

2013 Engine

Engine Mechanical - 1.8L (LUW, LWE) - Sonic

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (1.8L LUW AND LWE)

Fastener Tightening Specifications (1.8L LUW and LWE)

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)

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• 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)

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• 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 (M32, F17)	40	30 lb ft
Oil Pan Transmission Housing Bolt M12 (M32, F17)	60	44 lb ft
Oil Pan Transmission Housing Bolt M10 (D16, D20)	45	33 lb ft

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Oil Pan Transmission Housing Bolt M12 (D16, D20)	75	55 lb ft
Oil Pan Transmission Housing Bolt (GF6)	58	43 lb ft
Oil Pressure Measurement Closure Bolt Cylinder Head	15	11 lb ft
Oil Pressure Relief Valve Closure Bolt	21	15 lb ft
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 (M32, F17)	60	44 lb ft
Transmission to Cylinder Block Nut (M32, F17)	40	30 lb ft
Transmission to Cylinder Block Bolt (D16, D20)	75	55 lb ft
Transmission to Cylinder Block Bolt (GF6)	58	43 lb ft
Transmission to Cylinder Block Nut (GF6)	58	43 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 (1.8L LUW AND LWE)

Engine Mechanical Specifications (1.8L LUW and LWE)

Application	Specification	
	Metric	English
General Data		

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• 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	
• Maximum Power / Engine Speed kW/RPM - Gasoline	103 KW/6300	
• Maximum Power / Engine Speed kW/RPM - E85 Ethanol	106 KW/6300	
• Maximum Torque / Engine Speed - Gasoline Y/RPM/lb ft/RPM	170 N.m/ 3800	125 lb ft/3800
• Maximum Torque / Engine Speed - E85 Ethanol Y/RPM/lb ft/RPM	183 N.m/ 3800	135 lb ft/3800
• Idle Speed RPM	700-780	
• Overspeed RPM	6500	
• Firing Order	1-3-4-2	
• Engine Length - RFB to Front of Poly V Belt	513 mm	20 in
• Engine Height - Crank Center to Top	420 mm	17 in
• Engine Weight - MT Version	120.5 kg	266 lb
Block		
• Cylinder Block Height	198.5 mm	8 in
• Cylinder Bore Diameter - Standard Size Guiding Value 00	80.492-80.508 mm	3.169-3.1694 in
• Cylinder Bore Diameter - Standard Size Guiding Value 05	80.542-80.558 mm	3.171-3.1716 in
• Cylinder Bore Diameter - Oversize Guiding Value 00+05	80.992-81.008 mm	3.188-3.1893 in
Crankshaft		
• Crankshaft Main Bearing Journal 1-5 Diameter - Standard Size (brown/green)	54.980-54.997 mm	2.165-2.166 in
• Crankshaft Main Bearing Journal 1-5 Diameter - Undersize 0.25 (brown/green)	54.730-54.747 mm	2.155-2.156 in
• Crankshaft Main Bearing Journal 1-5 Diameter - Undersize 0.50 (brown/green)	54.482-54.495 mm	2.145-2.146 in
• Crankshaft Main Bearing Journal 3 Width -		

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Standard Size	26.000-26.052 mm	1.024-1.026 in
• Crankshaft Main Bearing Journal 3 Width - Undersize 0.25	26.200-26.252 mm	1.032-1.034 in
• Crankshaft Main Bearing Journal 3 Width - Undersize 0.50	26.400-26.452 mm	1.040-1.042 in
• Con-Rod Bearing Journal - Standard Size	42.971-42.987 mm	1.692-1.693 in
• Con-Rod Bearing Journal - Undersize 0.25 (blue)	42.721-42.737 mm	1.682-1.683 in
• 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

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• Pin Diameter	19 mm	0.748 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 Ring	1.170-1.190 mm	0.0461-0.0469 in
• 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

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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
• 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	

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• Cooling System Capacity	5,61	5.92 quarts
• Flow (Engine Outlet 6000 min^{-1} , Thermostat Fully Open)	160 l/min	42.27 US gal/min
• Flow (Radiator 6000 min^{-1} , Thermostat Fully Open)	165 l/min	174.4 quarts/min
• Thermostat Opening - Electrical	90°C	194°F
• 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 Cover Bolt	Pipe Sealant	12346004	10953480
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

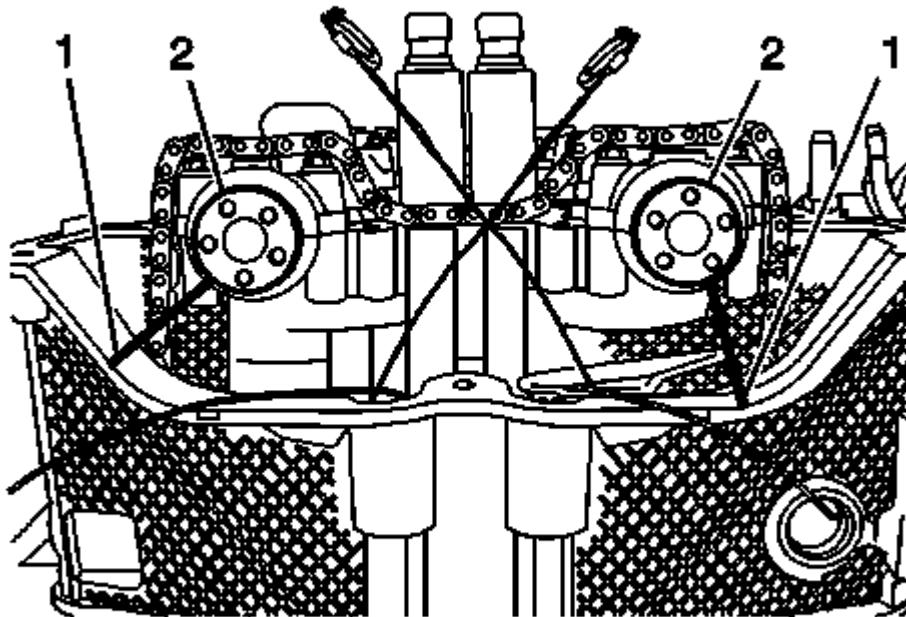


Fig. 1: View Of Engine Identification Code On Cylinder Block

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 \(LUW\)](#).

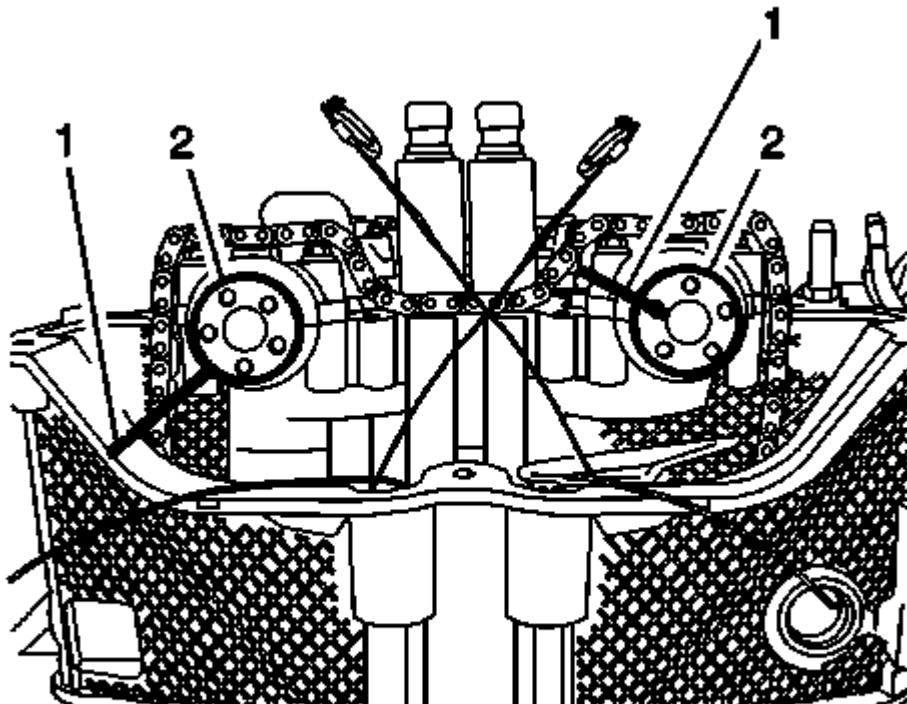


Fig. 2: View Of Closure Bolt

Courtesy of GENERAL MOTORS COMPANY

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

Measurement Procedure

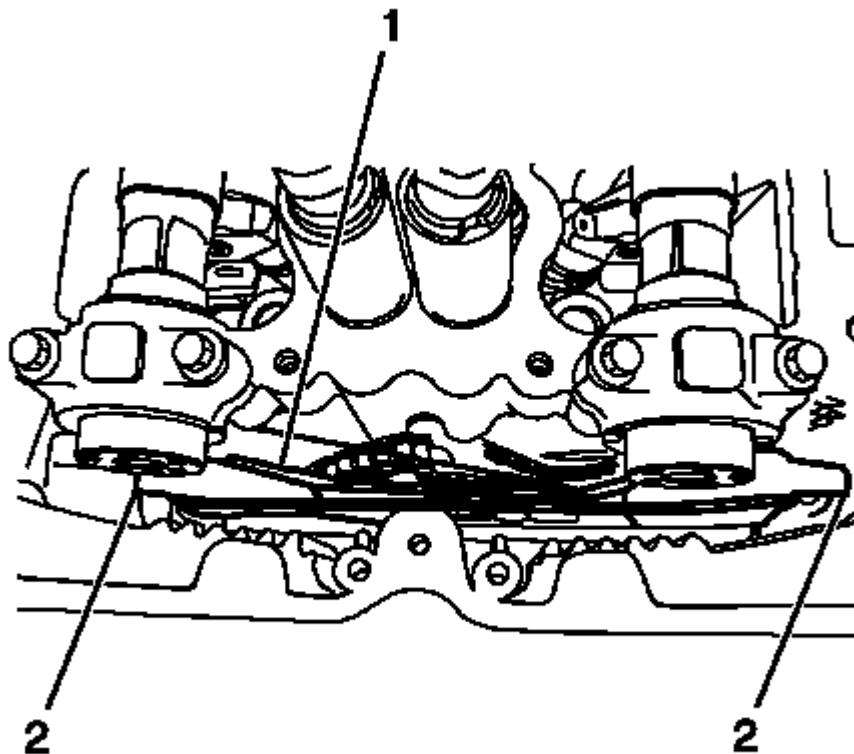


Fig. 3: Oil Pressure Test Gauge

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 .

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 (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"> 1. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine Mechanical Specifications (1.8L LUW and LWE)</u>. 2. Park the vehicle on a level surface over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. <p>Are drippings present?</p>		
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	<ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p>		
4	<ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid and the approximate location of the leak. 		

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

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	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	<ol style="list-style-type: none">1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas:<ul style="list-style-type: none">• Higher than recommended fluid levels• Higher than recommended fluid pressures• Plugged or malfunctioning fluid filters or pressure bypass valves• Plugged or malfunctioning engine ventilation system• Improperly tightened or damaged fasteners• Cracked or porous components• Improper sealants or gaskets, where required• Improper sealant or gasket installation• Damaged or worn gaskets or seals• Damaged or worn sealing surfaces2. Inspect the engine for customer modifications. <p>Is there mechanical damage or customer modifications to the engine?</p>	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to Step 1	-

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
- 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.	
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> .	
2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.	
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.	
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 <u>Engine Compression Test</u> .	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Replacement</u> .
Cracked cylinder head	Replace the cylinder head and gasket. <u>Cylinder Head Replacement</u>
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 an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	

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

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

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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"> 1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	<ol style="list-style-type: none"> 1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	<ol style="list-style-type: none"> 1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
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"> 1. Verify correct engine oil viscosity by changing the engine oil and filter. Reevaluate the concern. 2. Isolate the noise to a specific camshaft position actuator. 3. Replace the camshaft actuator, oil and filter.

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	Replace the 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.	
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 condition.	Repair or replace the flywheel and/or balancer as required.
Restricted exhaust system 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.	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.
Improperly installed or damaged manifold absolute pressure (MAP)	Repair or replace the MAP

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sensor The sealing grommet of the MAP sensor should not be torn or damaged.	sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to 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 lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	<ul style="list-style-type: none"> • Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage.	Replace the sensor and/or crankshaft as required.
<ul style="list-style-type: none"> • 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"> • Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
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.

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"> Inspect for spark plugs saturated by coolant. Perform a cylinder leak down test. Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. Repair or replace as required.

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"> Inspect the spark plugs for oil deposits. Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> Inspect the spark plugs for oil deposits. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. 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**

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

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"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn accessory drive components-abnormalities, such as severe cracking,	<ol style="list-style-type: none"> 1. Inspect the accessory drive system. 2. Repair or replace as required.

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bumps, or missing areas in the accessory drive belt and/or misalignment of system components	
Loose or damaged crankshaft balancer	<ol style="list-style-type: none"> 1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to Symptoms - Engine Controls .
Loose torque converter bolts	<ol style="list-style-type: none"> 1. Inspect the torque converter bolts and flywheel. 2. Repair or replace as required.
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"> 1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	<ol style="list-style-type: none"> 1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"> 1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	<ol style="list-style-type: none"> 1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair as required: <ul style="list-style-type: none"> • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components and repair as required: <ul style="list-style-type: none"> • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin, and connecting rod installation 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.	<ol style="list-style-type: none"> 1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

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

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.

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.

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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
CAUTION:			
Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of chirping:			
<ul style="list-style-type: none">• A high pitched noise that is heard once per revolution of the drive belt or a pulley.• Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.			
DEFINITION: The following items are indications of drive belt squeal:			
<ul style="list-style-type: none">• 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:			
<ul style="list-style-type: none">• 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 Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids
	1. Remove the drive belt.		

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	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.		
3	<p>2. Operate the engine for no longer than 30-40 seconds.</p> <p>3. Repeat this test if necessary by removing the remaining belt(s).</p> <p>Does the chirping, squeal or whine noise still exist?</p>	Go to Symptoms - Engine Mechanical	Go to Step 4
4	<p>If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth.</p> <p>If diagnosing a squeal or whine noise, proceed to step 13.</p> <p>Do the belt grooves have pilling?</p>	Go to Step 5	Go to Step 6
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (1.8L LUW and LWE)</u>.</p> <p>2. Replace any improper or missing fasteners.</p> <p>Did you complete the repair?</p>	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition? If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids.	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Did you find and correct the condition?	Go to Step 20	Go to Step 15

15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

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.

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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 plys of the belt separating and may be seen at the edge of the belt our 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
CAUTION:			
Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of drive belt rumbling:			
<ul style="list-style-type: none">• A low pitch tapping, knocking, or thumping noise heard at or just above idle.• Heard once per revolution of the drive belt or a pulley.• Rumbling may be caused from:<ul style="list-style-type: none">○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove○ The separation of the drive belt○ A damaged drive belt○ A worn drive belt idler pulley			
DEFINITION: The following items are indications of drive belt vibration:			

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	<ul style="list-style-type: none"> • The vibration is engine-speed related. • The vibration may be sensitive to accessory load. 		
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</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 Step 3	Go to Diagnostic Aids
3	<ol style="list-style-type: none"> 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). <p>Does the rumbling or vibration still exist?</p>	Go to <u>Symptoms - Engine Mechanical</u>	Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	<ol style="list-style-type: none"> 1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement</u>. <p>Did you correct the condition?</p>	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <ol style="list-style-type: none"> 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (1.8L LUW and LWE)</u>. 		

	2. Replace improper or missing fasteners.		
	Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

CYLINDER LEAKAGE TEST

Removal Procedure

NOTE: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High leakage may indicate one or more of the following:

- Worn or burnt valves
- Broken valve springs
- Stuck valve lash adjusters
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

1. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .

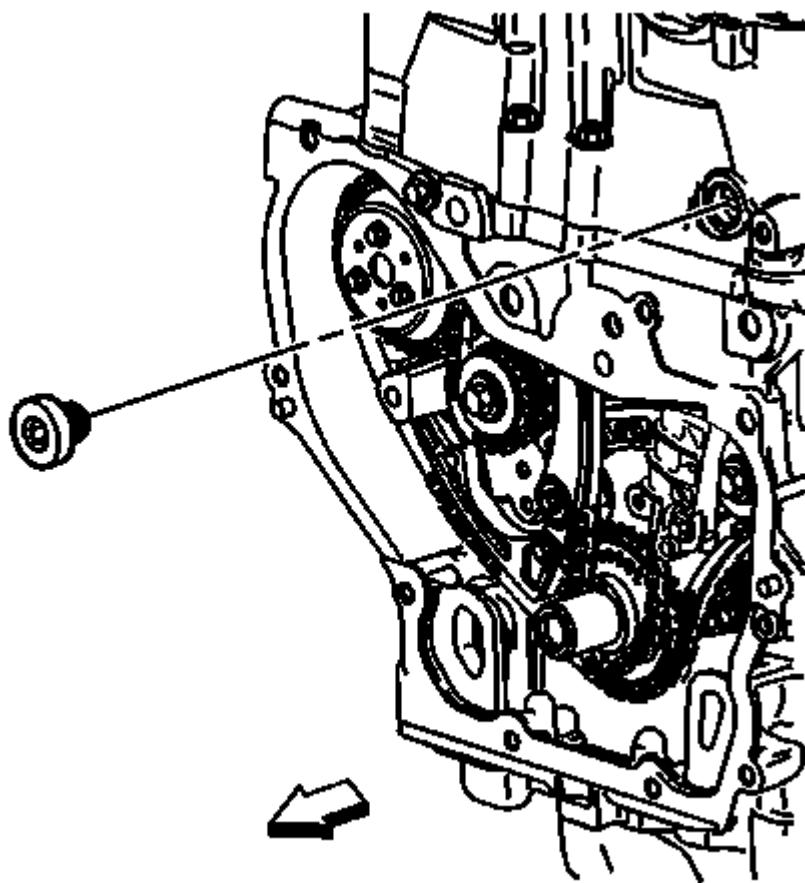


Fig. 4: View Of Crankshaft TDC Position

Courtesy of GENERAL MOTORS COMPANY

3. Set up the crankshaft.
4. Move the crankshaft in the direction of the engine rotation to the first cylinder TDC position (mark 1).
5. Lower the vehicle.
6. Remove the timing belt upper front cover. Refer to [**Timing Belt Upper Front Cover Replacement**](#).
7. Remove the spark plugs. Refer to [**Spark Plug Replacement**](#).
8. Detach the engine wiring harness from intake manifold, cylinder head cover and engine wiring harness bracket.
9. Remove the coolant expansion tank closure cap.
10. Remove the oil dipstick.

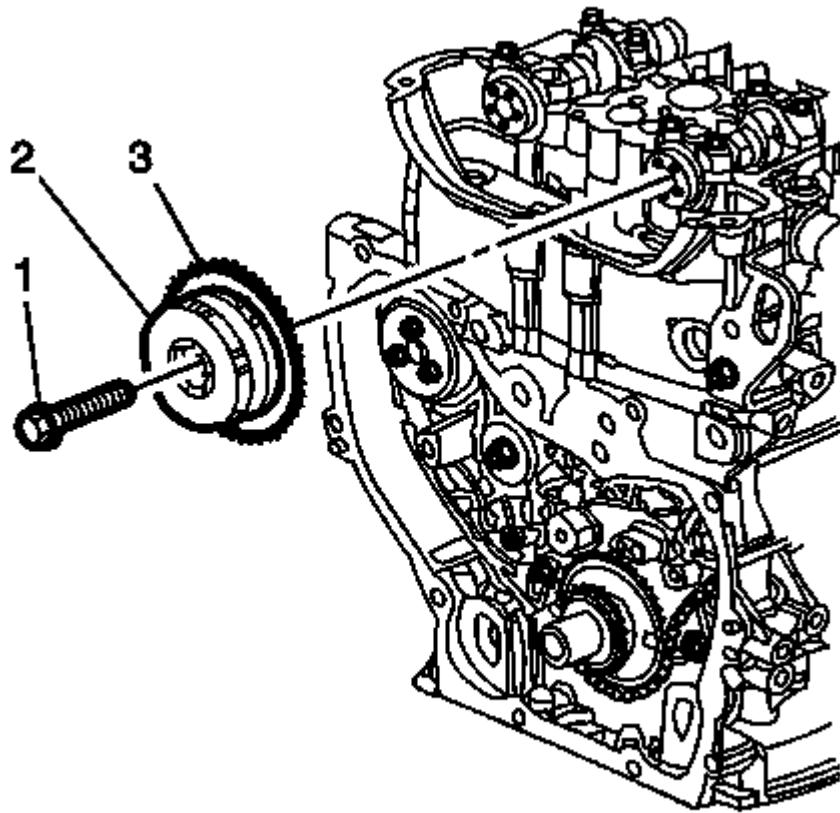


Fig. 5: View Of Guidance Marks

Courtesy of GENERAL MOTORS COMPANY

11. Apply guidance marks.
12. 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.

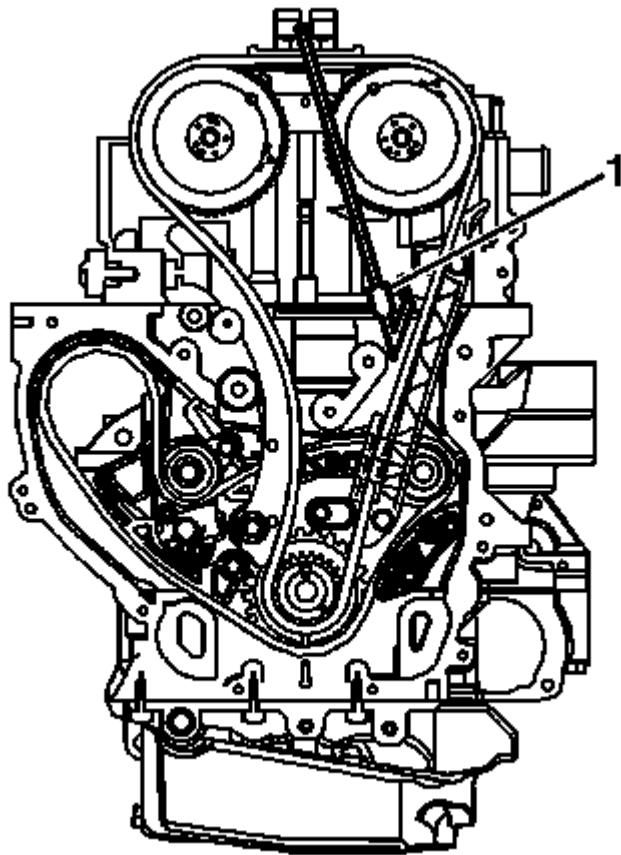


Fig. 6: View Of Pressure Loss Tester

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.

4. Take note of any visible escape of compressed air. In excessive leakage situations, inspect for the following conditions:

- Air leakage sounds at the throttle body, intake manifold or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
- Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve

or a broken valve spring.

- Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
- Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.

5. 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 management wiring harness to the intake manifold, cylinder head cover and engine wiring harness bracket.
8. Install the timing belt upper front cover. Refer to [**Timing Belt Upper Front Cover Replacement**](#).
9. Raise the vehicle.
10. Install the front wheelhouse liner Inner front extension. Refer to [**Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)**](#) , [**Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)**](#) .
11. Lower the vehicle.

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 sludging 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 plies.

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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
CAUTION:			
Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.		DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.	
Did you review the Drive Belt Symptom operation and		Go to <u>Symptoms</u> -	

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1	perform the necessary inspections?	Go to Step 2	<u>Engine Mechanical</u>
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	CAUTION: <u>Refer to Fastener Caution .</u> 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (1.8L LUW and LWE)</u> . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement</u> . Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
	Replace the drive belt. Refer to <u>Drive Belt</u>		

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16	Replacement. Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	Remove the drive belt and inspect the drive belt tensioner pulley. Refer to Drive Belt Replacement . Is the drive belt tensioner pulley loose or misaligned?	Go to Step 4	Go to Step 2
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 4
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	System OK	Go to Step 4
4	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement . Is the repair complete?	System OK	-

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

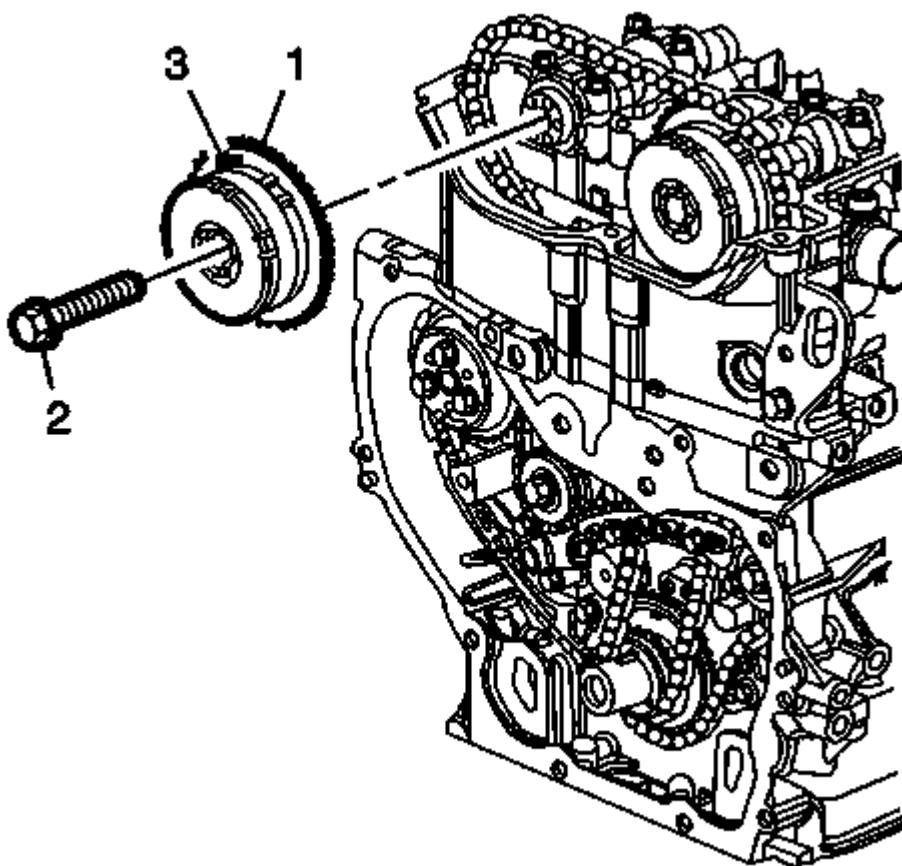


Fig. 7: Overview Dual Mass Flywheel

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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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

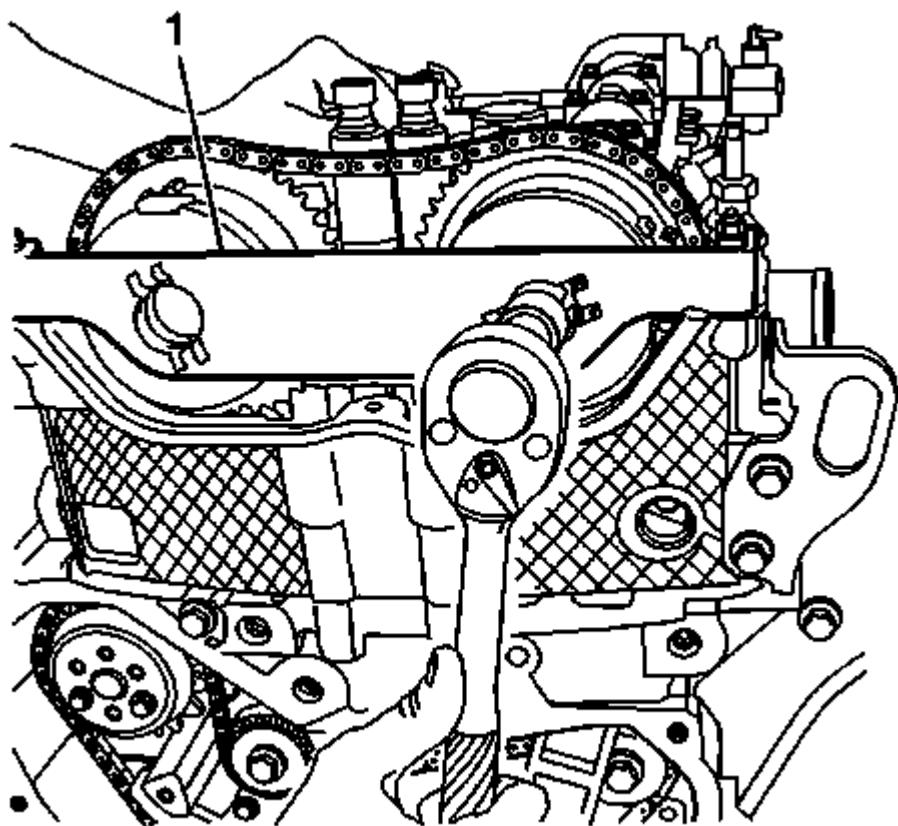


Fig. 8: Exploded View Dual Mass Flywheel with Additional Mass
Courtesy of GENERAL MOTORS COMPANY

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.

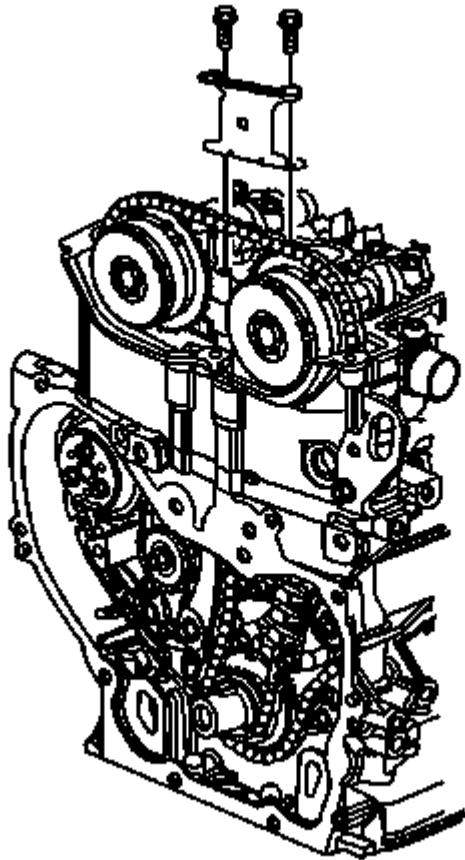


Fig. 9: Plain Bearing

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.

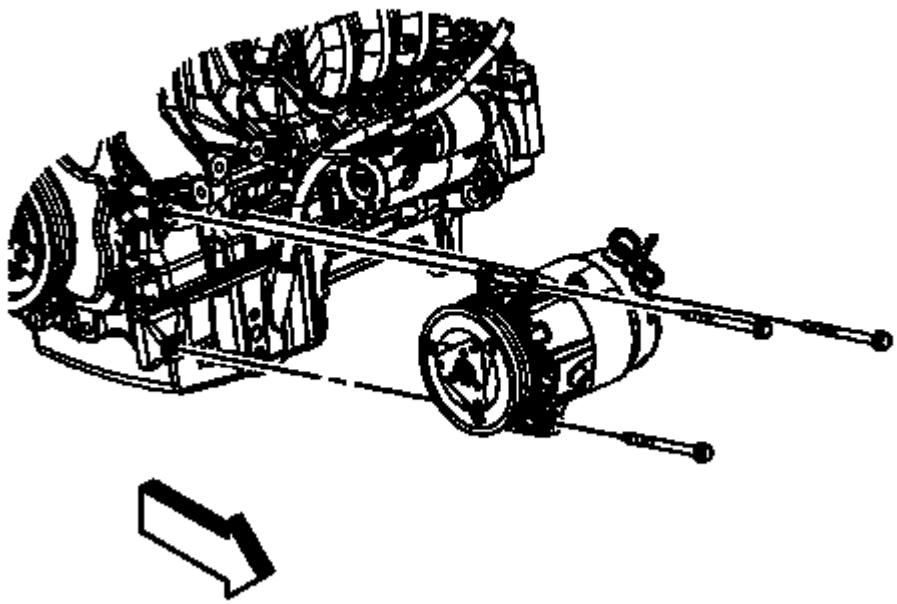


Fig. 10: Toothed Ring

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.

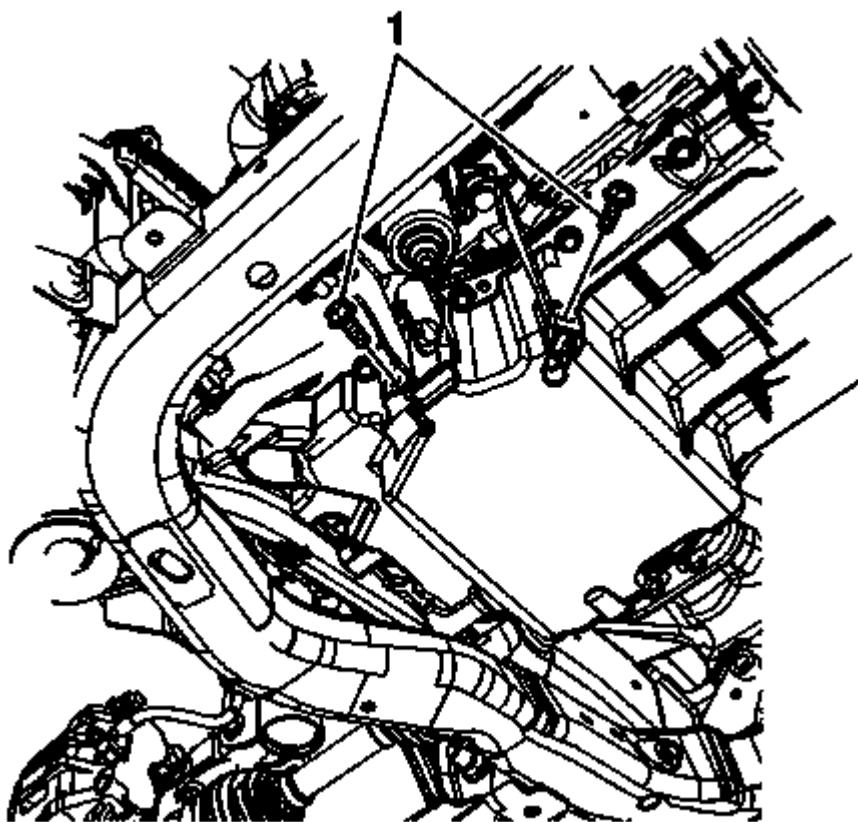


Fig. 11: Inspecting Tilt Clearance

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.

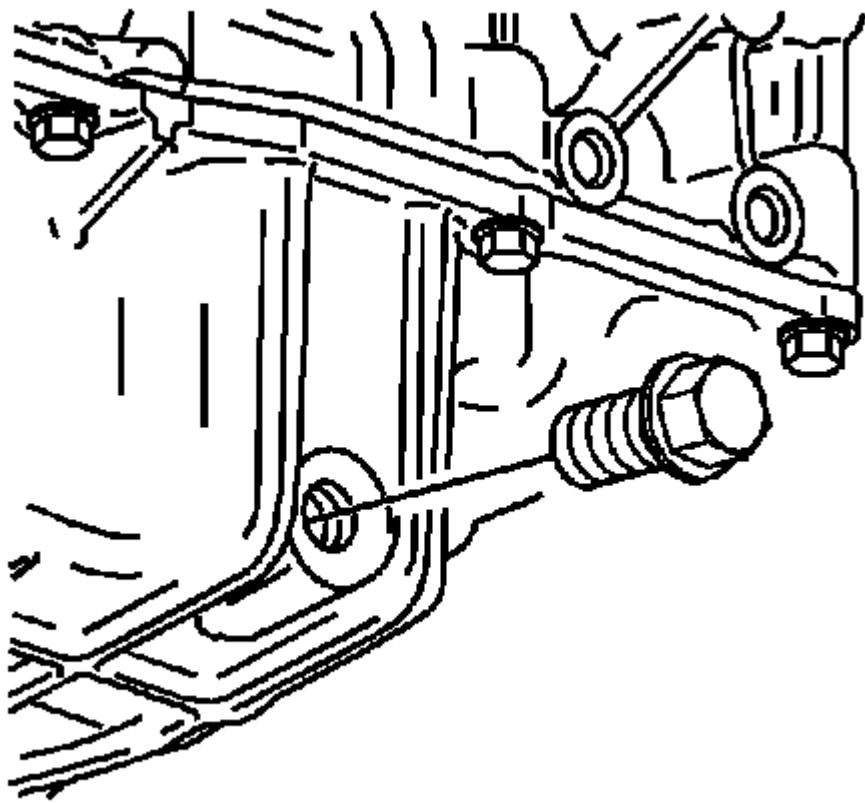


Fig. 12: Tilt Clearance Height

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.

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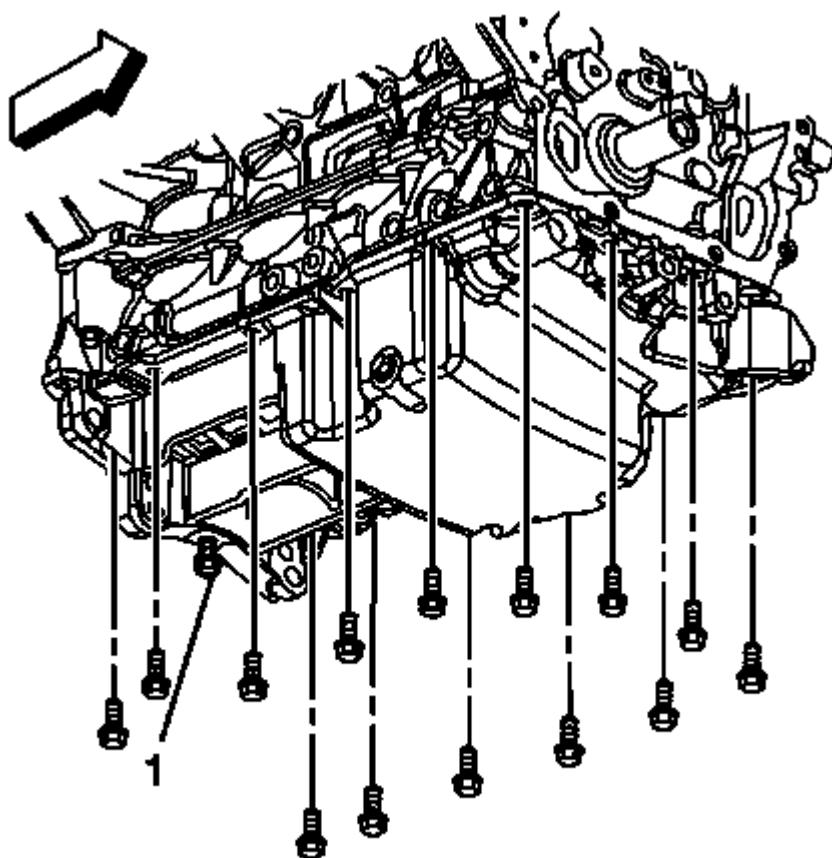


Fig. 13: Tilt Clearance Angle

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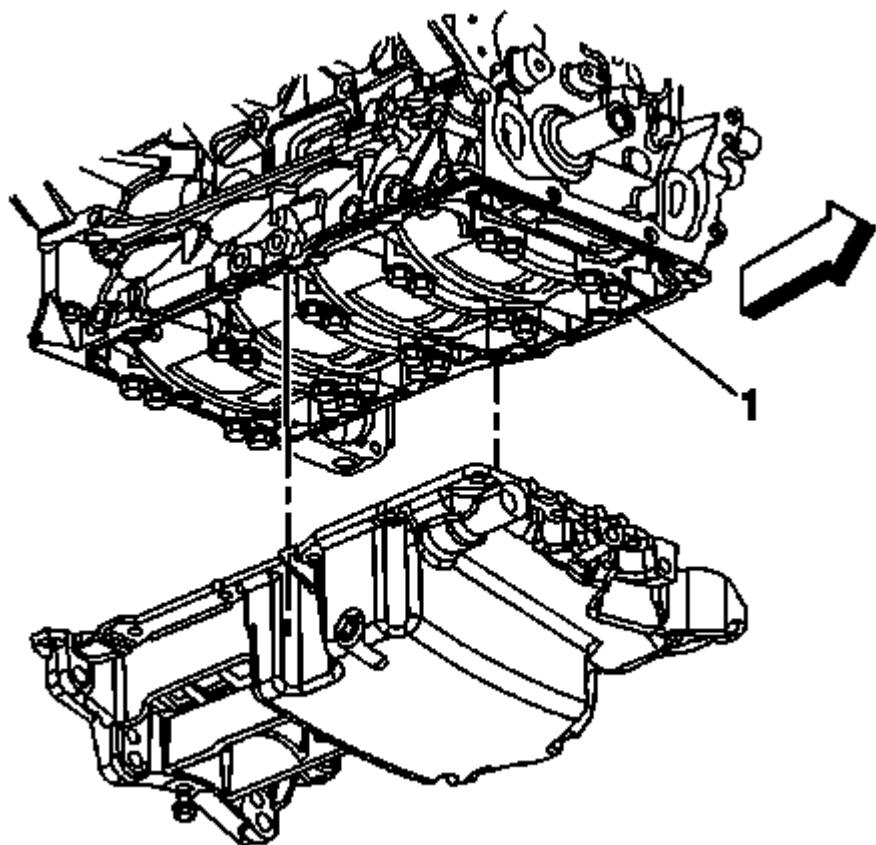


Fig. 14: Rotating Secondary Flywheel Anticlockwise

Courtesy of GENERAL MOTORS COMPANY

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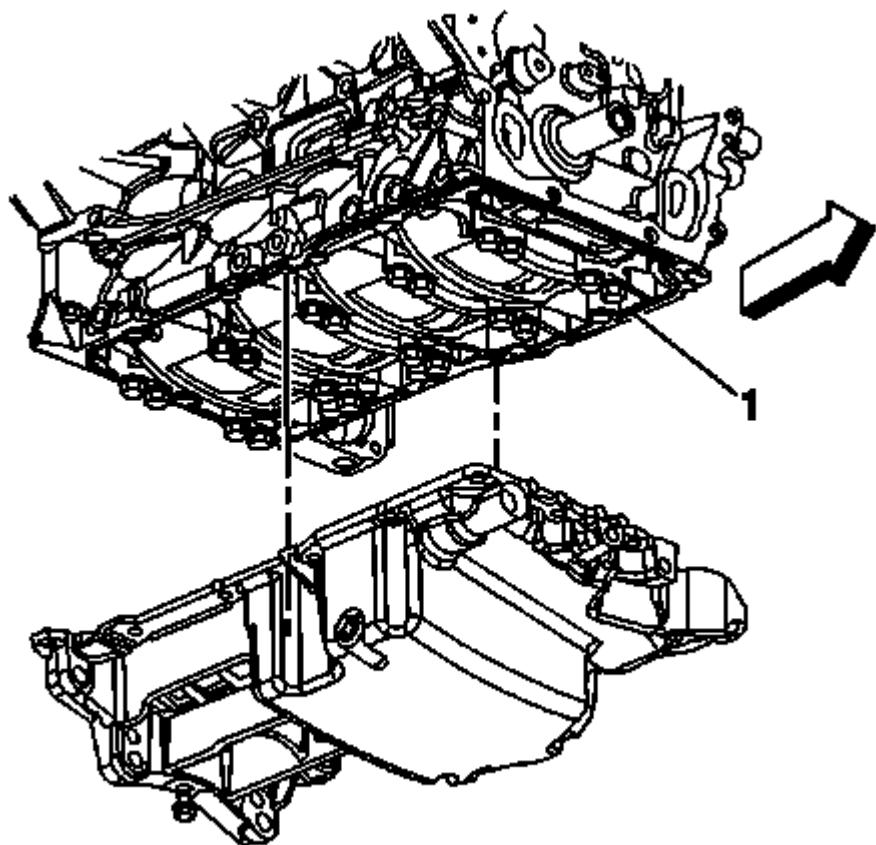


Fig. 15: Releasing Secondary Flywheel
Courtesy of GENERAL MOTORS COMPANY

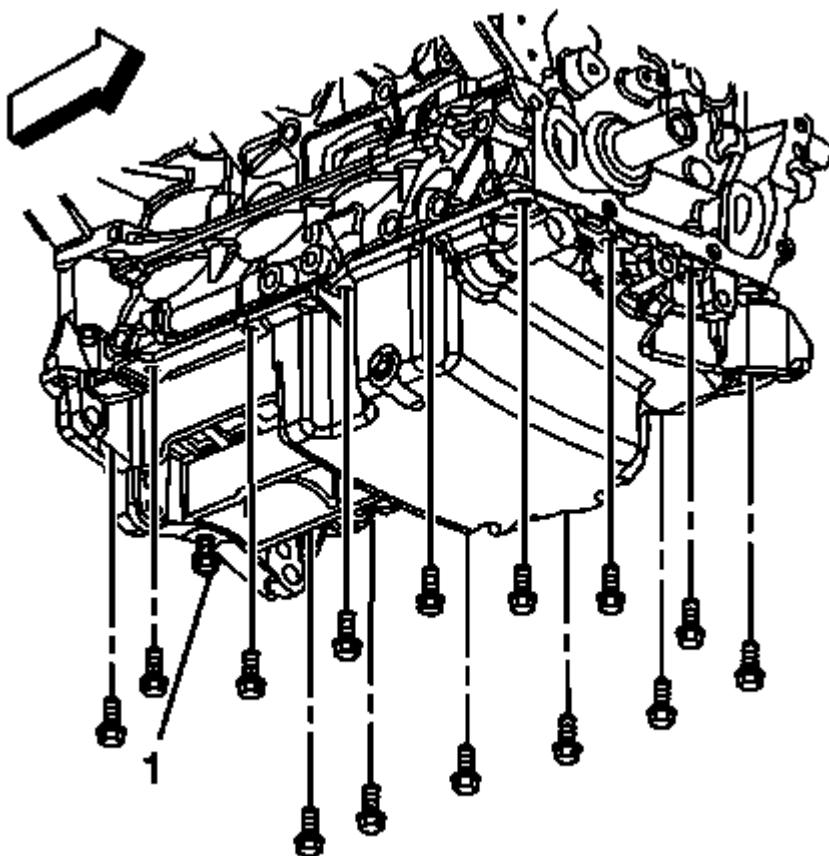


Fig. 16: Mark On Flywheel And Toothed Ring For Starter
 Courtesy of GENERAL MOTORS COMPANY

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. Remove the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .

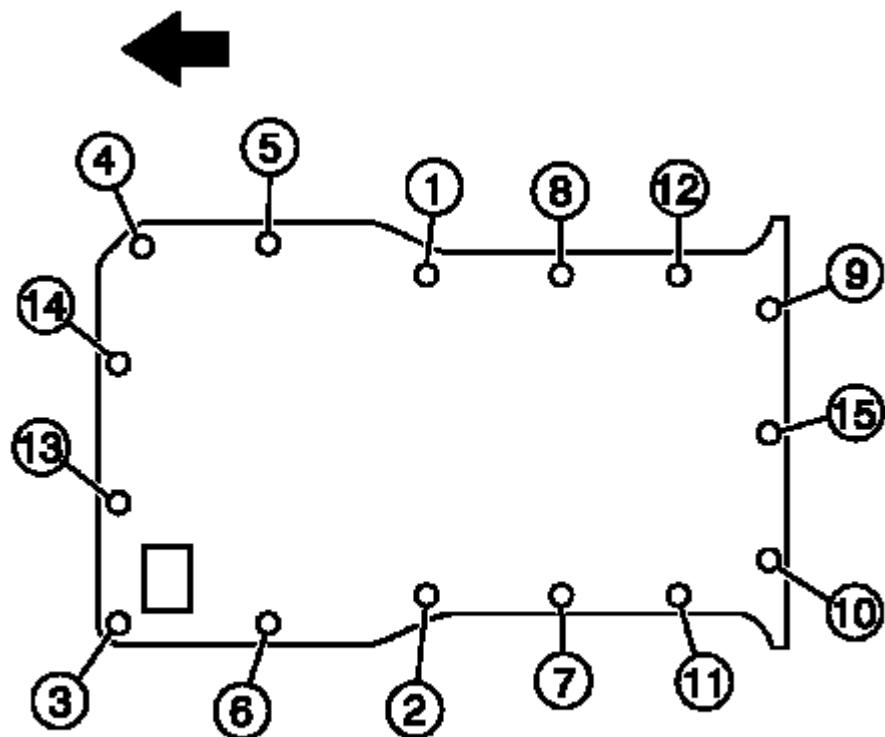


Fig. 17: Drive Belt Tensioner And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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

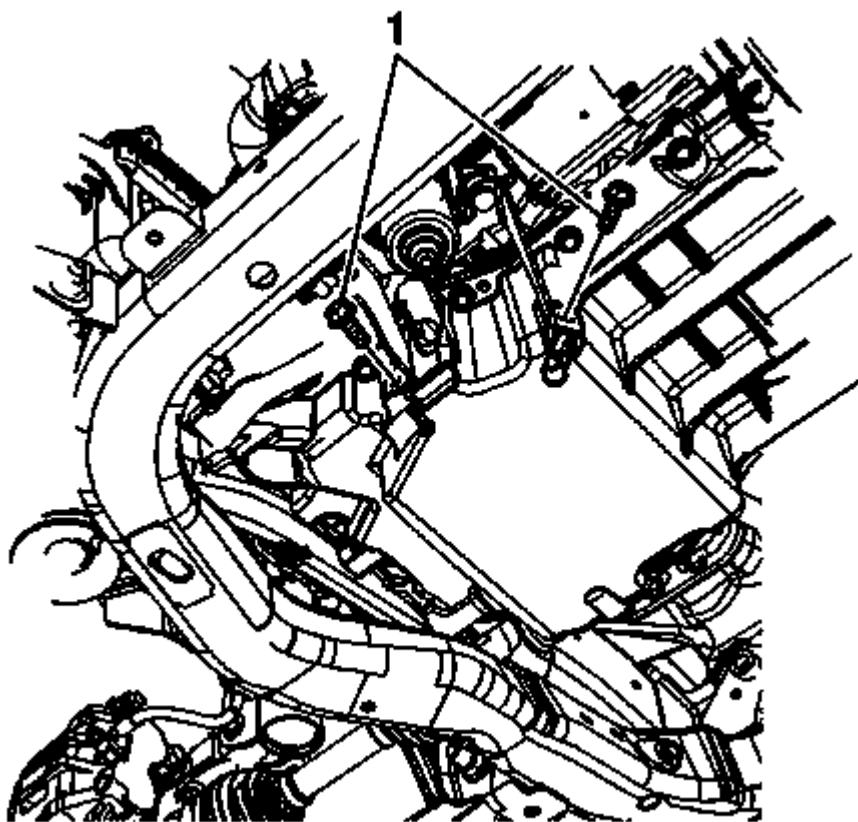


Fig. 18: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

3. Remove the drive belt (1).

Installation Procedure

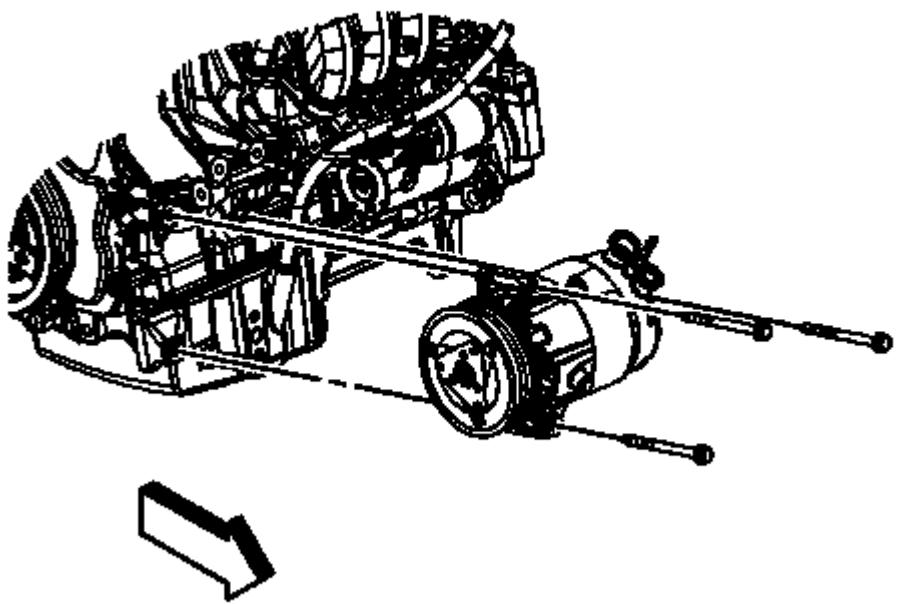


Fig. 19: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt (1).

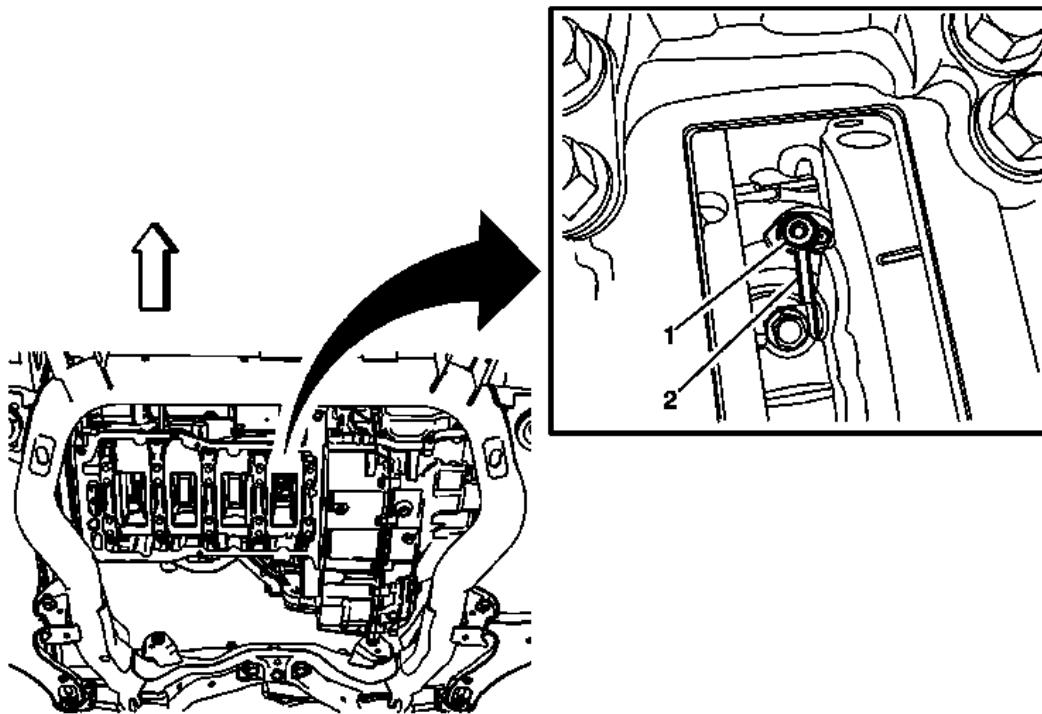


Fig. 20: Drive Belt Tensioner And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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

NOTE: Allow tensioner to slide back slowly.

3. Remove EN 6349 pin (2).
4. Apply tension to the tensioner clockwise (1).
5. Install the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

1. Remove the drive belt. Refer to [Drive Belt Replacement](#).

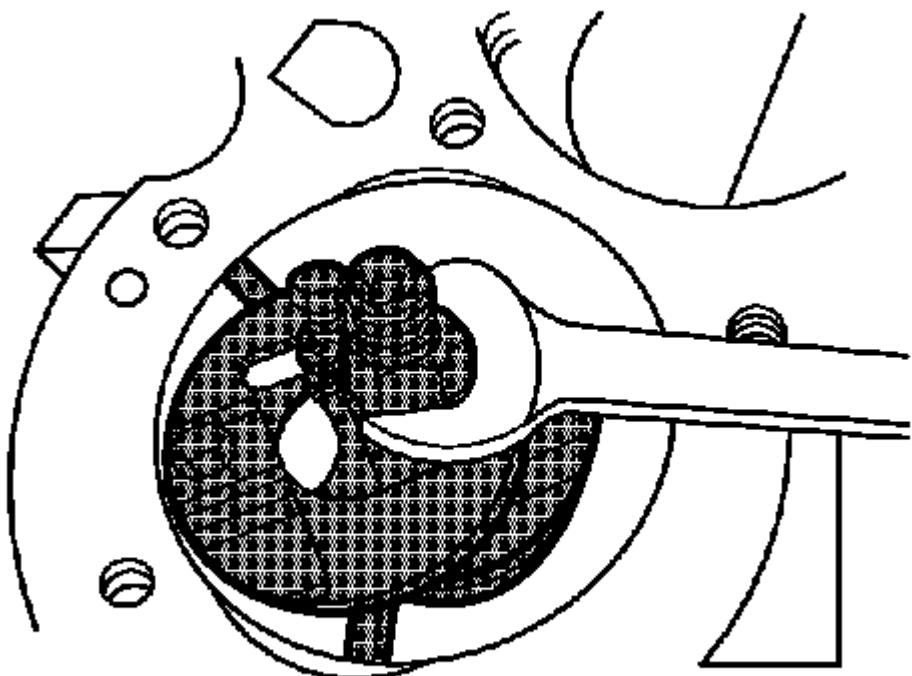


Fig. 21: Drive Belt Tensioner Bolt

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.

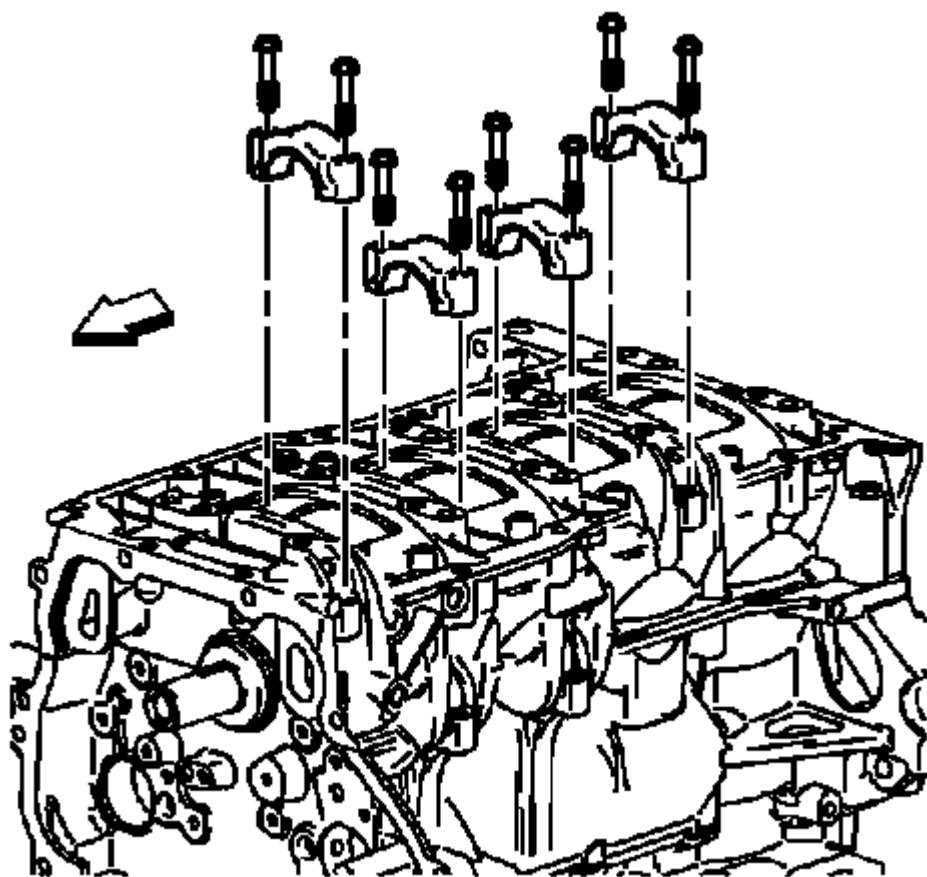


Fig. 22: Drive Belt Tensioner Bolt

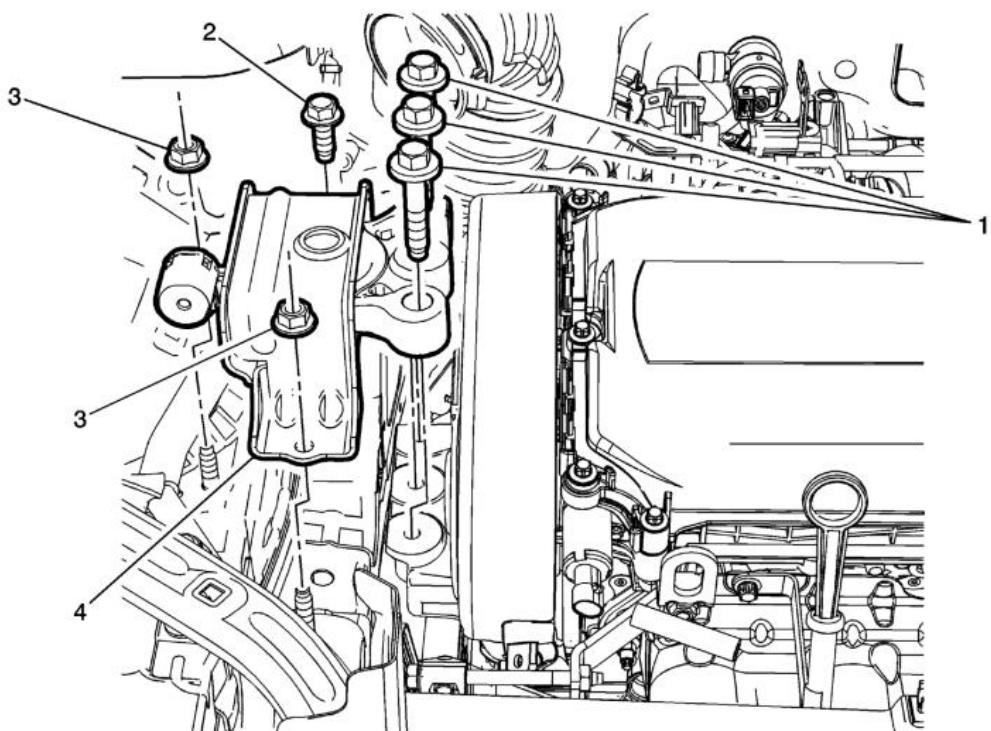
Courtesy of GENERAL MOTORS COMPANY

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).
4. Install the drive belt. Refer to Drive Belt Replacement.

ENGINE MOUNT REPLACEMENT

**Fig. 23: Engine Mount & Components**

Courtesy of GENERAL MOTORS COMPANY

Engine Mount Replacement

Callout	Component Name
Preliminary Procedures	
1	<p>1. Remove the air cleaner assembly. Refer to <u>Air Cleaner Assembly Replacement</u> .</p> <p>2. Install the engine support fixture. Refer to <u>Engine Support Fixture</u>.</p> <p>3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.</p> <p>Engine Mount Bracket to Mount Bolt (Qty; 3)</p> <p>CAUTION: <u>Refer to Fastener Caution</u> .</p> <p>NOTE: Use NEW bolts whenever mount is removed.</p> <p>Tighten 58 (43 lb ft)</p> <p>Special Tools EN-45059 Torque Angle Sensor Kit.</p>

	For equivalent regional tools, refer to Special Tools
2	Engine Mount Bracket Bolt (Qty; 1) NOTE: Ensure to use a NEW bolt whenever the mount is removed. Tighten 58 (43 lb ft)
3	Engine Mount Nut (Qty; 2) Tighten 58 (43 lb ft)
4	Engine Mount

ENGINE MOUNT BRACKET REPLACEMENT

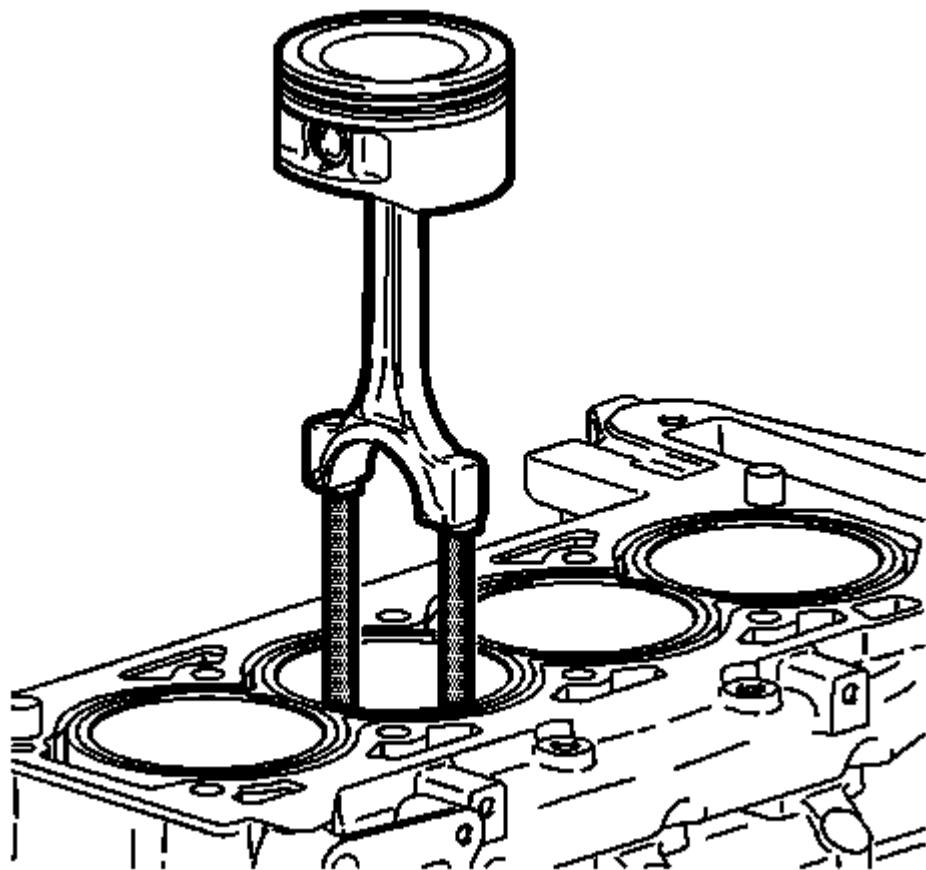


Fig. 24: Engine Mount Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

Engine Mount Bracket Replacement

Callout	Component Name
Preliminary Procedure	
	Remove the engine mount. Refer to Engine Mount Replacement .
1	Engine Mount Bracket Bolt (Qty: 3) CAUTION: Refer to Fastener Caution .
2	Tighten 50 (37 lb ft) Engine Mount Bracket

INTAKE MANIFOLD REPLACEMENT (LDE)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#) .
2. Remove the throttle body assembly. Refer to [Throttle Body Assembly Replacement](#) .

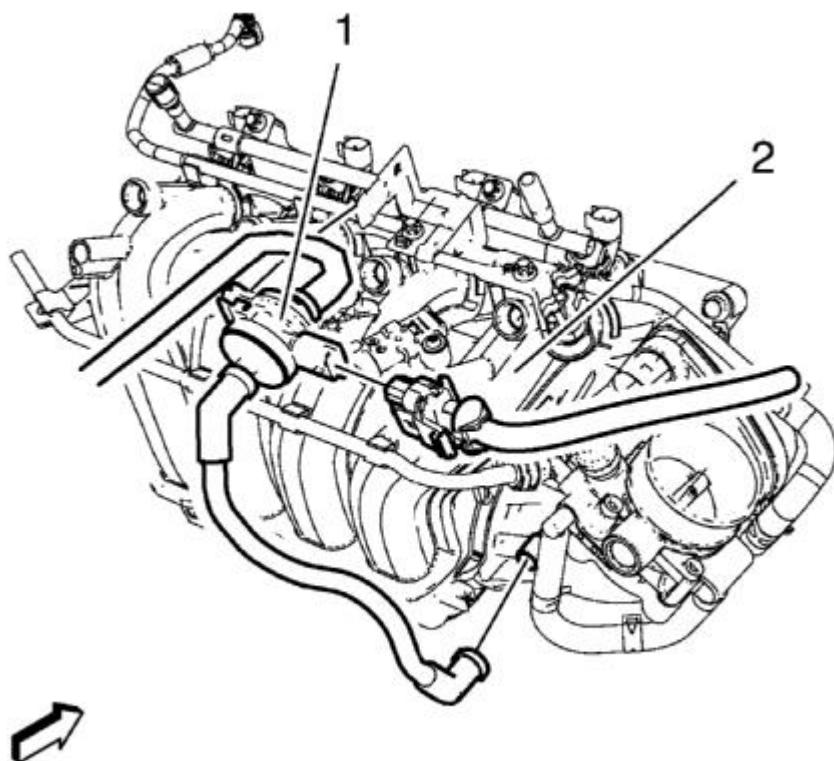
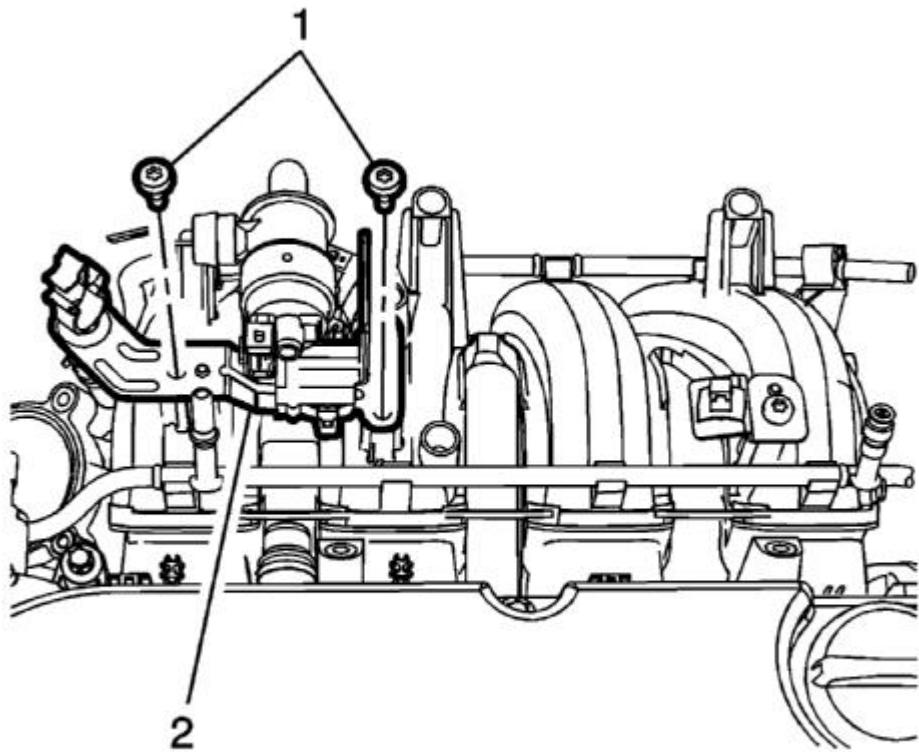


Fig. 25: Evaporative Emission Canister Purge Solenoid Valve, Rubber Mounting And Intake

Manifold

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect wiring harness plug.
4. Disconnect the pipes from the evaporative emission canister purge solenoid valve (1).
5. Remove the evaporative emission canister purge solenoid valve (1) and the rubber mounting from the intake manifold (2).
6. Disconnect and reposition the electrical connectors as necessary.
7. Remove the fuel injector rail. Refer to [**Fuel Injector Replacement**](#).
8. Remove the manifold absolute pressure sensor. Refer to [**Manifold Absolute Pressure Sensor Replacement**](#).

**Fig. 26: Evaporative Emission Canister Purge Solenoid Valve Bracket & Bolts**

Courtesy of GENERAL MOTORS COMPANY

9. Remove the evaporative emission canister purge solenoid valve bracket bolts (1).
10. Remove the evaporative emission canister purge solenoid valve bracket (2).

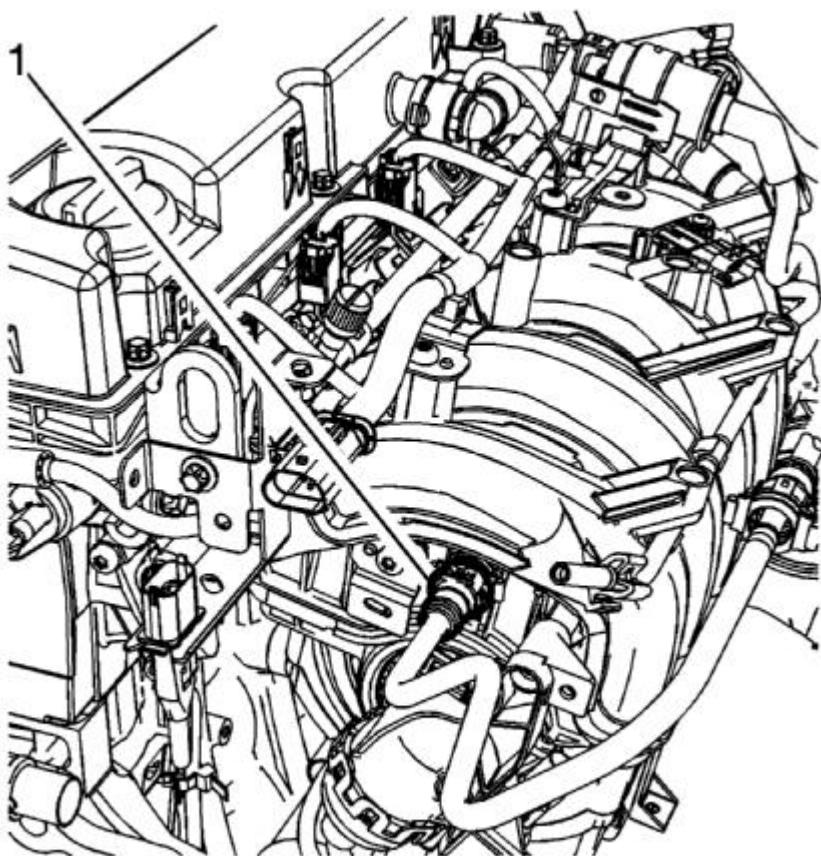


Fig. 27: Booster Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the booster vacuum pipe (1) from the intake manifold.
12. Remove the front wheel drive shaft right side. Refer to [Front Wheel Drive Shaft Replacement](#) .
13. Remove the starter. Refer to [Starter Replacement \(LUW\)](#) .
14. Remove the generator. Refer to [Generator Replacement \(LUW\)](#) .

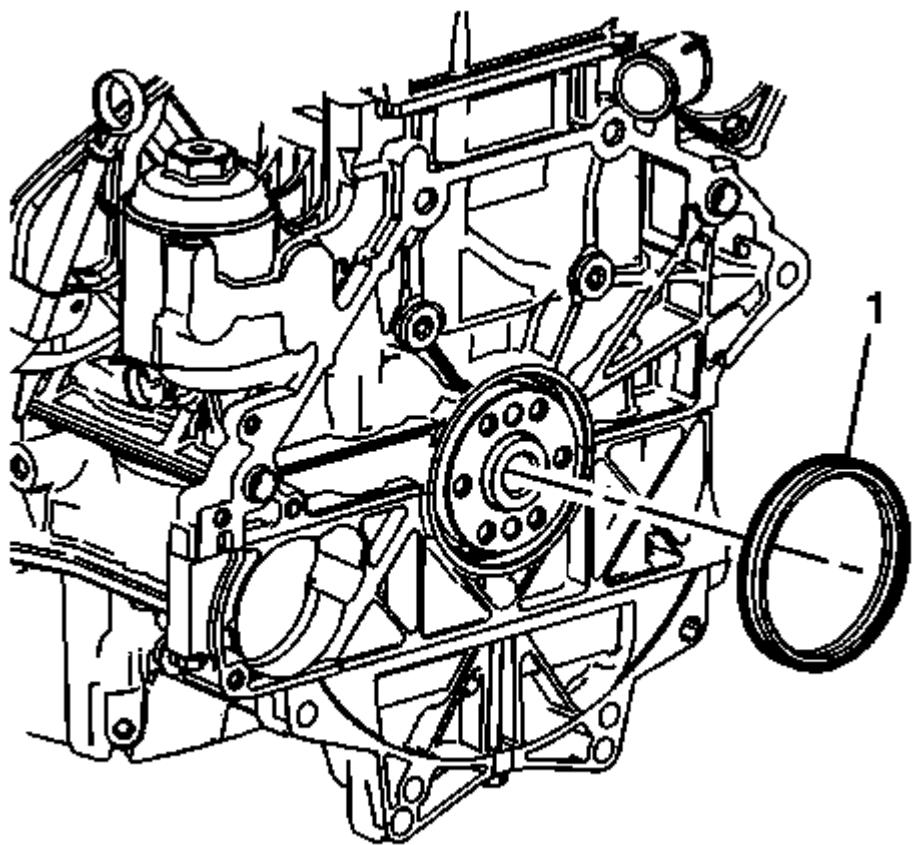


Fig. 28: Transmission Rear Mount Bracket Through Bolt

Courtesy of GENERAL MOTORS COMPANY

15. Remove and DISCARD the transmission rear mount to bracket through bolt (1).

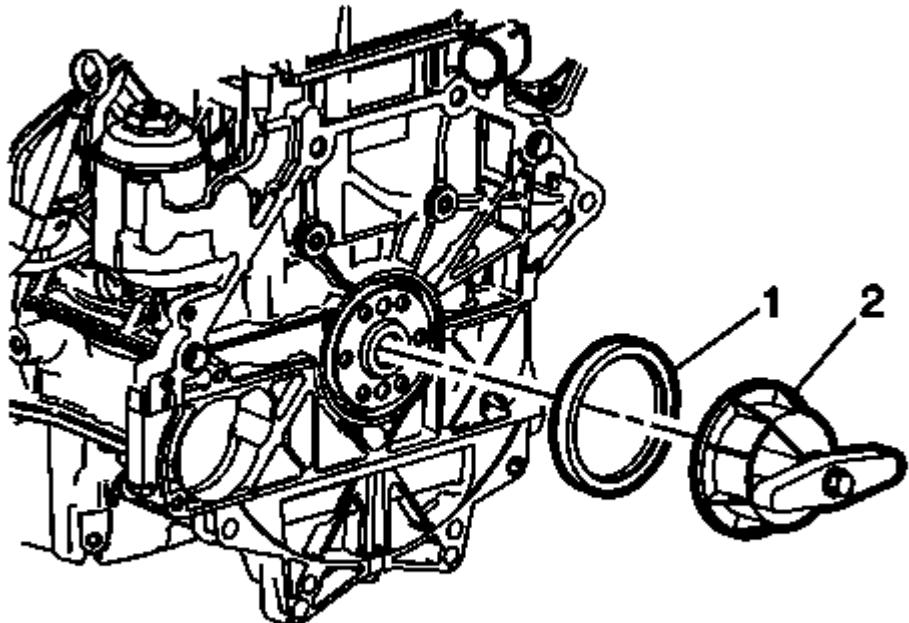


Fig. 29: Intake Manifold And Bolts

Courtesy of GENERAL MOTORS COMPANY

16. Remove the intake manifold bolts (1).
17. Remove the intake manifold (2).
18. Clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

Installation Procedure

1. Clean the sealing surfaces.
2. Install the NEW gasket.

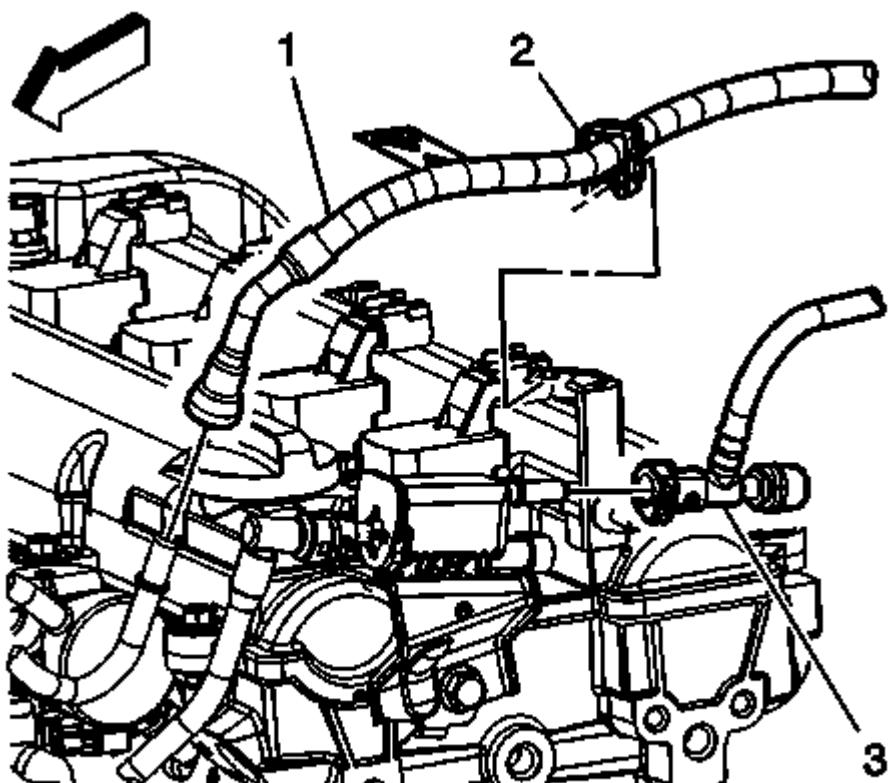


Fig. 30: Intake Manifold And Bolts

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).

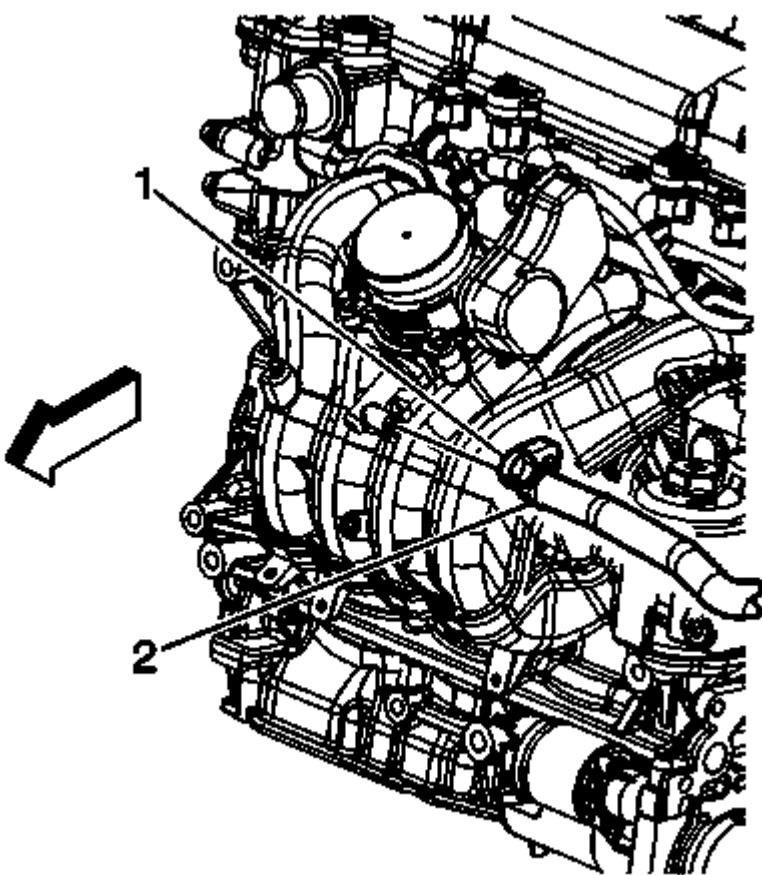


Fig. 31: Transmission Rear Mount Bracket Through Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW transmission rear mount to bracket through bolt (1) and tighten to 80 N.m (59 lb ft) plus 45-60 degrees.
5. Install the generator. Refer to [Generator Replacement \(LUW\)](#) .
6. Install the starter. Refer to [Starter Replacement \(LUW\)](#) .
7. Install the front wheel drive shaft right side. Refer to [Front Wheel Drive Shaft Replacement](#) .

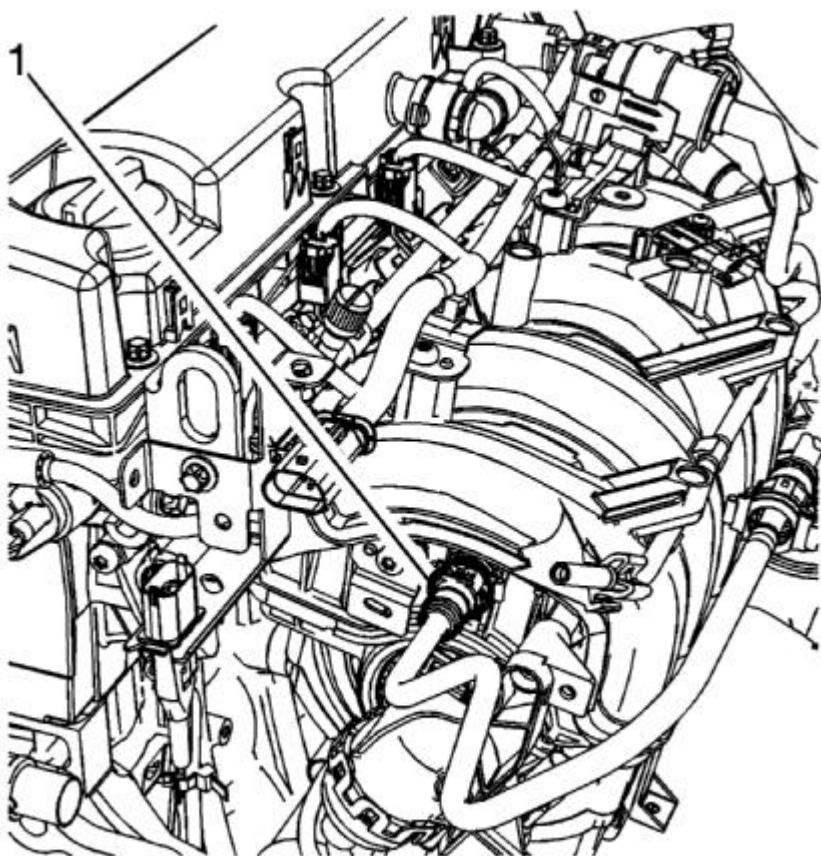


Fig. 32: Booster Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

8. Connect the booster vacuum pipe (1) to the intake manifold.
9. Install the manifold absolute pressure sensor. Refer to **Manifold Absolute Pressure Sensor Replacement**.

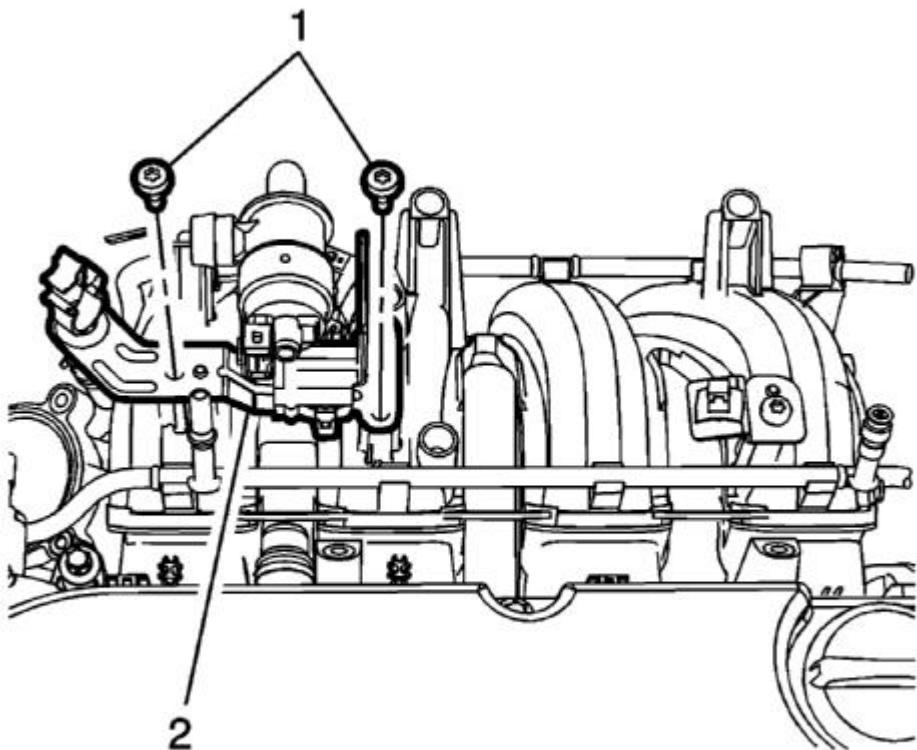


Fig. 33: Evaporative Emission Canister Purge Solenoid Valve Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the evaporative emission canister purge solenoid valve bracket (2).
11. Install the evaporative emission canister purge solenoid valve bracket bolts (1) and tighten to 8 N.m (71 lb in).
12. Connect the electrical connectors as necessary.
13. Install the fuel injector rail. Refer to [Fuel Injector Replacement](#).

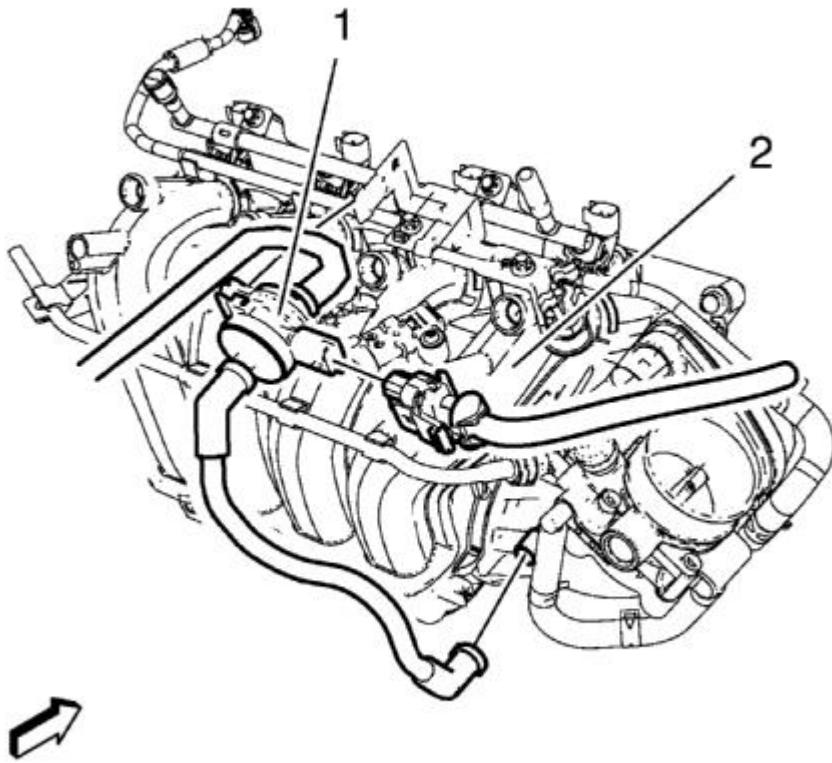


Fig. 34: Evaporative Emission Canister Purge Solenoid Valve, Rubber Mounting And Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

14. Install the evaporative emission canister purge solenoid valve (1) and the rubber mounting to the intake manifold (2).
15. Connect the pipes to the evaporative emission canister purge solenoid valve (1).
16. Connect wiring harness as necessary.
17. Install the throttle body assembly. Refer to [**Throttle Body Assembly Replacement**](#) .
18. Connect the negative battery cable. Refer to [**Battery Negative Cable Disconnection and Connection**](#) .

INTAKE MANIFOLD REPLACEMENT (LUW)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [**Battery Negative Cable Disconnection and Connection**](#) .
2. Remove the throttle body assembly. Refer to [**Throttle Body Assembly Replacement**](#) .

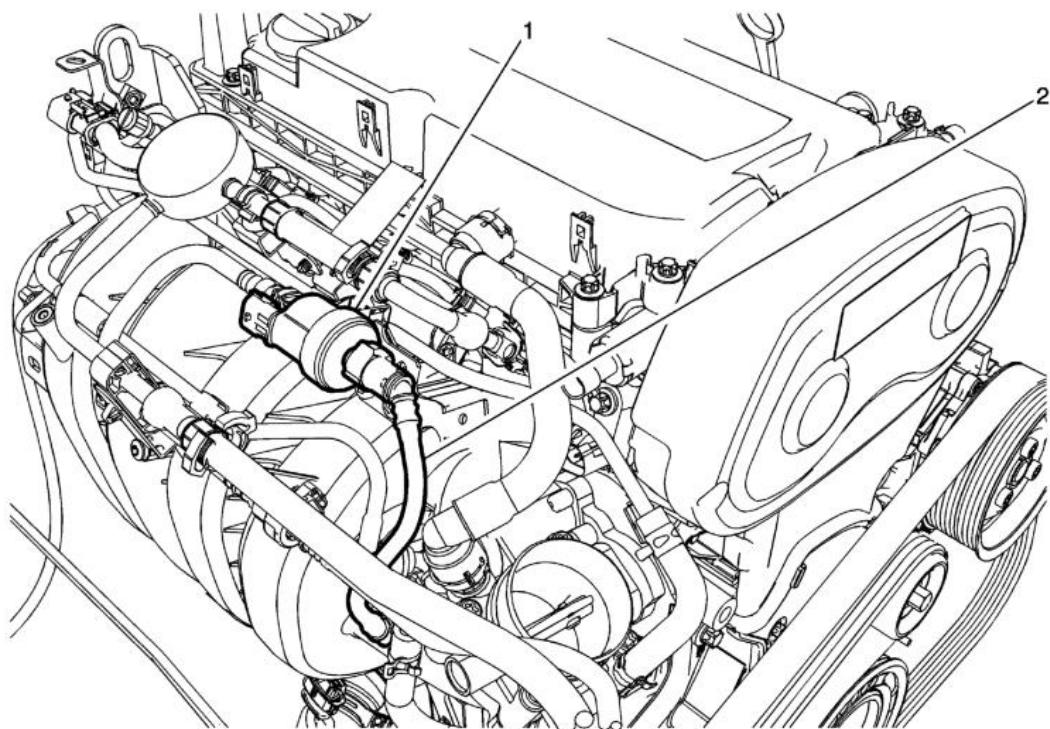


Fig. 35: Evaporative Emission Canister Purge Solenoid Valve & Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect wiring harness plug.
4. Disconnect the pipes from the evaporative emission canister purge solenoid valve (1).
5. Remove the evaporative emission canister purge solenoid valve (1) and the rubber mounting from the intake manifold (2).
6. Disconnect and reposition the electrical connectors as necessary.
7. Remove the fuel injector rail. Refer to [Fuel Injector Replacement](#) .
8. Remove the manifold absolute pressure sensor. Refer to [Manifold Absolute Pressure Sensor Replacement](#) .

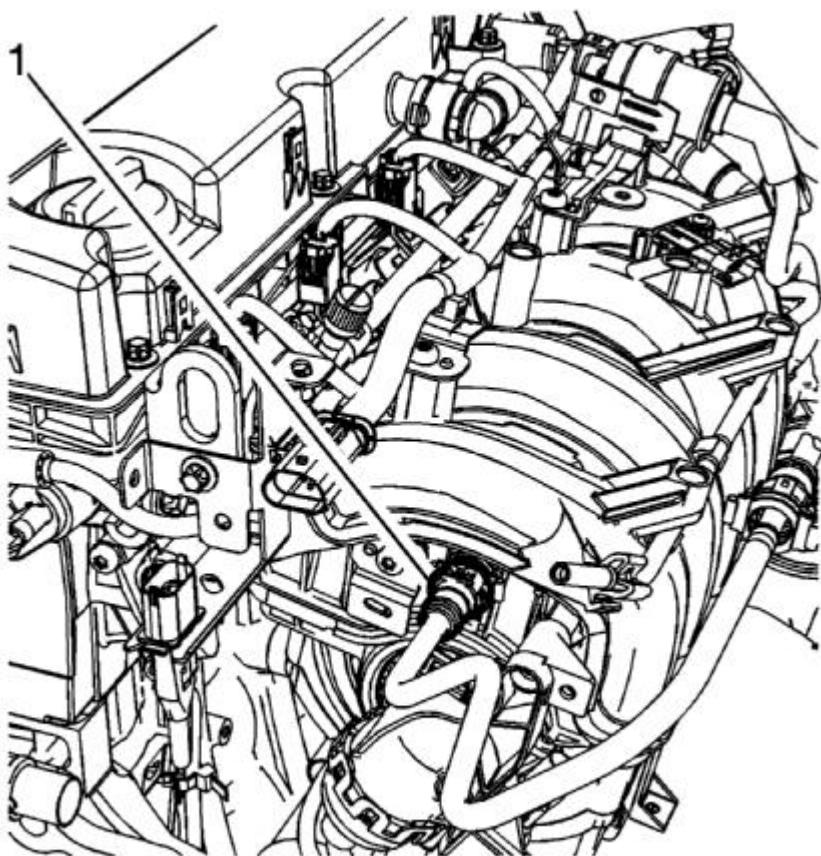


Fig. 36: Booster Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the booster vacuum pipe (1) from the intake manifold.
10. Remove the front wheel drive shaft right side. Refer to [Front Wheel Drive Shaft Replacement](#) .
11. Remove the starter. Refer to [Starter Replacement \(LUW\)](#) .
12. Remove the generator. Refer to [Generator Replacement \(LUW\)](#) .
13. Remove the front exhaust pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#) .

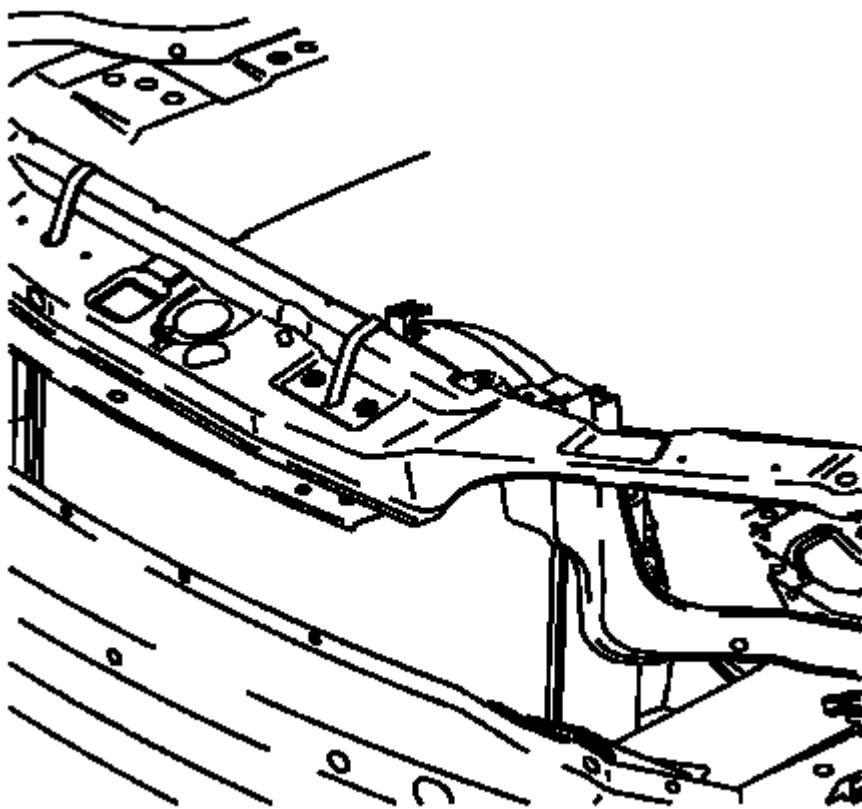


Fig. 37: Transmission Rear Mount Bracket Through Bolt

Courtesy of GENERAL MOTORS COMPANY

14. Remove and DISCARD the transmission rear mount to bracket through bolt (1).

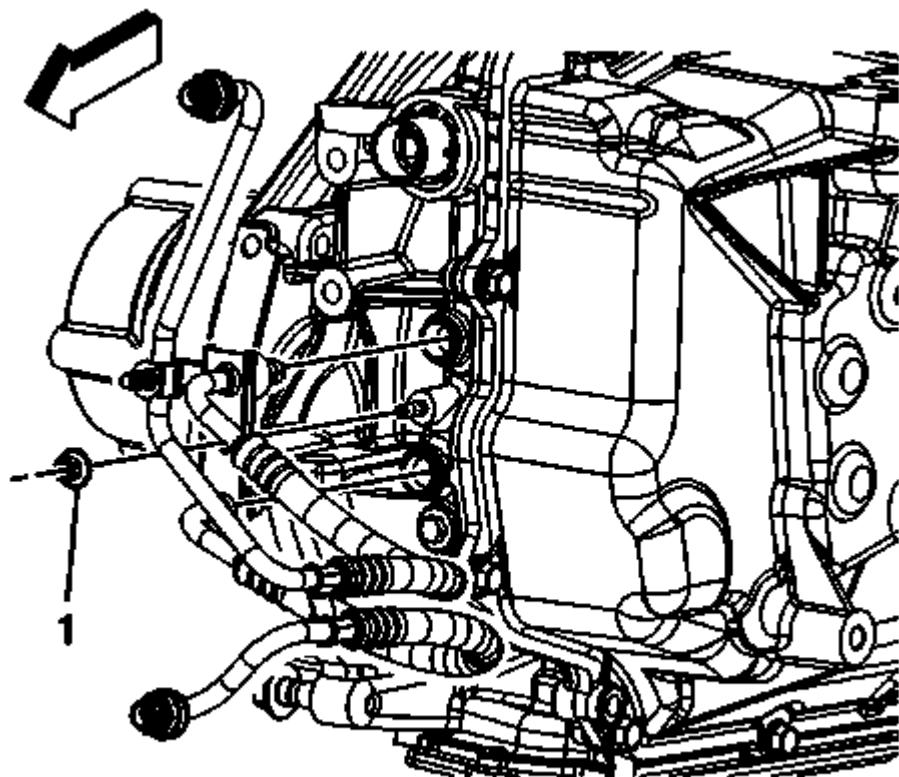


Fig. 38: Intake Manifold And Bolts

Courtesy of GENERAL MOTORS COMPANY

15. Remove the intake manifold bolts (1).
16. Remove the intake manifold (2).
17. Clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

Installation Procedure

1. Clean the sealing surfaces.
2. Install the NEW gasket.

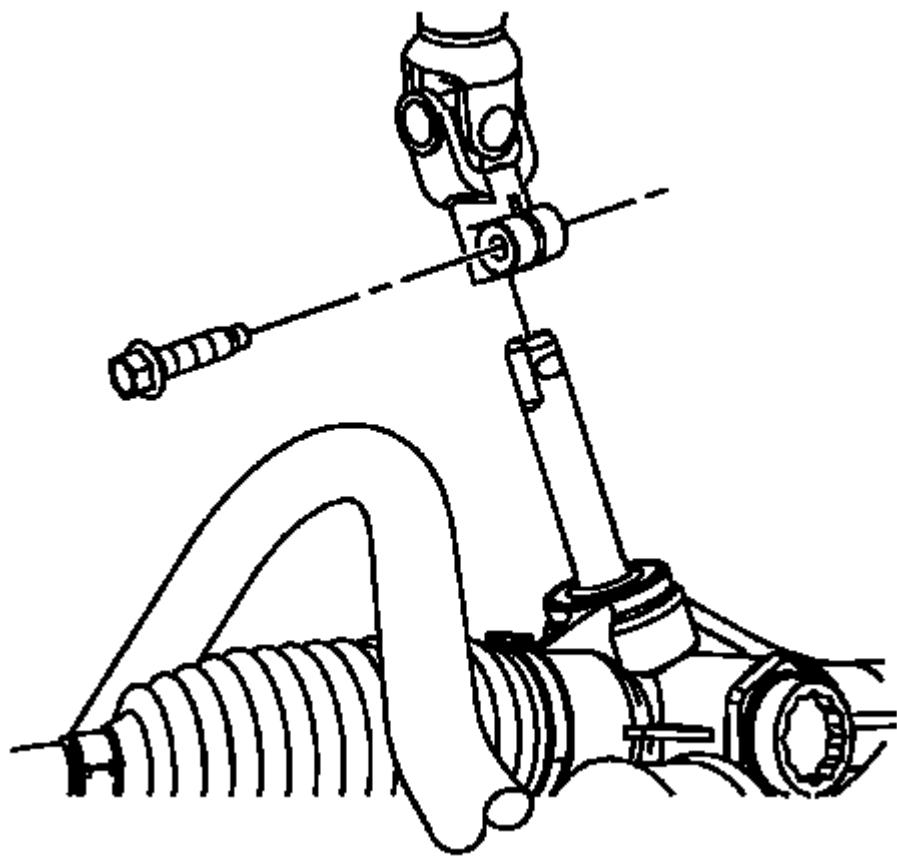


Fig. 39: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

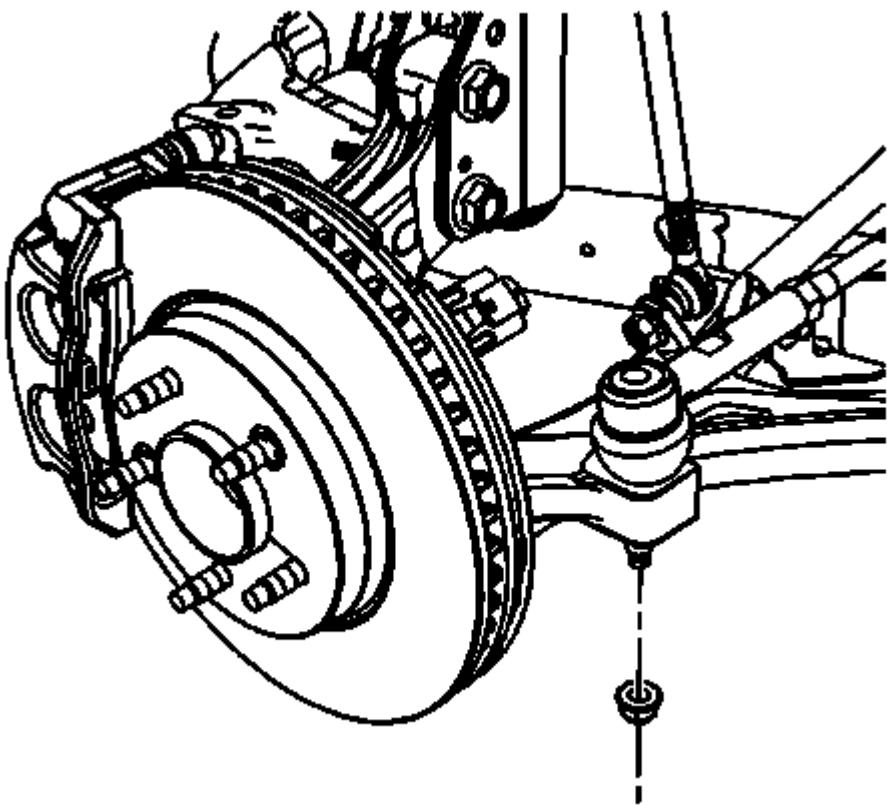


Fig. 40: Transmission Rear Mount Bracket Through Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW transmission rear mount to bracket through bolt (1) and tighten to 80 N.m (59 lb ft) plus 45-60 degrees.
5. Install the generator. Refer to [Generator Replacement \(LUW\)](#) .
6. Install the starter. Refer to [Starter Replacement \(LUW\)](#) .
7. Install the front exhaust pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#) .
8. Install the front wheel drive shaft right side. Refer to [Front Wheel Drive Shaft Replacement](#) .

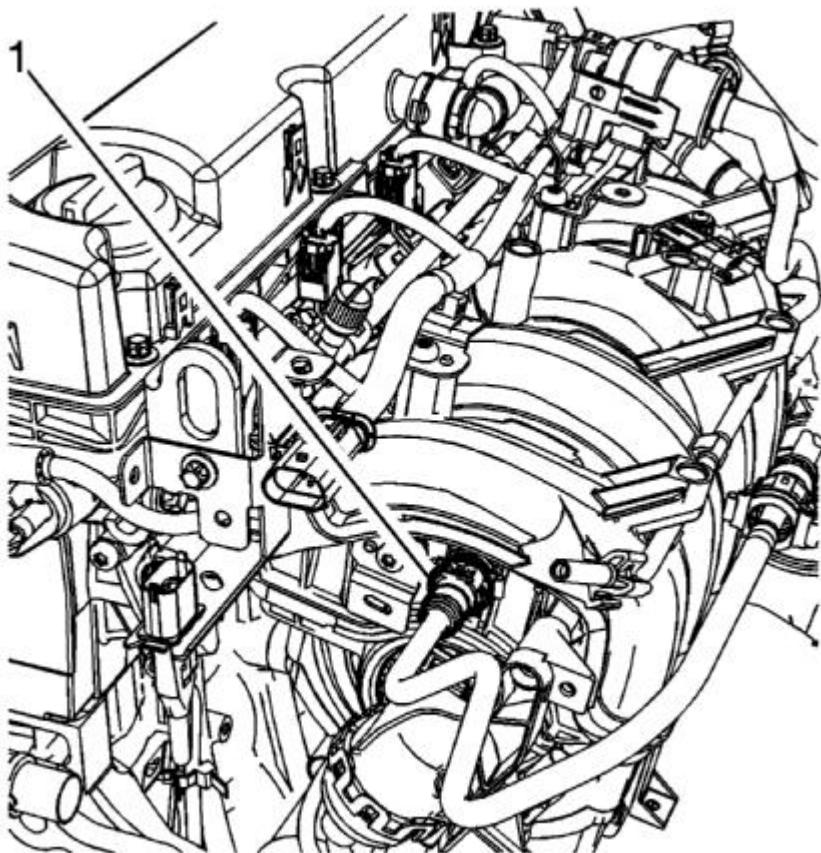


Fig. 41: Booster Vacuum Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Connect the booster vacuum pipe (1) to the intake manifold.
10. Install the manifold absolute pressure sensor. Refer to [Manifold Absolute Pressure Sensor Replacement](#).
11. Connect the electrical connectors as necessary.
12. Install the fuel injector rail. Refer to [Fuel Injector Replacement](#).

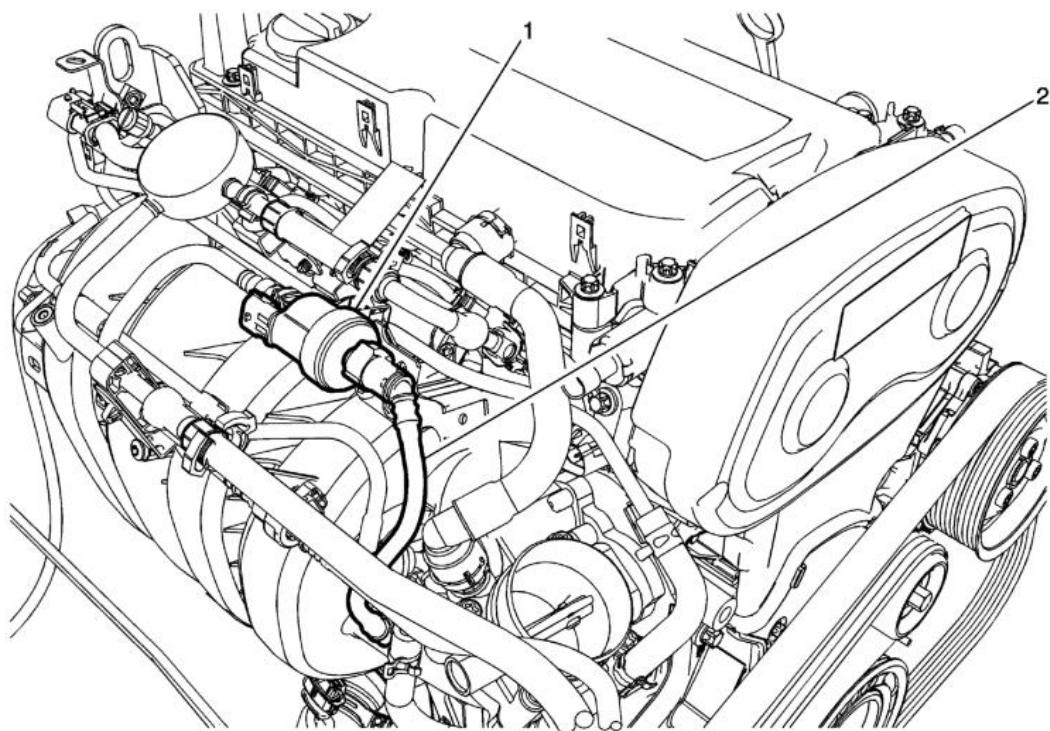


Fig. 42: Evaporative Emission Canister Purge Solenoid Valve & Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

13. Install the evaporative emission canister purge solenoid valve (1) and the rubber mounting to the intake manifold (2).
14. Connect the pipes to the evaporative emission canister purge solenoid valve (1).
15. Connect wiring harness as necessary.
16. Install the throttle body assembly. Refer to [Throttle Body Assembly Replacement](#) .
17. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#) .

TIMING BELT REPLACEMENT

Special Tools

- EN-6333 Timing Belt Tensioner Locking Pin
- EN-6340 Camshaft Locking Tool

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

Removal Procedure

NOTE: **If the timing belt is being replaced due to the maintenance schedule interval, then the timing belt tensioner and idler pulley must also be replaced.**

1. Remove the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .
2. Remove the timing belt upper front cover. Refer to [Timing Belt Upper Front Cover Replacement](#) .
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
4. Remove the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .
5. Remove the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#) .

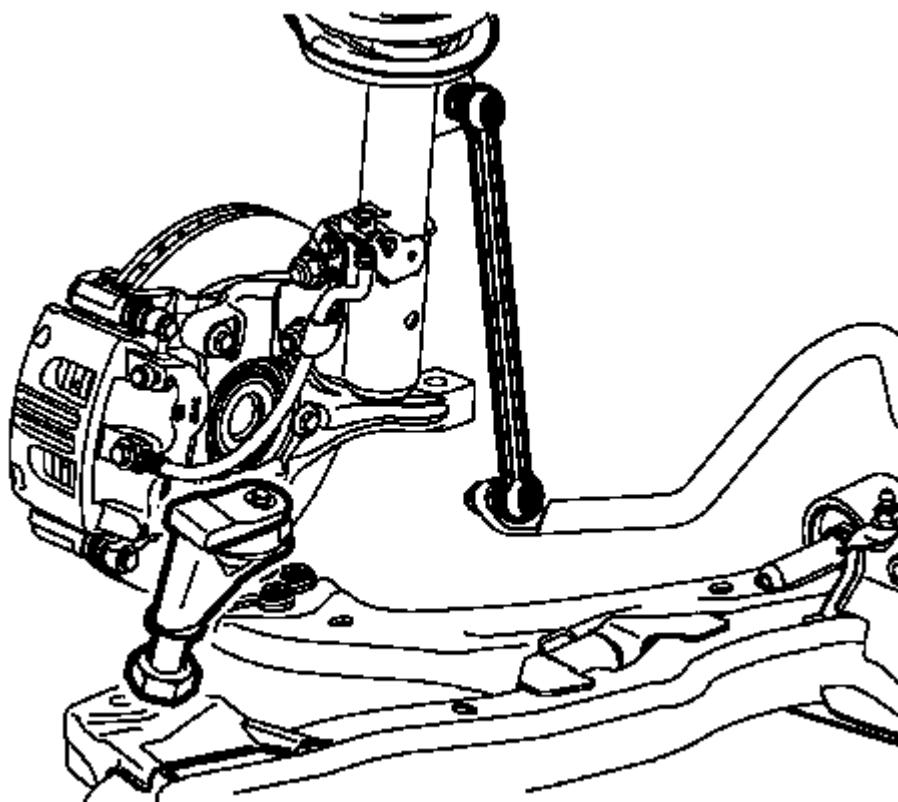


Fig. 43: View Of Crankshaft TDC Position
Courtesy of GENERAL MOTORS COMPANY

6. Set crankshaft balancer in direction of engine rotation to cylinder 1 TDC of combustion stroke (1).

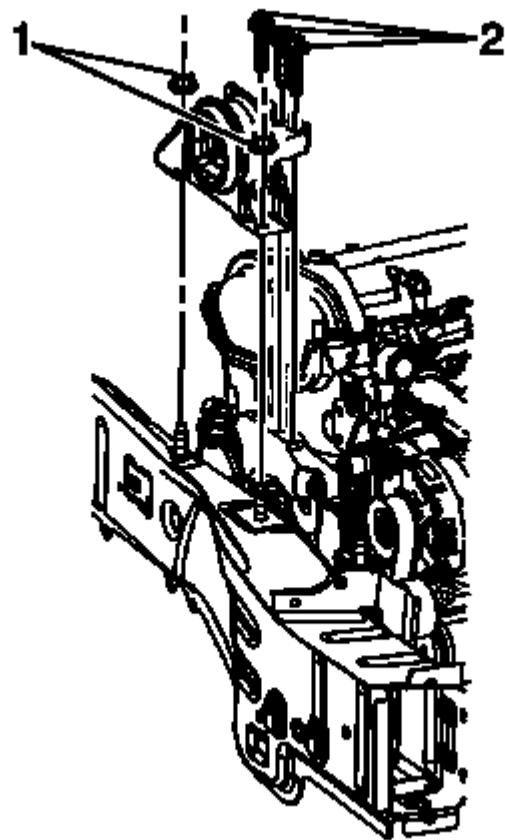


Fig. 44: Crankshaft Balancer & Bolt

Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft balancer bolt (1).
8. Remove the crankshaft balancer (2). Refer to [Crankshaft Balancer Replacement](#).

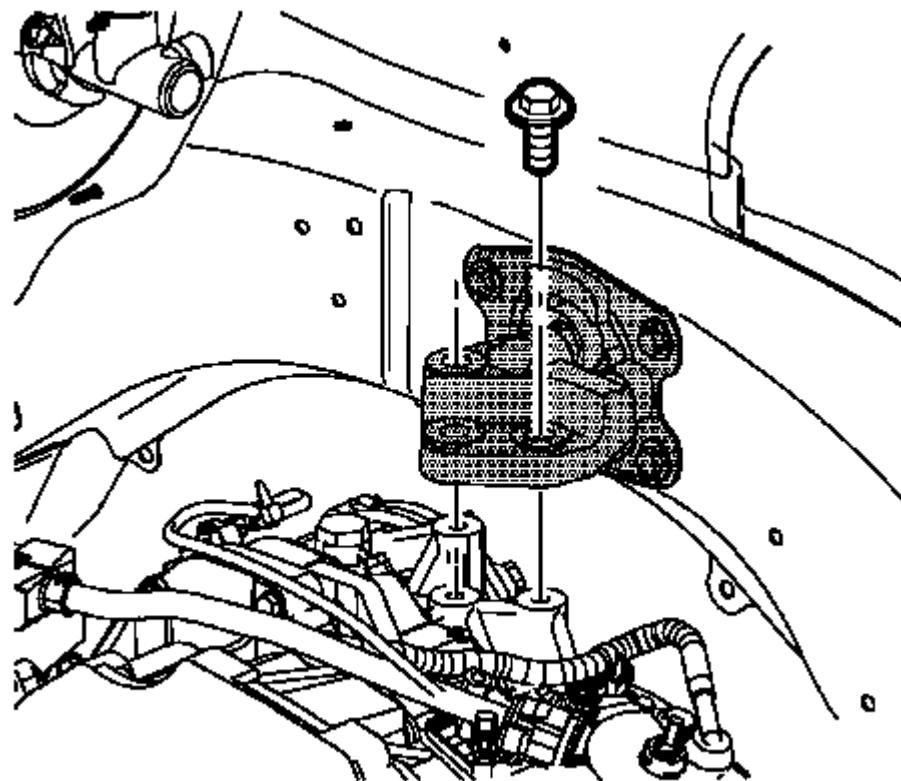


Fig. 45: Lower Timing Belt Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

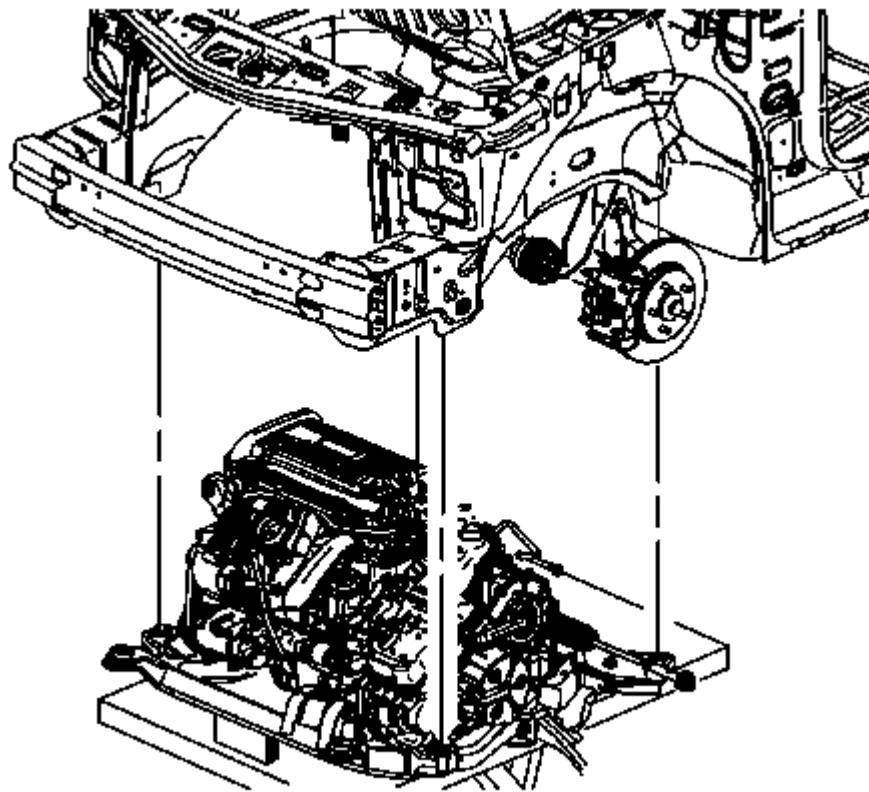


Fig. 46: Front Panel And Bolts

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.

11. 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-right locking tool.

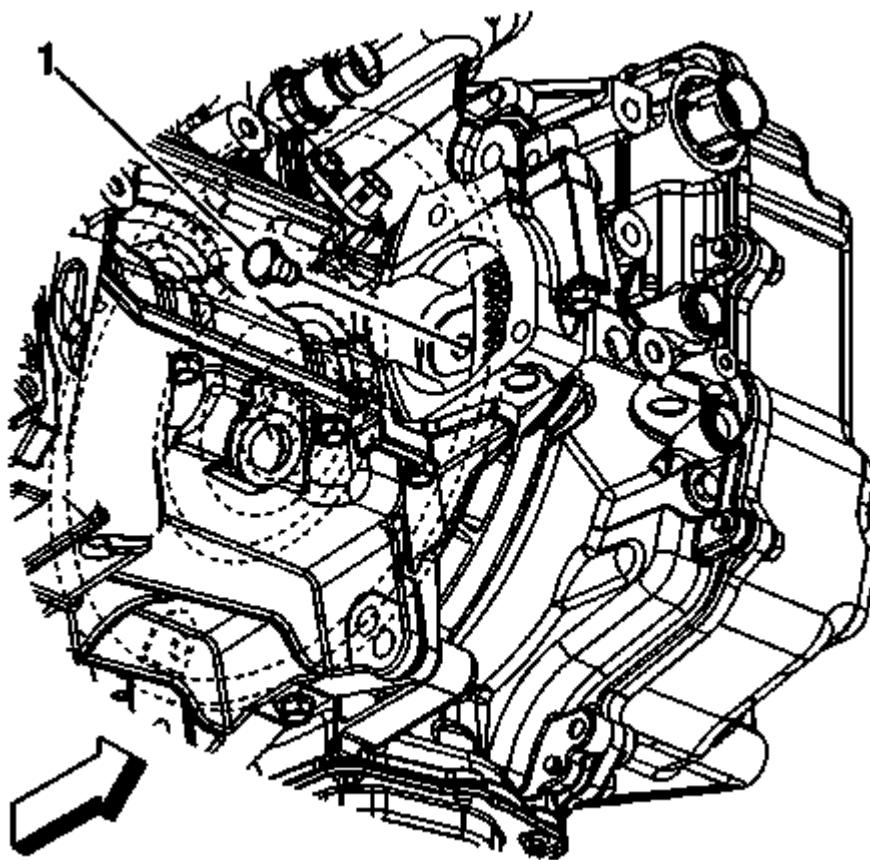


Fig. 47: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install **EN-6340** locking tool into the camshaft position actuator 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 **EN-6340-left** locking tool (1) in the camshaft position actuator 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-right** locking tool (2) in the camshaft position actuator adjusters as shown.

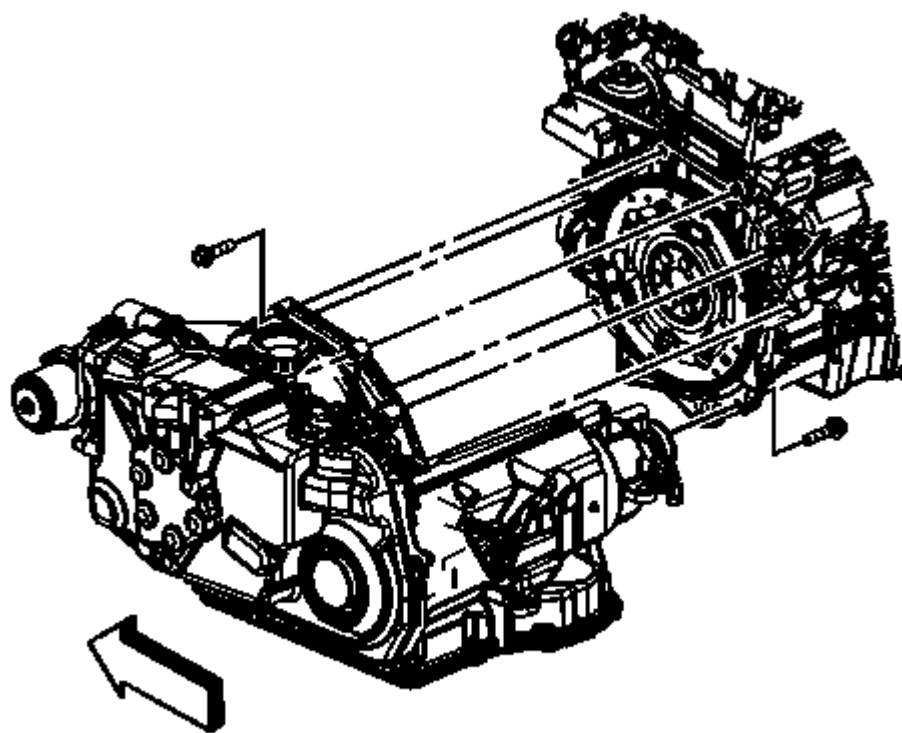


Fig. 48: Timing Belt Tensioner, Locking Pin & Allen Key

Courtesy of GENERAL MOTORS COMPANY

13. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an Allen key (1).
14. Install the EN-6333 locking pin (3).

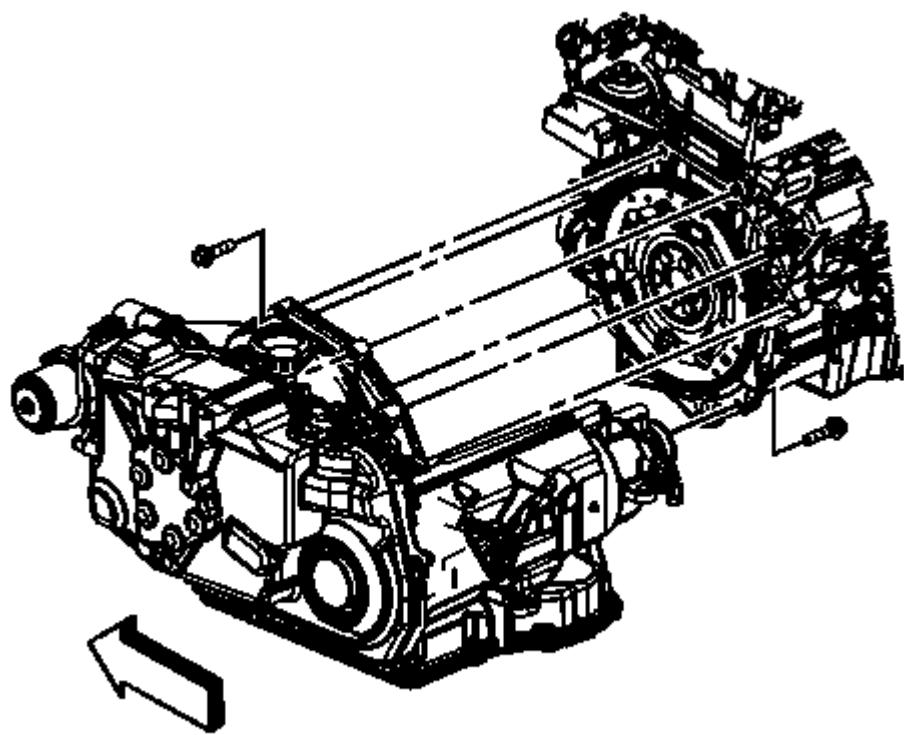


Fig. 49: Timing Belt

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the direction of the belt.

15. Remove the timing belt (1).

Installation Procedure

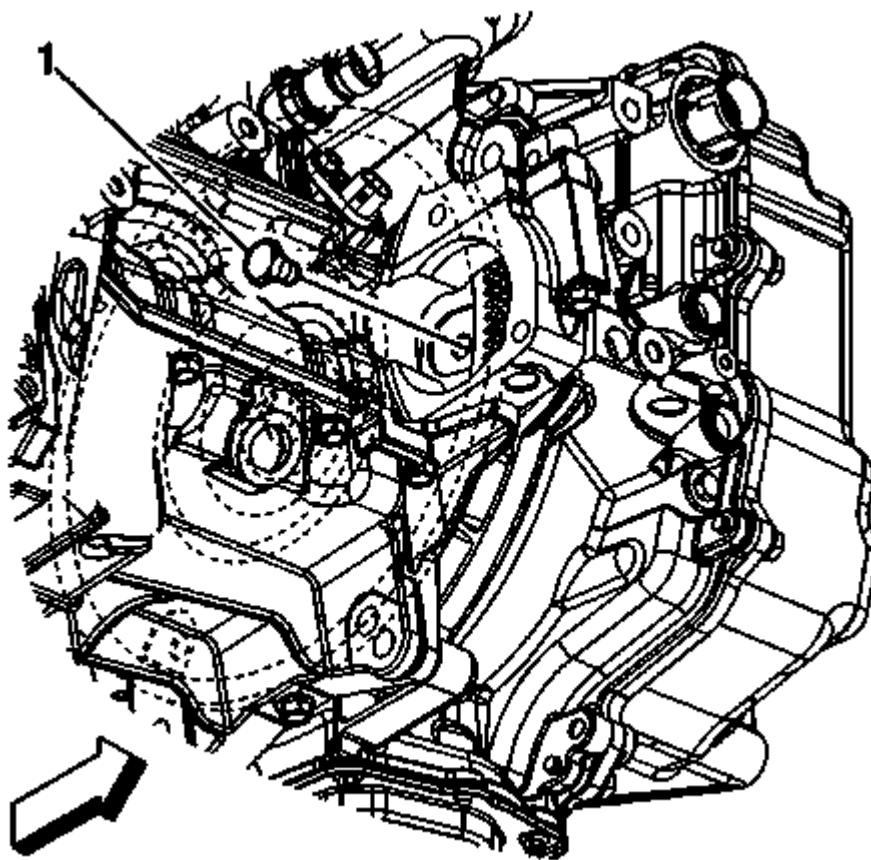


Fig. 50: Timing Belt

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.

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

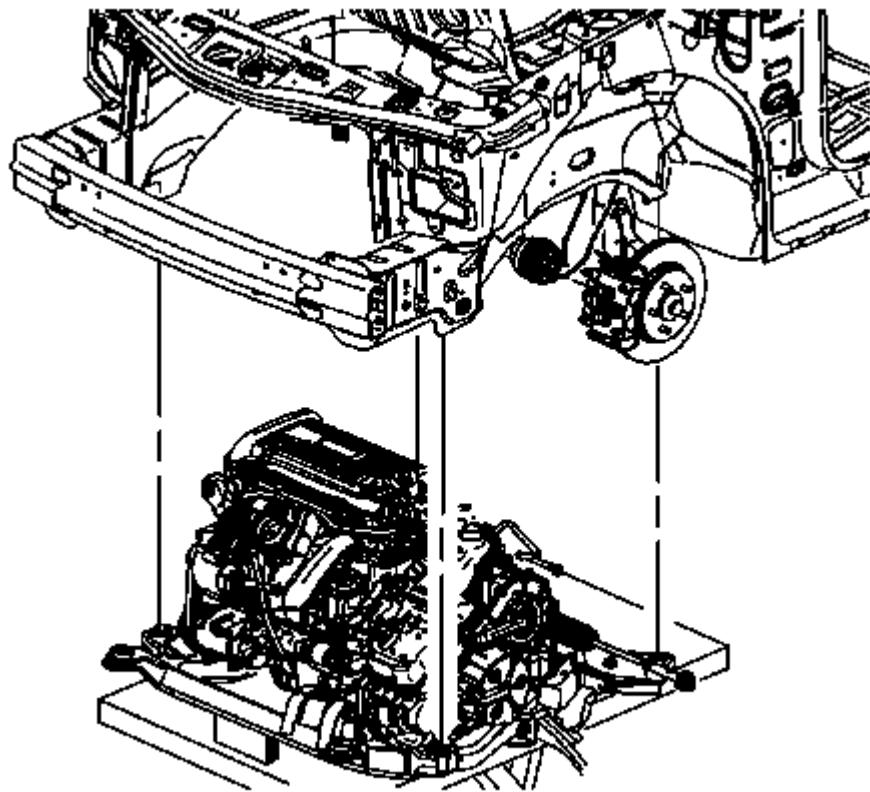


Fig. 51: Timing Belt Tensioner, Locking Pin & Allen Key

Courtesy of GENERAL MOTORS COMPANY

4. Apply tension to the timing belt tensioner (2) in the direction of the arrow, using an Allen key (1).
5. Remove the **EN-6333** locking pin (3).

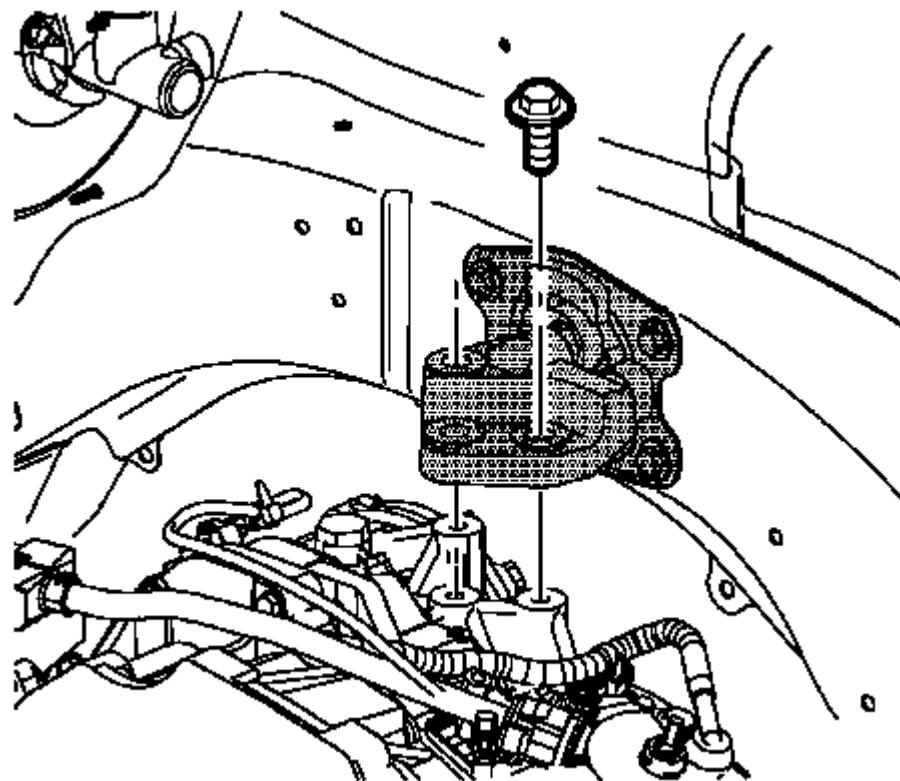


Fig. 52: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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

6. Check the timing.

NOTE: Note the marking at the camshaft sprockets.

1. 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 position actuator adjuster does not correspond to the groove of EN-6340-left during this process but must be slightly above as shown.

2. Install EN-6340-left locking tool (1) into 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-right.

3. Install **EN-6340-right** locking tool (2) into the camshaft position actuator adjusters as shown.
7. Remove the **EN-6340** locking tool.

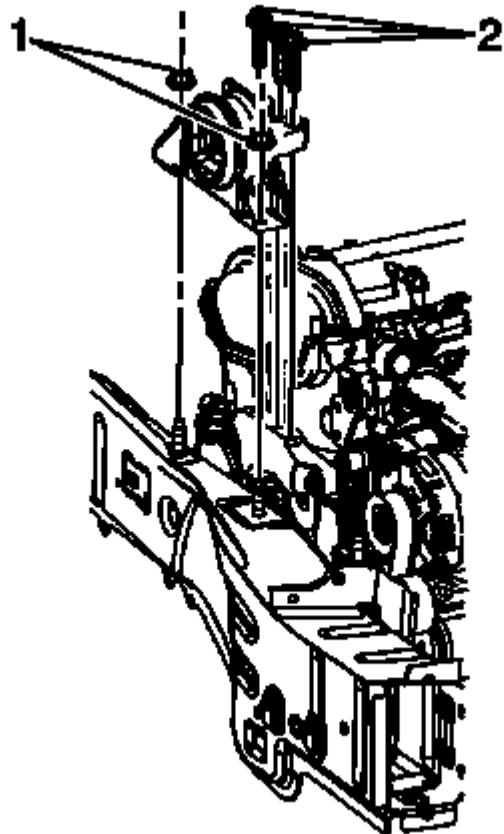


Fig. 53: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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

8. Control the crankshaft balancer position.

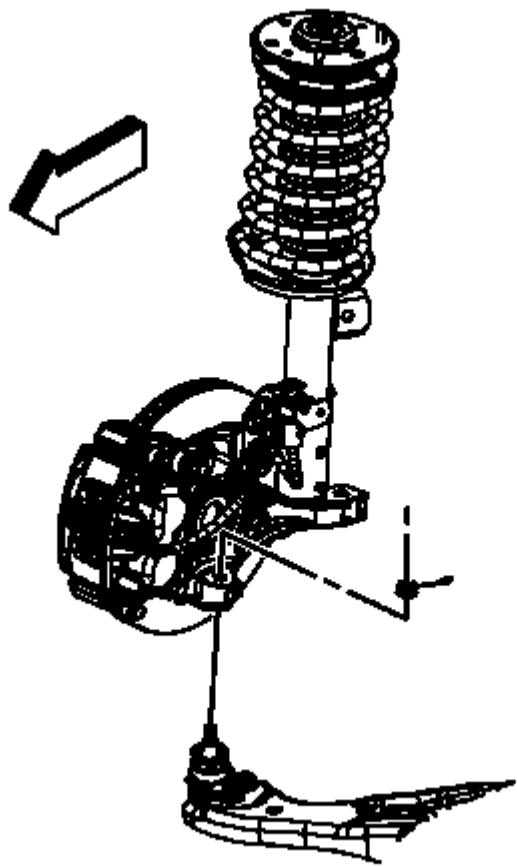


Fig. 54: Lower Timing Belt Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

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

CAUTION: Refer to Fastener Caution .
10. Install the 4 lower timing belt cover bolts (2) and tighten to 6 N.m (53 lb in).

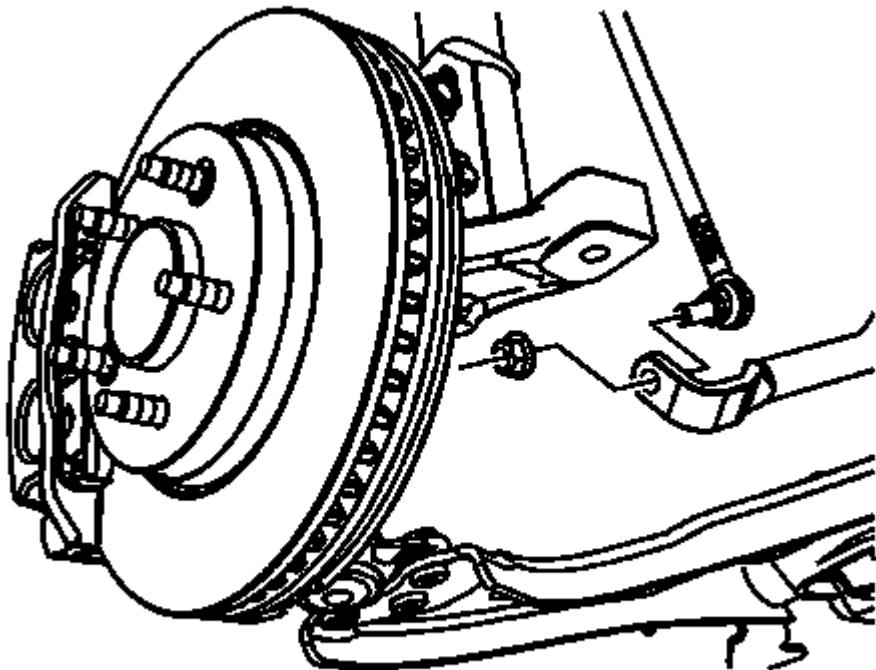


Fig. 55: Crankshaft Balancer & Bolt

Courtesy of GENERAL MOTORS COMPANY

11. Install the crankshaft balancer (2). Refer to [Crankshaft Balancer Replacement](#) if necessary.
12. Install the crankshaft balancer bolt (1) and tighten to 95 N.m (70 lb ft) plus 30 degrees plus 15 degrees.
13. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
14. Install the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .
15. Install the timing belt upper front cover. Refer to [Timing Belt Upper Front Cover Replacement](#).
16. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#) .

TIMING BELT IDLER PULLEY REPLACEMENT

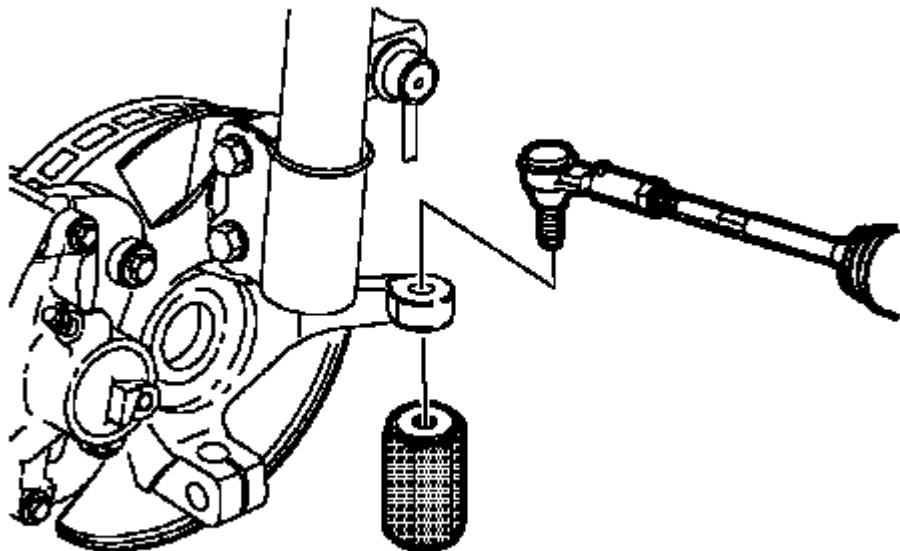


Fig. 56: Timing Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS COMPANY

Timing Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure	
Remove the timing belt. Refer to <u>Timing Belt Replacement</u> .	
1	<p>Timing Belt Idler Pulley Bolt</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten</p> <ul style="list-style-type: none">• First pass 20 (15 lb ft)• Second pass 120 degrees• Third pass 15 degrees <p>Special Tools EN-45059 Torque Angle Sensor Kit</p>

	For equivalent regional tools, refer to <u>Special Tools</u> .
2	Timing Belt Idler Pulley Procedure Ensure to use a NEW BOLT whenever the timing belt idler pulley is removed.

TIMING BELT TENSIONER REPLACEMENT

Special Tools

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

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

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
2. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
3. Remove the timing belt upper front cover. Refer to **Timing Belt Upper Front Cover Removal**.

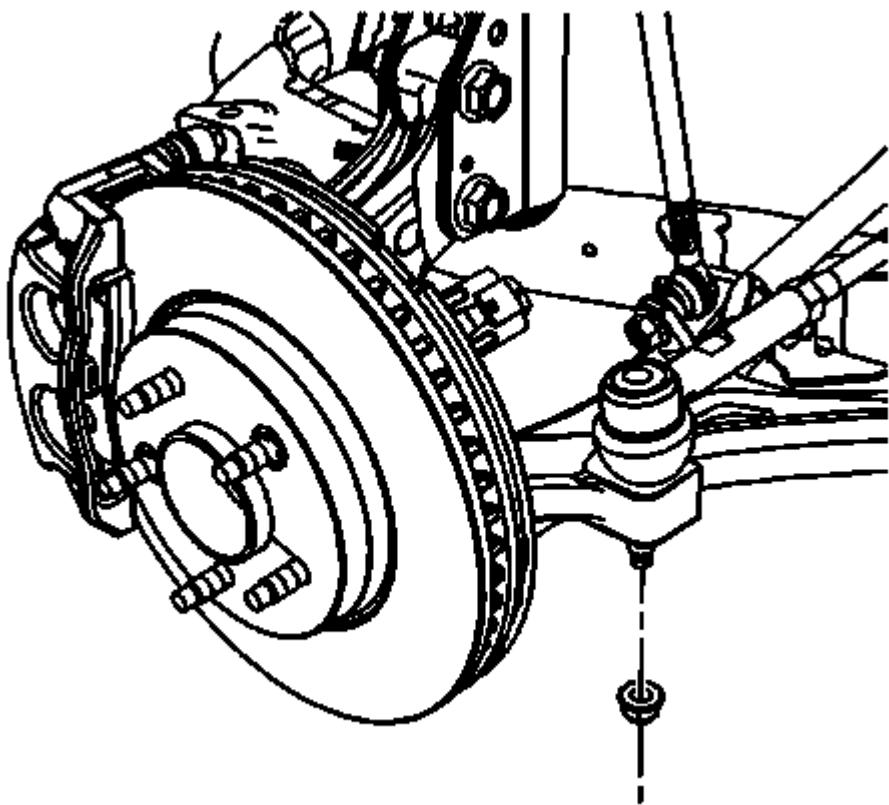


Fig. 57: View Of Crankshaft TDC Position

Courtesy of GENERAL MOTORS COMPANY

4. Set crankshaft balancer in direction of engine rotation to cylinder 1 TDC of combustion stroke (1).

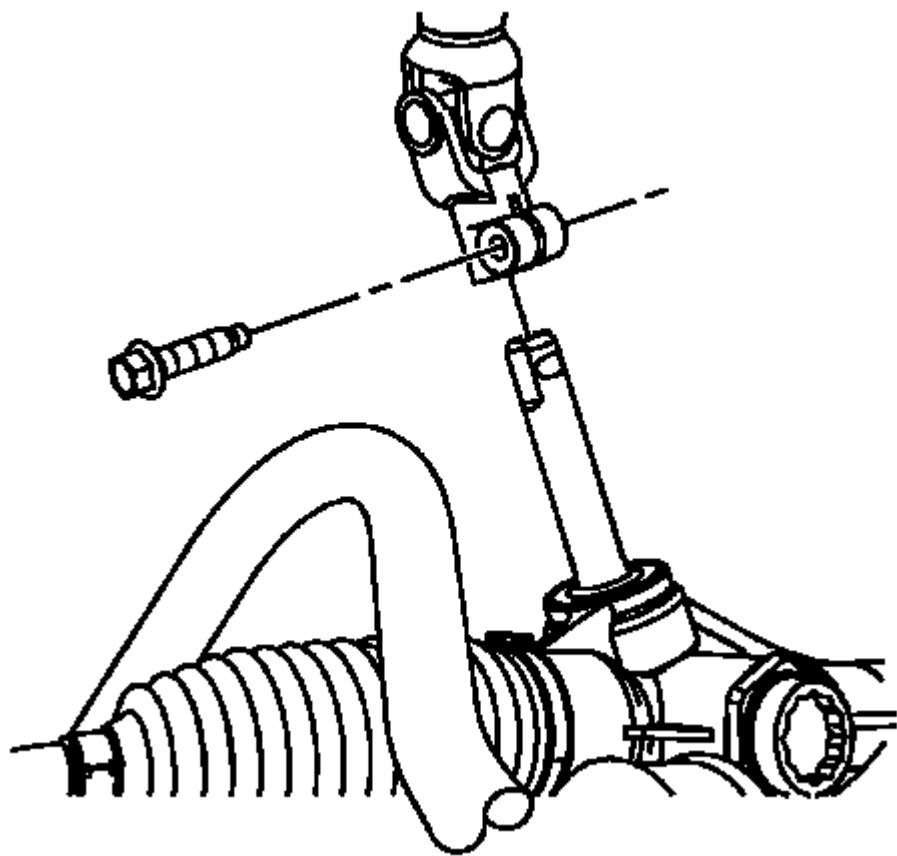


Fig. 58: Front Panel And Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Prepare the right half of the **EN-6340** locking tool.
 1. Remove the 2 bolts (2).
 2. Remove the front panel (1).

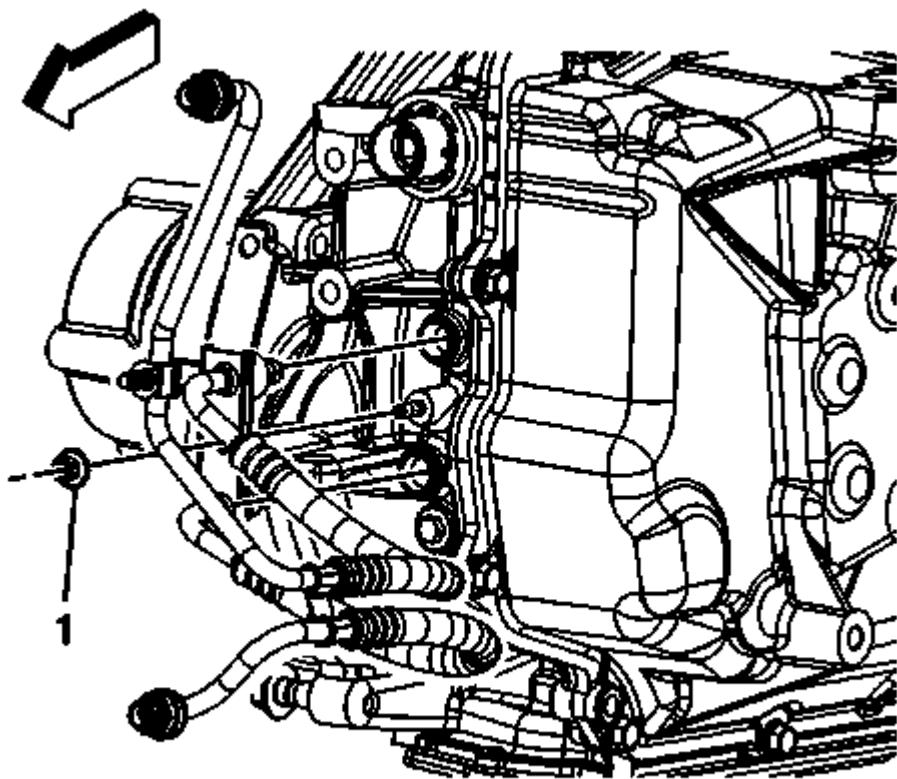


Fig. 59: Spot Type Markings And Special Tool

Courtesy of GENERAL MOTORS COMPANY

6. 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.

7. Install the **EN-6340-left** locking tool (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.

8. Install **EN-6340-right** locking tool (2) in the camshaft adjusters as shown.
9. Remove **EN-6340** locking tool.
10. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
11. Remove the engine mount bracket. Refer to [Engine Mount Bracket Replacement](#).
12. Remove the timing belt center front cover. Refer to [Timing Belt Center Front Cover Removal](#).
13. Remove the timing belt lower front cover. Refer to [Timing Belt Lower Front Cover Removal](#).

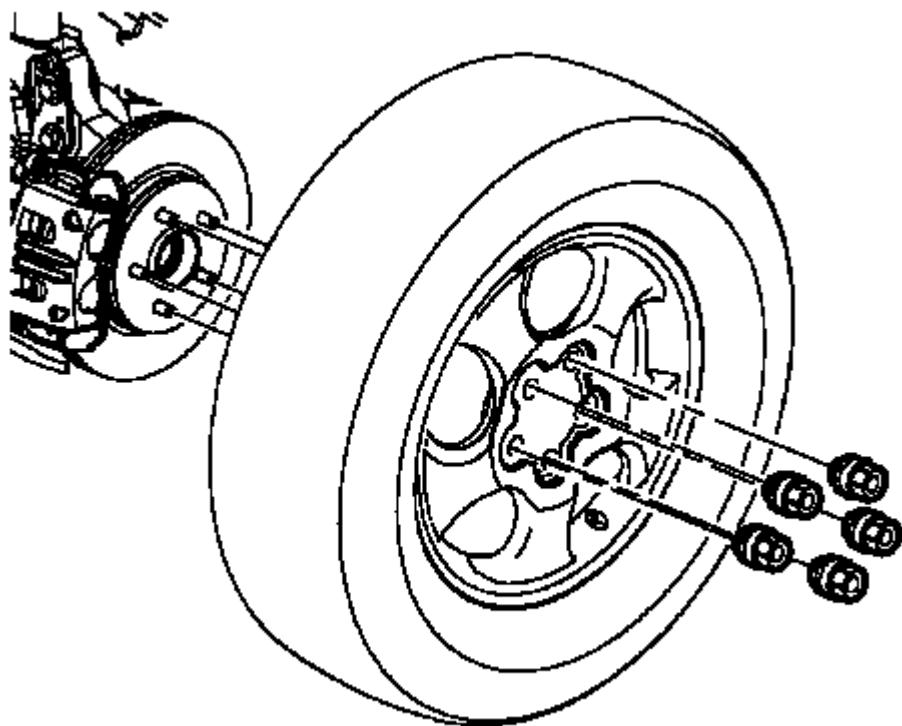


Fig. 60: Timing Belt Tensioner, Locking Pin & Allen Key

Courtesy of GENERAL MOTORS COMPANY

14. Loosen the timing belt tensioner bolt.
15. Apply tension to the drive belt tensioner (2) in the direction of the arrow, using an allen key (1).
16. Install the **EN-6333** locking pin (3).

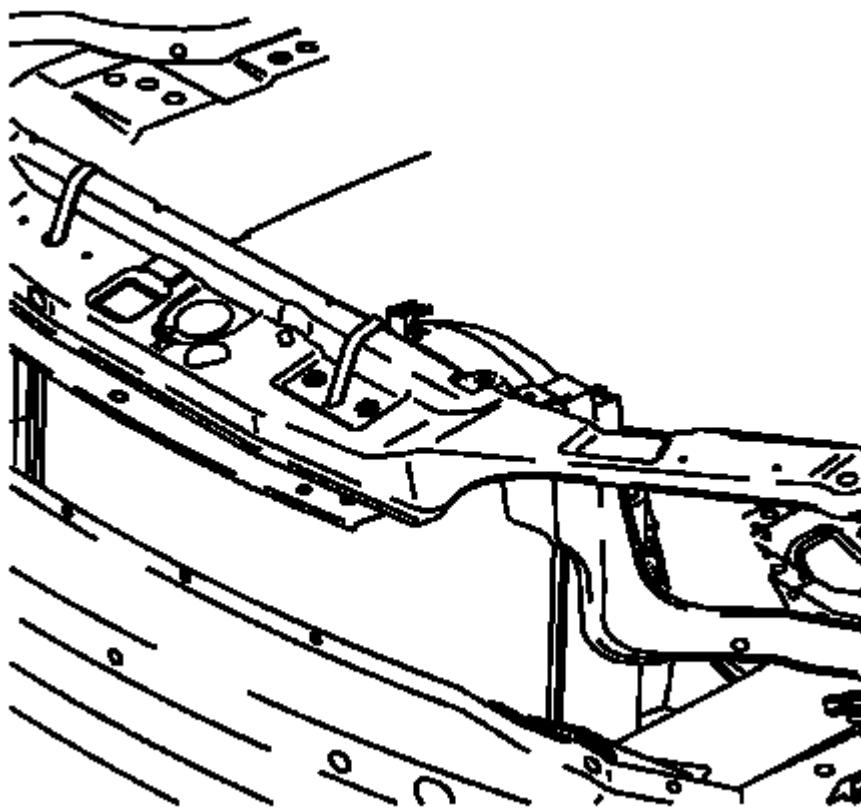


Fig. 61: Timing Belt Tensioner & Bolt

Courtesy of GENERAL MOTORS COMPANY

17. Remove the timing belt tensioner bolt (1) and the timing belt tensioner (2).
18. Discard the timing belt tensioner bolt (1).

Installation Procedure

1. Clean the timing belt tensioner thread.

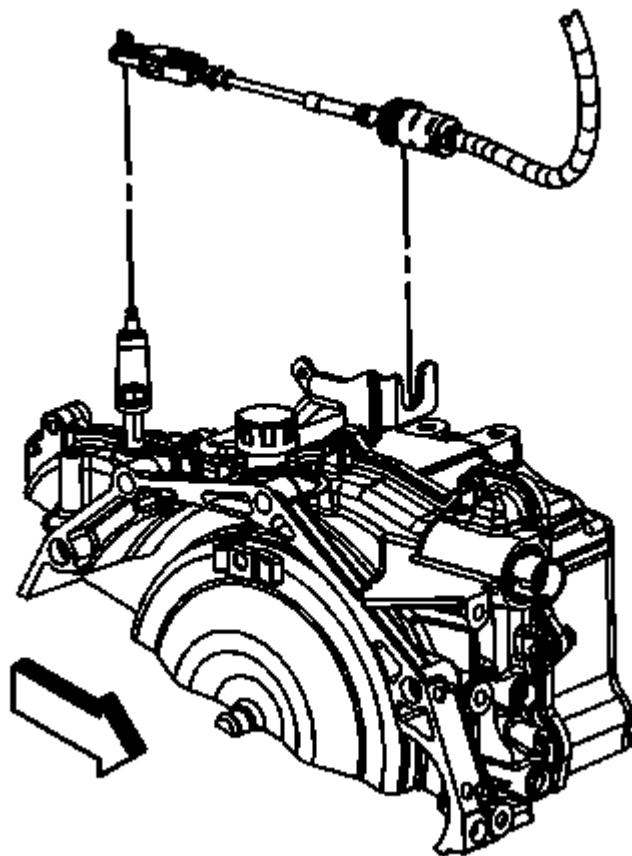


Fig. 62: Timing Belt Tensioner & Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Install the timing belt tensioner (2).
3. Install a new timing belt tensioner bolt (1).

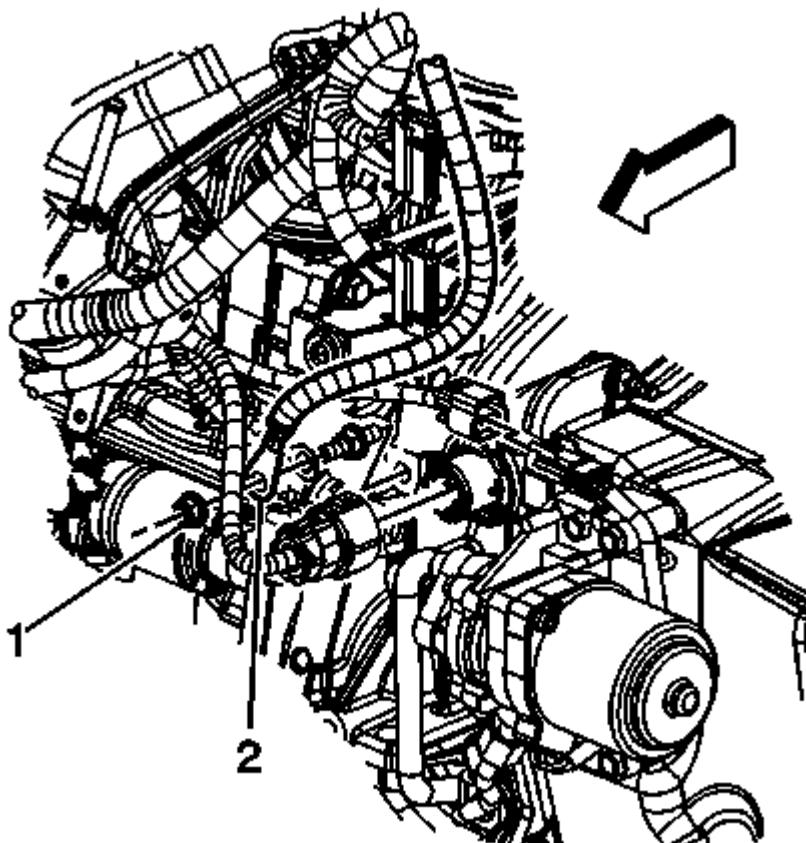


Fig. 63: Timing Belt Tensioner, Locking Pin & Allen Key
Courtesy of GENERAL MOTORS COMPANY

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

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

6. Release tension on timing belt tensioner.

CAUTION: Refer to Fastener Caution .

7. Tighten the timing belt tensioner bolt in three passes using the EN-45059 torque angle :
 1. First pass tighten to 20 (15 lb ft).
 2. Second pass to 120 degrees.
 3. Third pass to 15 degrees.
8. Install the timing belt lower front cover. Refer to Timing Belt Lower Front Cover Installation.
9. Install the timing belt center front cover. Refer to Timing Belt Center Front Cover Installation.

10. Install the engine mount bracket. Refer to [Engine Mount Bracket Replacement](#).
11. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

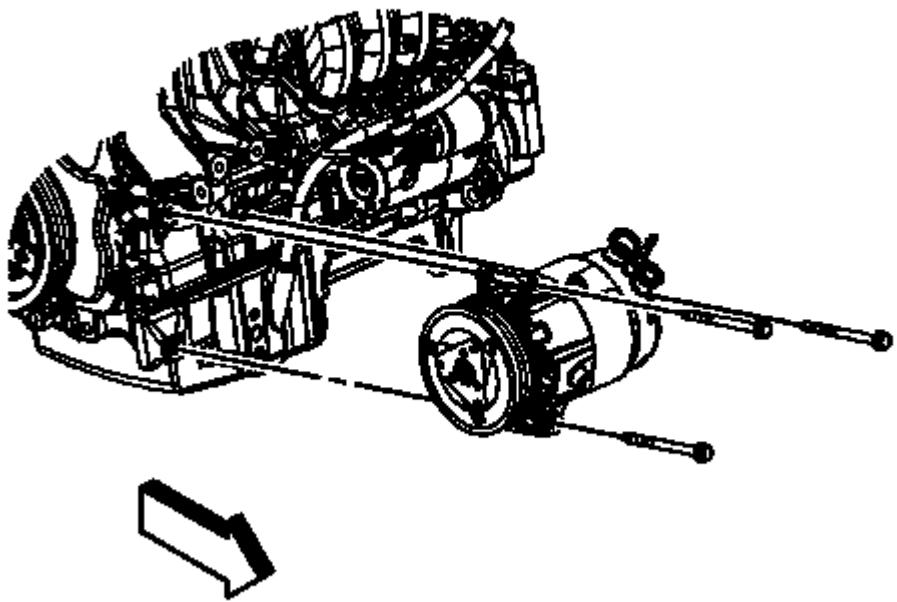


Fig. 64: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Check the timing.

NOTE: Note the marking at the camshaft sprockets.

1. 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-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.

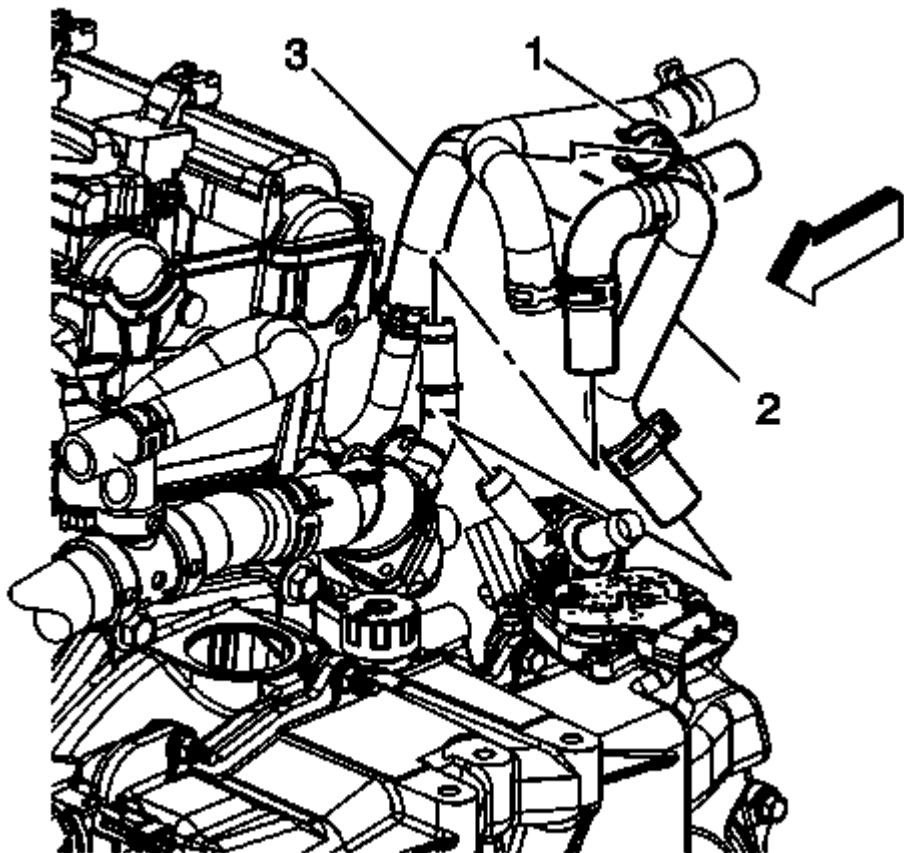


Fig. 65: View Of Crankshaft TDC Position

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the marking at the crankshaft balancer and the cover (1) must align before installing the drive belt.

13. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
14. Remove the EN-6340 locking tool.
15. Install the timing belt upper front cover. Refer to [Timing Belt Upper Front Cover Installation](#).
16. Install the air cleaner assembly. Refer to [Air Cleaner Assembly Replacement](#).

TIMING BELT CENTER FRONT COVER REPLACEMENT

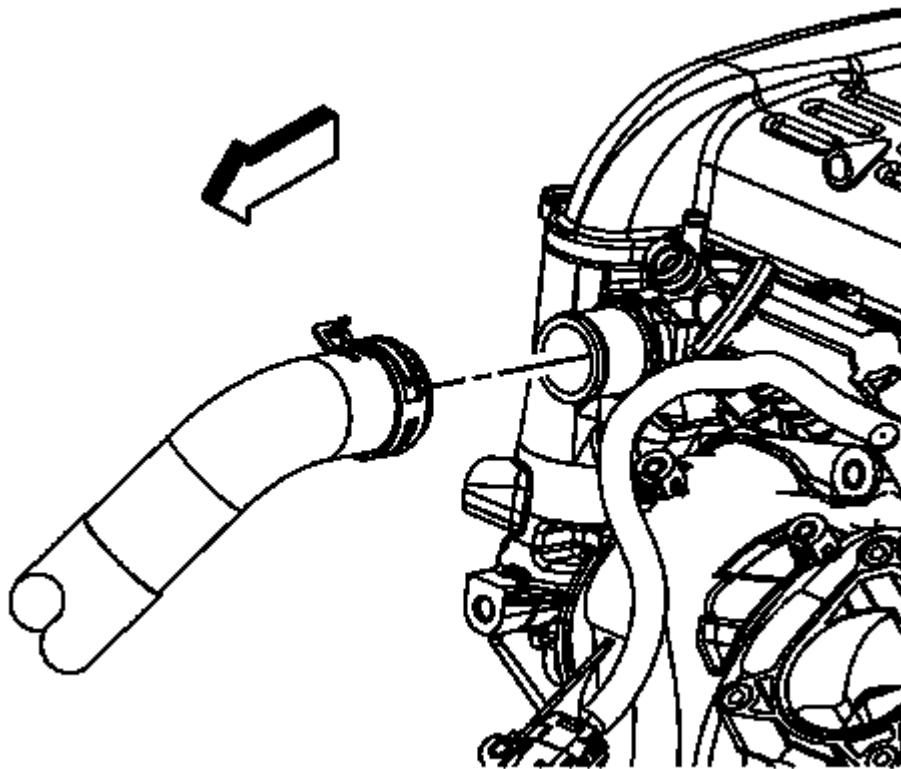
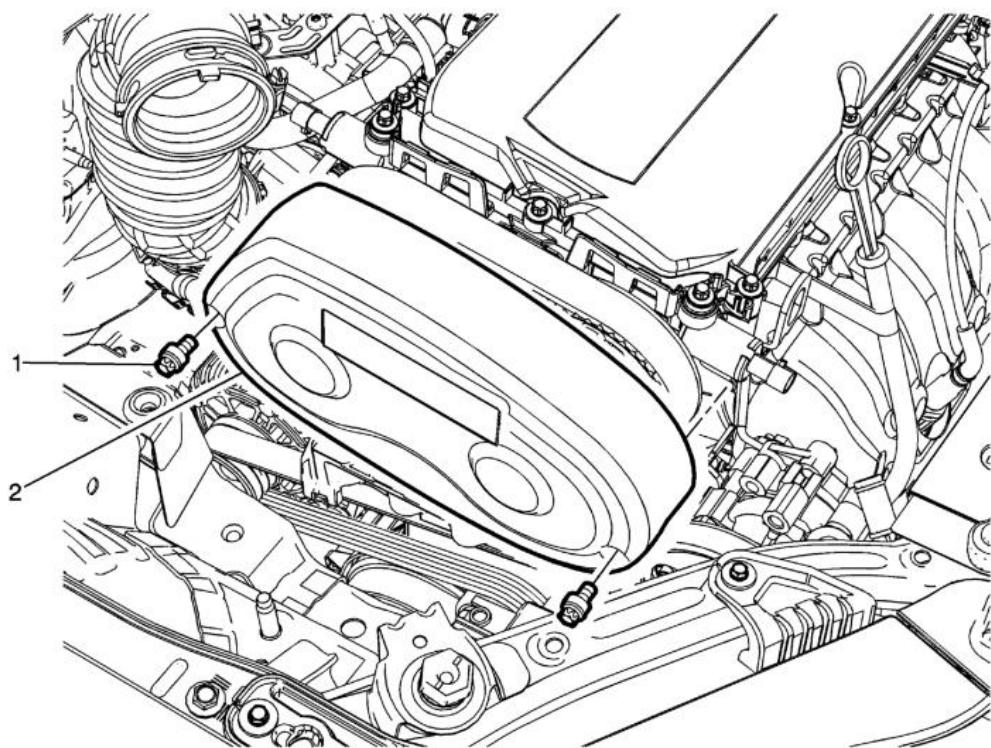


Fig. 66: Timing Belt Center Front Cover
Courtesy of GENERAL MOTORS COMPANY

Timing Belt Center Front Cover Replacement

Callout	Component Name
Preliminary Procedure	
1	Timing Belt Center Front Cover Procedure Transfer Parts as necessary.

TIMING BELT UPPER FRONT COVER REPLACEMENT

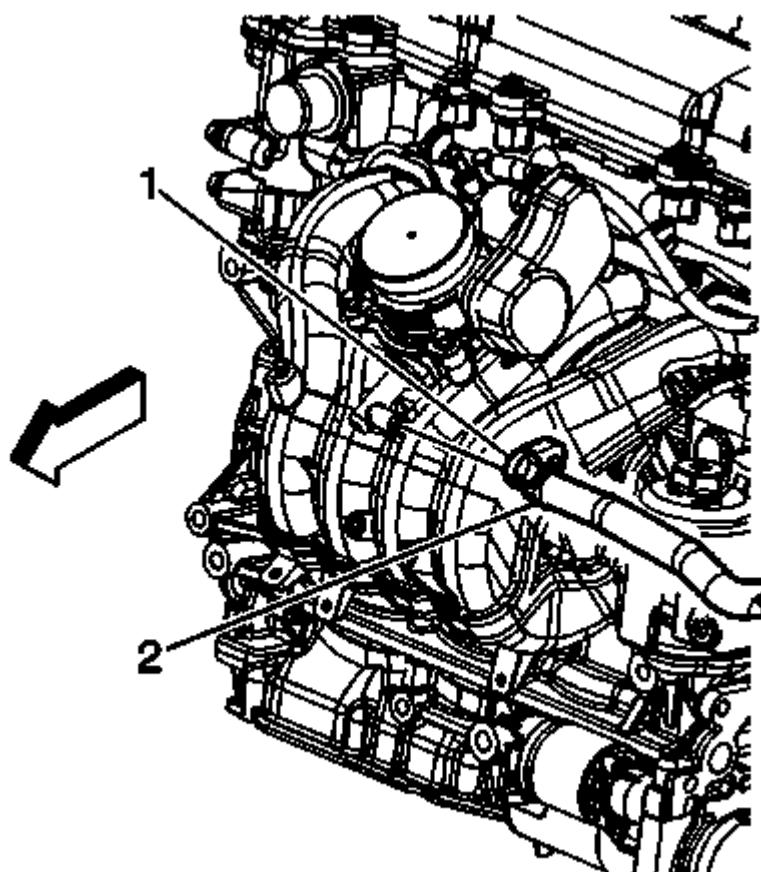
**Fig. 67: Timing Belt Upper Front Cover & Fasteners**

Courtesy of GENERAL MOTORS COMPANY

Timing Belt Upper Front Cover Replacement

Callout	Component Name
	Timing Belt Upper Front Cover Fastener (Qty: 2)
1	CAUTION: Refer to <u>Fastener Caution</u> .
2	Tighten 6 N.m (53 lb in)
	Timing Belt Upper Front Cover

TIMING BELT LOWER FRONT COVER REPLACEMENT

**Fig. 68: Timing Belt Lower Front Cover & Fasteners**

Courtesy of GENERAL MOTORS COMPANY

Timing Belt Lower Front Cover Replacement

Callout	Component Name
Preliminary Procedures	
1	<p>1. Remove the front wheelhouse liner inner front extension. Refer to <u>Front Wheelhouse Liner Inner Front Extension Replacement (Left Side)</u> , <u>Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW)</u> .</p> <p>2. Remove the crankshaft balancer. Refer to <u>Crankshaft Balancer Replacement</u>.</p> <p>3. Remove the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement</u>.</p> <p>Timing Belt Lower Front Cover Fastener (Qty: 4)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten 6 (53 lb in)</p>

2

Timing Belt Lower Front Cover

Procedure

Transfer parts as necessary.

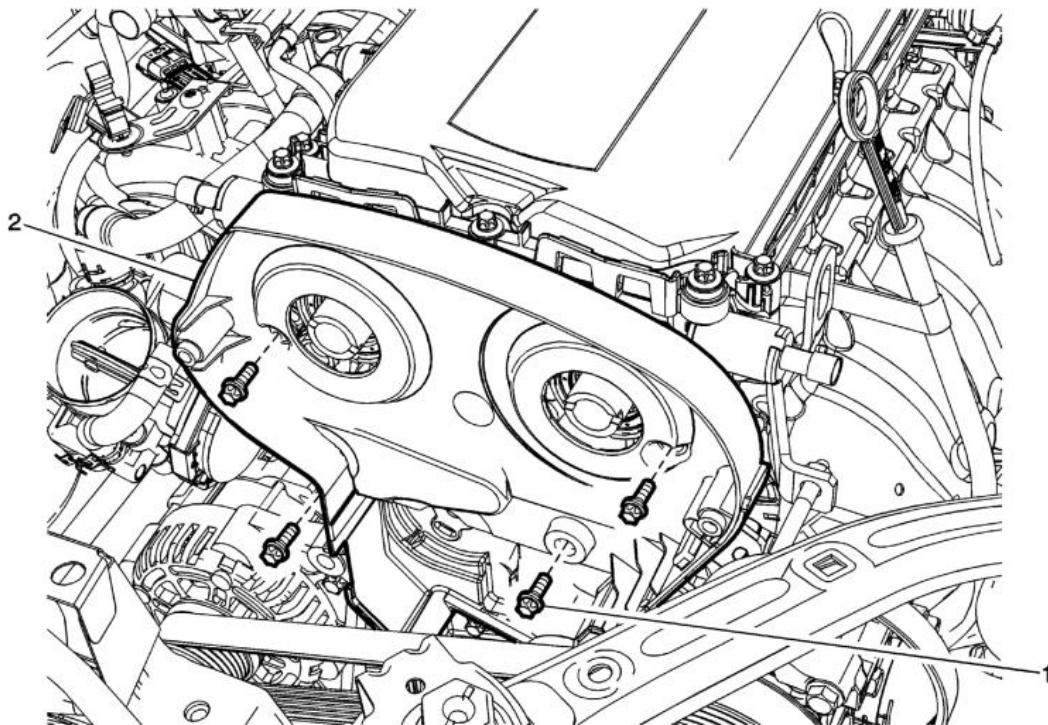
TIMING BELT REAR COVER REPLACEMENT

Fig. 69: Timing Belt Rear Cover & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Timing Belt Rear Cover Replacement

Callout	Component Name
Preliminary Procedures Remove the camshaft sprocket. Refer to <u>Camshaft Sprocket Replacement</u>	
1	<p>Timing Belt Rear Cover Fastener (Qty 4)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. New bolt must be used whenever the cover is removed. 2. Apply locking compound to the NEW timing belt rear cover bolts.

	Tighten 6 N.m (53 lb in)
2	Timing Belt Rear Cover Procedure Transfer parts as necessary.

VALVE LIFTER REPLACEMENT

Special Tools

EN-845 Suction Device

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

Removal Procedure

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

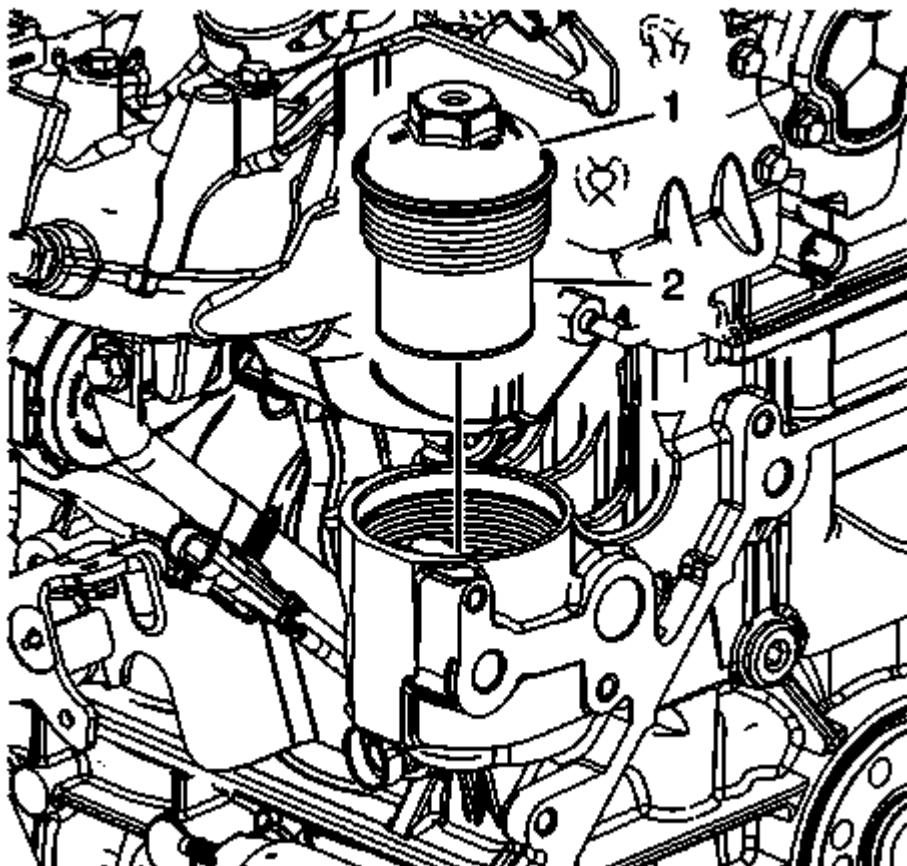


Fig. 70: Valve Lifters

Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the assignments.

2. Remove the valve lifter (1) use the **EN-845** suction device.

Installation Procedure

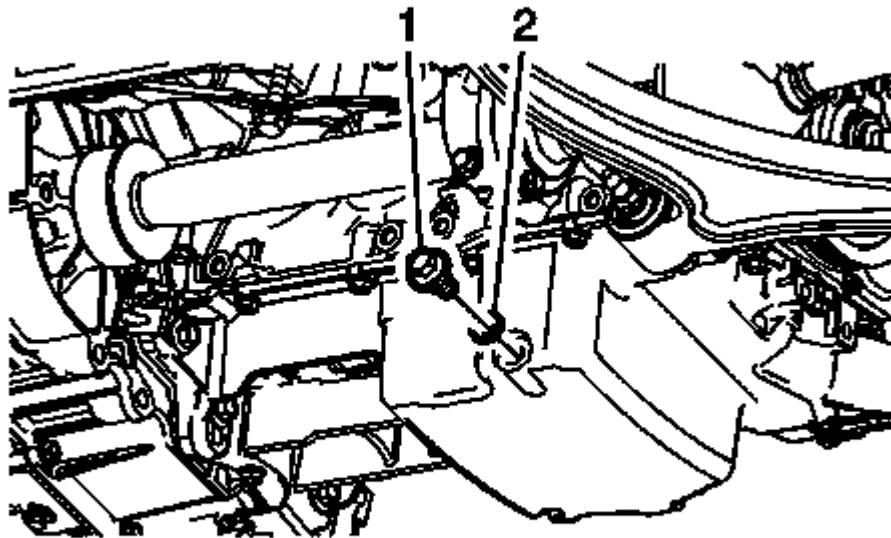


Fig. 71: Valve Lifters

Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe the correct assignment.

NOTE: Coat the sliding surfaces with NEW engine oil.

1. Install the valve lifter (1) use the **EN-845** suction device.
2. Install the camshaft. Refer to [Camshaft Replacement](#).

CAMSHAFT SPROCKET REPLACEMENT

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](#).

Removal Procedure

1. Open the hood.
2. Remove the air cleaner housing. Refer to [Air Cleaner Assembly Replacement](#).
3. Remove the camshaft cover. Refer to [Camshaft Cover Replacement](#).
4. Remove the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
5. Remove the timing belt. Refer to [Timing Belt Replacement](#).
6. Remove the timing belt idler pulley. Refer to [Timing Belt Idler Pulley Removal](#).

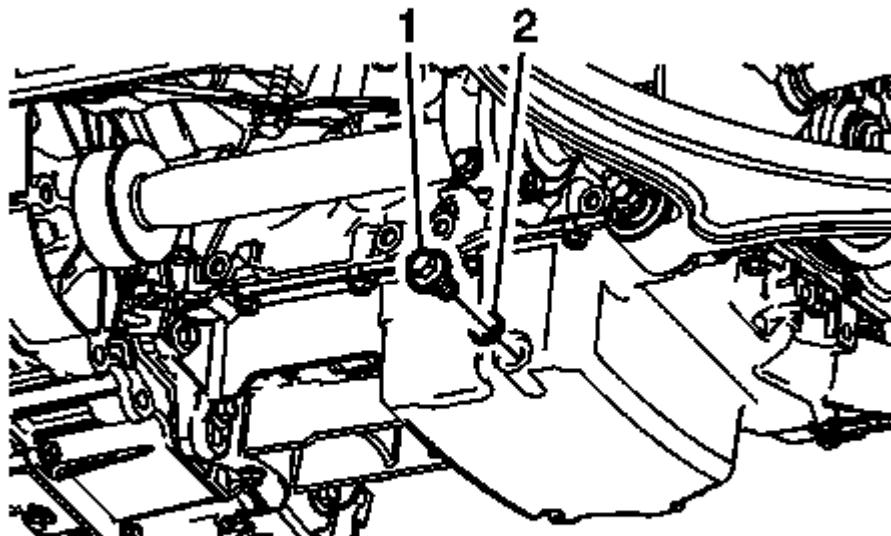


Fig. 72: Turning Crankshaft Against Direction Of Engine Rotation
Courtesy of GENERAL MOTORS COMPANY

7. Set the crankshaft in direction of engine rotation to 60°(a) before TDC. Use the EN-45059 meter and the crankshaft balancer bolt.
8. Remove the crankshaft sprocket. Refer to [Crankshaft Sprocket Removal](#).

9. Lower the vehicle.
10. Remove the engine mount bracket. Refer to [Engine Mount Bracket Replacement](#).

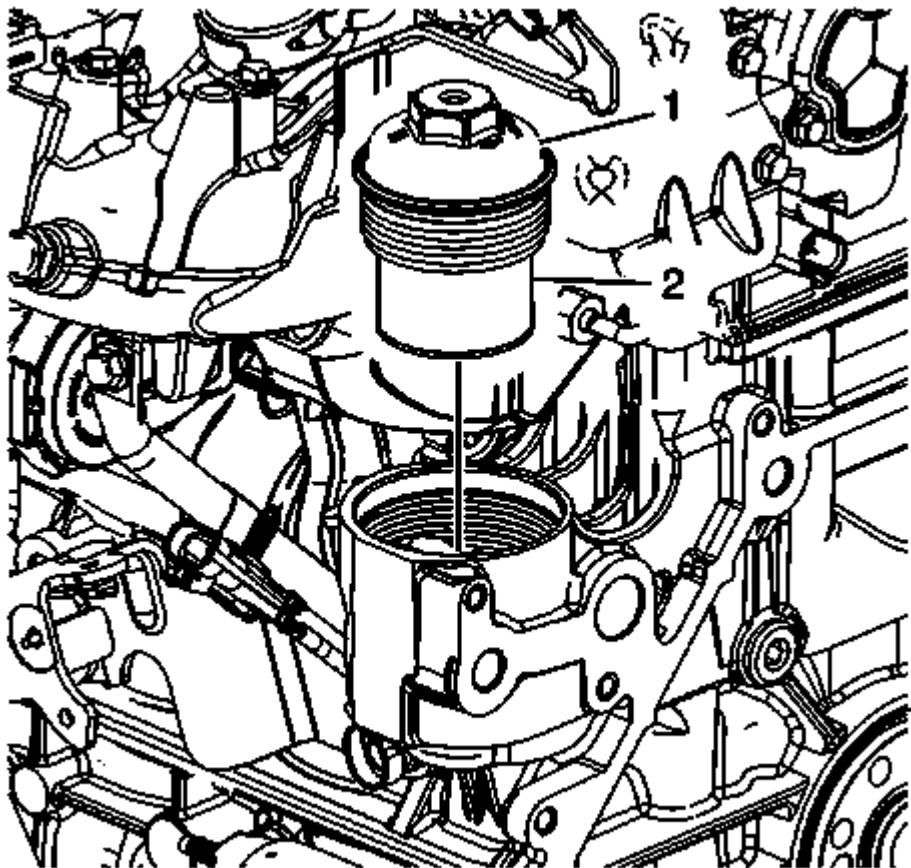


Fig. 73: Timing Belt Center Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

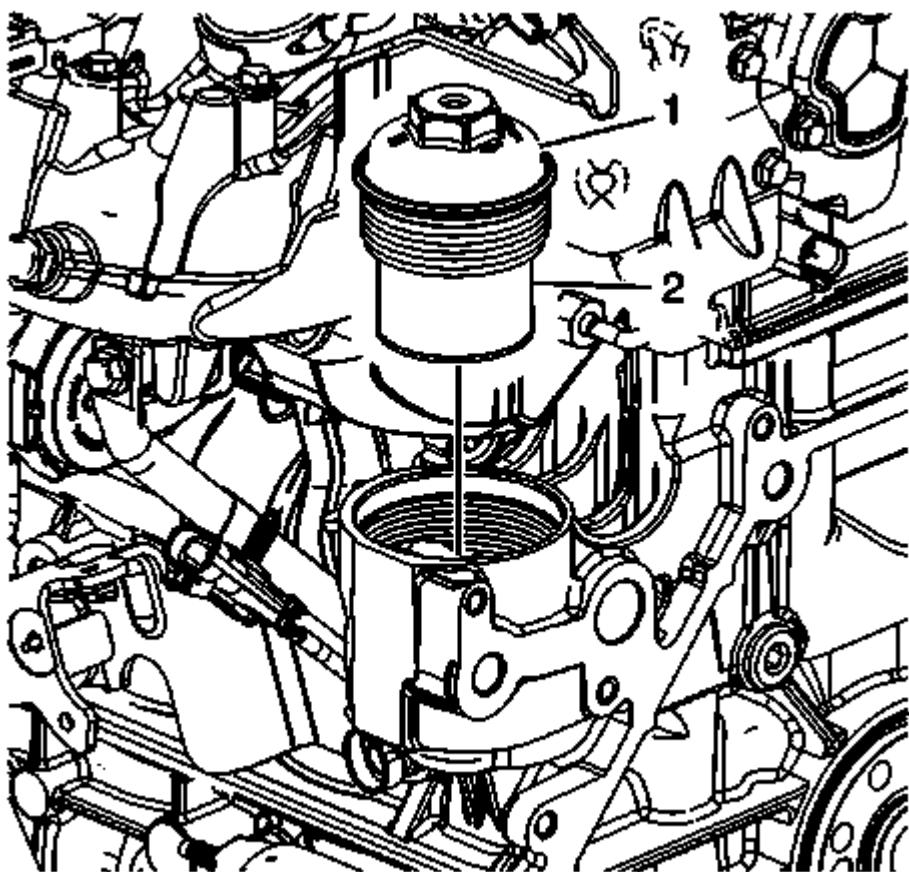


Fig. 74: Timing Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

13. Remove the tensioner bolt (1).
14. Remove the timing belt tensioner (2).

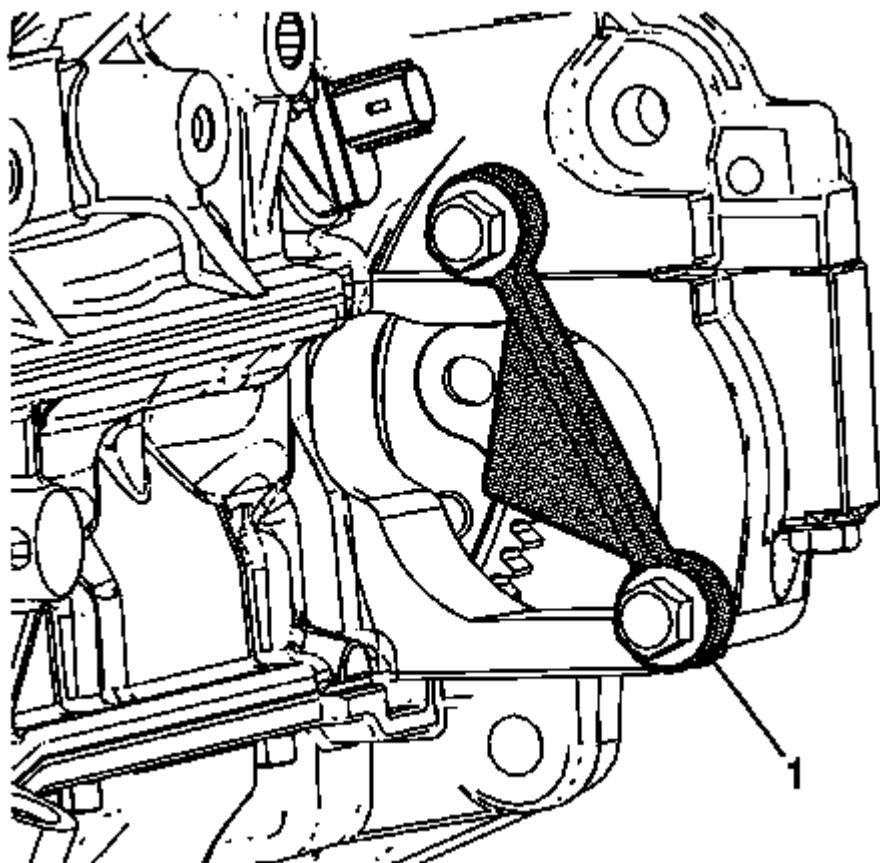


Fig. 75: Aligning Camshafts Horizontally
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the arrows.

15. Turn the camshaft by the hexagon until the groove on the end of the camshafts is horizontal.

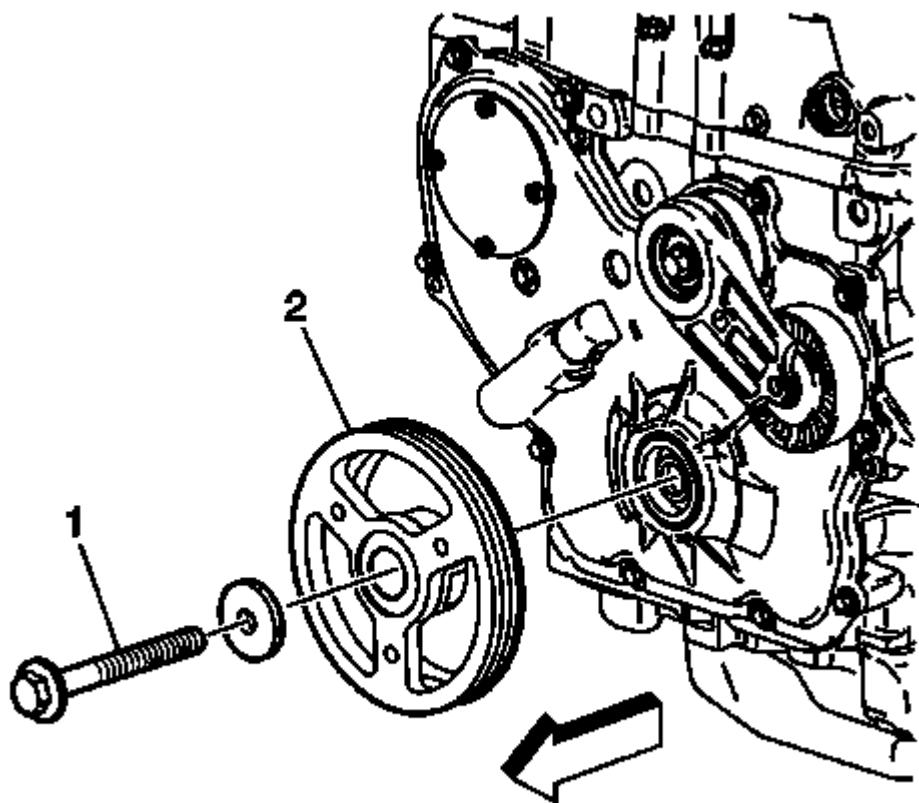


Fig. 76: Locking Tool

Courtesy of GENERAL MOTORS COMPANY

16. Install the EN-6628-A locking tool (1).
17. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle.

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.

18. Place a collecting basin underneath the vehicle.

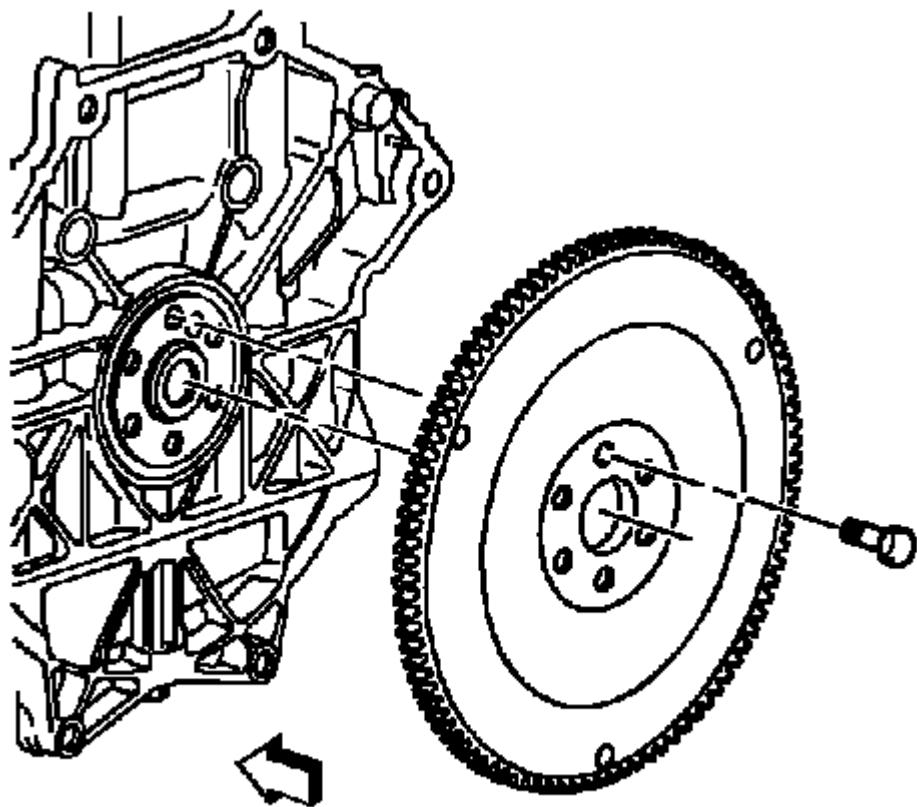


Fig. 77: Camshaft Position Actuator Adjuster Closure Bolt

Courtesy of GENERAL MOTORS COMPANY

19. 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).
20. Remove and DISCARD the intake camshaft position actuator adjuster bolt and/or the exhaust camshaft position actuator adjuster bolt (2).

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

21. Remove the intake camshaft position actuator adjuster and/or the exhaust camshaft position actuator adjuster (3).

Installation Procedure

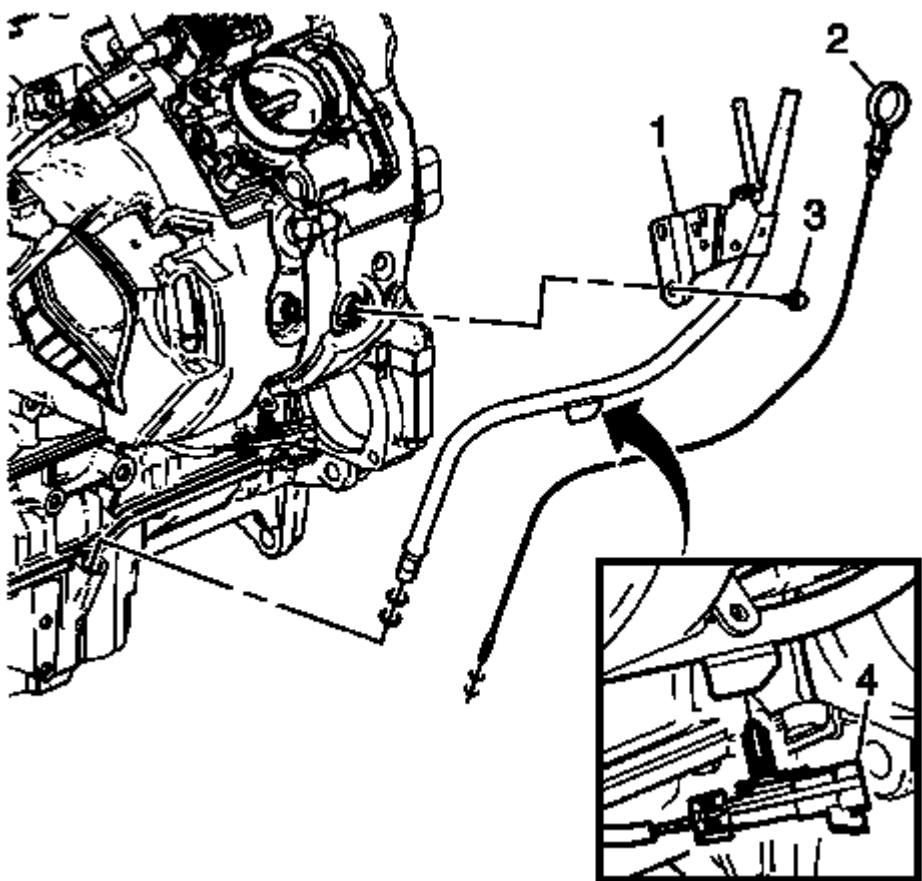


Fig. 78: Camshaft Position Actuator Adjuster Closure Bolt

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.

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).

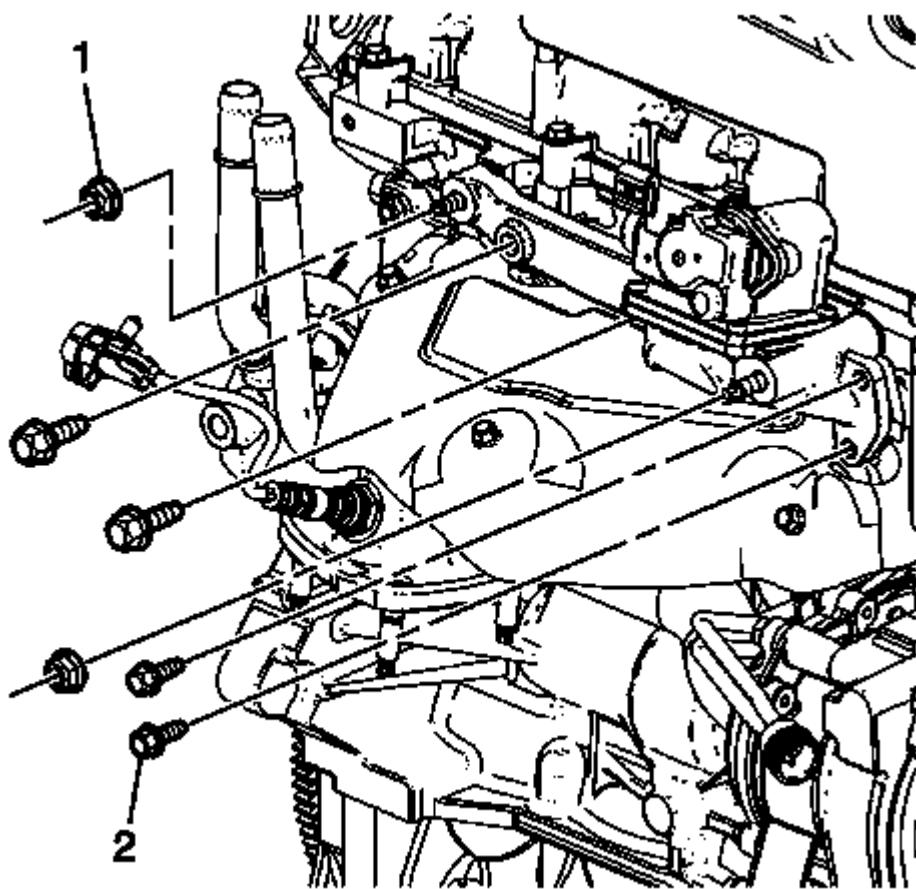


Fig. 79: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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 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-right.**

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

CAUTION: Refer to Fastener Caution .

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

NOTE: A second person is required. Counterhold at the camshaft hexagon.

4. Tighten the intake camshaft position actuator adjuster or exhaust camshaft position actuator adjuster bolts to 50 (37 lb ft) + 15° + 15° use the **EN-45059** meter.

NOTE: Install a NEW seal ring.

5. Install camshaft closure bolt and tighten to 30 (22 lb ft).
6. Remove the **EN-6628-A** locking tool.

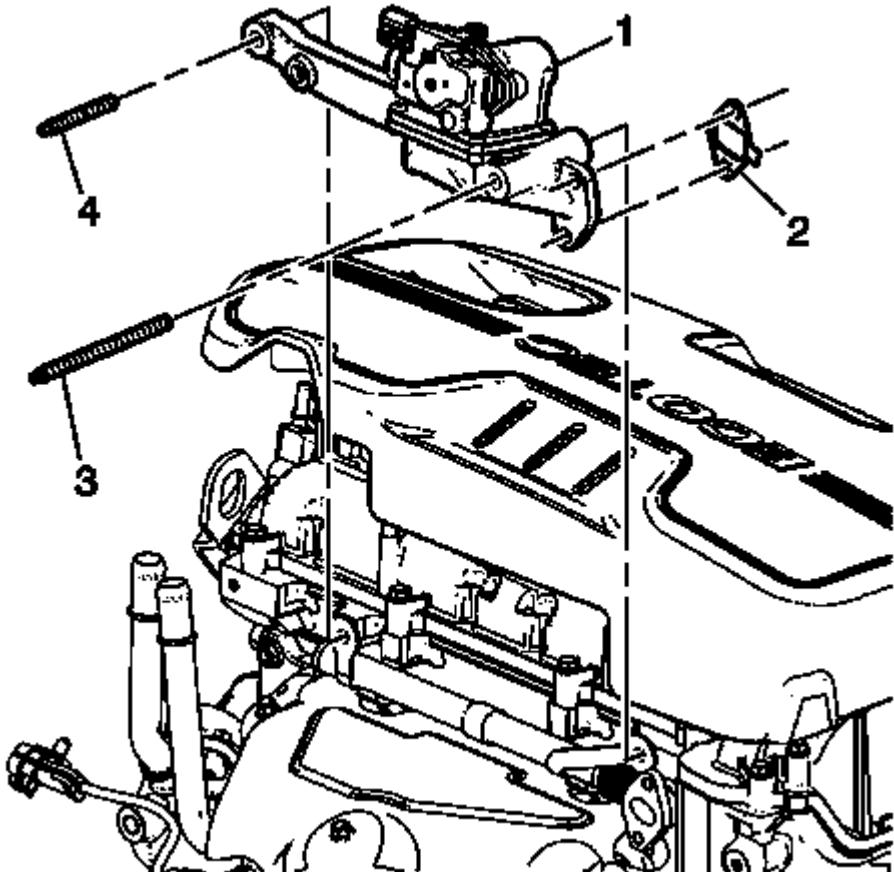


Fig. 80: Timing Belt Tensioner

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 (15 lb ft).

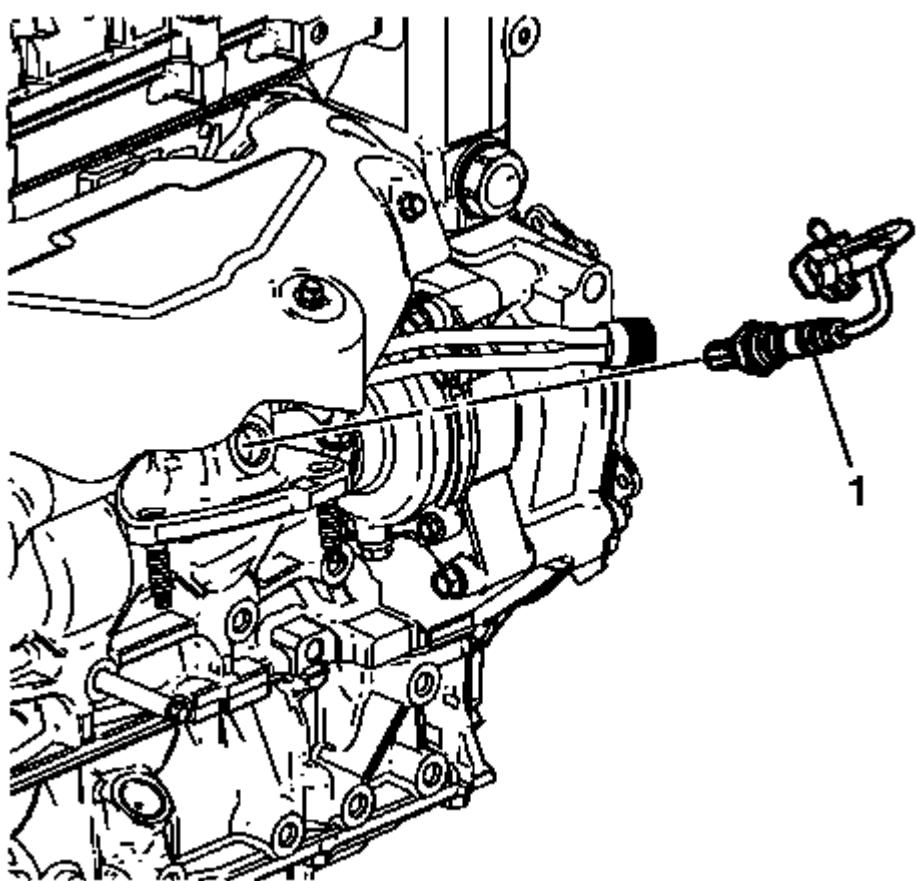


Fig. 81: Timing Belt Center Front Cover

Courtesy of GENERAL MOTORS COMPANY

9. Install the timing belt center front cover (1) to the timing belt rear cover at 2 locations.
10. Install the engine mount bracket. Refer to [Engine Mount Bracket Replacement](#).
11. Raise the vehicle.
12. Install the crankshaft sprocket. Refer to [Crankshaft Sprocket Installation](#).

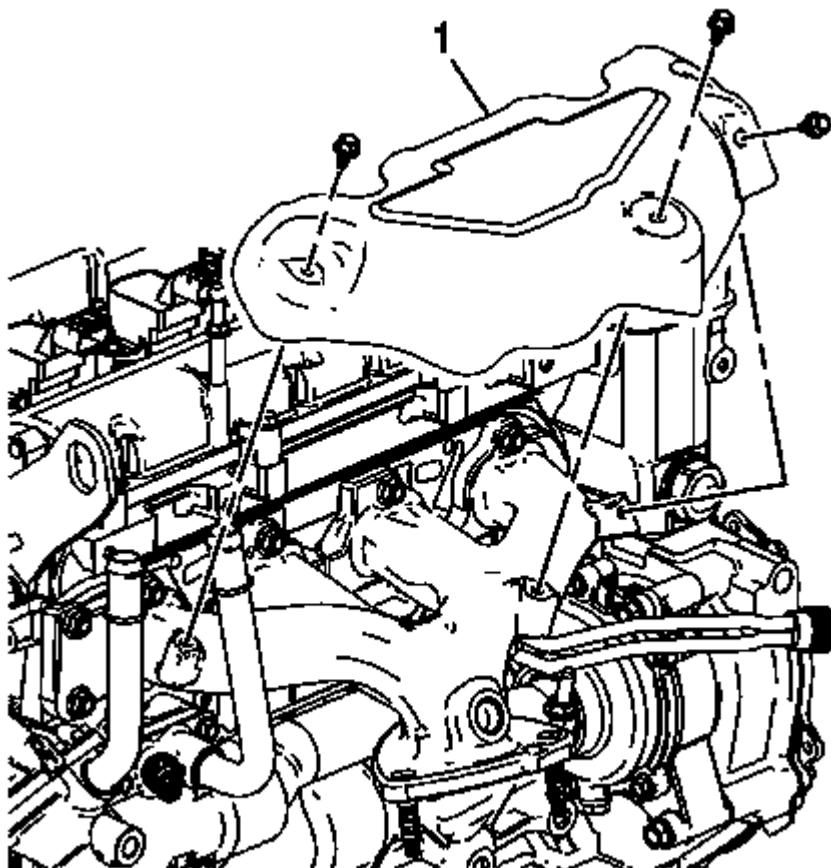


Fig. 82: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

13. Set the crankshaft in the direction of engine rotation to TDC. Use the crankshaft balancer bolt.
14. Install the timing belt idler pulley. Refer to [Timing Belt Idler Pulley Installation](#).
15. Install the timing belt. Refer to [Timing Belt Replacement](#).
16. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
17. Install the camshaft cover. Refer to [Camshaft Cover Replacement](#).
18. Install the air cleaner housing. Refer to [Air Cleaner Assembly Replacement](#).
19. Close the hood.

CYLINDER HEAD REPLACEMENT

Special Tools

- BO-38185 Hose Clamp Pliers
- EN-45059 Angle Meter

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

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Relieve fuel system pressure. Refer to [Fuel Pressure Relief](#).
3. Disconnect the fuel feed pipe. Refer to [Fuel Feed Pipe Replacement](#).
4. Disconnect EVAP purge solenoid pipes from solenoid. Refer to [Evaporative Emission System Hose/Pipe Replacement](#).
5. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
6. Remove the coolant surge tank. Refer to [Radiator Surge Tank Replacement](#).

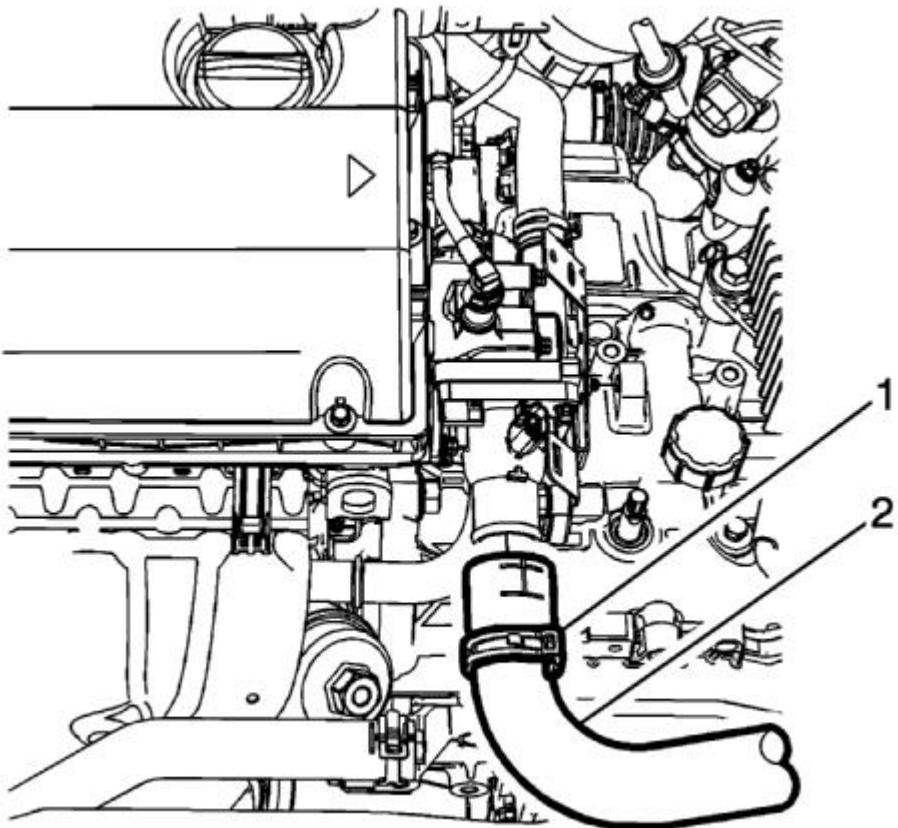


Fig. 83: Radiator Air Inlet Hose & Clamp
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the radiator inlet hose clamp (1) at the engine using **BO-38185** pliers.
8. Remove the radiator inlet hose (2) from the engine.

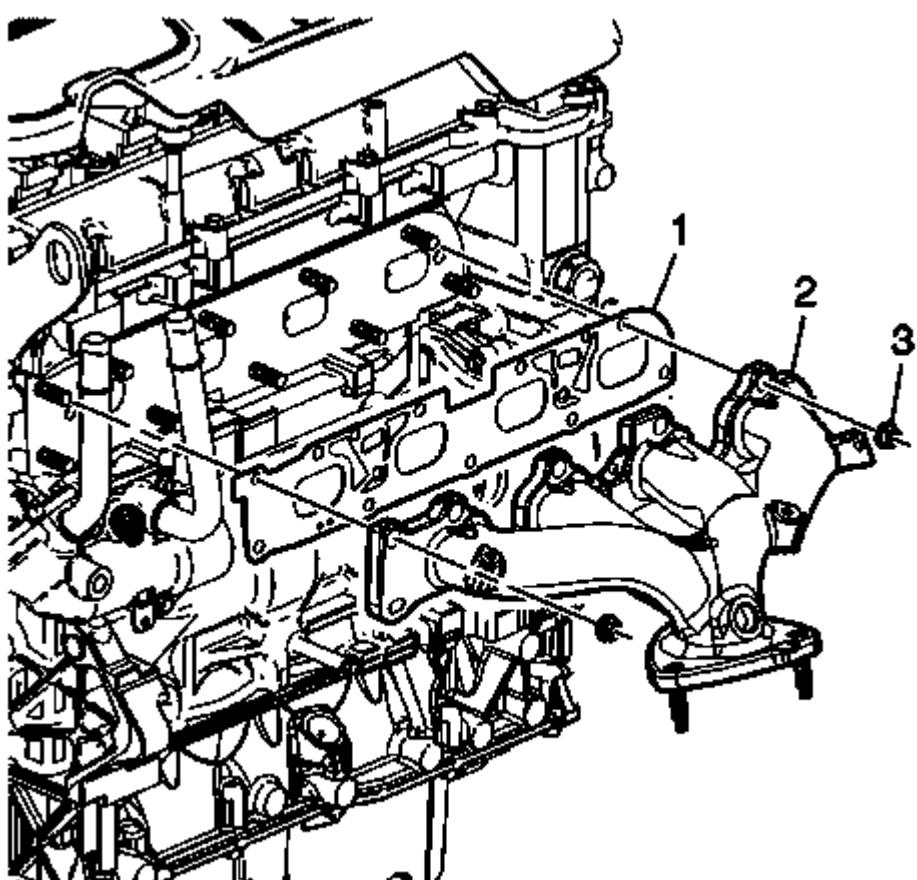


Fig. 84: Radiator Air Inlet/Outlet Hose & Clamp

Courtesy of GENERAL MOTORS COMPANY

9. Remove the inlet and outlet heater hose clamp (1) at the engine using **BO-38185** pliers.
10. Remove the inlet hose (2) and outlet (3) from the engine.

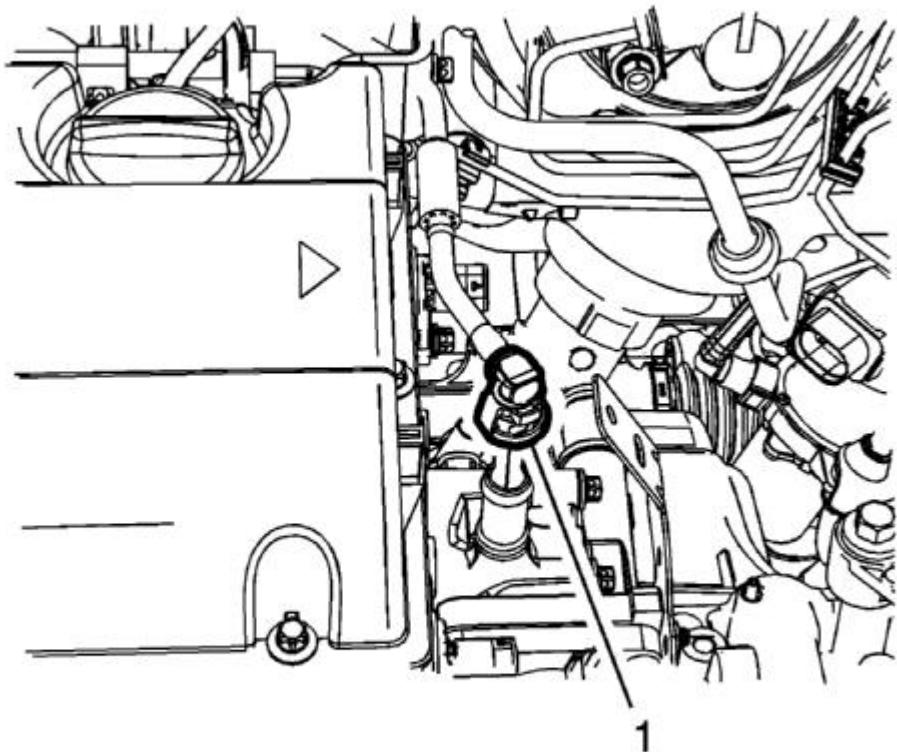


Fig. 85: Throttle Body Heater Inlet Pipe

Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the throttle body heater inlet pipe (1).

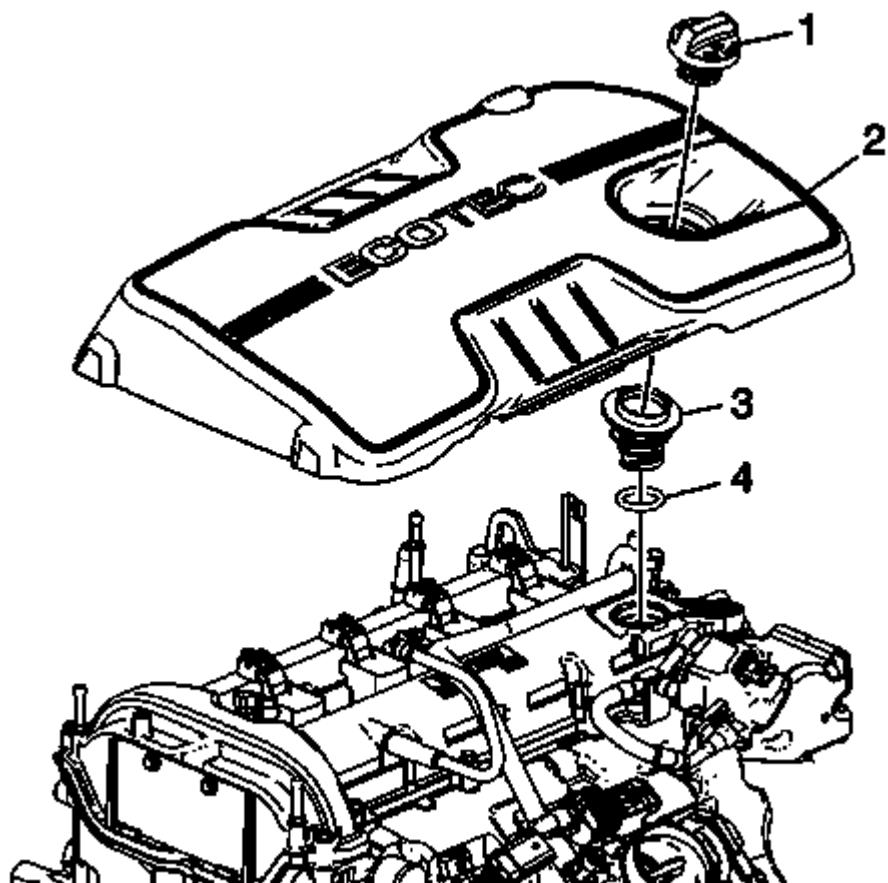


Fig. 86: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

12. Remove the ignition coil (2) . Refer to [Ignition Coil Replacement](#) .
13. Disconnect PCV hose. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).

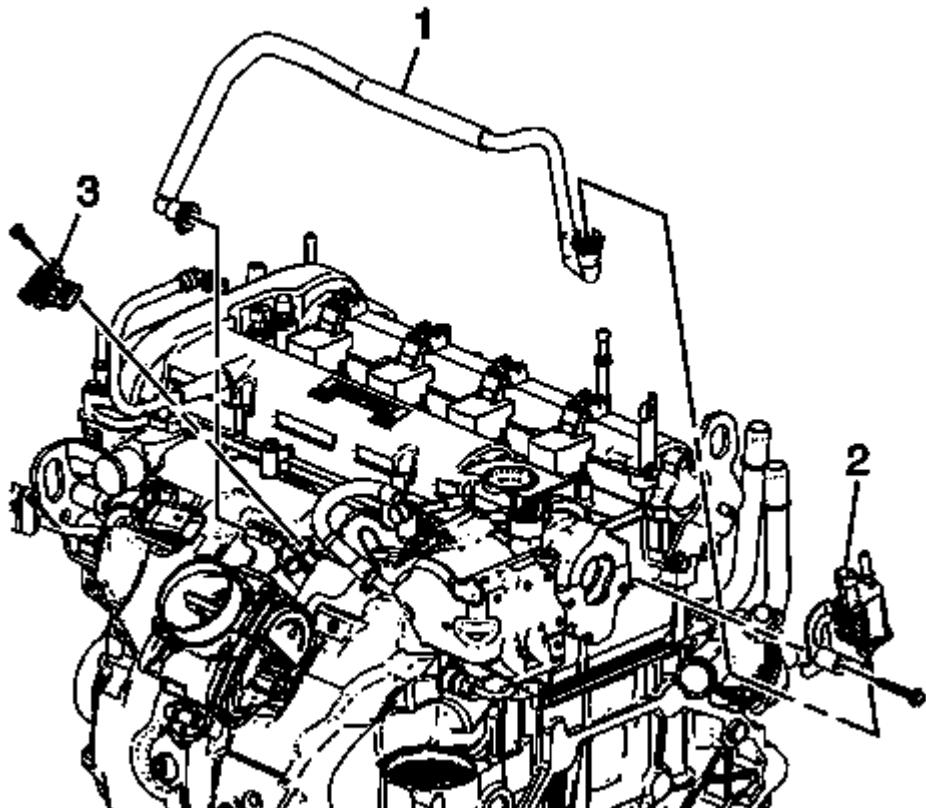


Fig. 87: Camshaft Cover

Courtesy of GENERAL MOTORS COMPANY

14. Remove the camshaft cover (1). Refer to [Camshaft Cover Replacement](#).
15. Install engine support fixture. Refer to [Engine Support Fixture](#).
16. Remove the engine mount. Refer to [Engine Mount Replacement](#).

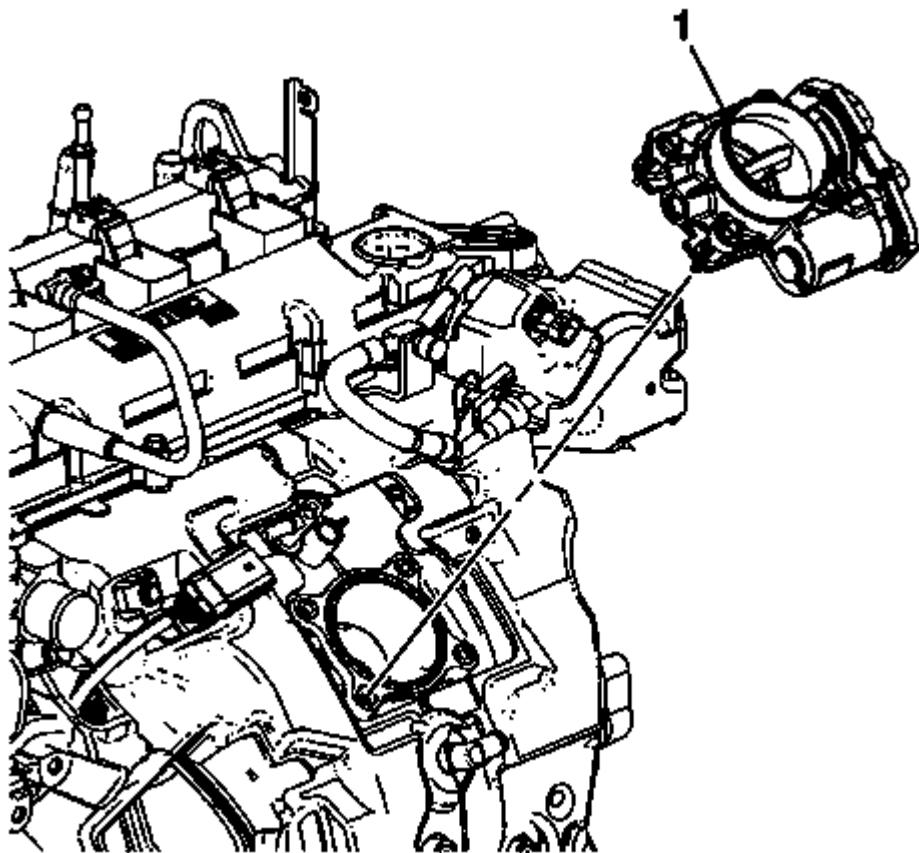


Fig. 88: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

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

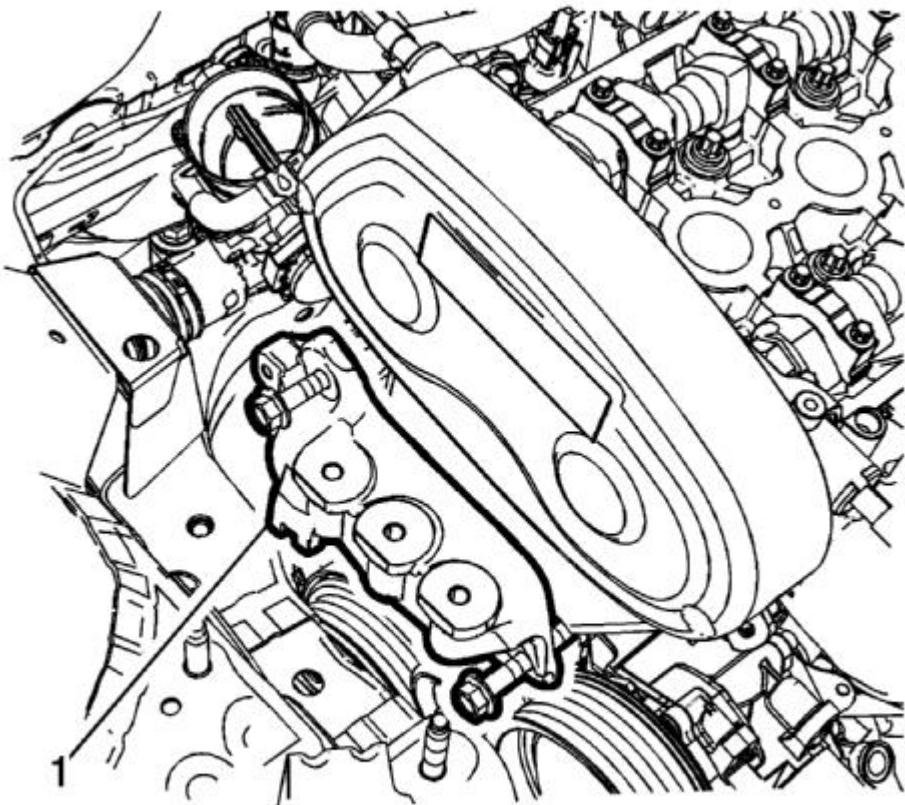


Fig. 89: Engine Mount Bracket

Courtesy of GENERAL MOTORS COMPANY

18. Remove the engine mount bracket (1). Refer to [Engine Mount Bracket Replacement](#).

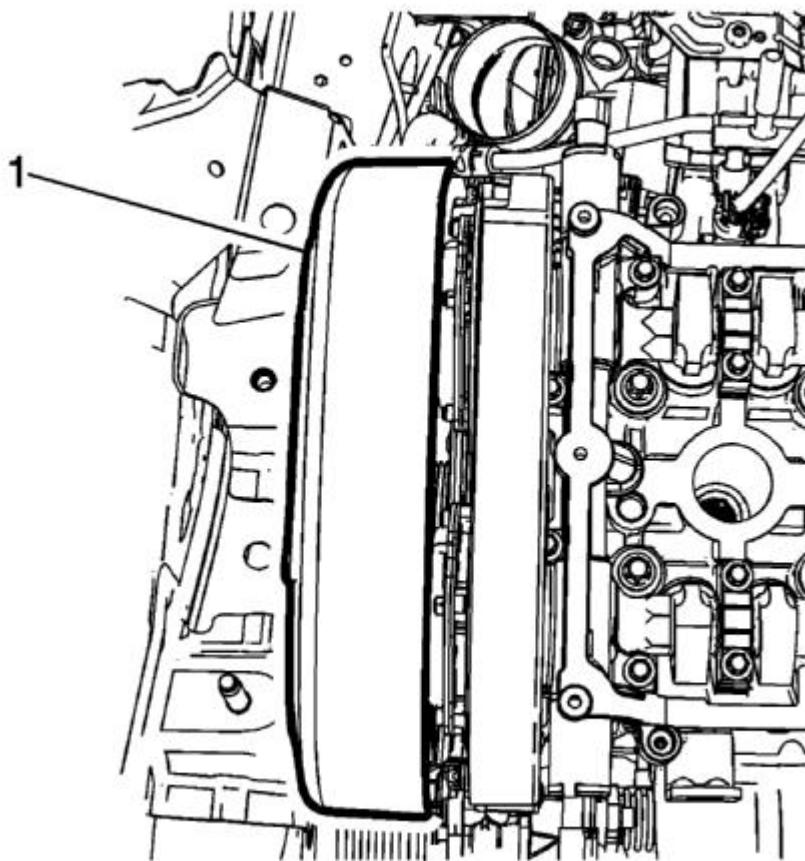


Fig. 90: Upper Timing Cover

Courtesy of GENERAL MOTORS COMPANY

19. Remove the upper timing cover (1). Refer to [Timing Belt Upper Front Cover Replacement](#).
20. Remove the timing belt center front cover. Refer to [Timing Belt Center Front Cover Replacement](#).
21. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

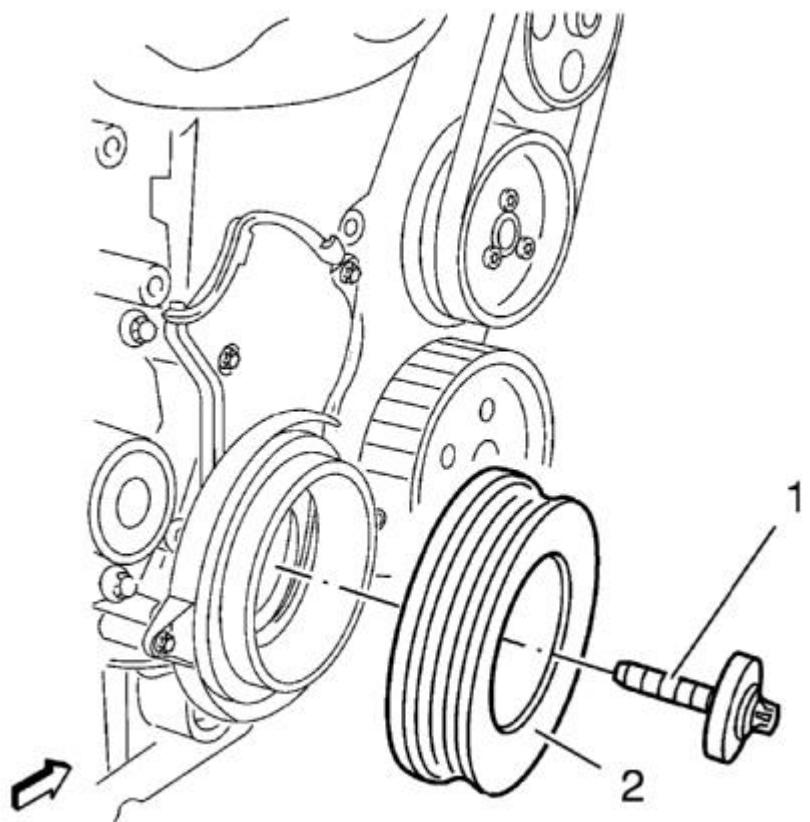


Fig. 91: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

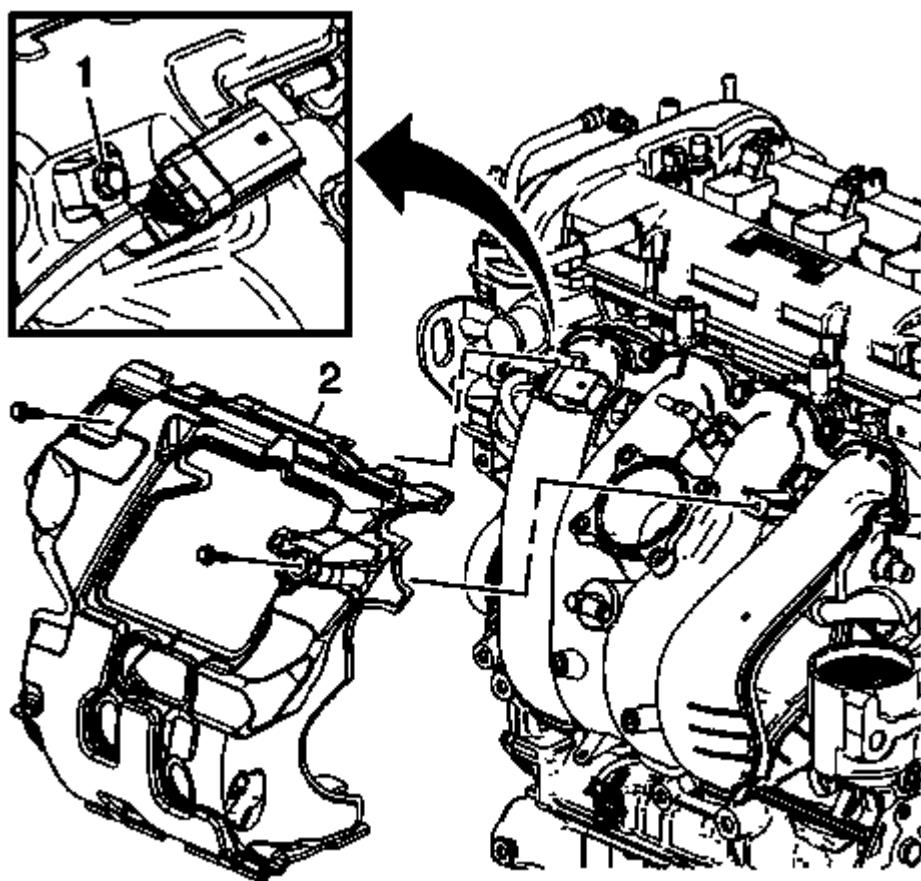


Fig. 92: Timing Belt Lower Front Cover
Courtesy of GENERAL MOTORS COMPANY

23. Remove the timing belt lower front cover (1). Refer to [Timing Belt Lower Front Cover Replacement](#).

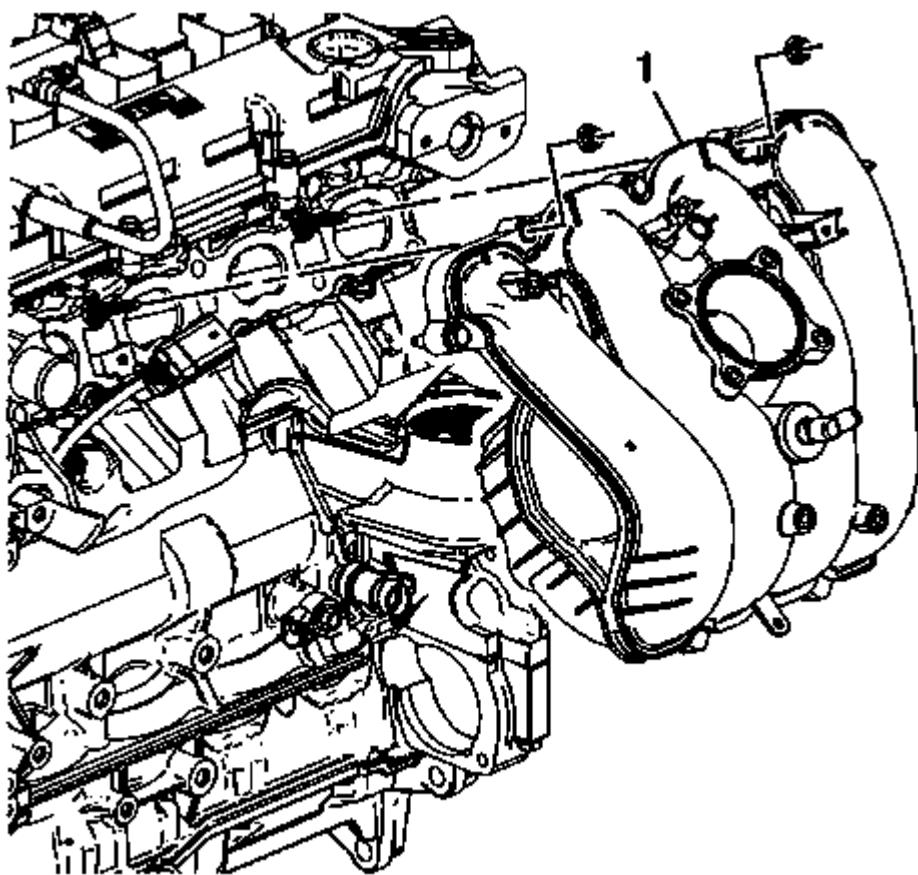


Fig. 93: Timing Belt Tensioner & Bolt

Courtesy of GENERAL MOTORS COMPANY

24. Remove the timing belt tensioner bolt (1) and the timing belt tensioner (2). Refer to [Timing Belt Tensioner Replacement](#).

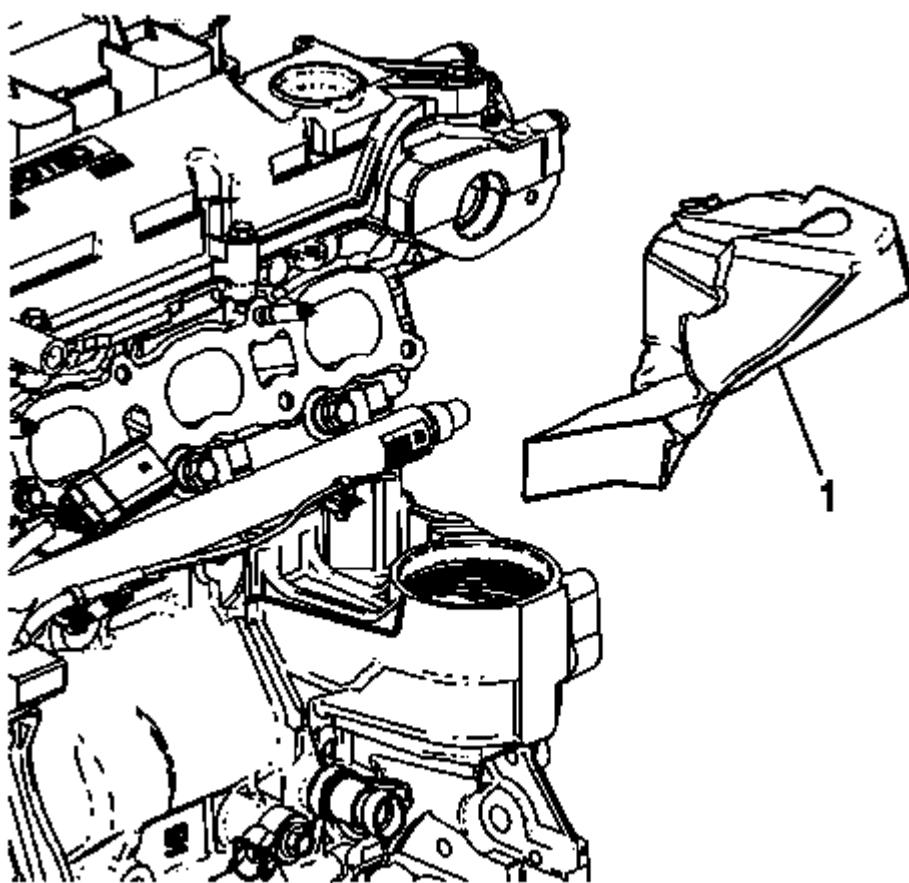


Fig. 94: Timing Belt
Courtesy of GENERAL MOTORS COMPANY

25. Remove the timing belt (1). Refer to [Timing Belt Replacement](#).

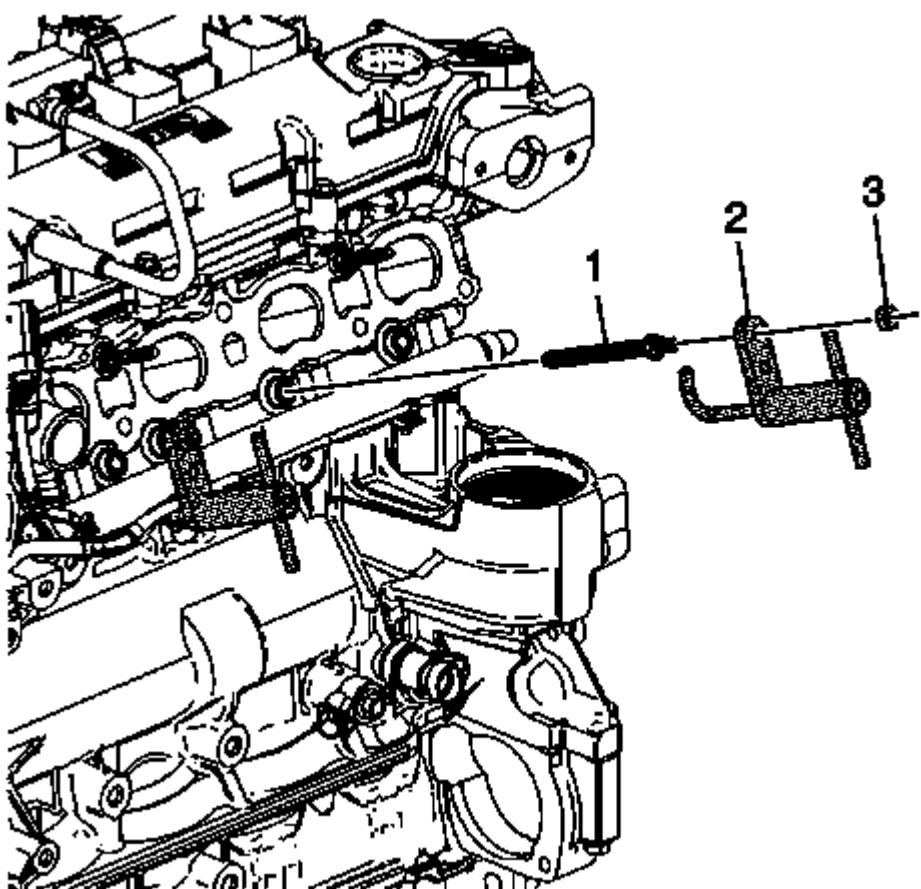


Fig. 95: Camshaft Sprocket Intake
Courtesy of GENERAL MOTORS COMPANY

26. Remove the camshaft sprocket intake (1) and exhaust (2). Refer to [Camshaft Sprocket Replacement](#).

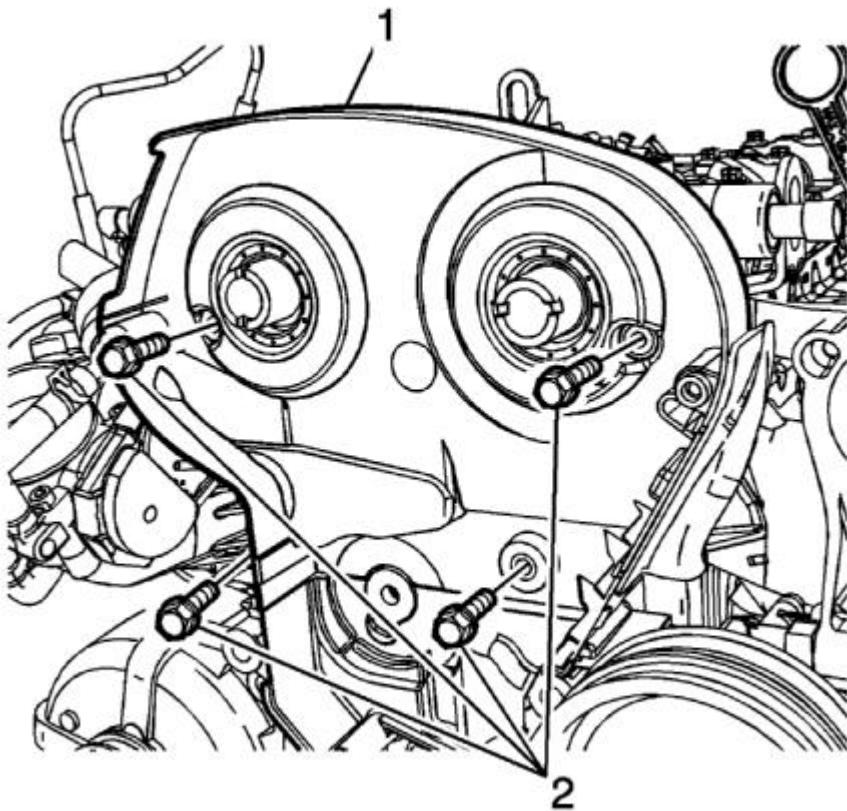


Fig. 96: Timing Belt Rear Cover & Bolts

Courtesy of GENERAL MOTORS COMPANY

27. Remove the timing belt rear cover (1). Refer to [Timing Belt Rear Cover Replacement](#).
28. Remove the exhaust manifold. Refer to [Exhaust Manifold with Catalytic Converter Replacement \(LUW\)](#).
29. Place a floor jack with block of wood under the oil pan.
30. Remove the engine support fixture. Refer to [Engine Support Fixture](#).

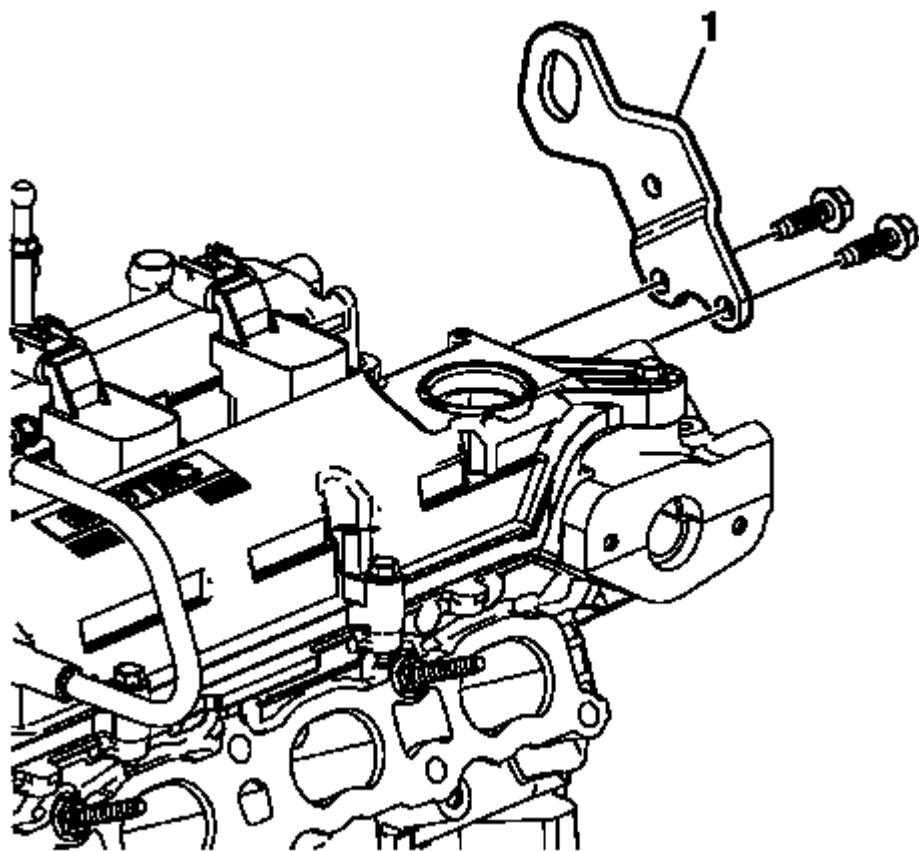


Fig. 97: Cylinder Head Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Disconnect electrical and reposition harness and hose as necessary.

31. Remove the ten cylinder head bolts in sequence as shown.
 - Loosen the 10 bolts 90°.
 - Loosen the 10 bolts 180°.
32. Remove the cylinder head and place on a suitable base.
33. Remove the cylinder head gasket.

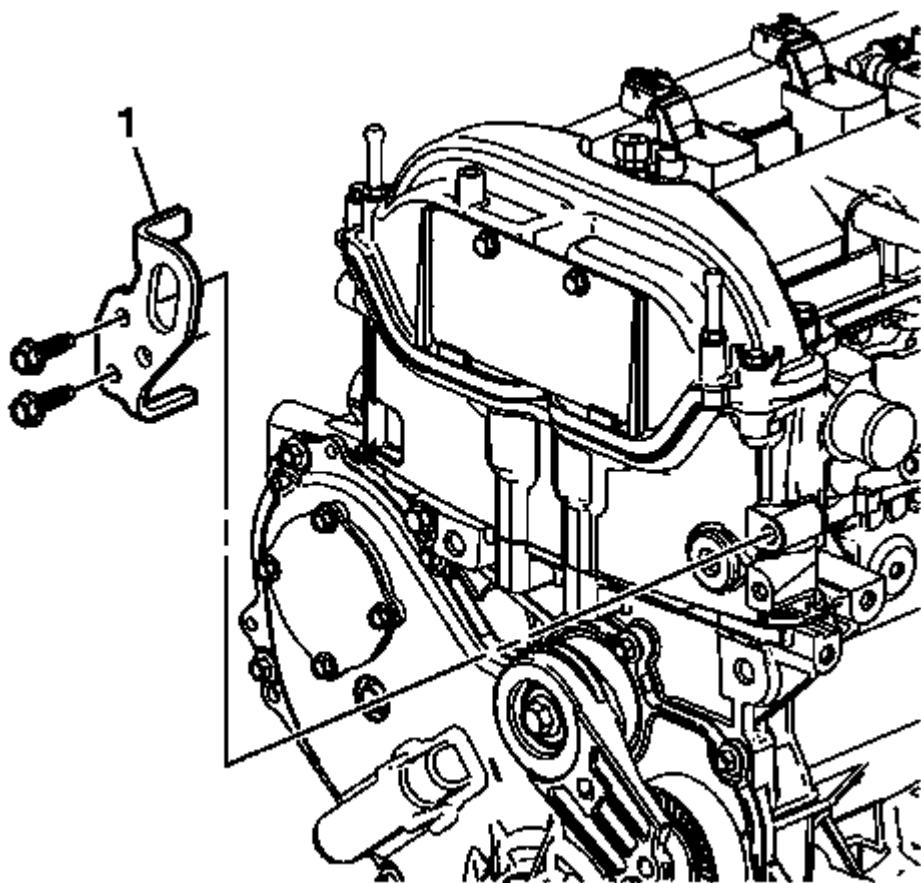


Fig. 98: Intake Manifold And Bolts

Courtesy of GENERAL MOTORS COMPANY

34. Remove the intake manifold bolts (1) intake manifold (2).
35. Remove engine coolant thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement \(LUW\)](#) .
36. Remove the 2 camshaft position actuator solenoid valve. Refer [Camshaft Position Actuator Solenoid Valve Replacement](#) .
37. Remove the 2 camshaft position sensor. Refer to [Camshaft Position Sensor Replacement](#) .
38. Clean and inspect the cylinder head. Refer to [Cylinder Head Cleaning and Inspection](#) .
39. For disassembly of the cylinder head, refer to [Cylinder Head Disassemble](#).

Installation Procedure

1. For assembly of the cylinder head, refer to [Cylinder Head Assemble](#).
2. Clean sealing surfaces of engine front cover and engine block from grease and old gasket material.
3. Install the 2 camshaft position sensor. Refer to [Camshaft Position Sensor Replacement](#) .
4. Install the 2 camshaft position actuator solenoid valve. Refer [Camshaft Position Actuator Solenoid Valve Replacement](#) .
5. Install engine coolant thermostat housing. Refer to [Engine Coolant Thermostat Housing Replacement](#)

(LUW) .

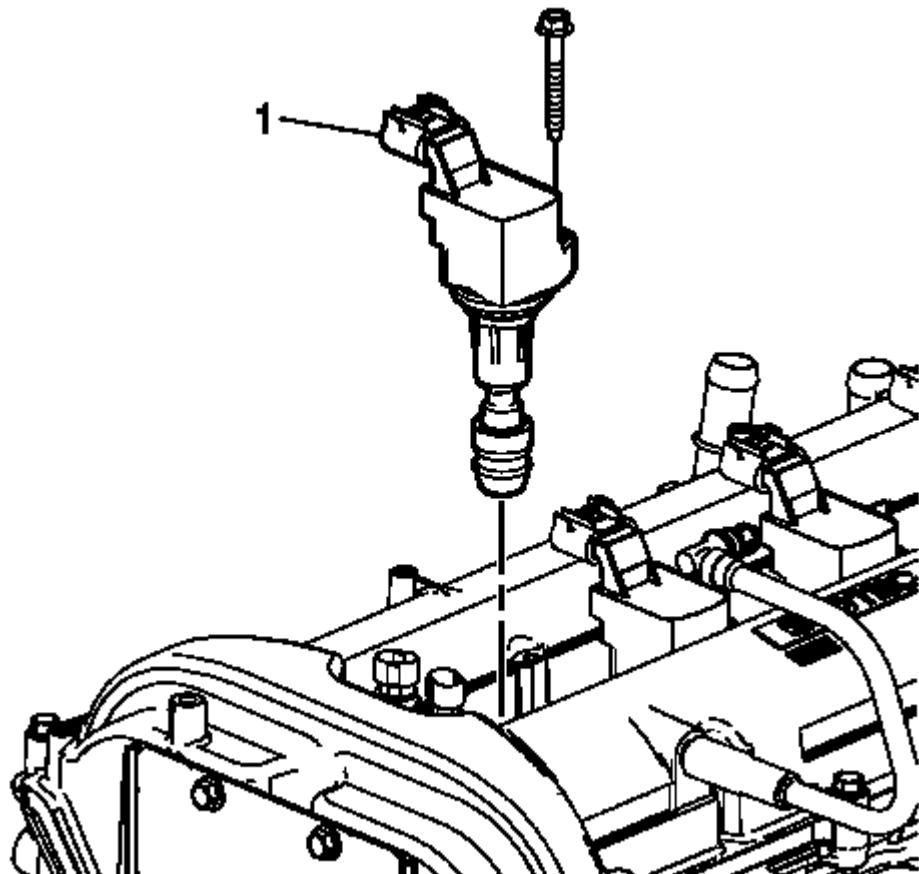


Fig. 99: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

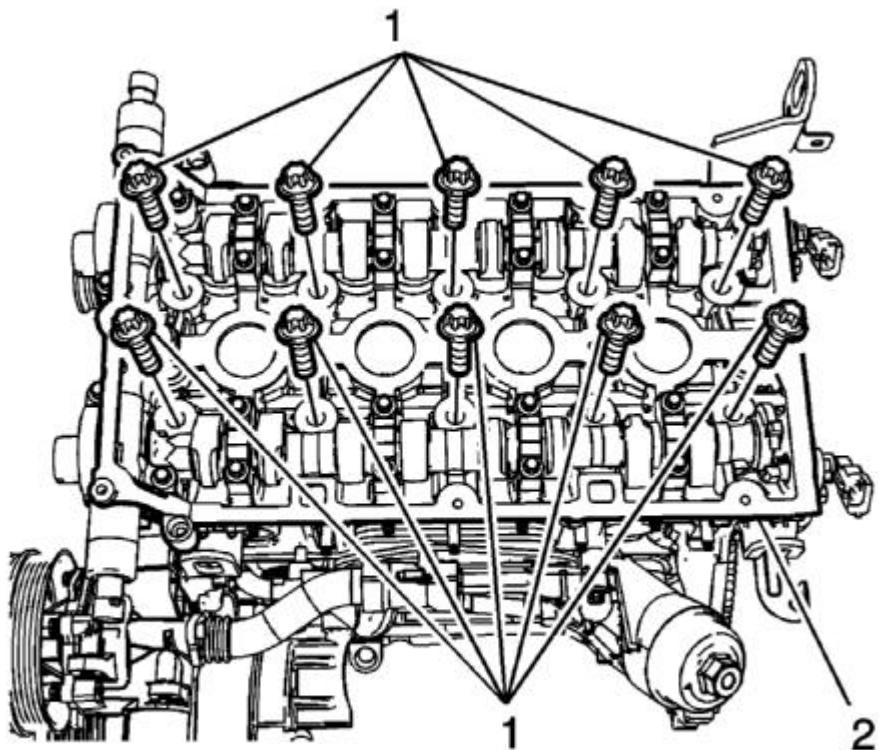


Fig. 100: Cylinder Head Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Install the cylinder head (2) with the NEW gasket and hand start the NEW bolts.

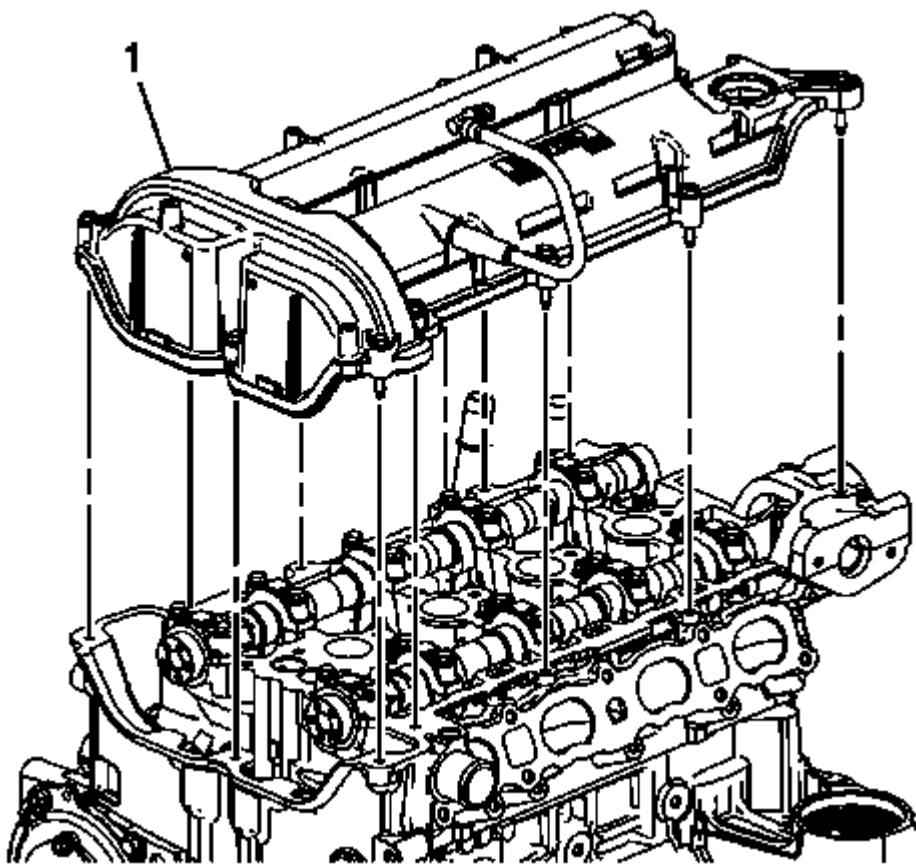


Fig. 101: Cylinder Head Bolts Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the correct tightening sequence.

8. 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°.
 - Final pass to 45°.
9. Install engine support fixture. Refer to [Engine Support Fixture](#).
10. Remove the floor jack from the vehicle.
11. Install the exhaust manifold. Refer to [Exhaust Manifold with Catalytic Converter Replacement \(LUW\)](#).

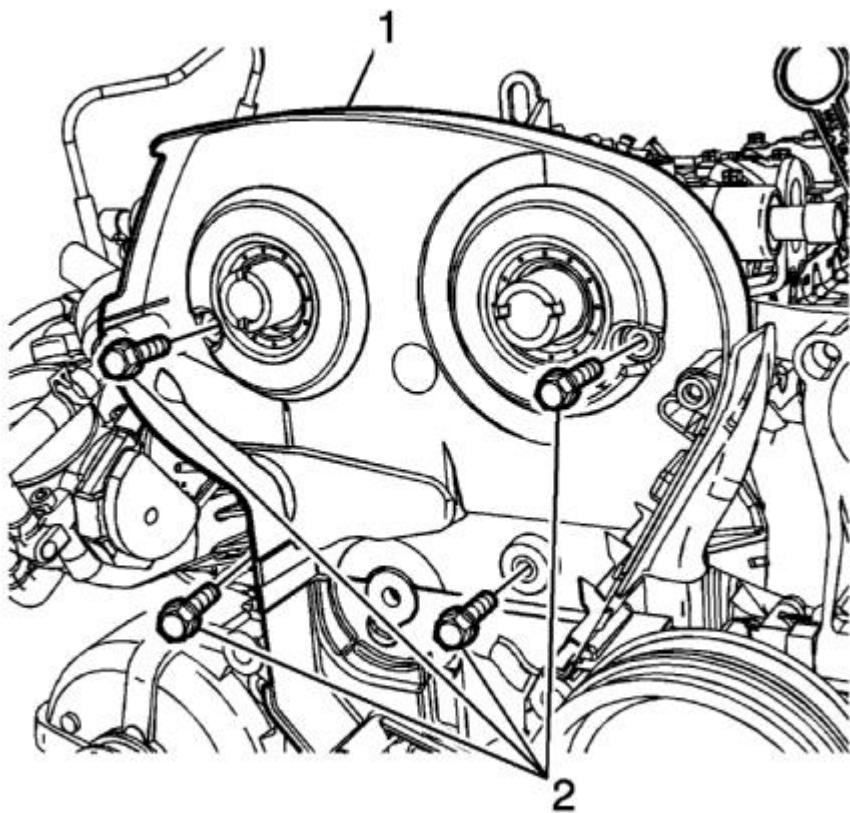


Fig. 102: Timing Belt Rear Cover & Bolts

Courtesy of GENERAL MOTORS COMPANY

12. Install the timing belt rear cover (1) and tighten to 6 N.m (53.1 lb in).

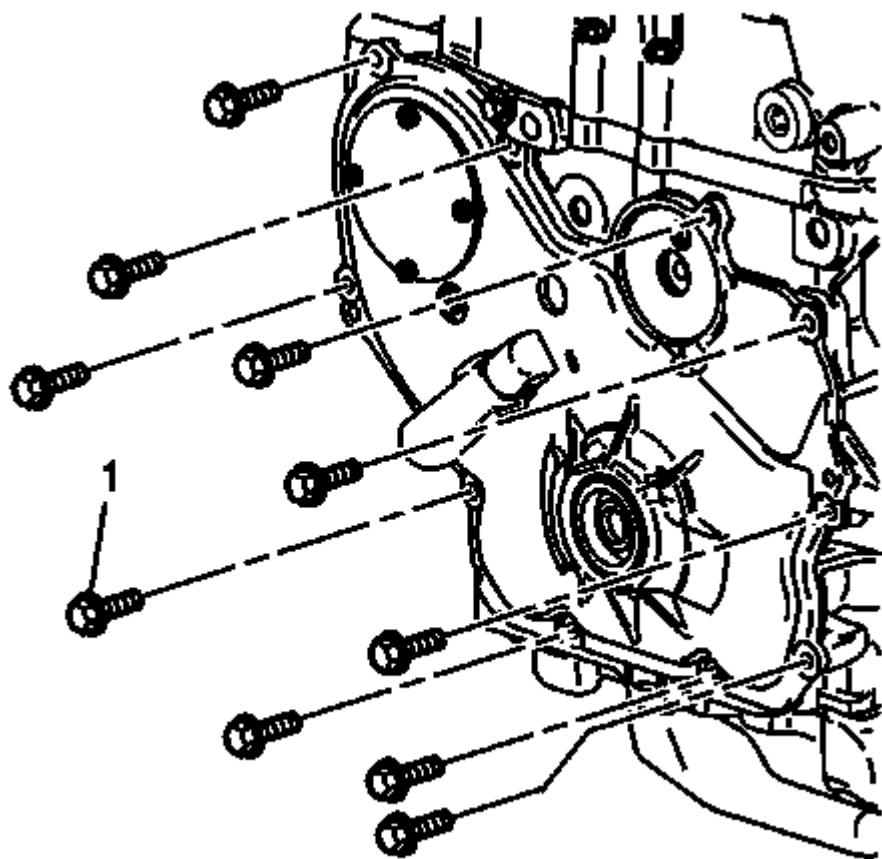


Fig. 103: Camshaft Sprocket Intake

Courtesy of GENERAL MOTORS COMPANY

13. Install the camshaft sprocket intake (1) and exhaust (2). Refer to [Camshaft Sprocket Replacement](#).

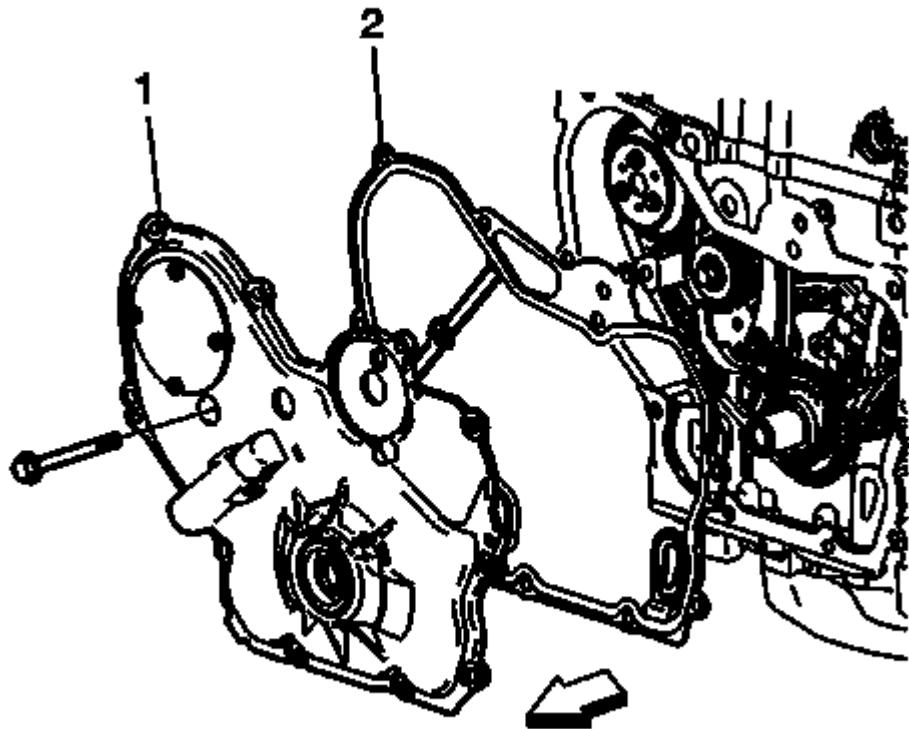


Fig. 104: Timing Belt

Courtesy of GENERAL MOTORS COMPANY

14. Install the timing belt (1). Refer to [Timing Belt Replacement](#).

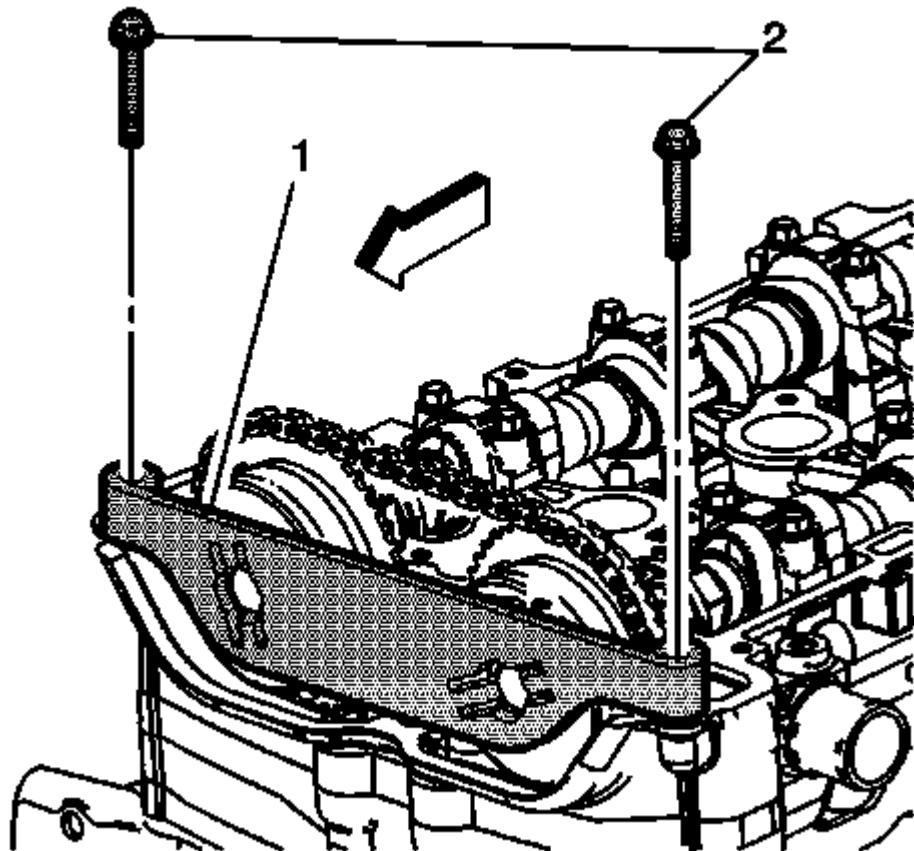


Fig. 105: Timing Belt Tensioner & Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Install the timing belt tensioner bolt (1) and the timing belt tensioner (2). Refer to [Timing Belt Tensioner Replacement](#).

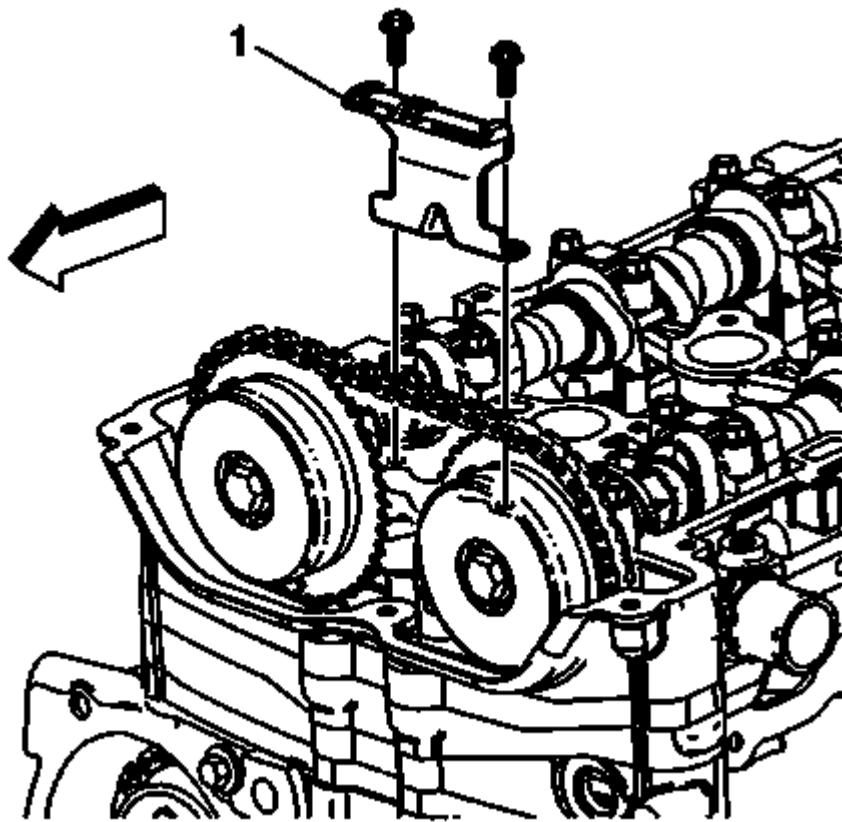


Fig. 106: Timing Belt Lower Front Cover
Courtesy of GENERAL MOTORS COMPANY

16. Install the timing belt lower front cover (1). Refer to [Timing Belt Lower Front Cover Replacement](#).

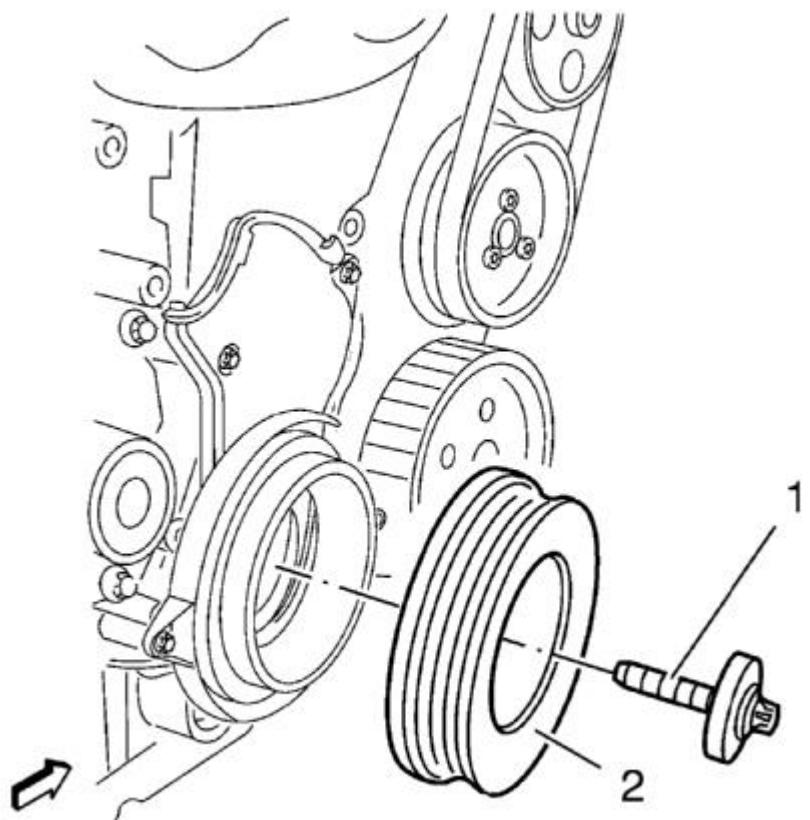


Fig. 107: Crankshaft Balancer And Bolt

Courtesy of GENERAL MOTORS COMPANY

17. Install the crankshaft balancer (2). Refer to [Crankshaft Balancer Replacement](#).
18. Install the timing belt center front cover. Refer to [Timing Belt Center Front Cover Replacement](#).

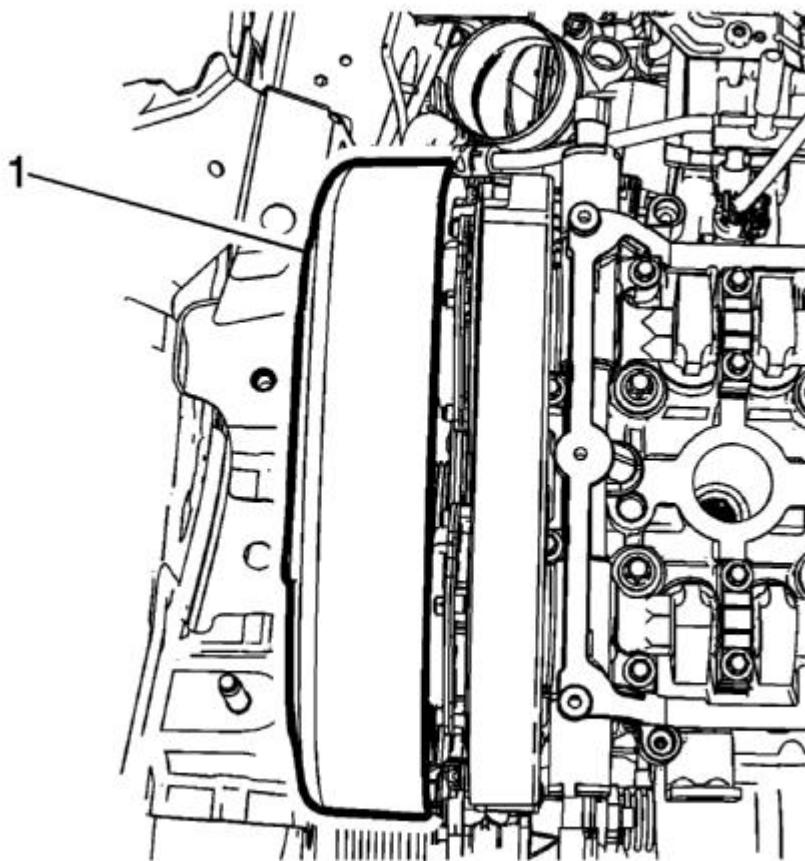


Fig. 108: Upper Timing Cover

Courtesy of GENERAL MOTORS COMPANY

19. Install the upper timing cover (1). Refer to [Timing Belt Upper Front Cover Replacement](#).

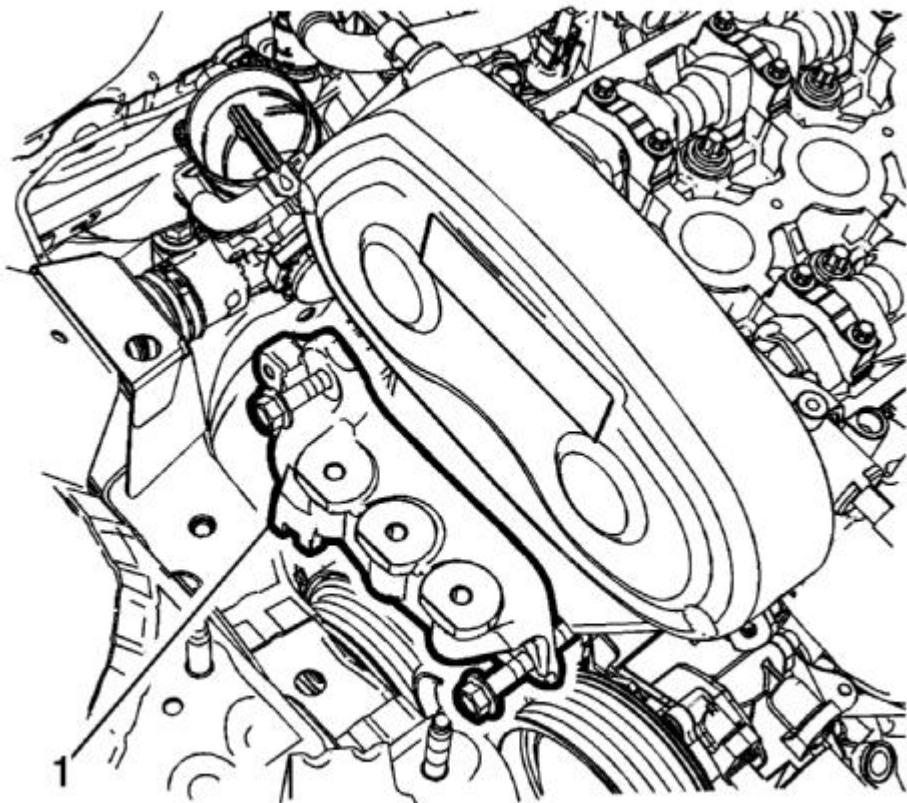


Fig. 109: Engine Mount Bracket

Courtesy of GENERAL MOTORS COMPANY

20. Install the engine mount bracket (1). Refer to [Engine Mount Bracket Replacement](#).

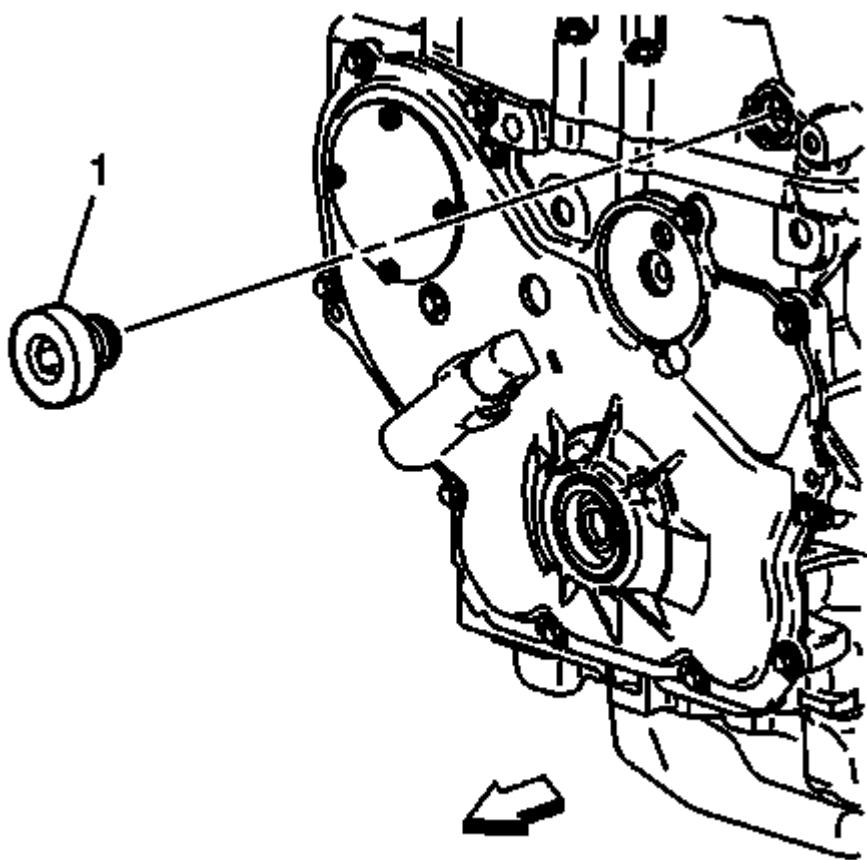


Fig. 110: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

21. Install the drive belt (1). Refer to [Drive Belt Replacement](#).
22. Install the engine mount. Refer to [Engine Mount Replacement](#).
23. Remove engine support fixture. Refer to [Engine Support Fixture](#).

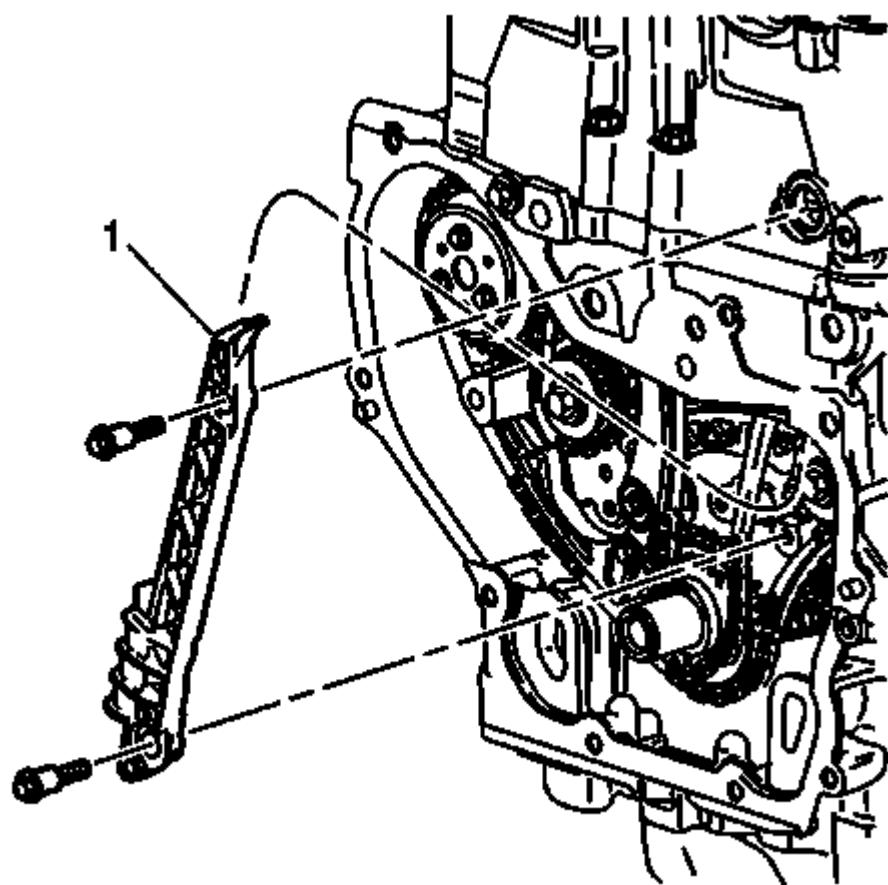


Fig. 111: Camshaft Cover

Courtesy of GENERAL MOTORS COMPANY

24. Install the camshaft cover (1). Refer to [Camshaft Cover Replacement](#).
25. Connect PCV hose. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).

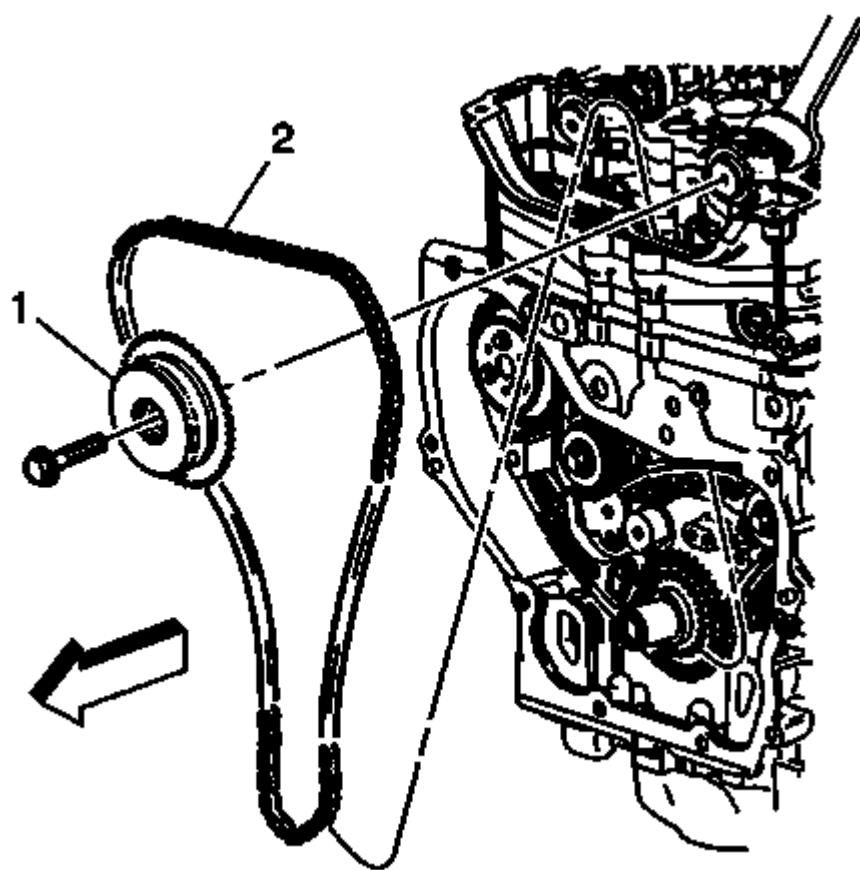


Fig. 112: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

26. Install the ignition coil (2) . Refer to [Ignition Coil Replacement](#) .

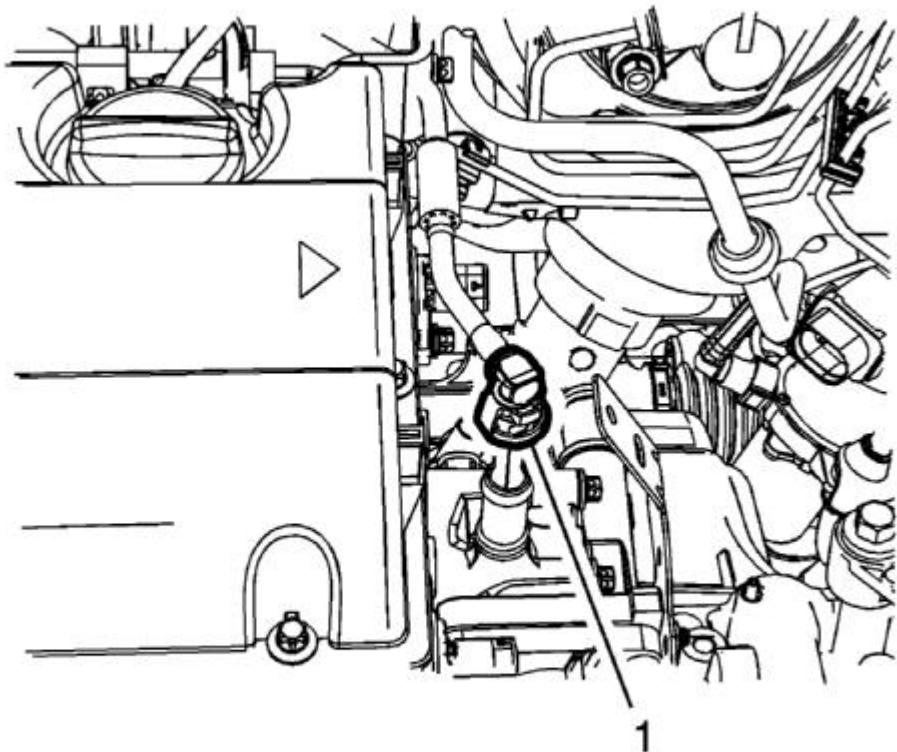


Fig. 113: Throttle Body Heater Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

27. Connect the throttle body heater inlet pipe (1).

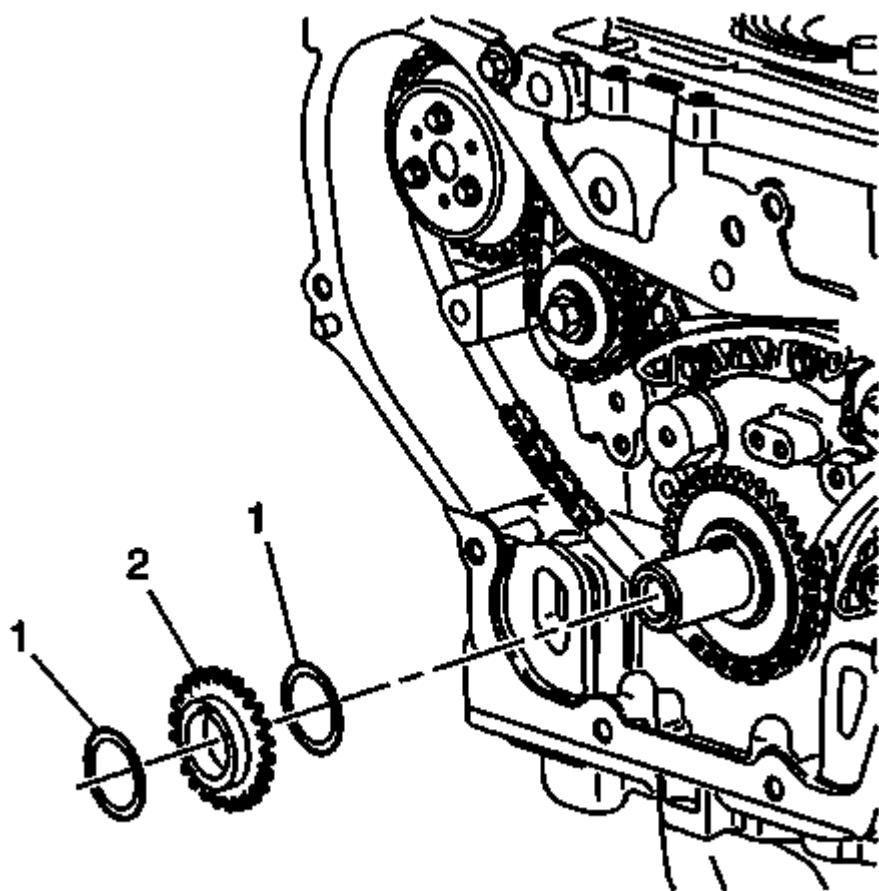


Fig. 114: Radiator Air Inlet/Outlet Hose & Clamp

Courtesy of GENERAL MOTORS COMPANY

28. Install the inlet hose (2) and outlet (3) to the engine.
29. Install the inlet and outlet heater hose clamp (1) at the engine using **BO-38185** pliers.

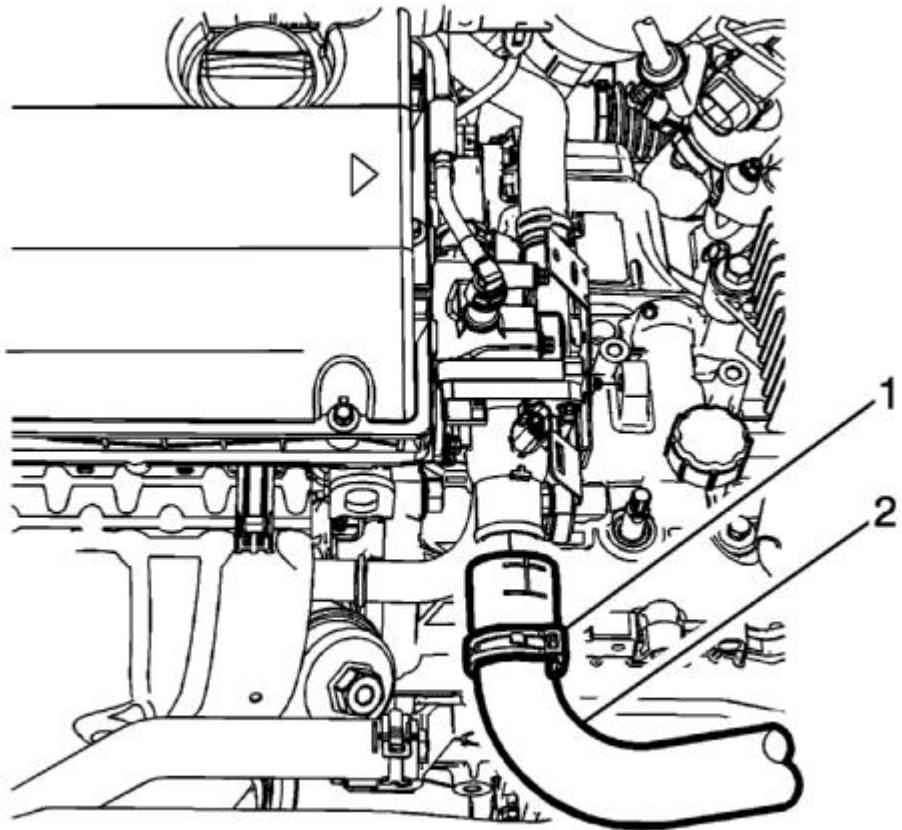


Fig. 115: Radiator Air Inlet Hose & Clamp

Courtesy of GENERAL MOTORS COMPANY

30. Install the radiator inlet hose (2) to the engine.
31. Install the radiator inlet hose clamp (1) at the engine using **BO-38185** pliers.
32. Install the coolant surge tank. Refer to **Radiator Surge Tank Replacement**.
33. Connect the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement**.
34. Connect EVAP purge solenoid pipes from solenoid. Refer to **Evaporative Emission System Hose/Pipe Replacement**.
35. Fill the cooling system. Refer to **Cooling System Draining and Filling**.
36. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
37. Check and correct the engine oil.

OIL PAN REPLACEMENT

Removal Procedure

1. Drain the engine oil . Refer to **Engine Oil and Oil Filter Replacement**.
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**
3. Remove the front wheelhouse liner Inner front extension. Refer to **Front Wheelhouse Liner Inner**

Front Extension Replacement (Left Side) , Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW)

4. Remove the exhaust flexible pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#)

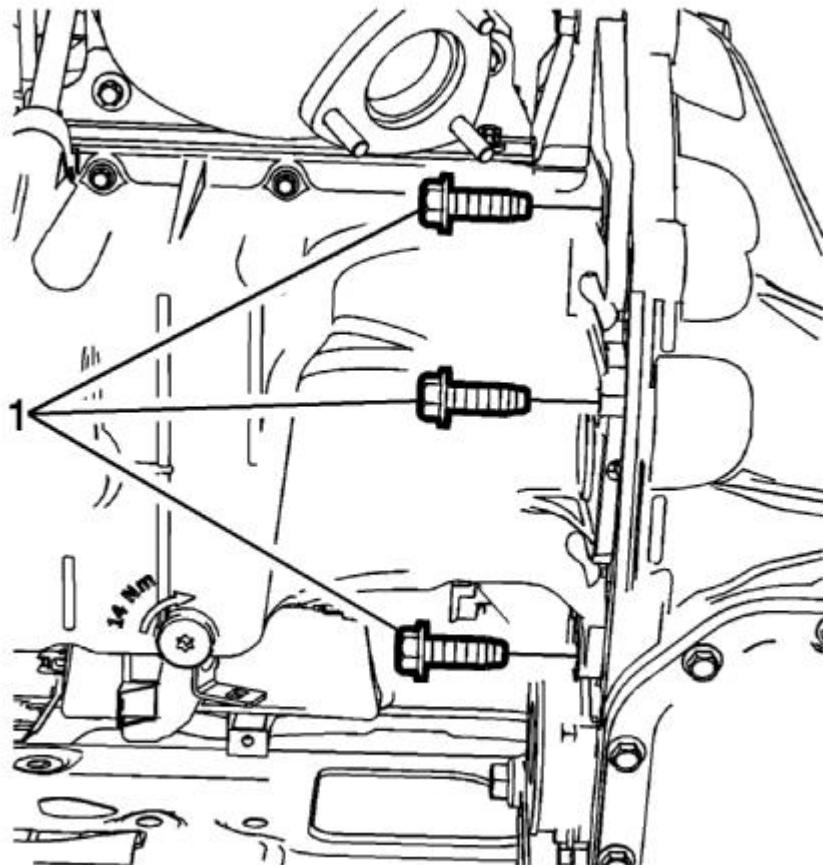


Fig. 116: Transmission Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pan bolts (1) from the transmission.

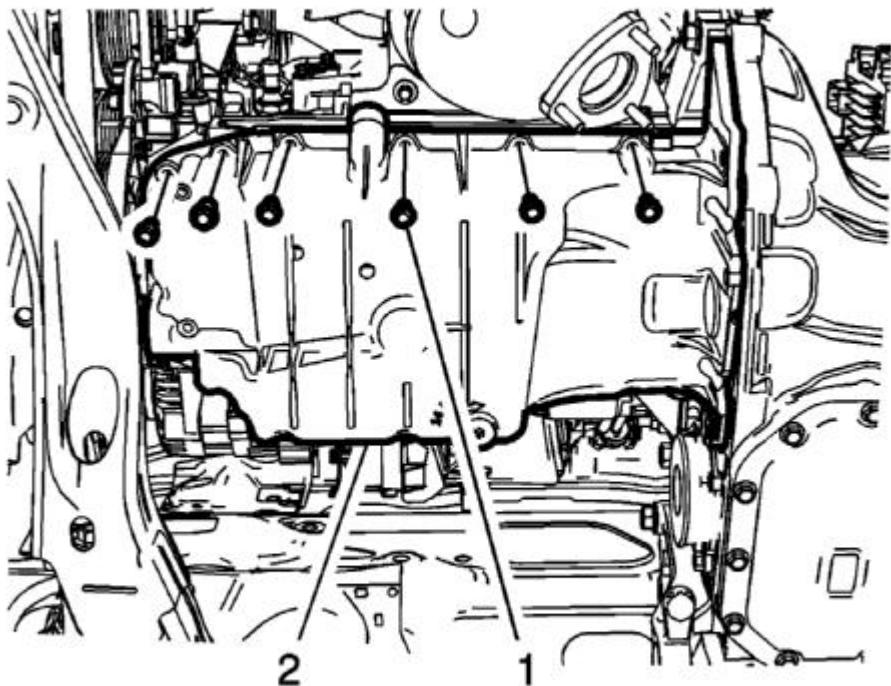


Fig. 117: Oil Pan & Bolts

Courtesy of GENERAL MOTORS COMPANY

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

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

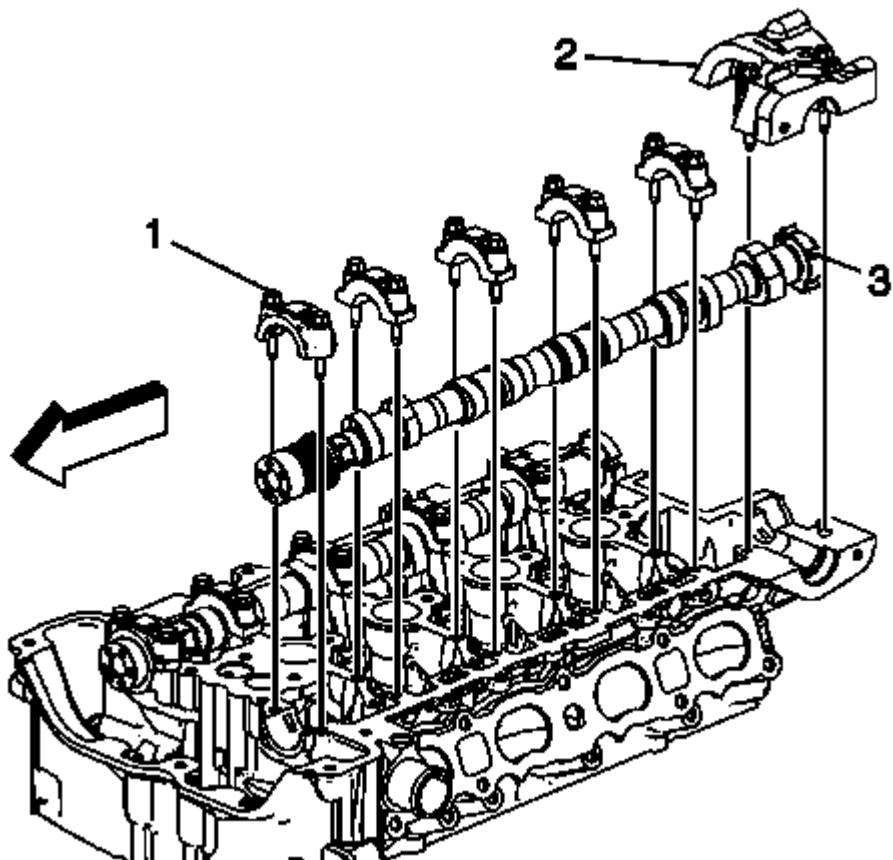


Fig. 118: Protecting Oil Screen From Damage

Courtesy of GENERAL MOTORS COMPANY

7. 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.
8. Remove the oil pan.

Installation Procedure

1. Clean the sealing surfaces.

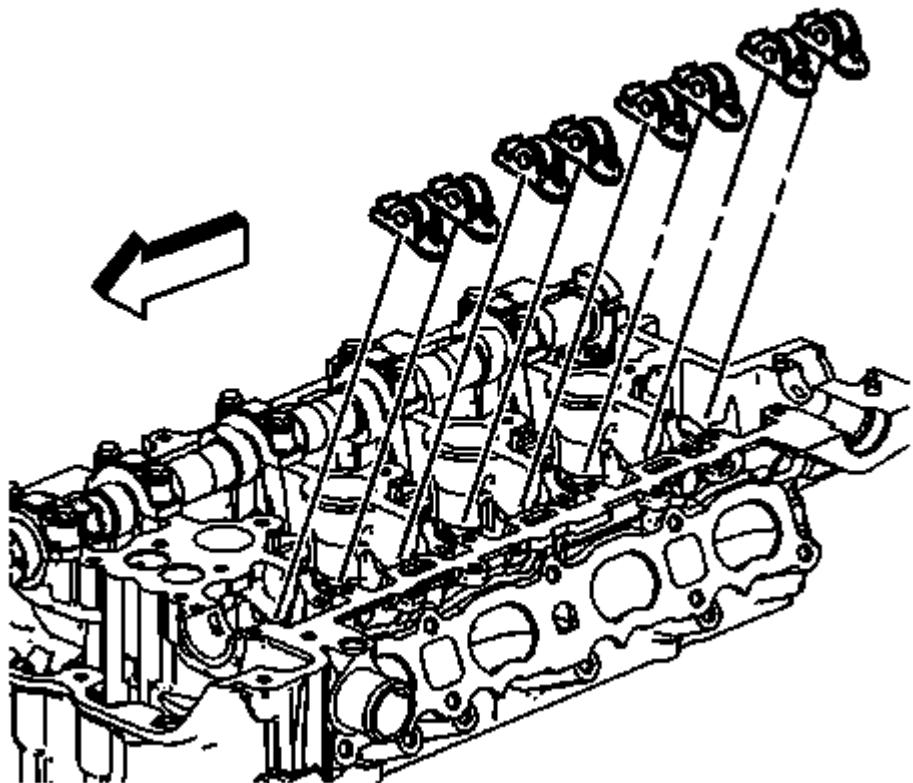


Fig. 119: View Of Joints For Sealant
Courtesy of GENERAL MOTORS COMPANY

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

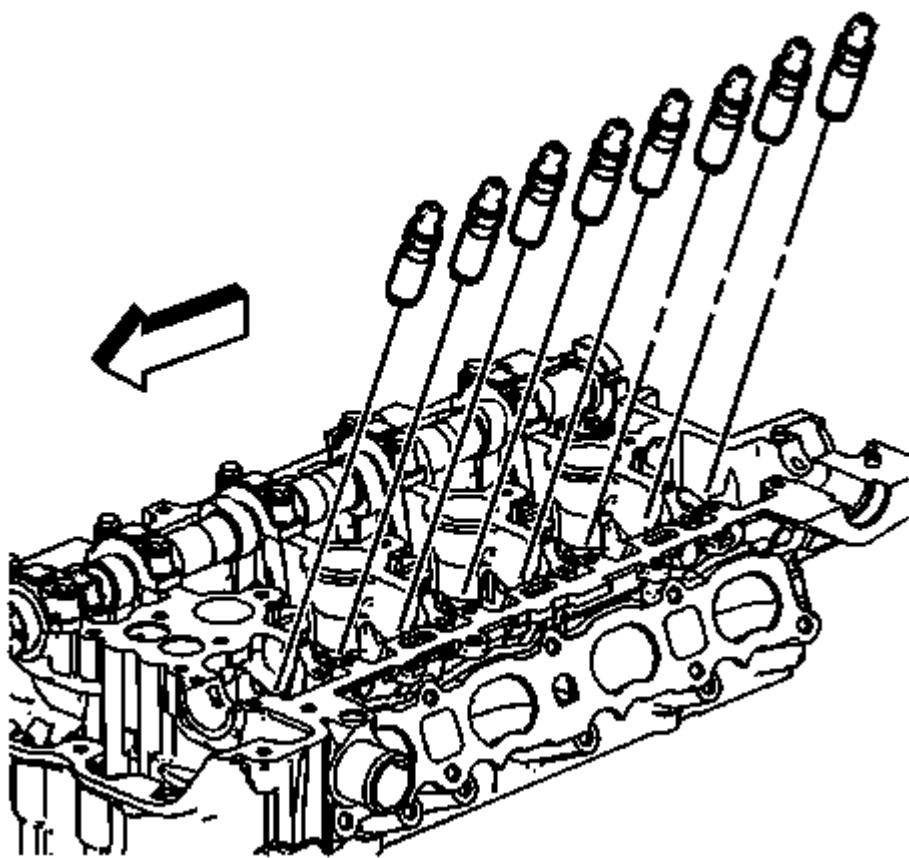


Fig. 120: Sealant Application Area
Courtesy of GENERAL MOTORS COMPANY

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.

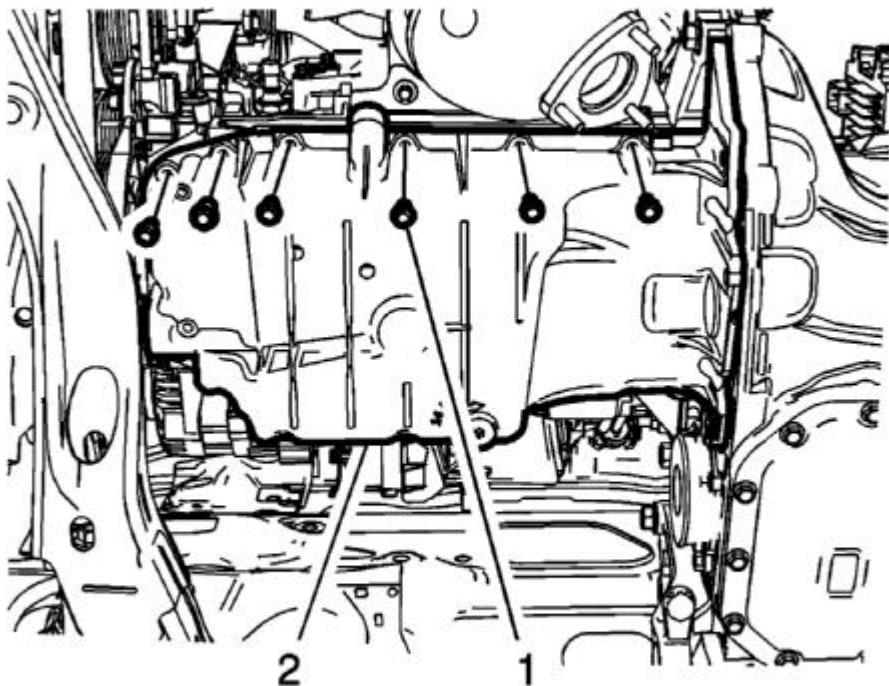


Fig. 121: Oil Pan & Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

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

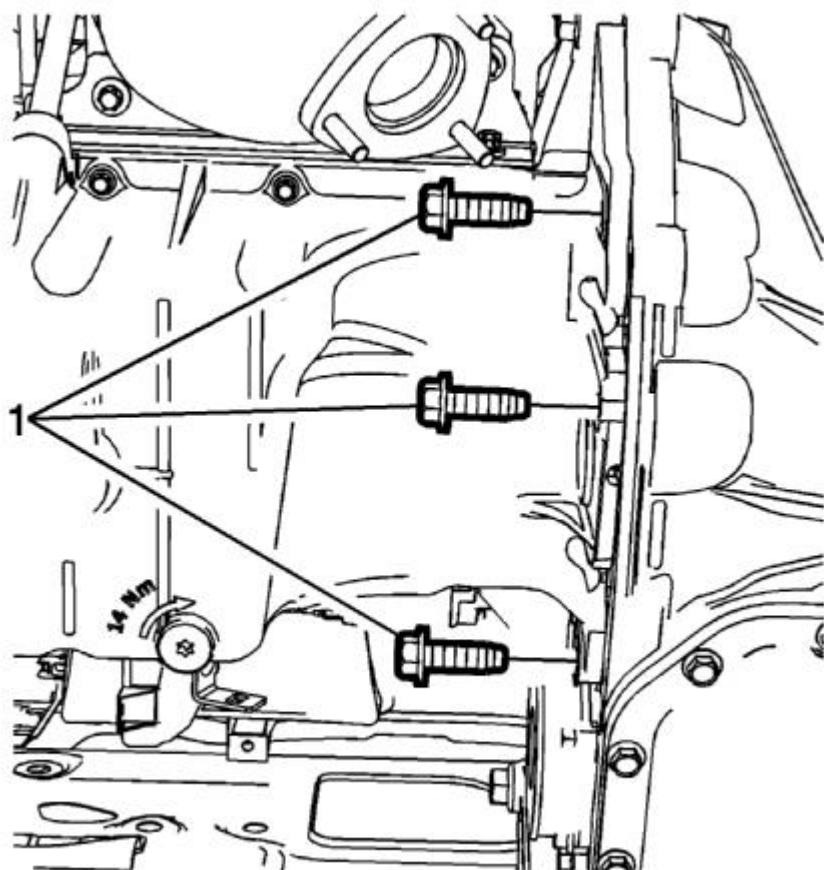


Fig. 122: Transmission Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan bolts (1) and (2) to the transmission and tighten to 40 N.m (30 lb ft).
6. Install the exhaust flexible pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#)
7. Install the front wheelhouse liner Inner front extension. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .
8. Install the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#)
9. Refill the engine oil . Refer to [Engine Oil and Oil Filter Replacement](#).

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

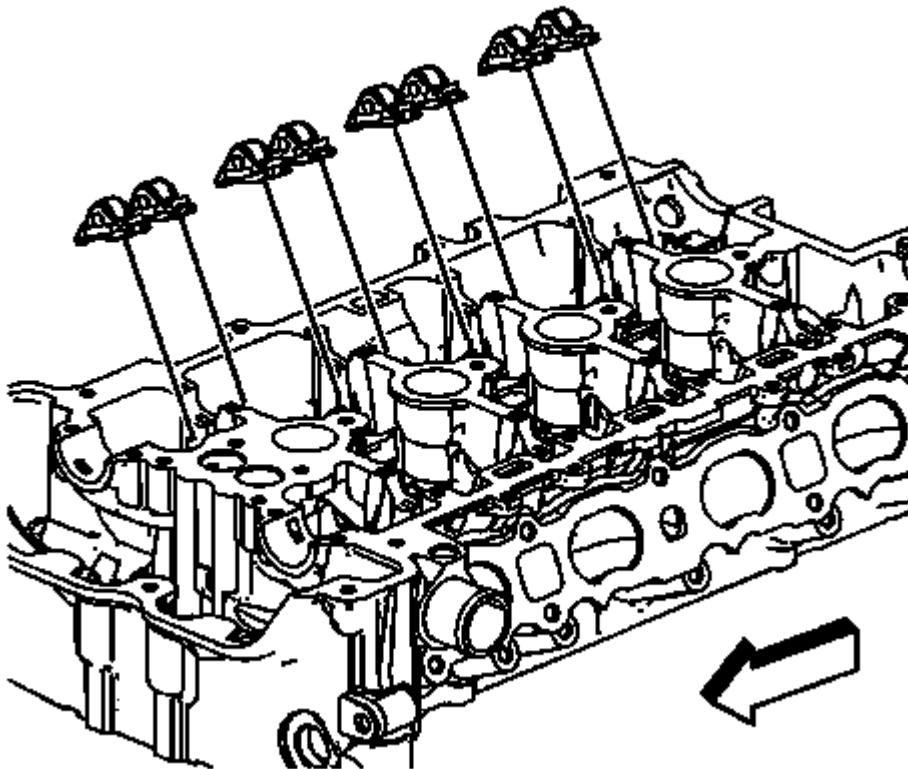


Fig. 123: Automatic Transmission Flex Plate & Components

Courtesy of GENERAL MOTORS COMPANY

Automatic Transmission Flex Plate Replacement

Callout	Component Name
Preliminary Procedure	
Remove the transmission. Refer to <u>Transmission Replacement (With 1.6L or 1.8L Engine)</u> .	
1	Automatic Transmission Flex Plate Fastener (Qty: 6)
	<p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Tighten</p> <ul style="list-style-type: none"> • 60 N.m (44 lb ft) • Tighten the bolt an additional 5 degrees.
2	Flex Plate

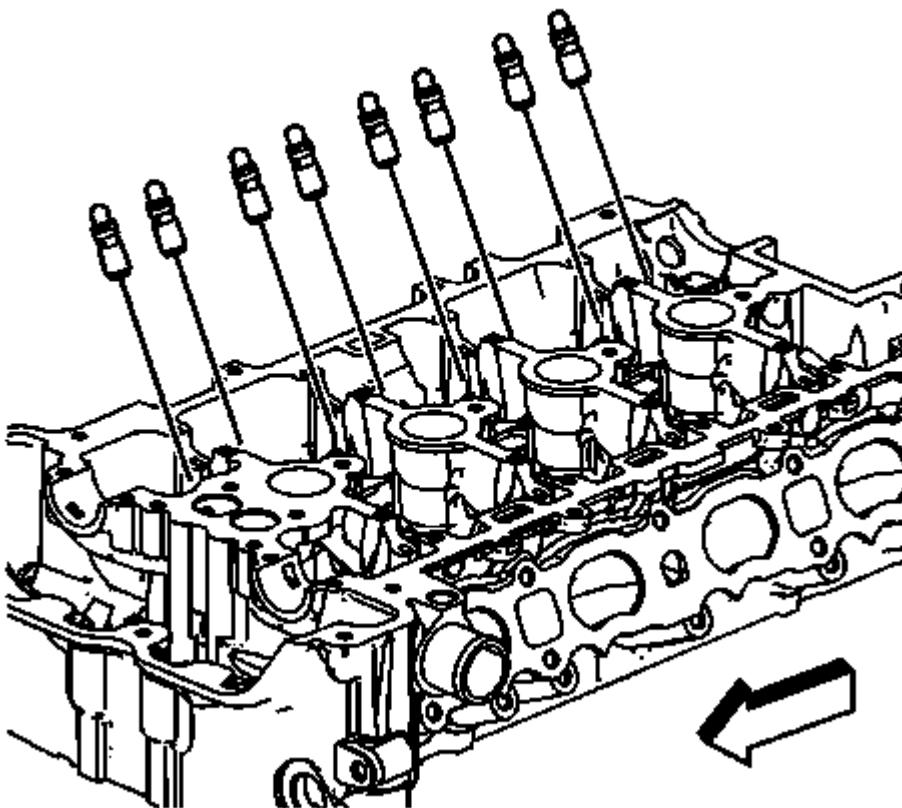
Automatic Transmission Flex Plate

Procedure

Inspect the engine flex plate for the following:

3

1. Stress cracks around the engine flex plate.
2. Cracks at welded areas that retain the ring gear onto the engine flex plate.
3. Damaged or missing ring gear teeth.
4. Do not attempt to repair the welded areas that retain the ring gear to the flex plate.

ENGINE FLYWHEEL REPLACEMENT**Fig. 124: Engine Flywheel & Fasteners**

Courtesy of GENERAL MOTORS COMPANY

Engine Flywheel Replacement

Callout	Component Name
Preliminary Procedure	

Remove the clutch pressure and driven Plate . Refer to [Clutch Pressure and Driven Plate Replacement](#)

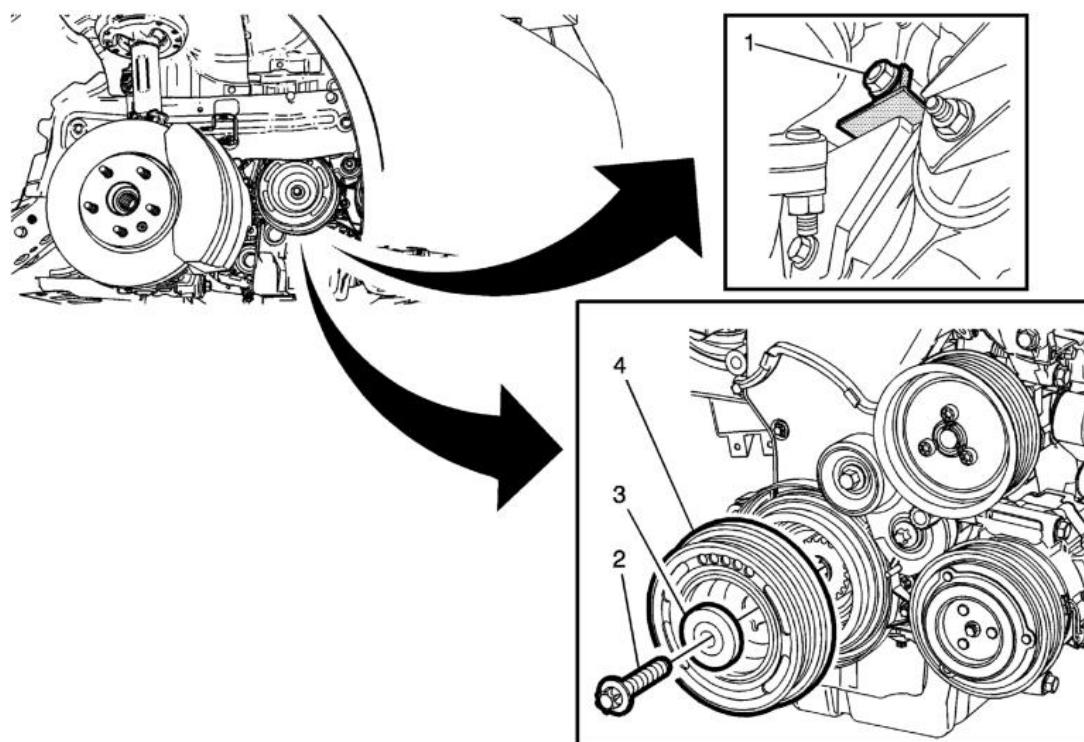
(1.8L).**Special Tools**

- **EN-652** Flywheel Holder
- **EN-45059** Torque Angle Sensor Kit

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

	Flywheel Fastener (Qty: 6) CAUTION: Refer to <u>Fastener Caution</u> .
1	Procedure Discard the flywheel fastener and use a NEW fastener for installation. Tighten <ul style="list-style-type: none">• First pass to 35 N.m (26 lb ft)• Second pass to additional 30°.• Final pass to an additional 15°.
2	Flywheel Procedure Inspect the engine flywheel for the following: <ol style="list-style-type: none">1. Stress cracks around the engine flywheel.2. Cracks at welded areas that retain the ring gear onto the engine flywheel.3. Damaged or missing ring gear teeth.4. Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.

CRANKSHAFT BALANCER REPLACEMENT

**Fig. 125: Crankshaft Balancer Components**

Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Replacement

Callout	Component Name
Preliminary Procedure	
Remove the drive belt. Refer to Drive Belt Replacement .	
1	<p>Engine to Transmission Fastener</p> <p>CAUTION: Refer to Fastener Caution .</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Install the EN-6625 device on the stud. 2. Ensure the locking device is engaged on the flywheel teeth. 3. Install the engine to transmission nut to hold the locking device. <ul style="list-style-type: none"> • For Manual Transmission, tighten to 75 N.m (55 lb ft) • For Automatic Transmission, tighten to 40 N.m (30 lb ft) <p>Special Tools EN-6625 Flywheel Locking Device For equivalent regional tools, refer to Special Tools.</p>

	Crankshaft Balancer Bolt
Procedure	Discard the crankshaft balancer bolt and use a NEW bolt for installation.
Tighten	
2	<ol style="list-style-type: none">1. 95 N.m (70 lb ft)2. First pass tighten the bolt to 45 degrees.3. Final pass tighten the bolt to 15 degrees.
	Special Tools
	EN-45059 Torque Angle Sensor Kit.
	For equivalent regional tools, refer to <u>Special Tools</u> .
3	Crankshaft Balancer Washer
4	Crankshaft Balancer

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. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Replacement**.

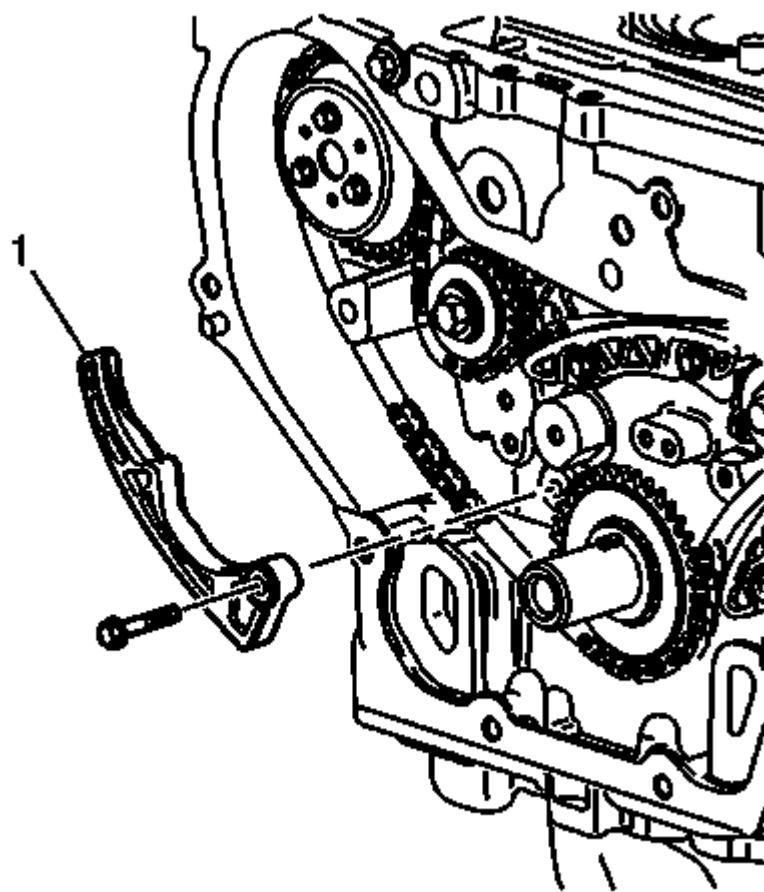


Fig. 126: Crankshaft Front Oil Seal Removal Tool

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

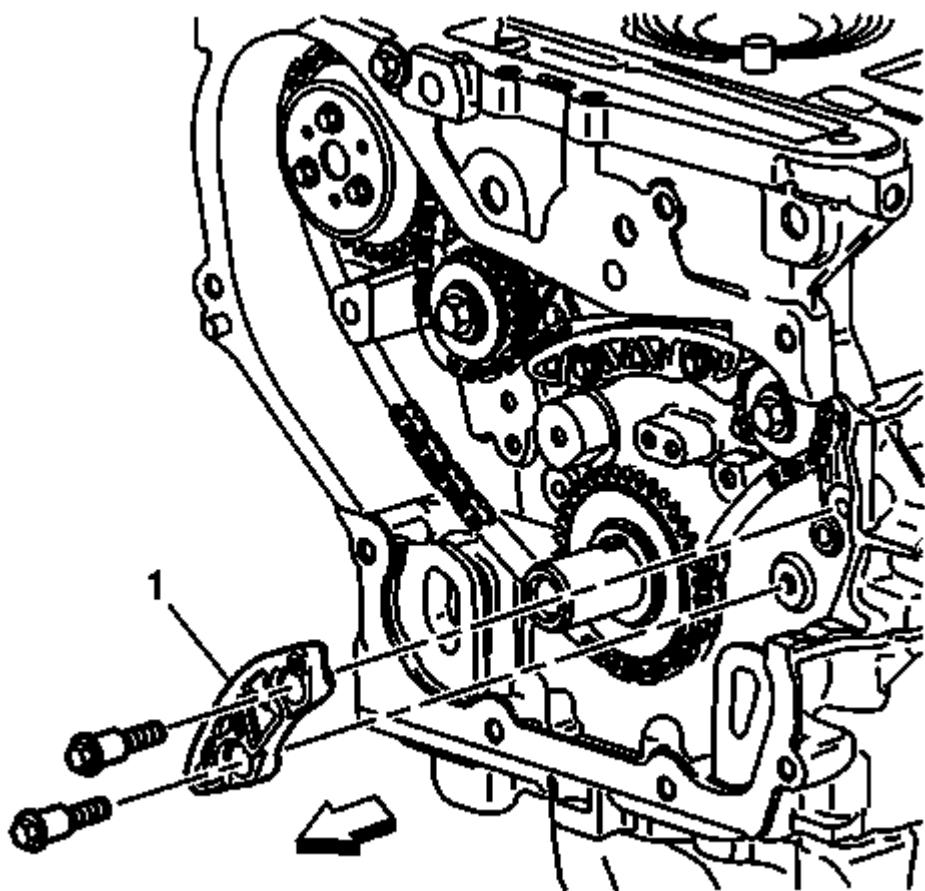


Fig. 127: Crankshaft And Crankshaft Front Oil Seal

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.

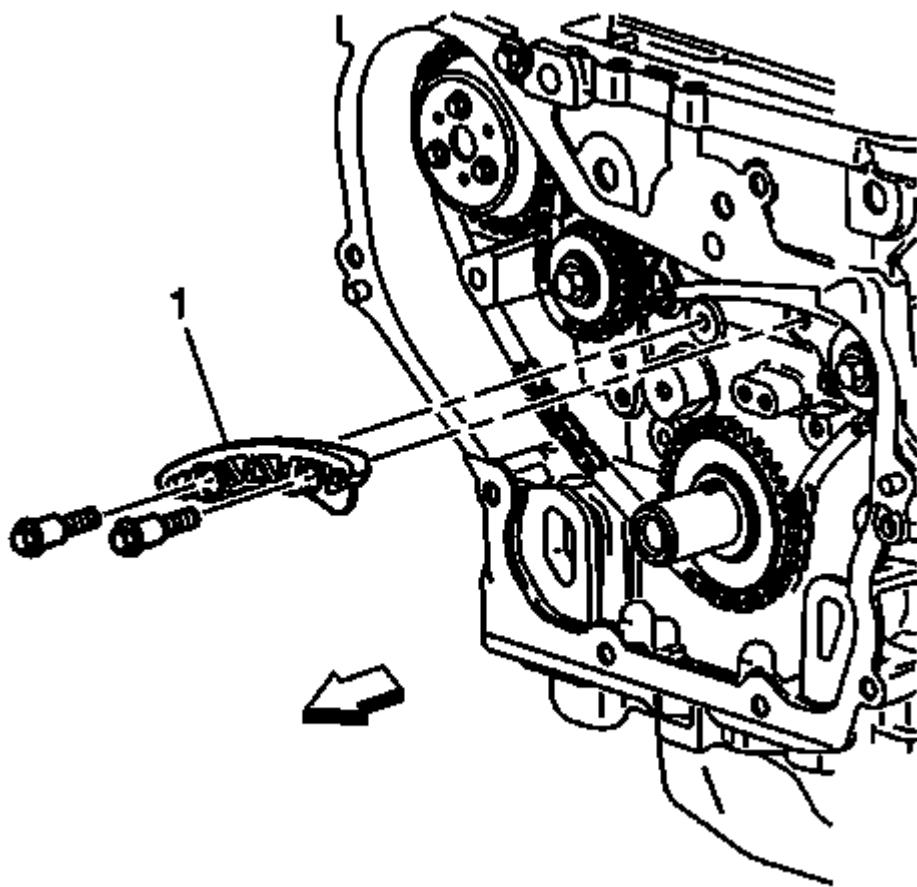


Fig. 128: Crankshaft Drive Gear Bolt, Washer And Sleeves

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.
6. Install the crankshaft sprocket. Refer to [Crankshaft Sprocket Replacement](#).

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

- **EN-235-D** Installer
- **EN-235-6** Installer
- **EN-328-B Pin** Pin Remover
- **EN-658-1** Installer
- **EN-6624** Remover

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

Removal Procedure

1. If equipped with a manual transmission remove the flywheel. Refer to [Engine Flywheel Replacement](#).
2. If equipped with a automatic transmission, remove the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).

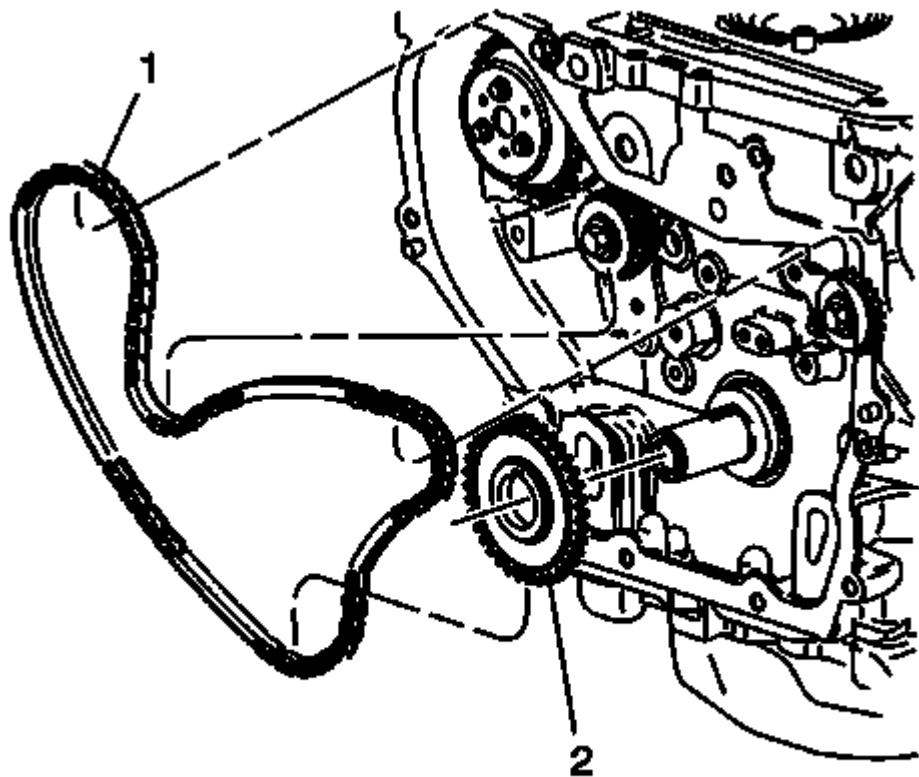


Fig. 129: Crankshaft Position Sensor, Crankshaft Rear Oil Seal Housing And Crankshaft Position Sensor Bolt

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

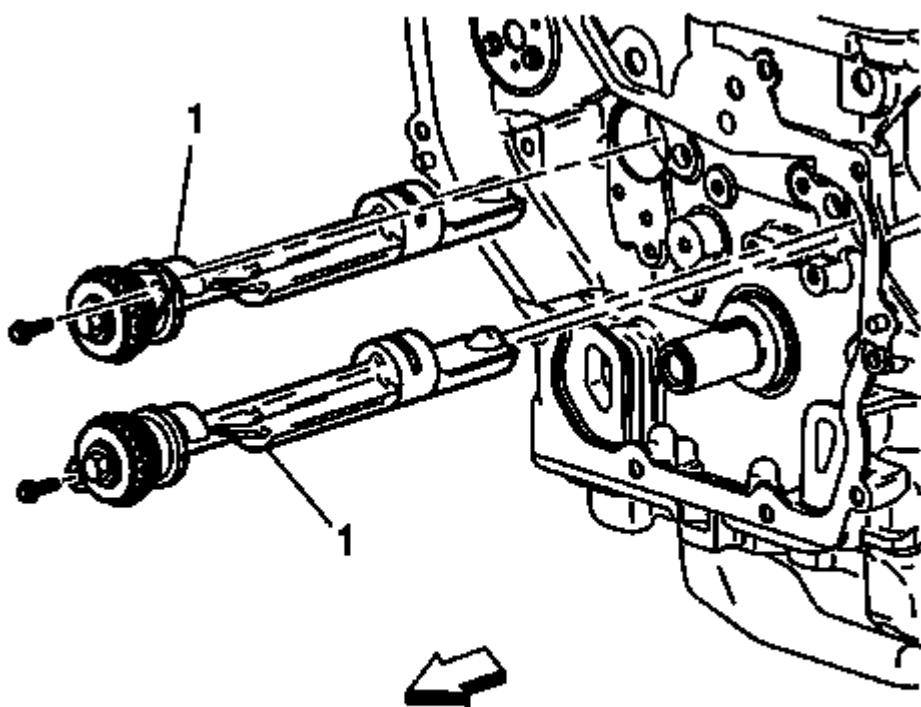


Fig. 130: Removing Plastic Ring With Screwdriver
Courtesy of GENERAL MOTORS COMPANY

6. Remove the plastic ring (1) with a flat bladed tool (2).

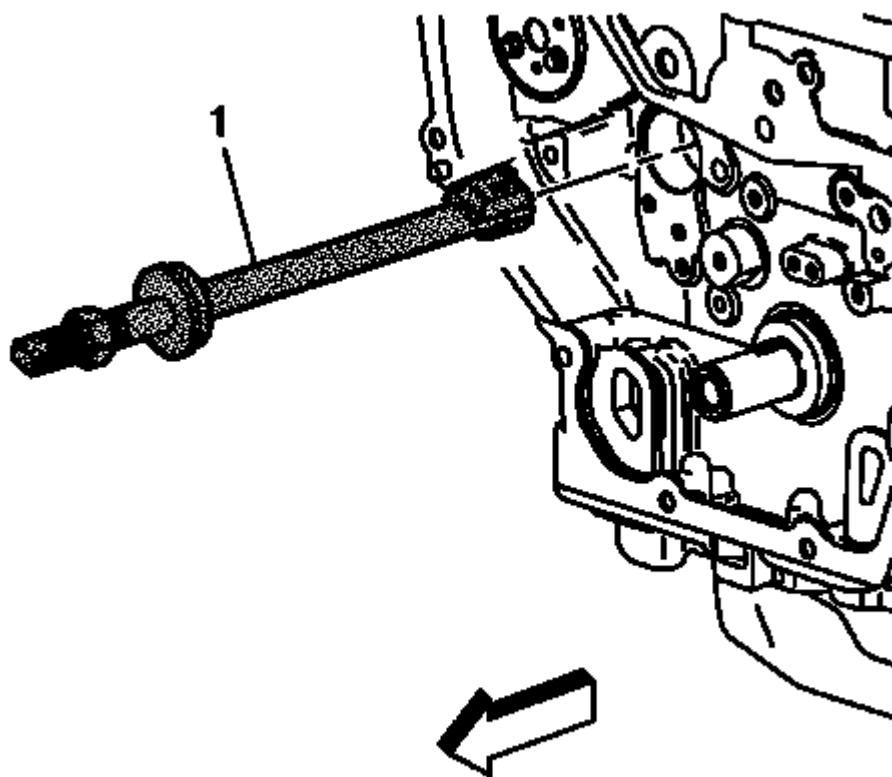


Fig. 131: Holes At 5 O'clock And 7 O'clock Positions

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.

7. 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.

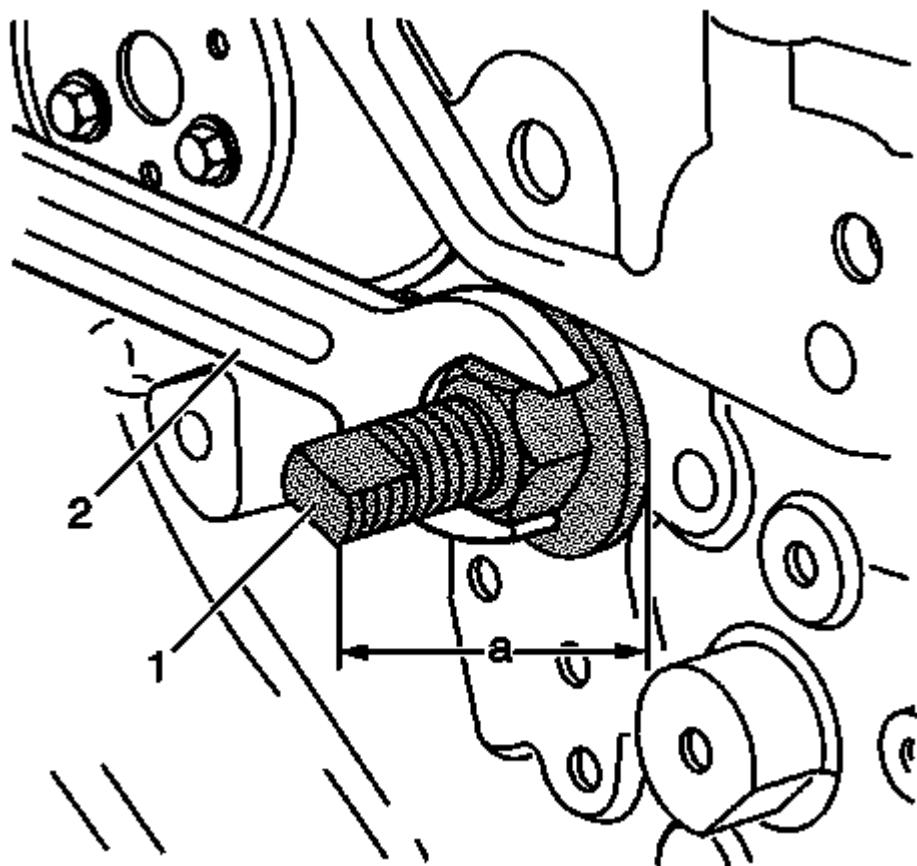


Fig. 132: Scribe Tool

Courtesy of GENERAL MOTORS COMPANY

8. Position the scribe (1) at the outer edge of the crankshaft rear oil seal.
9. Remove the seal ring.

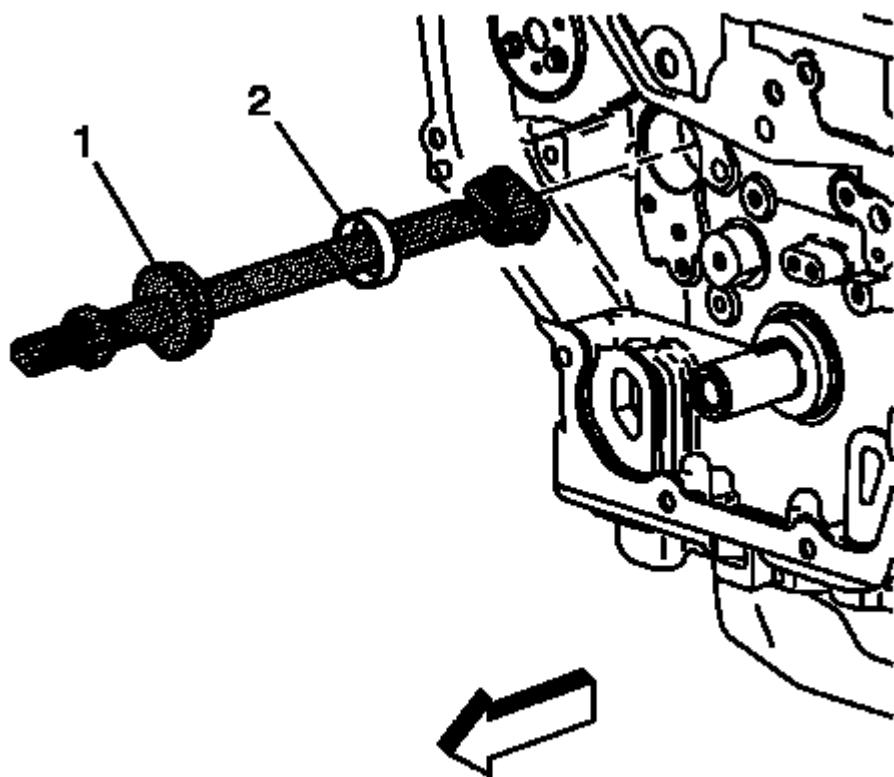


Fig. 133: Crankshaft Rear Oil Seal Removal Tool

Courtesy of GENERAL MOTORS COMPANY

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

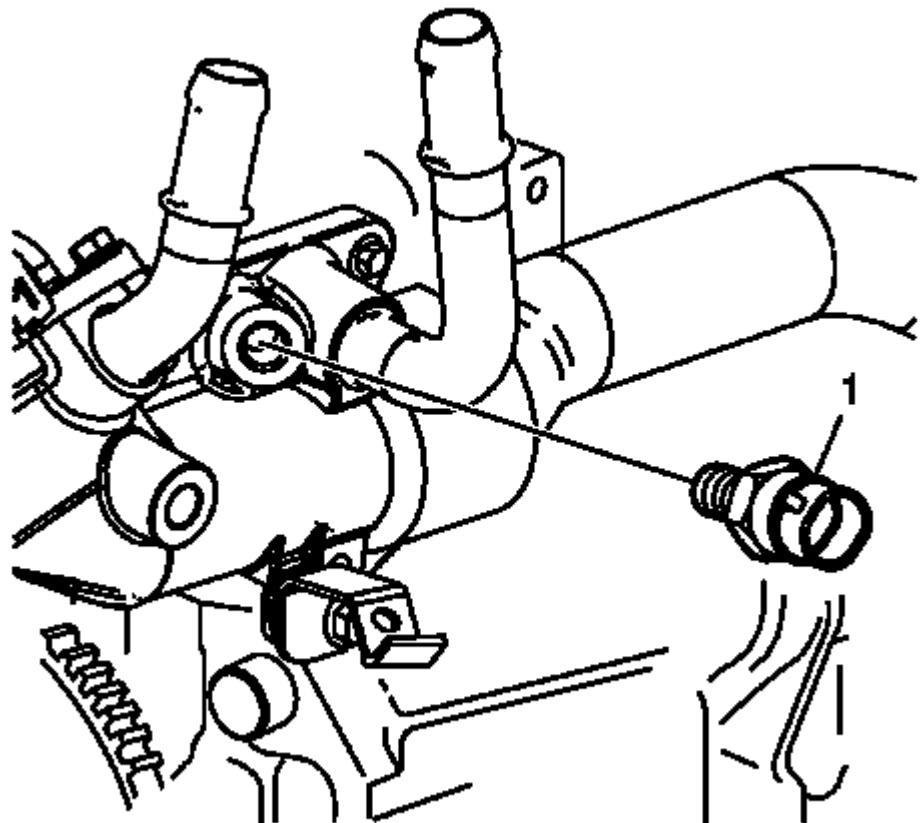


Fig. 134: Crankshaft Rear Oil Seal Removal Tools

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

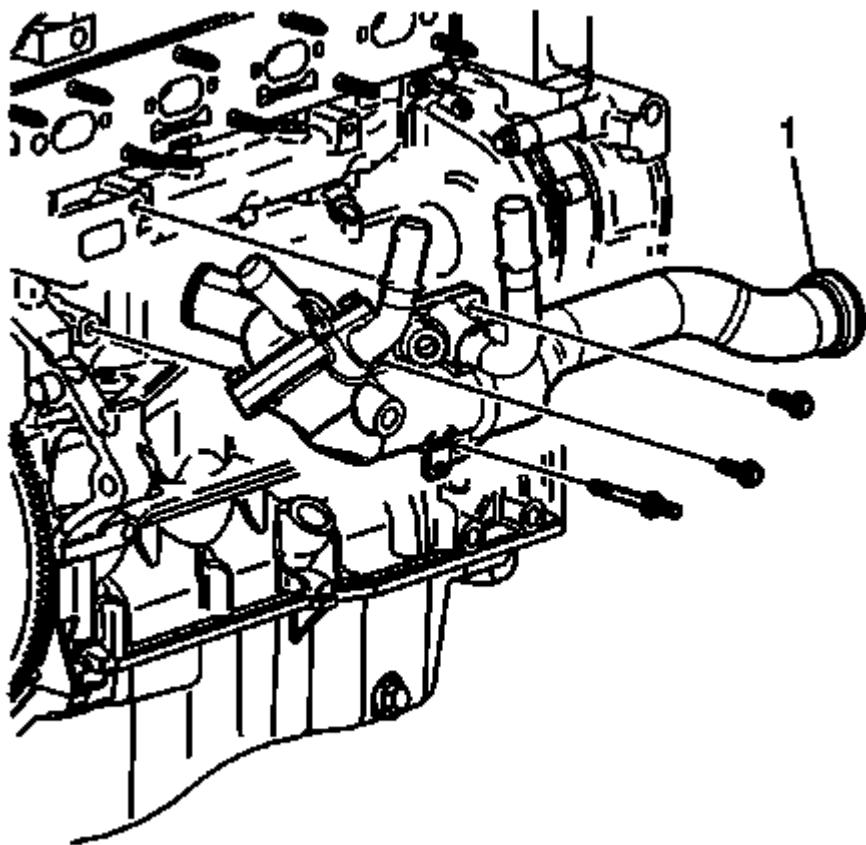


Fig. 135: Crankshaft Rear Oil Seal And Installer

Courtesy of GENERAL MOTORS COMPANY

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

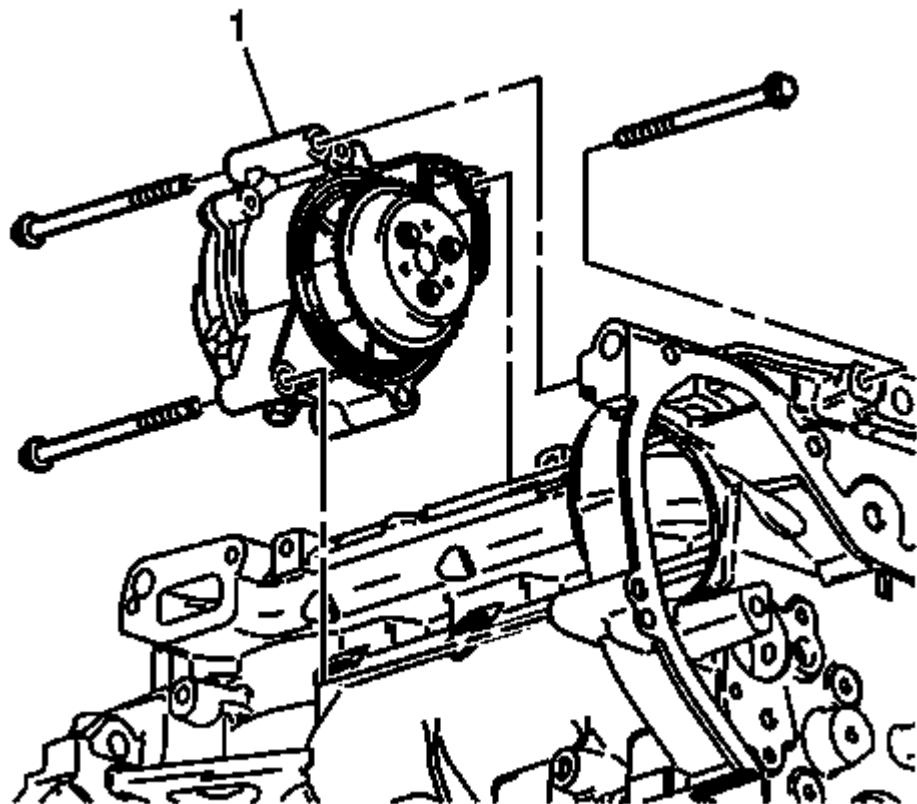
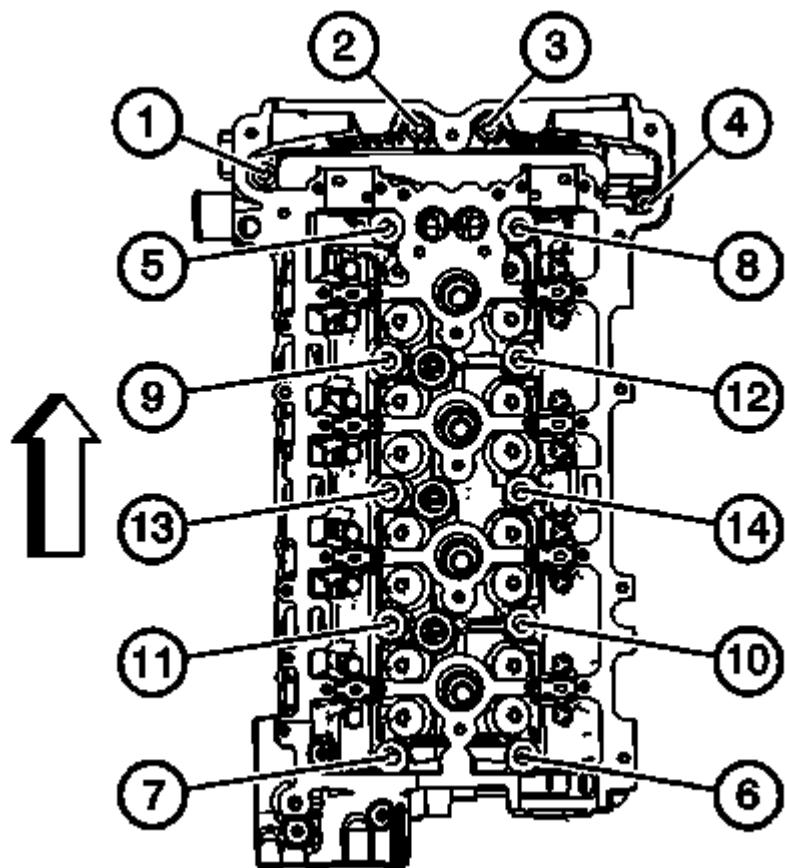


Fig. 136: Installer Tool

Courtesy of GENERAL MOTORS COMPANY

2. Use **EN-658-1** installer (1) to strike the crankshaft rear oil seal.
3. If equipped with a manual transmission install the flywheel. Refer to [Engine Flywheel Replacement](#).
4. If equipped with a automatic transmission, install the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).

CRANKSHAFT SPROCKET REPLACEMENT

**Fig. 137: Crankshaft Sprocket**

Courtesy of GENERAL MOTORS COMPANY

Crankshaft Sprocket Replacement

Callout	Component Name
Preliminary Procedure	
Remove the timing belt. Refer to Timing Belt Replacement .	
1	<p>Crankshaft Sprocket Procedure</p> <p>When installing the crankshaft sprocket, the sprocket and the groove must align.</p>

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

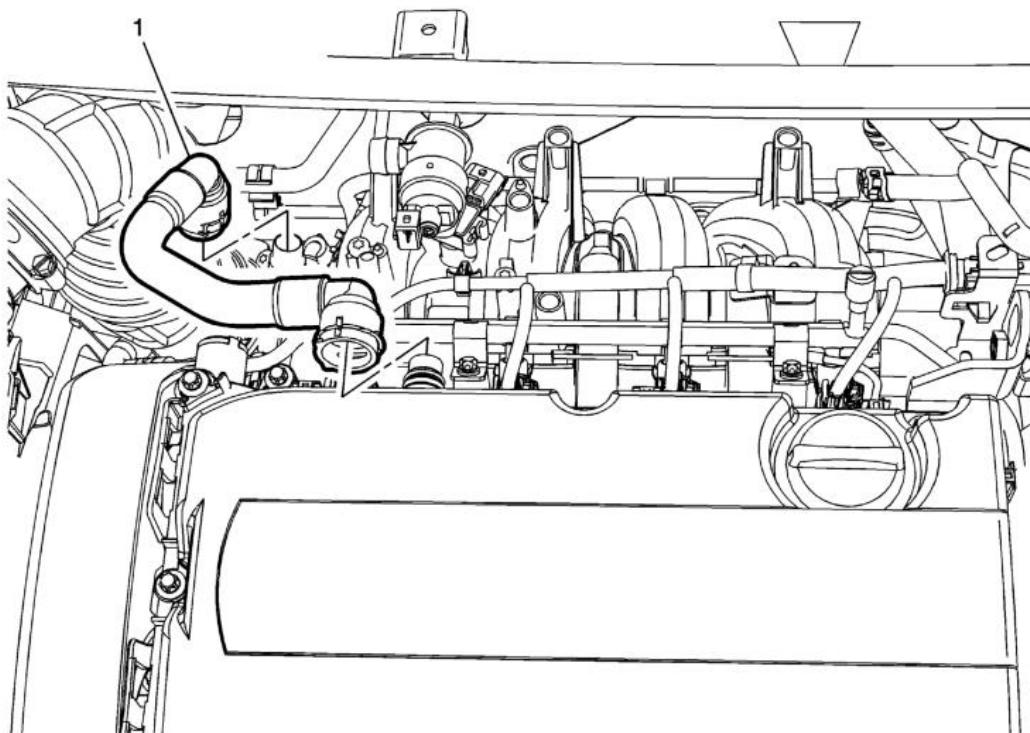


Fig. 138: Positive Crankcase Ventilation Hose/Pipe/Tube

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Callout	Component Name
1	<p>Positive Crankcase Ventilation Hose/Pipe/Tube</p> <p>Procedure</p> <ol style="list-style-type: none">1. Release the quick connects.2. Disconnect electrical connectors as necessary.

ENGINE FRONT COVER WITH OIL PUMP REPLACEMENT

Removal Procedure

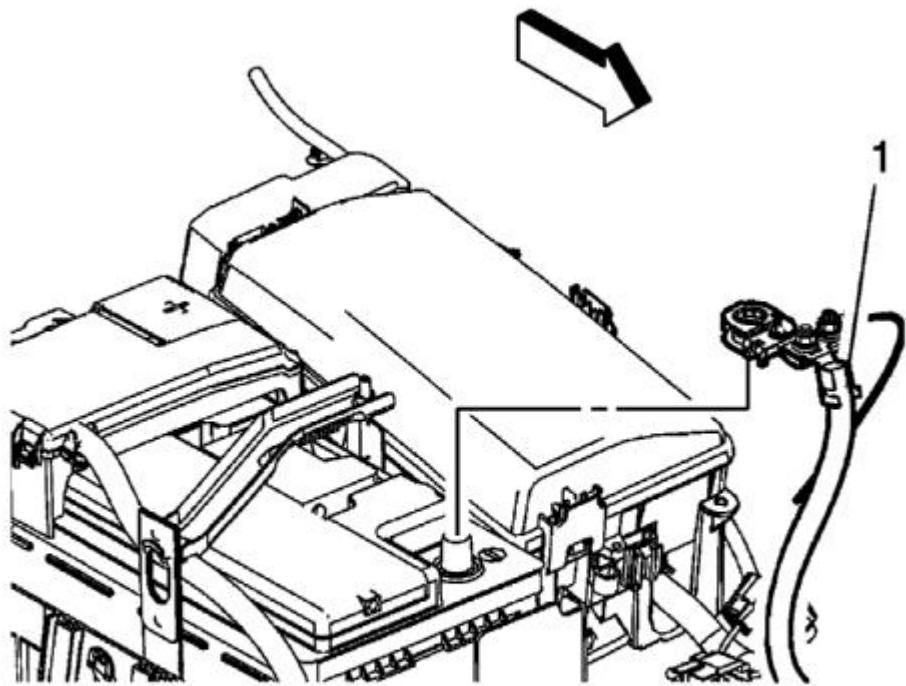


Fig. 139: Negative Battery Cable

Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the negative battery cable (1). Refer to [Battery Negative Cable Disconnection and Connection](#) .
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#) .

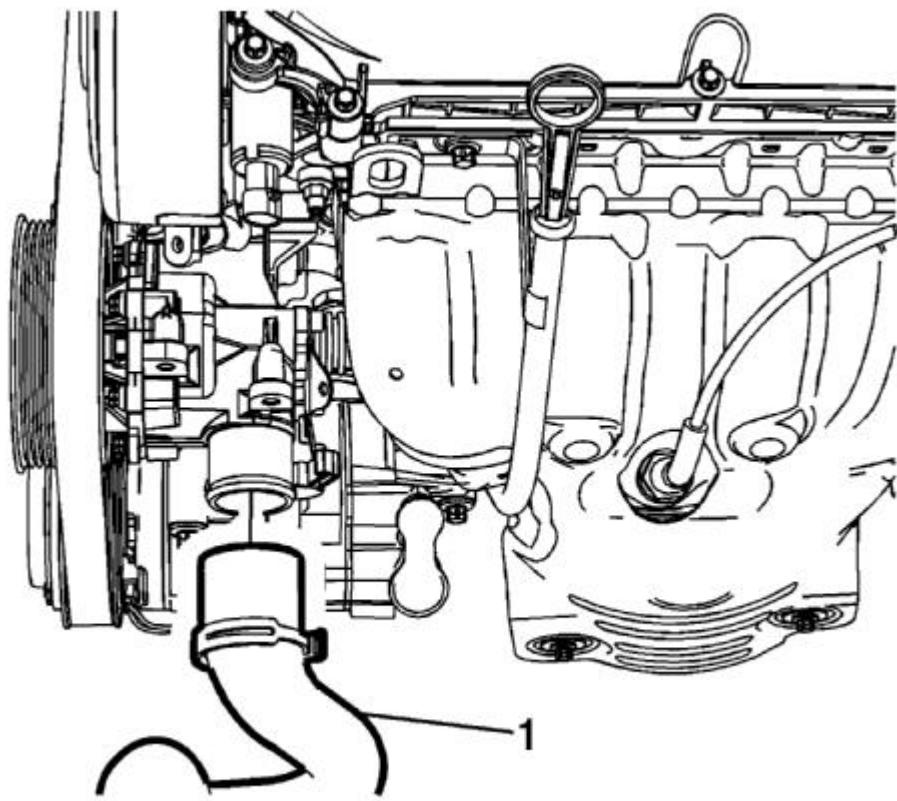


Fig. 140: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

3. Remove the radiator outlet hose (1) from the water pump. Refer to [Radiator Outlet Hose Replacement \(LDE LUW\)](#) .
4. Remove the exhaust manifold. Refer to [Exhaust Manifold with Catalytic Converter Replacement \(LUW\)](#) .

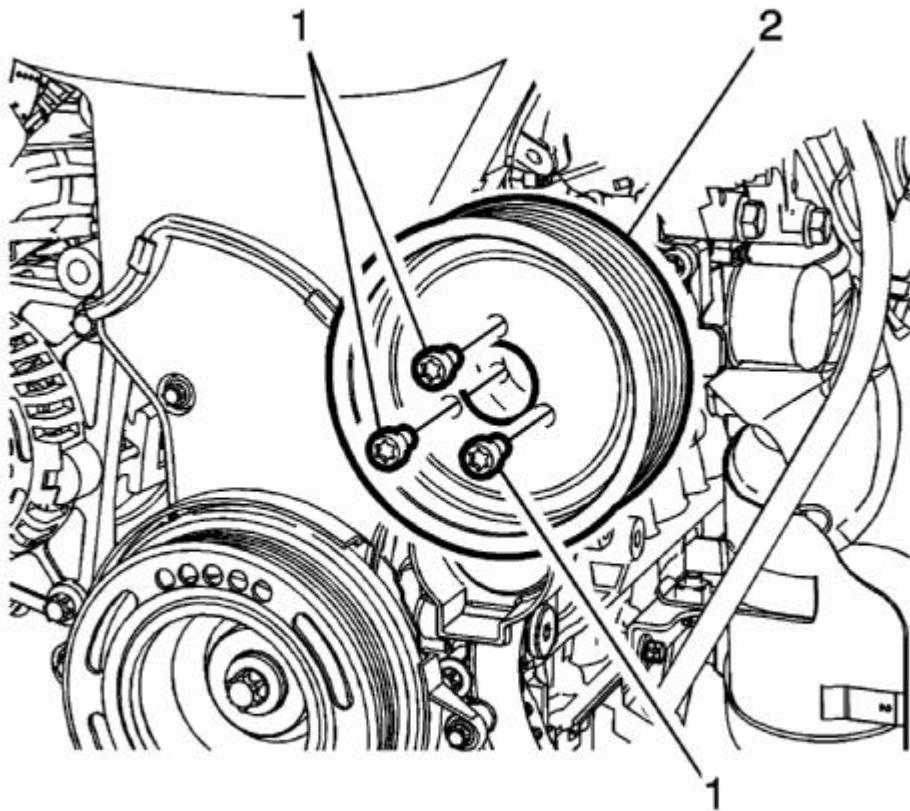


Fig. 141: Water Pump & Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Loosen the bolts before the belt is removed.
6. Remove the water pump bolts (1) and water pump pulley (2). Refer to [Water Pump Pulley Replacement \(LUW\)](#) .
7. Remove the generator. Refer to [Generator Replacement \(LUW\)](#) .
8. Remove the air conditioning compressor. Refer to [Air Conditioning Compressor Replacement \(LDE, LUW, LWE\)](#) .
9. Remove the timing belt tensioner. Refer to [Timing Belt Tensioner Replacement](#).

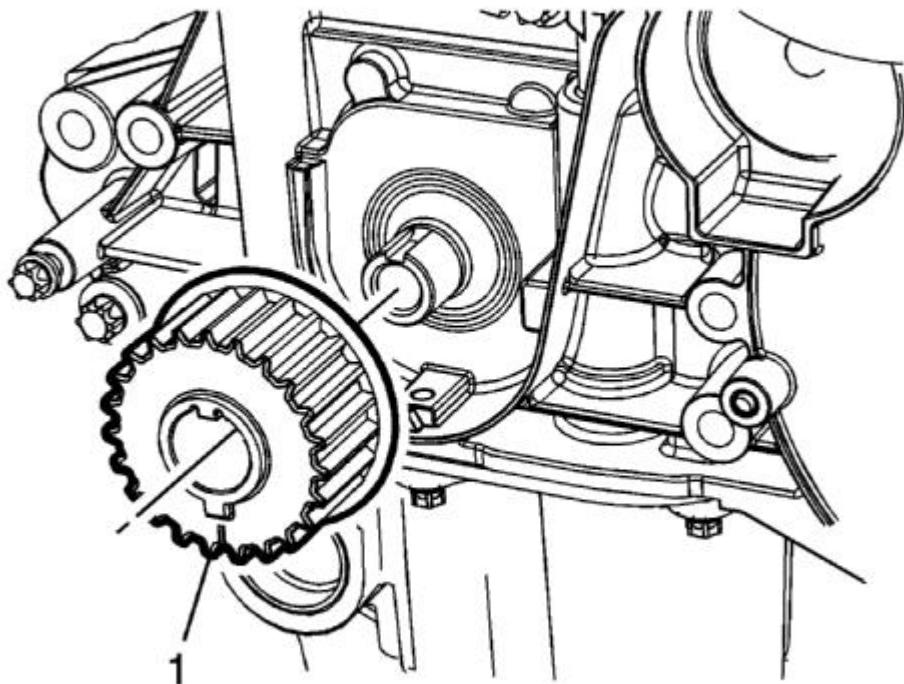


Fig. 142: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

10. Remove the crankshaft sprocket (1). Refer to [Crankshaft Sprocket Replacement](#).
11. Remove the oil pan. Refer to [Oil Pan Replacement](#).

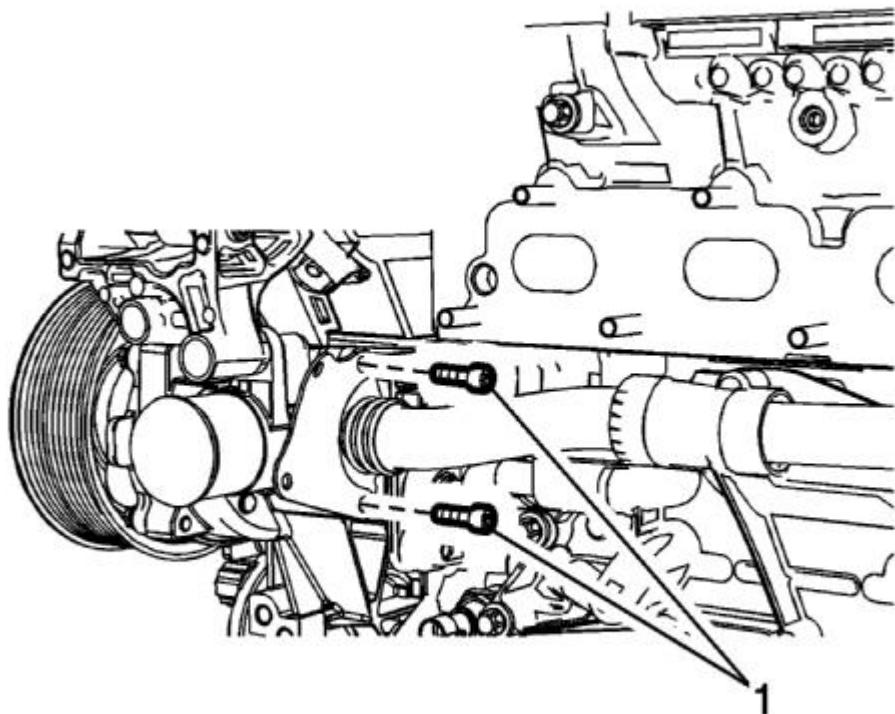


Fig. 143: Engine Oil Cooler Outlet Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the engine oil cooler outlet pipe bolt (1).

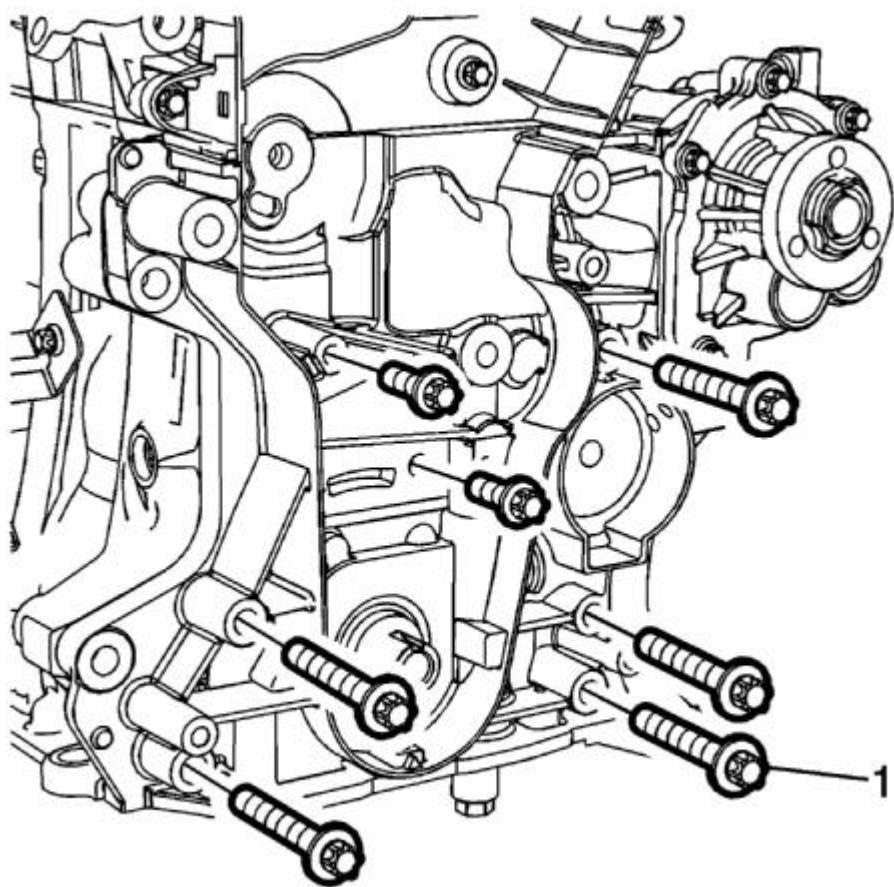


Fig. 144: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the engine front cover bolts (1).

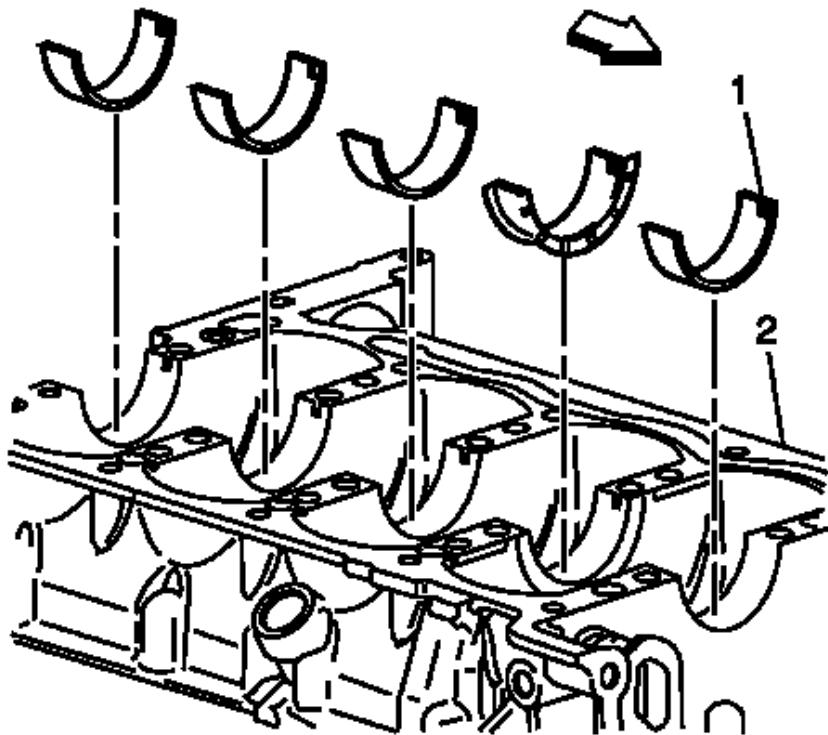


Fig. 145: Engine Front Cover & Seal
Courtesy of GENERAL MOTORS COMPANY

14. Remove the engine front cover (1).
15. Remove the engine front cover seal (2).

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

16. Carefully clean the engine front cover sealing surfaces.

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

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

Installation Procedure

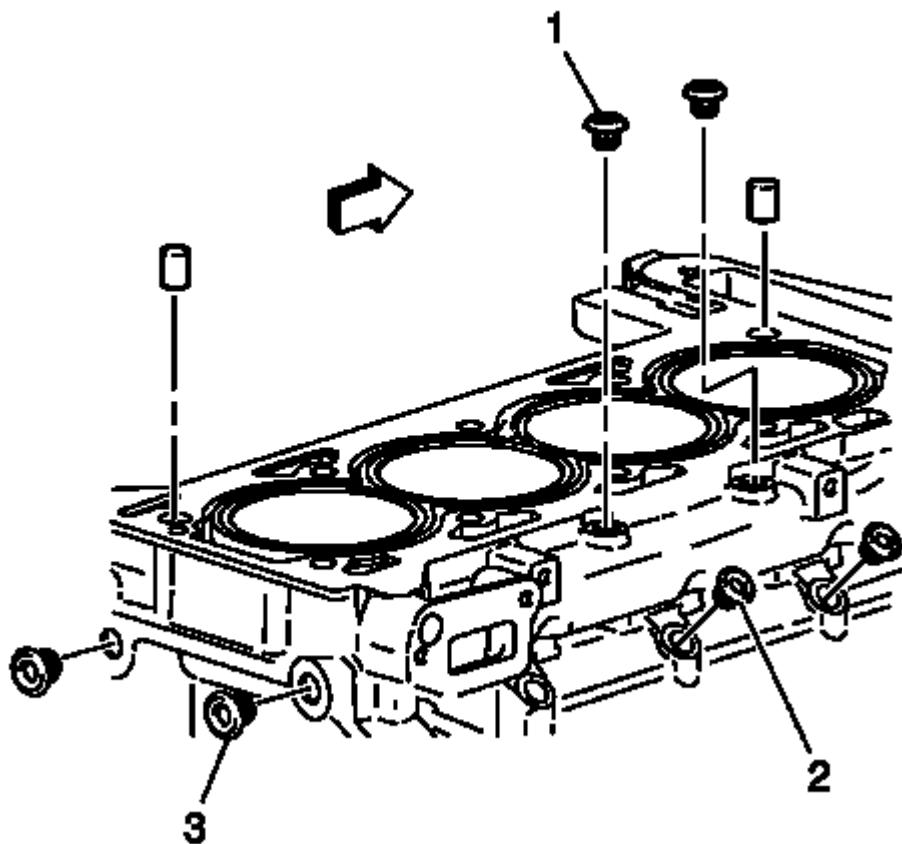


Fig. 146: Engine Front Cover & Seal

Courtesy of GENERAL MOTORS COMPANY

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

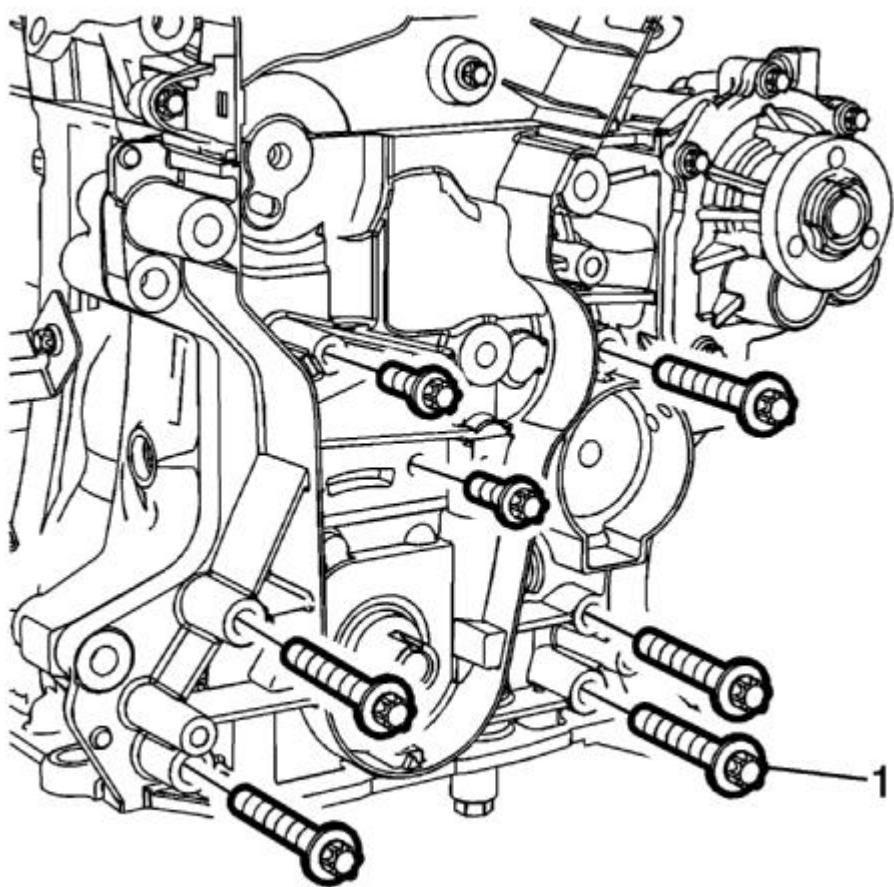


Fig. 147: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the engine front cover bolts (1) and tighten to 20 N.m (15 lb ft).

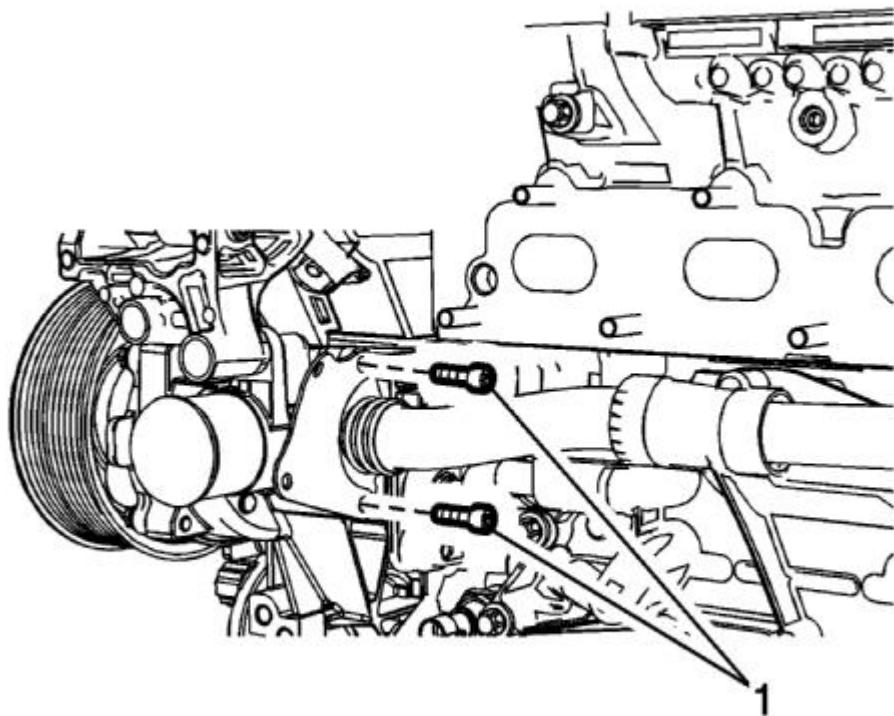


Fig. 148: Engine Oil Cooler Outlet Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

4. Install the engine oil cooler outlet pipe bolt (1) and tighten to 8 N.m (71 lb in).
5. Install the oil pan. Refer to [Oil Pan Replacement](#).

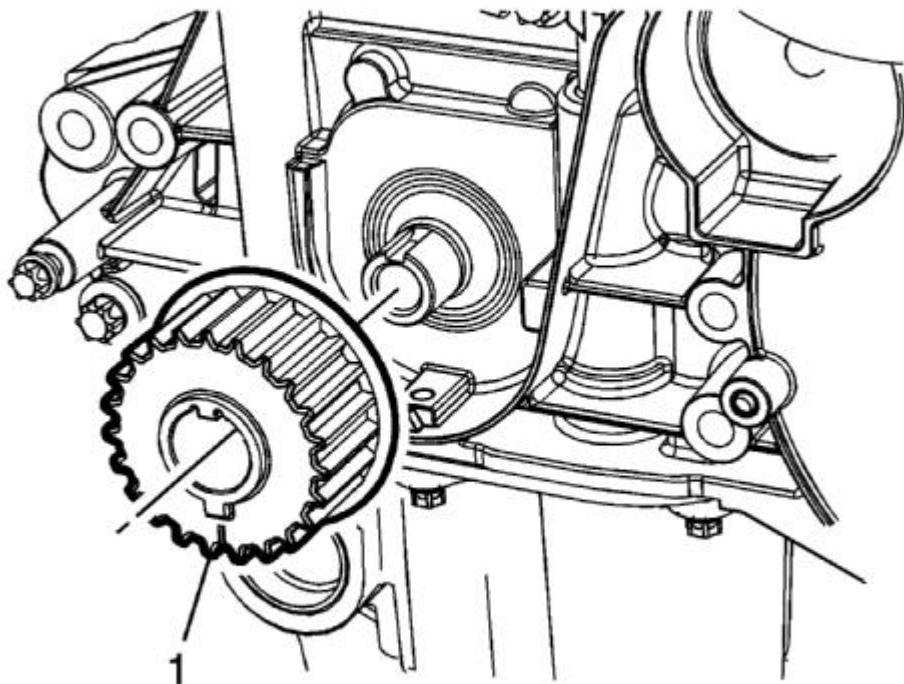


Fig. 149: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

6. Install the crankshaft sprocket (1). Refer to [Crankshaft Sprocket Replacement](#).

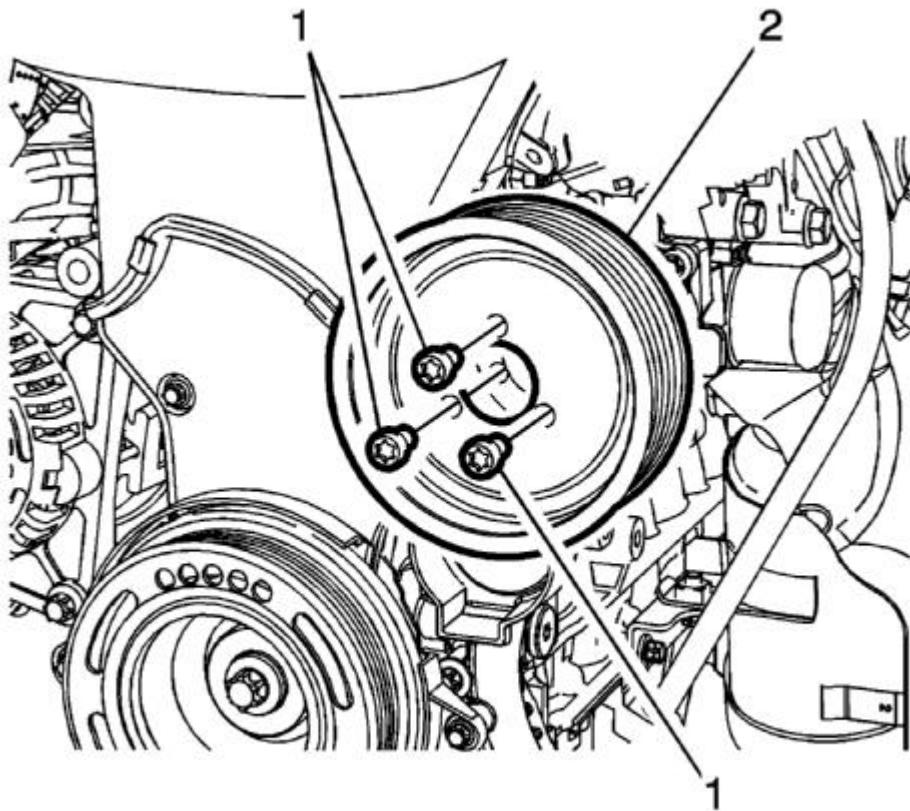


Fig. 150: Water Pump & Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Install the water pump bolts (1) and water pump pulley (2) and tighten to 20 N.m (15 lb ft).
8. Install the generator. Refer to [Generator Replacement \(LUW\)](#).
9. Install the air conditioning compressor. Refer to [Air Conditioning Compressor Replacement \(LDE, LUW, LWE\)](#).
10. Install the timing belt tensioner. Refer to [Timing Belt Tensioner Replacement](#).

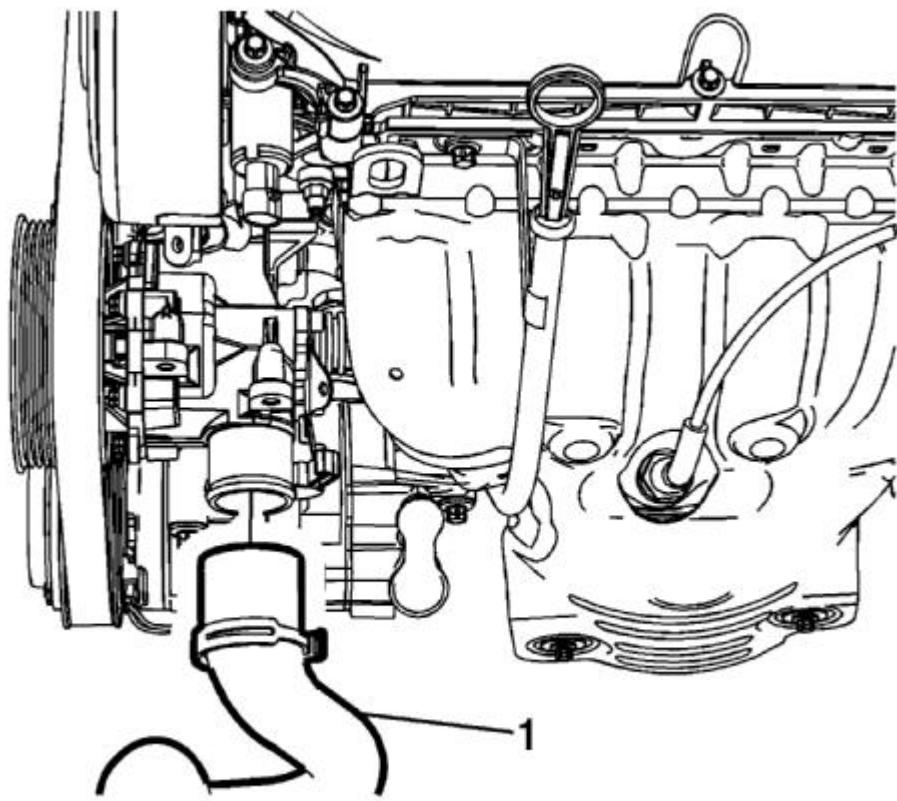


Fig. 151: Radiator Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

11. Install the radiator outlet hose (1) to the water pump. Refer to [**Radiator Outlet Hose Replacement \(LDE LUW\)**](#) .
12. Fill the cooling system. Refer to [**Cooling System Draining and Filling**](#) .

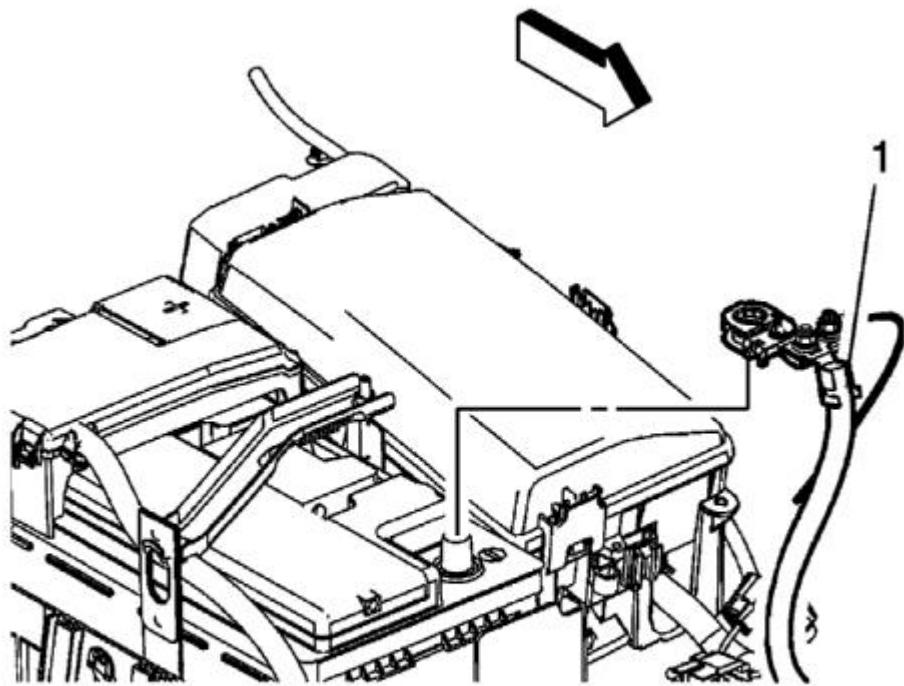


Fig. 152: Negative Battery Cable

Courtesy of GENERAL MOTORS COMPANY

13. Connect the negative battery cable (1). Refer to [Battery Negative Cable Disconnection and Connection](#).

OIL PRESSURE RELIEF VALVE REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to [Oil Pan Replacement](#).

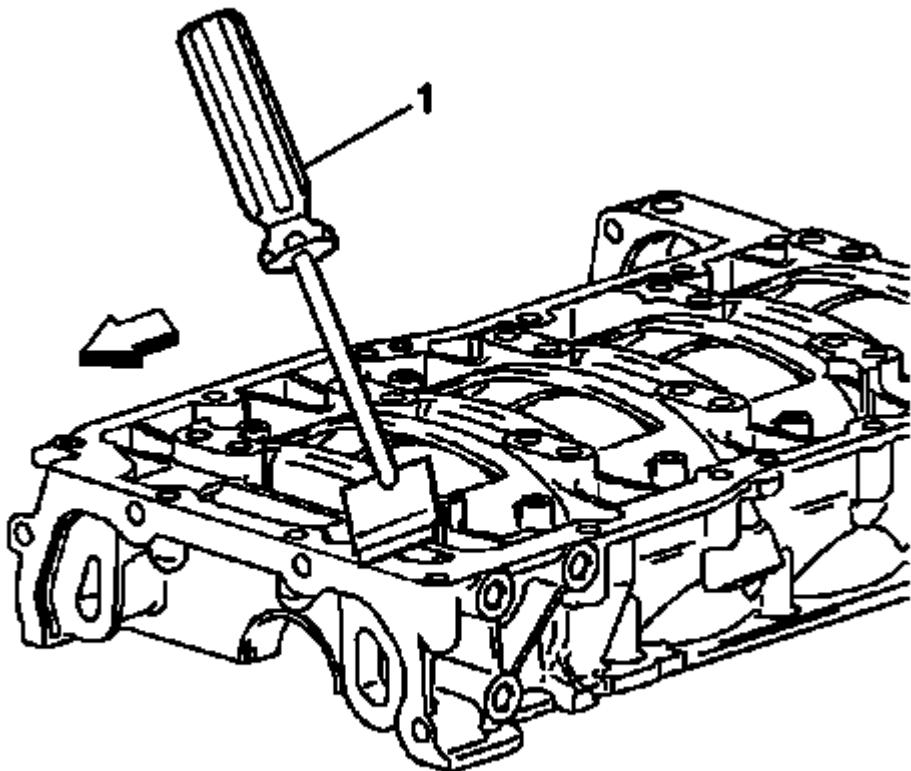


Fig. 153: Oil Pressure Relief Valve Assembly

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. Separate 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

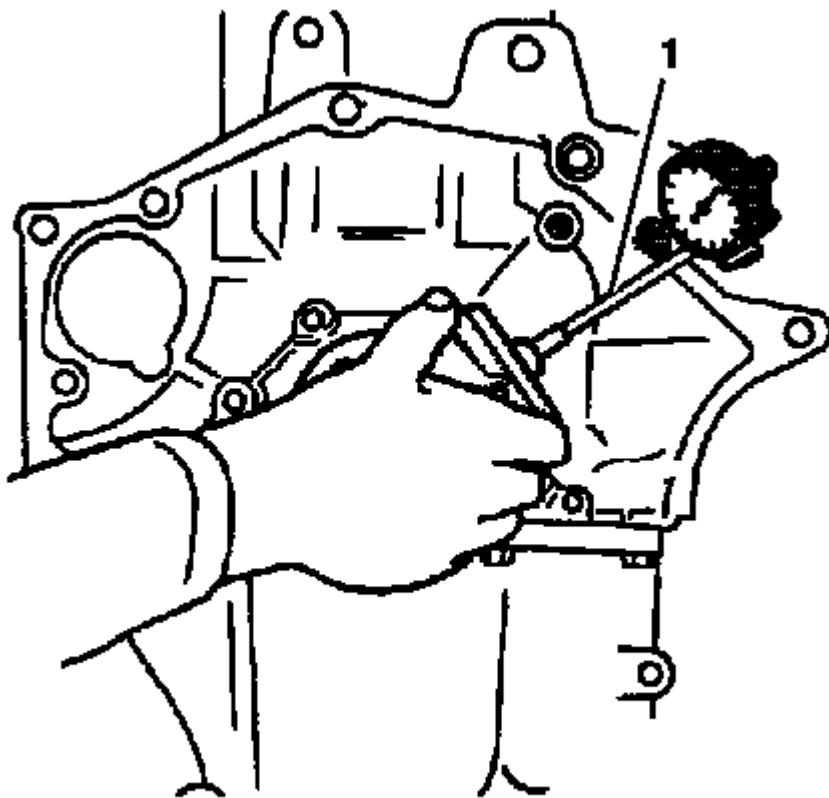


Fig. 154: Oil Pressure Relief Valve Assembly
Courtesy of GENERAL MOTORS COMPANY

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

Removal Procedure

1. Drain the engine coolant. Refer to Cooling System Draining and Filling .
2. Drain the engine oil. Refer to Engine Oil and Oil Filter Replacement.

2013 Chevrolet Sonic LS

2013 Engine Engine Mechanical - 1.8L (LUW, LWE) - Sonic

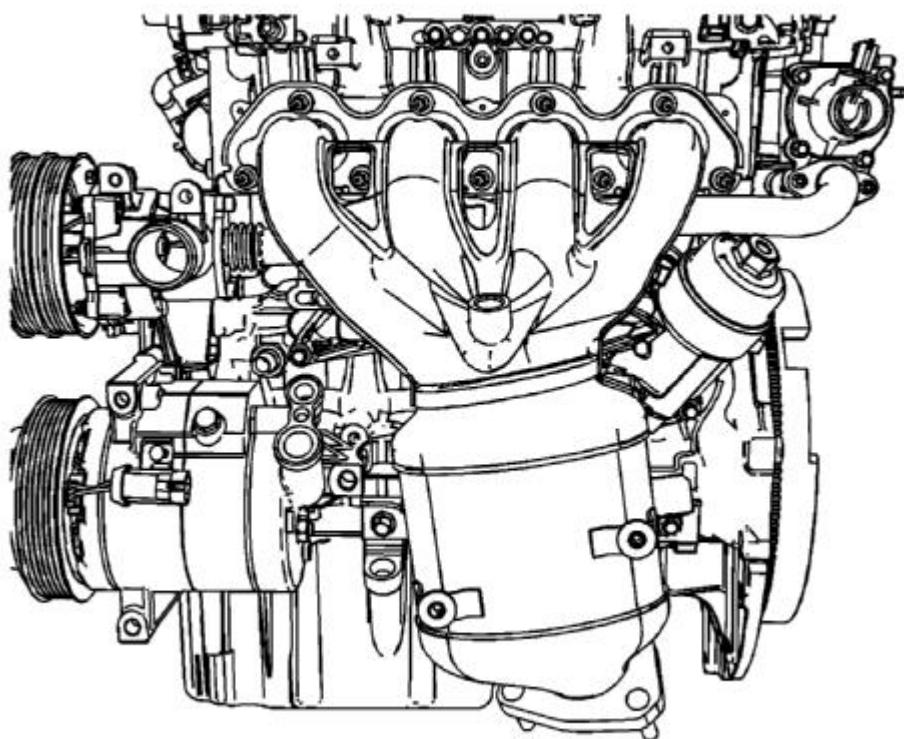


Fig. 155: View of Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust manifold. Refer to [Exhaust Manifold with Catalytic Converter Replacement \(LUW\)](#).

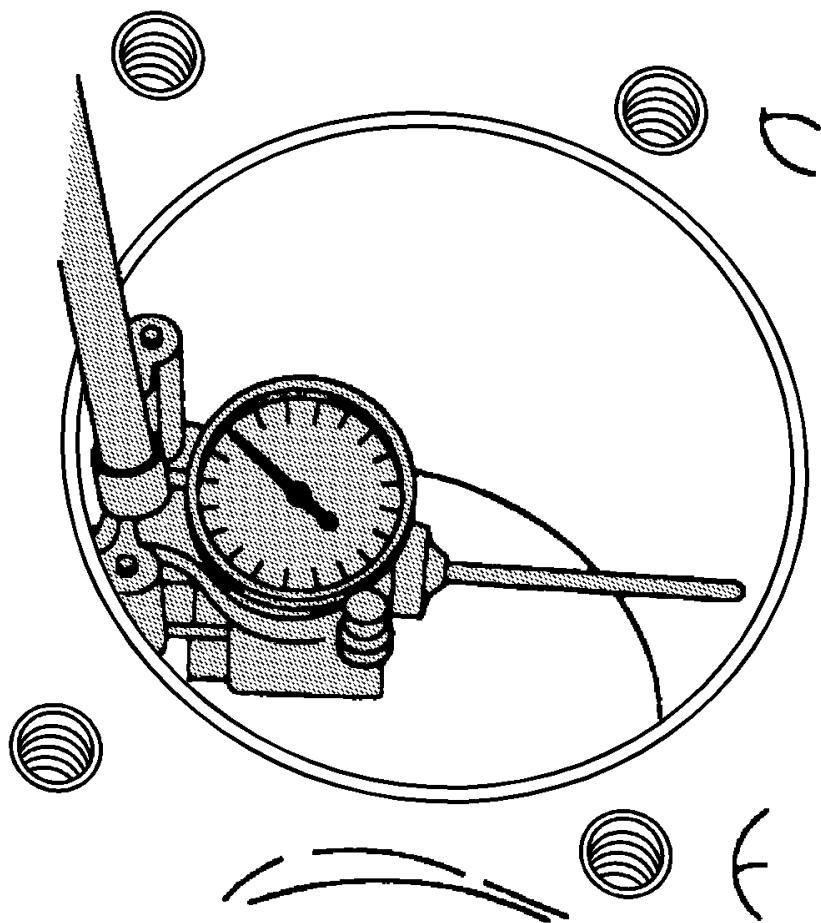


Fig. 156: Coolant Pipe Bolts And Engine Coolant Distributor Case
Courtesy of GENERAL MOTORS COMPANY

4. Remove the coolant pipe bolts (1) from the engine coolant distributor case .
5. Remove the coolant pipe bolts (2) from the engine front cover.
6. Remove the oil cooler tightening bolts (3).

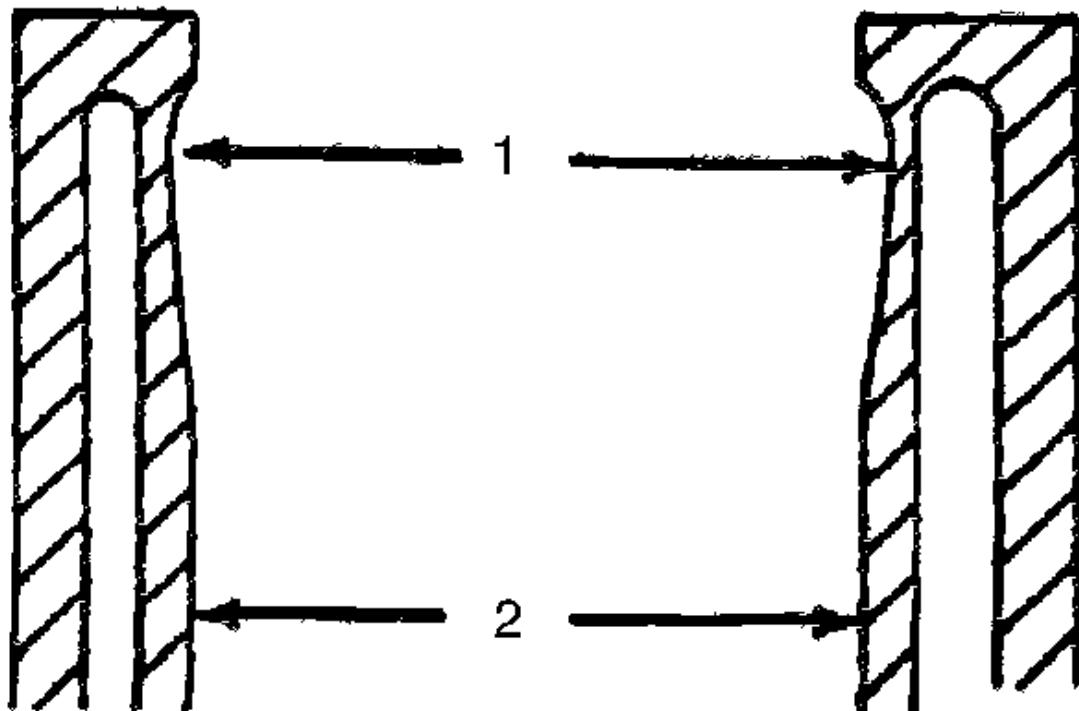


Fig. 157: Heat Exchanger & Gasket
Courtesy of GENERAL MOTORS COMPANY

7. Remove the heat exchanger (4) with the gasket.

Installation Procedure

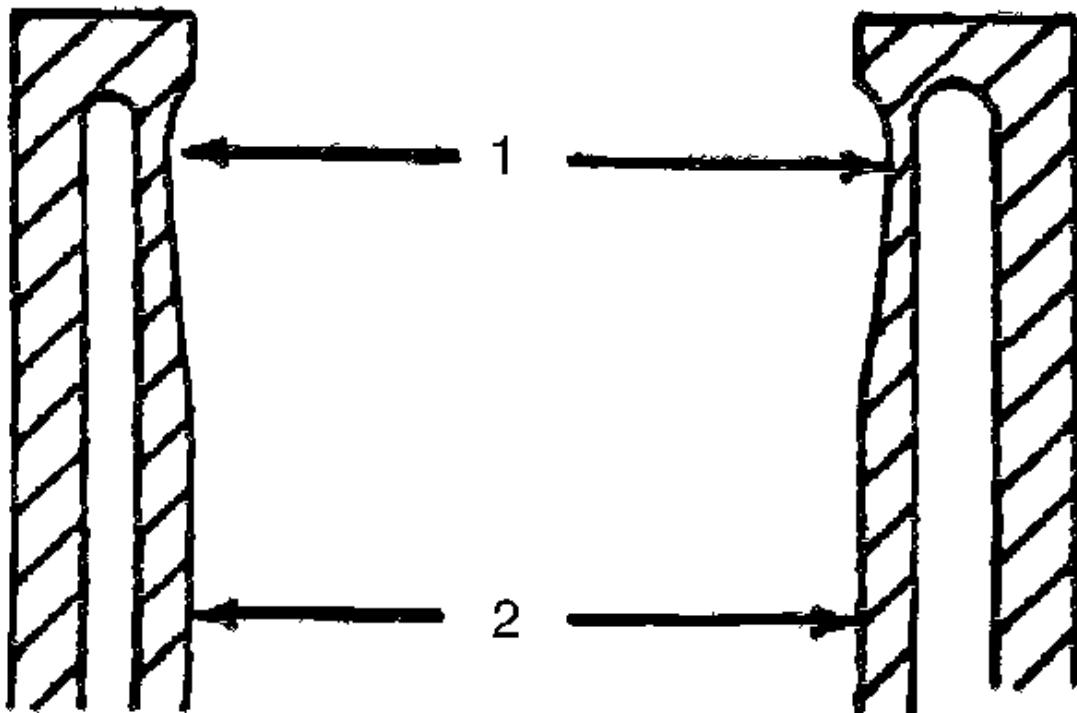


Fig. 158: Heat Exchanger & Gasket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: **Check for damage or leakage on the oil cooler gaskets. If damage or leakage, replace the related gasket with a new one.**

1. Install the heat exchanger (4) with the gasket to the oil cooler housing.

Tighten

Tighten the heat exchanger bolts to 8 N.m (70.8 lb in).

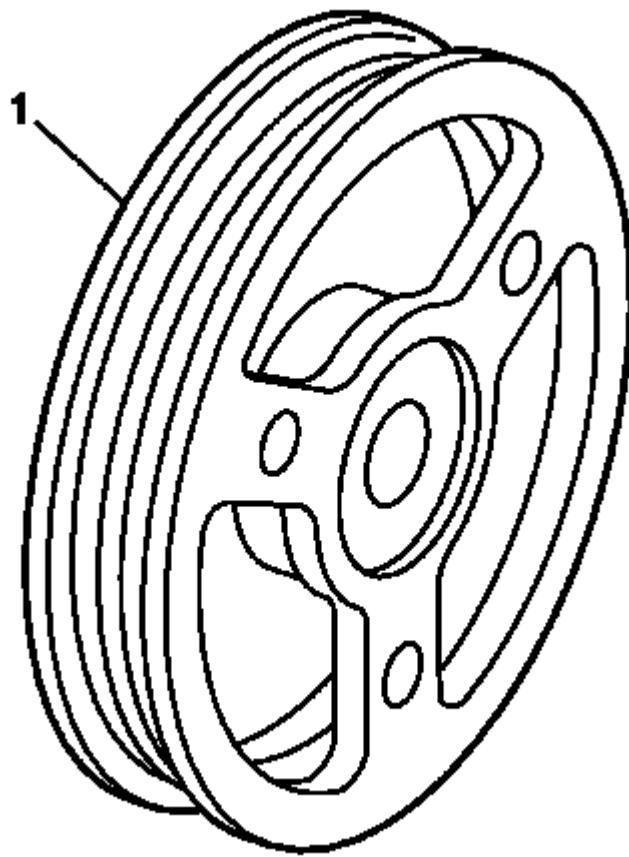


Fig. 159: Coolant Pipe Bolts And Engine Coolant Distributor Case
Courtesy of GENERAL MOTORS COMPANY

2. Insert the coolant pipes to the oil cooler housing with the gasket.
3. Install the oil cooler tightening bolts (3).

Tighten

Tighten the oil cooler tightening bolts to 25 N.m (18 lb ft).

4. Install the coolant pipe bolts (2) to the engine front cover.

Tighten

Tighten the coolant pipe bolts to 8 N.m (71 lb in).

5. Install the coolant pipe bolts (1) to the engine coolant distributor case.

Tighten

Tighten the coolant pipe bolts to 8 N.m (71 lb in).

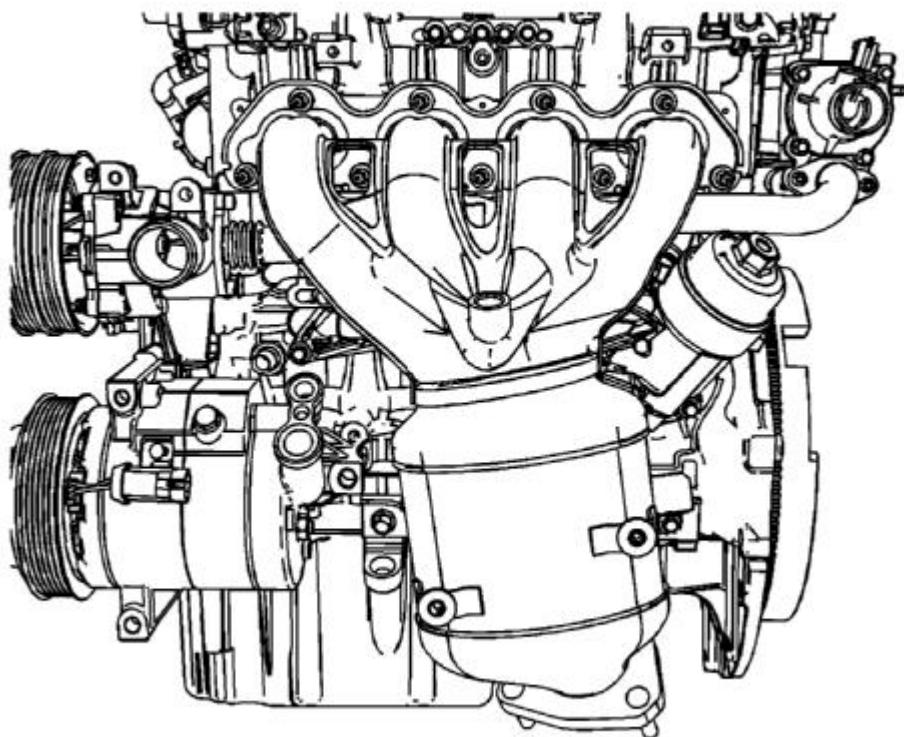


Fig. 160: View of Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS COMPANY

6. Install the exhaust manifold. Refer to [Exhaust Manifold with Catalytic Converter Replacement \(LUW\)](#).
7. Refill the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
8. Refill the engine coolant. Refer to [Cooling System Draining and Filling](#).

OIL FLOW CHECK VALVE REPLACEMENT

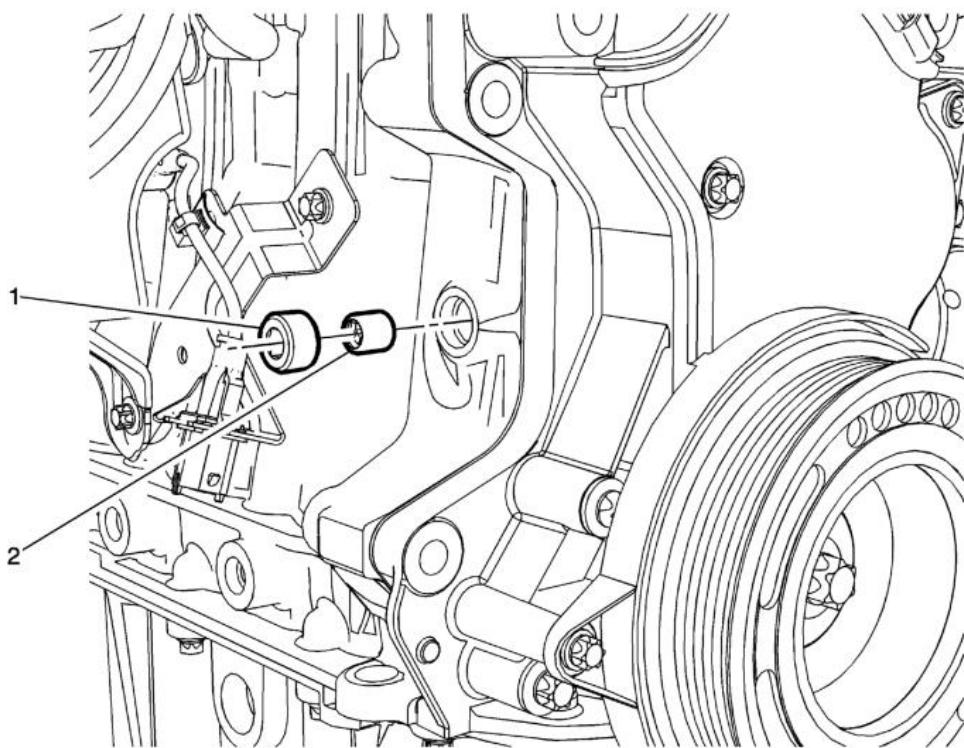


Fig. 161: Oil Flow Check Valve & Bore Plug
Courtesy of GENERAL MOTORS COMPANY

Oil Flow Check Valve Replacement

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

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

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

1. Place collecting basin underneath.

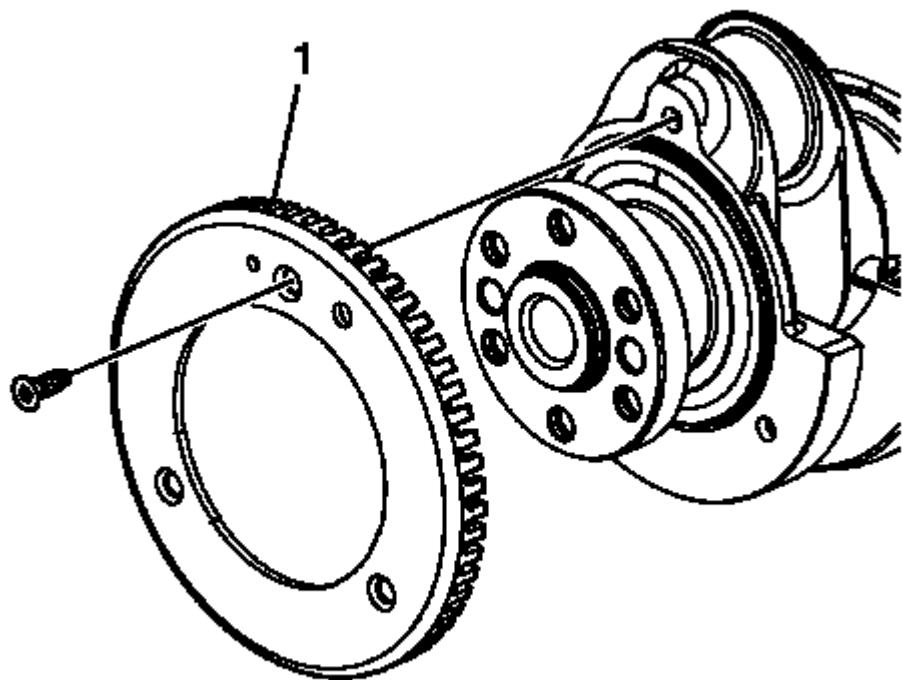


Fig. 162: Oil Level Indicator Tube And Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator tube bolt (1).
3. Remove the oil level indicator tube (2).

Installation Procedure

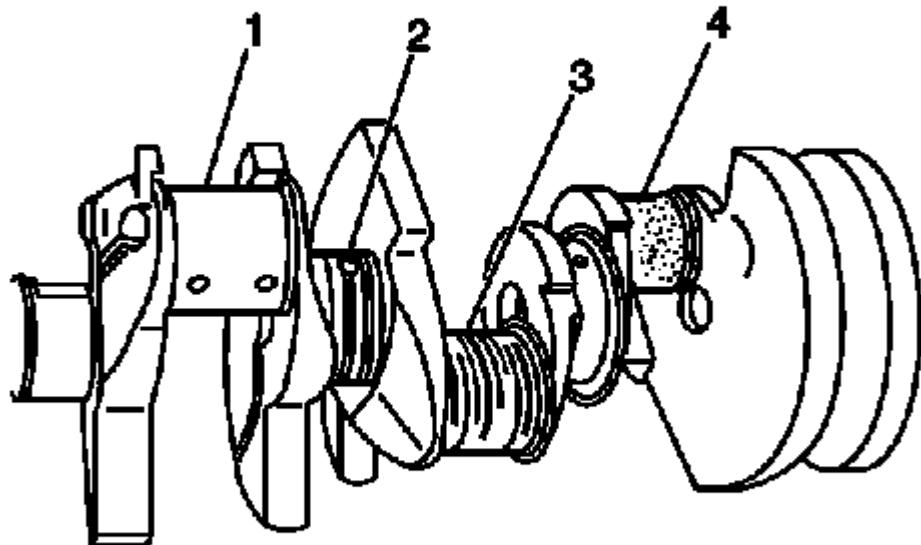


Fig. 163: Oil Level Indicator Tube And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a NEW oil level indicator tube seal

1. Install the oil level indicator tube (2).

CAUTION: Refer to Fastener Caution .

2. Install the oil level indicator tube bolt (1) and tighten to 15 N.m (11 lb ft).
3. Check the oil level and adjust as necessary.

ENGINE REPLACEMENT (AUTOMATIC TRANSMISSION)

Special Tools

- **J-45859** Wheel Drive Shaft Remover
- **CH-807** Closure Plugs

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

Removal Procedure

1. Remove the battery and battery tray. Refer to [Battery Tray Replacement](#).
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
3. Recover the refrigerant. Refer to [Refrigerant Recovery and Recharging](#).
4. Remove the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).
6. Remove the front wheelhouse liner inner front extensions. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#), [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#).
7. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).

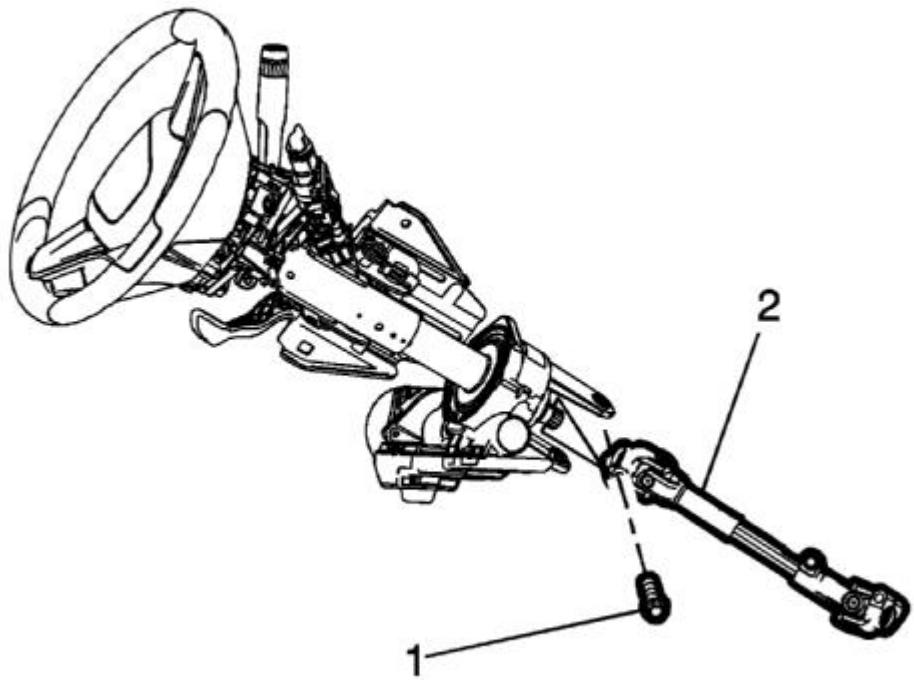


Fig. 164: Lower Intermediate Steering Shaft & Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the lower intermediate steering shaft bolt (1) and slide the shaft away from steering column. Refer to [Intermediate Steering Shaft Replacement](#).

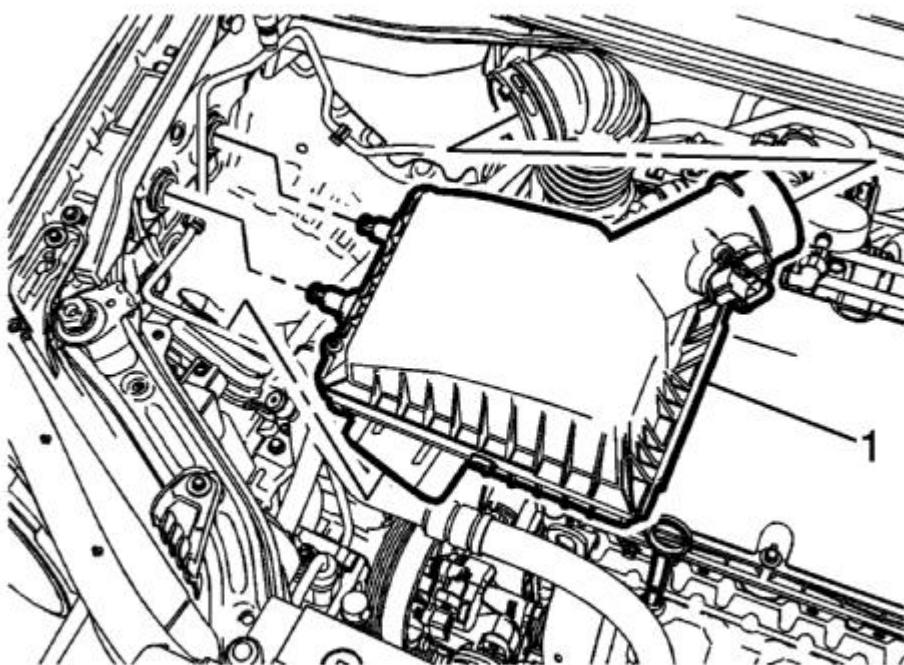


Fig. 165: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

9. Remove the air cleaner assembly (1). Refer to [Air Cleaner Assembly Replacement](#).

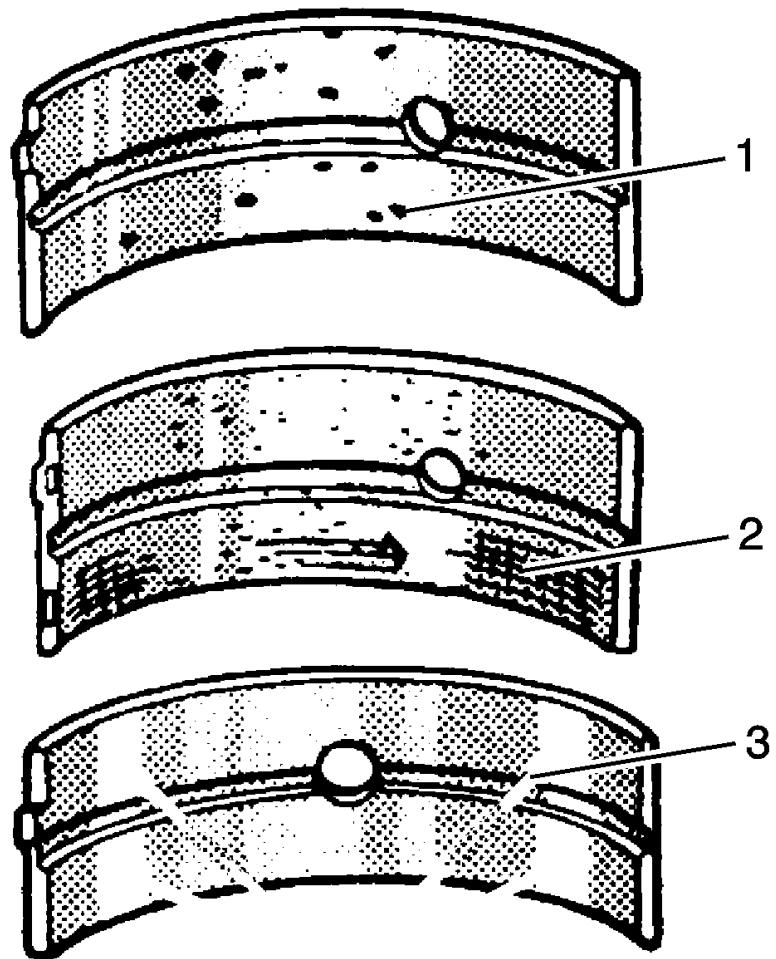


Fig. 166: Junction Block & Cover

Courtesy of GENERAL MOTORS COMPANY

10. Remove the junction block cover (1).

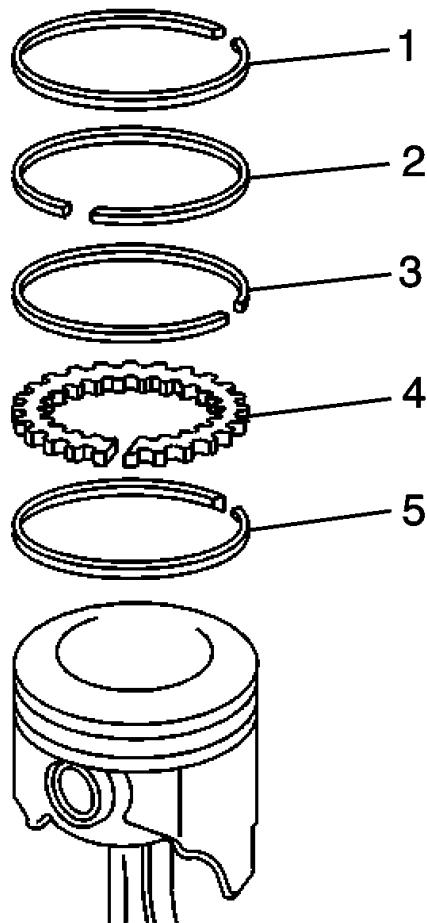


Fig. 167: Positive Battery Cable & Nut
Courtesy of GENERAL MOTORS COMPANY

11. Remove the positive battery cable nut (1) from the junction block.
12. Remove the positive battery cable (2) from the junction block.

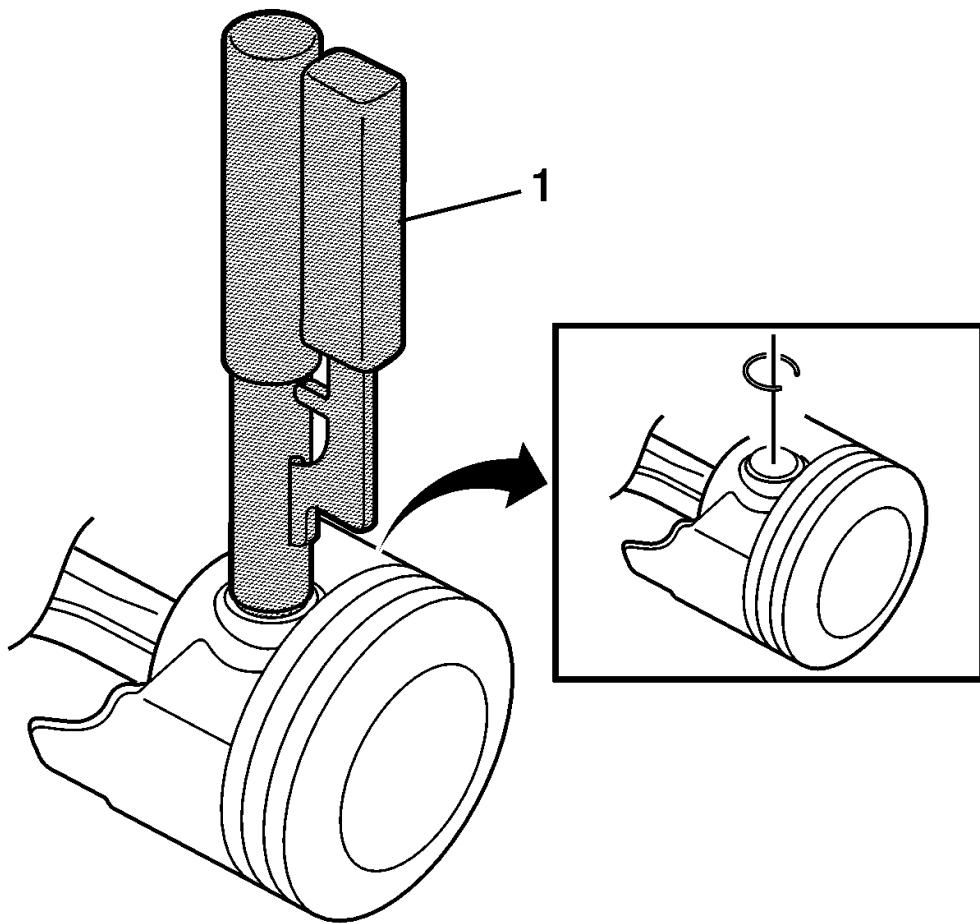


Fig. 168: Body Wiring Harness Connector & Positive Cable Nut
Courtesy of GENERAL MOTORS COMPANY

13. Remove the positive cable nut (1) and battery positive cable, from the battery positive cable junction block.
14. Disconnect the body wiring master harness connector (2), from the battery positive cable junction block.

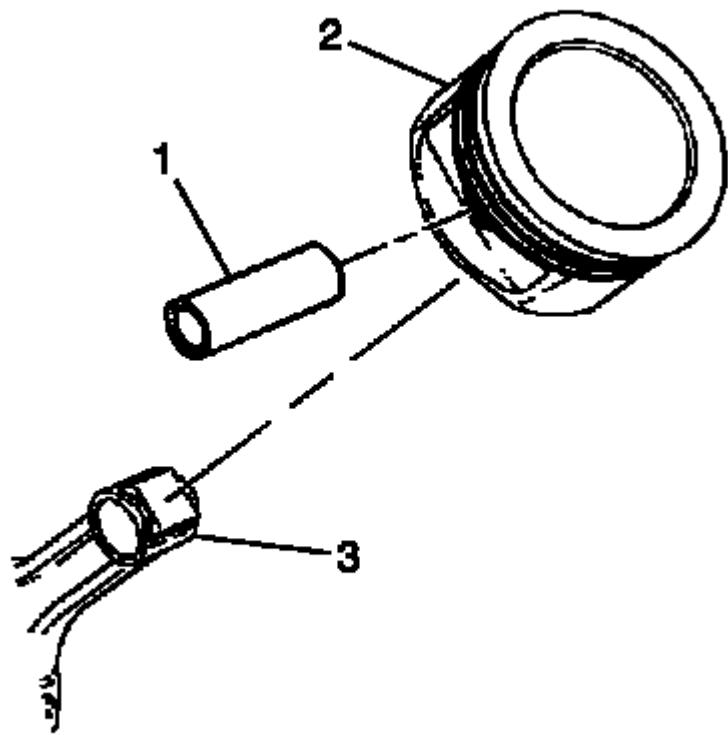


Fig. 169: Junction Block
Courtesy of GENERAL MOTORS COMPANY

15. Remove the junction block nut (1).
16. Remove the junction block bolts (2).
17. Disconnect the wiring harness from the junction block base.
18. Remove the junction block (3) from the base.
19. Disconnect the wiring harness plug from the front compartment fuse block.

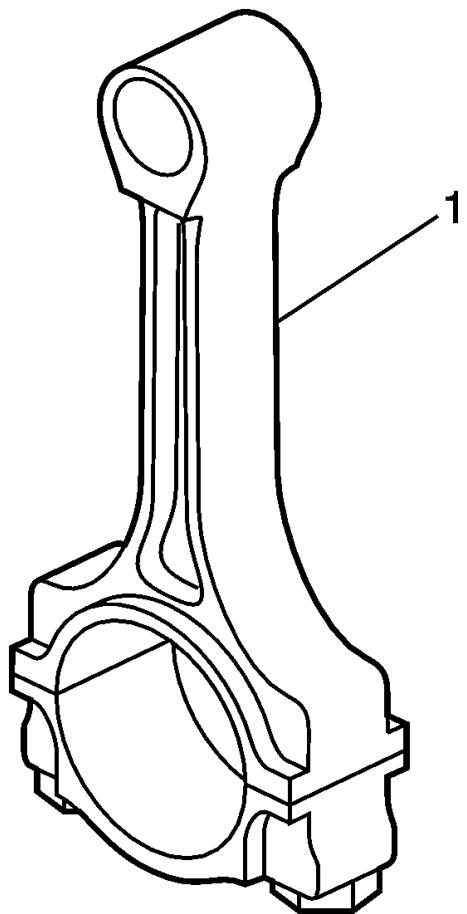


Fig. 170: Wiring Harness - Top Of Engine
Courtesy of GENERAL MOTORS COMPANY

20. Reposition the wiring harness (1) on top of the engine.

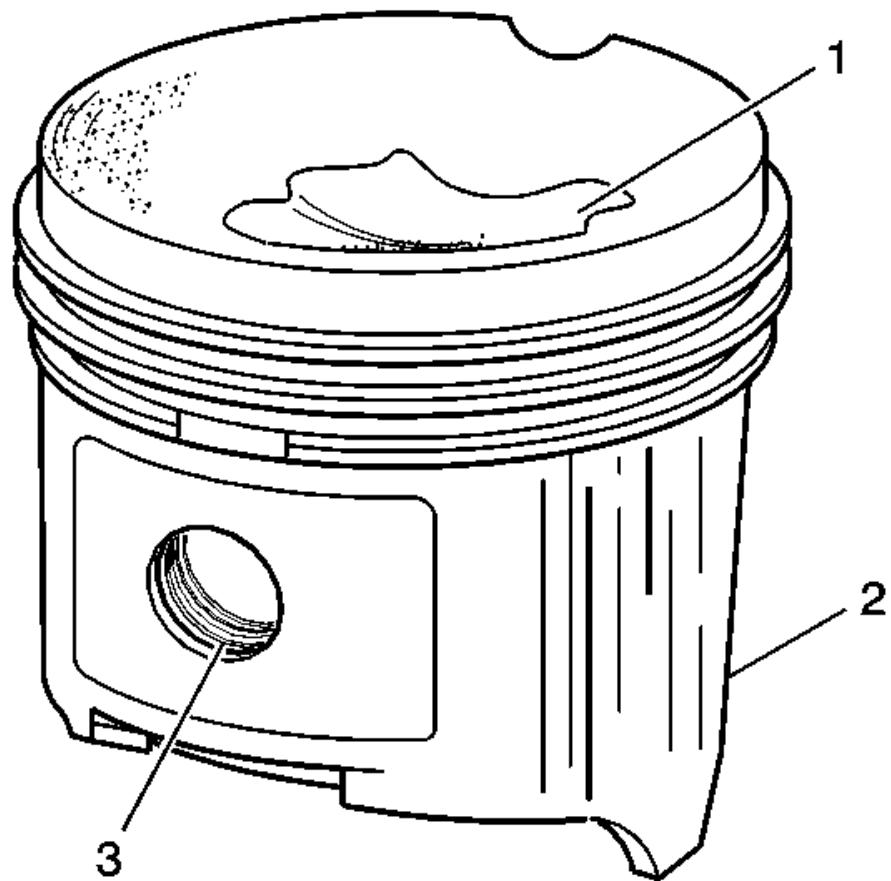


Fig. 171: Wiring Harness & Ground Nuts
Courtesy of GENERAL MOTORS COMPANY

21. Remove the ground nuts (1) and reposition the wiring harness (2) aside.

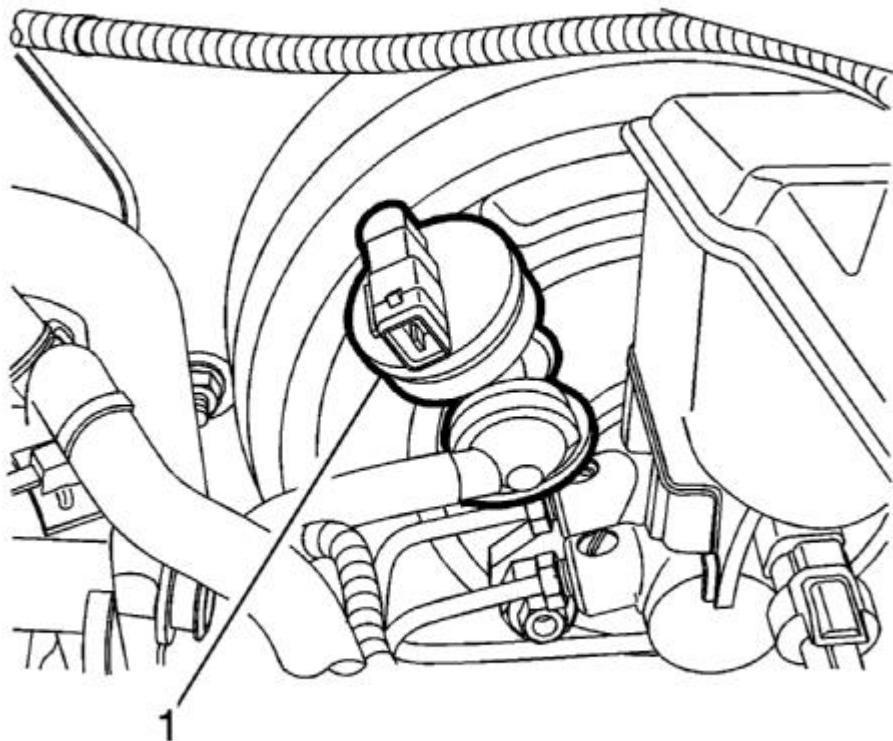


Fig. 172: Electrical Vacuum Pump

Courtesy of GENERAL MOTORS COMPANY

22. If equipped with electrical vacuum pump, disconnect the electrical connector and remove the brake booster hose (1).

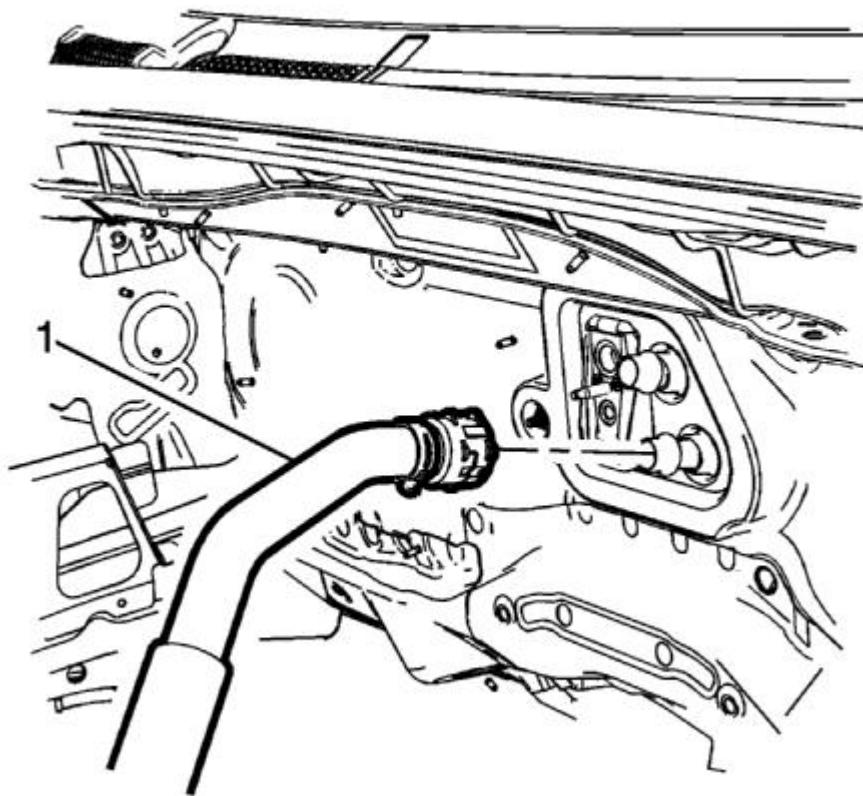


Fig. 173: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

23. Disconnect the heater inlet hose (1) from the heater core. Refer to [Heater Inlet Hose Replacement \(LDE, LUW\)](#).

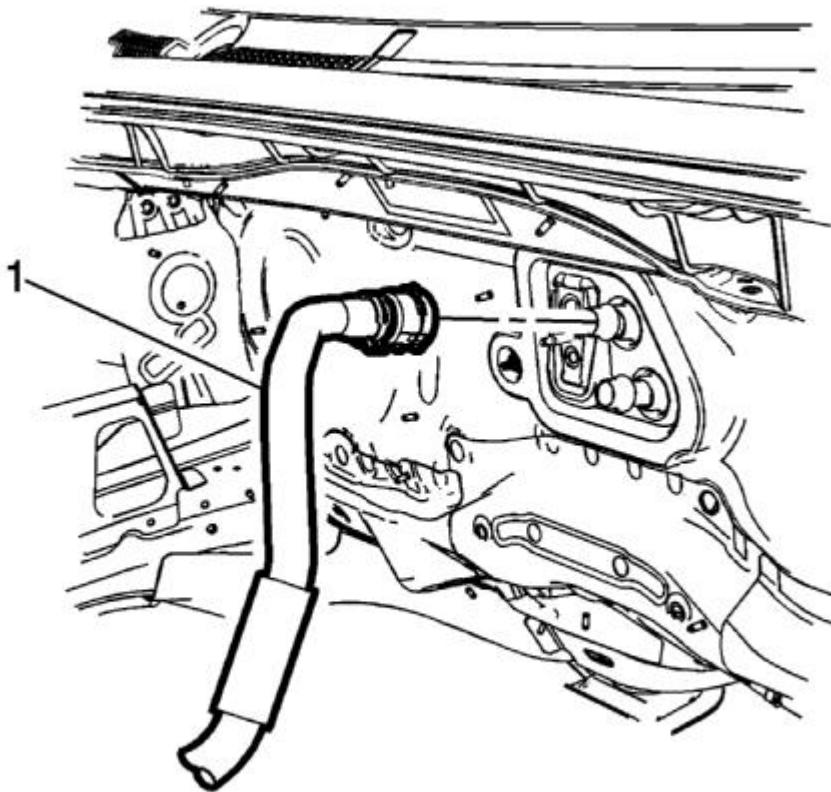


Fig. 174: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

24. Disconnect the heater outlet hose (1) from the heater core. Refer to [Heater Outlet Hose Replacement \(LDE, LUW\)](#).

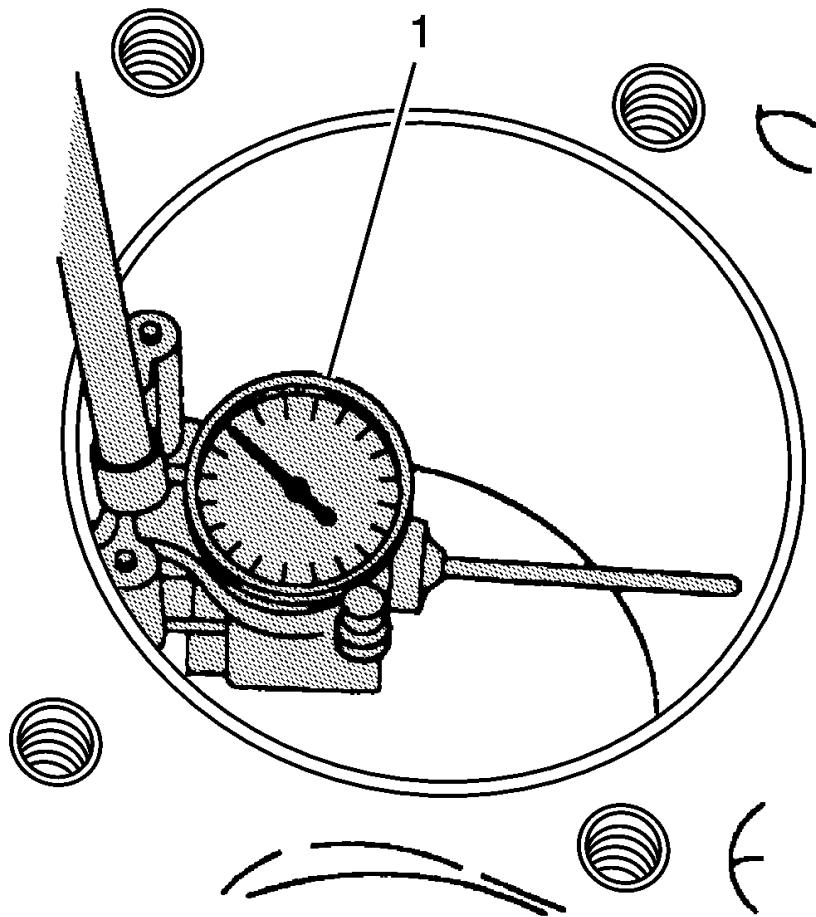


Fig. 175: Automatic Transmission Range Selector Lever Cable Terminal & Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

25. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.
26. Remove the transmission range selector lever cable (2) from the cable bracket.

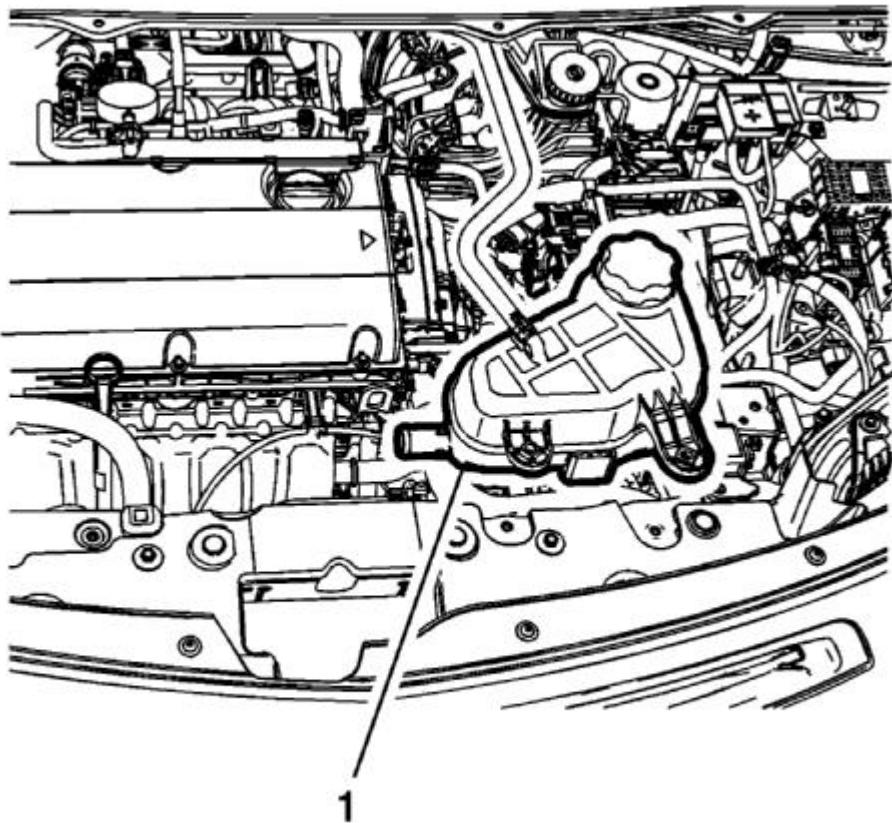


Fig. 176: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

27. Remove the radiator surge tank (1) and position aside. Refer to [Radiator Surge Tank Replacement](#) .
28. Disconnect the fan connector.

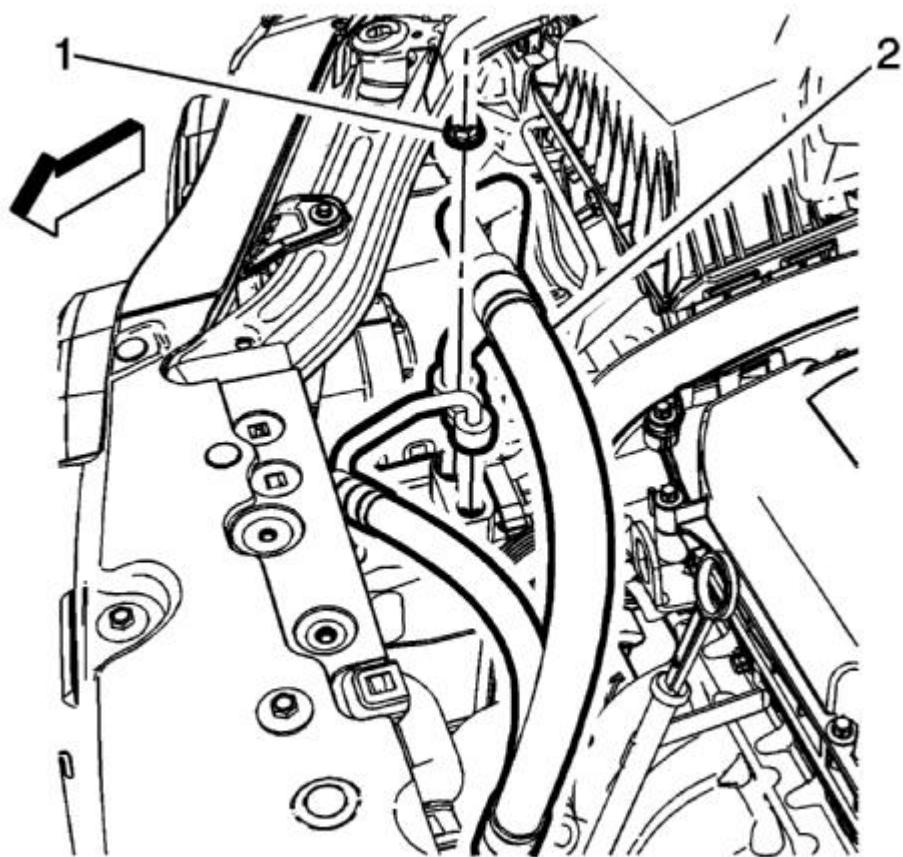


Fig. 177: Air Conditioning Compressor, Condenser Hose & Nut
Courtesy of GENERAL MOTORS COMPANY

29. Remove air conditioning compressor and condenser hose nut (1).
30. Remove air conditioning compressor and condenser hose (2) from refrigerant hose.

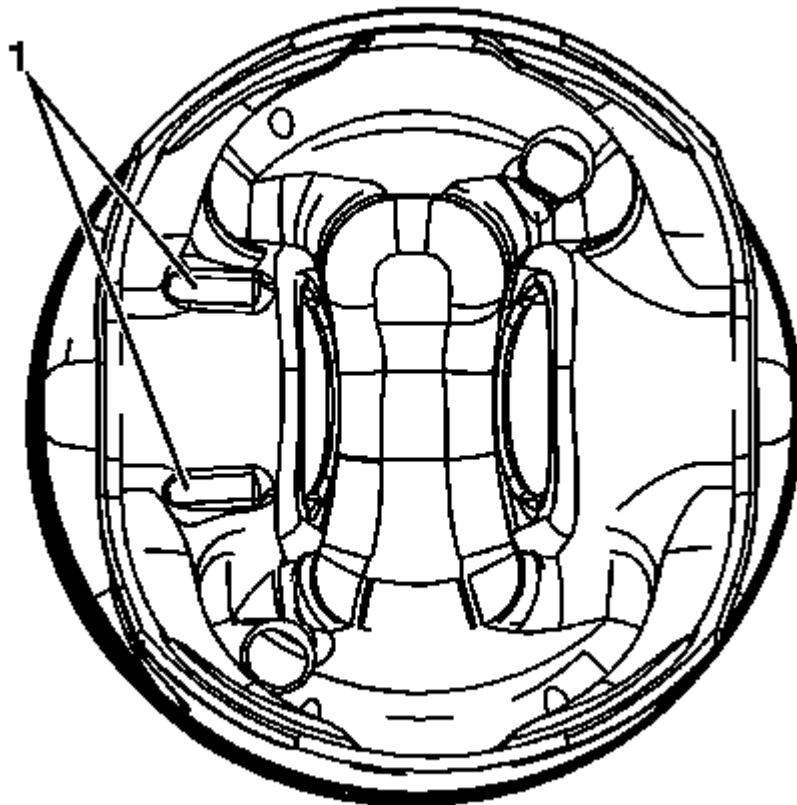


Fig. 178: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

31. Disconnect the fuel feed pipe (1). Refer to [Plastic Collar Quick Connect Fitting Service](#) .
32. Install and close the fuel feed pipe with CH-807 plug.
33. Disconnect the engine coolant sensor from radiator.

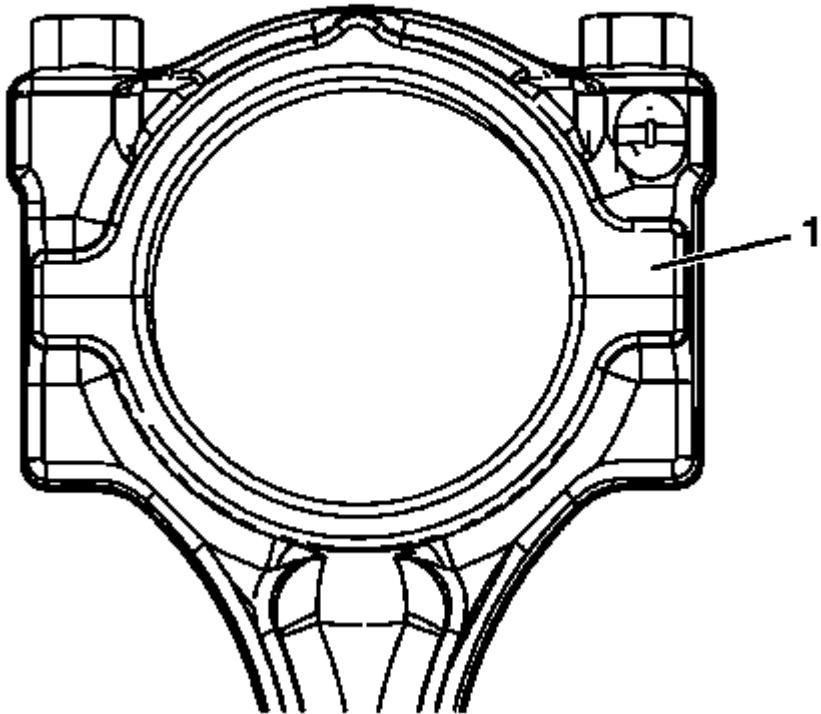


Fig. 179: View Of Brake Rotor, Caliper & Axle Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Perform steps 33 through 41 to both sides.

34. Insert a brass drift or punch (1) in the cooling fins of the front brake rotor (2).
35. Rotate the brake rotor until it comes in contact with the brake caliper mount bracket (5).

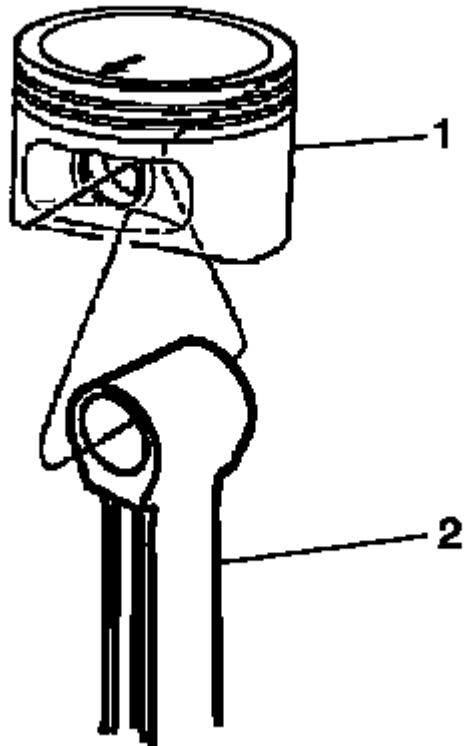


Fig. 180: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Use a suitable tool to release the crimping on the wheel drive shaft retaining nut.
- The wheel drive shaft retaining nut (1) must be discarded after removal.

36. Remove and discard the wheel drive shaft nut (1).

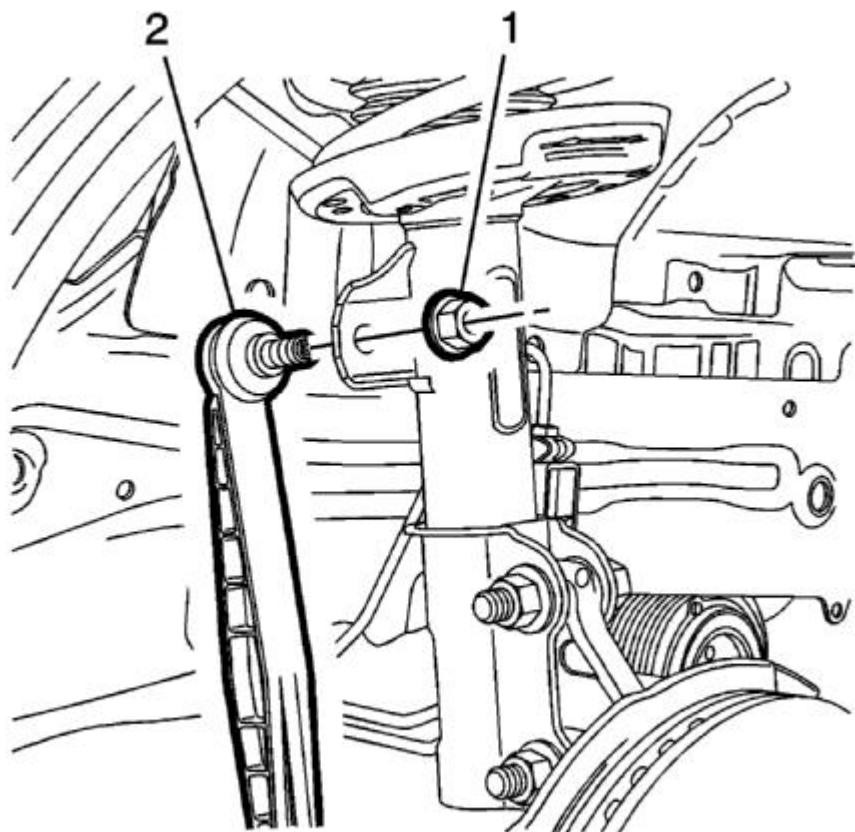


Fig. 181: Upper Stabilizer Shaft Link

Courtesy of GENERAL MOTORS COMPANY

37. Remove the upper stabilizer shaft link nut (1).
38. Disconnect the stabilizer shaft link (2).

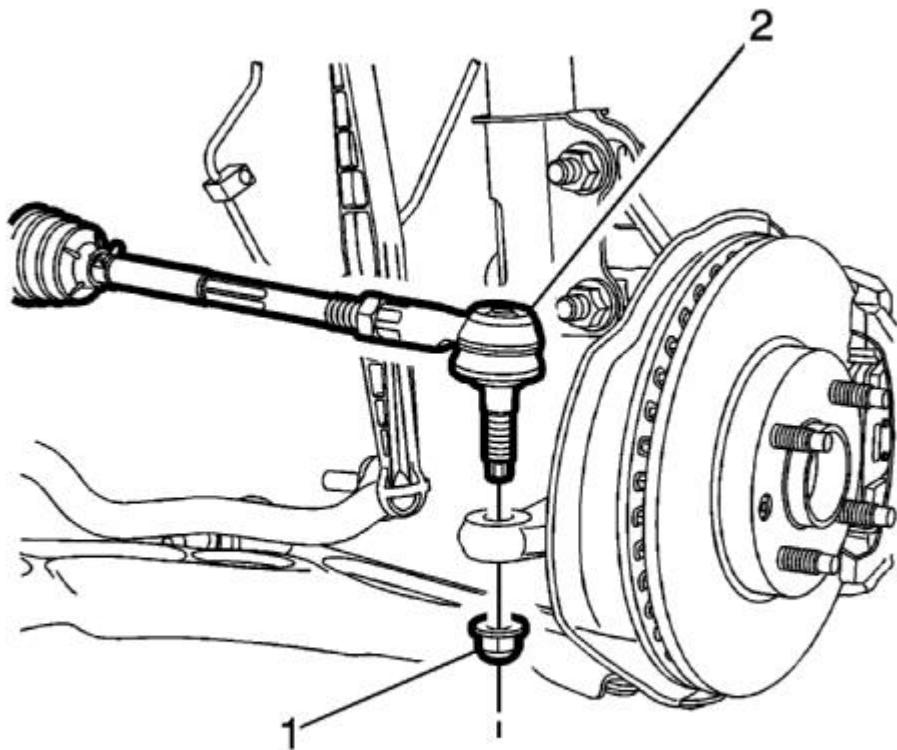


Fig. 182: Steering Linkage Outer Tie Rod

Courtesy of GENERAL MOTORS COMPANY

39. Remove and **DISCARD** the steering linkage outer tie rod nut (1).
40. Separate the steering linkage outer tie rod (2) from the steering knuckle. **Steering Linkage Outer Tie Rod Replacement**.
41. Separate the control arm ball joint from the steering knuckle. Refer to **Lower Control Arm Replacement**.

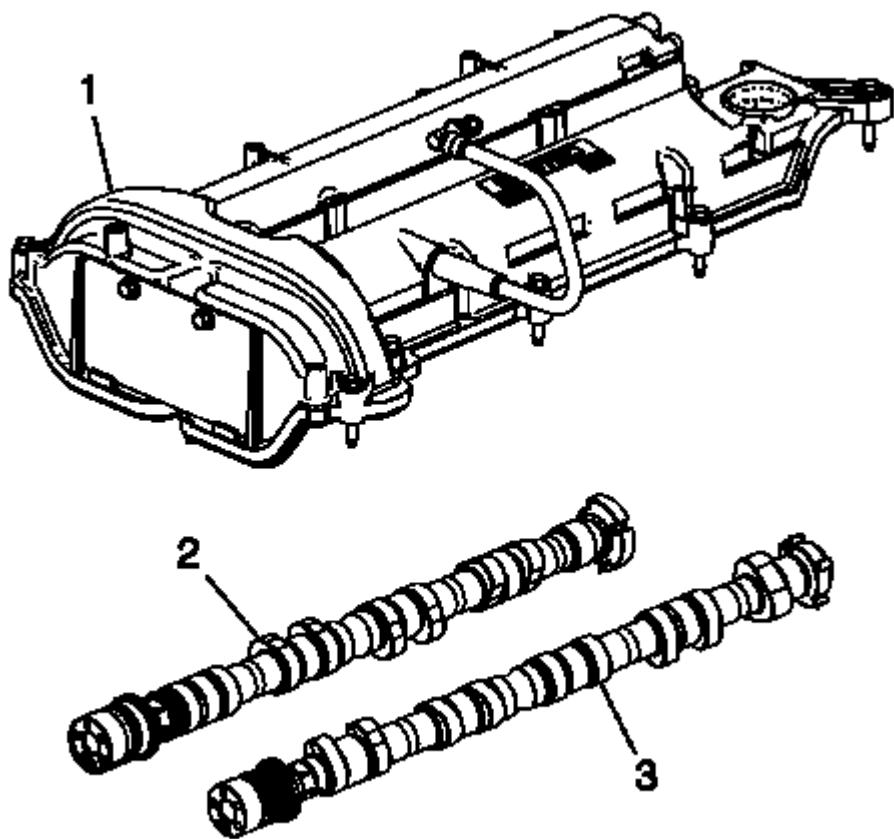


Fig. 183: Wheel Lug Nuts & Remover

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Reverse the wheel lug nuts and washers so the flat part of the wheel nut is facing the washers.**

42. Using the **J-45859** wheel drive shaft remover (2), separate the wheel drive shaft from the steering knuckle (1).
43. Remove the upper stabilizer shaft link from the absorber on both sides. Refer to [Stabilizer Shaft Link Replacement](#).
44. Remove the front exhaust pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#).

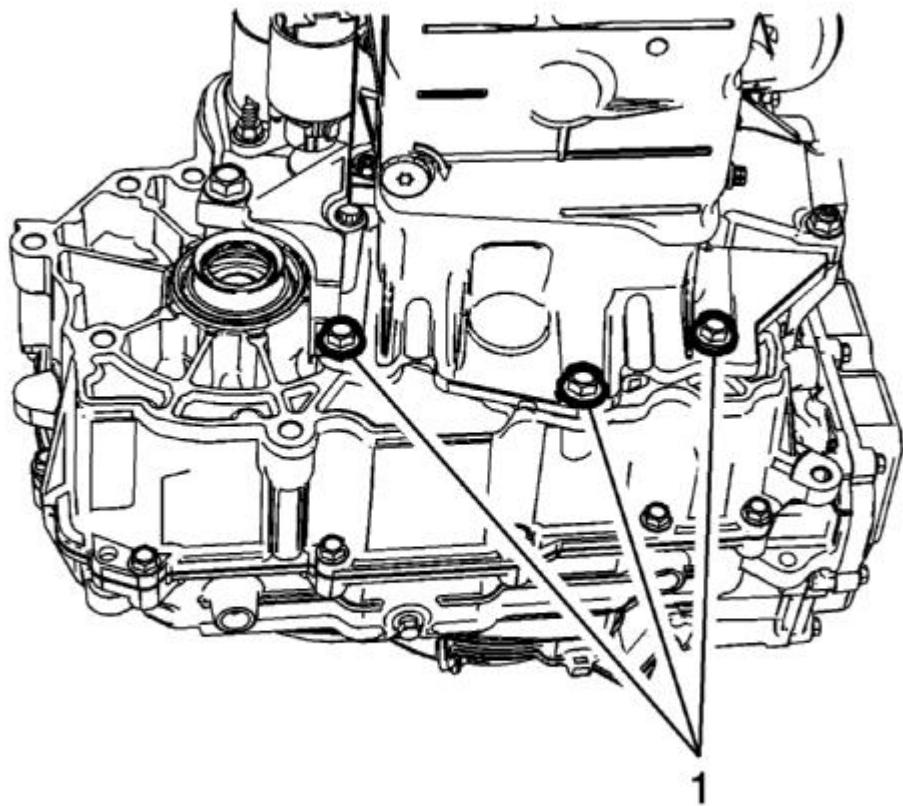


Fig. 184: Lower Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

45. Remove the lower oil pan to transmission lower bolts (1).

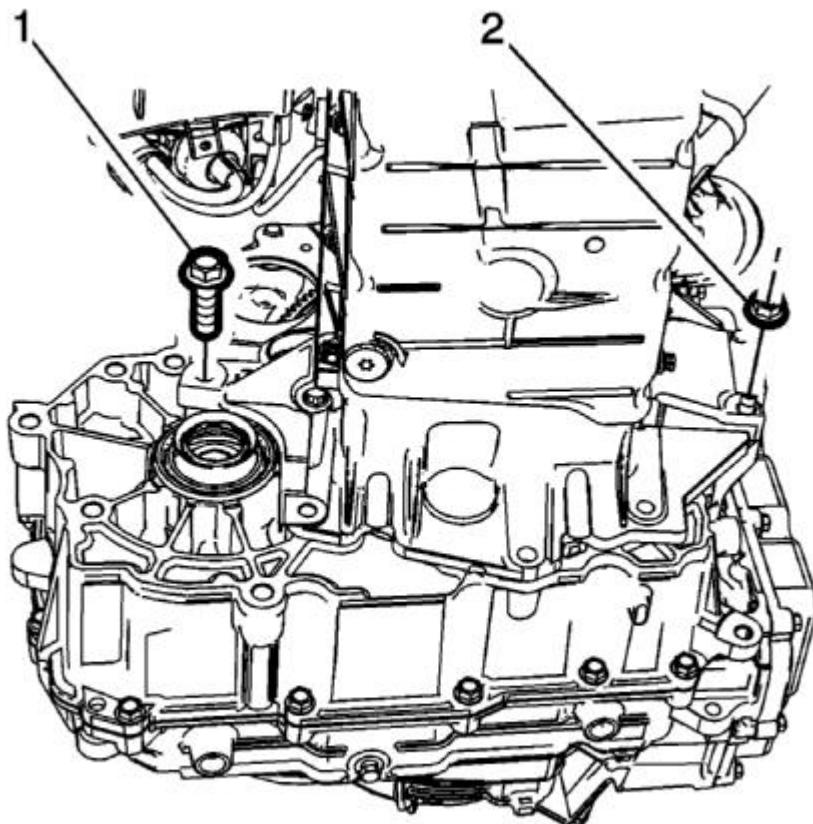


Fig. 185: Lower Oil Pan Bolts & Nut
Courtesy of GENERAL MOTORS COMPANY

46. Remove the lower oil pan to transmission lower bolts (1) and nut (2).
47. Remove the frame braces.

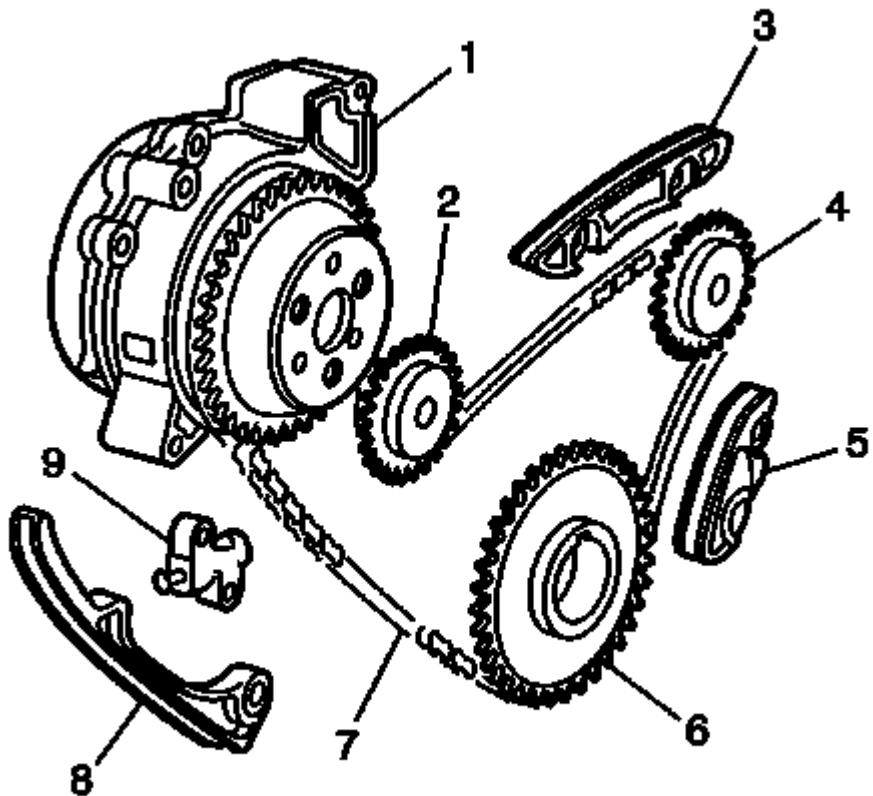


Fig. 186: Front Frame Bolts

Courtesy of GENERAL MOTORS COMPANY

48. Remove the frame front bolts (1).

NOTE: **Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.**

49. Position an engine support table under the powertrain assembly.

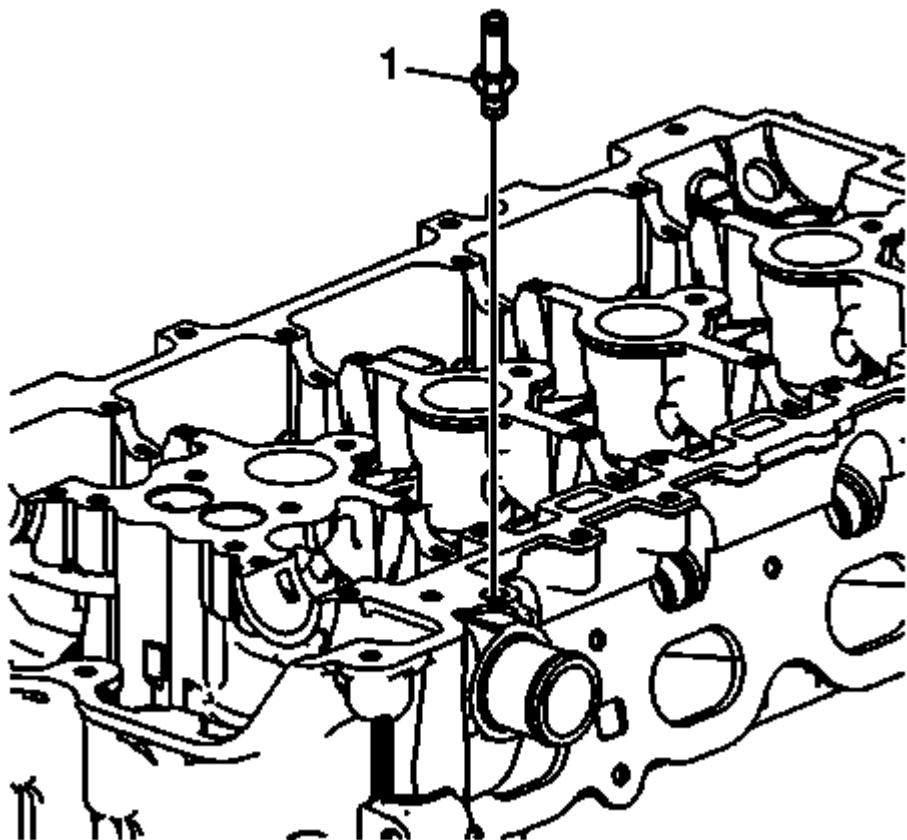


Fig. 187: Frame Suspension Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

50. Remove the upper frame suspension retaining bolts (1) on both sides.

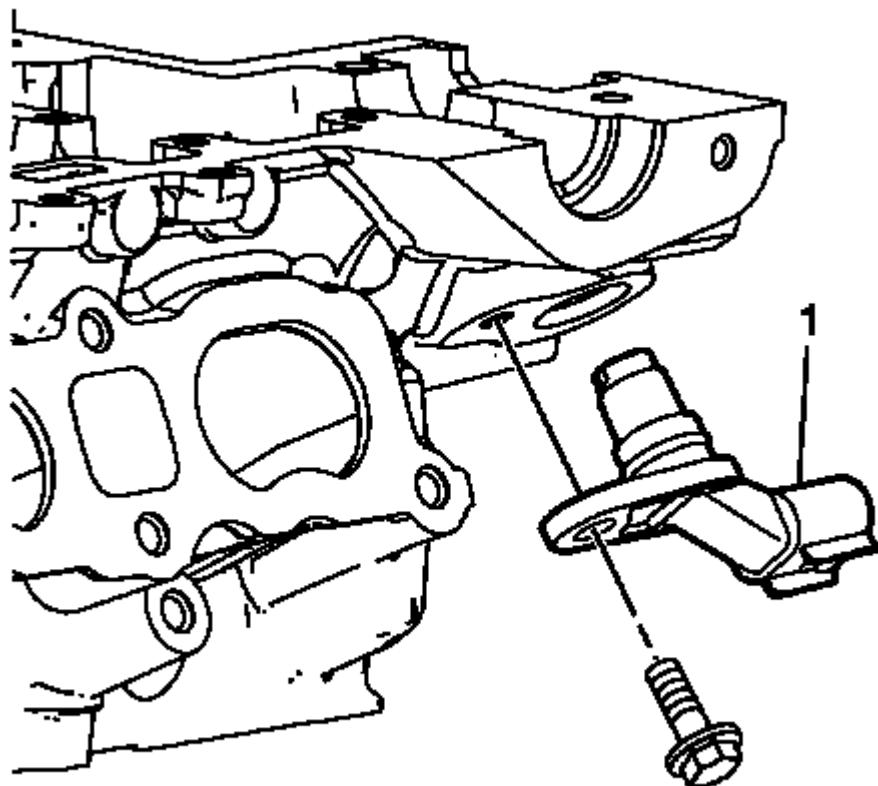


Fig. 188: Right Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

51. Mark the location of the right engine mount bolts (1) before removing.
52. Remove and Discard the right side engine mount bolts (1). Refer to [Engine Mount Replacement](#).

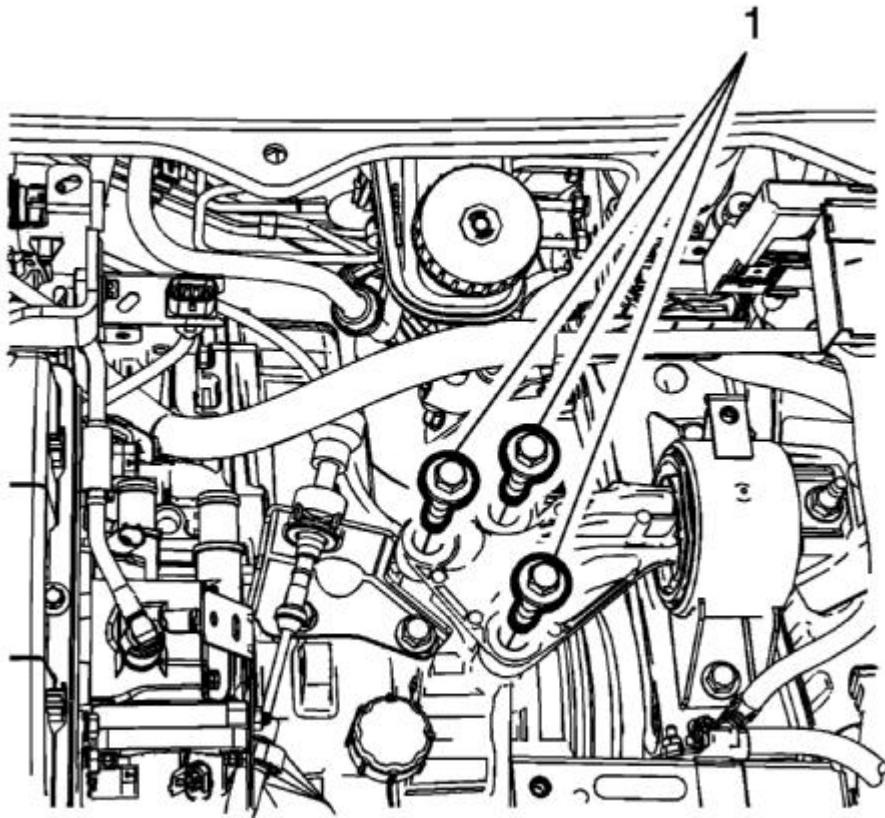


Fig. 189: Transmission Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

53. Mark the location of the transmission mount bolts (1) before removing.
54. Remove and DISCARD the transmission mount bolts (1) - left side. Refer to [Transmission Mount Replacement - Left Side](#) .
55. Disconnect any additional electrical connections as necessary.
56. Raise the vehicle until the powertrain is clear for removal.
57. Remove the starter. Refer to [Starter Replacement \(LUW\)](#) .
58. Remove the torque converter bolt access plug next to the starter opening.
59. Remove the torque converter bolts.

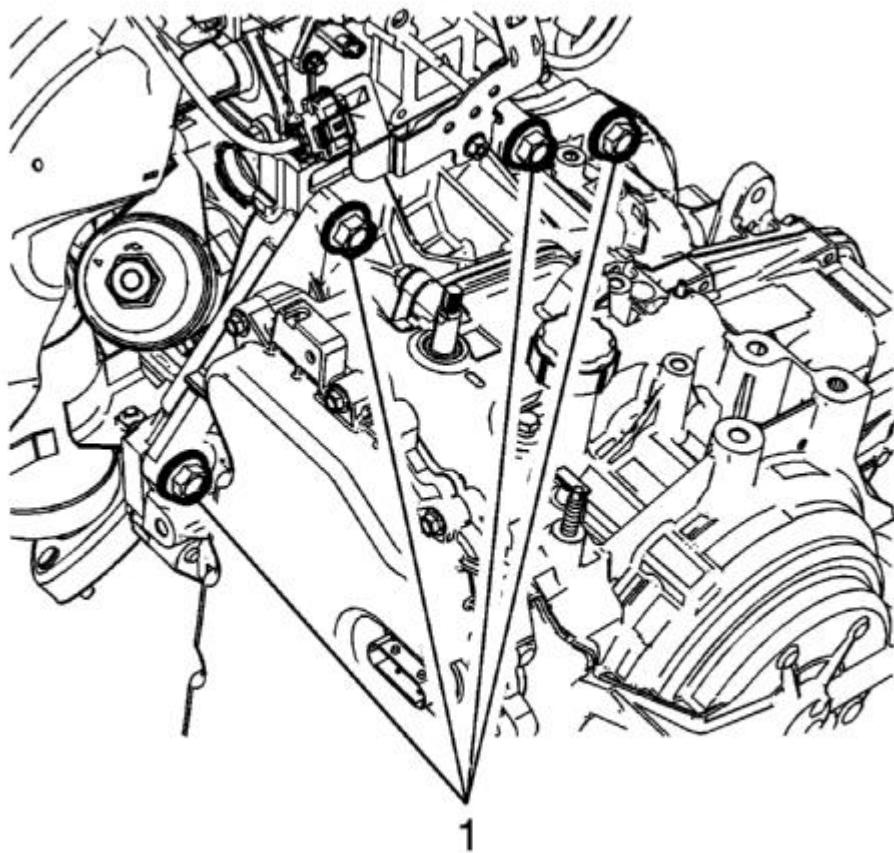


Fig. 190: Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

60. Remove the upper transmission to engine bolts (1) and separate the engine and transmission.
61. Disconnect any electrical connectors as needed.
62. Install the engine to the engine stand.
63. Transfer parts as needed.

Installation Procedure

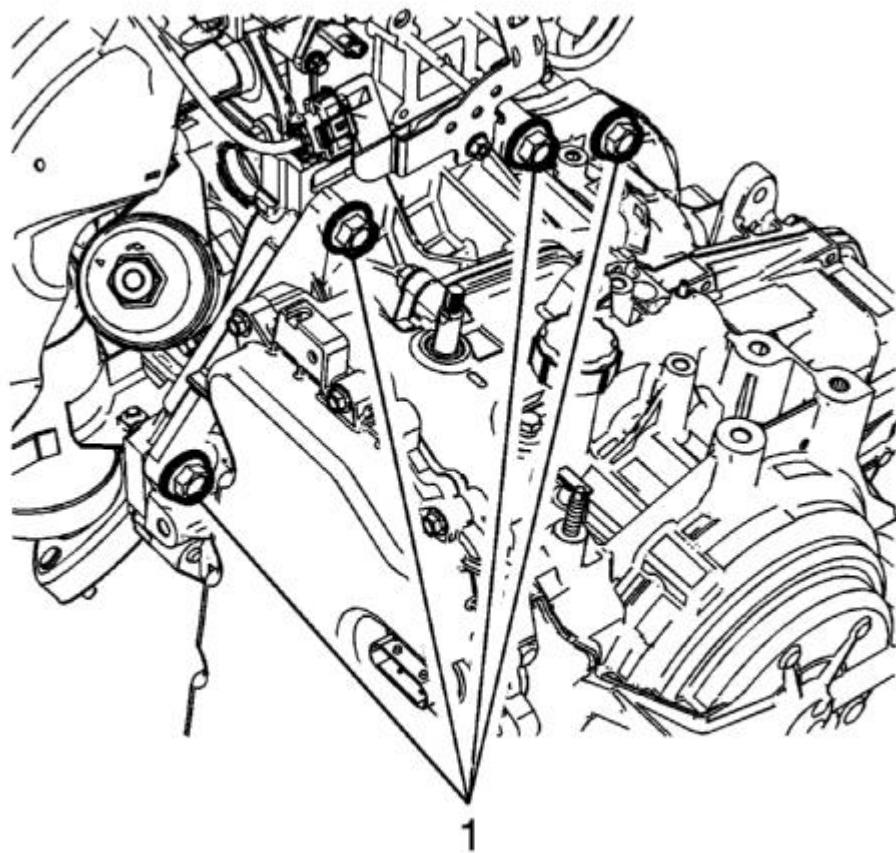


Fig. 191: Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine from the engine stand.
2. Install the transmission to the engine.

CAUTION: Refer to Fastener Caution .

3. Install the upper transmission to engine bolts (1) and tighten to 60 (44 lb ft).
4. Place the powertrain into the front frame.
5. Slowly lower the body onto the powertrain.

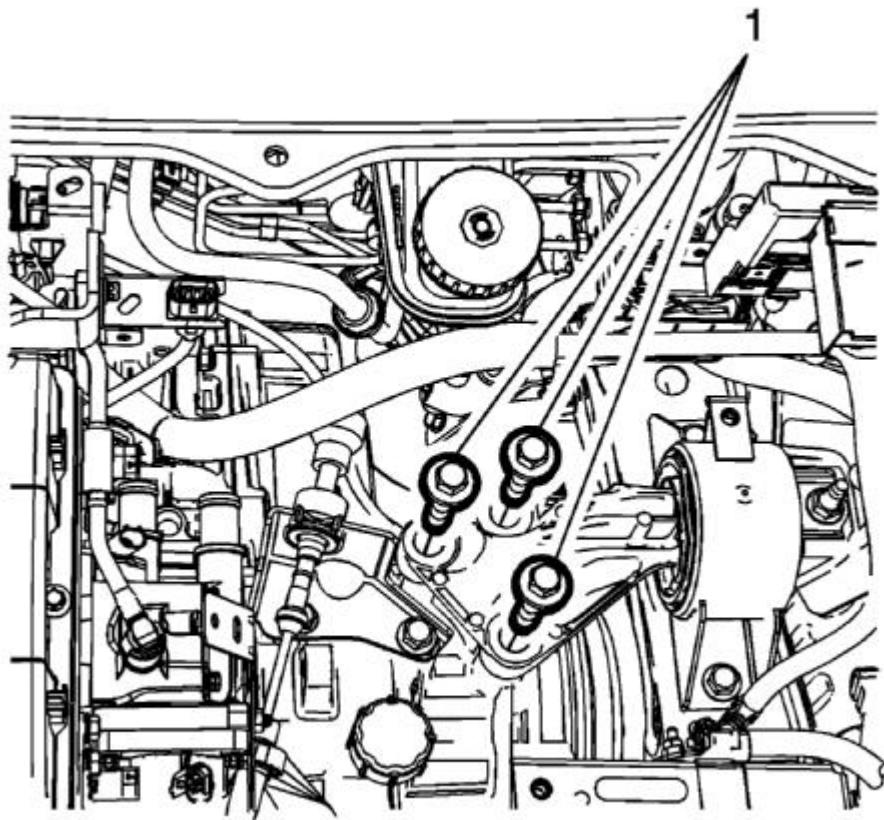


Fig. 192: Transmission Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

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

6. Install the NEW left transmission mount to transmission bolts (1) and tighten to 50 (37 lb ft) plus 70 degrees.

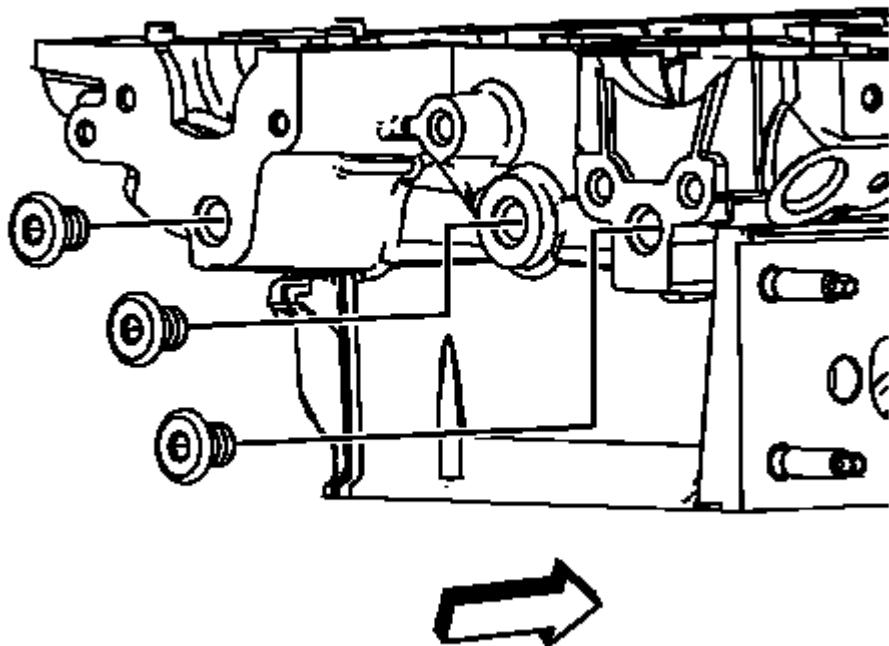


Fig. 193: Right Engine Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

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

7. Install the NEW right side engine mount bolts (1) and tighten to 50 (37 lb ft) plus 70 degrees.
8. Perform Powertrain Mount Balancing.

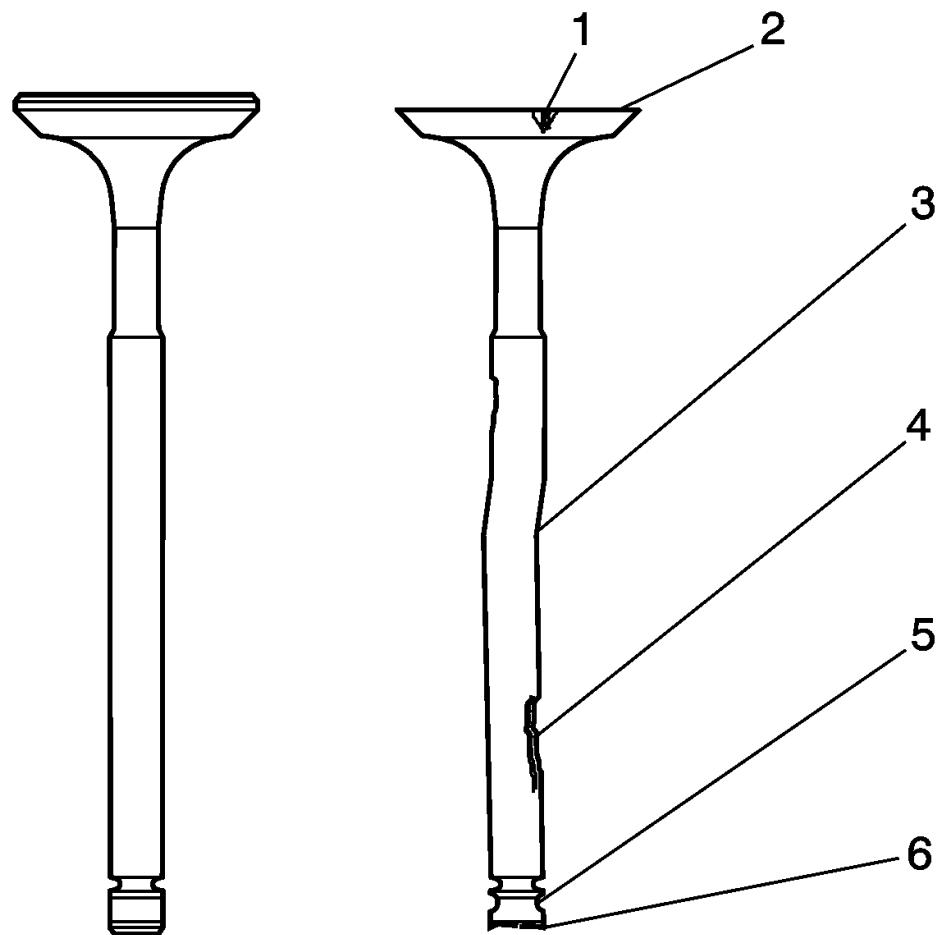


Fig. 194: Frame & Body Through Alignment Hole
Courtesy of GENERAL MOTORS COMPANY

9. Align the frame and body through alignment hole (1).

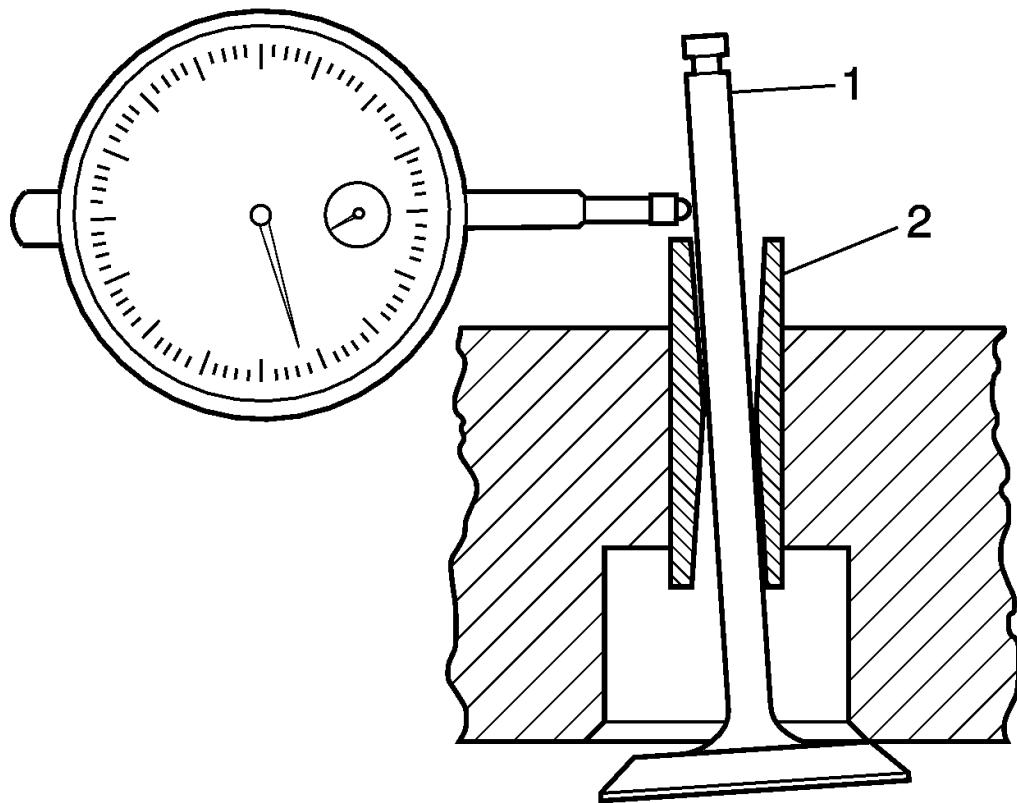


Fig. 195: Frame & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the frame (3) rear bolts (2) and tighten to 135 (100 lb ft).
11. Install the frame (3) front bolts (1) and tighten to 58 (43 lb ft).

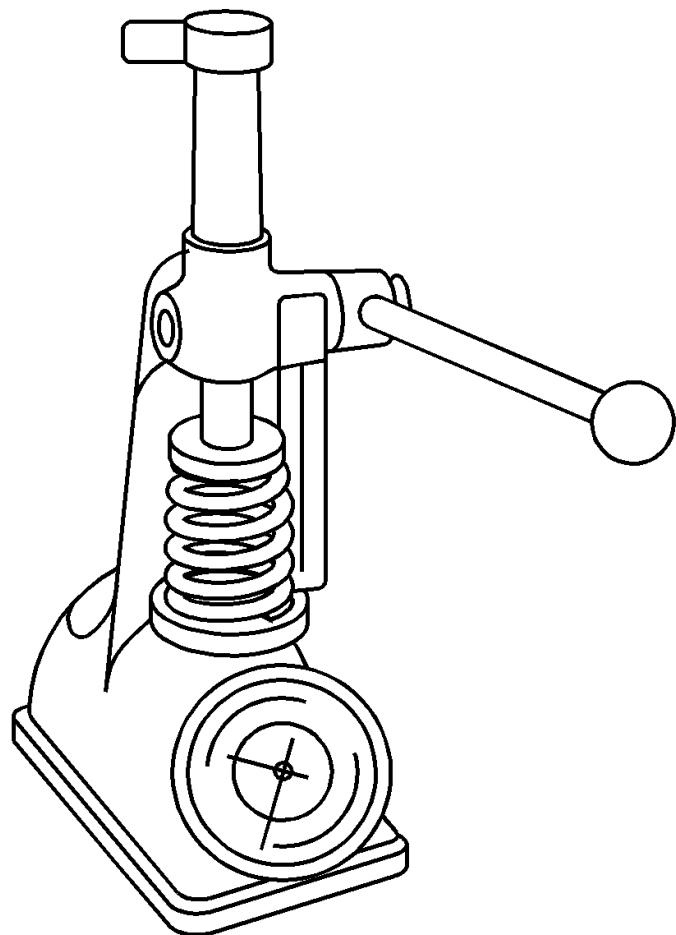


Fig. 196: Frame Suspension Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the upper frame suspension retaining bolts (1) on both sides and tighten to 135 (100 lb ft).
13. Remove the lift table.

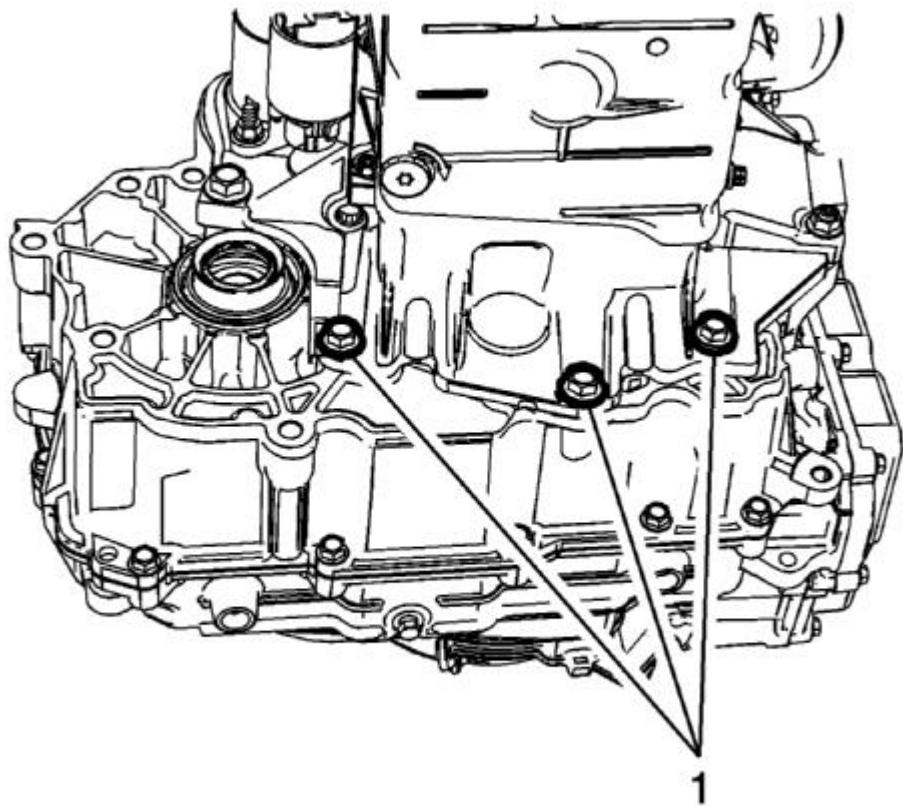


Fig. 197: Lower Oil Pan Bolts

Courtesy of GENERAL MOTORS COMPANY

14. Install the lower oil pan to transmission bolts (1) and tighten to 40 (30 lb ft).

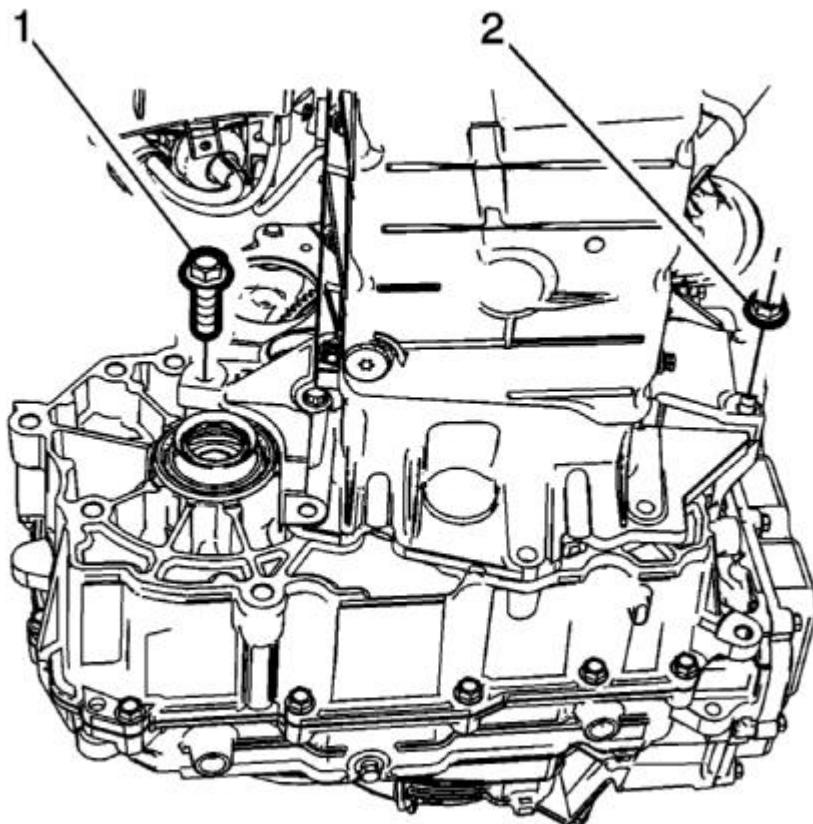


Fig. 198: Lower Oil Pan Bolts & Nut

Courtesy of GENERAL MOTORS COMPANY

15. Install the lower oil pan to transmission lower bolts (1) and tighten to 60 (44 lb ft).
16. Install the lower oil pan to transmission lower and nut (2) and tighten to 40 (30 lb ft).
17. Install NEW flex plate to torque converter bolts and tighten to 60 (44 lb ft).
18. Install the starter. Refer to [**Starter Replacement \(LUW\)**](#) .
19. Install the front exhaust pipe. Refer to [**Exhaust Front Pipe Replacement \(LUV,LUW\)**](#) .

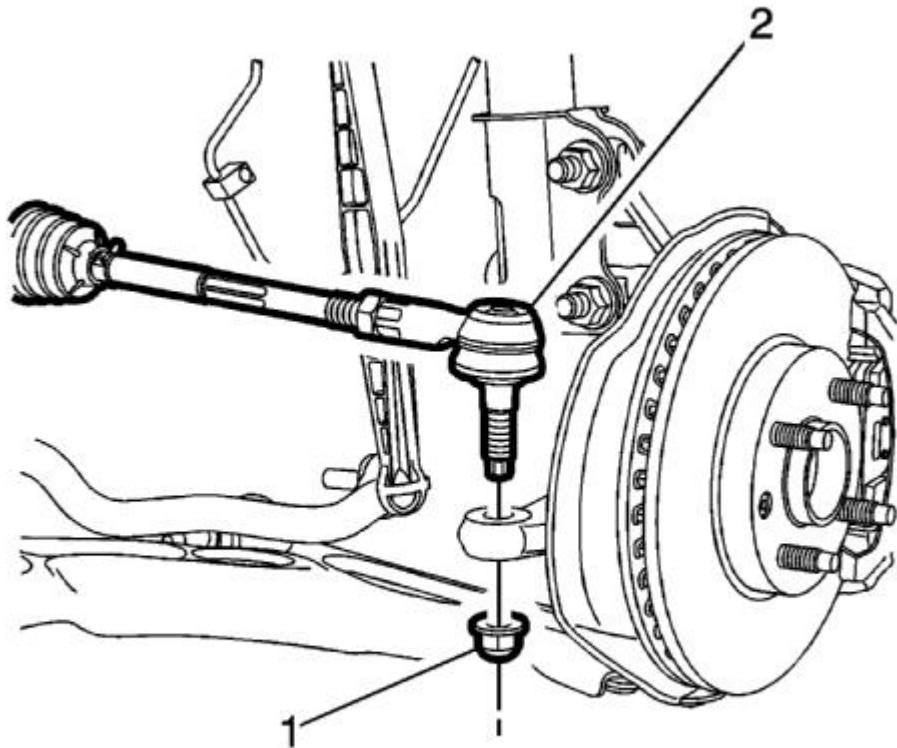


Fig. 199: Steering Linkage Outer Tie Rod

Courtesy of GENERAL MOTORS COMPANY

NOTE: Perform steps 20 through 29 to both sides.

20. Inset the wheel drive shaft to the steering knuckle.

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

21. Install the NEW steering linkage outer tie rod nut (1) and tighten to 30 (22 lb ft) Plus 128 degrees.
22. Install the steering linkage outer tie rod to the steering knuckle. Refer to Steering Linkage Outer Tie Rod Replacement .

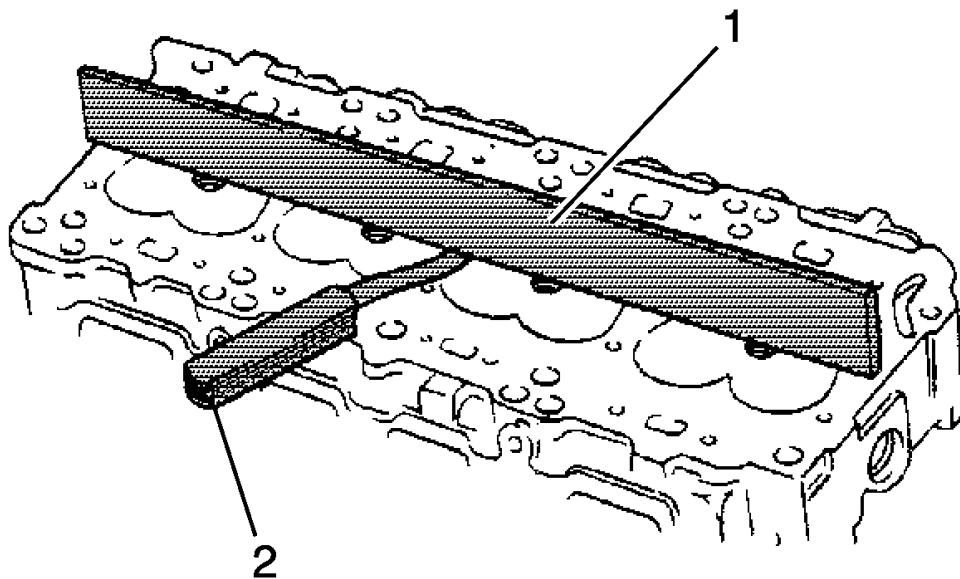


Fig. 200: Control Arm Ball Joint To Steering Knuckle Bolt
Courtesy of GENERAL MOTORS COMPANY

23. Install the control arm ball joint to the steering knuckle. Refer to [Lower Control Arm Replacement](#) .

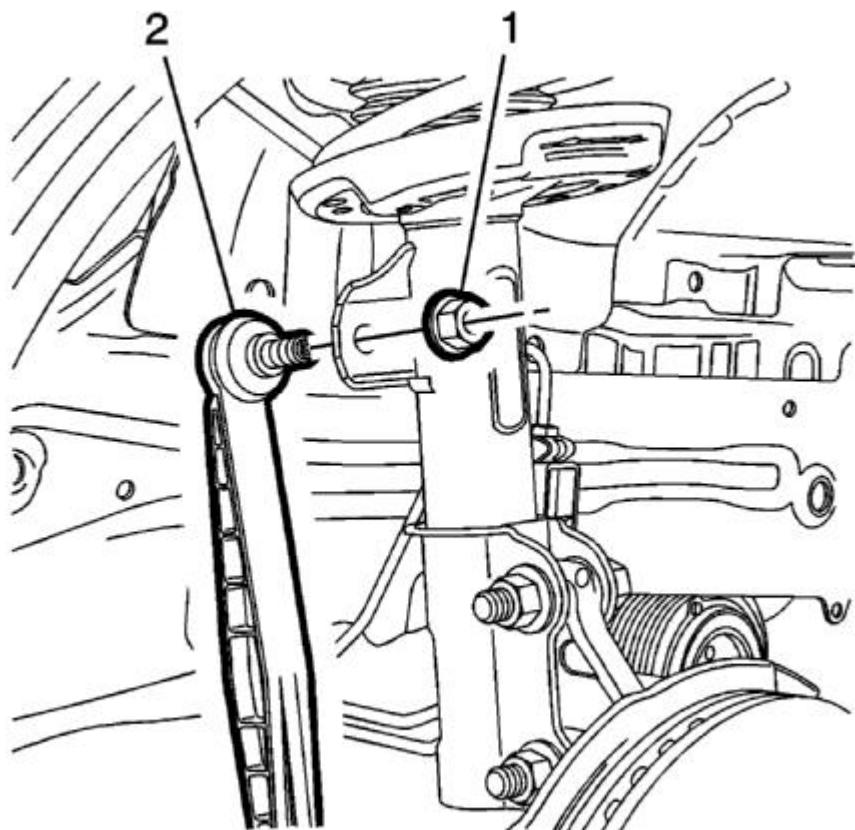


Fig. 201: Upper Stabilizer Shaft Link

Courtesy of GENERAL MOTORS COMPANY

24. Connect the stabilizer shaft link (2).
25. Install the upper stabilizer shaft link nut (1) and tighten to 65 (48 lb ft).

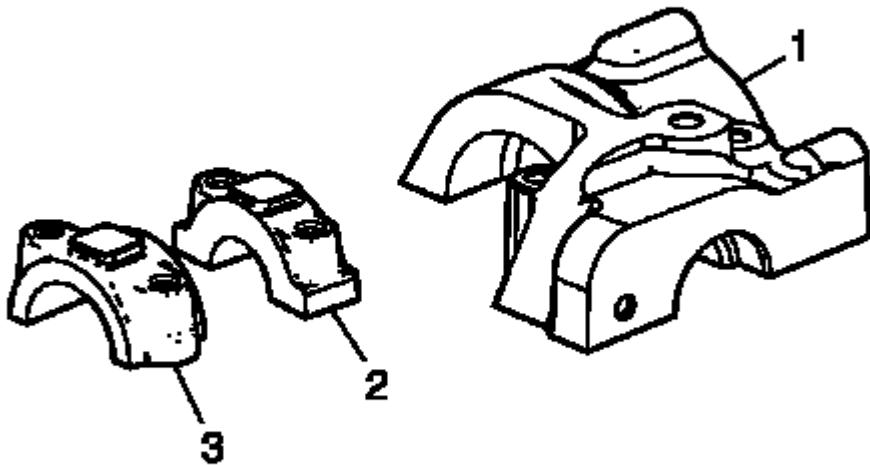


Fig. 202: View Of Brake Rotor, Caliper & Axle Nut

Courtesy of GENERAL MOTORS COMPANY

26. Insert a brass drift or punch (1) in the cooling fins of the front brake rotor (2).
27. Rotate the brake rotor until it comes in contact with the brake caliper mount bracket (5).

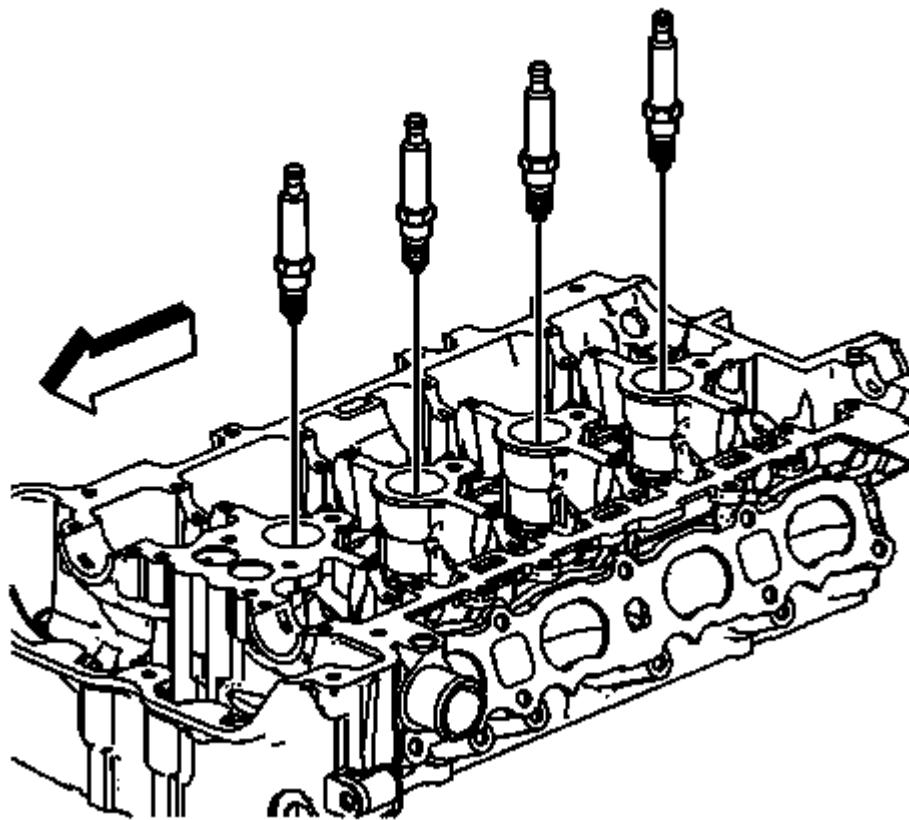


Fig. 203: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

28. Install the NEW wheel drive shaft nut (1) and tighten to 250 (184 lb ft).

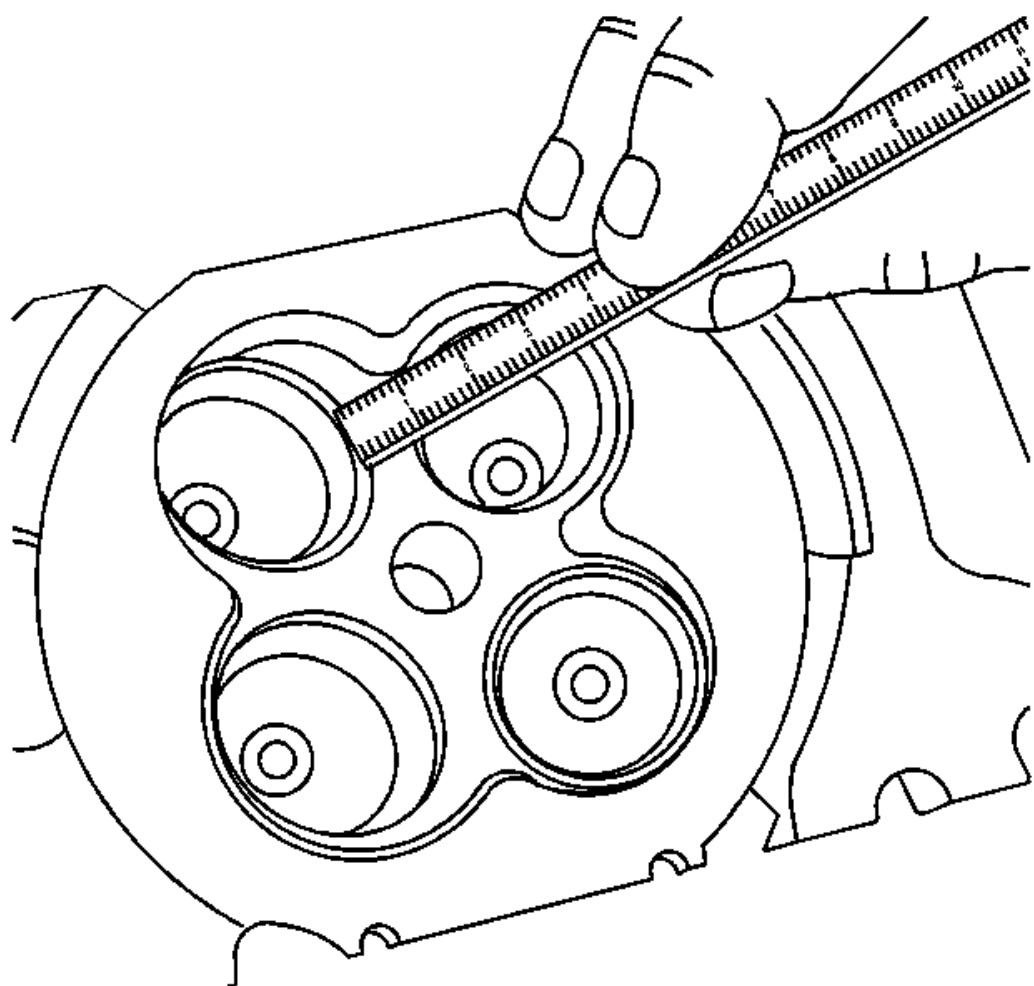


Fig. 204: Staking Wheel Drive Shaft Nut With Punch
Courtesy of GENERAL MOTORS COMPANY

29. Using a punch (1), stake the wheel drive shaft nut.

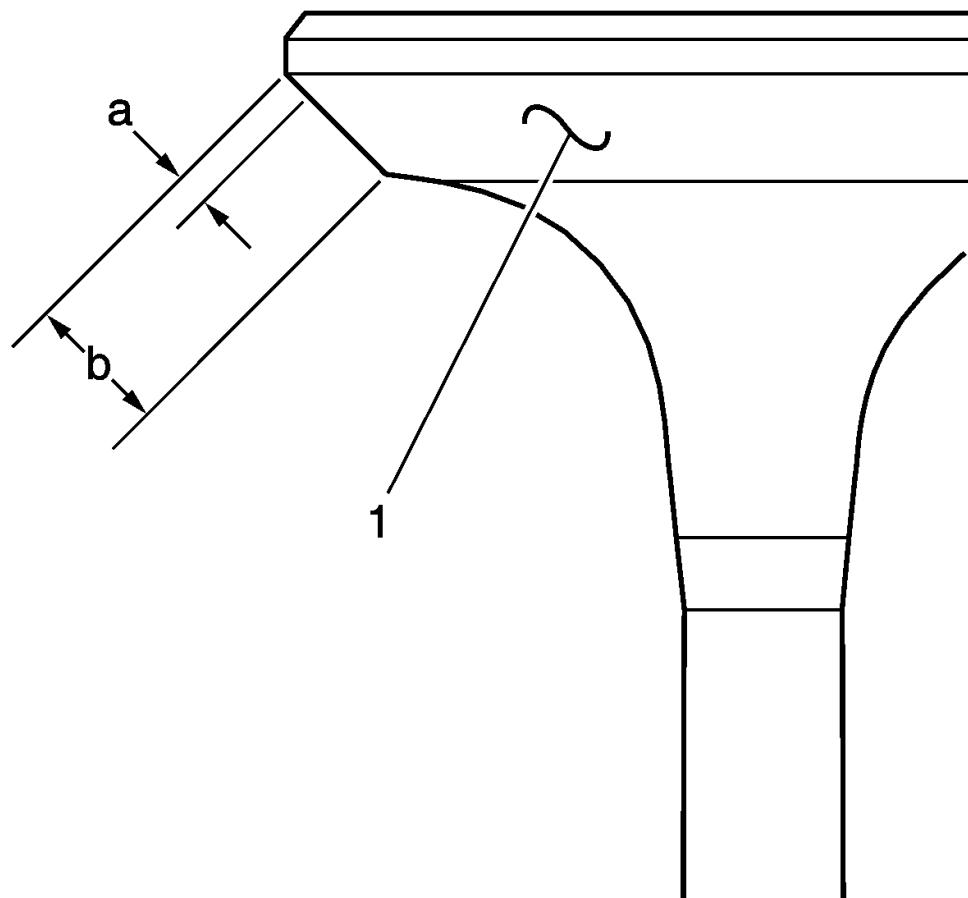


Fig. 205: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

30. Remove the CH-807 plug.
31. Connect the fuel feed pipe (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
32. Connect the engine coolant sensor from radiator.

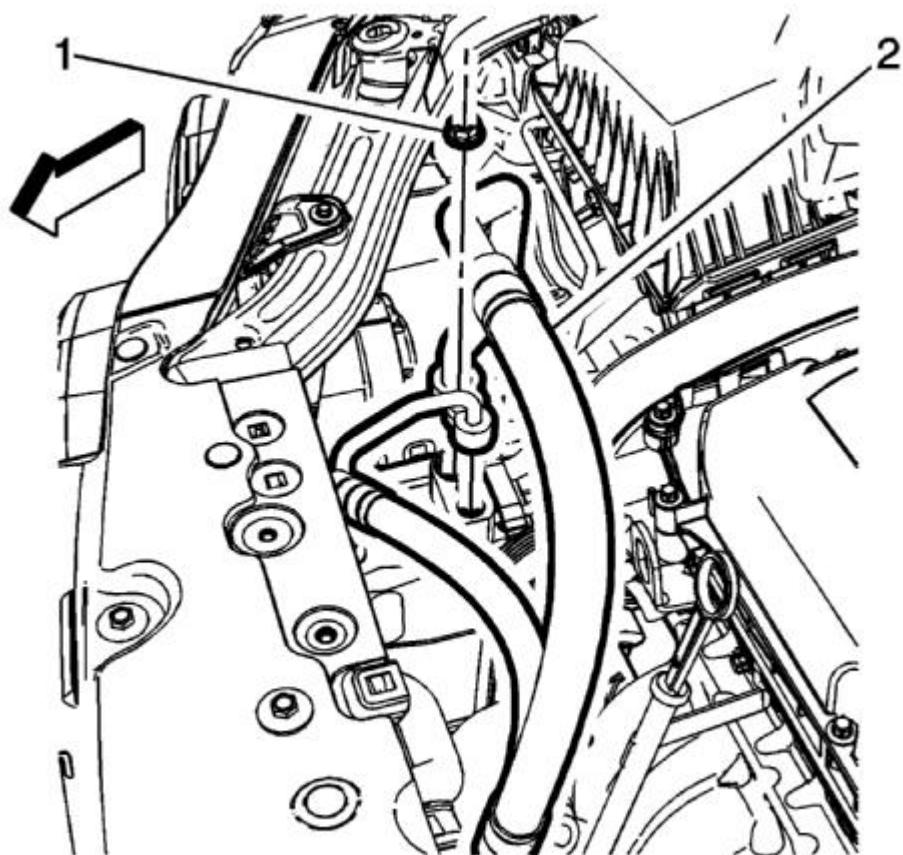


Fig. 206: Air Conditioning Compressor, Condenser Hose & Nut
Courtesy of GENERAL MOTORS COMPANY

33. Install air conditioning compressor and condenser hose to the refrigerant hose.
34. Install air conditioning compressor and condenser hose nut (1) tighten nut to 22 (16 lb ft).

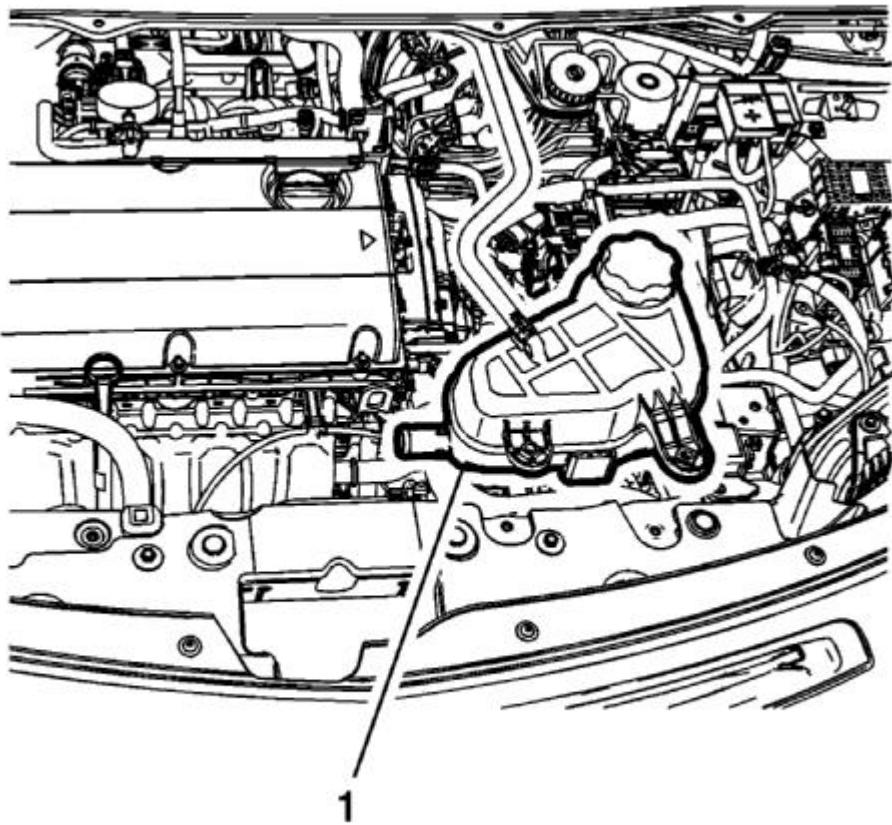


Fig. 207: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

35. Install the radiator surge tank (1). Refer to [Radiator Surge Tank Replacement](#) .
36. Connect the fan connector.

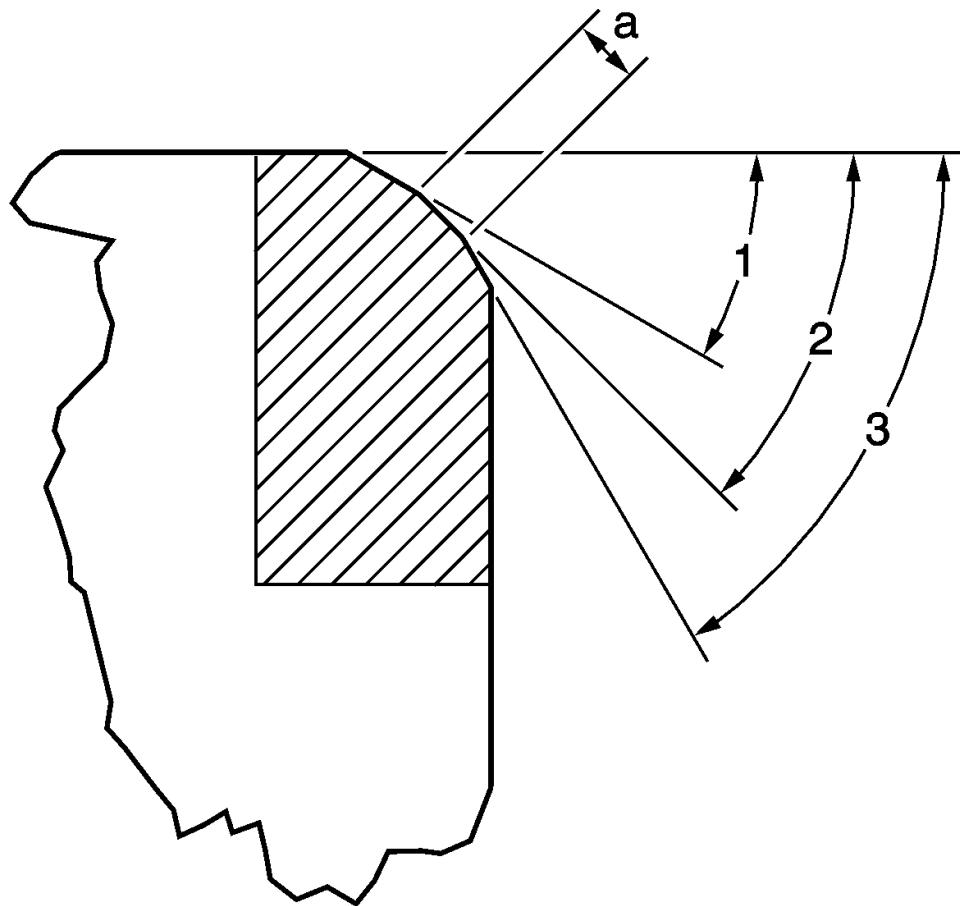


Fig. 208: Automatic Transmission Range Selector Lever Cable Terminal & Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

37. Install the transmission range selector lever cable (2) to the cable bracket.
38. Connect the transmission range selector lever cable terminal (1) to the transmission manual shift lever pin.
39. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.

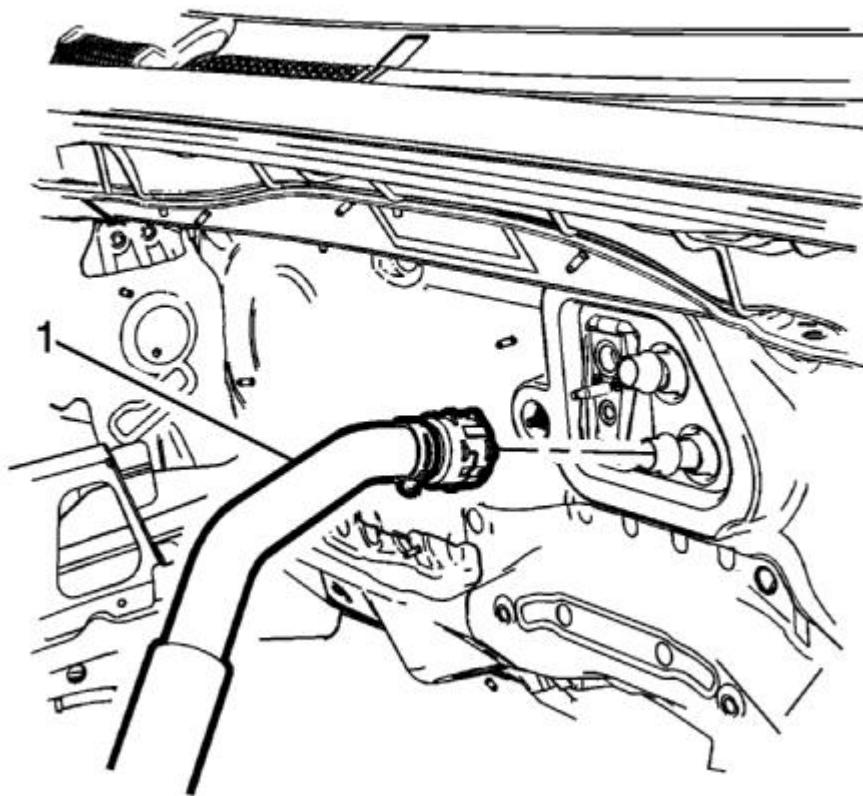


Fig. 209: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

40. Connect the heater inlet hose to the heater core (1). Refer to [Heater Inlet Hose Replacement \(LDE, LUW\)](#).

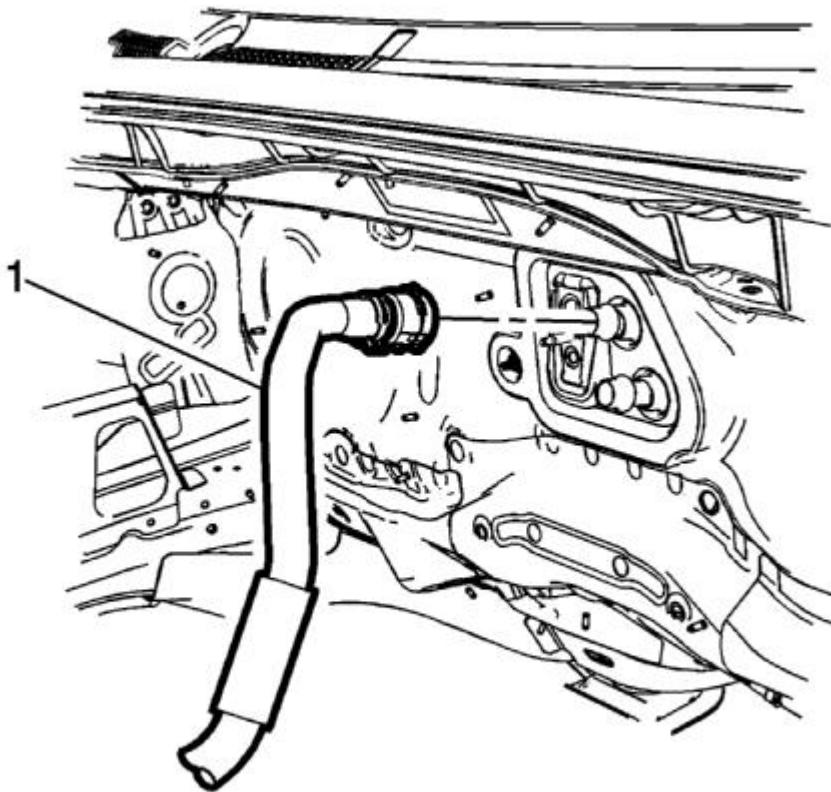


Fig. 210: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

41. Connect the heater outlet hose to the heater core (1). Refer to [Heater Outlet Hose Replacement \(LDE, LUW\)](#).

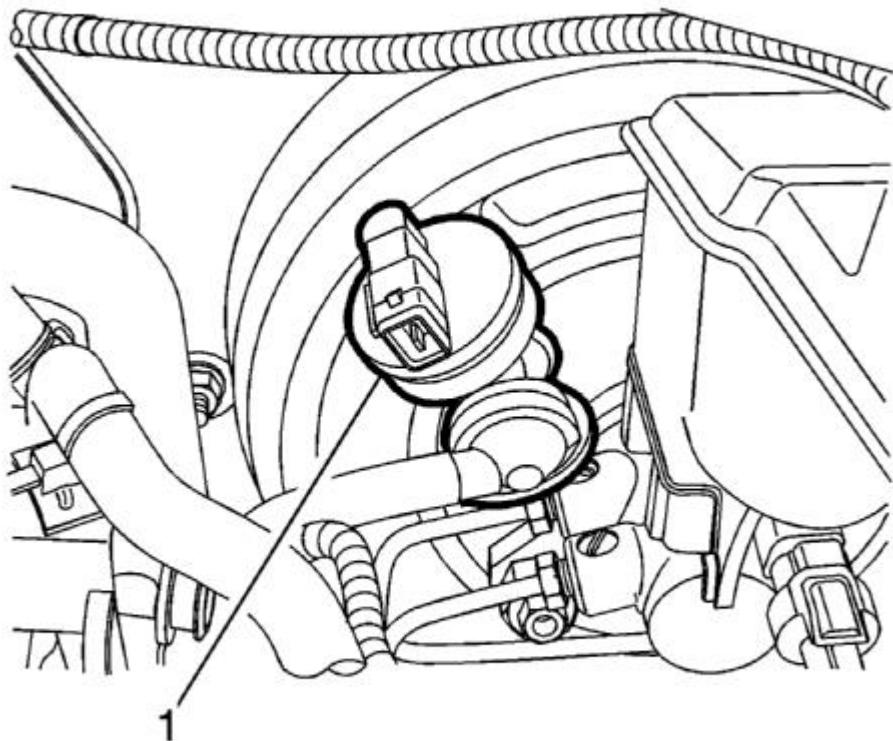


Fig. 211: Electrical Vacuum Pump

Courtesy of GENERAL MOTORS COMPANY

42. If equipped with electrical vacuum pump, connect the electrical connector and install the brake booster hose (1).

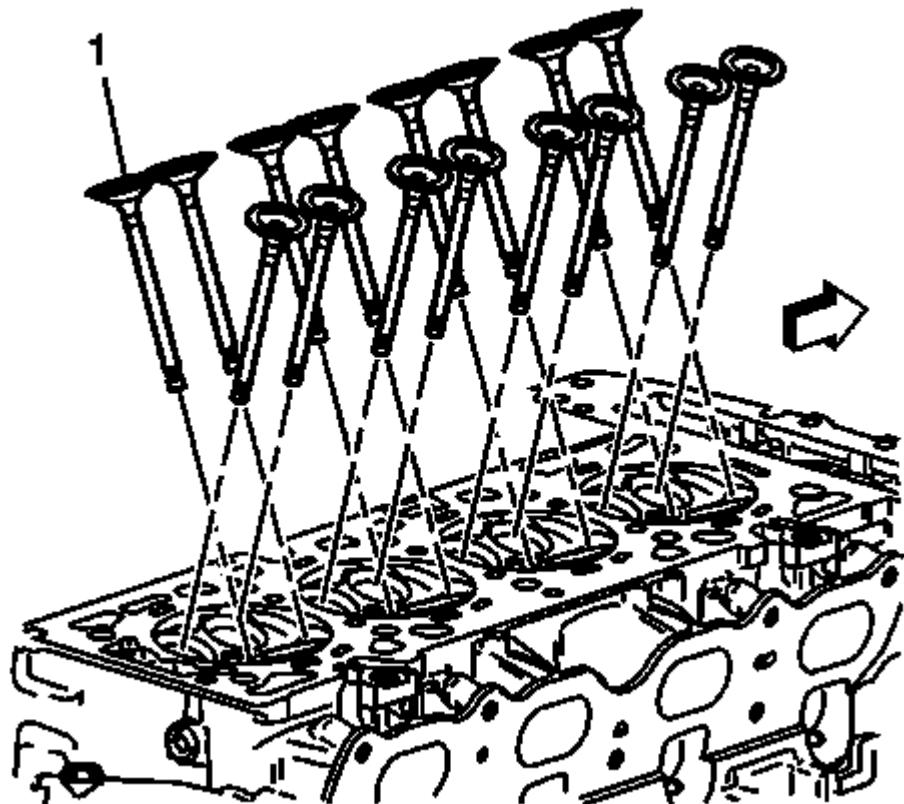


Fig. 212: Wiring Harness & Ground Nuts
Courtesy of GENERAL MOTORS COMPANY

43. Install the ground nuts (1) and reposition the wiring harness (2).

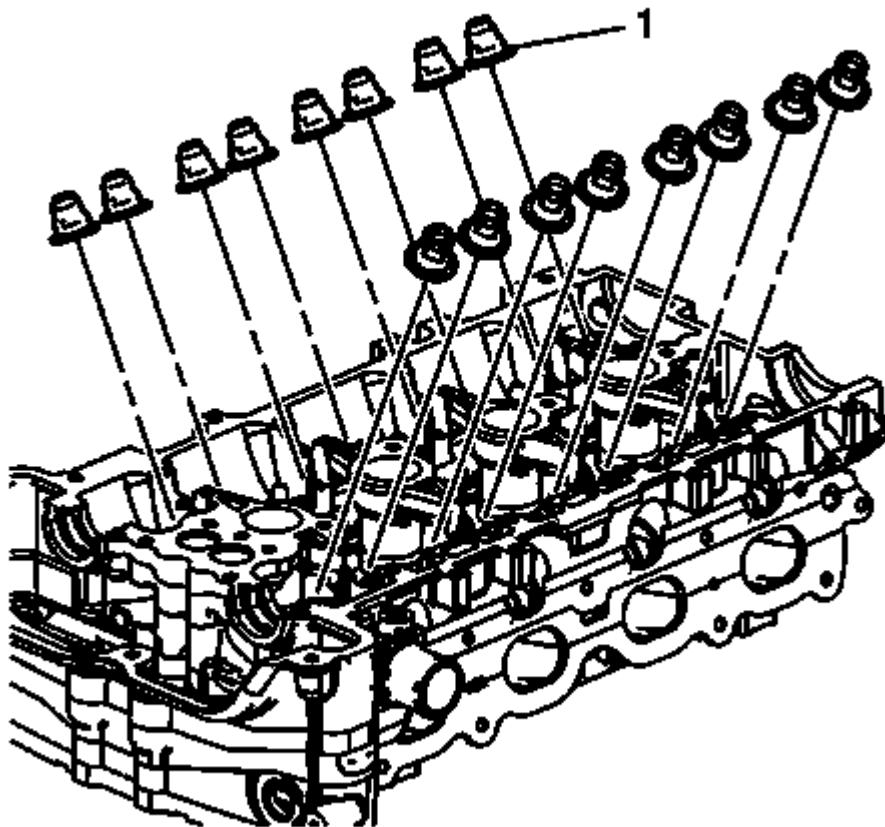


Fig. 213: Wiring Harness - Top Of Engine
Courtesy of GENERAL MOTORS COMPANY

44. Clip in the wiring harness plugs (1).

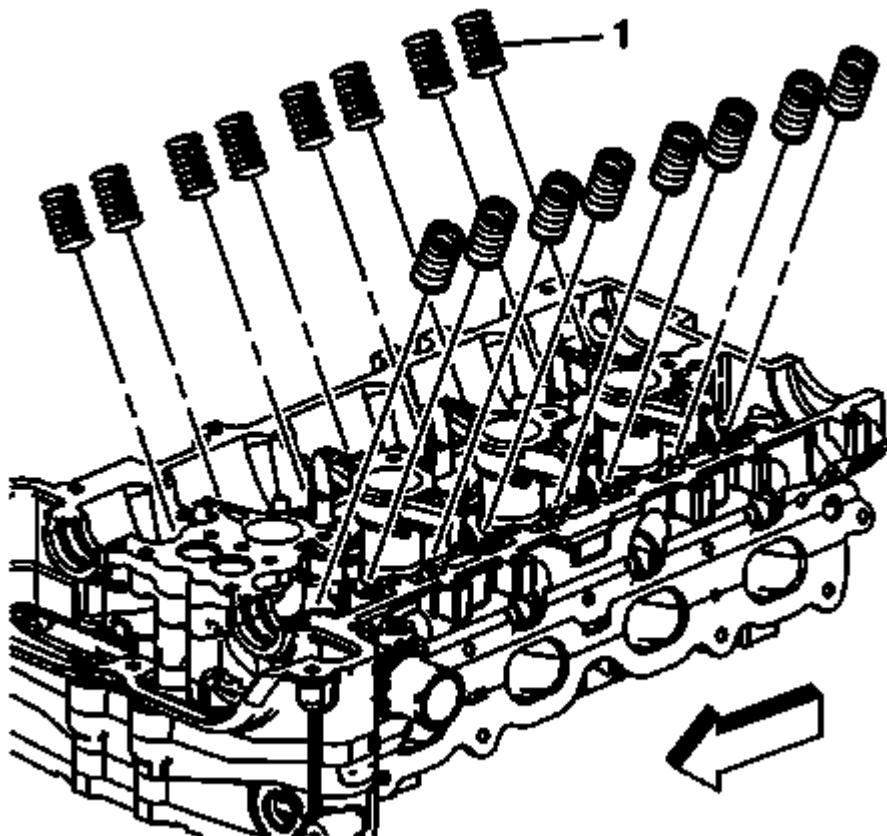


Fig. 214: Junction Block
Courtesy of GENERAL MOTORS COMPANY

45. Install the junction block to the base.
46. Install the junction block bolts (2) and tighten to 5 (44 lb in).
47. Install the junction block nut (1) and tighten to 5 (44 lb in).

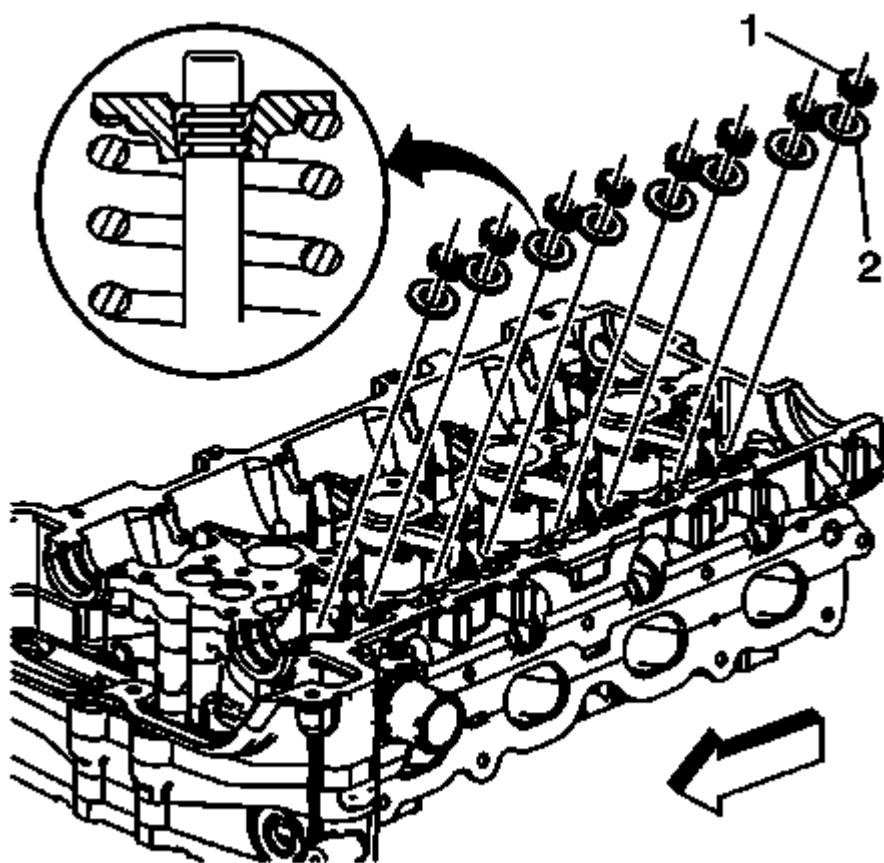


Fig. 215: Body Wiring Harness Connector & Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

48. Install the battery positive cable to the battery positive cable junction block and tighten nut (1) to 5 (44 lb in).
49. Connect the body wiring master harness connector (2), to the battery positive cable junction block.

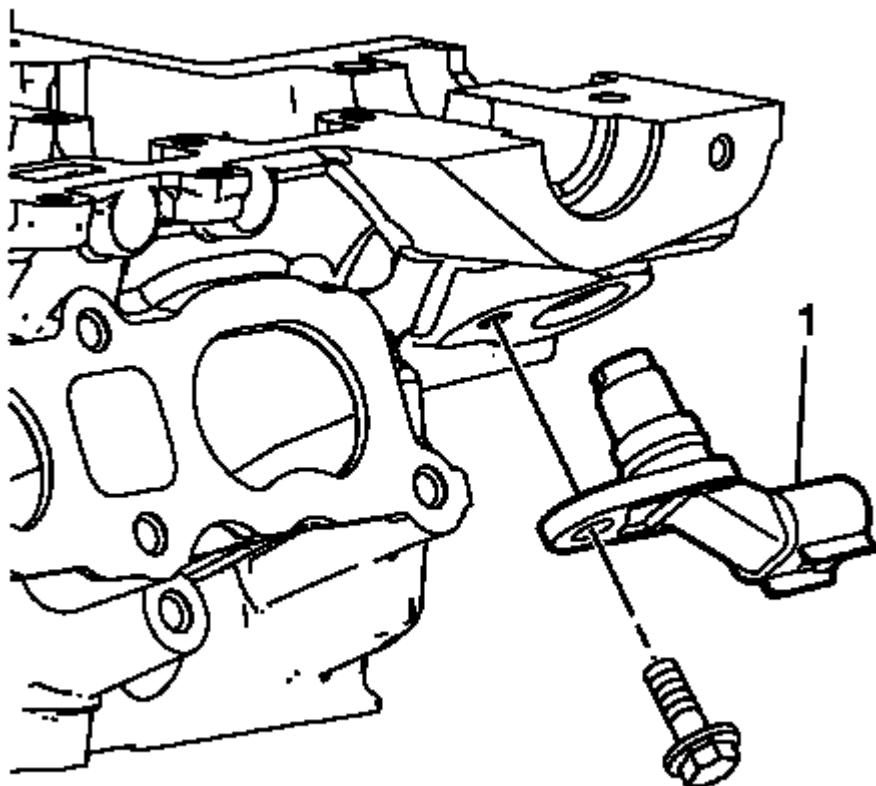


Fig. 216: Positive Battery Cable & Nut

Courtesy of GENERAL MOTORS COMPANY

50. Position the positive battery cable to the junction block.
51. Install the positive battery cable nut (2) and tighten to 7 (62 lb in).

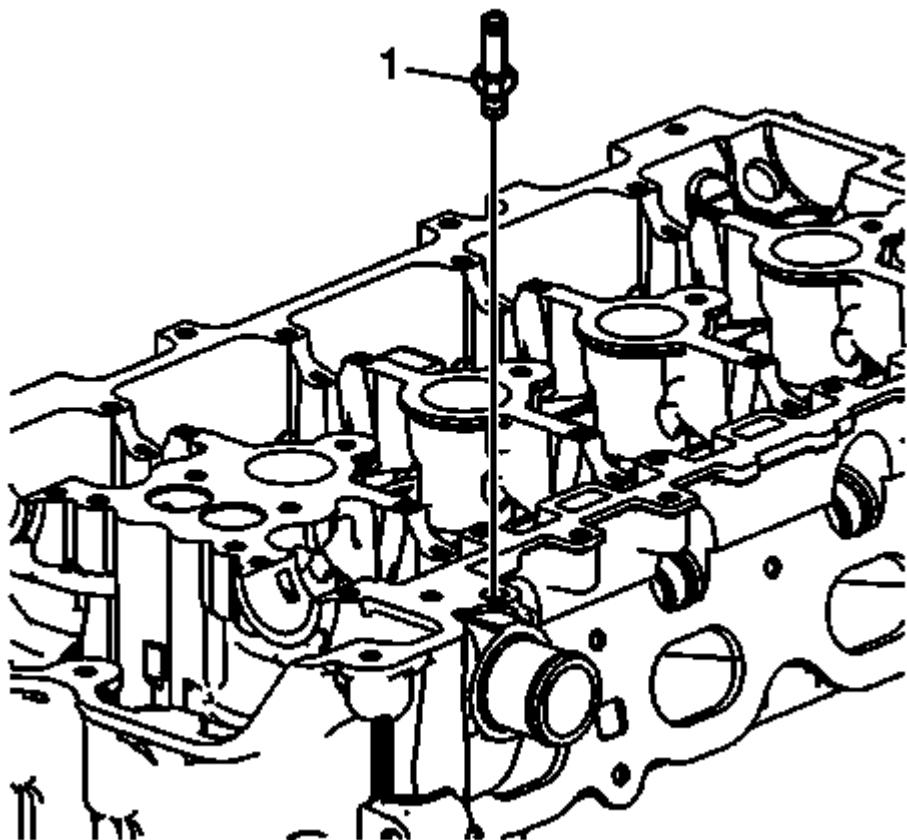


Fig. 217: Junction Block & Cover
Courtesy of GENERAL MOTORS COMPANY

52. Install the junction block cover (1).

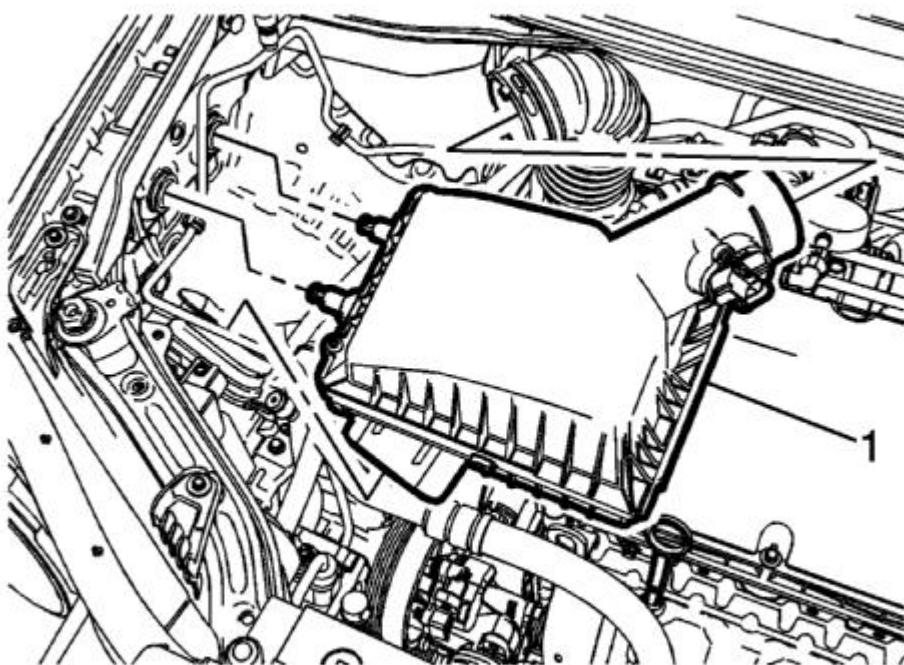


Fig. 218: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

53. Install the air cleaner assembly (1). Refer to [Air Cleaner Assembly Replacement](#).

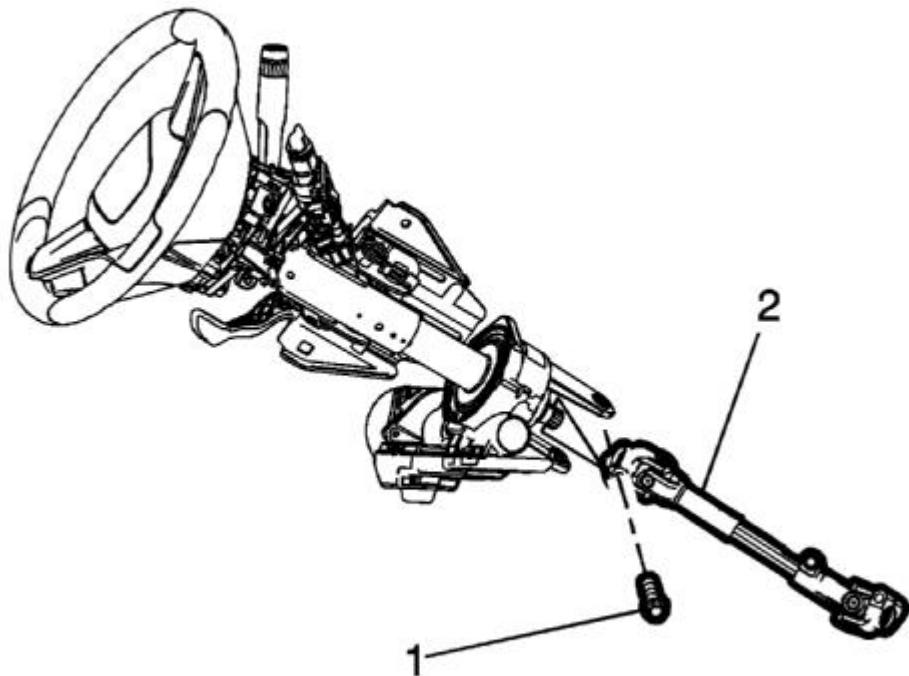


Fig. 219: Lower Intermediate Steering Shaft & Bolt
Courtesy of GENERAL MOTORS COMPANY

54. Install the lower intermediate steering shaft bolt (1). Refer to [Intermediate Steering Shaft Replacement](#).
55. Install the battery and battery tray. Refer to [Battery Tray Replacement](#).
56. Install the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
57. Install the front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).
58. Install the front wheelhouse liner inner front extensions. Refer to [Front Wheelhouse Liner Inner Front Extension Replacement \(Left Side\)](#) , [Front Wheelhouse Liner Inner Front Extension Replacement \(Right Side, LWE, LUW\)](#) .
59. Evacuate and charge the refrigerant system. Refer to [Refrigerant Recovery and Recharging](#) .
60. Fill the cooling system. Refer to [Cooling System Draining and Filling](#) .

ENGINE REPLACEMENT (MANUAL TRANSMISSION)

Special Tools

- **J-45859** Wheel Drive Shaft Remover .
- **CH-807** Closure Plugs .

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

Removal Procedure

1. Remove the battery and battery tray. Refer to [Battery Tray Replacement](#).
2. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).
3. Recover the refrigerant. Refer to [Refrigerant Recovery and Recharging](#).
4. Remove the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).
6. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).

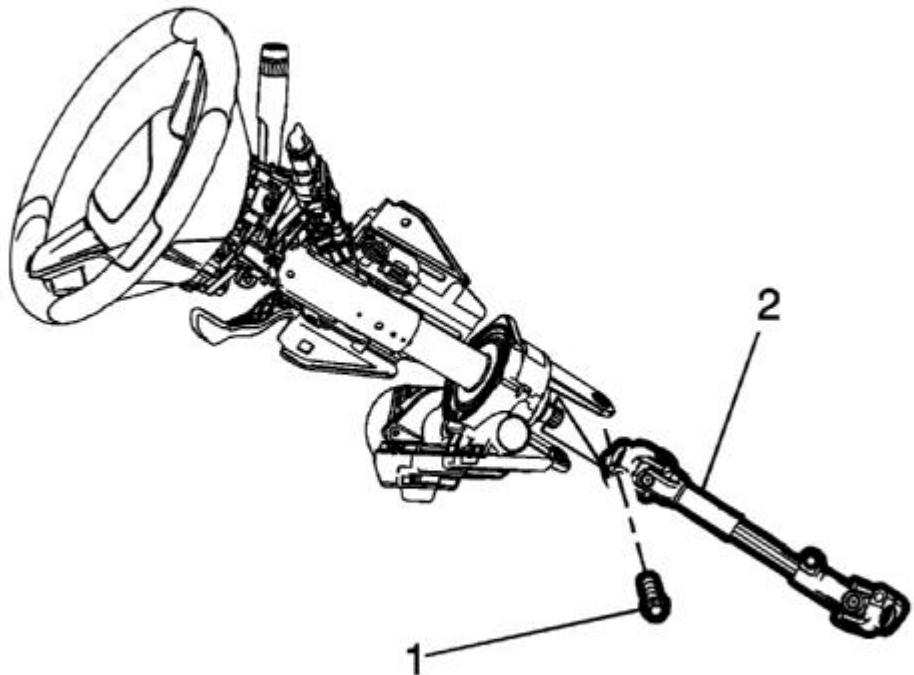


Fig. 220: Lower Intermediate Steering Shaft & Bolt

Courtesy of GENERAL MOTORS COMPANY

7. Remove the lower intermediate steering shaft bolt (1) and slide the shaft away from steering column. Refer to [Intermediate Steering Shaft Replacement](#).

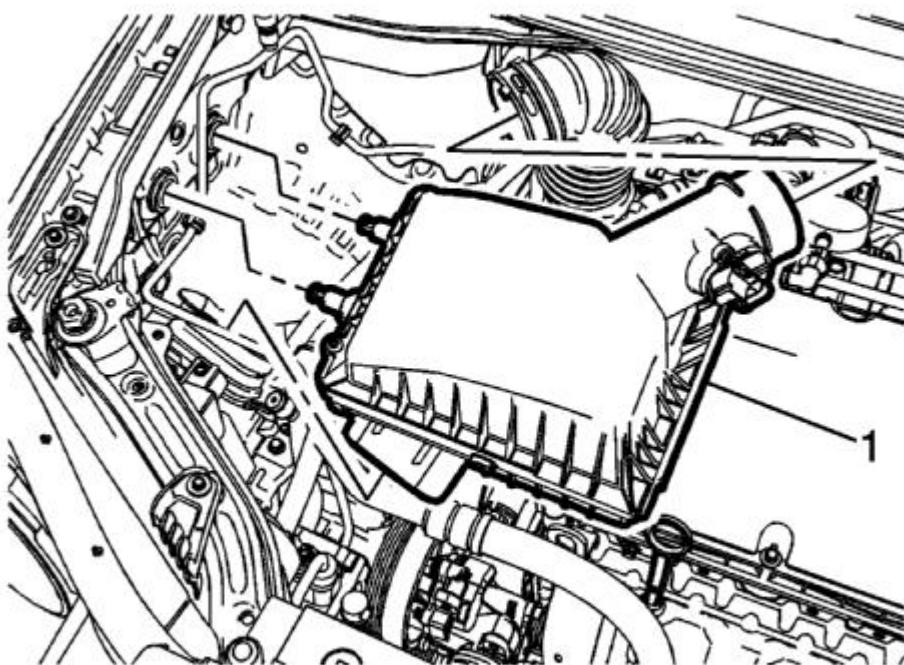


Fig. 221: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

8. Remove the air cleaner assembly (1). Refer to [Air Cleaner Assembly Replacement](#).

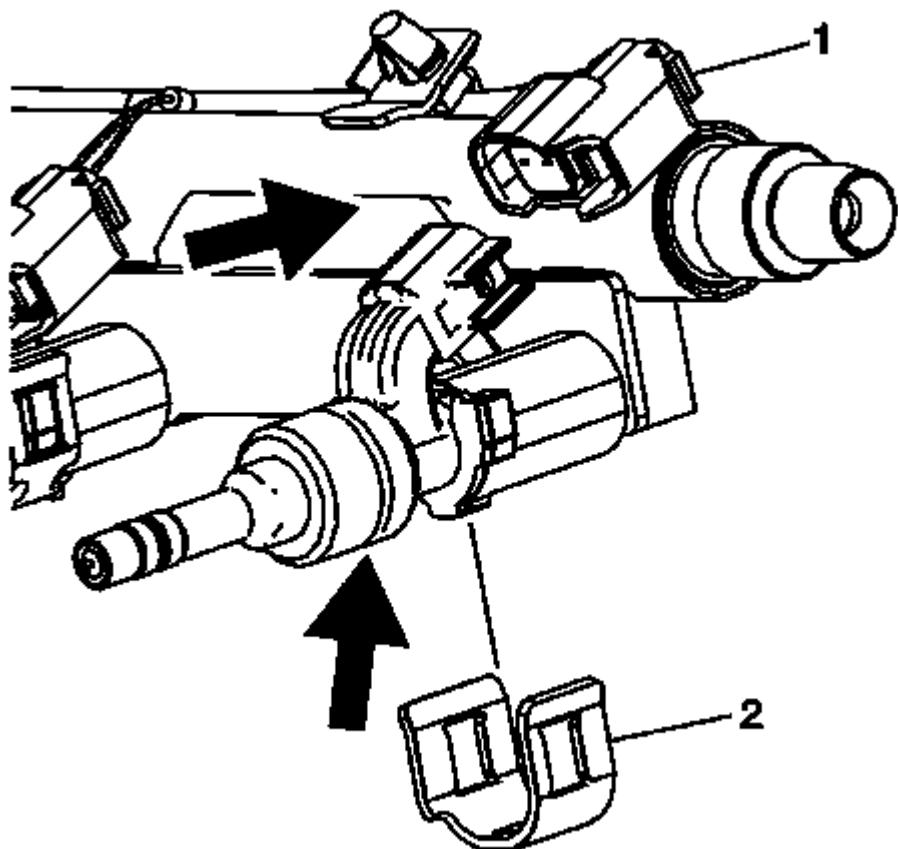


Fig. 222: Junction Block & Cover
Courtesy of GENERAL MOTORS COMPANY

9. Remove the junction block cover (1).

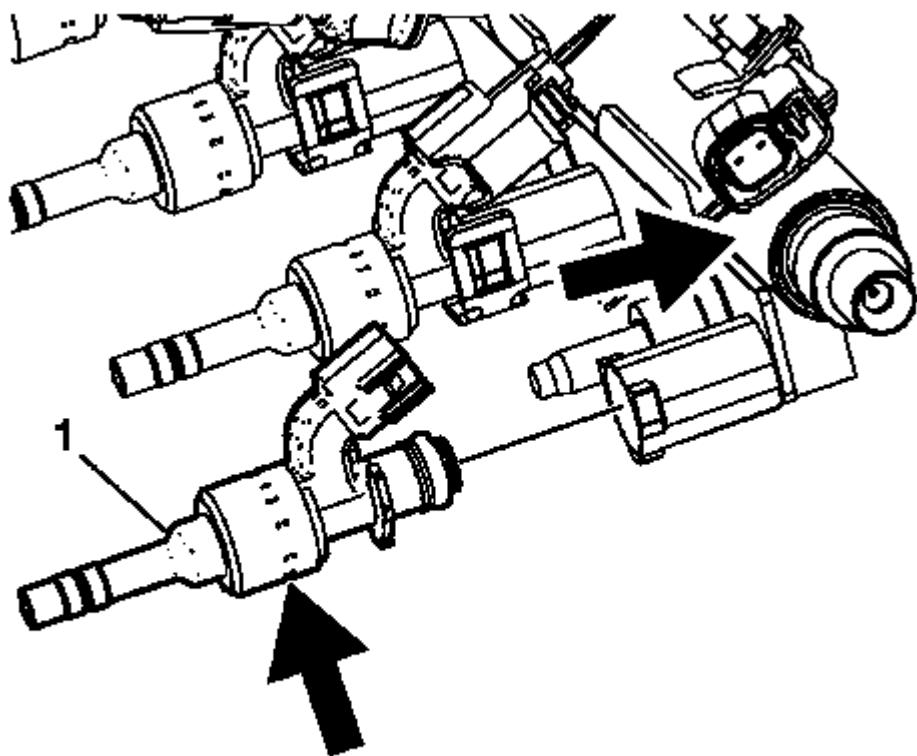


Fig. 223: Positive Battery Cable & Nut

Courtesy of GENERAL MOTORS COMPANY

10. Remove the positive battery cable nut (1) from the junction block.
11. Remove the positive battery cable (2) from the junction block.

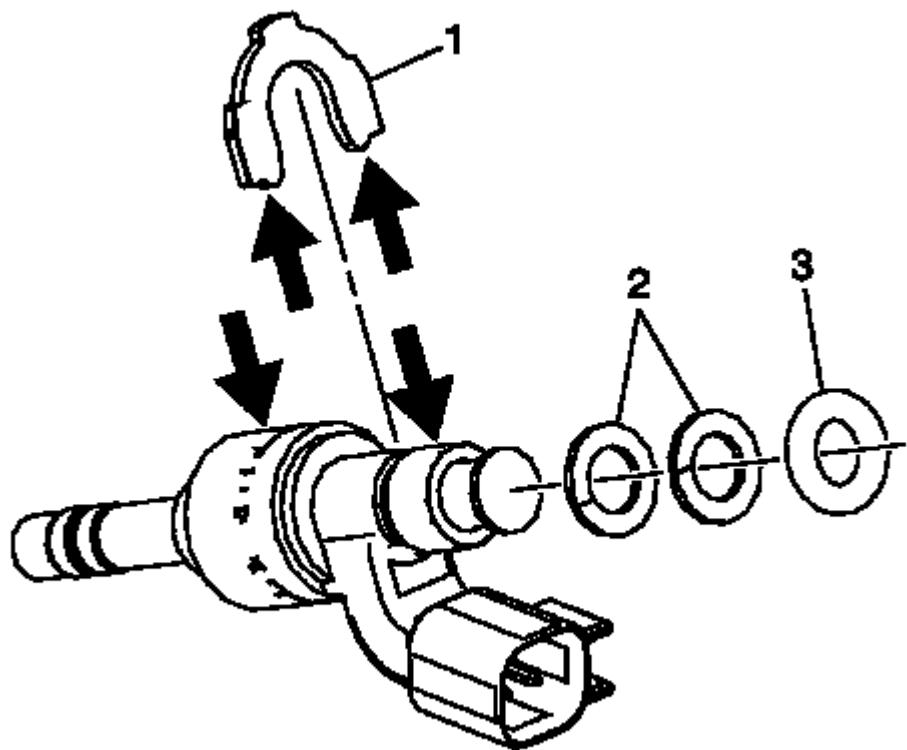


Fig. 224: Body Wiring Harness Connector & Positive Cable Nut
Courtesy of GENERAL MOTORS COMPANY

12. Remove the positive cable nut (1) and battery positive cable, from the battery positive cable junction block.
13. Disconnect the body wiring master harness connector (2), from the battery positive cable junction block.

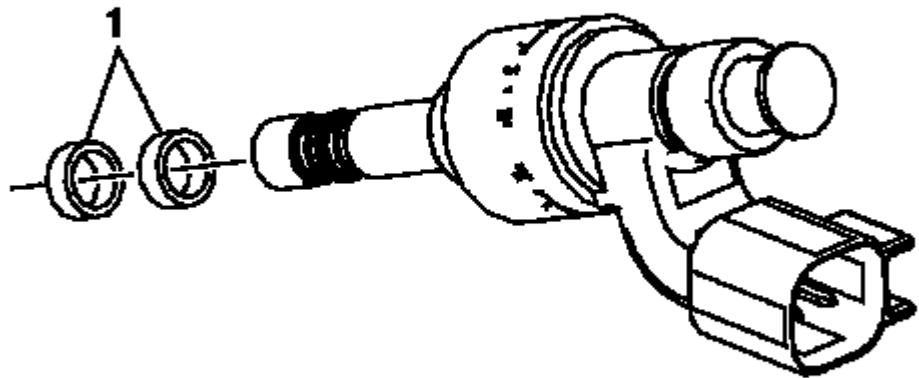


Fig. 225: Junction Block
Courtesy of GENERAL MOTORS COMPANY

14. Remove the junction block nut (1).
15. Remove the junction block bolts (2).
16. Disconnect the wiring harness from the junction block base.
17. Remove the junction block (3) from the base.
18. Disconnect the wiring harness plug from the front compartment fuse block.

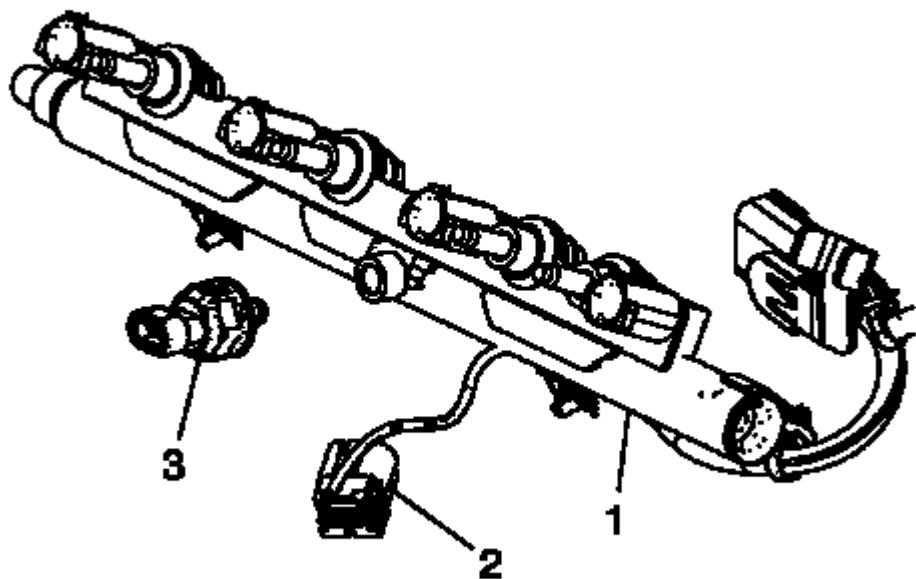


Fig. 226: Wiring Harness - Top Of Engine
Courtesy of GENERAL MOTORS COMPANY

19. Reposition the wiring harness (1) on top of the engine.

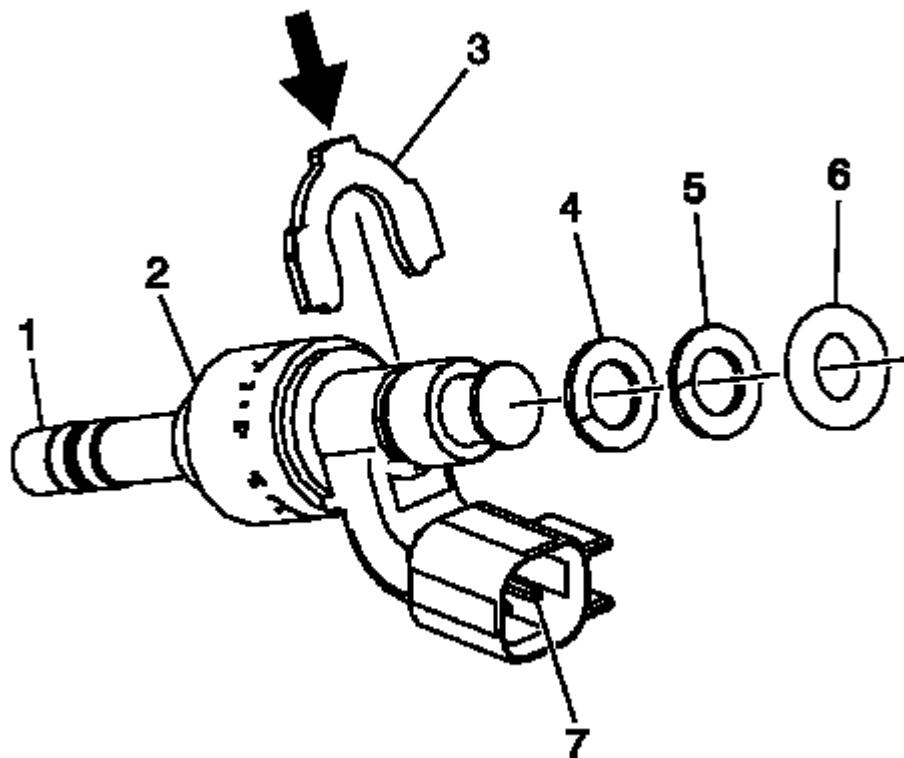


Fig. 227: Wiring Harness & Ground Nuts
Courtesy of GENERAL MOTORS COMPANY

20. Remove the ground nuts (1) and reposition the wiring harness (2) aside.

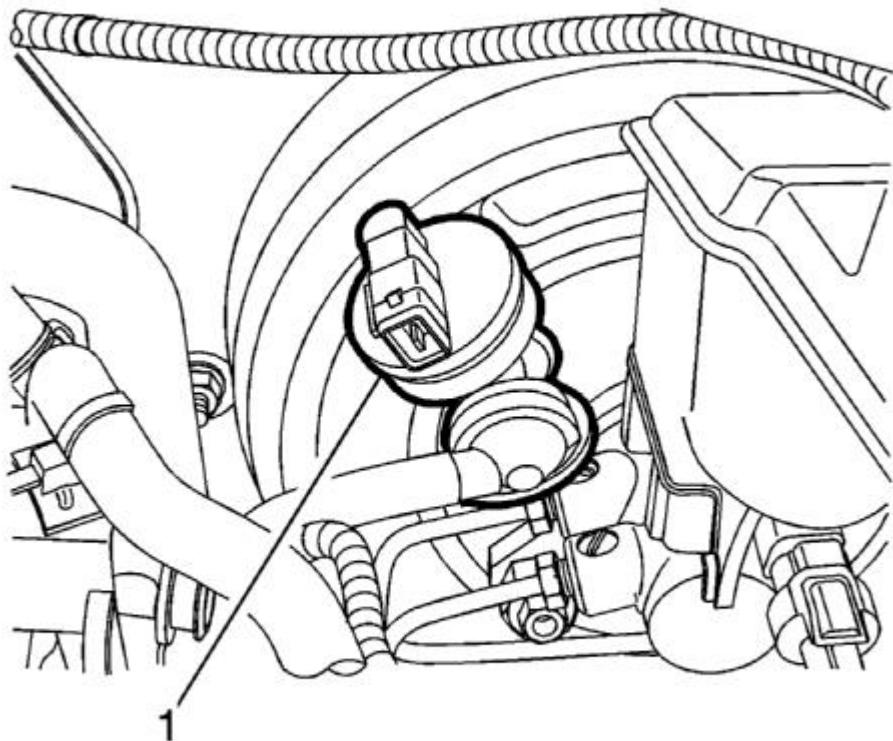


Fig. 228: Electrical Vacuum Pump

Courtesy of GENERAL MOTORS COMPANY

21. If equipped with electrical vacuum pump, disconnect the electrical connector and remove the brake booster hose (1).

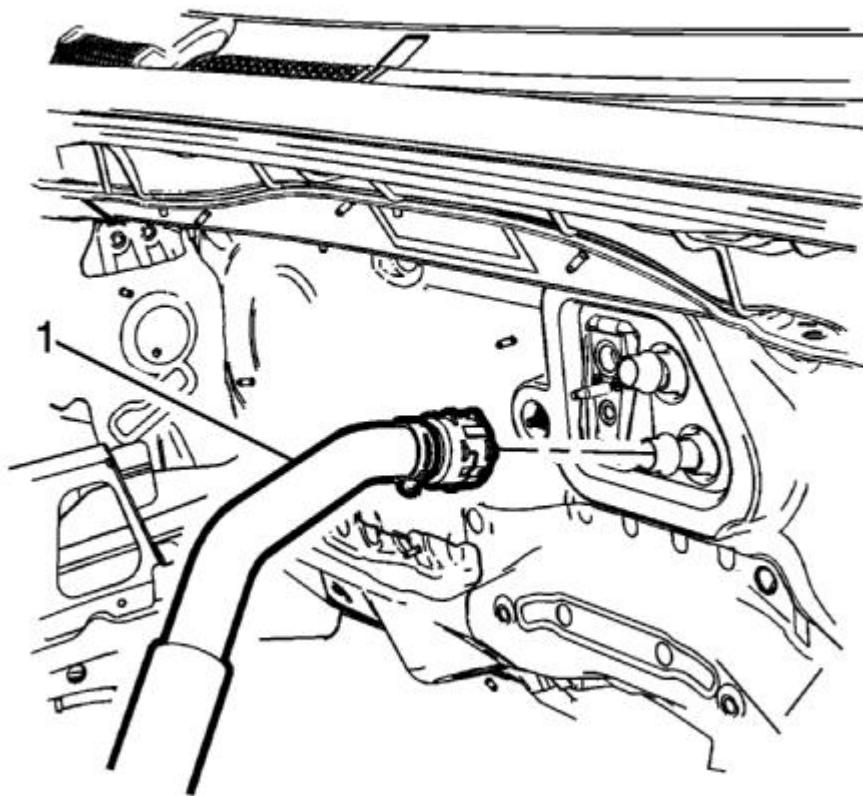


Fig. 229: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

22. Disconnect the heater inlet hose (1) from the heater core. Refer to [Heater Inlet Hose Replacement \(LDE, LUW\)](#).

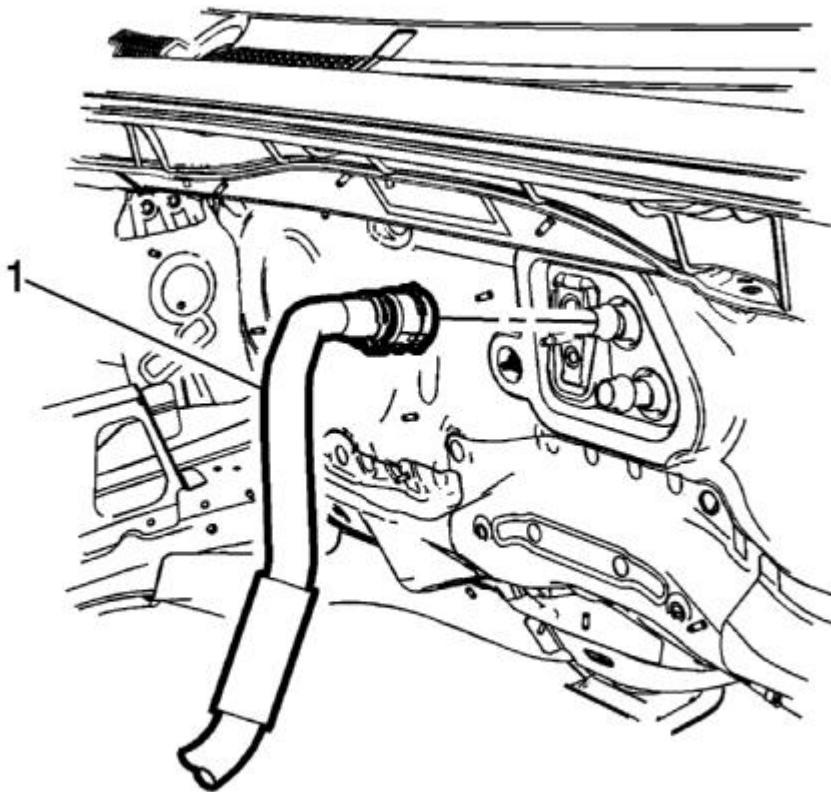


Fig. 230: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

23. Disconnect the heater outlet hose (1) from the heater core. Refer to [Heater Outlet Hose Replacement \(LDE, LUW\)](#).

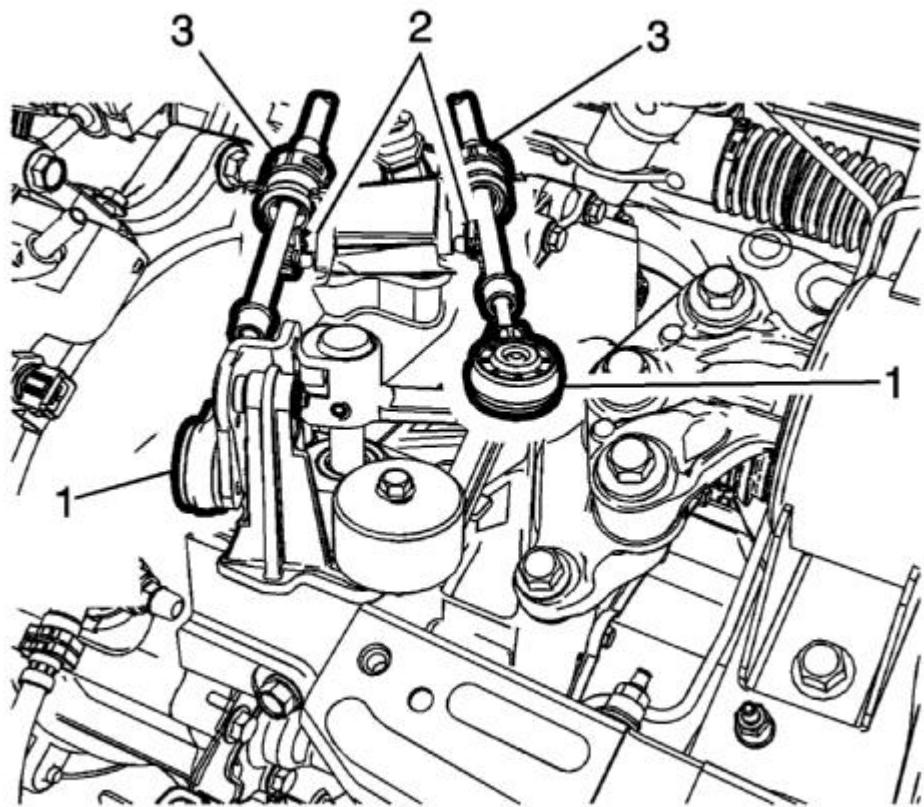


Fig. 231: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

24. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual pin.
25. Press the locking tab forward in order to release the transmission range selector lever cable (2) from the cable bracket.

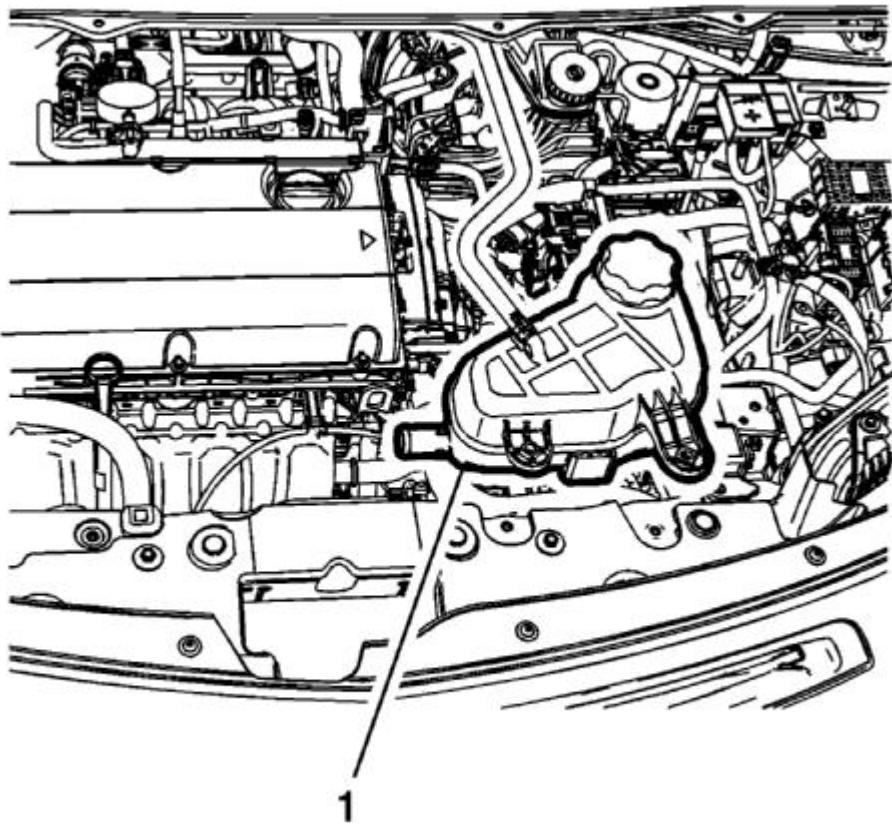


Fig. 232: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

26. Remove the radiator surge tank (1) and position aside. Refer to [Radiator Surge Tank Replacement](#) .
27. Disconnect the fan connector.

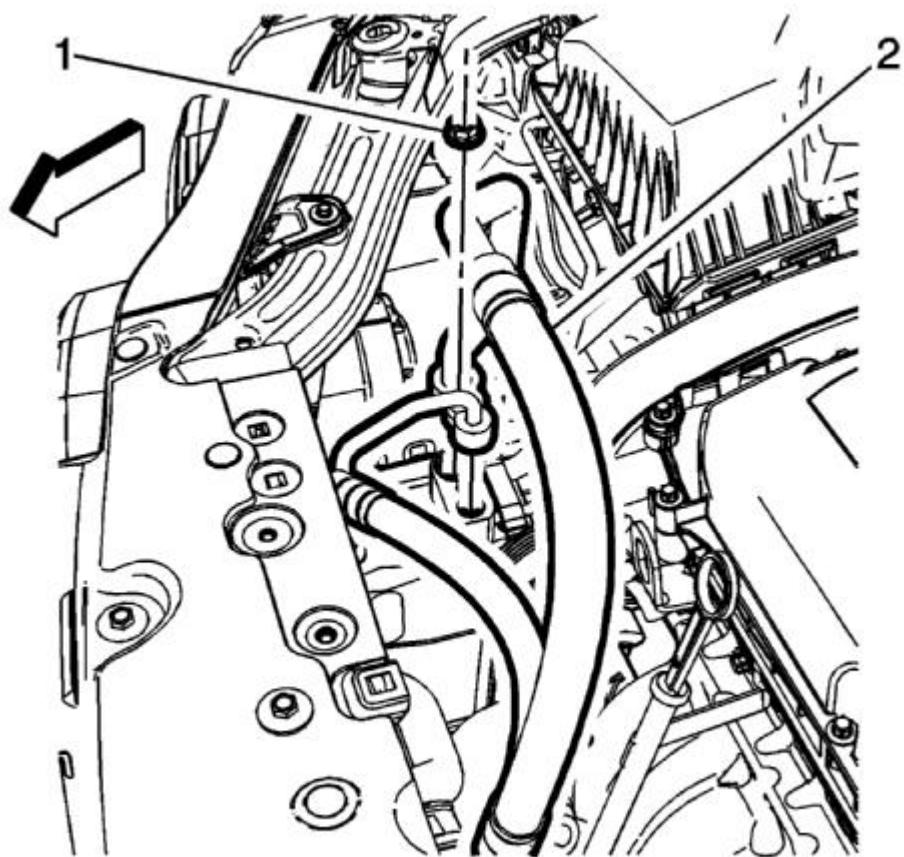


Fig. 233: Air Conditioning Compressor, Condenser Hose & Nut
Courtesy of GENERAL MOTORS COMPANY

28. Remove air conditioning compressor and condenser hose nut (1).
29. Remove air conditioning compressor and condenser hose (2) from refrigerant hose.

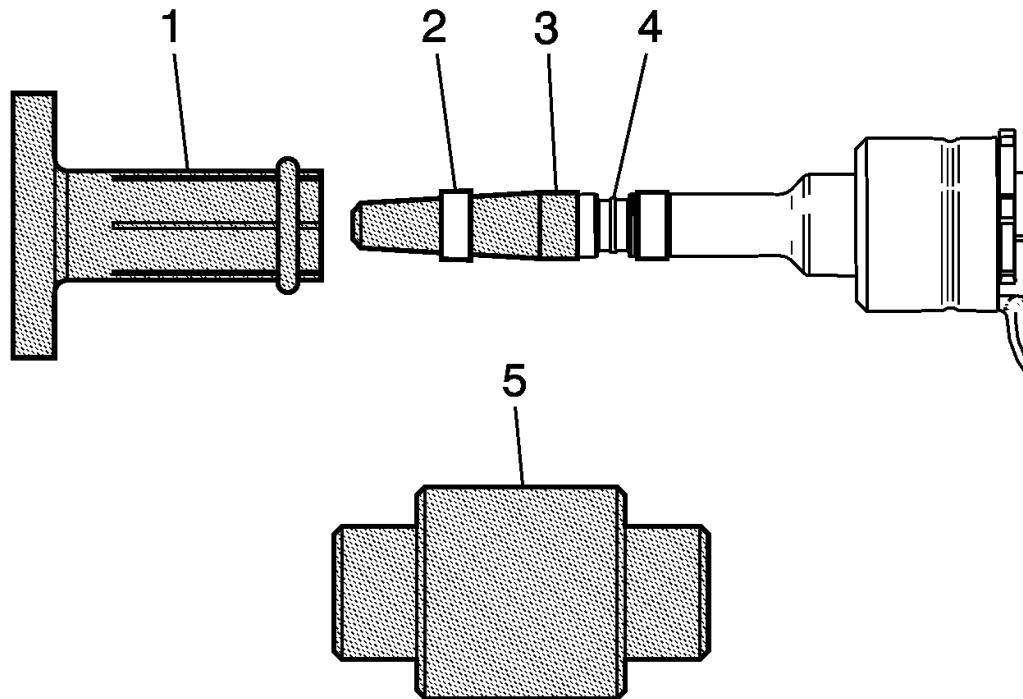


Fig. 234: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

30. Disconnect the fuel feed pipe (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
31. Install and close the fuel feed pipe with **CH-807** plug.
32. Disconnect the engine coolant sensor from radiator.

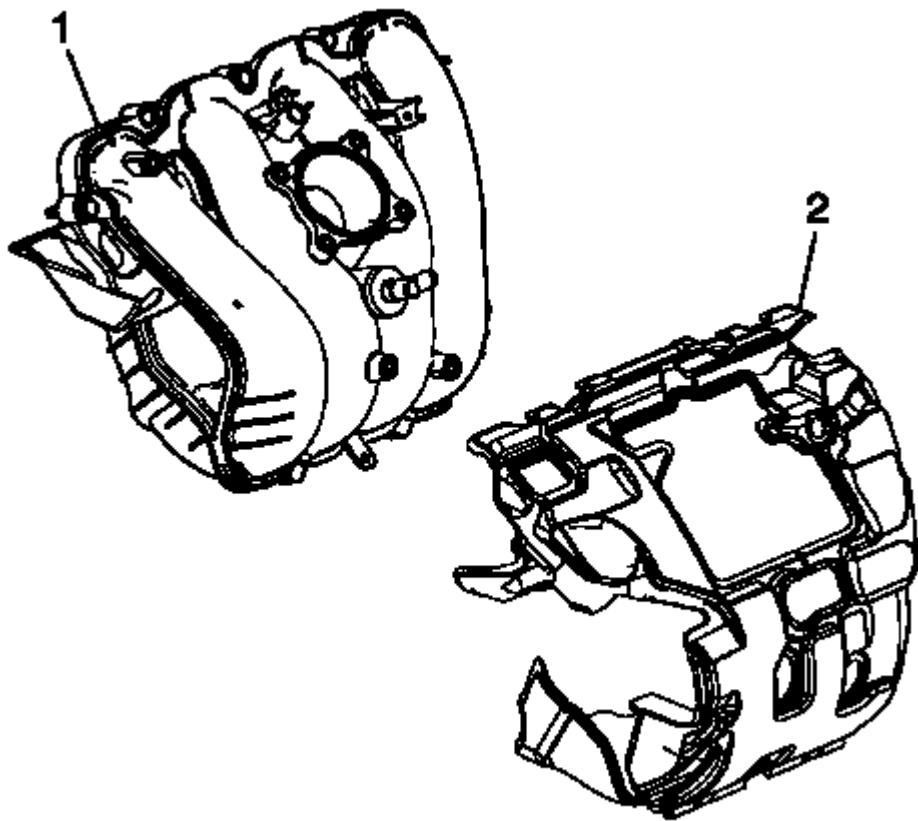


Fig. 235: View Of Brake Rotor, Caliper & Axle Nut

Courtesy of GENERAL MOTORS COMPANY

NOTE: Perform steps 33 through 41 to both sides.

33. Insert a brass drift or punch (1) in the cooling fins of the front brake rotor (2).
34. Rotate the brake rotor until it comes in contact with the brake caliper mount bracket (5).

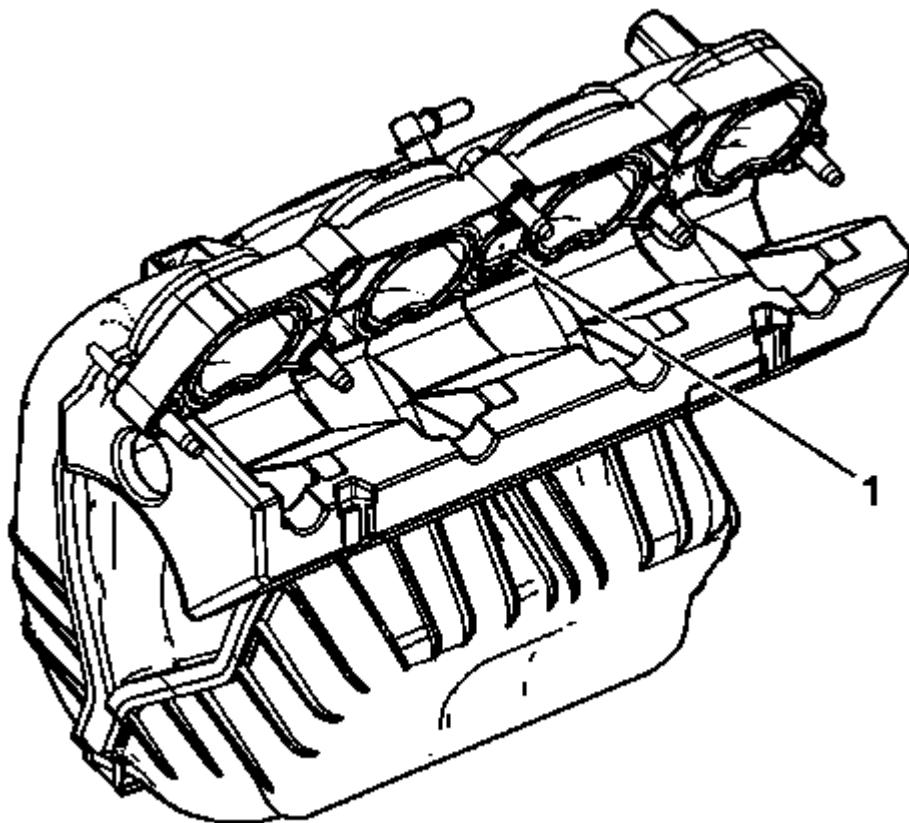


Fig. 236: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Use a suitable tool to release the crimping on the wheel drive shaft retaining nut.
- The wheel drive shaft retaining nut (1) must be discarded after removal.

35. Remove and discard the wheel drive shaft nut (1). Replace with NEW only.

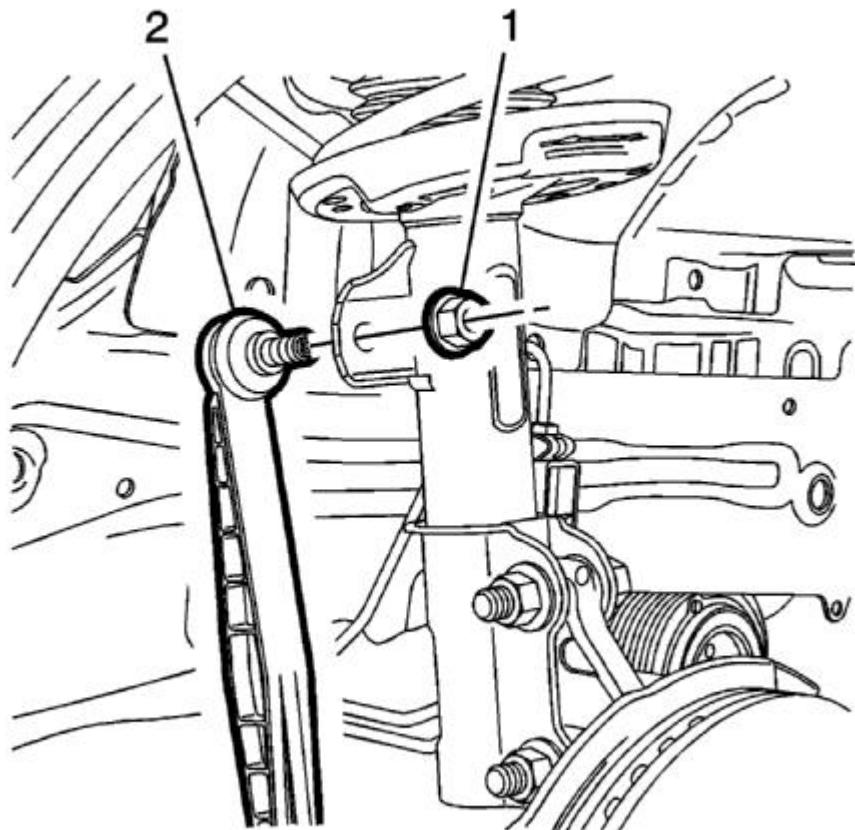


Fig. 237: Upper Stabilizer Shaft Link

Courtesy of GENERAL MOTORS COMPANY

36. Remove the upper stabilizer shaft link nut (1).
37. Disconnect the stabilizer shaft link (2).

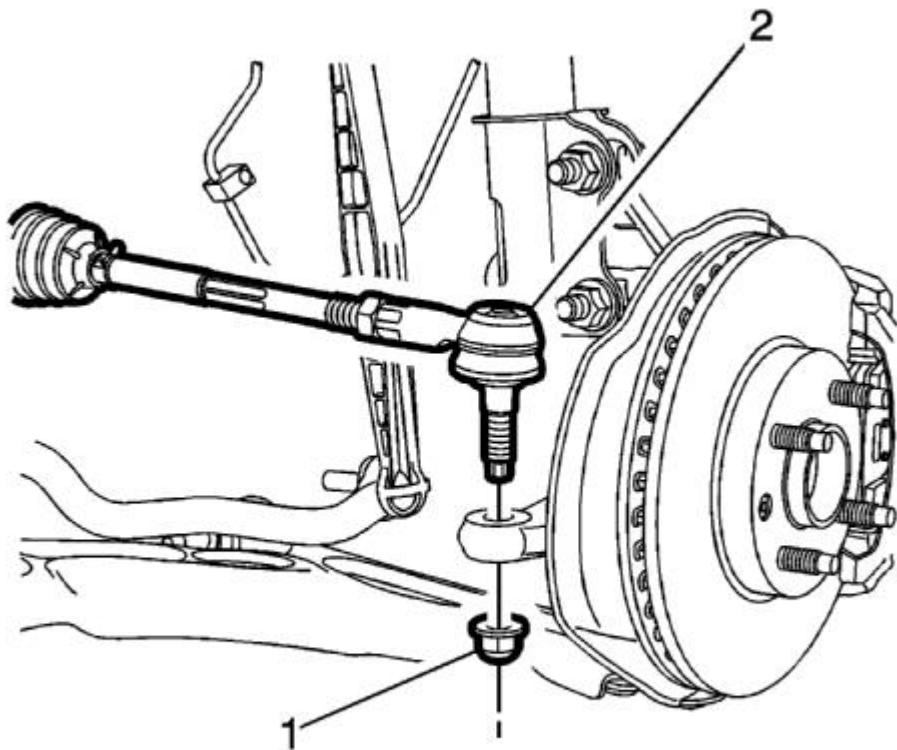


Fig. 238: Steering Linkage Outer Tie Rod

Courtesy of GENERAL MOTORS COMPANY

38. Remove the steering linkage outer tie rod nut (1).
39. Separate the steering linkage outer tie rod (2) from the steering knuckle. [Steering Linkage Outer Tie Rod Replacement](#) .
40. Separate the control arm ball joint from the steering knuckle. Refer to [Lower Control Arm Replacement](#) .

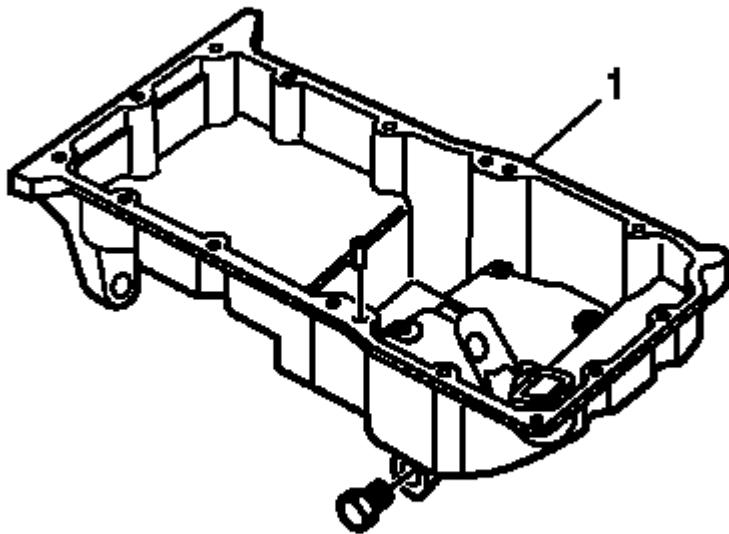


Fig. 239: Wheel Lug Nuts & Remover

Courtesy of GENERAL MOTORS COMPANY

NOTE: Reverse the wheel lug nuts and washers so the flat part of the wheel nut is facing the washers.

41. Using the **J-45859** remover (2), separate the wheel drive shaft from the steering knuckle (1).
42. Remove the upper stabilizer shaft link from the absorber on both sides. Refer to [Stabilizer Shaft Link Replacement](#).
43. Remove the front exhaust pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#) .

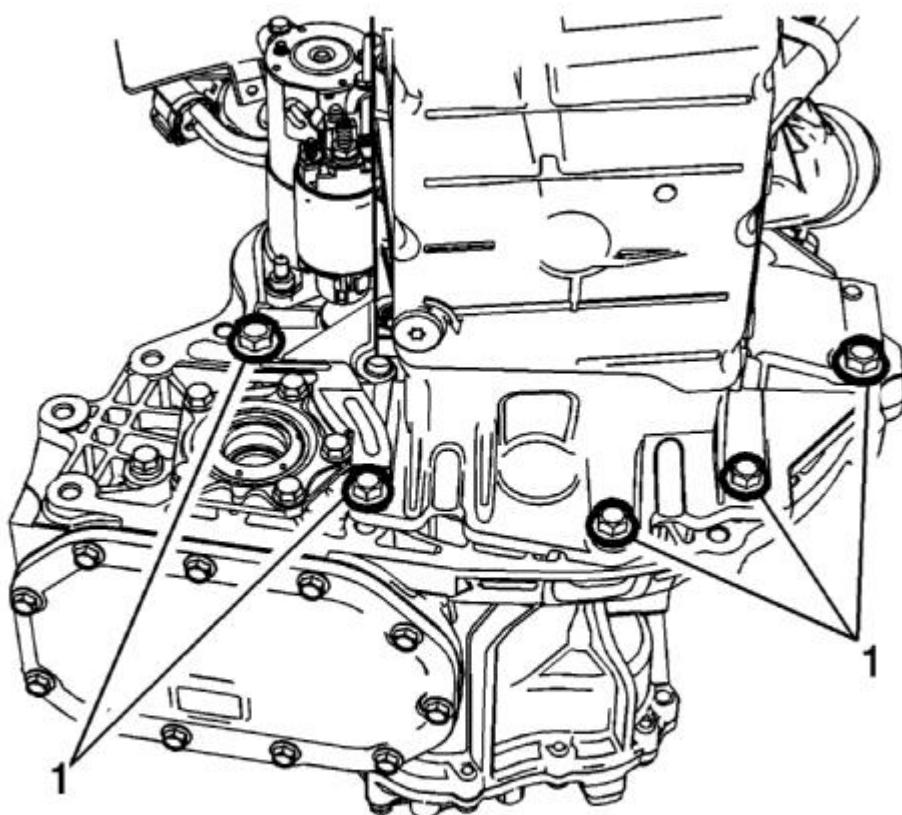


Fig. 240: Lower Oil Pan To Transmission Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

44. Remove the lower oil pan to transmission lower bolts (1).

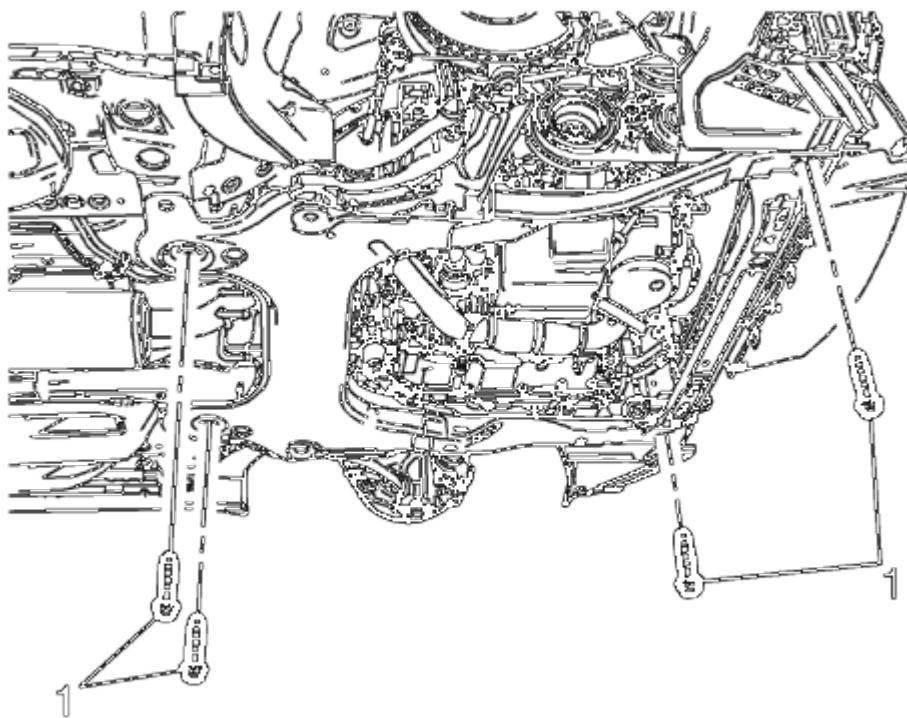


Fig. 241: Front Frame Bolts

Courtesy of GENERAL MOTORS COMPANY

45. Remove the frame front bolts (1).

NOTE: **Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.**

46. Position a engine support table under the powertrain assembly.

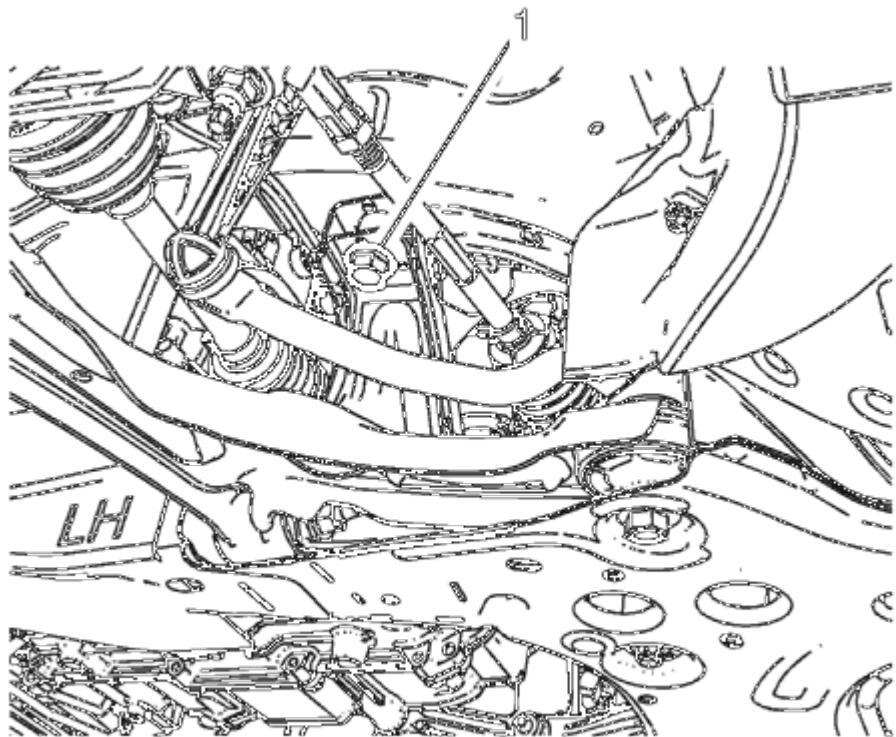


Fig. 242: Frame Suspension Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

47. Remove the upper frame suspension retaining bolts (1) on both sides.

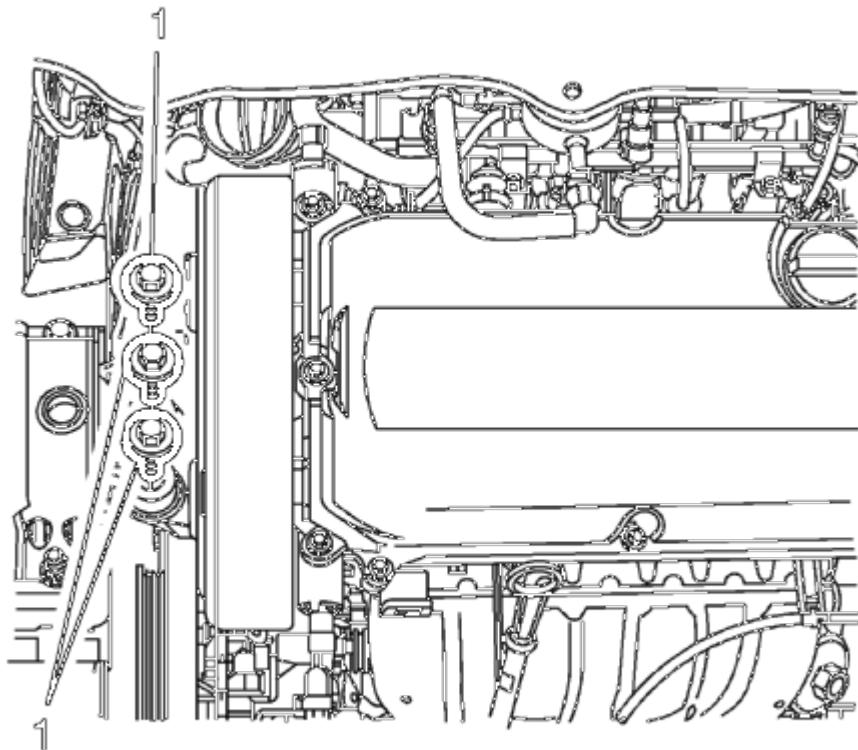


Fig. 243: Right Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

48. Mark the location of the bolts (1) before removing.
49. Remove the right side engine mount bolts (1). Refer to [Engine Mount Replacement](#).

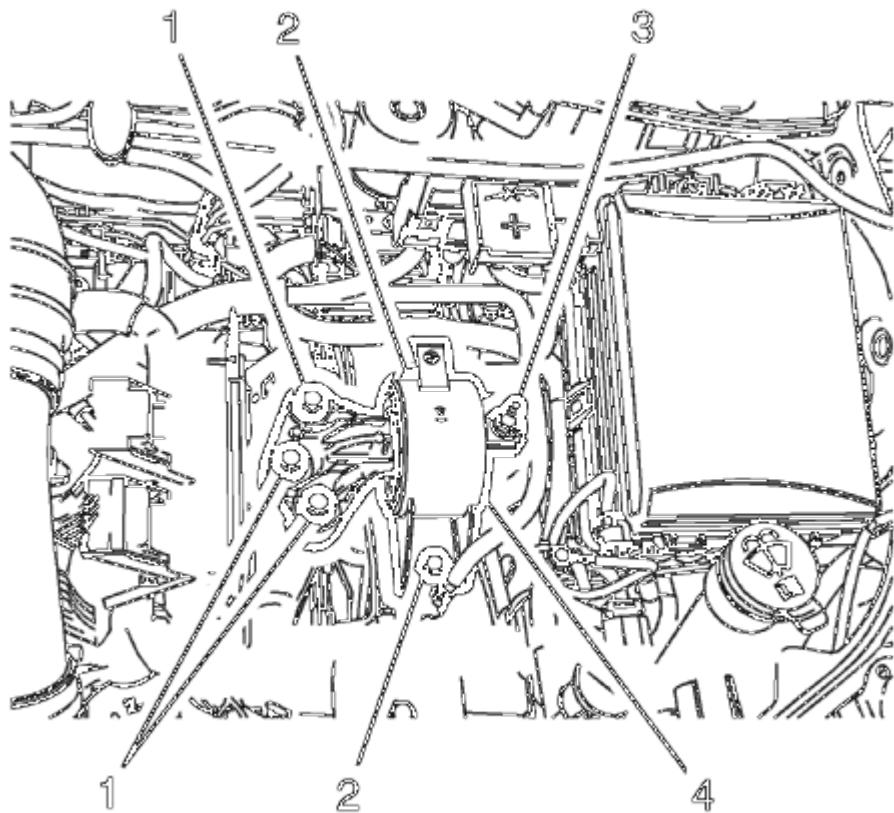


Fig. 244: Transmission Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

50. Mark the location of the bolts (1) before removing.
51. Remove the transmission mount bolts (1) - left side. Refer to [Engine Mount Replacement](#).
52. Disconnect any additional electrical connections as necessary.
53. Raise the vehicle until the powertrain is clear for removal.

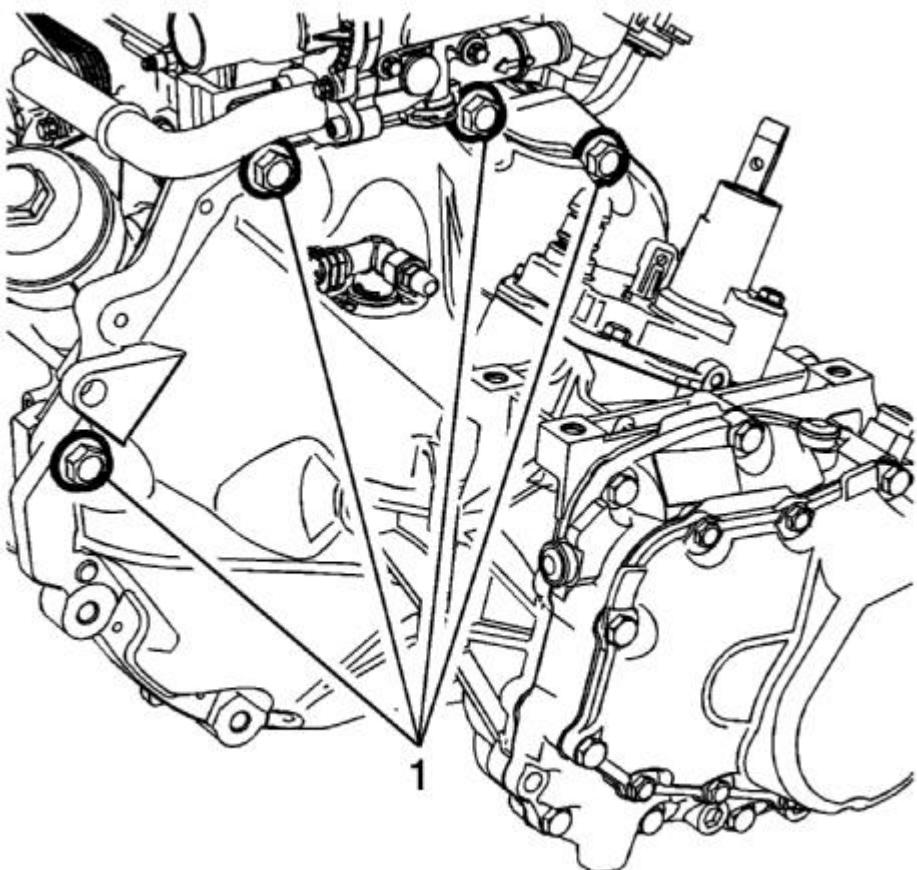


Fig. 245: Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

54. Remove the upper transmission to engine bolts (1) and separate the engine and transmission.
55. Disconnect any electrical connectors as needed.
56. Install the engine to the engine stand.
57. Transfer parts as needed.

Installation Procedure

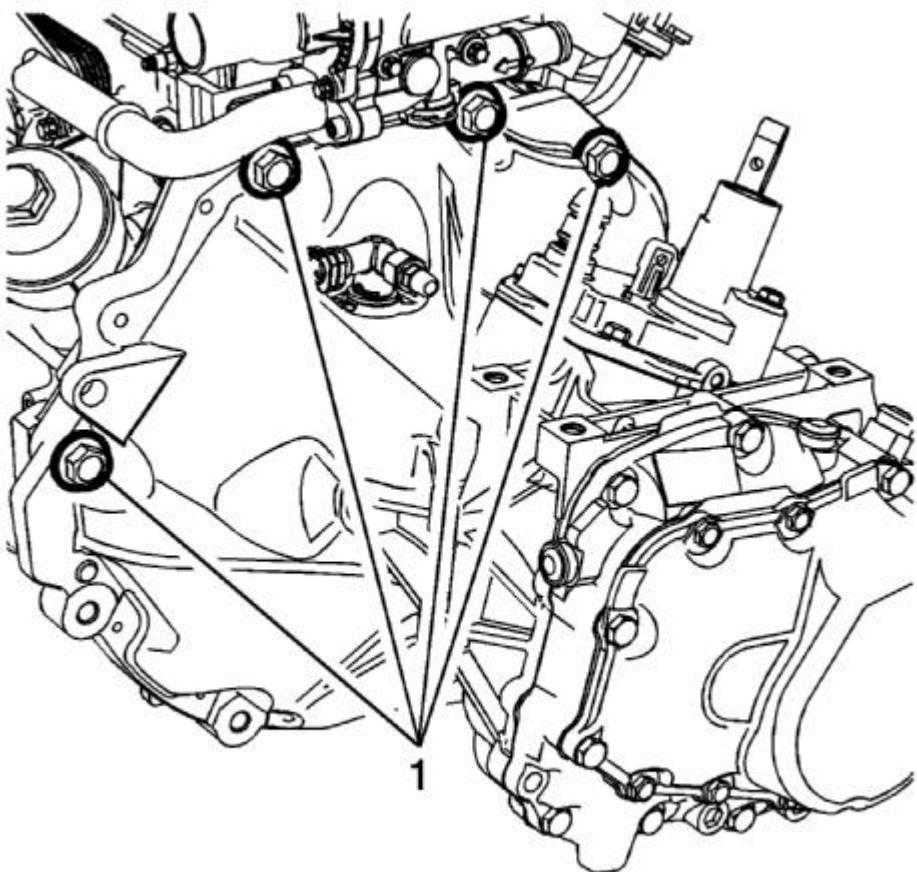


Fig. 246: Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine from the engine stand.
2. Install the transmission to the engine.

CAUTION: Refer to Fastener Caution .

3. Install the upper transmission to engine bolts (1) and tighten to 60 (44 lb ft).
4. Place the powertrain into the front frame.
5. Slowly lower the body onto the powertrain.

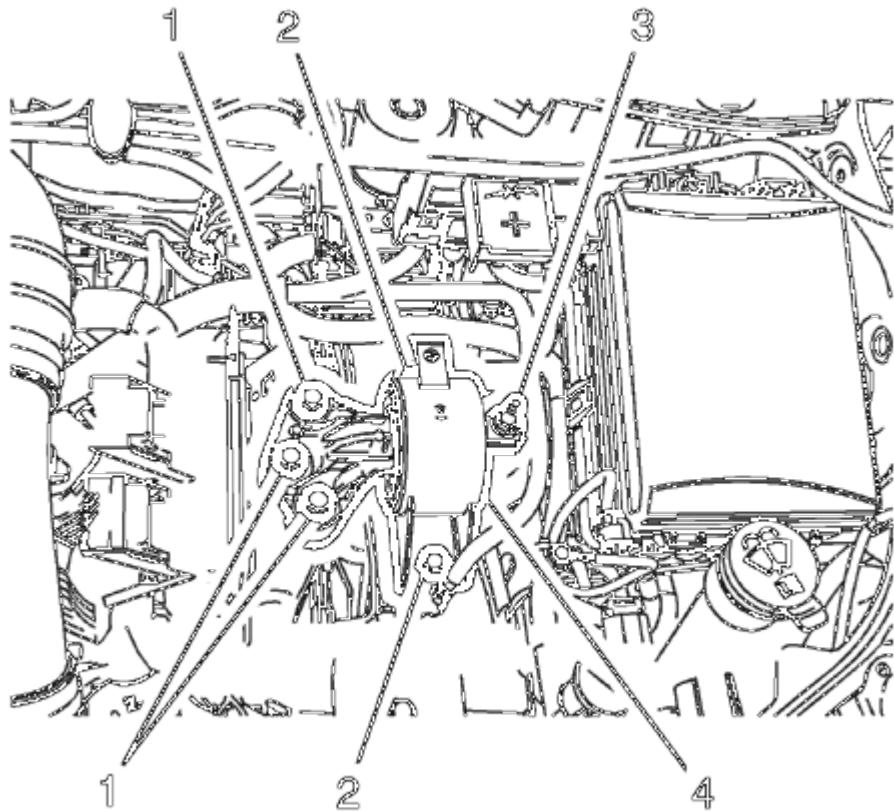


Fig. 247: Transmission Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

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

6. Install the NEW left transmission mount to transmission bolts (1) and tighten to 50 (37 lb ft) plus 70 degrees.

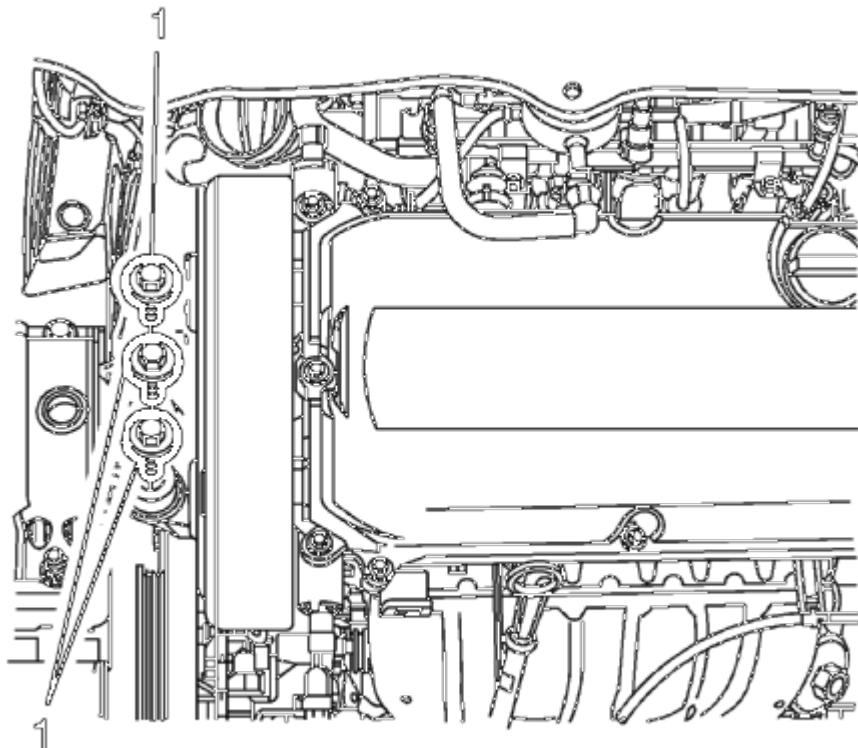


Fig. 248: Right Engine Mount Bolts

Courtesy of GENERAL MOTORS COMPANY

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

7. Install the right side engine mount bolts (1) and tighten to 50 (37 lb ft) plus 70 degrees.
8. Perform Powertrain Mount Balancing.

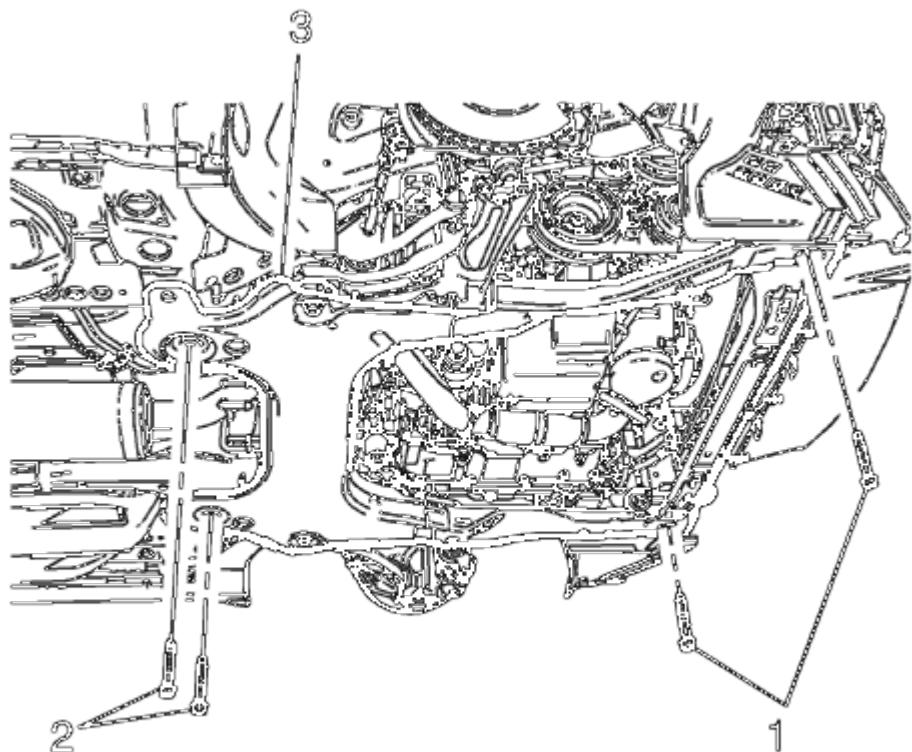


Fig. 249: Frame & Bolts

Courtesy of GENERAL MOTORS COMPANY

9. Install the frame (3) rear bolts (2) and front bolts (1), tighten a little bit.

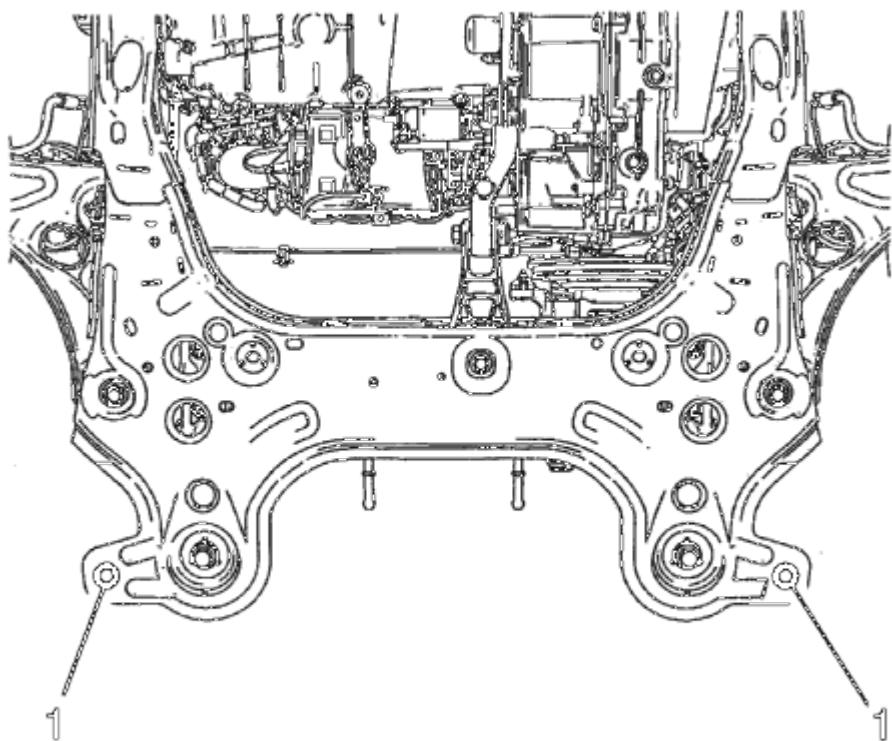


Fig. 250: Frame & Body Through Alignment Hole

Courtesy of GENERAL MOTORS COMPANY

10. Align the frame and body through alignment hole (1).

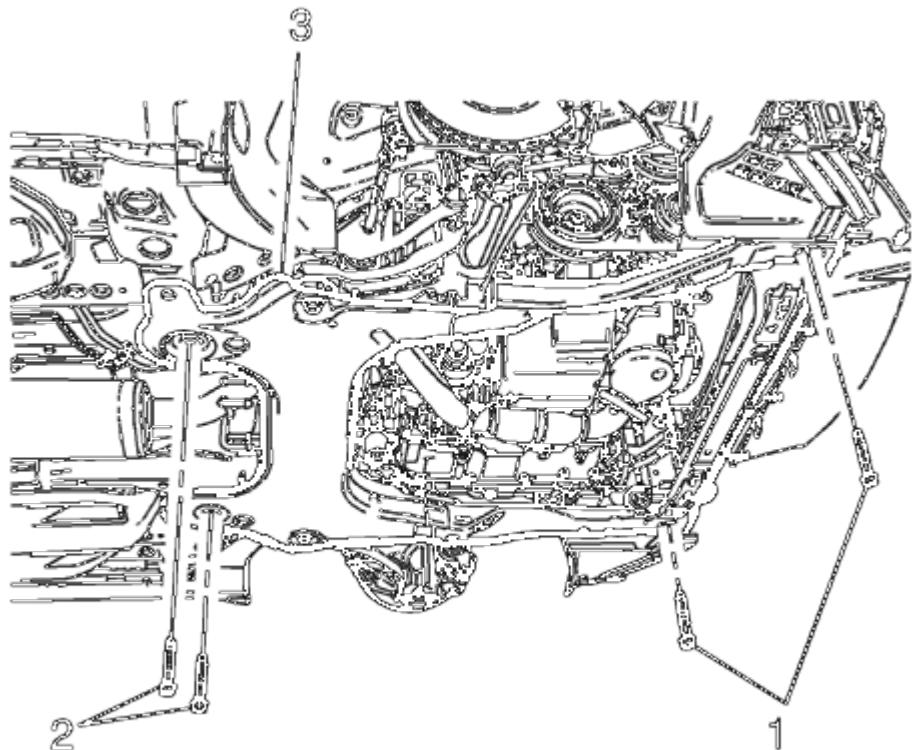


Fig. 251: Frame & Bolts

Courtesy of GENERAL MOTORS COMPANY

11. Install the frame (3) rear bolts (2) and tighten to 135 (100 lb ft).
12. Install the frame (3) front bolts (1) and tighten to 58 (43 lb ft).

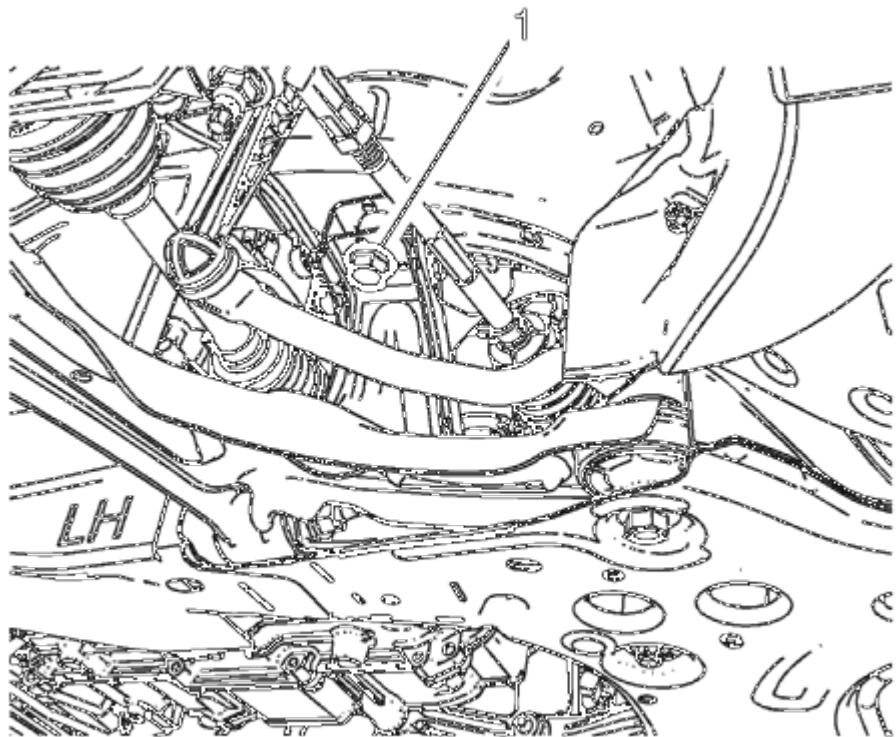


Fig. 252: Frame Suspension Retaining Bolts

Courtesy of GENERAL MOTORS COMPANY

13. Install the upper frame suspension retaining bolts (1) on both sides and tighten to 135 (100 lb ft).
14. Remove the lift table.

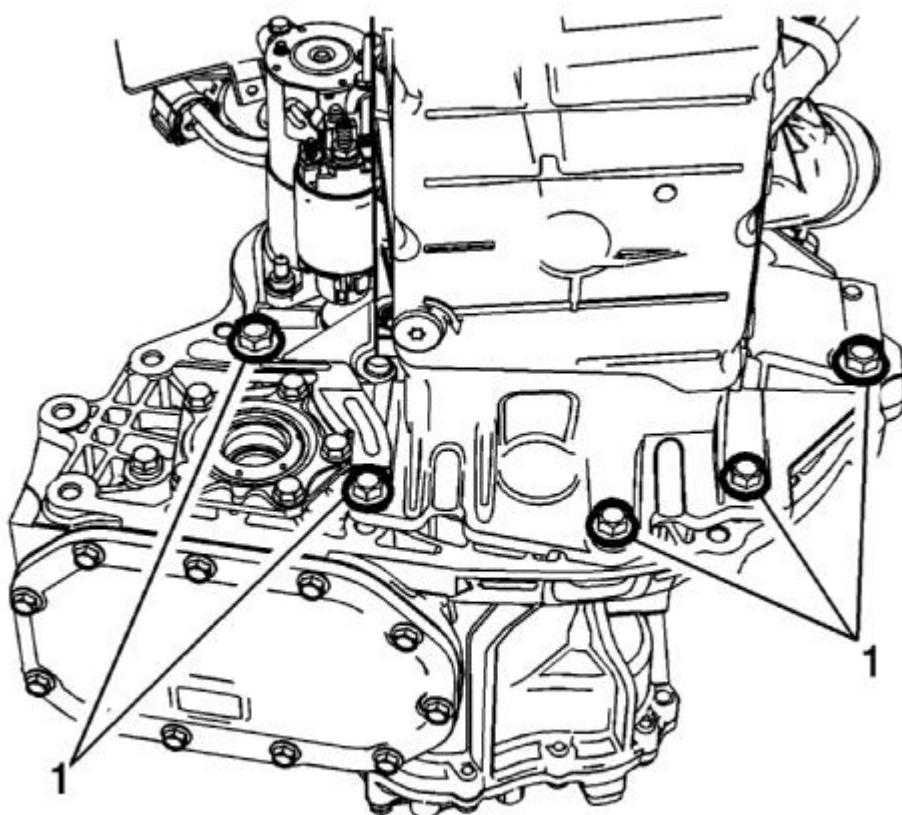


Fig. 253: Lower Oil Pan To Transmission Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Install the lower oil pan to transmission lower bolts (1) and tighten to 60 (44 lb ft).
16. Install the front exhaust pipe. Refer to [Exhaust Front Pipe Replacement \(LUV,LUW\)](#) .

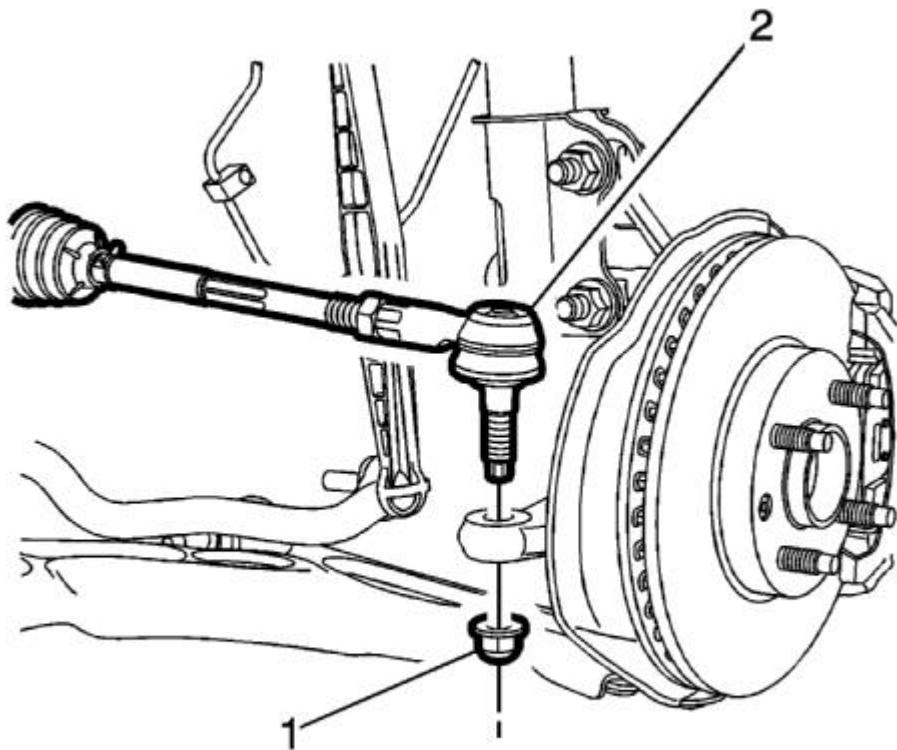


Fig. 254: Steering Linkage Outer Tie Rod

Courtesy of GENERAL MOTORS COMPANY

17. Inset the wheel drive shaft to the steering knuckle.

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

18. Install the NEW steering linkage outer tie rod nut (1) and tighten to 30 (22 lb ft) Plus 128 degrees.
19. Install the steering linkage outer tie rod to the steering knuckle. Refer to Steering Linkage Outer Tie Rod Replacement .

2013 Chevrolet Sonic LS

2013 Engine Engine Mechanical - 1.8L (LUW, LWE) - Sonic

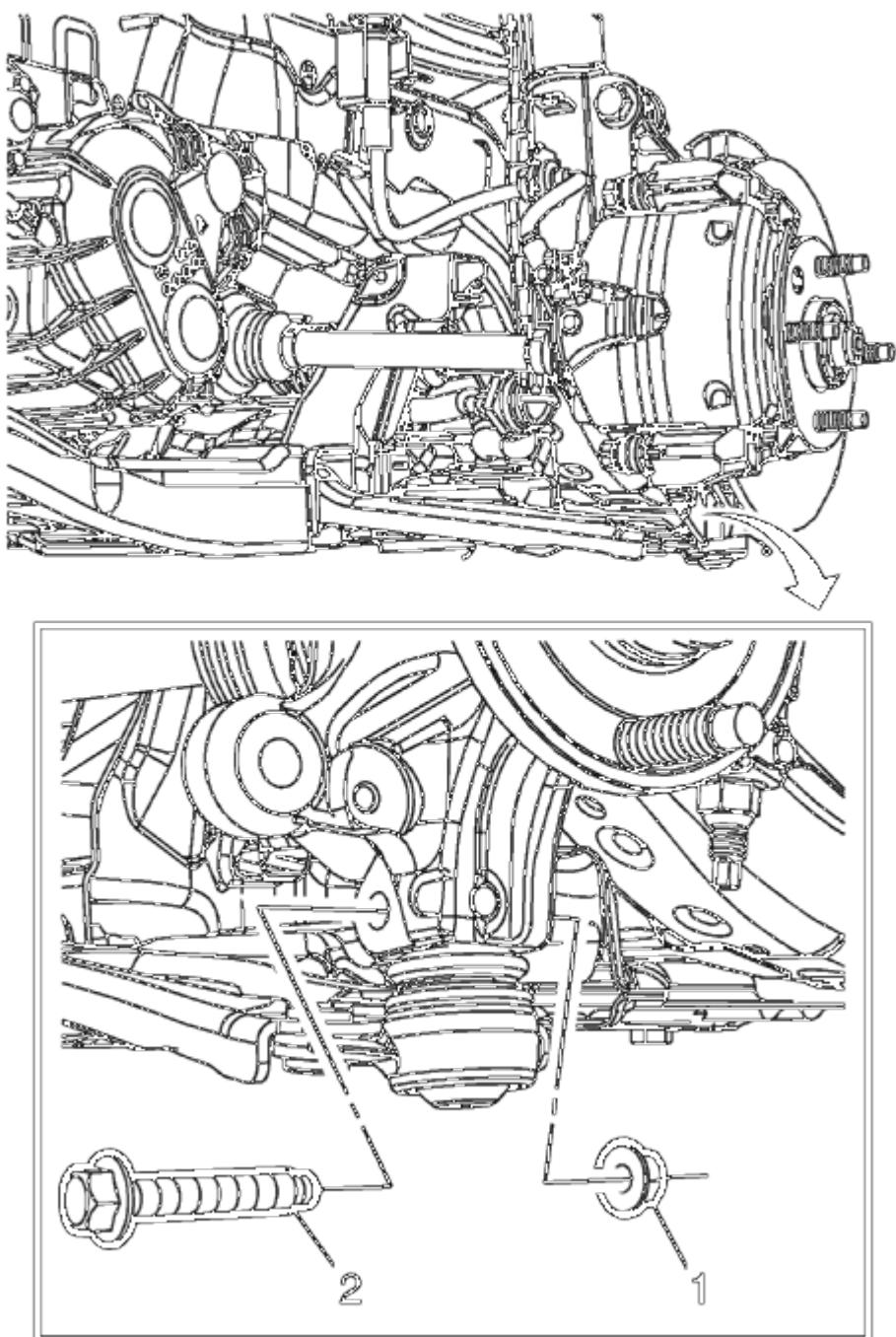


Fig. 255: Control Arm Ball Joint To Steering Knuckle Bolt
Courtesy of GENERAL MOTORS COMPANY

20. Install the control arm ball joint to the steering knuckle. Refer to [Lower Control Arm Replacement](#) .

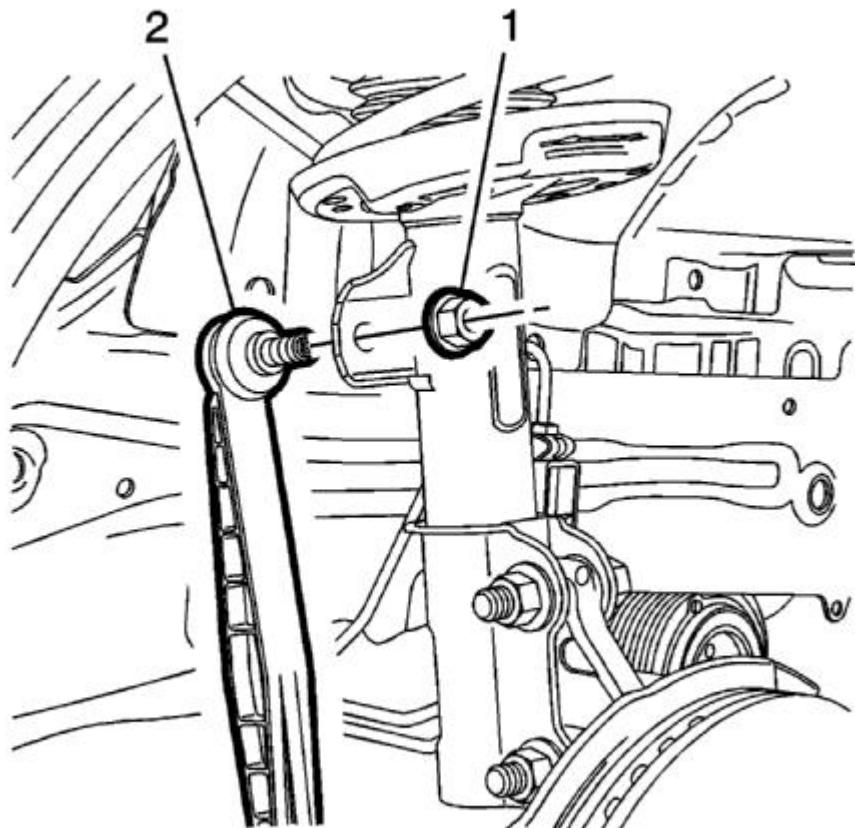


Fig. 256: Upper Stabilizer Shaft Link

Courtesy of GENERAL MOTORS COMPANY

21. Connect the stabilizer shaft link (2).
22. Install the upper stabilizer shaft link nut (1) and tighten to 65 (48 lb ft).

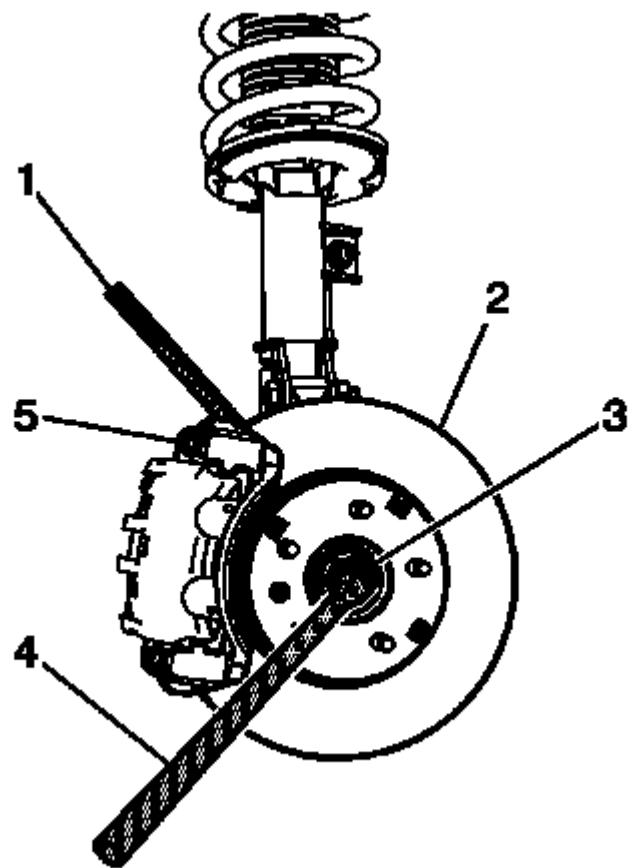


Fig. 257: View Of Brake Rotor, Caliper & Axle Nut

Courtesy of GENERAL MOTORS COMPANY

23. Insert a brass drift or punch (1) in the cooling fins of the front brake rotor (2).
24. Rotate the brake rotor until it comes in contact with the brake caliper mount bracket (5).

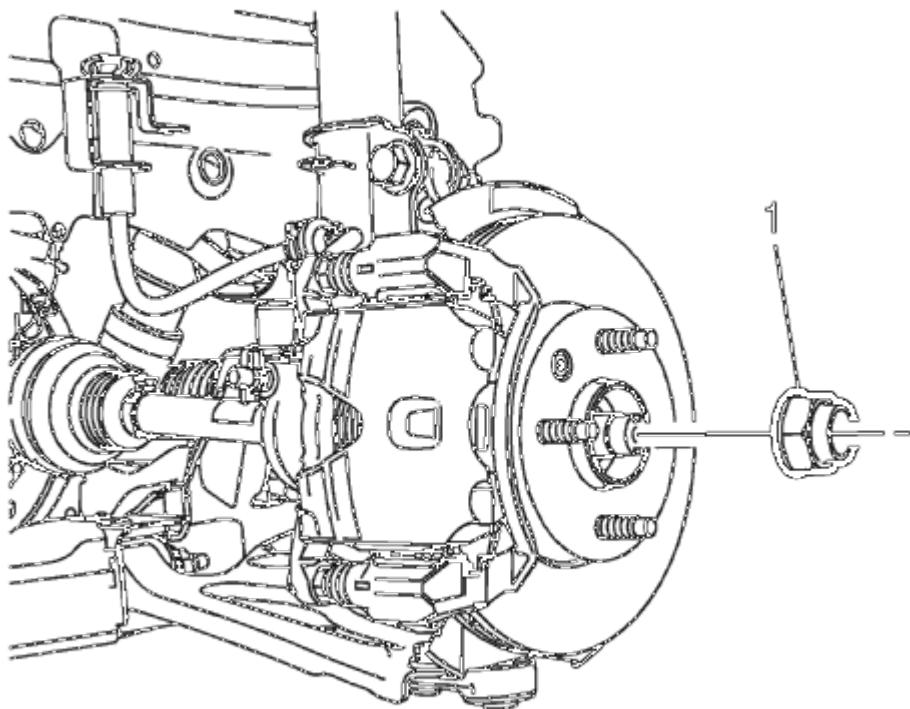


Fig. 258: Wheel Drive Shaft Nut

Courtesy of GENERAL MOTORS COMPANY

25. Install the NEW wheel drive shaft nut (1) and tighten to 250 (184 lb ft).

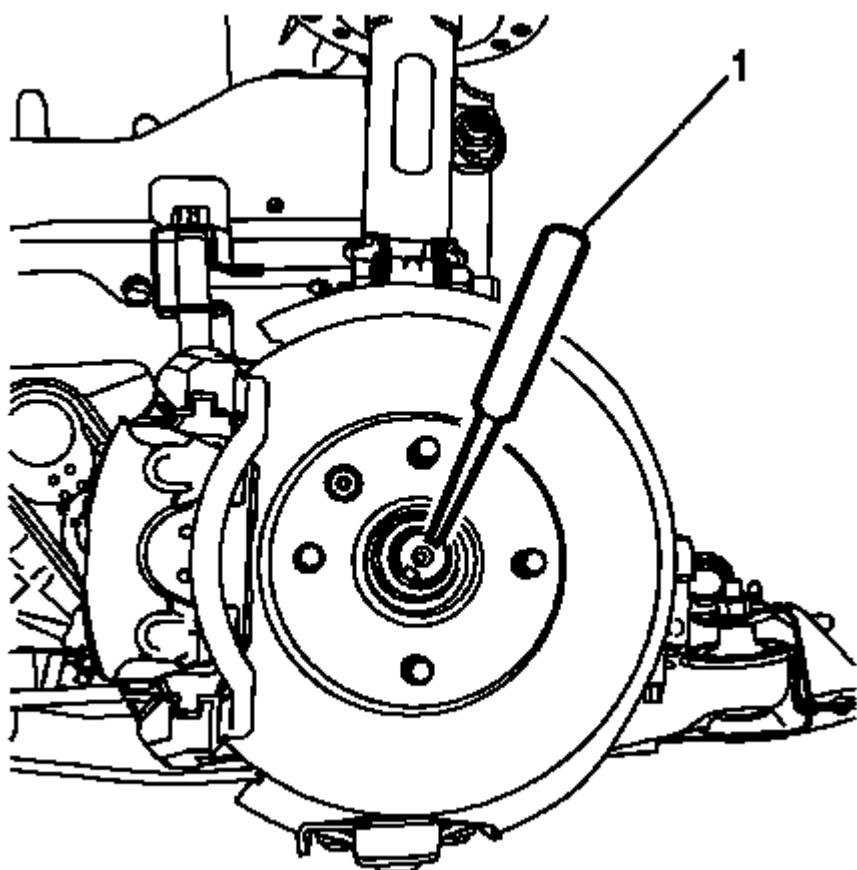


Fig. 259: Staking Wheel Drive Shaft Nut With Punch
Courtesy of GENERAL MOTORS COMPANY

26. Using a punch (1), stake the wheel drive shaft nut.

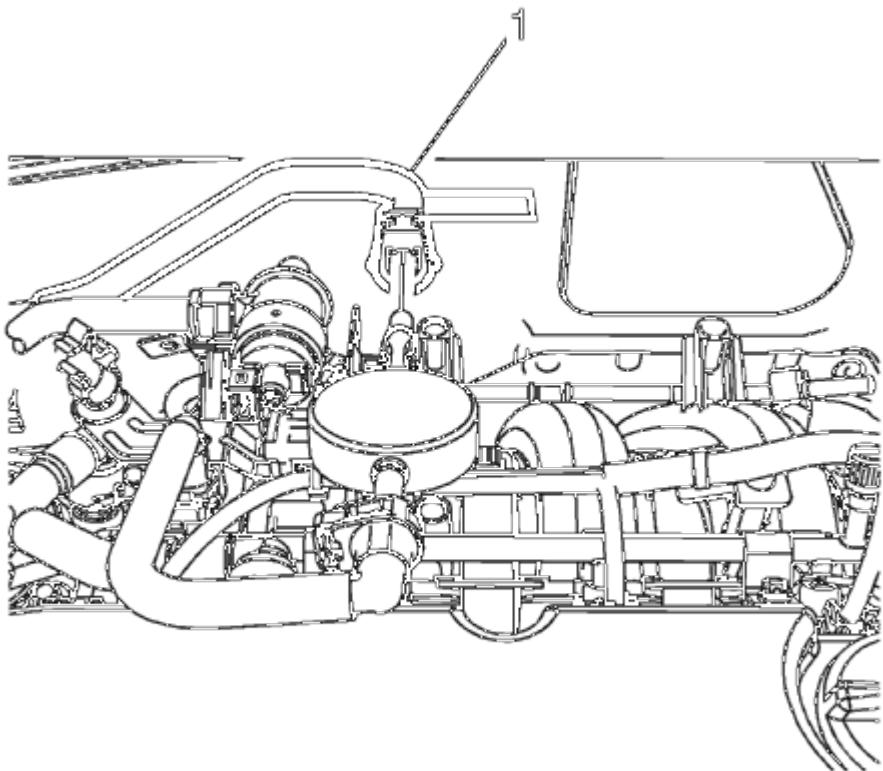


Fig. 260: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

27. Remove the **CH-807** plug.
28. Connect the fuel feed pipe (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
29. Connect the engine coolant sensor from radiator.

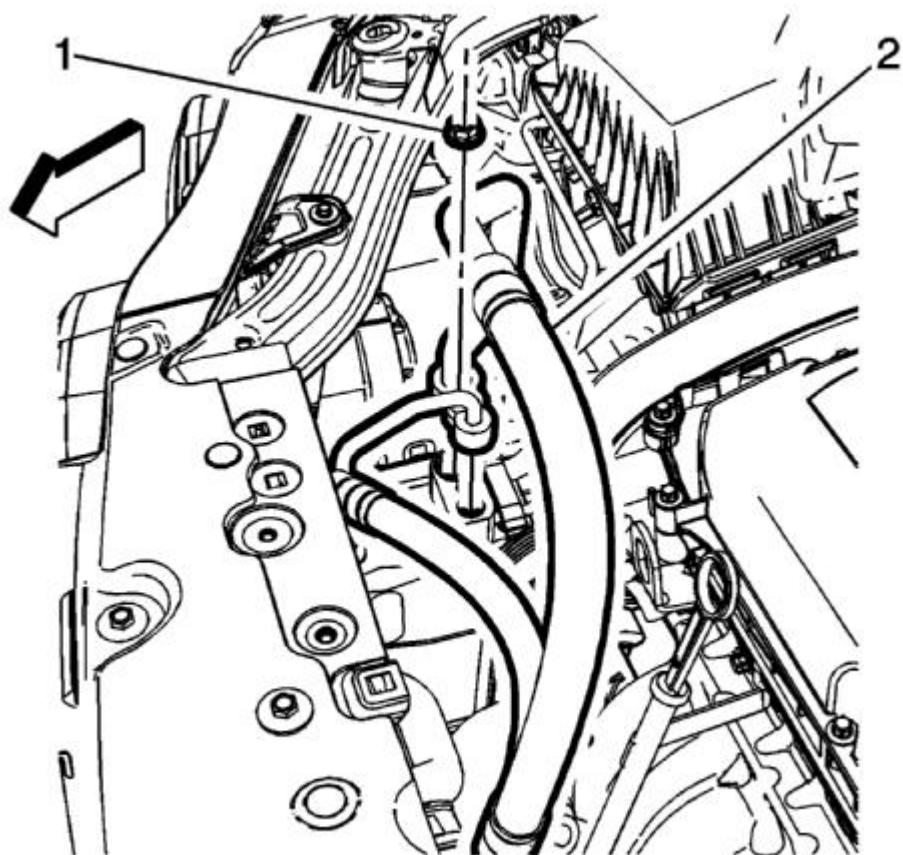


Fig. 261: Air Conditioning Compressor, Condenser Hose & Nut
Courtesy of GENERAL MOTORS COMPANY

30. Install air conditioning compressor and condenser hose to the refrigerant hose
31. Install air conditioning compressor and condenser hose nut (1) tighten nut to 22 (16 lb ft).

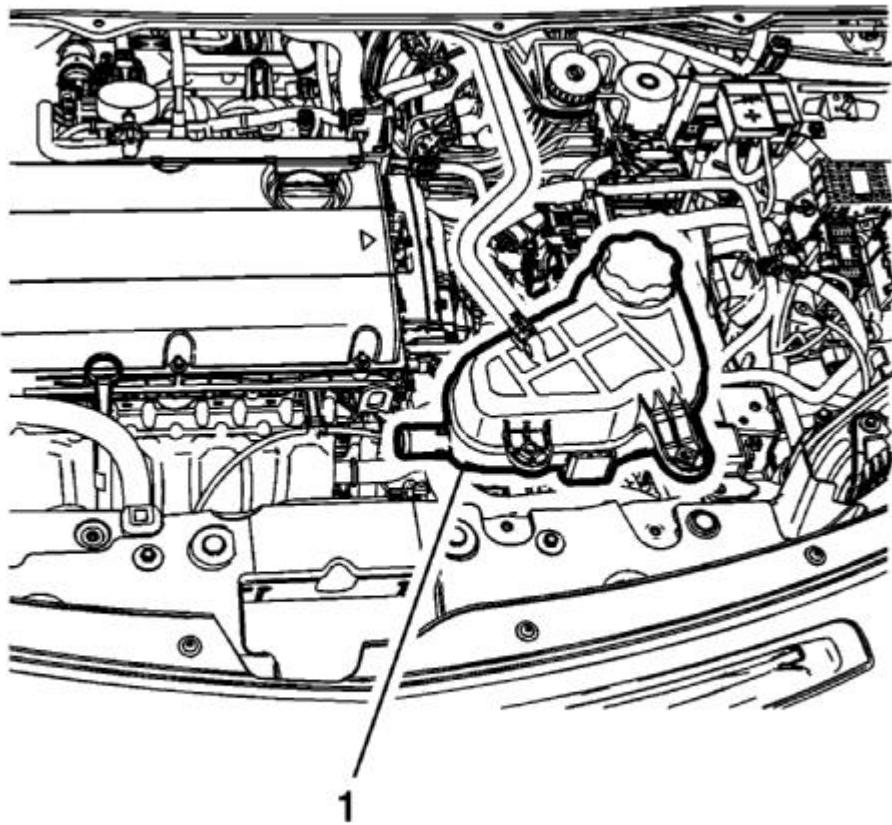


Fig. 262: Radiator Surge Tank

Courtesy of GENERAL MOTORS COMPANY

32. Install the radiator surge tank (1). Refer to [Radiator Surge Tank Replacement](#) .
33. Connect the fan connector.

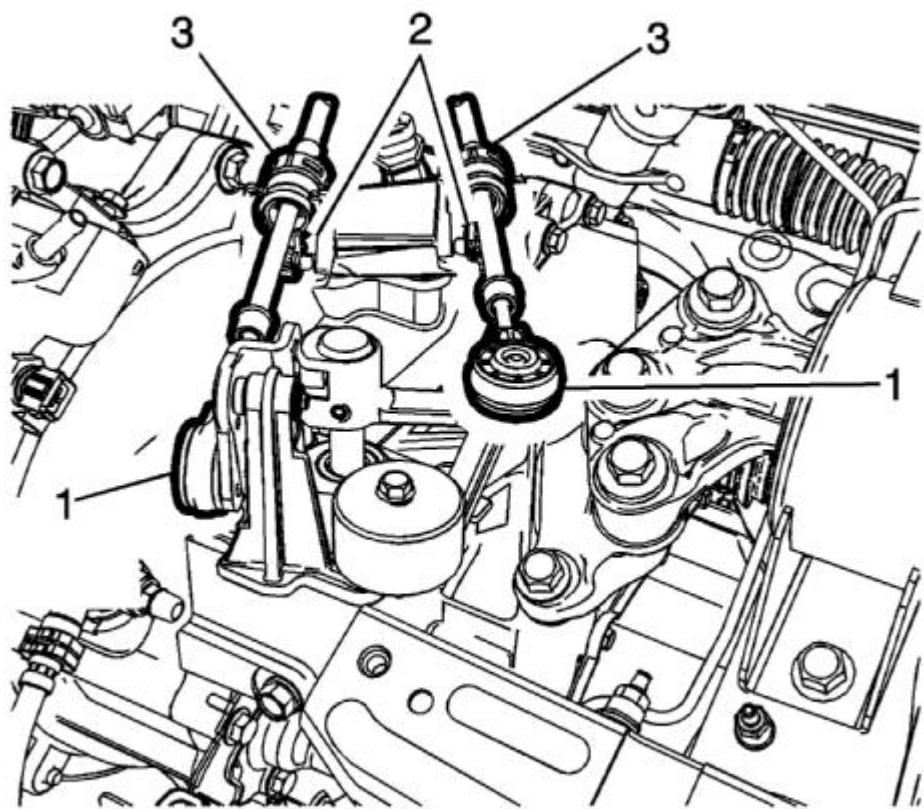


Fig. 263: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

34. Connect the transmission range selector lever cable terminals (1) to the transmission manual pins.
35. Press the locking tab rearward in order to lock the transmission range selector lever cable (2) to the cable bracket.

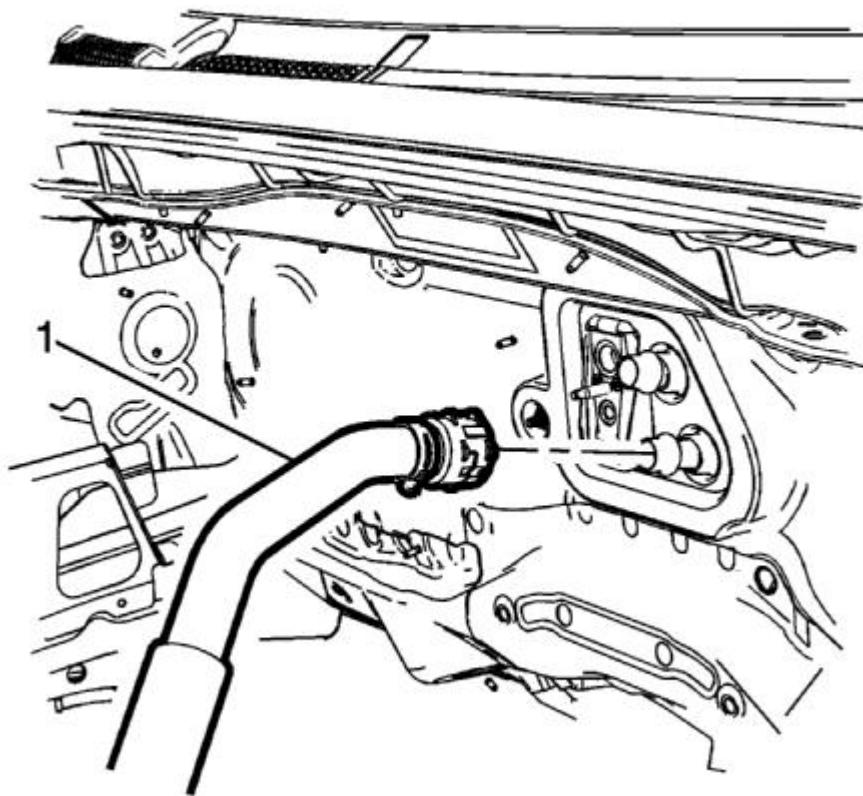


Fig. 264: Heater Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

36. Connect the heater inlet hose to the heater core (1). Refer to [Heater Inlet Hose Replacement \(LDE, LUW\)](#).

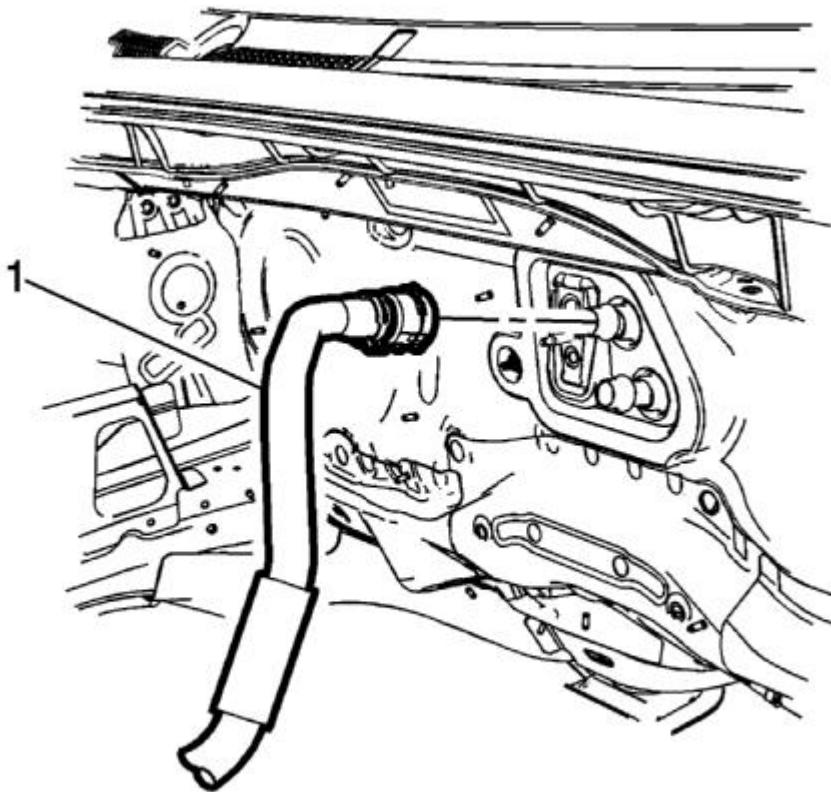


Fig. 265: Heater Outlet Hose

Courtesy of GENERAL MOTORS COMPANY

37. Connect the heater outlet hose to the heater core (1). Refer to [Heater Outlet Hose Replacement \(LDE, LUW\)](#).

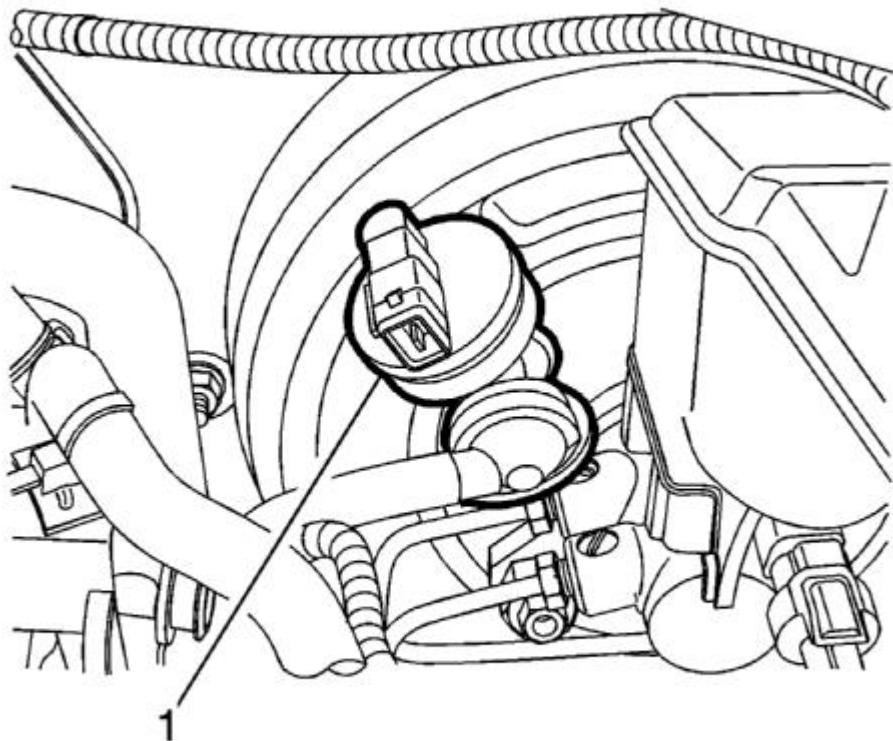


Fig. 266: Electrical Vacuum Pump

Courtesy of GENERAL MOTORS COMPANY

38. If equipped with electrical vacuum pump, connect the electrical connector and install the brake booster hose (1).

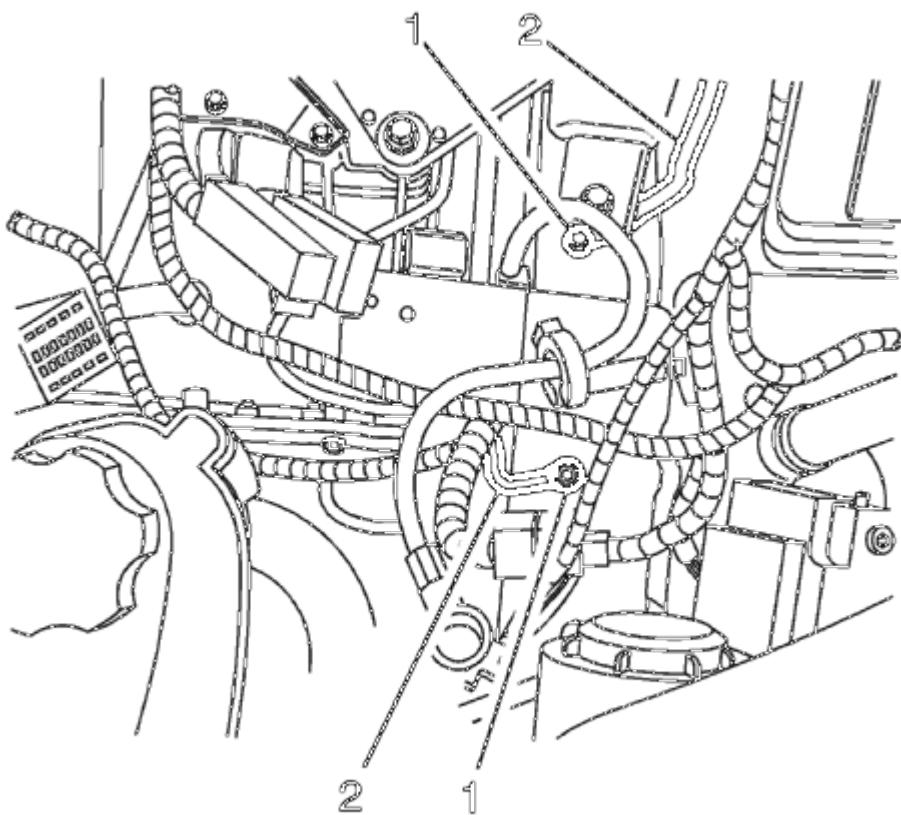


Fig. 267: Wiring Harness & Ground Nuts
Courtesy of GENERAL MOTORS COMPANY

39. Install the ground nuts (1) and reposition the wiring harness (2).

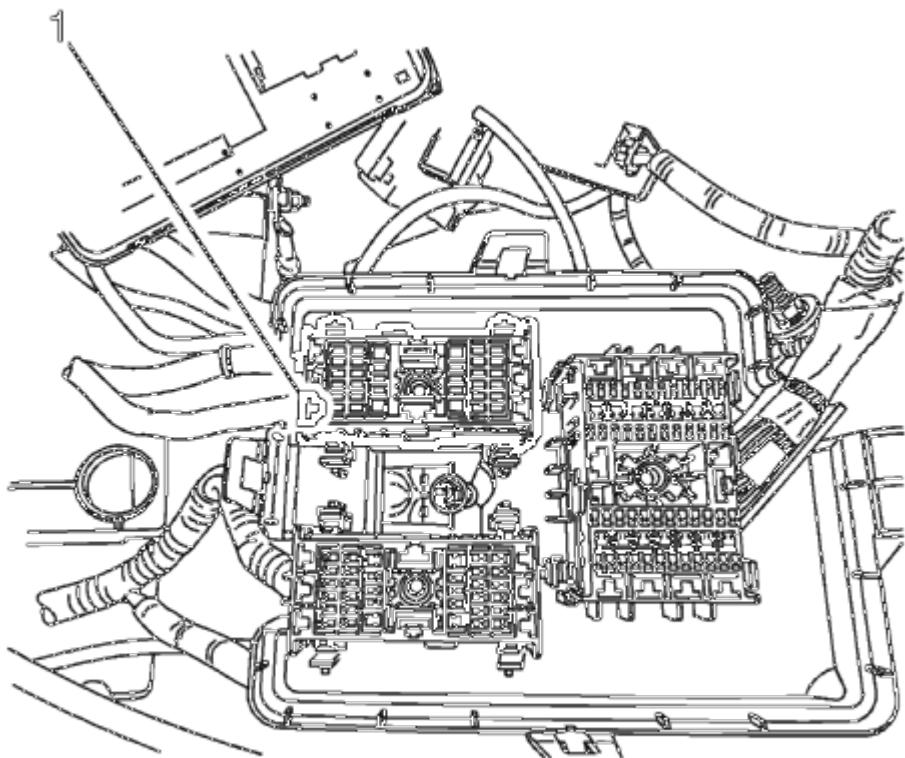


Fig. 268: Wiring Harness - Top Of Engine
Courtesy of GENERAL MOTORS COMPANY

40. Clip in the wiring harness plugs (1).

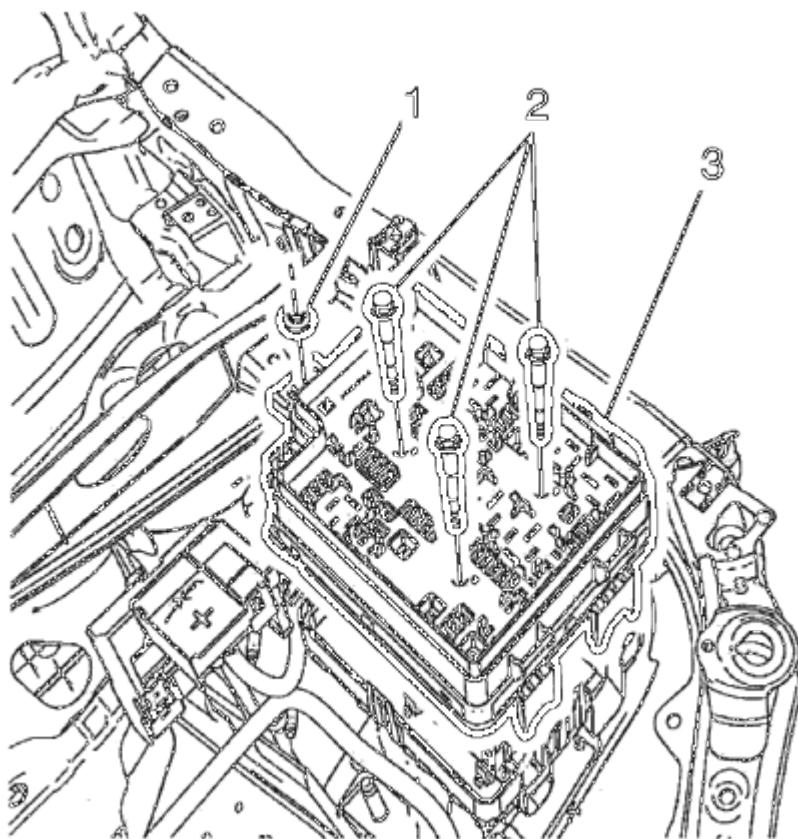


Fig. 269: Junction Block
Courtesy of GENERAL MOTORS COMPANY

41. Install the junction block to the base.
42. Install the junction block bolts (2) and tighten to 5 (44 lb in).
43. Install the junction block nut (1) and tighten to 5 (44 lb in).

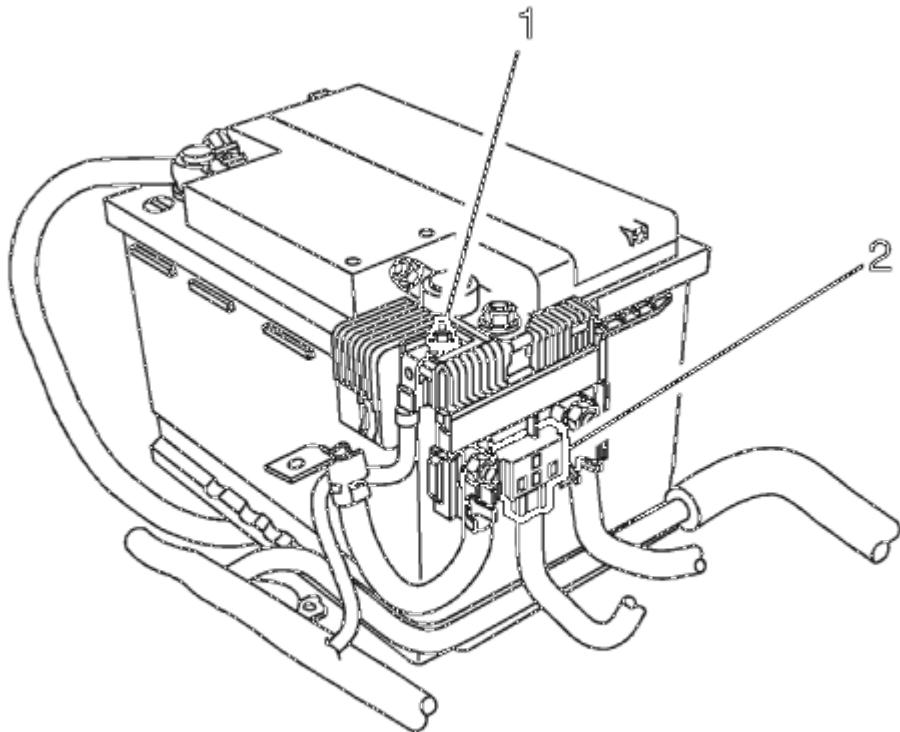


Fig. 270: Body Wiring Harness Connector & Positive Cable Nut
Courtesy of GENERAL MOTORS COMPANY

44. Install the battery positive cable to the battery positive cable junction block and tighten nut (1) to 5 (44 lb in).
45. Connect the body wiring master harness connector (2), to the battery positive cable junction block.

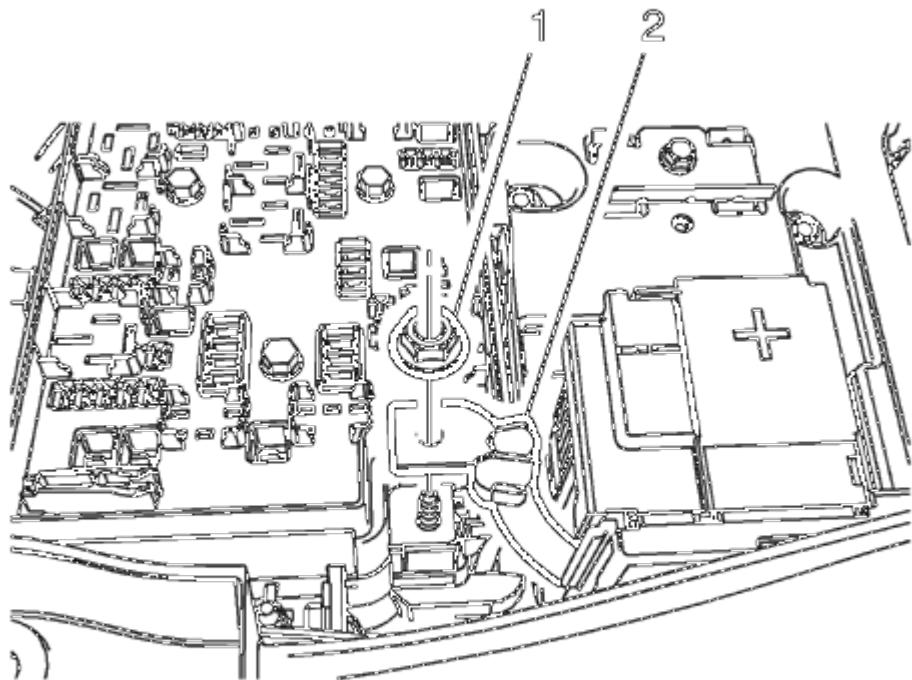


Fig. 271: Positive Battery Cable & Nut

Courtesy of GENERAL MOTORS COMPANY

46. Position the positive battery cable to the junction block.
47. Install the positive battery cable nut (2) and tighten to 10 (89 lb in).

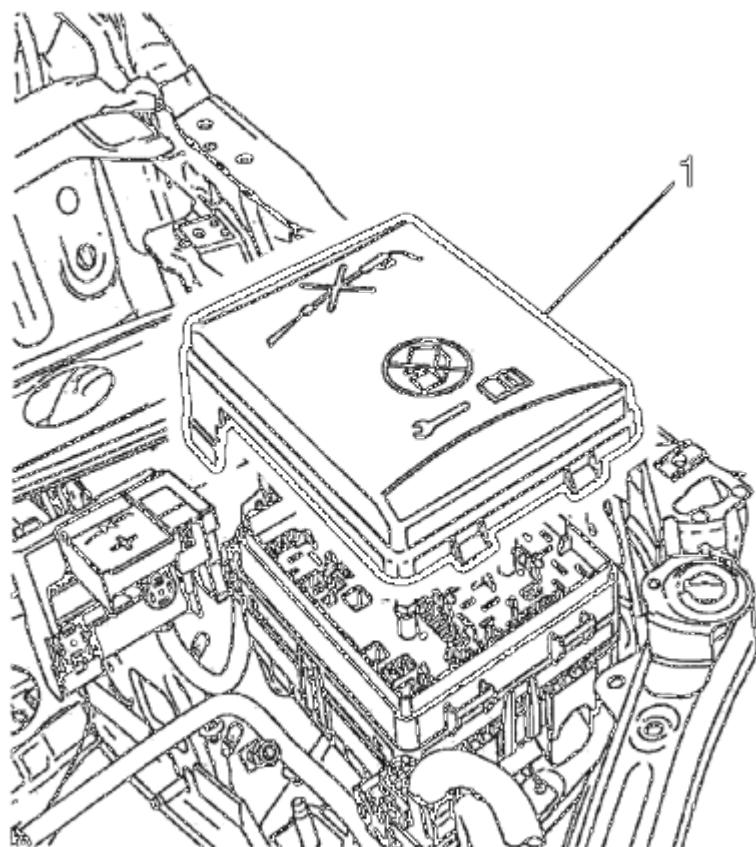


Fig. 272: Junction Block & Cover

Courtesy of GENERAL MOTORS COMPANY

48. Install the junction block cover (1).

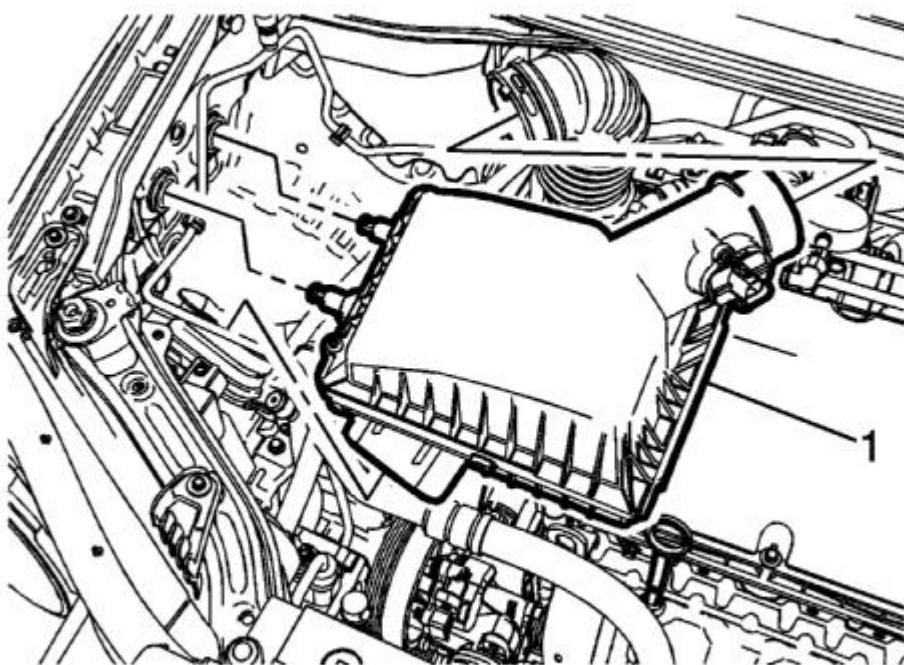


Fig. 273: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

49. Install the air cleaner assembly (1). Refer to [Air Cleaner Assembly Replacement](#).

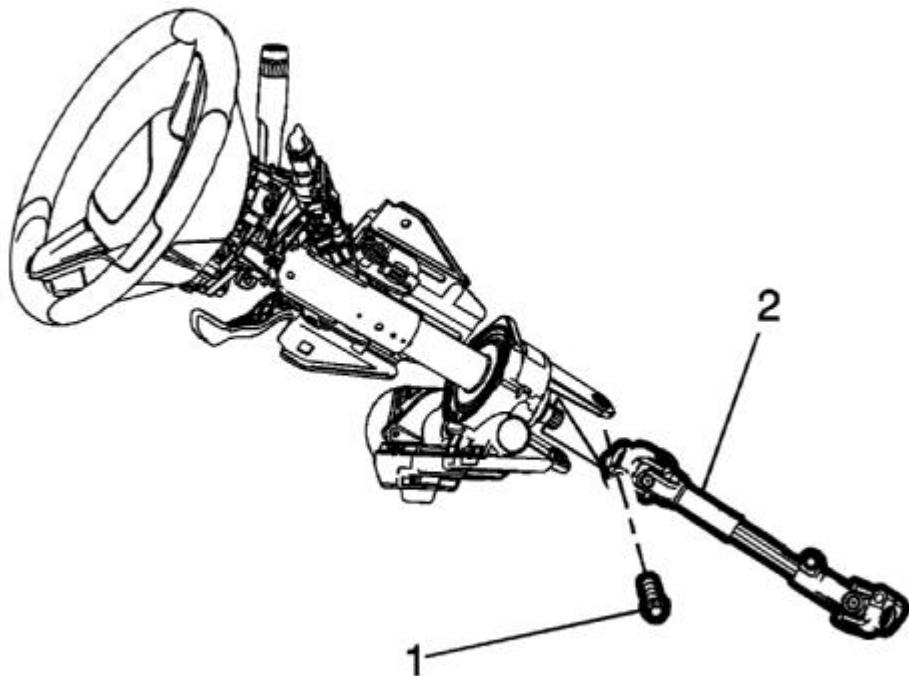


Fig. 274: Lower Intermediate Steering Shaft & Bolt
Courtesy of GENERAL MOTORS COMPANY

50. Install the lower intermediate steering shaft bolt (1). Refer to [Intermediate Steering Shaft Replacement](#).
51. Install the battery and battery tray. Refer to [Battery Tray Replacement](#).
52. Install the front tire and wheel assembly. Refer to [Tire and Wheel Removal and Installation](#).
53. Install the front bumper fascia. Refer to [Front Bumper Fascia Replacement](#).
54. Evacuate and charge the refrigerant system. Refer to [Refrigerant Recovery and Recharging](#).
55. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

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.

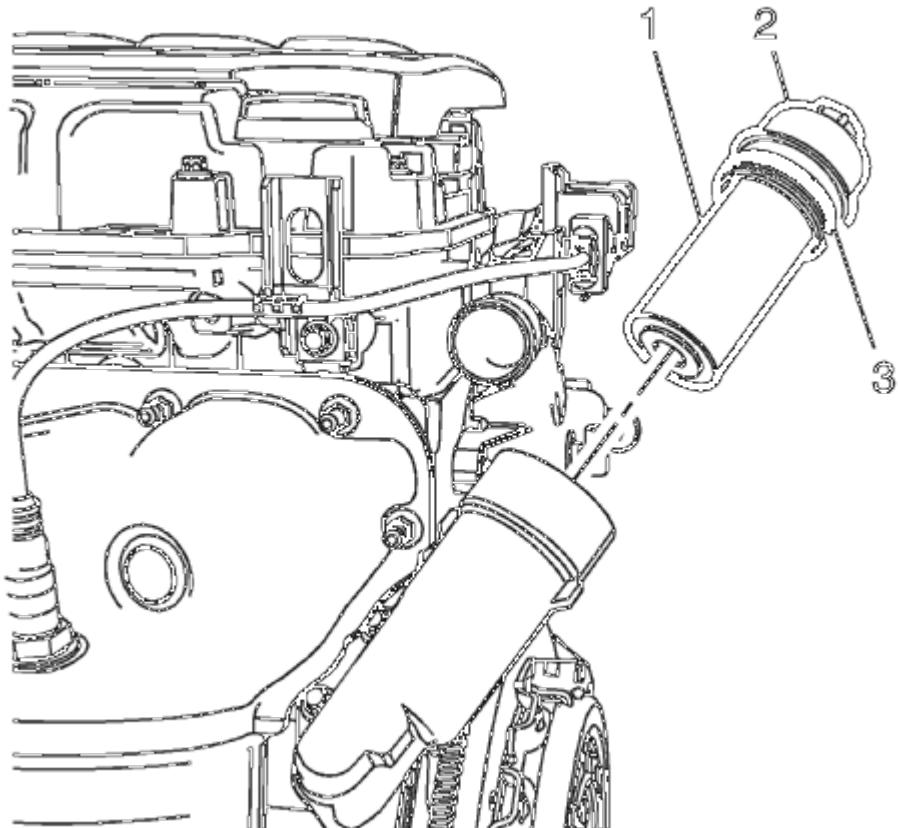


Fig. 275: Engine Oil Filter Cap, Cap Seal Ring And Oil Filter Element
Courtesy of GENERAL MOTORS COMPANY

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.

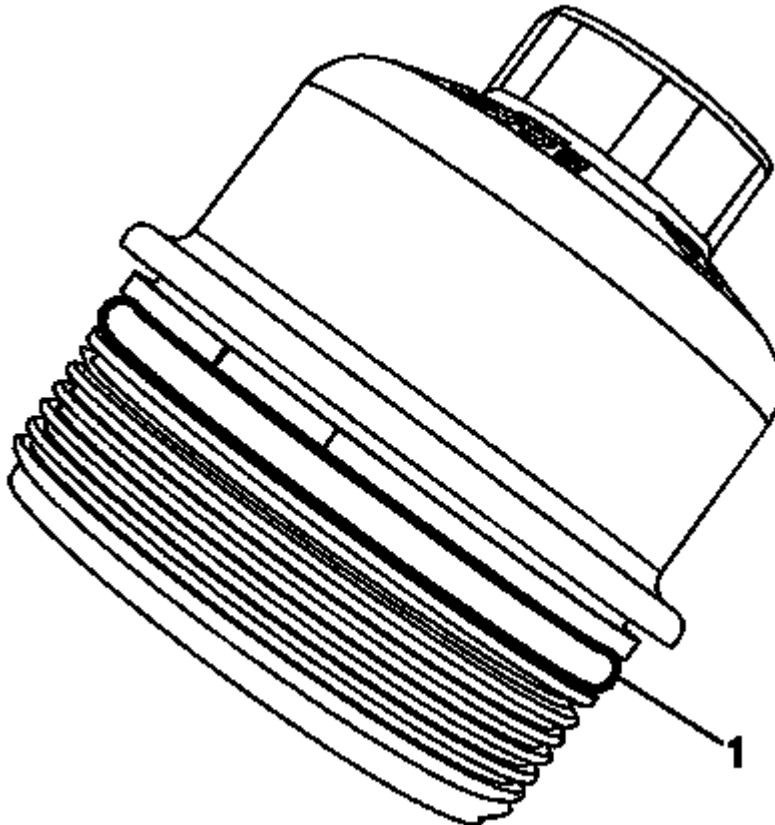


Fig. 276: Oil Filter Cap Seal Ring

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).

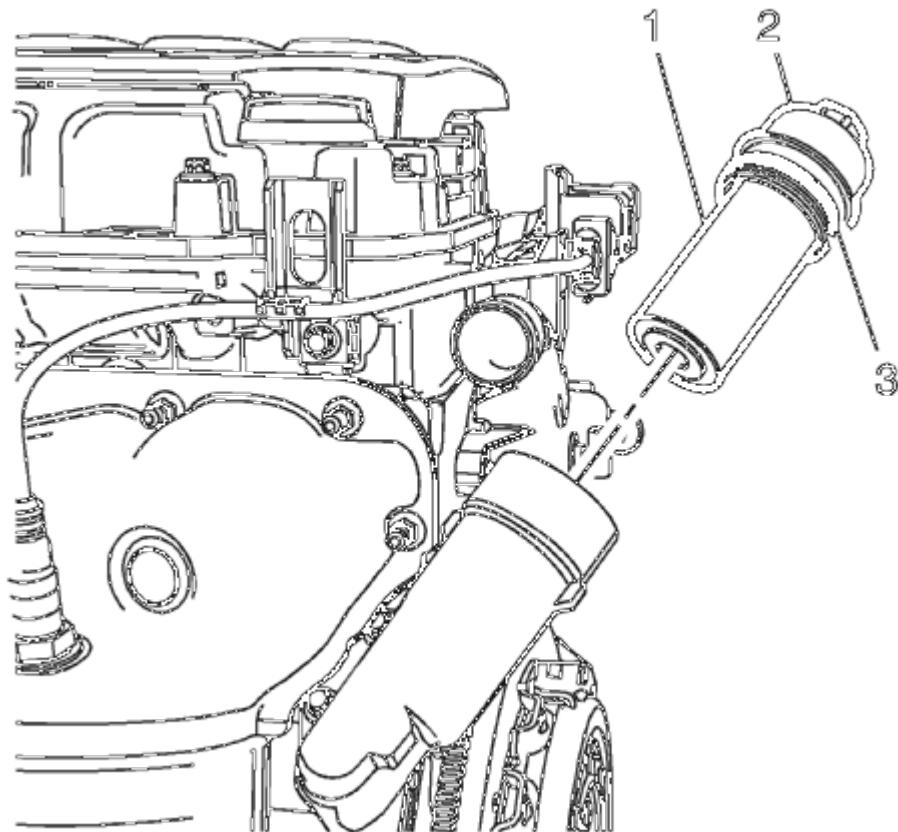


Fig. 277: Engine Oil Filter Cap, Cap Seal Ring And Oil Filter Element
Courtesy of GENERAL MOTORS COMPANY

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.

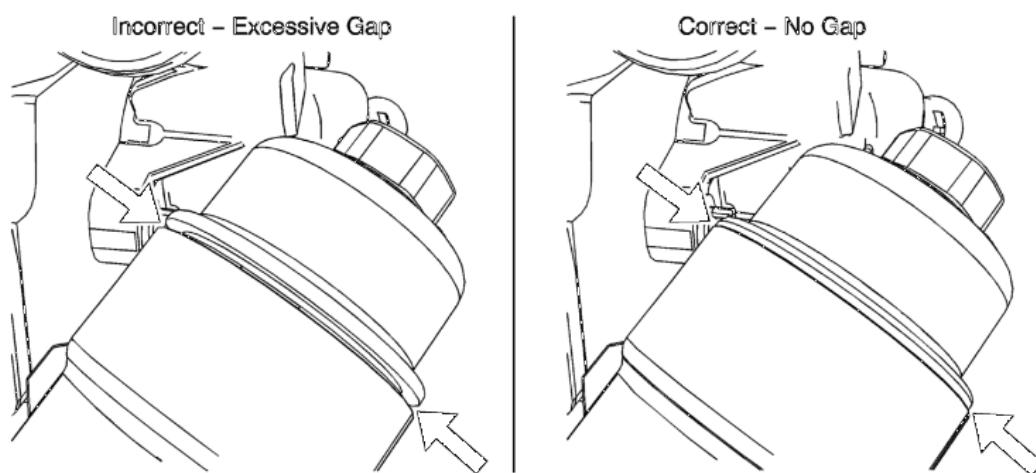


Fig. 278: Oil Filter Cap Seal Ring
Courtesy of GENERAL MOTORS COMPANY

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.

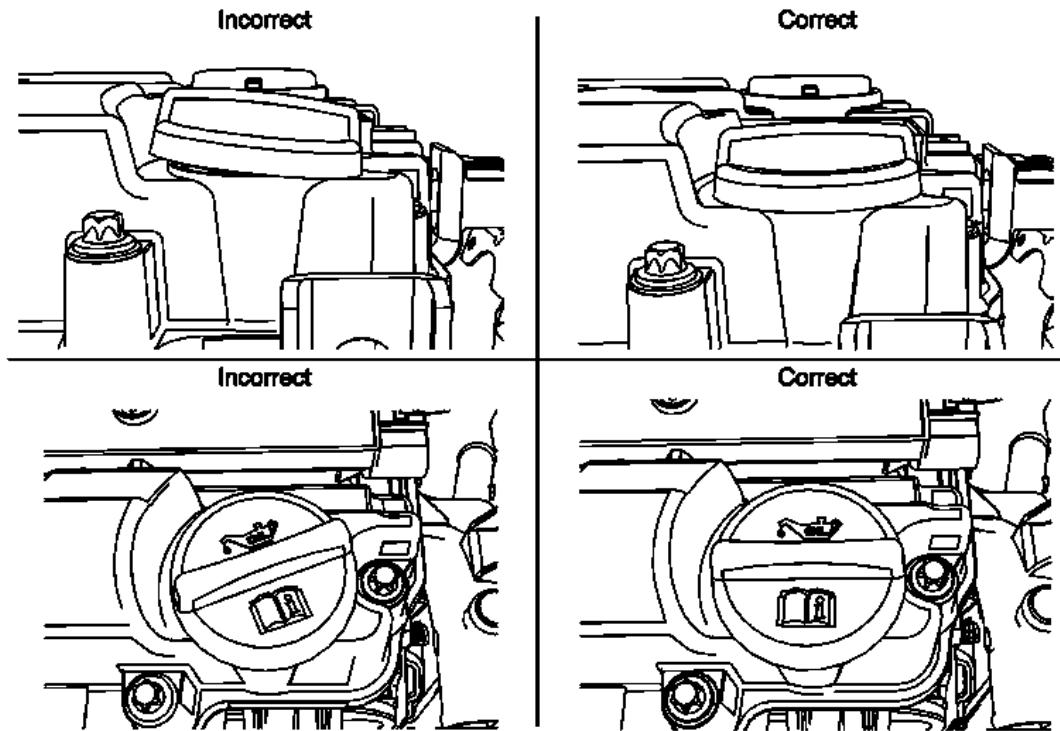


Fig. 279: Proper Oil Filler Cap Seating
Courtesy of GENERAL MOTORS COMPANY

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.

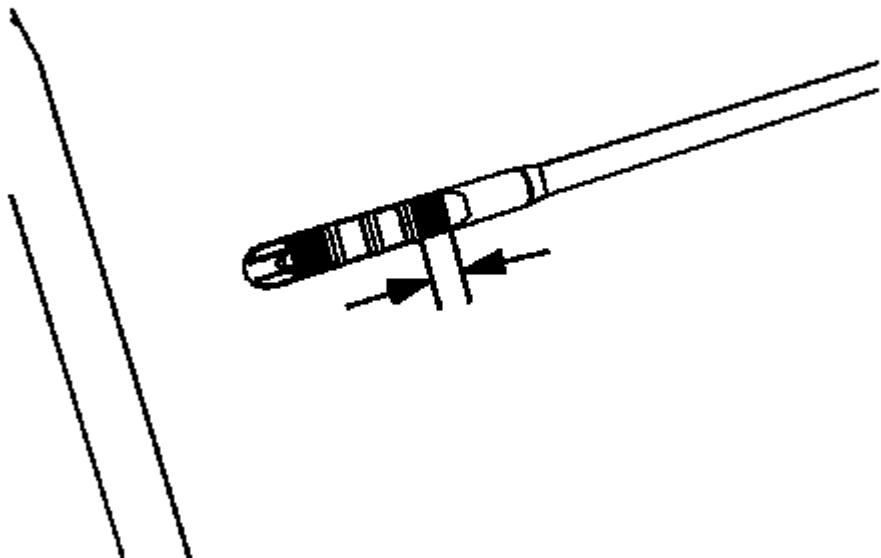


Fig. 280: Engine Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

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 intake and exhaust camshaft sprocket. Refer to [Camshaft Sprocket Replacement](#).

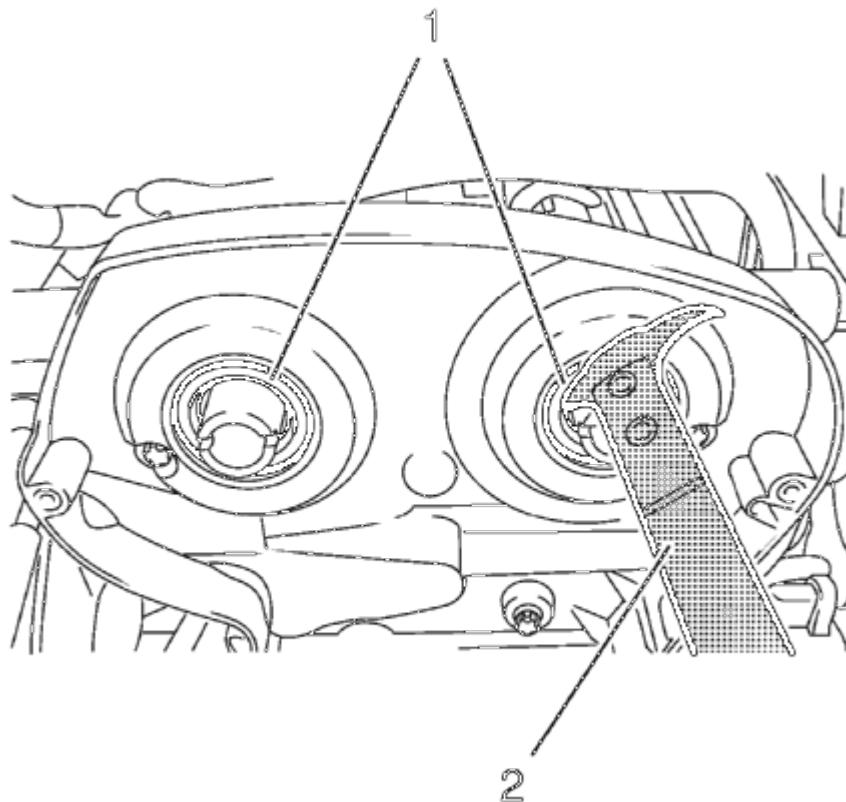


Fig. 281: Camshaft Front Oil Seals And Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the sealing surfaces.

2. Use the EN-45000 remover to loosen the camshaft front oil seals (1).

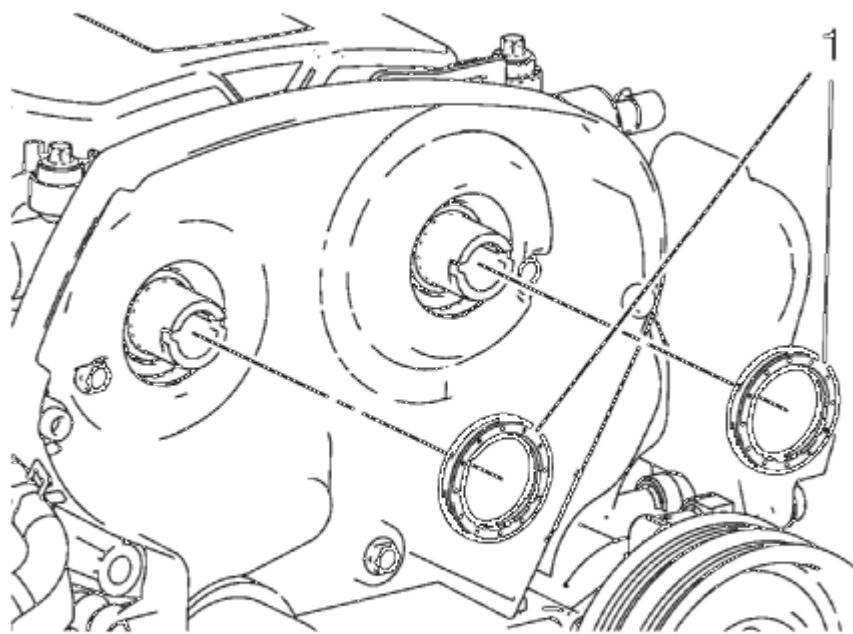


Fig. 282: Camshaft Front Oil Seals

Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft front oil seals (1).

Installation Procedure

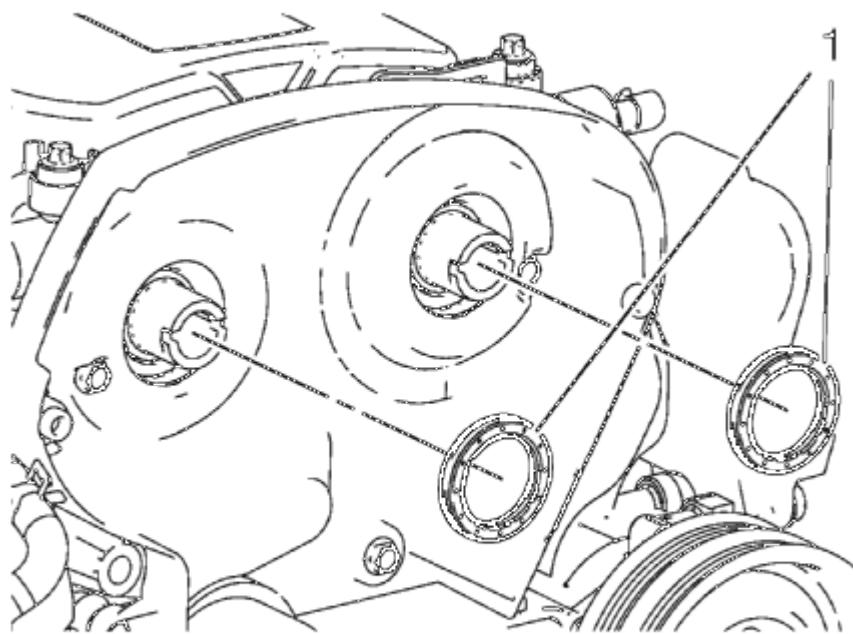


Fig. 283: Camshaft Front Oil Seals

Courtesy of GENERAL MOTORS COMPANY

1. Insert 2 NEW camshaft front oil seals (1).

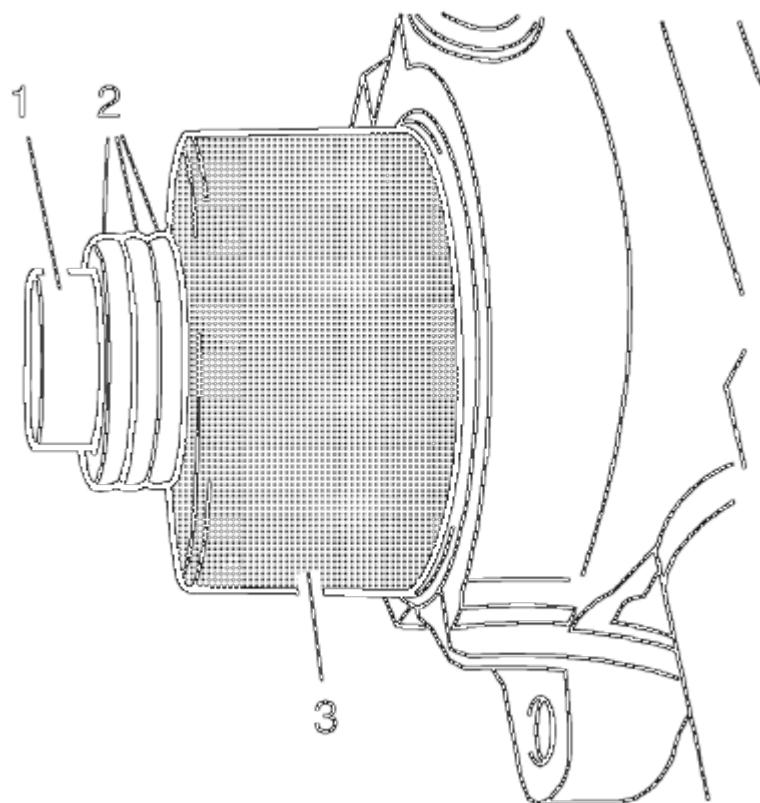
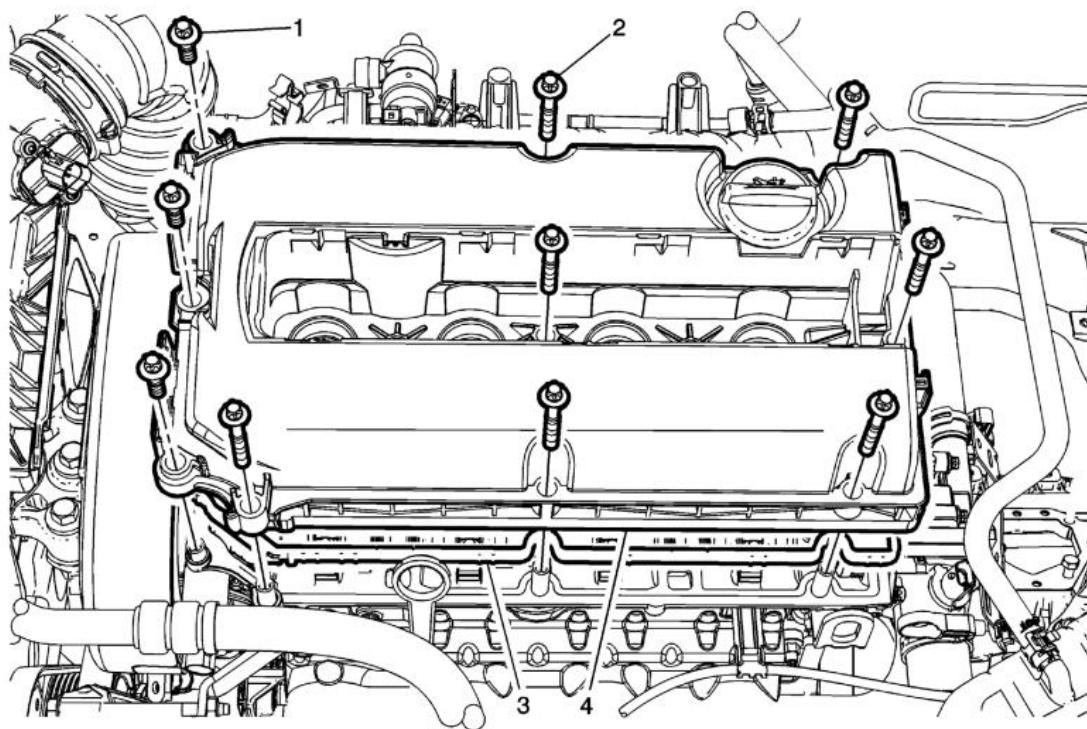


Fig. 284: Camshaft Sprocket Bolt, Shims And Tool

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 sprocket intake and exhaust. Refer to [Camshaft Sprocket Replacement](#).

CAMSHAFT COVER REPLACEMENT

**Fig. 285: Camshaft Cover Components**

Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Replacement

Callout	Component Name
Preliminary Procedures	
1	<p>Camshaft Cover Fastener (Qty: 3)</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>NOTE: Apply pipe sealant to the center bolt during reinstallation. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u>.</p> <p>Tighten 8 (71 lb in)</p>
2	<p>Camshaft Cover Fastener (Qty: 8)</p> <p>Tighten 8 (71 lb in)</p>

3	Camshaft Cover Gasket Procedure Do not reuse the camshaft gasket. Also use a new gasket when removing or replacing camshaft cover.
4	Camshaft Cover Procedure <ol style="list-style-type: none"> 1. Remove or reposition the clips as necessary. 2. Disconnect electrical connector as necessary. 3. Transfer components as necessary.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT

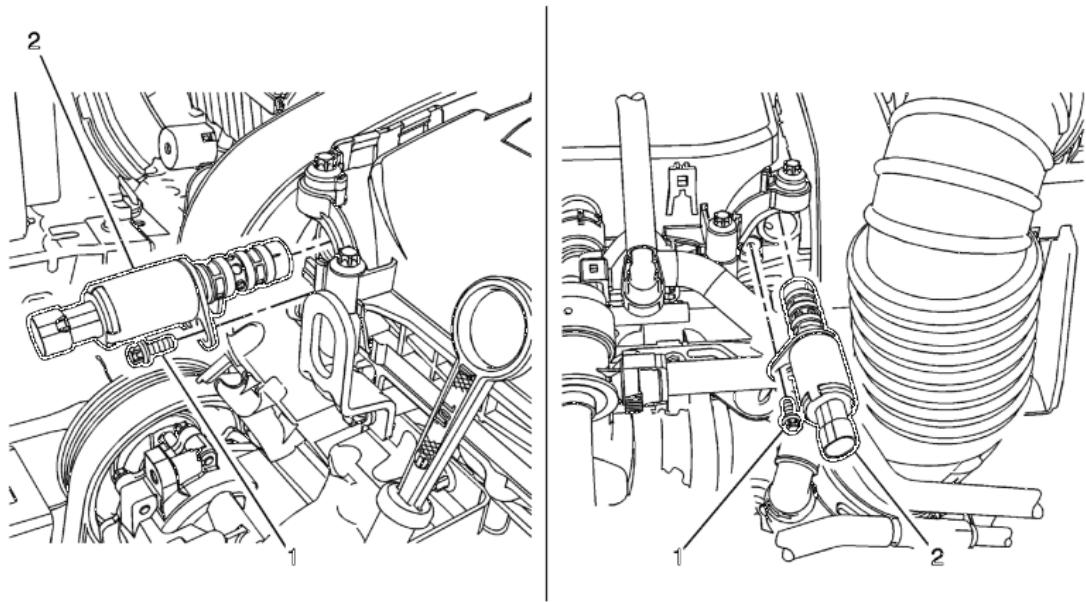


Fig. 286: Camshaft Position Actuator Solenoid Valve & Bolt

Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Solenoid Valve Replacement

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Bolt CAUTION: Refer to <u>Fastener Caution</u> .

Tighten
6 N.m (53 lb in)

2

Camshaft Position Actuator Solenoid Valve
TIP: Coat the camshaft position actuator solenoid valve seals with NEW engine oil.

CAMSHAFT REPLACEMENT

Special Tools

EN-422 Installer

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

Removal Procedure

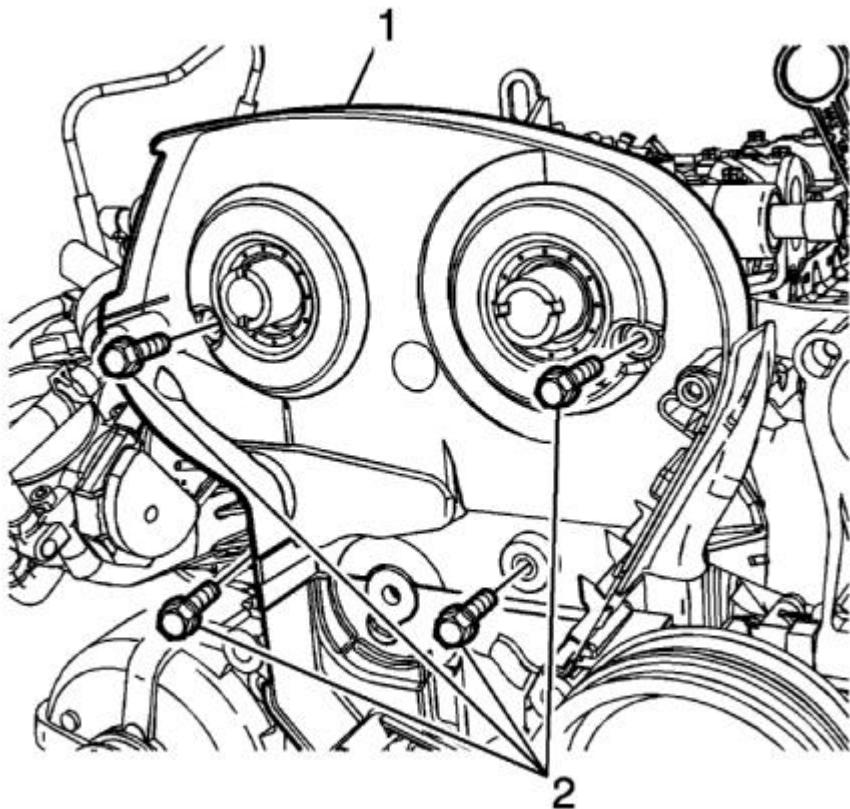


Fig. 287: Timing Belt Rear Cover & Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Take extreme care to prevent any scratches, nicks or damage to the

camshafts and caps bearing surfaces.

1. Remove the timing belt rear cover (1). Refer to [**Timing Belt Rear Cover Replacement**](#).

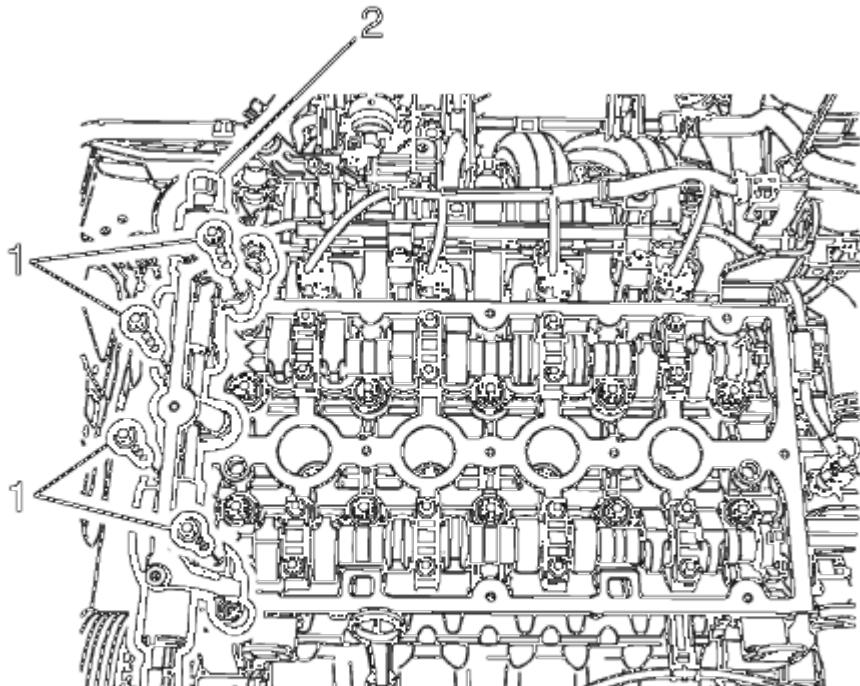


Fig. 288: Camshaft Position Solenoid Valve Housing & Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft position solenoid valve housing bolts (1) and housing (2).

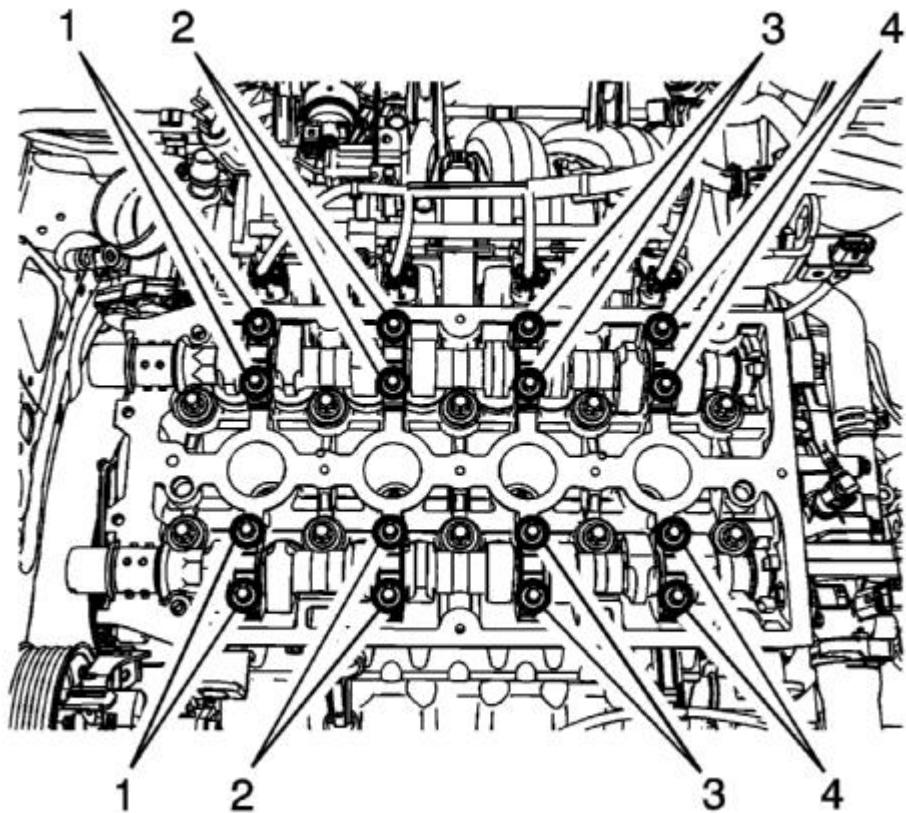


Fig. 289: Camshaft Cap Bolt Removal Sequence

Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft cap bolts in sequence (1, 4, 2, 3).
4. Remove the camshaft caps.

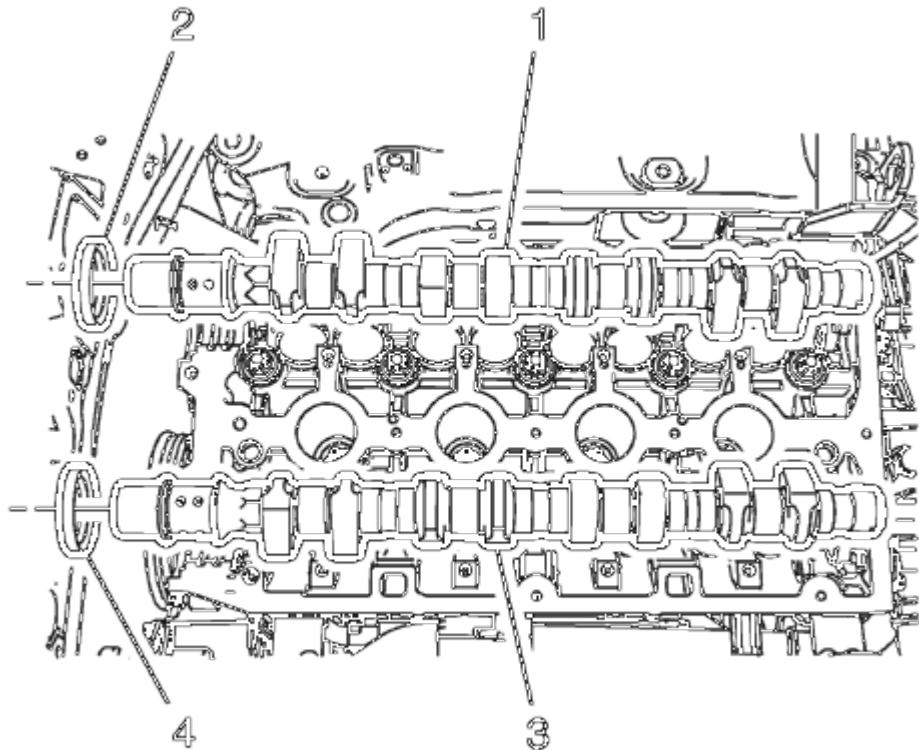


Fig. 290: Exhaust Camshaft, Intake Camshaft & Seals
Courtesy of GENERAL MOTORS COMPANY

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

5. Remove the exhaust camshaft (1) and intake camshaft (3) as necessary.

NOTE: **The camshaft seal MUST be replaced whenever the camshaft is removed.**

6. Remove exhaust camshaft seal (2) and intake camshaft seal (4) as necessary.

Installation Procedure

1. Coat and lubricate the camshaft bearing and cam surfaces with clean engine oil.

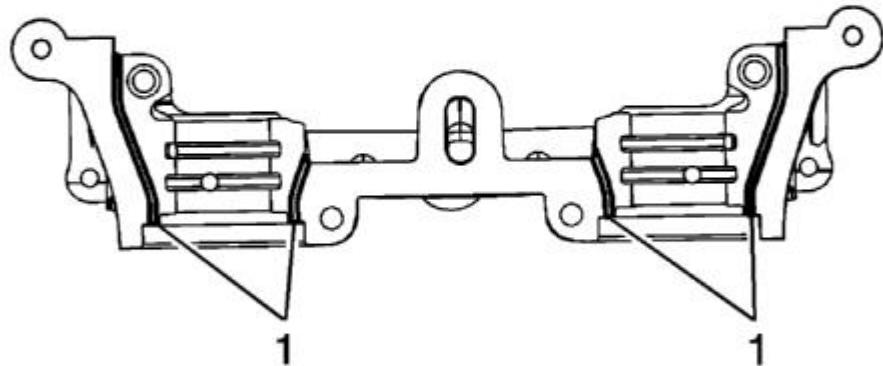


Fig. 291: Sealing Surfaces Of Camshaft Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

NOTE: It is essential to ensure that no sealant is applied outside the marked sealing areas.

2. Apply sealant to the surface (1) of the 1st camshaft bearing cap.

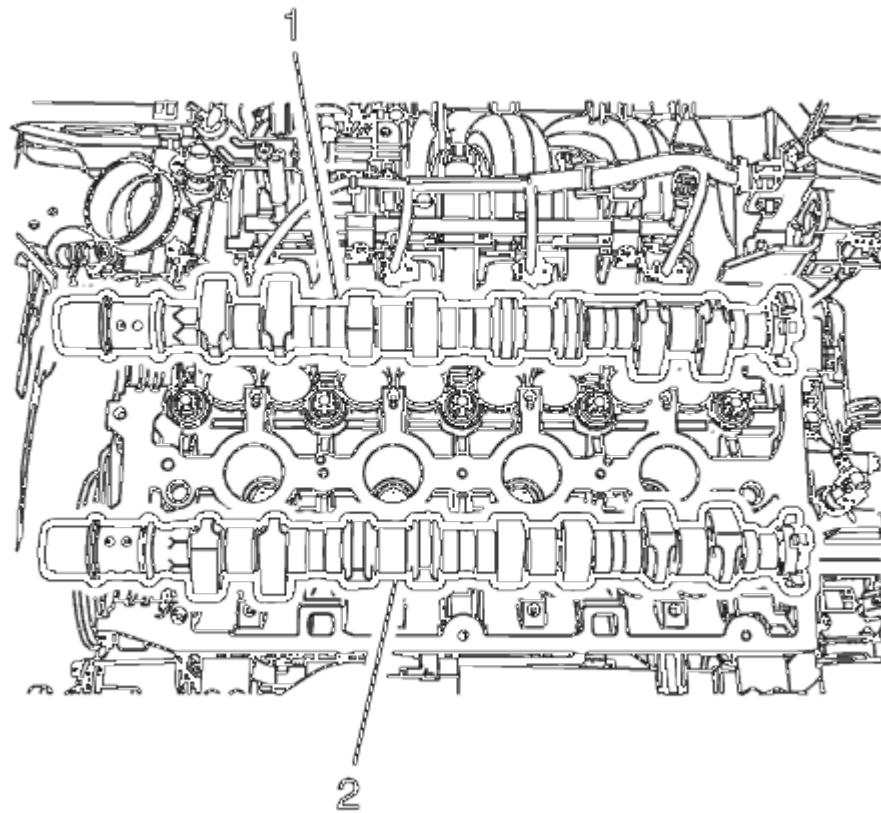


Fig. 292: Camshafts

Courtesy of GENERAL MOTORS COMPANY

3. Install the exhaust camshaft (1) and intake camshaft (2) on the cylinder head.

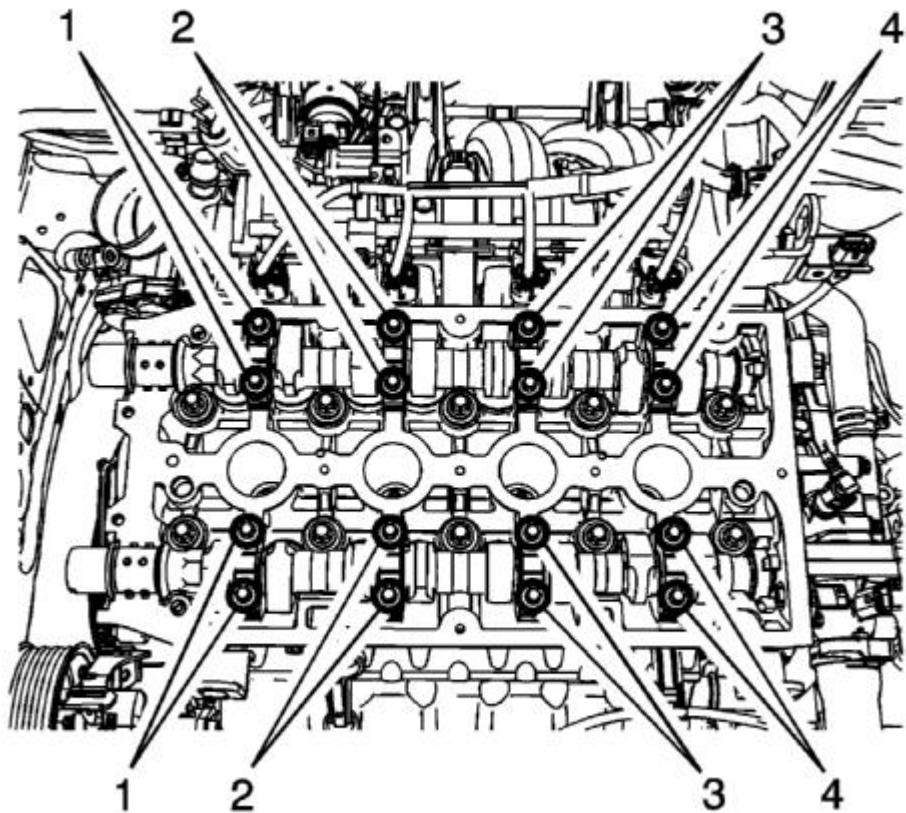


Fig. 293: Camshaft Cap Bolt Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the camshaft bearing caps in sequence (2, 3, 1, 4) Tighten the camshaft bearing cap bolts to 8 N.m (71 lb in).

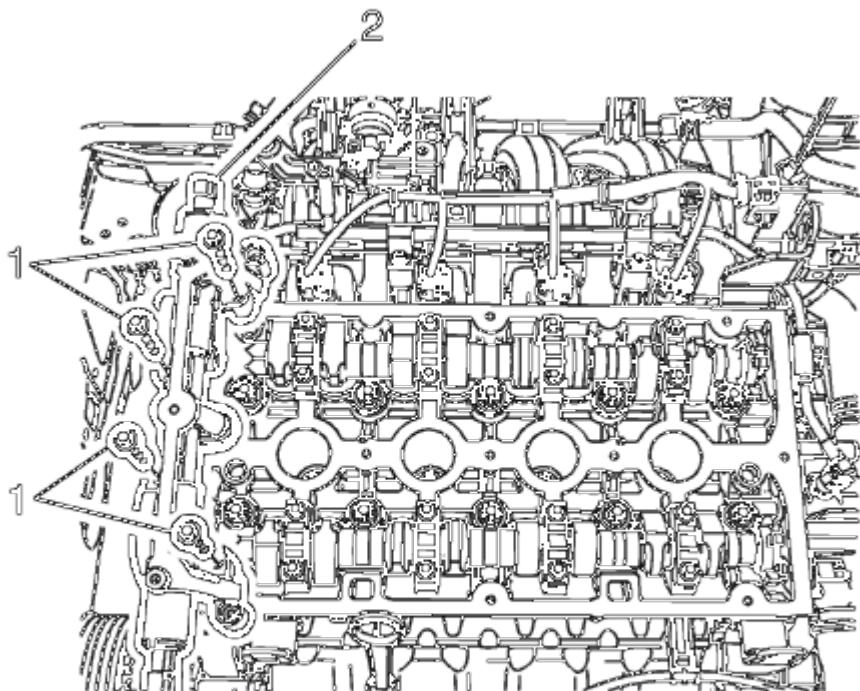


Fig. 294: Camshaft Position Solenoid Valve Housing & Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Install the camshaft position solenoid valve housing (2) and camshaft position solenoid valve housing bolts (1). Tighten the bolts to 8 N.m (71 lb in).
6. Install the new camshaft oil seal rings using **EN-422** installer.

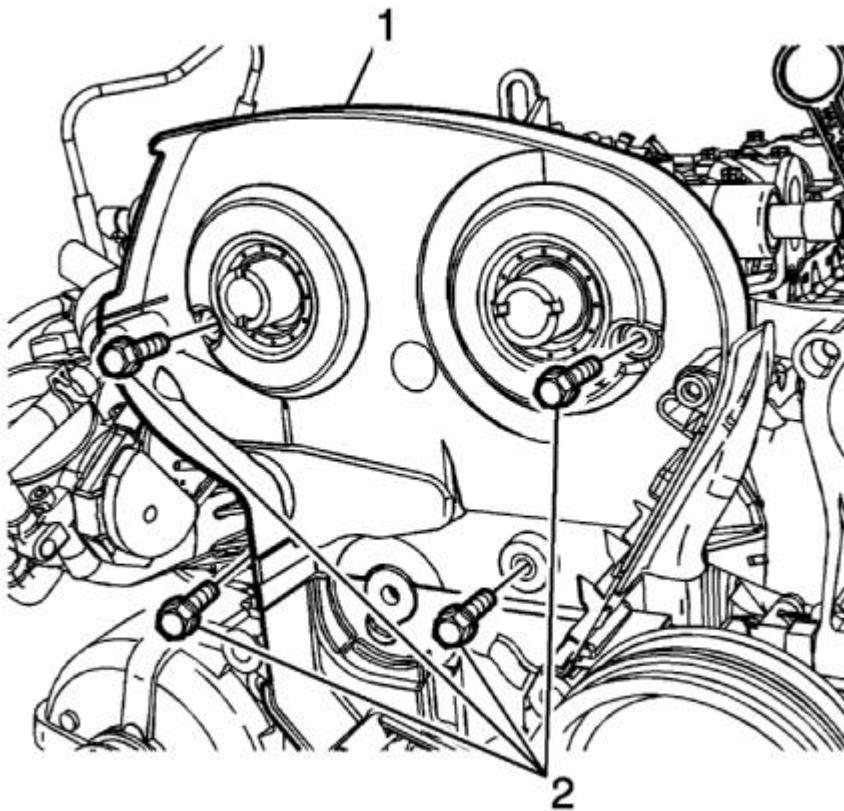


Fig. 295: Timing Belt Rear Cover & Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Install the timing belt rear cover (1) and tighten the bolts (2) to 6 N.m (53 lb in). Refer to [Timing Belt Rear Cover 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. Refer to [Camshaft Sprocket Replacement](#).
3. Remove both camshafts. Refer to [Camshaft Replacement](#).
4. Remove the valve lifter. Refer to [Valve Lifter Replacement](#).

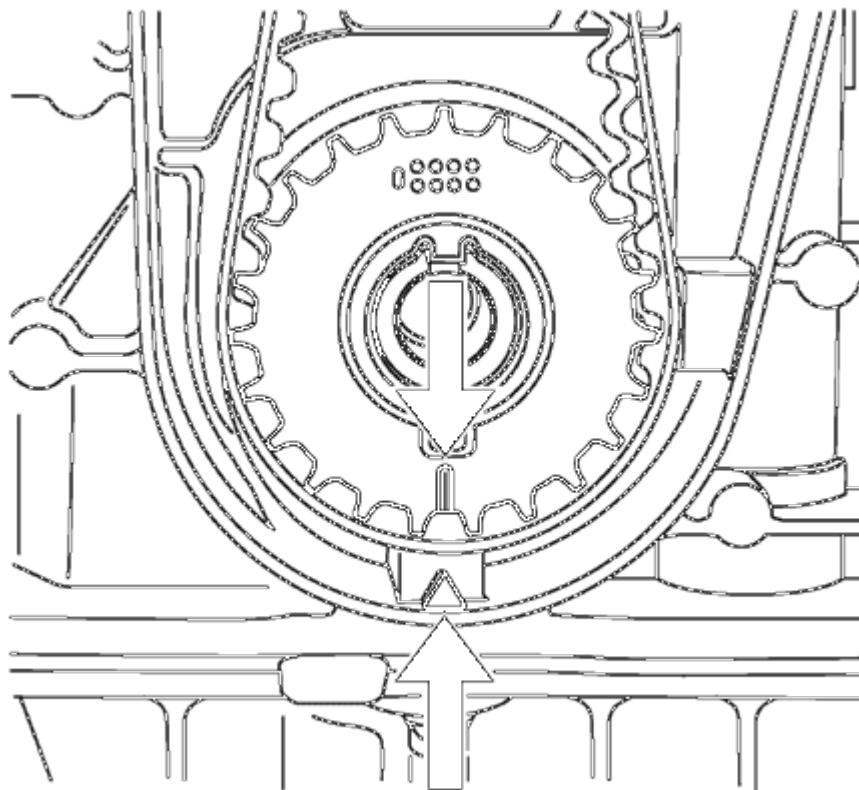


Fig. 296: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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

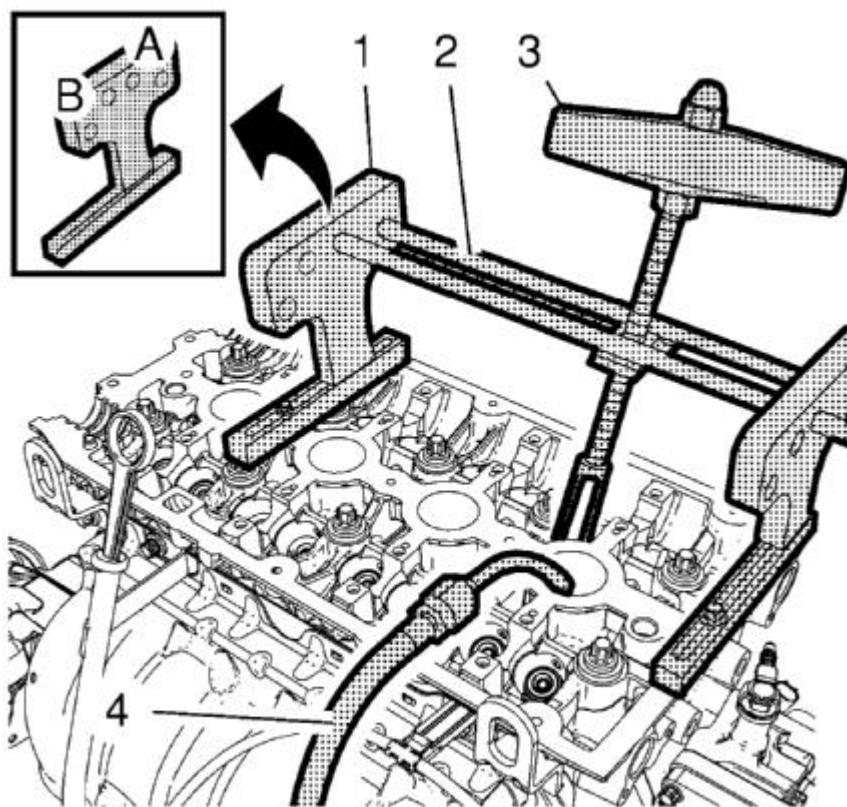


Fig. 297: Valve Stem Oil Seal Removal Tools
Courtesy of GENERAL MOTORS COMPANY

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.

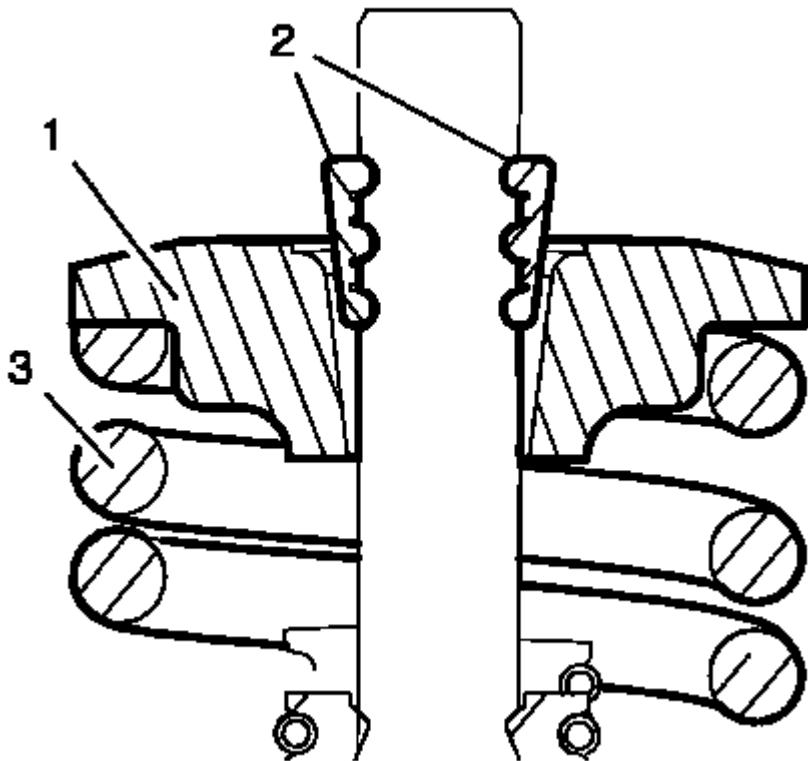


Fig. 298: Valve Spring Retainer And Valve Spring

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 vale 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).

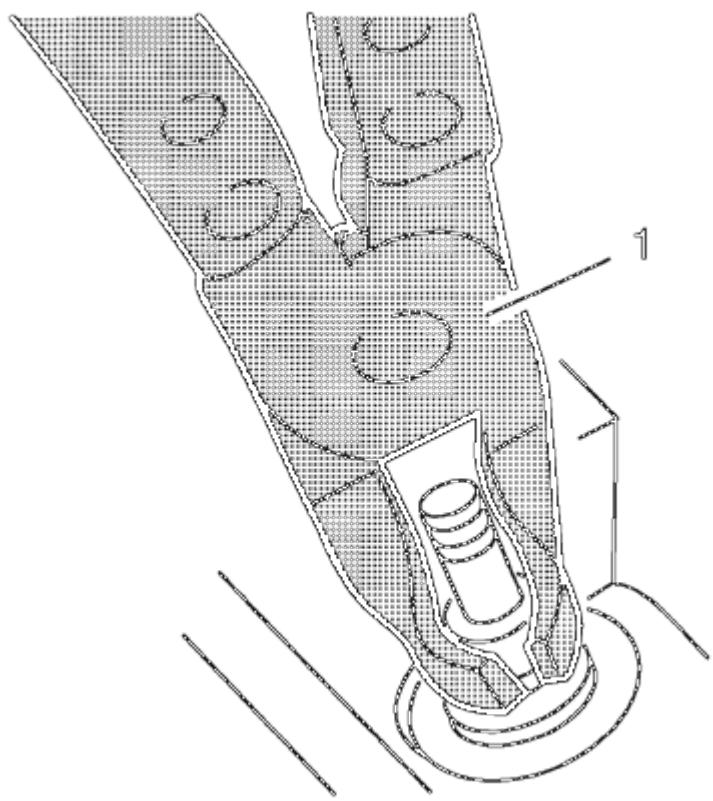


Fig. 299: Valve Stem Seal Removal Tool
Courtesy of GENERAL MOTORS COMPANY

9. Remove and DISCARD the valve stem oil seal, using the **EN-840** pliers (1).

Valve Stem Oil Seal Installation

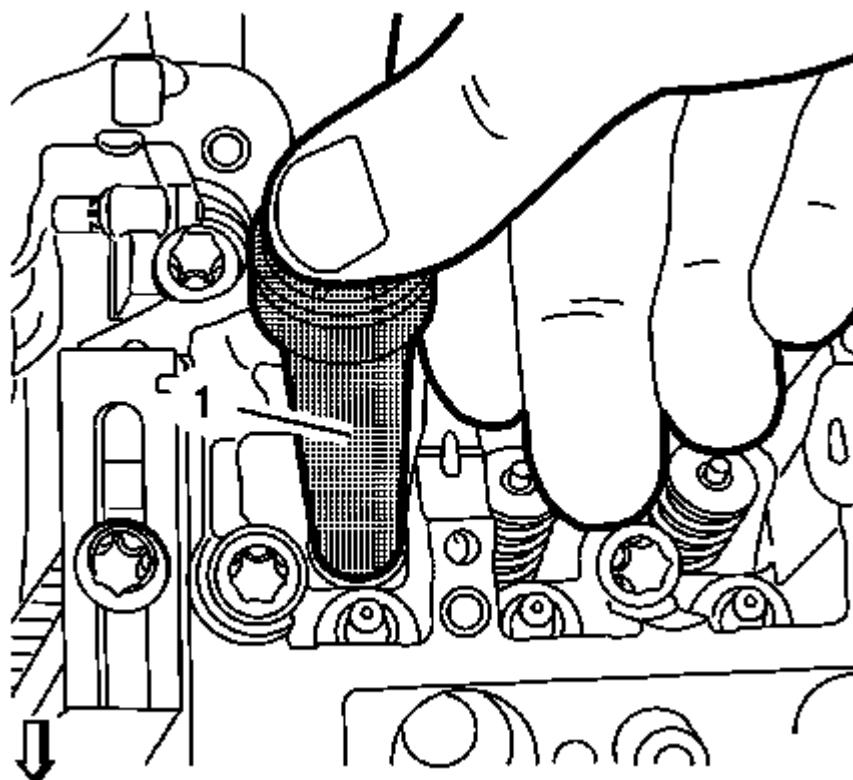


Fig. 300: Intake Valve Stem Oil Seal Installation Tool

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.

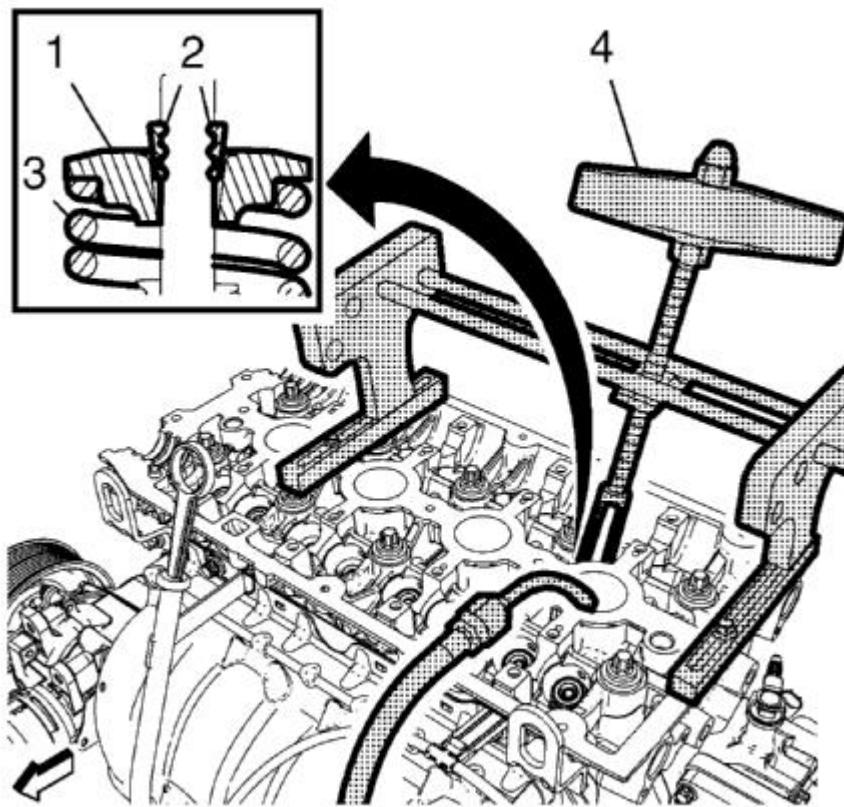


Fig. 301: Valve Spring Compressor

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

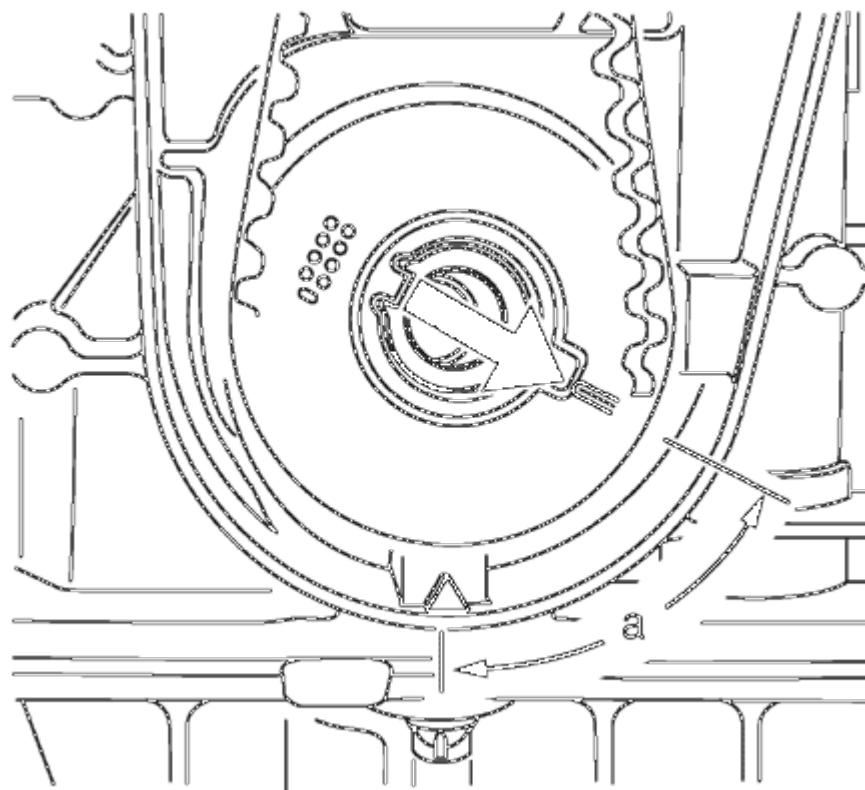


Fig. 302: Turning Crankshaft Against Direction Of Engine Rotation
Courtesy of GENERAL MOTORS COMPANY

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. Refer to [Camshaft Sprocket 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

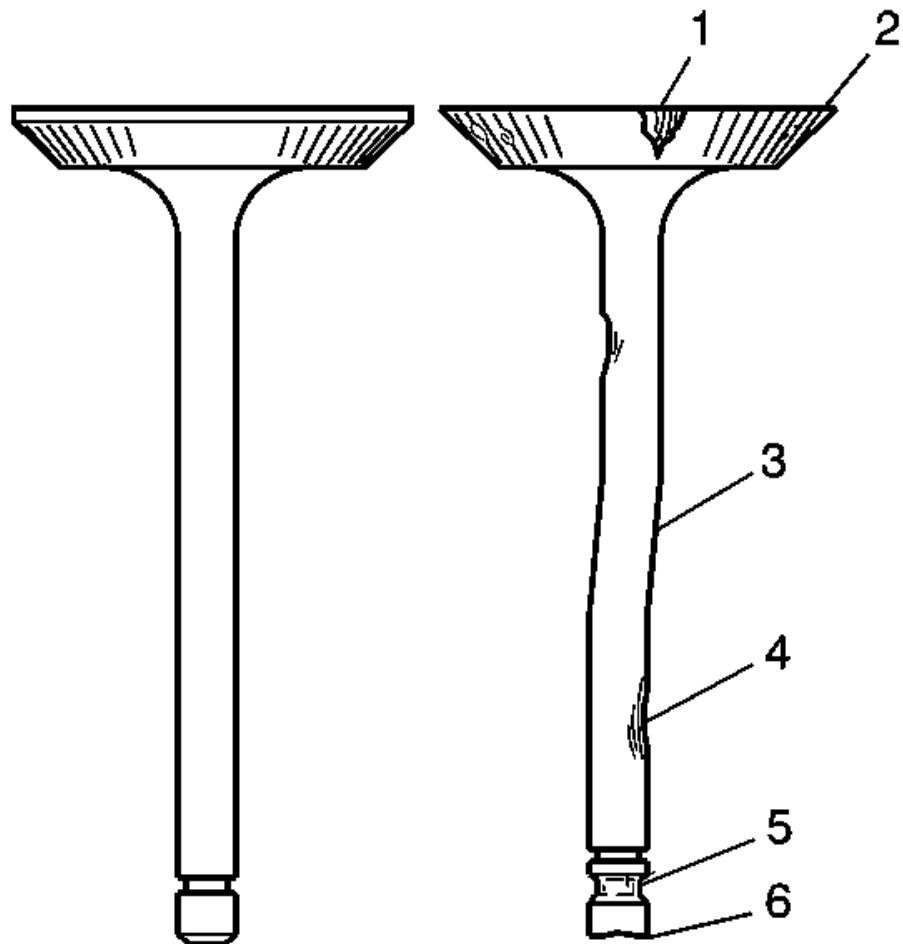


Fig. 303: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

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

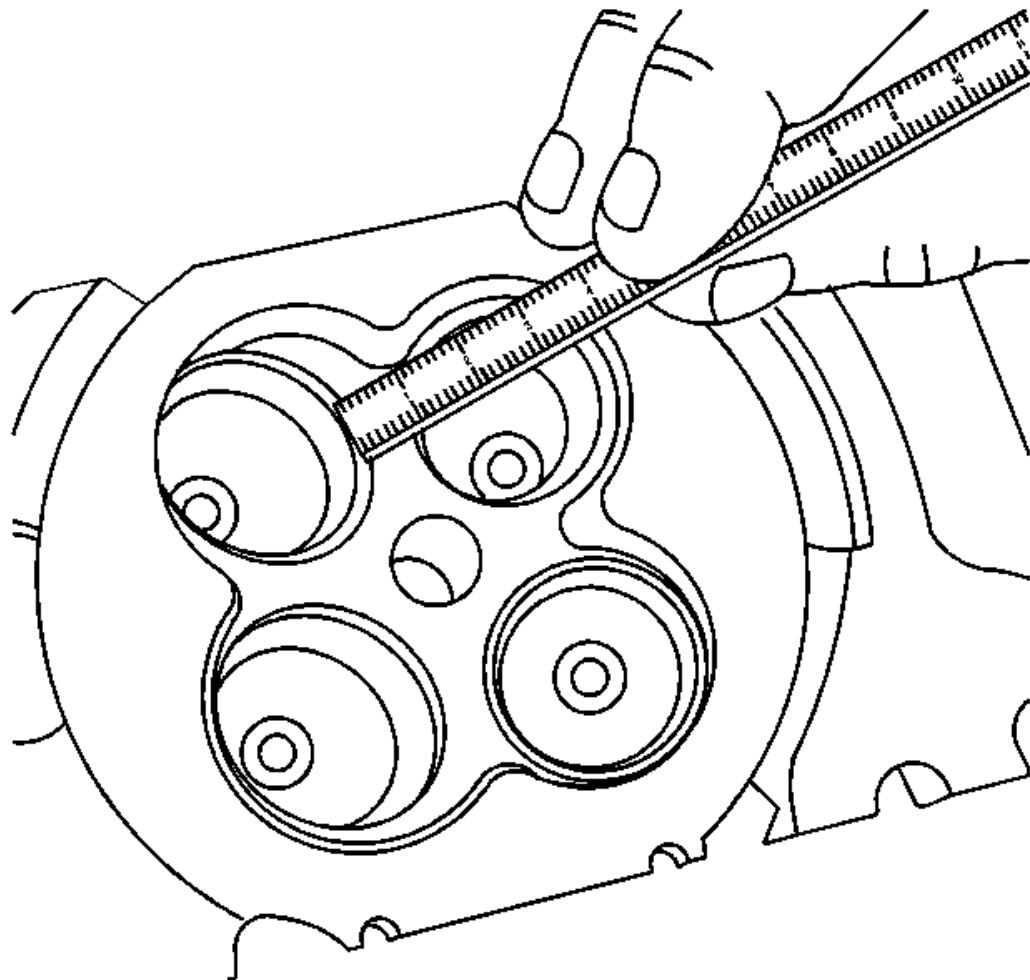


Fig. 304: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

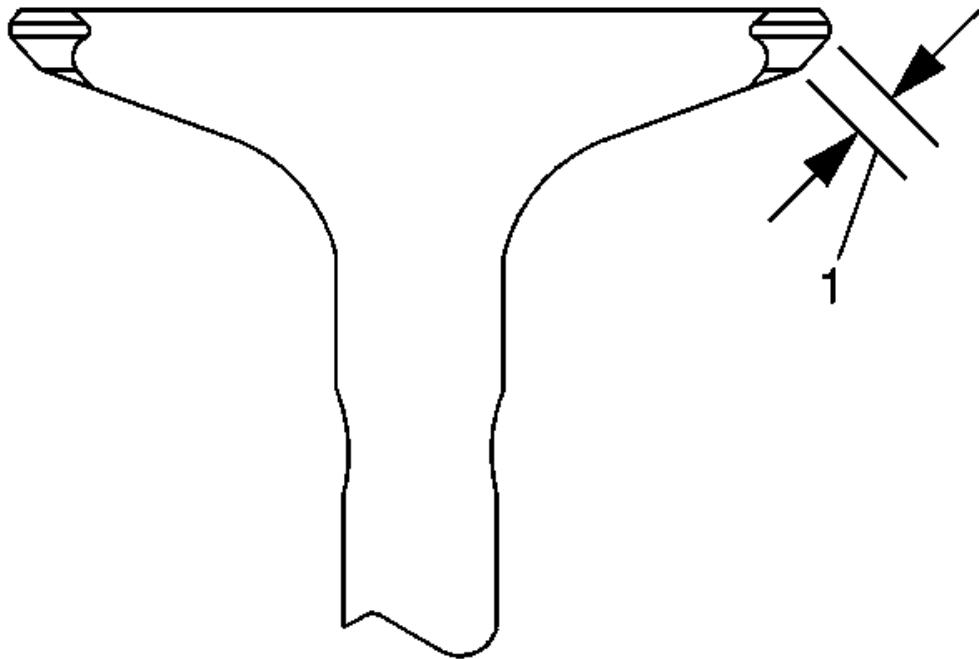


Fig. 305: Measuring Seat Width On Valve Face
Courtesy of GENERAL MOTORS COMPANY

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 \(1.8L LUW and LWE\)](#).
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 \(1.8L LUW and LWE\)](#).
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

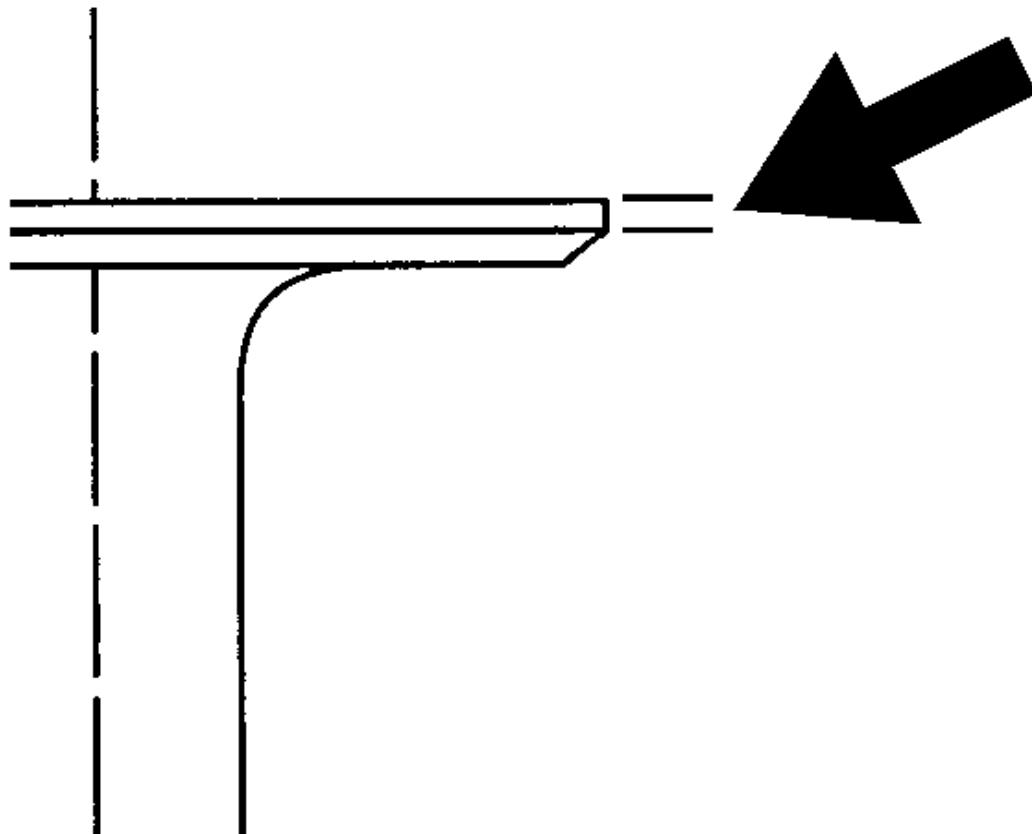


Fig. 306: View Of Valve Margin Measurement
Courtesy of GENERAL MOTORS COMPANY

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

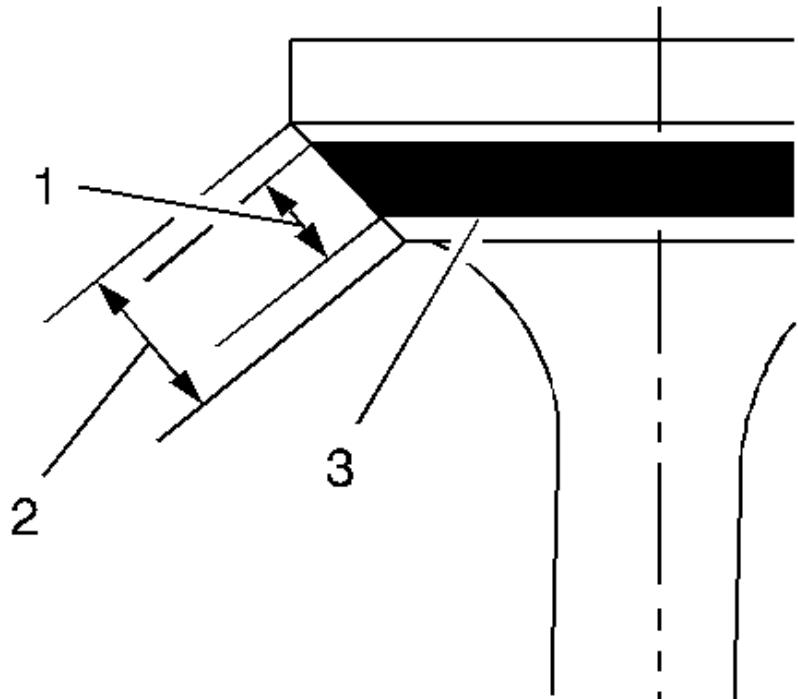


Fig. 307: View Of Valve Contact Face Measurements

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

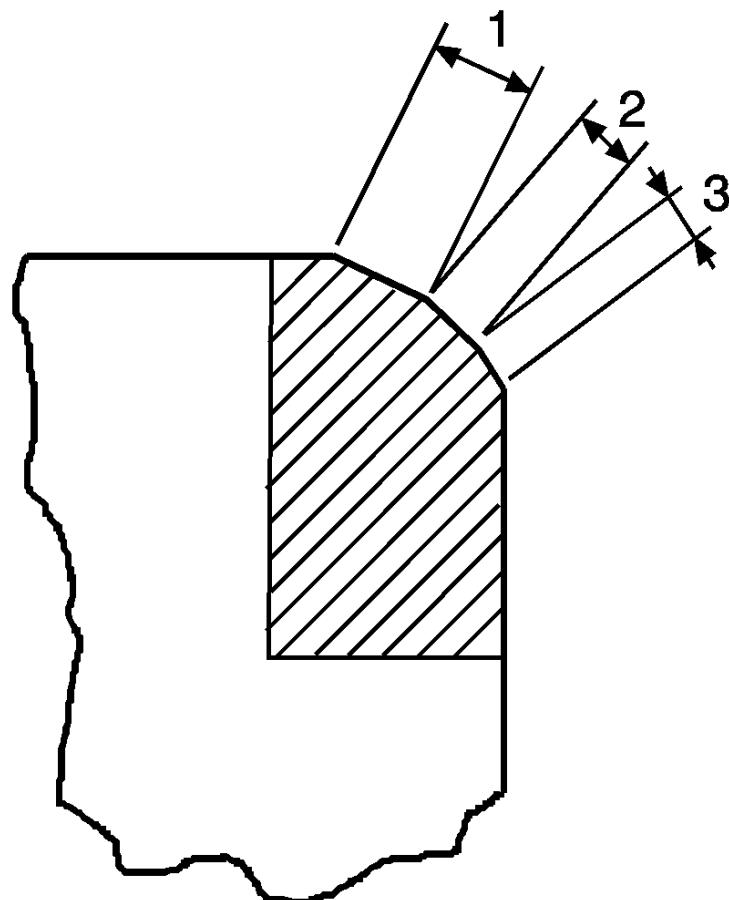


Fig. 308: View Of Valve Seat Proper Angles

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 \(1.8L LUW and LWE\)](#).
2. Using the proper angle specification, refer to [Engine Mechanical Specifications \(1.8L LUW and LWE\)](#) 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 \(1.8L LUW and LWE\)](#) grind, undercut, the valve seats (3) to narrow the valve seat widths to the specifications, refer to [Engine Mechanical Specifications \(1.8L LUW and LWE\)](#).
4. If the original valve is being used, grind the valve to the specifications, refer to [Engine Mechanical Specifications \(1.8L LUW and LWE\)](#). 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

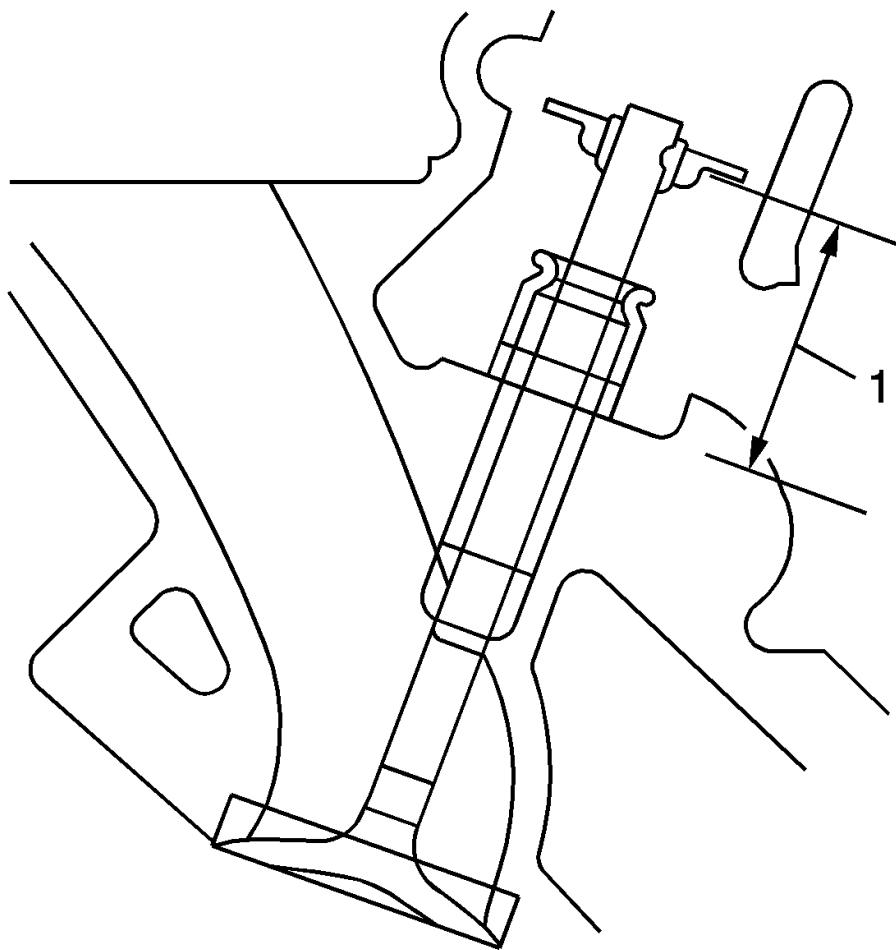


Fig. 309: Measuring Valve Stem Height
Courtesy of GENERAL MOTORS COMPANY

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 \(1.8L LUW and LWE\)](#).
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.

REPAIR INSTRUCTIONS - OFF VEHICLE

ENGINE SUPPORT FIXTURE

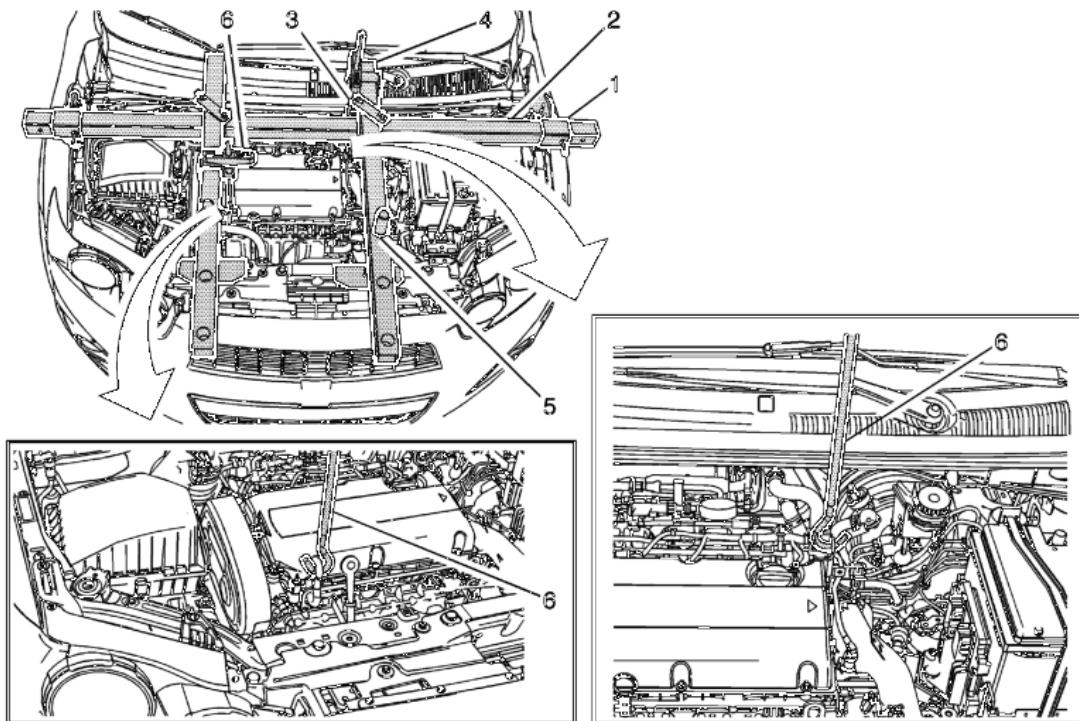


Fig. 310: Engine Support Fixture

Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
---------	----------------

Preliminary Procedure

Remove the radiator opening upper cover. Refer to [Front Opening Upper Cover Replacement](#).

Special Tools

- EN-28467-300 Engine Support Fixture Adapter

- **J-28467-518** Main Support Beam
- **J-28467-1A** Cross Bracket
- **J-28467-5A** Strut Tower Support Assembly
- **J-28467-2A** Radiator Tube Shelf Assembly
- **J-36857** Engine Lift Bracket
- **J-28467-8A** Hook Assembly

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

1	Engine Support Fixture Adapter Leg (Qty: 2) Procedure Install the bracket to fender frame. Do not install on top of fender lip.
2	Main Support Beam
3	Cross Bracket
4	Strut Tower Support Assembly Procedure Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly
6	Hook Assembly NOTE: If the engine is not equipped with engine lift bracket, install J-36857 in place. Procedure Use a grade 10.9 bolt to install the engine lift bracket.

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**.

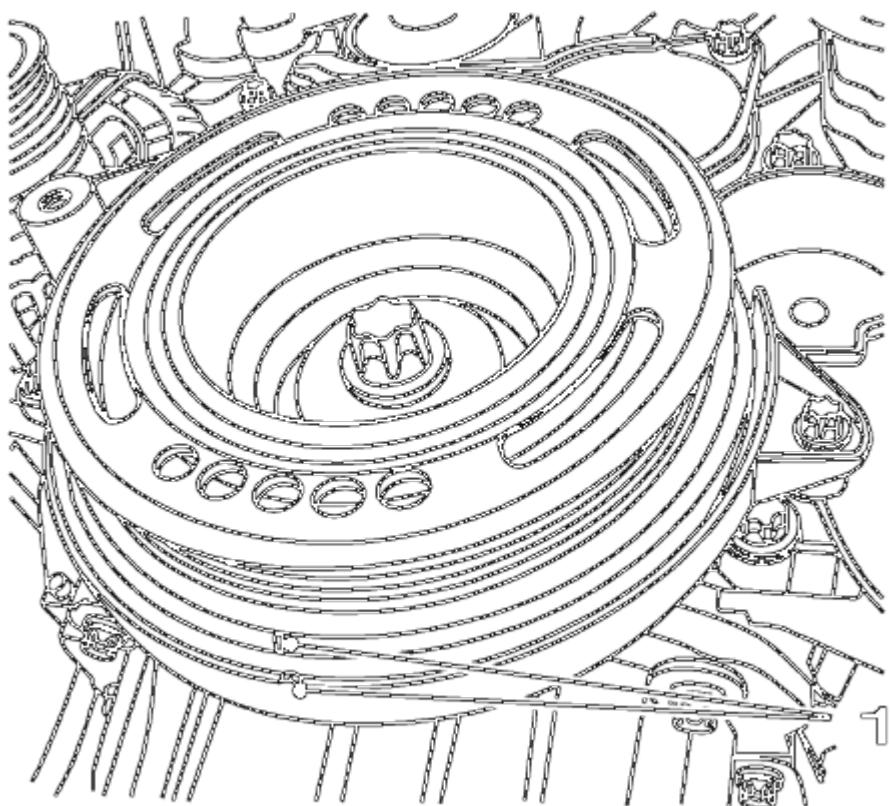


Fig. 311: View Of Crankshaft TDC Position

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](#).

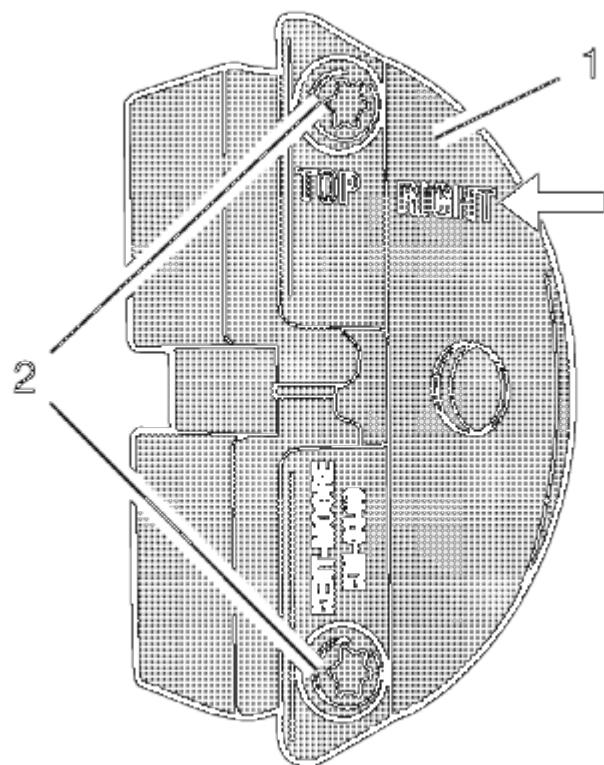


Fig. 312: Front Panel And Bolts

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.

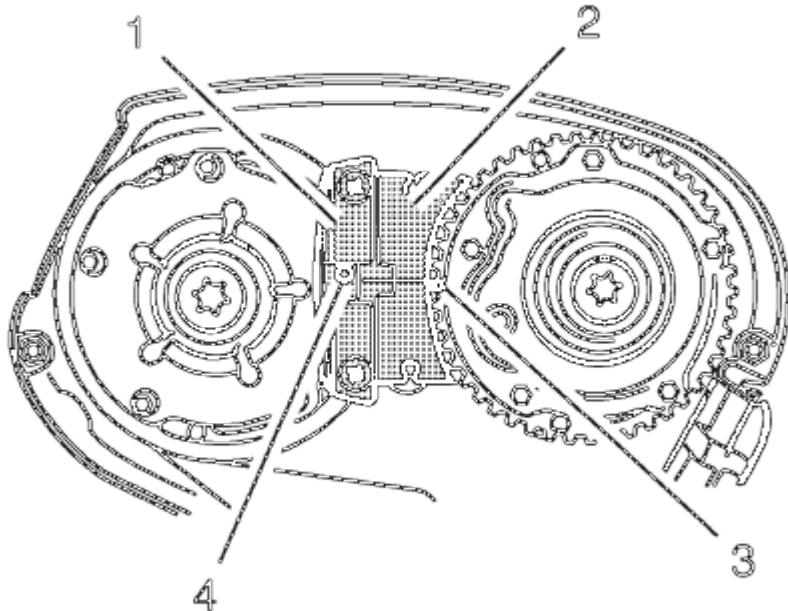


Fig. 313: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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.

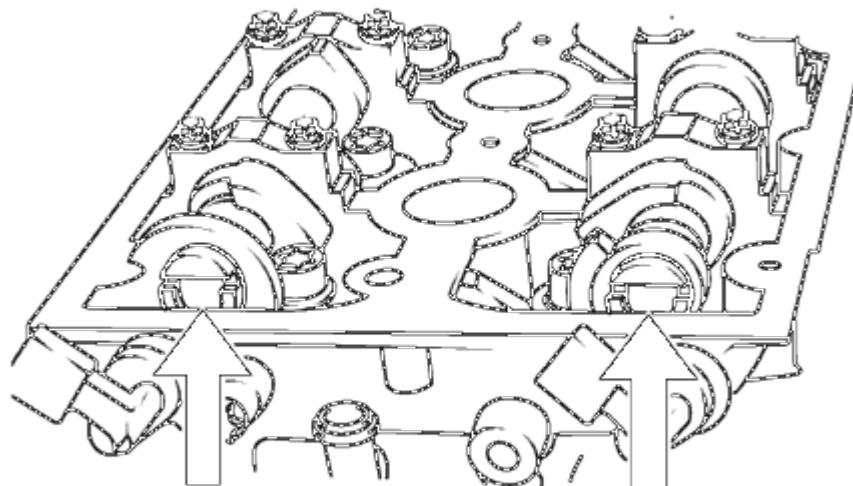


Fig. 314: Aligning Camshafts Horizontally

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.

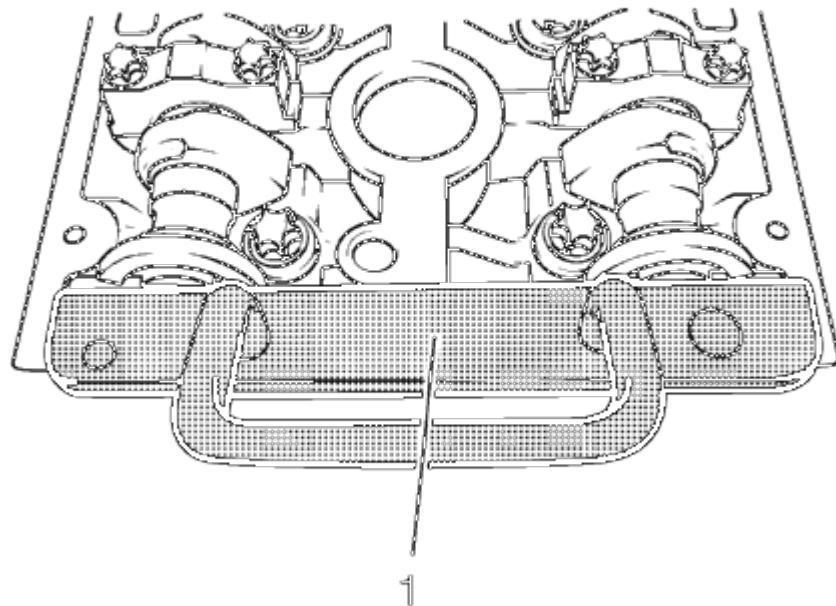


Fig. 315: Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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**.

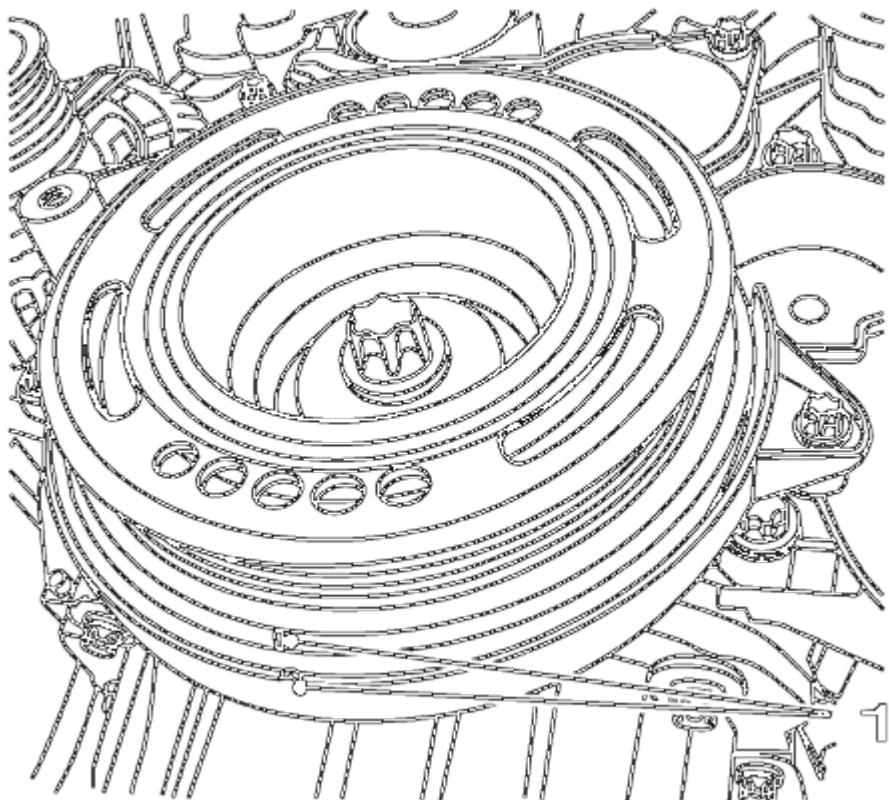


Fig. 316: View Of Crankshaft TDC Position

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**.

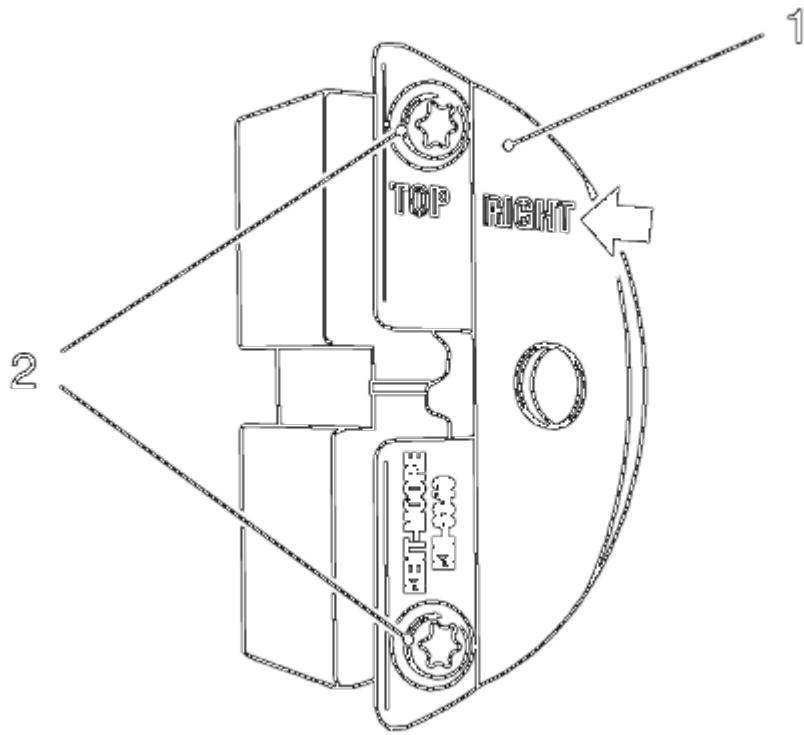


Fig. 317: View Of Front Panel And Bolts

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.

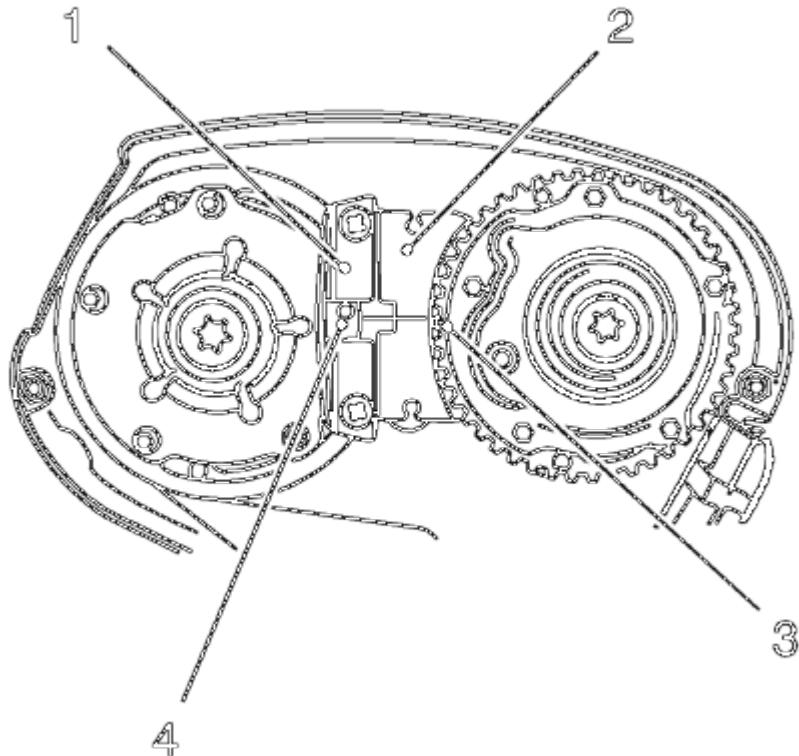


Fig. 318: View Of Camshaft Holder And Markings

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.

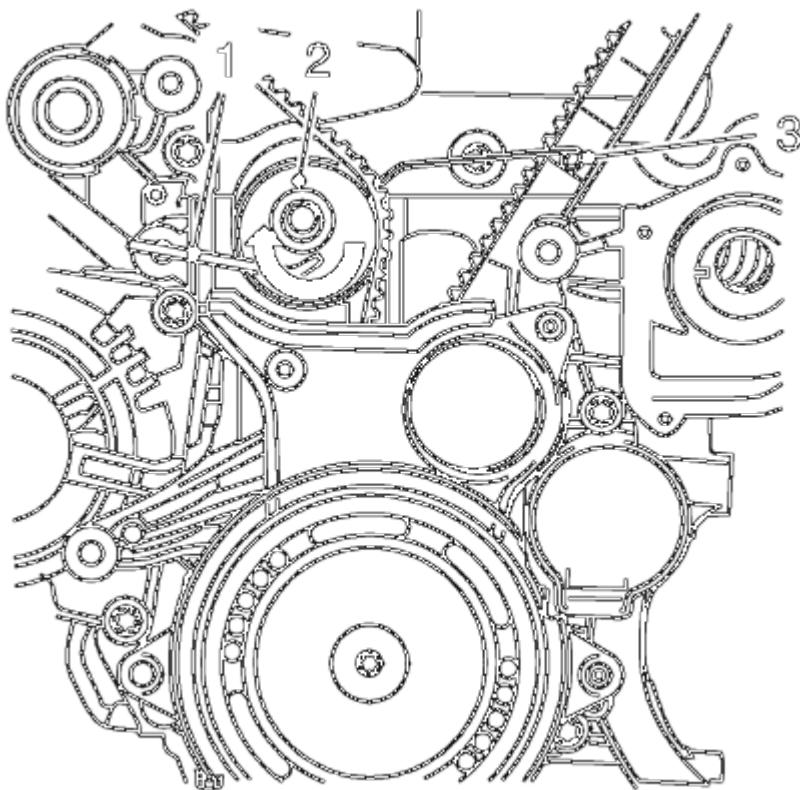


Fig. 319: View Of Tooth Belt Tensioner Components

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.

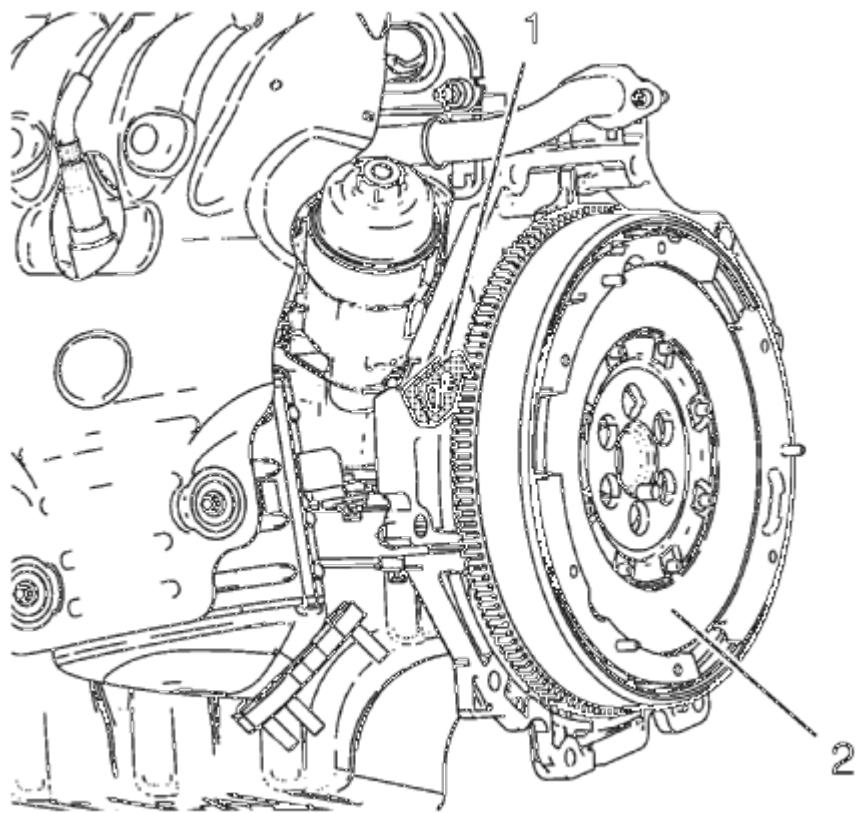


Fig. 320: Flywheel And Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-652** flywheel holder (1), lock the flywheel (2) (or automatic transmission flex respectively) via the starter ring gear.

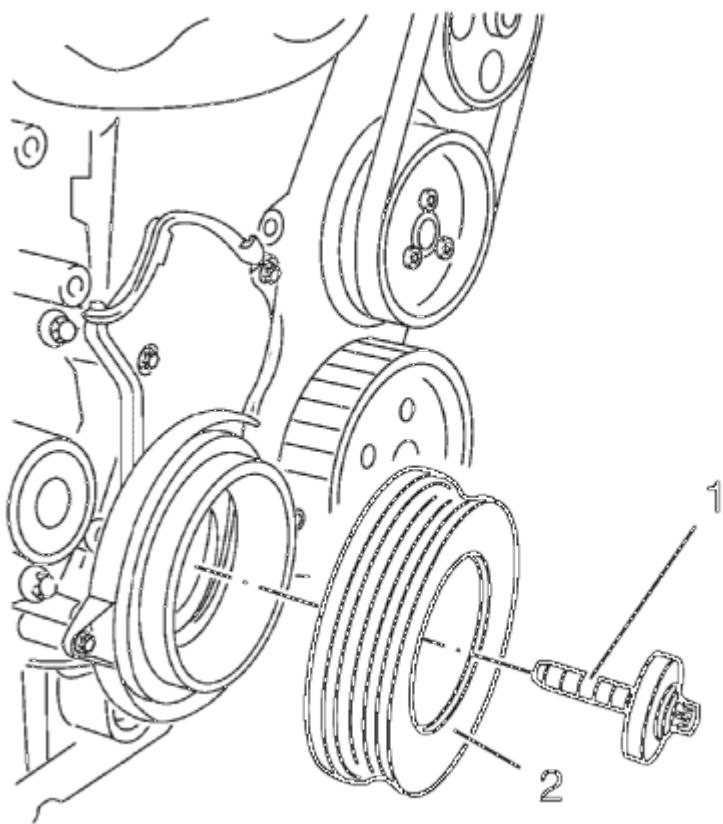


Fig. 321: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

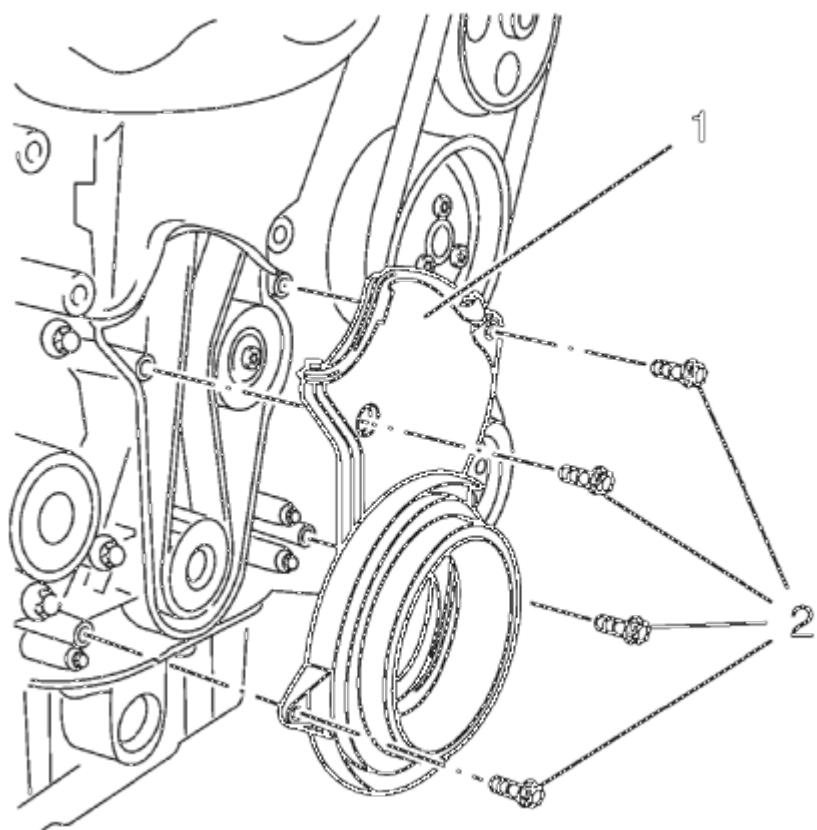


Fig. 322: Timing Belt Lower Front Cover
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 4 timing belt lower front cover bolts (2).
12. Remove the timing belt lower front cover (1).

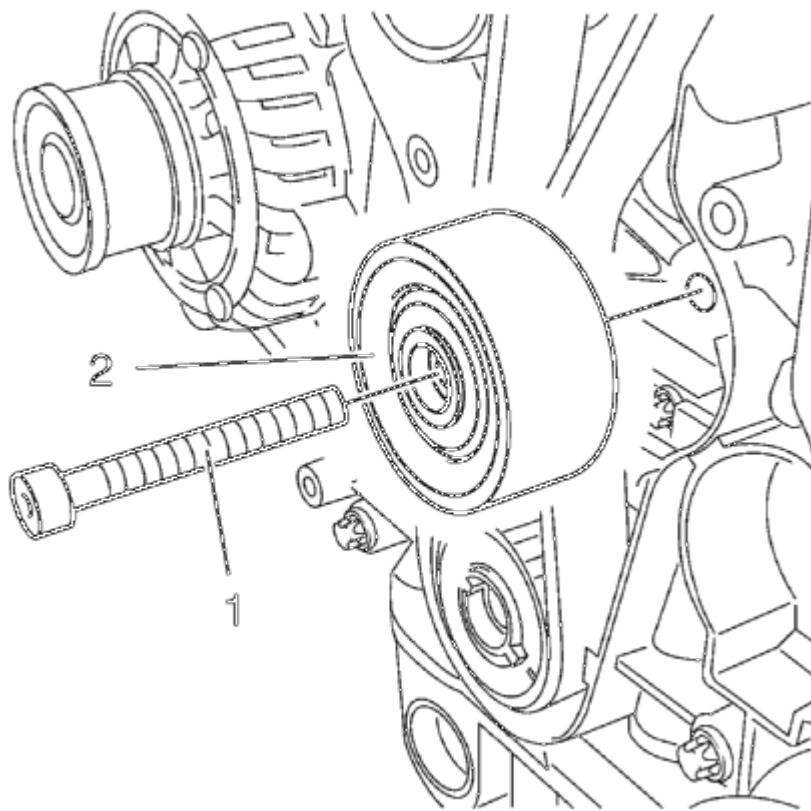


Fig. 323: Timing Belt Idler Pulley Bolt

Courtesy of GENERAL MOTORS COMPANY

13. Remove the timing belt idler pulley bolt (1).
14. Remove the timing belt idler pulley (2).

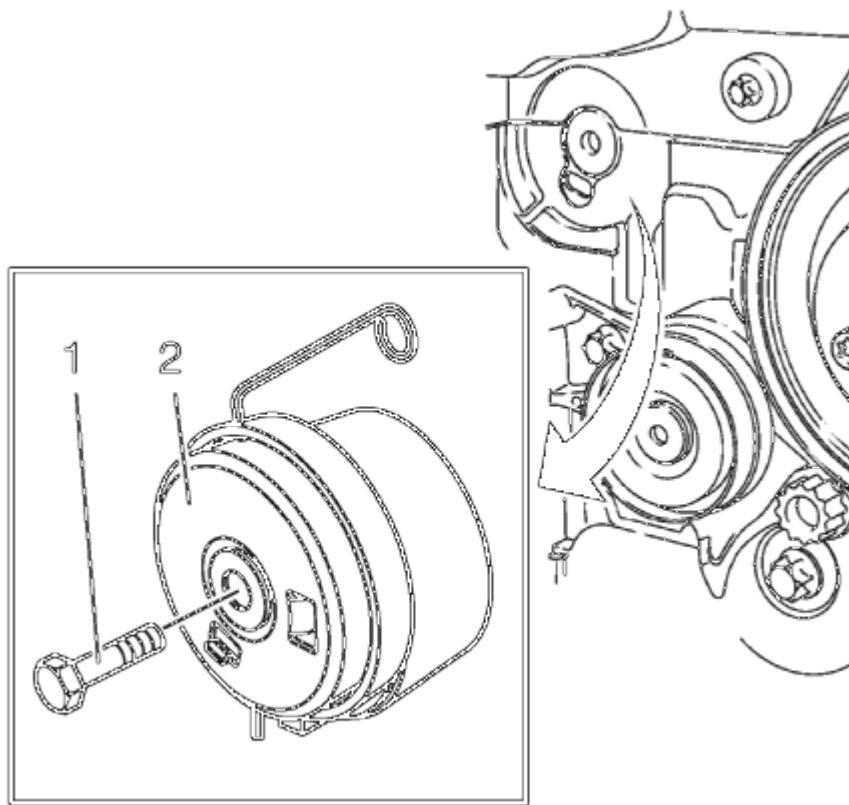


Fig. 324: Timing Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

15. Remove the tensioner bolt (1).
16. Remove the timing belt tensioner (2).

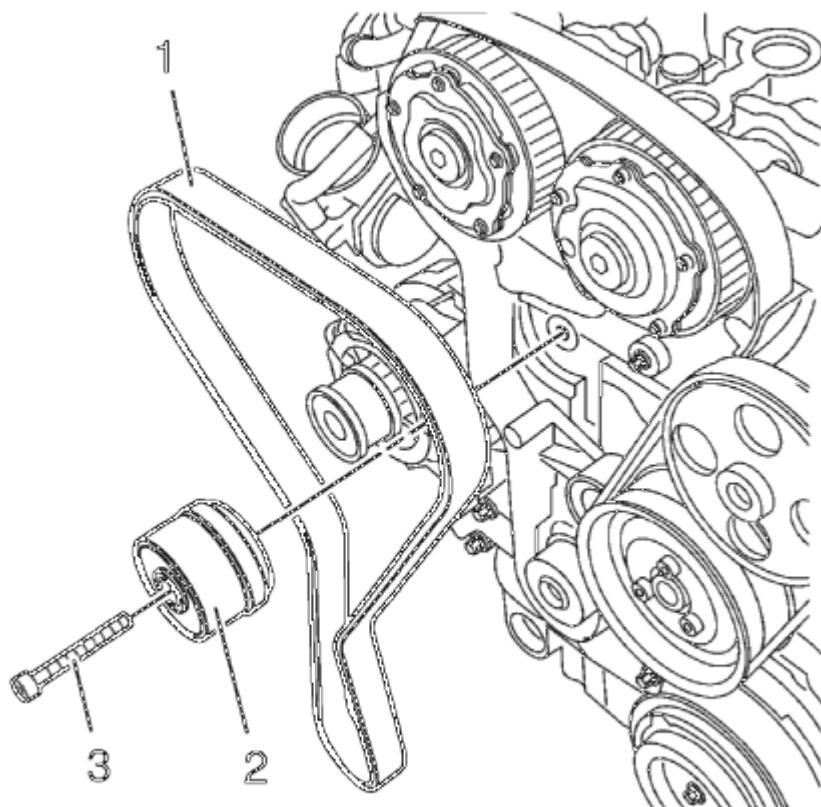


Fig. 325: Timing Belt, Timing Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

17. Remove the timing belt (1).
18. Stop the timing belt tensioner (2).
19. Remove the **EN-652** flywheel holder to unlock the crankshaft.

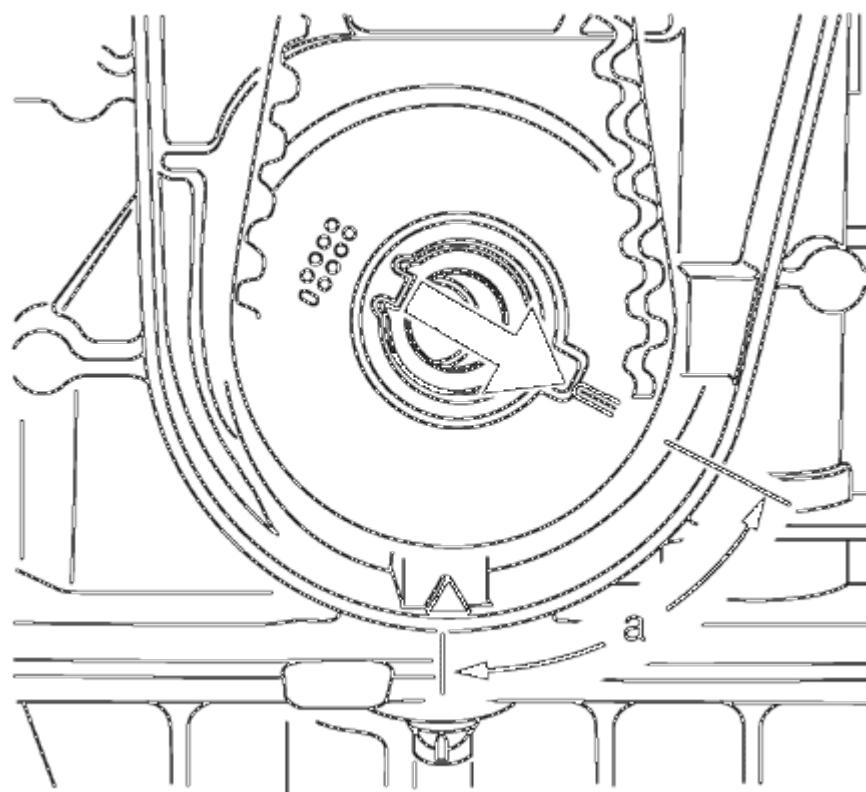


Fig. 326: Turning Crankshaft Against Direction Of Engine Rotation
Courtesy of GENERAL MOTORS COMPANY

20. Turn the crankshaft 60° (A) against the direction of engine rotation.

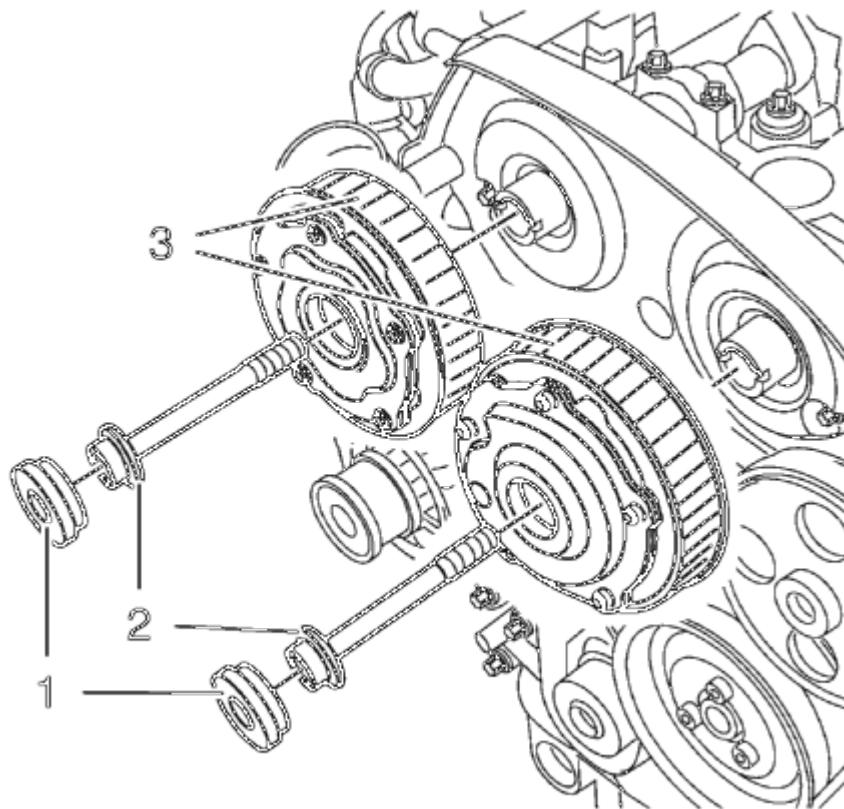


Fig. 327: Camshaft Position Actuator Adjuster Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

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).

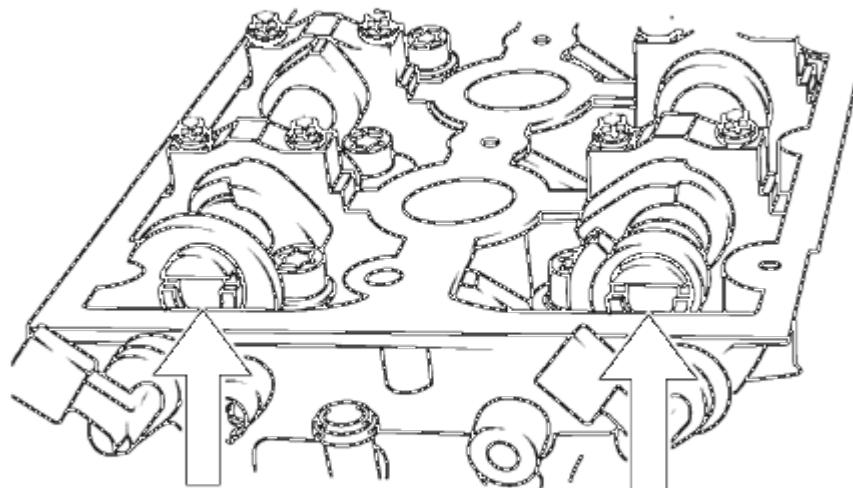


Fig. 328: Aligning Camshafts Horizontally

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.

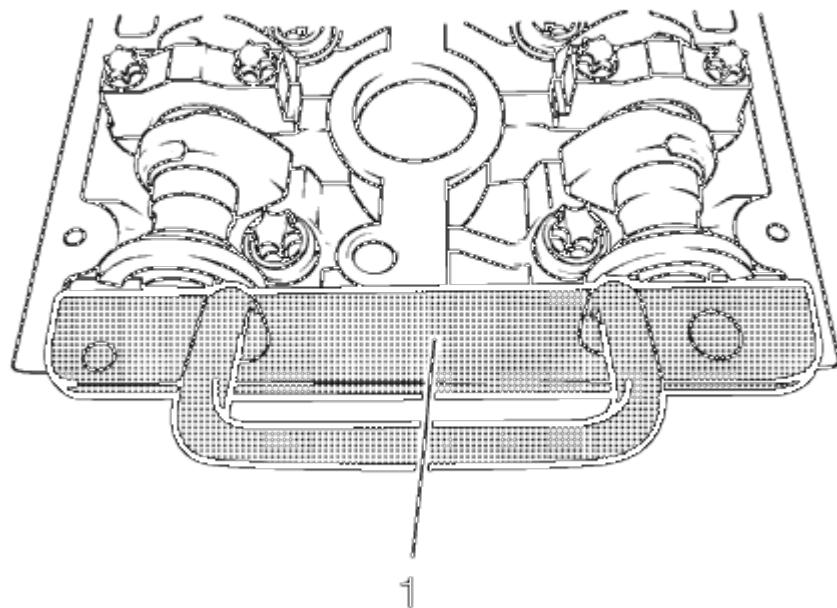


Fig. 329: Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

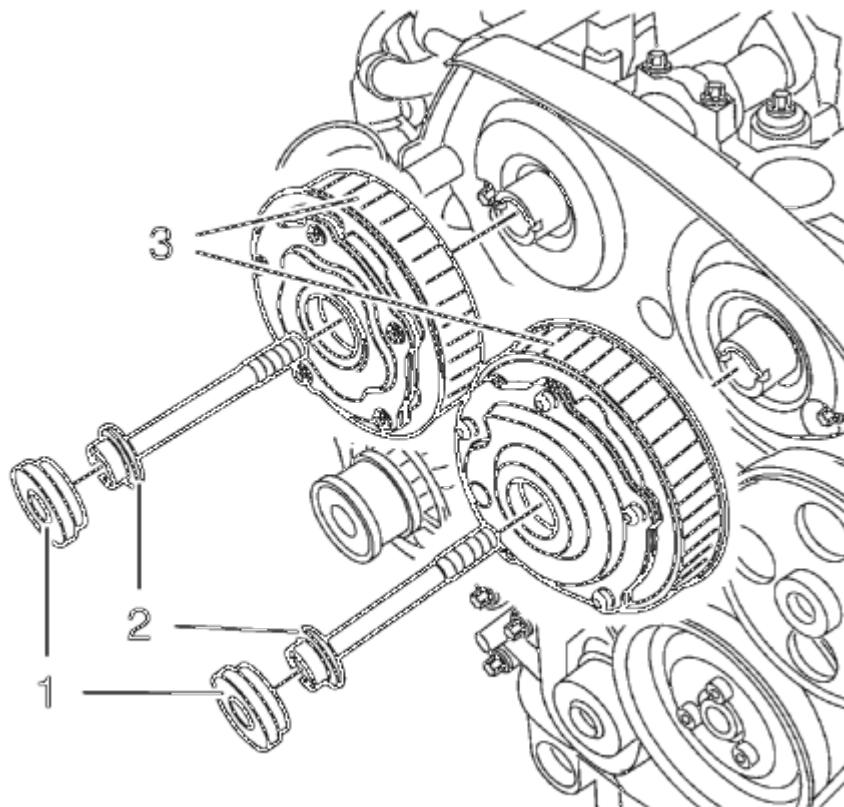


Fig. 330: Camshaft Position Actuator Adjuster Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

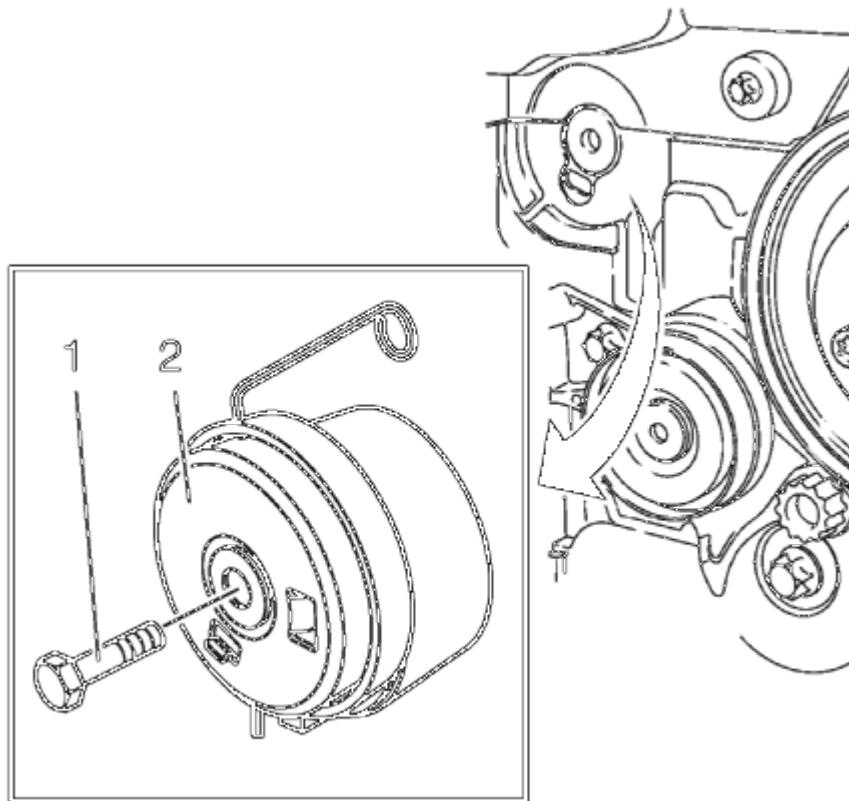


Fig. 331: Timing Belt Tensioner

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.

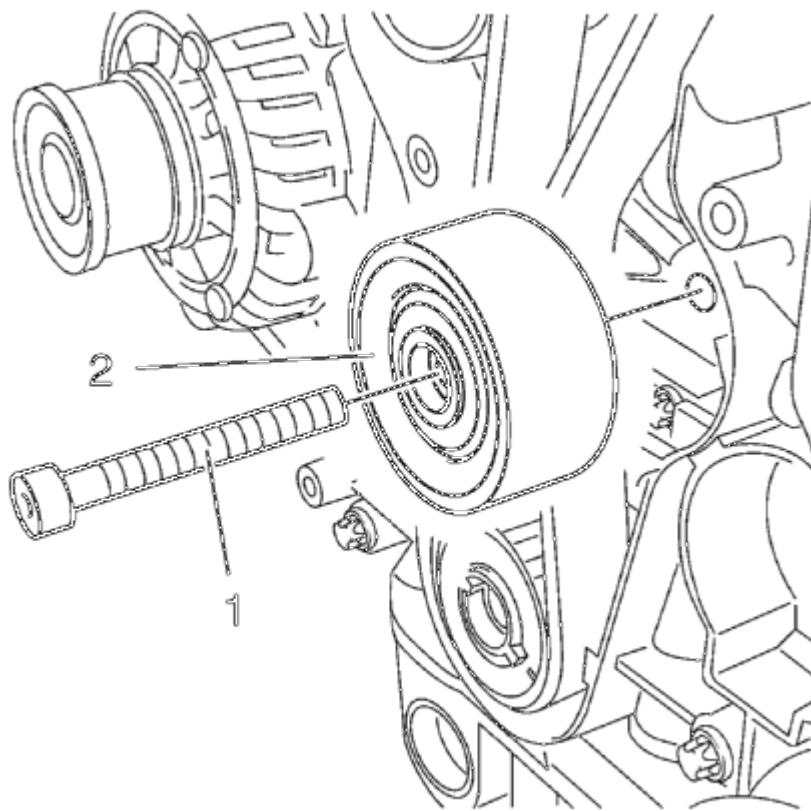


Fig. 332: Timing Belt Idler Pulley Bolt

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).

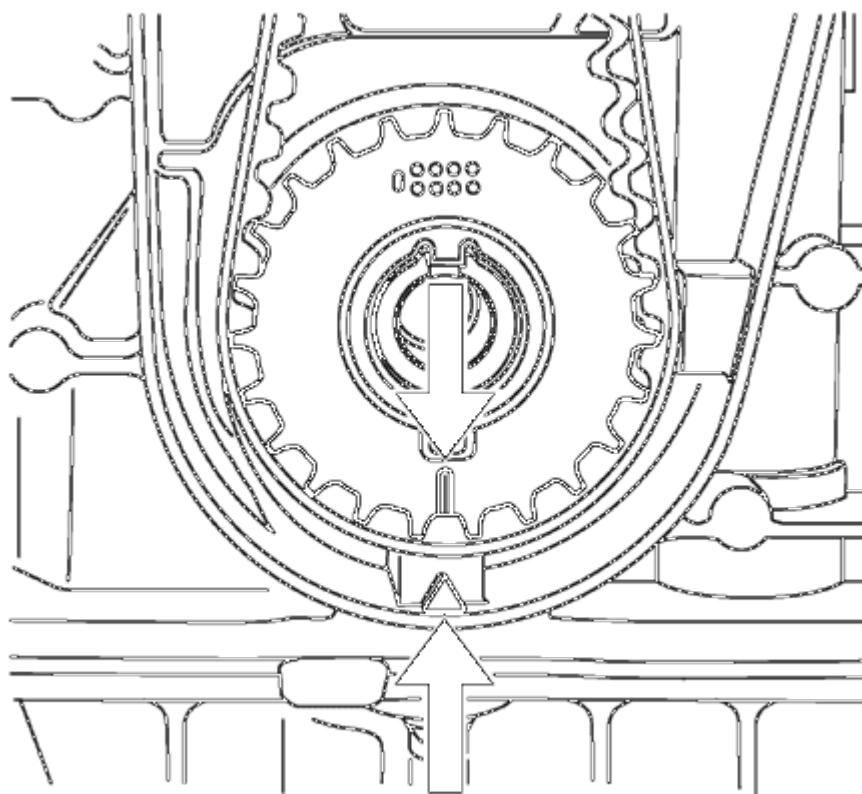


Fig. 333: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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.

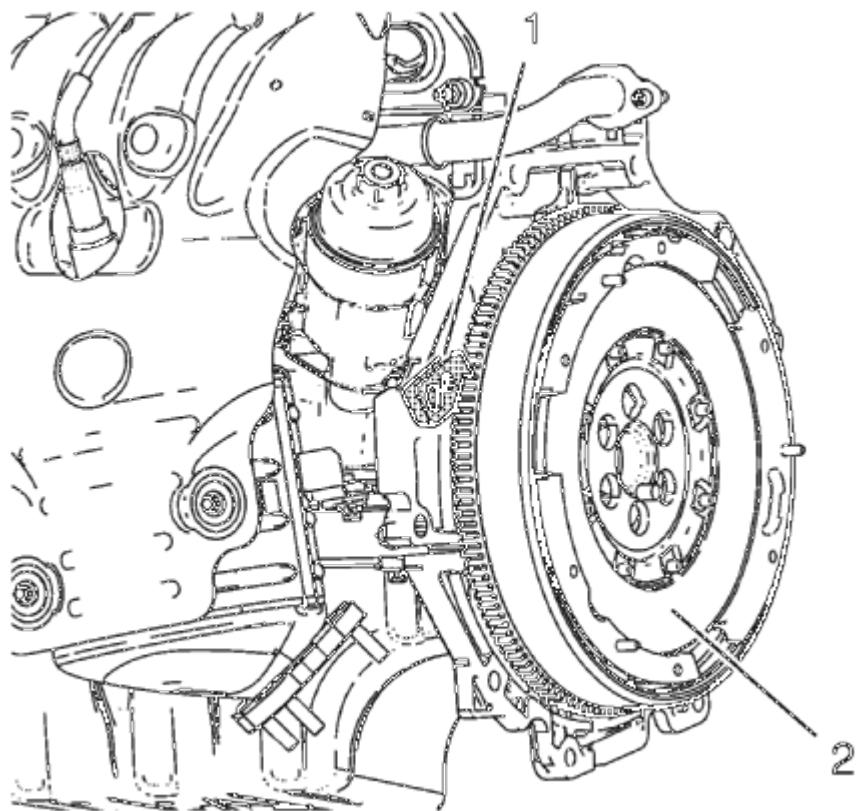


Fig. 334: Flywheel And Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

12. Install the **EN-652** flywheel holder (1), lock the flywheel (2) (or automatic transmission flex respectively) via the starter ring gear.

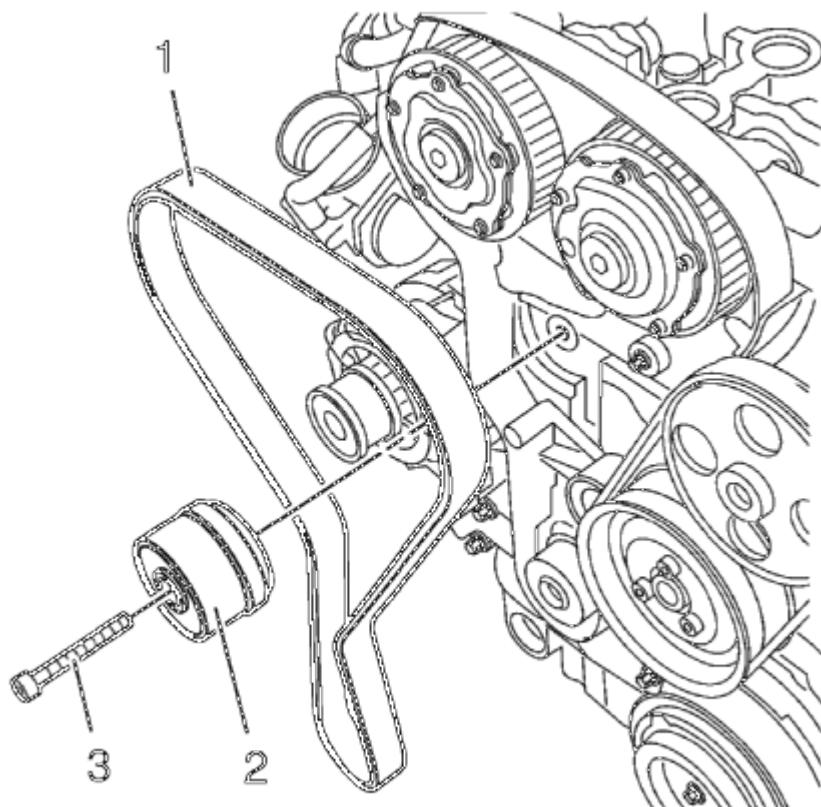


Fig. 335: Timing Belt, Timing Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe direction of rotation.

13. Insert the timing belt (1).
14. Apply preliminary tension clockwise to the timing belt tension roller.
15. Remove the **EN-6333** locking pin.
16. Release the tension on the timing belt tensioner.

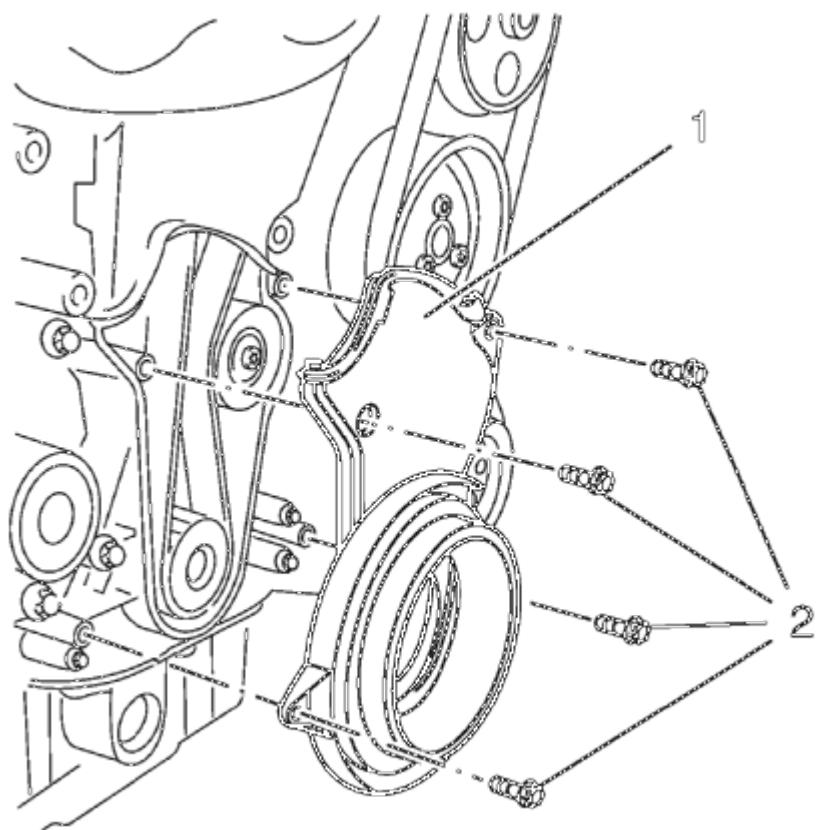


Fig. 336: Timing Belt Lower Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

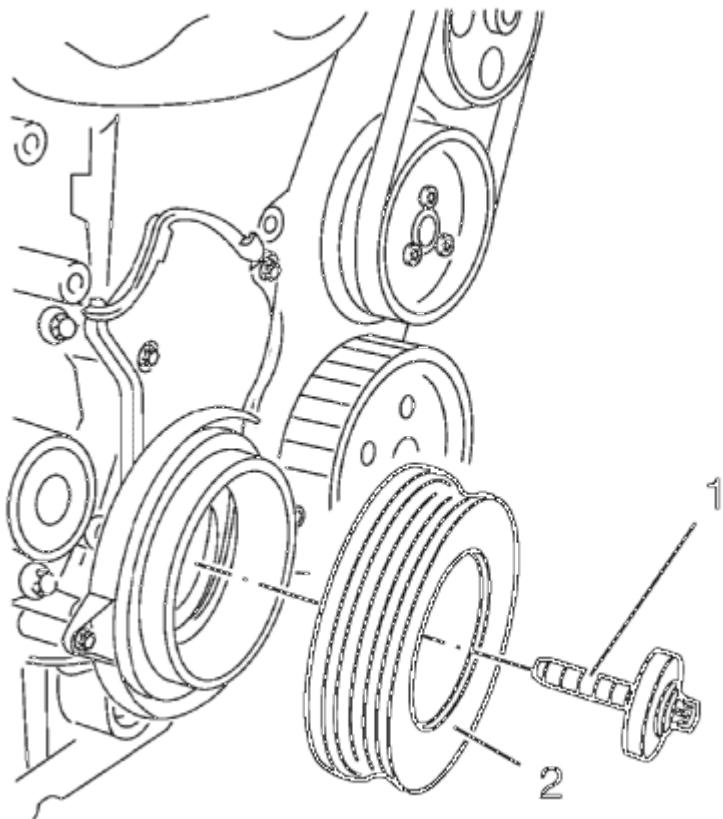


Fig. 337: Crankshaft Balancer And Bolt

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.

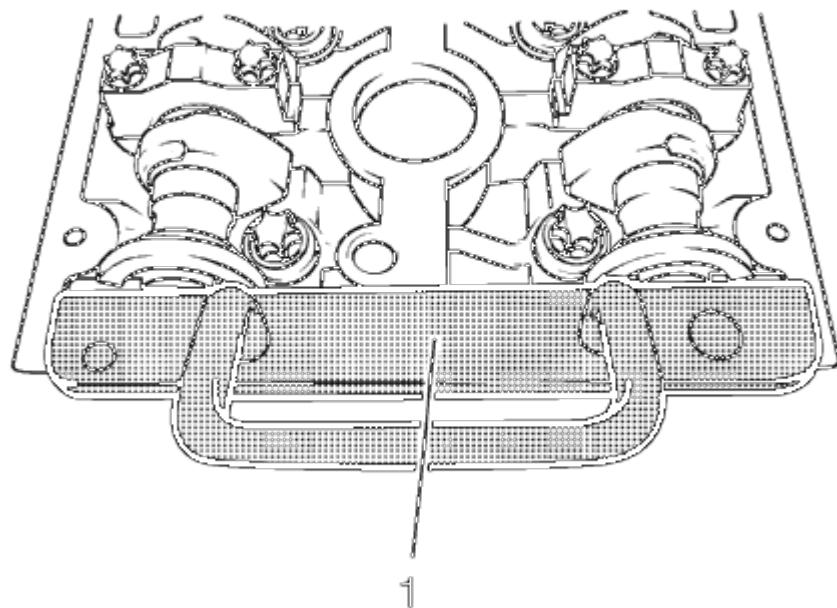


Fig. 338: Locking Tool
Courtesy of GENERAL MOTORS COMPANY

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.

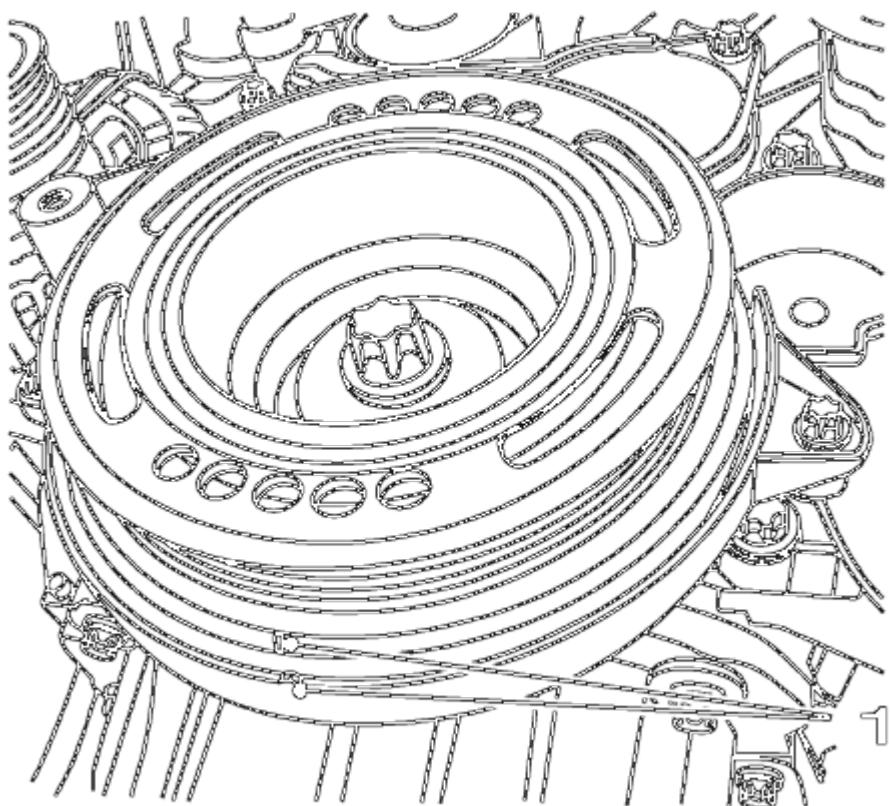


Fig. 339: View Of Crankshaft TDC Position

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

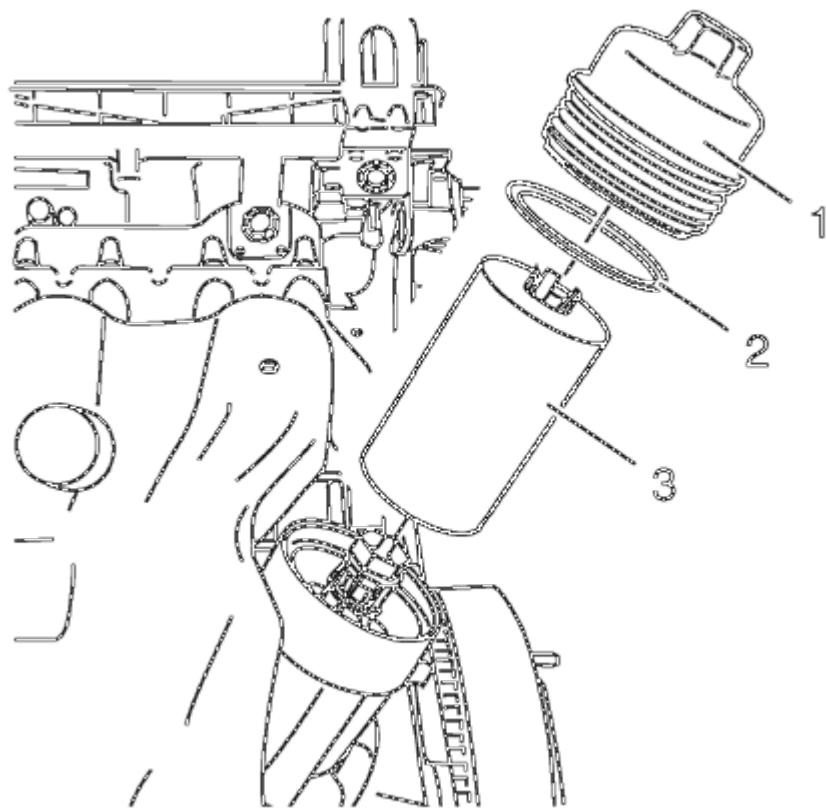


Fig. 340: Oil Filter Cap, Oil Filter Seal And Oil Filter Insert
Courtesy of GENERAL MOTORS COMPANY

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**.

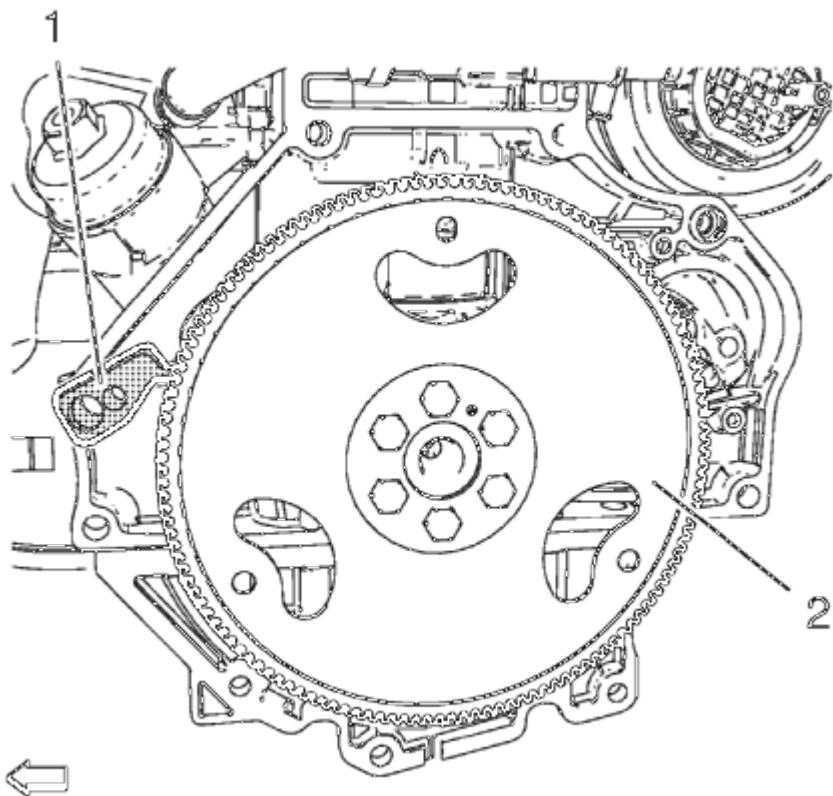


Fig. 341: Automatic Transmission Flex Plate And Holder

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).

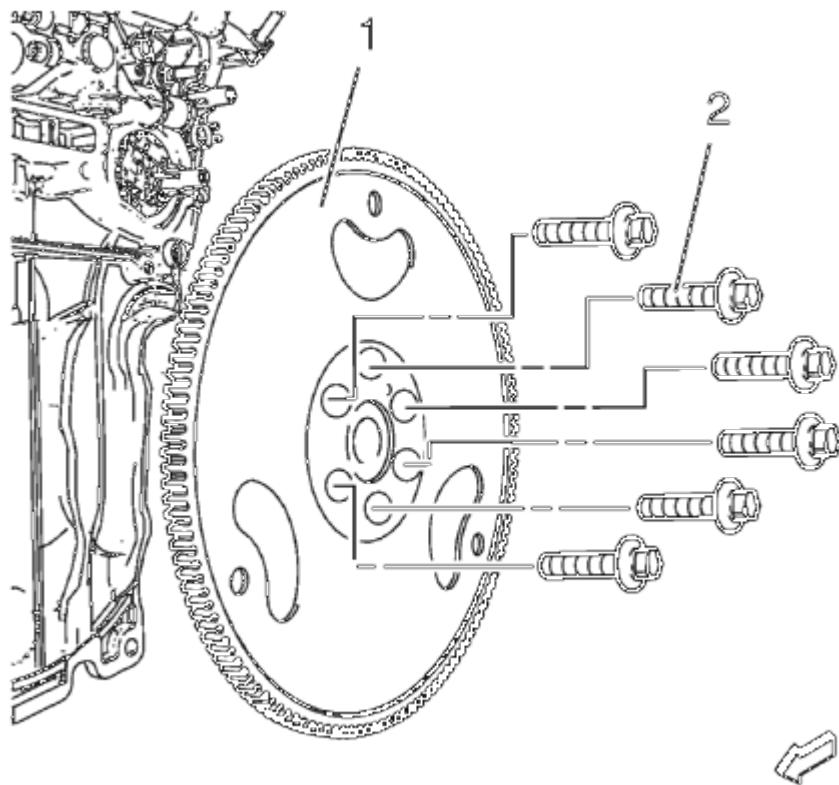


Fig. 342: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

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**.

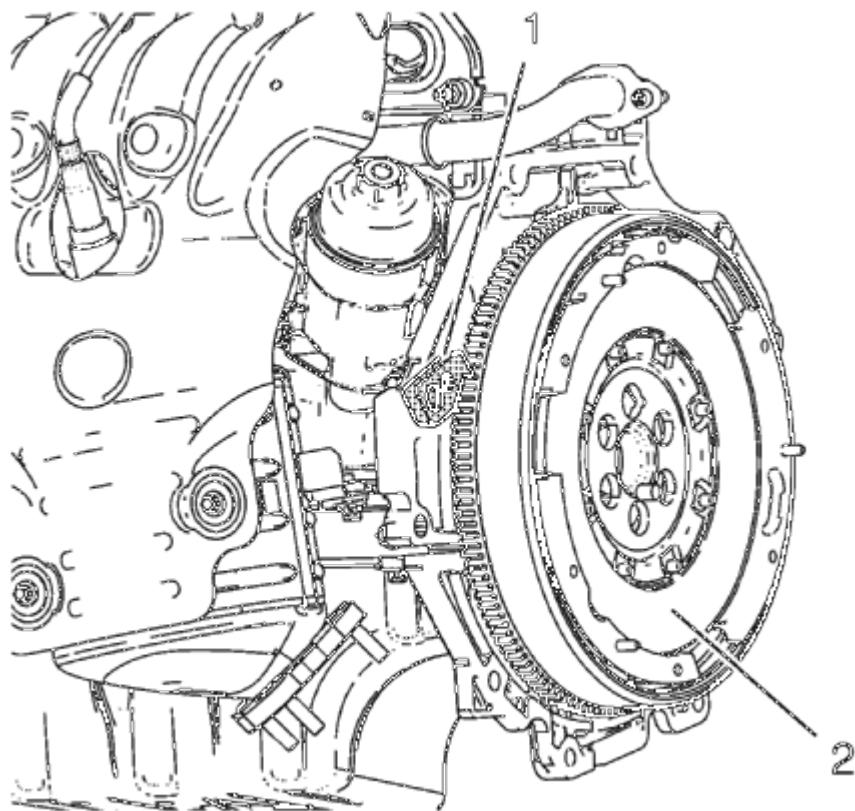


Fig. 343: Flywheel And Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

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).

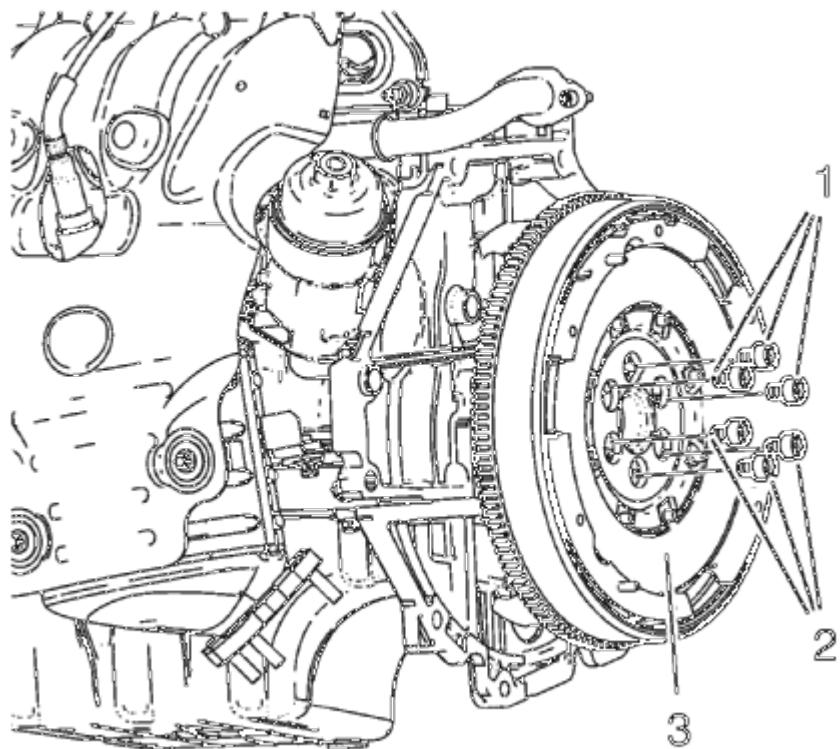


Fig. 344: Flywheel And Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the 6 flywheel bolts (1, 2).
5. Remove the flywheel (3).

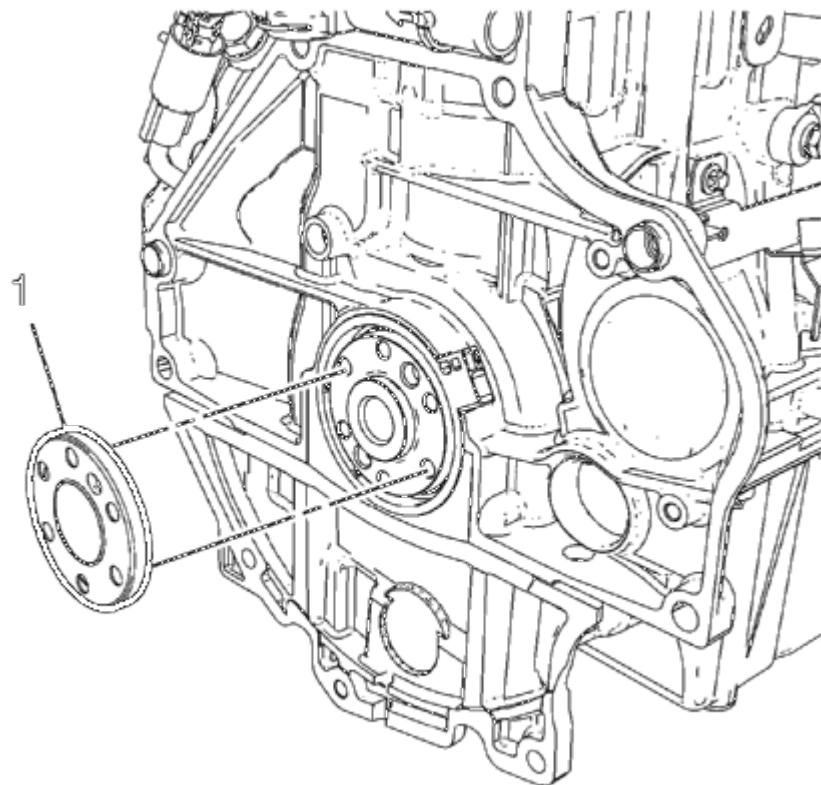


Fig. 345: Crankshaft Position Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

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](#).

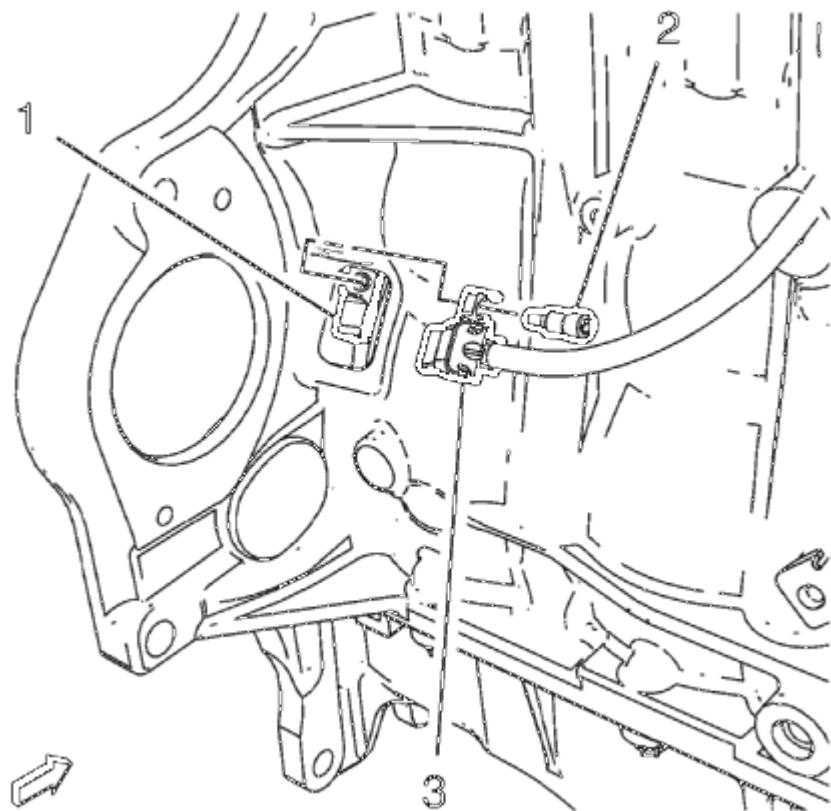


Fig. 346: Crankshaft Position Sensor And Bolt

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).

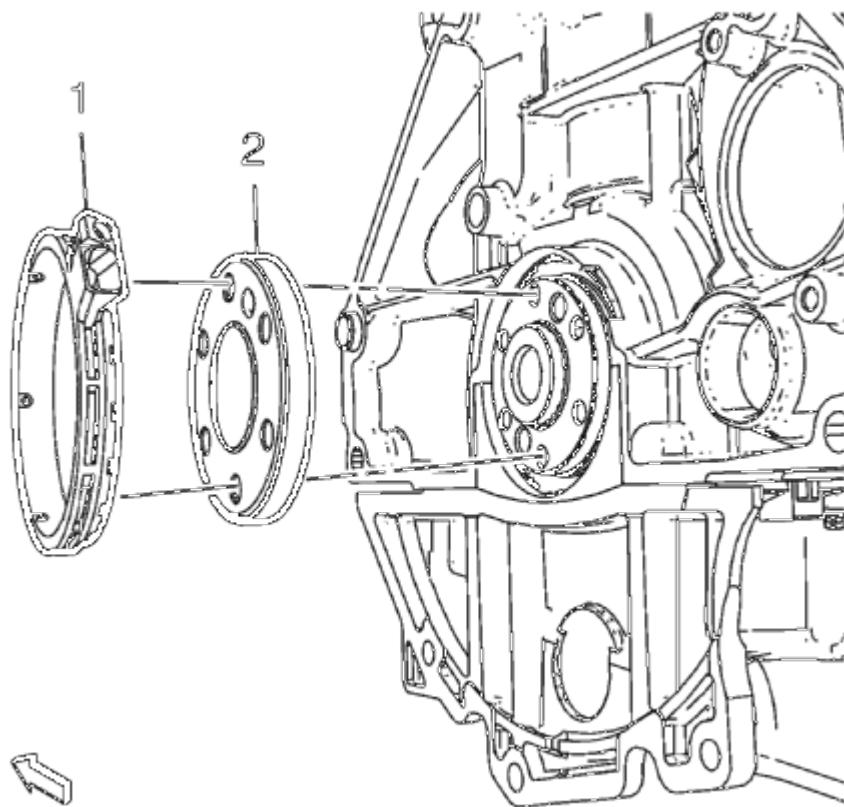


Fig. 347: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

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).

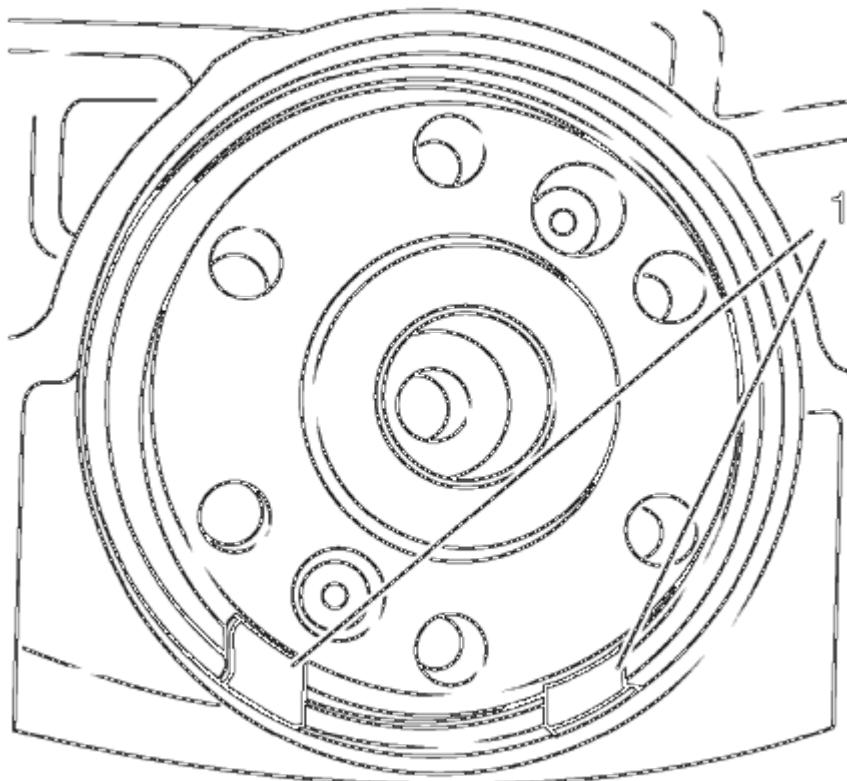


Fig. 348: Holes At 5 O'clock And 7 O'clock Positions

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.

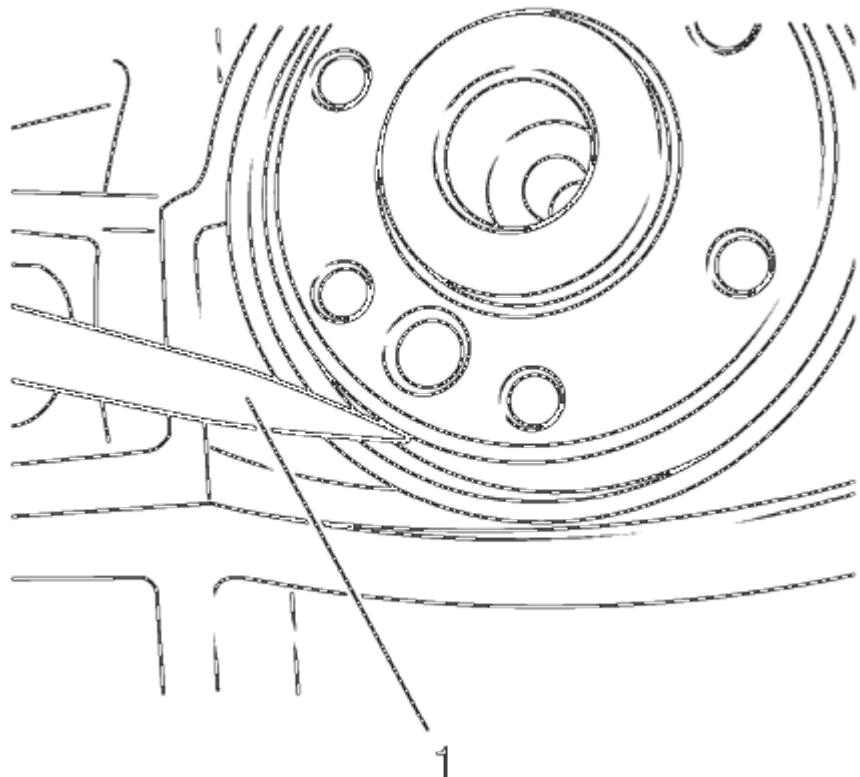


Fig. 349: Scribe Tool
Courtesy of GENERAL MOTORS COMPANY

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.

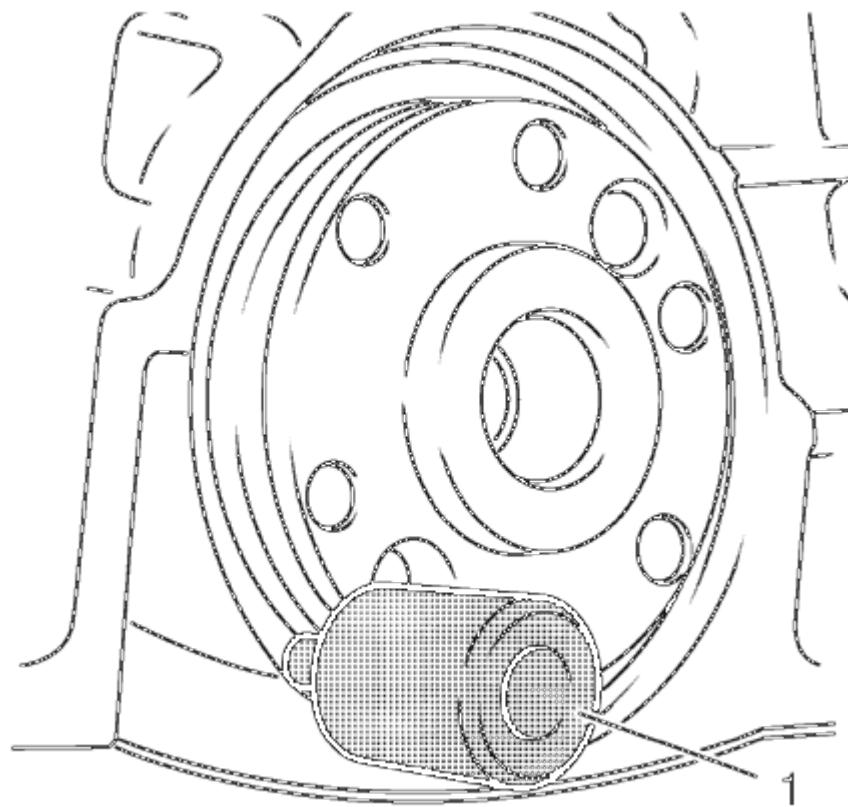


Fig. 350: Crankshaft Rear Oil Seal Removal Tool

Courtesy of GENERAL MOTORS COMPANY

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

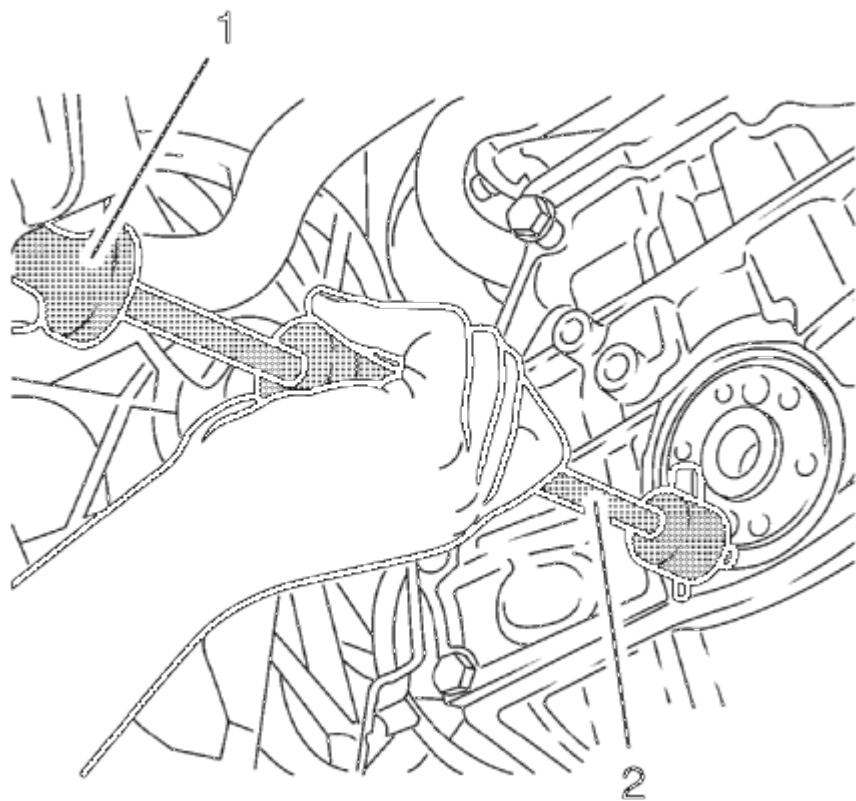


Fig. 351: Special Removal Tools

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

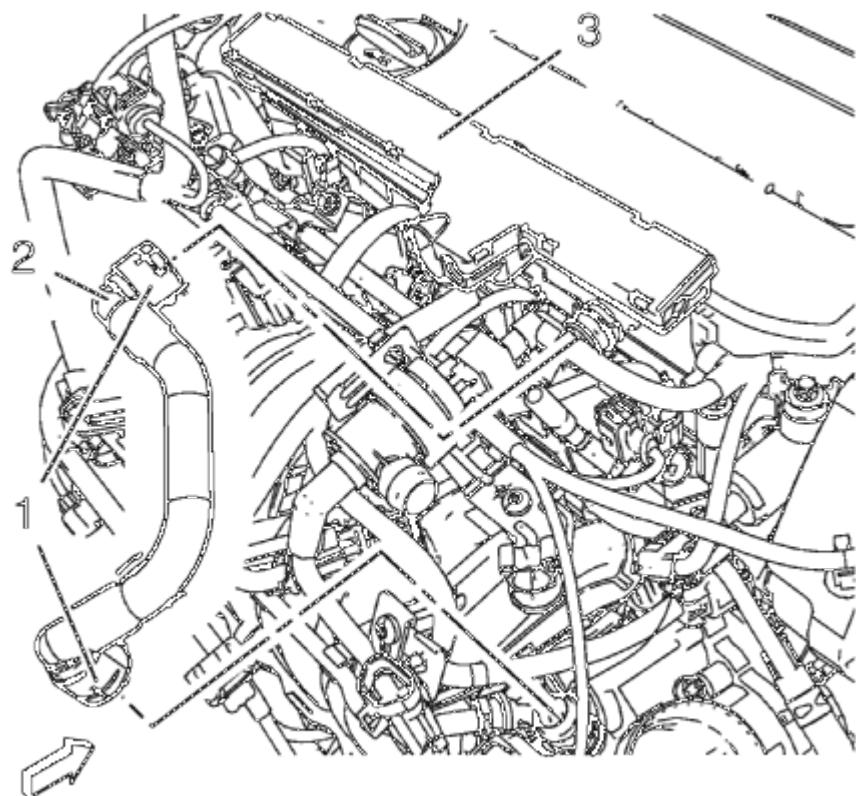


Fig. 352: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide
Courtesy of GENERAL MOTORS COMPANY

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).

SECONDARY AIR INJECTION PUMP PIPE REMOVAL

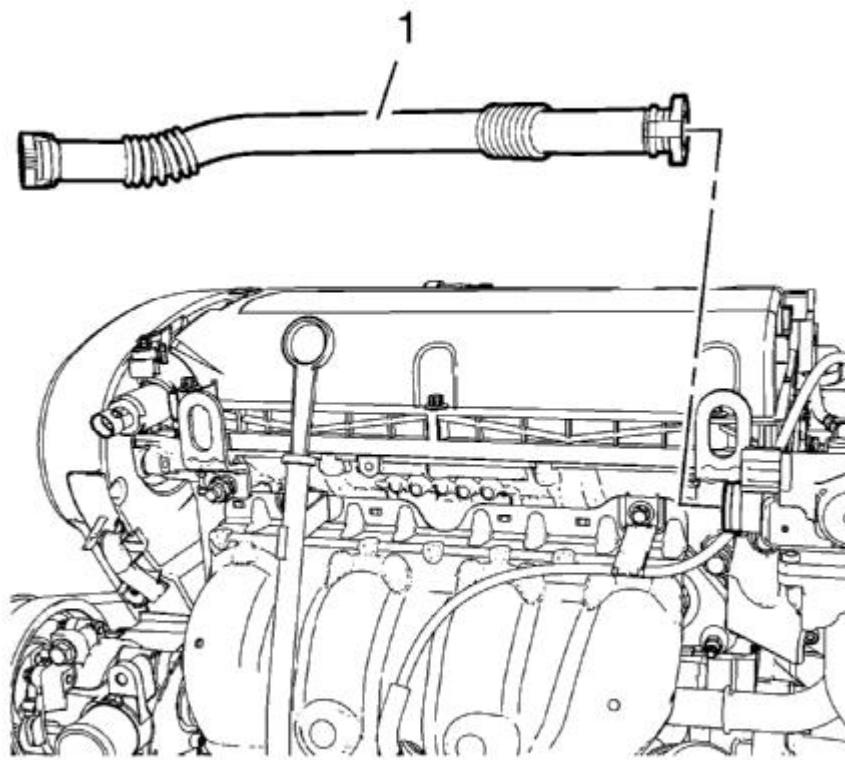


Fig. 353: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the secondary air injection pump pipe (3) from the secondary air injection check valve. Refer to [Plastic Collar Quick Connect Fitting Service](#).

SECONDARY AIR INJECTION PUMP REMOVAL

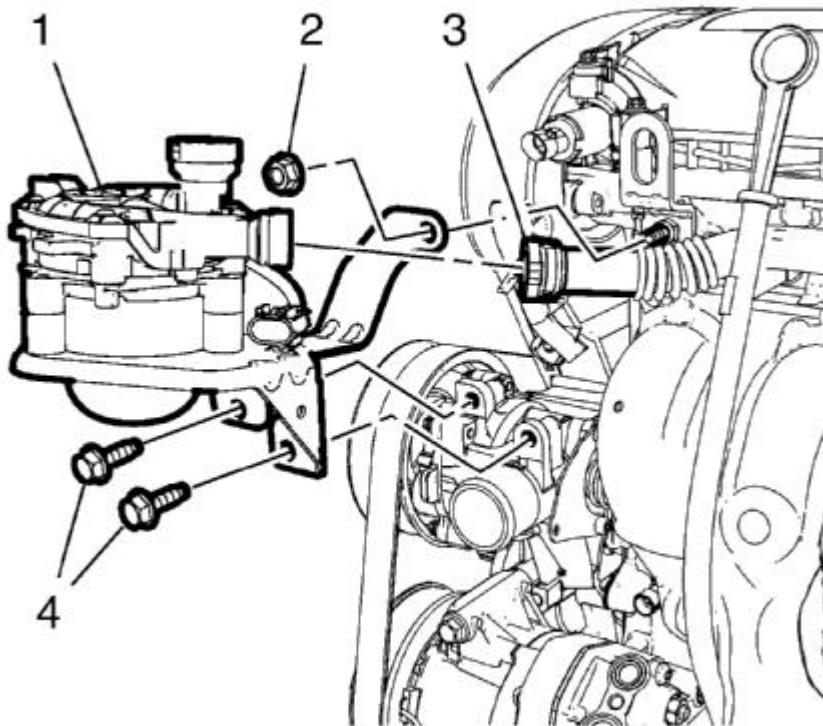


Fig. 354: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the secondary air injection pump pipe (3). Refer to [Plastic Collar Quick Connect Fitting Service](#) .
2. Remove the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4).
3. Remove the secondary air injection pump (1).

SECONDARY AIR INJECTION CHECK VALVE REMOVAL

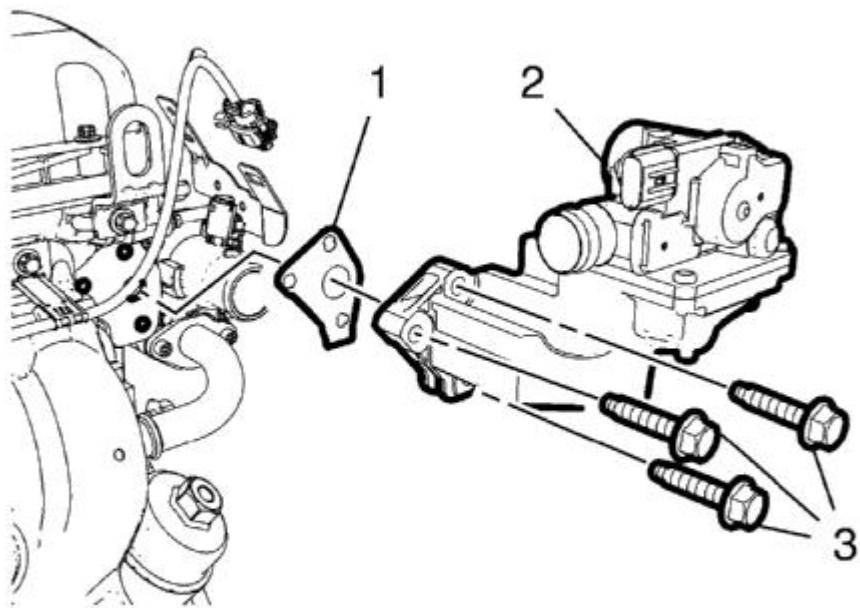


Fig. 355: Secondary Air Injection Check Valve Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 secondary air injection check valve bolts (3).
2. Remove the secondary air injection check valve (2).
3. Remove and DISCARD the secondary air injection check valve gasket (1).

POWER STEERING PUMP BELT REMOVAL

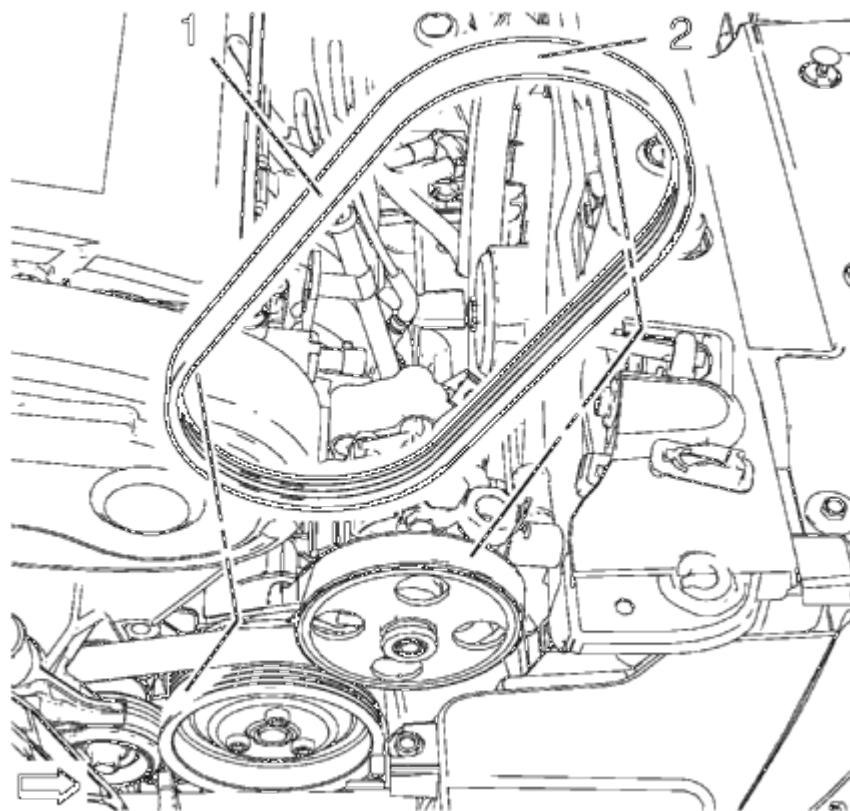


Fig. 356: Power Steering Pump Belt

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.

1. Cut the power steering pump belt (2) with a appropriate cutting tool at position (1).
2. Remove the power steering pump belt (2).

DRIVE BELT REMOVAL

Special Tools

EN-6349 Locking Pin

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

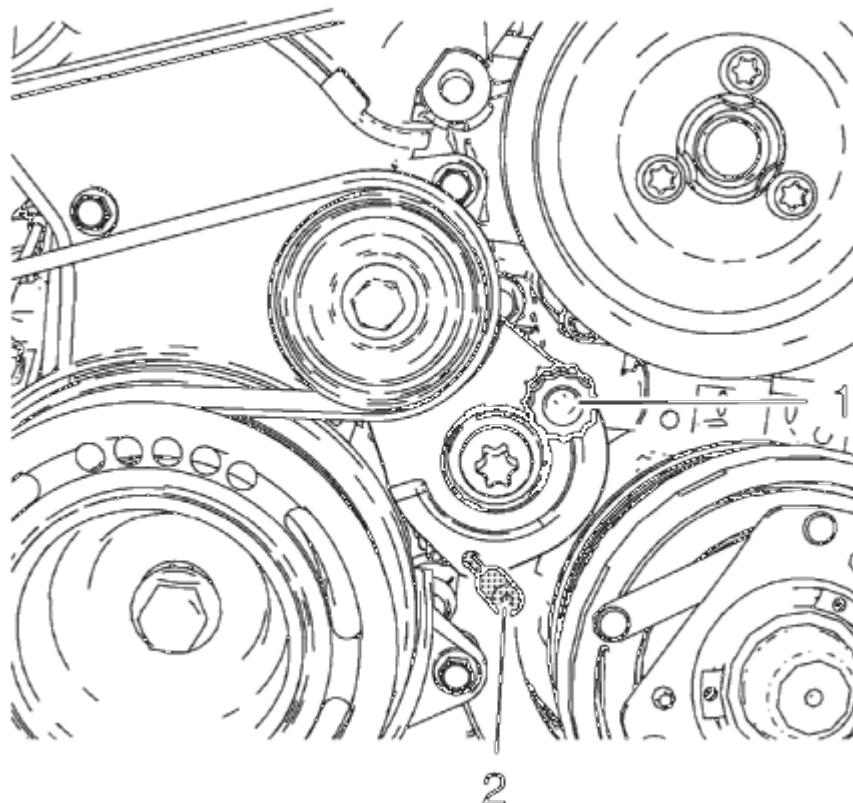


Fig. 357: Drive Belt Tensioner And Special Tool
Courtesy of GENERAL MOTORS COMPANY

1. Release tension to the drive belt tensioner counterclockwise (1) and lock with EN-6349 pin (2).

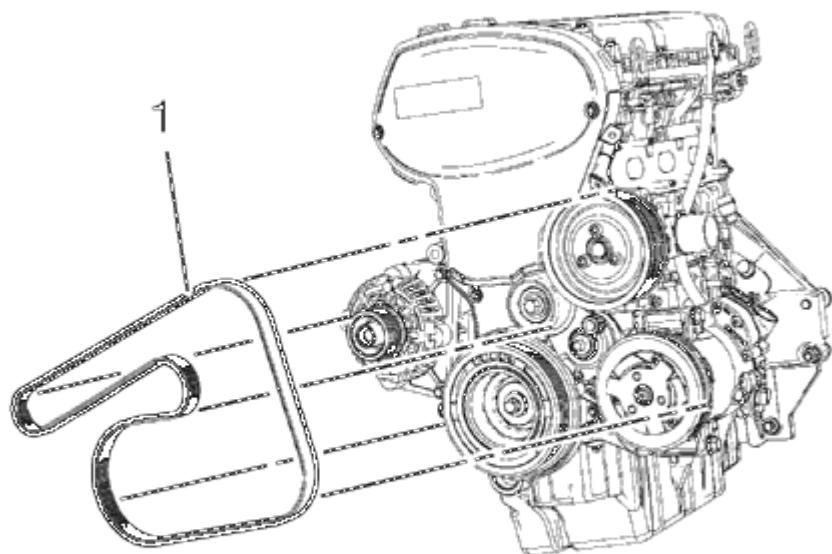


Fig. 358: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt (1).

DRIVE BELT TENSIONER REMOVAL

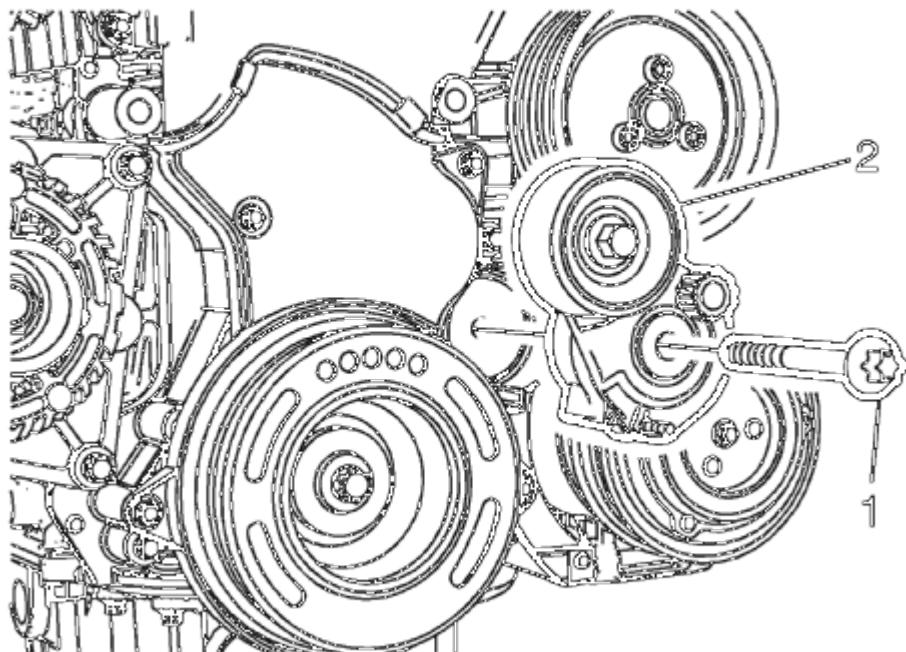


Fig. 359: Drive Belt Tensioner Bolt

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

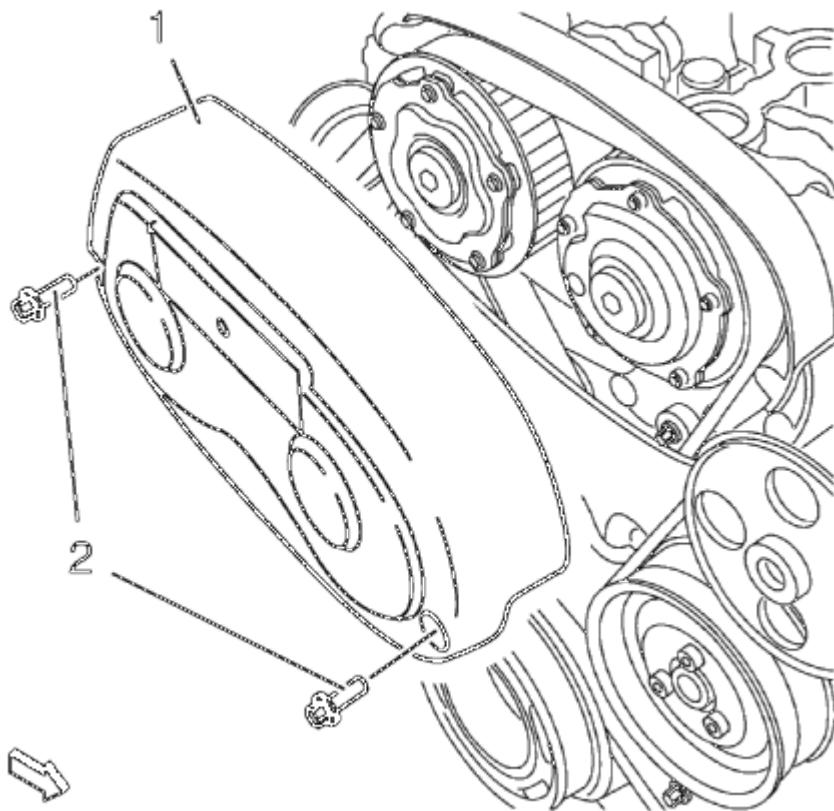


Fig. 360: Timing Belt Upper Front Cover
Courtesy of GENERAL MOTORS COMPANY

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

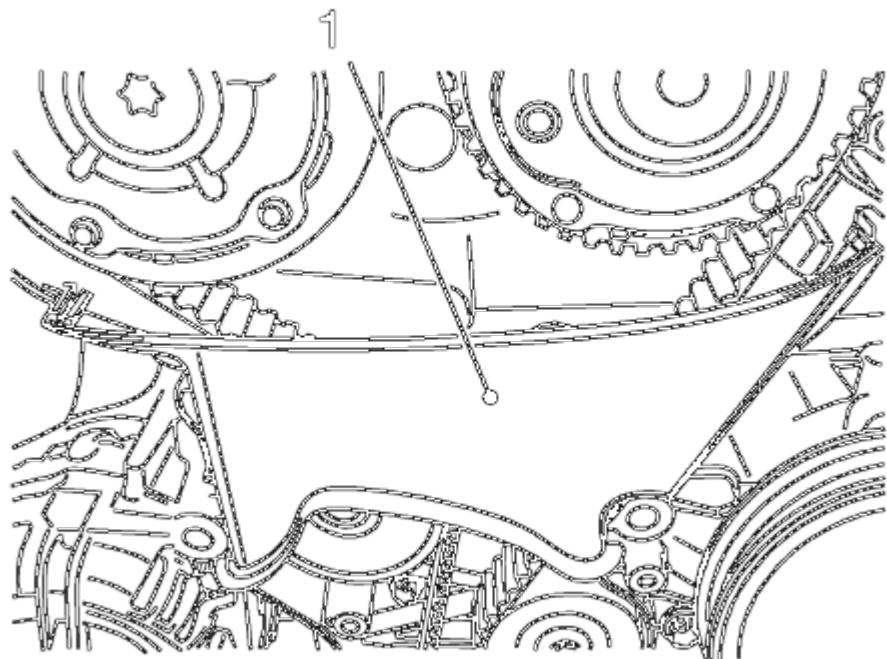


Fig. 361: View Of Toothed Belt Cover

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 Holder

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

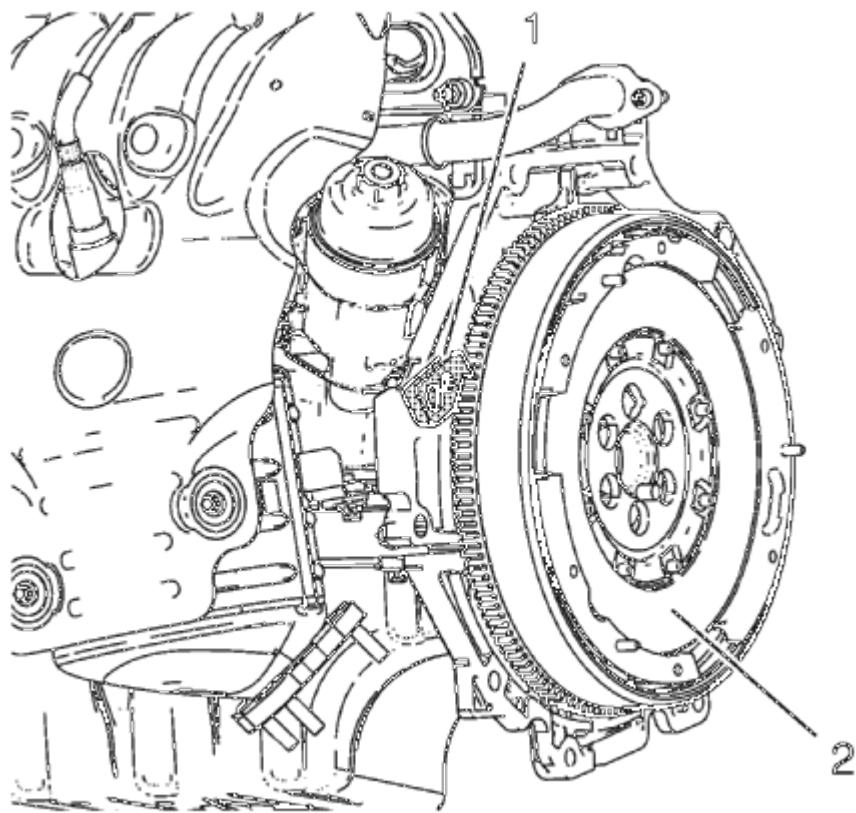


Fig. 362: Flywheel And Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-652** holder (1). Lock the flywheel (2) or the automatic transmission flex plate via the starter ring gear.

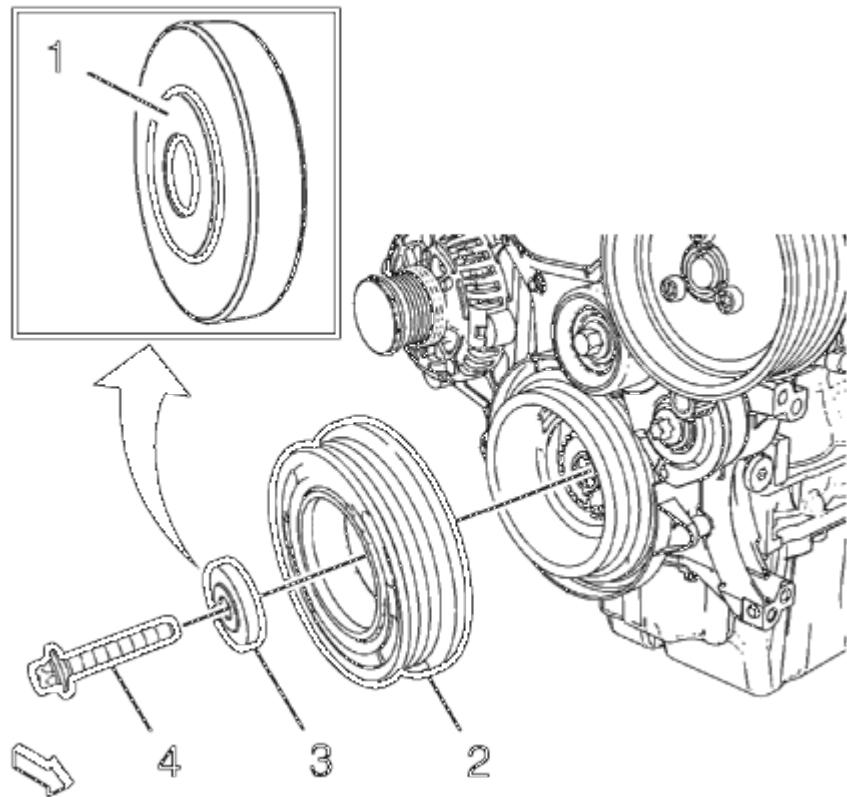


Fig. 363: Crankshaft Balancer, Washer And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

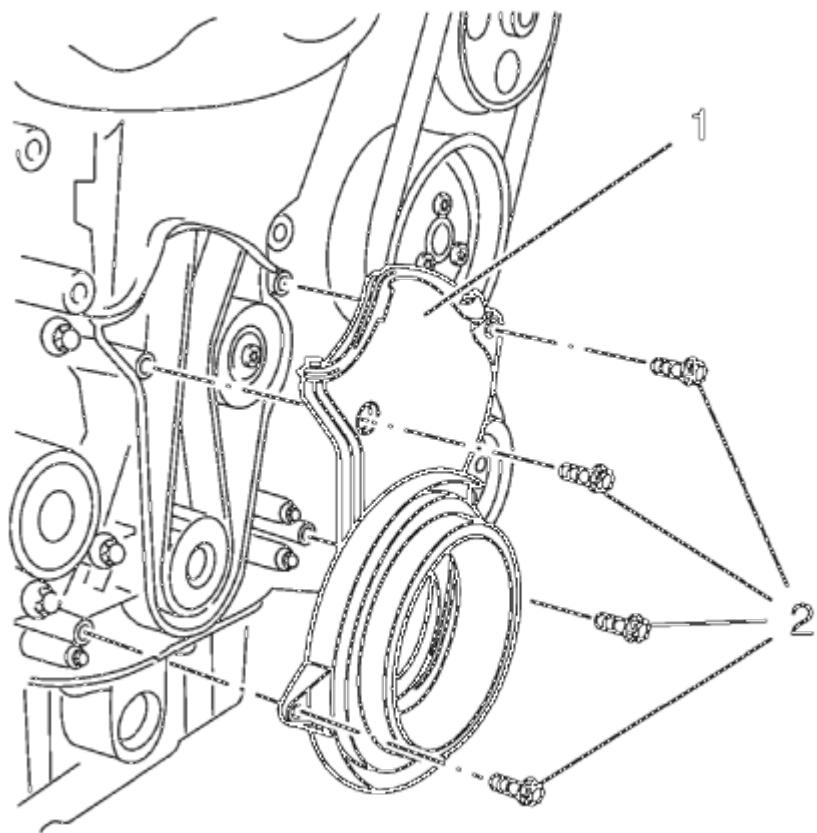


Fig. 364: Timing Belt Lower Front Cover

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**.

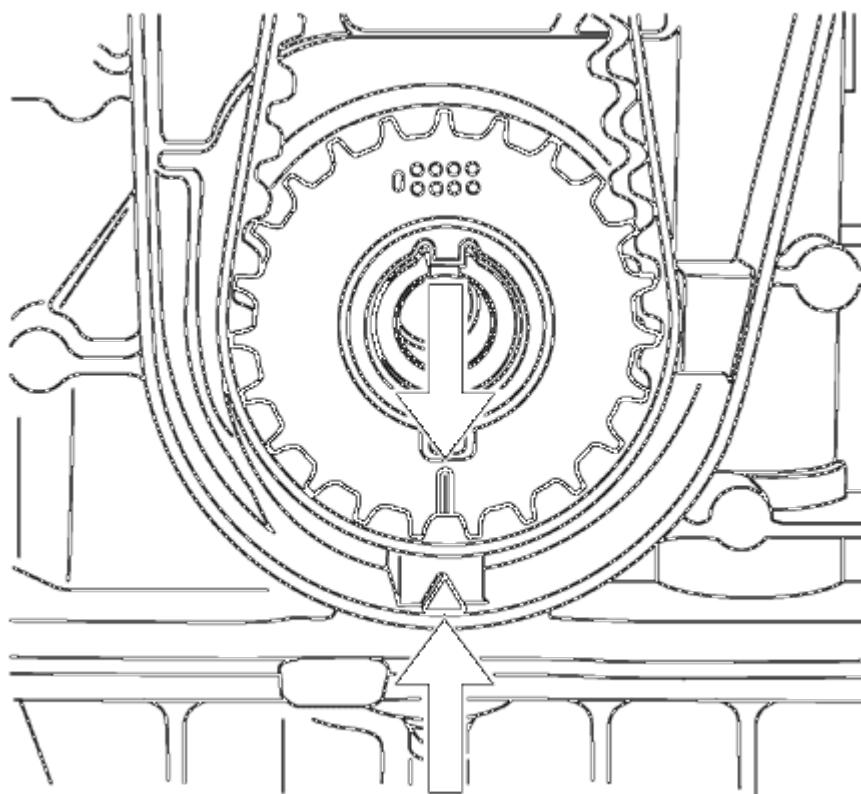


Fig. 365: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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.

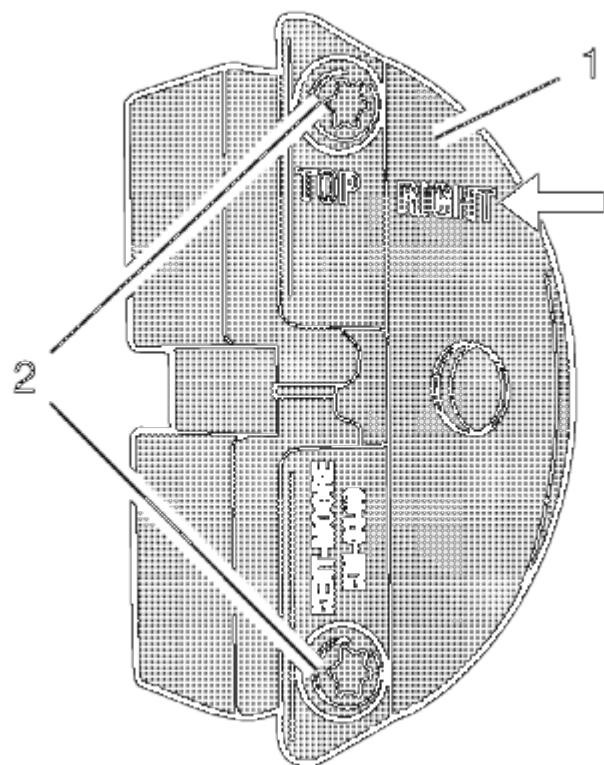


Fig. 366: Front Panel And Bolts

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.

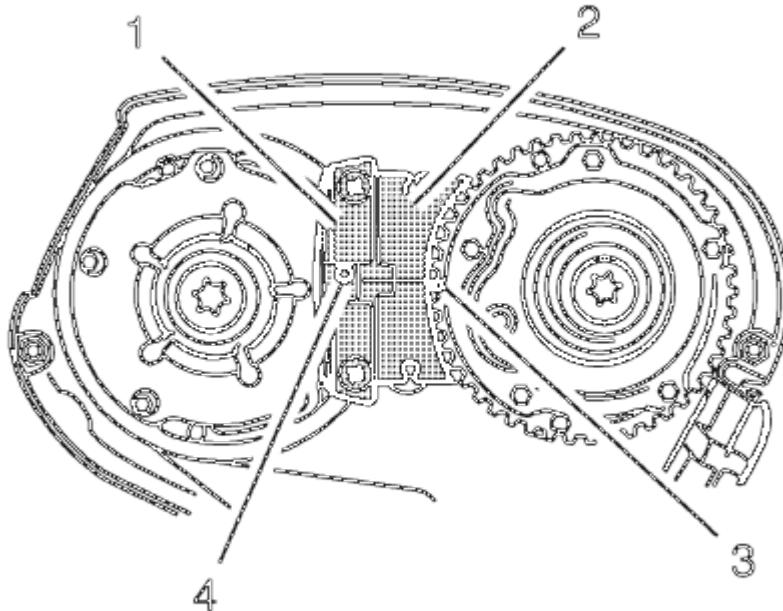


Fig. 367: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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.

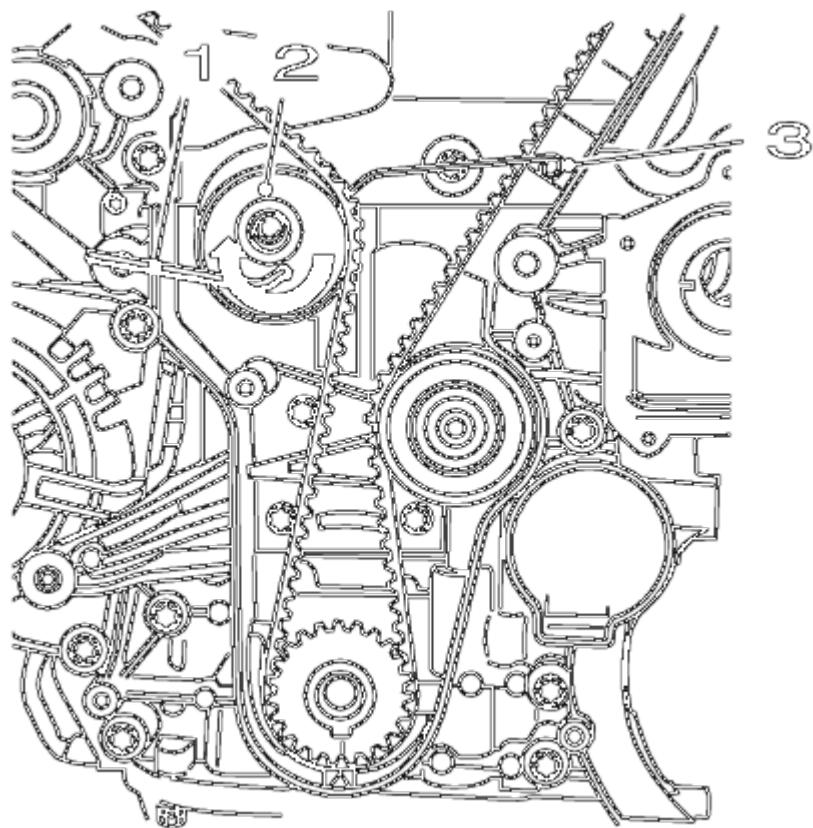


Fig. 368: View Of Drive Belt Tensioner, Allen Key And KM-6333
Courtesy of GENERAL MOTORS COMPANY

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.

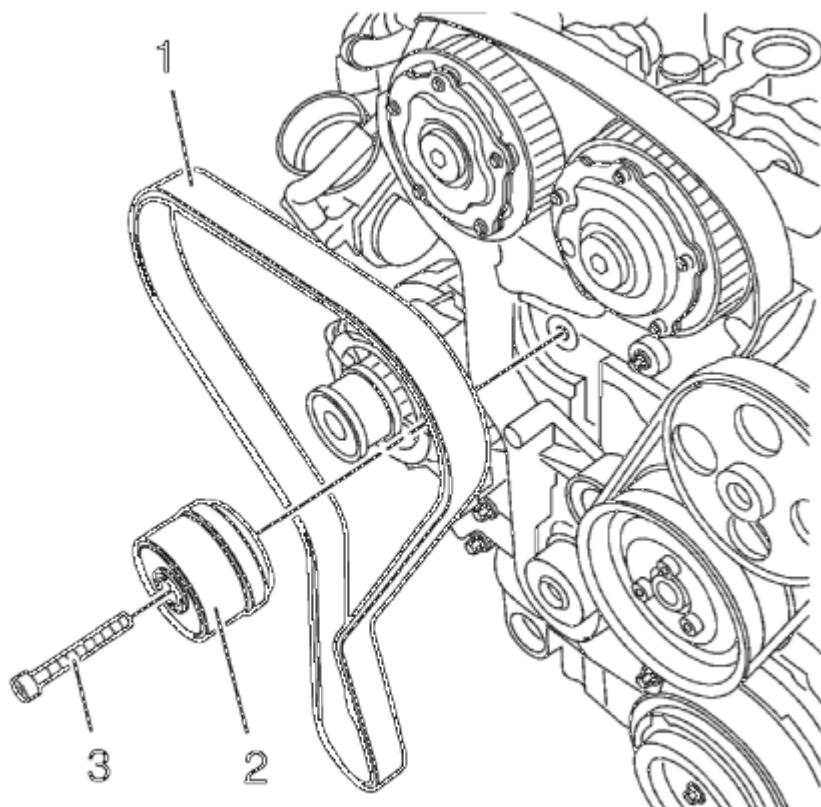


Fig. 369: Timing Belt, Timing Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe direction of rotation.

6. Remove the timing belt (1).

TIMING BELT TENSIONER REMOVAL

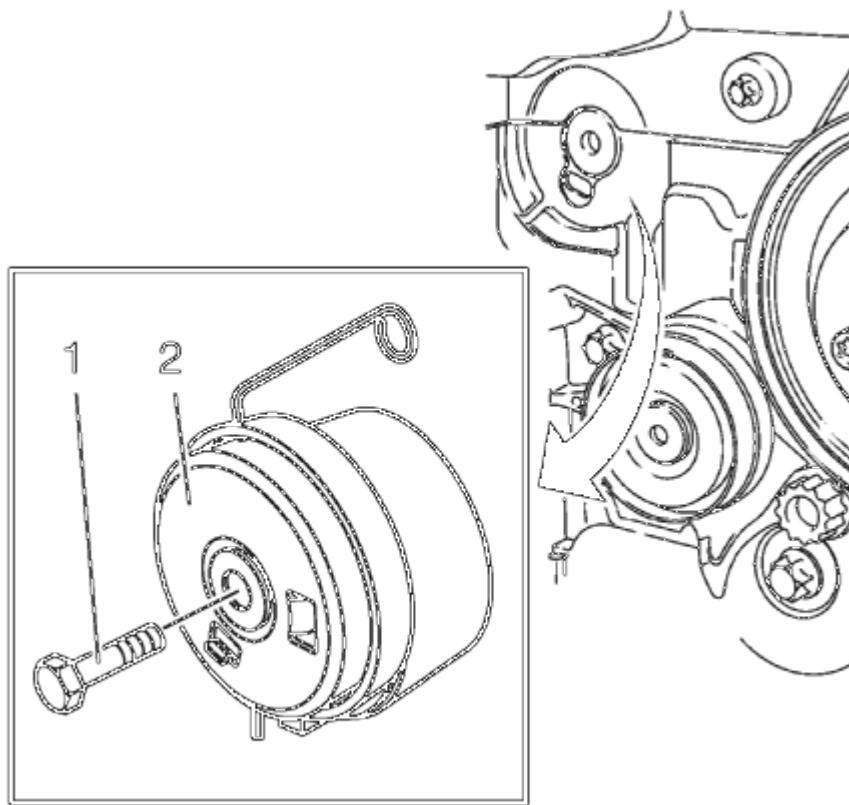


Fig. 370: Timing Belt Tensioner

Courtesy of GENERAL MOTORS COMPANY

1. Remove the tensioner bolt (1).
2. Remove the timing belt tensioner (2).

TIMING BELT IDLER PULLEY REMOVAL

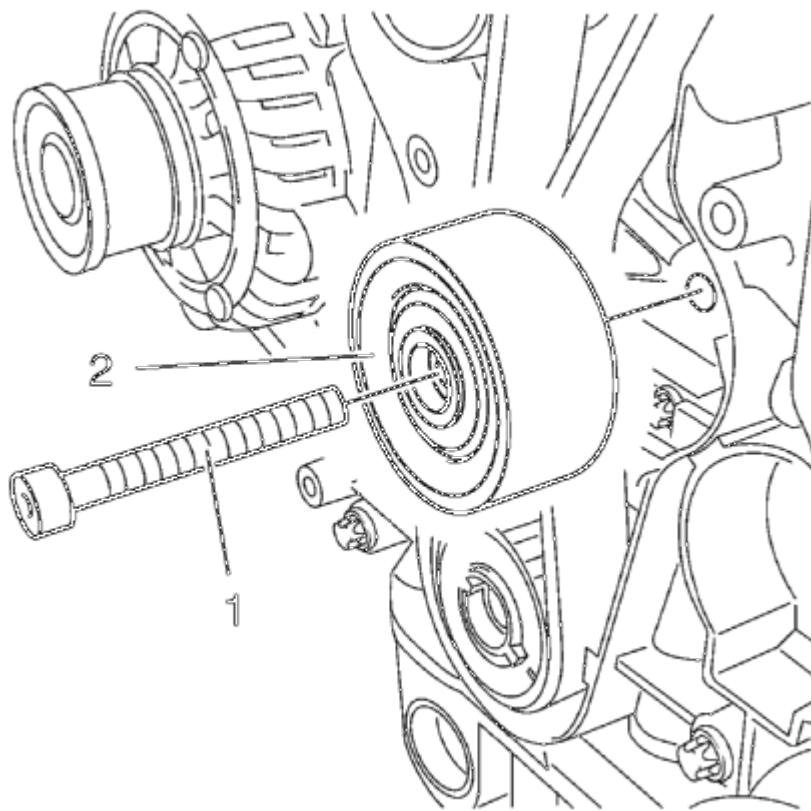


Fig. 371: Timing Belt Idler Pulley Bolt

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

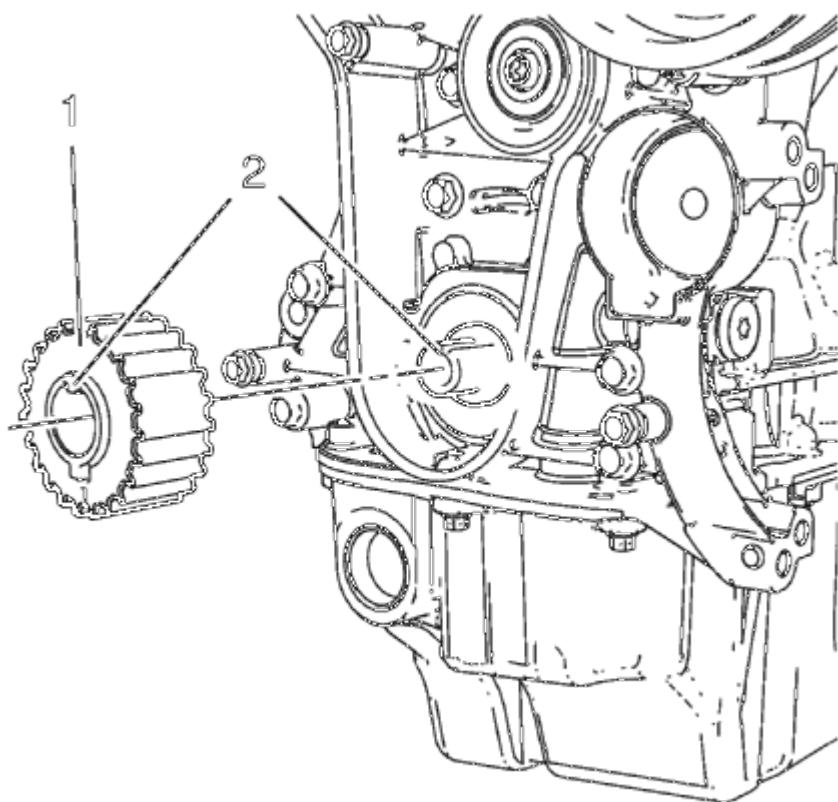


Fig. 372: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

Remove the crankshaft sprocket (1).

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REMOVAL

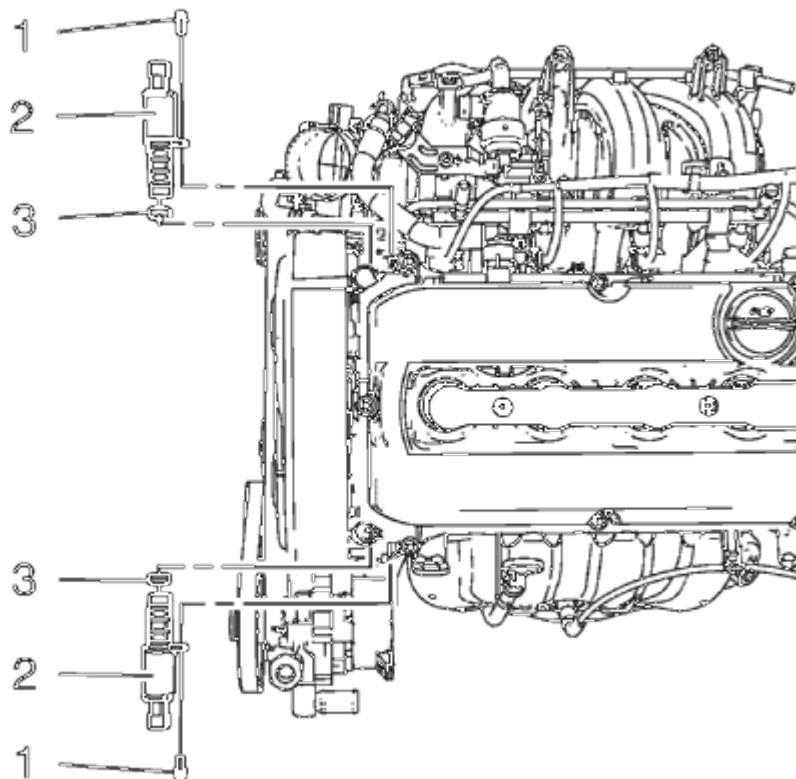


Fig. 373: Camshaft Position Actuator Solenoid Valves, Bolts And Seals
Courtesy of GENERAL MOTORS COMPANY

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**.

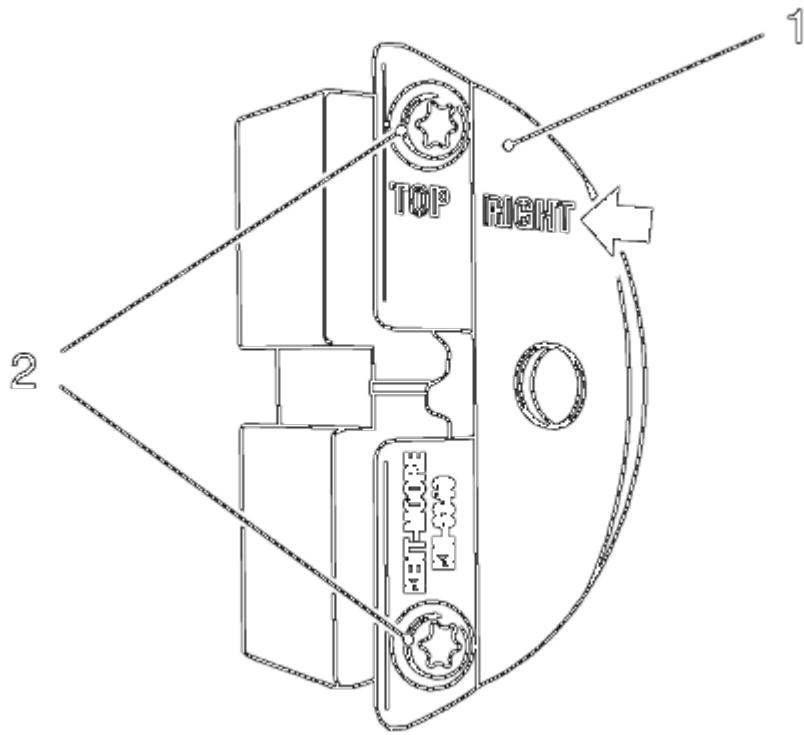


Fig. 374: View Of Front Panel And Bolts

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.

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.

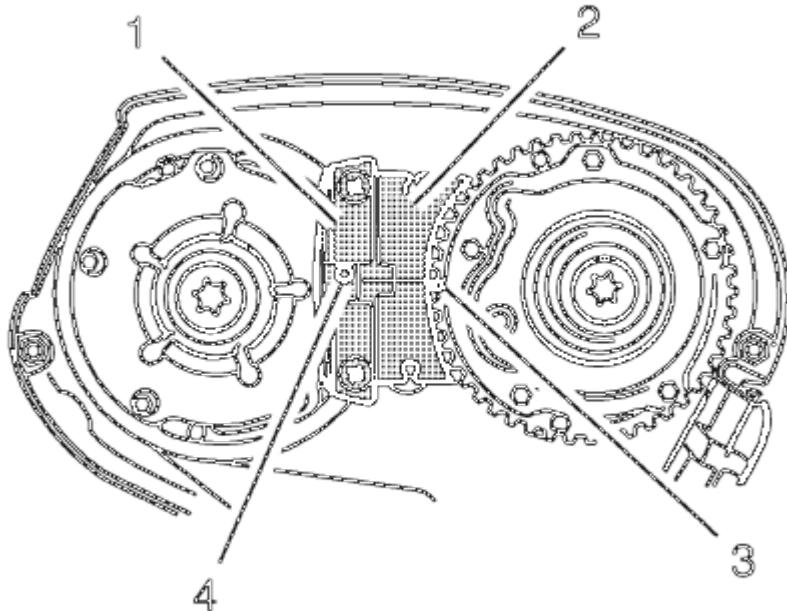


Fig. 375: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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.

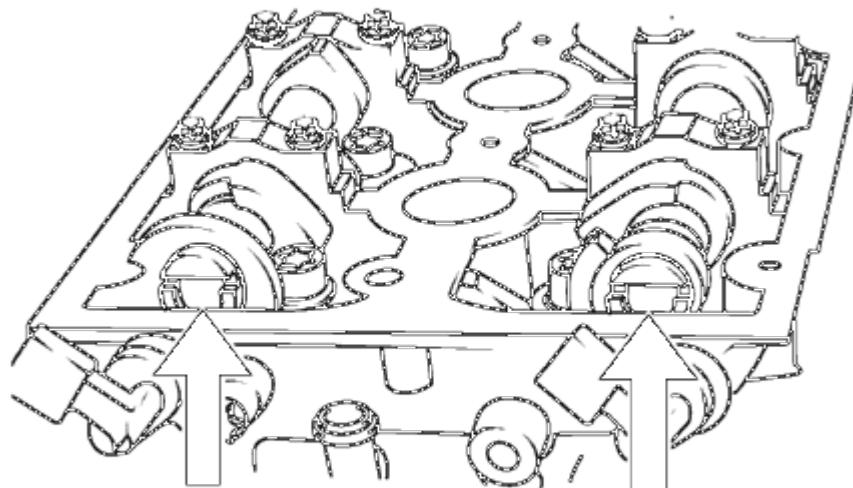


Fig. 376: Aligning Camshafts Horizontally

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.

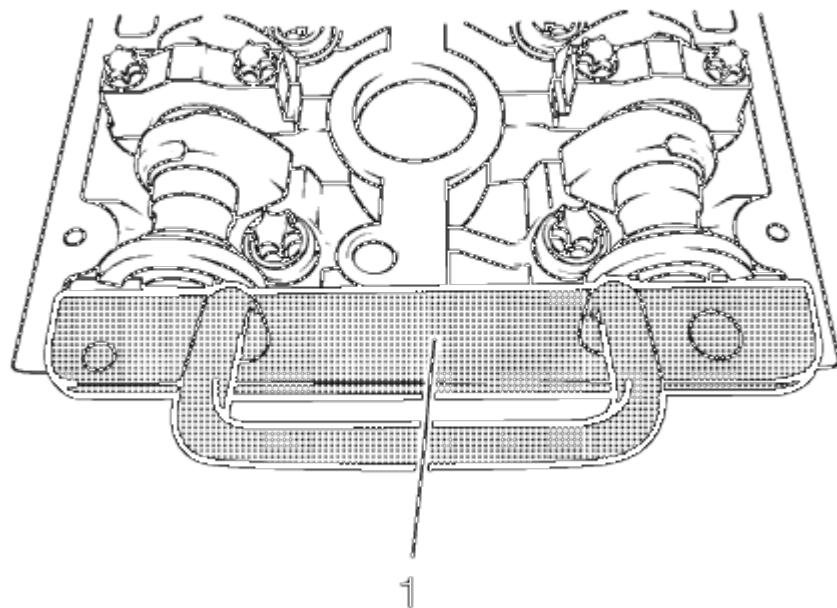


Fig. 377: Locking Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the EN-6628-A locking tool (1).

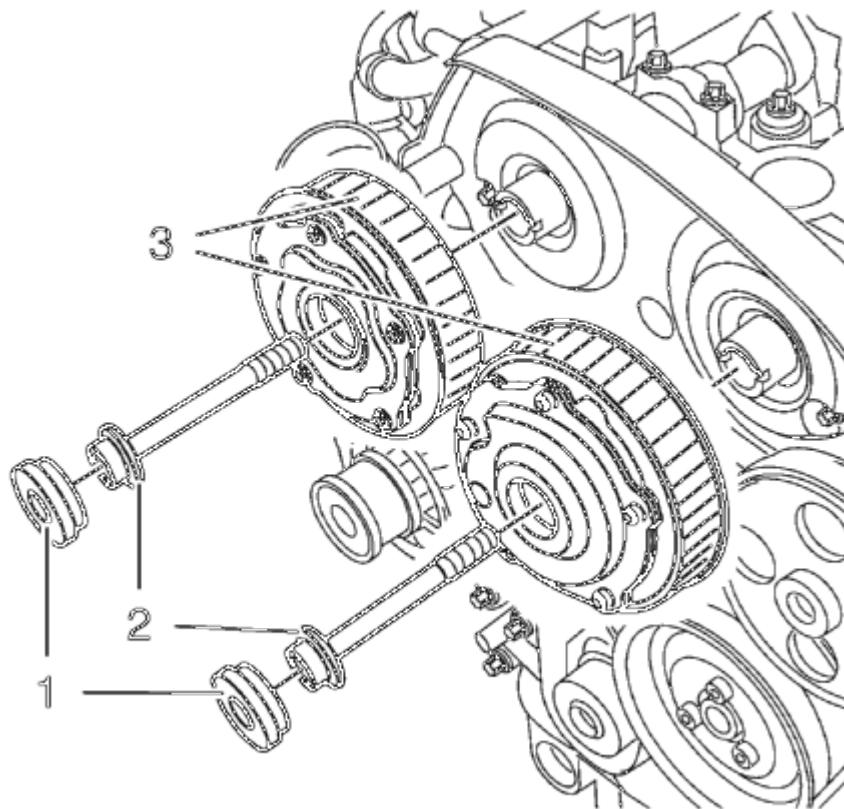


Fig. 378: Camshaft Position Actuator Adjuster Closure Bolt

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**.

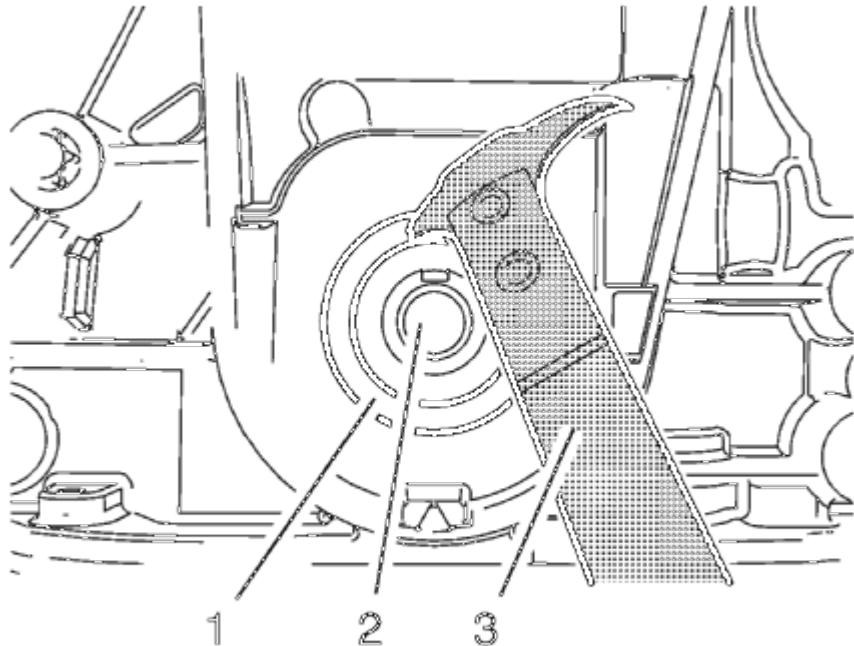


Fig. 379: Crankshaft Front Oil Seal Removal Tool

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

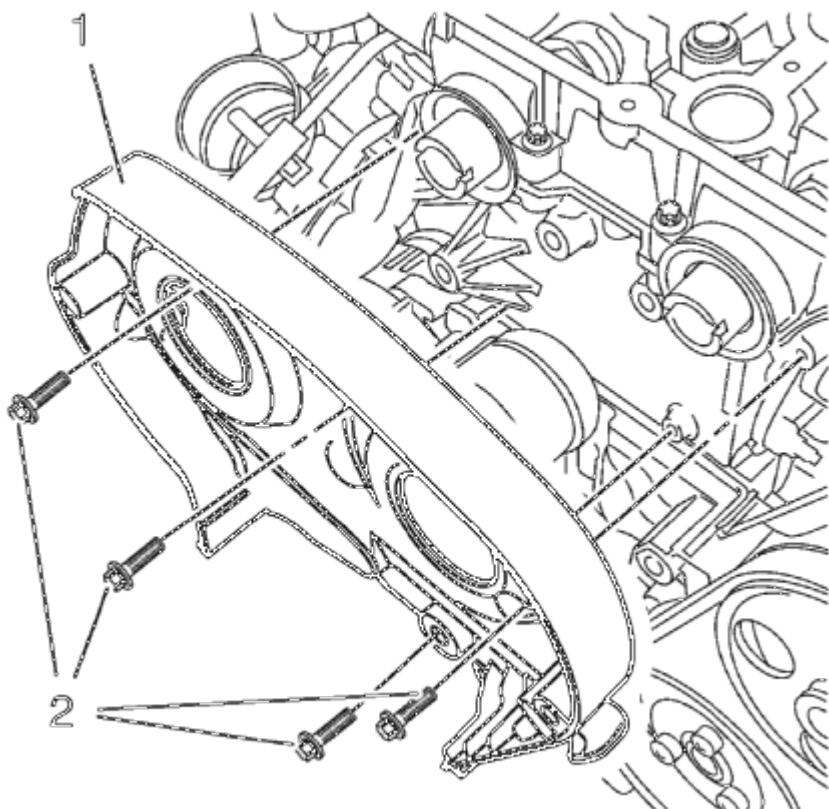


Fig. 380: Timing Belt Rear Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD the 4 timing belt rear cover bolts (2).
2. Remove the timing belt rear cover (1).

THROTTLE BODY ASSEMBLY REMOVAL

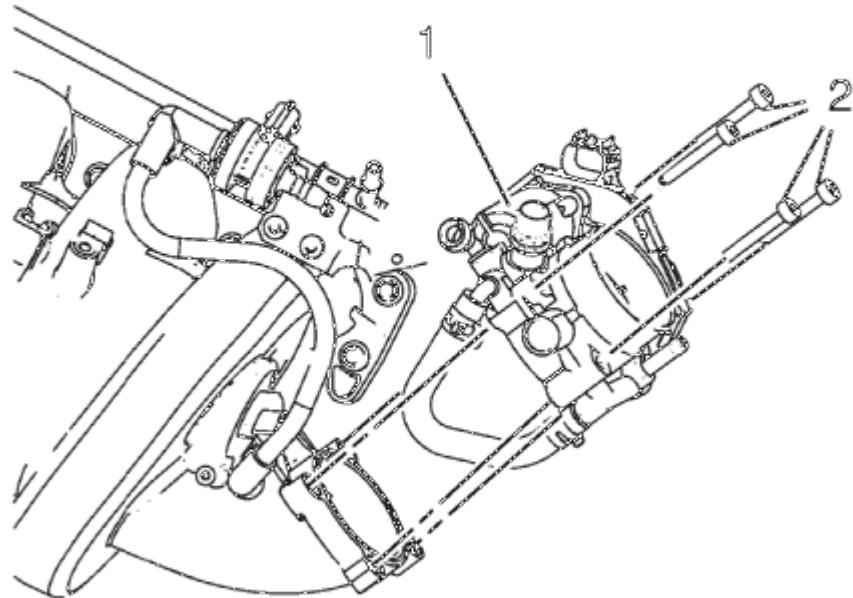


Fig. 381: Throttle Body And Bolts

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 (1.8L LUW AND LWE)

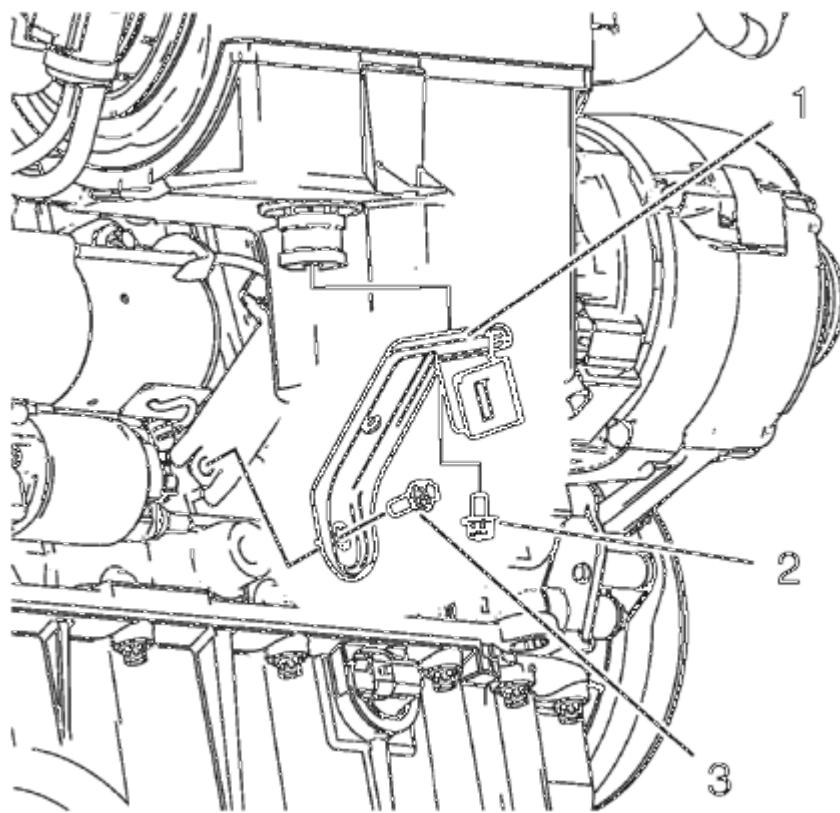


Fig. 382: Intake Manifold Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 intake manifold brace bolts (2, 3).
2. Remove the intake manifold brace (1).

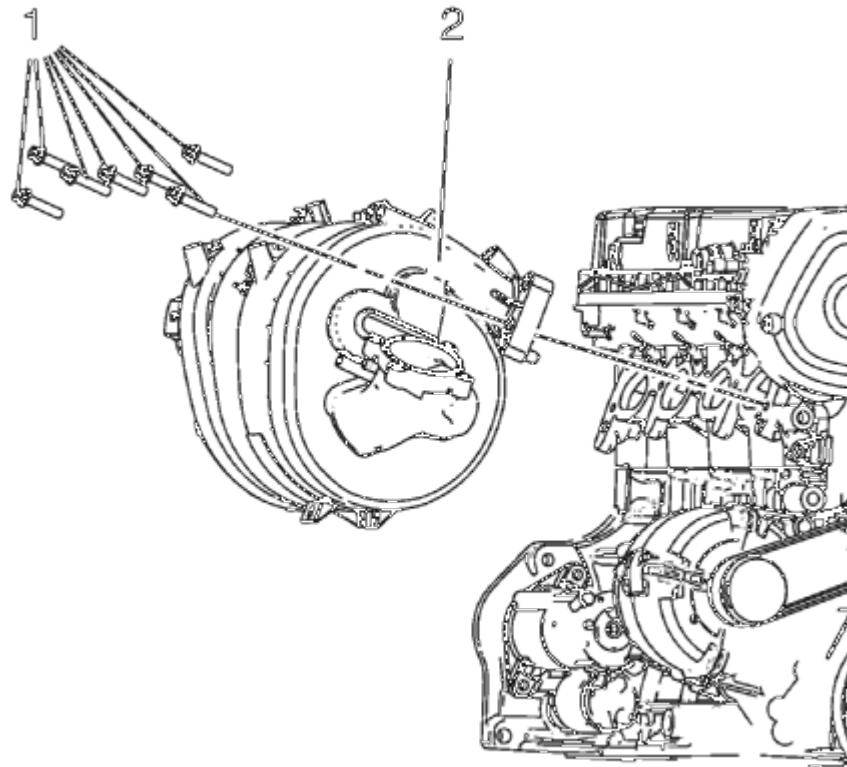


Fig. 383: Intake Manifold And Bolts

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.

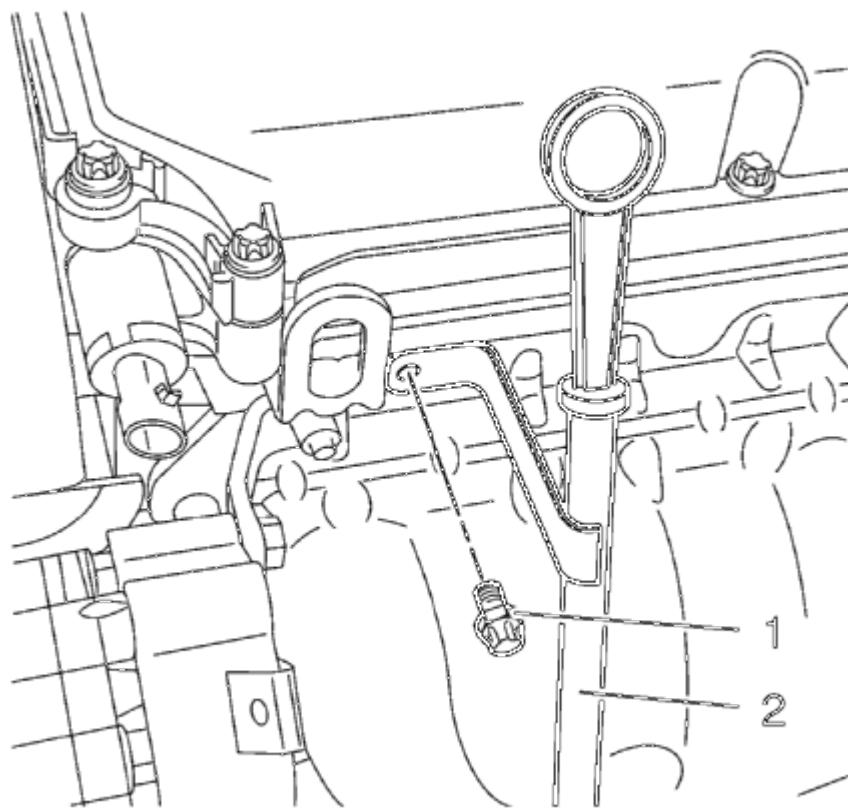


Fig. 384: Oil Level Indicator Tube And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

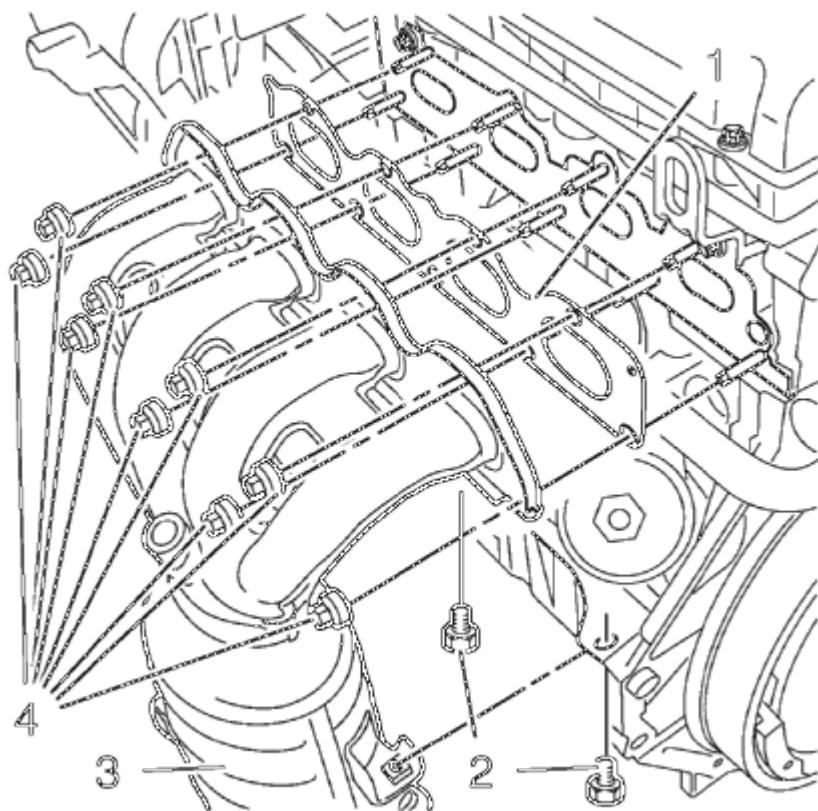


Fig. 385: Exhaust Manifold And Bolts

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

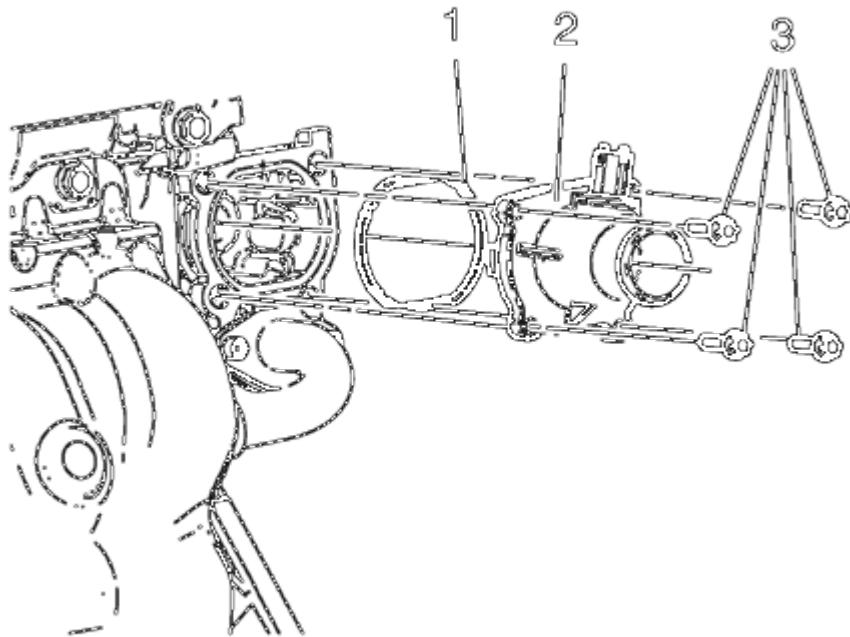


Fig. 386: Identifying Engine Coolant Thermostat Assembly
Courtesy of GENERAL MOTORS COMPANY

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

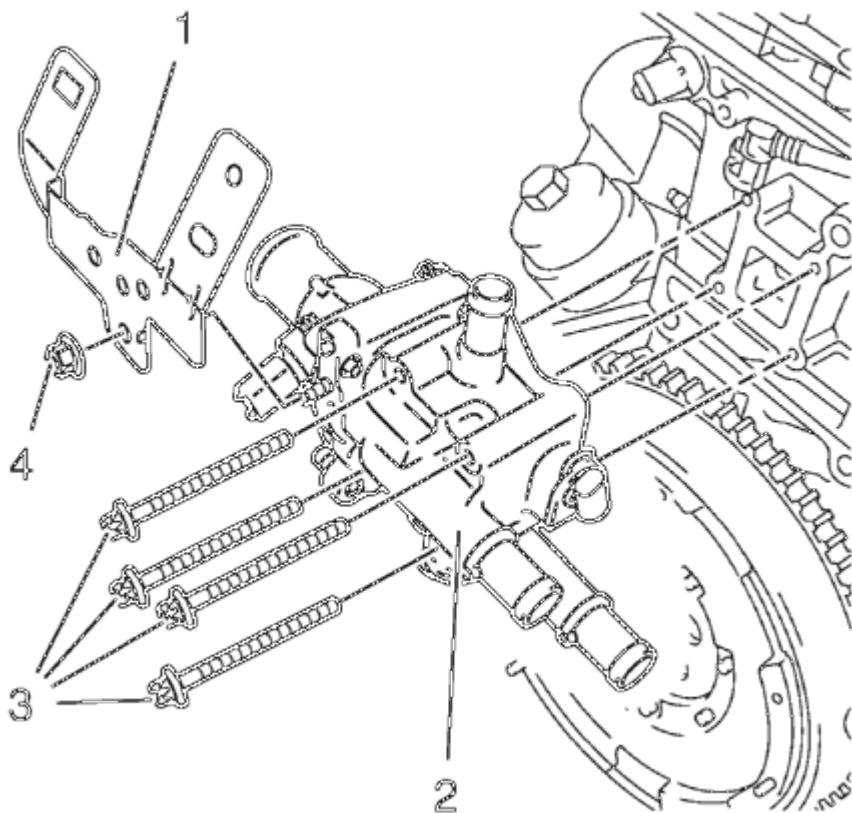


Fig. 387: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

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

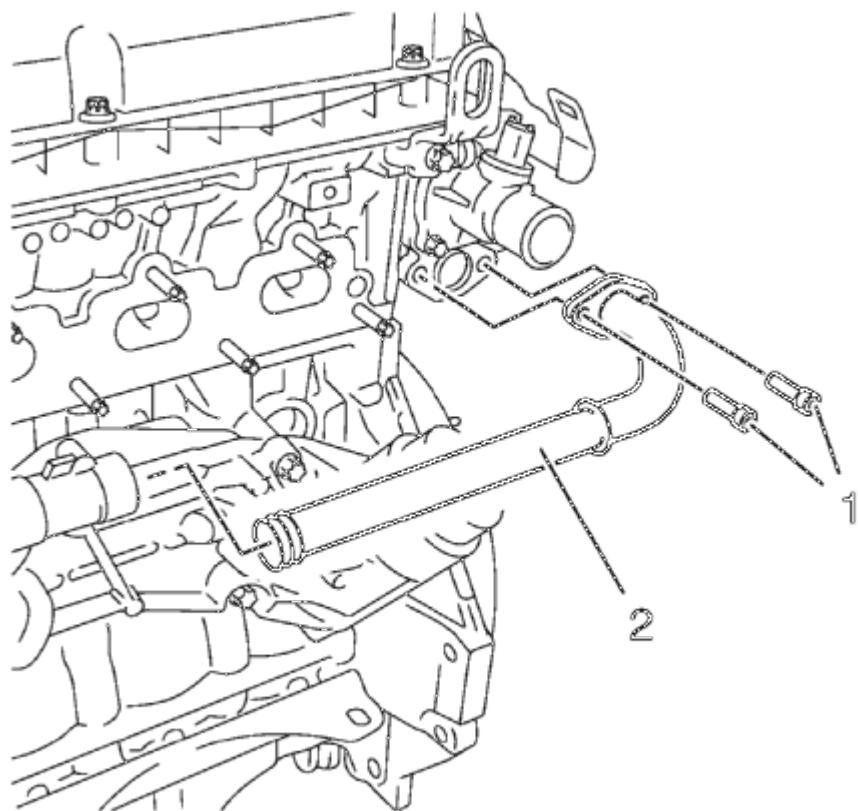


Fig. 388: Identifying Engine Oil Cooler Outlet Pipe And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 engine oil cooler pipe bolts (1).
2. Remove the oil cooler pipe (2).

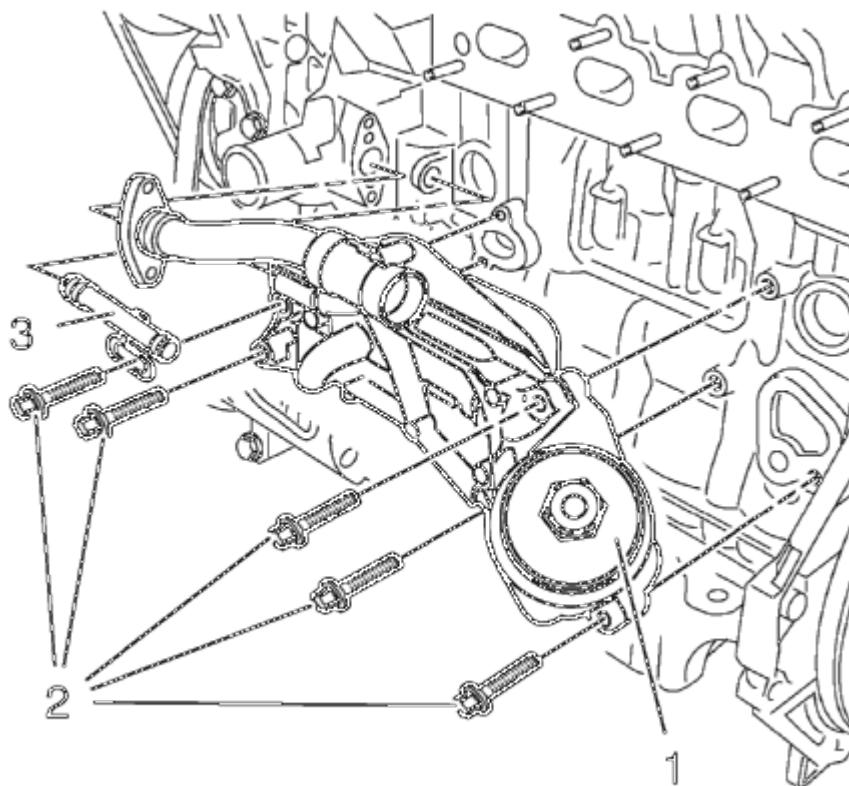


Fig. 389: Identifying Engine Oil Cooler Housing, Bolts And Engine Oil Cooler Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

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

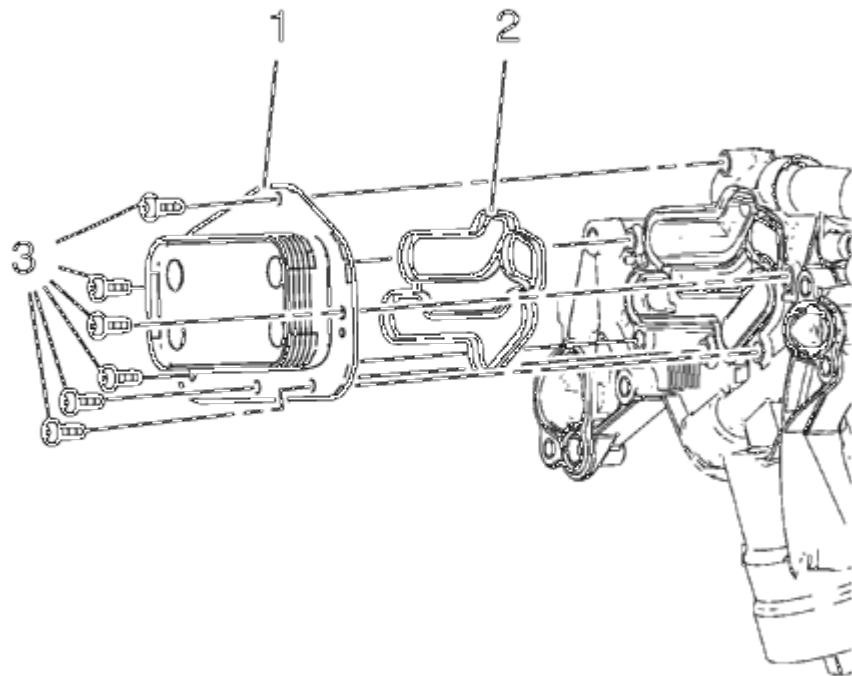


Fig. 390: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

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

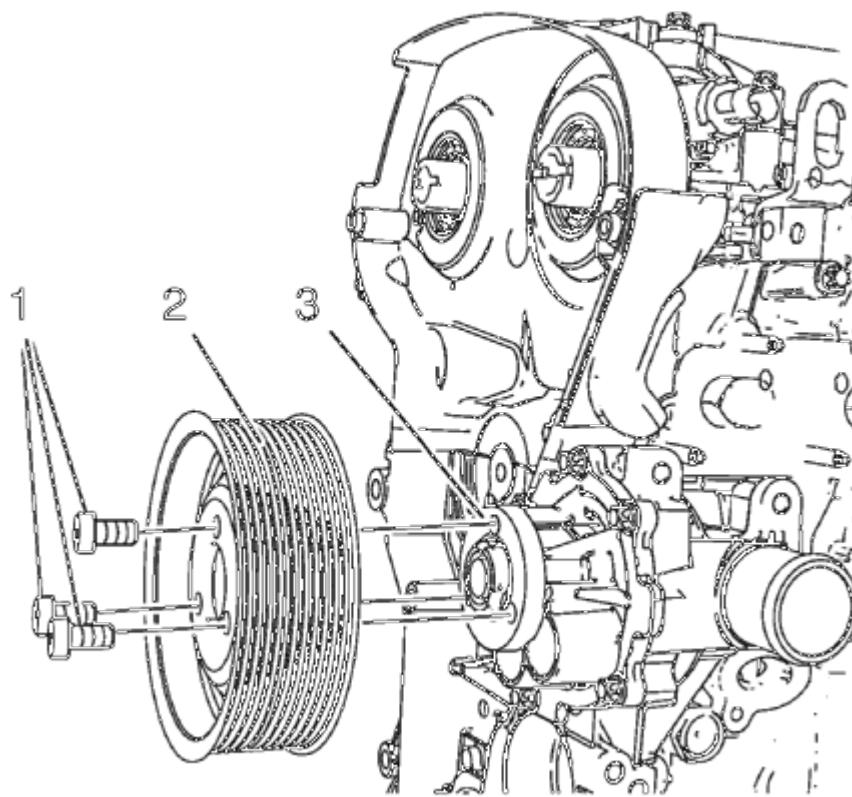


Fig. 391: Water Pump And Water Pump Pulley
Courtesy of GENERAL MOTORS COMPANY

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

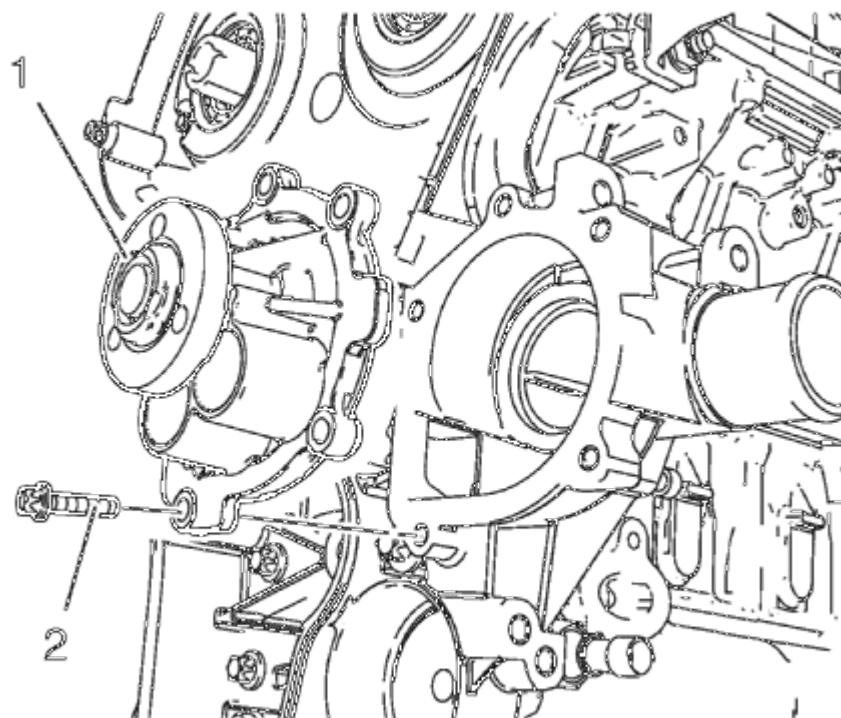


Fig. 392: Water Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 5 water pump bolts (2).
2. Remove the water pump (1).
3. Remove the water pump seal.

ENGINE OIL HEATER REMOVAL

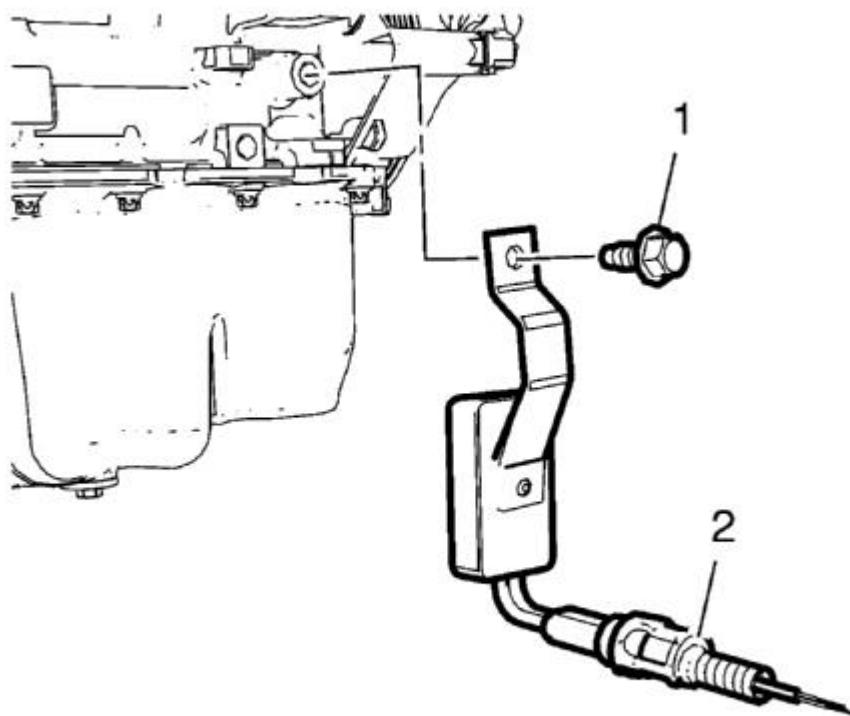


Fig. 393: Engine Oil Heater

Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil heater bolt (1).
2. Remove the engine oil heater (2).

OIL PAN REMOVAL

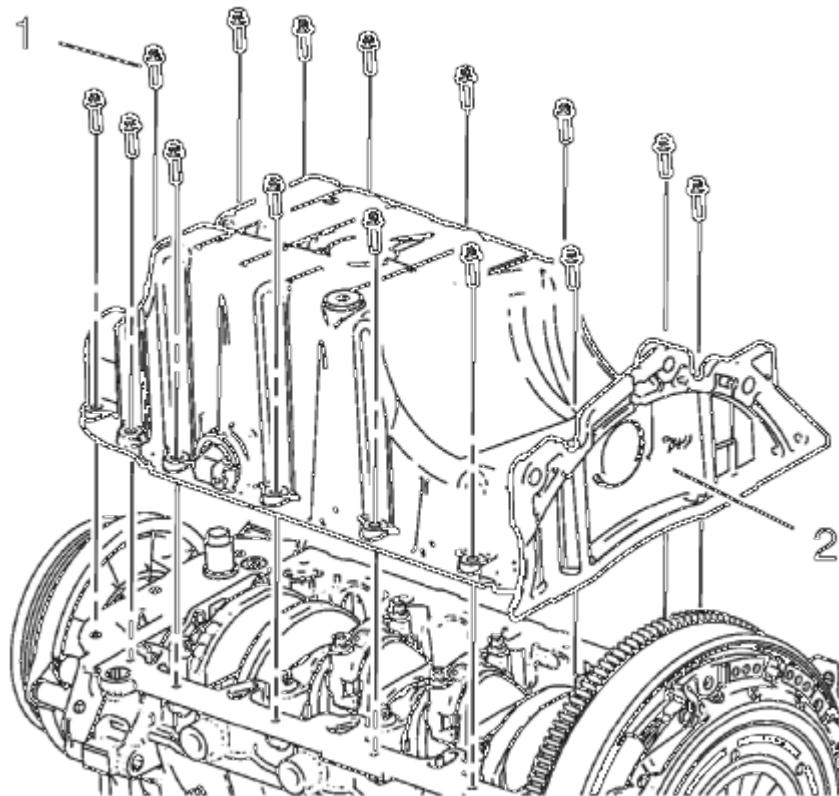


Fig. 394: Oil Pan And Bolts

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

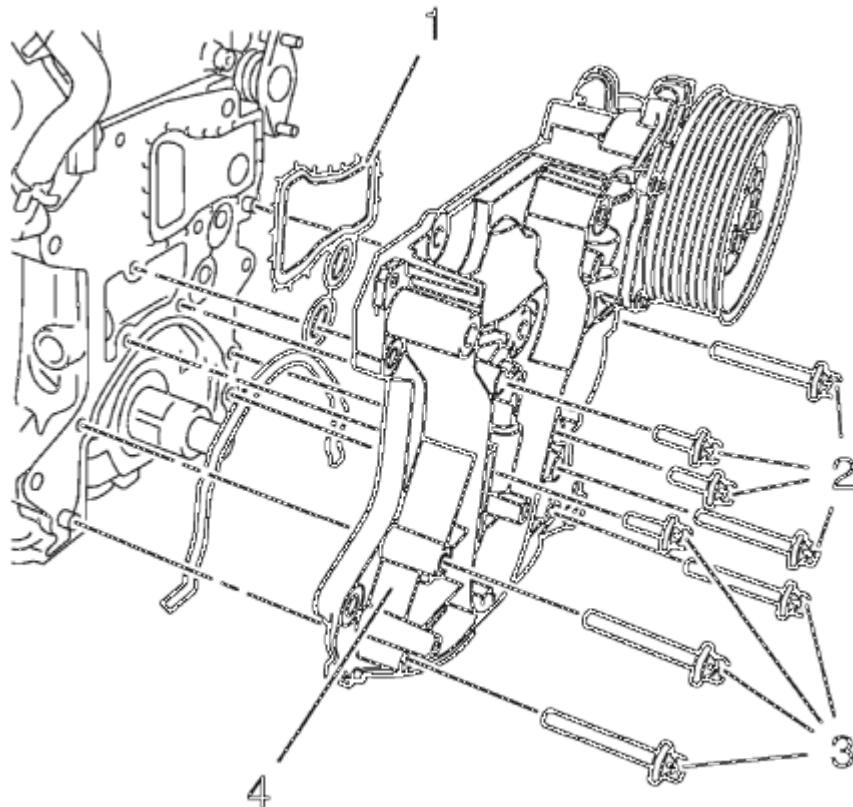


Fig. 395: Engine Oil Pump

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.

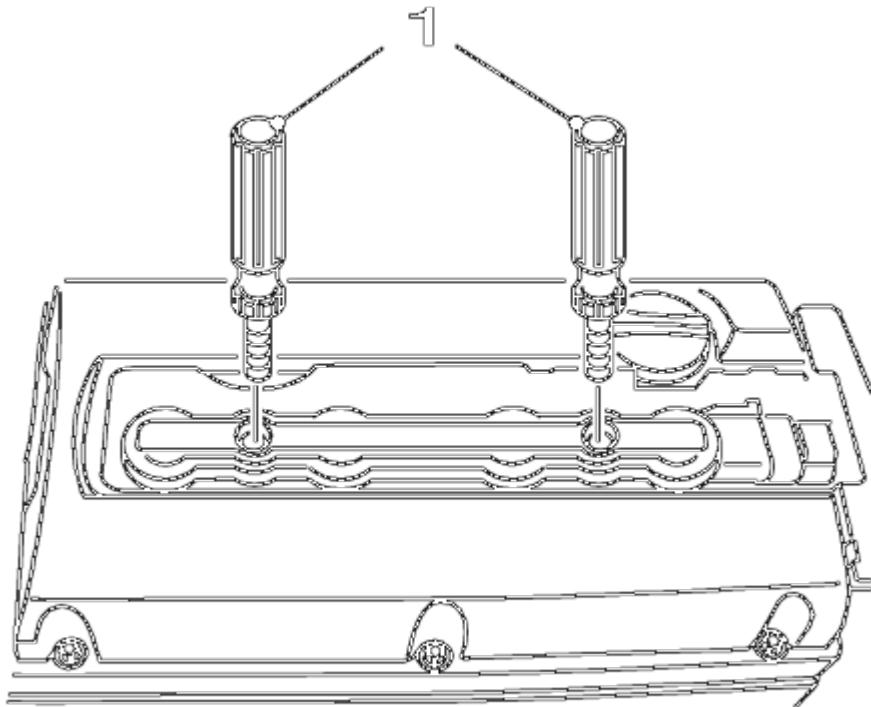


Fig. 396: View Of KM-6009
Courtesy of GENERAL MOTORS COMPANY

3. Install the EN-6009 remover/installer (1).

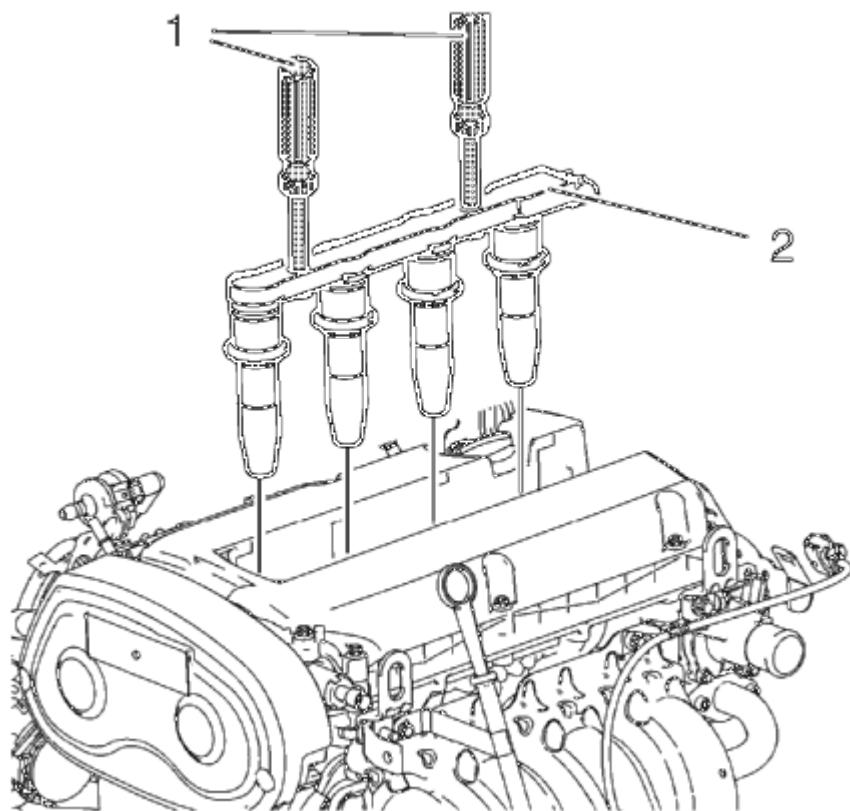


Fig. 397: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ignition coil module (2) with the **EN-6009** remover/installer (1).

CAMSHAFT COVER REMOVAL

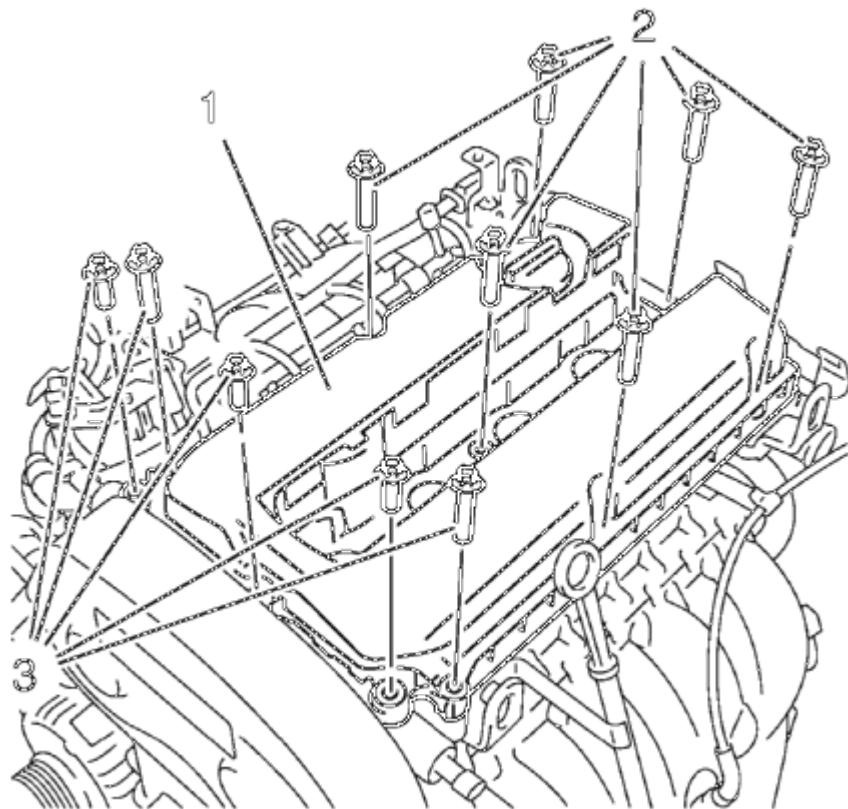


Fig. 398: Camshaft Cover And Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 11 bolts (2, 3).
2. Remove the camshaft cover (1).

CAMSHAFT REMOVAL

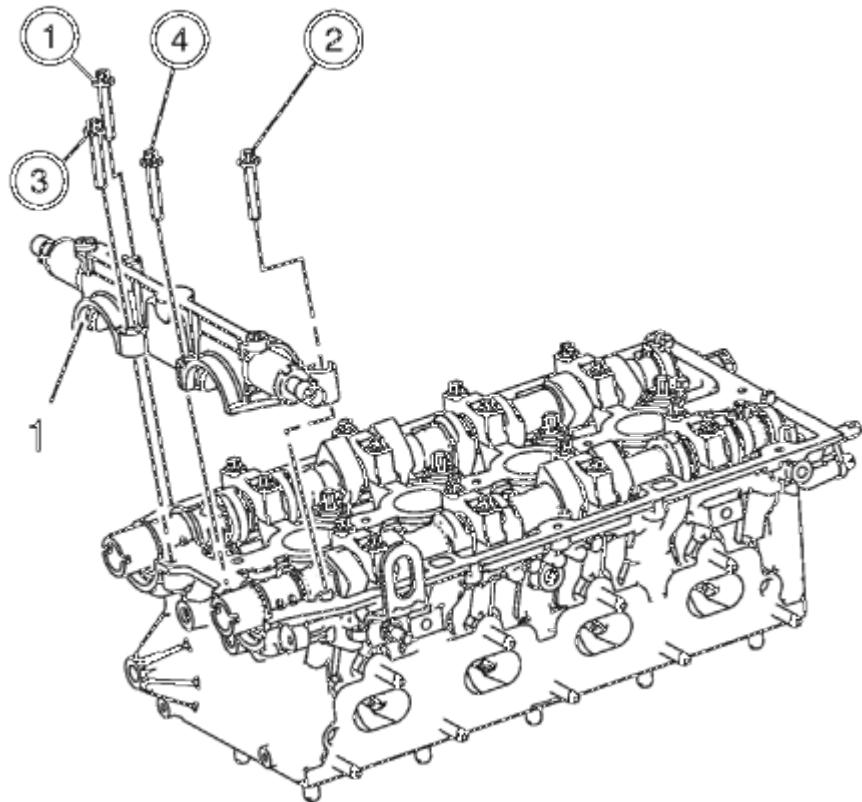


Fig. 399: Camshaft Bearing Cap And Camshaft Bearing Cap Bolts Removal Sequence
Courtesy of GENERAL MOTORS COMPANY

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).

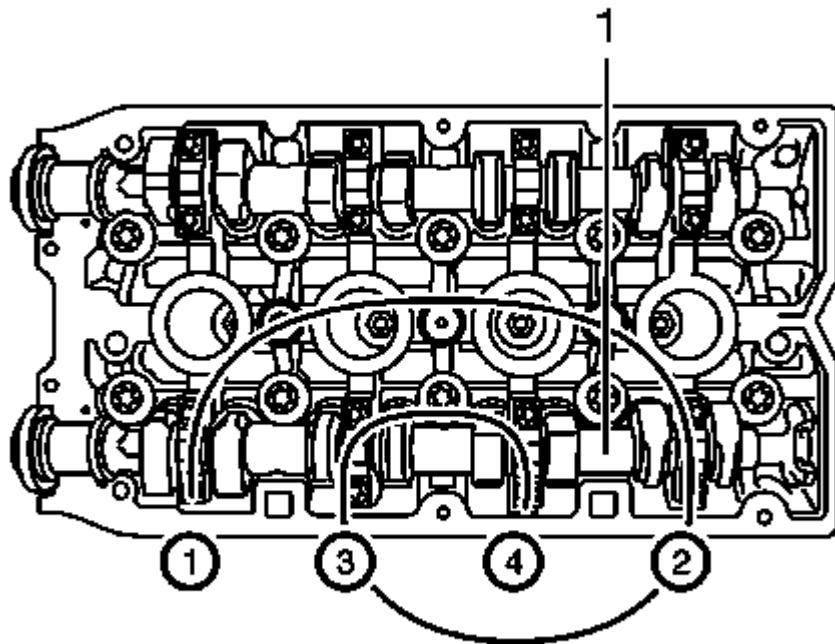


Fig. 400: Exhaust Camshaft Bearing Cap Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

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).

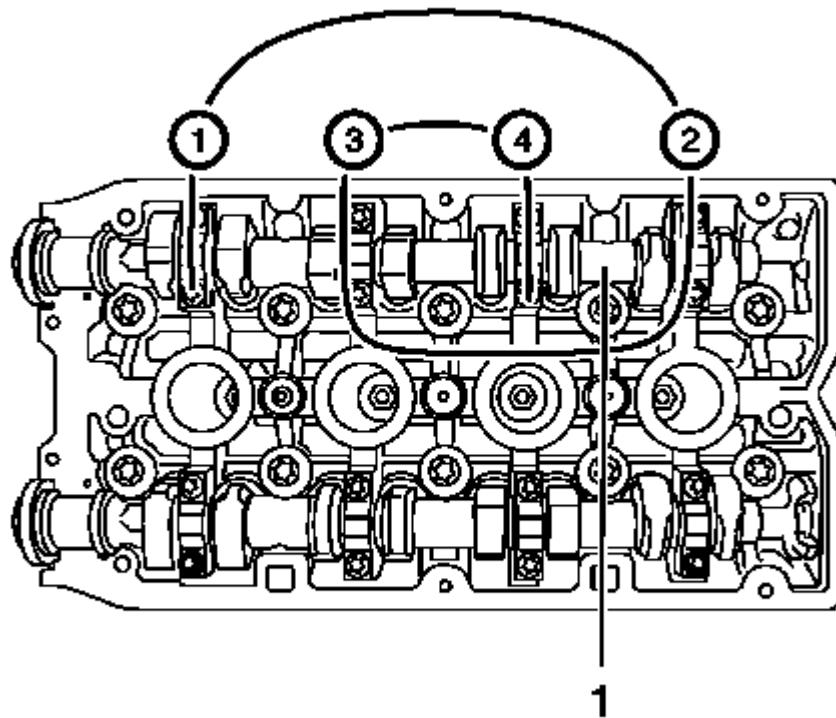


Fig. 401: Intake Camshaft Bearing Cap Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

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**.

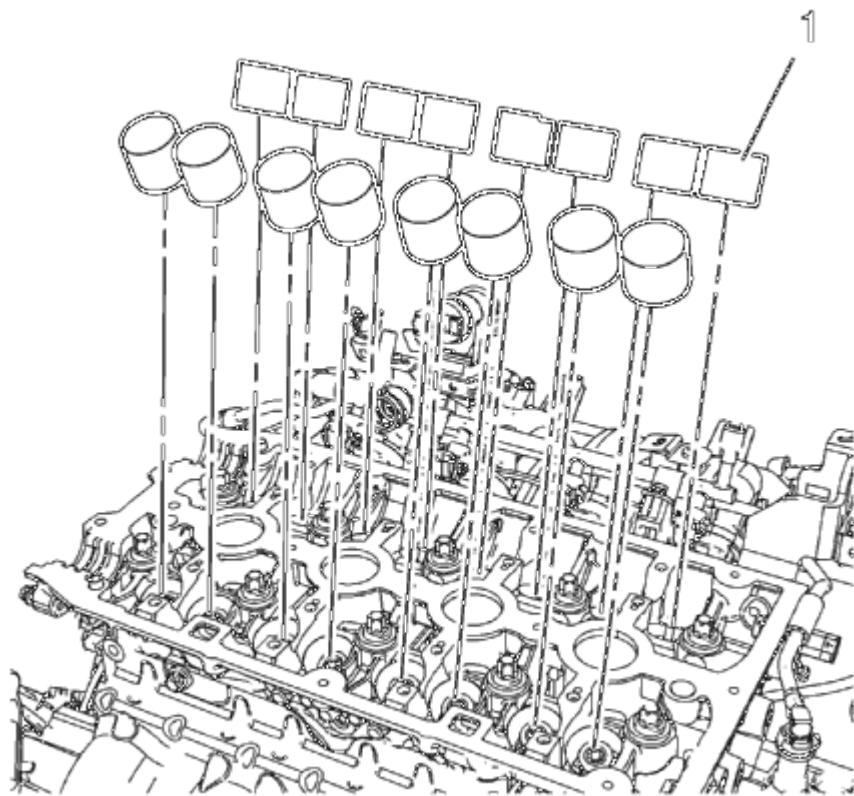


Fig. 402: Valve Lifters

Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the locations.

Remove the 16 valve lifter (1) use the **EN-845** suction device.

CYLINDER HEAD REMOVAL

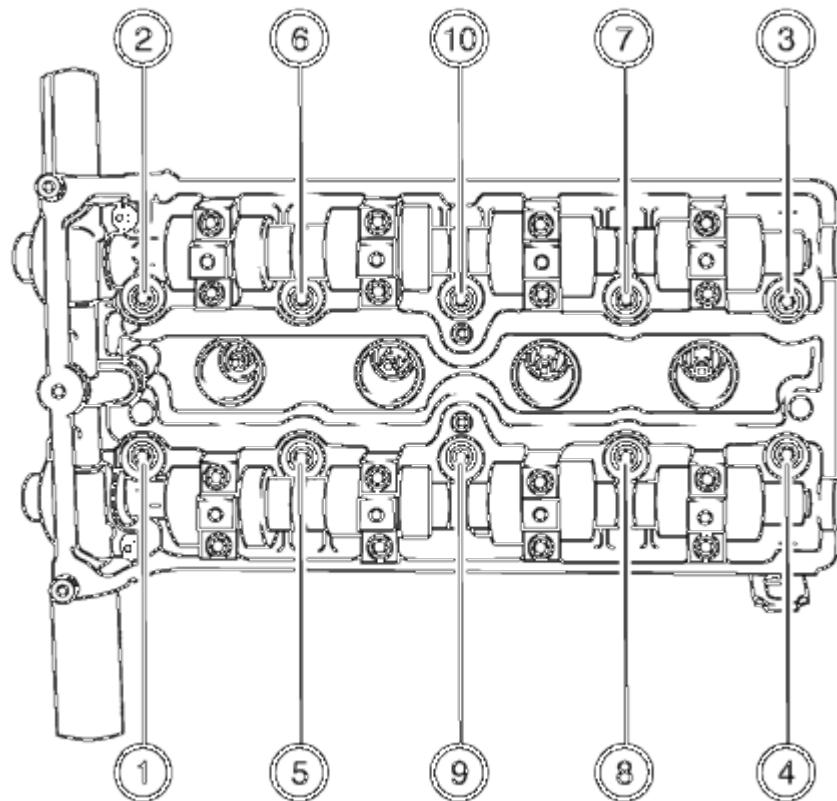


Fig. 403: Cylinder Head Bolts Tightening Sequence

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.

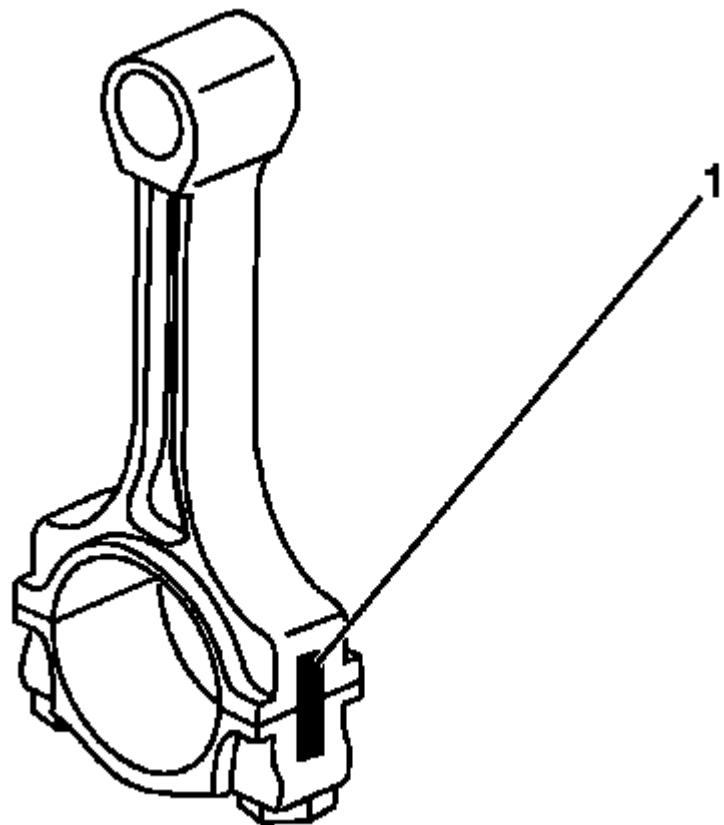


Fig. 404: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note cylinder sequence.

3. Mark the connecting rod with the connecting rod bearing cover (1).

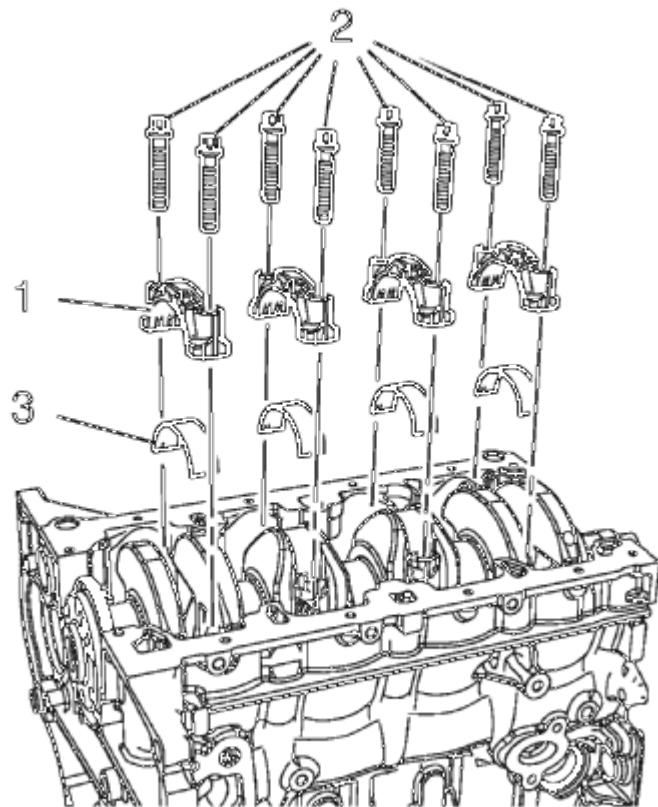


Fig. 405: Connecting Rod Bearing, Connecting Rod Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

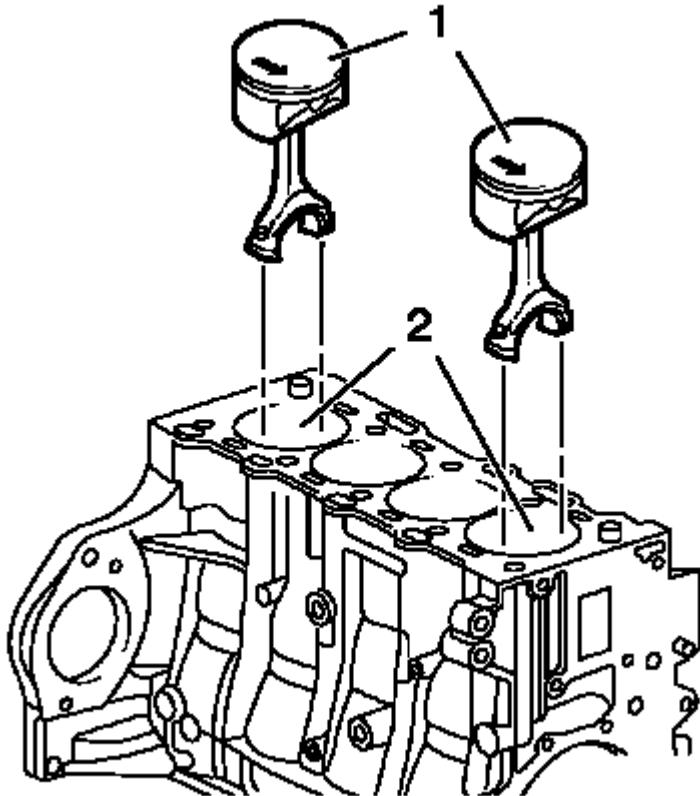


Fig. 406: Pistons 1, 4 And Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

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.

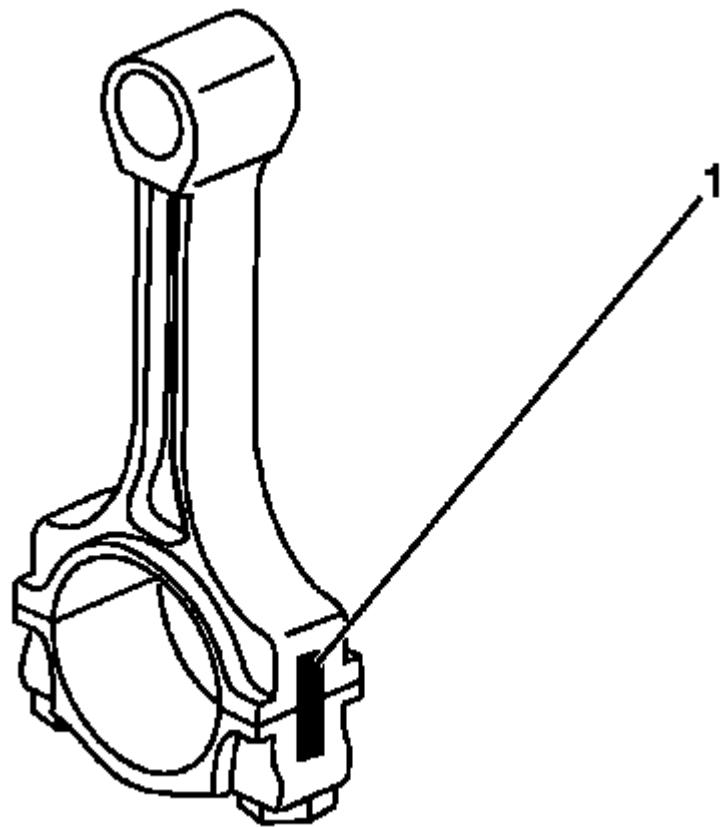


Fig. 407: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note cylinder sequence.

9. Mark the connecting rod with the connecting rod bearing cover (1).

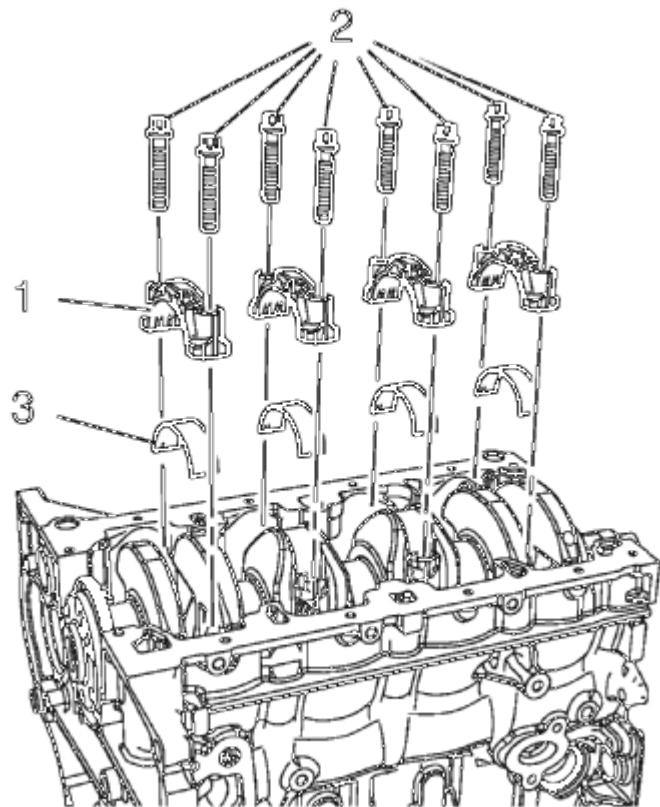


Fig. 408: Connecting Rod Bearing, Connecting Rod Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

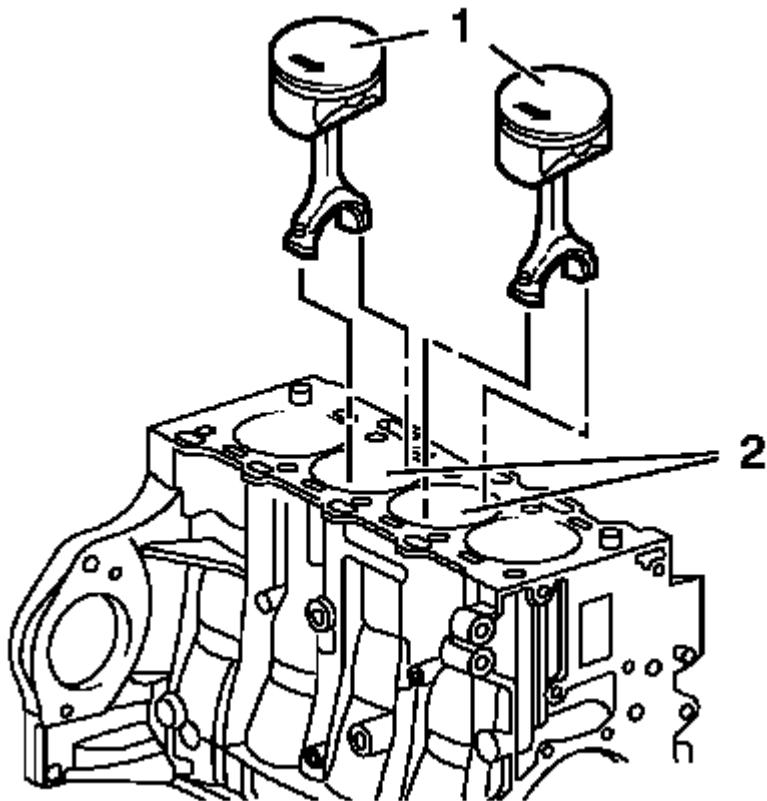


Fig. 409: Pistons 2, 3 And Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

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).

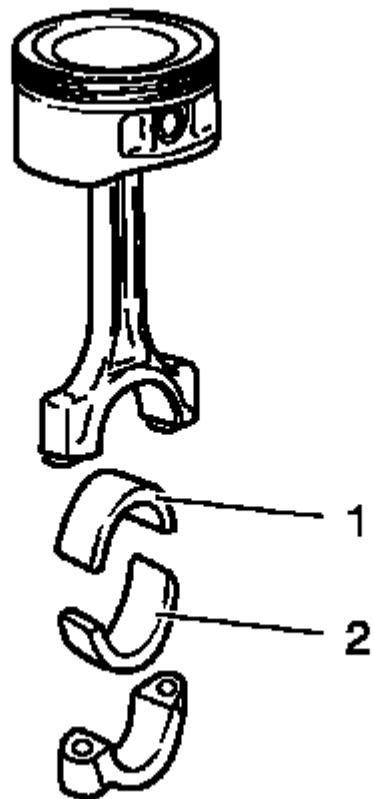


Fig. 410: Connecting Rod Bearing
Courtesy of GENERAL MOTORS COMPANY

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

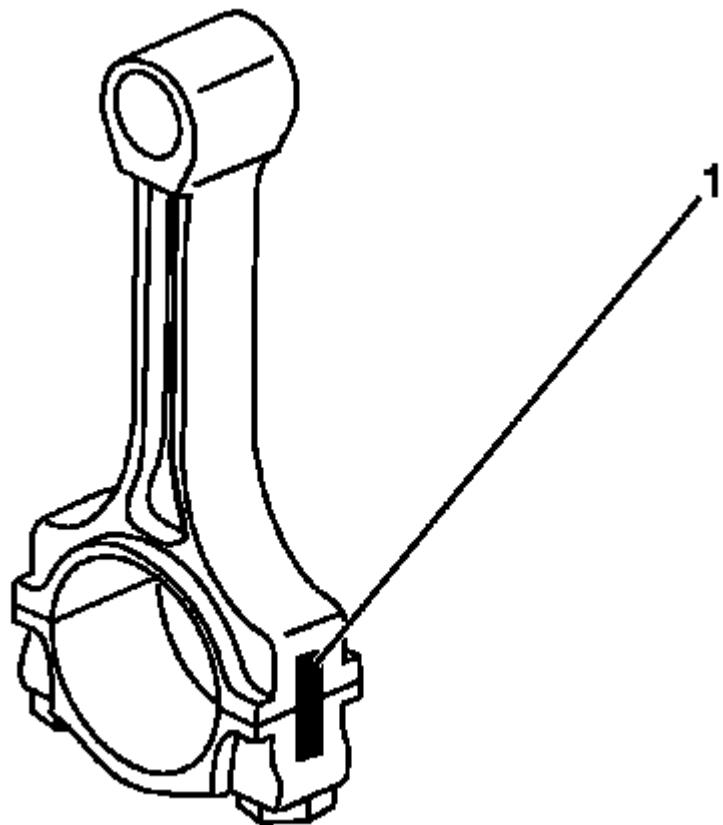


Fig. 411: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

1. Identify all the connecting rod bearing caps (1).

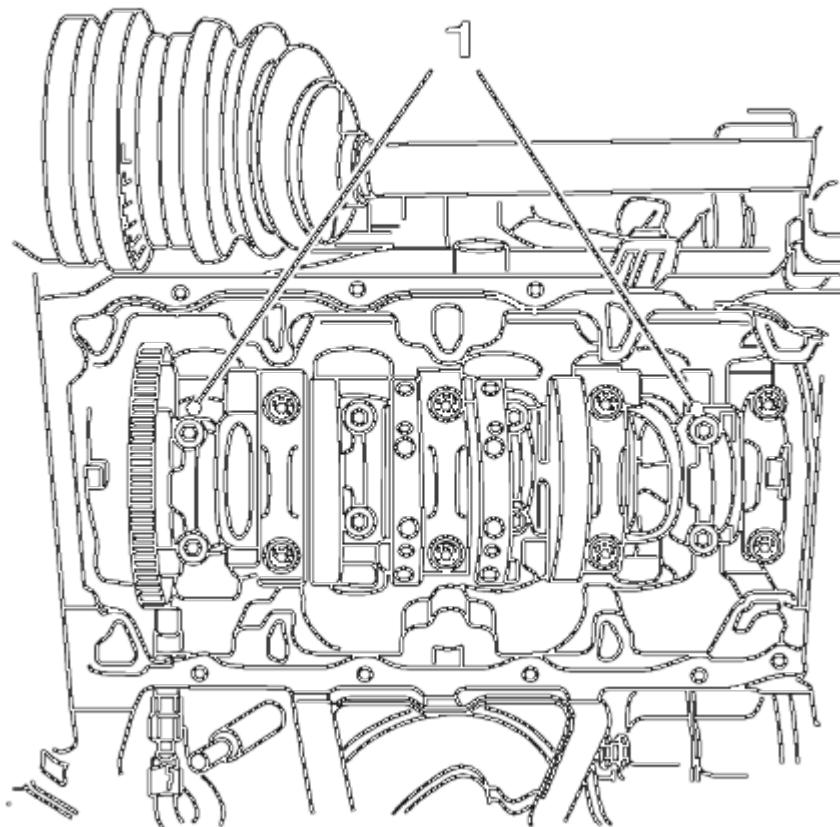


Fig. 412: View Of Con-Rod Bearing Caps

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°.

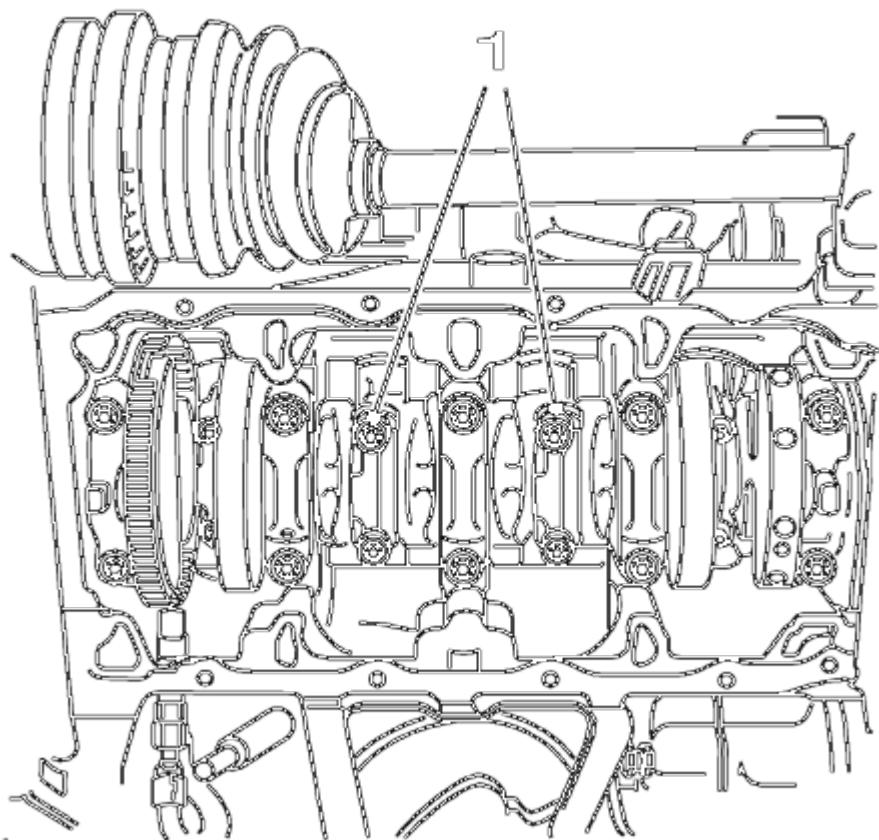


Fig. 413: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 bolts.
6. Remove the connecting rod bearing caps 2 and 3 (1).
7. Identify the crankshaft bearing caps.

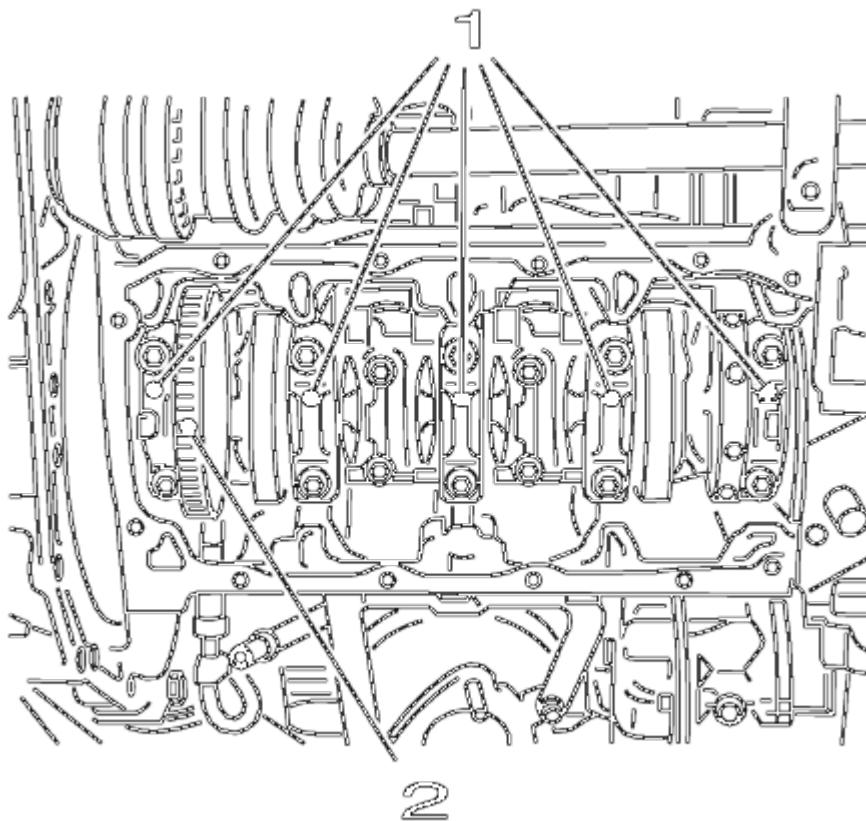


Fig. 414: View Of Crankshaft Bearing Cap Bolts

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 (1.8L LUW AND LWE)

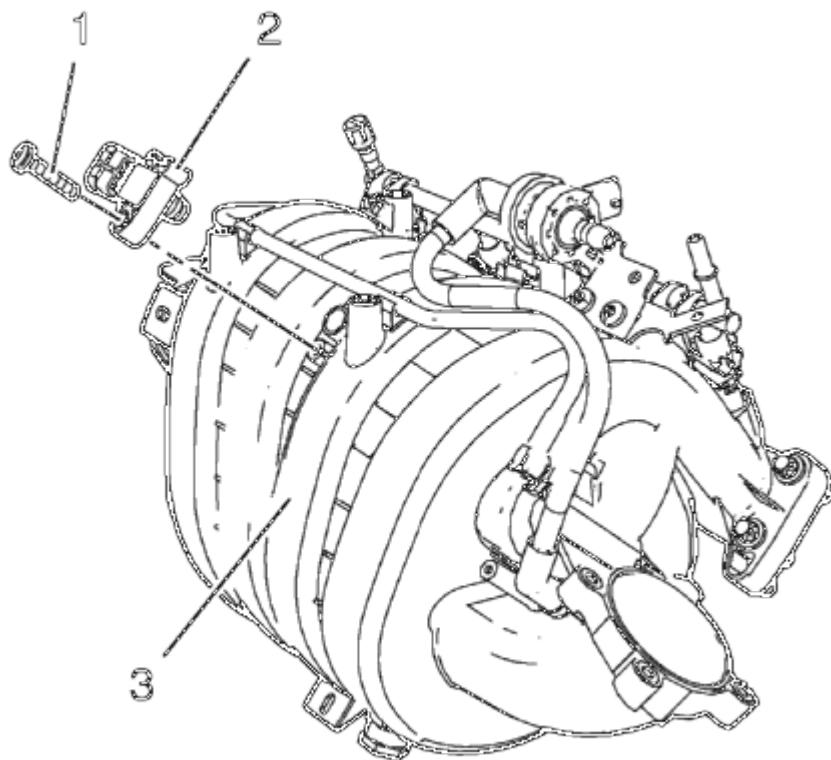


Fig. 415: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

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

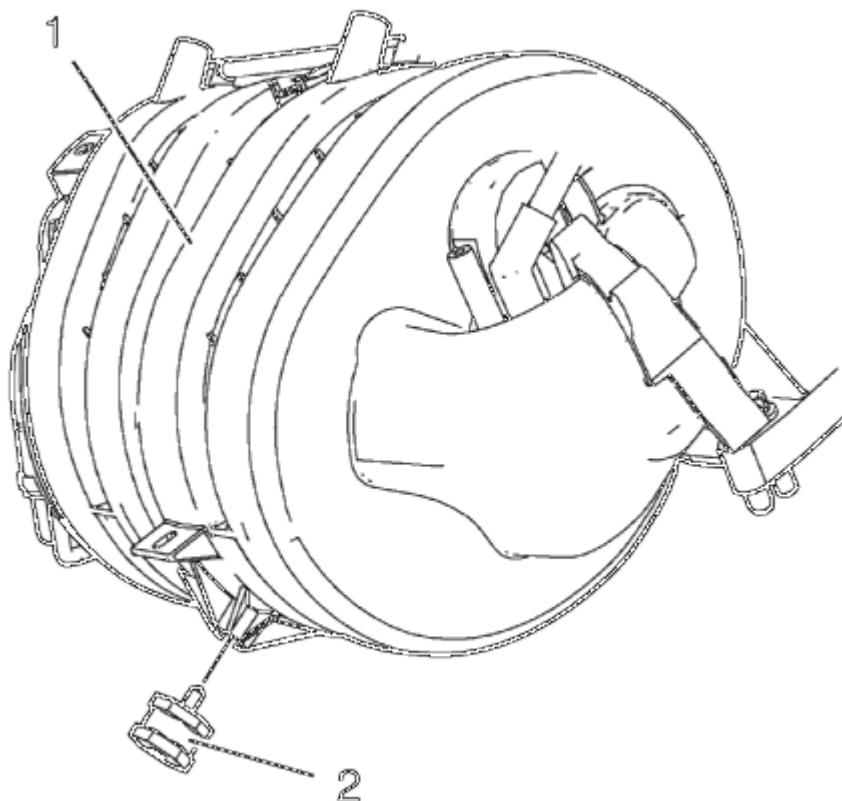


Fig. 416: Intake Manifold And Mount

Courtesy of GENERAL MOTORS COMPANY

3. Remove the intake manifold mount (2) from the intake manifold (1).

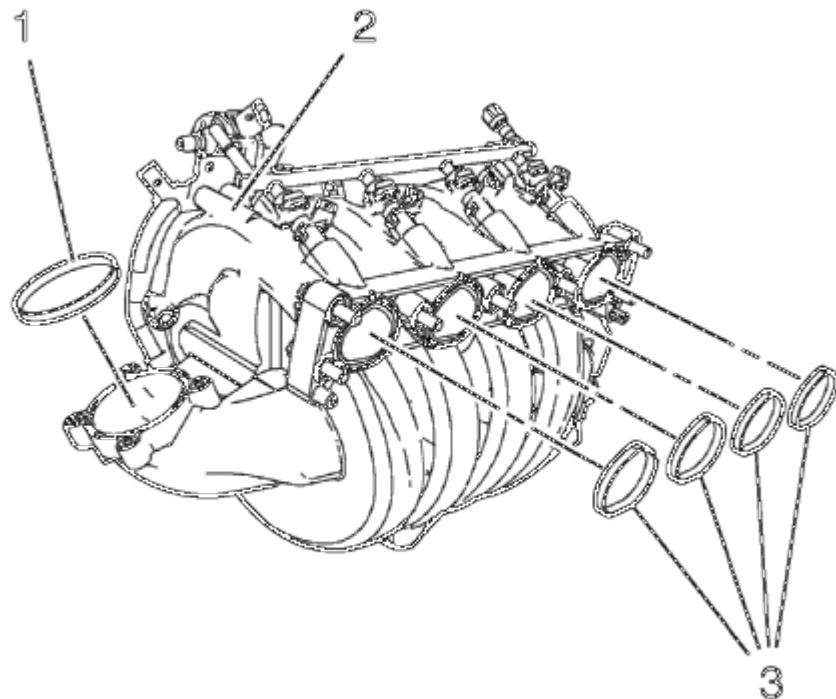


Fig. 417: Intake Manifold, Seal And Throttle Body Seal
Courtesy of GENERAL MOTORS COMPANY

4. Remove the throttle body seal (1).
5. Remove the intake manifold seal (3) from the intake manifold (2).

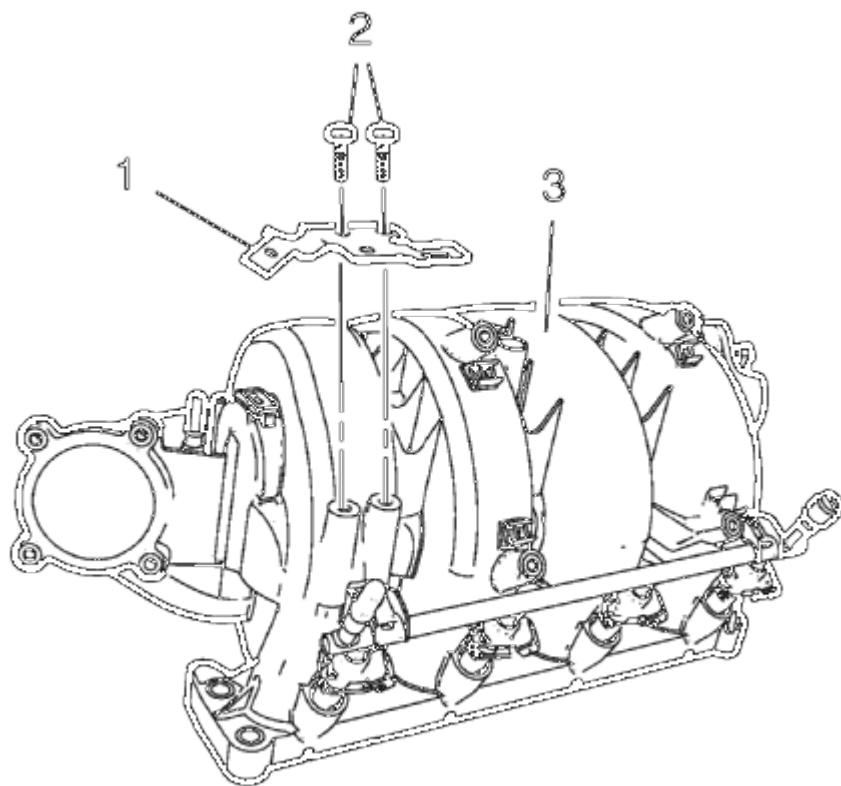


Fig. 418: Intake Manifold, Evaporative Emission Canister Purge Solenoid Valve Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

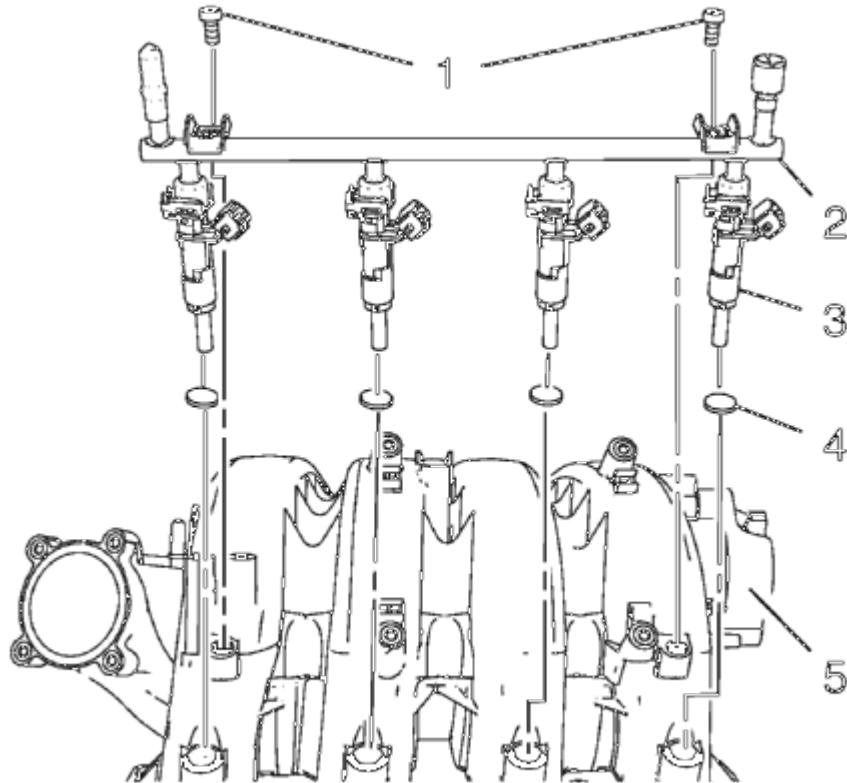


Fig. 419: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts
Courtesy of GENERAL MOTORS COMPANY

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](#).

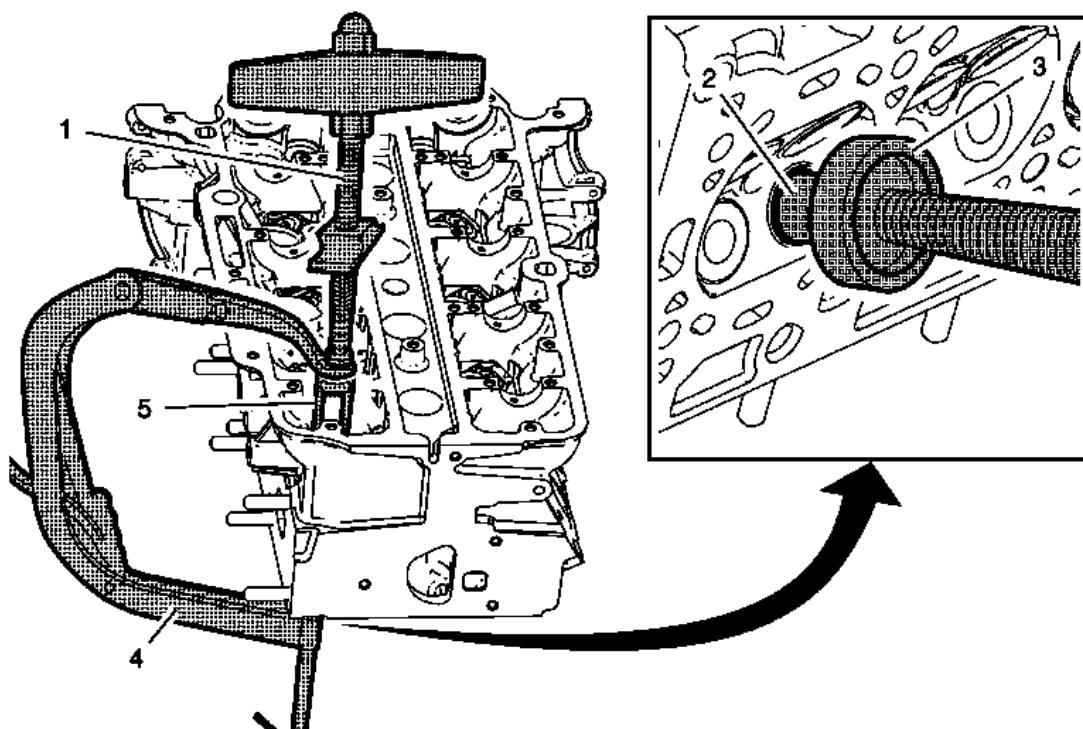


Fig. 420: Valve Spring Compressor And Adapter Assembly

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).

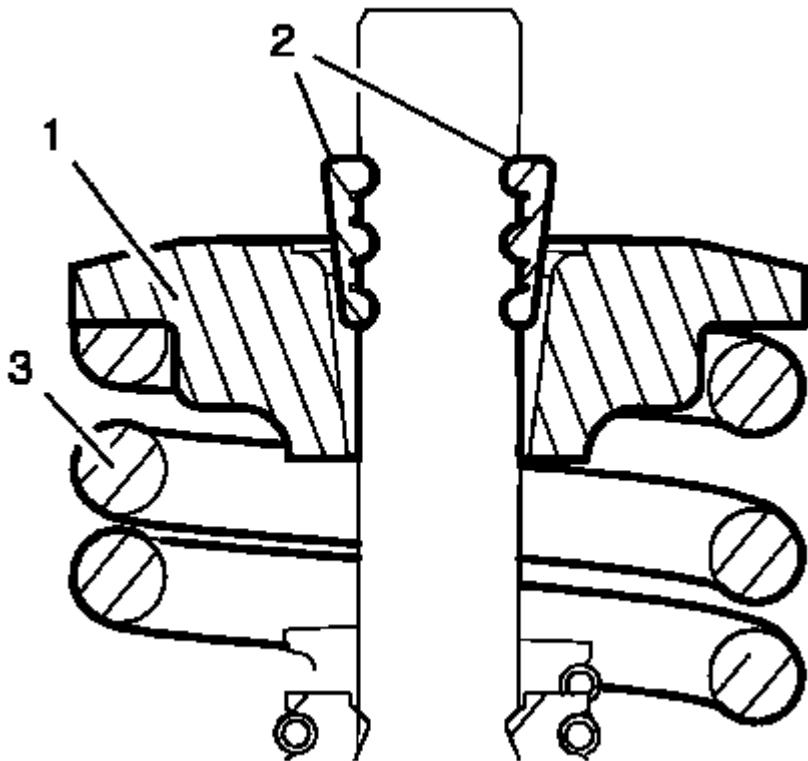
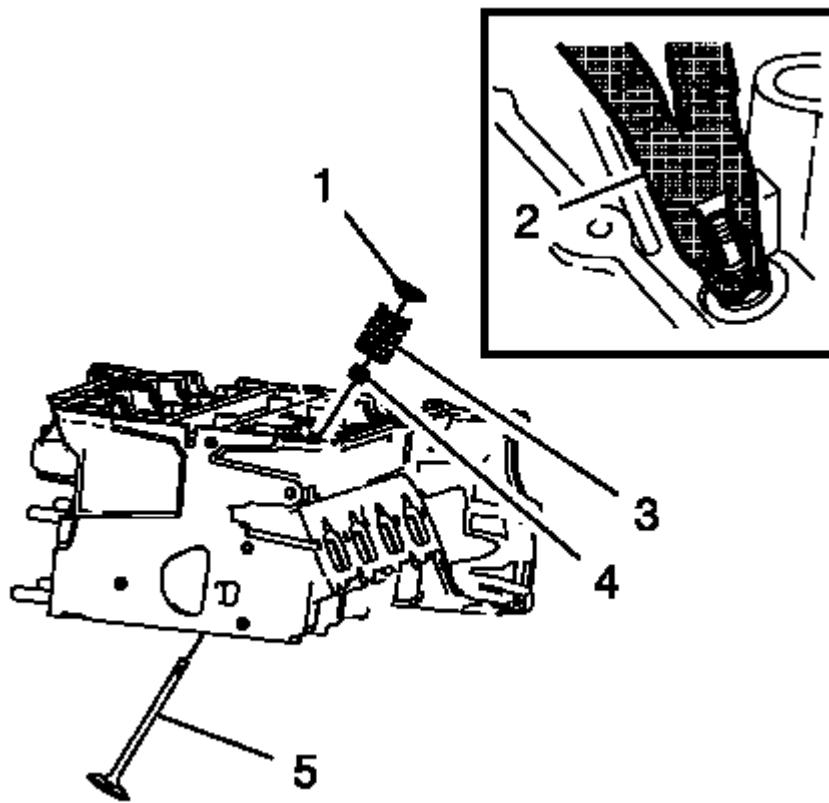


Fig. 421: Valve Spring Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

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 vale spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension. Carefully remove the valve keys.

**Fig. 422: 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**.

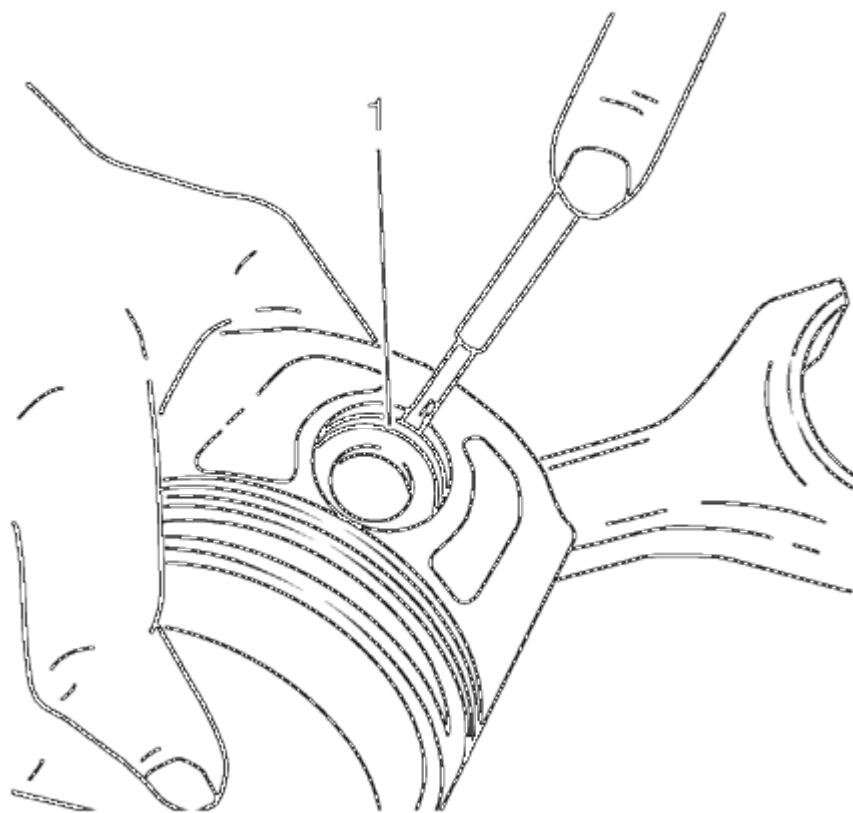


Fig. 423: Detaching Piston From Connecting Rod

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.

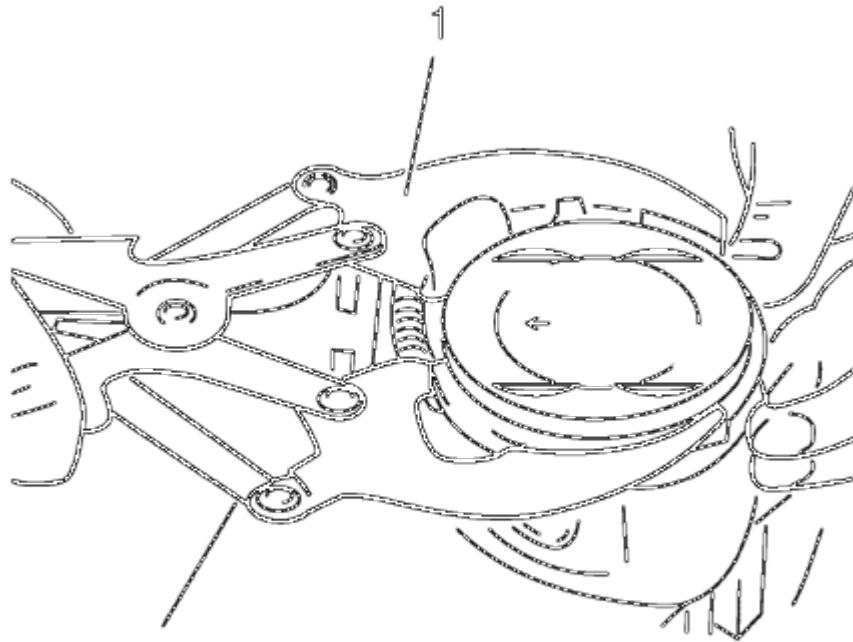


Fig. 424: Removing Piston Rings Using Piston Ring Pliers

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.

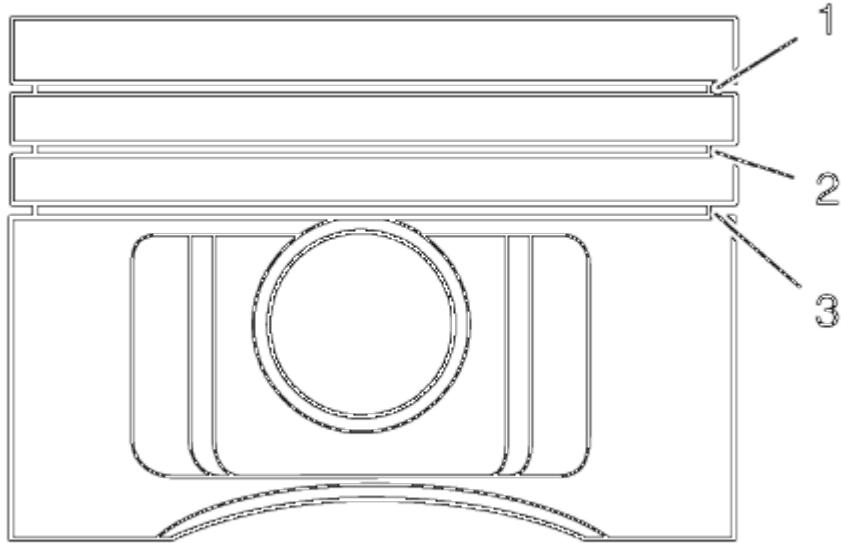


Fig. 425: Rectangular Compression Ring, Tapered Compression Ring And Oil Scraper Ring
Courtesy of GENERAL MOTORS COMPANY

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)

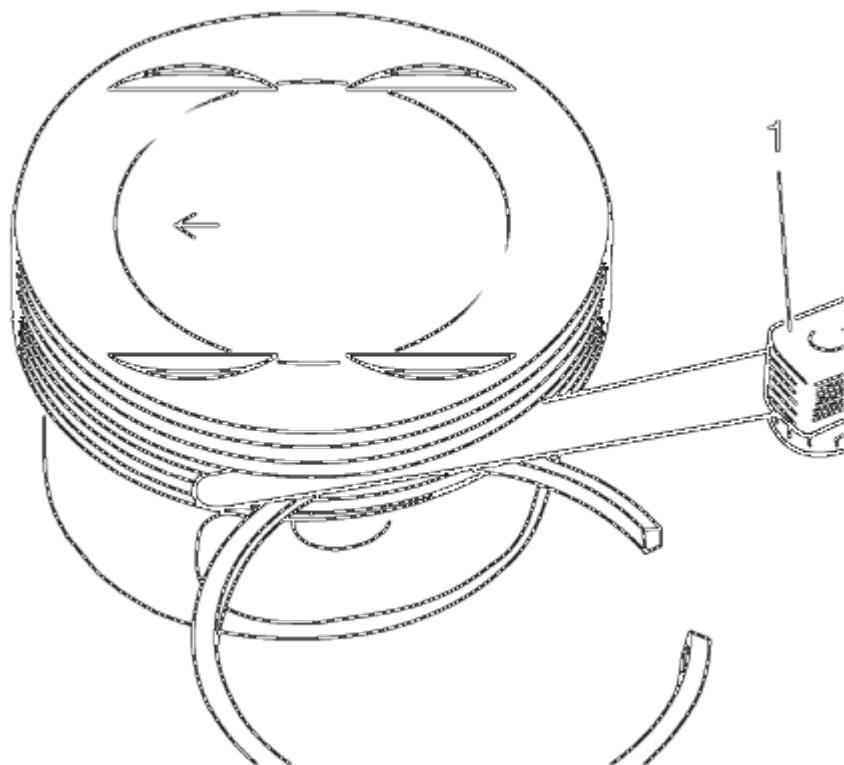


Fig. 426: Checking Piston Ring Vertical Play With Feeler Gauge
Courtesy of GENERAL MOTORS COMPANY

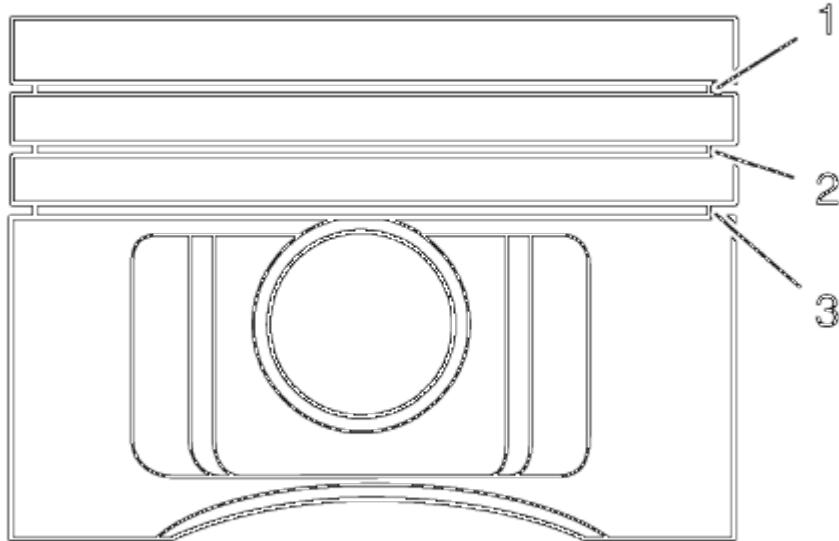


Fig. 427: Rectangular Compression Ring, Tapered Compression Ring And Oil Scraper Ring
Courtesy of GENERAL MOTORS COMPANY

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

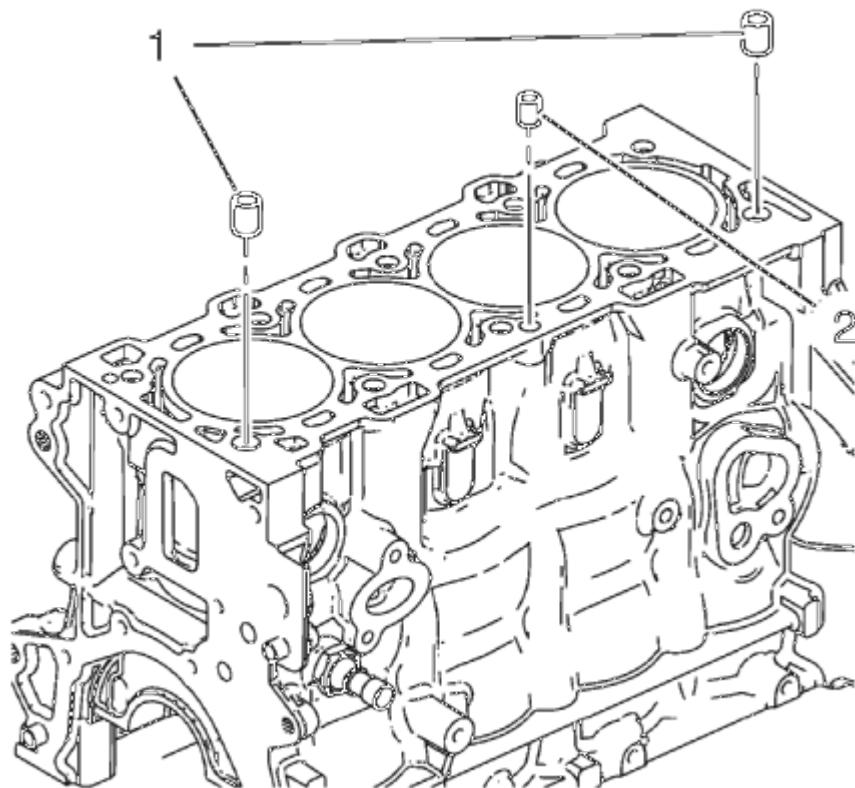


Fig. 428: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS COMPANY

1. Remove the cylinder head locating (1, 2).

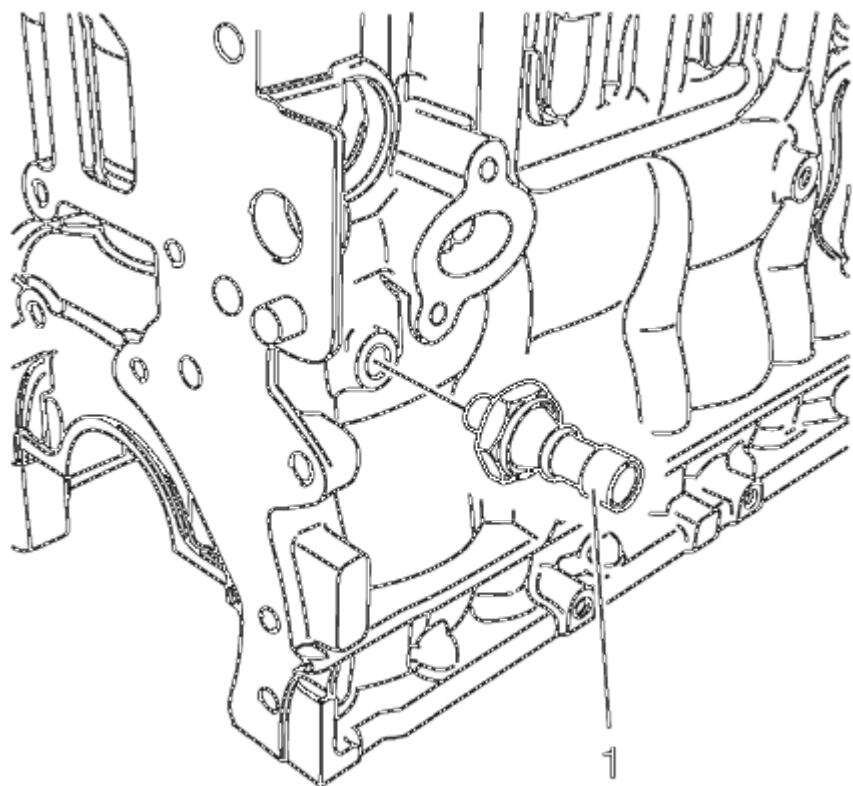


Fig. 429: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pressure switch (1).

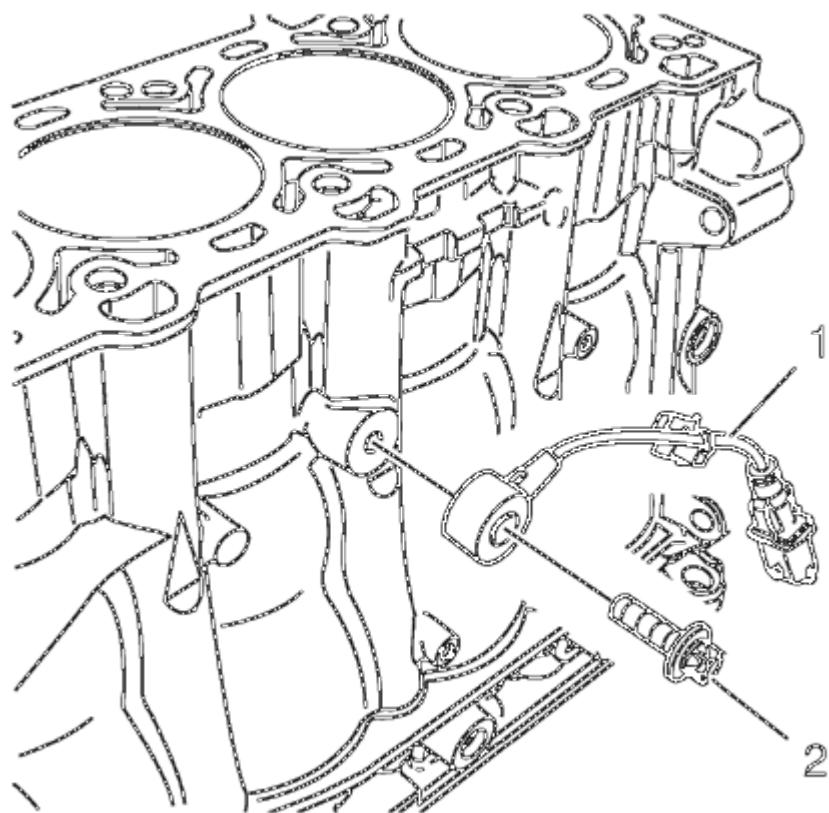


Fig. 430: Knock Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the knock sensor bolt (2) and the knock sensor (1).
4. Clean the thread.

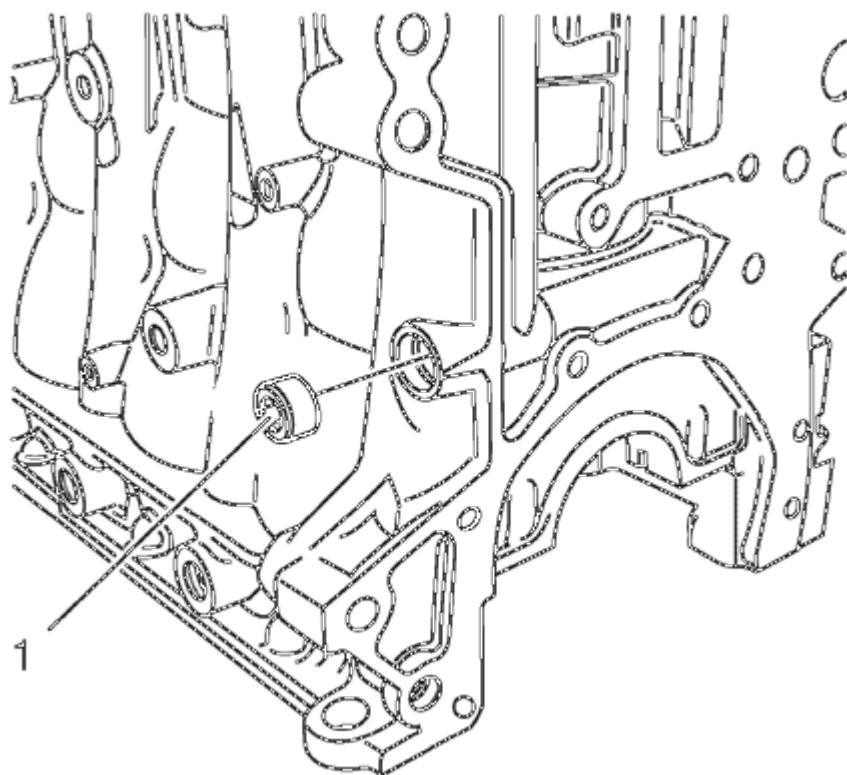


Fig. 431: Oil Flow Check Valve

Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil flow check valve (1).

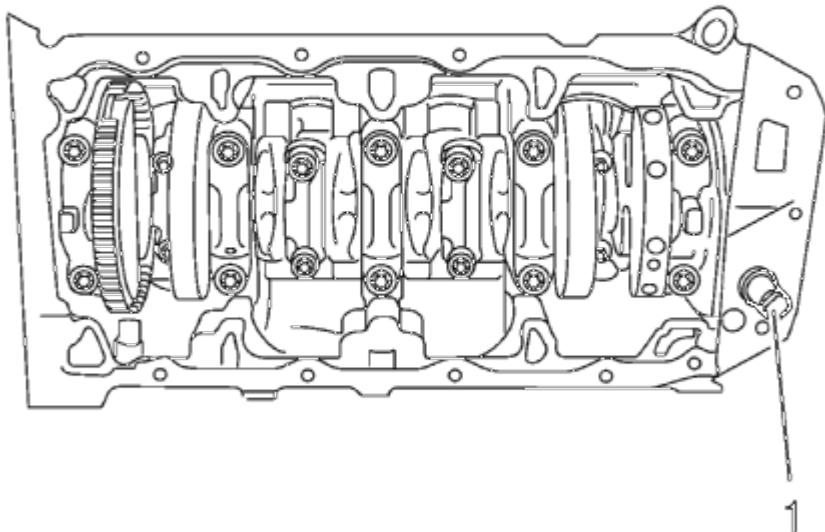


Fig. 432: Oil Pressure Relief Valve Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pressure relief valve closure bolt (1) and the oil pressure relief valve.

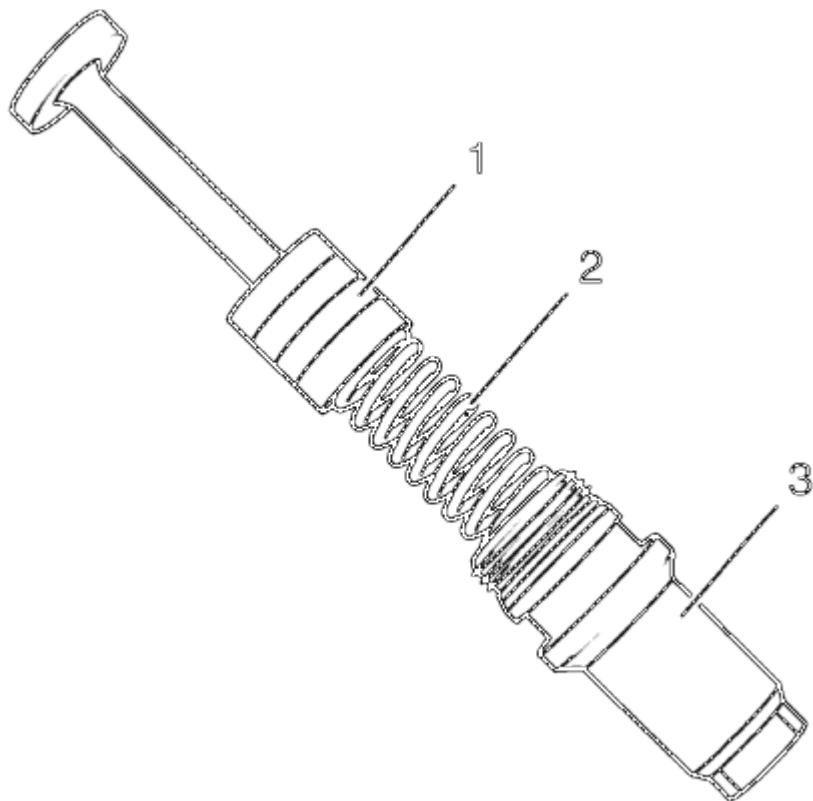


Fig. 433: Piston, Spring And Oil Pressure Relief Valve Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

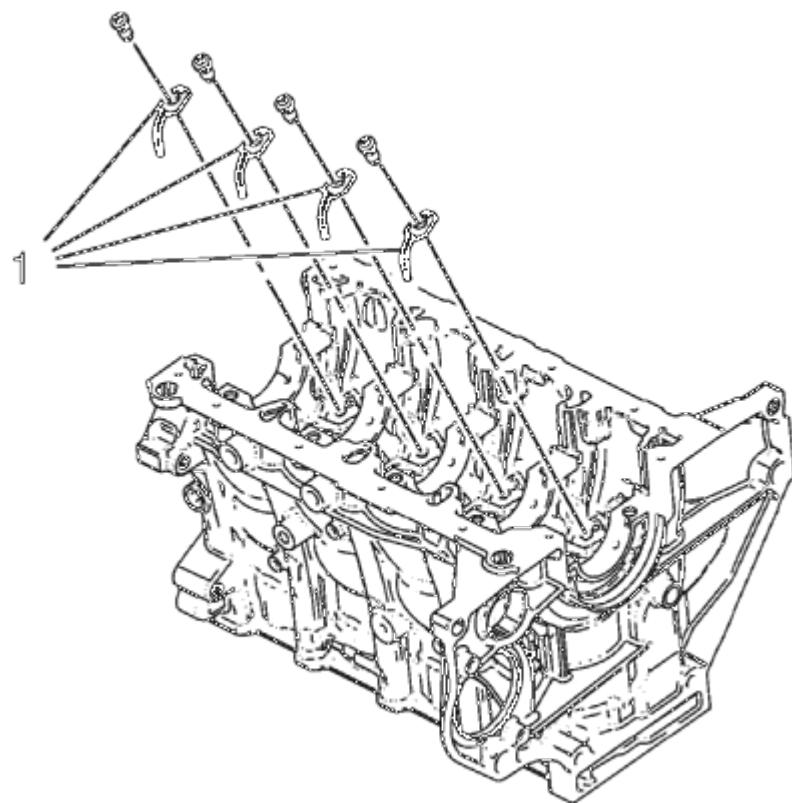


Fig. 434: Piston Oil Nozzles

Courtesy of GENERAL MOTORS COMPANY

10. Remove the 4 piston oil nozzles (1).

INTAKE MANIFOLD CLEANING AND INSPECTION

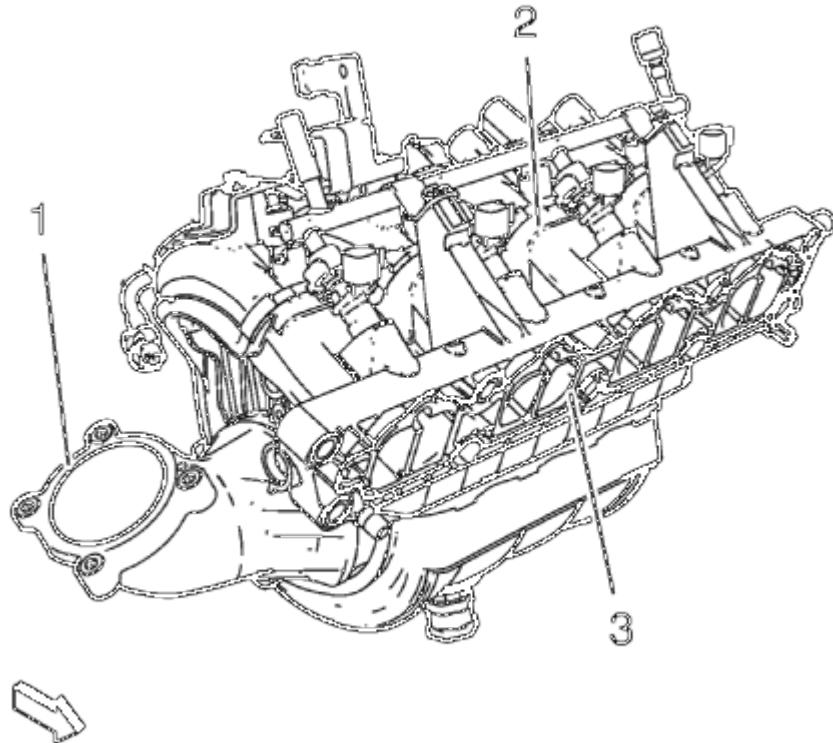


Fig. 435: Intake Manifold And Sealing Surfaces
Courtesy of GENERAL MOTORS COMPANY

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

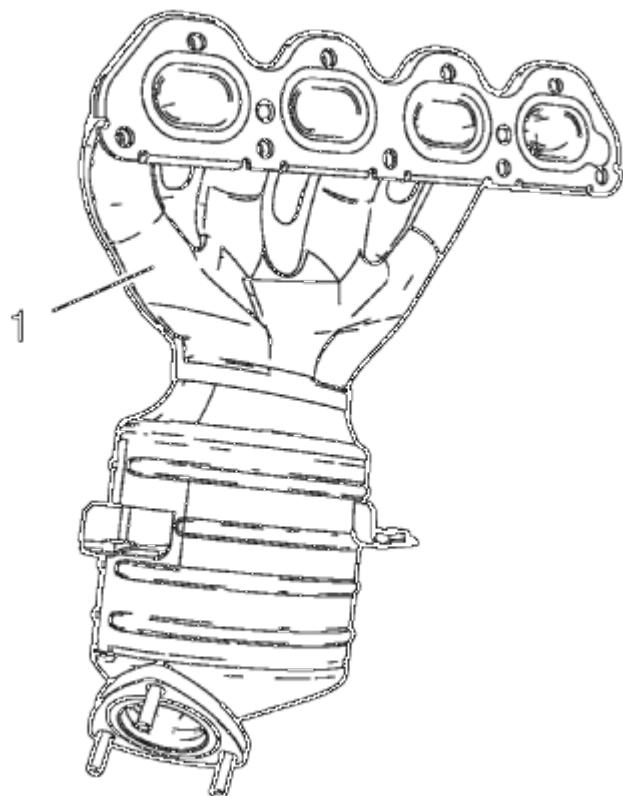


Fig. 436: Exhaust Manifold

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

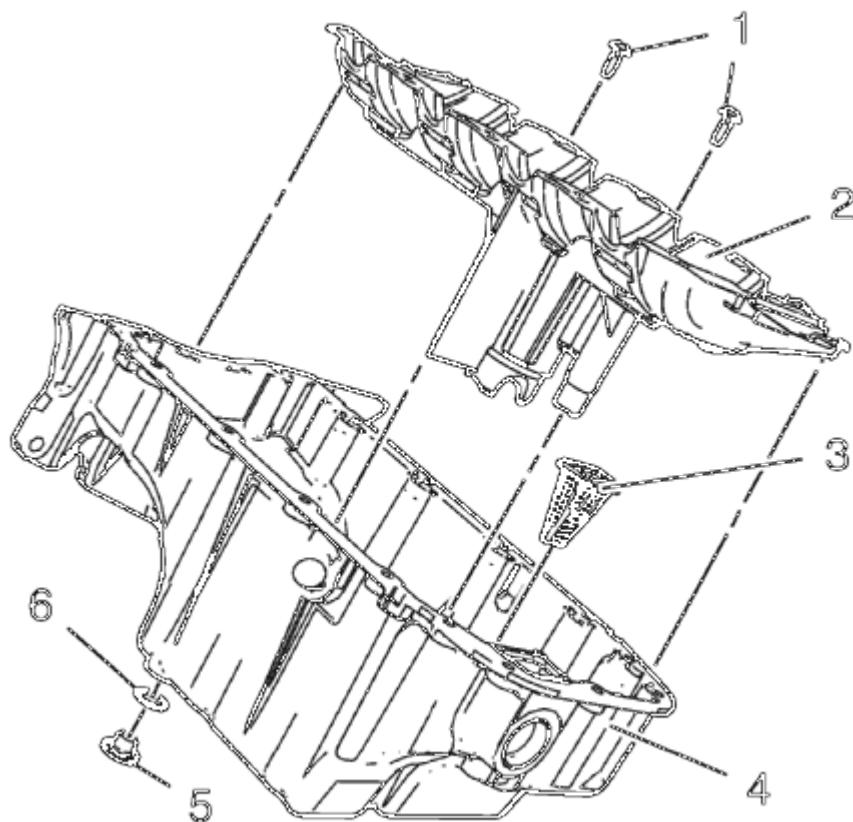


Fig. 437: Oil Pan Components

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

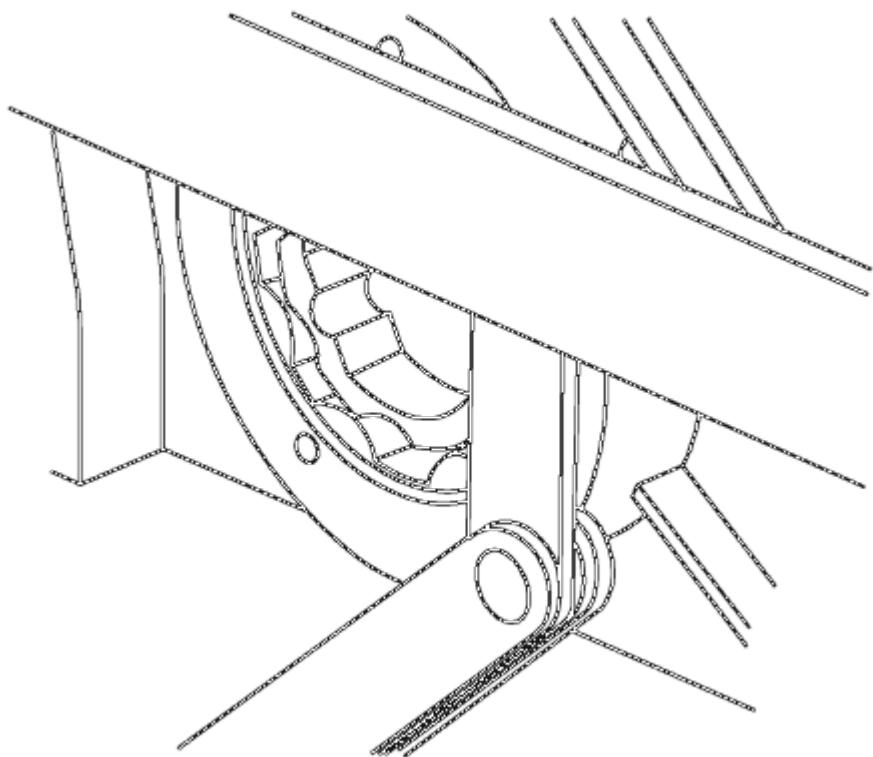


Fig. 438: Inspecting Axial Clearance
Courtesy of GENERAL MOTORS COMPANY

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

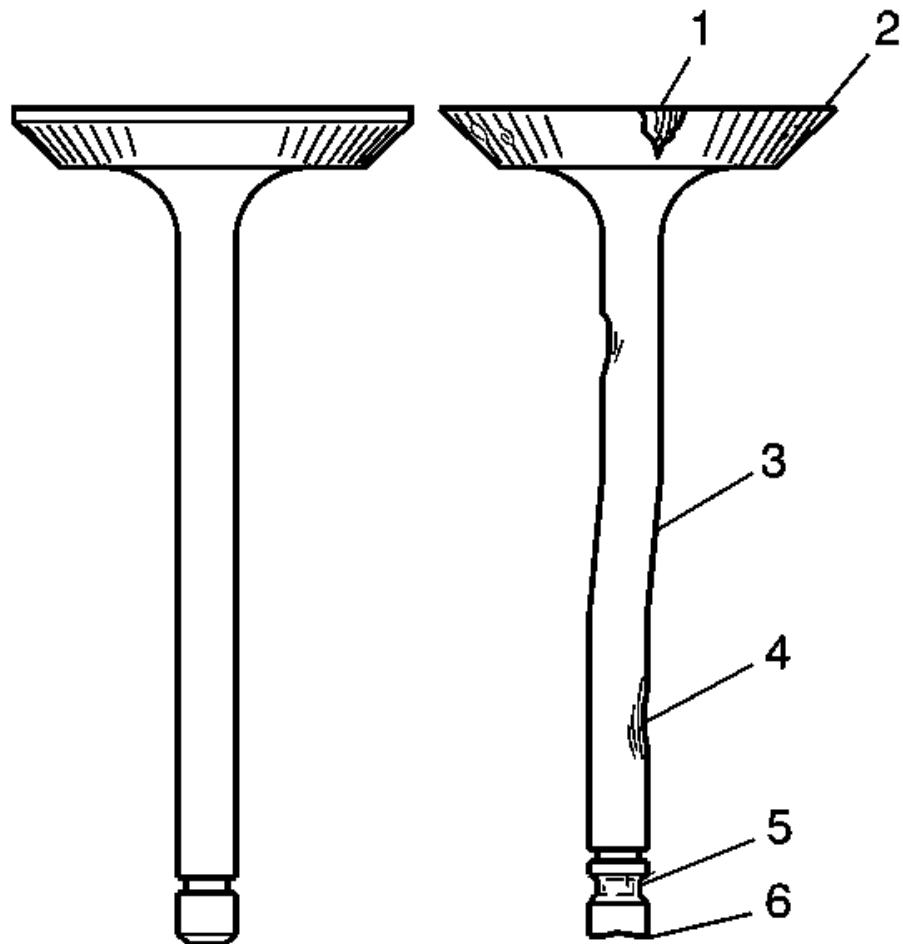


Fig. 439: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

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.

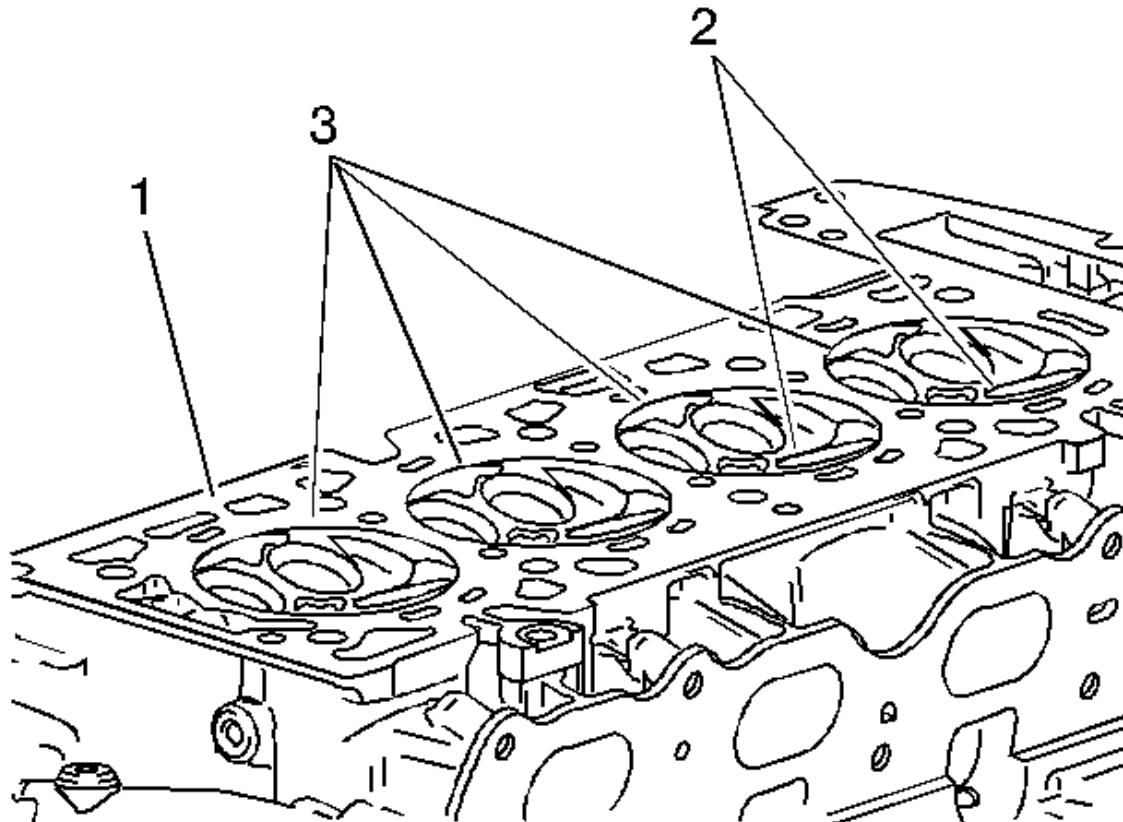


Fig. 440: Locating Combustion Chambers
Courtesy of GENERAL MOTORS COMPANY

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.

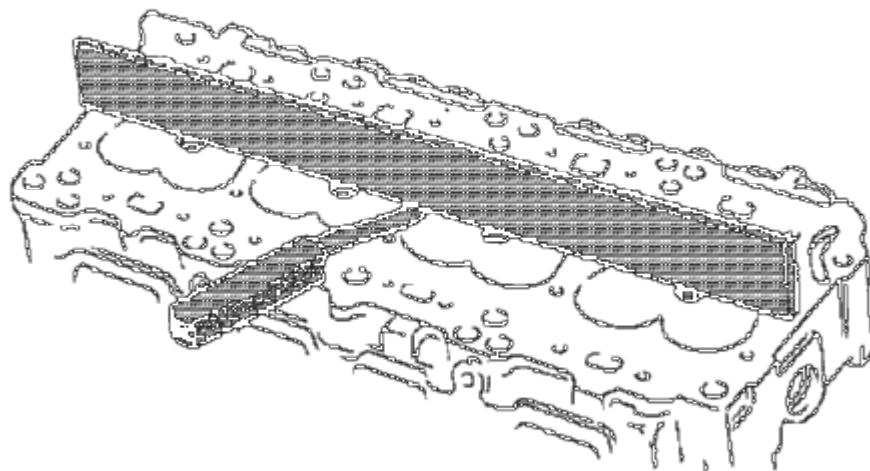


Fig. 441: Inspecting Cylinder Head Surfaces For Flatness
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the cylinder head deck surface for flatness. Refer to **Engine Mechanical Specifications (1.8L LUW and LWE)**. 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](#).

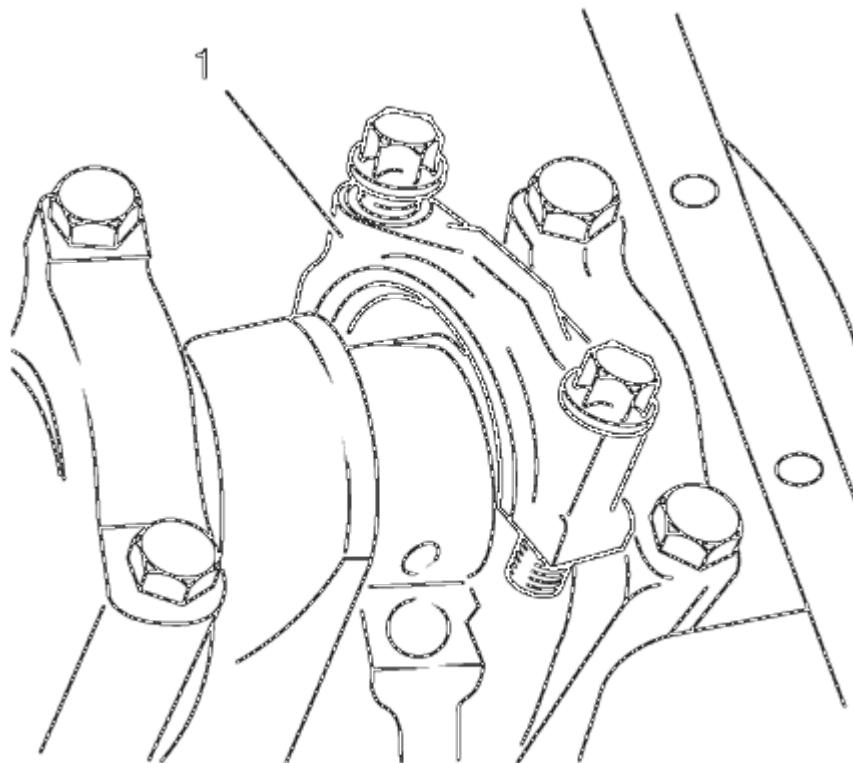


Fig. 442: Connecting Rod Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

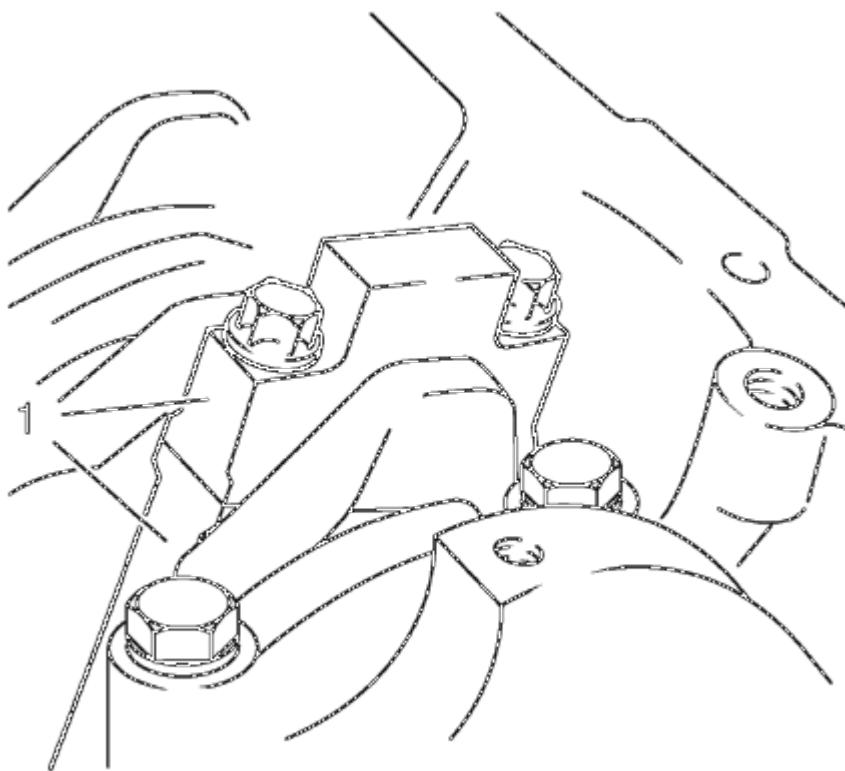


Fig. 443: Marking Position On Connecting Rod Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

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°

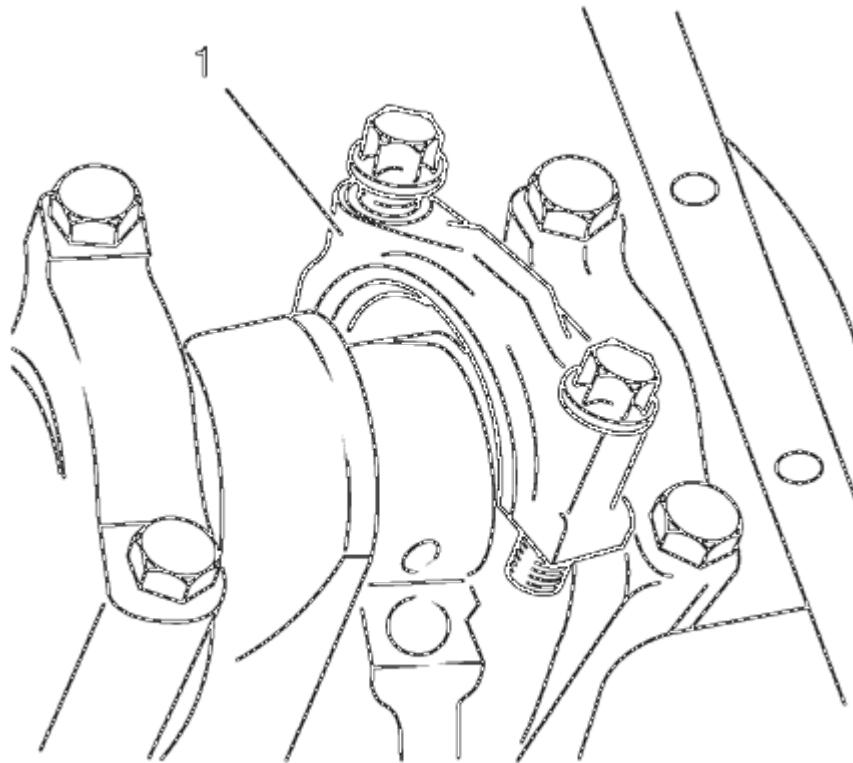


Fig. 444: Connecting Rod Bearing Cap

Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 bolts.
7. Remove the connecting rod bearing cap (1).

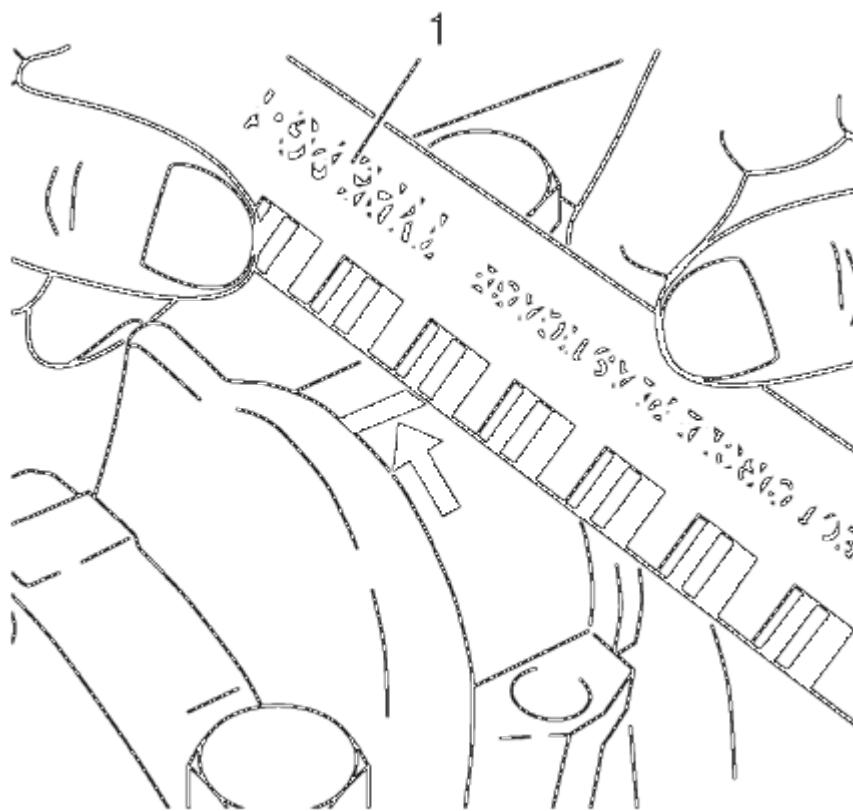


Fig. 445: Measuring Connecting Rod Bearing Play Using Measuring Scale
Courtesy of GENERAL MOTORS COMPANY

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

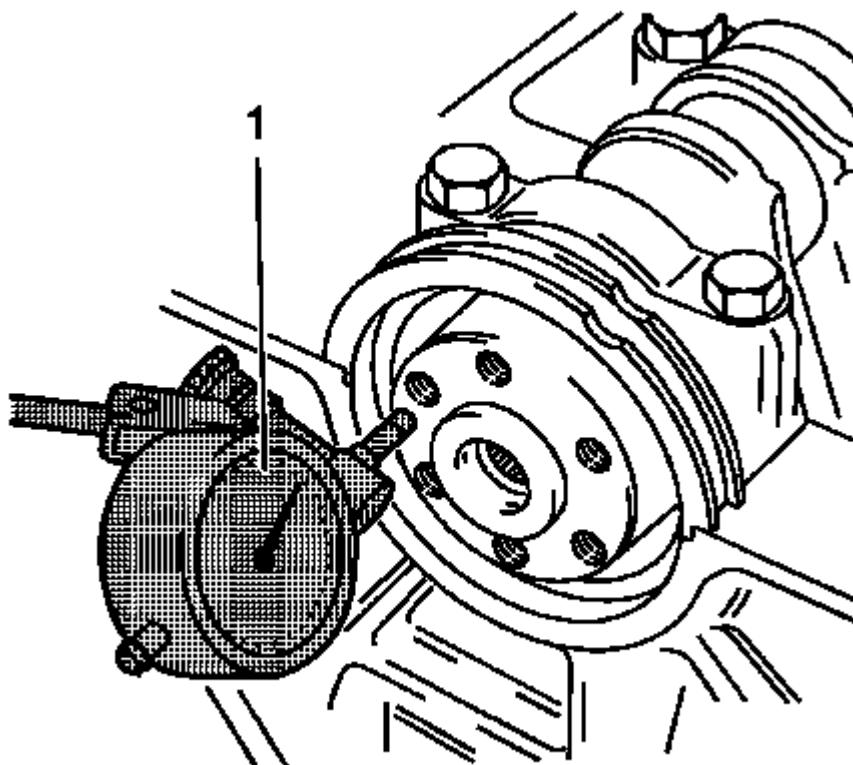


Fig. 446: Gauge Tool
Courtesy of GENERAL MOTORS COMPANY

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

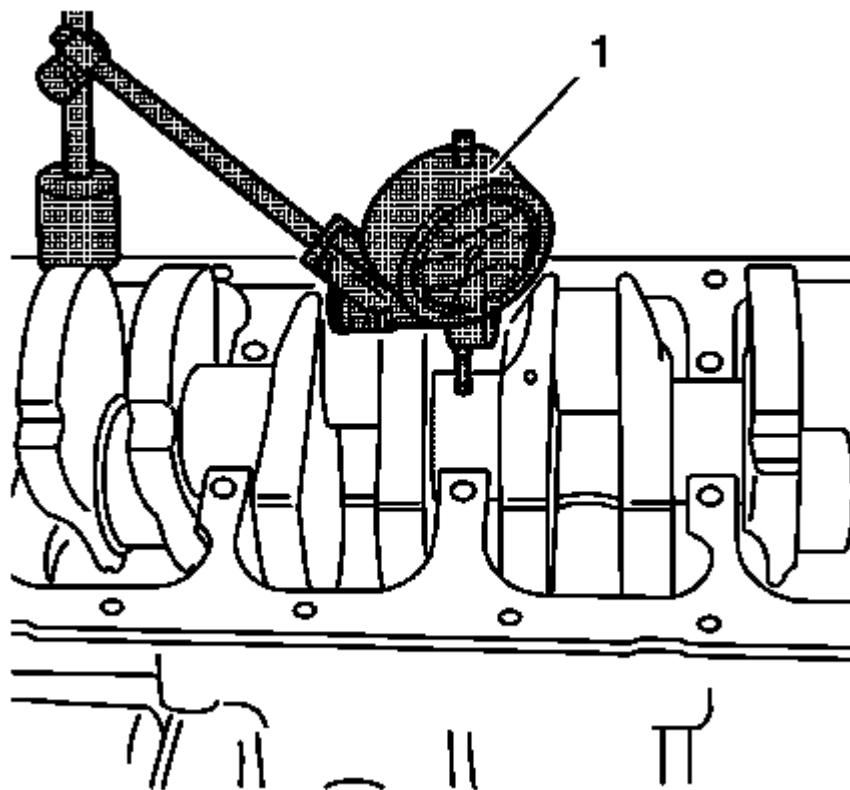


Fig. 447: Gauge Tool
Courtesy of GENERAL MOTORS COMPANY

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)

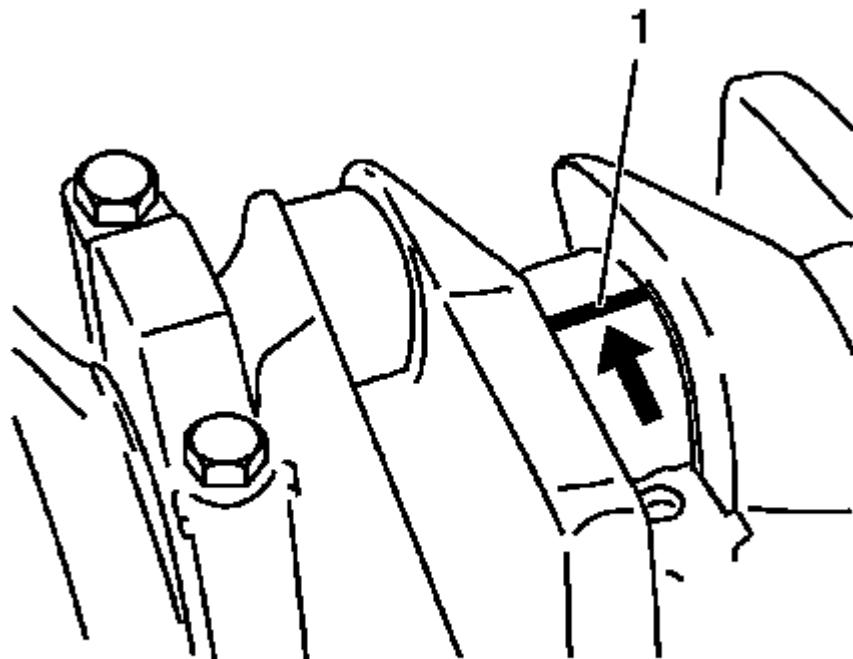


Fig. 448: Plastigage On Bearing Journal

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.

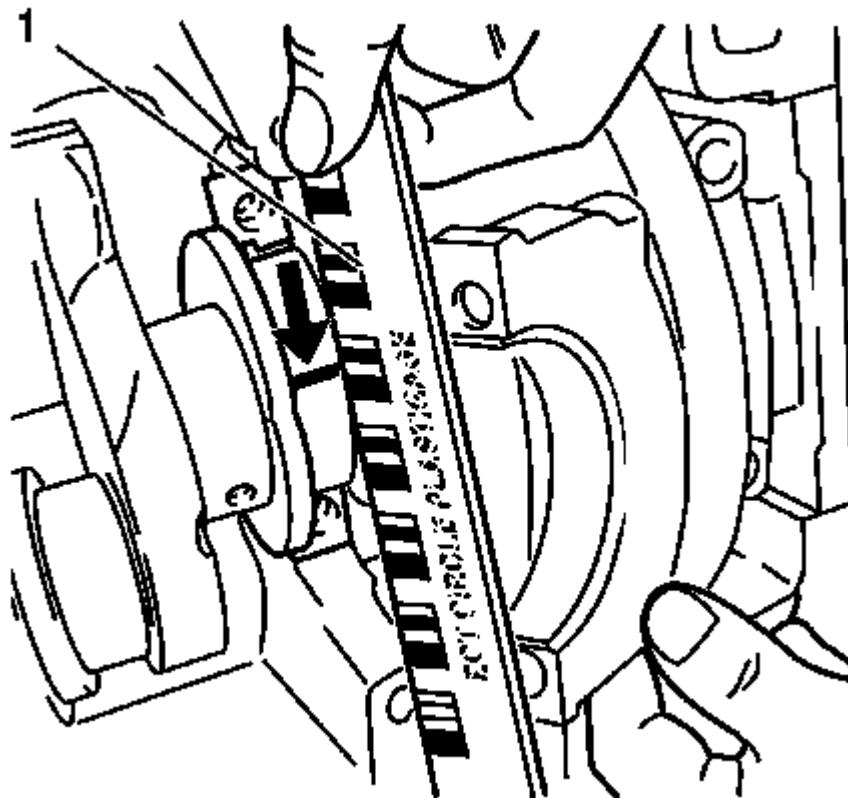


Fig. 449: Measuring Crankshaft Bearing Play Using Measuring Scale
Courtesy of GENERAL MOTORS COMPANY

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°

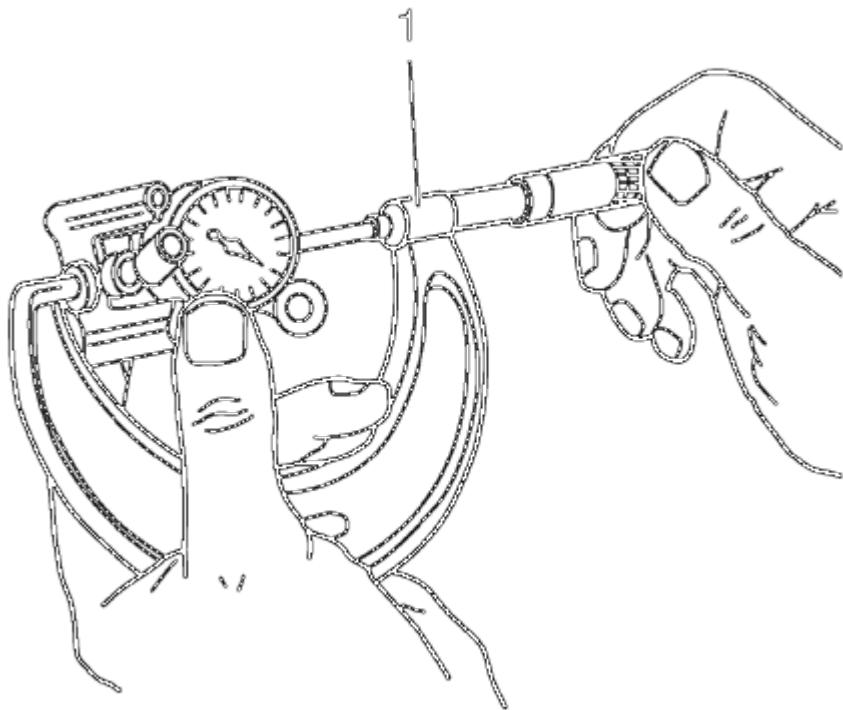


Fig. 450: Micrometer Gauge
Courtesy of GENERAL MOTORS COMPANY

2. Install the inner plunger and calibrate with the micrometer gauge (1).

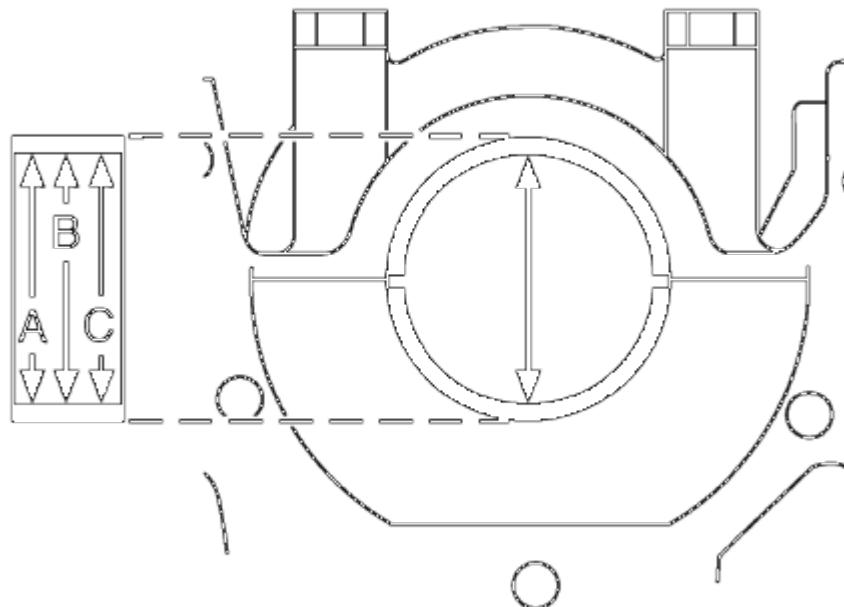


Fig. 451: Measuring Crankshaft Bearing Diameter At Points
Courtesy of GENERAL MOTORS COMPANY

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: $A + B + C / 3$.

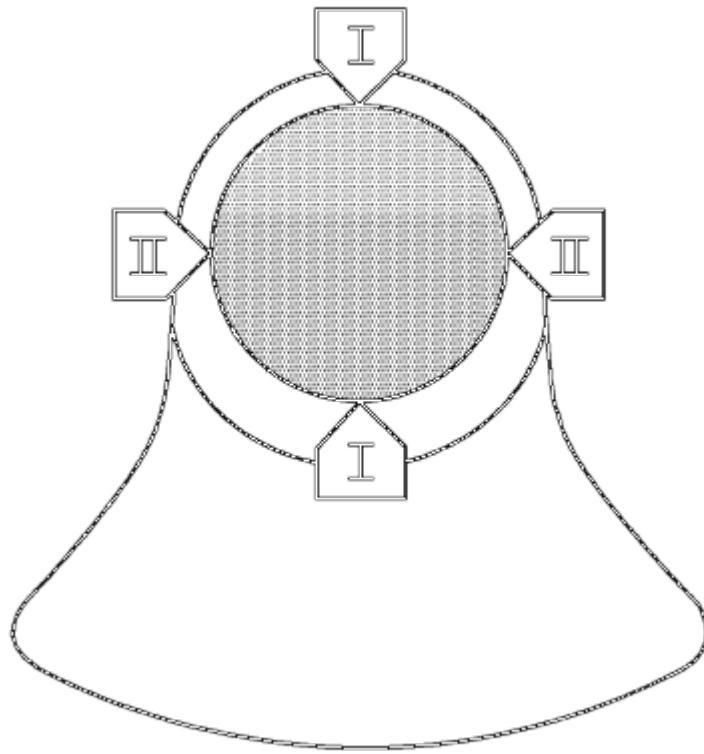


Fig. 452: Measuring Crankshaft Bearing Journal Diameter At 2 Points
Courtesy of GENERAL MOTORS COMPANY

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](#).

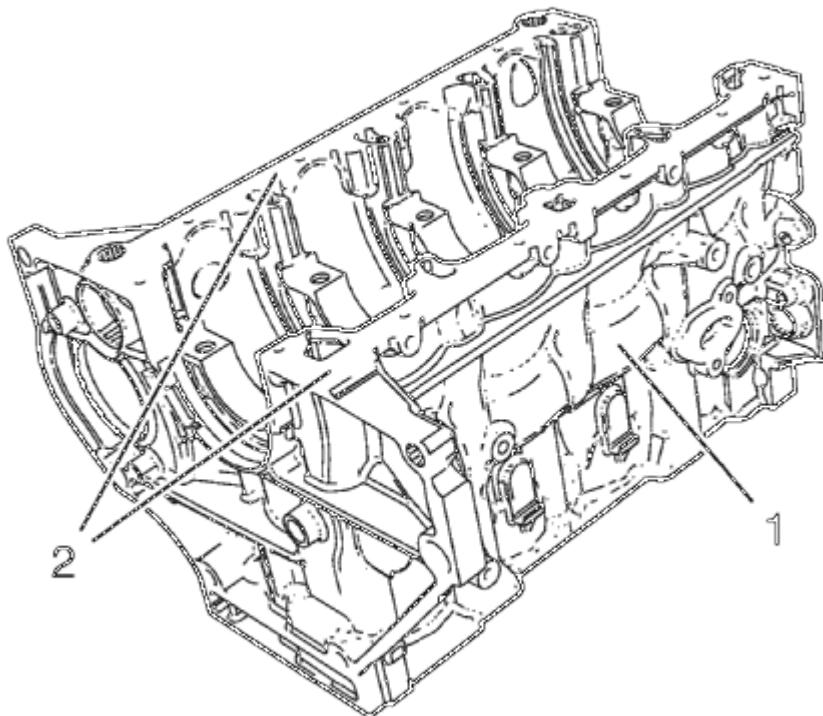


Fig. 453: Engine Block
Courtesy of GENERAL MOTORS COMPANY

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](#).

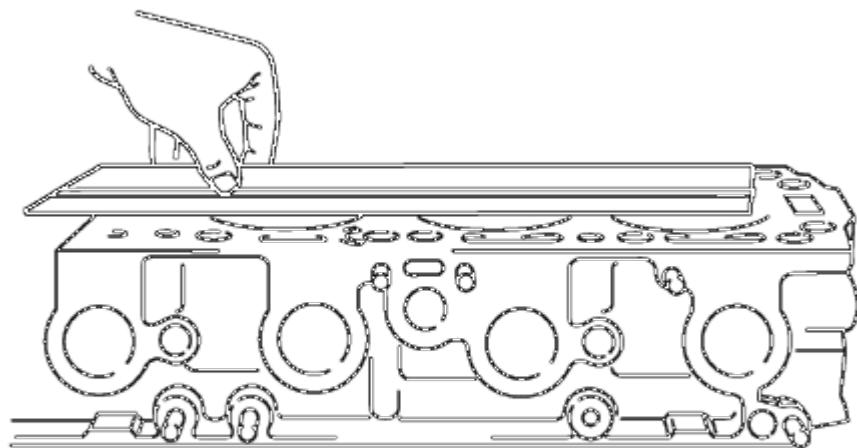


Fig. 454: Inspecting Engine Block For Sag In Length And Width On Sealing Surfaces
Courtesy of GENERAL MOTORS COMPANY

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.

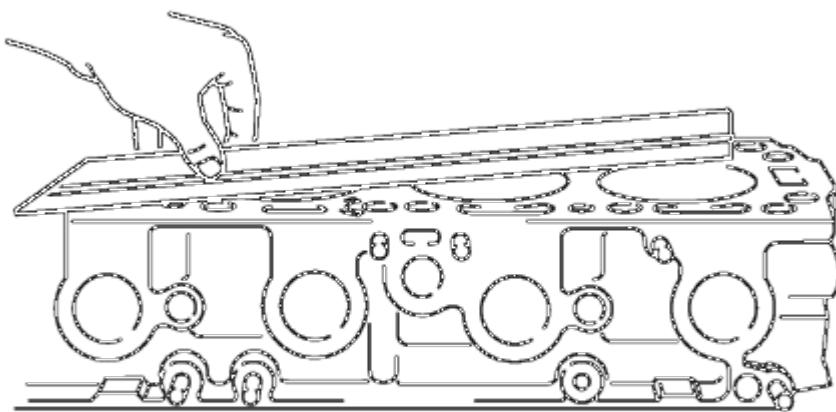


Fig. 455: Inspecting Engine Block For Distortion Along Diagonals
Courtesy of GENERAL MOTORS COMPANY

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.

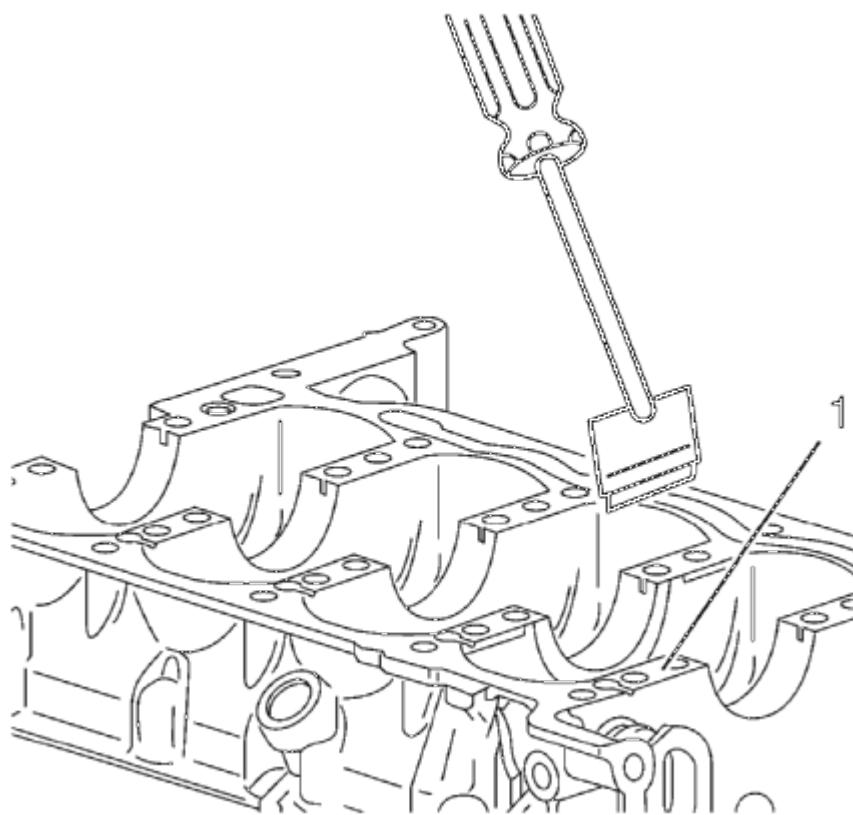


Fig. 456: Gasket Mating Surfaces
Courtesy of GENERAL MOTORS COMPANY

10. Clean the sealing material from the gasket mating surfaces (1) on the lower crankcase oil pan side.

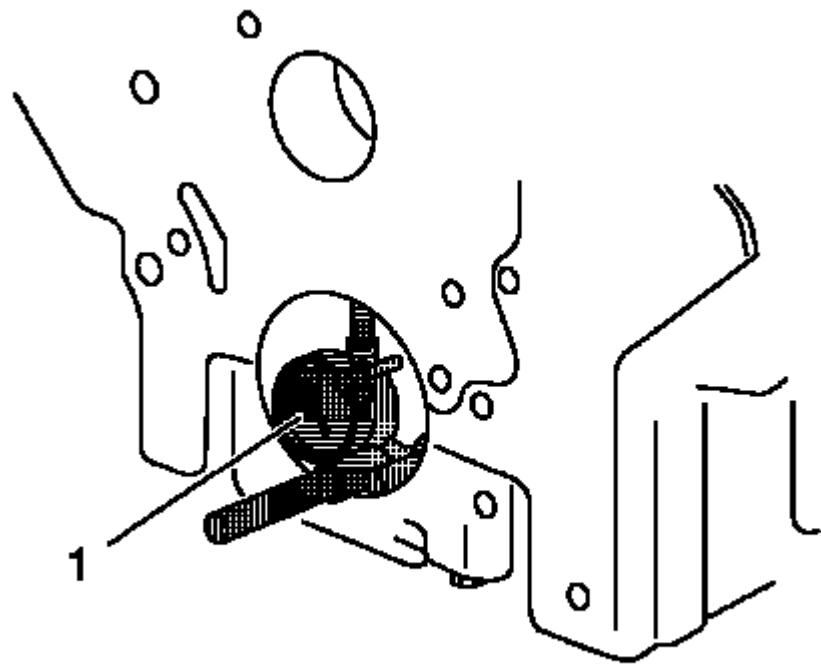


Fig. 457: Measuring Bearing Bore Concentricity And Alignment Using Gauge Tool
Courtesy of GENERAL MOTORS COMPANY

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.

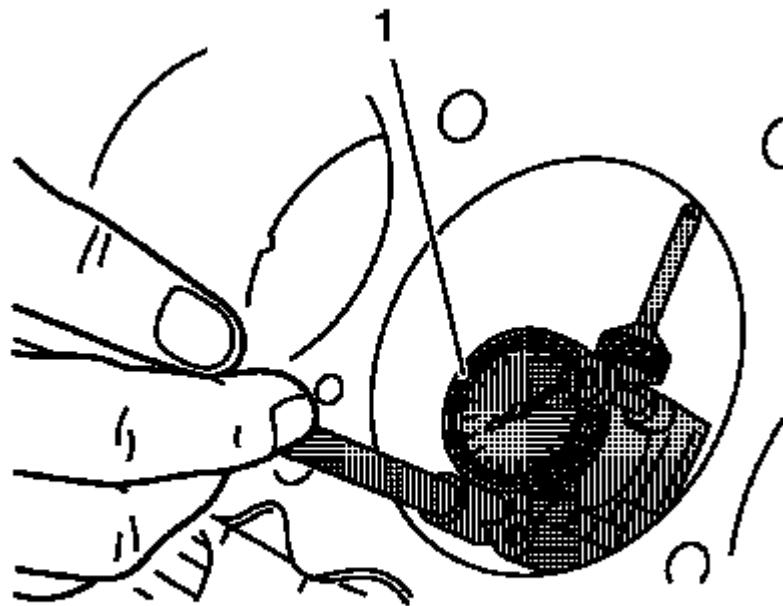


Fig. 458: Inspecting Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

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 (1.8L LUW and LWE)**.
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 ASSEMBLE

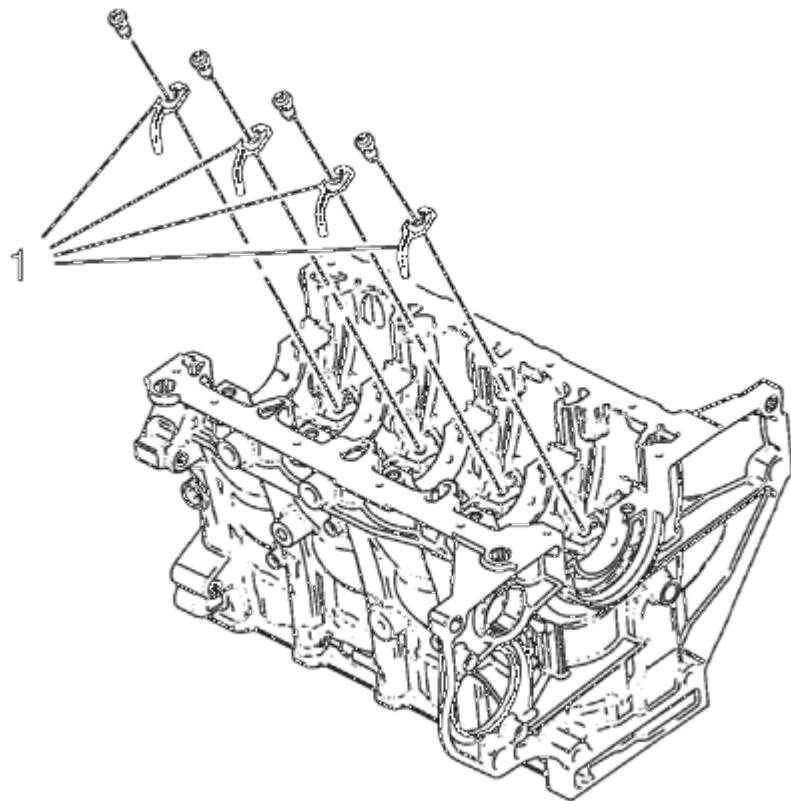


Fig. 459: Piston Oil Nozzles

Courtesy of GENERAL MOTORS COMPANY

1. Install the 4 piston oil nozzles (1).

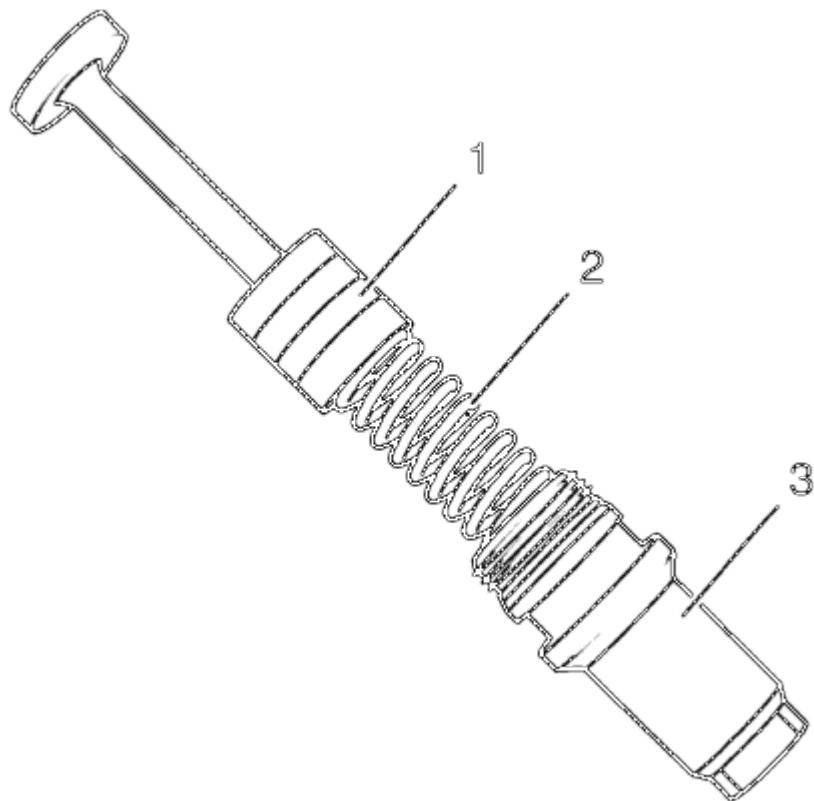


Fig. 460: Piston, Spring And Oil Pressure Relief Valve Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the piston (1) and spring (2) to the oil pressure relief valve closure bolt (3).

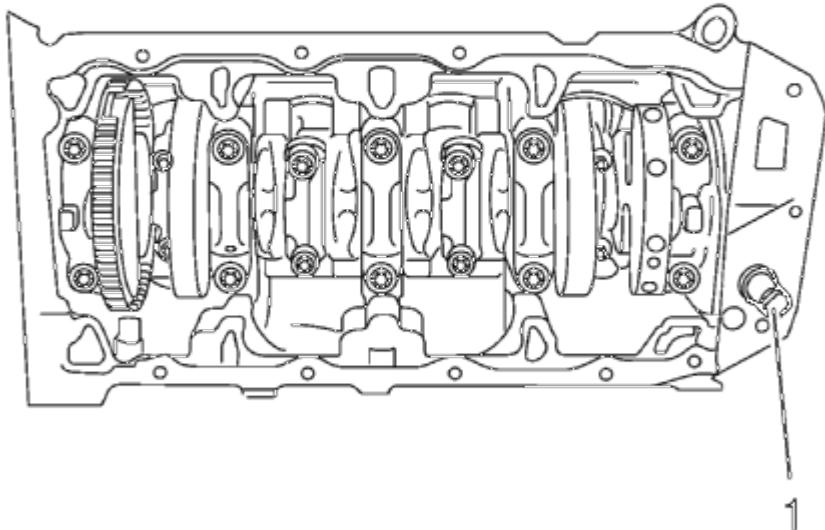


Fig. 461: Oil Pressure Relief Valve Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

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).

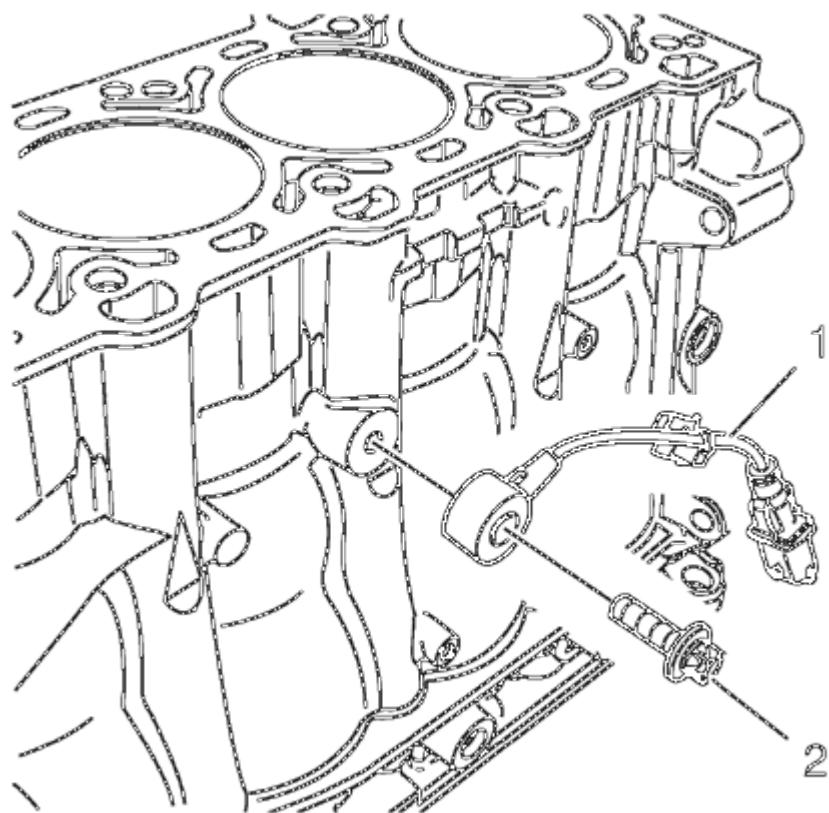


Fig. 462: Knock Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the knock sensor (1) and the knock sensor bolt (2) and tighten to 20 N.m (15 lb ft).

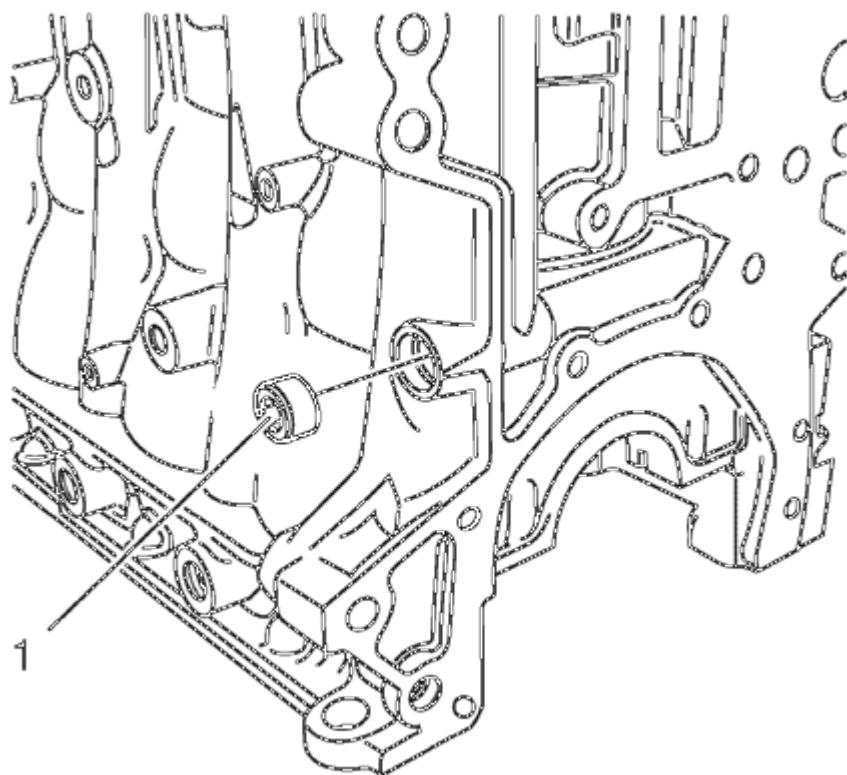


Fig. 463: Oil Flow Check Valve

Courtesy of GENERAL MOTORS COMPANY

5. Install the oil flow check valve (1).

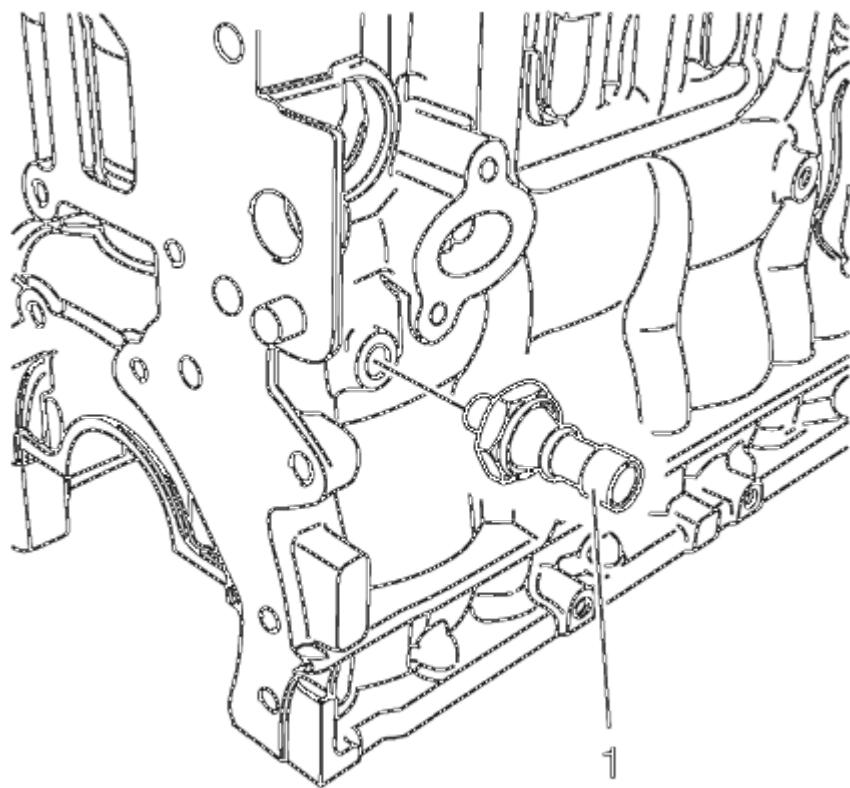


Fig. 464: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pressure switch (1) and tighten to 20 N.m (15 lb ft).

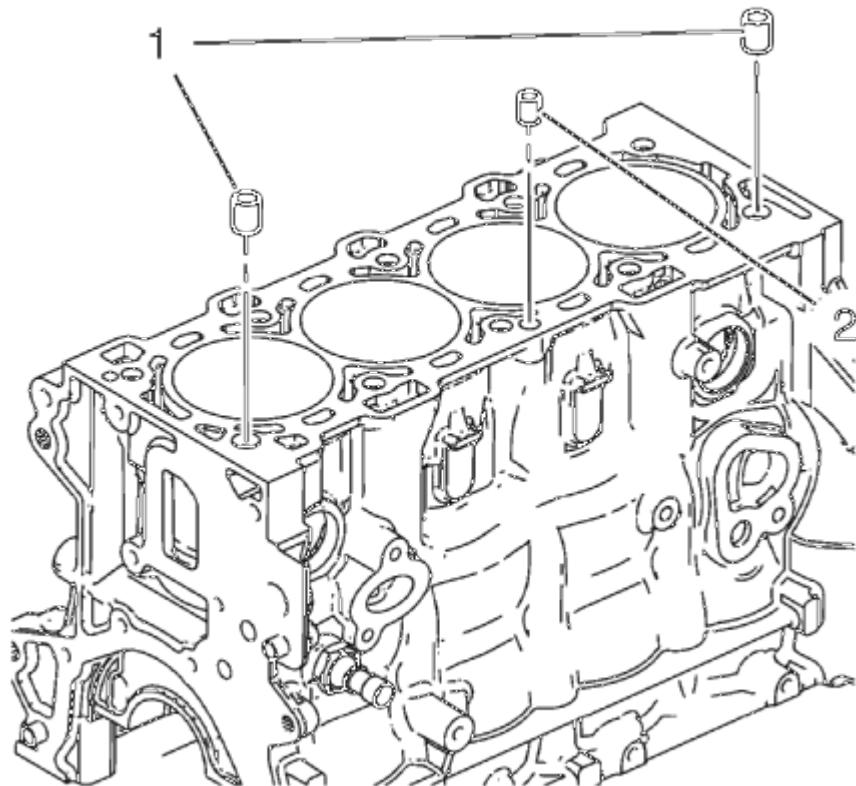


Fig. 465: Cylinder Head Locating Pins

Courtesy of GENERAL MOTORS COMPANY

7. Install the cylinder head locating (1, 2).

PISTON AND CONNECTING ROD ASSEMBLE

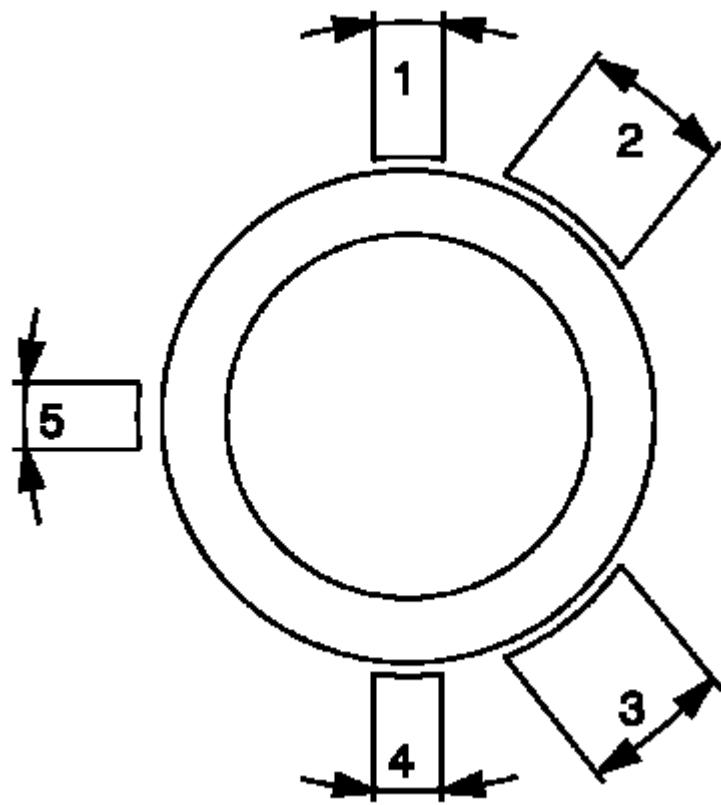


Fig. 466: View Of Piston Ring Joint Positions
Courtesy of GENERAL MOTORS COMPANY

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](#).

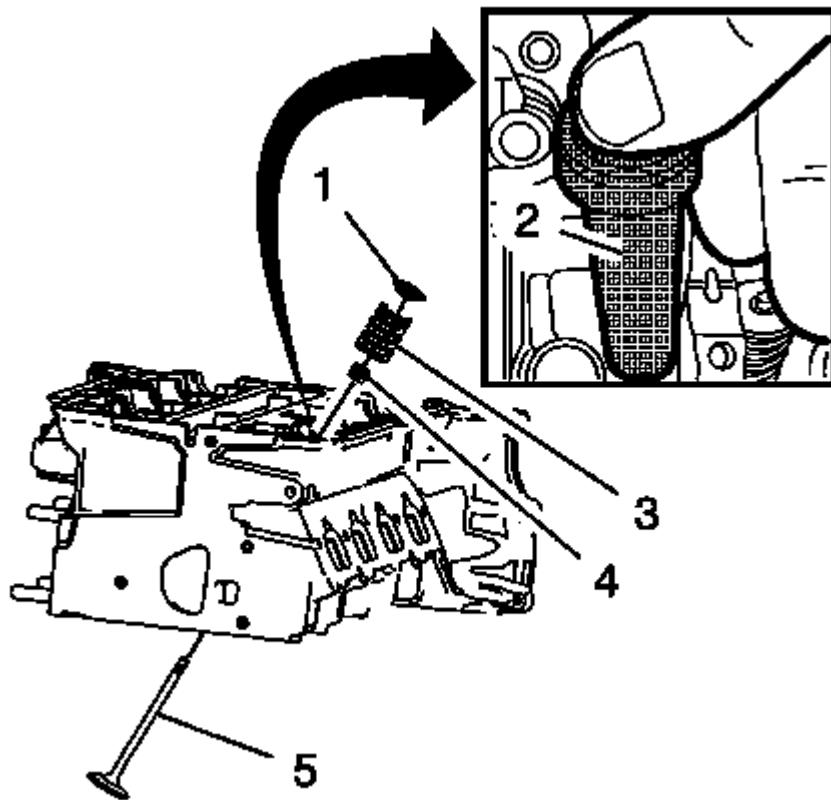


Fig. 467: Valve Stem Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

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).

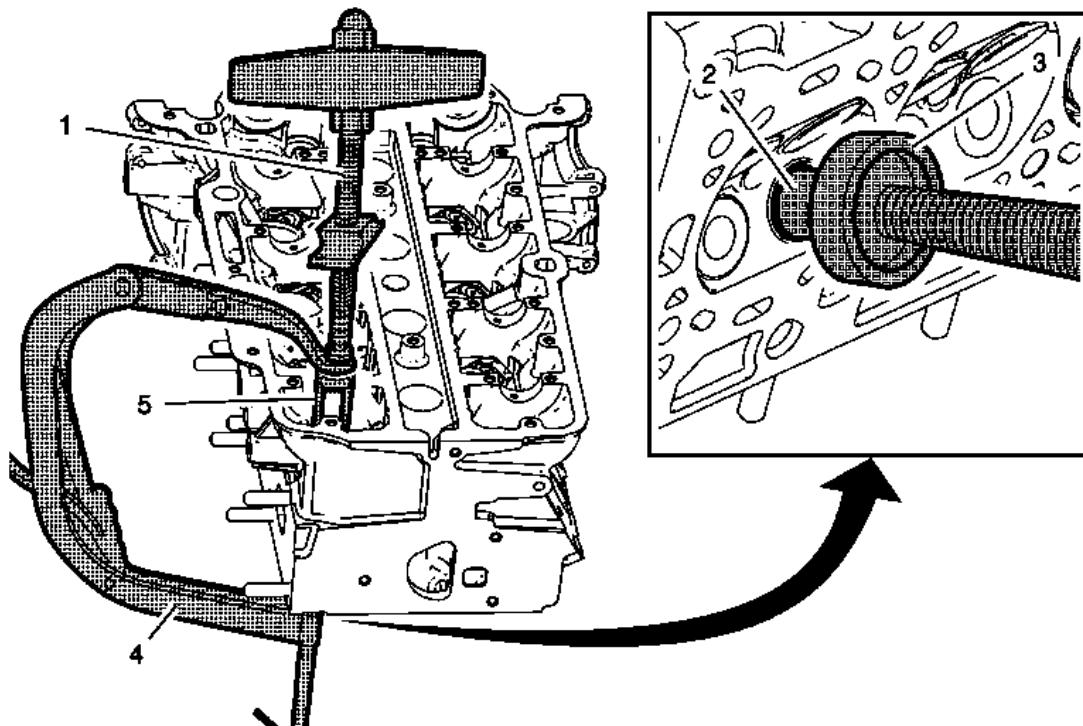


Fig. 468: Valve Spring Compressor And Adapter Assembly
Courtesy of GENERAL MOTORS COMPANY

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).

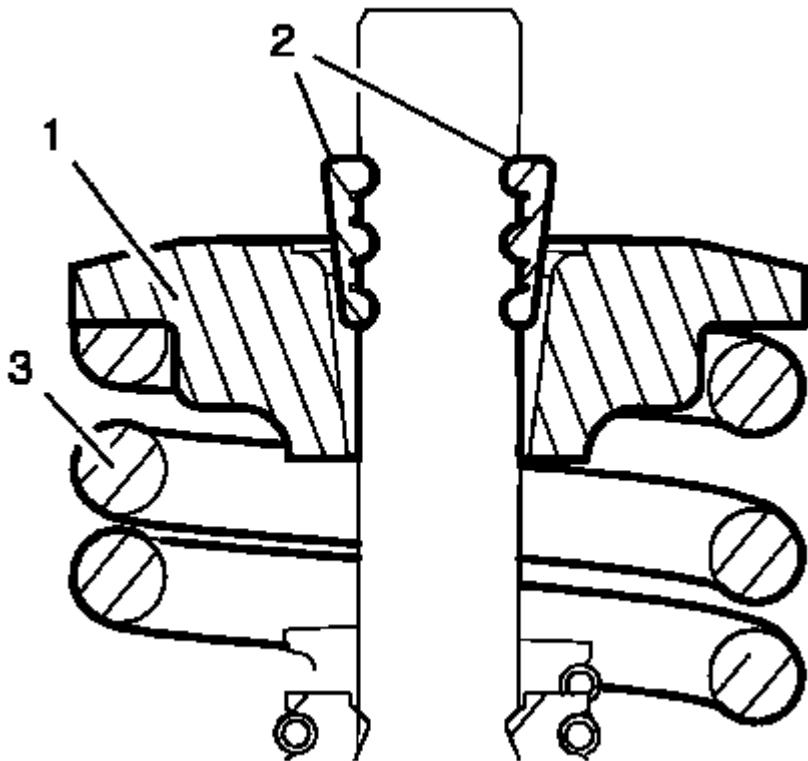


Fig. 469: Valve Spring Retainer And Valve Spring

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 vale 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 proper 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 ASSEMBLE (1.8L LUW AND LWE)

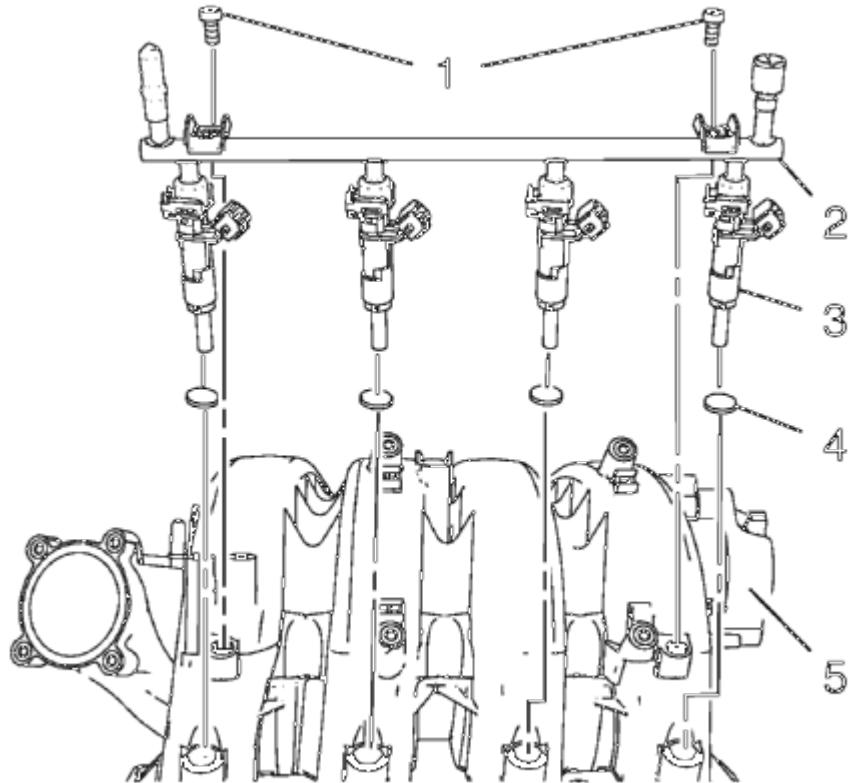


Fig. 470: Intake Manifold, Multiport Fuel Injection Fuel Rail, Fuel Injectors, Seals And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

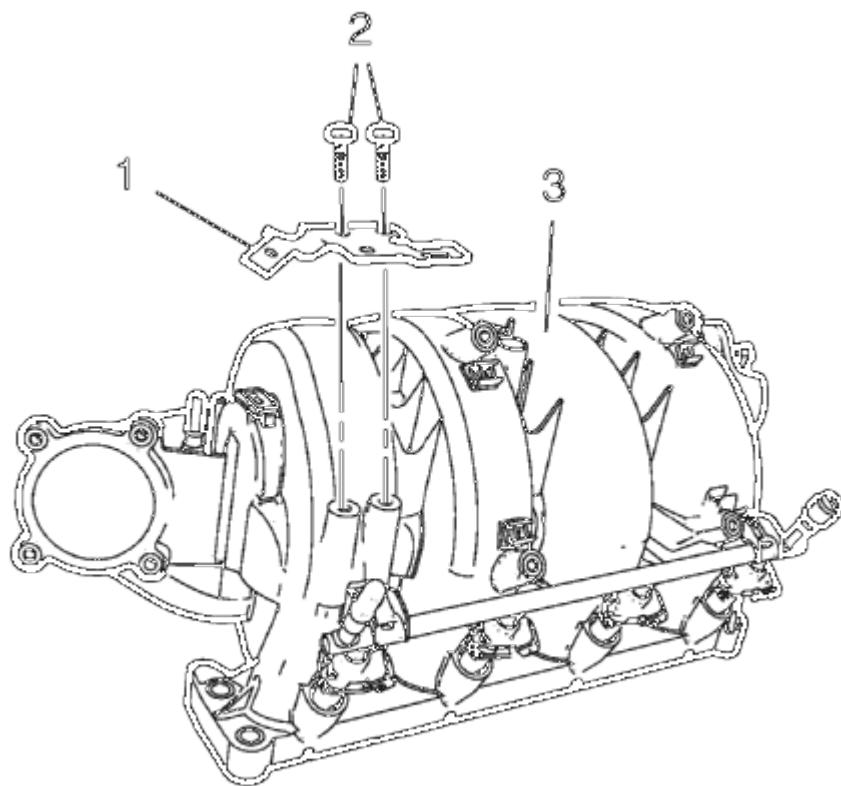


Fig. 471: Intake Manifold, Evaporative Emission Canister Purge Solenoid Valve Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

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).

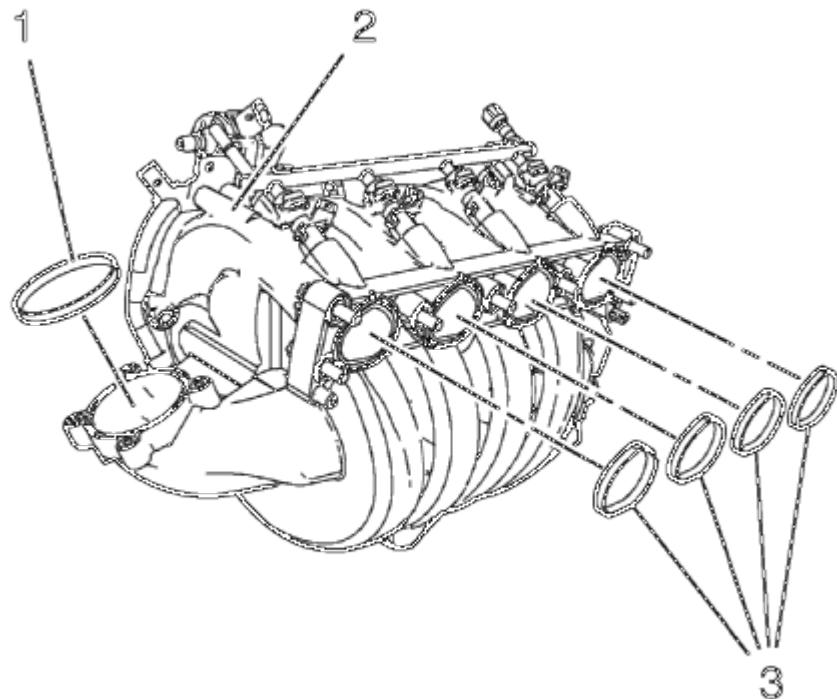


Fig. 472: Intake Manifold, Seal And Throttle Body Seal
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW intake manifold seal (3) to the intake manifold (2).
7. Install the NEW throttle body seal (1).

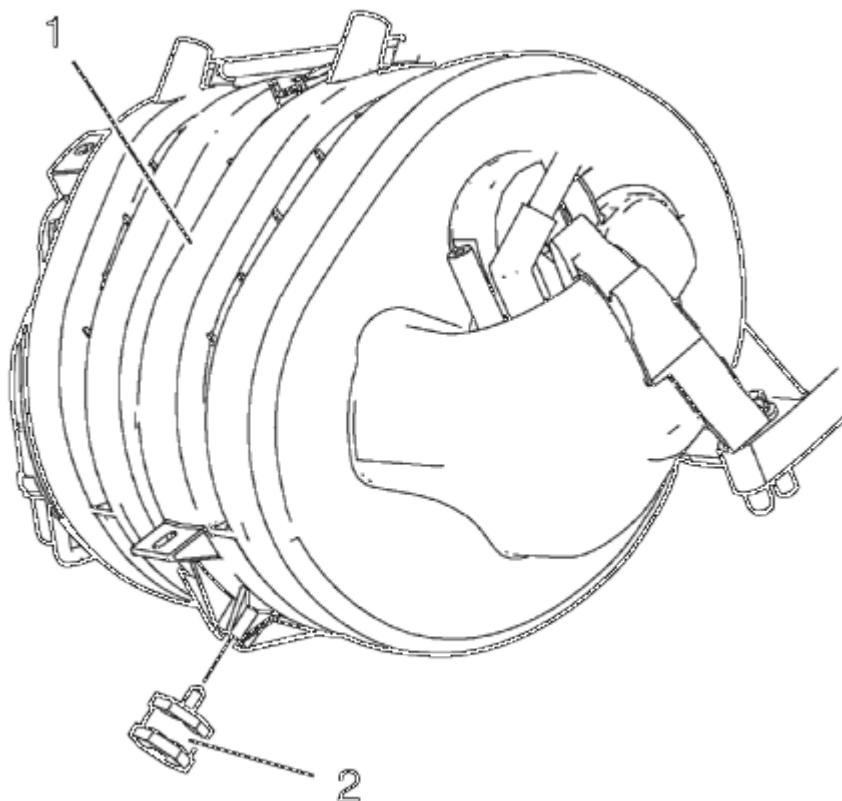


Fig. 473: Intake Manifold And Mount

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).

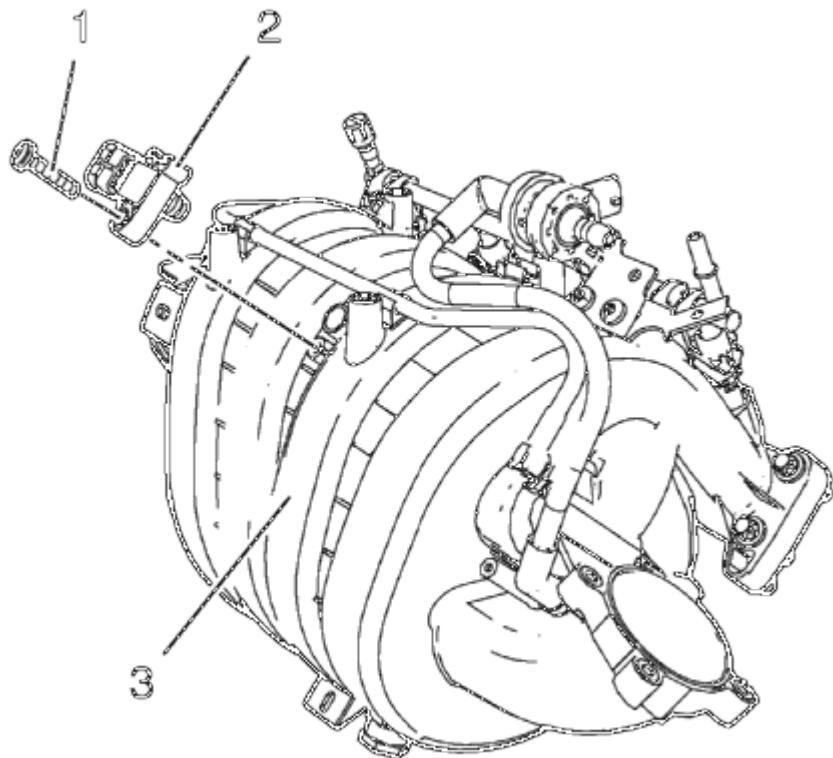


Fig. 474: Intake Manifold, Manifold Absolute Pressure Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

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**

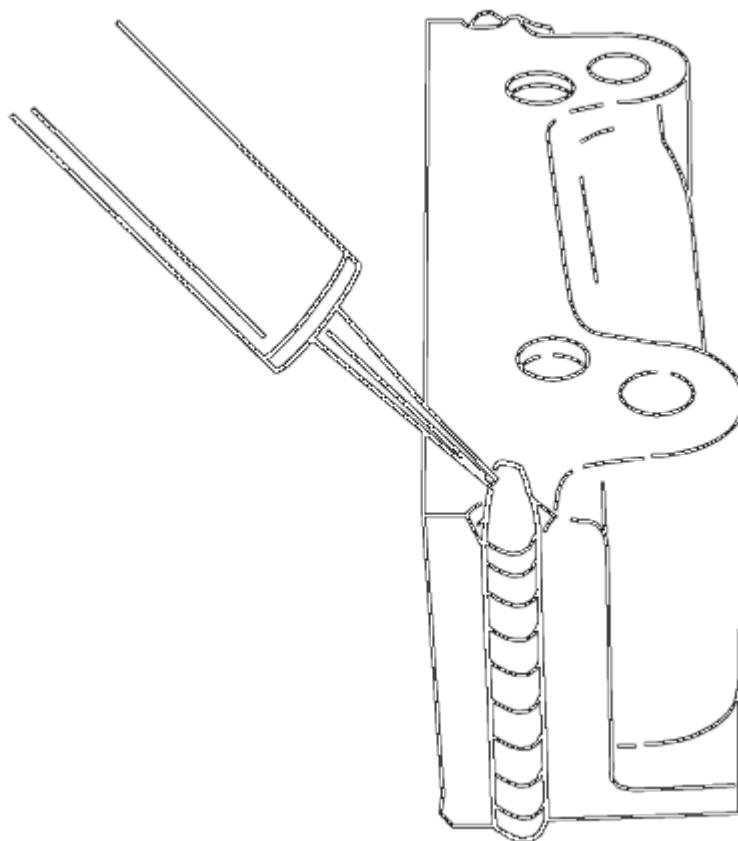


Fig. 475: View Of Crankshaft Bearing Clip

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.

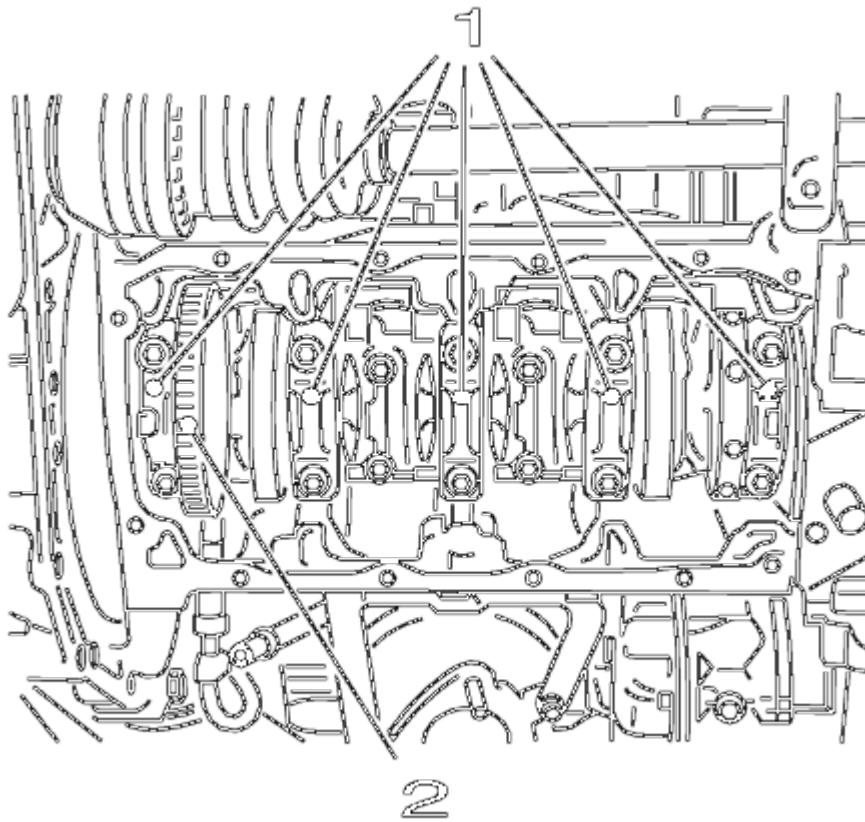


Fig. 476: View Of Crankshaft Bearing Cap Bolts

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°

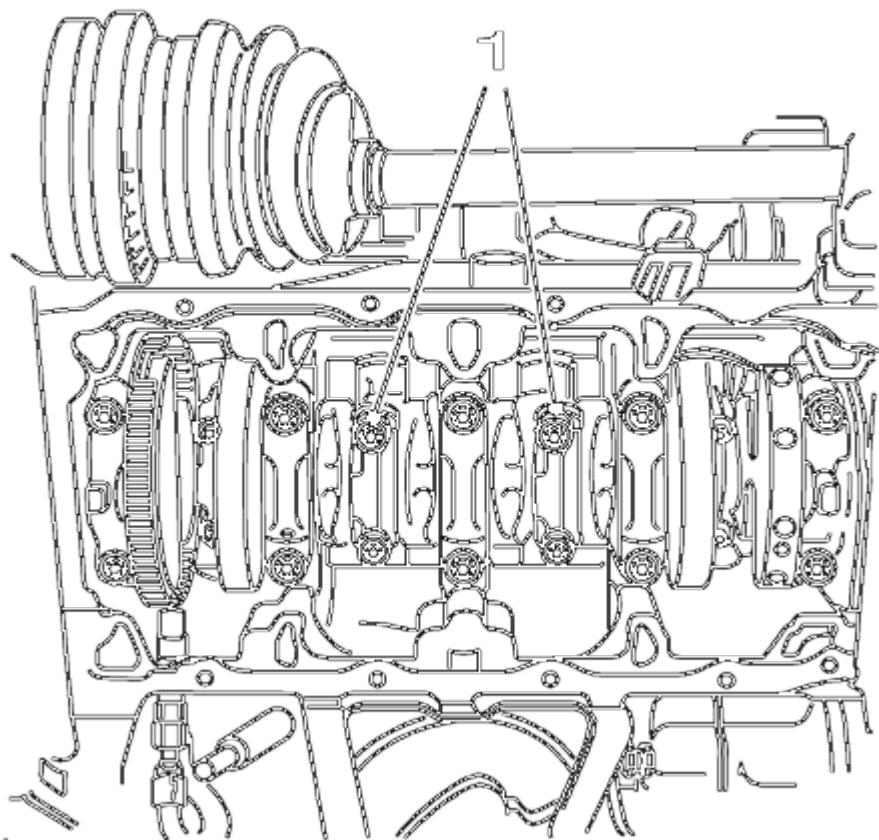


Fig. 477: View Of Con-Rod Bearing Caps

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°

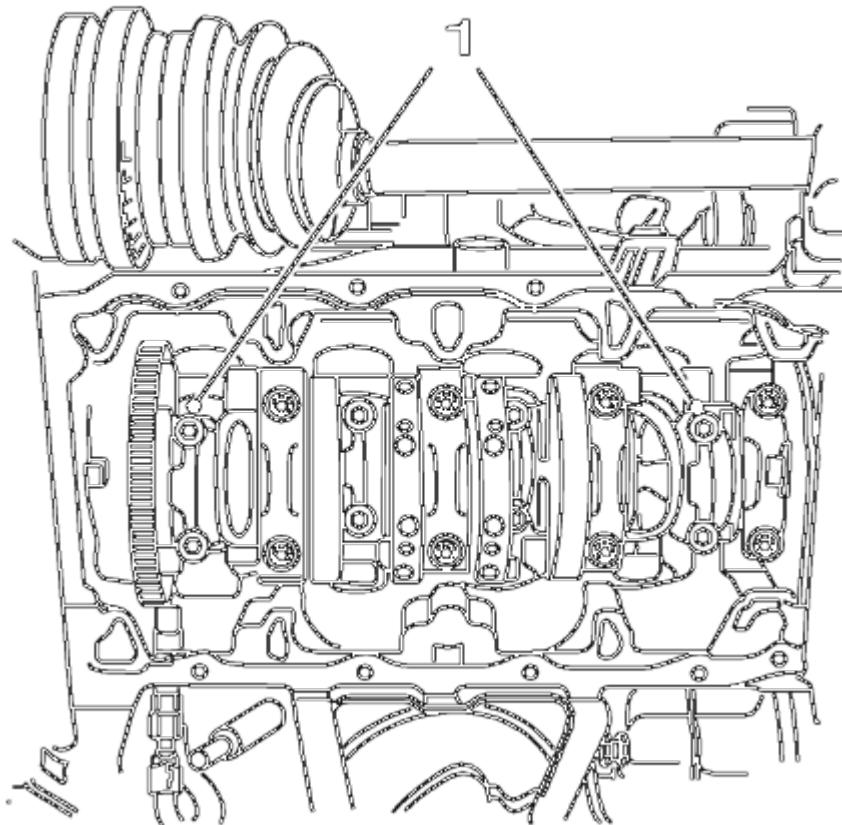


Fig. 478: View Of Con-Rod Bearing Caps

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.

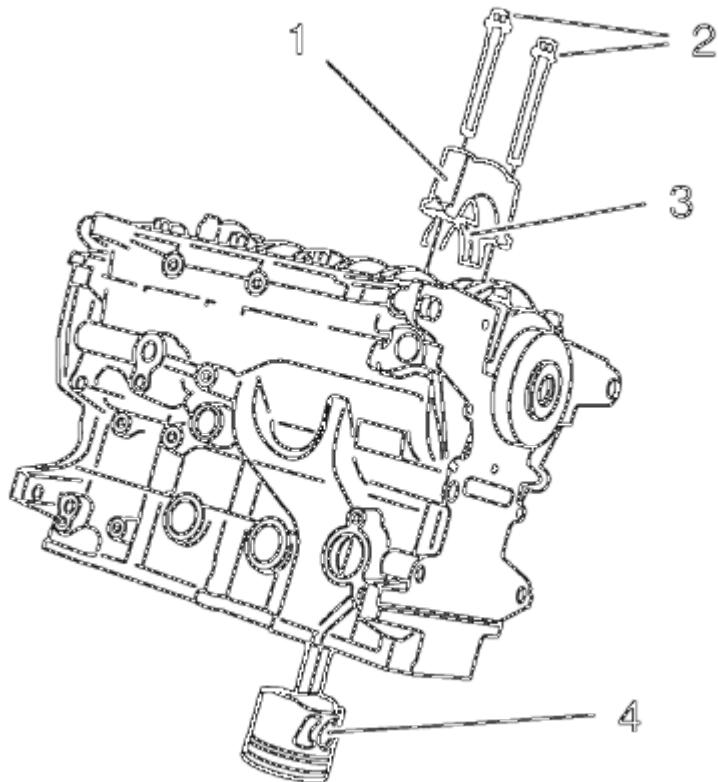


Fig. 479: Connecting Rod Assembly, Connecting Rod Bearing And Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

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.

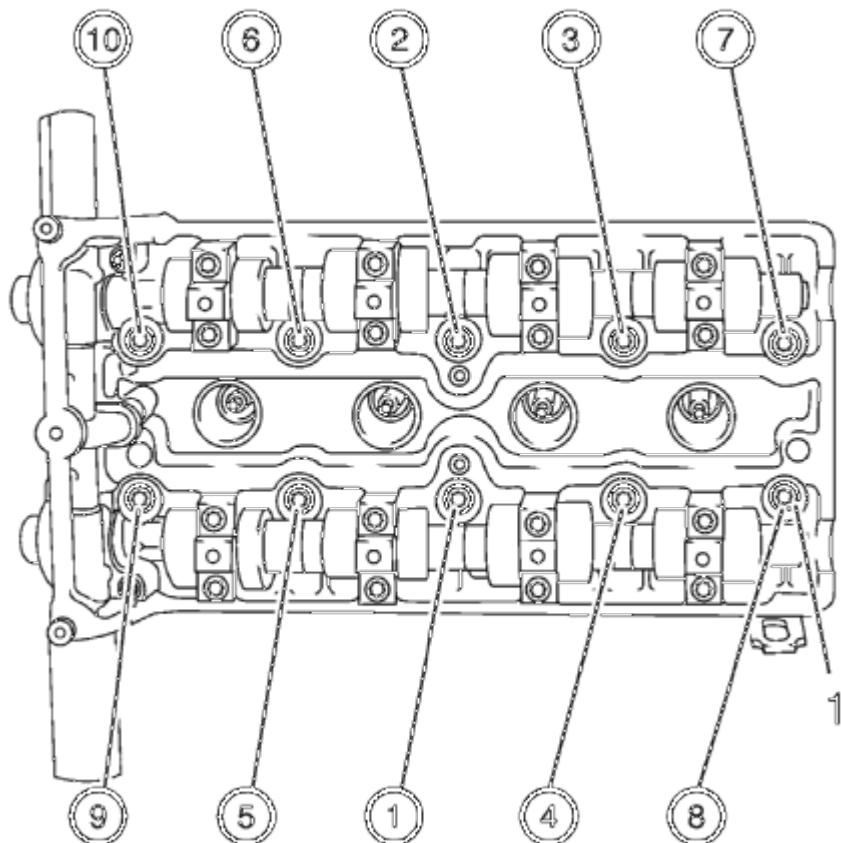


Fig. 480: Cylinder Head Bolts Tightening Sequence

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 Device

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

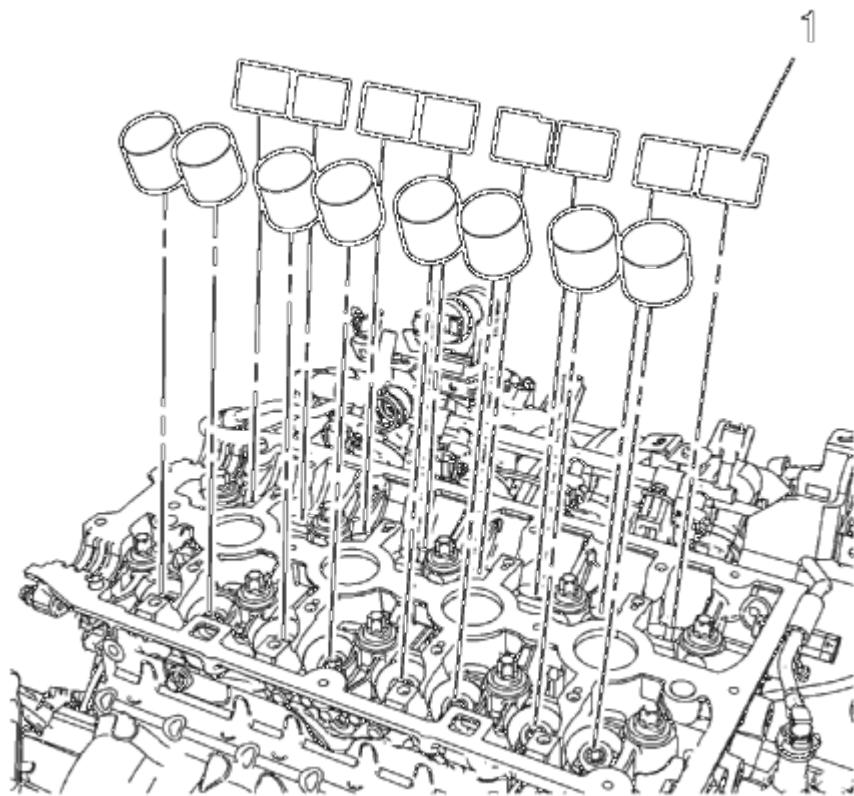


Fig. 481: Valve Lifters

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**.

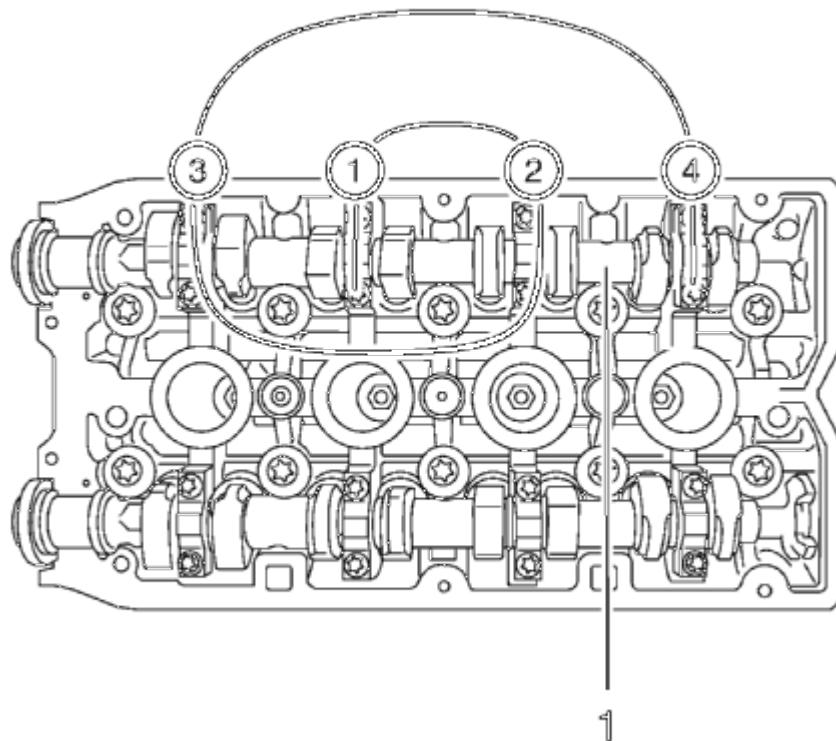


Fig. 482: Intake Camshaft Bearing Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

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).

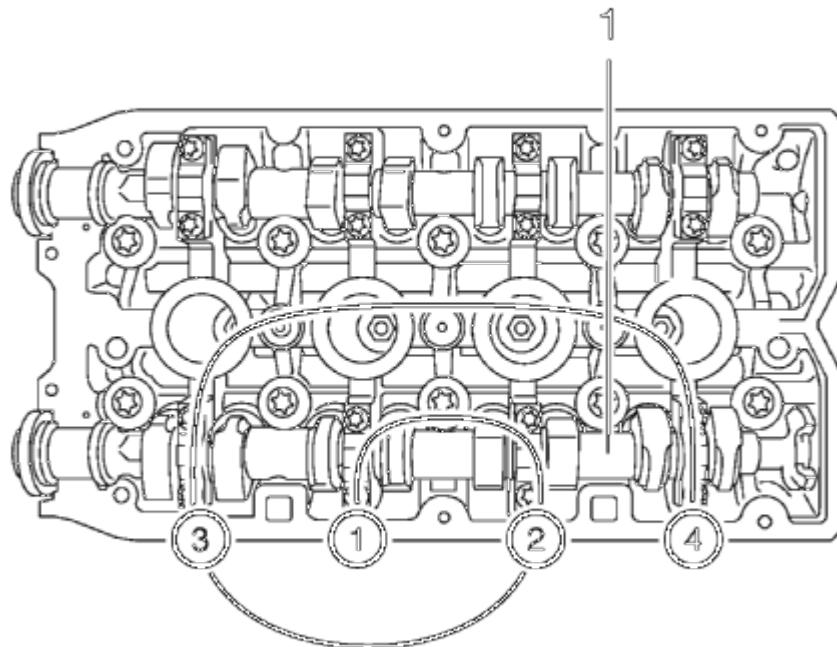


Fig. 483: Exhaust Camshaft Bearing Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

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).

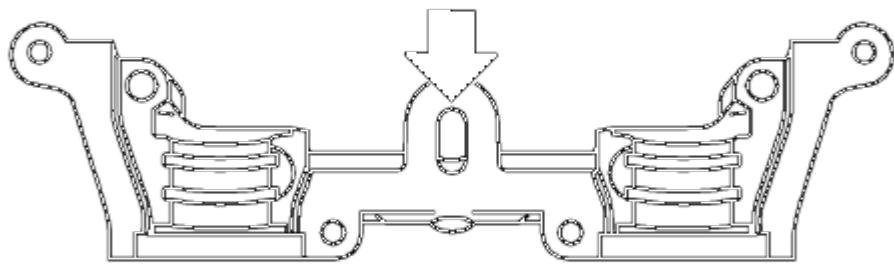


Fig. 484: View Of Oil Duct

Courtesy of GENERAL MOTORS COMPANY

NOTE: Sealing surfaces must be free from oil and grease.

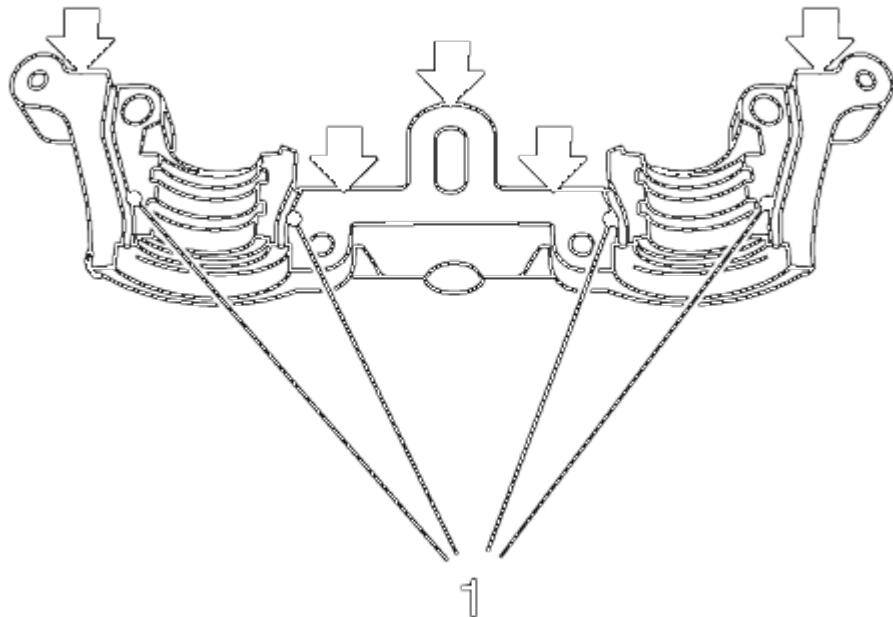


Fig. 485: View Of Sealing Surfaces And Grooves
Courtesy of GENERAL MOTORS COMPANY

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).

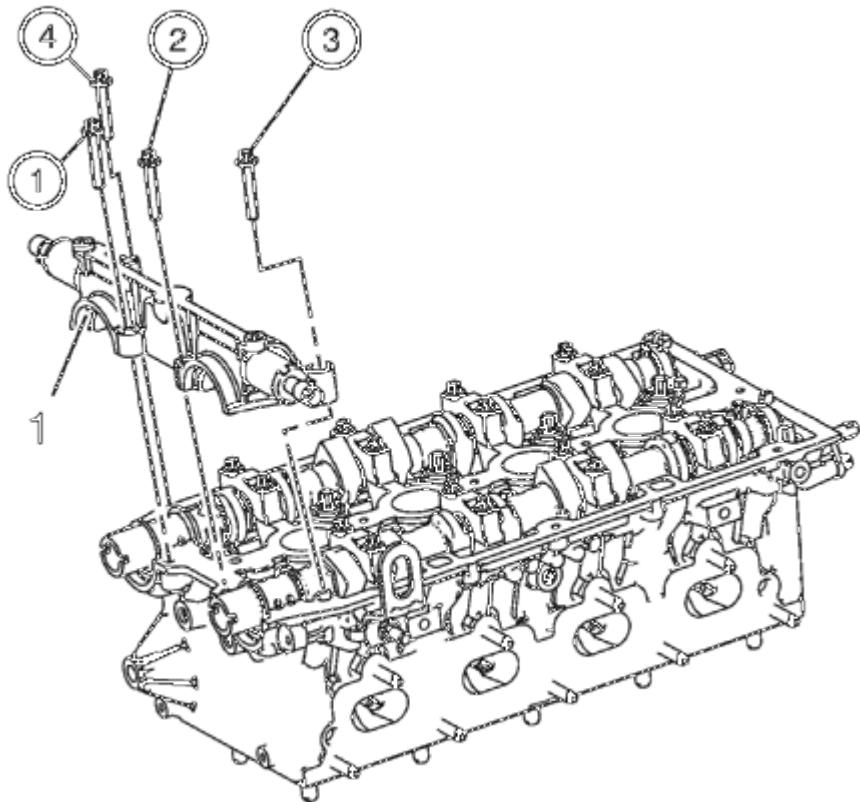


Fig. 486: Camshaft Bearing Cap

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).

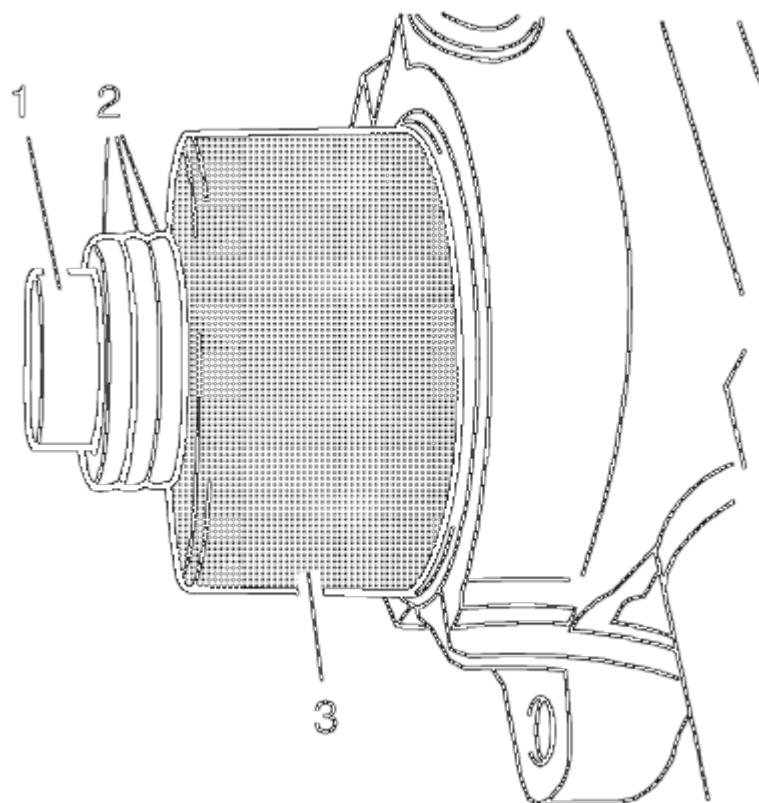


Fig. 487: Camshaft Sprocket Bolt, Shims And Tool

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

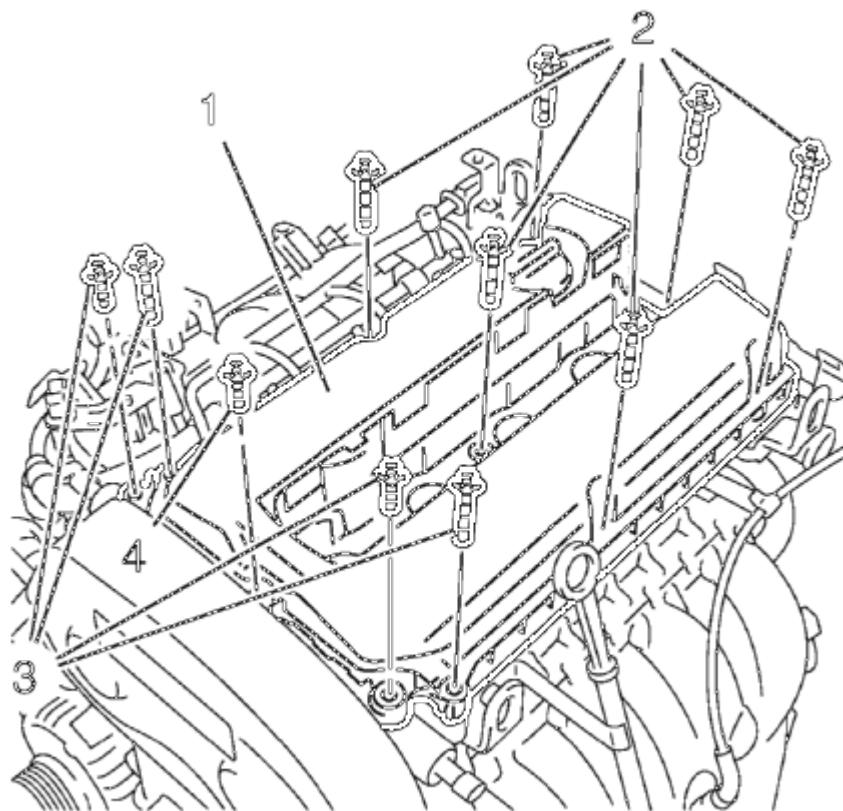


Fig. 488: Camshaft Cover Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Clean the bolt and the camshaft cover bolt (4) thread.
2. Apply sealant to the camshaft cover bolt (4). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
3. Insert a NEW gasket in the camshaft cover.
4. Install the camshaft cover (1).

CAUTION: Refer to [Fastener Caution](#) .

5. Install the 11 bolts (2, 3, 4) 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](#).

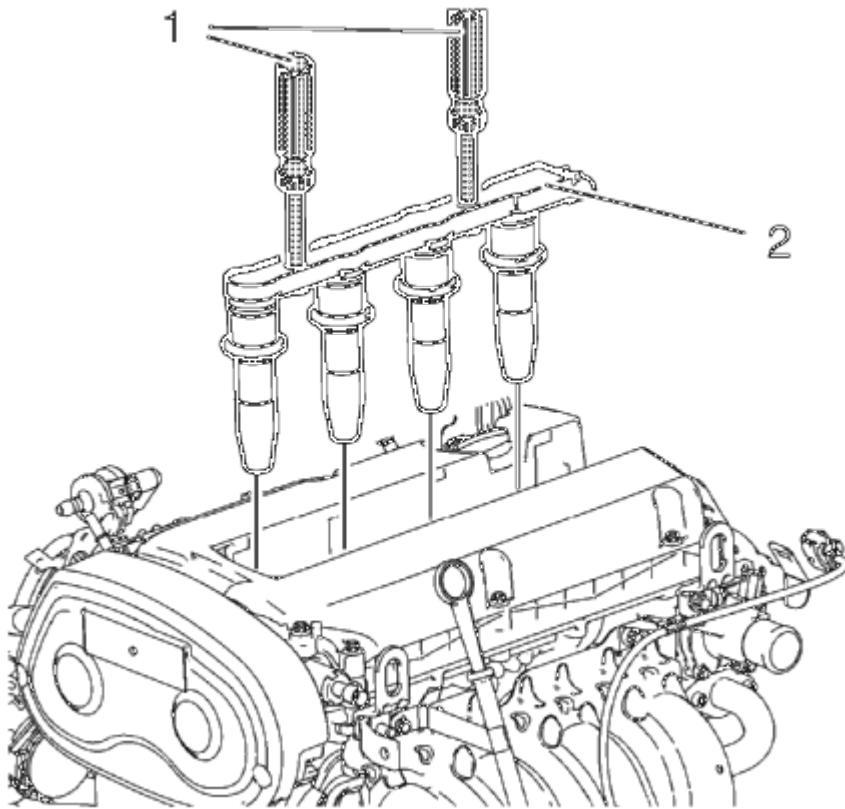


Fig. 489: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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

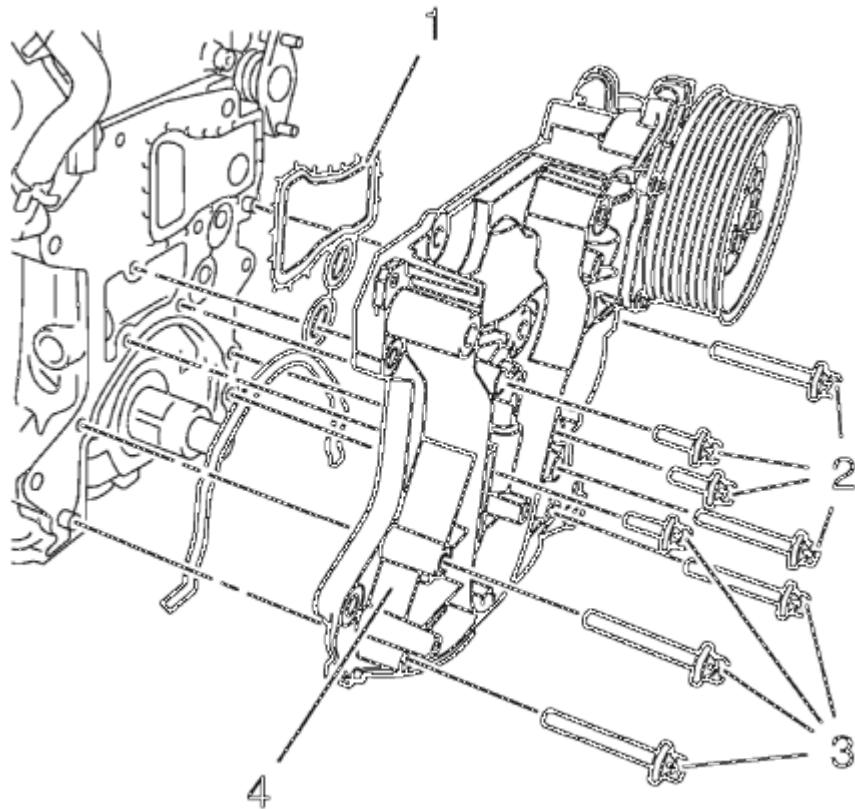


Fig. 490: Engine Oil Pump

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

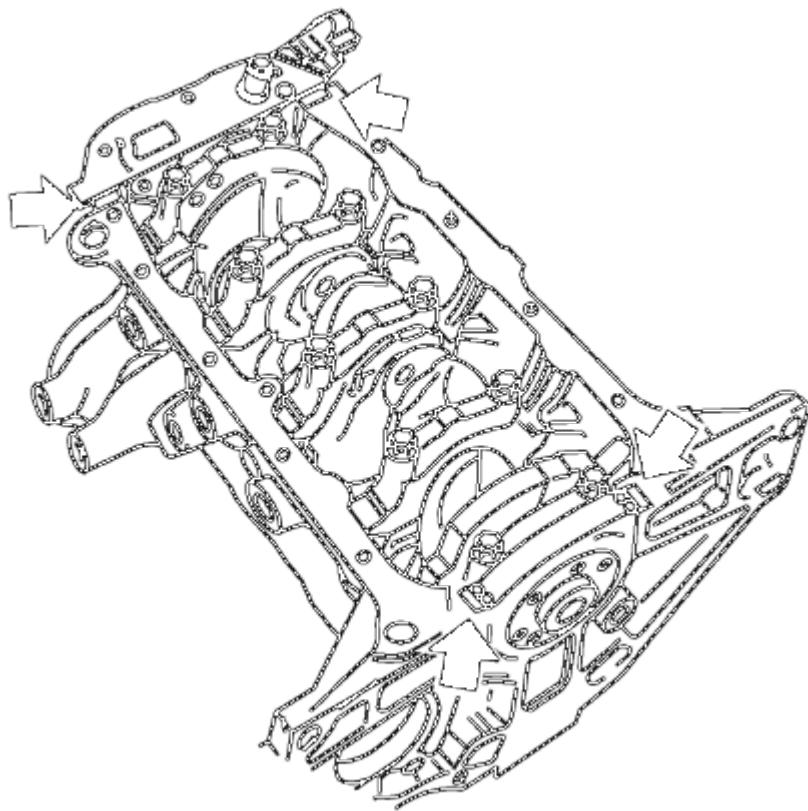


Fig. 491: View Of Joints For Sealant

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.

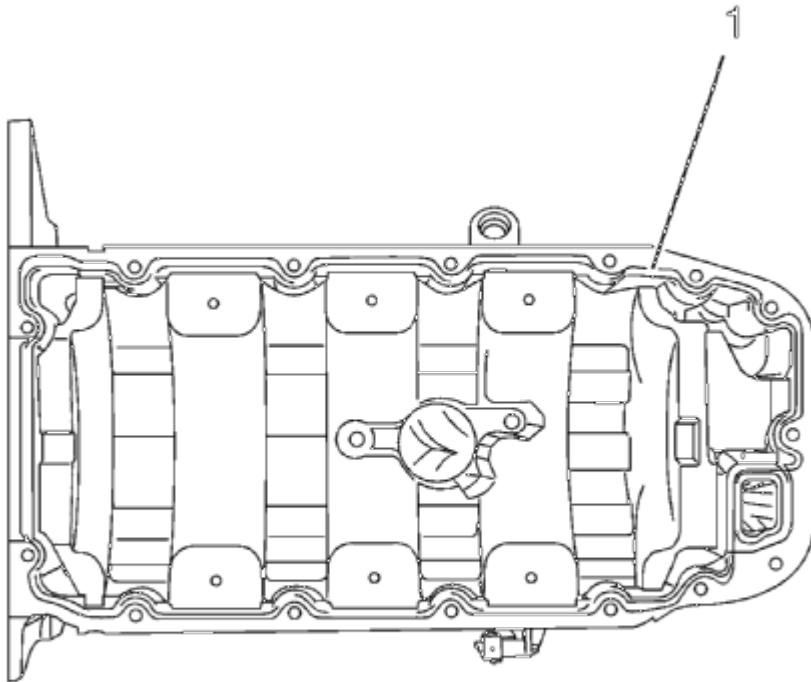


Fig. 492: Sealant Application Area

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.

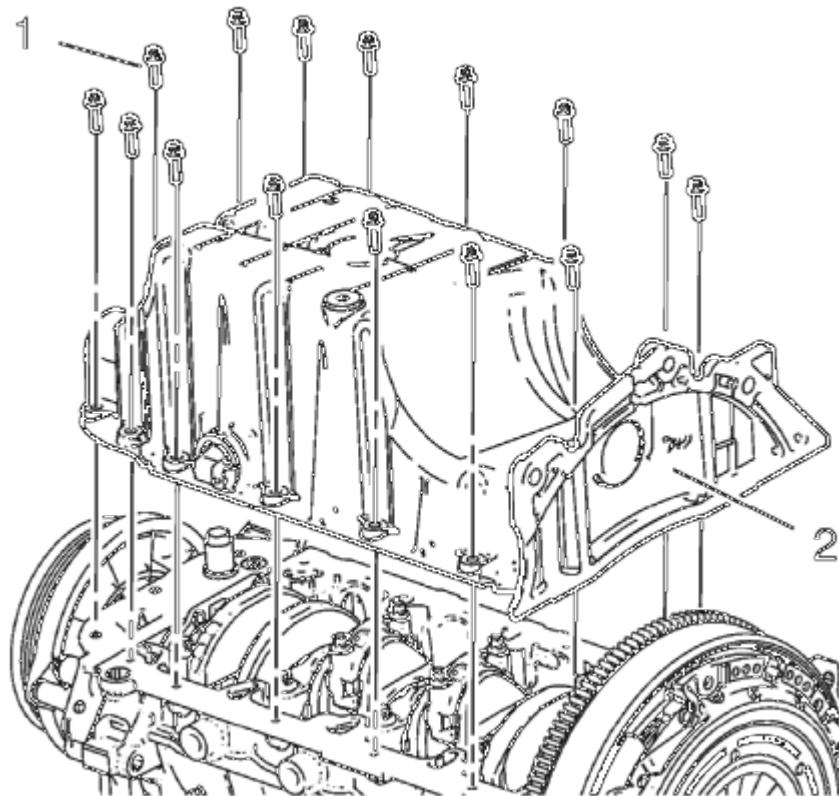


Fig. 493: Oil Pan And Bolts

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

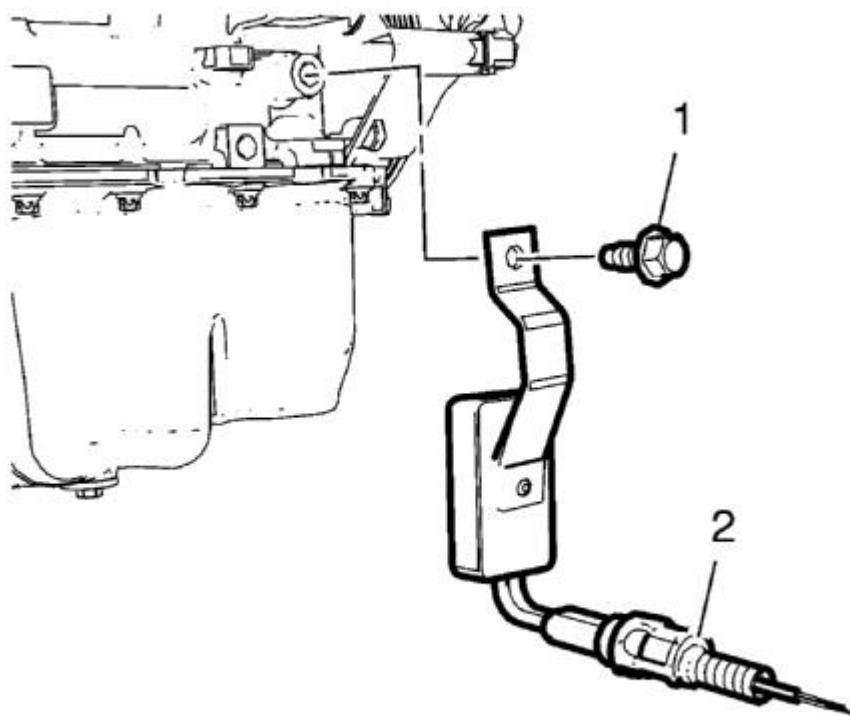


Fig. 494: Engine Oil Heater

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

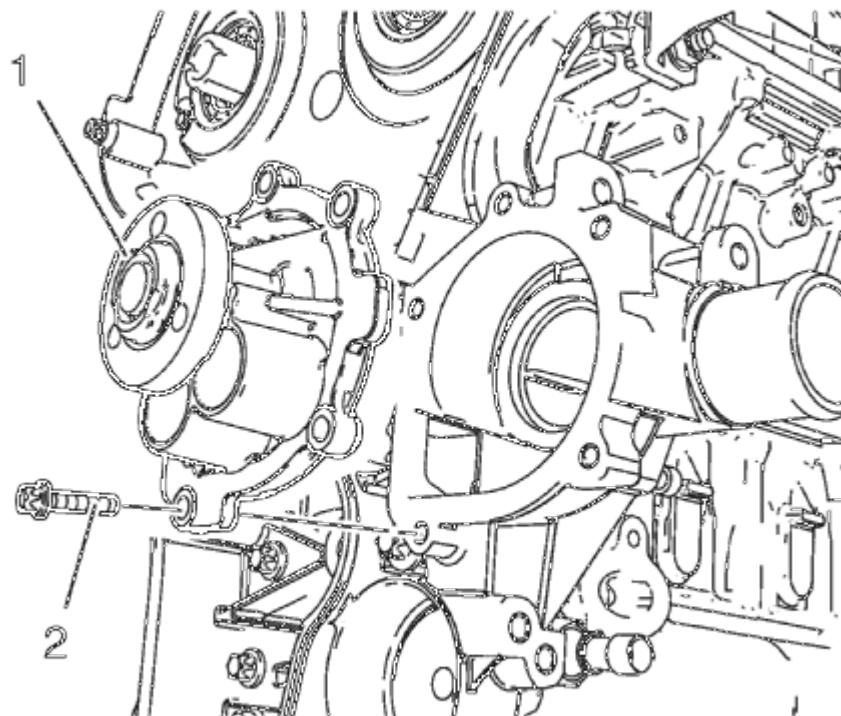


Fig. 495: Water Pump And Bolts

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

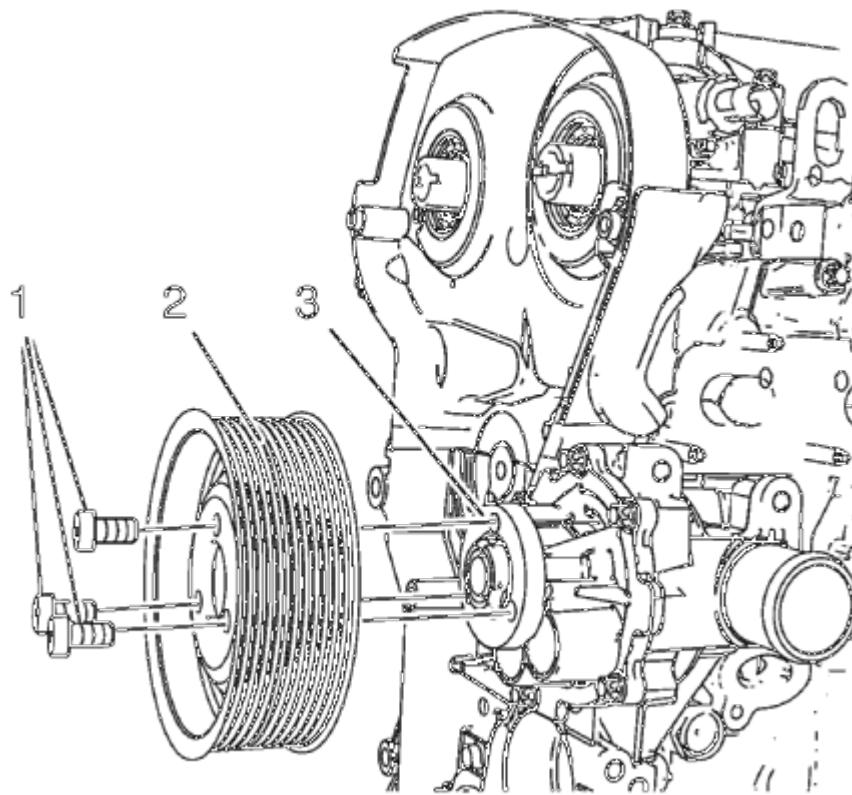


Fig. 496: Water Pump And Water Pump Pulley

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.

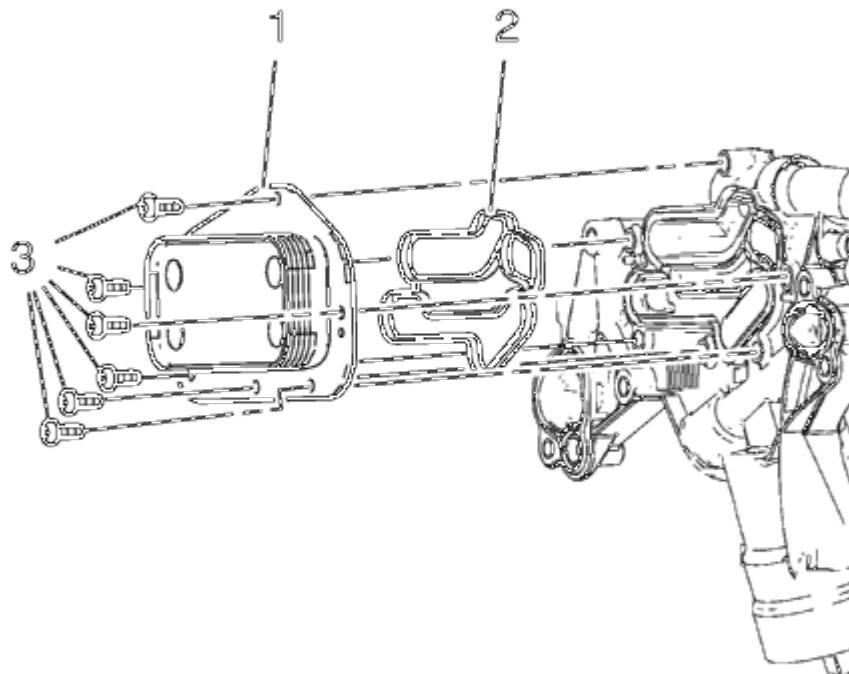


Fig. 497: Engine Oil Cooler

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.

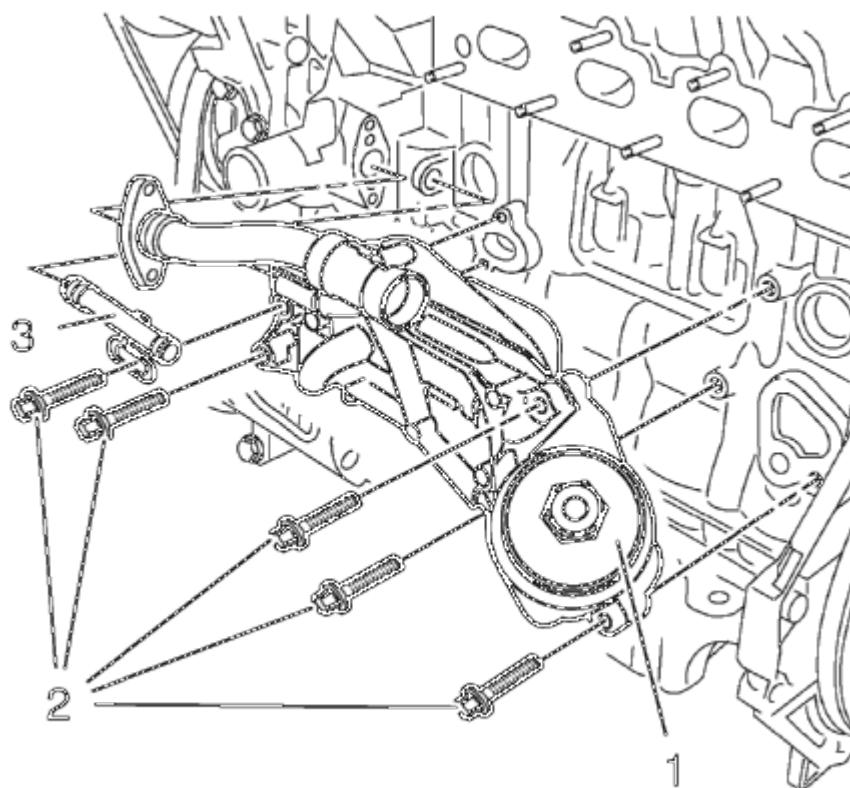


Fig. 498: Identifying Engine Oil Cooler Housing, Bolts And Engine Oil Cooler Inlet Pipe
Courtesy of GENERAL MOTORS COMPANY

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).

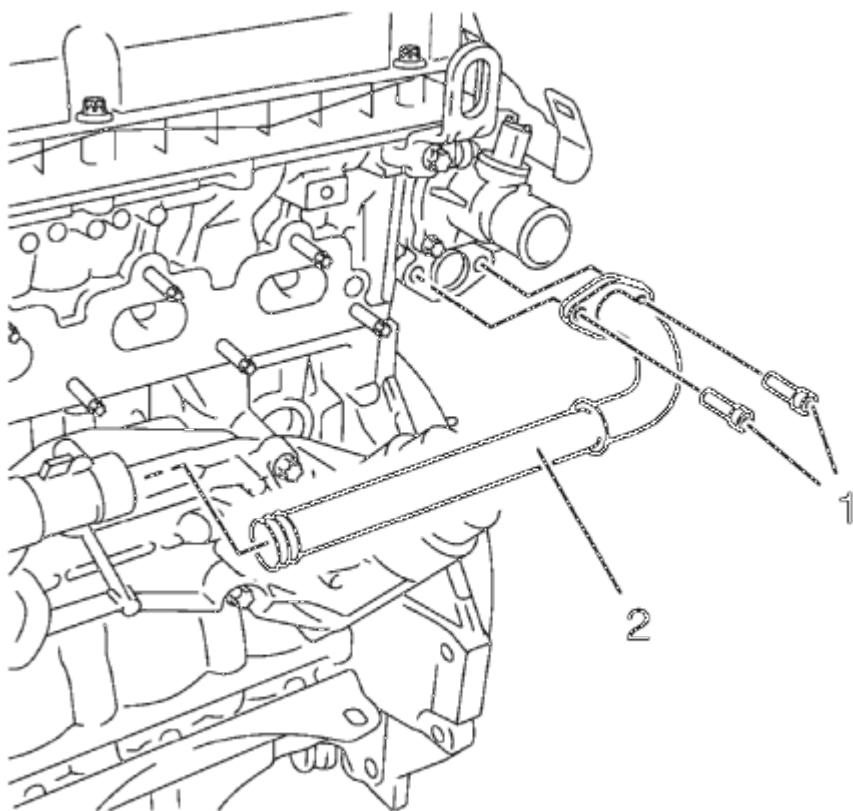


Fig. 499: Identifying Engine Oil Cooler Outlet Pipe And Bolts
Courtesy of GENERAL MOTORS COMPANY

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.

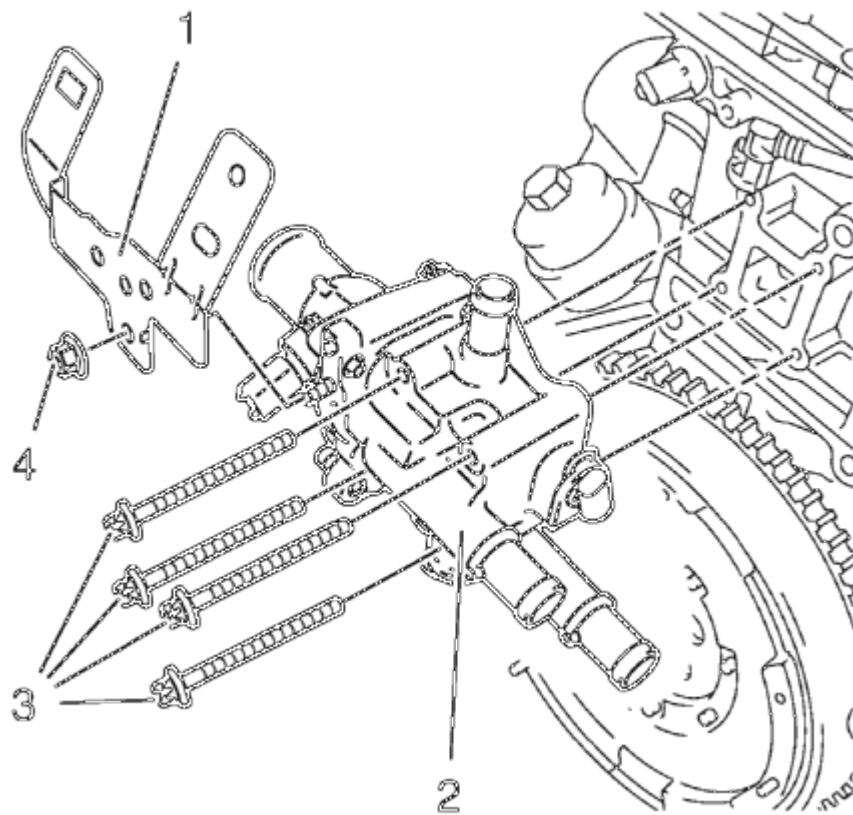


Fig. 500: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

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).

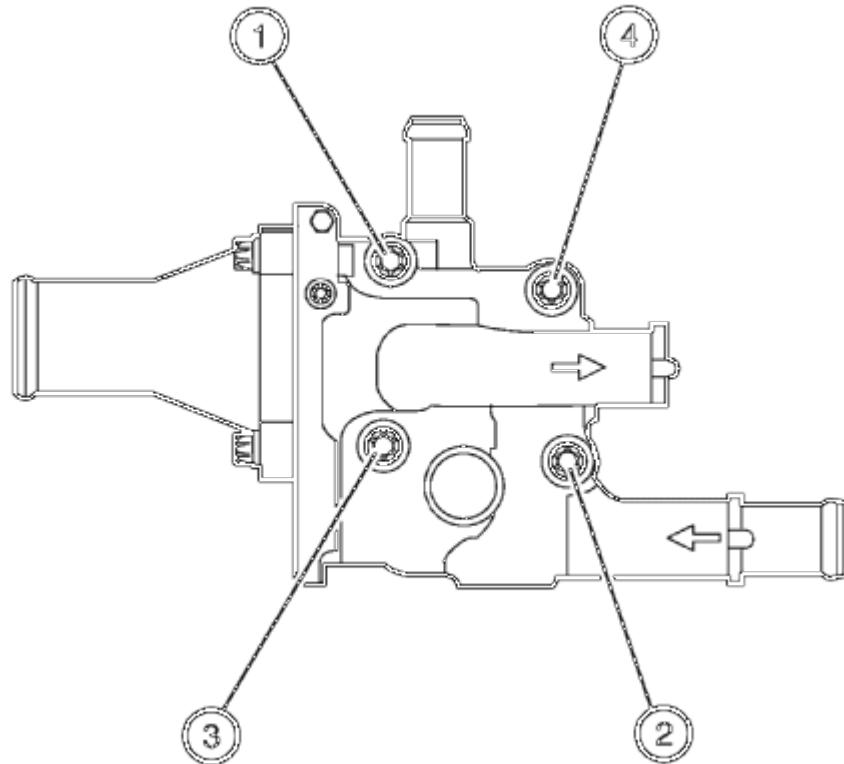


Fig. 501: Identifying Engine Coolant Thermostat Housing Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

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).

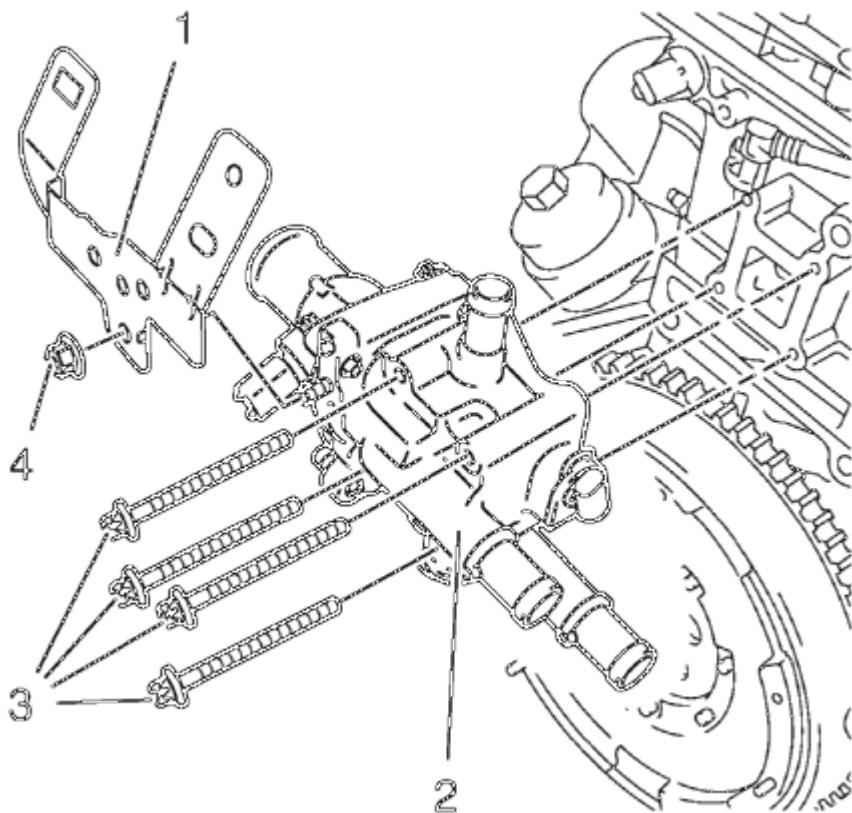


Fig. 502: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

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.

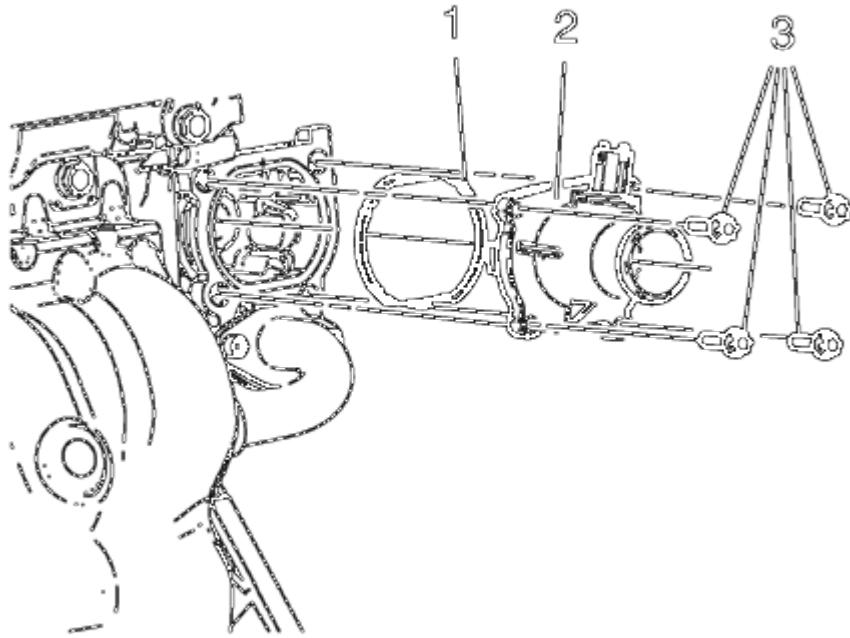


Fig. 503: Identifying Engine Coolant Thermostat Assembly
Courtesy of GENERAL MOTORS COMPANY

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

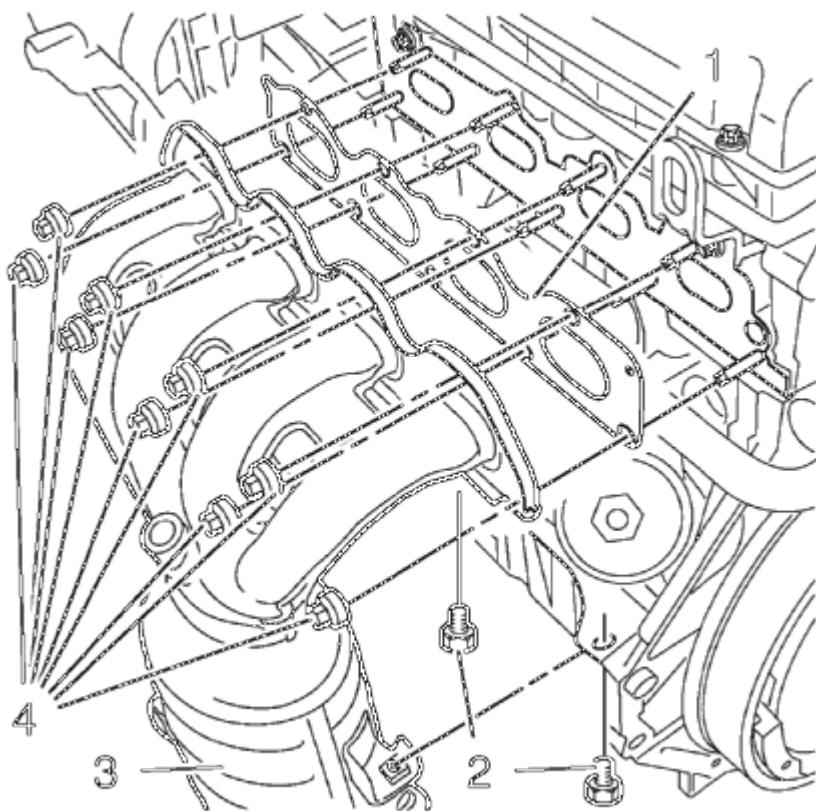


Fig. 504: Exhaust Manifold And Bolts

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

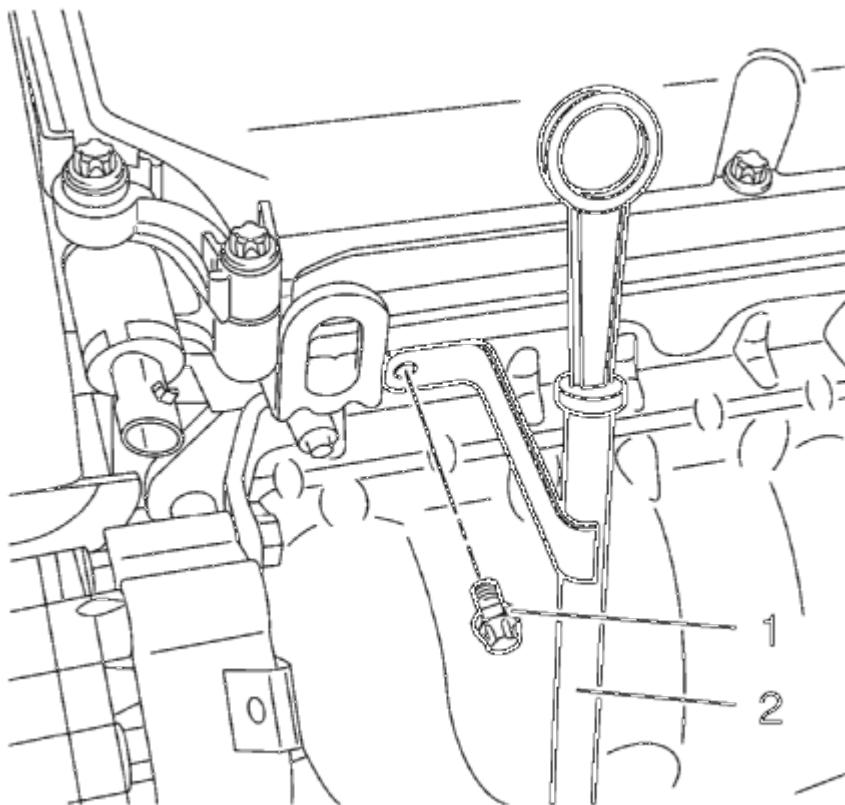


Fig. 505: Oil Level Indicator Tube And Bolt
Courtesy of GENERAL MOTORS COMPANY

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 (1.8L LUW AND LWE)

1. Clean the sealing surfaces.
2. Install 4 NEW gaskets.

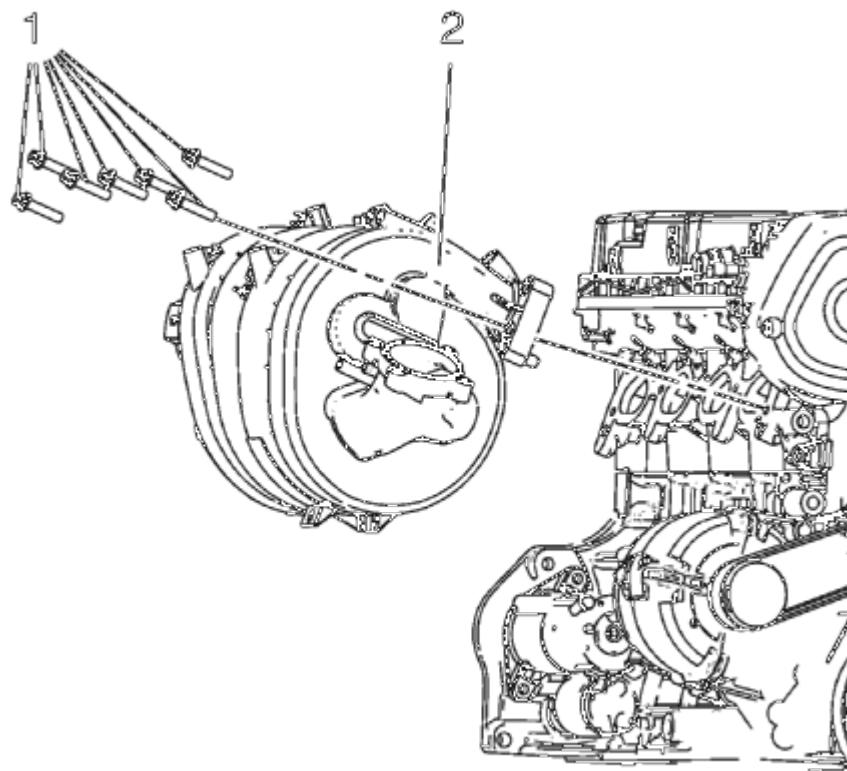


Fig. 506: Intake Manifold And Bolts

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).

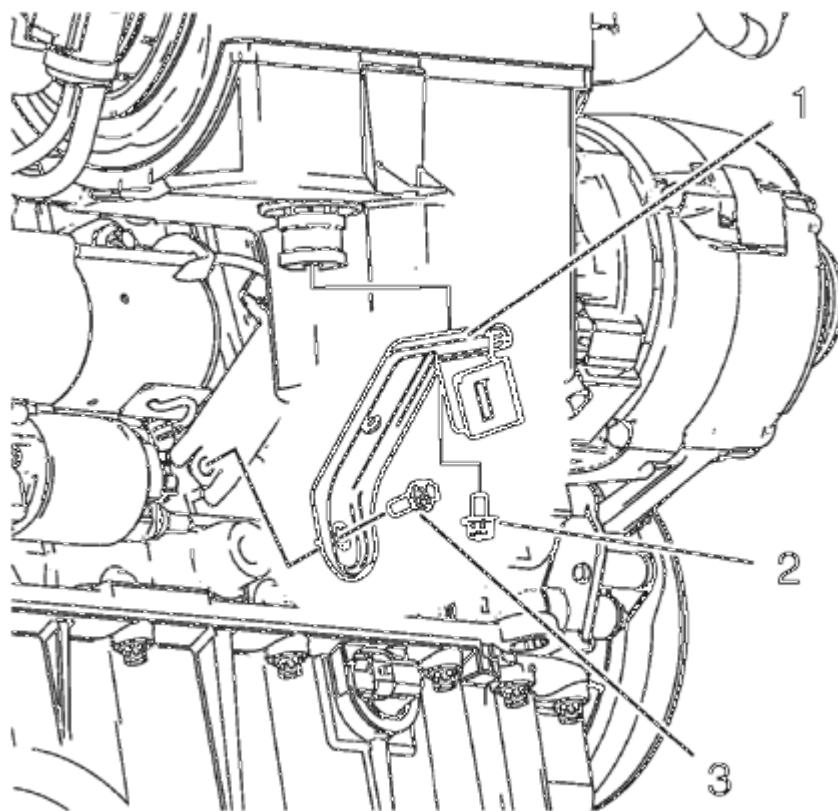


Fig. 507: Intake Manifold Bracket

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

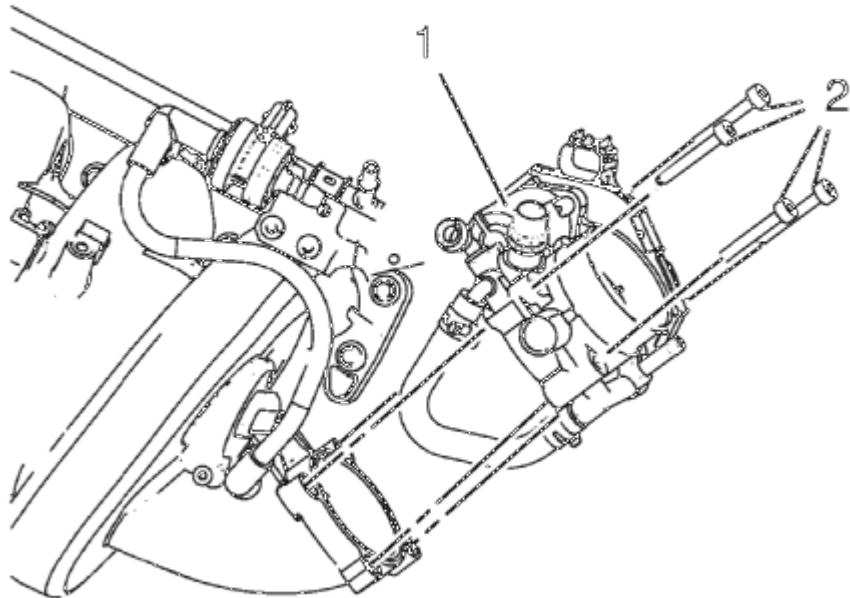


Fig. 508: Throttle Body And Bolts

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**.

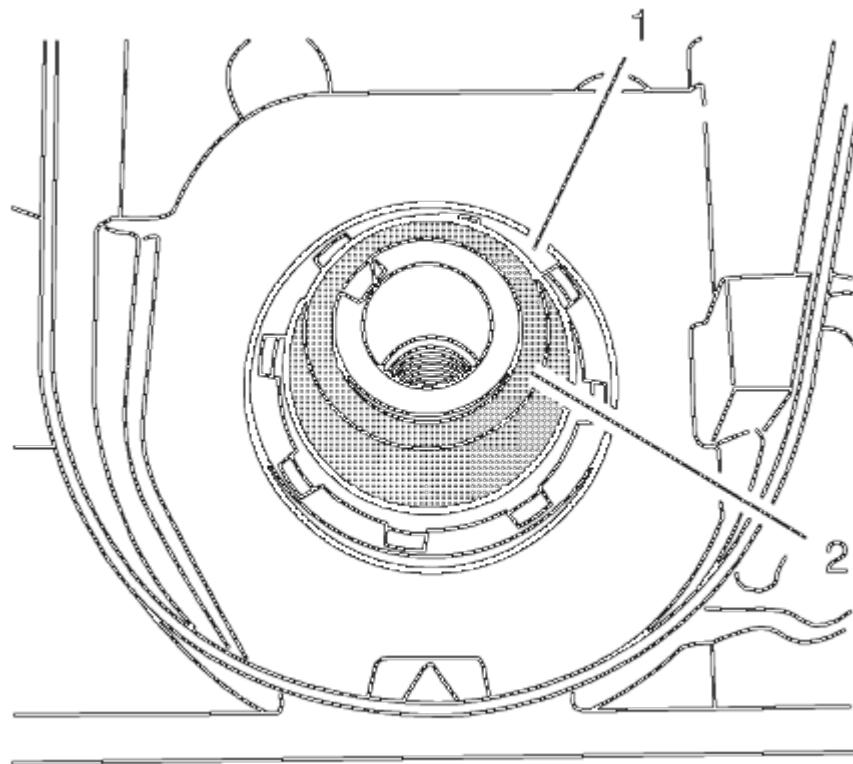


Fig. 509: Crankshaft And Crankshaft Front Oil Seal

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.

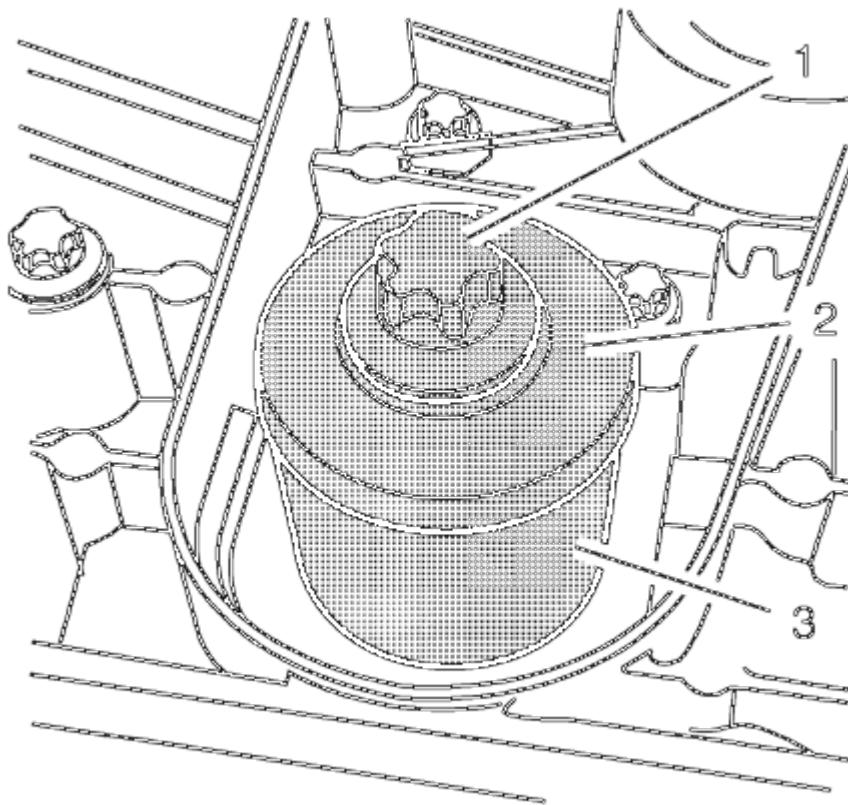


Fig. 510: Crankshaft Drive Gear Bolt, Washer And Sleeves

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.

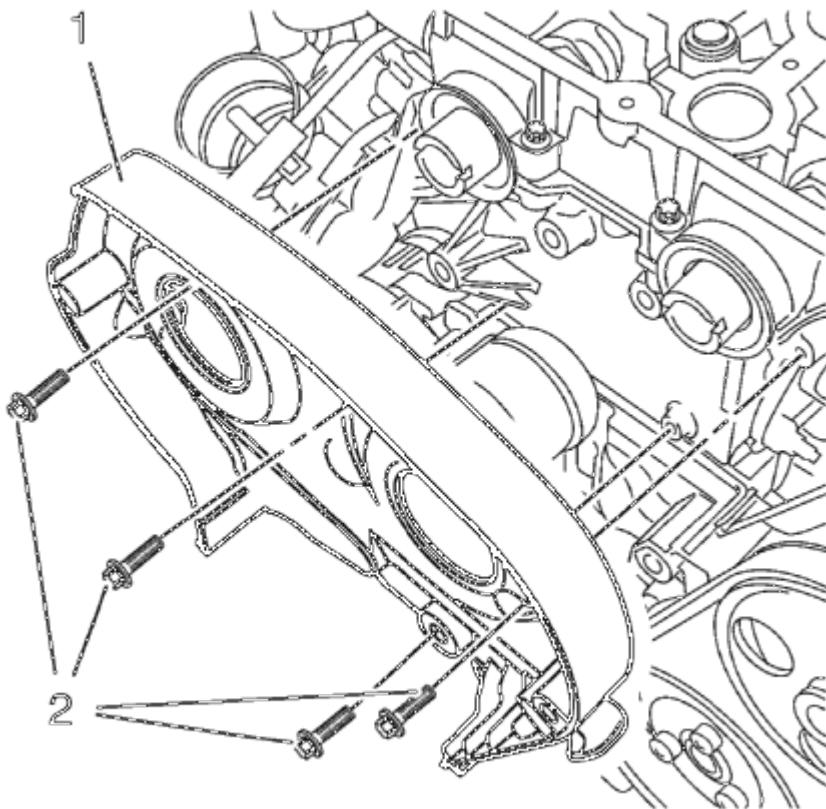


Fig. 511: Timing Belt Rear Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

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**.

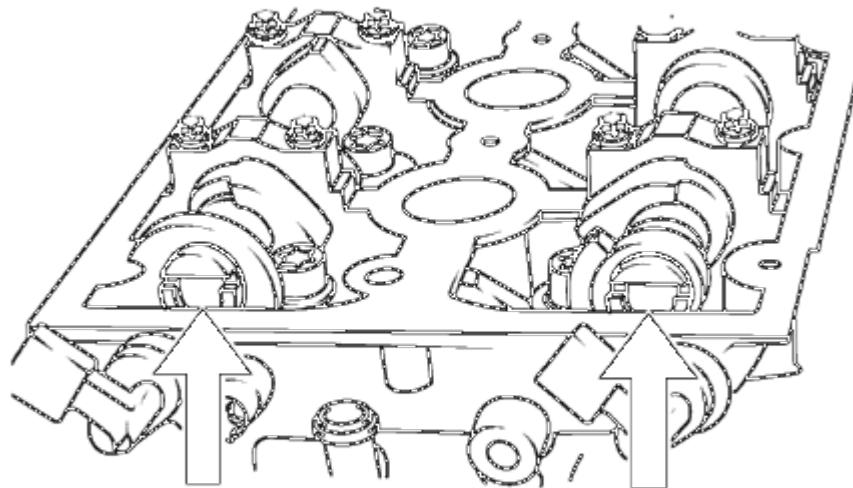


Fig. 512: Aligning Camshafts Horizontally

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.

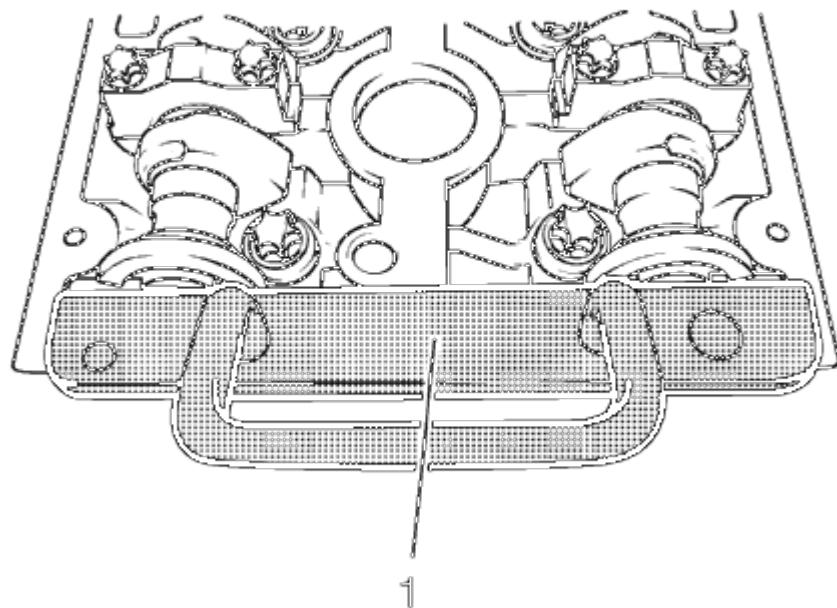


Fig. 513: Locking Tool
Courtesy of GENERAL MOTORS COMPANY

2. Install the EN-6628-A locking tool (1).

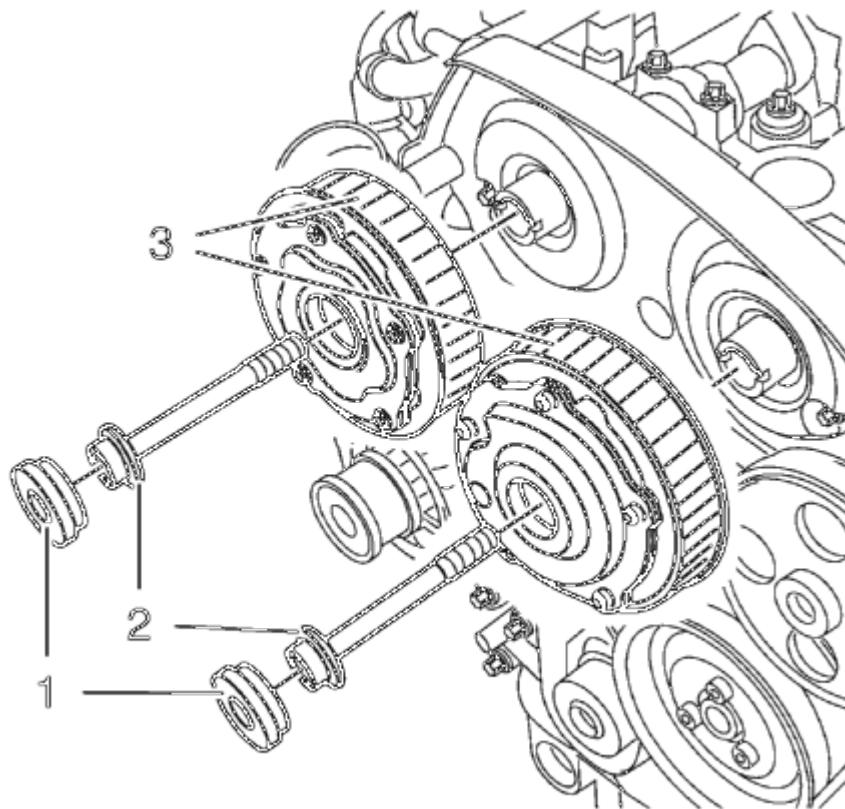


Fig. 514: Camshaft Position Actuator Adjuster Closure Bolt

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.

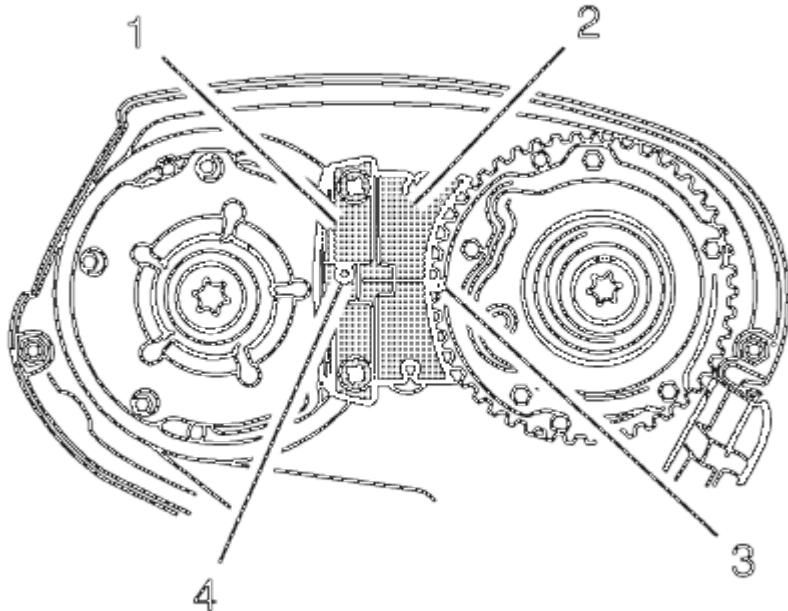


Fig. 515: Spot Type Markings And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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.

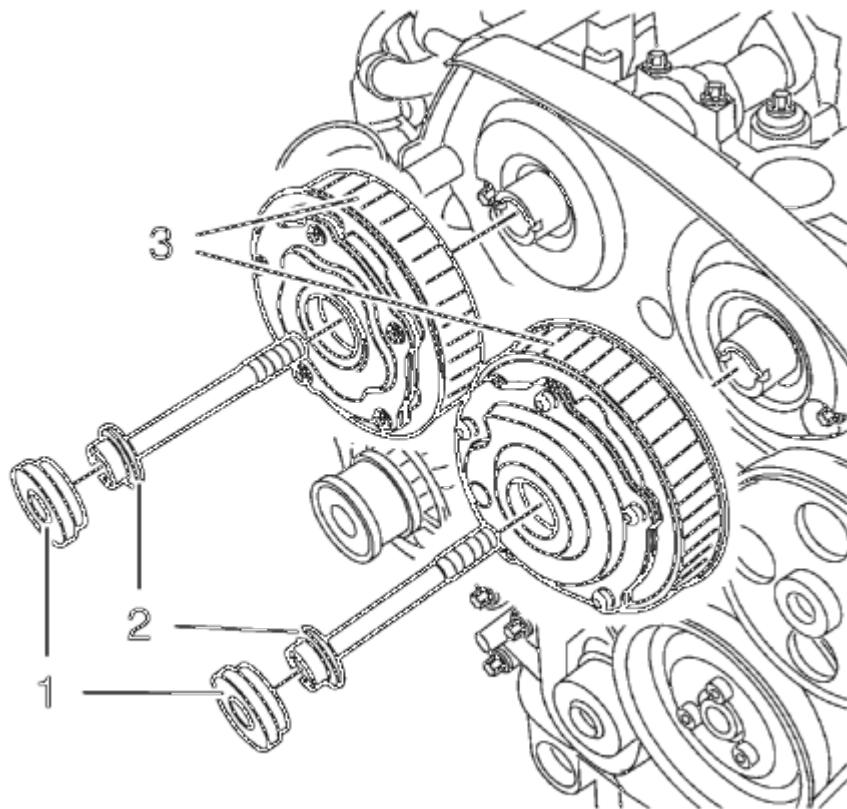


Fig. 516: Camshaft Position Actuator Adjuster Closure Bolt
Courtesy of GENERAL MOTORS COMPANY

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

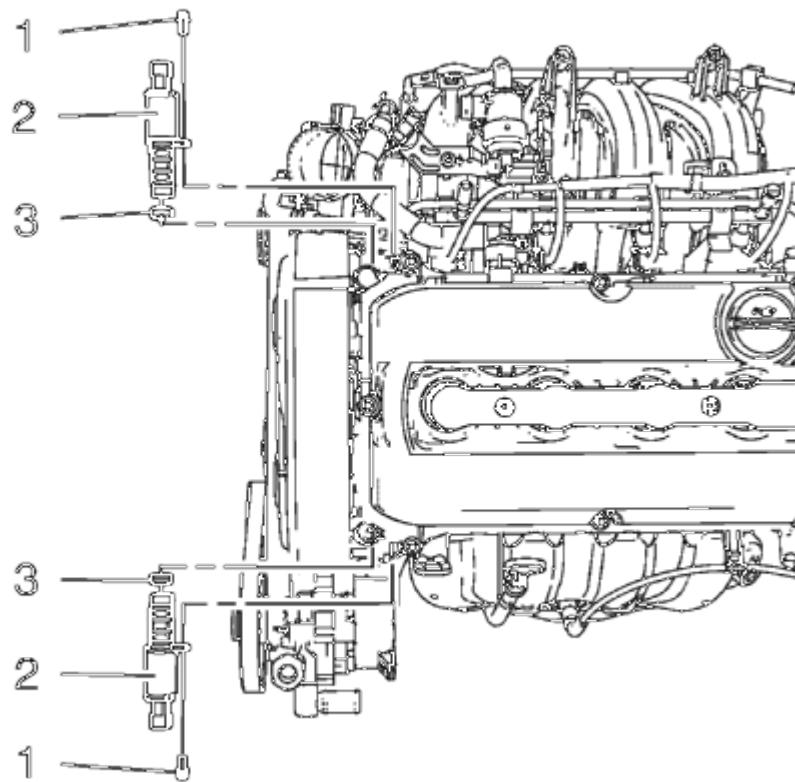


Fig. 517: Camshaft Position Actuator Solenoid Valves, Bolts And Seals
Courtesy of GENERAL MOTORS COMPANY

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

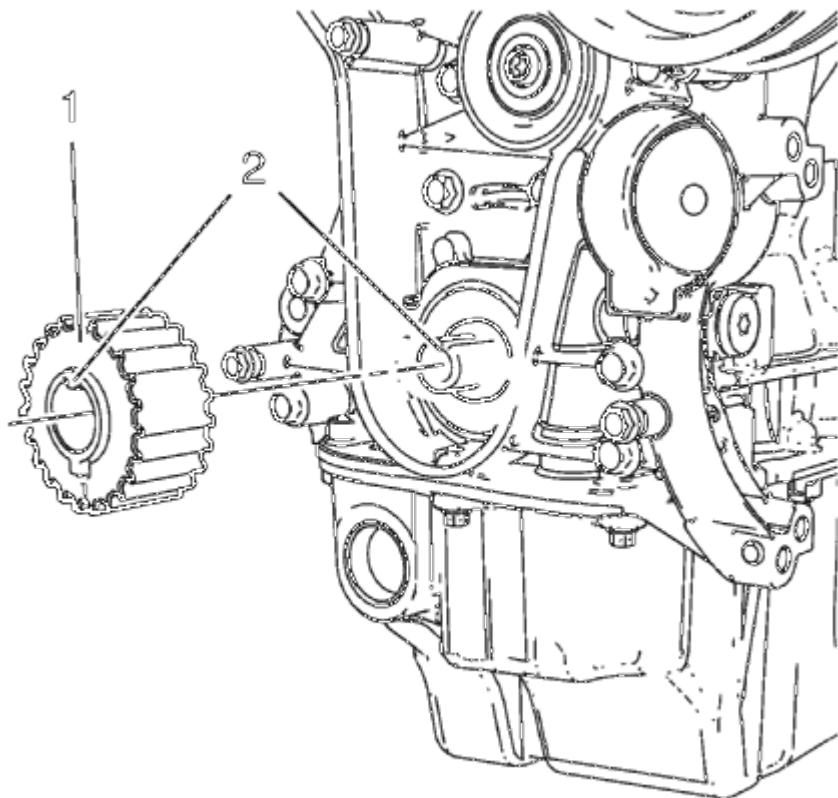


Fig. 518: Crankshaft Sprocket

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

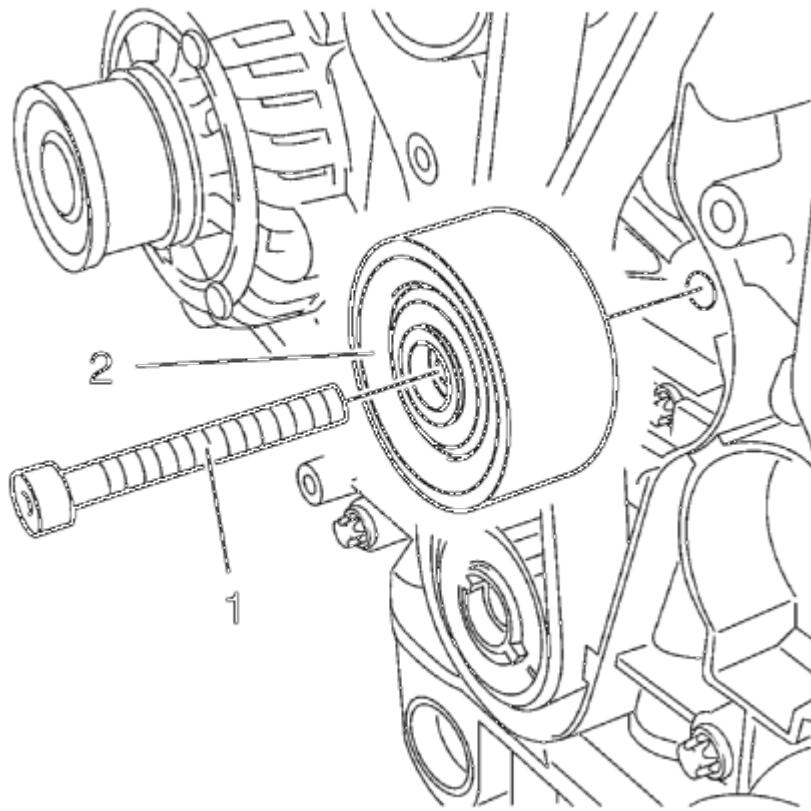


Fig. 519: Timing Belt Idler Pulley Bolt

Courtesy of GENERAL MOTORS COMPANY

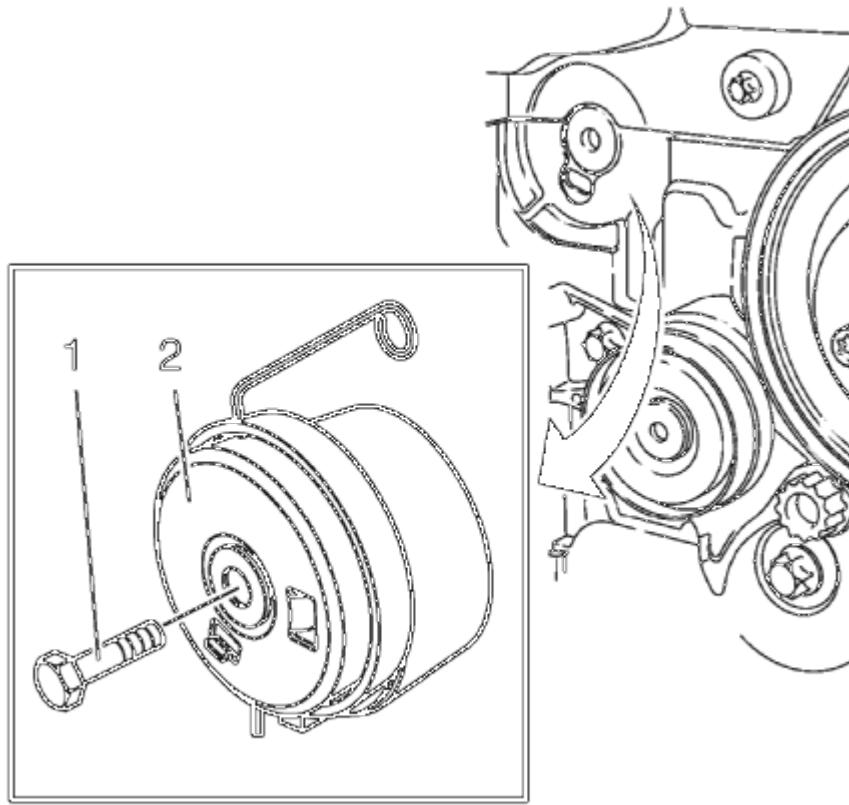
CAUTION: Refer to Fastener Caution .

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

1. Re-cut the timing belt idler pulley thread.
2. Install the timing belt idler pulley (2) and tighten the NEW timing belt idler pulley bolt (1) a first pass to 20 N.m (15 lb ft).
3. Tighten the NEW timing belt idler pulley bolt a second pass to an additional 120 degrees, using the **EN-45059** meter.
4. Tighten the NEW timing belt idler pulley bolt a final pass to an additional 15 degrees, using the **EN-45059** meter.

TIMING BELT TENSIONER INSTALLATION

Special Tools

EN-45059 Angle Meter**Fig. 520: 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](#).

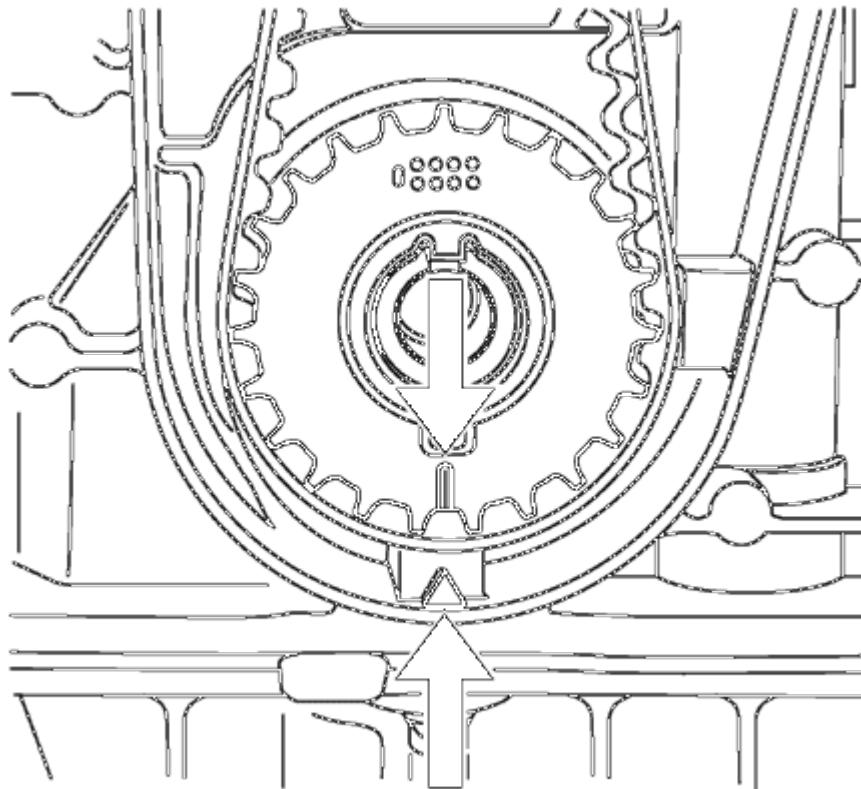


Fig. 521: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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.

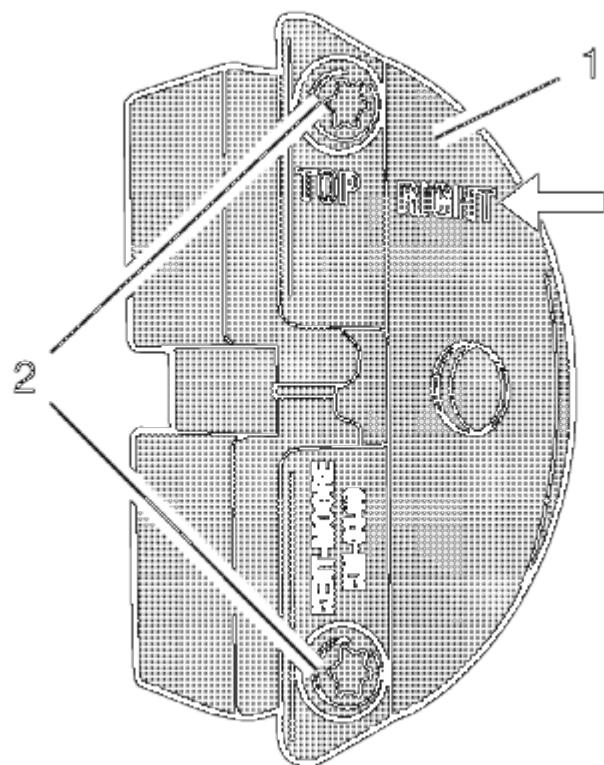


Fig. 522: Front Panel And Bolts

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.

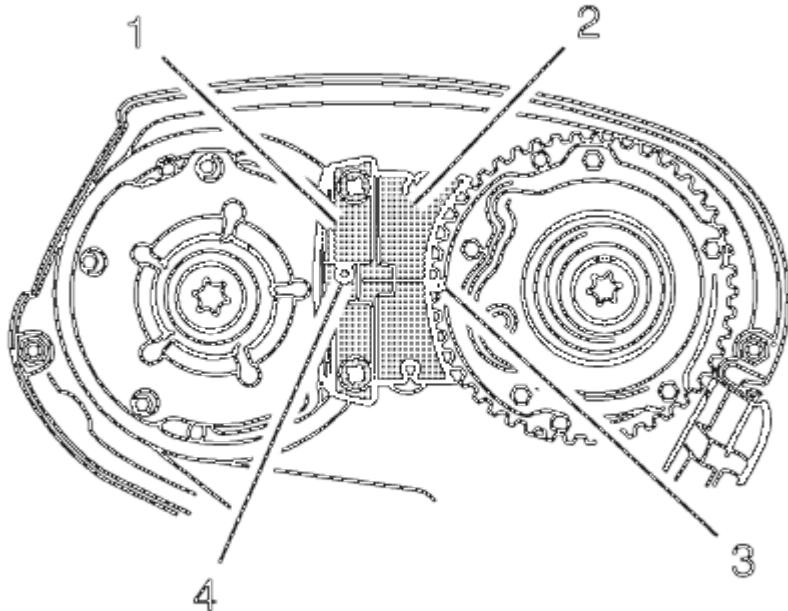


Fig. 523: Spot Type Markings And Special Tool

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.

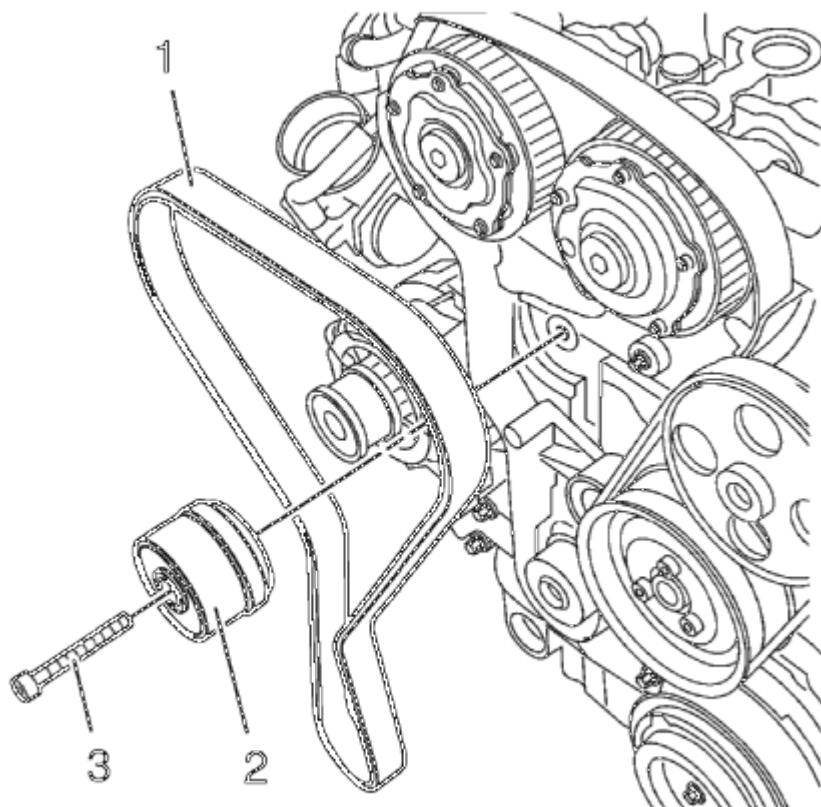


Fig. 524: Timing Belt, Timing Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe direction of rotation.

4. Insert the timing belt (1).

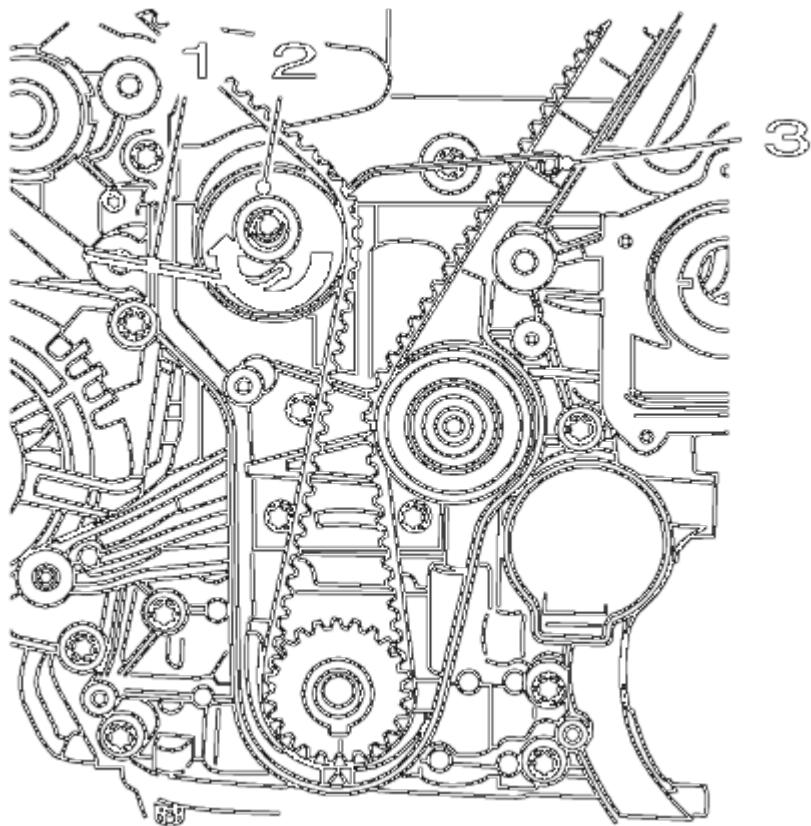


Fig. 525: View Of Drive Belt Tensioner, Allen Key And KM-6333
Courtesy of GENERAL MOTORS COMPANY

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.

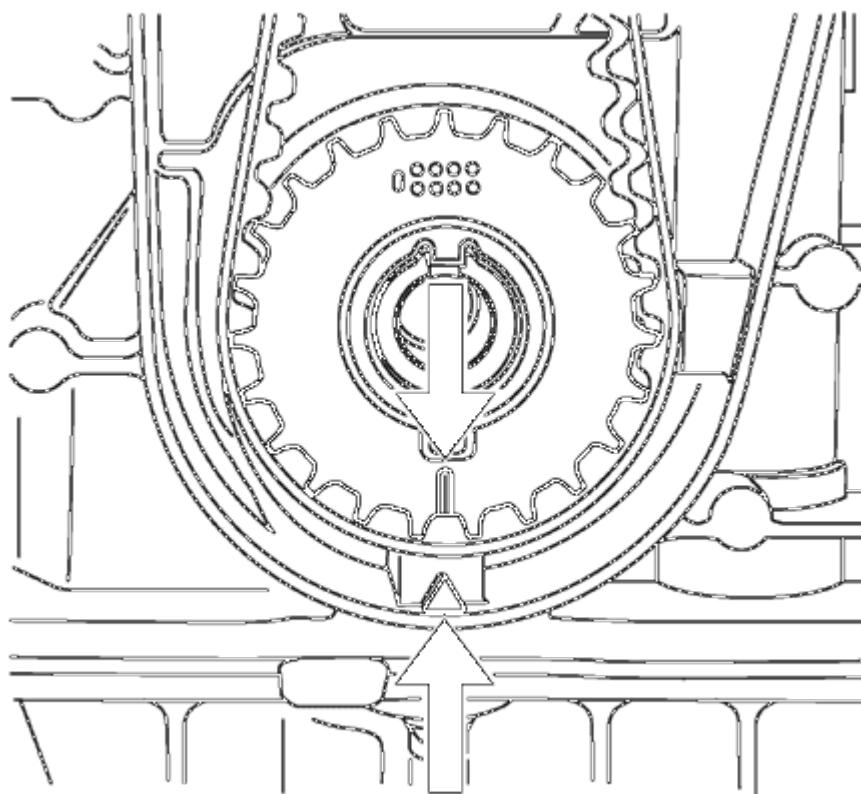


Fig. 526: Aligning Timing Belt Drive Gear And Oil Pump Housing
Courtesy of GENERAL MOTORS COMPANY

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

10. Check the crankshaft position.

TIMING BELT LOWER FRONT COVER INSTALLATION

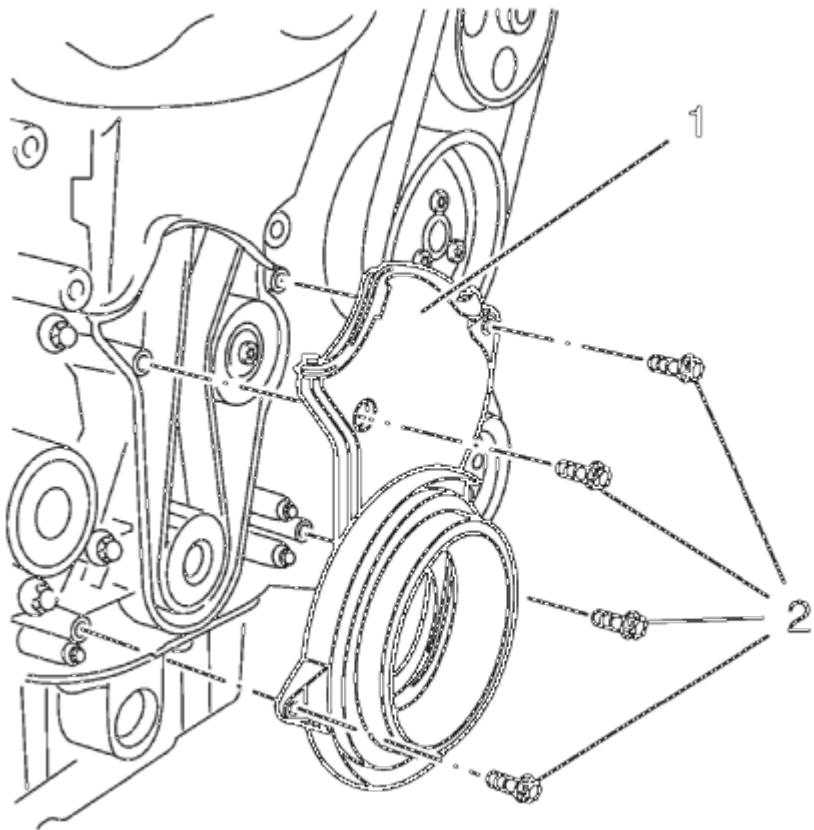


Fig. 527: Timing Belt Lower Front Cover
Courtesy of GENERAL MOTORS COMPANY

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.

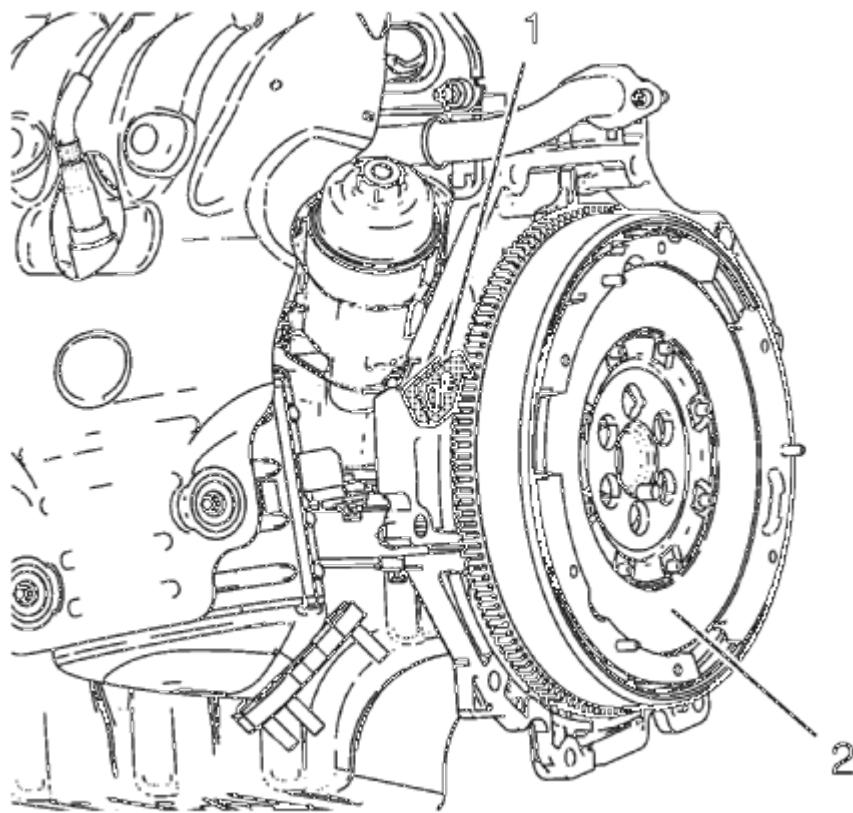


Fig. 528: Flywheel And Flywheel Holder

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.

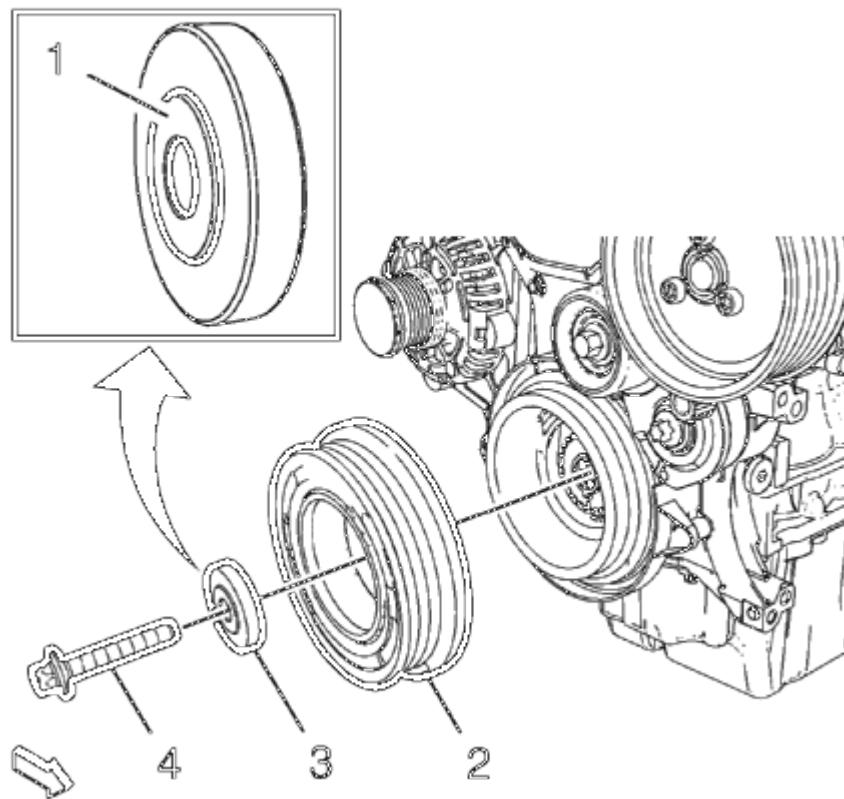


Fig. 529: Crankshaft Balancer, Washer And Bolt

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

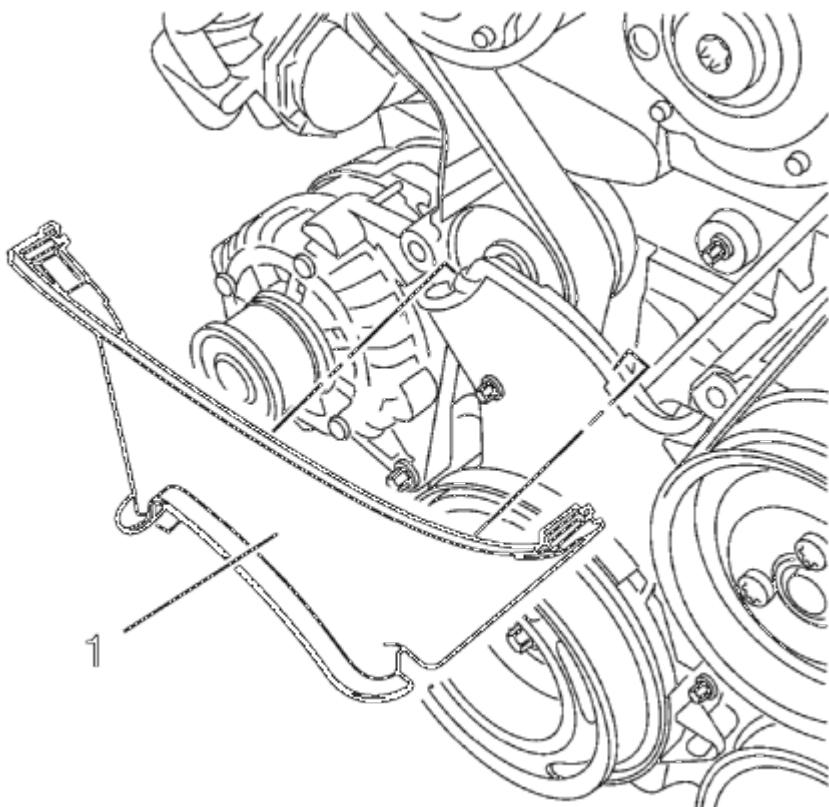


Fig. 530: Timing Belt Center Front Cover
Courtesy of GENERAL MOTORS COMPANY

Install the timing belt center front cover (1) to the timing belt rear cover at 2 locations.

TIMING BELT UPPER FRONT COVER INSTALLATION

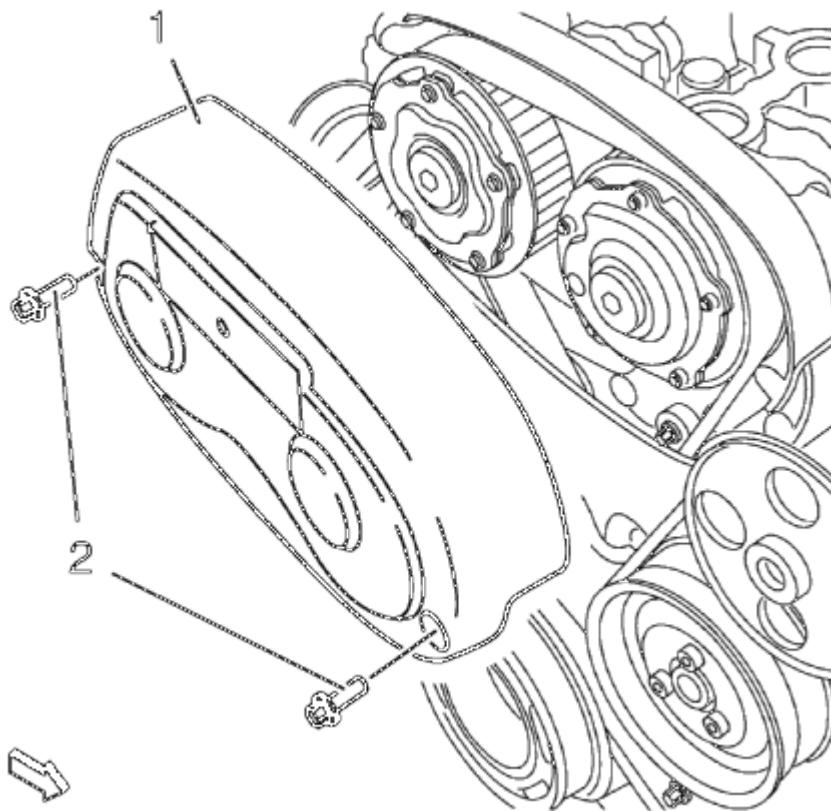


Fig. 531: Timing Belt Upper Front Cover
Courtesy of GENERAL MOTORS COMPANY

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**.

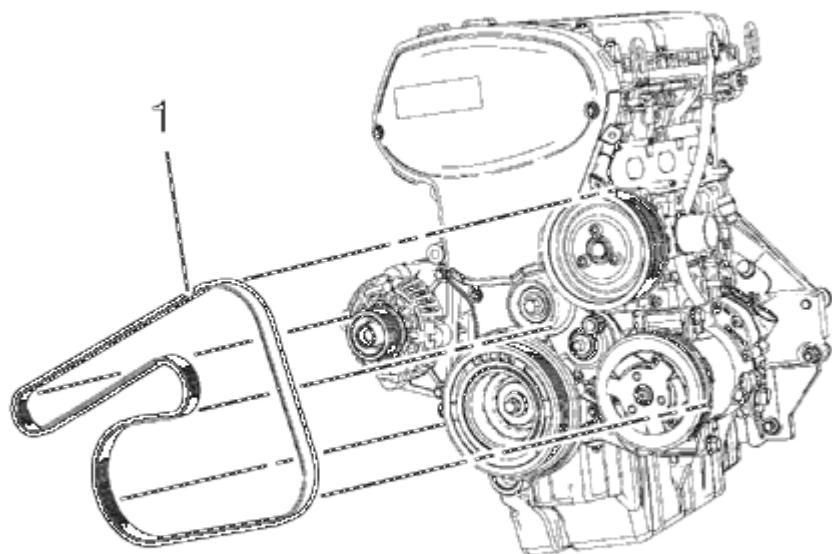


Fig. 532: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt (1).

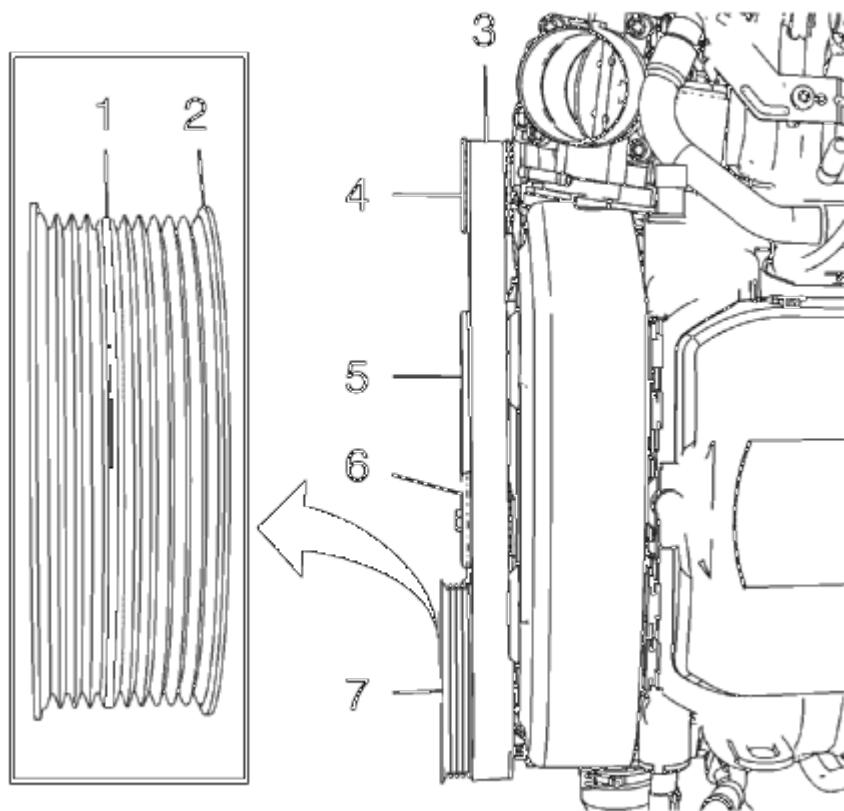


Fig. 533: Checking Drive Belt Position

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).

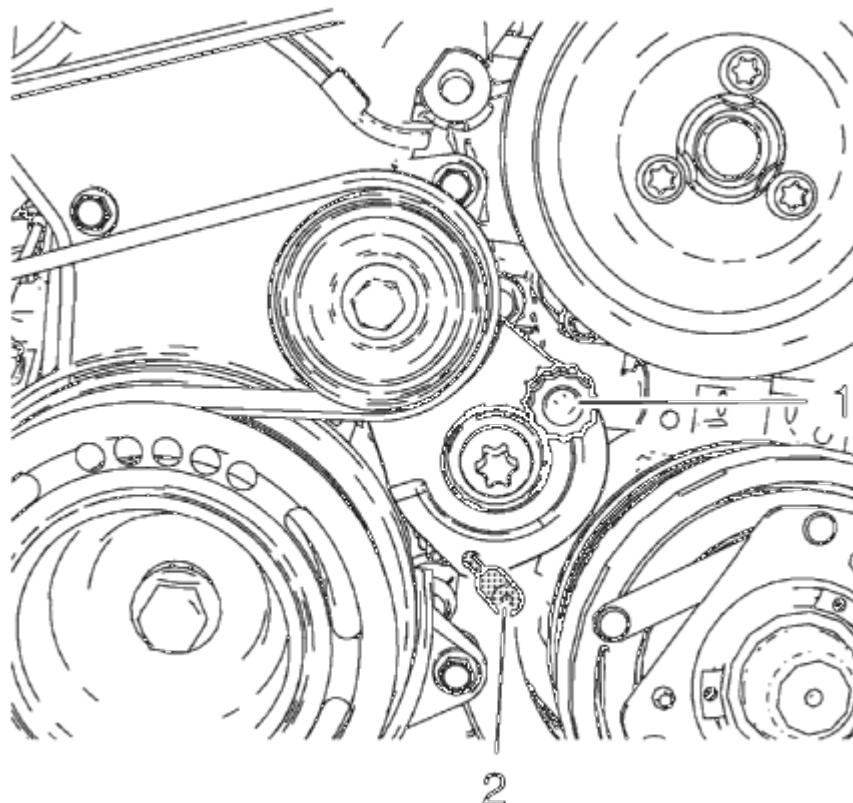


Fig. 534: Drive Belt Tensioner And Special Tool
Courtesy of GENERAL MOTORS COMPANY

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.

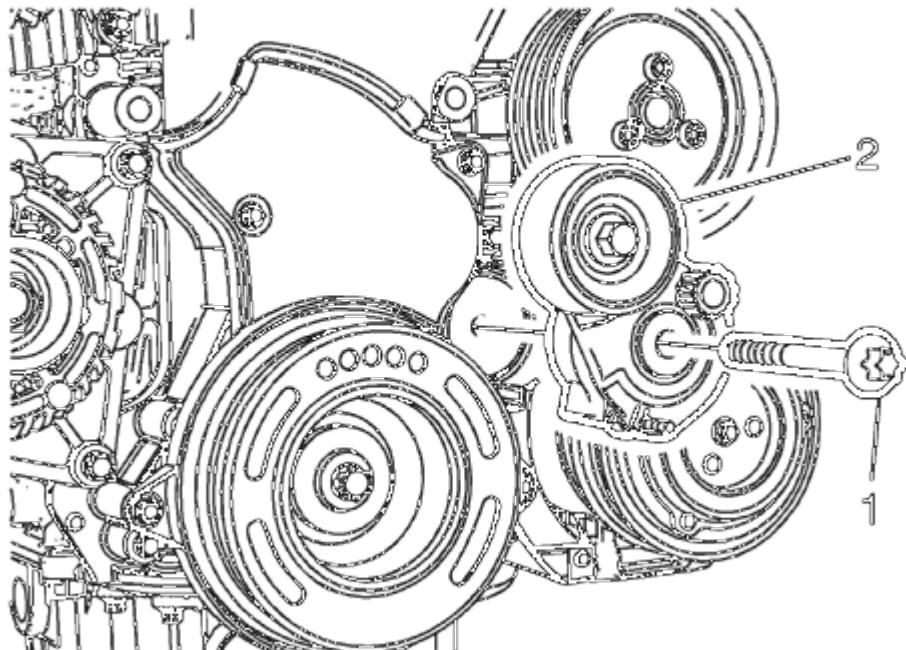


Fig. 535: Drive Belt Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

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).

POWER STEERING PUMP BELT INSTALLATION

Special Tools

EN-50098 Belt Installer

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

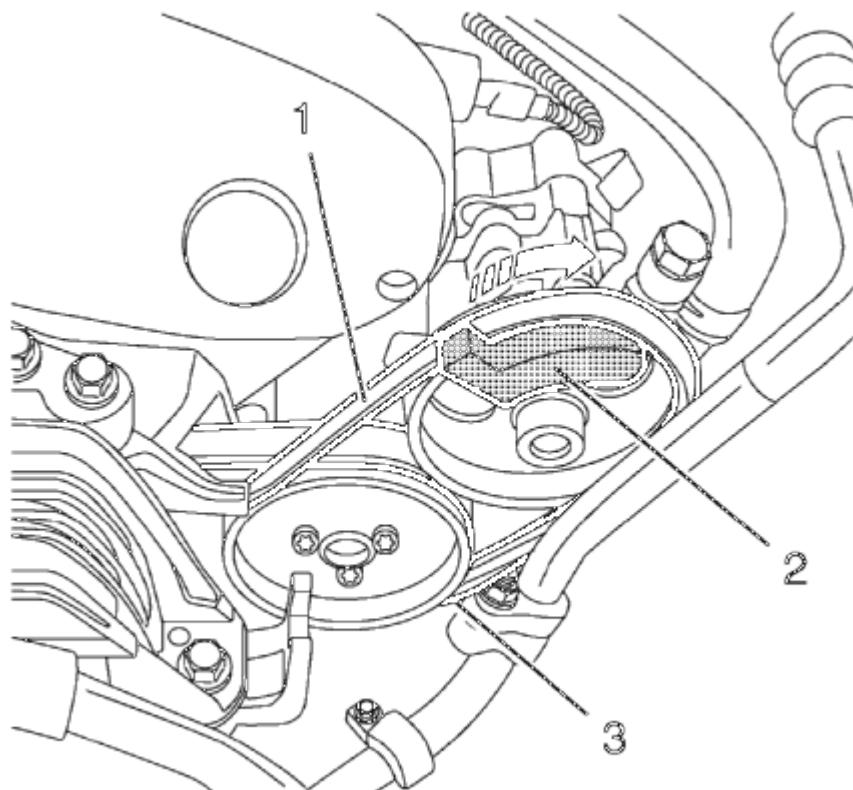


Fig. 536: Power Steering Pump Belt, Installer & Water Pump Pulley
Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-50098** installer (2) and a NEW power steering pump belt (1) to water pump pulley and power steering pump pulley.
2. Turn the engine slowly clockwise at the crankshaft balancer bolt.
3. During turn the engine take care of the proper installation of the power steering pump belt to the water pump pulley (3).
4. Remove the **EN-50098** installer (2).
5. Check the power steering pump belt is installed clearly.

SECONDARY AIR INJECTION CHECK VALVE INSTALLATION

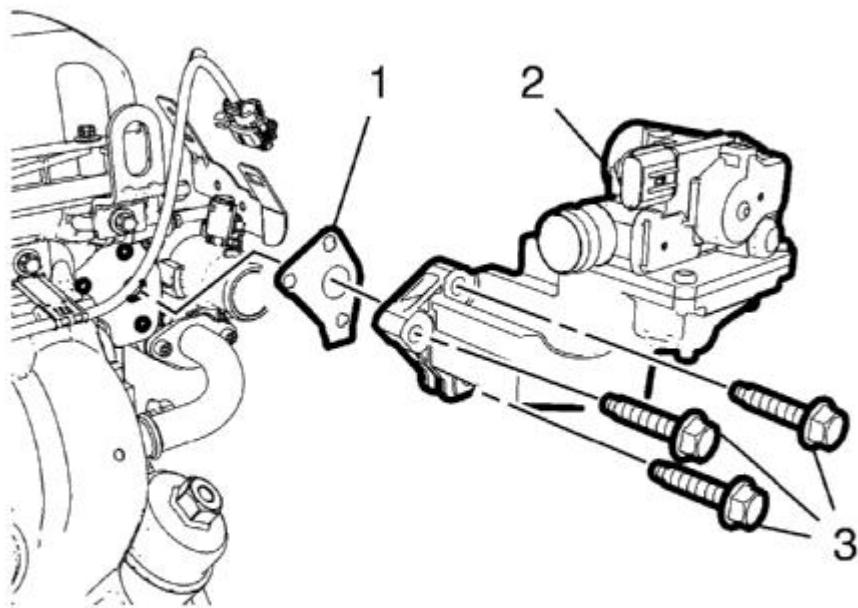


Fig. 537: Secondary Air Injection Check Valve Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW secondary air injection check valve gasket (1).
2. Install the secondary air injection check valve (2).

CAUTION: Refer to Fastener Caution .

3. Install the 3 secondary air injection check valve bolts (3) and tighten to 22 N.m (16 lb ft).

SECONDARY AIR INJECTION PUMP INSTALLATION

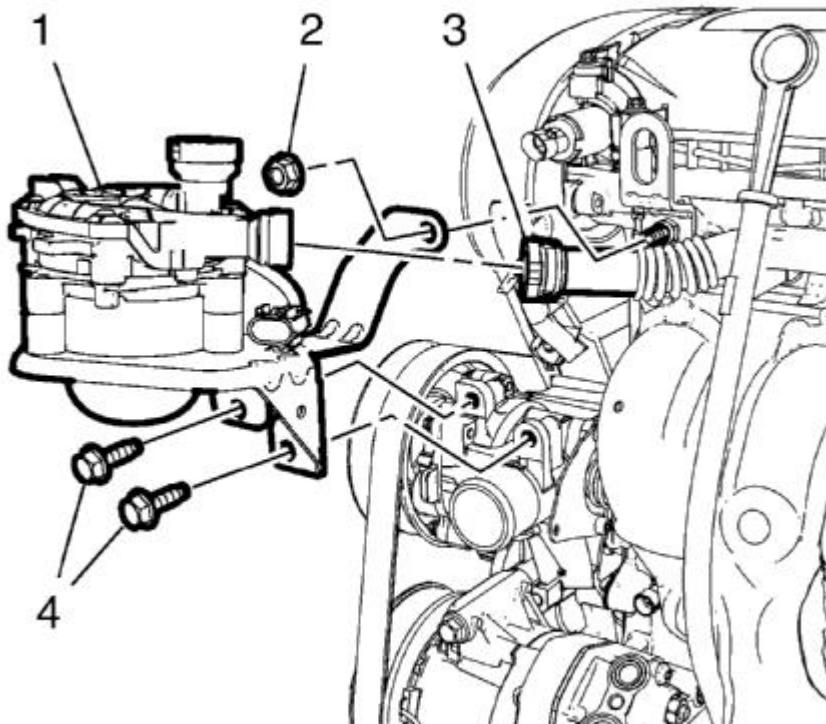


Fig. 538: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the secondary air injection pump (1).
2. Loosely install the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4).

CAUTION: Refer to Fastener Caution .

3. Tighten the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4) to 22 N.m (16 lb ft).
4. Connect the secondary air injection pump pipe (3). Refer to Plastic Collar Quick Connect Fitting Service .

SECONDARY AIR INJECTION PUMP PIPE INSTALLATION

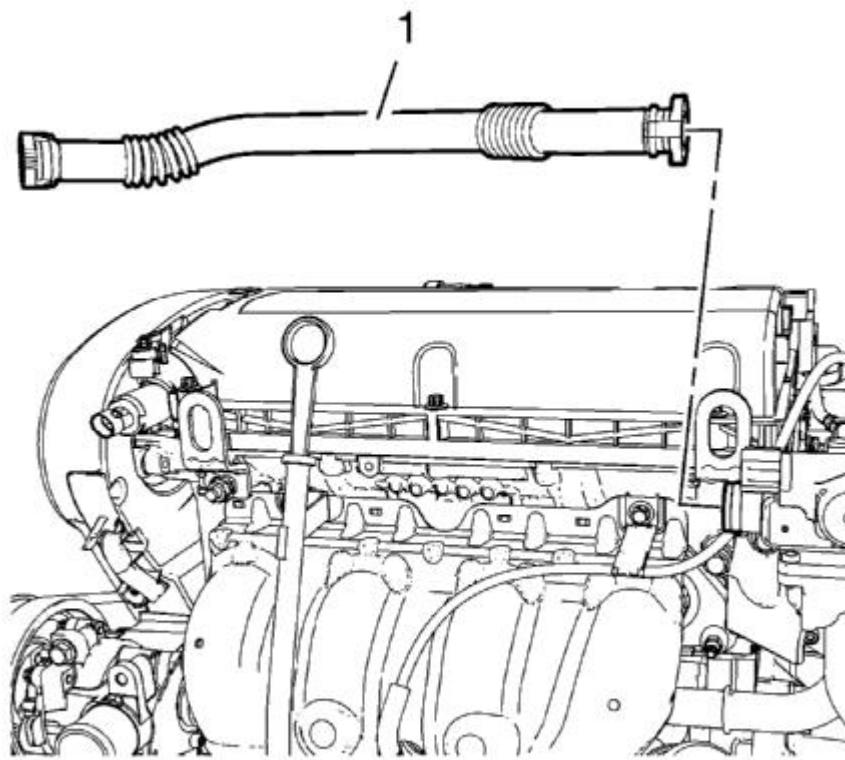


Fig. 539: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Connect the secondary air injection pump pipe (3) to the secondary air injection check valve. Refer to [Plastic Collar Quick Connect Fitting Service](#).

POSITIVE CRANKCASE VENTILATION PIPE INSTALLATION

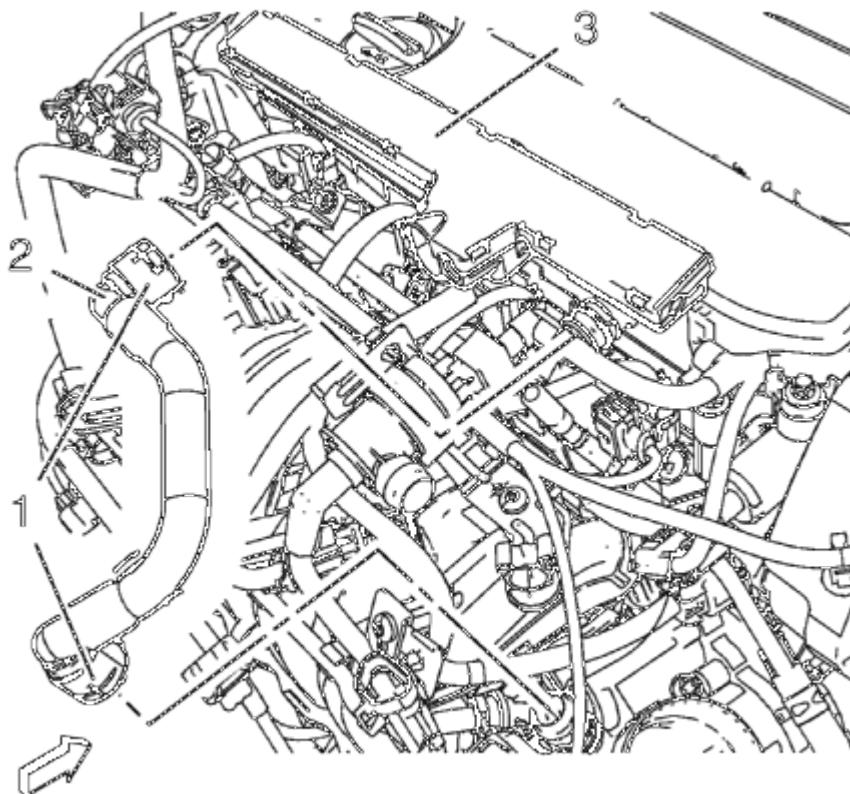


Fig. 540: Positive Crankcase Ventilation Tube, Connectors And ECM Wiring Harness Guide
Courtesy of GENERAL MOTORS COMPANY

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**.

1. Clean the thread in the crankshaft.

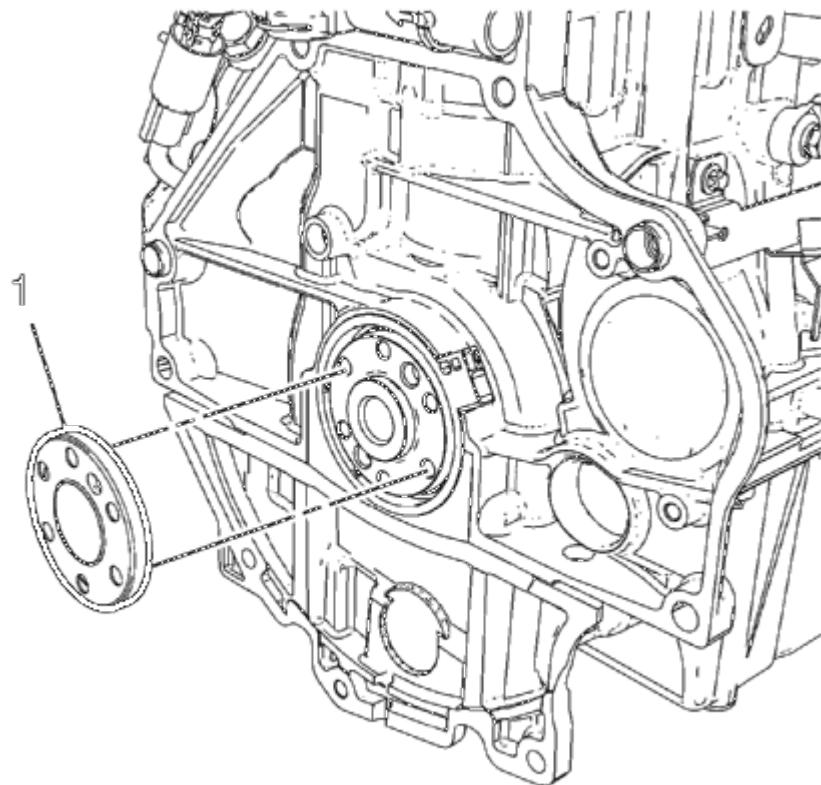


Fig. 541: Crankshaft Position Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft position reluctor ring (1).

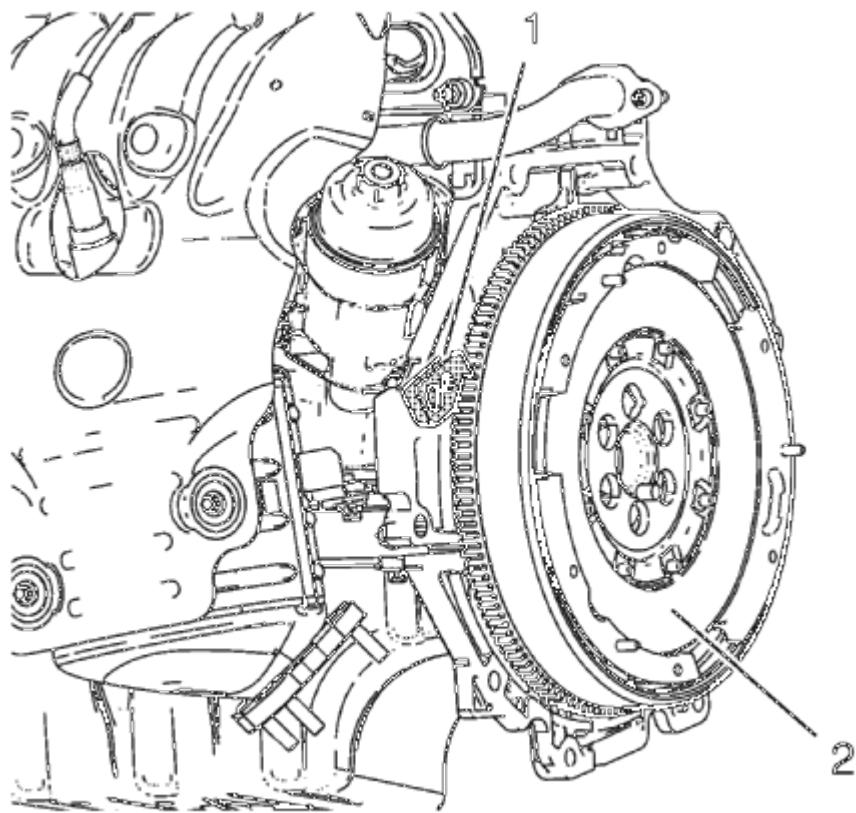


Fig. 542: Flywheel And Flywheel Holder

Courtesy of GENERAL MOTORS COMPANY

3. Install the flywheel (2).
4. Install the **EN-652** holder (1).

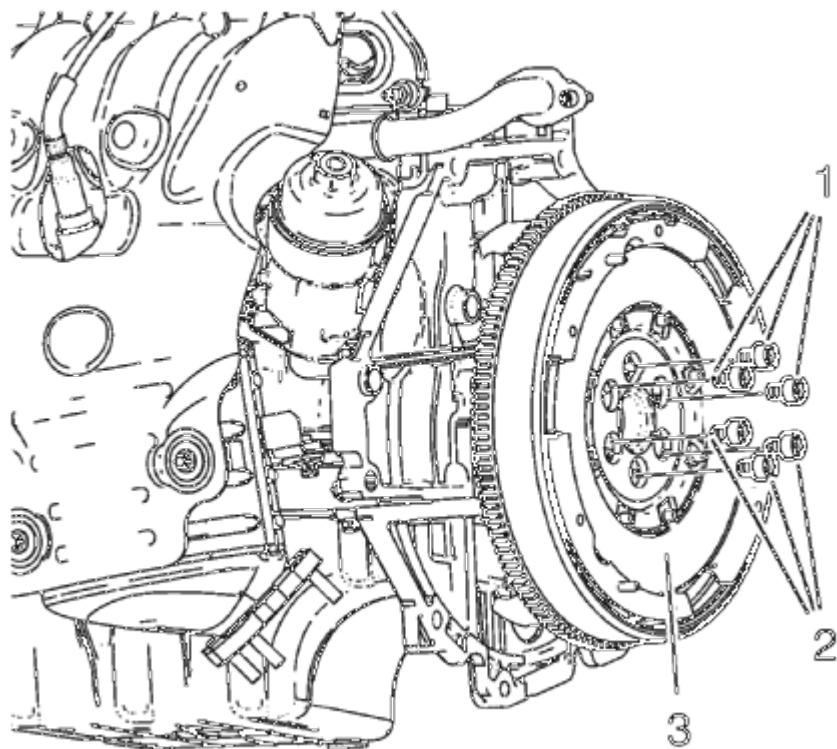


Fig. 543: Flywheel And Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

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

5. 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 35 N.m (26 lb ft).
 2. Second pass to additional 30°.
 3. Third pass to an additional 15°.
6. 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.

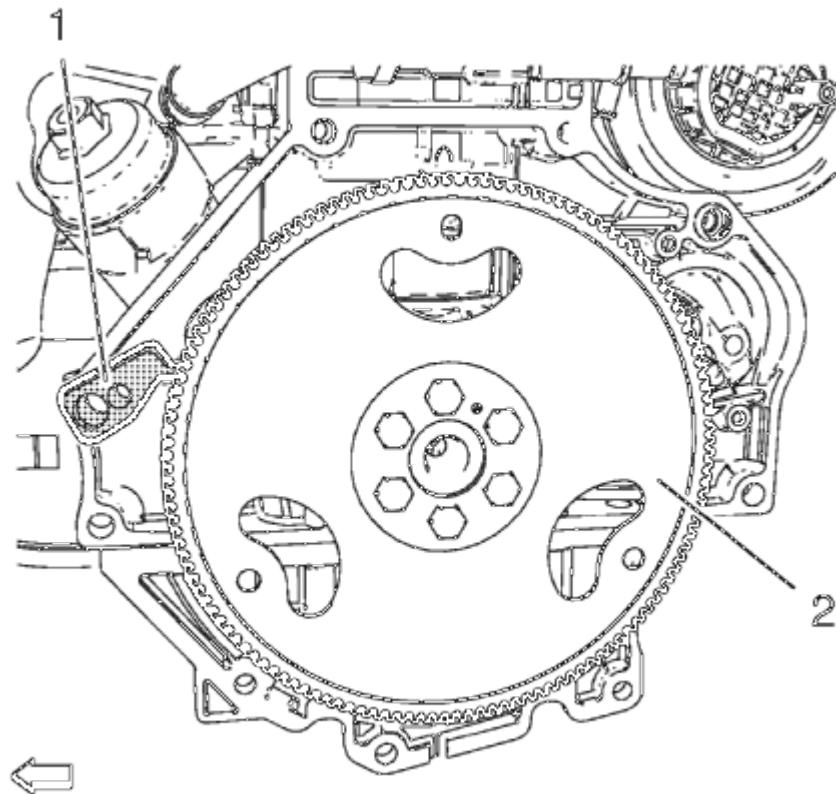


Fig. 544: Automatic Transmission Flex Plate And Holder
Courtesy of GENERAL MOTORS COMPANY

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

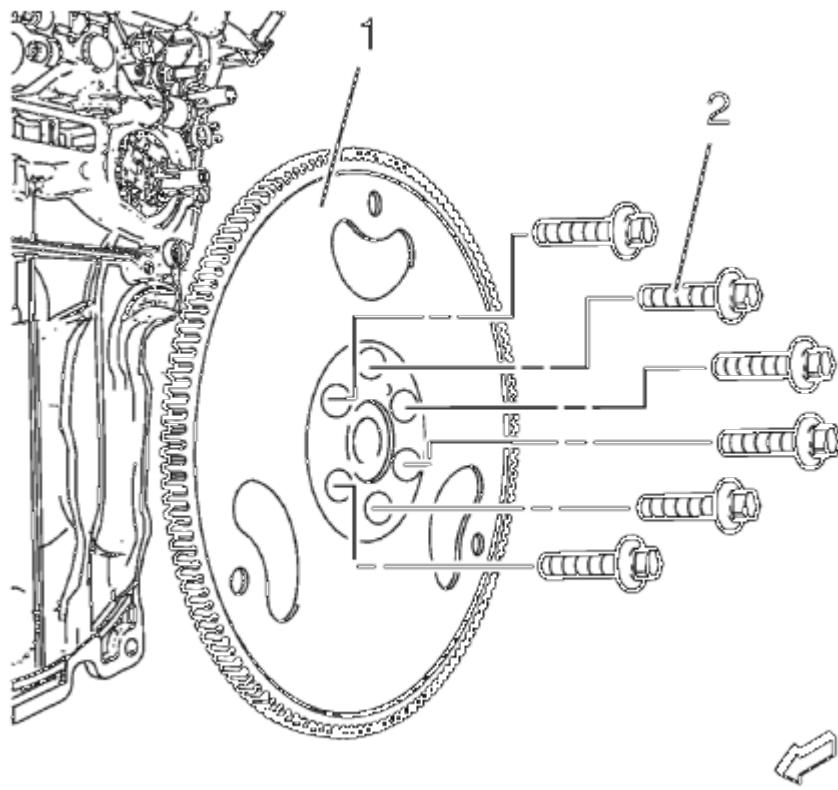


Fig. 545: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

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.

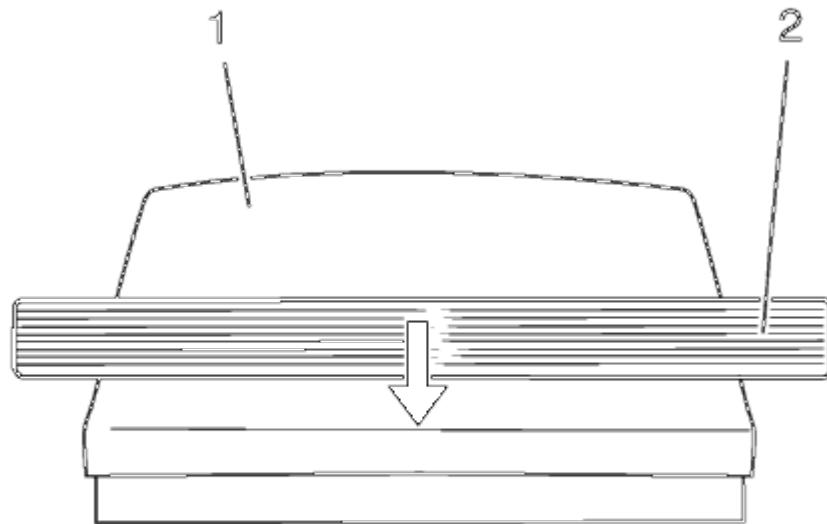


Fig. 546: Crankshaft Rear Oil Seal

Courtesy of GENERAL MOTORS COMPANY

1. Slide the crankshaft rear oil seal (2) across the EN-235-6 installer (1).

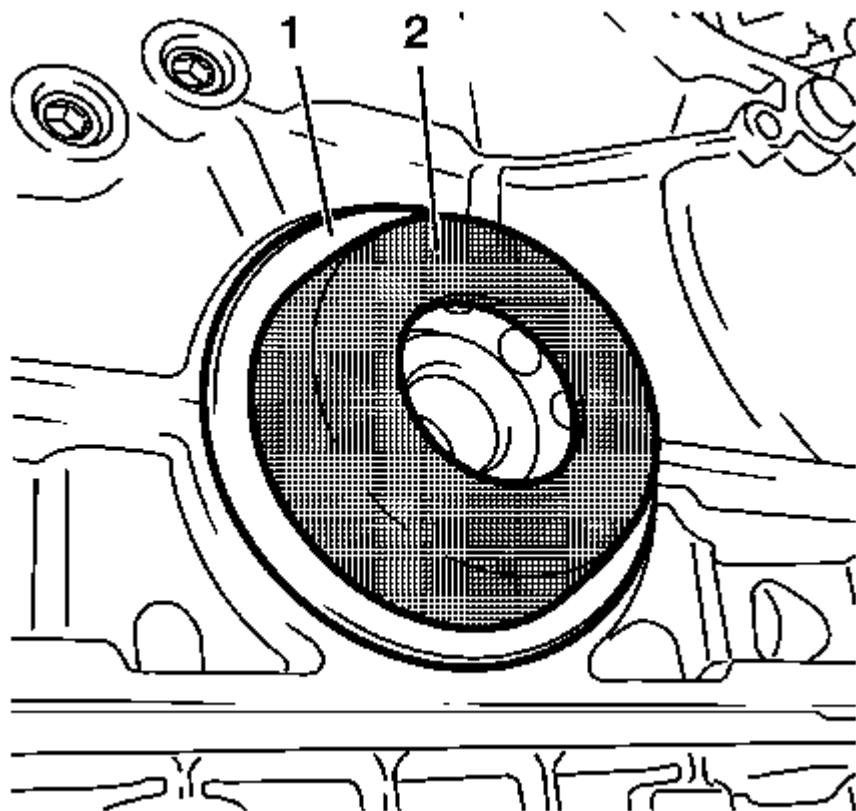


Fig. 547: Crankshaft Rear Oil Seal And Installer

Courtesy of GENERAL MOTORS COMPANY

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

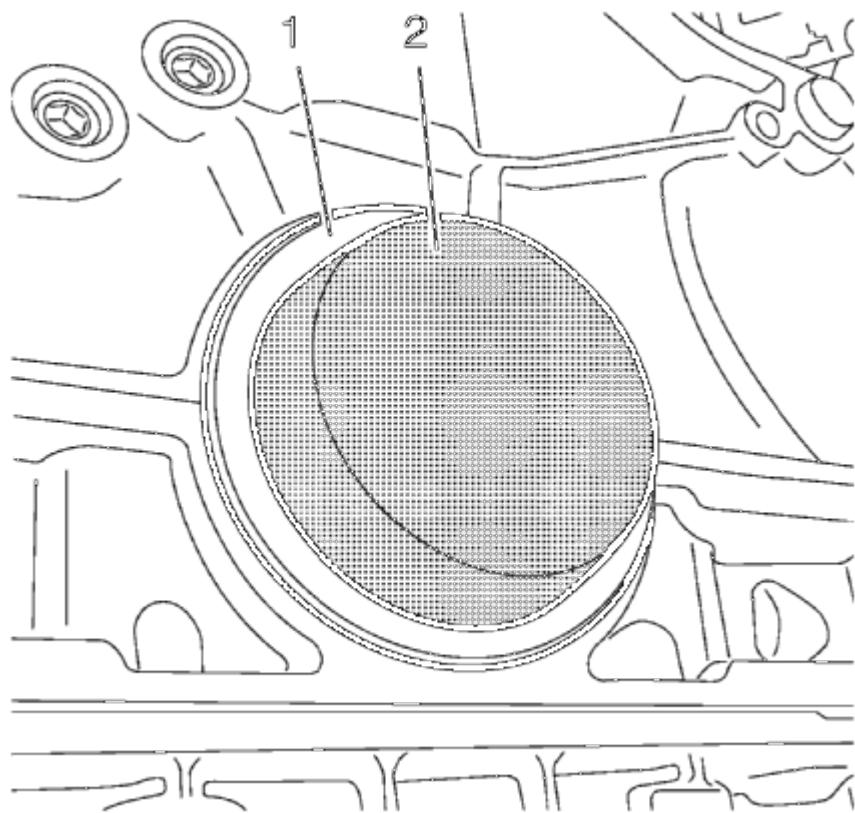


Fig. 548: Oil Seal Installer

Courtesy of GENERAL MOTORS COMPANY

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

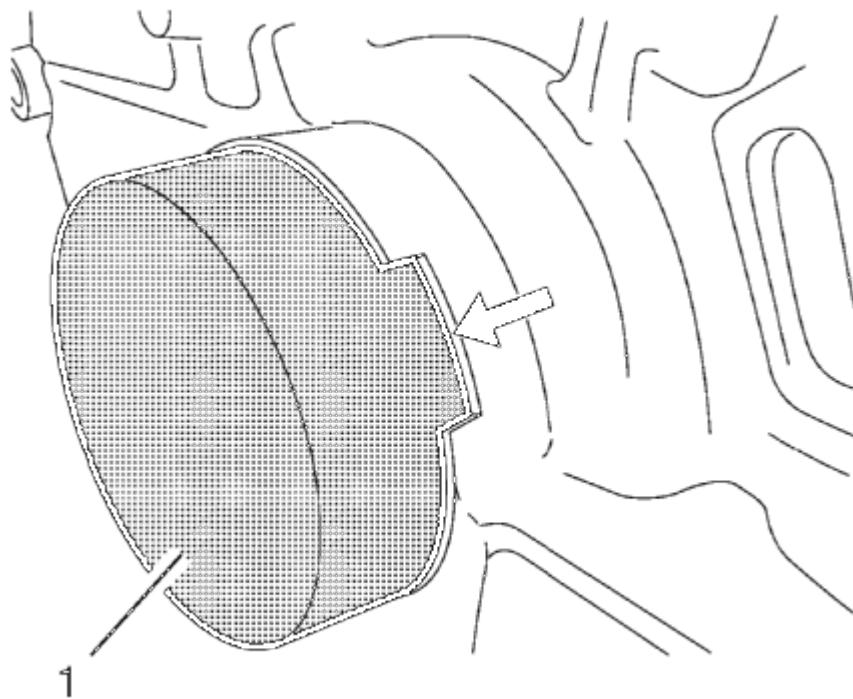


Fig. 549: Check Crankshaft Rear Oil Seal For Proper Seat

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).

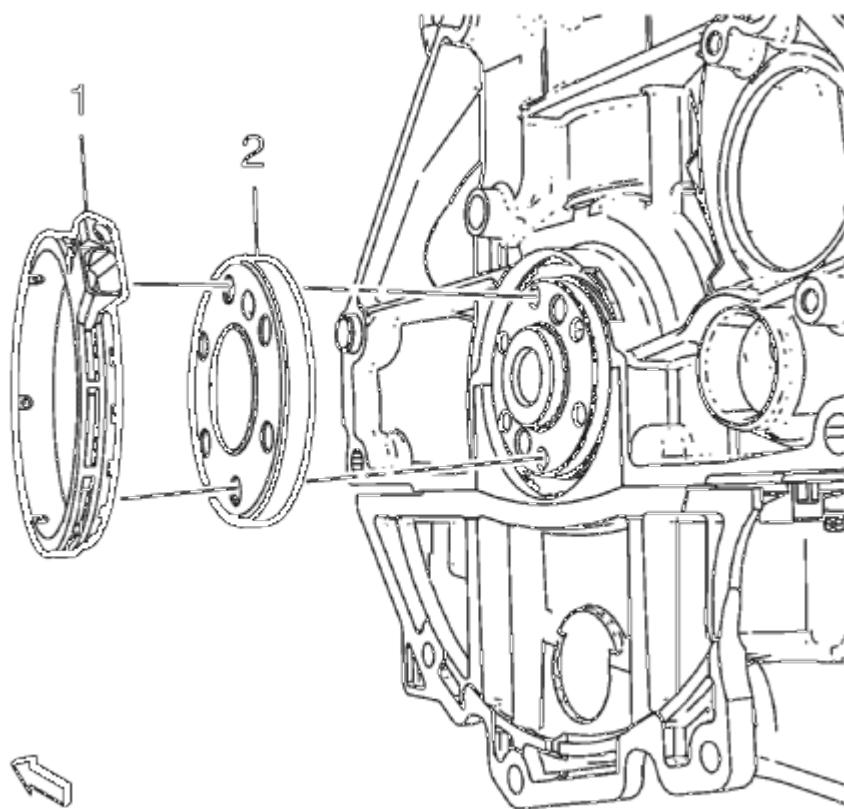


Fig. 550: Crankshaft Position Sensor Reluctor Ring And Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

5. Install the reluctor ring (2).
6. Install the crankshaft rear oil seal housing (1).

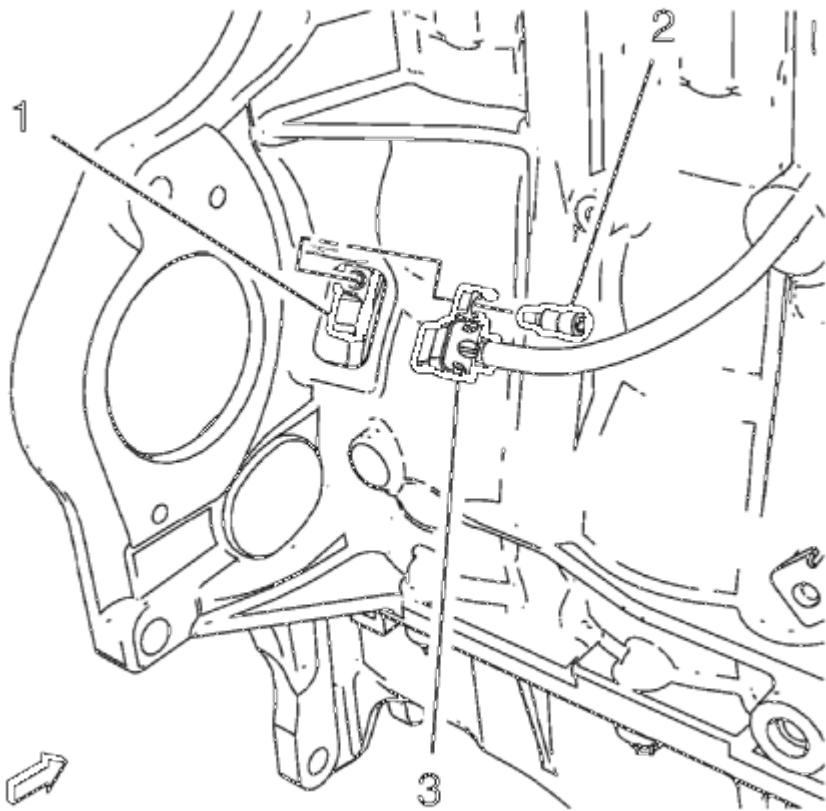


Fig. 551: Crankshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

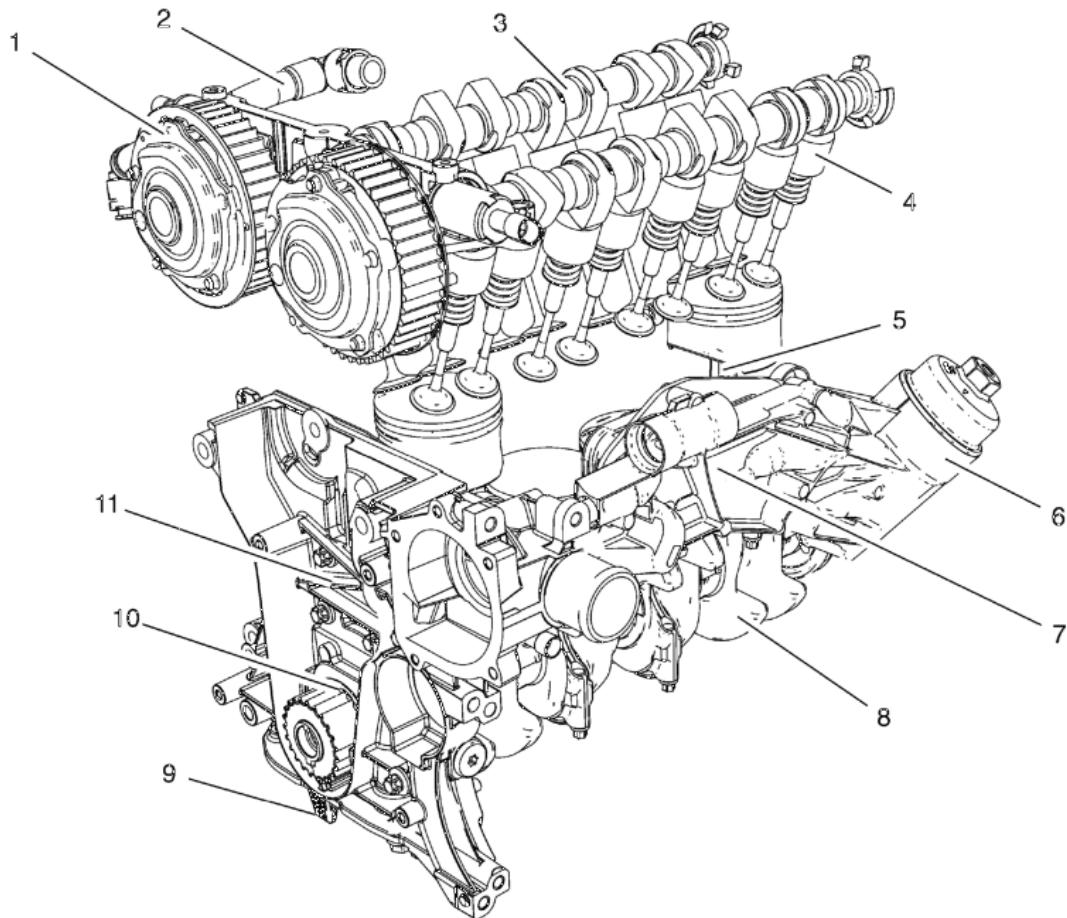
Exhaust Manifold

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. 552: 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.**

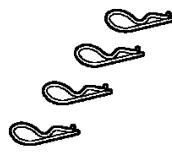
- Pipe joint compound is a pliable sealer that does not completely harden. This type sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust 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.

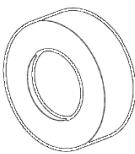
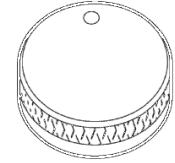
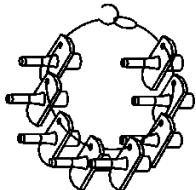
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	207649 Rod Hairpins
	547324 Flange Screws
	EN-232 KM-232 J-21867-L40 Oil Pressure Check Adapter

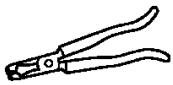
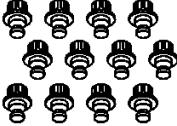
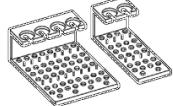
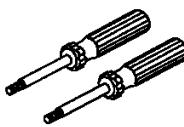
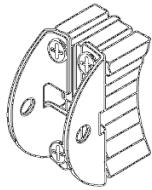
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	EN-235-6 KM-235-6 Installer
	EN-328-B GE-328-B KM-328-B GE-6125-1B Remover
	EN-422 KM-422 83 94 959 Installer
	EN-498-B GE-21867-A J-21867-A KM-498-B CH-48027 Pressure Gauge and Adapter Set
	EN-652 KM-652 Flywheel Holder
	EN-658-1 KM-658-1 J-35264 Installer
	EN-796 KM-796-A Dismantler
	CH-807 KM-807 Closure Plugs
	EN-840

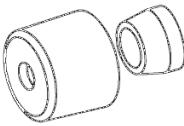
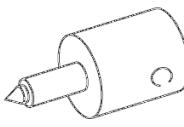
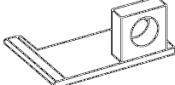
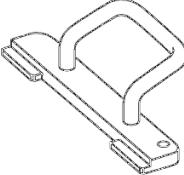
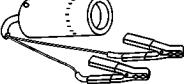
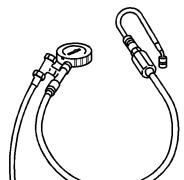
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	KM-840 J-36017 83 94 157 Remover
	EN-845 KM-845 Suction Device
	EN-849 KM-849 Assembly Tray
	EN-958 KM-958 Valve Stem Seal Installer
	EN-6009 KM-6009 83 96 335 J-43301 Remover/Installer
	EN-6333 KM-6333 Locking Pin
	EN-6340 KM-6340 Locking Tool
	EN-6349 KM-6349 Locking Pin

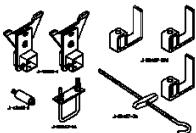
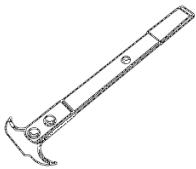
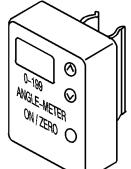
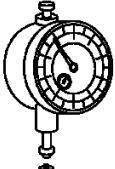
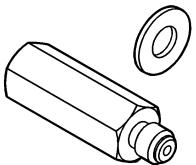
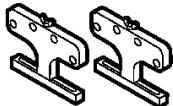
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	EN-6351 KM-6351 Assembly Sleeves
	EN-6361 KM-6361 Feeler Gauge Set
	EN-6624 KM-6624 Remover
	EN-6625 KM-6625 Flywheel Locking Device
	EN-6628-A KM-6628-A Locking Tool
	EN-8087 J-8087 Cylinder Bore Gauge
	EN-28467-B J-28467-B Universal Engine Support Fixture
	EN-34730-91 KM-34730-91 Pressure Tester

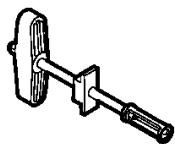
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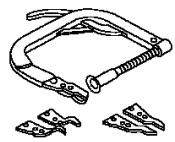
	EN-36857 J-36857 Engine Lift Bracket
	EN-43405 J-43405 Support Foot Set
	EN-45000 KM-45000 J-45000 Seal Remover
	EN-45059 J-45059 Angle Meter
	GE-571-B MKM-571-B GE-8001 J-8001 Dial Gauge
	GE-22738-B J-22738-B Valve Spring Tester
	J-37088-A KM-37088A Fuel Line Disconnect Tool Set
	EN-50717-1 Stands

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EN-50717-2
Compressor



EN-8062
J-8062
Valve Spring Compressor