder head cover.
2. Disconnect the 2 positive crankcase ventilation tube connectors (1).
3. Remove the positive crankcase ventilation tube (2).

## DRIVE BELT REMOVAL

### Special Tools

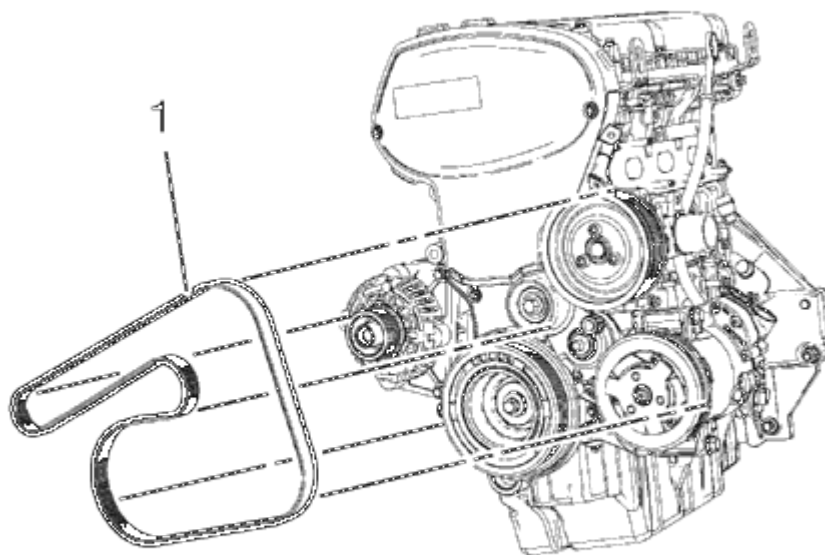
**EN-6349** Locking Pin

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



**Fig. 350: Drive Belt Tensioner And Special Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Release tension to the drive belt tensioner counterclockwise (1) and lock with **EN-6349** pin (2).

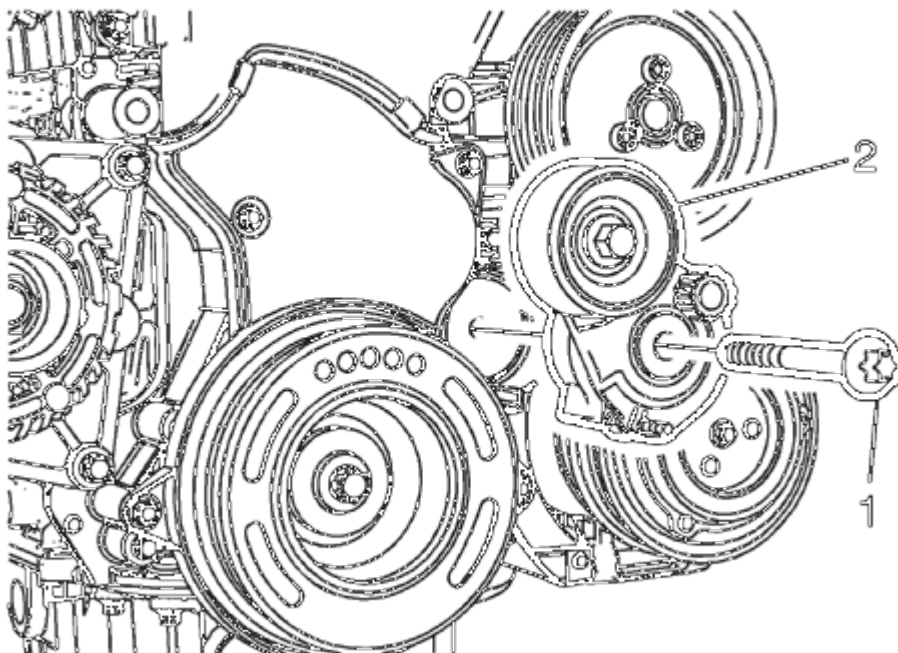


**Fig. 351: Drive Belt Routing**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt (1).

#### **DRIVE BELT TENSIONER REMOVAL**

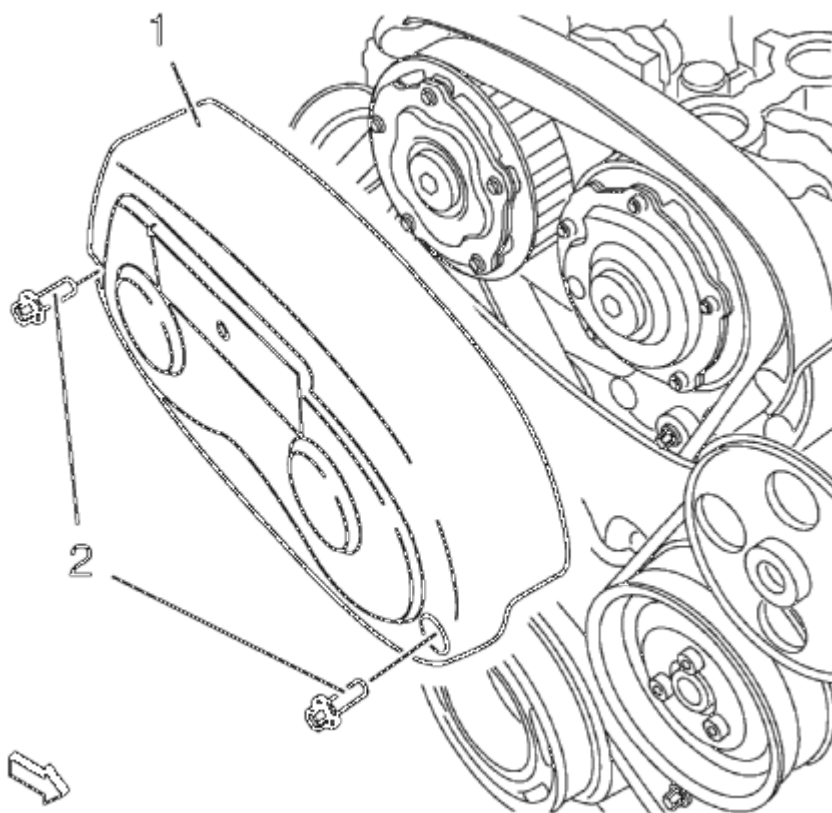


**Fig. 352: Drive Belt Tensioner Bolt**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt tensioner bolt (1).
2. Remove the drive belt tensioner (2).

#### **TIMING BELT UPPER FRONT COVER REMOVAL**



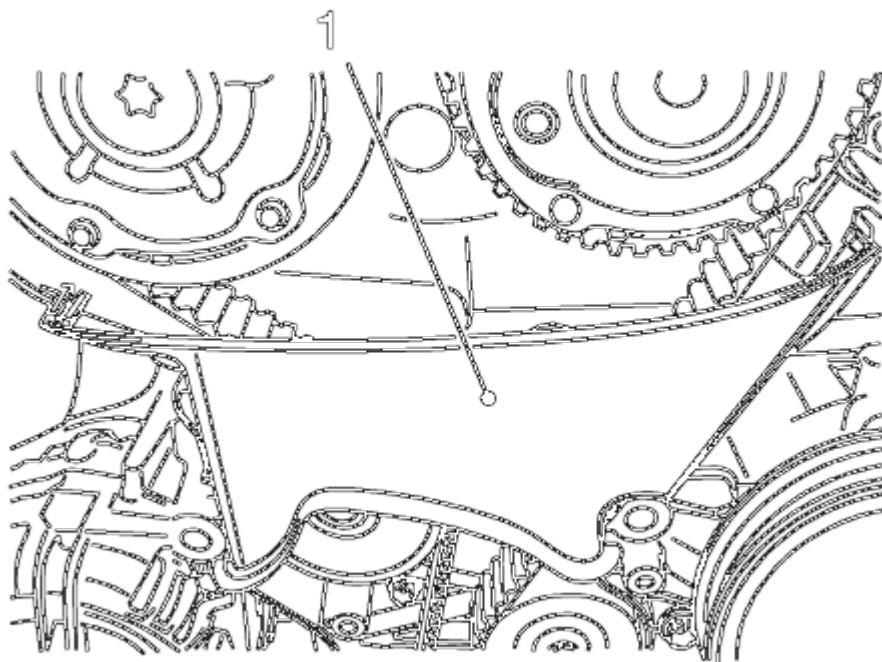


**Fig. 353: Timing Belt Upper Front Cover**

Courtesy of GENERAL MOTORS COMPANY

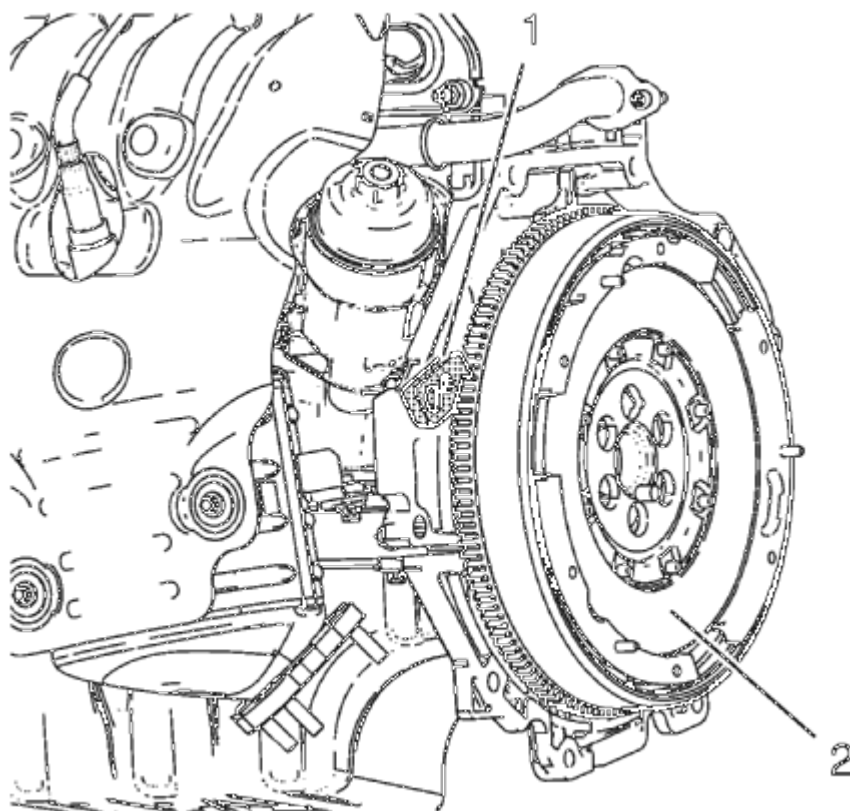
1. Remove the 2 timing belt upper front cover bolts (2).
2. Remove the timing belt upper front cover (1).

#### **TIMING BELT CENTER FRONT COVER REMOVAL**

**Fig. 354: Toothed Belt Cover****Courtesy of GENERAL MOTORS COMPANY**

1. Remove the center front timing belt cover from the rear timing belt cover at 2 locations.
2. Remove the center front timing belt cover (1).

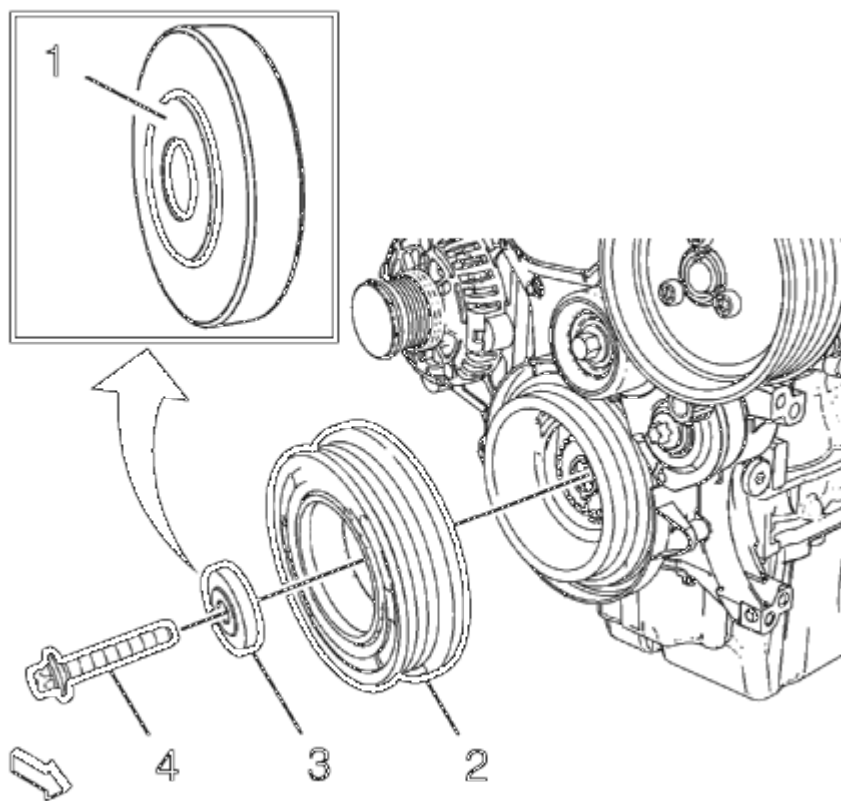
**CRANKSHAFT BALANCER REMOVAL****Special Tools****EN-652** Flywheel HolderFor equivalent regional tools, refer to **Special Tools**.



**Fig. 355: Flywheel And Flywheel Holder**

**Courtesy of GENERAL MOTORS COMPANY**

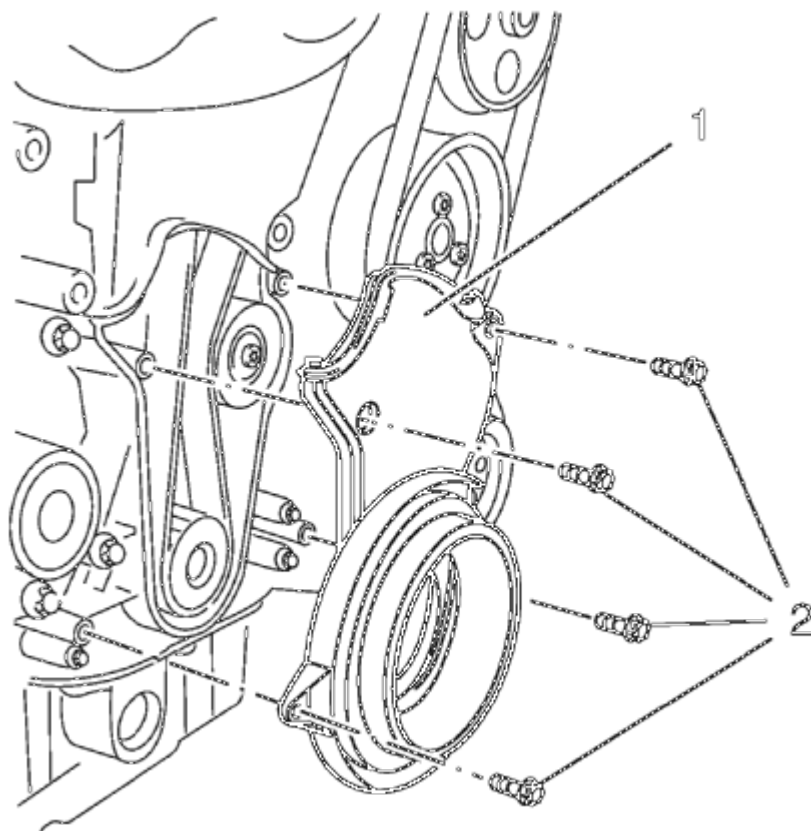
1. Install the **EN-652** holder (1). Lock the flywheel (2) or the automatic transmission flex plate via the starter ring gear.



**Fig. 356: Crankshaft Balancer, Washer And Bolt**  
 Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the crankshaft balancer bolt (4).
3. Remove the crankshaft balancer washer (3).
4. Remove the crankshaft balancer (2).

#### **TIMING BELT LOWER FRONT COVER REMOVAL**



**Fig. 357: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

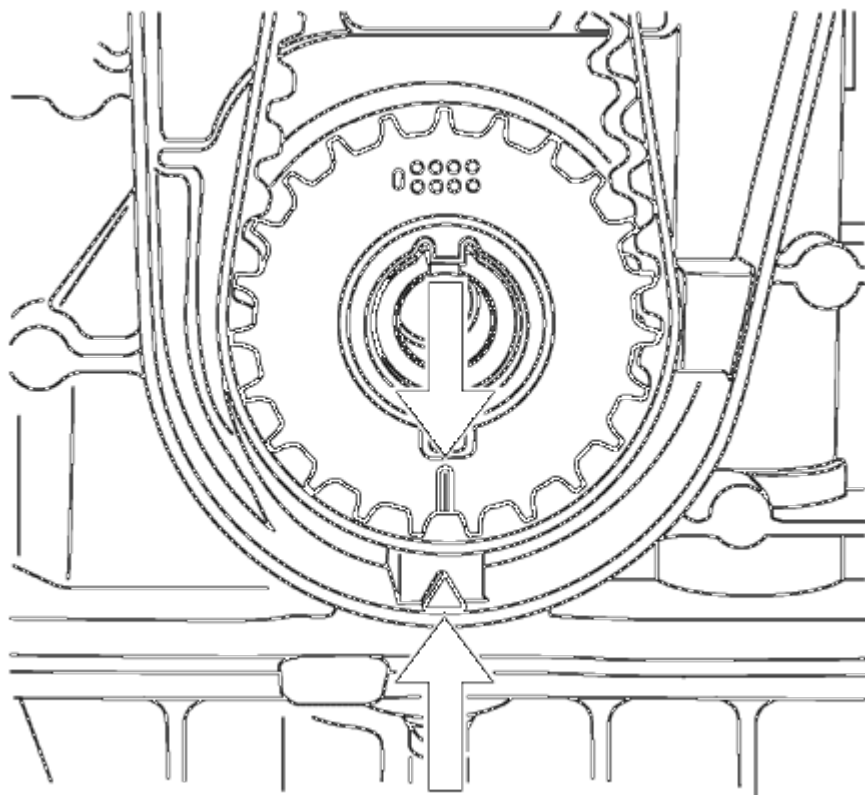
1. Remove the 4 timing belt lower front cover bolts (2).
2. Remove the timing belt lower front cover (1).

## TIMING BELT REMOVAL

### Special Tools

- EN-6333 Locking Pin
- EN-6340 Locking Tool

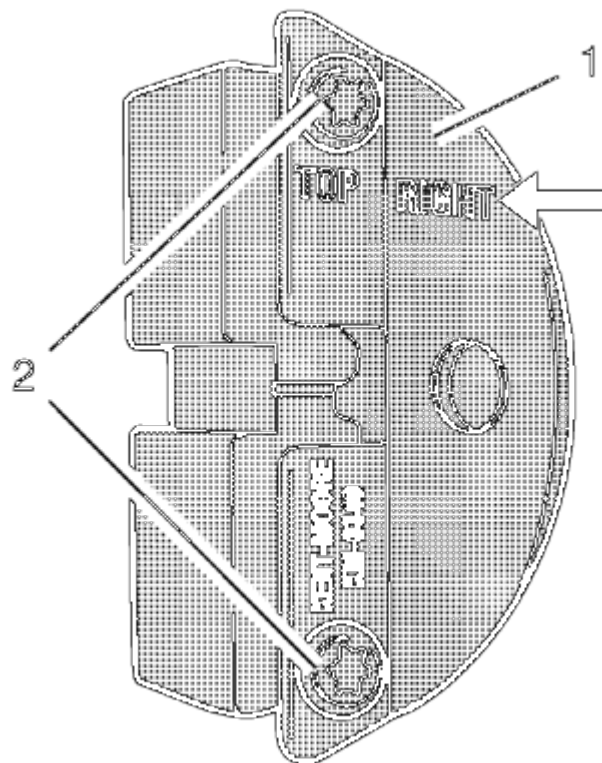
For equivalent regional tools, refer to **Special Tools**.



**Fig. 358: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **The timing belt drive gear and oil pump housing must align.**

1. Turn the crankshaft in the direction of engine rotation, by the crankshaft balancer bolt, to cylinder 1 TDC of combustion stroke.

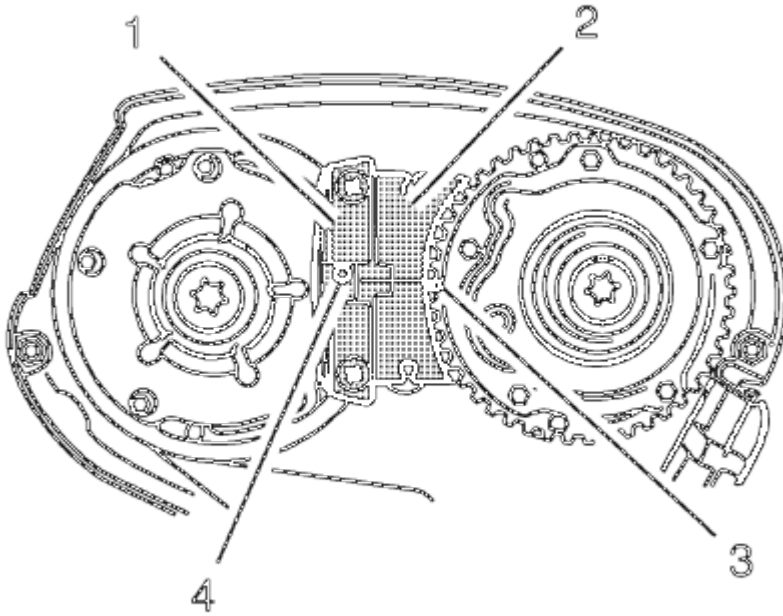


**Fig. 359: Front Panel And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering right, arrow, on the tool.

2. Prepare the right half of the **EN-6340** locking tool.
  1. Remove the 2 bolts (2).
  2. Detach the front panel (1) from the **EN-6340** locking tool - right.



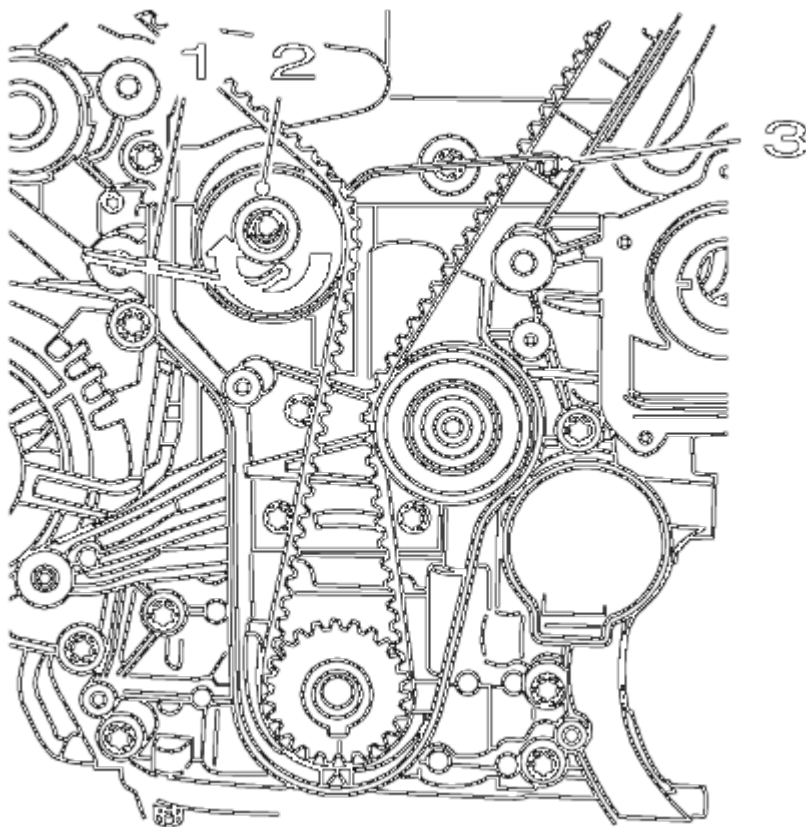
**Fig. 360: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of the EN-6340 locking tool - left (1) during this process, but must be somewhat above.
- The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right (2).

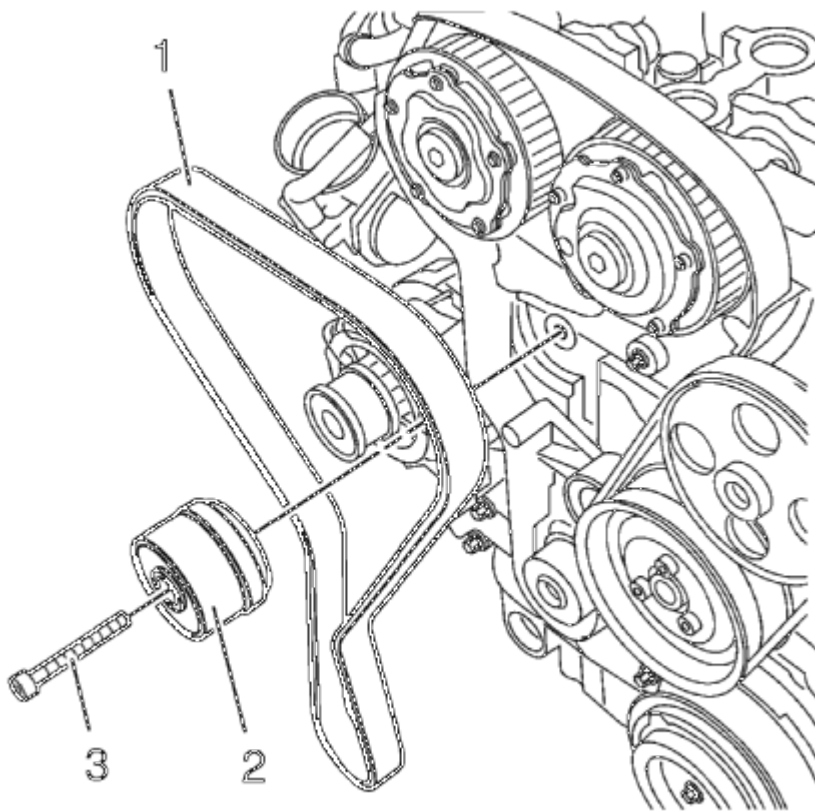
3. Insert the **EN-6340** locking tool - left (1) and the **EN-6340** locking tool - right (2) in the camshaft adjuster.





**Fig. 361: Drive Belt Tensioner, Allen Key And Locking Pin**  
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-6333** locking pin (3), apply tension to the timing belt tension roller (2) in the direction of the arrow, using an Allen key (1).
5. Stop the timing belt tensioner.

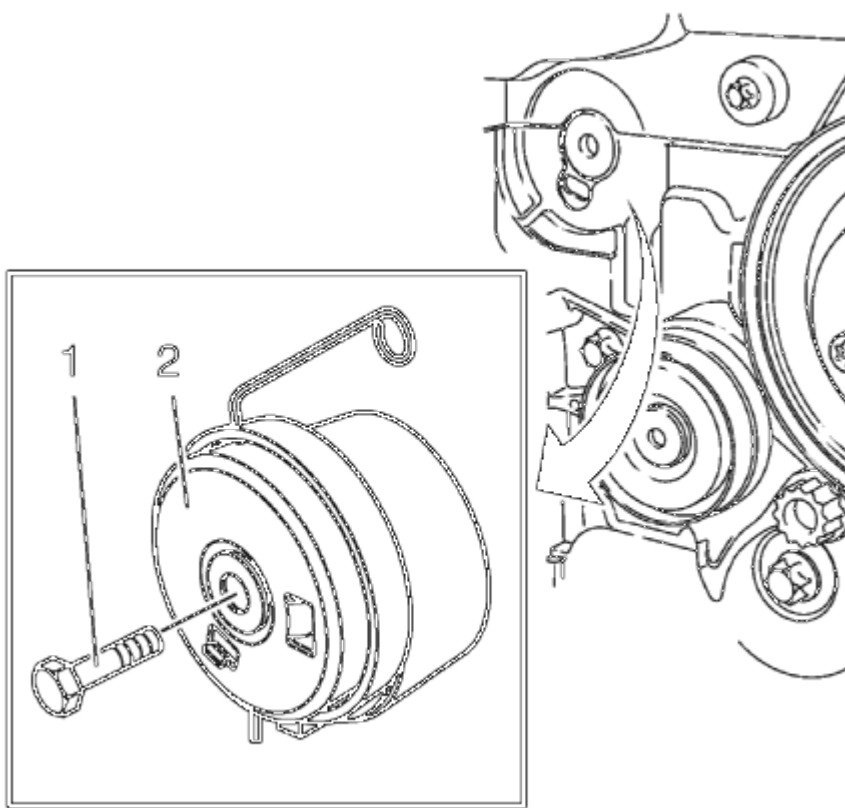


**Fig. 362: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Observe direction of rotation.**

6. Remove the timing belt (1).

#### **TIMING BELT TENSIONER REMOVAL**

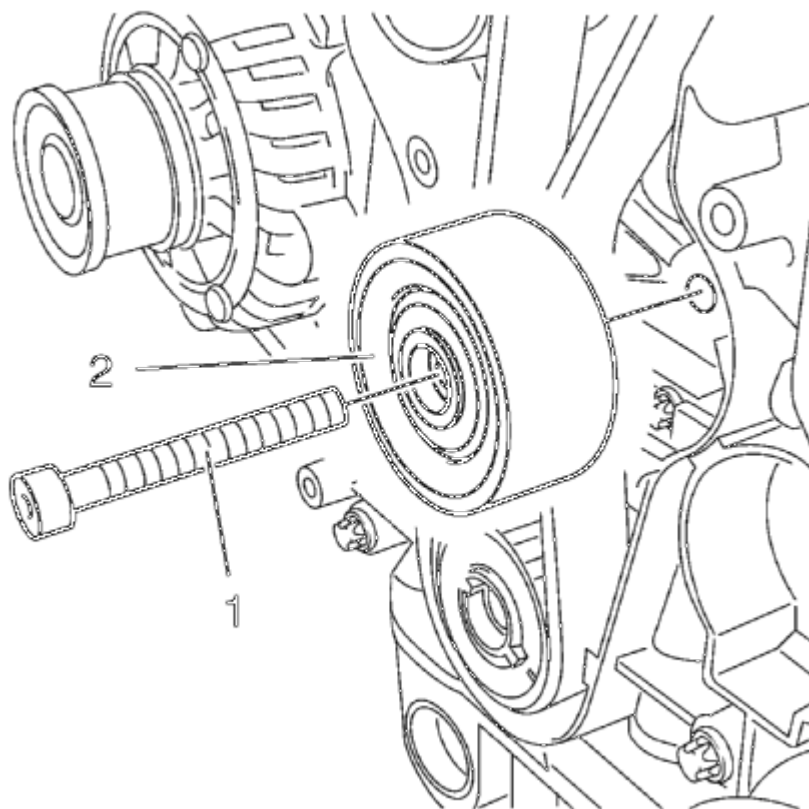


**Fig. 363: Timing Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the tensioner bolt (1).
2. Remove the timing belt tensioner (2).

#### **TIMING BELT IDLER PULLEY REMOVAL**

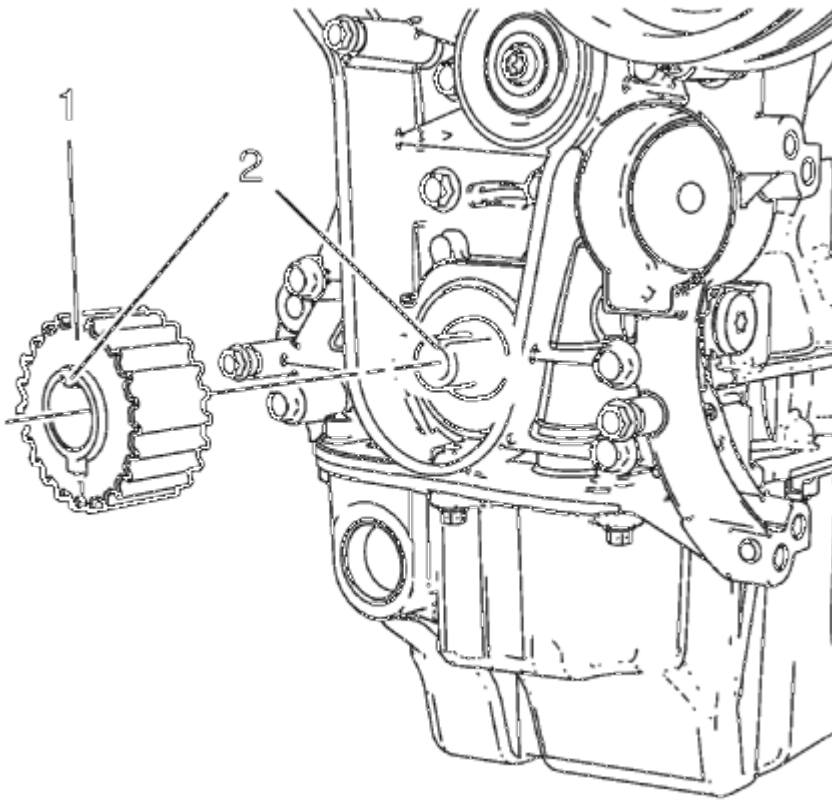


**Fig. 364: Timing Belt Idler Pulley Bolt**

**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the timing belt idler pulley bolt (1).
2. Remove the timing belt idler pulley (2).

## **CRANKSHAFT SPROCKET REMOVAL**

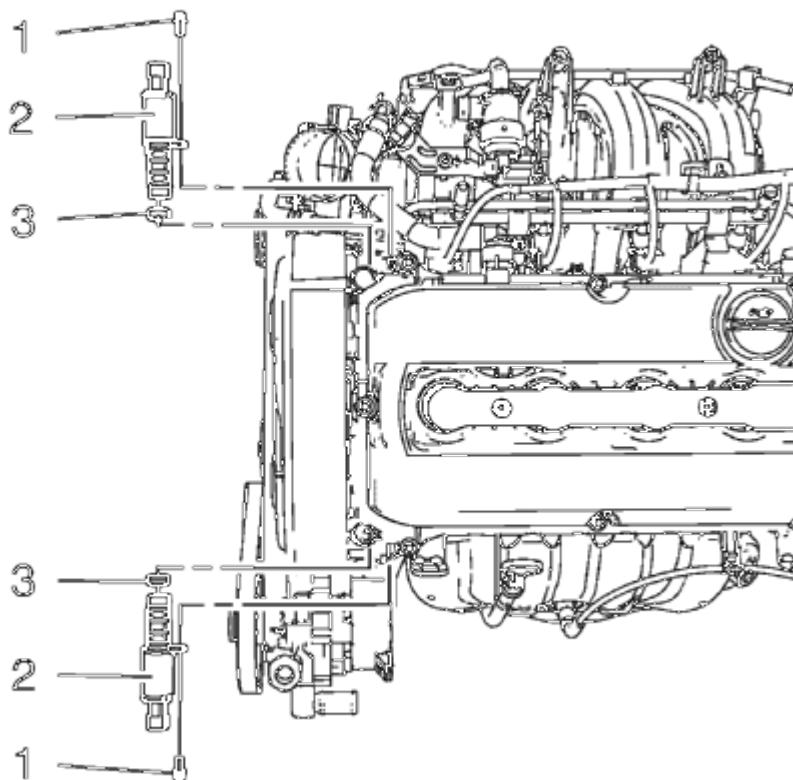


**Fig. 365: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

Remove the crankshaft sprocket (1).

#### **CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REMOVAL**



**Fig. 366: Camshaft Position Actuator Solenoid Valves, Bolts And Seals**  
Courtesy of GENERAL MOTORS COMPANY

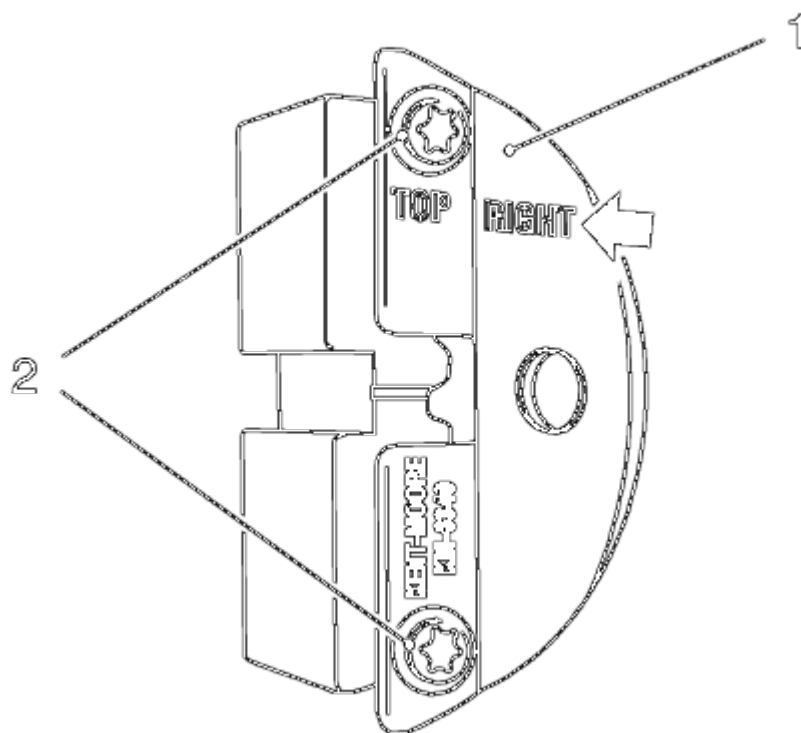
1. Remove the camshaft position actuator solenoid valve bolts (1).
2. Remove the camshaft position actuator solenoid valves (2).
3. Remove the camshaft position actuator solenoid valve seals (3).

### CAMSHAFT POSITION ACTUATOR ADJUSTER REMOVAL

#### Special Tools

- **EN-6340** Camshaft Adjuster Locking Tool
- **EN-6628-A** Camshaft Locking Tool

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

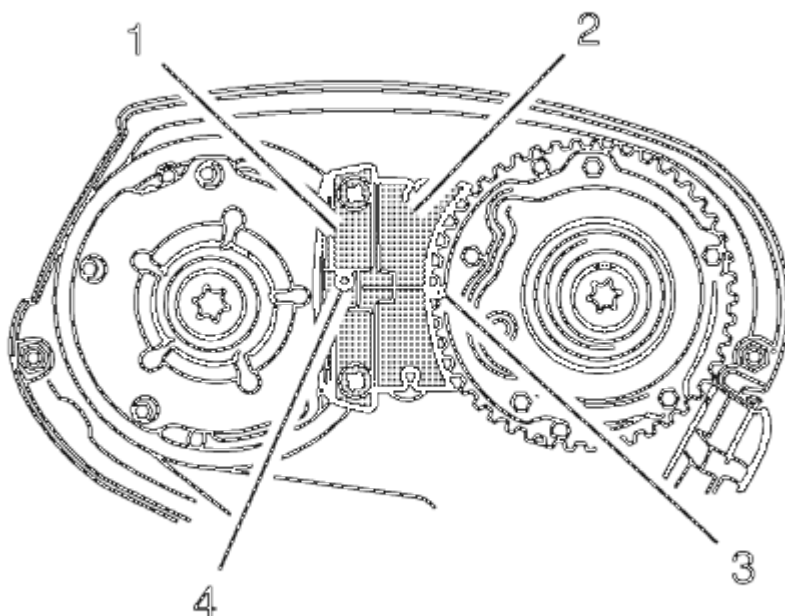


**Fig. 367: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering "right", arrow, on the tool.

1. Prepare the right half of the **EN-6340** locking tool.
  1. Remove the 2 bolts (2).
  2. Remove the front panel (1) from the **EN-6340** locking tool - right.



**Fig. 368: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-6340** locking tool into the camshaft adjusters.

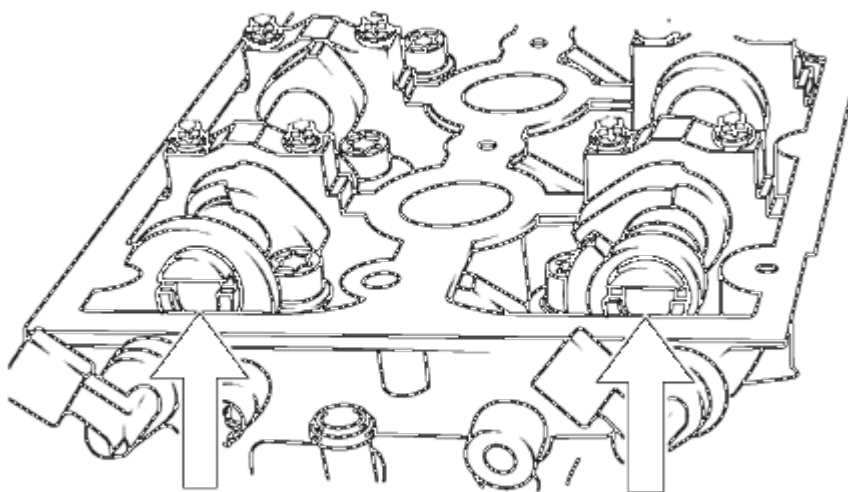
**NOTE:** The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of EN-6340 locking tool - left during this process but must be somewhat above as shown.

- Install the **EN-6340** locking tool - left (1) into the camshaft adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right.

- Install **EN-6340** locking tool - right (2) into the camshaft adjusters as shown.

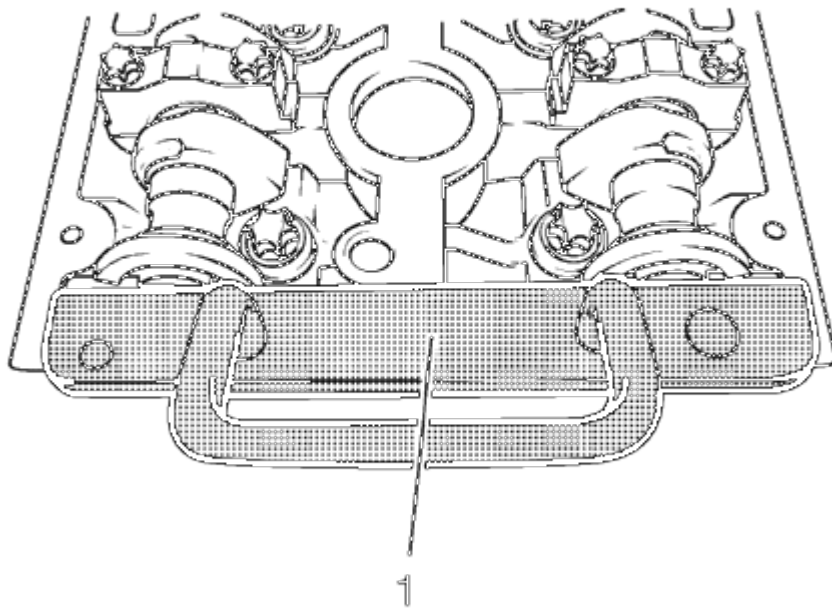




**Fig. 369: Aligning Camshafts Horizontally**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Note the arrows.**

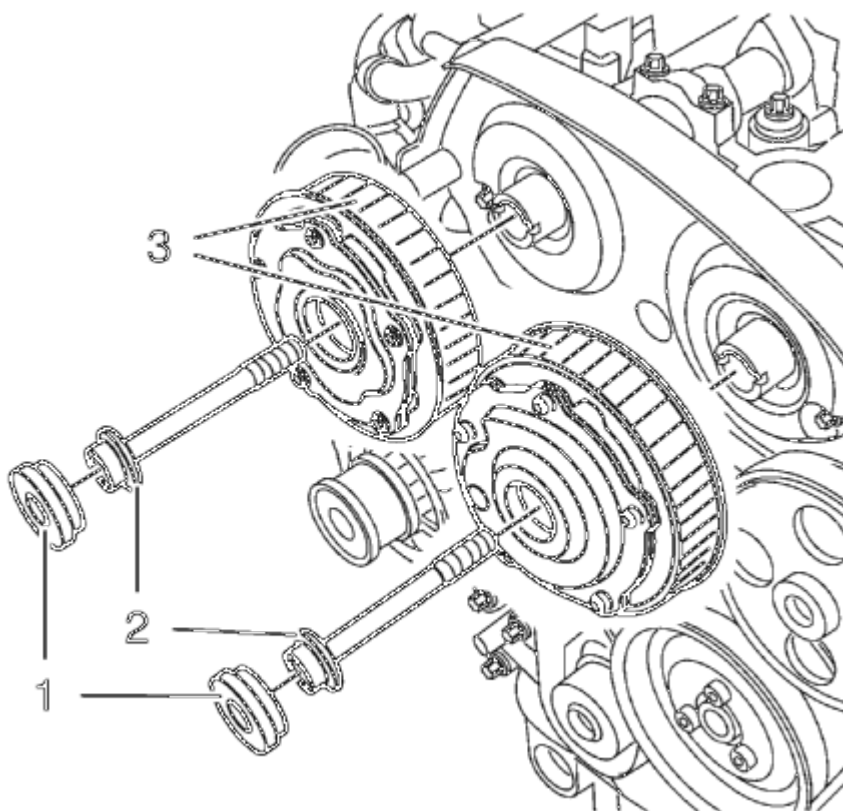
3. Turn the camshaft by the hexagon until the groove on the end of the camshafts is horizontal.



**Fig. 370: Locking Tool**

**Courtesy of GENERAL MOTORS COMPANY**

4. Install the **EN-6628-A** locking tool (1).



**Fig. 371: Camshaft Position Actuator Adjuster Closure Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

5. Remove the camshaft position actuator adjuster closure bolt (1) of the intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).

**NOTE:**        **A second technician is required.**

**NOTE:**        **Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The usage of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.**

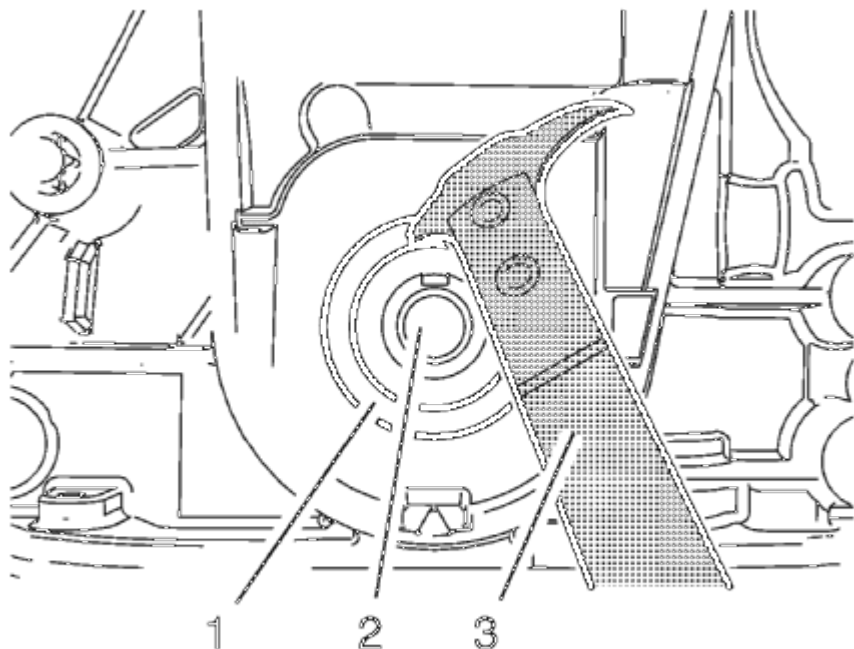
6. Remove and DISCARD the intake camshaft position actuator adjuster bolt and/or the exhaust camshaft position actuator adjuster bolt (2).
7. Remove the intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).

## CRANKSHAFT FRONT OIL SEAL REMOVAL

## Special Tools

### EN-45000 Remover

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



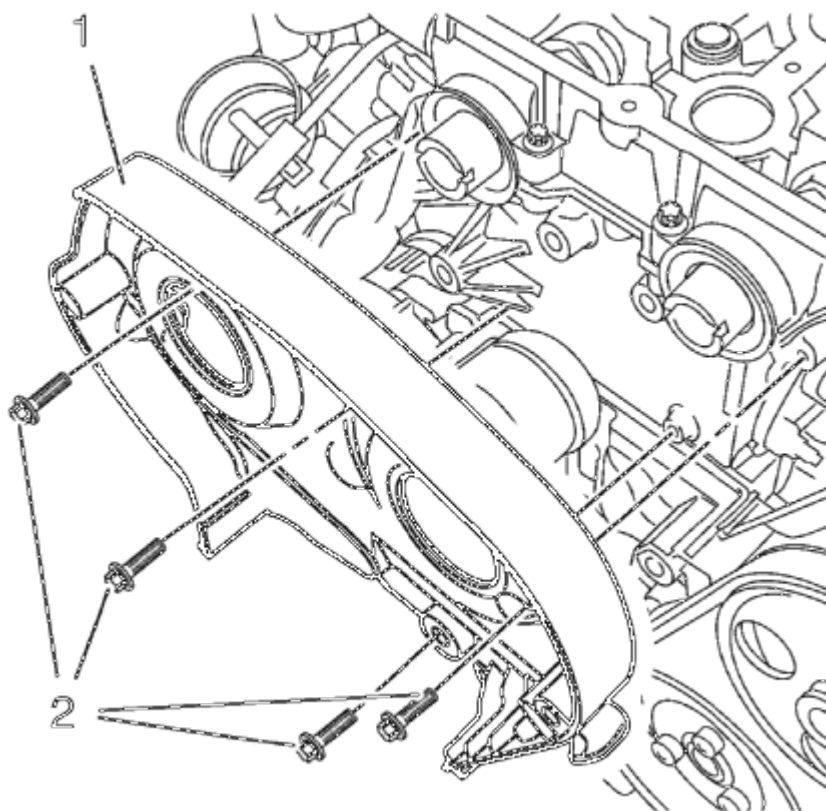
**Fig. 372: Crankshaft Front Oil Seal Removal Tool**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Clean the crankshaft sealing surface with a clean, lint-free towel. Inspect lead-in edge of crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove burrs/sharp edges with crocus cloth before proceeding.

Using the **EN-45000** remover (3), remove the crankshaft front oil seal (1) from the crankshaft (2).

## TIMING BELT REAR COVER REMOVAL

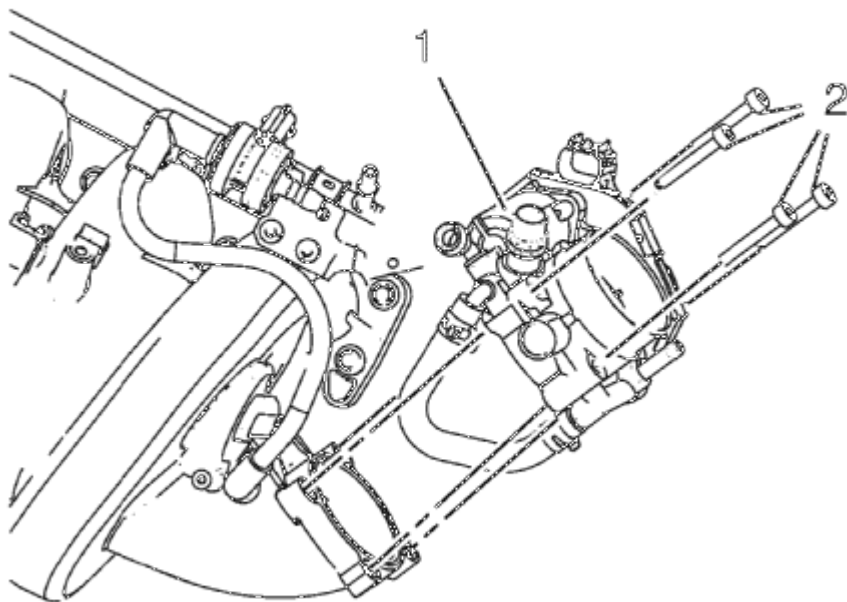


**Fig. 373: Timing Belt Rear Cover And Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

1. Remove and DISCARD the 4 timing belt rear cover bolts (2).
2. Remove the timing belt rear cover (1).

## **THROTTLE BODY ASSEMBLY REMOVAL**

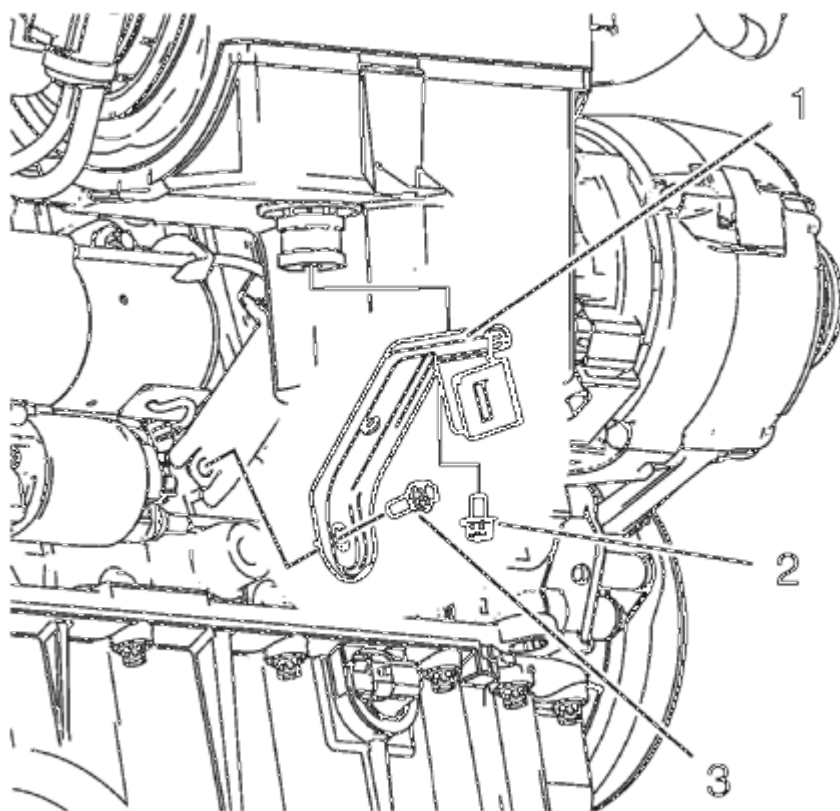


**Fig. 374: Throttle Body And Bolts**

Courtesy of GENERAL MOTORS COMPANY

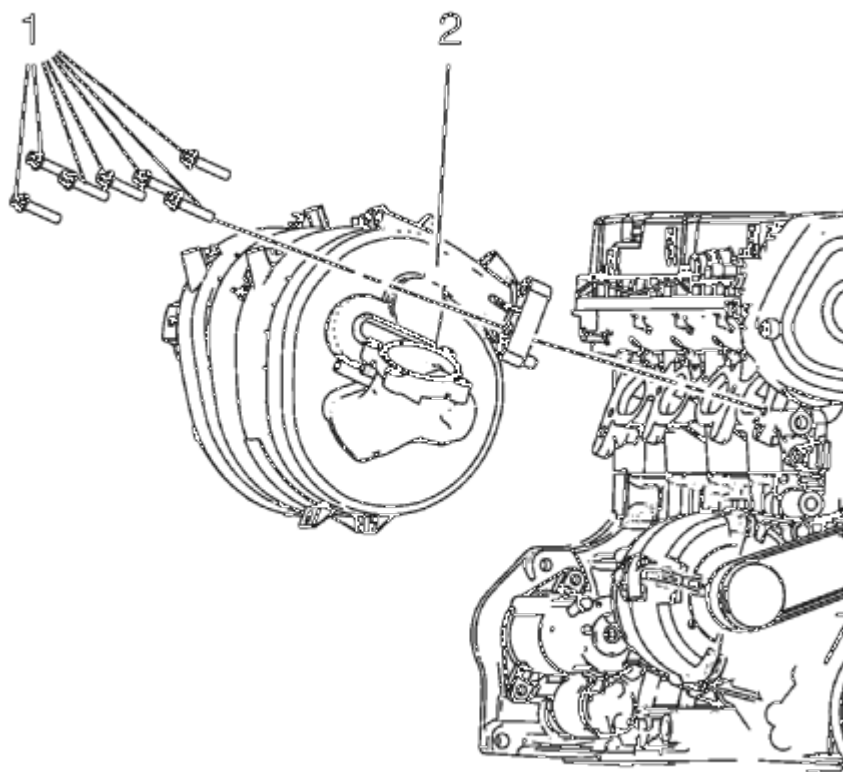
1. Remove the 4 throttle body bolts (2).
2. Remove the throttle body (1).
3. Remove the throttle body seal.

## INTAKE MANIFOLD REMOVAL



**Fig. 375: Intake Manifold Brace And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 intake manifold brace bolts (2, 3).
2. Remove the intake manifold brace (1).



**Fig. 376: Intake Manifold And Bolts**

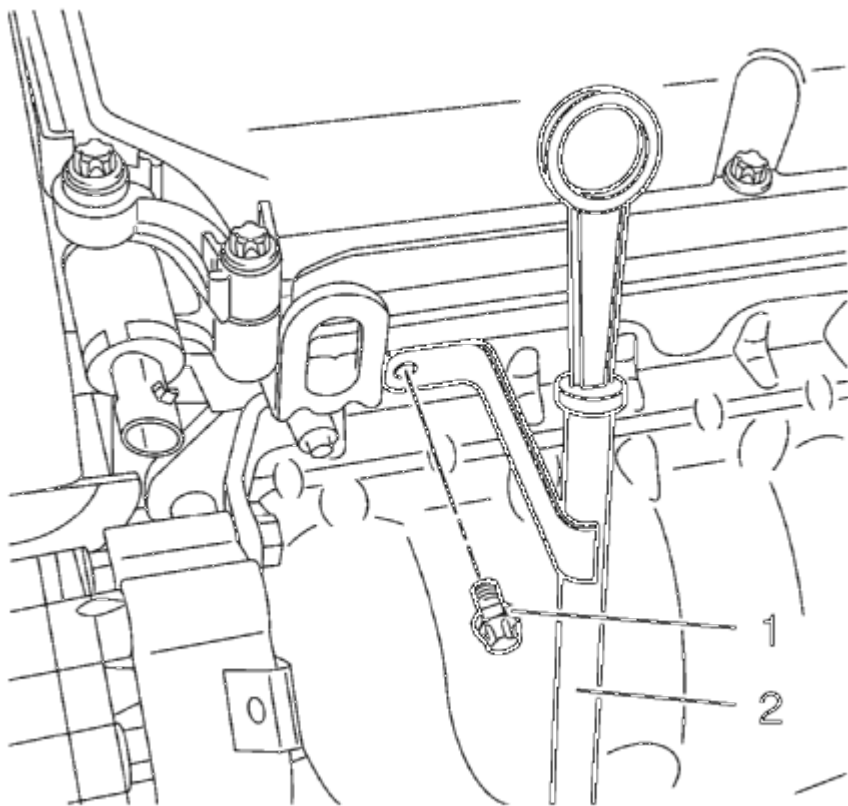
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 7 intake manifold bolts (1).
4. Remove the intake manifold (2) and the 4 intake manifold gaskets.

#### **OIL LEVEL INDICATOR AND TUBE REMOVAL**

1. Remove the oil dipstick.





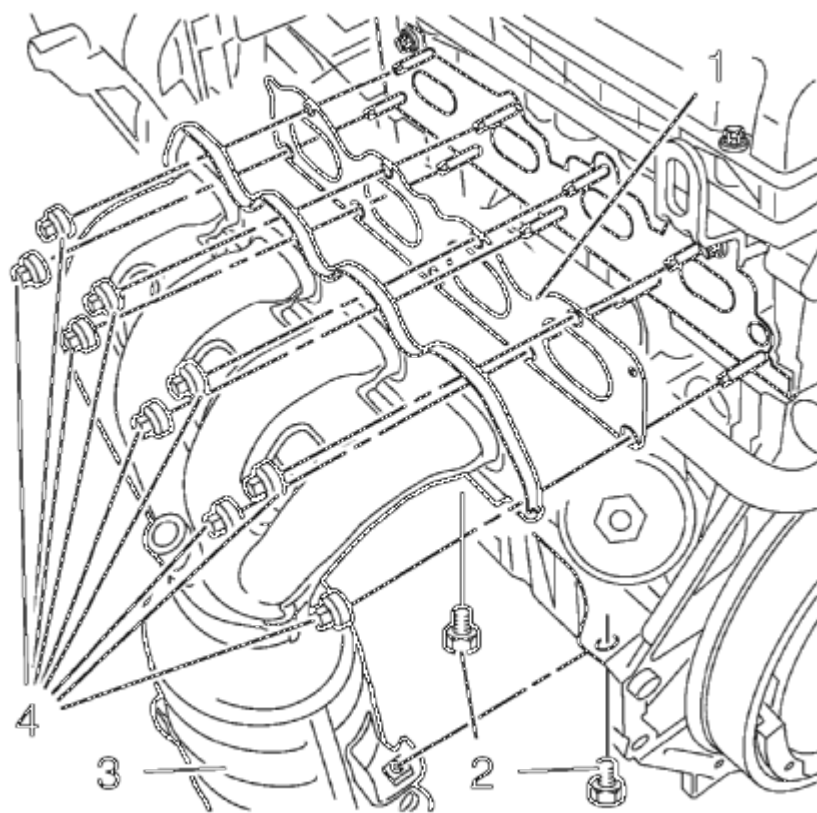
**Fig. 377: Oil Level Indicator Tube And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator tube bolt (1).

**NOTE:** If the engine oil level is at the maximum level, oil may emerge while removing the oil dipstick guide tube.

3. Remove the oil level indicator tube (2) and oil level indicator seal.

## EXHAUST MANIFOLD REMOVAL

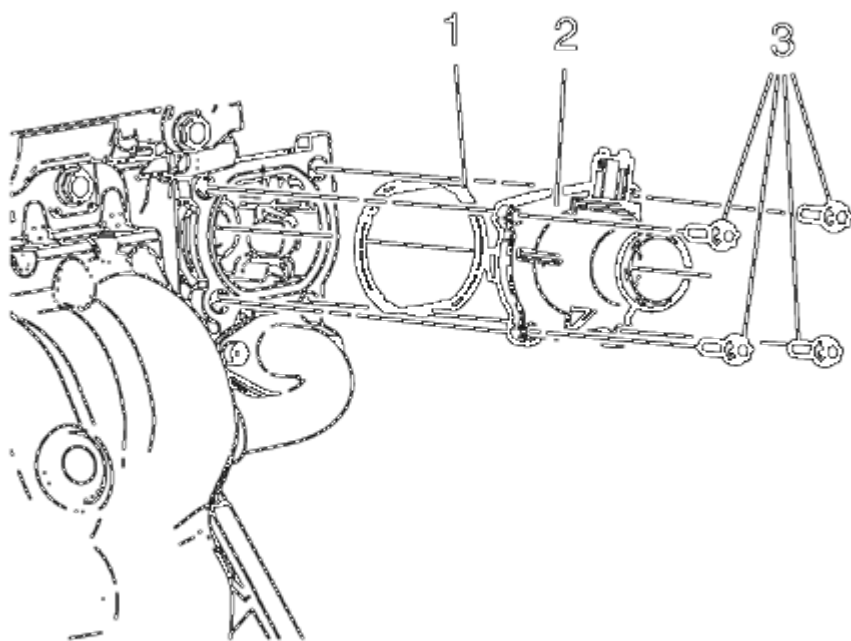


**Fig. 378: Exhaust Manifold And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 9 exhaust manifold nuts (4).
2. Remove the 2 exhaust manifold bolts (2)
3. Remove the exhaust manifold (3) and gasket (1).
4. Clean all of the gasket surfaces.

## ENGINE COOLANT THERMOSTAT REMOVAL

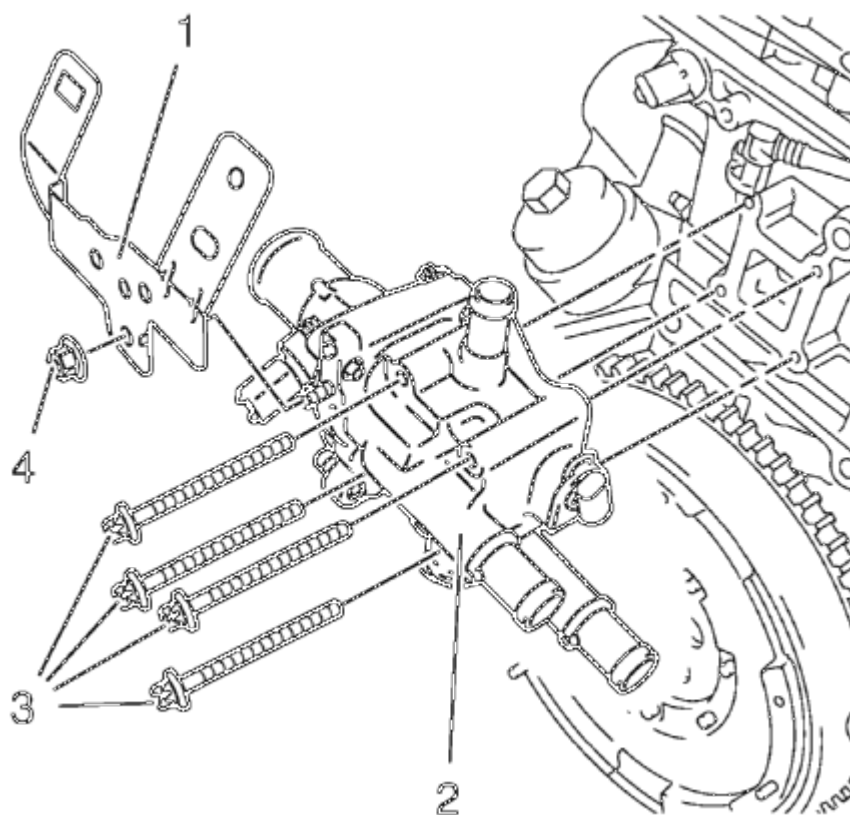


**Fig. 379: Engine Coolant Thermostat Assembly**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Engine Coolant Thermostat Housing Caution .

1. Remove the 4 engine coolant thermostat bolts (3).
2. Remove the engine coolant thermostat assembly (2).
3. Remove the engine coolant seal (1).

#### **ENGINE COOLANT THERMOSTAT HOUSING REMOVAL**

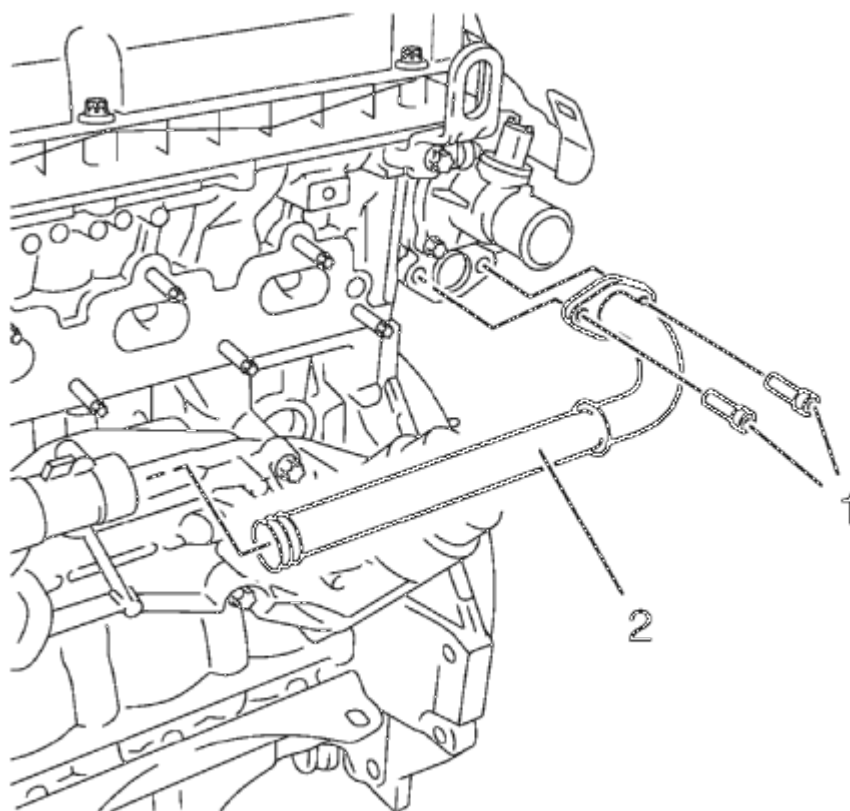


**Fig. 380: Engine Coolant Thermostat Housing**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Engine Coolant Thermostat Housing Caution .

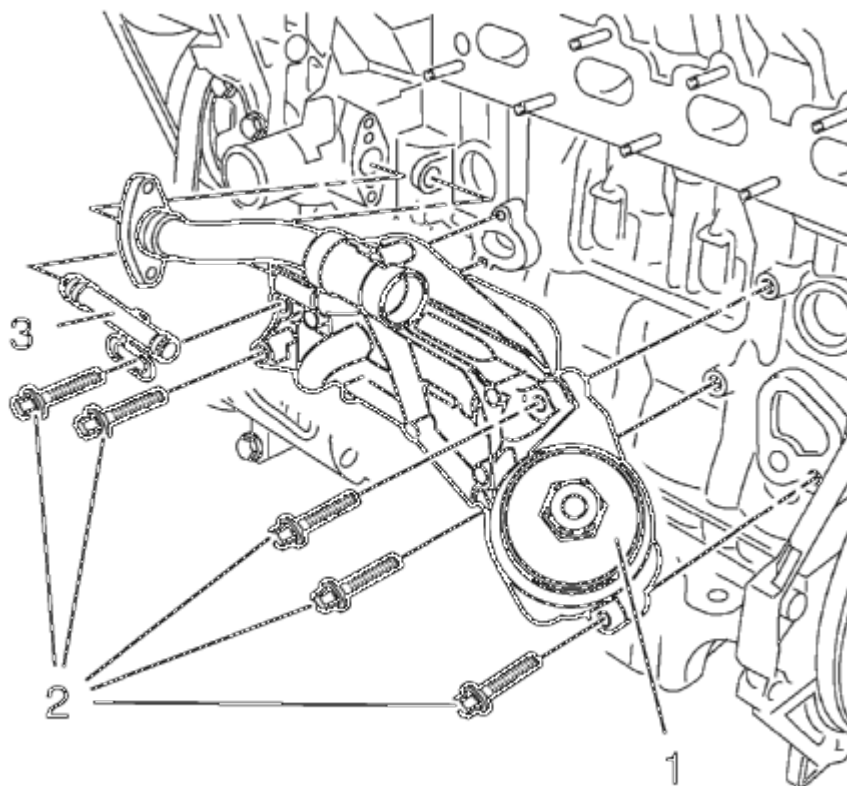
1. Remove the engine coolant thermostat housing retainer nut (4).
2. Remove the engine coolant thermostat housing retainer (1).
3. Remove the 4 engine coolant thermostat housing bolts (3).
4. Remove the engine coolant thermostat housing (2).

## ENGINE OIL COOLER HOUSING REMOVAL



**Fig. 381: Engine Oil Cooler Outlet Pipe And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

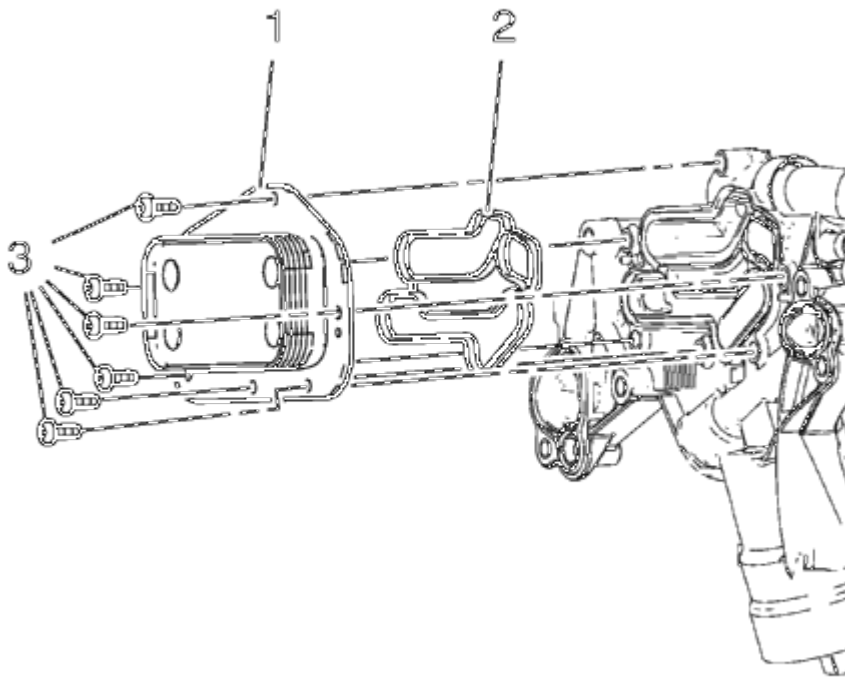
1. Remove the 2 engine oil cooler pipe bolts (1).
2. Remove the oil cooler pipe (2).



**Fig. 382: Engine Oil Cooler Housing, Bolts And Engine Oil Cooler Inlet Pipe**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 5 engine oil cooler housing bolts (2).
4. Remove the engine oil cooler housing (1).
5. Remove the engine oil cooler inlet pipe (3).

#### **ENGINE OIL COOLER REMOVAL**

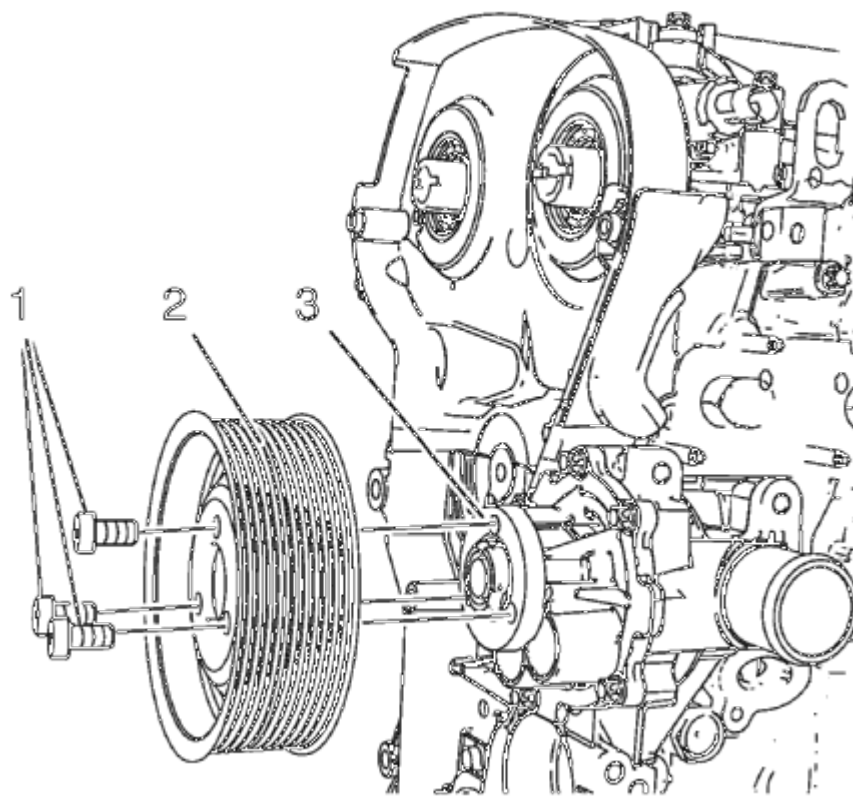


**Fig. 383: Engine Oil Cooler**

Courtesy of GENERAL MOTORS COMPANY

Remove the 6 engine oil cooler bolts (3), the engine oil cooler (1) and the engine oil cooler gasket (2) from the engine oil cooler housing.

### **WATER PUMP PULLEY REMOVAL**



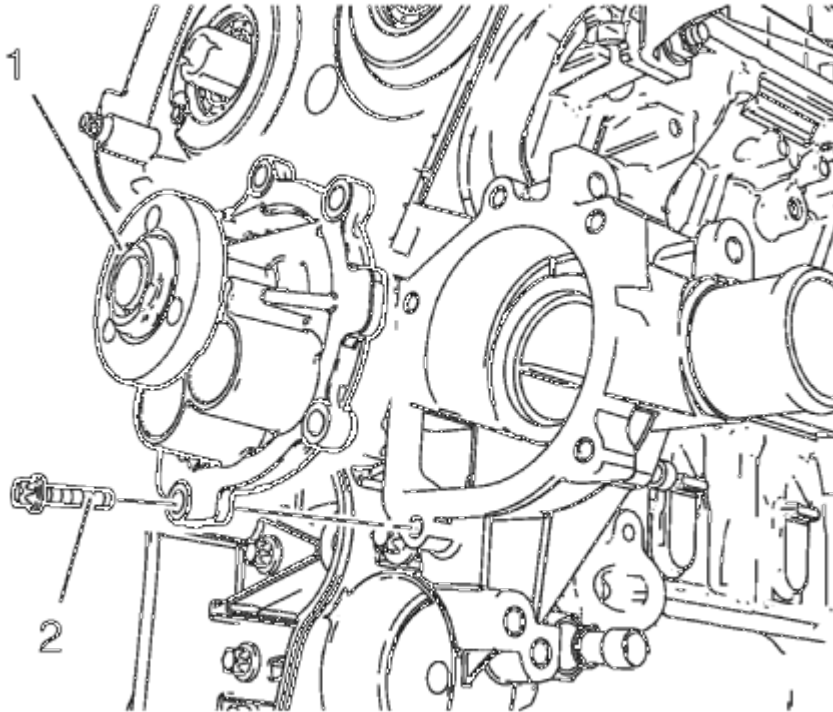
**Fig. 384: Water Pump And Water Pump Pulley**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Counterhold the crankshaft balancer. For this procedure the drive belt has to be installed.

1. Loosen the 3 water pump pulley bolts (1).
2. Remove the 3 water pump pulley bolts (1).
3. Remove the water pump pulley (2) from the water pump (3).

## **WATER PUMP REMOVAL**



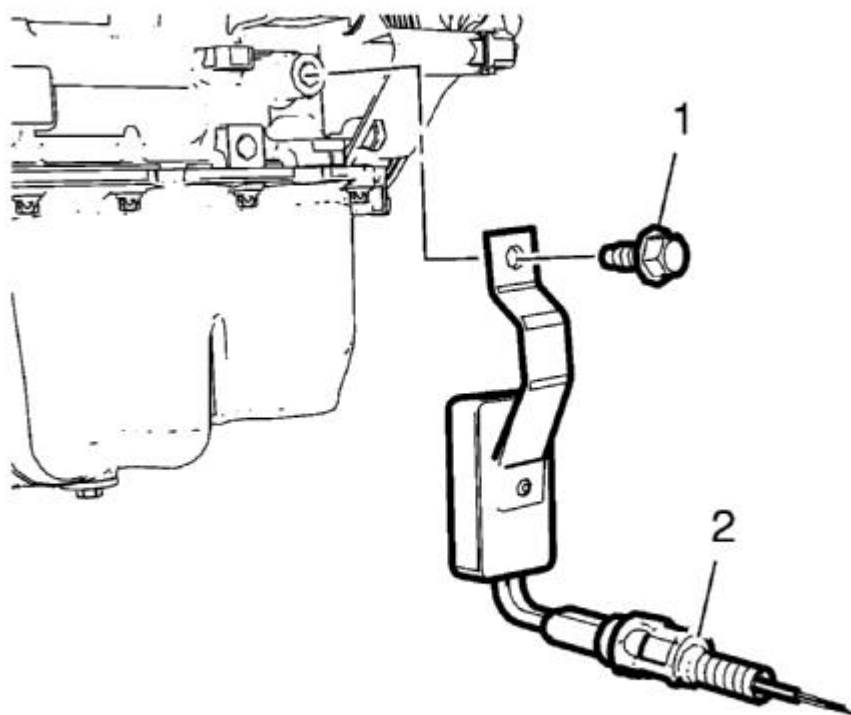


**Fig. 385: Water Pump And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 5 water pump bolts (2).
2. Remove the water pump (1).
3. Remove the water pump seal.

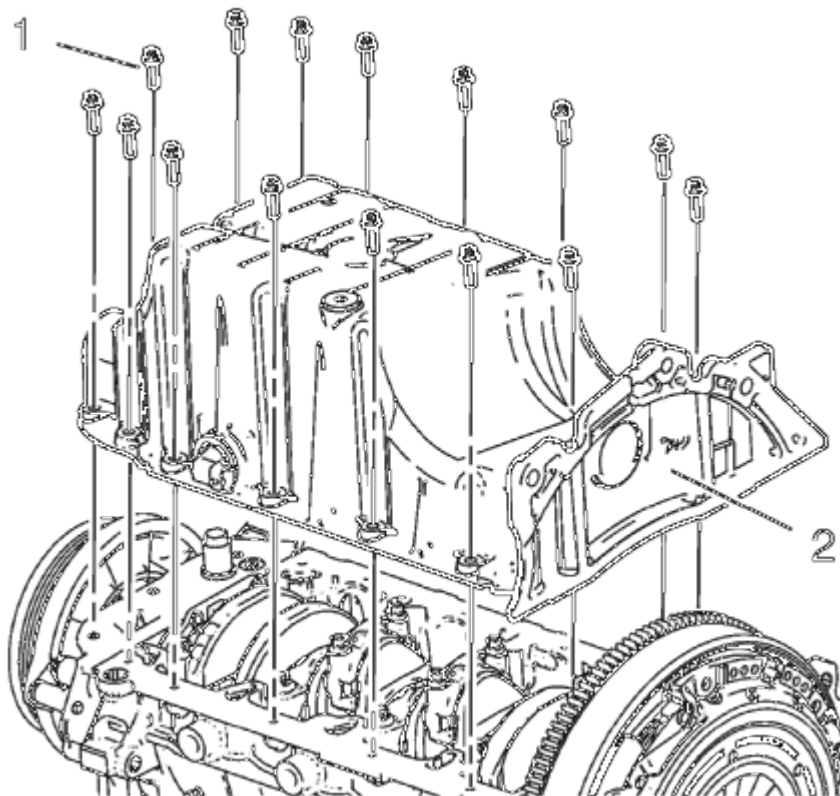
## ENGINE OIL HEATER REMOVAL

**Fig. 386: Engine Oil Heater**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil heater bolt (1).
2. Remove the engine oil heater (2).

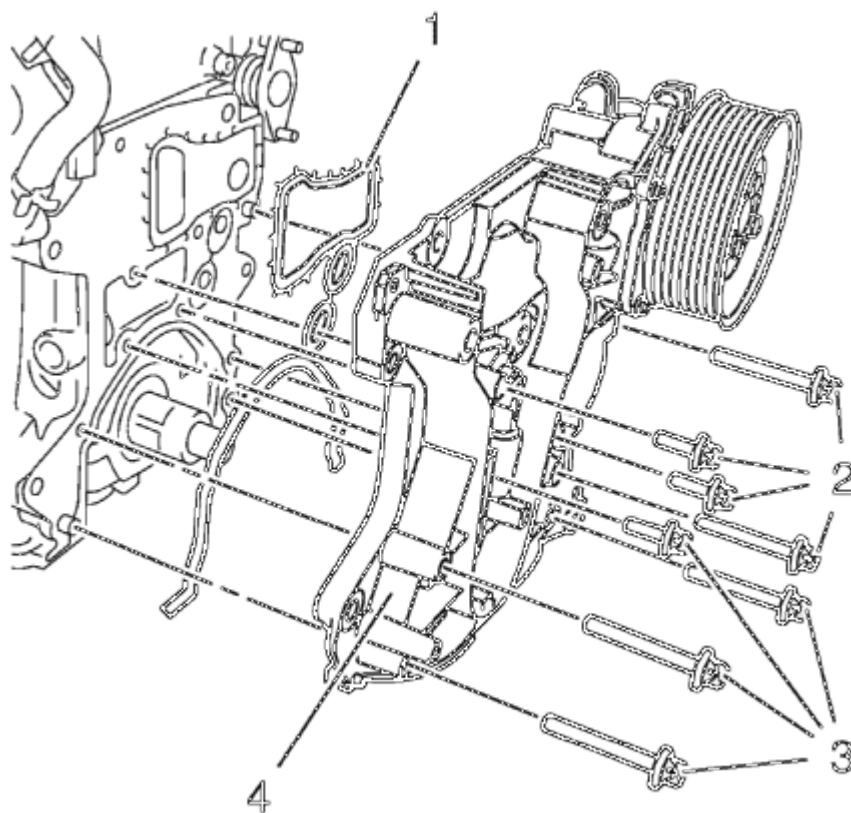
## OIL PAN REMOVAL

**Fig. 387: Oil Pan And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 15 oil pan bolts (1) from the engine block.
2. Use a suitable tool to remove the oil pan (2) evenly all the way around.

## ENGINE FRONT COVER AND OIL PUMP REMOVAL



**Fig. 388: Engine Oil Pump**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Note the different screw lengths.

1. Remove the 8 bolts (2, 3).
2. Remove the engine front cover with the included oil pump (4).
3. Remove the gasket (1).

**NOTE:** Do not damage the sealing surfaces.

4. Clean the sealing surface.

## IGNITION COIL REMOVAL

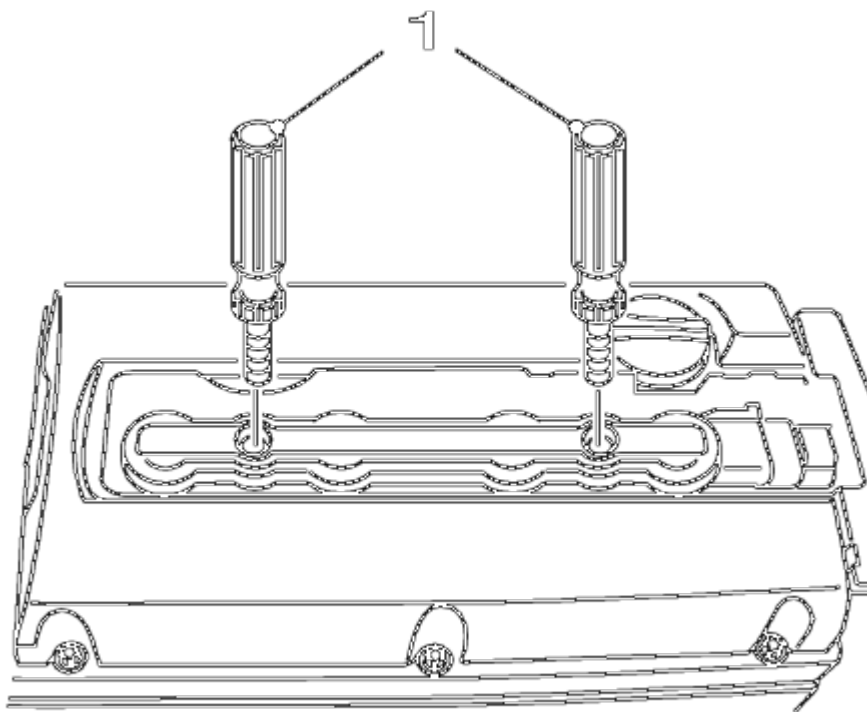
### Special Tools

**EN-6009** Remover/Installer Ignition Module

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

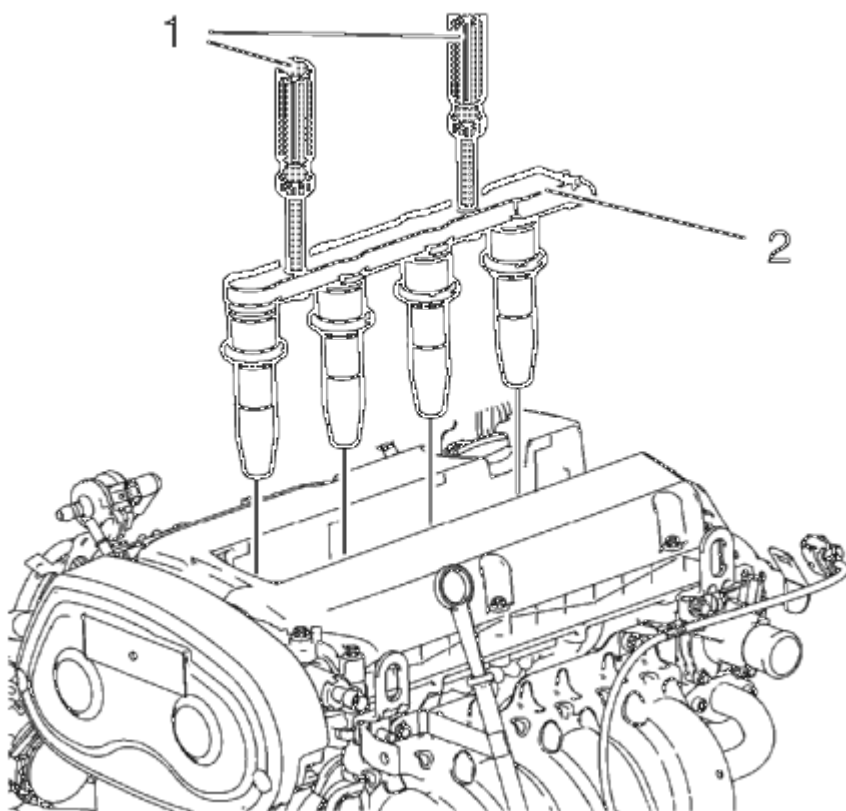
**NOTE:**      **Note the arrow on the cover.**

1. Remove the cover of the DIS ignition coil in the direction of the arrow.
2. Remove the 2 ignition coil bolts.



**Fig. 389: Special Remover/Installer Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

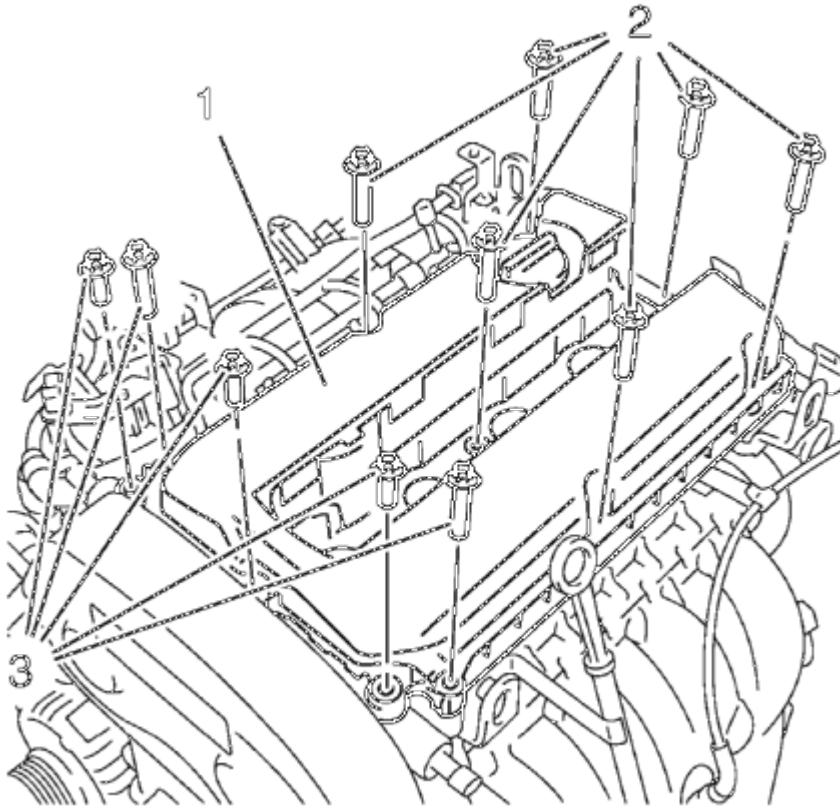
3. Install the **EN-6009** remover/installer (1).



**Fig. 390: Ignition Coil Module And Special Tool**  
**Courtesy of GENERAL MOTORS COMPANY**

4. Remove the ignition coil module (2) with the **EN-6009** remover/installer (1).

#### **CAMSHAFT COVER REMOVAL**

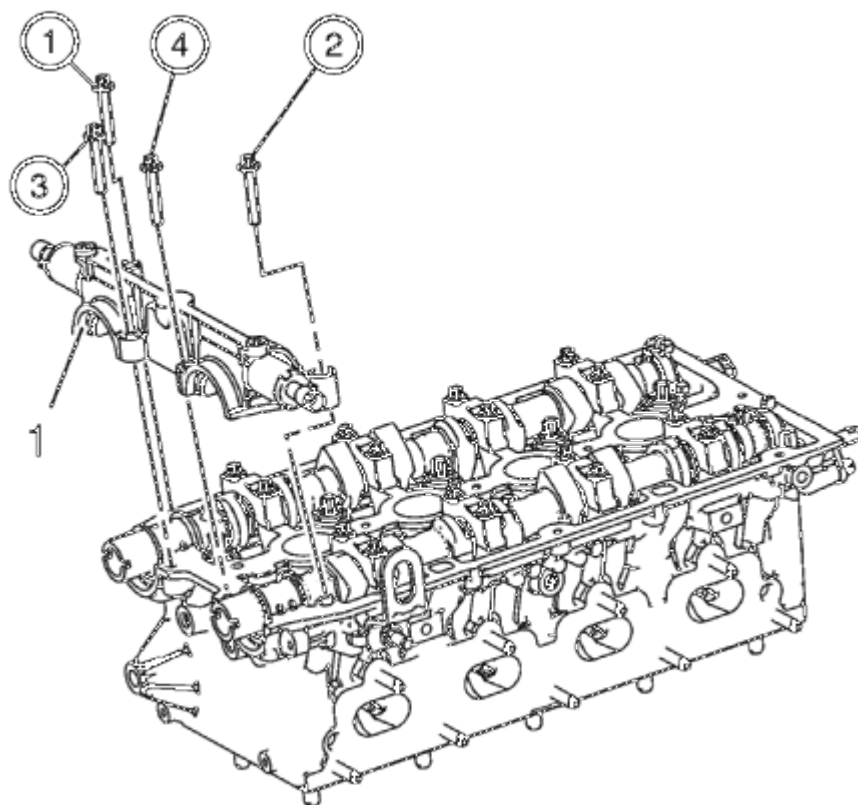


**Fig. 391: Camshaft Cover And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 11 bolts (2, 3).
2. Remove the camshaft cover (1).

## CAMSHAFT REMOVAL



**Fig. 392: Camshaft Bearing Cap And Camshaft Bearing Cap Bolts Removal Sequence**  
 Courtesy of GENERAL MOTORS COMPANY

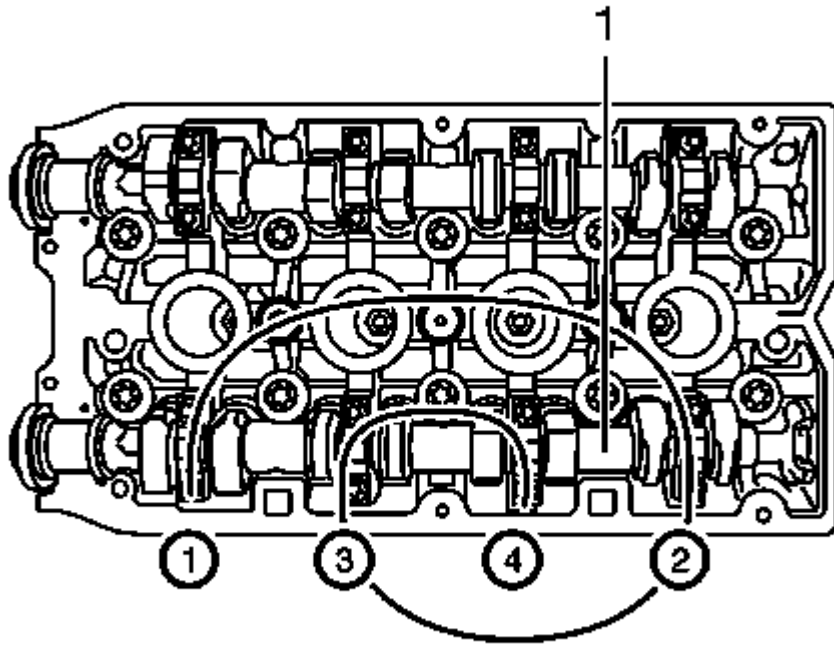
**NOTE:** Note removal sequence 1-4.

1. Remove the 4 camshaft bearing cap bolts.

**NOTE:** Release the bearing support by striking it gently with a plastic hammer.

2. Remove the first camshaft bearing cap (1).



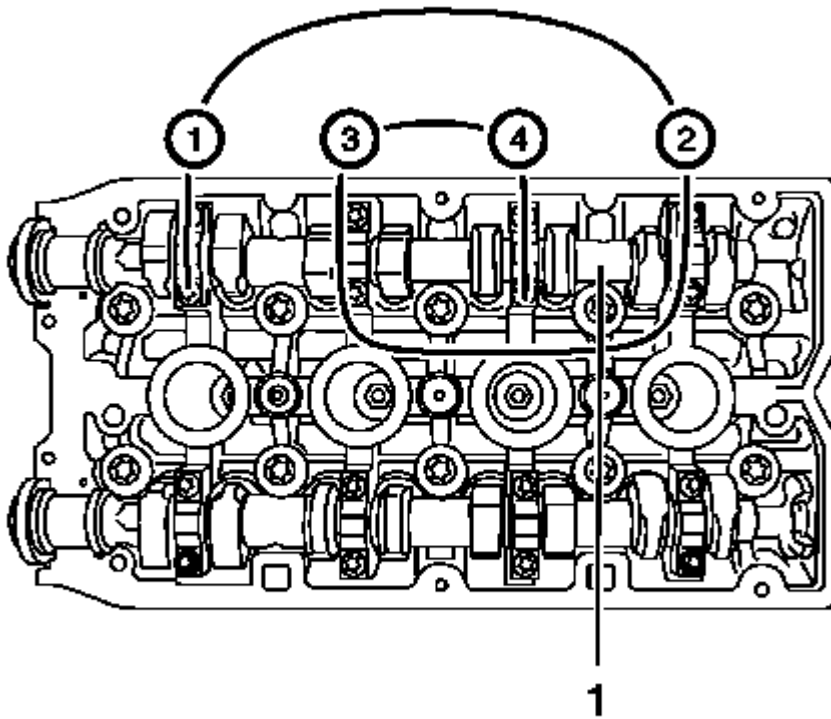


**Fig. 393: Exhaust Camshaft Bearing Cap Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the 8 exhaust camshaft bearing cap bolts working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
4. Remove the 8 exhaust camshaft bearing cap bolts.

**NOTE:**        **Mark camshaft bearing caps before removal.**

5. Remove the 4 exhaust camshaft bearing caps numbers 6-9 from the cylinder head.
6. Remove the exhaust camshaft (1).



**Fig. 394: Intake Camshaft Bearing Cap Bolts Loosening Sequence**  
 Courtesy of GENERAL MOTORS COMPANY

7. Loosen the 8 intake camshaft bearing cap bolts working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
8. Remove the 8 intake camshaft bearing cap bolts.

**NOTE:** Mark camshaft bearing caps before removal.

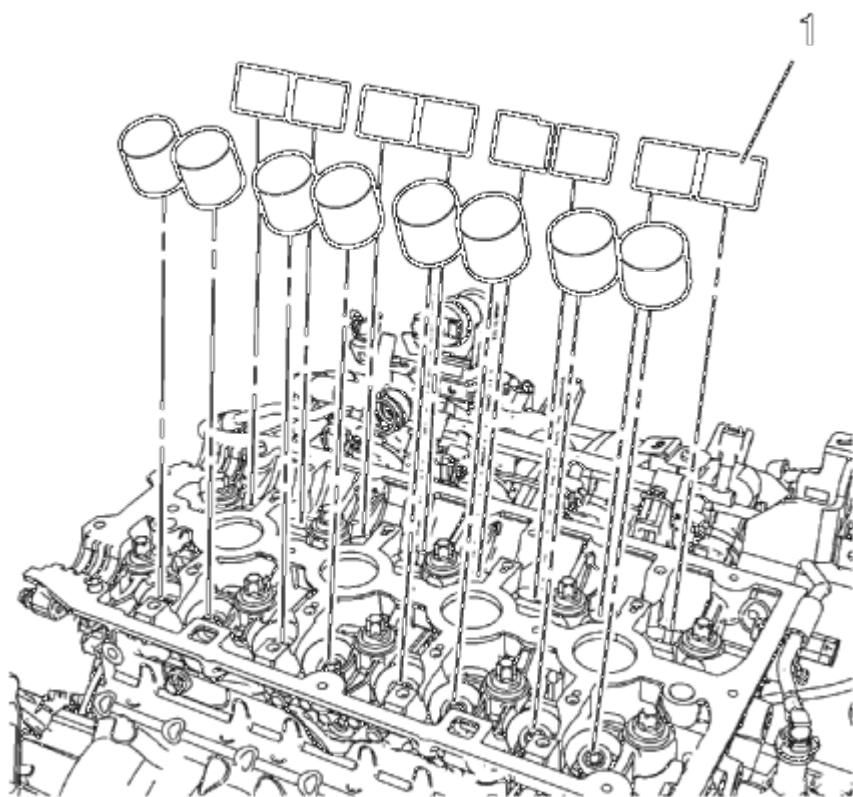
9. Remove the 4 intake camshaft bearing caps numbers 2-5 from the cylinder head.
10. Remove the intake camshaft (1).
11. Remove the camshaft seal rings.

## VALVE LIFTER REMOVAL

### Special Tools

**EN-845** Suction Device

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

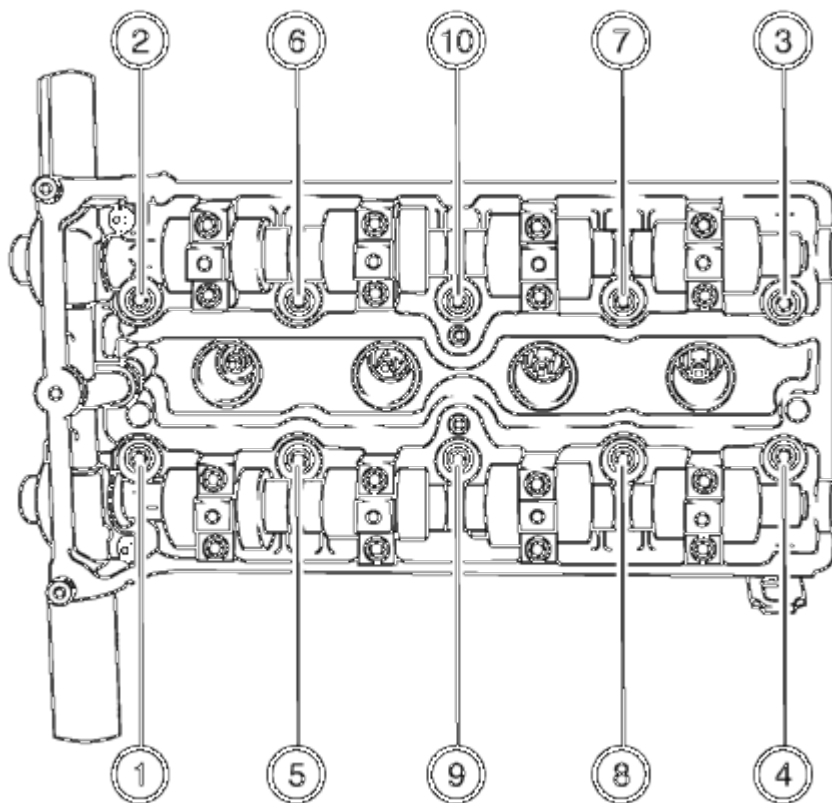
**Fig. 395: Valve Lifters**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mark the locations.

Remove the 16 valve lifter (1) use the **EN-845** suction device.

### **CYLINDER HEAD REMOVAL**

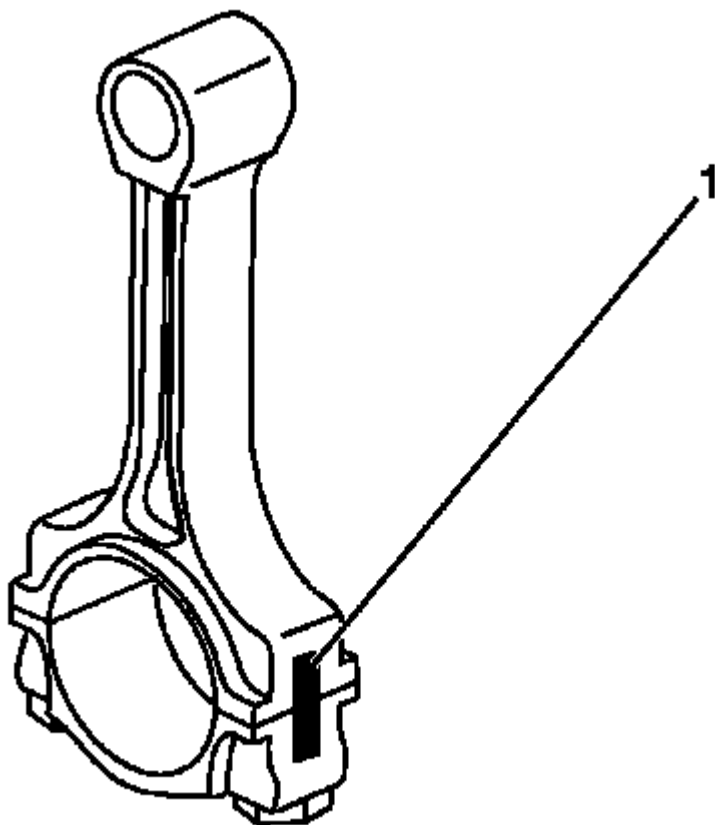


**Fig. 396: Cylinder Head Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 10 cylinder head bolts in sequence as shown.
  1. Loosen the 10 bolts 90°.
  2. Loosen the 10 bolts 180°.
2. Remove the cylinder head and place on a suitable base.
3. Remove the cylinder head gasket.

#### **PISTON, CONNECTING ROD, AND BEARING REMOVAL**

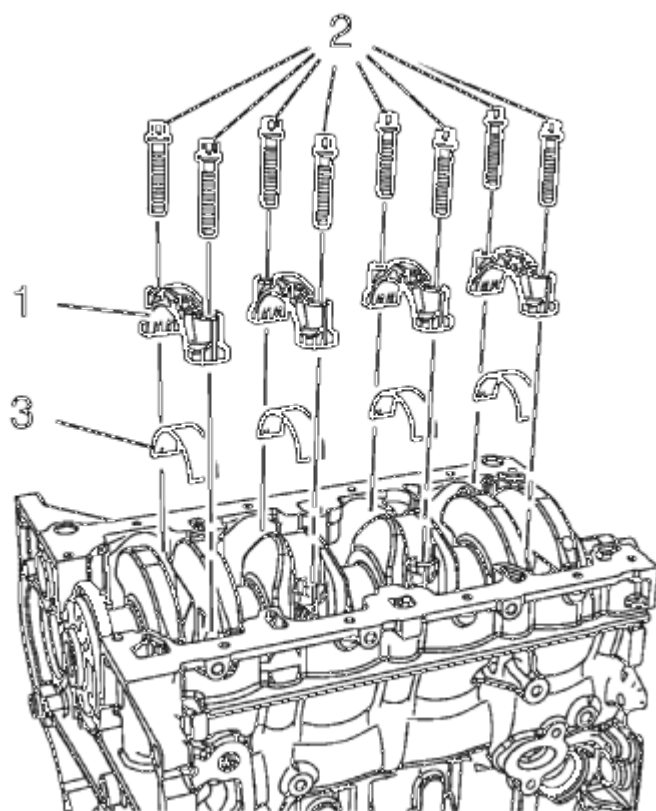
1. Install the crankshaft balancer bolt.
2. Set the pistons 1 and 4 to TDC in direction of engine rotation.



**Fig. 397: Connecting Rod And Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY

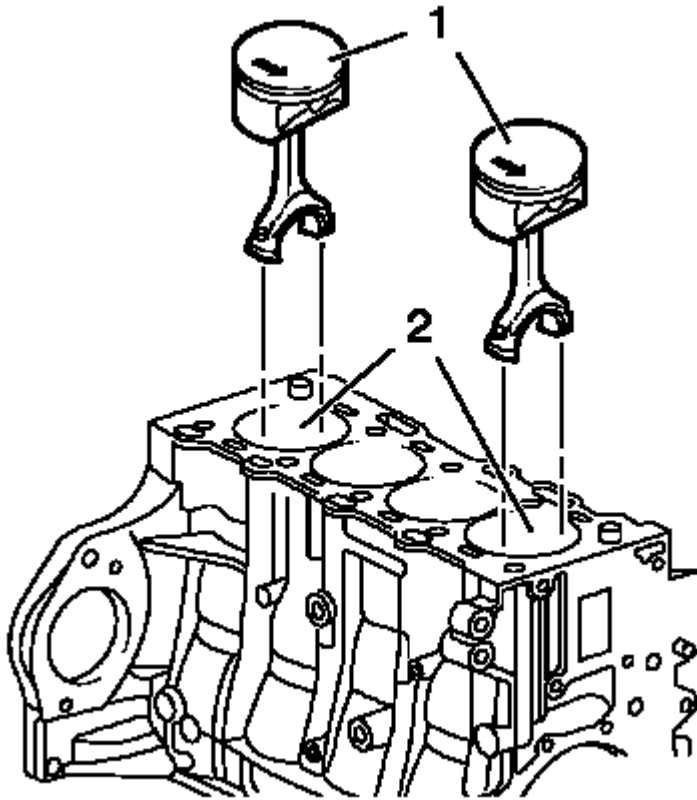
**NOTE:**      **Note cylinder sequence.**

3. Mark the connecting rod with the connecting rod bearing cover (1).



**Fig. 398: Connecting Rod Bearing, Connecting Rod Bearing Caps And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

4. Remove the 4 connecting rod bearing caps bolts (2) of cylinder 1 and 4.
5. Remove the connecting rod bearing caps (1) and the connecting rod bearing (3).

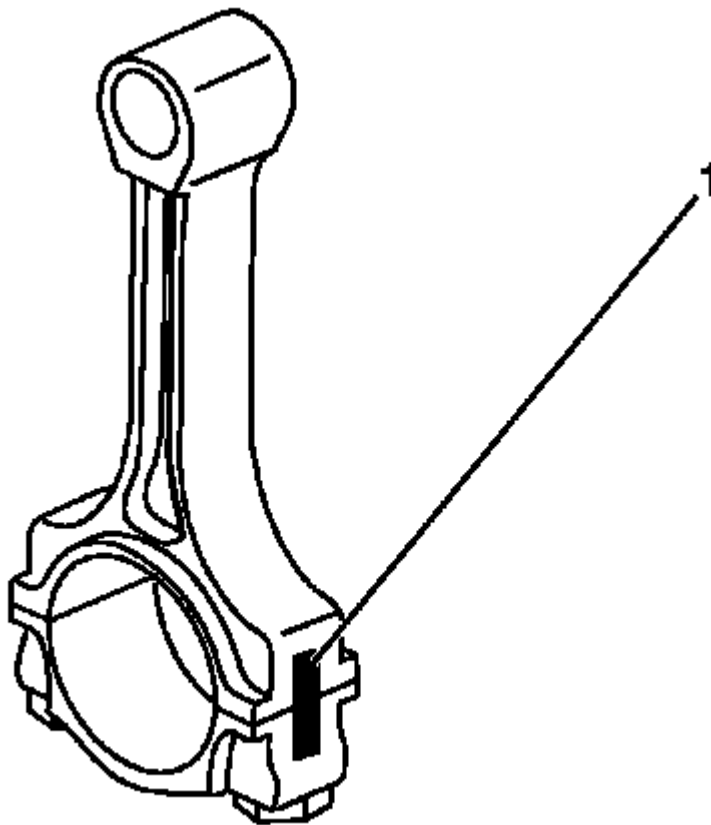


**Fig. 399: Pistons 1, 4 And Cylinder Bore**  
 Courtesy of GENERAL MOTORS COMPANY

6. Push the pistons 1 and 4 (1) out of the cylinder bore (2).

**NOTE:**      The shear surfaces of the con-rod and the con-rod bearing cover form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.

7. Remove the pistons 1 and 4 (1).
8. Turn crankshaft on crankshaft balancer through 180° in direction of rotation of engine.

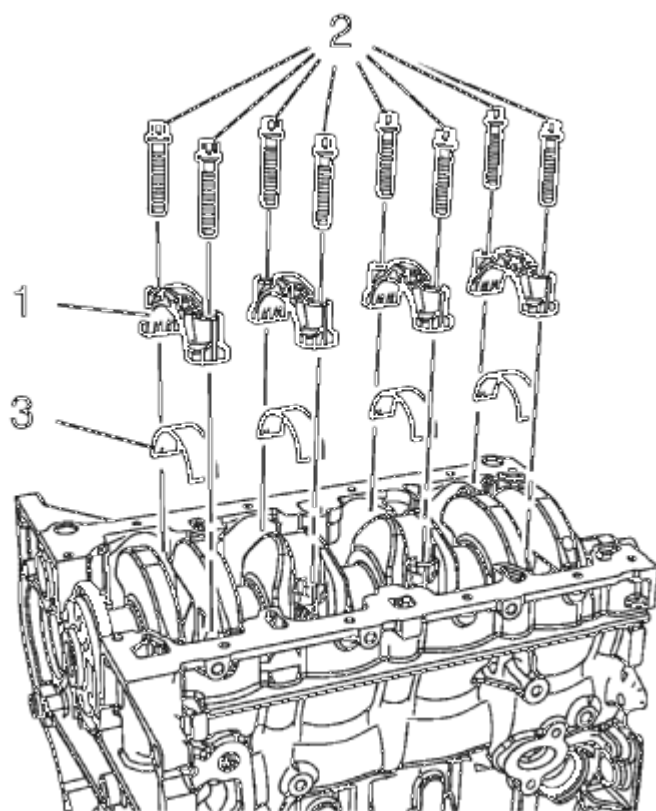


**Fig. 400: Connecting Rod And Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**      **Note cylinder sequence.**

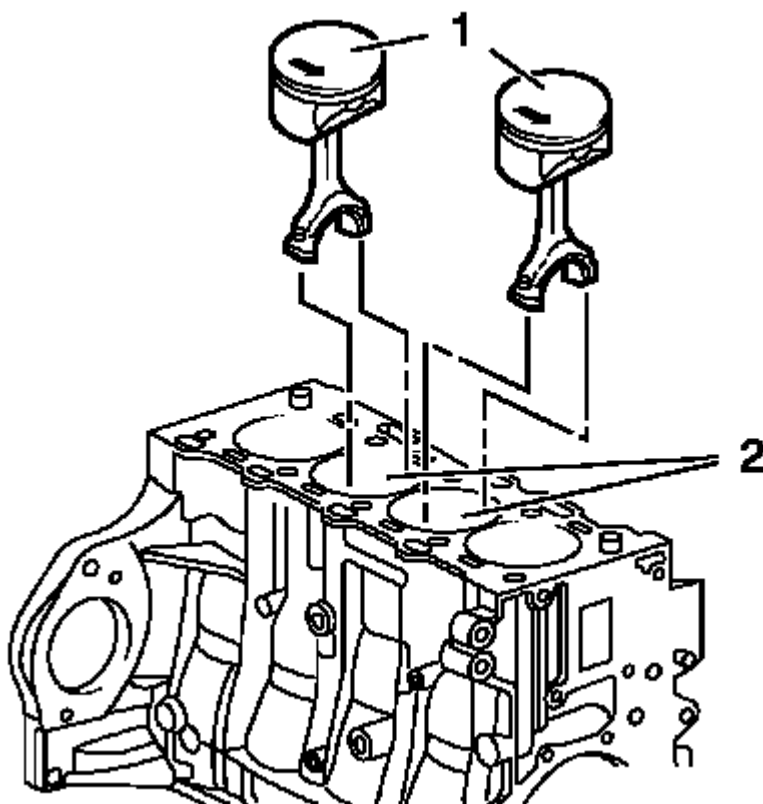
9. Mark the connecting rod with the connecting rod bearing cover (1).





**Fig. 401: Connecting Rod Bearing, Connecting Rod Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove the 4 connecting rod bearing caps bolts (2) of cylinder 2 and 3.
11. Remove the connecting rod bearing caps (1) and the connecting rod bearing (3).



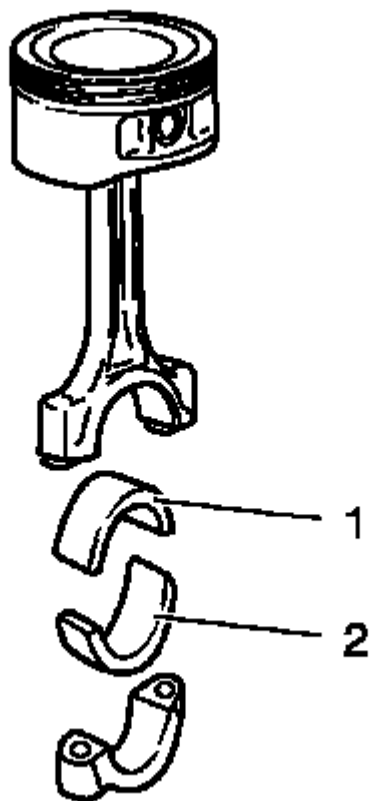
**Fig. 402: Pistons 2, 3 And Cylinder Bore**

Courtesy of GENERAL MOTORS COMPANY

12. Push the pistons 2 and 3 (1) out of the cylinder bore (2).

**NOTE:** The shear surfaces of the con-rod and the con-rod bearing cover form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.

13. Remove the pistons 2 and 3 (1).



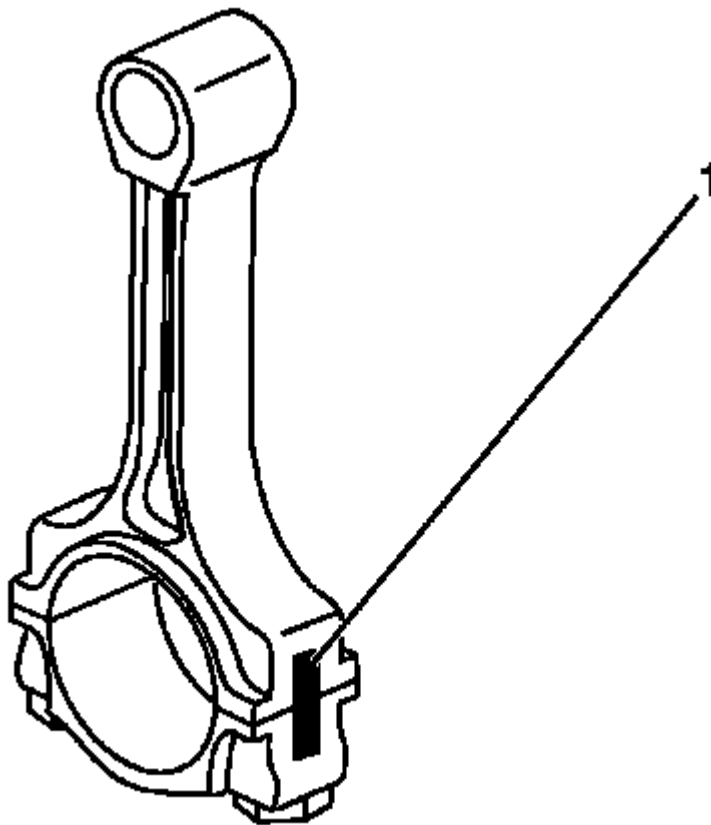
**Fig. 403: Connecting Rod And Bearings**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Observe correct fitting position, observe alignment.

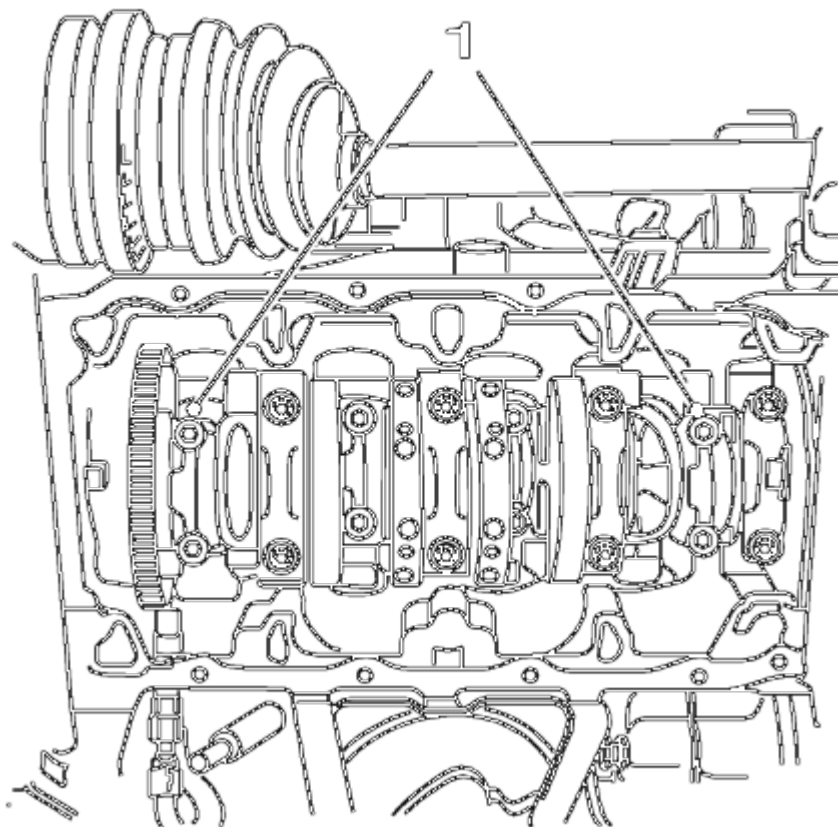
14. Remove the connecting rod bearing (1, 2).
15. Check the components. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection.**

## CRANKSHAFT AND BEARING REMOVAL



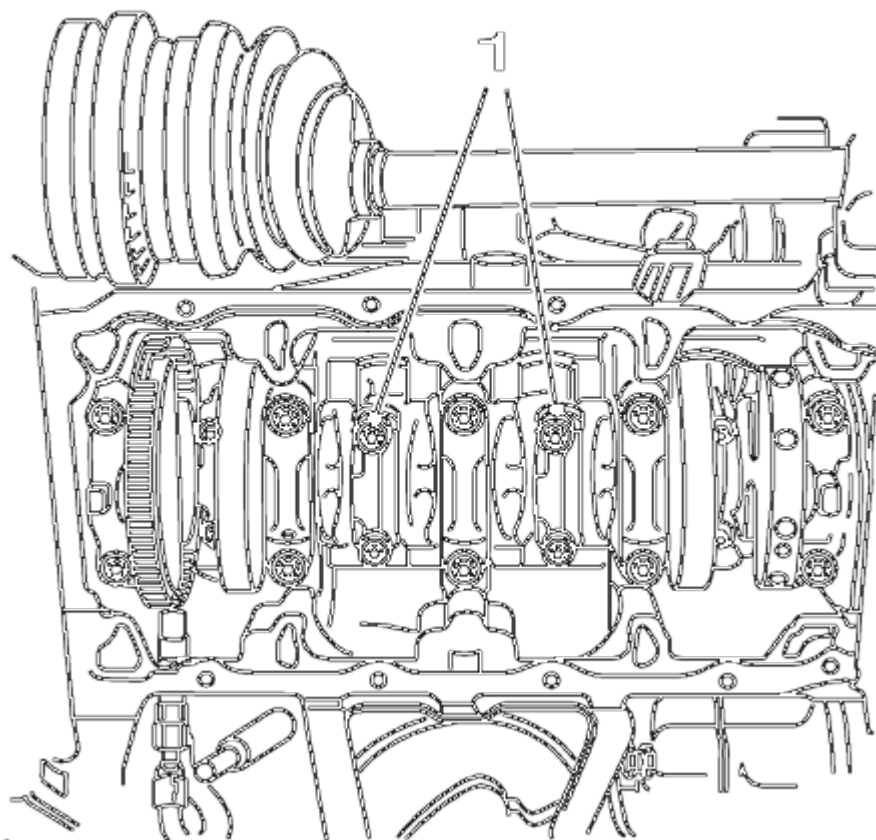
**Fig. 404: Connecting Rod And Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY

1. Identify all the connecting rod bearing caps (1).



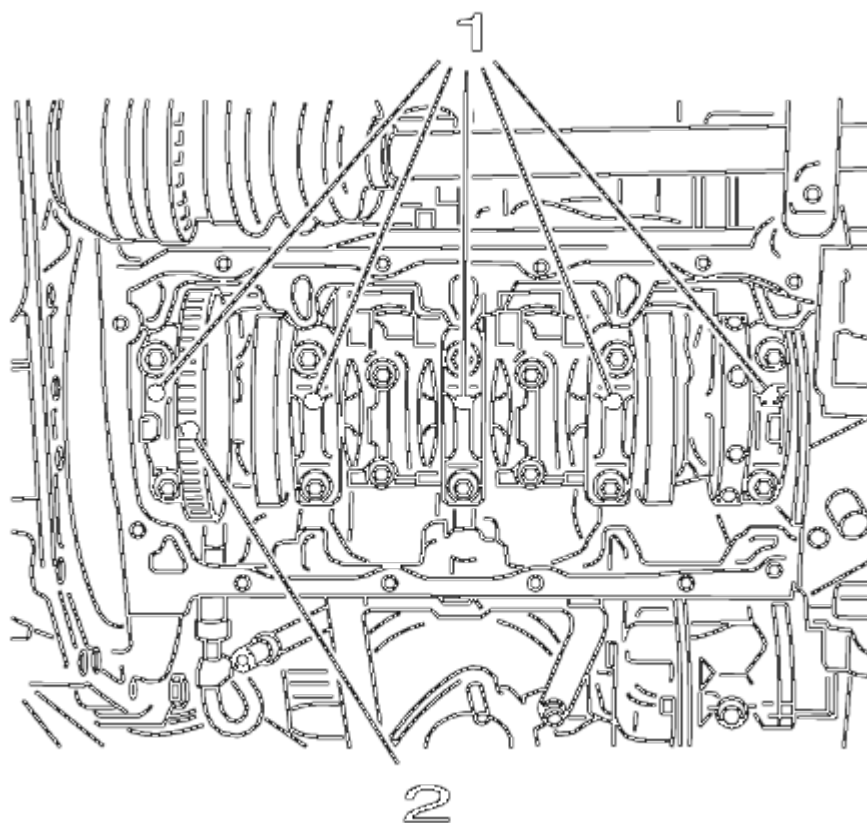
**Fig. 405: Connecting Rod Bearing Caps**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 4 bolts.
3. Remove the connecting rod bearing caps 1 and 4 (1).
4. Turn the crankshaft through 180°.



**Fig. 406: Connecting Rod Bearing Caps**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 bolts.
6. Remove the connecting rod bearing caps 2 and 3 (1).
7. Identify the crankshaft bearing caps.

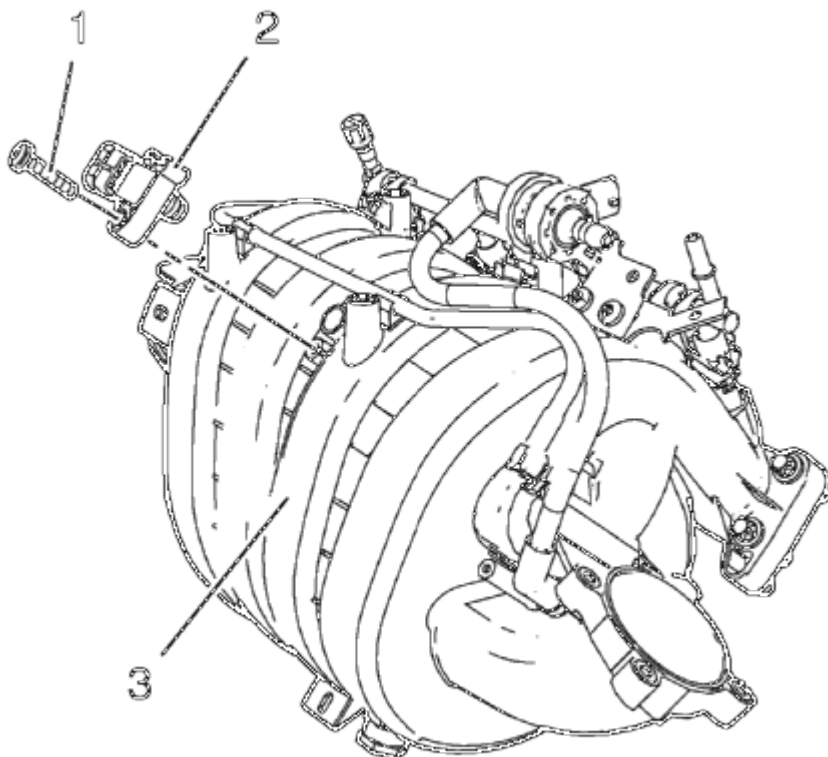


**Fig. 407: Crankshaft Bearing Cap Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

8. Remove the crankshaft bearing caps (1).
9. Remove the 10 bolts.
10. Remove the crankshaft (2).
11. Remove the crankshaft bearing clips.

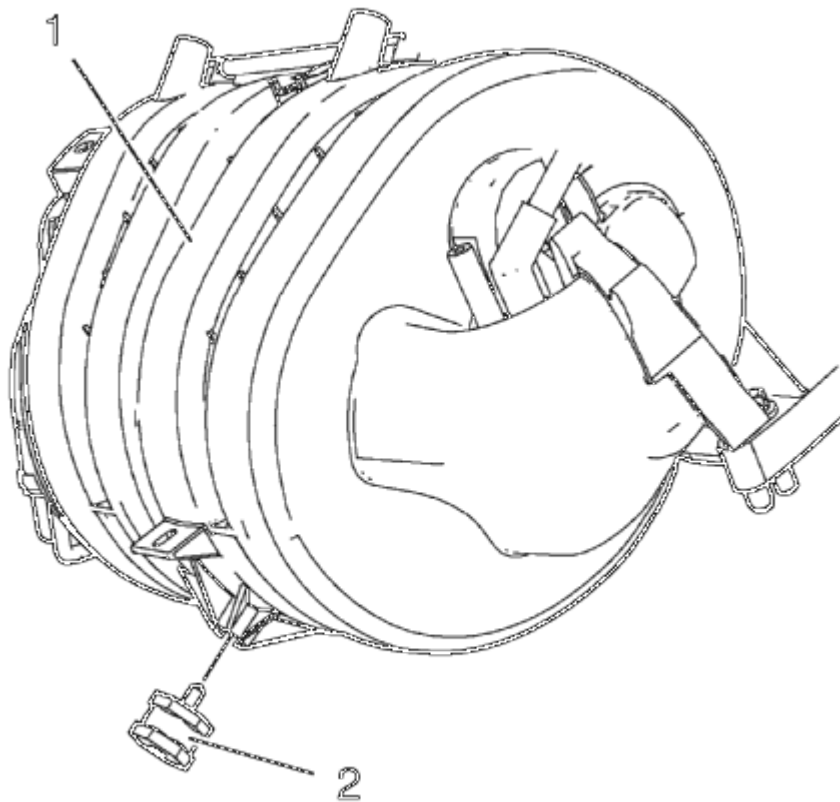
## **INTAKE MANIFOLD DISASSEMBLE**



**Fig. 408: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

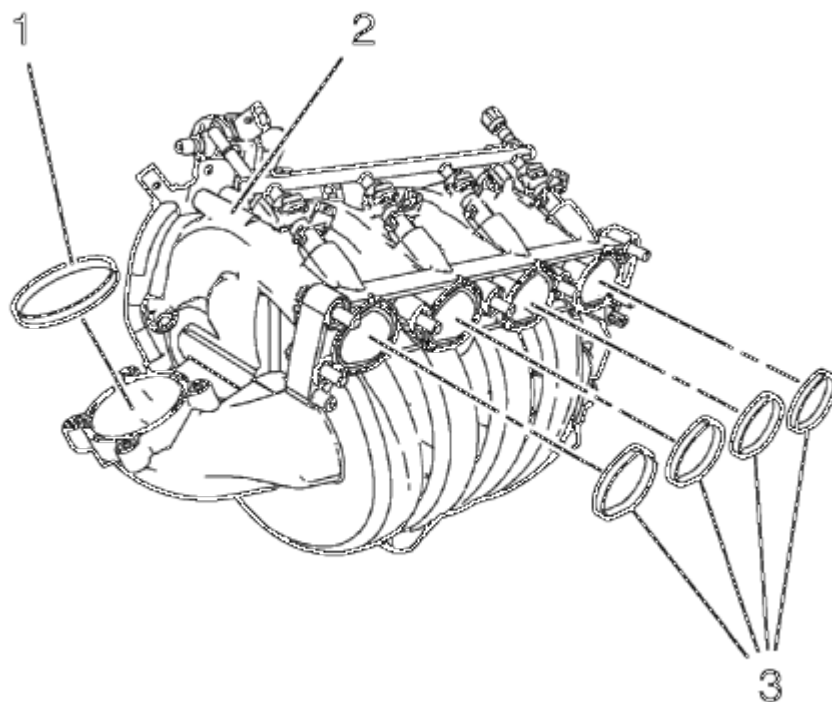
1. Remove the intake manifold absolute pressure sensor bolt (1).
2. Remove the manifold absolute pressure sensor (2) from the intake manifold (3).





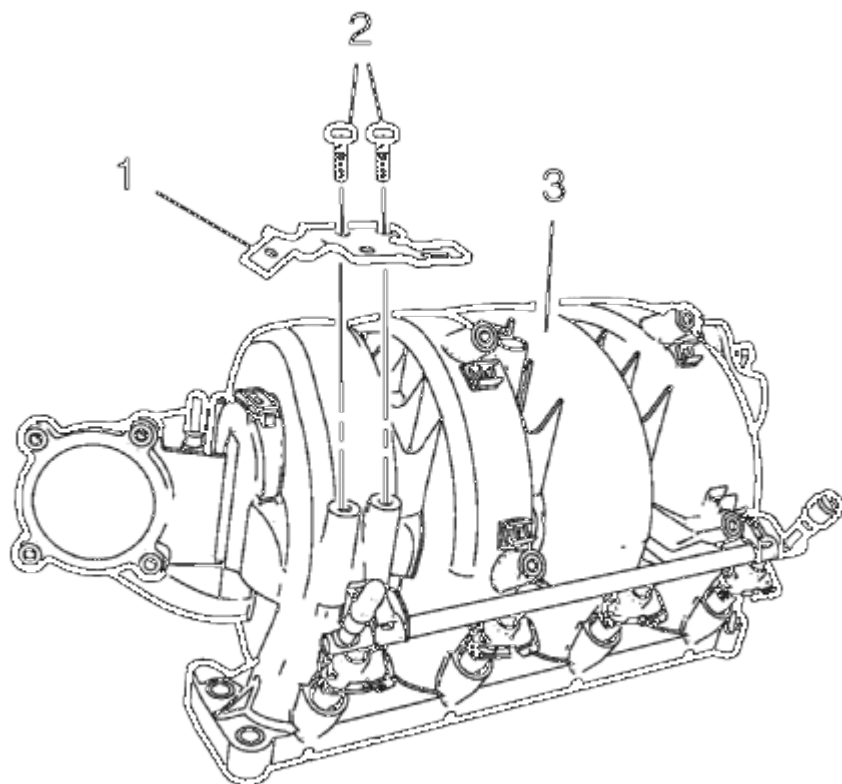
**Fig. 409: Intake Manifold And Mount**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove the intake manifold mount (2) from the intake manifold (1).



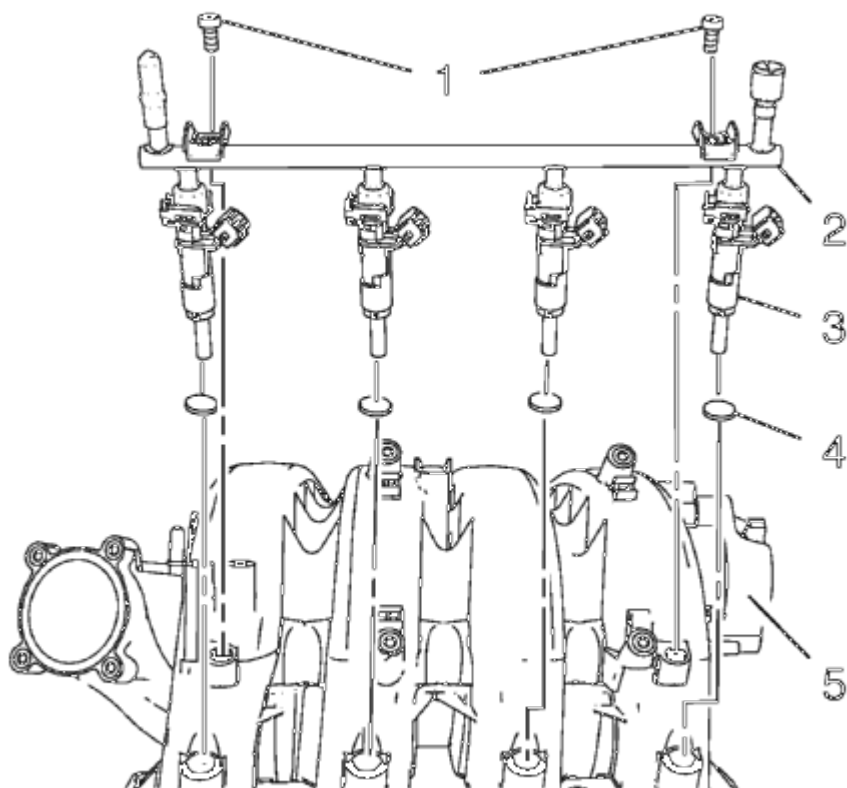
**Fig. 410: Intake Manifold, Intake Manifold Seal And Throttle Body Seal**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the throttle body seal (1).
5. Remove the intake manifold seal (3) from the intake manifold (2).



**Fig. 411: Intake Manifold, Evaporative Emission Canister Purge Solenoid Valve Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 evaporative emission canister purge solenoid valve bracket bolts (2).
7. Remove the evaporative emission canister purge solenoid valve bracket (1) from the intake manifold (3).



**Fig. 412: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

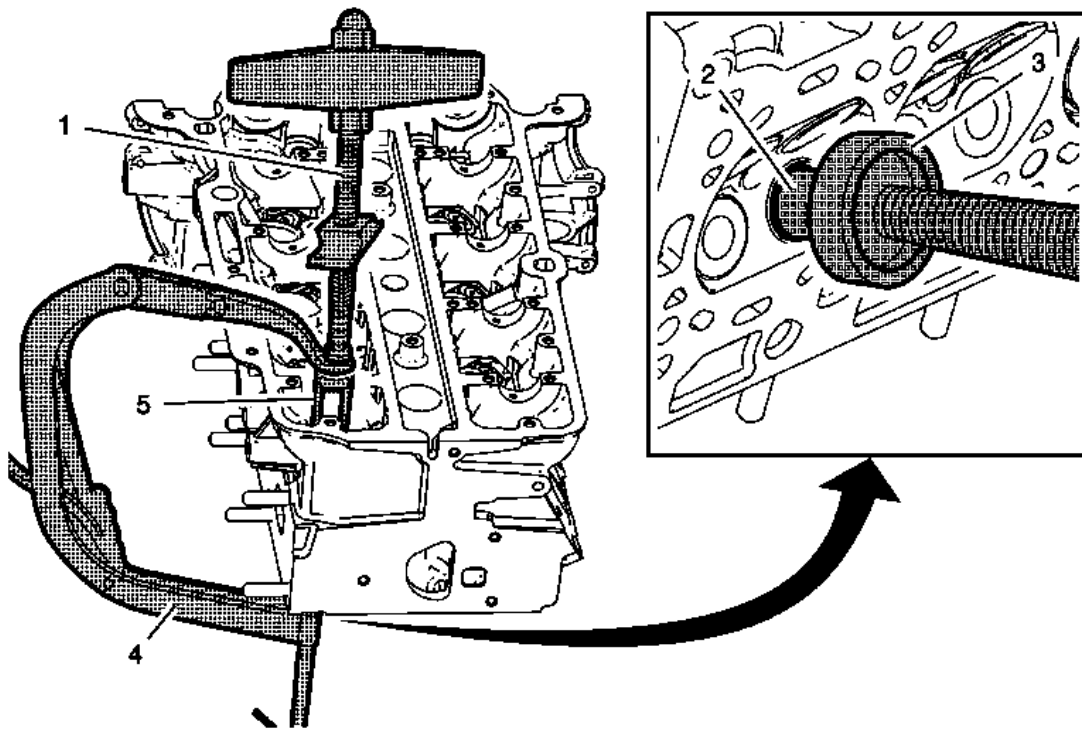
8. Remove the 2 multiport fuel injection fuel rail bolts (1).
9. Remove the multiport fuel injection fuel rail (2) and the fuel injectors (3) from the intake manifold (5).
10. Remove the 4 multiport fuel injector seals (4).

## CYLINDER HEAD DISASSEMBLE

### Special Tools

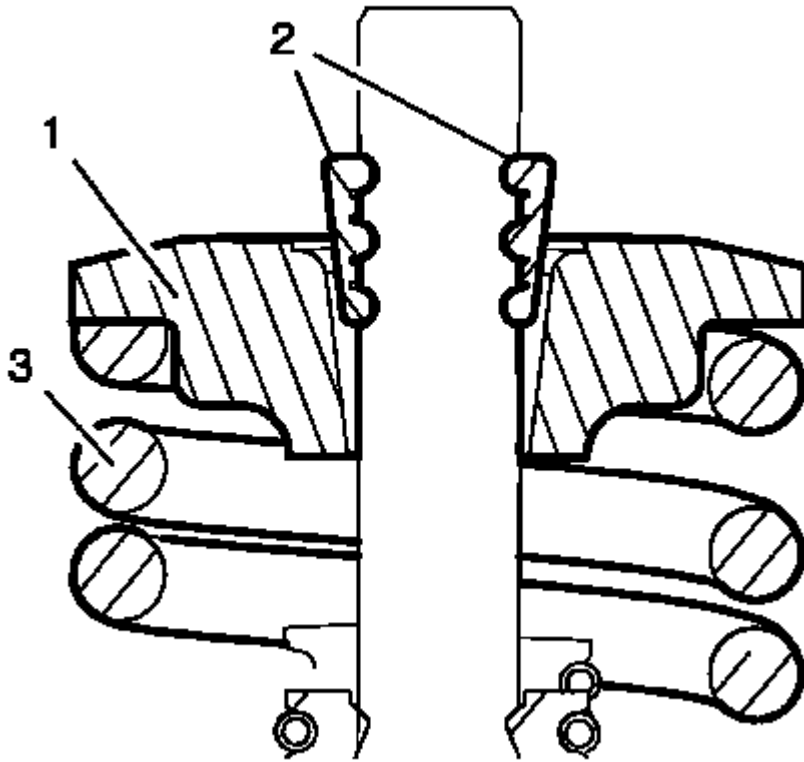
- EN-840 Pliers/Remover
- EN-8062 Valve Spring Compressor
- EN-8062-5 Adapter
- EN-50717-2 Compressor Assembly of EN-50717 Kit

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



**Fig. 413: Valve Spring Compressor And Adapter Assembly**  
Courtesy of GENERAL MOTORS COMPANY

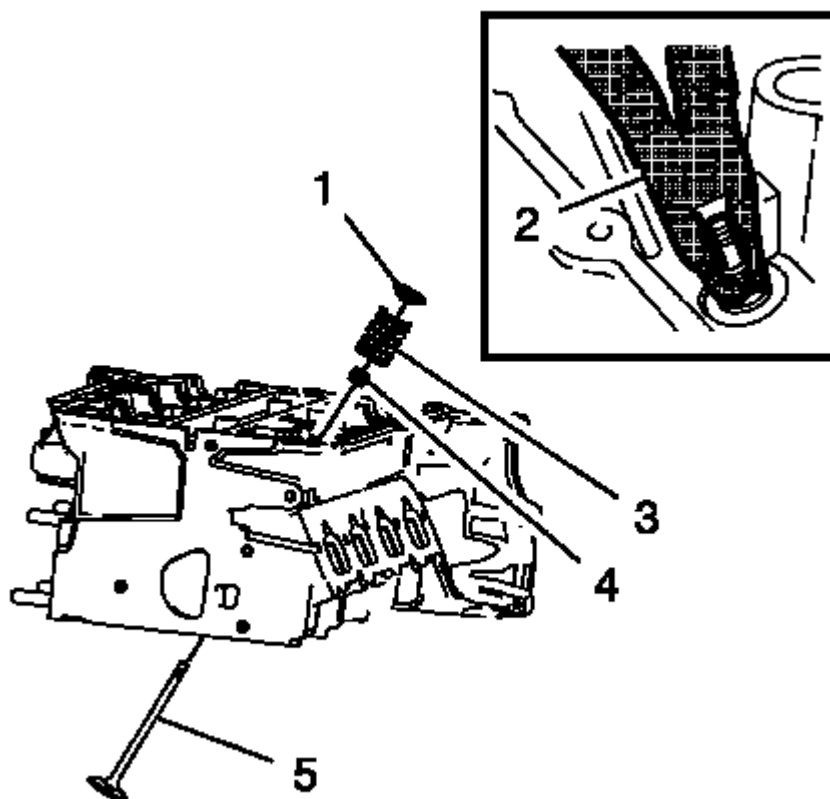
1. Install the **EN-50717-2** assembly (1) to the **EN-8062** compressor (4).
2. Install the **EN-8062-5** adapter (3) to the **EN-8062** compressor.
3. Install the compressor assembly to the cylinder head, so that the adapter (5) of the **EN-50717-2** assembly (1) contacts the valve spring retainer properly and the **EN-8062-5** adapter (3) contacts the valve disc (2). Prefix the **EN-8062** compressor (4).



**Fig. 414: Valve Spring Retainer And Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.

4. Apply pressure to the EN-50717-2 assembly to push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension. Carefully remove the valve keys.

**Fig. 415: Spring Compressor**

Courtesy of GENERAL MOTORS COMPANY

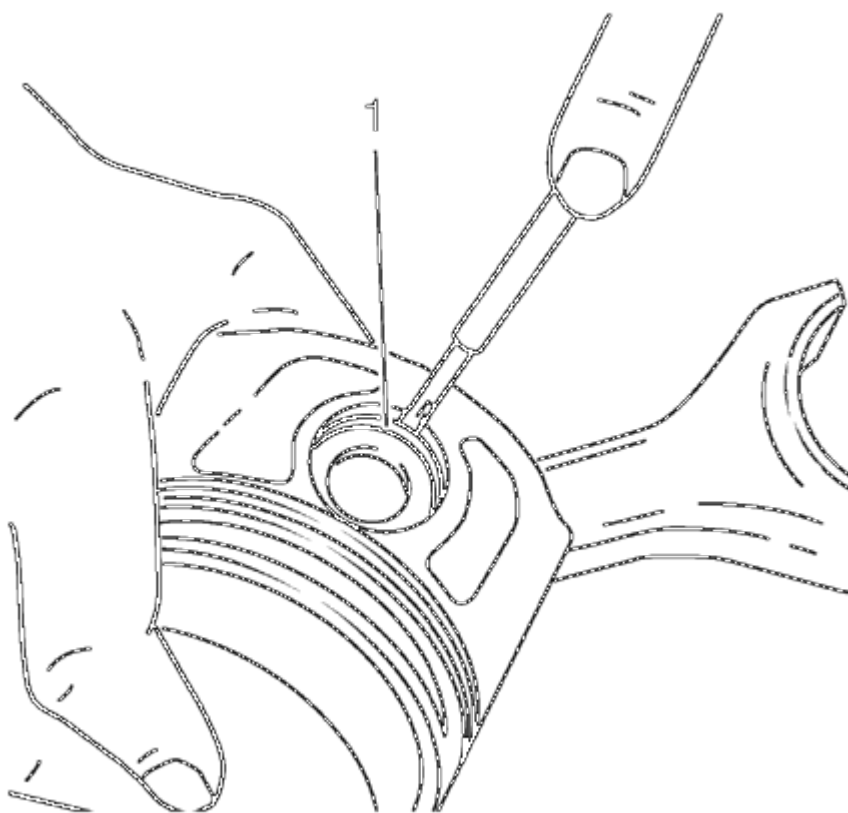
5. Slowly and carefully loosen the **EN-50717-2** assembly until the valve spring is entirely expanded.
6. Remove the compressor assembly from the cylinder head.
7. Remove the valve spring retainer (1) and the valve spring (3).
8. Remove and DISCARD the valve stem oil seal (4), using the **EN-840** pliers (2).
9. Remove the valve (5).

**NOTE:** Ensure that the valve train components are kept together and identified in order for proper installation in their original position.

10. Repeat the procedure with the remaining valves.
11. In case of re-using the cylinder head, refer to **Cylinder Head Cleaning and Inspection**.

## PISTON AND CONNECTING ROD DISASSEMBLE

1. Remove the piston with connection rod. Refer to **Piston, Connecting Rod, and Bearing Removal**.



**Fig. 416: Detaching Piston From Connecting Rod**  
Courtesy of GENERAL MOTORS COMPANY

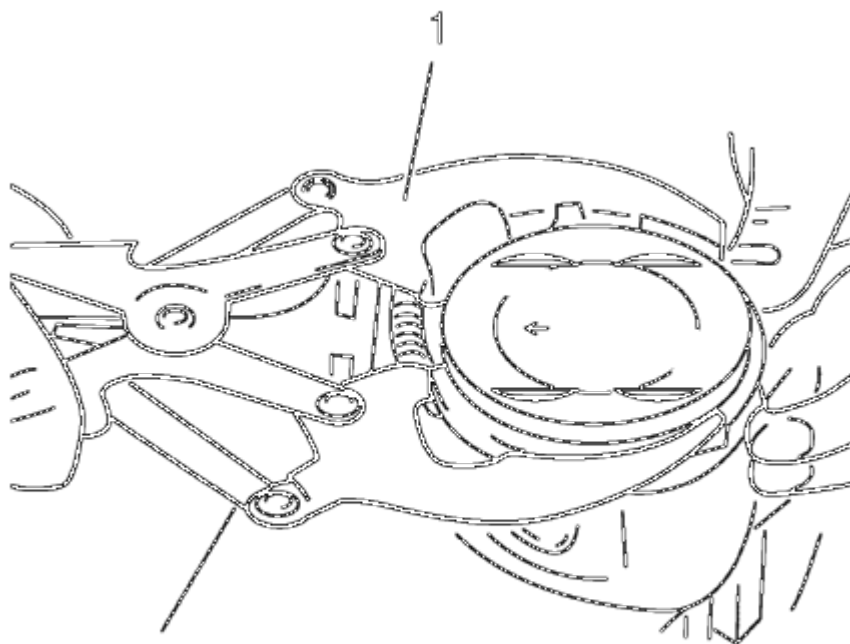
**NOTE:** Note installation position of the piston in respect of the connection rod.

2. Detach the piston from the connection rod.

**NOTE:** Do not damage the bore.

3. Remove the retainer (1) from the piston eye.
4. Press the piston pin out of the piston.

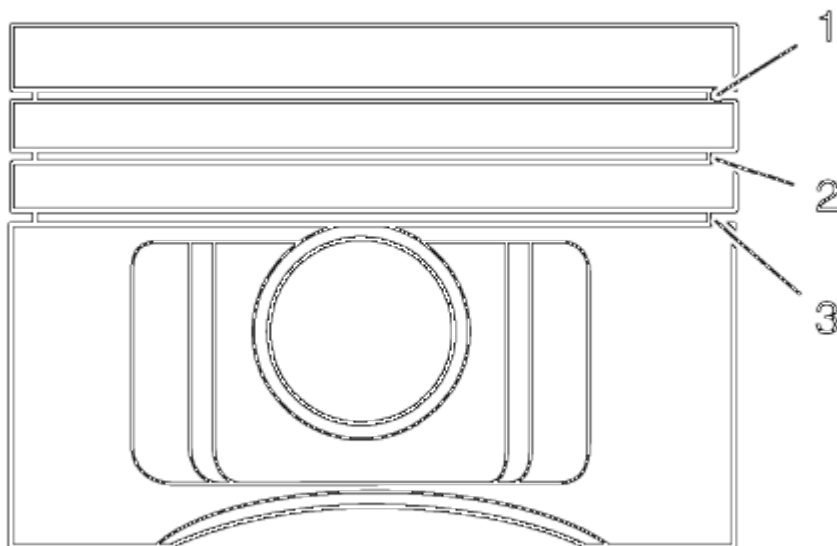




**Fig. 417: Piston Rings And Piston Ring Pliers**  
**Courtesy of GENERAL MOTORS COMPANY**

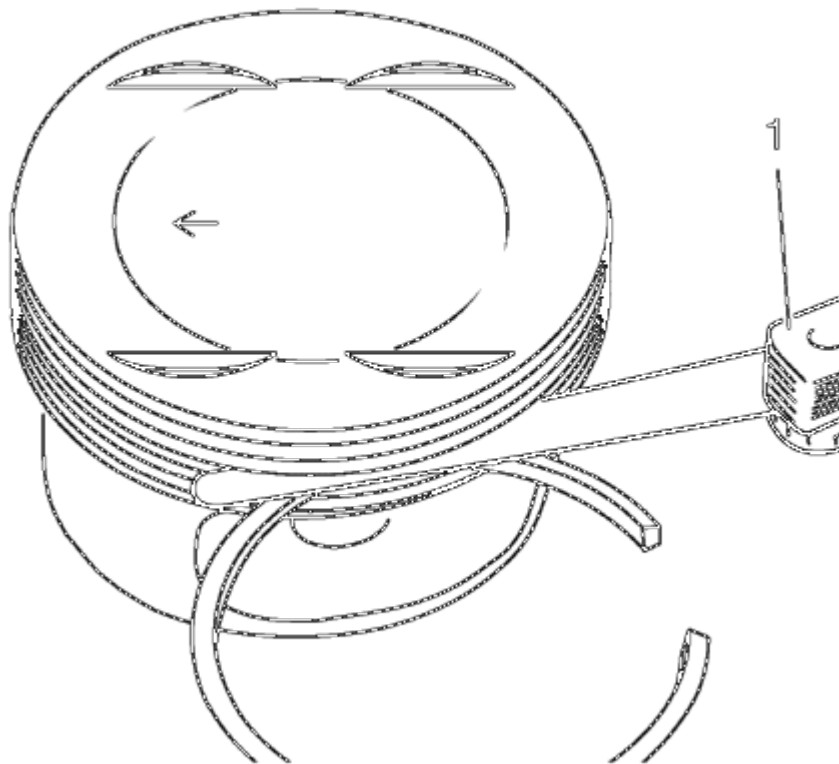
5. Remove the piston rings, using piston ring pliers (1).

Remove oil carbon from the groove with a split piston ring, filed to a wedge-shape.

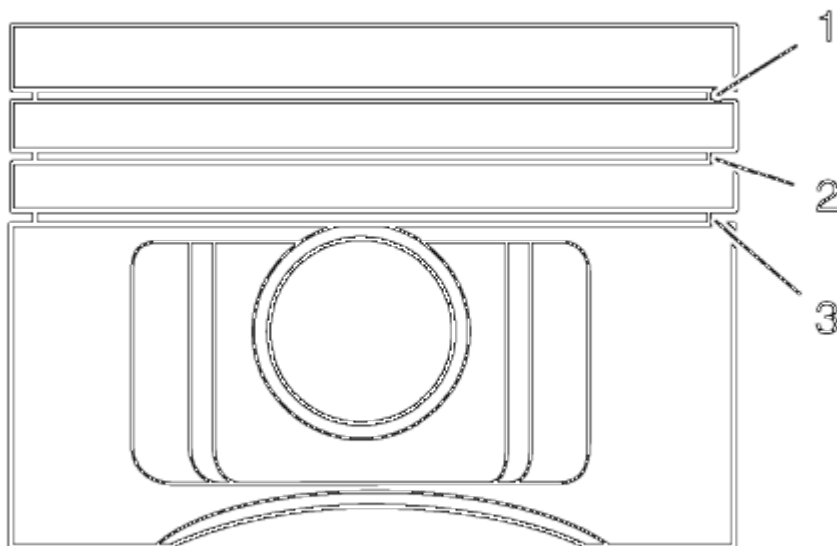


**Fig. 418: Rectangular Compression Ring, Tapered Compression Ring And Oil Scraper Ring**  
Courtesy of GENERAL MOTORS COMPANY

6. Measure the piston ring gap.
- Tension the piston ring in the cylinder and measure the gap with a feeler gauge.
  - Permissible ring gap:
    - Rectangular compression ring (1): 0.20-0.40 mm (0.007-0.015 in)
    - Tapered compression ring (2): 0.40-0.60 mm (0.015-0.023 in)
    - Oil scraper ring (3): 0.25-0.75 mm (0.009-0.029 in)



**Fig. 419: Checking Piston Ring Vertical Play With Feeler Gauge**  
Courtesy of GENERAL MOTORS COMPANY



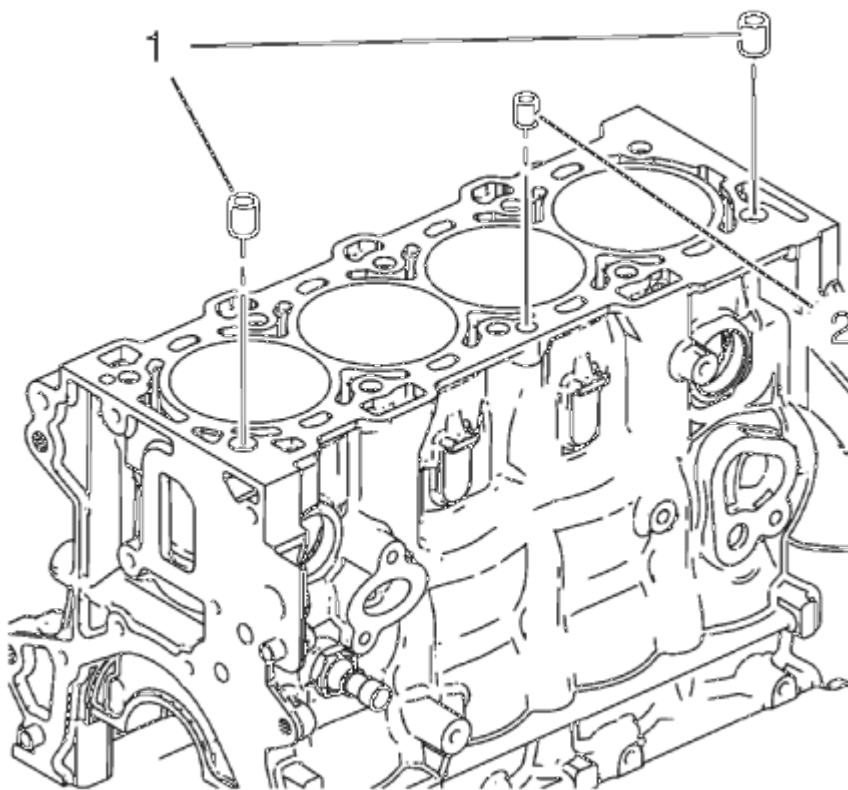
**Fig. 420: Rectangular Compression Ring, Tapered Compression Ring And Oil Scraper Ring**  
Courtesy of GENERAL MOTORS COMPANY

7. Check piston ring vertical play with a feeler gauge (1) in the piston ring groove.

Permissible vertical play:

- Rectangular compression ring (1): 0.04-0.08 mm (0.001-0.003 in)
- Tapered compression ring (2): 0.03-0.07 mm (0.001-0.002 in)
- Oil scraper ring (3): 0.03-0.13 mm (0.001-0.005 in)

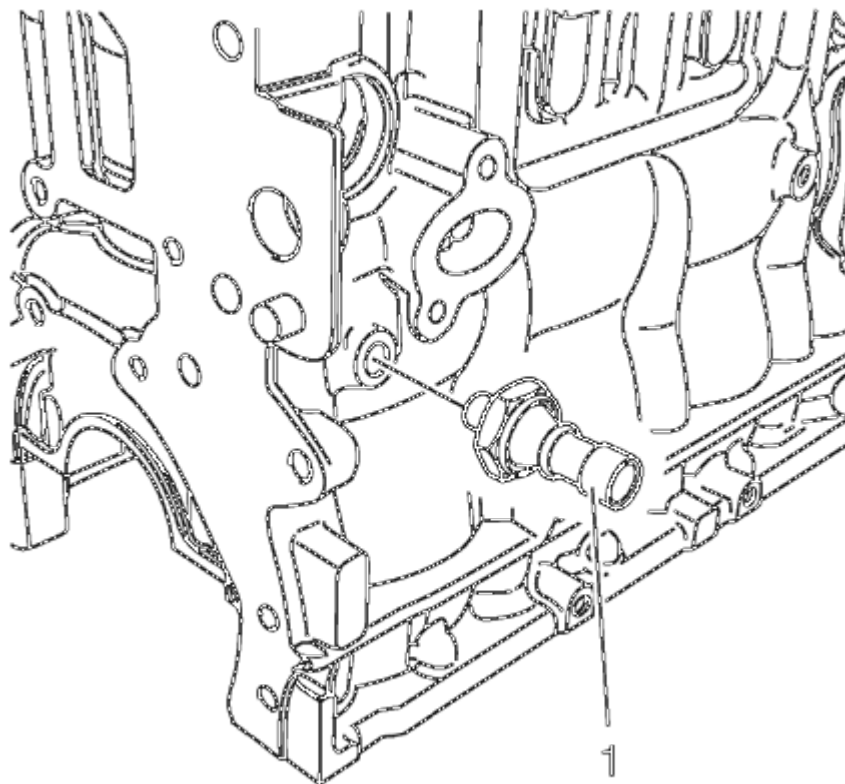
## ENGINE BLOCK DISASSEMBLE



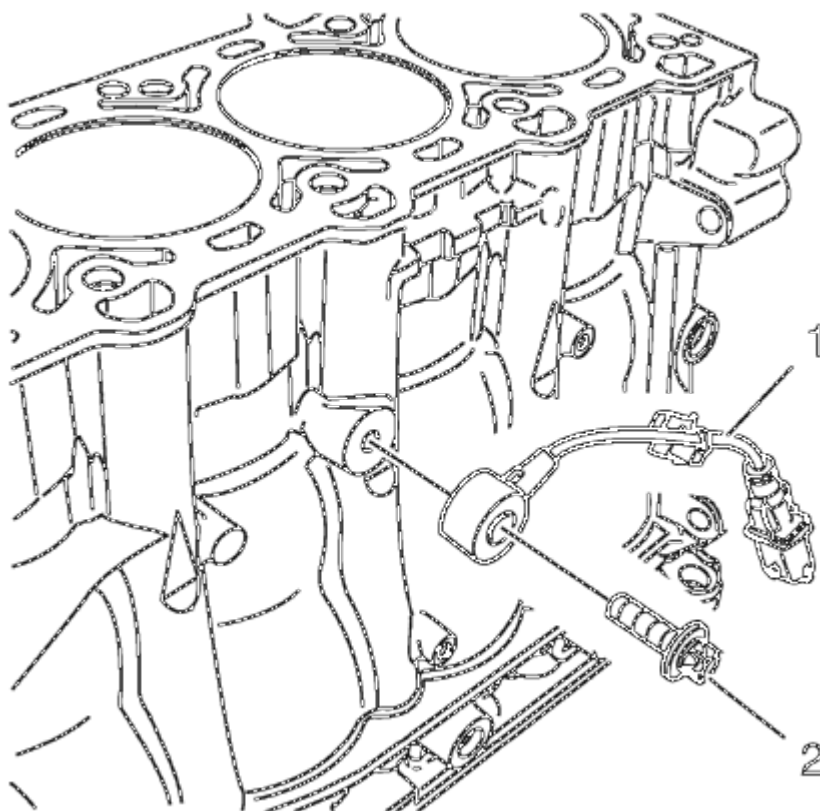
**Fig. 421: Cylinder Head Locating Pins**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the cylinder head locating (1, 2).

**Fig. 422: Oil Pressure Switch****Courtesy of GENERAL MOTORS COMPANY**

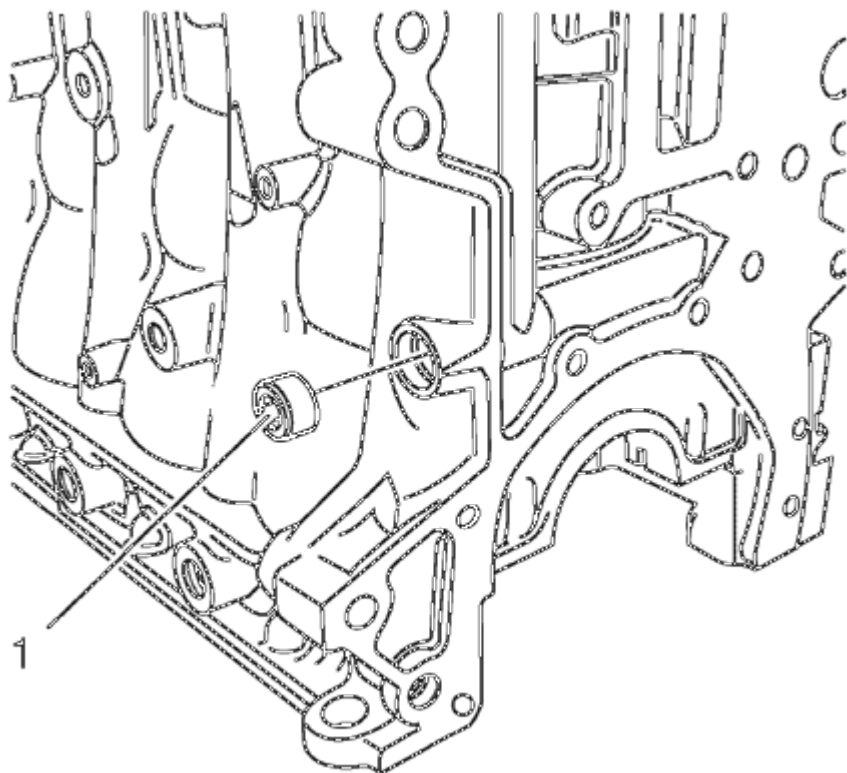
2. Remove the oil pressure switch (1).



**Fig. 423: Knock Sensor And Bolt**

Courtesy of GENERAL MOTORS COMPANY

3. Remove the knock sensor bolt (2) and the knock sensor (1).
4. Clean the thread.

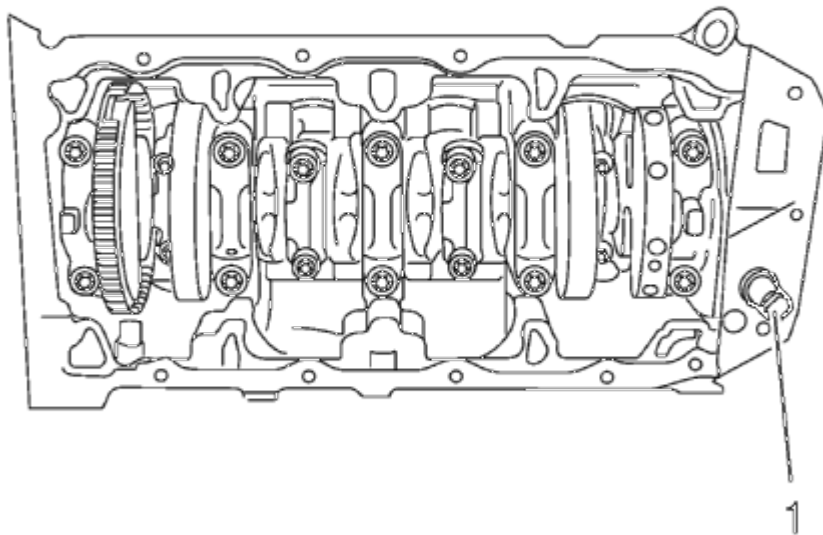


**Fig. 424: Oil Flow Check Valve**

**Courtesy of GENERAL MOTORS COMPANY**

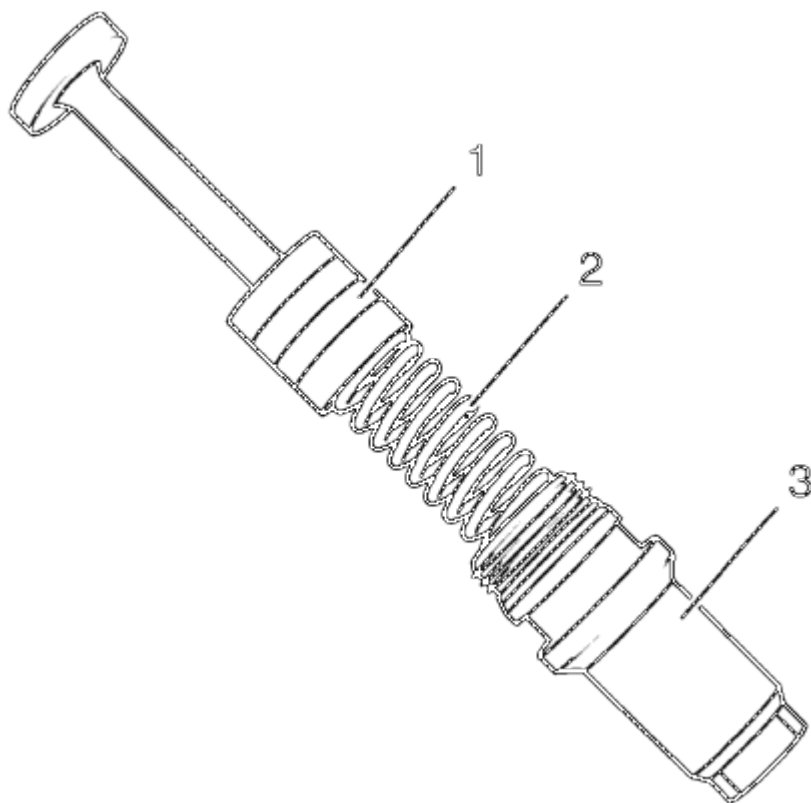
5. Remove the oil flow check valve (1).





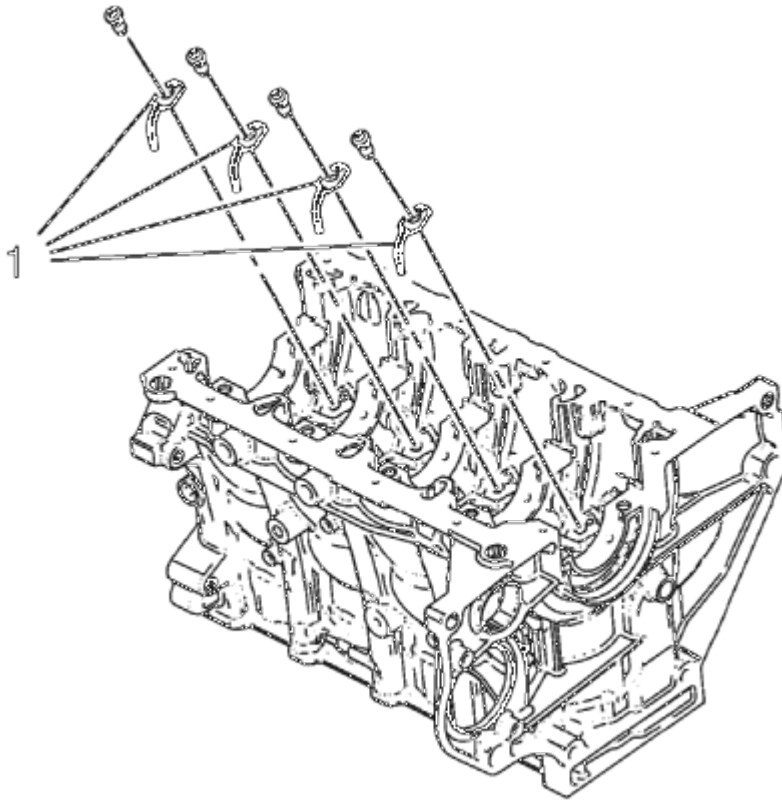
**Fig. 425: Oil Pressure Relief Valve Closure Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

6. Remove the oil pressure relief valve closure bolt (1) and the oil pressure relief valve.



**Fig. 426: Piston, Spring And Oil Pressure Relief Valve Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the piston (1) and spring (2) from the oil pressure relief valve closure bolt (3).
8. Clean and inspect the components. Refer to **Engine Block Cleaning and Inspection**.
9. Clean the thread.

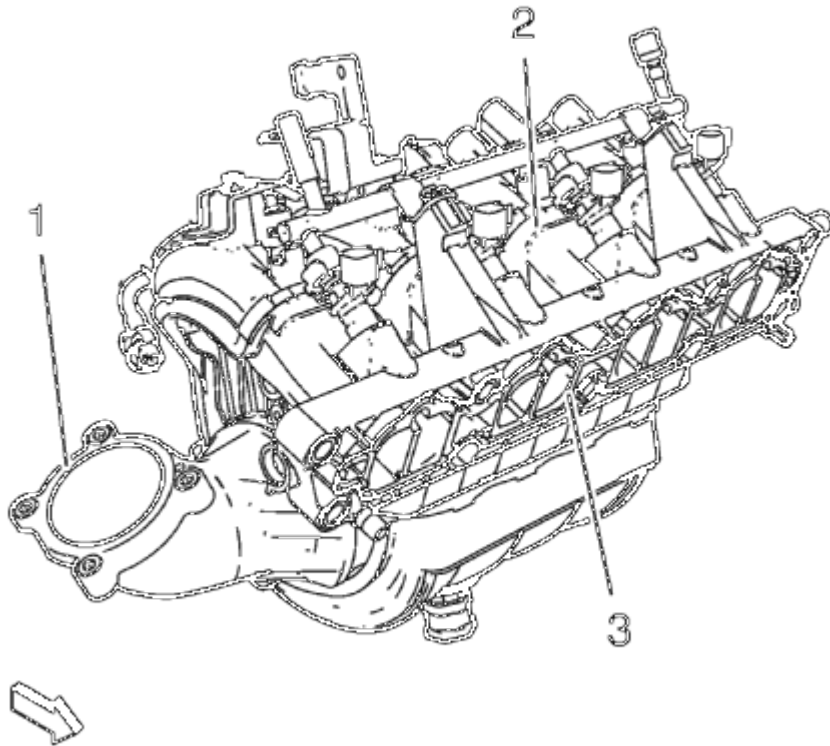


**Fig. 427: Piston Oil Nozzles**

**Courtesy of GENERAL MOTORS COMPANY**

10. Remove the 4 piston oil nozzles (1).

## **INTAKE MANIFOLD CLEANING AND INSPECTION**



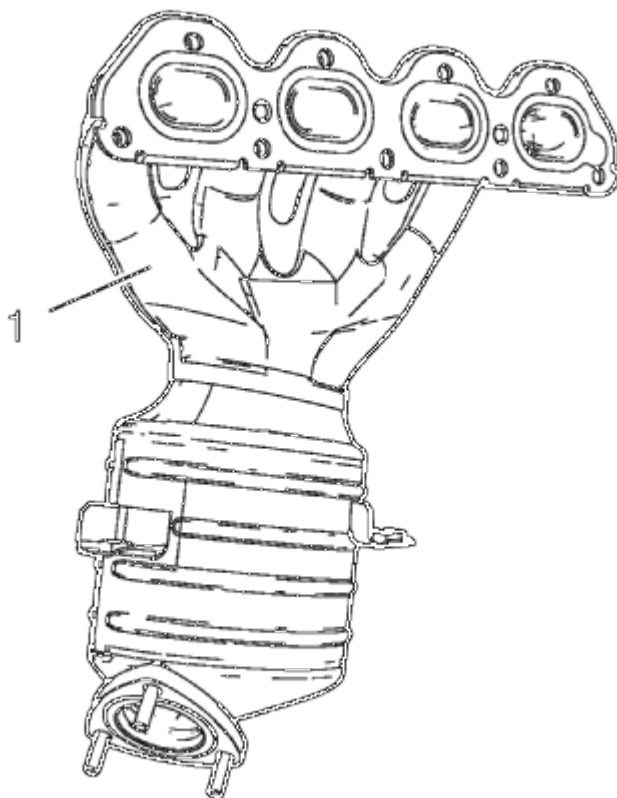
**Fig. 428: Intake Manifold And Sealing Surfaces**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Clean the intake manifold mating surfaces.
2. Inspect the intake manifold (2) for damage.
3. Inspect the intake manifold for cracks near metallic inserts.
4. Inspect the crankcase ventilation passages in the intake manifold face for blockage.

**WARNING: Wear safety glasses in order to avoid eye damage.**

5. Clean the crankcase ventilation passages with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
6. Clean the throttle body sealing surface (1).
7. Clean the intake manifold to cylinder head sealing surface (3).
8. Replace the intake manifold as necessary.

## **EXHAUST MANIFOLD CLEANING AND INSPECTION**

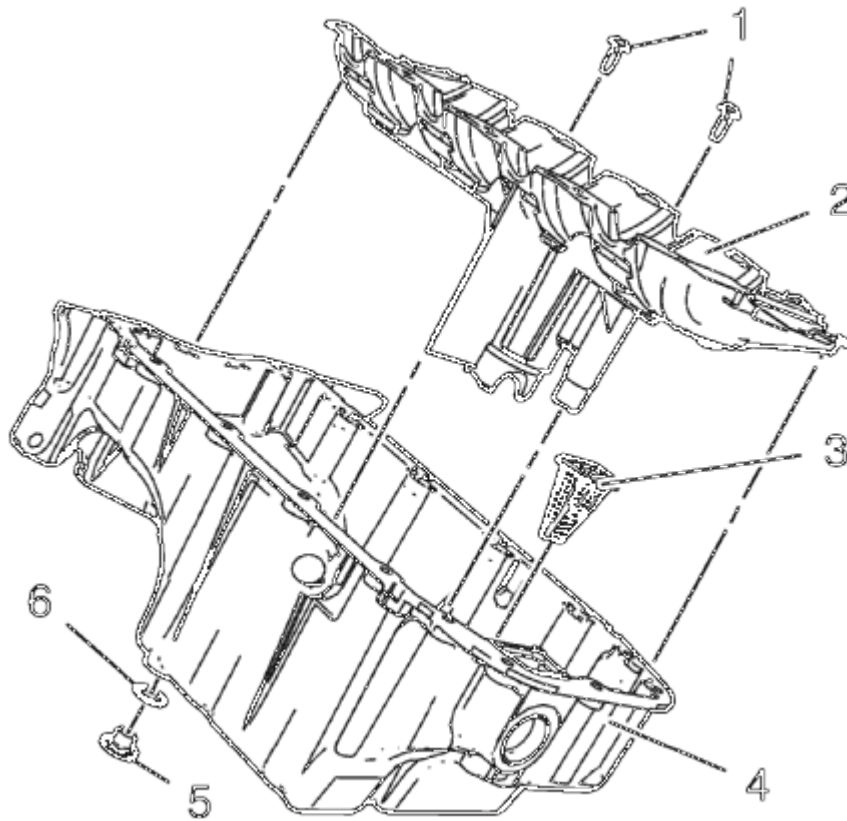
**Fig. 429: Exhaust Manifold****Courtesy of GENERAL MOTORS COMPANY**

1. Clean the exhaust manifold (1) in solvent.

**WARNING: Wear safety glasses in order to avoid eye damage.**

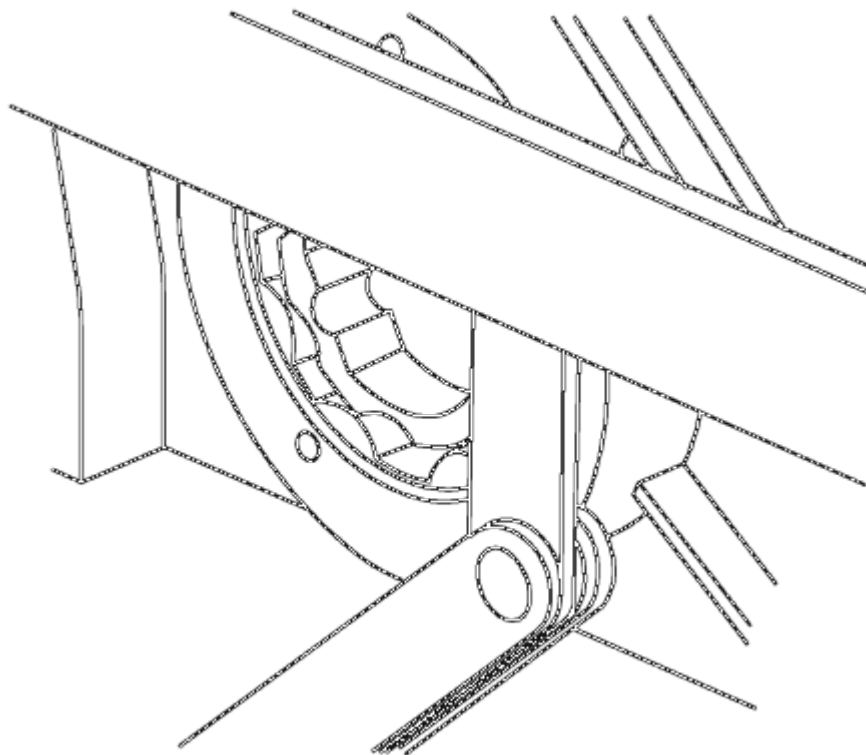
2. Dry the exhaust manifold (1) with compressed air.
3. An exhaust manifold leak or damage may cause an exhaust leak and may effect OBD II system performance. A damaged exhaust must be replaced.

## **OIL PAN CLEANING AND INSPECTION**

**Fig. 430: Oil Pan Components****Courtesy of GENERAL MOTORS COMPANY**

1. Remove the 2 oil pan baffle bolts (1) and the oil pan baffle (2).
2. Remove the oil pump screen (3).
3. Clean the oil pan (4). Remove all the sludge and the oil deposits.
4. Remove the oil pan drain plug (5) and the oil pan drain plug seal (6).
5. Inspect the thread of the oil pan drain plug.
6. Inspect the oil pan for cracking near the pan rail and the transmission mounting points.
7. Inspect the oil pan for cracking resulting from impact or flying road debris.
8. Inspect the oil pan baffle and oil pump screen.
9. Repair or replace the oil pan as necessary.

**OIL PUMP CLEANING AND INSPECTION**



**Fig. 431: Inspecting Axial Clearance**  
**Courtesy of GENERAL MOTORS COMPANY**

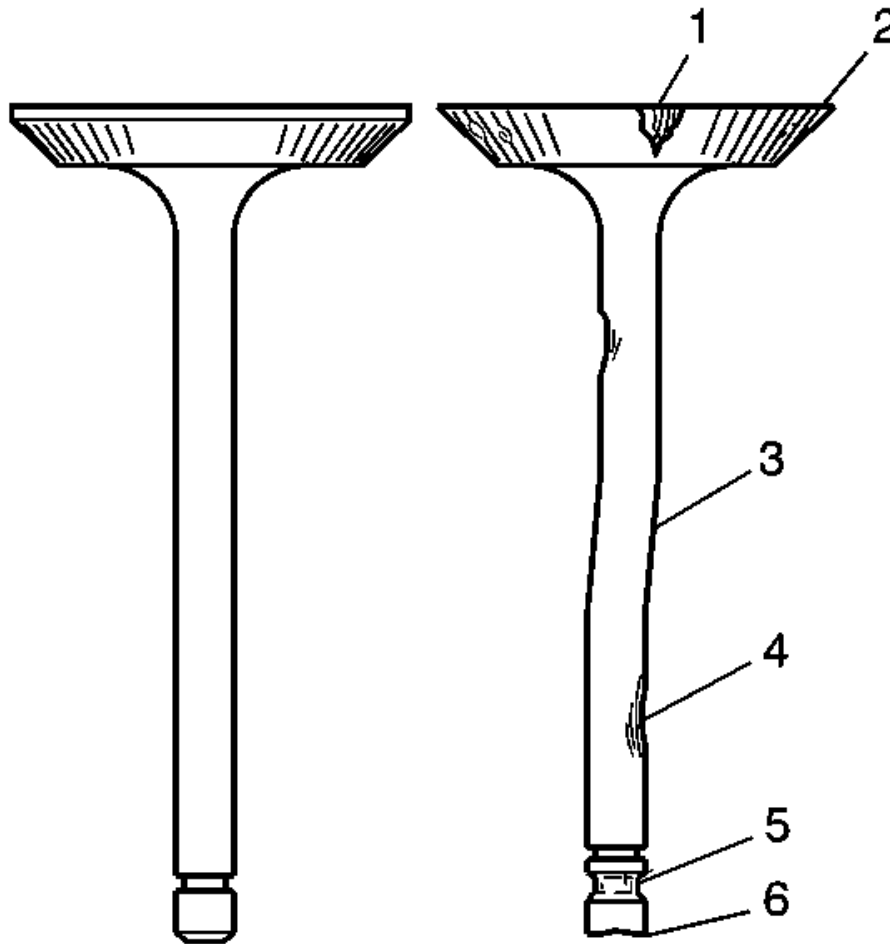
1. Remove the external rotor with the internal rotor.
2. Visually inspect the components.
3. Install the external and the internal rotors.
4. Inspect the axial clearance of the rotors in respect to the control unit housing upper edge.

### **Specifications**

Permissible measurement is 0.02-0.058 mm (0.00079-0.00228 in).

## **CYLINDER HEAD CLEANING AND INSPECTION**

### **Valve Cleaning and Inspection**



**Fig. 432: Inspection Points For Valve Damage**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Bodily injury may occur if the cleaning solvent is inhaled or exposed to the skin.

**NOTE:** Do not scratch the valve stem with the wire brush.

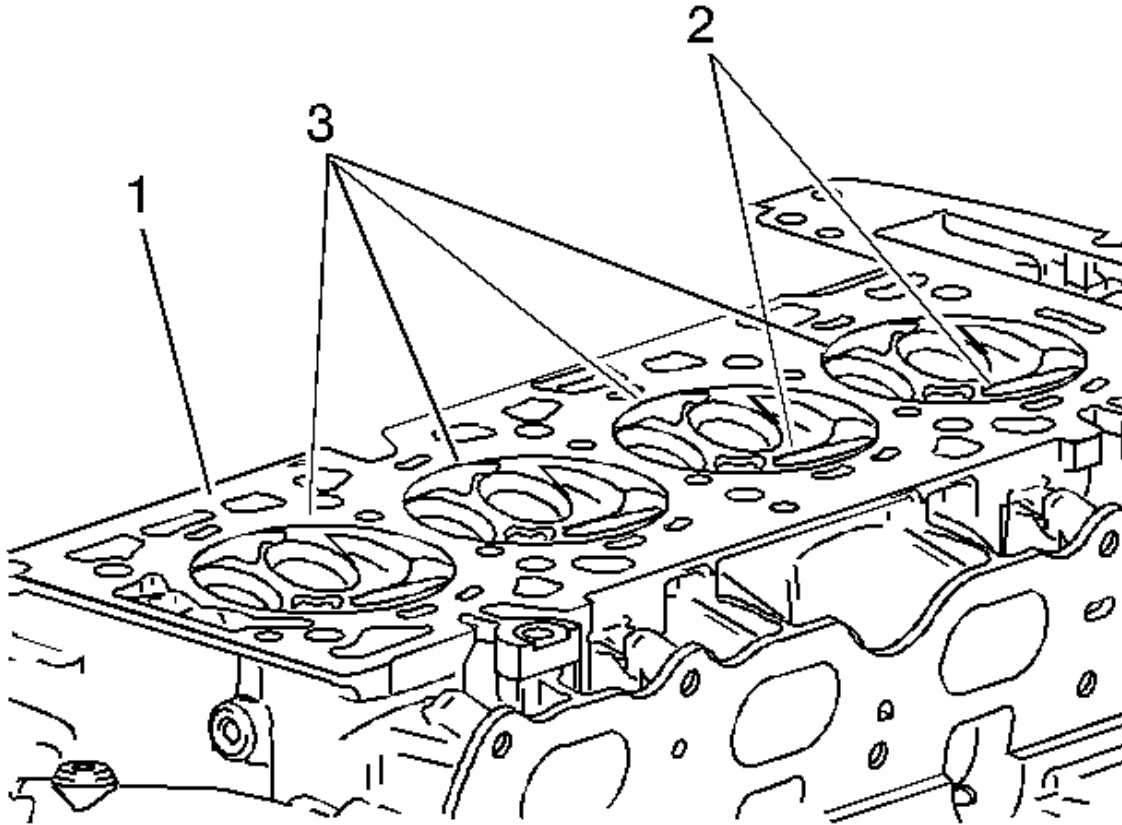
1. Clean the valves of carbon, oil and varnish. Carbon can be removed with a wire brush. Varnish can be removed by soaking in Parts Immersion Solvent.
2. Clean the valve guides.
3. Inspect the valve stem for wear (4).
4. Inspect the valve key groove for chipping or wear (5). Replace the valve if chipped or worn.
5. Inspect the valve face for burning or cracking (1). If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.



6. Inspect the valve stem for burrs and scratches. Burrs and minor scratches may be removed with an oil stone.
7. Inspect the valve stem for straightness and the valve head for bending or distortion (3) using V blocks. Bent or distorted valves must be replaced.
8. Clean the deposits from the valve face. Inspect the valve face for grooving.
9. Replace the valve if the face is grooved. Valve faces cannot be machined. If worn, or damaged, the valves must be replaced.
10. The valves may be lightly lapped to the valve seats.

**Cylinder Head and Gasket Surface Cleaning and Inspection**

1. Remove the spark plugs. Refer to **Spark Plug Replacement** .
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, use the following faults to determine the cause:
  1. Improper installation.
  2. Loose or warped cylinder head.
  3. Missing, off location or not fully seated dowel pins.
  4. Corrosion in the seal area around the coolant passages.
  5. Chips or debris in the cylinder head bolt holes.
  6. Bolt holes in the cylinder block not drilled or tapped deep enough.



**Fig. 433: Inspecting Cylinder Head Gasket Surface**  
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head gasket surface.
  - Cylinder head may be reused if corrosion is found only outside a 4 mm (0.375 in) band around each combustion chamber (1).
  - Replace the cylinder head if the area between the valve seats is cracked (2).
  - Replace the cylinder head if corrosion has been found inside a 4 mm (0.375 in) band around each combustion chamber (3).
4. Clean the cylinder head bolts.

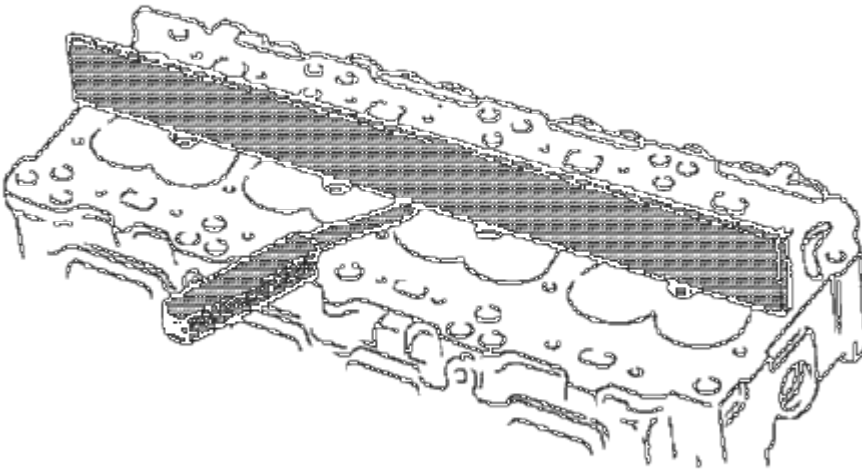
**NOTE:**      **Do not use a wire brush on any gasket sealing surface.**

5. Clean the cylinder head. Remove all varnish, soot and carbon to the bare metal.

6. Clean the valve guides.
7. Clean the threaded holes. Use a nylon bristle brush.
8. Clean the remains of the sealer from the plug holes.
9. Inspect the cylinder head bolts for damaged threads or stretching and damaged heads caused by improper use of tools.
10. Replace all suspect bolts.
11. Inspect the cylinder head for cracks. Check between the valve seats and in the exhaust ports.

**NOTE:**        **Do not attempt to weld the cylinder head, replace it.**

12. Inspect the cylinder head deck for corrosion, sand inclusions and blow holes.



**Fig. 434: Inspecting Cylinder Head Surfaces For Flatness**  
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the cylinder head deck surface for flatness. Refer to **Engine Mechanical Specifications**. If the cylinder head is out of specification, replace the cylinder head. Do not machine the cylinder head.
14. Inspect all the threaded holes for damage. Threads may be reconditioned with thread inserts.
15. Inspect the sealing surfaces.

16. Inspect the cylinder head plugs.

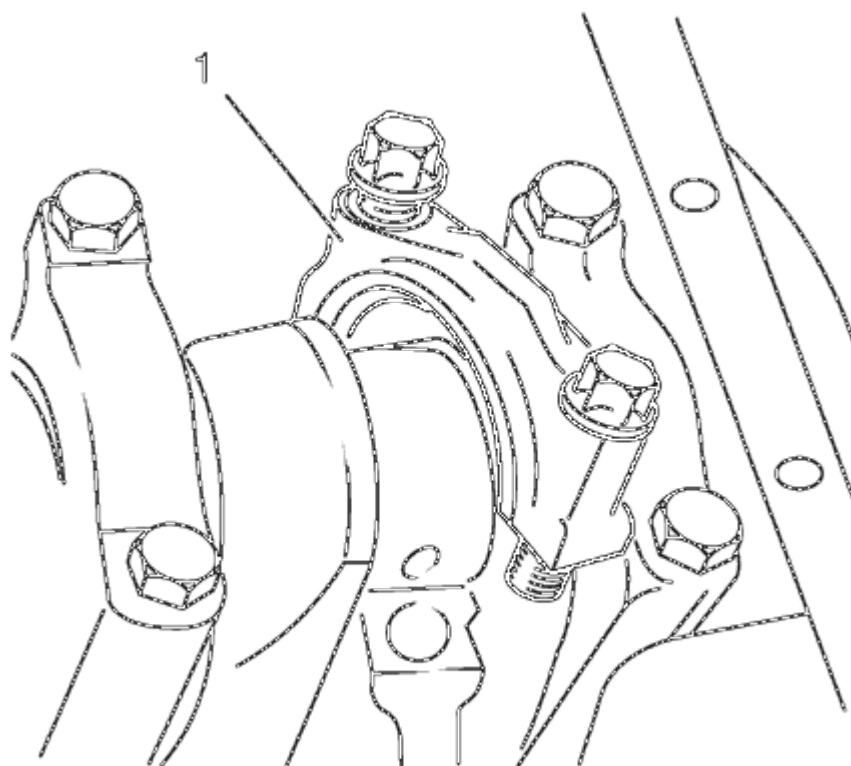
## **PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION**

### **Special Tools**

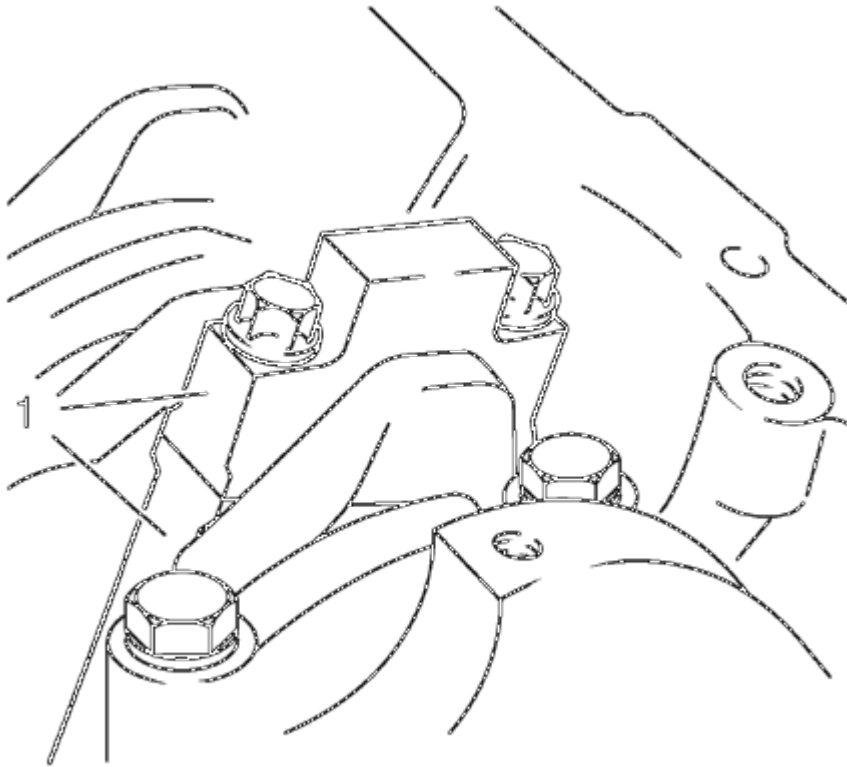
**EN-45059** Torque Angle Sensor Kit

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

1. Remove the oil pan. Refer to **Oil Pan Removal**.



**Fig. 435: Connecting Rod Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY



**Fig. 436: Marking Position On Connecting Rod Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the connecting rod bearing cap (1).
  1. Mark the installation position (1) of the connecting rod bearing cap.
  2. Remove the 2 bolts.
  3. Degrease the connecting rod bearing cap and wet the connecting rod bearing clip with engine oil.

**NOTE:** Do not rotate the crankshaft.

3. Lay on plastigage. Refer to Adhesives, Fluids, Lubricants, and Sealers.

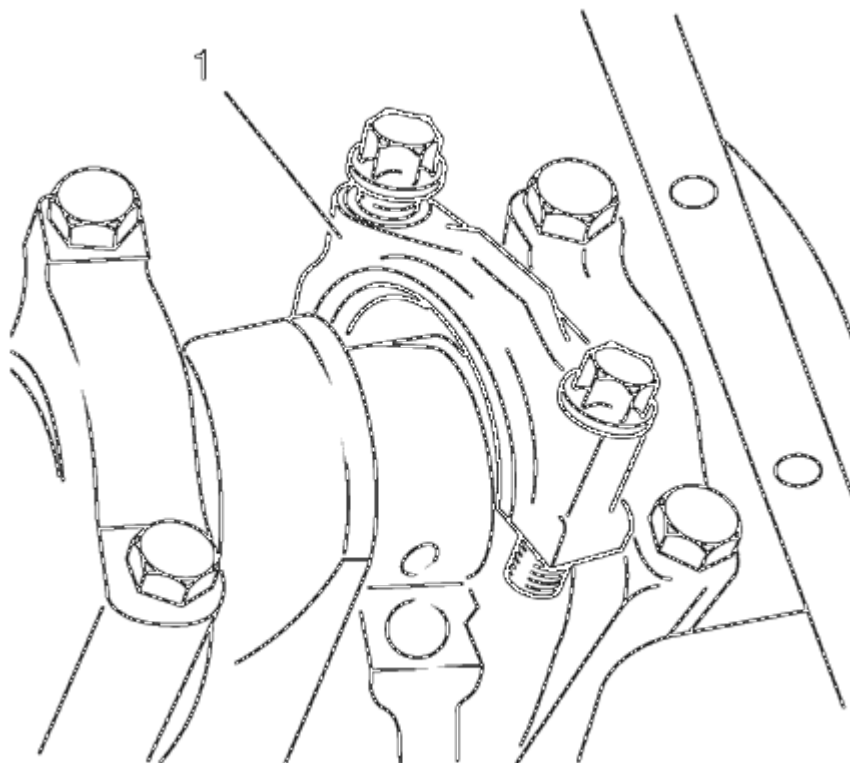
Lay plastigage (flexible plastic thread) over the entire width of the connecting rod bearing journal.

4. Install the connecting rod bearing cap.

**CAUTION:** Refer to Fastener Caution

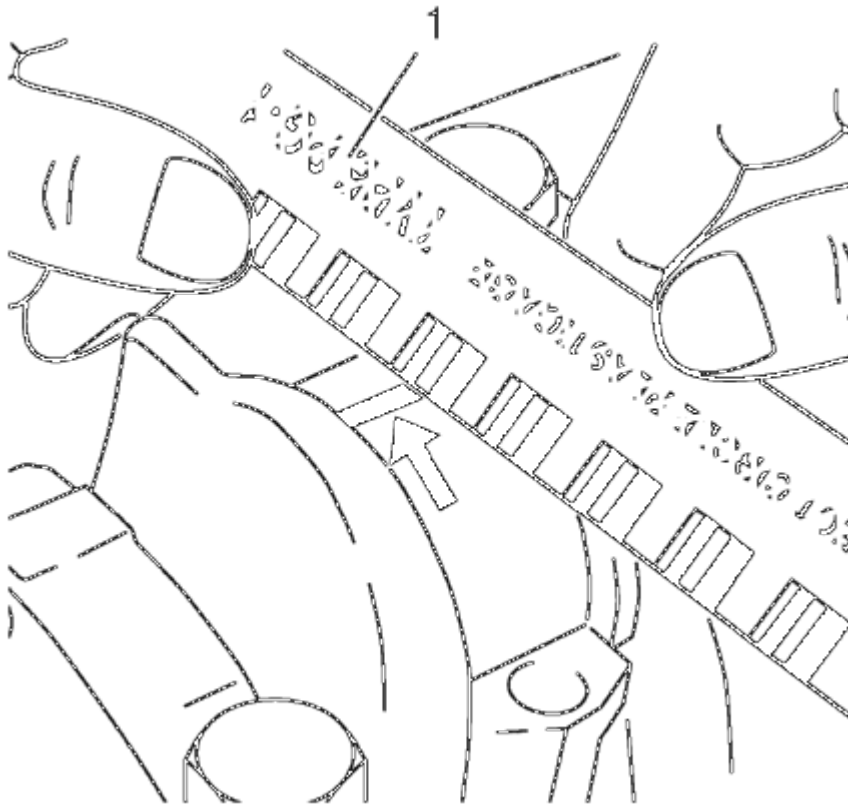
5. Tighten the 2 bolts in three passes using the **EN-45059** sensor kit :

1. First pass tighten to 35 N.m (26 lb ft).
2. Second pass tighten to an additional 45°
3. Third pass tighten to an additional 15°



**Fig. 437: Connecting Rod Bearing Cap**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 bolts.
7. Remove the connecting rod bearing cap (1).



**Fig. 438: Measuring Connecting Rod Bearing Play Using Measuring Scale**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When reading the value, do not confuse millimeters and inches on the measuring scale (1).

8. Measure the connecting rod bearing play.
  - Compare the width of the flattened plastic thread with the measuring scale.
  - Permissible connecting rod bearing play: 0.019-0.071 mm (0.0007-0.0028 in).

**NOTE:** Check markings on parts.

9. Install the connecting rod bearing cap.
  - Wet the connecting rod bearing journal and con-rod bearing clips with engine oil.
  - Renew the bolts.
10. Tighten the 2 bolts in three passes using the **EN-45059** sensor kit :
  1. First pass tighten to 35 N.m (26 lb ft)
  2. Second pass tighten to an additional 45°
  3. Third pass tighten to an additional 15°

11. Install the oil pan. Refer to **Oil Pan Installation**.

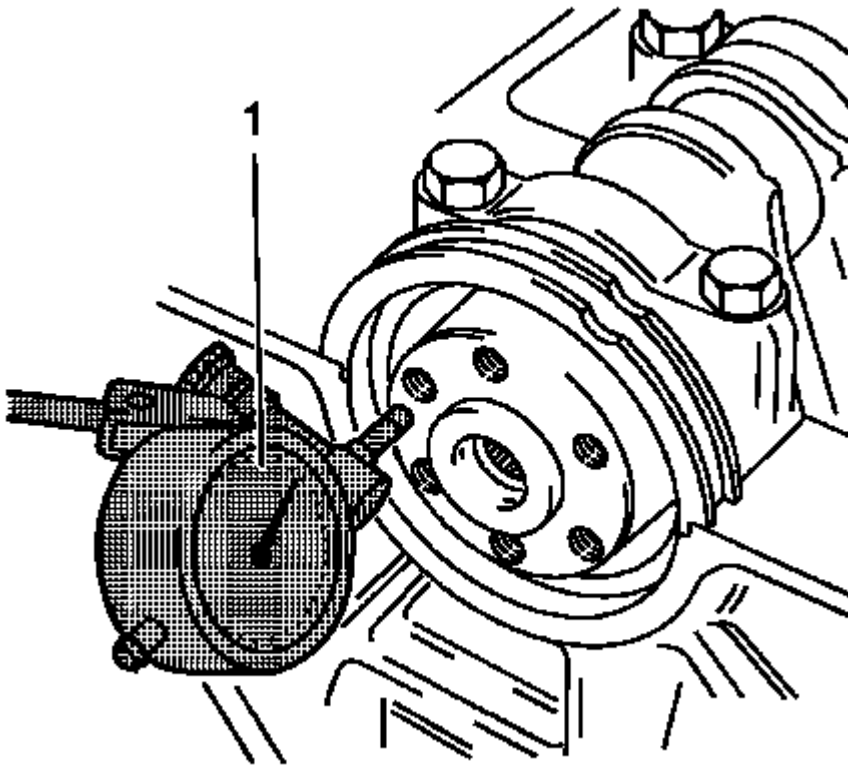
## CRANKSHAFT AND BEARING CLEANING AND INSPECTION

### Special Tools

- **EN-45059** Torque Angle Sensor Kit
- **GE-571-B** Dial Gauge

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

### Crankshaft End Play, Check



**Fig. 439: Gauge Tool**

Courtesy of GENERAL MOTORS COMPANY

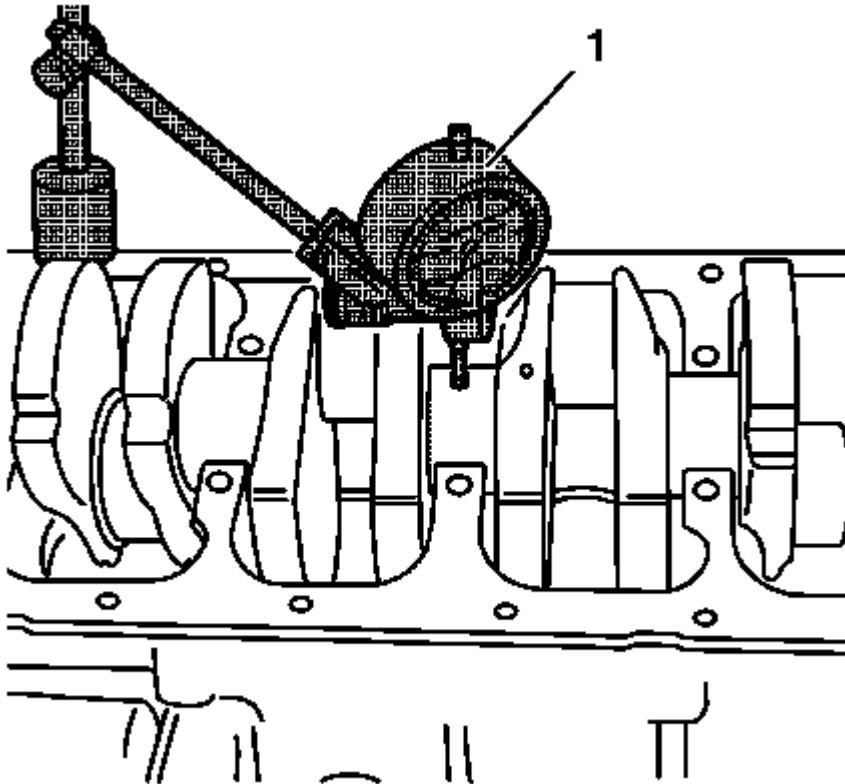
**NOTE:** Crankshaft attached with crankshaft bearing caps.

1. Install the **GE-571-B** gauge (1).
  1. Install in the holder on the front of the engine block.
  2. Place the dial gauge plunger against the crankshaft and adjust.



2. Measure the longitudinal play of the crankshaft.
  1. Move the crankshaft in the longitudinal direction.
  2. Permissible crankshaft end play: 0.100-0.202 mm (0.0039-0.0080 in)
3. Remove the **GE-571-B** gauge.

**Crankshaft Out-of-Round, Check**



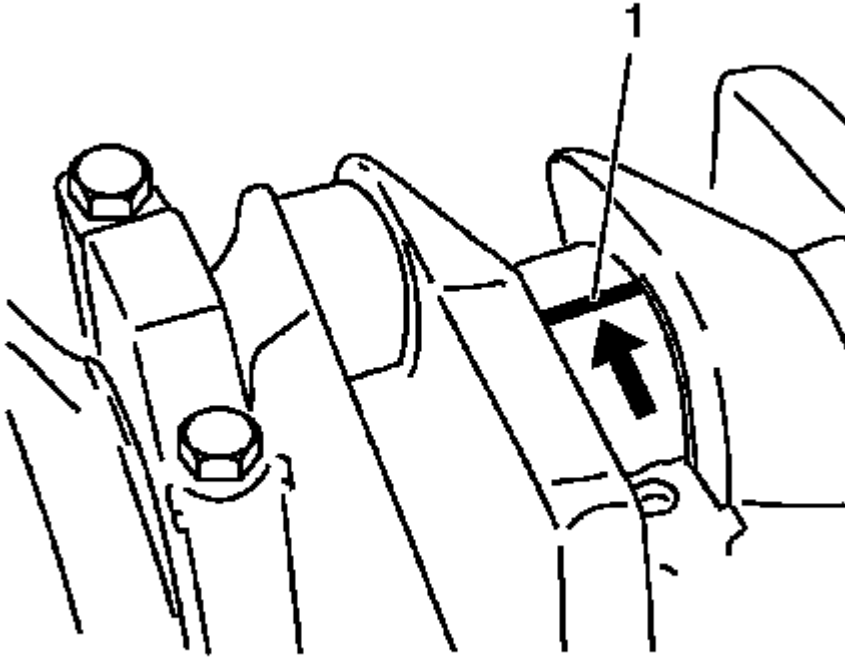
**Fig. 440: Gauge Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE: Crankshaft removed.**

1. Insert the crankshaft in the engine block.
2. Install the **GE-571-B** gauge.
  1. Attach to the bracket on the engine block.
  2. Place the dial gauge plunger against the crankshaft bearing journal and adjust.
3. Check the rotational play of the crankshaft.
  1. Turn the crankshaft evenly.
  2. Maximum permissible rotational play: 0.03 mm (0.001 in).

4. Remove the **GE-571-B** gauge (1).

**Check Crankshaft Bearing Clearance (With Plastigage)**

**Fig. 441: Plastigage On Bearing Journal**  
Courtesy of GENERAL MOTORS COMPANY

- NOTE:**
- Crankshaft removed.
  - Do not rotate the crankshaft.

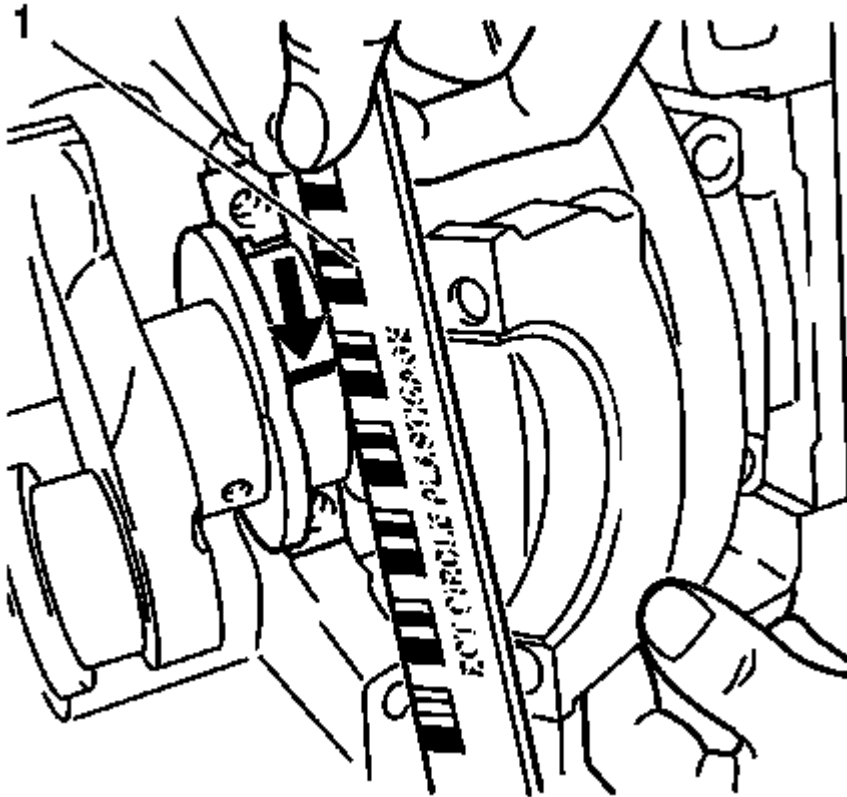
1. Lay on plastigage.

Lay out plastigage (flexible plastic thread) around the entire width of the con-rod bearing journal (1).

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

- NOTE:**
- Note the correct tightening sequence.
  - The bolts can be reused for checking the crankshaft bearing play.

2. Install the crankshaft bearing cap. Tighten the 2 crankshaft bearing cap bolts in 3 passes. Use the **EN-45059** sensor kit :
  1. First pass to 50 N.m (37 lb ft)
  2. Second pass to 45°
  3. Third pass to 15°
3. Remove the 2 crankshaft bearing cap bolts.



**Fig. 442: Measuring Crankshaft Bearing Play Using Measuring Scale**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When reading the value, do not confuse millimeters and inches on the measuring scale (1).

4. Measure the crankshaft bearing play.
  1. Compare the width of the flattened plastic thread (arrow) to the measuring scale.
  2. Permissible crankshaft bearing play: 0.005-0.059 mm (0.0002-0.0023 in).

**Check Crankshaft Bearing Clearance (With Micrometer Gauge Internal Measuring Device)**

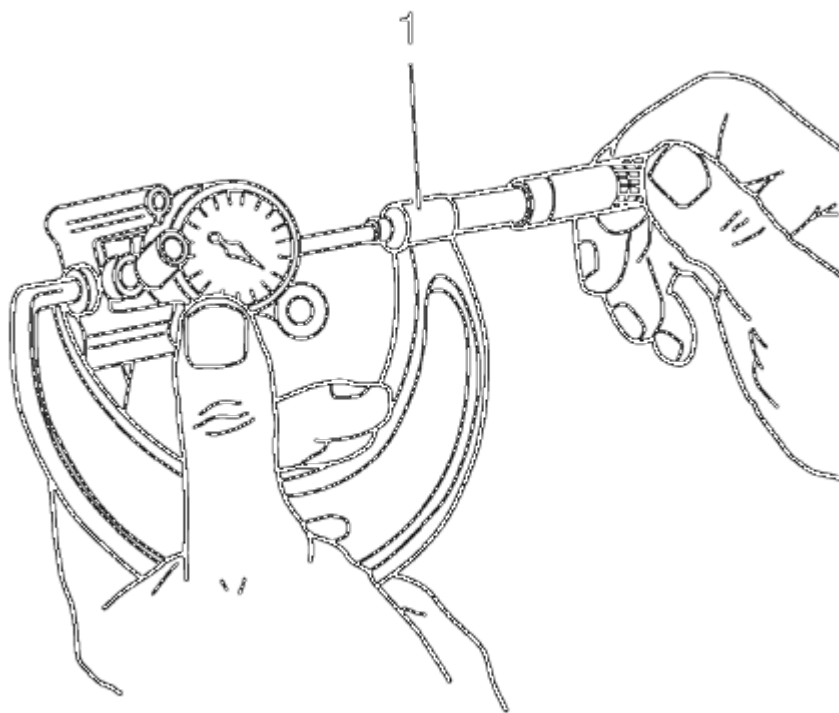
**NOTE:** • Note the correct tightening sequence.

- **The bolts can be reused for checking the crankshaft bearing play.**

1. Install the crankshaft bearing cap with the crankshaft bearing clips to the cylinder block.

Tighten the 2 crankshaft bearing cap bolts in 3 passes. Use the **EN-45059** sensor kit :

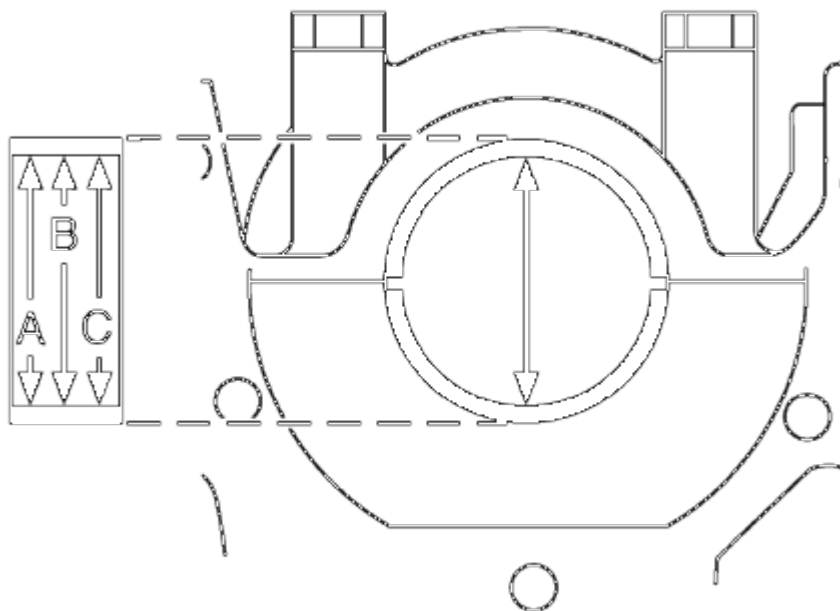
1. First pass to 50 N.m (37 lb ft)
2. Second pass to 45°
3. Third pass to 15°



**Fig. 443: Micrometer Gauge**

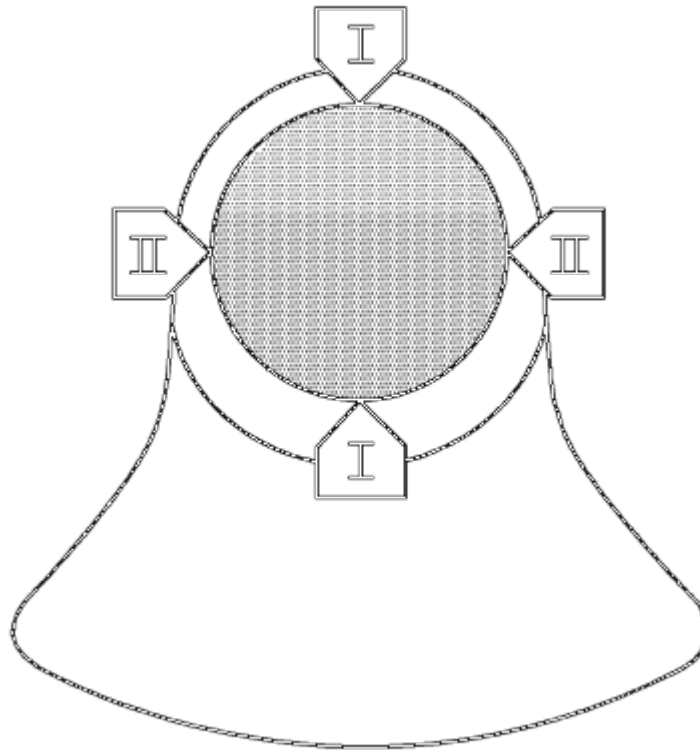
Courtesy of GENERAL MOTORS COMPANY

2. Install the inner plunger and calibrate with the micrometer gauge (1).



**Fig. 444: Measuring Crankshaft Bearing Diameter At Points**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Measure the crankshaft bearing diameter at 3 points.
  - Measure at points A, B and C with the internal measuring device.
  - Calculate the average crankshaft bearing diameter.
  - Formula:  $A + B + C / 3$ .



**Fig. 445: Measuring Crankshaft Bearing Journal Diameter At 2 Points**  
Courtesy of GENERAL MOTORS COMPANY

4. Measure the crankshaft bearing journal diameter at 2 points.

Measure at points I and II with the micrometer gauge.

5. Calculate the average crankshaft bearing journal diameter.

Formula:  $I + II/2$ .

6. Determine the crankshaft bearing play.

Calculation formula: average crankshaft bearing diameter minus average crankshaft bearing journal diameter.

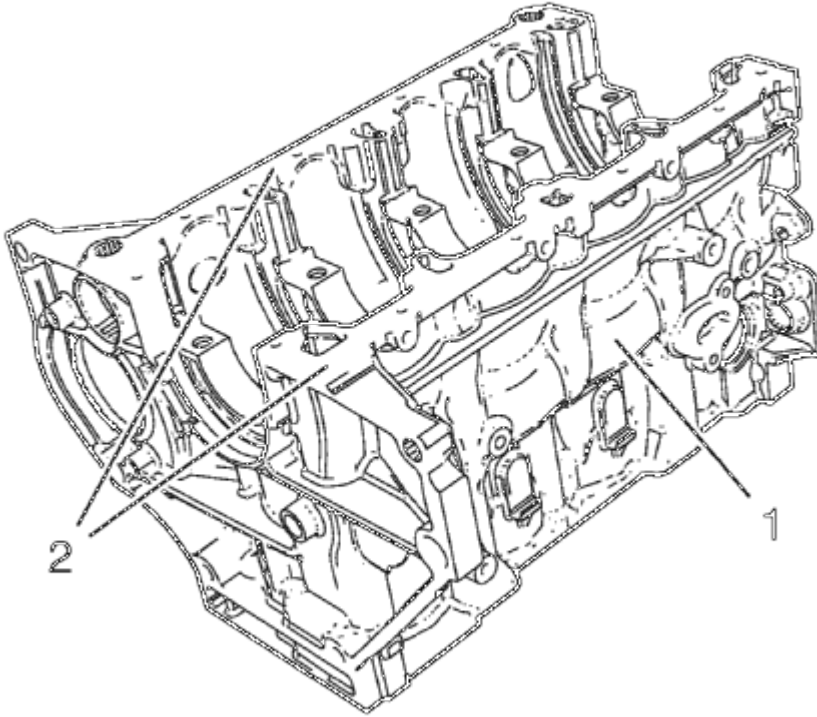
7. Nominal-Actual comparison.

Permissible crankshaft bearing play: 0.005-0.059 mm (0.0002-0.0023 in).

## ENGINE BLOCK CLEANING AND INSPECTION

**Special Tools****EN-8087** Cylinder Gauge

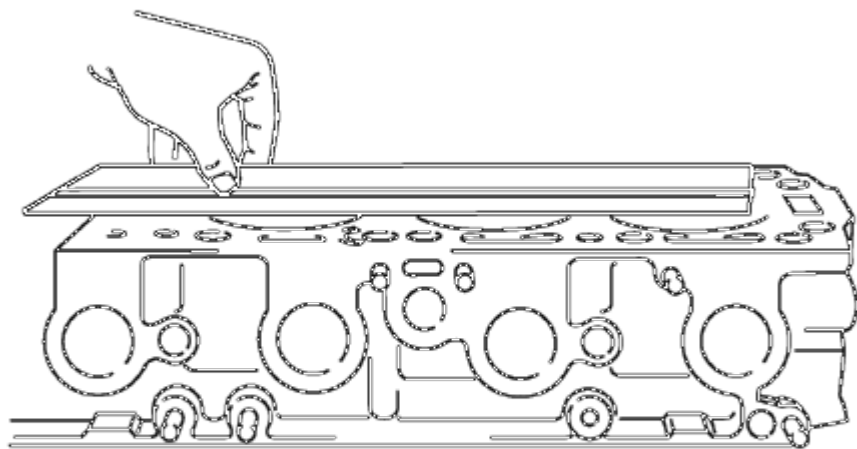
For equivalent regional tools, refer to **Special Tools**.



**Fig. 446: Engine Block**

Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing material from the gasket mating surfaces (2).
2. Clean the engine block (1) and lower crankcase in a cleaning tank with solvent appropriate for aluminum. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended solvent.
3. Flush the engine block with clean water or steam.
4. Clean the oil passages.
5. Clean the blind holes.
6. Spray the cylinder bores and the machined surfaces with engine oil.
7. Inspect the threaded holes. Clean the threaded holes with a rifle brush. If necessary, drill out the holes and install thread inserts. Refer to **Thread Inserts**.

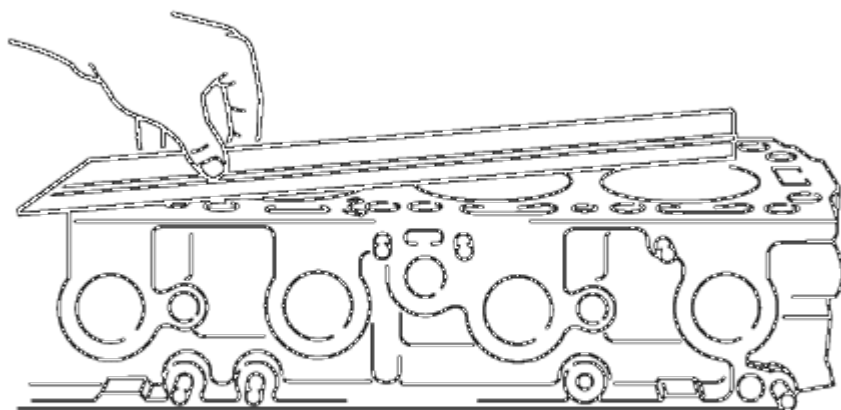


**Fig. 447: Inspecting Engine Block For Sag In Length And Width On Sealing Surfaces**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not attempt to machine the lower crankcase to engine block surfaces.

8. Inspect the engine block for sag in length and width on the sealing surfaces.

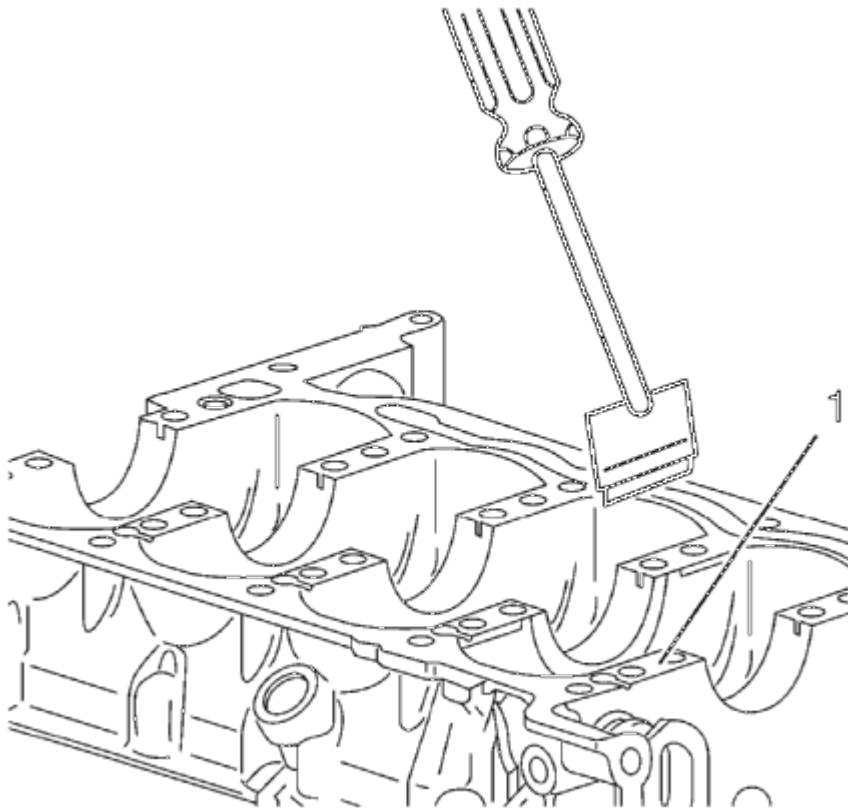




**Fig. 448: Inspecting Engine Block For Distortion Along Diagonals**  
Courtesy of GENERAL MOTORS COMPANY

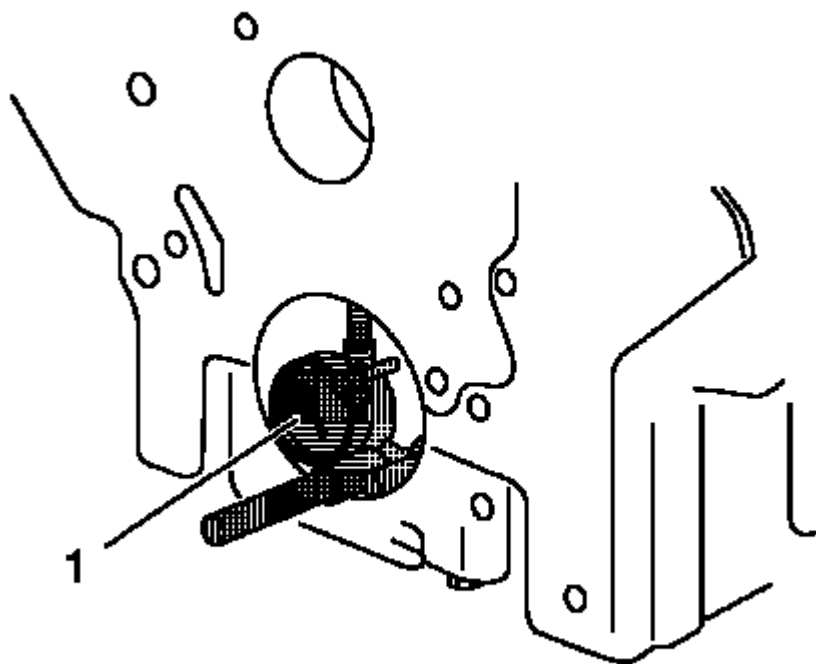
9. Inspect the engine block for distortion along the diagonals.

If the deck surface is out of specification, replace the block. Do not machine the block.



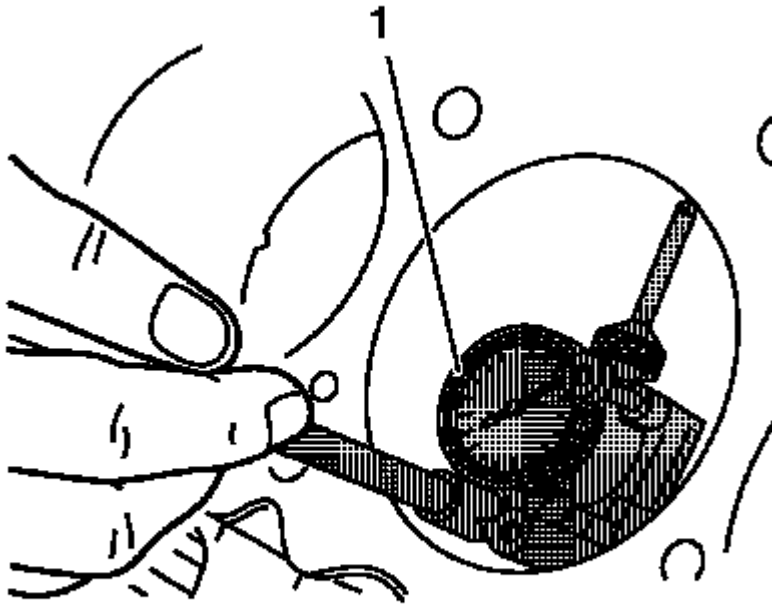
**Fig. 449: Cleaning Gasket Mating Surfaces**  
**Courtesy of GENERAL MOTORS COMPANY**

10. Clean the sealing material from the gasket mating surfaces (1) on the lower crankcase oil pan side.



**Fig. 450: Measuring Bearing Bore Concentricity And Alignment Using Gauge Tool**  
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the crankshaft main bearing bores. Use the **EN-8087** gauge (1) to measure the bearing bore concentricity and alignment.
12. Replace the engine block and bed plate if the crankshaft bearing bores are out of specification.



**Fig. 451: Inspecting Cylinder Bore**  
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the cylinder bores using the **EN-8087** gauge (1). Inspect for the following items:
  - Wear
  - Taper
  - Runout
  - Ridging
14. Check the cylinder bores specifications. Refer to **Engine Mechanical Specifications**.
15. If the cylinder bores are out of specification, replace the engine block.

### **SERVICE PRIOR TO ASSEMBLY**

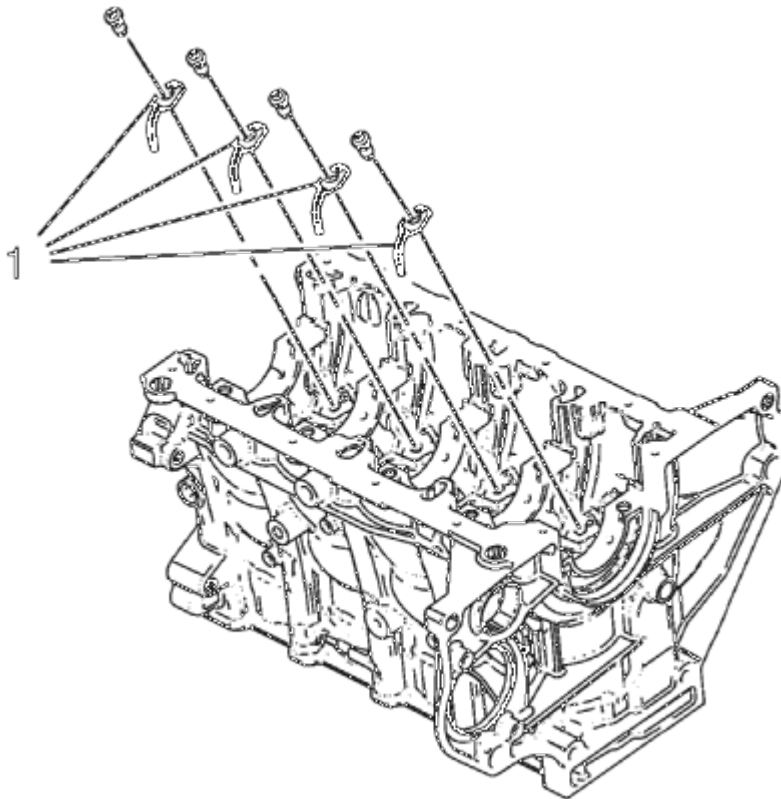
The importance of cleanliness during assembly cannot be overstated. Dirt or debris will cause engine damage. An automobile engine is a combination of many machined, honed, polished and lapped surfaces with minor tolerances. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.

Lubricate all moving parts with engine oil or a specified assembly lubricant. This will provide lubrication for initial start up.

When the components are reinstalled into an engine, return the components to their original location, position, and direction.

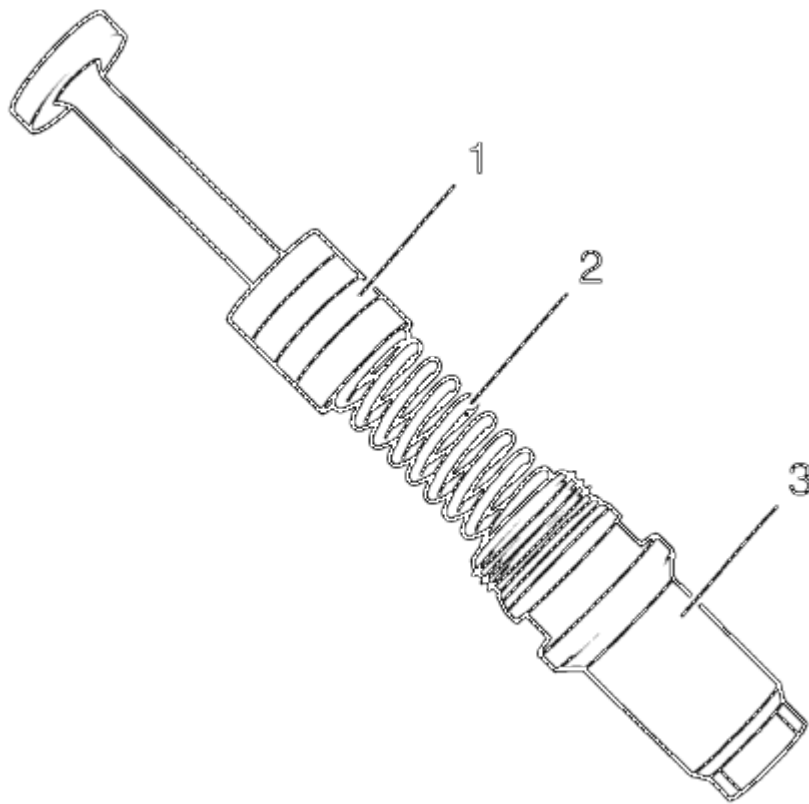
## ENGINE BLOCK ASSEMBLY



**Fig. 452: Piston Oil Nozzles**

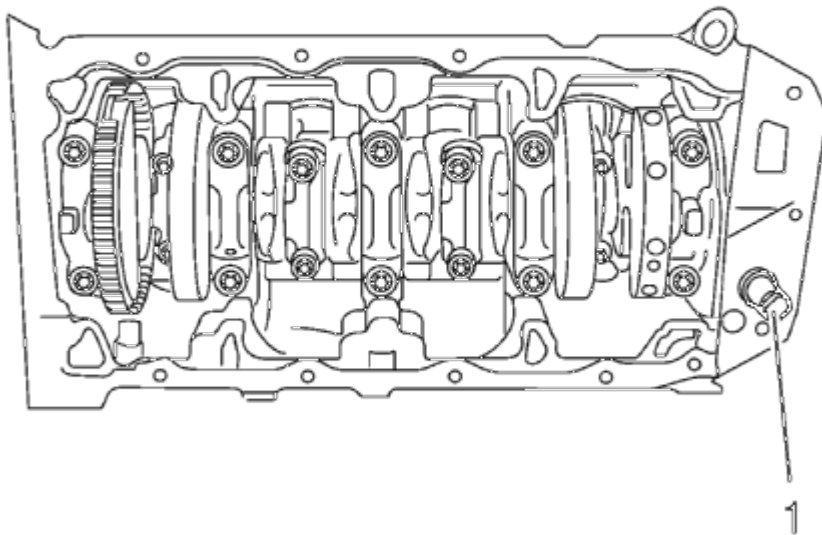
**Courtesy of GENERAL MOTORS COMPANY**

1. Install the 4 piston oil nozzles (1).



**Fig. 453: Piston, Spring And Oil Pressure Relief Valve Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

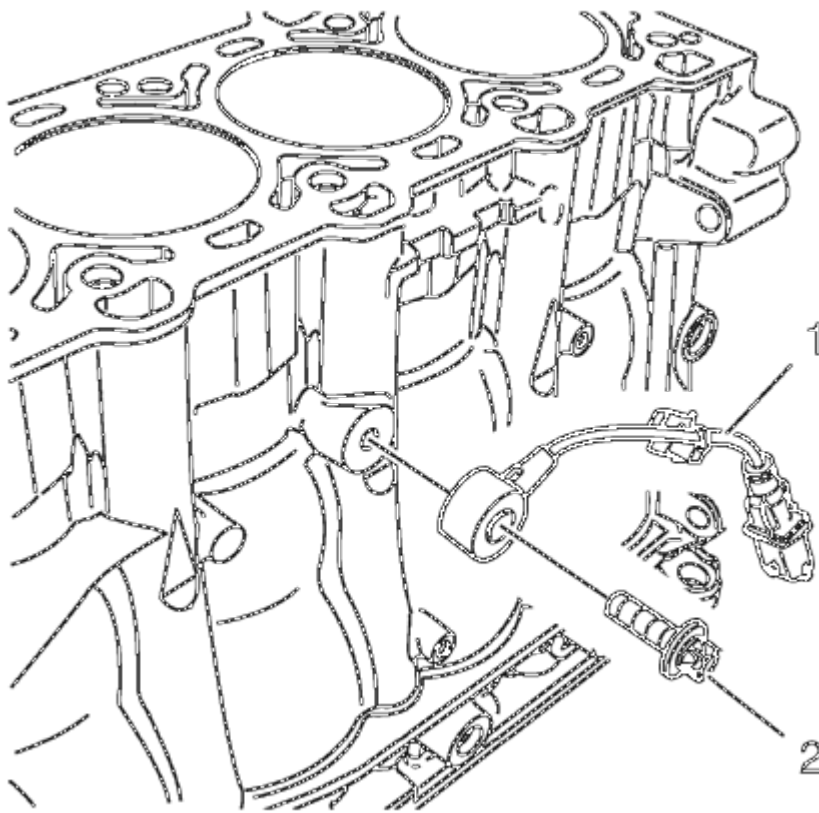
2. Install the piston (1) and spring (2) to the oil pressure relief valve closure bolt (3).



**Fig. 454: Oil Pressure Relief Valve Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

3. Install the oil pressure relief valve and the oil pressure relief valve closure bolt (1) and tighten to 21 N.m (16 lb ft).

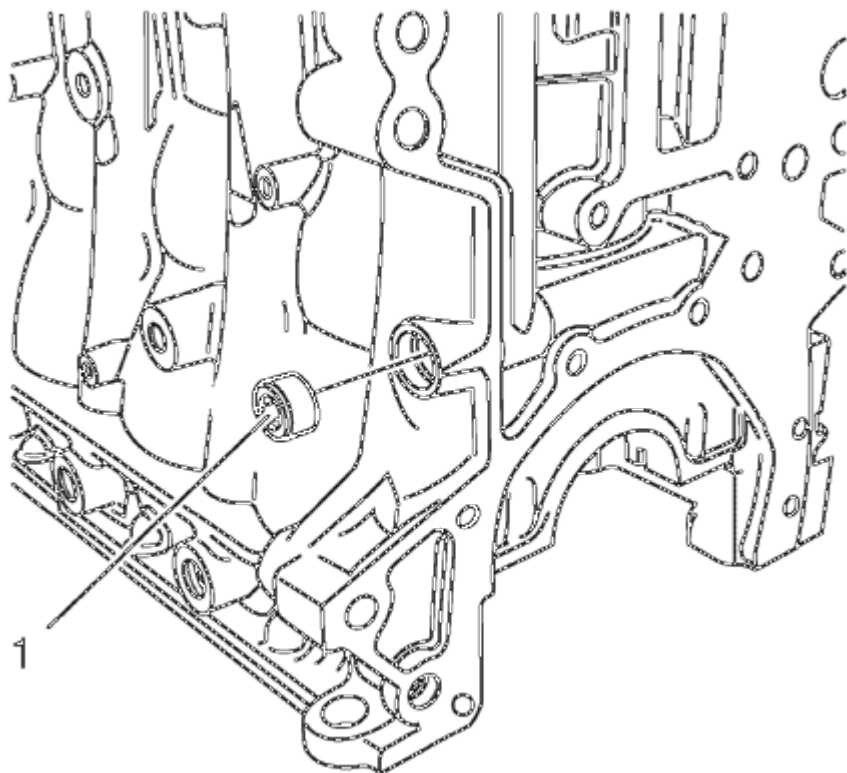


**Fig. 455: Knock Sensor And Bolt**

Courtesy of GENERAL MOTORS COMPANY

4. Install the knock sensor (1) and the knock sensor bolt (2) and tighten to 20 N.m (15 lb ft).

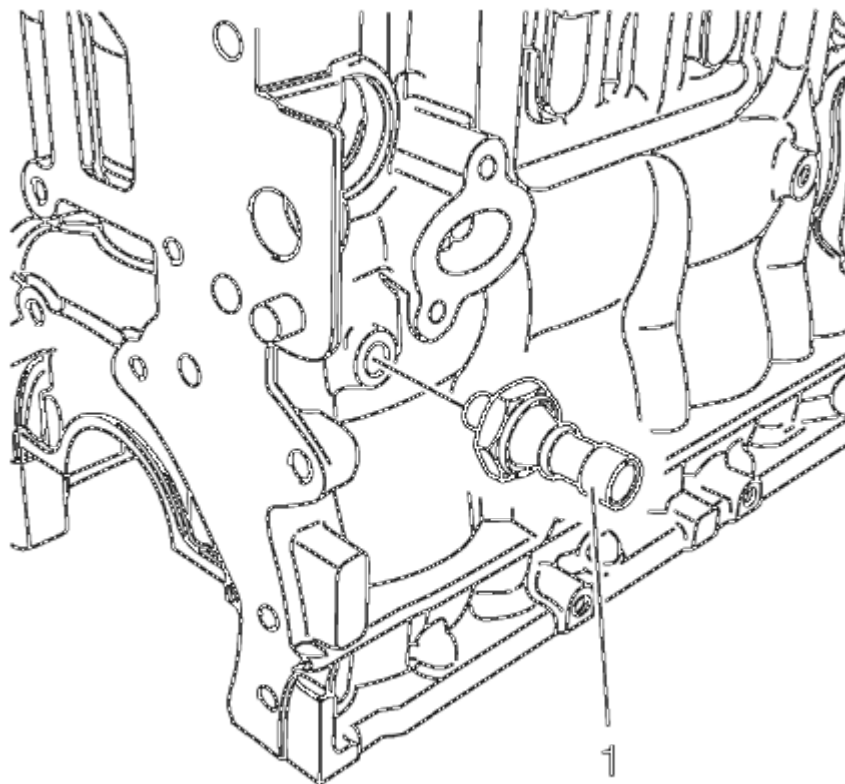




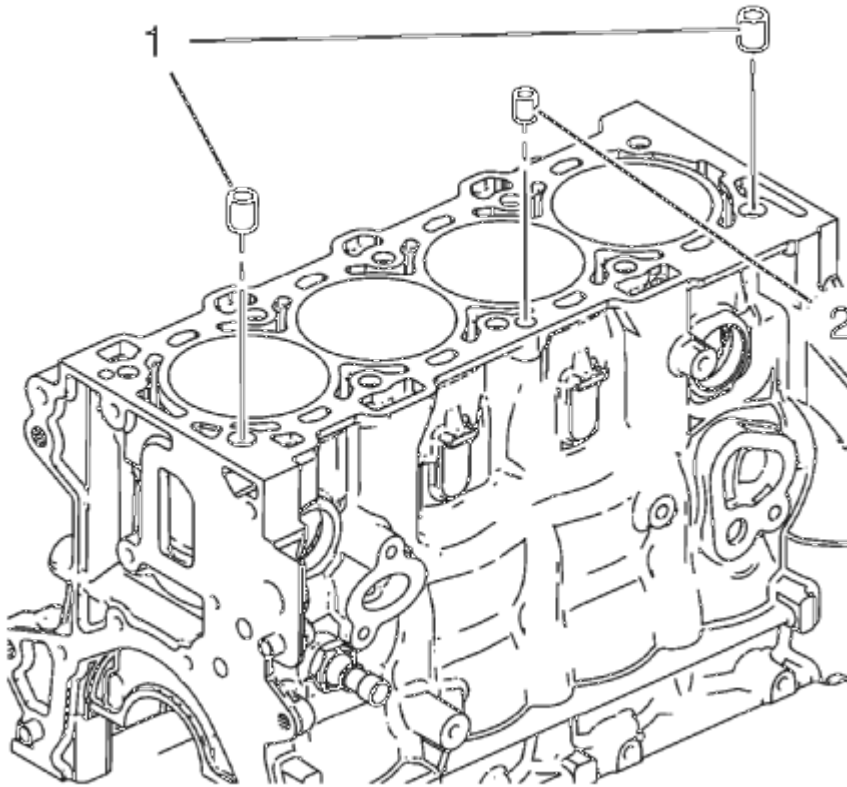
**Fig. 456: Oil Flow Check Valve**

**Courtesy of GENERAL MOTORS COMPANY**

5. Install the oil flow check valve (1).

**Fig. 457: Oil Pressure Switch****Courtesy of GENERAL MOTORS COMPANY**

6. Install the oil pressure switch (1) and tighten to 20 N.m (15 lb ft).

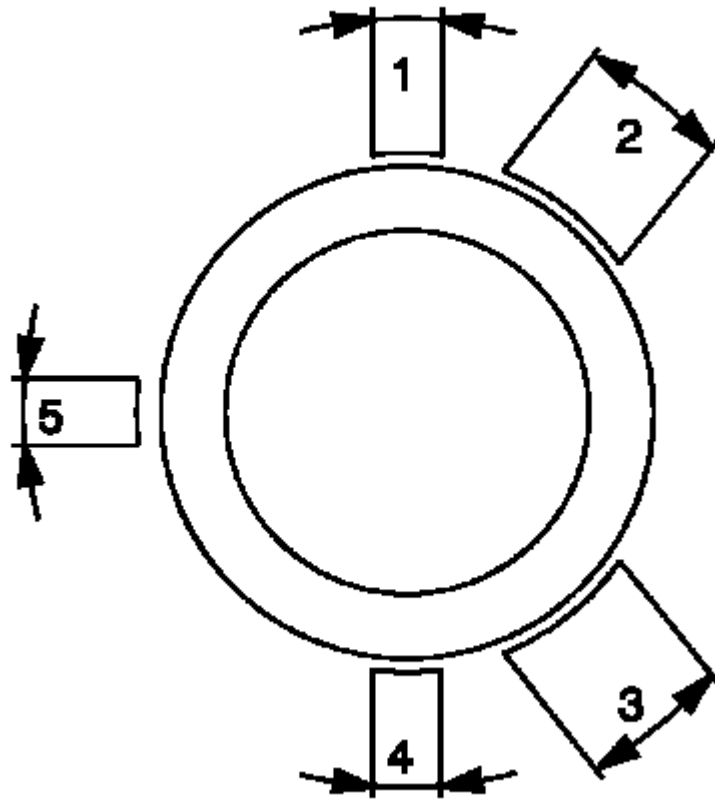


**Fig. 458: Cylinder Head Locating Pins**

Courtesy of GENERAL MOTORS COMPANY

7. Install the cylinder head locating (1, 2).

## **PISTON AND CONNECTING ROD ASSEMBLE**



**Fig. 459: Piston Ring Joint Positions**

Courtesy of GENERAL MOTORS COMPANY

1. Install the piston rings.
  - Insert into the pistons with piston ring wrench and "TOP" pointing upwards.
  - Set the piston ring gap.
    - First piston ring (right-hand ring) in position (1)
    - Second piston ring (minute ring) in position (2)
    - Interim ring of oil scraper ring in position (3), steel band rings of oil scraper ring in position (4 and/or 5)

**NOTE:** Note installation position of the piston in respect of the connection rod.

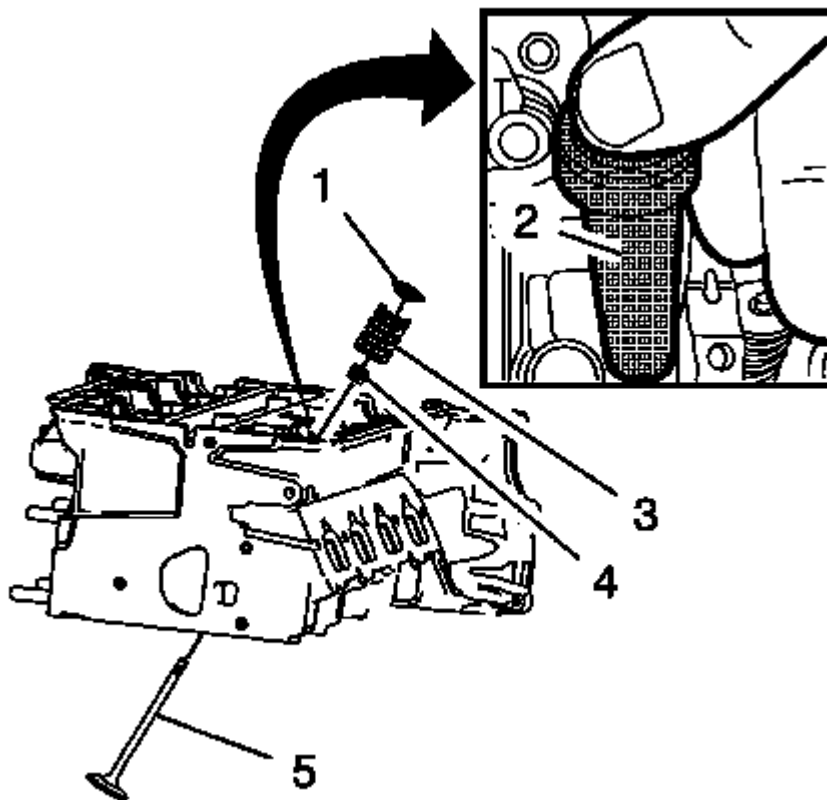
2. Attach the piston to the connection rod.
  1. Press the piston pin into the piston and the connection rod by hand.
  2. Insert the retainer in the annular groove on the piston.
  3. Ensure the retainer is firmly seated in the groove.
3. Install the piston with connection rod. Refer to **Piston, Connecting Rod, and Bearing Installation.**

## CYLINDER HEAD ASSEMBLE

### Special Tools

- **EN-958** Valve Stem Seal Installer
- **EN-8062** Valve Spring Compressor
- **EN-8062-5** Adapter
- **EN-50717-2** Compressor Assembly of **EN-50717** Kit

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



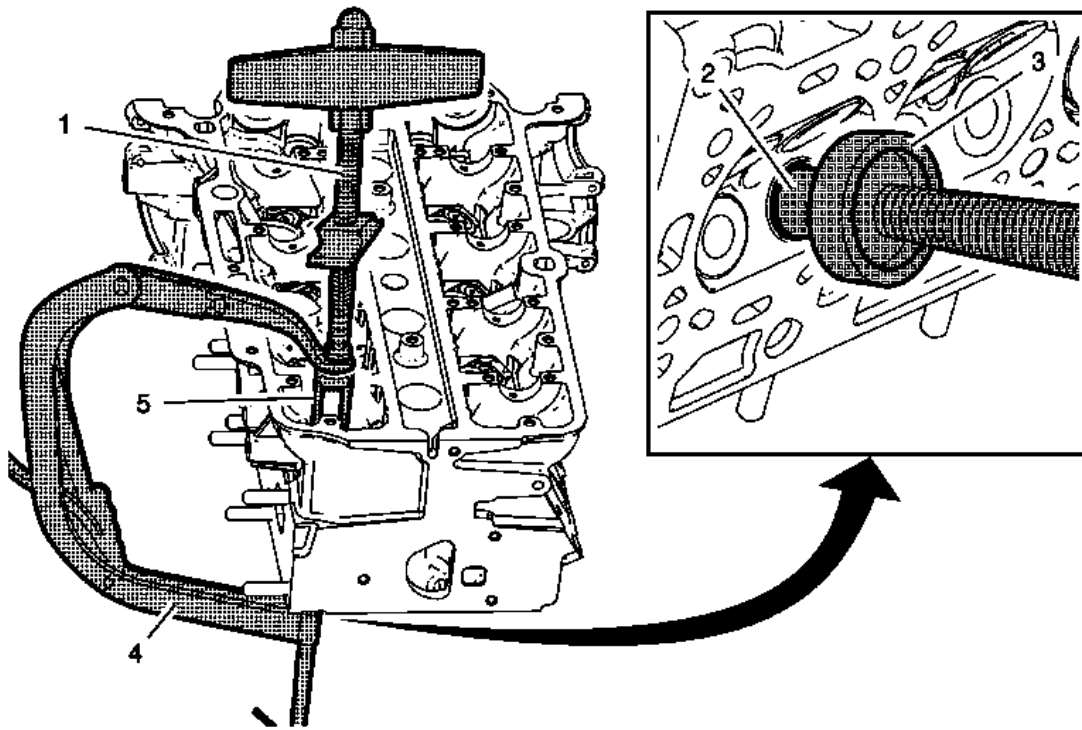
**Fig. 460: Valve Stem Oil Seal And Installer**  
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve stem and the valve guide with clean engine oil.

**NOTE:** Ensure all valve train components will be installed in their original position.

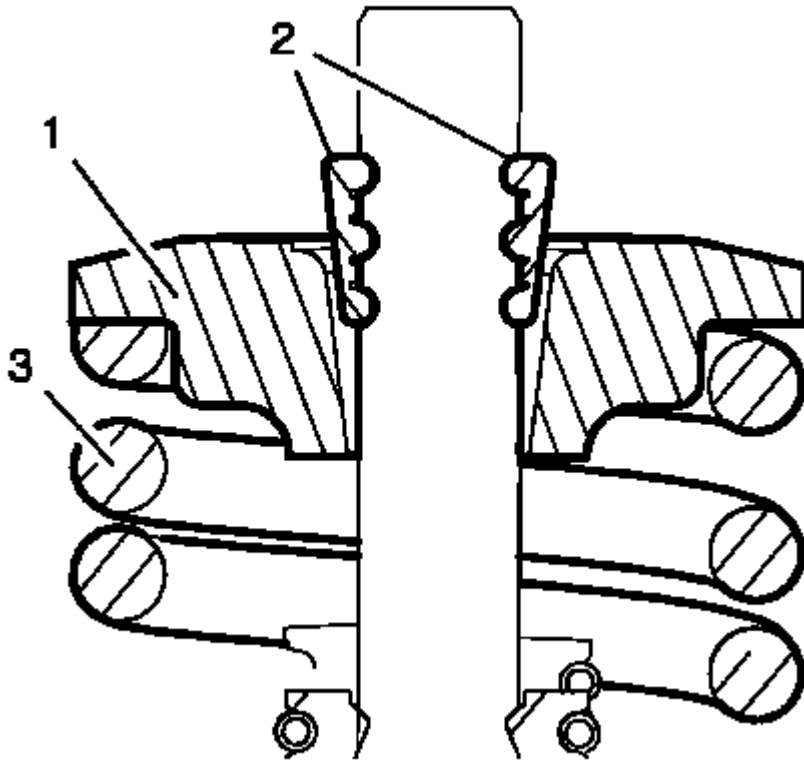
2. Install the valve (5).
3. Install the NEW valve stem oil seal (4), using the **EN-958** installer (2).

4. Loosely install the valve spring (3) and the valve spring retainer (1).



**Fig. 461: Valve Spring Compressor And Adapter Assembly**  
 Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-50717-2** assembly (1) to the **EN-8062** compressor (4).
6. Install the **EN-8062-5** adapter (3) to the **EN-8062** compressor.
7. Install the compressor assembly to the cylinder head, so that the adapter (5) of the **EN-50717-2** assembly (1) contacts the valve spring retainer properly and the **EN-8062-5** adapter (3) contacts the valve disc (2). Prefix the **EN-8062** compressor (4).

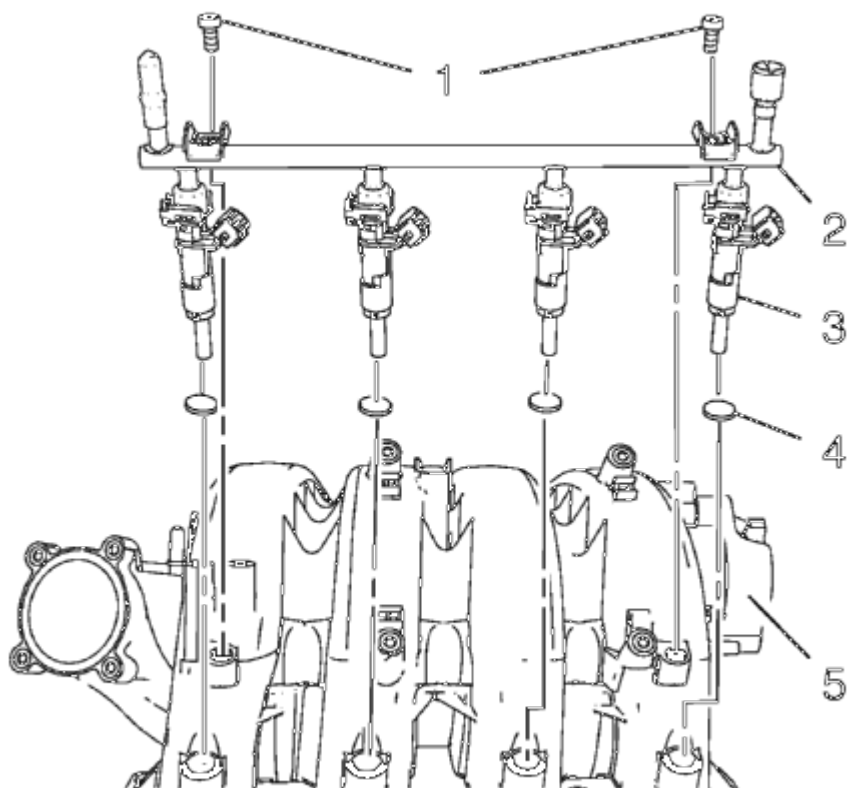


**Fig. 462: Valve Spring Retainer And Valve Spring**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** The valve stem keys must correctly seat in the valve spring cap.  
Engine damage may occur by not installing properly.

8. Apply pressure to the **EN-50717-2** assembly to push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) can be inserted. Carefully insert the valve keys then, so that they are properly installed to the valve stem grooves.
9. Carefully release the tension from the **EN-50717-2** assembly.
10. Inspect the valve keys and valve spring retainers for proper seat.
11. Remove the compressor assembly from the cylinder head.
12. Repeat the procedure with the remaining valves.

## INTAKE MANIFOLD ASSEMBLY



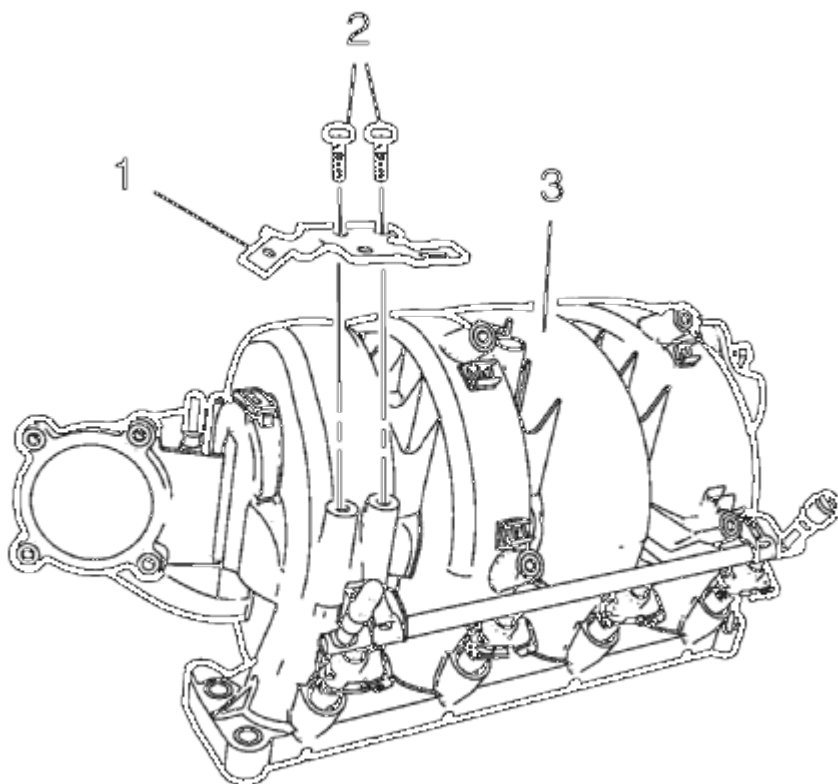
**Fig. 463: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the 4 NEW multiport fuel injector seals (4).
2. Install the multiport fuel injection fuel rail (2) and the fuel injectors (3) to the intake manifold (5).

**CAUTION: Refer to Fastener Caution .**

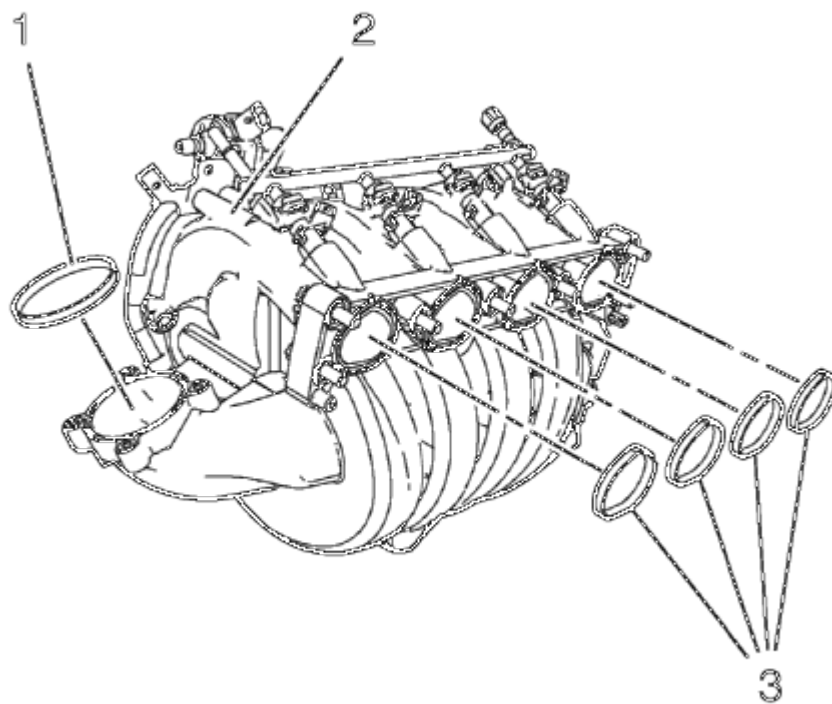
3. Install the 2 multiport fuel injection fuel rail bolts (1) and tighten to 8 N.m (71 lb in).





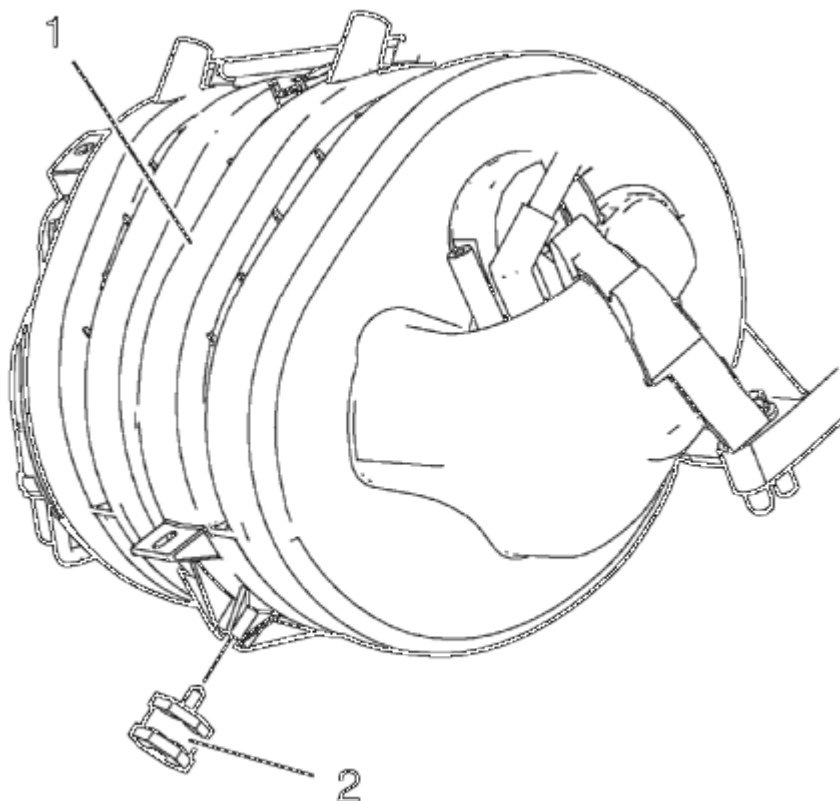
**Fig. 464: Intake Manifold, Evaporative Emission Canister Purge Solenoid Valve Bracket And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

4. Install the evaporative emission canister purge solenoid valve bracket (1) to the intake manifold (3).
5. Install the 2 evaporative emission canister purge solenoid valve bracket bolts (2) and tighten to 7 N.m (62 lb in).



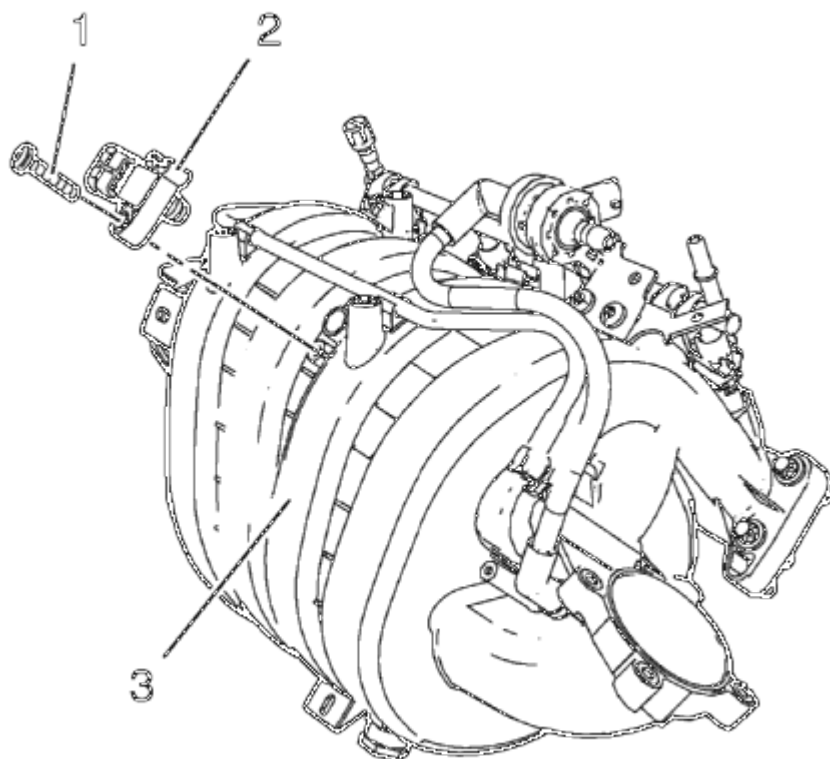
**Fig. 465: Intake Manifold, Intake Manifold Seal And Throttle Body Seal**  
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW intake manifold seal (3) to the intake manifold (2).
7. Install the NEW throttle body seal (1).



**Fig. 466: Intake Manifold And Mount**  
**Courtesy of GENERAL MOTORS COMPANY**

8. Install the intake manifold mount (2) to the intake manifold (1) and tighten to 8 N.m (71 lb in).



**Fig. 467: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

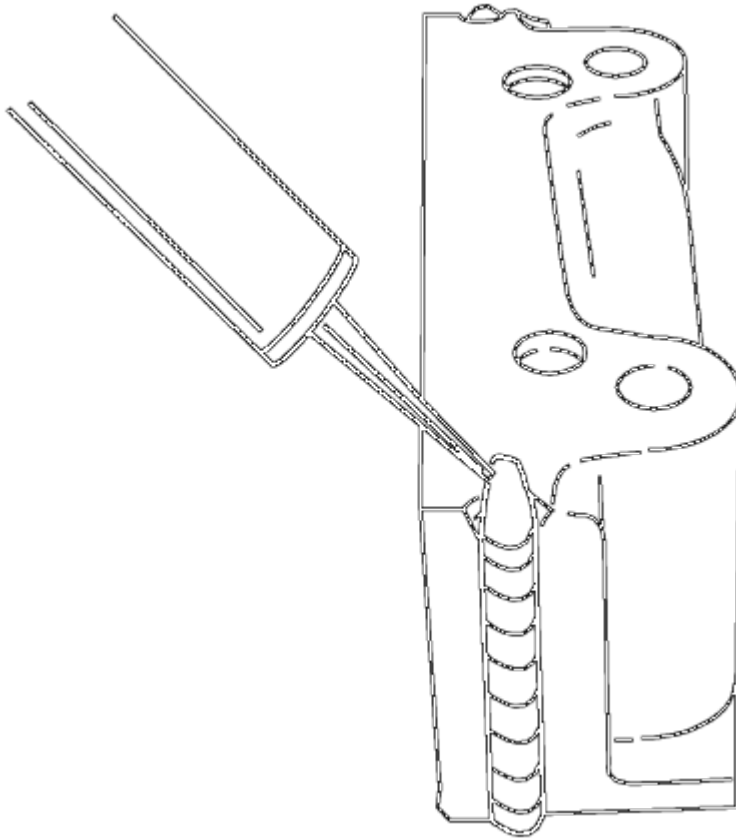
9. Install the manifold absolute pressure sensor (2) to the intake manifold (3).
10. Install the intake manifold absolute pressure sensor bolt (1) and tighten to 6 N.m (53 lb in).

## **CRANKSHAFT AND BEARING INSTALLATION**

### **Special Tools**

**EN-45059** Torque Angle Sensor Kit

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



**Fig. 468: Crankshaft Bearing Clip**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Inspect the installation position.**

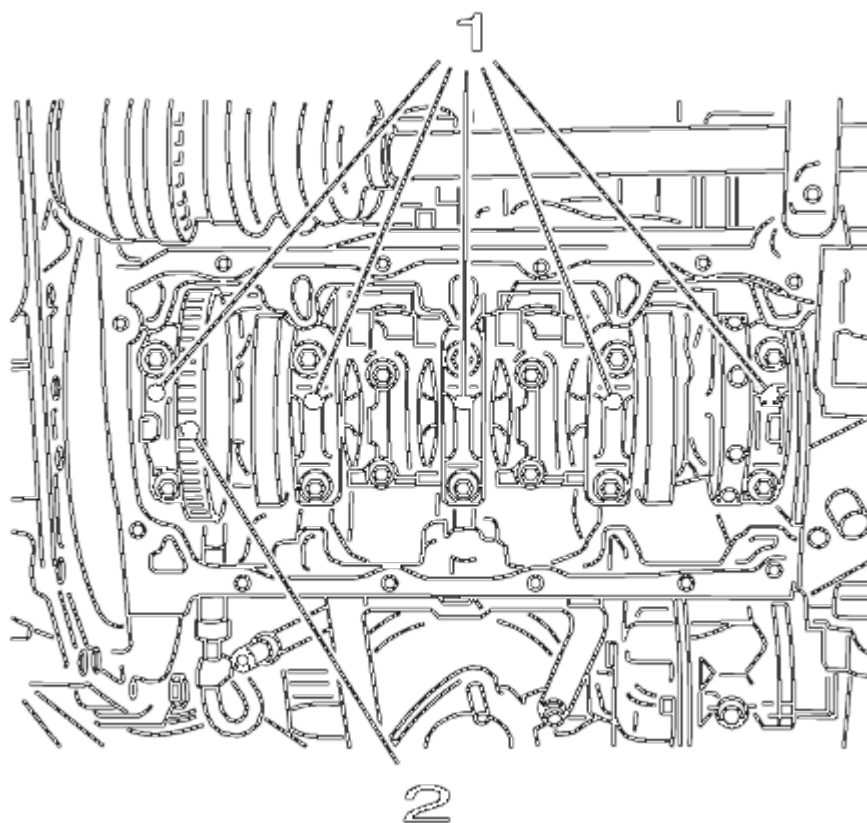
1. Install the crankshaft bearing clips, oil bearing clips.
2. Install the crankshaft.

**NOTE:**        **Inspect the installation position.**

3. Install the crankshaft bearing caps 1-4.
  - Oil bearing clips.
  - Install the 8 NEW crankshaft bearing cap bolts.

**NOTE:**        **Inspect the installation position.**

4. Install the crankshaft bearing cap.
  1. Apply black adhesive sealing compound to the grooves of the rear crankshaft bearing cap.
  2. Install the 2 NEW crankshaft bearing cap bolts.



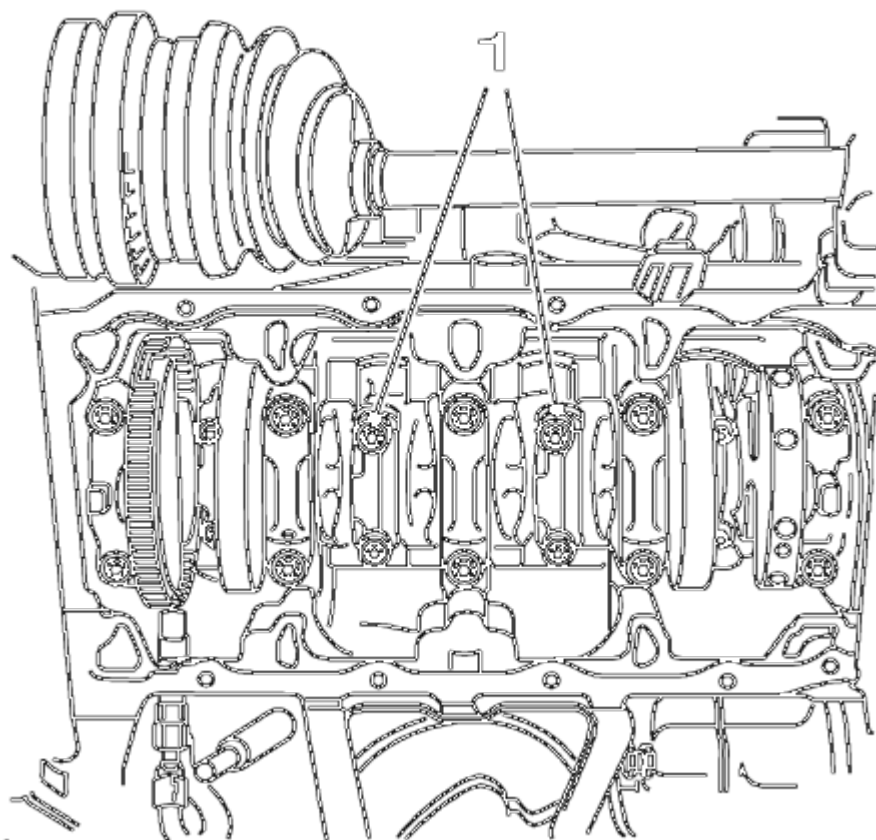
**Fig. 469: Crankshaft Bearing Cap Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

5. Tighten the bolts for the crankshaft bearing caps (1) in 3 passes using the **EN-45059** sensor kit:
- First pass to 50 N.m (37 lb ft)
  - Second pass to 45°
  - Third pass to 15°

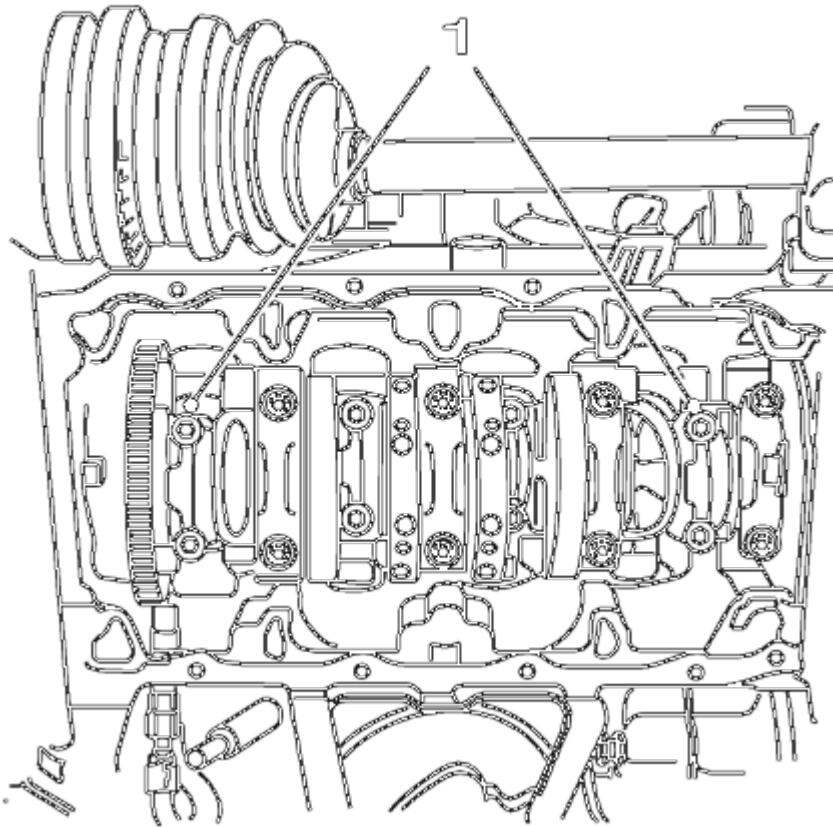


**Fig. 470: Connecting Rod Bearing Caps**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Inspect the installation position.**

6. Install the connecting rod bearing caps 2 and 3 (1) and oil the bearing clips.
7. Install 4 NEW connecting rod bearing cap bolts and tighten in 3 passes use the **EN-45059** sensor kit:
  - First pass to 35 N.m (26 lb ft)
  - Second pass to 45°
  - Third pass to 15°



**Fig. 471: Connecting Rod Bearing Caps**  
Courtesy of GENERAL MOTORS COMPANY

8. Turn the crankshaft through 180°.

**NOTE:**        **Inspect the installation position.**

9. Install the connecting rod bearing caps 1 and 4 (1) and oil the bearing clips.
10. Install 4 NEW connecting rod bearing cap bolts and tighten in 3 passes use the **EN-45059** sensor kit:
- First pass to 35 N.m (26 lb ft)
  - Second pass to 45°
  - Third pass to 15°

## **PISTON, CONNECTING ROD, AND BEARING INSTALLATION**

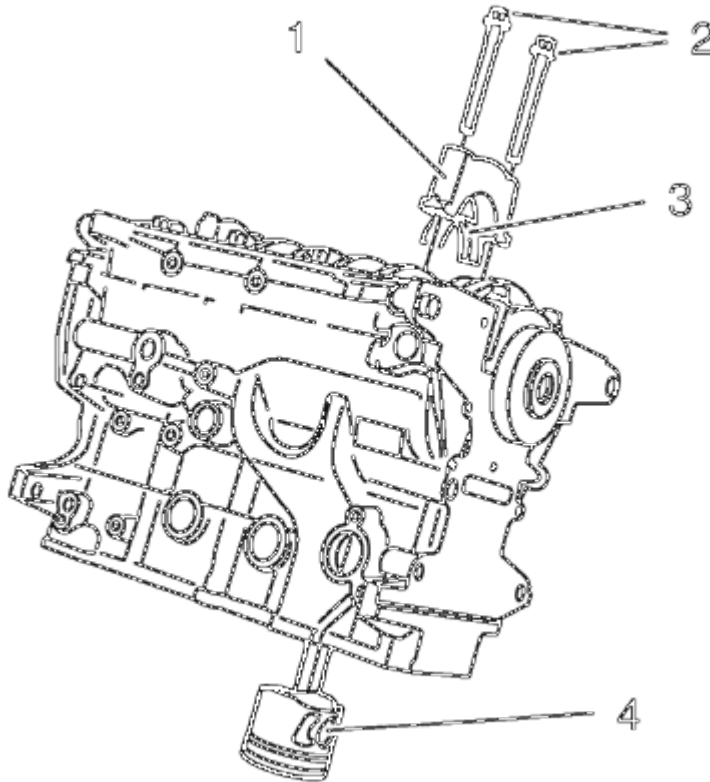
### **Special Tools**

**EN-45059** Angle Meter

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



1. Lubricate the piston rings, piston, inner cylinder bore surface and a piston ring compressor with clean engine oil.
2. Install the piston ring compressor in order to compress the piston rings.



**Fig. 472: Connecting Rod Assembly, Connecting Rod Bearing And Connecting Rod Cap**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the piston and connecting rod assembly (4).
4. Install the connecting rod bearing (3).
5. Install the connecting rod cap (1).

**CAUTION: Refer to Fastener Caution .**

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

6. Install NEW connecting rod bolts (2) and tighten a first pass to 35 N.m (26 lb ft).
7. Tighten the NEW connecting rod bolts a second pass to an additional 45 degrees, using the **EN-45059** meter.

8. Tighten the NEW connecting rod bolts a final pass to an additional 15 degrees, using the **EN-45059** meter.
9. Assemble the caps and connecting rods in the marked position.
10. Rotate the crankshaft to a position where the connecting rod bolts are easy accessible.

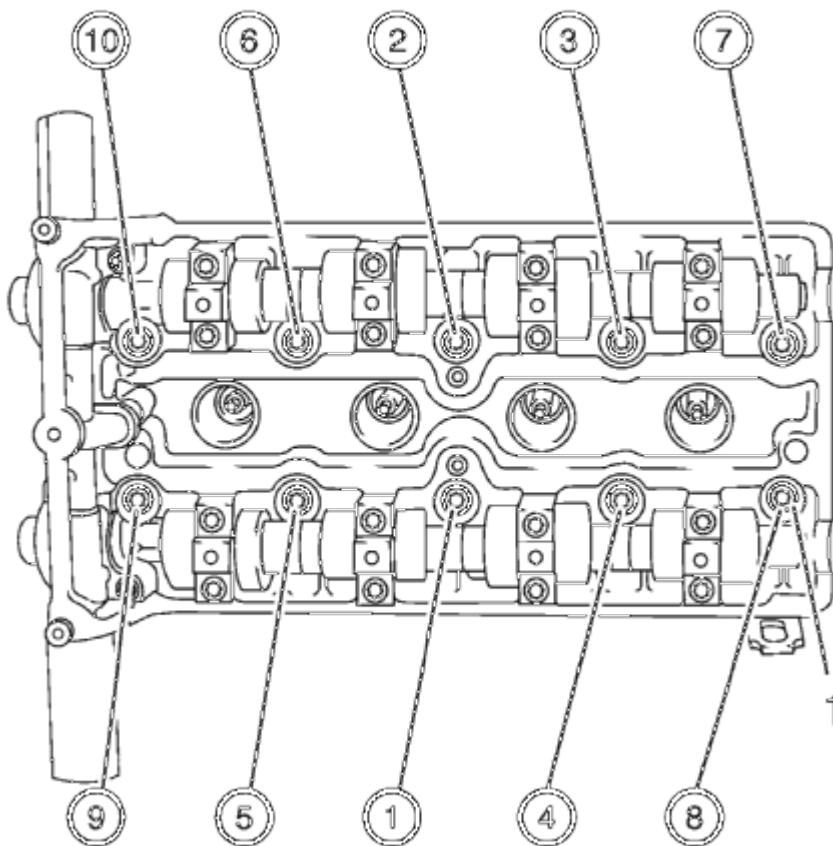
## CYLINDER HEAD INSTALLATION

### Special Tools

#### **EN-45059** Torque Angle Sensor Kit

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

1. Clean the sealing surfaces.
2. Inspect for plane surface.
  - Cylinder block, cylinder head
  - Straight-edge, feeler gauge
3. Install the cylinder head gasket.
4. Install the cylinder head.



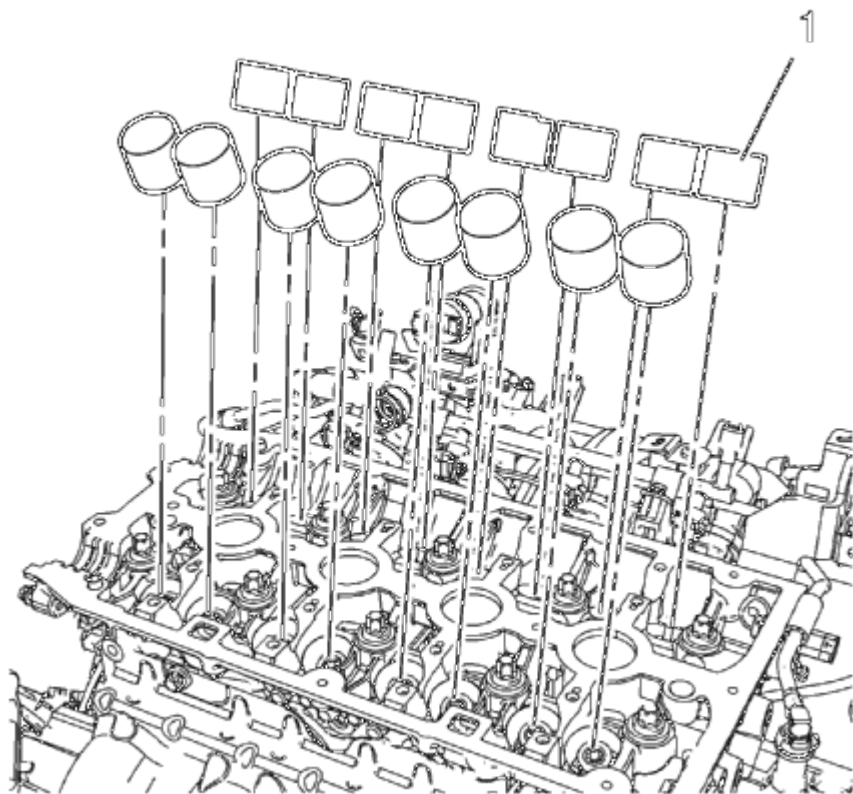
**Fig. 473: Cylinder Head Bolts Tightening Sequence**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .**CAUTION:** Refer to Torque-to-Yield Fastener Caution .**NOTE:**        **Note the correct tightening sequence.**

5. Install NEW cylinder head bolts.
6. Tighten the bolts (1) in 5 passes. Use the **EN-45059** sensor kit :
  - First pass to 25 N.m (18 lb ft)
  - Second pass to 90°
  - Third pass to 90°
  - Fourth pass to 90°
  - Fifth pass to 45°

**VALVE LIFTER INSTALLATION****Special Tool****EN-845** Suction DeviceFor equivalent regional tools, refer to Special Tools.

**Fig. 474: Valve Lifters**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Observe the correct locations.

**NOTE:** Coat the sliding surfaces with **NEW** engine oil.

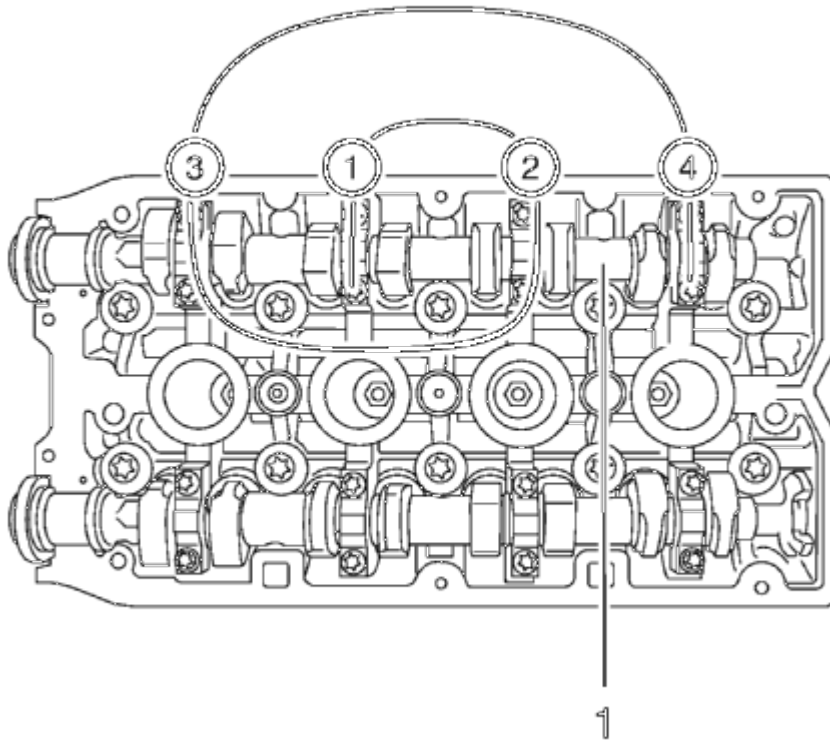
Install the 16 valve lifter (1), using the **EN-845** suction device.

## **CAMSHAFT INSTALLATION**

### **Special Tools**

**EN-422** Installer

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



**Fig. 475: Intake Camshaft Bearing Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Coat with MoS 2 lubricating paste. Refer to Adhesives, Fluids, Lubricants, and Sealers.

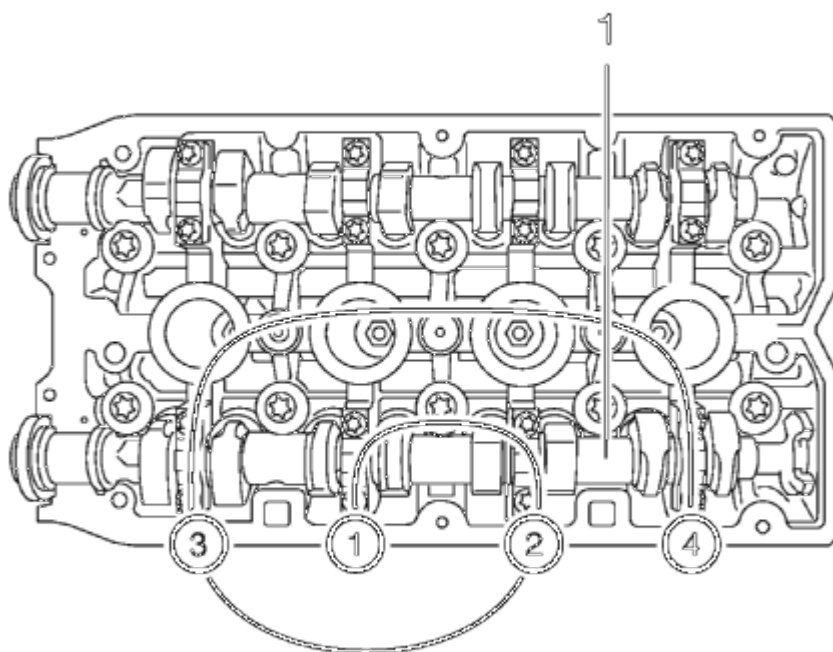
1. Install the intake camshaft (1).

**NOTE:** Note the identification marking on the camshaft bearing cover.

2. Install the 4 intake camshaft bearing cover number 2-5.

**CAUTION:** Refer to Fastener Caution .

3. Install the 8 intake camshaft bearing cover bolts and tighten in a spiral from the inside to the outside to 8 N.m (71 lb in).



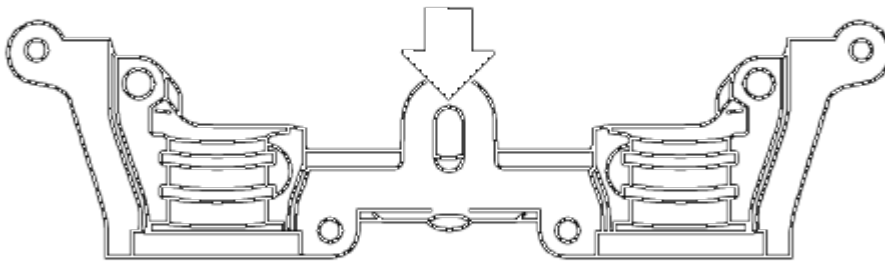
**Fig. 476: Exhaust Camshaft Bearing Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Coat with MoS 2 lubricating paste. Refer to Adhesives, Fluids, Lubricants, and Sealers.

4. Install the exhaust camshaft (1).

**NOTE:** Note the identification marking on the camshaft bearing cover.

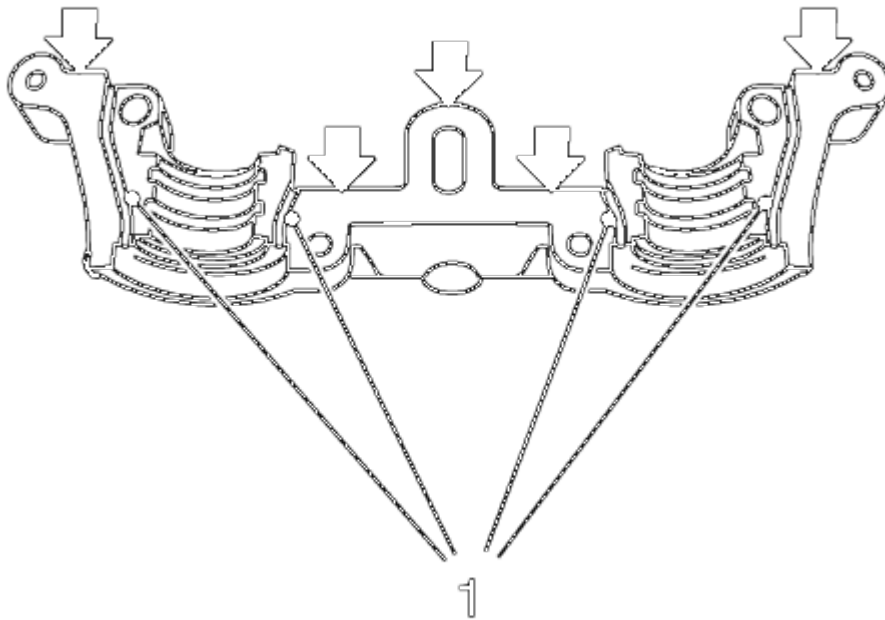
5. Install the 4 exhaust camshaft bearing cover number 6-9.
6. Install the 8 exhaust camshaft bearing cover bolts and tighten in a spiral from the inside to the outside to 8 N.m (71 lb in).



**Fig. 477: Oil Duct**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Sealing surfaces must be free from oil and grease.**



**Fig. 478: Sealing Surfaces And Grooves**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- Sealing surfaces (arrows) must be free from oil and grease.
- It is essential to ensure that no sealant is applied outside the marked sealing areas (1).
- The grooves adjacent to the sealing surfaces must remain free from sealant.

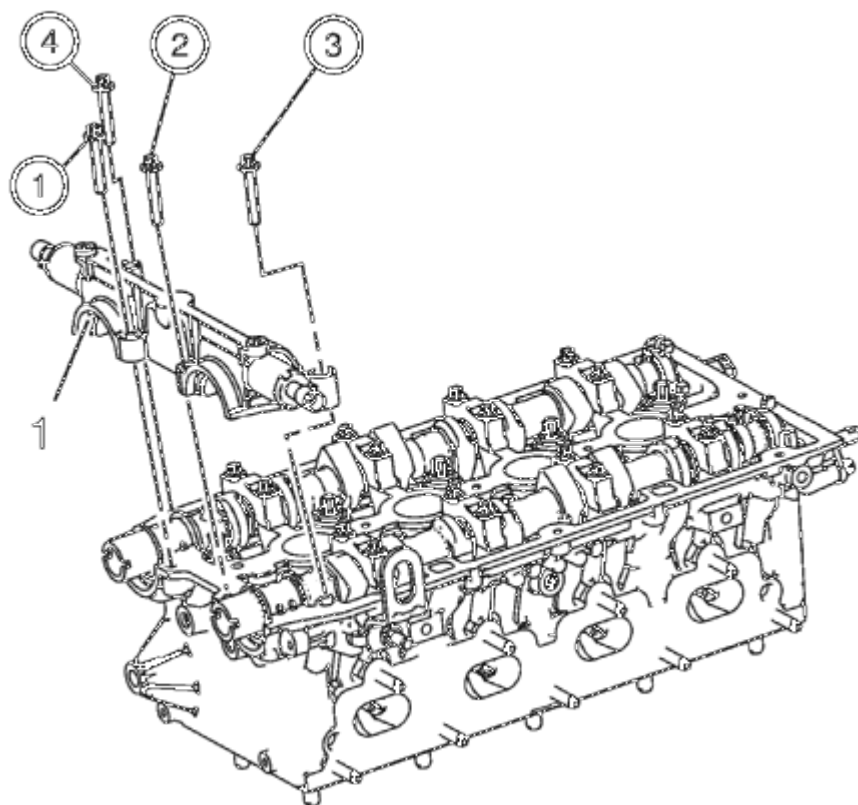
7. Clean sealing surfaces of the first camshaft bearing support and the cylinder head with a suitable tool.

Clean oil duct from any sealant residue.

8. Apply surface sealant to sealing surfaces of the first camshaft bearing cap thinly and evenly.

9. Position the first camshaft bearing cap on the cylinder block and tighten the bolts approximately to 2 N.m (18 lb in).





**Fig. 479: Camshaft Bearing Cap**

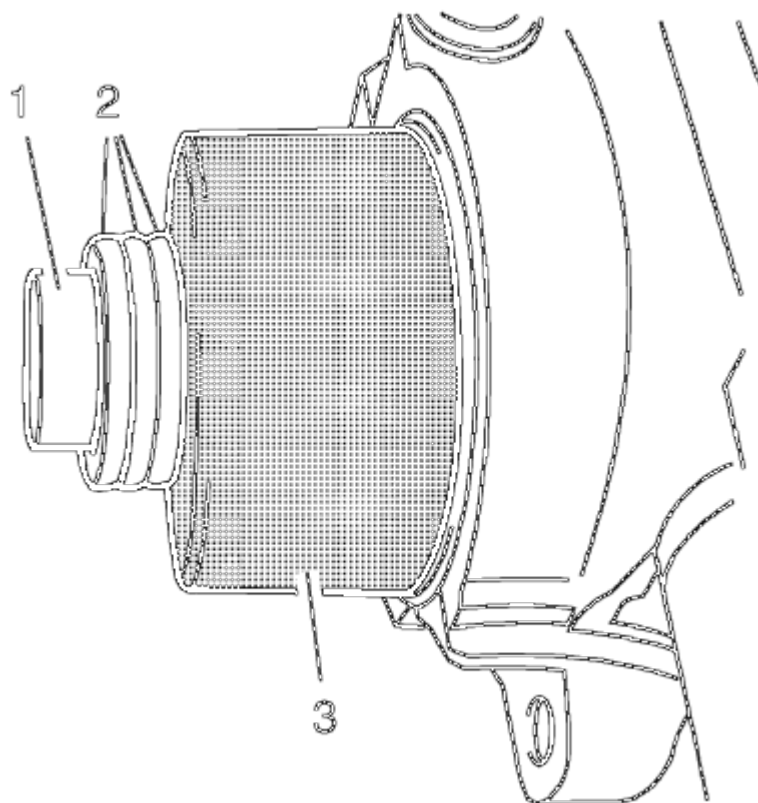
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** No sealant may reach the camshafts.

10. Install the first camshaft bearing cap.

**NOTE:** Note installation sequence 1-4.

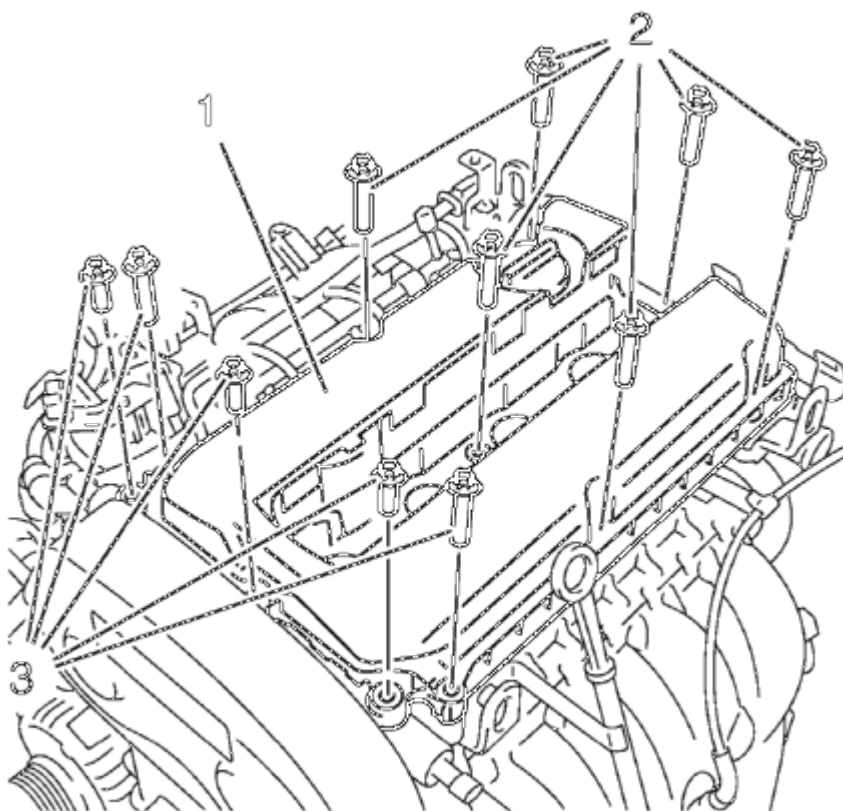
11. Install the first camshaft bearing cap (1) bolts and tighten to 8 N.m (71 lb in).



**Fig. 480: Camshaft Sprocket Bolt, Shims And Tool**  
 Courtesy of GENERAL MOTORS COMPANY

12. Install 2 NEW sealing rings to the camshafts.
13. Tighten the seal ring with **EN-422** installer (3) on the camshaft until this is in contact with the cylinder head.
14. To install, use camshaft sprocket bolt (1) in conjunction with shims (2) with a total thickness of approximately 10 mm.
15. Remove the **EN-422** installer (3).

## CAMSHAFT COVER INSTALLATION



**Fig. 481: Camshaft Cover And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft cover (1).

Insert a NEW gasket in the camshaft cover.

**CAUTION: Refer to Fastener Caution .**

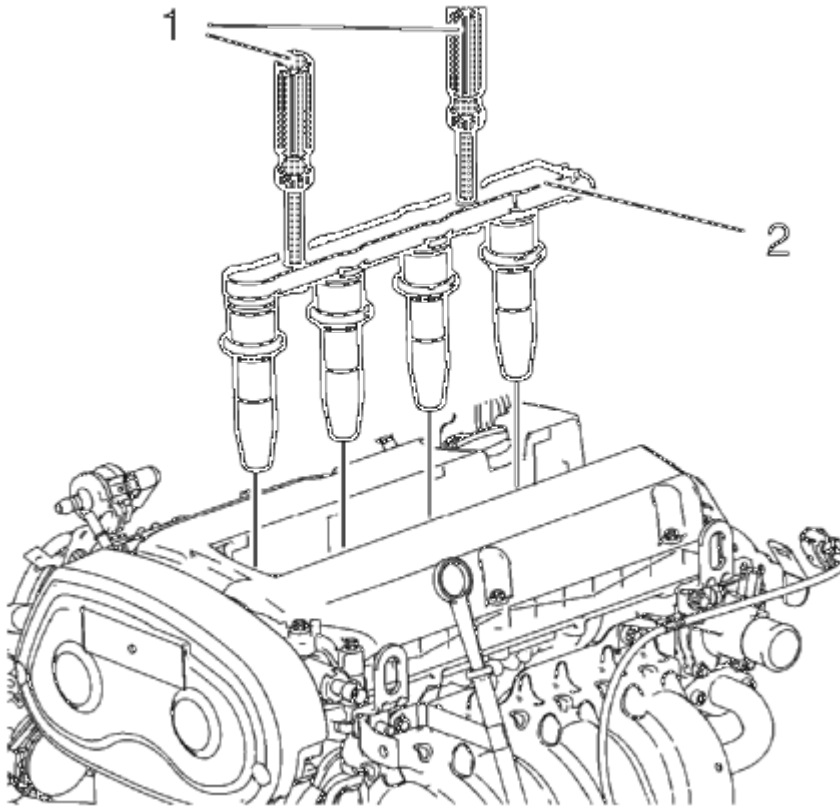
2. Install the 11 bolts (2, 3) and tighten to 8 N.m (71 lb in).

## IGNITION COIL INSTALLATION

### Special Tools

**EN-6009** Remover/Installer Ignition Module

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



**Fig. 482: Ignition Coil Module And Special Tool**  
 Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil module (2) with the **EN-6009** remover/installer (1).
2. Remove the **EN-6009** remover/installer (1).

**CAUTION:** Refer to Fastener Caution

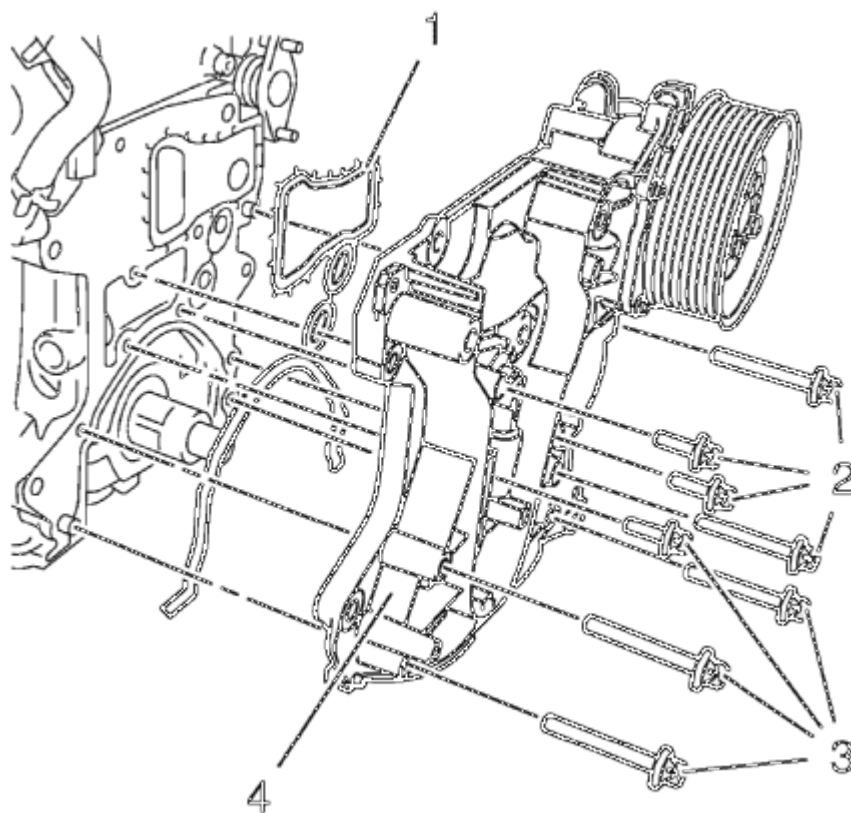
**NOTE:** Note the arrow on the cover.

3. Install the 2 ignition coil bolts and tighten to 8 N.m (71 lb in).

**NOTE:** Note the arrow on the cover.

4. Install the cover of the DIS ignition coil against the direction of the arrow.

## ENGINE FRONT COVER AND OIL PUMP INSTALLATION



**Fig. 483: Engine Oil Pump**

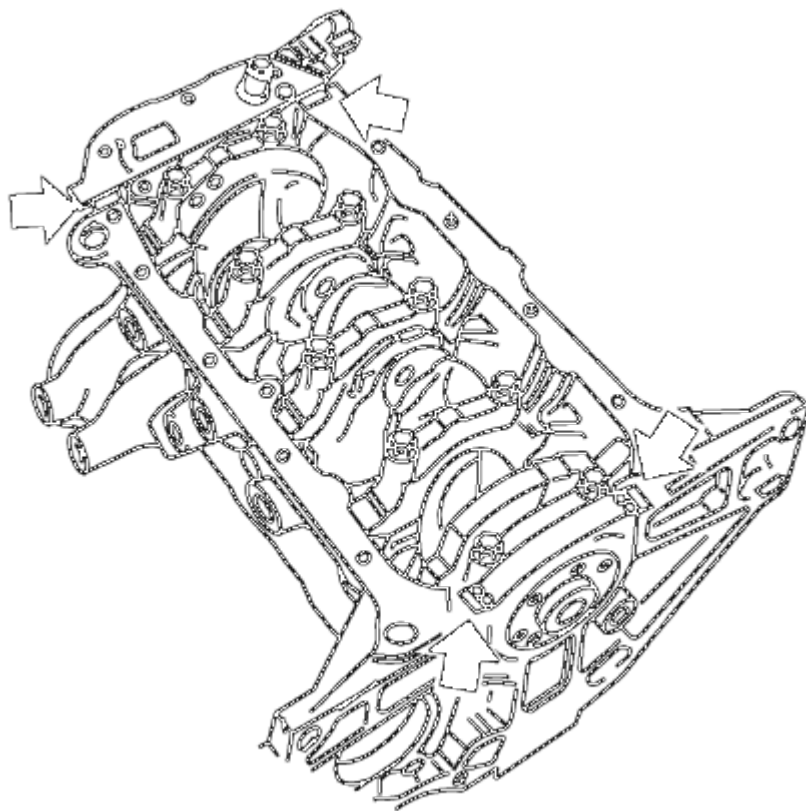
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW engine cover gasket (1).
2. Install the engine cover with the included oil pump (4).

**CAUTION:** Refer to Fastener Caution .

3. Install the 8 engine cover bolts (2, 3) and tighten to 20 N.m (15 lb ft).

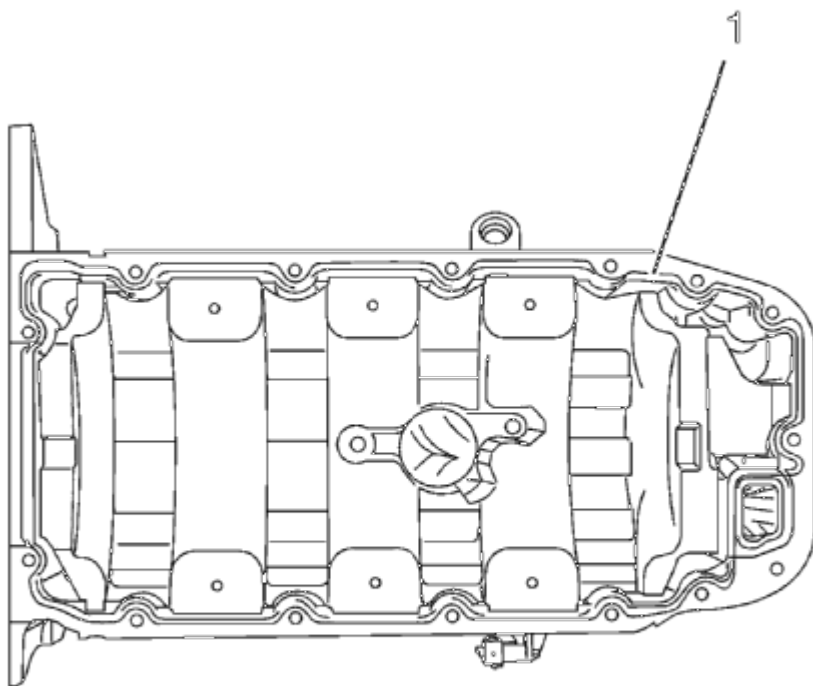
## OIL PAN INSTALLATION



**Fig. 484: Joints For Sealant Application**

Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing surfaces.
2. Apply approximately a 3.5 mm (0.138 in) thick bead of oil pan sealant to the joints (arrows). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.

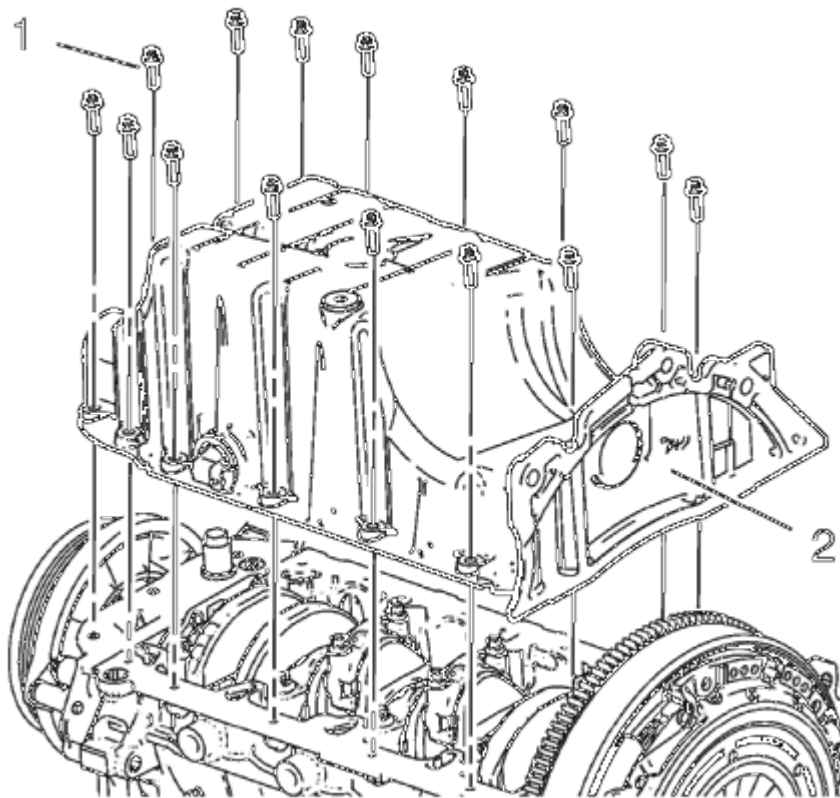


**Fig. 485: Sealant Application Area**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The assembly time, including torque check, must take no longer than 10 minutes.

3. Apply approximately a 3.5 mm (0.138 in) thick bead of oil pan sealant (1) to the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended sealant.

**Fig. 486: Oil Pan And Bolts**

Courtesy of GENERAL MOTORS COMPANY

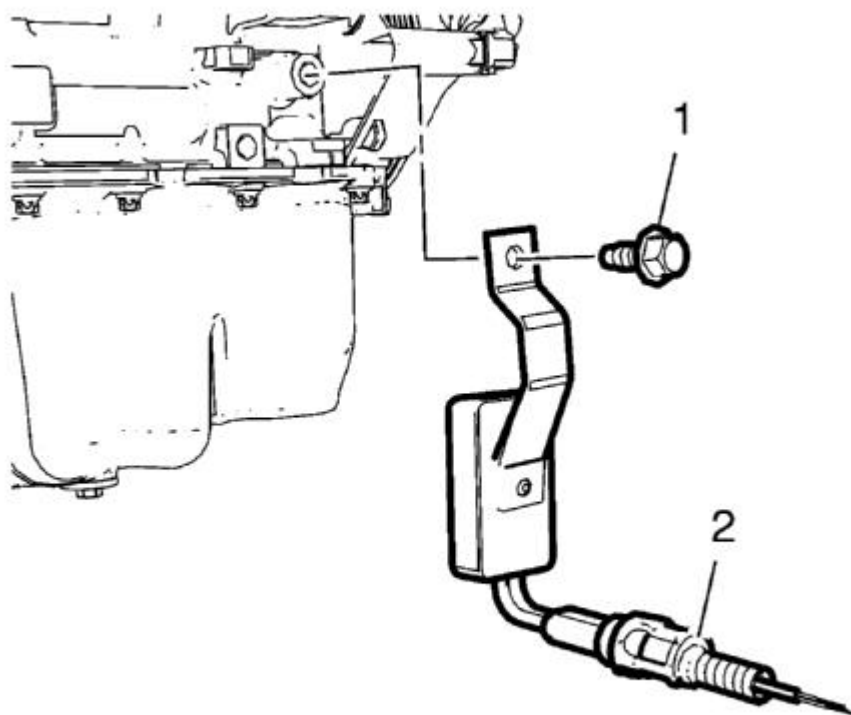
4. Install the oil pan (2).

**CAUTION:** Refer to Fastener Caution

5. Install the 15 oil pan bolts (1) on the cylinder block and tighten to 10 N.m (89 lb in).

## ENGINE OIL HEATER INSTALLATION



**Fig. 487: Engine Oil Heater**

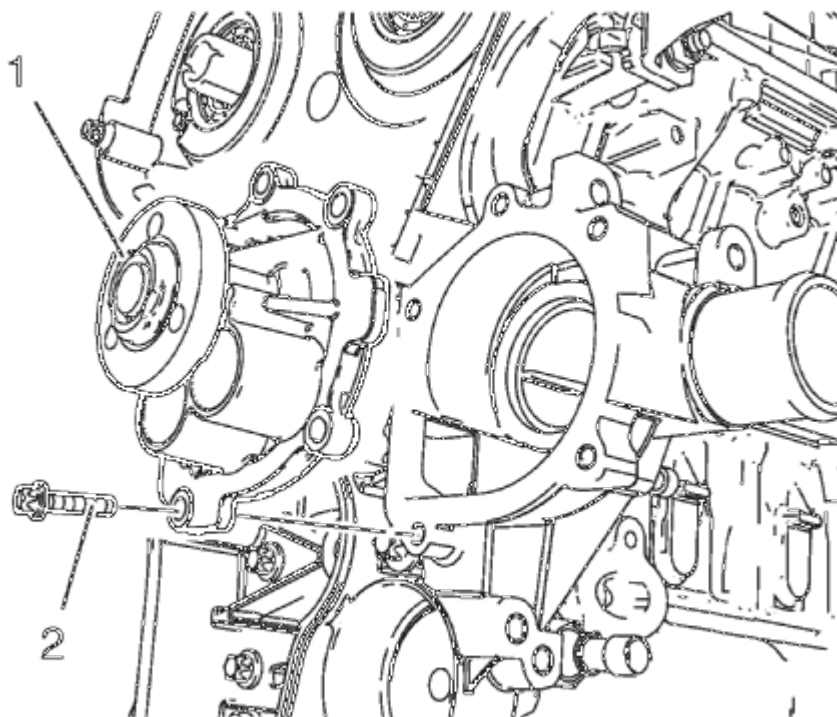
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil heater (2).

**CAUTION:** Refer to Fastener Caution .

2. Install the engine oil heater bolt (1) and tighten to 40 N.m (30 lb ft).

## **WATER PUMP INSTALLATION**

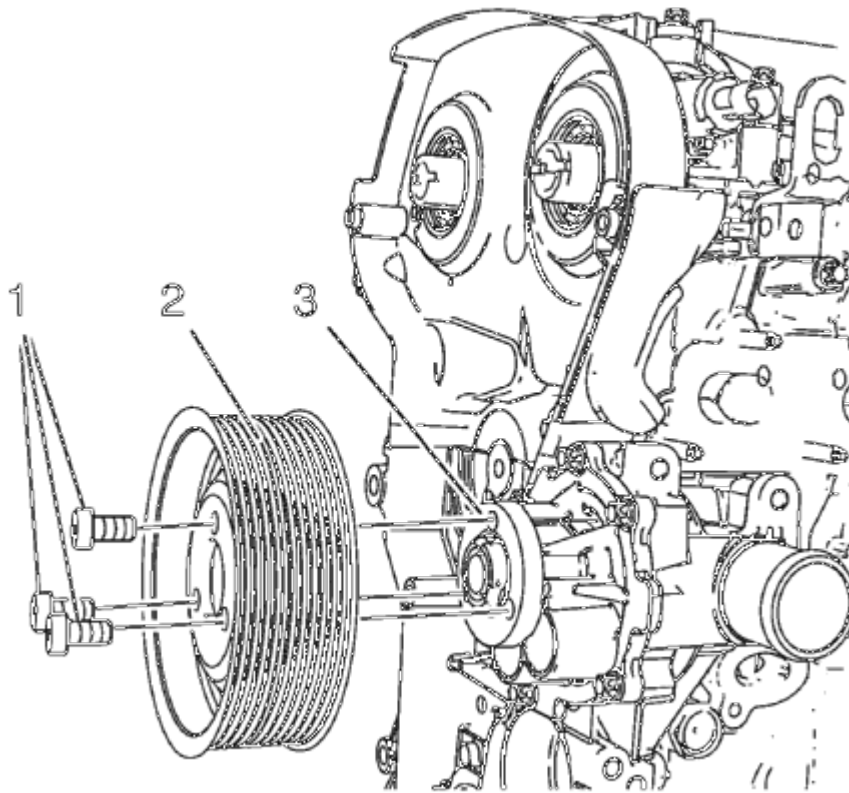
**Fig. 488: Water Pump And Bolts****Courtesy of GENERAL MOTORS COMPANY**

1. Clean the sealing surfaces and the 3 coolant pump threads.
2. Install NEW gasket.

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

3. Install the coolant pump (1).
4. Install 5 NEW bolts (2) and tighten to 8 N.m (71 lb in).

**WATER PUMP PULLEY INSTALLATION**



**Fig. 489: Water Pump And Water Pump Pulley**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Counterhold the crankshaft balancer. The belt has to be installed for this procedure.

1. Install the water pump pulley (2) to the water pump (3).

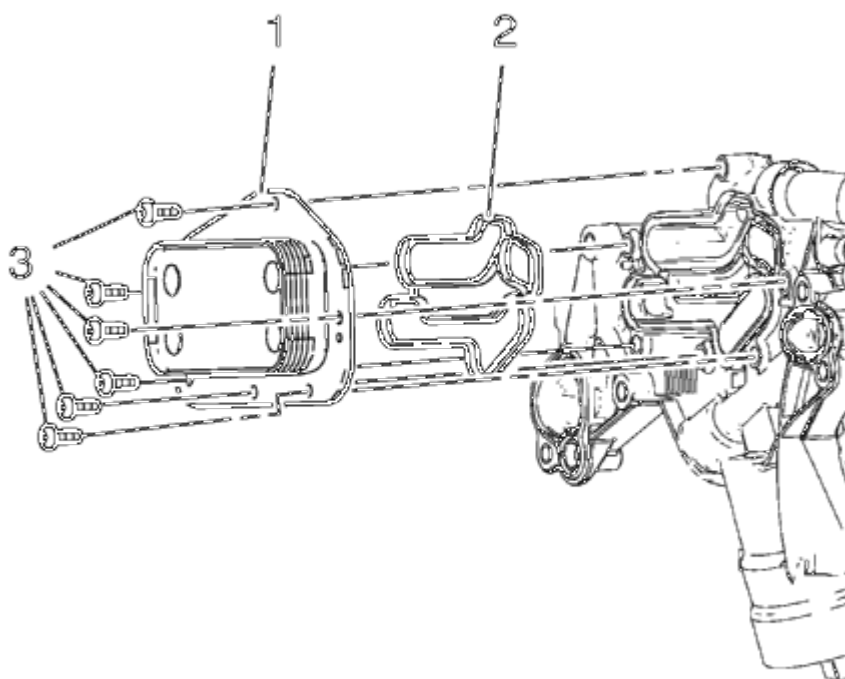
**CAUTION:** Refer to Fastener Caution .

2. Install the 3 water pump pulley bolts (1) with locking compound and tighten to 20 N.m (15 lb ft).

Refer to Adhesives, Fluids, Lubricants, and Sealers.

## ENGINE OIL COOLER INSTALLATION

1. Clean the engine oil cooler to the oil filter housing sealing surfaces.

**Fig. 490: Engine Oil Cooler**

Courtesy of GENERAL MOTORS COMPANY

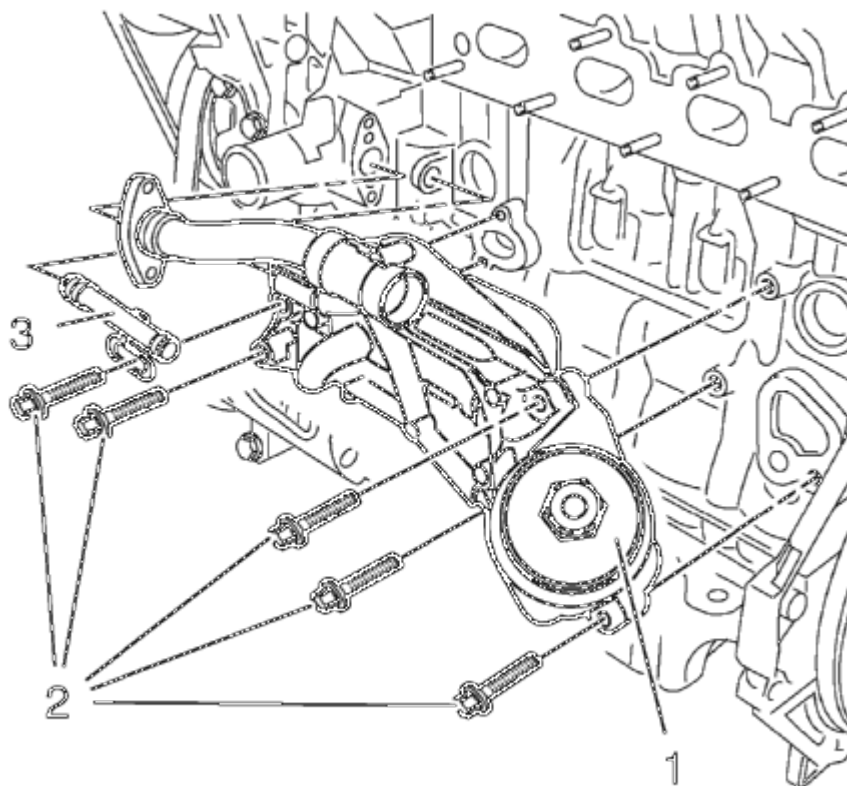
2. Install the NEW engine oil cooler gasket (2) and the engine oil cooler (1) to the engine oil cooler housing.

**CAUTION:** Refer to Fastener Caution .

3. Install the 6 engine oil cooler bolts (3) and tighten to 8 N.m (71 lb in).

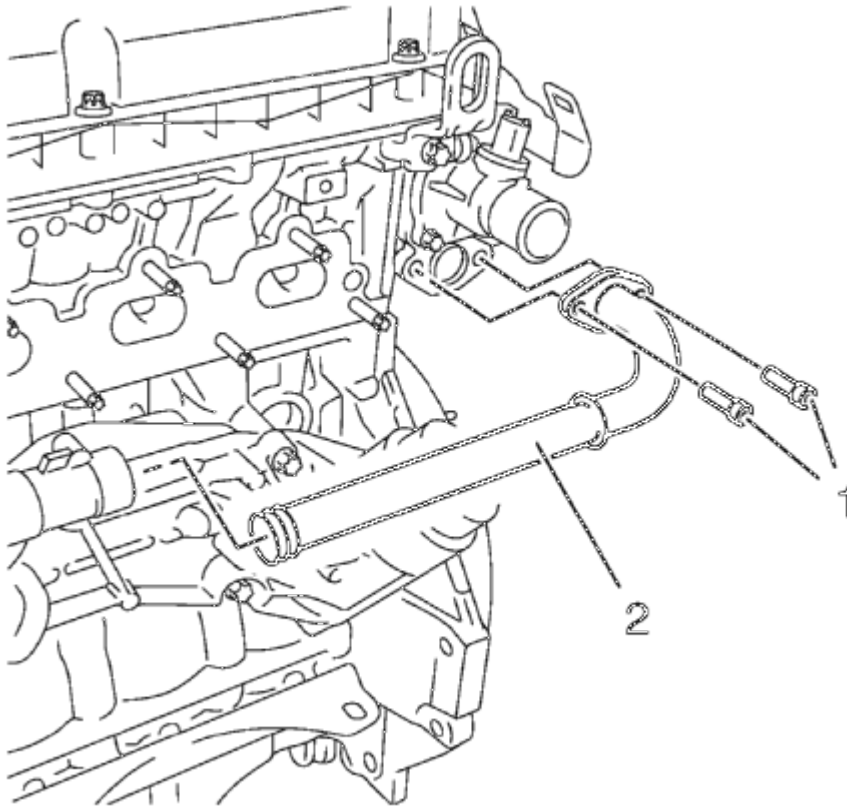
### ENGINE OIL COOLER HOUSING INSTALLATION

1. Clean the engine oil cooler housing to thermostat housing sealing surfaces.
2. Install 2 NEW gaskets.



**Fig. 491: Engine Oil Cooler Housing, Bolts And Engine Oil Cooler Inlet Pipe**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine oil cooler inlet pipe (3).
4. Install the engine oil cooler housing (1) and the 5 engine oil cooler bolts (2) and tighten to 25 N.m (18 lb ft).



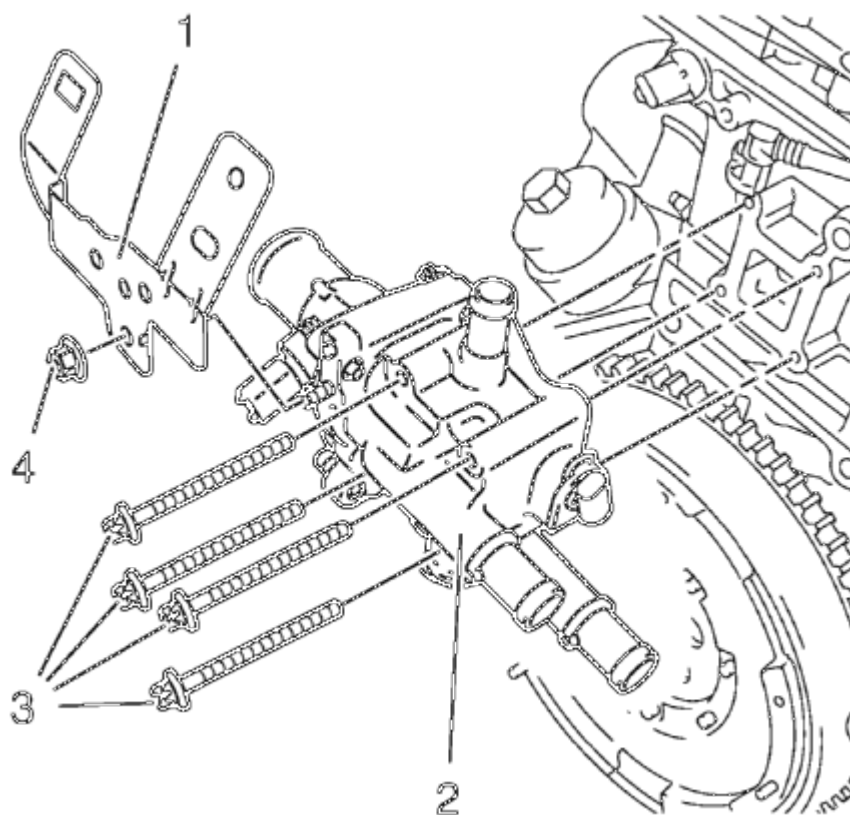
**Fig. 492: Engine Oil Cooler Outlet Pipe And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the thermostat housing coolant pipe (2) to the engine oil cooler housing.
6. Install the 2 thermostat housing coolant pipe bolts (1) and tighten to 8 N.m (71 lb in).

#### **ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION**

**CAUTION:** Refer to Engine Coolant Thermostat Housing Caution .

1. Clean sealing surface.
2. Install a NEW engine coolant thermostat housing seal.



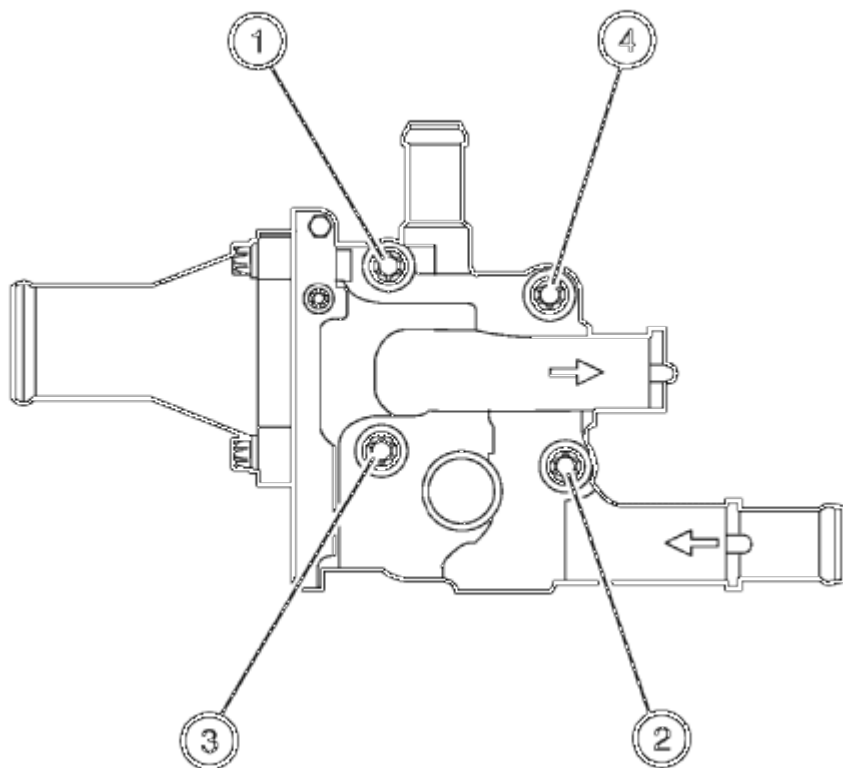
**Fig. 493: Engine Coolant Thermostat Housing**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine coolant thermostat housing (2).

**CAUTION:** Refer to Fastener Caution .

**NOTE:** Screw in the 4 bolts until the engine coolant thermostat housing is in contact with the cylinder head.

4. Install the 4 engine coolant thermostat housing bolts (3) and tighten to 2 N.m (18 lb in).

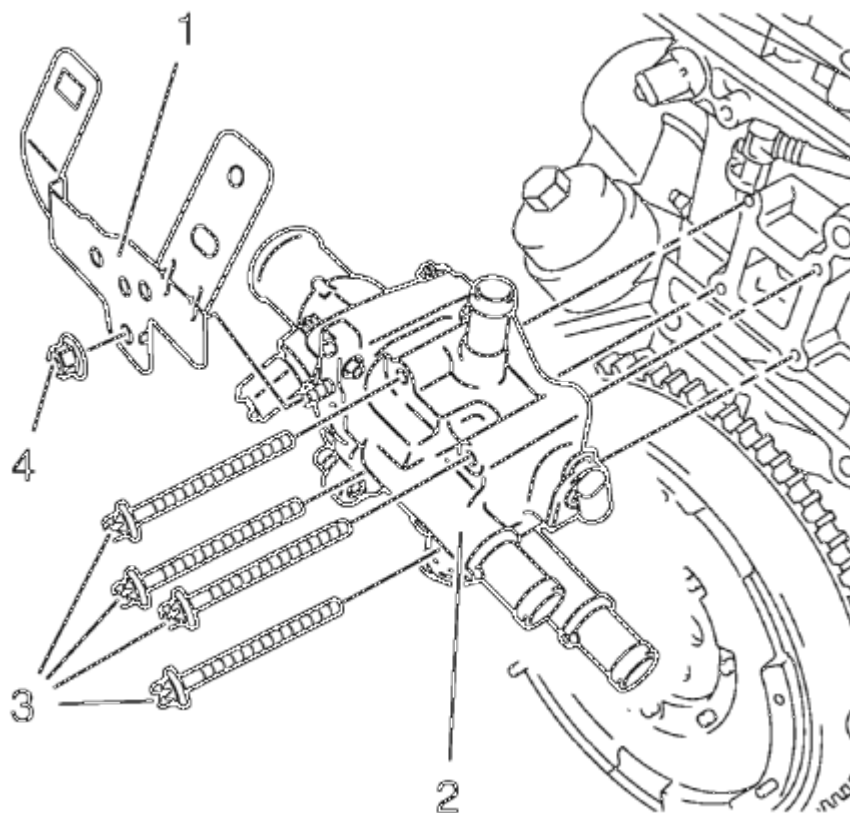


**Fig. 494: Engine Coolant Thermostat Housing Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Following the proper fastener tightening sequence and torque is essential. Failure to do so may fracture the thermostat housing.

5. Tighten the 4 engine coolant thermostat housing bolts to 8 N.m (71 lb in) in sequence (1-2-3-4).





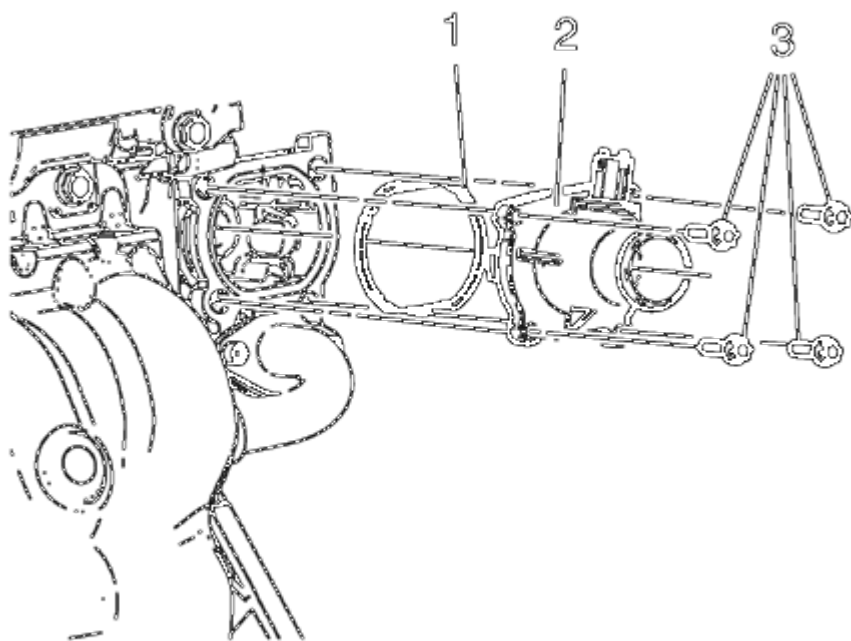
**Fig. 495: Engine Coolant Thermostat Housing**  
 Courtesy of GENERAL MOTORS COMPANY

6. Install the engine coolant thermostat housing retainer (1).
7. Install the engine coolant thermostat housing retainer nut (4) and tighten to 6 N.m (53 lb in).

## ENGINE COOLANT THERMOSTAT INSTALLATION

**CAUTION:** Refer to Engine Coolant Thermostat Housing Caution .

1. Clean the engine coolant sealing surfaces.



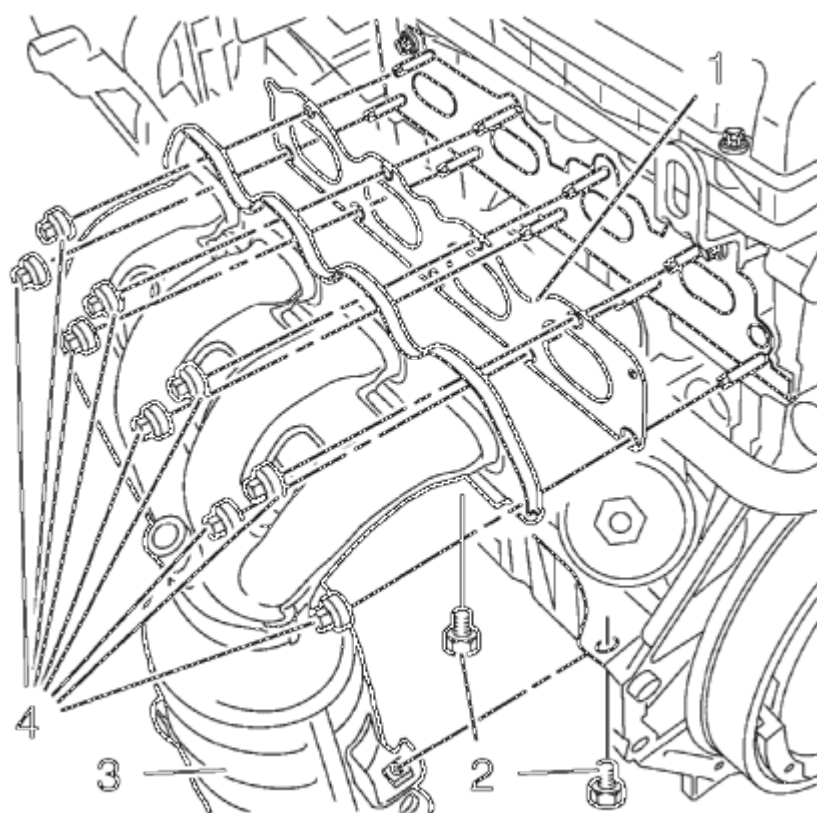
**Fig. 496: Engine Coolant Thermostat Assembly**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine coolant seal (1).
3. Install the engine coolant thermostat assembly (2).

**CAUTION:** Refer to Fastener Caution .

4. Install the 4 engine coolant thermostat bolts (3) and tighten to 8 N.m (71 lb in).

## EXHAUST MANIFOLD INSTALLATION



**Fig. 497: Exhaust Manifold And Bolts**

Courtesy of GENERAL MOTORS COMPANY

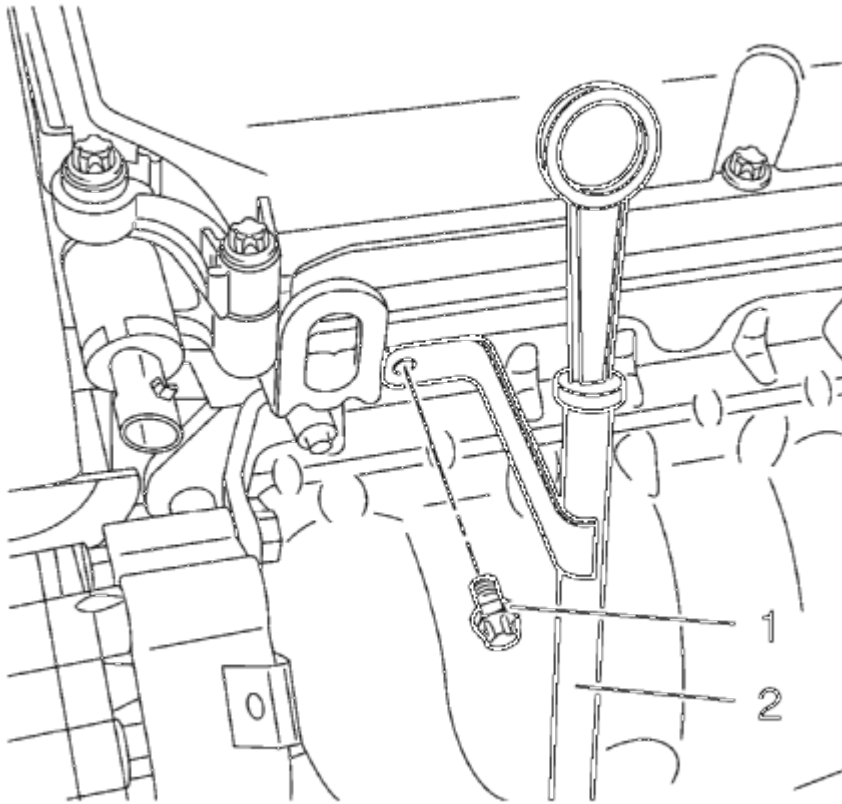
1. Clean the exhaust manifold sealing surface.
2. Install a NEW exhaust manifold gasket (1) to the cylinder head.

**CAUTION: Refer to Fastener Caution .**

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

3. Install the exhaust manifold (3) and tighten the NEW nuts (4) to 20 N.m (15 lb ft).
4. Install the 2 exhaust manifold bracket bolts (2) to 20 N.m (15 lb ft).

## OIL LEVEL INDICATOR AND TUBE INSTALLATION



**Fig. 498: Oil Level Indicator Tube And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

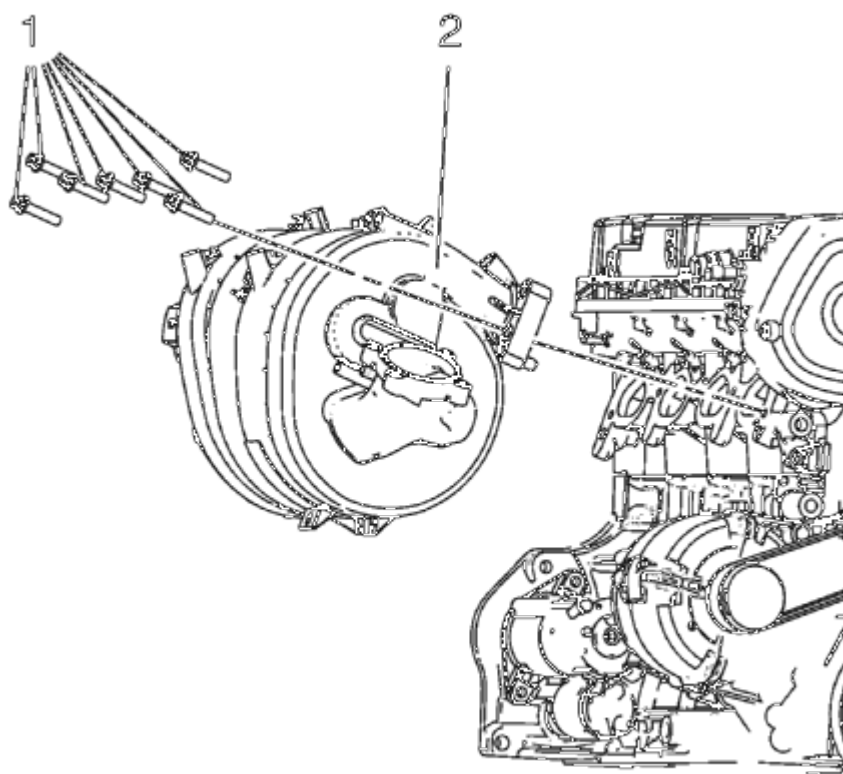
1. Install a NEW oil level indicator tube gasket.
2. Install the oil level indicator tube (2).

**CAUTION:** Refer to Fastener Caution .

3. Install the oil level indicator tube bolt (1) and tighten to 15 N.m (11 lb ft).
4. Install the oil dipstick.

## INTAKE MANIFOLD INSTALLATION

1. Clean the sealing surfaces.
2. Install 4 NEW gaskets.

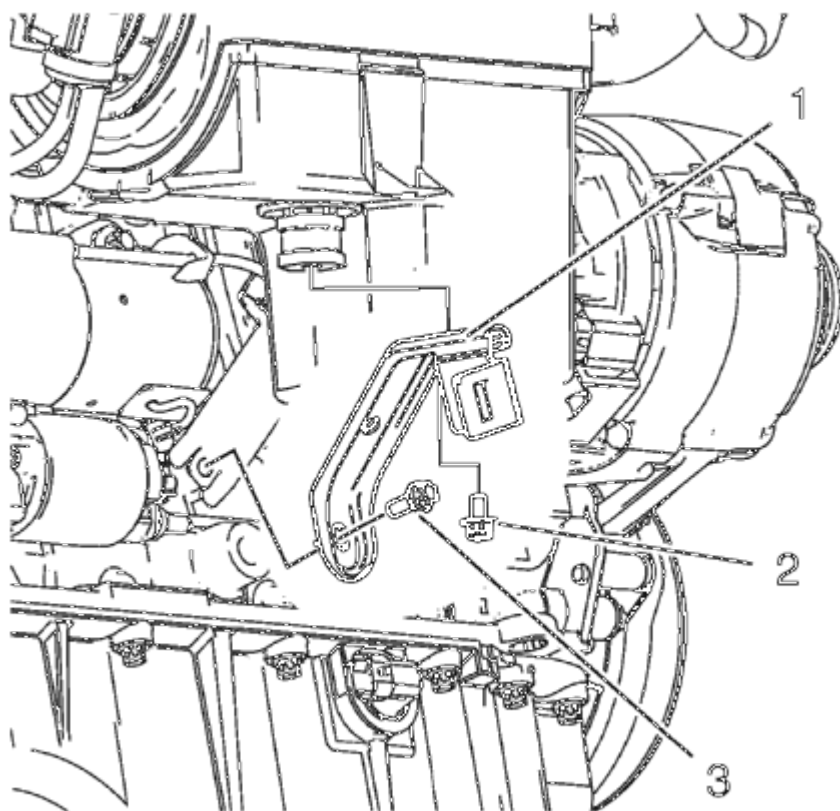


**Fig. 499: Intake Manifold And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

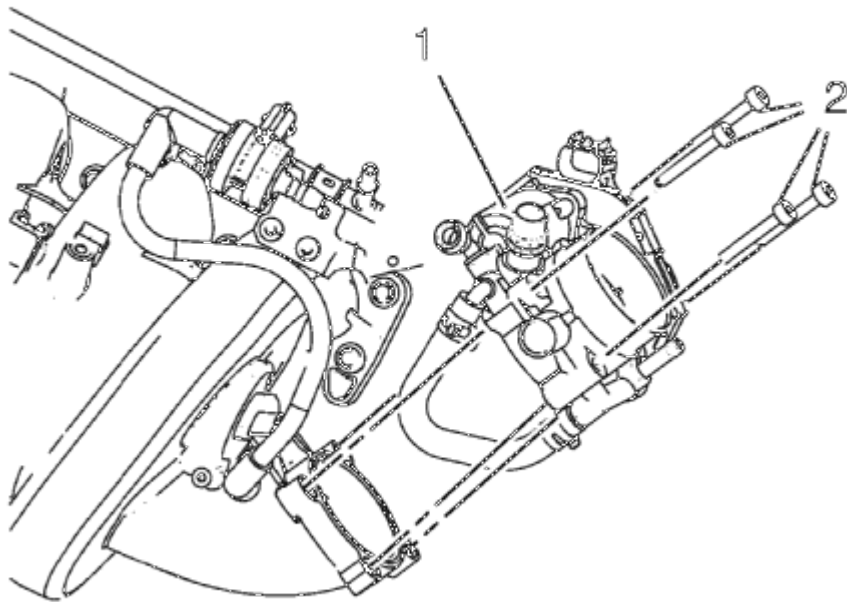
3. Install the intake manifold (2) and the 7 intake manifold bolts (1) and tighten to 20 N.m (15 lb ft).



**Fig. 500: Intake Manifold Brace And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

4. Install the intake manifold brace (1).
5. Install the 2 intake manifold brace bolts (2, 3) and tighten to 8 N.m (71 lb in).

## **THROTTLE BODY ASSEMBLY INSTALLATION**



**Fig. 501: Throttle Body And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW throttle body seal.
2. Install the throttle body (1).

**CAUTION: Refer to Fastener Caution .**

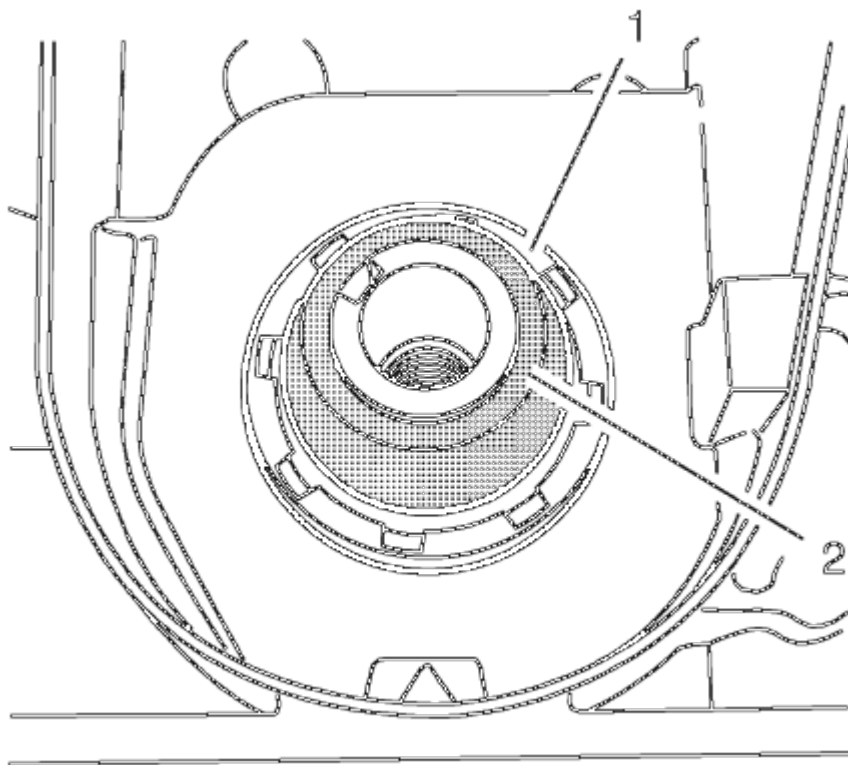
3. Install the 4 throttle body bolts (2) and tighten to 8 N.m (71 lb in).

## **CRANKSHAFT FRONT OIL SEAL INSTALLATION**

### **Special Tools**

**EN-6351** Mounting Sleeves

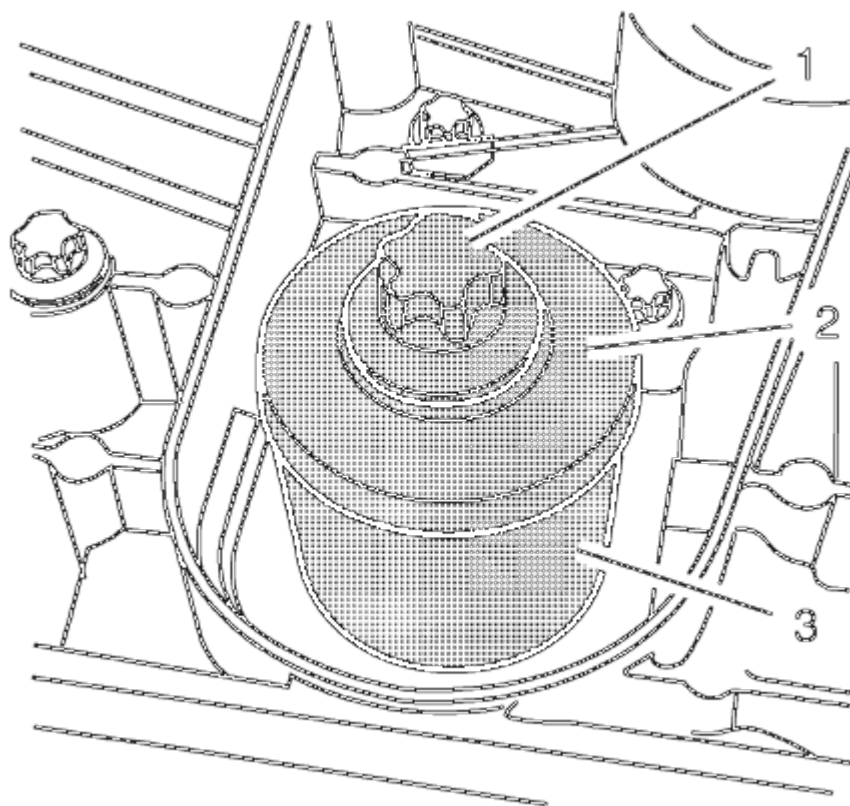
For equivalent regional tools, refer to **Special Tools**.



**Fig. 502: Crankshaft And Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing surfaces.
2. Slide the **EN-6351** sleeves (2) protective sleeve onto the crankshaft journal.
3. Slide the crankshaft front oil seal (1) over the protective sleeve on the crankshaft journal.



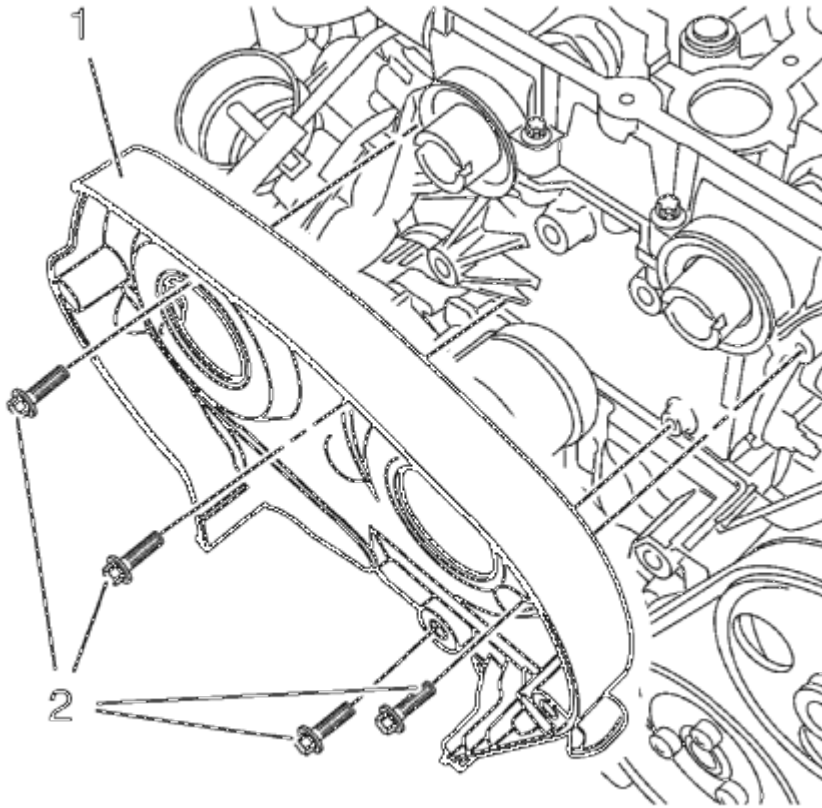


**Fig. 503: Crankshaft Drive Gear Bolt, Washer And Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the protective sleeve, and using the **EN-6351** sleeves (3), press the seal ring into the pump housing.
5. Use the crankshaft drive gear bolt (1) and washer (2) to press in the crankshaft front oil seal.

## **TIMING BELT REAR COVER INSTALLATION**

1. Re-cut the 4 rear timing belt cover threads.



**Fig. 504: Timing Belt Rear Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing belt rear cover (1).

**CAUTION:** Refer to Fastener Caution .

**NOTE:** Service may offer bolts that are not microencapsulated. If this is the case apply thread lock agent to the bolt. If fastener is microencapsulated, install a NEW 4 timing belt rear cover bolts. DO NOT reuse the old bolt.

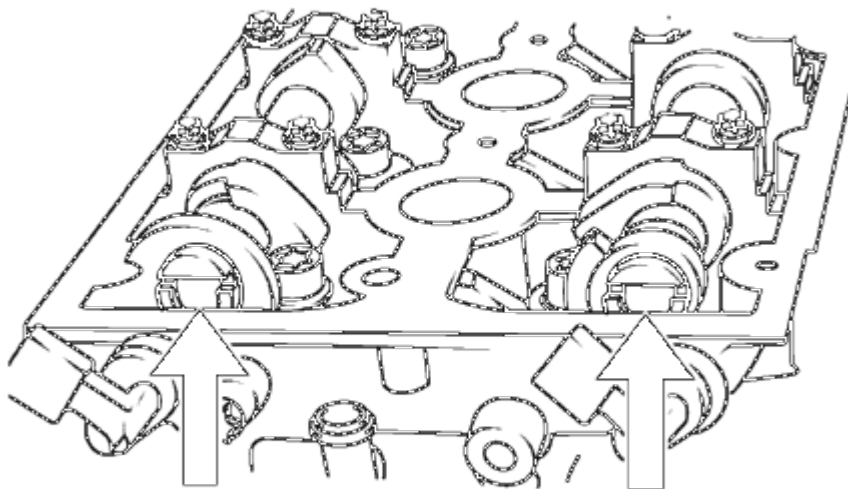
3. Install the 4 NEW timing belt rear cover bolts (2) and tighten to 6 N.m (53 lb in).

## CAMSHAFT POSITION ACTUATOR ADJUSTER INSTALLATION

### Special Tools

- **EN-6340** Camshaft Adjuster Locking Tool
- **EN-6628-A** Camshaft Locking Tool
- **EN-45059** Angle Meter

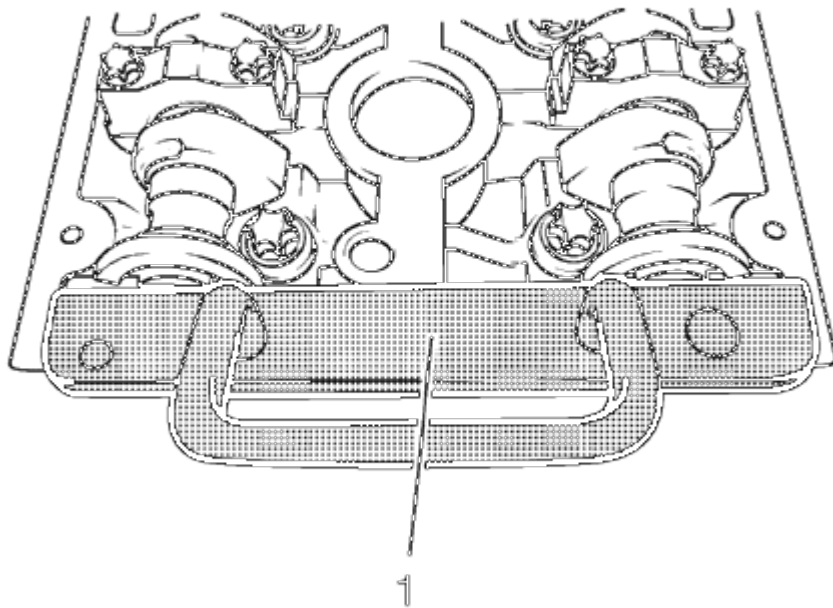
For equivalent regional tools, refer to **Special Tools**.



**Fig. 505: Aligning Camshafts Horizontally**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Note the arrows.**

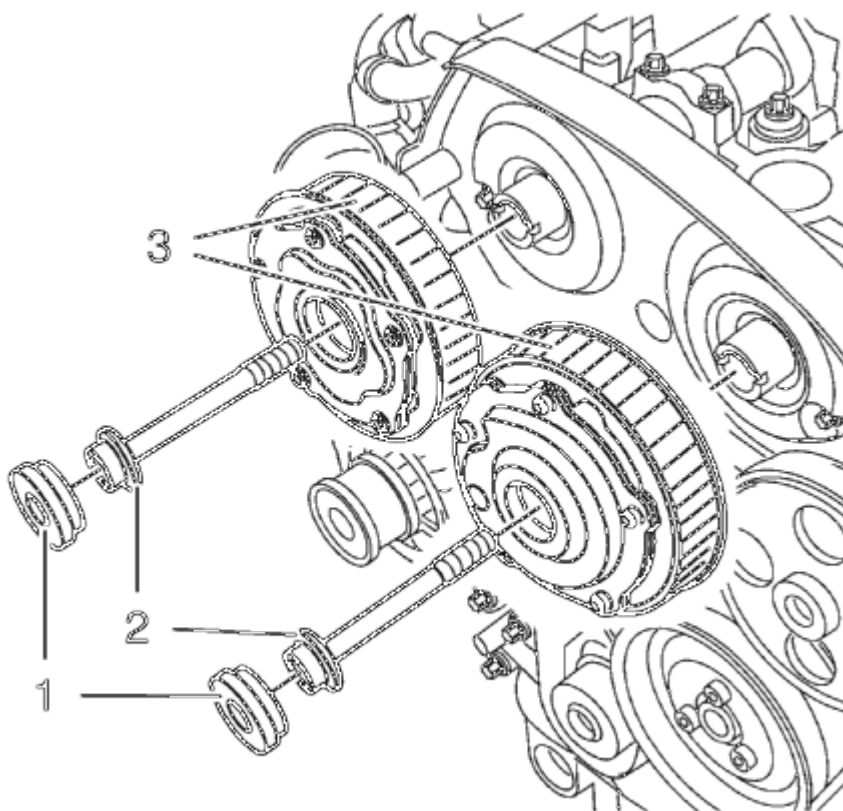
1. Turn the camshaft by the hexagon until the groove on the end of the camshafts is horizontal.



**Fig. 506: Locking Tool**

Courtesy of GENERAL MOTORS COMPANY

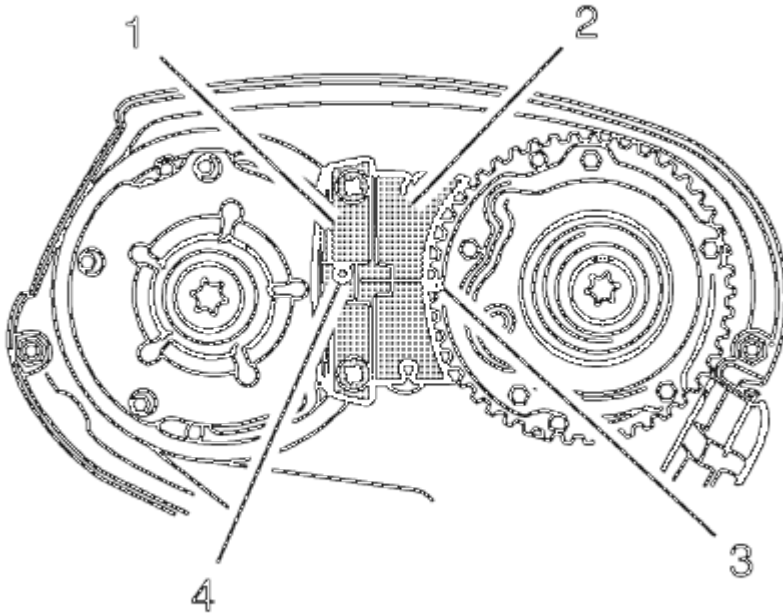
2. Install the **EN-6628-A** locking tool (1).



**Fig. 507: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** If the cover is contaminated with oil, you have to clean it close.

3. Install intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).
4. Install a NEW intake camshaft position actuator adjuster bolt and/or a NEW exhaust camshaft position actuator adjuster bolt (2). DO NOT tighten the bolts yet.



**Fig. 508: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

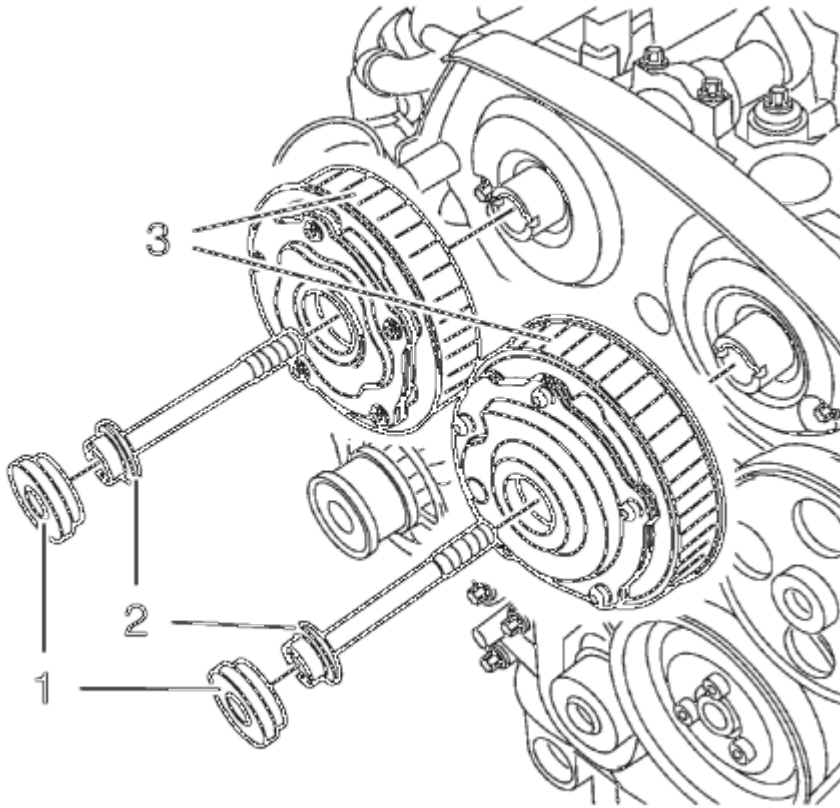
5. Install the **EN-6340** locking tool into the camshaft position actuator adjusters.

**NOTE:** The spot type marking (4) on the intake camshaft position actuator adjuster does not correspond to the groove of EN-6340-left locking tool - left during this process but must be somewhat above as shown.

1. Install the **EN-6340-left** locking tool (1) in the camshaft position actuator adjusters as shown.

**NOTE:** The spot type marking (3) on the exhaust camshaft position actuator adjuster must correspond to the groove on EN-6340-left locking tool - right.

2. Install the **EN-6340-right** locking tool (2) in the camshaft position actuator adjusters as shown.



**Fig. 509: Camshaft Position Actuator Adjuster Closure Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

**NOTE:** A second technician is required.

**NOTE:** Use an appropriate open-end wrench in order to counterhold the camshaft hexagon. A thin cross-section wrench is required for a better fit. The usage of EN-6628-A locking tool is for the camshaft adjustment to prevent misalignment of the camshafts. The wrench is required to counterhold the camshafts during bolt torque procedure.

6. Install the camshaft position actuator adjuster bolts (2) and tighten the bolts in 3 passes using the **EN-45059** meter.

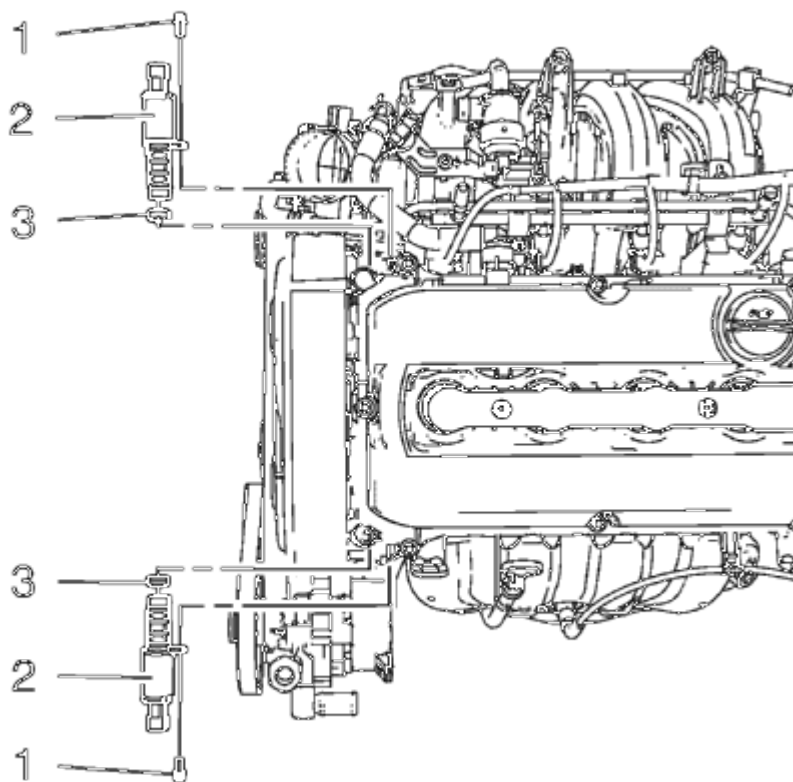
1. First pass to 50 N.m (37 lb ft)

2. Second pass to an additional 150 degrees
3. Final pass to an additional 15 degrees

**NOTE:** Check the closure bolt seal ring.

7. Install the 2 camshaft position actuator adjuster closure plugs (1) and tighten to 30 N.m (22 lb ft).
8. Remove the **EN-6628-A** locking tool.
9. After the installation of the timing belt, rotate the engine 720 degrees and check the position of the crankshaft and camshafts, again. Refer to **Timing Belt Adjustment**.

### CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSTALLATION



**Fig. 510: Camshaft Position Actuator Solenoid Valves, Bolts And Seals**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate the **NEW** camshaft position actuator solenoid valve seals with **NEW** engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

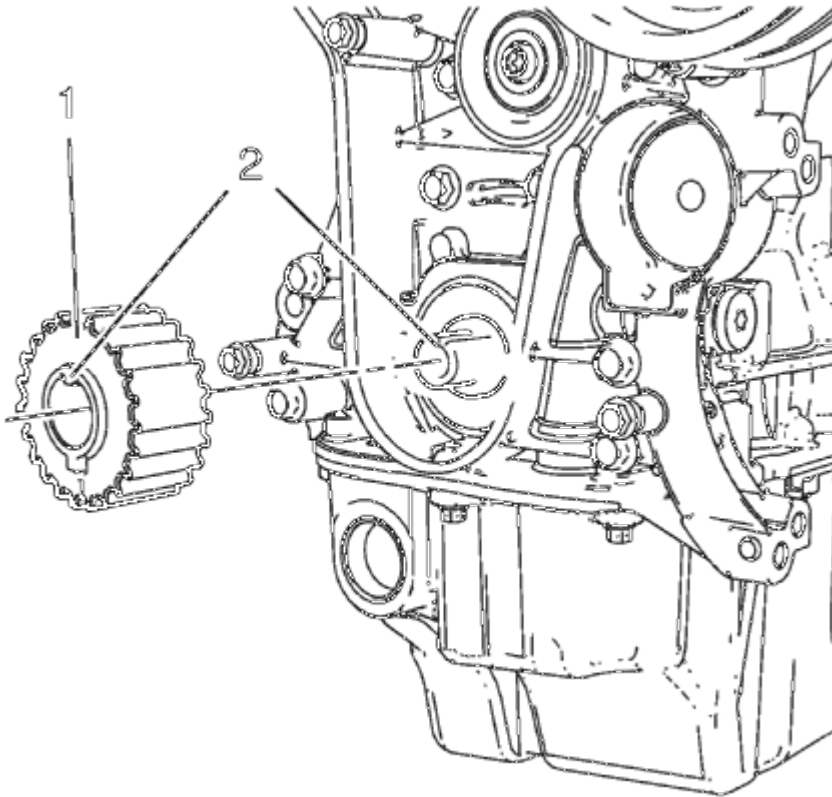
1. Install NEW camshaft position actuator solenoid valve seals (3).
2. Install the camshaft position actuator solenoid valves (2).



**CAUTION:** Refer to Fastener Caution .

3. Install the camshaft position actuator solenoid valve bolts (1) and tighten to 6 N.m (53 lb in).

## CRANKSHAFT SPROCKET INSTALLATION



**Fig. 511: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** When installing the crankshaft sprocket, the cam and the groove must align (2).

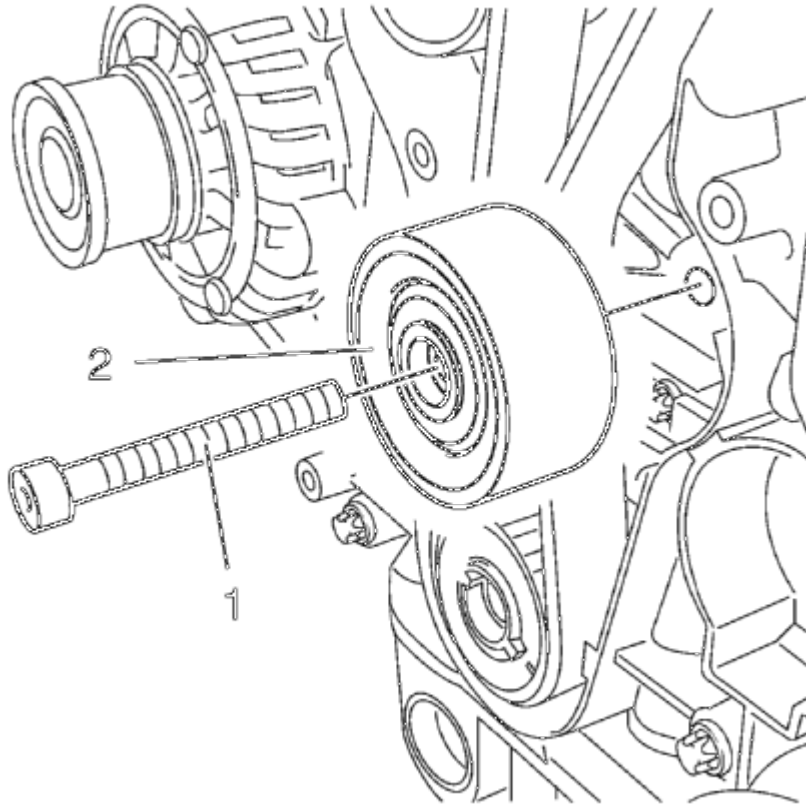
Install the crankshaft sprocket (1).

## TIMING BELT IDLER PULLEY INSTALLATION

### Special Tools

**EN-45059** Angle Meter

For equivalent tools, refer to Special Tools.



**Fig. 512: Timing Belt Idler Pulley Bolt**  
Courtesy of GENERAL MOTORS COMPANY

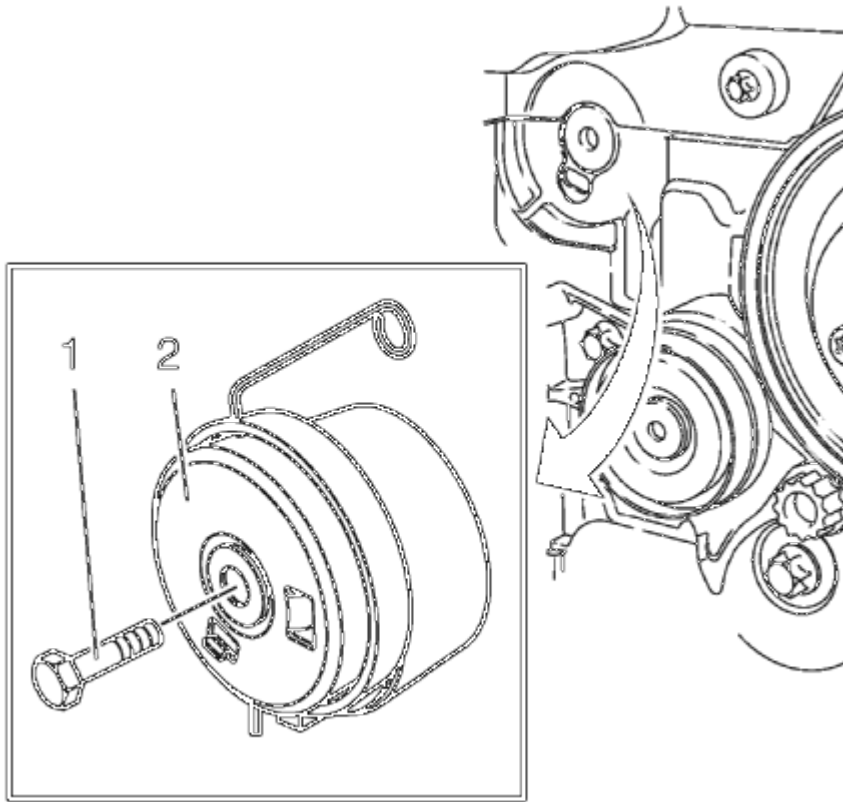
**CAUTION:** Refer to Fastener Caution .

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

1. Install the timing belt idler pulley (1) and tighten the NEW bolt (2) in three passes use the **EN-45059** meter :
  1. First pass tighten to 20 N.m (15 lb ft).
  2. Second pass to 120 degrees.
  3. Final pass to 15 degrees.
2. Install the timing belt. Refer to Timing Belt Replacement.

## **TIMING BELT TENSIONER INSTALLATION**

### **Special Tools**

**EN-45059** Angle Meter**Fig. 513: Timing Belt Tensioner**

Courtesy of GENERAL MOTORS COMPANY

1. Clean the timing belt tensioner thread.
2. Install the timing belt tensioner (2).

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

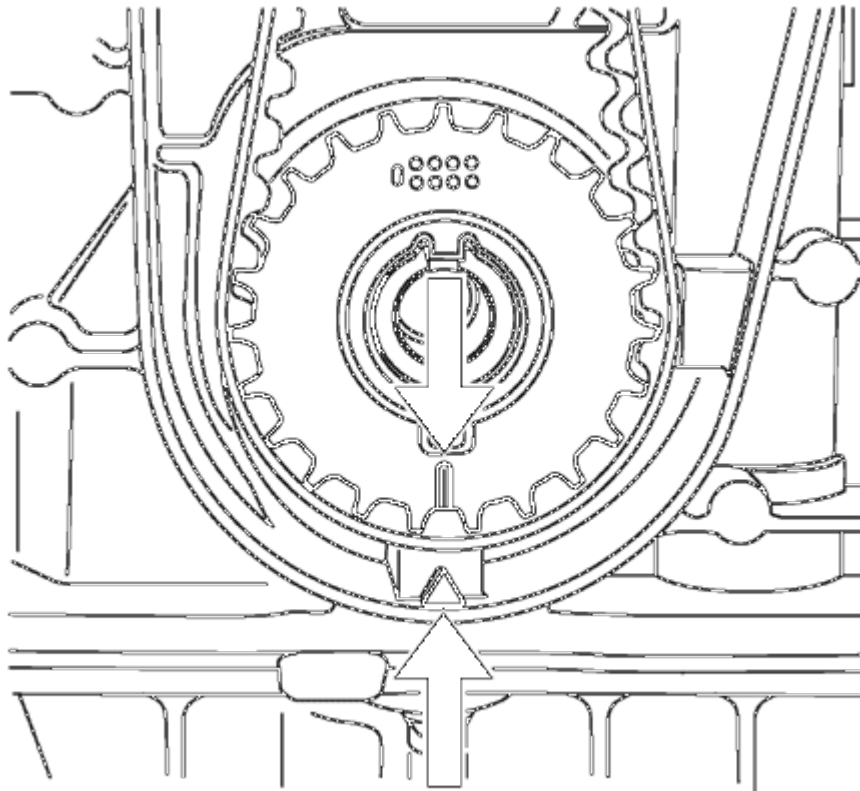
3. Install a NEW timing belt tensioner bolt (1) and tighten the bolt in 3 passes using the **EN-45059** meter.
  1. First pass to 20 N.m (15 lb ft).
  2. Second pass to an additional 120 degrees.
  3. Final pass to an additional 15 degrees.

**TIMING BELT INSTALLATION**

**Special Tools**

- **EN-6333** Locking Pin
- **EN-6340** Locking Tool

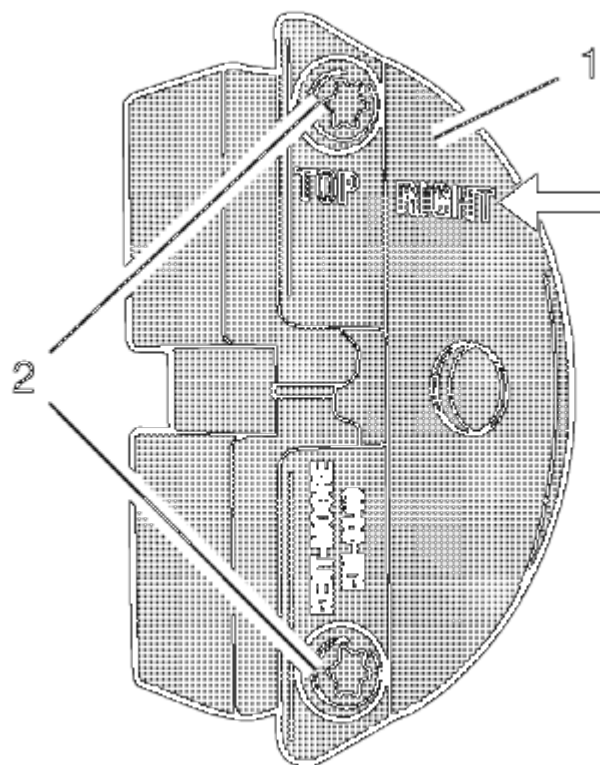
For equivalent regional tools, refer to **Special Tools**.



**Fig. 514: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The timing belt drive gear and oil pump housing must align.

1. Turn the crankshaft in the direction of engine rotation, by the crankshaft balancer bolt, to cylinder 1 TDC of combustion stroke.

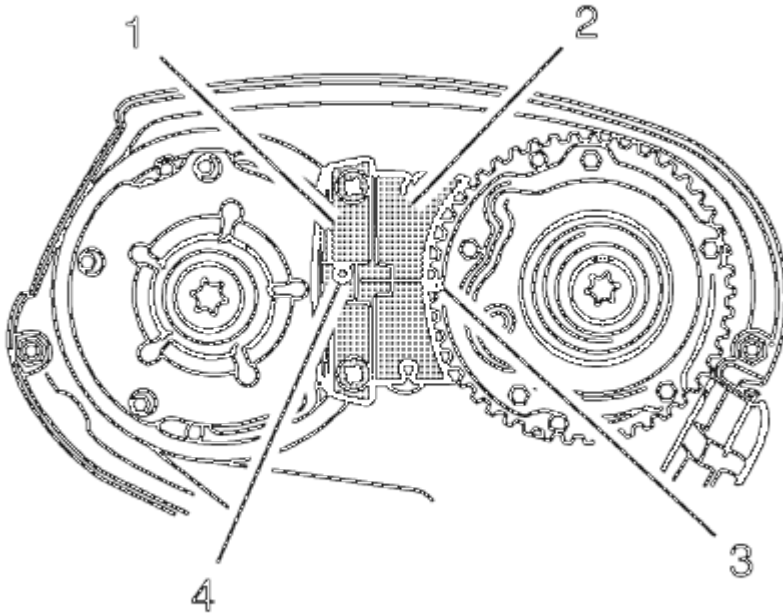


**Fig. 515: Front Panel And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The right half of the EN-6340 locking tool can be recognized by the lettering right, arrow, on the tool.

2. Prepare the right half of the **EN-6340** locking tool.
  1. Remove the 2 bolts (2).
  2. Detach the front panel (1) from the **EN-6340** locking tool - right.

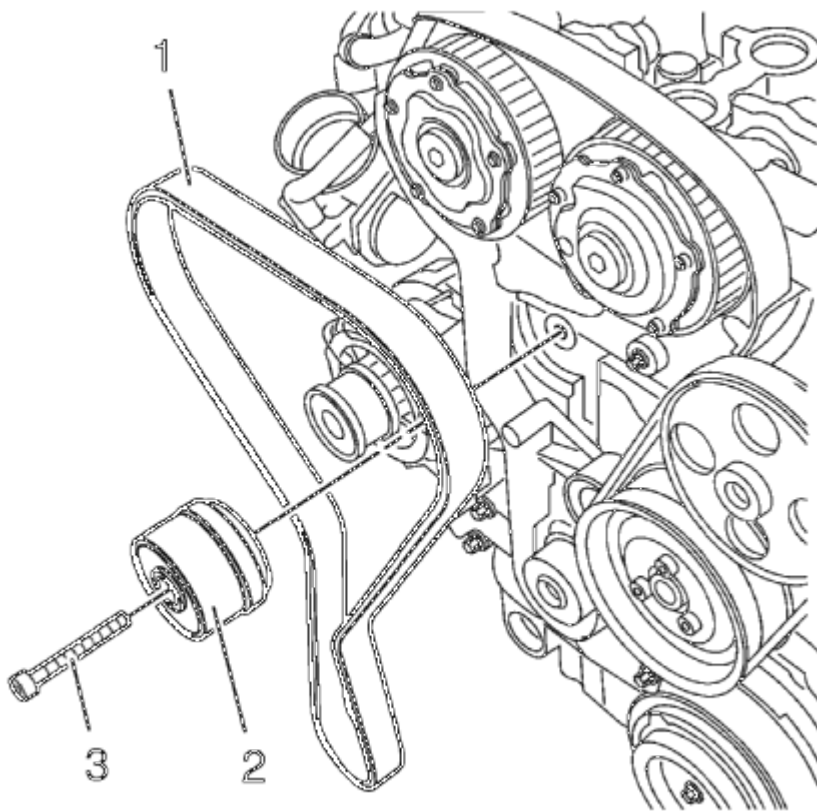


**Fig. 516: Spot Type Markings And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- The spot type marking (4) on the intake camshaft adjuster does not correspond to the groove of the EN-6340 locking tool - left (1) during this process, but must be somewhat above.
- The spot type marking (3) on the exhaust camshaft adjuster must correspond to the groove on EN-6340 locking tool - right (2).

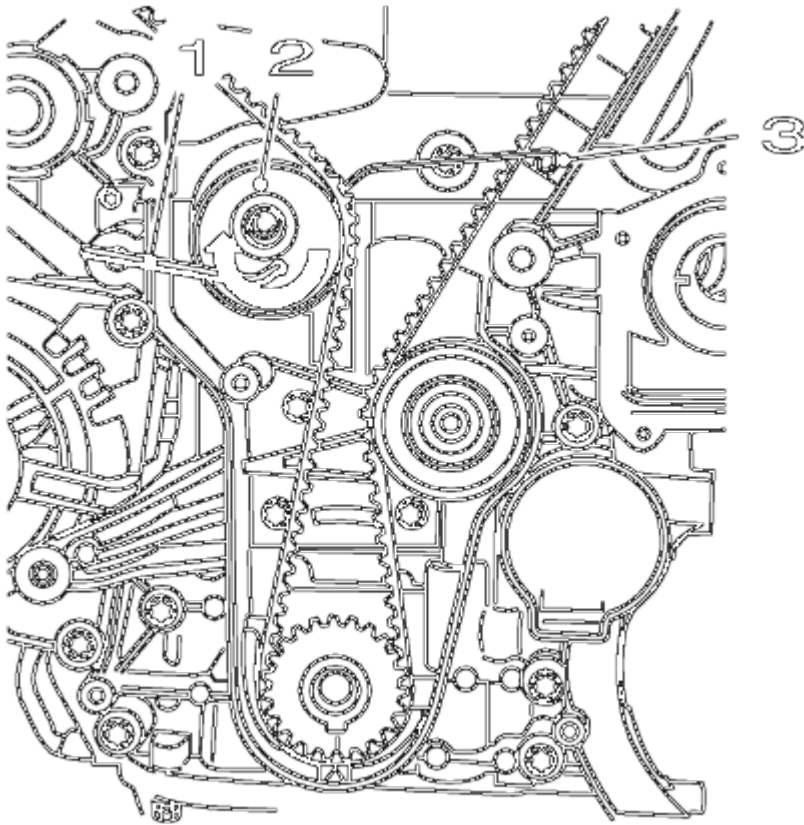
3. Insert the **EN-6340** locking tool - left (1) and the **EN-6340** locking tool - right (2) in the camshaft adjuster.



**Fig. 517: Timing Belt And Timing Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**        **Observe direction of rotation.**

4. Insert the timing belt (1).



**Fig. 518: Drive Belt Tensioner, Allen Key And Locking Pin**  
 Courtesy of GENERAL MOTORS COMPANY

5. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an Allen key (1).
6. Remove the **EN-6333** locking pin (3).

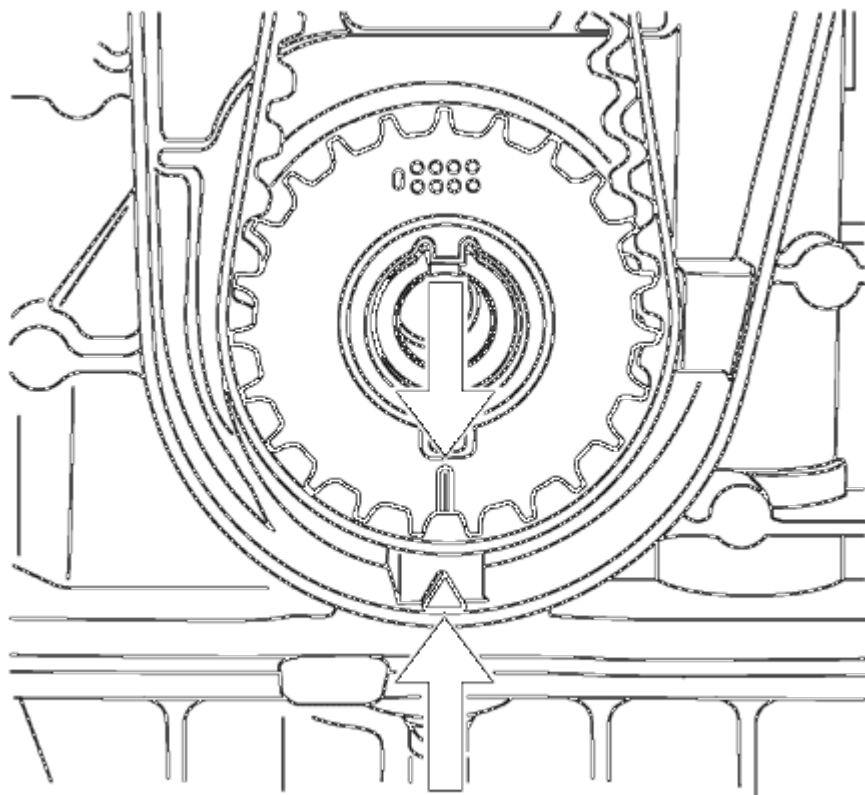
**NOTE:** The timing belt tensioner moves automatically to the correct position.

7. Release tension on timing belt tensioner.
8. Remove the **EN-6340** locking tool.
9. Check position of the camshaft sprocket.
  1. Turn crankshaft 720° in the direction of engine rotation by the crankshaft balancer bolt.

**NOTE:** Note the marking on the camshaft sprocket.

2. Insert **EN-6340** locking tool into camshaft sprockets.



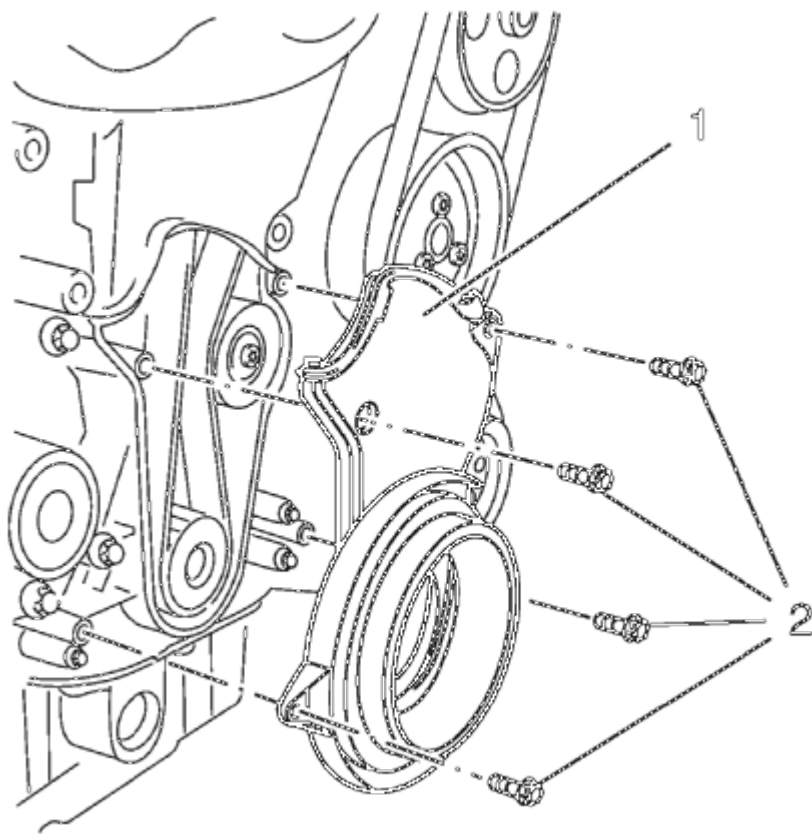


**Fig. 519: Aligning Timing Belt Drive Gear And Oil Pump Housing**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The timing belt drive gear and oil pump housing must align.

10. Check the crankshaft position.

#### **TIMING BELT LOWER FRONT COVER INSTALLATION**



**Fig. 520: Timing Belt Lower Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

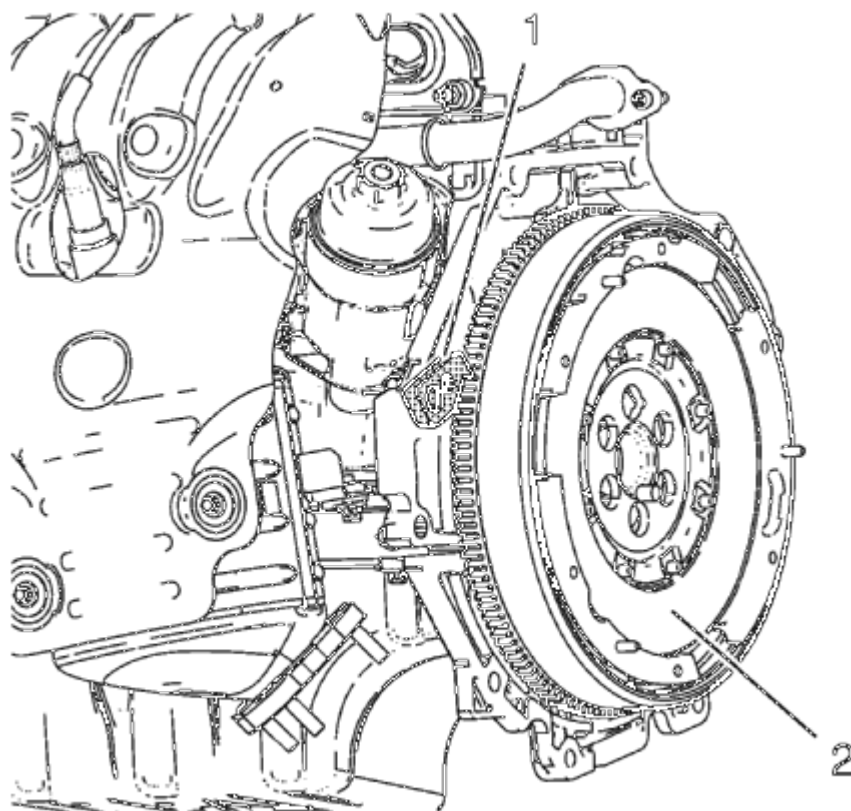
Install the timing belt cover (1) and tighten the 4 timing belt lower front cover bolts (2) to 6 N.m (53 lb in).

## CRANKSHAFT BALANCER INSTALLATION

### Special Tools

- **EN-652** Flywheel Holder
- **EN-45059** Angle Meter

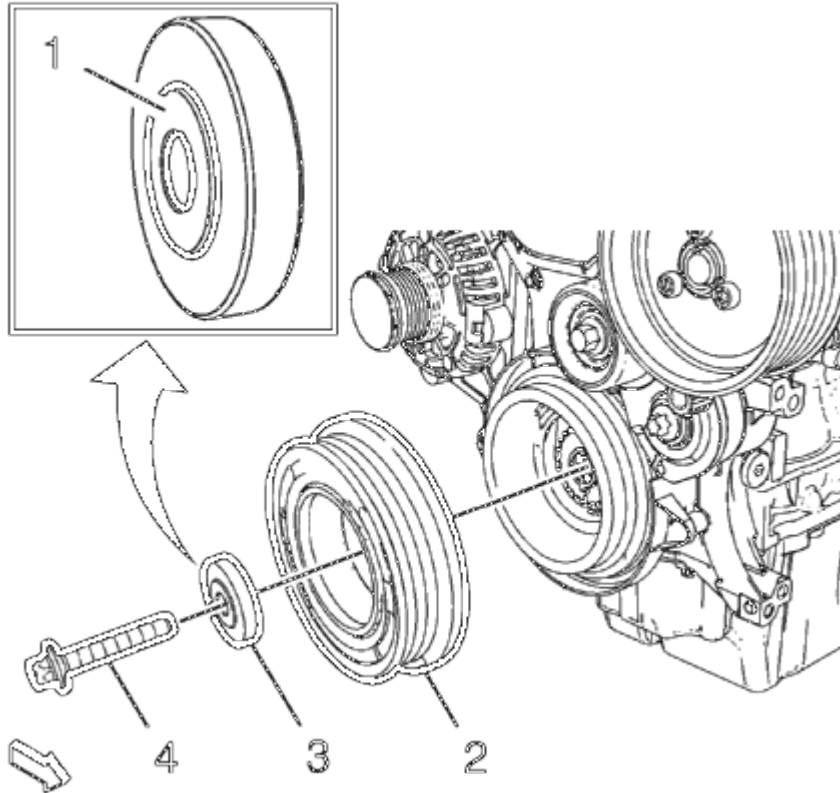
For equivalent regional tools, refer to Special Tools.



**Fig. 521: Flywheel And Flywheel Holder**

**Courtesy of GENERAL MOTORS COMPANY**

1. Install the **EN-652** holder (1), lock the flywheel (2) or the automatic transmission flex plate via the starter ring gear.



**Fig. 522: Crankshaft Balancer, Washer And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Use care that the height (1) of the washer is facing towards the bolt.

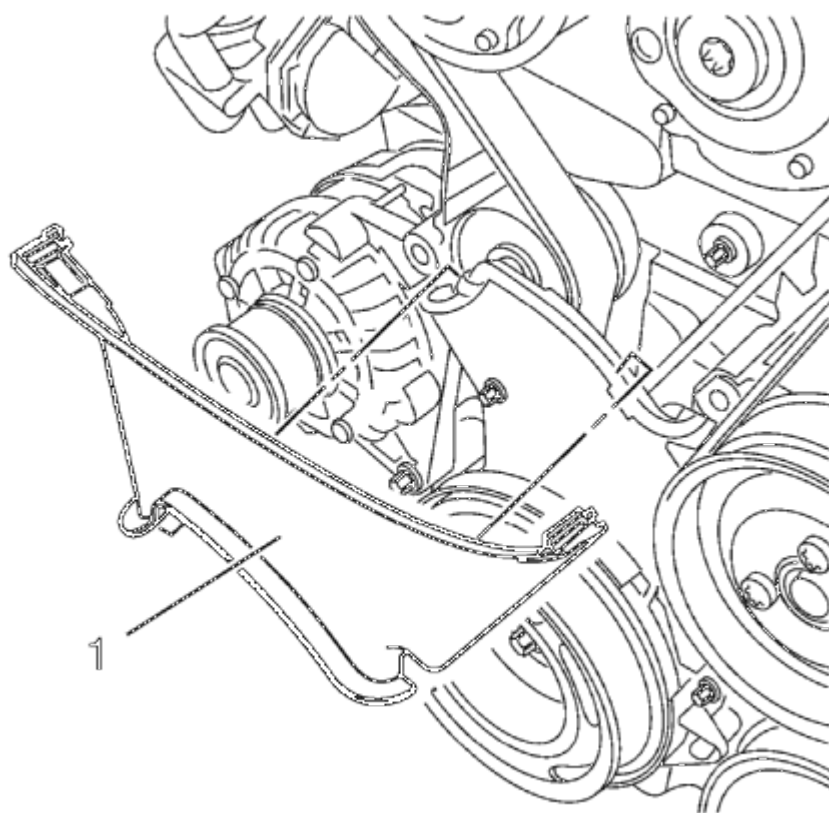
2. Install the crankshaft balancer (2) and the washer (3).

**CAUTION:** Refer to Fastener Caution .

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

3. Install a NEW crankshaft balancer bolt (4) and tighten the bolt in 3 passes using the **EN-45059** meter
  1. First pass to 95 N.m (70 lb ft).
  2. Second pass to an additional 45°,
  3. Final pass to an additional 15°.

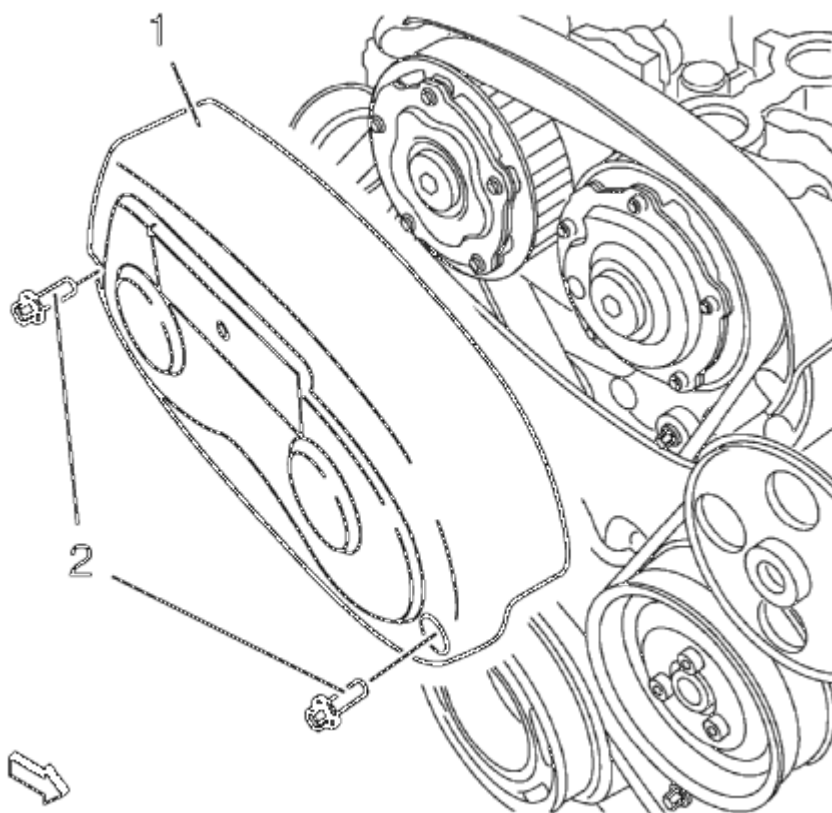
## TIMING BELT CENTER FRONT COVER INSTALLATION



**Fig. 523: Timing Belt Center Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

Install the timing belt center front cover (1) to the timing belt rear cover at 2 locations.

#### **TIMING BELT UPPER FRONT COVER INSTALLATION**



**Fig. 524: Timing Belt Upper Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the timing belt upper front cover (1).

**CAUTION:** Refer to Fastener Caution .

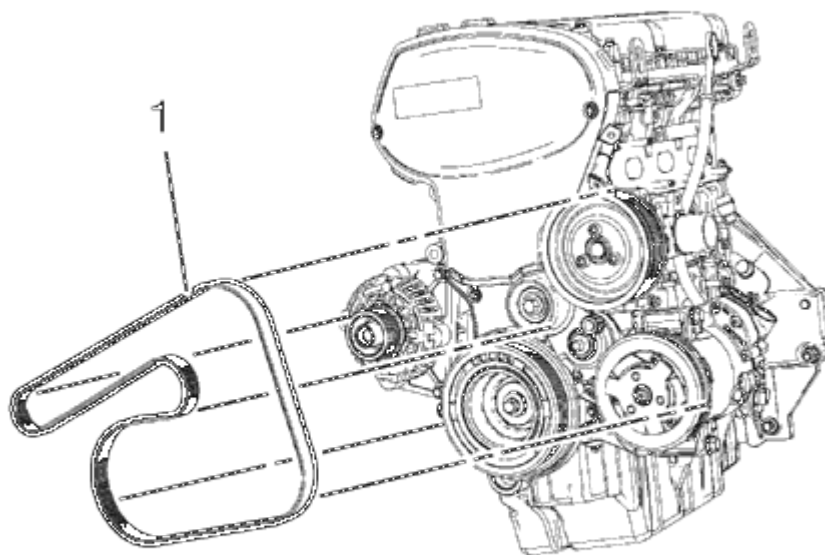
2. Install the 2 timing belt upper front cover bolts (2) and tighten to 6 N.m (53 lb in).

## DRIVE BELT INSTALLATION

### Special Tools

**EN-6349** Locking Pin

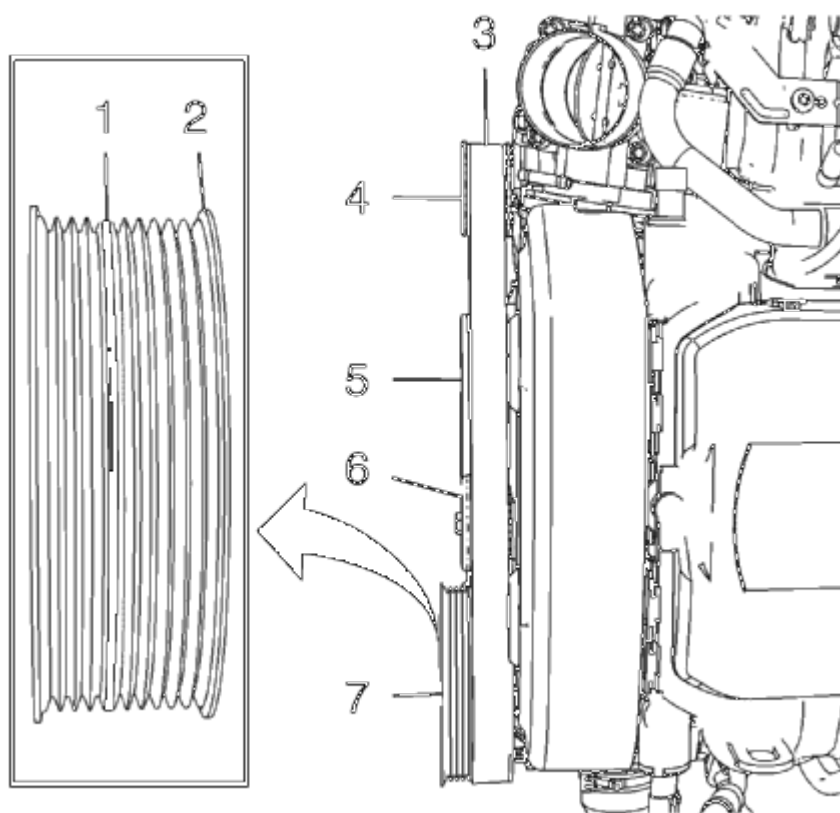
For equivalent regional tools, refer to Special Tools.



**Fig. 525: Drive Belt Routing**

**Courtesy of GENERAL MOTORS COMPANY**

1. Install the drive belt (1).



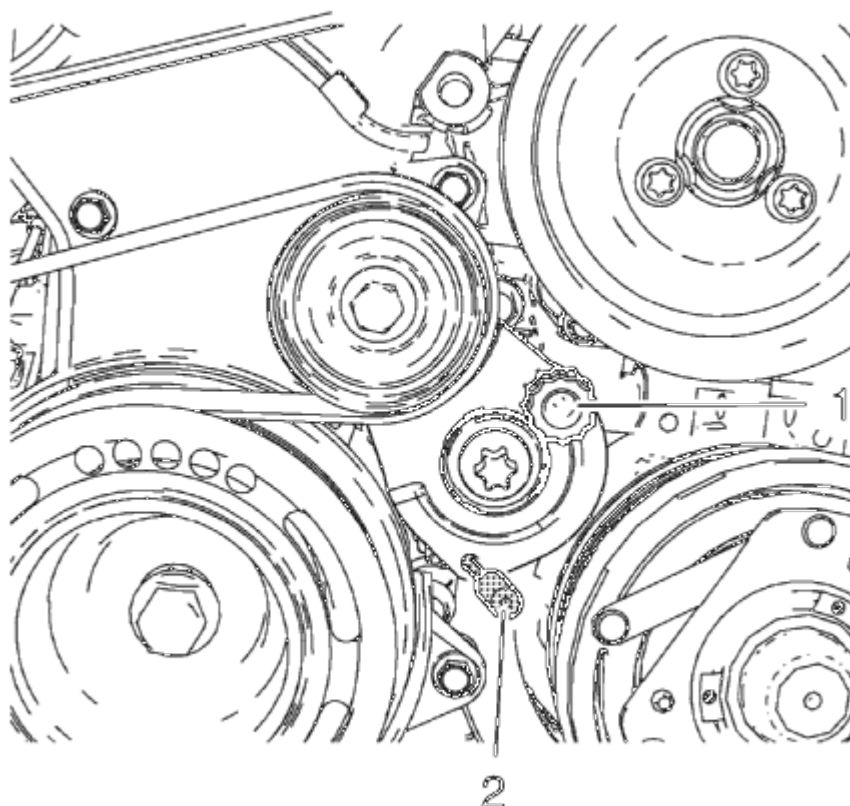
**Fig. 526: Checking Drive Belt Position**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Make sure that the drive belt is aligned on the generator pulley (4), crankshaft balancer (5), drive belt tensioner (6) and water pump pulley (7). The drive belt must lie on the water pump pulley between the flange (1) and (2).

2. Check the position of the drive belt (3).





**Fig. 527: Drive Belt Tensioner And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

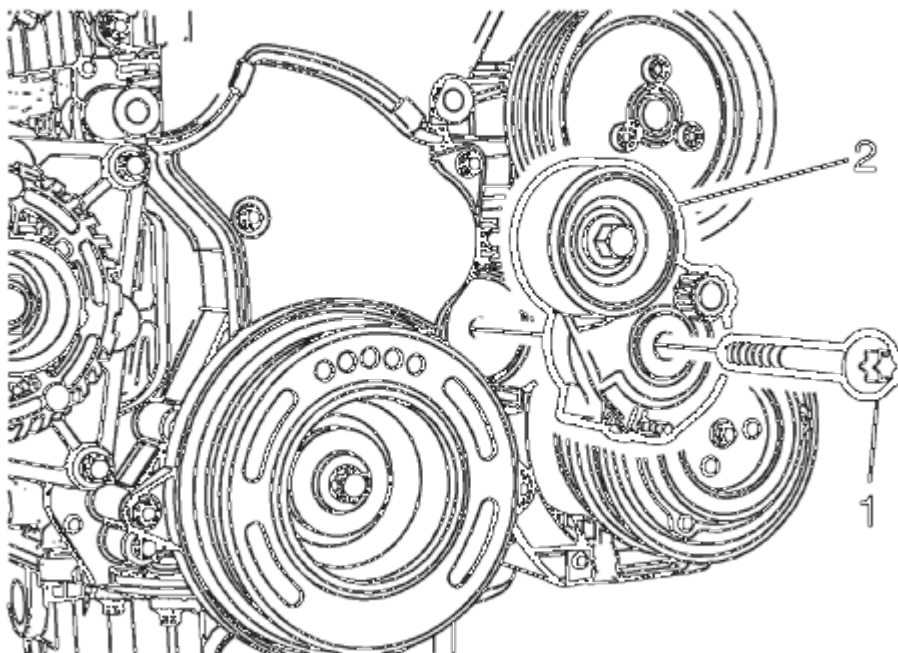
3. Release tension to the tensioner counterclockwise (1).

**NOTE:** Allow tensioner to slide back slowly.

4. Remove **EN-6349** pin (2).
5. Apply tension to the tensioner at projection (1) clockwise.

## DRIVE BELT TENSIONER INSTALLATION

1. Clean the drive belt tensioner thread.



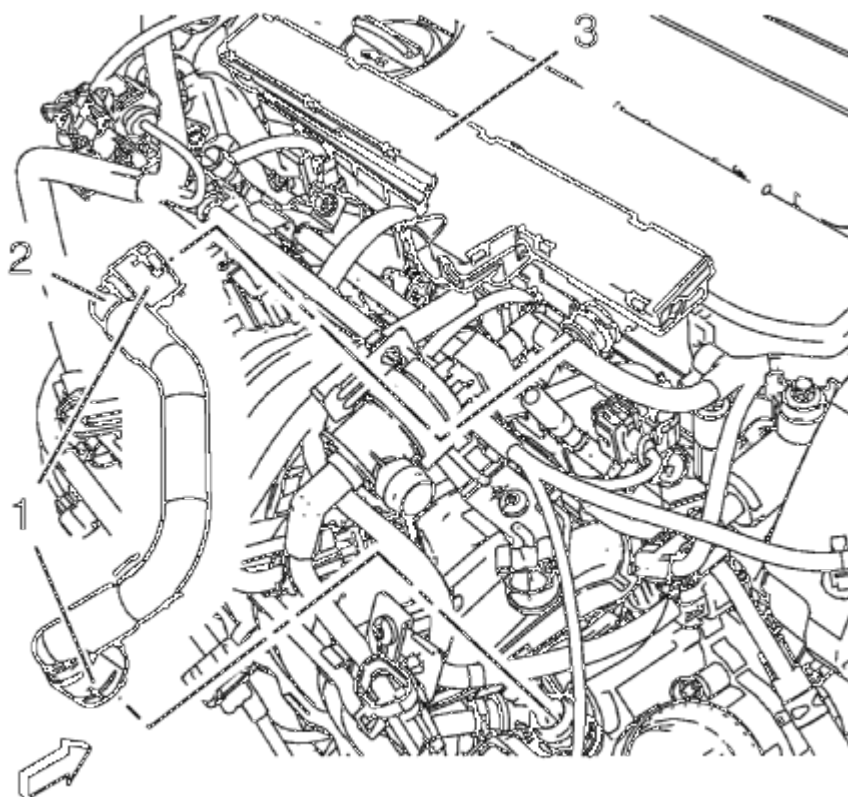
**Fig. 528: Drive Belt Tensioner Bolt**  
Courtesy of GENERAL MOTORS COMPANY

2. Install drive belt tensioner (2).

**CAUTION:** Refer to Fastener Caution .

3. Install drive belt tensioner bolt (1) and tighten to 55 N.m (41 lb ft).

#### **POSITIVE CRANKCASE VENTILATION PIPE INSTALLATION**



**Fig. 529: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide**  
Courtesy of GENERAL MOTORS COMPANY

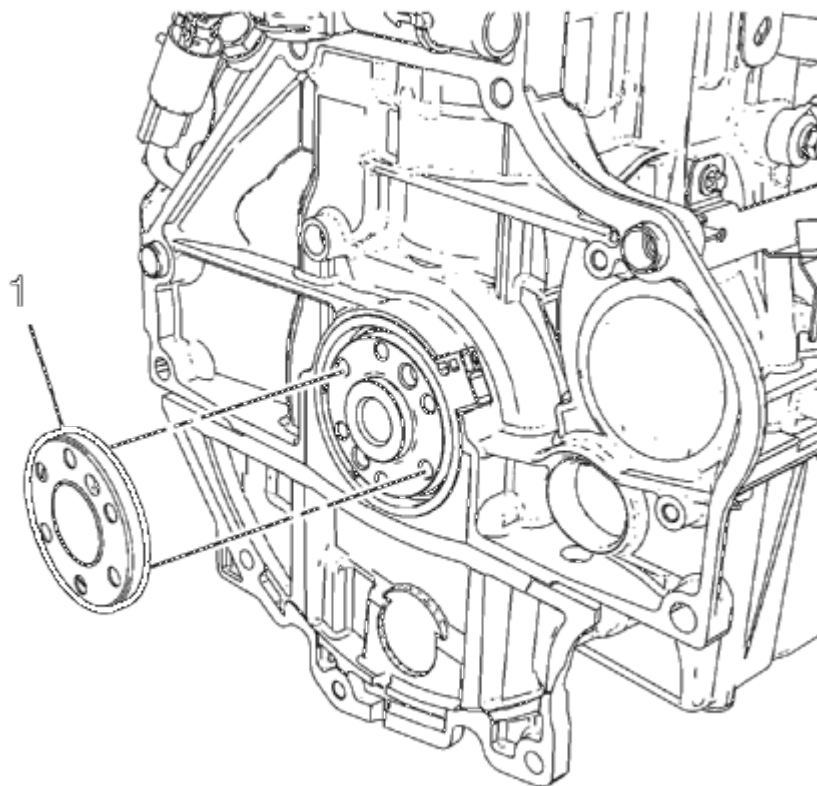
1. Install the positive crankcase ventilation tube (2).
2. Connect the 2 positive crankcase ventilation tube connectors (1).
3. Clip in the ECM wiring harness guide (3) to the cylinder head cover.

## ENGINE FLYWHEEL INSTALLATION

### Special Tools

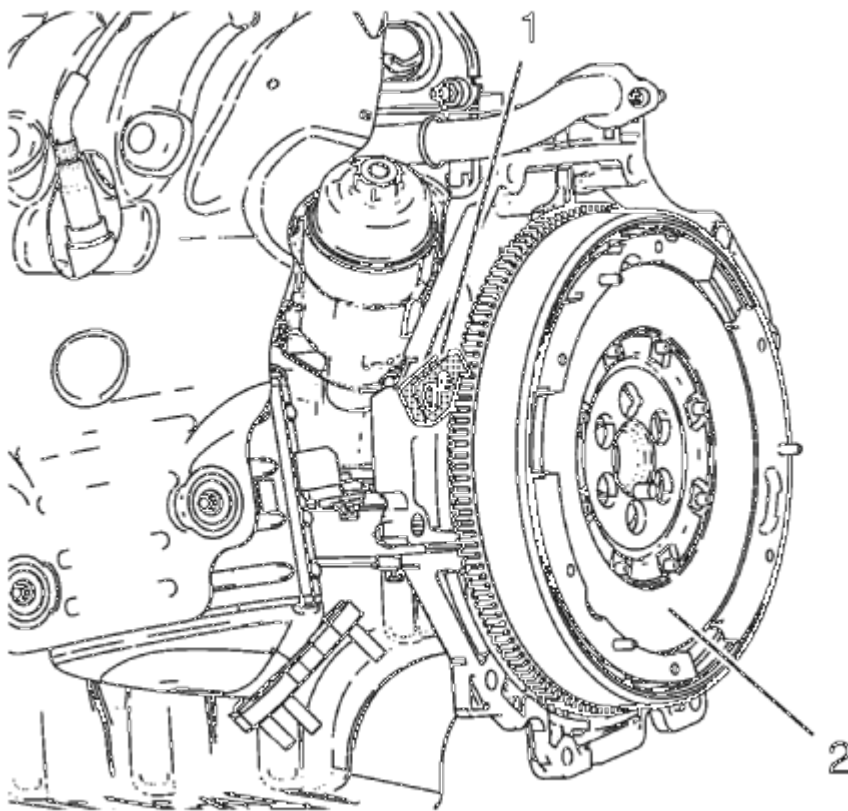
- **EN-652** Flywheel Holder
- **EN-45059** Torque Angle Sensor Kit

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



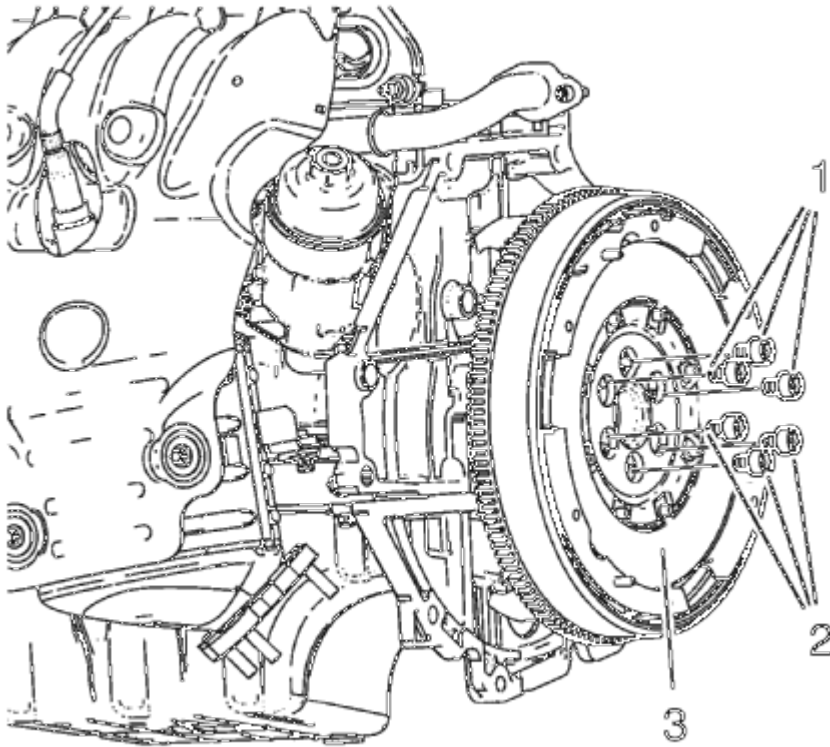
**Fig. 530: Crankshaft Position Reluctor Ring**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Install the crankshaft position reluctor ring (1).



**Fig. 531: Flywheel And Flywheel Holder**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the flywheel (2).
3. Install the **EN-652** holder (1).



**Fig. 532: Flywheel And Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

4. Install the 6 NEW flywheel bolts (1, 2) and tighten the bolts in 3 passes using the **EN-45059** sensor kit :
  1. First pass to 60 N.m (44 lb ft).
  2. Second pass to additional 45°.
  3. Third pass to an additional 15°.
5. Remove the **EN-652** holder.

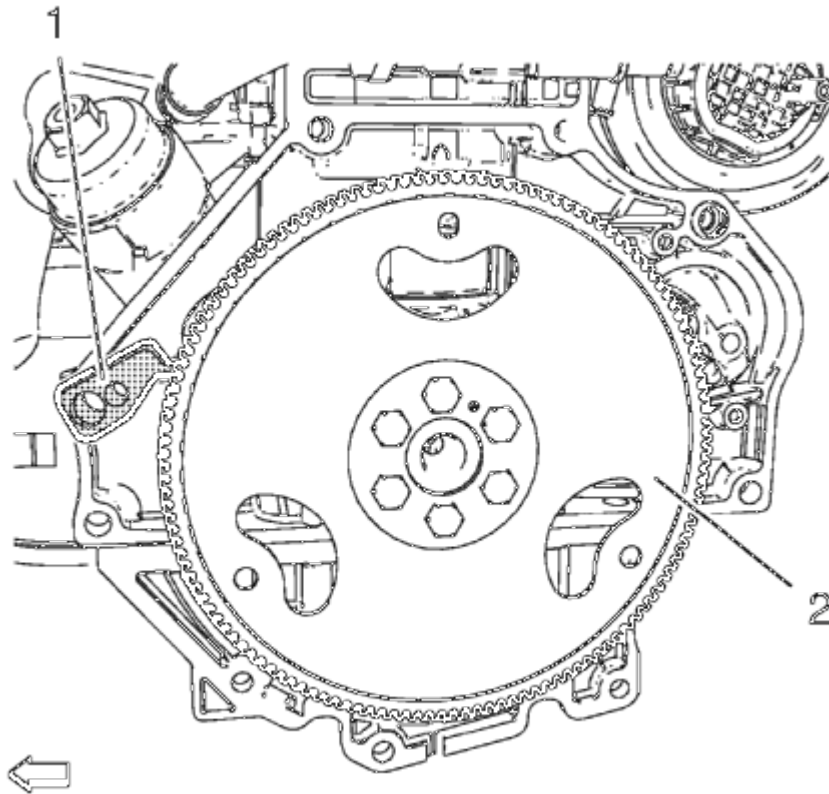
## **AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION**

### **Special Tools**

#### **EN-652** Automatic Transmission Flex Plate Holder

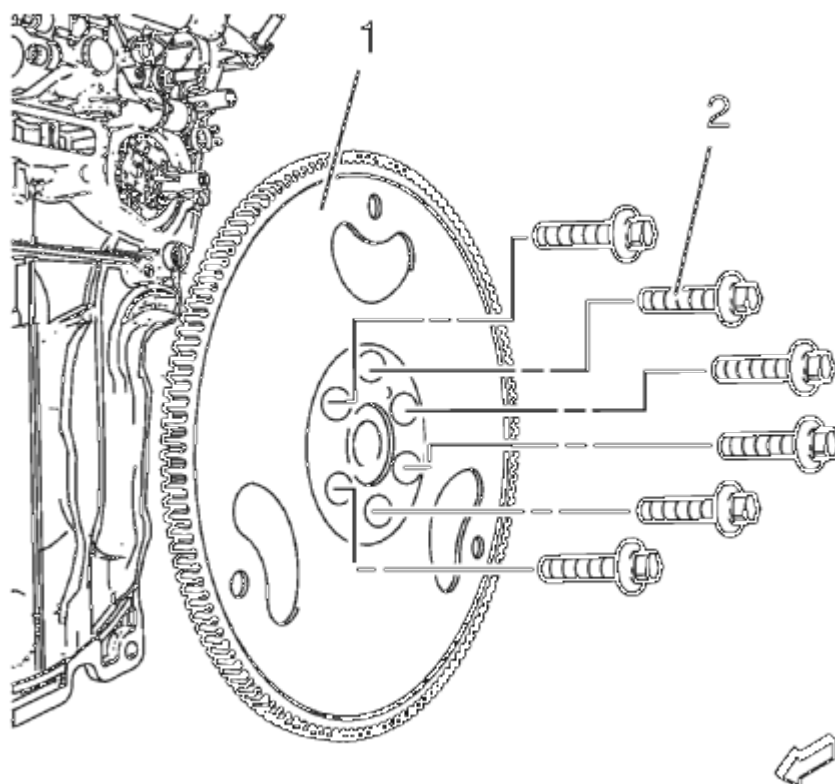
For equivalent regional tools, refer to **Special Tools**.

1. Clean the automatic transmission flex plate bolt threads.



**Fig. 533: Automatic Transmission Flex Plate And Holder**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the automatic transmission flex plate (2) and the **EN-652** holder to hold the automatic transmission flex plate (2).



**Fig. 534: Automatic Transmission Flex Plate And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

3. Install the 6 NEW automatic transmission flex plate bolts (2) and tighten the bolts to 60 N.m (44 lb ft)  $\pm$  5°.
4. Remove the EN-652 holder.

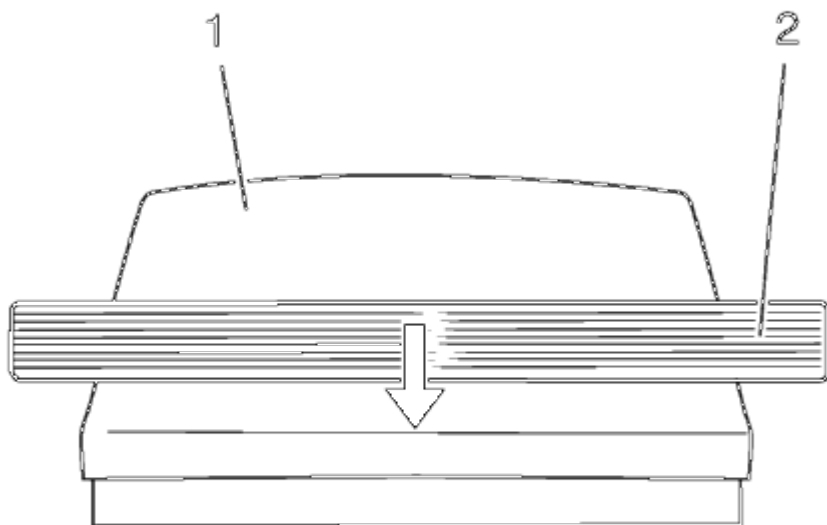
## CRANKSHAFT REAR OIL SEAL INSTALLATION

### Special Tools

- EN-658-1 Installer
- EN-235-6 Installer



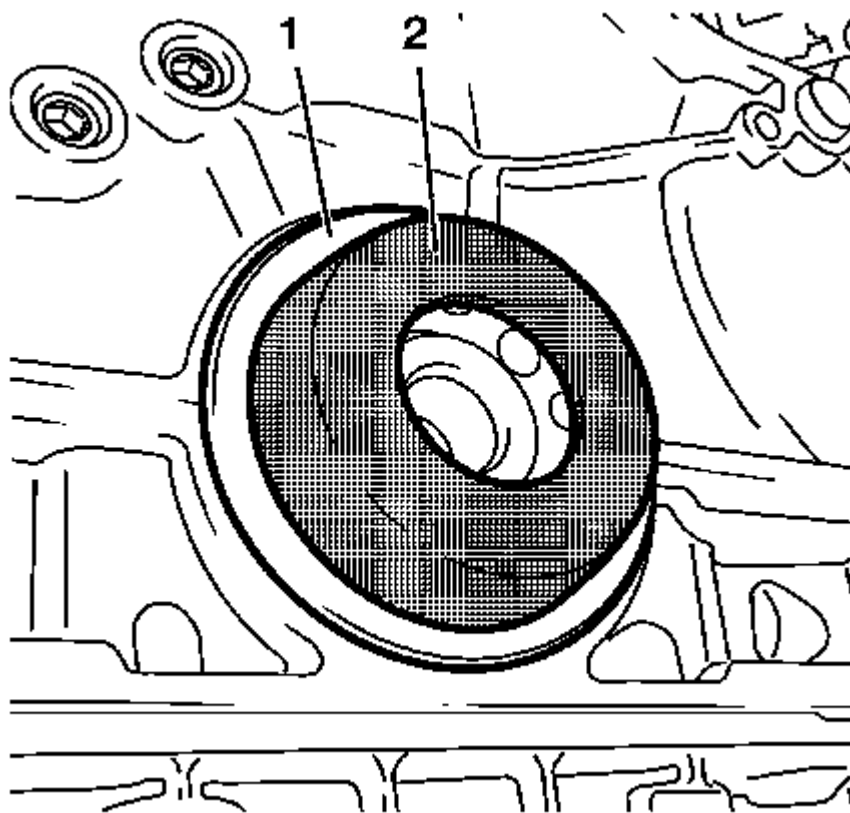
For equivalent regional tools, refer to **Special Tools**.



**Fig. 535: Crankshaft Rear Oil Seal**

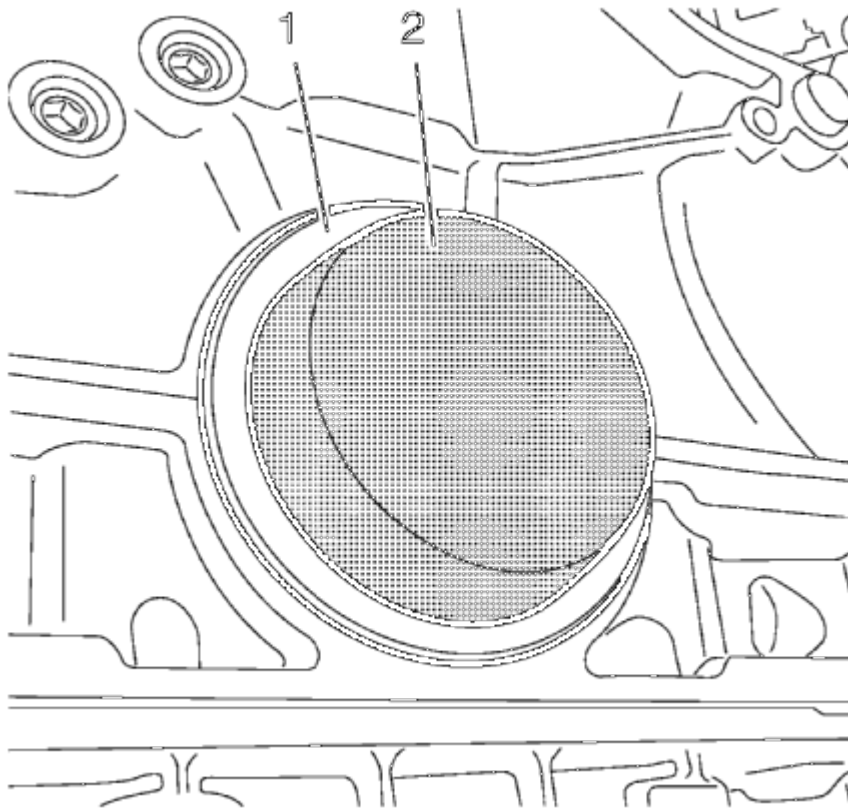
Courtesy of GENERAL MOTORS COMPANY

1. Slide the crankshaft rear oil seal (2) across the **EN-235-6** installer (1).



**Fig. 536: Crankshaft Rear Oil Seal And Installer**  
**Courtesy of GENERAL MOTORS COMPANY**

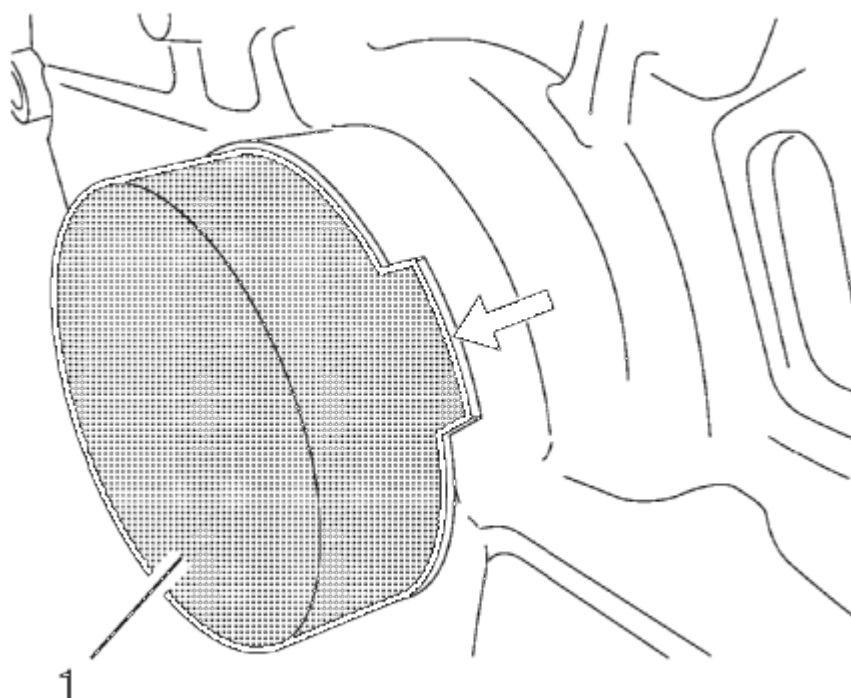
2. Install the crankshaft rear oil seal (1) with **EN-235-6** installer (2) to the crankshaft.



**Fig. 537: Oil Seal Installer**

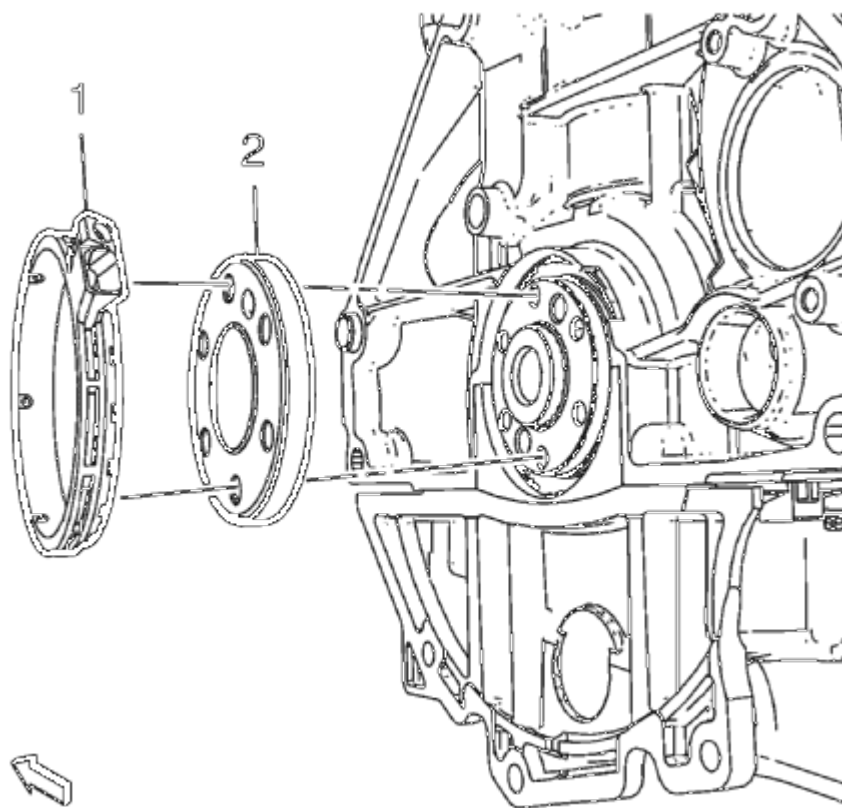
Courtesy of GENERAL MOTORS COMPANY

3. Use **EN-658-1** installer (2) to strike the crankshaft rear oil seal (1)



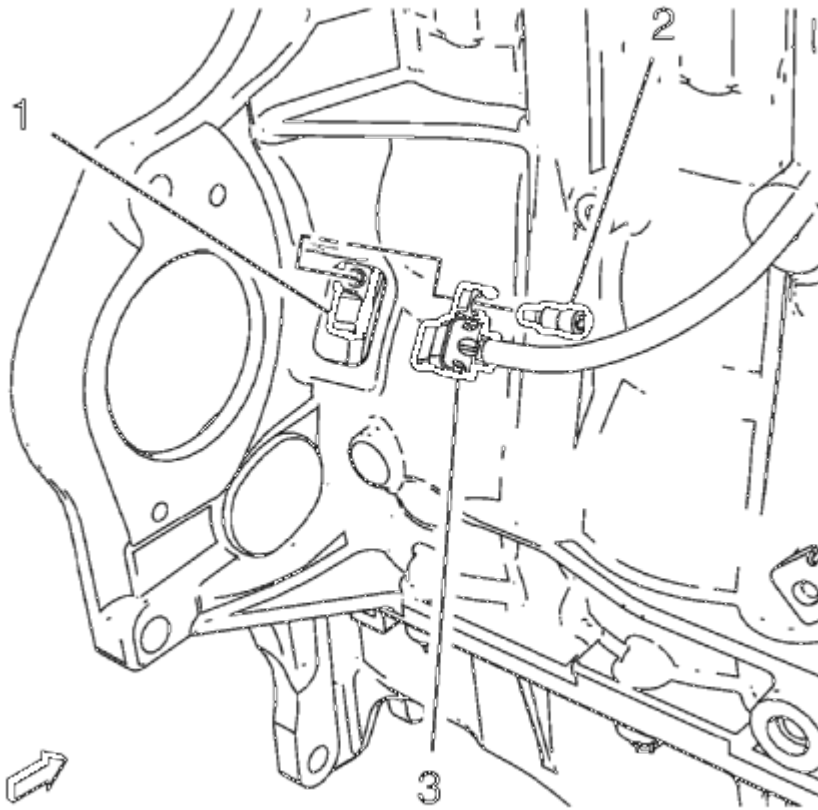
**Fig. 538: Check Crankshaft Rear Oil Seal For Proper Seat**  
Courtesy of GENERAL MOTORS COMPANY

4. Check the crankshaft rear oil seal for proper seat, the **EN-658-1** installer must be flush with the cylinder block at the position (1).



**Fig. 539: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing**  
**Courtesy of GENERAL MOTORS COMPANY**

5. Install the reluctor ring (2).
6. Install the crankshaft rear oil seal housing (1).



**Fig. 540: Crankshaft Position Sensor And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the crankshaft position sensor (3) to the crankshaft rear oil seal housing (1).

**CAUTION: Refer to Fastener Caution .**

8. Install the crankshaft position sensor bolt (2) and tighten to 4.5 N.m (40 lb in).

## DESCRIPTION AND OPERATION

### CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

## **ENGINE COMPONENT DESCRIPTION**

### **Cylinder Block**

The cylinder hollow frame structured 4 cylinder in-line. The block has 5 crankshaft bearings with the thrust bearing located on the third bearing from the front of the engine.

### **Crankshaft**

The crankshaft is a steel crankshaft. It is supported in 5 main journals with main bearings which have oil clearance for lubricating. The 3rd bearing of the 5 main bearing is the thrust bearing whose the crankshaft has properly axial end play. A harmonic damper is used to control torsional vibration.

### **Oil Pump**

The oil pump is a crankshaft driven oil pump integrated in pump module. The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. This causes the space between the gears to constantly open and narrow, pulling oil in from the oil pan when the space opens and pumping the oil out to the engine as it narrows. At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages.

### **Oil Pan**

The oil pan is a structural aluminum oil pan with transmission attachment. It includes the oil suction pipe, this pipe is connected with the oil pump. The oil pan is attached at the engine block.

### **Piston and Connecting Rod**

The Pistons are aluminum pistons with top land and floating pin. The connecting rods are fractured steel connecting rods with bushing.

### **Cylinder Head**

This cylinder head is double over head camshaft (DOHC) type and has 2 camshafts that open 4 valves per cylinder with tappets. The camshaft sprocket wheels are installed in front of the camshafts. The cylinder head is made of cast aluminum alloy for better strength in hardness with light weight. The combustion chamber of the cylinder head is designed for increasing of squish and swirl efficiency and then this is maximized to gasoline combustion efficiency.

### **Valves**

There are 2 intake and 2 exhaust valves with tappets per cylinder.

### **Camshaft**

Two camshafts are used, one for all intake valves, the other for all exhaust valves. The camshafts are cast iron. The camshafts are driven by the crankshaft over the timing belt.

### **Camshaft Drive**

A timing belt is used for camshaft drive. There is a tensioner to control the tension of the belt. Instead of camshaft gears or camshaft sprockets the engine is equipped with camshaft adjuster. The camshaft adjuster readjust itself at the engine speed. So the valve timing is adjusted for a low consumption, optimal power and torque.

### **Intake Manifold**

The intake manifold is the air flow passage to the cylinder combustion chamber through the throttle body and has an effect on engine torque, power, noise, drivability, emission, fuel economy and performance. It is made of plastic for better strength in hardness with little weight.

### **Exhaust Manifold**

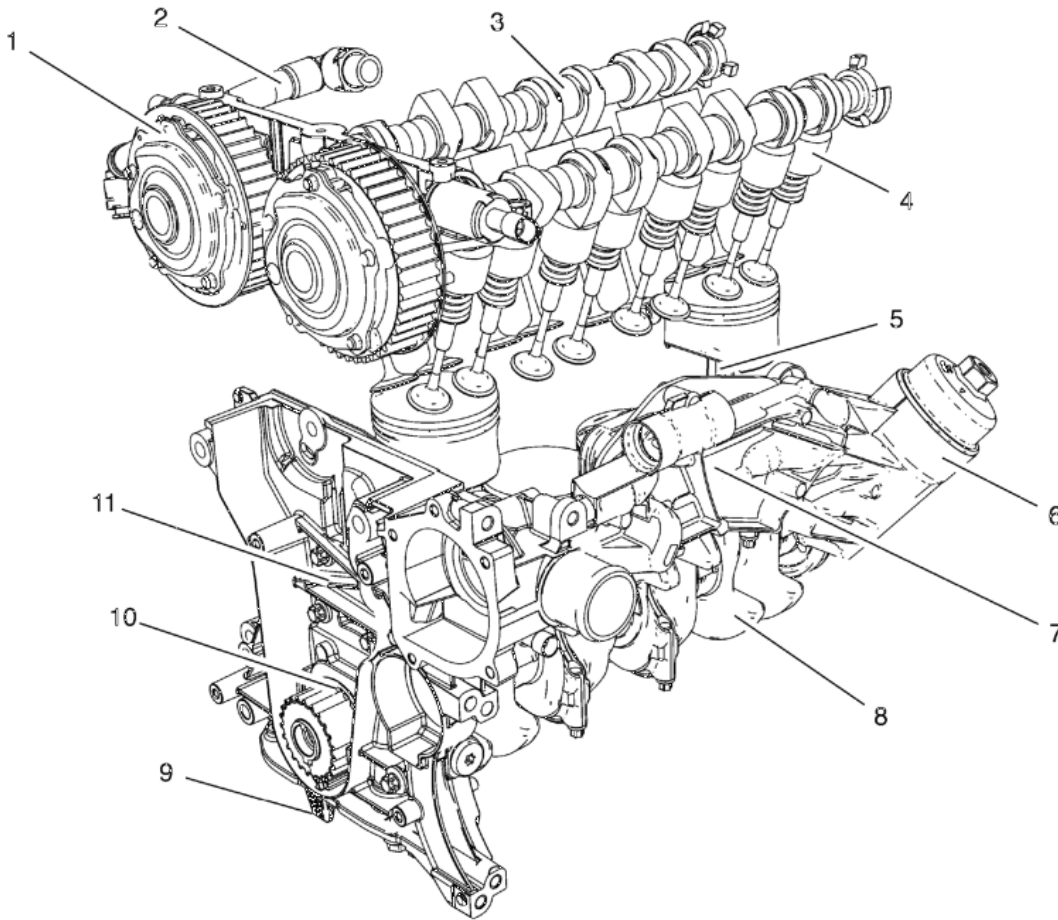
The exhaust manifold is located to the cylinder head and channels the exhaust gas out of the combustion chamber. It is designed to endure on high pressure and high temperature. The exhaust manifold includes the catalytic converter.

### **Positive Crankcase Ventilation System**

The crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting vapors to the atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow-by gases and then passed through a calibrated orifice into the throttle body. The primary control is through the positive crankcase ventilation (PCV) orifice which meters the flow at a rate depending on inlet vacuum. The PCV orifice is an integral part of the camshaft cover. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent into the intake system to be consumed by normal combustion.

### **LUBRICATION DESCRIPTION**





**Fig. 541: Engine Lubrication System**  
Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft (8), connecting rods (5), camshaft adjuster (1), camshaft bearing surfaces (3) and valve tappets (4). All other moving parts are lubricated by gravity flow or splash. Oil enters the rotor type oil pump (10) through a fixed inlet screen (9). The oil pump is driven by the crankshaft. The oil pump body is within the engine front cover (11). The pressurized oil from the pump passes through the oil cooling system and the oil filter (6). The oil filter is integrated with the oil cooling system housing (7) that is connected to the front of the engine block. The oil filter is a disposable cartridge type. A by-pass valve in the filter cap allows continuous oil flow in case the oil filter should become restricted. The connecting rod bearings are oiled by constant oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. An engine oil pressure switch or sensor is installed at the end. Oil returns to the oil pan through passages cast into the cylinder head. The crankcase ventilation system does not contain to the lubrication system, but to the oil circuit. It is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice of the crankcase ventilation tube (2) into the intake manifold.

## REPLACING ENGINE GASKETS

### Gasket Reuse and Applying Sealants

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

### Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

### Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using a scraping tool.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
  - This grit is abrasive and has been known to cause internal engine damage.

### Assembling Components

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

## SEPARATING PARTS

### NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**

- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod to the crankshaft journal
- Connecting rod to the bearing cap-A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.
- Crankshaft main and connecting rod bearings
- Camshaft and valve tappets
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

## **TOOLS AND EQUIPMENT**

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

## **USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT**

## Pipe Joint Compound

**NOTE:** Three types of sealer are commonly used in engines. These are RTV sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. **DO NOT** interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

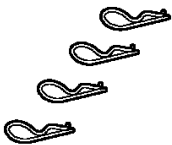

- Pipe joint compound is a pliable sealer that does not completely harden. This type sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material.

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when the bolt is tightened.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.


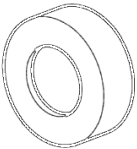


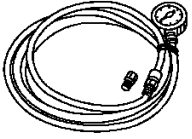
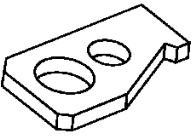


## SPECIAL TOOLS AND EQUIPMENT

## SPECIAL TOOLS

Illustration	Tool Number/Description
	207649 Rod Hairpins
	547324 Flange Screws
	EN-232 KM-232 J-21867-L40 Oil Pressure Check Adapter

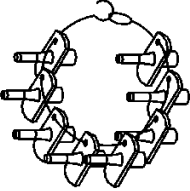
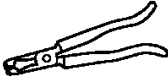
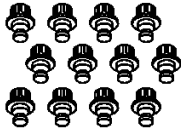
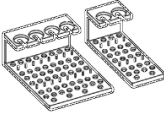

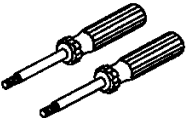

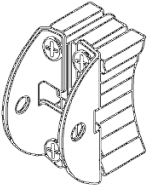
# 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	
	EN-235-6 KM-235-6 Installer
	EN-328-B GE-328-B KM-328-B GE-6125-1B Remover
	EN-422 KM-422 83 94 959 Installer
	EN-498-B GE-21867-A J-21867-A KM-498-B CH-48027 Pressure Gauge and Adapter Set
	EN-652 KM-652 Flywheel Holder
	EN-658-1 KM-658-1 J-35264 Installer
	EN-796 KM-796-A Dismantler

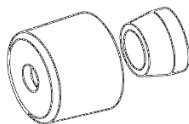
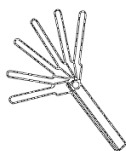
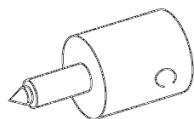
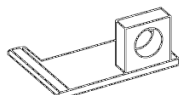
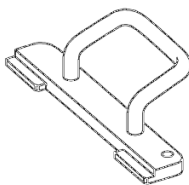
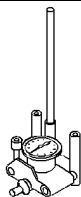
## 2012 Chevrolet Cruze LS

2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze

	CH-807 KM-807 Closure Plugs
	EN-840 KM-840 J-36017 83 94 157 Remover
	EN-845 KM-845 Suction Device
	EN-849 KM-849 Assembly Tray
	EN-958 KM-958 Valve Stem Seal Installer
	EN-6009 KM-6009 83 96 335 J-43301 Remover/Installer
	EN-6333 KM-6333 Locking Pin
	EN-6340 KM-6340 Locking Tool

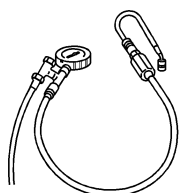
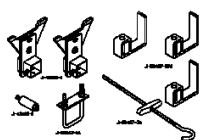
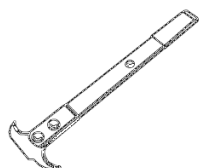
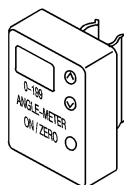
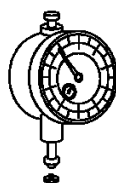
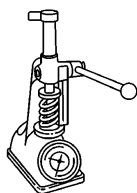
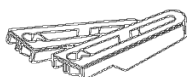
**2012 Chevrolet Cruze LS**

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EN-6349  
KM-6349  
Locking PinEN-6351  
KM-6351  
Assembly SleevesEN-6361  
KM-6361  
Feeler Gauge SetEN-6624  
KM-6624  
RemoverEN-6625  
KM-6625  
Flywheel Locking DeviceEN-6628-A  
KM-6628-A  
Locking ToolEN-8087  
J-8087  
Cylinder Bore GaugeEN-28467-B  
J-28467-B  
Universal Engine Support Fixture

**2012 Chevrolet Cruze LS**

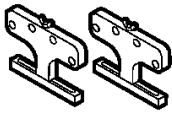
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EN-34730-91  
KM-34730-91  
Pressure TesterEN-36857  
J-36857  
Engine Lift BracketEN-43405  
J-43405  
Support Foot SetEN-45000  
KM-45000  
J-45000  
Seal RemoverEN-45059  
J-45059  
Angle MeterGE-571-B  
MKM-571-B  
GE-8001  
J-8001  
Dial GaugeGE-22738-B  
J-22738-B  
Valve Spring TesterJ-37088-A  
KM-37088A  
Fuel Line Disconnect Tool Set

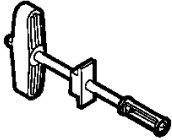


## 2012 Chevrolet Cruze LS

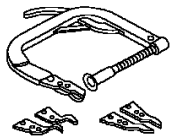
2012 ENGINE Engine Mechanical - 1.8L (LUW) - Cruze



EN-50717-1  
Stands



EN-50717-2  
Compressor



EN-8062  
J-8062  
Valve Spring Compressor