

2014 Chevrolet Spark LT

2014 ENGINE Engine Mechanical - 1.0L, 1.19L or 1.2L - Spark

2014 ENGINE**Engine Mechanical - 1.0L, 1.19L or 1.2L - Spark****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS (LL0)****Fastener Tightening Specifications (LL0)**

Application	Specification	
	Metric	English
A/C Compressor Suction Pipe Bolt	22	16 lb ft
A/C Condenser Discharger Pipe Bolt	10	89 lb in
Air Conditioning Compressor Bracket Bolt	22	16 lb ft
Automatic Transmission Flex Plate Bolt	20 + 25°	15 lb ft + 25°
Block Heater Connecting Plug Holder Bolt	8	71 lb in
Camshaft Bearing Cap Bolt	10	89 lb in
Camshaft Cover Bolt	10	89 lb in
Camshaft Cover Front Bracket Bolt	10	89 lb in
Camshaft Position Actuator Solenoid Valve Bolt	10	89 lb in
Connecting Rod Bearing Cap Bolt	20 + 90°	15 lb ft + 90°
Coolant Surge Tank Retaining Bolt	8	71 lb in
Cradle Bolt	135	100 lb ft
Crankshaft Balancer Bolt	95 + 55°	70 lb ft + 55°
Crankshaft Bearing Cap Bolt	30 + 30°	22 lb ft + 30°
Crankshaft Rear Oil Seal Housing Bolt	10	89 lb in
Cylinder Head Bolt	22 + 82°	16 lb in + 82°
Electronic Brake Control Module (EBCM) and Brake Pressure Modular Valve (BPMV) Bracket Bolt	22	16 lb ft
Electronic Brake Control Module (EBCM) and Brake Pressure Modular Valve (BPMV) Bracket Nut	22	16 lb ft
Engine Block Heater	60	44 lb ft
Engine Block Oil Gallery Plug	12.5	9 lb ft
Engine Coolant Outlet Adapter Housing Bolt	25	18 lb ft
Engine Coolant Thermostat Bolt	10	89 lb in
Engine Front Cover Bolt (M6)	10	89 lb in
Engine Front Cover Bolt (M8)	22	16 lb ft
Engine Injection and Ignition Bracket Bolt	10	89 lb in
Engine Lift Front Bracket Bolt	25	18 lb ft
Engine Lift Rear Bracket Bolt	25	18 lb ft
Engine Mount - Body Retaining Bolt	50	37 lb ft
Engine Mount - Engine Retaining Bolt	66	49 lb ft

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Engine Mount - Engine Retaining Nut	66	49 lb ft
Exhaust Camshaft Bearing Cap Bolt	10	89 lb in
Exhaust Camshaft Sprocket Bolt	32 + 50°	24 lb ft + 50°
Exhaust Manifold Bolt	20	15 lb ft
Exhaust Manifold Heat Shield Bolt	9	80 lb in
Flywheel Bolt	20 + 25°	15 lb ft + 25°
Front Brake Caliper Bolt	95	70 lb ft
Front Upper Stabilizer Shaft Link Nut	43	32 lb ft
Generator Bracket Retaining Bolt	22	16 lb ft
Generator Bracket Tensioner Nut	50	37 lb ft
Ground Wiring Harness Bolt	10	89 lb in
Ignition Coil Bolt	10	89 lb in
Ignition Coil Cover Bolt	10	89 lb in
Intake Camshaft Bearing Cap Bolt	10	89 lb in
Intake Camshaft Sprocket Bolt	32 + 50°	24 lb ft + 50°
Intake Manifold Bolt	10	89 lb in
Intake Manifold Rear Bracket Bolt (down)	58	42 lb ft
Intake Manifold Rear Bracket Bolt (up)	22	16 lb ft
Intake Manifold Upper Bracket (Left) Bolt (M8)	25	18 lb ft
Knock Sensor Bolt	25	18 lb ft
Lower Intake Manifold Bolt	10	89 lb in
Lower Intermediate Steering Shaft Bolt	27	20 lb ft
Lower Transmission Housing Bolt	61	45 lb ft
Lower Transmission Housing Nut	61	45 lb ft
Oil Filter	16	12 lb ft
Oil Level Indicator Tube Bolt	10	89 lb in
Oil Pan Bolt	10	89 lb in
Oil Pan Drain Plug	25	18 lb ft
Oil Pan Nut	10	89 lb in
Oil Pressure Switch	35	26 lb ft
Oil Pump Hosing Retaining Bolt	10	89 lb in
Positive Cable Retaining Nut	10	89 lb in
Radiator Surge Tank Mounting Bolt	8	71 lb in
Spark Plug	20	15 lb ft
Throttle Body Bolt	10	89 lb in
Timing Chain Guide Retaining Bolt	10	89 lb in
Timing Chain Shoe Retaining Bolt	10	89 lb in
Timing Chain Tensioner Retaining Bolt	10	89 lb in
Torque Converter Bolt	60	44 lb ft
Torque Converter Cover Plate Bolt	9	80 lb in
Transmission Housing Bolt	61	45 lb ft

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	60	44 lb ft
Transmission Mount - Transmission Retaining Bolt (M12)	95	70 lb ft
Transmission Mount - Transmission Retaining Nut	95	70 lb ft
Upper Intake Manifold Side Bracket Bolt (M6)	10	89 lb in
Upper Intake Manifold Side Bracket Bolt (M8)	25	18 lb ft
Water Pump Bolt	25	18 lb ft
Wiring Harness Plug Retaining Bolt	6	53 lb in

FASTENER TIGHTENING SPECIFICATIONS (LFM)**Fastener Tightening Specifications (LFM)**

Application	Specification	
	Metric	English
A/C Compressor Suction Pipe Bolt	22	16 lb ft
A/C Condenser Discharger Pipe Bolt	10	89 lb in
Air Conditioning Compressor Bracket Bolt	22	16 lb ft
Automatic Transmission Flex Plate Bolt	20 + 25°	15 lb ft + 25°
Camshaft Bearing Cap Bolt	10	89 lb in
Camshaft Cover Bolt	10	89 lb in
Camshaft Cover Front Bracket Bolt	10	89 lb in
Camshaft Position Actuator Solenoid Valve Bolt	10	89 lb in
Connecting Rod Bearing Cap Bolt	20 + 90°	15 lb ft + 90°
Coolant Surge Tank Retaining Bolt	8	71 lb in
Cradle Bolt	135	100 lb ft
Crankshaft Balancer Bolt	95 + 55°	70 lb ft + 55°
Crankshaft Bearing Cap Bolt	30 + 30°	22 lb ft + 30°
Crankshaft Rear Oil Seal Housing Bolt	10	89 lb in
Cylinder Head Bolt	22 + 82°	16 lb in + 82°
Electronic Brake Control Module (EBCM) and Brake Pressure Modular Valve (BPMV) Bracket Bolt	22	16 lb ft
Electronic Brake Control Module (EBCM) and Brake Pressure Modular Valve (BPMV) Bracket Nut	22	16 lb ft
Engine Block Oil Gallery Plug	12.5	9 lb ft
Engine Coolant Outlet Adapter Housing Bolt	25	18 lb ft
Engine Coolant Thermostat Bolt	10	89 lb in
Engine Injection and Ignition Bracket Bolt	10	89 lb in
Engine Front Cover Bolt (M6)	10	89 lb in
Engine Front Cover Bolt (M8)	22	16 lb ft
Engine Lift Front Bracket Bolt	25	18 lb ft
Engine Lift Rear Bracket Bolt	25	18 lb ft
Engine Mount - Body Retaining Bolt	50	37 lb ft
Engine Mount - Engine Retaining Bolt	66	49 lb ft

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Engine Mount - Engine Retaining Nut	66	49 lb ft
Exhaust Camshaft Bearing Cap Bolt	10	89 lb in
Exhaust Camshaft Sprocket Bolt	32 + 50°	24 lb ft + 50°
Exhaust Manifold Bolt	20	15 lb ft
Exhaust Manifold Heat Shield Bolt	9	80 lb in
Front Brake Caliper Bolt	95	70 lb ft
Front Upper Stabilizer Shaft Link Nut	43	32 lb ft
Generator Bracket Retaining Bolt	22	16 lb ft
Generator Bracket Tensioner Nut	55	41 lb ft
Ground Wiring Harness Bolt	10	89 lb in
Ignition Coil Bolt	10	89 lb in
Ignition Coil Cover Bolt	10	89 lb in
Intake Camshaft Bearing Cap Bolt	10	89 lb in
Intake Camshaft Sprocket Bolt	32 + 50°	24 lb ft + 50°
Intake Manifold Rear Bracket Bolt (Down)	58	42 lb ft
Intake Manifold Rear Bracket Bolt (Up)	22	16 lb ft
Knock Sensor Bolt	25	18 lb ft
Lower Intake Manifold Bolt	10	89 lb in
Lower Intermediate Steering Shaft Bolt	27	20 lb ft
Lower Transmission Housing Bolt	61	45 lb ft
Lower Transmission Housing Nut	61	45 lb ft
Oil Filter	16	12 lb ft
Oil Level Indicator Tube Bolt	10	89 lb in
Oil Pan Bolt	10	89 lb in
Oil Pan Drain Plug	25	18 lb ft
Oil Pan Nut	10	89 lb ft
Oil Pressure Switch	35	26 lb ft
Oil Pump Hosing Retaining Bolt	10	89 lb in
Positive Cable Retaining Nut	10	89 lb in
Radiator Surge Tank Mounting Bolt	8	71 lb in
Spark Plug	20	15 lb ft
Throttle Body Bolt	10	89 lb in
Timing Chain Guide Retaining Bolt	10	89 lb in
Timing Chain Shoe Retaining Bolt	10	89 lb in
Timing Chain Tensioner Retaining Bolt	10	89 lb in
Torque Converter Bolt	60	44 lb ft
Torque Converter Cover Plate Bolt	9	80 lb in
Transmission Housing Bolt	61	45 lb ft
Transmission Mount - Body Retaining Bolt	60	44 lb ft
Transmission Mount - Transmission Retaining Bolt (M12)	95	70 lb ft
Transmission Mount - Transmission Retaining Nut	95	70 lb ft

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	10	89 lb in
Upper Intake Manifold Front Bracket Bolt (M8)	25	18 lb ft
Upper Intake Manifold Side Bracket Bolt (M6)	10	89 lb in
Upper Intake Manifold Side Bracket Bolt (M8)	25	18 lb ft
Water Pump Bolt	25	18 lb ft
Wiring Harness Plug Retaining Bolt	6	53 lb in

ENGINE MECHANICAL SPECIFICATIONS (LL0)**1.2L (LL0)**

Application	Specification	
	Metric	English
General Data		
• Engine Type	4 Cylinder (In-Line)	
• Displacement	1249 cm ³	
• Bore - Stroke	70.5-80 mm	2.7756- 3.1496 in
• Compression Ratio	10.5	
• Firing Order	1-3-4-2	
• Engine Idle Speed	670 RPM (A/C OFF) 800 RPM (A/C ON)	
Cylinder Bore		
• Diameter	70.5 mm	2.7756 in
• Out of Round (Maximum)	0.0005 mm	0.0000197 in
Piston		
• Diameter	70.455-70.469 mm	2.7738-2.7743 in
• Clearance to Bore	0.023-0.053 mm	0.00091-0.00209 in
Piston Rings		
Piston Ring End Gap		
• Top Ring	0.15-0.30 mm	0.0059-0.0118 in
• 2nd Ring	0.30-0.45 mm	0.0118-0.0177 in
• Oil Ring	0.20-0.70 mm	0.0078-0.0276 in
Groove Clearance		
• Top Ring	0.03-0.07 mm	0.0118-0.00276 in
• 2nd Ring	0.03-0.07 mm	0.0118-0.00276 in
• Oil Ring	0.04-0.12 mm	0.00157-0.00472 in
Piston Pin		
• Diameter	17.996-18.000 mm	0.7085-0.7087 in
	0.006 -0.014 mm	0.00024-0.00055 in

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• Pin Clearance to Piston Bore		
Camshaft		
• End Play	0.08-0.26 mm	0.00314-0.01024 in
Journal OD		
• No. 1	31.934-31.95 mm	1.2572-1.2579 in
• No. 2	22.939-22.96 mm	0.9031-0.9039 in
• No. 3	22.939-22.96 mm	0.9031-0.9039 in
• No. 4	22.939-22.96 mm	0.9031-0.9039 in
• No. 5	22.939-22.96 mm	0.9031-0.9039 in
Journal ID		
• No. 1	32-32.021 mm	1.2598-1.2607 in
• No. 2	23-23.021 mm	0.9055-0.9063 in
• No. 3	23-23.021 mm	0.9055-0.9063 in
• No. 4	23-23.021 mm	0.9055-0.9063 in
• No. 5	23-23.021 mm	0.9055-0.9063 in
Crankshaft		
Main Journal		
• Diameter (All)	48.979-48.995 mm	1.9283-1.9289 in
• Main Bearing Clearance (All)	0.018-0.058 mm	0.00071-0.00228 in
• Crankshaft End Play	0.08-0.29 mm	0.00314-0.01142 in
Connecting Rod Journal		
• Diameter (All)	37.979-37.995 mm	1.4952-1.4959 in
• Rod Bearing Clearance (All)	0.02-0.06 mm	0.00079-0.00236 in
• End Play	0.1-0.25 mm	0.00393-0.00984 in
Valve System		
Seat Inner Diameter		
• Intake	23.862 mm	0.9394 in
• Exhaust	21.079 mm	0.8299 in
• Valve Guide Inside Diameter (All)	5.0-5.012 mm	0.1969-0.1973 in
Valve Stem Diameter		
• Intake	4.972 ± 0.007 mm	0.1957 ± 0.00028 in
• Exhaust	4.963-0.007 mm	0.1954-0.00028 in
Valve Length		
• Intake	87.16 ± 0.225 mm	3.4315-0.00886 in
• Exhaust	88.18 ± 0.225 mm	3.4717 ± 0.00886 in

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Valve Spring

• Free Length	46.52 mm	1.8315 in
• Valve Closed	260 ± 13 N (1919.6 lbs) @ 32 mm (1.25 in)	

ENGINE MECHANICAL SPECIFICATIONS (LFM)**1.0L (LFM)**

Application	Specification	
	Metric	English
General Data		
• Engine Type	4 Cylinder (In-Line)	
• Displacement	995 cm ³	
• Bore - Stroke	68.5-67.5 mm	2.6969-2.6575 in
• Compression Ratio	10.5	
• Firing Order	1-3-4-2	
• Engine Idle Speed	670 RPM (A/C OFF) 800 RPM (A/C ON)	
Cylinder Bore		
• Diameter	68.51 mm	2.6972 in
• Out of Round (Maximum)	0.0005 mm	0.0000197 in
Piston		
• Diameter	68.465-68.479 mm	2.6955-2.6960 in
• Clearance to Bore	0.023-0.053 mm	0.00091-0.00209 in
Piston Rings		
Piston Ring End Gap		
• Top Ring	0.15-0.30 mm	0.0059-0.0118 in
• 2nd Ring	0.30-0.45 mm	0.0118-0.0177 in
• Oil Ring	0.20-0.50 mm	0.0078-0.0197 in
Groove Clearance		
• Top Ring	0.03-0.07 mm	0.0118-0.00276 in
• 2nd Ring	0.03-0.07 mm	0.0118-0.00276 in
• Oil Ring	0.04-0.12 mm	0.00157-0.00472 in
Piston Pin		
• Diameter	17.996-18.000 mm	0.7085-0.7087 in
• Pin Clearance to Piston Bore	0.006 -0.014 mm	0.00024-0.00055 in
Camshaft		
• End Play	0.08-0.26 mm	0.00314-0.01024 in

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Journal OD

• No. 1	31.934-31.95 mm	1.2572-1.2579 in
• No. 2	22.939-22.96 mm	0.9031-0.9039 in
• No. 3	22.939-22.96 mm	0.9031-0.9039 in
• No. 4	22.939-22.96 mm	0.9031-0.9039 in
• No. 5	22.939-22.96 mm	0.9031-0.9039 in

Journal ID

• No. 1	32-32.021 mm	1.2598-1.2607 in
• No. 2	23-23.021 mm	0.9055-0.9063 in
• No. 3	23-23.021 mm	0.9055-0.9063 in
• No. 4	23-23.021 mm	0.9055-0.9063 in
• No. 5	23-23.021 mm	0.9055-0.9063 in

Crankshaft**Main Journal**

• Diameter (All)	48.979-48.995 mm	1.9283-1.9289 in
• Main Bearing Clearance (All)	0.018-0.058 mm	0.00071-0.00228 in
• Crankshaft End Play	0.08-0.29 mm	0.00314-0.01142 in

Connecting Rod Journal

• Diameter (All)	37.979-37.995 mm	1.4952-1.4959 in
• Rod Bearing Clearance (All)	0.02-0.06 mm	0.00079-0.00236 in
• End Play	0.1-0.25 mm	0.00393-0.00984 in

Valve System**Seat Inner Diameter**

• Intake	22-22.2 mm	0.8661-0.8740 in
• Exhaust	18.5-18.7 mm	0.7283-0.7362 in
• Valve Guide Inside Diameter (All)	5.0-5.012 mm	0.1969-0.1973 in

Valve Stem Diameter

• Intake	4.972 ± 0.007 mm	0.1957 ± 0.00028 in
• Exhaust	4.963 ± 0.007 mm	0.1954 ± 0.00028 in

Valve Length

• Intake	99.17 ± 0.225 mm	3.9043 ± 0.00886 in
• Exhaust	100.01 ± 0.225 mm	3.9374 ± 0.00886 in

Valve Spring

• Free Length	4.33 mm	1.7453 in
• Valve Closed	118 ± 4.72 N @ 34	26.5264 ± 1.0611 lbs

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mm

@ 1.3386 in

ADHESIVES, FLUIDS, LUBRICANTS AND SEALERS

Adhesives, Fluids, Lubricants and Sealers

Application	Type of Material	GM Part Number
Bolt Connections	Screw Locking Compound	Refer to Electronic Parts Catalog
Engine Block Oil Gallery Plug	Sealant	Refer to Electronic Parts Catalog
Engine Oil	Dexos 1, 5W-20 Extreme cold area -29°C (20°F) below: 0W-30	Refer to Electronic Parts Catalog
First Camshaft Bearing Cap	Surface Sealant	Refer to Electronic Parts Catalog
Oil Pan	RTV Sealant	Refer to Electronic Parts Catalog
Oxygen Sensor	Assembly Paste	Refer to Electronic Parts Catalog
Seal Rings	Silicon Grease	Refer to Electronic Parts Catalog

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Cylinder Block

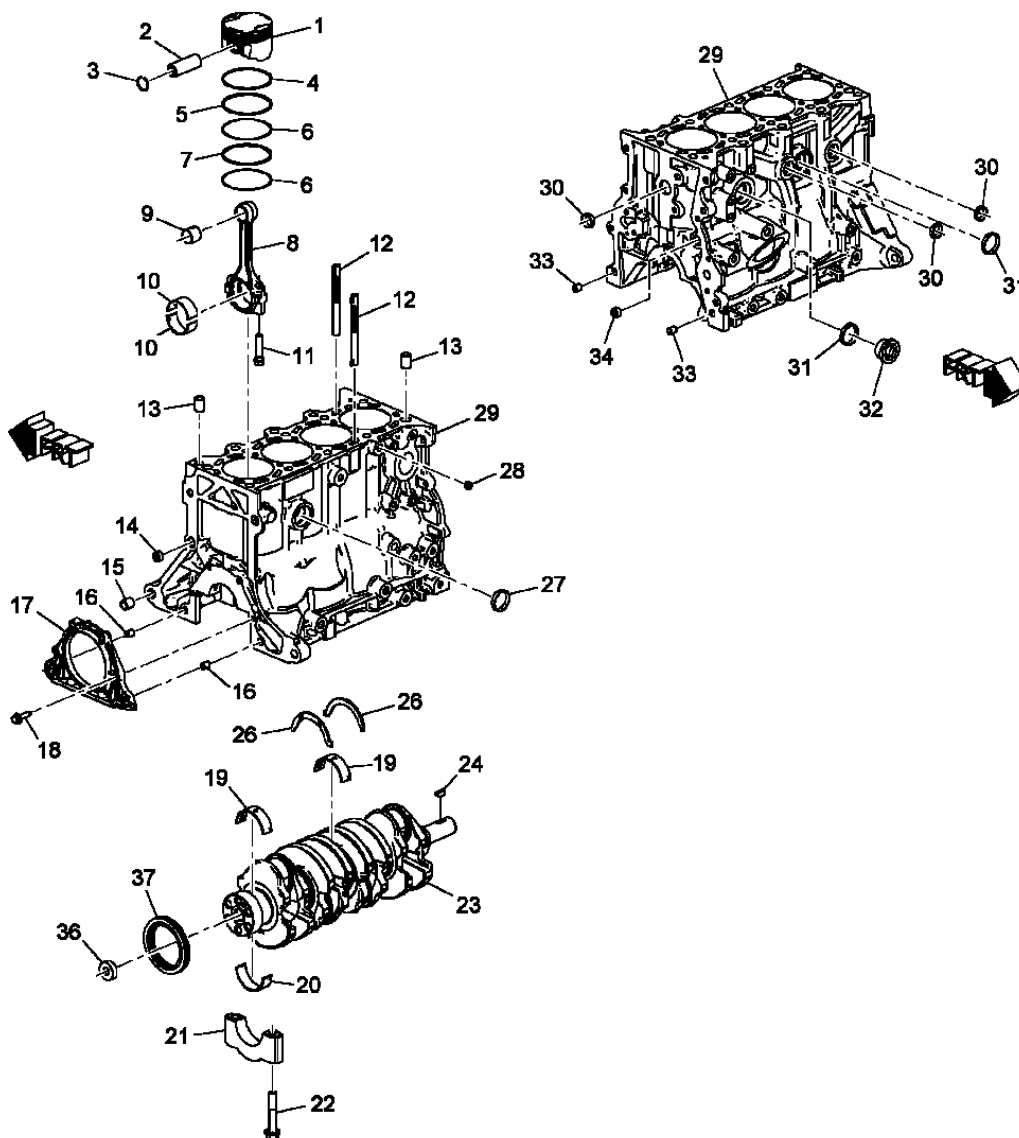


Fig. 1: Cylinder Block Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Piston Assembly
2	Piston Pin
3	Piston Pin Retainer
4	Piston Ring - Upper
5	Piston Ring - Lower
6	Piston Oil Ring Rail

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7	Piston Oil Ring
8	Connecting Rod
9	Pin Guide
10	Connecting Rod Bearing
11	Connecting Rod Cap Bolt
12	Engine Cooling Guide
13	Dowel Pin
14	Plug
15	Dowel Pin
16	Dowel Pin
17	Crankshaft Rear Oil Seal Cover
18	Crankshaft Rear Oil Seal Cover Bolt
19	Crankshaft Upper Bearing
20	Crankshaft Lower Bearing
21	Crankshaft Bearing Cap Cover
22	Crankshaft Bearing Cap Cover Bolt
23	Crankshaft
24	Key
26	Bearing
27	Plug Cup
28	Plug
29	Cylinder Block
30	Plug Cup
31	Plug Cup
32	Plug
33	Dowel Pin
34	Plug
36	Plug
37	Crankshaft Rear Oil Seal

Cylinder Head

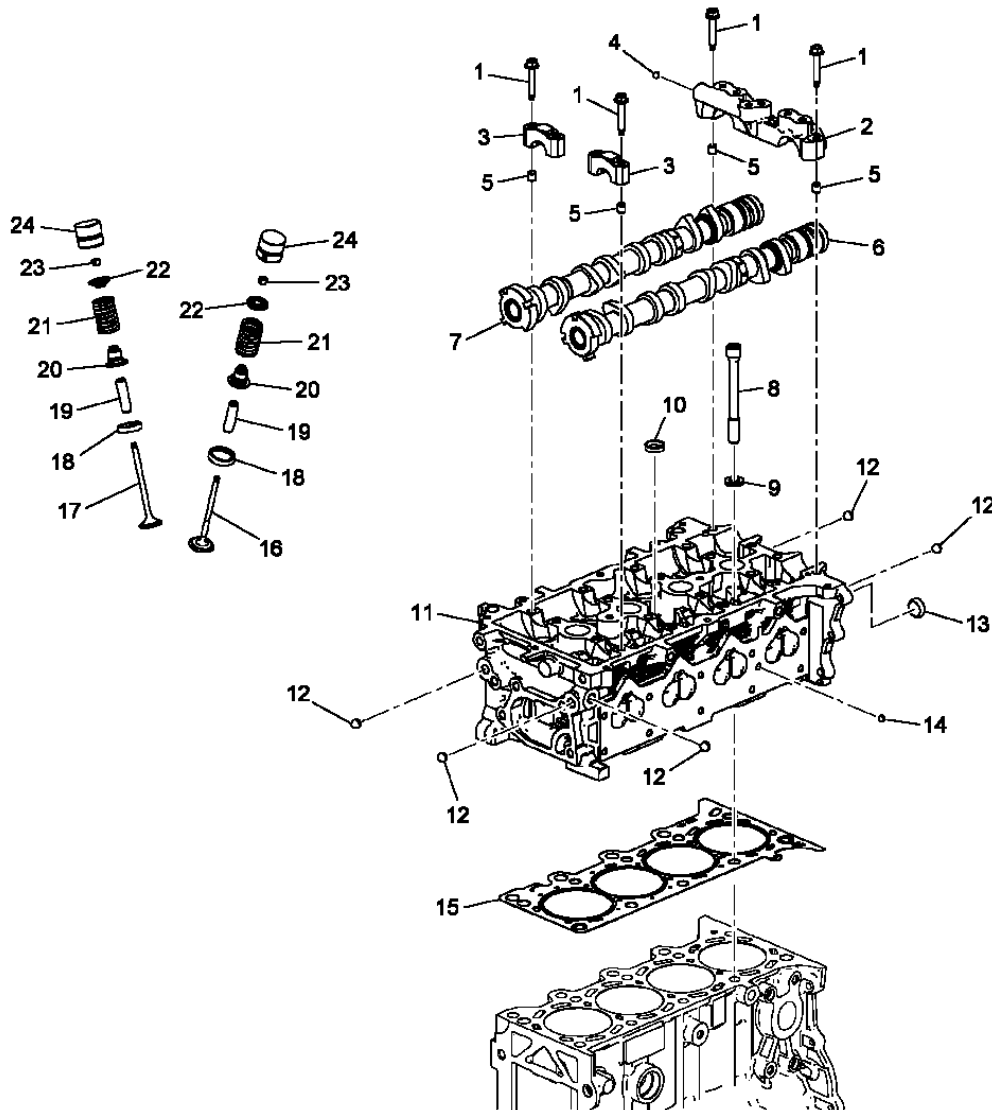


Fig. 2: Cylinder Head Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Cap Bolt
2	Camshaft Front Bearing Cap
3	Camshaft Cap
4	Plug
5	Plug
6	Camshaft (Intake)

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7	Camshaft (Exhaust)
8	Cylinder Head Bolt
9	Cylinder Head Bolt Washer
10	Plug
11	Cylinder Head
12	Plug
13	Plug
14	Plug
15	Cylinder Head Gasket
16	Valve (Intake)
17	Valve (Exhaust)
18	Valve Seat
19	Valve Guide
20	Valve Stem Oil Seal
21	Valve Spring
22	Valve Spring Retainer
23	Valve Key
24	Valve Tappet

Oil Pan

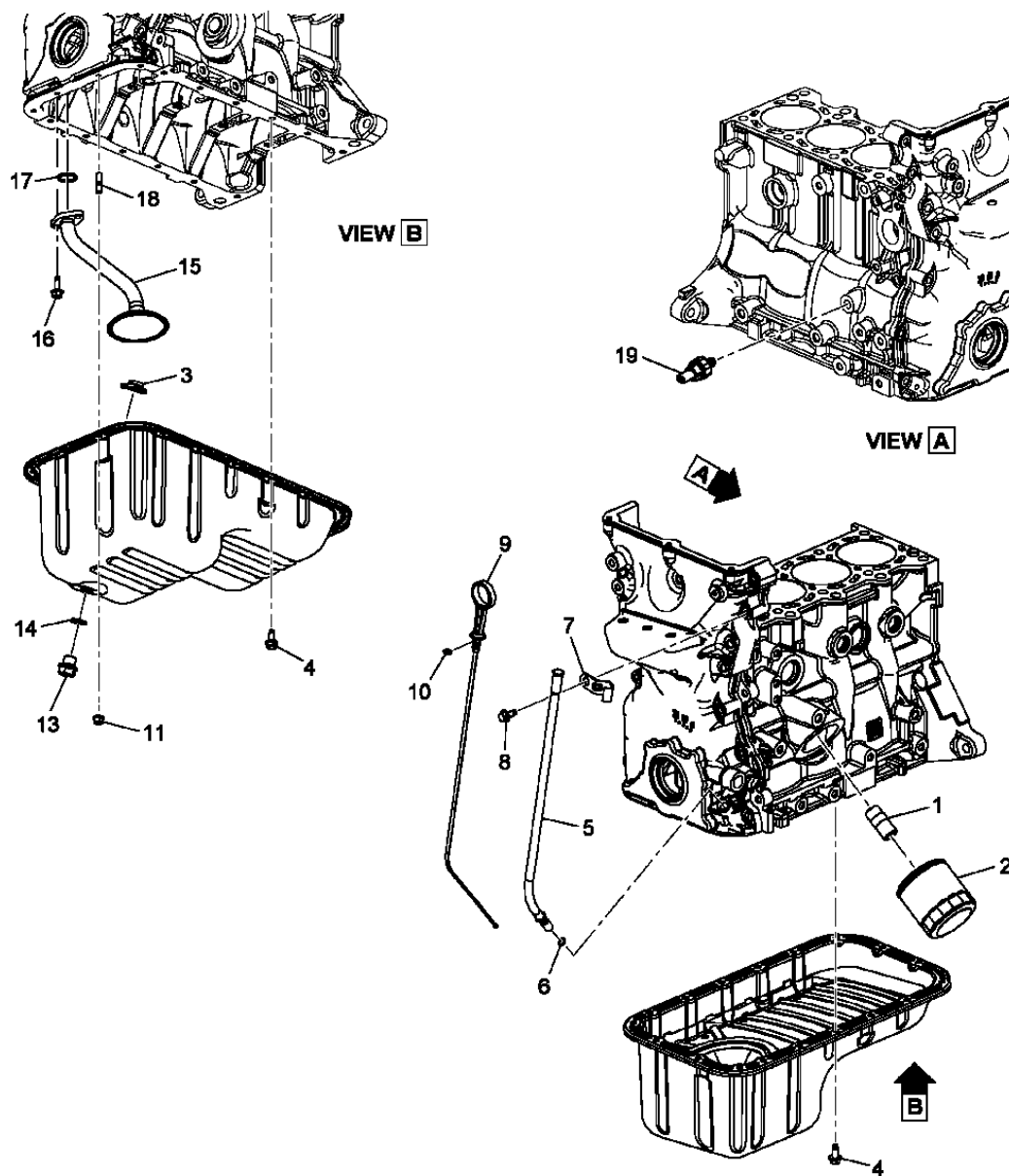


Fig. 3: Oil Pan Components

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Filter
2	Oil Filter Stud
3	Oil Pan Drain Plug Nut
4	Engine Oil Pan Bolt
5	Oil Level Indicator Tube
6	Oil Level Indicator Tube Oil Seal

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7	Oil Level Indicator Tube Bracket
8	Oil Level Indicator Tube Bracket Bolt
9	Oil Level Indicator
10	Oil Level Indicator Oil Seal
11	Engine Oil Pan Nut
13	Oil Pan Drain Plug
14	Oil Pan Drain Plug Seal Ring
15	Oil Strainer
16	Oil Strainer Bolt
17	Oil Strainer Seal Ring
18	Bolt Stud
19	Oil Pressure Switch

Timing System

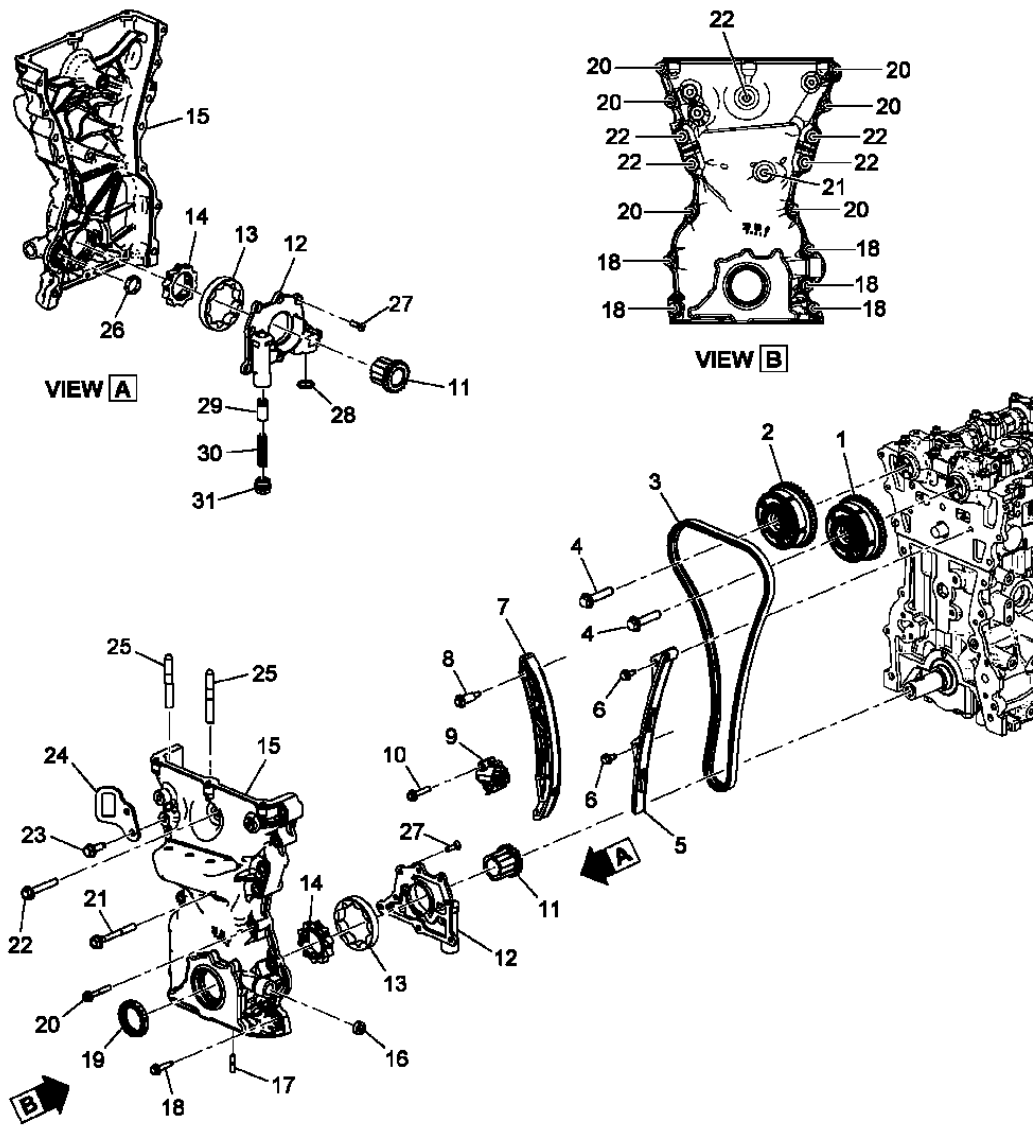


Fig. 4: Timing System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Sprocket (Exhaust)
2	Camshaft Sprocket (Intake)
3	Timing Chain
4	Camshaft Sprocket Retaining Bolt
5	Timing Chain Guide
6	Timing Chain Guide Bolt

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7	Timing Chain Shoe
8	Timing Chain Shoe Bolt
9	Timing Chain Tensioner
10	Timing Chain Tensioner Bolt
11	Crankshaft Sprocket
12	Oil Pump Housing
13	Oil Pump Drive Gear
14	Oil Pump Drive Gear
15	Engine Front Cover
16	Plug
17	Stud Bolt
18	Engine Front Cover Bolt
19	Crankshaft Front Oil Seal
20	Engine Front Cover Bolt
21	Engine Front Cover Bolt
22	Engine Front Cover Bolt
23	Bracket Bolt
24	Bracket
25	Stud Bolt
26	Oil Seal
27	Oil Pump Housing Retaining Bolt
28	Oil Seal
29	Oil Relief Valve
30	Oil Relief Valve Spring
31	Oil Relief Valve Plug

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:

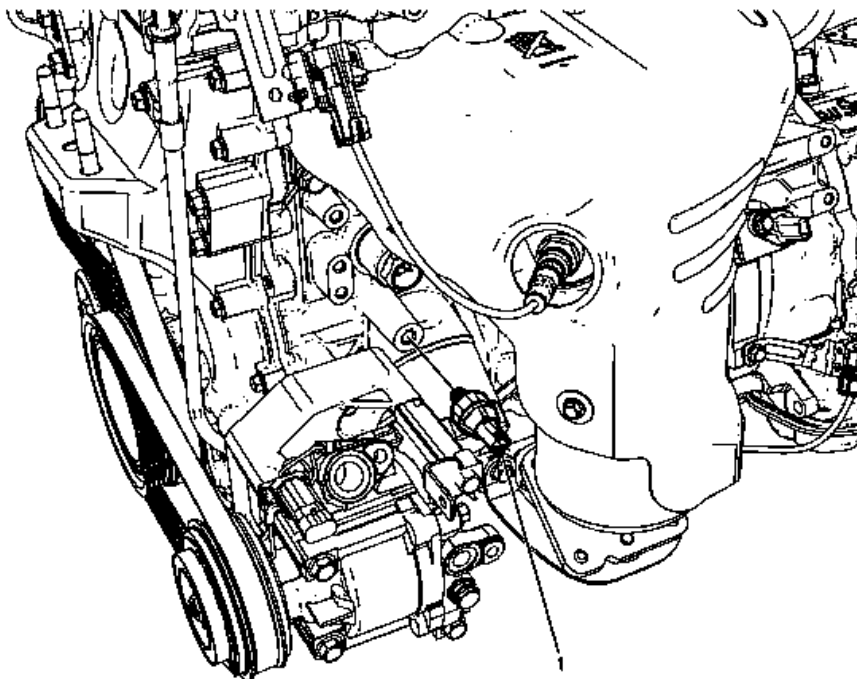
- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine 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**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Drive Belt Chirping, Squeal and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **EN-21867-850** Adapter Oil Pressure Check
- **EN-50207** Oil Pressure Switch Remover/Installer
- **KM-498-B** Oil Pressure Gauge

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

Removal Procedure**Fig. 5: Oil Pressure Switch****Courtesy of GENERAL MOTORS COMPANY**

1. Remove the oil pressure switch (1) using the **EN-50207** oil pressure switch remover/installer.
2. Clean the thread.

Measurement Procedure

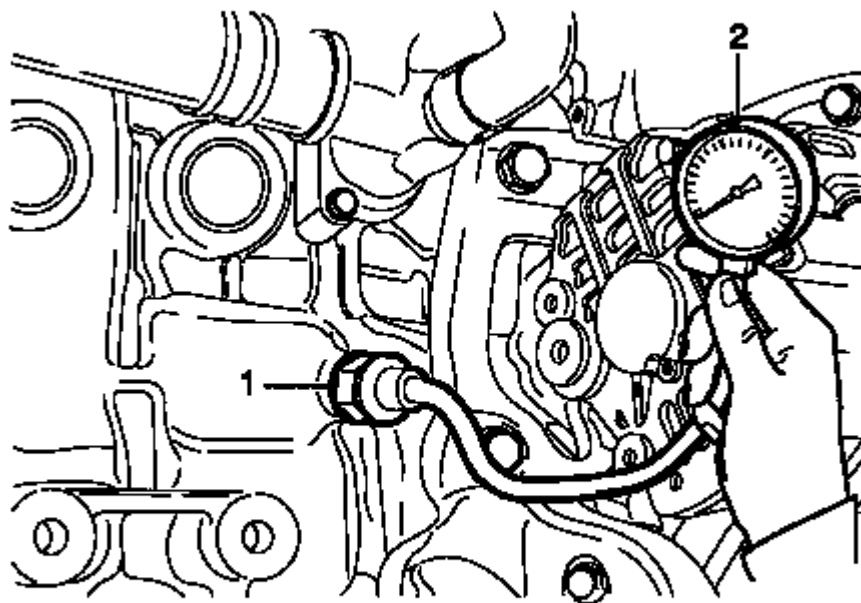


Fig. 6: Installing EN-21867-850 adapter Oil Pressure Check
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-21867-850** adapter oil pressure check (1) to the **KM-498-B** oil pressure gauge (2).
2. Install the **EN-21867-01** adapter oil pressure check (1) with **EN 498-B** oil pressure gauge (2) to the oil pressure switch hole.
3. Start the engine.
4. Check oil pressure.

At idling speed, the oil pressure must be at least 110 kPa (15.95 psi) and the oil temperature must be less than or equal to 120°C (170°F).

5. Switch off the engine.
6. Remove the **EN-21867-01** adapter oil pressure check (1) with **EN 498-B** oil pressure gauge (2) from the oil pressure switch hole.

Installation Procedure

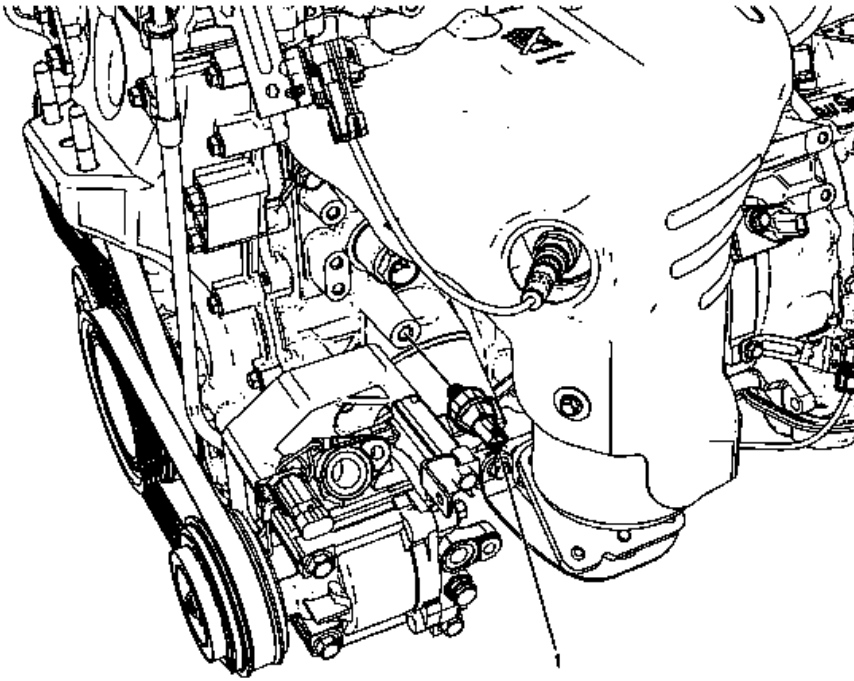


Fig. 7: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil pressure switch and tighten to 18 (13 lb ft).
2. Check the engine oil level.

ENGINE COMPRESSION TEST

Removal Procedure

1. Remove the ignition coil cover. Refer to Ignition Coil Cover Replacement (LL0), Ignition Coil Cover Replacement (LFM).
2. Remove the spark plugs. Refer to Spark Plug Replacement (LL0) , Spark Plug Replacement (LFM) .
3. Remove the relay holder cover.
4. Remove the fuel pump relay.

Measurement Procedure

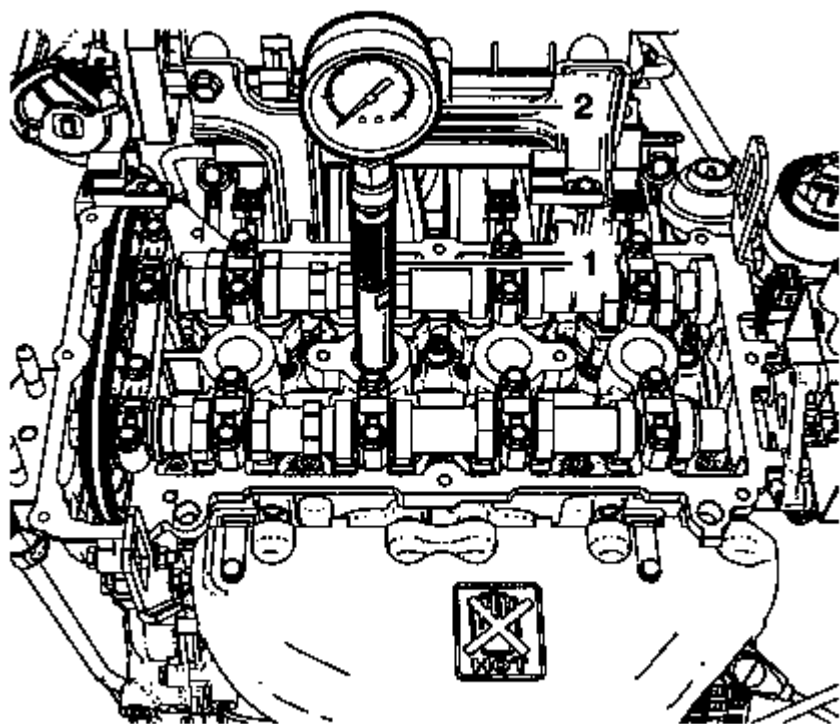


Fig. 8: Engine Compression Test Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the suitable engine compression test tool to the spark plug hole.
2. Start the engine (approximately 4 seconds).
3. Compare the compression values.

NOTE: Engine revs at least 300/min.

4. Maximum pressure differential is 100 kPa (14.5 psi).
5. Check compression for all cylinders.

Installation Procedure

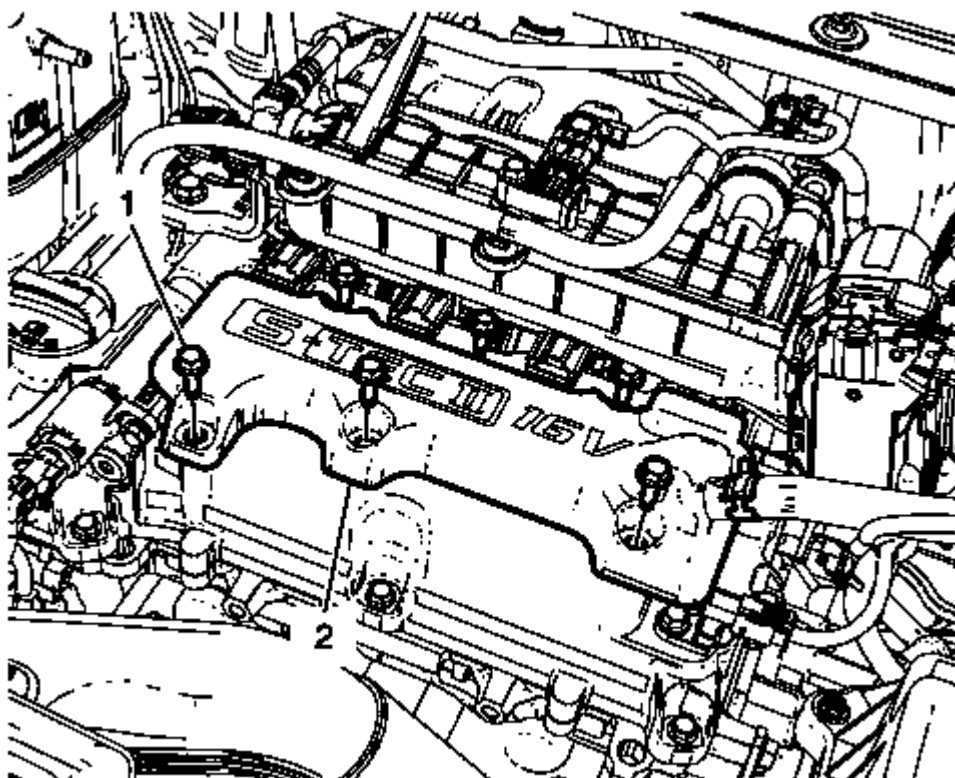


Fig. 9: Engine Compression Test Tool
Courtesy of GENERAL MOTORS COMPANY

1. Remove the suitable engine compression test tool to the spark plug hole.
2. Install the fuel pump relay.
3. Install the relay carrier cover.
4. Install the spark plugs and tighten the spark plug to 20 (14.7 lb ft).
5. Install the ignition coil cover (2). Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.

CAUTION: Refer to Fastener Caution .

6. Tighten the bolts (1) to 10 (89 lb in).

DRIVE BELT CHIRPING, SQUEAL AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern.

If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.

- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

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

2

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

3

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

4

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

6

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

10

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

12

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

surface of a pulley when the back side of the belt is used to drive the pulley.

14

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

15

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

16

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

17

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

19

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

Drive Belt Chirping, Squeal and Whine Diagnosis

Step	Action	Yes	No
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:

- 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 Symptoms - Engine Mechanical
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
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to 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	CAUTION: Refer to <u>Fastener Caution</u>		
	1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (LL0)</u> , <u>Fastener Tightening Specifications (LFM)</u> . 2. Replace any improper or missing fasteners.		
	Did you complete the repair?	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	<ul style="list-style-type: none"> Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. 		
	Did you find and correct the condition?	Go to 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>Water Pump and Generator 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.

4

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

5

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

9

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

11

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

12

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

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
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: <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	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	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

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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	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall a drive belt. Refer to <u>Water Pump and Generator Belt Replacement</u> . Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a drive belt. Refer to <u>Water Pump and Generator 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	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (LL0)</u> , <u>Fastener Tightening Specifications (LFM)</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. Refer to <u>Water Pump Replacement</u> . 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

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 have occurred to the drive belt when the drive belt fell off. The drive belt may have been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing or damaged belt plies.

4

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

5

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

6

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

7

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

13

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

14

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

15

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

Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
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.			
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	<ul style="list-style-type: none"> 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	Replace the drive belt. Refer to <u>Water Pump and Generator 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: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications (LL0)</u> , <u>Fastener Tightening Specifications (LFM)</u> .		

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	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. Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Generator Bracket 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	Replace the drive belt. Refer to <u>Water Pump and Generator 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
16	Replace the drive belt. Refer to <u>Water Pump and Generator Belt Replacement</u> . 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	-

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	1. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine Mechanical Specifications (LL0)</u> , <u>Engine Mechanical Specifications (LFM)</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. Are drippings present?	Go to Step 2	System OK

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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>	Go to Step 10	Go to Step 4
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. <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 5
5	<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>	Go to Step 10	Go to Step 6
6	<ol style="list-style-type: none">1. Completely clean the entire engine and surrounding components.2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area.3. Operate the vehicle for several miles at normal operating temperature and at varying speeds.4. Identify the type of fluid and the approximate location of the leak from the discolorations in the powder surface.		

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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 7
7	<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>	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	<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>	Go to Step 10	System OK
10	<ol style="list-style-type: none"> 1. Inspect the engine for mechanical damage. 2. 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 surfaces 3. Inspect the engine for customer modifications. 		

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	Is there mechanical damage or customer modifications to the engine?	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**Oil Consumption Diagnosis**

Checks	Causes
The causes of excessive oil consumption may include the following conditions:	
Preliminary	<ul style="list-style-type: none">• External oil leaks.• Incorrect oil level or improper reading of the oil level indicator. <p>With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level.</p> <ul style="list-style-type: none">• Improper oil viscosity. <p>Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures.</p> <ul style="list-style-type: none">• Continuous high speed driving and/or severe usage.• Crankcase ventilation system restrictions or malfunctioning components.• Worn valve guides and/or valve stems.• Worn, missing or improperly installed valve stem oil seals.• Piston rings broken, worn, not seated properly. <p>Allow adequate time for the rings to seat.</p> <p>Replace worn piston rings as necessary.</p> <ul style="list-style-type: none">• Piston and rings improperly installed or miss-fitted to the cylinder bore.

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 **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>Engine Component Description</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Engine Component Description</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
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: <ol style="list-style-type: none">1. The connecting rod bearings2. The connecting rods3. The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components and repair as required: <ol style="list-style-type: none">1. The crankshaft bearings2. The crankshaft journals3. The cylinder block crankshaft bearing bore

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS
Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	<ol style="list-style-type: none"> 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
<ul style="list-style-type: none"> Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine revolutions per minute (RPM) variations and lead to a misfire diagnostic trouble code (DTC). A misfire code may be present without an actual misfire condition. 	Replace the drive belt.
<ul style="list-style-type: none"> 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.
<ul style="list-style-type: none"> 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.
	Repair or replace as required.

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<ul style="list-style-type: none"> • 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. 	
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.
<ul style="list-style-type: none"> • Improperly installed or damaged manifold absolute pressure (MAP) sensor • The sealing grommet of the MAP sensor should not be torn or damaged. 	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
<ul style="list-style-type: none"> • 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.
<ul style="list-style-type: none"> • 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.
<ul style="list-style-type: none"> • Excessive oil pressure • A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression. 	<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 the oil pump as required.
<ul style="list-style-type: none"> • 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. 	<ol style="list-style-type: none"> 1. Inspect for spark plugs saturated by coolant. 2. Inspect the cylinder heads, engine block, and/or head gaskets. 3. Repair or replace as required.
<ul style="list-style-type: none"> • Worn piston rings • Oil consumption may or may not cause the engine to misfire. 	<ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. 2. Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. 3. Perform cylinder leak down and compression testing to identify the cause. 4. Repair or replace as required.
<ol style="list-style-type: none"> 1. A damaged crankshaft reluctor wheel. 2. A damaged crankshaft reluctor wheel can 	Replace the sensor and/or crankshaft as required.

result in different symptoms depending on the severity and location of the damage.

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

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
<ul style="list-style-type: none"> • 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.
<ul style="list-style-type: none"> • 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.
<ul style="list-style-type: none"> • 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.
<ul style="list-style-type: none"> • Worn piston rings. • Oil consumption may or may not cause the engine to misfire. 	<ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. 2. Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>.

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	<ol style="list-style-type: none">3. Perform cylinder leak down and compression testing to determine the cause.4. Repair or replace as required.
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• 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.
<ul style="list-style-type: none">• 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
<ul style="list-style-type: none">• 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.	<ol style="list-style-type: none">1. Inspect for spark plugs saturated by coolant.2. Perform a cylinder leak down test.3. Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket.4. 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	<ol style="list-style-type: none">1. Inspect the spark plugs for oil deposits.

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	2. Repair or replace as required.
<ul style="list-style-type: none"> Worn piston rings Oil consumption may or may not cause the engine to misfire. 	<ol 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.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ol 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	<ol 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	Inspect the following components and repair or replace as required: <ol 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	<ol style="list-style-type: none"> Inspect the engine camshaft lobes. Replace the camshaft and valve lifters as required.
Worn valve guides or valve stems	Inspect the following components and repair as required: <ol style="list-style-type: none"> The valves The valve guides
	Inspect the following components and repair as

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- Stuck valves
- Carbon on the valve stem or valve seat may cause the valve to stay open.

required:

1. The valves
2. The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED**Lower Engine Noise, Regardless of Engine Speed**

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 damaged components as required.
Worn accessory drive components- abnormalities, such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components	<ol style="list-style-type: none"> 1. Inspect the accessory drive system. 2. Repair or replace as required.
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 <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 or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
<ul style="list-style-type: none"> • 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: <ol style="list-style-type: none"> 1. The connecting rod bearings

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	<ol style="list-style-type: none"> 2. The connecting rods 3. The crankshaft 4. The crankshaft journals
Excessive crankshaft bearing clearance	<p>Inspect the following components and repair as required:</p> <ol style="list-style-type: none"> 1. The crankshaft bearings 2. The crankshaft journals
<ul style="list-style-type: none"> • 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 <ol style="list-style-type: none"> 1. Coolant/antifreeze in cylinder 2. Oil in cylinder 3. 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	<ol style="list-style-type: none"> 1. Inspect timing chain and gears. 2. Repair as required.
Seized balance shaft	<ol style="list-style-type: none"> 1. Inspect balance shaft. 2. Repair as required.
Material in cylinder	<ol style="list-style-type: none"> 1. Inspect cylinder for damaged components

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1. Broken valve 2. Piston material 3. Foreign material 4. Cracked cylinder wall	and/or foreign materials. 2. Inspect for fallen cylinder wall. 3. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Inspect for fallen cylinder wall. 3. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Results of Incorrect Operation

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

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

Functional Check

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

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

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

1. Remove the PCV hose from the cylinder head cover.
2. Operate the engine at idle.
3. Place your thumb over the end of the hose in order to check for a vacuum. If there is no vacuum at the hose, inspect for the following items:
 - Plugged hoses

- The manifold port
4. Turn OFF the engine.
 5. Inspect the PCV orifice in the cylinder head cover for debris or blockage.

REPAIR INSTRUCTIONS - ON VEHICLE

WATER PUMP AND GENERATOR BELT REPLACEMENT

Removal Procedure

1. Support and raise the vehicle. Refer to Lifting and Jacking the Vehicle .

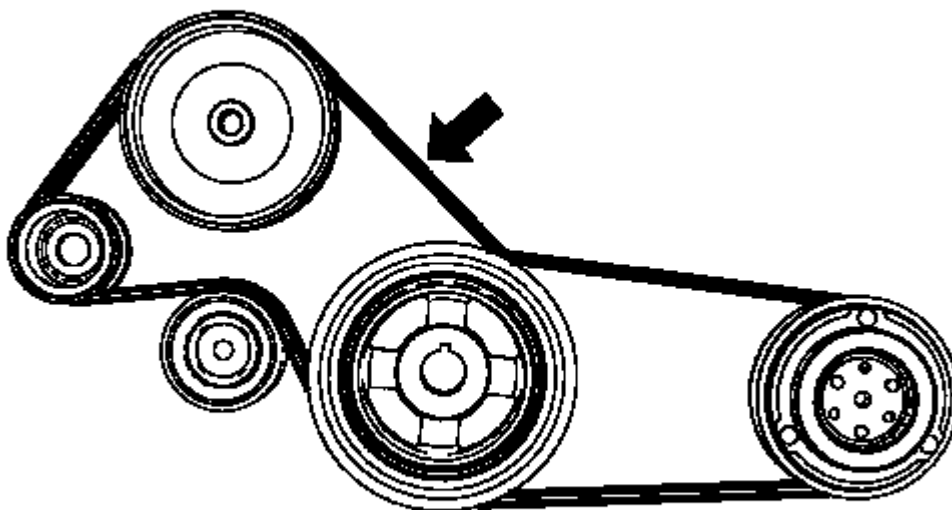


Fig. 10: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

2. Note the routing of the water pump and generator belt.

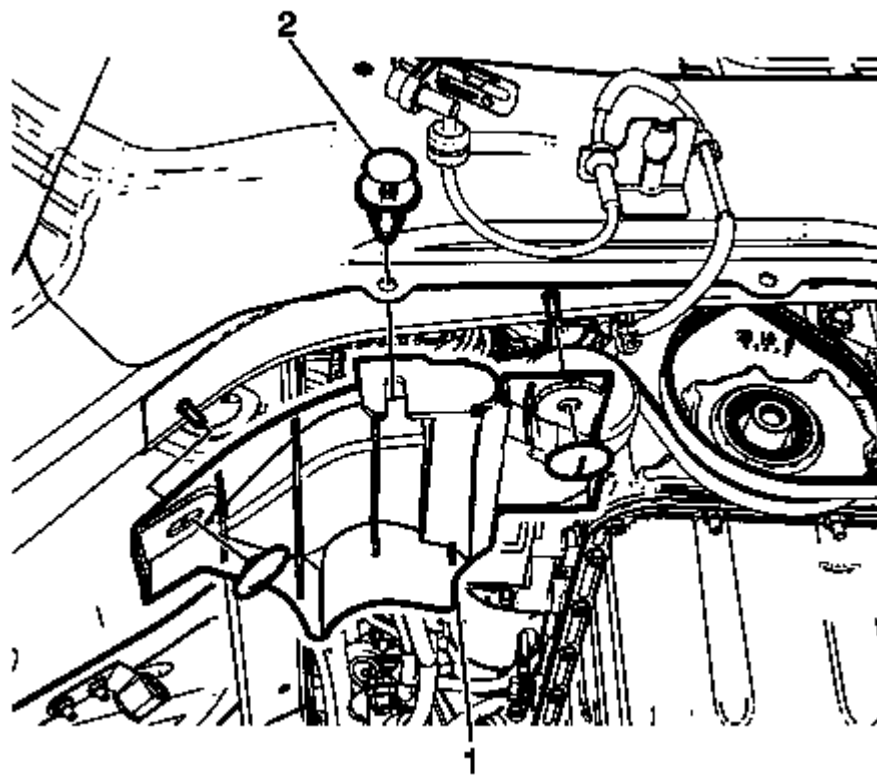


Fig. 11: Retainers And Water Deflector

Courtesy of GENERAL MOTORS COMPANY

3. Remove the retainers (2) and the water deflector (1).

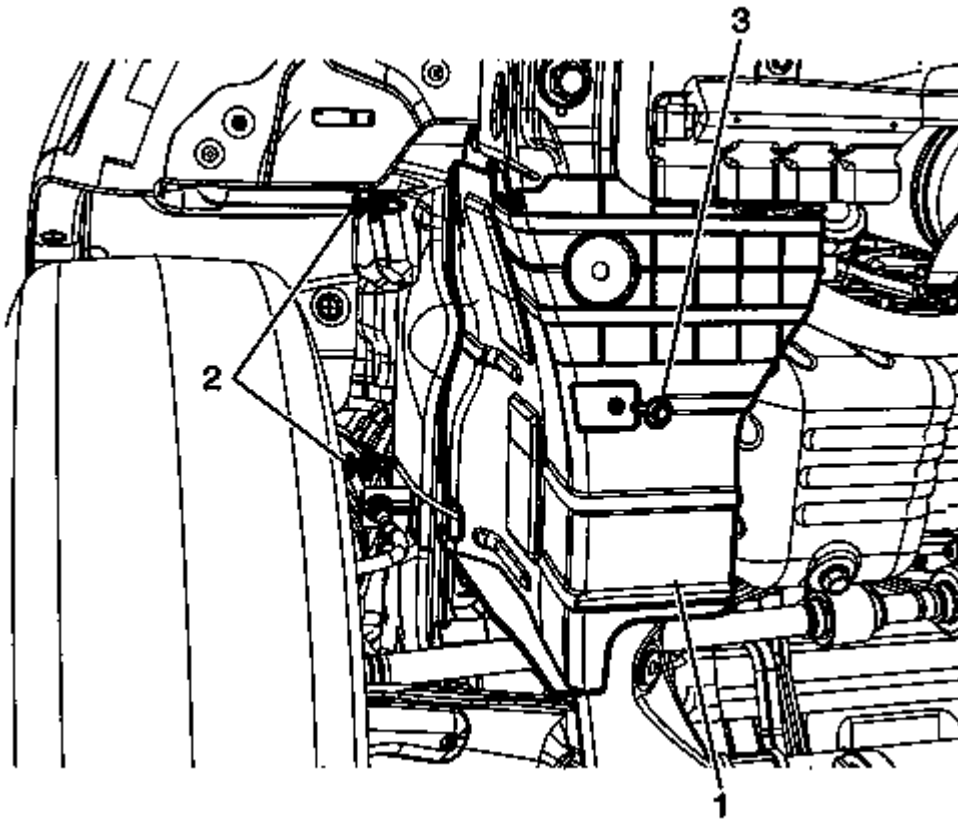


Fig. 12: Front Compartment Splash Shield Retainers And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front compartment splash shield retainers (2) and bolt (3).
5. Remove the front compartment splash shield (1).
6. Remove the air conditioning compressor belt. Refer to **Air Conditioning Compressor Belt Replacement**.

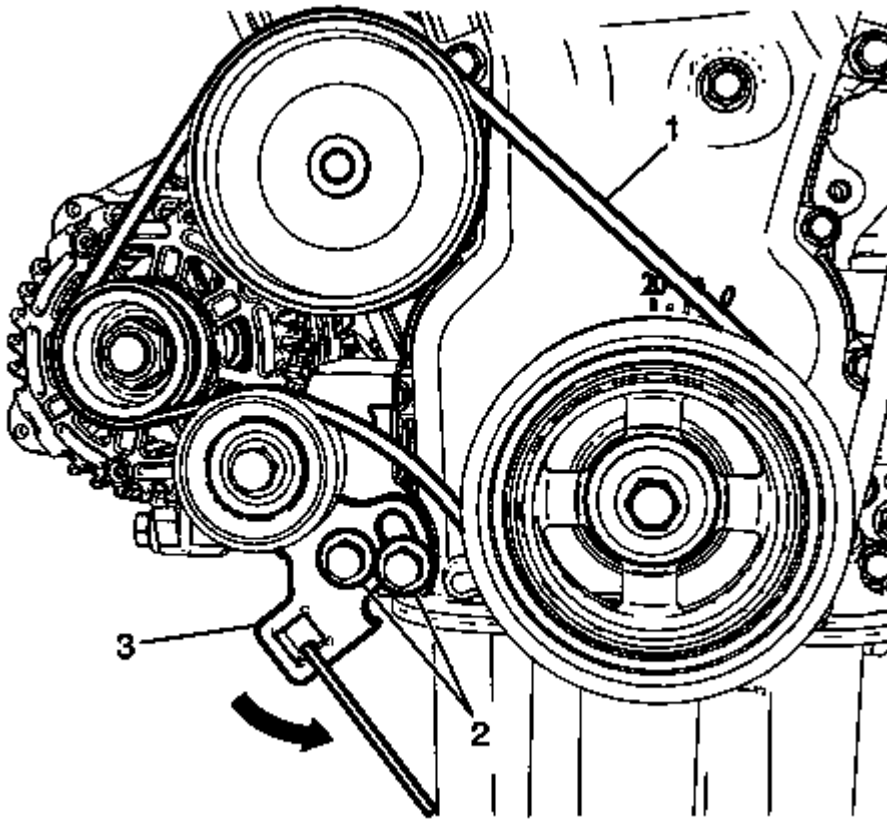


Fig. 13: Generator Bracket With Tensioner Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the generator bracket with tensioner bolts (2).
8. Rotate the generator bracket arm (3) counterclockwise by using an extensional tool or suitable tool.
9. Remove the water pump and generator belt (1).

Installation Procedure

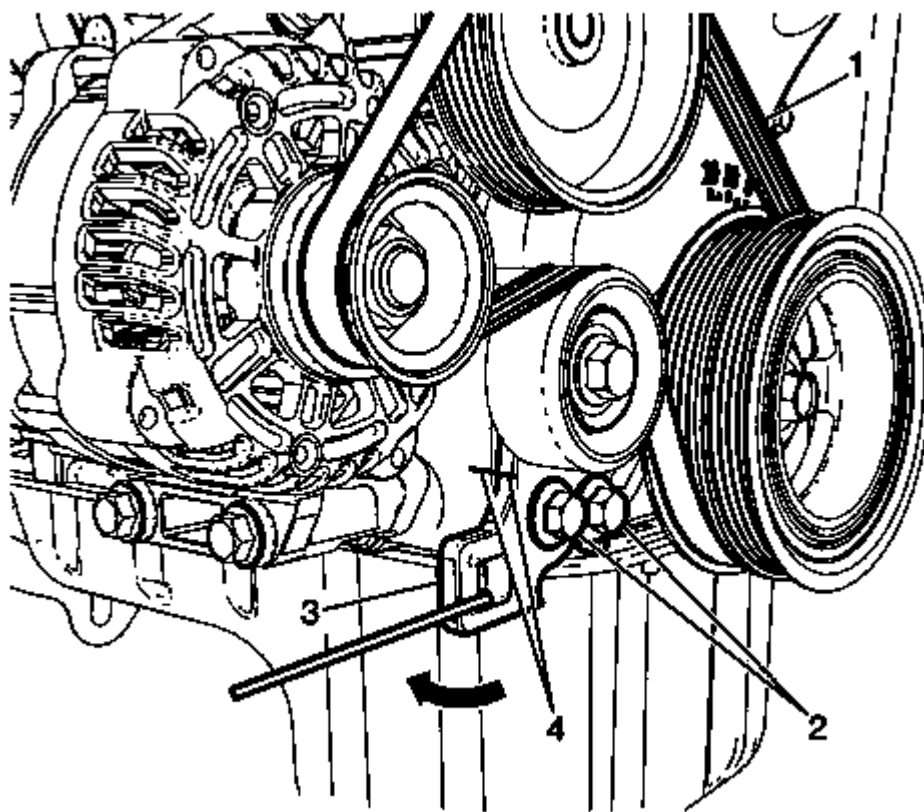


Fig. 14: Water Pump And Generator Belt
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the water pump and generator belt is correctly aligned and seated into the grooves of the generator pulley, crankshaft balancer and water pump pulley.

1. Install the water pump and generator belt (1).
2. Rotate the generator bracket arm (3) clockwise by using an extensional tool or suitable tool.
3. Keep turning the bracket arm until the indicator lines (4) are located at collinear position.

CAUTION: Refer to Fastener Caution .

4. Tighten the generator bracket with tensioner bolts (2) to 55 (41 lb ft).
5. Install the air conditioning compressor belt. Refer to Air Conditioning Compressor Belt Replacement.
6. Rotate engine one full revolution.

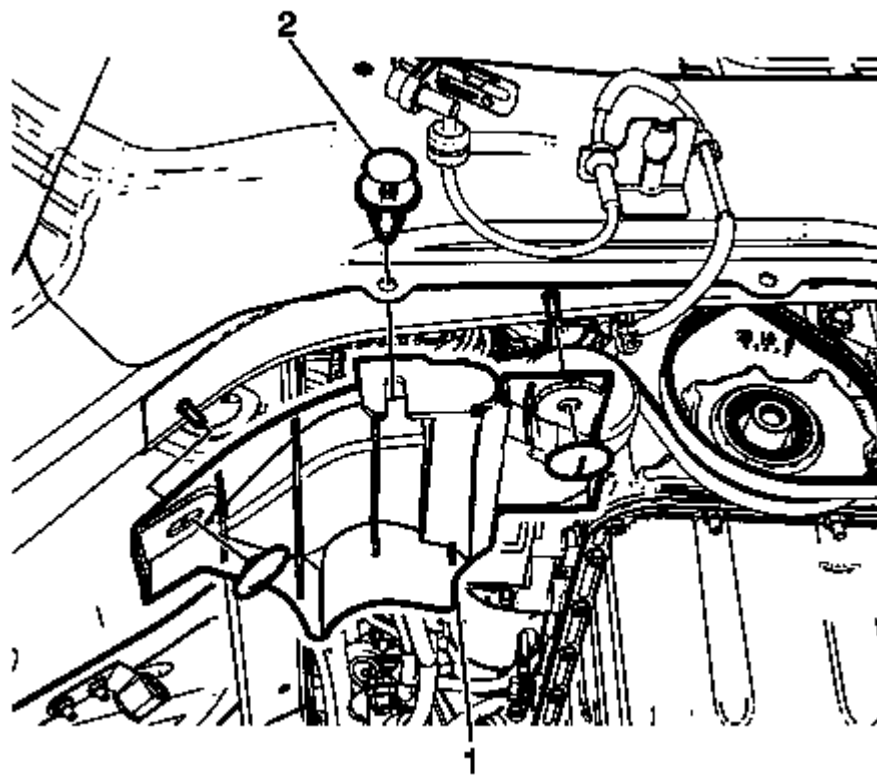


Fig. 15: Retainers And Water Deflector

Courtesy of GENERAL MOTORS COMPANY

7. Install the retainers (2) and the water deflector (1).

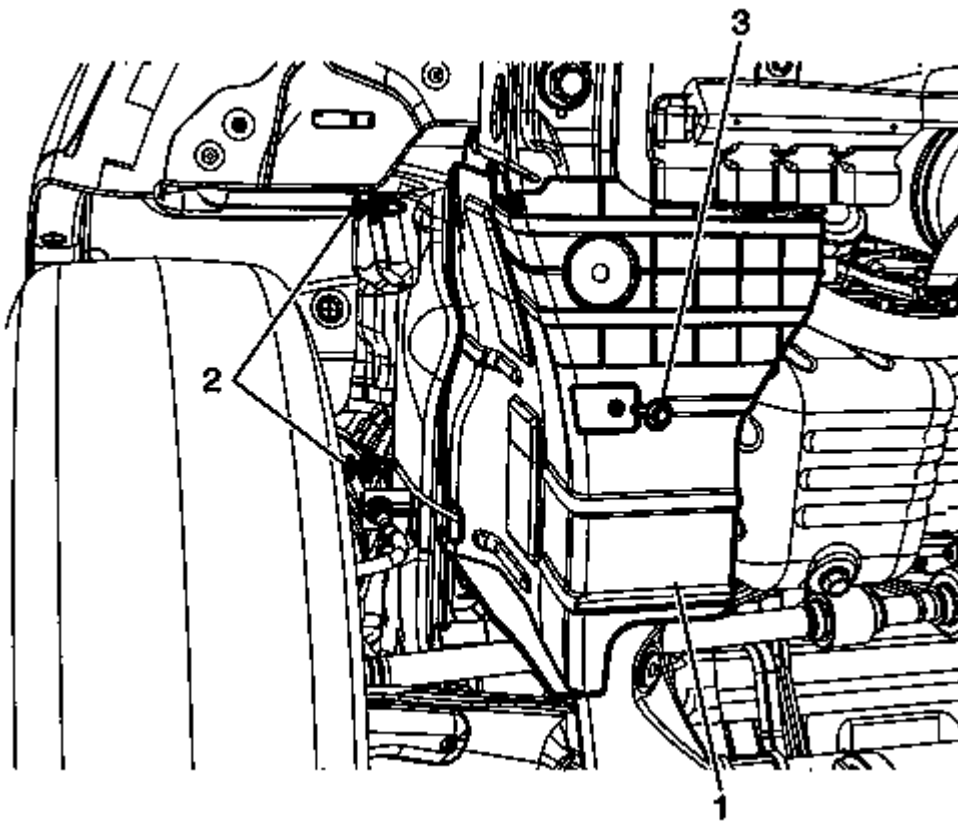


Fig. 16: Front Compartment Splash Shield Retainers And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the front compartment splash shield (1).
9. Install the front compartment splash shield retainers (2) and bolt (3).
10. Tighten the bolt (3) to 9 (80 lb in).
11. Lower the vehicle.

WATER PUMP AND GENERATOR BELT TENSION INSPECTION

Special Tools

GE-50576 Acoustic Belt Tension Tester

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

1. Support and raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

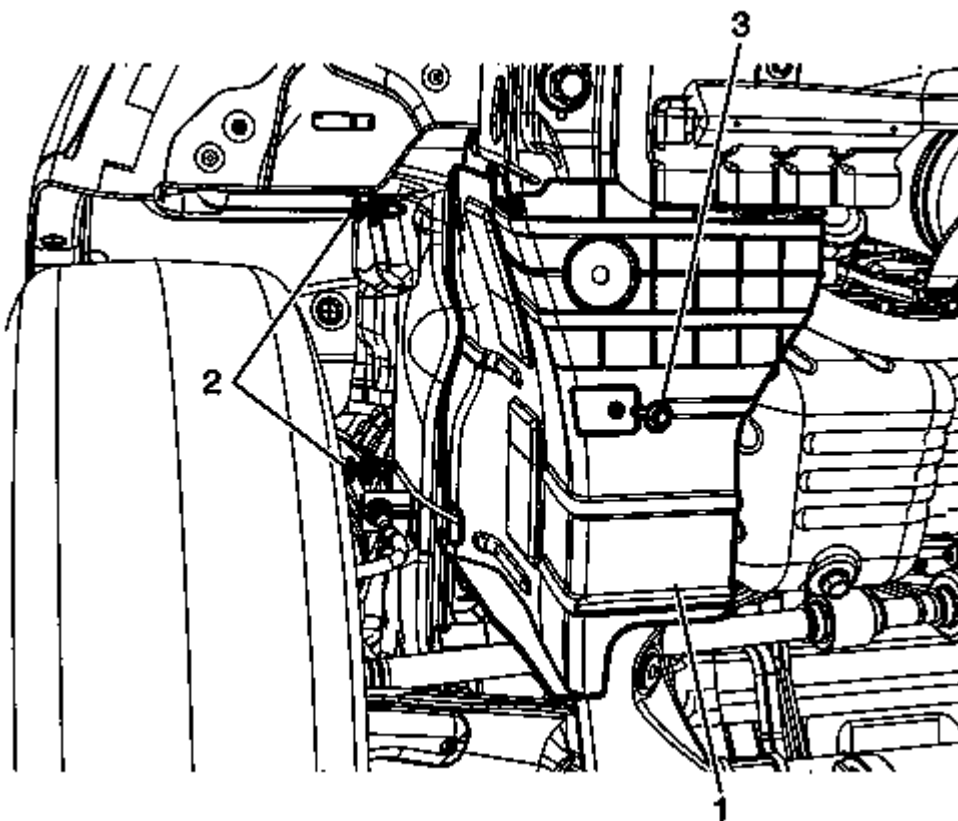


Fig. 17: Front Compartment Splash Shield Retainers And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the front compartment splash shield retainers (2) and bolt (3).
3. Remove the front compartment splash shield (1).

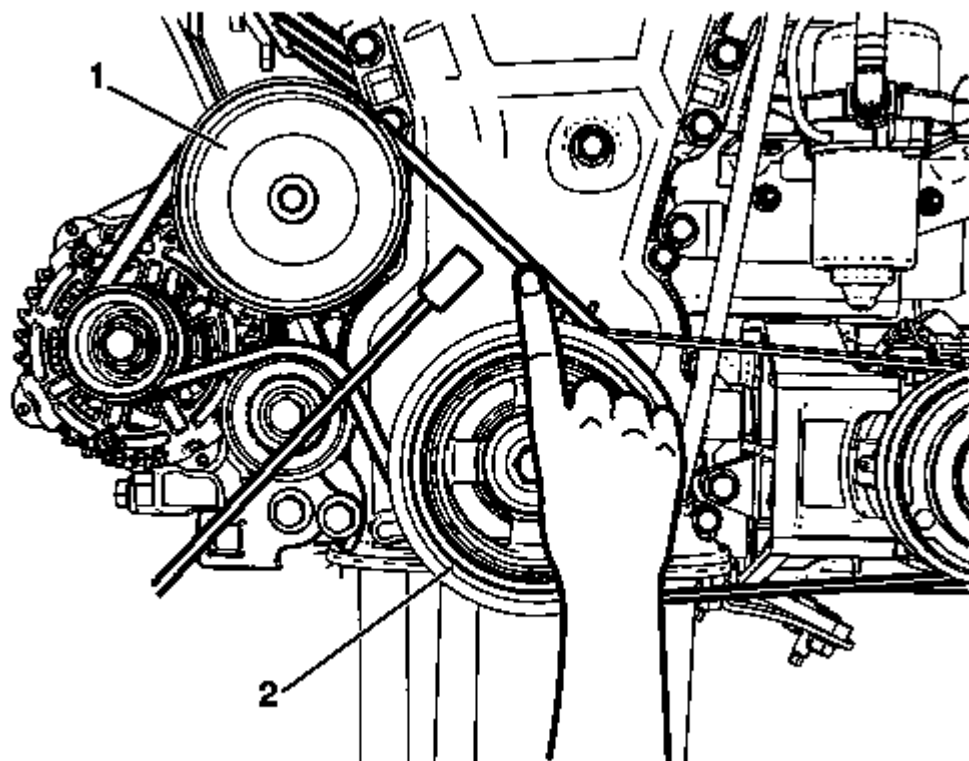


Fig. 18: Locating Finger On Center Of Belt Span Between Water Pump Pulley And Crankshaft Pulley

Courtesy of GENERAL MOTORS COMPANY

WARNING: Always allow the engine to cool before servicing the engine system. Failure to follow this instruction may result in serious personal injury.

NOTE: Space between tension gauge and the belt should be around 10 mm apart.

4. Use **GE-50576** acoustic belt tension tester to measure the water pump and generator belt tension.
 1. Locate **GE-50576** acoustic belt tension tester near the center of the belt span between the water pump pulley and crankshaft pulley.
 2. Locate a finger on the center of the belt span between water pump pulley (1) and crankshaft pulley (2). Pluck the belt between the water pump pulley and the crankshaft pulley. Repeat 3 times to get an average tension result on **GE-50576** acoustic belt tension tester.
 3. If water pump and generator belt tension is over 158 Hz the belt tension is within specification. Go to step 5.
 4. If water pump and generator belt tension is not within the specification, below 158 Hz, inspect the belt for excessive wear, fraying or cracking. Replace the belt as necessary. Refer to **Water Pump and Generator Belt Replacement**.

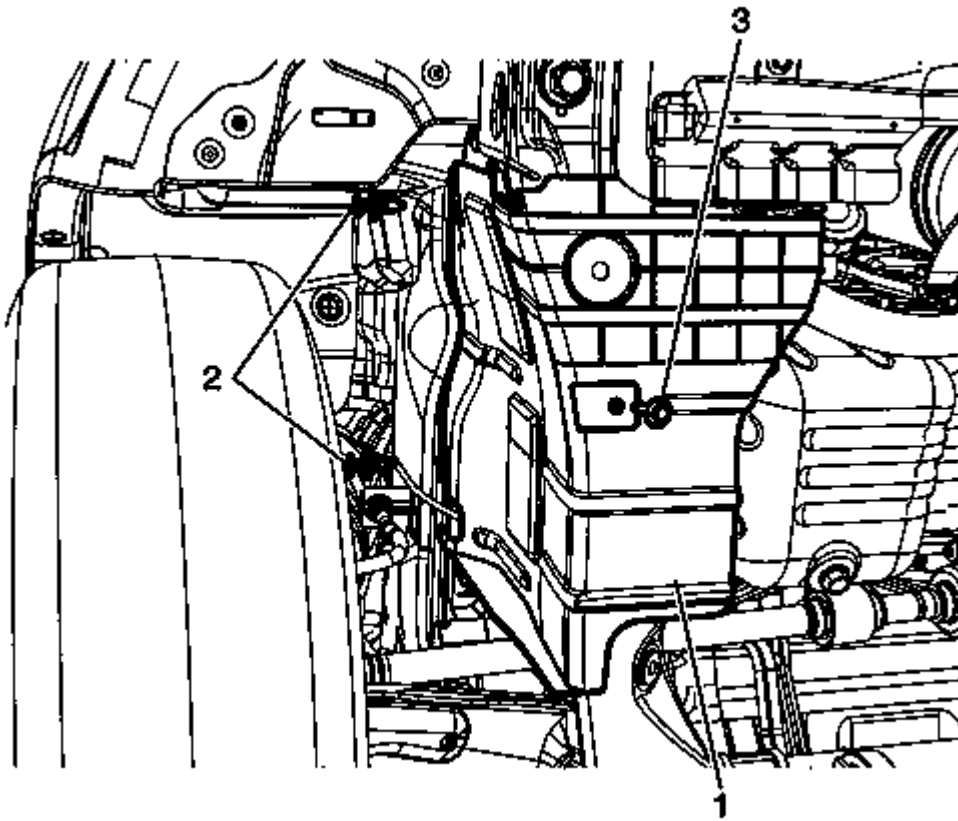


Fig. 19: Front Compartment Splash Shield Retainers And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the front compartment splash shield (1).
6. Install the front compartment splash shield retainers (2) and bolt (3). Tighten the bolt (3) to 9 (80 lb in).
7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT

Removal Procedure

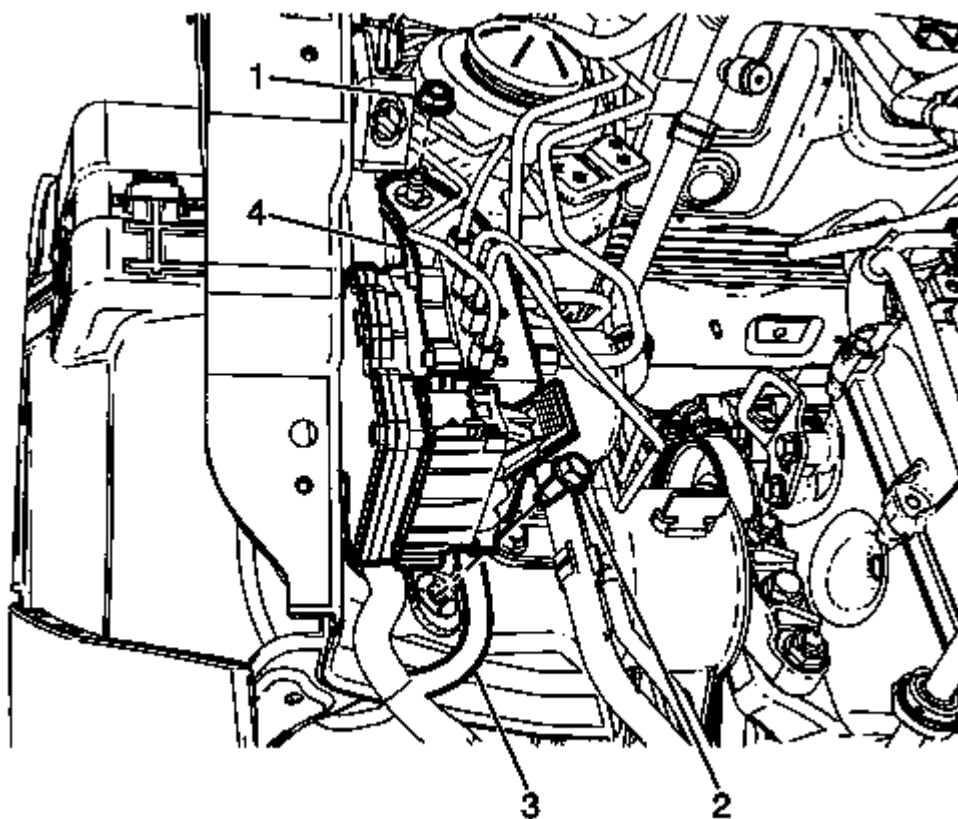


Fig. 20: Electrical Connector And Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

1. Remove the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LL0)** , **Radiator Surge Tank Replacement (LFM)** .
2. Remove the electrical connector (3) from the electronic brake control module (EBCM).
3. Remove the EBCM/BPMV (brake pressure modular valve) bracket nut (1), bolt (2).
4. Reposition the EBCM/BPMV assembly (4) aside.
5. Install the engine support fixture. Refer to **Engine Support Fixture**.
6. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.

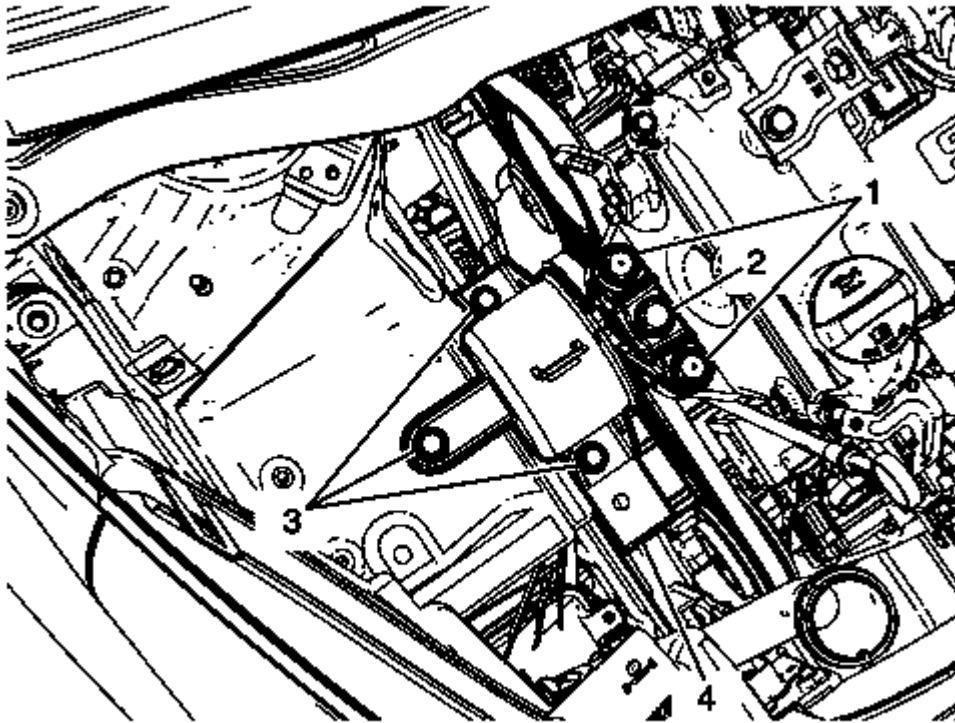


Fig. 21: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine mount nuts (1).
8. Remove the engine mount bolt (2).
9. Remove the engine mount to body retaining bolts (3).
10. Remove the engine mount (4).
11. Transfer parts as necessary.

Installation Procedure

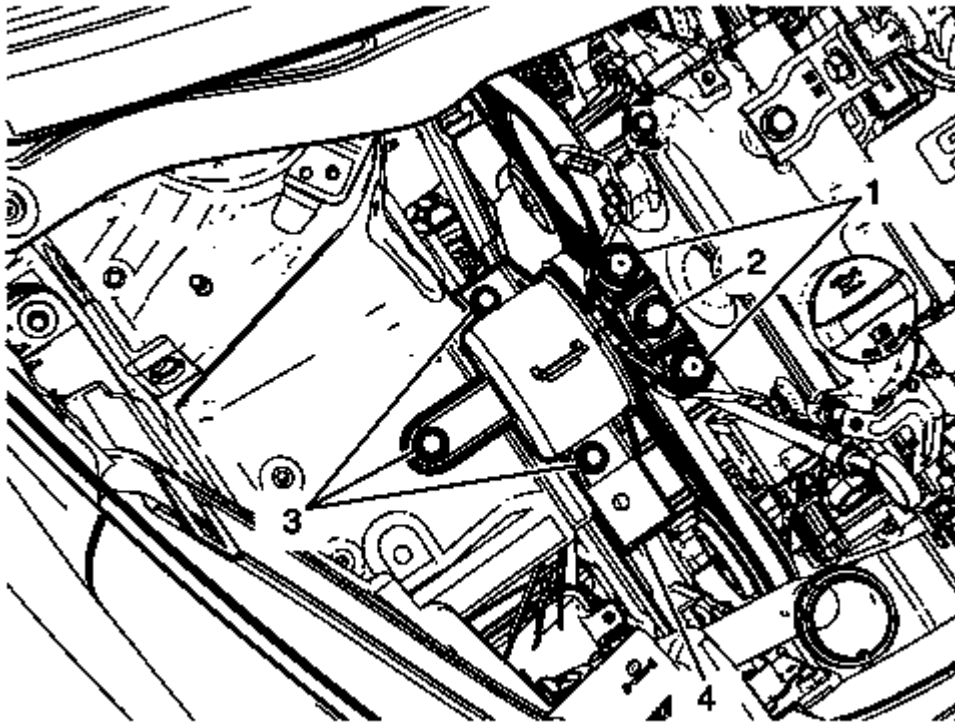


Fig. 22: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

1. Install the engine mount (4).

CAUTION: Refer to Fastener Caution .

2. Install the engine mount to body retaining bolts (3) and tighten to 50 (37 lb ft).
3. Install the engine mount bolt (2), nuts (1) and tighten to 66 (49 lb ft).
4. Remove the engine support fixture. Refer to Engine Support Fixture.

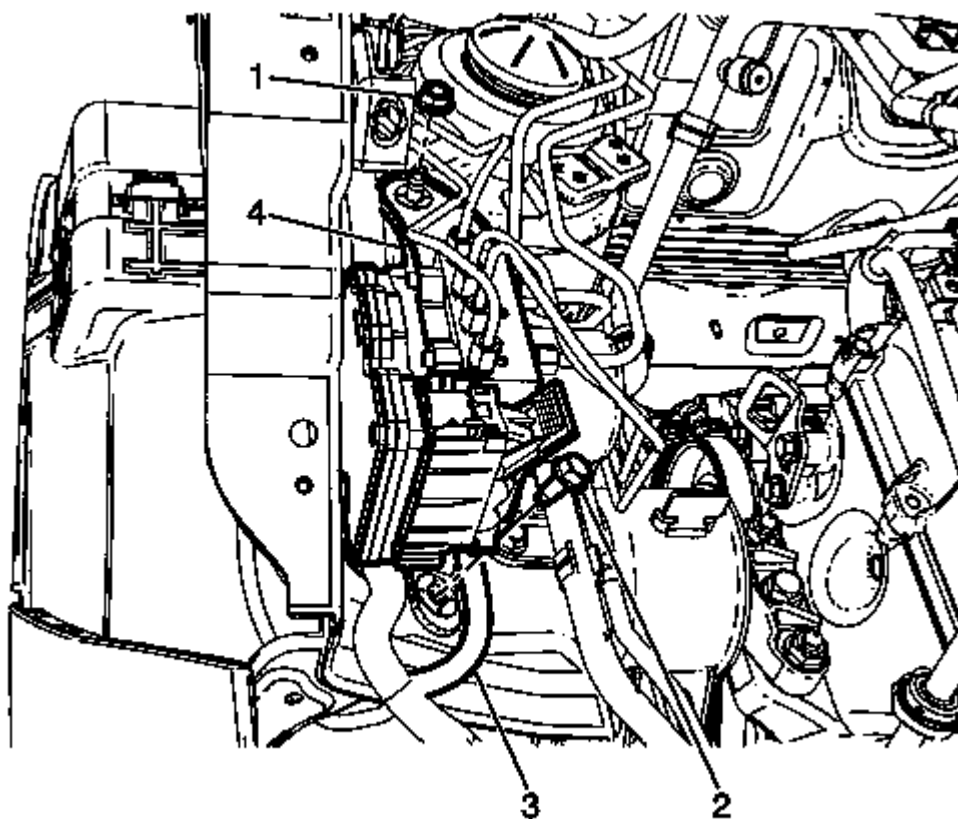


Fig. 23: Electrical Connector And Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

5. Install the EBCM/BPMV assembly (4).
6. Install the EBCM/BPMV (brake pressure modular valve) bracket nut (1), bolt (2) and tighten to 22 (16 lb ft).
7. Connect the EBCM electrical connector (3) to the EBCM.
8. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (LL0)** , **Radiator Surge Tank Replacement (LFM)** .

UPPER INTAKE MANIFOLD REPLACEMENT (LFM)

Removal Procedure

1. Open the hood.
2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement (LL0)** , **Throttle Body Assembly Replacement (LFM)** .
5. Remove the manifold absolute pressure sensor. Refer to **Manifold Absolute Pressure Sensor**

Replacement (LL0) , Manifold Absolute Pressure Sensor Replacement (LFM) .

6. Remove the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LL0) , Evaporative Emission Canister Purge Solenoid Valve Replacement (LFM) .**
7. Disconnect the power brake booster vacuum hose from intake manifold. Refer to **Power Brake Booster Vacuum Hose Replacement .**

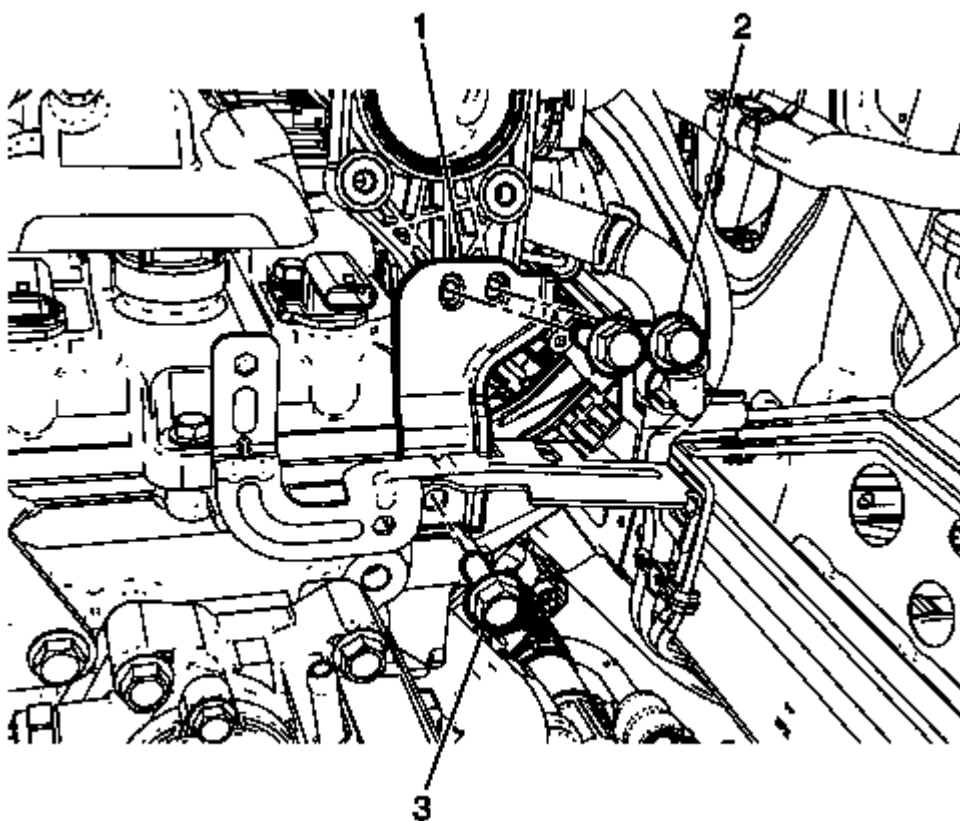


Fig. 24: Upper Intake Manifold Side Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the upper intake manifold side bracket bolts (2).
9. Remove the upper intake manifold side bracket bolt (3).
10. Remove the upper intake manifold side bracket (1).

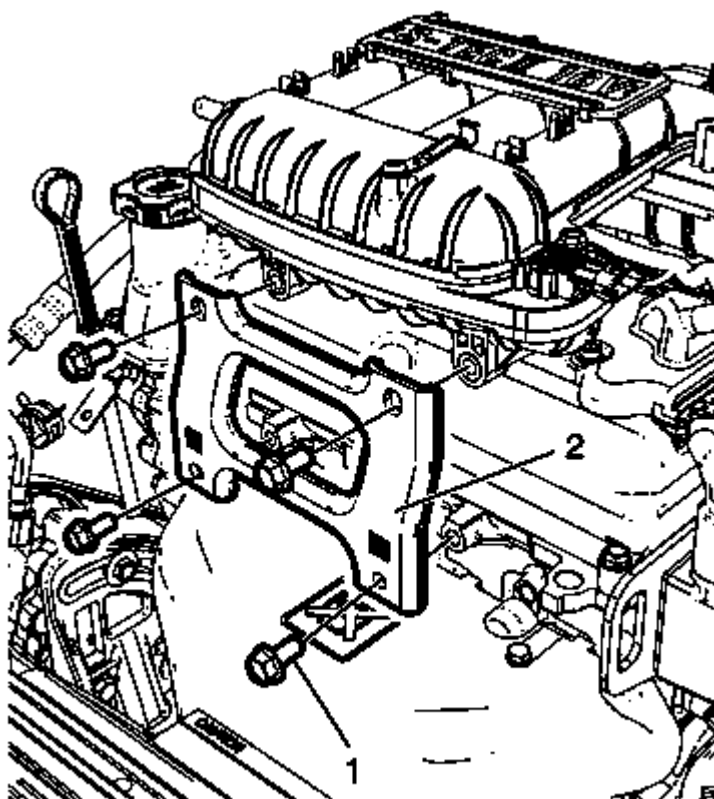


Fig. 25: Upper Intake Manifold Front Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

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

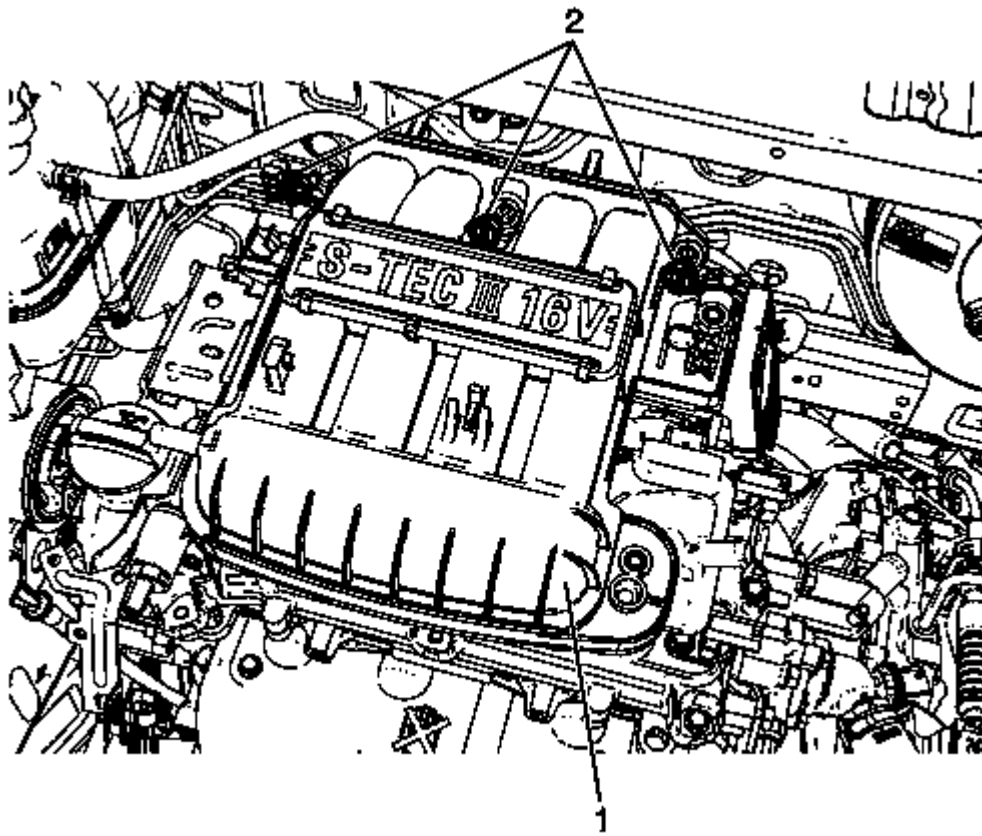


Fig. 26: Upper Intake Manifold 3 Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the upper intake manifold 3 bolts (2).
14. Remove the upper intake manifold (1).
15. Disconnect any electrical connectors as needed.
16. Transfer parts as necessary.

Installation Procedure

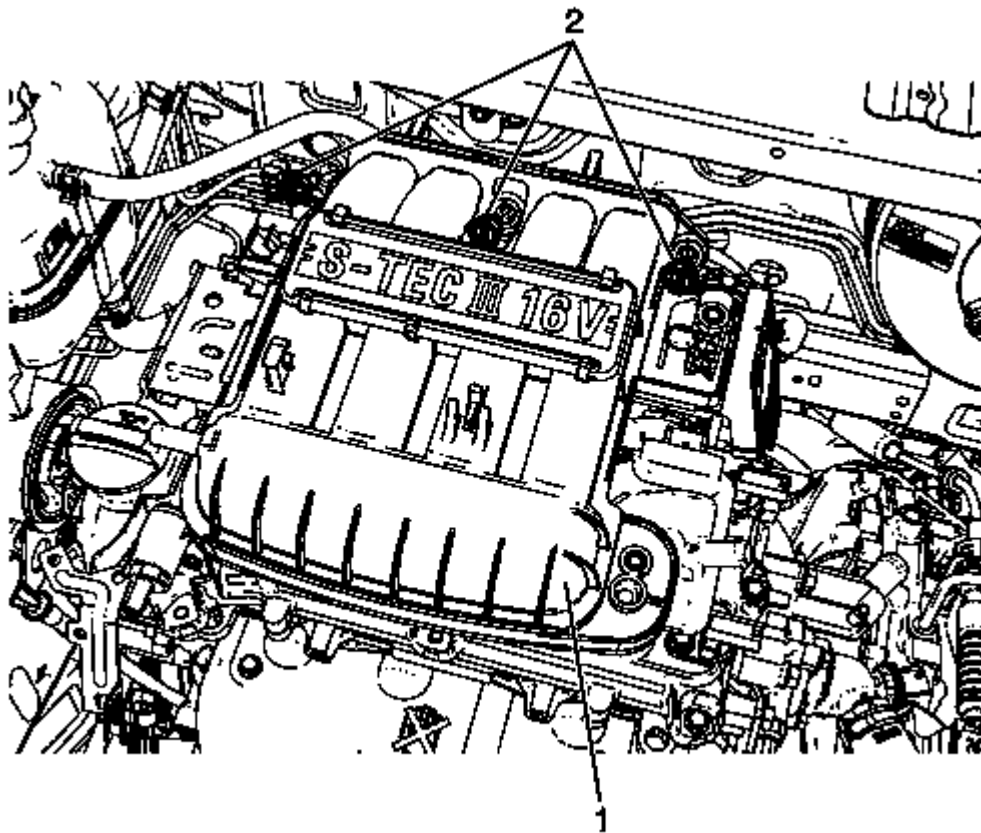


Fig. 27: Upper Intake Manifold 3 Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the upper intake manifold (1).

CAUTION: Refer to Fastener Caution .

2. Install the upper intake manifold 3 bolts (2) and tighten to 10 (89 lb in).

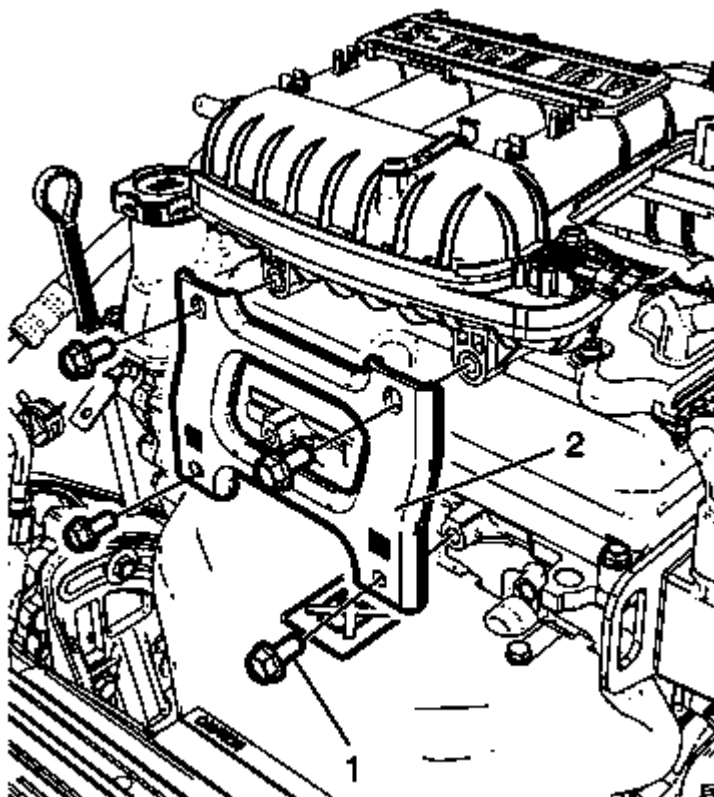


Fig. 28: Upper Intake Manifold Front Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the upper intake manifold front bracket (2).
4. Install the upper intake manifold front bracket bolts (1) and tighten to 25 (18 lb ft).

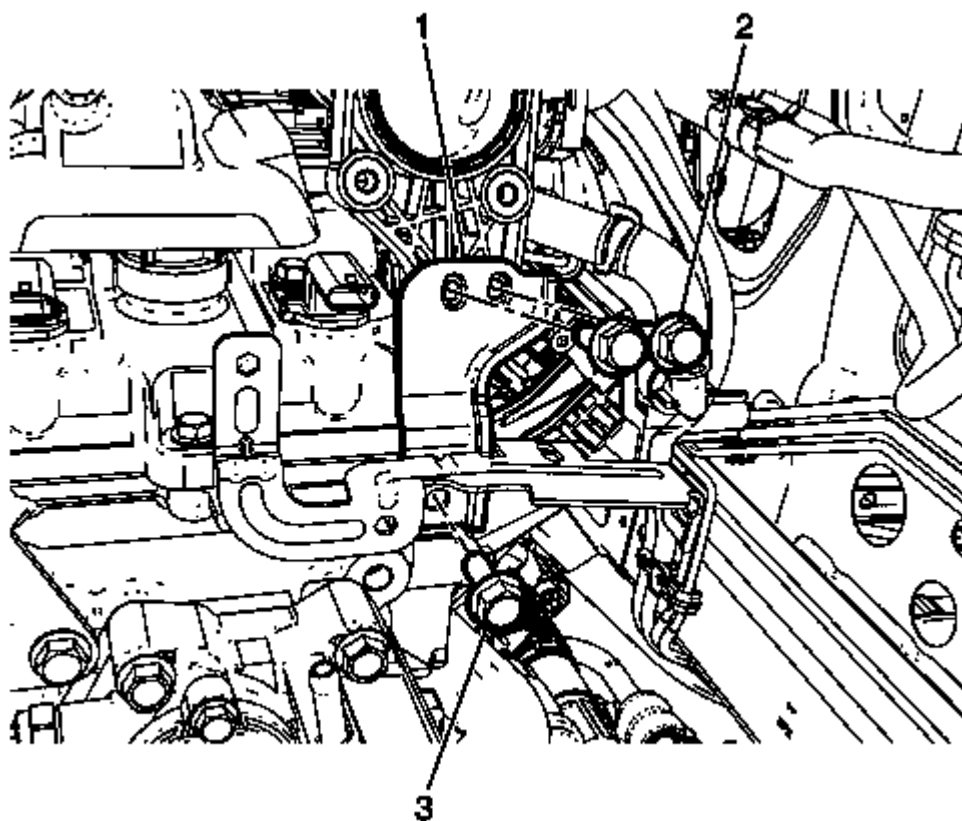


Fig. 29: Upper Intake Manifold Side Bracket Bolts
 Courtesy of GENERAL MOTORS COMPANY

5. Install the upper intake manifold side bracket (1).
6. Install the upper intake manifold side bracket bolts (2) and tighten to 10 (89 lb in).
7. Install the upper intake manifold side bracket bolt (3) and tighten to 25 (18 lb ft)
8. Connect the power brake booster vacuum hose to intake manifold. Refer to **Power Brake Booster Vacuum Hose Replacement** .
9. Install the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LL0)** , **Evaporative Emission Canister Purge Solenoid Valve Replacement (LFM)** .
10. Install the manifold absolute pressure sensor. Refer to **Manifold Absolute Pressure Sensor Replacement (LL0)** , **Manifold Absolute Pressure Sensor Replacement (LFM)** .
11. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement (LL0)** , **Throttle Body Assembly Replacement (LFM)** .
12. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
13. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
14. Close the hood.

LOWER INTAKE MANIFOLD REPLACEMENT (LFM)

Removal Procedure

1. Open the hood.
2. Remove the upper intake manifold housing. Refer to **Upper Intake Manifold Replacement (LFM)**.

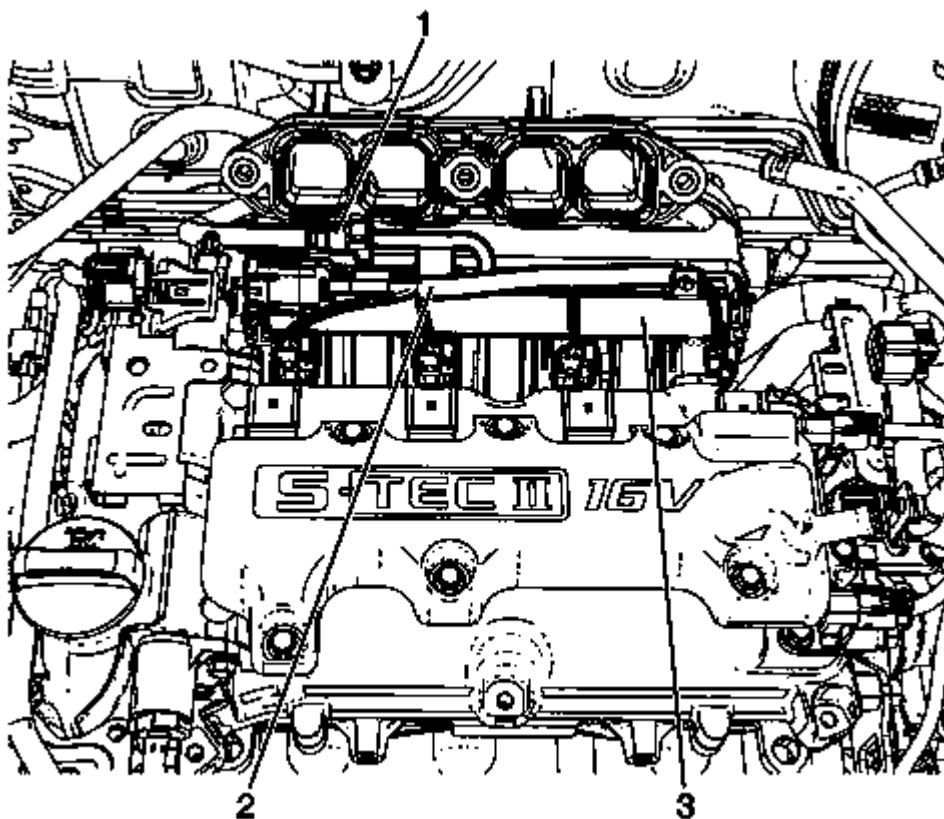


Fig. 30: Positive Crankcase Ventilation Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove the positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
4. Disconnect the ignition coil connectors. Refer to **Ignition Coil Removal**.
5. Disconnect the fuel feed hose (1) from the fuel rail (3).
6. Disconnect the fuel injector electrical connector and remove the fuel injector rail wiring harness (2).
7. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**.
8. Remove the exhaust pipe assembly. Refer to **Exhaust Pipe Replacement (LFM)**.
9. Remove any electrical retainers as needed.
10. Disconnect the starter connector. Refer to **Starter Replacement**.
11. Disconnect the generator connector. Refer to **Generator Replacement**.

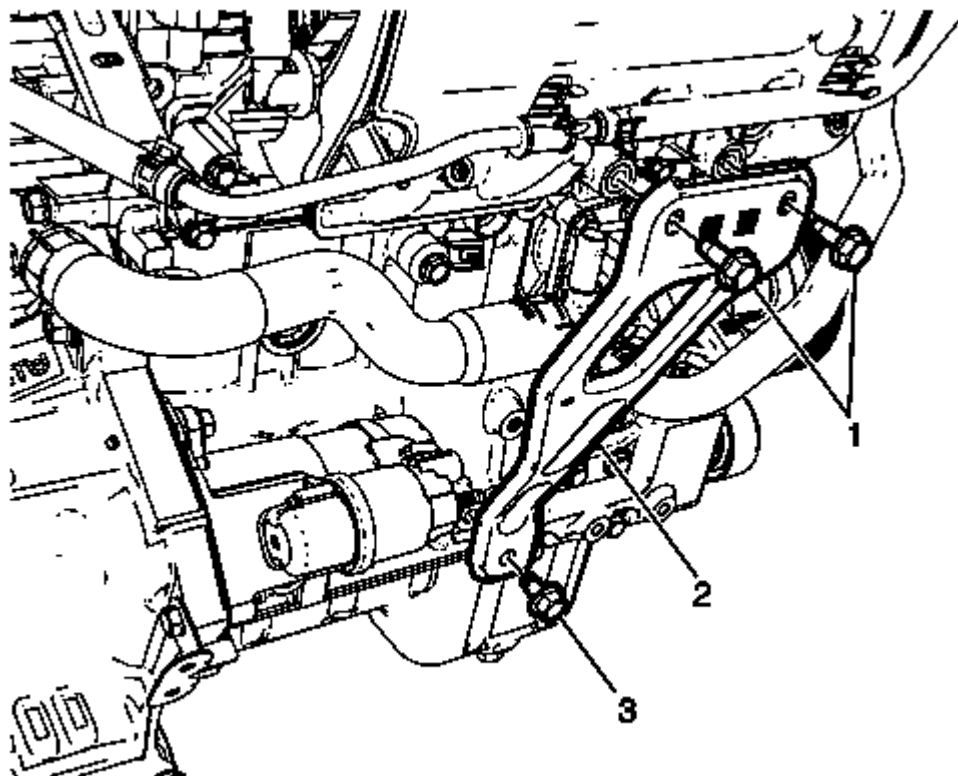


Fig. 31: Intake Manifold Rear Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the intake manifold rear bracket (2) and bolts (1, 3).

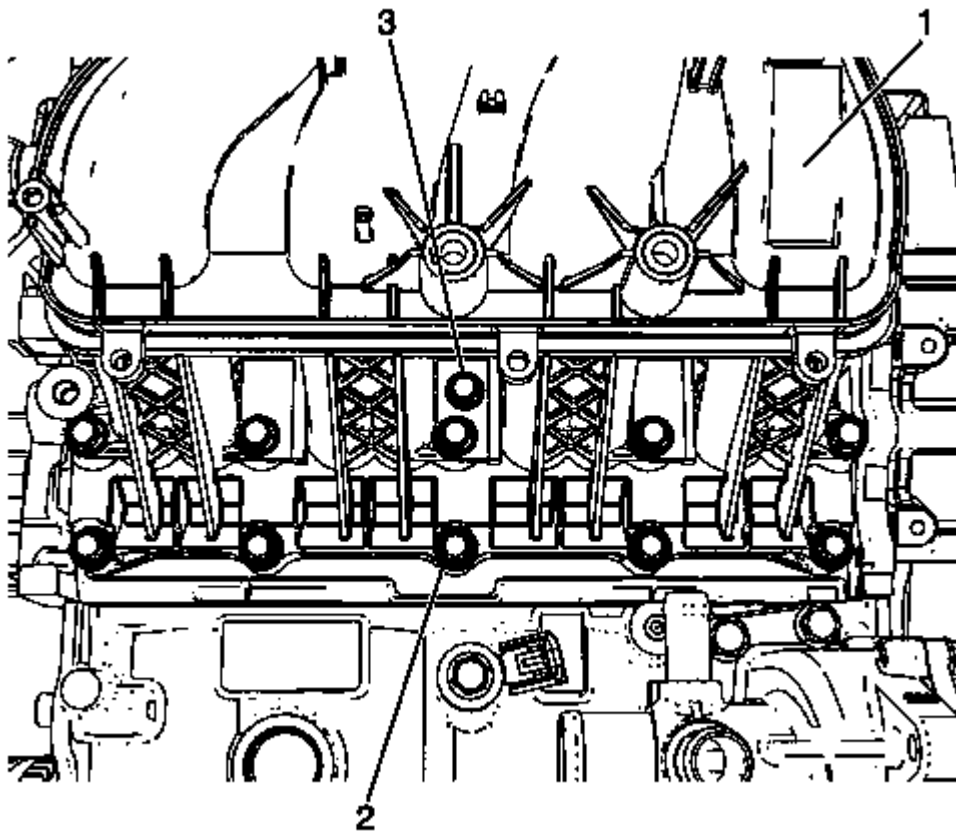


Fig. 32: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the lower intake manifold 11 bolts (2, 3).
14. Remove the lower intake manifold (1) and fuel injection fuel rail assembly.
15. Transfer parts as necessary.

Installation Procedure

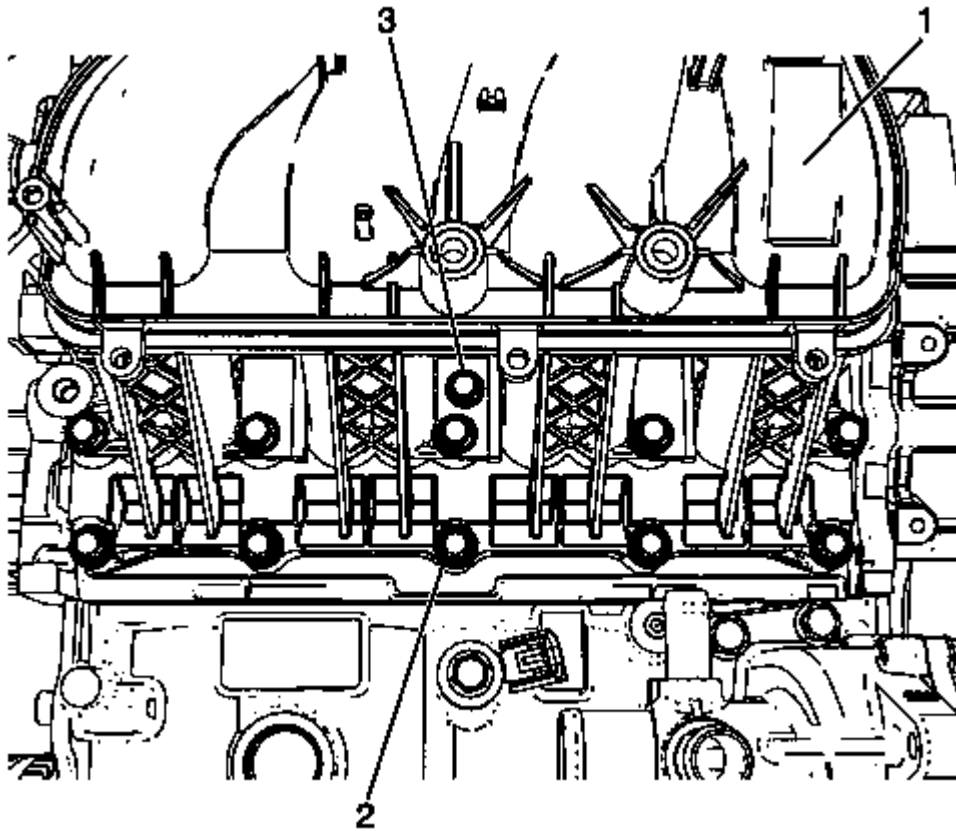


Fig. 33: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the lower intake manifold (1) and fuel injector fuel rail assembly.

CAUTION: Refer to Fastener Caution .

2. Install the lower intake manifold 11 bolts (2, 3) and tighten to 10 (89 lb in).

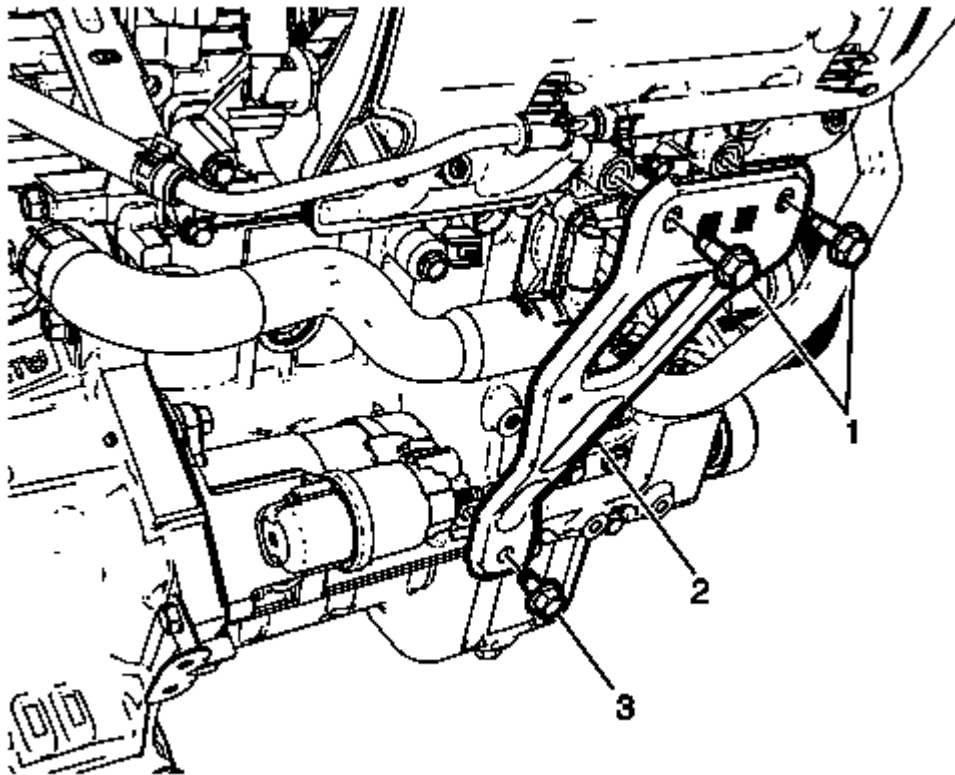


Fig. 34: Intake Manifold Rear Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the intake manifold support bracket (2).
4. Install the intake manifold rear bracket bolts (1) and tighten to 22 (16 lb ft).
5. Install the intake manifold rear bracket bolt (3) and tighten to 58 (42 lb ft).
6. Connect the generator connector. Refer to **Generator Replacement** .
7. Connect the starter connector. Refer to **Starter Replacement** .
8. Install any electrical retainers.
9. Install the exhaust pipe assembly. Refer to **Exhaust Pipe Replacement (LFM)** .
10. Lower the vehicle.

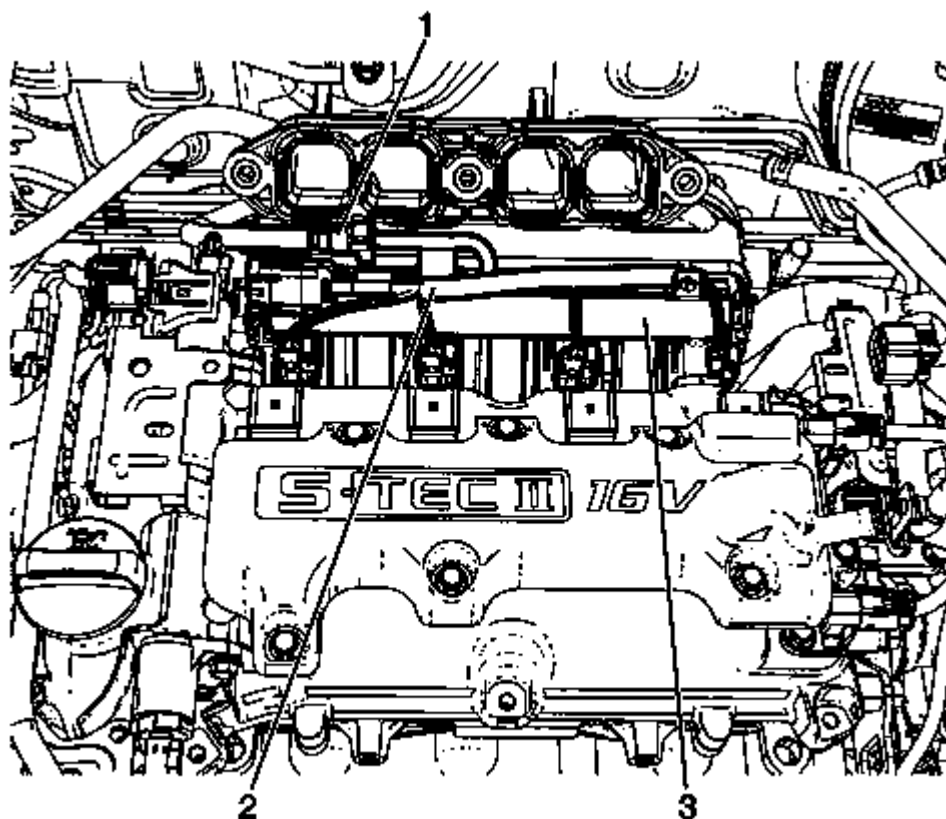


Fig. 35: Positive Crankcase Ventilation Hose
Courtesy of GENERAL MOTORS COMPANY

11. Connect the ignition coil connectors. Refer to **Ignition Coil Installation**.
12. Install the fuel injector rail wiring harness (2) and connect the fuel injector electrical connector.
13. Connect the fuel feed hose (1) to the fuel rail (3).
14. Install the positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
15. Install the upper intake manifold housing. Refer to **Upper Intake Manifold Replacement (LFM)**.
16. Close the hood.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Open the hood.
2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling**.
4. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.
5. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement (LL0)**, **Throttle**

Body Assembly Replacement (LFM) .

6. Remove the positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
7. Remove the manifold absolute pressure sensor. Refer to **Manifold Absolute Pressure Sensor Replacement (LL0)** , **Manifold Absolute Pressure Sensor Replacement (LFM)** .
8. Remove the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LL0)** , **Evaporative Emission Canister Purge Solenoid Valve Replacement (LFM)** .

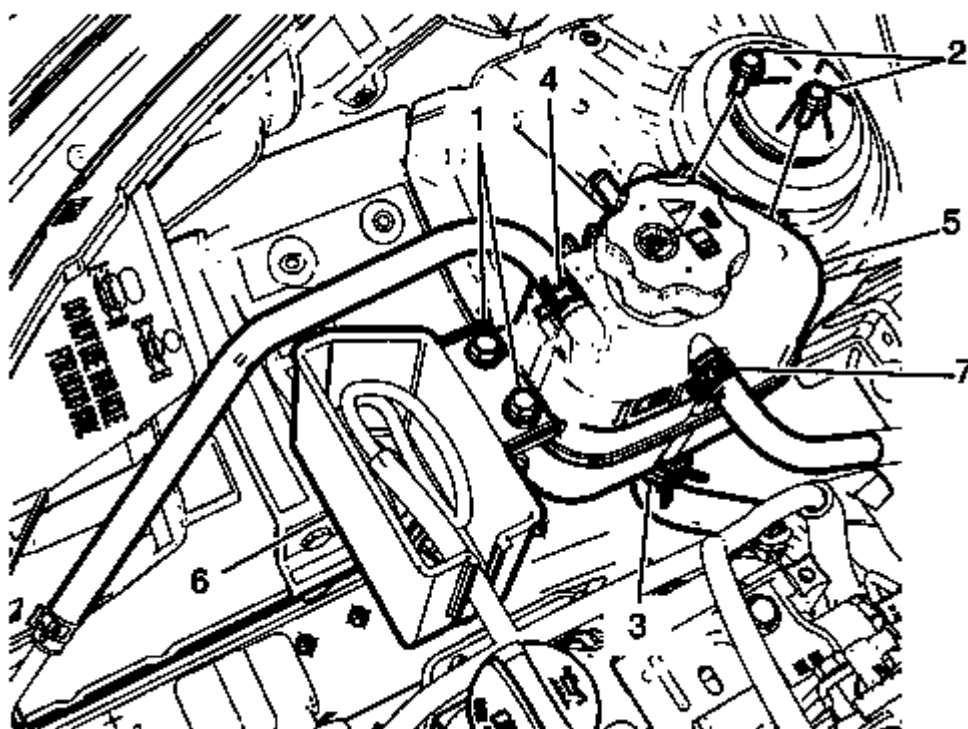


Fig. 36: Block Heater Connecting Plug Holder Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the coolant hose and clamp (7) from the radiator surge tank and intake manifold.
10. If equipped with a block heater, remove the block heater connecting plug holder bolts (1) and reposition block heater connecting plug holder (6) aside.
11. Remove the radiator surge tank mounting bolt (2) and reposition radiator surge tank (5) aside.
12. Disconnect the power brake booster vacuum hose from intake manifold. Refer to **Power Brake Booster Vacuum Hose Replacement** .
13. Disconnect the fuel feed line quick connect fitting from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

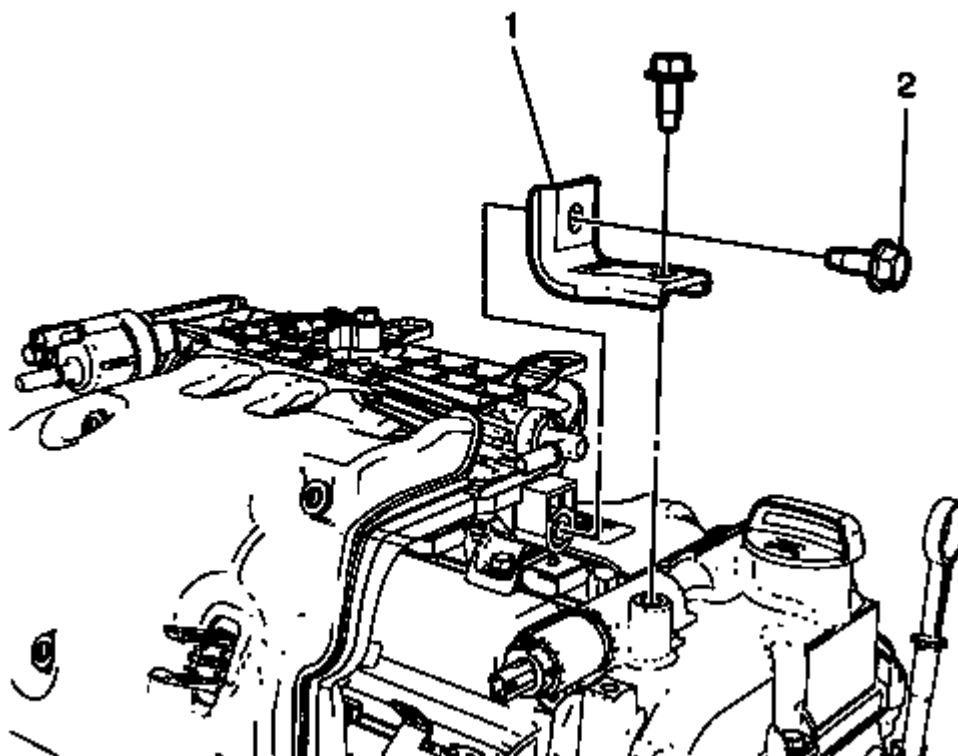


Fig. 37: Intake Manifold Upper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Remove the intake manifold upper bracket bolts (2).
15. Remove the intake manifold upper bracket (1).

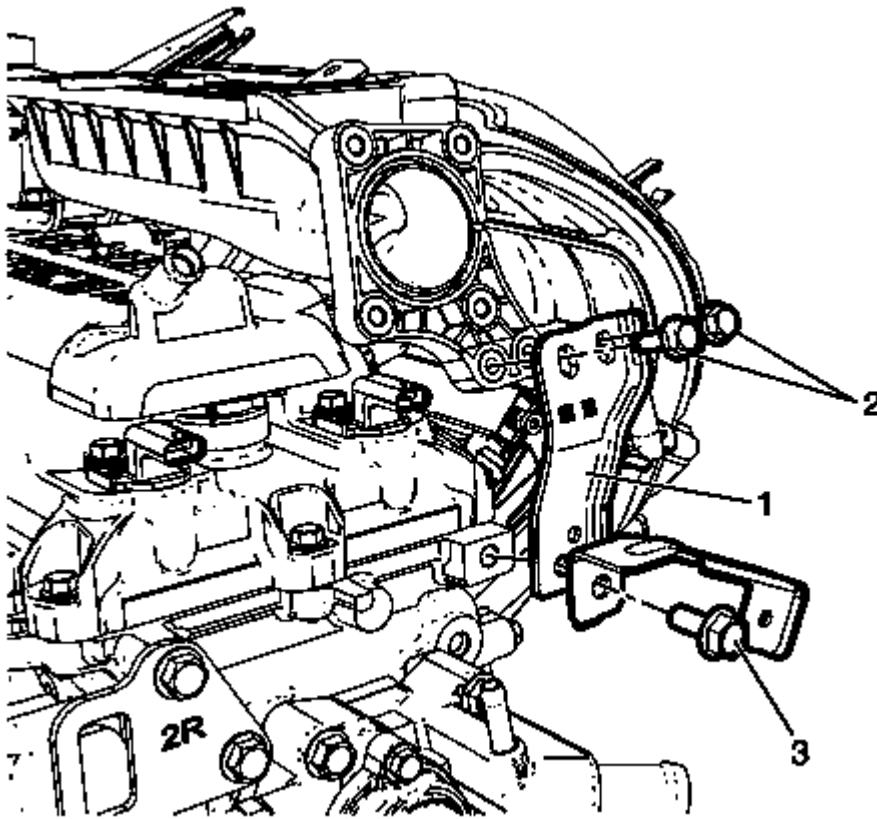


Fig. 38: Intake Manifold Side Bracket And Bolts
 Courtesy of GENERAL MOTORS COMPANY

16. Remove the intake manifold side bracket (1) and bolts (2, 3).
17. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
18. Remove the exhaust front pipe assembly. Refer to **Exhaust Front Pipe Replacement (LL0)** .

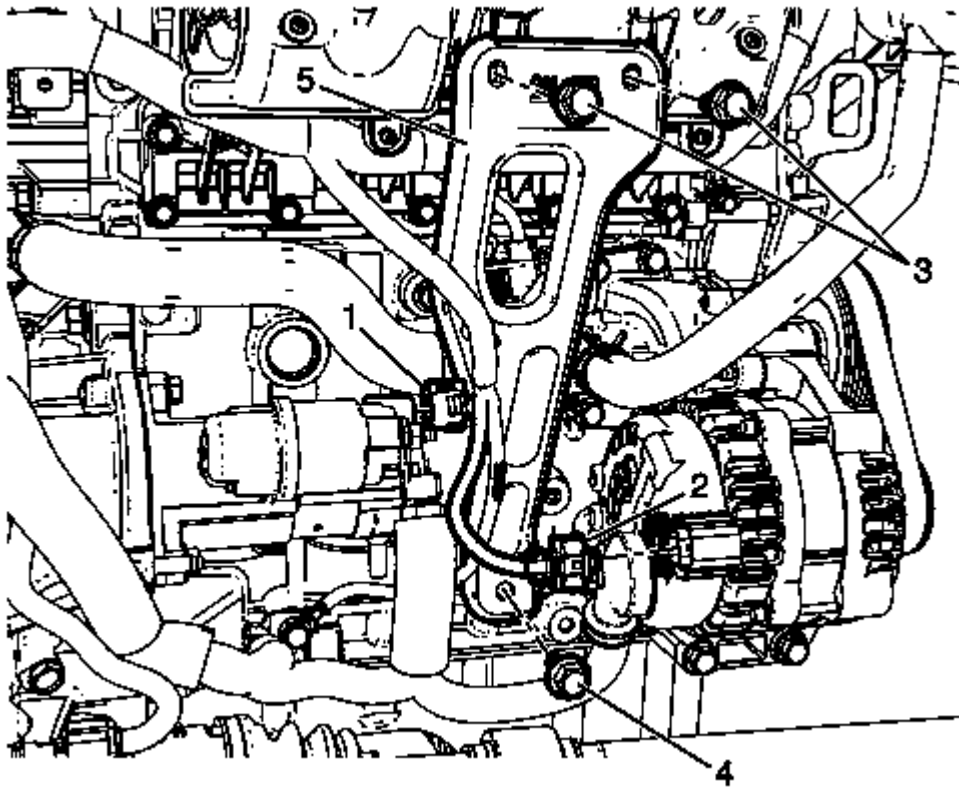


Fig. 39: Starter Connector Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

19. Disconnect the starter connector wiring harness plug (1).
20. Disconnect the generator connector wiring harness plug (2).
21. Remove the 2 intake manifold rear bracket bolts (up) (3).
22. Remove the intake manifold rear bracket bolt (down) (4).
23. Remove the intake manifold bracket (5).
24. Transfer parts as necessary.

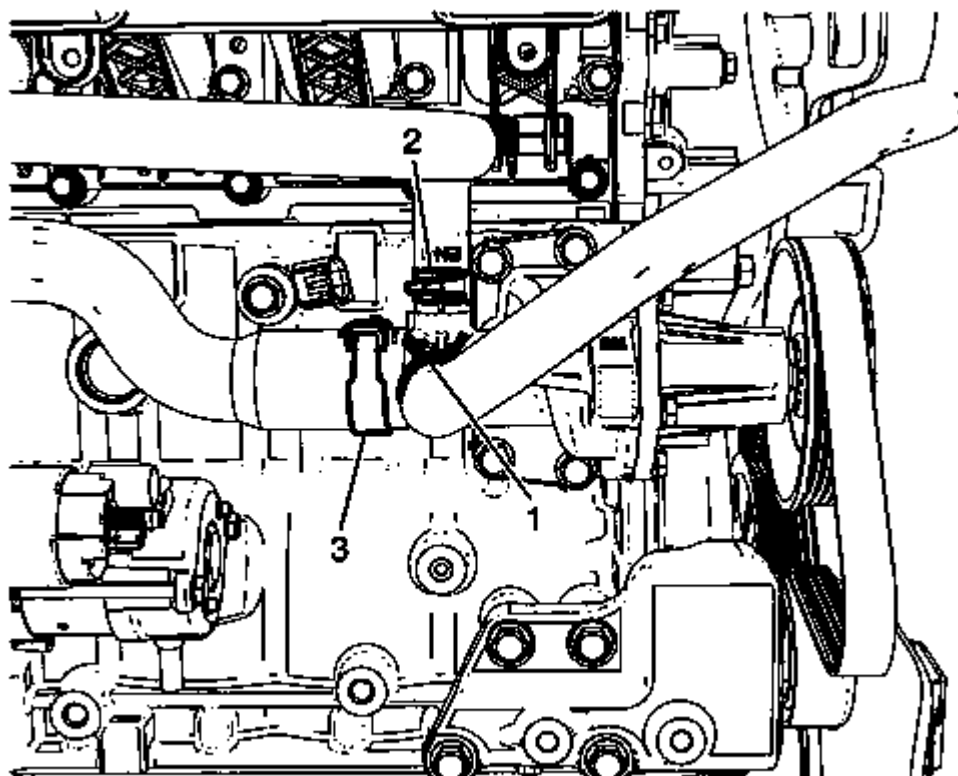


Fig. 40: Heater Outlet Hose And Clamp

Courtesy of GENERAL MOTORS COMPANY

25. Disconnect the heater outlet hose and clamp (2).

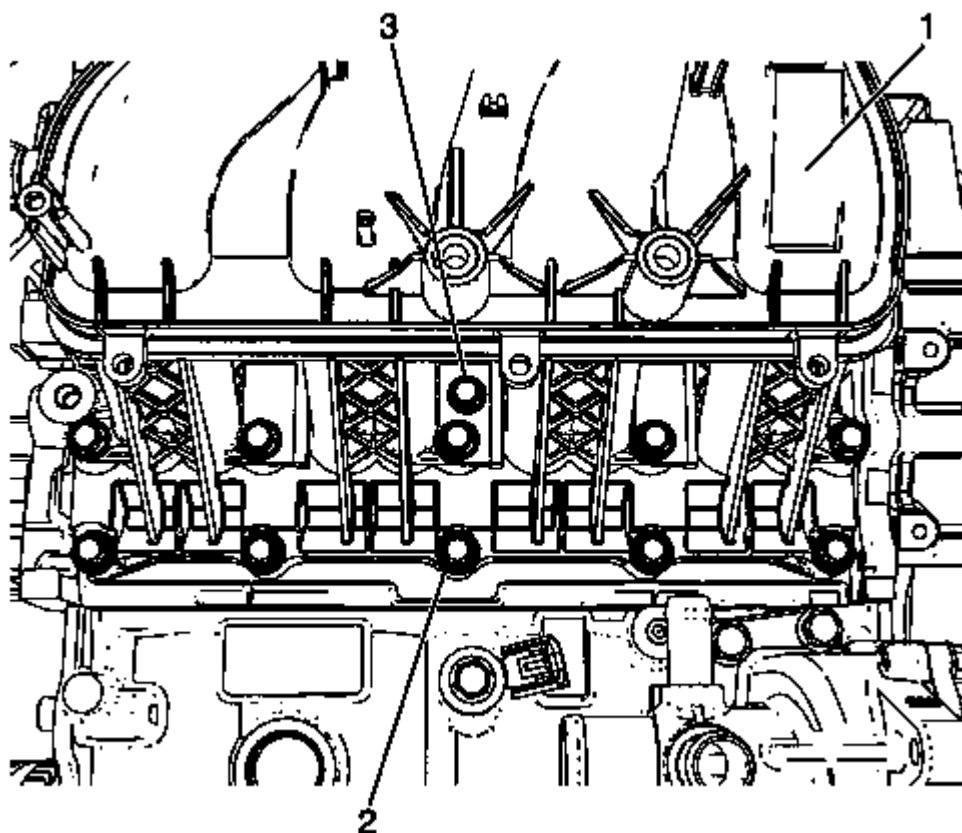


Fig. 41: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

26. Remove the intake manifold 11 bolts (2, 3).
27. Lower the vehicle.
28. Remove the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.
29. Remove the intake manifold (1).
30. Disconnect any electrical connectors as needed.
31. Transfer parts as necessary.

Installation Procedure

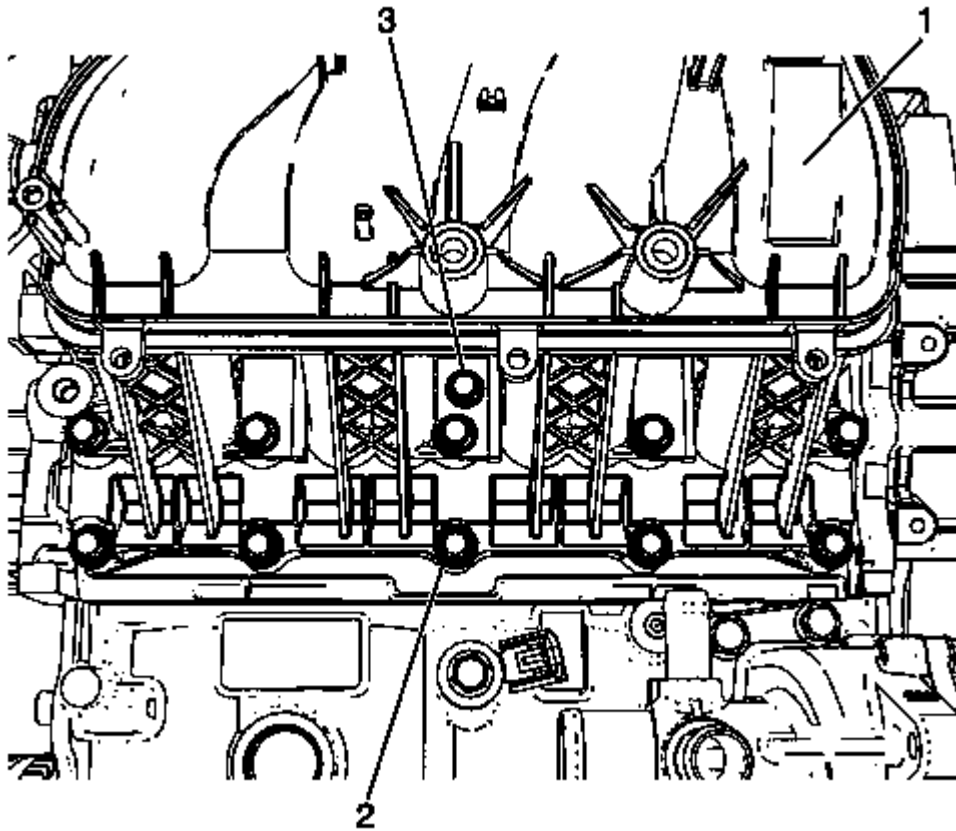


Fig. 42: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold (1).
2. Install the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.
3. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

CAUTION: Refer to Fastener Caution .

4. Install the intake manifold 11 bolts (2, 3) and tighten to 10 (89 lb in).

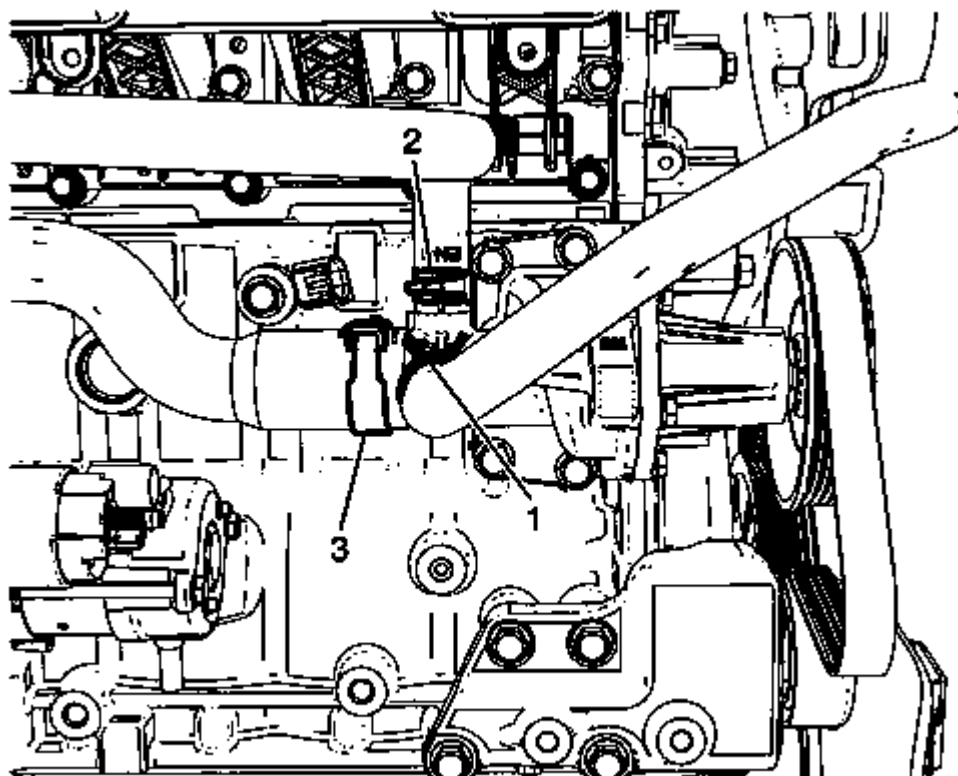


Fig. 43: Heater Outlet Hose And Clamp

Courtesy of GENERAL MOTORS COMPANY

5. Connect the heater outlet hose and clamp (2).

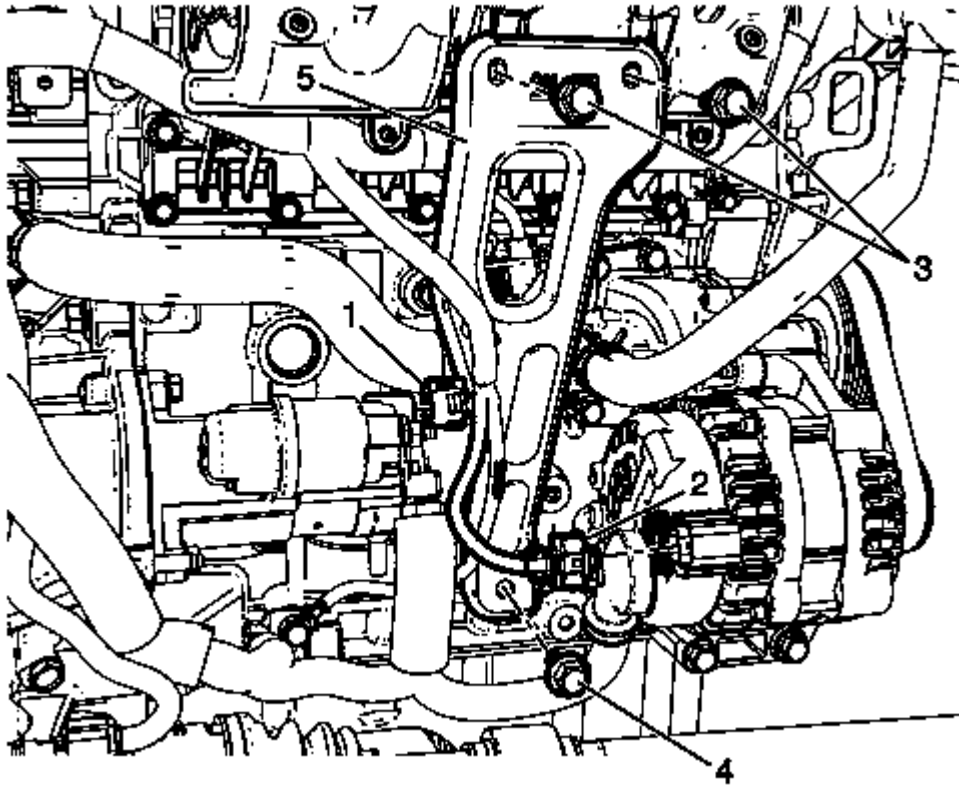


Fig. 44: Starter Connector Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

6. Install the intake manifold rear bracket (5).

CAUTION: Refer to Fastener Caution .

7. Install the 2 intake manifold rear bracket bolts (up) (3) and tighten to 22 (16 lb ft)
8. Install the intake manifold rear bracket bolt (down) (4) and tighten to 58 (42 lb ft)
9. Connect the starter connector wiring harness plug (1).
10. Connect the generator connector wiring harness plug (2).
11. Install the exhaust front pipe assembly. Refer to **Exhaust Front Pipe Replacement (LL0)** .
12. Lower the vehicle.

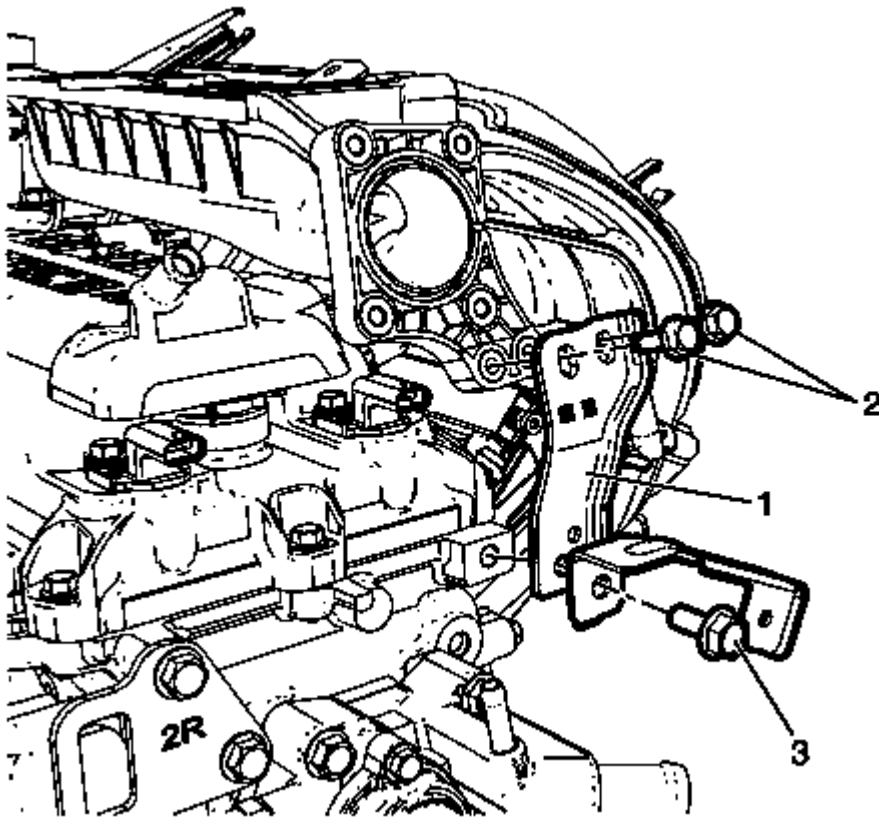


Fig. 45: Intake Manifold Side Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the intake manifold side bracket (1).
14. Install the intake manifold side bracket bolts (2) and tighten to 10 (89 lb in).
15. Install the intake manifold side bracket bolt (3) and tighten to 25 (18 lb ft).

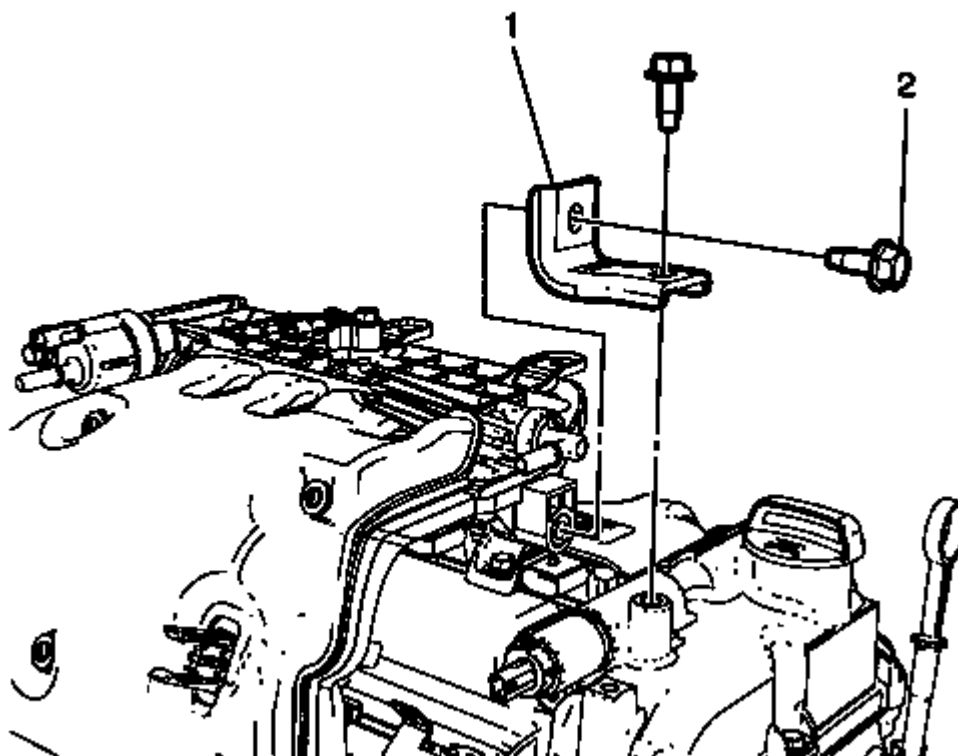


Fig. 46: Intake Manifold Upper Bracket Bolts
 Courtesy of GENERAL MOTORS COMPANY

16. Install the intake manifold upper bracket (1).
17. Install the intake manifold upper bracket bolts (2) and tighten to 25 (18 lb ft).
18. Connect the fuel feed line quick connect fitting to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
19. Connect the power brake booster vacuum hose to intake manifold. Refer to **Power Brake Booster Vacuum Hose Replacement**.

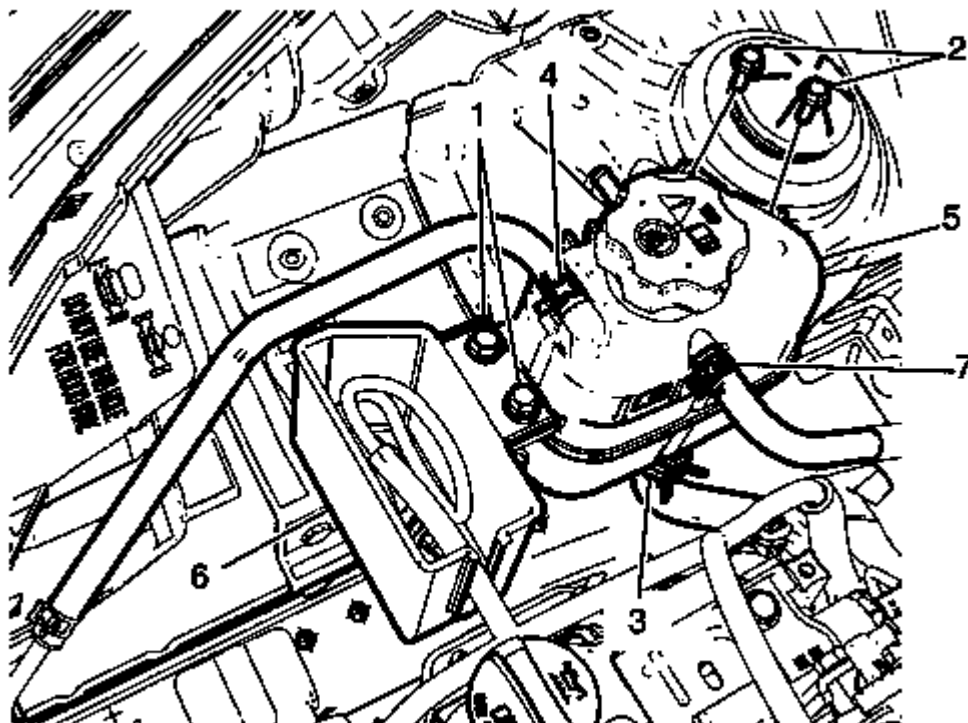


Fig. 47: Block Heater Connecting Plug Holder Bolt
 Courtesy of GENERAL MOTORS COMPANY

20. Install the radiator surge tank mounting bolts (2) and tighten to 8 (71 lb in)
21. If equipped with a block heater, install the block heater connecting plug holder bolts (1) and tighten to 10 (89 lb in)
22. Install the coolant hose and clamp (7) to the radiator surge tank and intake manifold.
23. Install the evaporative emission canister purge solenoid valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LL0)** , **Evaporative Emission Canister Purge Solenoid Valve Replacement (LFM)** .
24. Install the manifold absolute pressure sensor. Refer to **Manifold Absolute Pressure Sensor Replacement (LL0)** , **Manifold Absolute Pressure Sensor Replacement (LFM)** .
25. Install the positive crankcase ventilation hose. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
26. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement (LL0)** , **Throttle Body Assembly Replacement (LFM)** .
27. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
28. Fill the cooling system. Refer to **Cooling System Draining and Filling** .
29. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
30. Close the hood.

CYLINDER HEAD REPLACEMENT (LL0)**Removal Procedure**

1. Remove the engine from the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.
2. Remove the exhaust manifold. Refer to **Exhaust Manifold Removal**.
3. Remove the intake manifold. Refer to **Intake Manifold Removal (LL0)**, **Intake Manifold Removal (LFM)**.
4. Remove the engine coolant outlet adapter. Refer to **Engine Water Outlet Adapter Removal**.
5. Remove the ignition coil. Refer to **Ignition Coil Removal**.
6. Remove the spark plug.
7. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.
8. Remove the camshaft cover. Refer to **Camshaft Cover Removal**.
9. Remove the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Removal**.
10. Remove the generator. Refer to **Generator Replacement**.
11. Remove the generator bracket. Refer to **Generator Bracket Removal**.
12. Remove the water pump. Refer to **Water Pump Removal**.
13. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
14. Remove the oil pan. Refer to **Oil Pan Removal**.
15. Remove the engine front cover. Refer to **Engine Front Cover and Oil Pump Removal**.
16. Remove the timing chain tensioner. Refer to **Timing Chain Tensioner Removal**.
17. Remove the timing chain guide. Refer to **Timing Chain Guide Removal**.
18. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain Removal**.
19. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal**.
20. Remove the camshaft. Refer to **Camshaft Removal (LL0)**, **Camshaft Removal (LFM)**.
21. Remove the cylinder head. Refer to **Cylinder Head and Gasket Removal**.
22. For disassembly of the cylinder head, refer to **Cylinder Head Disassemble**.
23. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection**.

Installation Procedure

1. For assembly of the cylinder head, refer to **Cylinder Head Assemble**.
2. Install the cylinder head. Refer to **Cylinder Head and Gasket Installation**.
3. Install the camshaft. Refer to **Camshaft Installation (LL0)**, **Camshaft Installation (LFM)**.
4. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation**.
5. Install the camshaft timing chain. Refer to **Camshaft Timing Chain Installation**.
6. Install the timing chain guide. Refer to **Timing Chain Guide Installation**.
7. Install the timing chain tensioner. Refer to **Timing Chain Tensioner Installation**.

8. Install the engine front cover. Refer to **Engine Front Cover and Oil Pump Installation**.
9. Install the oil pan. Refer to **Oil Pan Installation**.
10. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation**.
11. Install the water pump. Refer to **Water Pump Installation**.
12. Install the generator bracket. Refer to **Generator Bracket Installation**.
13. Install the generator. Refer to **Generator Replacement**.
14. Install the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Installation**.
15. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
16. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Installation**.

CAUTION: Refer to **Fastener Caution**.

17. Install the spark plug and tighten to 20 (15 lb ft).
18. Install the ignition coil. Refer to **Ignition Coil Installation**.
19. Install the engine coolant outlet adapter. Refer to **Engine Water Outlet Adapter Removal**.
20. Install the intake manifold. Refer to **Intake Manifold Installation (LL0)**, **Intake Manifold Installation (LFM)**.
21. Install the exhaust manifold. Refer to **Exhaust Manifold Installation**.
22. Install the engine to the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.

CYLINDER HEAD REPLACEMENT (LFM)

Removal Procedure

1. Remove the engine from the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.
2. Remove the exhaust manifold. Refer to **Exhaust Manifold Removal**.
3. Remove the intake manifold. Refer to **Intake Manifold Removal (LL0)**, **Intake Manifold Removal (LFM)**.
4. Remove the engine coolant outlet adapter. Refer to **Engine Water Outlet Adapter Removal**.
5. Remove the ignition coil. Refer to **Ignition Coil Removal**.
6. Remove the spark plug.
7. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.
8. Remove the camshaft cover. Refer to **Camshaft Cover Removal**.
9. Remove the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Removal**.
10. Remove the generator. Refer to **Generator Replacement**.
11. Remove the generator bracket. Refer to **Generator Bracket Removal**.

12. Remove the water pump. Refer to **Water Pump Removal**.
13. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
14. Remove the oil pan. Refer to **Oil Pan Removal**.
15. Remove the engine front cover. Refer to **Engine Front Cover and Oil Pump Removal**.
16. Remove the timing chain tensioner. Refer to **Timing Chain Tensioner Removal**.
17. Remove the timing chain guide. Refer to **Timing Chain Guide Removal**.
18. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain Removal**.
19. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal**.
20. Remove the camshaft. Refer to **Camshaft Removal (LL0)**, **Camshaft Removal (LFM)**.
21. Remove the cylinder head. Refer to **Cylinder Head and Gasket Removal**.
22. For disassembly of the cylinder head, refer to **Cylinder Head Disassemble**.
23. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection**.

Installation Procedure

1. For assembly of the cylinder head, refer to **Cylinder Head Assemble**.
2. Install the cylinder head. Refer to **Cylinder Head and Gasket Installation**.
3. Install the camshaft. Refer to **Camshaft Installation (LL0)**, **Camshaft Installation (LFM)**.
4. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation**.
5. Install the camshaft timing chain. Refer to **Camshaft Timing Chain Installation**.
6. Install the timing chain guide. Refer to **Timing Chain Guide Installation**.
7. Install the timing chain tensioner. Refer to **Timing Chain Tensioner Installation**.
8. Install the engine front cover. Refer to **Engine Front Cover and Oil Pump Installation**.
9. Install the oil pan. Refer to **Oil Pan Installation**.
10. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation**.
11. Install the water pump. Refer to **Water Pump Installation**.
12. Install the generator bracket. Refer to **Generator Bracket Installation**.
13. Install the generator. Refer to **Generator Replacement**.
14. Install the oil level indicator and tube. Refer to **Oil Level Indicator and Tube Installation**.
15. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
16. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Installation**.

CAUTION: Refer to Fastener Caution .

17. Install the spark plug and tighten to 20 (15 lb ft).
18. Install the ignition coil. Refer to **Ignition Coil Installation**.
19. Install the engine coolant outlet adapter. Refer to **Engine Water Outlet Adapter Installation**.

20. Install the intake manifold. Refer to **Intake Manifold Installation (LL0)**, **Intake Manifold Installation (LFM)**.
21. Install the exhaust manifold. Refer to **Exhaust Manifold Installation**.
22. Install the engine to the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.

OIL PAN REPLACEMENT

Removal Procedure

1. Open the hood.
2. Raise the vehicle by its full height. Refer to **Lifting and Jacking the Vehicle** .
3. Place collecting basin underneath.
4. Remove the oil drain bolt.
5. Collect the engine oil.
6. Install the oil drain bolt.
7. Lower the vehicle by its full height.
8. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.
9. Raise the vehicle by its full height.
10. Remove the front compartment splash shield. Refer to **Front Compartment Splash Shield Replacement** .
11. If equipped with an exhaust front pipe assembly, refer to **Exhaust Front Pipe Replacement (LL0)** .
12. If equipped with an exhaust pipe assembly, refer to **Exhaust Pipe Replacement (LFM)** .

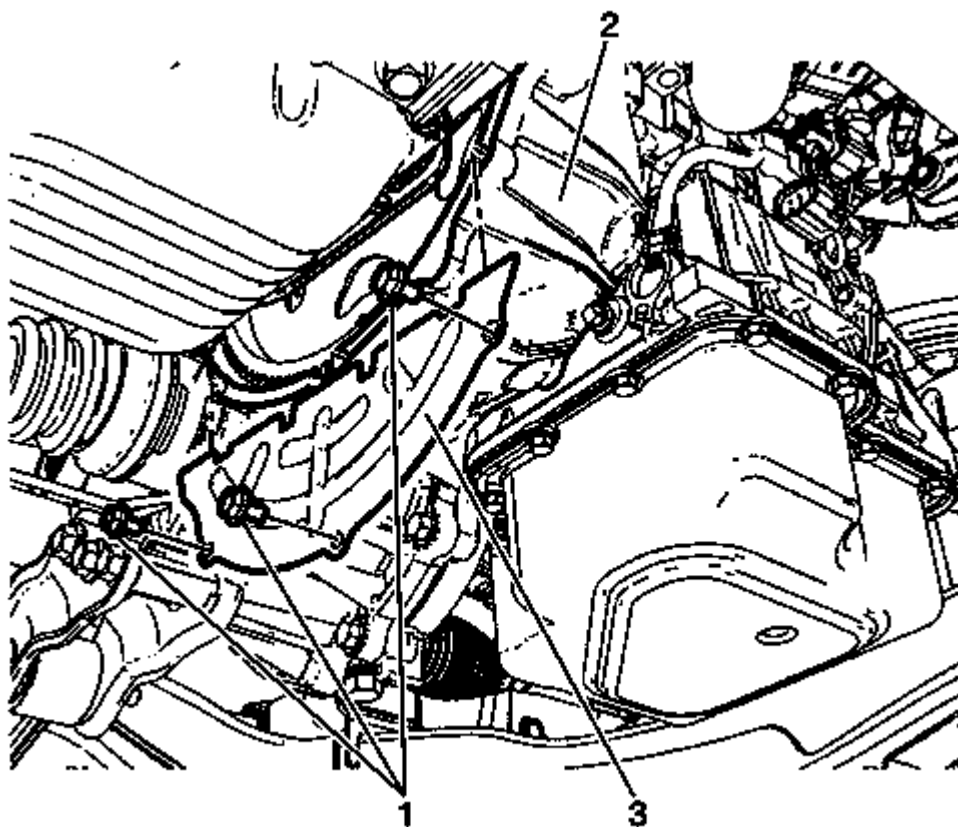


Fig. 48: Housing Lower Plate Bolts

Courtesy of GENERAL MOTORS COMPANY

13. Remove the 3 housing lower plate bolts (1) from the transmission (2).
14. Remove the transmission housing lower plate (3).

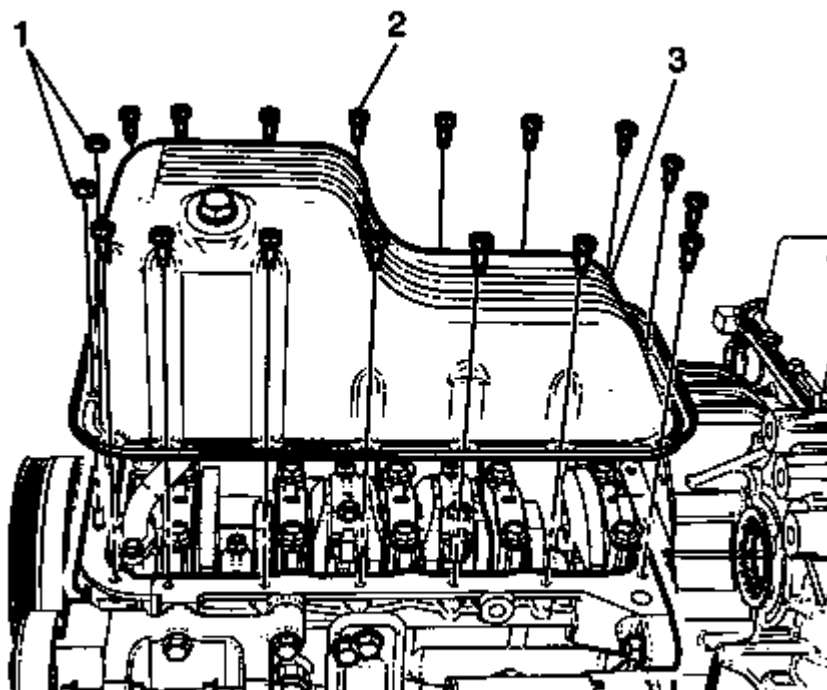


Fig. 49: Oil Pan Bolts And Nuts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Remove the oil pan evenly all the way around with a suitable tool. Do not damage sealing surfaces on block.

15. Remove the 16 oil pan bolts (2), 2 nuts (1) and remove the oil pan (3) and discard oil pan.

Installation Procedure

NOTE: Cleaning of the sealing surfaces (1-4): Refer to Replacing Engine Gaskets.

1. Remove any old thread sealant, gasket material or sealant.
2. Clean the sealing surfaces of front cover and front cover components with solvent.

NOTE: Ensure that the sealing surface is clear of oil, grease and oil sealant material.

3. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

4. Dry the front cover and front cover components with compressed air.

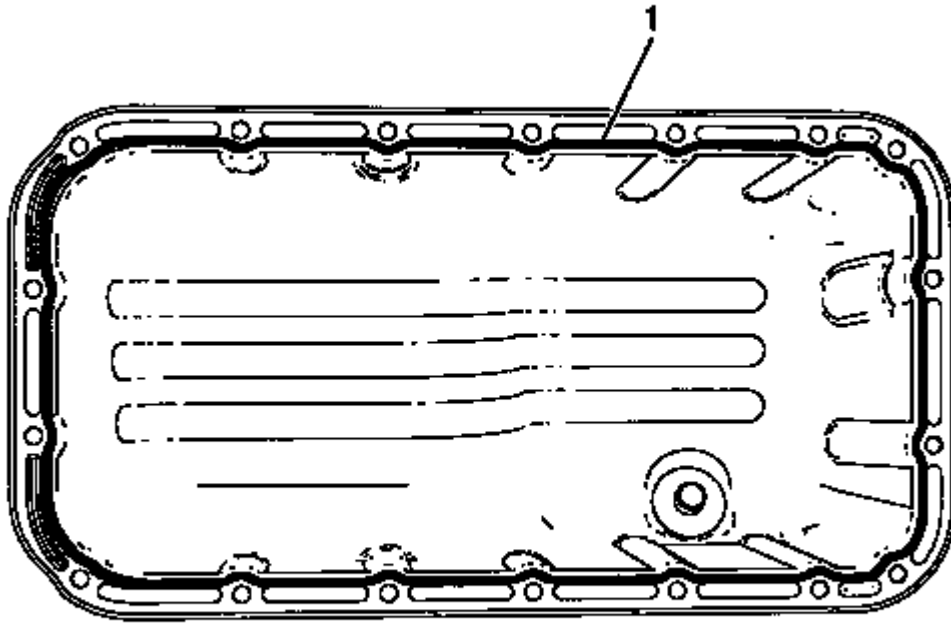


Fig. 50: Oil Pan Sealant

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new oil pan.

NOTE: Do not coat sealant (RTV) on the front cover bolt holes and bolt threads

5. Apply approximately a 4.5 mm (0.177 in) thick bead of oil pan sealant (1) to the oil pan.

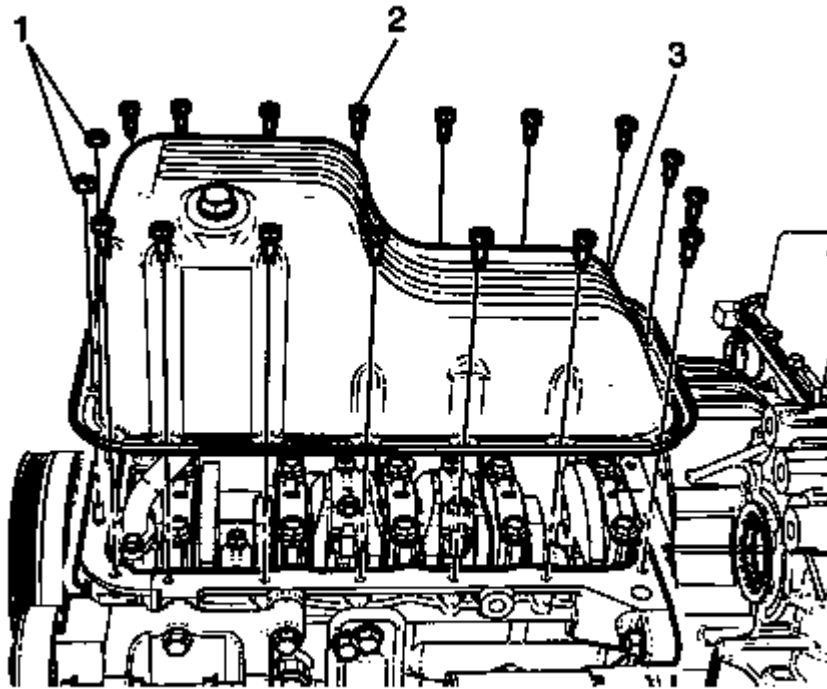


Fig. 51: Oil Pan Bolts And Nuts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: After sealant (RTV) dispensing, the assembly completion time including torque check must be done within 8 minutes.

6. Install the 16 oil pan bolts (2), 2 nuts (1) to the oil pan (3) and tighten to 10 (89 lb in).
7. Install the oil drain bolt, tighten to 25 (18 lb ft).

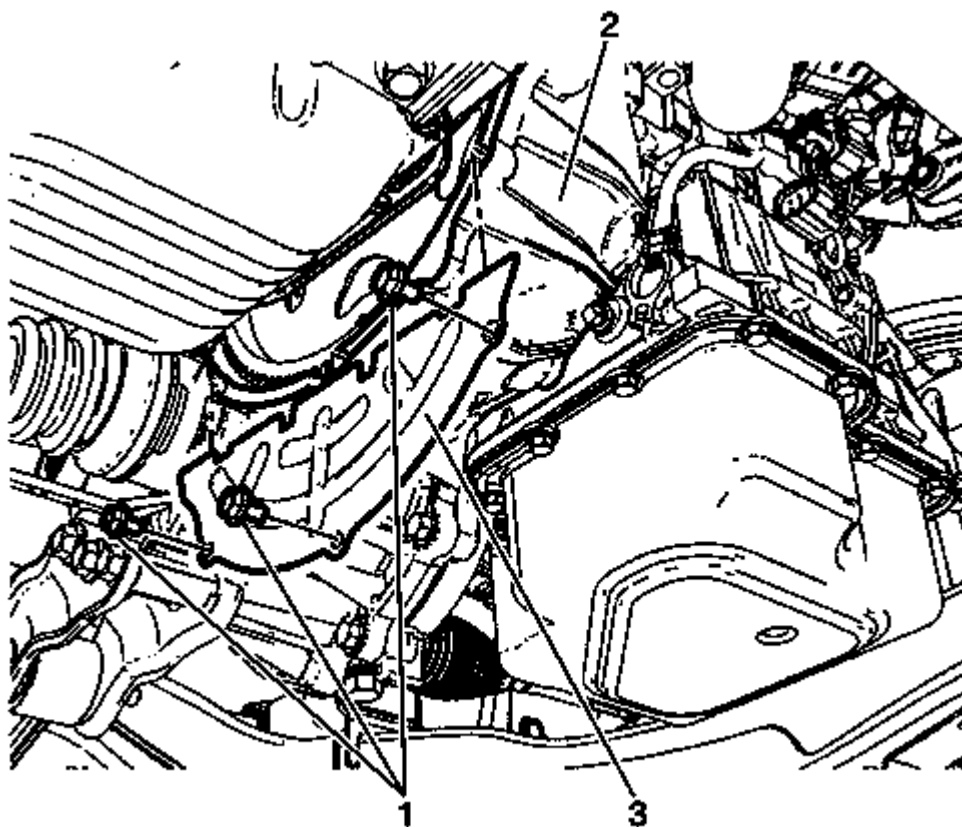


Fig. 52: Housing Lower Plate Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the transmission housing lower plate (3).
9. Install the 3 housing lower plate bolts (1) to the transmission (2) and tighten to 9 (80 lb in).
10. If equipped with an exhaust front pipe assembly, refer to **Exhaust Front Pipe Replacement (LL0)** .
11. If equipped with an exhaust pipe assembly, refer to **Exhaust Pipe Replacement (LFM)** .
12. Install the front compartment splash shield. Refer to **Front Compartment Splash Shield Replacement** .
13. Lower the vehicle.
14. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

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

15. Refill the collected engine oil.
16. Close the hood.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

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

2. Remove the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Removal**.

Installation Procedure

1. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Installation**.
2. Install the automatic transmission. Refer to **Transmission Replacement** .

ENGINE FLYWHEEL REPLACEMENT**Removal Procedure**

1. Remove the manual transmission. Refer to **Transmission Replacement (MX2, MFM)** .
2. Remove the clutch pressure and driven plate. Refer to **Clutch Pressure and Driven Plate Replacement** .
3. Remove the engine flywheel. Refer to **Engine Flywheel Removal**.

Installation Procedure

1. Install the engine flywheel. Refer to **Engine Flywheel Installation**.
2. Install the clutch pressure and driven plate. Refer to **Clutch Pressure and Driven Plate Replacement** .
3. Install the manual transmission. Refer to **Transmission Replacement (MX2, MFM)** .

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT**Removal Procedure**

1. Remove the right front compartment splash. Refer to **Front Compartment Splash Shield Replacement**

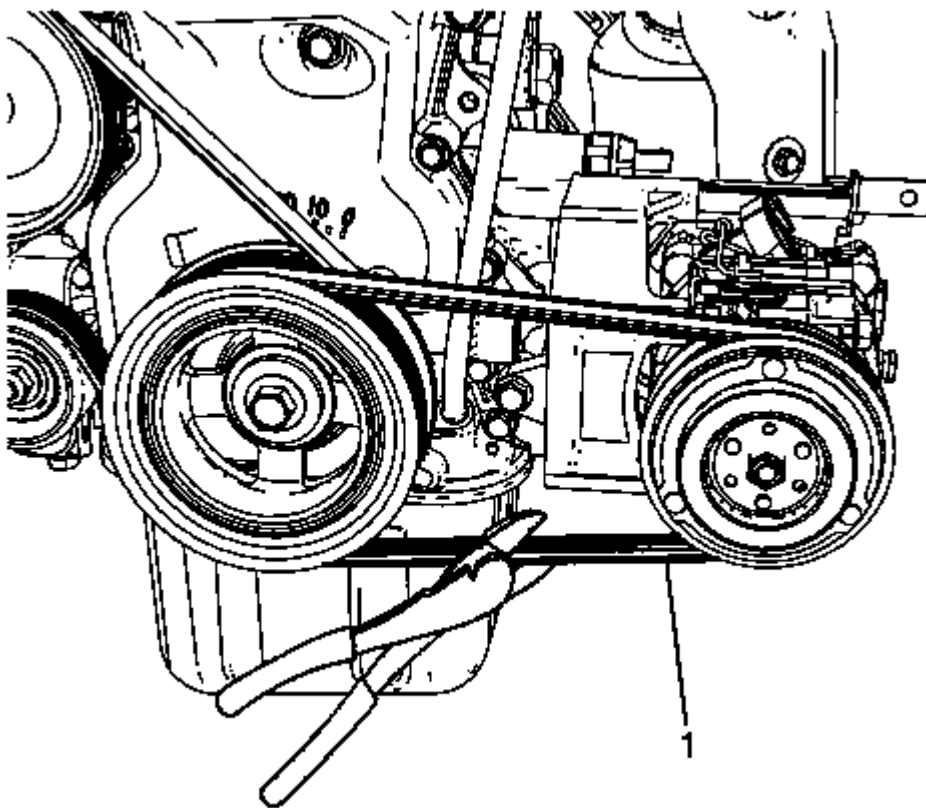


Fig. 53: Air Conditioning (A/C) Belt
Courtesy of GENERAL MOTORS COMPANY

2. Cut the air conditioning (A/C) belt (1) with a appropriate cutting tool as shown.
3. Remove and discard the air conditioning (A/C) belt (1).

Installation Procedure

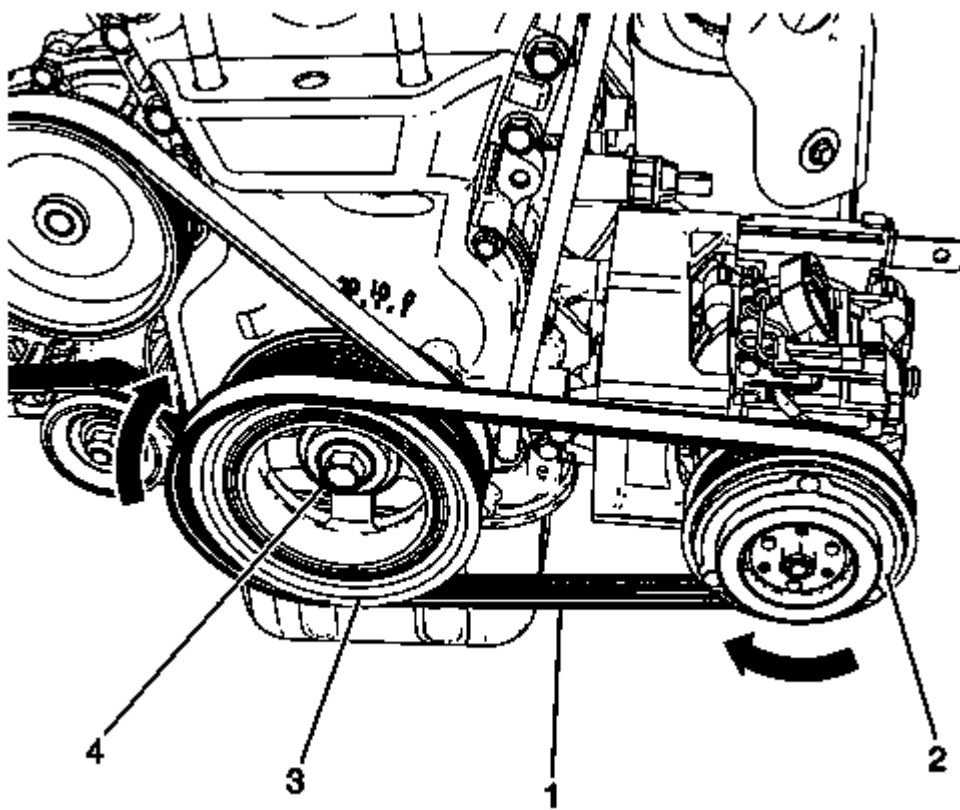


Fig. 54: New Air Conditioning (A/C) Belt
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW air conditioning (A/C) belt (1) on the crankshaft pulley (3) and air conditioning (A/C) compressor (2) as shown.

NOTE: Push the on belt while rotating the crankshaft pulley.

2. Using a socket and ratchet on the crankshaft pulley bolt (4), rotate the crankshaft in the direction of the arrow until the belt (1) is fully installed on the air conditioning (A/C) compressor (2).
3. After the belt is on the air conditioning (A/C) compressor pulley (2), rotate the crankshaft (3) an additional complete revolution and ensure the air conditioning (A/C) belt (1) is fully seated on the crankshaft (3) and air conditioning (A/C) compressor (2).
4. Install the front wheelhouse liner inner front extension. Refer to **Front Compartment Splash Shield Replacement**.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- EN 50175 Crankshaft Locking Device
- EN-51218 Crankshaft Balancer Installer

- **J-22888-20A** Crankshaft Balancer Puller

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

Removal Procedure

1. Open the hood.
2. Raise the vehicle by its full height. Refer to **Lifting and Jacking the Vehicle**.

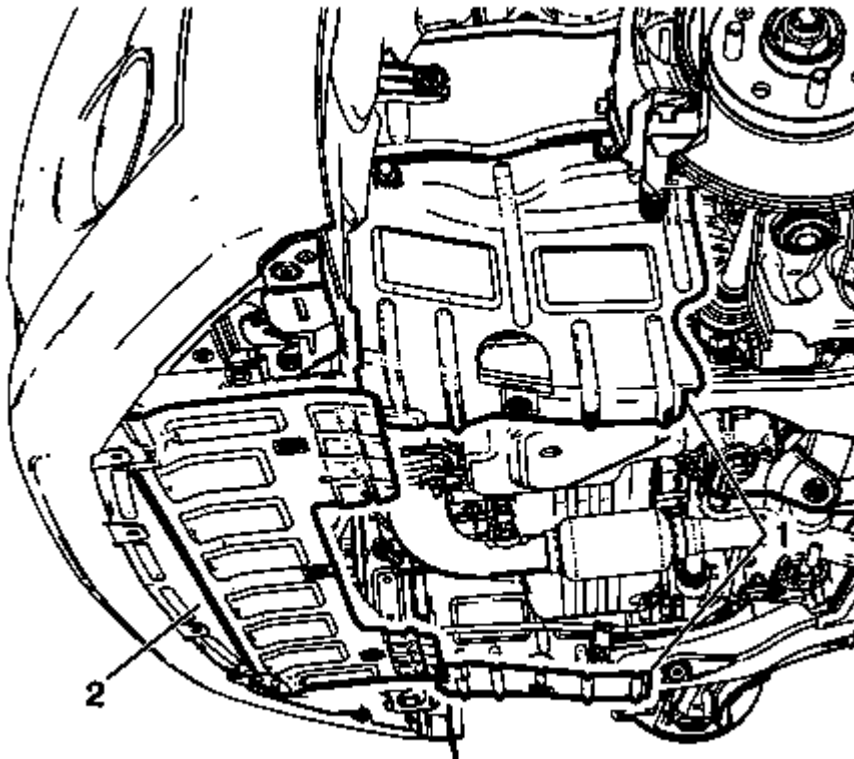


Fig. 55: Compartment Splash Shield
Courtesy of GENERAL MOTORS COMPANY

3. Remove the compartment splash shield (1) right side only. Refer to **Front Compartment Splash Shield Replacement**.
4. Remove the water pump and generator belt. Refer to **Water Pump and Generator Belt Replacement**.

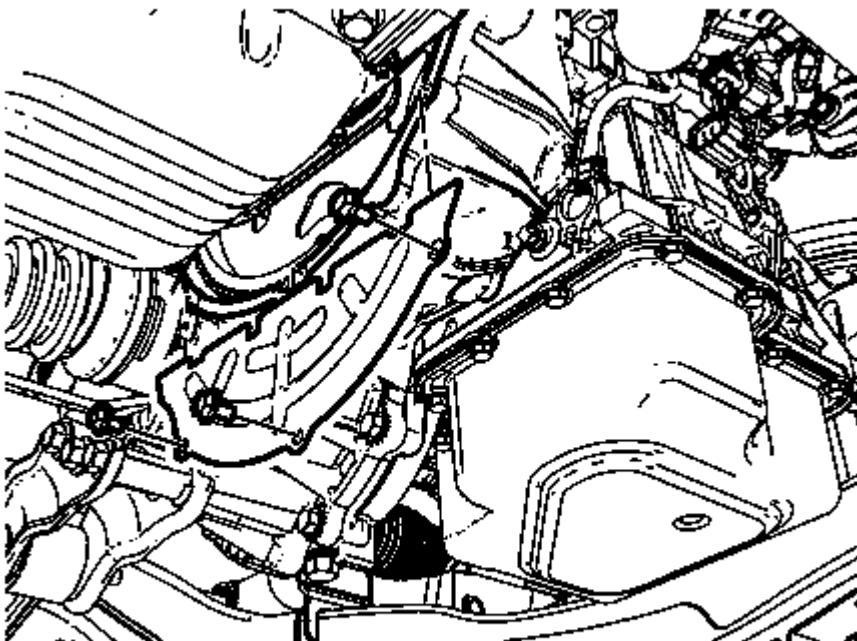


Fig. 56: Housing Lower Plate Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Remove the 3 housing lower plate bolts from the transmission.
6. Remove the transmission housing lower plate.

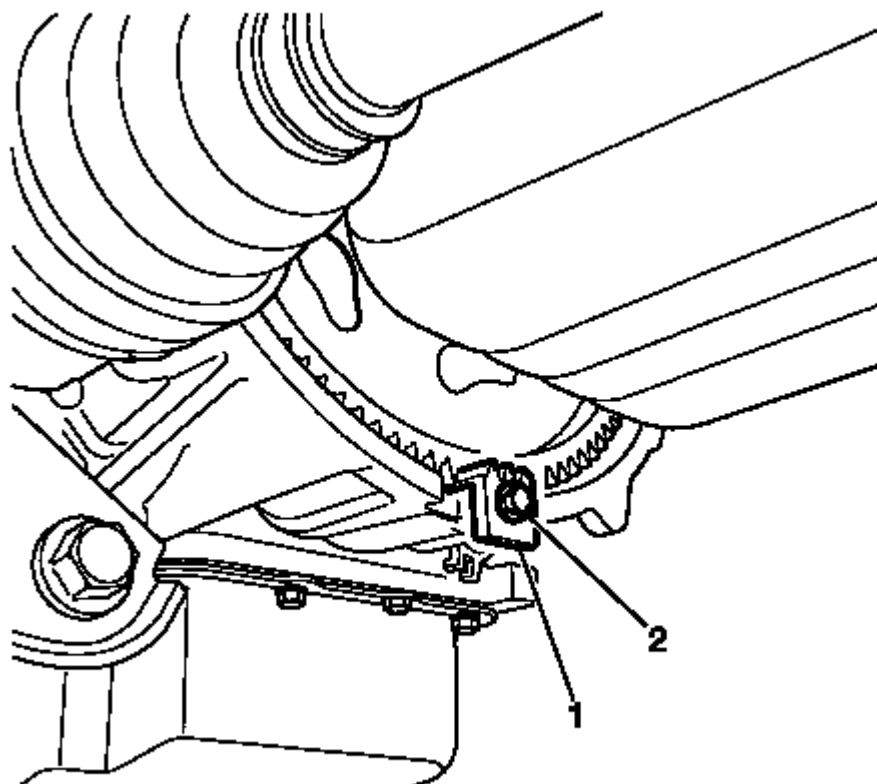


Fig. 57: EN-50175 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-50175** crankshaft locking device (1) to lock the crankshaft.
8. Install the bolt (2).

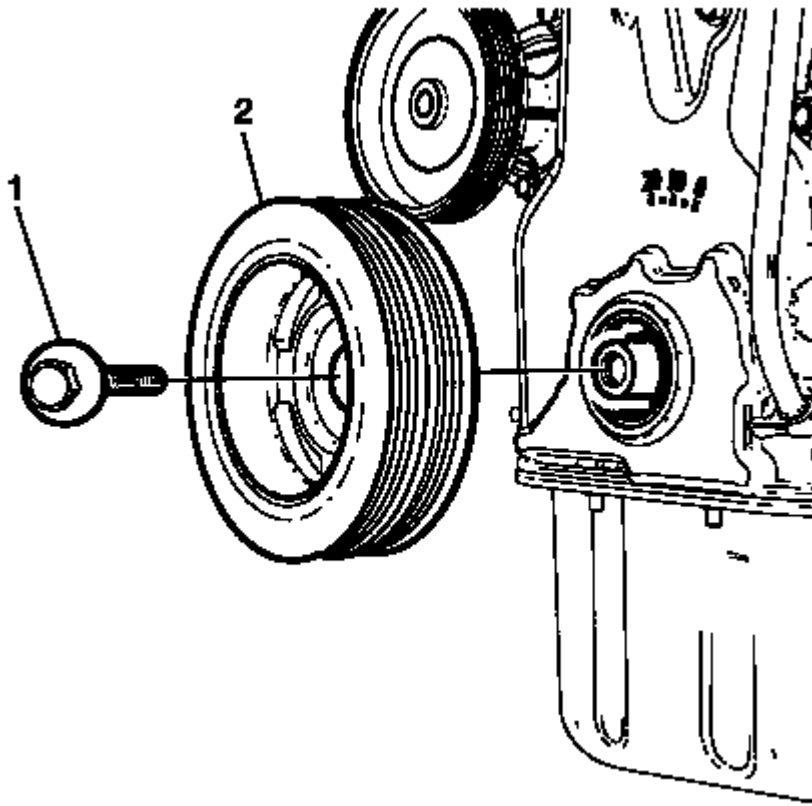


Fig. 58: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft balancer bolt (1).
10. Install **J-22888-20A** crankshaft balancer puller to the crankshaft balancer (2).
11. Remove the crankshaft balancer (2).

Installation Procedure

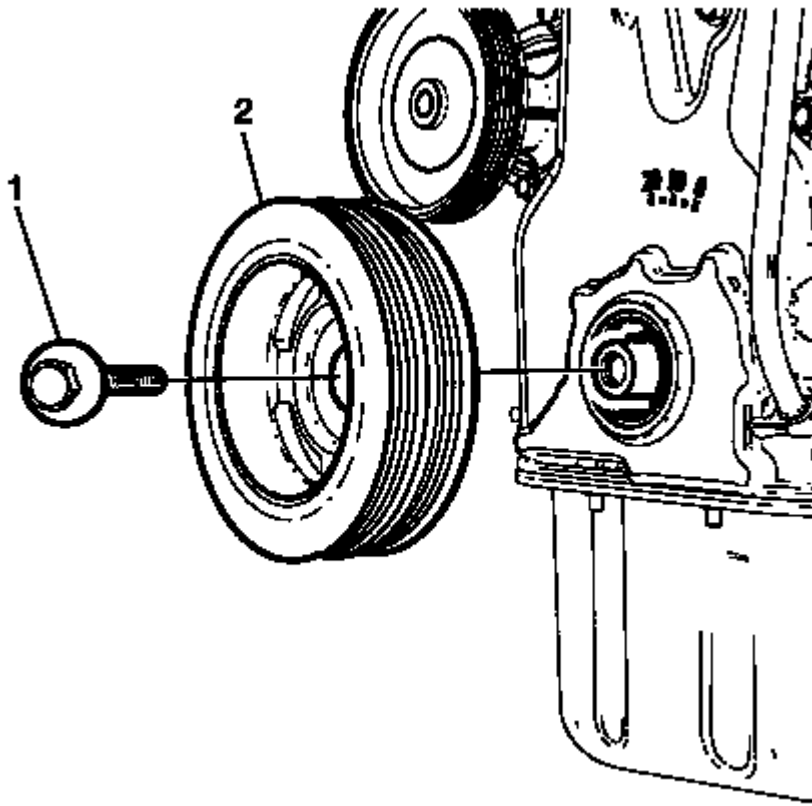


Fig. 59: Crankshaft Balancer Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-51218** crankshaft balancer installer or equivalent to the crankshaft balancer (2).
2. Install the crankshaft balancer (2).

CAUTION: Refer to Fastener Caution .

3. Install the NEW crankshaft balancer bolt (1) and tighten to $95 + 55^\circ$ (70 lb ft + 55°).

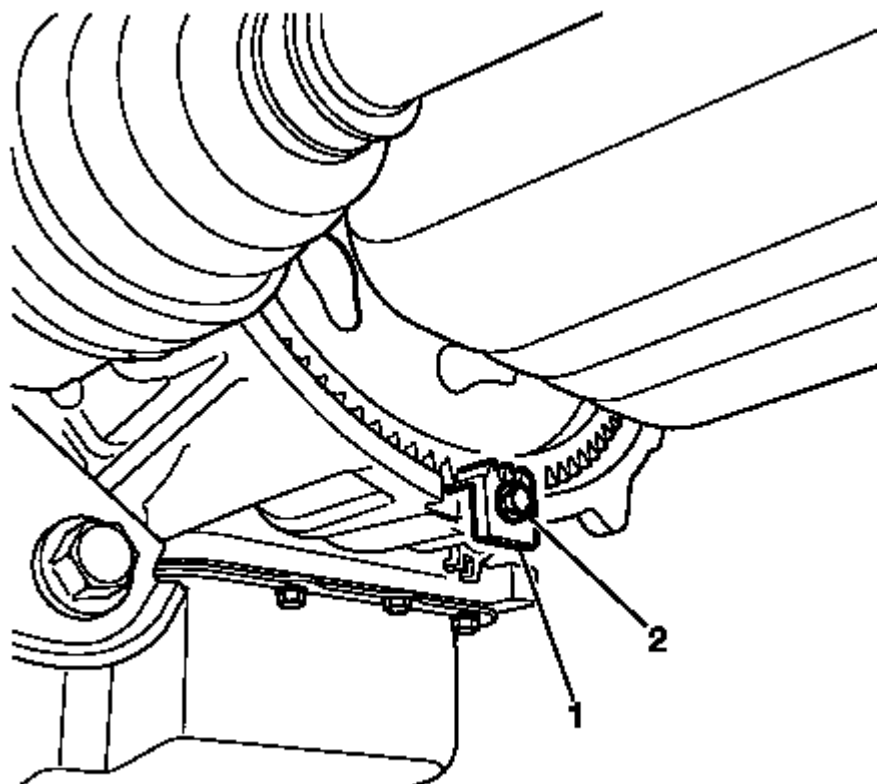


Fig. 60: EN-50175 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

4. Remove the bolt (1).
5. Remove the **EN 50175** crankshaft locking device (1).

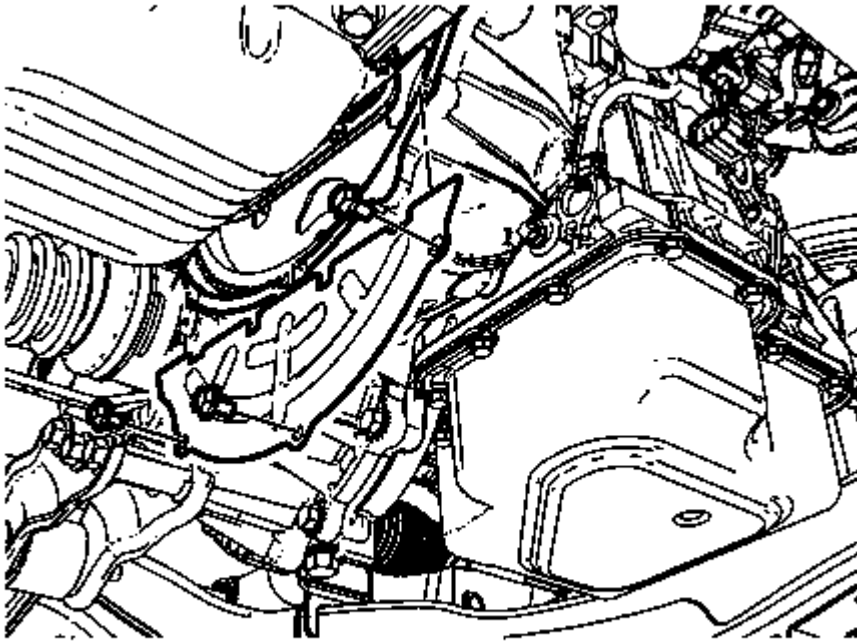


Fig. 61: Housing Lower Plate Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the transmission housing lower plate.
7. Install the 3 housing lower plate bolts to the transmission and tighten to 9 (80 lb in).
8. Install the water pump and generator belt. Refer to **Water Pump and Generator Belt Replacement**.

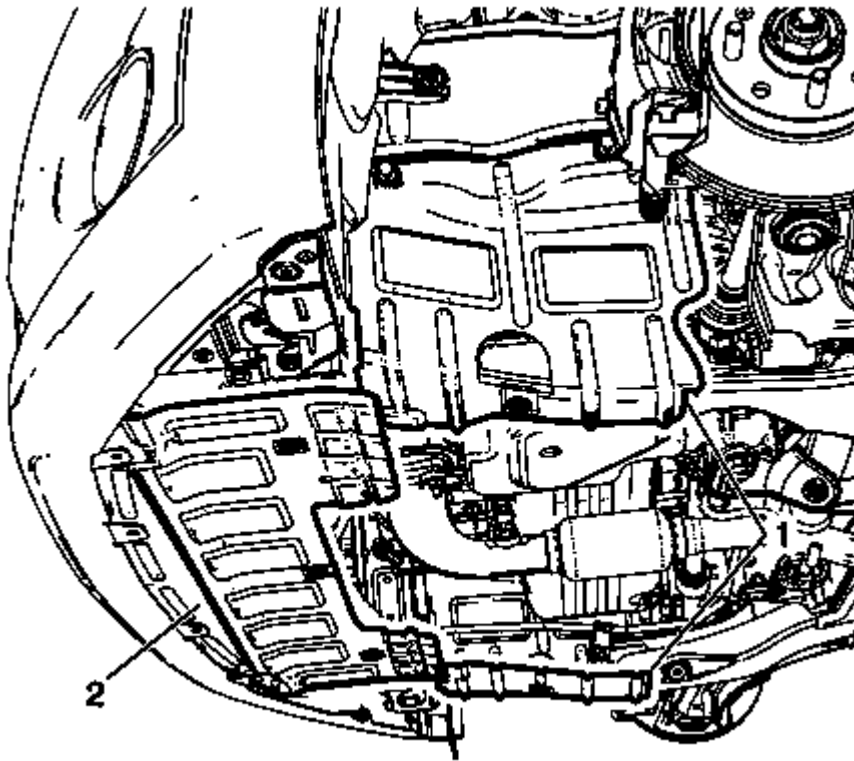


Fig. 62: Compartment Splash Shield

Courtesy of GENERAL MOTORS COMPANY

9. Install the compartment splash shield (1) right side only. Refer to **Front Compartment Splash Shield Replacement** .
10. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle** .
11. Close the hood.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tool

J-50172 Crankshaft Front Oil Seal Installer

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

Removal Procedure

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

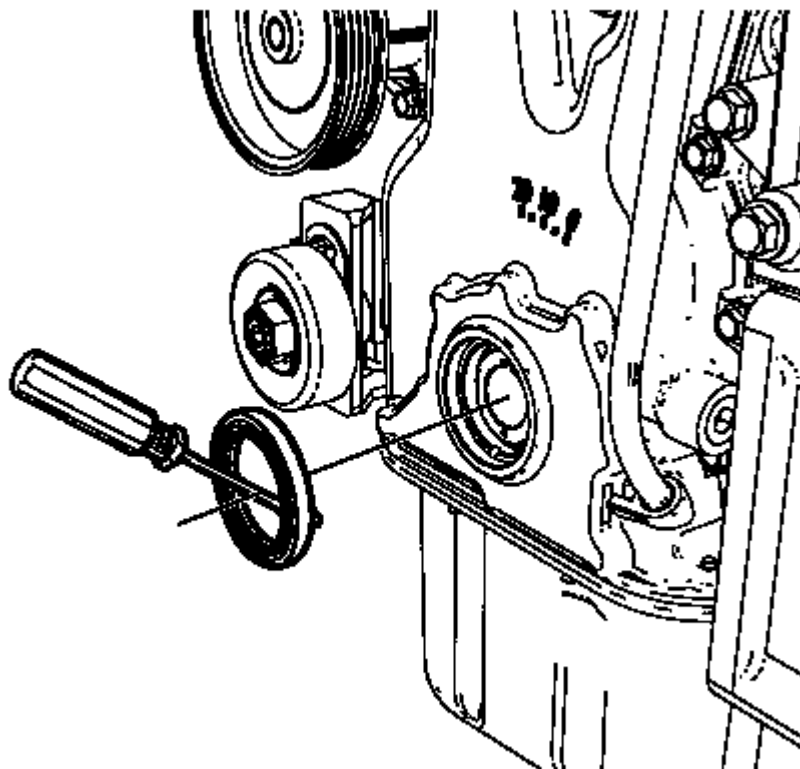


Fig. 63: Using Flat-Bladed Tool To Remove Seal From Front Cover
Courtesy of GENERAL MOTORS COMPANY

2. Use a flat-bladed tool to remove the seal from the front cover.

Installation Procedure

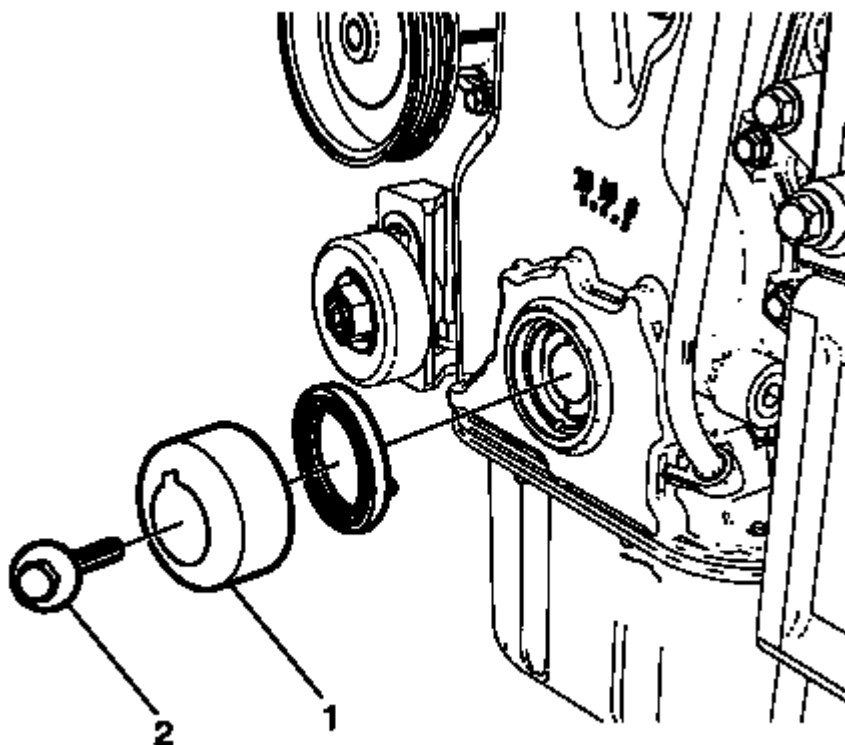


Fig. 64: Crankshaft Bolt And Crankshaft Front Oil Seal Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use the J-50172 crankshaft front oil seal installer in order to install the crankshaft front oil seal to the engine front cover.

1. Install the new crankshaft front oil seal to crankshaft with **J-50172** crankshaft front oil seal installer (1).
2. Tighten the crankshaft bolt (2) till the **J-50172** crankshaft front oil seal installer seats on the engine front cover.
3. Remove the crankshaft bolt (2).
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LL0)

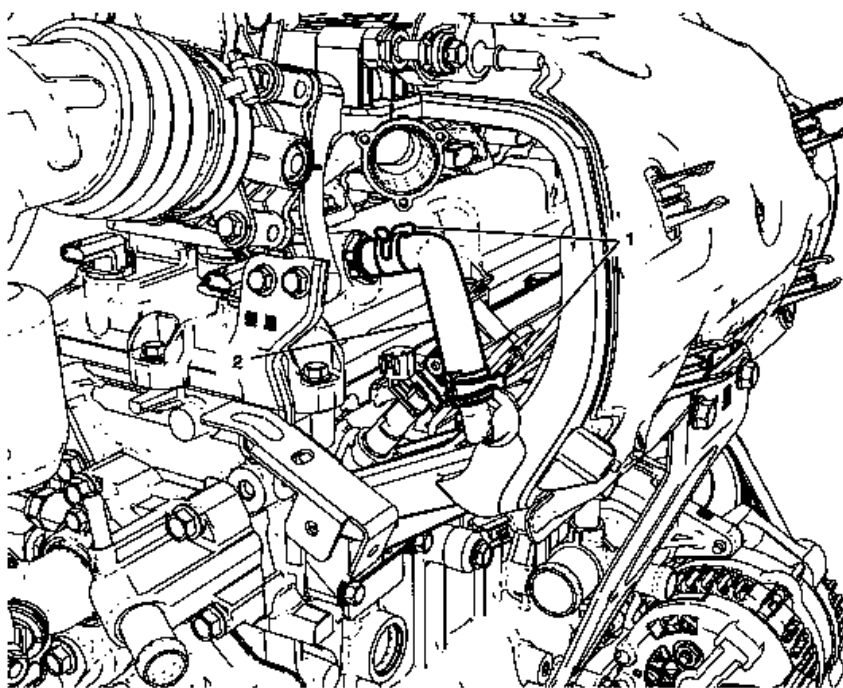


Fig. 65: Positive Crankcase Ventilation Hose/Pipe/Tube

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)

Callout	Component Name
1	Positive Crankcase Ventilation Hose Clamp (Qty: 2) Procedure Remove the positive crankcase ventilation hose clamp.
2	Positive Crankcase Ventilation Hose

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (LFM)

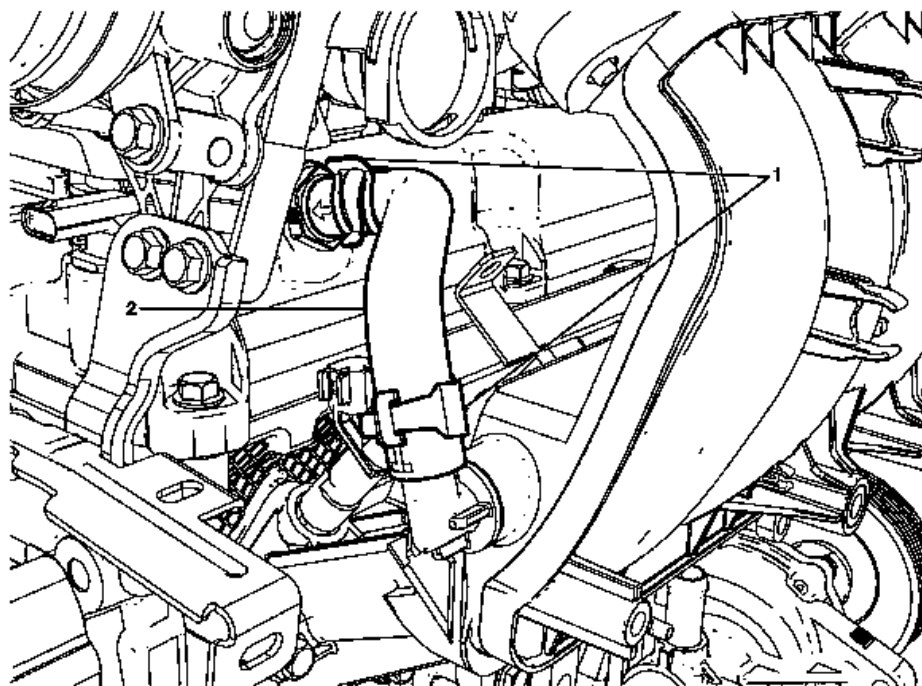


Fig. 66: Positive Crankcase Ventilation Hose/Pipe/Tube (LFM)

Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)

Callout	Component Name
1	Positive Crankcase Ventilation Hose Clamp (Qty: 2) Procedure Remove the positive crankcase ventilation hose clamp.
2	Positive Crankcase Ventilation Hose

ENGINE FRONT COVER WITH OIL PUMP REPLACEMENT

Removal Procedure

1. Remove the engine from the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.
2. Remove the intake manifold. Refer to **Intake Manifold Removal (LL0)**, **Intake Manifold Removal (LFM)**.
3. Remove the ignition coil. Refer to **Ignition Coil Removal**.
4. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.
5. Remove the camshaft cover. Refer to **Camshaft Cover Removal**.
6. Remove the engine oil level indicator and tube. Refer to **Oil Level Indicator and Tube Removal**.
7. Remove the engine lift rear bracket. Refer to **Engine Lift Rear Bracket Removal**.
8. Remove the generator. Refer to **Generator Replacement**.

9. Remove the generator bracket. Refer to **Generator Bracket Removal**.
10. Remove the water pump. Refer to **Water Pump Removal**.
11. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal**.
12. Remove the oil pan and discard. Refer to **Oil Pan Removal**.

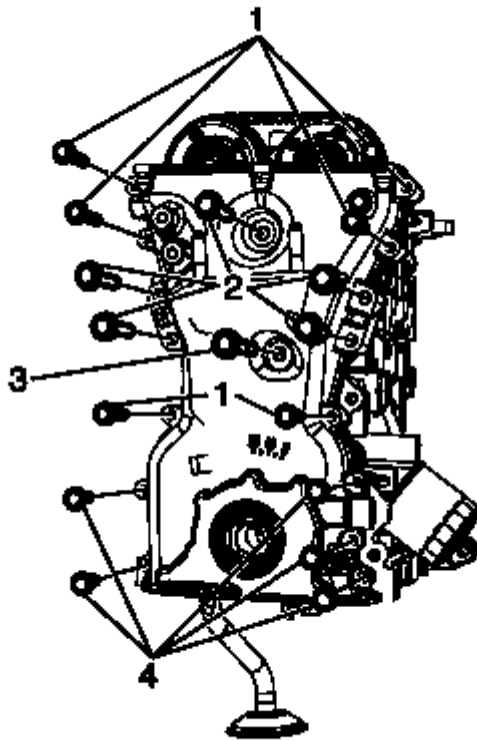


Fig. 67: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the engine front cover bolts (1, 2, 3, 4).

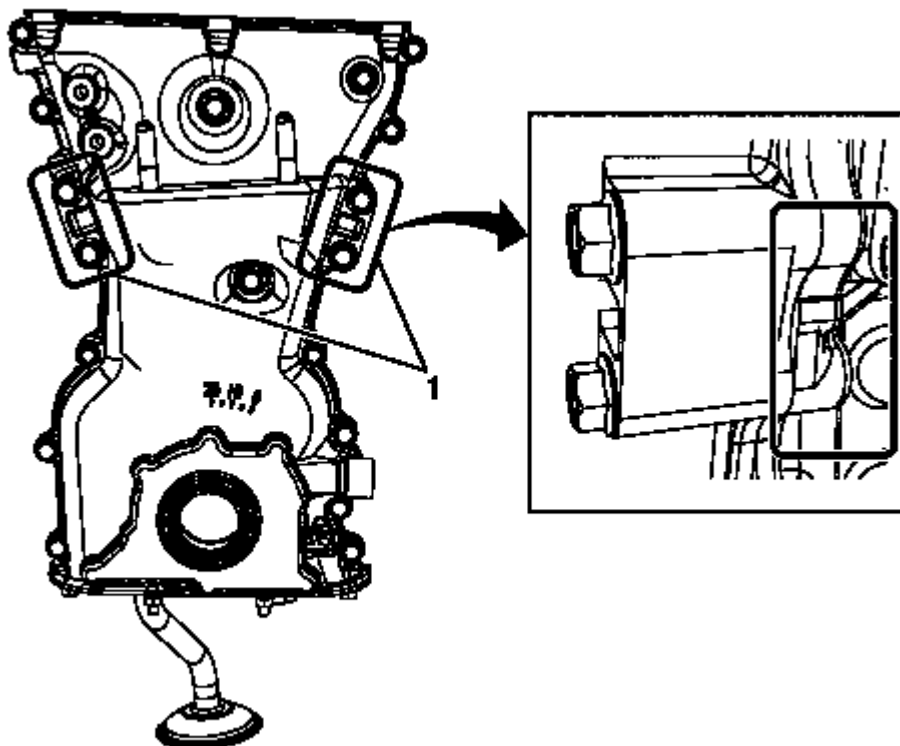


Fig. 68: View Of Pry Points

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use the pry points and a bolt in the jackscrew hole in order to remove the engine front cover.

14. Using the pry points (1) located at the edge of the front cover, shear the room temperature vulcanizing (RTV) sealant.
15. Remove the engine front cover evenly all the way around with a suitable tool.
16. Disassemble the engine front cover and inspect the oil pump. Refer to **Oil Pump Disassemble**.

Installation Procedure

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

NOTE: Cleaning of the sealing surfaces (1-4): Refer to **Replacing Engine Gaskets**.

1. Remove any old thread sealant, gasket material or sealant using remover such as chisel or scraper.
2. Clean the sealing surfaces of front cover and front cover components with solvent.

NOTE: Ensure that the sealing surface is clear of oil, grease and oil sealant material.

3. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

4. Dry the front cover and front cover components with compressed air.
5. Assemble the engine front cover with the oil pump. Refer to Oil Pump Assemble.

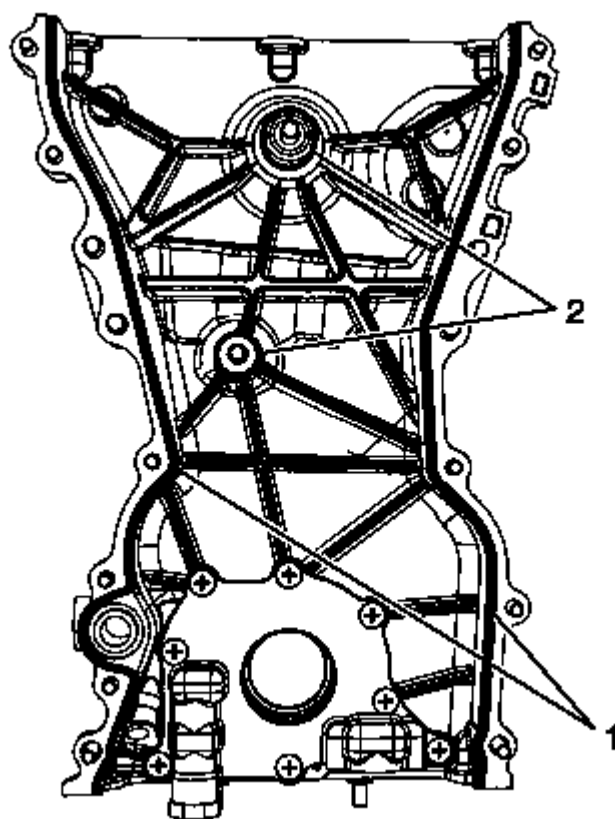


Fig. 69: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply sealant (RTV) on lines (1) and 2 hole faces (2). Apply sealant (RTV) to the edges of top and bottom step chamfers.

6. Apply approximately a 4.5 mm (0.177 in) thick bead of front cover sealant.

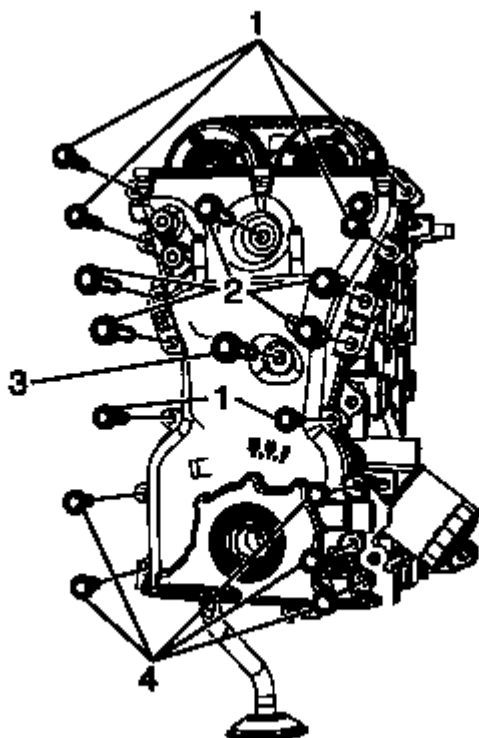


Fig. 70: Engine Front Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

7. Install the engine front cover.

NOTE: Check the different screw lengths.

8. Install the engine front cover bolts (1, 2, 3, 4).

CAUTION: Refer to Fastener Caution .

9. Tighten the engine front cover bolts (1, 4) to 10 (89 lb in).

NOTE: After sealant (RTV) dispensing, the assembly completion time including torque check must be done within 8 minutes.

10. Tighten the engine front cover bolts (2, 3) to 22 (16 lb ft).
11. Install a new oil pan. Refer to Oil Pan Installation.
12. Install the crankshaft balancer. Refer to Crankshaft Balancer Installation.
13. Install the water pump. Refer to Water Pump Installation.

14. Install the generator bracket. Refer to **Generator Bracket Installation**.
15. Install the generator. Refer to **Generator Replacement**.
16. Install the engine lift rear bracket. Refer to **Engine Lift Rear Bracket Installation**.
17. Install the engine oil level indicator and tube. Refer to **Oil Level Indicator and Tube Installation**.
18. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
19. Install the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Installation**.
20. Install the ignition coil. Refer to **Ignition Coil Installation**.
21. Install the intake manifold. Refer to **Intake Manifold Installation (LL0)**, **Intake Manifold Installation (LFM)**.
22. Install the engine to the vehicle. Refer to **Engine Replacement (LFM)**, **Engine Replacement (LL0)**.

CAMSHAFT TIMING CHAIN REPLACEMENT AND ADJUSTMENT

Removal Procedure

1. Remove the engine front cover evenly all the way around with a suitable tool. Refer to **Engine Front Cover with Oil Pump Replacement**.
2. Install the crankshaft balancer bolt to crankshaft.

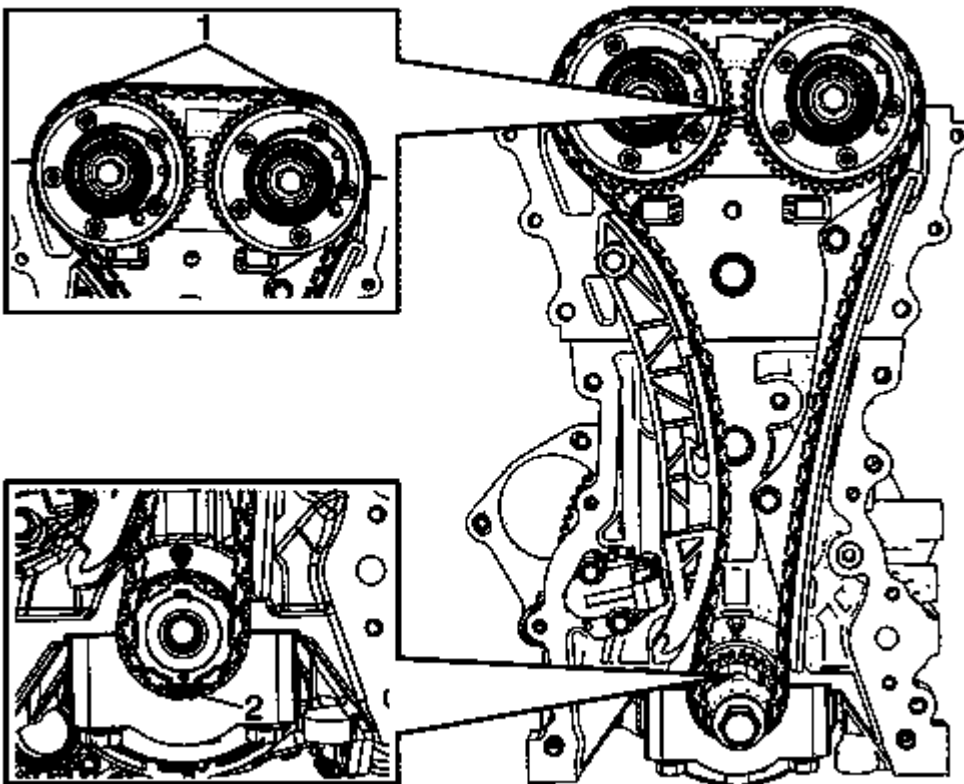


Fig. 71: Rotating Crankshaft To TDC (Top Dead Center) Position
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the crankshaft to the TDC (Top Dead Center) position.

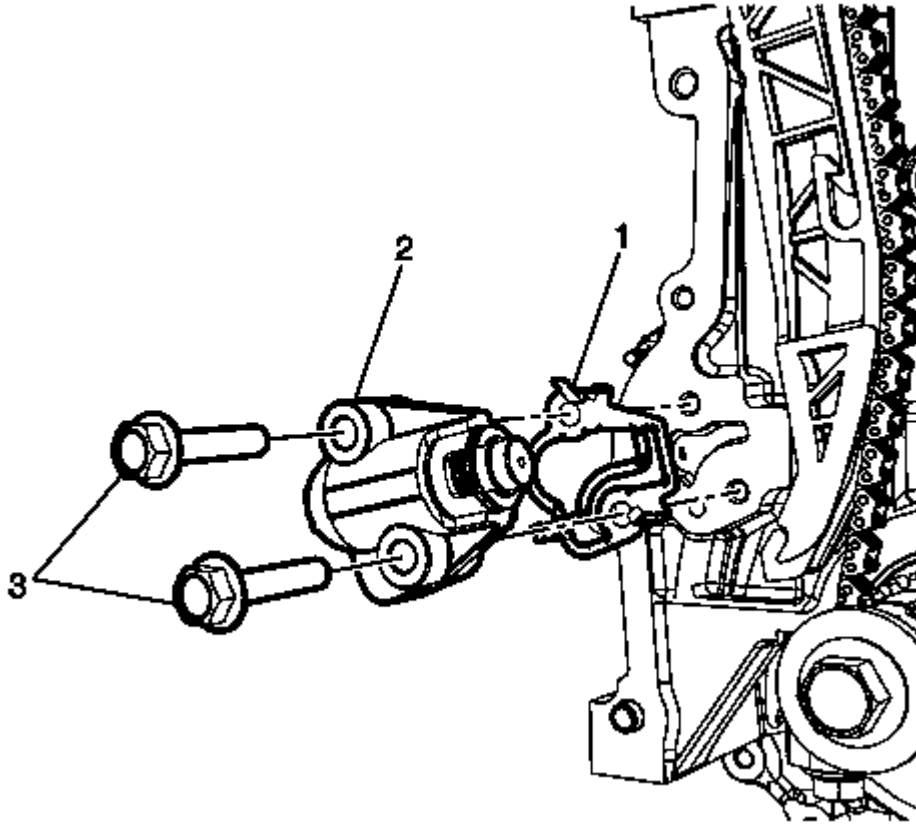


Fig. 72: Timing Chain Tensioner Bolts And Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain tensioner bolts (3) and the timing chain tensioner (2) with the timing chain tensioner gasket (1).

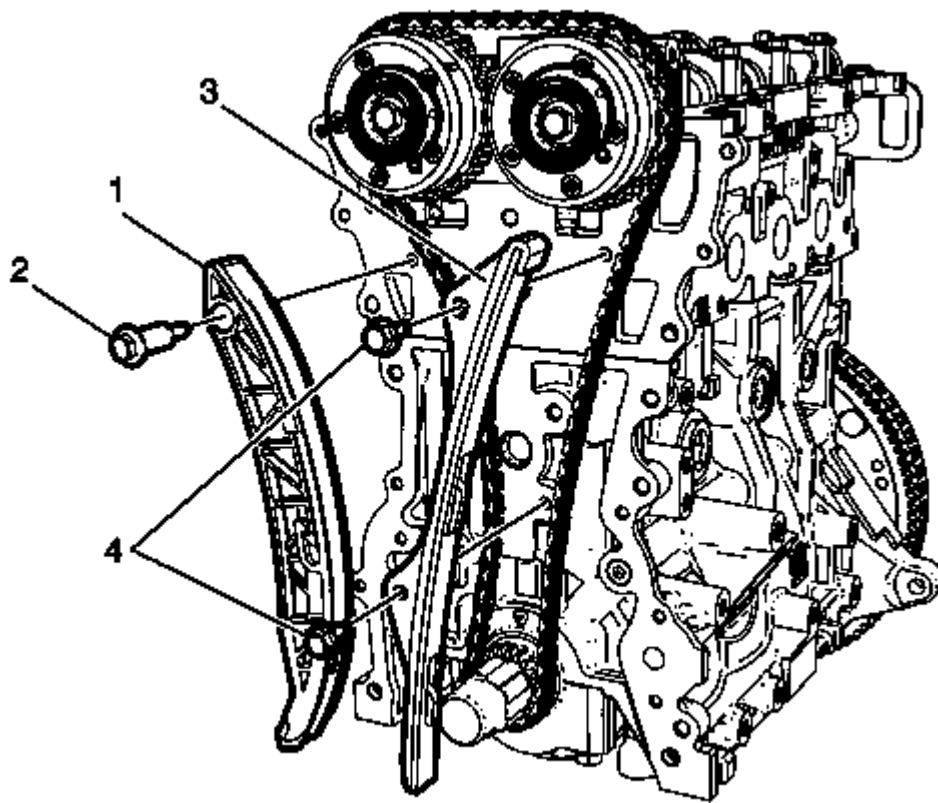


Fig. 73: Left Timing Chain Shoe Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left timing chain shoe retaining bolt (2) and the left timing chain shoe (1).
6. Remove the right timing chain guide retaining bolts (4) and the right timing chain guide (3).

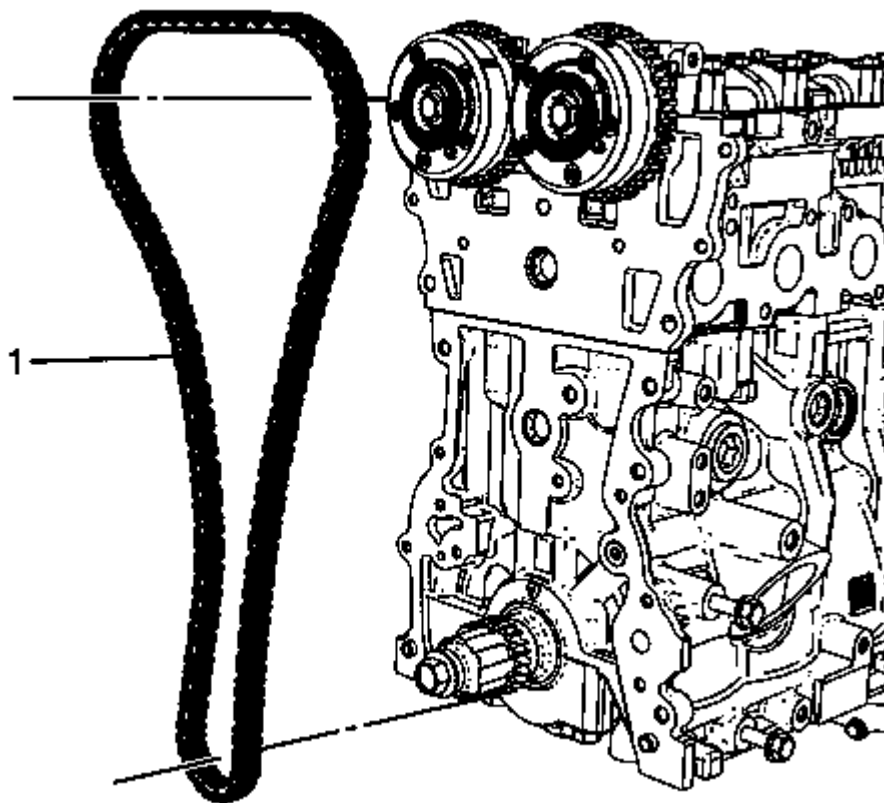


Fig. 74: Timing Chain

Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain (1).

Installation Procedure

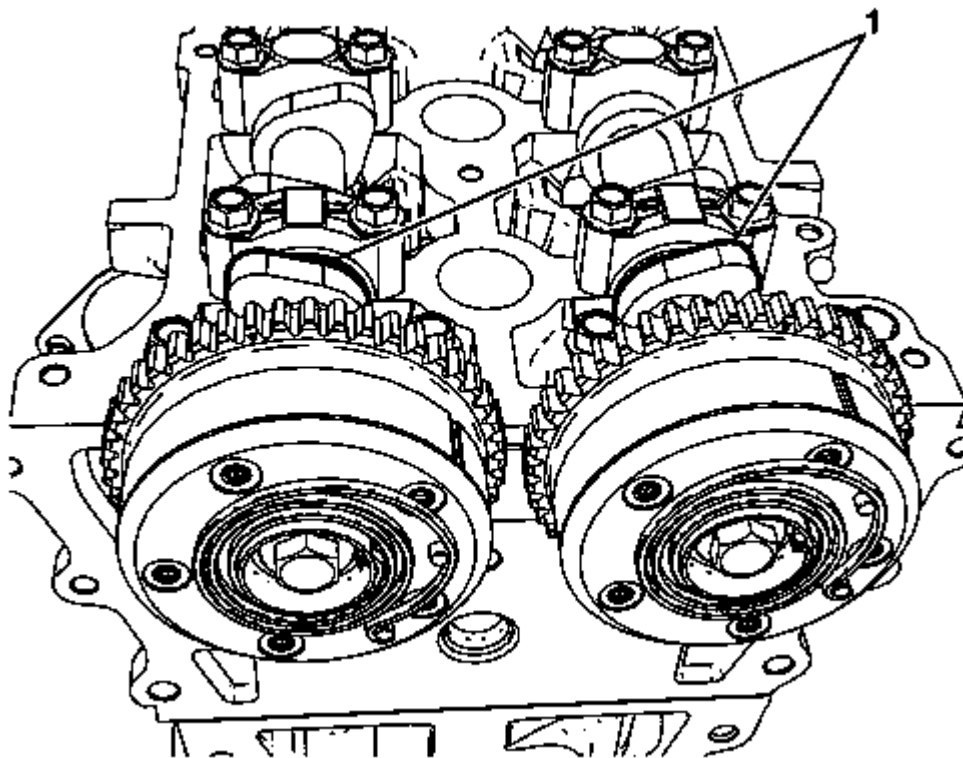


Fig. 75: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft lobes (1) are in a neutral position.

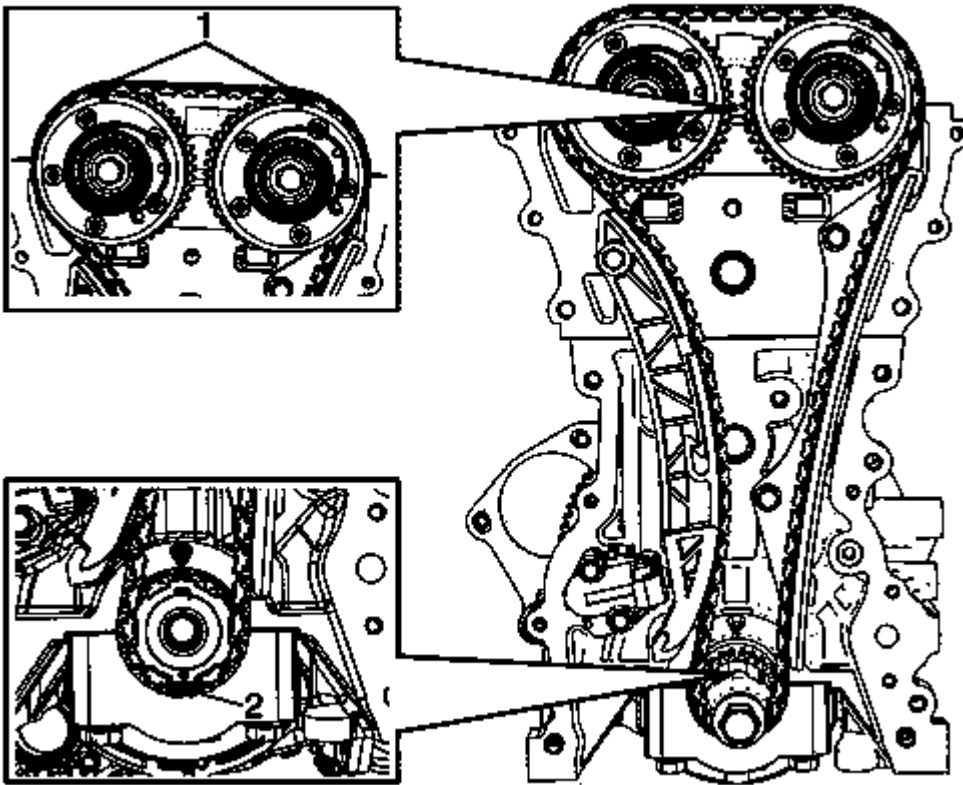


Fig. 76: Rotating Crankshaft To TDC (Top Dead Center) Position
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain after aligning both the marks (1) on the camshaft sprockets and on the timing chain.
3. Align the colored link with the timing mark on the camshaft sprocket (2).

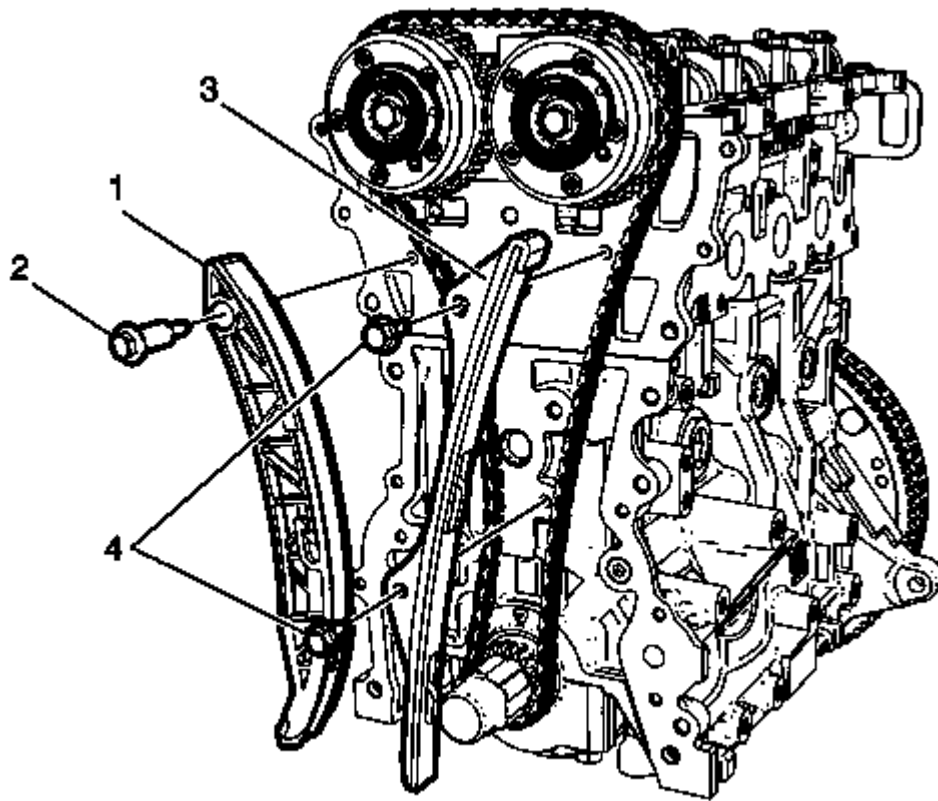


Fig. 77: Left Timing Chain Shoe Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the timing chain guide (3) and tighten the timing chain guide retaining bolts (4) to 10 (89 lb in).
5. Install the timing chain shoe (1) and tighten the timing chain shoe retaining bolt (2) to 10 (89 lb in).

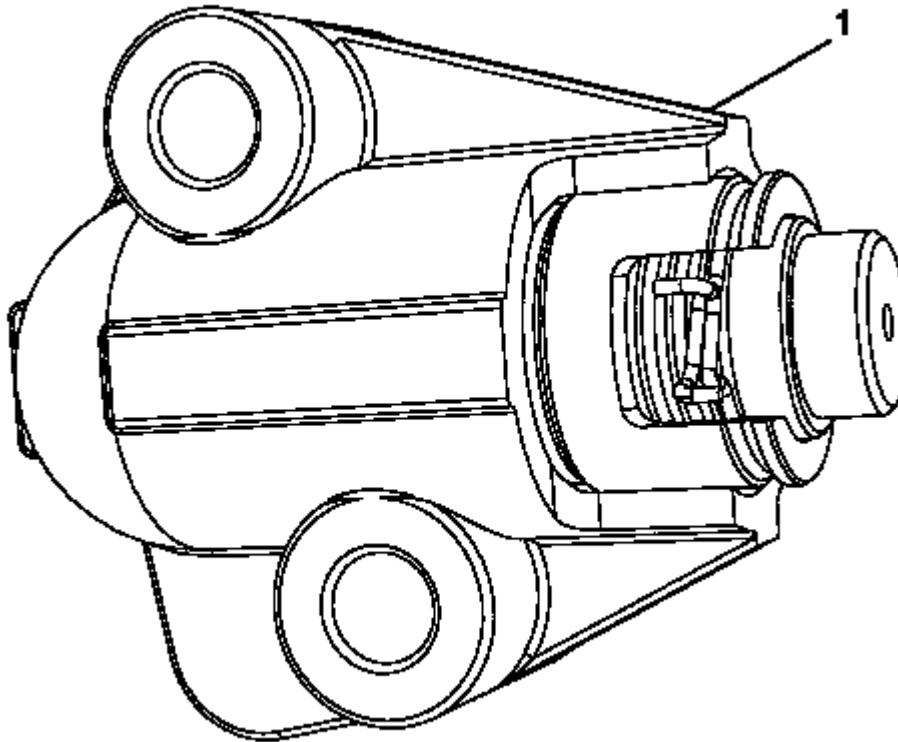


Fig. 78: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

6. Push the timing chain shoe towards the timing chain and hold the timing chain shoe. Using the other hand, push the timing chain tensioner (1) with a new timing chain tensioner gasket towards the timing chain shoe. The timing chain tensioner plunger might be pushed into the timing chain tensioner housing. While holding the timing chain tensioner, install the timing chain tensioner bolts and tighten the timing chain tensioner retaining bolts to 10 (89 lb in). - Old Tensioner

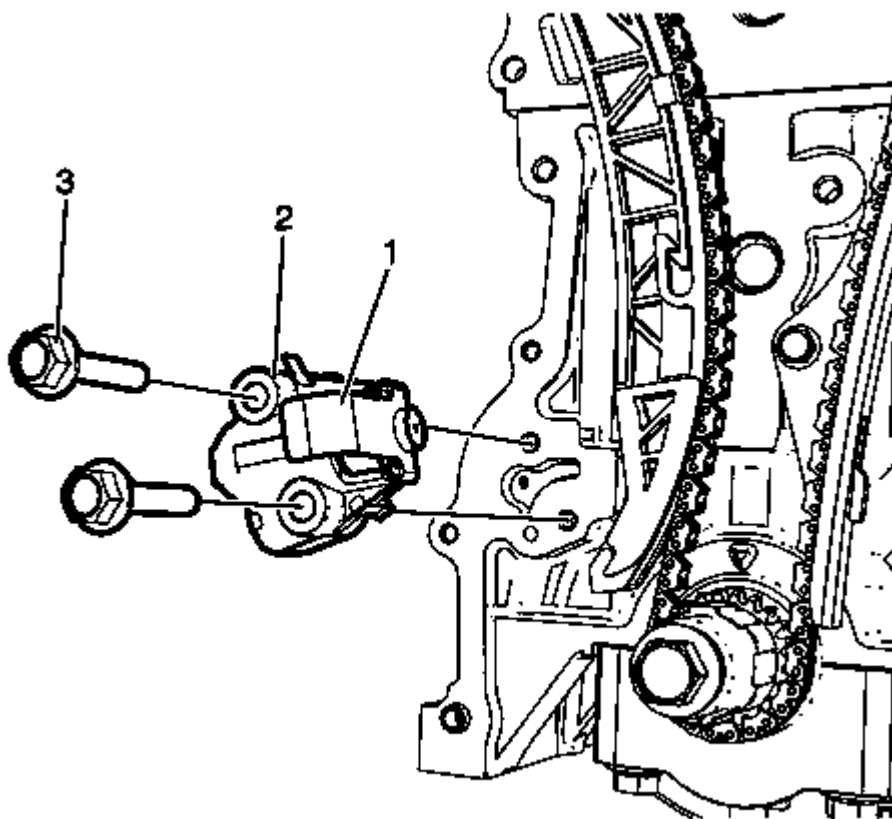


Fig. 79: New Timing Tensioner

Courtesy of GENERAL MOTORS COMPANY

7. Install a new timing tensioner (2) with a new timing chain tensioner gasket and tighten the timing tensioner retaining bolts (3) to 10 (89 lb in). - New Tensioner
8. Remove the timing tensioner plunger holder (1).
9. Remove the crankshaft balancer bolt.
10. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.

OIL PUMP REPLACEMENT

Removal Procedure

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

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

2. Remove the oil pump bolts and the oil pump.
3. Perform the following steps as necessary:

- Disassemble the oil pump. Refer to **Oil Pump Disassemble**
- Clean and inspect the oil pump. Refer to **Oil Pump Disassemble**

Installation Procedure

1. Assemble the oil pump as necessary. Refer to **Oil Pump Assemble**.
2. Install the oil pump. Refer to **Oil Pump Assemble**.
3. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT**Removal Procedure**

1. Open the hood.

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

2. Place collecting basin underneath.

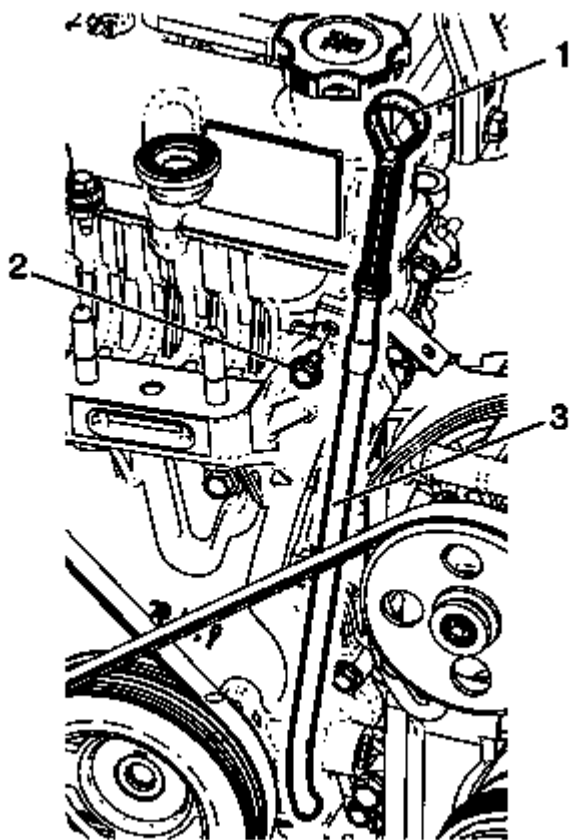


Fig. 80: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

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

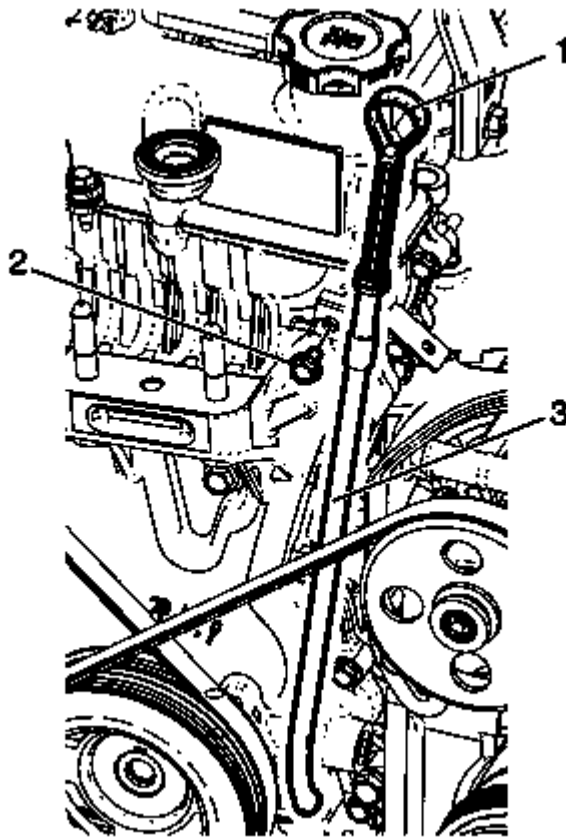
Installation Procedure

Fig. 81: Oil Level Indicator

Courtesy of GENERAL MOTORS COMPANY

1. Install the oil level indicator tube (3).

Use a NEW oil level indicator tube gasket.

CAUTION: Refer to Fastener Caution .

2. Install the oil level indicator tube bolt (2) and tighten to 10 (89 lb in).
3. Install the oil level indicator (1).
4. Close the hood.

ENGINE REPLACEMENT (LFM)

Removal Procedure

1. Open the hood.
2. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .
3. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
5. Drain the cooling system. Refer to Cooling System Draining and Filling .
6. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .
7. Remove the front wheels and tires. Refer to Tire and Wheel Removal and Installation .
8. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .
9. Remove the battery. Refer to Battery Replacement .
10. Remove the engine control module. Refer to Engine Control Module Replacement .
11. Remove the battery tray. Refer to Battery Tray Replacement .

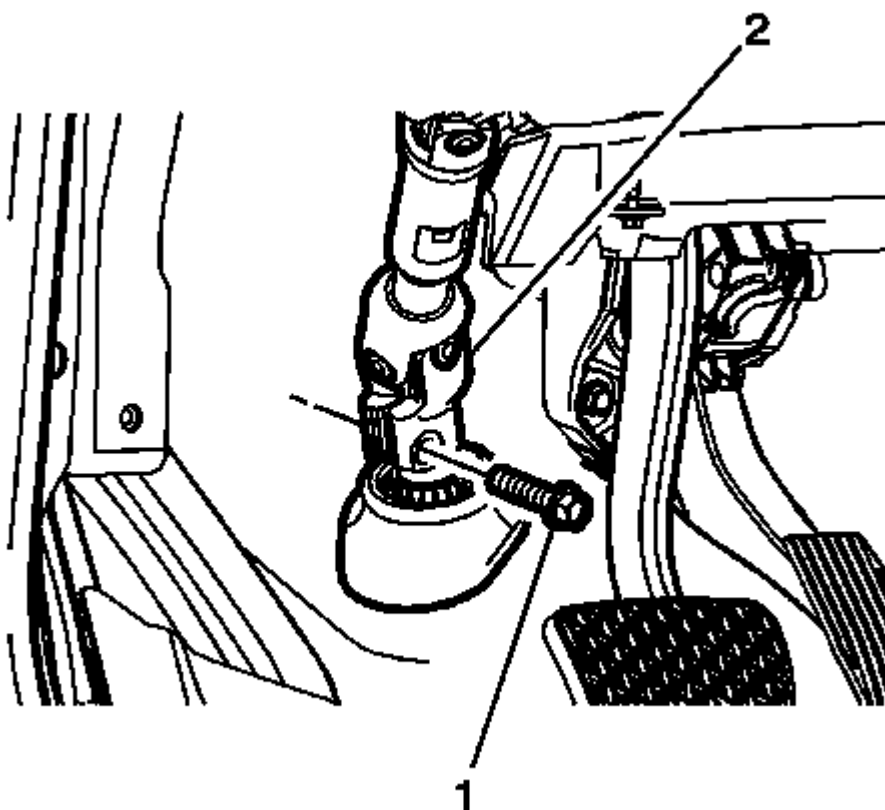


Fig. 82: Lower Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the lower intermediate steering shaft bolt (1) and detach the lower intermediate steering shaft (2).

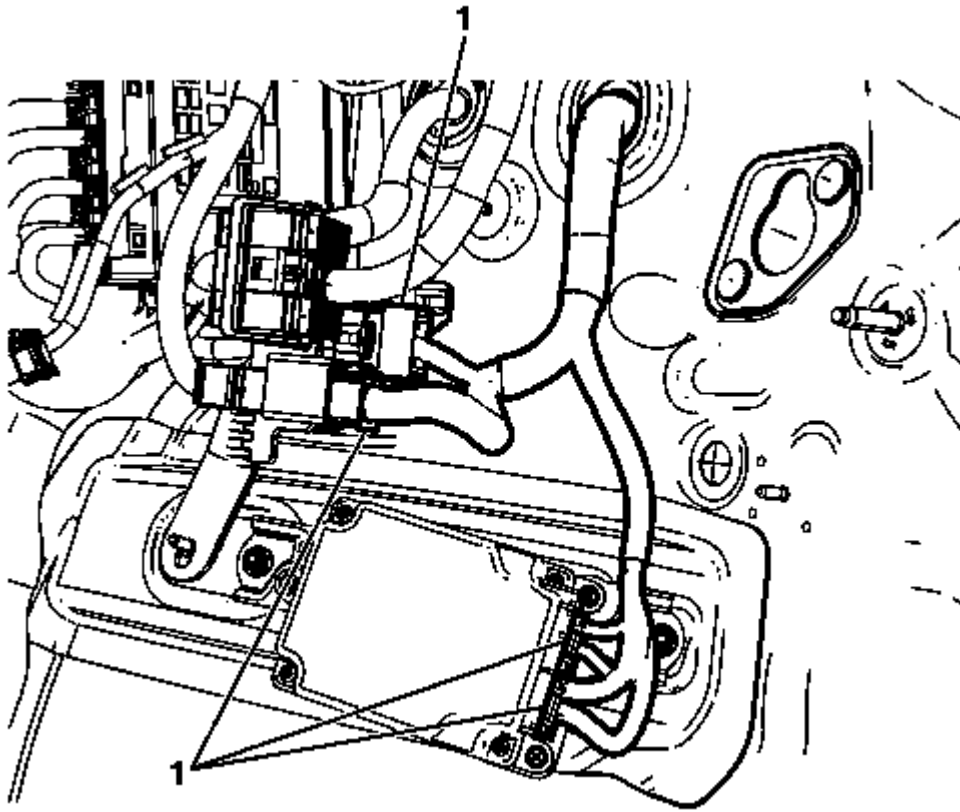


Fig. 83: Engine Wiring Harnesses Connectors
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect 4 engine wiring harnesses connectors (1) from under dash, left of the steering shaft and pull out the engine wiring harnesses through the front of dash to the engine compartment.

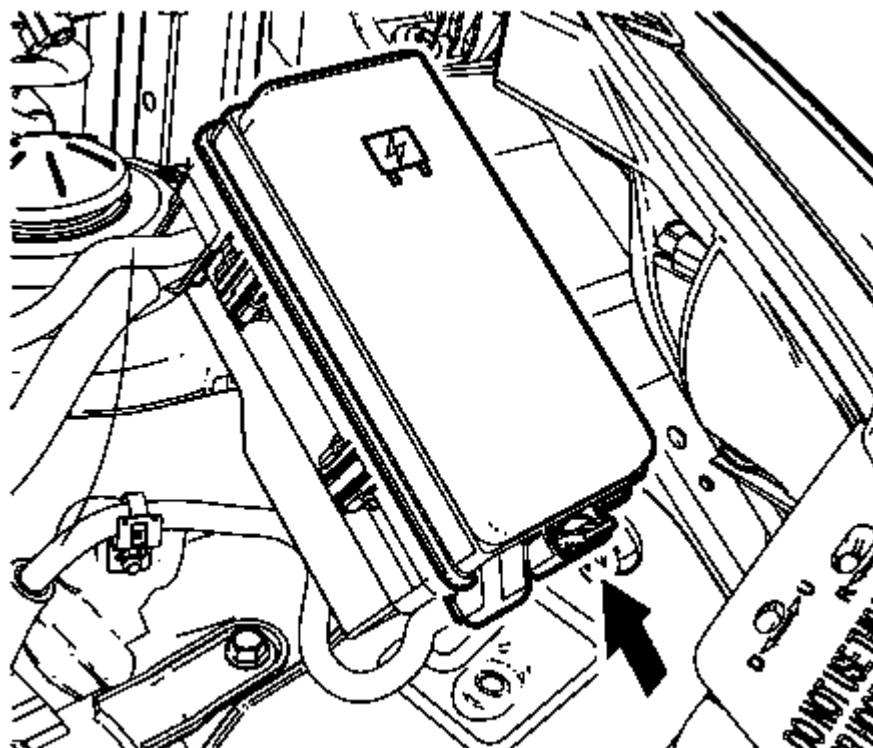


Fig. 84: Front Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

14. Remove the engine wiring harness fuse block cover.

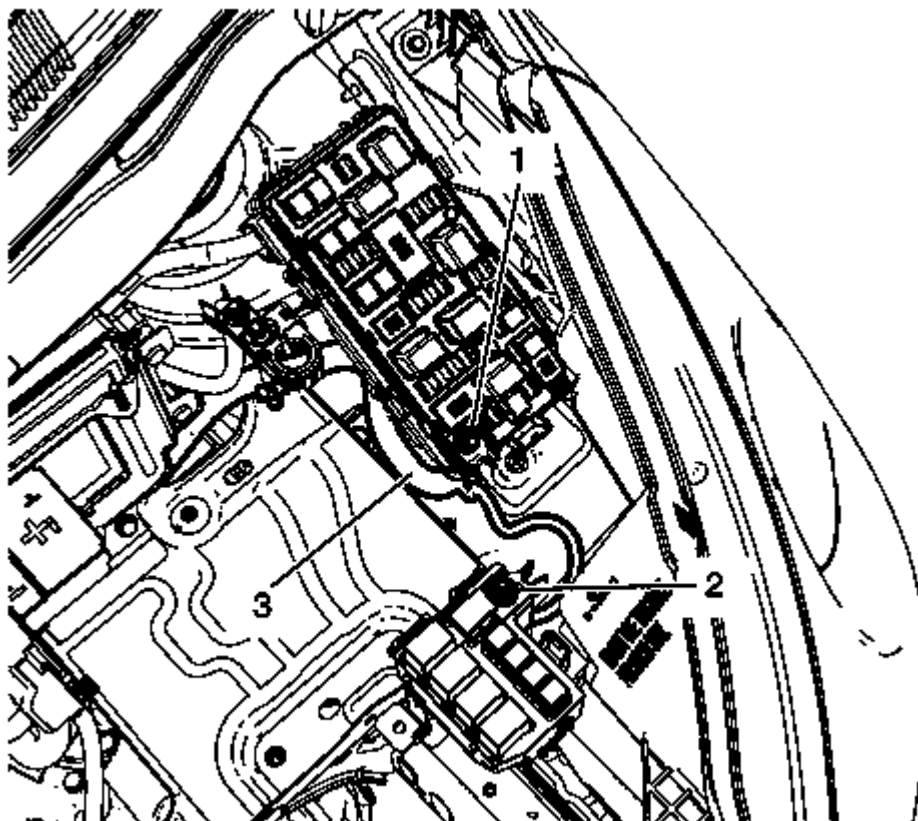


Fig. 85: Positive Battery Cable Nut
Courtesy of GENERAL MOTORS COMPANY

15. Remove the positive cable retaining nut (1, 2) and the positive cable (3).

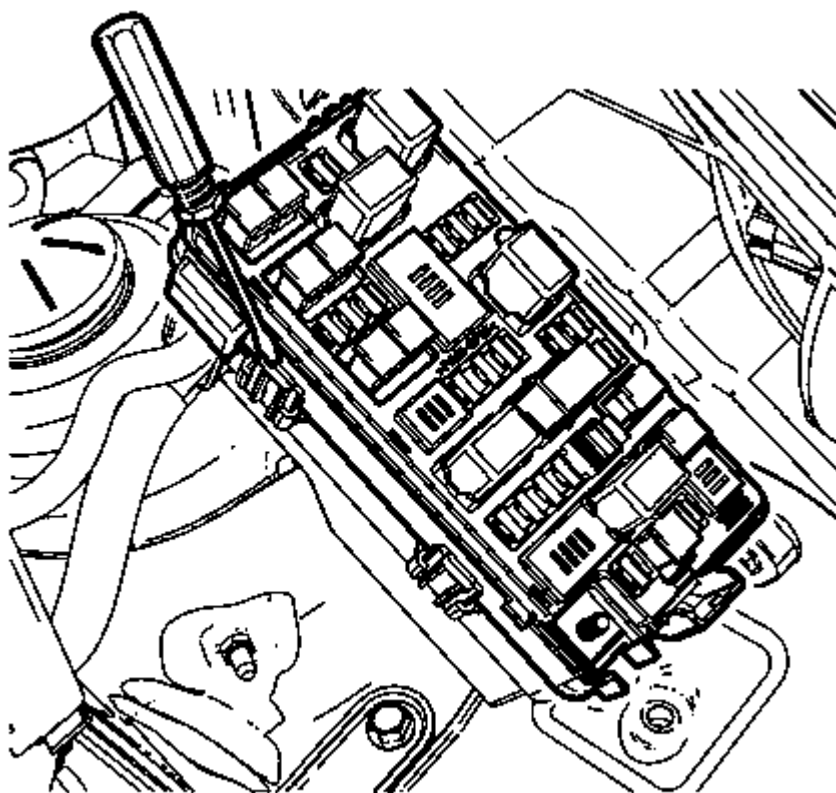


Fig. 86: Detaching Upper Plate With Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

16. Detach the upper plate with suitable tool.

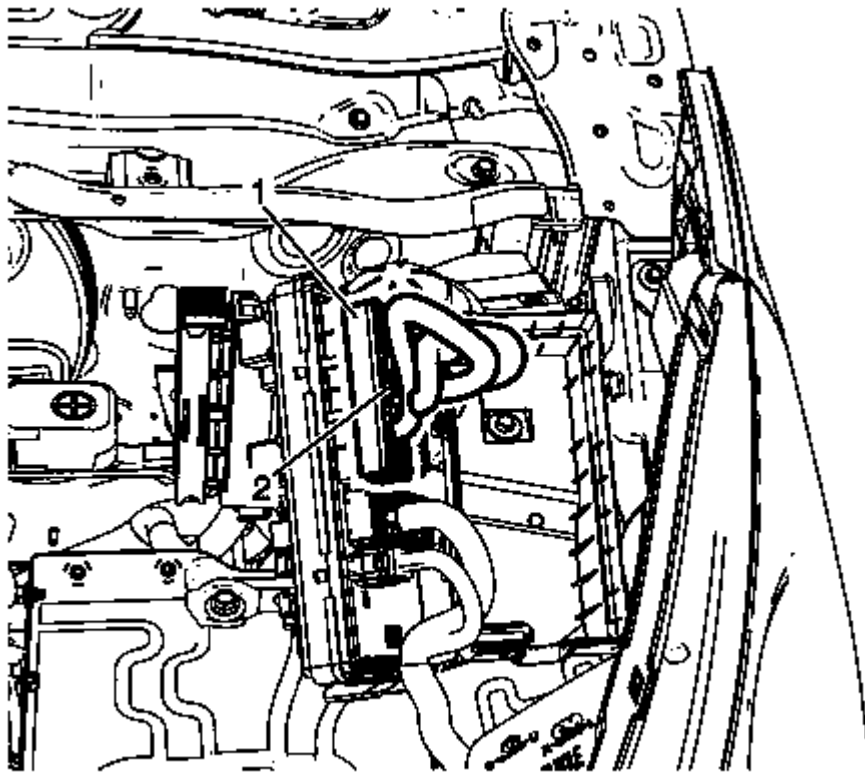


Fig. 87: Front Compartment Fuse Block

Courtesy of GENERAL MOTORS COMPANY

17. Lift up the engine wiring harness fuse block from the lower plate.
18. Loosen the wiring harness connector retaining bolt (2) and disconnect the wiring harness connector (1) from the engine wiring harness fuse block. Repeat for remaining connector.
19. Disconnect remaining wiring harness.

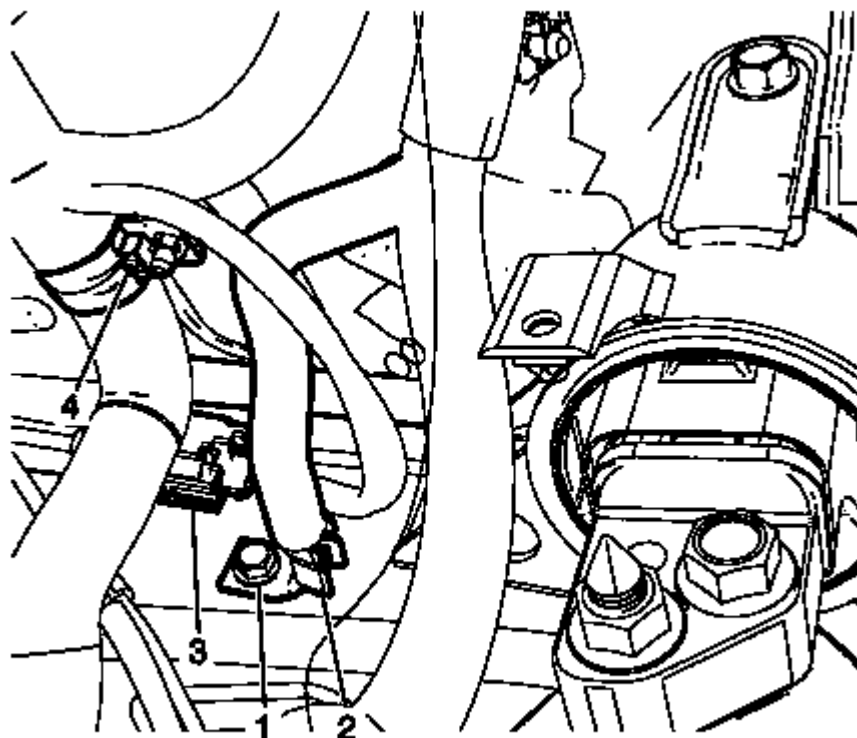


Fig. 88: Ground Bolt And Put Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

20. Remove the ground bolt (1) and put the wiring harness (2) aside.
21. Disconnect the wheel speed sensor connector (3).
22. Remove the wiring harness retainer (4).
23. Disconnect the heater inlet hose. Refer to **Heater Inlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.
24. Disconnect the heater outlet hose. Refer to **Heater Outlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.
25. Plug or cap the cooling system hoses and inlets.

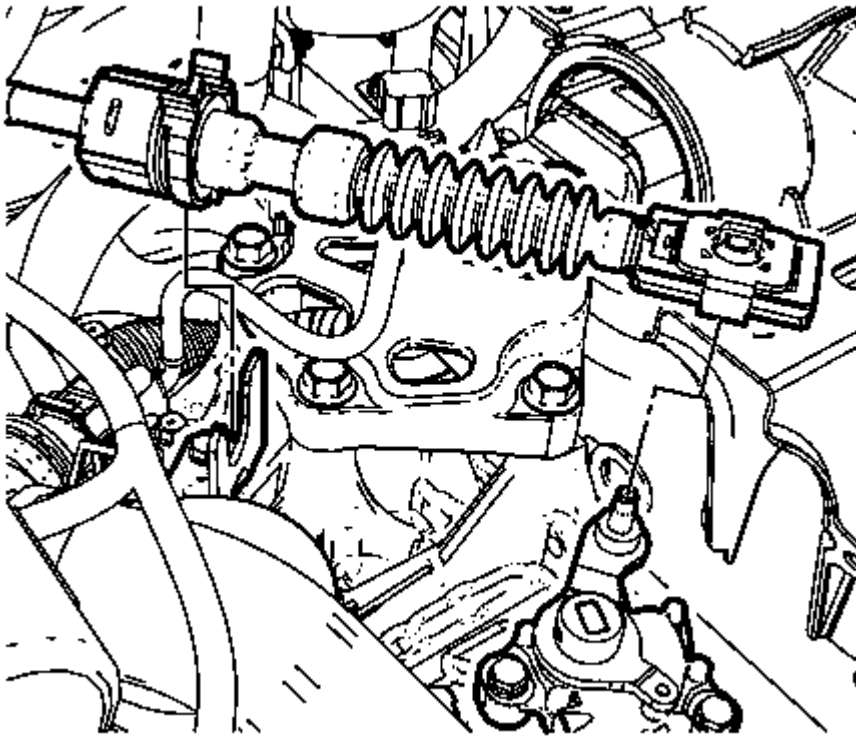


Fig. 89: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

26. Disconnect the transmission range selector lever cable terminal from the transmission lever pin.
27. Press the locking tabs inward in order to release the transmission range selector lever cable from the cable bracket.

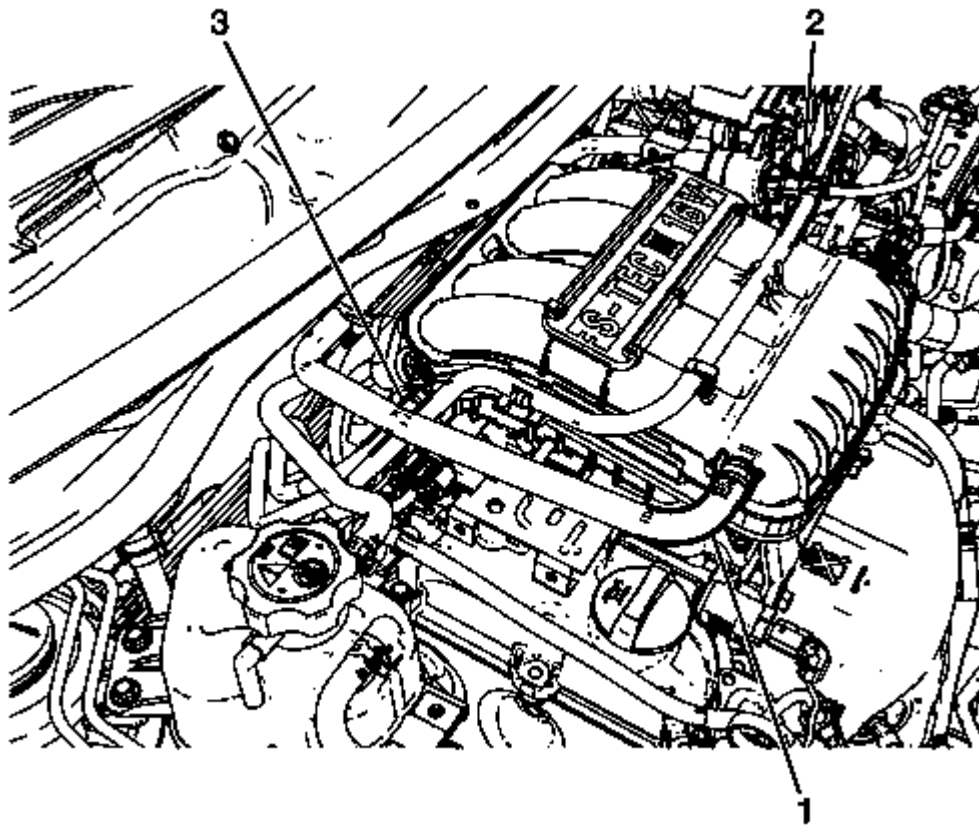


Fig. 90: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

28. Disconnect the vacuum hose (1) from the intake manifold.
29. Disconnect the evaporative canister purge solenoid valve hose (2).
30. Disconnect the fuel feed hose (3).

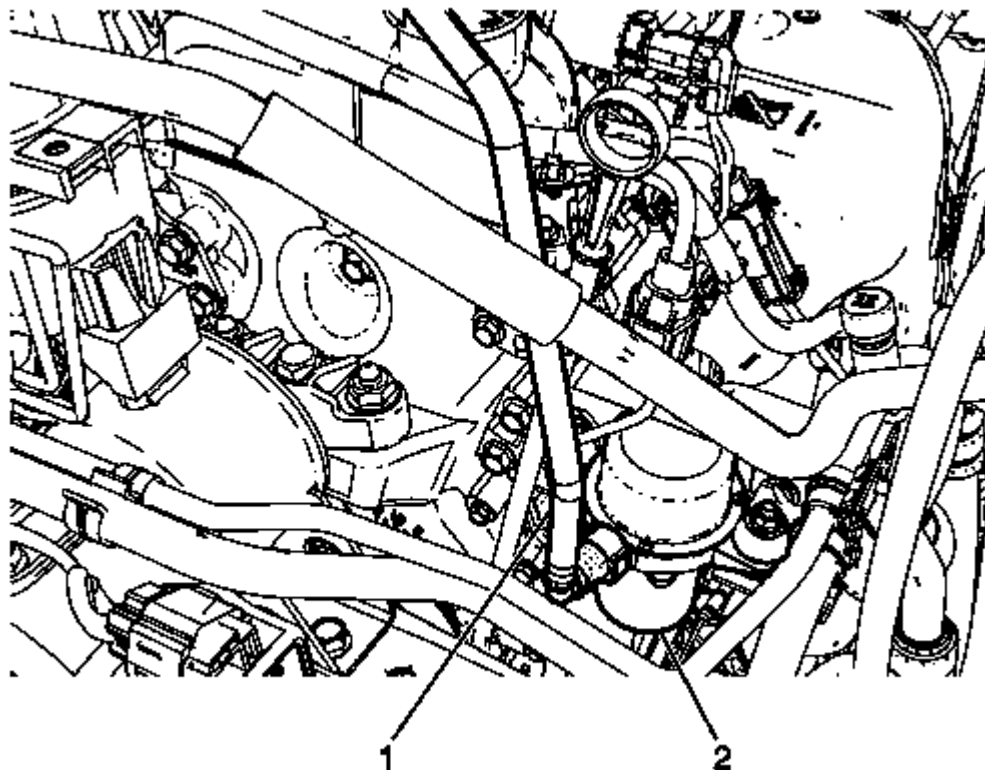


Fig. 91: Vacuum Pump Hose And Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

31. Remove the vacuum pump hose (1) from the vacuum pump (2).

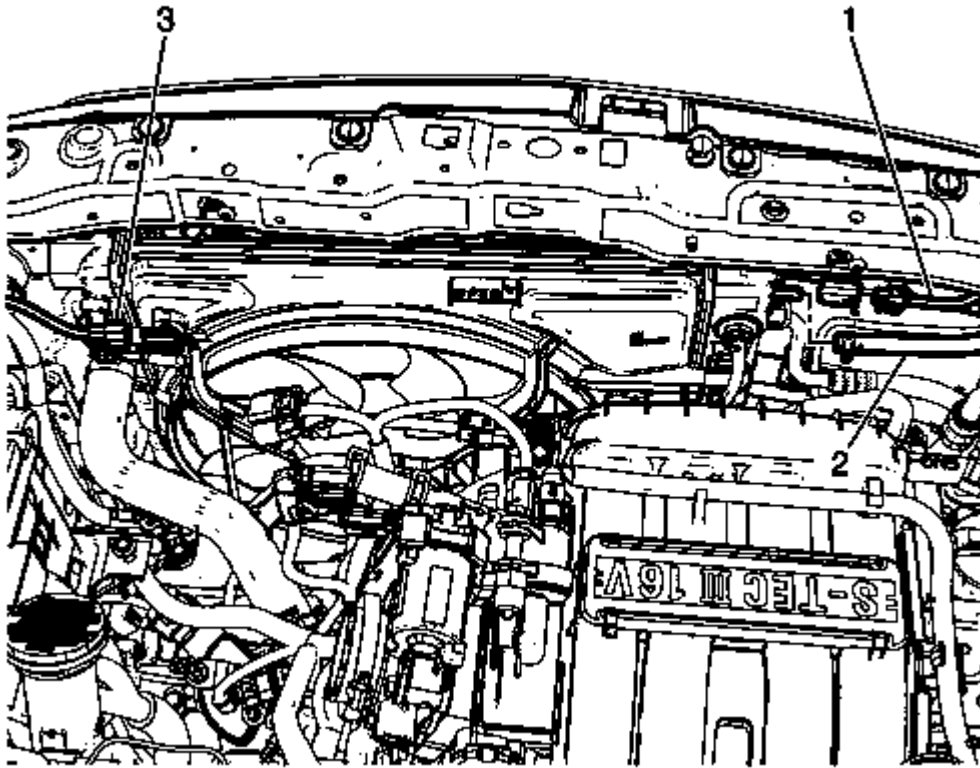


Fig. 92: Ambient Air Temperature Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

32. Disconnect the wiring harness connector (3) from the engine cooling fan harness connector.
33. Disconnect the ambient air temperature sensor connector (1) from the ambient air temperature sensor if equipped.
34. Disconnect the coolant hose (2) from the radiator.

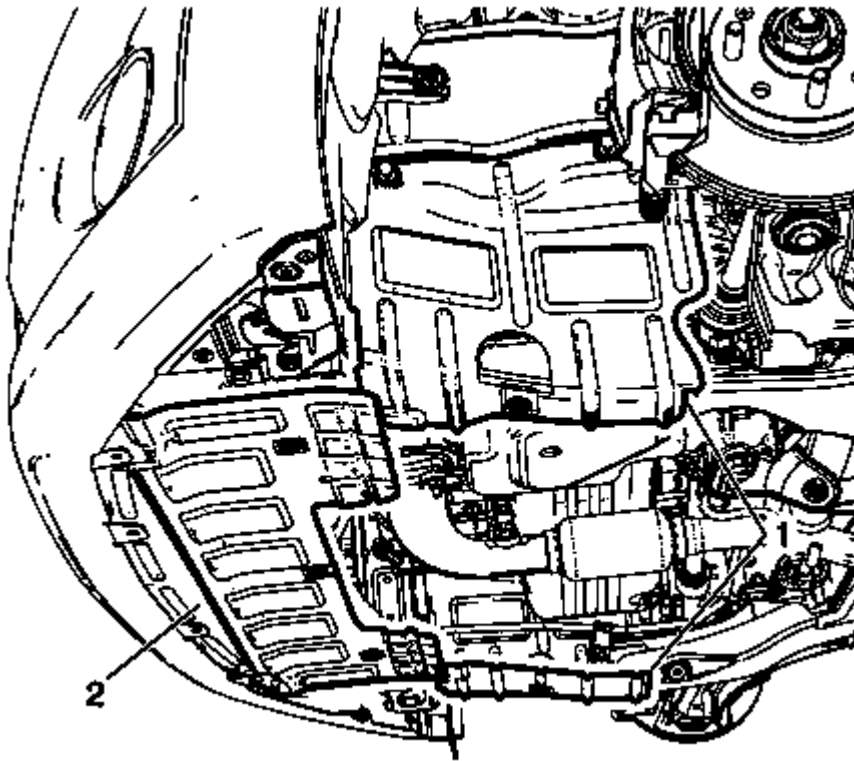


Fig. 93: Compartment Splash Shield

Courtesy of GENERAL MOTORS COMPANY

35. Remove the compartment splash shield (1, 2). Refer to **Front Compartment Splash Shield Replacement** .
36. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

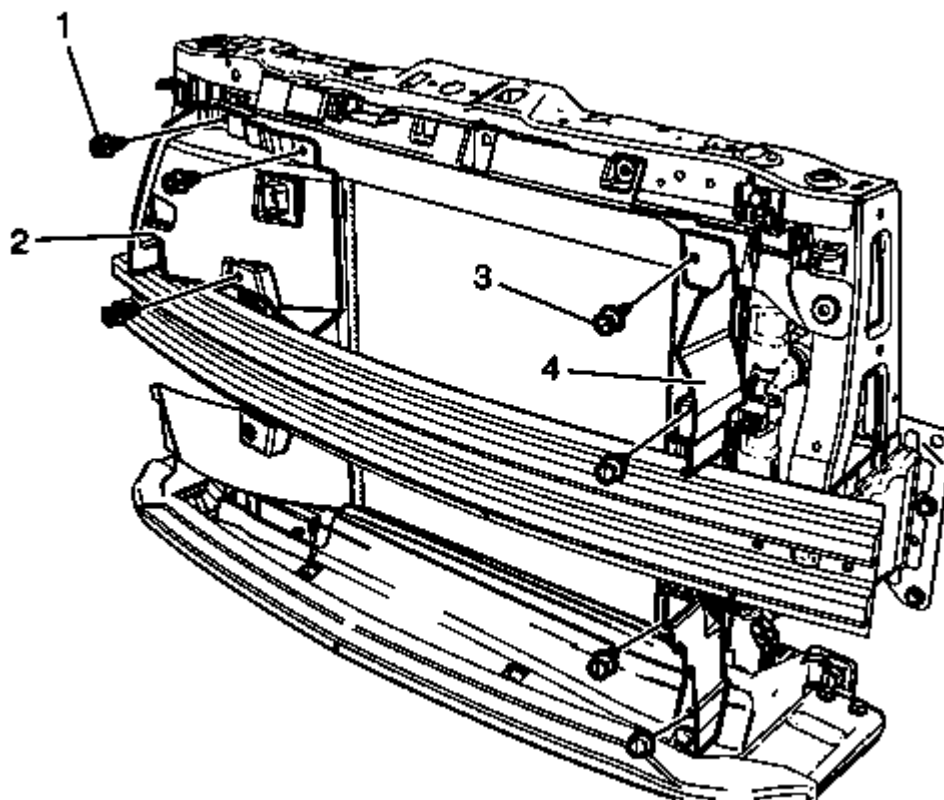


Fig. 94: Front Side Air Baffle Retainers

Courtesy of GENERAL MOTORS COMPANY

37. Remove the front side air baffle retainers (1, 3) and the front side air baffles (2, 4).

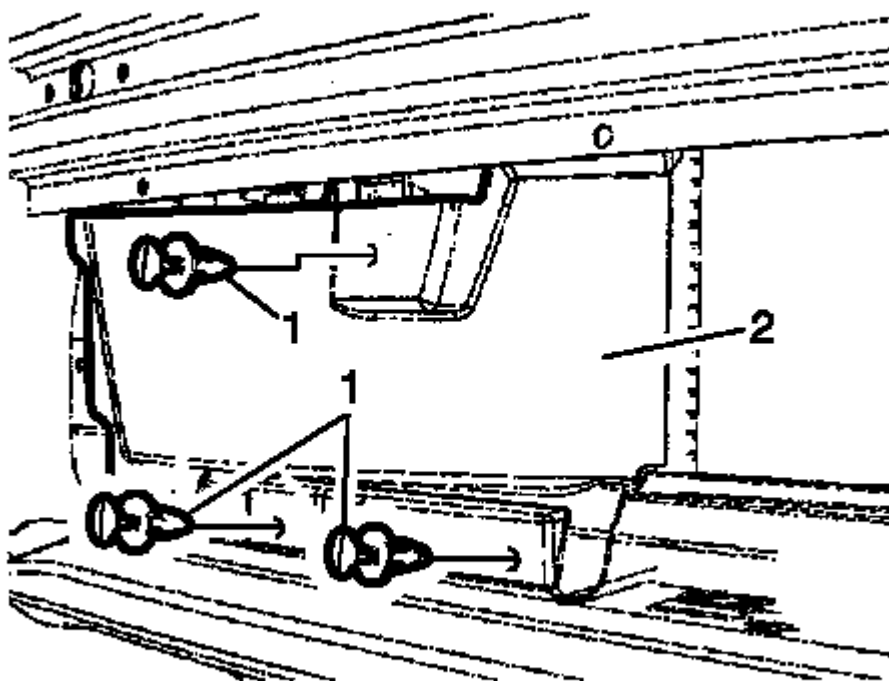


Fig. 95: Front Lower Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

38. Remove the front lower air baffle retainers (1) and the front lower air baffle (2).

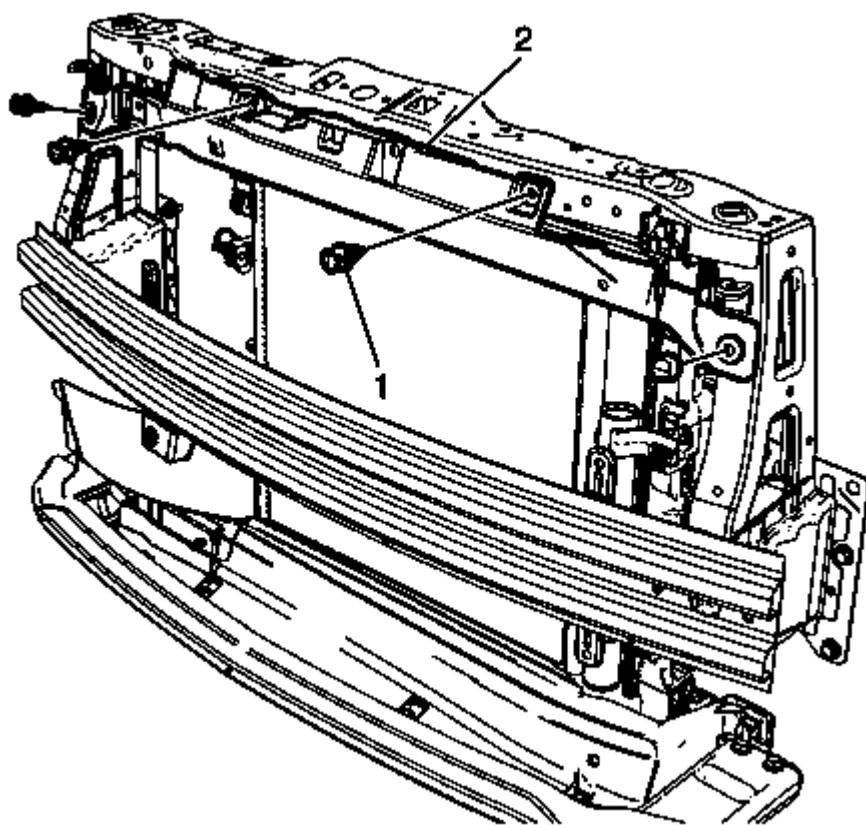


Fig. 96: Upper Air Guard Retainers
Courtesy of GENERAL MOTORS COMPANY

39. Remove the upper air guard retainers (1) and the upper air guard (2).

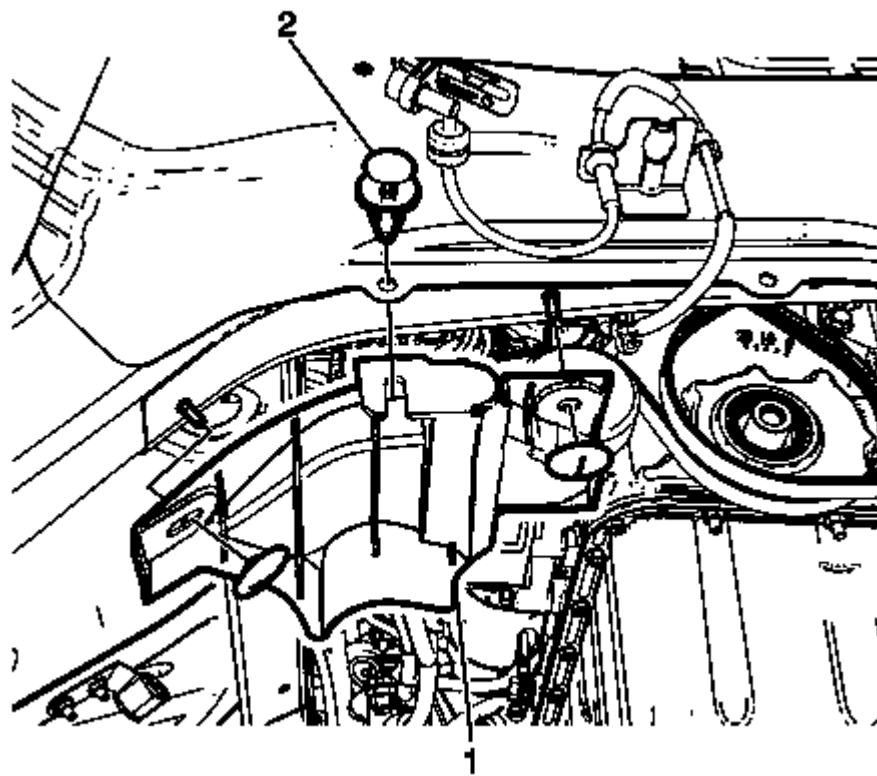
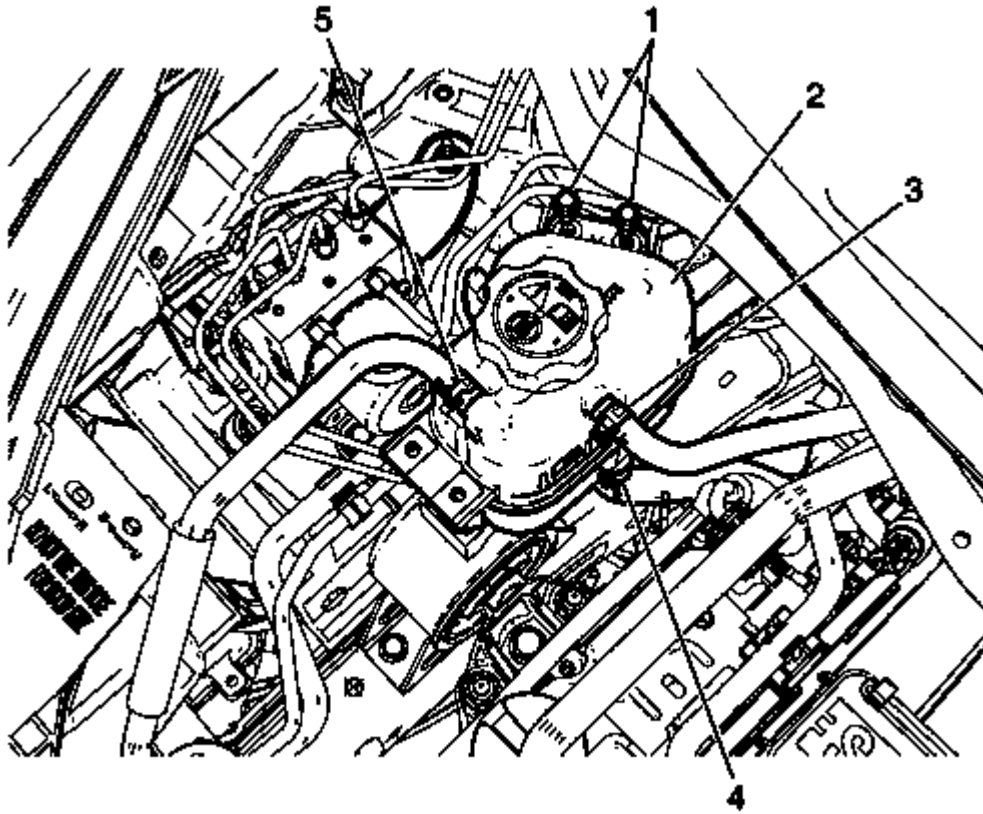


Fig. 97: Retainers And Water Deflector

Courtesy of GENERAL MOTORS COMPANY

40. Remove the retainers (2) and the water deflector (1).

**Fig. 98: Coolant Surge Tank**

Courtesy of GENERAL MOTORS COMPANY

41. Remove coolant surge tank retaining bolts (1).
42. Remove the coolant hose clips (3, 4, 5) and coolant surge tank (2).
43. Plug or cap the cooling system hoses and inlets.

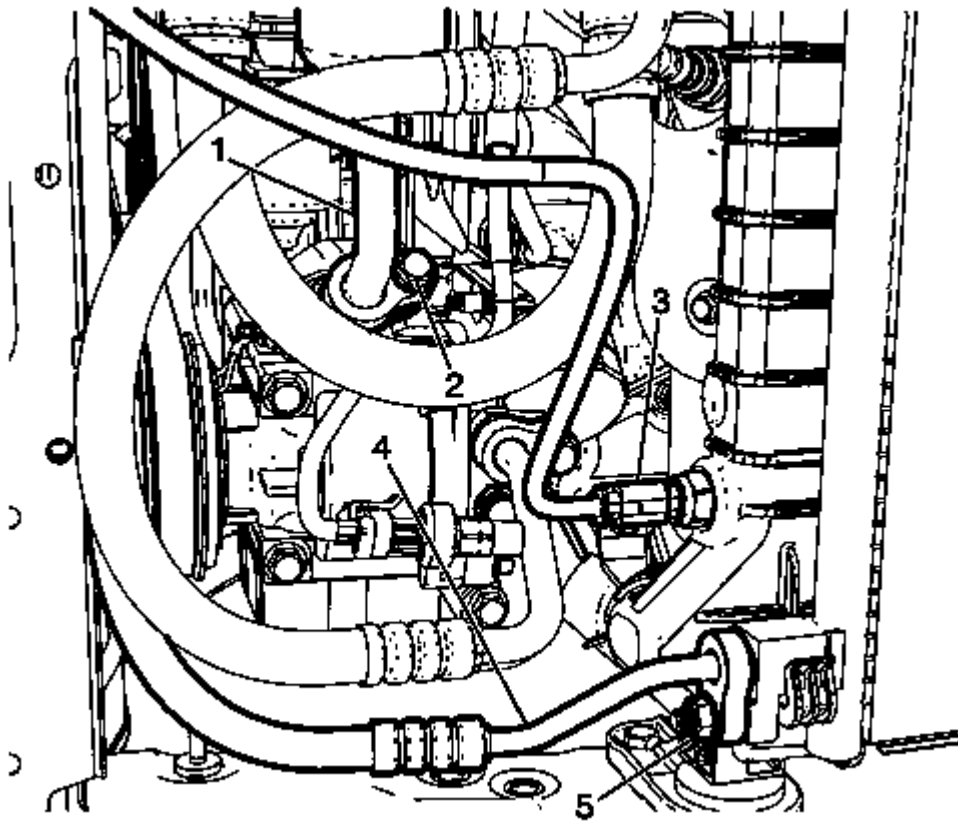


Fig. 99: Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

44. Remove the suction pipe bolt (2) from the A/C compressor.
45. Remove the suction pipe (1) from the A/C compressor.
46. Remove the discharge pipe nut (5) from the A/C condenser.
47. Remove the discharge pipe (4) from the A/C condenser.
48. Disconnect the coolant temperature sensor wiring connector (3) from the radiator.

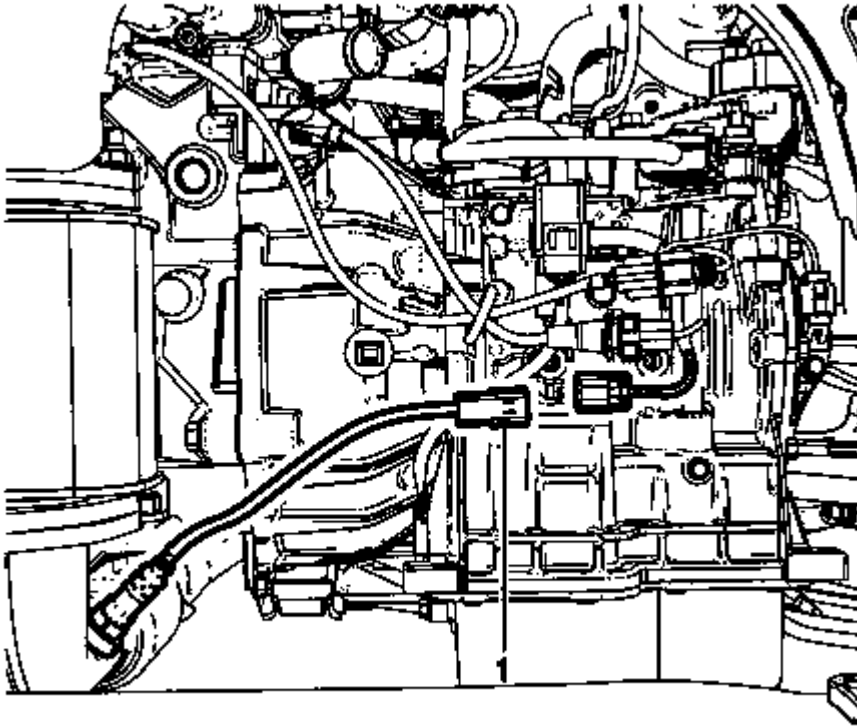


Fig. 100: Oxygen Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

49. Disconnect the oxygen sensor connector (1).
50. Remove the exhaust pipe. Refer to **Exhaust Pipe Replacement (LFM)** .
51. Remove the transmission rear mount bracket. Refer to **Transmission Rear Mount Bracket Replacement** .

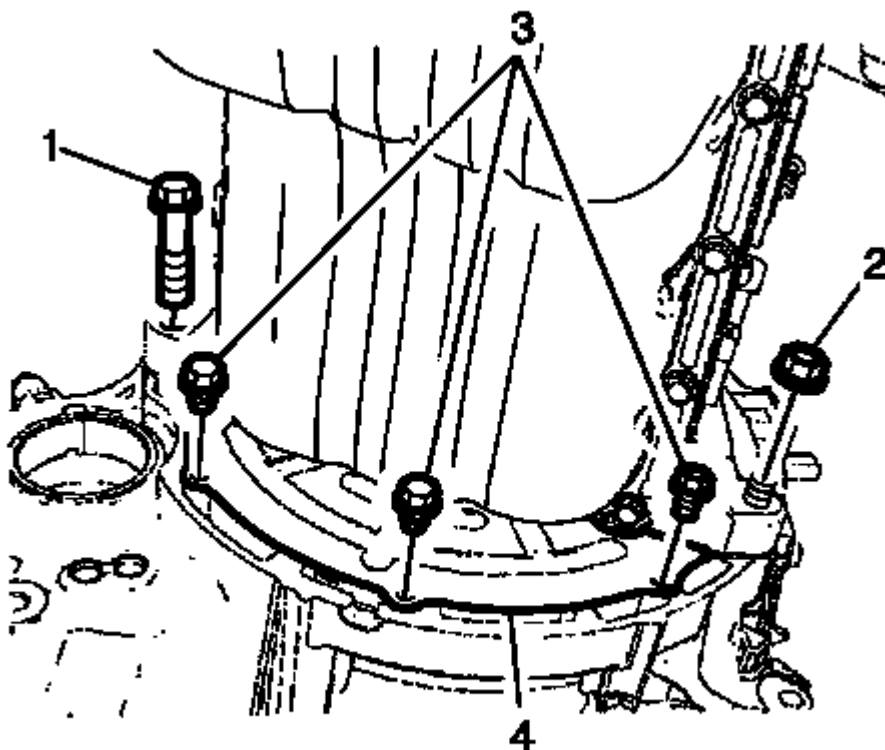


Fig. 101: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

52. Remove the transmission dust cover bolts (3) and the transmission dust cover (4).

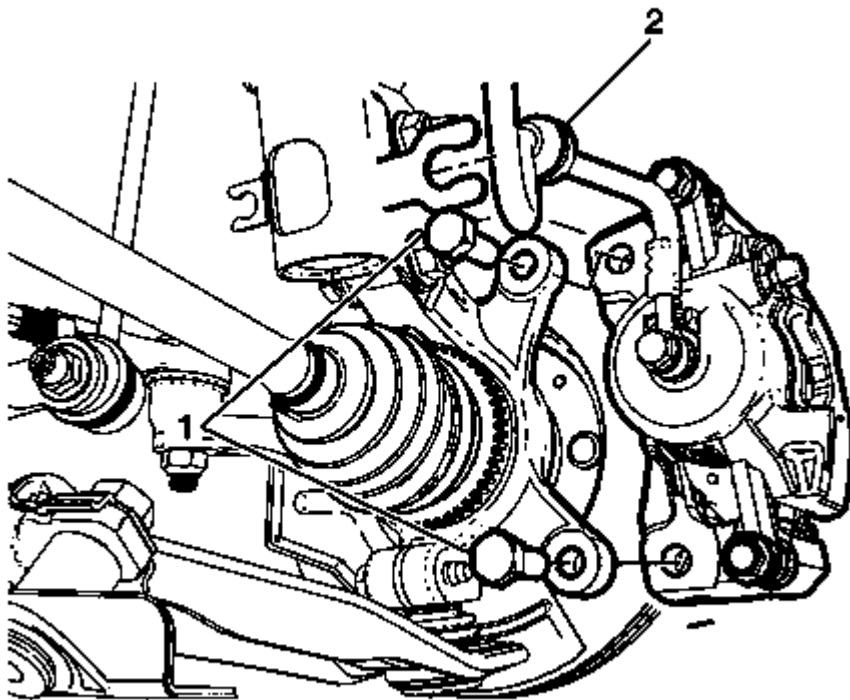


Fig. 102: Front Brake Hose And Front Brake Caliper Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT** disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

53. Detach the front brake hose (2) from the strut mounted brake hose retaining bracket and remove the front brake caliper retaining bolts (1) from the front steering knuckle. Repeat for opposite side.

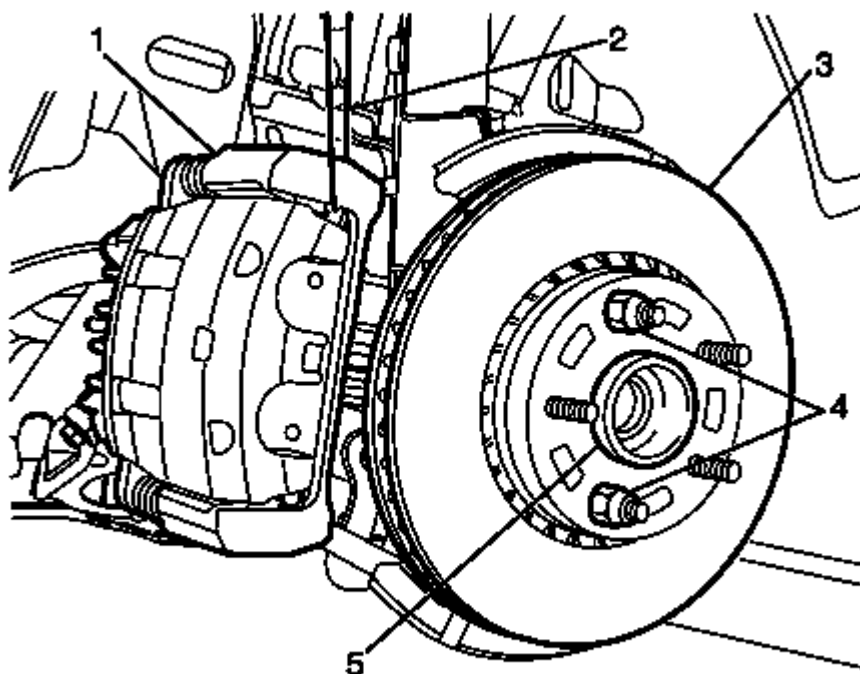


Fig. 103: View Of Hub, Wheel Nuts, Front Brake Disc, Heavy Mechanic's Wire & Front Brake Caliper

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Support the brake caliper with heavy mechanic wire or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

54. Support the front brake caliper (1) with heavy mechanics wire or equivalent (2). Repeat for opposite side.
55. Disconnect the outer tie rod assembly from the steering knuckle. Repeat for opposite side. Refer to **Steering Linkage Outer Tie Rod Replacement**.
56. Remove the wheel drive shaft nut and washer from the wheel drive shaft and discard. Repeat for opposite side. Refer to **Front Wheel Drive Shaft Replacement**.
57. Separate the control arm ball joint from the steering knuckle. Repeat for opposite side. Refer to **Lower Control Arm Replacement**.

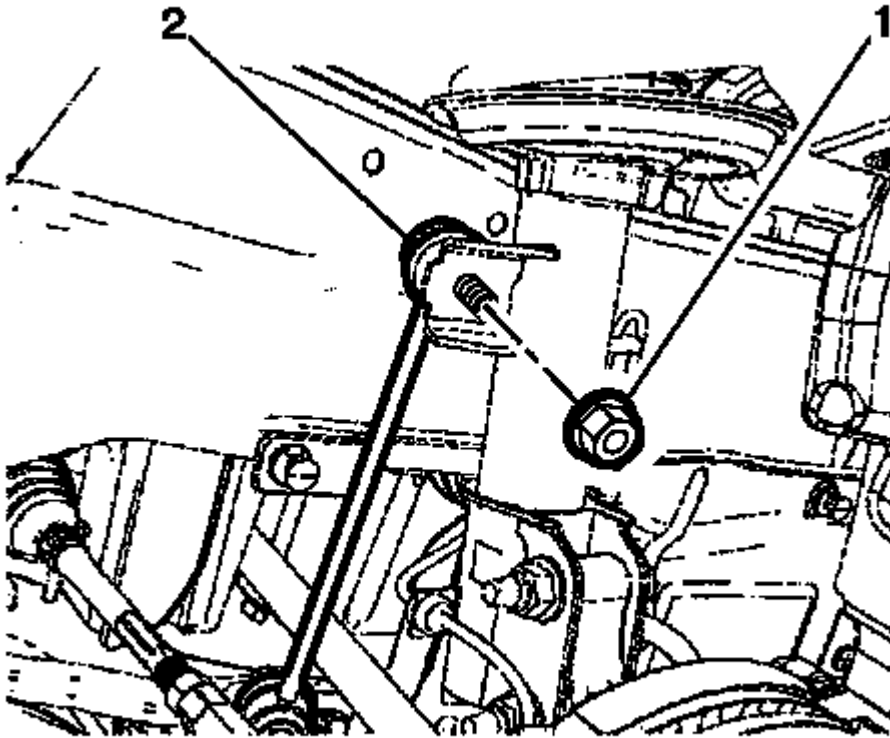


Fig. 104: Front Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

58. Remove the front upper stabilizer shaft link nut (1) and push the front upper stabilizer shaft link (2) aside. Repeat for opposite side.
59. Disconnect any additional electrical connections as necessary.

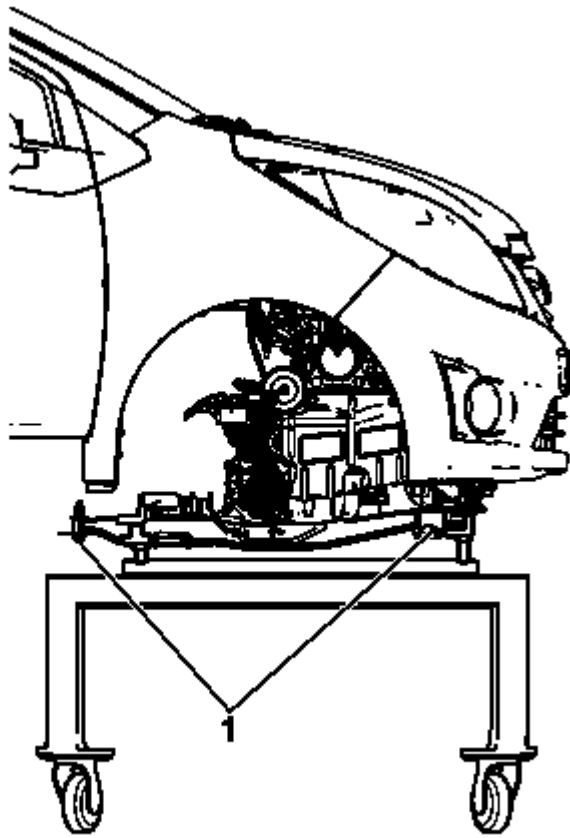


Fig. 105: View Of Cradle Bolts

Courtesy of GENERAL MOTORS COMPANY

60. Position the engine assembly on a suitable powertrain table or an engine lifter below the cradle with suitable woodblocks or suitable rubber blocks as shown.
61. Lower the vehicle until the suitable powertrain table or the engine lifter with suitable woodblocks or suitable rubber blocks.
62. Remove the 4 cradle bolts (1).

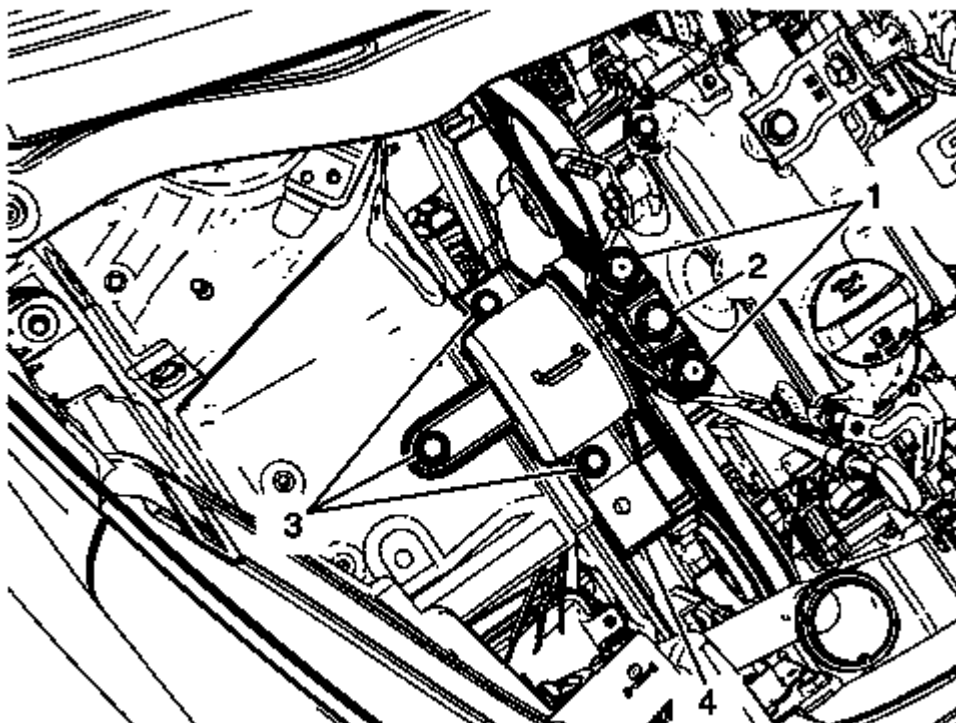


Fig. 106: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

63. Mark the location of the bolts before removing.
64. Remove the engine mount retaining bolts (2, 3), nuts (1) and the engine mount.

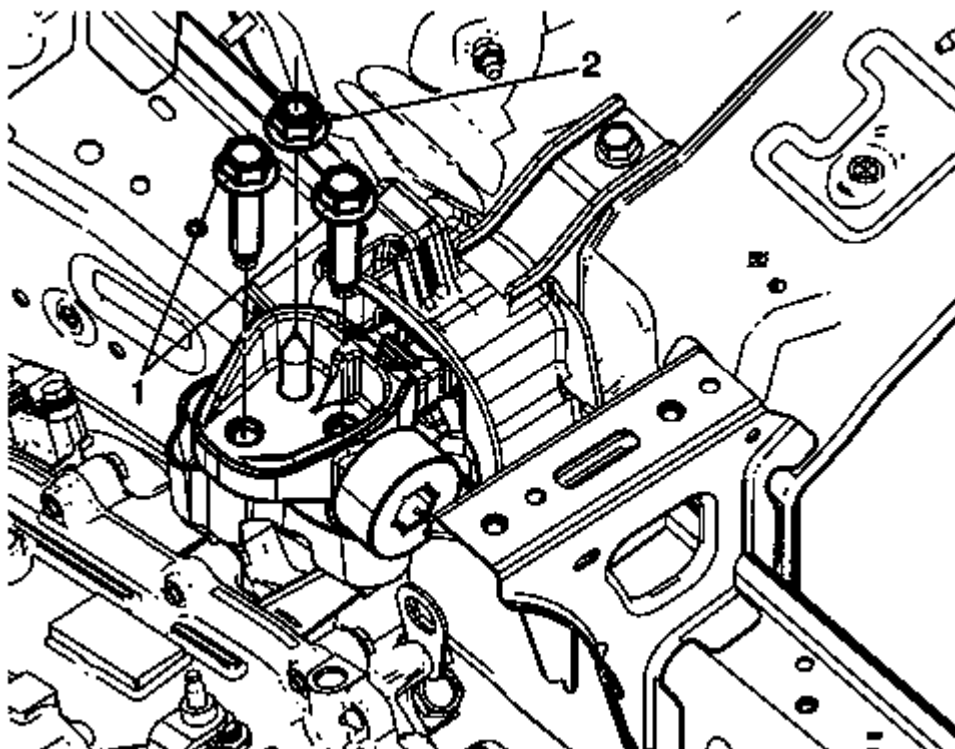


Fig. 107: Location Of Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the location of the bolts (1) and nut (2) before removing.

65. Remove the left transmission mount bolts (1) and nut (2) from the transmission mount bracket.

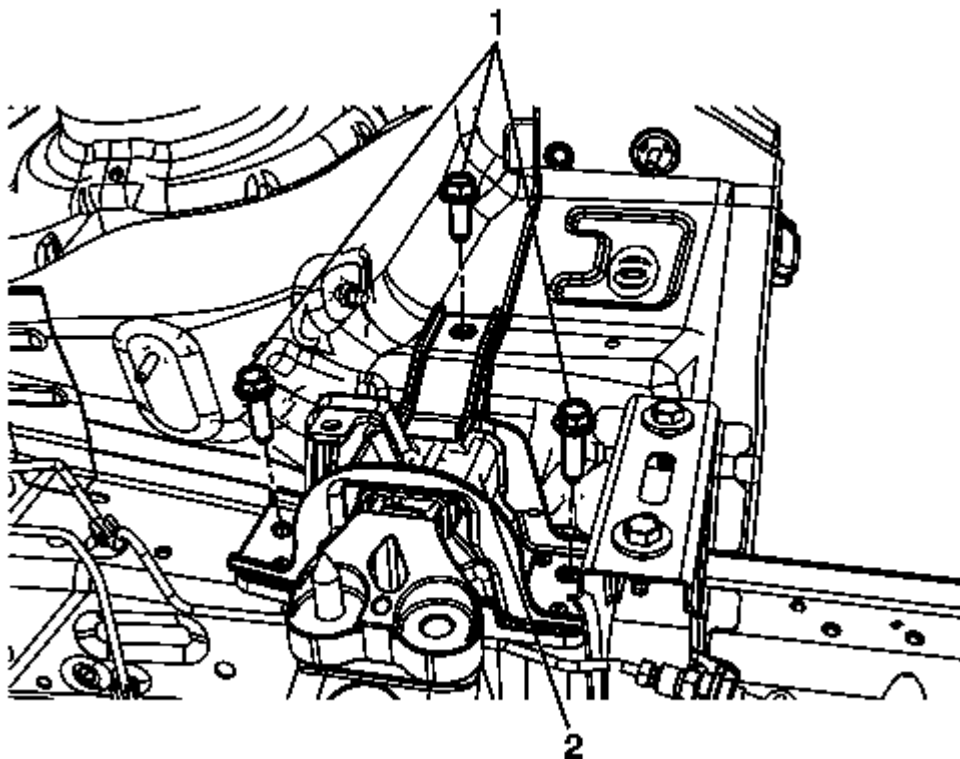


Fig. 108: Left Transmission Mount And Body Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the location of the bolts (1) and nut (2) before removing.

66. Remove the transmission mount retaining bolts (1) and the transmission mount (2).
67. Transfer parts as needed.

NOTE: Make sure that all the hoses, wires, pipes and front struts clear the vehicle during the removal process.

68. With the aid of an assistant, lower the engine lifter or raise the vehicle to remove the engine, transmission and cradle assembly from the vehicle.
69. Remove the starter. Refer to Starter Replacement .

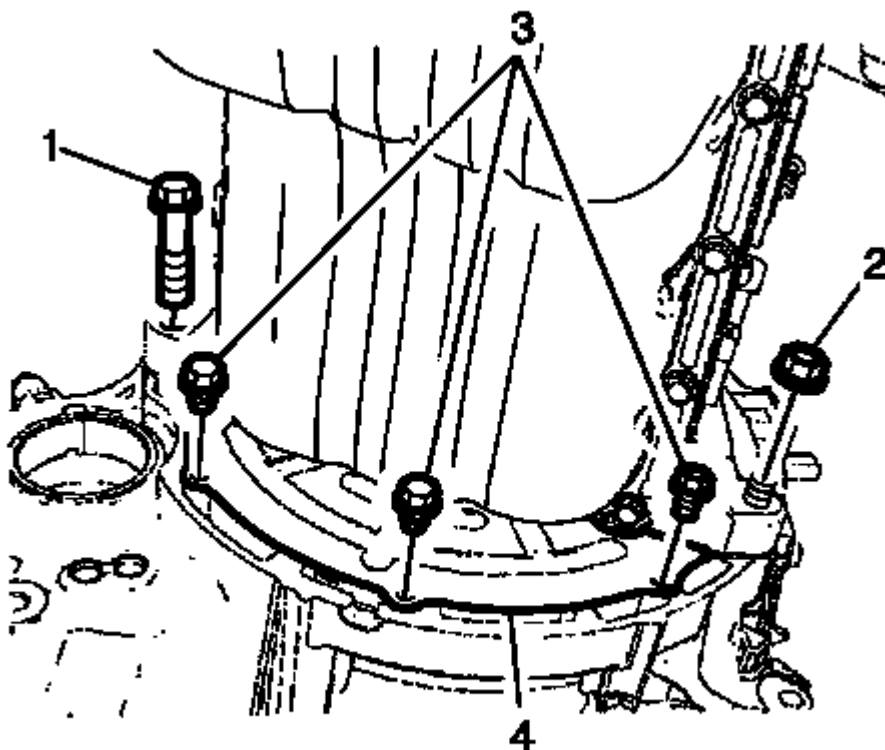


Fig. 109: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

70. Remove the lower transmission housing bolt (1) and nut (2).

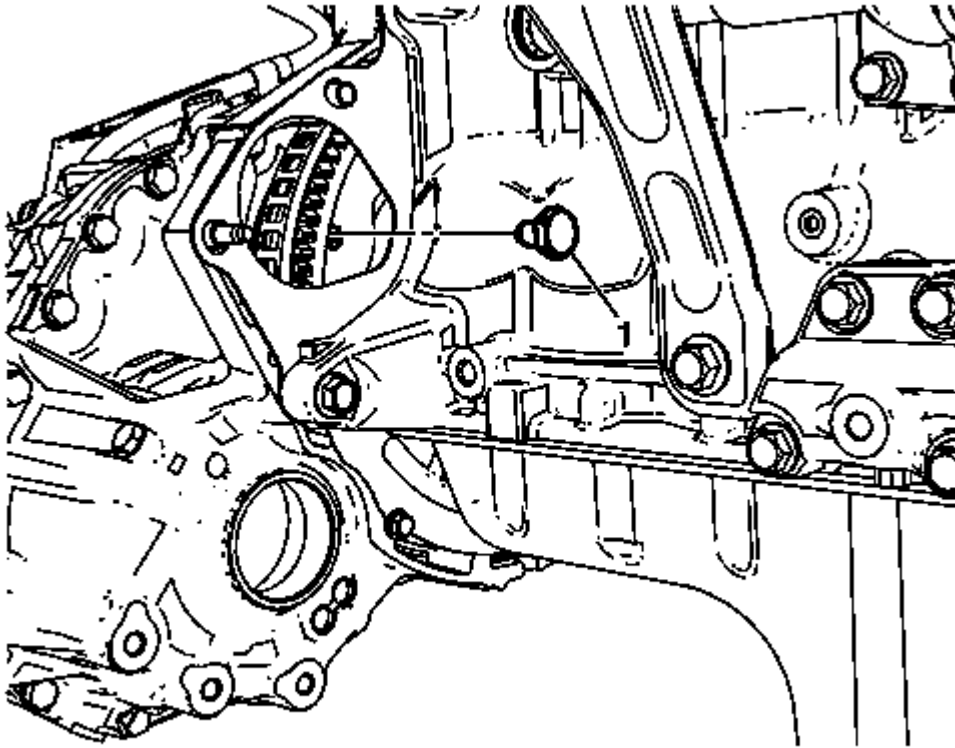


Fig. 110: Torque Converter Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Only rotate the engine in a clockwise direction only or engine damage will occur.

71. Remove the 3 torque converter bolts (1).

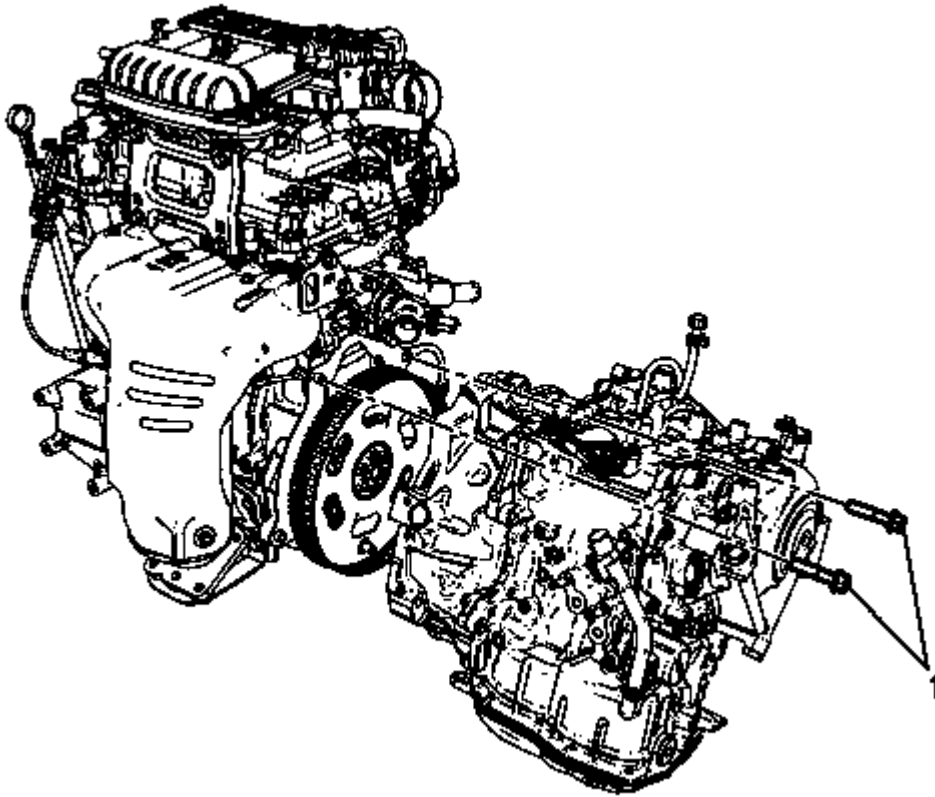


Fig. 111: Upper Transmission Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

72. Remove the upper transmission housing bolts (1) and separate the transmission from the engine.
73. Install the engine to an engine stand. (Using M10 x 1.25 approximately 130 mm long)
74. Transfer parts as needed.

Installation Procedure

1. Remove the engine from the engine stand.

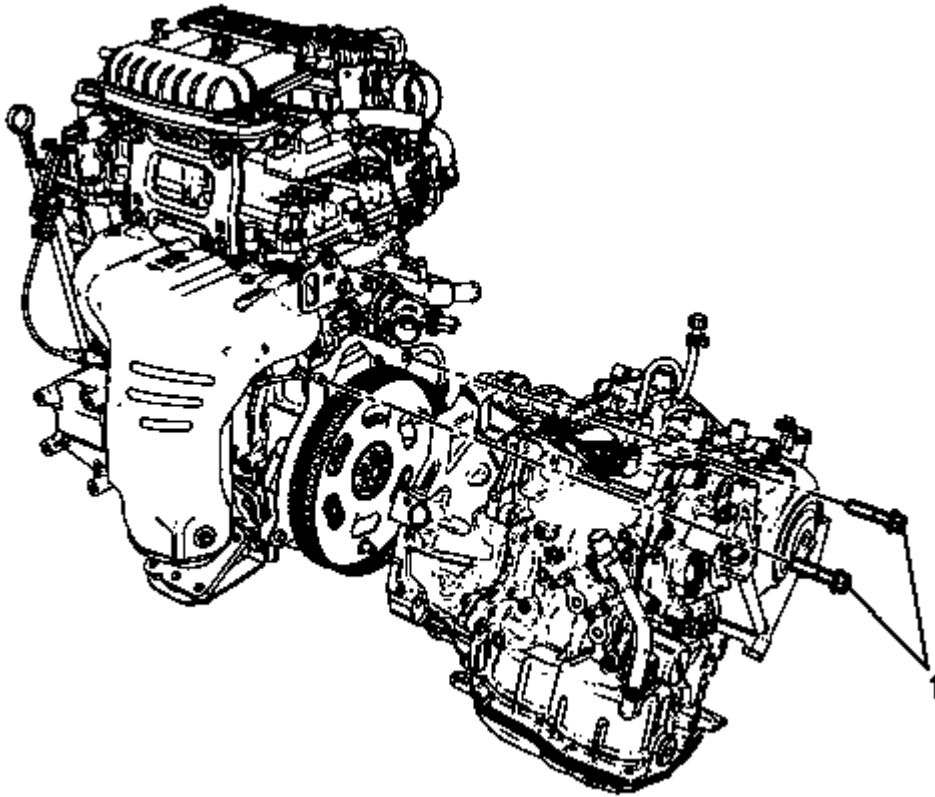


Fig. 112: Upper Transmission Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Combine the engine with the transmission and tighten upper auto transmission housing bolts (1) to 61 (44 lb ft).

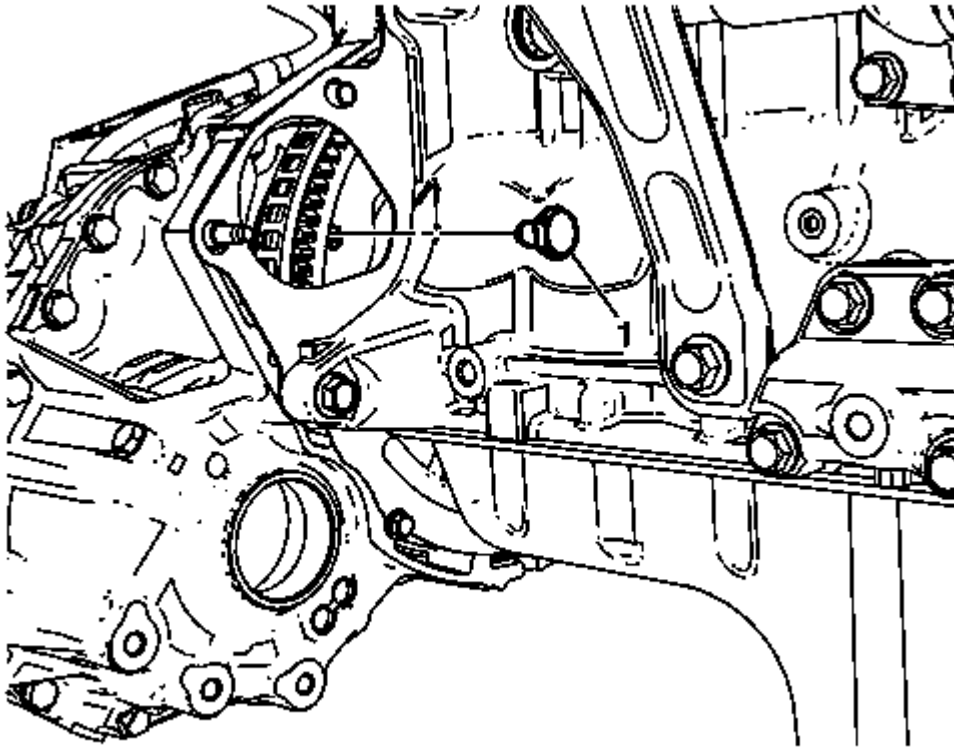


Fig. 113: Torque Converter Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Only rotate the engine in a clockwise direction only or engine damage will occur.

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

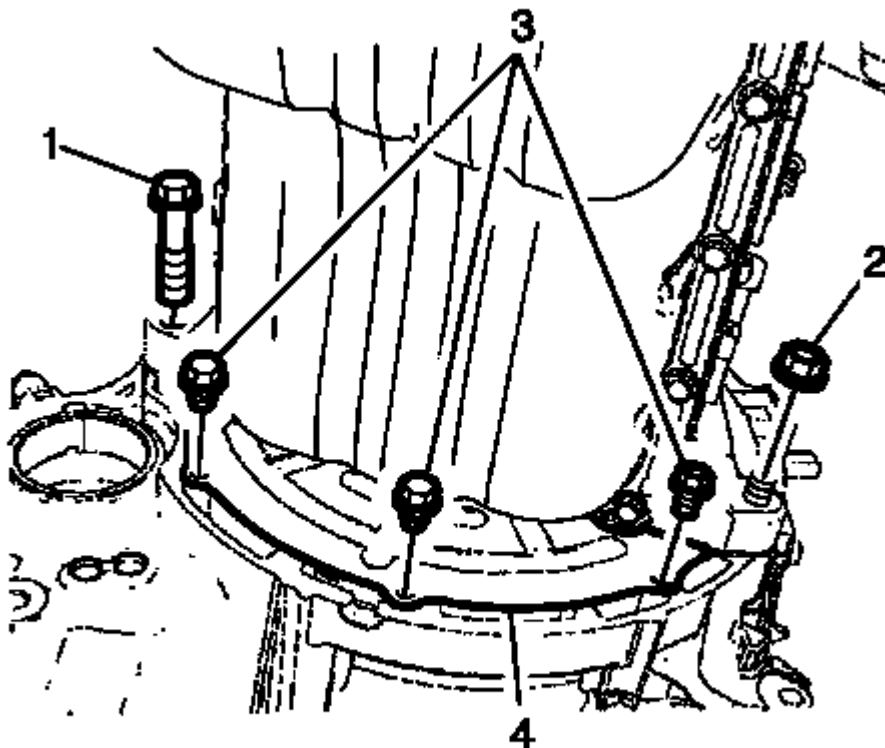


Fig. 114: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the lower transmission housing bolt (1) and nut (2) and tighten to 61 (45 lb ft).
5. Install the starter. Refer to **Starter Replacement** .

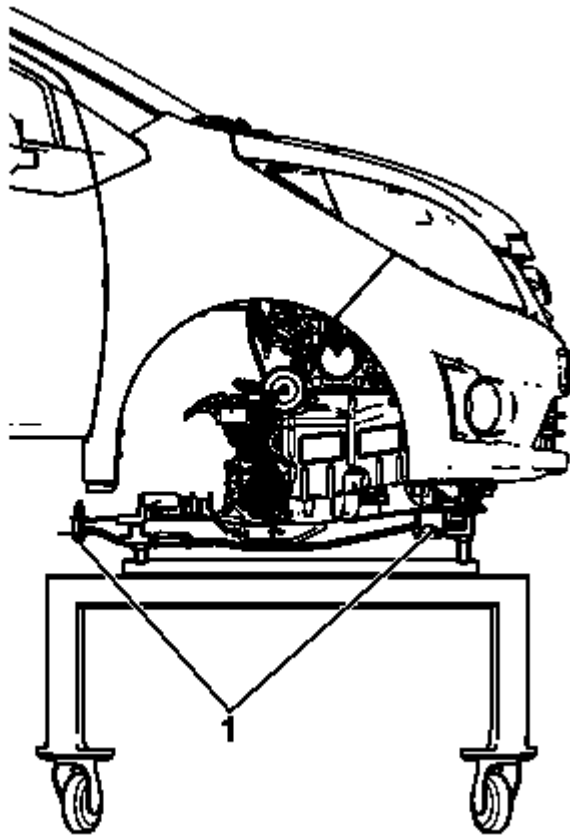


Fig. 115: View Of Cradle Bolts

Courtesy of GENERAL MOTORS COMPANY

6. With the aid of an assistant, raise the engine lifter or lower the vehicle to install the engine, transmission and cradle assembly to the vehicle.
7. Tighten the 4 cradle bolt (1) to 135 (100 lb ft).

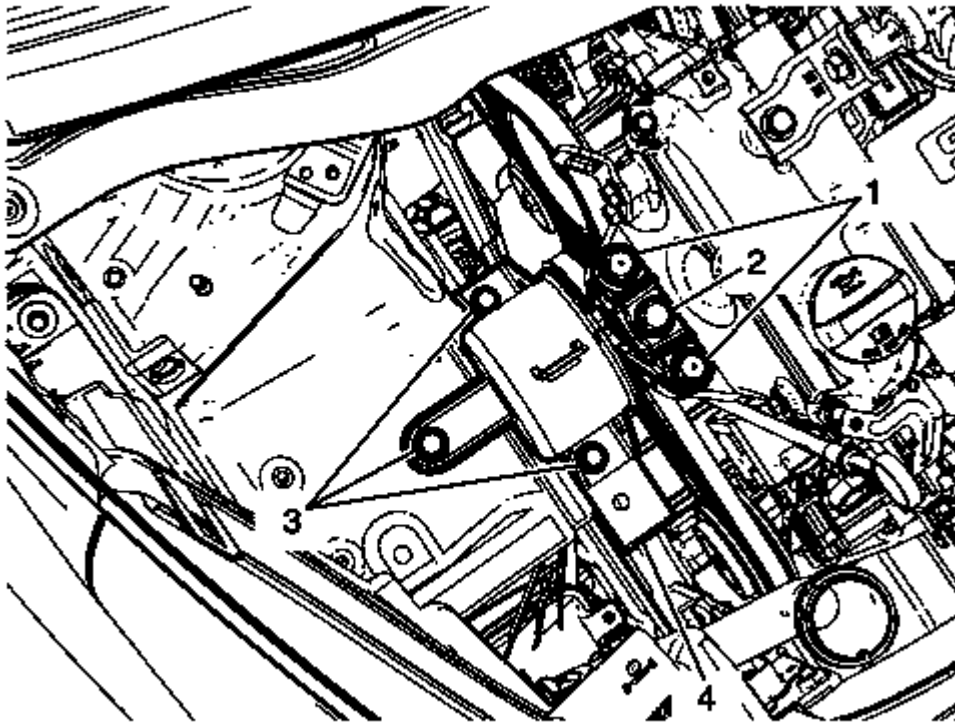


Fig. 116: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine mount and the engine mount bolts and nuts.
9. Tighten the engine mount retaining nuts (1) to 66 (49 lb ft).
10. Tighten the engine mount retaining bolt (2) to 66 (49 lb ft).
11. Tighten the engine mount retaining bolts (3) to 50 (37 lb ft).

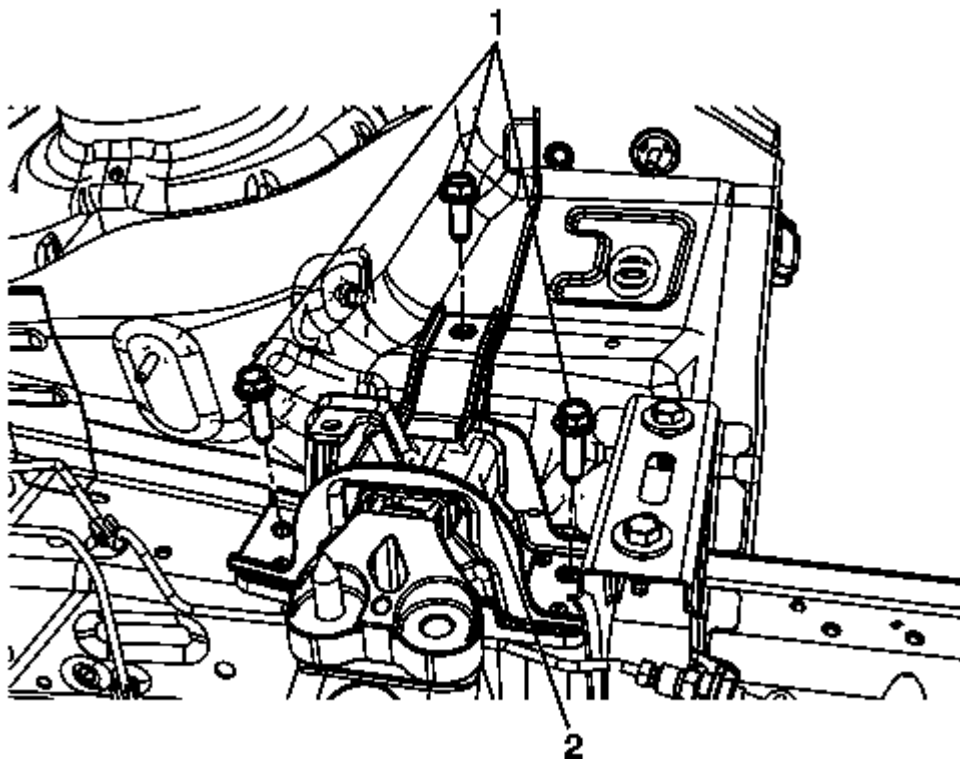


Fig. 117: Left Transmission Mount And Body Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install the transmission mount (2) and the transmission mount bolts (1).
13. Tighten to 50 (37 lb ft).

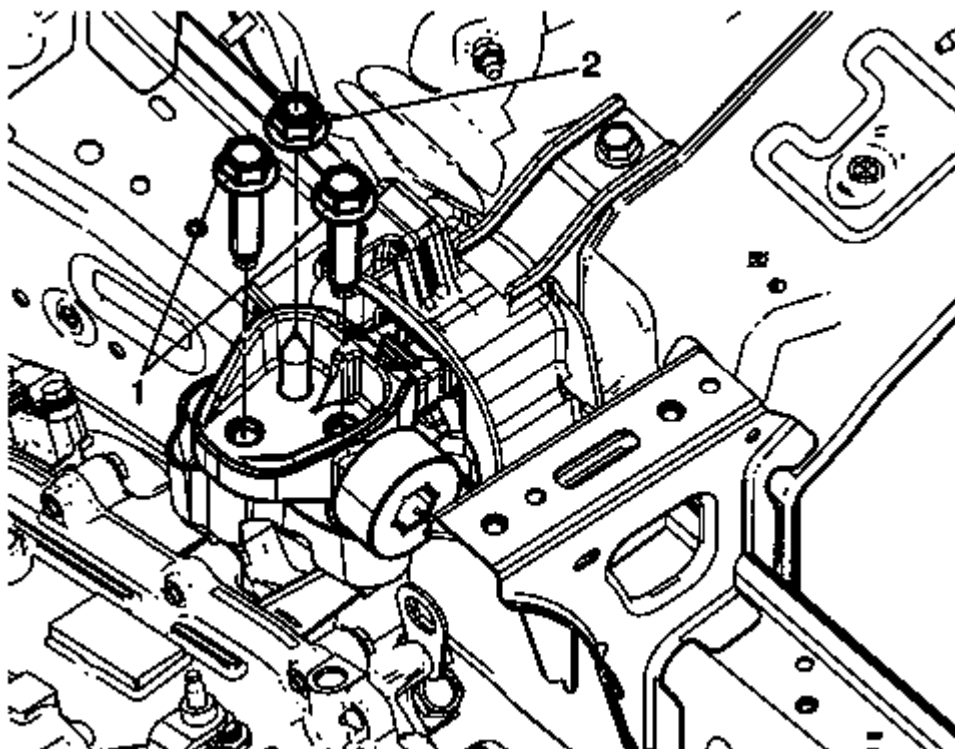


Fig. 118: Location Of Bolts And Nut

Courtesy of GENERAL MOTORS COMPANY

14. Install the left transmission mount bolts (1) and nut (2) to the transmission mount bracket (2) and tighten to 95 (70 lb ft).
15. Connect additional electrical connections as necessary.

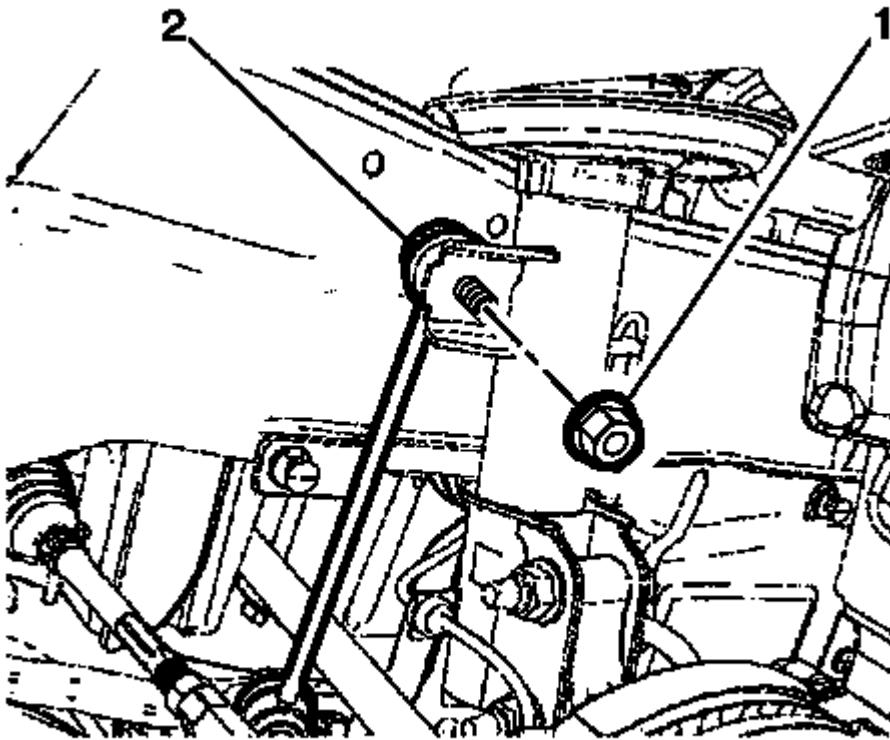


Fig. 119: Front Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

16. Install the front upper stabilizer shaft link (2) and the front upper stabilizer shaft link nut (1).
17. Tighten to 43 (32 lb ft). Repeat for opposite side.

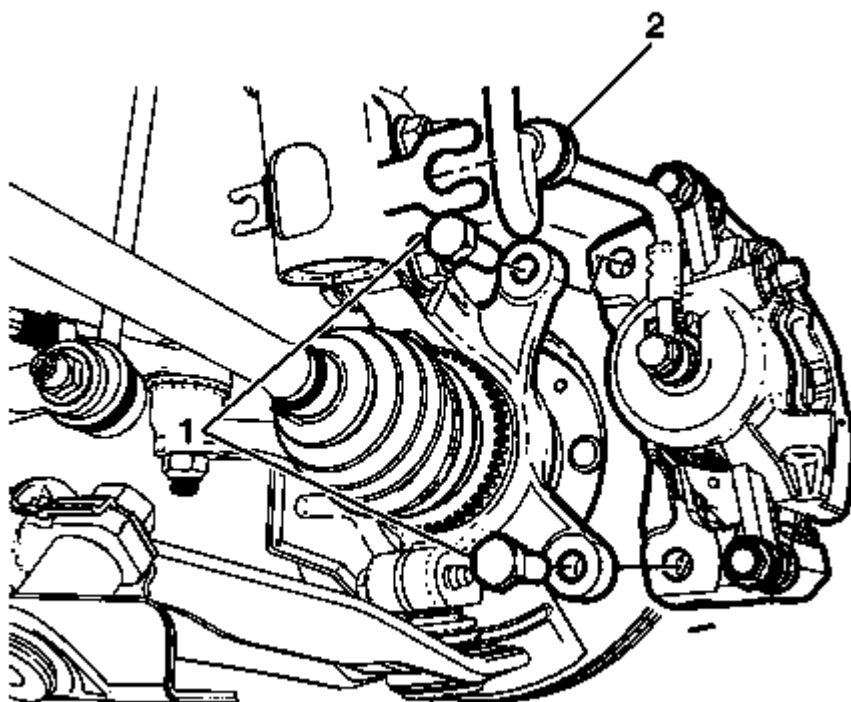


Fig. 120: Front Brake Hose And Front Brake Caliper Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the front brake caliper and tighten the front brake caliper bolts (1) to 95 (70 lb ft).
19. Install the front brake hose (2) to the strut mounted brake hose retaining bracket. Repeat for opposite side.
20. Install the outer tie rod assembly from the steering knuckle. Repeat for opposite side. Refer to **Steering Linkage Outer Tie Rod Replacement** .
21. Install the wheel drive shaft to the front steering knuckle. Refer to **Front Wheel Drive Shaft Replacement** .
22. Install the wheel drive shaft nut and washer to the wheel drive shaft. Repeat for opposite side. Refer to **Front Wheel Drive Shaft Replacement** .
23. Install the control arm ball joint to the steering knuckle. Repeat for opposite side. Refer to **Lower Control Arm Replacement** .

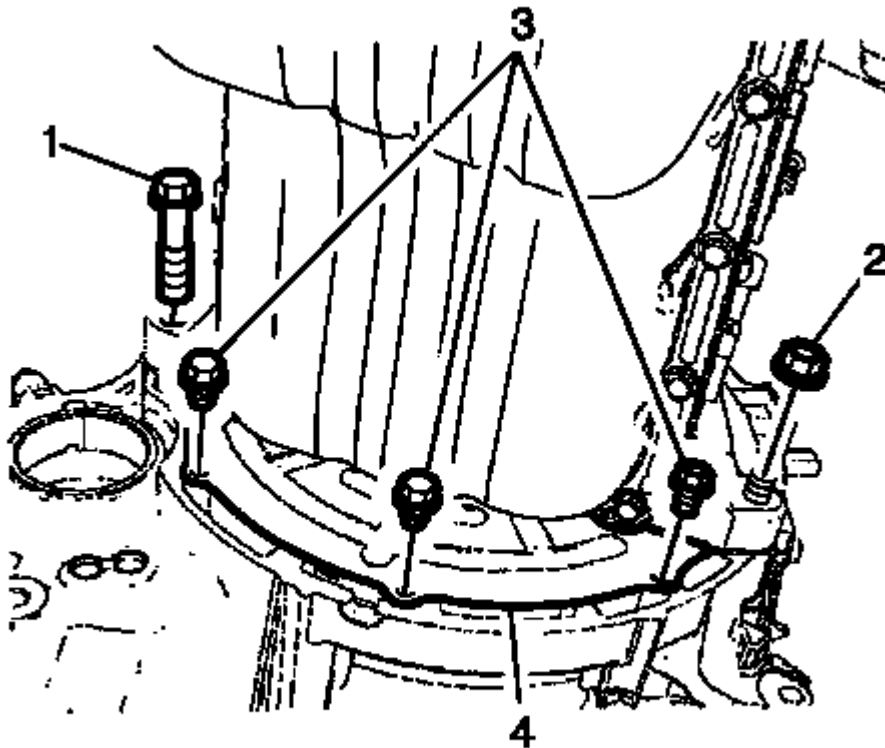


Fig. 121: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Install the transmission dust cover (4) and tighten the transmission dust cover bolts (3) to 9 (80 lb ft).
25. Install the transmission rear mount bracket. Refer to **Transmission Rear Mount Bracket Replacement** .
26. Install the exhaust pipe. Refer to **Exhaust Pipe Replacement (LFM)** .

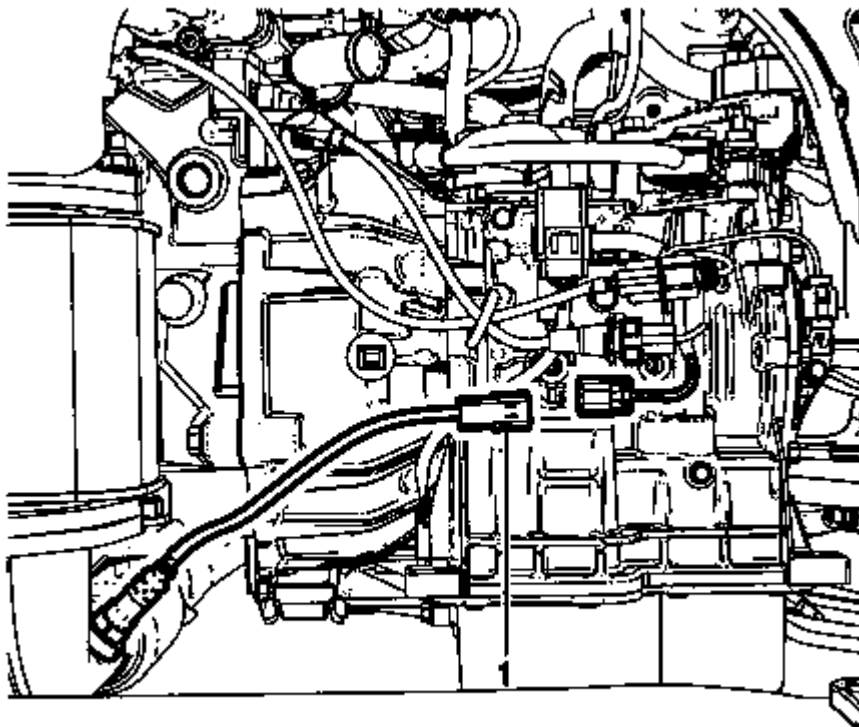


Fig. 122: Oxygen Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

27. Connect the oxygen sensor connector.

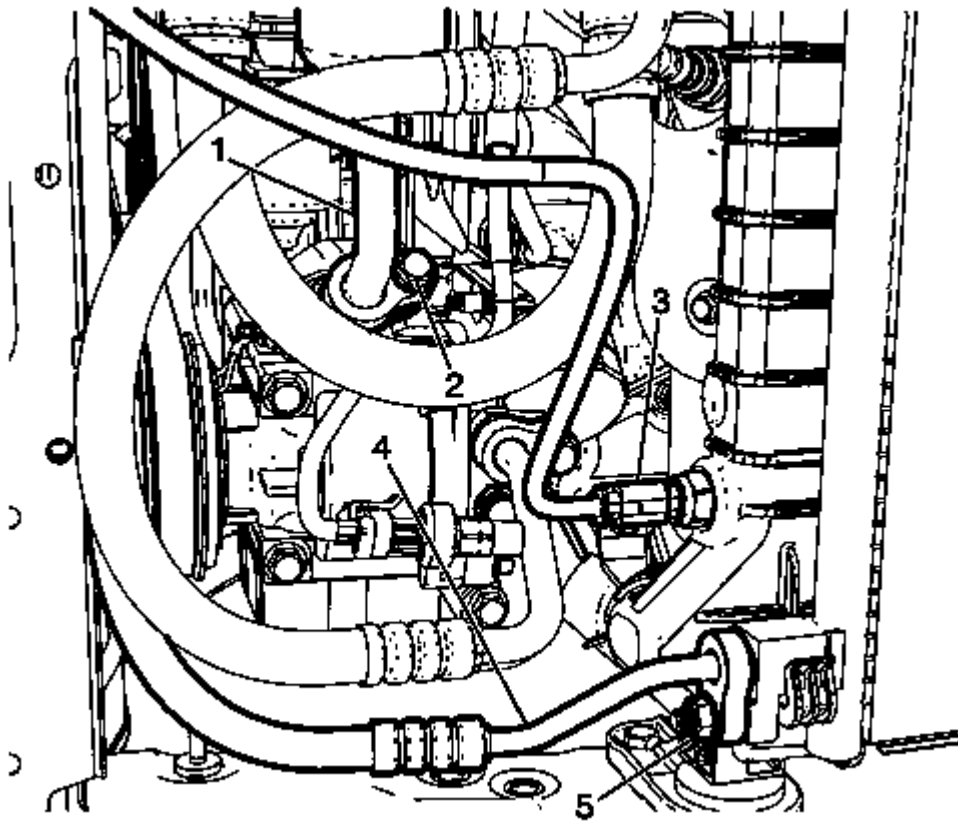


Fig. 123: Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

28. Install the suction pipe (1) to the A/C compressor.
29. Install the suction pipe bolt (2) to the A/C compressor and tighten to 22 (16 lb ft).
30. Install the discharge pipe (4) to the A/C condenser.
31. Install the discharge pipe nut (5) to the A/C condenser and tighten to 10 (89 lb in).
32. Connect the coolant temperature sensor wiring connector (3) from the radiator.

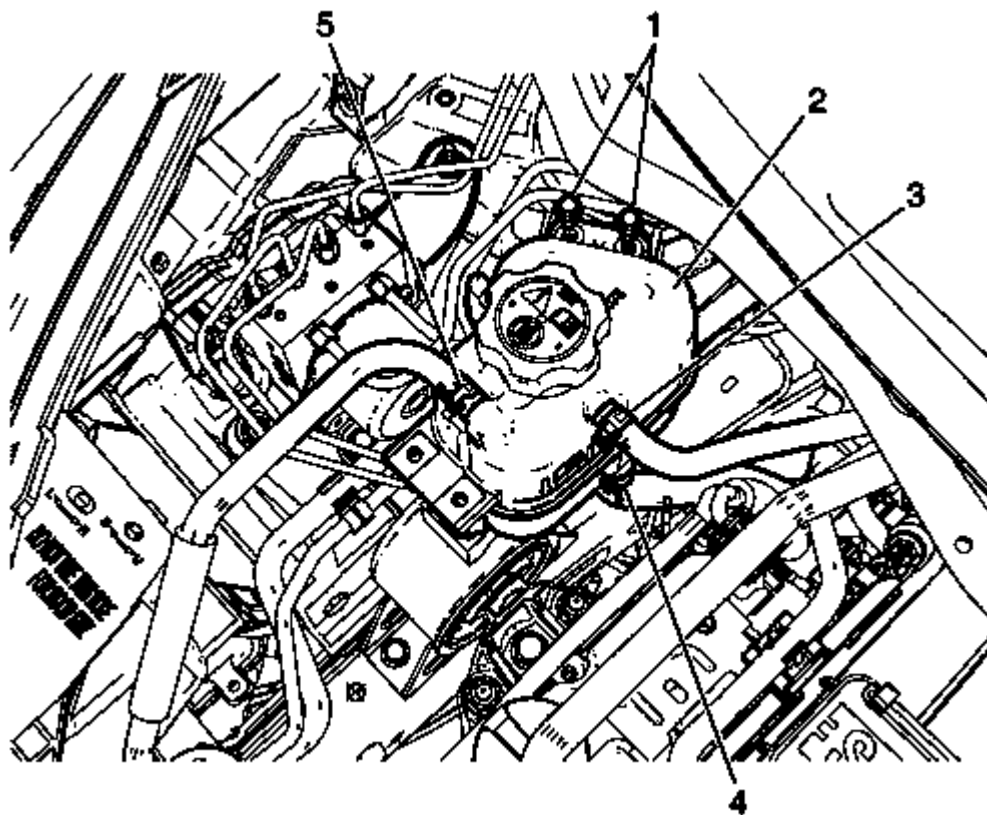


Fig. 124: Coolant Surge Tank

Courtesy of GENERAL MOTORS COMPANY

33. Install the coolant surge tank (2) and coolant hoses with the coolant hose clips (3, 4, 5).
34. Install the coolant surge tank retaining bolts (1) and tighten to 8 (71 lb in).

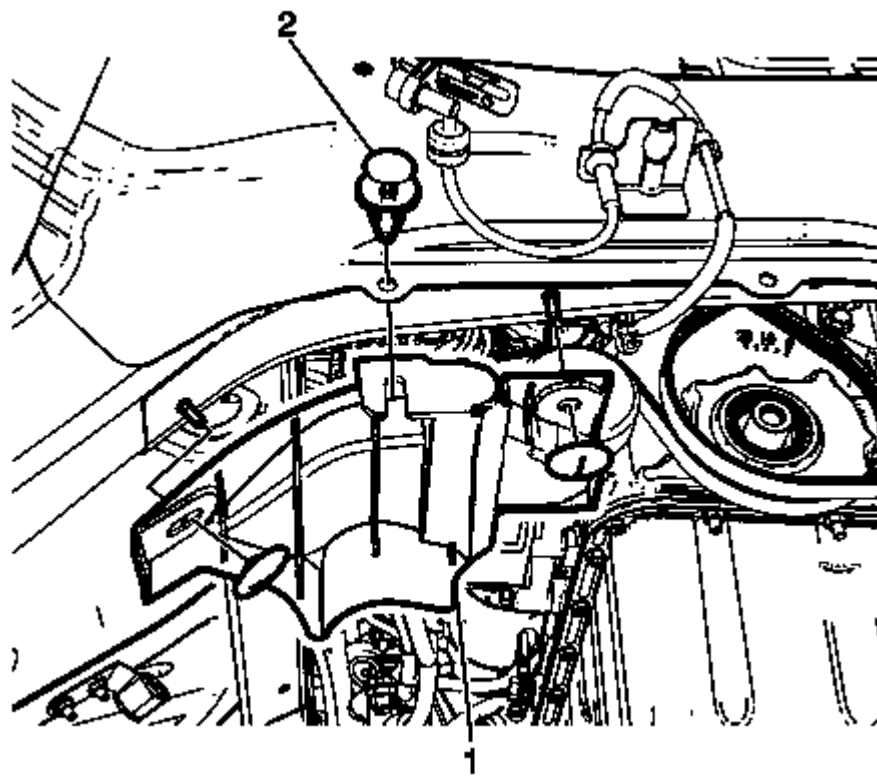


Fig. 125: Retainers And Water Deflector
Courtesy of GENERAL MOTORS COMPANY

35. Install the water deflector (1) with retainers (2).

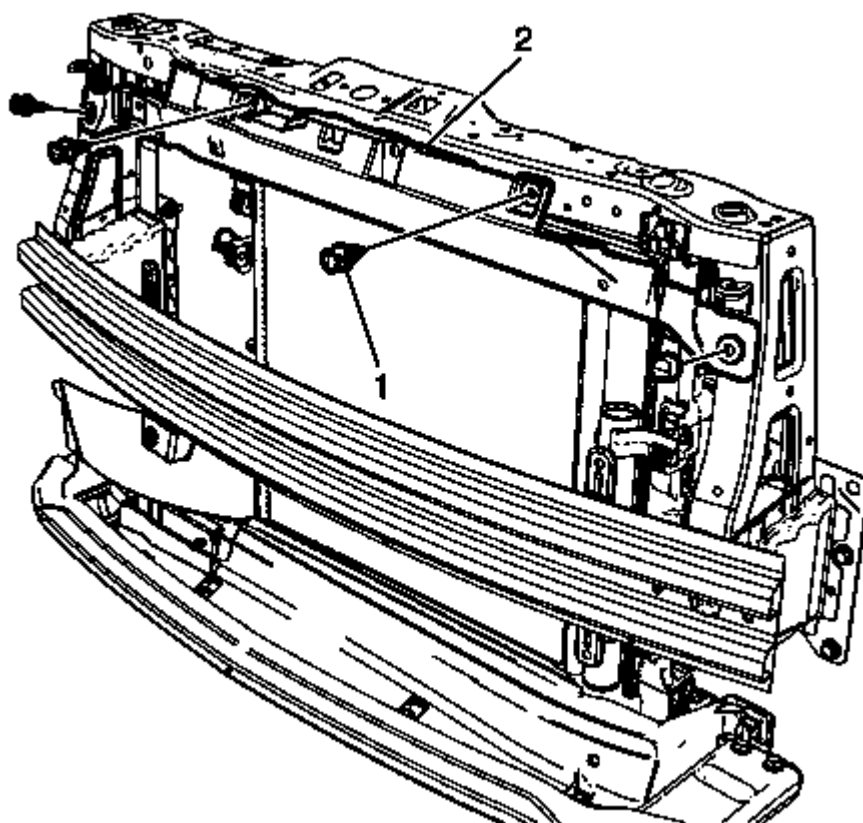


Fig. 126: Upper Air Guard Retainers
Courtesy of GENERAL MOTORS COMPANY

36. Install the upper air guard (2) and the upper air guard retainers (1).

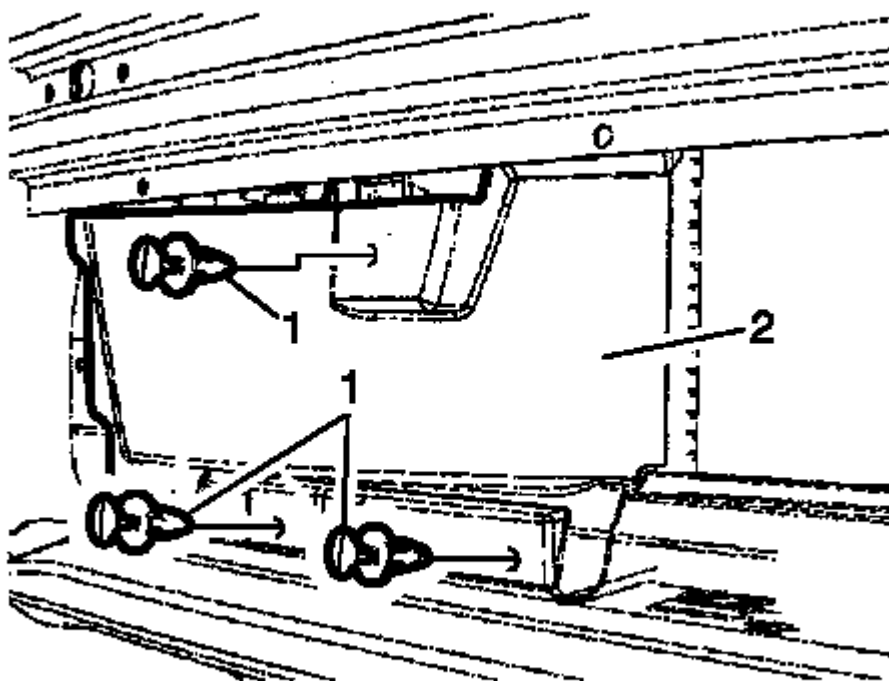


Fig. 127: Front Lower Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

37. Install the front lower air baffles (2) and the front lower air baffle retainers (1).

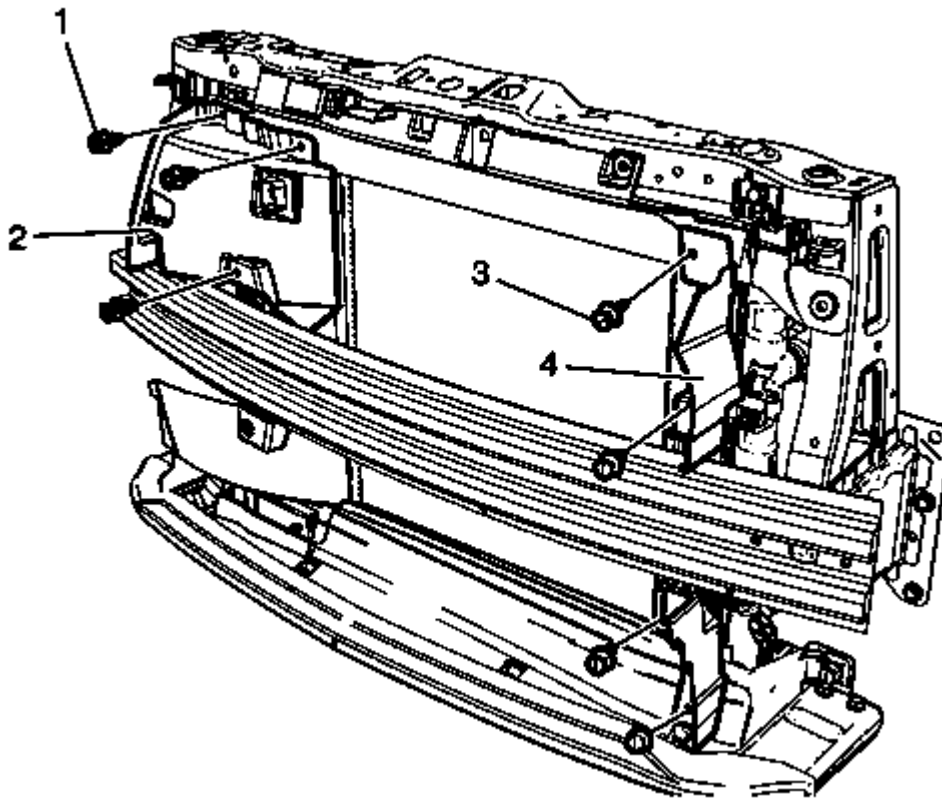


Fig. 128: Front Side Air Baffle Retainers
 Courtesy of GENERAL MOTORS COMPANY

38. Install the front side air baffles (2, 4) and the front side air baffle retainers (1, 3).
39. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

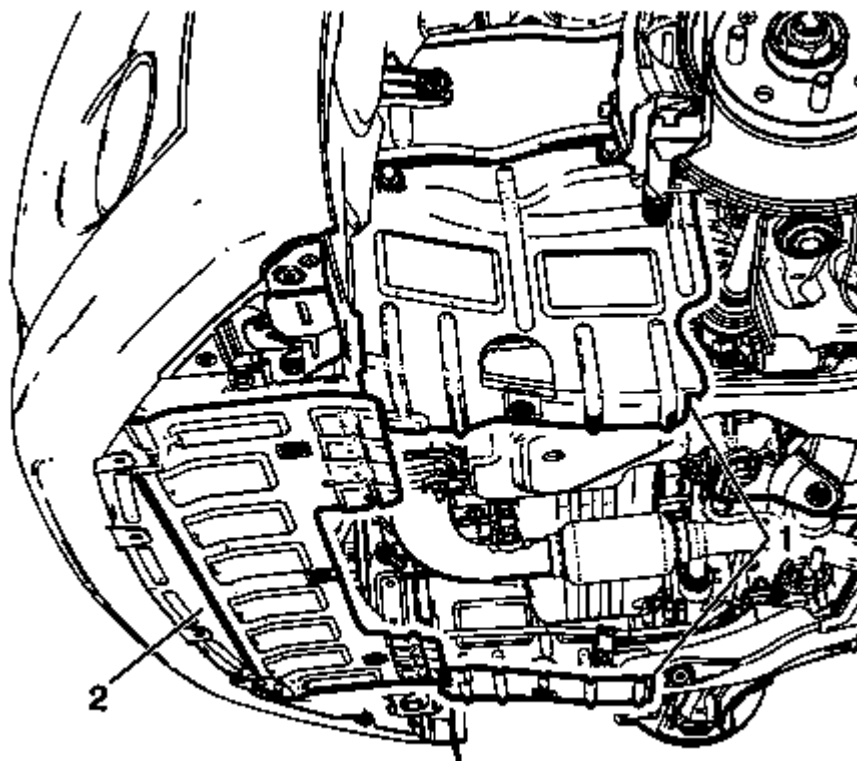


Fig. 129: Compartment Splash Shield

Courtesy of GENERAL MOTORS COMPANY

40. Install the compartment splash shield (1, 2). Refer to **Front Compartment Splash Shield Replacement** .

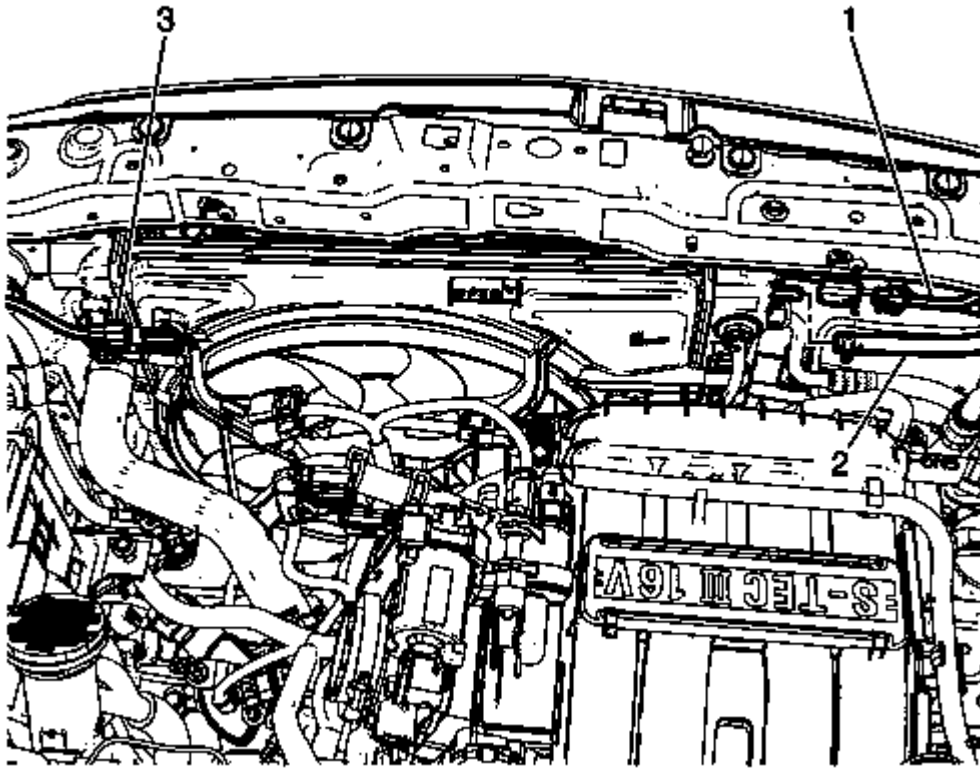


Fig. 130: Ambient Air Temperature Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

41. Connect the coolant hose (2) to the radiator.
42. Connect the ambient air temperature sensor connector (1) to the ambient air temperature sensor if equipped.
43. Install the wiring harness connector (3) to the engine cooling fan harness connector.

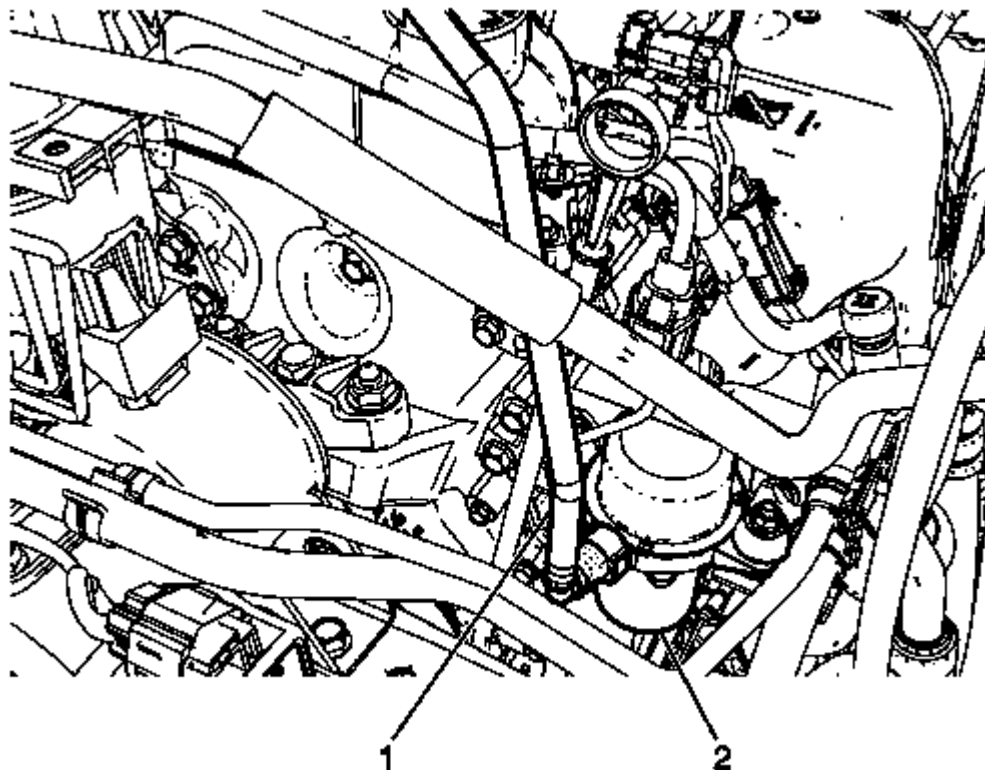


Fig. 131: Vacuum Pump Hose And Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

44. Install the vacuum pump hose (1) to the vacuum pump (2).

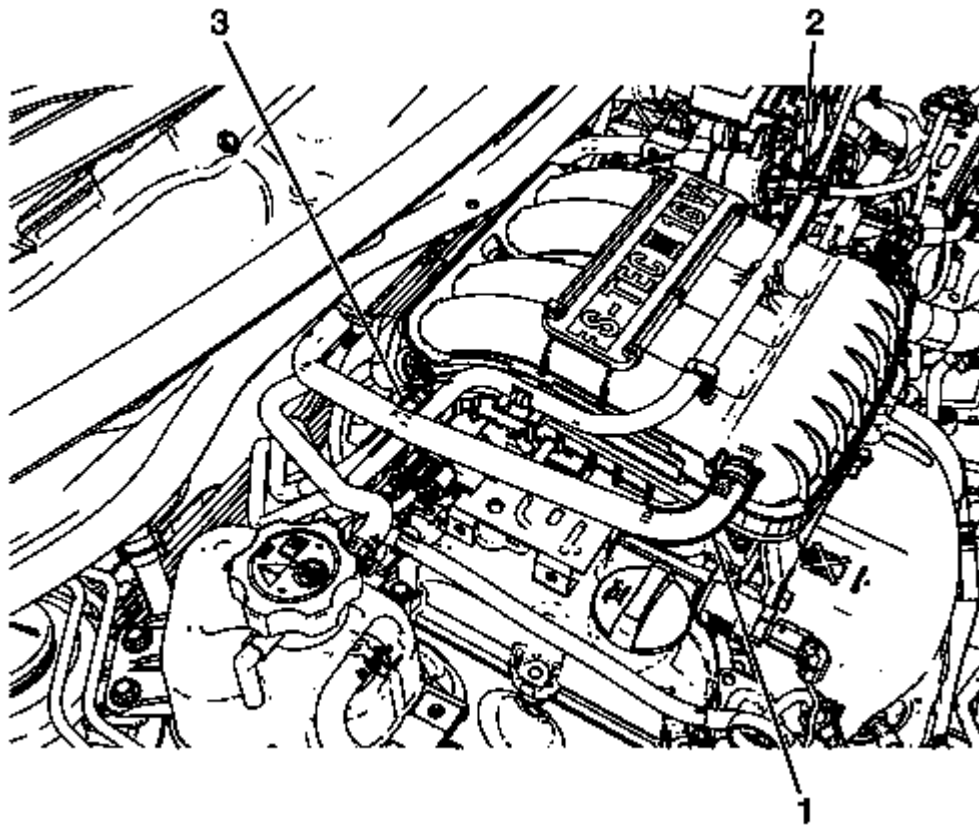


Fig. 132: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

45. Connect the fuel feed hose (3).
46. Connect the evaporative canister purge solenoid valve hose (2).
47. Connect the vacuum hose (1) to the intake manifold.

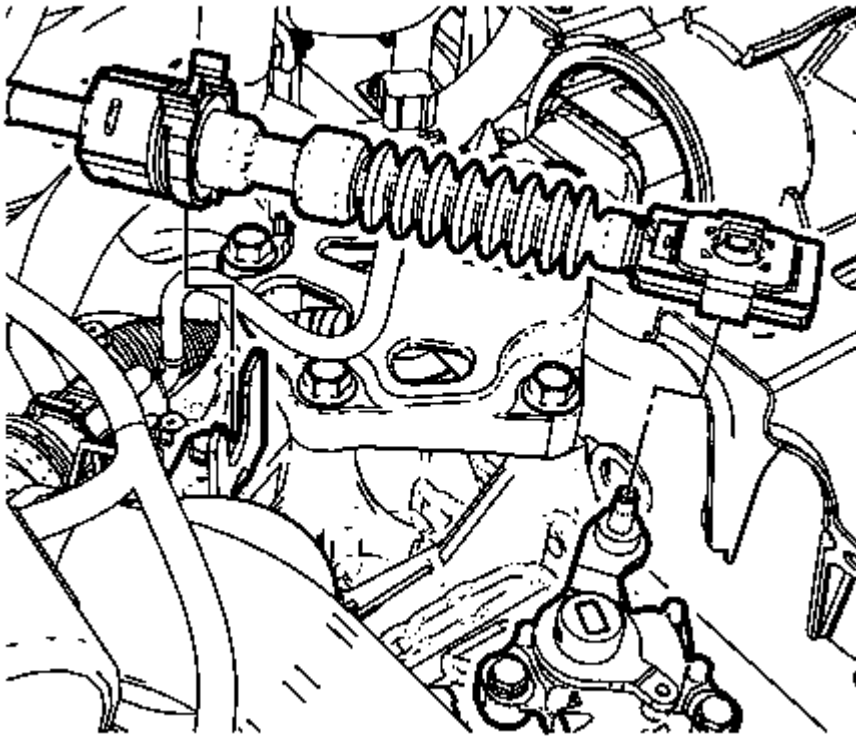


Fig. 133: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

48. Connect the transmission range selector lever cable terminal to the transmission lever pin.
49. Install the transmission range selector lever cable to the cable bracket.
50. Install the heater inlet hose. Refer to **Heater Inlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.
51. Install the heater outlet hose. Refer to **Heater Outlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.

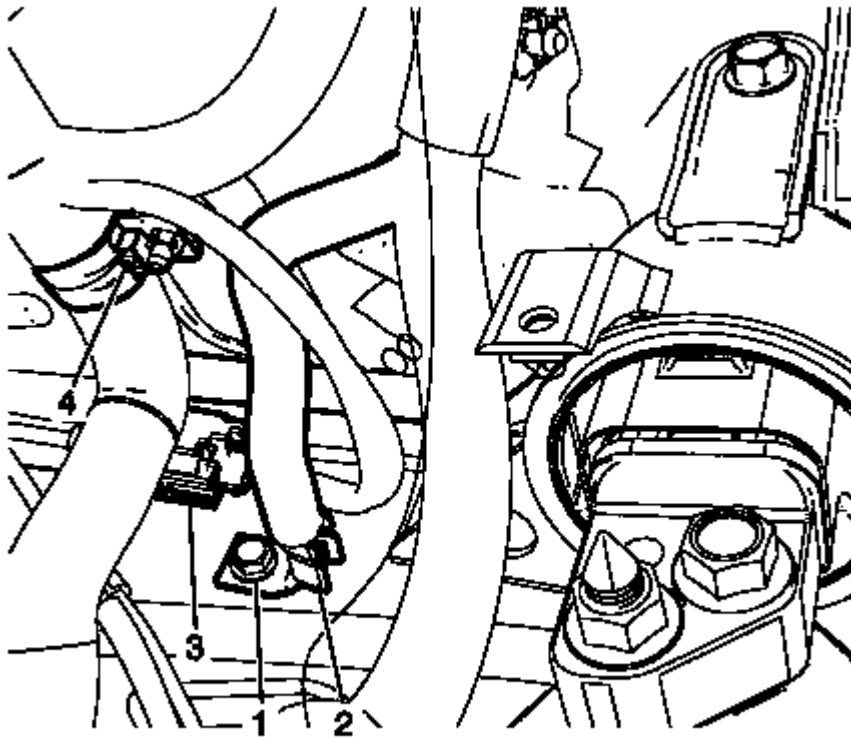


Fig. 134: Ground Bolt And Put Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

52. Install the wiring harness retainer (4).
53. Connect the wheel speed sensor connector (3).
54. Install the ground wiring harness and bolt (1) and tighten to 10 (89 lb in).

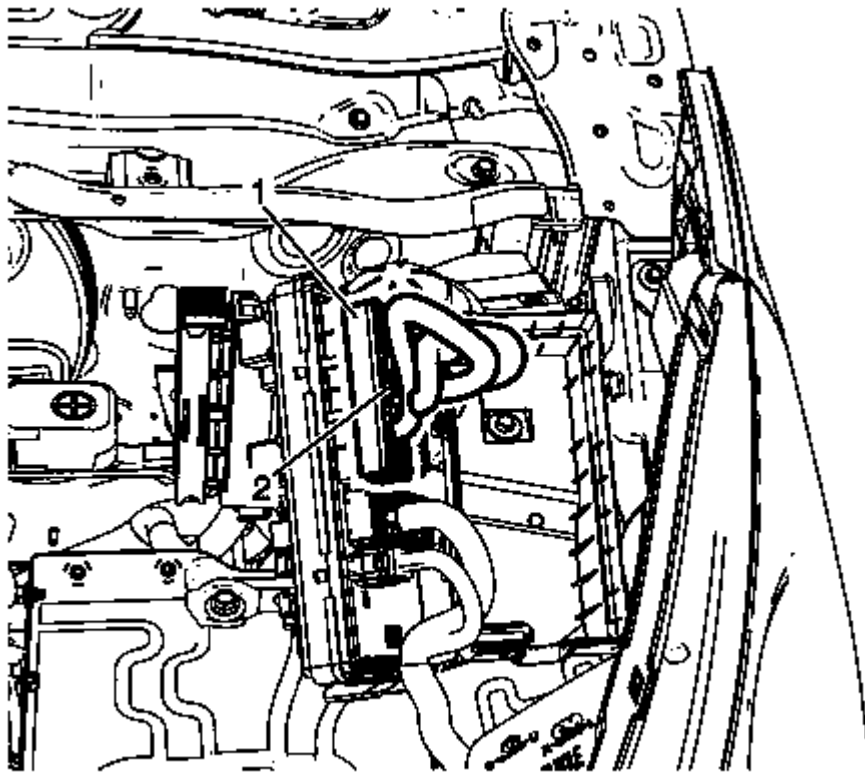


Fig. 135: Front Compartment Fuse Block

Courtesy of GENERAL MOTORS COMPANY

55. Connect the engine wiring harness connector (1) to the fuse block and tighten the wiring harness connector retaining bolt (2) to 6 (53 lb in). Repeat for remaining connector.
56. Connect the remaining wiring harness to the compartment fuse block.
57. Install the engine wiring harness fuse block to the lower plate.

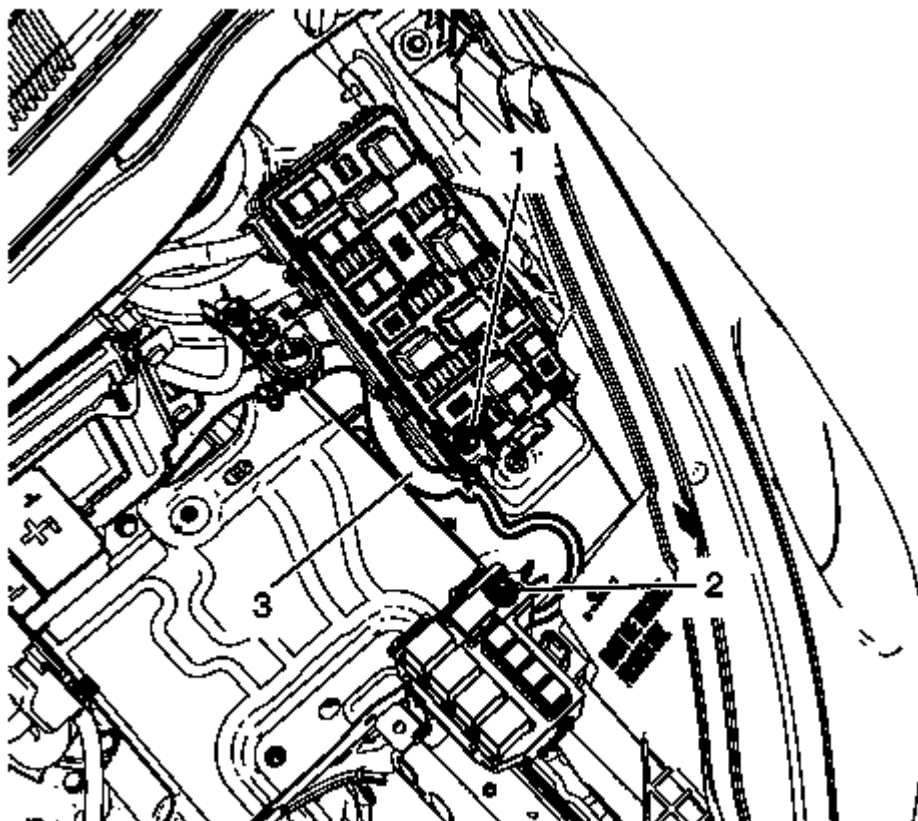


Fig. 136: Positive Battery Cable Nut

Courtesy of GENERAL MOTORS COMPANY

58. Install the positive cable (3) to the engine wiring harness fuse block and tighten the positive cable retaining nut (1, 2) to 10 (89 lb in).

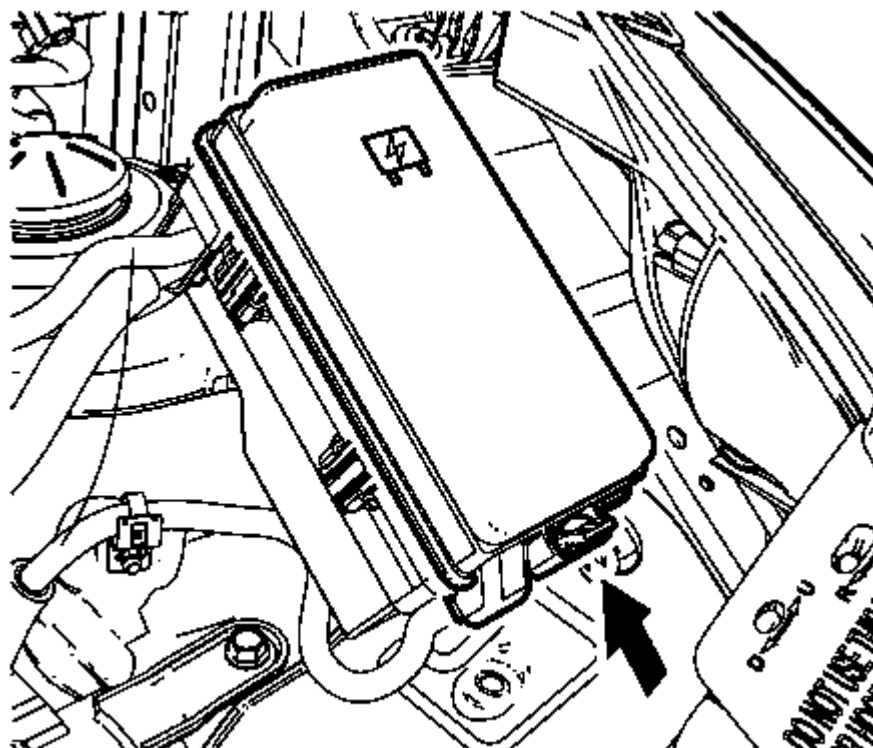


Fig. 137: Front Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

59. Install the engine wiring harness fuse block cover.

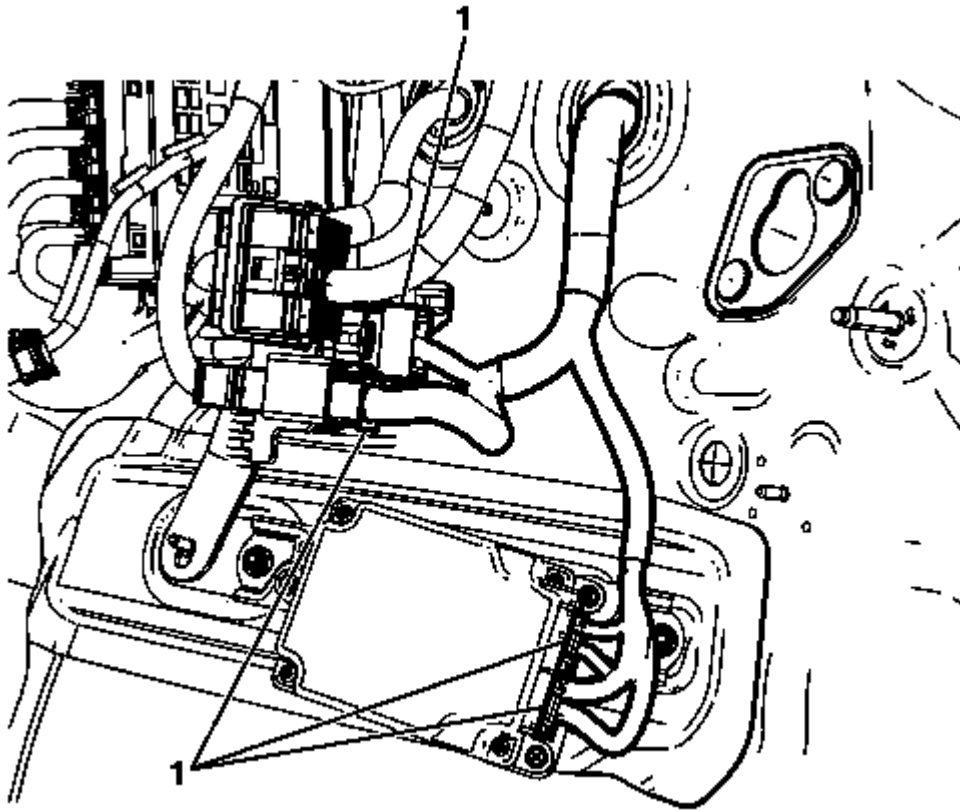


Fig. 138: Engine Wiring Harnesses Connectors

Courtesy of GENERAL MOTORS COMPANY

60. Install the engine wiring harness through the front of dash on the left of the steering shaft under the dash and connect the 4 engine wiring harnesses connectors (1).

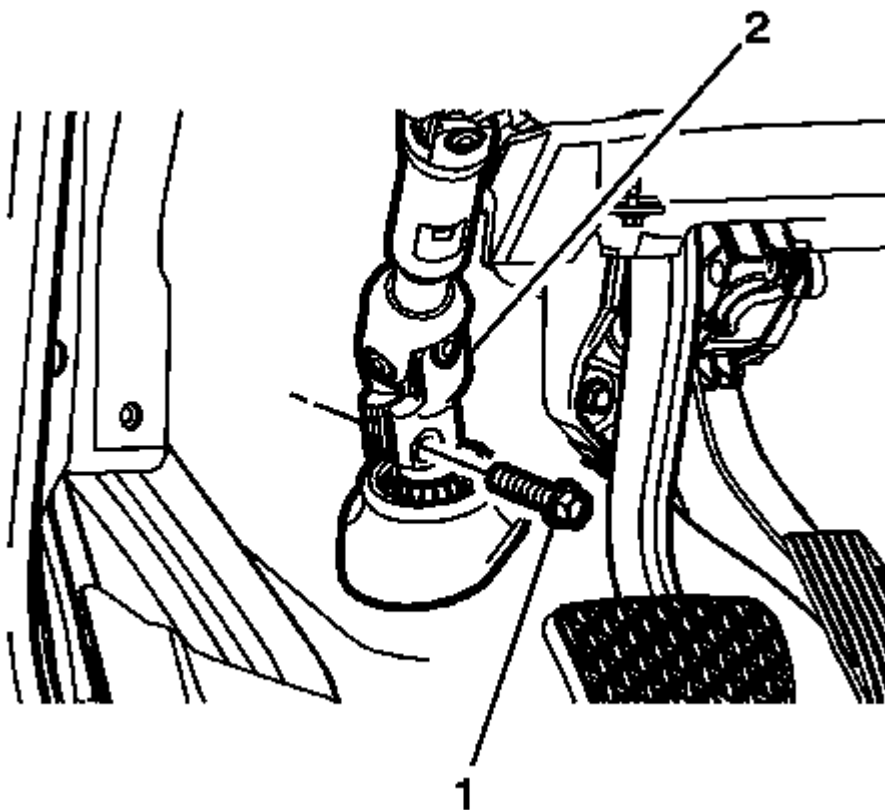


Fig. 139: Lower Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

61. Install the lower intermediate steering shaft (2) and tighten the lower intermediate steering shaft bolt (1) to 27 (20 lb ft).
62. Install the battery tray. Refer to **Battery Tray Replacement** .
63. Install the engine control module. Refer to **Engine Control Module Replacement** .
64. Install the battery. Refer to **Battery Replacement** .
65. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
66. Install the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
67. Recharge the refrigerant. Refer to **Refrigerant Recovery and Recharging** .
68. Refill the cooling system. Refer to **Cooling System Draining and Filling** .
69. Check the engine oil level and fill new engine oil up if necessary.
70. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
71. Close the hood.

ENGINE REPLACEMENT (LL0)

Removal Procedure

1. Open the hood.
2. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .
3. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .
5. Drain the cooling system. Refer to Cooling System Draining and Filling .
6. Recover the refrigerant. Refer to Refrigerant Recovery and Recharging .
7. Remove the front wheels and tires. Refer to Tire and Wheel Removal and Installation .
8. Remove the air cleaner assembly. Refer to Air Cleaner Assembly Replacement .
9. Remove the battery. Refer to Battery Replacement .
10. Remove the engine control module. Refer to Engine Control Module Replacement .
11. Remove the battery tray. Refer to Battery Tray Replacement .

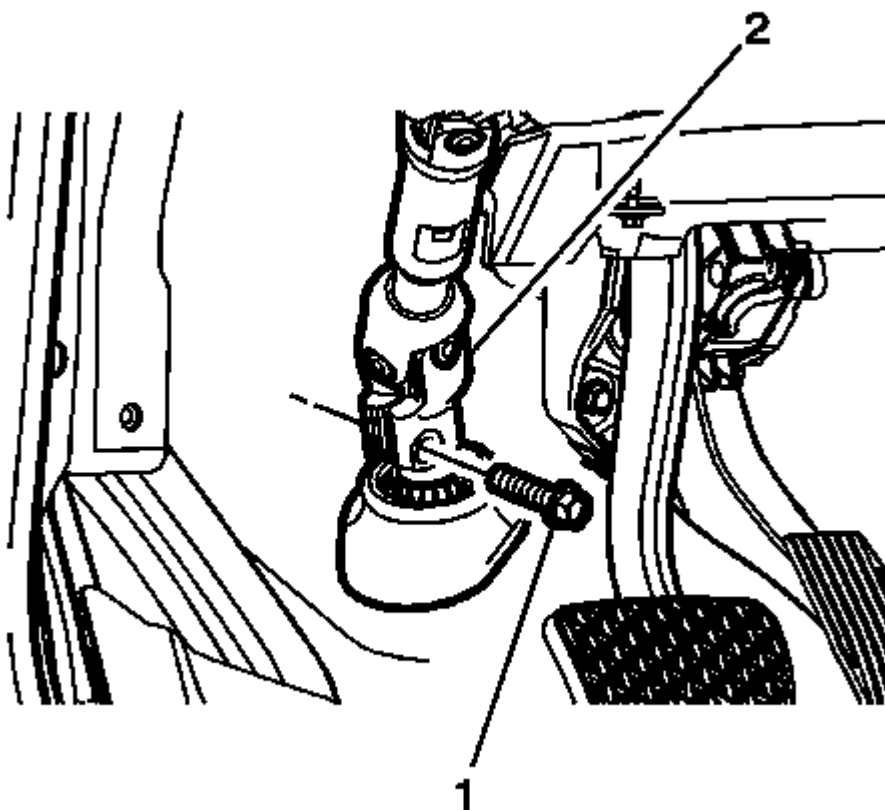


Fig. 140: Lower Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the lower intermediate steering shaft bolt (1) and detach the lower Intermediate steering shaft (2).

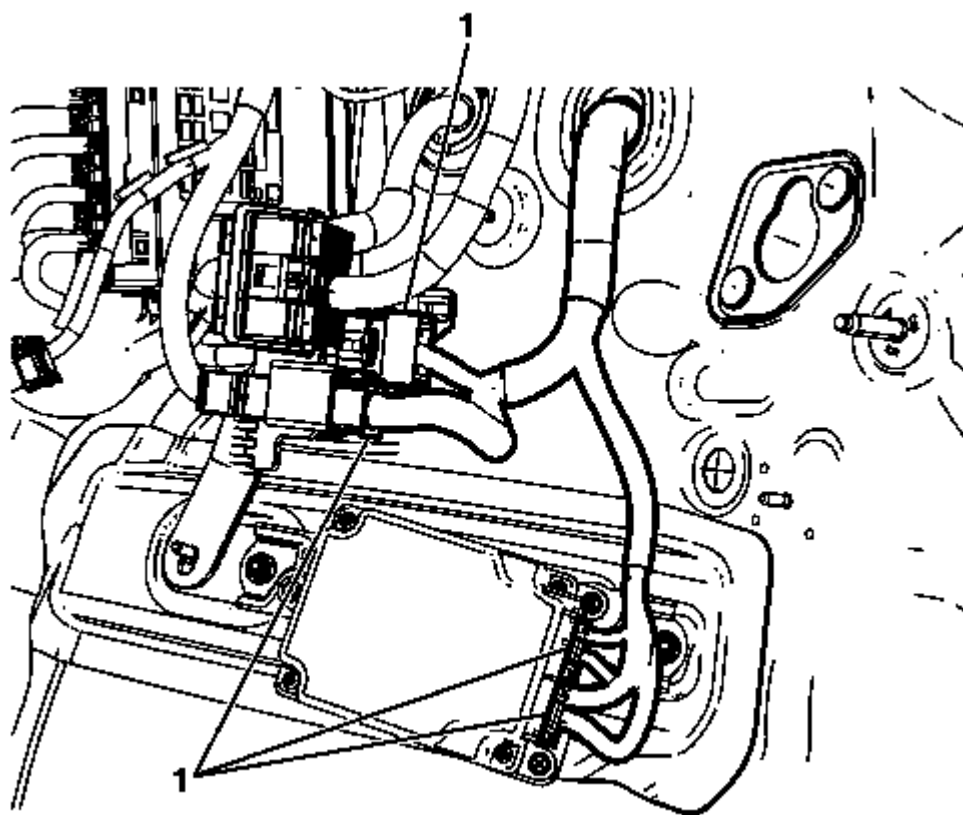


Fig. 141: Engine Wiring Harnesses Connectors

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect 4 engine wiring harnesses connectors (1) from under dash, left of the steering shaft and pull out the engine wiring harnesses through the front of dash to the engine compartment.

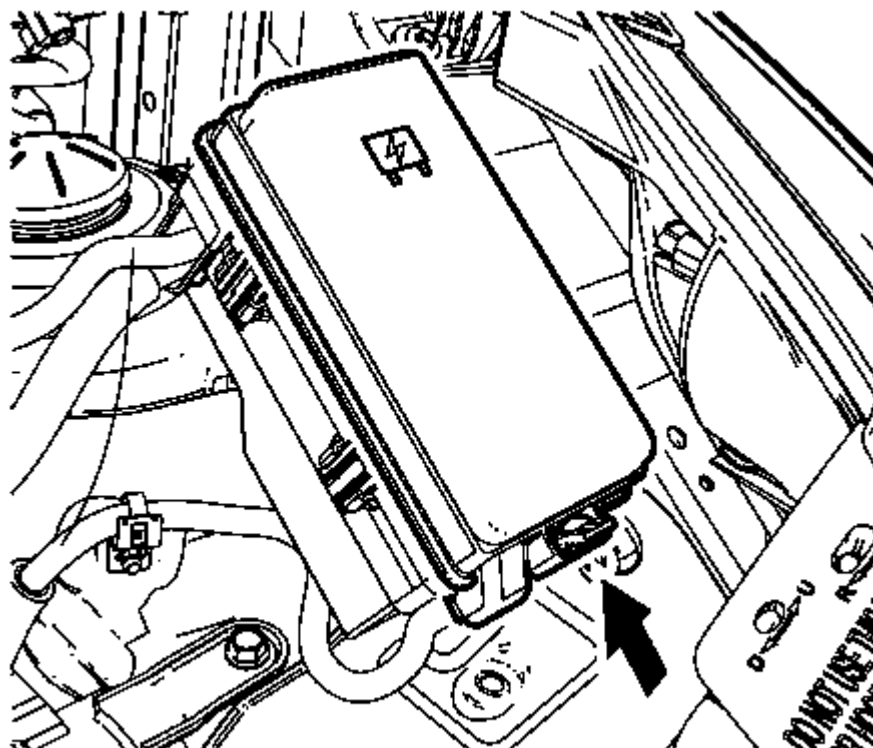


Fig. 142: Front Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

14. Remove the engine wiring harness fuse block cover.

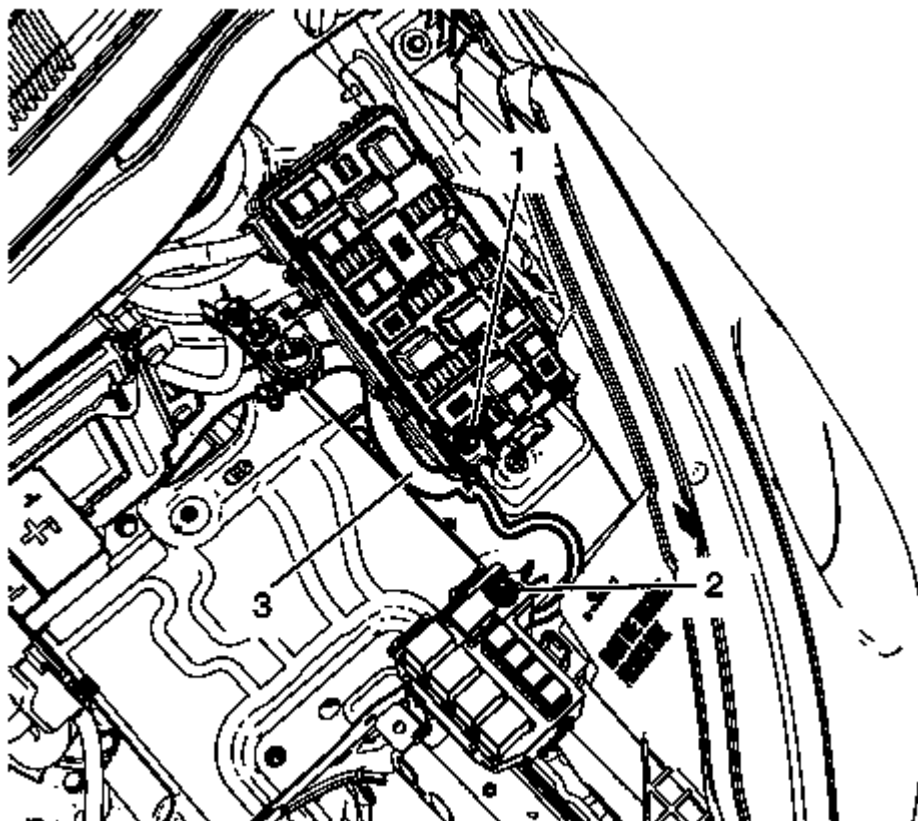


Fig. 143: Positive Battery Cable Nut
Courtesy of GENERAL MOTORS COMPANY

15. Remove the positive cable retaining nut (1, 2) and the positive cable (3).

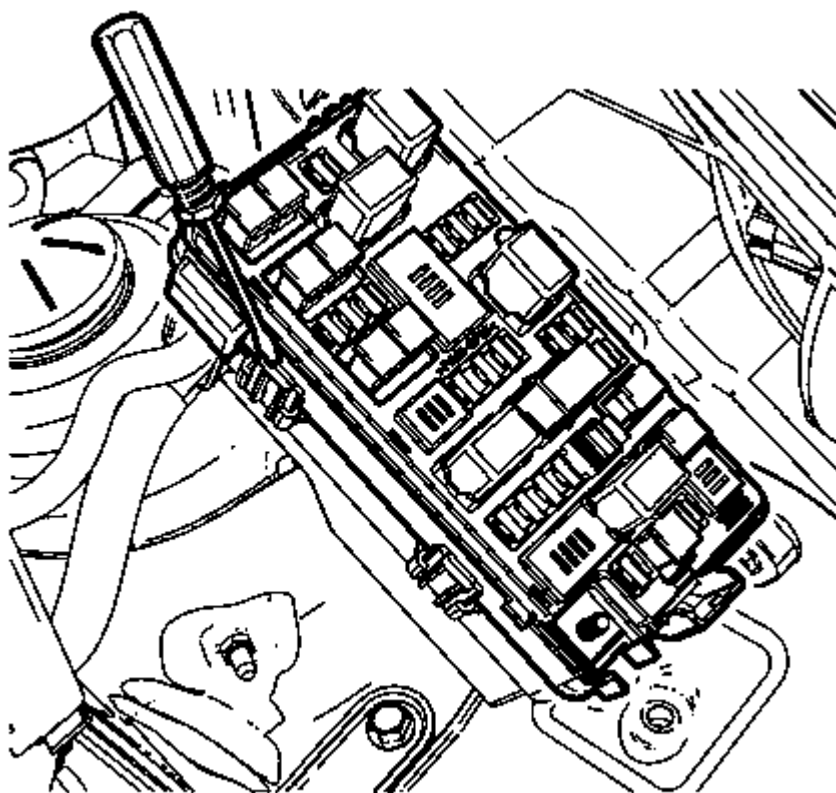


Fig. 144: Detaching Upper Plate With Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

16. Detach the upper plate with suitable tool.

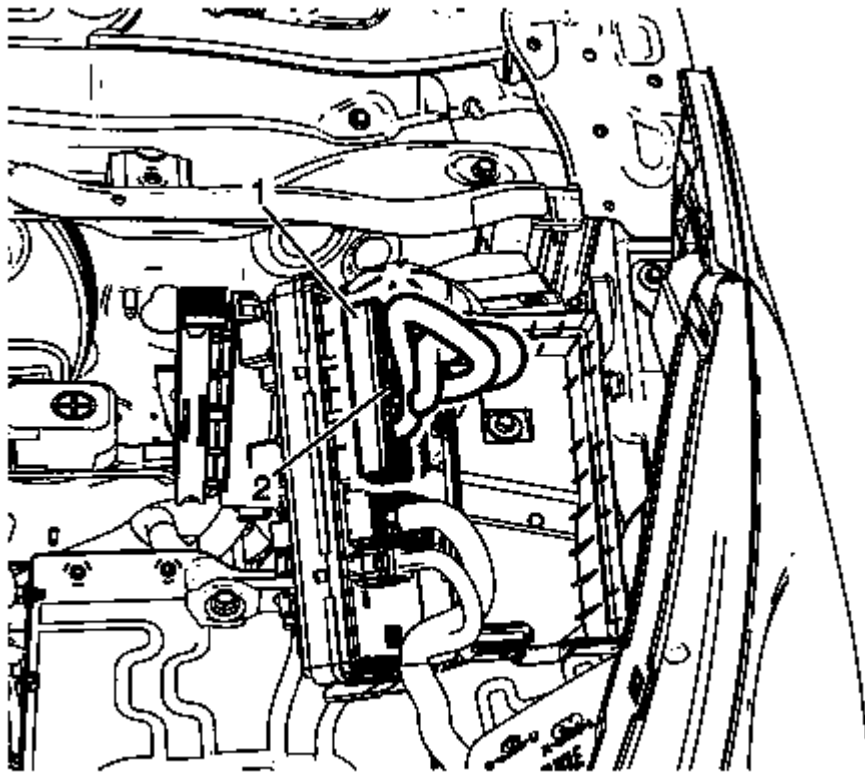


Fig. 145: Front Compartment Fuse Block
Courtesy of GENERAL MOTORS COMPANY

17. Lift up the engine wiring harness fuse block from the lower plate.
18. Loosen the wiring harness connector retaining bolt (2) and disconnect the wiring harness connector (1) from the engine wiring harness fuse block. Repeat for remaining connector.
19. Disconnect remaining wiring harness.

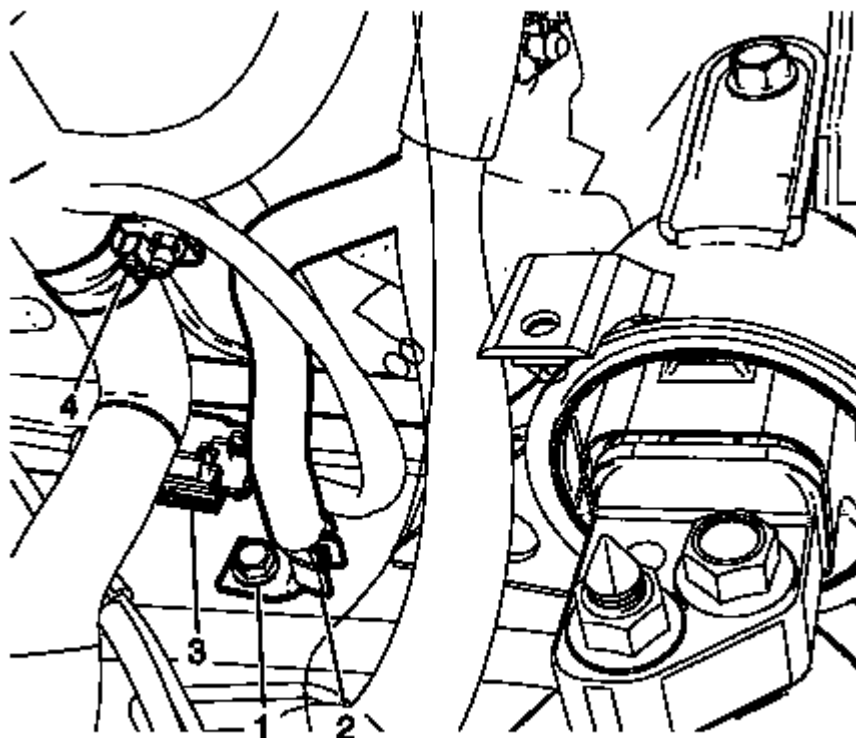


Fig. 146: Ground Bolt And Put Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

20. Remove the ground bolt (1) and put the wiring harness (2) aside.
21. Disconnect the wheel speed sensor connector (3).
22. Remove the wiring harness retainer (4).
23. Disconnect the heater inlet hose. Refer to **Heater Inlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.
24. Disconnect the heater outlet hose. Refer to **Heater Outlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)**.
25. Plug or cap the cooling system hoses and inlets.

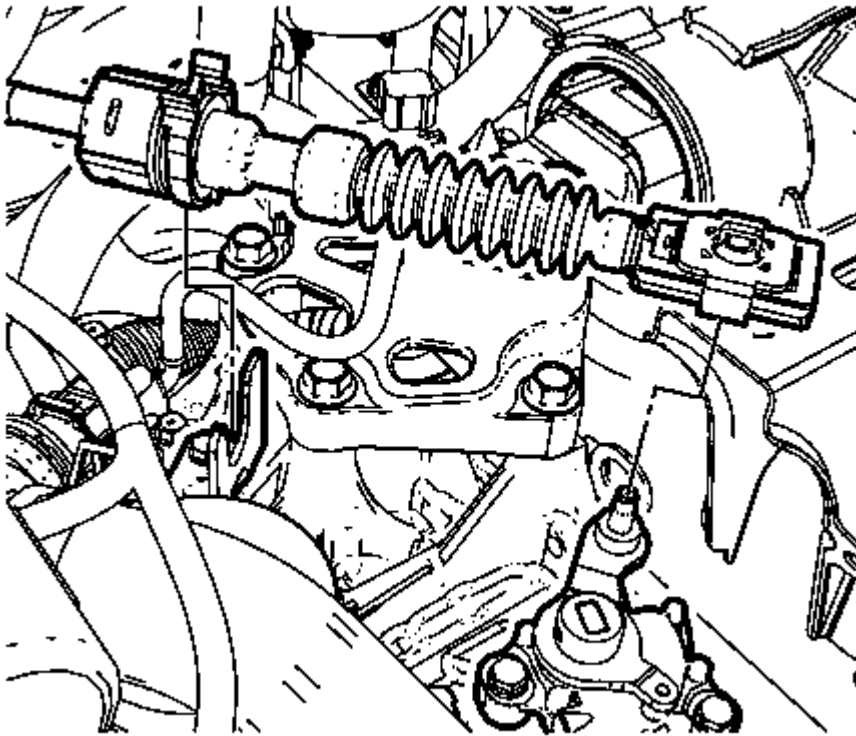


Fig. 147: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

26. Disconnect the transmission range selector lever cable terminal from the transmission lever pin. For manual transmission refer to **Manual Transmission Shift Lever and Selector Lever Cable Replacement (MX2, MFM)** .
27. Press the locking tabs inward in order to release the transmission range selector lever cable from the cable bracket.
28. Remove the clutch actuator cylinder if equipped. Refer to **Clutch Actuator Cylinder Replacement** .

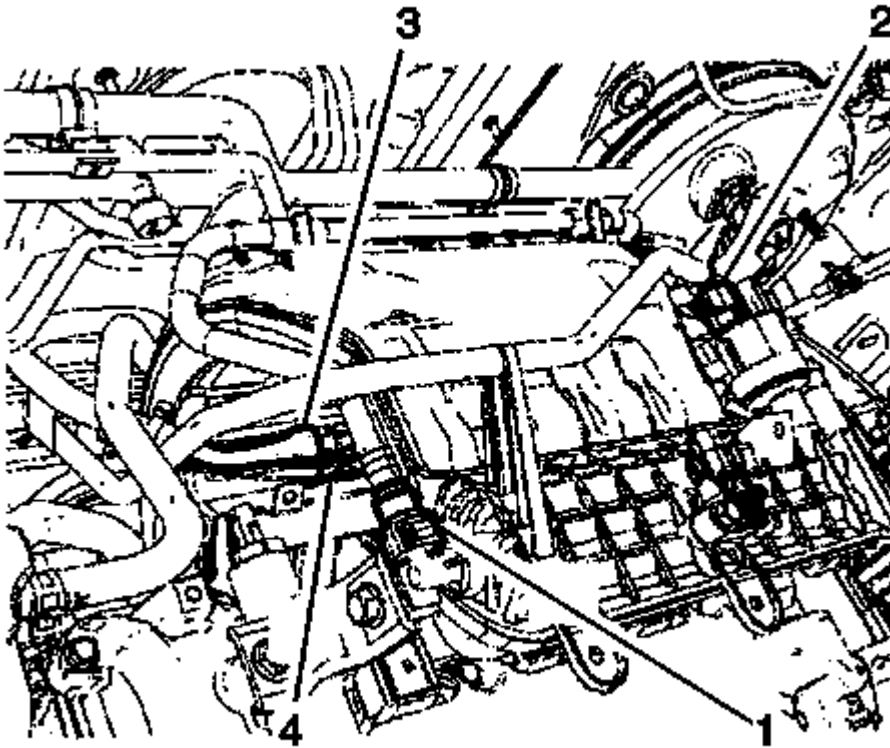


Fig. 148: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

29. Disconnect the vacuum hose (1) from the intake manifold.
30. Disconnect the evaporative canister purge solenoid valve hose (2).
31. Remove the fuel feed hose retaining clip (4) and disconnect the fuel feed hose (3). Refer to **Metal Collar Quick Connect Fitting Service** .

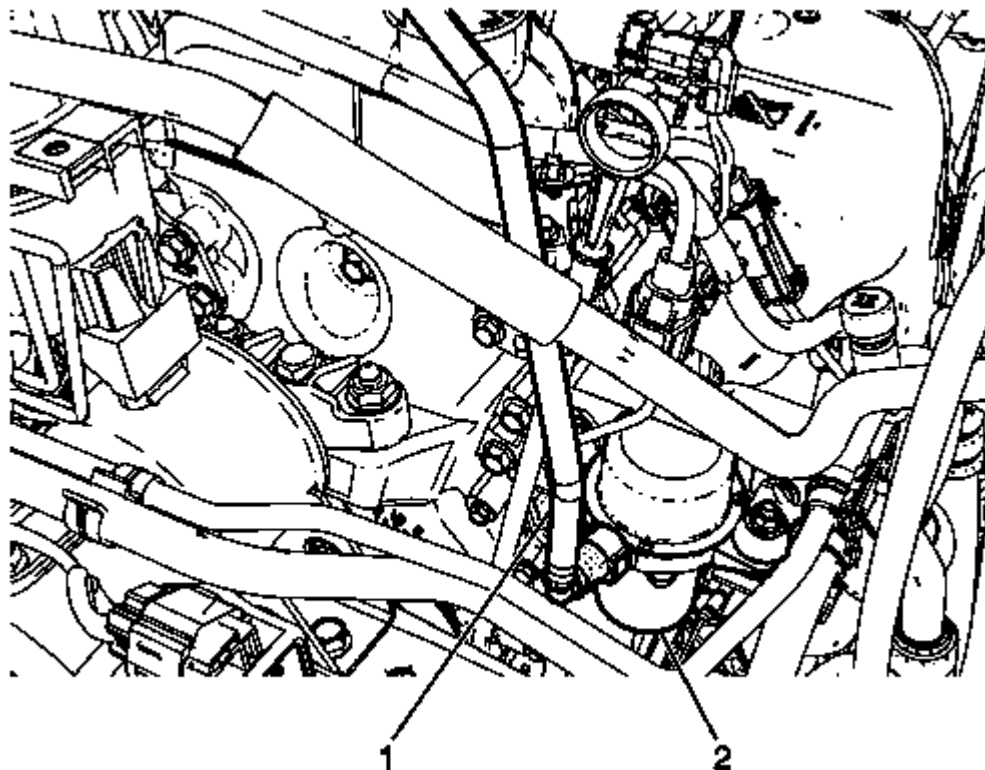


Fig. 149: Vacuum Pump Hose And Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

32. Remove the vacuum pump hose (1) from the vacuum pump (2).

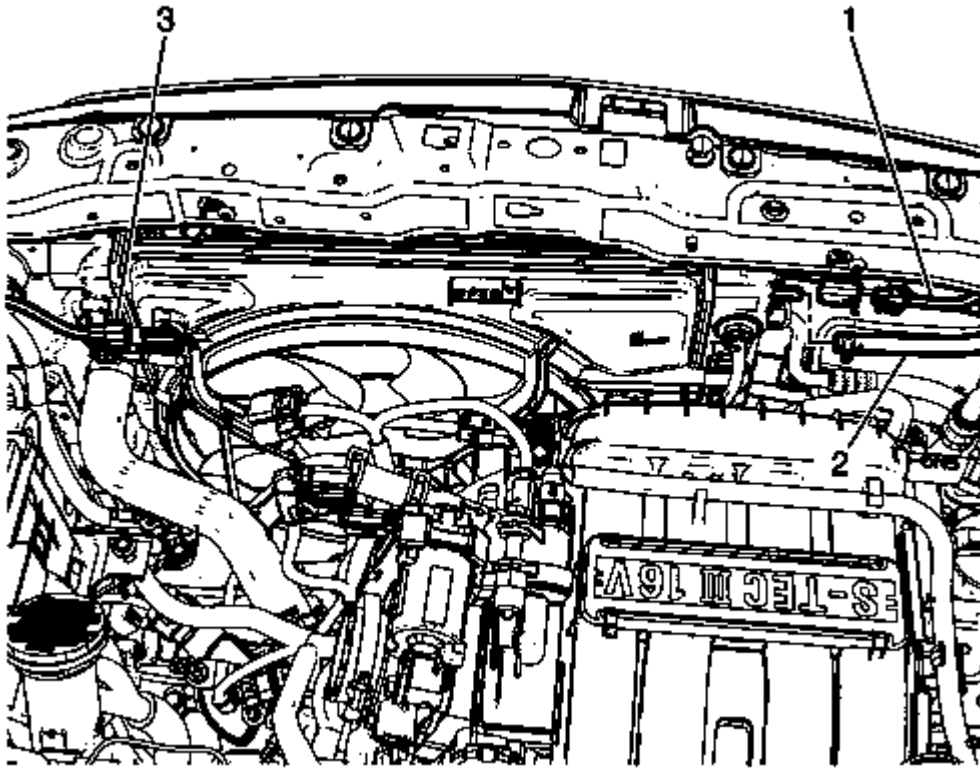


Fig. 150: Ambient Air Temperature Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

33. Disconnect the wiring harness connector (3) from the engine cooling fan harness connector.
34. Disconnect the ambient air temperature sensor connector (1) from the ambient air temperature sensor if equipped.
35. Disconnect the coolant hose (2) from the radiator.

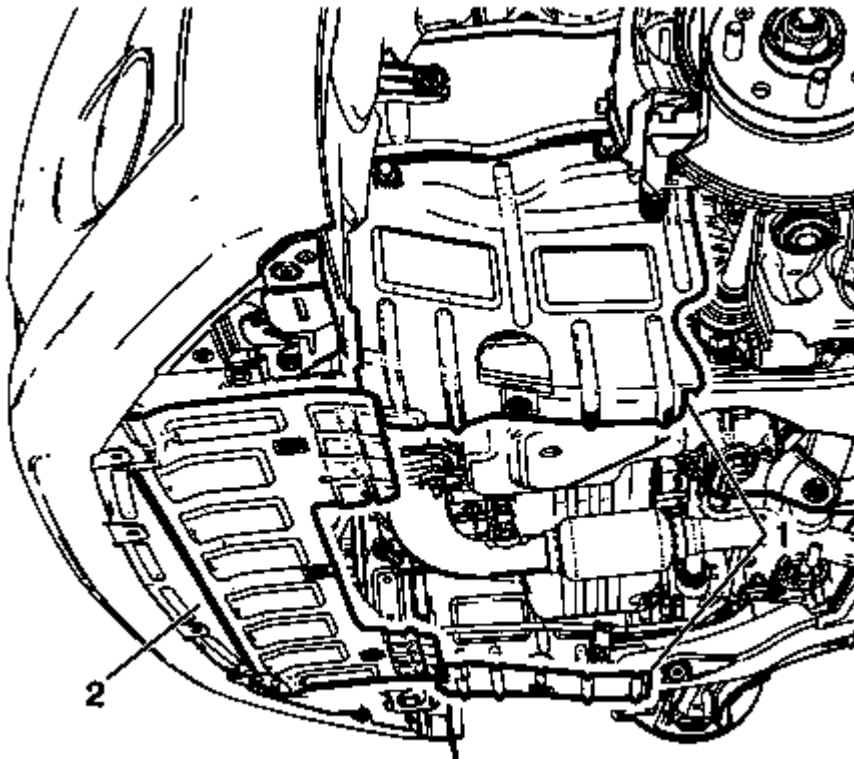


Fig. 151: Compartment Splash Shield

Courtesy of GENERAL MOTORS COMPANY

36. Remove the compartment splash shield (1, 2). Refer to **Front Compartment Splash Shield Replacement** .
37. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

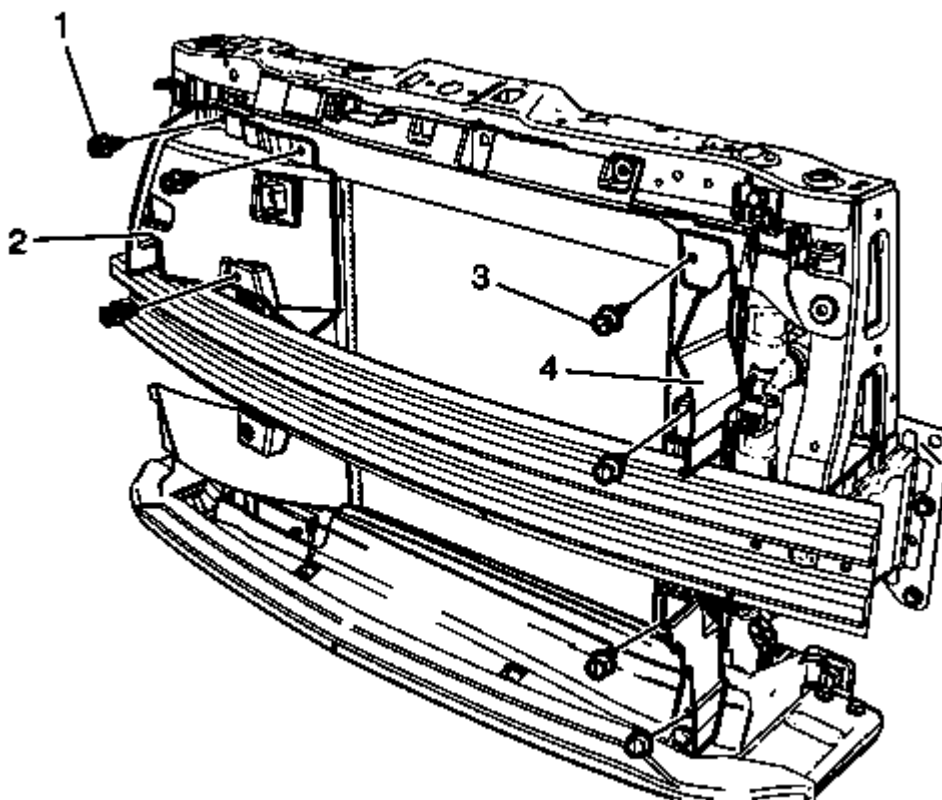


Fig. 152: Front Side Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

38. Remove the front side air baffle retainers (1, 3) and the front side air baffles (2, 4).

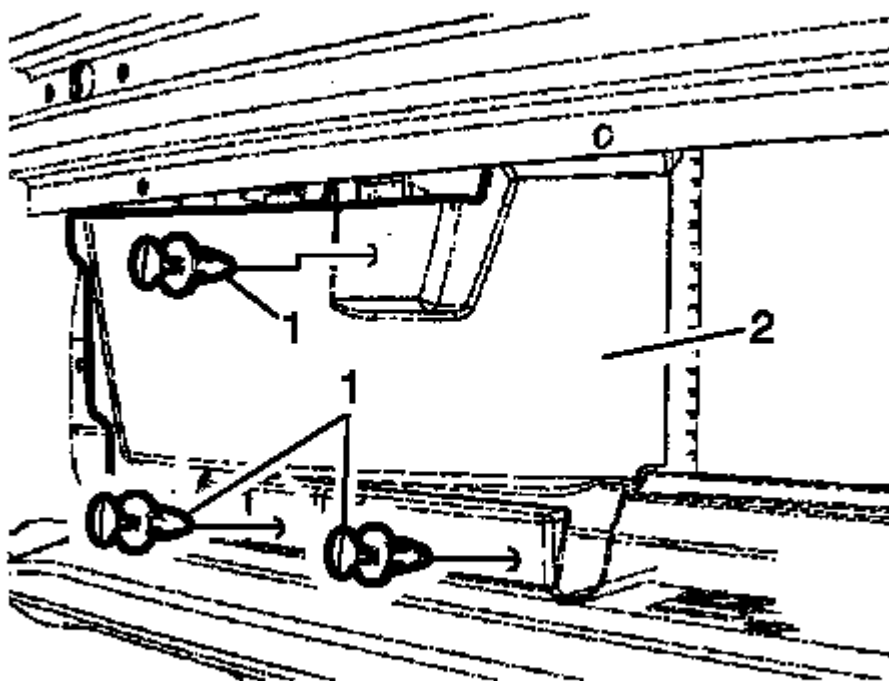


Fig. 153: Front Lower Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

39. Remove the front lower air baffle retainers (1) and the front lower air baffle (2).

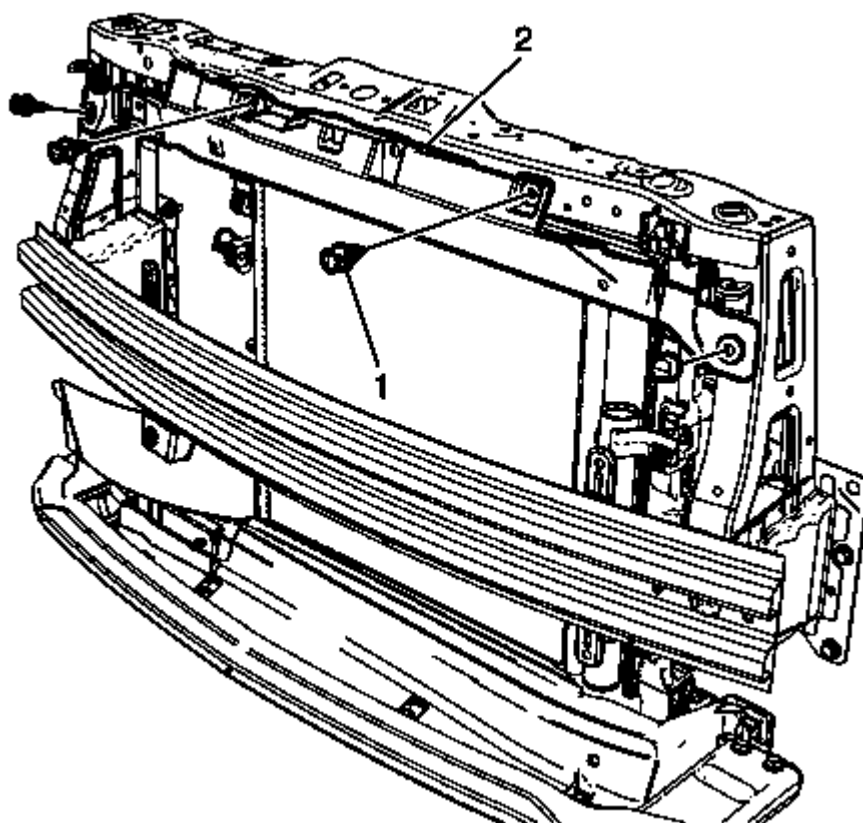


Fig. 154: Upper Air Guard Retainers
Courtesy of GENERAL MOTORS COMPANY

40. Remove the upper air guard retainers (1) and the upper air guard (2).

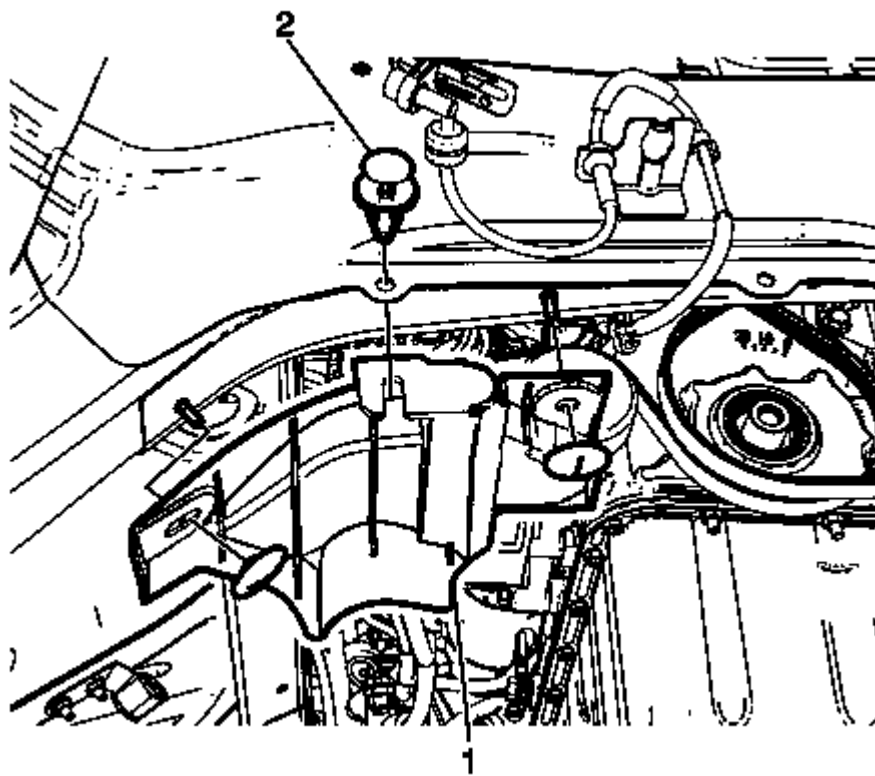


Fig. 155: Retainers And Water Deflector
Courtesy of GENERAL MOTORS COMPANY

41. Remove the retainers (2) and the water deflector (1).

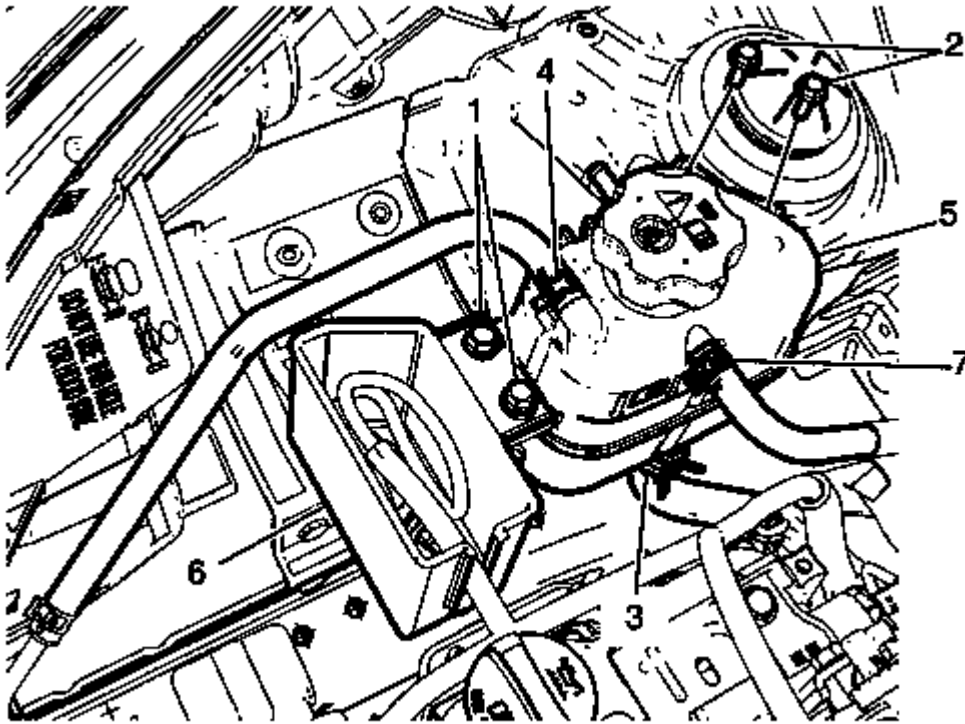


Fig. 156: Block Heater Connecting Plug Holder Bolt
 Courtesy of GENERAL MOTORS COMPANY

42. Remove the block heater cord container bolts (1) if equipped and coolant surge tank retaining bolts (2).
43. Remove the block heater code container (6) if equipped.
44. Remove the coolant hose clips (3, 4, 7) and coolant surge tank (5).
45. Plug or cap the cooling system hoses and inlets.

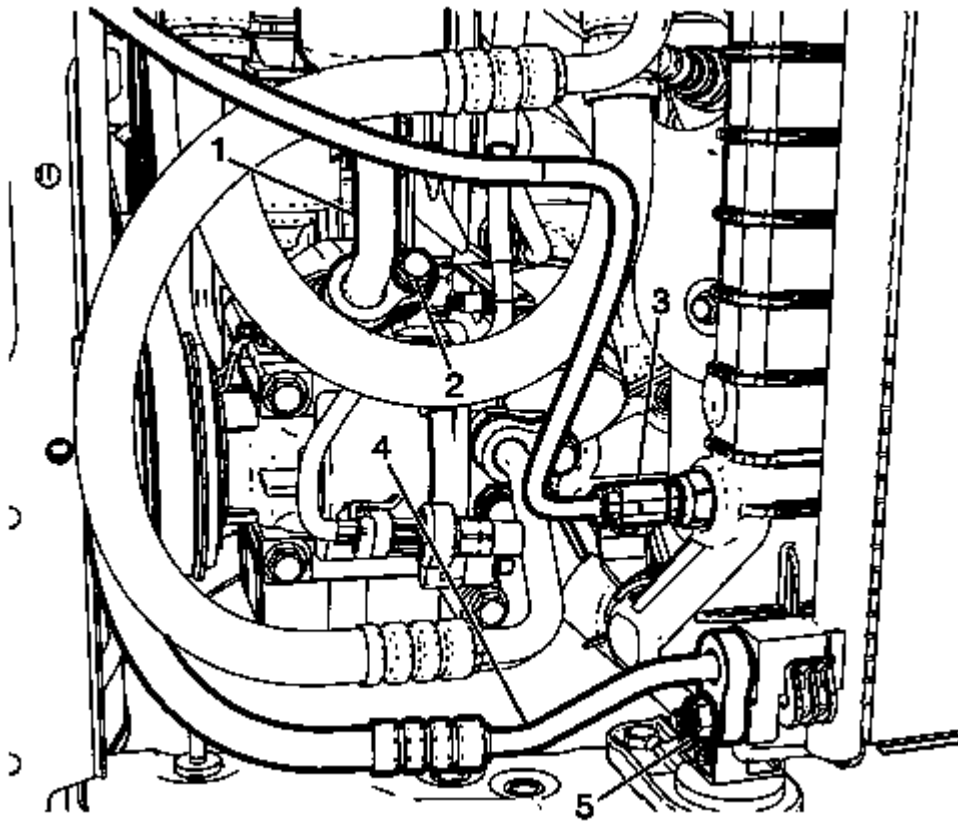


Fig. 157: Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

46. Remove the suction pipe bolt (2) from the A/C compressor.
47. Remove the suction pipe (1) from the A/C compressor.
48. Remove the discharge pipe nut (5) from the A/C condenser.
49. Remove the discharge pipe (4) from the A/C condenser.
50. Disconnect the coolant temperature sensor wiring connector (3) from the radiator.

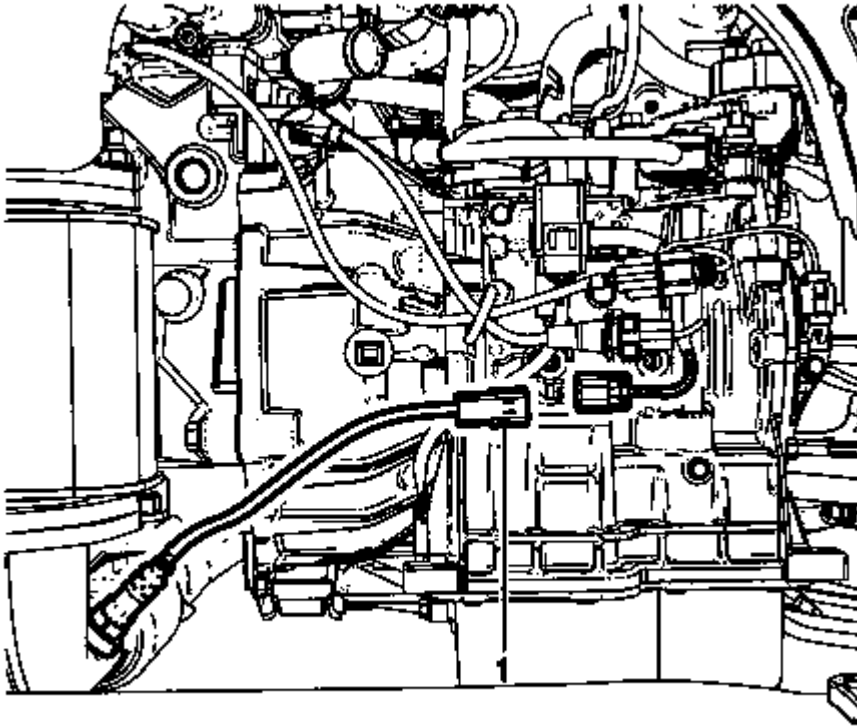


Fig. 158: Oxygen Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

51. Disconnect the oxygen sensor connector (1).
52. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LL0)** .
53. Remove the transmission rear mount bracket. Refer to **Transmission Rear Mount Bracket Replacement** .

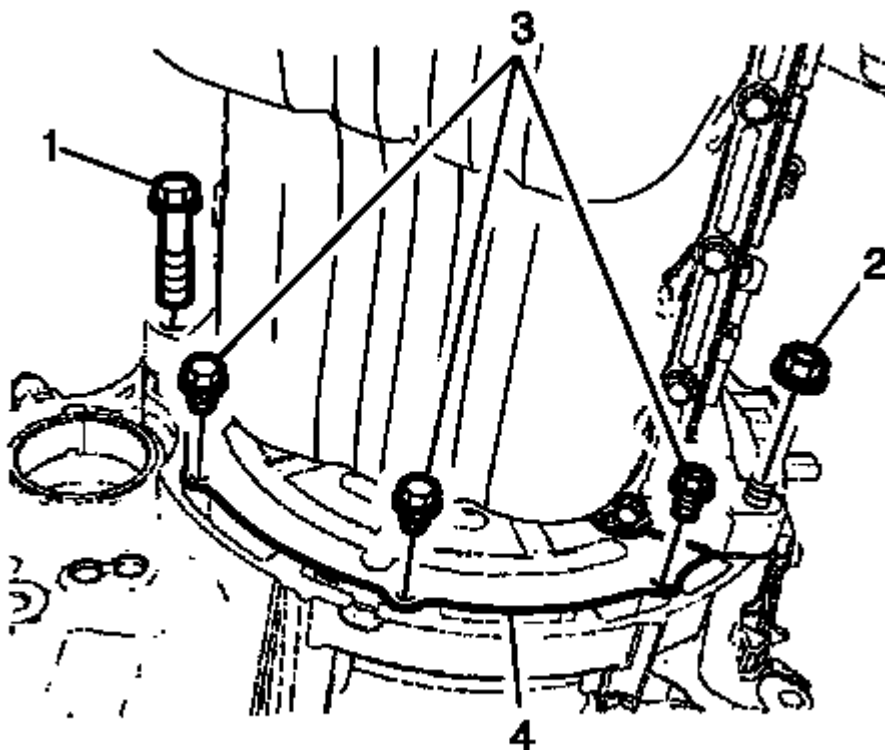


Fig. 159: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

54. Remove the transmission dust cover bolts (3) and the transmission dust cover (4).

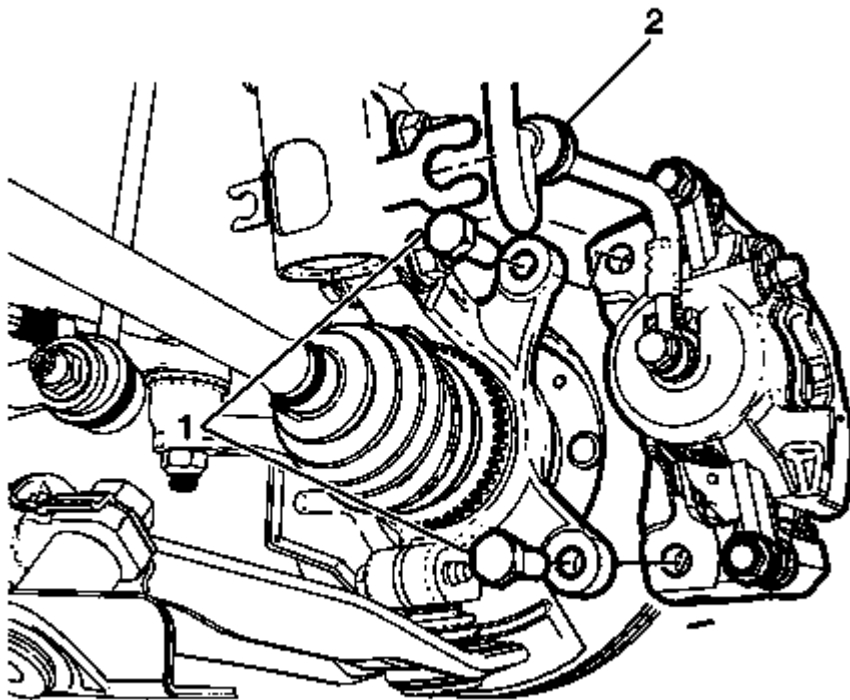


Fig. 160: Front Brake Hose And Front Brake Caliper Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT** disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

55. Detach the front brake hose (2) from the strut mounted brake hose retaining bracket and remove the front brake caliper retaining bolts (1) from the front steering knuckle. Repeat for opposite side.

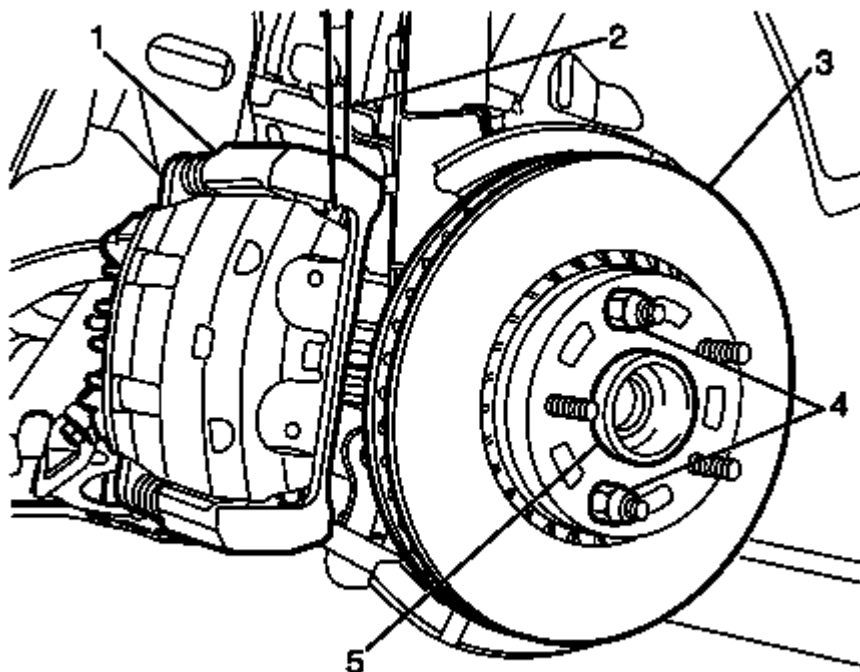


Fig. 161: View Of Hub, Wheel Nuts, Front Brake Disc, Heavy Mechanic's Wire & Front Brake Caliper

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Support the brake caliper with heavy mechanic wire or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

56. Support the front brake caliper (1) with heavy mechanics wire or equivalent (2). Repeat for opposite side.
57. Disconnect the outer tie rod assembly from the steering knuckle. Repeat for opposite side. Refer to **Steering Linkage Outer Tie Rod Replacement**.
58. Remove the wheel drive shaft nut and washer from the wheel drive shaft and discard. Repeat for opposite side. Refer to **Front Wheel Drive Shaft Replacement**.
59. Separate the control arm ball joint from the steering knuckle. Repeat for opposite side. Refer to **Lower Control Arm Replacement**.

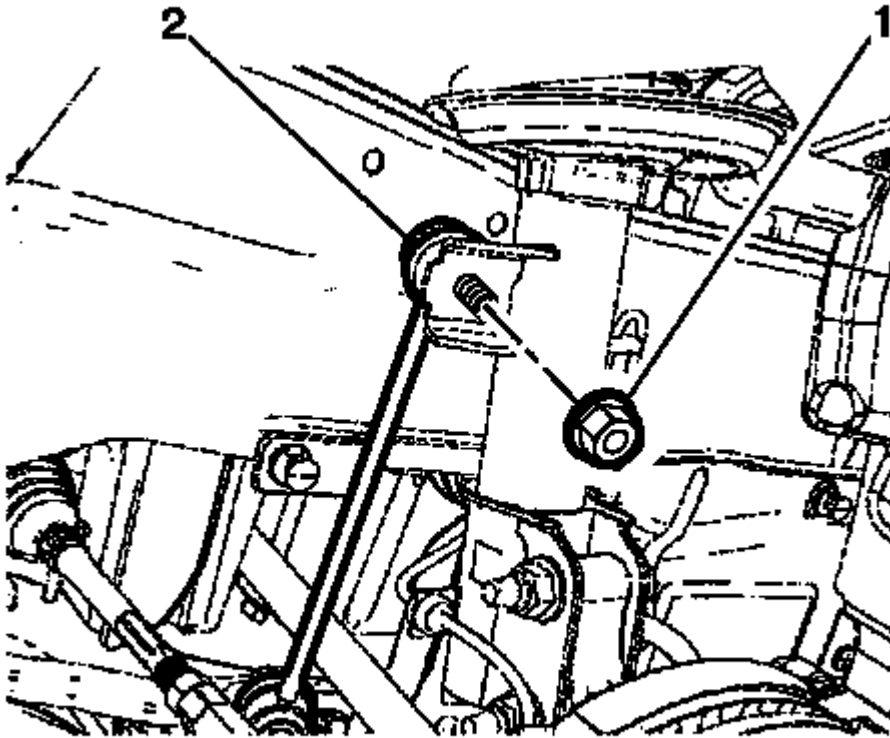


Fig. 162: Front Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

60. Remove the front upper stabilizer shaft link nut (1) and push the front upper stabilizer shaft link (2) aside. Repeat for opposite side.
61. Disconnect any additional electrical connections as necessary.

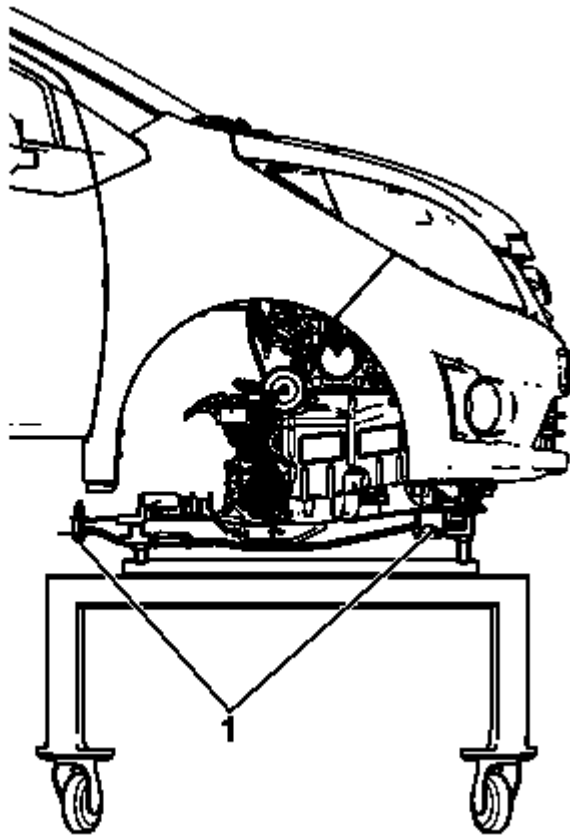


Fig. 163: View Of Cradle Bolts

Courtesy of GENERAL MOTORS COMPANY

62. Position the engine assembly on a suitable powertrain table or an engine lifter below the cradle with suitable woodblocks or suitable rubber blocks as shown.
63. Lower the vehicle until the suitable powertrain table or the engine lifter with suitable woodblocks or suitable rubber blocks.
64. Remove the 4 cradle bolts (1).

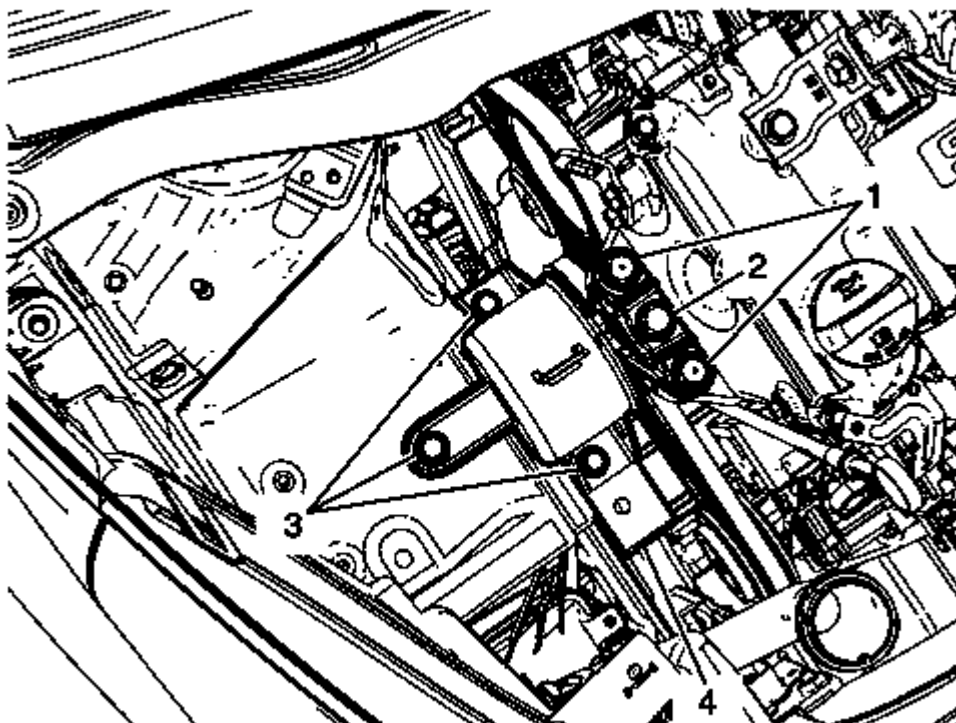


Fig. 164: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

65. Mark the location of the bolts before removing.
66. Remove the engine mount retaining bolts (2, 3), nuts (1) and the engine mount.

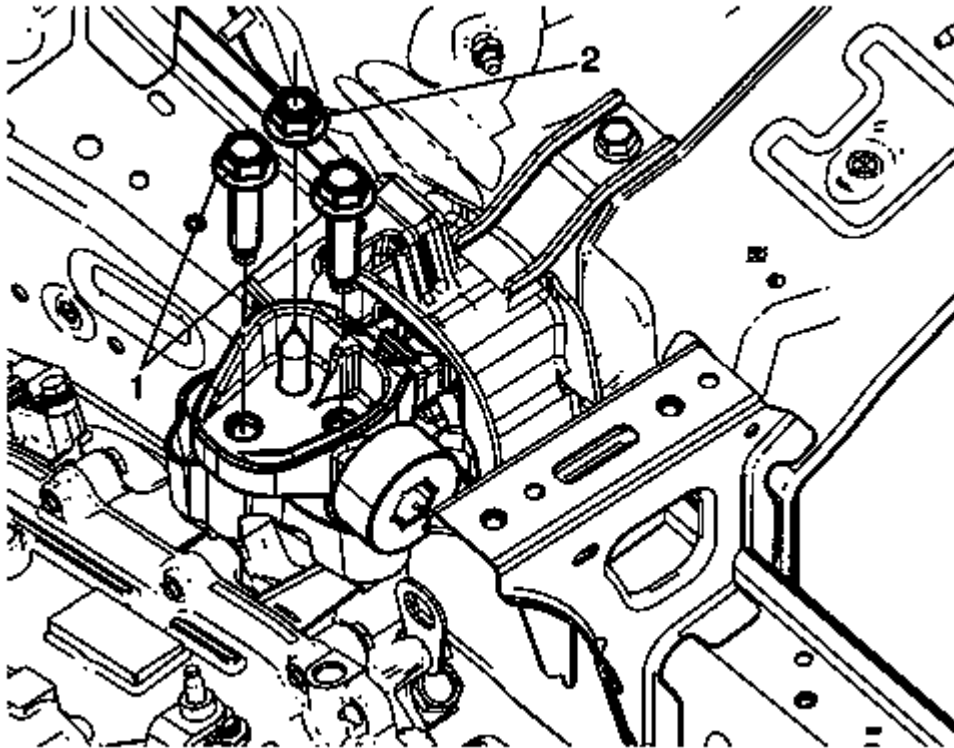


Fig. 165: Location Of Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the location of the bolts (1) and nut (2) before removing.

67. Remove the left transmission mount bolts (1) and nut (2) from the transmission mount bracket.

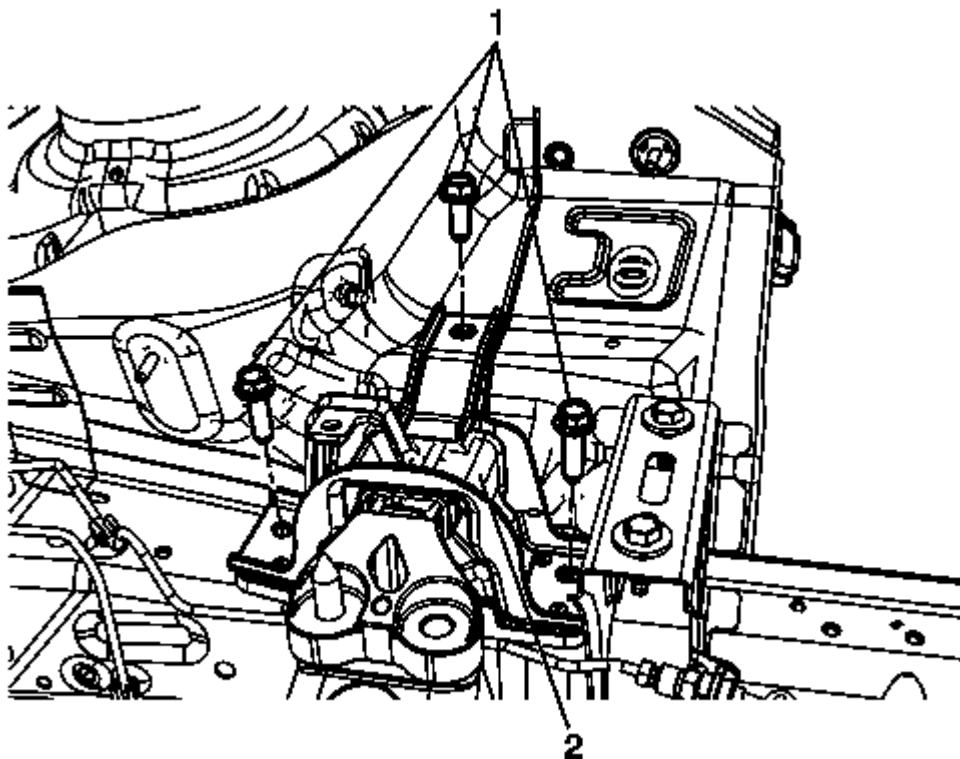


Fig. 166: Left Transmission Mount And Body Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mark the location of the bolts (1) and nut (2) before removing.

68. Remove the transmission mount retaining bolts (1) and the transmission mount (2).
69. Transfer parts as needed.

NOTE: Make sure that all the hoses, wires, pipes and front struts clear the vehicle during the removal process.

70. With the aid of an assistant, lower the engine lifter or raise the vehicle to remove the engine, transmission and cradle assembly from the vehicle.
71. Remove the starter. Refer to Starter Replacement .

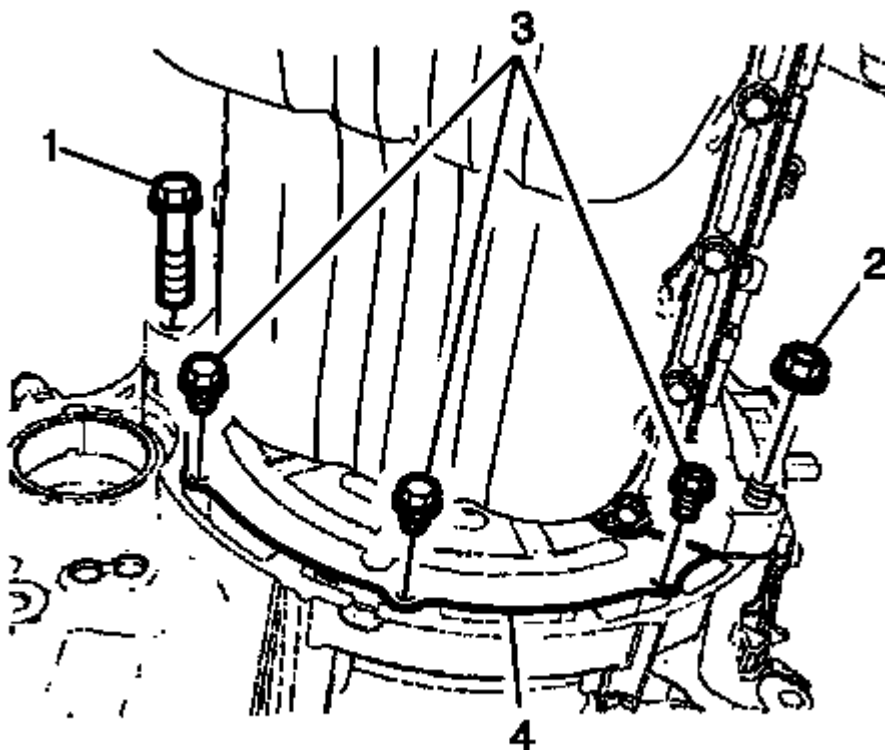


Fig. 167: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

72. Remove the lower transmission housing bolt (1) and nut (2). (M/T)

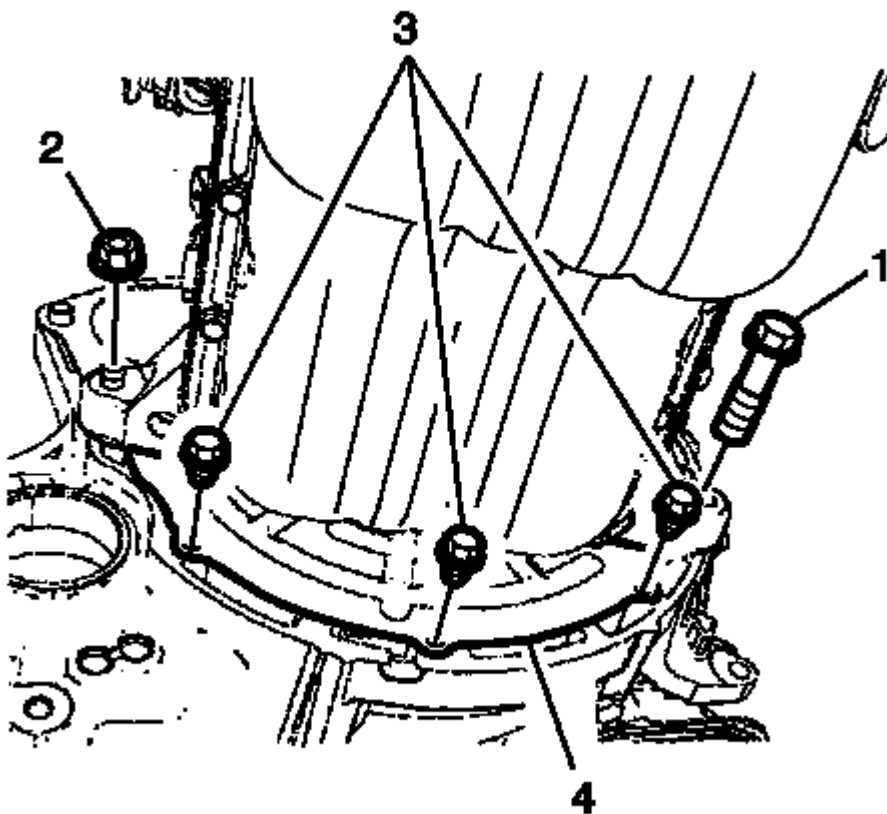


Fig. 168: Lower Transmission Housing Bolt And Nut
Courtesy of GENERAL MOTORS COMPANY

73. Remove the lower transmission housing bolt (1) and nut (2). (A/T)

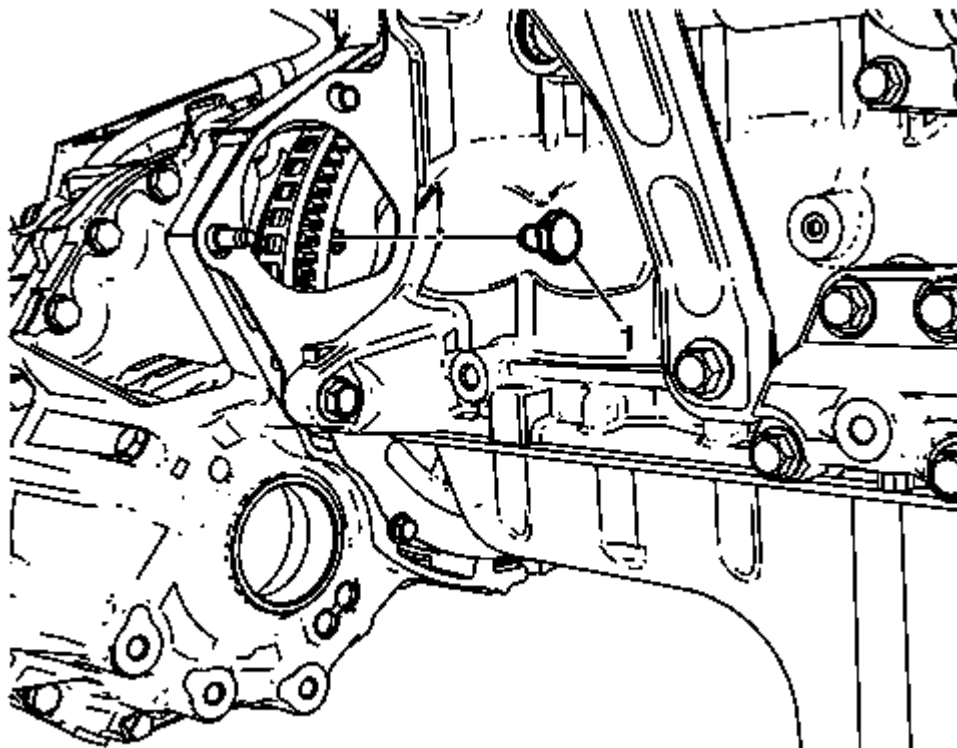


Fig. 169: Torque Converter Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Only rotate the engine in a clockwise direction only or engine damage will occur.

74. Remove the torque converter bolts (1). (A/T)

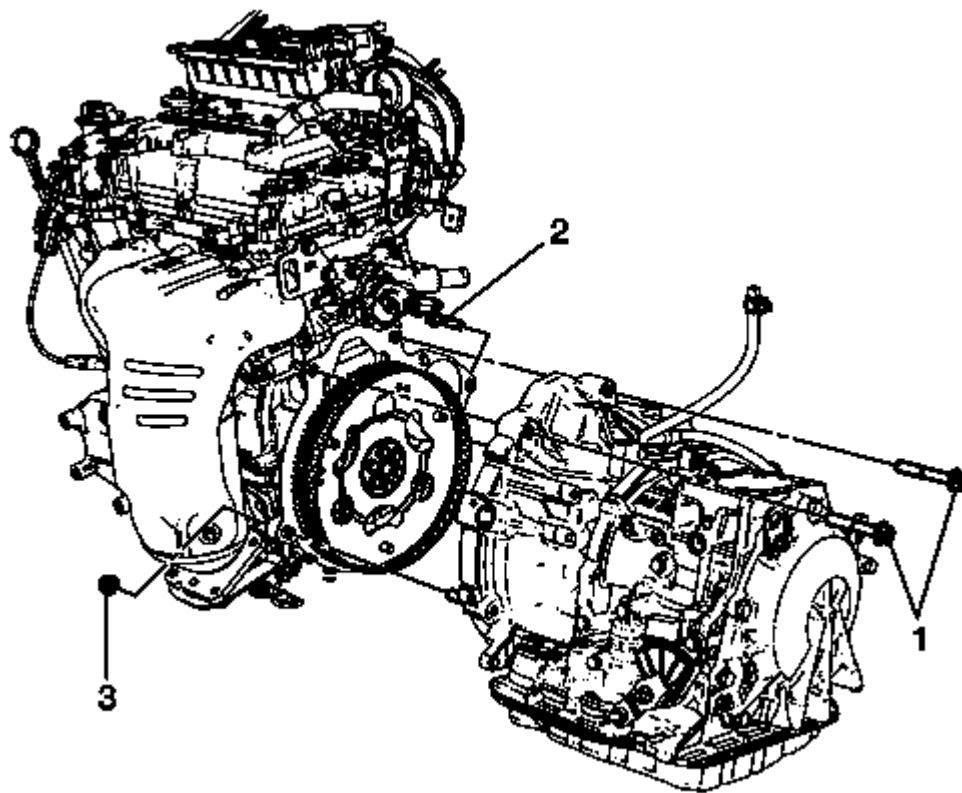


Fig. 170: Upper Transmission Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

75. Remove the upper transmission housing bolts (1) and separate the transmission from the engine.
76. Install the engine to an engine stand. (Using M10 x 1.25 approximately 130 mm long)
77. Transfer parts as needed.

Installation Procedure

1. Remove the engine from the engine stand.

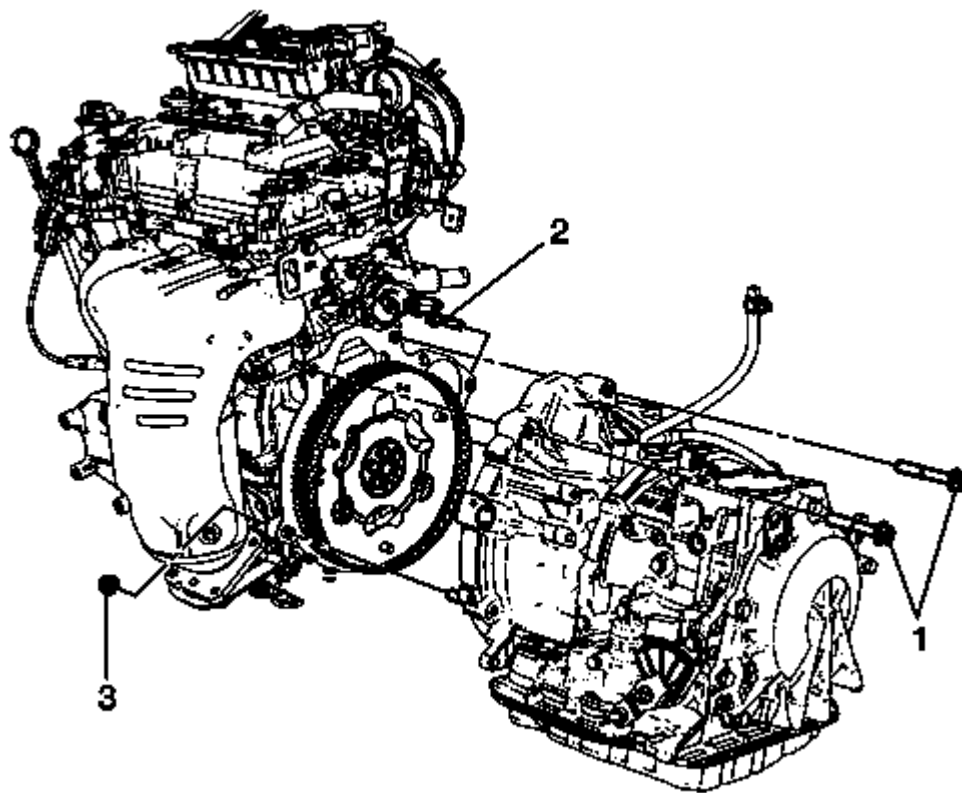


Fig. 171: Upper Transmission Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Combine the engine with the transmission and tighten upper auto transmission housing bolts (1) to 61 (44 lb ft).

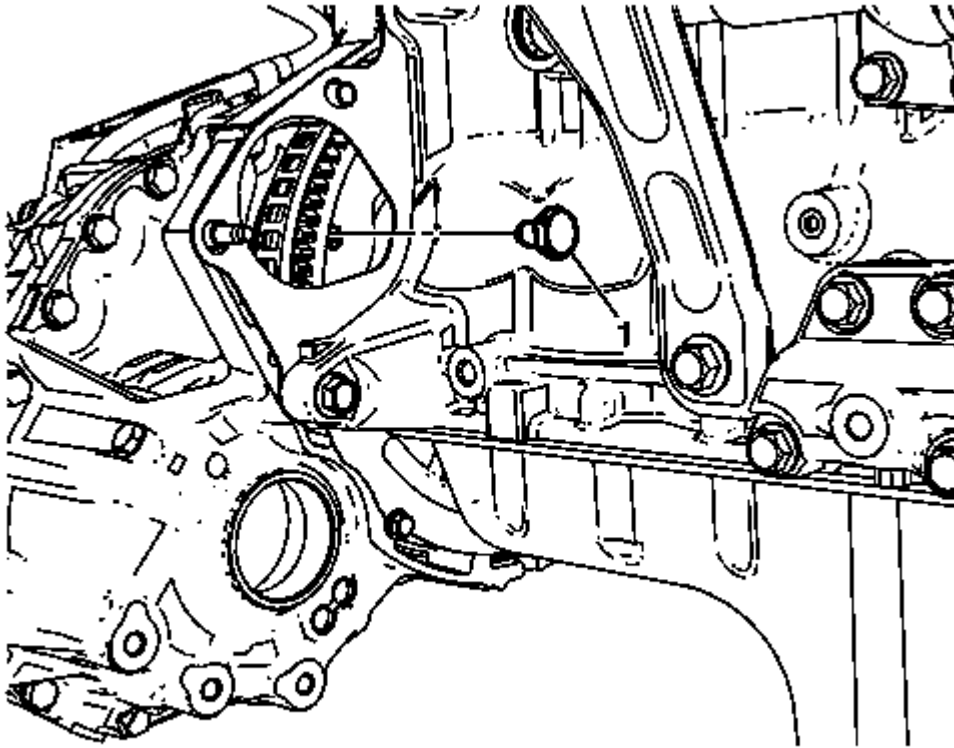


Fig. 172: Torque Converter Bolts

Courtesy of GENERAL MOTORS COMPANY

NOTE: Only rotate the engine in a clockwise direction only or engine damage will occur.

3. Install the torque converter bolts (1) and tighten to 60 (44 lb ft). (A/T)

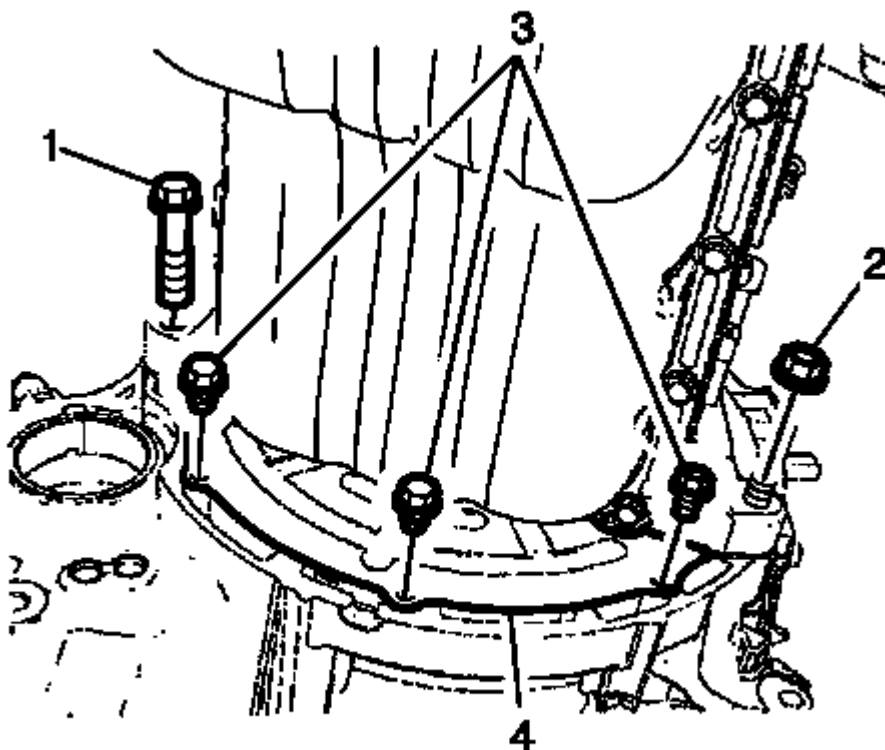


Fig. 173: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the lower transmission housing bolt (1) and nut (2) and tighten to 61 (45 lb ft). (M/T)

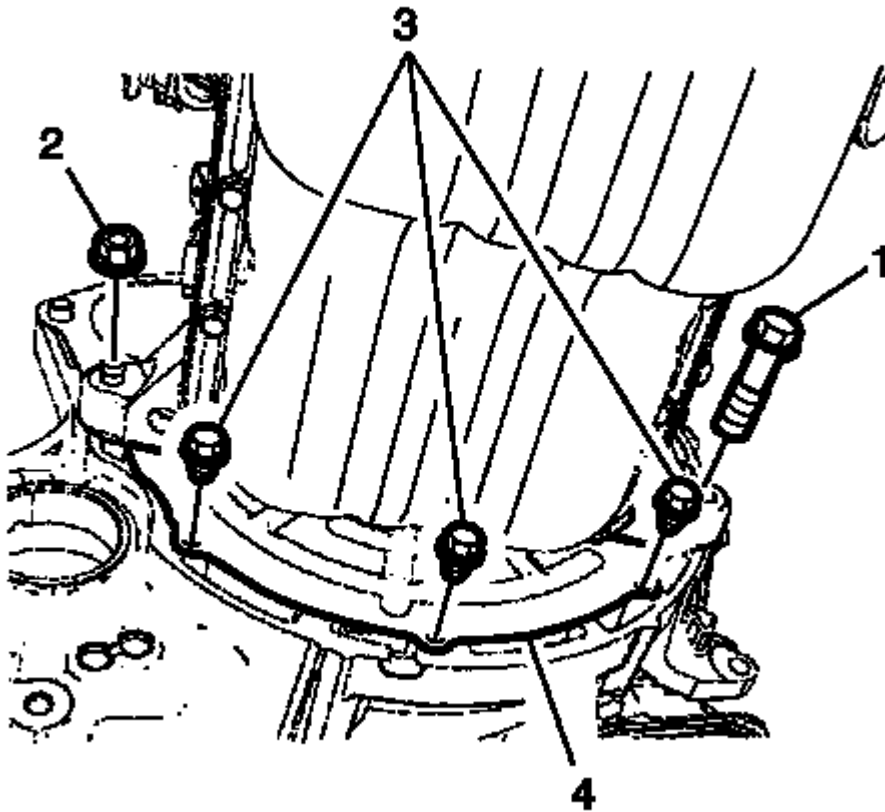


Fig. 174: Lower Transmission Housing Bolt And Nut
 Courtesy of GENERAL MOTORS COMPANY

5. Install the lower transmission housing bolt (1) and nut (2) and tighten to 61 (45 lb ft). (A/T)
6. Install the starter. Refer to **Starter Replacement** .

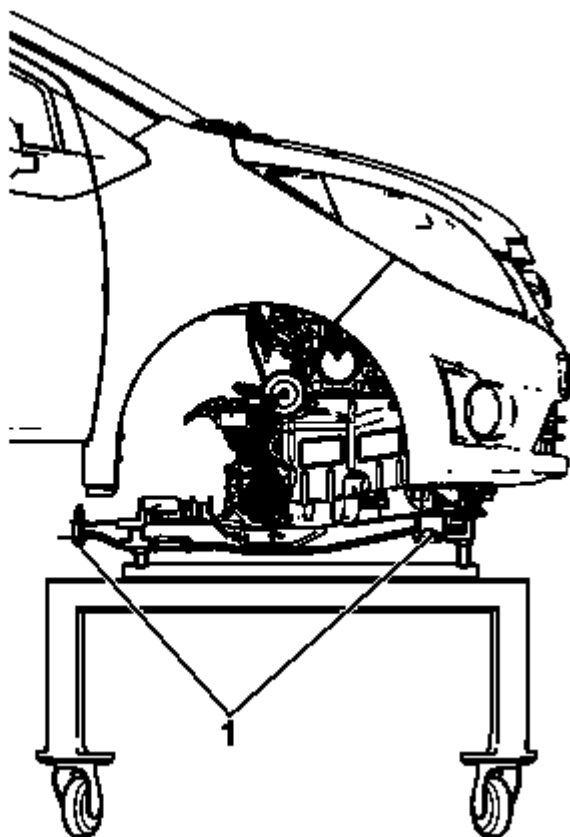


Fig. 175: View Of Cradle Bolts

Courtesy of GENERAL MOTORS COMPANY

7. With the aid of an assistant, raise the engine lifter or lower the vehicle to install the engine, transmission and cradle assembly to the vehicle.
8. Tighten the 4 cradle bolt (1) to 135 (100 lb ft).

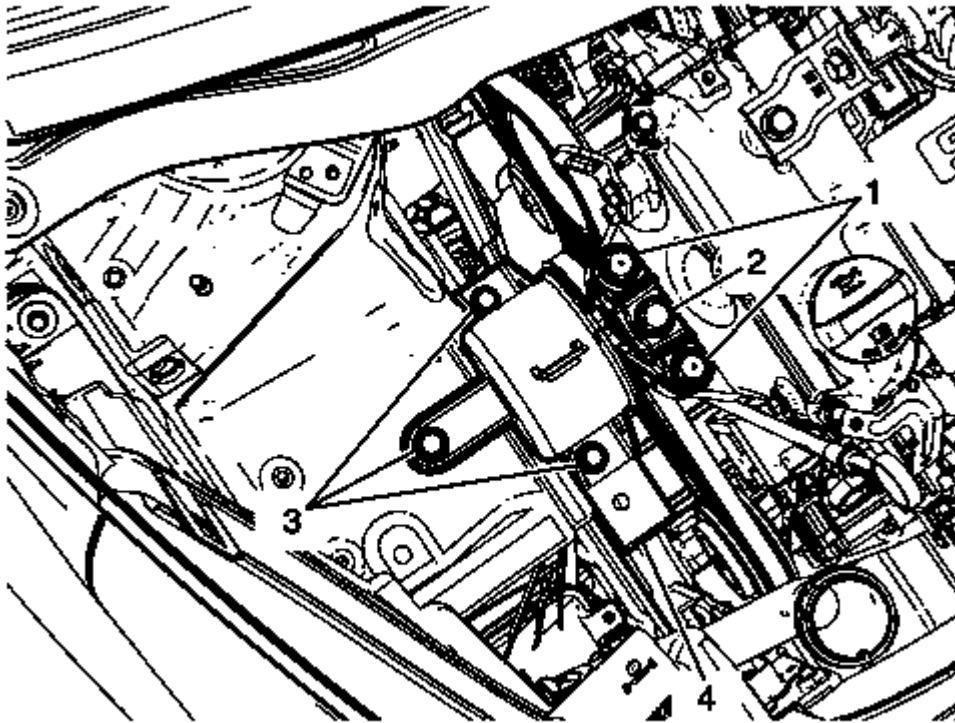


Fig. 176: Engine Mount Nuts

Courtesy of GENERAL MOTORS COMPANY

9. Install the engine mount and the engine mount bolts and nuts.
10. Tighten the engine mount retaining nuts (1) to 66 (49 lb ft).
11. Tighten the engine mount retaining bolt (2) to 66 (49 lb ft).
12. Tighten the engine mount retaining bolts (3) to 50 (37 lb ft).

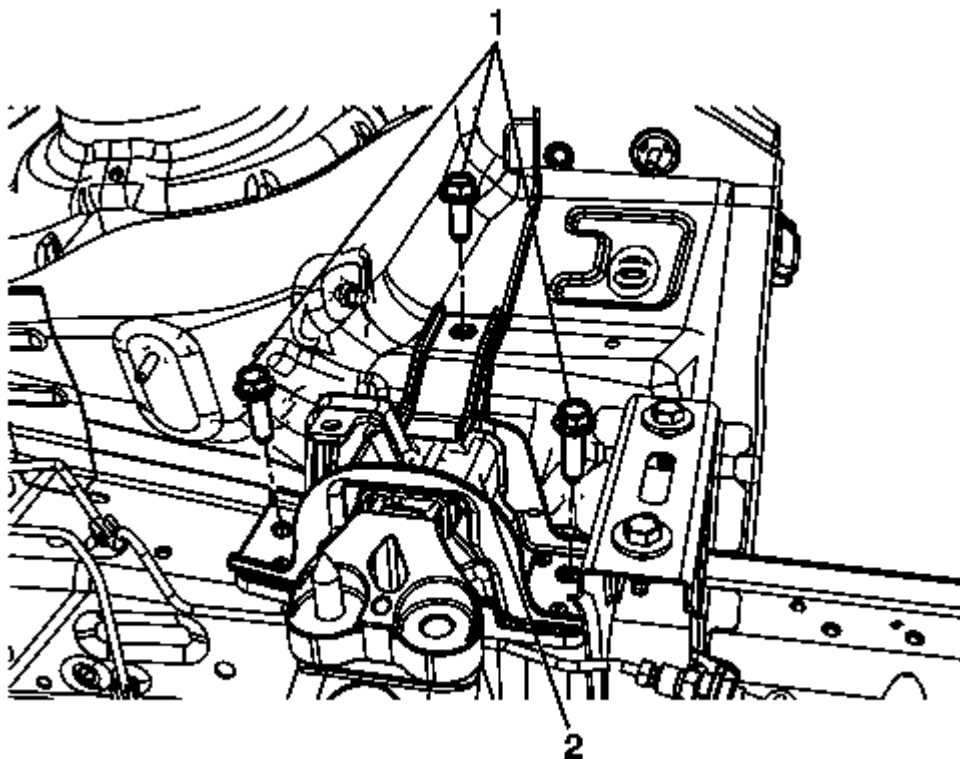


Fig. 177: Left Transmission Mount And Body Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the transmission mount (2) and the transmission mount bolts (1).
14. Tighten to 50 (37 lb ft).

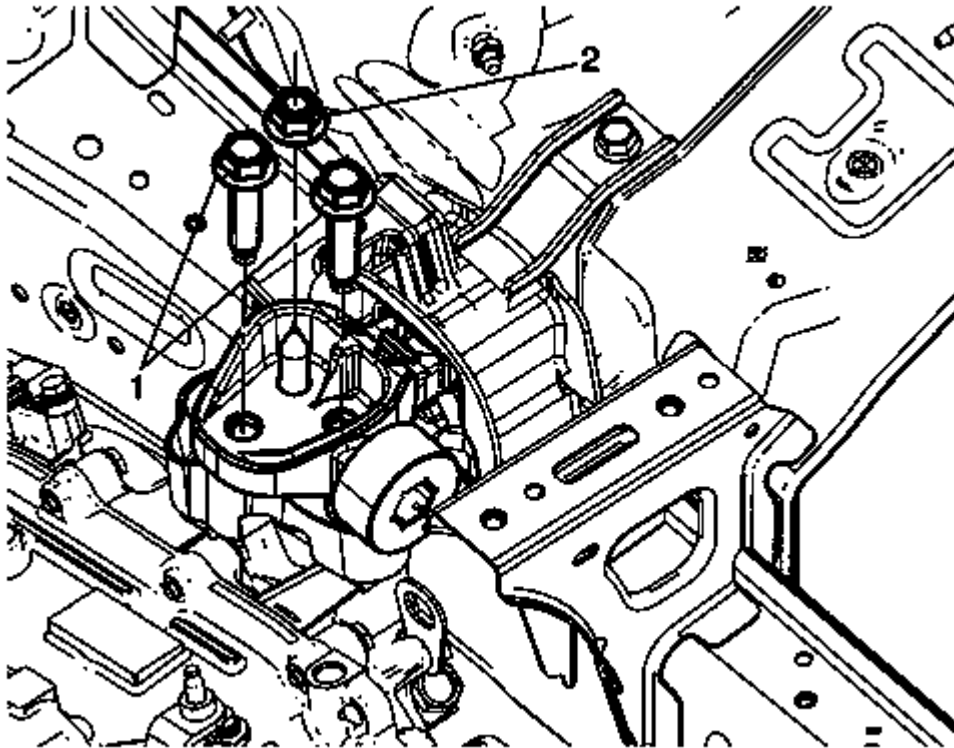


Fig. 178: Location Of Bolts And Nut

Courtesy of GENERAL MOTORS COMPANY

15. Install the left transmission mount bolts (1) and nut (2) to the transmission mount bracket (2) and tighten to 95 (70 lb ft).
16. Connect additional electrical connections as necessary.

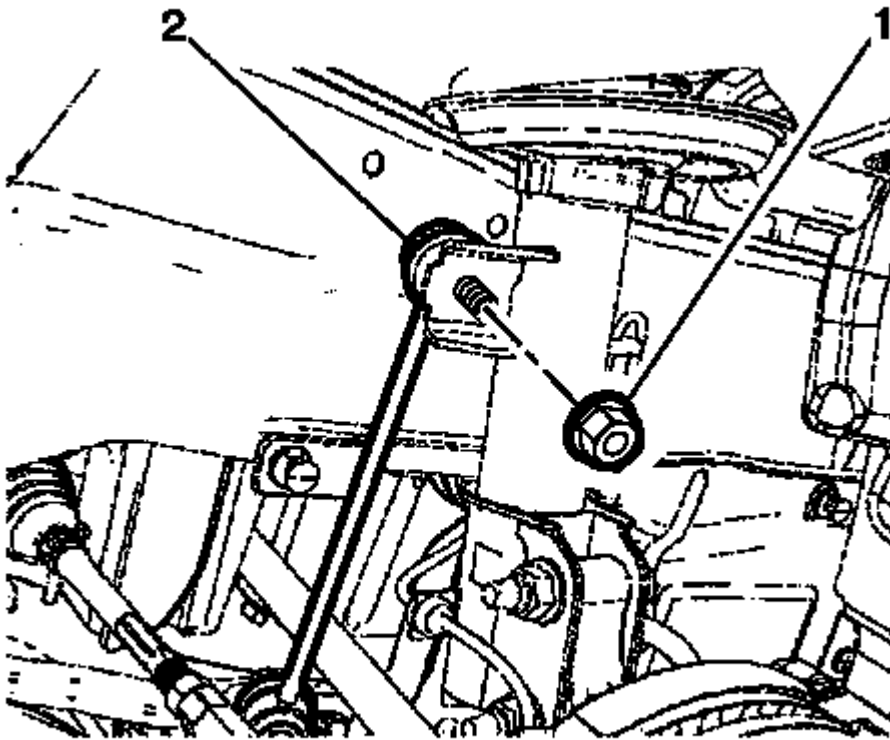


Fig. 179: Front Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

17. Install the front upper stabilizer shaft link (2) and the front upper stabilizer shaft link nut (1).
18. Tighten to 43 (32 lb ft). Repeat for opposite side.

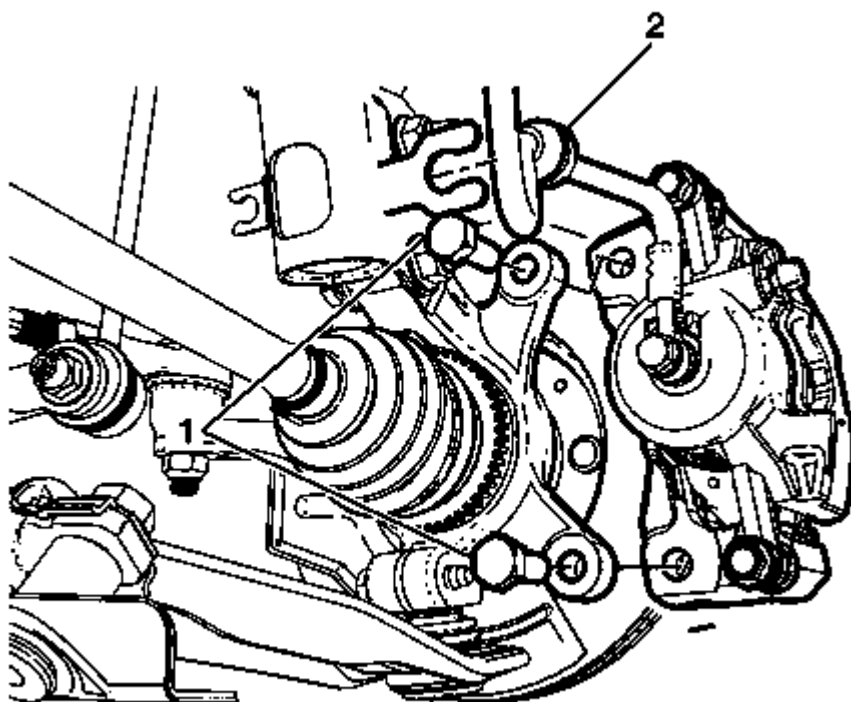


Fig. 180: Front Brake Hose And Front Brake Caliper Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Install the front brake caliper and tighten the front brake caliper bolts (1) to 95 (70 lb ft).
20. Install the front brake hose (2) to the strut mounted brake hose retaining bracket. Repeat for opposite side.
21. Install the outer tie rod assembly from the steering knuckle. Repeat for opposite side. Refer to **Steering Linkage Outer Tie Rod Replacement**.
22. Install the wheel drive shaft to the front steering knuckle. Refer to **Front Wheel Drive Shaft Replacement**.
23. Install the wheel drive shaft nut and washer to the wheel drive shaft. Repeat for opposite side. Refer to **Front Wheel Drive Shaft Replacement**.
24. Install the control arm ball joint to the steering knuckle. Repeat for opposite side. Refer to **Lower Control Arm Replacement**.

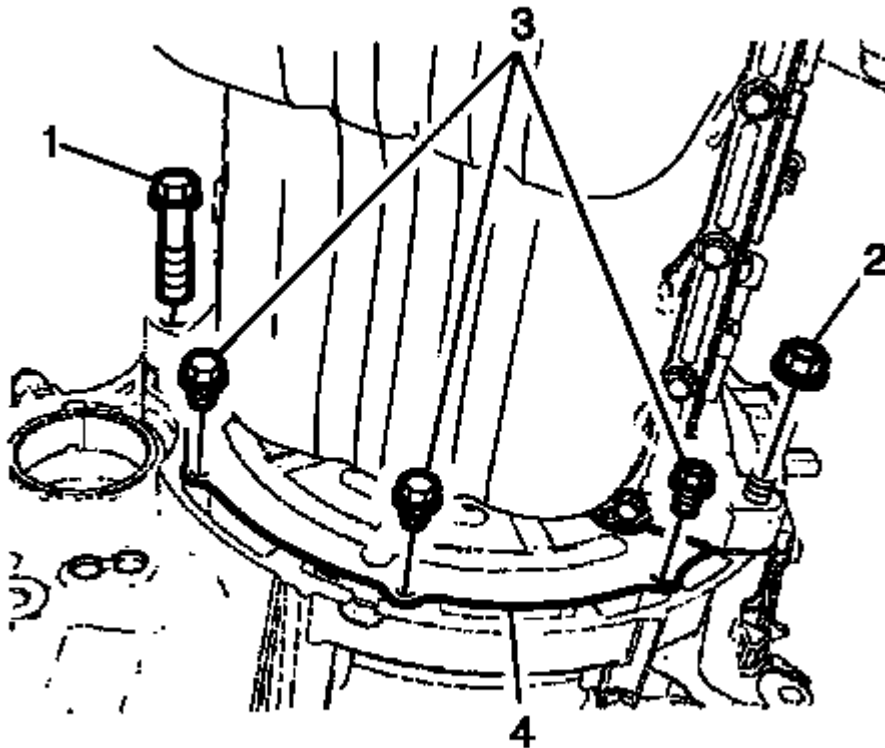


Fig. 181: Lower Transmission Housing Bolt
Courtesy of GENERAL MOTORS COMPANY

25. Install the transmission dust cover (4) and tighten the transmission dust cover bolts (3) to 9 (80 lb ft).
26. Install the transmission rear mount bracket. Refer to **Transmission Rear Mount Bracket Replacement** .
27. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LL0)** .

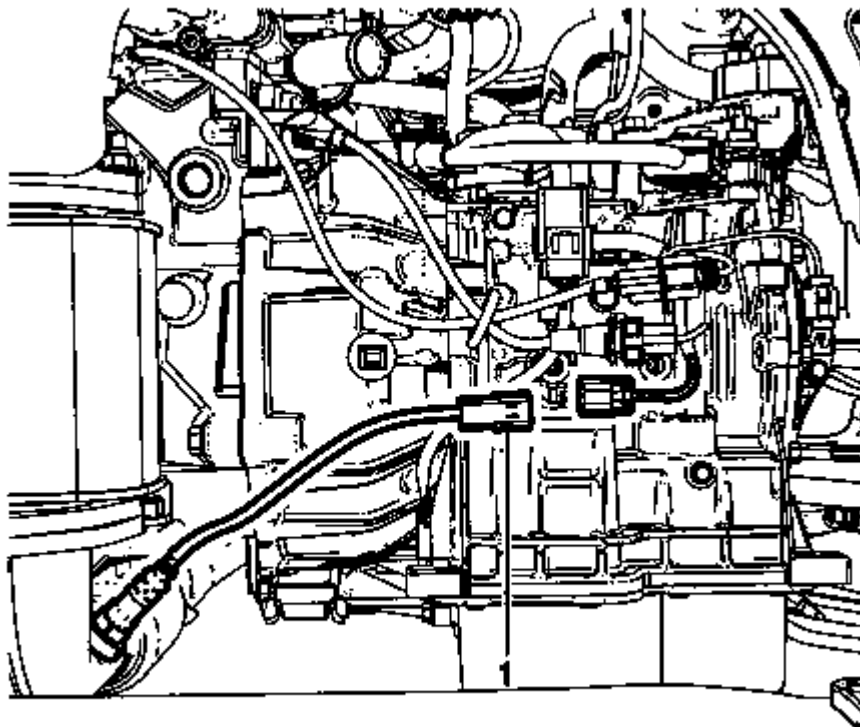


Fig. 182: Oxygen Sensor Connector

Courtesy of GENERAL MOTORS COMPANY

28. Connect the oxygen sensor connector.

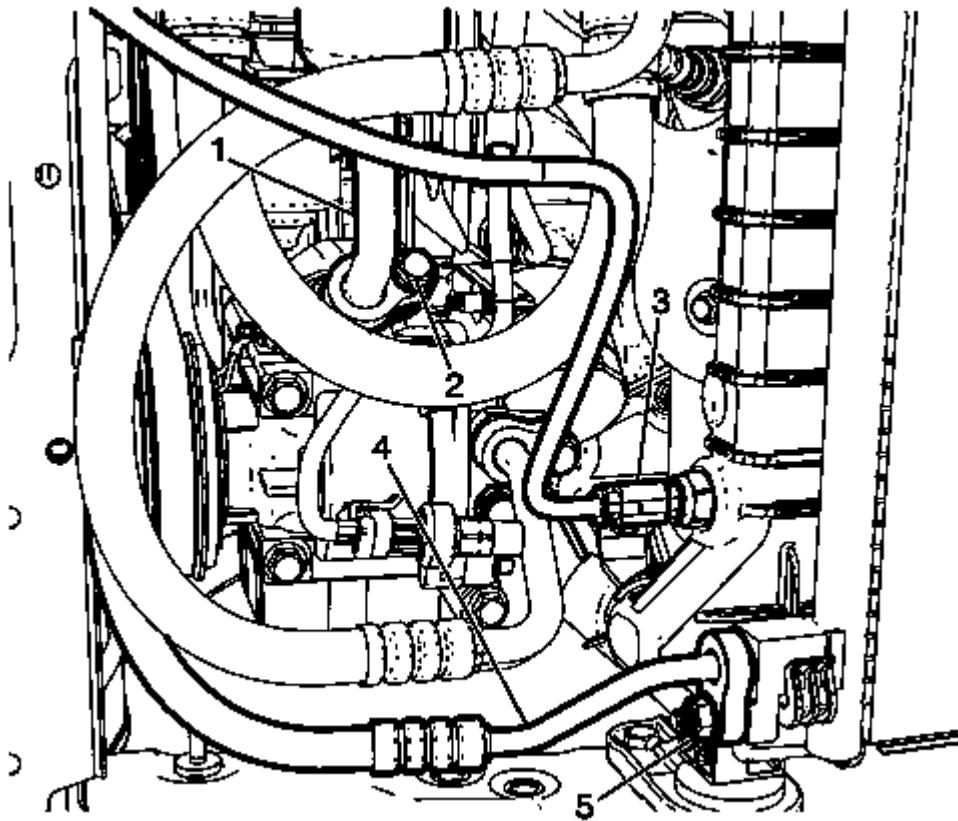


Fig. 183: Suction Pipe Bolt

Courtesy of GENERAL MOTORS COMPANY

29. Install the suction pipe (1) to the A/C compressor.
30. Install the suction pipe bolt (2) to the A/C compressor and tighten to 22 (16 lb ft).
31. Install the discharge pipe (4) to the A/C condenser.
32. Install the discharge pipe nut (5) to the A/C condenser and tighten to 10 (89 lb in).
33. Connect the coolant temperature sensor wiring connector (3) from the radiator.

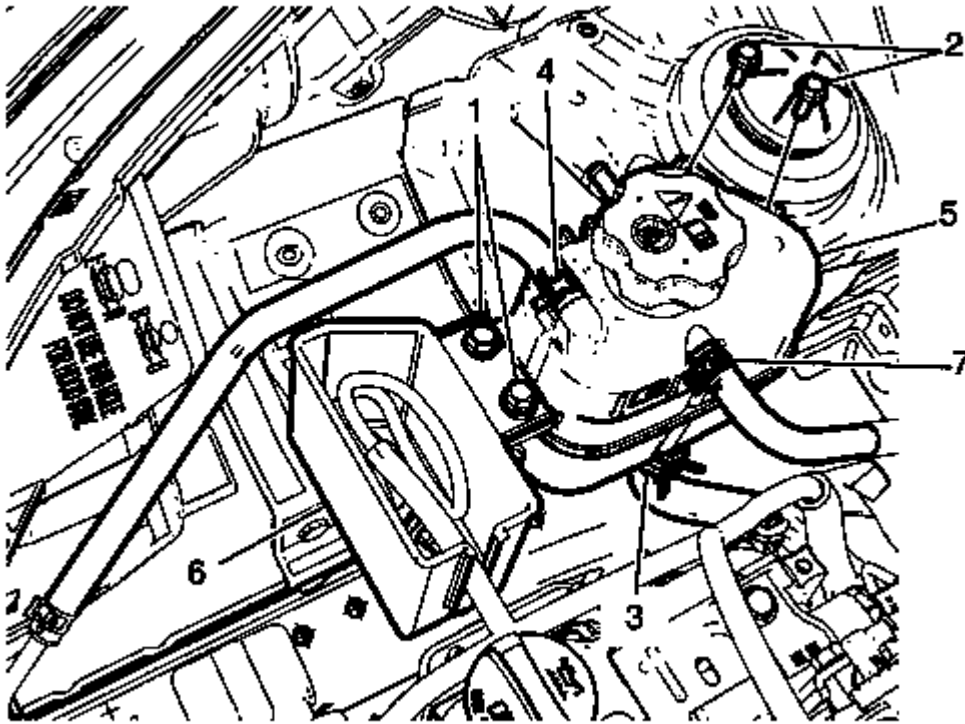


Fig. 184: Block Heater Connecting Plug Holder Bolt
Courtesy of GENERAL MOTORS COMPANY

34. Install the coolant surge tank (5) and coolant hoses with the coolant hose clips (3, 4, 7).
35. Install the coolant surge tank retaining bolts (2) and tighten to 8 (71 lb in).
36. Install the block heater cord container and tighten the block heater code container bolts (1) to 8 (71 lb in).

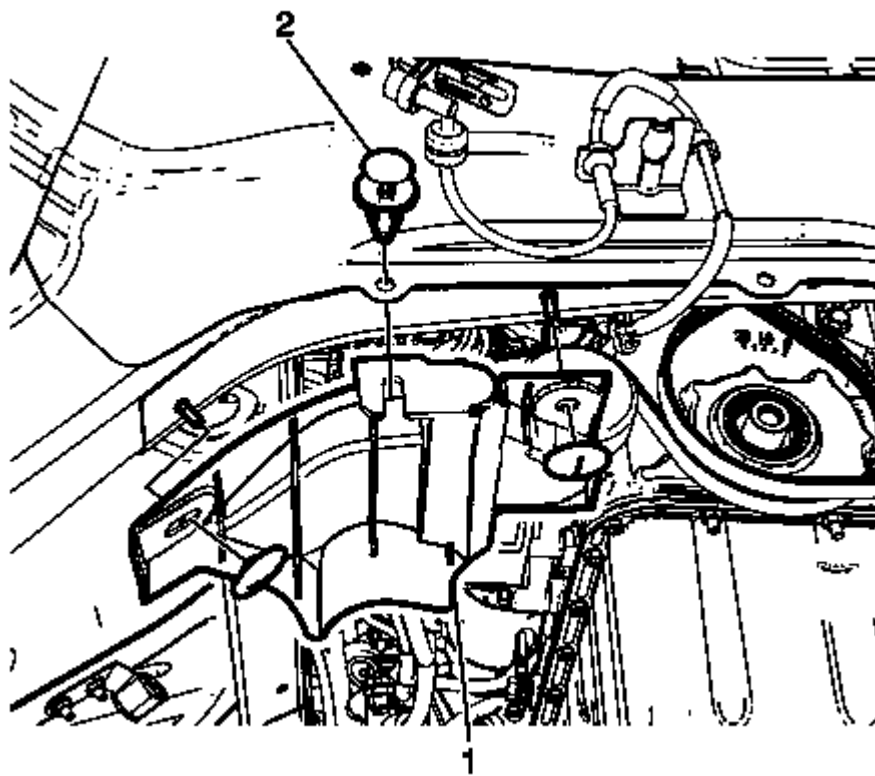


Fig. 185: Retainers And Water Deflector
Courtesy of GENERAL MOTORS COMPANY

37. Install the water deflector (1) with retainers (2).

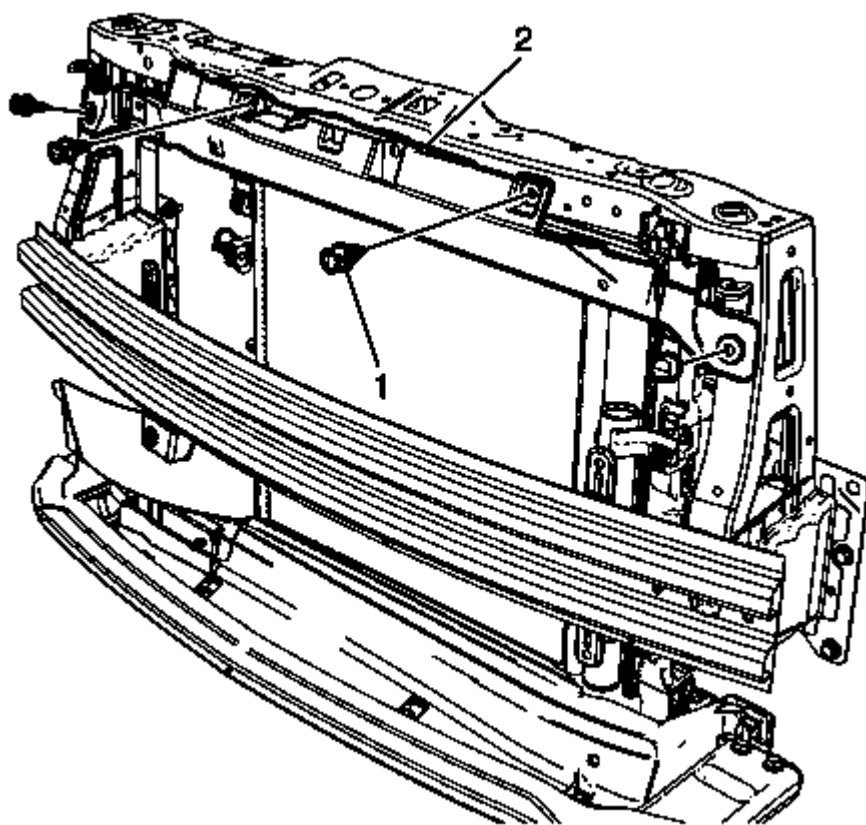


Fig. 186: Upper Air Guard Retainers
Courtesy of GENERAL MOTORS COMPANY

38. Install the upper air guard (2) and the upper air guard retainers (1).

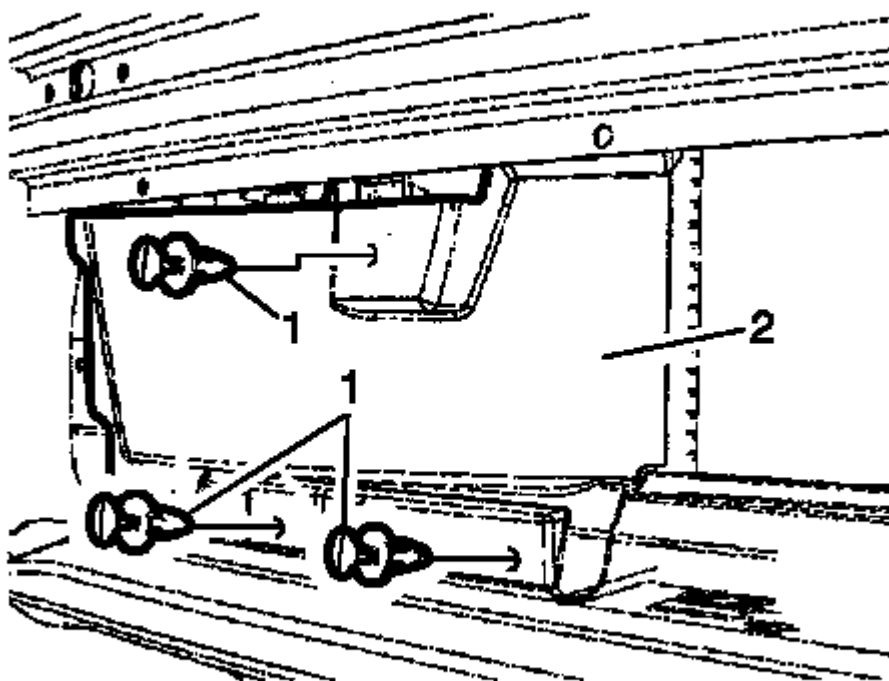


Fig. 187: Front Lower Air Baffle Retainers
Courtesy of GENERAL MOTORS COMPANY

39. Install the front lower air baffles (2) and the front lower air baffle retainers (1).

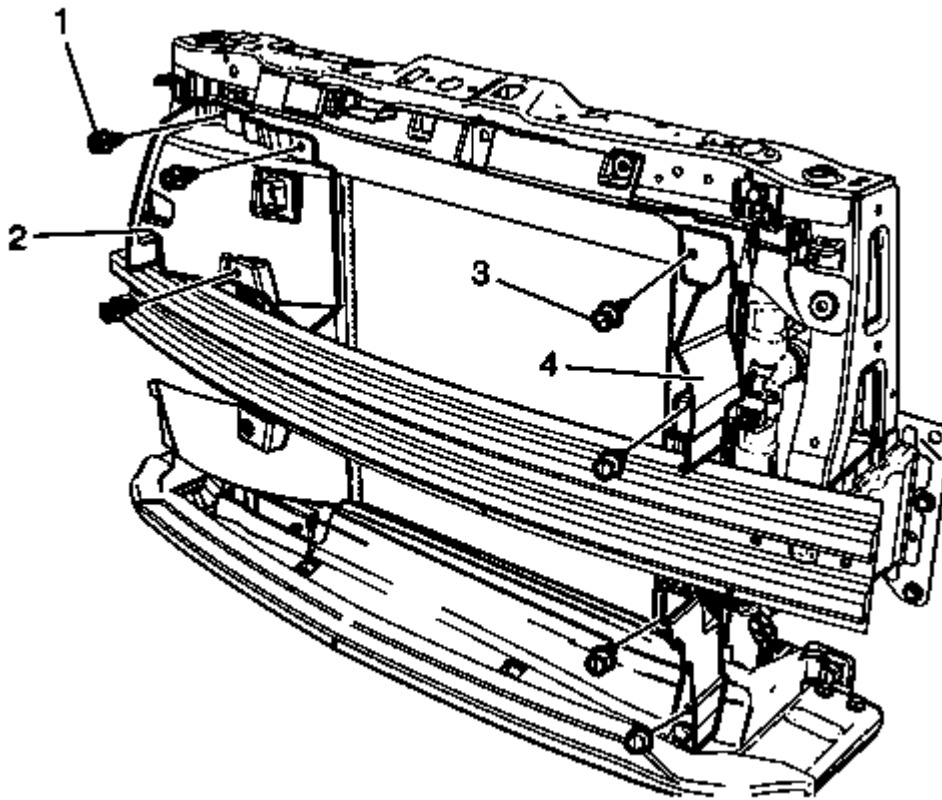


Fig. 188: Front Side Air Baffle Retainers
 Courtesy of GENERAL MOTORS COMPANY

40. Install the front side air baffles (2, 4) and the front side air baffle retainers (1, 3).
41. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement**.

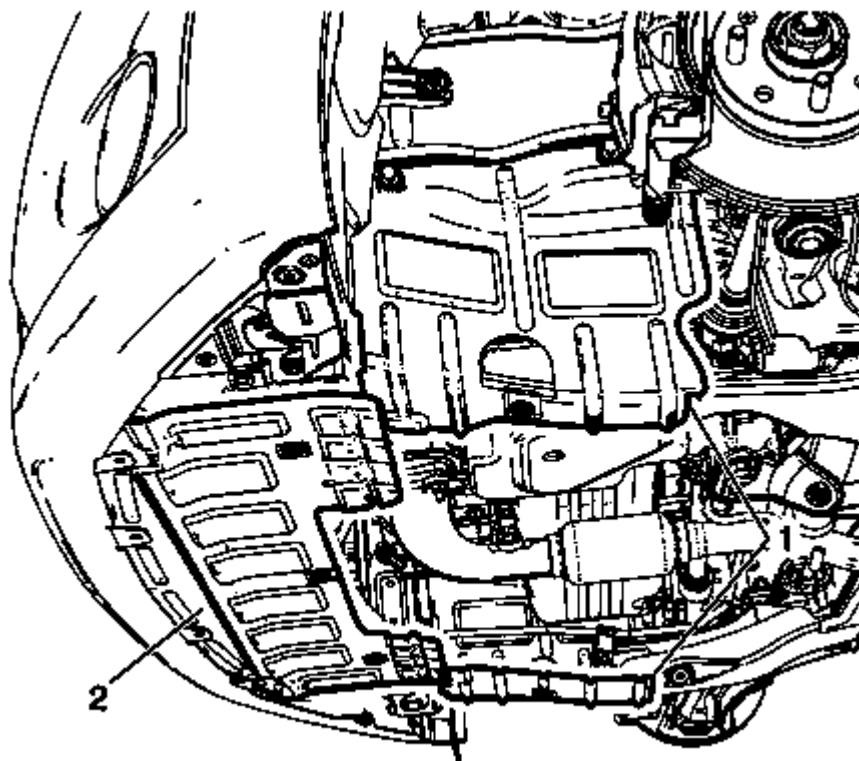


Fig. 189: Compartment Splash Shield

Courtesy of GENERAL MOTORS COMPANY

42. Install the compartment splash shield (1, 2). Refer to **Front Compartment Splash Shield Replacement** .

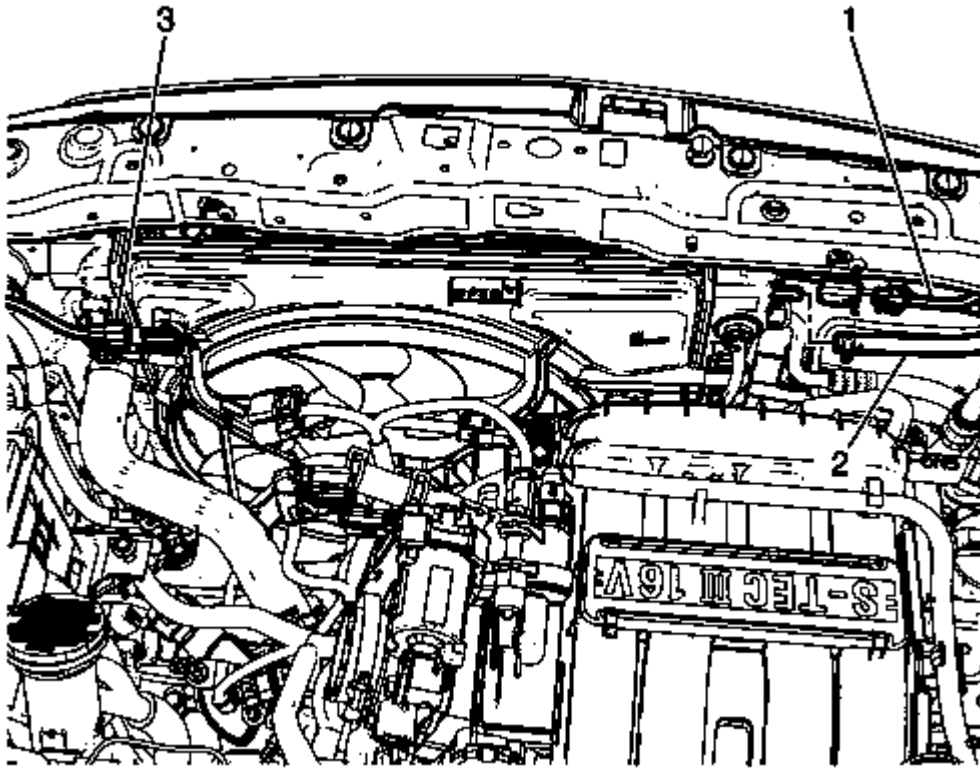


Fig. 190: Ambient Air Temperature Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

43. Connect the coolant hose (2) to the radiator.
44. Connect the ambient air temperature sensor connector (1) to the ambient air temperature sensor if equipped.
45. Install the wiring harness connector (3) to the engine cooling fan harness connector.

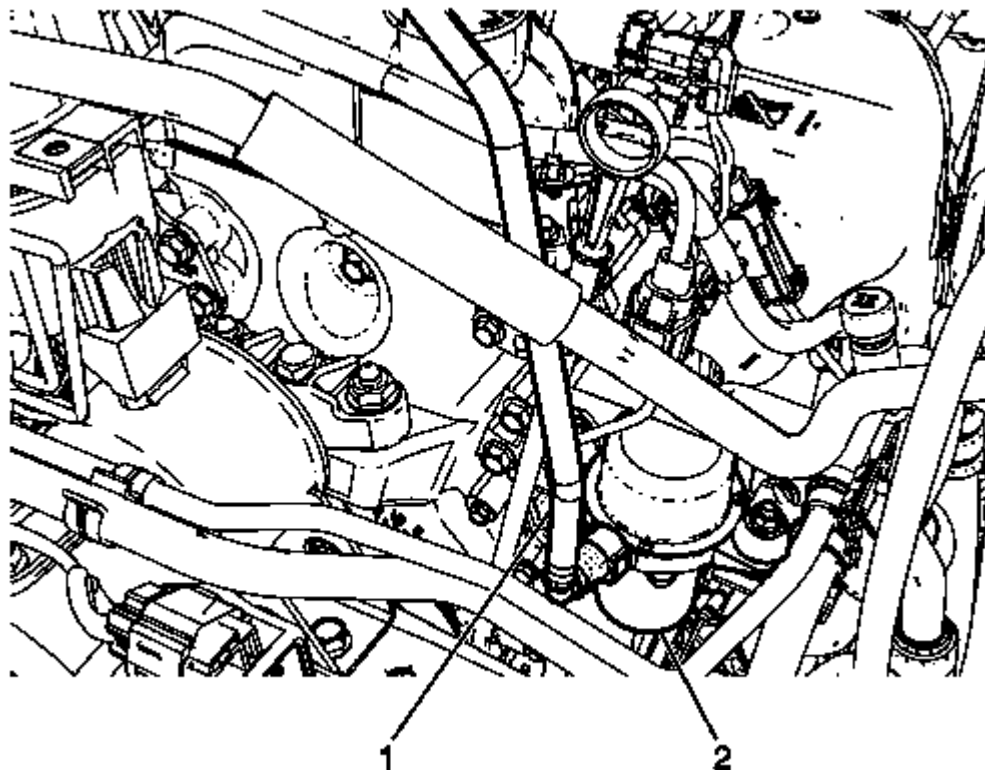


Fig. 191: Vacuum Pump Hose And Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

46. Install the vacuum pump hose (1) to the vacuum pump (2).

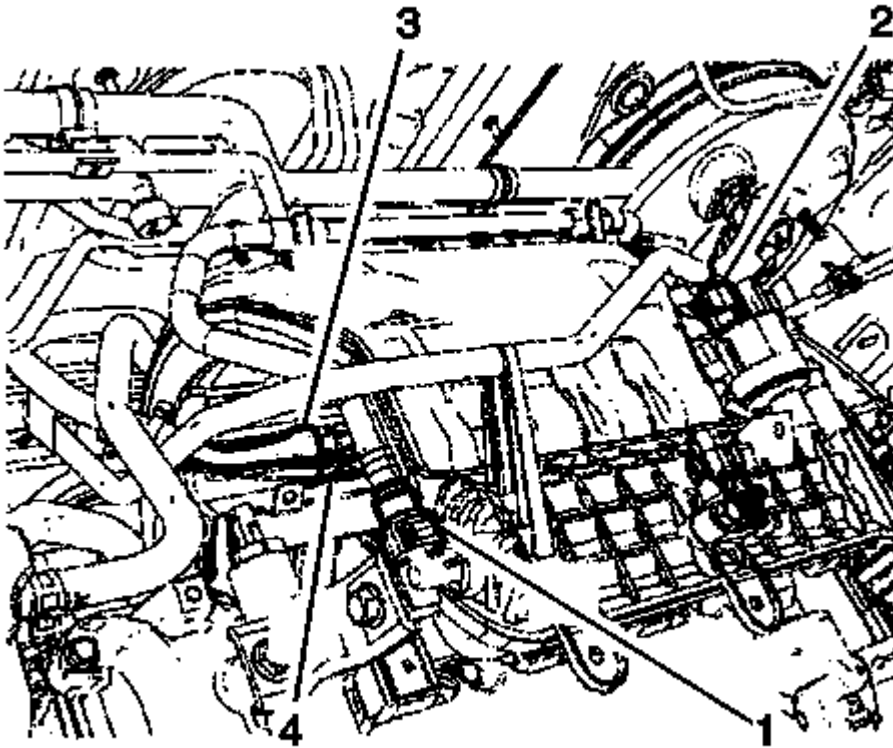


Fig. 192: Vacuum Hose

Courtesy of GENERAL MOTORS COMPANY

47. Connect the fuel feed hose (3) and install the fuel feed hose retaining clip (4). Refer to **Metal Collar Quick Connect Fitting Service**.
48. Connect the evaporative canister purge solenoid valve hose (2).
49. Connect the vacuum hose (1) to the intake manifold.

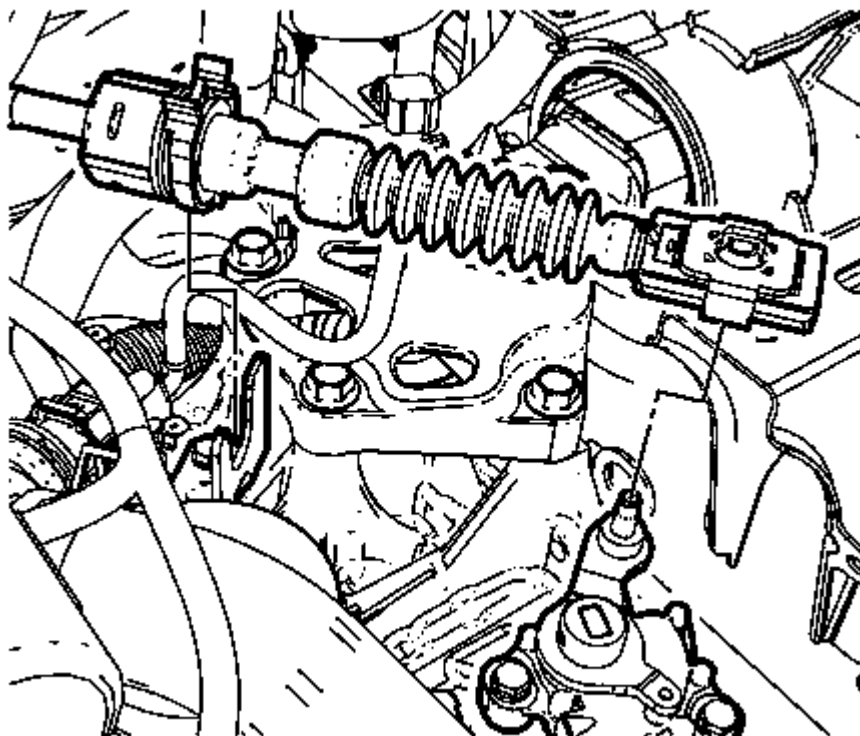


Fig. 193: Transmission Range Selector Lever Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

50. Connect the transmission range selector lever cable terminal to the transmission lever pin. For manual transmission refer to **Manual Transmission Shift Lever and Selector Lever Cable Replacement (MX2, MFM)** .
51. Install the transmission range selector lever cable to the cable bracket.
52. Install the clutch actuator cylinder if equipped. Refer to **Clutch Actuator Cylinder Replacement** . (M/T)
53. Install the heater inlet hose. Refer to **Heater Inlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)** .
54. Install the heater outlet hose. Refer to **Heater Outlet Hose Replacement (1.0L LMT, 1.19L LC5 and 1.2L LMU)** .

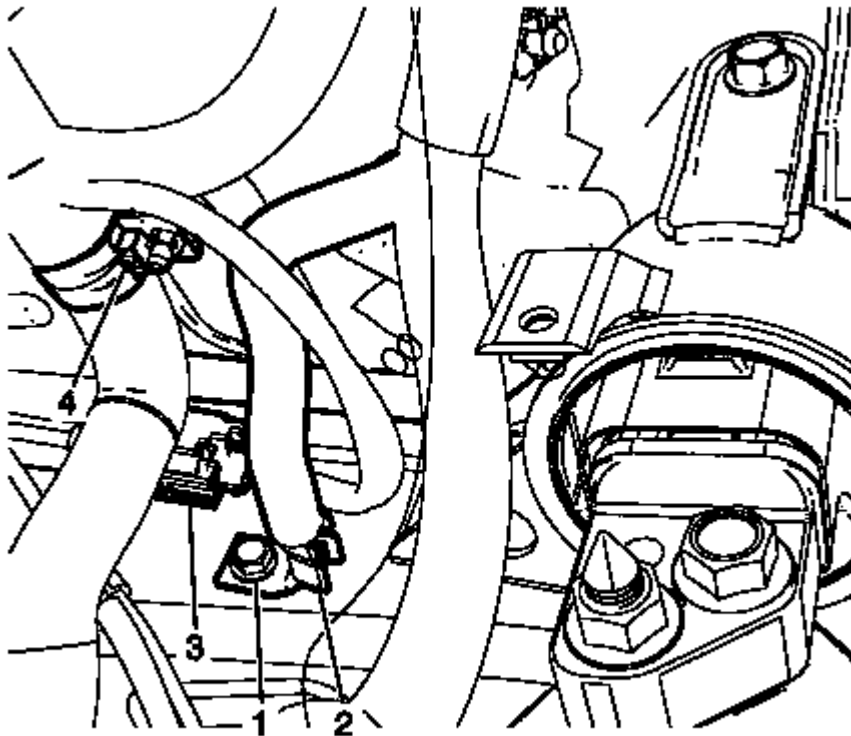


Fig. 194: Ground Bolt And Put Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

55. Install the wiring harness retainer (4).
56. Connect the wheel speed sensor connector (3).
57. Install the ground wiring harness and bolt (1) and tighten to 10 (89 lb in).

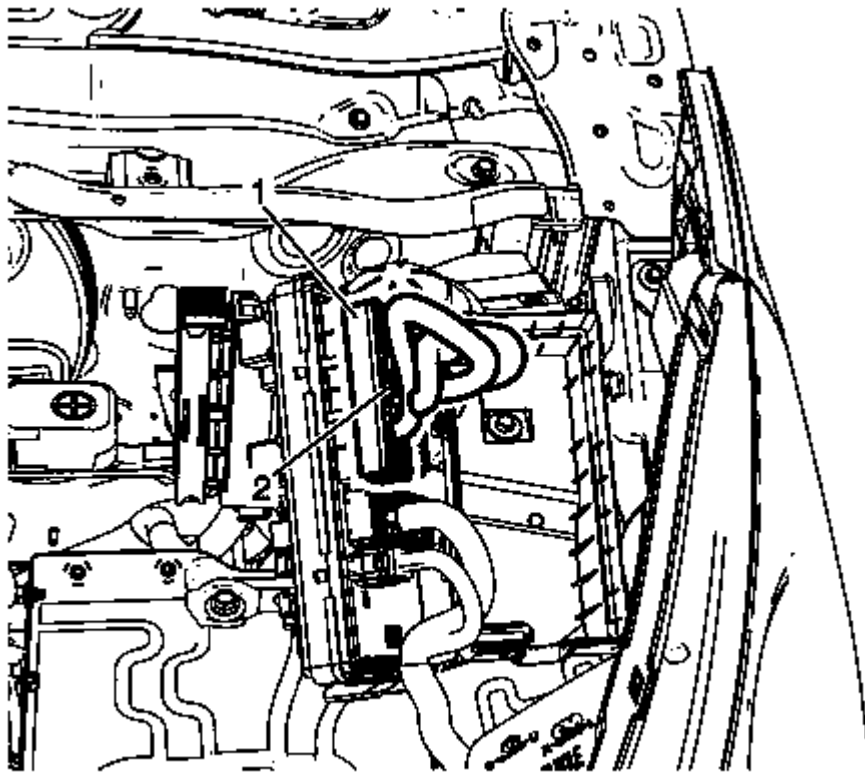


Fig. 195: Front Compartment Fuse Block

Courtesy of GENERAL MOTORS COMPANY

58. Connect the engine wiring harness connector (1) to the fuse block and tighten the wiring harness connector retaining bolt (2) to 6 (53 lb in). Repeat for remaining connector.
59. Connect the remaining wiring harness to the compartment fuse block.
60. Install the engine wiring harness fuse block to the lower plate.

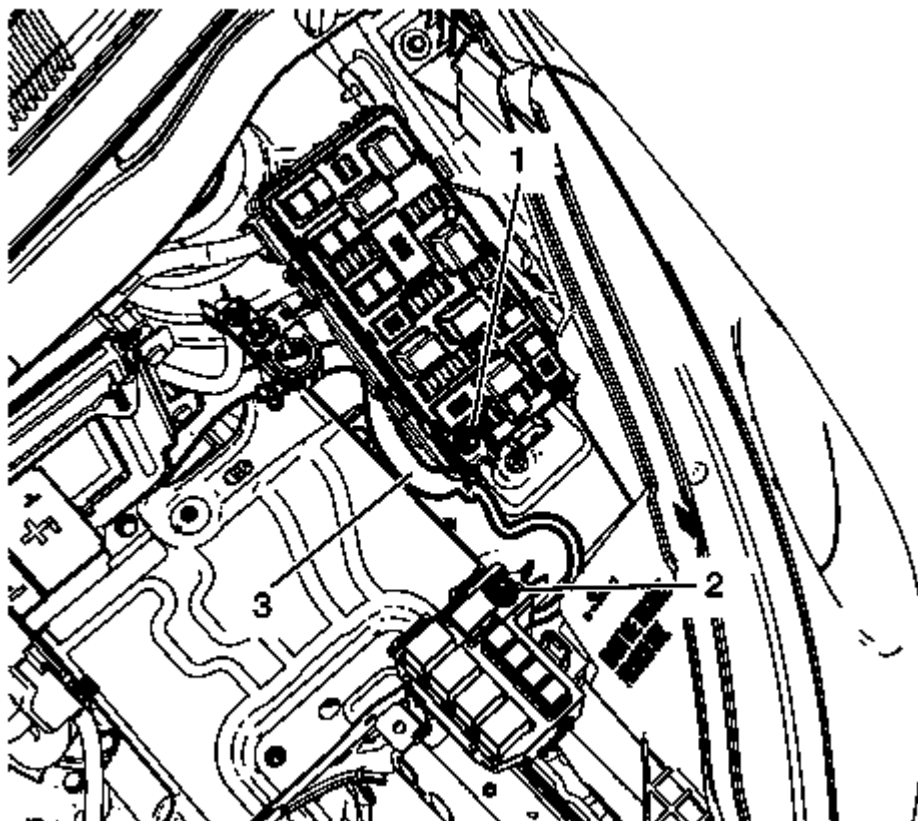


Fig. 196: Positive Battery Cable Nut

Courtesy of GENERAL MOTORS COMPANY

61. Install the positive cable (3) to the engine wiring harness fuse block and tighten the positive cable retaining nut (1, 2) to 10 (89 lb in).

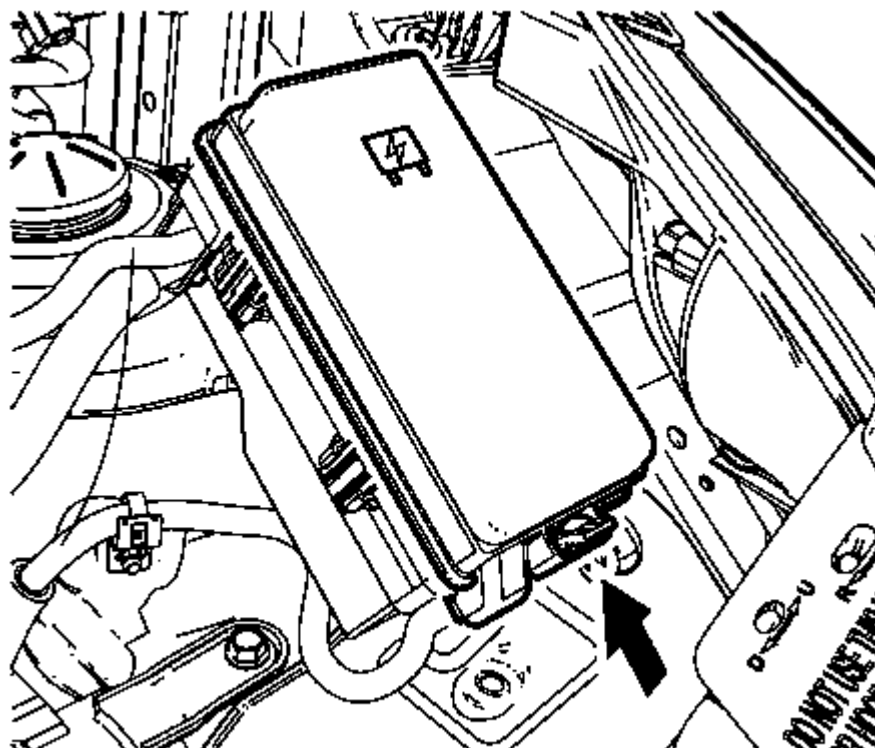


Fig. 197: Front Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

62. Install the engine wiring harness fuse block cover.

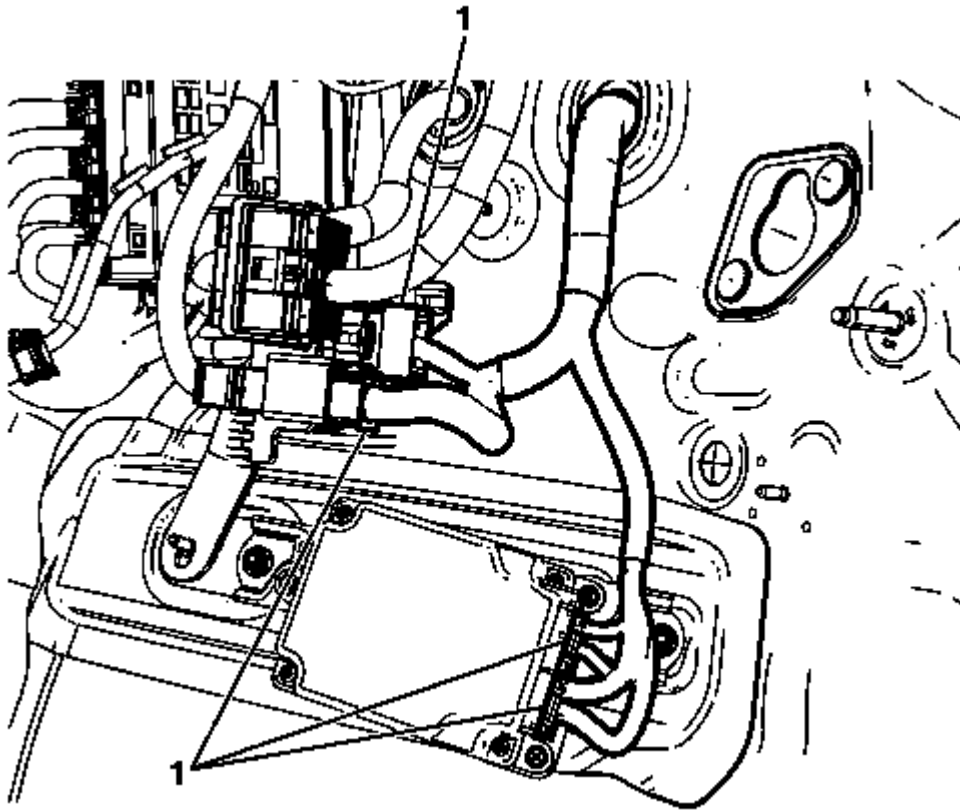


Fig. 198: Engine Wiring Harnesses Connectors

Courtesy of GENERAL MOTORS COMPANY

63. Install the engine wiring harness through the front of dash on the left of the steering shaft under the dash and connect the 4 engine wiring harnesses connectors (1).

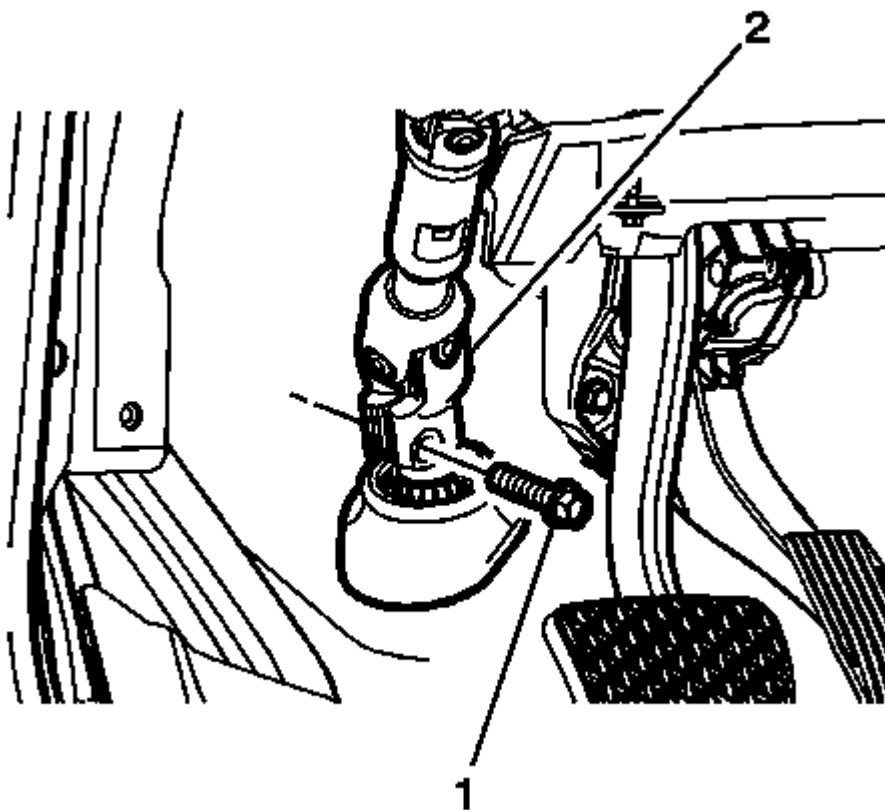
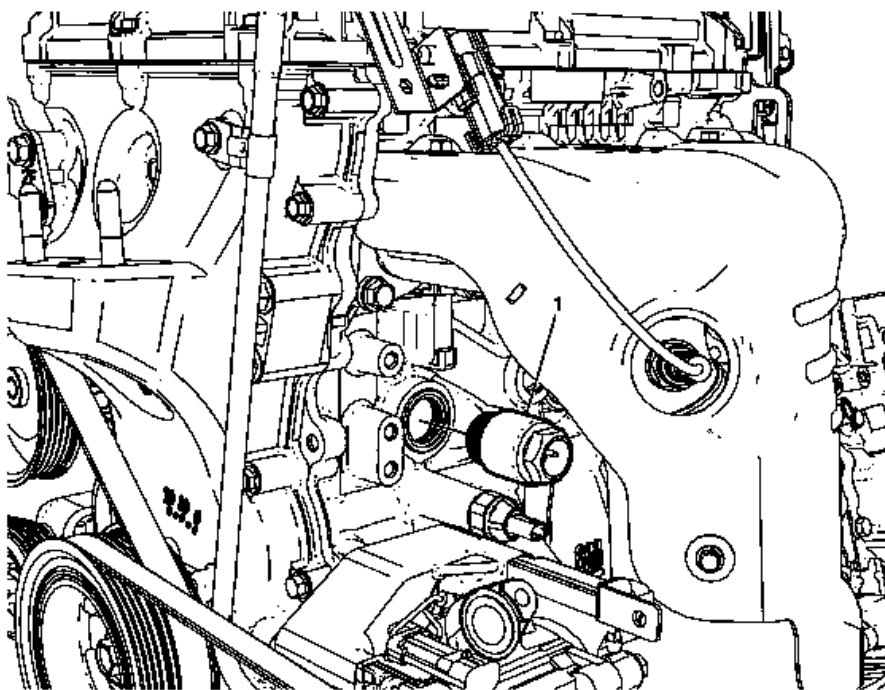


Fig. 199: Lower Intermediate Steering Shaft Bolt
Courtesy of GENERAL MOTORS COMPANY

64. Install the lower intermediate steering shaft (2) and tighten the lower Intermediate steering shaft bolt (1) to 27 (20 lb ft).
65. Install the battery tray. Refer to **Battery Tray Replacement** .
66. Install the engine control module. Refer to **Engine Control Module Replacement** .
67. Install the battery. Refer to **Battery Replacement** .
68. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
69. Install the front wheels and tires. Refer to **Tire and Wheel Removal and Installation** .
70. Recharge the refrigerant. Refer to **Refrigerant Recovery and Recharging** .
71. Refill the cooling system. Refer to **Cooling System Draining and Filling** .
72. Check the engine oil level and fill new engine oil up if necessary.
73. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
74. Close the hood.

ENGINE BLOCK HEATER REPLACEMENT (LL0)

**Fig. 200: Engine Block Heater**

Courtesy of GENERAL MOTORS COMPANY

Engine Block Heater Replacement (LL0)

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Drain the cooling system. Refer to Cooling System Draining and Filling . 2. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection 3. Disconnect the engine block heater electrical connector. 	
1	Engine Block Heater CAUTION: Refer to Component Fastener Tightening Caution . Procedure Remove the engine block heater. Tighten 60 (44 lb ft)

ENGINE OIL AND OIL FILTER REPLACEMENT**Removal Procedure**

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

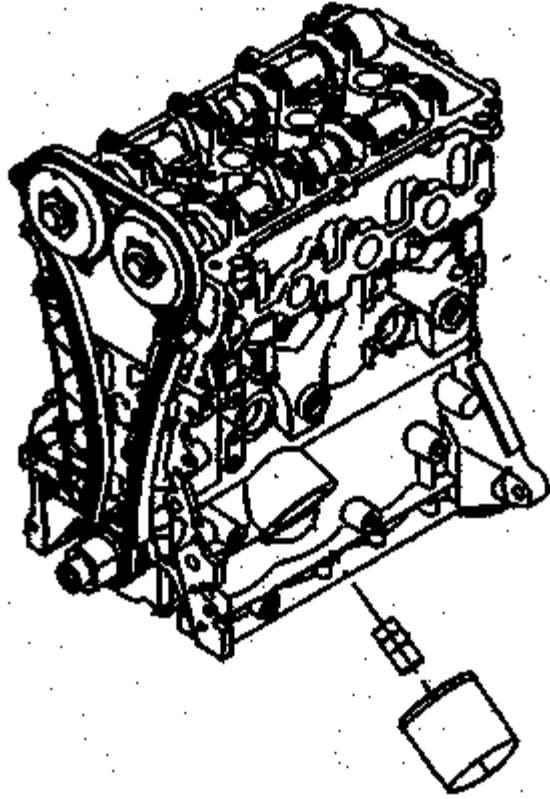
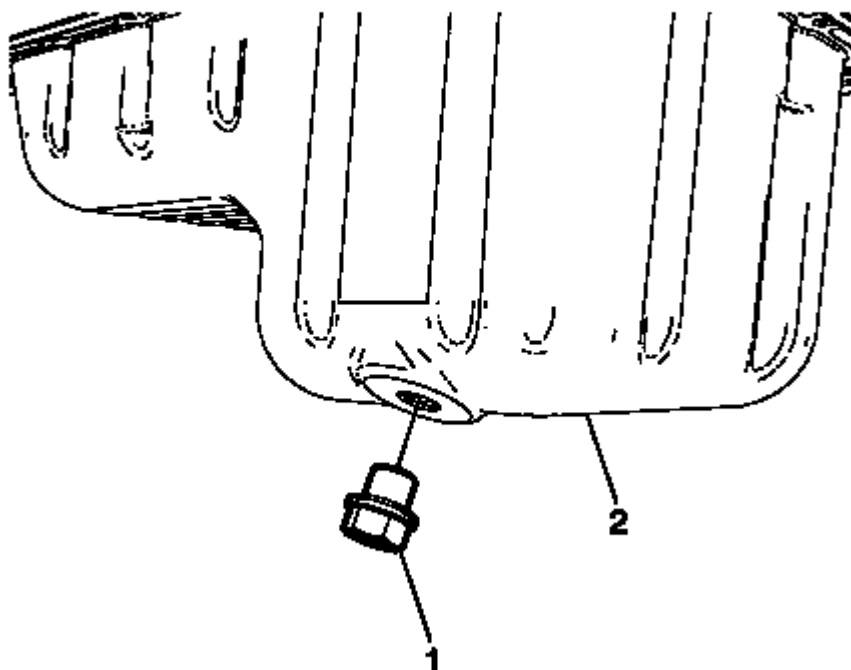


Fig. 201: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil filter, using suitable tool.
4. Discard the oil filter.

**Fig. 202: Oil Pan Drain Plug****Courtesy of GENERAL MOTORS COMPANY**

5. Place a suitable container below the oil pan drain plug (1).
6. Remove the oil pan drain plug (1) from the oil pan (2).
7. Allow the oil to drain completely.

Installation Procedure

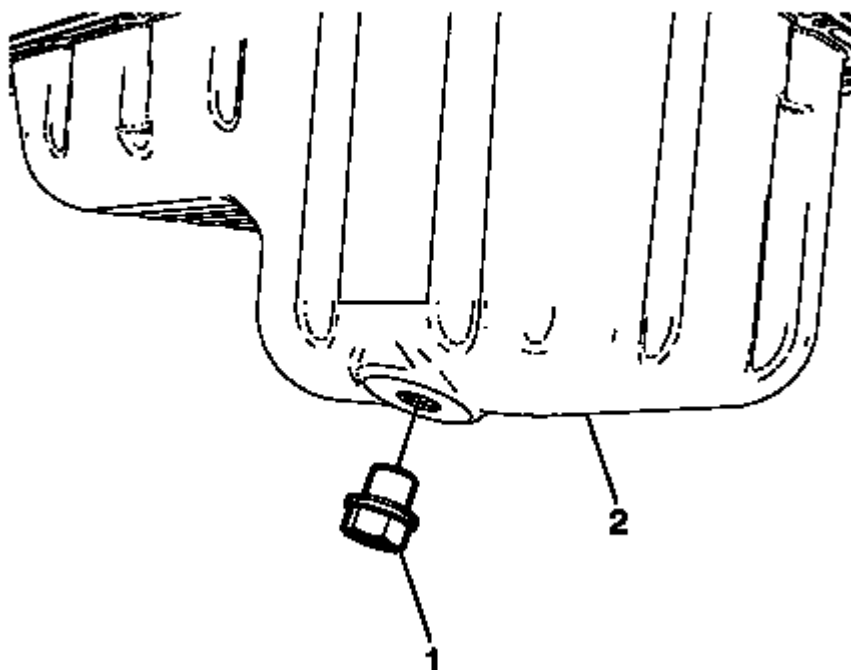


Fig. 203: Oil Pan Drain Plug

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug (1) to the oil pan (2) and tighten the oil pan drain plug to 25 (18 lb ft).

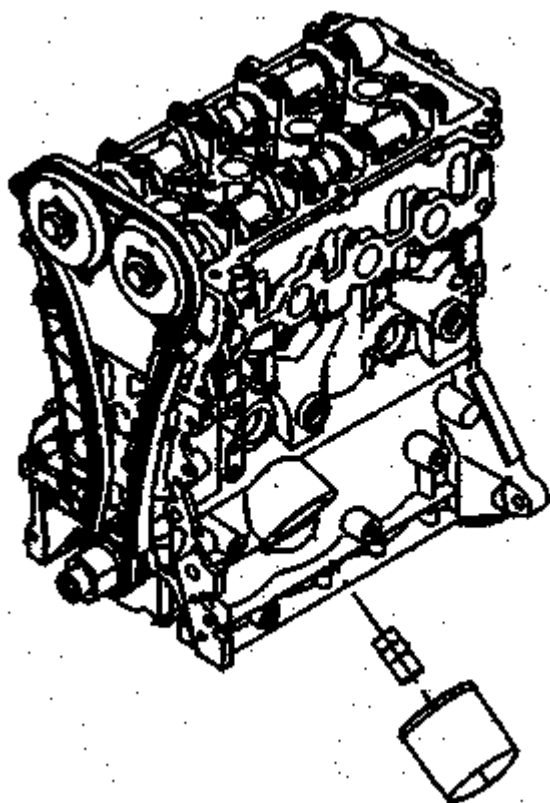


Fig. 204: Oil Filter

Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW oil filter.
3. Install the oil filter using suitable tool.
4. Tighten the oil filter to 16 (12 lb ft).
5. Lower the vehicle.
6. Fill the engine with the appropriate oil type and quantity. Refer to **Fluid and Lubricant Recommendations** and **Approximate Fluid Capacities** .

PISTON, CONNECTING ROD AND BEARING REPLACEMENT

Special Tools

- **EN-50174** Piston Ring Compressor (1.0L only)
- **J-8037** Piston Ring Compressor

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

Removal Procedure

1. Remove the cylinder head. Refer to **Cylinder Head Replacement (LL0)**, **Cylinder Head Replacement**

(LFM).

2. Remove the oil pan. Refer to **Oil Pan Replacement**
3. Raise the vehicle by its full height. Refer to **Lifting and Jacking the Vehicle** .
4. Install the crankshaft balancer bolt.
5. Set the pistons 1 and 4 to TDC in direction of engine rotation.

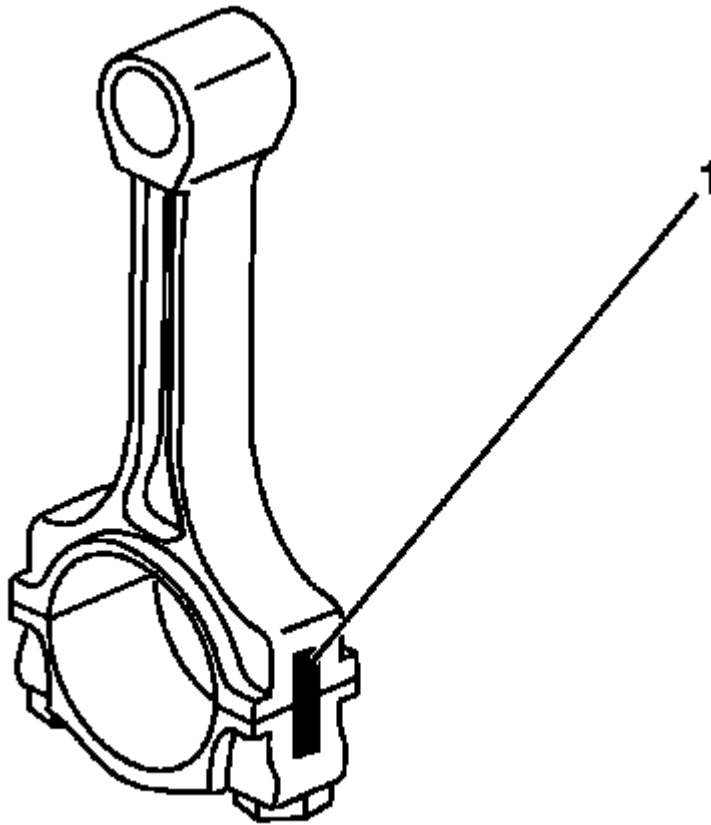
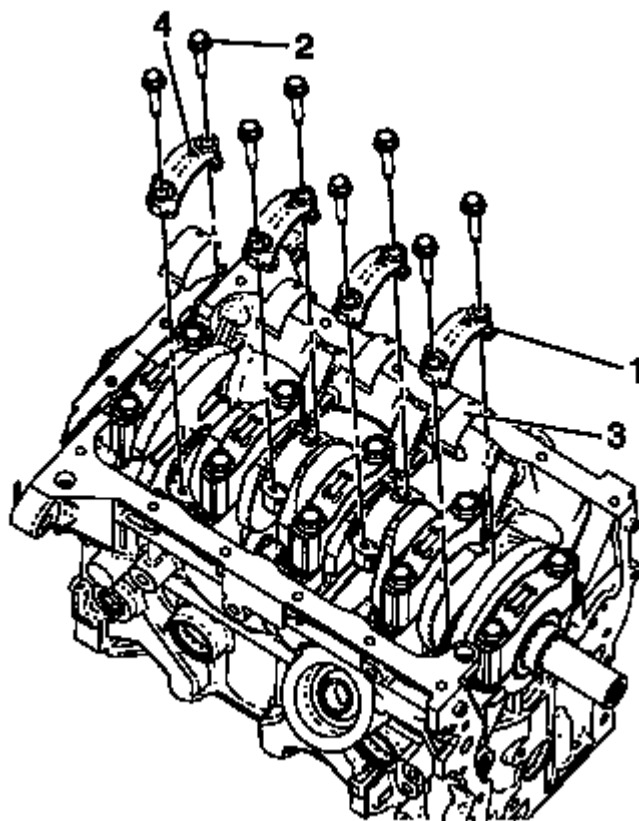


Fig. 205: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

**Fig. 206: Rod Bearing Caps Nuts****Courtesy of GENERAL MOTORS COMPANY**

7. Remove the 4 connecting rod bearing caps nuts (2) of cylinder 1 and 4.
8. Remove the connecting rod bearing caps (1) and the connecting rod bearing (3).

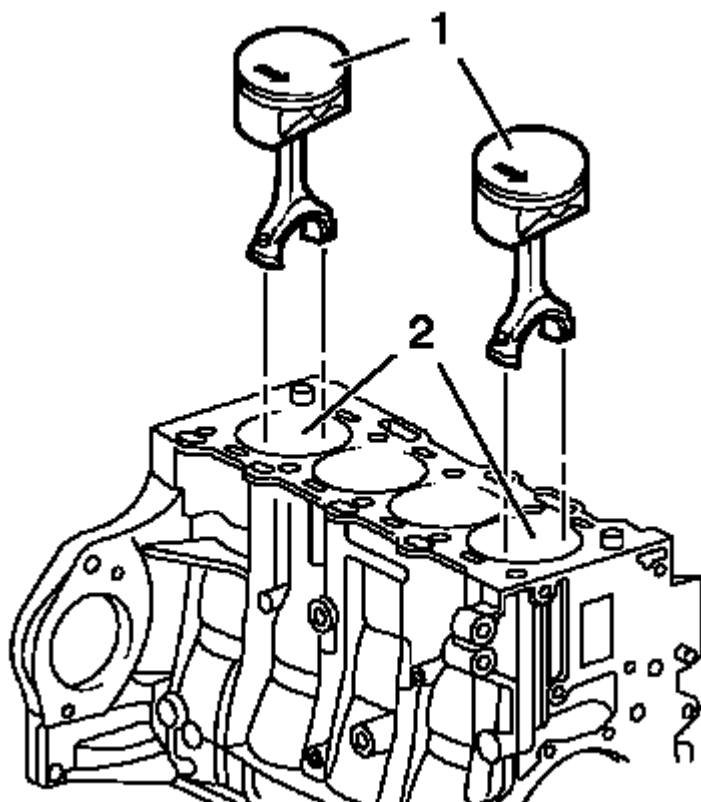


Fig. 207: Pistons 1, 4 And Cylinder Bore

Courtesy of GENERAL MOTORS COMPANY

9. Push the pistons 1 and 4 (1) out of the cylinder bore (2).
10. Lower the vehicle.

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.

11. Remove the pistons 1 and 4 (1).
12. Raise the vehicle by its full height.
13. Turn crankshaft on crankshaft balancer through 180 degrees in direction of rotation of engine.
14. Repeat for the piston 2 and 3.

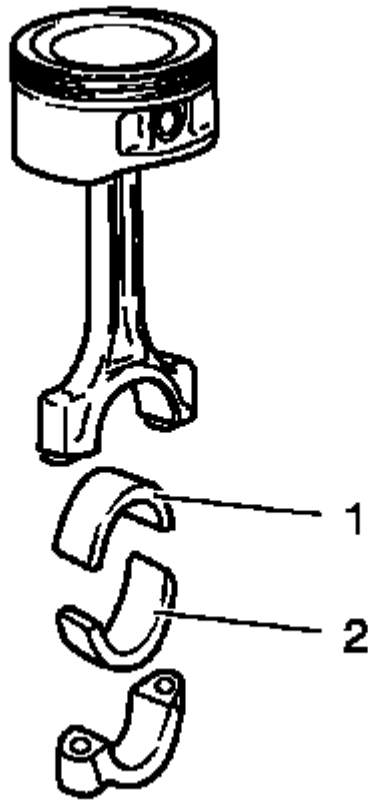


Fig. 208: Connecting Rod Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe correct fitting position, observe alignment.

15. Remove the connecting rod bearing (1, 2).
16. Check the components. Refer to **Piston, Connecting Rod and Bearing Cleaning and Inspection (LL0)**, **Piston, Connecting Rod and Bearing Cleaning and Inspection (LFM)**.

Installation Procedure

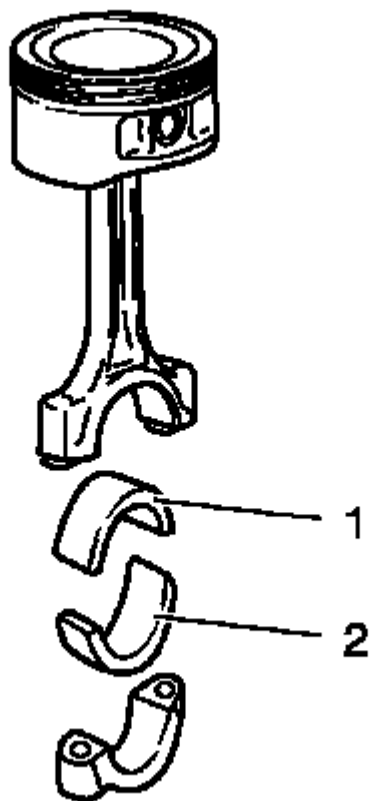


Fig. 209: Connecting Rod Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the connection rod bearing with **NEW** engine oil.

1. Install the connecting rod bearing (1, 2).

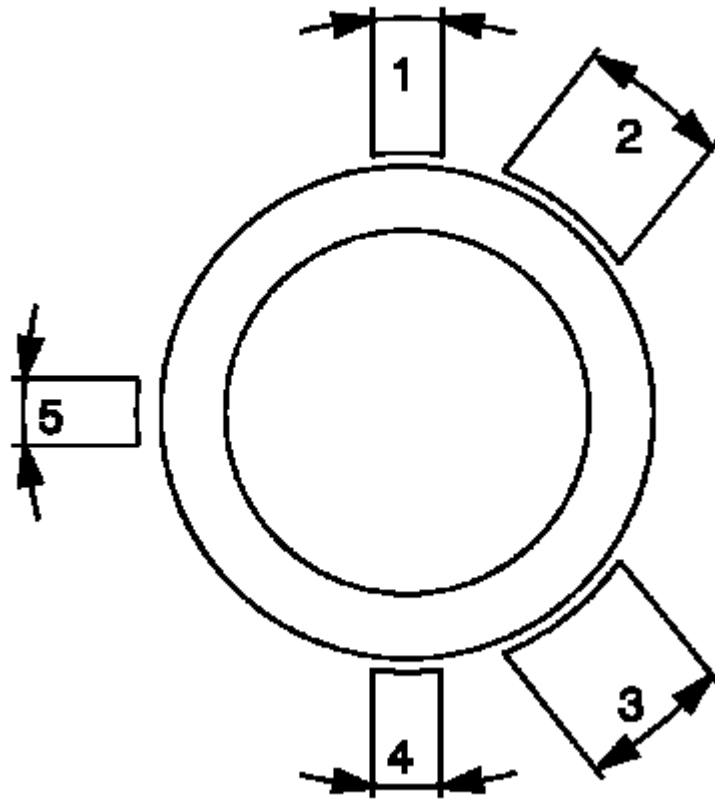


Fig. 210: View Of Piston Ring Joint Positions
Courtesy of GENERAL MOTORS COMPANY

2. Set piston ring joints.
 - Piston compression upper ring in position (1).
 - Piston compression lower ring in position (4).
 - Interim ring of the piston oil ring rail in position (5), steel band rings of the piston oil ring rail in position (2) and/or (3).

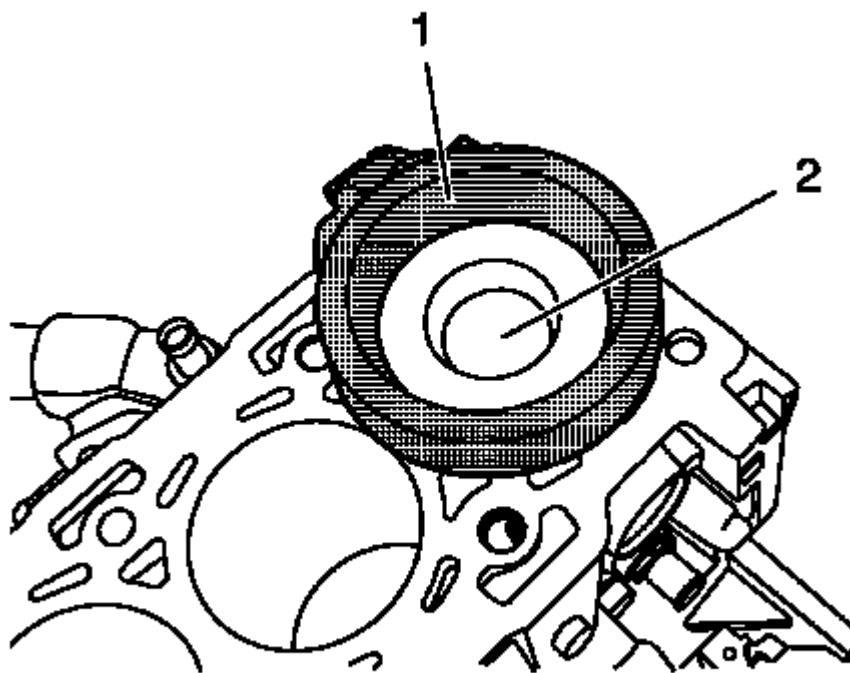


Fig. 211: Piston Rings, Piston And Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the piston rings, piston (1), inner cylinder bore surface and **EN-50174 (J-8037)** piston ring compressor (2) with clean engine oil.

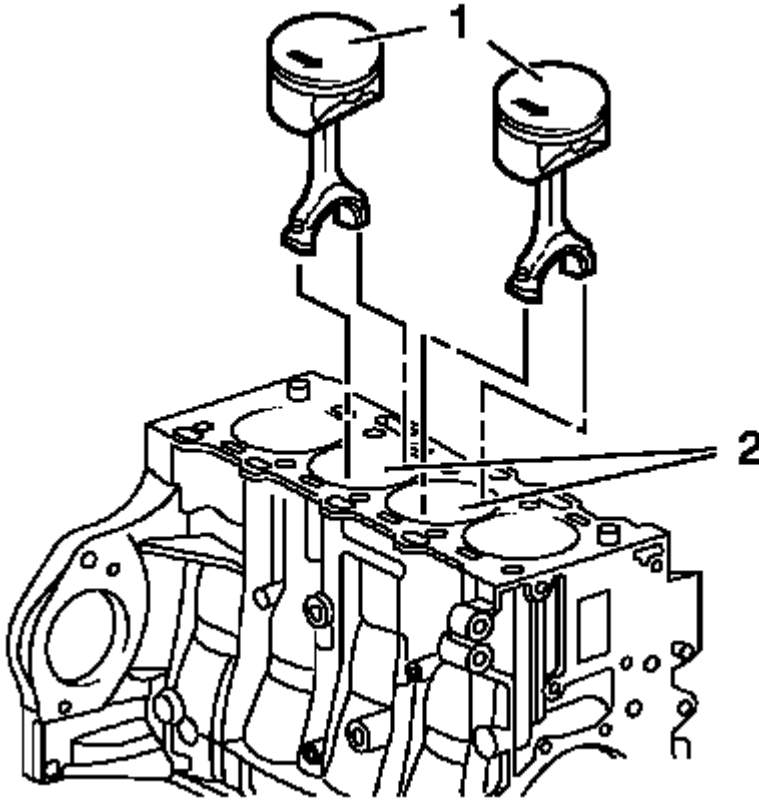


Fig. 212: Pistons 2, 3 And Cylinder Bore
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Arrow on piston head points to engine timing side, bead on connecting rod points to transmission side of engine.

4. Push the pistons 2 and 3 (1) into the cylinder bore (2).
5. Raise the vehicle by its full height.

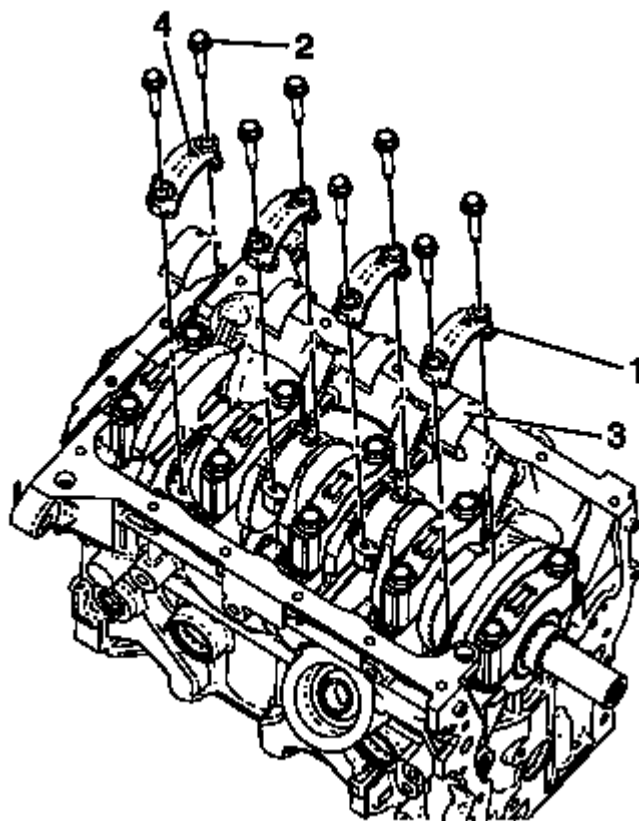


Fig. 213: Rod Bearing Caps Nuts

Courtesy of GENERAL MOTORS COMPANY

6. Install the connecting rod bearing caps (1) and the connecting rod bearing (3).

CAUTION: Refer to Fastener Caution .

7. Install 4 NEW connecting rod bearing caps bolts (2) of cylinder 2 and 3 and tighten to $20 + 90^\circ$ (15 lb ft + 90°).
8. Turn crankshaft on crankshaft balancer through 180 degrees in direction of rotation of engine.
9. Repeat for the piston 1 and 4.
10. Set the crankshaft in direction of engine rotation to 60 degrees before UDC.
11. Install the oil pan. Refer to Oil Pan Replacement.
12. Install the cylinder head. Refer to Cylinder Head Replacement (LL0), Cylinder Head Replacement (LFM).

CAMSHAFT COVER REPLACEMENT (LL0)

Removal Procedure

1. Open the hood.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
4. Remove the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.

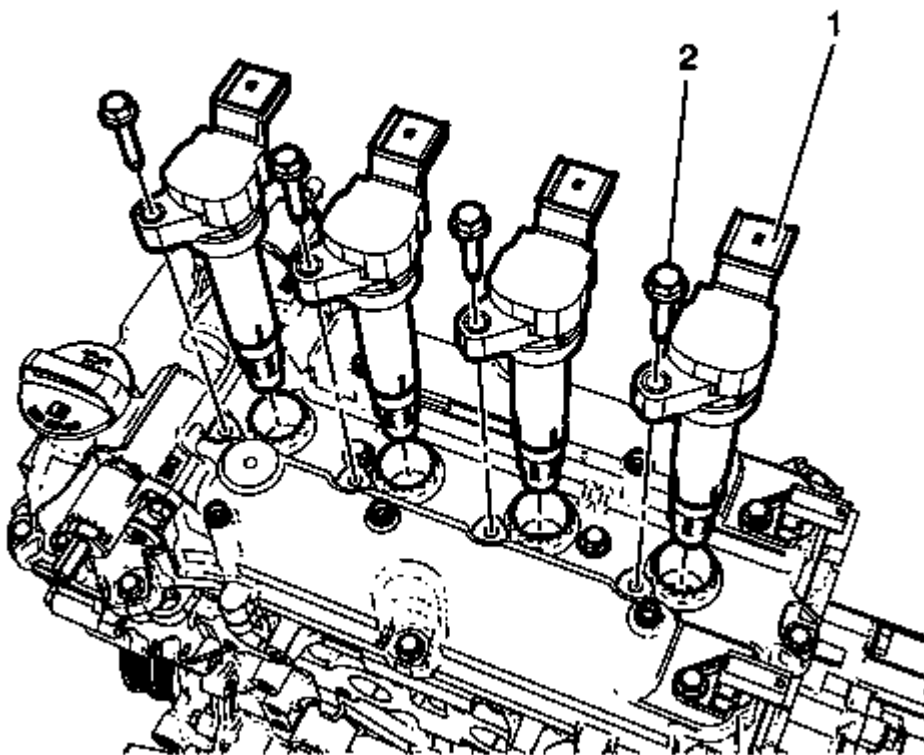


Fig. 214: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the fuel injector connectors. Refer to **Fuel Injection Fuel Rail Assembly Replacement (LFM)**, **Fuel Injection Fuel Rail Assembly Replacement (LL0)**.
6. Remove the ignition coil (1). Refer to **Ignition Coil Replacement (LL0)**, **Ignition Coil Replacement (LFM)**.
7. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement (LFM)**, **Camshaft Position Sensor Replacement (LL0)**.
8. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.
9. Remove the oil filler cap.

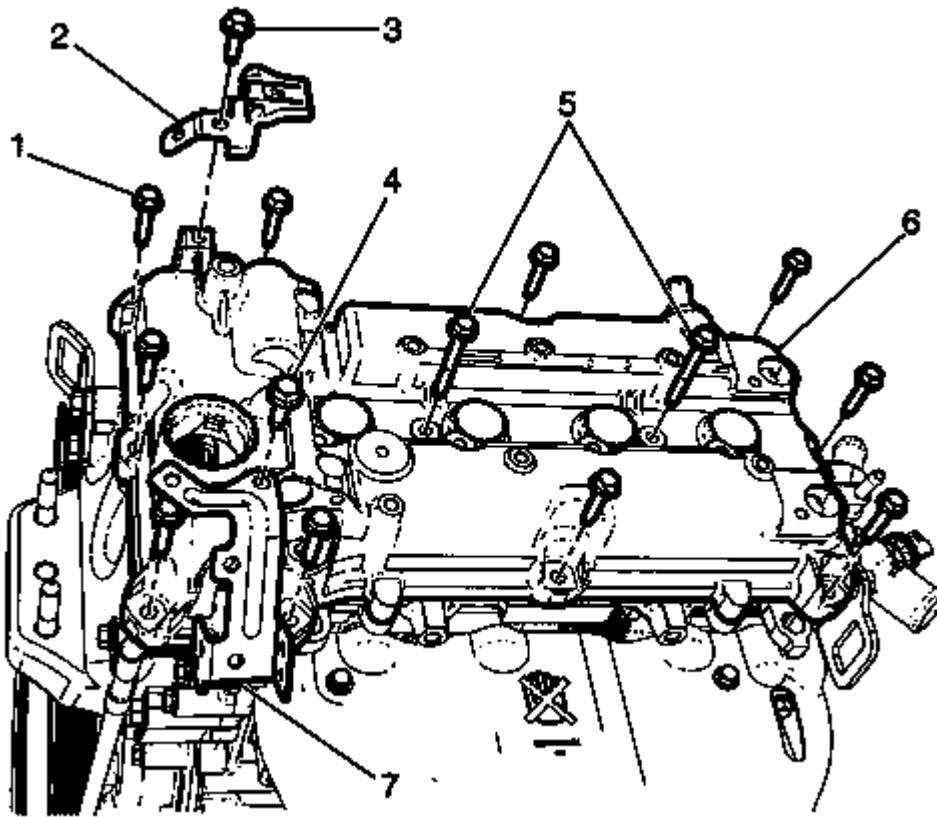


Fig. 215: Engine Injection And Ignition Bracket Bolt
 Courtesy of GENERAL MOTORS COMPANY

10. Remove The 1 Engine Injection And Ignition Bracket Bolt (3).
11. Remove the engine injection and ignition bracket (2).
12. Remove the 1 camshaft cover front bracket bolt (4).
13. Remove the camshaft cover front bracket (7).
14. Remove the 2 camshaft cover bolts (5).
15. Remove the 10 camshaft cover bolts (1).
16. Remove the camshaft cover (6).

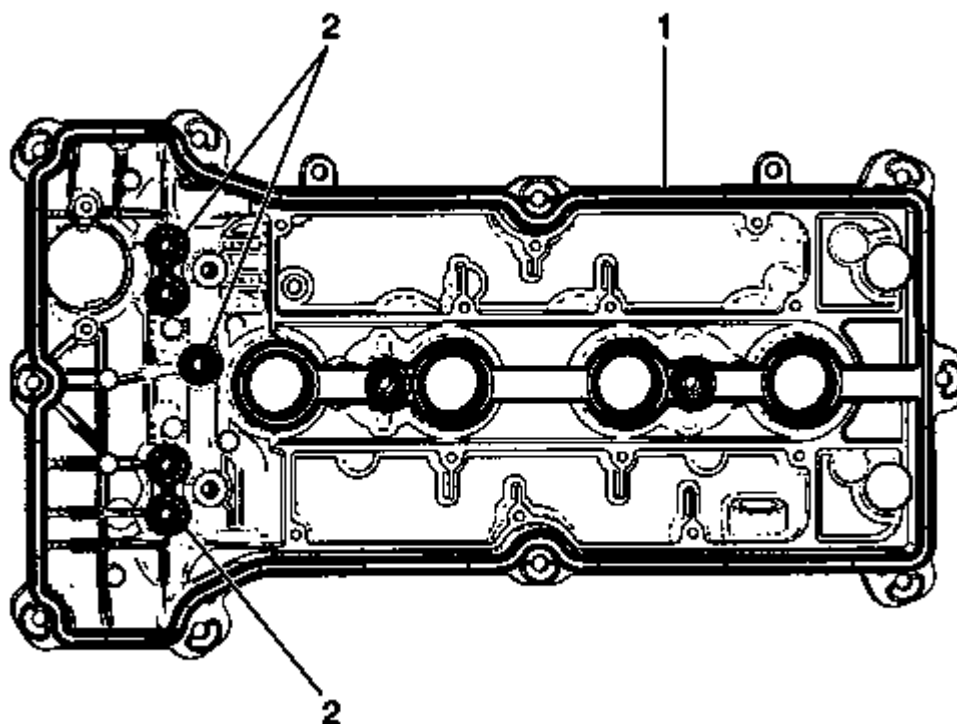


Fig. 216: Camshaft Cover Gasket

Courtesy of GENERAL MOTORS COMPANY

17. Remove the camshaft cover gasket (1).
18. Remove the camshaft cover seals (2).

Installation Procedure

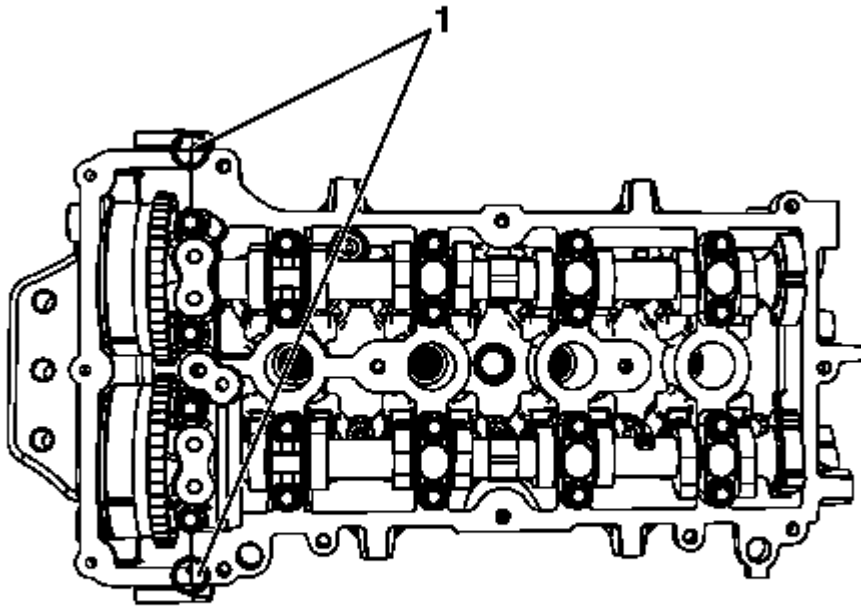


Fig. 217: Cured RTV Carefully

Courtesy of GENERAL MOTORS COMPANY

1. Remove the cured RTV carefully (1) and then clean the sealing surfaces.

NOTE: After RTV applying, the assembly completion time including torque check must be done within 8 minutes.

2. Apply RTV sealant to T-joint between cylinder head and front cover (1).

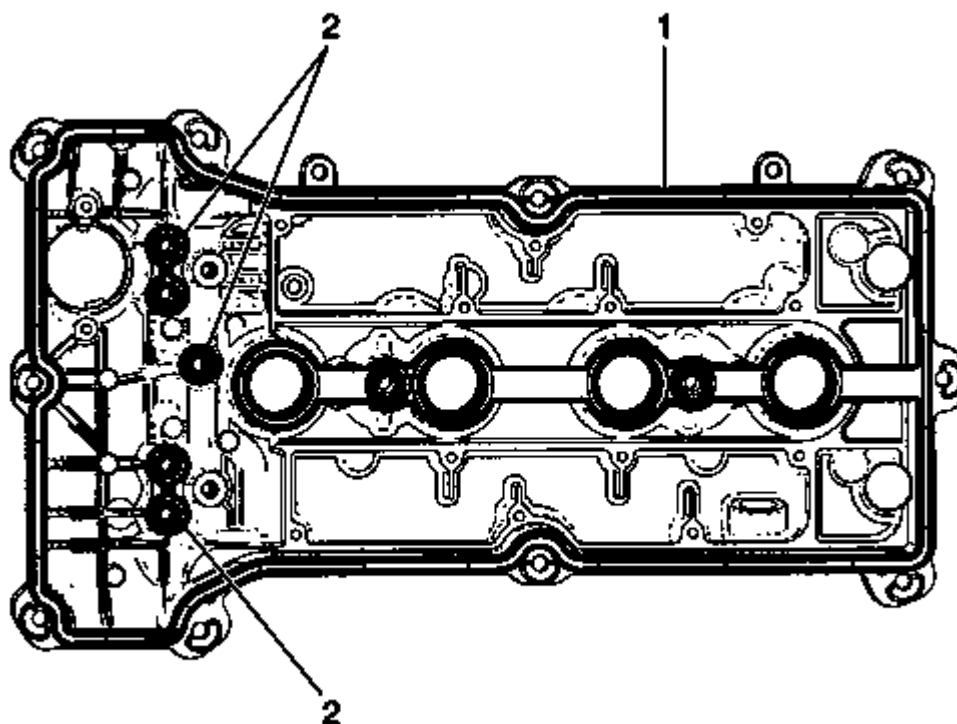


Fig. 218: Camshaft Cover Gasket

Courtesy of GENERAL MOTORS COMPANY

3. Install the camshaft cover seals (2) to the camshaft cover.
4. Install the camshaft cover gasket (1) to the camshaft cover.

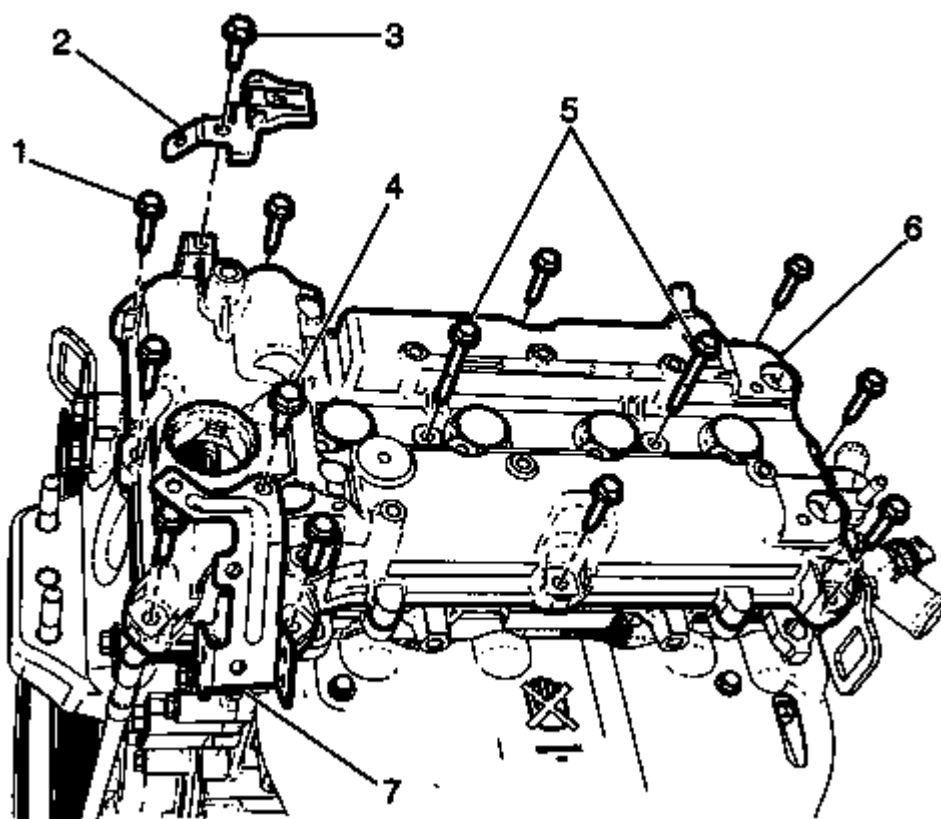


Fig. 219: Engine Injection And Ignition Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the camshaft cover (6).

CAUTION: Refer to Fastener Caution .

6. Install the 2 camshaft cover bolts (5) and tighten to 10 (89 lb in).
7. Install the 10 camshaft cover bolts (1) and tighten to 10 (89 lb in).
8. Install the camshaft cover front bracket (7).
9. Install the 1 camshaft cover front bracket bolt (4) and tighten to 10 (89 lb in).
10. Install the engine injection and ignition bracket (2).
11. Install the 1 engine injection and ignition bracket bolt (3) and tighten to 10 (89 lb in).
12. Install the oil filler cap.

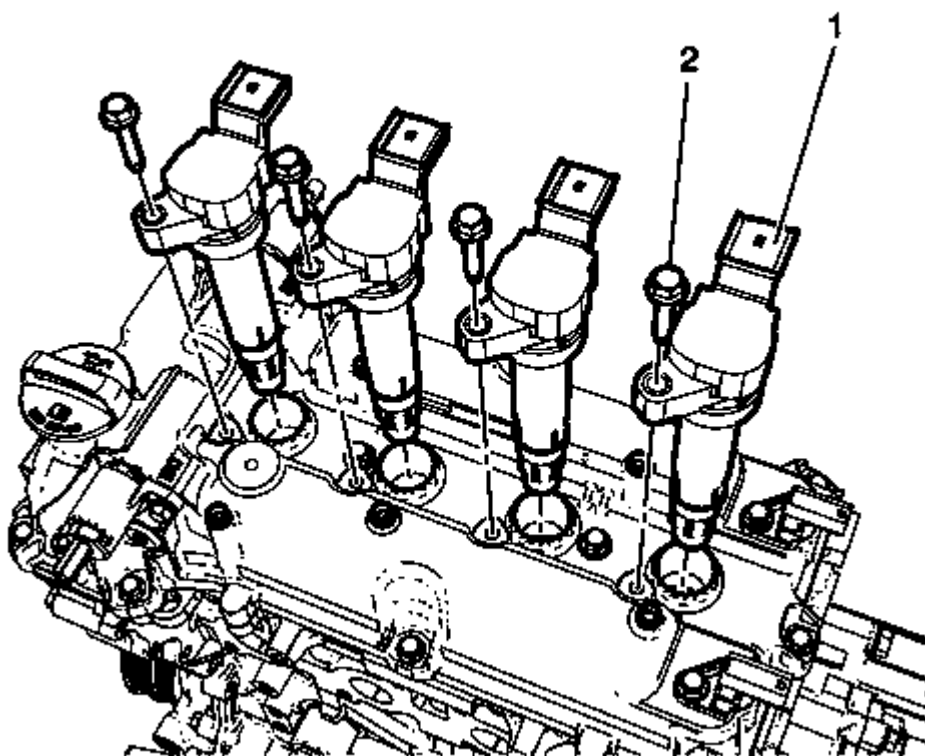


Fig. 220: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

13. Install the ignition coil (1). Refer to **Ignition Coil Replacement (LL0)** , **Ignition Coil Replacement (LFM)** .
14. Connect the fuel injector connectors. Refer to **Fuel Injection Fuel Rail Assembly Replacement (LFM)** , **Fuel Injection Fuel Rail Assembly Replacement (LL0)** .
15. Install the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement (LFM)** , **Camshaft Position Sensor Replacement (LL0)** .
16. Install the camshaft position actuator solenoid valve. Refer **Camshaft Position Actuator Solenoid Valve Installation** .
17. Install the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.
18. Install the intake manifold. Refer to **Intake Manifold Replacement**.
19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
20. Close the hood.

CAMSHAFT COVER REPLACEMENT (LFM)

Removal Procedure

1. Open the hood.
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
3. Remove the upper intake manifold. Refer to **Upper Intake Manifold Replacement (LFM)**.
4. Remove the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
5. Remove the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.

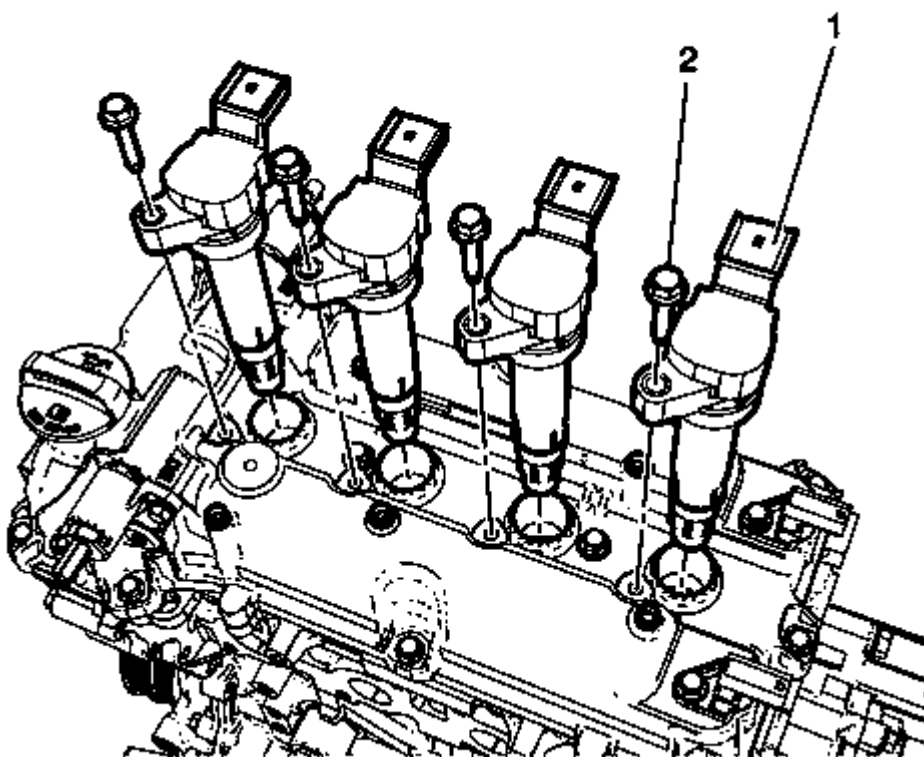


Fig. 221: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel injector connectors. Refer to **Fuel Injection Fuel Rail Assembly Replacement (LFM)**, **Fuel Injection Fuel Rail Assembly Replacement (LL0)**.
7. Remove the ignition coil. Refer to **Ignition Coil Replacement (LL0)**, **Ignition Coil Replacement (LFM)**.
8. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement (LFM)**, **Camshaft Position Sensor Replacement (LL0)**.
9. Remove the camshaft position actuator solenoid valve. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.

10. Remove the oil filler cap.

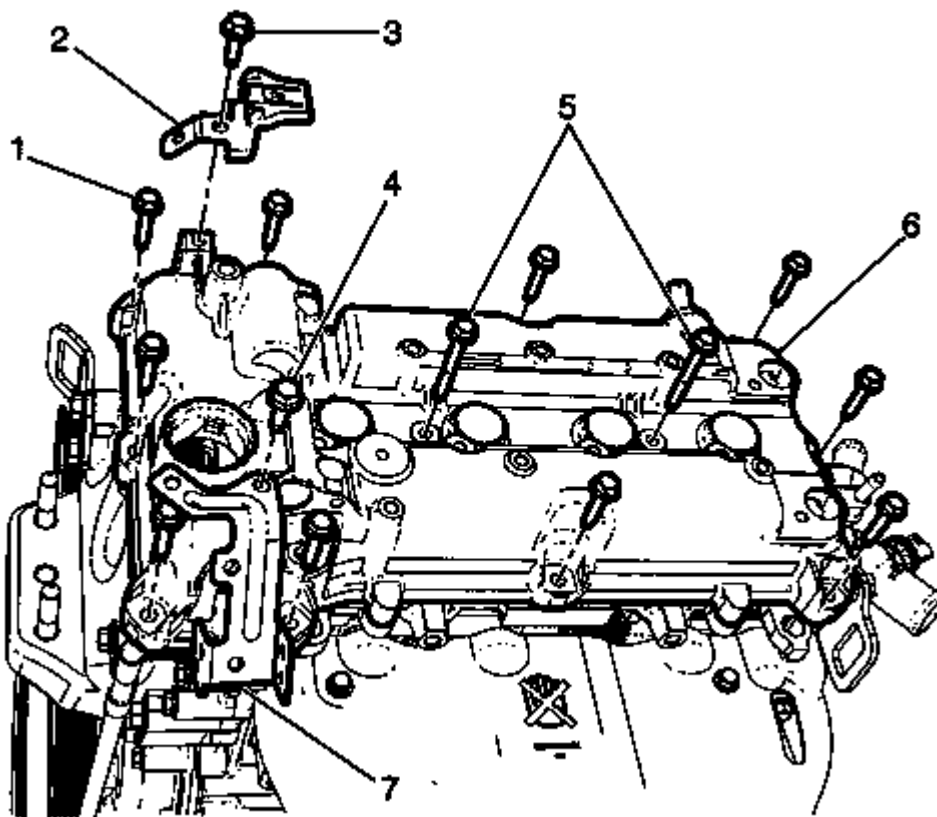


Fig. 222: Engine Injection And Ignition Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 1 engine injection and ignition bracket bolt (3).
12. Remove the engine injection and ignition bracket (2).
13. Remove the 1 camshaft cover front bracket bolt (4).
14. Remove the camshaft cover front bracket (7).
15. Remove the 2 camshaft cover bolts (5).
16. Remove the 10 camshaft cover bolts (1).
17. Remove the camshaft cover (6).

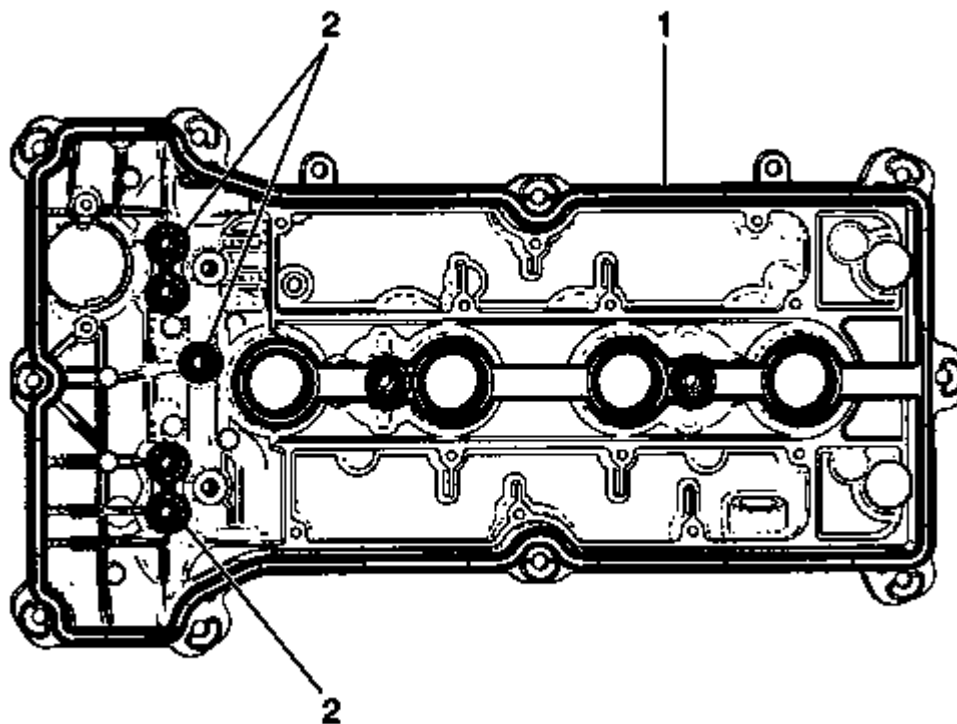


Fig. 223: Camshaft Cover Gasket

Courtesy of GENERAL MOTORS COMPANY

18. Remove the camshaft cover gasket (1).
19. Remove the camshaft cover seals (2).

Installation Procedure

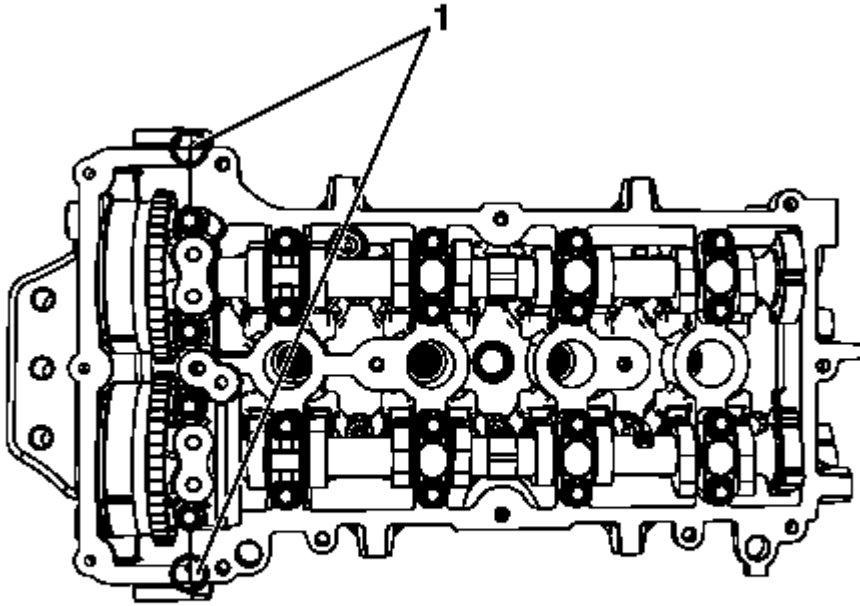


Fig. 224: Cured RTV Carefully

Courtesy of GENERAL MOTORS COMPANY

1. Remove the cured RTV carefully (1) and then clean the sealing surfaces.

NOTE: After RTV applying, the assembly completion time including torque check must be done within 8 minutes.

2. Apply RTV sealant to T-joint between cylinder head and front cover (1).

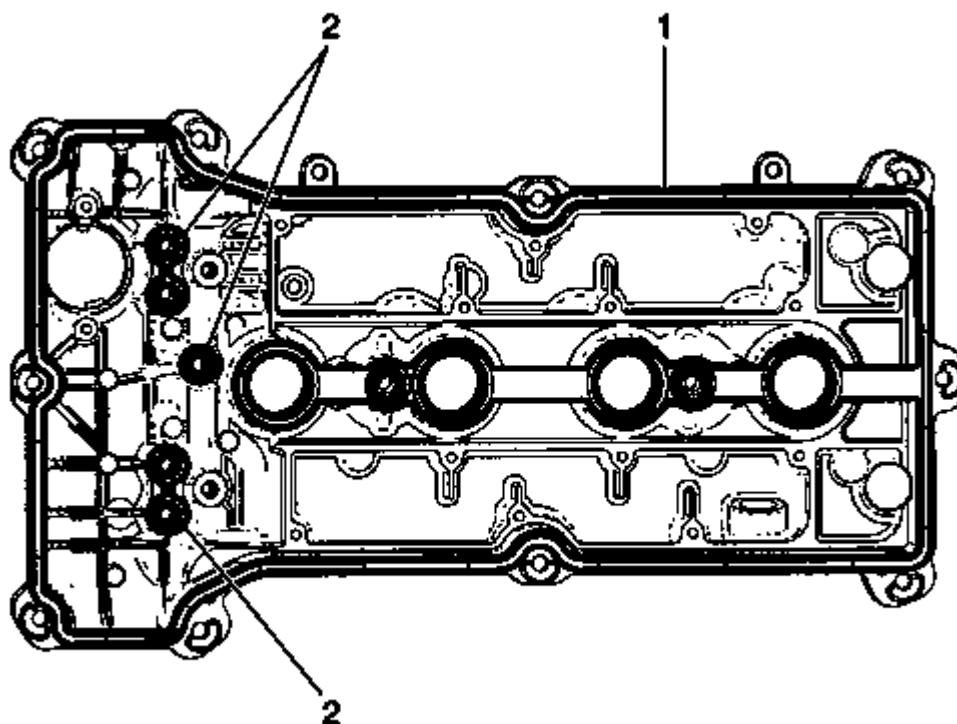


Fig. 225: Camshaft Cover Gasket

Courtesy of GENERAL MOTORS COMPANY

3. Install the camshaft cover seals (2) to the camshaft cover.
4. Install the camshaft cover gasket (1) to the camshaft cover.

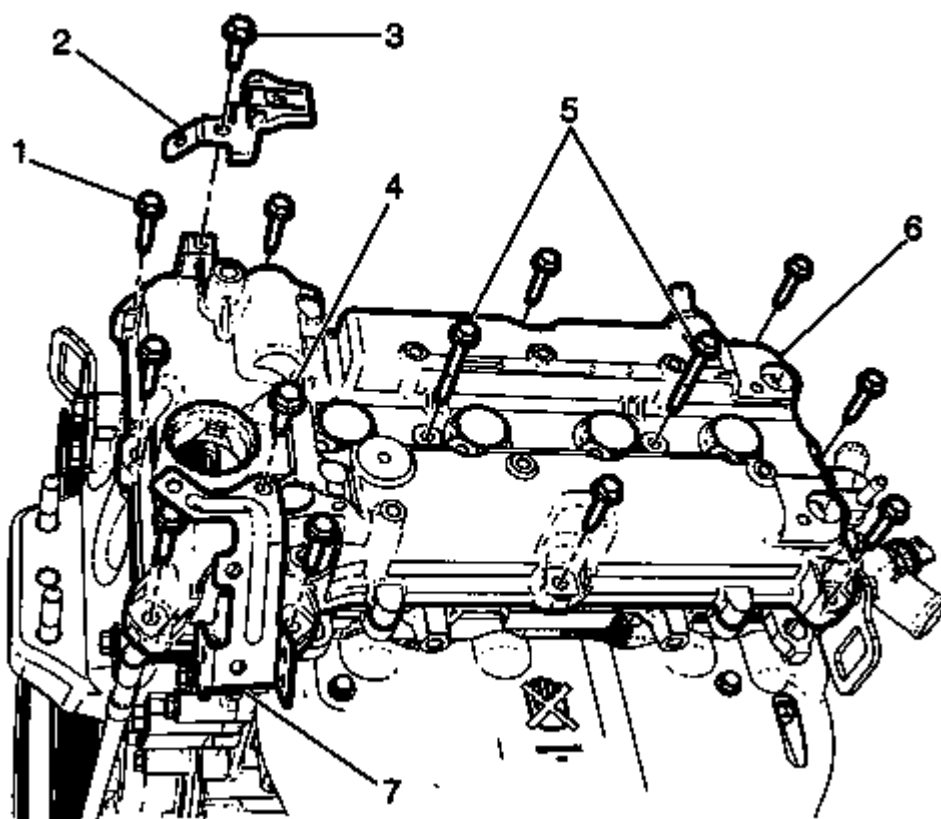


Fig. 226: Engine Injection And Ignition Bracket Bolt
 Courtesy of GENERAL MOTORS COMPANY

5. Install the camshaft cover (3).

CAUTION: Refer to Fastener Caution .

6. Install the 2 camshaft cover bolts (5) and tighten to 10 (89 lb in).
7. Install the 10 camshaft cover bolts (1) and tighten to 10 (89 lb in).
8. Install the camshaft cover front bracket (7).
9. Install the 1 camshaft cover front bracket bolt (4) and tighten to 10 (89 lb in).
10. Install the engine injection and ignition bracket (2).
11. Install the 1 engine injection and ignition bracket bolt (3) and tighten to 10 (89 lb in).
12. Install the oil filler cap.

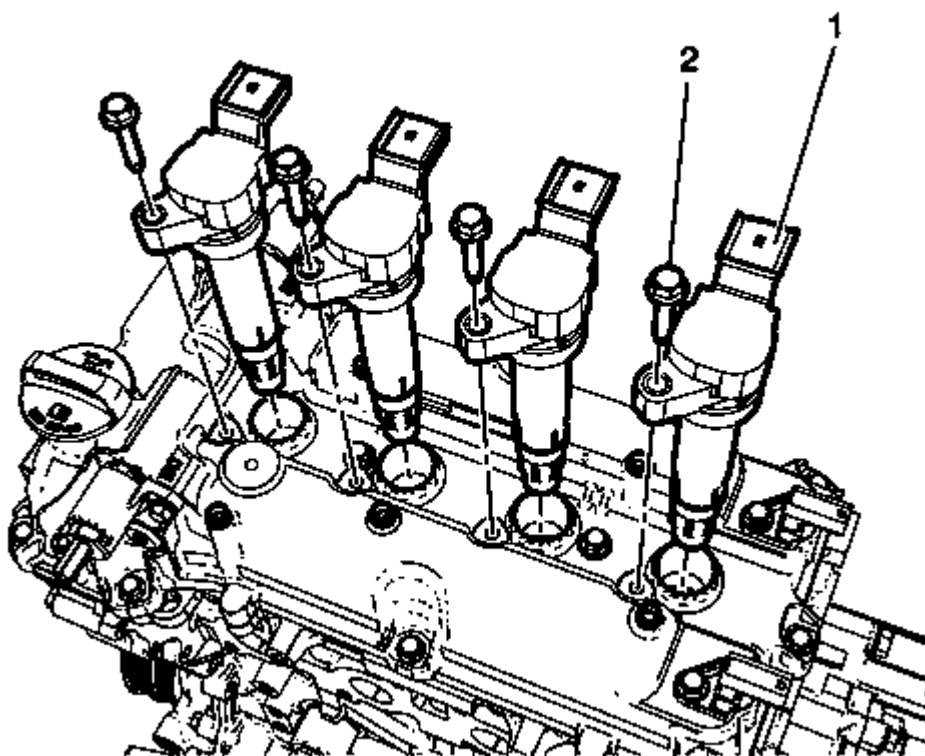


Fig. 227: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

13. Install the ignition coil (1). Refer to **Ignition Coil Replacement (LL0)** , **Ignition Coil Replacement (LFM)** .
14. Connect the fuel injector connectors. Refer to **Fuel Injection Fuel Rail Assembly Replacement (LFM)** , **Fuel Injection Fuel Rail Assembly Replacement (LL0)** .
15. Install the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement (LFM)** , **Camshaft Position Sensor Replacement (LL0)** .
16. Install the camshaft position actuator solenoid valve. Refer **Camshaft Position Actuator Solenoid Valve Installation** .
17. Install the ignition coil cover. Refer to **Ignition Coil Cover Replacement (LL0)**, **Ignition Coil Cover Replacement (LFM)**.
18. Remove the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LL0)**, **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LFM)**.
19. Install the upper intake manifold. Refer to **Upper Intake Manifold Replacement (LFM)**.
20. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
21. Close the hood.

CAMSHAFT EXHAUST SPROCKET REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.
2. Remove the timing chain. Refer to **Camshaft Timing Chain Replacement and Adjustment**.

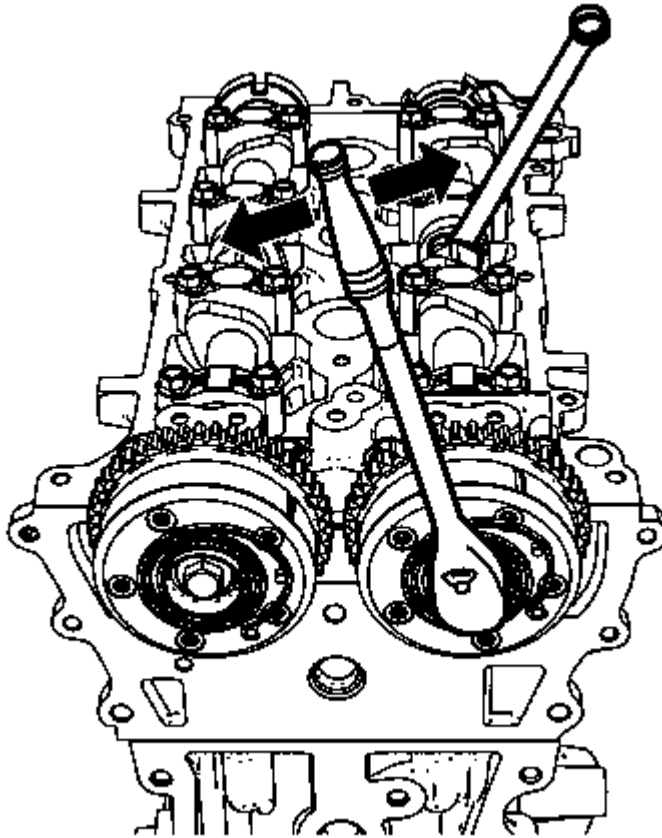


Fig. 228: Intake And Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use extreme care when installing the camshaft not to nick, scratch or damage the camshaft lobes or bearing surfaces.

3. While holding the intake camshaft firmly in place, loosen the intake camshaft sprocket bolt.
4. While holding the exhaust camshaft firmly in place, loosen the exhaust camshaft sprocket bolt.

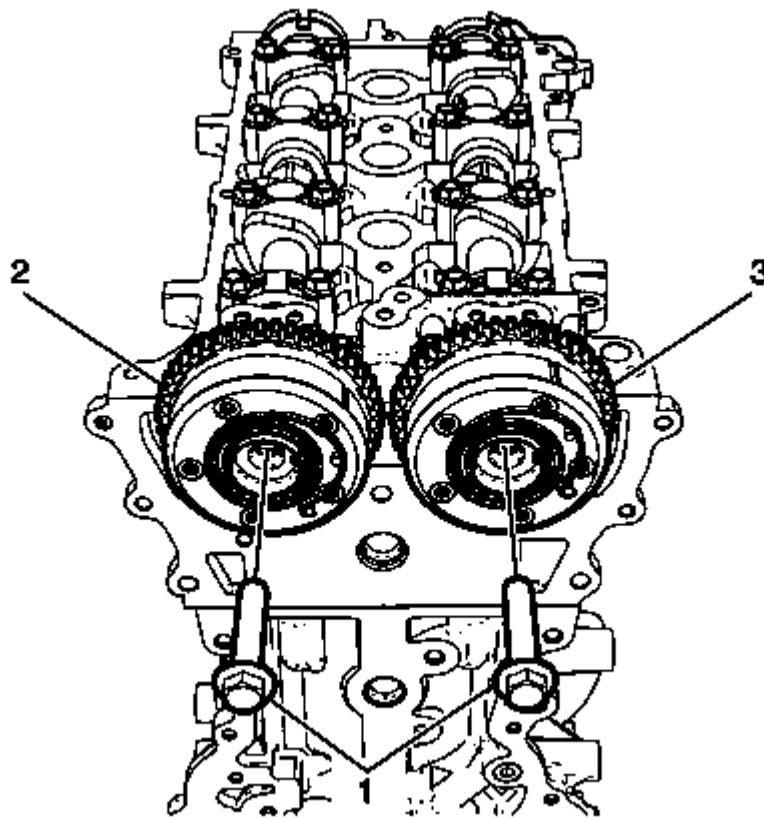


Fig. 229: Intake And Exhaust Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intake and exhaust camshaft sprocket bolts (1).
6. Remove the intake camshaft sprocket (2).
7. Remove the exhaust camshaft sprocket (3).

Installation Procedure

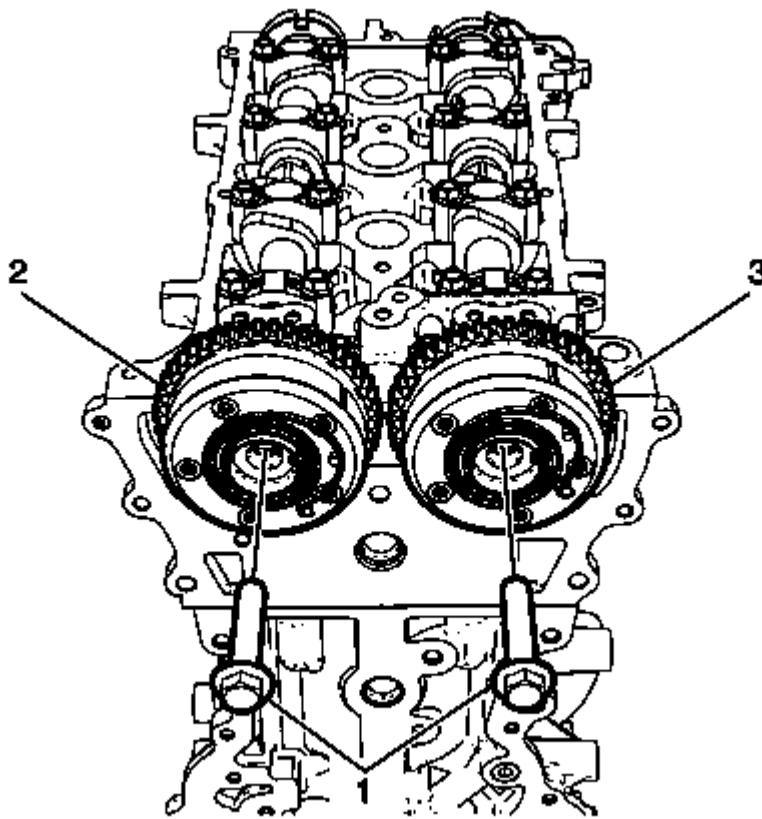


Fig. 230: Intake And Exhaust Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft sprocket (3).
2. Install the intake camshaft sprocket (2).

CAUTION: Refer to Fastener Caution .

3. Install the intake and exhaust camshaft sprocket bolts (1).

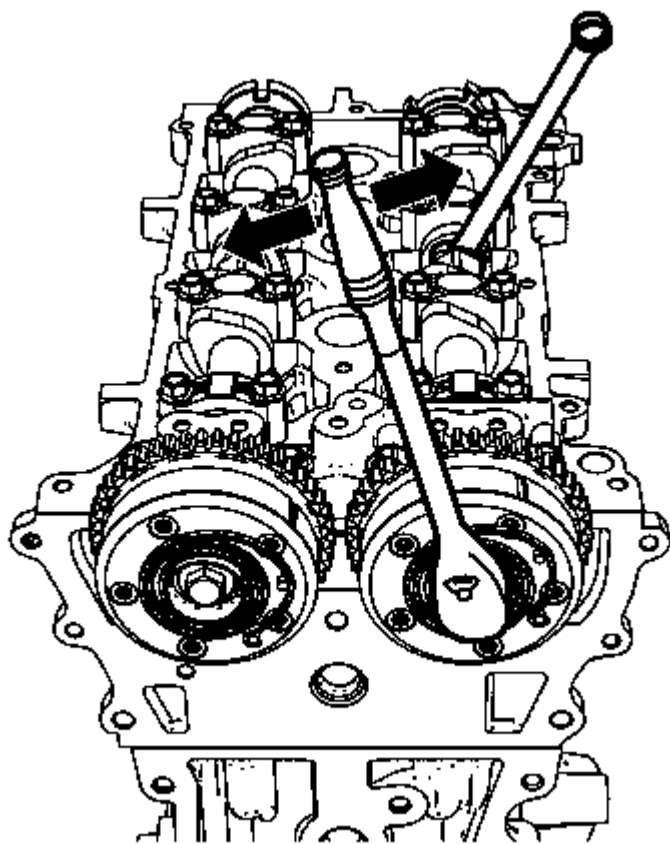


Fig. 231: Intake And Exhaust Camshaft

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use extreme care when installing the camshaft not to nick, scratch or damage the camshaft lobes or bearing surfaces.

4. While holding the intake camshaft firmly in place, install the intake camshaft sprocket bolt and tighten to $32 + 50^{\circ}$ (24 lb ft + 50°).
5. While holding the exhaust camshaft firmly in place, tighten the exhaust camshaft sprocket bolt to $32 + 50^{\circ}$ (24 lb ft + 50°).
6. Install the timing chain. Refer to **Camshaft Timing Chain Replacement and Adjustment.**
7. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement.**

ENGINE OIL PRESSURE INDICATOR SWITCH REPLACEMENT

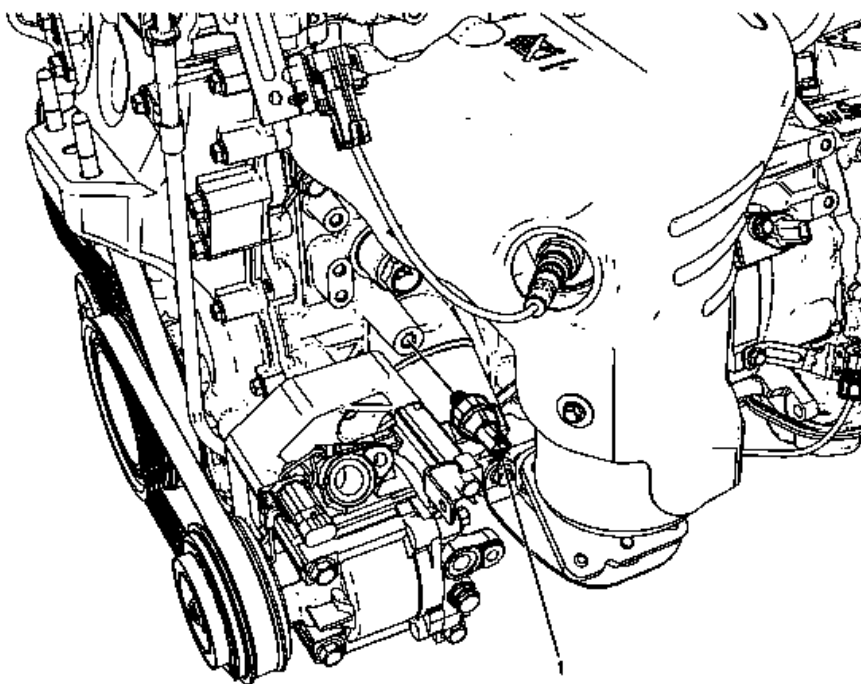


Fig. 232: Engine Oil Pressure Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Indicator Switch Replacement

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
1	<p>Oil Pressure Indicator Switch</p> <p>CAUTION: Refer to <u>Fastener Caution</u> .</p> <p>Procedure Disconnect the oil pressure indicator switch electrical wiring harness connector and remove the oil pressure indicator switch.</p> <p>Tighten 35 (26 lb ft)</p>

CAMSHAFT REPLACEMENT (LL0)

Removal Procedure

1. Remove the camshaft sprocket. Refer to **Camshaft Exhaust Sprocket Replacement**.

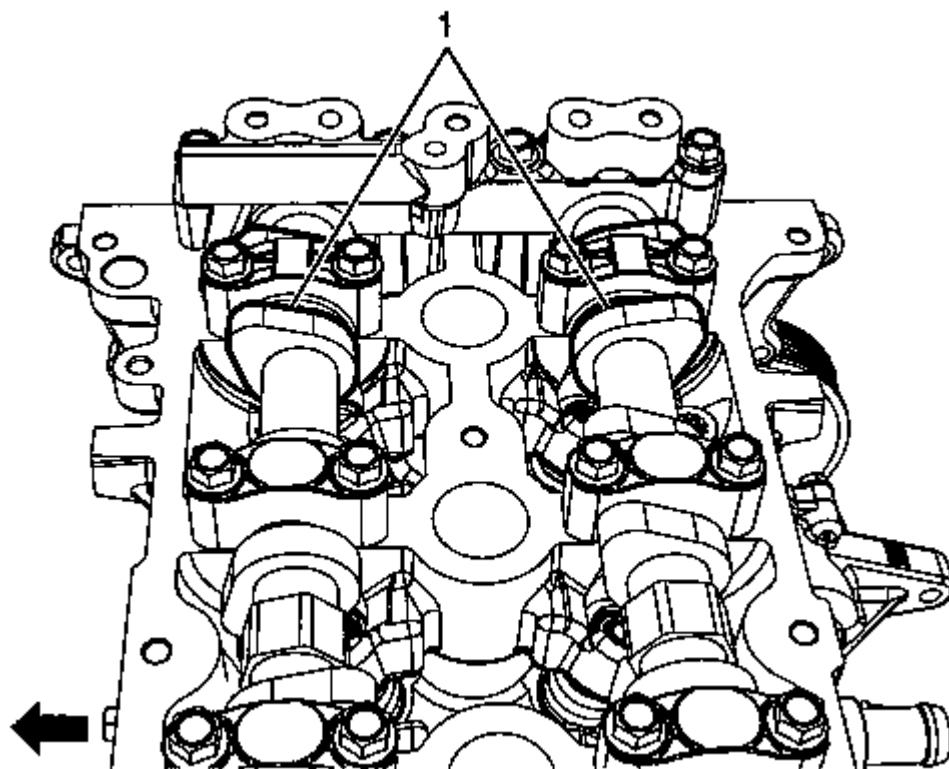


Fig. 233: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft lobes (1) in a neutral position.

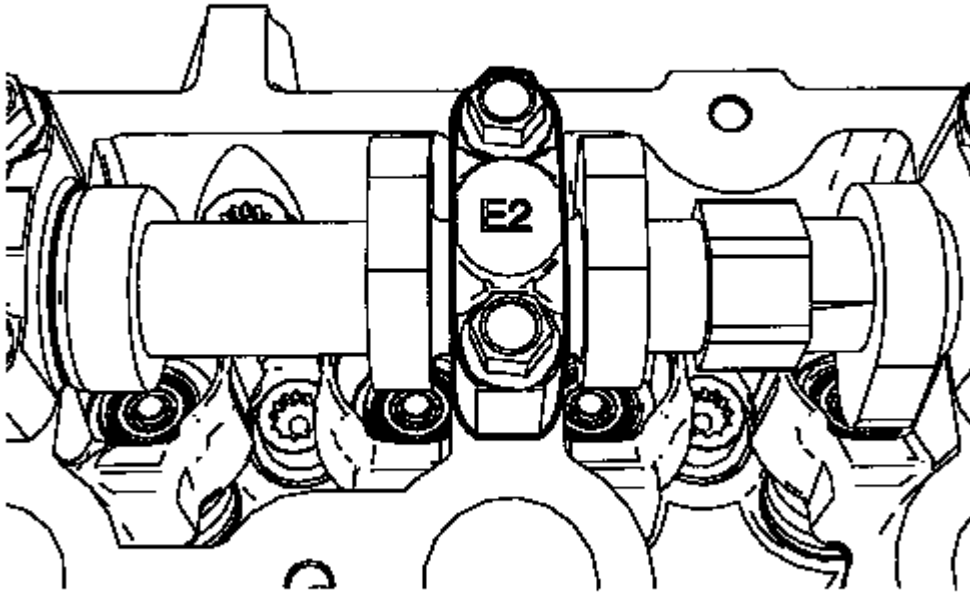


Fig. 234: View Of Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

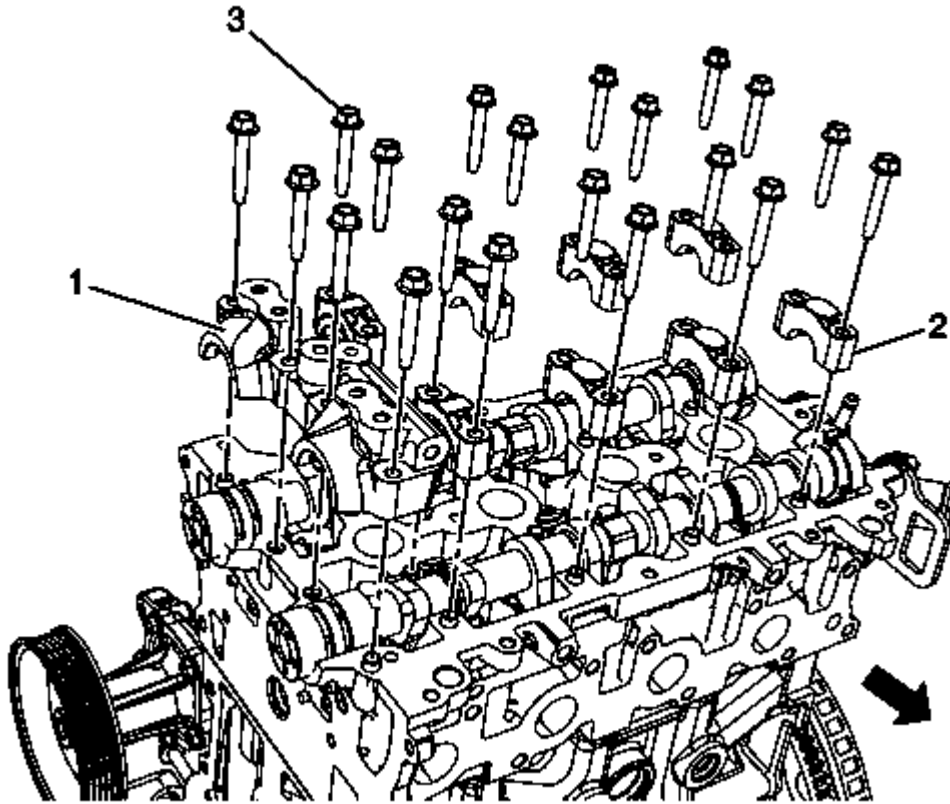


Fig. 235: Camshaft Bearing Cap Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Loosen the 20 camshaft bearing cap bolts (3) working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
5. Remove the 20 camshaft bearing cap bolts (3).

NOTE: Mark camshaft bearing caps before removal.

6. Remove the camshaft bearing caps (1, 2) from the cylinder head.

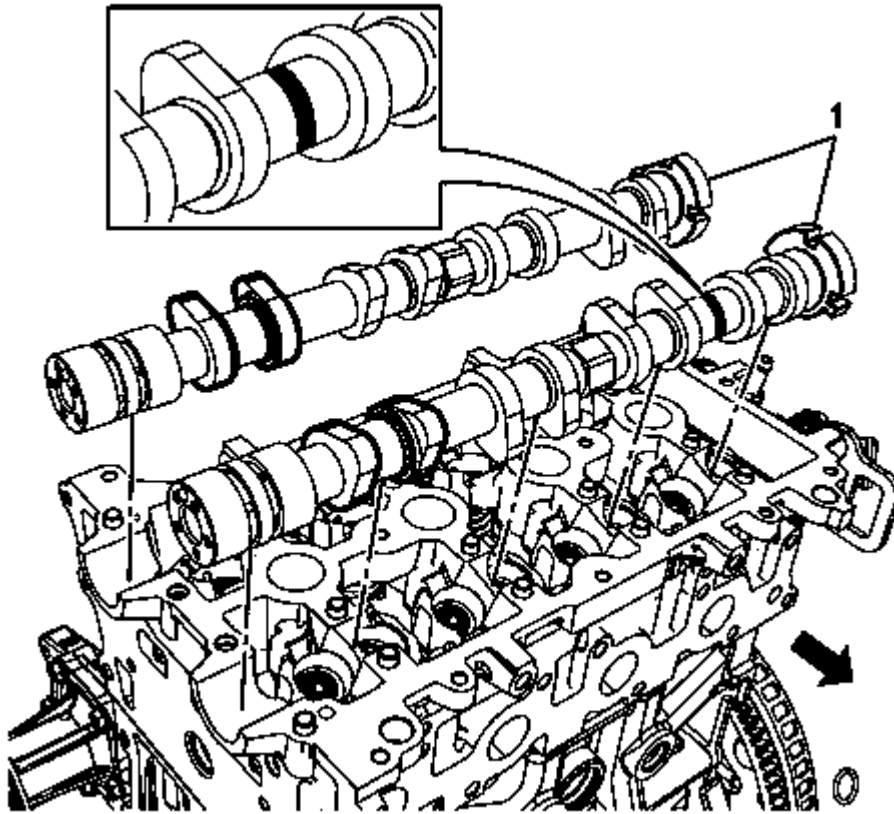


Fig. 236: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has a groove between the No. 3 journal and No. 4 journal. The intake camshaft has no groove.

7. Remove the camshafts (1).

Installation Procedure

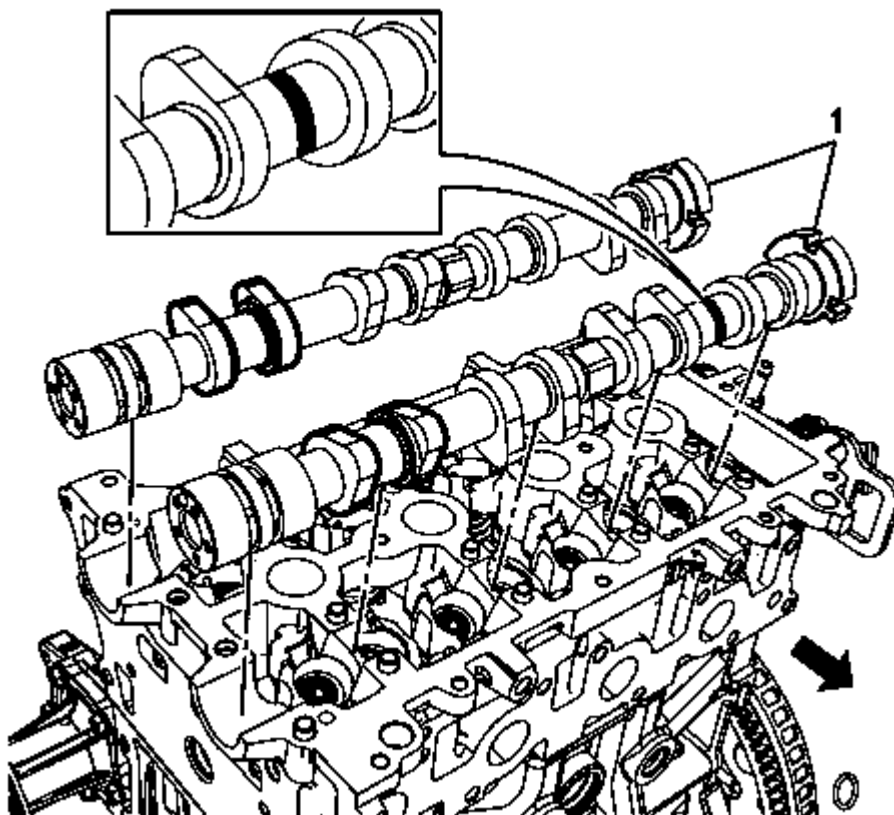


Fig. 237: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has a groove between the No. 3 journal and No. 4 journal. The intake camshaft has no groove.

1. Install the camshafts (1).

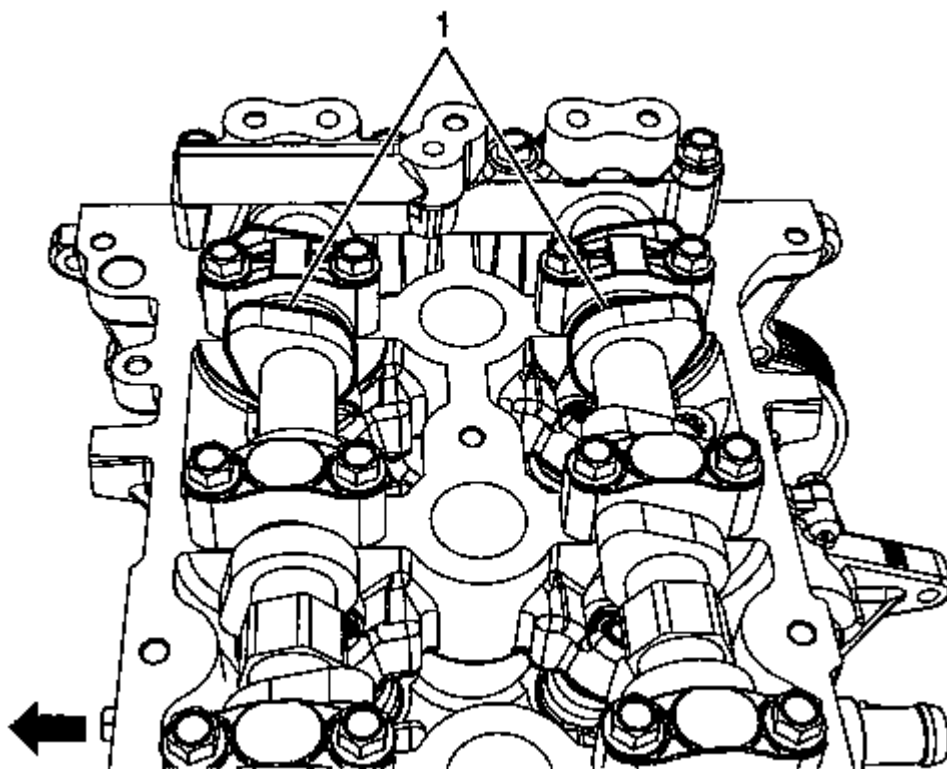


Fig. 238: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Check the camshaft lobes (1) are in a neutral position.

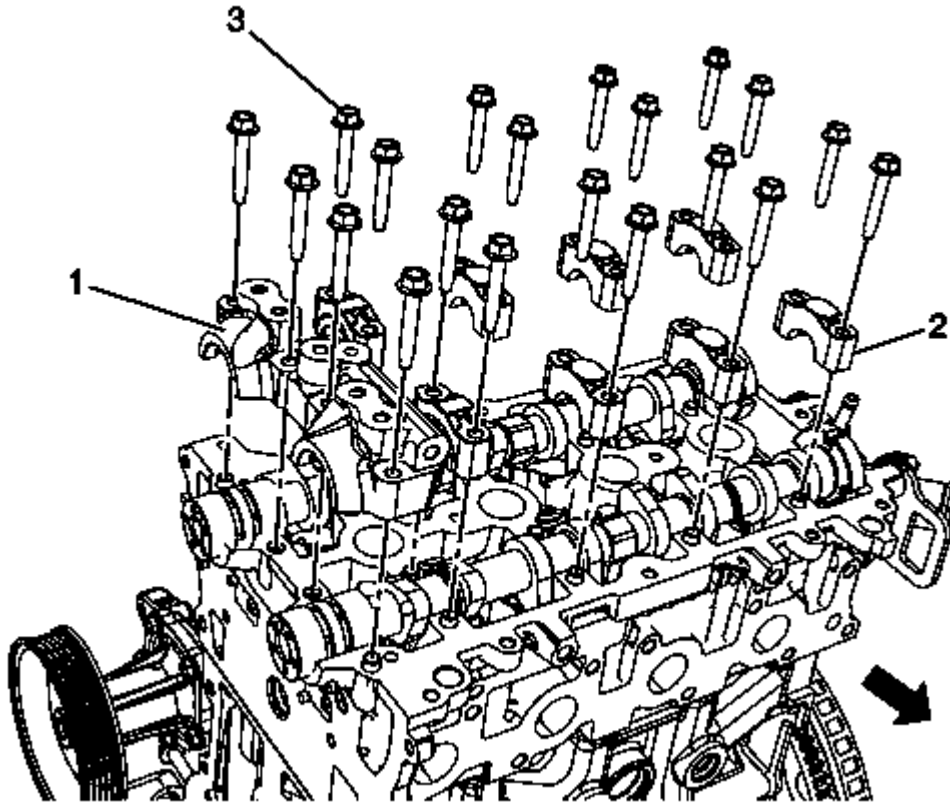


Fig. 239: Camshaft Bearing Cap Bolts
 Courtesy of GENERAL MOTORS COMPANY

3. Install the camshaft bearing thrust cap (1) in the first journal of the right cylinder head.
4. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
5. Hand start to tighten the all cylinder head retaining bolts (3).
6. Tighten the 20 camshaft bearing cap bolts (3) working from inside to outside in a spiral.
7. Tighten the 20 camshaft bearing cap bolts to 10 (89 lb in).

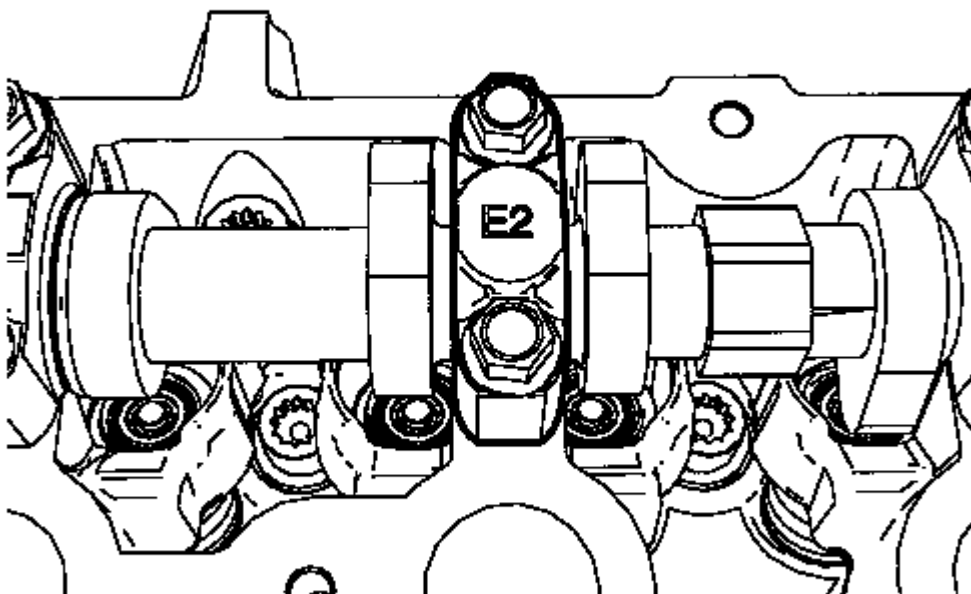


Fig. 240: View Of Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

8. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the cylinder block.
9. Install the camshaft sprocket. Refer to **Camshaft Exhaust Sprocket Replacement**.

CAMSHAFT REPLACEMENT (LFM)

Removal Procedure

1. Remove the camshaft sprocket. Refer to **Camshaft Exhaust Sprocket Replacement**.

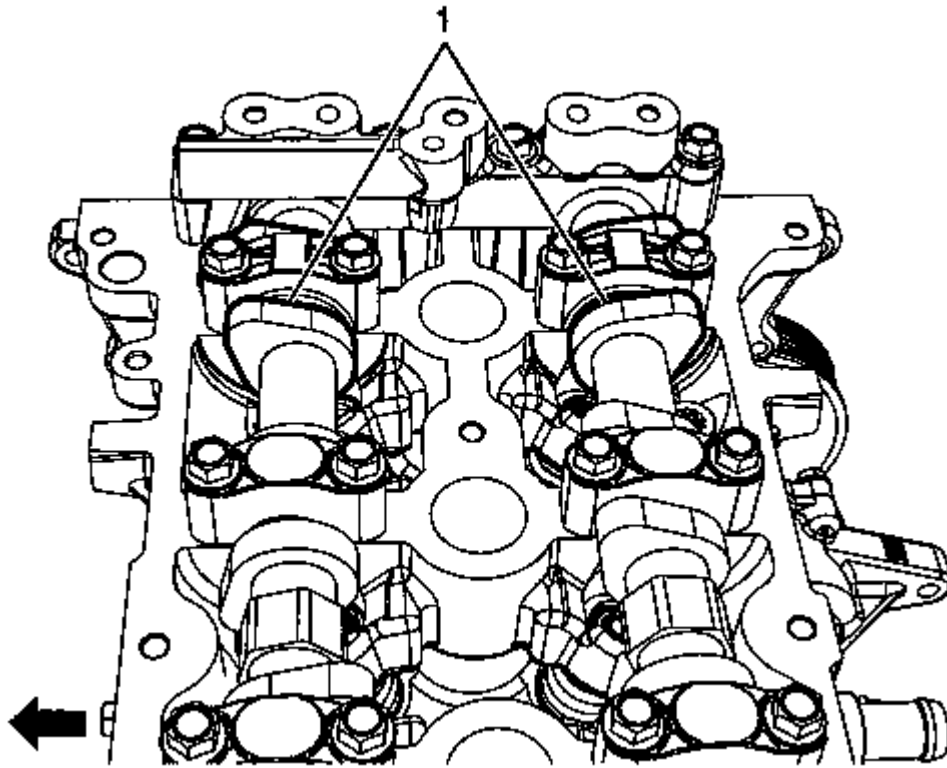


Fig. 241: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft lobes (1) in a neutral position.

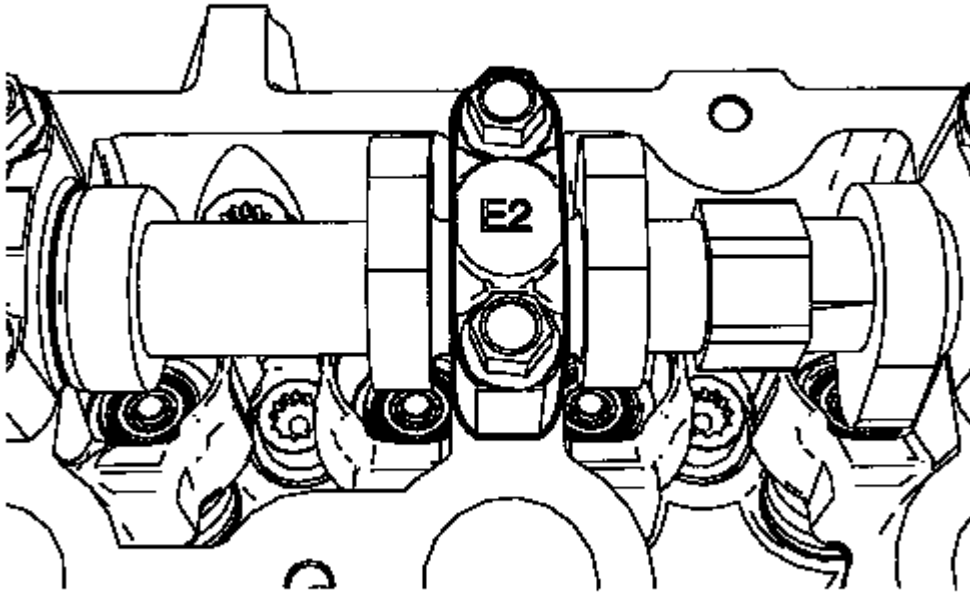


Fig. 242: View Of Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

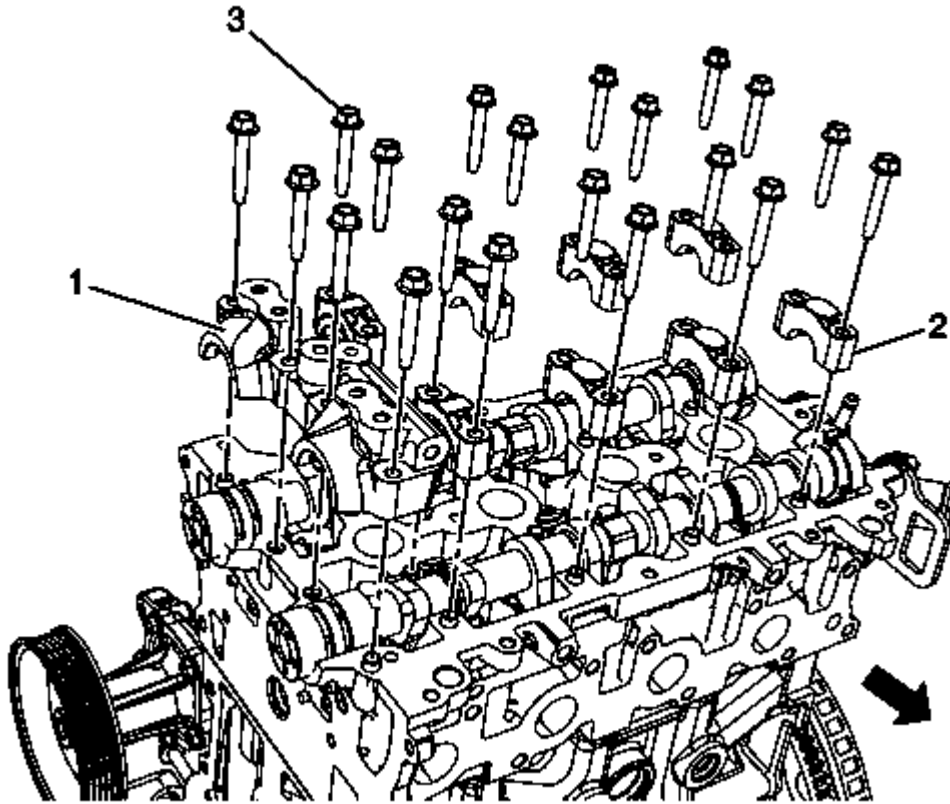


Fig. 243: Camshaft Bearing Cap Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Loosen the 20 camshaft bearing cap bolts (3) working from outside to inside in a spiral in steps of 1/2 up to 1 turn.
5. Remove the 20 camshaft bearing cap bolts (3).

NOTE: Mark camshaft bearing caps before removal.

6. Remove the camshaft bearing caps (1, 2) from the cylinder head.

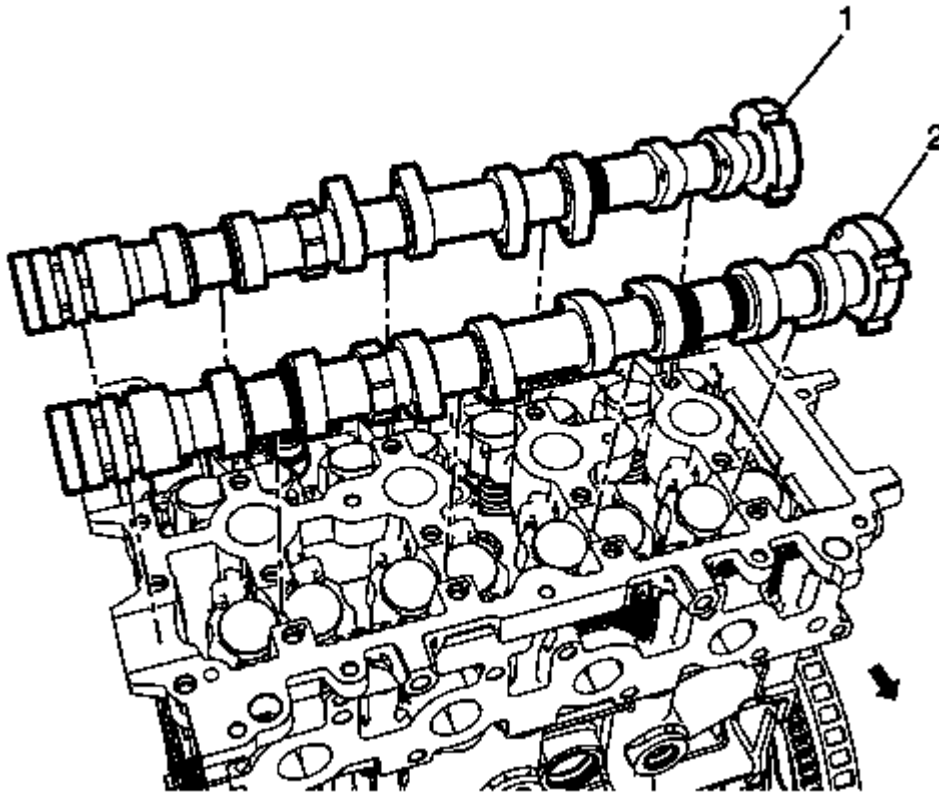


Fig. 244: Intake Camshaft

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has 2 grooves between the No. 3 journal and No. 4 journal. The intake camshaft has 1 groove.

7. Remove the intake camshaft (1) and exhaust camshaft (2).

Installation Procedure

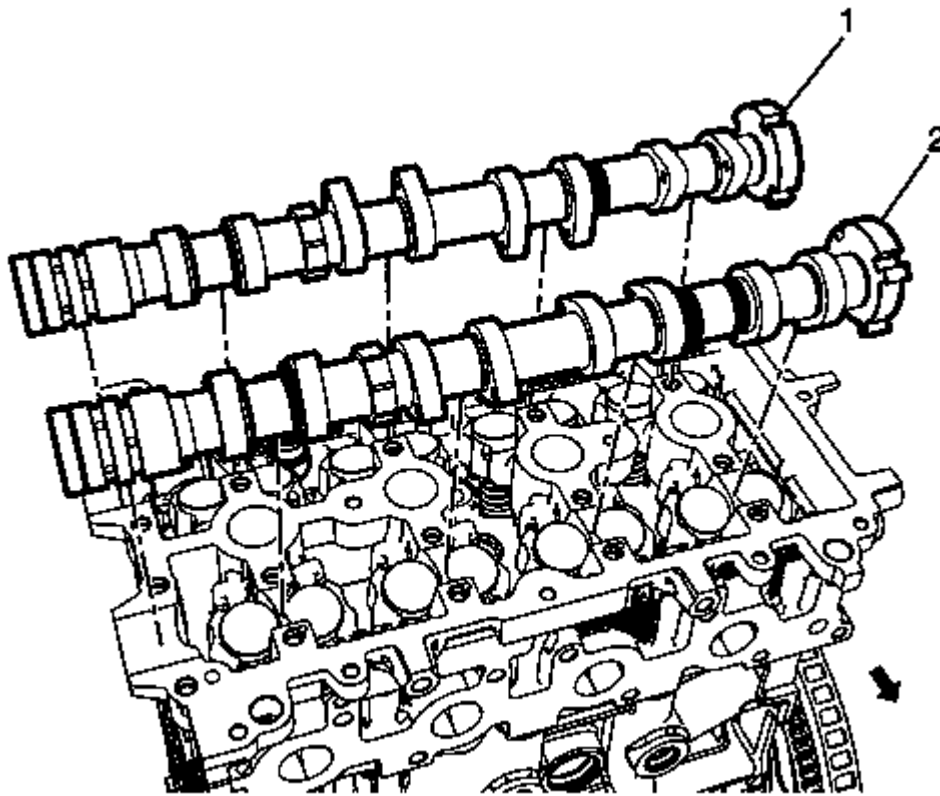


Fig. 245: Intake Camshaft

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has 2 grooves between the No. 3 journal and No. 4 journal. The intake camshaft has 1 groove.

1. Install the intake camshaft (1) and exhaust camshaft (2).

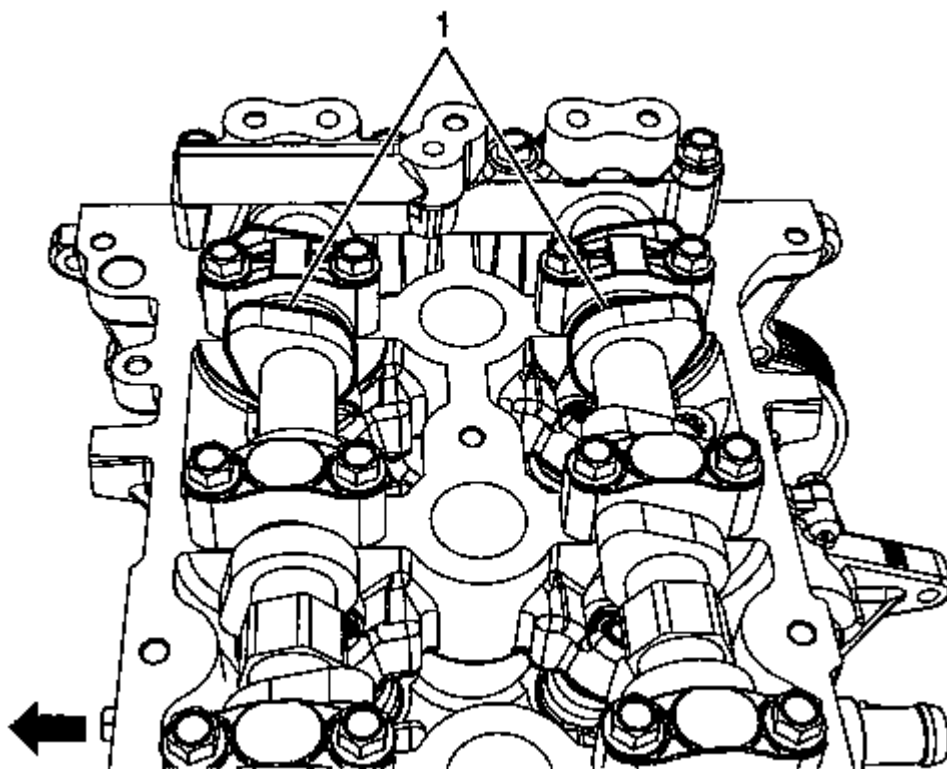
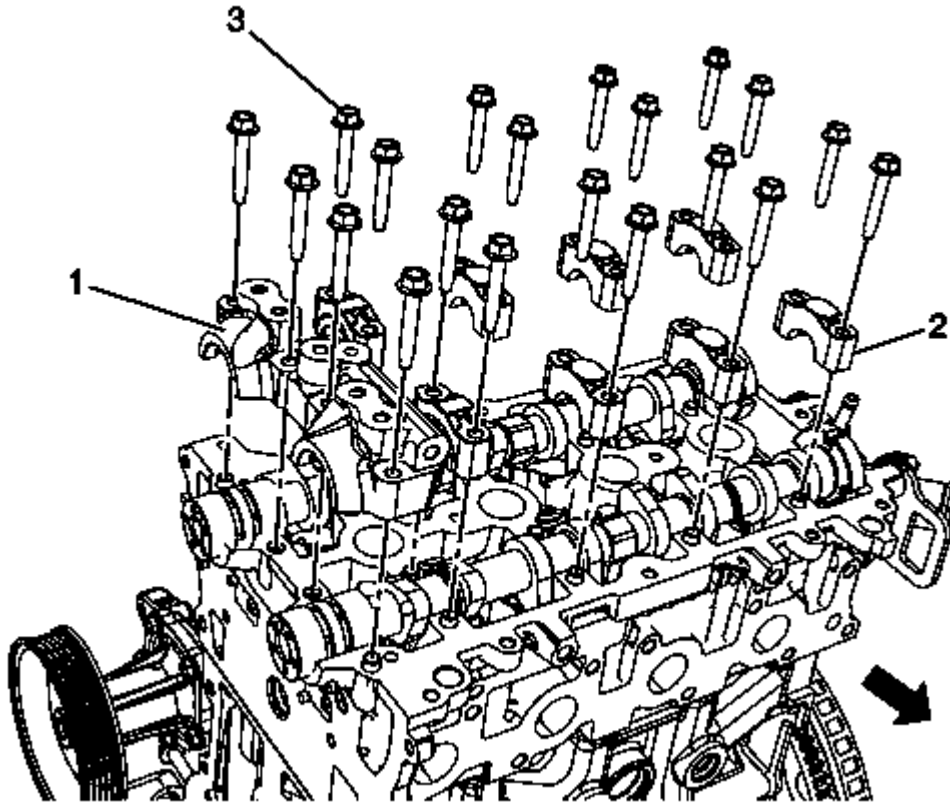


Fig. 246: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Check the camshaft lobes (1) are in a neutral position.

**Fig. 247: Camshaft Bearing Cap Bolts****Courtesy of GENERAL MOTORS COMPANY**

3. Install the camshaft bearing thrust cap (1) in the first journal of the right cylinder head.
4. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
5. Hand start to tighten all cylinder head retaining bolts (3).
6. Tighten the 20 camshaft bearing cap bolts (3) working from inside to outside in a spiral.
7. Tighten the 20 camshaft bearing cap bolts to 10 (89 lb in).

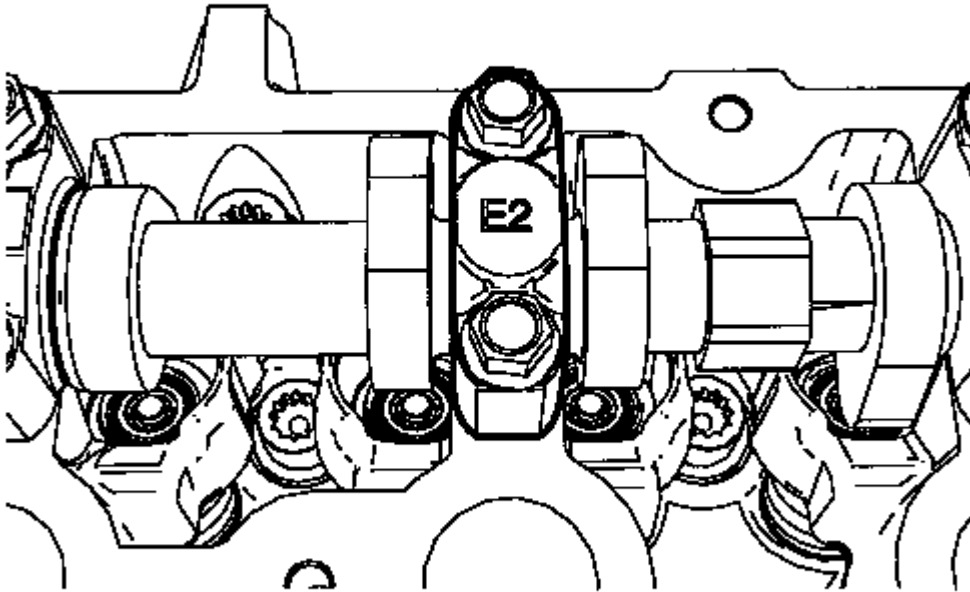
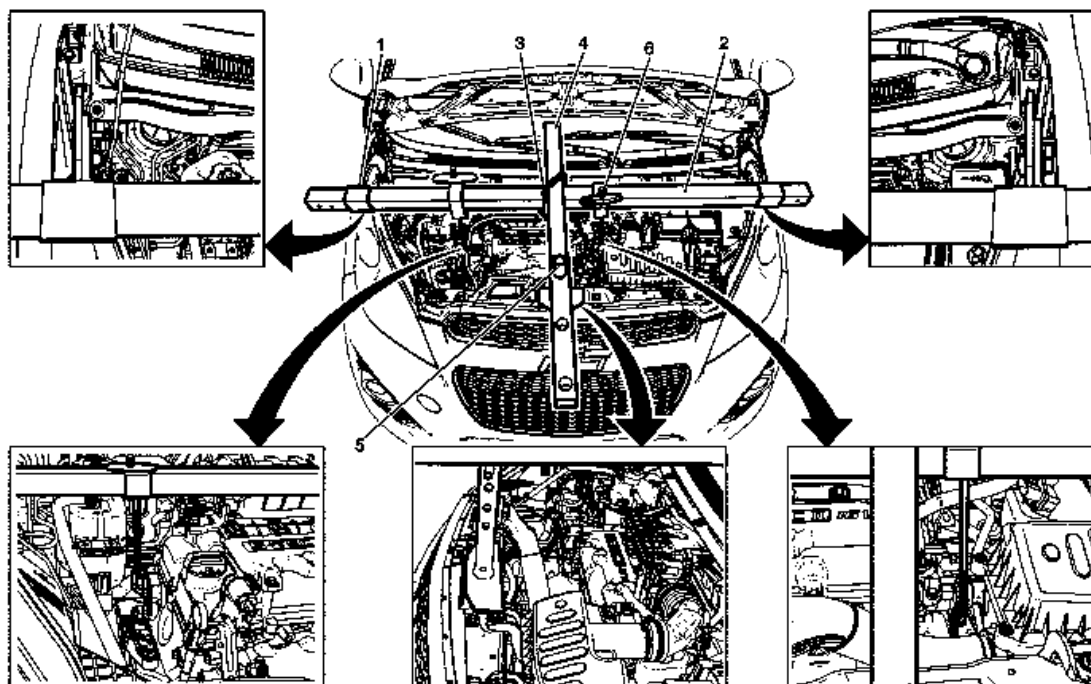


Fig. 248: View Of Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

8. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The raised feature must always be oriented toward the center of the cylinder head.
 - The I indicates the intake camshaft.
 - The E indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the cylinder block.
9. Install the camshaft sprocket. Refer to **Camshaft Exhaust Sprocket Replacement**.

ENGINE SUPPORT FIXTURE

**Fig. 249: Engine Support Fixture**

Courtesy of GENERAL MOTORS COMPANY

Engine Support Fixture

Callout	Component Name
Preliminary Procedure <ol style="list-style-type: none"> 1. Open the hood. 2. Disconnect the 2 hood muckets from the fender frame. <ul style="list-style-type: none"> • 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-28467-8A Hook Assembly • J-36857 Engine Lift Bracket 	
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
	Strut Tower Support Assembly

2014 Chevrolet Spark LT

2014 ENGINE Engine Mechanical - 1.0L, 1.19L or 1.2L - Spark

4	Procedure Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly
6	Hook Assembly (Qty: 2) Procedure Use a grade 10.9 bolt to install the engine lift bracket. NOTE: If the engine is not equipped with engine lift bracket, install J-36857 in place.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **EN 46116** Valve Stem Seal Remover/Installer
- **EN-49075** Valve Spring Compressor Adapter
- **EN-49076** Cylinder Pressure Adapter
- **EN-50173** Universal Valve Spring Compressor
- **KM-845** Tappet Suction Device

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

Removal Procedure

1. Remove the camshaft. Refer to **Camshaft Replacement (LL0)**, **Camshaft Replacement (LFM)**.

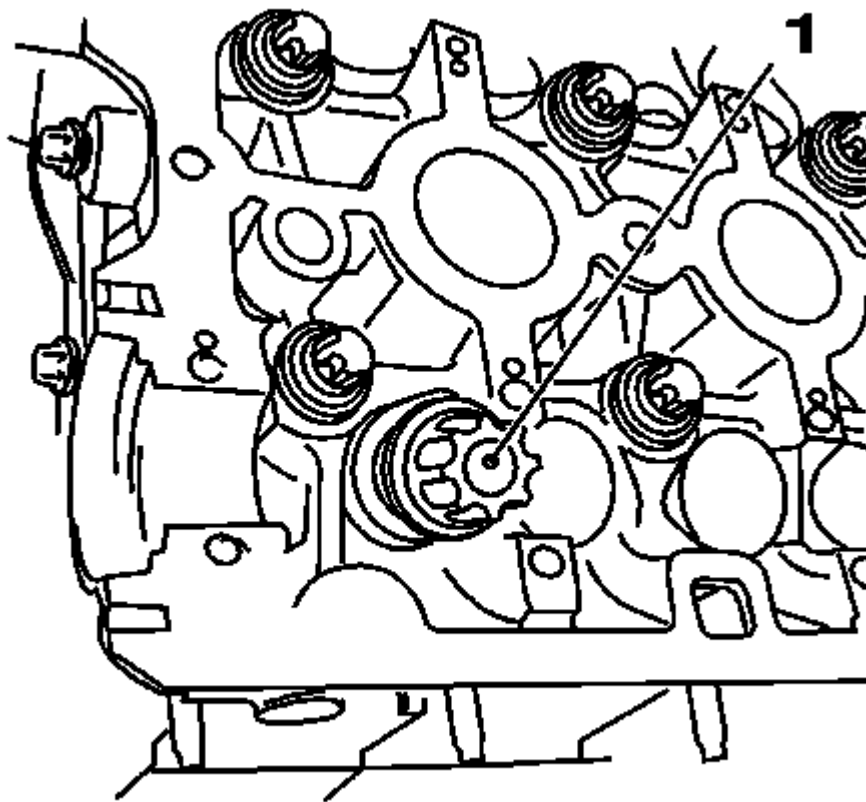


Fig. 250: View Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

2. Remove the valve tappet (1) using **KM-845** tappet suction device.

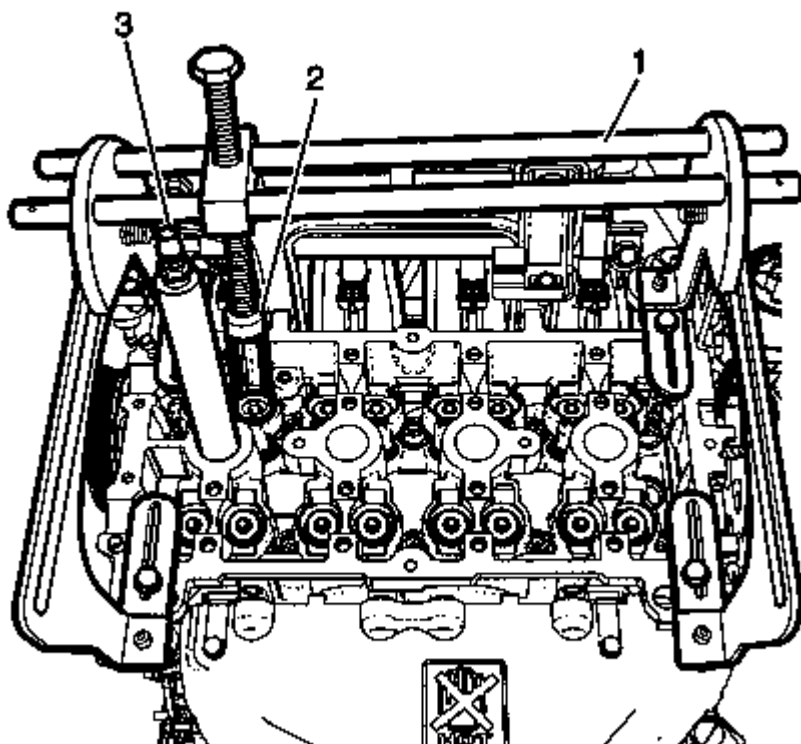


Fig. 251: Universal Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-50173** universal valve spring compressor (1) and **EN- 49075** valve spring compressor adapter (2).
4. Remove the spark plug and install the **EN-49076** cylinder pressure adapter.
5. Connect the compressed air hose to **EN-49076** cylinder pressure adapter. It keeps the valve not slip into the cylinder by blowing compressed air into the cylinder.
6. Use the magnet in order to remove the valve collet.

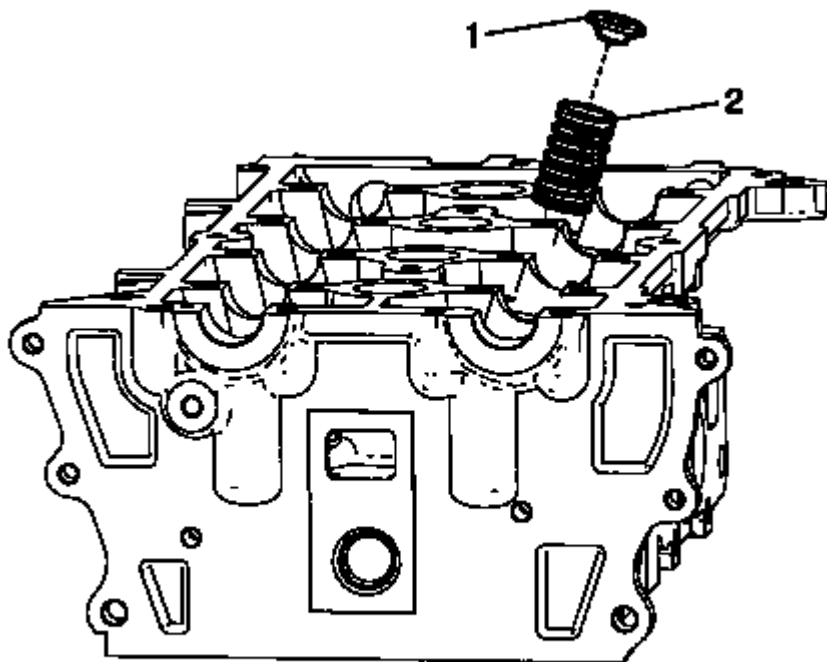


Fig. 252: Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

7. Remove the retainer (1) and valve spring (2).

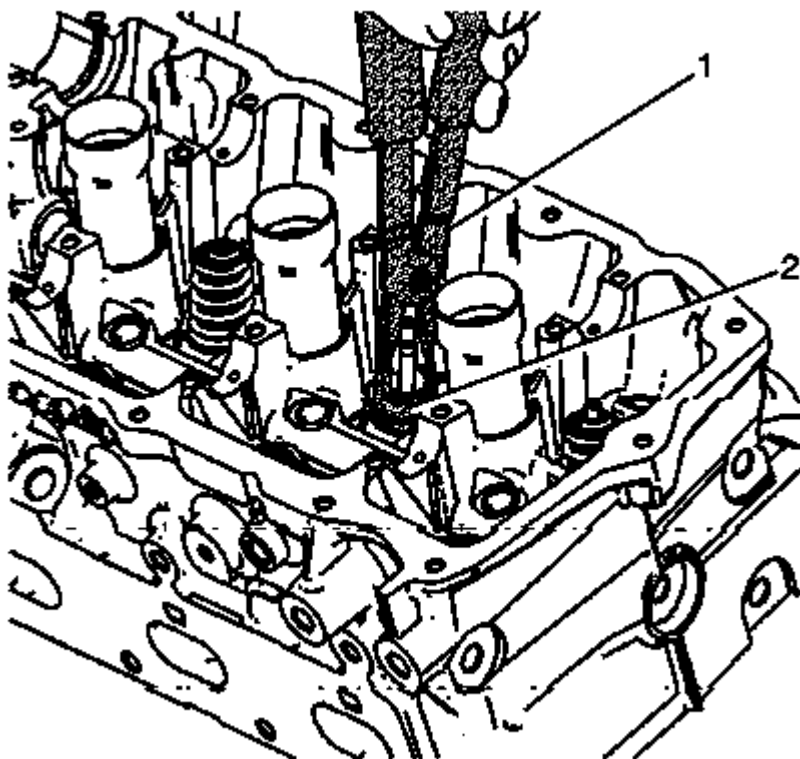


Fig. 253: View Of EN 46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

8. Remove the valve stem seal (2) using EN 46116 valve stem seal remover/installer (1).

Installation Procedure

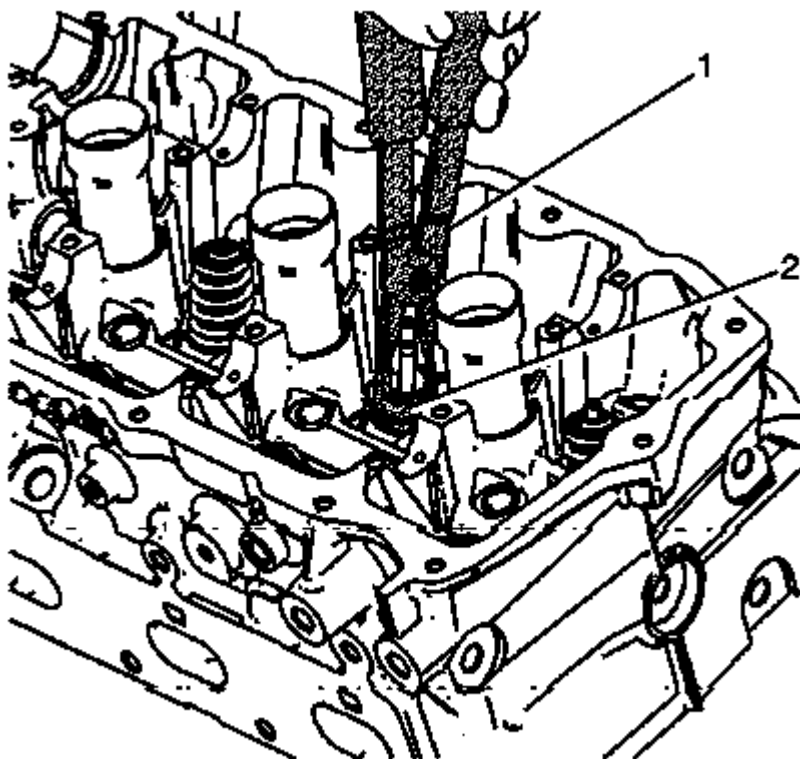


Fig. 254: View Of EN 46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the valve stem seal (2) using EN 46116 valve stem seal remover/installer (1).

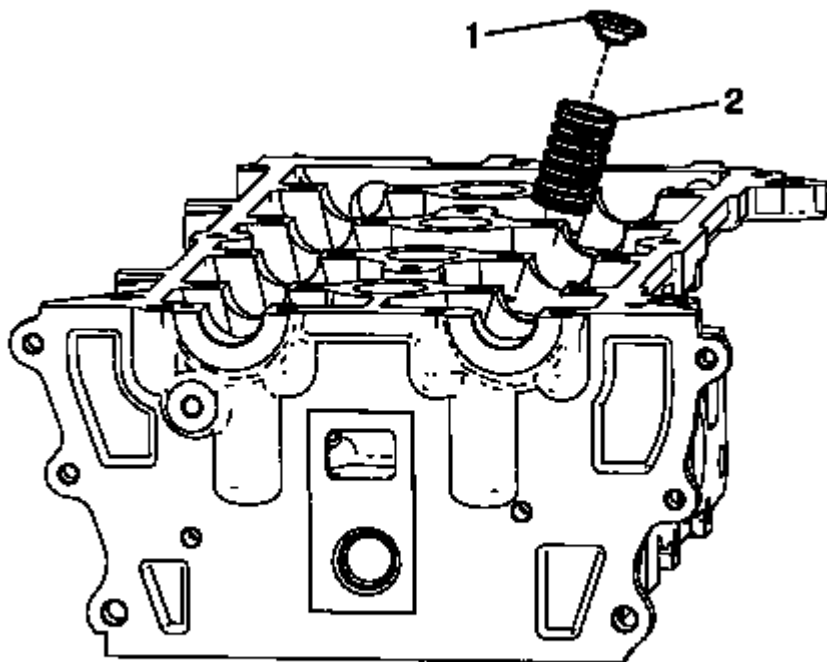


Fig. 255: Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring (2), retainer (1) and seal.

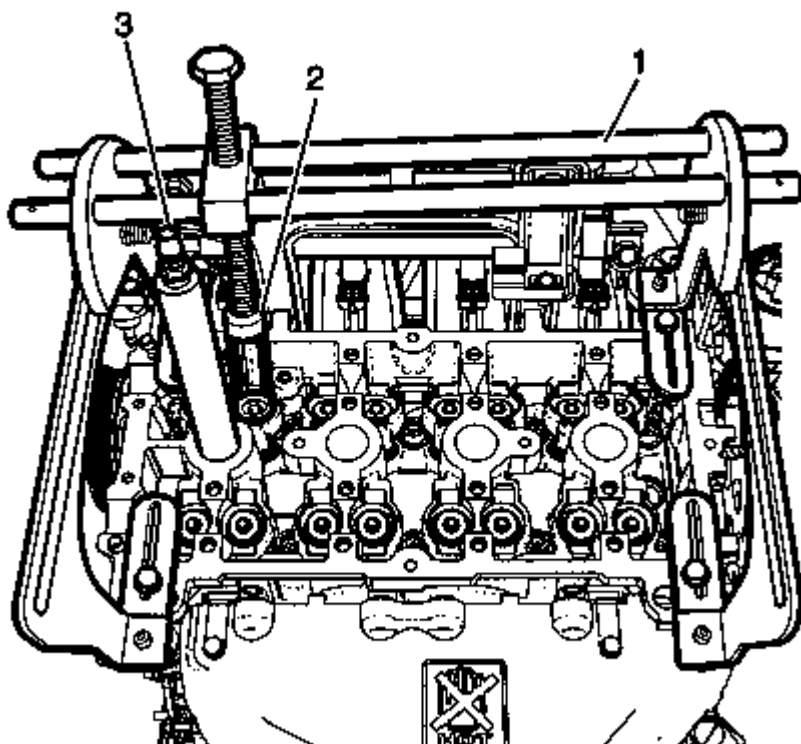


Fig. 256: Universal Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the compressed air hose from EN 49076 cylinder pressure adapter.

CAUTION: Refer to Fastener Caution .

4. Remove the EN 49076 cylinder pressure adapter (3), install the spark plug and tighten the spark plug to 20 (15 lb ft).
5. Remove the EN-50173 universal valve spring compressor (1) and EN-49075 valve spring compressor adapter (2).

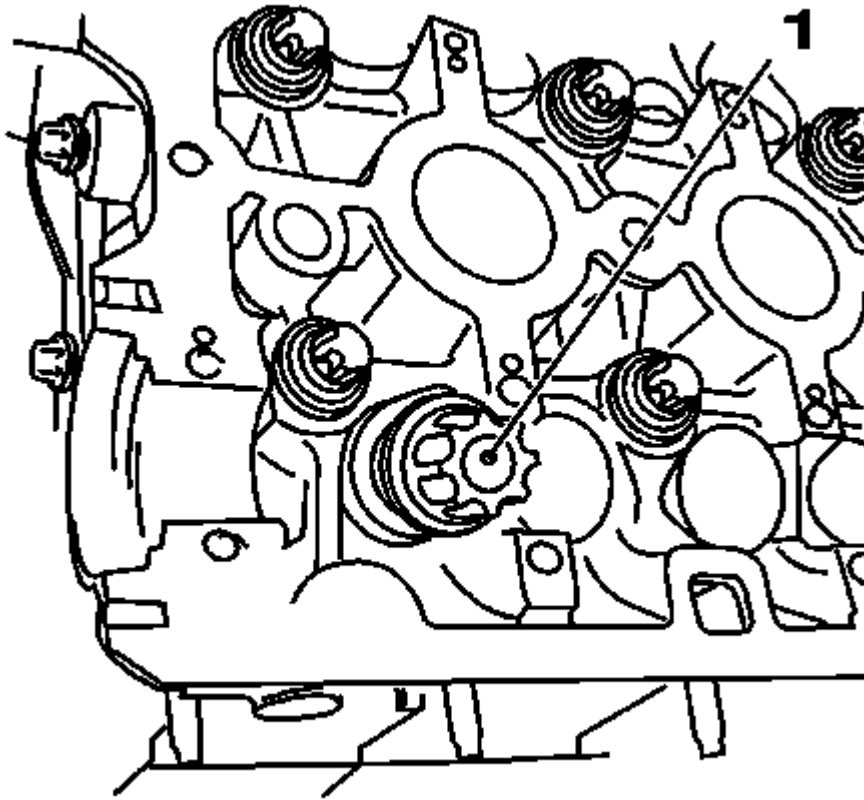


Fig. 257: View Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

6. Install the valve tappet (1).
7. Install the camshaft. Refer to Camshaft Replacement (LL0), Camshaft Replacement (LFM).

VALVE CLEARANCE ADJUSTMENT (LFM)

Measurement

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement (LL0), Camshaft Cover Replacement (LFM).

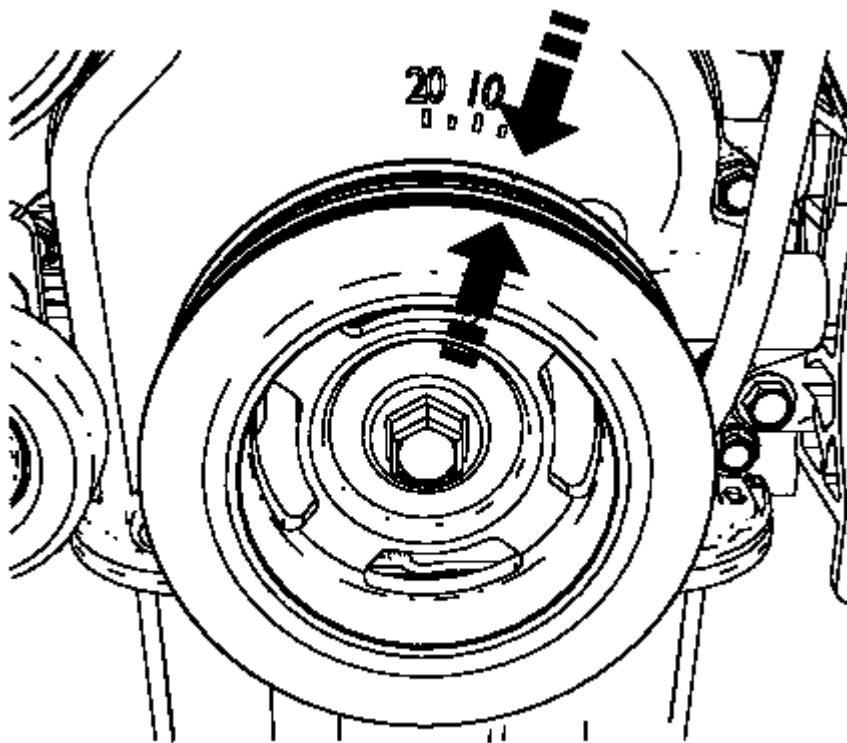


Fig. 258: Crankshaft Pulley

Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft pulley in direction of engine rotation, aligning the pulley groove with the 0 point on the cover, in order to set engine to TDC.

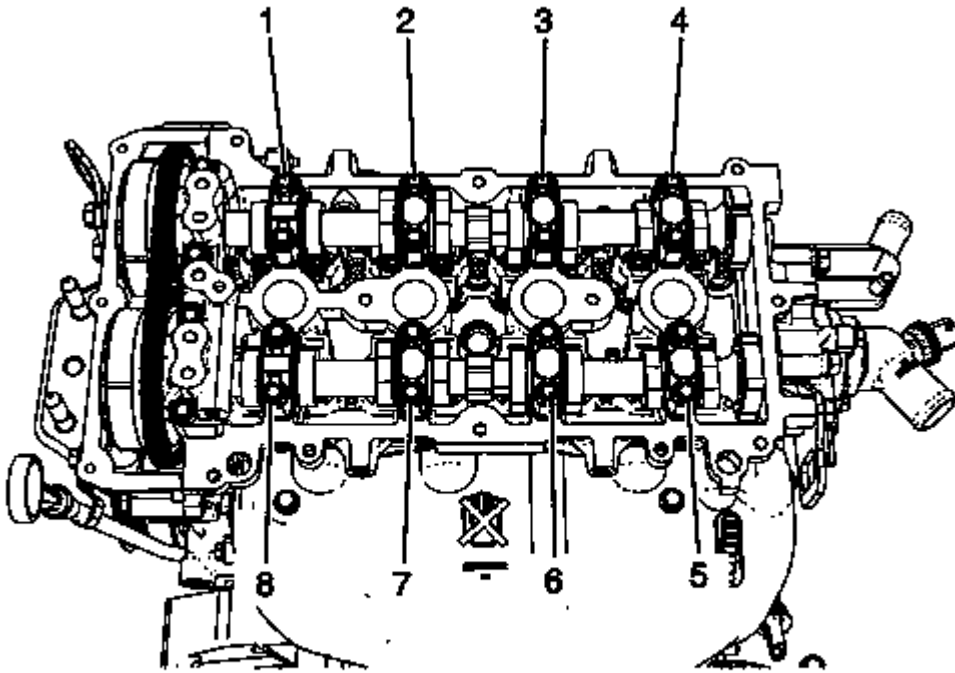
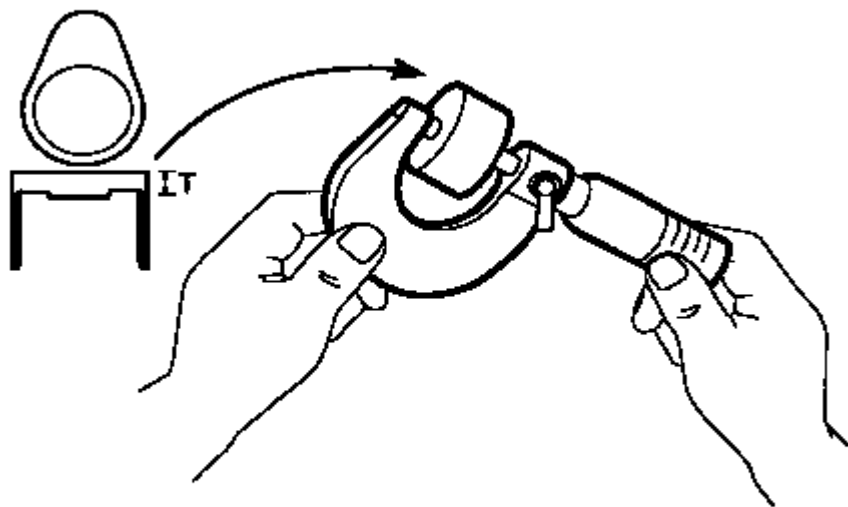


Fig. 259: Measuring valve clearance At positions (1), (2), (6) and (8)
Courtesy of GENERAL MOTORS COMPANY

3. Measure the valve clearance at positions (1), (2), (6) and (8).
4. Rotate the crankshaft pulley 360 degrees in direction of engine rotation.
5. Measure the valve clearance at positions (3), (4), (5) and (7).
6. If the measured values are not within specifications, replace the valve tappets.

Specifications

- Intake Side: 0.075-0.125 mm
- Exhaust Side: 0.245-0.295 mm

**Fig. 260: Measuring Old Tappet**

Courtesy of GENERAL MOTORS COMPANY

7. Determine the tappet size. Refer to determining replacement tappet size.
 1. Remove the old tappet. Refer to **Valve Stem Oil Seal and Valve Spring Replacement**.
 2. Measure the old tappet.
 3. Perform the following calculation to determine the replacement tappet size:

Specifications

- Intake: value of removed tappet + measured clearance - 0.1 mm = new tappet size
- Exhaust: value of removed tappet + measured clearance - 0.27 mm = new tappet size

Example:

- Old tappet = 3.20 mm, clearance was 0.30 mm, Intake clearance value is 0.1 mm
- $3.20 \text{ mm} + 0.30 \text{ mm} - 0.1 \text{ mm} = 3.40 \text{ mm}$
- 3.40 mm = 96449615 (part number)

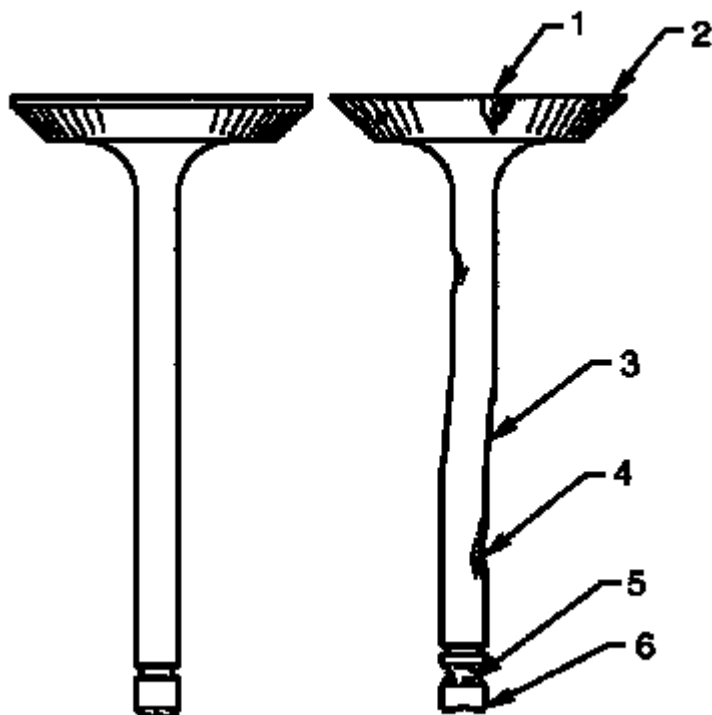
Tappet Selection

Part Number	ID Number	Value (mm)
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2014 Chevrolet Spark LT

2014 ENGINE Engine Mechanical - 1.0L, 1.19L or 1.2L - Spark

96449601	312	3.12 ± 0.01
96449602	314	3.14 ± 0.01
96449603	316	3.16 ± 0.01
96449604	318	3.18 ± 0.01
96449605	320	3.20 ± 0.01
96449606	322	3.22 ± 0.01
96449607	324	3.24 ± 0.01
96449608	326	3.26 ± 0.01
96449609	328	3.28 ± 0.01
96449610	330	3.30 ± 0.01
96449611	332	3.32 ± 0.01
96449612	334	3.34 ± 0.01
96449613	336	3.36 ± 0.01
96449614	338	3.38 ± 0.01
96449615	340	3.40 ± 0.01
96449616	342	3.42 ± 0.01
96449617	344	3.44 ± 0.01
96449618	346	3.46 ± 0.01
96449619	348	3.48 ± 0.01
96449620	350	3.50 ± 0.01
96449621	352	3.52 ± 0.01
96449622	354	3.54 ± 0.01
96449623	356	3.56 ± 0.01
96449624	358	3.58 ± 0.01
96449625	360	3.60 ± 0.01
96449626	362	3.62 ± 0.01
96449627	364	3.64 ± 0.01
96449628	366	3.66 ± 0.01
96449629	368	3.68 ± 0.01
96449630	370	3.70 ± 0.01
96449631	372	3.72 ± 0.01
96449632	374	3.74 ± 0.01
96449633	376	3.76 ± 0.01
96449634	378	3.78 ± 0.01
96449635	380	3.80 ± 0.01
96449636	382	3.82 ± 0.01
96449637	384	3.84 ± 0.01
96449638	386	3.86 ± 0.01
96449639	388	3.88 ± 0.01
96449640	390	3.90 ± 0.01

VALVE STEM AND VALVE GUIDE CLEARANCE INSPECTION**Fig. 261: Valve Stem and Valve Guide Clearance Inspection**

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.

NOTE: **Valve guide is not removable. Replace the cylinder head if it is out of specification.**

3. Measure the valve stem diameter (1) and valve guide inside diameter. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Special Tools

J 45507 Crankshaft Rear Oil Seal Installer

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 an automatic transmission, remove the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Replacement.
3. Place a collecting container under the vehicle.
4. Remove the oil pan. Refer to Oil Pan Replacement.

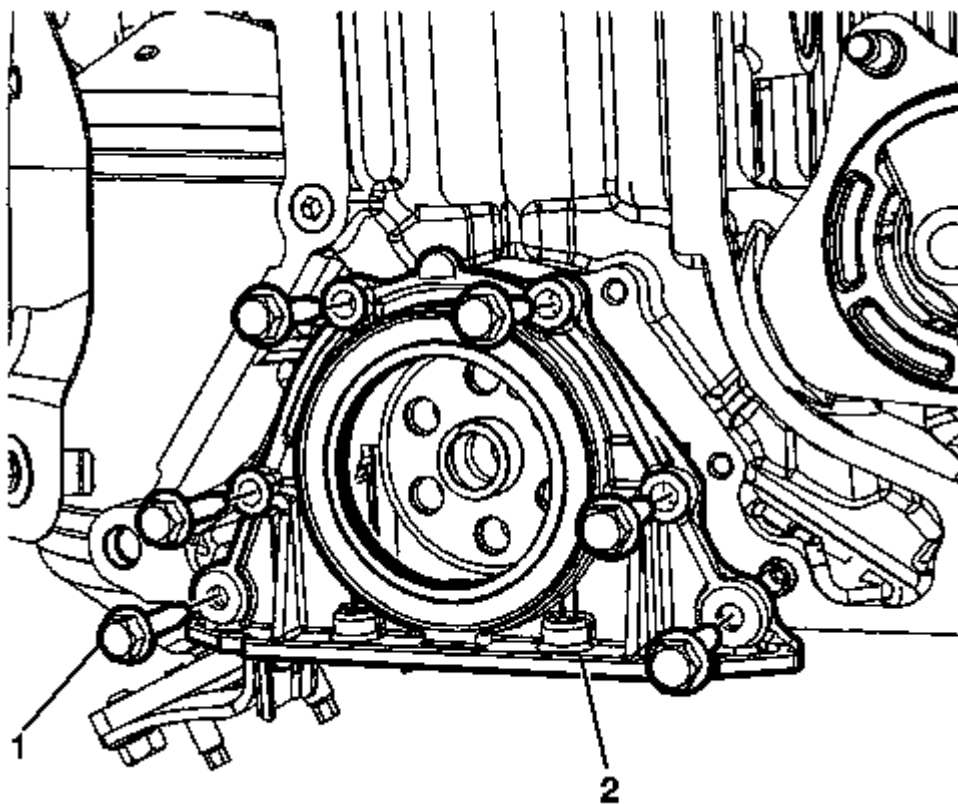


Fig. 262: Fasteners, Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 6 fasteners (1) from the oil seal and housing (2).
6. Clean the threads of the 6 fasteners (1).

NOTE: Take care when removing the oil seal and housing to avoid damage to the crankshaft and oil pan.

7. Remove the oil seal and housing using a suitable tool.

Installation Procedure

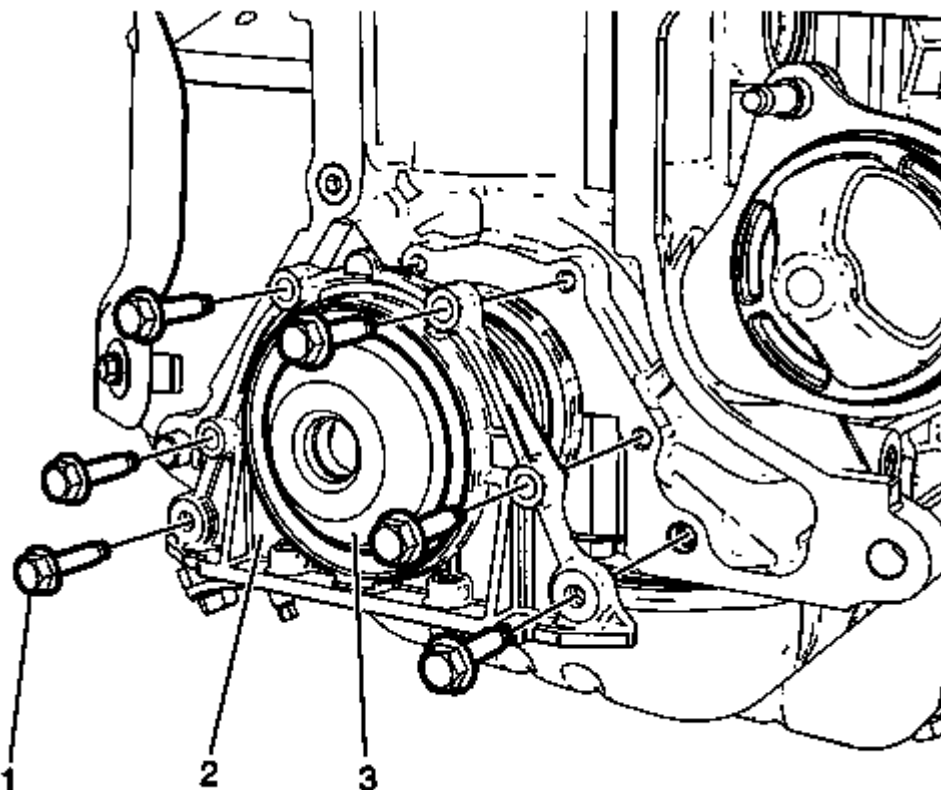


Fig. 263: Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

1. Apply sealant to the crankshaft rear oil seal and housing. Refer to **Adhesives, Fluids, Lubricants and Sealers**.
2. Install the **J 45507** Crankshaft Rear Oil Seal Installer (3) to the crankshaft rear oil seal and housing (2).
3. Push the crankshaft rear oil seal and housing (2) until the crankshaft rear oil seal and housing is flush and sits evenly in the cylinder block.
4. Remove the **J 45507** Crankshaft Rear Oil Seal Installer (3) from the crankshaft.
5. Apply thread locker to the threads of the 6 fasteners (1). Refer to **Adhesives, Fluids, Lubricants and Sealers**.

CAUTION: Refer to Fastener Caution .

6. Install the 6 fasteners (1) and tighten to 10 (89 lb in).
7. Install the oil pan. Refer to **Oil Pan Replacement**.

8. If equipped with a manual transmission, install the flywheel. Refer to **Engine Flywheel Replacement**.
9. If equipped with an automatic transmission, install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

IGNITION COIL COVER REPLACEMENT (LL0)

Removal Procedure

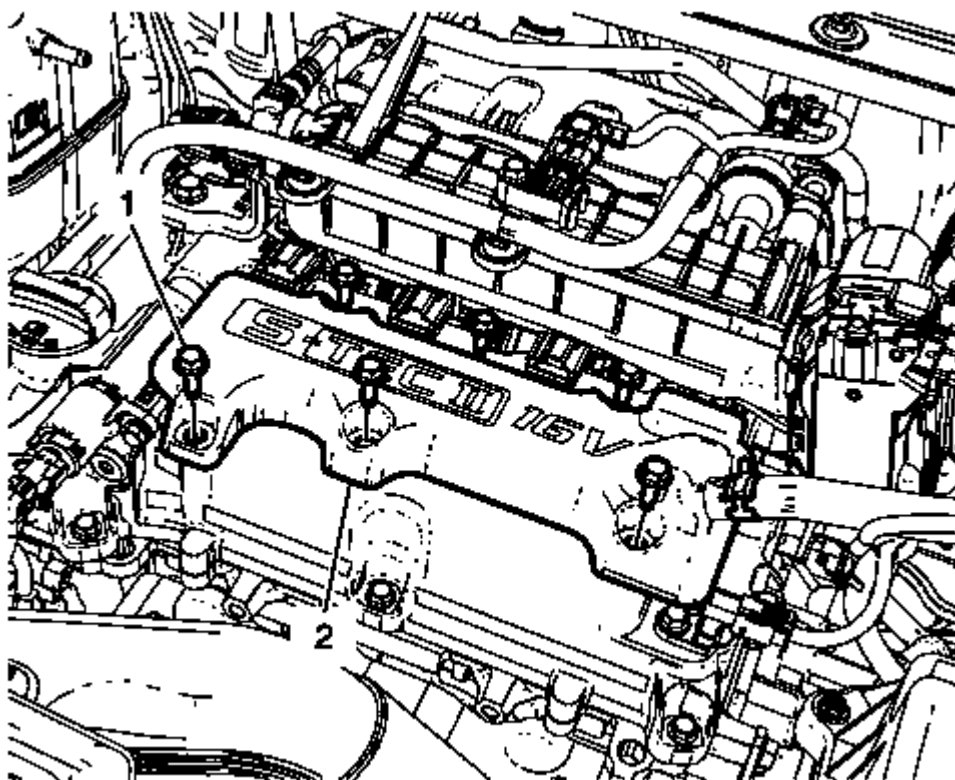


Fig. 264: Engine Compression Test Tool
Courtesy of GENERAL MOTORS COMPANY

1. Open the hood.
2. Disconnect the breather hose and clamp from the ignition coil cover.
3. Remove the 6 ignition coil cover bolts (1).
4. Remove the ignition coil cover (2).

Installation Procedure

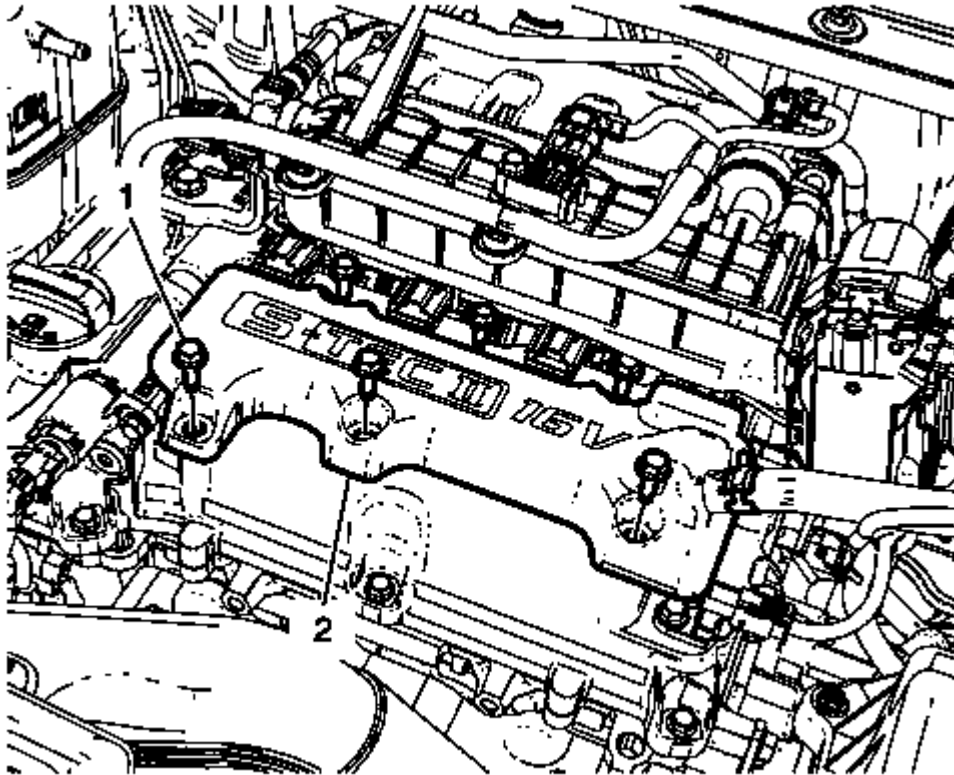


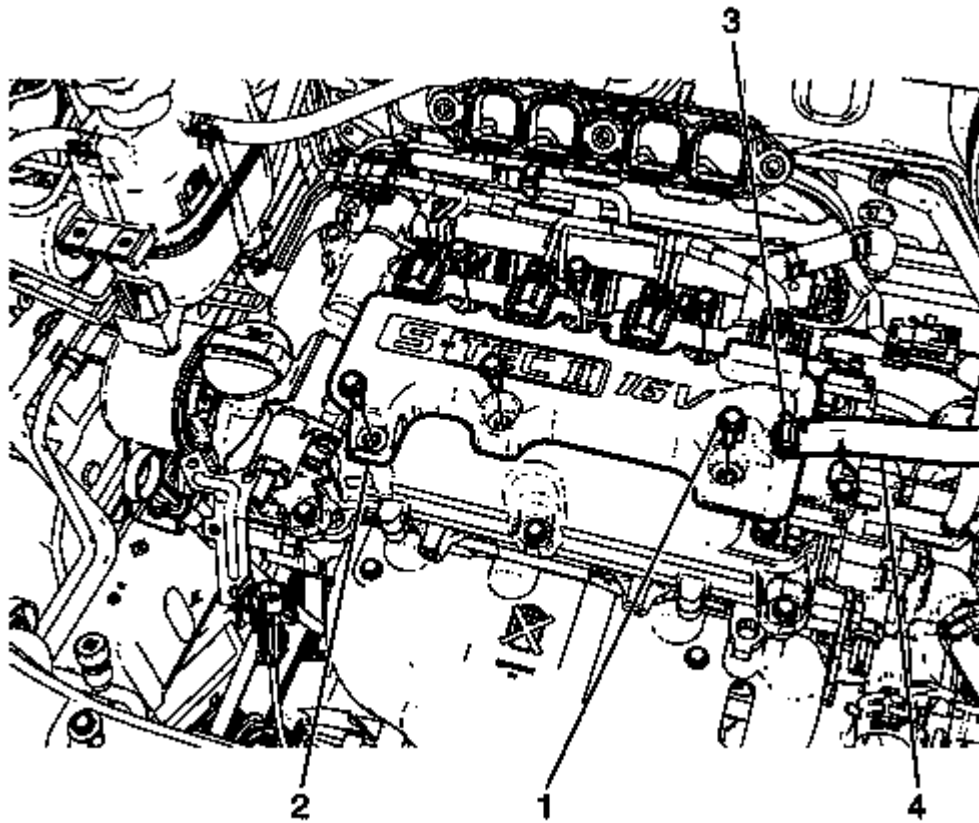
Fig. 265: Engine Compression Test Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil cover (2).
2. Install the 6 ignition coil cover bolts (1) and tighten to 10 (80 lb in).
3. Connect the breather hose and clamp to the ignition coil cover.
4. Close the hood.

IGNITION COIL COVER REPLACEMENT (LFM)

Removal Procedure

1. Open the hood.
2. Remove the upper intake manifold. Refer to **Upper Intake Manifold Replacement (LFM)**.

**Fig. 266: Breather Hose**

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the breather hose (4) and clamp (3) from the ignition coil cover.
4. Remove the 6 ignition coil cover bolts (1).
5. Remove the ignition coil cover (2).

Installation Procedure

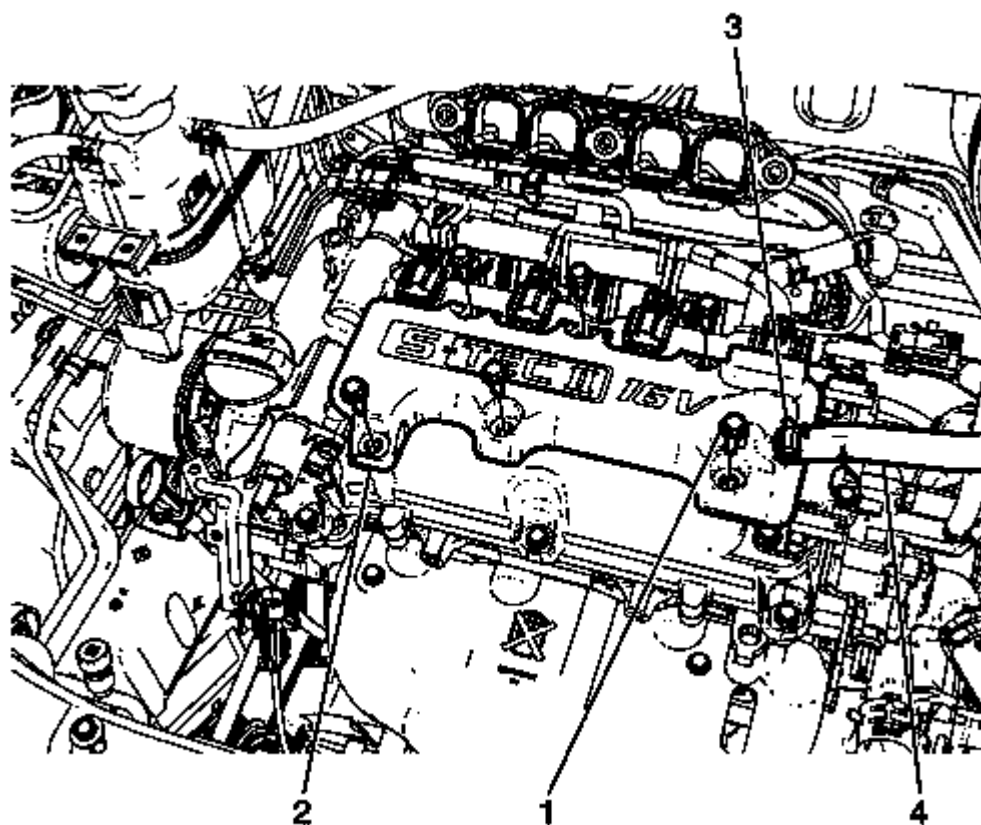


Fig. 267: Breather Hose

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil cover (2).
2. Install the 6 ignition coil cover bolts (1) and tighten to 10 (80 lb in).
3. Connect the breather hose (4) and clamp (3) to the ignition coil cover.
4. Install the upper intake manifold housing. Refer to **Upper Intake Manifold Replacement (LFM)**.
5. Close the hood.

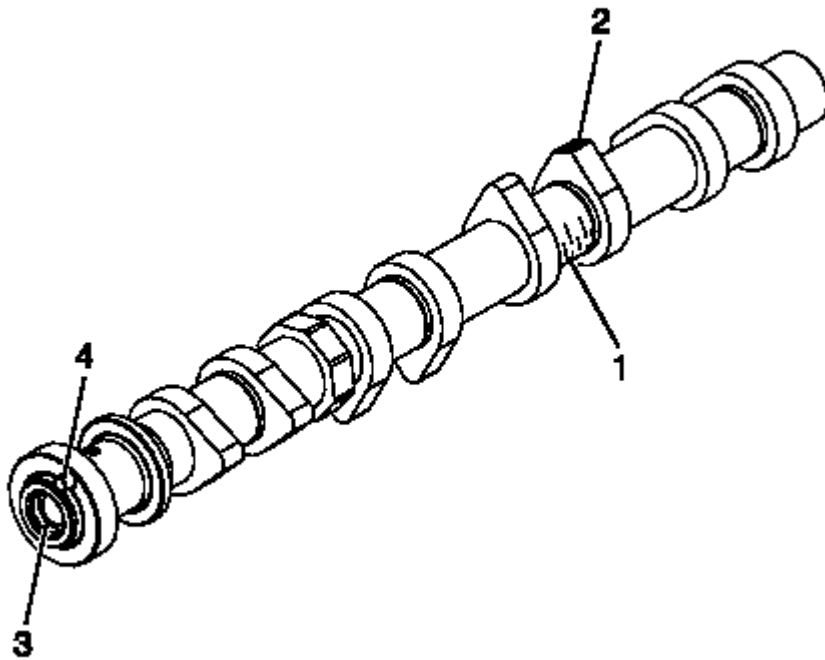
REPAIR INSTRUCTIONS - OFF VEHICLE

CAMSHAFT CLEANING AND INSPECTION

1. Clean the camshaft in solvent.

WARNING: Refer to **Safety Glasses Warning** .

2. Dry the camshaft with compressed air.

**Fig. 268: Bearing Journals****Courtesy of GENERAL MOTORS COMPANY**

3. Inspect the camshaft for the following conditions:

- Camshaft bearing journals (1) that are:
 - Worn
 - Scored
 - Damaged
- Worn camshaft lobes (2)
- Damaged sprocket bolt threads (3)
- Damaged sprocket pin

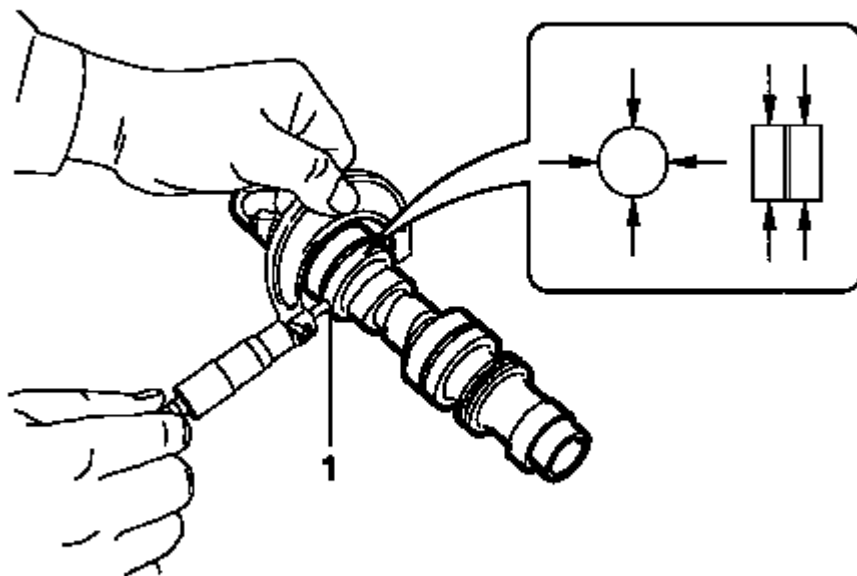


Fig. 269: Measuring Outer Diameter Of Each Journal
Courtesy of GENERAL MOTORS COMPANY

4. Measure the outer diameter of each journal (1) at the 4 different places.
5. Replace the camshaft if the measured value is not as specified.

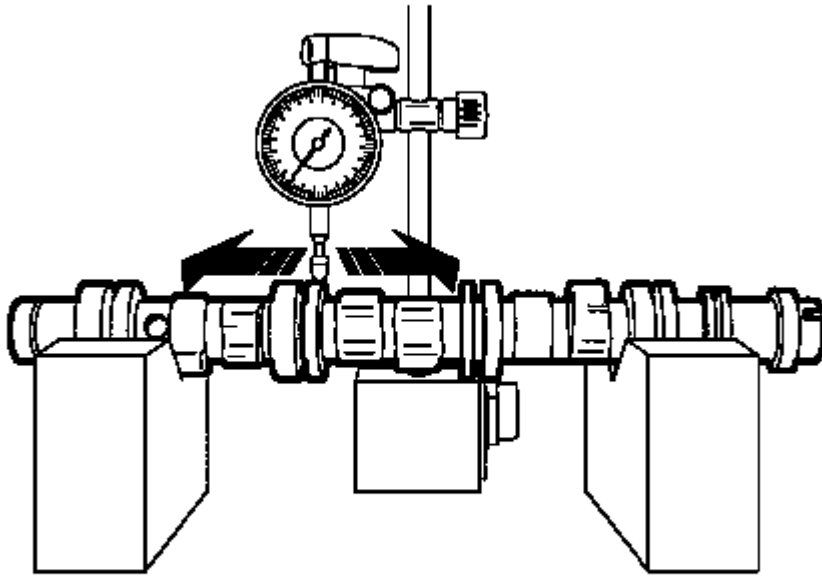


Fig. 270: Measuring Excessive Camshaft Runout Using Indicator
 Courtesy of GENERAL MOTORS COMPANY

6. Measure for excessive camshaft runout, using the indicator.
 1. Mount the camshaft in a suitable fixture.
 2. Use the indicator in order to measure for a bent camshaft. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.
7. Replace the camshaft if runout exceeds specifications.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REMOVAL

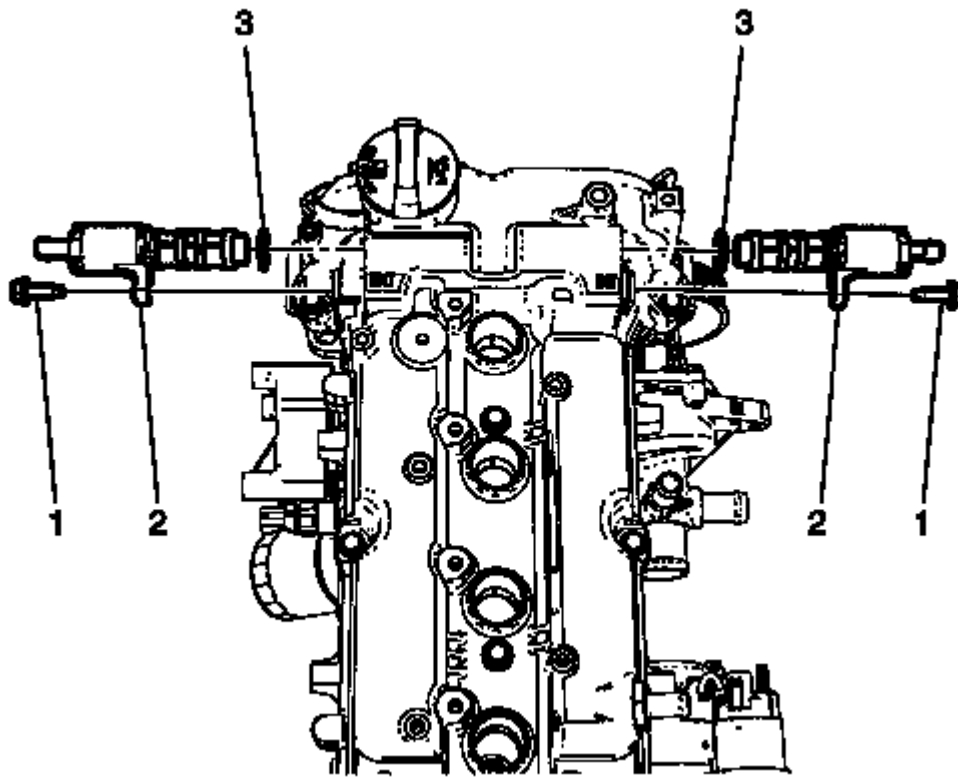


Fig. 271: Camshaft Position Actuator Solenoid Valve Bolts And Valves
Courtesy of GENERAL MOTORS COMPANY

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).

GENERATOR BRACKET REMOVAL

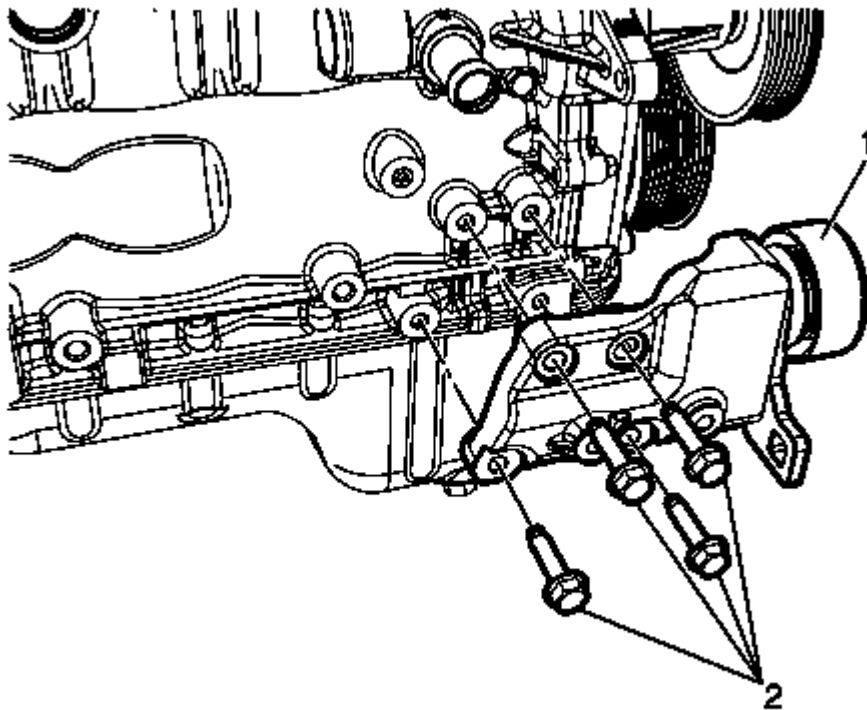


Fig. 272: Generator Bracket Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the generator bracket retaining bolts (2).
2. Remove the generator bracket (1).

AIR CONDITIONING COMPRESSOR BRACKET REMOVAL

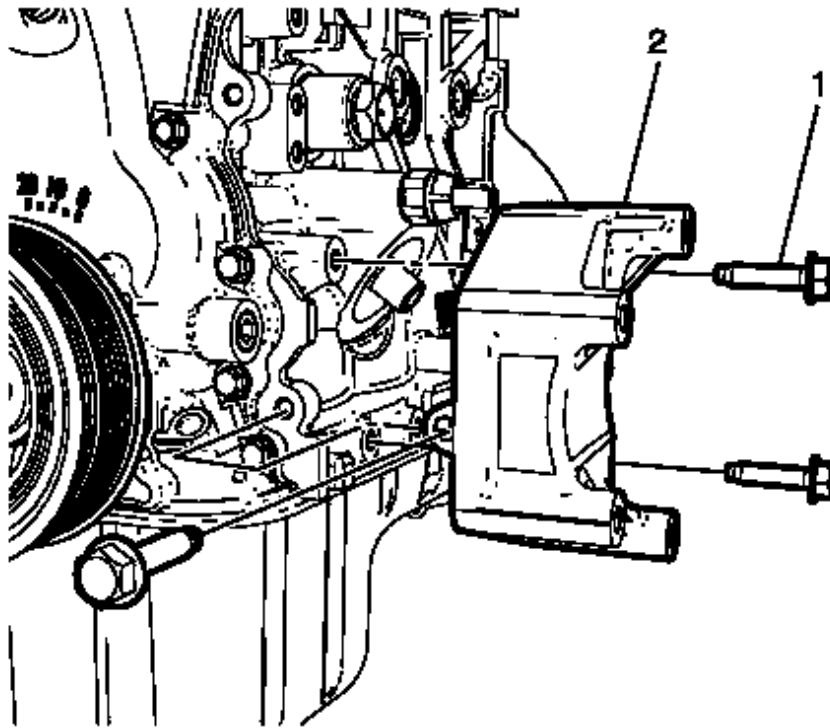


Fig. 273: Air Conditioning Compressor Bolts And Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 air conditioning compressor bolts (1).
2. Remove the air conditioning compressor bracket (2).

CRANKSHAFT BALANCER REMOVAL

Special Tools

- EN 50175 Crankshaft Locking Device
- J-22888-20A Crankshaft Balancer Puller

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

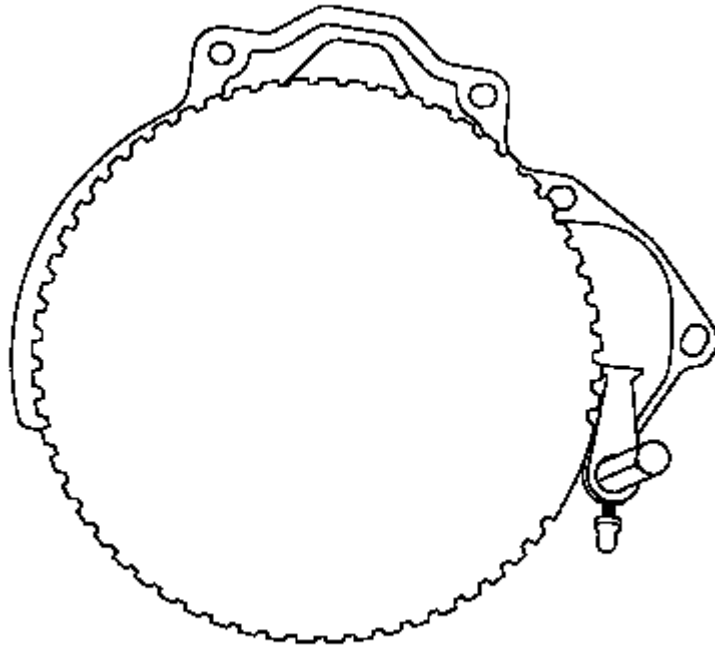


Fig. 274: EN 50050 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 50050** crankshaft locking device. Lock the flywheel via the starter ring gear.

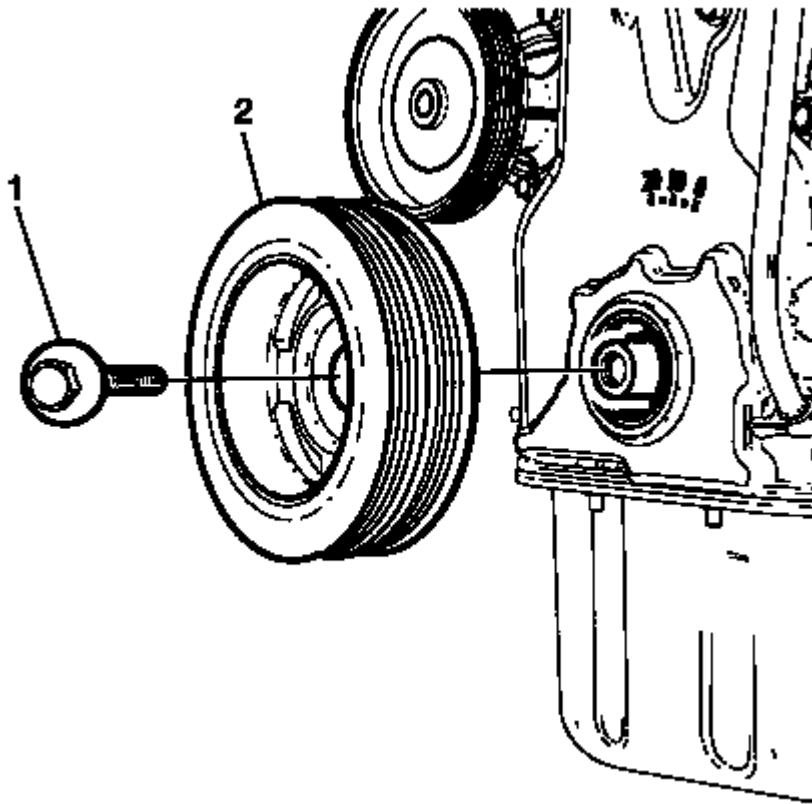


Fig. 275: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the bolt (1).
3. Install **J-22888-20A** crankshaft balancer puller to the crankshaft balancer (2).
4. Remove the crankshaft balancer (2).
5. Remove the **EN 50050** crankshaft locking device.

CRANKSHAFT SPROCKET REMOVAL

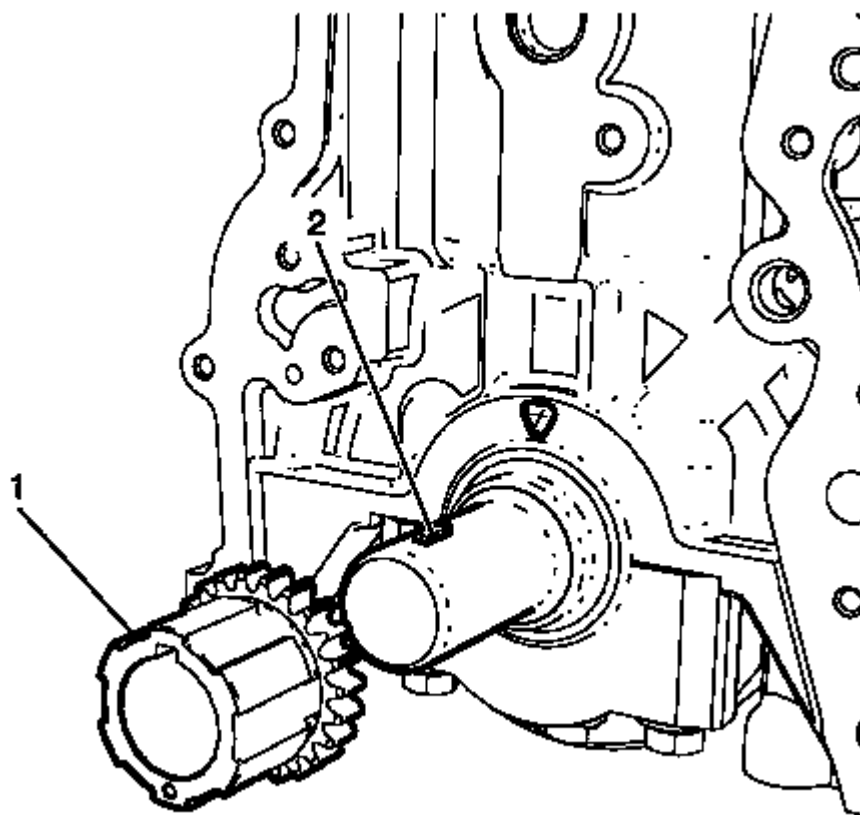


Fig. 276: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

Remove the crankshaft sprocket (1).

ENGINE FLYWHEEL REMOVAL

Special Tools

EN-50050 Crankshaft Locking Device

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

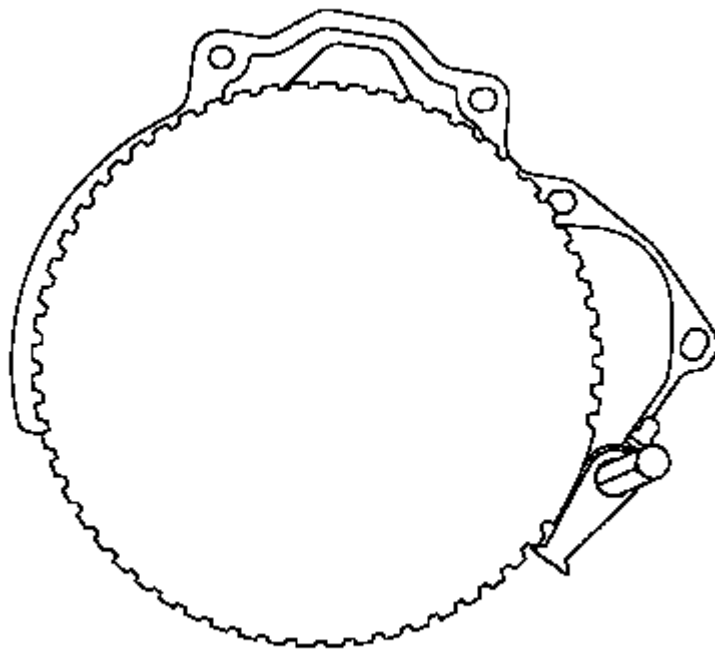


Fig. 277: EN-50050 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-50050** crankshaft locking device, lock the flywheel via the starter ring gear.
2. Loosen the flywheel bolts.
3. Remove the **EN-50050** crankshaft locking device.

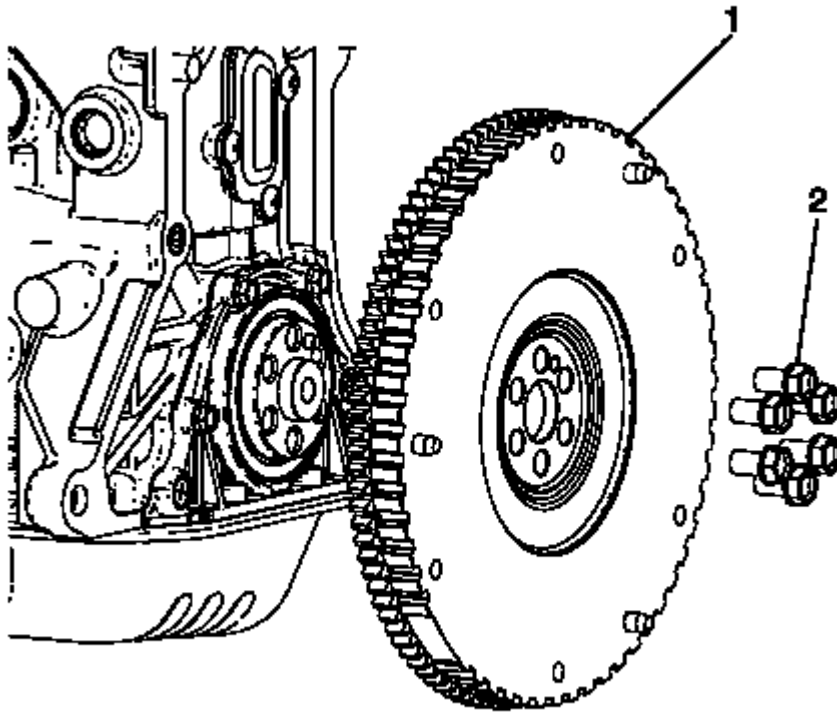


Fig. 278: Flywheel And Bolts

Courtesy of GENERAL MOTORS COMPANY

4. Remove the 6 flywheel bolts (2).
5. Remove the flywheel.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN 50050 Crankshaft Locking Device

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

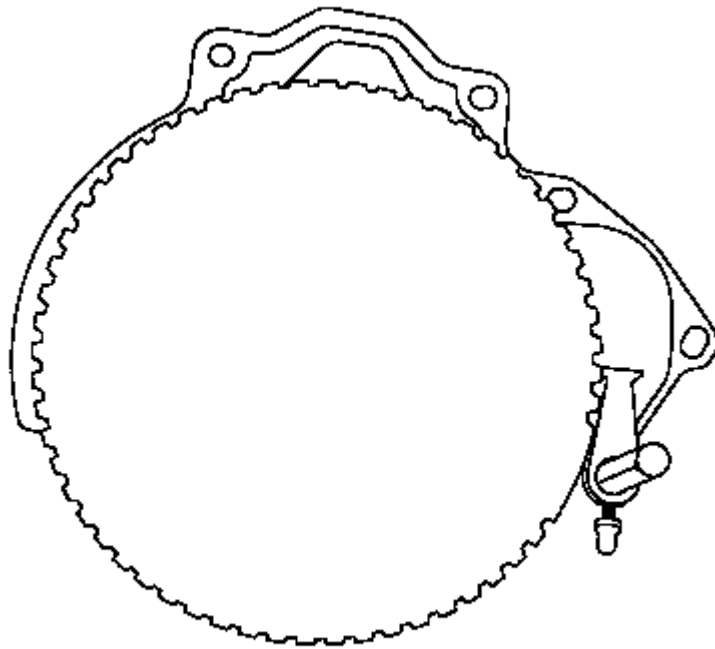


Fig. 279: EN 50050 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 50050** crankshaft locking device, lock the automatic transmission flex plate via the starter ring gear.
2. Loosen the 6 automatic transmission flex plate bolts.
3. Remove the **EN 50050** crankshaft locking device.

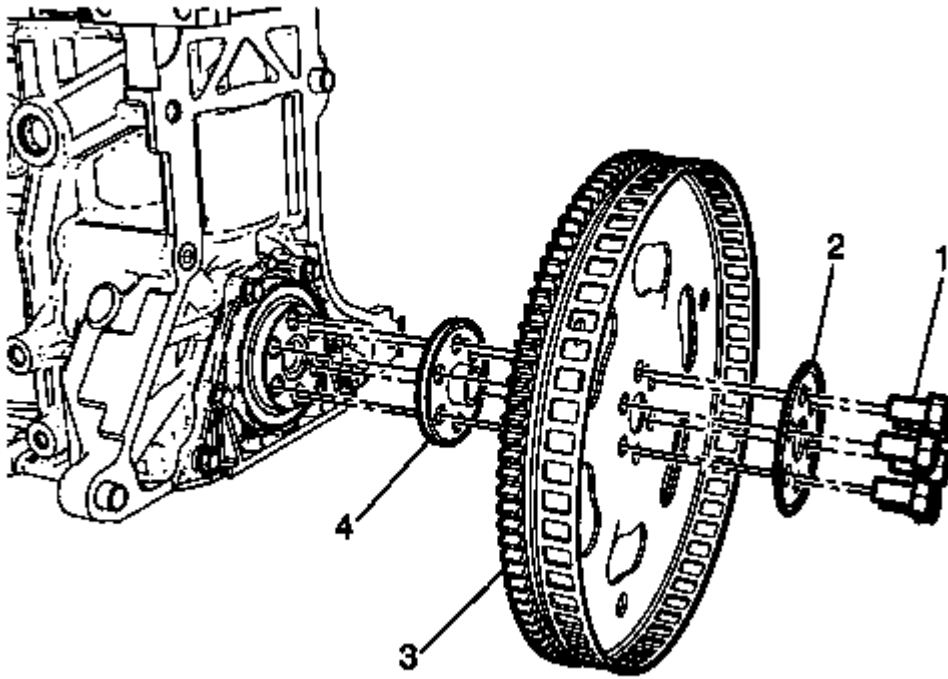


Fig. 280: Automatic Transmission Flex Plate Bolts And Automatic Transmission Flex Plate Retainer

Courtesy of GENERAL MOTORS COMPANY

4. Remove the 6 automatic transmission flex plate bolts (1).
5. Remove the automatic transmission flex plate retainer (2).
6. Remove the automatic transmission flex plate (3).
7. Remove the automatic transmission flex plate spacer (4).

OIL LEVEL INDICATOR AND TUBE REMOVAL

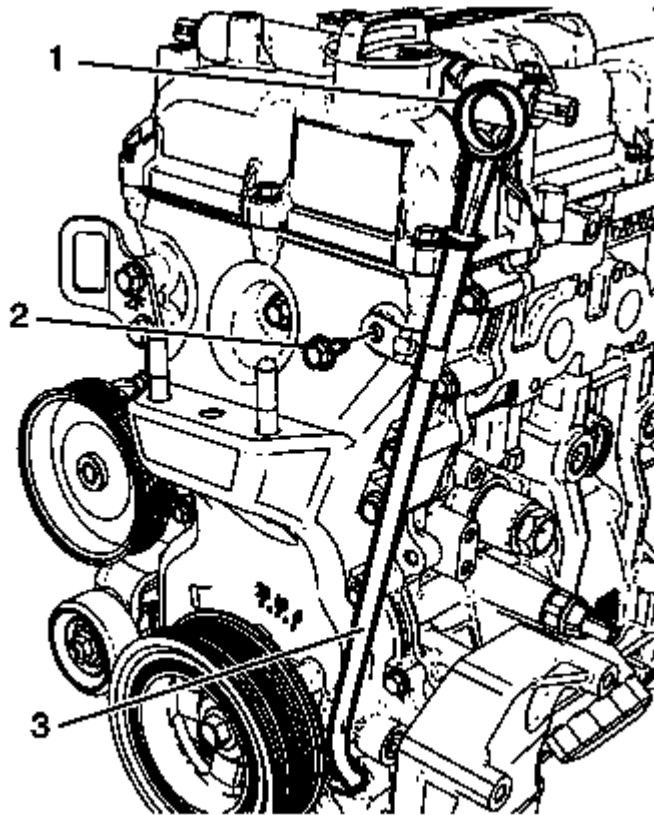


Fig. 281: Oil Dipstick And Oil Level Indicator Tube Bolt
 Courtesy of GENERAL MOTORS COMPANY

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

NOTE: If the engine oil level is at maximum, oil may emerge while removing the oil dipstick guide tube.

3. Remove the oil level indicator tube (3) and oil level indicator seal.

ENGINE COOLANT THERMOSTAT REMOVAL

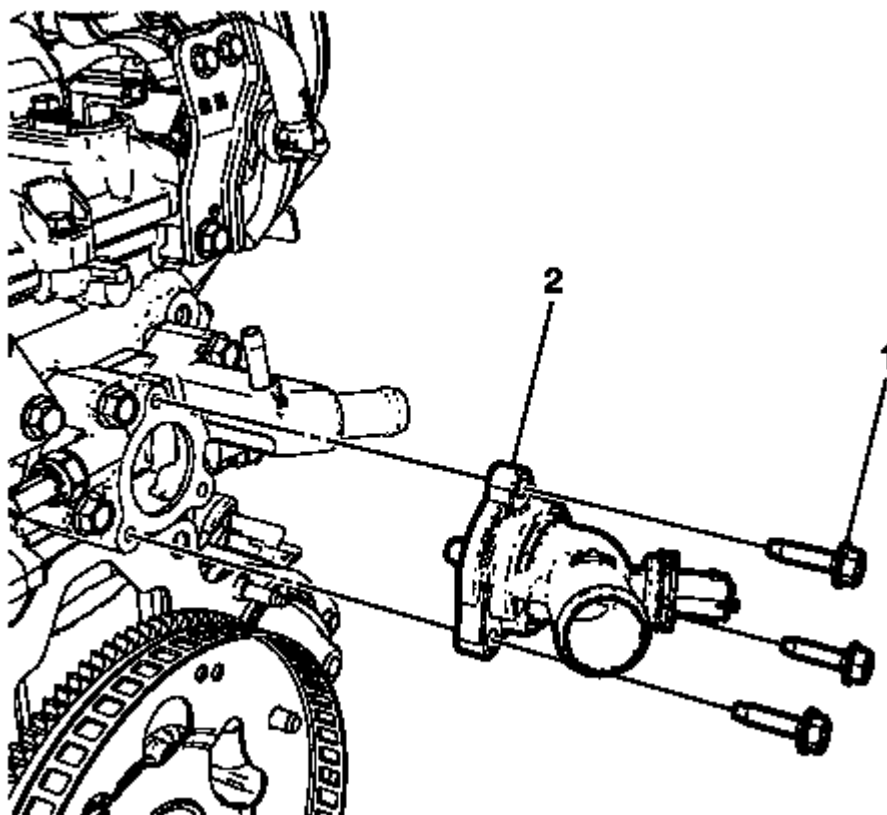


Fig. 282: Engine Coolant Thermostat Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 engine coolant thermostat bolts (1).
2. Remove the engine coolant thermostat assembly (2).

ENGINE WATER OUTLET ADAPTER REMOVAL

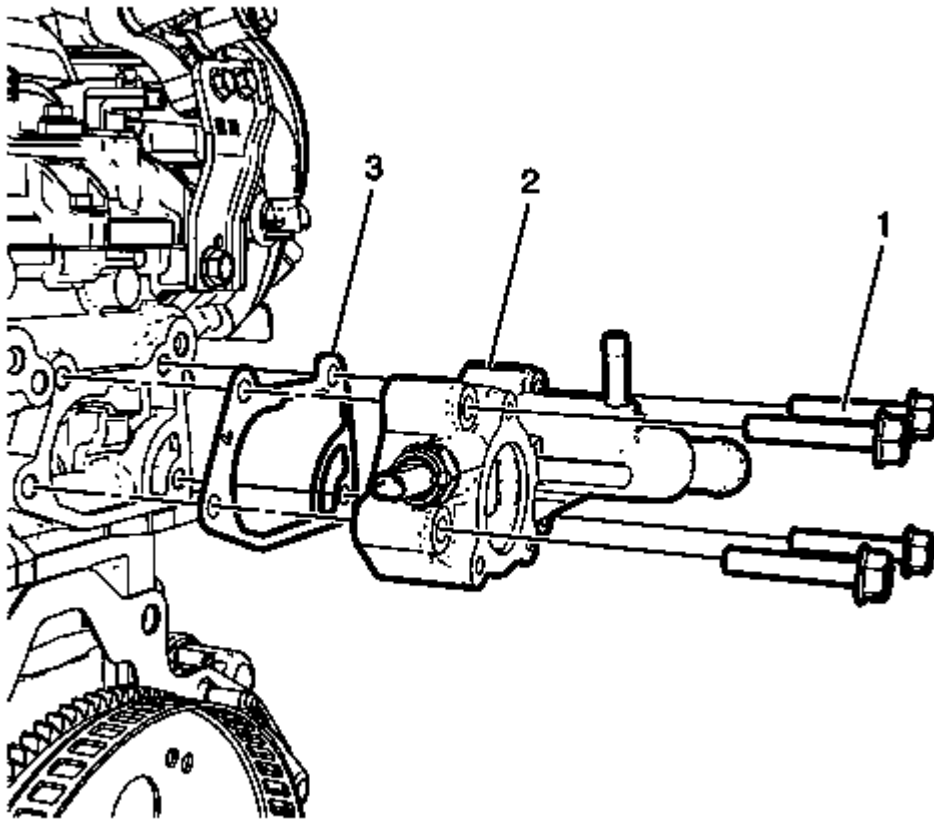


Fig. 283: Engine Water Outlet Adapter Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 engine water outlet adapter housing bolts (1).

NOTE: Replace the engine water outlet housing if it is porous or cracked.

2. Remove the engine water outlet adapter housing (2).
3. Inspect the engine water outlet adapter gasket (3).

THROTTLE BODY ASSEMBLY REMOVAL

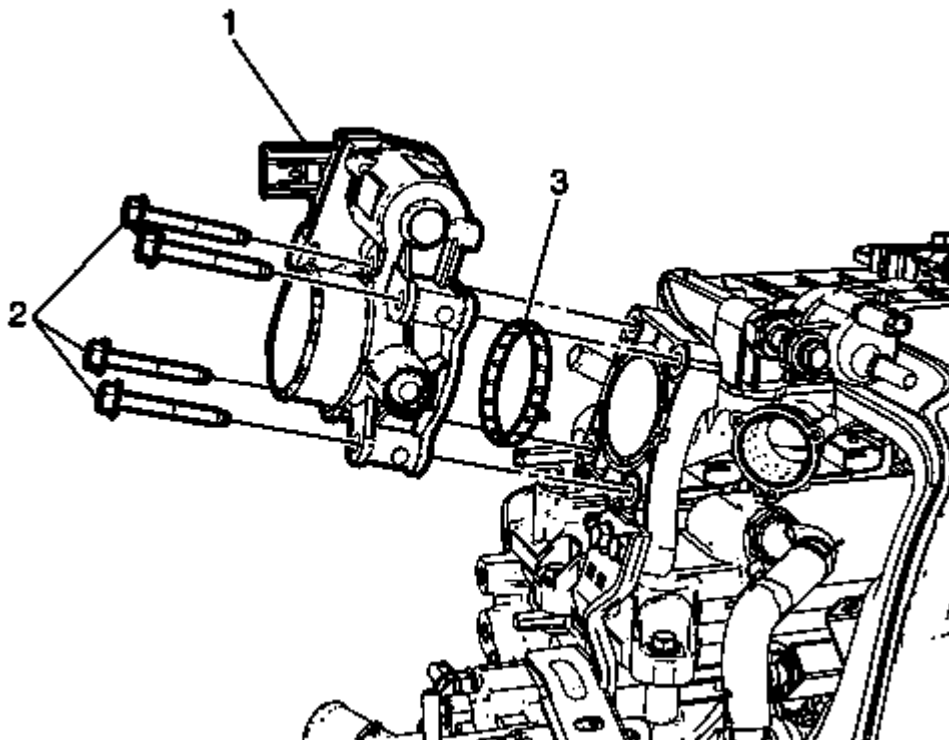


Fig. 284: Throttle Body Assembly

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 (3).

INTAKE MANIFOLD REMOVAL (LL0)

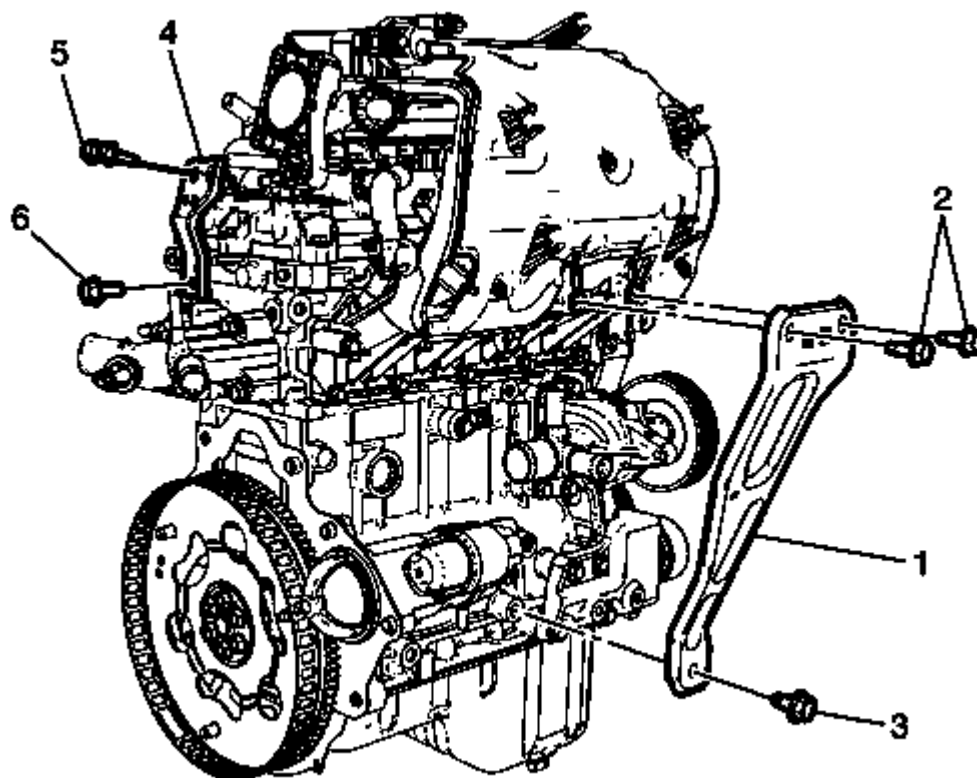


Fig. 285: Intake Manifold Upper Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold rear bracket (1) and bolts (2, 3).
2. Remove the upper intake manifold side bracket (4) and bolts (5, 6).

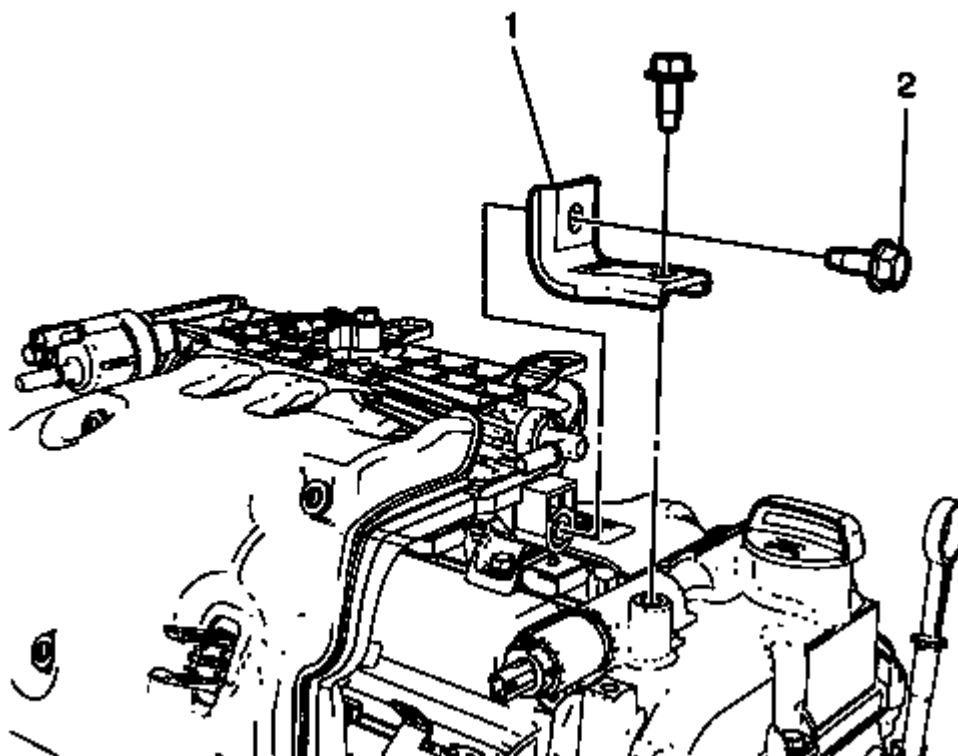


Fig. 286: Intake Manifold Upper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the intake manifold upper bracket bolts (2).
4. Remove the intake manifold upper bracket (1).

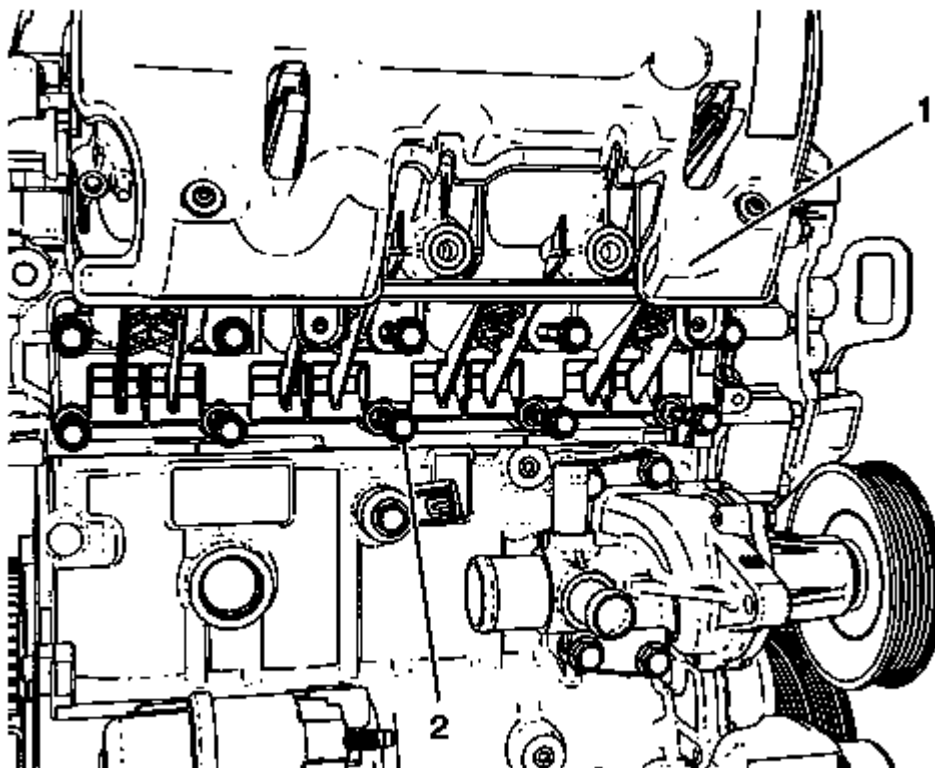


Fig. 287: Intake Manifold 10 Bolts

Courtesy of GENERAL MOTORS COMPANY

5. Remove the lower intake manifold 10 bolts (2).
6. Remove the intake manifold (1).

INTAKE MANIFOLD REMOVAL (LFM)

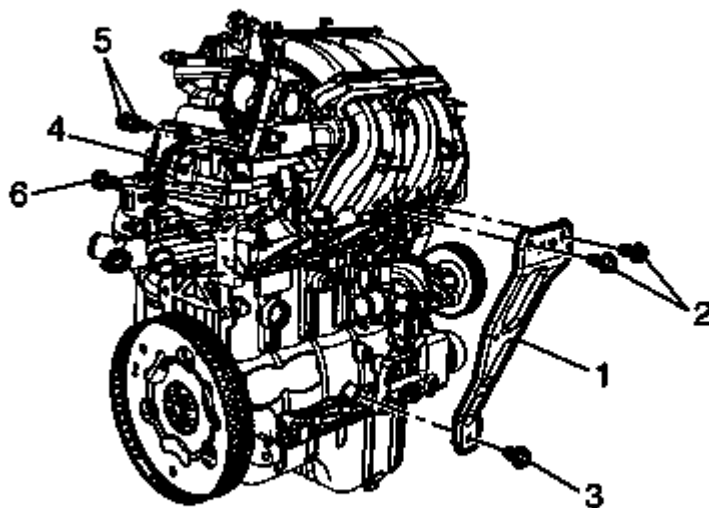


Fig. 288: Intake Manifold Rear Bracket

Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold rear bracket (1) and bolts (2, 3).
2. Remove the upper intake manifold side bracket (4) and bolts (5, 6).

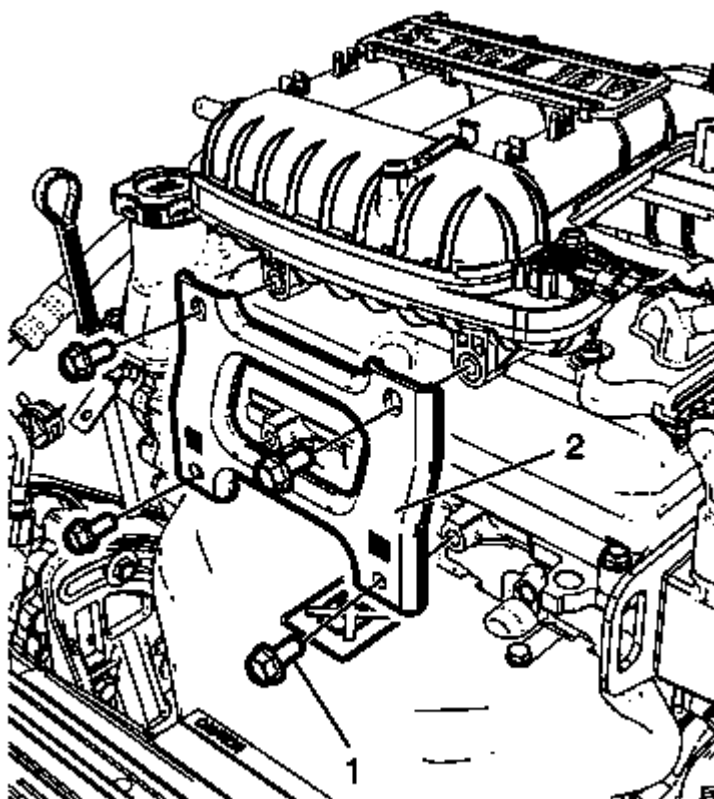


Fig. 289: Upper Intake Manifold Front Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the upper intake manifold front bracket bolts (1).
4. Remove the upper intake manifold front bracket (2).

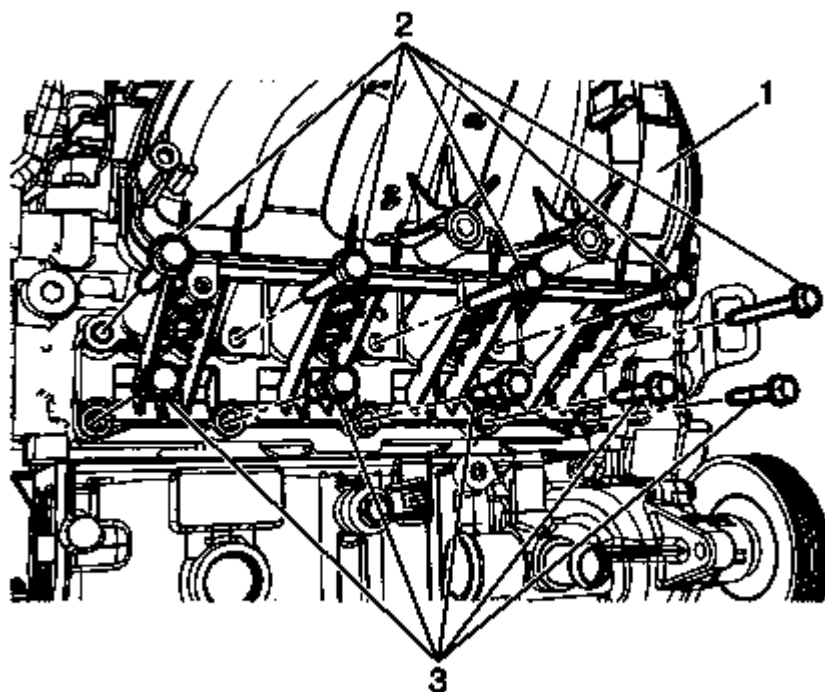


Fig. 290: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the lower intake manifold 10 bolts (2, 3).
6. Remove the lower intake manifold (1).

IGNITION COIL REMOVAL

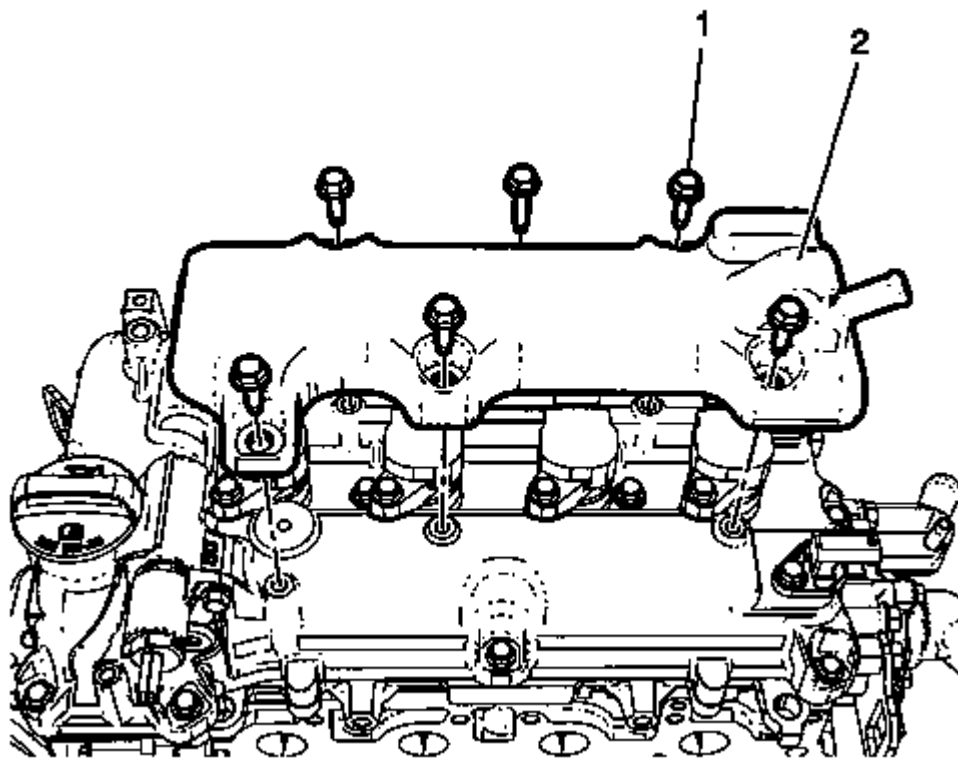


Fig. 291: Ignition Coil Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil cover bolts (1).
2. Remove the ignition coil cover (2).

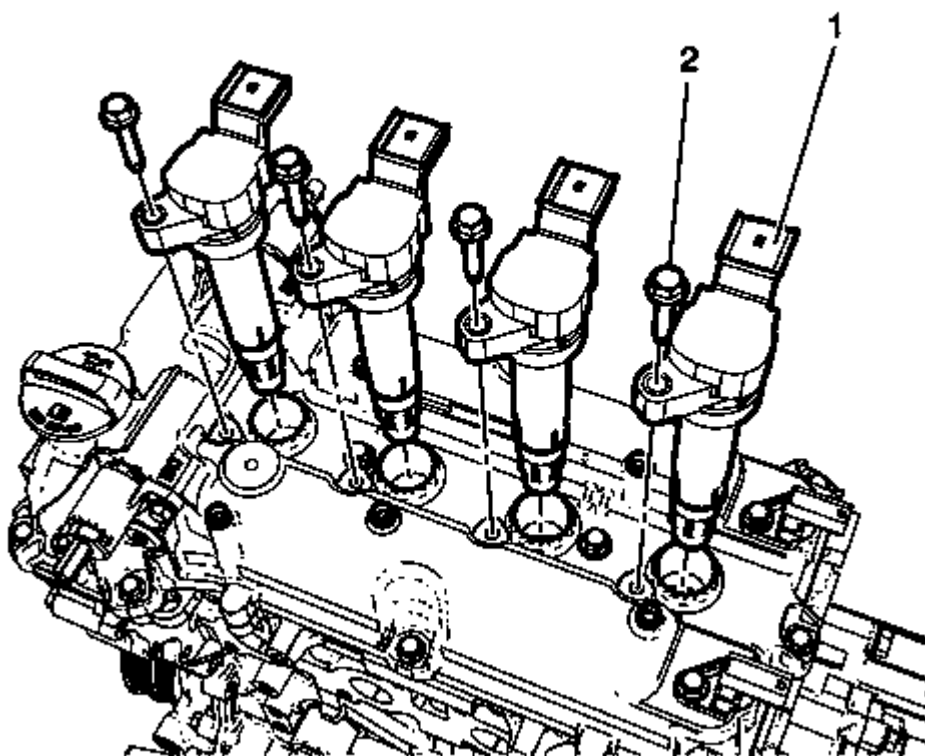


Fig. 292: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolts (2).
4. Remove the ignition coil (1).

CAMSHAFT COVER REMOVAL

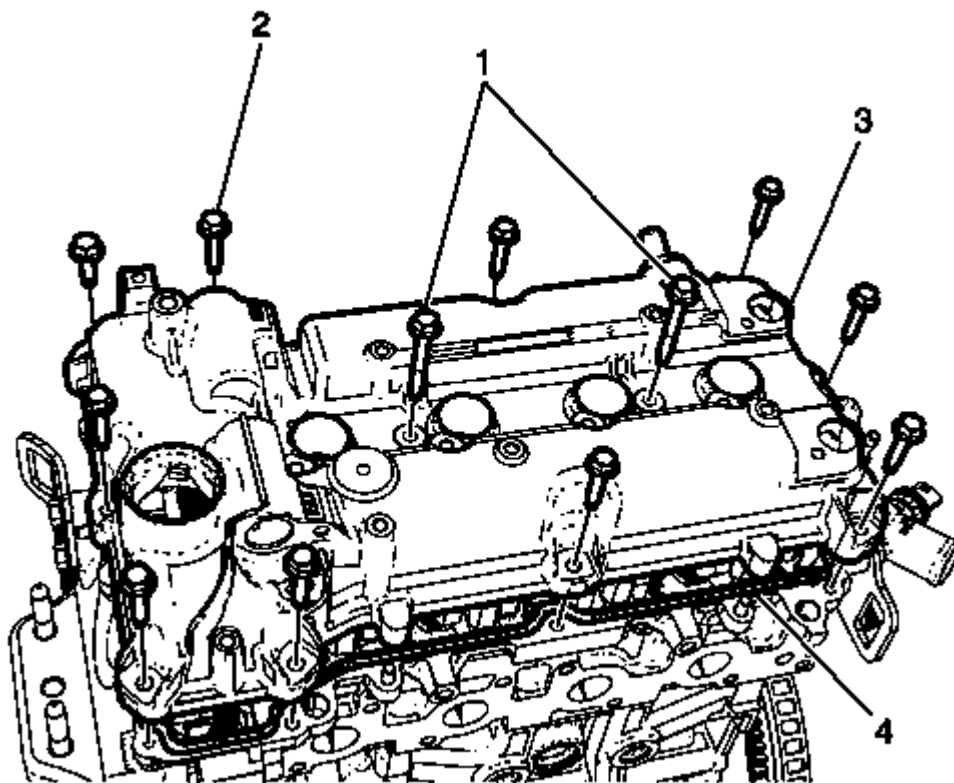


Fig. 293: Camshaft Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft cover bolts (1, 2).
2. Remove the camshaft cover (3).
3. Remove the camshaft cover gasket (4).

WATER PUMP REMOVAL

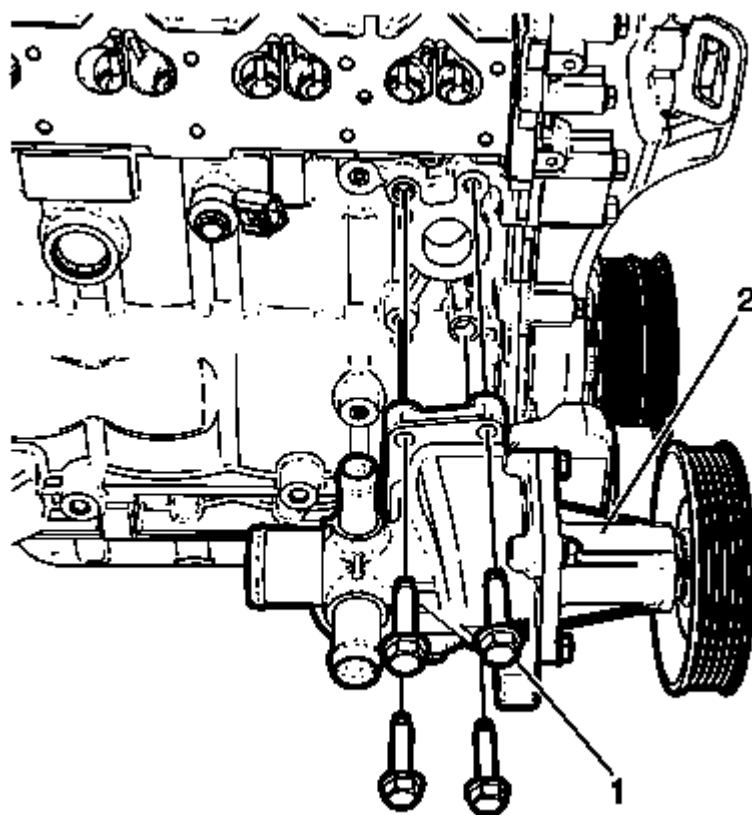


Fig. 294: Water Pump Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 water pump bolts (1).
2. Remove the water pump (2).

ENGINE FRONT COVER AND OIL PUMP REMOVAL

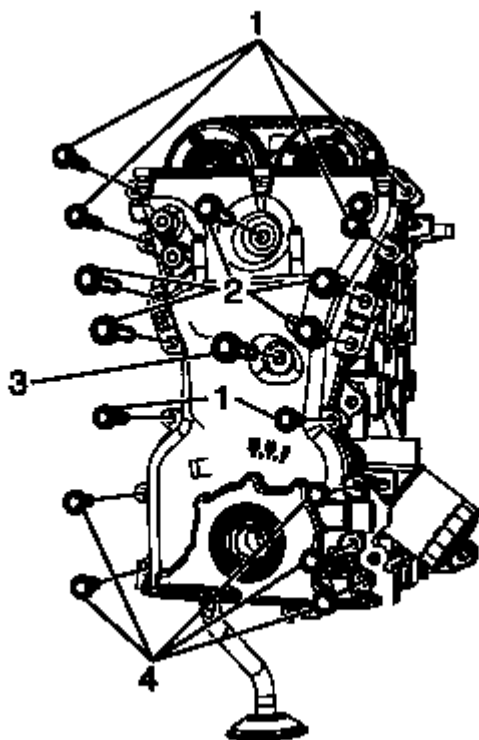


Fig. 295: Engine Front Cover Bolts
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the different screw lengths.

1. Remove the bolts (1, 2, 3, 4).

NOTE: Do not damage the sealing surfaces.

2. Remove the engine front cover with the included oil pump.

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

3. Clean the sealing surface.

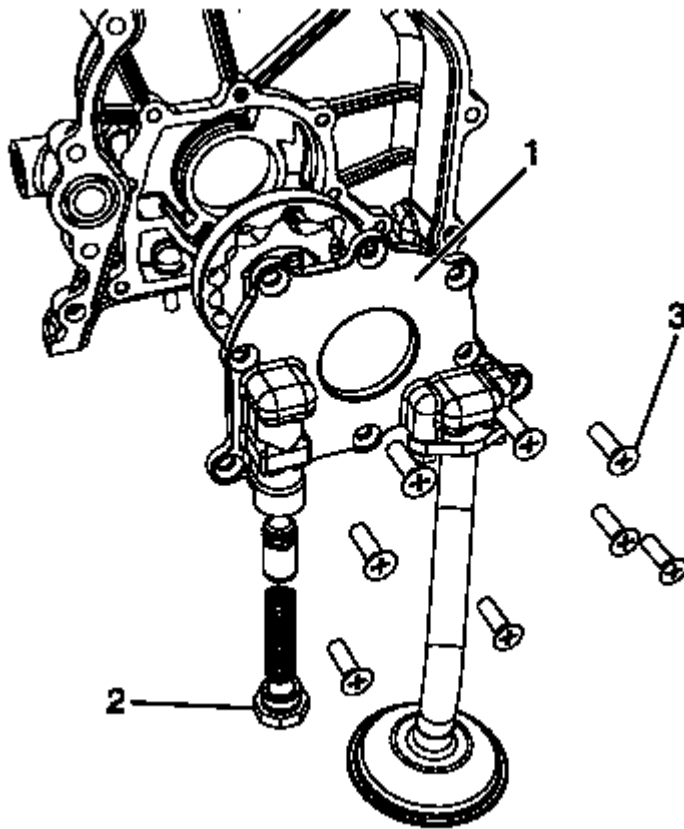


Fig. 296: Oil Pump Screws

Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump screws (3).
5. Remove the oil pump (1).
6. Remove the plug, holding the plug for the oil relief valve components.
7. Remove the plug, spring and plunger (2), from the oil pump housing (1).

CAMSHAFT TIMING CHAIN REMOVAL

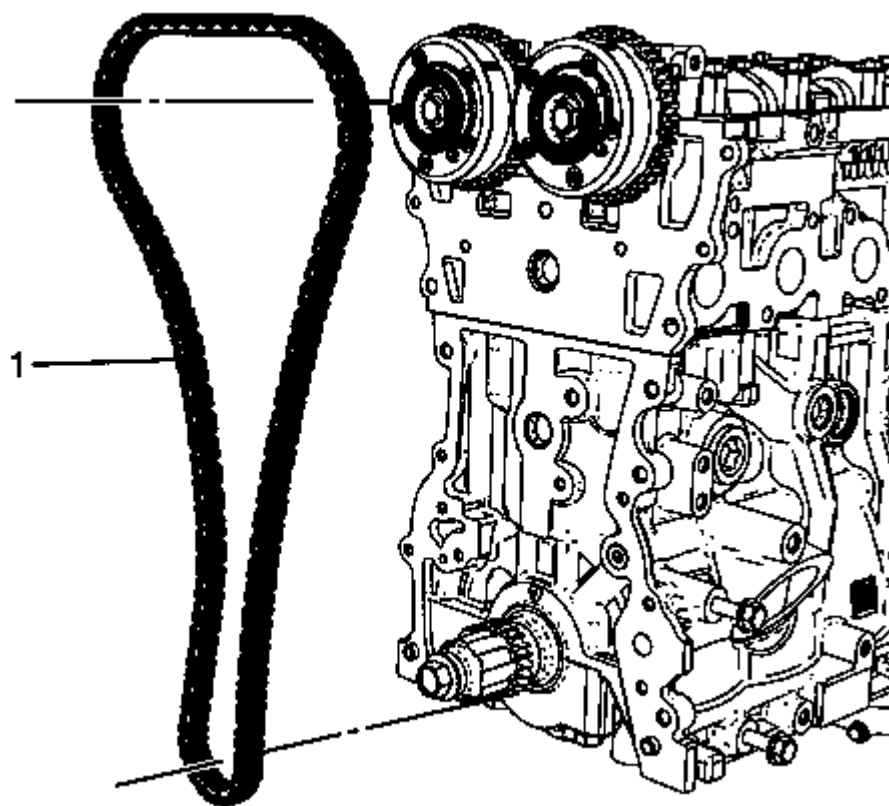


Fig. 297: Timing Chain

Courtesy of GENERAL MOTORS COMPANY

Remove the timing chain (1).

TIMING CHAIN TENSIONER REMOVAL

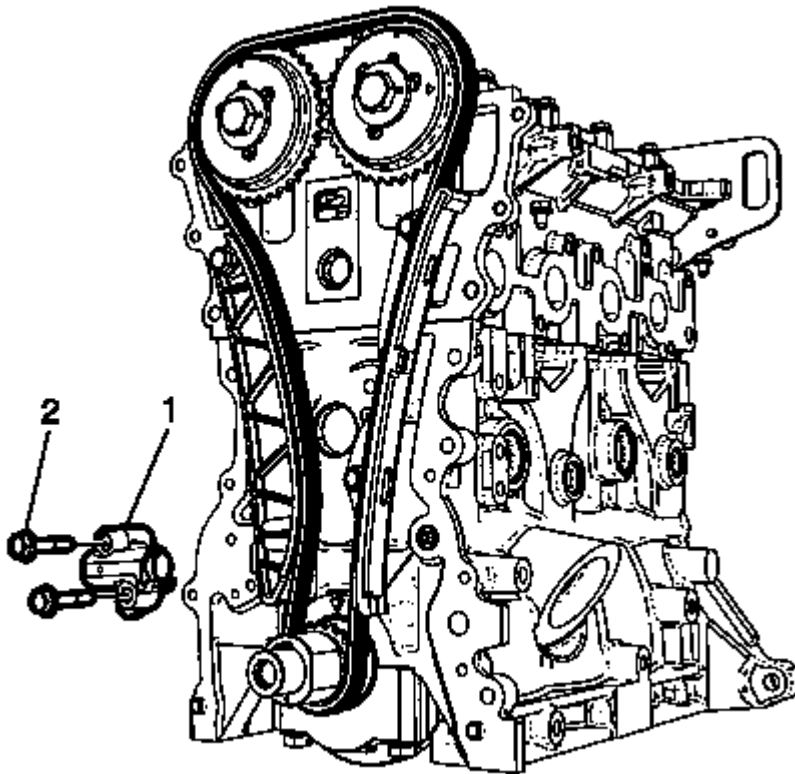


Fig. 298: Timing Chain Tensioner Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the timing chain tensioner retaining bolts (2).
2. Remove the timing chain tensioner (1).
3. Inspect the timing chain tensioner mounting surface on the cylinder head for burrs or any defects that may degrade the sealing.

TIMING CHAIN GUIDE REMOVAL

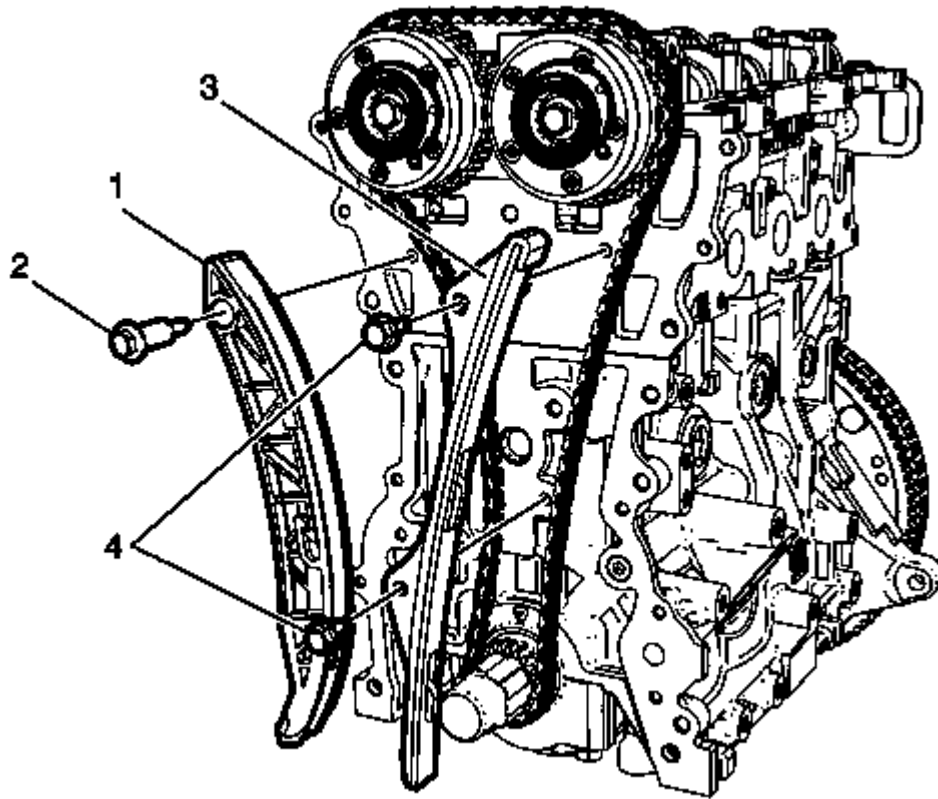


Fig. 299: Left Timing Chain Shoe Retaining Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the timing chain guide retaining bolts (4).
2. Remove the timing chain guide (3).
3. Remove the timing chain shoe retaining bolt (2).
4. Remove the timing chain shoe (1).

ENGINE LIFT FRONT BRACKET REMOVAL

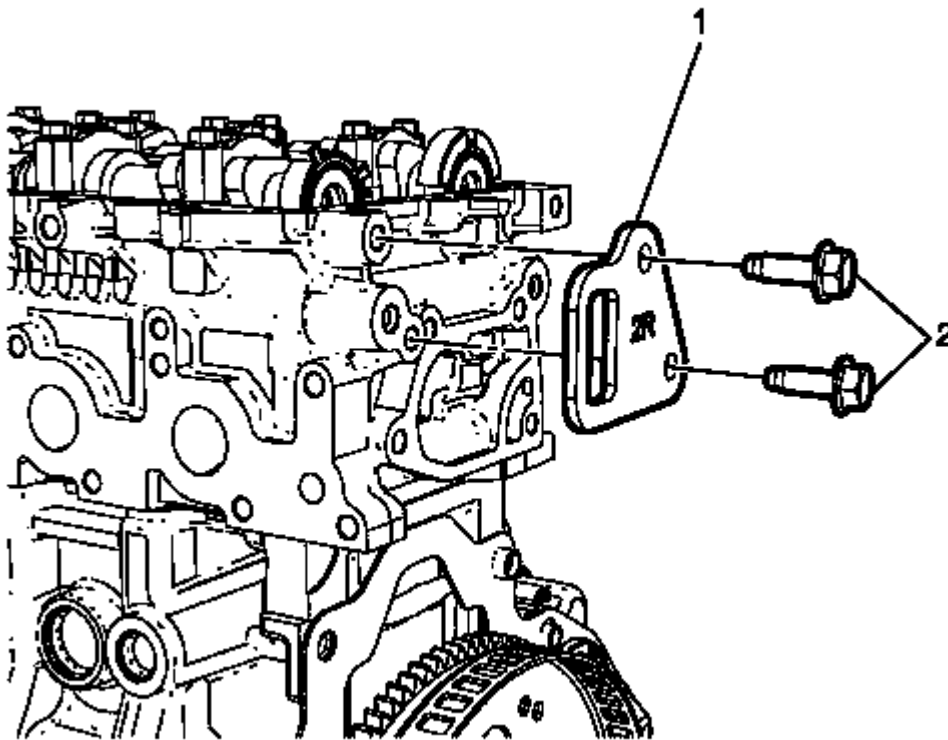


Fig. 300: Engine Lift Front Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine lift front bracket bolts (2) from the cylinder head.
2. Remove the engine lift front bracket (1).

ENGINE LIFT REAR BRACKET REMOVAL

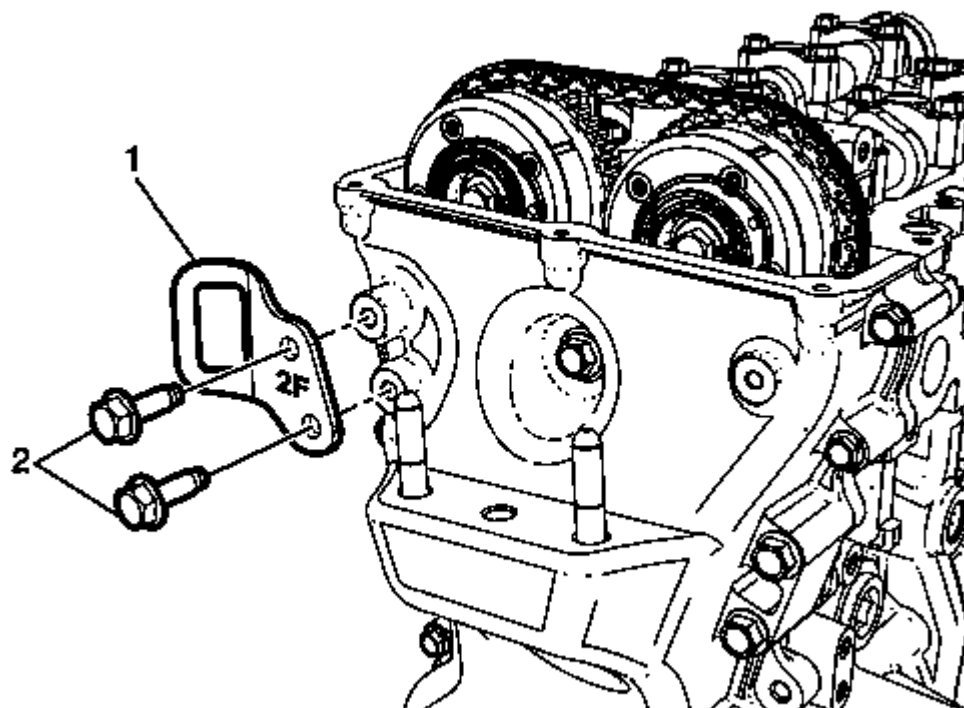


Fig. 301: Engine Lift Rear Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine lift rear bracket bolts (2) from the timing chain cover.
2. Remove the engine lift rear bracket (1).

CAMSHAFT REMOVAL (LL0)

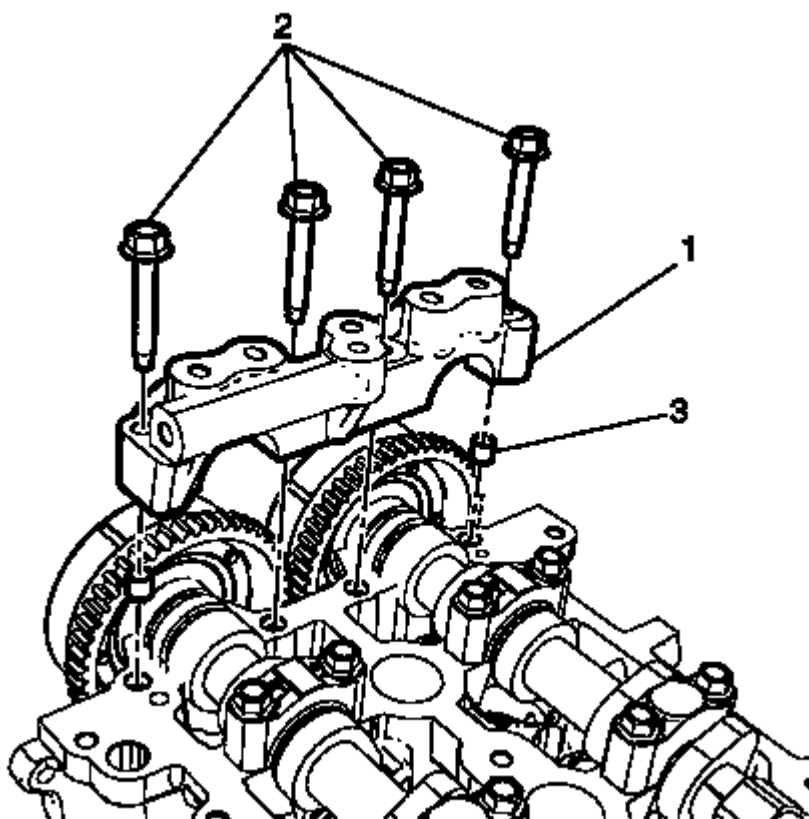


Fig. 302: First Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the first camshaft bearing cap bolts (2).
2. Remove the first camshaft bearing cap (1) and dowel pin (3).

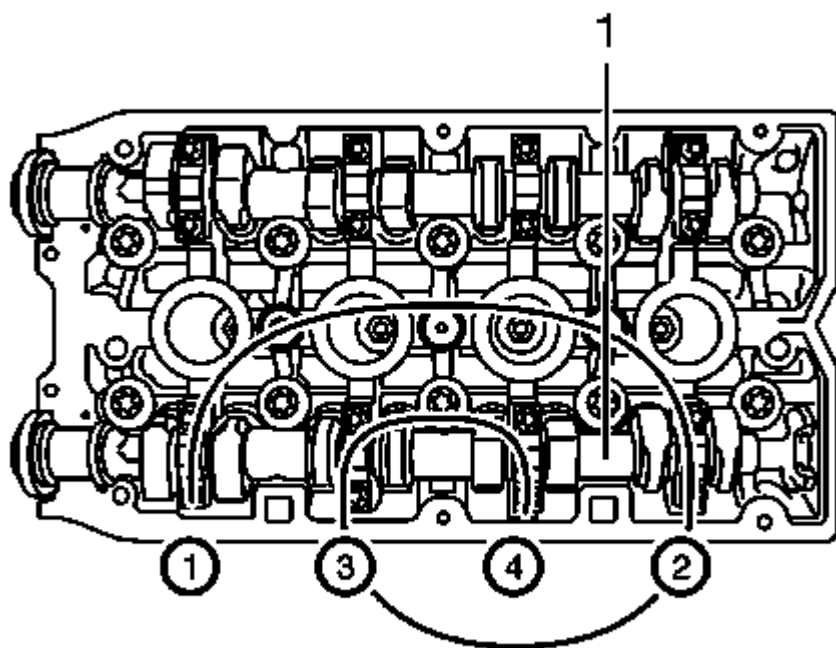


Fig. 303: Exhaust Camshaft Bearing Cap Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note removal sequence 1-4.

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.

NOTE: Mark camshaft bearing caps before removal.

4. Remove the 8 exhaust camshaft bearing cap bolts.
5. Remove the 4 exhaust camshaft bearing caps numbers 6-9 from the cylinder head.
6. Remove the exhaust camshaft.

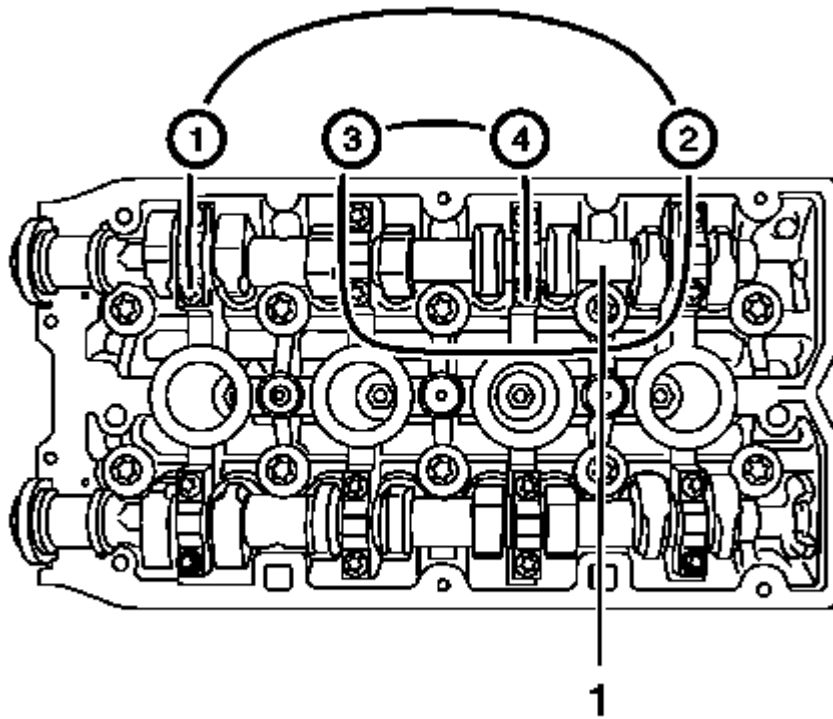


Fig. 304: Intake Camshaft Bearing Cap Bolts Loosening Sequence
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Note removal sequence 1-4.

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.

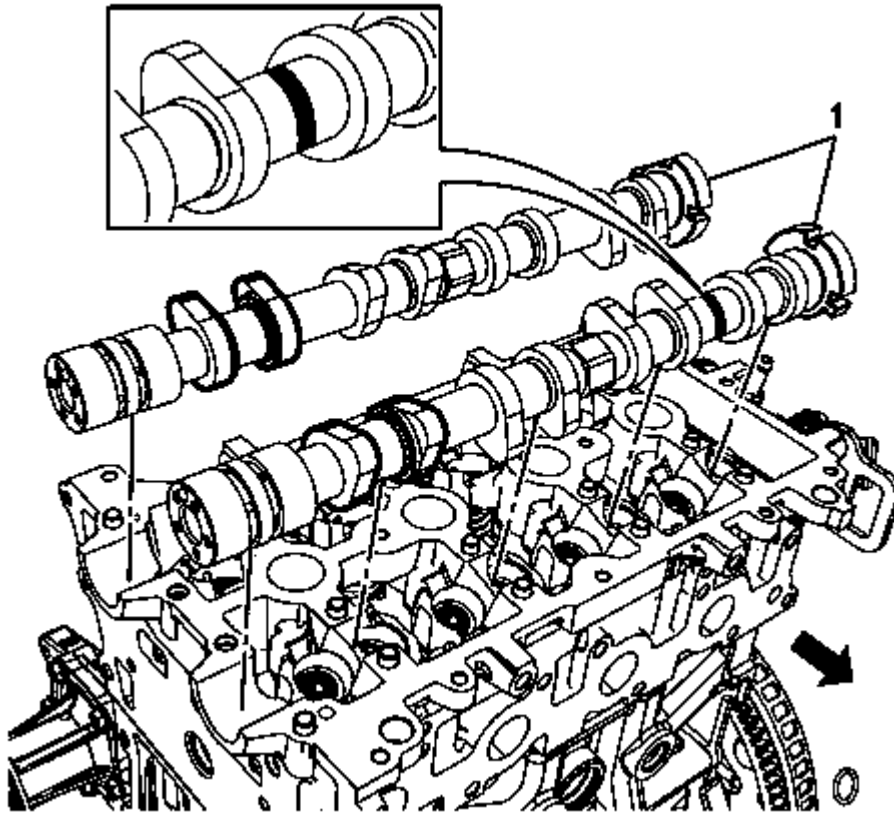


Fig. 305: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has a groove between the No. 3 journal and No. 4 journal. The intake camshaft has no groove.

10. Remove the intake camshaft and the exhaust camshaft (1).

CAMSHAFT REMOVAL (LFM)

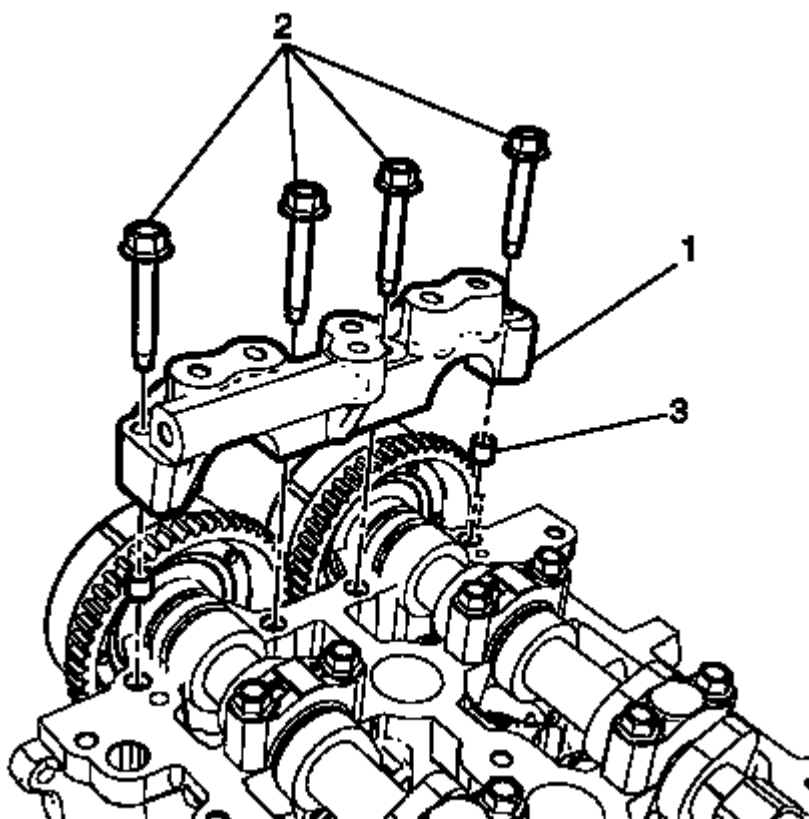


Fig. 306: First Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the first camshaft bearing cap bolts (2).
2. Remove the first camshaft bearing cap (1) and dowel pin (3).

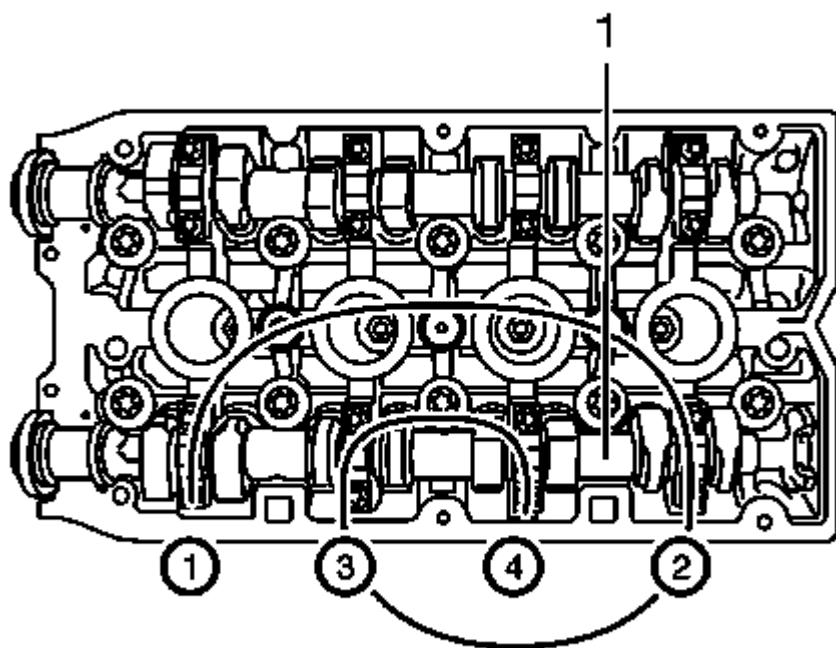


Fig. 307: Exhaust Camshaft Bearing Cap Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note removal sequence 1-4.

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.

NOTE: Mark camshaft bearing caps before removal.

4. Remove the 8 exhaust camshaft bearing cap bolts.
5. Remove the 4 exhaust camshaft bearing caps numbers 6-9 from the cylinder head.
6. Remove the exhaust camshaft.

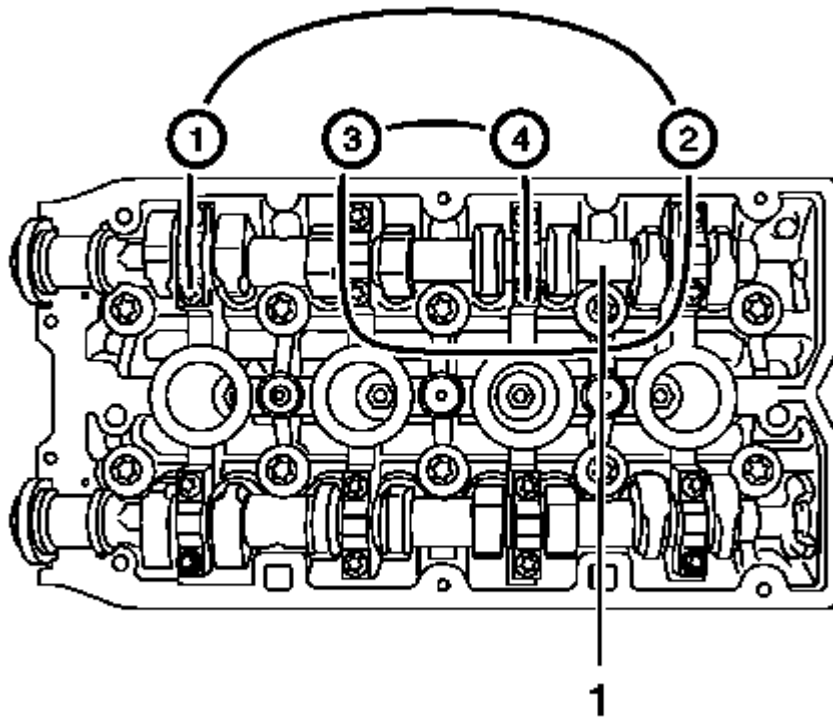


Fig. 308: Intake Camshaft Bearing Cap Bolts Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note removal sequence 1-4.

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.

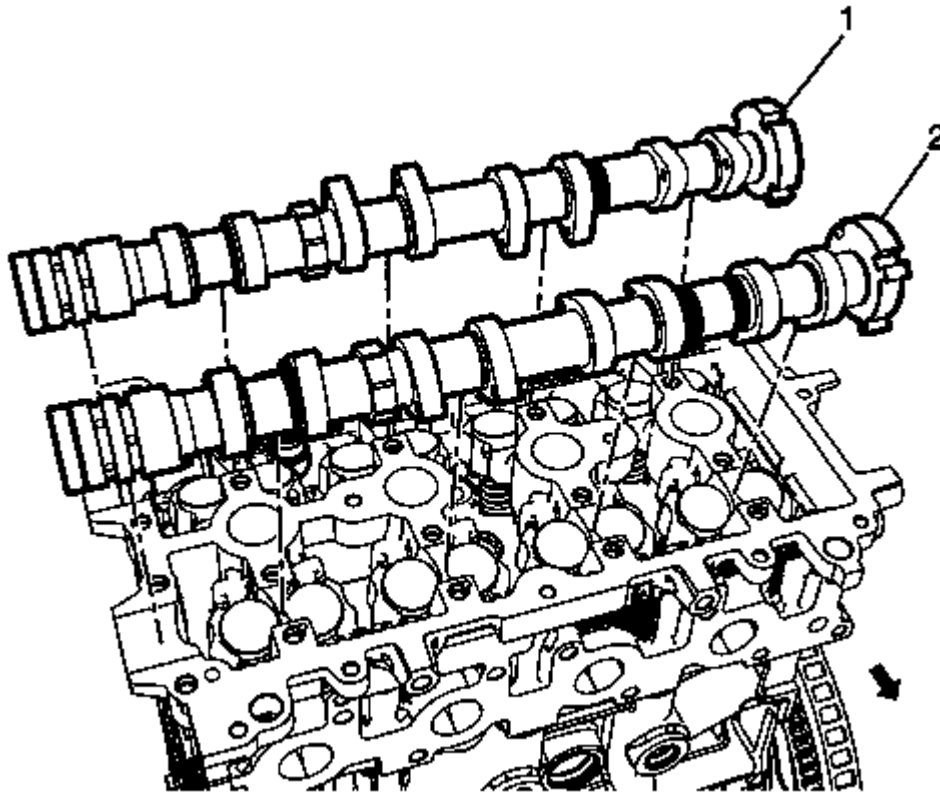


Fig. 309: Intake Camshaft

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has 2 grooves between the No. 3 journal and No. 4 journal. The intake camshaft has 1 groove.

10. Remove the intake camshaft (1) and the exhaust camshaft (2).

CYLINDER HEAD AND GASKET REMOVAL

Special Tools

GE-42072 Cylinder Head Bolt Remover/Installer

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

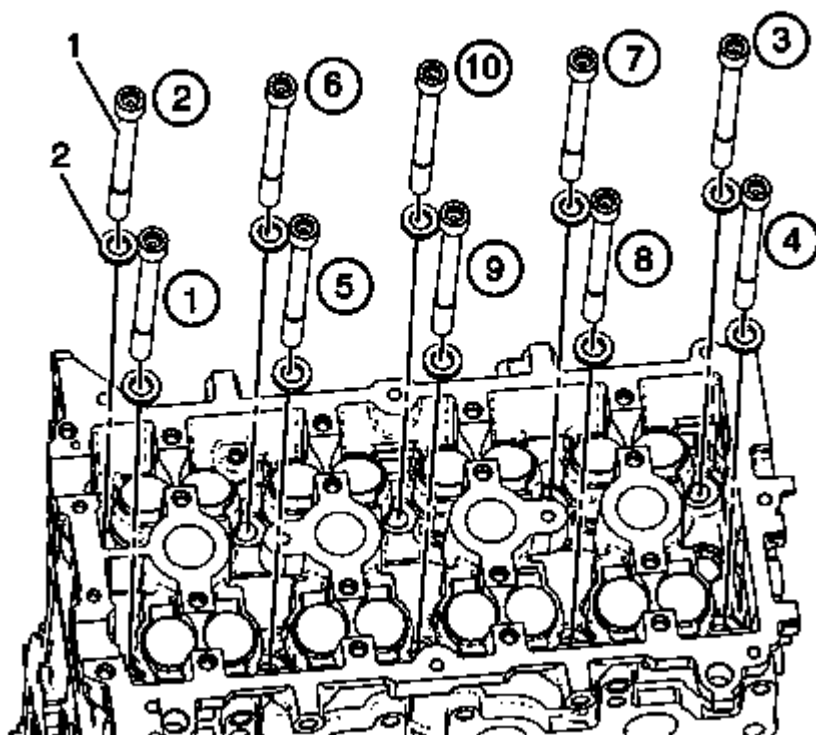


Fig. 310: Identifying Cylinder Head Bolts With GE-42072 Cylinder Head Bolt Remover/Installer In Sequence

Courtesy of GENERAL MOTORS COMPANY

NOTE: The cylinder head bolts require a 10 mm 12 point triple square tool for proper servicing. Use GE-42072 Cylinder Head Bolt Remover/Installer or equivalent when servicing head bolts.

1. Remove the 10 cylinder head bolts with the **GE-42072** cylinder head bolt remover/installer (1) 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.

OIL PUMP DISASSEMBLE

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

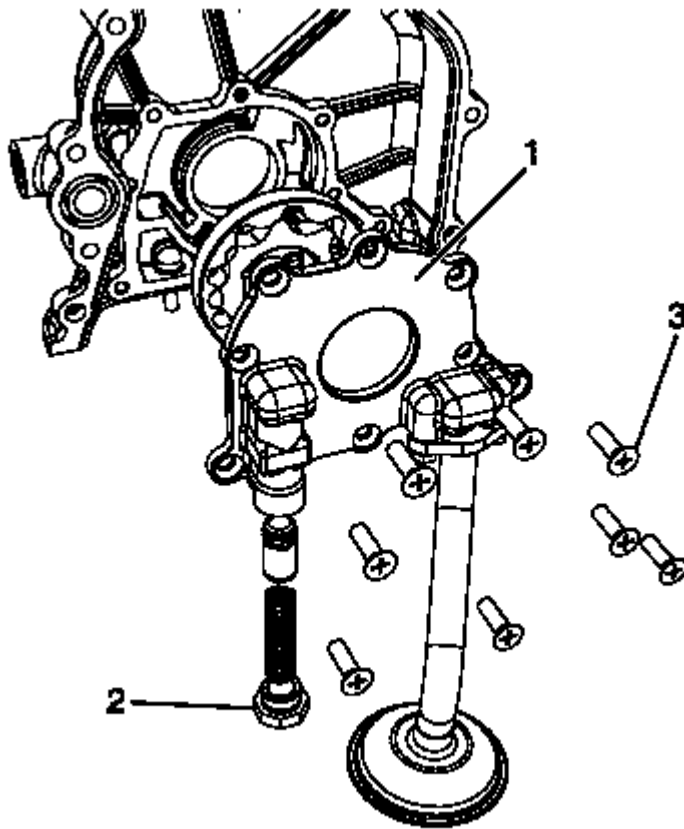


Fig. 311: Oil Pump Screws

Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump housing retaining bolts (3).
2. Remove the oil pump housing (1).
3. Remove the inner oil pump drive gear.
4. Remove the outer oil pump driven gear.
5. Remove the plug (2), holding the plug, for the oil relief valve components.
6. Remove the plug, spring and plunger from the oil pump housing (1).

OIL PUMP ASSEMBLE

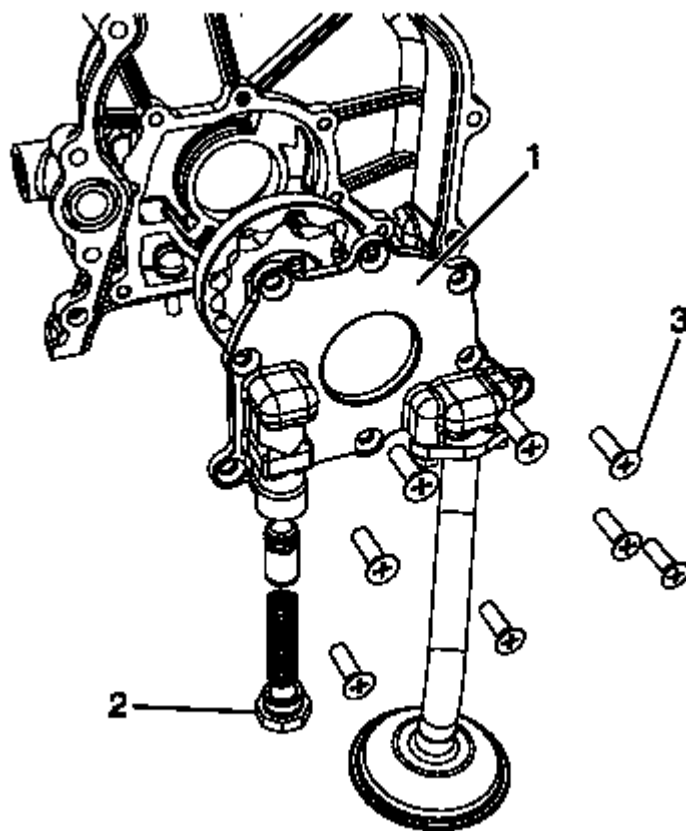


Fig. 312: Oil Pump Screws

Courtesy of GENERAL MOTORS COMPANY

1. Install the oil relief components to oil pump housing (1).
2. Install the plug (2).

NOTE: The dimpled surface must be face-up in the pump body.

3. Install the inner oil pump drive gear and the outer oil pump driven gear in the engine front cover in the same orientation as removed.
4. Install the oil pump housing (1) to the engine front cover.

CAUTION: Refer to Fastener Caution .

5. Install the oil pump housing retaining bolts (3) and tighten to 10 (89 lb in).

OIL PAN REMOVAL

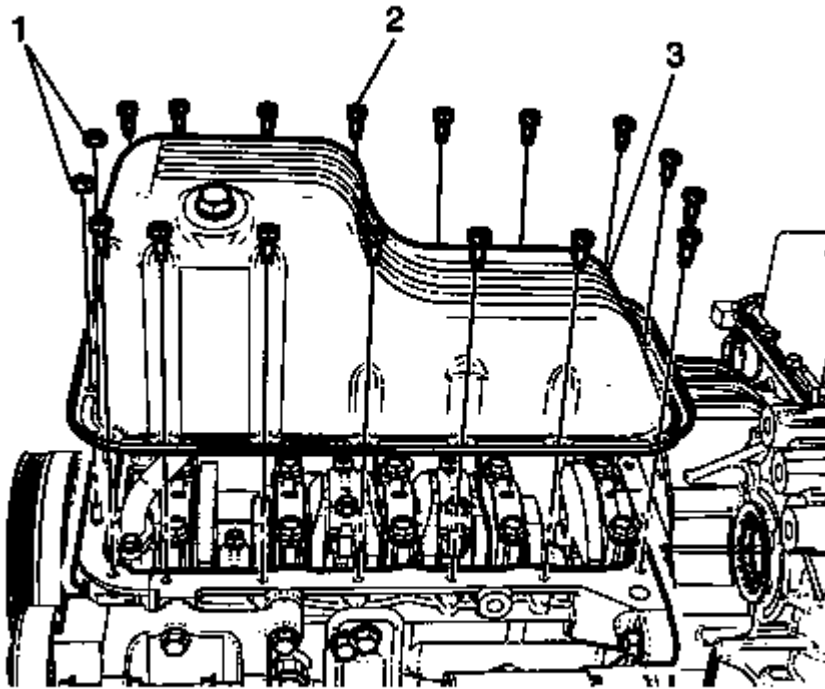


Fig. 313: Oil Pan Bolts And Nuts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 16 oil pan bolts (2) and 2 nuts (1) from the engine block.
2. Use a suitable tool to remove the oil pan (3) evenly all the way around.
3. Discard the oil pan.

PISTON, CONNECTING ROD AND BEARING REMOVAL

1. Install the crankshaft balancer bolt.
2. Set the pistons 1 and 4 to BDC in direction of engine rotation.

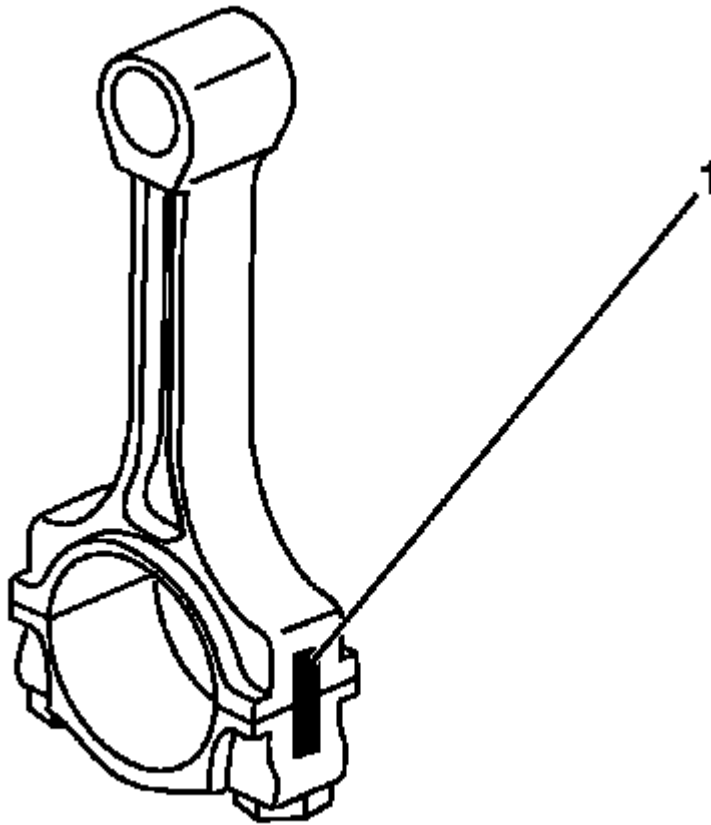


Fig. 314: View Of Con-Rod Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

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

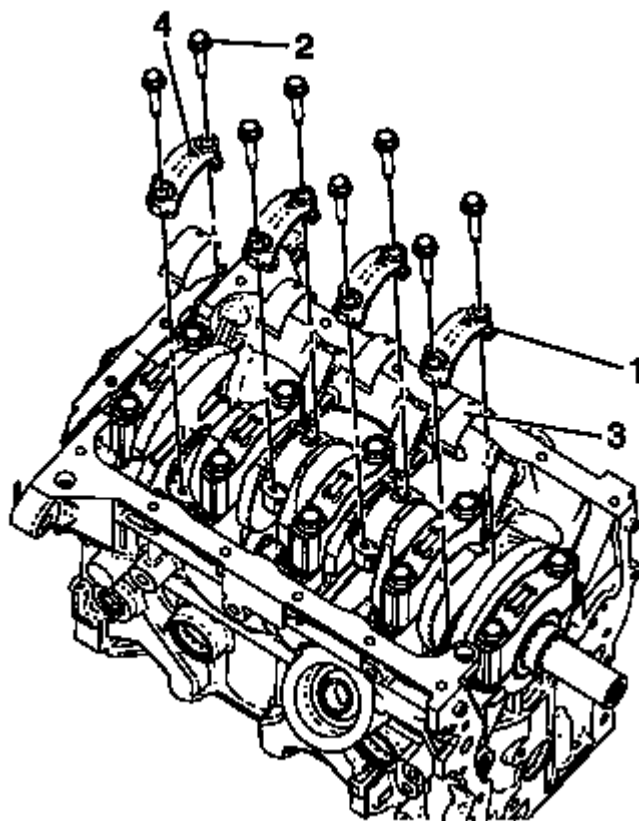


Fig. 315: Rod Bearing Caps Nuts

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).

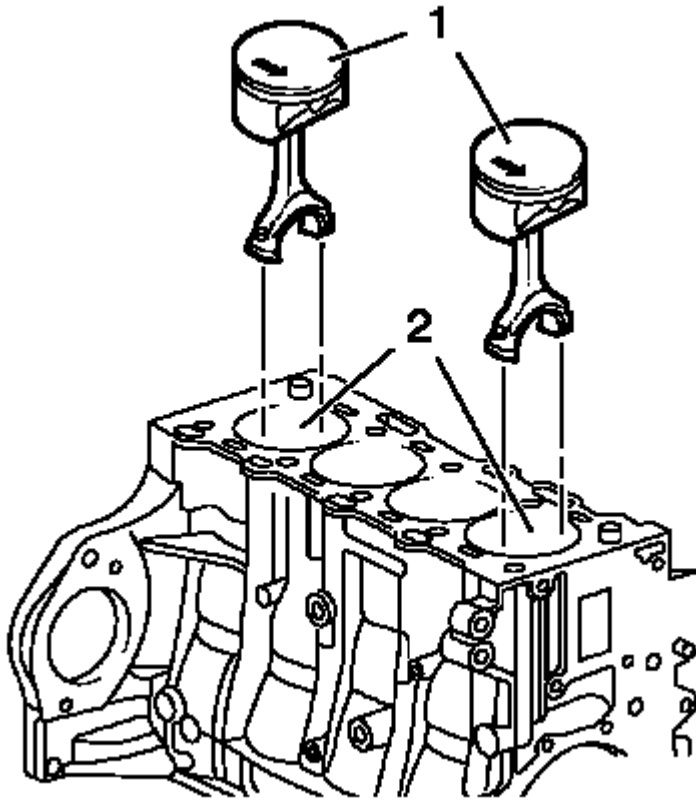


Fig. 316: Pistons 1, 4 And Cylinder Bore
 Courtesy of GENERAL MOTORS COMPANY

6. Push the pistons 1 and 4 (1) out of the cylinder bore (2).
7. Remove the pistons 1 and 4 (1).
8. Turn crankshaft on crankshaft balancer through 180 degrees in direction of rotation of engine.
9. Repeat for the piston 2 and 3.

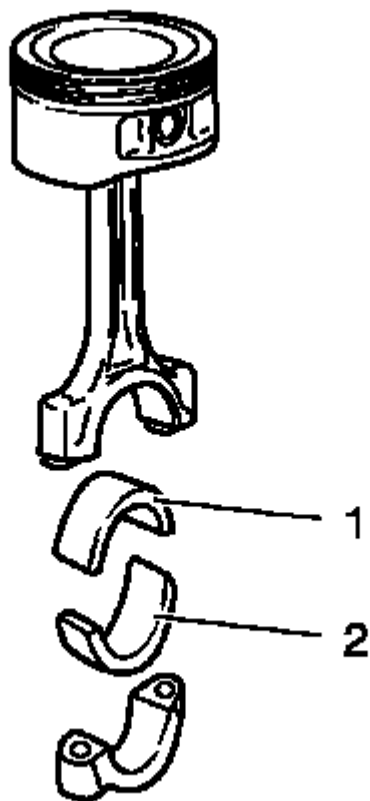


Fig. 317: Connecting Rod Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Observe correct fitting position, observe alignment.**

10. Remove the connecting rod bearing (1, 2).

CRANKSHAFT FRONT OIL SEAL REMOVAL

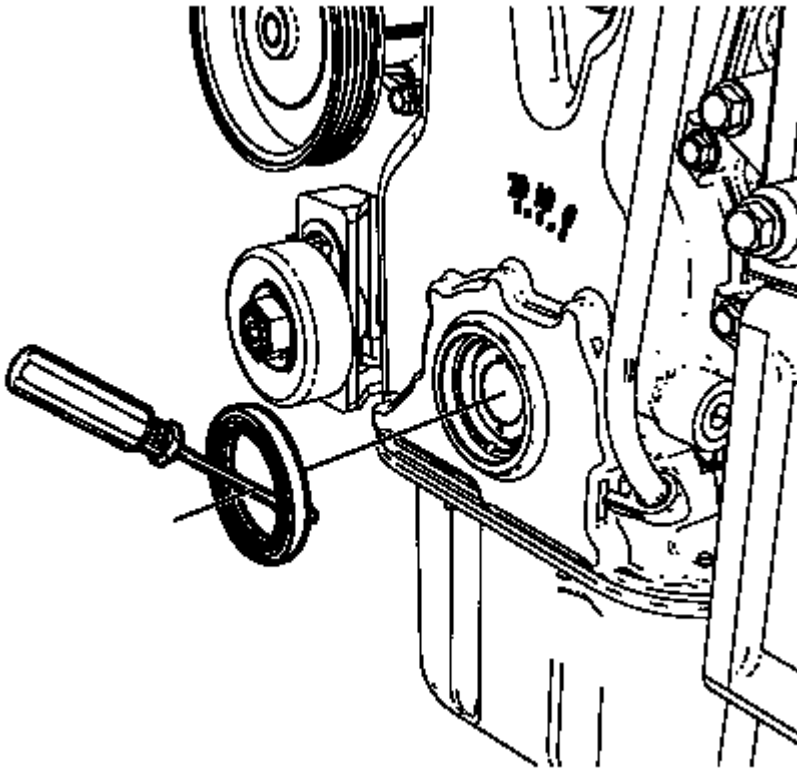


Fig. 318: Using Flat-Bladed Tool To Remove Seal From Front Cover
Courtesy of GENERAL MOTORS COMPANY

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 suitable tool, remove the crankshaft front oil seal from the crankshaft.

CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL

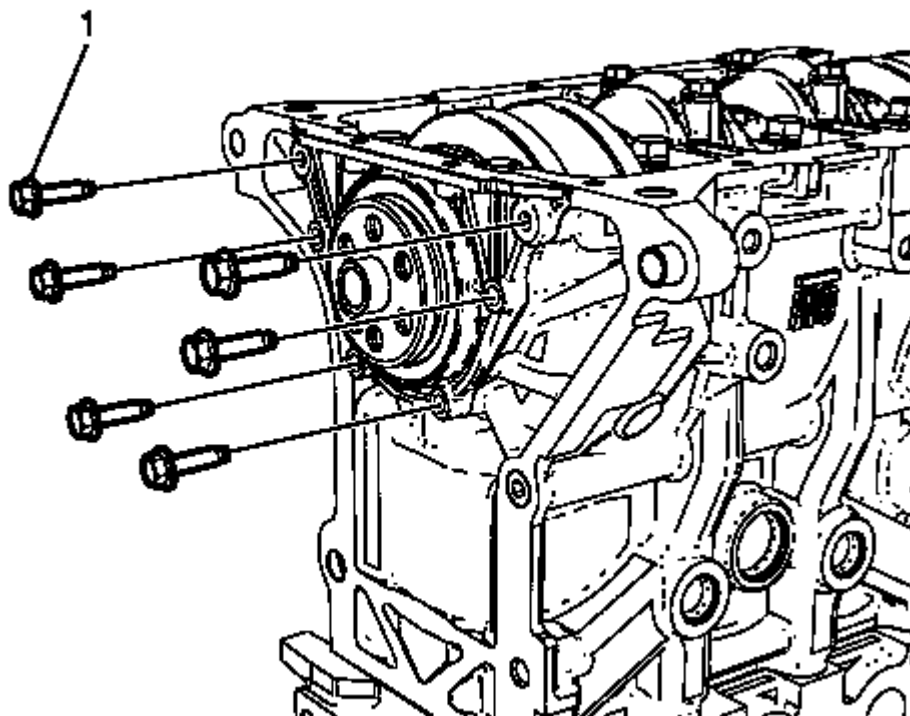


Fig. 319: Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

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

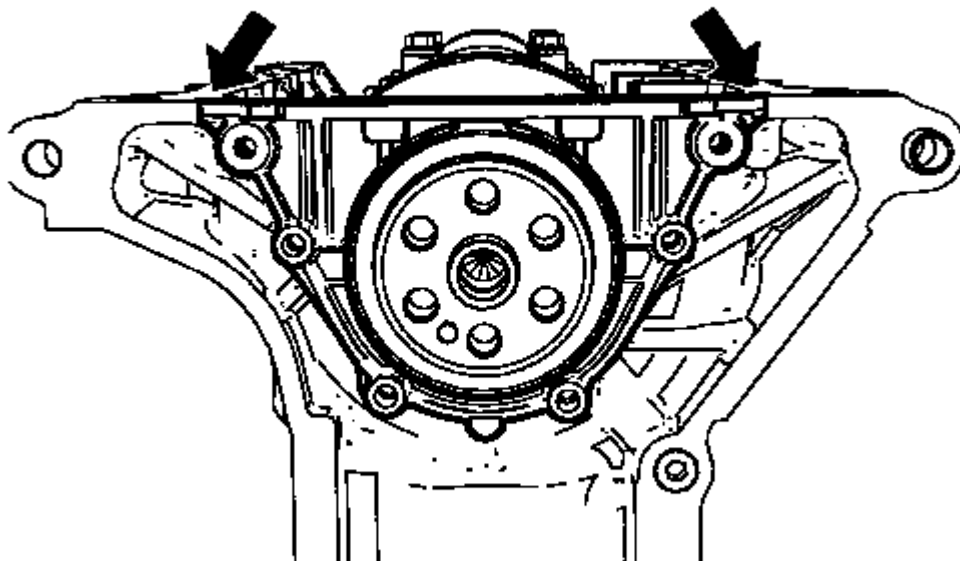


Fig. 320: Edge Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

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

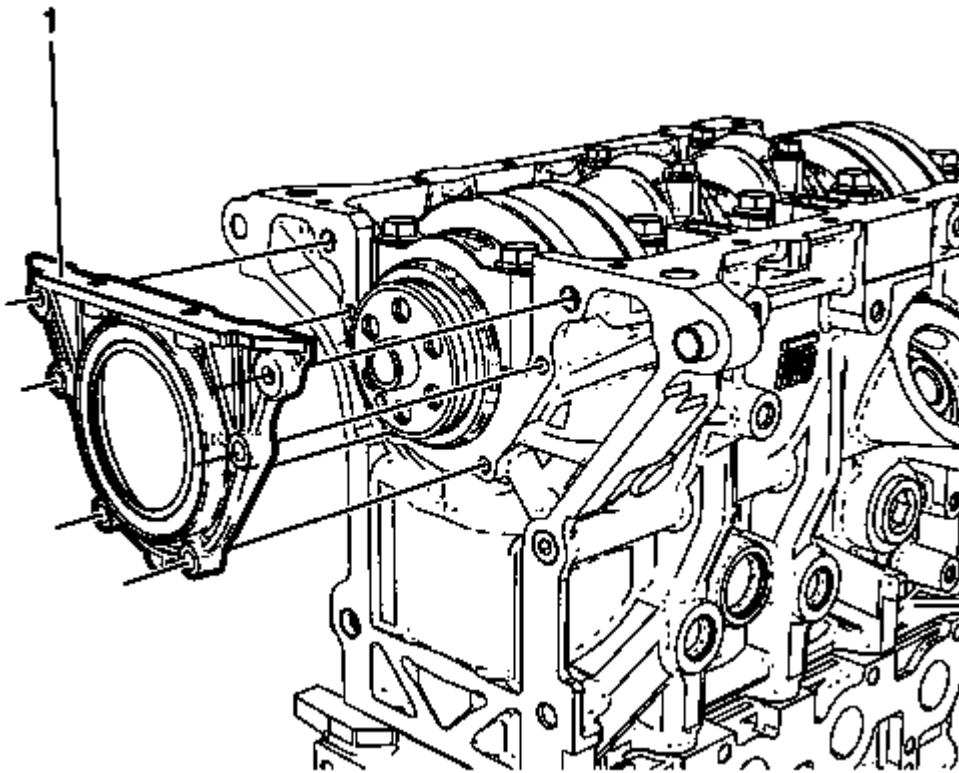


Fig. 321: Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the crankshaft rear oil seal and housing (1).

CRANKSHAFT AND BEARING REMOVAL

NOTE: Take extreme care to prevent any scratches, nicks or damage to the inner side of the cylinder and bearings.

NOTE: Check and confirm the sequence of the crankshaft caps and bearings.

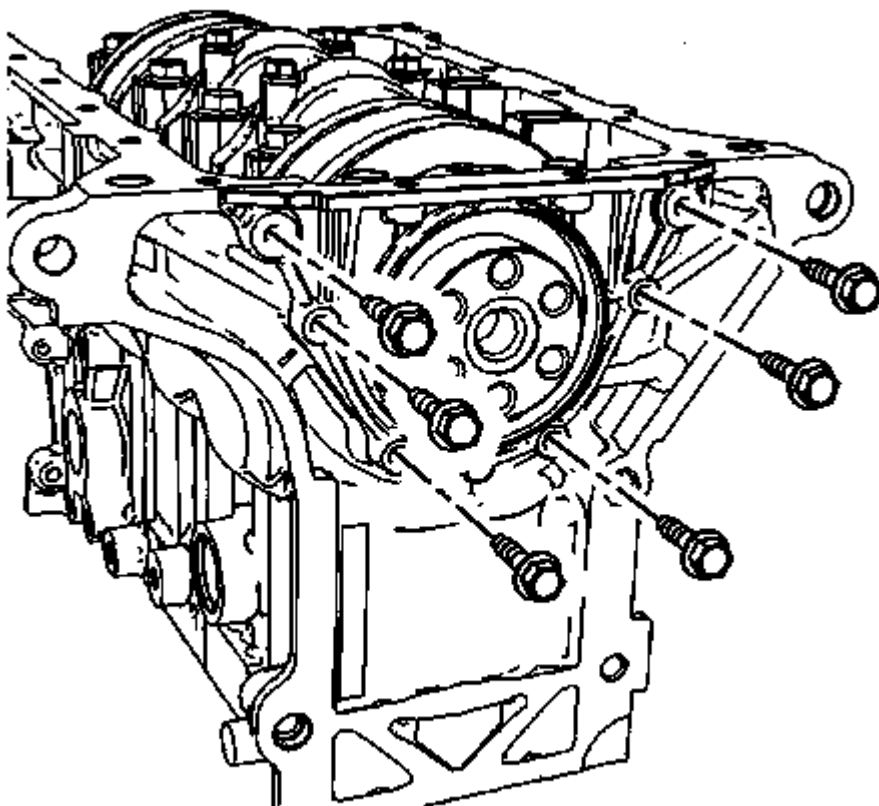


Fig. 322: Crankshaft Rear Oil Seal With Housing
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft rear oil seal with housing.

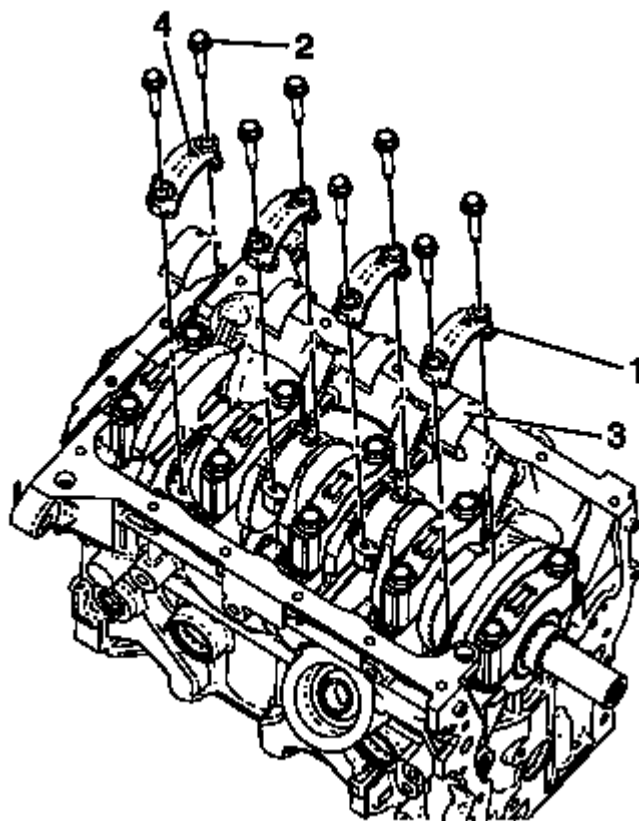


Fig. 323: Rod Bearing Caps Nuts

Courtesy of GENERAL MOTORS COMPANY

2. Remove the connecting rod bearing cap bolts (2).
3. Remove the connecting rod bearing caps (1) and bearing (3).

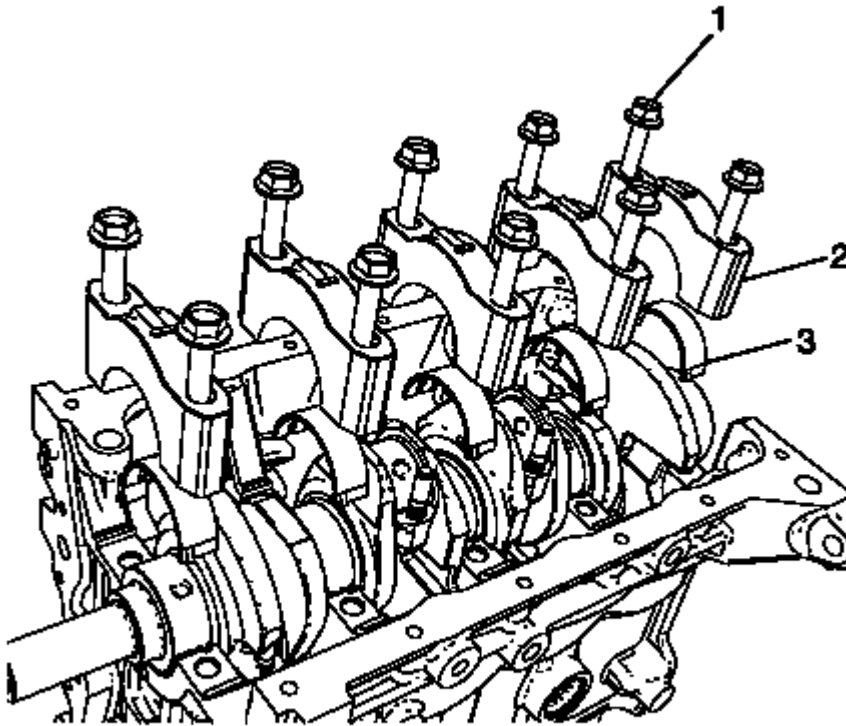


Fig. 324: Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

4. Identify the crankshaft bearing caps.
5. Remove the 10 bolts (1).
6. Remove the crankshaft bearing caps (2).
7. Remove the crankshaft bearing cap bearing (3).
8. Remove the crankshaft.

ENGINE BLOCK DISASSEMBLE (LL0)

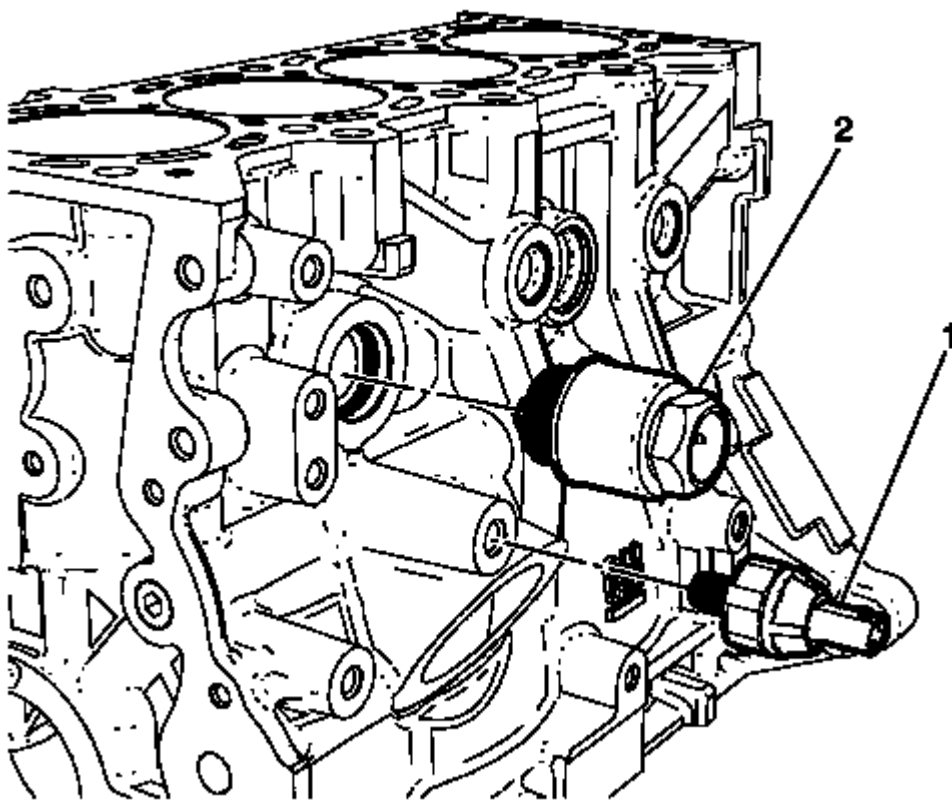


Fig. 325: Oil Pressure Switch And Block Heater
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pressure switch (1) and block heater (2).

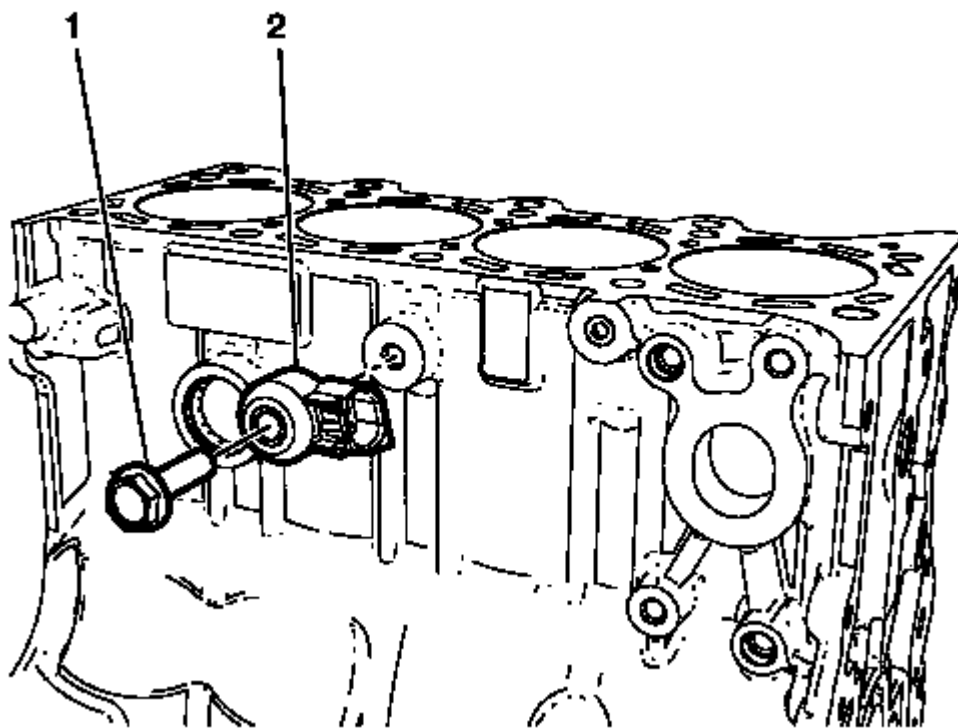


Fig. 326: Knock Sensor Bolt And Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

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

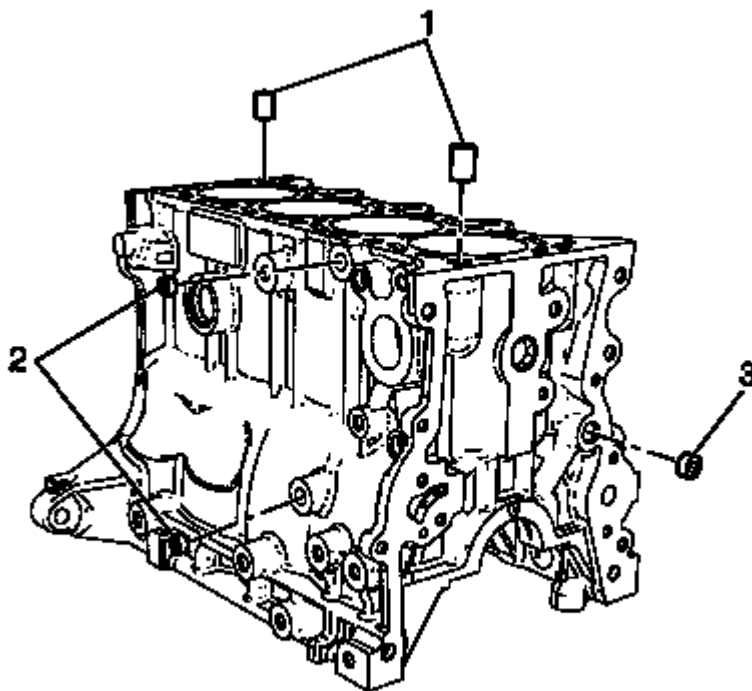


Fig. 327: Cylinder Head Locating

Courtesy of GENERAL MOTORS COMPANY

4. Remove the cylinder head locating (1).
5. Remove the engine block oil gallery plugs (2, 3).

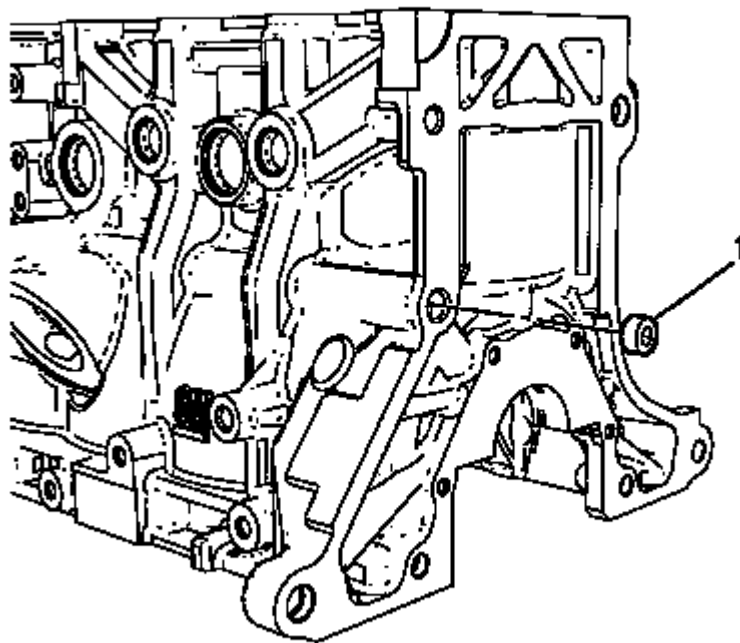


Fig. 328: Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine block oil gallery plug (1).

ENGINE BLOCK DISASSEMBLE (LFM)

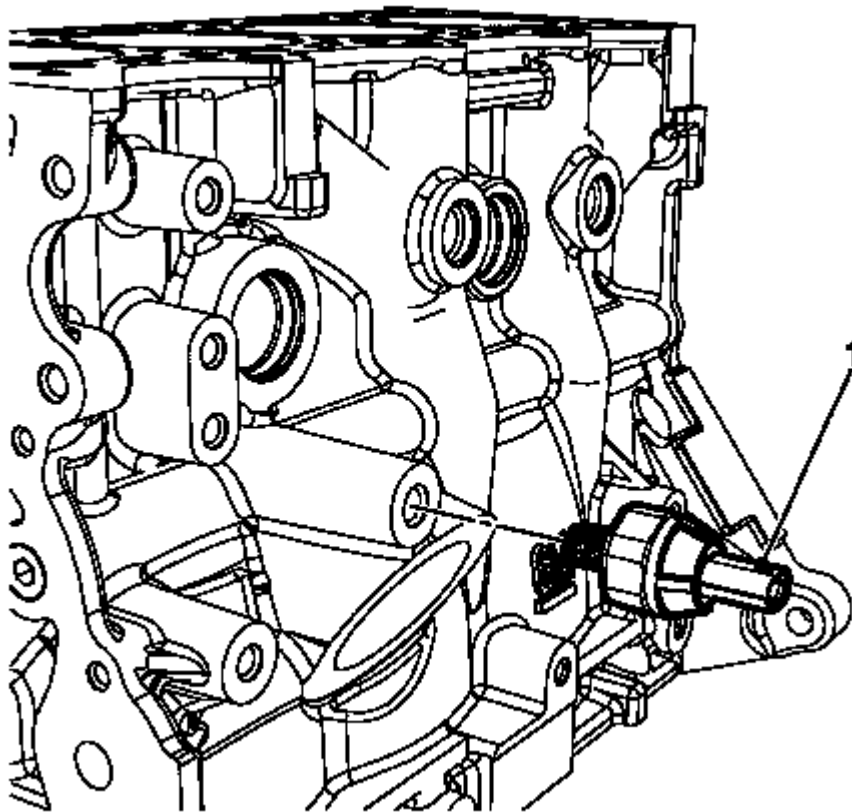


Fig. 329: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pressure switch (1).

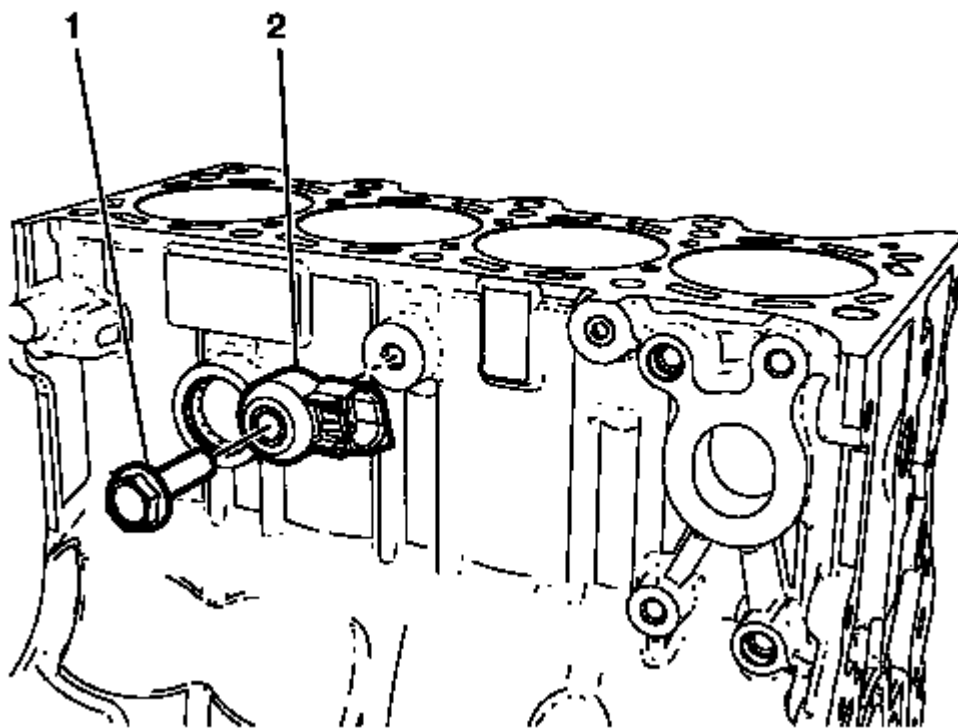


Fig. 330: Knock Sensor Bolt And Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

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

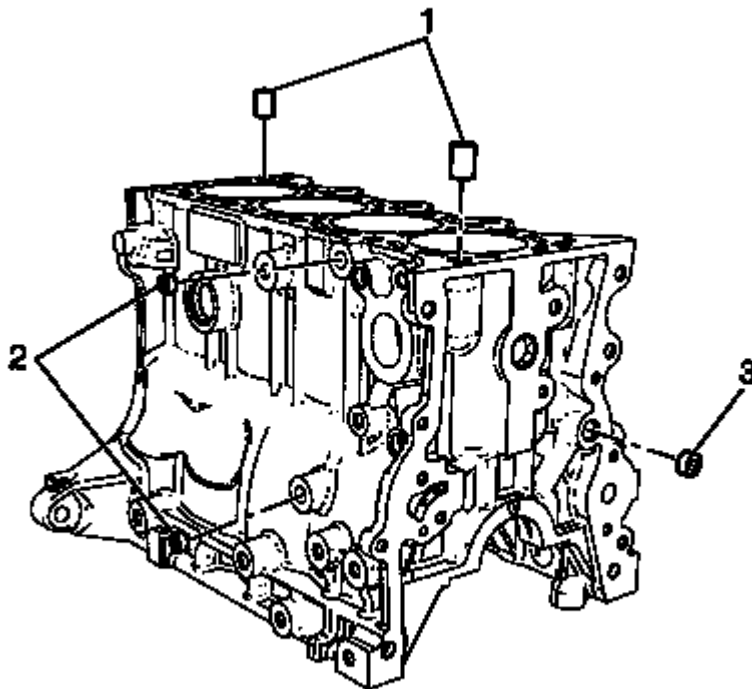


Fig. 331: Cylinder Head Locating

Courtesy of GENERAL MOTORS COMPANY

4. Remove the cylinder head locating (1).
5. Remove the engine block oil gallery plugs (2, 3).

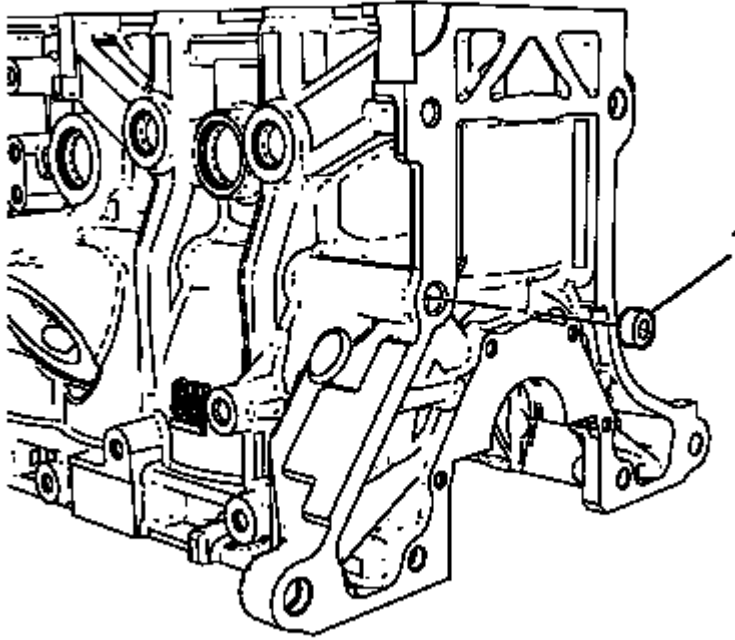


Fig. 332: Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine block oil gallery plug (1).

PISTON, CONNECTING ROD AND BEARING CLEANING AND INSPECTION (LL0)

Cleaning Procedure

NOTE: **DO NOT use a wire brush any part of the piston.**

1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the piston with compressed air.

Piston Inspection Procedure

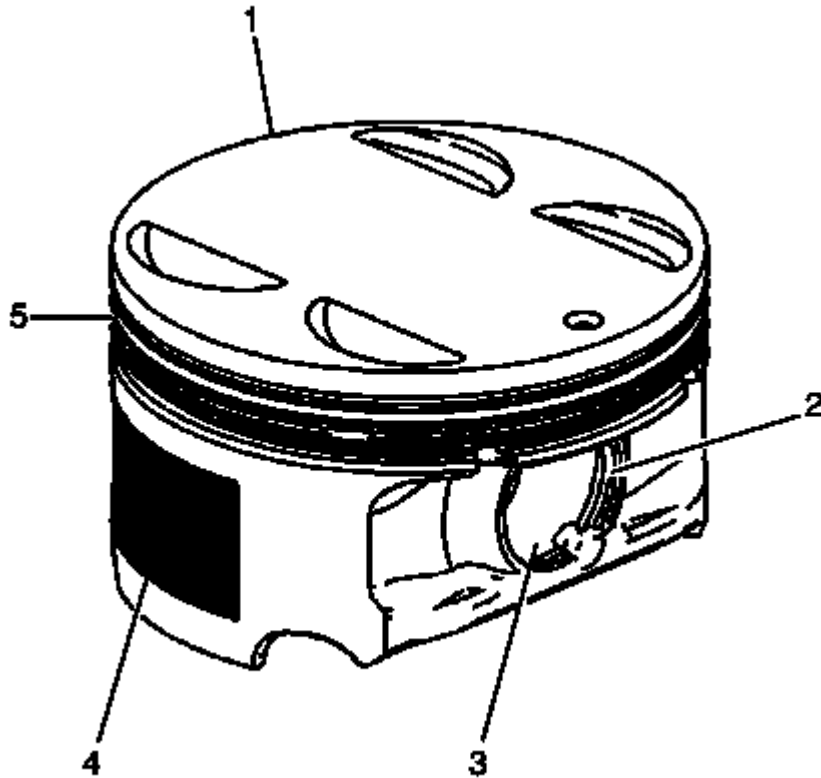


Fig. 333: Identifying Piston

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the pistons for the following conditions:
 - Ring grooves for nicks, burrs that may cause binding (5)
 - Warped or worn ring lands (5)
 - Piston pin retainer grooves for burrs (2)
 - Eroded areas at the top of the piston (1)
 - Scuffed or damaged skirt coating (4)
 - Worn piston pin bores or worn piston pins (3)
2. Replace pistons that show any signs of damage or wear above acceptable tolerances.

Piston Measurement Procedure

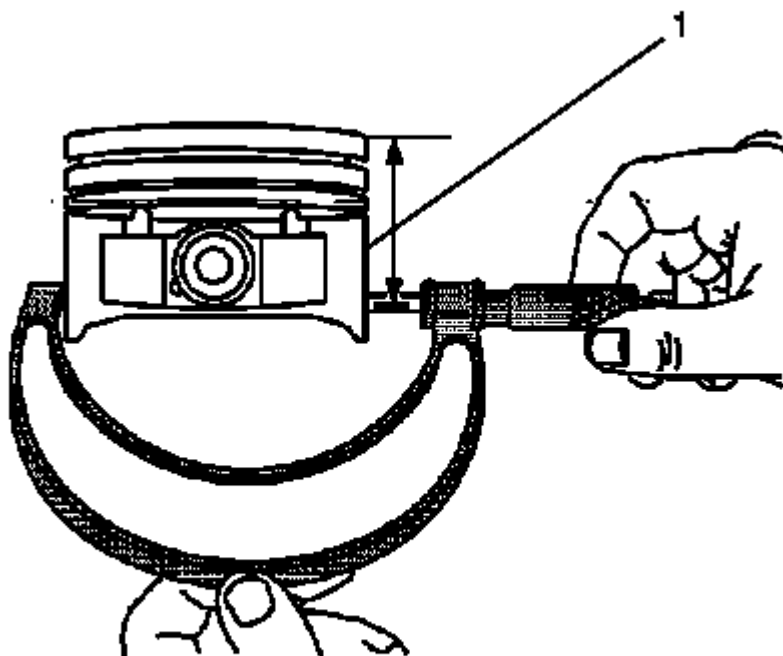


Fig. 334: View Of Piston Measurement

Courtesy of GENERAL MOTORS COMPANY

1. Measure piston width using the following procedure:
 1. Using an outside micrometer, measure the width of the piston at 8.5 mm (0.335 in) from the skirt bottom end (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
 2. Compare your results with the engine mechanical specifications. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.
 3. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

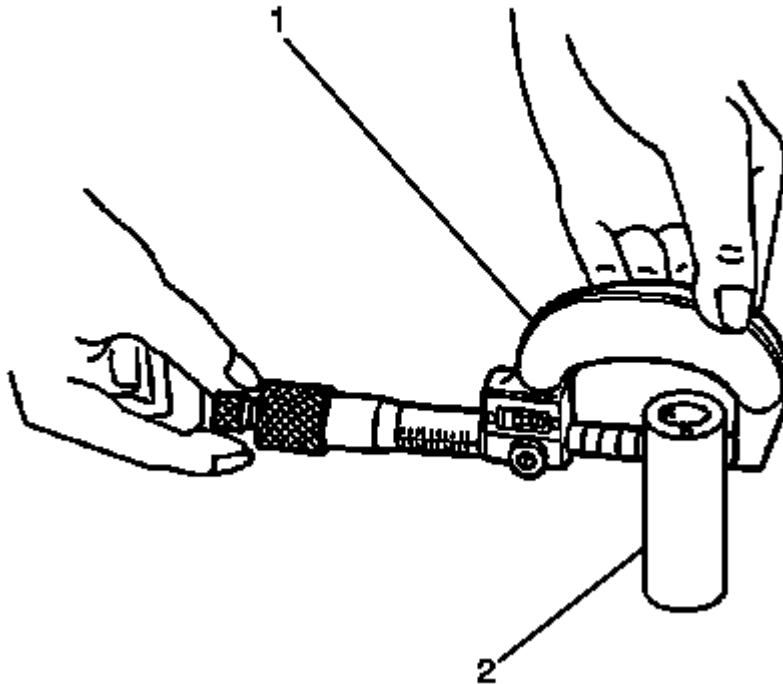
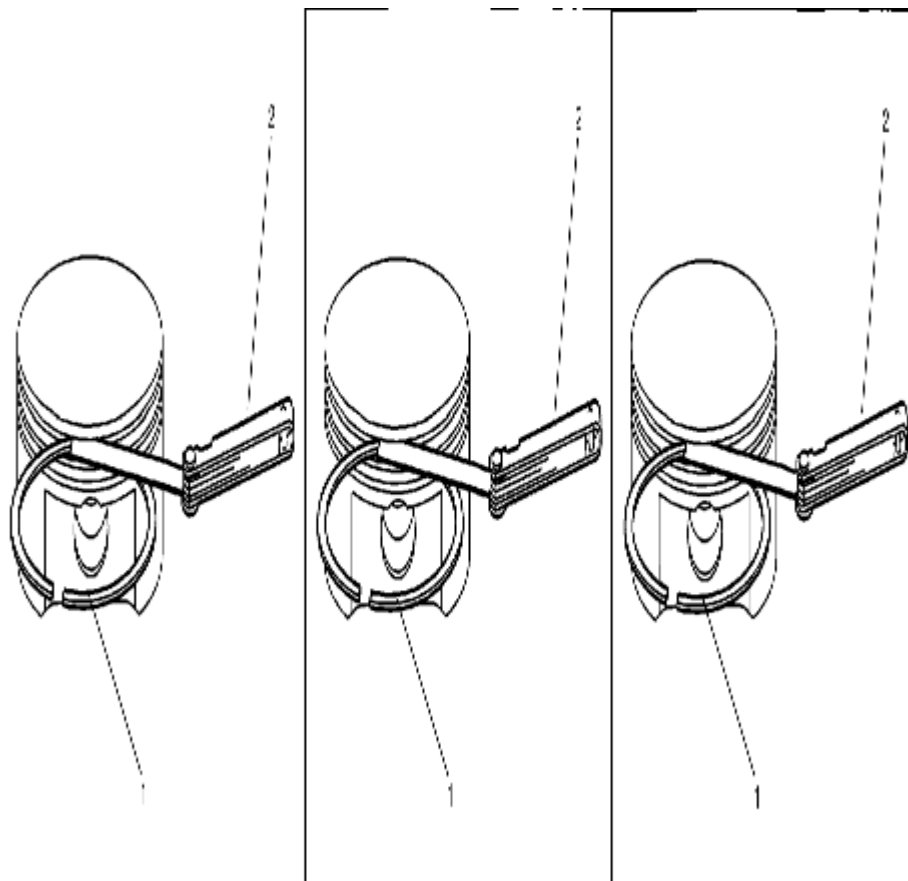


Fig. 335: Identifying Piston Pin Bore To Piston Pin Measurement From Outside Micrometer
 Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston pin bore to piston pin (2) clearances using the following procedure:
 1. Piston pin bores and pins must be free of varnish or scuffing.
 2. Use an outside micrometer (1) to measure the piston pin in the piston contact areas.

Piston Ring Measurement Procedure

**Fig. 336: Piston Ring**

Courtesy of GENERAL MOTORS COMPANY

1. Measure the piston ring (1) side clearance using the following procedure:
 1. Roll the piston ring (1) entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring (1), replace the piston ring (1).
 2. With the piston ring (1) on the piston, use feeler gauges (2) to check clearance at multiple locations.
 3. Compare the measurements with piston ring side clearance listed in the.
 4. If the clearance is greater than specifications, replace the piston ring (1).

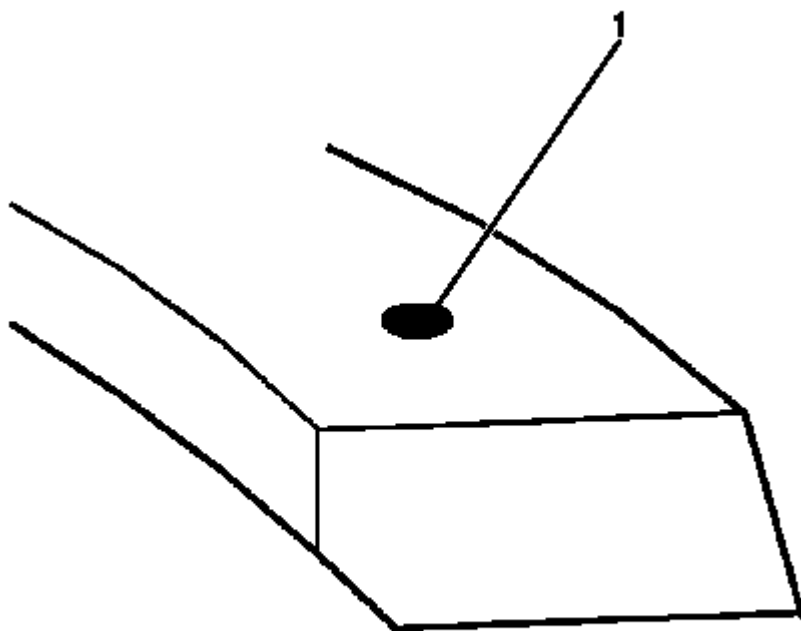


Fig. 337: Identifying Locating Dimple

Courtesy of GENERAL MOTORS COMPANY

2. There is a locating marking 'R' (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
3. If the new ring does not reduce the clearance to the correct specification, install a new piston.
4. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Connecting Rod Cleaning Procedure

1. Clean the connecting rods in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the connecting rod using compressed air.

Connecting Rod Visual Inspection Procedure

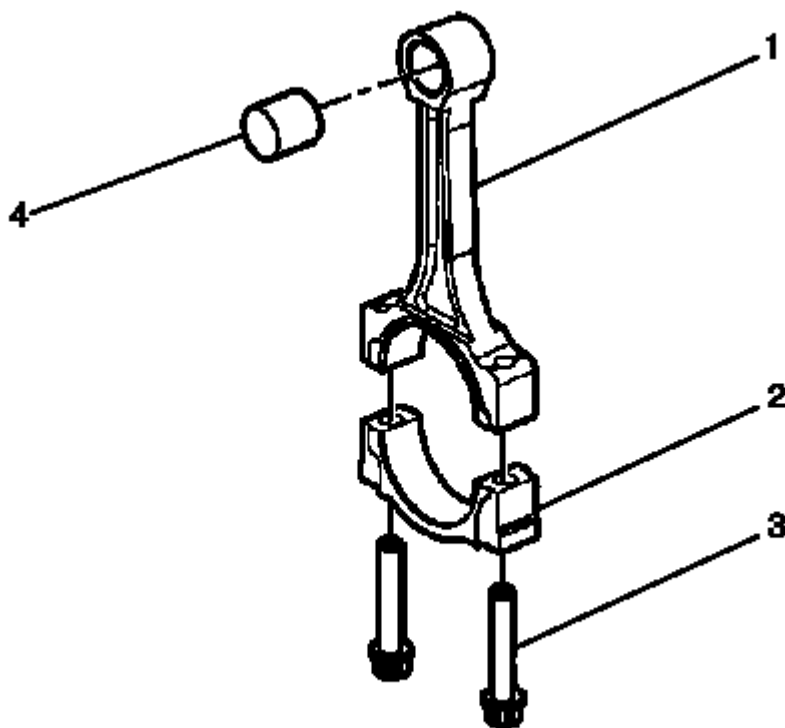


Fig. 338: Identifying Piston Pin Bushing, Connecting Rod Beam, Rod Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

NOTE: DO NOT scrape the rod or rod cap.

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.
6. Inspect the connecting rod bolts (3) for damage or stretching.

Connecting Rod Measurement Procedure

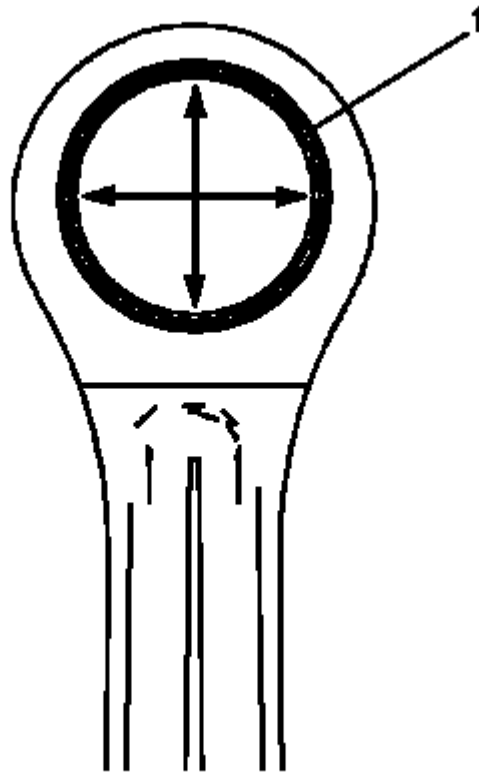


Fig. 339: Identifying Connecting Rod Piston Pin Bore
Courtesy of GENERAL MOTORS COMPANY

1. Using an inside micrometer, measure the connecting rod piston pin bore (1).
2. Subtract the piston pin diameter from the piston pin bore (1).
3. Compare the clearance measurements with the.
4. If the clearance is above acceptable tolerances, replace the piston pin. If a new pin does not resolve the clearance condition, replace the connecting rod.

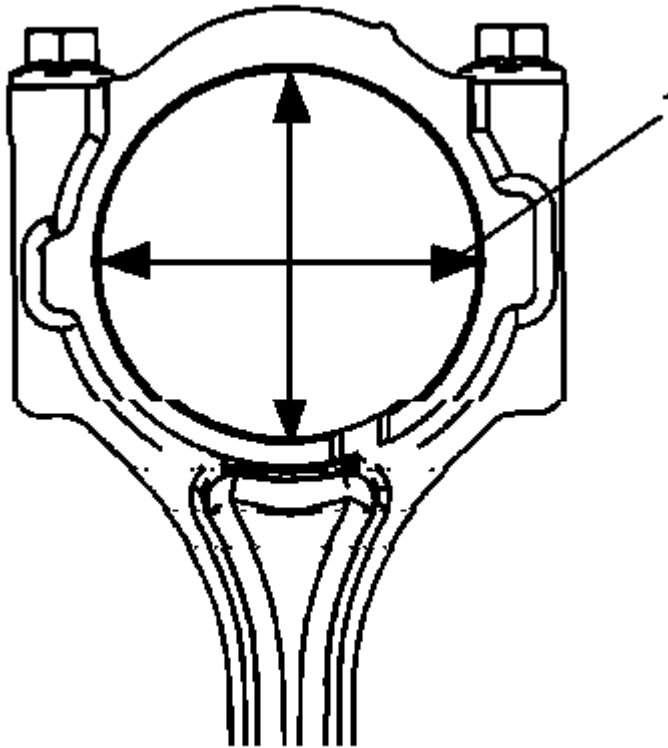


Fig. 340: Identifying Connecting Rod Crankshaft Bearing Bore Measurement From Inside Micrometer

Courtesy of GENERAL MOTORS COMPANY

5. Using an inside micrometer, measure the connecting rod crankshaft bearing bore (1).
6. Compare the bore measurements with the.
7. Replace the connecting rod if the connecting rod crankshaft bearing bore (1) is out of specifications. DO NOT recondition the connecting rod.

Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

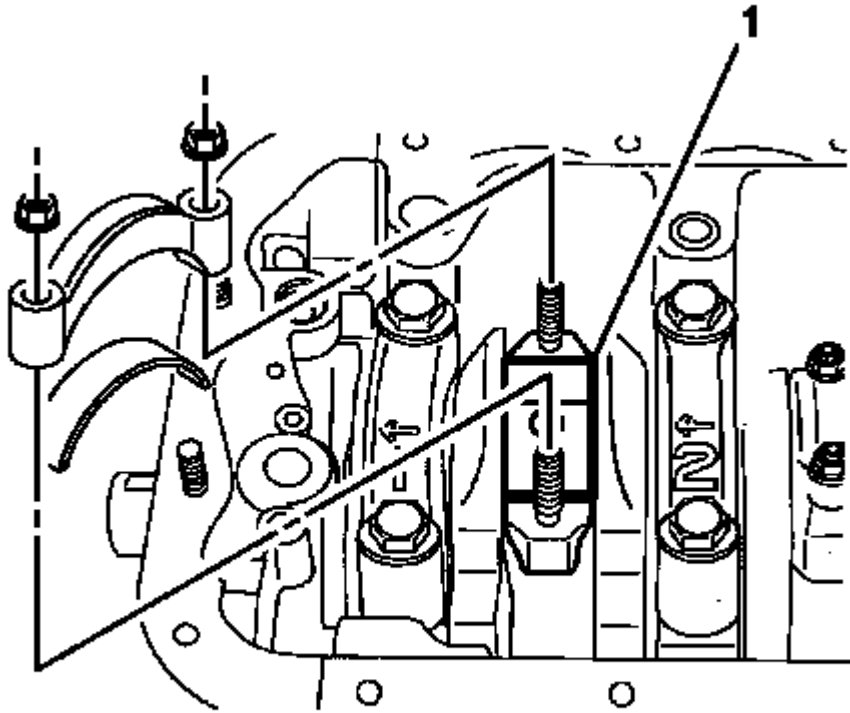


Fig. 341: Plastic Gauge

Courtesy of GENERAL MOTORS COMPANY

1. Cut the plastic gauge (1) the same length as the bearing width and put it on the crankshaft bearing. It should be parallel with the crankshaft.

CAUTION: Refer to Fastener Caution .

2. Install the connecting rod bearing and caps, tighten to $20 + 90^\circ$ (15 lb ft + 90°).
3. Remove the connecting rod cap and bearing.

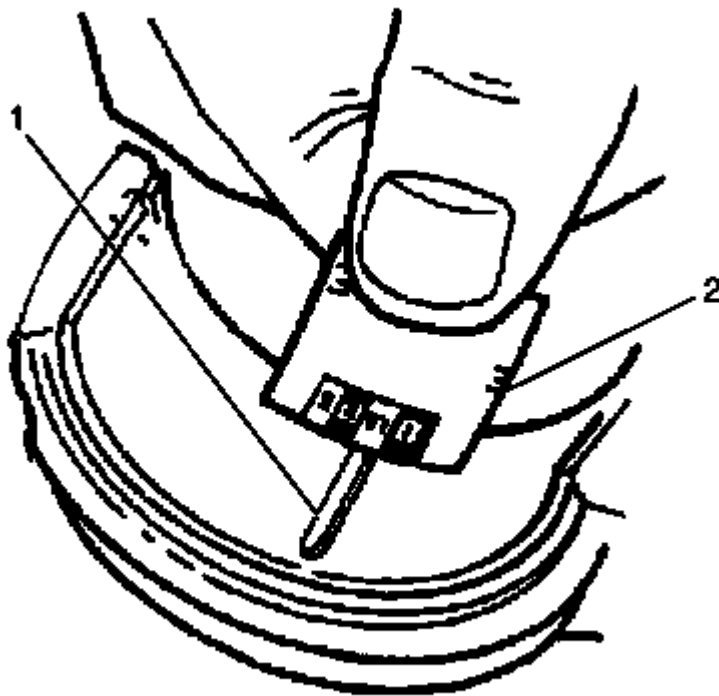


Fig. 342: View Of Crankshaft Bearing Clearance
Courtesy of GENERAL MOTORS COMPANY

4. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gauging material (1) at its widest point with the graduation on the gauging material container (2).
5. Compare your measurements with the engine mechanical specifications. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**. If the new bearings DO NOT provide the proper crankshaft to connecting rod bearing clearance, inspect the following: **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.
6. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

PISTON, CONNECTING ROD AND BEARING CLEANING AND INSPECTION (LFM)

Cleaning Procedure

NOTE: DO NOT use a wire brush any part of the piston.

1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

WARNING: Refer to **Safety Glasses and Compressed Air Warning** .

3. Dry the piston with compressed air.

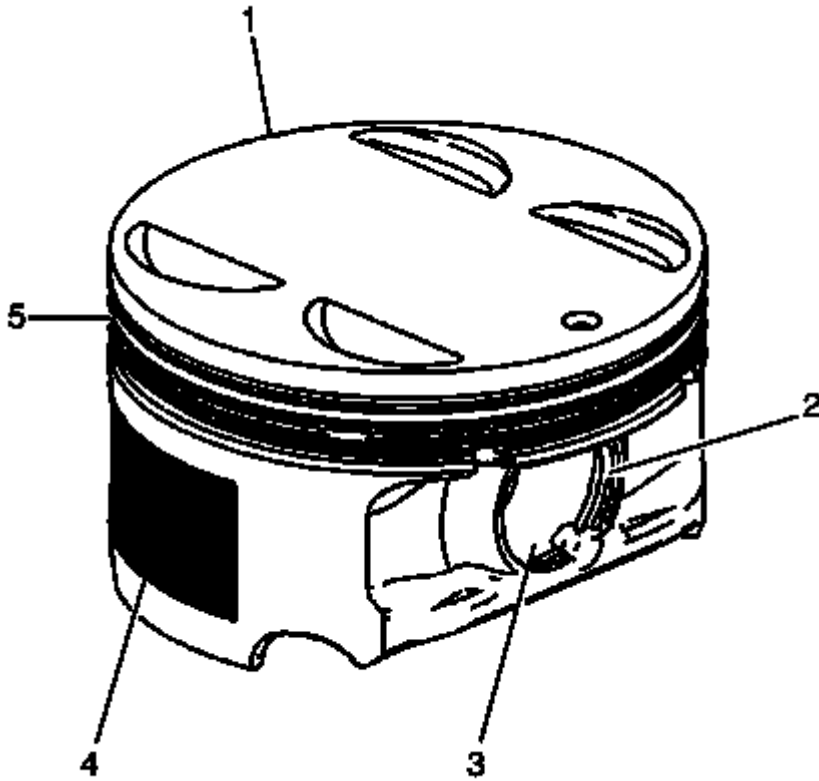
Piston Inspection Procedure

Fig. 343: Identifying Piston

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the pistons for the following conditions:
 - Ring grooves for nicks, burrs that may cause binding (5)
 - Warped or worn ring lands (5)
 - Piston pin retainer grooves for burrs (2)
 - Eroded areas at the top of the piston (1)
 - Scuffed or damaged skirt coating (4)
 - Worn piston pin bores or worn piston pins (3)
2. Replace pistons that show any signs of damage or wear above acceptable tolerances.

Piston Measurement Procedure

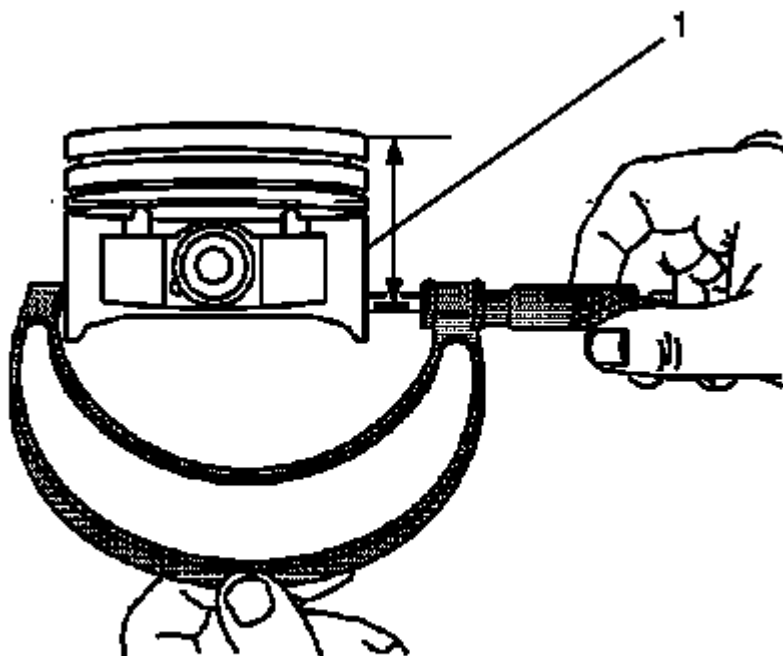


Fig. 344: View Of Piston Measurement

Courtesy of GENERAL MOTORS COMPANY

1. Measure piston width using the following procedure:
 1. Using an outside micrometer, measure the width of the piston at 7.5 mm (0.295 in) from the skirt bottom end (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
 2. Compare your results with the engine mechanical specifications. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.
 3. If the piston clearance to bore obtained through measurement is greater than the provided specifications (0.023-0.053 mm) and the cylinder bores are within specification (68.502-68.518), replace the piston.

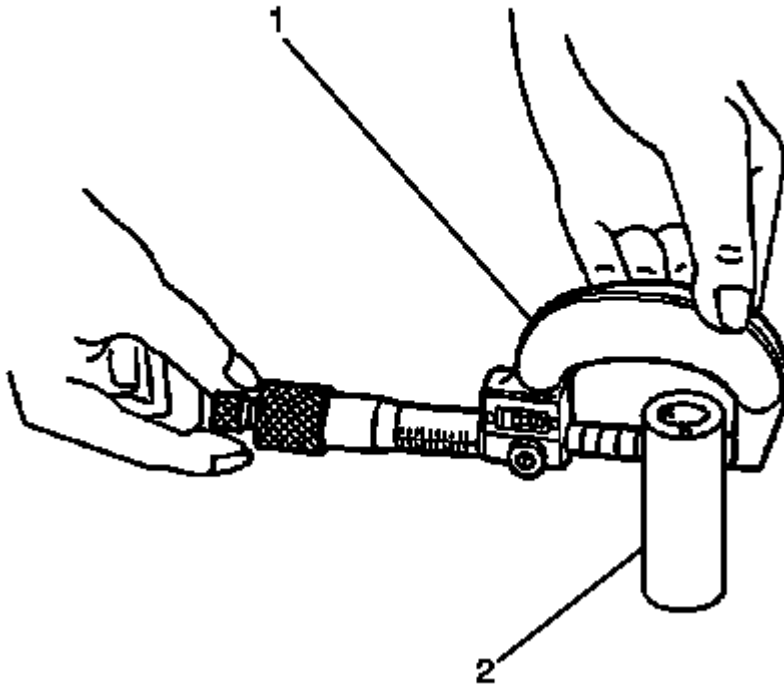
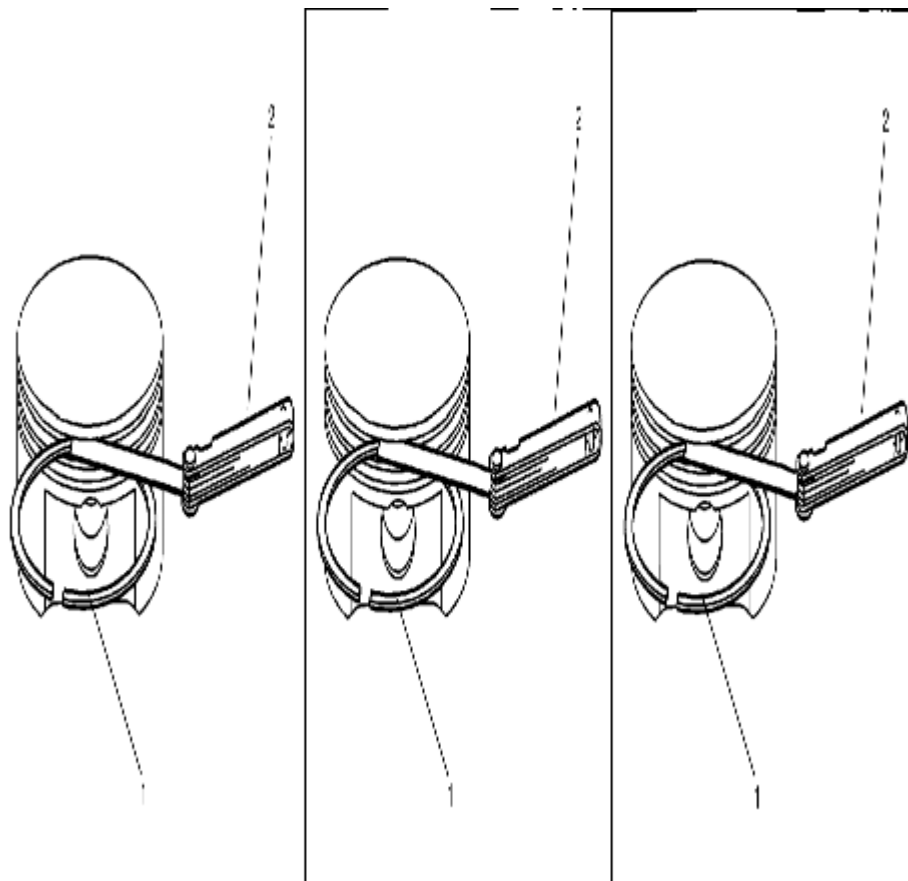


Fig. 345: Identifying Piston Pin Bore To Piston Pin Measurement From Outside Micrometer
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston pin bore to piston pin (2) clearances using the following procedure:
 1. Piston pin bores and pins must be free of varnish or scuffing.
 2. Use an outside micrometer (1) to measure the piston pin in the piston contact areas.
 3. If the result is out of specification (17.996-18.0), replace the pin.

Piston Ring Measurement Procedure

**Fig. 346: Piston Ring**

Courtesy of GENERAL MOTORS COMPANY

1. Measure the piston ring (1) side clearance using the following procedure:
 1. Roll the piston ring (1) entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring (1), replace the piston ring (1).
 2. With the piston ring (1) on the piston, use feeler gauges (2) to check clearance at multiple locations.
 3. Compare the measurements with piston ring side clearance listed in the.
 4. If the clearance is greater than the following specifications, replace the piston ring (1).
 - Top and 2nd: 0.03-0.07
 - Oil: 0.04-0.12

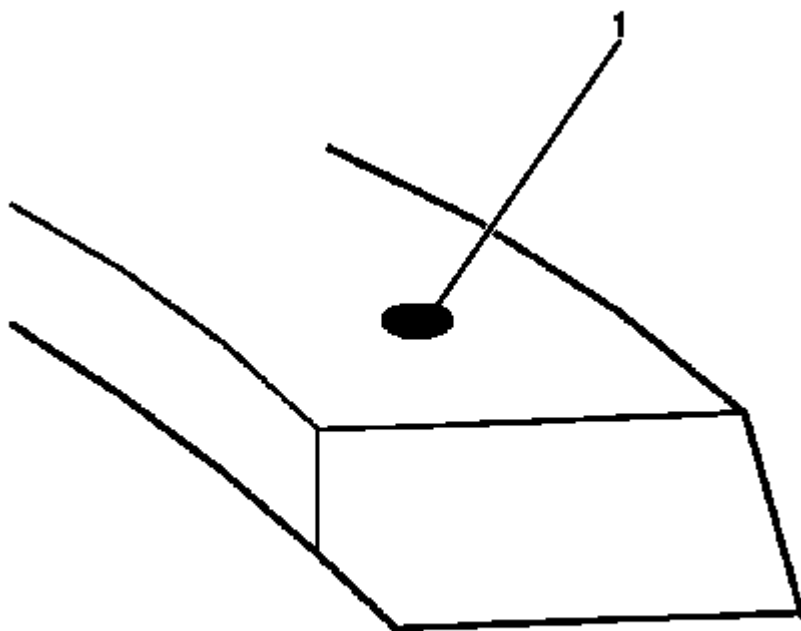


Fig. 347: Identifying Locating Dimple

Courtesy of GENERAL MOTORS COMPANY

2. There is a locating marking 'R' (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
3. If the new ring does not reduce the clearance to the correct specification, install a new piston.
4. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Connecting Rod Cleaning Procedure

1. Clean the connecting rods in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the connecting rod using compressed air.

Connecting Rod Visual Inspection Procedure

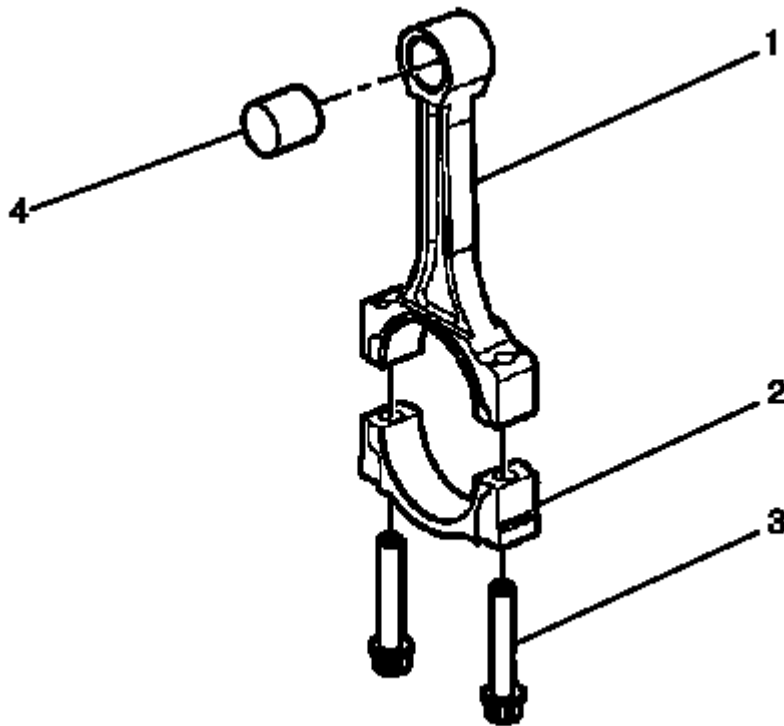


Fig. 348: Identifying Piston Pin Bushing, Connecting Rod Beam, Rod Cap & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

NOTE: DO NOT scrape the rod or rod cap.

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.
6. Inspect the connecting rod bolts (3) for damage or stretching.

Connecting Rod Measurement Procedure

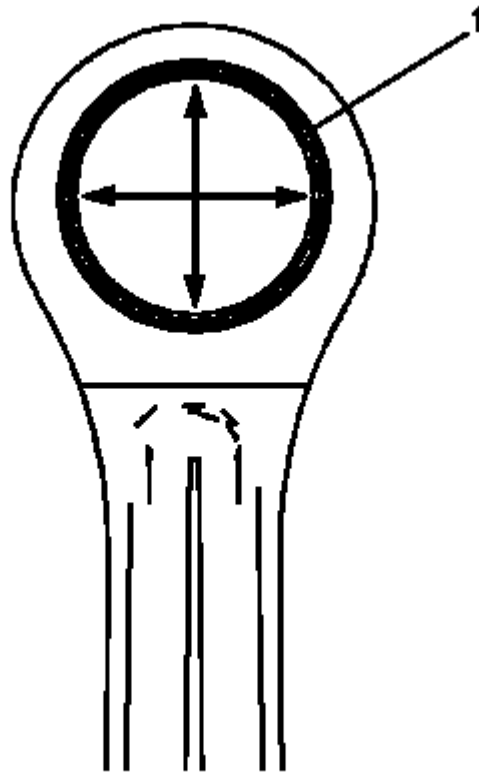


Fig. 349: Identifying Connecting Rod Piston Pin Bore
Courtesy of GENERAL MOTORS COMPANY

1. Using an inside micrometer, measure the connecting rod piston pin bore (1).
2. Subtract the piston pin diameter from the piston pin bore (1).
3. Compare the clearance measurements with the.
4. If the clearance is above acceptable tolerances (0.006-0.018), replace the piston pin. If a new pin does not resolve the clearance condition, replace the connecting rod.

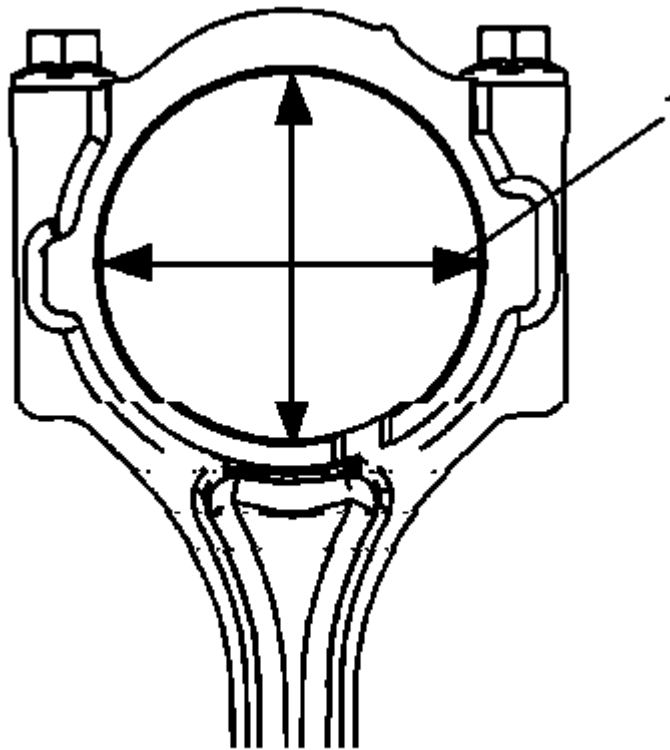


Fig. 350: Identifying Connecting Rod Crankshaft Bearing Bore Measurement From Inside Micrometer

Courtesy of GENERAL MOTORS COMPANY

5. Using an inside micrometer, measure the connecting rod crankshaft bearing bore (1).
6. Compare the bore measurements with the.
7. Replace the connecting rod if the connecting rod crankshaft bearing bore (1) is out of specifications. DO NOT recondition the connecting rod.

Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

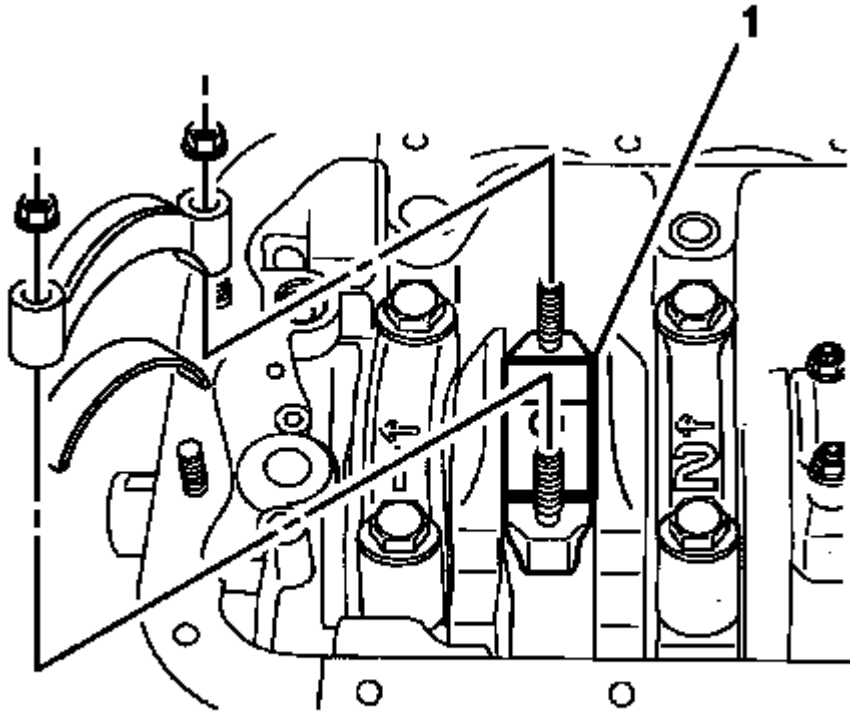


Fig. 351: Plastic Gauge

Courtesy of GENERAL MOTORS COMPANY

1. Cut the plastic gauge (1) the same length as the bearing width and put it on the crankshaft bearing. It should be parallel with the crankshaft.

CAUTION: Refer to Fastener Caution .

2. Install the connecting rod bearing and caps, tighten the connecting rod bearing cap bolts to 20 + 90° (15 lb ft + 90°).
3. Remove the connecting rod cap and bearing.

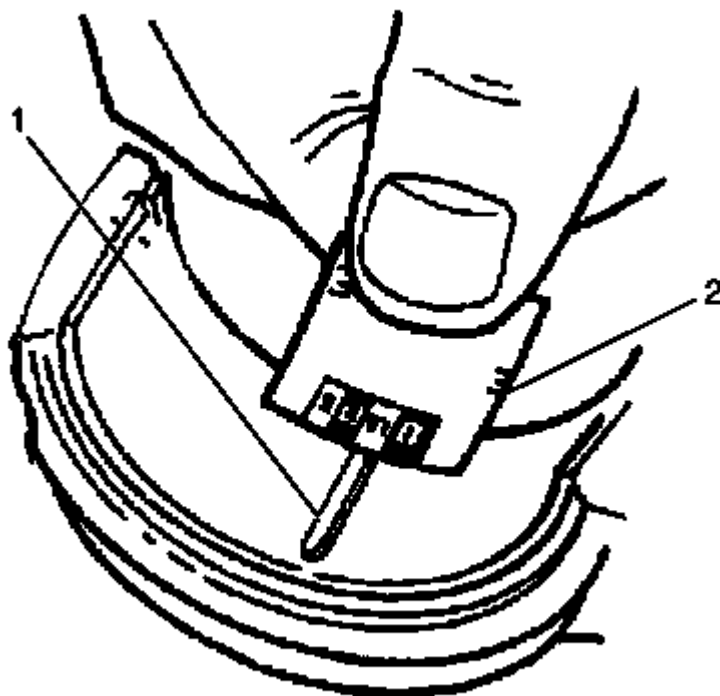


Fig. 352: View Of Crankshaft Bearing Clearance
Courtesy of GENERAL MOTORS COMPANY

4. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gauging material (1) at its widest point with the graduation on the gauging material container (2).
5. Compare your measurements with the engine mechanical specifications. Refer to **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**. If the new bearings DO NOT provide the proper crankshaft to connecting rod bearing clearance, inspect the following: **Engine Mechanical Specifications (LL0)**, **Engine Mechanical Specifications (LFM)**.
6. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

ENGINE BLOCK ASSEMBLE (LL0)

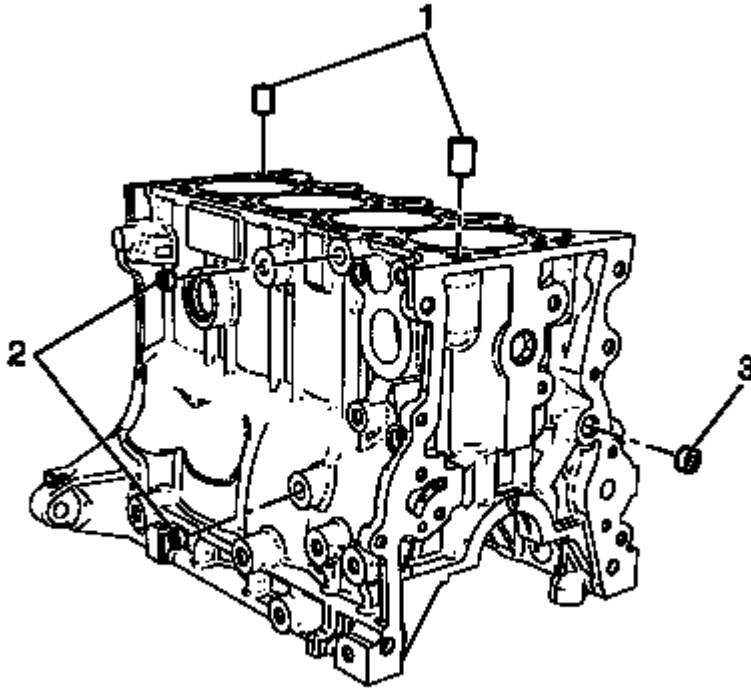


Fig. 353: Cylinder Head Locating

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new engine block oil gallery plug.

1. Install the cylinder head locating (1).
2. Clean the thread of engine block and apply sealant to all plugs prior to installation. Refer to **Adhesives, Fluids, Lubricants and Sealers**.

CAUTION: Refer to **Fastener Caution** .

3. Install the new engine block oil gallery plugs (2, 3) and tighten to 12.5 (9 lb ft).

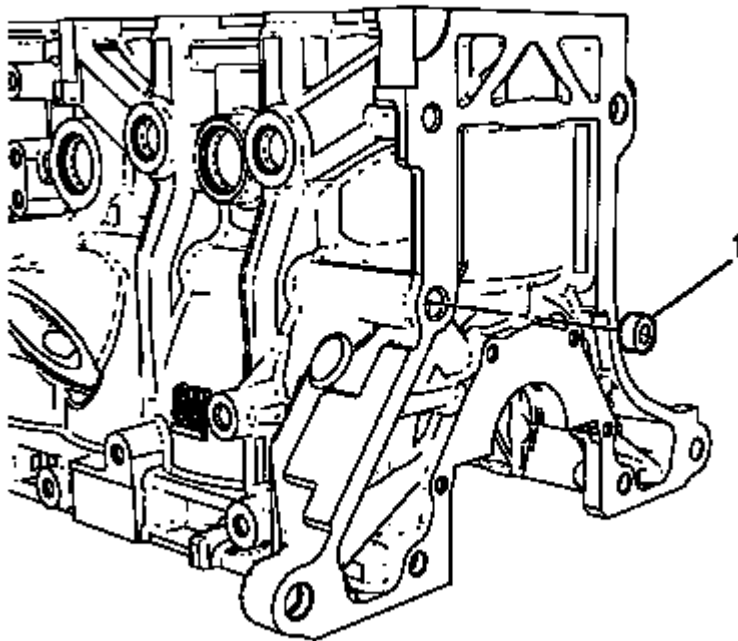


Fig. 354: Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new engine block oil gallery plug.

4. Install the new engine block oil gallery plug (1) and tighten to 12.5 (9 lb ft).

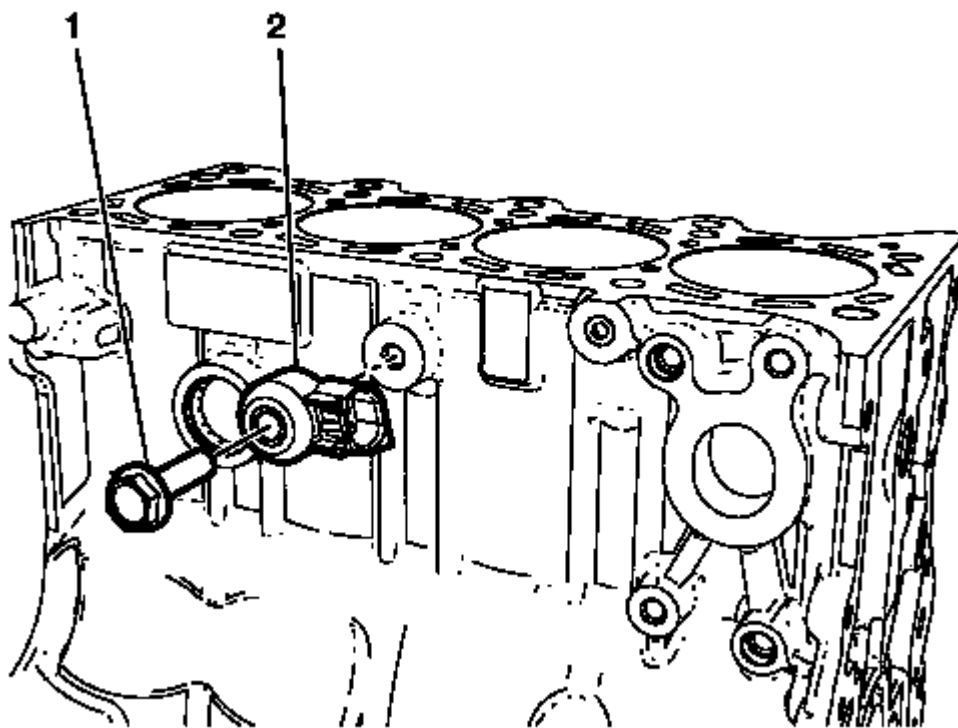


Fig. 355: Knock Sensor Bolt And Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Install the knock sensor (2) and the knock sensor bolt (1) and tighten to 25 (18 lb ft).

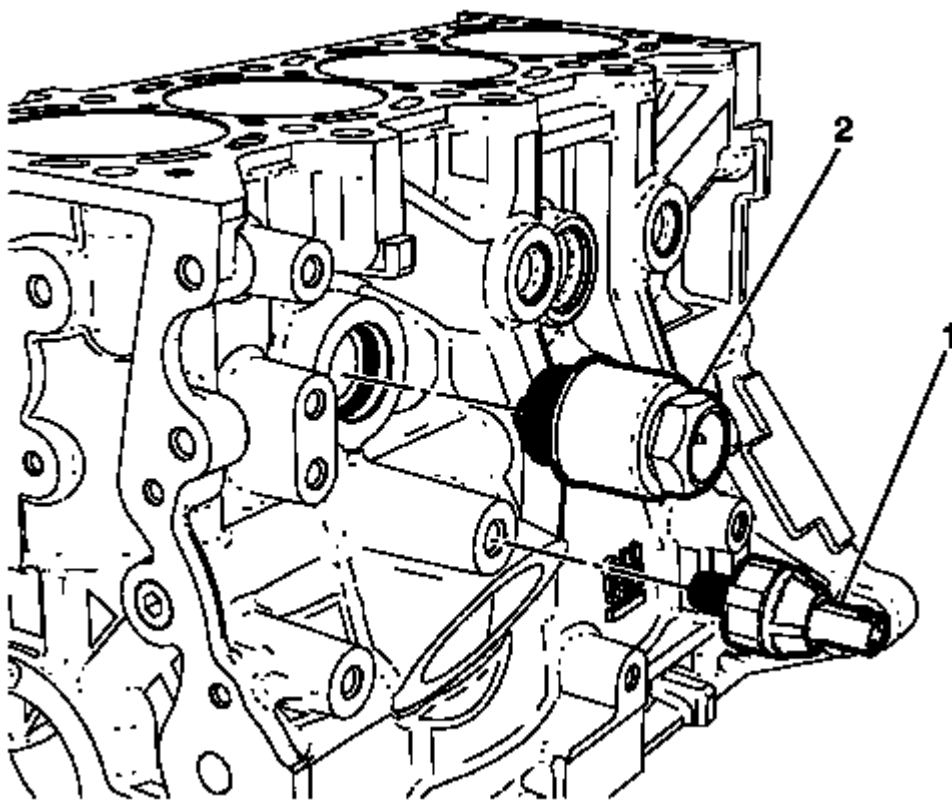


Fig. 356: Oil Pressure Switch And Block Heater
Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pressure switch (1) and tighten to 35 (26 lb ft).
7. Install the block heater (2) and tighten to 60 (44 lb ft).

ENGINE BLOCK ASSEMBLE (LFM)

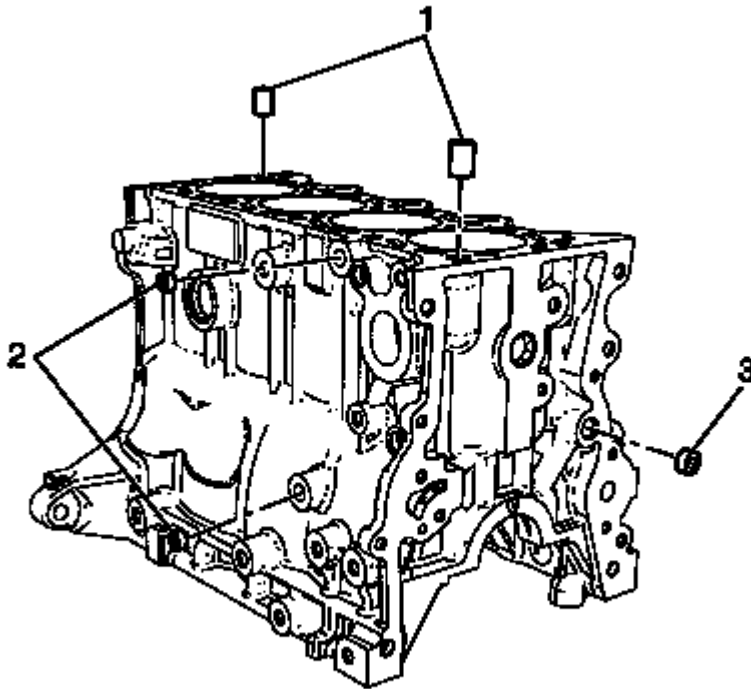


Fig. 357: Cylinder Head Locating

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new engine block oil gallery plug.

1. Install the cylinder head locating (1).
2. Clean the thread of engine block and apply sealant to all plugs prior to installation. Refer to Adhesives, Fluids, Lubricants and Sealers.

CAUTION: Refer to Fastener Caution .

3. Install the new engine block oil gallery plugs (2, 3) and tighten to 12.5 (9 lb ft).

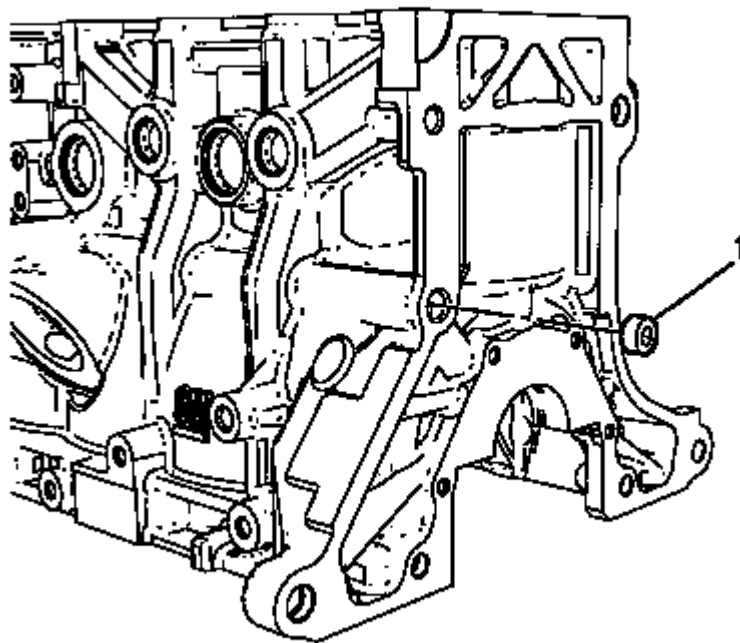


Fig. 358: Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new engine block oil gallery plug.

4. Install the new engine block oil gallery plug (1) and tighten to 12.5 (9 lb ft).

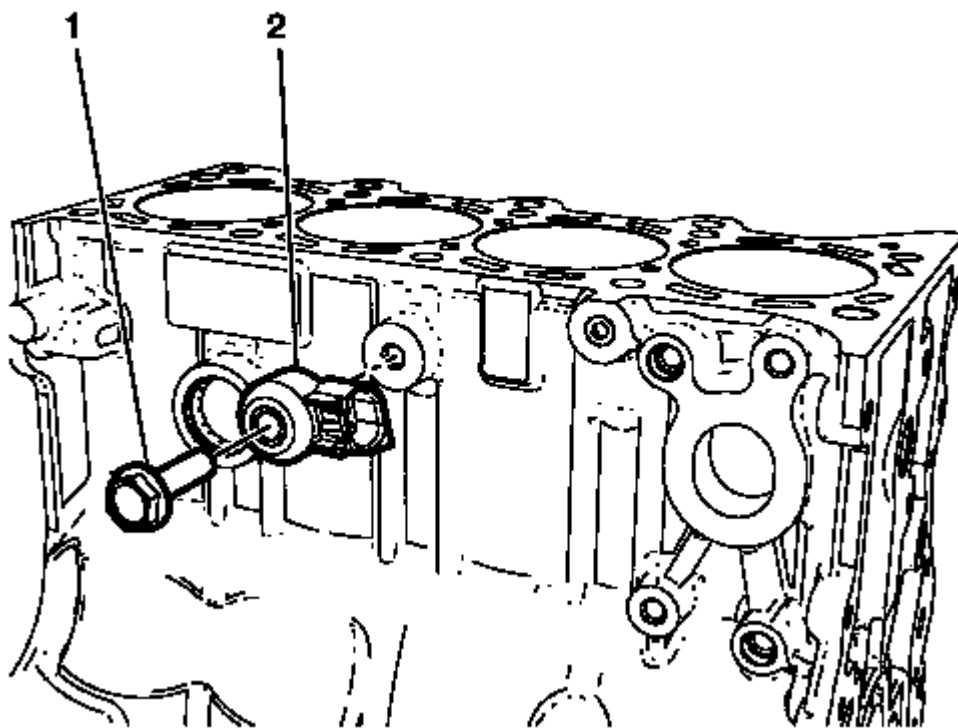


Fig. 359: Knock Sensor Bolt And Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Install the knock sensor (2) and the knock sensor bolt (1) and tighten to 25 (18 lb ft).

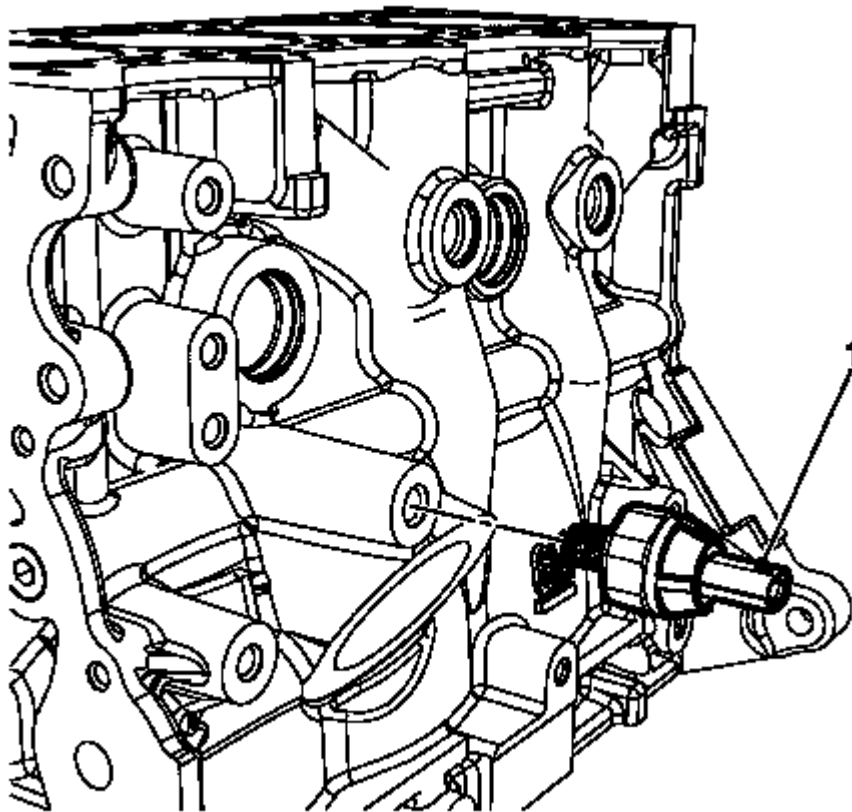


Fig. 360: Oil Pressure Switch

Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pressure switch (1) and tighten to 35 (26 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

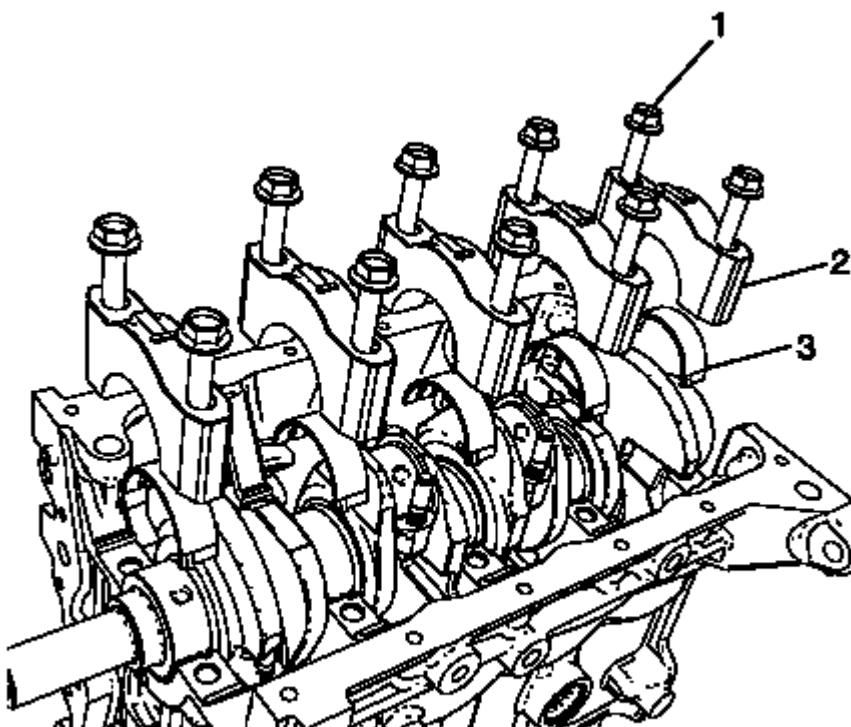


Fig. 361: Crankshaft Bearing Caps
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Inspect the installation position.

1. Install the crankshaft.

NOTE: Inspect the installation position.

2. Install the crankshaft bearing (3).

NOTE: Inspect the installation position.

3. Install the crankshaft bearing cap (2).

CAUTION: Refer to Fastener Caution .

4. Install the crankshaft bearing cap bolts (1) and tighten to 30 + 30° (22 lb ft + 30°).

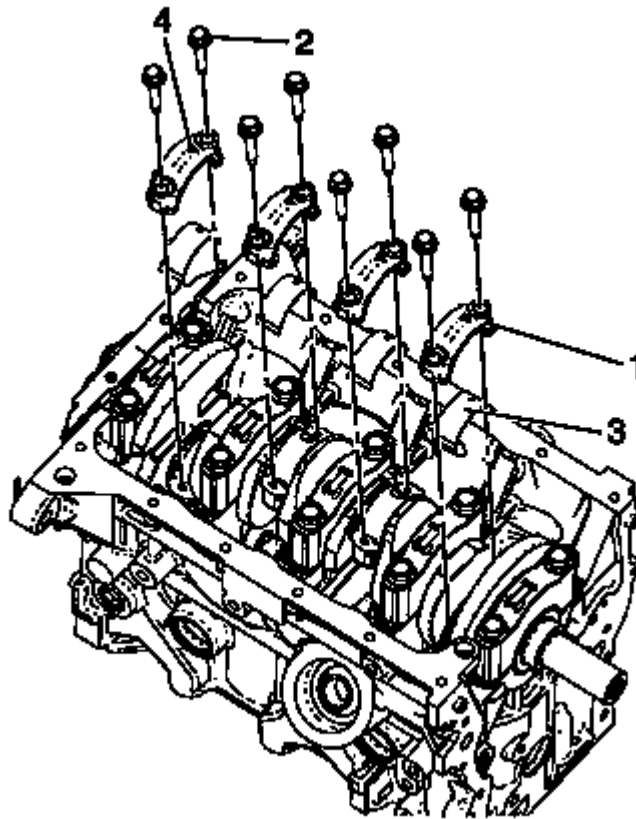


Fig. 362: Connecting Rod Bearing

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the installation position.**

5. Install the connecting rod bearing (3) and connecting rod bearing caps (1) and tighten the 8 connecting rod bearing cap bolts to 20 + 90° (15 lb ft + 90°).

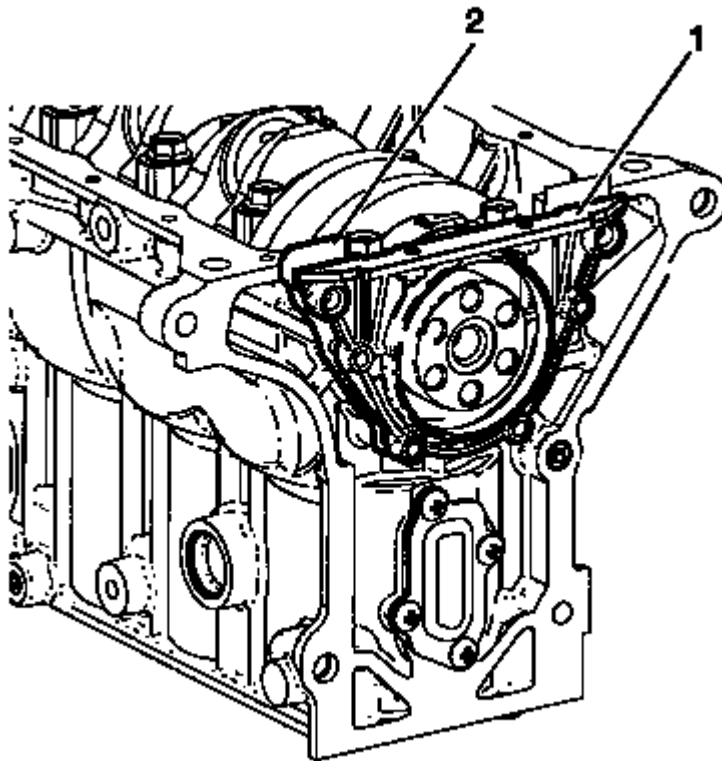


Fig. 363: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

6. Install the crankshaft rear oil seal housing (1) with the new gasket (2) and tighten to 10 (89 lb in).

CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION

Special Tools

J 45507 Crankshaft Rear Oil Seal Installer

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

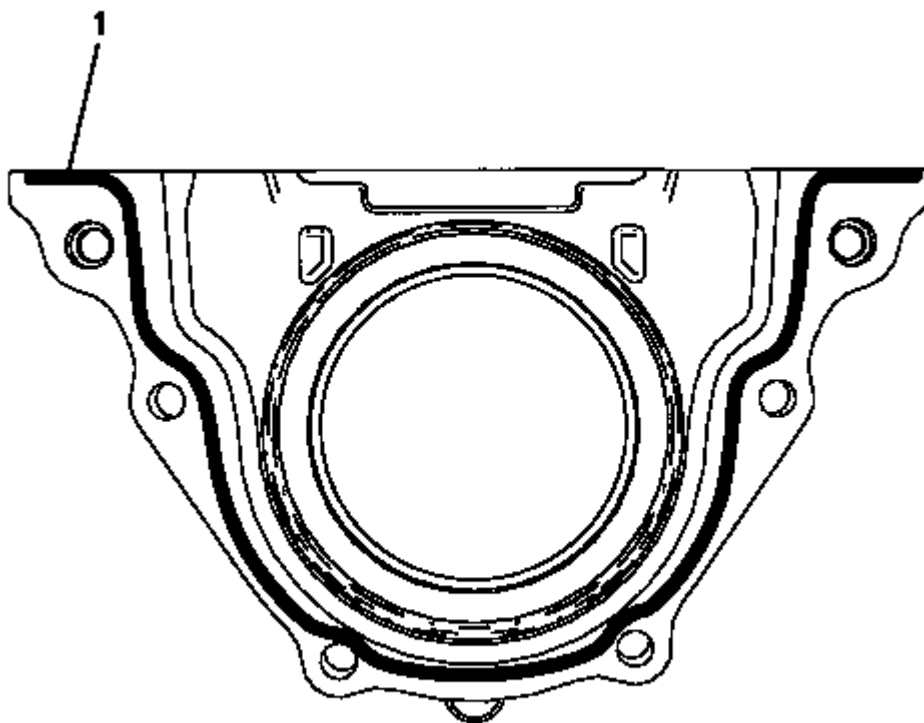


Fig. 364: Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

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

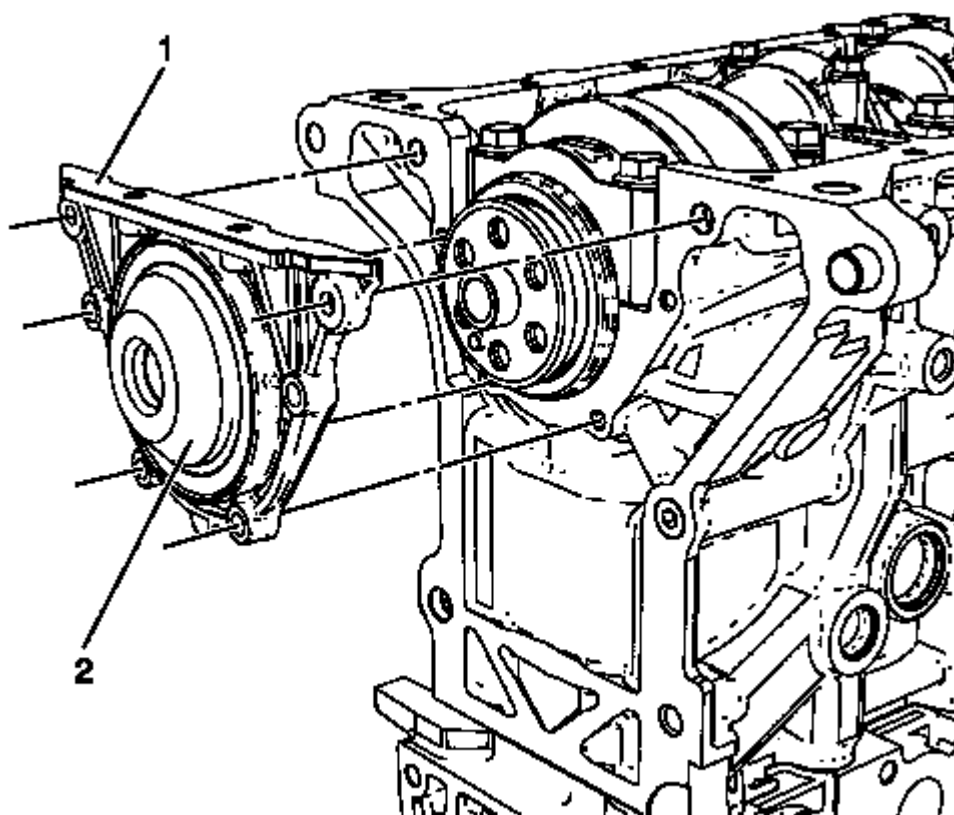


Fig. 365: Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

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

2. Install the **J 45507** Crankshaft Rear Oil Seal Installer (2) to the crankshaft rear oil seal and housing (1).
3. Push the crankshaft rear oil seal and housing (1) until the crankshaft rear oil seal and housing is flush and sits evenly in the cylinder block.
4. Remove the **J 45507** Crankshaft Rear Oil Seal Installer (2) from the crankshaft.

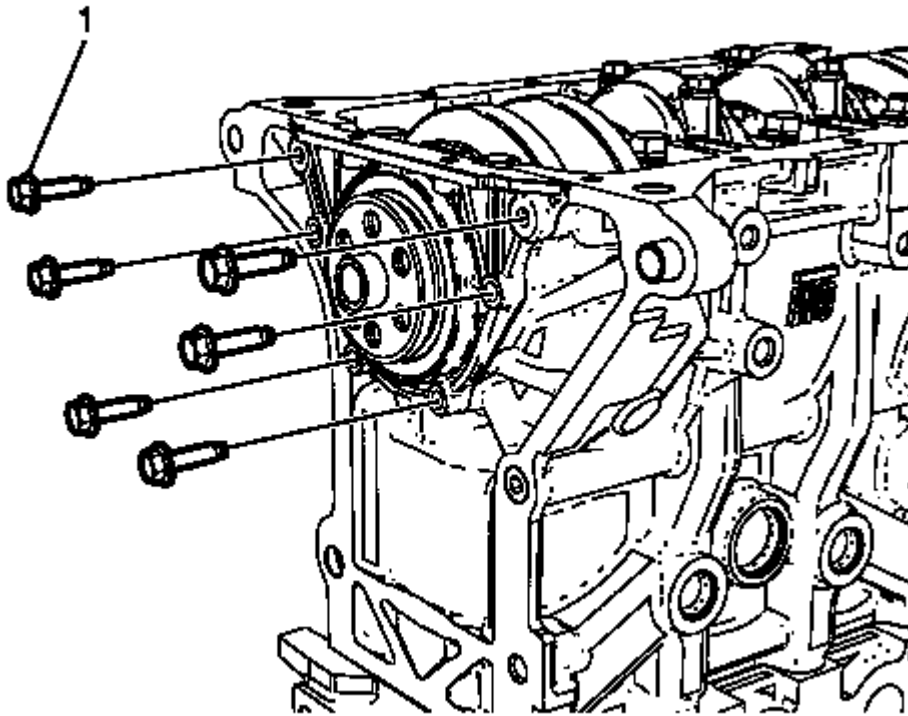


Fig. 366: Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the crankshaft rear oil seal housing bolts (1) and tighten to 10 (89 lb in).

PISTON, CONNECTING ROD AND BEARING INSTALLATION

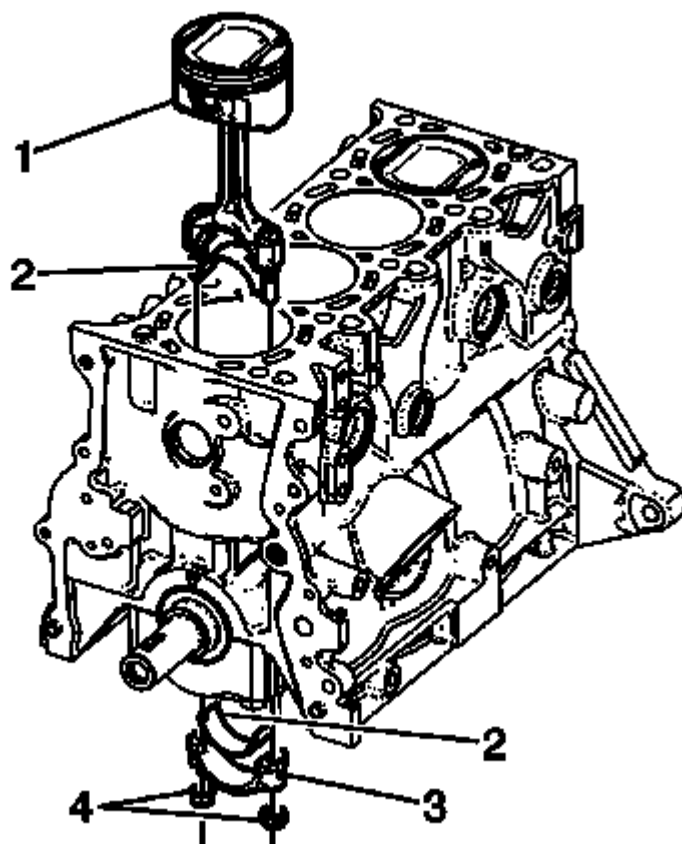


Fig. 367: Piston And Rod Assembly

Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to a position where the connecting rod bolts are in the best situation for install.

NOTE: Arrow on piston head points to engine timing side, bead on connecting rod points to transmission side of engine.

2. Install the piston and connecting rod assembly (1).
3. Install the connecting rod bearing (2).
4. Assemble the caps and connecting rods in the marked position. Install the connecting rod cap (3).

CAUTION: Refer to Fastener Caution .

5. Install the connecting rod bearing bolts (4) and tighten to 20 + 90° (15 lb ft + 90°).

CAMSHAFT TIMING CHAIN INSTALLATION

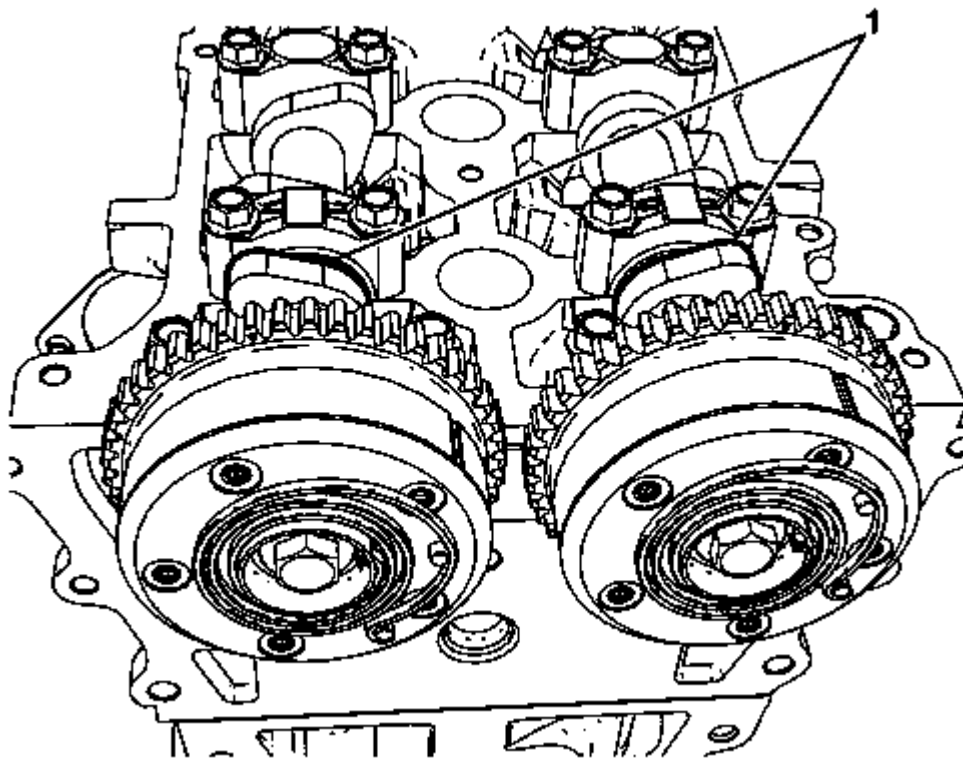


Fig. 368: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

1. Position the camshaft lobes in a neutral position.

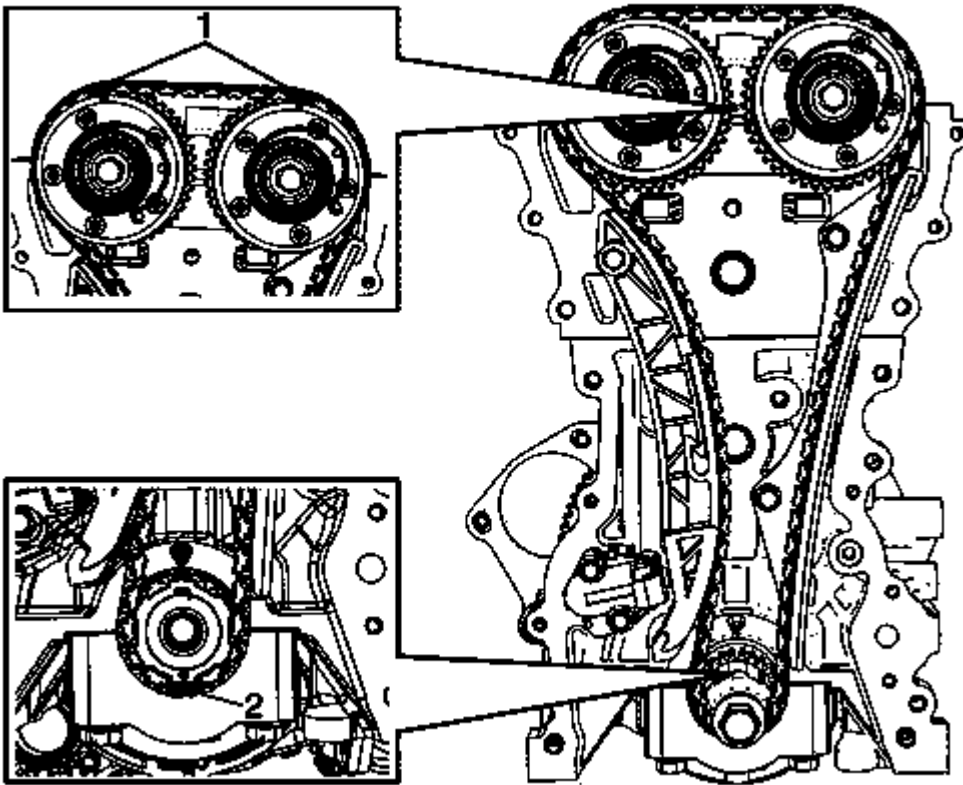


Fig. 369: Camshaft Sprockets And Timing Chain

Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain after aligning both the marks (1) on the camshaft sprockets and on the timing chain.
3. Align both the timing marks on the crankshaft sprocket and on the timing chain (2).

TIMING CHAIN TENSIONER INSTALLATION

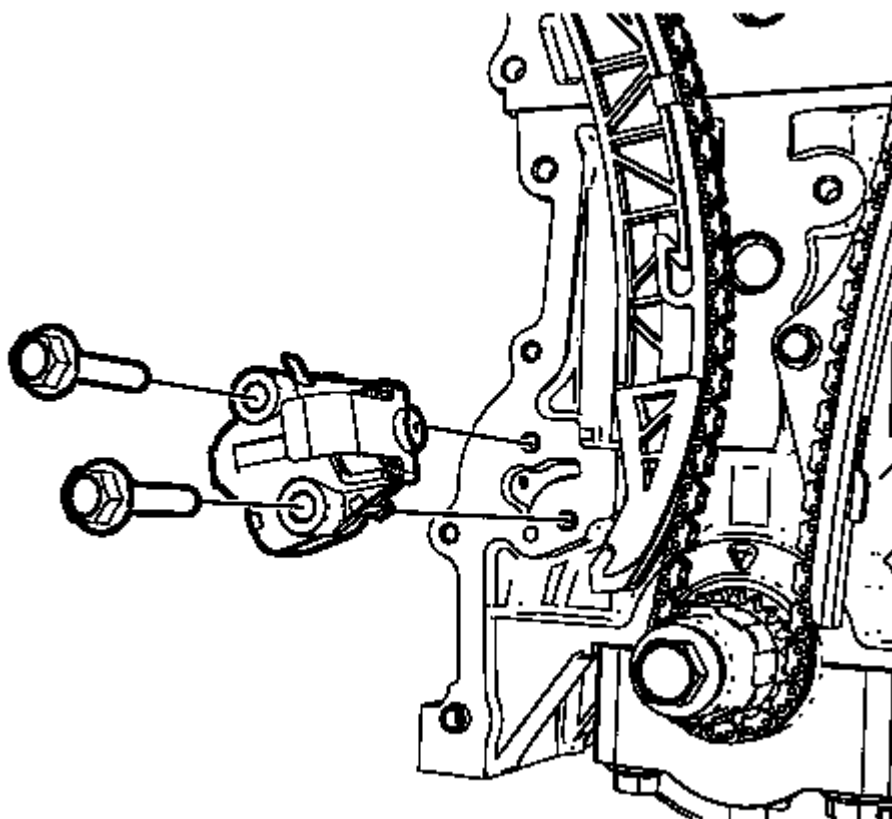


Fig. 370: Timing Chain Tensioner

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain tensioner mounting surface on the cylinder block for burrs or any defects that may degrade the sealing of the timing chain tensioner.

CAUTION: Refer to Fastener Caution .

2. Push the timing chain shoe towards the timing chain and hold the timing chain shoe. Using the other hand, push the timing chain tensioner towards the timing chain shoe. The timing chain tensioner plunger might be pushed into the timing chain tensioner housing. While holding the timing chain tensioner, install the timing chain tensioner bolts and tighten the timing chain tensioner retaining bolts to 10 (89 lb in).
3. Pull out the shipping clip.

TIMING CHAIN GUIDE INSTALLATION

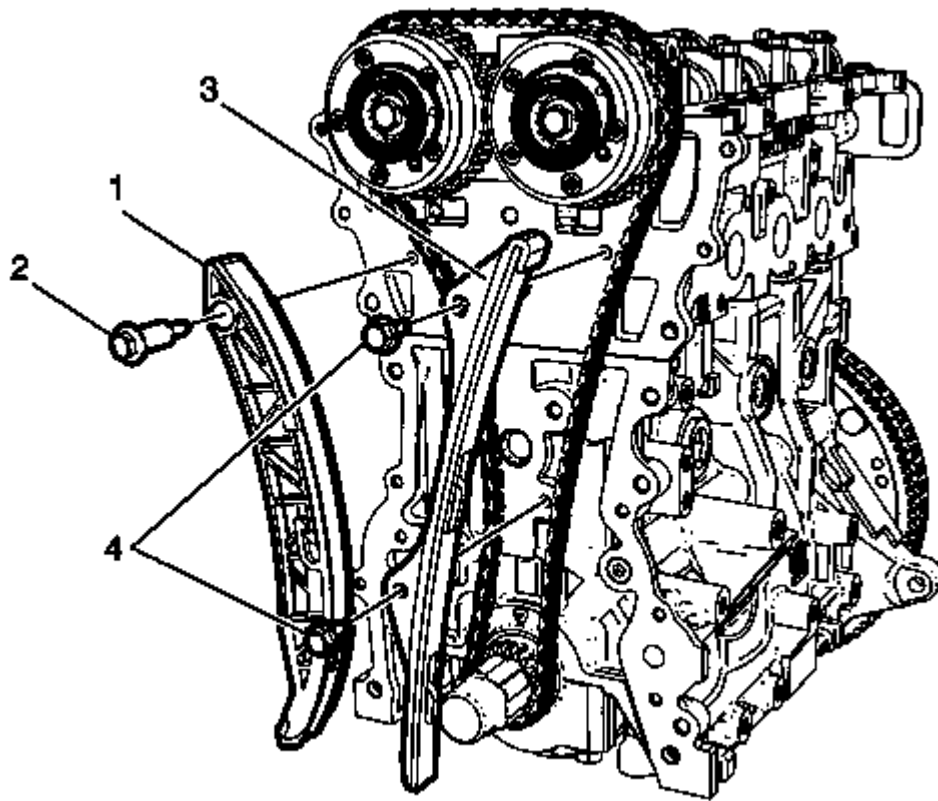


Fig. 371: Left Timing Chain Shoe Retaining Bolt
 Courtesy of GENERAL MOTORS COMPANY

1. Install the timing chain shoe (1).

CAUTION: Refer to Fastener Caution .

2. Tighten the timing chain shoe retaining bolt (2) to 10 (89 lb in)
3. Install the timing chain guide (3).
4. Install the timing chain guide retaining bolts (4) to 10 (89 lb in).

CAMSHAFT INSTALLATION (LL0)

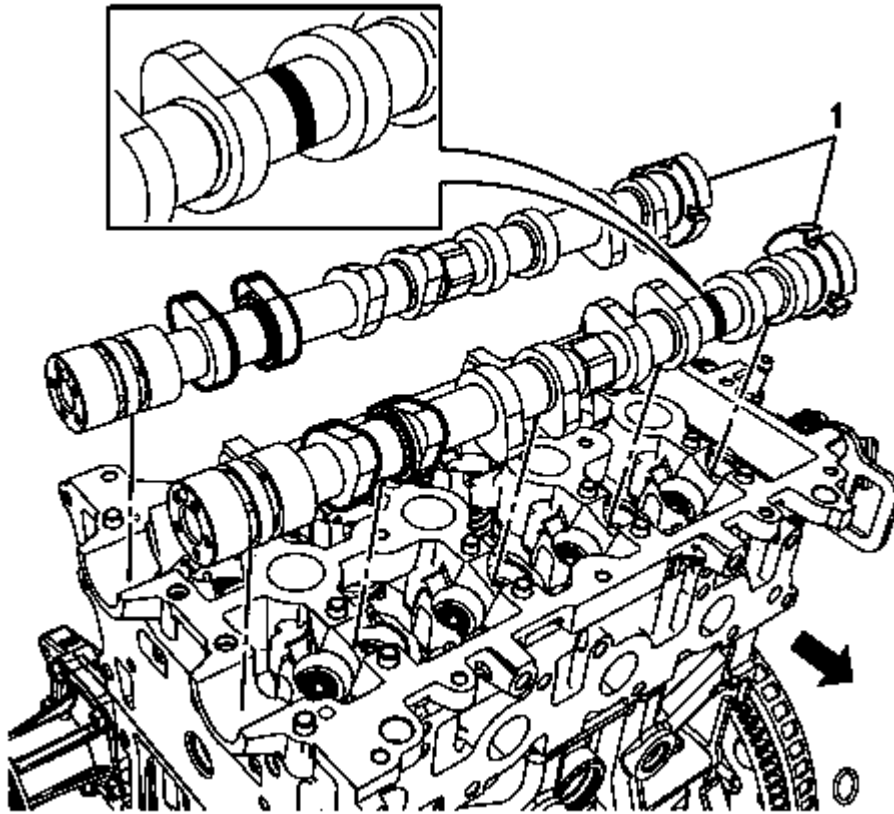


Fig. 372: Camshafts

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has a groove between the No. 3 journal and No. 4 journal. The intake camshaft has no groove.

1. Install the intake camshaft and the exhaust camshaft (1).

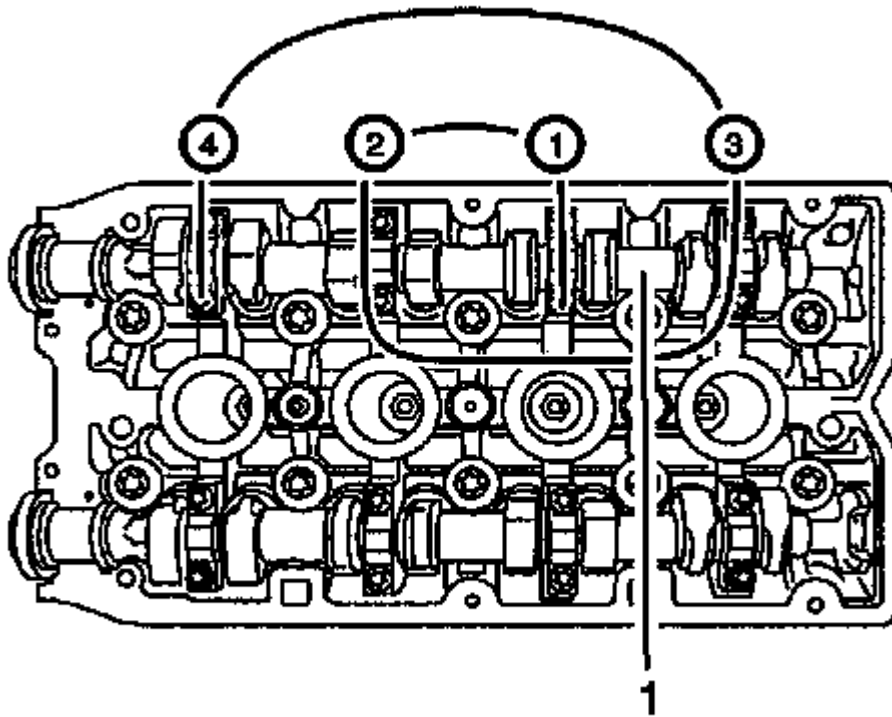


Fig. 373: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft lobes in a neutral position.

NOTE: Note the identification marking on the camshaft bearing cover.

3. Install the 4 intake camshaft bearing caps numbers 2-5 from the cylinder head.

CAUTION: Refer to Fastener Caution .

4. Tighten the 8 intake camshaft bearing cap bolts working from inside to outside in a spiral to 10 (89 lb in).

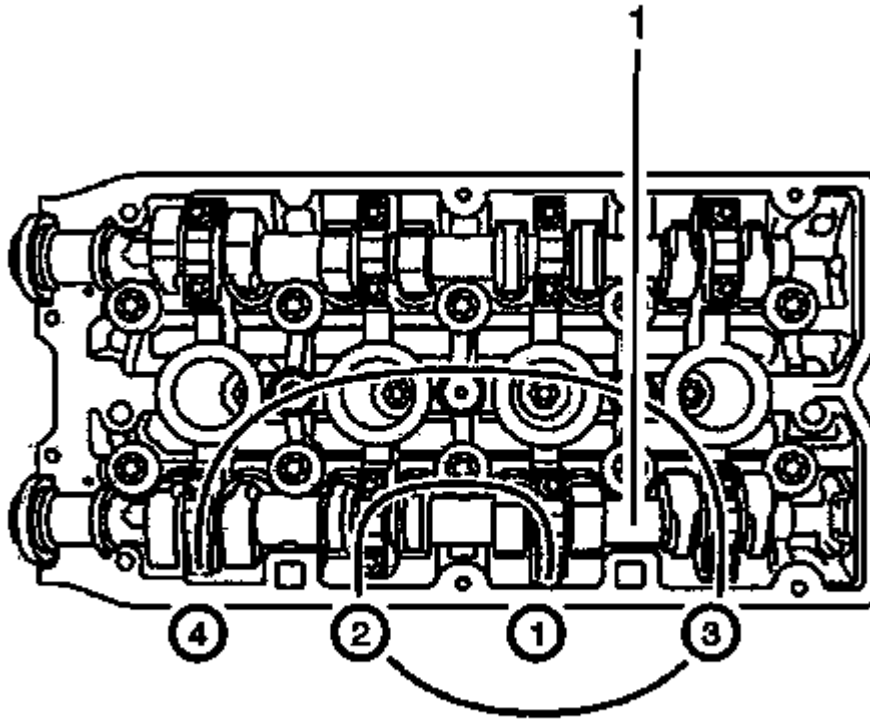


Fig. 374: Exhaust Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the identification marking on the camshaft bearing cover.

5. Install the 4 exhaust camshaft bearing caps numbers 6-9 from the cylinder head.
6. Tighten the 8 exhaust camshaft bearing cap bolts working from inside to outside in a spiral to 10 (89 lb in).

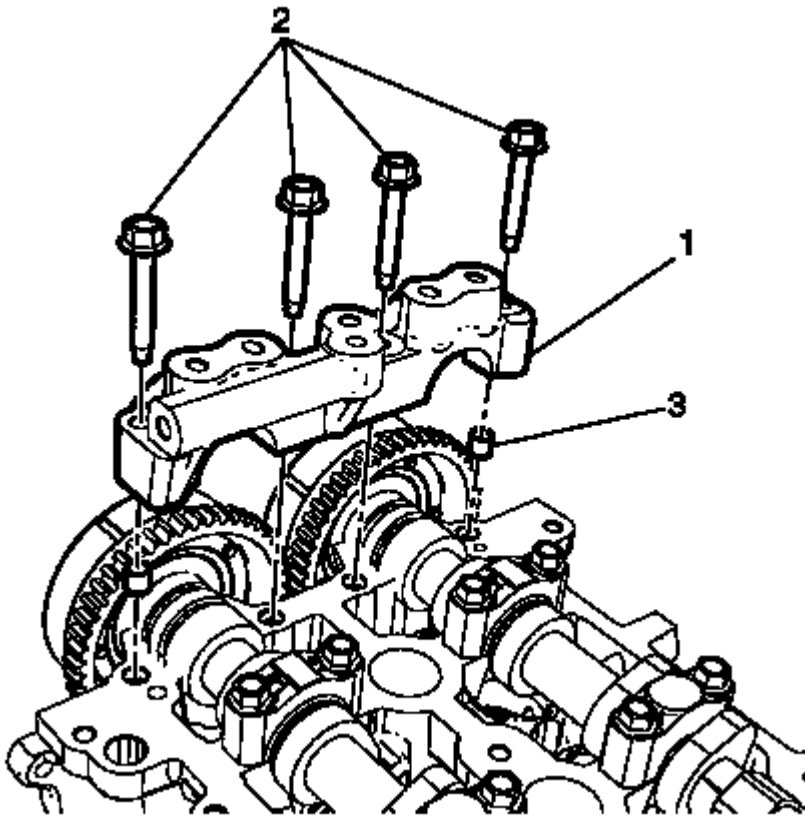


Fig. 375: First Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Clean sealing surfaces of the first camshaft bearing support and the cylinder head with a suitable tool.
8. Clean oil duct from any sealant residue.
9. Install the first camshaft bearing cap (1) and dowel pin (3).
10. Tighten camshaft bearing cap bolts (2) to 10 (89 lb in).

CAMSHAFT INSTALLATION (LFM)

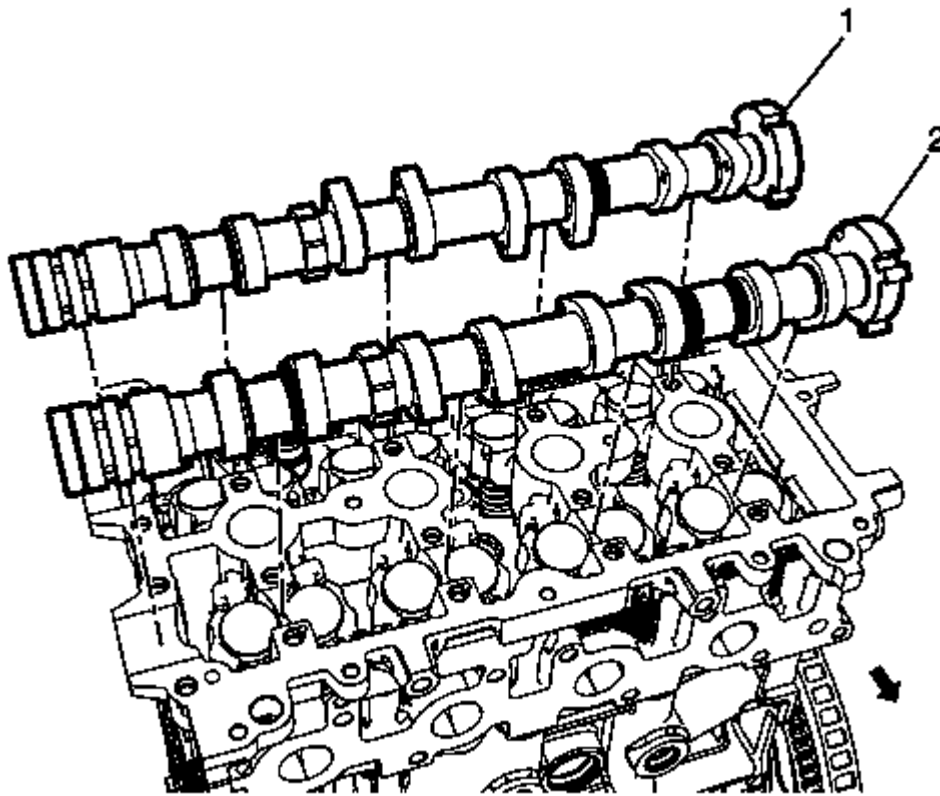


Fig. 376: Intake Camshaft

Courtesy of GENERAL MOTORS COMPANY

NOTE: The exhaust camshaft has 2 grooves between the No. 3 journal and No. 4 journal. The intake camshaft has 1 groove.

1. Install the intake camshaft (1) and the exhaust camshaft (2).

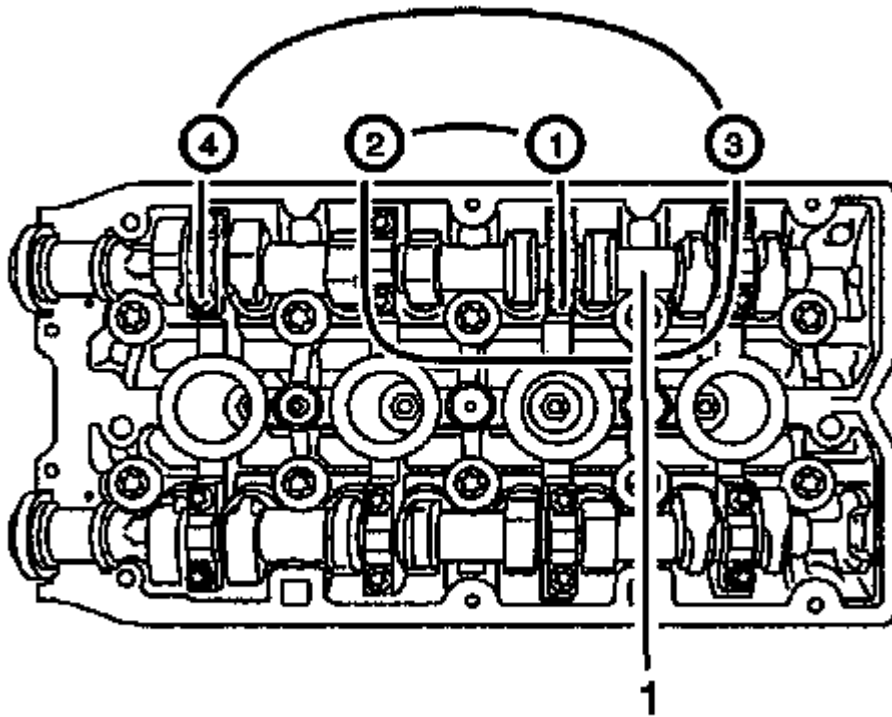


Fig. 377: Camshaft Lobes

Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft lobes in a neutral position.

NOTE: Note the identification marking on the camshaft bearing cover.

3. Install the 4 intake camshaft bearing caps numbers 2-5 from the cylinder head.

CAUTION: Refer to Fastener Caution .

4. Tighten the 8 intake camshaft bearing cap bolts working from inside to outside in a spiral to 10 (89 lb in).

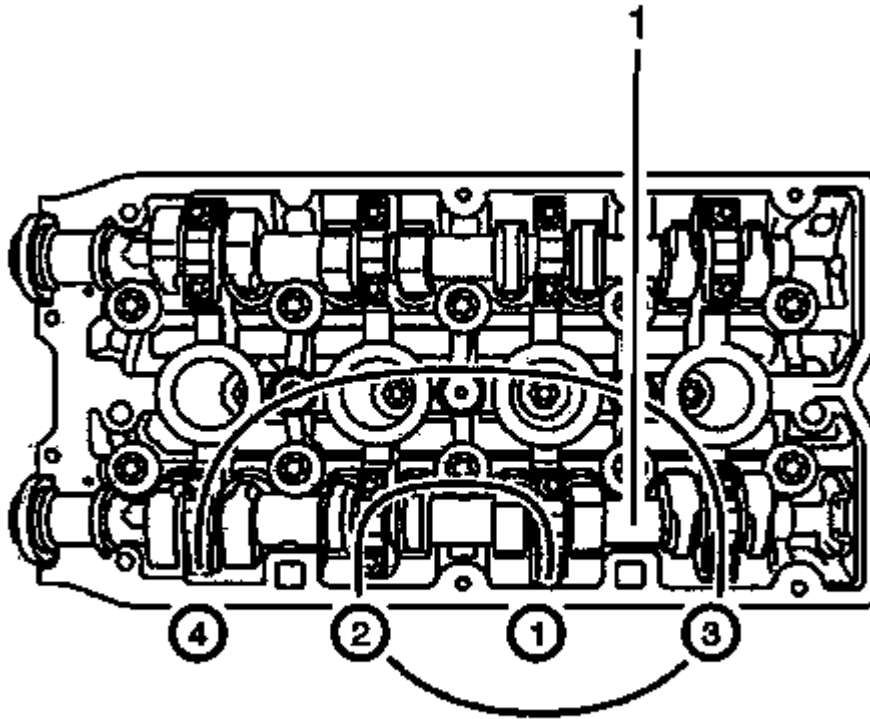


Fig. 378: Exhaust Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the identification marking on the camshaft bearing cover.

5. Install the 4 exhaust camshaft bearing caps numbers 6-9 from the cylinder head.
6. Tighten the 8 exhaust camshaft bearing cap bolts working from inside to outside in a spiral to 10 (89 lb in).

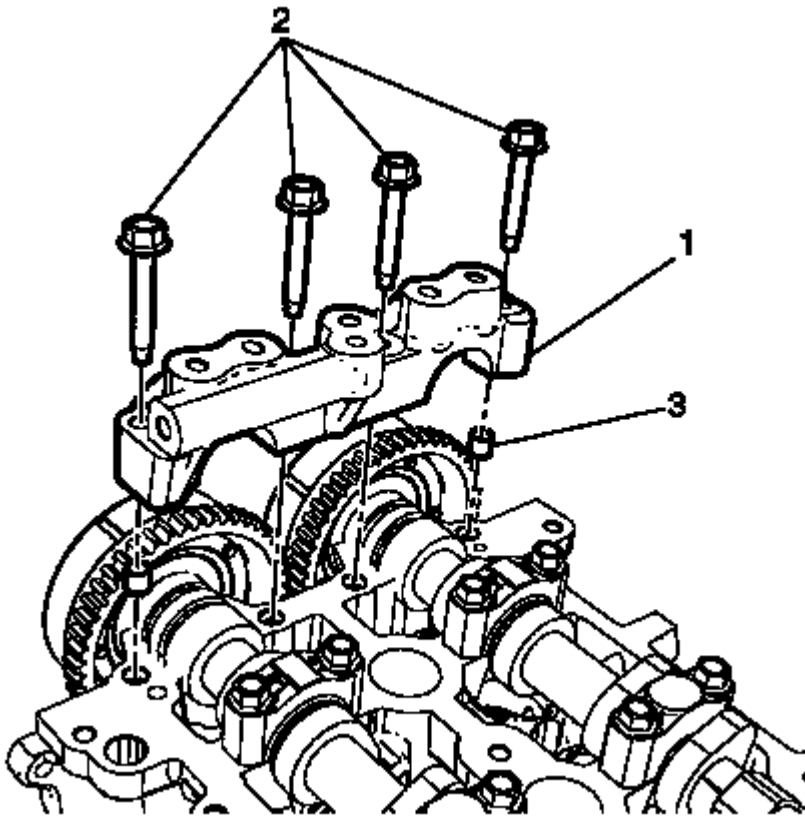


Fig. 379: First Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Clean sealing surfaces of the first camshaft bearing support and the cylinder head with a suitable tool.
8. Clean oil duct from any sealant residue.
9. Install the first camshaft bearing cap (1) and dowel pin (3).
10. Tighten camshaft bearing cap bolts (2) to 10 (89 lb in).

ENGINE LIFT REAR BRACKET INSTALLATION

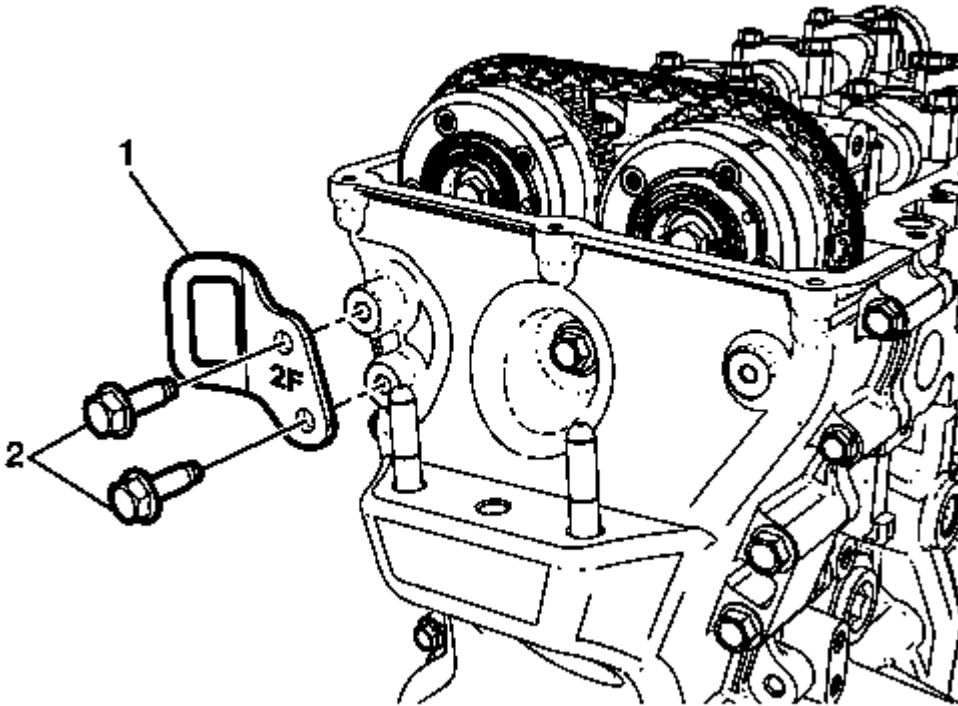


Fig. 380: Engine Lift Rear Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine lift rear bracket (1).

CAUTION: Refer to Fastener Caution .

2. Install the engine lift rear bracket bolts (2) to the engine lift rear bracket (1) and tighten to 25 (18 lb ft).

ENGINE LIFT FRONT BRACKET INSTALLATION

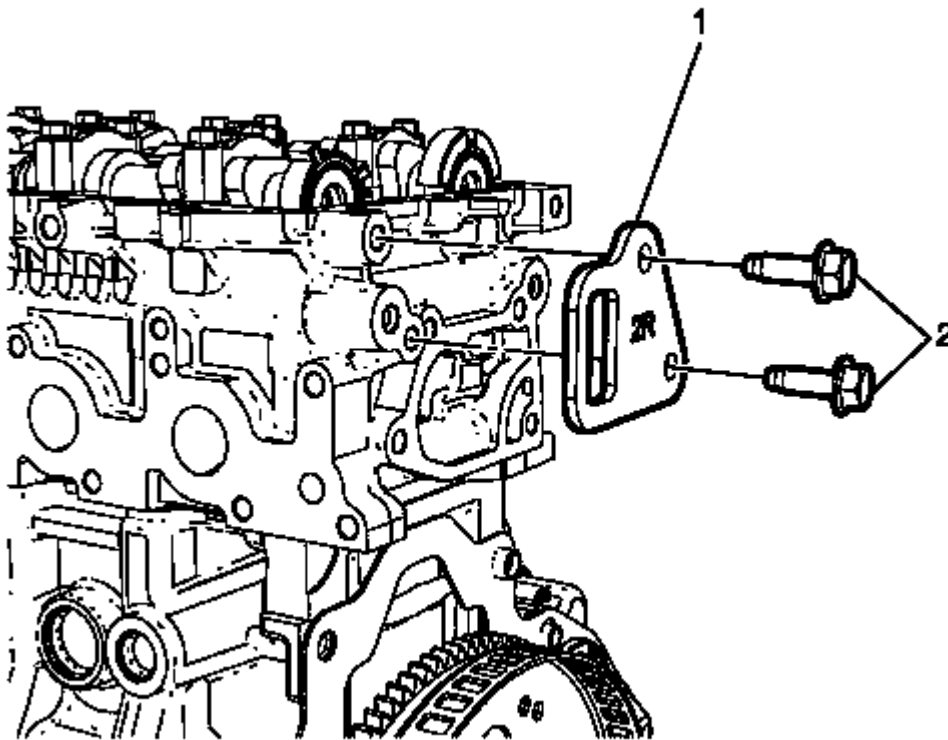


Fig. 381: Engine Lift Front Bracket Bolts
 Courtesy of GENERAL MOTORS COMPANY

1. Install the engine lift front bracket (1).

CAUTION: Refer to Fastener Caution .

2. Install the engine lift front bracket bolts (2) to the engine lift front bracket and tighten to 25 (18 lb ft).

CYLINDER HEAD AND GASKET INSTALLATION

Special Tools

GE-42072 Cylinder Head Bolt Remover/Installer

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

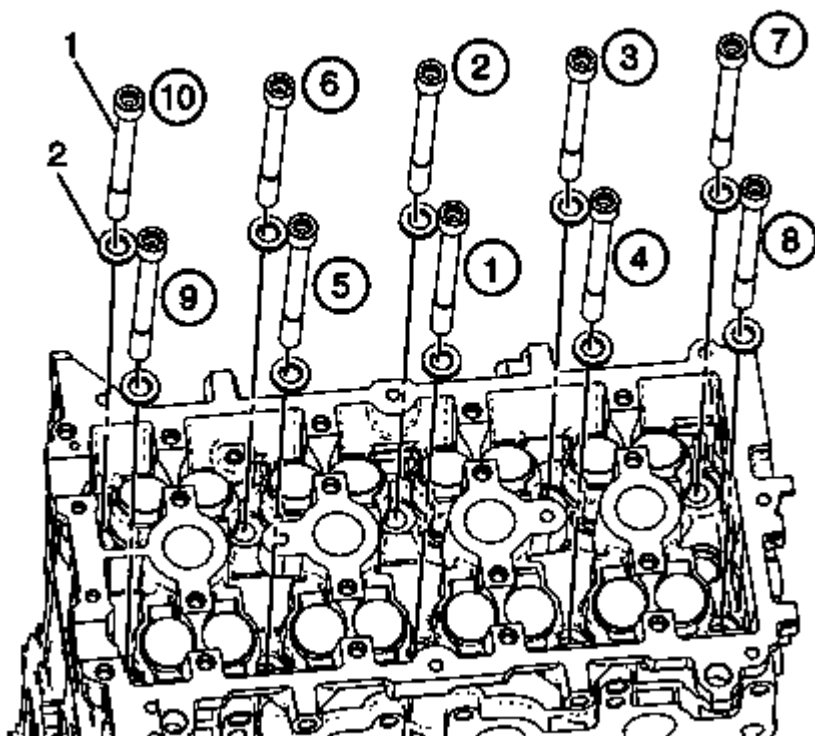


Fig. 382: Cylinder Head Bolts In Sequence

Courtesy of GENERAL MOTORS COMPANY

NOTE: The cylinder head bolts require a 10 mm 12 point triple square tool for proper servicing. Use GE-42072 Cylinder Head Bolt Remover/Installer or equivalent when servicing head bolts.

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.

CAUTION: Refer to Fastener Caution .

5. Install the 10 cylinder head bolts with the **GE-42072** cylinder head bolt remover/installer (1) in sequence as shown.

Tighten to 22 + 82° (16 lb ft + 82°)

1. 10 bolts 22 (16 lb ft)
2. Recheck for 10 bolts tightening torque for getting 22 balance.
3. 10 bolts 82°

ENGINE FRONT COVER AND OIL PUMP INSTALLATION

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

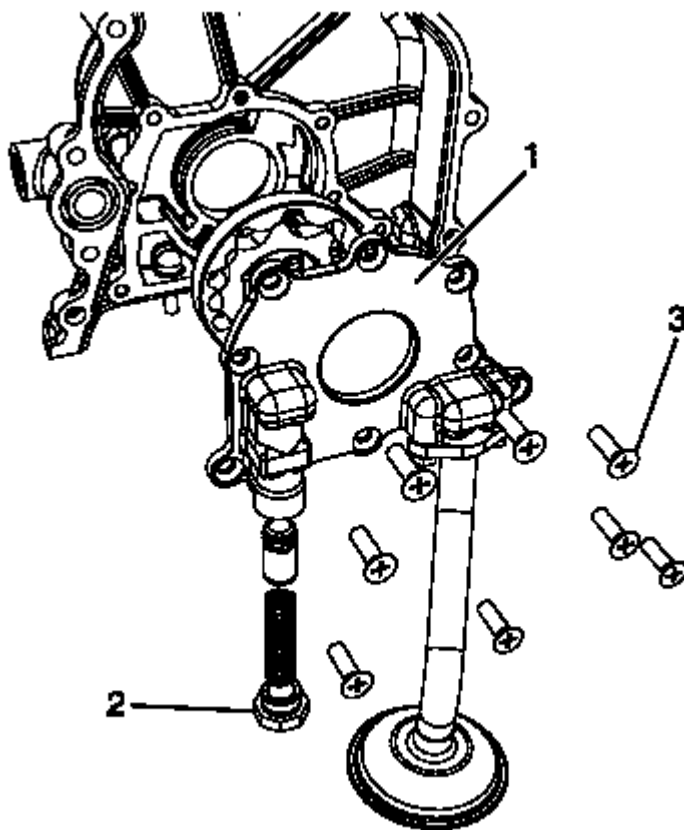


Fig. 383: Oil Pump Screws
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil relief valve components and plug to oil pump housing (1).

CAUTION: Refer to Fastener Caution .

2. Tighten the oil pump housing retaining bolts (3) to 10 (89 lb in).

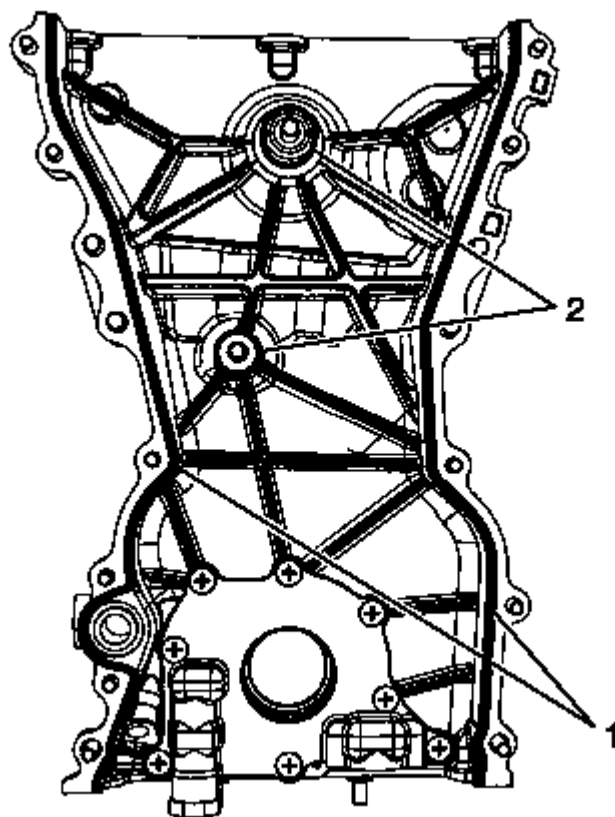


Fig. 384: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not damage the sealing surfaces.

NOTE: Cleaning of the sealing surfaces (3-6): Refer to Replacing Engine Gaskets.

3. Remove any old thread sealant, gasket material or sealant using remover such as chisel or scraper.
4. Clean the sealing surfaces of front cover and front cover components with solvent.

NOTE: Ensure that the sealing surface is clear of oil, grease and oil sealant material.

5. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

6. Dry the front cover and front cover components with compressed air.

NOTE: Do not coat sealant (RTV) on the front cover bolt holes and bolt threads.

NOTE: Apply sealant (RTV) on lines (1) and 2 hole faces (2). Apply sealant (RTV) to the edges of top and bottom step chamfers.

7. Apply approximately a 4.5 mm (0.177 in) thick bead of oil pan sealant (1) to the oil pan.

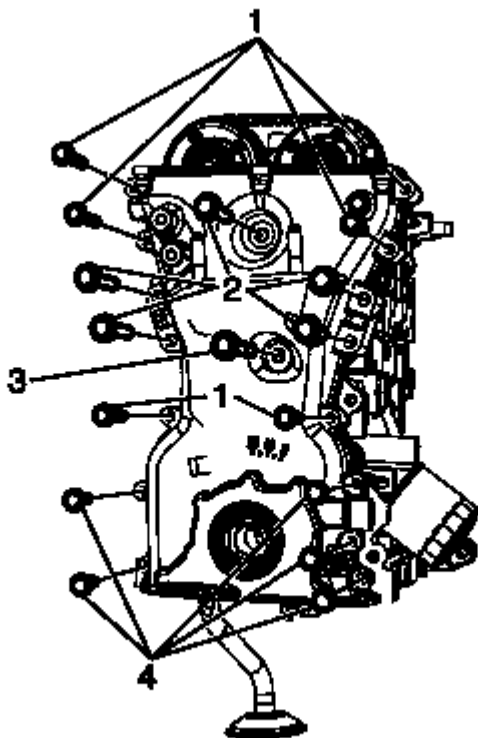


Fig. 385: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

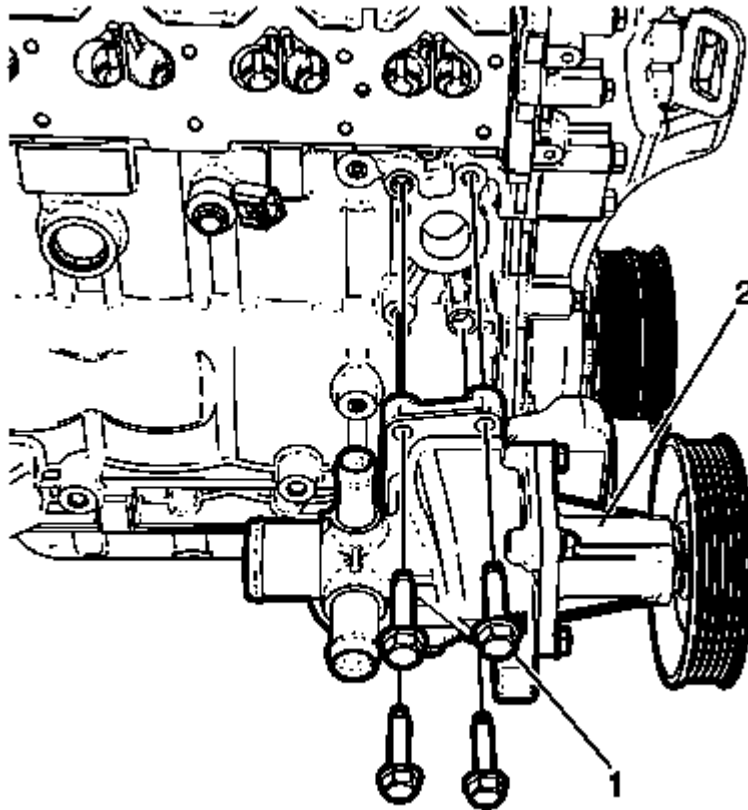
8. Install the engine front cover with the included oil pump.

NOTE: Check the different screw lengths.

9. Install the engine front cover bolts (2, 3) and tighten to 22 (16 lb ft).

NOTE: After sealant (RTV) dispensing, the assembly completion time including torque check must be done within 8 minutes.

10. Install the engine front cover bolts (1, 4) and tighten to 10 (89 lb in).

WATER PUMP INSTALLATION**Fig. 386: Water Pump Bolts****Courtesy of GENERAL MOTORS COMPANY**

1. Clean the sealing surfaces and the water pump threads.

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

2. Install the water pump (2) and the 4 NEW water pump bolts (1).
3. Tighten the water pump bolts to 25 (89 lb ft).

CRANKSHAFT FRONT OIL SEAL INSTALLATION**Special Tools****EN 50172** Crankshaft Front Oil Seal Installer

For equivalent regional tools, refer to Special Tools.

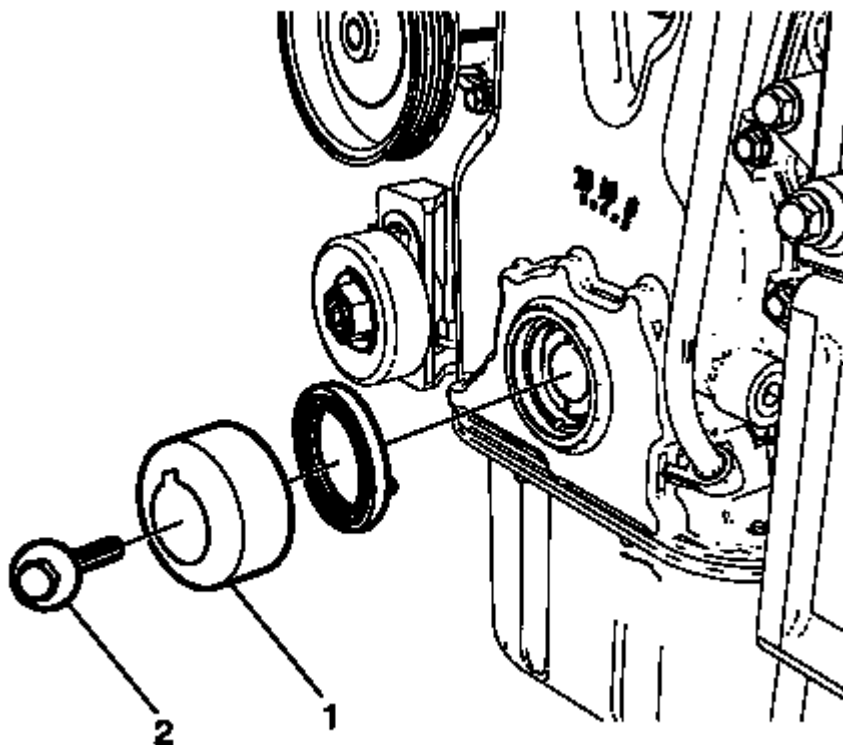


Fig. 387: Crankshaft Bolt And Crankshaft Front Oil Seal Installer
Courtesy of GENERAL MOTORS COMPANY

1. Position the NEW crankshaft front oil seal.
 1. Position the crankshaft front oil seal in such a way that the engine front cover is over the corresponding cut-out on the cylinder block.

NOTE: Do not press in the seal ring all the way.

2. Slide the crankshaft front oil seal over the crankshaft. Push, until the crankshaft front oil seal is flush and sits evenly in the cylinder block.
2. Install the **EN 50172** crankshaft front oil seal installer (1) to the crankshaft.
3. Tighten the **EN 50172** crankshaft front oil seal installer to crankshaft pulley retaining bolt (2).
4. Using the **EN 50172** crankshaft front oil seal installer, install the crankshaft front oil seal.
5. Remove the **EN 50172** crankshaft front oil seal installer (1).

OIL PAN INSTALLATION

NOTE: Cleaning of the sealing surfaces (1-4): Refer to Replacing Engine Gaskets.

1. Remove any old thread sealant, gasket material or sealant.
2. Clean the sealing surfaces of front cover and front cover components with solvent.

NOTE: Ensure that the sealing surface is clear of oil, grease and oil sealant material.

3. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

4. Dry the front cover and front cover components with compressed air.

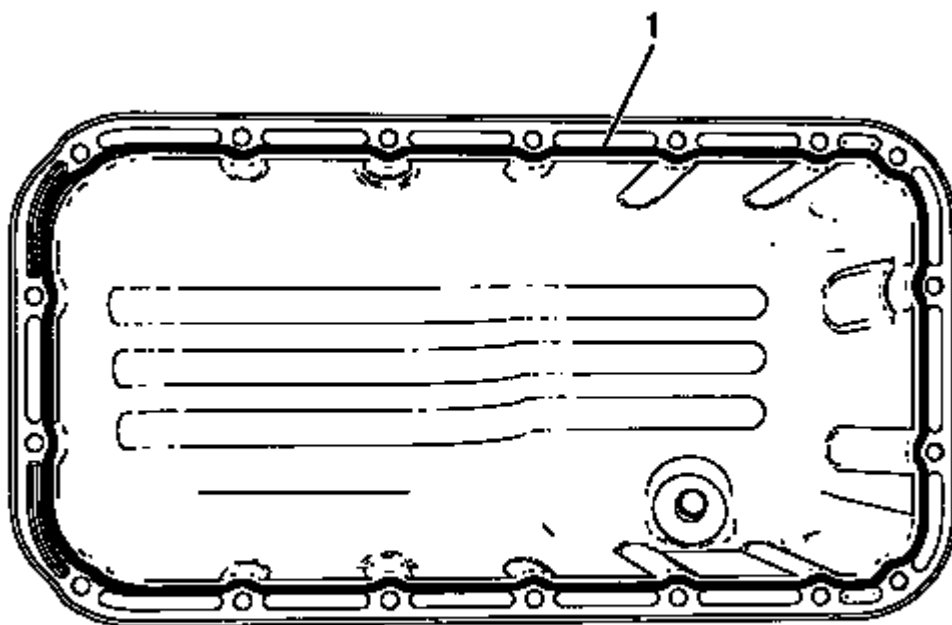


Fig. 388: Oil Pan Sealant

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use a new oil pan.

NOTE: Do not coat sealant (RTV) on the front cover bolt holes and bolt threads

5. Apply approximately a 4.5 mm (0.177 in) thick bead of oil pan sealant (1) to the oil pan.

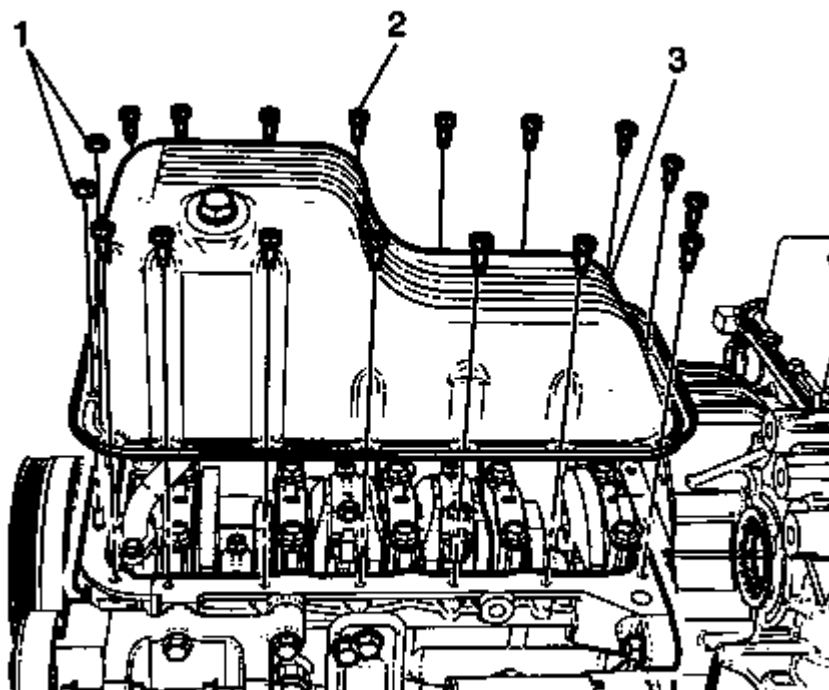


Fig. 389: Oil Pan Bolts And Nuts

Courtesy of GENERAL MOTORS COMPANY

6. Install the oil pan (3).
7. Install the 16 oil pan bolts (2) and 2 nuts (1).

CAUTION: Refer to Fastener Caution .

NOTE: After sealant (RTV) dispensing, the assembly completion time including torque check must be done within 8 minutes.

8. Tighten the oil pan bolts and nuts on the cylinder block to 10 (89 lb in).

CAMSHAFT COVER INSTALLATION

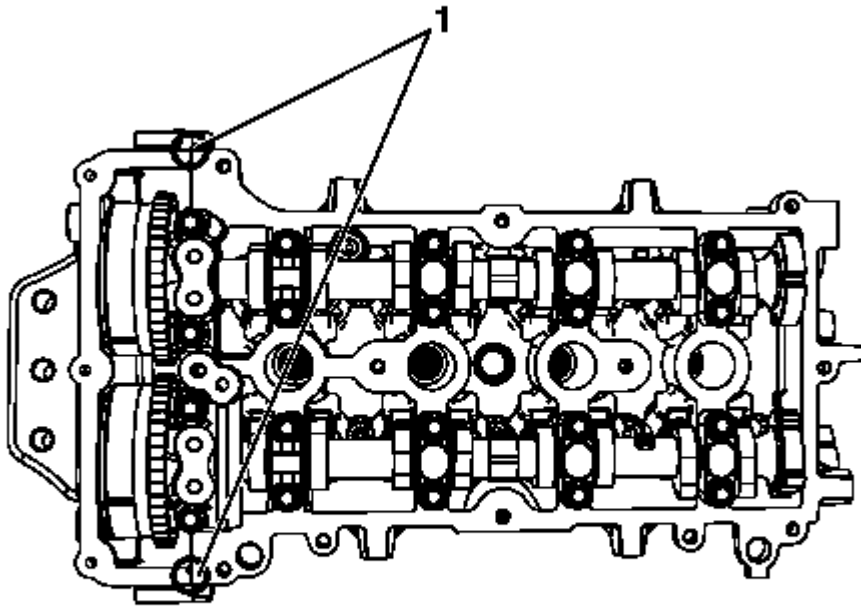


Fig. 390: Cured RTV Carefully

Courtesy of GENERAL MOTORS COMPANY

1. Remove the cured RTV carefully (1) and then clean the sealing surfaces.

NOTE: After RTV applying, the assembly completion time including torque check must be done within 8 minutes.

2. Apply RTV sealant to T-joint between cylinder head and front cover (1).

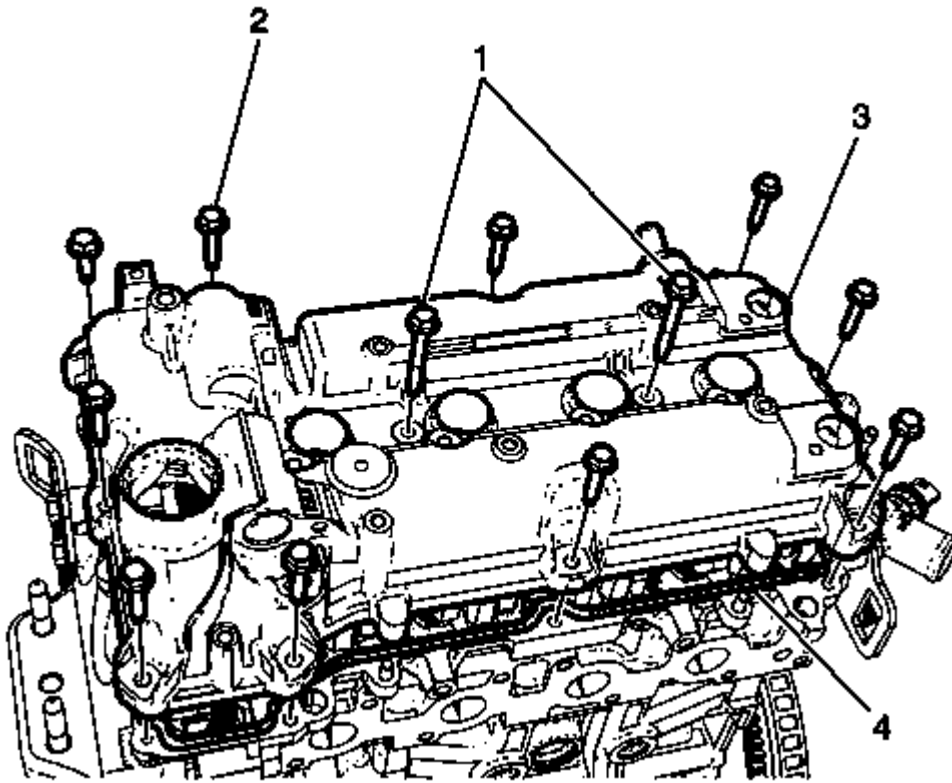


Fig. 391: Camshaft Cover Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Insert a NEW gasket (4) in the camshaft cover.
4. Install the camshaft cover (3).

CAUTION: Refer to Fastener Caution .

5. Install the camshaft cover 12 bolts (1, 2) and tighten to 10 (89 lb in).

IGNITION COIL INSTALLATION

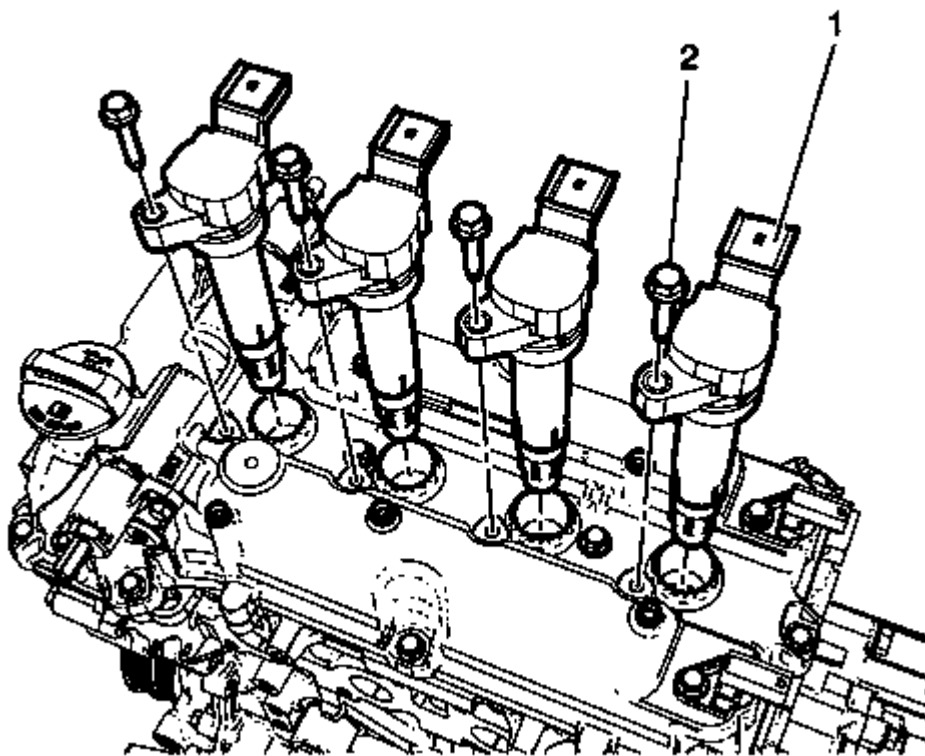


Fig. 392: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil (1).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolts (2) and tighten to 10 (89 lb in).

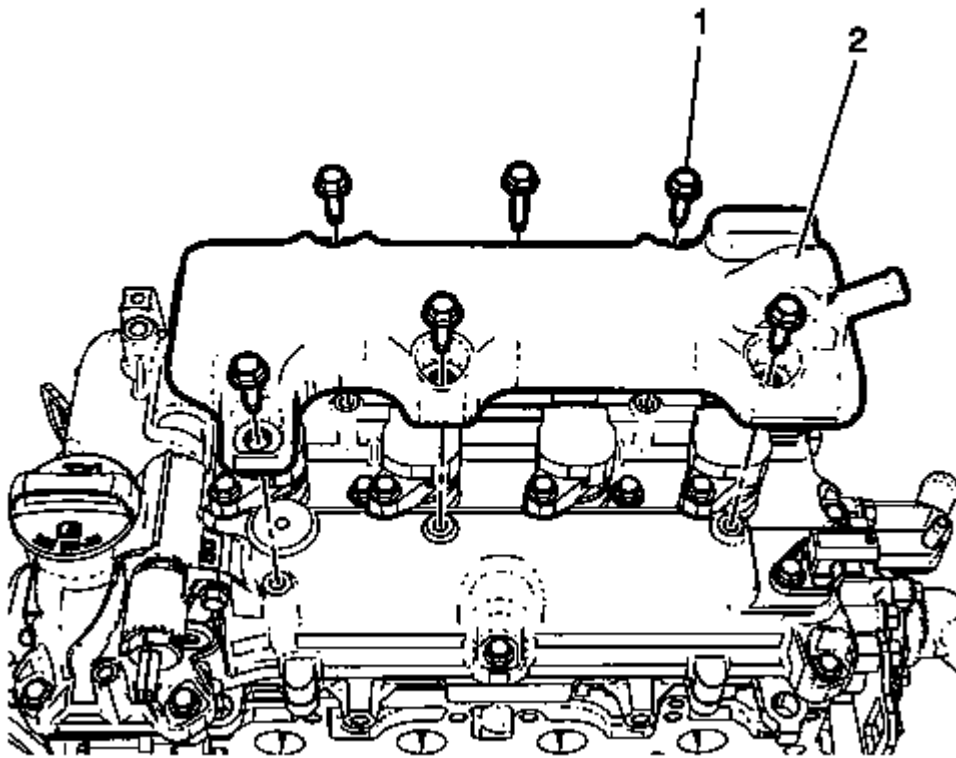


Fig. 393: Ignition Coil Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the ignition coil cover (2) and tighten the ignition coil cover bolts (1) to 10 (89 lb in).

OIL LEVEL INDICATOR AND TUBE INSTALLATION

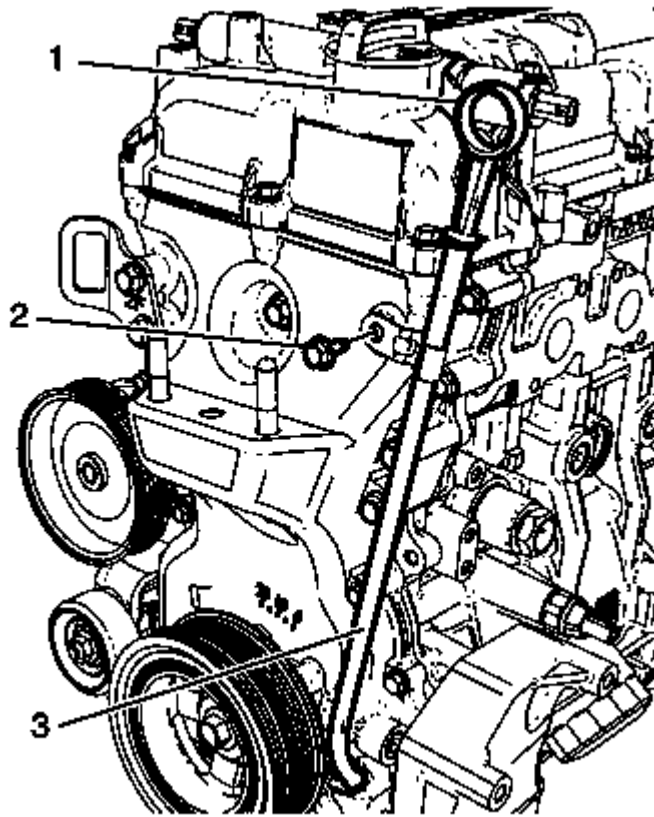


Fig. 394: Oil Dipstick And Oil Level Indicator Tube Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil level indicator tube (3) and oil level indicator seal and tighten the oil level indicator tube bolt (2) to 10 (89 lb in).
2. Install the oil dipstick (1).

INTAKE MANIFOLD INSTALLATION (LL0)

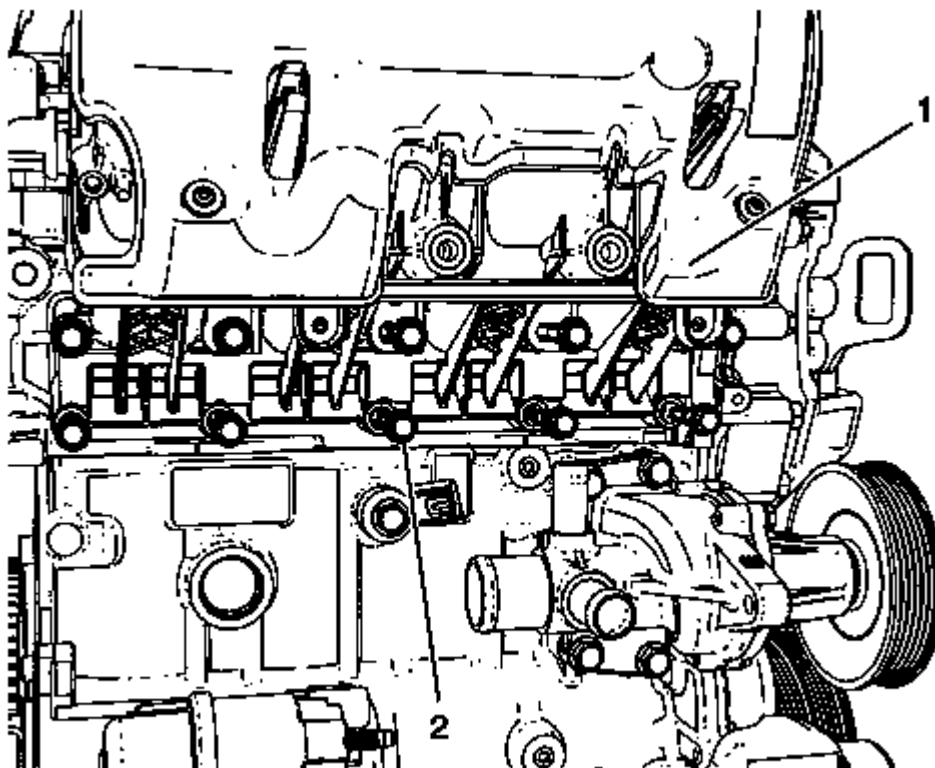


Fig. 395: Intake Manifold 10 Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the lower intake manifold (1) and tighten the bolts (2) to 10 (89 lb in)

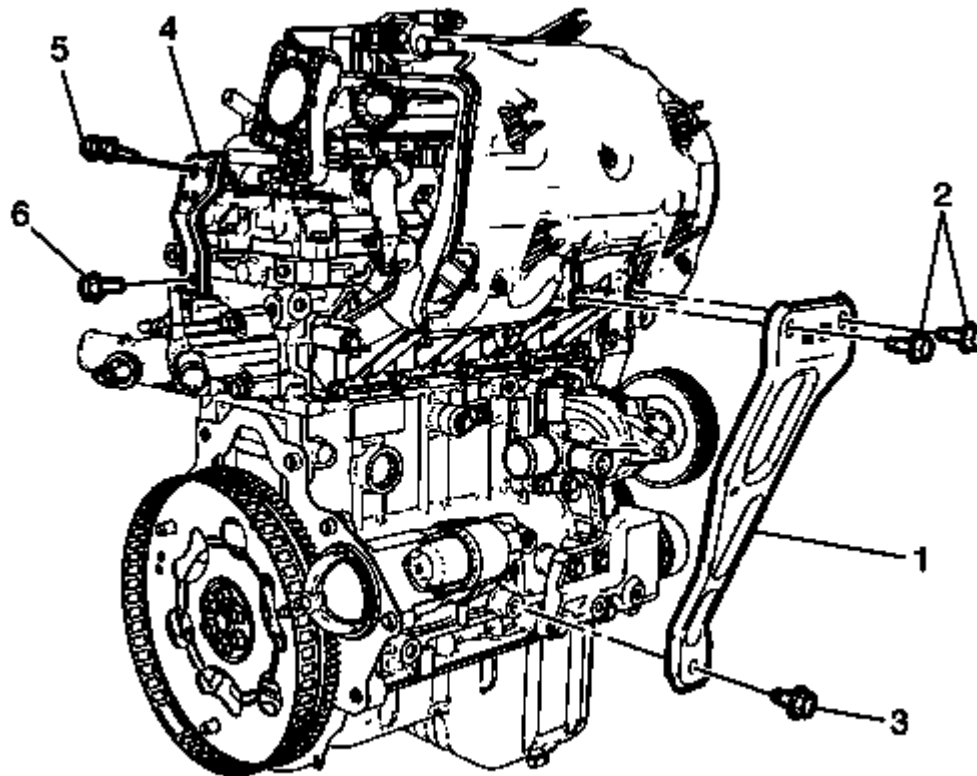


Fig. 396: Intake Manifold Upper Bracket
 Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold rear bracket (1) and tighten the bolts (2) to 22 (18 lb ft).
3. Install the intake manifold rear bracket bolt (3) and tighten to 58 (42 lb ft).
4. Install the upper intake manifold side bracket (4) and tighten the bolts (5) to 10 (89 lb in).
5. Install the upper intake manifold side bracket bolt (6) and tighten to 10 (89 lb in)

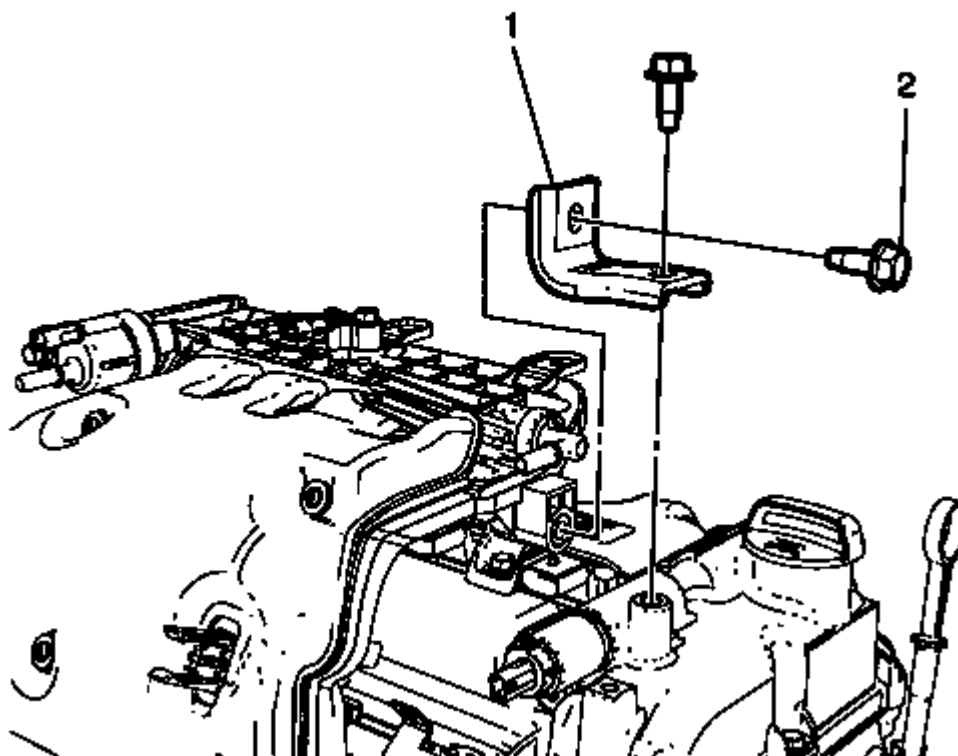


Fig. 397: Intake Manifold Upper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the intake manifold upper bracket (1) tighten the bolts (2) to 25 (18 lb ft).

INTAKE MANIFOLD INSTALLATION (LFM)

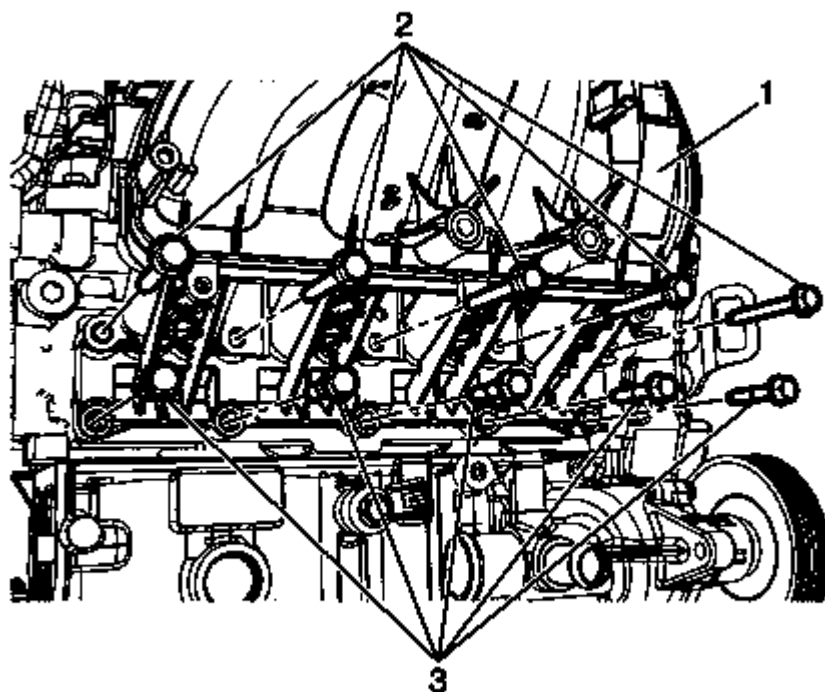


Fig. 398: Lower Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the lower intake manifold (1) and tighten the lower intake manifold bolts (2, 3) to 10 (89 lb in).

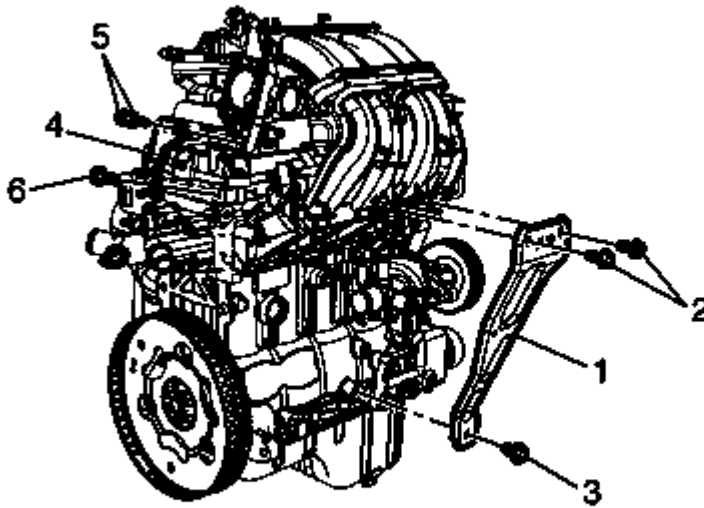


Fig. 399: Intake Manifold Rear Bracket

Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold rear bracket (1) and tighten the intake manifold rear bracket bolts (up) (2) to 22 (16 lb ft).
3. Install the intake manifold rear bracket bolt (down) (3) and tighten to 58 (42 lb ft).
4. Install the upper intake manifold side bracket (4) and tighten the upper intake manifold side bracket bolts (5) to 10 (89 lb in).
5. Install the upper intake manifold side bracket bolt (6) and tighten to 25 (18 lb ft).

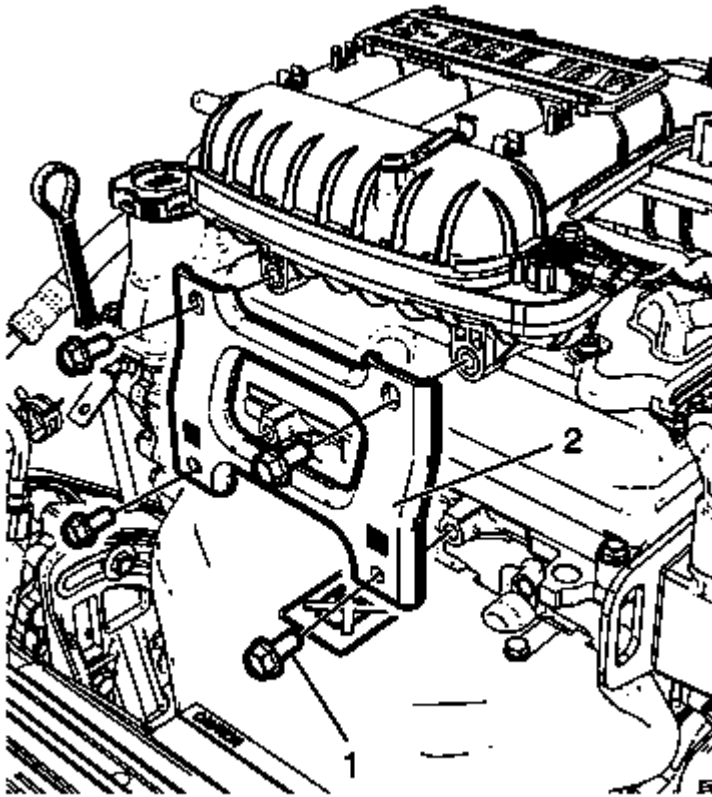
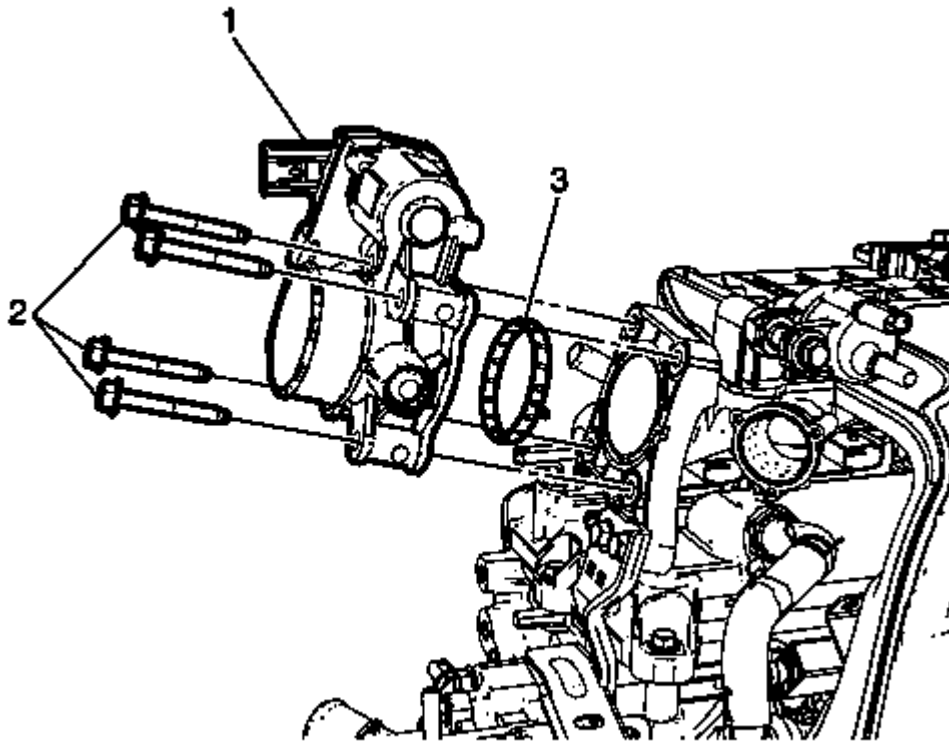


Fig. 400: Upper Intake Manifold Front Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the upper intake manifold front bracket (2), tighten the upper intake manifold front bracket bolts (1) to 25 (18 lb ft).

THROTTLE BODY ASSEMBLY INSTALLATION

**Fig. 401: Throttle Body Assembly****Courtesy of GENERAL MOTORS COMPANY**

1. Install the new throttle body seal (3).
2. Install the throttle body (1).

CAUTION: Refer to Fastener Caution .

3. Install the 4 throttle body bolts (2) and tighten to 10 (89 lb in).

ENGINE WATER OUTLET ADAPTER INSTALLATION

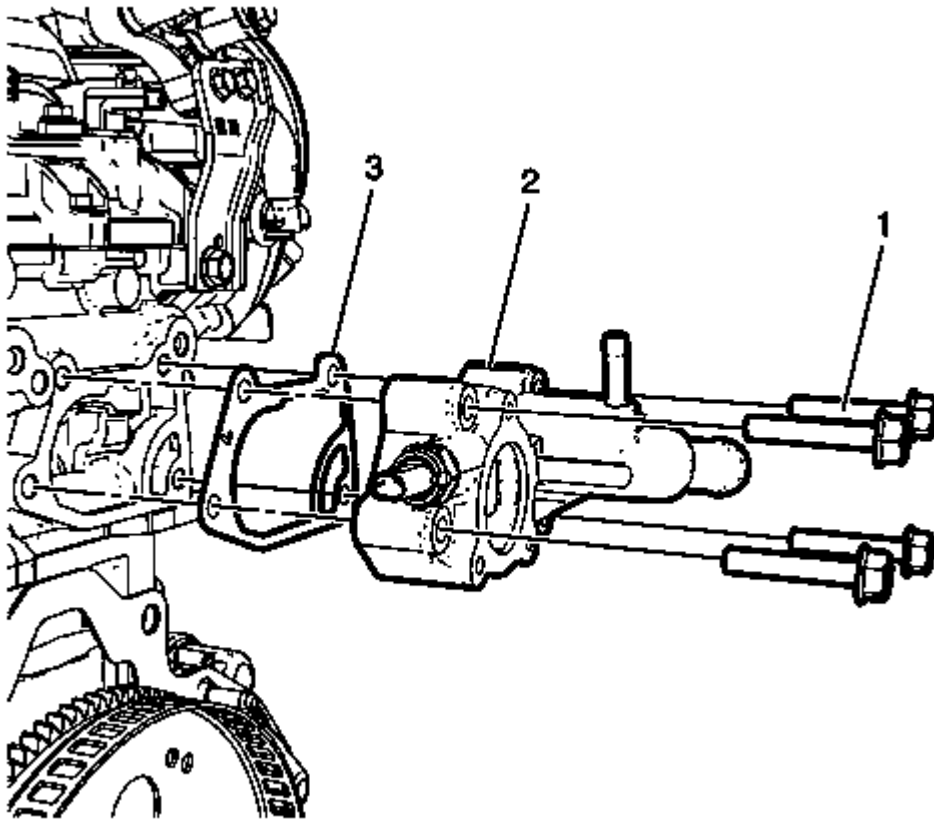


Fig. 402: Engine Water Outlet Adapter Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine coolant outlet adapter housing (2) and a NEW gasket (3).

CAUTION: Refer to Fastener Caution .

2. Install the 4 engine coolant outlet adapter housing bolts (1) and tighten to 25 (18 lb ft).

ENGINE COOLANT THERMOSTAT INSTALLATION

1. Clean the engine coolant sealing surfaces.

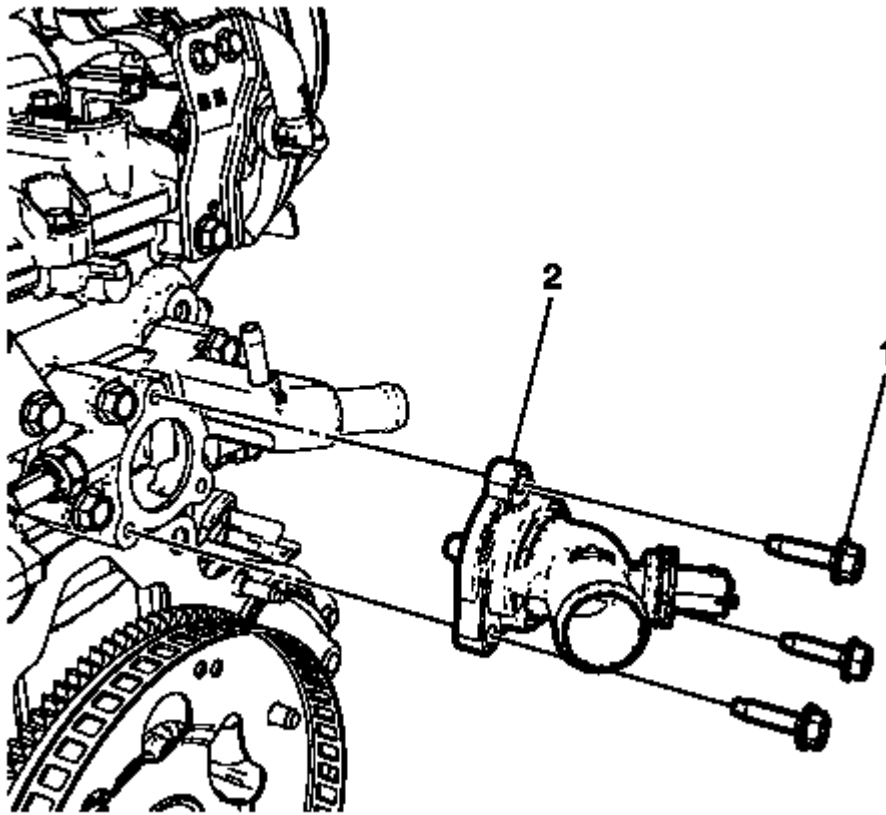


Fig. 403: Engine Coolant Thermostat Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine coolant thermostat assembly (2).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

CAUTION: Refer to Fastener Caution .

3. Install the 3 engine coolant thermostat bolts (1) and tighten to 10 (89 lb ft).

AIR CONDITIONING COMPRESSOR BRACKET INSTALLATION

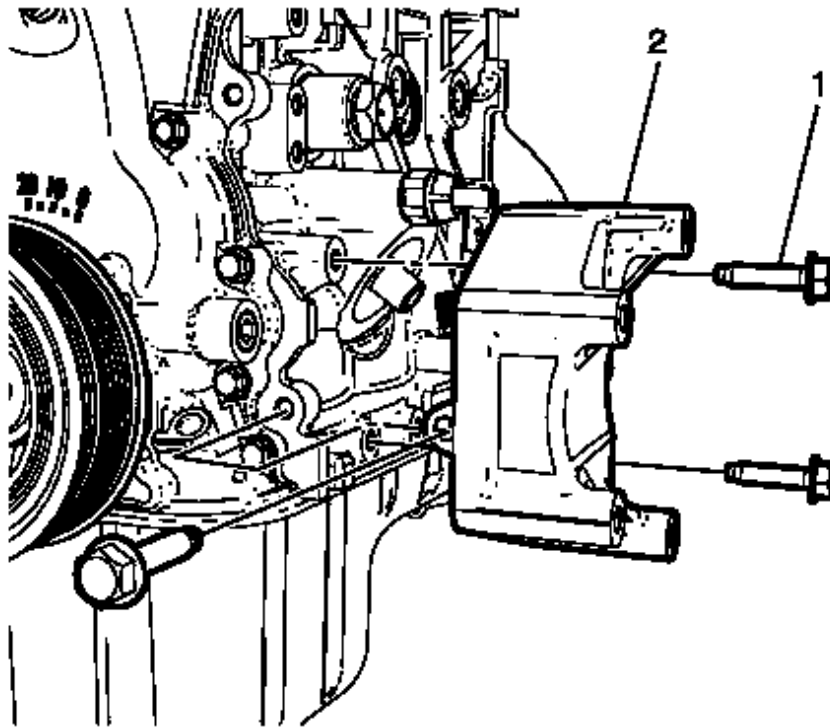


Fig. 404: Air Conditioning Compressor Bolts And Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the air conditioning compressor bracket (2).

CAUTION: Refer to Fastener Caution .

2. Install the 3 air conditioning compressor bracket bolts (1) and tighten to 22 (16 lb ft).

GENERATOR BRACKET INSTALLATION

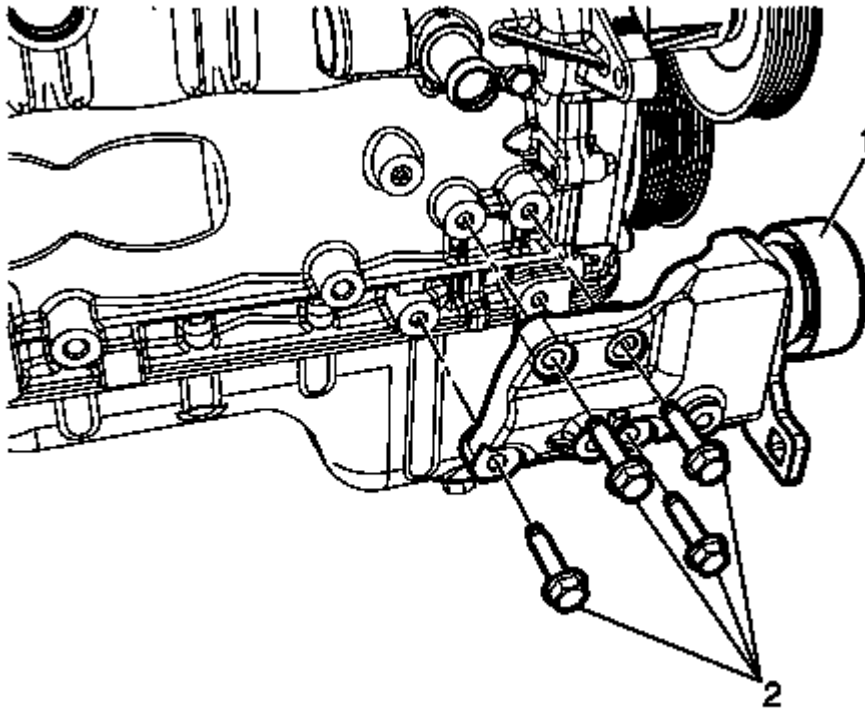


Fig. 405: Generator Bracket Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

Install the generator bracket (1), generator retaining bolts (2) and tighten to 22 (16 lb ft).

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSTALLATION

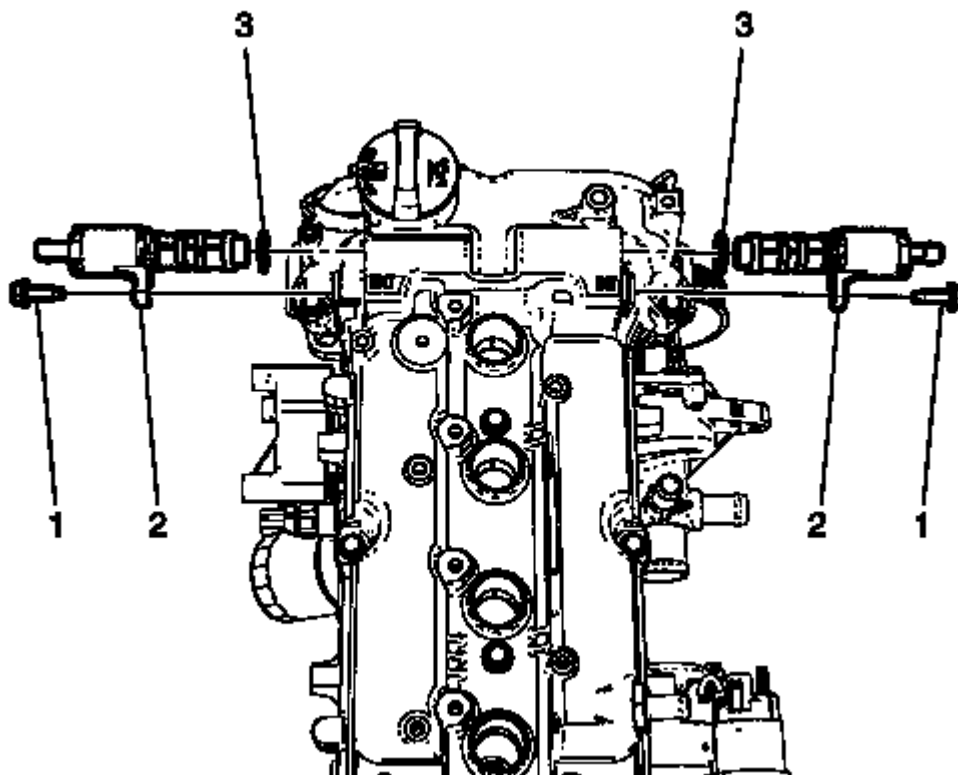


Fig. 406: Camshaft Position Actuator Solenoid Valve Bolts And Valves
Courtesy of GENERAL MOTORS COMPANY

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 10 (89 lb in).

CRANKSHAFT SPROCKET INSTALLATION

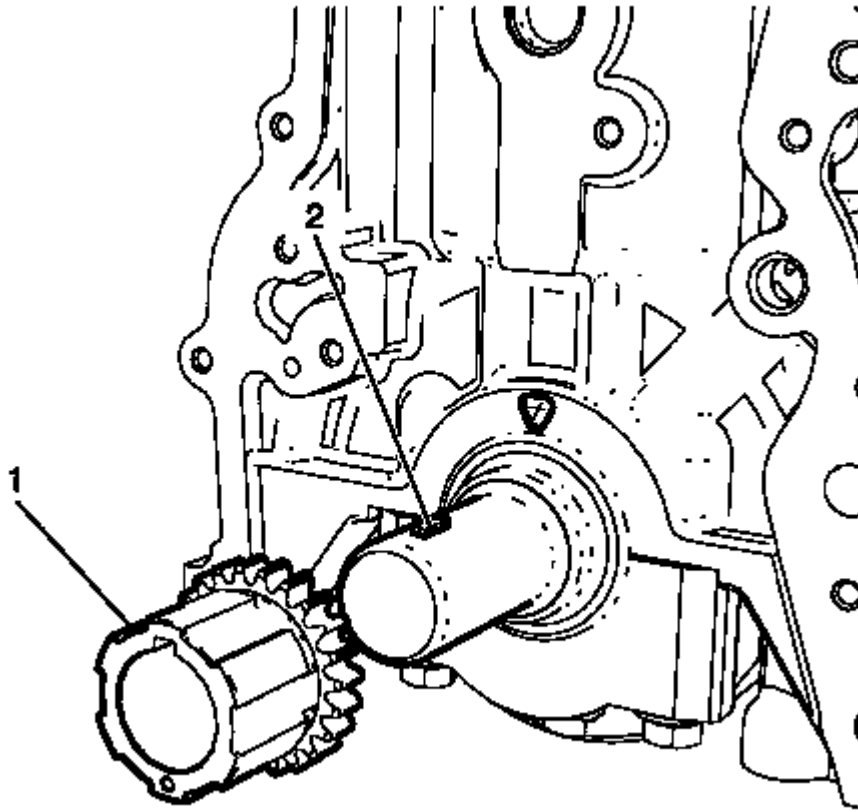


Fig. 407: Crankshaft Sprocket

Courtesy of GENERAL MOTORS COMPANY

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

Install the crankshaft sprocket (1).

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN 50175** Crankshaft Locking Device
- **EN-51218** Crankshaft Balancer Installer

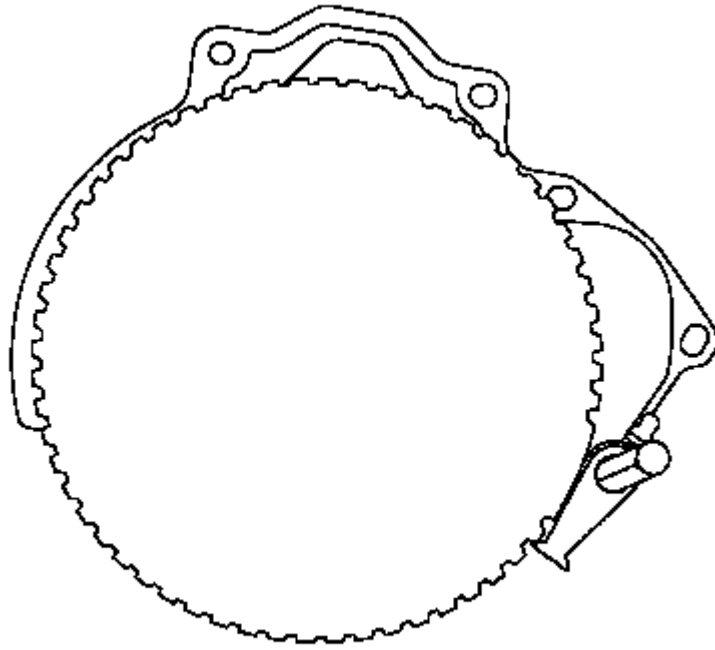


Fig. 408: EN-50050 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 50050** crankshaft locking device. Lock the flywheel via the starter ring gear.

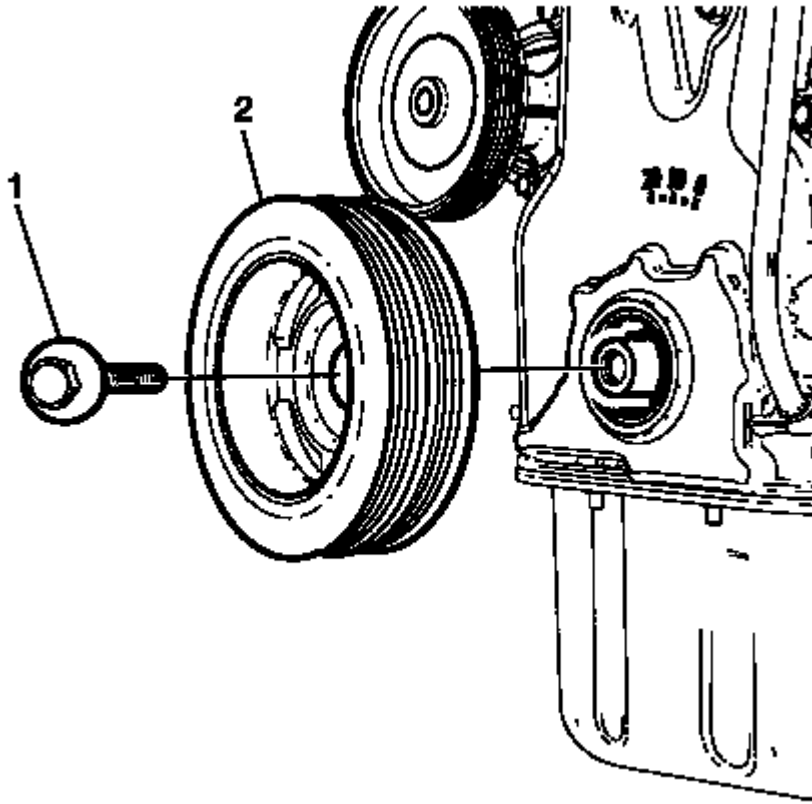


Fig. 409: Crankshaft Balancer Bolt
 Courtesy of GENERAL MOTORS COMPANY

2. Install **EN-51218** crankshaft balancer installer or equivalent to the crankshaft balancer (2).

CAUTION: Refer to Fastener Caution .

NOTE: When installing the crankshaft balancer, the cam and the groove must align.

3. Install the crankshaft balancer (2) to the crankshaft and tighten the bolt (1) to $95 + 55^\circ$ (70 lb ft + 55°).

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

EN 50050 Crankshaft Locking Device

For equivalent regional tools, refer to Special Tools.

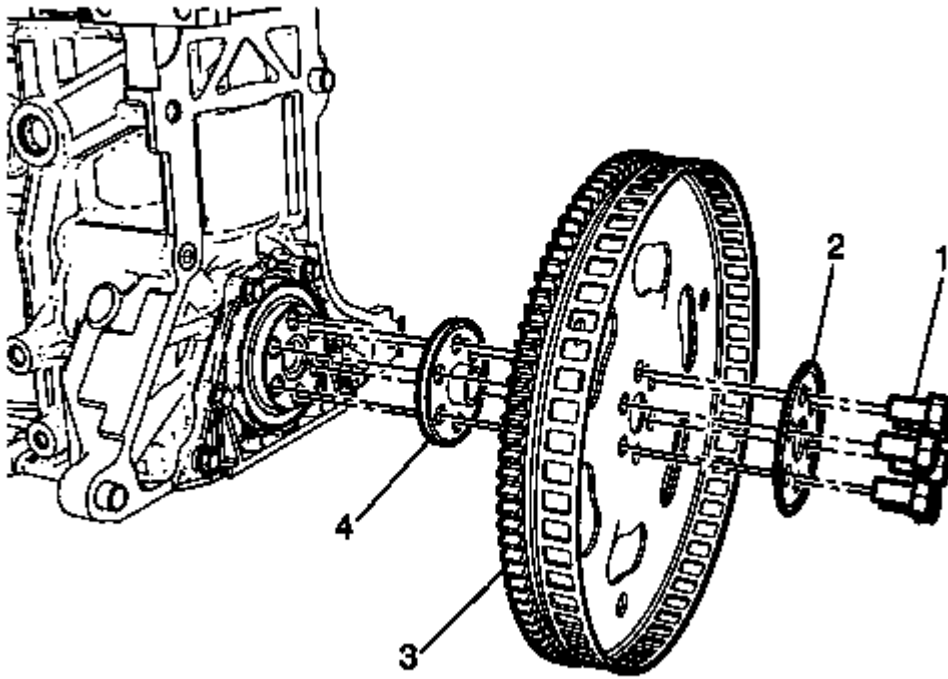


Fig. 410: Automatic Transmission Flex Plate Bolts And Automatic Transmission Flex Plate Retainer

Courtesy of GENERAL MOTORS COMPANY

1. Install the automatic transmission flex plate spacer (4).
2. Install the automatic transmission flex plate (3).
3. Install the automatic transmission flex plate retainer (2).
4. Install the 6 automatic transmission flex plate bolts (1).

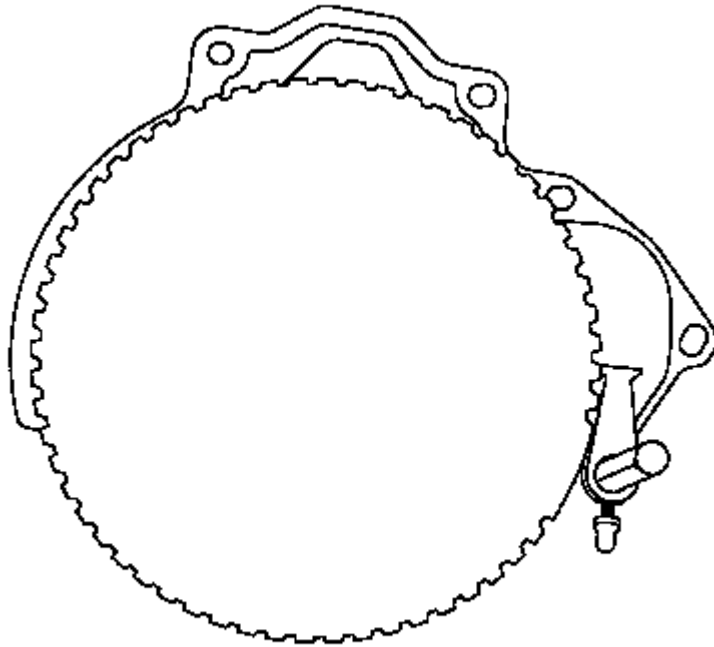


Fig. 411: EN 50050 Crankshaft Locking Device
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN 50050** crankshaft locking device, lock the automatic transmission flex plate via the starter ring gear.

CAUTION: Refer to Fastener Caution .

6. Tighten the 6 automatic transmission flex plate bolts to 20 + 25° (15 lb ft + 25°).
7. Remove the **EN 50050** crankshaft locking device.

ENGINE FLYWHEEL INSTALLATION

Special Tools

EN-50050 Crankshaft Locking Device

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

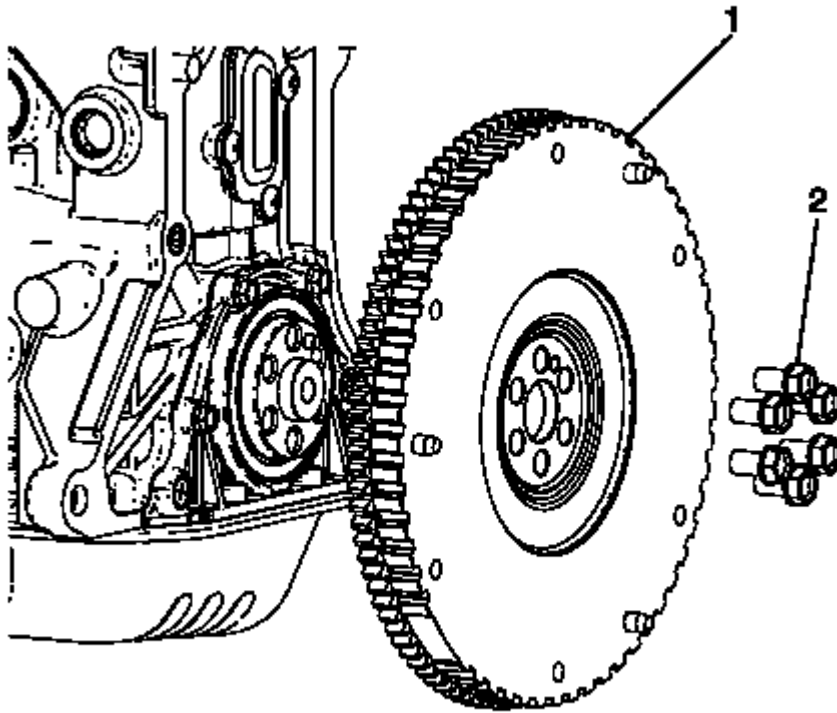


Fig. 412: Flywheel And Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install the flywheel (1).
2. Install the 6 flywheel bolts (2).
3. Install the **EN-50050** crankshaft locking device and lock the flywheel via the starter ring gear.

CAUTION: Refer to Fastener Caution .

4. Tighten the 6 flywheel bolts to 20 (15 lb ft + 25°).
5. Remove the **EN-50050** crankshaft locking device.

EXHAUST MANIFOLD HEAT SHIELD REMOVAL

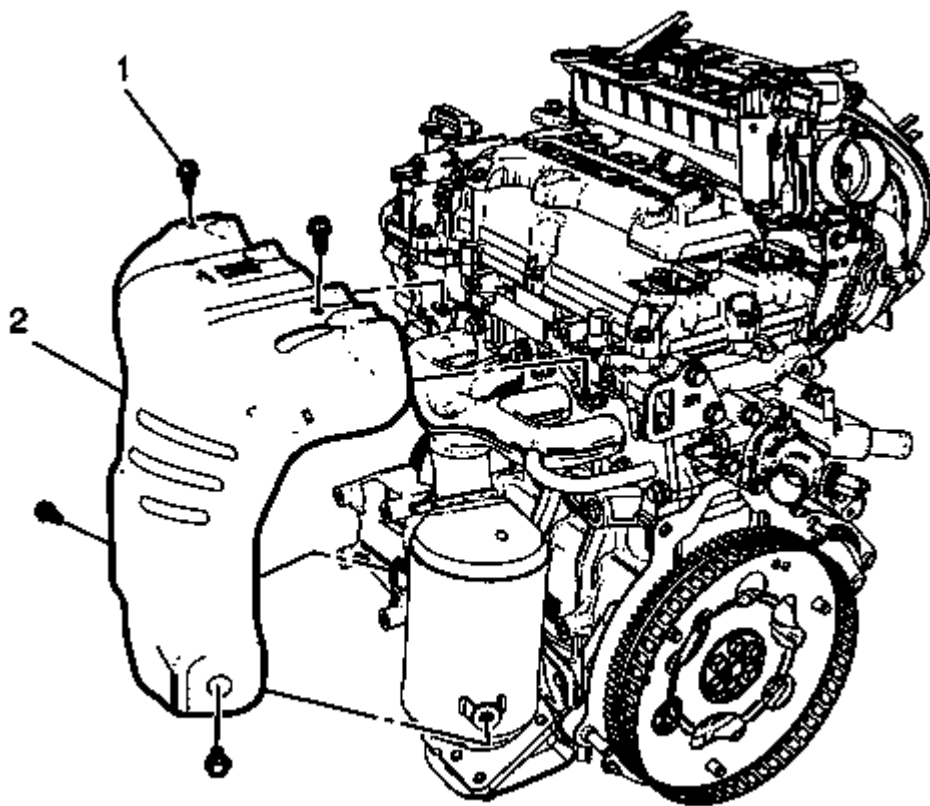


Fig. 413: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 exhaust manifold heat shield bolts (1).
2. Remove the exhaust manifold heat shield (2).

EXHAUST MANIFOLD REMOVAL

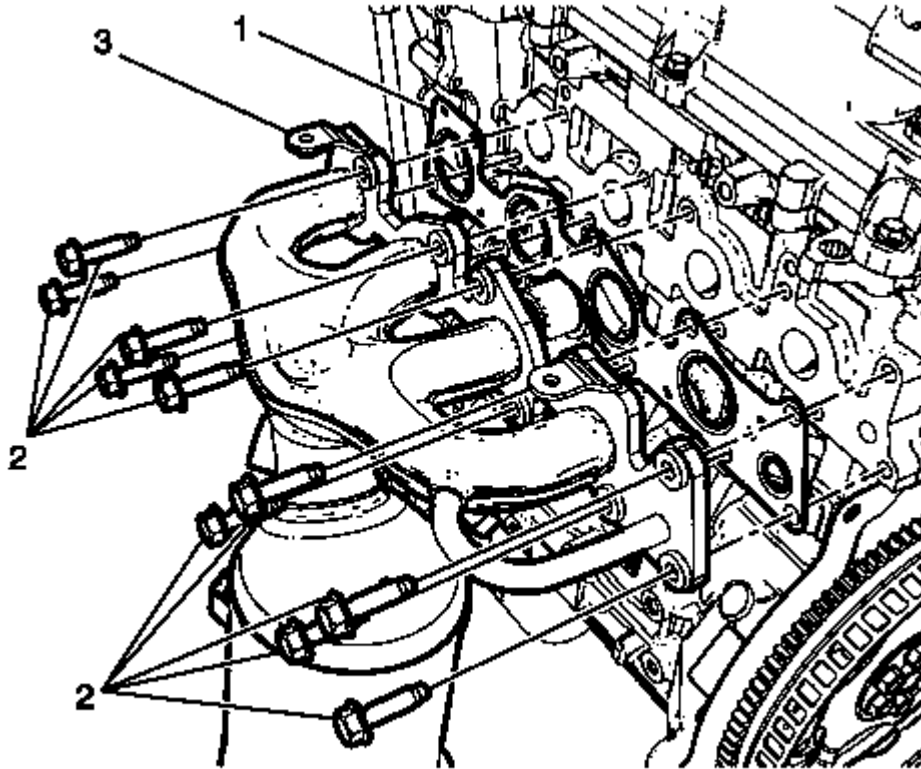


Fig. 414: Exhaust Manifold Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 10 exhaust manifold bolts (2).
2. Remove the exhaust manifold (3) and gasket (1).
3. Clean all of the gasket surfaces.

CYLINDER HEAD DISASSEMBLE

Special Tools

- **EN 46116** Valve Stem Seal Remover/Installer
- **EN 46569** Valve Spring Compressor - Head Off
- **EN 49075** Valve Spring Compressor Adapter

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

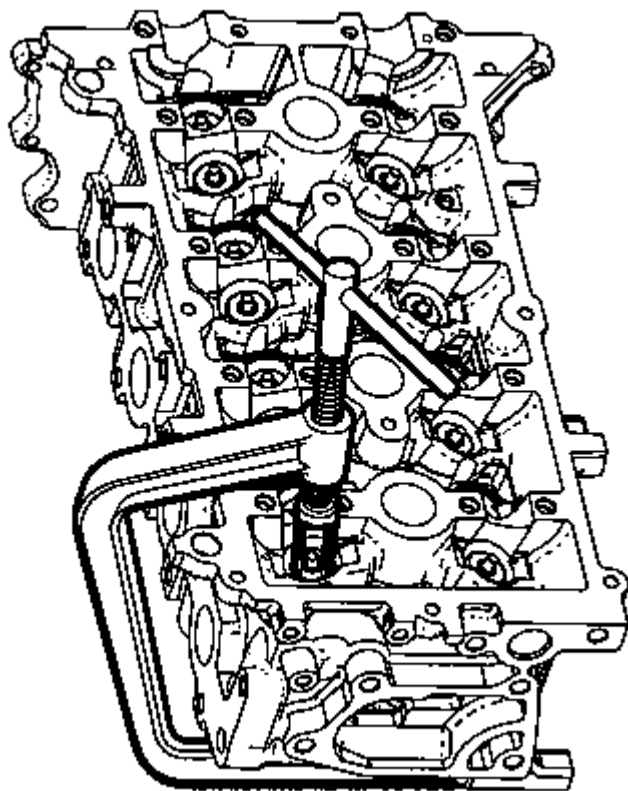


Fig. 415: EN 46569 Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

1. Compress the valve spring using the **EN 46569** valve spring compressor - head off and the **EN 49075** valve spring compressor adapter.
2. Use the magnet of the in order to remove the valve collets.
3. Remove the valve spring compressor and the adapter.

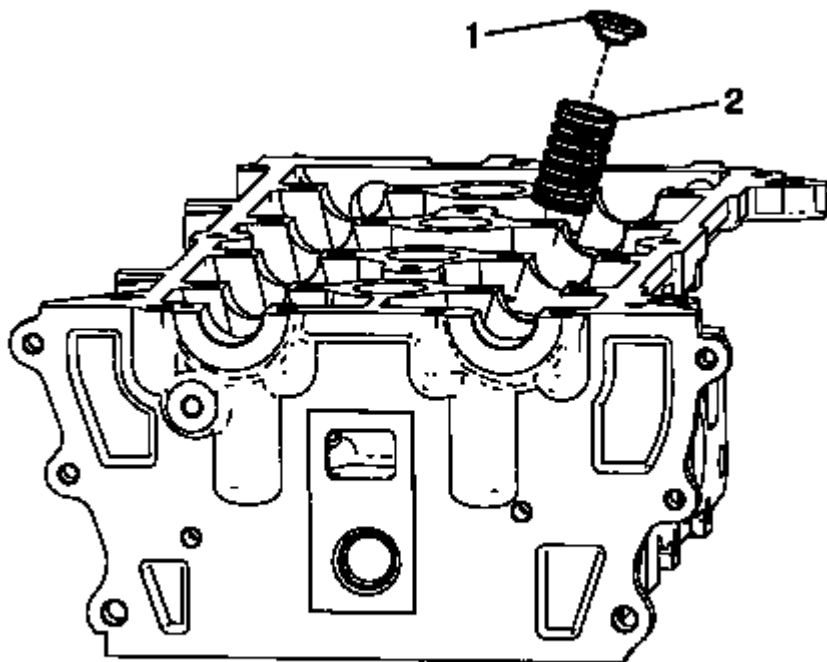


Fig. 416: Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

4. Remove the valve spring retainer (1).
5. Remove the valve spring (2).

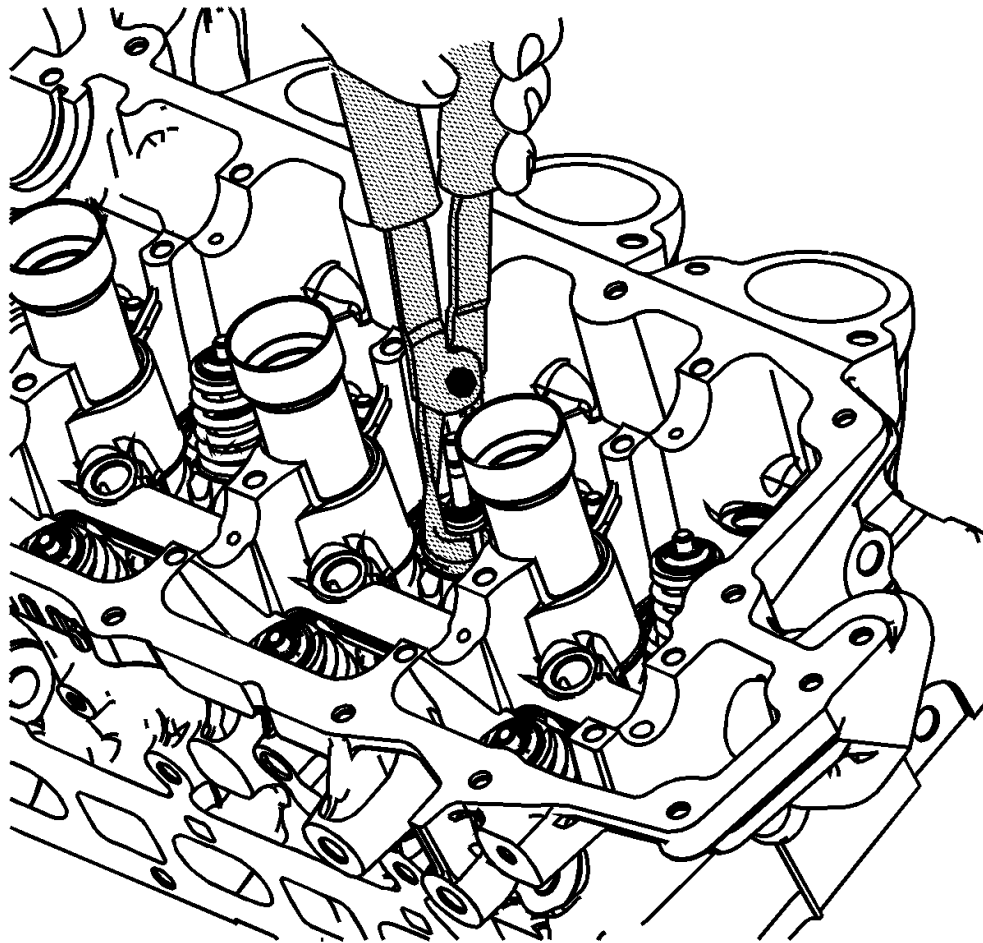


Fig. 417: View of Special Tool EN 46116 & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: **NEVER** reuse a valve stem oil seal.

6. Remove the valve stem oil seal using the **EN 46116** valve stem seal remover/installer.
7. Discard the valve stem oil seals.

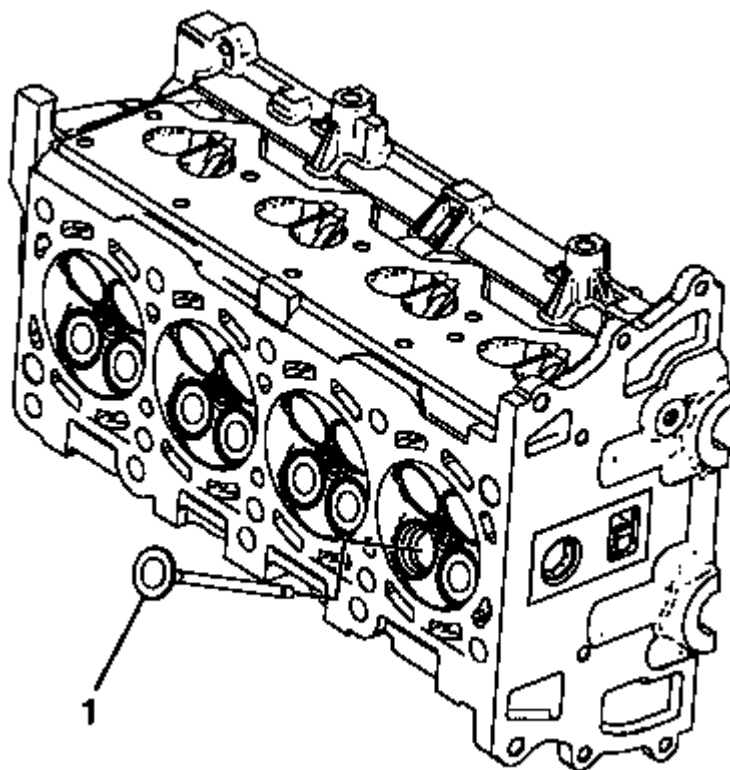


Fig. 418: Valve

Courtesy of GENERAL MOTORS COMPANY

8. Remove the valve (1).
9. Repeat these procedures for the remaining valves.

CYLINDER HEAD CLEANING AND INSPECTION

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all cylinder head surfaces with non-corrosive solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chambers.
5. Clean any debris or build-up from the lifter pockets.

Visual Inspection

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
 - Scoring or pitting above acceptable tolerances
 - Discoloration from overheating
 - Deformation from wear above acceptable tolerances
 - If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.
2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
 - Cracks, damage or pitting in the combustion chambers
 - Debris in the oil galleries-Continue to clean the galleries until all debris is removed.
 - Coolant leaks or damage to the deck face sealing surface-If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
 - Burrs or any defects that may degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
 - Damage to any gasket surfaces
 - Damage to any threaded bolt holes
 - Burnt or eroded areas in the combustion chamber
 - Cracks in the exhaust ports and combustion chambers
 - External cracks in the water passages
 - Restrictions in the intake or exhaust passages
 - Restrictions in the cooling system passages
 - Rusted, damaged or leaking core plugs
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.

Cylinder Head Measurement

Deck Flatness Inspection

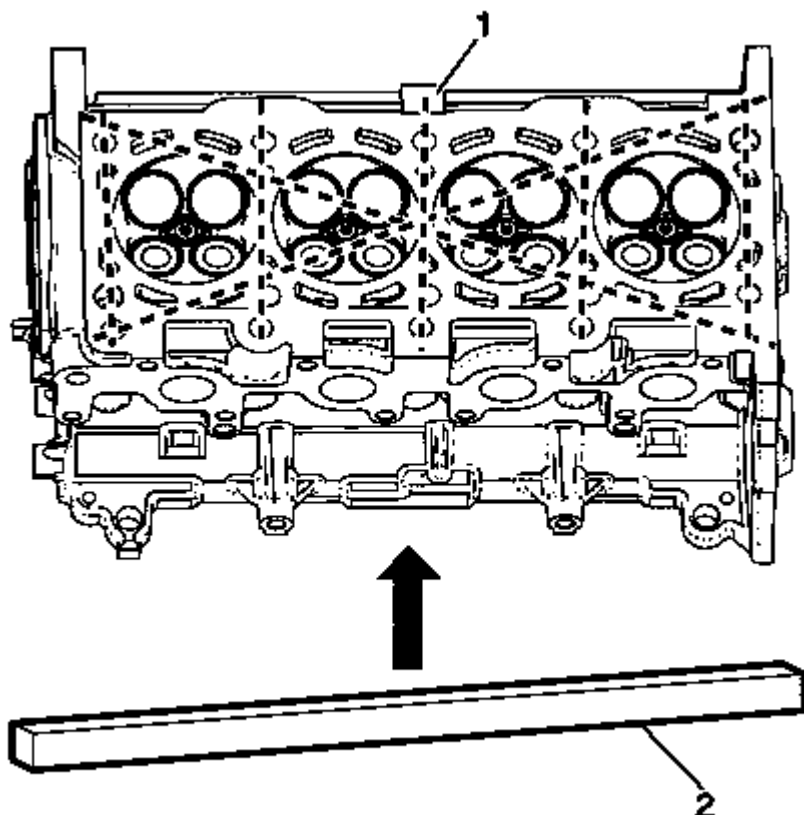


Fig. 419: Cylinder Head And Straight-Edge
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head (1) decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that may inhibit correct cylinder head gasket sealing.
3. Place a straight-edge (2) diagonally across the cylinder head (1) deck face surface.
4. Measure the clearance between the straight-edge (2) and the cylinder head (1) deck face using a feeler gage at 4 points along the straight-edge (2).
 - If the warpage is less than 0.05 mm (0.002 in), the cylinder head (1) deck surface does not require resurfacing.
 - If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that may inhibit correct cylinder head gasket sealing are present, the cylinder head (1) deck surface requires resurfacing.
 - If the cylinder head (1) deck surface requires more than 0.25 mm (0.010 in) material removal the cylinder head (1) must be replaced.

CYLINDER HEAD ASSEMBLE

Special Tools

- **EN 46116** Valve Stem Seal Remover/Installer
- **EN 46569** Valve Spring Compressor - Head Off
- **EN 49075** Valve Spring Compressor Adapter

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

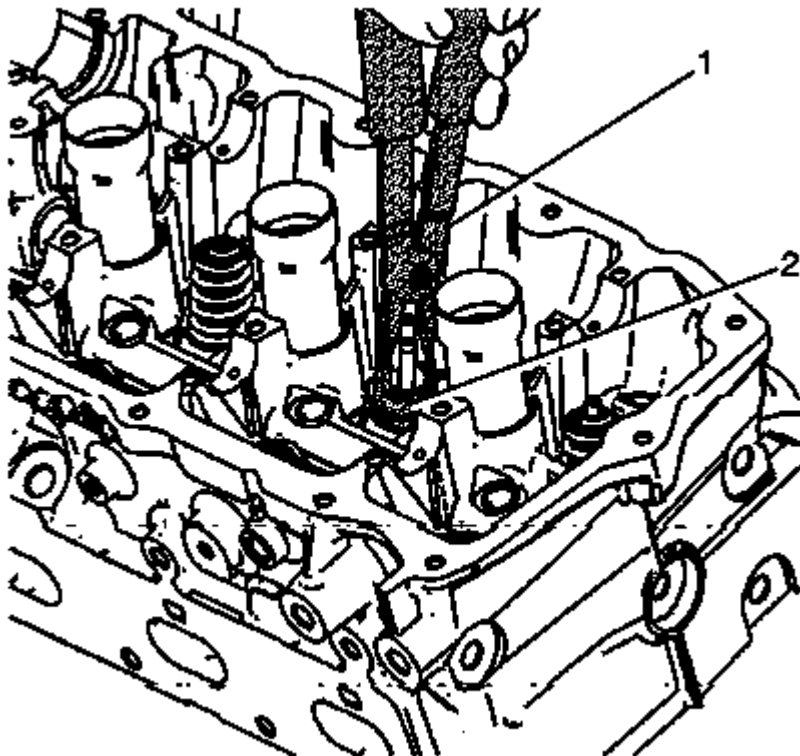


Fig. 420: View Of EN 46116 & Valve Stem Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **NEVER** reuse a valve stem oil seal (2). Always use new seals when assembling the cylinder head.

1. Mount a new valve stem oil seal (2) using the **EN 46116** valve stem seal remover/installer.

NOTE: **Force should only be applied to the valve spring contact area of the new valve stem oil seal (2) during installation.**

2. Push and twist the valve stem oil seal (2) into position on the valve guide until the seal positively locks on the guide using the **EN 46116** valve stem seal remover/installer.
3. Lubricate the valve stem and valve guide ID with clean engine oil.

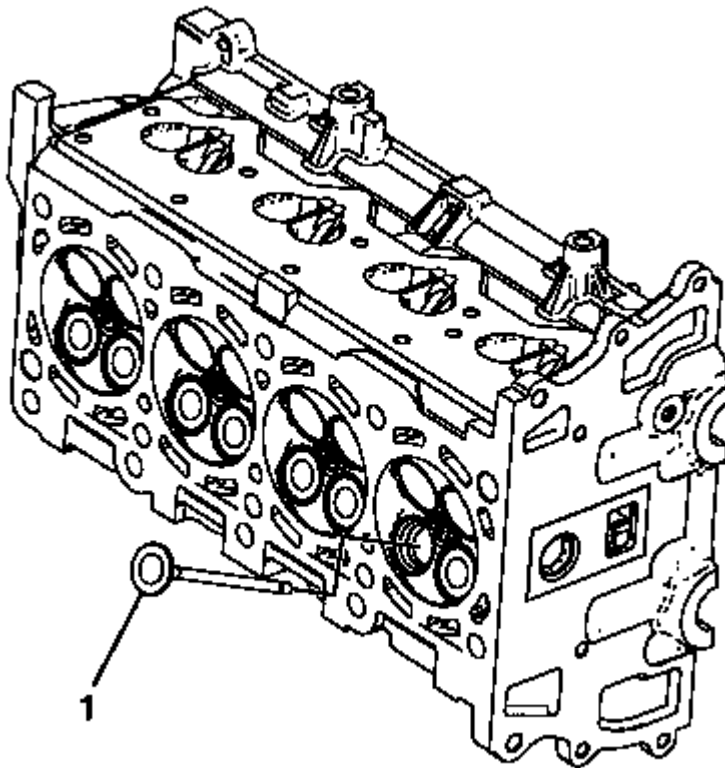


Fig. 421: Valve

Courtesy of GENERAL MOTORS COMPANY

NOTE: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

4. Insert the valve (1) into the valve guide until it bottoms on the valve seat.

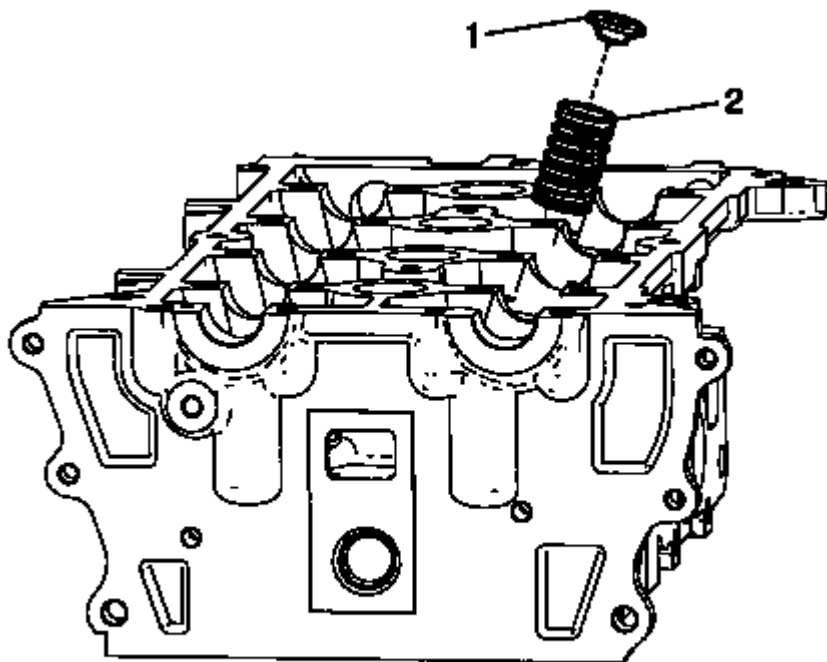


Fig. 422: Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring (2).
6. Place the valve spring retainer (1) onto the valve spring (2).

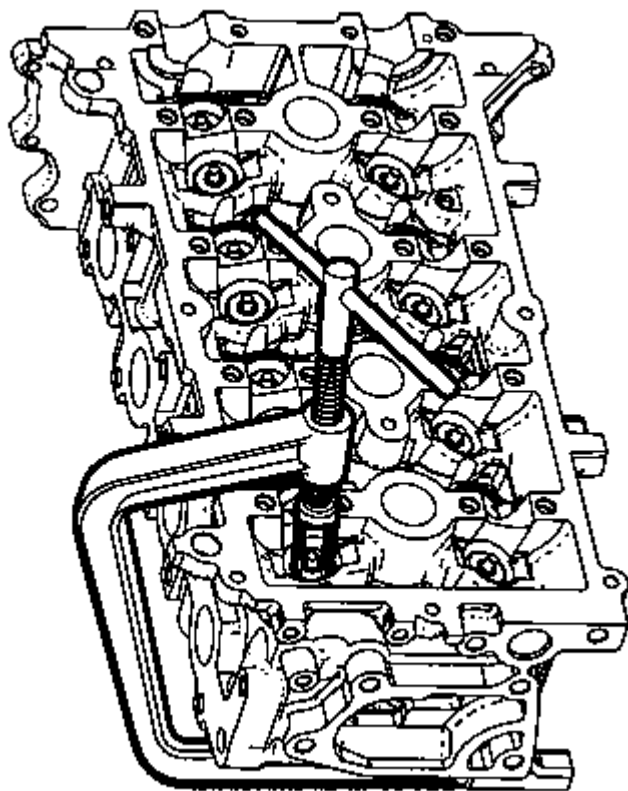


Fig. 423: EN 46569 Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

7. Compress the valve spring using the **EN 46569** valve spring compressor - head off and the **EN 49075** valve spring compressor adapter.

NOTE: Ensure correct directional placement of valve collets. The valve collets must be installed with the tapered end towards the valve stem seal.

8. With the spring compressed, install the valve collets.

9. Remove the **EN 46569** valve spring compressor - head off and the **EN 49075** valve spring compressor adapter.
10. Verify that the valve collets are installed by placing a rag over the valve tip and tapping with a dead-blow hammer. The valve keepers and the spring should remain in place.

EXHAUST MANIFOLD INSTALLATION

1. Clean the exhaust manifold sealing surface.

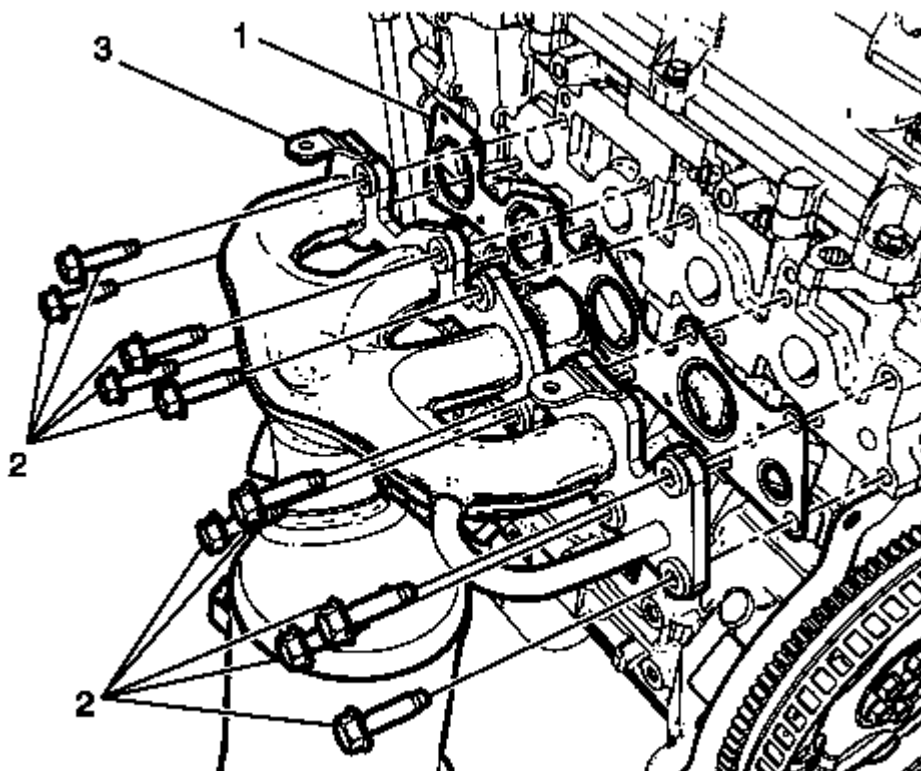


Fig. 424: Exhaust Manifold Bolts

Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW exhaust manifold gasket (1) to the exhaust manifold.
3. Install the exhaust manifold (3).

CAUTION: Refer to Fastener Caution .

4. Install the new exhaust manifold bolts (2) and tighten to 20 (15 lb ft).

EXHAUST MANIFOLD HEAT SHIELD INSTALLATION

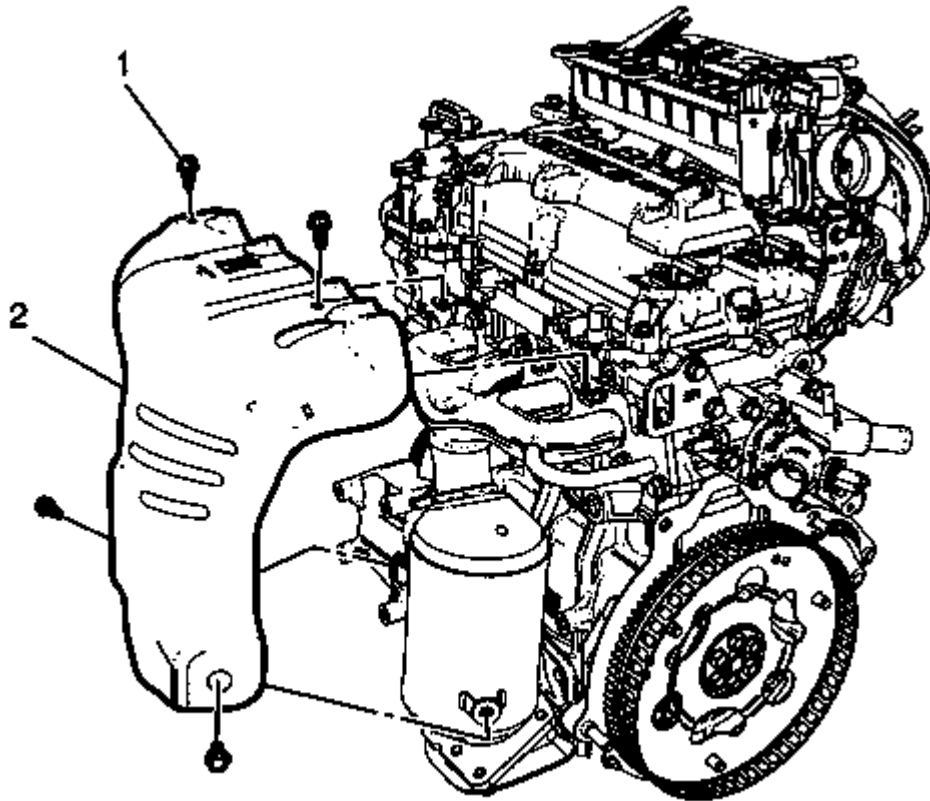


Fig. 425: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust manifold heat shield (2).

CAUTION: Refer to Fastener Caution .

2. Install the 4 exhaust manifold heat shield bolts (1) and tighten to 9 (80 lb in).

DESCRIPTION AND OPERATION

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 stamping (steel) component include baffle and oil drain plug. The oil pan is attached at the engine block.

Piston and Connecting Rod

The pistons are aluminum pistons with anodized top ring groove. The connecting rods are fractured steel connecting rods with bushing and floating pin type.

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 chain is used for camshaft drive. There is a tensioner to control the tension of the chain.

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, driveability, 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.

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.

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.

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

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 over tighten.

Cleaning Sealant (RTV) Surface and Application

- Sealant (RTV) sealing surface and mating surface must be free of any evidence oils, machining fluids and any liquid or solid residue on sealing surface to assure sealant (RTV) adhesion.
- Clean approved solvent based cleaner (LPS Precision, Zero TRI cleaner (PN03520) with dry lint-free clothes to wipe surface. Lint-free cloths cannot be reused.
- In case of maximum open time (8 minutes) with joint not closed after RTV dispensing, Remove cured sealant (RTV) squeeze-out carefully.

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 over tighten.

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

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wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

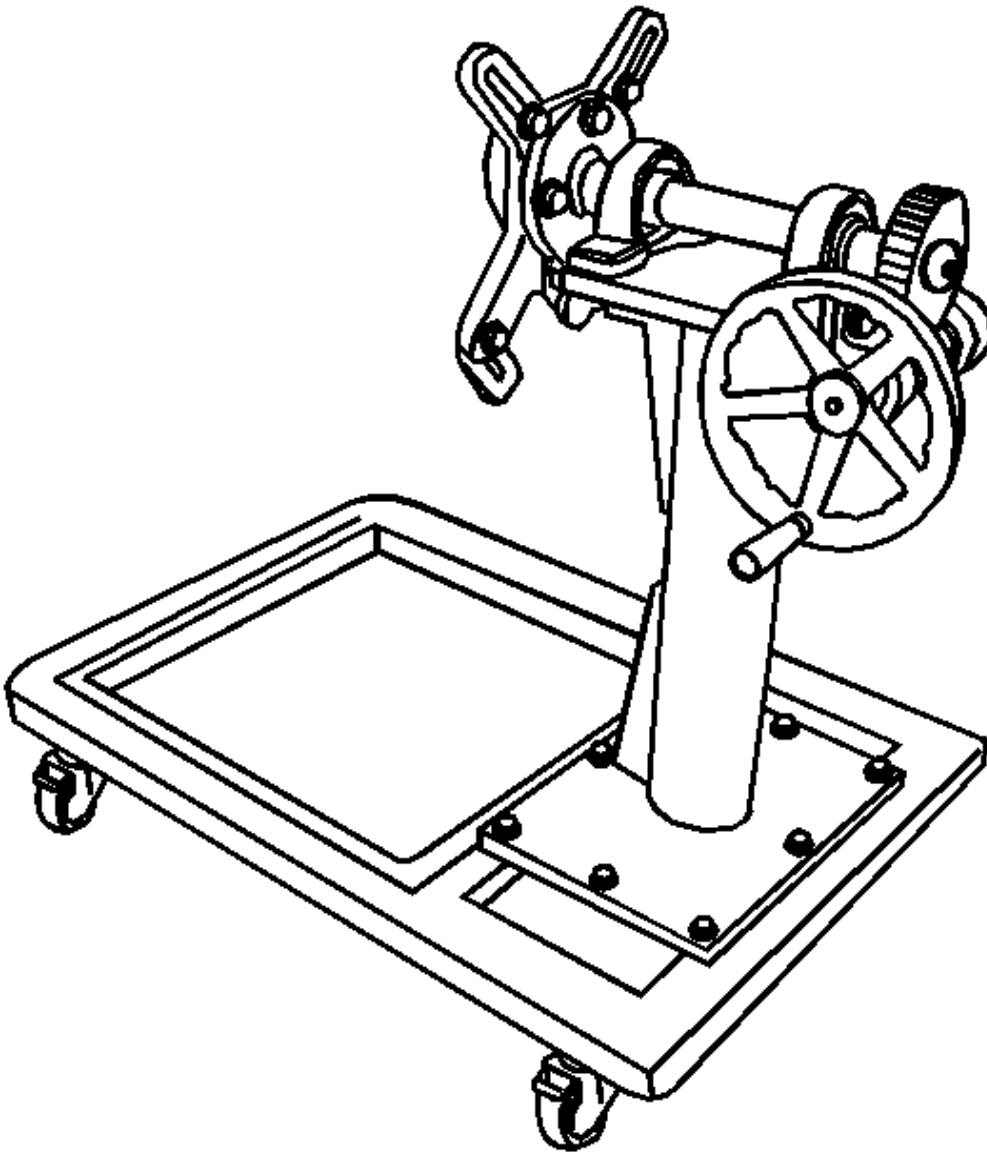
To properly service the engine assembly, the following items should be readily available:

- 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

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EN-50057 Engine Overhaul Stand

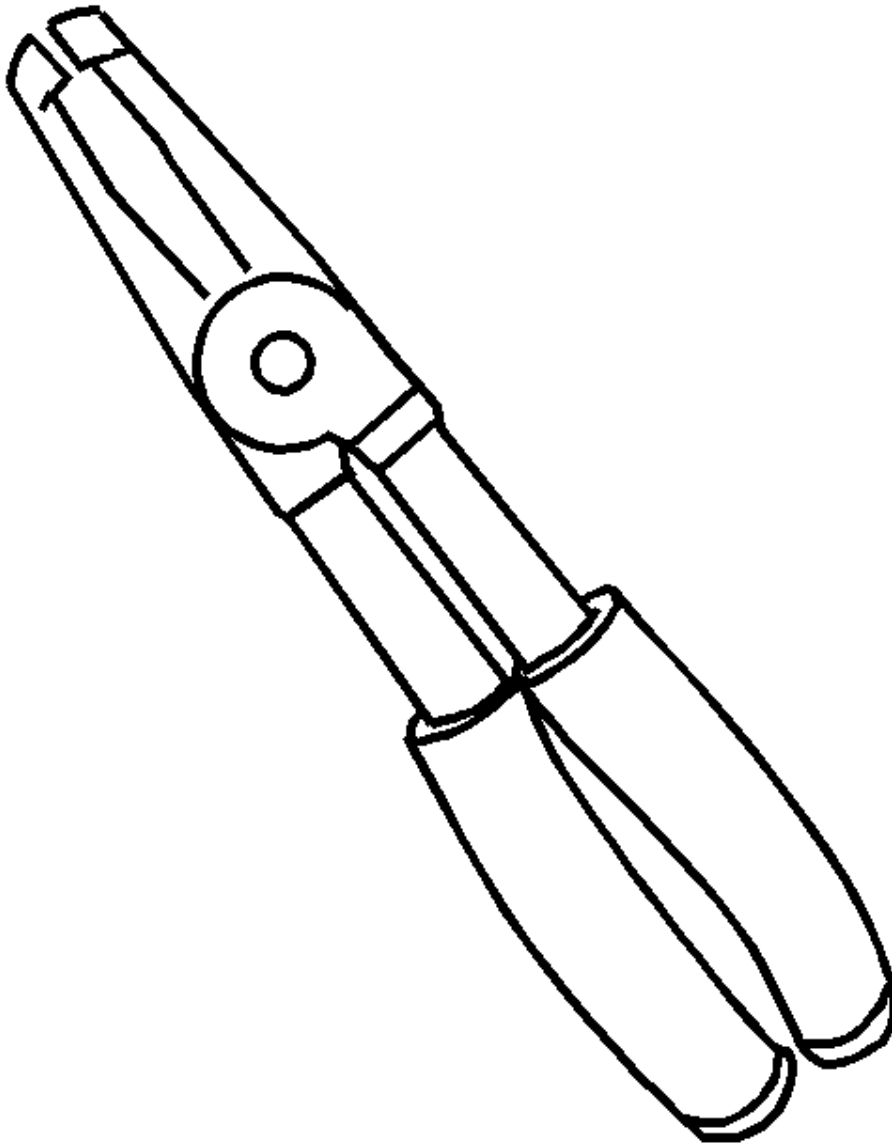


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EN-28467-B
J-28467-B
Universal Engine
Support Fixture

EN-46116
Valve Stem Seal
Remover



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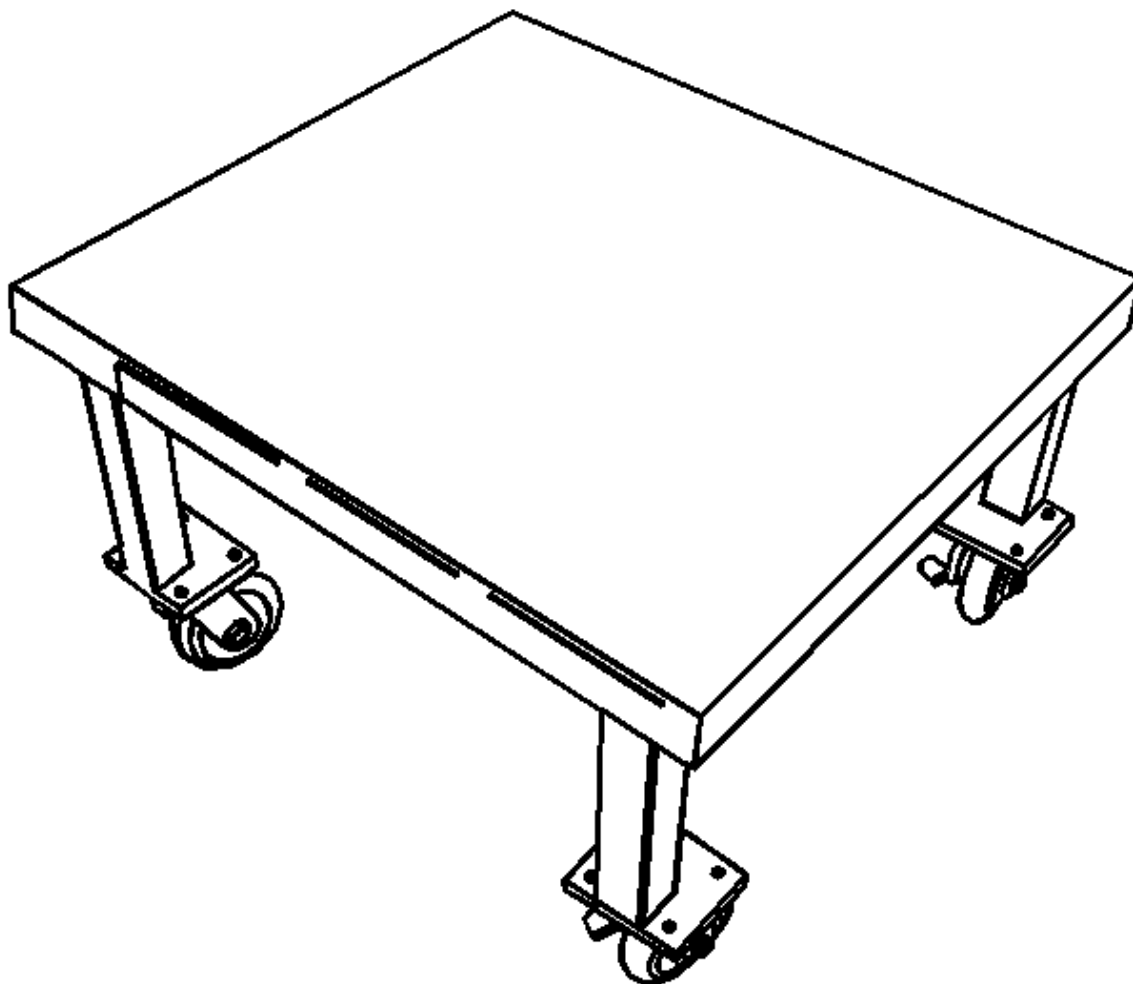
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EN 46569
J-8062
Valve Spring
Compressor (Off
Vehicle)

EN-48244
Engine Assembly
Remove/Install
Pallet Supporter

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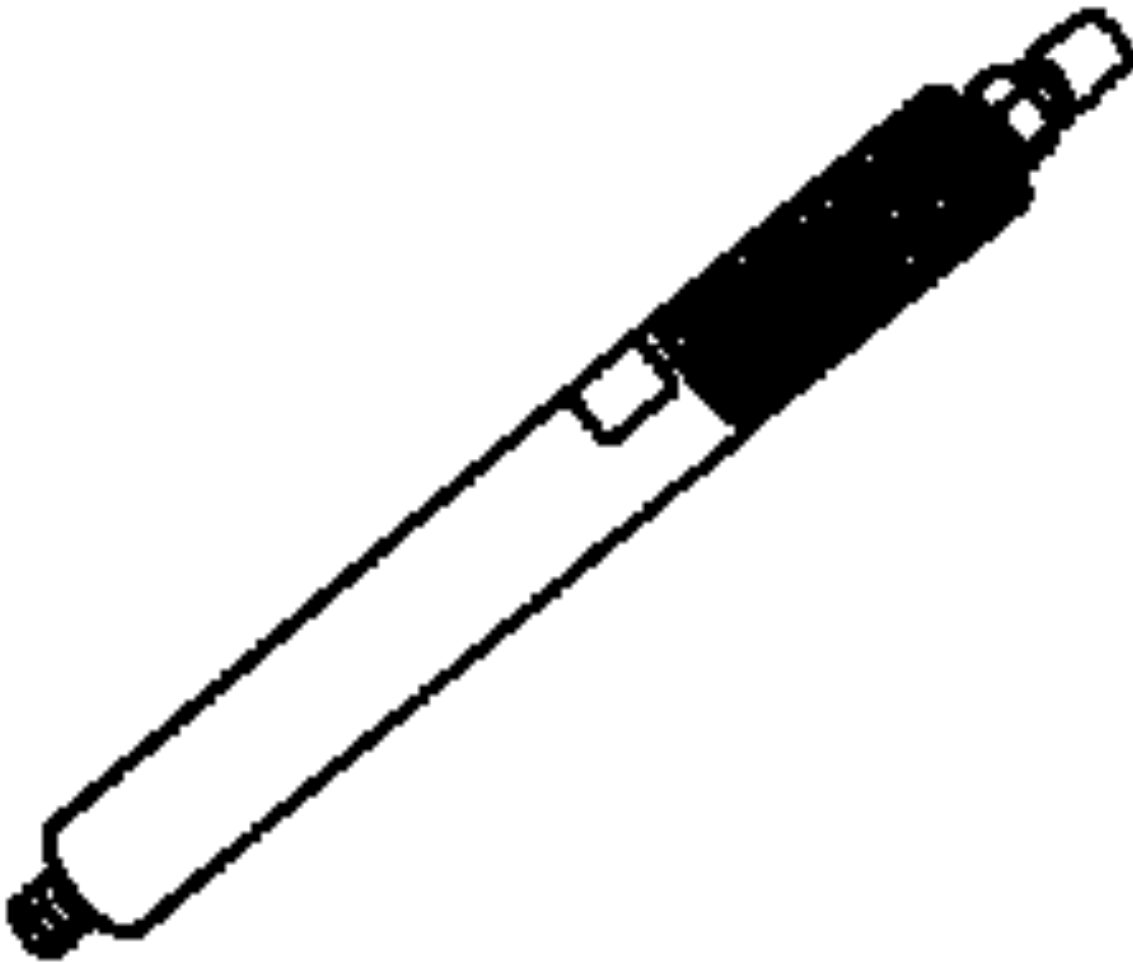
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EN-49075
EN-50717
Valve Spring
Compressor
Adapter

EN-49076
Cylinder Pressure
Adapter

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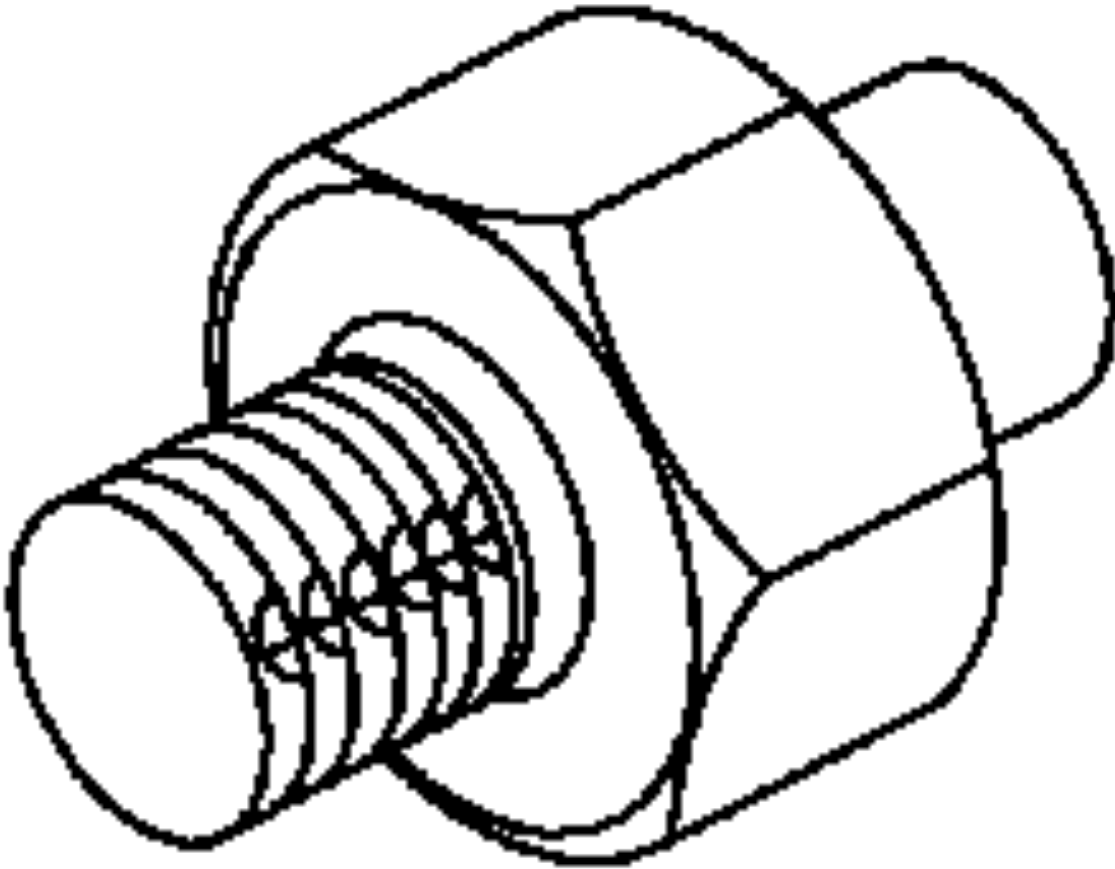


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EN-50050
DT-47562
09924-17810
Crankshaft
Locking Device
(Off vehicle)

EN-50170-01
Engine Oil
Pressure Gauge
Adapter

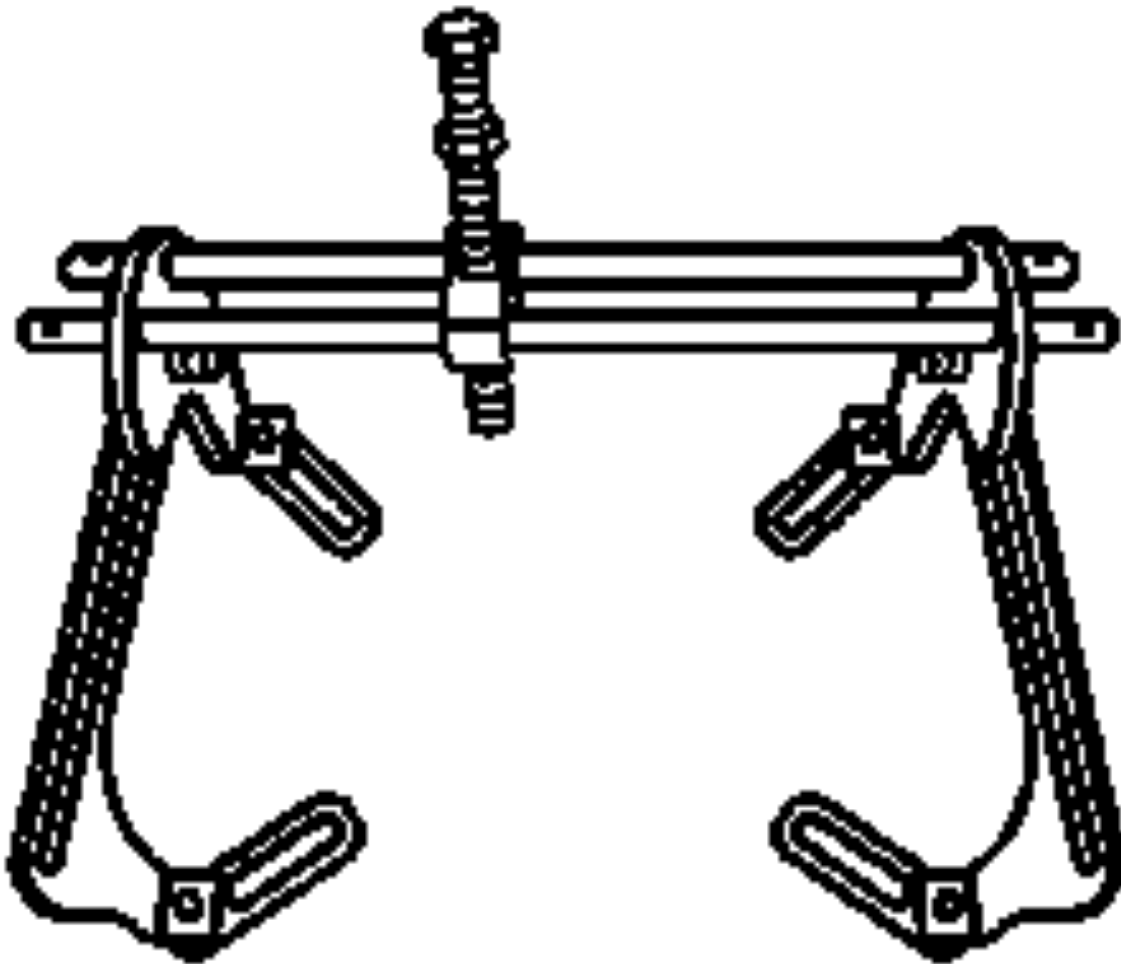


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EN-50172
Crankshaft Front
Seal Installer

EN-50173
EN-50717
Universal Valve
Spring
Compressor

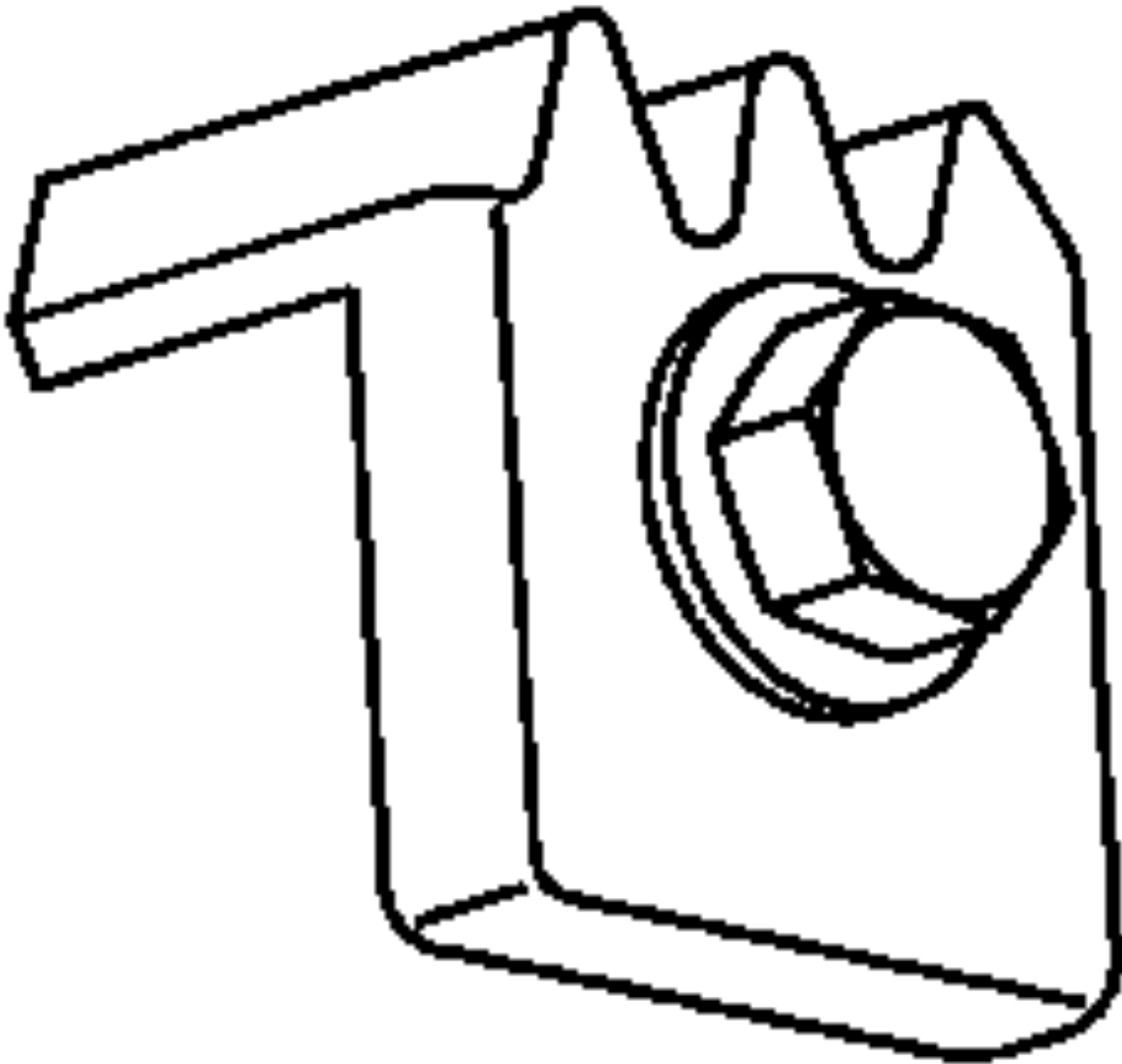


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EN-50174
J-8037
Piston Installer

EN-50175
Crankshaft
Locking Device
(On Vehicle)

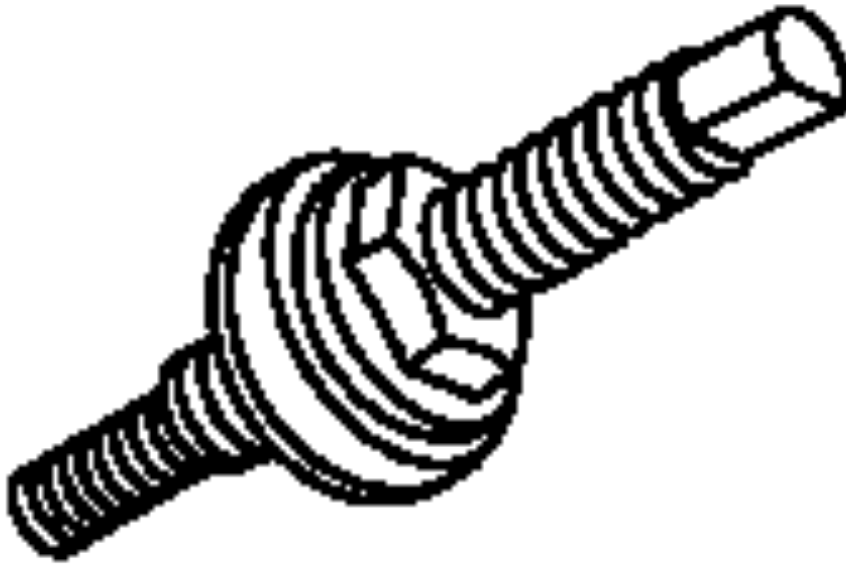


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EN-50207
Oil Pressure
Switch
Remover/Installer

EN-51218
Crankshaft
Balancer Installer

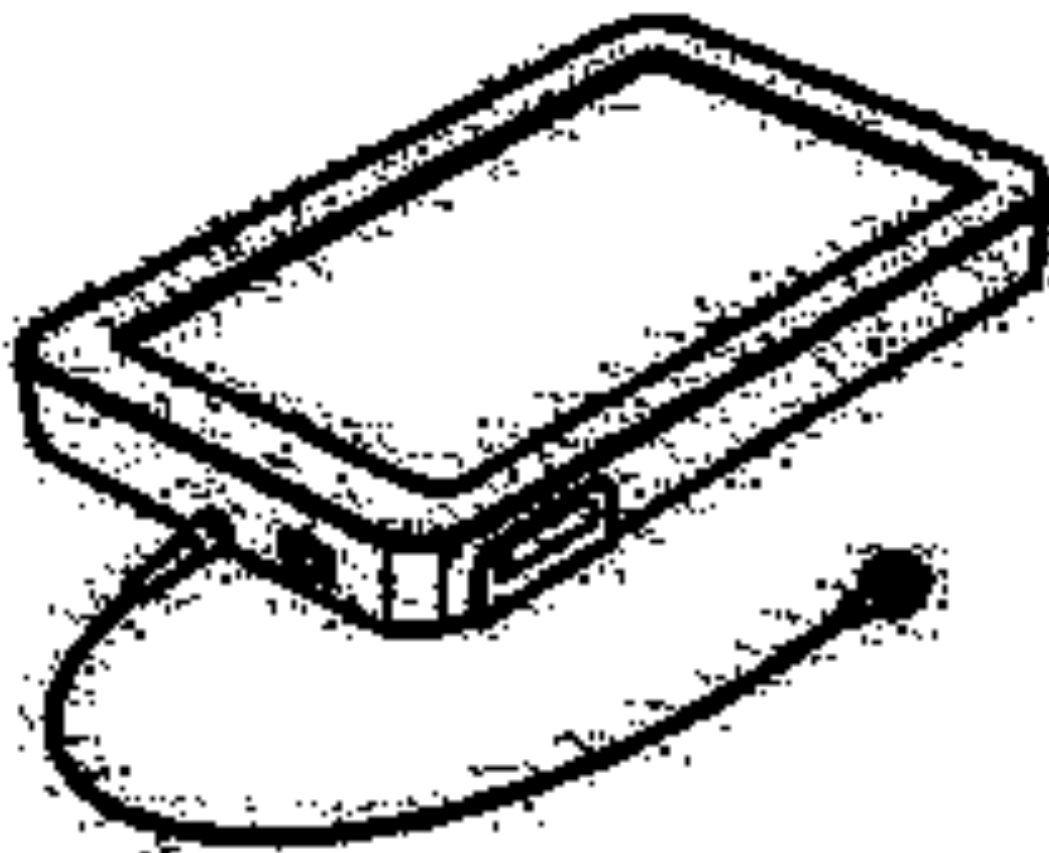


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GE-42072
Cylinder Head
Bolt
Remover/Installer

GE-50576
Acoustic Belt
Tension Tester

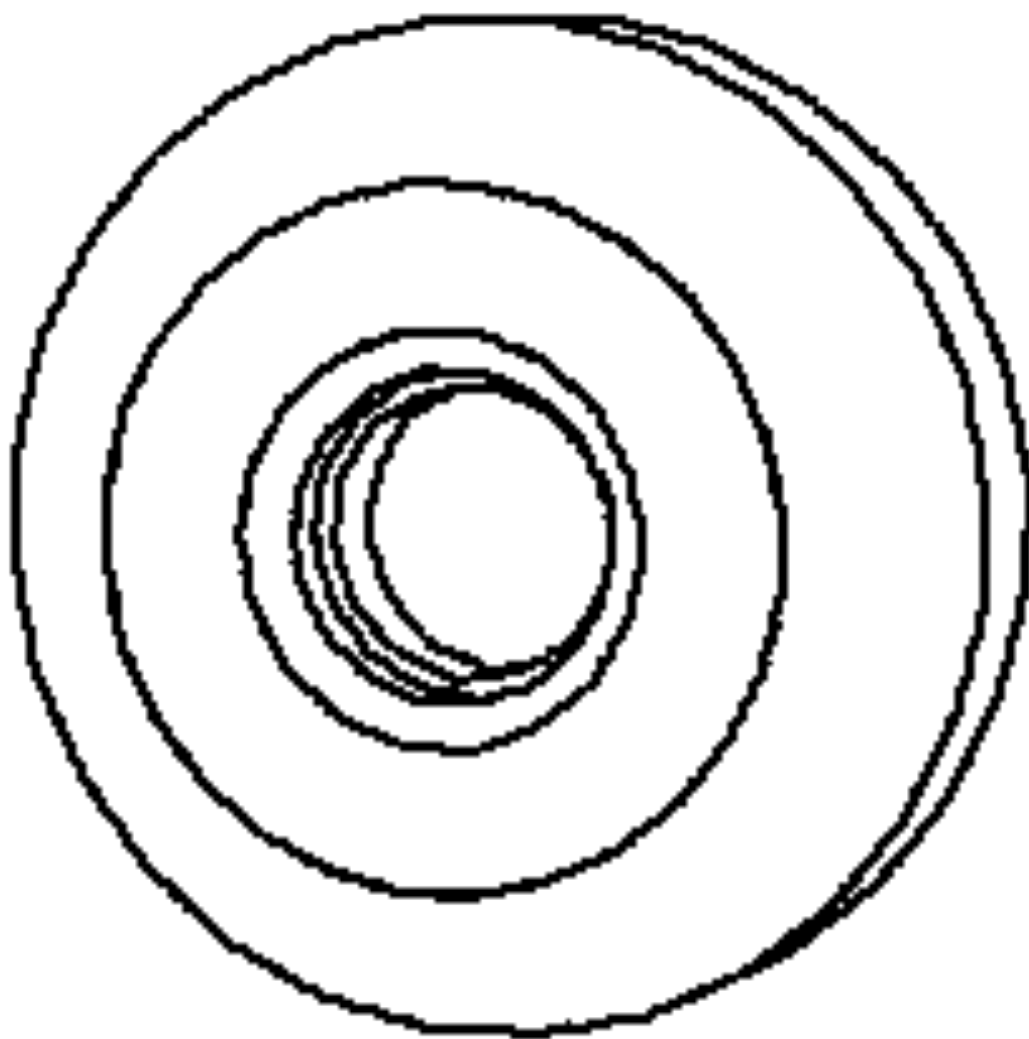


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J-22888-20A
Crankshaft
Balancer Puller

J-45507
Crankshaft Rear
Oil Seal Installer

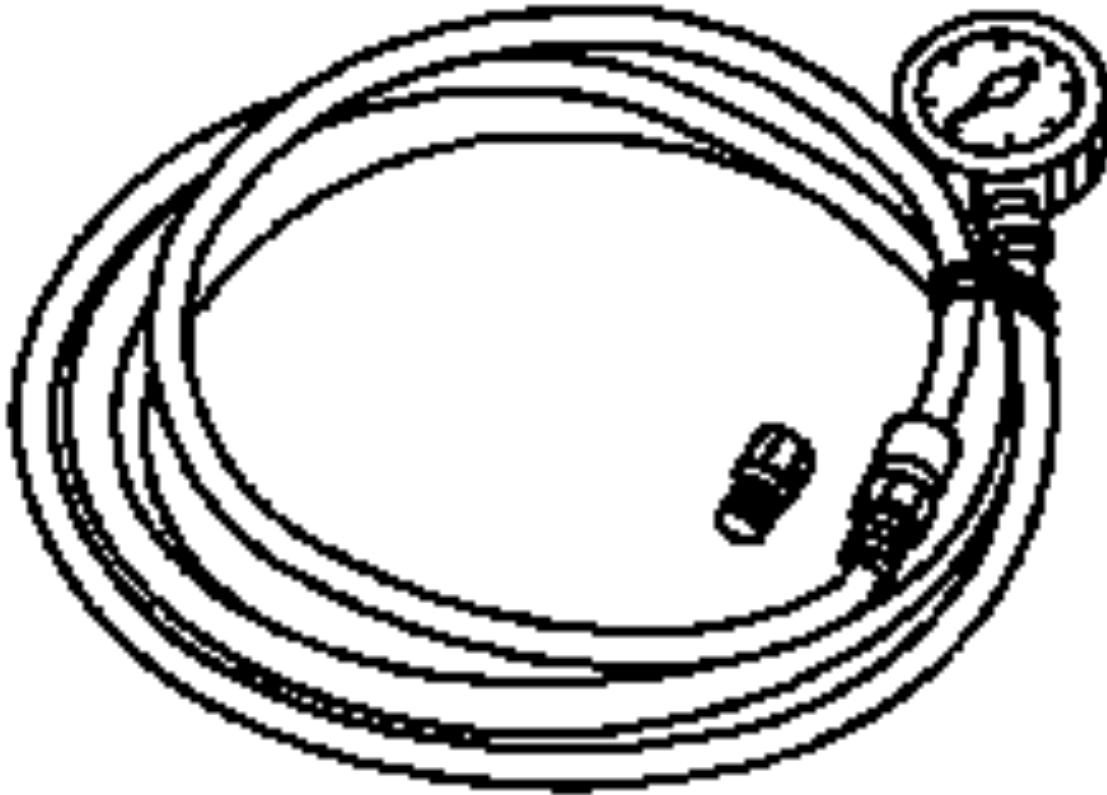


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KM-470-B
J-45059
Angular Torque
Gauge

KM-498-B
Pressure Gauge



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KM-845
Tappet Suction
Device