

**2012 Chevrolet Sonic LTZ**

2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic

**2012 ENGINE****Engine Mechanical - 1.4L (LUV) - Sonic****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS (1.4L LUV)****Fastener Tightening Specifications (1.4L LUV)**

Application	Specification	
	Metric	English
Air Conditioning Compressor Bracket Bolts	22 N.m	16 lb ft
Camshaft Actuator	50 N.m + 45° + 15° (1)	37 lb ft + 45° + 15° (1)
Camshaft Bearing Cap Bolts	8 N.m	71 lb in
Camshaft Cover Bolts	8 N.m	71 lb in
Camshaft Position Actuator Solenoid Valve	8 N.m	71 lb in
Camshaft Position Sensor Bolt	6 N.m	53 lb in
Camshaft Sprocket Bolt	50 N.m + 60° (1)	37 lb ft + 60° (1)
Catalytic Converter Bracket to Cylinder Block	22 N.m	16 lb ft
Catalytic Converter to Bracket	22 N.m	16 lb ft
Catalytic Converter to Turbocharger (V-Clamp)	13 N.m	115 lb in
Connecting Rod Bearing Cap	25 N.m + 45° (1)	18 lb ft + 45° (1)
Crankshaft Balancer Bolt	150 N.m + 45° + 15° (1)	111 lb ft + 45° + 15° (1)
Crankshaft Bearing Tie Plate Bolts (M6)	10 N.m + 60° + 15° (1)	89 lb in + 60° + 15° (1)
Crankshaft Bearing Tie Plate Bolts (M8)	25 N.m + 60° + 15° (1)	18 lb ft + 60° + 15° (1)
Crankshaft Position Sensor Bolt	8 N.m	71 lb in
Cylinder Head Bolts	35 N.m + 180° (1)	26 lb ft + 180° (1)
Drive Belt Tensioner Bolt M8	22 N.m	16 lb ft
Drive Belt Tensioner Bolt M10	55 N.m	41 lb ft
Engine Cooling Thermostat Housing Bolts	8 N.m	71 lb in
Engine Front Cover Bolts M10	35 N.m	26 lb ft
Engine Front Cover Bolts M6	8 N.m	71 lb in
Engine Mount Bracket Bolts	60 N.m + 45-60° (1)	44 lb ft + 45-60° (1)
Engine Mount Right Side to Body	62 N.m	44 lb ft
Engine Mount Right Side to Engine Mount Bracket	50 N.m + 60-75° (1)	37 lb ft + 60-75° (1)
Exhaust Manifold Heat Shield Bolts	8 N.m	71 lb in
Flywheel Bolts (Two-Mass)	60 N.m + 45° + 15° (1)	44 lb ft + 45° + 15° (1)
Fuel Injection Rail to Intake Manifold	6 N.m	53 lb in
Generator to Cylinder Block and Engine Cover	35 N.m	26 lb ft
Ignition Coil Bolts	8 N.m	71 lb in
Intake Manifold Bolt	20 N.m	15 lb ft

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Knock Sensor	20 N.m	15 lb ft
Oil Cooler Coolant Inlet Pipe to Oil Cooler	10 N.m	89 lb in
Oil Cooler to Engine Block	20 N.m	15 lb ft
Oil Cooler to Oil Filter Assembly (only bolts serviceable)	10 N.m	89 lb in
Oil Filler Plug to Engine Front Cover (M18)	30 N.m	22 lb ft
Oil Filter Assembly to Block	20 N.m	15 lb ft
Oil Gallery Plug in Engine Front Cover (M22)	60 N.m	44 lb ft
Oil Pan Bolt	10 N.m	89 lb in
Oil Pan Drain Plug	14 N.m	124 lb in
Oil Pressure Indicator	20 N.m	15 lb ft
Oil Pressure Relief Valve	50 N.m	37 lb ft
Oil Pump Cover Bolts	8 N.m	71 lb in
Oil Pump Housing Plug (M10)	10 N.m	89 lb in
Oxygen Sensor to Exhaust Manifold	42 N.m	31 lb ft
Oxygen Sensor to Exhaust Front Pipe	42 N.m	31 lb ft
Piston Oil Nozzles to Block	25 N.m	18 lb ft
Spark Plugs	25 N.m	18 lb ft
Starter Bolts	25 N.m	18 lb ft
Throttle Body Bolts	9 N.m	80 lb in
Timing Chain Guide	8 N.m	71 lb in
Timing Chain Tensioner	8 N.m	71 lb in
Timing Chain Tensioner Shoe	20 N.m	15 lb ft
Turbocharger Coolant Feed Pipe to Engine Block	30 N.m	22 lb ft
Turbocharger Coolant Feed Pipe to Turbocharger (Quick Fitting)	20 N.m	15 lb ft
Turbocharger Coolant Return Pipe to Turbocharger (Quick Fitting)	20 N.m	15 lb ft
Turbocharger Oil Feed Pipe to Oil Cooler/Filter	8 N.m	71 lb in
Turbocharger Oil Feed Pipe to Turbocharger	30 N.m	22 lb ft
Turbocharger Oil Return Pipe to Turbocharger	8 N.m	71 lb in
Turbocharger to Cylinder Head	8 N.m (1)	71 lb in (1)
Water Outlet	8 N.m	71 lb in
Water Pump Housing Bolts	8 N.m	71 lb in
Water Pump Drain Plug	15 N.m	11 lb ft
Water Pump Pulley Bolts	22 N.m	16 lb ft
1 = Use NEW Fastener.		

### ENGINE MECHANICAL SPECIFICATIONS

#### Engine Mechanical Specifications

	Specification
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Application	Metric	English
<b>General Data</b>		
• Engine Type	4-Cylinder Inline	
• Displacement	1364 ccm	83.24 cu in
• Bore	72.5 mm	2.854 in
• Stroke	82.6 mm	3.3 in
• Compression Ratio	9.5:1	
• Number of Valves	16	
• Maximum Power @ engine speed KW/RPM	105 KW /4900	
• Maximum Torque @ engine speed / RPM / lb ft / RPM	200 / 1850	148 lb ft / 4000
<b>Engine Block</b>		
• Cylinder Bore Diameter Standard	72.492 mm - 72.508 mm	2.8540 in - 2.8546 in
• Cylinder Bore Diameter Oversize 0.5	72.992 mm - 73.008 mm	2.8737 in - 2.8743 in
<b>Piston, Piston Rings and Piston Pins</b>		
• Piston Diameter Standard	72.453 mm - 72.467 mm	2.8525 in - 2.8530 in
• Piston Diameter Oversize 0.5	72.953 mm - 72.967 mm	2.8722 in - 2.8727 in
• Piston Clearance to Bore	0.025 mm -0.055 mm	0.001 in - 0.0022 in
• Piston - Upper Compression Ring Thickness	1.17 mm - 1.195 mm	0.0461 in 0.047 in
• Piston - Upper Compression Ring Gap	0.25 mm - 0.4 mm	0.0098 in - 0.0157 in
• Piston - Upper Compression Ring Side Clearance	0.025 mm - 0.07 mm	0.001 in - 0.0028 in
• Piston - Lower Compression Ring Thickness	1.17 mm - 1.195 mm	0.0461 in 0.047 in
• Piston - Lower Compression Ring Gap	0.4 mm - 0.6 mm	0.0157 in - 0.0236 in
• Piston - Lower Compression Ring Side Clearance	0.025 mm - 0.07 mm	0.001 in - 0.0028 in
• Piston - Oil Ring Thickness	1.92 mm - 2 mm	0.0756 in - 0.0787 in
• Piston - Oil Ring Gap	0.25 mm - 0.75 mm	0.0098 in - 0.0295 in
• Piston - Oil Ring Side Clearance	0.04 mm - 0.12 mm	0.0016 in - 0.0047 in
• Piston Pin Bore Diameter	18.006 mm - 18.012 mm	0.7089 in - 0.7091 in
• Piston Pin Outer Diameter	17.995 mm - 18 mm	0.7085 in - 0.7087 in
• Piston Pin Length	48 mm	1.8898 in
• Piston Pin Clearance to Piston Bore	0.005 mm - 0.010 mm	0.0002 in - 0.00039 in

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• Piston Pin Clearance to Conrod Bore	0.010 mm - 0.018 mm	0.0039 in - 0.00070 in
<b>Crankshaft</b>		
• Crankshaft Bearing Journal Standard Diameter (brown or green)	50.004 mm -50.017 mm	1.9687 in - 1.9692 in
• Crankshaft Bearing Journal Undersize 0.25 Diameter (brown/blue or green/blue)	49.754 mm -49.767 mm	1.9588 in - 1.9593 in
• Crankshaft Bearing Journal Undersize 0.5 Diameter (brown/white or green/white)	49.504 mm -49.517 mm	1.949 in - 1.9495 in
• Crankshaft Bearing Journal Width Standard	23.000 mm -23.052 mm	0.9055 in - 0.9076 in
• Crankshaft Bearing Journal Width Undersize 0.25	23.200 mm -23.252 mm	0.9134 in - 0.9154 in
• Crankshaft Bearing Journal Width Undersize 0.4	23.400 mm -23.452 mm	0.9213 in - 0.9233 in
• Crankshaft Bearing Mark 328N (brown) - Thickness	1.989 mm -1.995 mm	0.0783 in - 0.0785 in
• Crankshaft Bearing Mark 329N (green) - Thickness	1.995 mm -2.001 mm	0.0785 in - 0.0788 in
• Crankshaft Bearing Mark 330N - Thickness Undersize 0.25 (brown/blue)	2.114 mm - 2.120 mm	0.0832 in - 0.0835 in
• Crankshaft Bearing Mark 331 - Thickness Undersize 0.25 (green/blue)	2.120 mm - 2.126 mm	0.0835 in - 0.0837 in
• Crankshaft Bearing Mark 332 - Thickness Undersize 0.5 (brown/white)	2.239 mm - 2.245 mm	0.0881 in - 0.0884 in
• Crankshaft Bearing Mark 332 - Thickness Undersize 0.5 (green/white)	2.245 mm - 2.251 mm	0.0884 in - 0.0886 in
• Crankshaft Bearing Clearance	0.007 mm - 0.031 mm	0.0003 in - 0.0012 in
• Crankshaft Bearing Clearance Axial	0.100 mm - 0.202 mm	0.0039 in - 0.008 in
• Crankshaft Bearing Out Of Round	0.03 mm	0.0012 in
• Connecting Rod Bearing Journal Diameter Standard	42.971 mm - 42.987 mm	1.6918 in - 1.6924 in
• Connecting Rod Bearing Journal Diameter Undersize 0.25 (blue)	42.721 mm -42.737 mm	1.6819 in - 1.6826 in
• Connecting Rod Bearing Journal Diameter Undersize 0.5 (white)	42.471 mm -42.487 mm	1.6721 in - 1.6727 in
• Connecting Rod Bearing Thickness Standard	1.490 mm - 1.500 mm	0.0587 in - 0.0591 in
• Connecting Rod Bearing Thickness Undersize 0.25	1.615 mm - 1.625 mm	0.0636 in - 0.064 in
	1.740 mm - 1.750	



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• Connecting Rod Bearing Thickness Undersize 0.5	mm	0.0685 in - 0.0689 in
• Connecting Rod Bearing Diameter Standard (upper and lower)	1.490 mm - 1.500 mm	0.0587 in - 0.0591 in
• Connecting Rod Bearing Diameter Undersize 0.25 (upper and lower)	1.615 mm - 1.625 mm	0.0636 in - 0.064 in
• Connecting Rod Bearing Diameter Undersize 0.5 (upper and lower)	1.740 mm - 1.750 mm	0.0685 in - 0.0689 in
• Connecting Rod Bearing Clearance	0.013 mm - 0.061 mm	0.0005 in - 0.0024 in
<b>Cylinder Head</b>		
• Cylinder Head - Intake Valve Seat Width	1.4 mm - 1.8 mm	0.0551 in - 0.0709 in
• Cylinder Head - Exhaust Valve Seat Width	1 mm - 1.4 mm	0.0394 in - 0.0551 in
• Cylinder Head - Valve Seat Angle	90° 30'	
• Cylinder Head - Valve Seat Angle Adjustment Upper	110°	
• Cylinder Head - Valve Seat Angle Adjustment Lower	60°	
• Cylinder Head - Intake Valve Guide Inner Diameter Standard	4.991 mm - 5.007 mm	0.1965 in - 0.1971 in
• Cylinder Head - Intake Valve Guide Inner Diameter + 0.075	5.066 mm - 5.082 mm	0.1994 in - 0.2001 in
• Cylinder Head - Intake Valve Guide Inner Diameter 0.150	5.141 mm - 5.157 mm	0.2024 in - 0.203 in
• Cylinder Head - Exhaust Valve Guide Inner Diameter Standard	4.991 mm - 5.007 mm	0.1965 in - 0.1971 in
• Cylinder Head - Exhaust Valve Guide Inner Diameter + 0.075	5.066 mm - 5.082 mm	0.1994 in - 0.2001 in
• Cylinder Head - Exhaust Valve Guide Inner Diameter + 0.150	5.141 mm - 5.157 mm	0.2024 in - 0.203 in
• Cylinder Head - Valve Guide Length	38.7 mm - 39.3 mm	1.5236 in - 1.5472 in
• Cylinder Head - Surface Flatness (max) - Block Deck - longitude	0.05 mm	0.00197 in
• Cylinder Head - Surface Flatness (max) - Block Deck - transverse	0.03 mm	0.00118 in
<b>Valve Train</b>		
• Intake Valve Length Standard	92.9 mm	3.6575 in
• Exhaust Valve Length Standard	92.7 mm	3.6496 in
• Intake Valve Stem Diameter Standard	4.950 mm - 4.965 mm	0.1949 in - 0.1955 in
• Exhaust Valve Stem Diameter Standard	4.930 mm - 4.945	0.1941 in - 0.1947 in

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	mm	
• Intake Valve Stem Diameter + 0.075	5.025 mm - 5.040 mm	0.1978 in - 0.1984 in
• Exhaust Valve Stem Diameter + 0.075	5.005 mm - 5.020 mm	0.197 in - 0.1976 in
• Intake Valve Stem Diameter + 0.150	5.100 mm - 5.115 mm	0.2008 in - 0.2014 in
• Exhaust Valve Stem Diameter + 0.150	5.080 mm - 5.095 mm	0.2 in - 0.2006 in
• Intake Valve Disc Diameter	27.9 mm - 28.1 mm	1.0984 in - 1.1063 in
• Exhaust Valve Disc Diameter	24.9 mm - 25.1	0.9803 in - 0.9882 in
• Valve Spring Height Free	40 mm	1.5748 in
• Valve Spring Height Under Load - Valve open	21.5 mm	0.8465 in
• Valve Spring Height Under Load - Valve closed	30 mm	1.1811 in
• Valve Clearance to Guide Intake	0.026 mm - 0.057 mm	0.001 in - 0.0022 in
• Valve Clearance to Guide Exhaust	0.046 mm - 0.077 mm	0.0015 in - 0.003 in

**Engine Oil**

• Quality	Dexos I	
• Filling - With New Oil Filter	4 L	4.2 Quarts
• Viscosity	0W30 / 0W40 / 5W30 / 5W40	
• Oil Pressure @ Idle Speed	150 kpa	22 psi
• Oil Pressure @ 3000 rpm - 3500 rpm	380 kpa - 650 kpa	55 psi - 94 psi

**Oil Pump**

• Axial Clearance Vane Rotor to Cover	0.01 mm	0.0004 in
• Axial Clearance Vane to Cover	0.09 mm	0.0036 in
• Axial Clearance Vane Ring to Cover	0.04 mm	0.0016 in
• Axial Clearance Slide to Cover	0.08 mm	0.0031 in
• Axial Clearance Slide Seal to Cover	0.09 mm	0.0036 in
• Radial Clearance Vane to Vane Rotor	0.05 mm	0.002 in
• Radial Clearance Vane to Slide	0.2 mm	0.008 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

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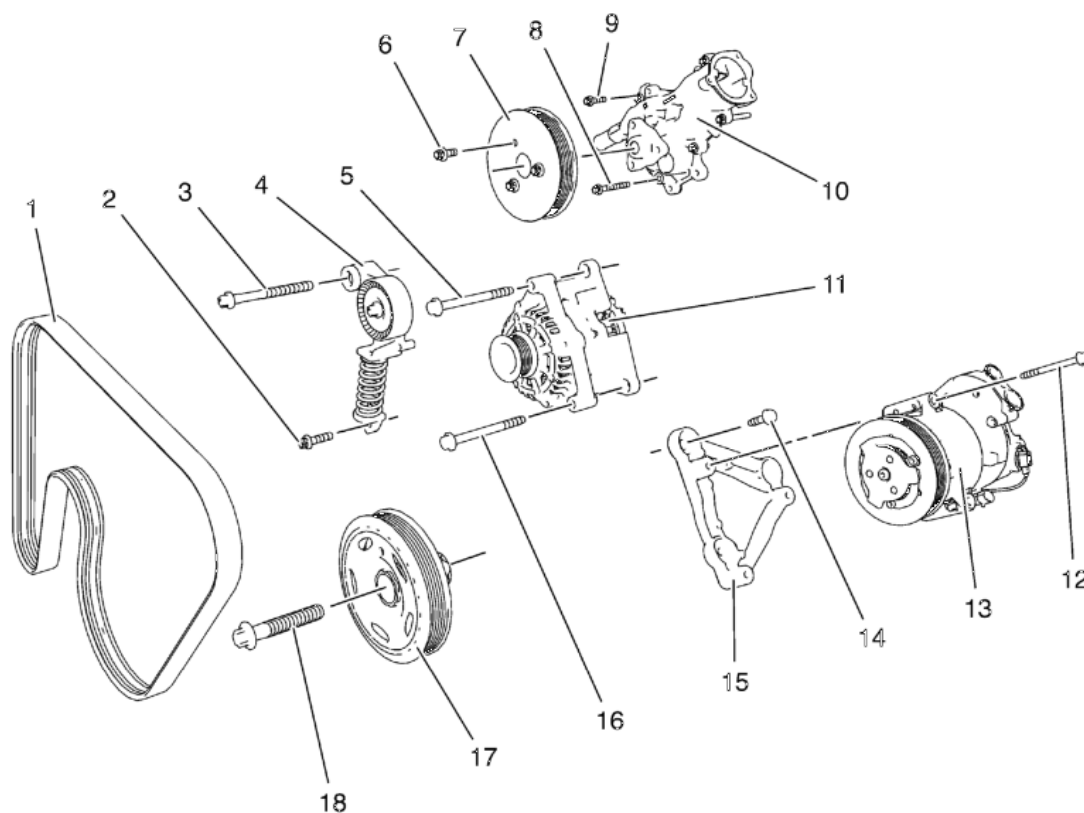
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Engine Oil	DEXOS II, 0-W30, 0-W40, 5-W30 and 5-W40	Refer to electronic parts catalog
First Camshaft Bearing Cap	Surface Sealant	Refer to electronic parts catalog
Oil Pan	Oil Pan Sealant	Refer to electronic parts catalog
Oxygen Sensor	Assembly Paste	Refer to electronic parts catalog
Seal Rings	Silicon Grease	Refer to electronic parts catalog

## COMPONENT LOCATOR

### DISASSEMBLED VIEWS

#### Accessory Drive Components



**Fig. 1: Locating Accessory Drive Components**  
Courtesy of GENERAL MOTORS COMPANY

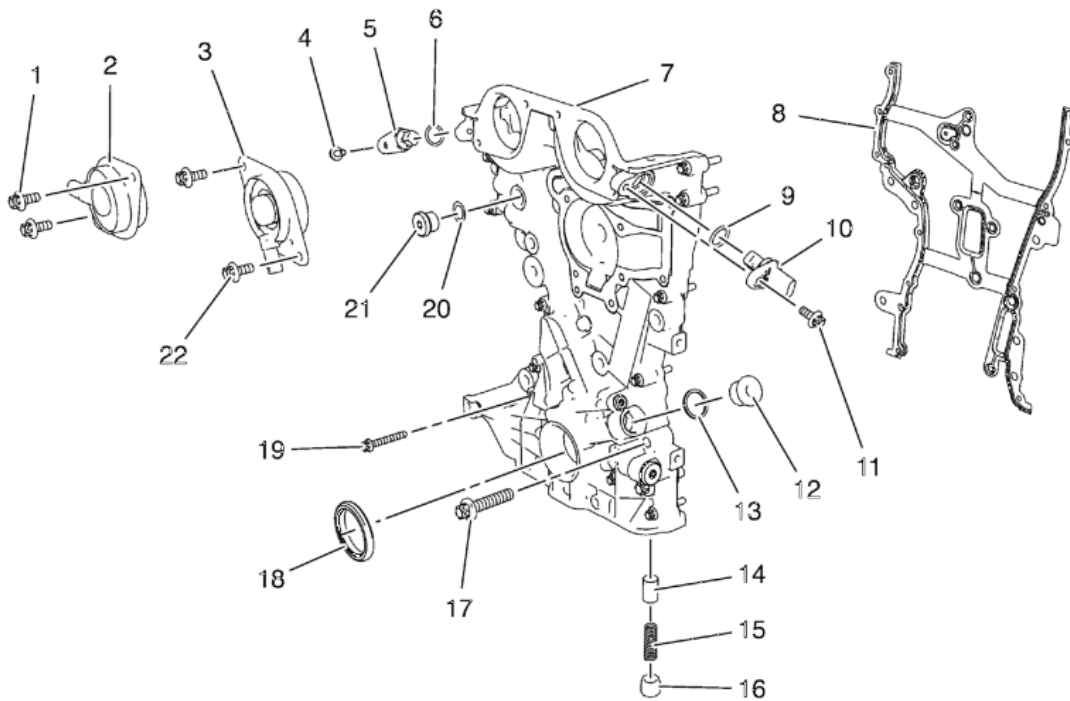
Callout	Component Name
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1	Generator And Air Conditioning Compressor Belt
2	Drive Belt Tensioner Bolt (short)
3	Drive Belt Tensioner Bolt (long)
4	Drive Belt Tensioner
5	Upper Generator Bolt
6	Water Pump Pulley Bolt
7	Water Pump Pulley
8	Water Pump Bolt (Long)
9	Water Pump Bolt (Short)
10	Water Pump
11	Generator
12	Air Conditioning Compressor Bolt
13	Air Conditioning Compressor
14	Air Conditioning Compressor Bracket Bolt
15	Air Conditioning Compressor Bracket
16	Lower Generator Bolt
17	Crankshaft Balancer
18	Crankshaft Balancer Bolt

**Engine Front Cover And Oil Pump Assembly (1 of 2)**



**Fig. 2: Locating Engine Front Cover And Oil Pump Assembly Components (1 Of 2)**  
 Courtesy of GENERAL MOTORS COMPANY

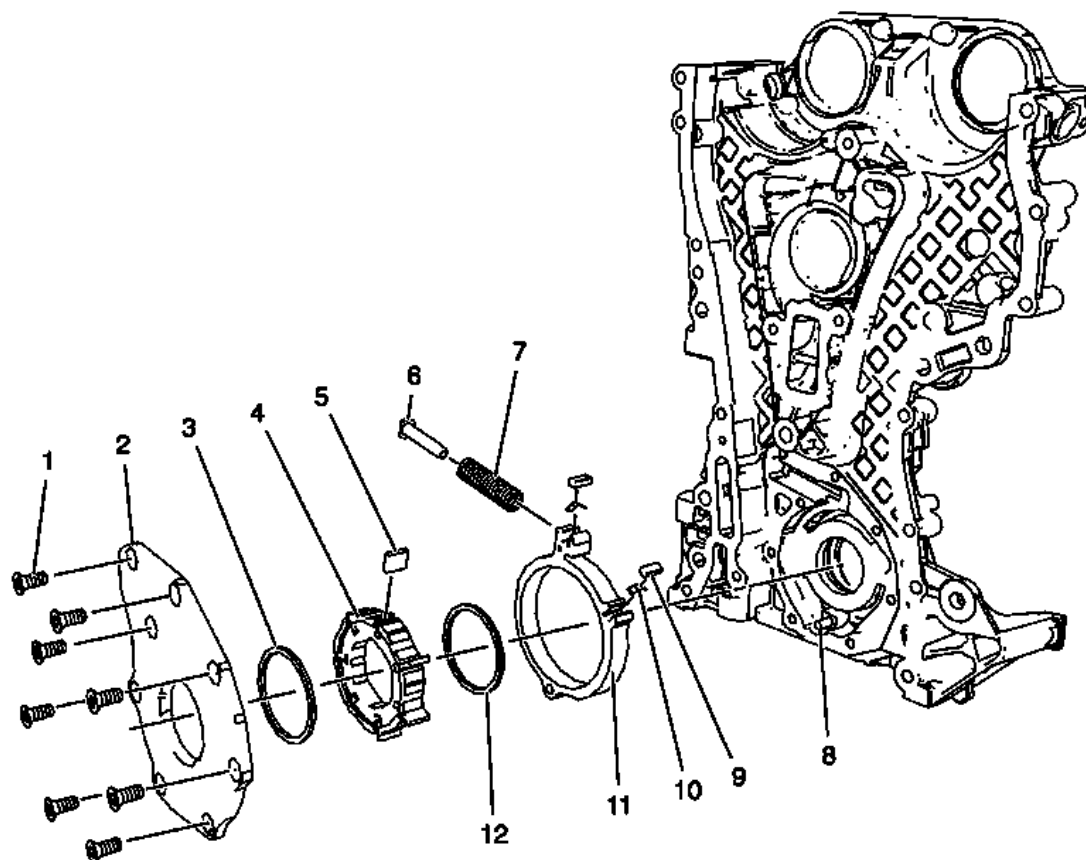
Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Bolt
2	Intake Camshaft Position Actuator Solenoid Valve
3	Exhaust Camshaft Position Actuator Solenoid Valve
4	Intake Camshaft Position Sensor Bolt
5	Intake Camshaft Position Sensor
6	Intake Camshaft Position Sensor Seal Ring
7	Engine Front Cover
8	Engine Front Cover Gasket
9	Exhaust Camshaft Position Sensor Seal Ring
10	Exhaust Camshaft Position Sensor
11	Exhaust Camshaft Position Sensor Bolt
12	Engine Front Cover Oil Gallery Plug

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13	Engine Front Cover Oil Gallery Plug Seal Ring
14	Oil Pressure Relief Valve Piston
15	Oil Pressure Relief Valve Spring
16	Oil Pressure Relief Valve Plug
17	Engine Front Cover Bolt (M10)
18	Crankshaft Front Oil Seal
19	Engine Front Cover Bolt (M6)
20	Water Drain Plug Seal Ring
21	Water Drain Plug
22	Exhaust Camshaft Position Actuator Solenoid Valve Bolt

### Engine Front Cover And Oil Pump Assembly (2 of 2)



**Fig. 3: Locating Engine Front Cover And Oil Pump Assembly Components (2 Of 2)**  
Courtesy of GENERAL MOTORS COMPANY

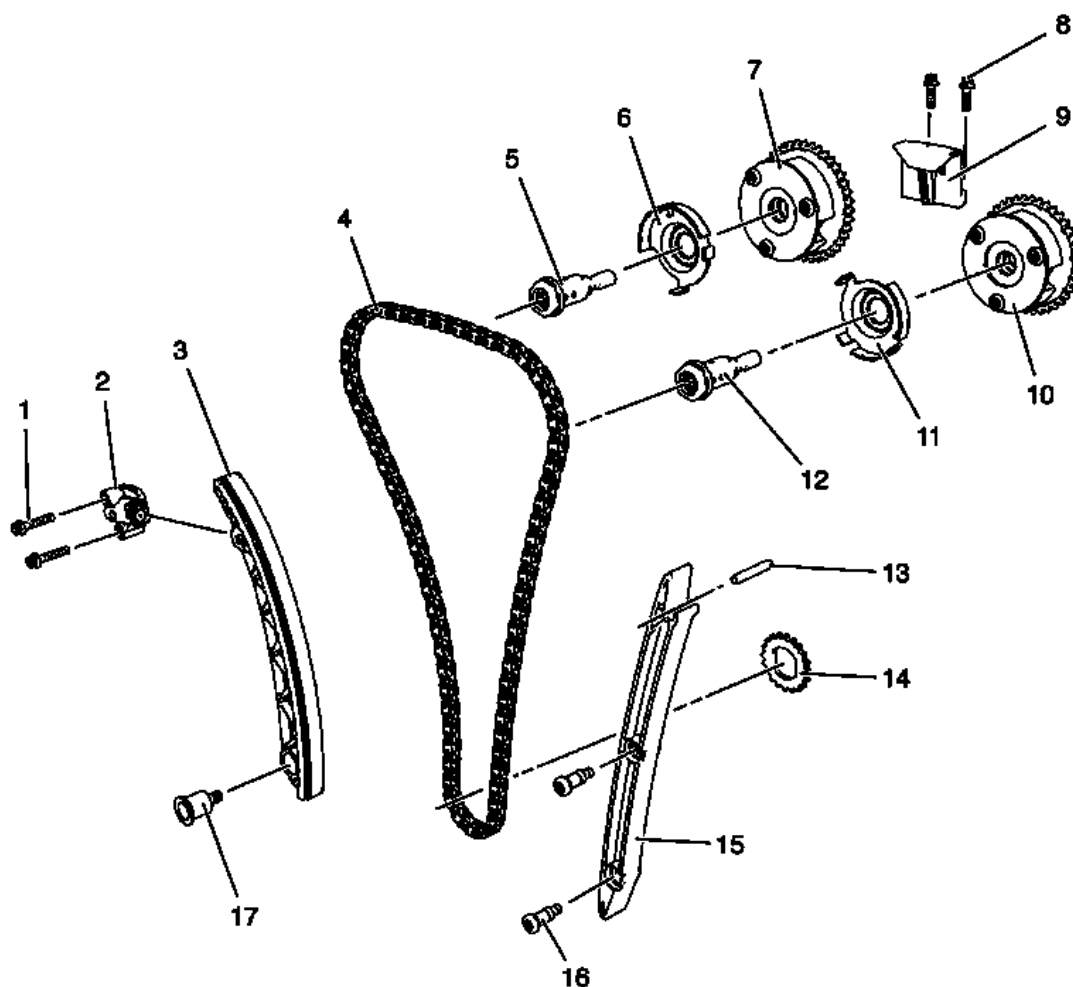
Callout	Component Name
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1	Oil Pump Cover Bolt
2	Oil Pump Cover
3	Oil Pump Vane Ring
4	Oil Pump Vane Rotor
5	Oil Pump Vane
6	Oil Pump Slide Spring Pin
7	Oil Pump Slide Spring
8	Oil Pump Slide Pivot Pin
9	Oil Pump Slide Seal
10	Oil Pump Slide Seal Spring
11	Oil Pump Slide
12	Oil Pump Vane Ring

### Timing Chain Components



**Fig. 4: Timing Chain Components**

Courtesy of GENERAL MOTORS COMPANY

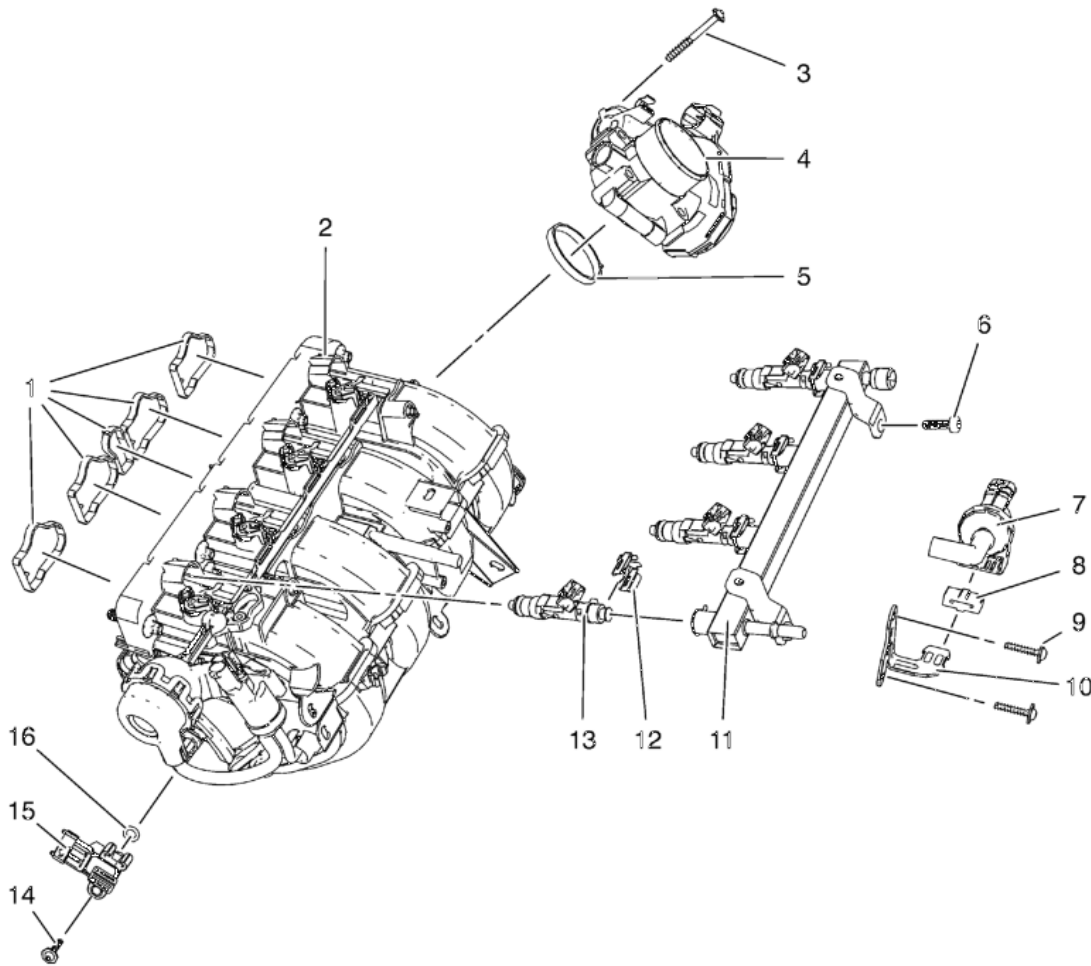
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<b>Callout</b>	<b>Component Name</b>
1	Timing Chain Tensioner Bolt
2	Timing Chain Tensioner
3	Timing Chain Tensioner Shoe
4	Camshaft Timing Chain
5	Intake Camshaft Sprocket Bolt (With Actuator)
6	Intake Camshaft Position Sensor Exciter Wheel
7	Intake Camshaft Sprocket (With Position Actuator)
8	Upper Timing Chain Guide Bolt
9	Upper Timing Chain Guide
10	Exhaust Camshaft Sprocket (With Position Actuator)
11	Exhaust Camshaft Position Sensor Exciter Wheel
12	Exhaust Camshaft Sprocket Bolt (With Actuator)
13	Timing Chain Guide Pivot Pin
14	Crankshaft Sprocket
15	Timing Chain Guide Right Side
16	Timing Chain Guide Bolt
17	Timing Chain Tensioner Shoe Bolt

**Intake Manifold Assembly - 1.4L LDD**



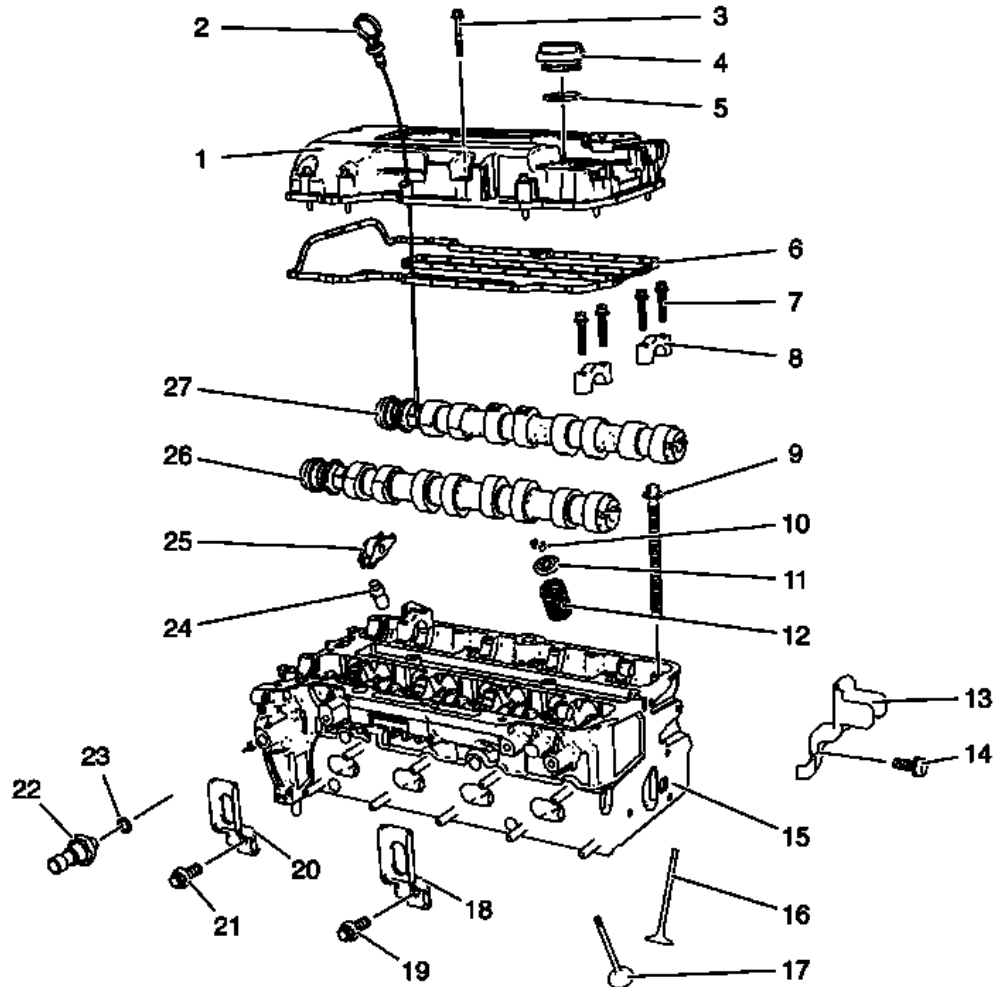


**Fig. 5: Locating Intake Manifold Assembly Components - 1.4L LDD**  
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Sealings
2	Intake Manifold (With Intake Manifold Runner and Intake Manifold Runner Valve)
3	Throttle Body Bolt
4	Throttle Body
5	Throttle Body Seal Ring
6	Fuel Injection Fuel Rail Bolt
7	Evaporative Emission Canister Purge Solenoid Valve
8	Evaporative Emission Canister Purge Solenoid Valve Rubber
9	Evaporative Emission Canister Purge Solenoid Valve Bracket Bolt
10	Evaporative Emission Canister Purge Solenoid Valve Bracket
11	Fuel Injection Fuel Rail

12	Fuel Injector Retainer Clamp
13	Fuel Injector
14	Manifold Absolute Pressure Sensor Bolt
15	Manifold Absolute Pressure Sensor
16	Manifold Absolute Pressure Sensor Seal Ring

### Cylinder Head Assembly



**Fig. 6: Identifying Cylinder Head Assembly Components**  
Courtesy of GENERAL MOTORS COMPANY

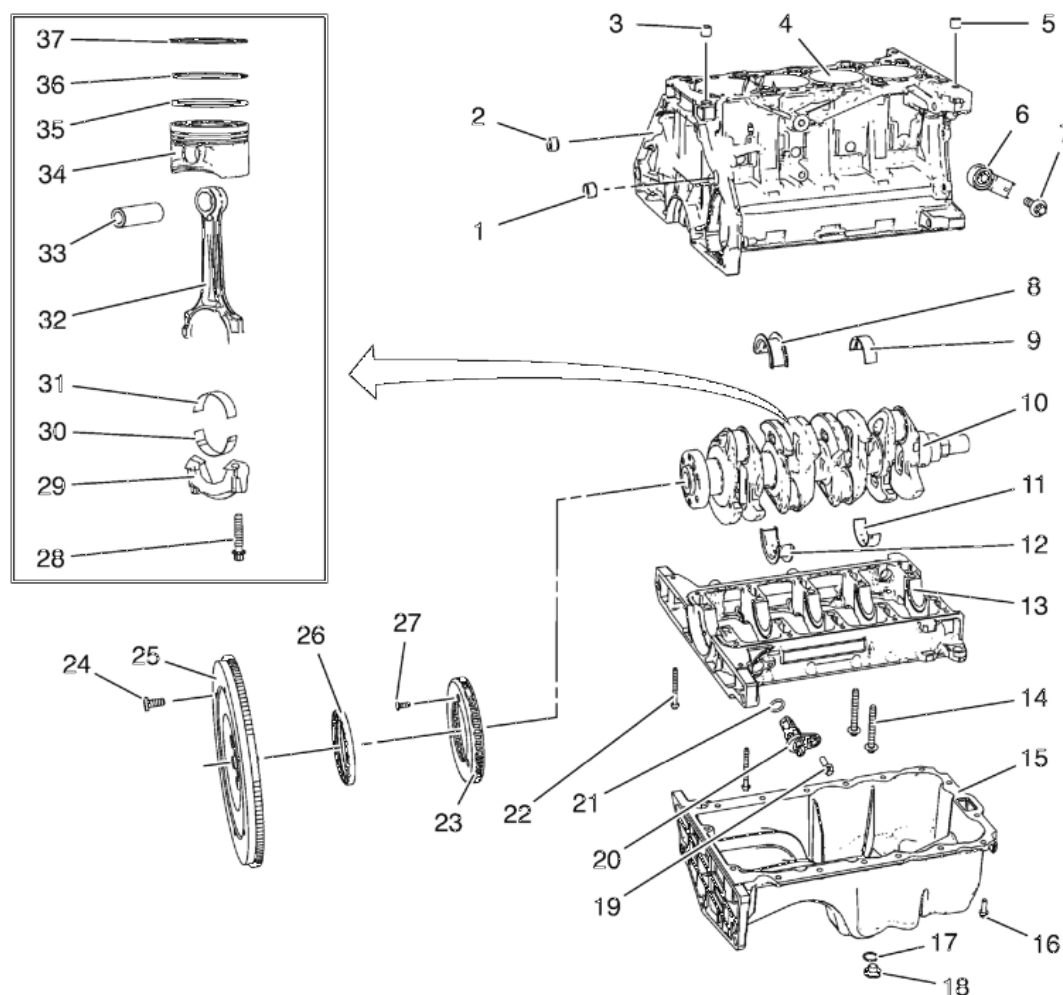
Callout	Component Name
1	Camshaft Cover
2	Oil Level Indicator
3	Camshaft Cover Bolt
4	Oil Filler Cap
5	Oil Filler Cap Seal Ring

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6	Camshaft Cover Gasket
7	Camshaft Bearing Cap Bolt
8	Camshaft Bearing Cap
9	Cylinder Head Bolt
10	Valve Keys
11	Valve Spring Retainer
12	Valve Spring
13	Engine Lift Bracket Left Side
14	Engine Lift Bracket Bolt
15	Cylinder Head
16	Intake Valve
17	Exhaust Valve
18	Engine Lift Bracket
19	Engine Lift Bracket Bolt
20	Engine Lift Bracket
21	Engine Lift Bracket Bolt
22	Oil Pressure Indicator Switch
23	Oil Pressure Indicator Switch Seal Ring
24	Hydraulic Valve Lash Adjuster
25	Hydraulic Valve Lash Adjuster Arm
26	Exhaust Camshaft
27	Intake Camshaft

**Engine Block Assembly - 1.4L LDD**



**Fig. 7: Identifying Engine Block Assembly Components - 1.4L LDD**  
 Courtesy of GENERAL MOTORS COMPANY

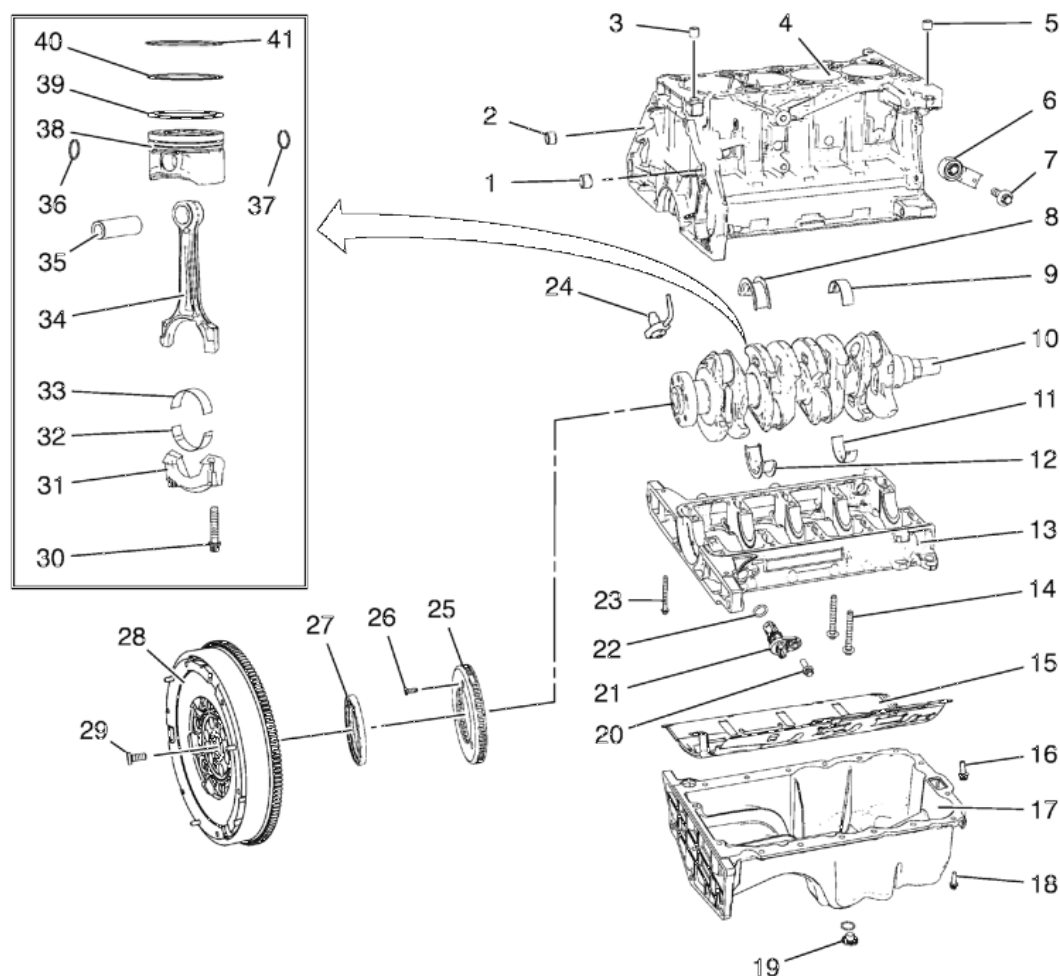
Callout	Component Name
1	Transmission Guide Sleeve
2	Transmission Guide Sleeve
3	Cylinder Head Guide Sleeve
4	Engine Block
5	Cylinder Head Guide Sleeve
6	Knock Sensor
7	Knock Sensor Bolt
8	Upper Crankshaft Thrust Bearing
9	Upper Crankshaft Bearing
10	Crankshaft
11	Lower Crankshaft Bearing
12	Lower Crankshaft Thrust Bearing

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13	Crankshaft Bearing Cap Tie Plate
14	Crankshaft Bearing Cap Tie Plate Bolt (M10)
15	Oil Pan
16	Oil Pan Bolt
17	Oil Pan Drain Plug Seal Ring
18	Oil Pan Drain Plug
19	Crankshaft Position Sensor Bolt
20	Crankshaft Position Sensor
21	Crankshaft Position Sensor Seal Ring
22	Crankshaft Bearing Cap Tie Plate Bolt (M8)
23	Crankshaft Position Sensor Reluctor Ring
24	Flywheel Bolt
25	Engine Flywheel
26	Crankshaft Rear Oil Seal
27	Crankshaft Position Sensor Reluctor Ring Bolt
28	Connecting Rod Bearing Cap Bolt
29	Connecting Rod Bearing Cap
30	Lower Connecting Rod Bearing
31	Upper Connecting Rod Bearing
32	Connecting Rod
33	Piston Pin
34	Piston
35	Piston Oil Ring (With oil Ring Spacer)
36	Lower Compression Ring
37	Upper Compression Ring

**Engine Block Assembly - 1.4L LUH and LUJ**



**Fig. 8: Identifying Engine Block Assembly Components - 1.4L LUH and LUJ**  
 Courtesy of GENERAL MOTORS COMPANY

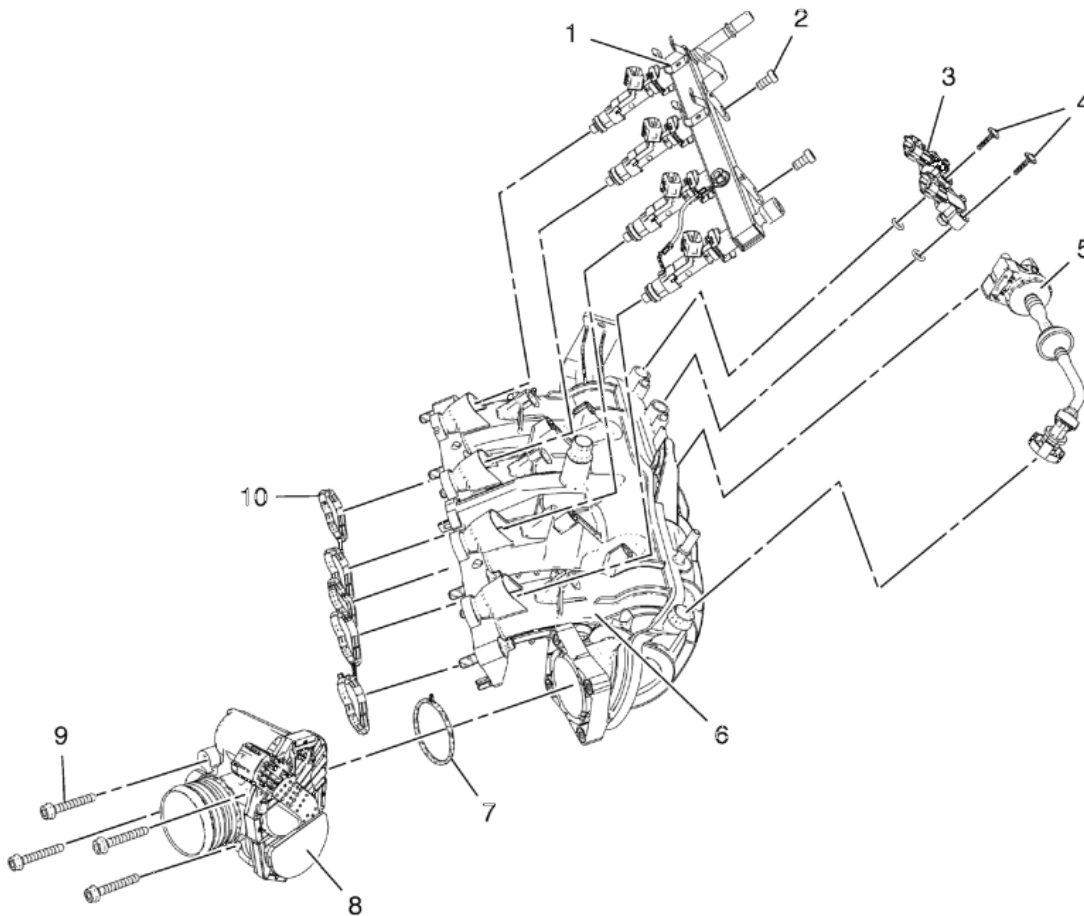
Callout	Component Name
1	Transmission Guide Sleeve
2	Transmission Guide Sleeve
3	Cylinder Head Guide Sleeve
4	Cylinder Head
5	Cylinder Head Guide Sleeve
6	Knock Sensor
7	Knock Sensor Bolt
8	Upper Crankshaft Thrust Bearing
9	Upper Crankshaft Bearing
10	Crankshaft
11	Lower Crankshaft Bearing
12	Lower Crankshaft Thrust Bearing

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13	Crankshaft Bearing Cap Tie Plate
14	Crankshaft Bearing Cap Tie Plate Bolt (M10)
15	Oil Pan Baffle
16	Oil Pan Baffle Bolt
17	Oil Pan
18	Oil Pan Bolt
19	Oil Pan Drain Plug
20	Crankshaft Position Sensor Bolt
21	Crankshaft Position Sensor
22	Crankshaft Position Sensor Seal Ring
23	Crankshaft Bearing Cap Tie Plate Bolt (M8)
24	Piston Oil Nozzle
25	Crankshaft Position Sensor Reluctor Ring
26	Crankshaft Position Sensor Reluctor Ring Bolt
27	Crankshaft Rear Oil Seal
28	Engine Flywheel (Two-Mass)
29	Engine Flywheel Bolt
30	Connecting Rod Bearing Cap Bolt
31	Connecting Rod Bearing Cap
32	Lower Connecting Rod Bearing
33	Upper Connecting Rod Bearing
34	Connecting Rod
35	Piston Pin
36	Piston Pin Retainer
37	Piston Pin Retainer
38	Piston
39	Piston Oil Ring (With Oil Ring Spacer)
40	Lower Compression Ring
41	Upper Compression Ring

**Intake Manifold Assembly - 1.4L LUH and LUJ**

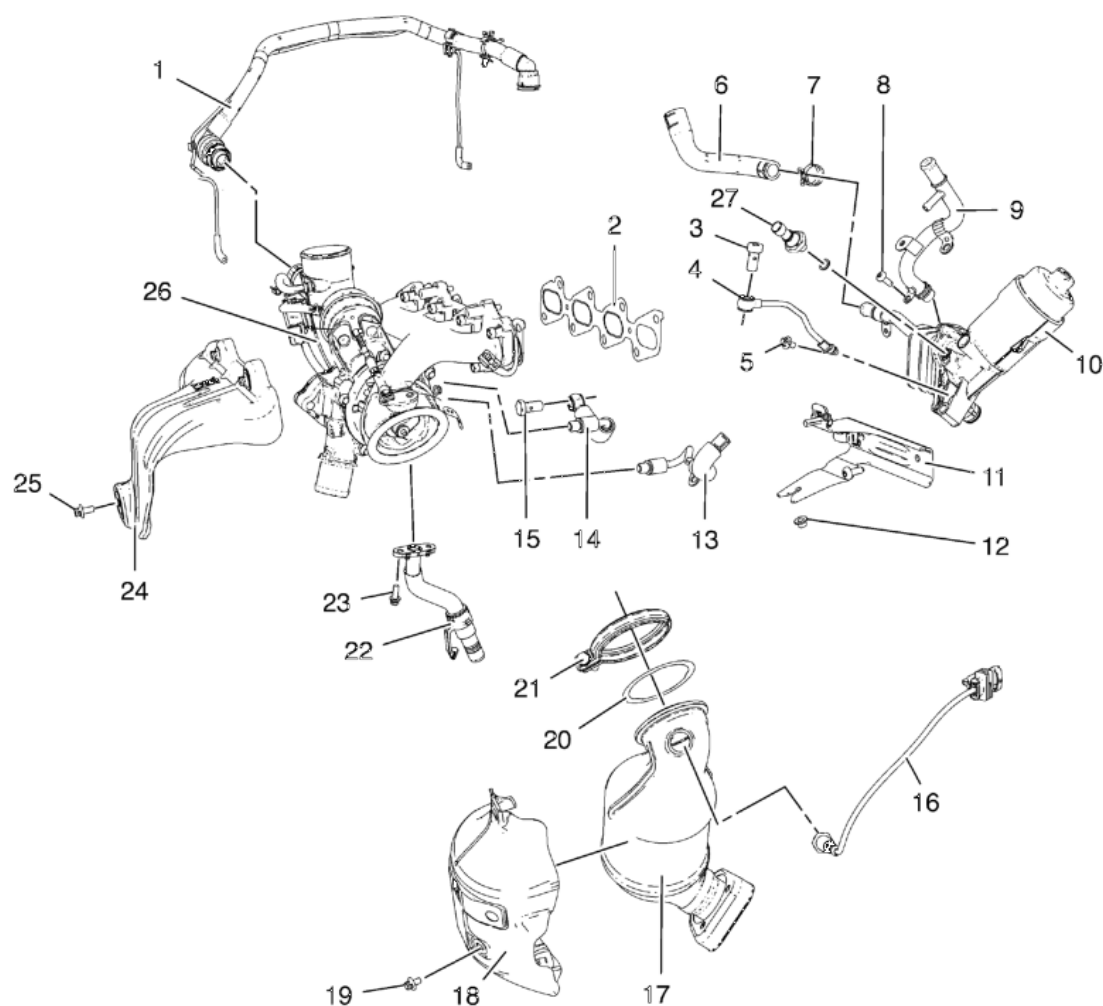


**Fig. 9: Intake Manifold Assembly - 1.4L LUH and LUJ**  
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Injector Fuel Rail
2	Fuel Injector Fuel Rail Bolt
3	Manifold Absolute Pressure Sensor
4	Manifold Absolute Pressure Sensor Bolt
5	Evaporative Emission Canister Purge Solenoid Valve
6	Intake Manifold
7	Throttle Body Seal Ring
8	Throttle Body
9	Throttle Body Bolt
10	Intake Manifold Gasket

**Exhaust Side - 1.4L LUH and LUJ**





**Fig. 10: Identifying Exhaust Side Components - 1.4L LUH and LUJ**  
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Pipe Assembly
2	Exhaust Manifold Gasket
3	Turbo Charger Oil Feed Pipe Hollow Screw
4	Turbo Charger Oil Feed Pipe
5	Turbo Charger Oil Feed Pipe Bolt
6	Oil Cooler Coolant Outlet Hose
7	Oil Cooler Coolant Outlet Hose Clamp
8	Oil Cooler Coolant Feed Pipe Bolt
9	Oil Cooler Coolant Feed Pipe
10	Engine Oil Cooler Assembly
11	Catalytic Converter Bracket
12	Catalytic Converter to Catalytic Converter Bracket Nut

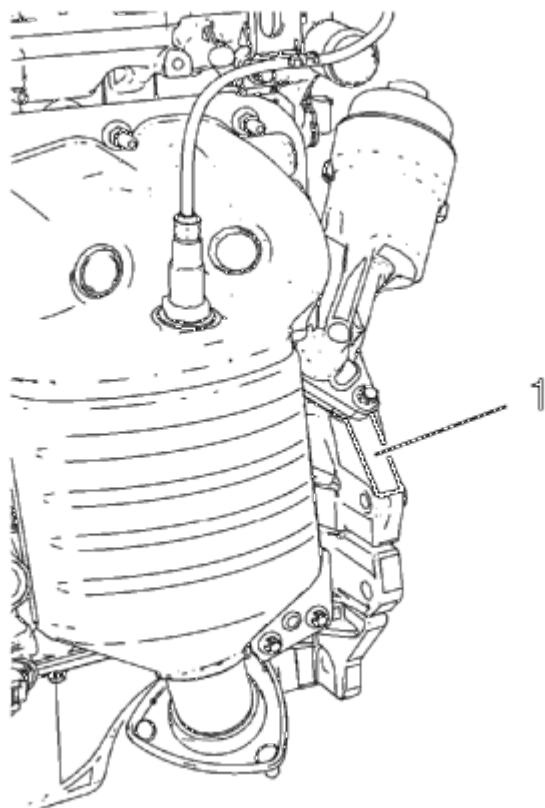
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13	Turbocharger Coolant Return Pipe
14	Turbocharger Coolant Feed Pipe
15	Turbocharger Coolant Feed Pipe Hollow Screw
16	Heated Oxygen Sensor 1
17	Catalytic Converter
18	Catalytic Converter Heat Shield
19	Catalytic Converter Heat Shield Bolt
20	Catalytic Converter Seal
21	Catalytic Converter V-Clamp
22	Turbocharger Oil Return Pipe
23	Turbocharger Oil Return Pipe Bolt
24	Exhaust Manifold Heat Shield
25	Exhaust Manifold Heat Shield Bolt
26	Turbocharger (with Exhaust Manifold)

### ENGINE IDENTIFICATION

#### Engine Number



**Fig. 11: Locating Engine Number**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The engine identification number must be stamped to the cylinder block in case of engine replacement.

The engine number is stamped to the engine block (1).

## **DIAGNOSTIC INFORMATION AND PROCEDURES**

### **SYMPTOMS - ENGINE MECHANICAL**

#### **Strategy Based Diagnostics**

Perform a **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**
- **Engine Compression Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing (1.4L LUV)**
- **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 (1.4L LUV)**

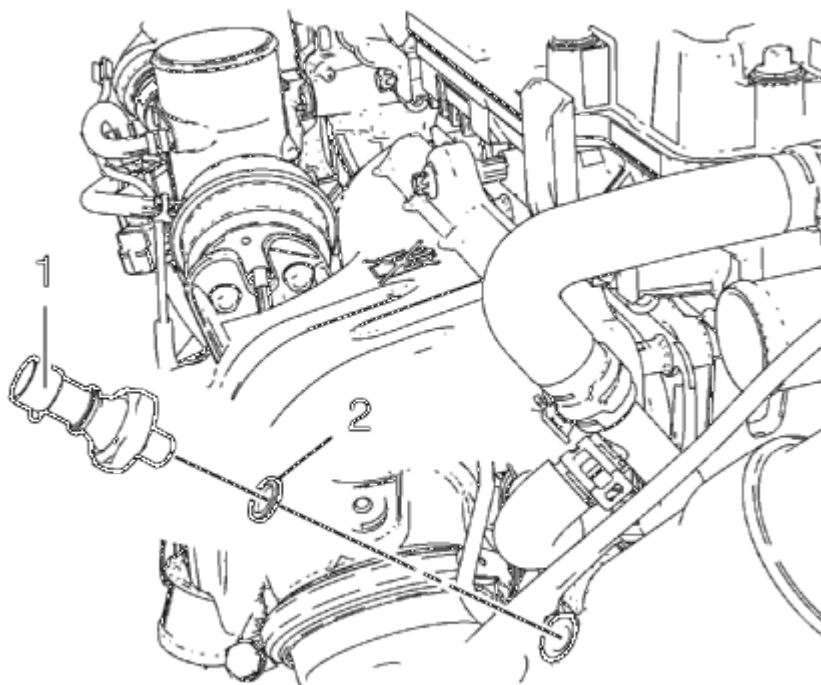
### **Special Tools**

- **EN-498-B** Oil Pressure Gauge
- **EN-498-3** Adapter

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

### **Removal Procedure**

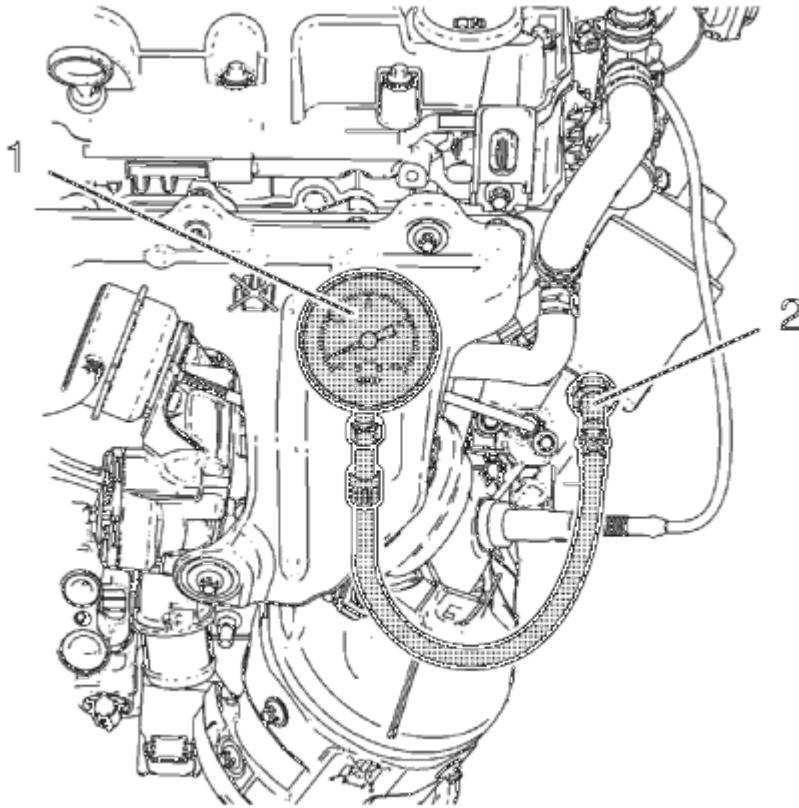
1. Disconnect the oil pressure indicator switch wiring harness plug.



**Fig. 12: Engine Oil Pressure Indicator Switch**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Remove the oil pressure indicator switch (1) and the oil pressure indicator switch seal ring (2).

#### **Measuring Procedure**



**Fig. 13: Gauge And Adapter**

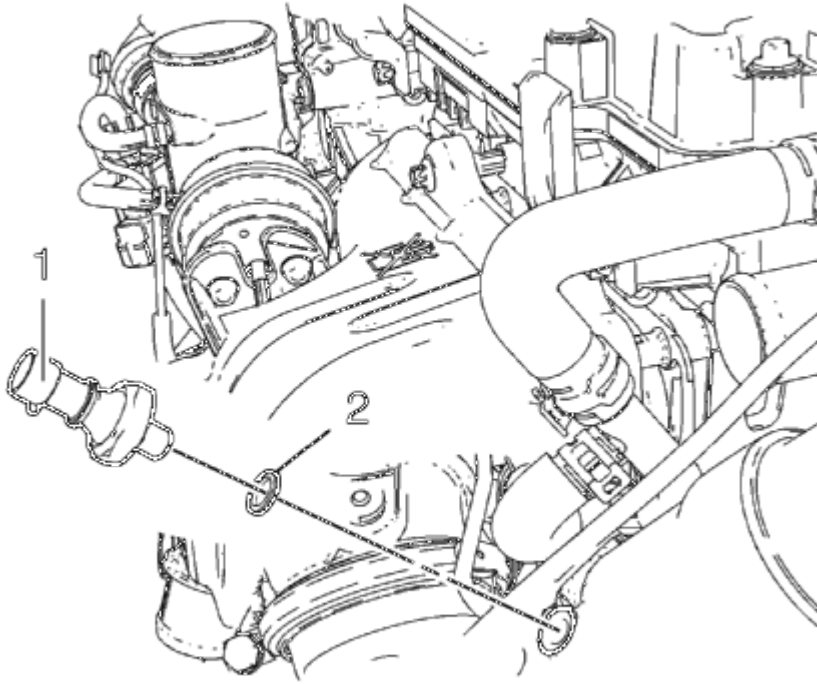
Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-498-B** gauge (1) along with **EN-498-3** adapter (2).
2. Start Engine.

**NOTE:** The oil temperature should be between 80°C (176°F) and 100°C (212°).

3. Measure the oil pressure:
  - The oil pressure at idle speed should be 150 kpa (22 psi).
  - The oil pressure between 3000 - 3500 rpm should be 380 - 650 kpa (55 - 94 psi).
4. Stop engine.
5. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
  - Oil pump worn or dirty. Refer to **Oil Pump Replacement**, and **Engine Front Cover and Oil Pump Cleaning and Inspection**.
  - Oil suction gallery clogged or dirty. Refer to **Oil Pan Cleaning and Inspection**
  - Cracked, porous, or restricted oil galleries.
  - Oil pressure relief valve malfunction.
6. Remove **EN-498-B** gauge and **EN-498-3** adapter.

## Installation Procedure



**Fig. 14: Engine Oil Pressure Indicator Switch**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pressure indicator switch (1) and a NEW oil pressure indicator switch seal ring (2).

**CAUTION: Refer to Fastener Caution .**

2. Tighten the oil pressure indicator switch to 20 N.m (15 lb ft).

## 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. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine</u>		

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1	<p><b><u>Mechanical Specifications.</u></b></p> <ol style="list-style-type: none"> <li>Park the vehicle on a level surface over a large sheet of paper or other clean surface.</li> <li>Wait 15 minutes.</li> <li>Inspect for drippings.</li> </ol> <p>Are drippings present?</p>	Go to <b>Step 2</b>	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to <b>Step 10</b>	Go to <b>Step 3</b>
3	<ol style="list-style-type: none"> <li>Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>Sealing surfaces</li> <li>Fittings</li> <li>Cracked or damaged components</li> </ul> </li> </ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 4</b>
4	<ol style="list-style-type: none"> <li>Completely clean the entire engine and surrounding components.</li> <li>Operate the vehicle for several miles at normal operating temperature and at varying speeds.</li> <li>Park the vehicle on a level surface over a large sheet of paper or other clean surface.</li> <li>Wait 15 minutes.</li> <li>Identify the type of fluid and the approximate location of the leak.</li> </ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 5</b>
5	<ol style="list-style-type: none"> <li>Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li> <li>Inspect for leaks at the following locations: <ul style="list-style-type: none"> <li>Sealing surfaces</li> <li>Fittings</li> <li>Cracked or damaged components</li> </ul> </li> </ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 6</b>
	<ol style="list-style-type: none"> <li>Completely clean the entire engine and surrounding components.</li> </ol>		



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6	<ol style="list-style-type: none"><li>2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area.</li><li>3. Operate the vehicle for several miles at normal operating temperature and at varying speeds.</li><li>4. Identify the type of fluid and the approximate location of the leak from the discolorations in the powder surface.</li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 7</b>
7	<ol style="list-style-type: none"><li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li><li>2. Inspect for leaks at the following locations:<ul style="list-style-type: none"><li>• Sealing surfaces</li><li>• Fittings</li><li>• Cracked or damaged components</li></ul></li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 8</b>
8	<p>Identify the type of fluid and the approximate location of the leak.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	Go to <b>Step 9</b>
9	<ol style="list-style-type: none"><li>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</li><li>2. Inspect for leaks at the following locations:<ul style="list-style-type: none"><li>• Sealing surfaces</li><li>• Fittings</li><li>• Cracked or damaged components</li></ul></li></ol> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to <b>Step 10</b>	System OK
	<ol style="list-style-type: none"><li>1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas:<ul style="list-style-type: none"><li>• Higher than recommended fluid levels</li><li>• Higher than recommended fluid pressures</li><li>• Plugged or malfunctioning fluid filters or pressure bypass valves</li><li>• Plugged or malfunctioning engine ventilation system</li><li>• Improperly tightened or damaged fasteners</li></ul></li></ol>		

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10	<ul style="list-style-type: none"> <li>• Cracked or porous components</li> <li>• Improper sealants or gaskets, where required</li> <li>• Improper sealant or gasket installation</li> <li>• Damaged or worn gaskets or seals</li> <li>• Damaged or worn sealing surfaces</li> </ul> <p>2. Inspect the engine for customer modifications.</p> <p>Is there mechanical damage or customer modifications to the engine?</p>	Go to <b>Step 11</b>	System OK
11	<p>Repair or replace all damaged or modified components.</p> <p>Did you complete the repair?</p>	Go to <b>Step 1</b>	-

**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"> <li>• External oil leaks.</li> <li>• Incorrect oil level or improper reading of the oil level indicator.</li> </ul> <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"> <li>• Improper oil viscosity.</li> </ul> <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"> <li>• Continuous high speed driving and/or severe usage.</li> <li>• Crankcase ventilation system restrictions or malfunctioning components.</li> <li>• Worn valve guides and/or valve stems.</li> <li>• Worn, missing or improperly installed valve stem oil seals.</li> <li>• Piston rings broken, worn, not seated properly.</li> </ul> <p>Allow adequate time for the rings to seat.</p> <p>Replace worn piston rings as necessary.</p> <ul style="list-style-type: none"> <li>• Piston and rings improperly installed or miss-fitted to the cylinder bore.</li> </ul>

## ENGINE NOISE UNDER LOAD

### Engine Noise Under Load

Cause	Correction
Low oil pressure	Insufficient or poor oil supply to components. <ol style="list-style-type: none"> <li>1. Perform oil pressure test.</li> <li>2. Repair or replace all damaged components.</li> </ol>
Loose torque converter bolts	<ol style="list-style-type: none"> <li>1. Inspect the torque converter bolts and flywheel.</li> <li>2. Repair or replace all damaged components.</li> </ol>
Loose and/or damaged flywheel	<ol style="list-style-type: none"> <li>1. Inspect the flywheel and flywheel attaching bolts.</li> <li>2. Repair or replace all damaged components.</li> </ol>
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"> <li>1. Inspect the piston rings for low ring tension, broken or worn rings, inspect cylinder bore.</li> <li>2. Repair or replace all damaged components.</li> </ol>
Excessive crankshaft thrust bearing clearance	<ol style="list-style-type: none"> <li>1. Inspect the crankshaft end play and crankshaft thrust bearings.</li> <li>2. Repair or replace all damaged components.</li> </ol>
Excessive crankshaft bearing clearance	<ol style="list-style-type: none"> <li>1. Inspect the crankshaft bearings and crankshaft journals.</li> <li>2. Repair or replace all damaged components.</li> </ol>

## 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	Drain the engine oil and replace with the correct viscosity oil.
High stationary hydraulic lash adjuster (SHLA), valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	<ul style="list-style-type: none"> <li>• Inspect the thrust bearing and crankshaft.</li> <li>• Repair or replace as required.</li> </ul>
Damaged or faulty oil filter by-pass valve	<ul style="list-style-type: none"> <li>• Inspect the oil filter by-pass valve for proper operation.</li> <li>• Repair or replace as required.</li> </ul>

## BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

### Base Engine Misfire without Internal Engine Noises

Condition	Action
Abnormalities (severe cracking,	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also

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bumps or missing areas) in the accessory drive belt. Also worn, damaged, or misaligned accessory drive components or excessive pulley runout.	lead to a misfire condition. A misfire code may be present without an actual misfire condition.  <ol style="list-style-type: none"><li>1. Inspect the accessory drive components.</li><li>2. Repair or replace all damaged components.</li></ol>
Loose and/or damaged crankshaft pulley	A misfire code may be present without an actual misfire condition.  <ol style="list-style-type: none"><li>1. Inspect crankshaft pulley and pulley bolt.</li><li>2. Repair or replace all damaged components.</li></ol>
Loose torque converter bolts	A misfire code may be present without an actual misfire condition.  <ol style="list-style-type: none"><li>1. Inspect torque converter bolts and flywheel.</li><li>2. Repair or replace all damaged components.</li></ol>
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition.  <ol style="list-style-type: none"><li>1. Inspect flywheel and flywheel attaching bolts.</li><li>2. Repair or replace all damaged components.</li></ol>
Restricted exhaust system	A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a misfire code. Possible causes of restrictions include collapsed or dented pipes, plugged mufflers and/or catalytic converters. Repair or replace all damaged components.
Air in fuel system	<ol style="list-style-type: none"><li>1. Inspect fuel filter, fuel system for leaks and/or restrictions.</li><li>2. Repair or replace all damaged components.</li></ol>
Bent and/or worn valve bridge and finger-follower	<ol style="list-style-type: none"><li>1. Inspect valve bridge and valve finger-follower.</li><li>2. Repair or replace all damaged components.</li></ol>
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick.  <ol style="list-style-type: none"><li>1. Inspect valves and valve guides.</li><li>2. Repair or replace all damaged components.</li></ol>
Damaged or misaligned timing gears	<ol style="list-style-type: none"><li>1. Inspect timing gears.</li><li>2. Replace all damaged components.</li></ol>
Worn or faulty camshaft lobes	<ol style="list-style-type: none"><li>1. Inspect camshaft lobes.</li><li>2. Repair or replace all damaged components.</li></ol>
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"><li>1. Perform compression tests.</li><li>2. Inspect the piston, piston rings and cylinder bore.</li><li>3. Repair or replace all damaged components.</li></ol>
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. (Coolant consumption may or	<ol style="list-style-type: none"><li>1. Perform compression tests.</li><li>2. Inspect the piston, piston rings and cylinder bore.</li><li>3. Repair or replace all damaged components.</li></ol>

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may not cause the engine to  
overheat.)

**BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES****Base Engine Misfire with Abnormal Internal Lower Engine Noises**

<b>Condition</b>	<b>Actions</b>
Abnormalities (server cracking, bumps or missing areas) in the accessory drive belt	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.  1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Worn, damaged, or misaligned accessory drive components or excessive pulley runout	A misfire code may be present without an actual misfire condition.  1. Inspect the accessory drive components. 2. Repair or replace all damage components.
Loose and/or damaged crankshaft pulley	A misfire code may be present without an actual misfire condition.  1. Repair or replace all damaged components. 2. Inspect crankshaft pulley and pulley bolt.
Loose torque converter bolts	A misfire code may be present without an actual misfire condition.  1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition.  1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform cylinder leak down and compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.
Excessive crankshaft thrust bearing clearance	Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit for and aft movement of the crankshaft and create a misfire code without an actual misfire condition.  1. Inspect the crankshaft end play and crankshaft thrust bearings. 2. Repair or replace all damaged.

**BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE****Base Engine Misfire with Abnormal Valve Train Noise**

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Condition	Action
Loose, worn or damaged valve bridge and finger-follower	<ol style="list-style-type: none"><li>1. Inspect valve bridge and finger-follower.</li><li>2. Repair or replace all damaged components.</li></ol>
Broken valve springs	<ol style="list-style-type: none"><li>1. Inspect valve springs.</li><li>2. Repair or replace all damaged components.</li></ol>
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. <ol style="list-style-type: none"><li>1. Inspect valves and valve guides.</li><li>2. Repair or replace all damaged components.</li></ol>
Worn or faulty camshaft lobes	<ol style="list-style-type: none"><li>1. Inspect camshaft lobes.</li><li>2. Repair or replace all damaged components.</li></ol>

**BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION****Base Engine Misfire with Coolant Consumption**

Inspection	Action
DEFINITION: Base engine misfire with coolant consumption	
Preliminary Inspection	Verify that there are no external coolant leaks.
Isolate Affected Cylinders	<ul style="list-style-type: none"><li>• Cylinder balance test with scan tool</li><li>• Cooling system pressurization</li><li>• Inspection of glow plugs</li><li>• Compression test</li></ul>
EGR System Inspection	<ul style="list-style-type: none"><li>• Inspect EGR valve and intake system for evidence of coolant leakage.</li><li>• Replace the EGR cooler if any problem is found.</li></ul>
Cylinder Head Gasket Leakage	<ul style="list-style-type: none"><li>• Remove cylinder heads of the affected cylinder bank and inspect for damage.</li><li>• Replace components as necessary.</li></ul>
Cylinder Head or Engine Block Damage	<ul style="list-style-type: none"><li>• Inspect the cylinder head for cracks.</li><li>• Inspect the cylinder block for damage.</li><li>• Inspect the cylinder block to head mating surface for straightness.</li><li>• Replace components as necessary.</li></ul>

**BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION****Base Engine Misfire with Excessive Oil Consumption**

Condition	Action
Worn valve guides	<ol style="list-style-type: none"><li>1. Inspect the valves and valve guides.</li><li>2. Repair or replace all damaged components.</li></ol>

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Worn valve stem oil seals	<ol style="list-style-type: none"><li>1. Inspect the valve stem oil seals.</li><li>2. Repair or replace all damaged components.</li></ol>
Excessive piston-to-cylinder bore clearance	<ol style="list-style-type: none"><li>1. Perform compression tests to determine the cause.</li><li>2. Inspect the piston rings for low ring tension, broken or worn rings.</li><li>3. Inspect cylinder bore.</li><li>4. Repair or replace all damaged components.</li></ol>

**UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED****Upper Engine Noise, Regardless of Engine Speed**

Condition	Action
Low oil pressure	<p>Insufficient or poor oil supply to valve train.</p> <ol style="list-style-type: none"><li>1. Perform oil pressure test.</li><li>2. Repair or replace all damaged components.</li></ol>
Improper lubrication to the valve finger-follower	<ol style="list-style-type: none"><li>1. Inspect valve finger-follower, valve bridge, valve finger follower lifter, oil pump and engine block oil galleries.</li><li>2. Repair or replace all damaged components.</li></ol>
Worn or damaged valve finger-follower	<ol style="list-style-type: none"><li>1. Inspect valve bridge and finger-follower.</li><li>2. Repair or replace all damaged components.</li></ol>
Sticking valve	<p>Carbon on the valve stem or valve seat may cause the valve to stick.</p> <ol style="list-style-type: none"><li>1. Inspect valves and valve guides.</li><li>2. Repair or replace all damaged components.</li></ol>
Worn or faulty camshaft lobes	<ol style="list-style-type: none"><li>1. Inspect camshaft lobes.</li><li>2. If damaged replace camshaft and all valve finger-followers.</li></ol>
Damaged or misaligned timing gears	<ol style="list-style-type: none"><li>1. Inspect timing gears.</li><li>2. Replace all damaged components.</li></ol>

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

Condition	Action
Worn accessory drive components (abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of the system components.)	<ol style="list-style-type: none"><li>1. Inspect the accessory drive components.</li><li>2. Repair or replace all damaged components.</li></ol>
	Insufficient or poor oil supply to crankshaft and connecting rod

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Low oil pressure	bearings.  1. Perform oil pressure test. 2. Repair or replace all damaged components.
Leaking and/or sticking fuel injection nozzle (A stuck fuel injection nozzle can cause a noise similar to a damaged piston, rod or rod bearing.)	1. Inspect the cylinder balance with scan tool to help locate the cylinder that is the source of the noise. 2. If you cannot locate the cylinder that is the source of the noise, diagnose the engine for mechanical damage. 3. If it has been determined that the fuel injection nozzle is causing the noise, replace the fuel injection nozzle.
Loose and/or damaged crankshaft pulley	1. Inspect crankshaft pulley and pulley bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace all damaged components.
Misaligned or bent connecting rod	1. Inspect connecting rod and connecting rod bearings. 2. Repair or replace all damaged components.
Excessive connecting rod bearing clearance	1. Inspect the connecting rod bearings, connecting rods, crankshaft and crankshaft journals. 2. Repair or replace all damaged components.
Excessive crankshaft bearing clearance	1. Inspect the crankshaft bearings and crankshaft journals. 2. Repair or replace all damaged components.

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

<b>Cause</b>	<b>Correction</b>
Seized accessory drive system component	1. Inspect the accessory drive system components. 2. Repair or replace all damaged components.
Hydraulically locked cylinder <ul style="list-style-type: none"> <li>• Coolant/antifreeze in cylinder</li> <li>• Oil in cylinder</li> <li>• Fuel in cylinder</li> </ul>	1. Inspect for broken head gasket(s). 2. Inspect for cracked engine block or cylinder head. 3. Inspect for a sticking fuel injector.
Seized automatic transmission	1. Remove the engine assembly. The torque converter bolts are not



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torque converter	accessible with the engine installed to the transmission. 2. Rotate the crankshaft at the pulley.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft at the pulley.
Material in cylinder <ul style="list-style-type: none"><li>• Broken valve</li><li>• Piston material</li><li>• Foreign material</li></ul>	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearing	1. Inspect the crankshaft and connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair as required.

### ENGINE COMPRESSION TEST

#### Special Tools

**EN-48248** Cylinder Compression Pressure Gauge

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

#### Removal Procedure

1. Remove the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.
2. Remove the spark plugs. Refer to **Spark Plug Replacement**.
3. Remove the relay holder cover.
4. Remove the fuel pump relay.

**NOTE:** The engine cranking time for the compression test should be less than 10 seconds and at 30 second intervals.

5. Crank the engine with the starter motor for 5 seconds to remove any foreign substances from the cylinders.
6. Prior to taking a compression reading, verify the cranking speed is greater than 300 RPM. If the cranking speed is below 300 RPM, repair the slow cranking speed condition before continuing with the compression test.
7. Install **EN-48248** gauge in the spark plug bore for the cylinder that is being checked.
8. Using the vehicle's starter motor, rotate or crank the engine for 4 compression strokes, puffs, for the cylinder being tested.

9. Observe the compression gauge and note the reading as the compression test is being performed. A normal cylinder reading will be indicated if compression builds up quickly and evenly to the specified level. An abnormal reading will be indicated if compression is low on the first compression stroke, starts increasing on the following compression strokes but does not reach the specified level.
10. Record the compression reading for the cylinder just tested.
11. Repeat steps for all remaining cylinders. All 4 cylinders must be tested to obtain valid test results. Record the readings.
12. The maximum pressure differential should not exceed 100 kPa (14.5 psi).
13. The nominal cylinder compression value is
  - for natural aspirated engines 1300 kPa - 1500 kPa (188.5 psi - 217.6 psi).
  - for turbo engines 1200 kPa - 1400 kPa (174 psi - 203.1 psi).

**Installation Procedure**

1. Install the fuel pump relay.
2. Install the relay holder cover.
3. Install the spark plugs. Refer to **Spark Plug Replacement**.
4. Install the throttle body assembly. Refer to **Throttle Body Assembly Replacement**.

**DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS****Diagnostic Aids**

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

**Test Description**

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

**2**

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

**3**

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

**4**

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

**6**

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

**10**

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

**12**

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

**14**

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

**15**

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

**16**

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

17

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

19

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

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

Step	Action	Yes	No
<b>CAUTION:</b> <b>Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.</b>			
<b>DEFINITION:</b> The following items are indications of chirping: <ul style="list-style-type: none"> <li>• A high pitched noise that is heard once per revolution of the drive belt or a pulley.</li> <li>• Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.</li> </ul>			
<b>DEFINITION:</b> The following items are indications of drive belt squeal: <ul style="list-style-type: none"> <li>• A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs.</li> <li>• 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.</li> </ul>			
<b>DEFINITION:</b> The following items are indications of drive belt whine: <ul style="list-style-type: none"> <li>• A high pitched continuous noise.</li> <li>• The noise may be caused by an accessory drive component failed bearing.</li> </ul>			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to <b>Step 2</b>	Go to <b>Symptoms - Engine Mechanical</b>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to <b>Step 3</b>	Go to Diagnostic Aids
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.		

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	<p>2. Operate the engine for no longer than 30-40 seconds.</p> <p>3. Repeat this test if necessary by removing the remaining belt(s).</p> <p>Does the chirping, squeal or whine noise still exist?</p>	Go to <b>Symptoms - Engine Mechanical</b>	Go to <b>Step 4</b>
<b>4</b>	<p>If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth.</p> <p>If diagnosing a squeal or whine noise, proceed to <b>Step 13</b>.</p> <p>Do the belt grooves have pilling?</p>	Go to <b>Step 5</b>	Go to <b>Step 6</b>
<b>5</b>	<p>Clean the drive belt pulleys with a suitable wire brush.</p> <p>Did you complete the repair?</p>	Go to <b>Step 20</b>	Go to <b>Step 6</b>
<b>6</b>	<p>Inspect for misalignment of the pulleys.</p> <p>Are any of the pulleys misaligned?</p>	Go to <b>Step 7</b>	Go to <b>Step 8</b>
<b>7</b>	<p>Replace or repair any misaligned pulleys.</p> <p>Did you complete the repair?</p>	Go to <b>Step 20</b>	Go to <b>Step 8</b>
<b>8</b>	<p>Inspect for bent or cracked brackets.</p> <p>Did you find any bent or cracked brackets?</p>	Go to <b>Step 9</b>	Go to <b>Step 10</b>
<b>9</b>	<p>Replace any bent or cracked brackets.</p> <p>Did you complete the repair?</p>	Go to <b>Step 20</b>	Go to <b>Step 10</b>
<b>10</b>	<p>Inspect for improper, loose or missing fasteners.</p> <p>Did you find the condition?</p>	Go to <b>Step 11</b>	Go to <b>Step 12</b>
<b>11</b>	<p><b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b></p> <p>1. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications (1.4L LUV)</u></b>.</p> <p>2. Replace any improper or missing fasteners.</p> <p>Did you complete the repair?</p>	Go to <b>Step 20</b>	Go to <b>Step 12</b>
<b>12</b>	<p>Inspect for a bent pulley.</p> <p>Did you find the condition?</p>	Go to <b>Step 18</b>	Go to <b>Step 19</b>
<b>13</b>	<p>Inspect for an accessory drive component seized bearing or a faulty accessory drive component.</p> <p>Did you find and correct the condition?</p> <p>If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids.</p>	Go to <b>Step 20</b>	Go to <b>Step 14</b>
<b>14</b>	<p>Test the drive belt tensioner for proper operation.</p> <p>Did you find and correct the condition?</p>	Go to <b>Step 20</b>	Go to <b>Step 15</b>
<b>15</b>	<p>Inspect for the correct drive belt length.</p> <p>Did you find and correct the condition?</p>	Go to <b>Step 20</b>	Go to <b>Step 16</b>
<b>16</b>	<p>Inspect for misalignment of a pulley.</p> <p>Did you find and correct the condition?</p>	Go to <b>Step 20</b>	Go to <b>Step 17</b>

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17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to <b>Step 20</b>	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to <b>Step 20</b>	Go to <b>Step 19</b>
19	Replace the drive belt. Refer to <b>Symptoms - Engine Mechanical</b> . Did you complete the repair?	Go to <b>Step 20</b>	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 3</b>

### DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

#### 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 can be recognized 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
<p>DEFINITION: The following items are indications of drive belt rumbling:</p> <ul style="list-style-type: none"> <li>• A low pitch tapping, knocking, or thumping noise heard at or just above idle.</li> <li>• Heard once per revolution of the drive belt or a pulley.</li> <li>• Rumbling may be caused from: <ul style="list-style-type: none"> <li>○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove</li> <li>○ The separation of the drive belt</li> <li>○ A damaged drive belt.</li> </ul> </li> </ul> <p>DEFINITION: The following items are indications of drive belt vibration:</p> <ul style="list-style-type: none"> <li>• The vibration is engine-speed related.</li> <li>• The vibration may be sensitive to accessory load.</li> </ul>			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to <b>Step 2</b>	Go to <b>Symptoms - Engine Mechanical</b>
2	Verify that there is a rumbling noise or that the vibration is engine related.		Go to Diagnostic

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	Does the engine make the rumbling noise or vibration?	Go to <b>Step 3</b>	Aids
<b>3</b>	<p>1. Remove the drive belt.</p> <p>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.</p> <p>2. Operate the engine for no longer than 30-40 seconds.</p> <p>3. Repeat this test if necessary by removing the remaining belt(s).</p> <p>Does the rumbling or vibration still exist?</p>	Go to <b>Symptoms - Engine Mechanical</b>	Go to <b>Step 4</b>
<b>4</b>	<p>Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up.</p> <p>Did you find any of these conditions?</p>	Go to <b>Step 7</b>	Go to <b>Step 5</b>
<b>5</b>	<p>Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves.</p> <p>Did you find severe pilling?</p>	Go to <b>Step 6</b>	Go to <b>Step 7</b>
<b>6</b>	<p>1. Clean the drive belt pulleys using a suitable wire brush.</p> <p>2. Reinstall the drive belts.</p> <p>Did you correct the condition?</p>	Go to <b>Step 8</b>	Go to <b>Step 7</b>
<b>7</b>	<p>Install a new drive belt.</p> <p>Did you complete the replacement?</p>	Go to <b>Step 8</b>	Go to <b>Step 9</b>
<b>8</b>	<p>Operate the system in order to verify the repair.</p> <p>Did you correct the condition?</p>	System OK	Go to <b>Step 9</b>
<b>9</b>	<p>Inspect for improper, loose or missing fasteners.</p> <p>Did you find any of these conditions?</p>	Go to <b>Step 10</b>	Go to <b>Step 11</b>
<b>10</b>	<p><b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b></p> <p>1. Tighten any loose fasteners. Refer to <b><u>Fastener Tightening Specifications (1.4L LUV)</u></b>.</p> <p>2. Replace improper or missing fasteners.</p> <p>Did you complete the repair?</p>	Go to <b>Step 12</b>	Go to <b>Step 11</b>
<b>11</b>	<p>Inspect for bent or cracked brackets.</p> <p>Did you find and correct the condition?</p>	Go to <b>Step 12</b>	Go to Diagnostic Aids
<b>12</b>	<p>Operate the system in order to verify the repair.</p> <p>Did you correct the condition?</p>	System OK	Go to <b>Step 3</b>

### DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS



**Diagnostic Aids**

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

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

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

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

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

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

**Test Description**

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

**2**

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

**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 two wide or two 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
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 <b>Step 2</b>	Go to <b>Symptoms - Engine Mechanical</b>
2	If diagnosing high wear, proceed to <b>Step 13</b> . If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to <b>Step 3</b>	Go to <b>Step 4</b>
3	Install a new drive belt. Refer to <b>Drive Belt Replacement</b> . Does the drive belt continue to fall off?	Go to <b>Step 4</b>	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 5</b>
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 6</b>
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to <b>Step 7</b>
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to <b>Step 8</b>	Go to <b>Step 9</b>
	<b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b>  1. Tighten any loose fasteners. Refer to <b>Fastener</b>		

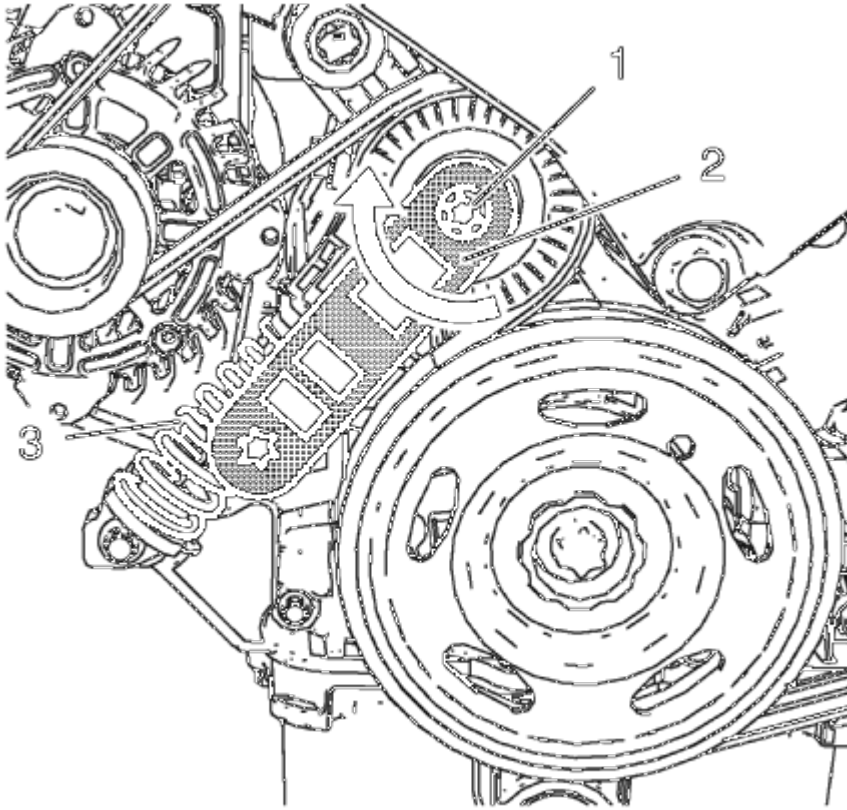
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8	<b><u>Tightening Specifications (1.4L LUV).</u></b>		
	2. Replace improper or missing fasteners.		
	Does the drive belt continue to fall off?	Go to <b>Step 9</b>	System OK
9	Test the drive belt tensioner for operating correctly. Does the drive belt tensioner operate correctly?	Go to <b>Step 11</b>	Go to <b>Step 10</b>
10	Replace the drive belt tensioner. Refer to <b><u>Drive Belt Tensioner Replacement.</u></b>		
	Does the drive belt continue to fall off?	Go to <b>Step 11</b>	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to <b>Step 12</b>	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 2</b>
13	Inspect the drive belt for the proper installation. Refer to <b><u>Drive Belt Replacement.</u></b>		
	Did you find this condition?	Go to <b>Step 16</b>	Go to <b>Step 14</b>
14	Inspect for the proper drive belt.		
	Did you find this condition?	Go to <b>Step 16</b>	Go to <b>Step 15</b>
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness.		
	Did you find and repair the condition?	Go to <b>Step 17</b>	Go to Diagnostic Aids
16	Replace the drive belt. Refer to <b><u>Drive Belt Replacement.</u></b>		
	Did you complete the replacement?	Go to <b>Step 17</b>	-
17	Operate the system in order to verify the repair.		
	Did you correct the condition?	System OK	-

**DRIVE BELT TENSIONER DIAGNOSIS****Special Tools****EN-48488** Holding WrenchFor equivalent regional tools, refer to **Special Tools.**

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



**Fig. 15: Drive Belt Tensioner Spring, Drive Belt Tensioner Pulley Bolt And Wrench**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-48488** wrench (2) to the drive belt tensioner pulley bolt (1).
3. Apply tension to the drive belt tensioner spring (3) by moving the drive belt tensioner pulley clockwise.
4. Allow the drive belt tensioner to slide back slowly and thereby inspect the drive belt tensioner mechanism for practicability.

## REPAIR INSTRUCTIONS - ON VEHICLE

### DRIVE BELT REPLACEMENT

#### Special Tools

- **EN-48488** Holding Wrench
- **EN-955** Locking Pin

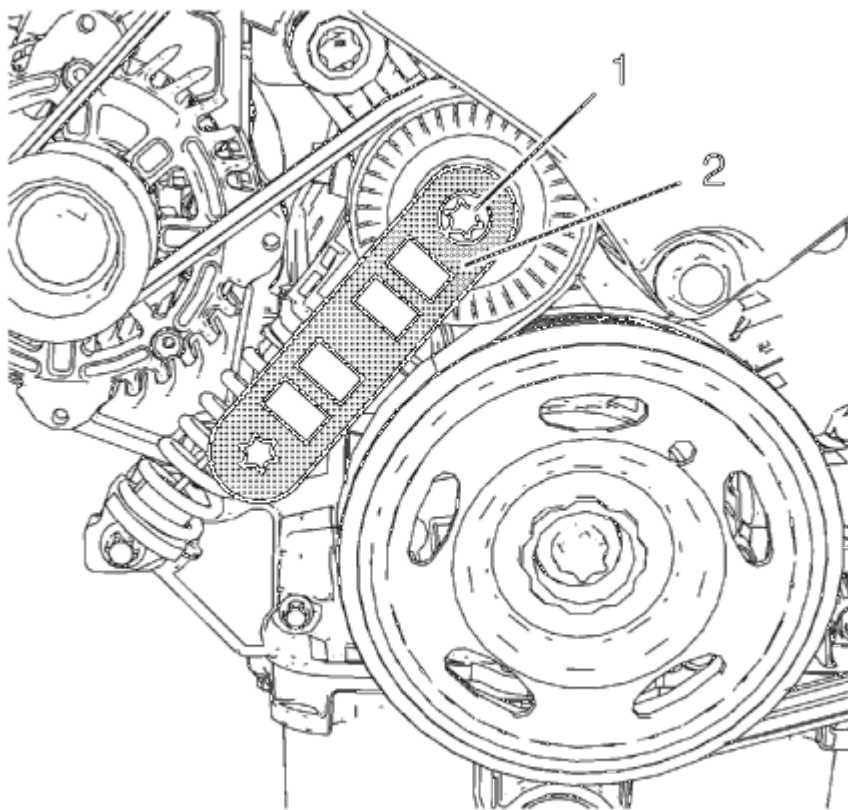
For equivalent regional tools, refer to **Special Tools**.

#### Removal Procedure

1. Remove the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front**

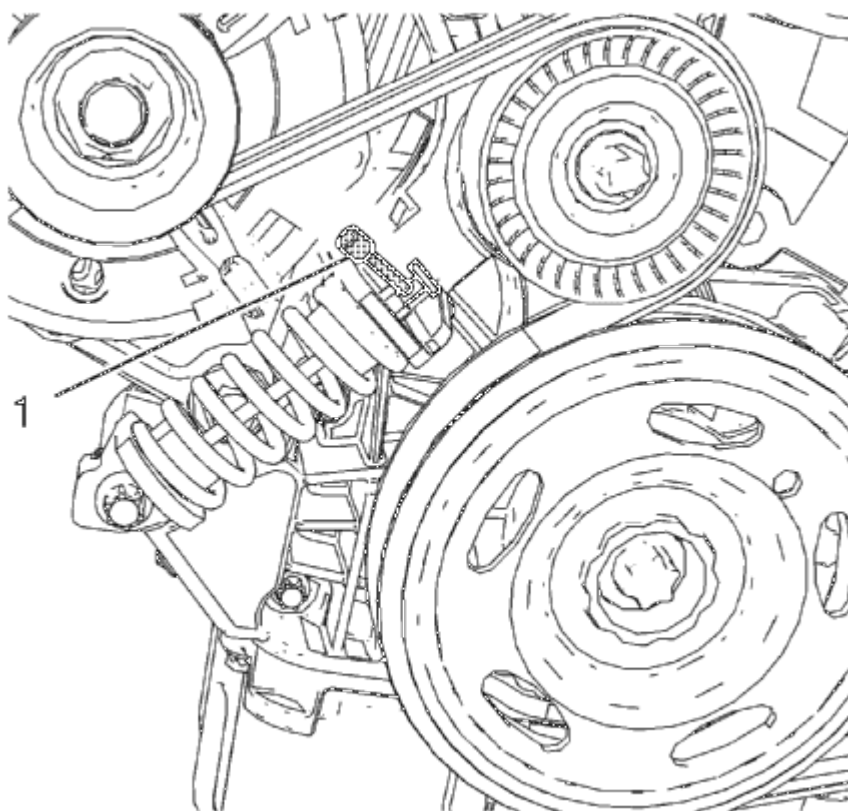
**Extension Replacement .**

2. Install the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.



**Fig. 16: Holding Wrench And Drive Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

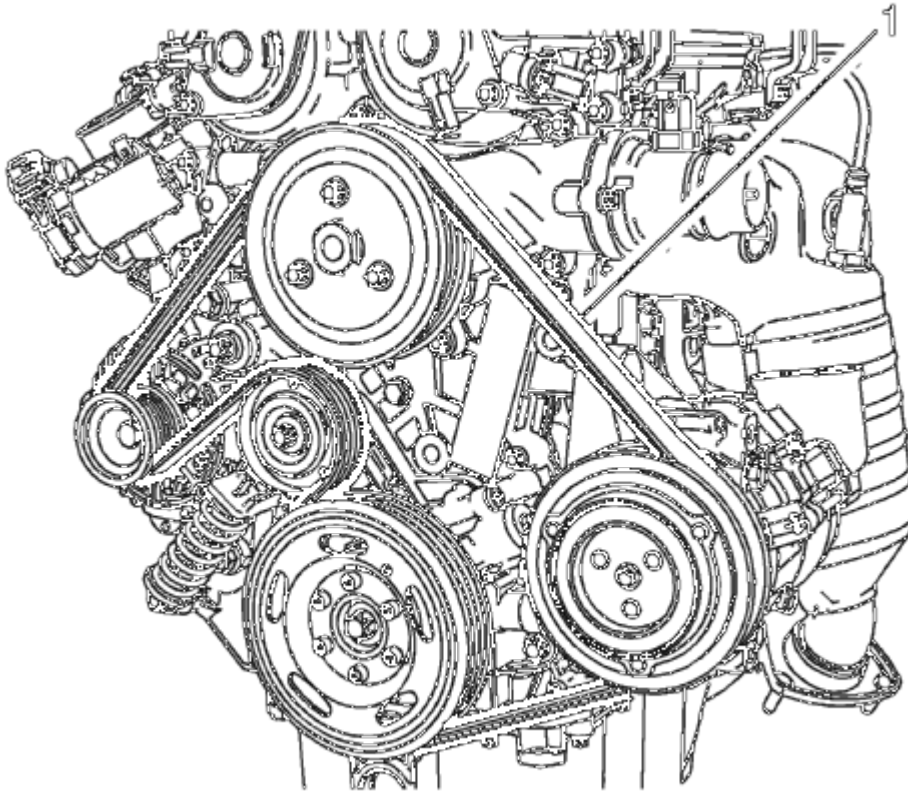
4. Install **EN-48488** holding wrench (2) to the drive belt tensioner (1).



**Fig. 17: Locking Pin**

Courtesy of GENERAL MOTORS COMPANY

5. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with **EN-955** locking pin (1).
6. Remove the **EN-48488** holding wrench.

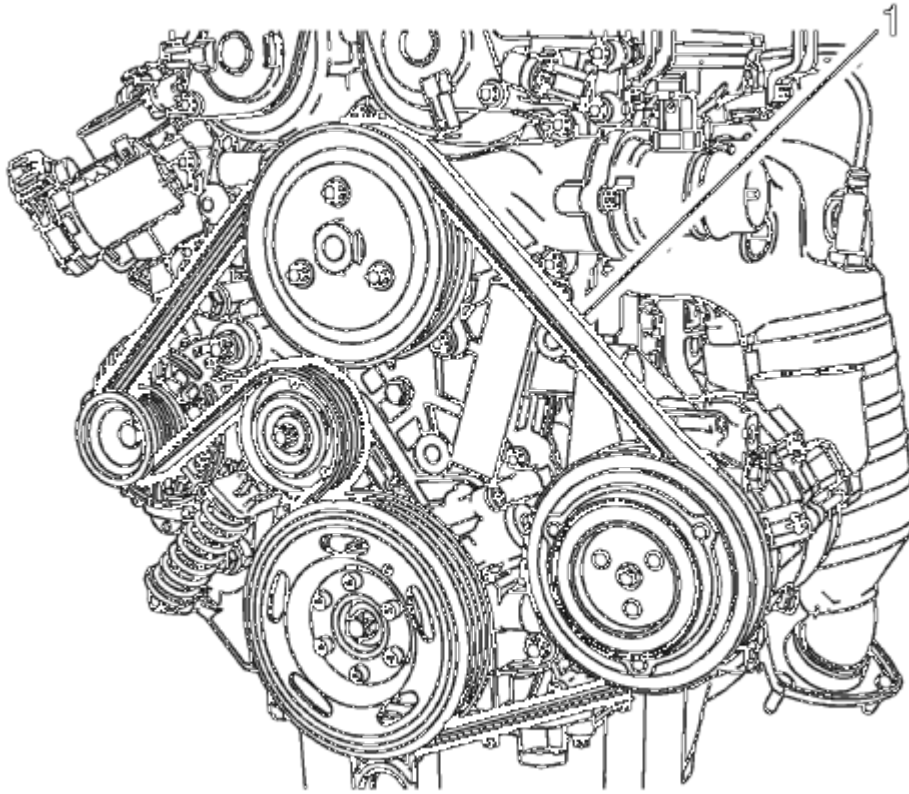


**Fig. 18: Drive Belt Routing**

**Courtesy of GENERAL MOTORS COMPANY**

7. Remove the drive belt (1).

#### **Installation Procedure**

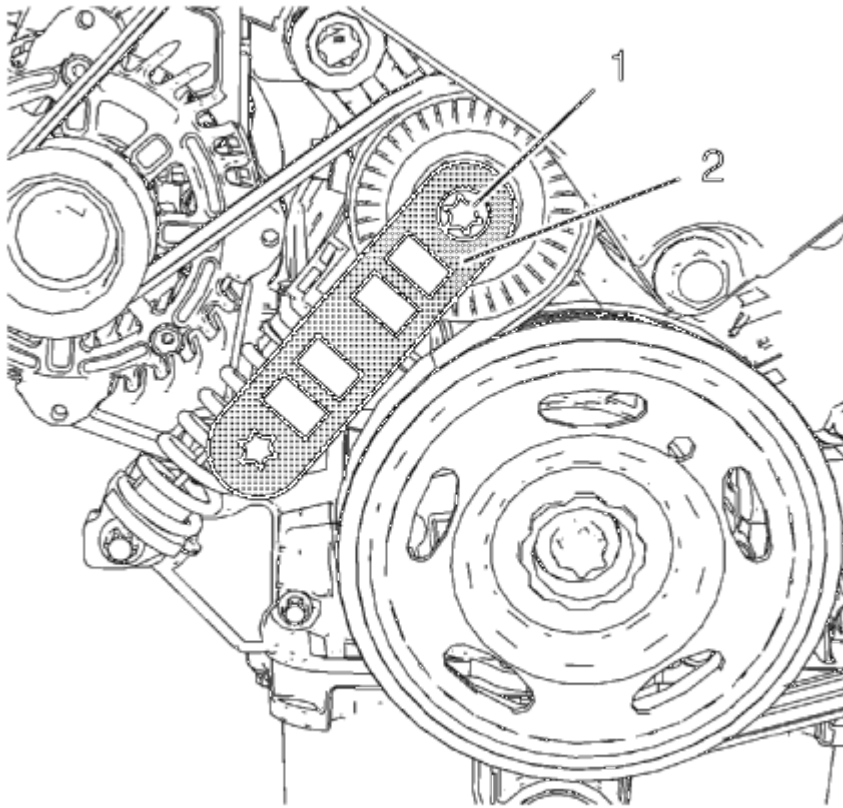


**Fig. 19: Drive Belt Routing**

**Courtesy of GENERAL MOTORS COMPANY**

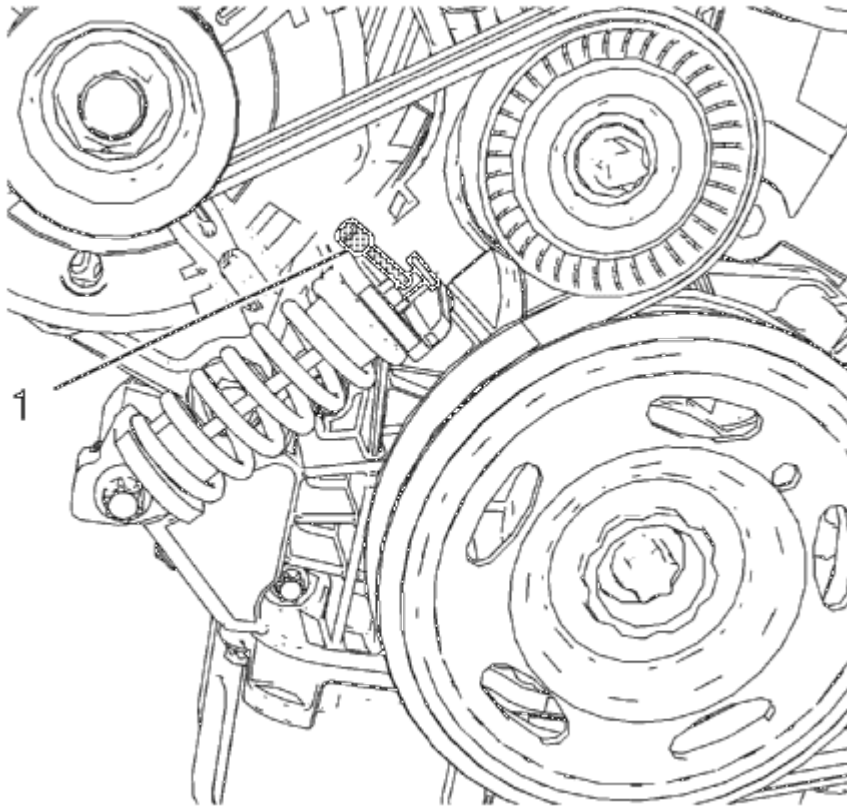
1. Install the drive belt (1).





**Fig. 20: Holding Wrench And Drive Belt Tensioner**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the **EN-48488** holding wrench (2) to the drive belt tensioner (1).



**Fig. 21: Locking Pin**

Courtesy of GENERAL MOTORS COMPANY

3. Move the drive belt tensioner clockwise until **EN-955** locking pin (1) can be removed.
4. Allow the tensioner to slide back slowly.
5. Remove the **EN-48488** holding wrench.
6. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
7. Install the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement**.
8. Remove the engine support fixture. Refer to **Engine Support Fixture**.

## DRIVE BELT TENSIONER REPLACEMENT

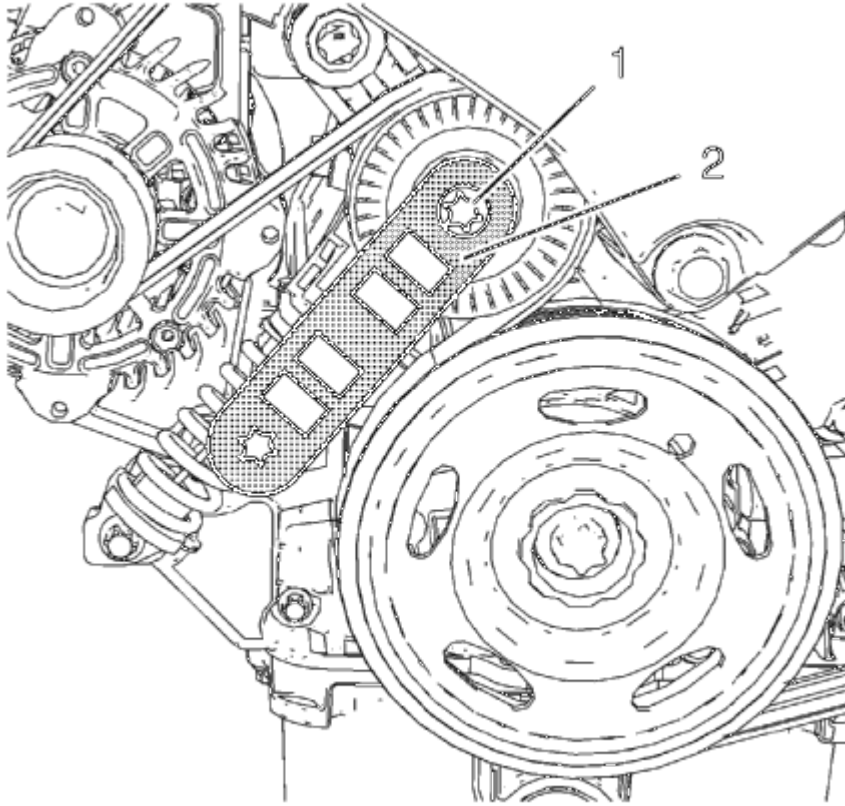
### Special Tools

- **EN-955** Locking Pin
- **EN-48488** Holding Wrench

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

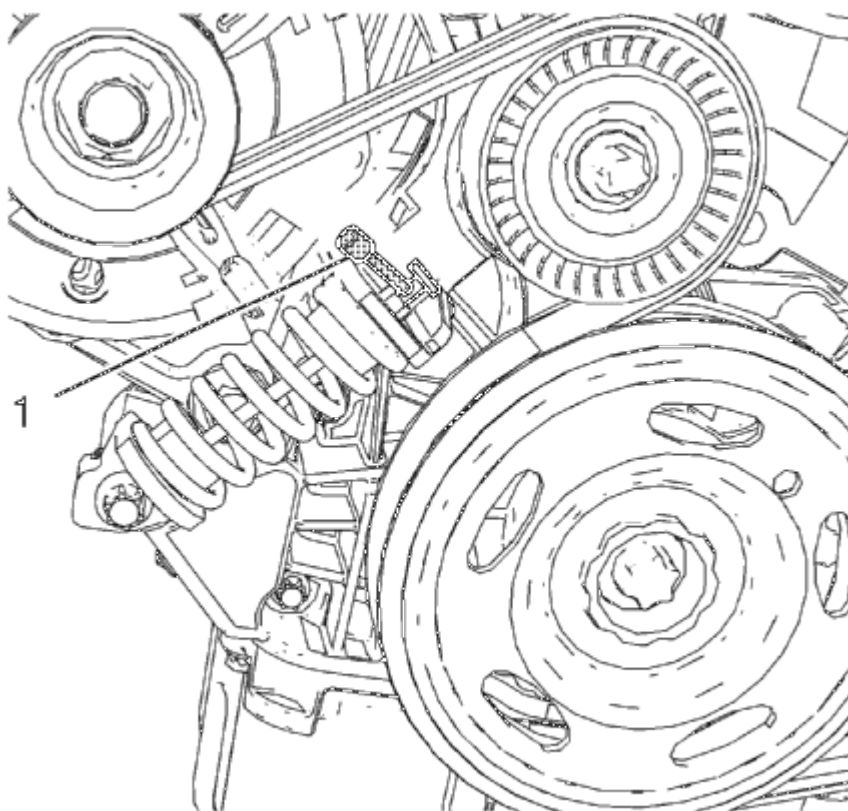
### Removal Procedure

1. Remove the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement**
2. Install the engine support fixture. Refer to **Engine Support Fixture**.
3. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.



**Fig. 22: Holding Wrench And Drive Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

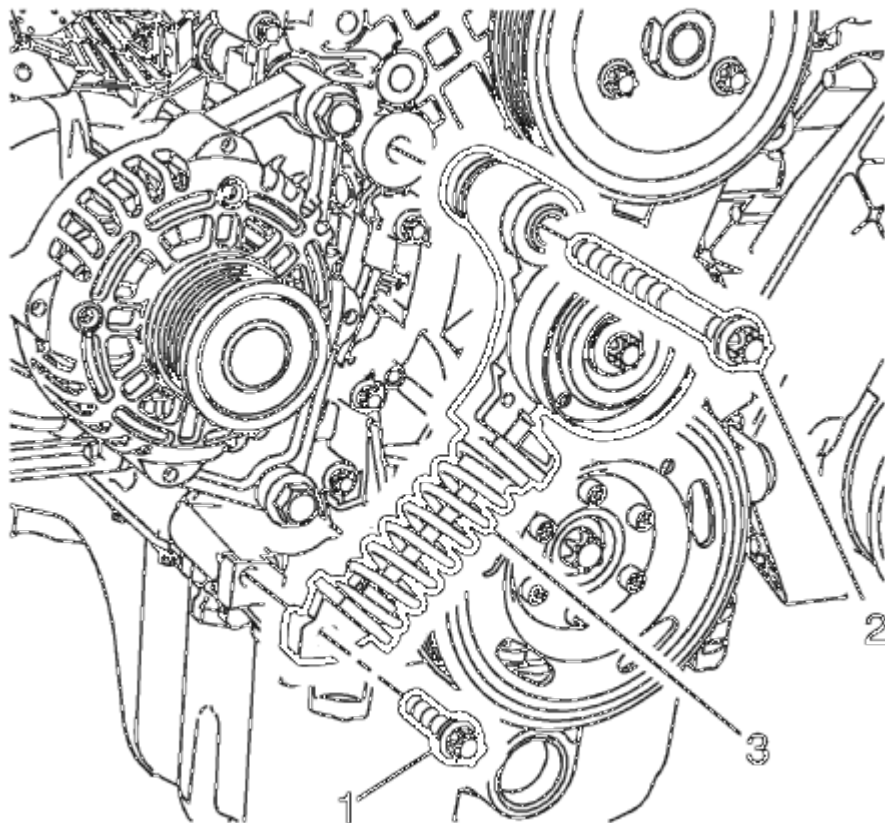
4. Install the **EN-48488** holding wrench (2) to the drive belt tensioner (1).



**Fig. 23: Locking Pin**

Courtesy of GENERAL MOTORS COMPANY

5. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with **EN-955** locking pin (1).
6. Remove the **EN-48488** holding wrench.
7. Remove the drive belt.
8. Repeat steps 4 and 5 in order to remove the **EN-955** locking pin from the drive belt tensioner.

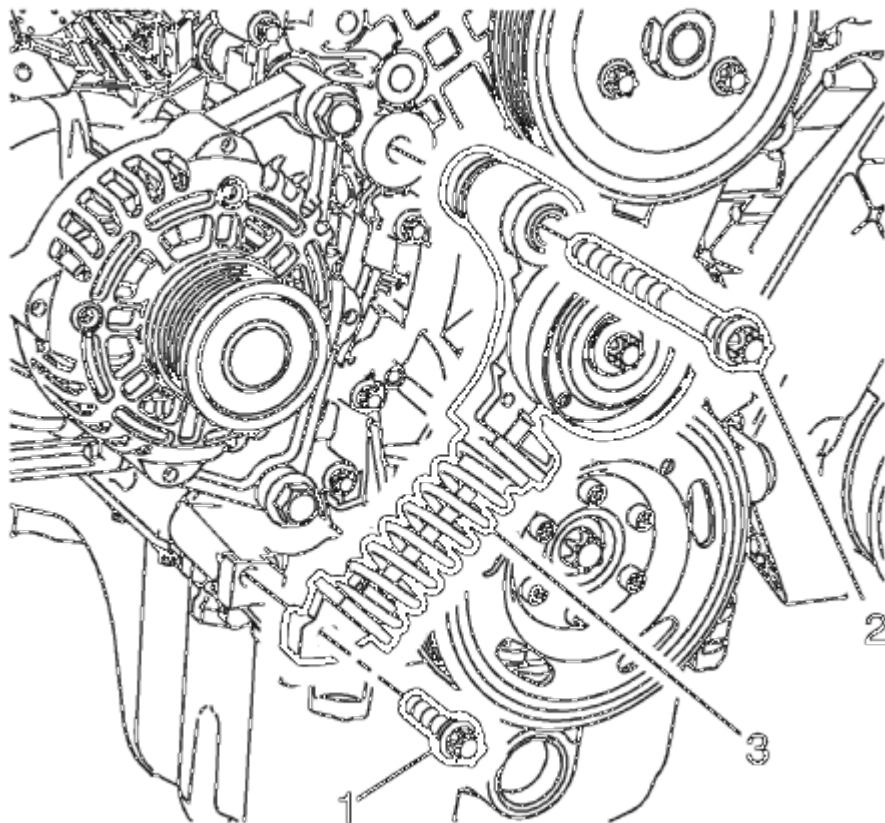


**Fig. 24: Drive Belt Tensioner & Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

9. Remove the lower drive belt tensioner bolt (1).
10. Remove the upper drive belt tensioner bolt (2).
11. Remove the drive belt tensioner (3).

**Installation Procedure**

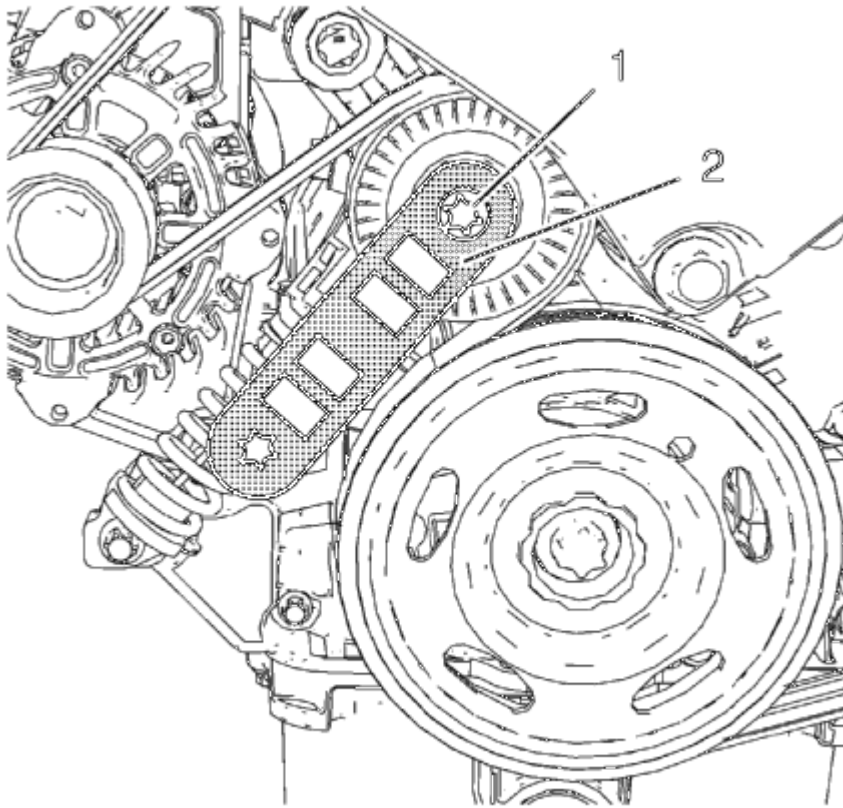


**Fig. 25: Drive Belt Tensioner & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt tensioner (3).
2. Install the lower drive belt tensioner bolt (1).
3. Install the upper drive belt tensioner bolt (2).

**CAUTION: Refer to Fastener Caution .**

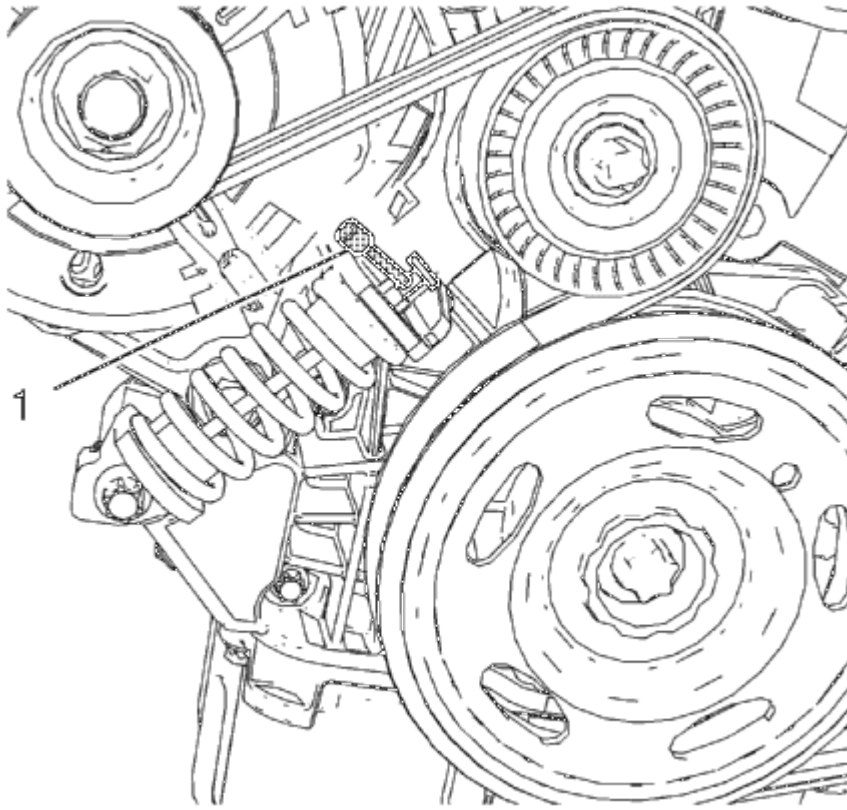
4. Tighten the lower drive belt tensioner bolt (1) to 22 N.m (16 lb ft).
5. Tighten the upper drive belt tensioner bolt (2) to 55 N.m (41 lb ft).



**Fig. 26: Holding Wrench And Drive Belt Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Engine mount bracket is removed.

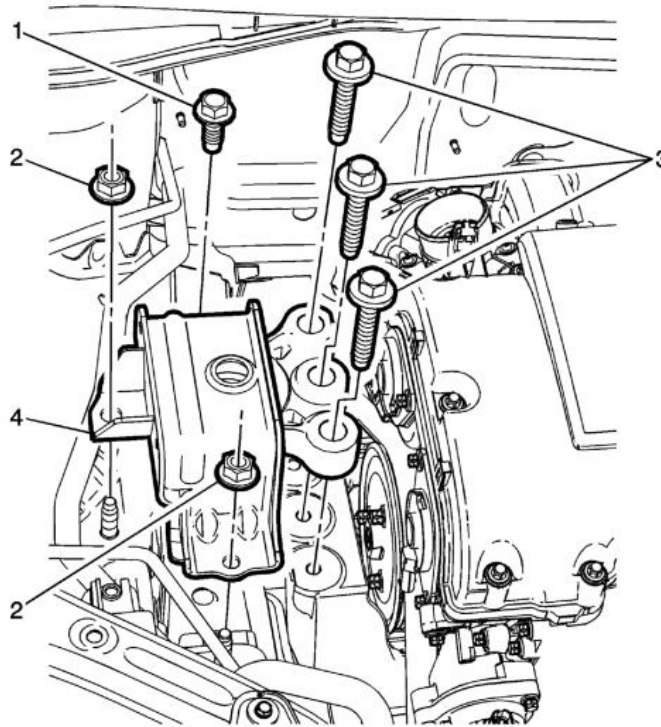
6. Install the **EN-48488** holding wrench (2) to drive belt tensioner (1).

**Fig. 27: Locking Pin****Courtesy of GENERAL MOTORS COMPANY**

7. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with **EN-955** locking pin (1).
8. Install the drive belt.
9. Move the drive belt tensioner clockwise until **EN-955** locking pin can be removed.
10. Allow the tensioner to slide back slowly.
11. Remove the **EN-48488** holding wrench.
12. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
13. Install the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement**.
14. Remove the engine support fixture. Refer to **Engine Support Fixture**.

**ENGINE MOUNT REPLACEMENT - RIGHT SIDE**



**Fig. 28: Engine Mount & Components**

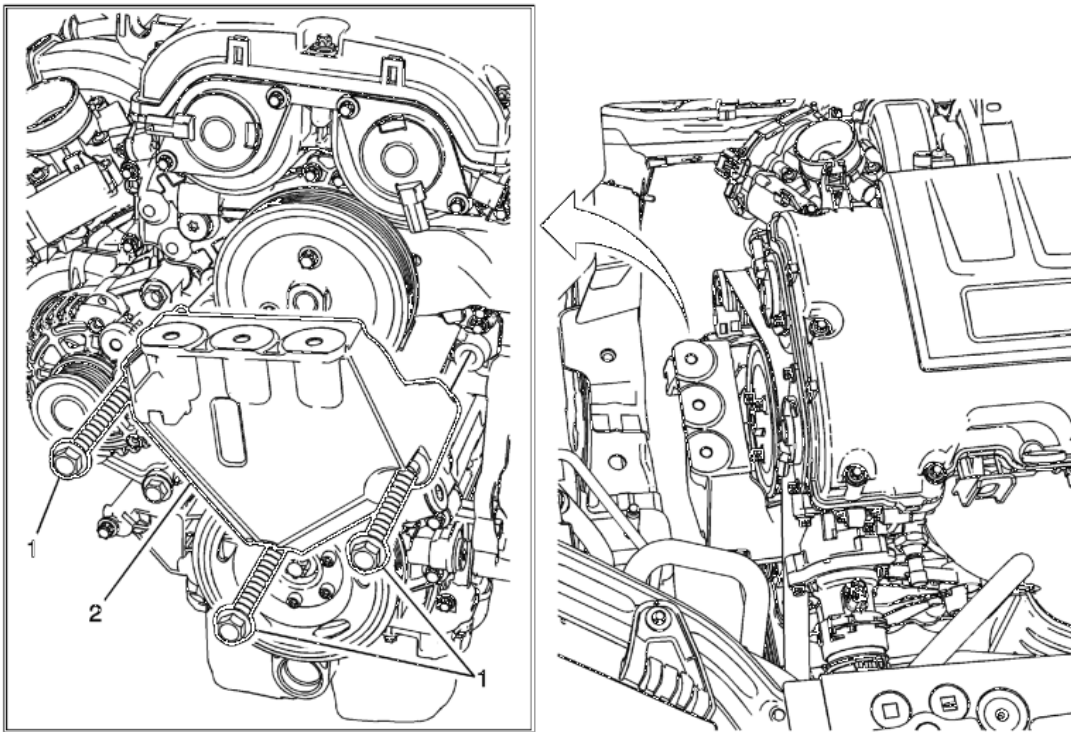
Courtesy of GENERAL MOTORS COMPANY

**Engine Mount Replacement - Right Side**

Callout	Component Name
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Remove the air cleaner assembly. Refer to <a href="#">Air Cleaner Assembly Replacement</a> .</li> <li>2. Install the engine support fixture. Refer to <a href="#">Engine Support Fixture</a>.</li> <li>3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.</li> </ol>	
1	Engine Mount Bolt (Qty: 1)  <b>CAUTION:</b> Refer to <a href="#">Fastener Caution</a> .  <b>Tighten</b> 62 N.m (46 lb ft)
2	Engine Mount Nut (Qty: 2) <b>Tighten</b> 62 N.m (46 lb ft)
	Engine Mount Bracket to Mount Bolt (Qty: 3) <b>Procedure</b>

3	<p>Ensure to use a NEW bolt whenever the mount is removed. .</p> <p><b>Tighten</b> 50 N.m+ 60° to 75° (37 lb ft + 60° to 75°)</p> <p><b>Special Tools</b> <b>EN-470-B</b> Angular Torque Wrench For equivalent regional tools, refer to <b>Special Tools</b></p>
4	Engine Mount

## ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE



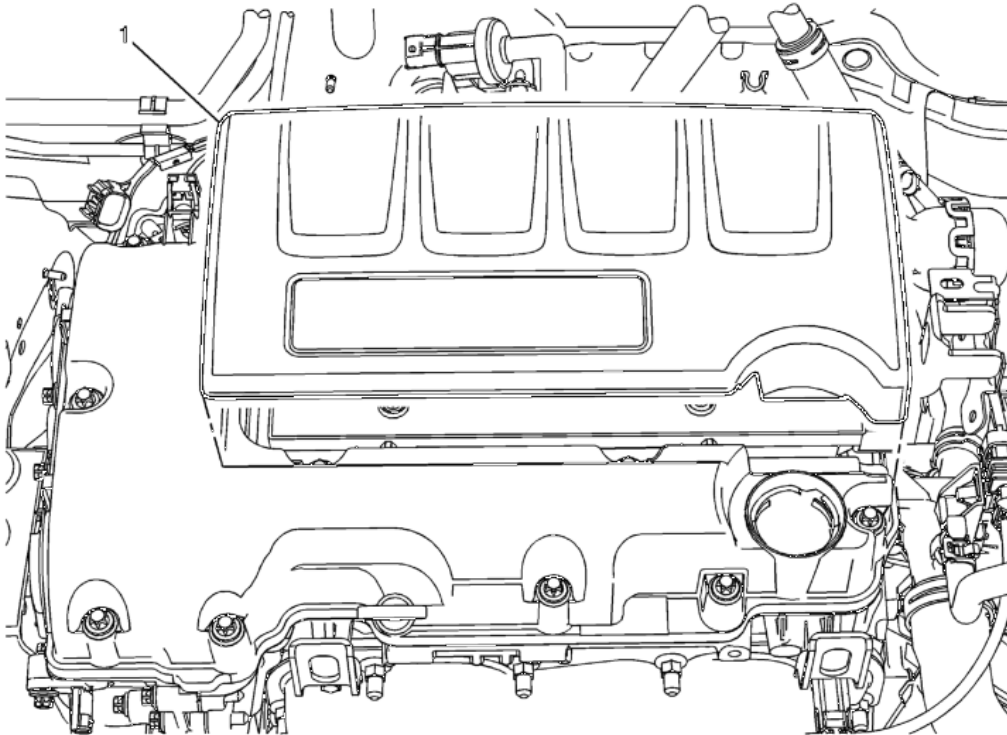
**Fig. 29: Engine Mount Bracket & Fasteners**  
Courtesy of GENERAL MOTORS COMPANY

### Engine Mount Bracket Replacement - Right Side

Callout	Component Name
<b>Preliminary Procedures</b> <ol style="list-style-type: none"> <li>1. Remove the engine mount. Refer to <b>Engine Mount Replacement - Right Side</b>.</li> <li>2. Remove the front wheelhouse front liner if necessary. Refer to <b>Front Wheelhouse Liner Replacement (Rear)</b> , <b>Front Wheelhouse Liner Replacement (Front)</b> .</li> </ol>	
	<p>Engine Mount Bracket Fastener (Qty: 3)</p> <p><b>CAUTION:</b> This component uses torque-to-yeild bolts. When servicing this component do not reuse the bolts, New torque-to-yeild bolts must be installed. Reusing used torque-to-</p>

1	<p>yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.</p> <p><b>CAUTION:</b> Refer to <u>Fastener Caution</u> .</p> <p><b>Procedure</b> Raise and lower the engine as needed to access the bolts.</p> <p><b>Tighten</b> 62 N.m (46 lb ft)</p>
2	Engine Mount Bracket

## ENGINE COVER REPLACEMENT



**Fig. 30: Engine Cover & Oil Cap**  
Courtesy of GENERAL MOTORS COMPANY

### Engine Cover Replacement

Callout	Component Name
1	Oil Cap
2	Engine Cover

## INTAKE MANIFOLD REPLACEMENT

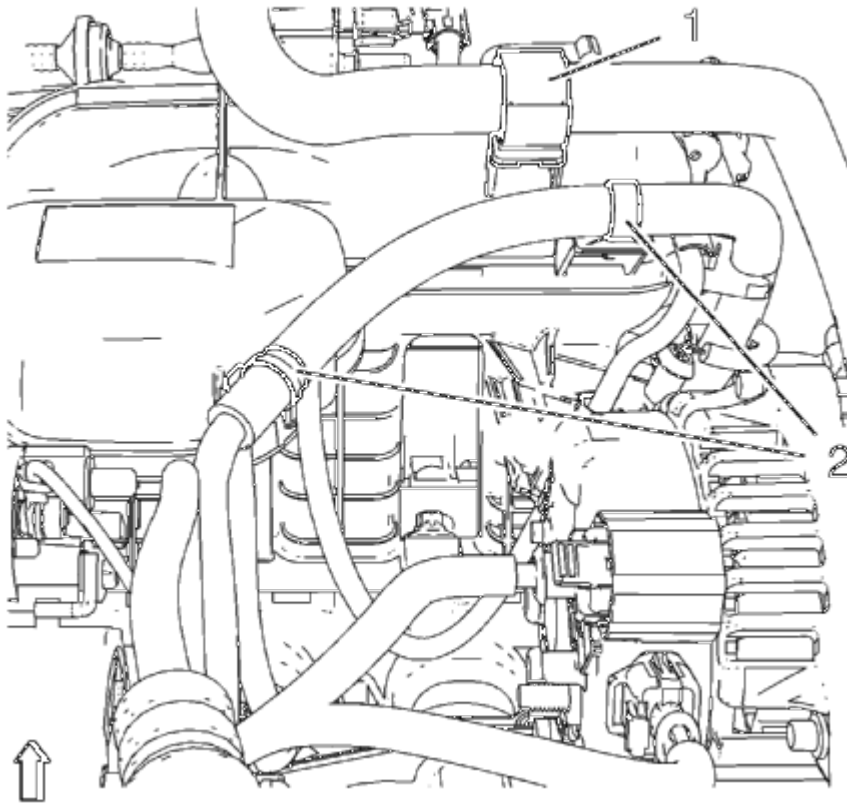
**Special Tools**

- **EN-34730-91** Pressure Tester
- **EN-6015** Closure Plugs

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

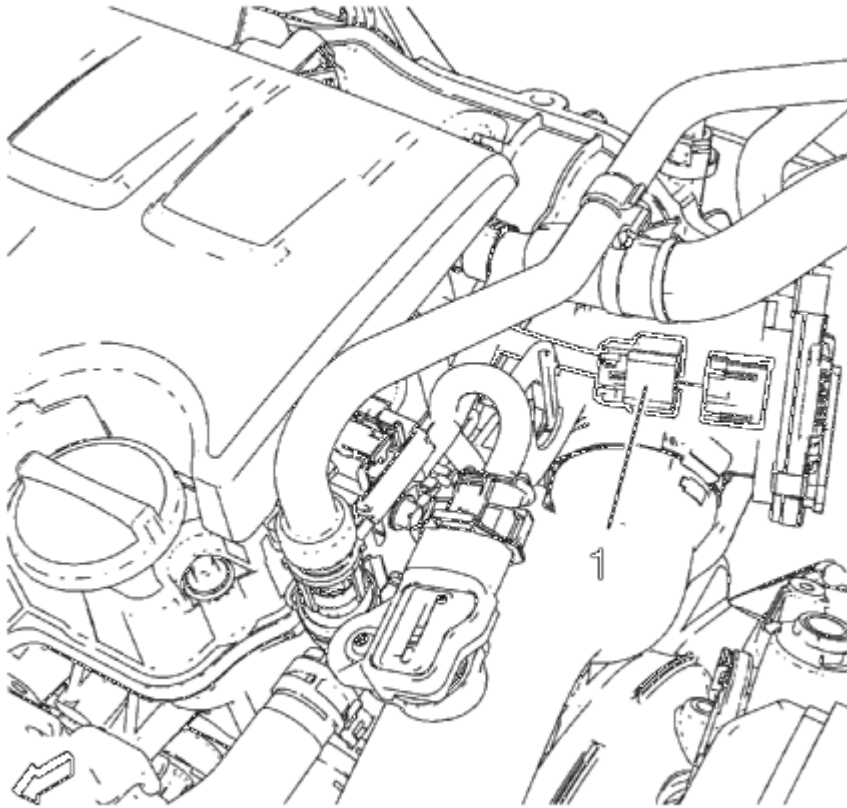
**Removal Procedure**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine sight shield.



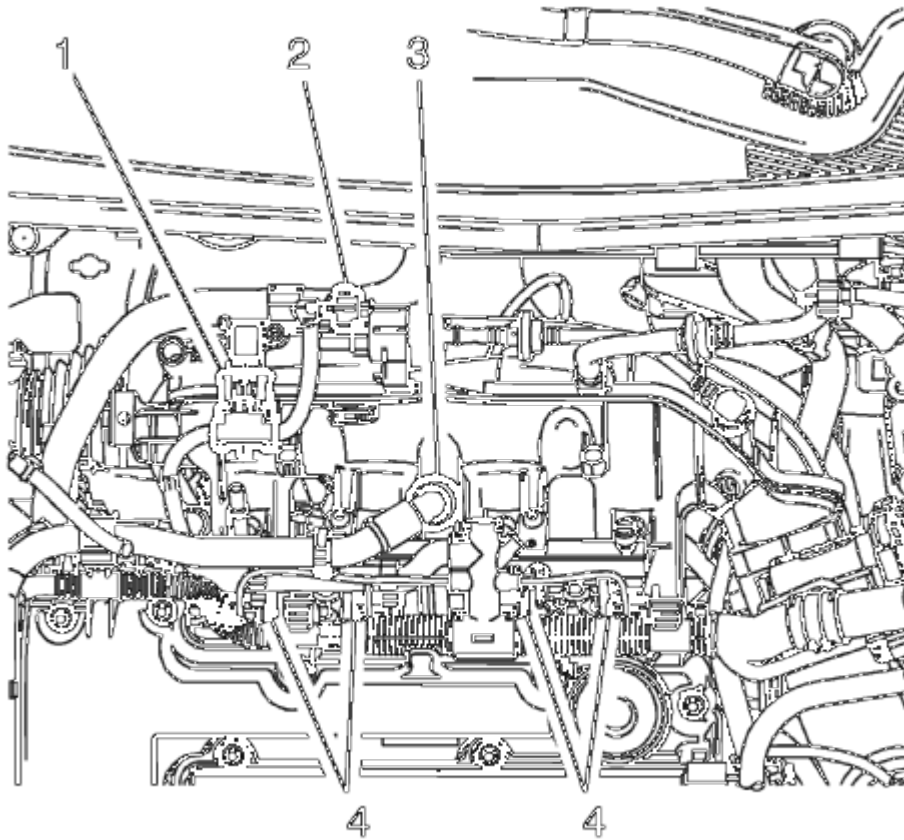
**Fig. 31: Heater Outlet Hose And ECM Wiring Harness Retainer Clips**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Unclip the heater outlet hose from retainer clip (1).
4. Unclip the engine control module wiring harness from 2 retainer clips (2).
5. Lower the vehicle.
6. Remove the charge air cooler outlet air hose from the throttle body. Refer to **Charge Air Cooler Outlet Air Hose Replacement** .



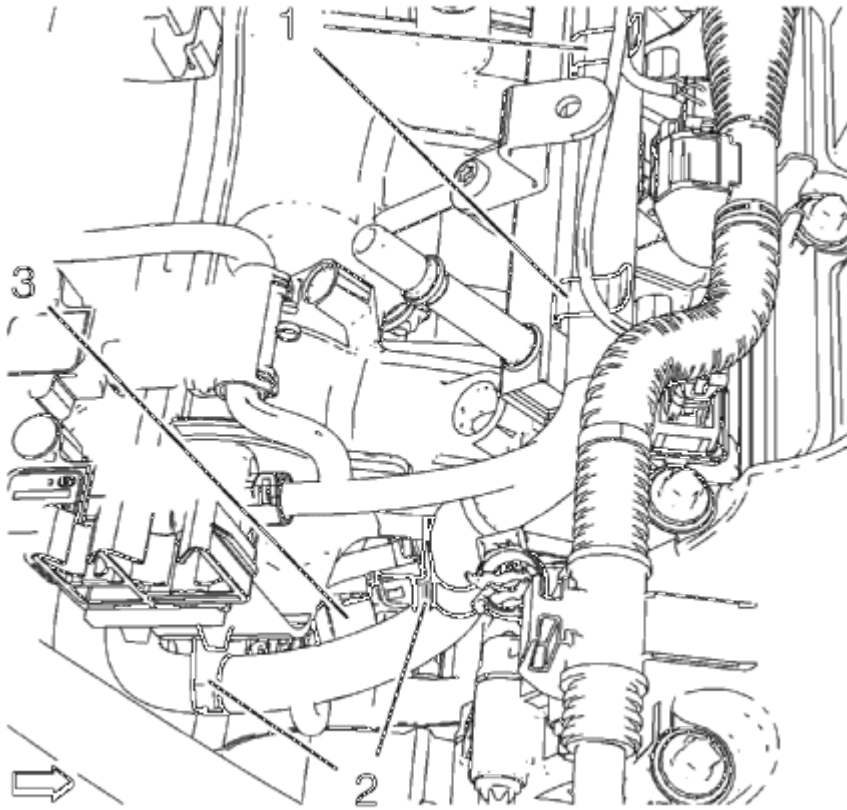
**Fig. 32: Throttle Body Wiring Harness Plug**  
**Courtesy of GENERAL MOTORS COMPANY**

7. Disconnect the throttle body wiring harness plug (1).



**Fig. 33: PCV Hose & Wiring Harness Plugs**  
**Courtesy of GENERAL MOTORS COMPANY**

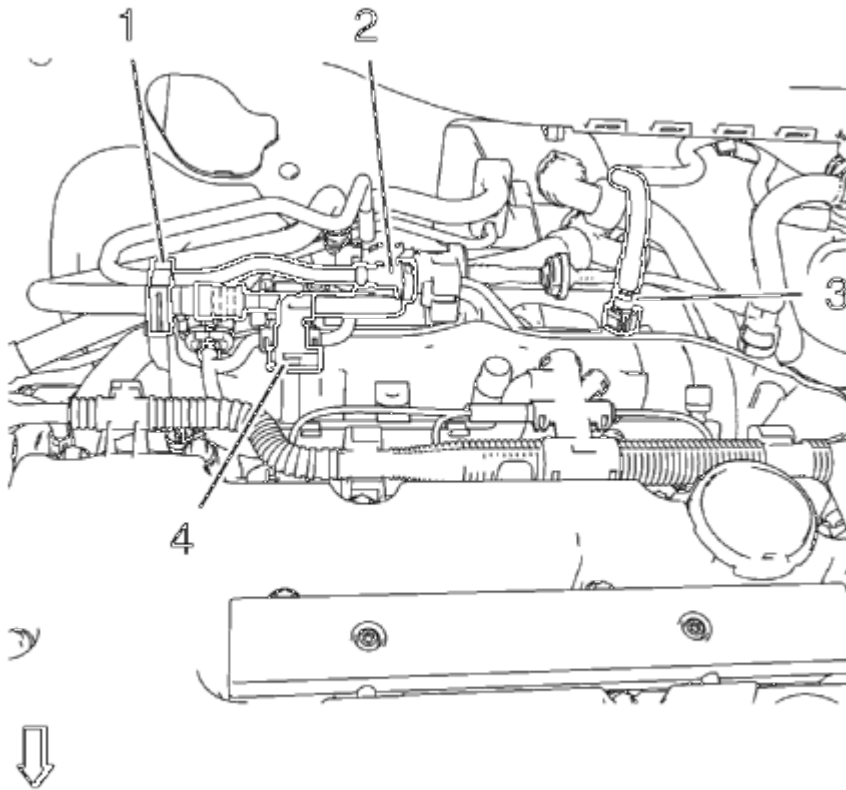
8. Disconnect the evaporative emission canister purge solenoid valve wiring harness plug (2).
9. Disconnect the manifold absolute pressure sensor wiring harness plug (1).
10. Disconnect the 4 fuel injector wiring harness plugs (4).
11. Unclip the engine control module wiring harness from the camshaft cover.
12. Disconnect the PCV hose (3).



**Fig. 34: Turbocharger Wastegate Regulator Solenoid Valve Wiring Harness Plug, Intake Manifold And Fuel Injection Rail Retainer Clips**

Courtesy of GENERAL MOTORS COMPANY

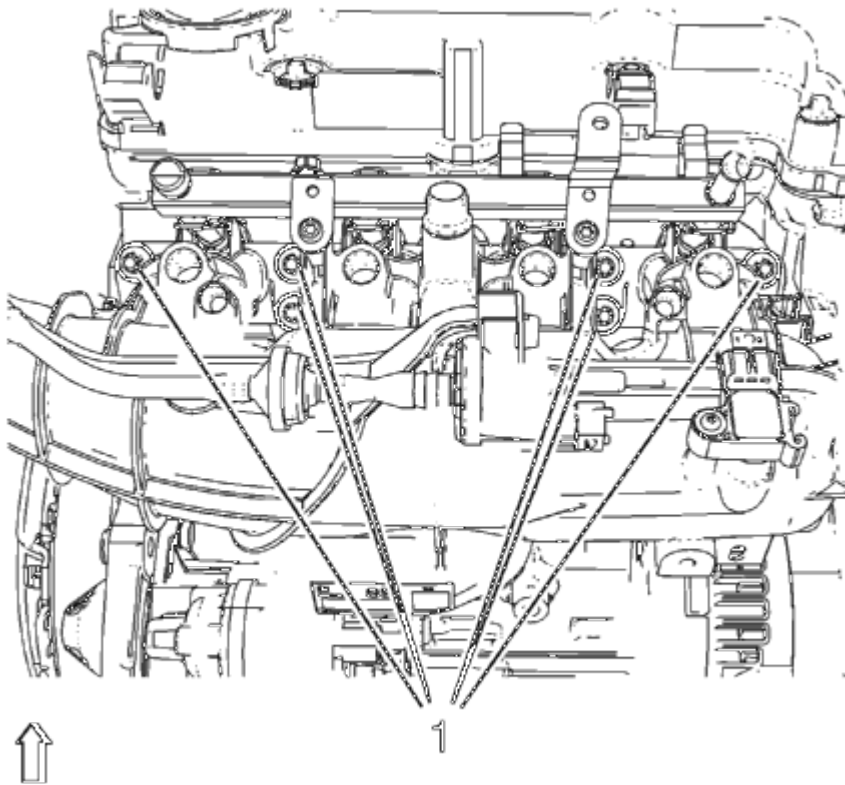
13. Disconnect the turbocharger wastegate regulator solenoid valve wiring harness plug (3).
14. Unclip the engine control module wiring harness from 2 intake manifold retainer clips (2) and from 2 fuel injection rail retainer clips (1).
15. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.



**Fig. 35: Fuel Feed Pipe And Fuel Injector Rail**  
**Courtesy of GENERAL MOTORS COMPANY**

16. Remove the fuel feed pipe (4) from fuel injector rail.
17. Unclip the fuel feed pipe from retainer clip (1).
18. Remove the fuel ventilation pipe (2) from evaporative emission canister purge solenoid valve.
19. Unclip the fuel ventilation pipe from retainer clip (1).
20. Close the vents with the **EN-6015** closure plugs.
21. Disconnect the brake booster vacuum pipe (3) from the intake manifold.



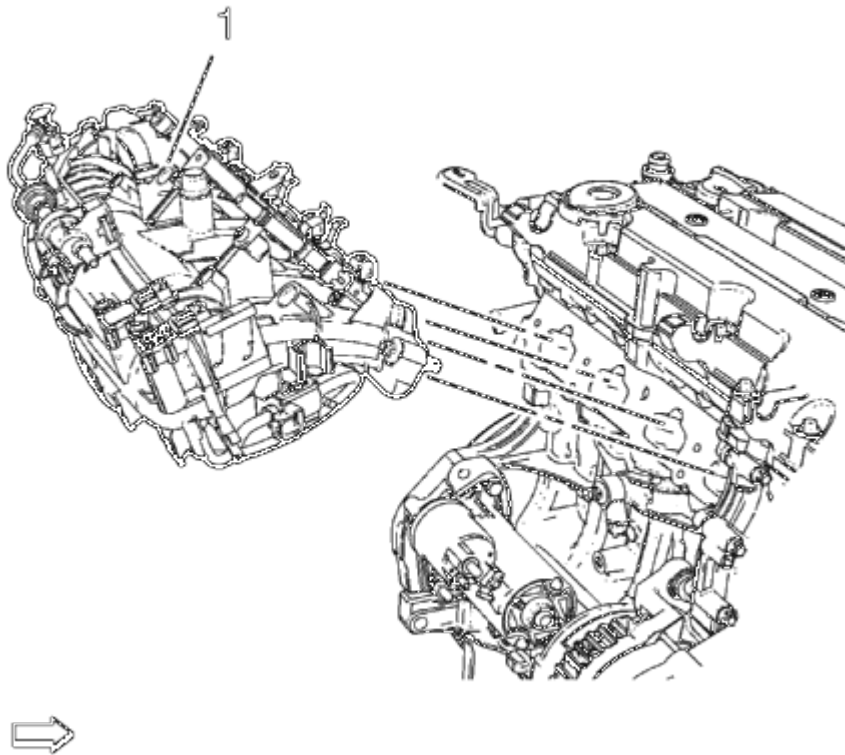


**Fig. 36: Intake Manifold Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The intake manifold bolts remain in intake manifold.

22. Remove the 6 intake manifold bolts (1).



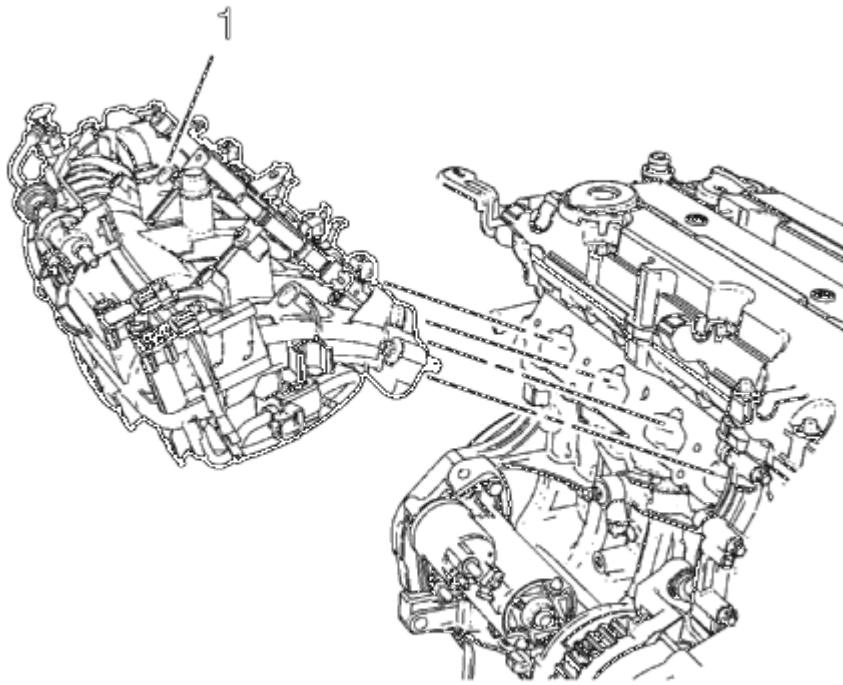
**Fig. 37: Intake Manifold**

Courtesy of GENERAL MOTORS COMPANY

23. Remove the intake manifold (1) and the intake manifold gasket.
24. Transfer parts from intake manifold as necessary. Refer to **Intake Manifold Disassemble (LUH,LUJ,LUV w. Returnless Fuel Syst.)**, and **Intake Manifold Assemble (LUH,LUJ,LUV w. Returnless Fuel Syst.)**.

#### **Installation Procedure**

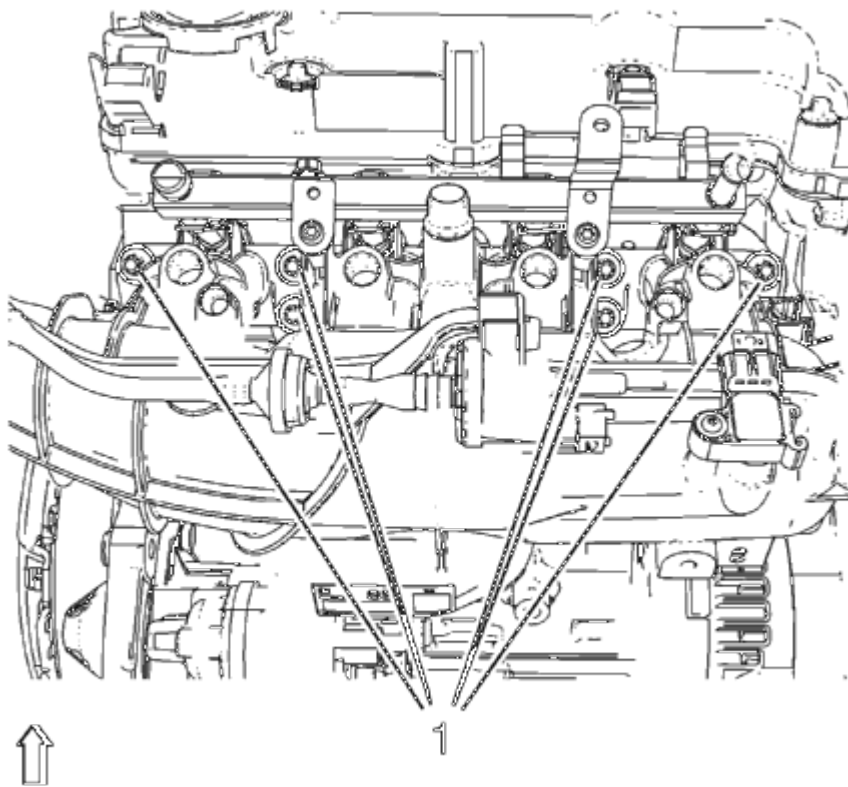
1. Clean the sealing surfaces.



**Fig. 38: Intake Manifold**

**Courtesy of GENERAL MOTORS COMPANY**

2. Install the intake manifold (1) along with a NEW intake manifold gasket.

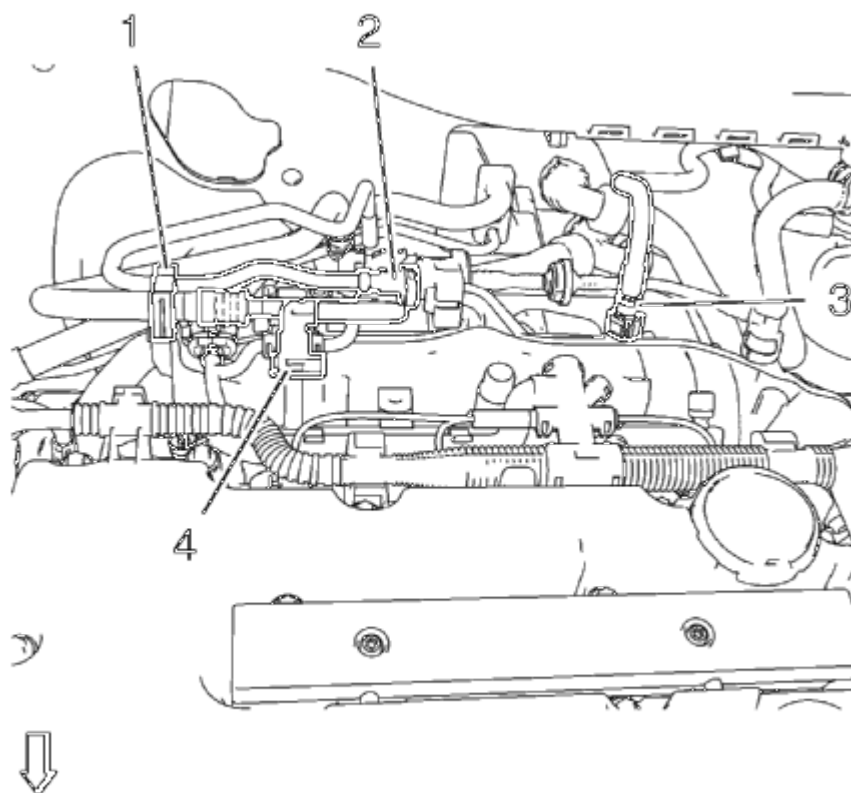


**Fig. 39: Intake Manifold Bolts**

Courtesy of GENERAL MOTORS COMPANY

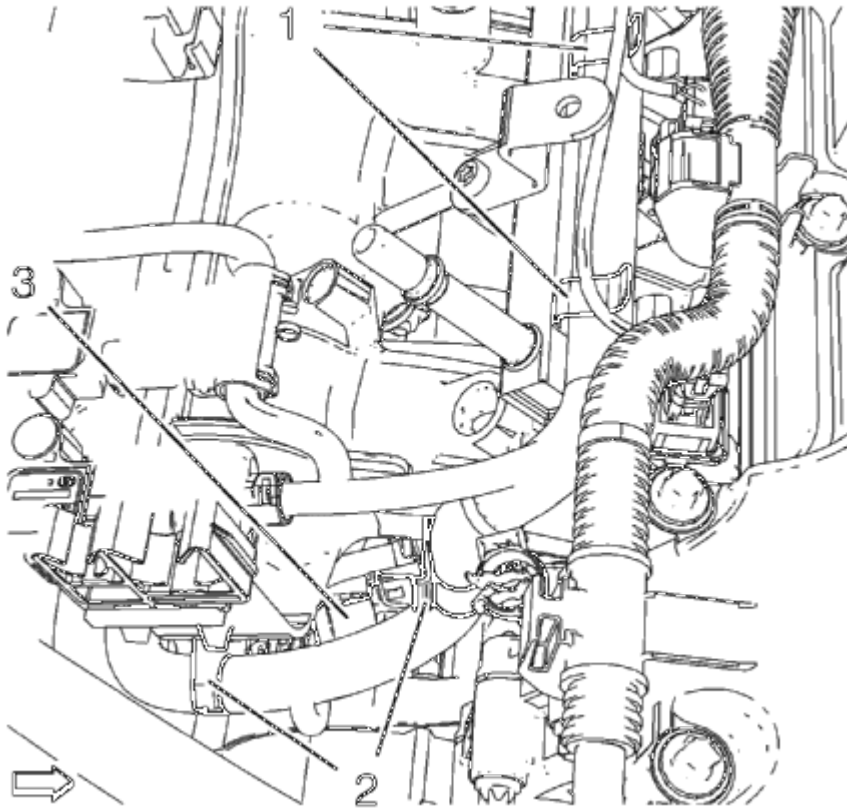
**CAUTION: Refer to Fastener Caution .**

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



**Fig. 40: Fuel Feed Pipe And Fuel Injector Rail**  
**Courtesy of GENERAL MOTORS COMPANY**

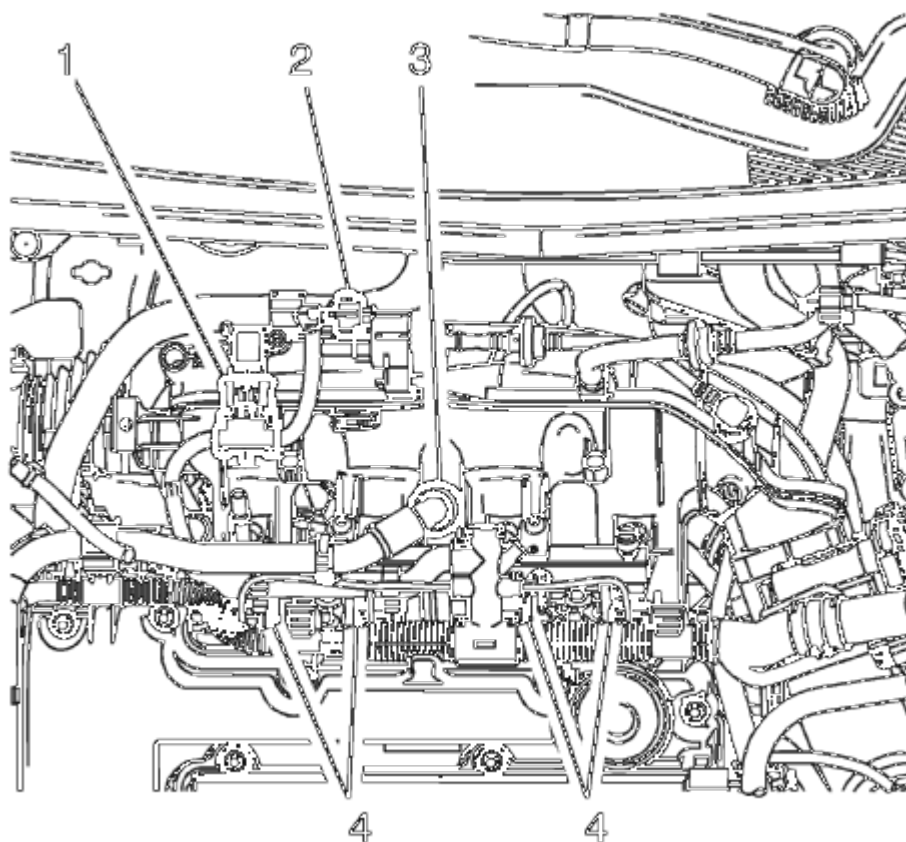
4. Connect the fuel ventilation pipe (2) to the evaporative emission canister purge solenoid valve.
5. Clip in the fuel ventilation pipe to the retainer clip (1).
6. Connect the fuel feed pipe (4) to the injector rail.
7. Clip in the fuel feed pipe to the retainer clip (1).
8. Connect the brake booster vacuum pipe (3) to the intake manifold.



**Fig. 41: Turbocharger Wastegate Regulator Solenoid Valve Wiring Harness Plug, Intake Manifold And Fuel Injection Rail Retainer Clips**

Courtesy of GENERAL MOTORS COMPANY

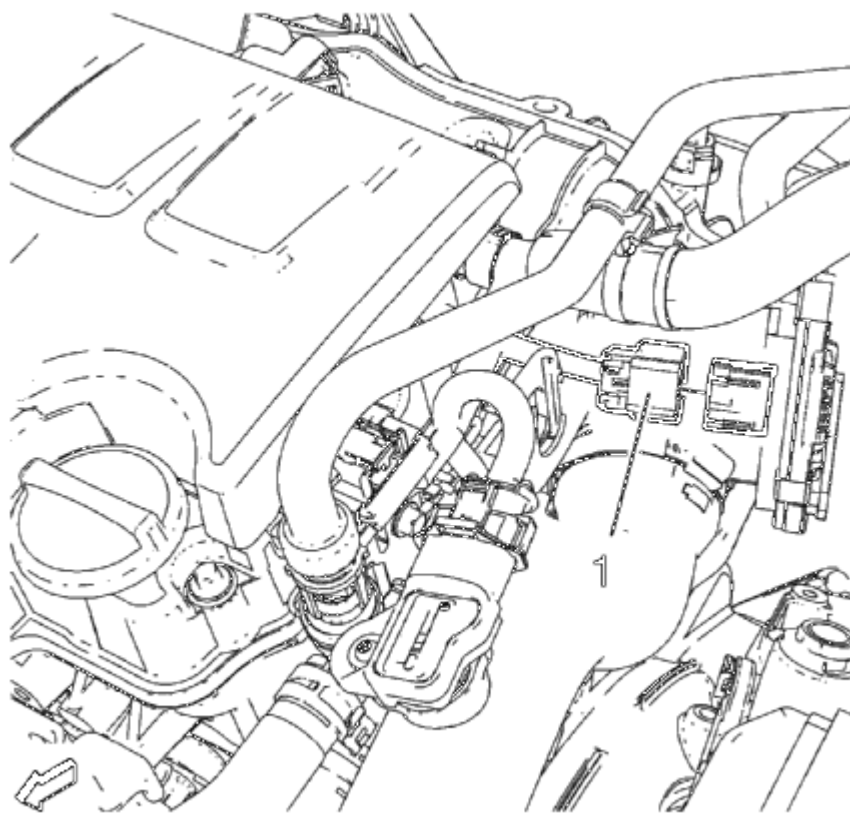
9. Connect the turbocharger wastegate regulator solenoid valve wiring harness plug (3).
10. Clip in the engine control module wiring harness to 2 intake manifold retainer clips (2) and from 2 fuel injection rail retainer clips (1).



**Fig. 42: PCV Hose & Wiring Harness Plugs**

**Courtesy of GENERAL MOTORS COMPANY**

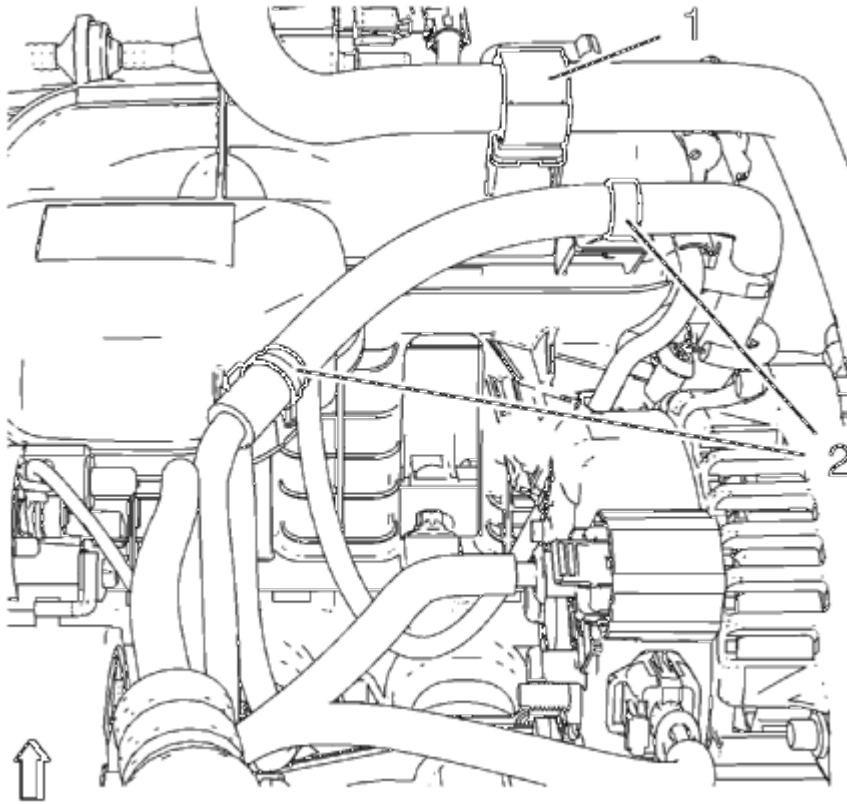
11. Clip in the engine control module wiring harness to the camshaft cover.
12. Connect the 4 fuel injector wiring harness plugs (4).
13. Connect the manifold absolute pressure sensor wiring harness plug (1) .
14. Disconnect the evaporative emission canister purge solenoid valve wiring harness plug (2).
15. Connect the PCV hose (3).



**Fig. 43: Throttle Body Wiring Harness Plug**  
**Courtesy of GENERAL MOTORS COMPANY**

16. Connect the throttle body wiring harness plug (1).
17. Install the charge air cooler outlet air hose to the throttle body. Refer to **Charge Air Cooler Outlet Air Hose Replacement**.
18. Raise and support the vehicle.





**Fig. 44: Heater Outlet Hose And ECM Wiring Harness Retainer Clips**  
 Courtesy of GENERAL MOTORS COMPANY

19. Clip in the heater outlet hose to retainer clip (1).
20. Clip in the engine control module wiring harness to 2 retainer clips (2).
21. Install the engine sight shield.
22. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

## CAMSHAFT TIMING CHAIN REPLACEMENT

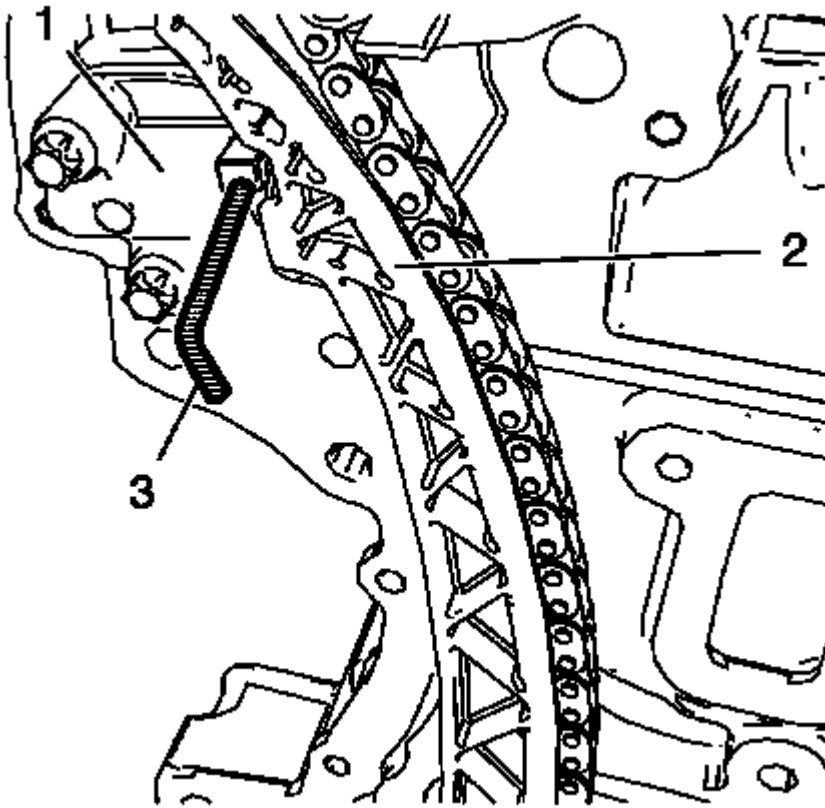
### Special Tools

**EN-955** Locking Pin

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

### Removal Procedure

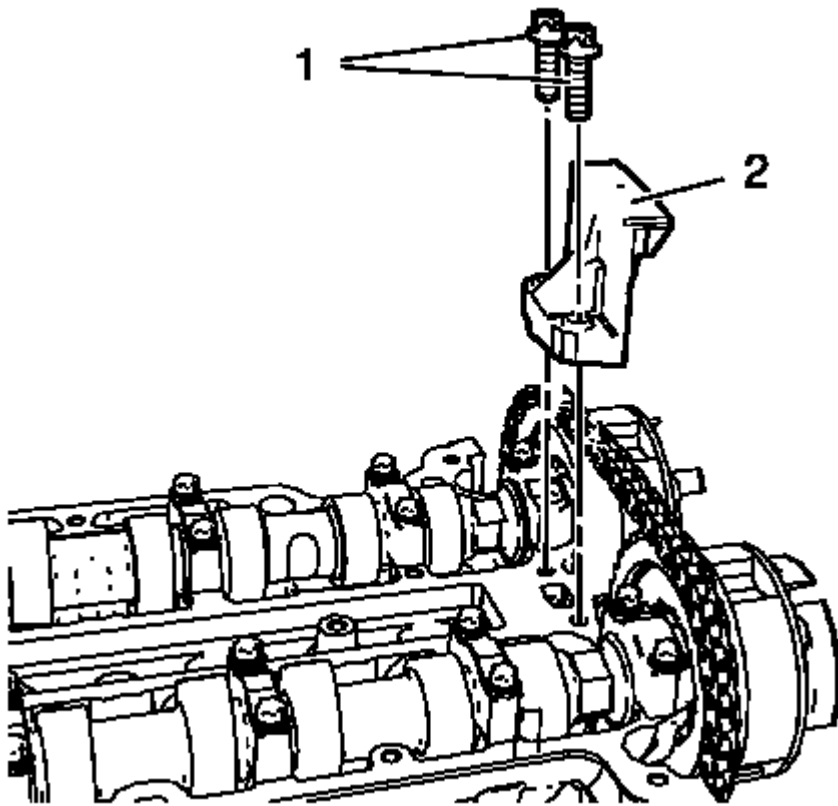
1. Remove the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.



**Fig. 45: Timing Chain And Timing Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

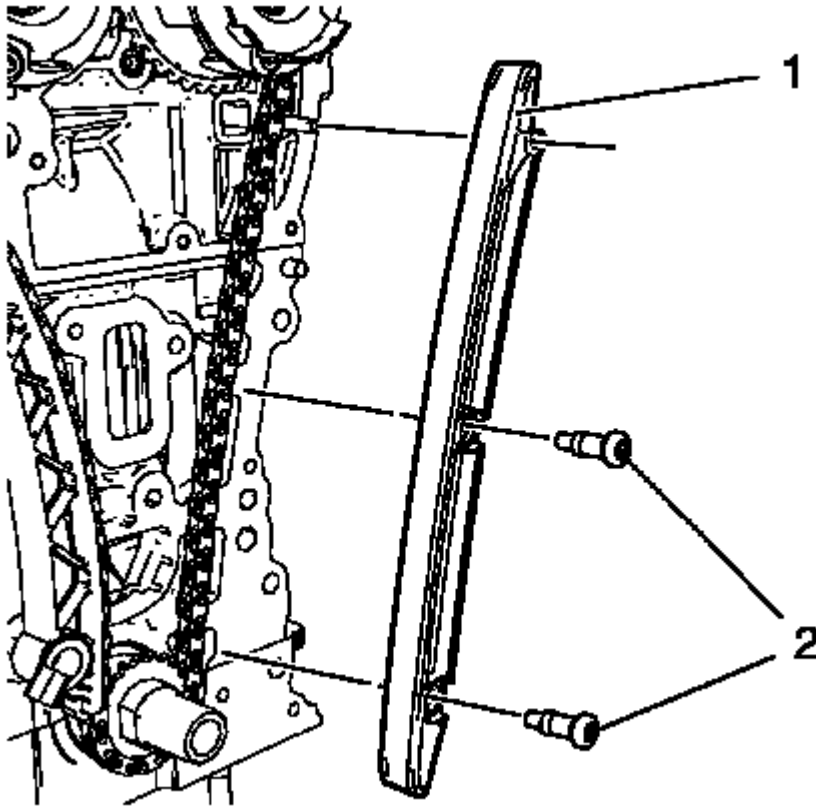
**NOTE:** If EN-955 fixing pin can not be inserted, compress the timing chain tensioner further with the aid of a flat bladed tool to allow complete insertion of the pin.

2. Push the timing chain (2) in direction to the timing chain tensioner (1) and install the **EN-955** pin (3).



**Fig. 46: Upper Timing Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

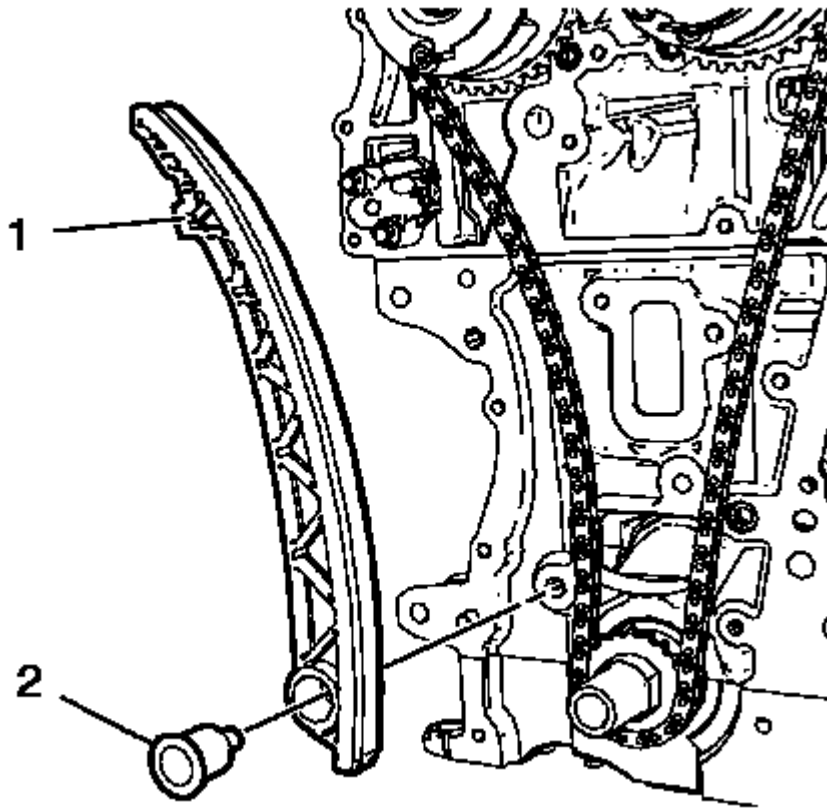
3. Remove the two upper timing chain guide bolts (1).
4. Remove the upper timing chain guide (2).



**Fig. 47: Timing Chain Guide Right Side**

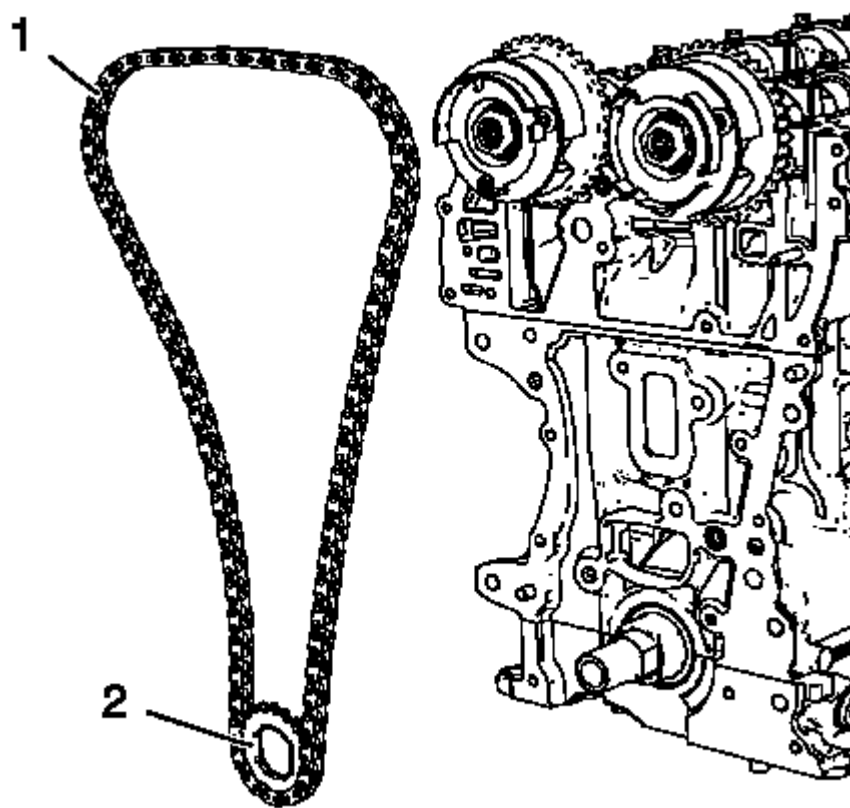
Courtesy of GENERAL MOTORS COMPANY

5. Remove the two timing chain guide right side bolts (2).
6. Remove the timing chain guide right side (1).



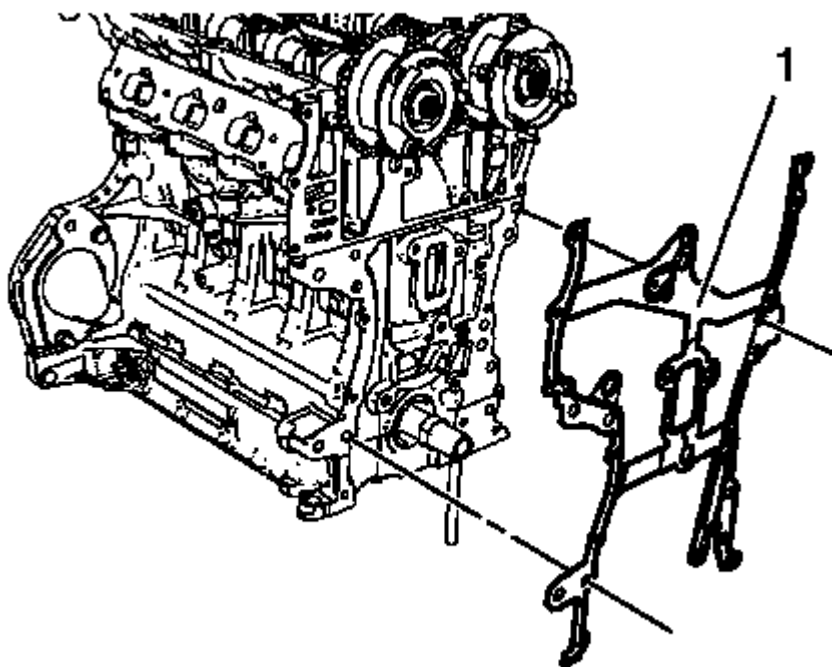
**Fig. 48: Timing Chain Tensioner Shoe And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain tensioner shoe bolt (2).
8. Remove the timing chain tensioner shoe (1).



**Fig. 49: Timing Chain And Crankshaft Sprocket**  
**Courtesy of GENERAL MOTORS COMPANY**

9. Remove the timing chain (1) and crankshaft sprocket (2) together as a unit.



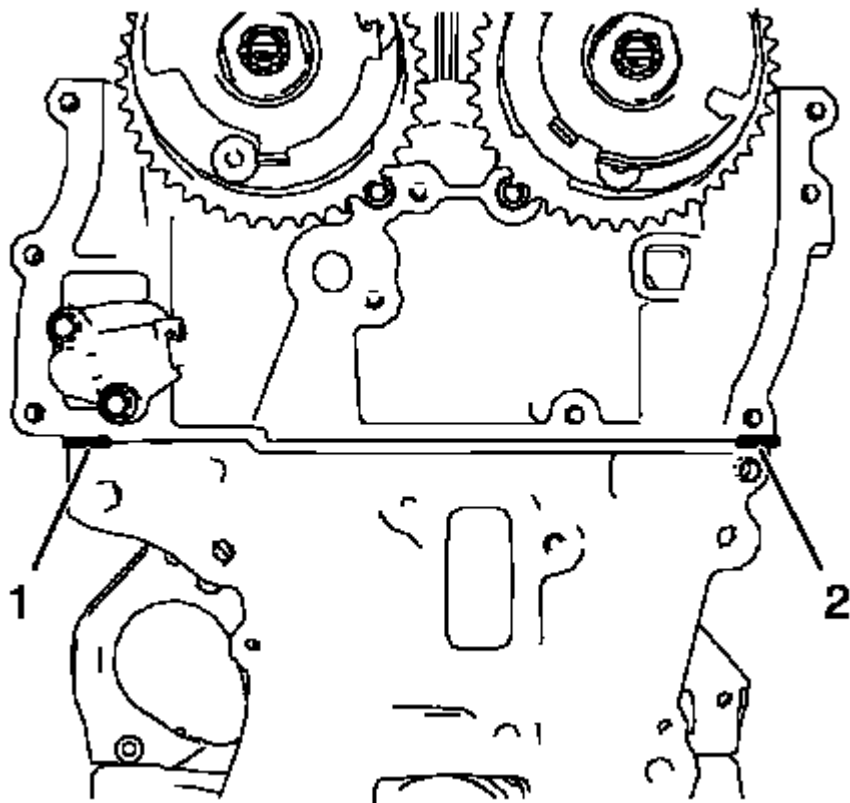
**Fig. 50: Engine Front Cover Gasket**

**Courtesy of GENERAL MOTORS COMPANY**

10. Remove the engine front cover gasket (1).

**Installation Procedure**

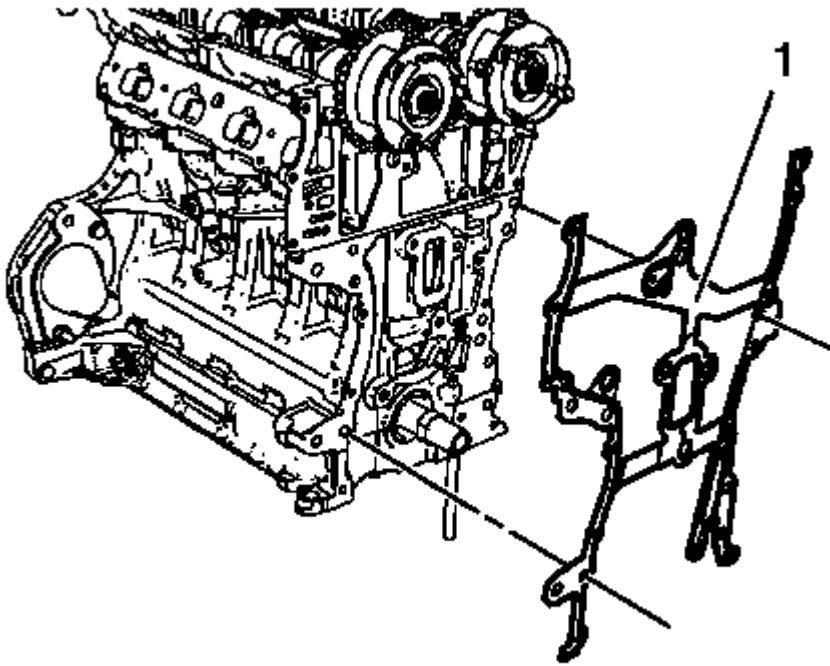
1. Clean the engine front cover sealing surfaces on engine block and cylinder head.



**Fig. 51: Sealing Compound Application Areas**  
**Courtesy of GENERAL MOTORS COMPANY**

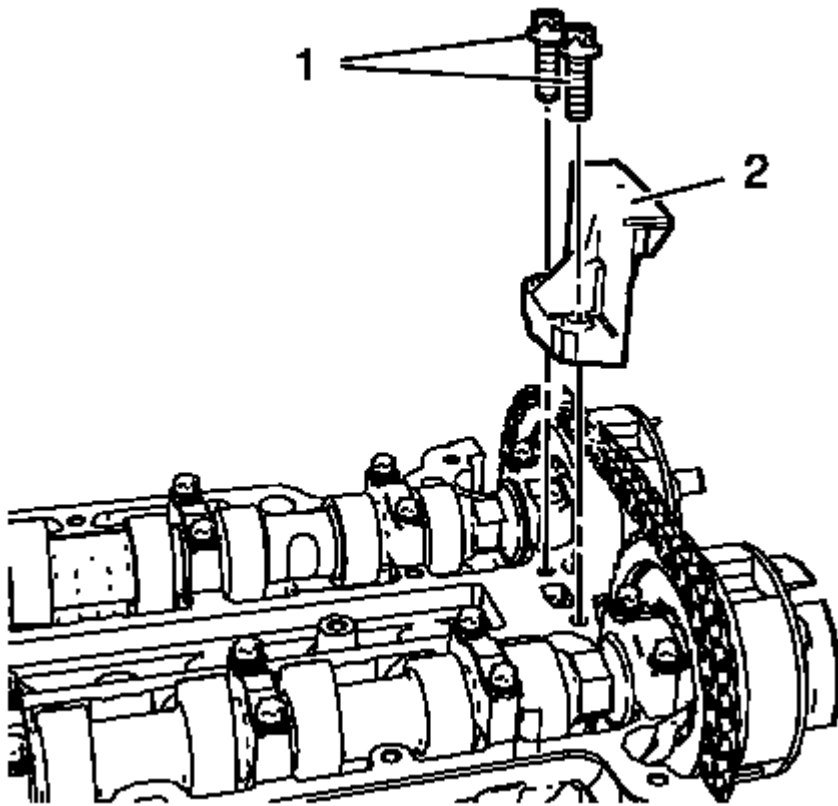
2. Apply a 2 mm (0.0787 in) bead of RTV sealant the areas shown above (1, 2).





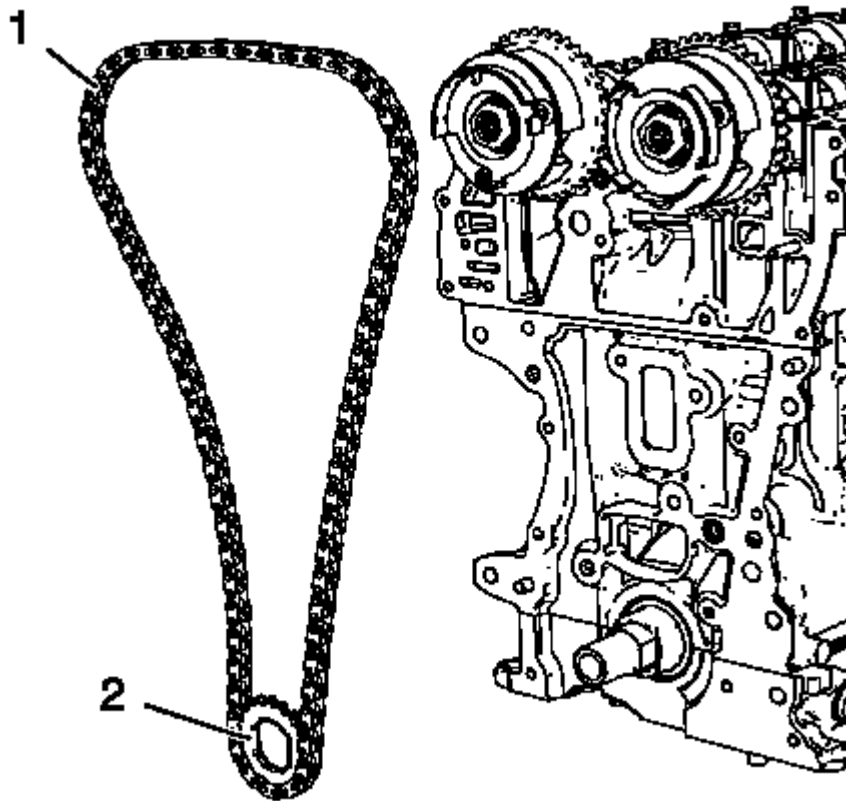
**Fig. 52: Engine Front Cover Gasket**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Install the engine front cover gasket (1).



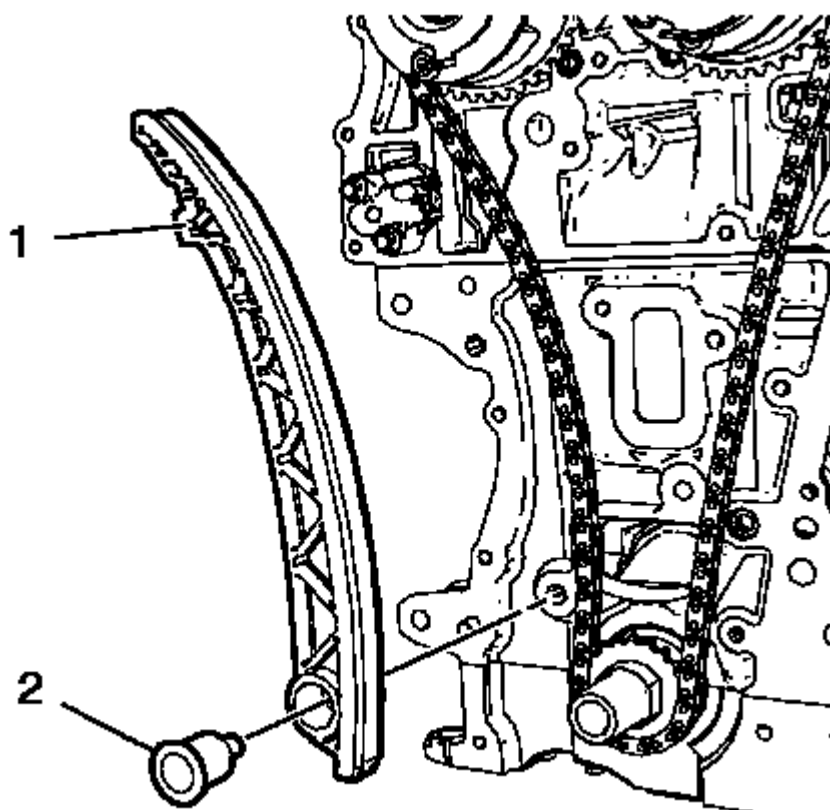
**Fig. 53: Upper Timing Chain Guide And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

4. Install the two upper timing chain guide bolts (1) and tighten to 8 N•m (71 lb in).
5. Install the upper timing chain guide (2).



**Fig. 54: Timing Chain And Crankshaft Sprocket**  
**Courtesy of GENERAL MOTORS COMPANY**

6. Install the timing chain (1) and crankshaft sprocket (2) together as a unit.

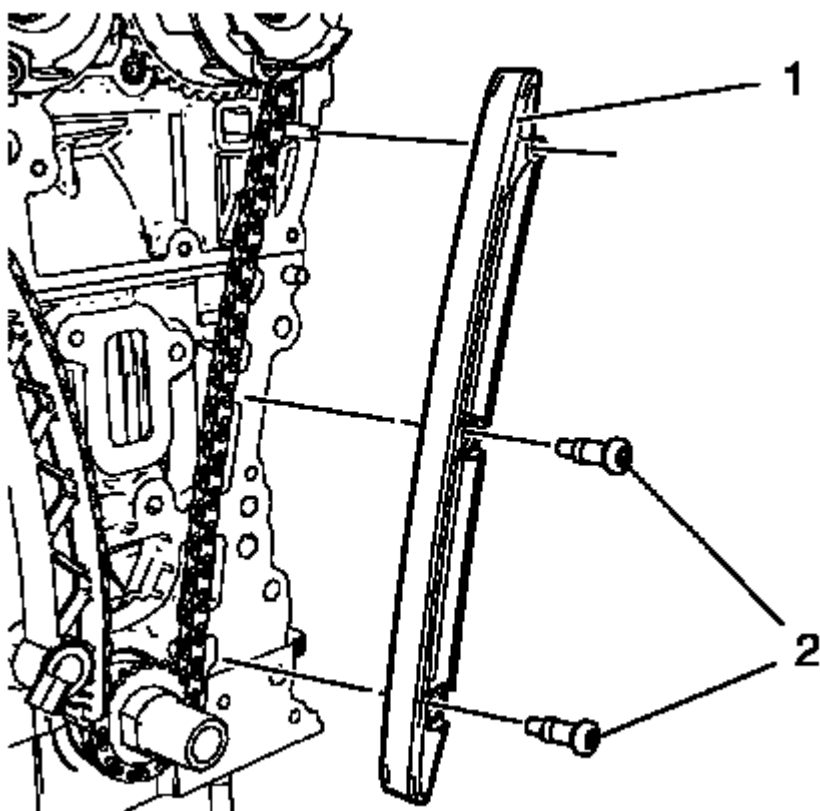


**Fig. 55: Timing Chain Tensioner Shoe And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the timing chain tensioner shoe (1).

**CAUTION: Refer to Fastener Caution .**

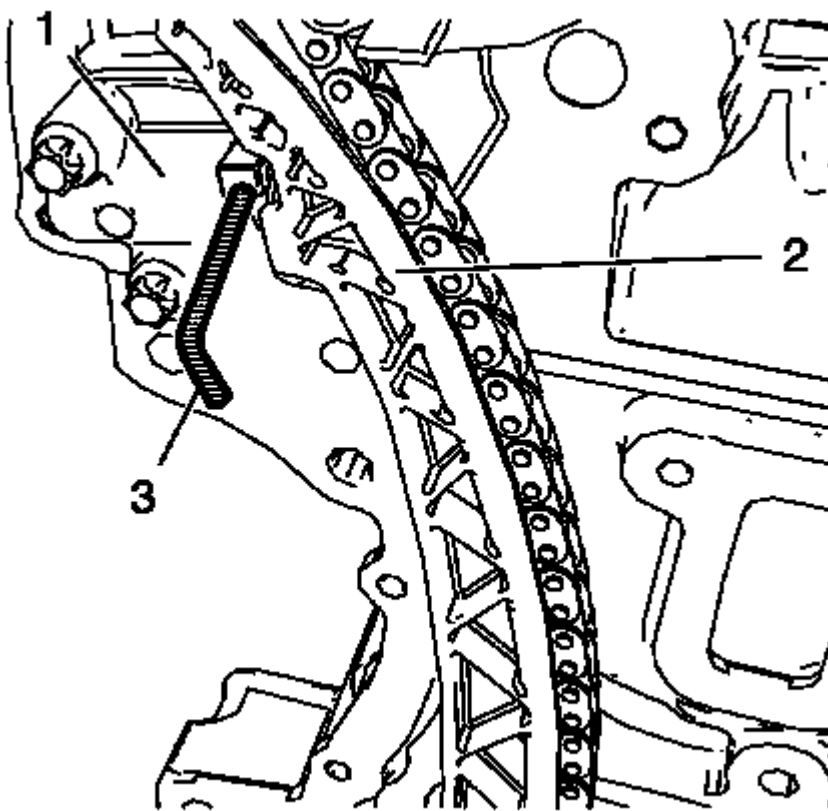
8. Install the timing chain tensioner shoe bolt (2) and tighten to 20 N.m (15 lb ft).



**Fig. 56: Timing Chain Guide Right Side**

Courtesy of GENERAL MOTORS COMPANY

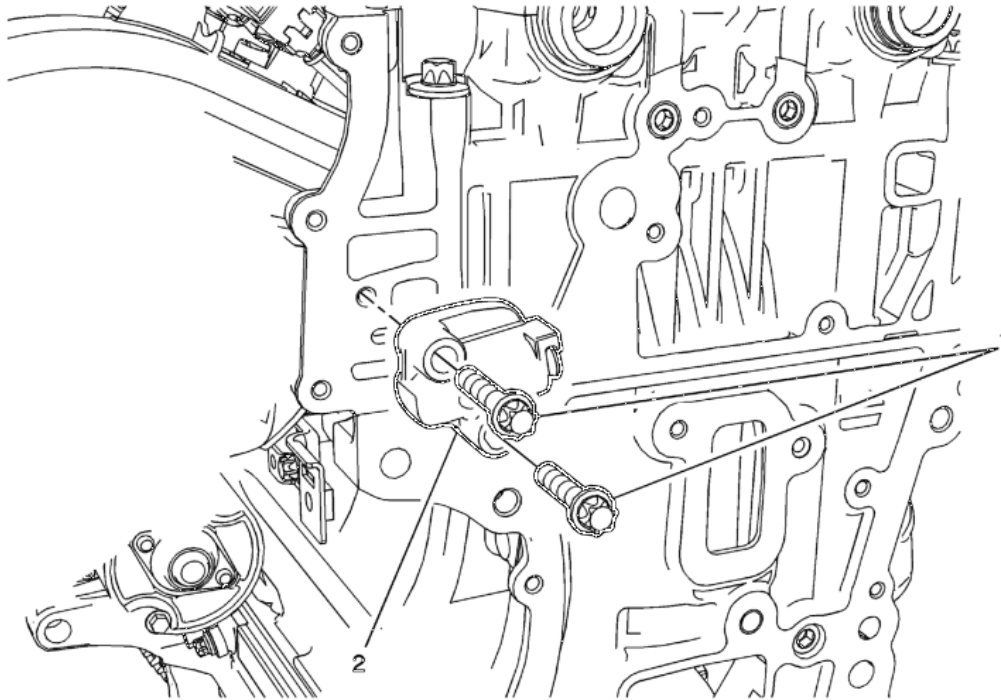
9. Install the timing chain guide right side (1).
10. Install the timing chain guide right side bolts (2) and tighten to 8 N.m (71 lb in).



**Fig. 57: Timing Chain And Timing Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

11. Push the timing chain (2) in direction of the timing chain tensioner (1) and remove **EN-955** pin (3).
12. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.

#### **TIMING CHAIN TENSIONER REPLACEMENT**

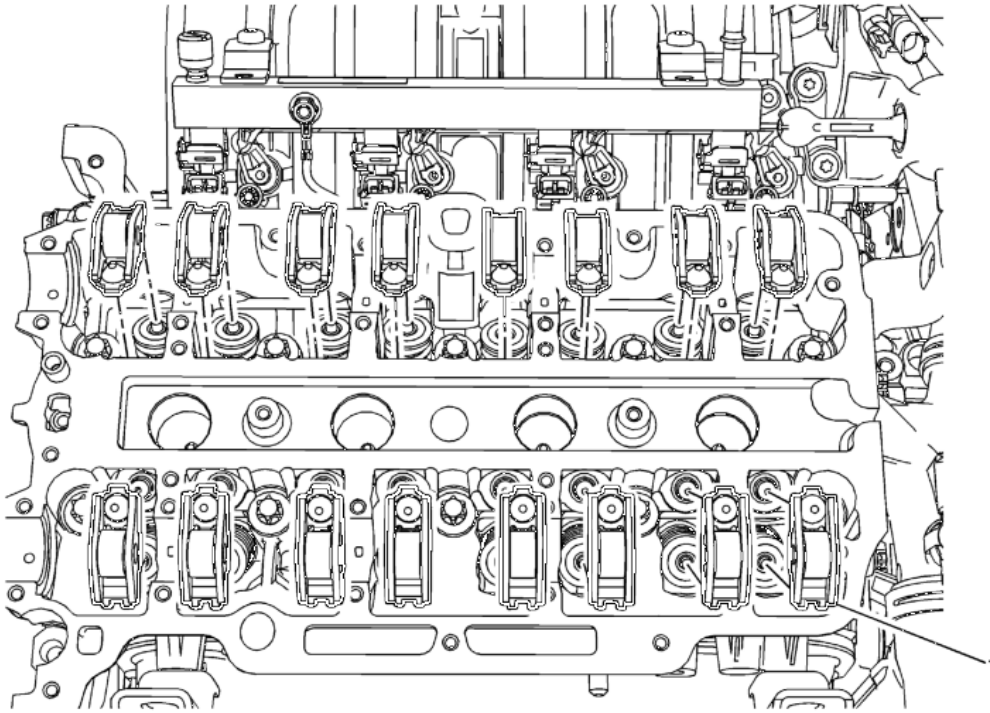
**Fig. 58: Timing Chain Tensioner**

Courtesy of GENERAL MOTORS COMPANY

**Timing Chain Tensioner Replacement**

Callout	Component Name
<b>Preliminary Procedure</b> Remove the camshaft timing chain . Refer to <u><b>Camshaft Timing Chain Replacement</b></u> .	
1	Timing Chain Tensioner Fastener (Qty: 2)  <b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u> .</b>  <b>Tighten</b> 8 N.m (71 lb in)
2	Timing Chain Tensioner

**HYDRAULIC VALVE LASH ADJUSTER ARM REPLACEMENT**



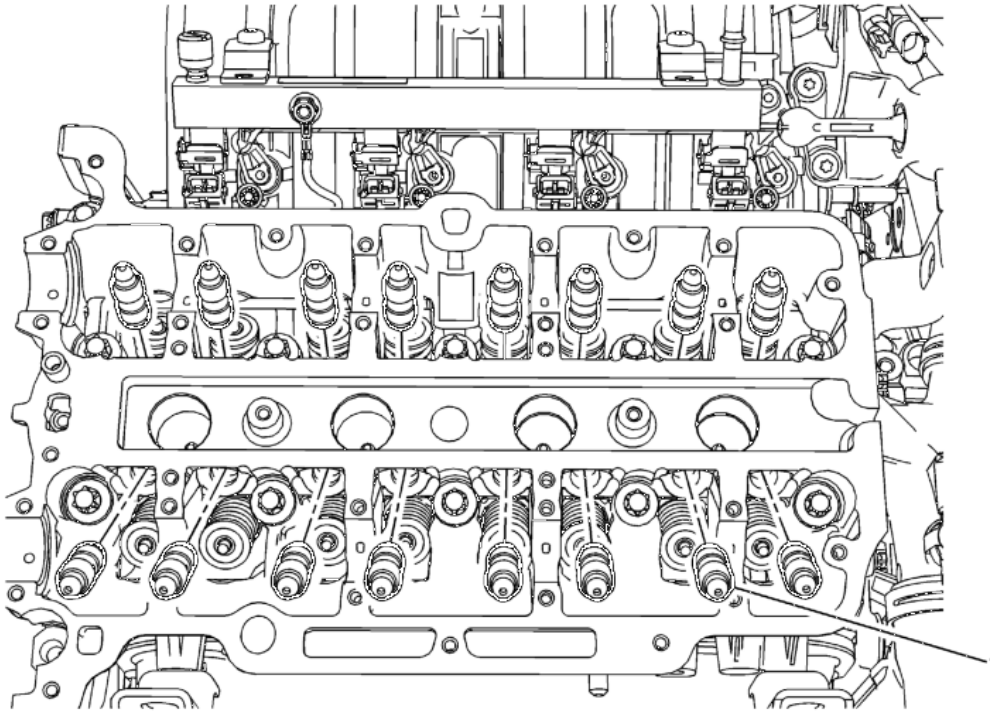
**Fig. 59: Hydraulic Valve Lash Adjuster Arms**  
 Courtesy of GENERAL MOTORS COMPANY

#### Hydraulic Valve Lash Adjuster Arm Replacement

Callout	Component Name
<b>Preliminary Procedures</b>	
1. Remove the intake camshaft. Refer to <b><u>Intake Camshaft Replacement</u></b> . 2. Remove the exhaust camshaft. Refer to <b><u>Exhaust Camshaft Replacement</u></b> .	
1	Hydraulic Valve Lash Adjuster Arms  <b>Procedure</b> <ol style="list-style-type: none"> <li>1. Mark the hydraulic valve lash adjuster arms upon removal to ensure installation is in the correct position.</li> <li>2. Lubricate the hydraulic valve lash adjuster arms with engine oil before installing the arms.</li> </ol>

#### HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT





**Fig. 60: Hydraulic Valve Lash Adjuster**  
 Courtesy of GENERAL MOTORS COMPANY

### Hydraulic Valve Lash Adjuster Replacement

Callout	Component Name
<b>Preliminary Procedures</b> Remove the hydraulic valve lash adjuster arms. Refer to <b><u>Hydraulic Valve Lash Adjuster Arm Replacement</u></b> .	
1	Hydraulic Valve Lash Adjuster  <b>Procedure</b> <ol style="list-style-type: none"> <li>1. Mark the hydraulic valve lash adjuster upon removal to ensure installation is in the correct position.</li> <li>2. Lubricate the hydraulic valve lash adjuster with engine oil before installation.</li> </ol>

### CAMSHAFT INTAKE AND EXHAUST SPROCKET REPLACEMENT

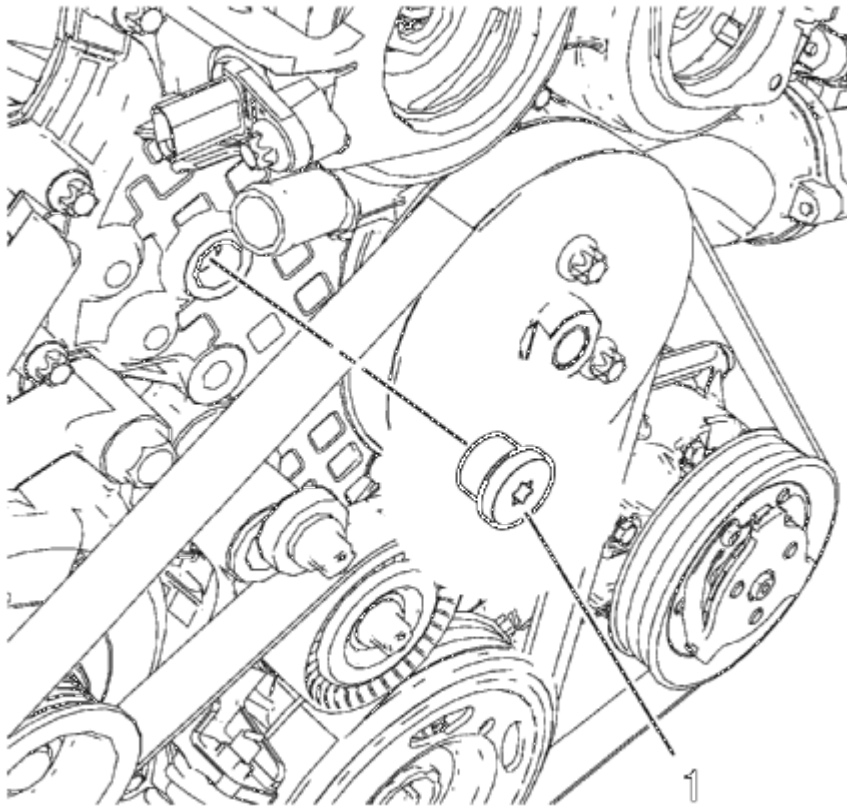
#### Special Tools

**EN-955** Locking Pin

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

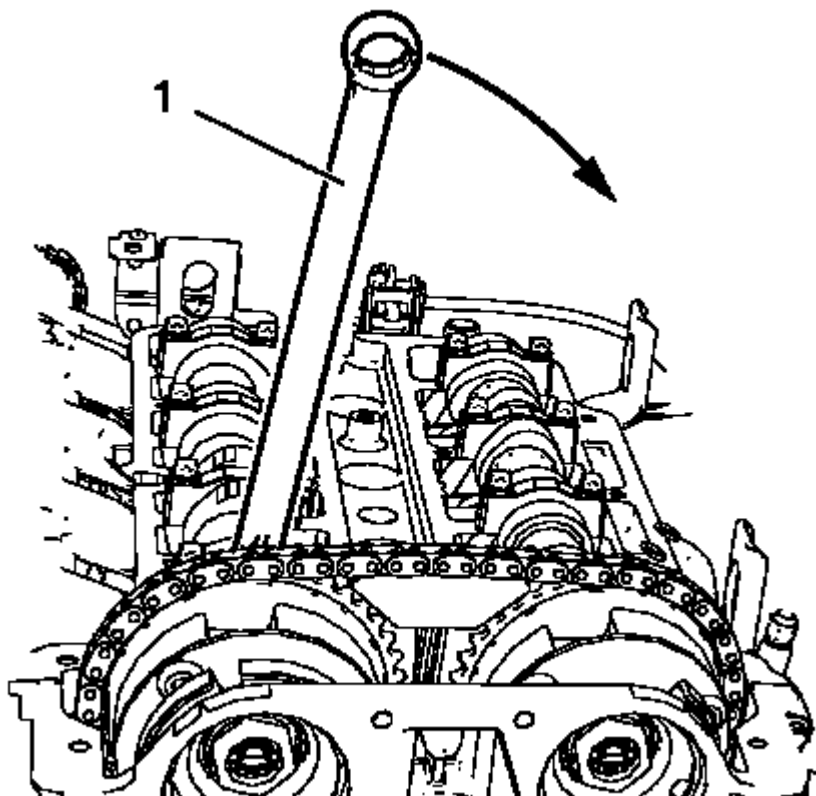
#### Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
3. Remove both camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
4. Adjust the engine to TDC. Refer to **Camshaft Timing Chain Adjustment**.



**Fig. 61: Timing Chain Tensioner Plug**  
Courtesy of GENERAL MOTORS COMPANY

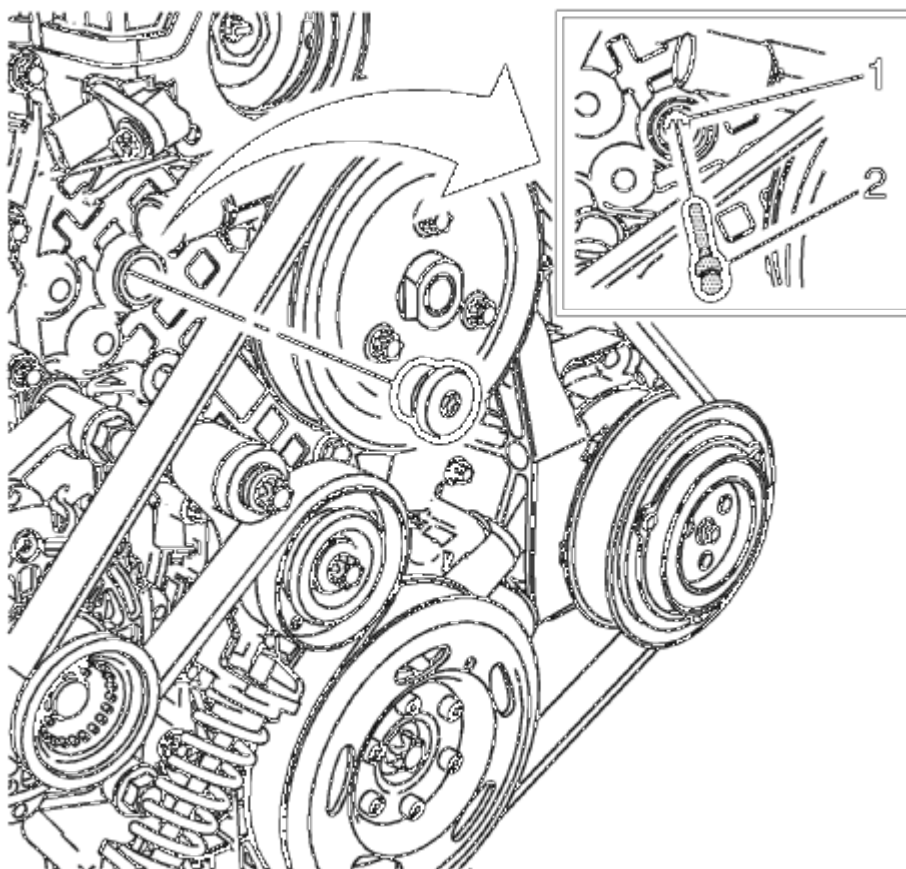
5. Remove the timing chain tensioner plug (1) from the engine front cover.



**Fig. 62: Hexagonal Wrench Rotation Direction**

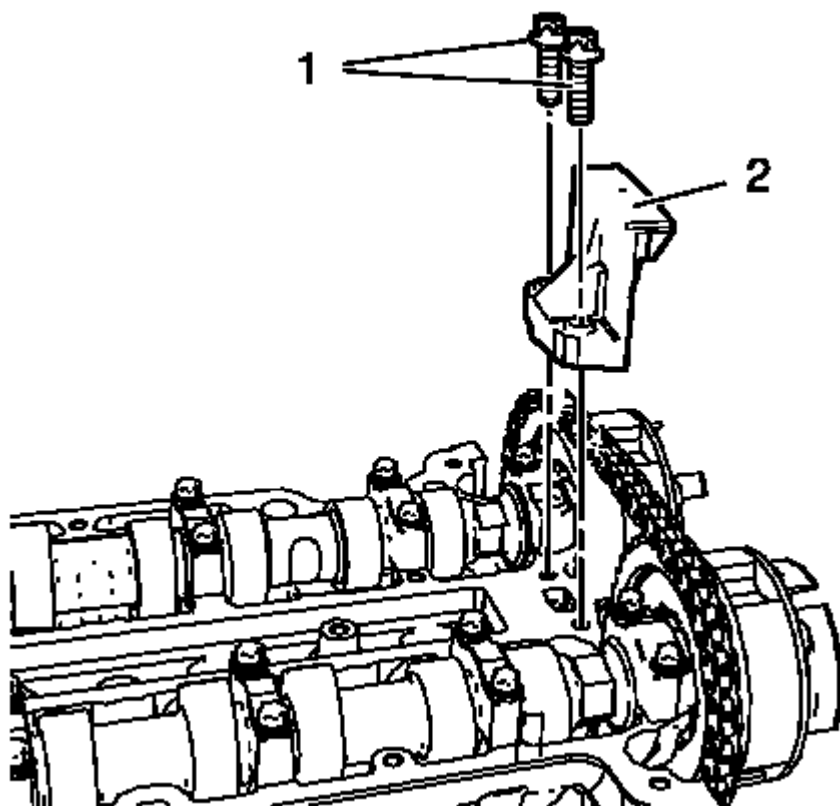
**Courtesy of GENERAL MOTORS COMPANY**

6. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.



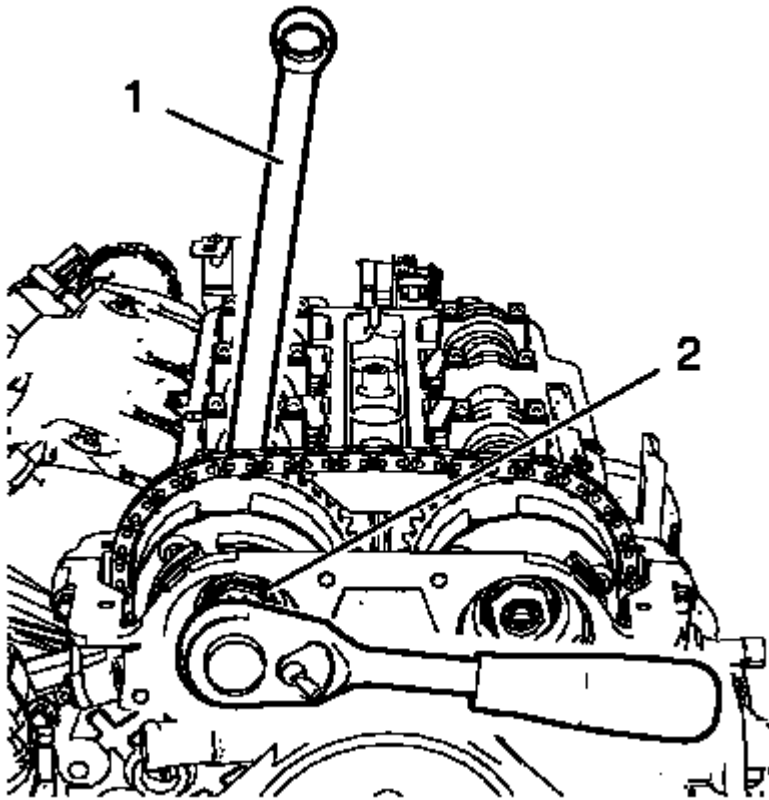
**Fig. 63: Timing Chain Tensioner Bore & Pin**  
**Courtesy of GENERAL MOTORS COMPANY**

7. Install **EN-955** pin (2) to the timing chain tensioner bore (1) to secure it in place.
8. Remove the wrench from intake camshaft.



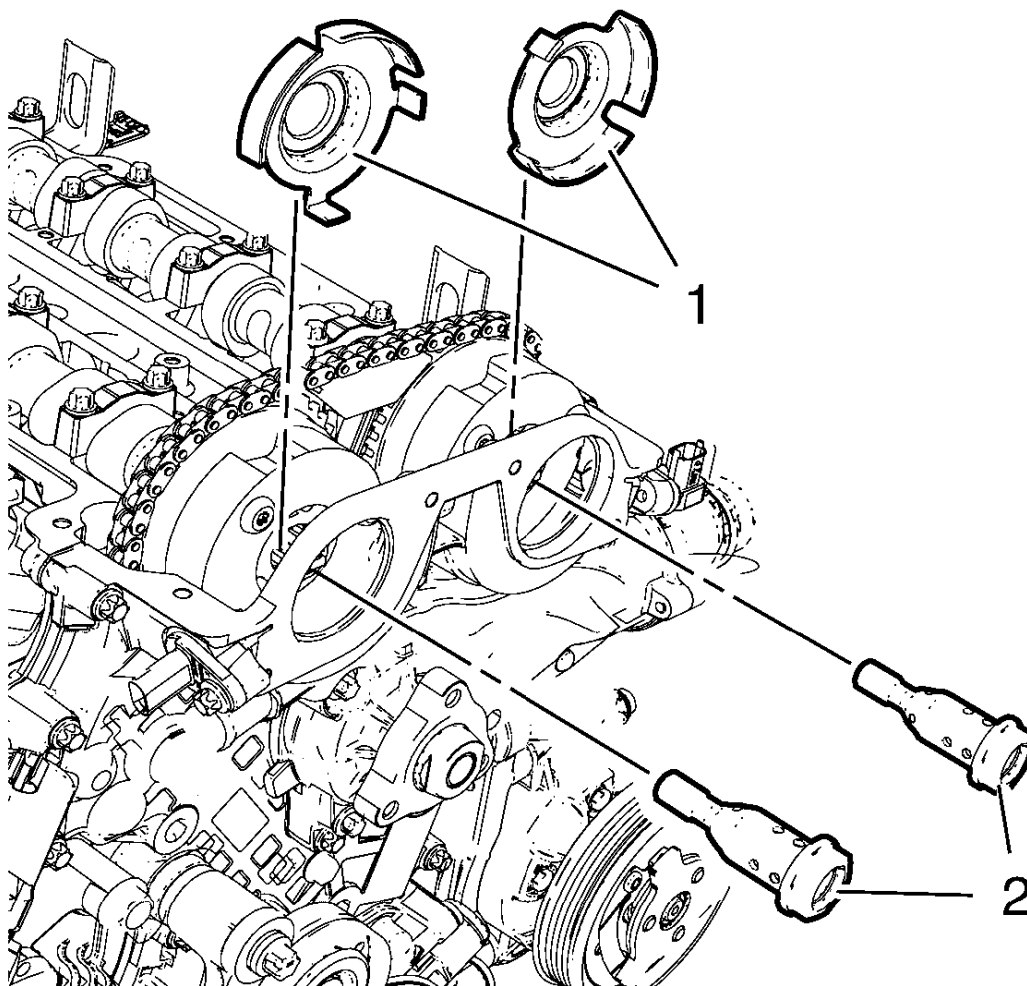
**Fig. 64: Upper Timing Chain Guide And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

9. Remove the upper timing chain guide bolts (1).
10. Remove the upper timing chain guide (2).



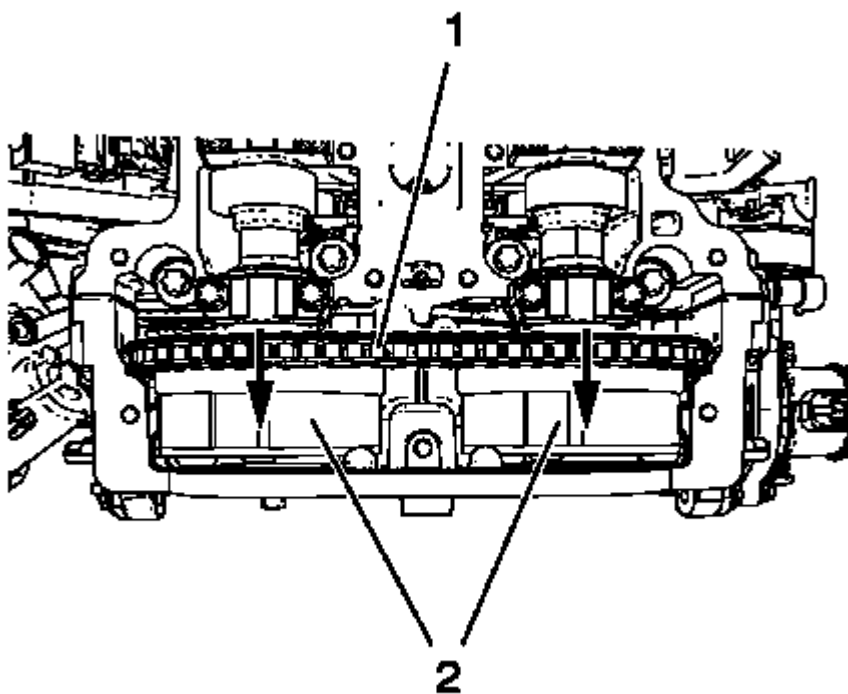
**Fig. 65: Intake Camshaft Sprocket Bolt And Hexagonal Wrench**  
Courtesy of GENERAL MOTORS COMPANY

11. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
12. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.



**Fig. 66: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

13. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).

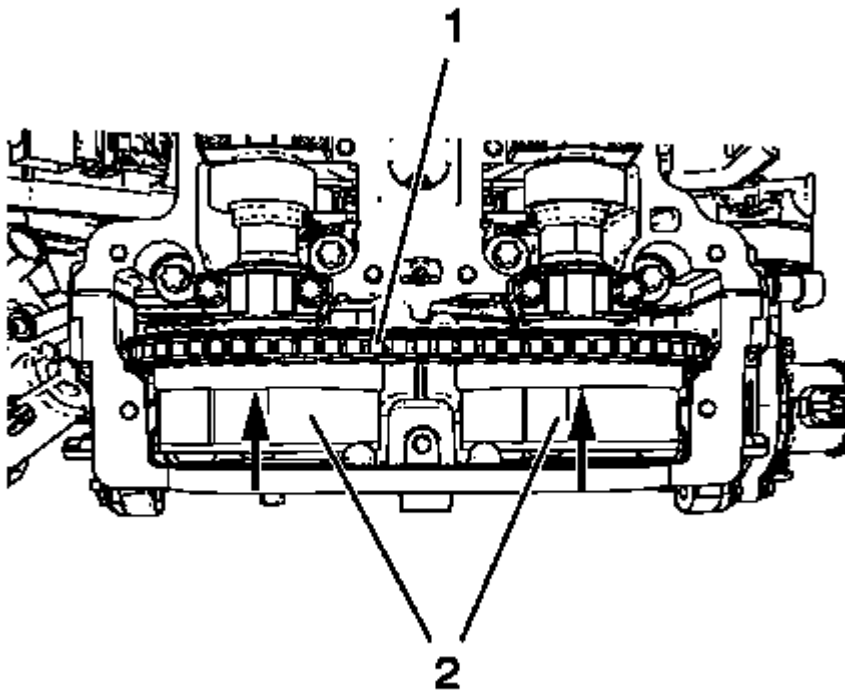


**Fig. 67: Timing Chain And Camshaft Sprockets**  
**Courtesy of GENERAL MOTORS COMPANY**

14. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
15. Remove the intake and exhaust camshaft sprocket.
16. Allow the chain to rest on the front cover.

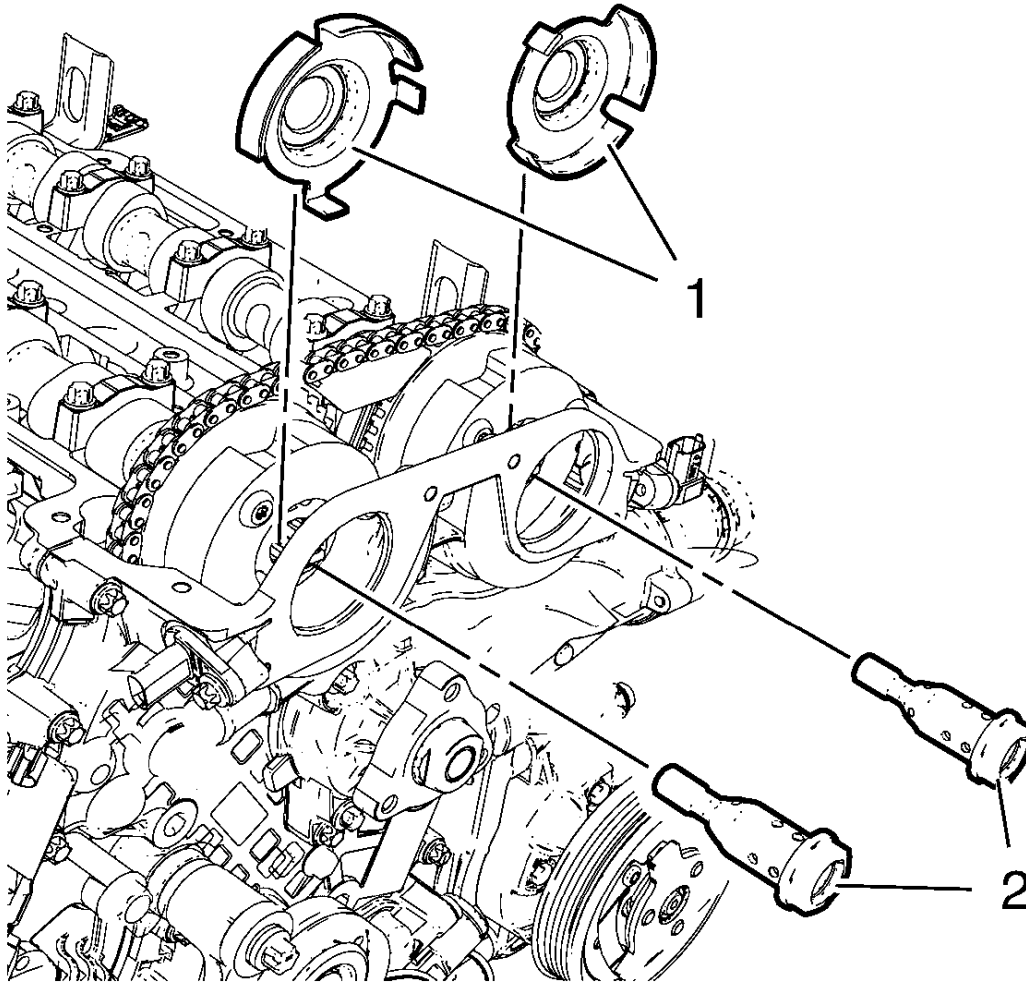
#### **Installation Procedure**





**Fig. 68: Timing Chain And Camshaft Sprockets**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft sprockets (2) and timing chain (1) as one unit.



**Fig. 69: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

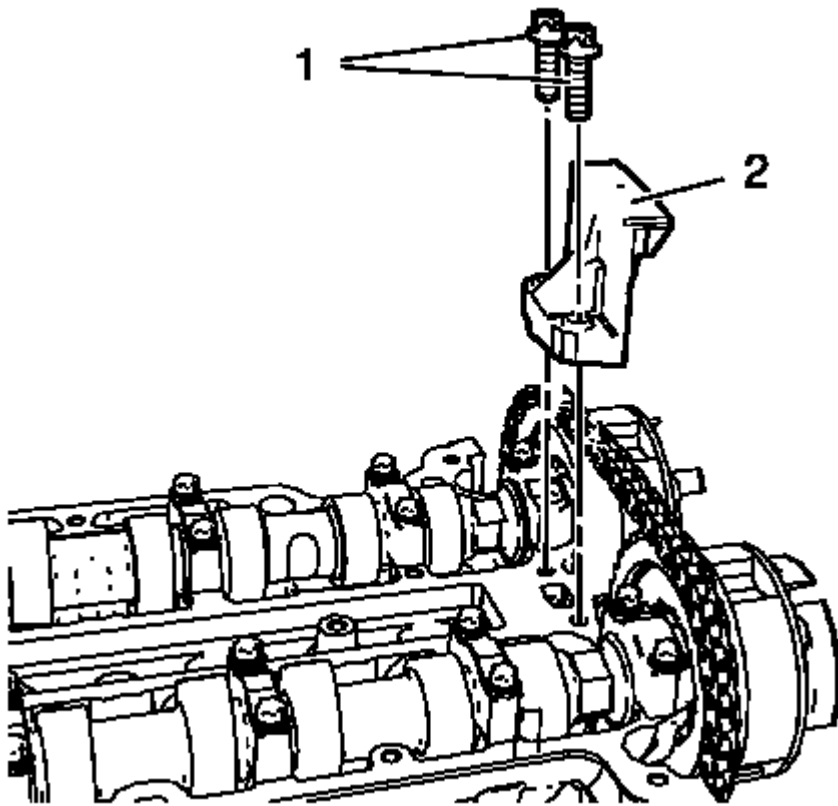
2. Install the camshaft position exciter wheels (1).

**CAUTION:** Refer to Fastener Caution .

3. Install the NEW camshaft sprocket bolts (2) and tighten to 50 N.m (37 lb ft) plus 60 degrees.
4. Remove the **EN-955** pin to apply tension to the timing chain .

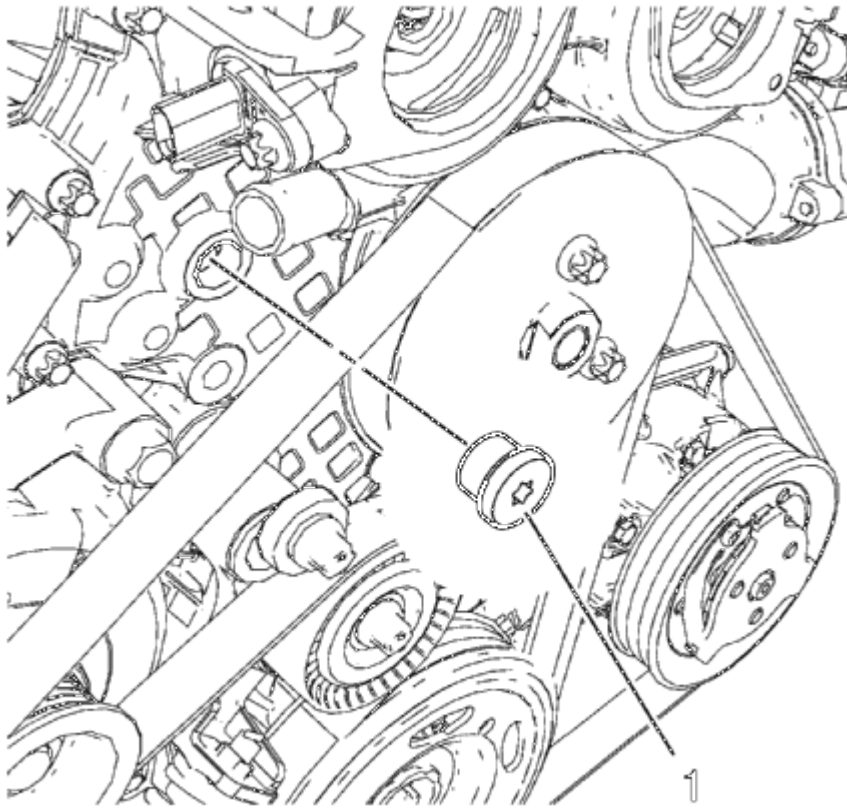
**NOTE:** Engine must be adjusted to TDC.

5. Adjust the camshaft timing chain. Refer to Camshaft Timing Chain Adjustment.



**Fig. 70: Upper Timing Chain Guide And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

6. Install the upper timing chain guide (2).
7. Install the upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).



**Fig. 71: Timing Chain Tensioner Plug**  
Courtesy of GENERAL MOTORS COMPANY

8. Install the timing chain tensioner plug (1) and tighten to 50 N.m (37 lb ft).
9. Install both camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
10. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
11. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
12. Check and correct engine oil level.

## CYLINDER HEAD REPLACEMENT

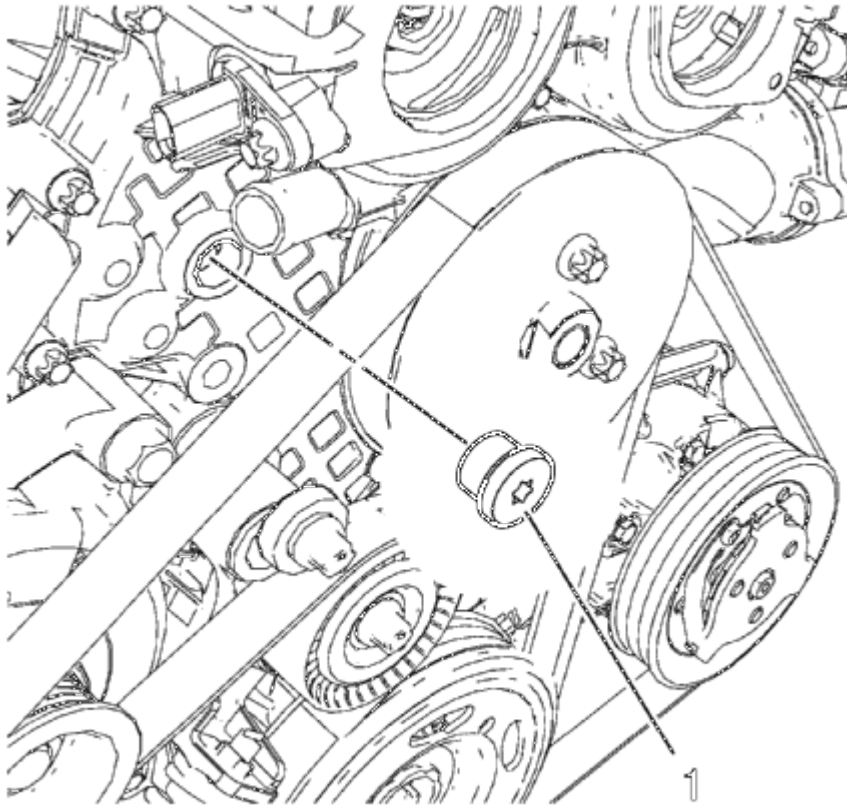
### Special Tools

- **EN-470-B** Angular Torque Wrench
- **EN-955** Fixing Pin
- **EN-953-A** Fixing Tool

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

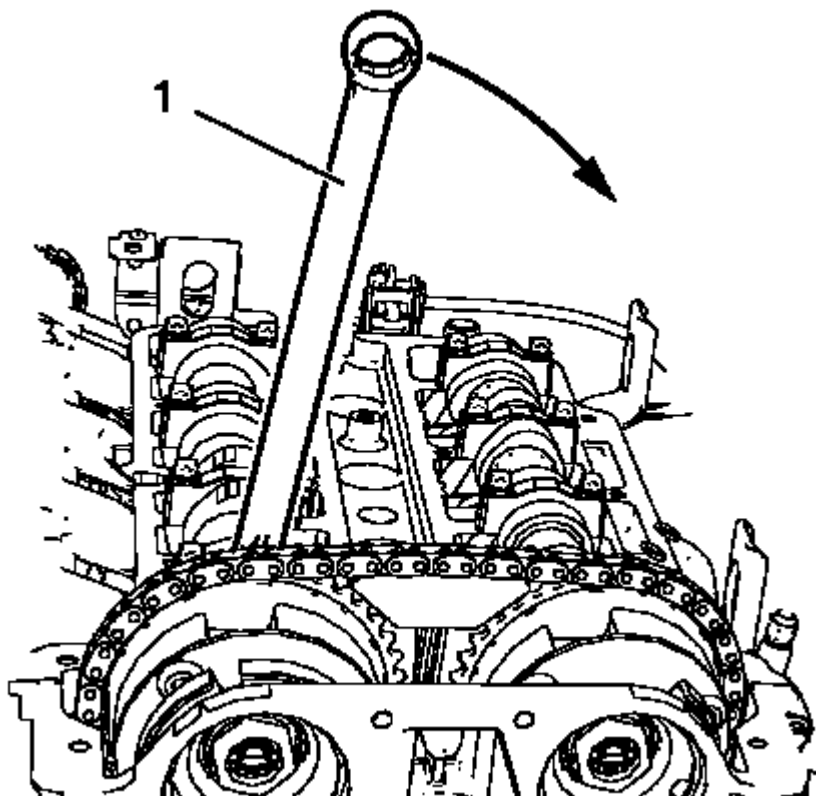
### Removal Procedure

1. Disconnect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the exhaust manifold with catalytic converter . Refer to **EXHAUST MANIFOLD REPLACEMENT (LUV)** .
3. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
4. Remove the water outlet. Refer to **Water Outlet Replacement (LUV)** .
5. Remove the camshaft position actuator solenoid valve intake and exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
6. Adjust the engine to TDC. Refer to **Camshaft Timing Chain Inspection**.



**Fig. 72: Timing Chain Tensioner Plug**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain tensioner plug (1) from the engine front cover.

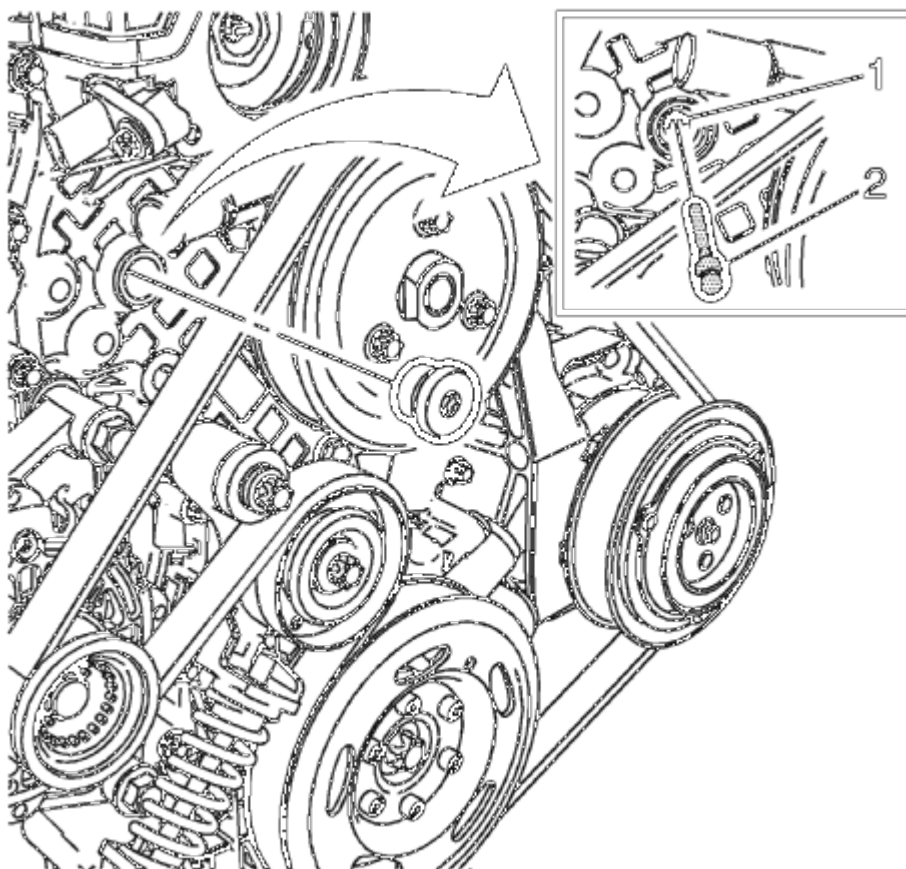


**Fig. 73: Hexagonal Wrench Rotation Direction**

Courtesy of GENERAL MOTORS COMPANY

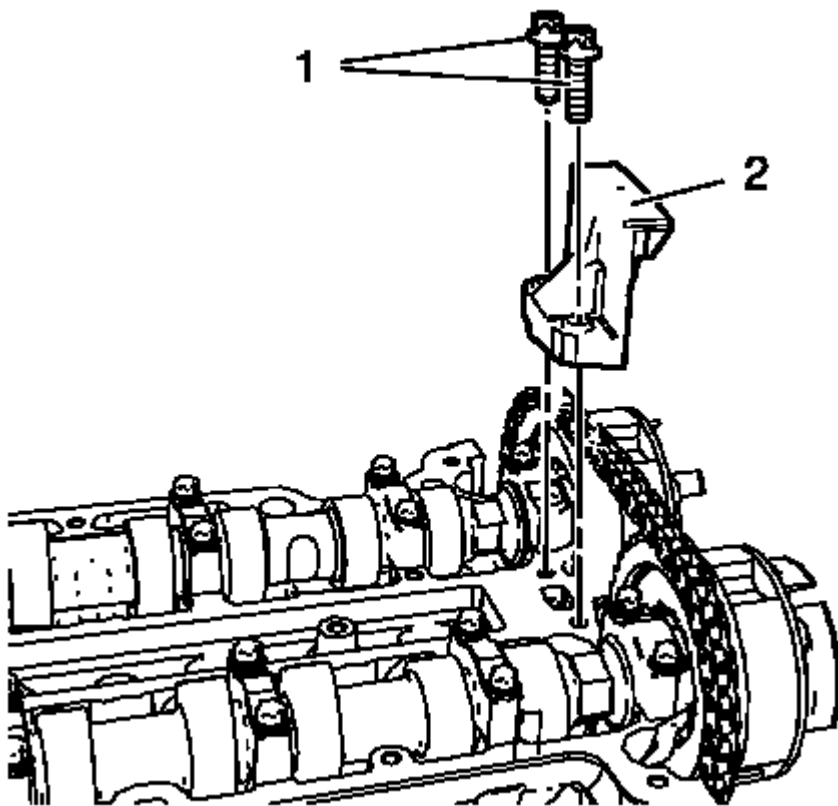
**NOTE:** Remove and reinstall the EN-953-A fixing tool for this step.

8. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.



**Fig. 74: Timing Chain Tensioner Bore & Pin**  
**Courtesy of GENERAL MOTORS COMPANY**

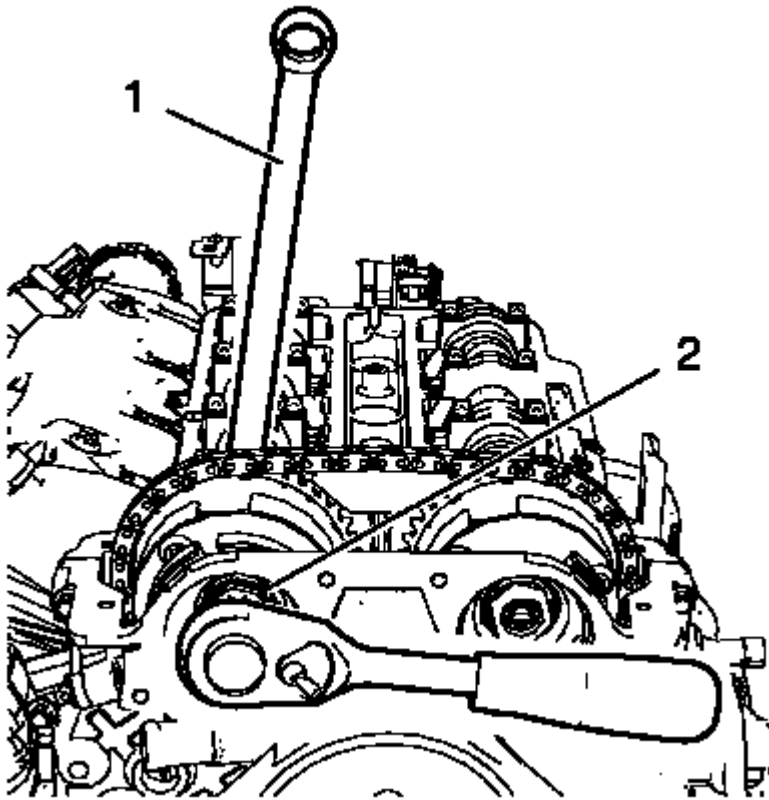
9. Install EN-955 pin (2) to the timing chain tensioner bore (1) to secure it in place.
10. Remove the wrench from intake camshaft.



**Fig. 75: Upper Timing Chain Guide And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

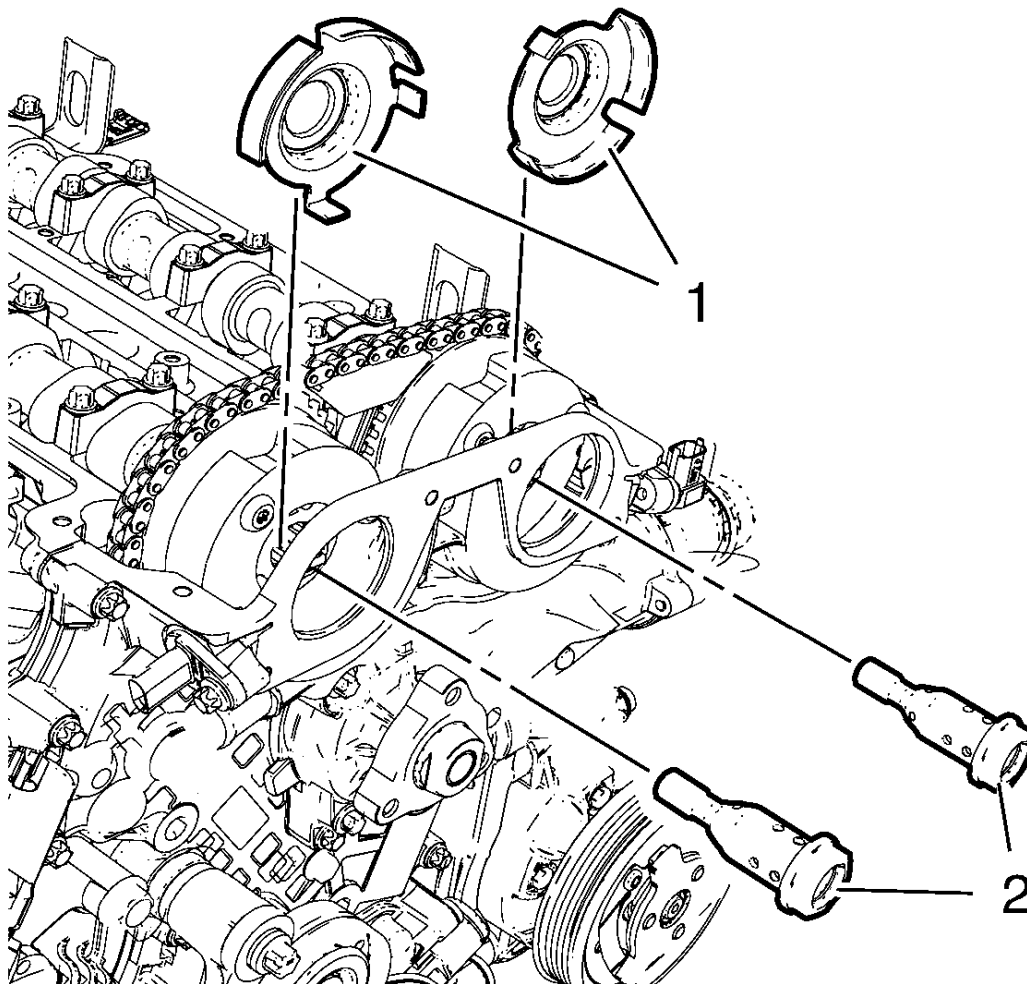
11. Remove the upper timing chain guide bolts (1).
12. Remove the upper timing chain guide (2).





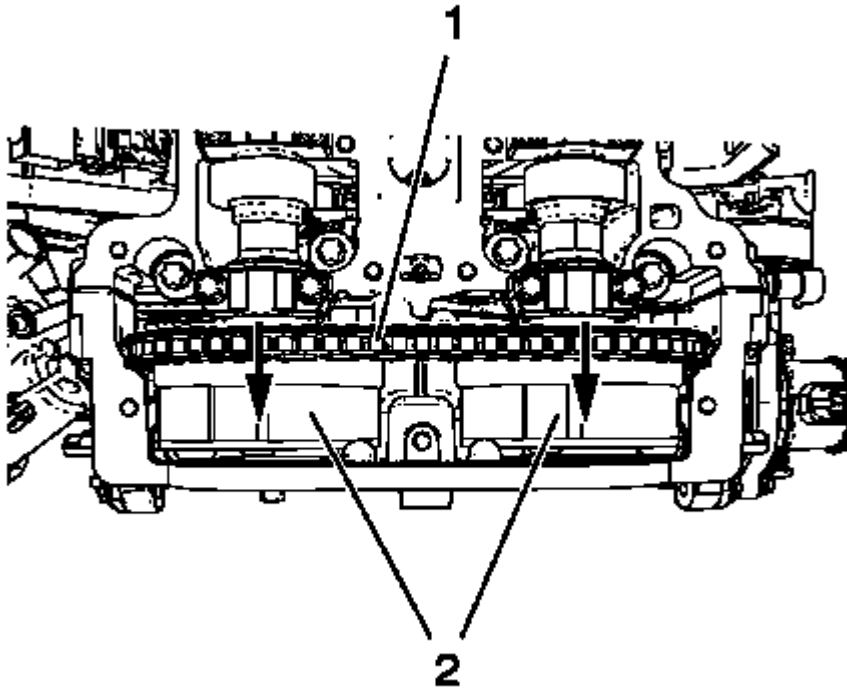
**Fig. 76: Intake Camshaft Sprocket Bolt And Hexagonal Wrench**  
Courtesy of GENERAL MOTORS COMPANY

13. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
14. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.



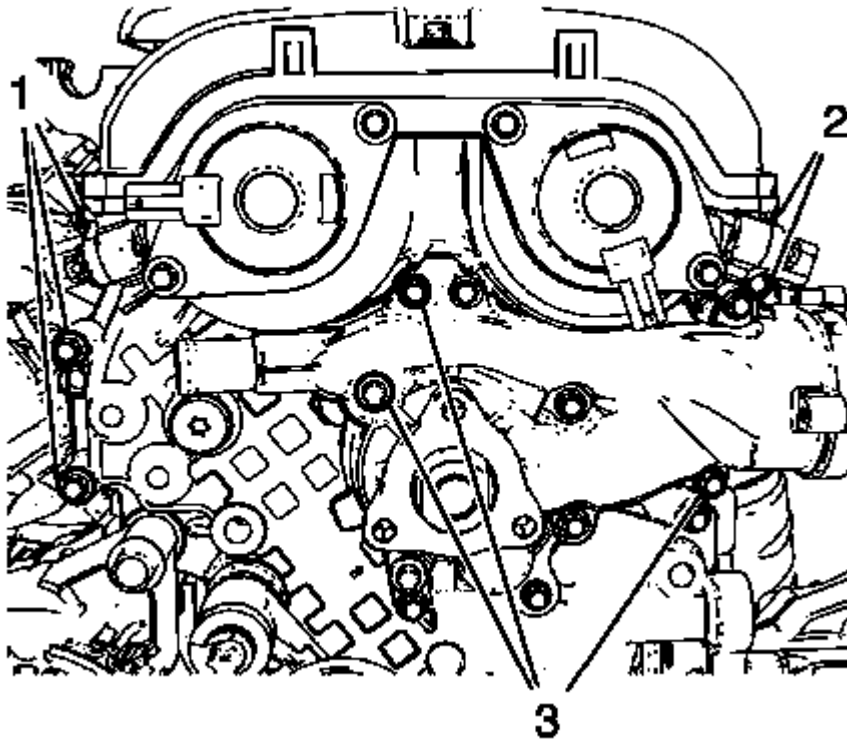
**Fig. 77: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

15. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).
16. Remove the both camshaft position sensors. Refer to **Camshaft Position Sensor Replacement** .



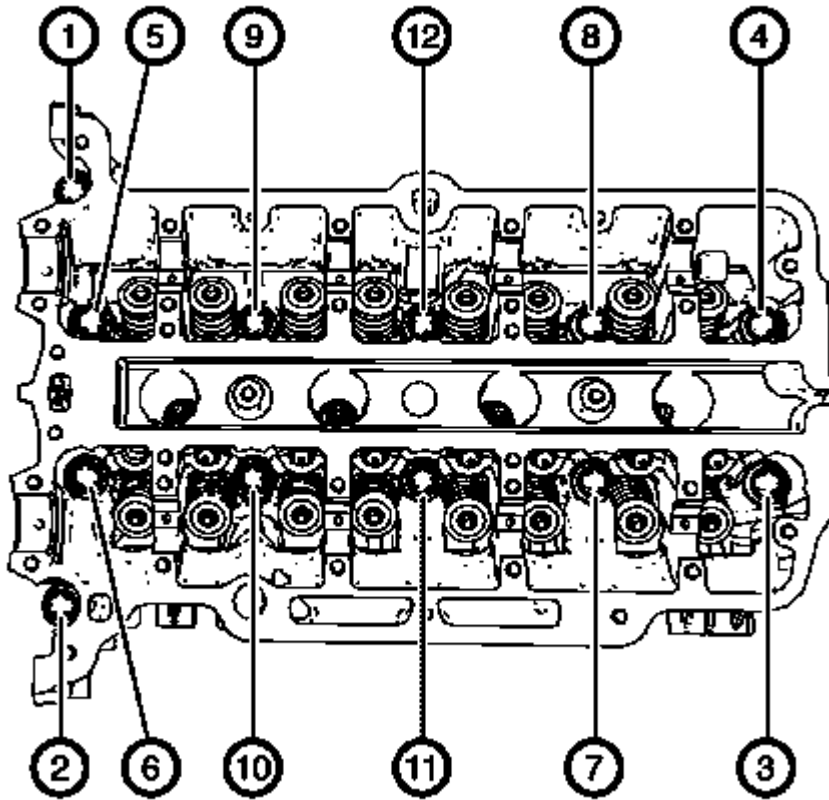
**Fig. 78: Timing Chain And Camshaft Sprockets**  
**Courtesy of GENERAL MOTORS COMPANY**

17. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
18. Allow the camshaft sprockets (2) and timing chain (1) rest on the front cover. Do NOT remove sprockets or chain.
19. Install the engine support fixture. Refer to **Engine Support Fixture**.
20. Remove the engine mount bracket. Refer **Engine Mount Bracket Replacement - Right Side**.
21. Remove the drive belt. Refer to **Drive Belt Replacement**.
22. Remove the water pump pulley. Refer to **Water Pump Pulley Replacement (LUV)** .



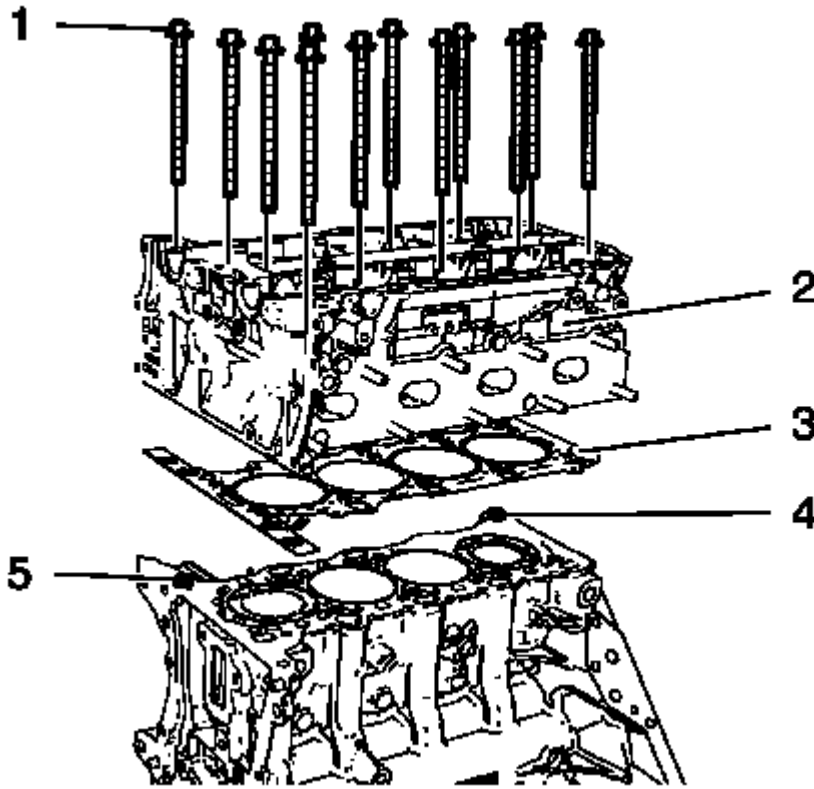
**Fig. 79: Engine Front Cover Bolts And Water Pump Bolts**  
Courtesy of GENERAL MOTORS COMPANY

23. Remove 5 engine front cover bolts (1, 2).
24. Remove 3 water pump bolts (3).
25. Install engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
26. Install engine mount. Refer to **Engine Mount Replacement - Right Side**.
27. Remove engine support fixture. Refer **Engine Support Fixture**.



**Fig. 80: Cylinder Head Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

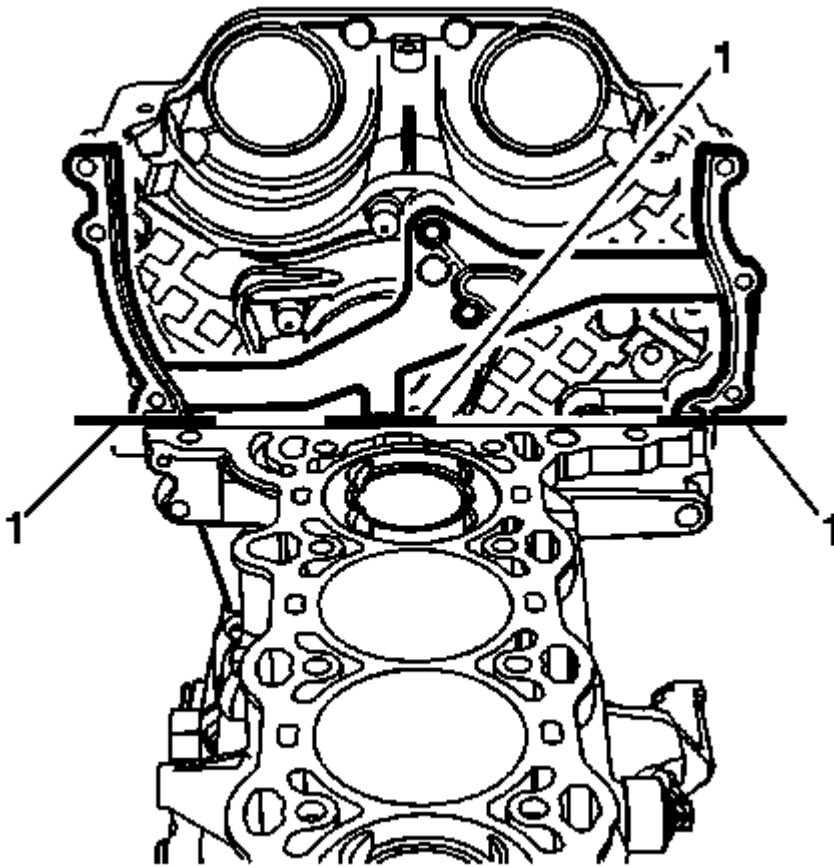
28. Loosen the 12 cylinder head bolts in the sequence as shown above. Use the following procedure:
- First pass: Loosen the cylinder head bolts 90 degrees.
  - Final pass: Loosen the cylinder head bolts 180 degrees.



**Fig. 81: Cylinder Head, Gasket, Bolts And Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not damage the guide sleeves (4, 5).

29. Remove and DISCARD the 12 cylinder head bolts (1).
30. With the aid of an assistant, lift the timing chain side of the cylinder head assembly slightly in direction of the transmission.
31. Remove the cylinder head (2).
32. Remove the cylinder head gasket (3) and discard the gasket.



**Fig. 82: Top Third Of Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS COMPANY

33. With the cylinder head out of vehicle, bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.
34. Remove the assembly parts from cylinder head
  - Remove the EN-953-A fixing tool
  - Remove the intake camshaft. Refer to **Intake Camshaft Removal**.
  - Remove the exhaust camshaft. Refer to **Exhaust Camshaft Removal**.
  - Remove the hydraulic valve lash adjuster arms. Refer to **Hydraulic Valve Lash Adjuster Arm Removal**.
  - Remove the hydraulic valve lash adjusters. Refer to **Hydraulic Valve Lash Adjuster Removal**.
  - Remove the spark plug. Refer to **Spark Plug Replacement**.
  - Remove the engine oil pressure indicator switch.
  - Remove the timing chain tensioner. Refer to **Timing Chain Tensioner Removal**.
  - Remove the 3 engine lift brackets.
35. For disassembly of the cylinder head. Refer to **Cylinder Head Disassemble**.
36. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection**.

37. Transfer parts as necessary.

**Installation Procedure**

1. For assembly of the cylinder head. Refer to Cylinder Head Assemble.

**CAUTION: Refer to Fastener Caution .**

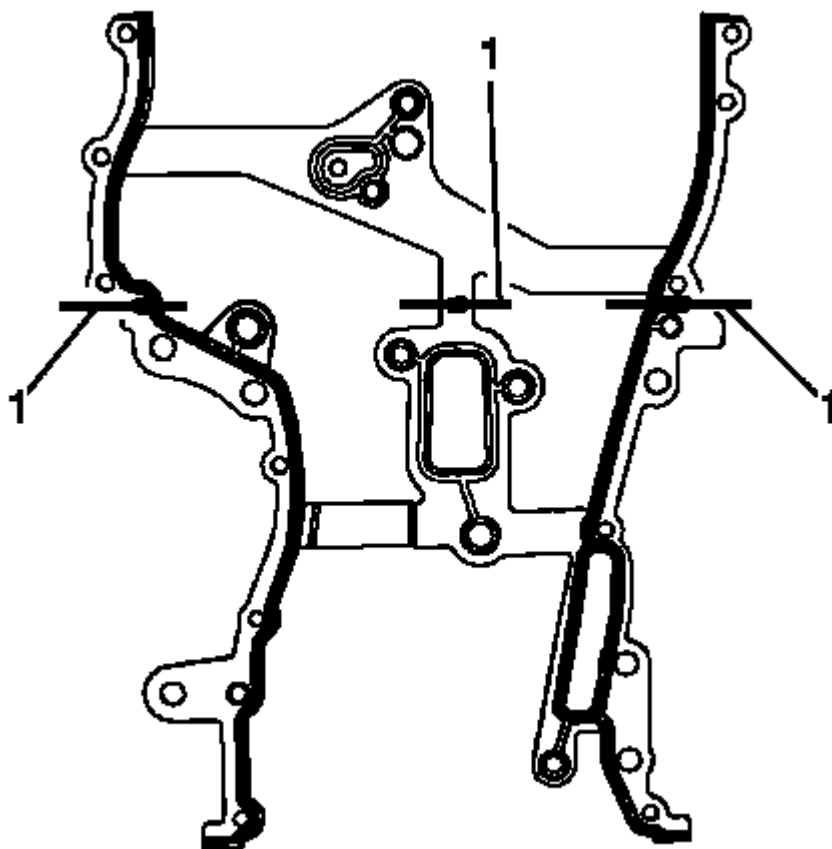
2. Install the cylinder head assembly parts:

- Install the 3 engine lift bracket bolts and tighten to 22 (16 lb ft).
- Install the timing chain tensioner. Refer to Timing Chain Tensioner Installation.
- Install the engine oil pressure indicator switch and tighten to 20 (15 lb ft)
- Install the spark plug. Refer to Spark Plug Replacement .
- Install the hydraulic valve lash adjusters. Refer to Hydraulic Valve Lash Adjuster Installation.
- Install the hydraulic valve lash adjuster arms. Refer to Hydraulic Valve Lash Adjuster Arm Installation.
- Install the exhaust camshaft. Refer to Exhaust Camshaft Installation.
- Install the intake camshaft. Refer to Intake Camshaft Installation.
- Install the **EN-953-A** fixing tool.

**NOTE:        Adjust the camshafts by means of the hexagon and a spanner.**

3. Clean sealing surfaces of engine front cover and engine block from grease and old gasket material.



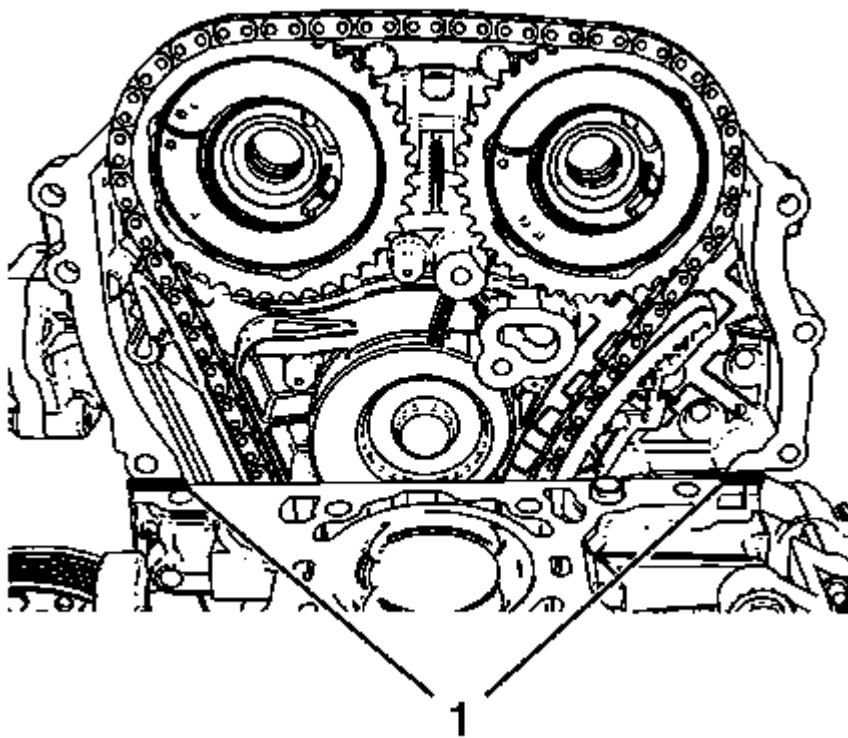


**Fig. 83: Engine Front Cover Gasket**

Courtesy of GENERAL MOTORS COMPANY

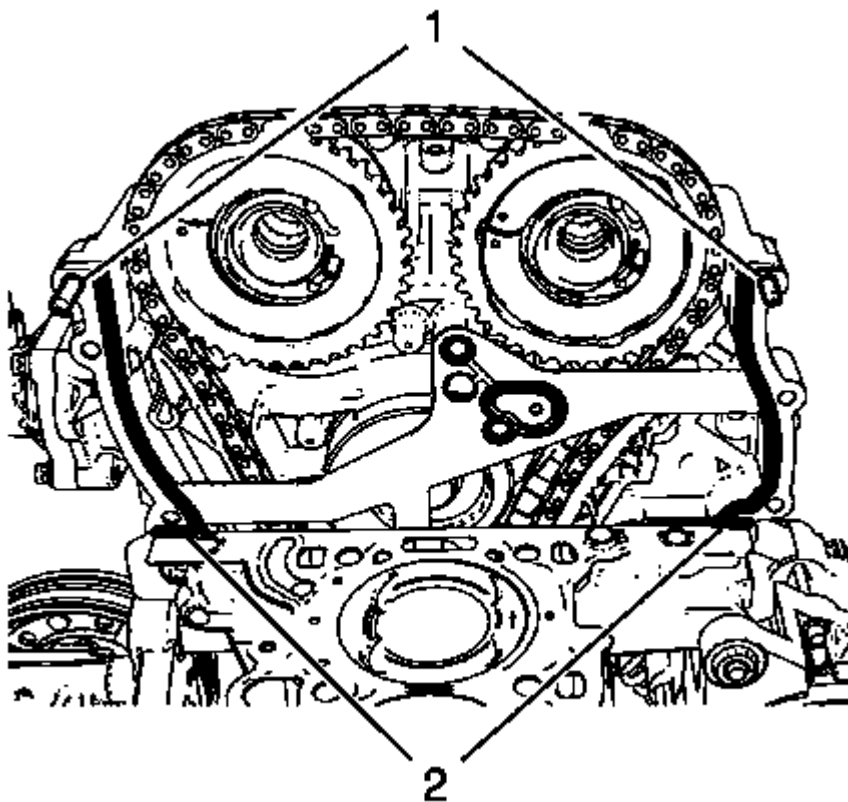
**NOTE:** The engine front cover gasket comes as a complete unit.

4. Before installation the of the new front cover gasket, bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.



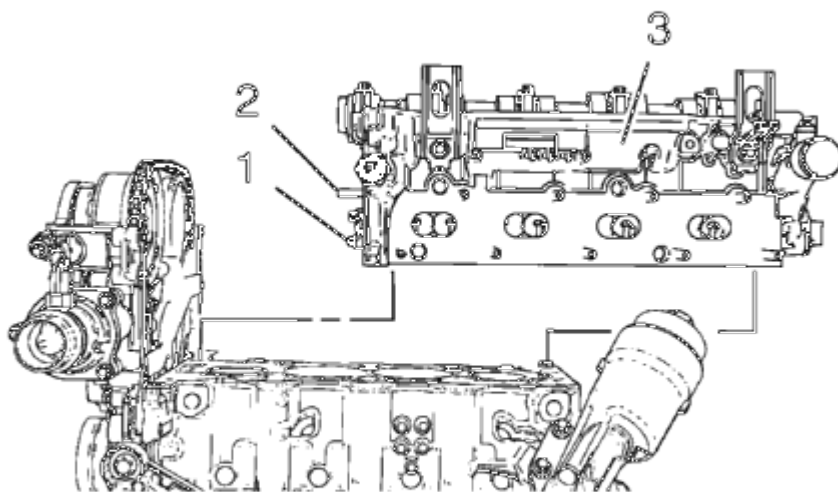
**Fig. 84: Sealing Compound Application Area**  
**Courtesy of GENERAL MOTORS COMPANY**

5. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (1).
6. Install a NEW cylinder head gasket. The marking "Top" should point to the cylinder head.



**Fig. 85: Engine Front Cover Bolts And Sealing Compound Application Areas**  
Courtesy of GENERAL MOTORS COMPANY

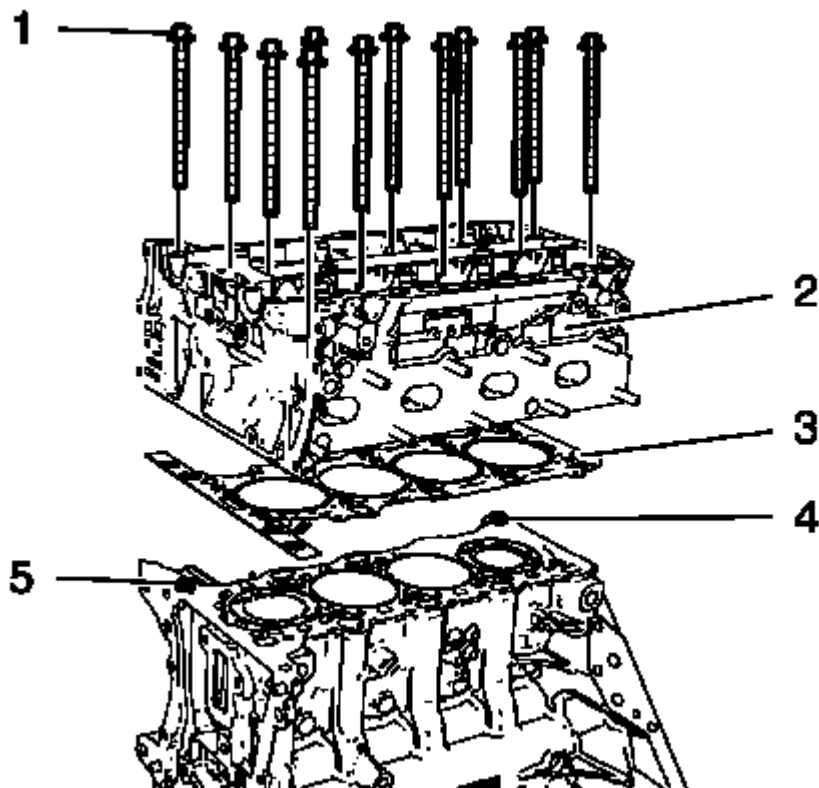
7. Install engine front cover bolts (1) in order to guide the NEW upper engine front cover gasket.
8. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (2).



**Fig. 86: Timing Chain Tensioner, Guide Pin And Cylinder Head**  
Courtesy of GENERAL MOTORS COMPANY

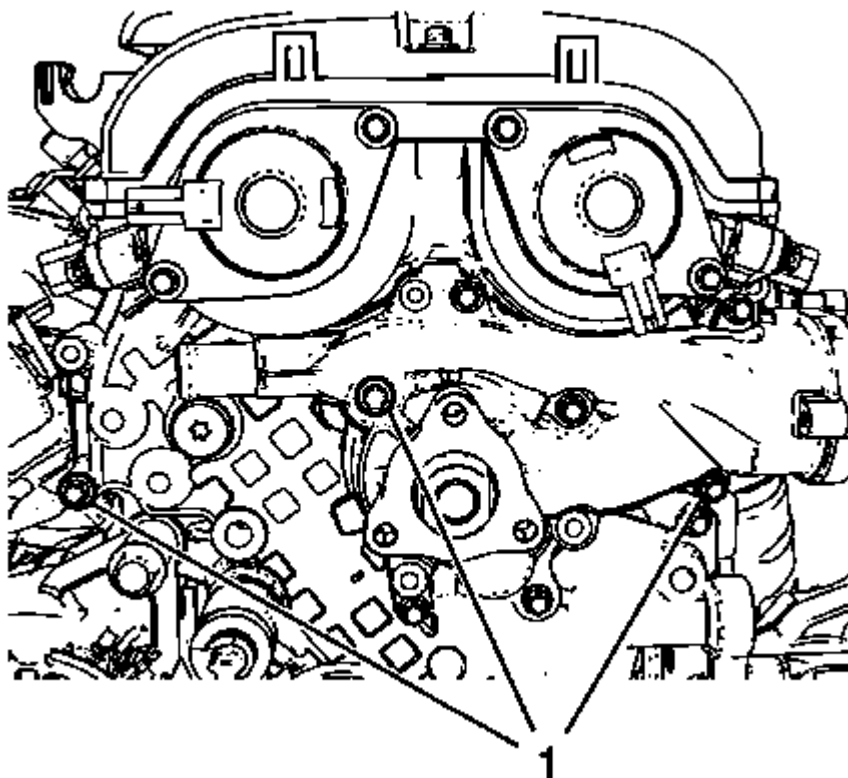
**NOTE:** A second mechanic is required.

9. Guide the timing chain guide pin (2) to the timing chain guide and the timing chain tensioner (1) with the installed fixing pin through the timing chain tensioner plug bore in engine front cover.



**Fig. 87: Cylinder Head, Gasket, Bolts And Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

10. Install the cylinder head (2).
11. Loosely install 12 NEW cylinder head bolts (1).



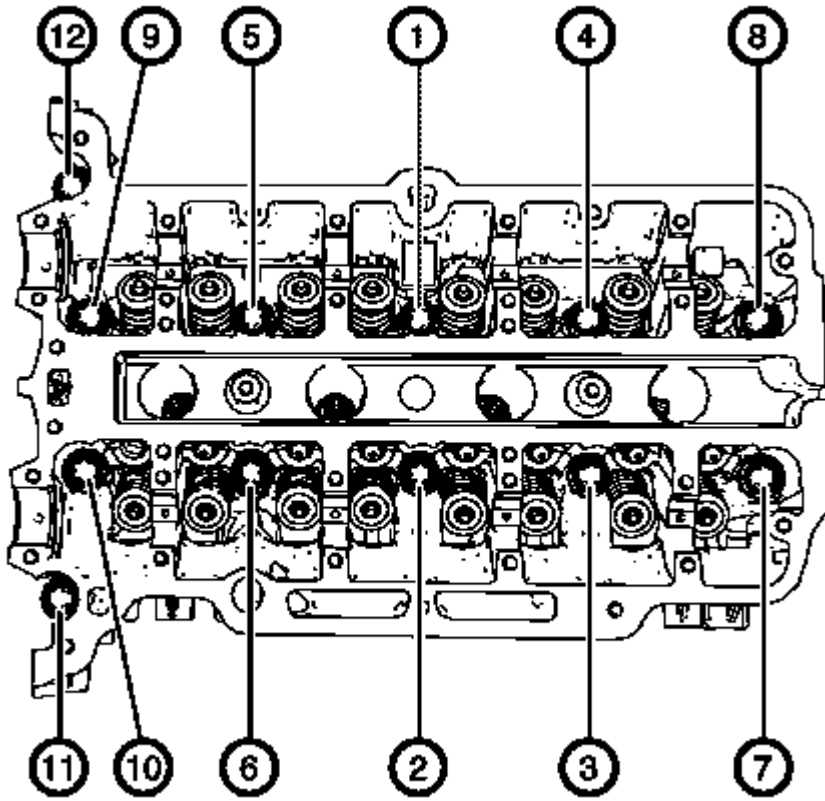
**Fig. 88: Engine Front Cover Bolts**

Courtesy of GENERAL MOTORS COMPANY

12. Adjust the cylinder head to the engine front cover. Use a rubber mallet.
13. Position the engine front cover to cylinder head by installing 3 bolts (1).

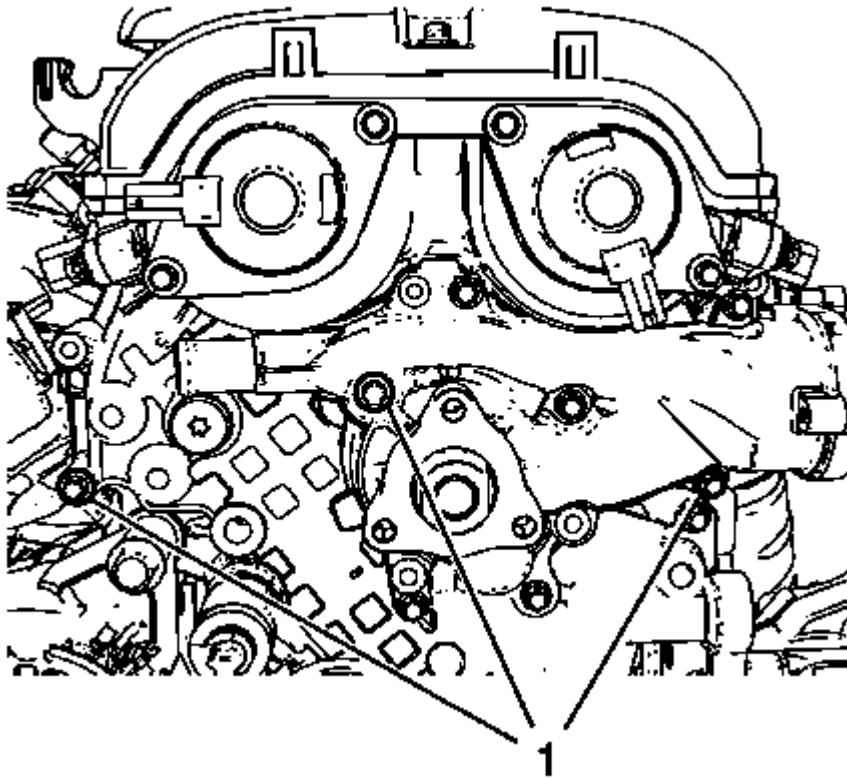
**CAUTION:** Refer to Fastener Caution .

14. Tighten the 3 bolts (1) to 8 N.m (71 lb in).



**Fig. 89: Cylinder Head Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

15. Tighten the cylinder head bolts in the sequence as shown and in the following order.
  - Tighten the cylinder head bolts to 35 (26 lb ft).
  - Tighten the cylinder head bolts an additional 180°. Use **EN-470-B** wrench.

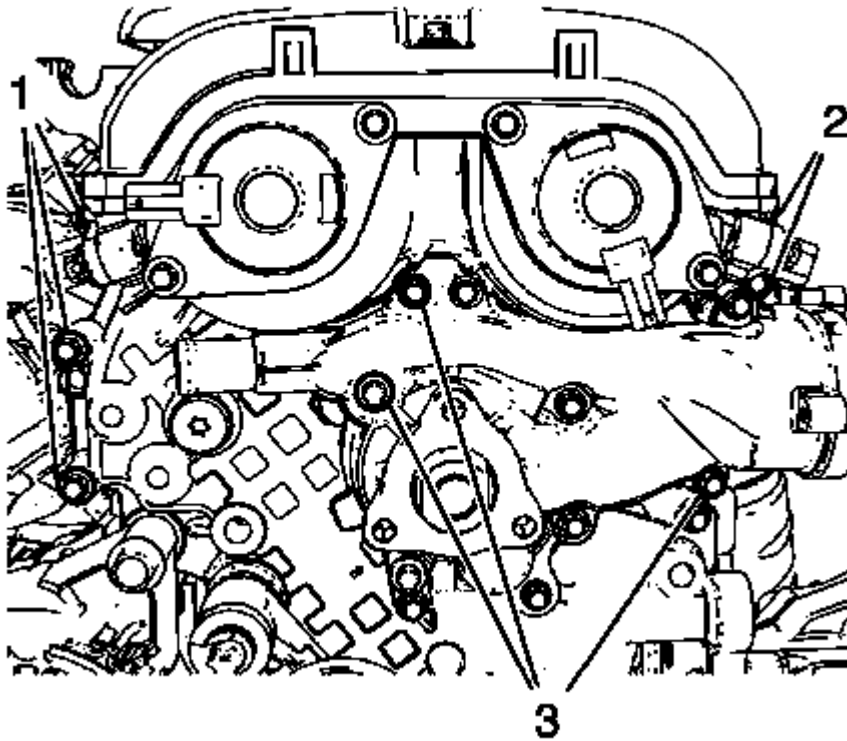


**Fig. 90: Engine Front Cover Bolts**

Courtesy of GENERAL MOTORS COMPANY

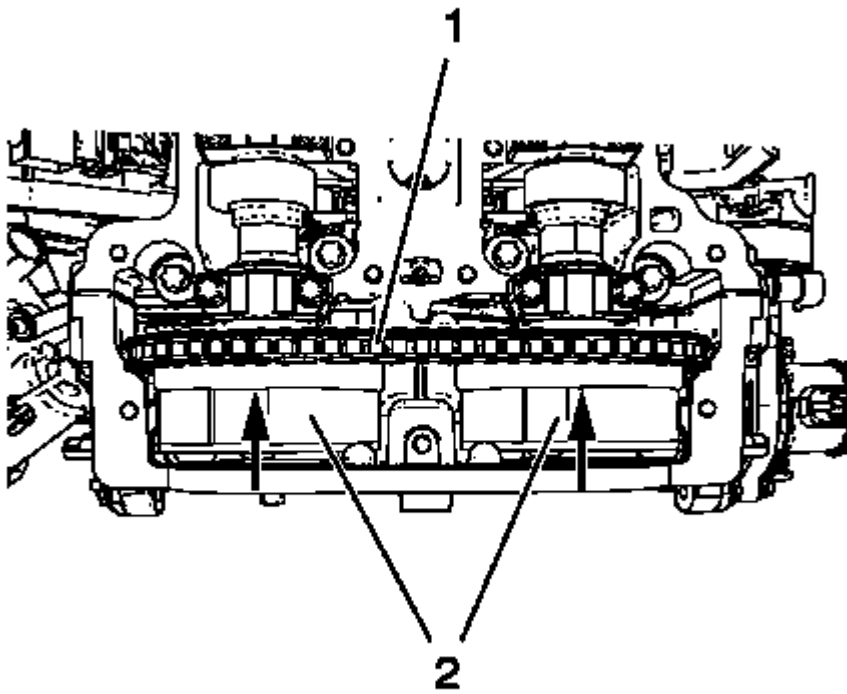
16. Loosen the bolts from engine front cover (1).





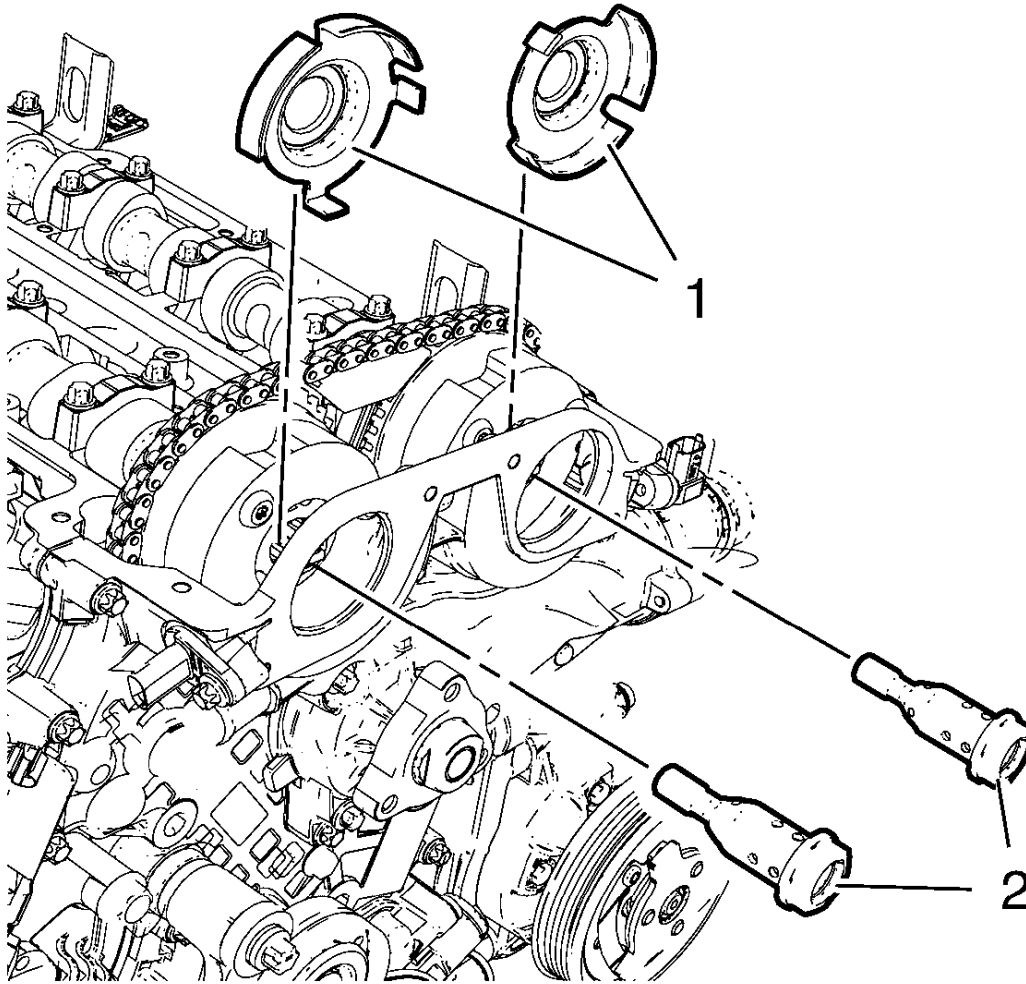
**Fig. 91: Engine Front Cover Bolts And Water Pump Bolts**  
Courtesy of GENERAL MOTORS COMPANY

17. Install the remaining bolts to engine front cover and water pump.
18. Tighten the engine front cover bolts (1, 2) to 8 N.m (71 lb in).
19. Tighten the water pump bolts (3) to 8 N.m (71 lb in).
20. Install the engine support fixture. Refer to **Engine Support Fixture**.
21. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
22. Install the water pump pulley. Refer to **Water Pump Pulley Replacement (LUV)**.
23. Install the drive belt. Refer to **Drive Belt Replacement**.
24. Install engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
25. Install the engine mount. Refer to **Engine Mount Replacement - Right Side**.
26. Remove the engine support fixture. Refer to **Engine Support Fixture**.



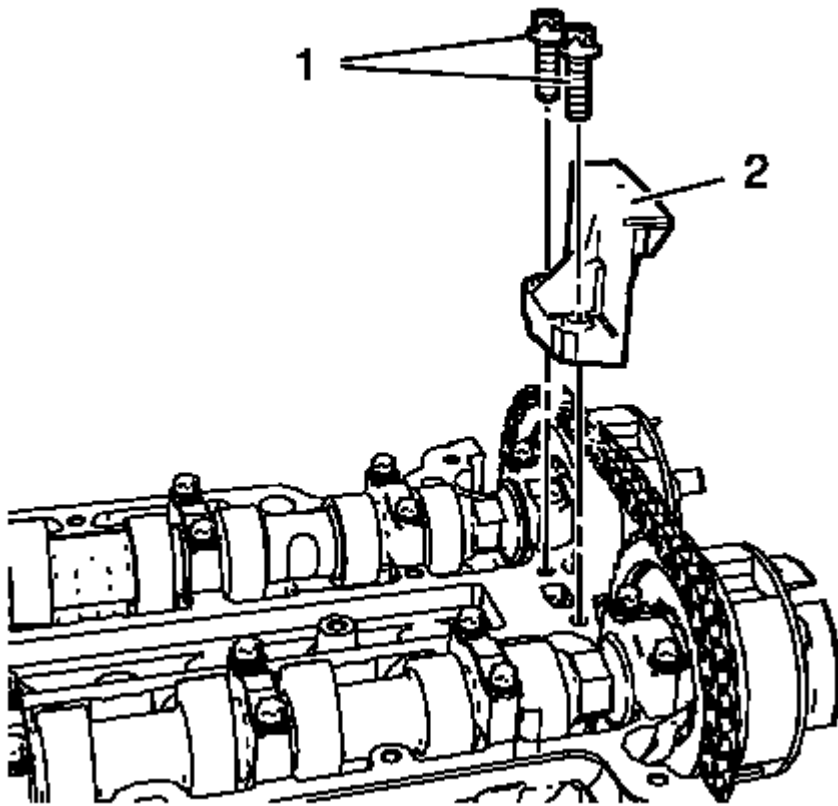
**Fig. 92: Timing Chain And Camshaft Sprockets**  
Courtesy of GENERAL MOTORS COMPANY

27. Install the camshaft sprockets (2) and timing chain (1) as one unit.



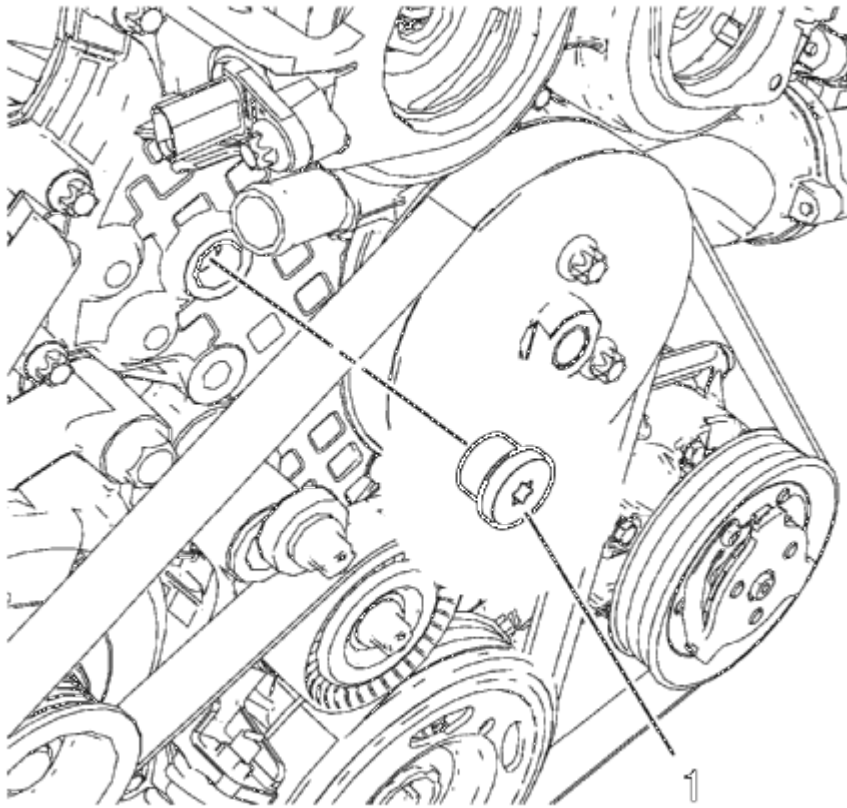
**Fig. 93: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

28. Install the camshaft position exciter wheels (1).
29. Install the NEW camshaft sprocket bolts (2) and tighten to 50 N.m (37 lb ft) plus 60 degrees.
30. Install the both camshaft position sensors. Refer to **Camshaft Position Sensor Replacement**.
31. Remove the **EN-955** pin to apply tension to the timing chain.
32. Adjust the camshaft timing chain. Refer to **Camshaft Timing Chain Inspection**.



**Fig. 94: Upper Timing Chain Guide And Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

33. Install the upper timing chain guide (2).
34. Install the upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).



**Fig. 95: Timing Chain Tensioner Plug**  
**Courtesy of GENERAL MOTORS COMPANY**

35. Install the timing chain tensioner plug and tighten to 50 N.m (37 lb ft).
36. Install the camshaft position actuator solenoid valve intake and exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
37. Install the exhaust manifold with catalytic converter . Refer to **EXHAUST MANIFOLD REPLACEMENT (LUV)** .
38. Install the Intake manifold. Refer to **Intake Manifold Replacement**.
39. Fill coolant fluid. Refer to **Cooling System Draining and Filling** .
40. Connect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
41. Check and correct the engine oil.
42. Test the vehicle using the following procedure:
  1. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
  2. Start the engine and listen for unusual noises.
  3. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
  4. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
  5. Listen for sticking lifter and other unusual noises.

6. Inspect for fuel, oil and/or coolant leaks while the engine is running.
43. Inspect for coolant, oil, gas or exhaust leaks.

## **OIL PAN REPLACEMENT**

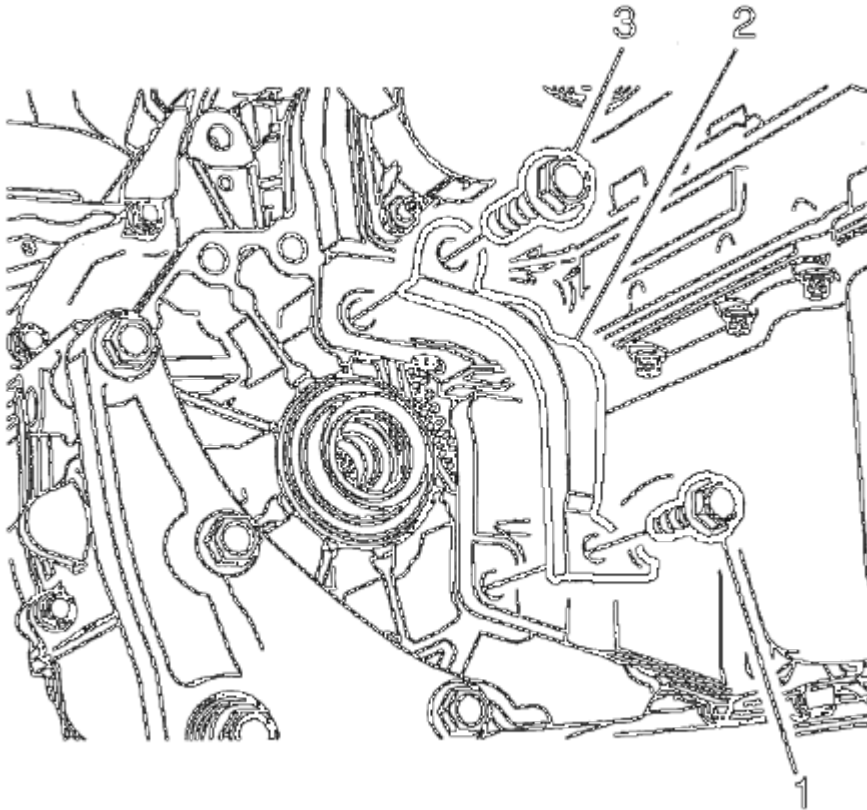
### **Special Tools**

**EN-49980** Guidance Pins

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

### **Removal Procedure**

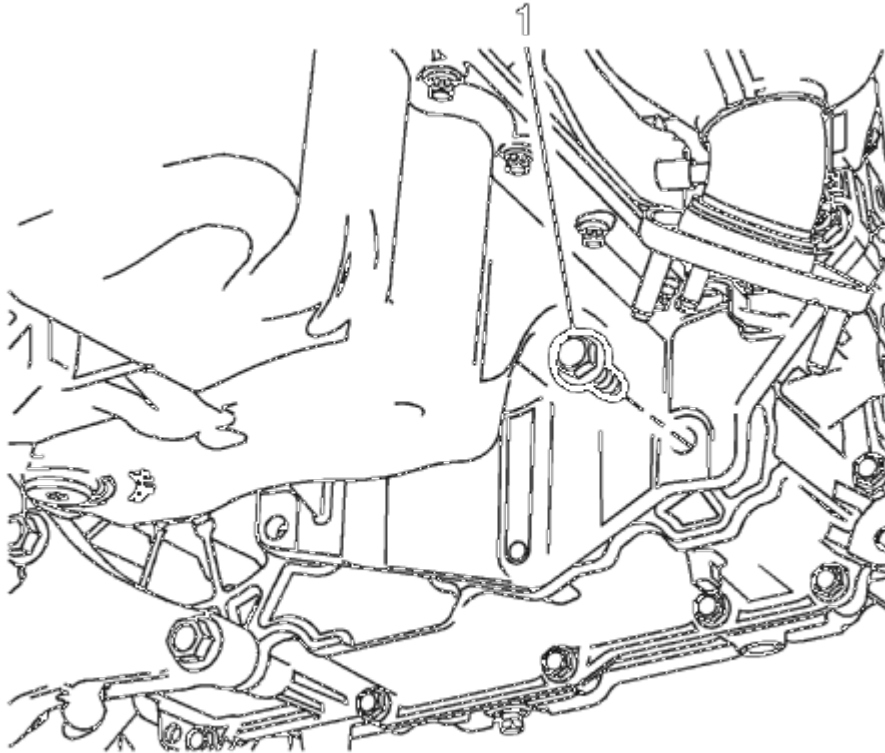
1. Remove the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement** .
2. Remove the oil filter and drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
3. Remove the front insulator cover. Refer to **Front Compartment Front Insulator Cover Replacement** .
4. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LUV, LUW)** .



**Fig. 96: Automatic Transmission Converter Cover & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

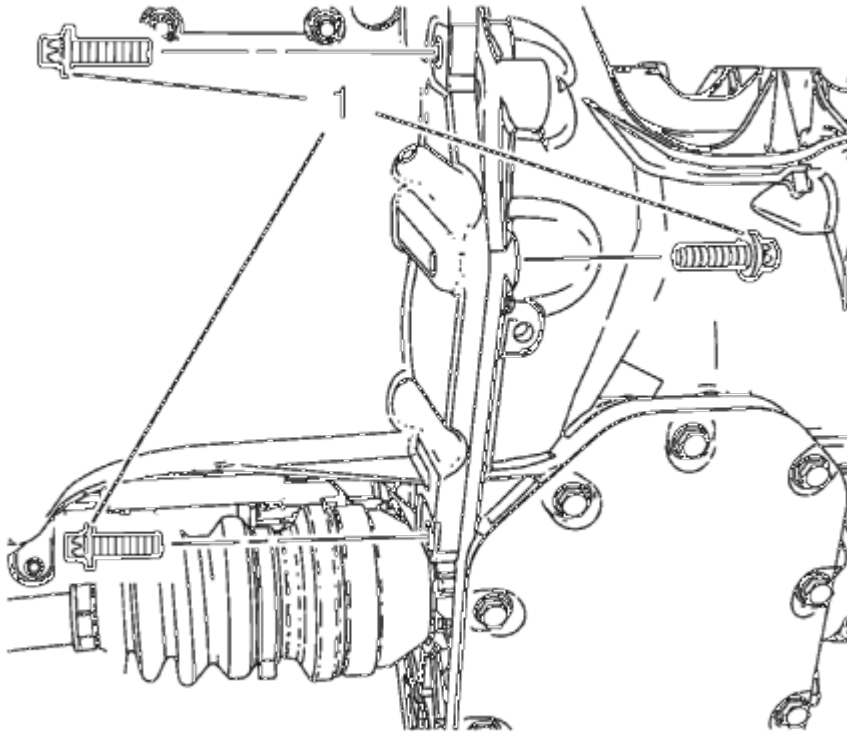
**NOTE:** The intermediate shaft is shown removed for visual purposes only.

5. If equipped with an automatic transmission, remove the oil pan to automatic transmission bolts (1, 3) and automatic transmission converter cover (2).



**Fig. 97: Oil Pan To Automatic Transmission Bolts**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pan to automatic transmission bolts (1) .

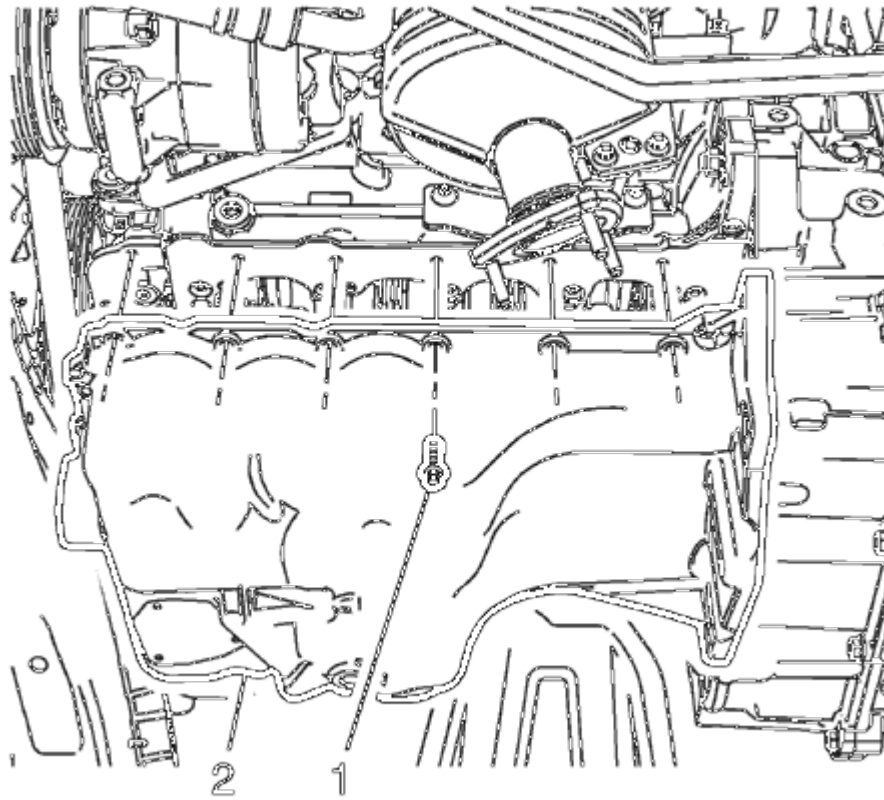


**Fig. 98: Oil Pan Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

7. If equipped with manual transmission, remove the 3 manual transmission to oil pan bolts (1).



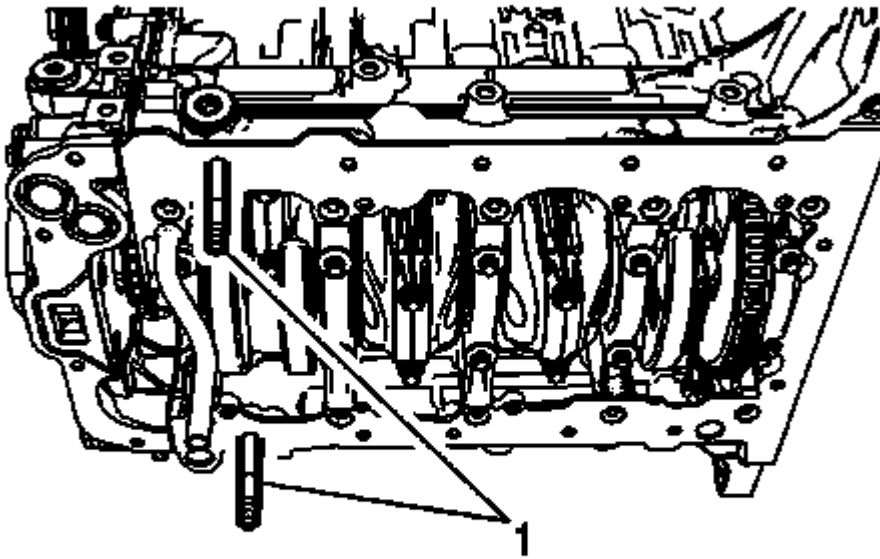
**Fig. 99: Oil Pan & Bolts**

Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil pan bolts (1) and oil pan.

#### **Installation Procedure**

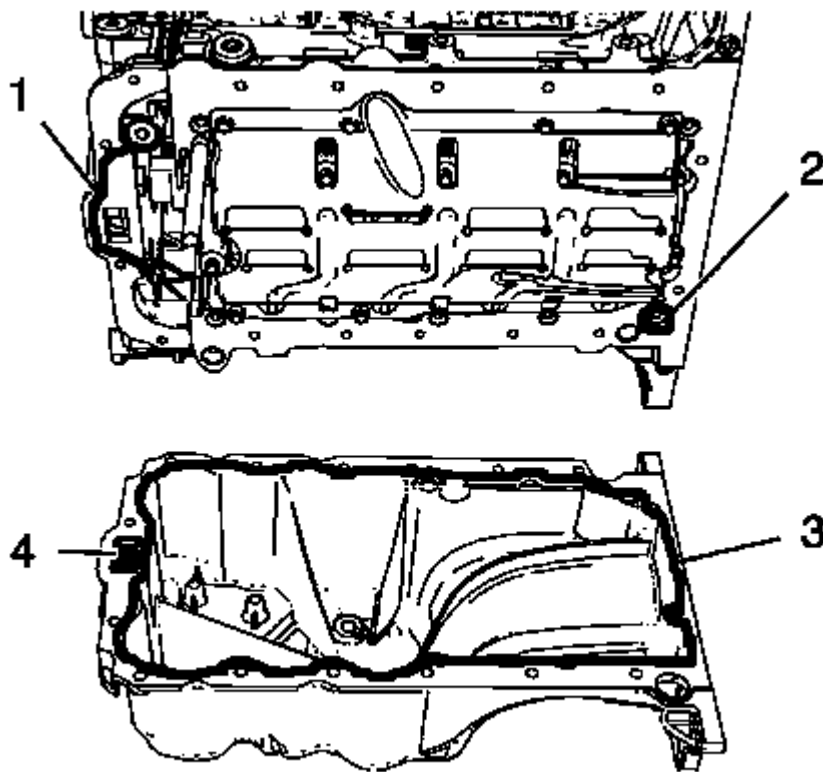
1. Clean the sealing surface of crankshaft bearing cap tie plate and the groove in the engine front cover from old gasket material, oil, dirt and grease.



**Fig. 100: Oil Pan Guidance Pins**

Courtesy of GENERAL MOTORS COMPANY

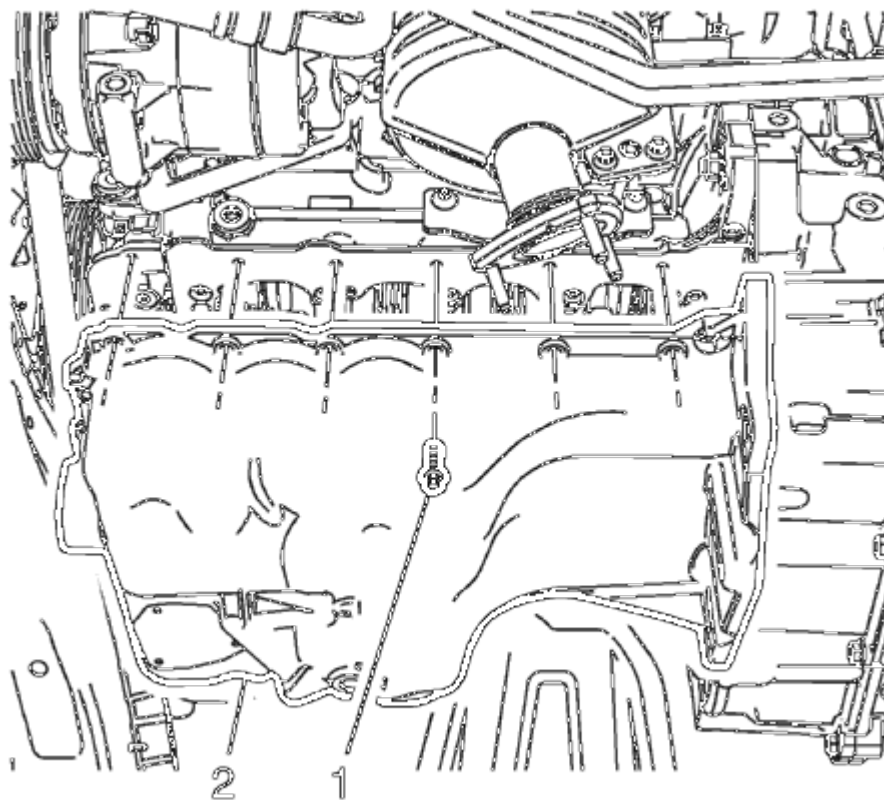
2. Install the 2 EN-49980 guidance pins (1) to the shown oil pan screw bores.



**Fig. 101: Engine Front Cover, Oil Suction Gallery And Screw Bore**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The sealing bead should be applied close to the inner edge of the oil pan. Take care that the oil suction gallery (4) will not get contaminated with sealing compound or dirt.

3. Apply 2 mm (0.0787 in) thickness of sealing compound (3, 2, 1).



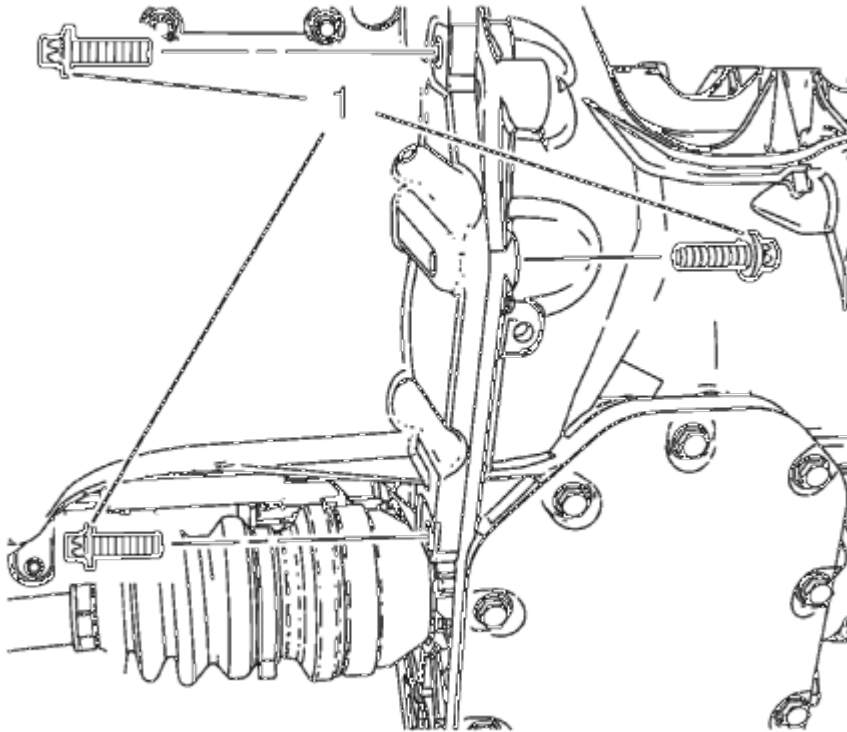
**Fig. 102: Oil Pan & Bolts**

Courtesy of GENERAL MOTORS COMPANY

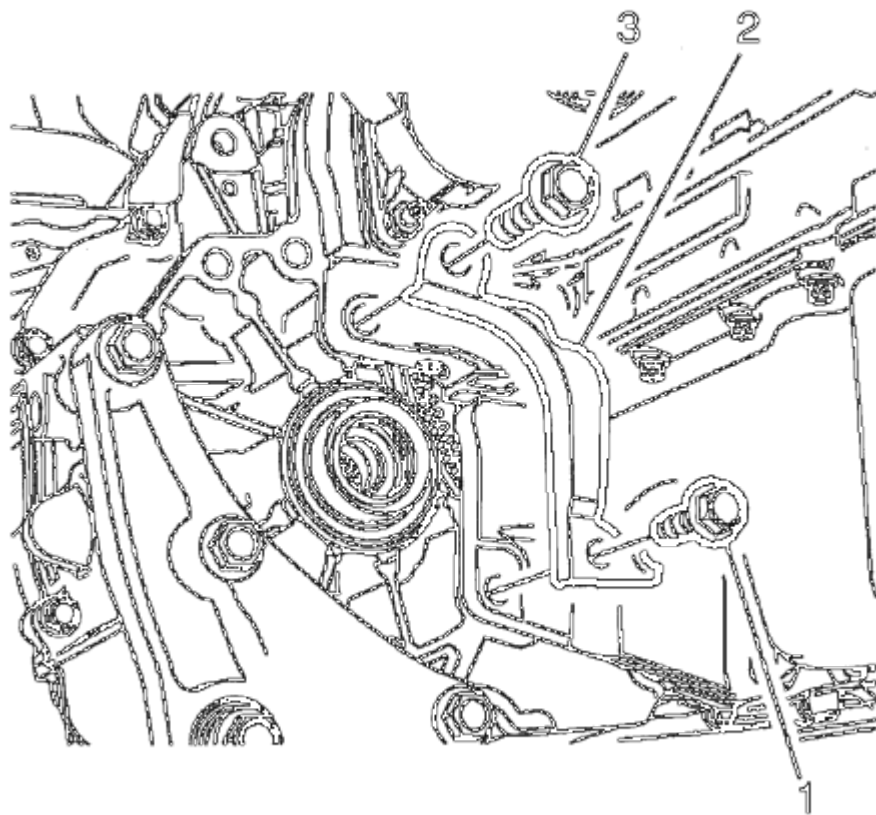
**CAUTION:** Refer to Fastener Caution .

**NOTE:** The complete installation procedure of the oil pan should be done in 10 minutes.

4. Loosely install the oil pan bolts (1) in all but the guidance pin locations.
5. Remove the **EN-49980** guidance pins and install the remaining oil pan bolts.
6. Tighten the oil pan bolts to 10 N.m (89 lb in).

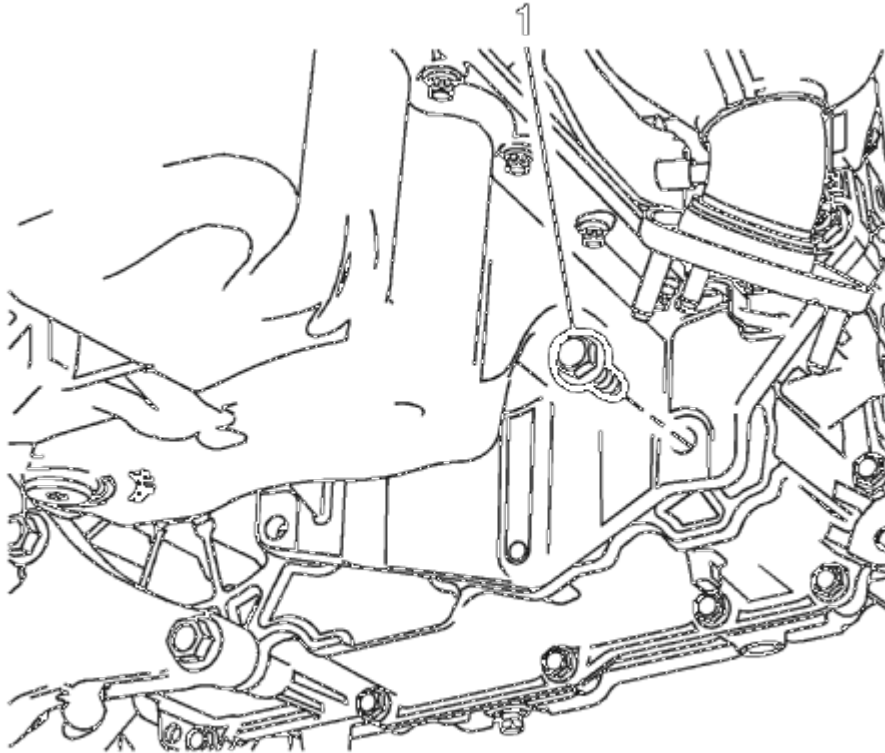
**Fig. 103: Oil Pan Bolts****Courtesy of GENERAL MOTORS COMPANY**

7. If equipped with manual transmission, install the 3 manual transmission to oil pan bolts (1) and tighten to 40 N.m (30 lb ft).



**Fig. 104: Automatic Transmission Converter Cover & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

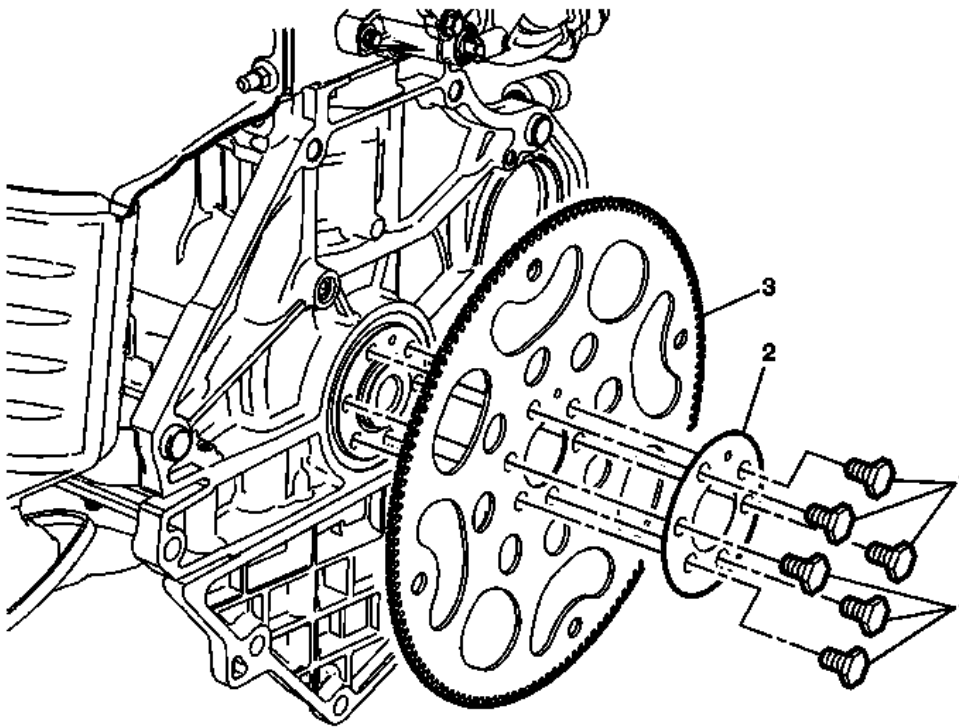
8. If equipped with an automatic transmission, install the automatic transmission converter cover (2) and tighten the cover to automatic transmission bolt (1) to 40 N.m (30 lb ft) and automatic transmission bolt (3) to 60 N.m (44 lb ft).



**Fig. 105: Oil Pan To Automatic Transmission Bolts**  
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pan to automatic transmission bolts (1), and tighten to 40 N.m (30 lb ft).
10. Install a NEW oil filter and fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
11. Install the exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LUV, LUW)**.
12. Install the front insulator cover. Refer to **Front Compartment Front Insulator Cover Replacement**.
13. Install the right front wheelhouse liner extension. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement**.

#### **AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT**



**Fig. 106: Automatic Transmission Flex Plate And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

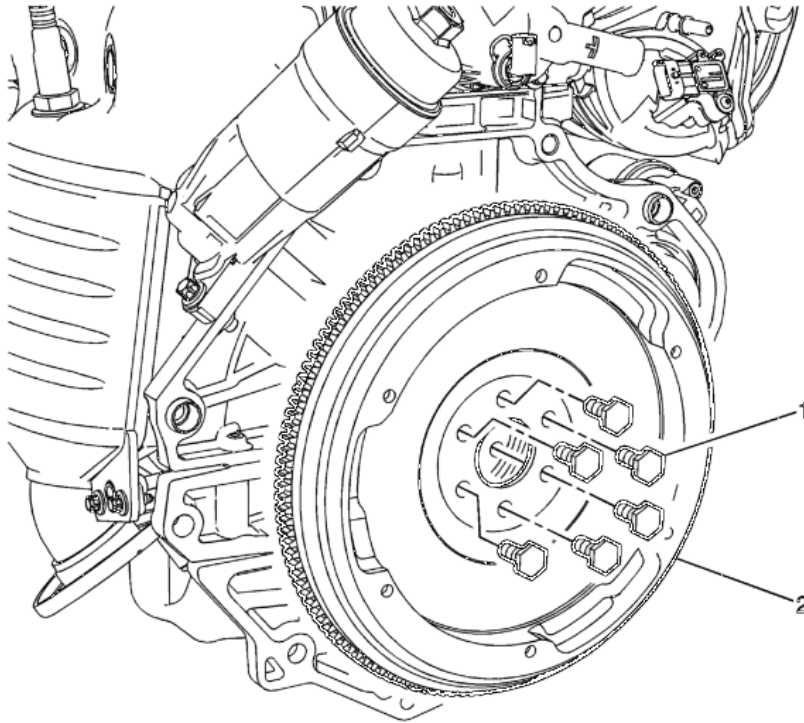
#### Automatic Transmission Flex Plate Replacement

Callout	Component Name
<b>Preliminary Procedure</b> Remove the transmission. Refer to <u>Transmission Replacement (With 1.4L Engine)</u> .	
<b>Special Tools</b> <ul style="list-style-type: none"> <li>• EN-470-B Angular Torque Wrench</li> <li>• EN-49979 Crankshaft Shock Mount Retainer</li> </ul>	
For equivalent regional tools, refer to <u>Special Tools</u> .	
1	Automatic Transmission Flex Plate Fastener (Qty: 6)  <b>CAUTION:</b> Refer to <u>Fastener Caution</u> .  <b>Procedure</b> Ensure to use a NEW fastener whenever the automatic transmission flex plate is removed. <b>Tighten</b>



	<ul style="list-style-type: none"> <li>• 35 N.m (26 lb ft)</li> <li>• Tighten the bolt an additional 30 degrees, and one more pass at 15 degrees using <b>EN-470-B</b> wrench.</li> </ul>
2	Flex Plate
3	<p>Automatic Transmission Flex Plate</p> <p><b>Procedure</b></p> <p>Inspect the automatic transmission flex plate for the following:</p> <ol style="list-style-type: none"> <li>1. Stress cracks around the flex plate.</li> <li>2. Cracks at welded areas that retain the ring gear onto the flex plate.</li> <li>3. Damaged or missing ring gear teeth.</li> <li>4. Do not attempt to repair the welded areas that retain the ring gear to the automatic transmission flex plate. Install a new flex plate.</li> </ol>

## ENGINE FLYWHEEL REPLACEMENT



**Fig. 107: Engine Flywheel & Fasteners**  
 Courtesy of GENERAL MOTORS COMPANY

### Engine Flywheel Replacement

Callout	Component Name
<b>Preliminary Procedures</b>	
1.	Remove the transmission. Refer to <u><b>Transmission Replacement</b></u> .

2. Remove the clutch pressure and driven plate. Refer to **Clutch Pressure and Driven Plate Replacement (1.4L)** .

### Special Tools

- **EN-652** Flywheel Holder.
- **EN-470-B** Angular Torque Wrench.

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

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

## CRANKSHAFT BALANCER REPLACEMENT

### Special Tools

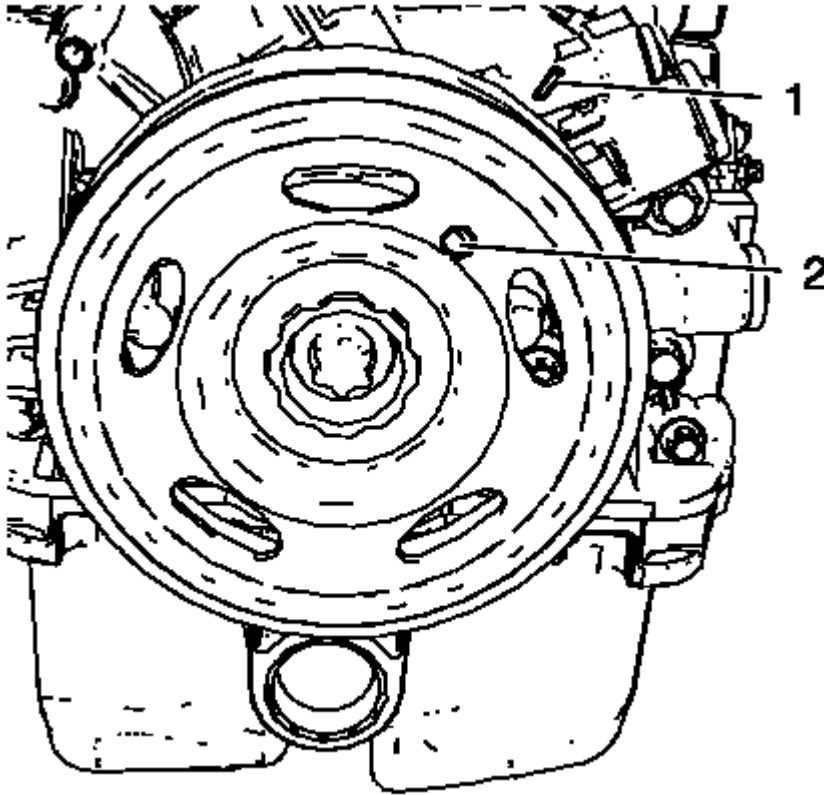
- **EN-470-B** Angular Torque Wrench
- **EN-49979** Crankshaft Shock Mount Retainer

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

### Removal Procedure

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

2. Remove front wheelhouse liner extension right side. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement**.
3. Remove the drive belt. Refer to **Drive Belt Replacement**.
4. Place collecting basin underneath.

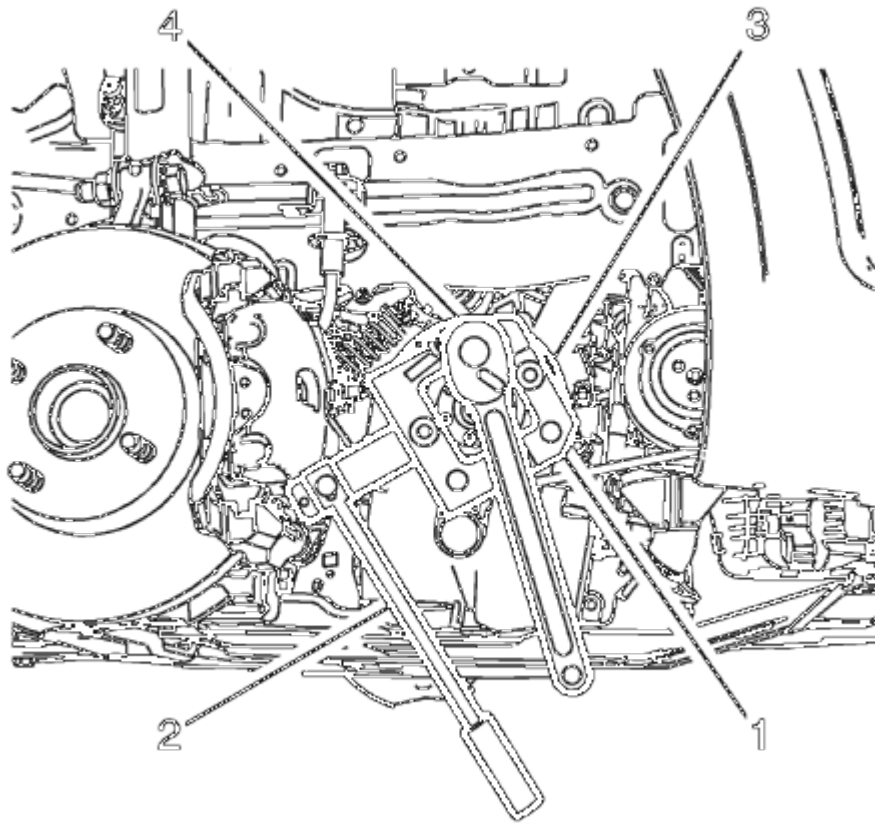


**Fig. 108: Bore And Mark**

Courtesy of GENERAL MOTORS COMPANY

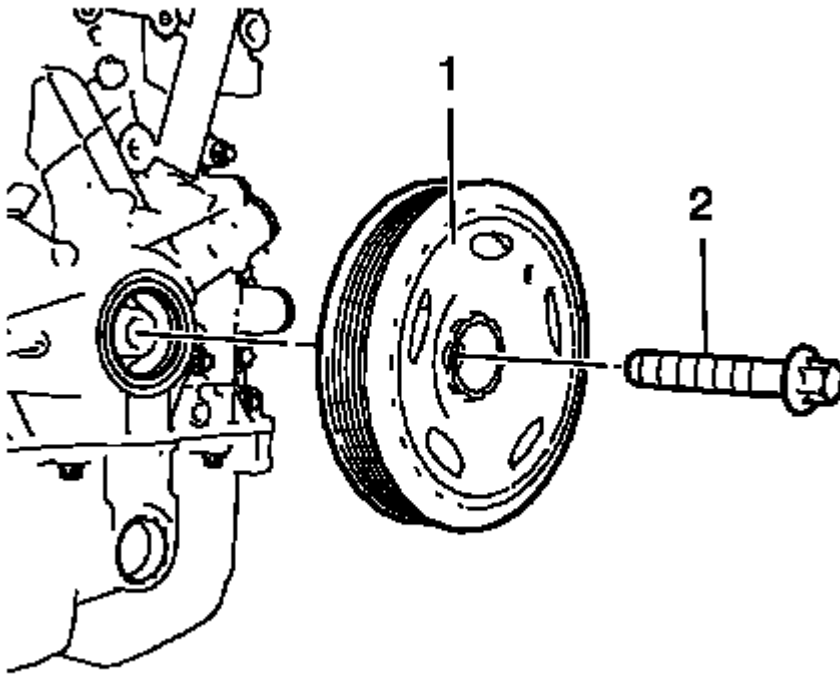
**NOTE:** The crankshaft balancer can be incorrectly installed 180° from the required position. Be sure to note the location of the alignment hole on the crankshaft balancer prior to removing the crankshaft balancer from the engine.

5. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.



**Fig. 109: Crankshaft Components & Tools**  
**Courtesy of GENERAL MOTORS COMPANY**

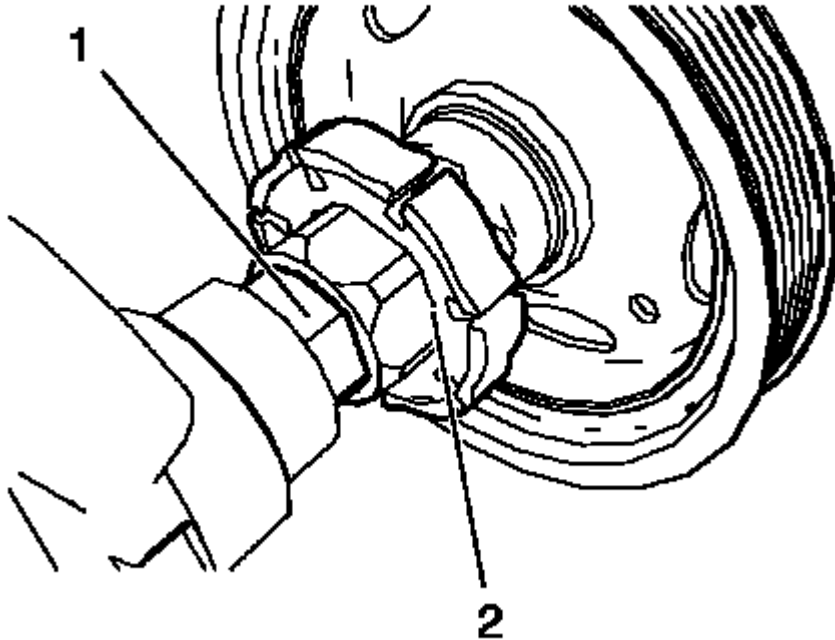
6. Install EN-49979 crankshaft shock mount retainer (1) to suitable tool (2).
7. Loosen the crankshaft balancer bolt (4) while holding the crankshaft balancer (3).



**Fig. 110: Crankshaft Balancer And Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

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

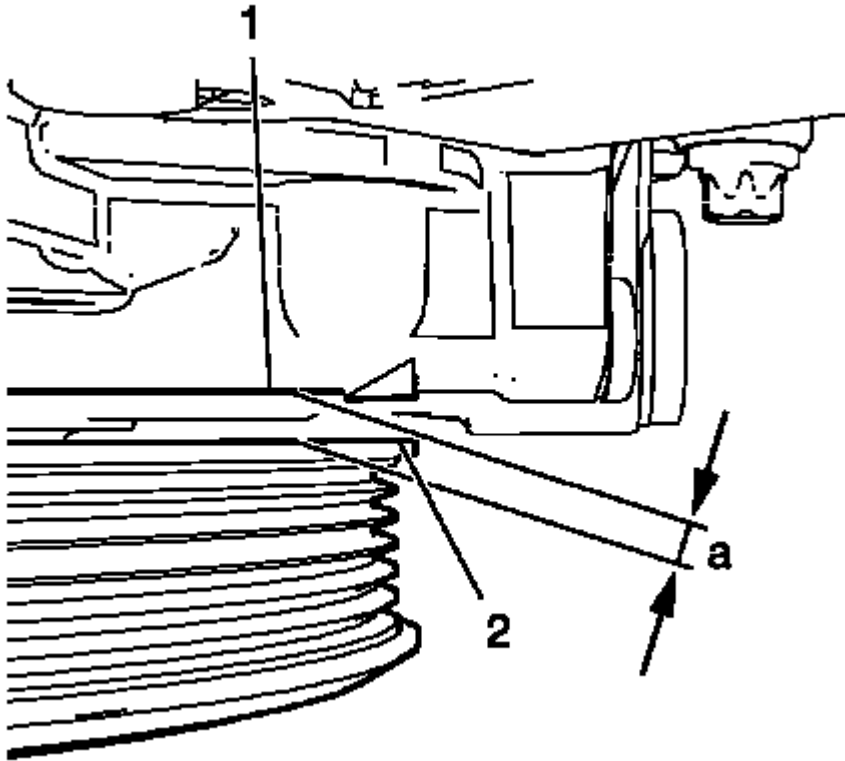
#### **Installation Procedure**



**Fig. 111: Engine Oil Pump Rotor And Crankshaft**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The crankshaft balancer flange must fit to the hexagon of the oil pump rotor (2) and to the two-flats of the crankshaft (1). The TDC markings on crankshaft balancer and engine front cover must match.

1. Install the crankshaft balancer carefully by pressing into position.

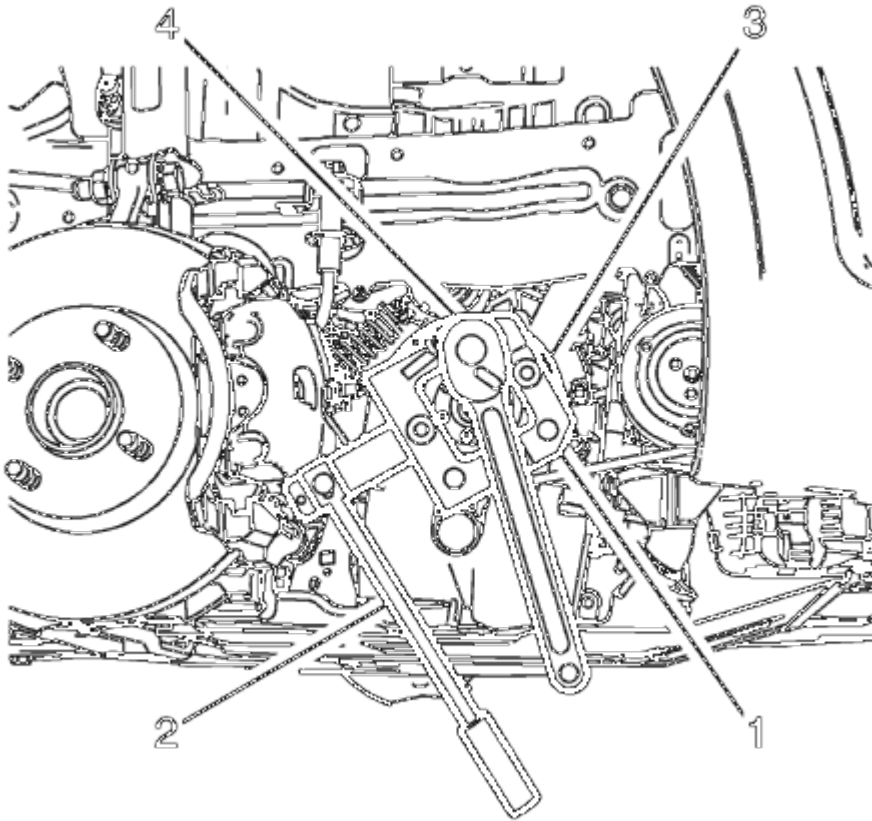


**Fig. 112: Engine Front Cover And Crankshaft Balancer**  
Courtesy of GENERAL MOTORS COMPANY

2. Measure the distance (a) between the crankshaft balancer (2) and the mark on the engine front cover (1). The distance (a) should be 5.5 mm (0.21654 in).

**NOTE:**        **Never re-use the crankshaft balancer bolt.**

3. Install a NEW crankshaft balancer bolt.



**Fig. 113: Crankshaft Components & Tools**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

4. Tighten the crankshaft balancer bolt (4) to 150 N•m (111 lb ft) while holding the crankshaft balancer (3) with EN-49979 crankshaft shock mount retainer (1) and suitable tool (2). Use EN-470-B wrench .
5. Tighten the crankshaft balancer bolt to an additional 60°.
6. Install the drive belt. Refer to Drive Belt Replacement.
7. Install the front wheelhouse liner extension right side. Refer to Front Wheelhouse Liner Inner Front Extension Replacement .
8. Lower the vehicle.
9. Check and correct engine oil level.

## CRANKSHAFT FRONT OIL SEAL REPLACEMENT



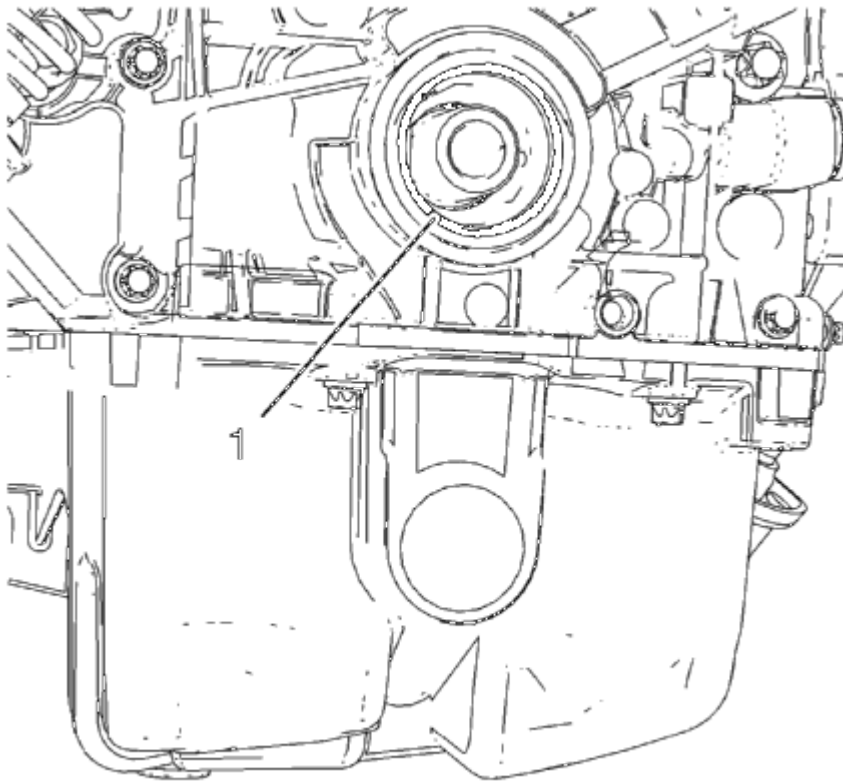
**Special Tools**

- **EN-960** Installer
- **EN-45000** Remover Oil seal

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

**Removal Procedure**

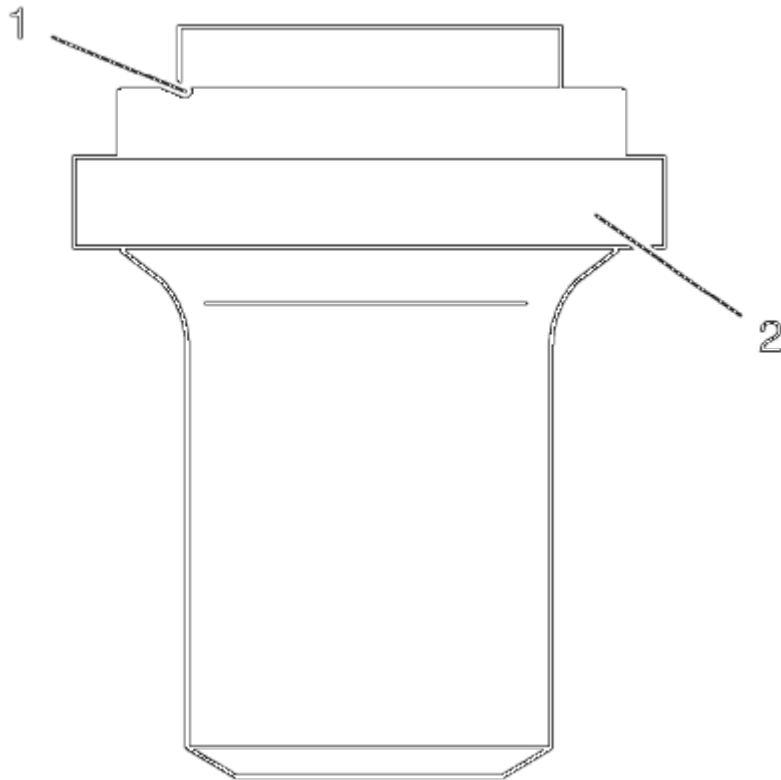
1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Place a drain pan underneath the front crankshaft seal area.



**Fig. 114: Crankshaft Front Oil Seal And Remover**  
Courtesy of GENERAL MOTORS COMPANY

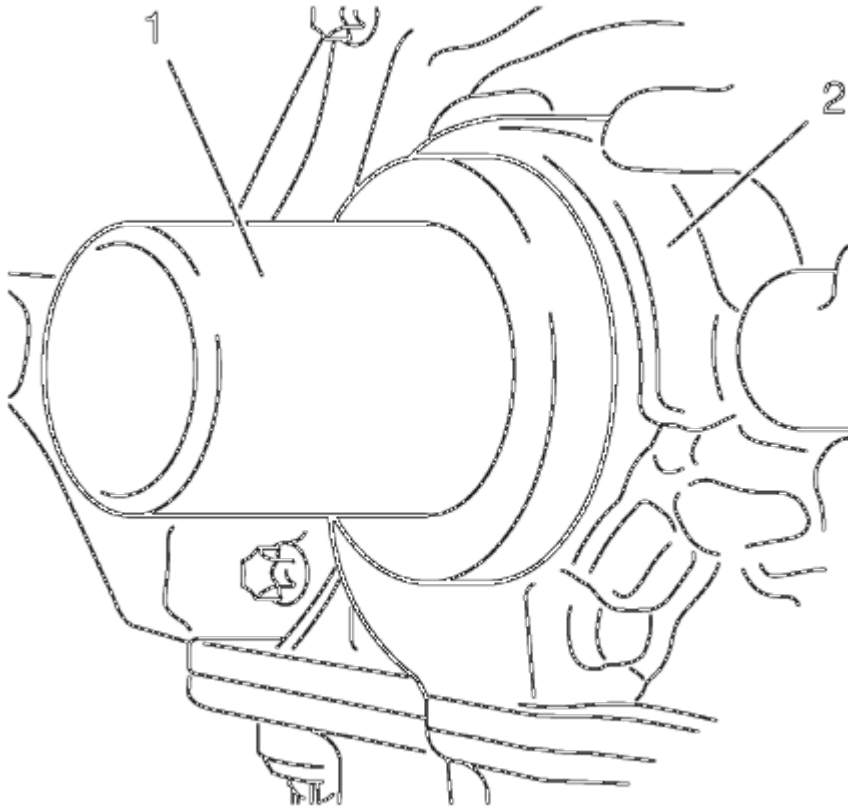
3. Remove crankshaft front oil seal (2) from engine front cover. Use **EN-45000** remover (1).

**Installation Procedure**



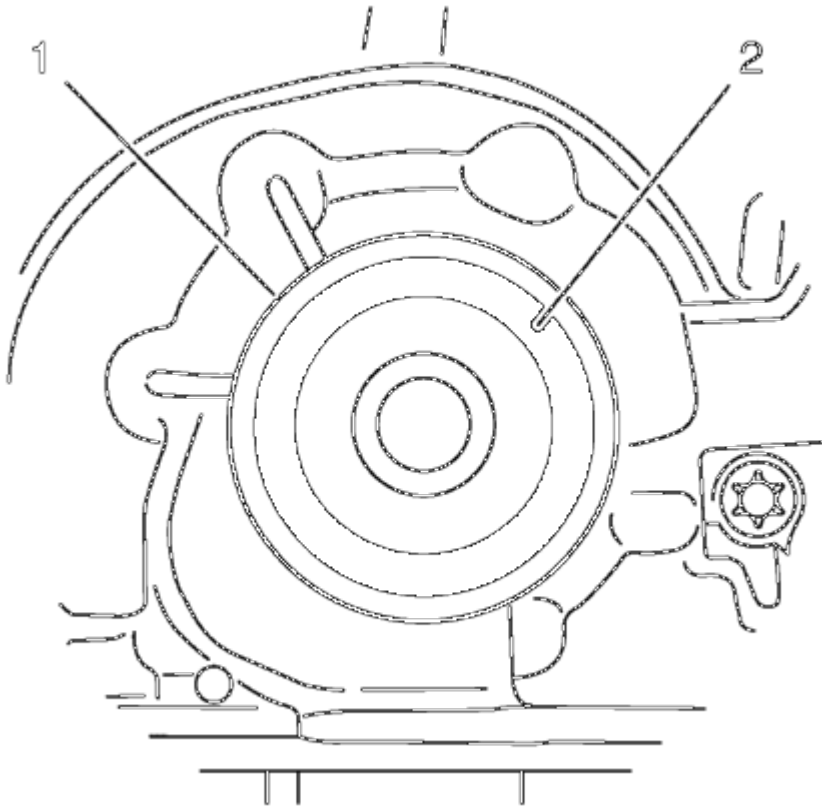
**Fig. 115: Crankshaft Front Oil Seal And Installer**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Install NEW crankshaft front oil seal (1) to **EN-960** installer (2).



**Fig. 116: Crankshaft Front Oil Seal Installer And Engine Front Cover**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install crankshaft front oil seal by means of **EN-960** installer (1) to engine front cover (2).



**Fig. 117: Engine Front Cover And Crankshaft Front Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that crankshaft front oil seal (2) is flush with engine front cover (1).
4. Install crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Remove the drain pan.
6. Check and correct engine oil level.

## CRANKSHAFT REAR OIL SEAL REPLACEMENT

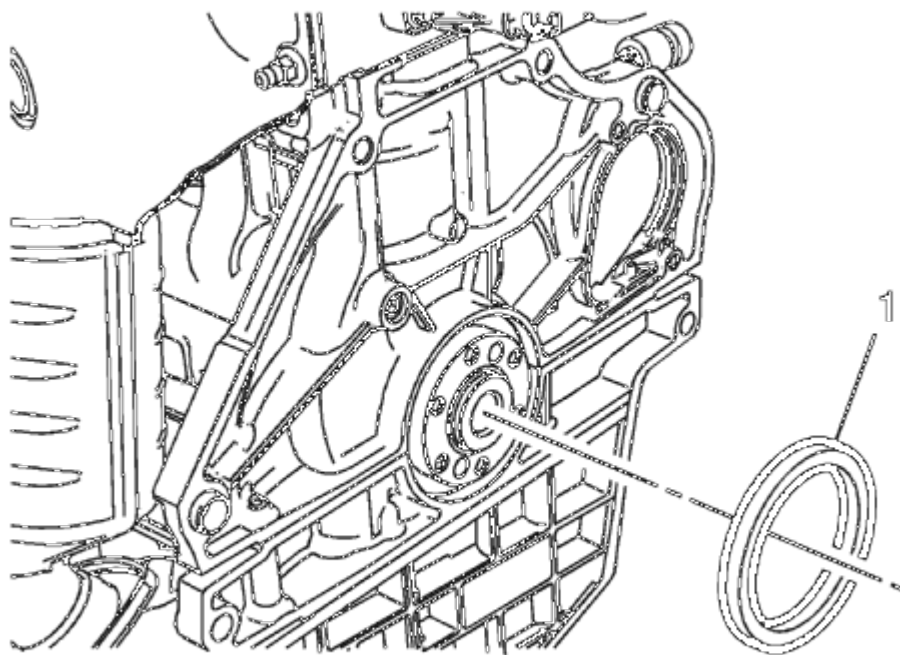
### Special Tools

**EN-658** Rear Main Seal Installer

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

### Removal Procedure

1. If equipped with automatic transmission remove the flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. If equipped with manual transmission remove the engine flywheel. Refer to **Engine Flywheel Replacement**

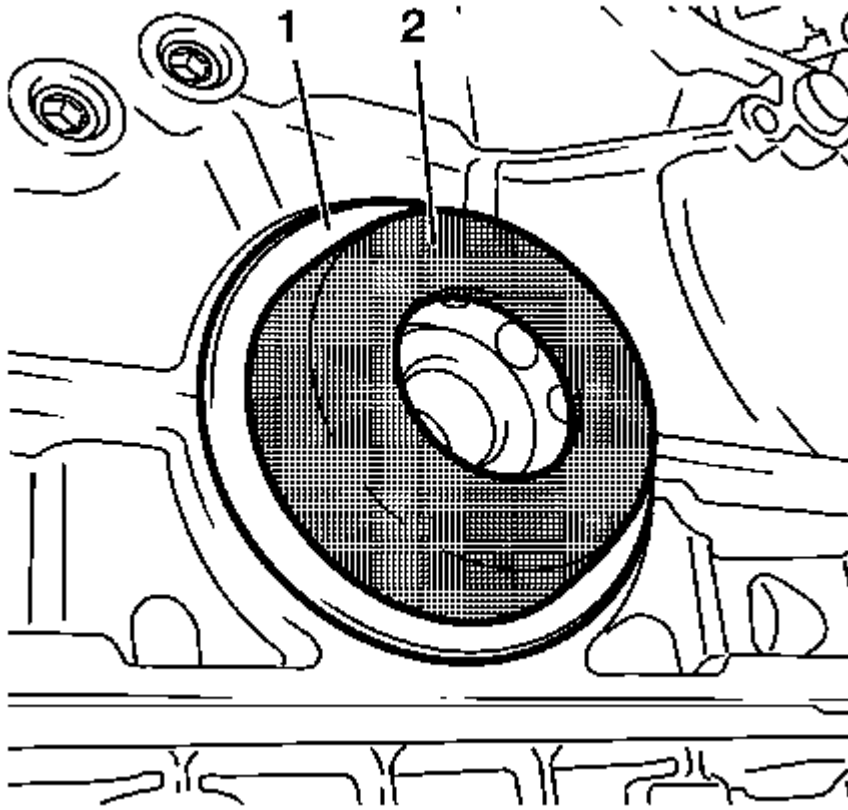


**Fig. 118: Rear Crankshaft Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not damage the outside diameter of the crankshaft or chamber with any tool.

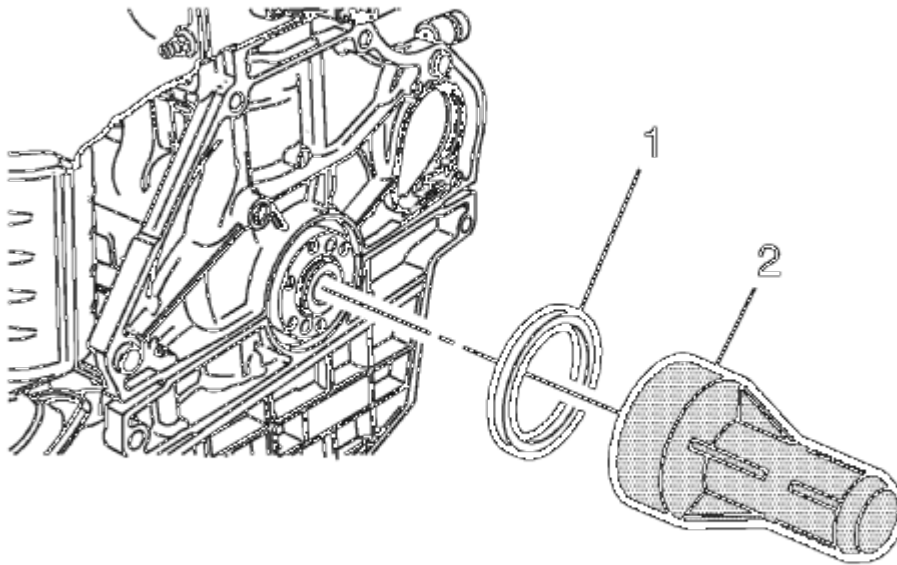
3. Using a flat-bladed tool, remove the rear crankshaft oil seal (1).

#### Installation Procedure



**Fig. 119: Crankshaft Rear Oil Seal And Installer**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Install the crankshaft rear oil seal (1) with **EN-658** installer (2).



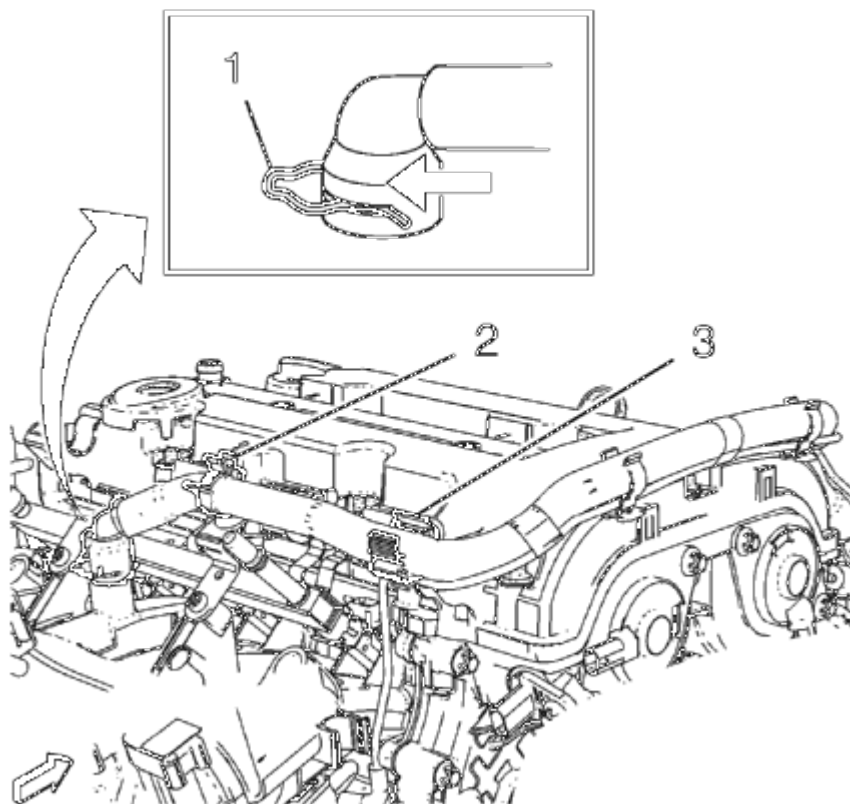
**Fig. 120: Crankshaft Real Oil Seal Installer**  
 Courtesy of GENERAL MOTORS COMPANY

2. Using the **EN-658** installer (2) , install a NEW crankshaft real oil seal (1).
3. If equipped with automatic transmission install the flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
4. If equipped with manual transmission install the engine flywheel. Refer to **Engine Flywheel Replacement**

## **POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT**

### **Removal Procedure**

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .



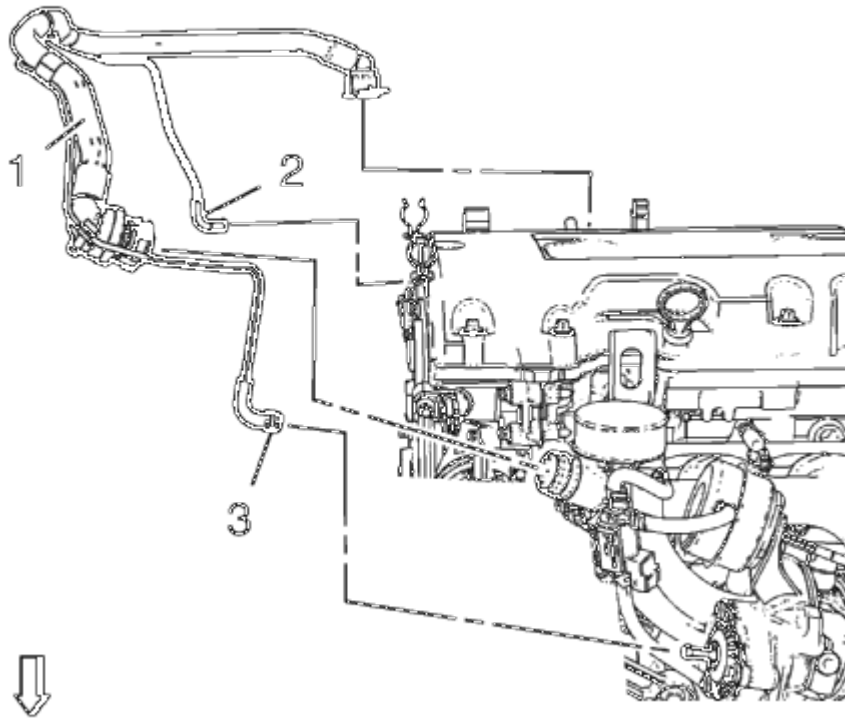
**Fig. 121: Positive Crankcase Ventilation Pipe Retainer Clips And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

2. Open the 2 positive crankcase ventilation pipe retainer clips (2) and (3).

**NOTE:**        **Move retainer clamp (1) in direction of the arrow.**

3. Remove the positive crankcase ventilation pipe from the intake manifold.

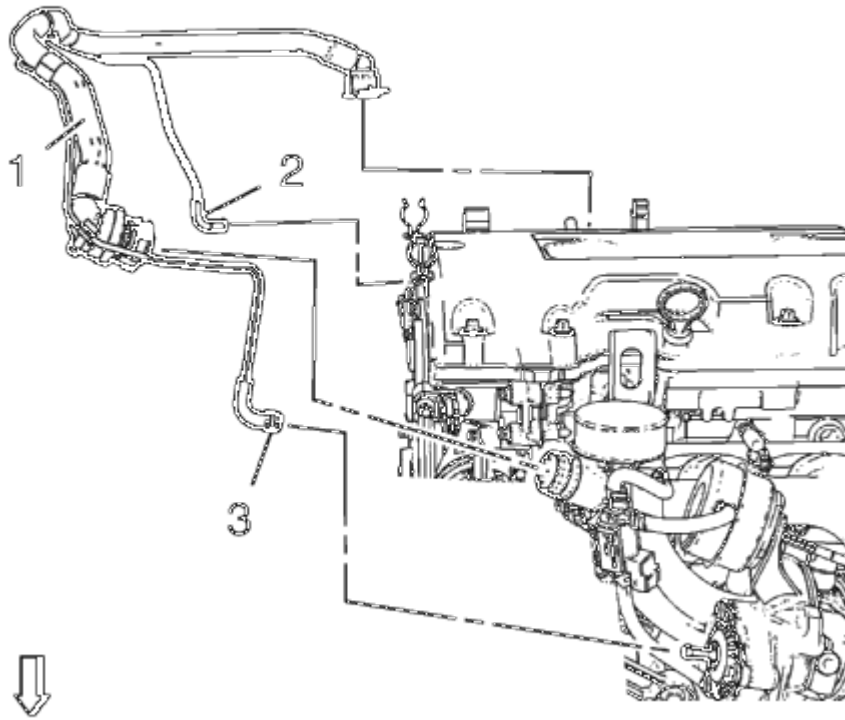




**Fig. 122: Positive Crankcase Ventilation Pipe, Charger Air Bypass Valve Pipe And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

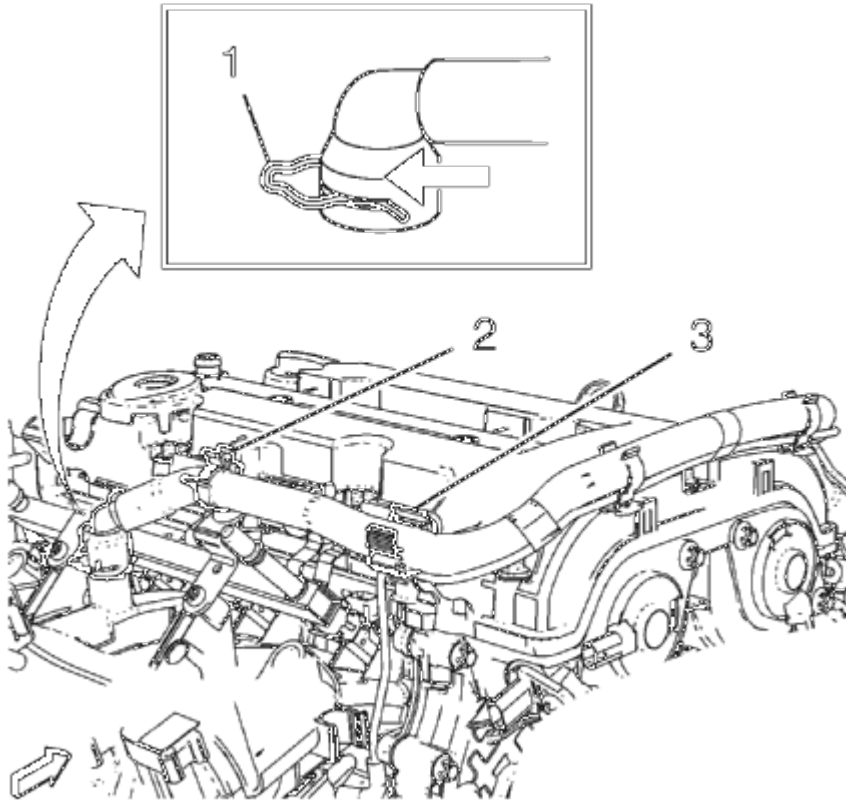
4. Loosen the charger air bypass valve pipe clamp (3).
5. Remove the charger air bypass valve pipe from turbocharger.
6. Remove the charger air bypass valve pipe (2) from turbo charger wastegate regulator solenoid valve.
7. Disconnect the positive crankcase ventilation pipe from turbocharger.
8. Unclip and remove the positive crankcase ventilation pipe assembly (1) from the camshaft cover retainer clips.

#### **Installation Procedure**



**Fig. 123: Positive Crankcase Ventilation Pipe, Charger Air Bypass Valve Pipe And Clamp**  
Courtesy of GENERAL MOTORS COMPANY

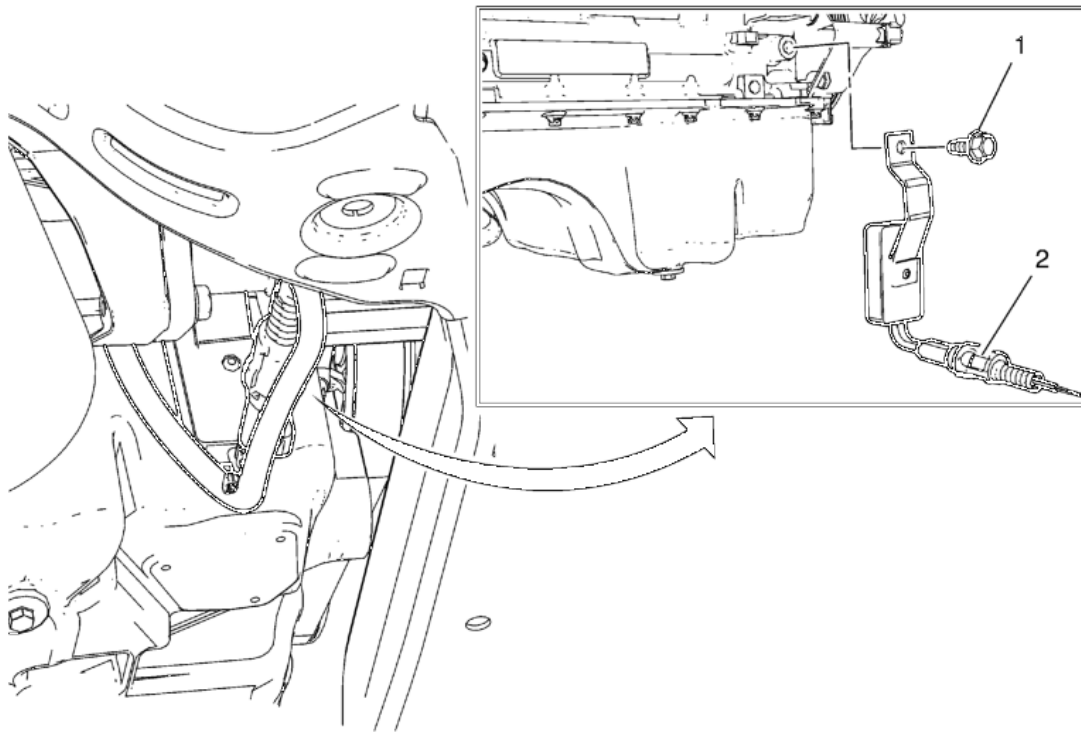
1. Install the positive crankcase ventilation pipe assembly (1) to the camshaft cover retainer clips.
2. Connect the positive crankcase ventilation pipe to turbocharger.
3. Install the charger air bypass valve pipe (2) to turbo charger wastegate regulator solenoid valve.
4. Install the charger air bypass valve pipe to turbocharger.
5. Fasten the charger air bypass valve pipe clamp (3).



**Fig. 124: Positive Crankcase Ventilation Pipe Retainer Clips And Clamp**  
 Courtesy of GENERAL MOTORS COMPANY

6. Install the positive crankcase ventilation pipe to the intake manifold and fix with retainer clamp (1).
7. Clip in the positive crankcase ventilation pipe to the 2 retainer clips (2) and (3).
8. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .

## ENGINE OIL HEATER REPLACEMENT

**Fig. 125: Engine Oil Heater And Bolt**

Courtesy of GENERAL MOTORS COMPANY

**Engine Oil Heater Replacement**

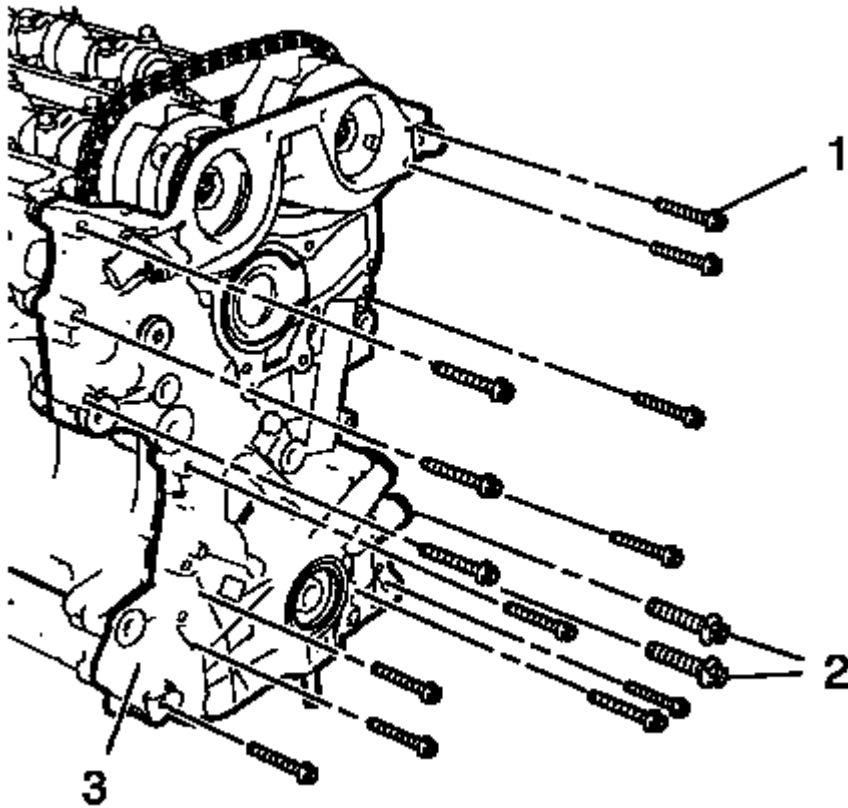
Callout	Component Name
<b>Preliminary Procedures</b>	
<ol style="list-style-type: none"> <li>1. Raise and support the vehicle. Refer to <b><u>Lifting and Jacking the Vehicle</u></b></li> <li>2. If equipped, remove the front insulator cover. Refer to <b><u>Front Compartment Front Insulator Cover Replacement</u></b>.</li> </ol>	
1	Engine Oil Heater Bolt  <b>CAUTION:</b> <b>Refer to <u>Fastener Caution</u>.</b>  <b>Tighten</b> 40 Y (30 lb ft)
2	Engine Oil Heater  <b>Procedure</b> <ol style="list-style-type: none"> <li>1. Disconnect the electrical connector.</li> <li>2. Loosely install the heater bracket to the engine block using provided bolt.</li> </ol>

3. Clean the oil pan surface and wipe dry with a clean lint-free towel prior to installing the heater.
4. Apply the heat conductive paste to the back side of the heater. Evenly coat the entire surface.
5. Install the heater to the oil pan and retain using the bracket.

## **ENGINE FRONT COVER WITH OIL PUMP REPLACEMENT**

### **Removal Procedure**

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Set the engine to TDC. Refer to **Camshaft Timing Chain Inspection**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the front wheelhouse liner extension, right side. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement** .
5. Remove the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (LUV)** .
6. Remove the air conditioning compressor bracket. Refer to **Air Conditioning Compressor Bracket Removal**.
7. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Remove the oil pan. Refer to **Oil Pan Replacement**.
9. Lower vehicle.
10. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
11. Remove the generator from above. Refer to **Generator Replacement (LUV)** .
12. Remove the water pump pulley and the water pump. Refer to **Water Pump Replacement (LUV)** .
13. Remove the camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Removal**.
14. Loosen the camshaft sprocket bolts until the camshaft position exciter wheels are free to rotate. Refer to **Camshaft Timing Chain Adjustment**.

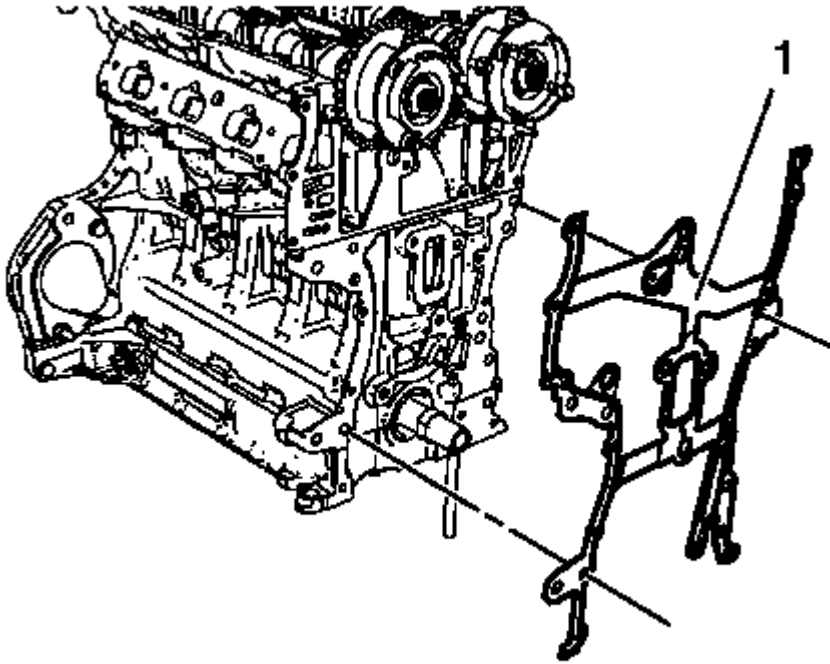


**Fig. 126: M6, M10 Front Cover Bolts And Engine Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

15. Remove the 13 engine front cover bolts M6 (1).
16. Remove the 2 engine front cover bolts M10 (2).
17. Remove the engine front cover (3).

**NOTE:** Removal of timing chain is necessary to get access to engine front cover gasket.

18. Remove the camshaft timing chain. Refer to Camshaft Timing Chain Replacement.

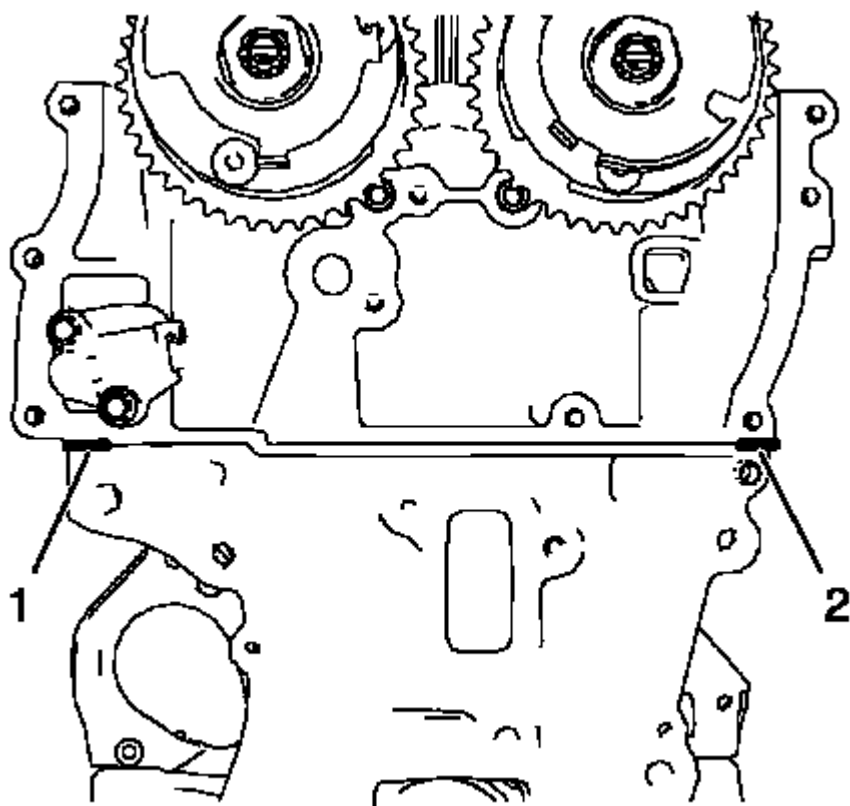


**Fig. 127: Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS COMPANY

19. Remove the engine front cover gasket (1).
20. Remove the intake and exhaust camshaft position sensors from the engine front cover. Refer to **Camshaft Position Sensor Replacement**.

#### Installation Procedure

1. Install the intake and exhaust camshaft position sensors to the engine front cover. Refer to **Camshaft Position Sensor Replacement**.
2. Clean the engine front cover sealing surfaces on engine block and cylinder head.

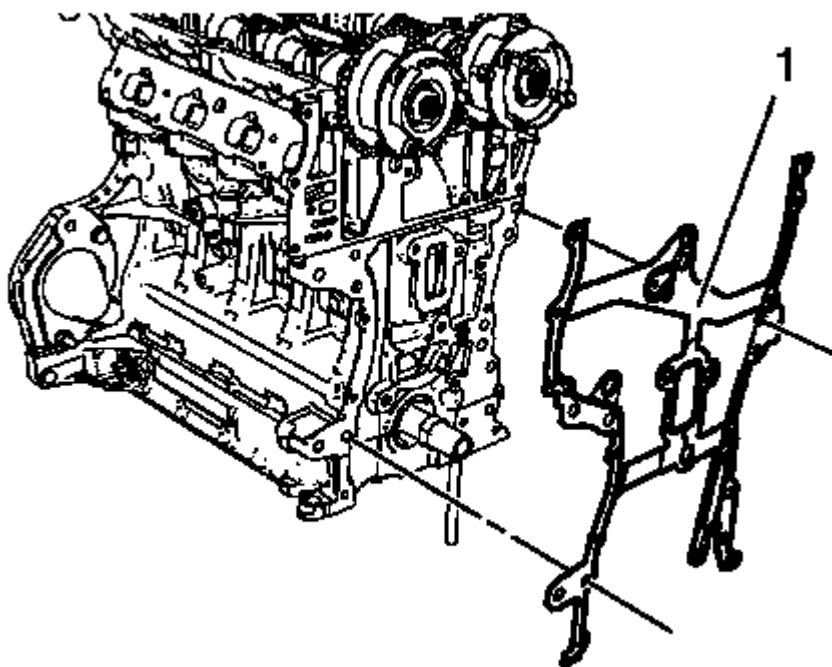


**Fig. 128: Sealing Compound Application Areas**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The thickness of the sealing bead should be 2 mm (0.0787 in).

3. Apply sealing compound to the shown areas (1) and (2). Refer to Adhesives, Fluids, Lubricants, and Sealers.

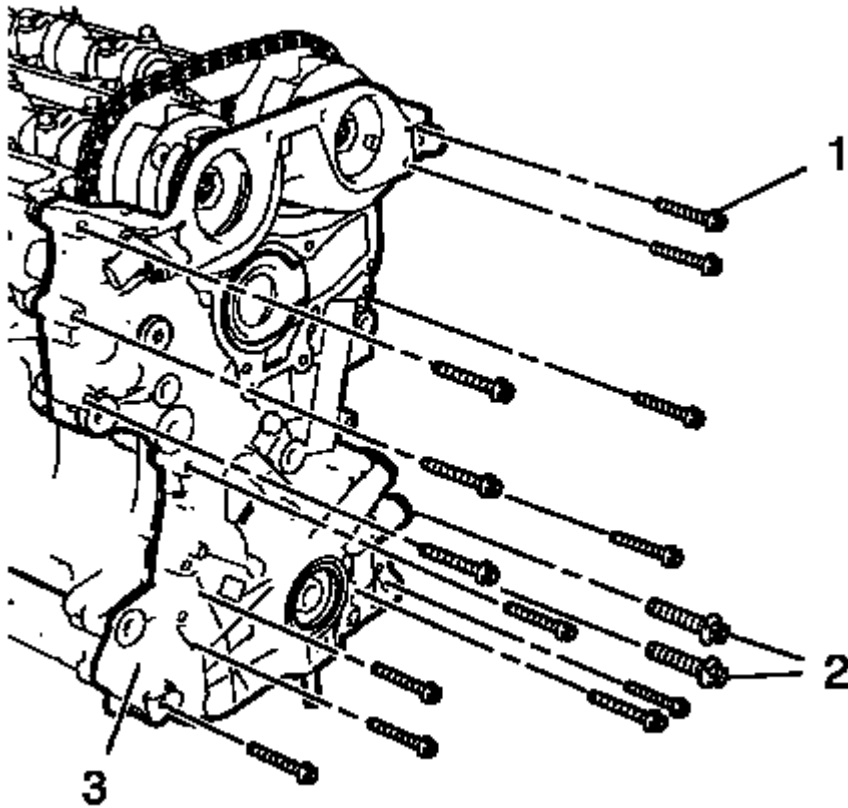




**Fig. 129: Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the guide sleeves.

4. Install a NEW engine front cover gasket (1).
5. Install the timing chain. Refer to **Camshaft Timing Chain Replacement**.



**Fig. 130: M6, M10 Front Cover Bolts And Engine Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the guide sleeves when installing the engine front cover. The complete installation procedure of the engine front cover should not take longer than 10 minutes.

6. Install the engine front cover (3).
7. Install the 13 engine front cover bolts M6 (1).
8. Install the 2 engine front cover bolts M10 (2).

**CAUTION:** Refer to Fastener Caution .

9. Tighten the 13 engine front cover bolts M6 to 8 N.m (71 lb in).
10. Tighten the 2 engine front cover bolts M10 to 35 N.m (26 lb ft).

**NOTE:** Engine should be adjusted and fixed in TDC position.

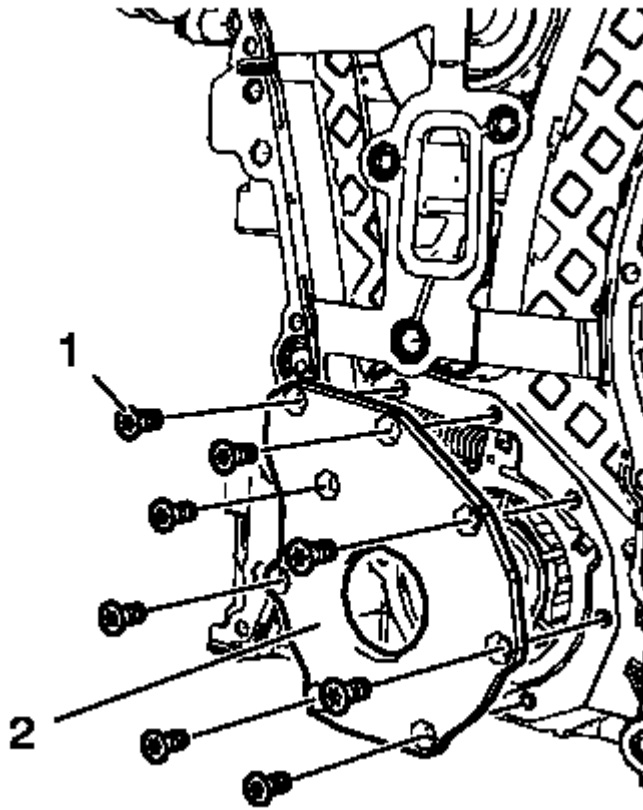
11. Tighten the camshaft sprockets, install the upper timing chain guide and remove all special tools. Refer to Camshaft Timing Chain Adjustment.

12. Install the 2 camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
13. Install the water pump and the water pump pulley. Refer to **Water Pump Replacement (LUV)** .
14. Install the generator from above. Refer to **Generator Replacement (LUV)** .
15. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
16. Install the air conditioning compressor bracket. Refer to **Air Conditioning Compressor Bracket Installation**.
17. Install the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (LUV)** .
18. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
19. Install the drive belt. Refer to **Drive Belt Replacement**.
20. Install the engine mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side**.
21. Install the engine mount. Refer to **Engine Mount Replacement - Right Side**.
22. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
23. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
24. Raise the vehicle.
25. Install the oil pan. Refer to **Oil Pan Replacement**.
26. Install the front wheelhouse liner extension, right side. Refer to **Front Wheelhouse Liner Inner Front Extension Replacement** .
27. Lower the vehicle.
28. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
29. Fill up engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

## **OIL PUMP REPLACEMENT**

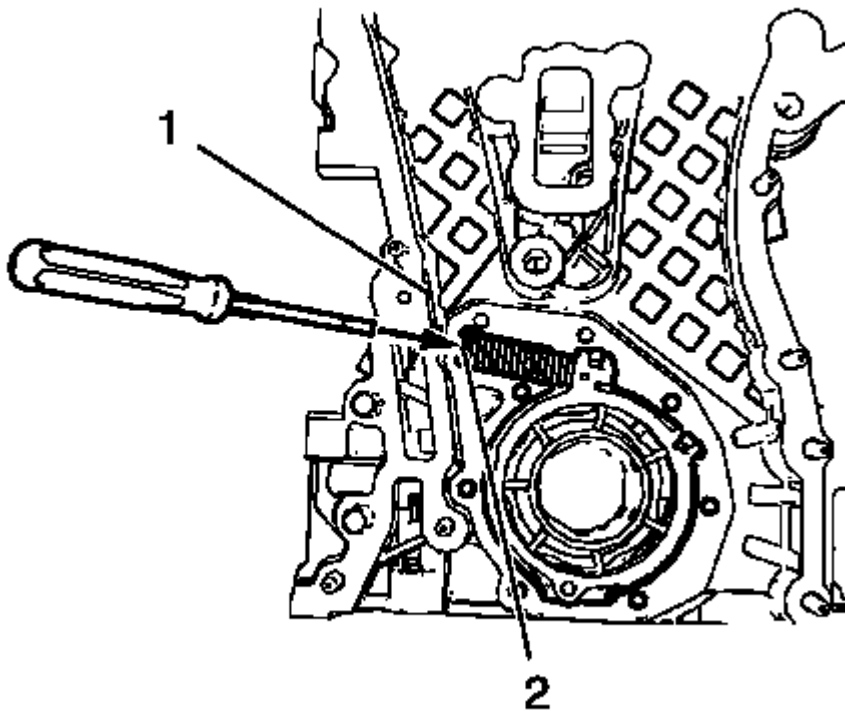
### **Removal Procedure**

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



**Fig. 131: Engine Oil Pump Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 8 oil pump cover bolts (1).
3. Remove the oil pump cover (2).

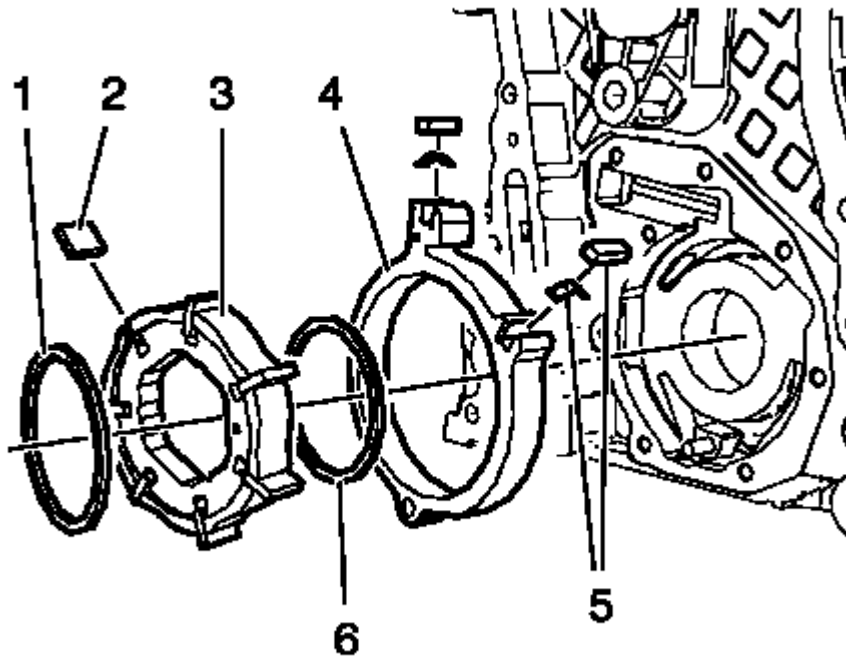


**Fig. 132: Oil Pump Slide Spring Windings And Engine Front Cover Edge**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Before removing the spring, cover the spring with a towel to prevent the spring from flying and possibly causing damage or personal injury.

**NOTE:** Insert the screw driver between the oil pump slide spring windings (2).

4. Protect the engine front cover edge (1) with a suitable piece of plastic.
5. Compress the oil pump slide spring with a screw driver and remove the oil pump slide spring in conjunction with the oil pump slide spring pin.



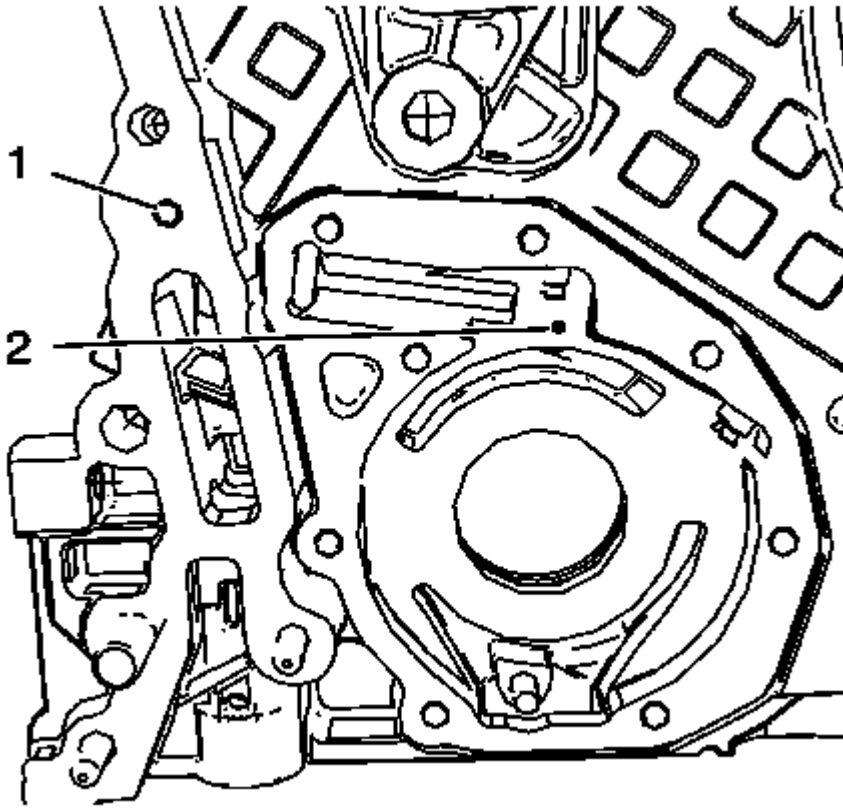
**Fig. 133: Locating Engine Oil Pump Components**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Keep the oil pump components in order to aid in installation.

6. Remove the oil pump components in the following order:
  1. Outer oil pump vane ring (1).
  2. Oil pump vane rotor (3) and the 7 oil pump vanes (2).
  3. Inner oil pump vane ring (6).
  4. Oil pump slide (4) and the 2 oil pump slide seals with the 2 oil pump slide seal springs (5).

#### **Cleaning And Inspection Procedure**

1. Inspect the engine front cover for cracks, scratches and damage.
2. Inspect the oil pump cover and the engine front cover for flatness.
3. Inspect the oil pump vanes, the oil pump vane rotor, the oil pump vane rings and the oil pump slide for localized flatting.
4. Inspect the oil pump slide pivot pin for firm seat.



**Fig. 134: Oil Gallery Bores**

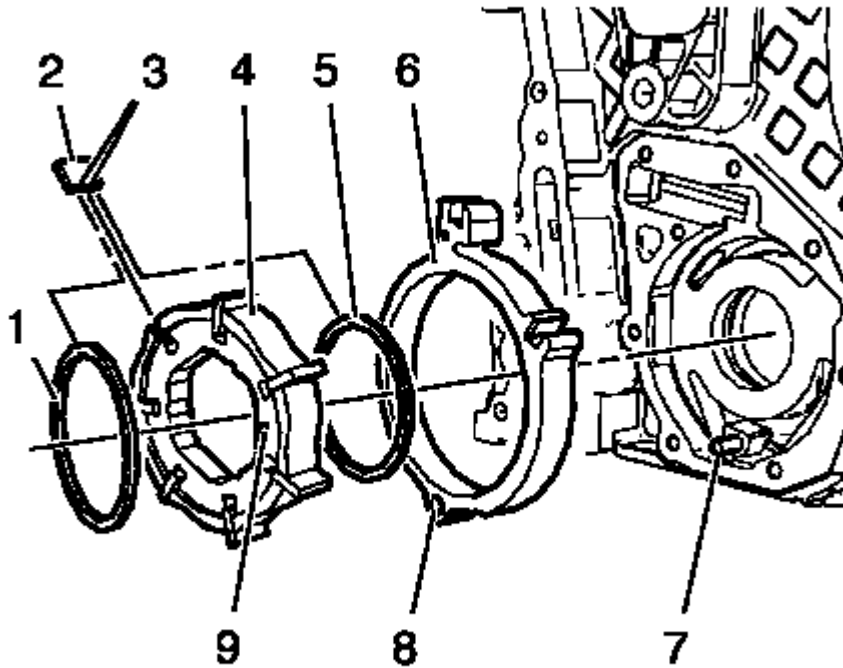
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Wear safety glasses when using compressed air in order to prevent eye injury.

**CAUTION:** To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

5. Clean the oil galleries with solvent and compressed air. Blow compressed air from bore (2) to bore (1).

#### Installation Procedure



**Fig. 135: Oil Pump Components**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Oil pump slide spring pin, oil pump slide spring and slide seal and slide seal spring can be ordered as single parts. All other oil pump components can only be ordered as a replacement kit.

1. Install the oil pump components in the following order:

**NOTE:** The bore (8) in the oil pump slide must fit smooth-running and without clearance to the oil pump slide pivot pin (7).

1. Install the oil pump slide (6).
2. Install the inner oil pump vane ring (5).

**NOTE:** Ensure the mark (9) of the oil pump vane rotor (4) points to the oil pump cover.

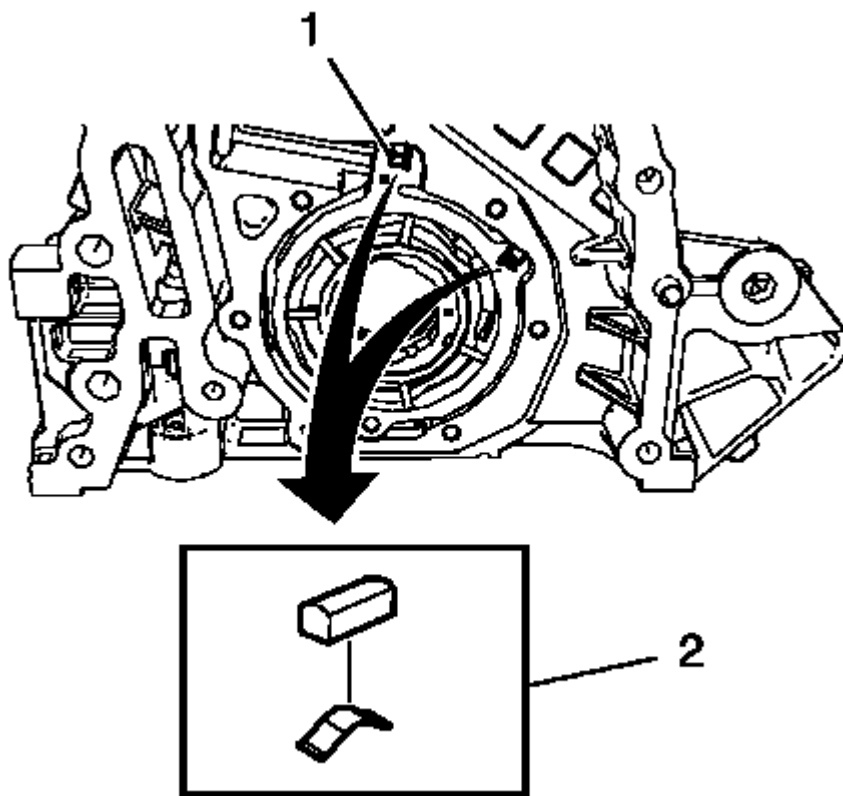
3. Install the oil pump vane rotor (4).

**NOTE:** Ensure the flats (3) on the oil pump vanes (2) point to the oil pump



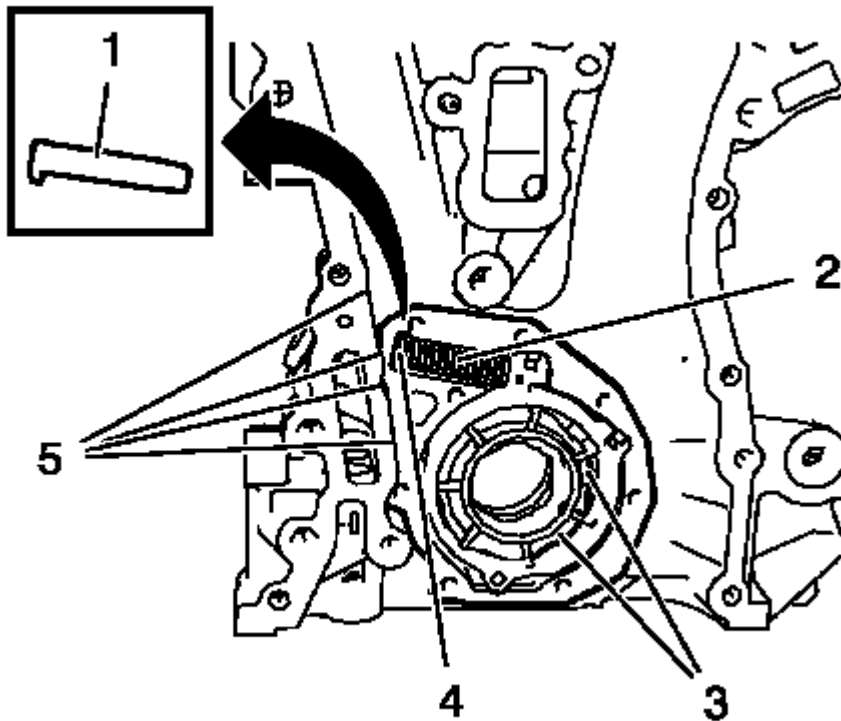
**vane rotor.**

4. Install the 7 oil pump vanes (2).
5. Install the outer oil pump vane ring (1).



**Fig. 136: Oil Pump Slide Seal Springs And Grooves**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the 2 oil pump slide seals and the 2 oil pump slide seal springs (2) in the position as shown to the 2 grooves (1) of the oil pump slide.

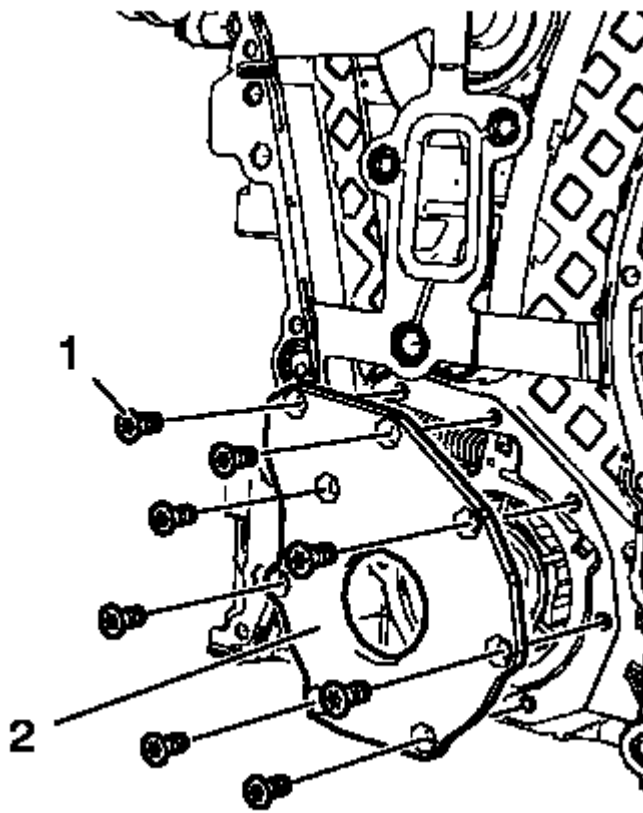


**Fig. 137: Oil Pump Slide Spring, Pin, Chambers And Front Cover Edge**  
 Courtesy of GENERAL MOTORS COMPANY

3. Protect the engine front cover edge (5) with a suitable piece of plastic.

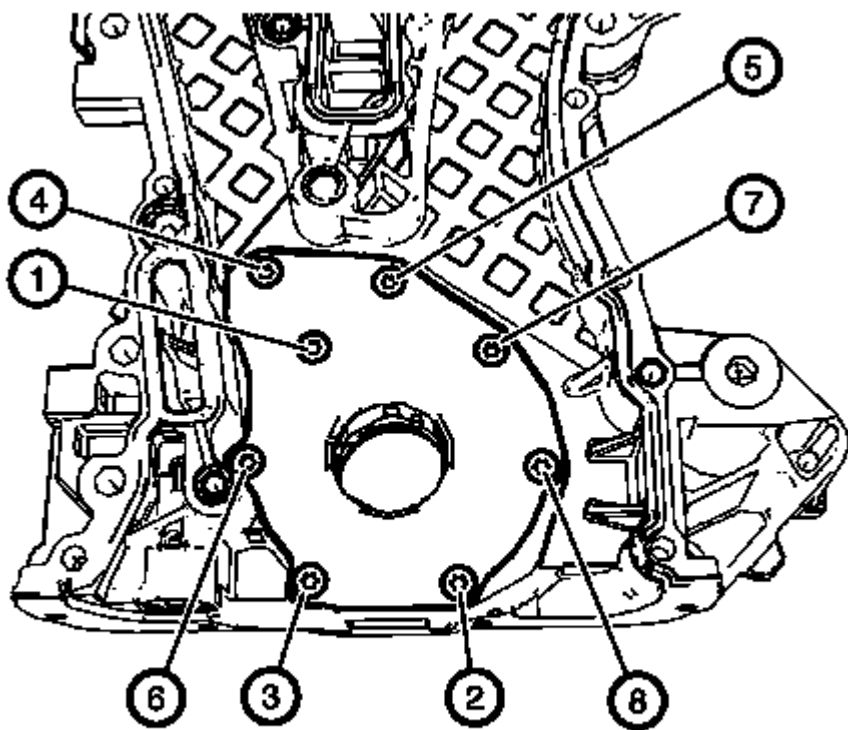
**NOTE:** The length of the removed oil pump slide spring (2) should be 76.5 mm (3.0118 in) for naturally aspirated engines and 61 mm (2.4016 in) for turbo engines.

4. Install the oil pump slide spring pin (1) in conjunction with the oil pump slide spring (4). Use a screwdriver to compress the oil pump slide spring. The flat side of oil pump slide spring pin must face upwards.
5. Lubricate the oil pump vanes, the oil pump vane rotor, the oil pump slide spring and the chambers (3) with engine oil.
6. Inspect the oil pump slide spring mechanism for proper function.
7. Measure the oil pump axial and radial clearances and compare with the specified values. Refer to **Engine Front Cover and Oil Pump Cleaning and Inspection**.



**Fig. 138: Engine Oil Pump Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

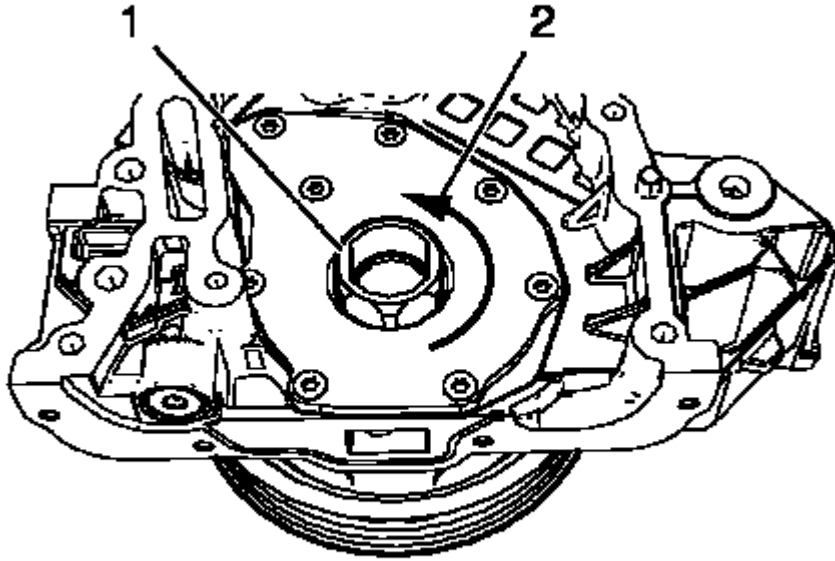
8. Install the oil pump cover (2) and the 8 oil pump cover bolts (1).



**Fig. 139: Oil Pump Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution

9. Tighten the oil pump cover bolts in a sequence as shown to 8 N.m (71 lb in).



**Fig. 140: Crankshaft Balancer**

Courtesy of GENERAL MOTORS COMPANY

10. Install the crankshaft balancer (1) and rotate in shown direction (2) in order to inspect the function of the oil pump mechanism. Crankshaft balancer should rotate easily.
11. Remove the timing chain and replace the engine front cover gasket. Refer to **Camshaft Timing Chain Replacement**.
12. Install the timing chain. Refer to **Camshaft Timing Chain Replacement**.
13. Install the engine front cover. Refer to **Engine Front Cover with Oil Pump Replacement**.
14. Measure the oil pressure and compare with the specified values. Refer to **Oil Pressure Diagnosis and Testing (1.4L LUV)**.

## ENGINE REPLACEMENT

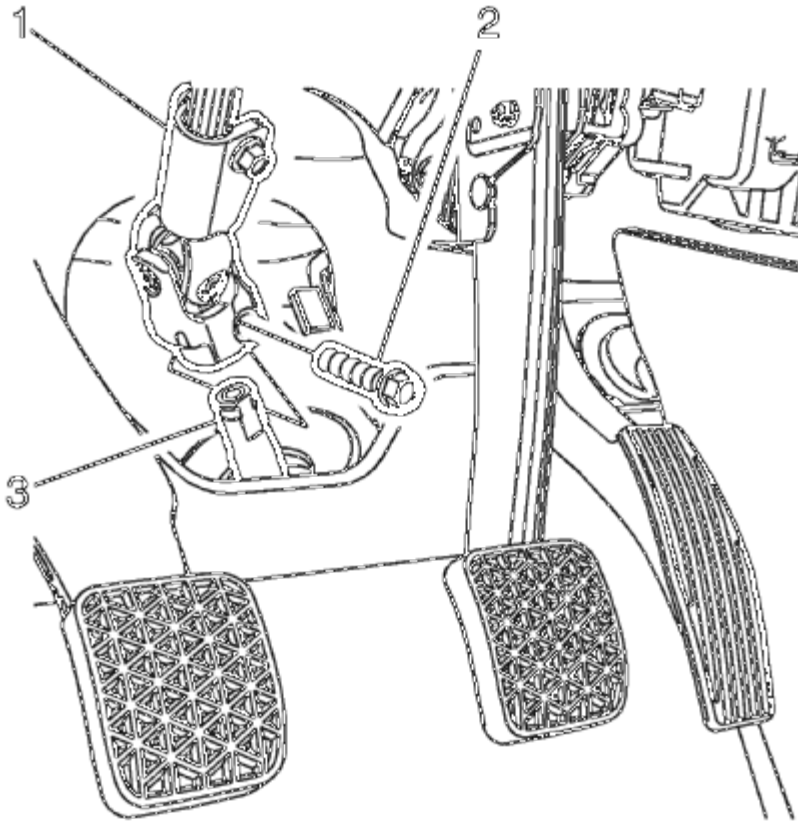
### Special Tools

**EN-48244** Engine Assembly Remove/Install Pallet Supporter

### Removal Procedure

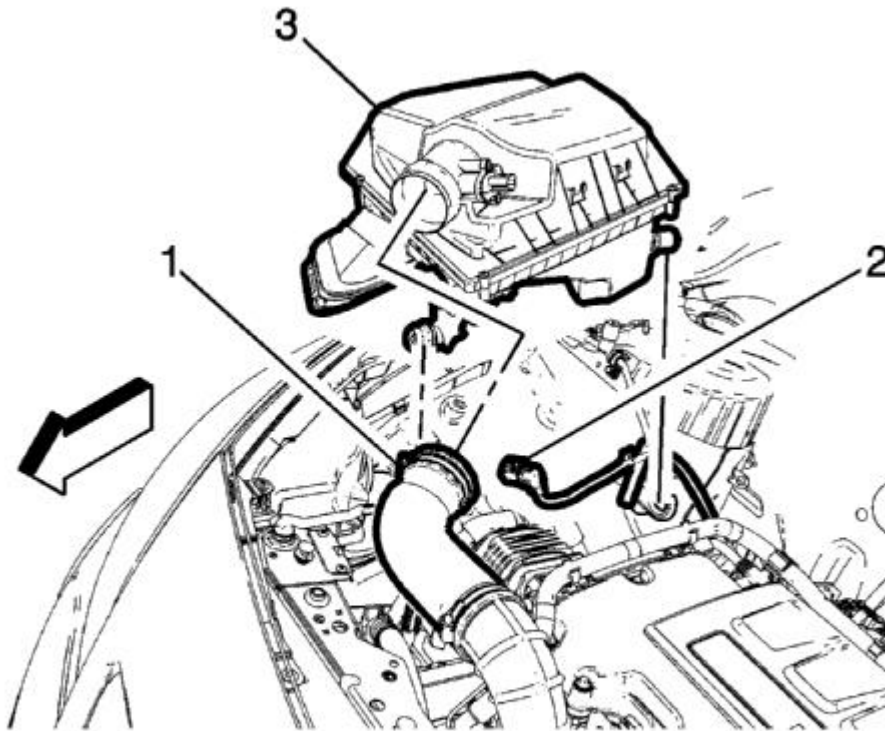
1. Remove the battery and battery tray. Refer to **Battery Tray Replacement**.
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

3. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging** .
4. Remove the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .
6. Drain the cooling system. Refer to **Cooling System Draining and Filling** .



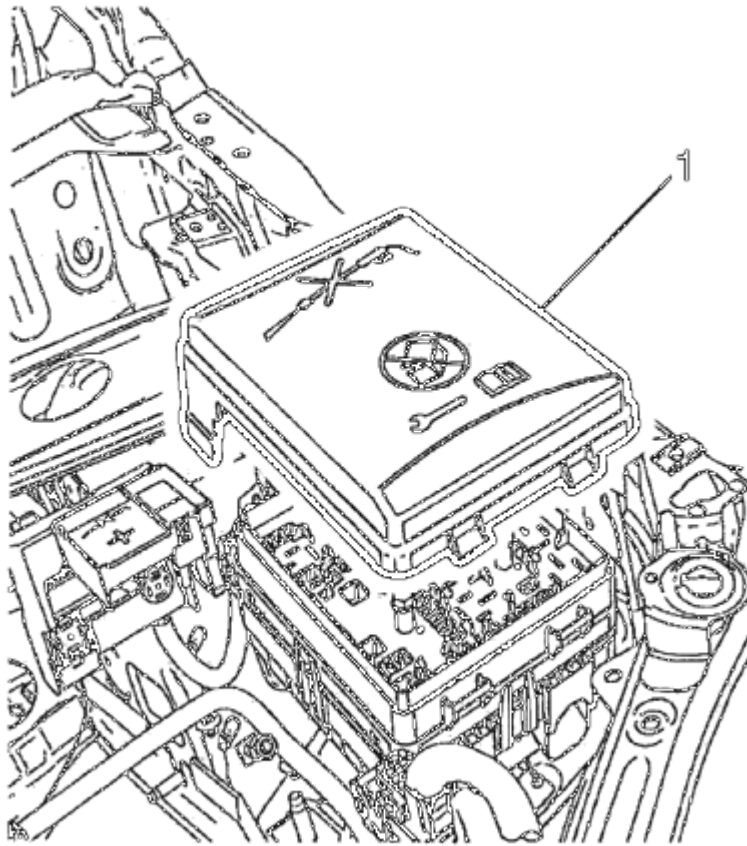
**Fig. 141: Intermediate Steering Shaft & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 142: Air Cleaner Assembly & Components**  
Courtesy of GENERAL MOTORS COMPANY

8. Remove the air cleaner assembly (1). Refer to **AIR CLEANER ASSEMBLY REPLACEMENT** .

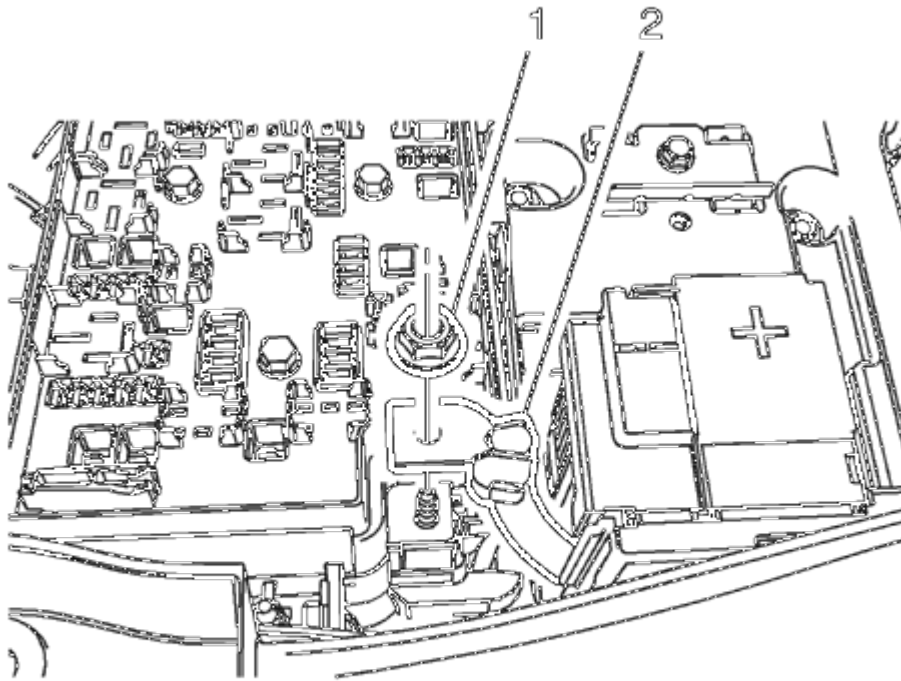


**Fig. 143: Junction Block & Cover**

Courtesy of GENERAL MOTORS COMPANY

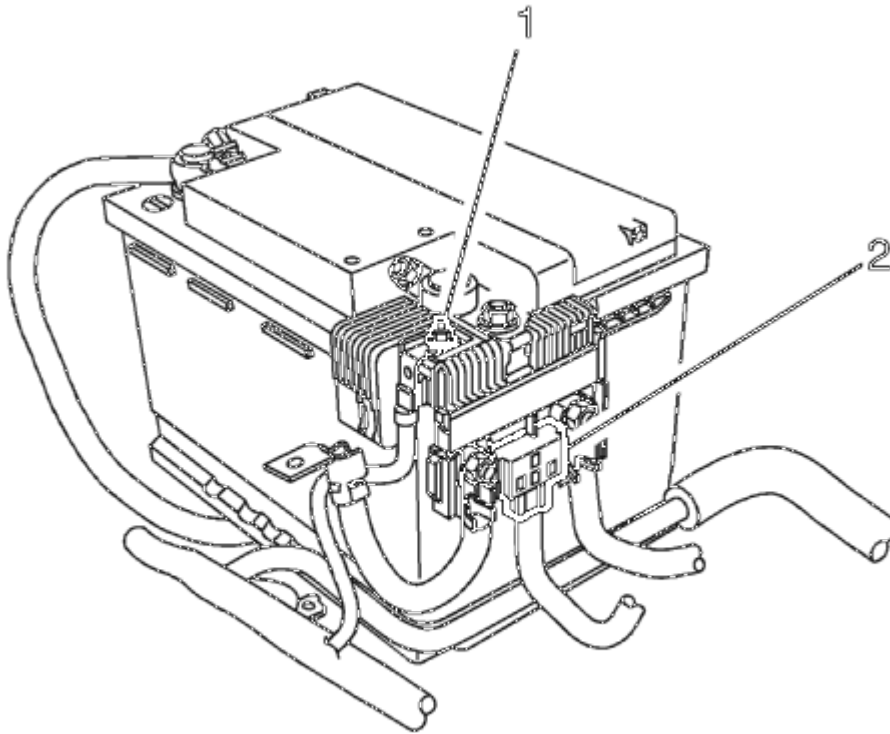
9. Remove the junction block cover (1).





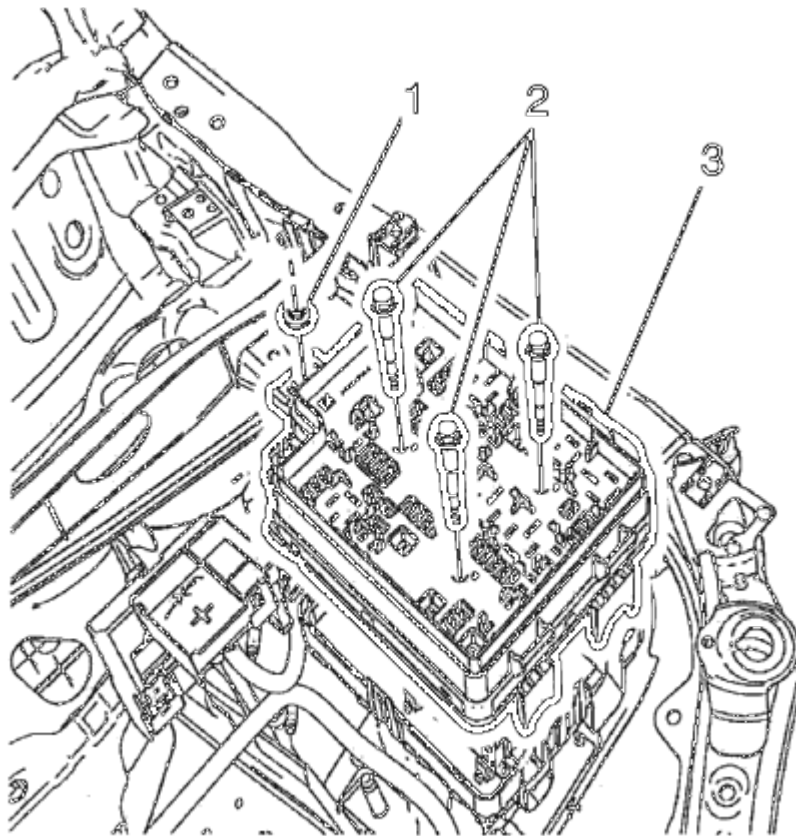
**Fig. 144: Positive Battery Cable & Nut**  
Courtesy of GENERAL MOTORS COMPANY

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

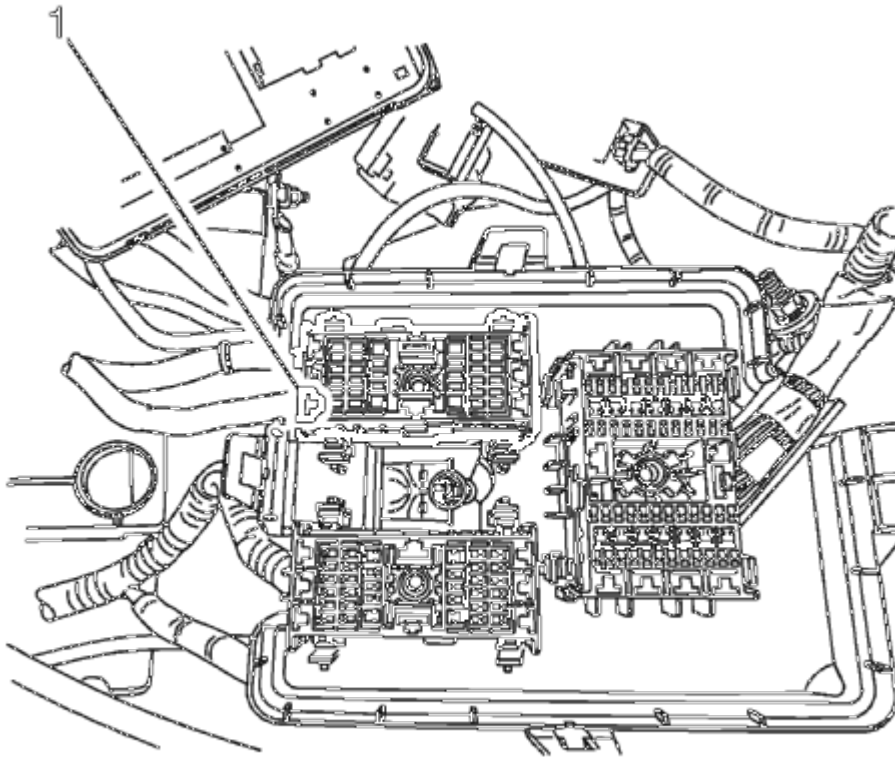


**Fig. 145: Body Wiring Harness Connector & Positive Cable Nut**  
Courtesy of GENERAL MOTORS COMPANY

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

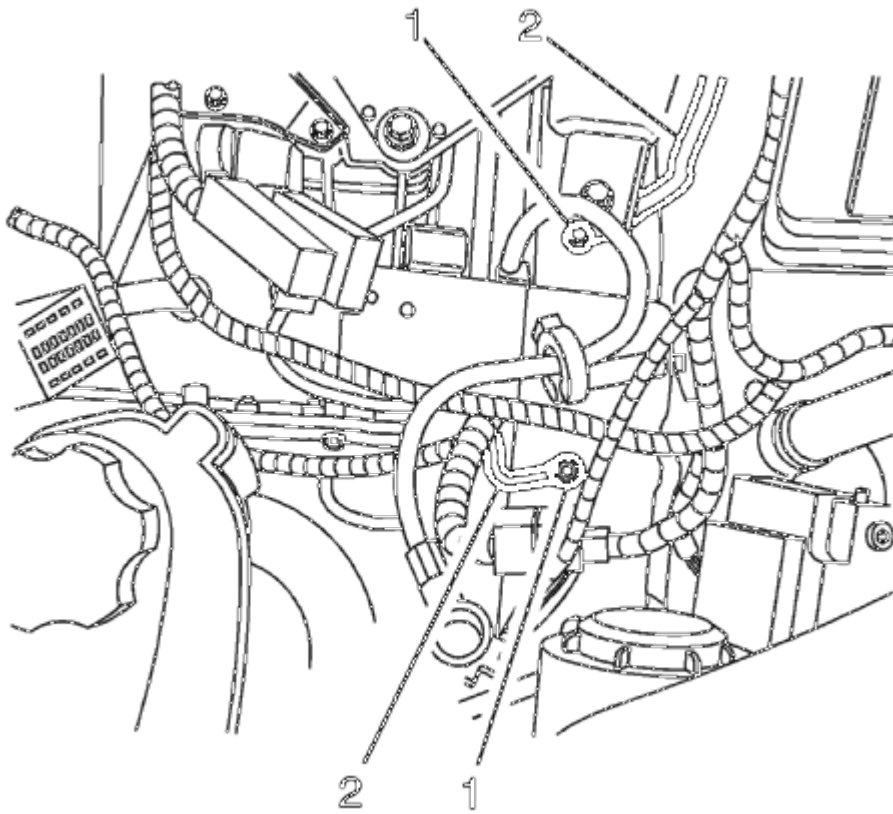
**Fig. 146: Junction Block****Courtesy of GENERAL MOTORS COMPANY**

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



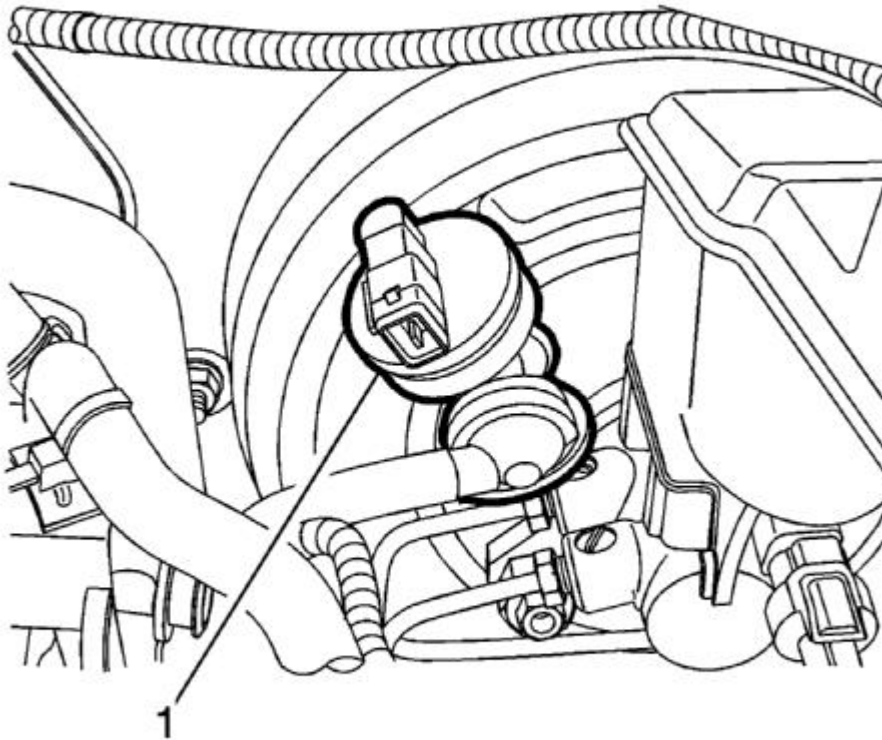
**Fig. 147: Wiring Harness - Top Of Engine**  
Courtesy of GENERAL MOTORS COMPANY

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



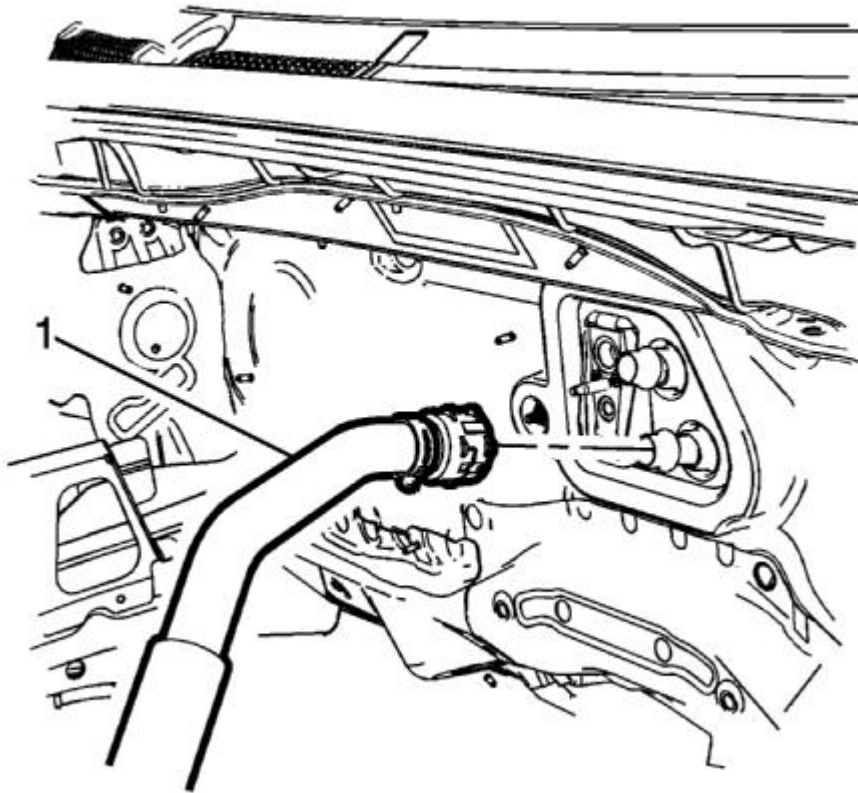
**Fig. 148: Wiring Harness & Ground Nuts**  
Courtesy of GENERAL MOTORS COMPANY

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



**Fig. 149: Electrical Vacuum Pump**  
Courtesy of GENERAL MOTORS COMPANY

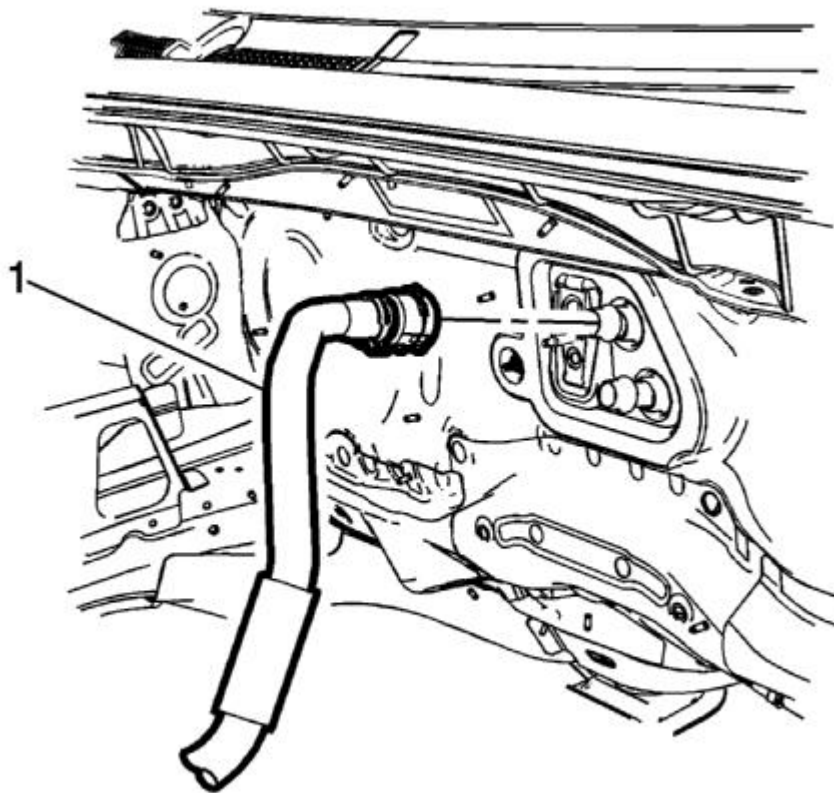
21. Disconnect the electrical connector and remove the brake booster hose (1) .



**Fig. 150: Heater Inlet Hose**

Courtesy of GENERAL MOTORS COMPANY

22. Disconnect the heater inlet hose (1) from the heater core. Refer to **Heater Inlet Hose Replacement (LUV)**.

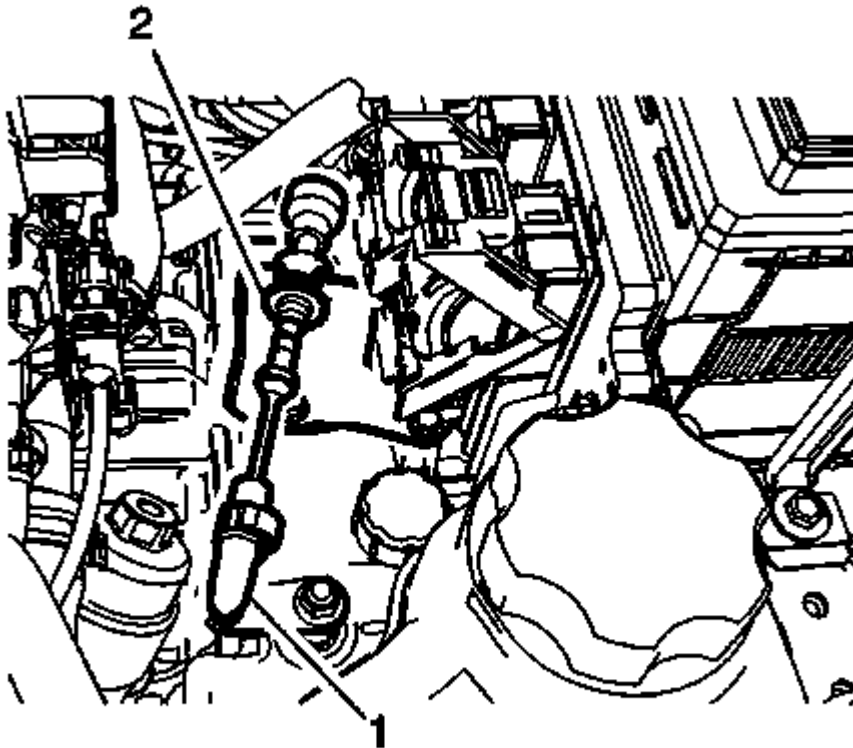


**Fig. 151: Heater Outlet Hose**

Courtesy of GENERAL MOTORS COMPANY

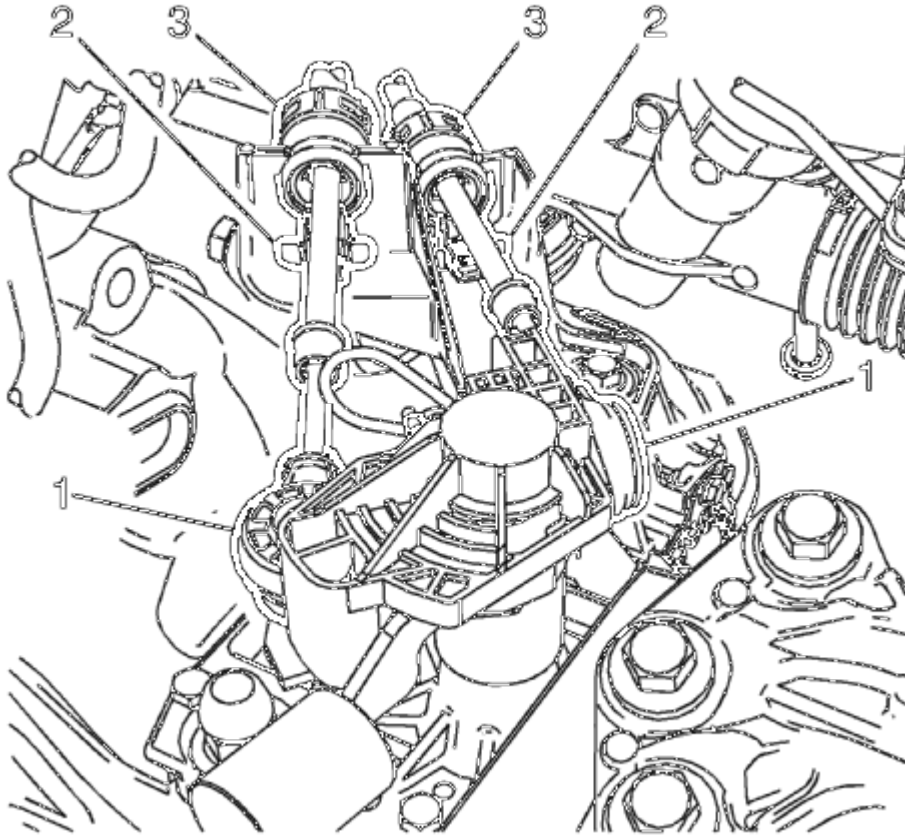
23. Disconnect the heater outlet hose (1) from the heater core. Refer to **Heater Outlet Hose Replacement (LUV)**.





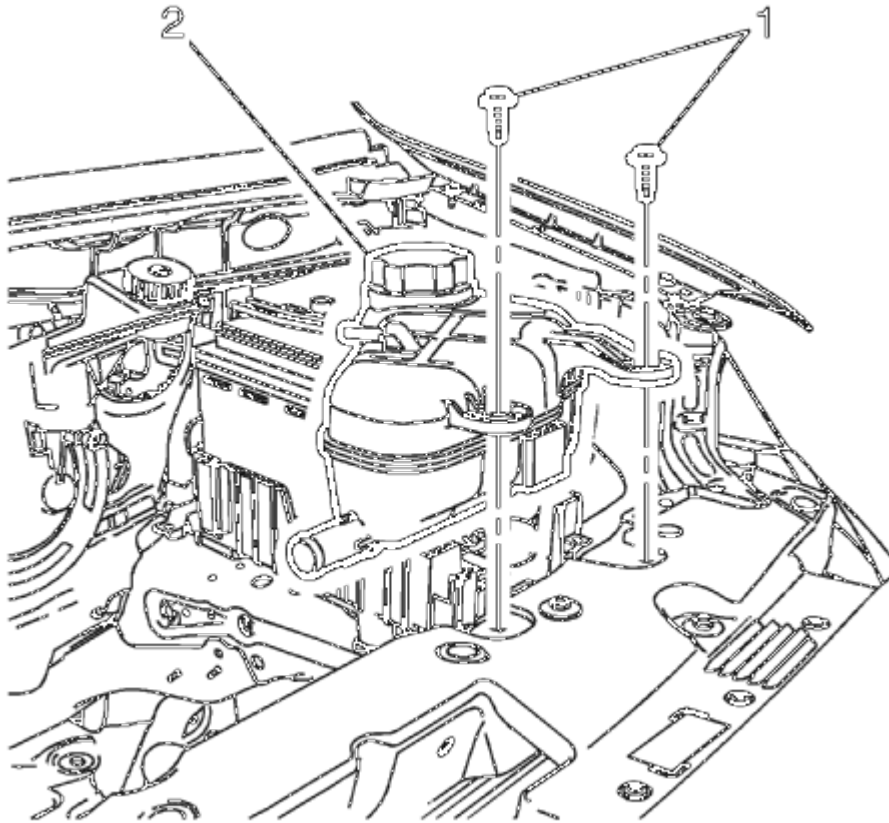
**Fig. 152: Automatic Transmission Range Selector Lever Cable Terminal & Shift Lever Pin**  
Courtesy of GENERAL MOTORS COMPANY

24. If equipped with an automatic transmission, disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.
25. Remove the transmission range selector lever cable (2) from the cable bracket.



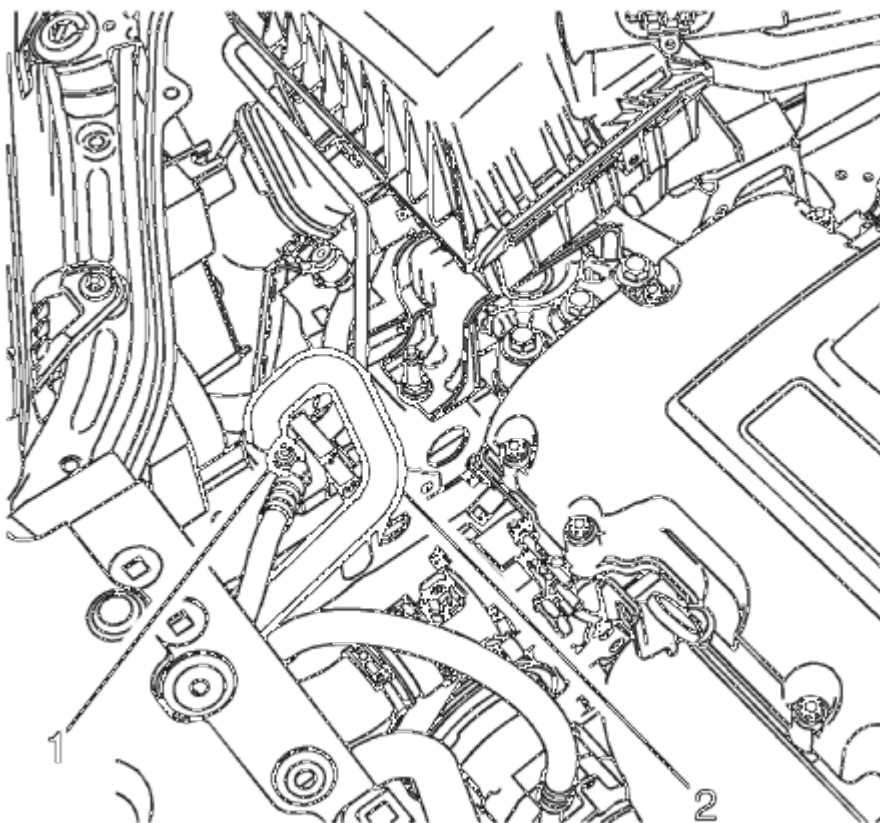
**Fig. 153: Selector Level Cable Components**  
**Courtesy of GENERAL MOTORS COMPANY**

26. If equipped with manual transmission, disconnect the shift lever and selector lever cable end (1) from the transmission shift lever and selector lever.
27. Pull the cable retainers (2) to release the shift lever and selector lever cable from the shift lever and selector lever cable bracket.
28. Disconnect the shift lever and selector lever cable from the shift lever and selector lever cable bracket.



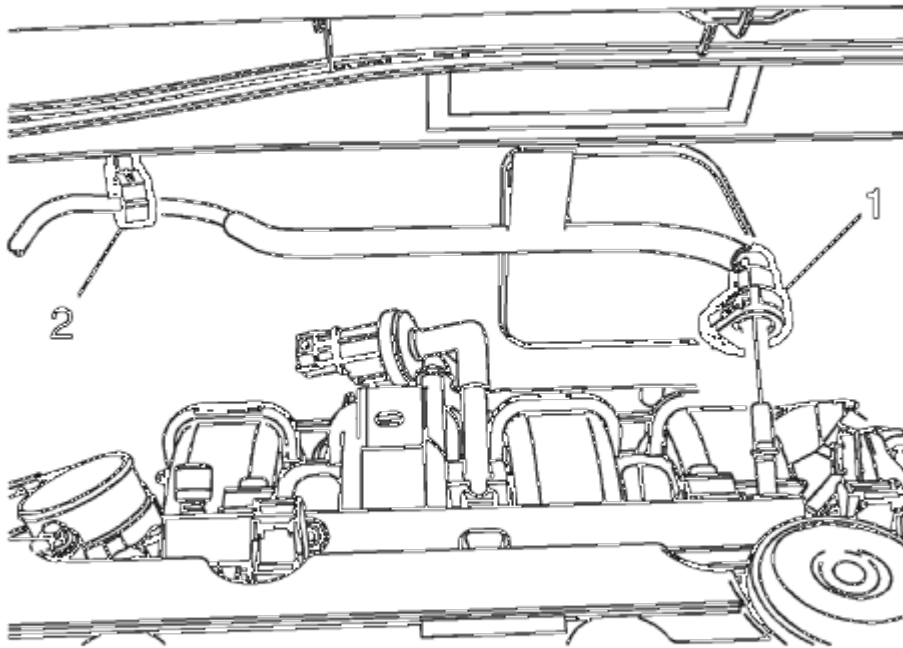
**Fig. 154: Radiator Surge Tank & Mounting Bolts**  
Courtesy of GENERAL MOTORS COMPANY

29. Remove the radiator surge tank (2) and position aside. Refer to **Radiator Surge Tank Replacement** .
30. Disconnect the fan connector.



**Fig. 155: A/C Compressor & Condenser Hose & Nut**  
**Courtesy of GENERAL MOTORS COMPANY**

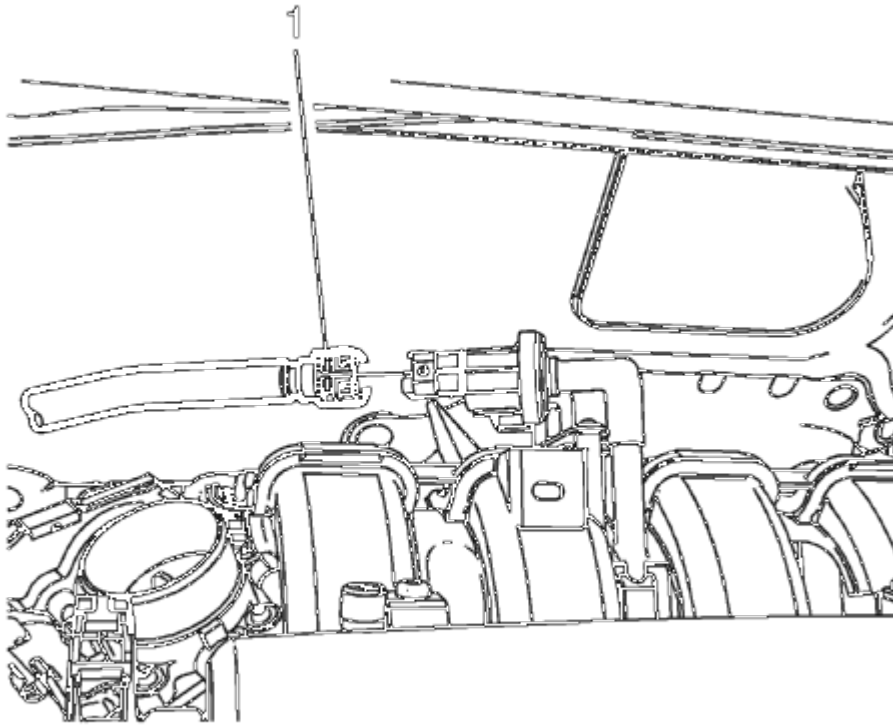
31. Remove air conditioning compressor and condenser hose nut (1).
32. Remove air conditioning compressor and condenser hose (2) from refrigerant hose.



**Fig. 156: Fuel Feed Pipe & Plastic Collars**

Courtesy of GENERAL MOTORS COMPANY

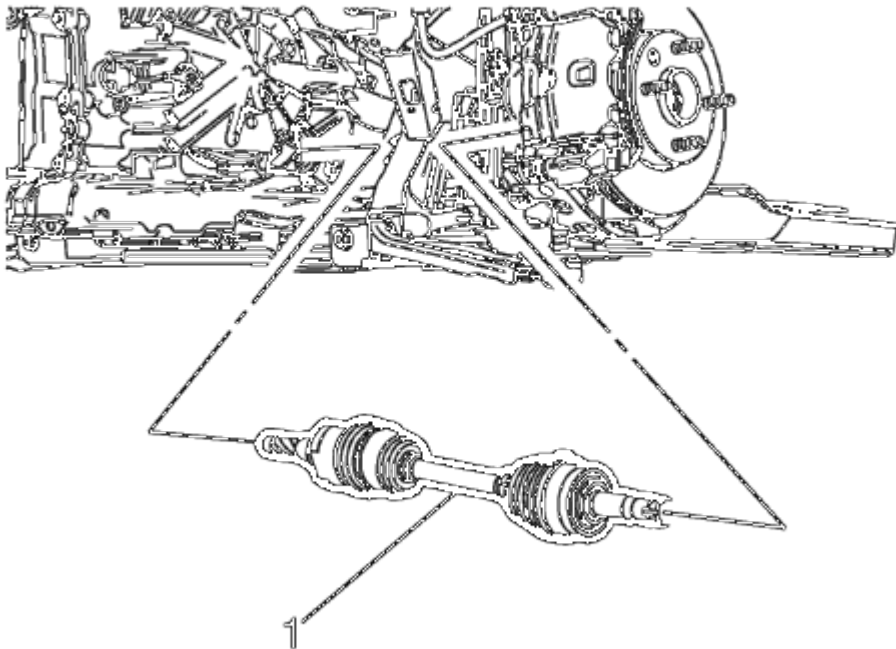
33. Disconnect the fuel feed pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service** .



**Fig. 157: Evaporative Emission Pipe**

Courtesy of GENERAL MOTORS COMPANY

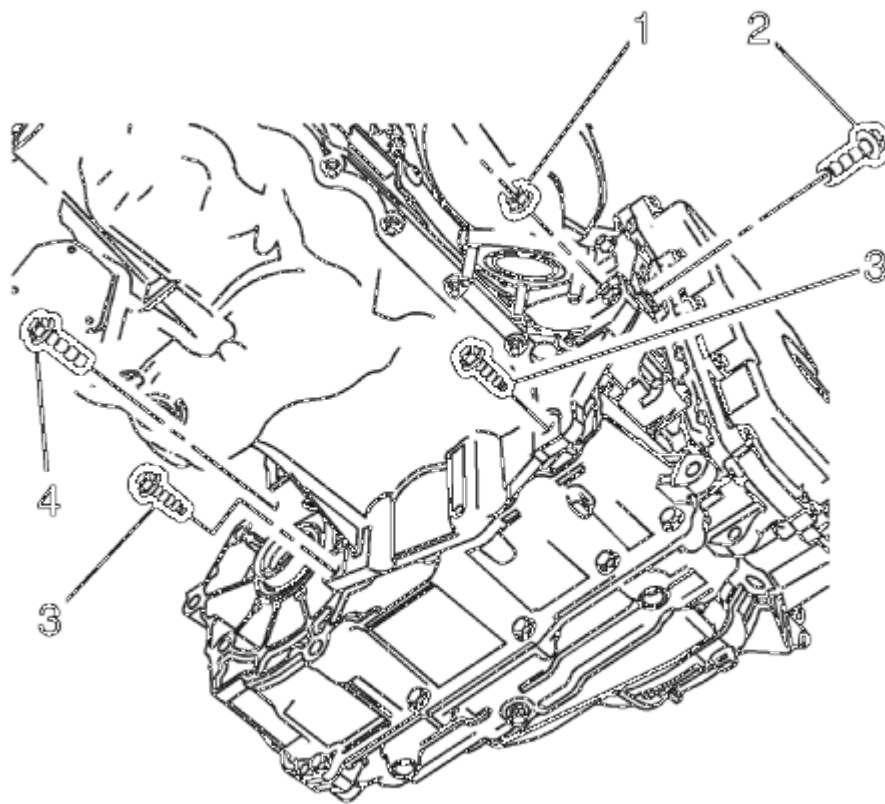
34. Disconnect the evaporative emission pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service** .



**Fig. 158: Wheel Drive Shaft**

Courtesy of GENERAL MOTORS COMPANY

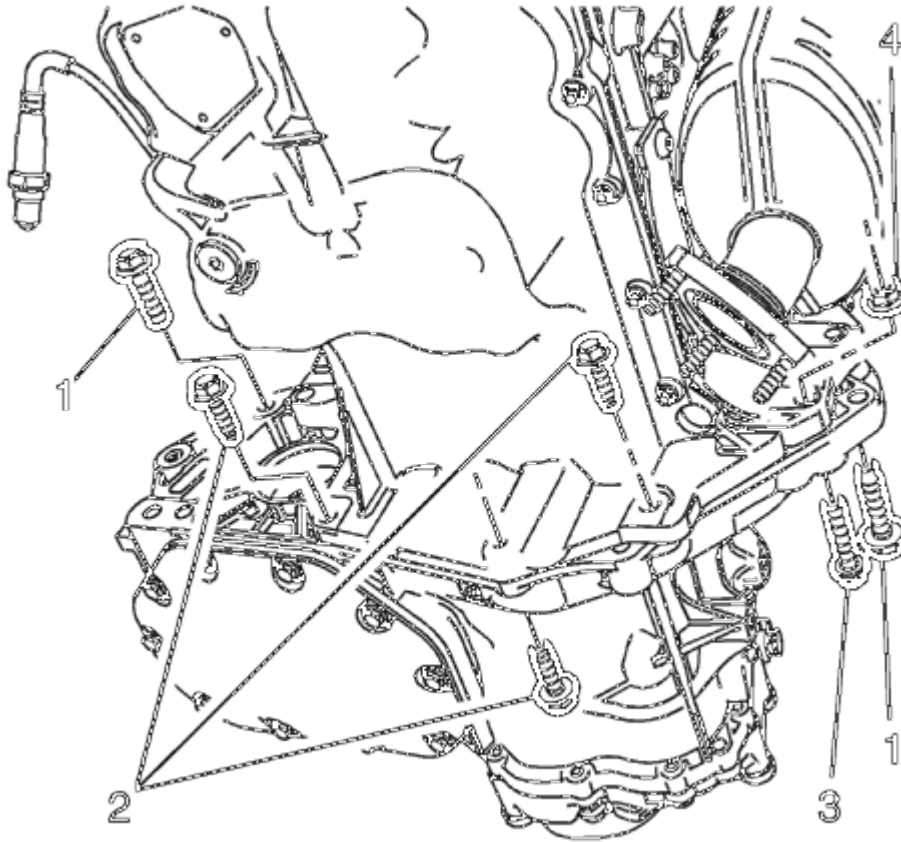
35. Remove the wheel drive shafts. Refer to **Front Wheel Drive Shaft Replacement**
36. Remove the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LUV, LUW)** .



**Fig. 159: Lower Transmission Nut & Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

37. If equipped with an automatic transmission, remove the lower transmission nut (1) and the lower transmission bolts (2, 3, 4).

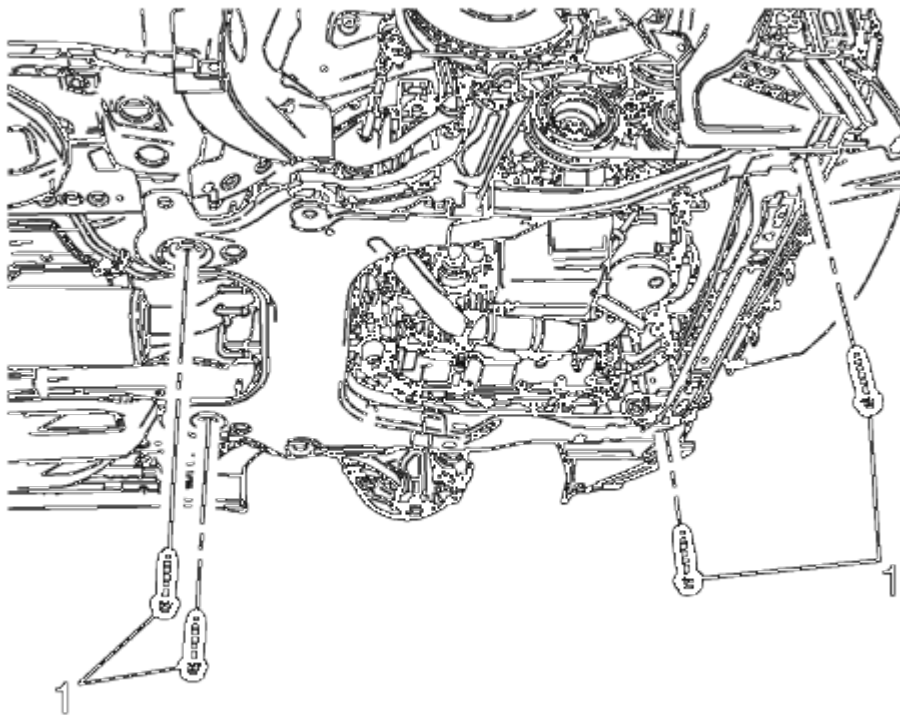




**Fig. 160: Lower Transmission Bolts**

Courtesy of GENERAL MOTORS COMPANY

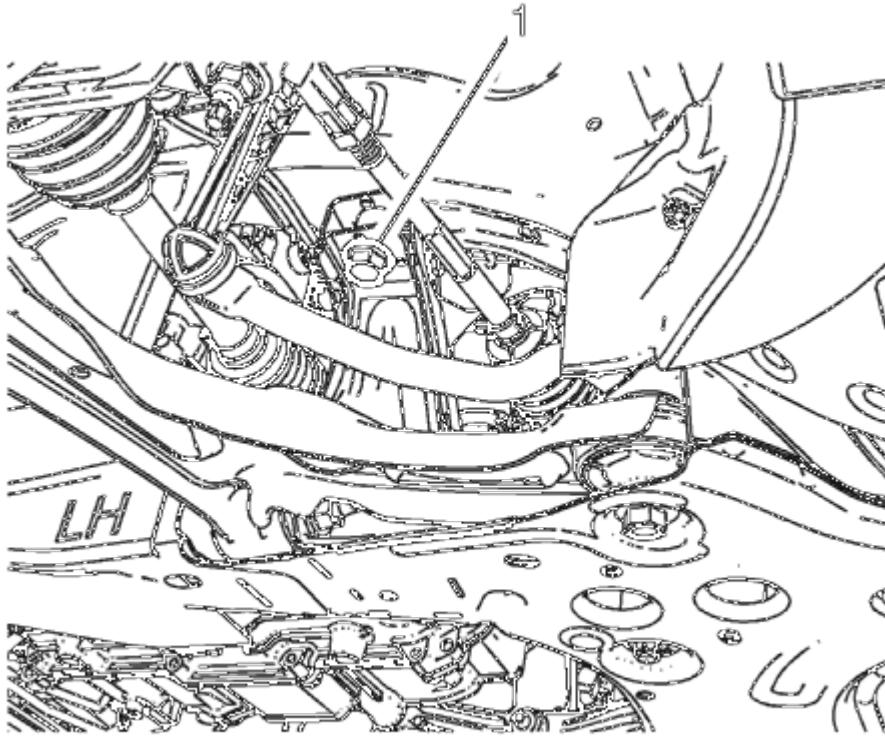
38. If equipped with manual transmission, remove the lower transmission bolt (3) and nut (4).
39. Remove the lower transmission bolts (1, 2).



**Fig. 161: Front Frame Bolts**

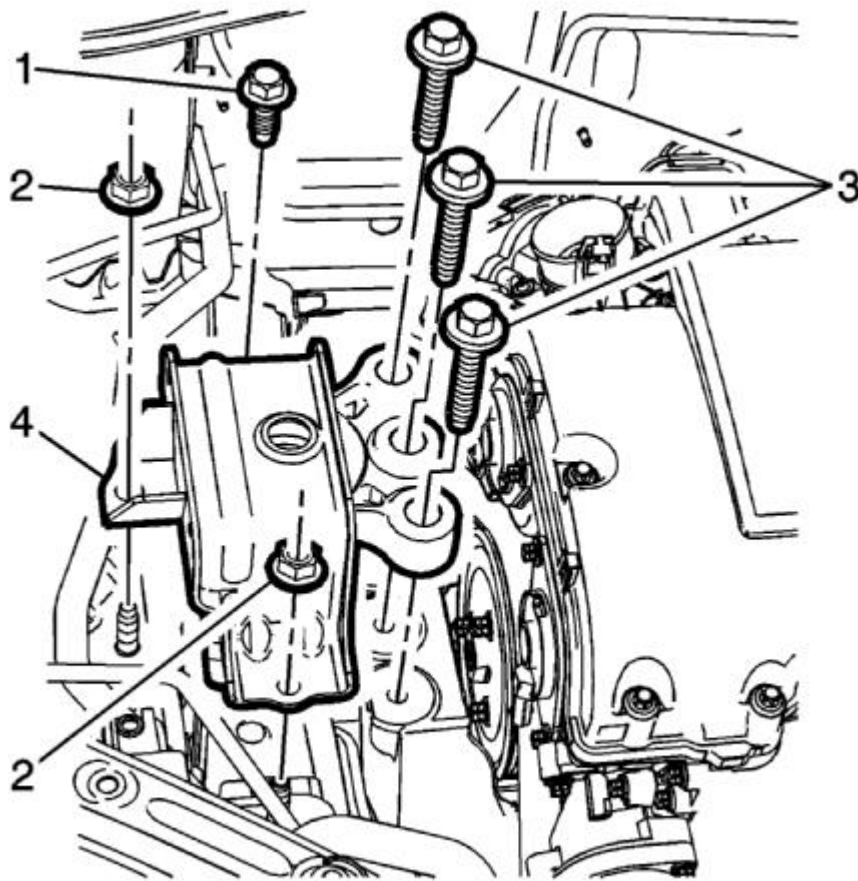
Courtesy of GENERAL MOTORS COMPANY

40. Remove the frame front bolts (1).
41. Position the **EN-48244** engine assembly remove/install pallet supporter under the powertrain and support with blocks of wood.



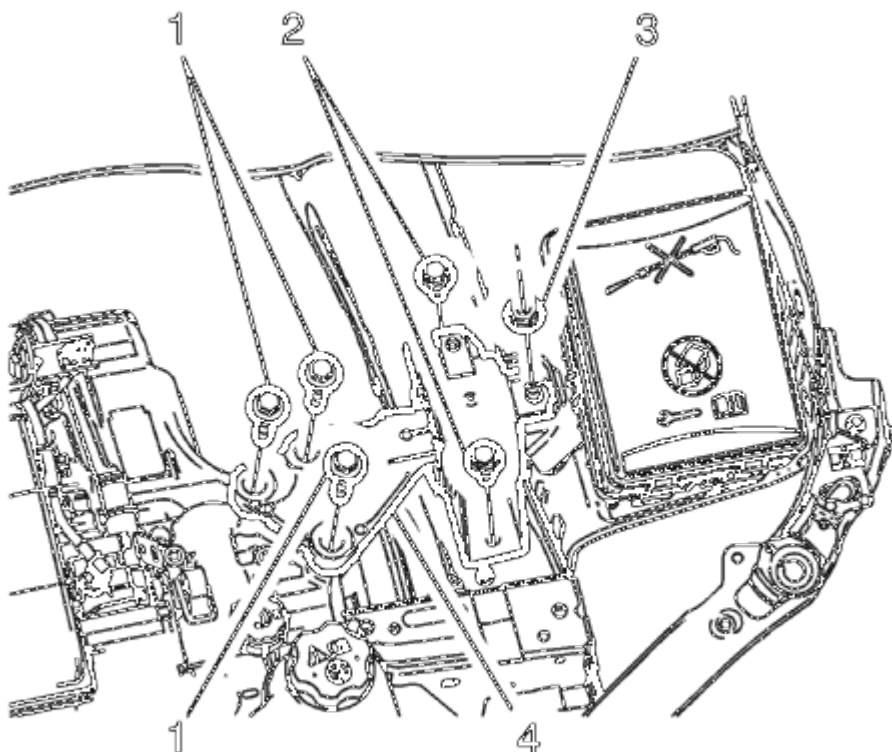
**Fig. 162: Frame Suspension Retaining Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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



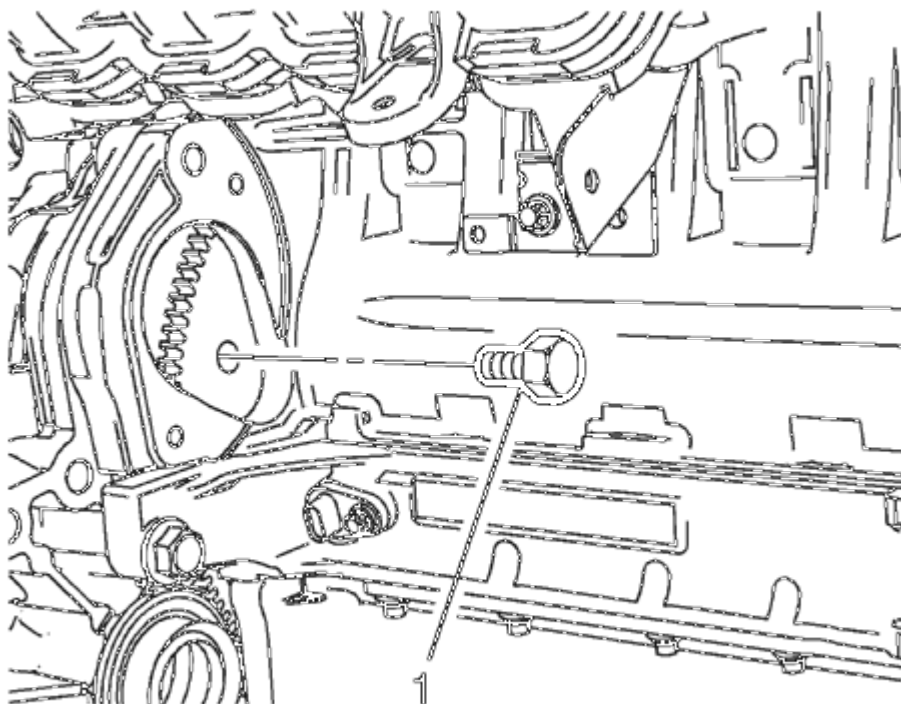
**Fig. 163: Right Side Engine Mount & Components**  
Courtesy of GENERAL MOTORS COMPANY

43. Remove the right side engine mount (4). Refer to **Engine Mount Replacement - Right Side.**



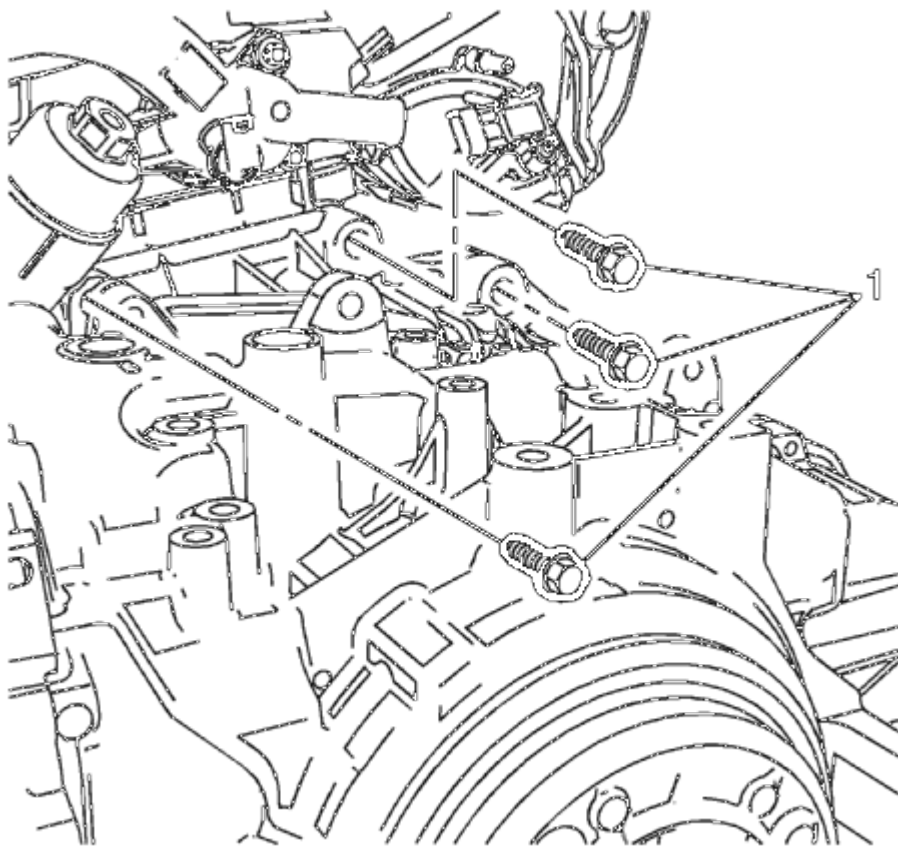
**Fig. 164: Left Transmission Mount & Components**  
Courtesy of GENERAL MOTORS COMPANY

44. Remove and DISCARD the transmission mount bolts (1) - left side. Refer to **Transmission Mount Replacement - Left Side** .
45. Disconnect any additional electrical connections as necessary.
46. Raise the vehicle until the powertrain is clear for removal.



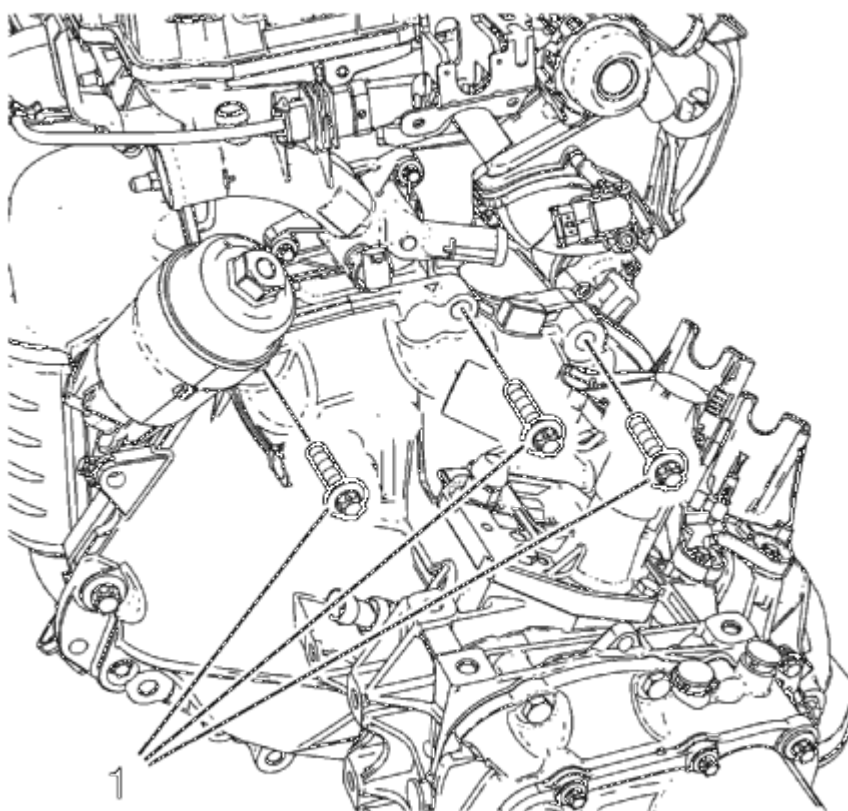
**Fig. 165: Torque Converter To Flywheel Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

47. If equipped with an automatic transmission, remove the starter. Refer to **Starter Replacement (LUV)** .
48. Mark the relationship of the flex plate to the torque converter for reassembly.
49. Remove and DISCARD the flex plate to torque converter bolts (1).



**Fig. 166: Upper Transmission To Engine Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

50. If equipped with an automatic transmission, remove the upper transmission to engine bolts (1) and separate the engine and transmission.



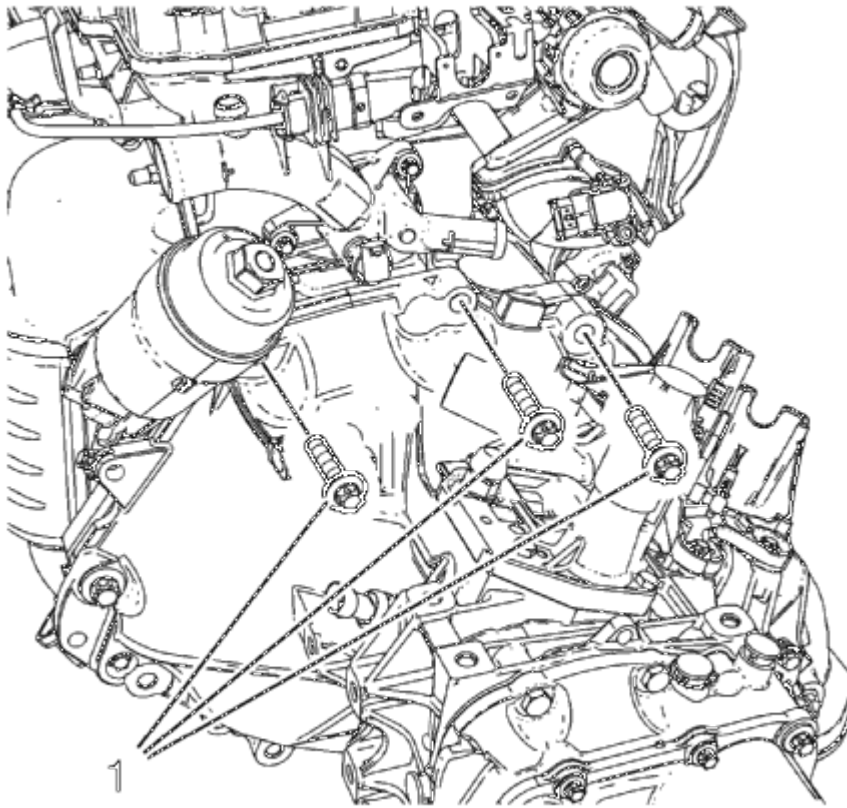
**Fig. 167: Upper Transmission To Engine Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

51. If equipped with manual transmission, remove the upper transmission to engine bolts (1). And separate the engine and transmission.
52. Disconnect any electrical connectors as needed.
53. Transfer parts as necessary.

#### **Installation Procedure**

1. Install the transmission to the engine.

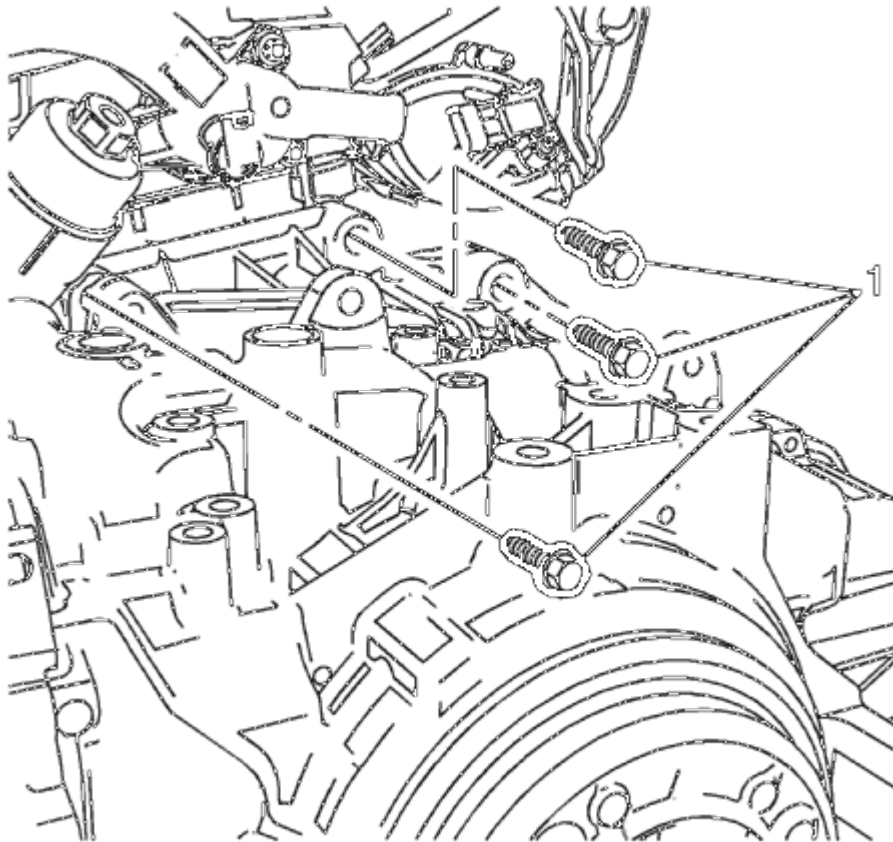




**Fig. 168: Upper Transmission To Engine Bolts**  
Courtesy of GENERAL MOTORS COMPANY

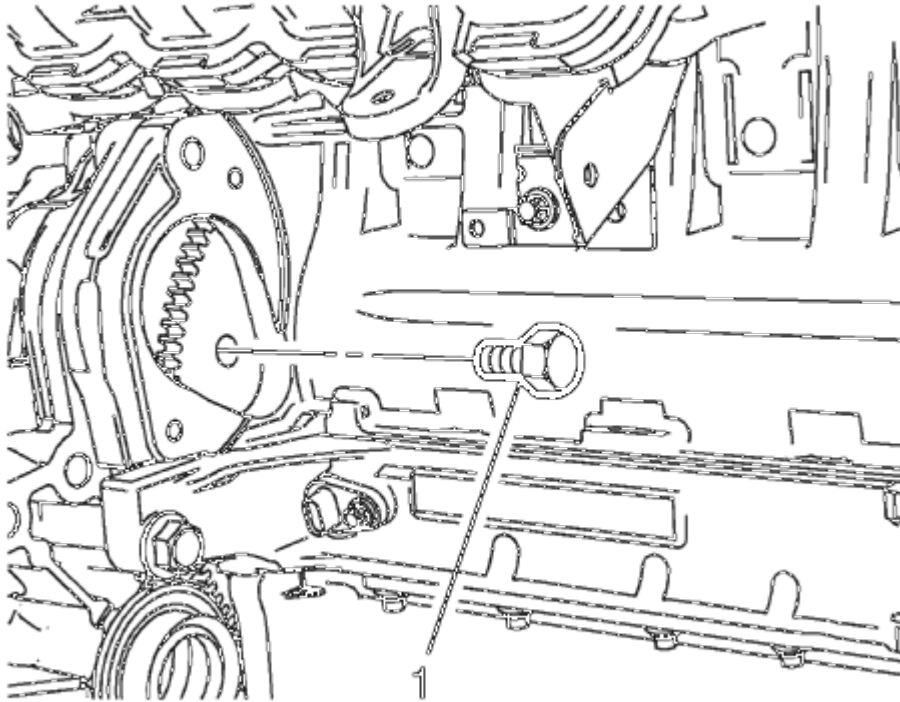
**CAUTION: Refer to Fastener Caution .**

2. If equipped with a manual transmission, install the upper transmission to engine bolts (1) to 60 N•m (44 lb ft).



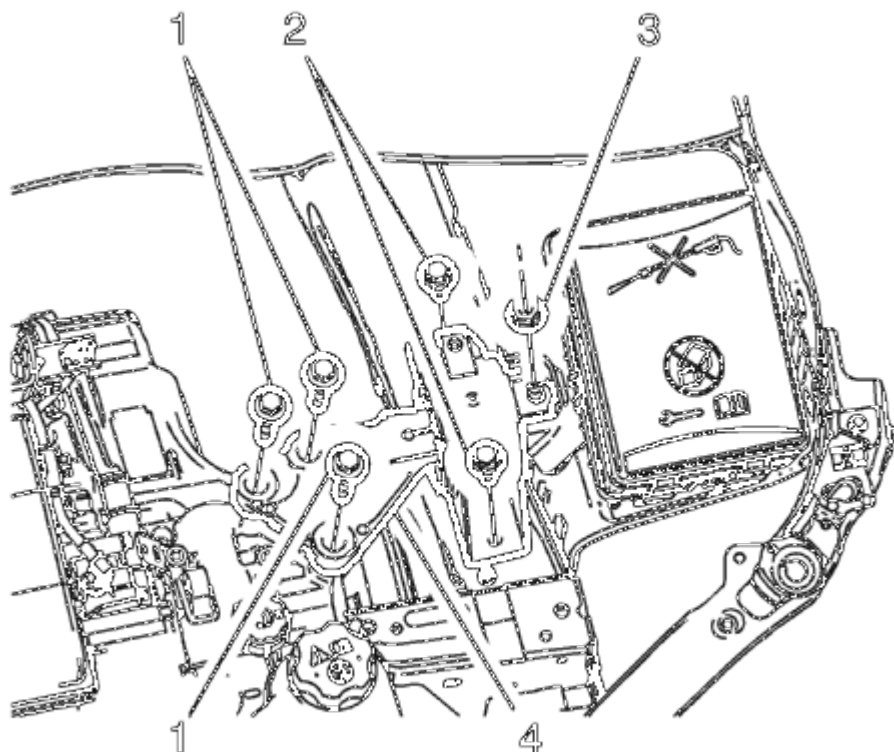
**Fig. 169: Upper Transmission To Engine Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

3. If equipped with automatic transmission, install the upper transmission to engine bolts (1) and tighten to 60 N•m (44 lb ft).



**Fig. 170: Torque Converter To Flywheel Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

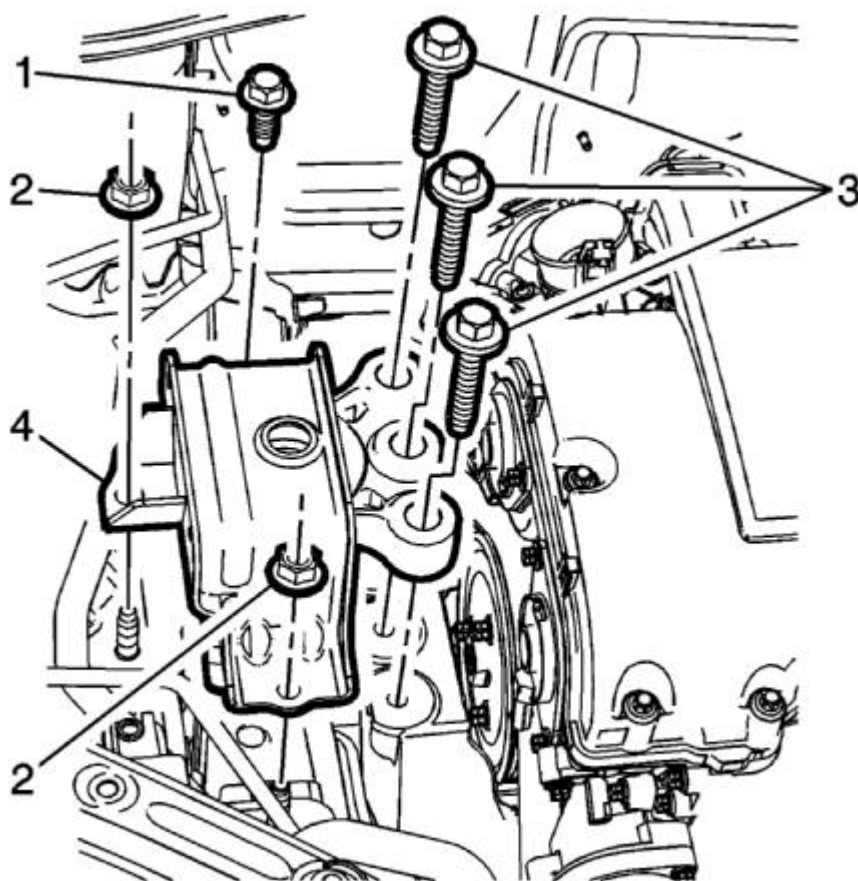
4. If equipped with an automatic transmission, install the torque converter to flex plate bolts (1) and tighten to 60 Y (44 lb ft).
5. Install the starter. Refer to **Starter Replacement (LUV)** .
6. Position the powertrain under the vehicle and slowly lower the body onto the powertrain.



**Fig. 171: Left Transmission Mount & Components**  
Courtesy of GENERAL MOTORS COMPANY

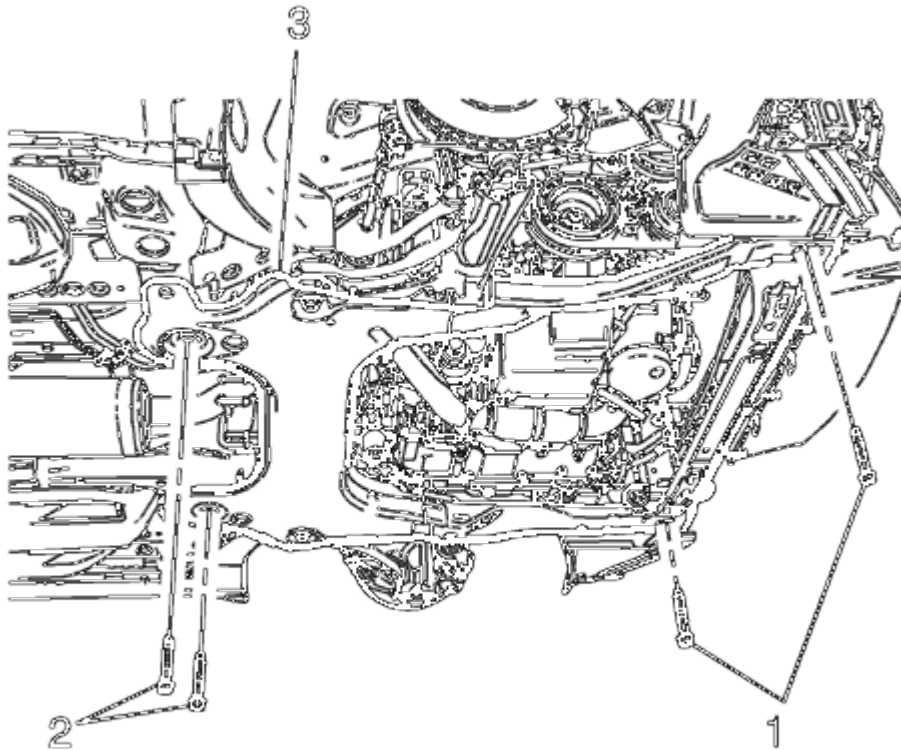
**CAUTION:** Refer to Torque-to-Yield Fastener Caution .

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

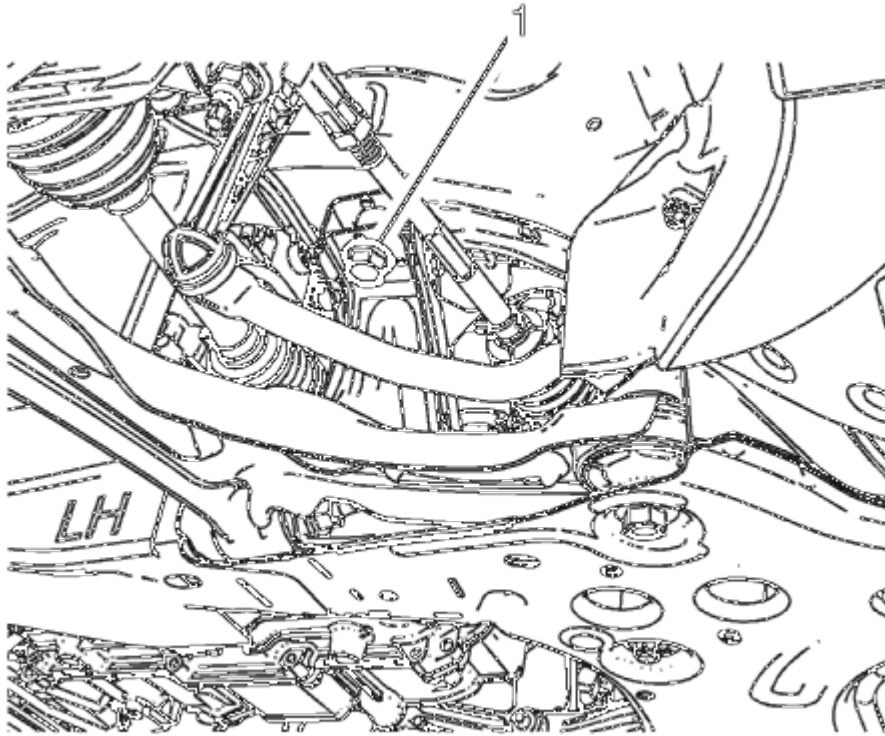


**Fig. 172: Right Side Engine Mount & Components**  
Courtesy of GENERAL MOTORS COMPANY

8. Install the right side engine mount (4). Refer to **Engine Mount Replacement - Right Side**.
9. Connect all previously disconnected electrical connections.

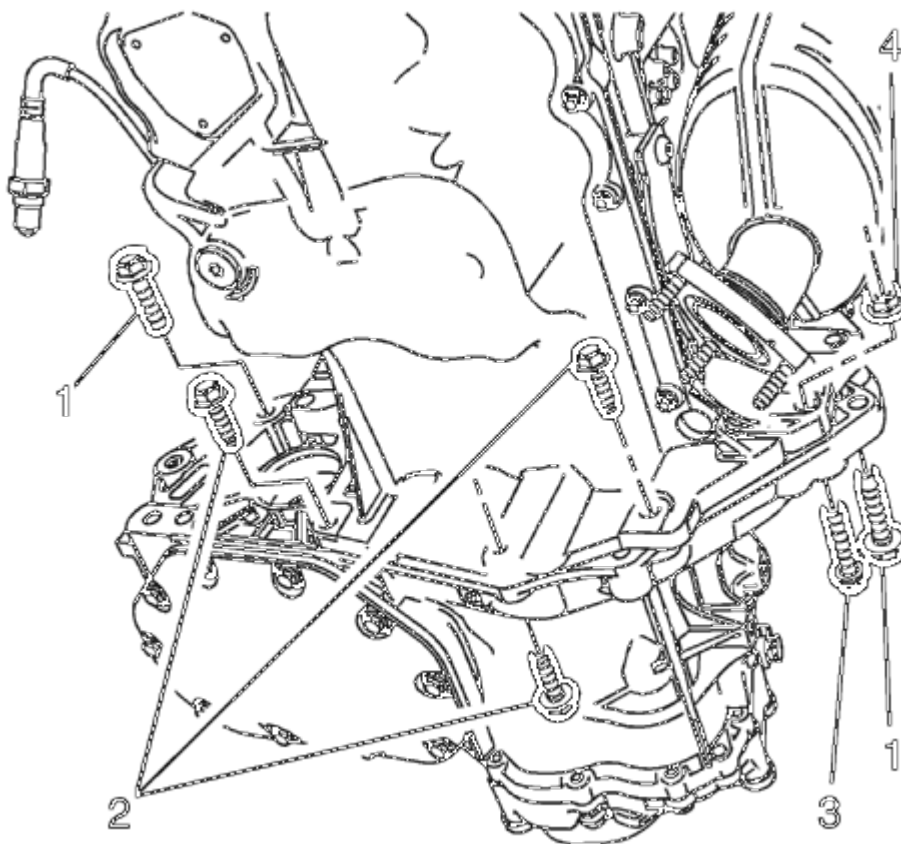
**Fig. 173: Frame & Bolts****Courtesy of GENERAL MOTORS COMPANY**

10. Install the frame (3) rear bolts (2) and front bolts (1), tighten a little bit.
11. Install the frame (3) rear bolts (2) and tighten to 135 Y (100 lb ft).
12. Install the frame (3) front bolts (1) and tighten to 58 Y (43 lb ft).



**Fig. 174: Frame Suspension Retaining Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

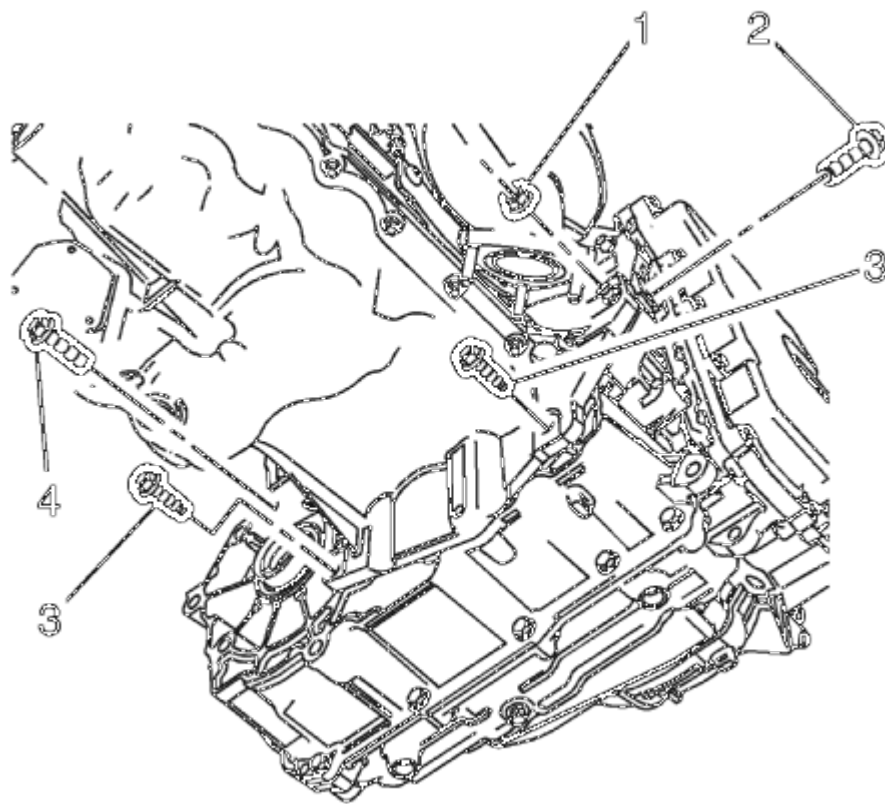


**Fig. 175: Lower Transmission Bolts**

Courtesy of GENERAL MOTORS COMPANY

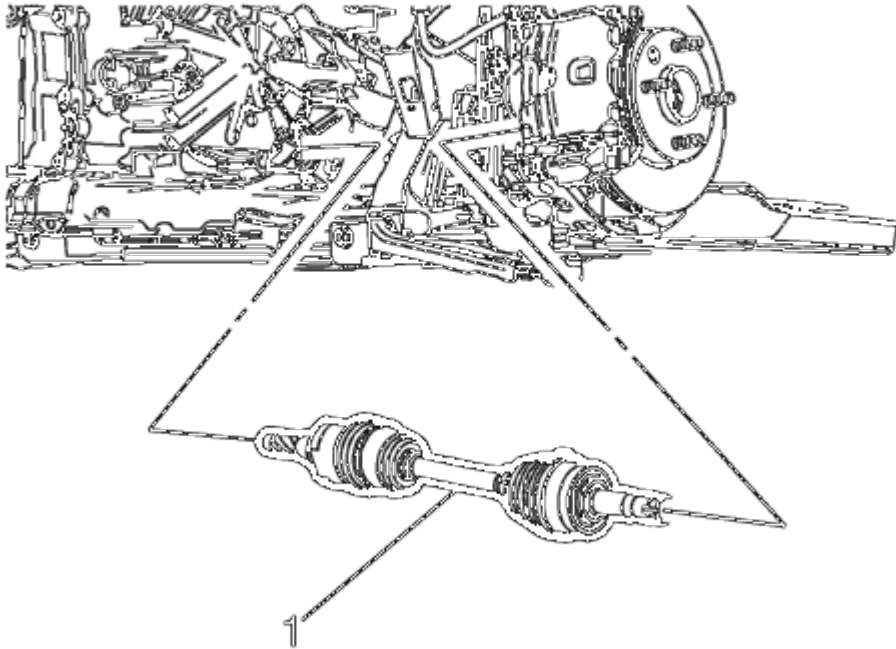
15. If equipped with manual transmission, install the lower transmission bolts (1) and tighten to 60 Y (44 lb ft).
16. Install the lower transmission bolts (2) and tighten 40 Y (30 lb ft).
17. Install the lower transmission bolt (3) and nut (4) and tighten to 40 Y (30 lb ft).





**Fig. 176: Lower Transmission Nut & Bolts**  
Courtesy of GENERAL MOTORS COMPANY

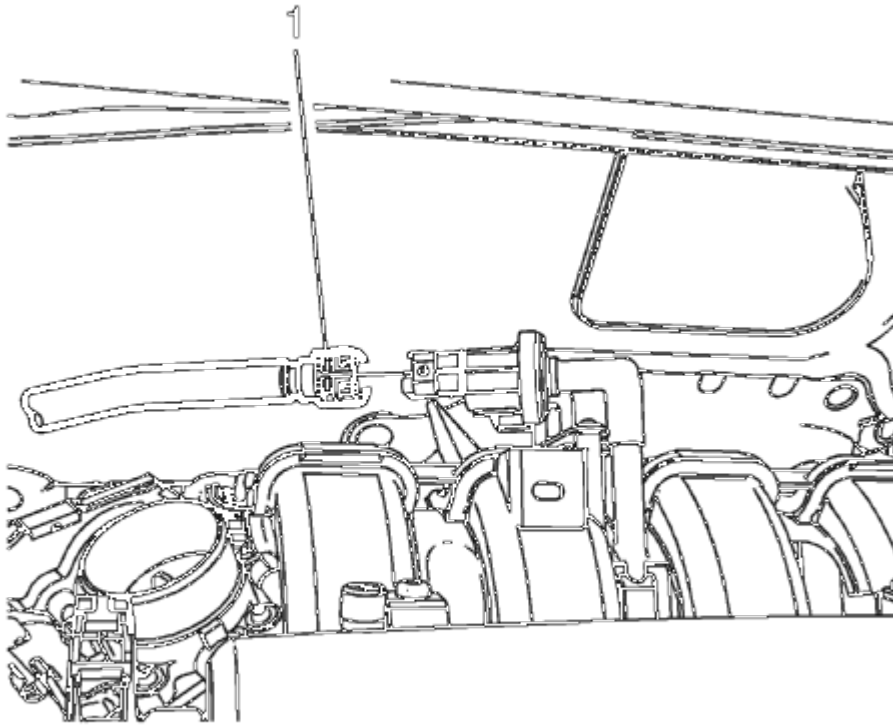
18. If equipped with an automatic transmission, install the lower transmission bolts (2, 4) and tighten to 60 Y (44 lb ft).
19. Install the lower transmission bolts (3) and the lower transmission nut (1) and tighten to 40 Y (30 lb ft).
20. Install the front exhaust pipe. Refer to **Exhaust Front Pipe Replacement (LUV, LUW)** .



**Fig. 177: Wheel Drive Shaft**

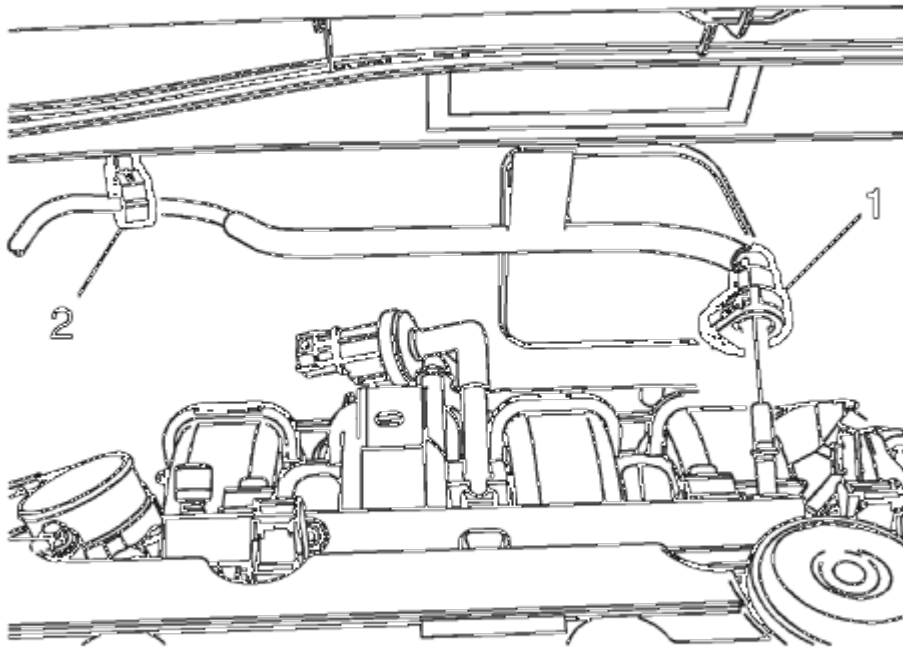
Courtesy of GENERAL MOTORS COMPANY

21. Install the wheel drive shafts. Refer to **Front Wheel Drive Shaft Replacement**



**Fig. 178: Evaporative Emission Pipe**  
Courtesy of GENERAL MOTORS COMPANY

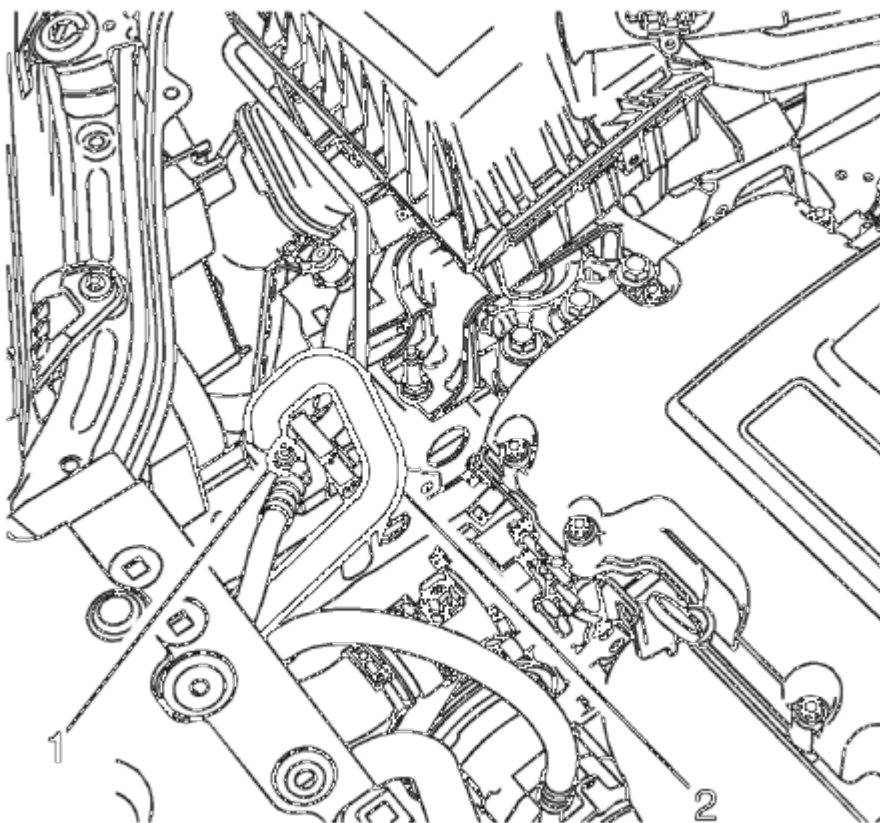
22. Connect the evaporative emission pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service** .



**Fig. 179: Fuel Feed Pipe & Plastic Collars**

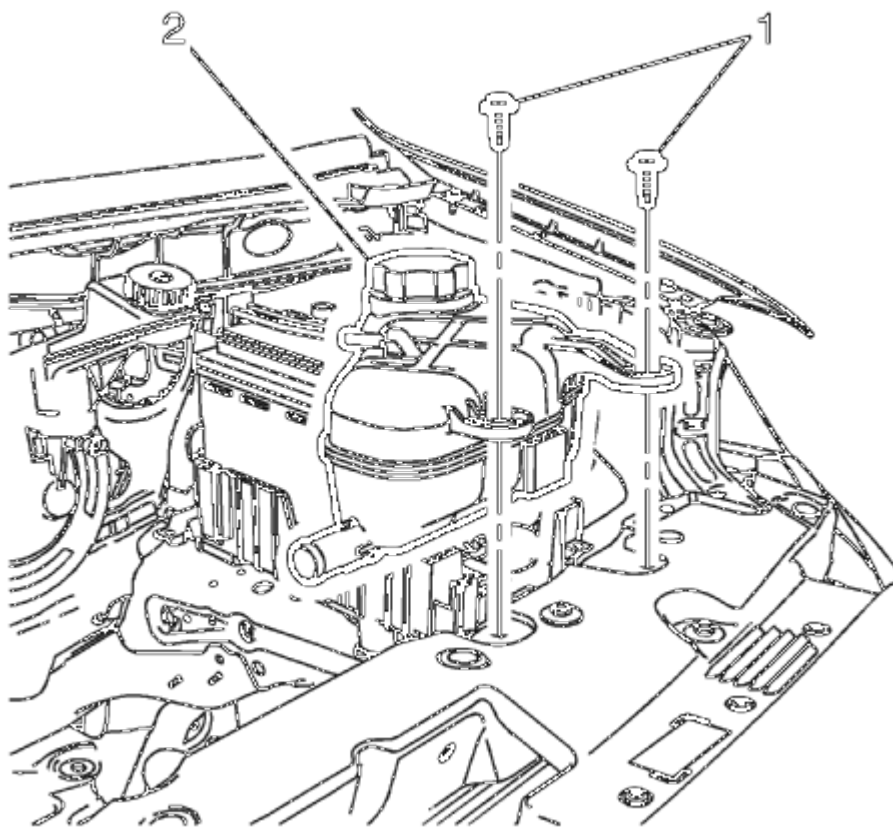
Courtesy of GENERAL MOTORS COMPANY

23. Connect the fuel feed pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service** .



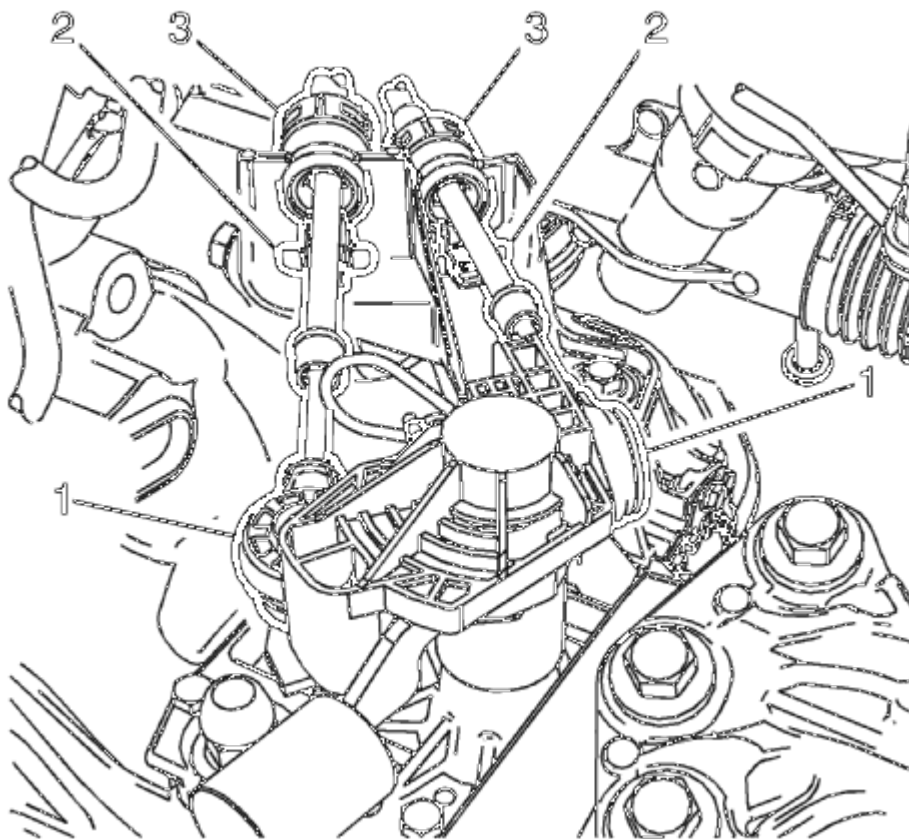
**Fig. 180: A/C Compressor & Condenser Hose & Nut**  
Courtesy of GENERAL MOTORS COMPANY

24. Install air conditioning compressor and condenser hose to the refrigerant hose.
25. Install air conditioning compressor and condenser hose nut (1) tighten nut to 22 N•m (16 lb ft).



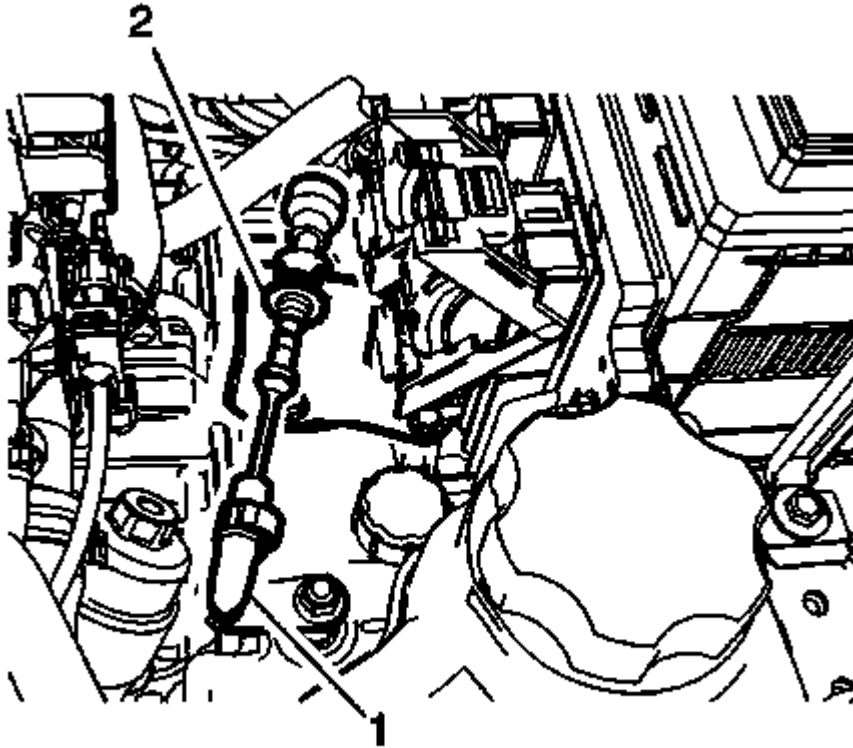
**Fig. 181: Radiator Surge Tank & Mounting Bolts**  
Courtesy of GENERAL MOTORS COMPANY

26. Install the radiator surge tank (2). Refer to **Radiator Surge Tank Replacement** .
27. Connect the fan connector.



**Fig. 182: Selector Level Cable Components**  
**Courtesy of GENERAL MOTORS COMPANY**

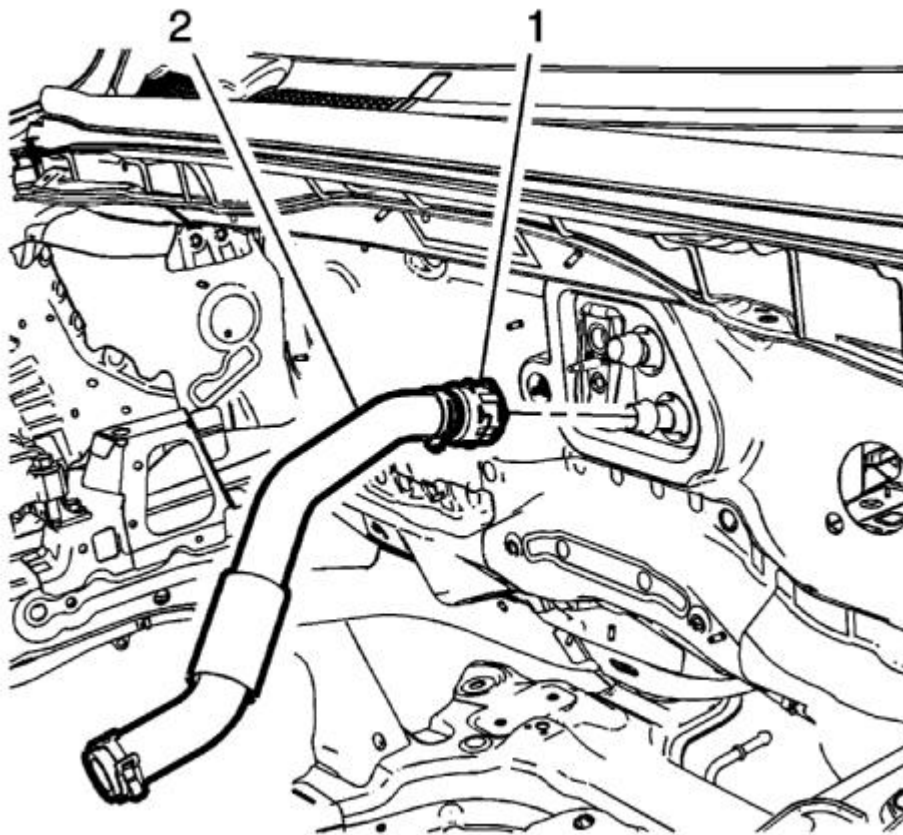
28. If equipped with manual transmission, Connect the shift lever and selector lever cable end (1) to the transmission shift lever and selector lever.
29. Connect the shift lever and selector lever cable to the shift lever and selector lever cable bracket.
30. Install the cable retainers (2) to the shift lever and selector lever cable bracket.



**Fig. 183: Automatic Transmission Range Selector Lever Cable Terminal & Shift Lever Pin**  
Courtesy of GENERAL MOTORS COMPANY

31. If equipped with automatic transmission, install the transmission range selector lever cable (2) to the cable bracket.
32. Connect the transmission range selector lever cable terminal (1) to the transmission manual shift lever pin.
33. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment** .

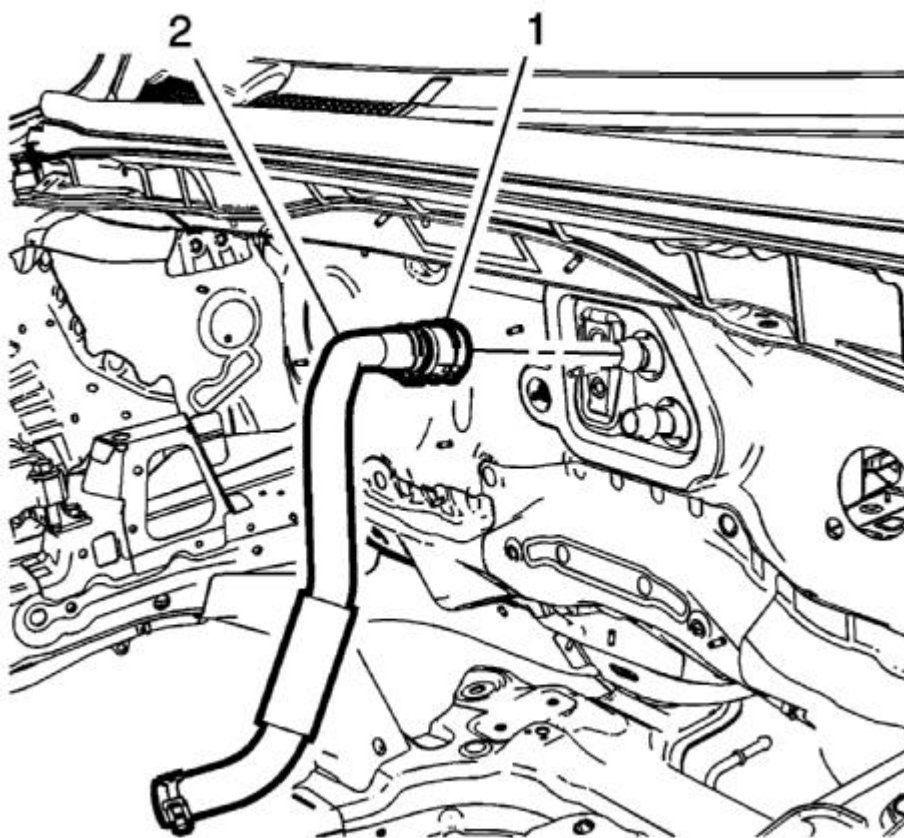




**Fig. 184: Heater Inlet Hose**

Courtesy of GENERAL MOTORS COMPANY

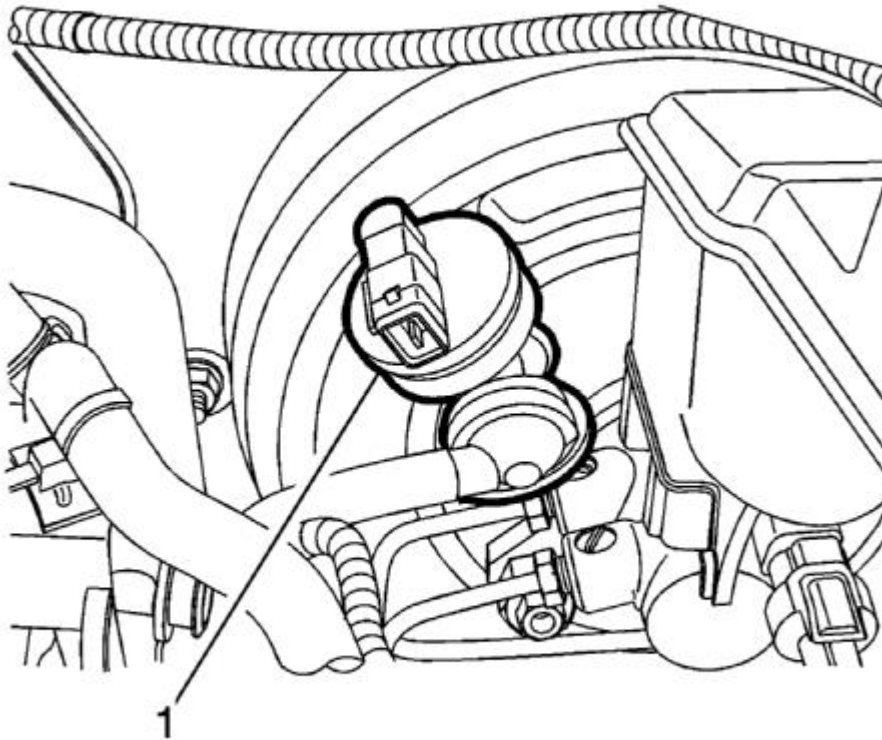
34. Connect the heater inlet hose (2) from the heater core. Refer to **Heater Inlet Hose Replacement (LUV)** .



**Fig. 185: Heater Outlet Hose**

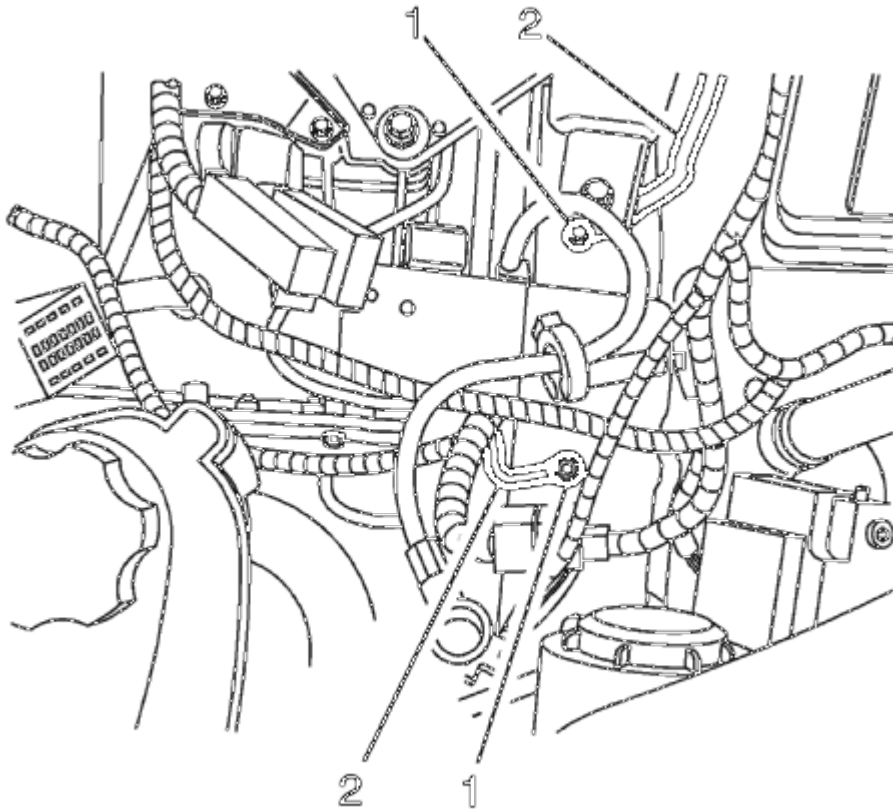
Courtesy of GENERAL MOTORS COMPANY

35. Connect the heater outlet hose (2) from the heater core. Refer to **Heater Outlet Hose Replacement (LUV)**.



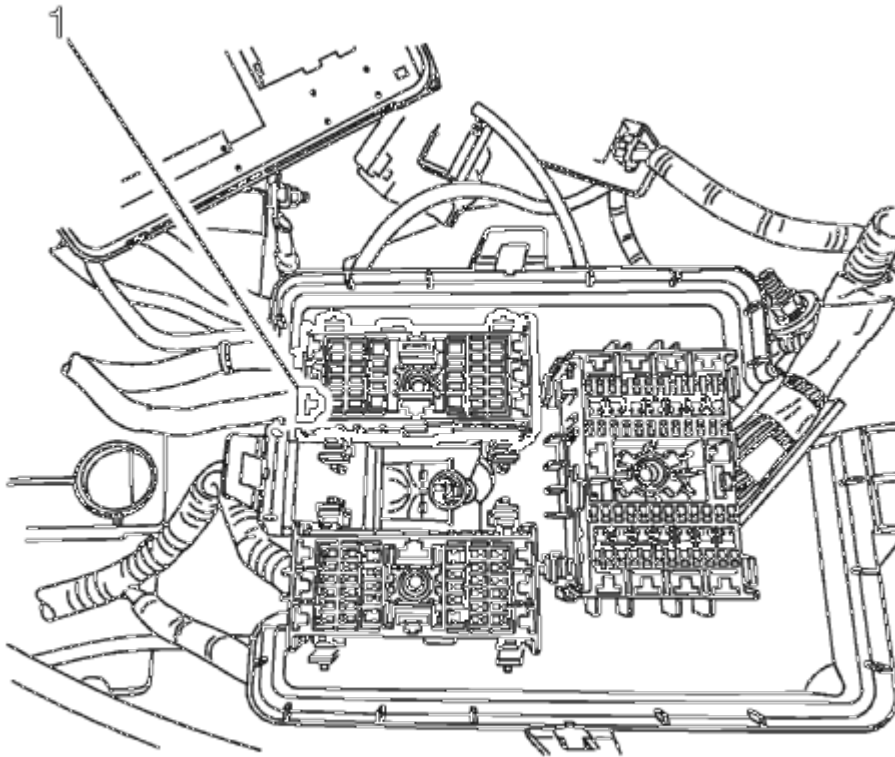
**Fig. 186: Electrical Vacuum Pump**  
Courtesy of GENERAL MOTORS COMPANY

36. Connect the electrical connector and install the brake booster hose (1).



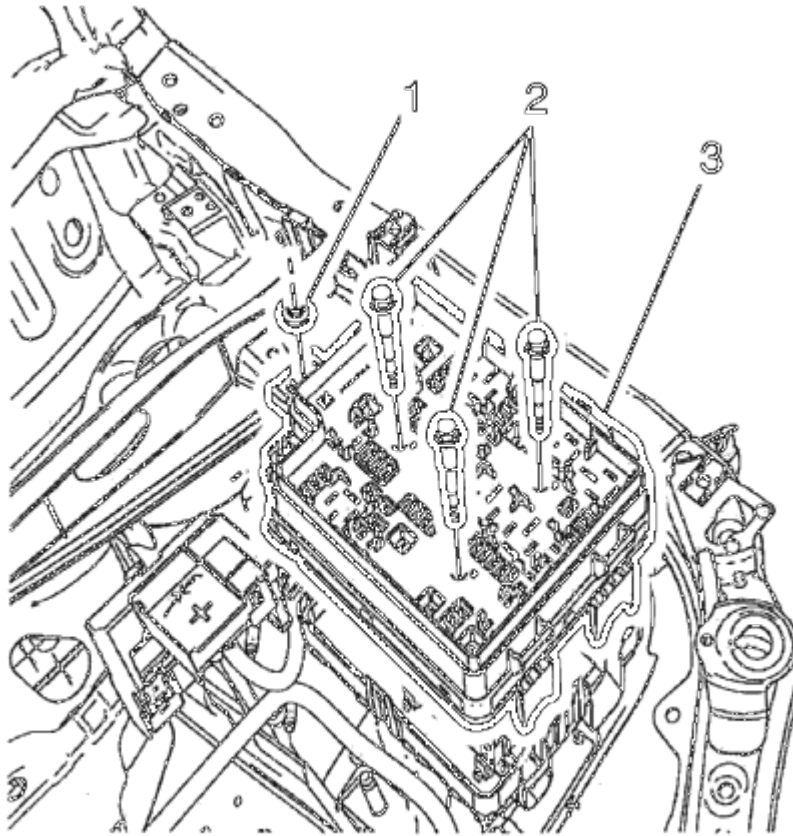
**Fig. 187: Wiring Harness & Ground Nuts**  
Courtesy of GENERAL MOTORS COMPANY

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

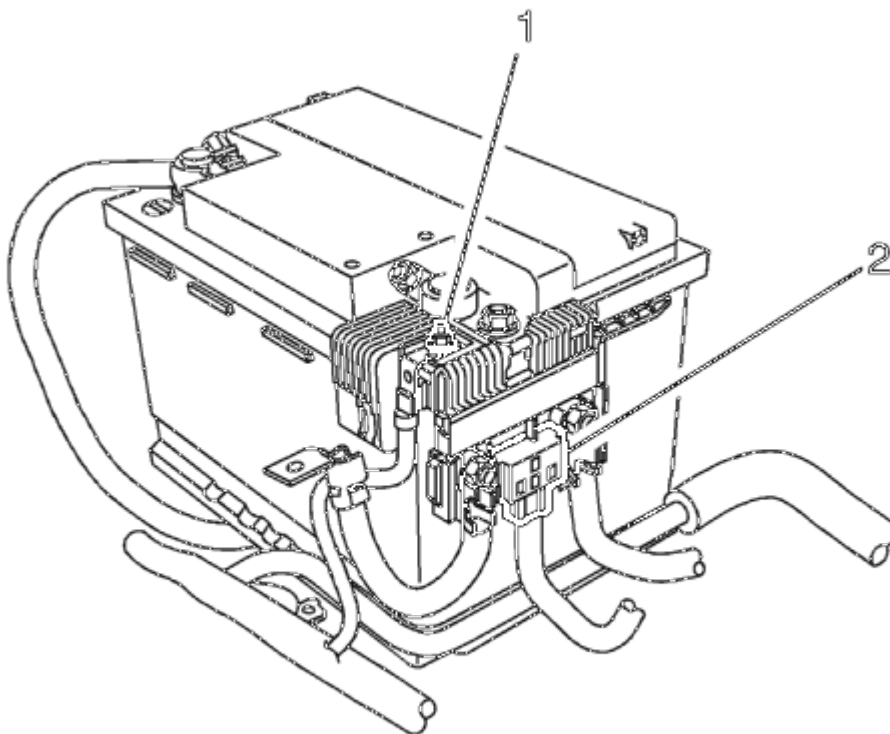


**Fig. 188: Wiring Harness - Top Of Engine**  
Courtesy of GENERAL MOTORS COMPANY

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

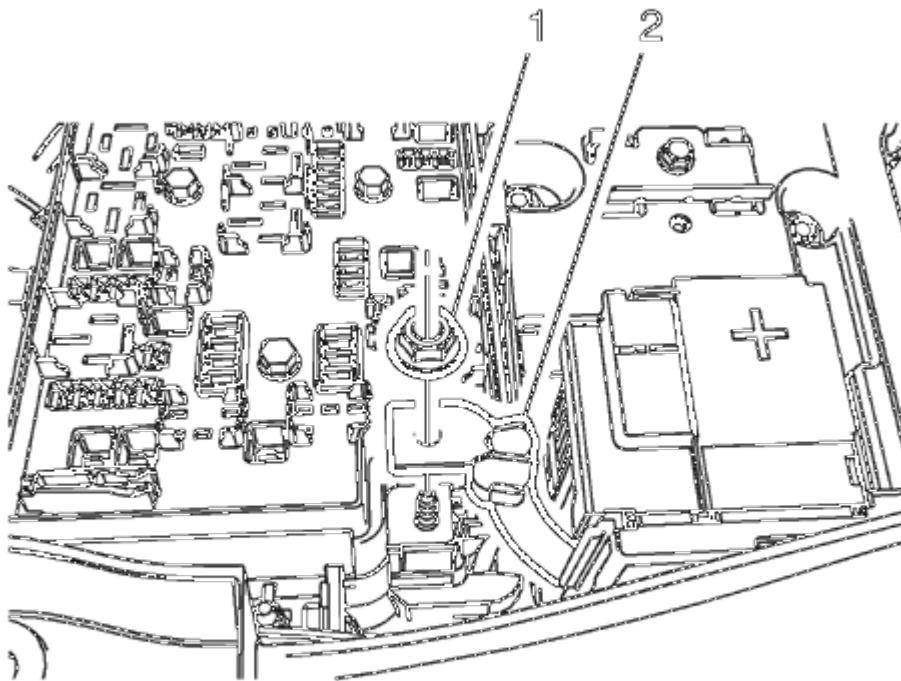
**Fig. 189: Junction Block****Courtesy of GENERAL MOTORS COMPANY**

39. Install the junction block to the base (3).
40. Install the junction block bolts (2) and tighten to 5 N•m (44 lb in).
41. Install the junction block nut (1) and tighten to 5 N•m (44 lb in).



**Fig. 190: Body Wiring Harness Connector & Positive Cable Nut**  
Courtesy of GENERAL MOTORS COMPANY

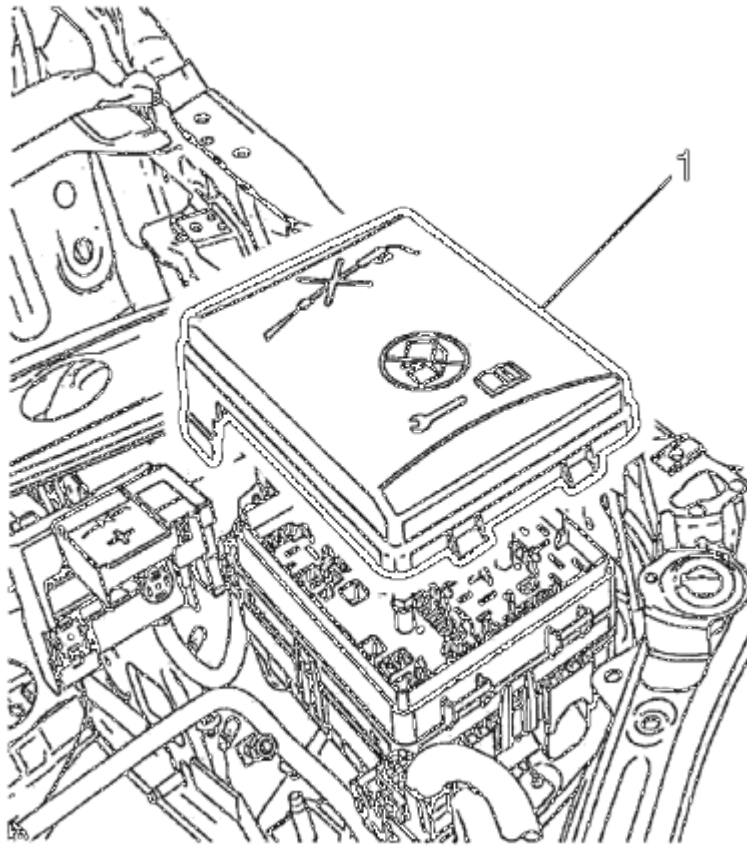
42. Install the battery positive cable to the battery positive cable junction block and tighten nut (1) to 5 N•m (44 lb in).
43. Connect the body wiring master harness connector (2), to the battery positive cable junction block.



**Fig. 191: Positive Battery Cable & Nut**  
Courtesy of GENERAL MOTORS COMPANY

44. Position the positive battery cable (2) to the junction block.
45. Install the positive battery cable nut (1) and tighten to 7 N•m (62 lb in).

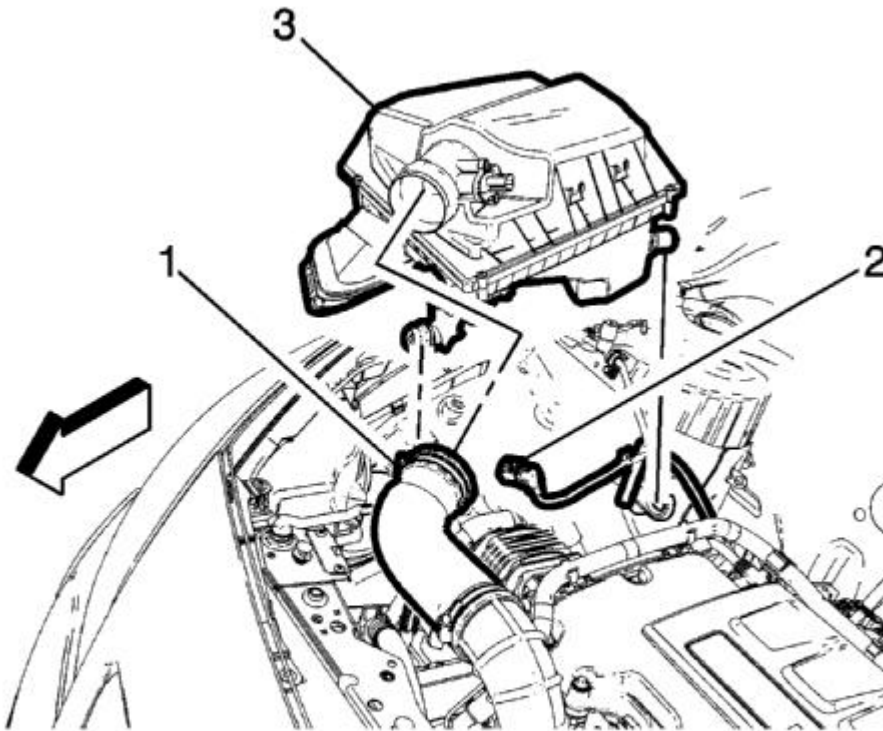




**Fig. 192: Junction Block & Cover**

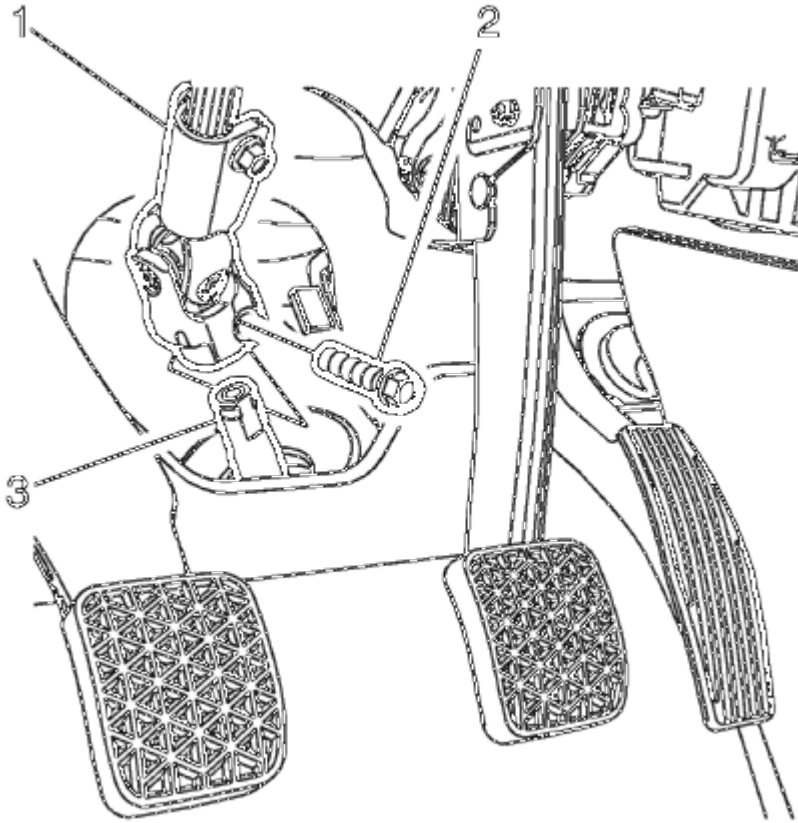
Courtesy of GENERAL MOTORS COMPANY

46. Install the junction block cover (1).



**Fig. 193: Air Cleaner Assembly & Components**  
Courtesy of GENERAL MOTORS COMPANY

47. Install the air cleaner assembly (1). Refer to **AIR CLEANER ASSEMBLY REPLACEMENT** .



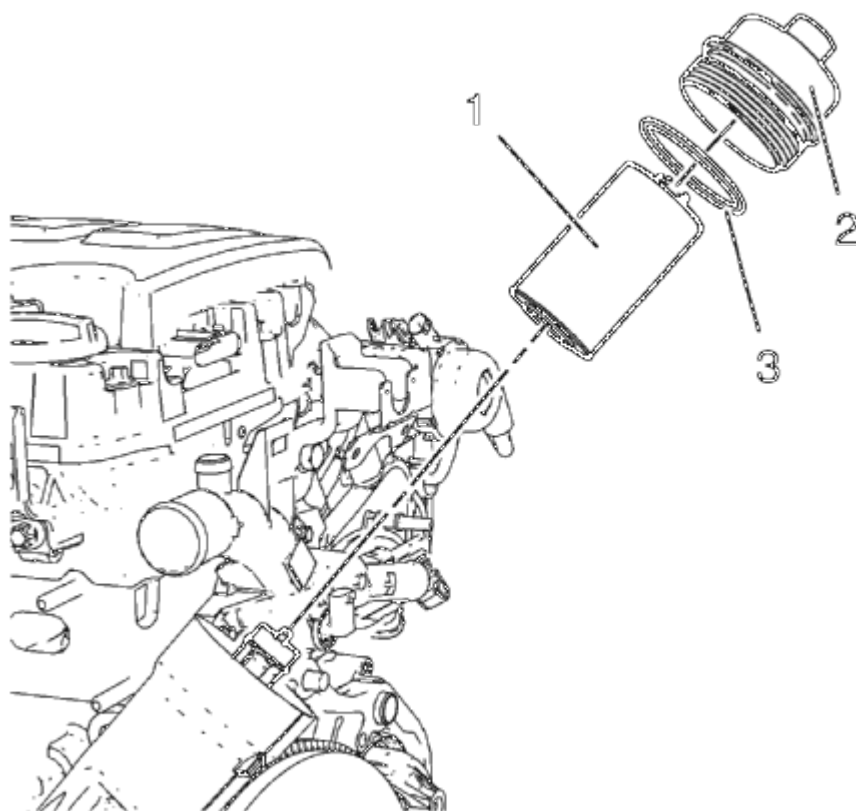
**Fig. 194: Intermediate Steering Shaft & Bolt**  
Courtesy of GENERAL MOTORS COMPANY

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

## ENGINE OIL AND OIL FILTER REPLACEMENT

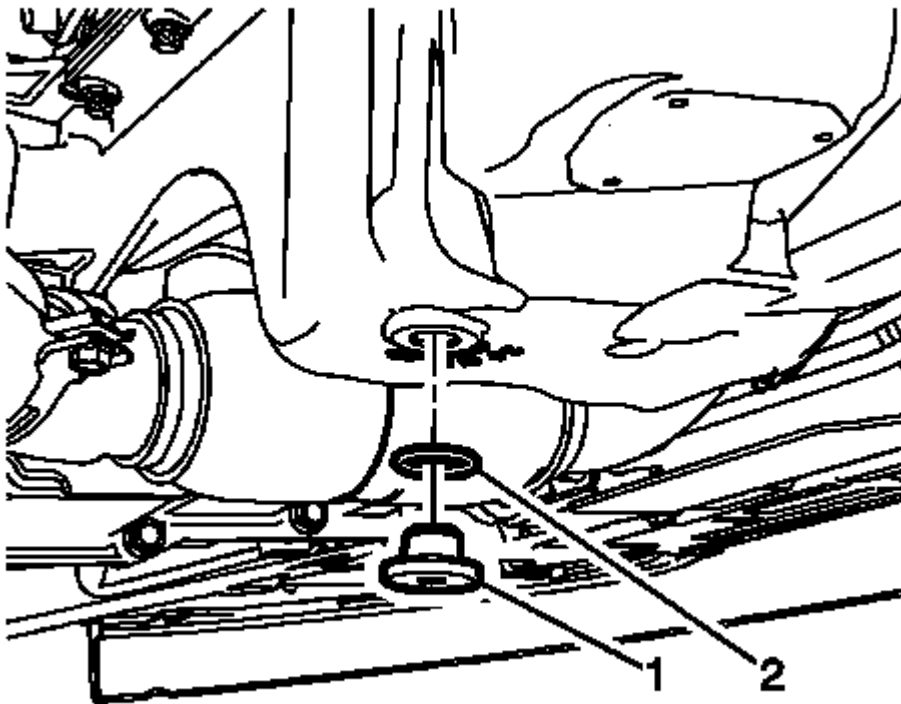
### Removal Procedure

1. Place a drain pan below the vehicle.



**Fig. 195: Engine Oil Filter Element, Cap And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

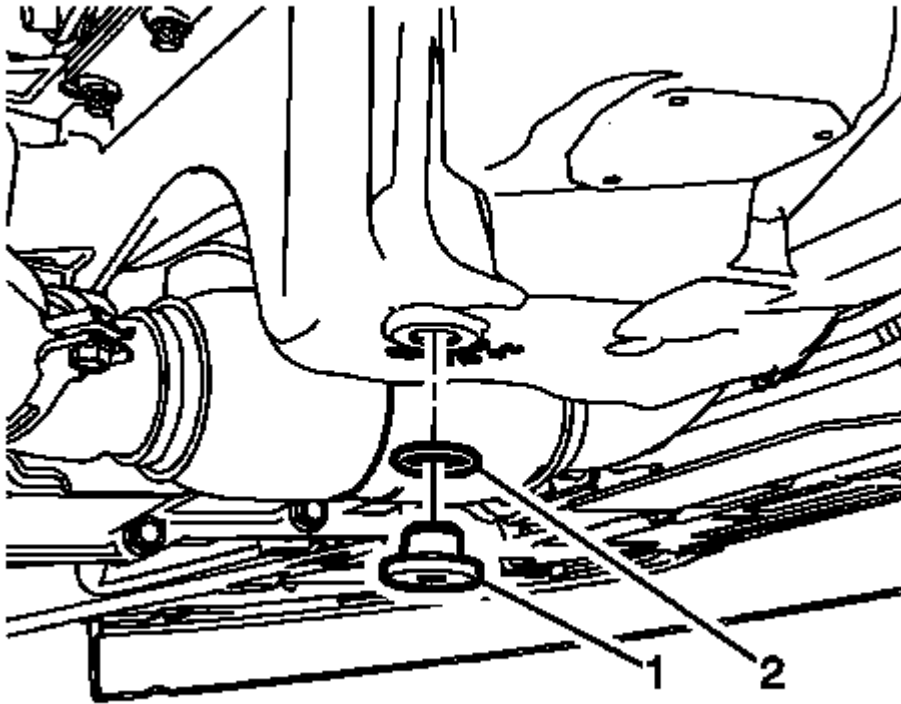
2. Remove the engine oil filter cap (2), cap seal ring (3) and the oil filter element (1).
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .



**Fig. 196: Oil Pan Drain Plug & Seal**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pan drain plug (1) and seal (2).
5. Allow the oil to drain into the drain pan.

**Installation Procedure**



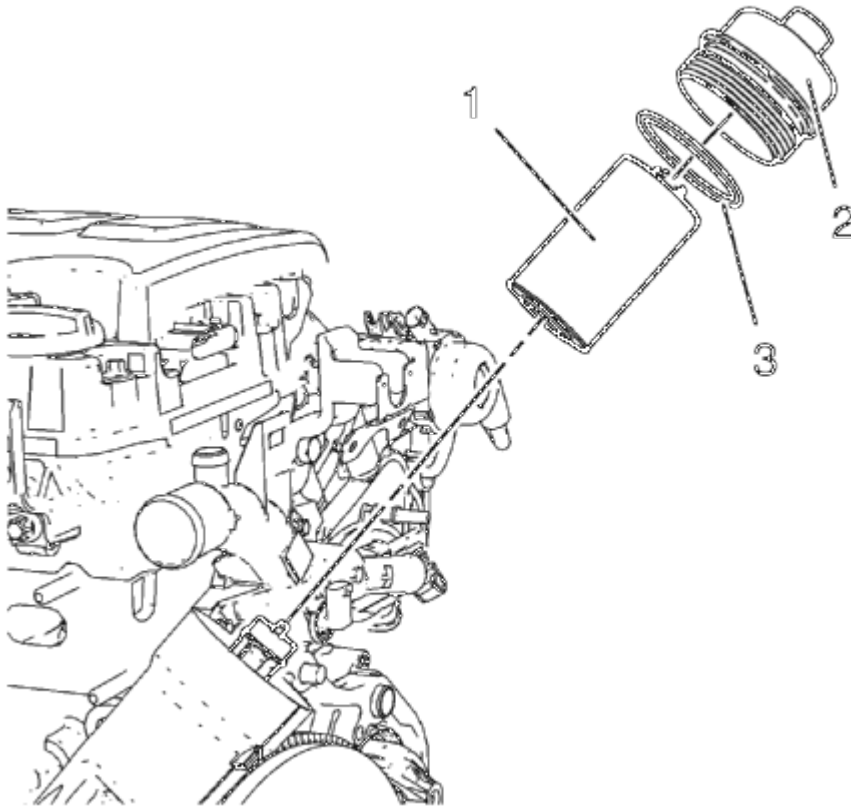
**Fig. 197: Oil Pan Drain Plug & Seal**

Courtesy of GENERAL MOTORS COMPANY

1. Clean the oil pan drain plug threads in the oil pan and plug (1).
2. Install a NEW seal ring (2) on the oil pan drain plug.

**CAUTION: Refer to Fastener Caution .**

3. Install the oil pan drain plug and tighten to 14 N.m (124 lb in).
4. Lower the vehicle.



**Fig. 198: Engine Oil Filter Element, Cap And Seal Ring**  
 Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate the **NEW** oil filter cap seal ring with engine oil.

5. Install the engine oil filter cap (2), NEW engine oil filter cap seal ring (3) and a NEW oil filter element (1).

**CAUTION:** Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

6. Tighten the engine oil filter cap to 25 N.m (18 lb ft).

**CAUTION:** Using engine oils of any viscosity other than those viscosities recommended could result in engine damage.

**NOTE:** Do not overfill the engine with engine oil.

7. Fill with engine oil. Refer to **Fluid and Lubricant Recommendations** to find the specified viscosity and volume.

8. Start the engine and allow it to run until the oil pressure builds and the indicator goes off.
9. Inspect the engine oil level.
10. If equipped, reset the service interval indicator.

## **TURBOCHARGER REPLACEMENT**

### **Special Tools**

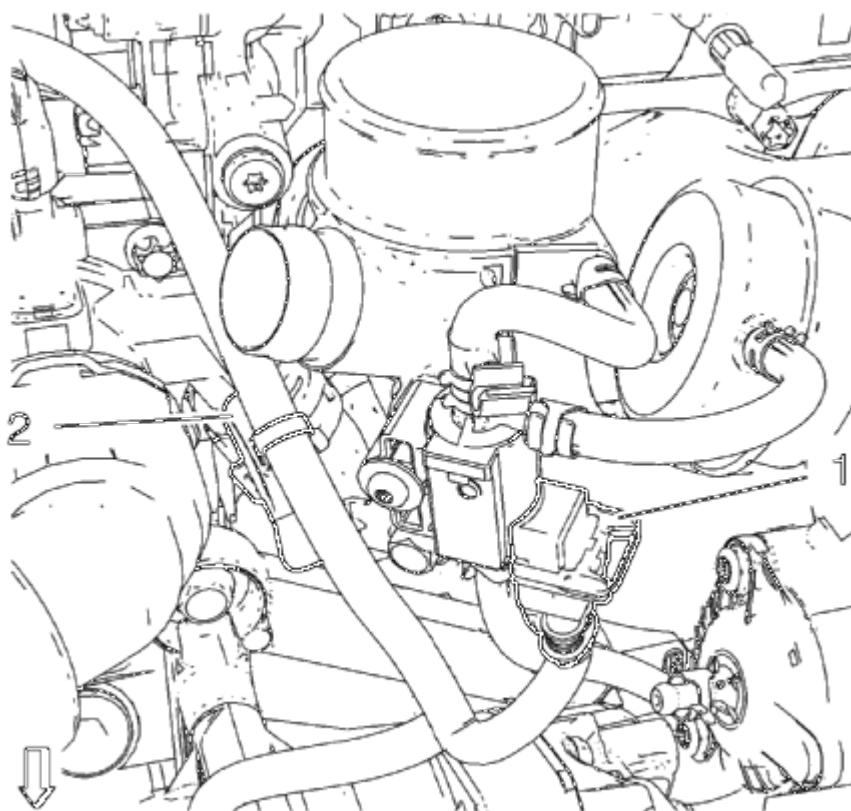
**EN-49942** Holding Wrench

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

### **Removal Procedure**

1. Disconnect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Disconnect the positive crankcase ventilation pipe from turbocharger. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.
5. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUV)** .

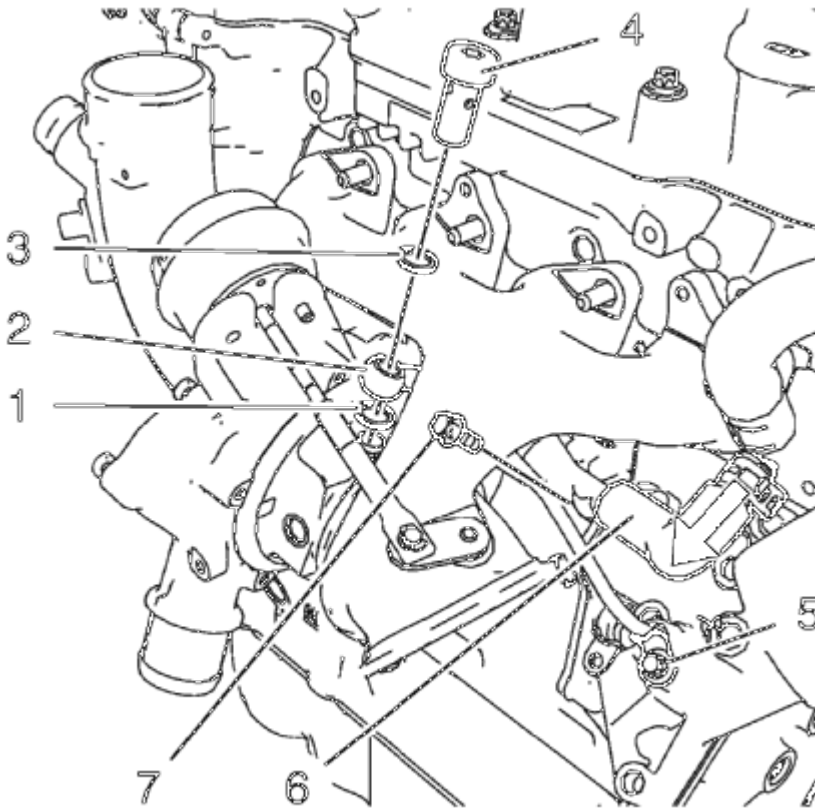




**Fig. 199: Turbocharger Wastegate Regulator Solenoid Valve Wiring Harness Connector And Retaining Clip**

Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the turbocharger wastegate regulator solenoid valve wiring harness connector (1) and unclip wiring harness from retainer clip (2).

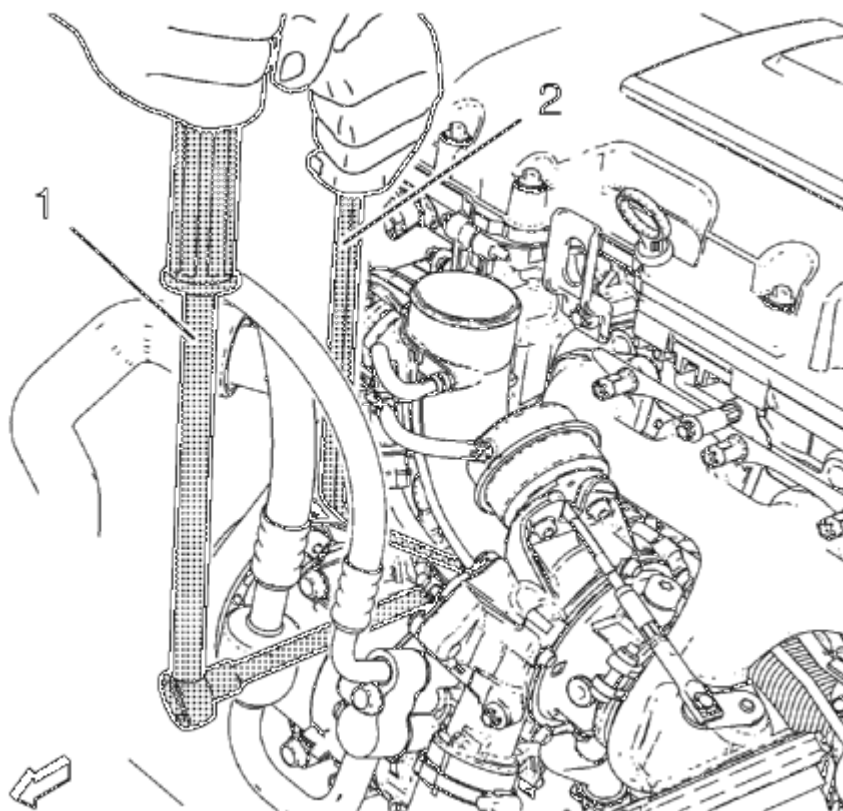


**Fig. 200: Turbocharger Oil Feed Pipe Components**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the turbocharger oil feed pipe hollow screw (4).
8. Remove and DISCARD the 2 seal rings (1) and (3).
9. Remove the turbocharger oil feed pipe bolt (5).

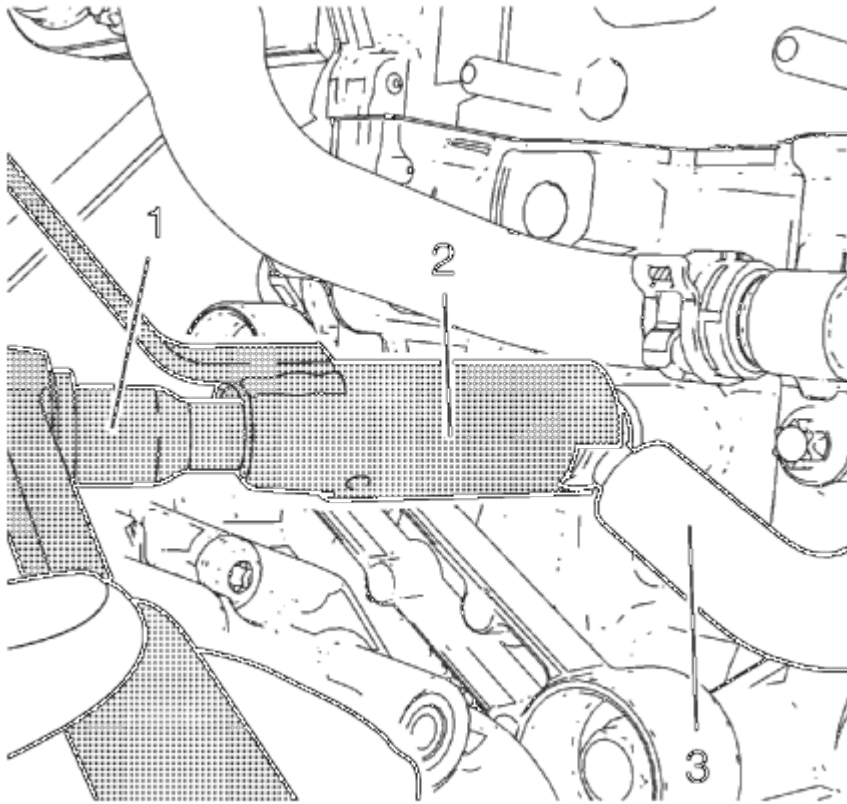
**NOTE:** Close the screw bore in the turbocharger in order to avoid contamination.

10. Remove the turbocharger oil feed pipe (2).
11. Loosen the turbocharger coolant return hose clamp and remove the turbocharger coolant return hose (6) from the oil cooler inlet pipe.
12. Remove the turbocharger coolant return pipe bolt (7).
13. Remove the charge air cooler inlet air hose from the turbocharger. Refer to **Charge Air Cooler Inlet Air Hose Replacement**.



**Fig. 201: Ratchet Wrench And Holding Wrench**  
Courtesy of GENERAL MOTORS COMPANY

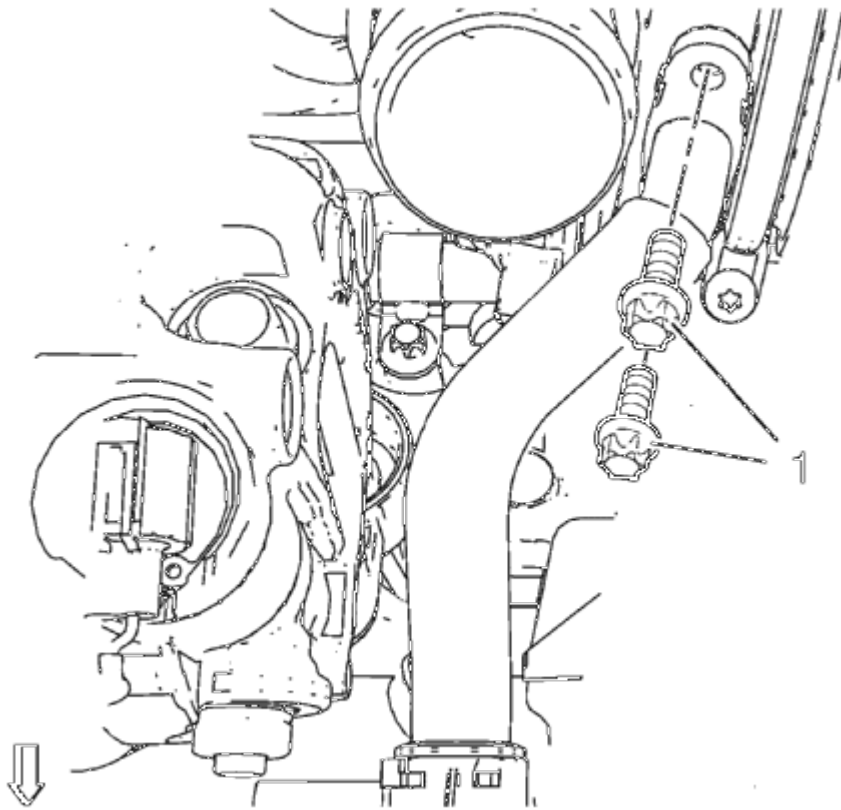
14. Install the **EN-49942** holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through **EN-49942** holding wrench to the turbocharger coolant feed pipe hollow screw.



**Fig. 202: Ratchet Wrench, Holding Wrench And Coolant Feed Pipe**  
Courtesy of GENERAL MOTORS COMPANY

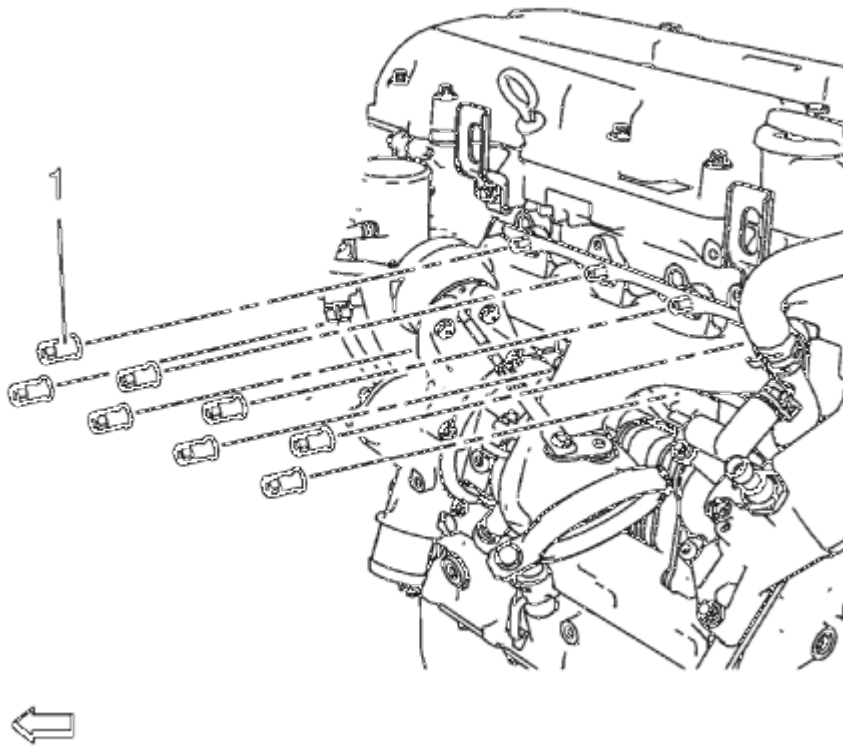
**NOTE:** EN-49942 holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the loosening procedure.

15. Loosen the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1).
16. Remove the turbocharger coolant feed pipe hollow screw.
17. Remove and DISCARD the 2 seal rings.
18. Remove the three way warm catalytic converter. Refer to Catalytic Converter Replacement (LUV) .

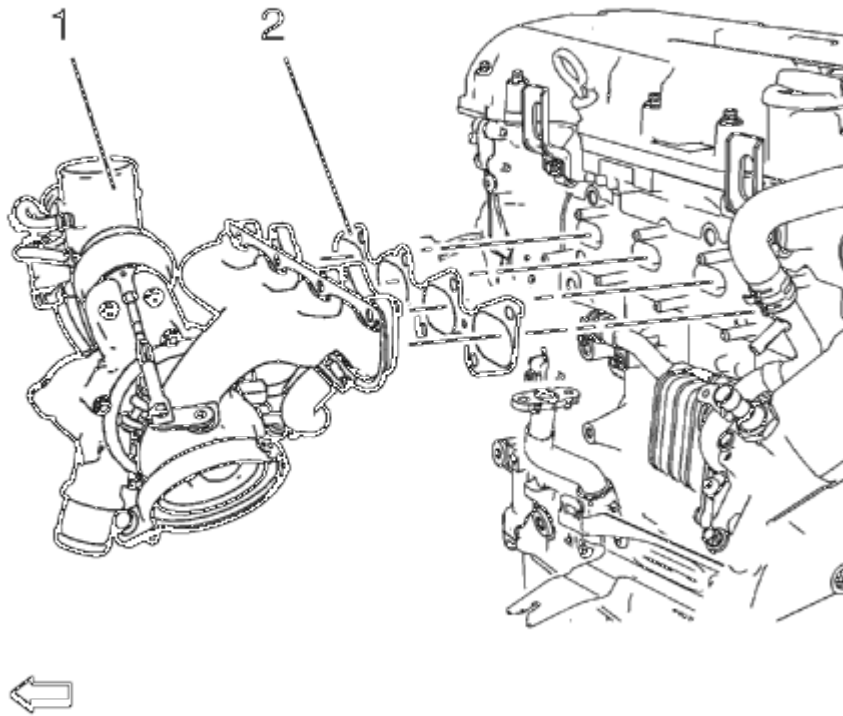


**Fig. 203: Turbocharger Oil Return Pipe Bolts**  
**Courtesy of GENERAL MOTORS COMPANY**

19. Remove the 2 turbocharger oil return pipe bolts (1) from turbocharger.
20. Remove the turbocharger oil return pipe from the turbocharger.
21. Remove and DISCARD the gasket.

**Fig. 204: Turbocharger Nuts****Courtesy of GENERAL MOTORS COMPANY**

22. Remove and DISCARD the 8 turbocharger nuts (1).

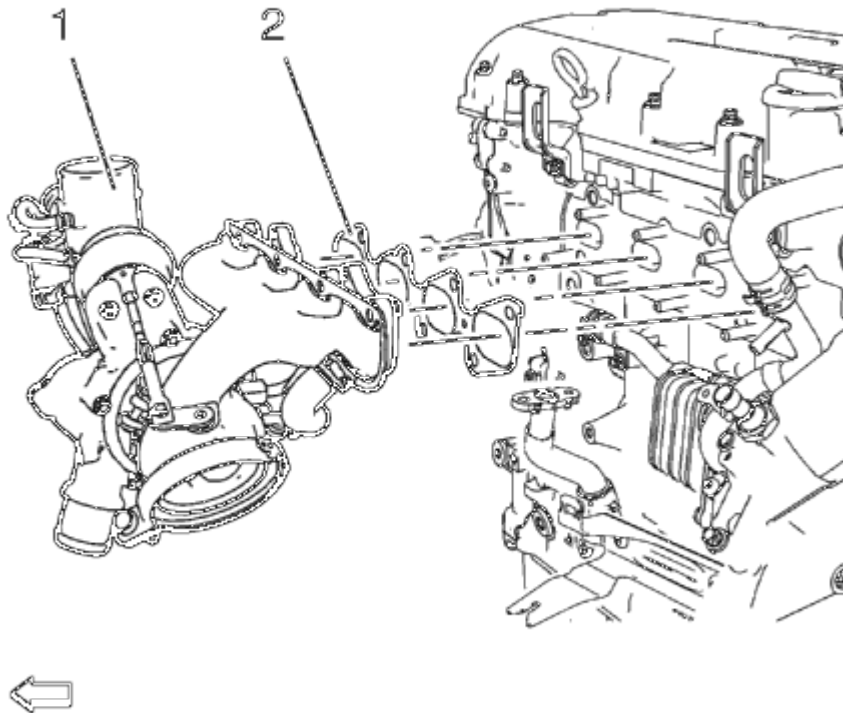


**Fig. 205: Turbocharger Assembly And Gasket**  
Courtesy of GENERAL MOTORS COMPANY

23. Remove the turbocharger assembly (1).
24. Remove and DISCARD the turbocharger gasket (2).
25. Remove the assembly parts from the turbocharger as necessary. Refer to **Turbocharger Disassemble**.
26. If the turbocharger is being reused, refer to **Turbocharger Cleaning and Inspection**.

#### Installation Procedure

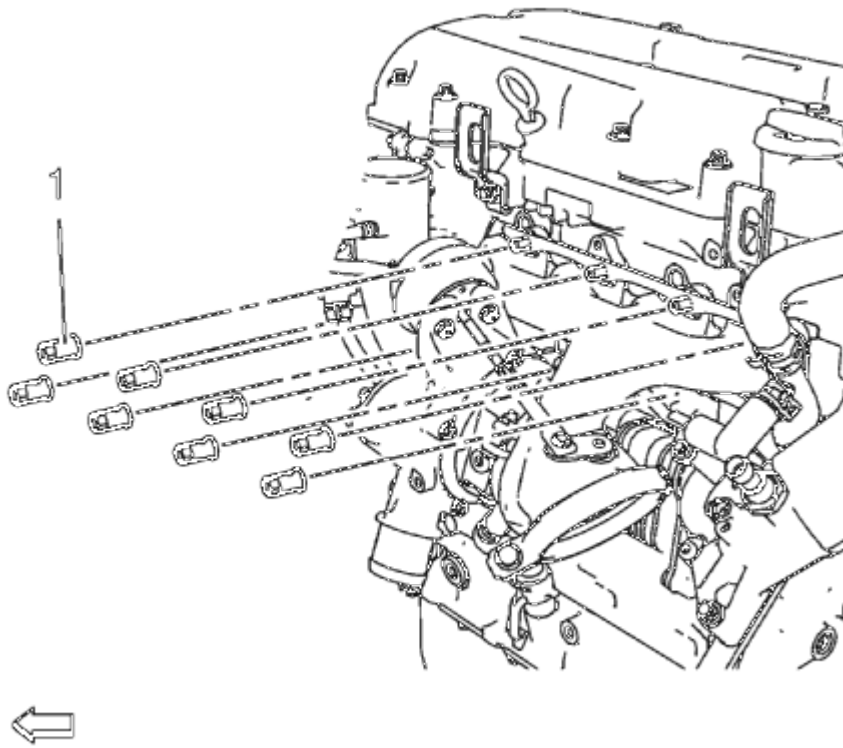
1. Install the assembly parts to the turbocharger as necessary. Refer to **Turbocharger Assemble**.
2. Clean the sealing surfaces.



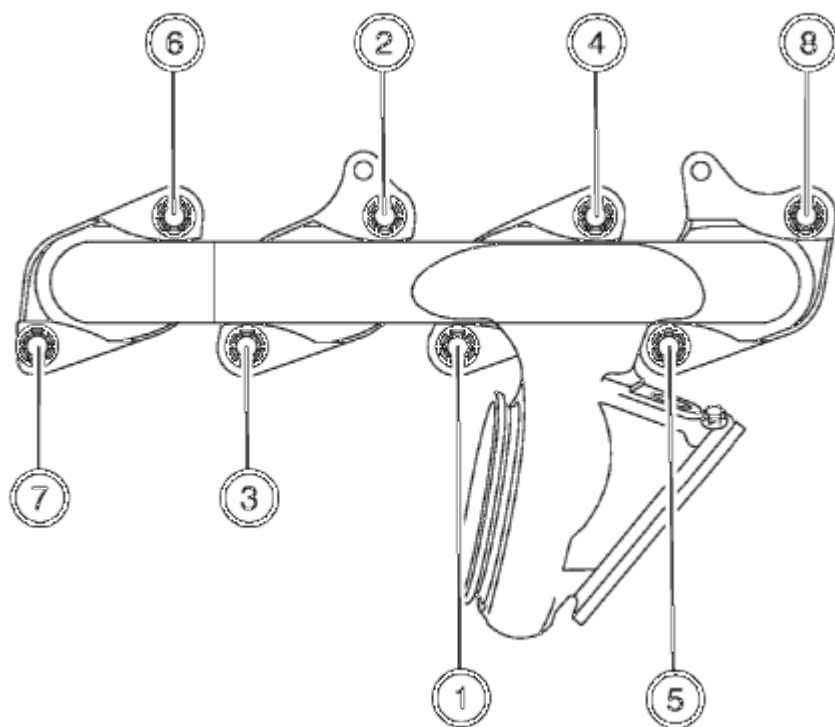
**Fig. 206: Turbocharger Assembly And Gasket**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Install a NEW turbocharger gasket.
4. Install the turbocharger assembly (1).



**Fig. 207: Turbocharger Nuts****Courtesy of GENERAL MOTORS COMPANY**

5. Install the 8 NEW turbocharger nuts (1).

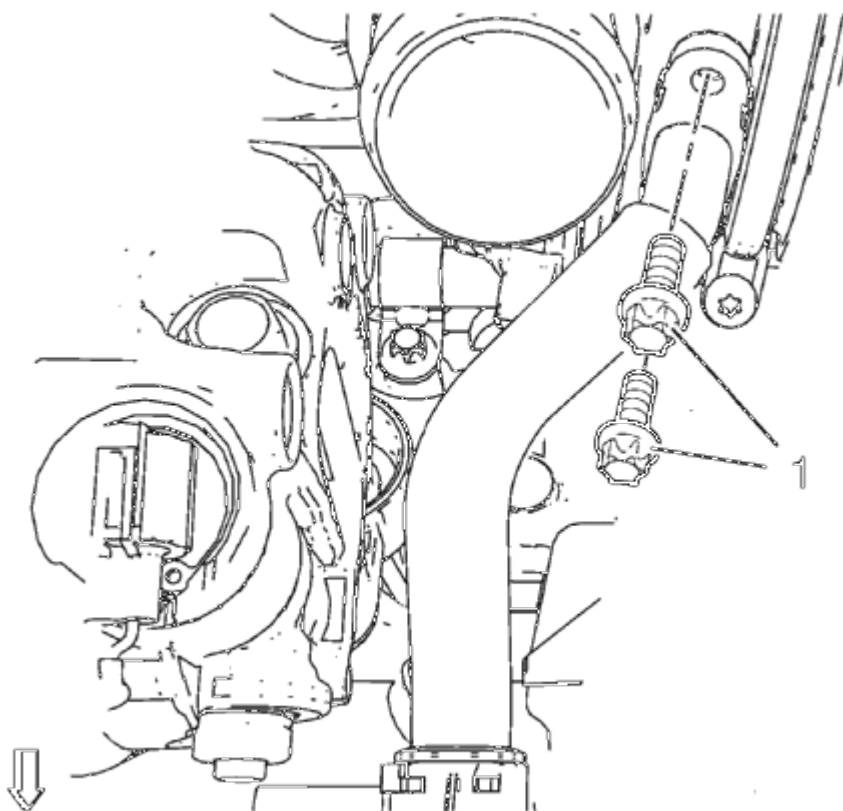


**Fig. 208: Turbocharger Nuts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

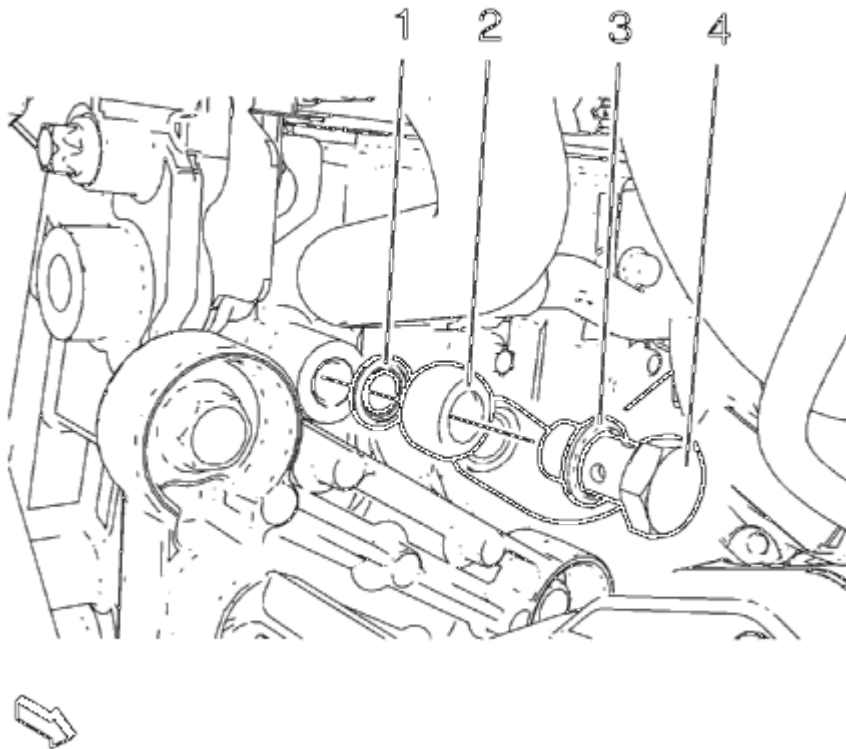
**CAUTION:** Refer to Torque-to-Yield Fastener Caution .

6. Tighten the 8 turbocharger nuts in a sequence as shown to 8 N.m (71 lb in).
7. Repeat the tightening procedure to ensure a proper fastening of the turbocharger nuts.



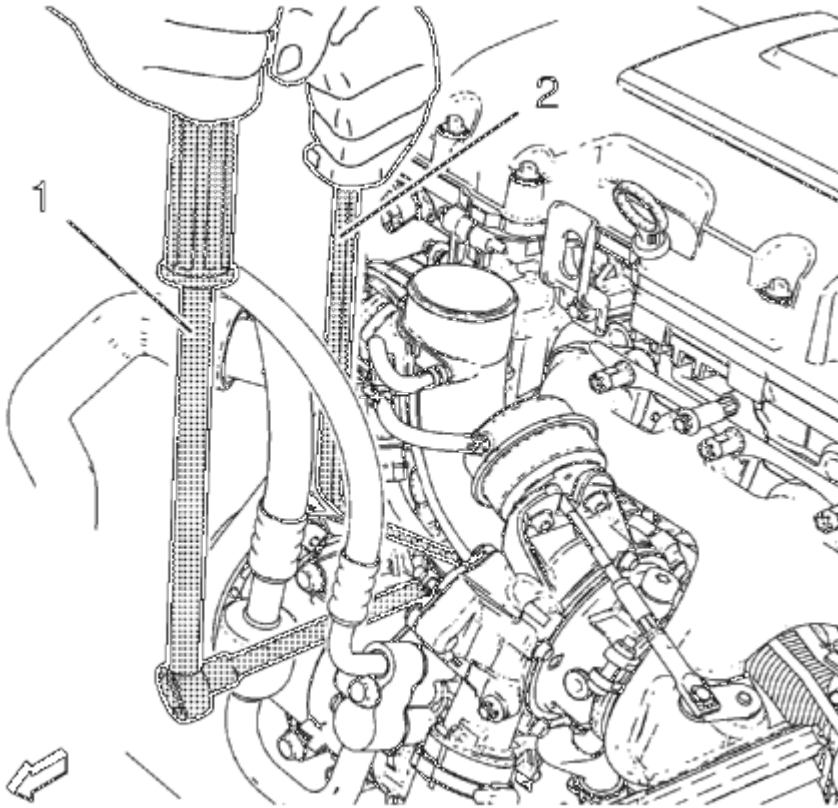
**Fig. 209: Turbocharger Oil Return Pipe Bolts**  
Courtesy of GENERAL MOTORS COMPANY

8. Install a NEW gasket and the 2 turbocharger oil return pipe bolts (1) and tighten to 8 N.m (71 lb in).
9. Install the three way warm up catalytic converter. Refer to **Catalytic Converter Replacement (LUV)**.



**Fig. 210: Turbocharger Coolant Feed Pipe Components**  
Courtesy of GENERAL MOTORS COMPANY

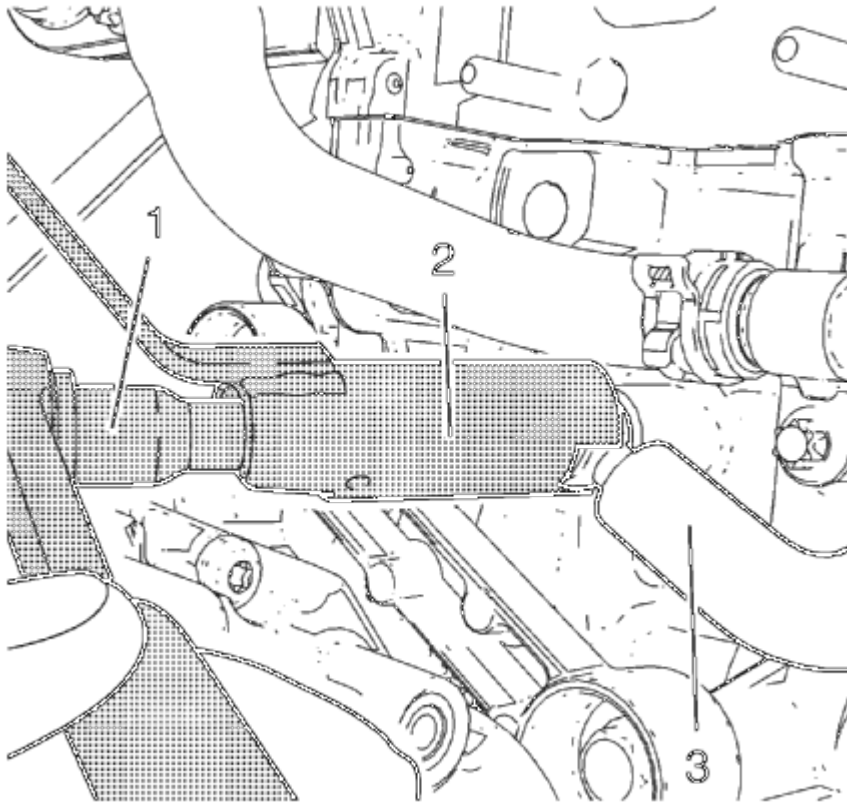
10. Install the turbocharger coolant feed pipe to the engine block. Use the following procedure:
  - Install a NEW seal ring (3) to the turbocharger coolant feed pipe hollow screw (4).
  - Install the turbocharger coolant feed pipe hollow screw along with the seal ring to the turbocharger coolant feed pipe (2).
  - Install a NEW seal ring (1) to the turbocharger coolant feed pipe hollow screw.
  - Install the turbocharger coolant feed pipe hollow screw along with the turbocharger coolant feed pipe and the 2 seal rings to the engine.



**Fig. 211: Ratchet Wrench And Holding Wrench**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The EN-49942 holding wrench should be installed in a perpendicular position as shown to ensure a proper installation position of the turbocharger coolant feed pipe.

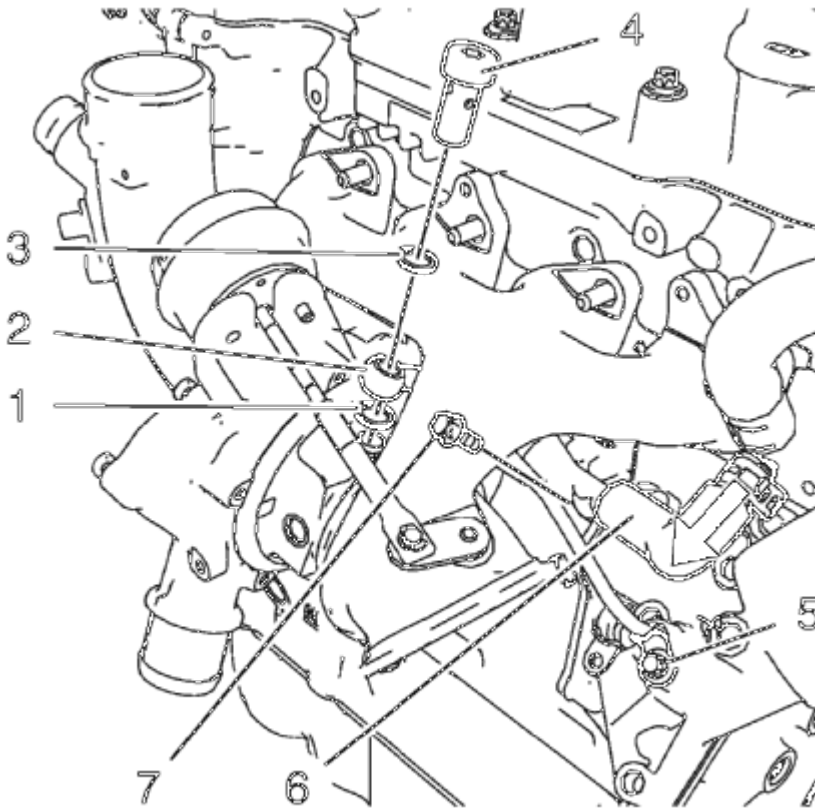
11. Install the **EN-49942** holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through **EN-49942** holding wrench to the turbocharger coolant feed pipe hollow screw.



**Fig. 212: Ratchet Wrench, Holding Wrench And Coolant Feed Pipe**  
Courtesy of GENERAL MOTORS COMPANY

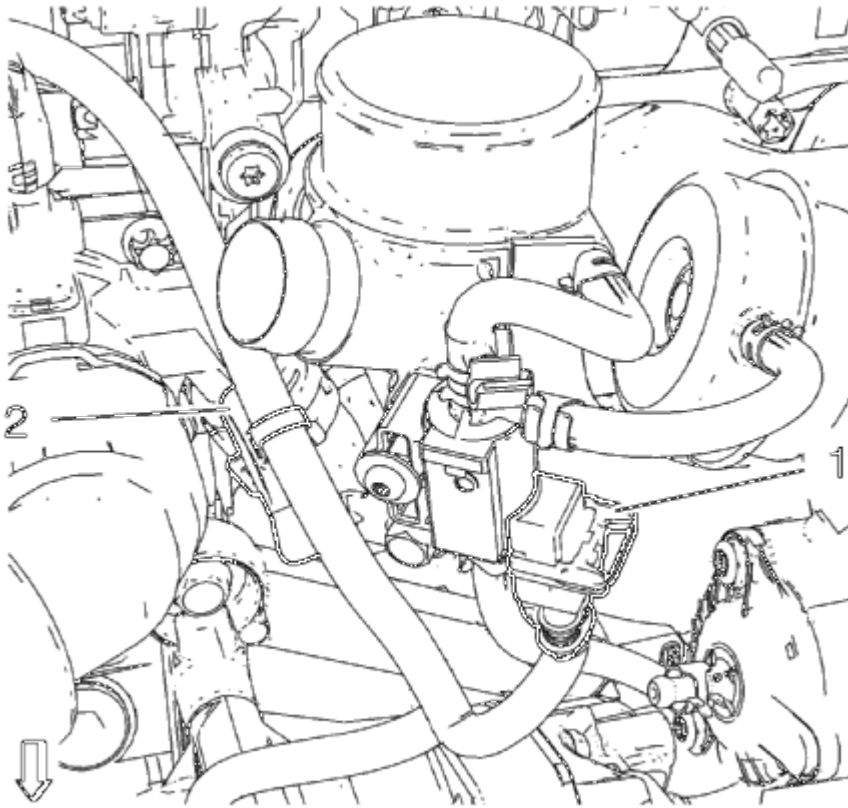
**NOTE:** EN-49942 holding wrench (2) should be installed to the turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the fastening procedure.

12. Tighten the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1) to 30 N.m (22 lb ft).
13. Install the charge air cooler inlet air hose to the turbocharger. Refer to **Charge Air Cooler Inlet Air Hose Replacement**.



**Fig. 213: Turbocharger Oil Feed Pipe Components**  
**Courtesy of GENERAL MOTORS COMPANY**

14. Install the turbocharger coolant return pipe bolt (7) and tighten to 8 N.m (71 lb in).
15. Install the turbocharger coolant return hose (6) to the oil cooler inlet pipe.
16. Install the turbocharger coolant return hose clamp.
17. Install the turbocharger oil feed pipe (2) to the oil cooler and the turbocharger.
18. Install the turbocharger oil feed pipe bolt (5).
19. Install the turbocharger oil feed pipe hollow screw (4) along with the 2 NEW seal rings (1) and (3) and tighten to 30 N.m (22 lb ft).
20. Tighten the turbocharger oil feed pipe bolt to 10 N.m (89 lb in).



**Fig. 214: Turbocharger Wastegate Regulator Solenoid Valve Wiring Harness Connector And Retaining Clip**

Courtesy of GENERAL MOTORS COMPANY

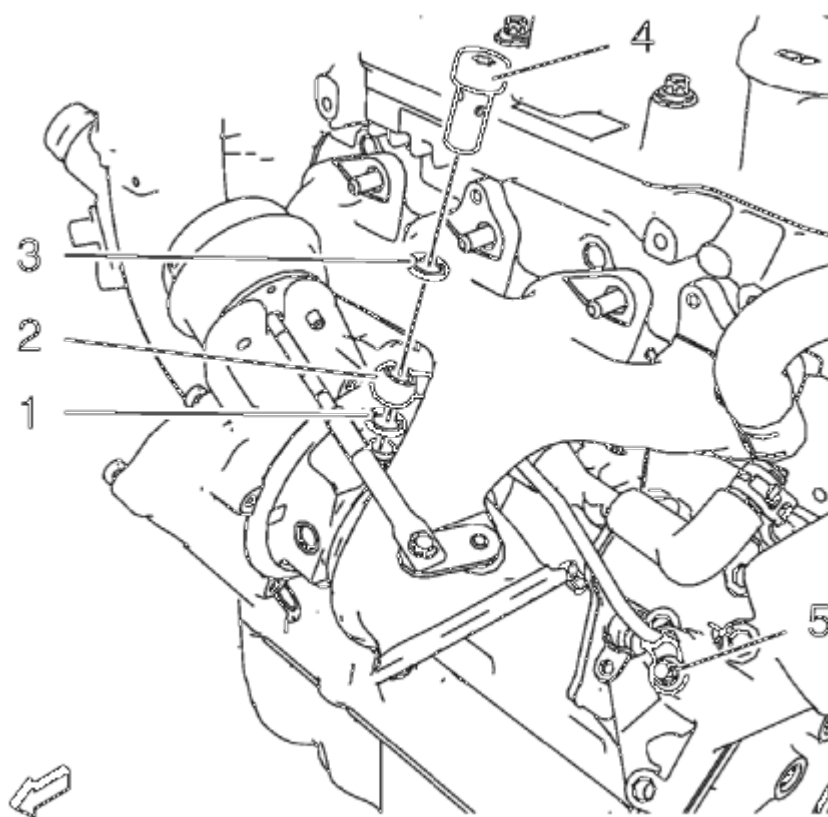
21. Connect the turbocharger wastegate regulator solenoid valve wiring harness connector (1) and clip in wiring harness to retainer clip (2).
22. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUV)** .
23. Connect the positive crankcase ventilation pipe to the turbocharger. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.
24. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
25. Connect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
26. Fill the cooling system. Refer to **Cooling System Draining and Filling** .

## **TURBOCHARGER OIL FEED PIPE REPLACEMENT**

### **Removal Procedure**

1. Open the hood.
2. Disconnect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LUV)** .



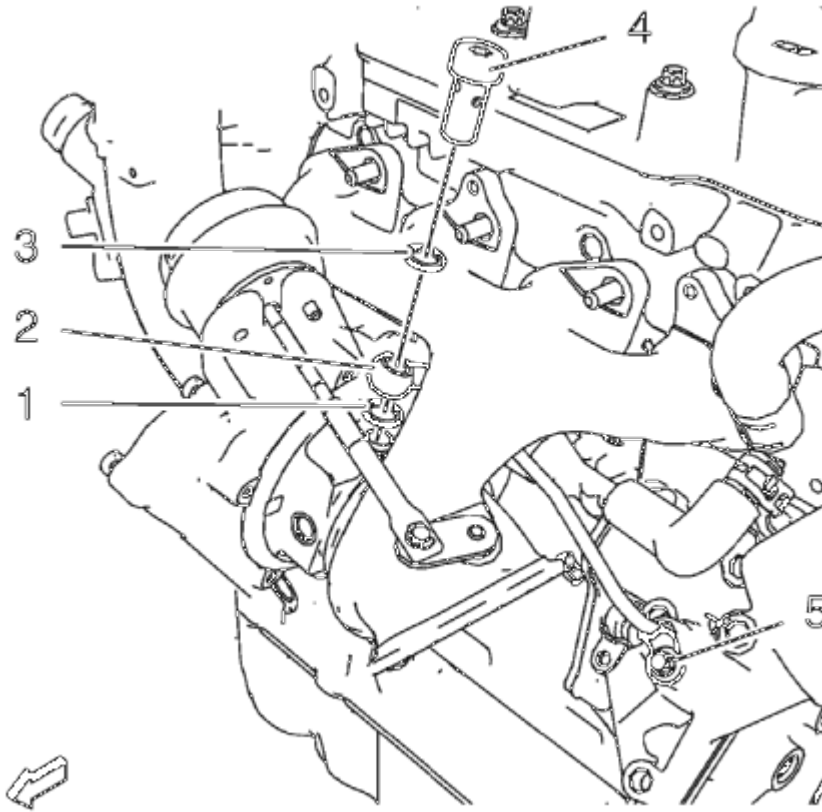


**Fig. 215: Turbocharger Oil Feed Pipe Components**  
Courtesy of GENERAL MOTORS COMPANY

4. Remove the turbocharger oil feed pipe bolt (5).
5. Remove the turbocharger oil feed pipe hollow screw (4) and the 2 seal rings (1) and (3).
6. Remove the turbocharger oil feed pipe (2) and the rubber seal ring.

#### Installation Procedure

1. Clean the sealing surfaces.



**Fig. 216: Turbocharger Oil Feed Pipe Components**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the turbocharger oil feed pipe (2) along with a NEW rubber seal ring.
3. Install the turbocharger oil feed pipe hollow screw (4) and 2 NEW seal rings (1) and (3).

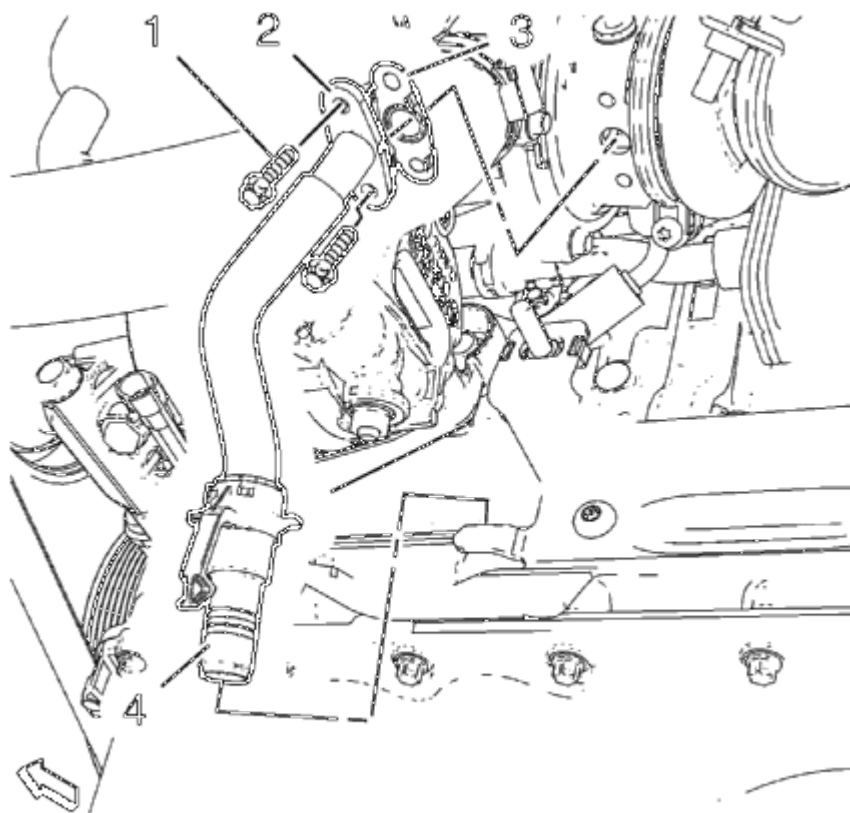
**CAUTION:** Refer to Fastener Caution .

4. Install the turbocharger oil feed pipe bolt (5) and tighten to 10 N.m (89 lb in).
5. Tighten the turbocharger oil feed pipe hollow screw to 30 N.m (22 lb ft).
6. Install the exhaust manifold heat shield. Refer to Exhaust Manifold Heat Shield Replacement (LUV) .
7. Connect battery negative cable. Refer to Battery Negative Cable Disconnection and Connection .
8. Close the hood.

## TURBOCHARGER OIL RETURN PIPE REPLACEMENT

### Removal procedure

1. Open the hood.
2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle



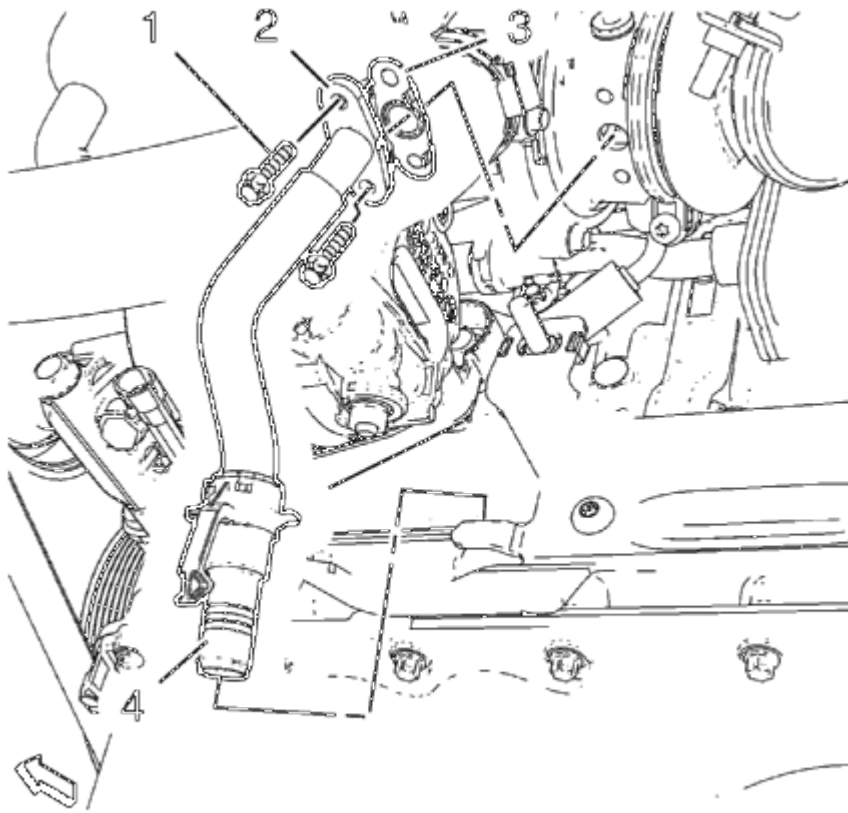
**Fig. 217: Turbocharger Oil Return Pipe Components**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Simplified Graphic. DO NOT remove the warm up three way catalytic converter.

3. Remove the 2 turbocharger oil return pipe bolts (1).
4. Place a drain pan below the vehicle.
5. Release the turbocharger oil return pipe connector (4) and disconnect the turbocharger oil return pipe from the engine block.
6. Remove the turbocharger oil return pipe (2) and the gasket (3).

#### Installation Procedure

1. Clean the sealing surfaces.



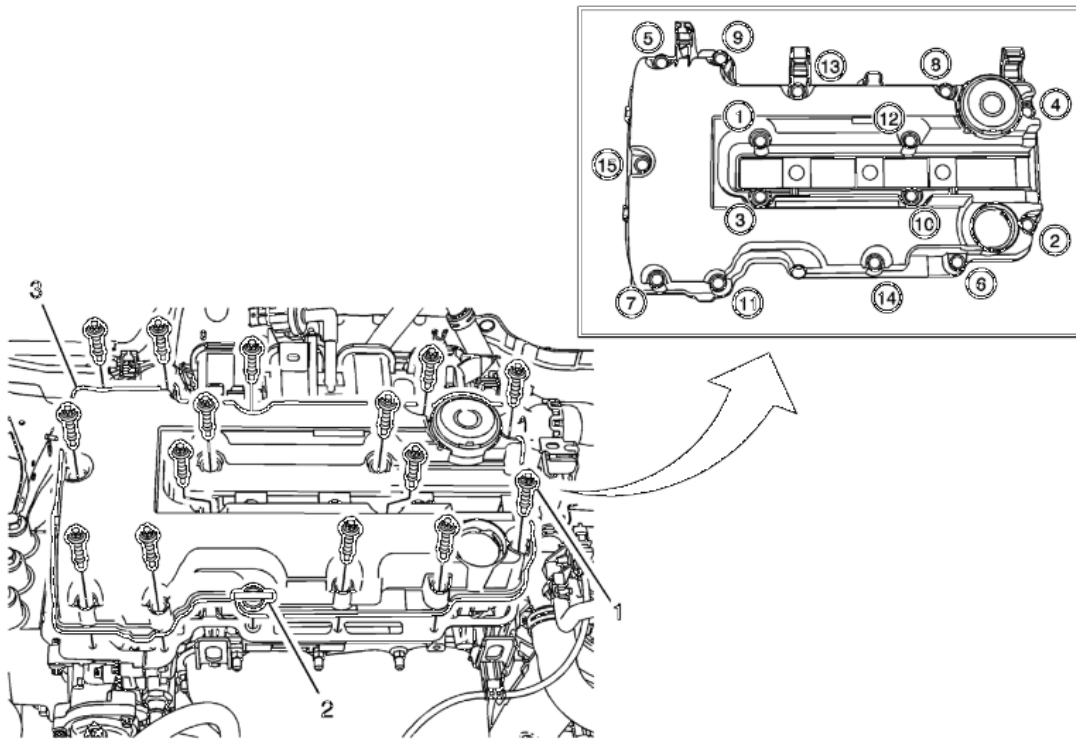
**Fig. 218: Turbocharger Oil Return Pipe Components**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install the turbocharger oil return pipe (2) in compound with a NEW gasket (3) and connect to the engine block.

**CAUTION: Refer to Fastener Caution .**

3. Install the 2 turbocharger oil return pipe bolts (1) and tighten to 8 N.m (71 lb in).
4. Lower the vehicle.
5. Check engine oil level.
6. Close the hood.

## **CAMSHAFT COVER REPLACEMENT**



**Fig. 219: Camshaft Cover, Fasteners & Oil Level Indicator**  
 Courtesy of GENERAL MOTORS COMPANY

### Camshaft Cover Replacement

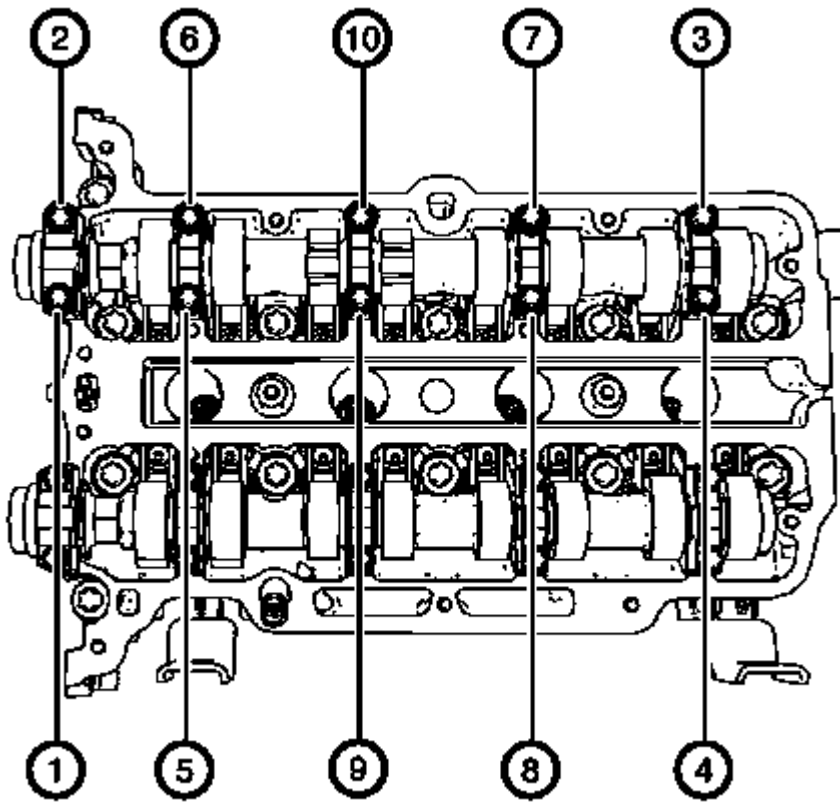
Callout	Component Name
<b>Preliminary Procedure</b> Remove the ignition coil. Refer to <b><u>Ignition Coil Replacement</u></b> .	
1	Camshaft Cover Fastener (Qty: 15)  <b>CAUTION:</b> Refer to <b><u>Fastener Caution</u></b> .  <b>Procedure</b> Ensure to follow the tighten sequence shown. <b>Tighten</b> 8 N.m (71 lb in)
2	Oil Level Indicator <b>TIP:</b> Remove the oil level indicator from camshaft cover.
3	Camshaft Cover  <b>Procedure</b> <ol style="list-style-type: none"> <li>1. Remove or reposition the clips as necessary.</li> <li>2. Do not reuse the camshaft gasket. Also use a new gasket whenever removing or</li> </ol>

- replacing camshaft cover.
3. Disconnect electrical connector as necessary.
  4. Transfer components as necessary.

## INTAKE CAMSHAFT REPLACEMENT

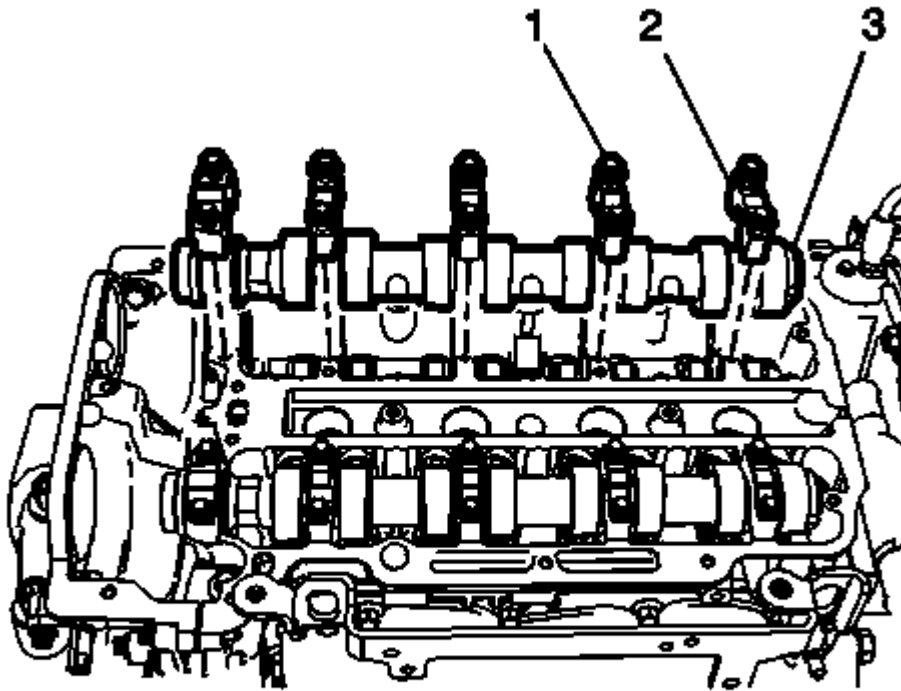
### Removal Procedure

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



**Fig. 220: Intake Camshaft Bearing Cap Bolts Removal Sequence**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

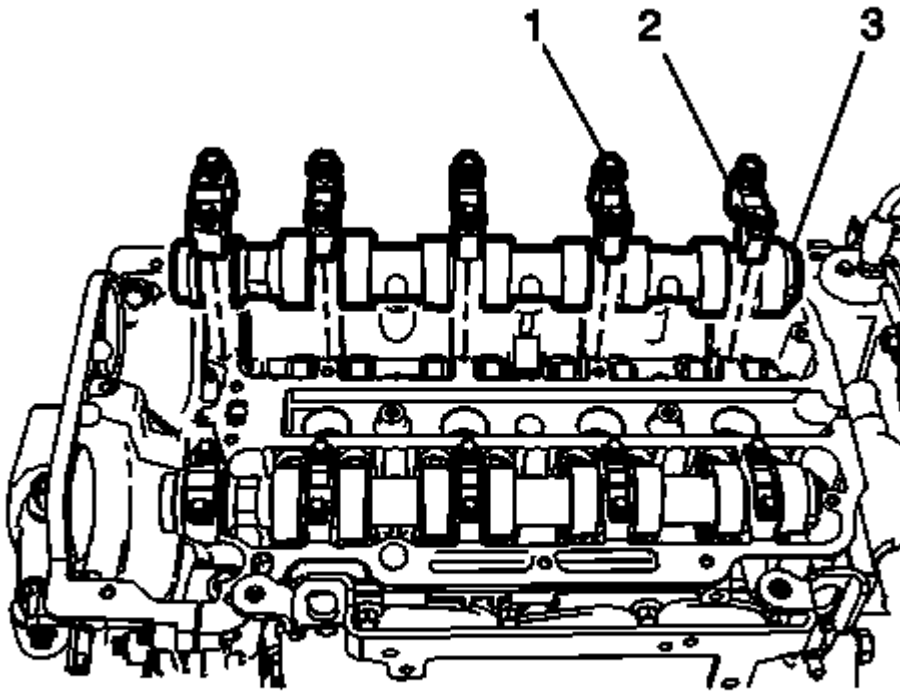


**Fig. 221: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).
5. Remove the intake camshaft (3).

#### Installation Procedure



**Fig. 222: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

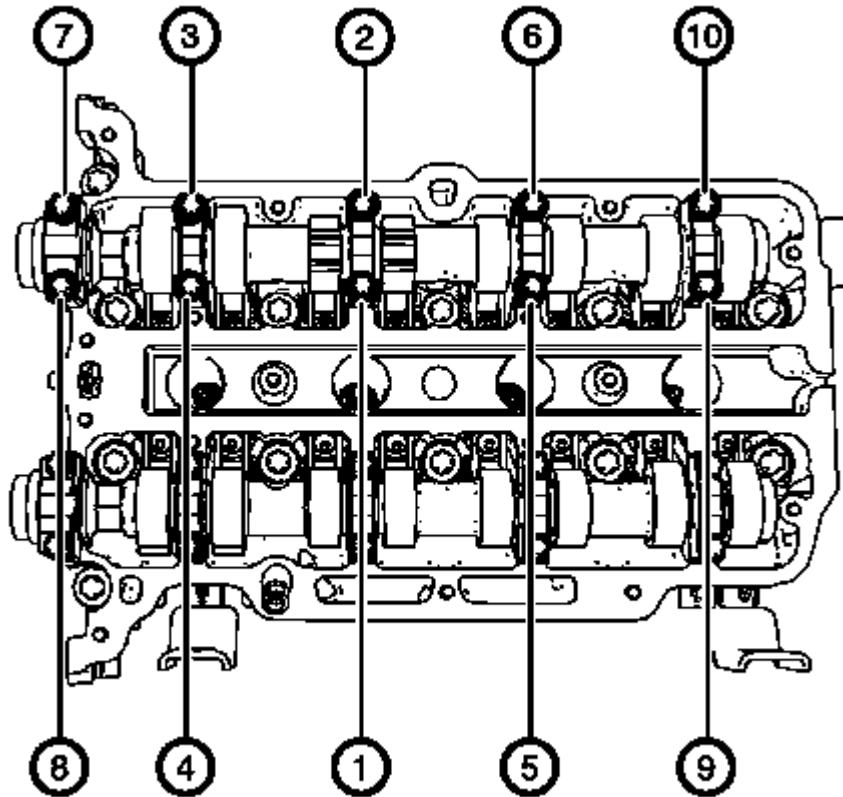
**NOTE:** Ensure that the camshaft sealing rings are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

1. Lubricate the camshaft and camshaft bearing caps with engine oil.
2. Install the intake camshaft (3).
3. Install the camshaft bearing caps (2).

**CAUTION:** Refer to Fastener Caution .

4. Install the camshaft bearing cap and hand tighten the bolts (1).





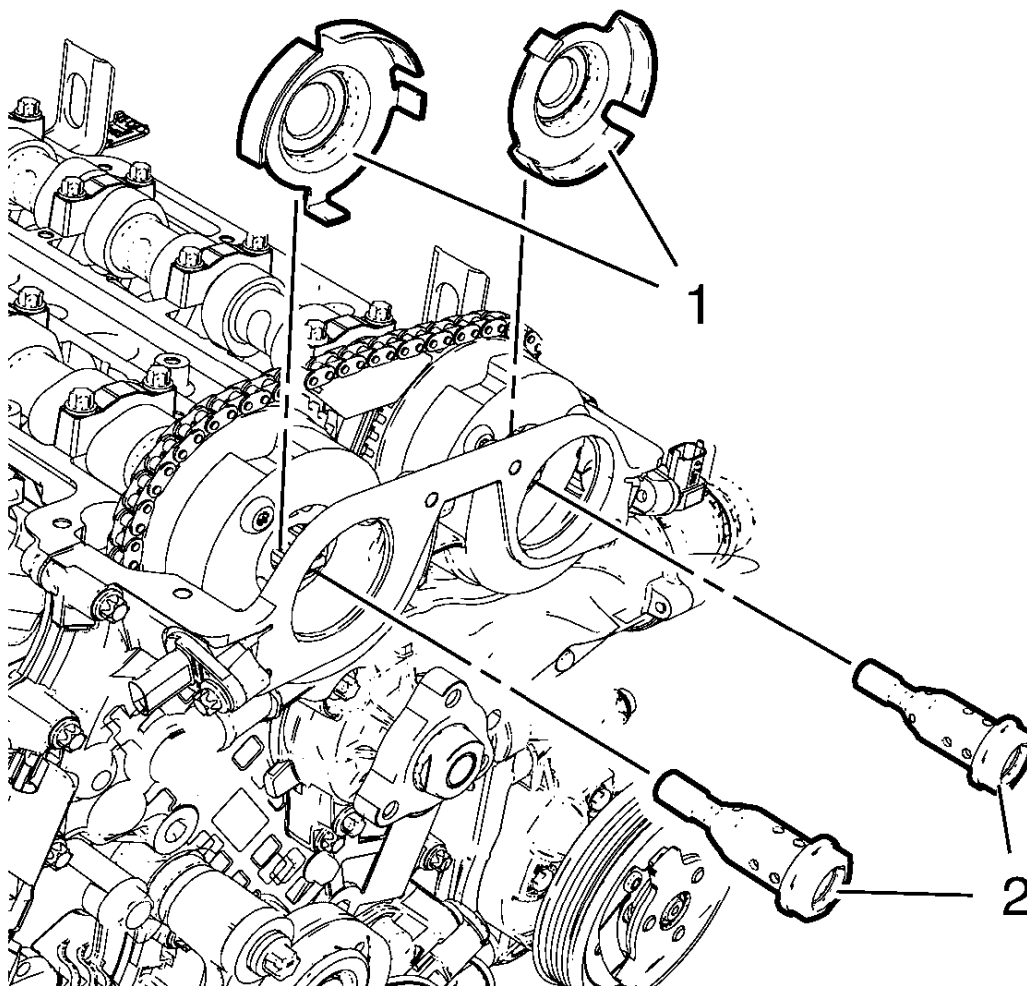
**Fig. 223: Intake Camshaft Bearing Cap Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown to 8 N.m (71 lb in).
6. Install the camshaft intake sprocket. Refer to **Camshaft Intake and Exhaust Sprocket Replacement**.

## EXHAUST CAMSHAFT REPLACEMENT

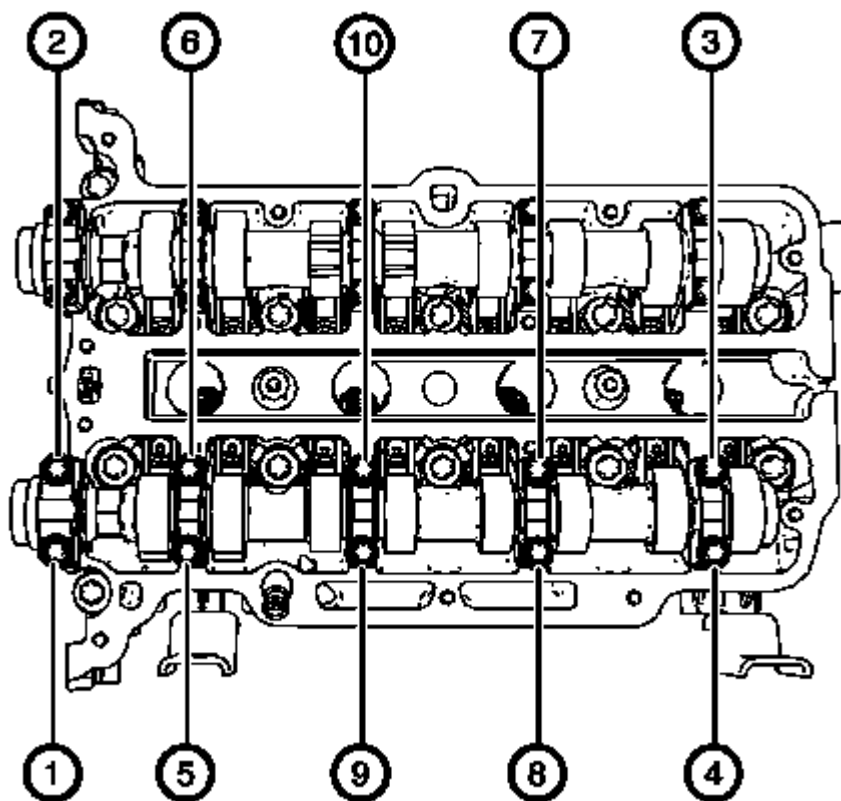
### Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
2. Remove the both camshaft position sensors. Refer to **Camshaft Position Sensor Replacement**.



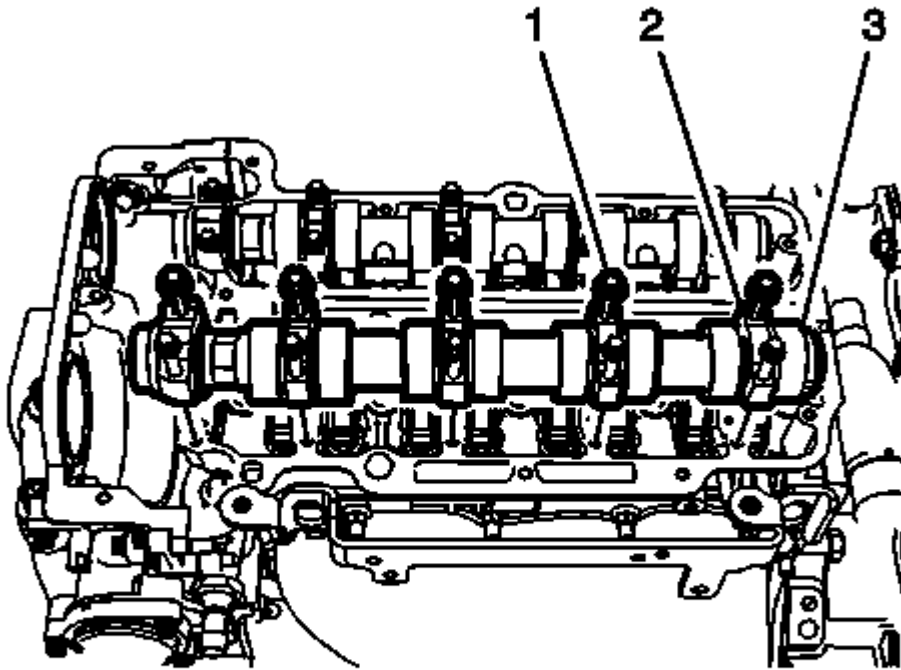
**Fig. 224: Camshaft Position Exciter Wheels And Camshaft Sprocket Bolts**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).
4. Allow the both camshaft sprockets with the timing chain to rest on the engine front cover.



**Fig. 225: Exhaust Camshaft Bearing Cap Bolts Removal Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

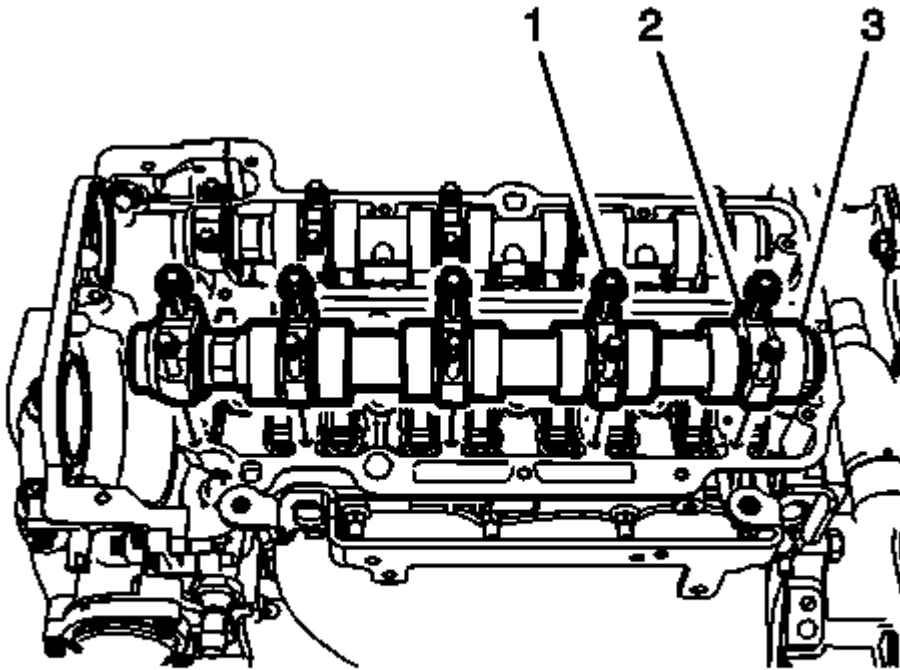


**Fig. 226: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

6. Remove the camshaft bearing cap bolts (1).
7. Remove the camshaft bearing caps (2).
8. Remove the exhaust camshaft (3).

#### Installation Procedure



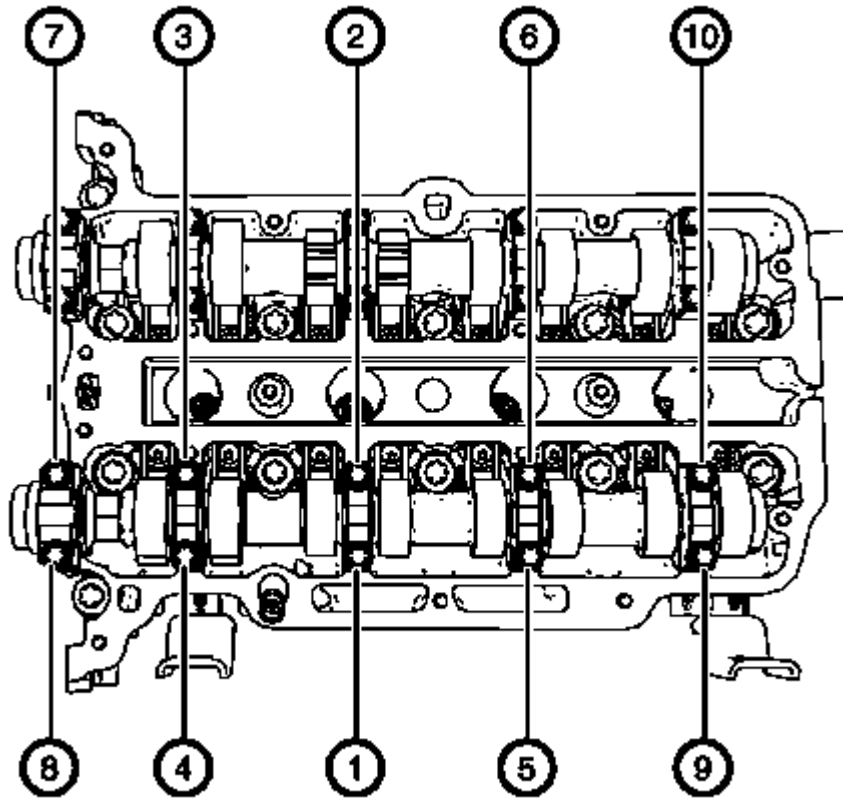
**Fig. 227: Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the exhaust camshaft (3).
3. Install the camshaft bearing caps (2).

**CAUTION:** Refer to Fastener Caution .

4. Install the camshaft bearing cap and hand tighten the bolts (1).

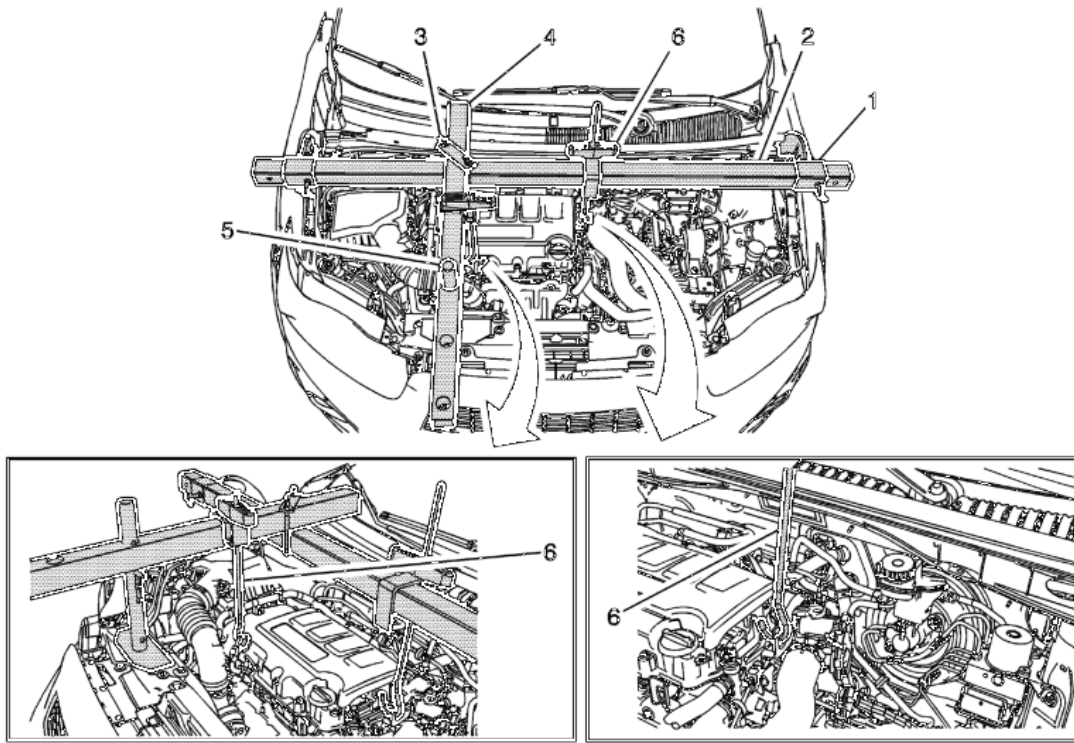


**Fig. 228: Exhaust Camshaft Bearing Cap Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown 8 N.m (71 lb in).
6. Install the both camshaft sprockets. Refer to **Camshaft Intake and Exhaust Sprocket Replacement**.
7. Install the both camshaft position sensors. Refer to **Camshaft Position Sensor Replacement**.
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.

## REPAIR INSTRUCTIONS - OFF VEHICLE

### ENGINE SUPPORT FIXTURE



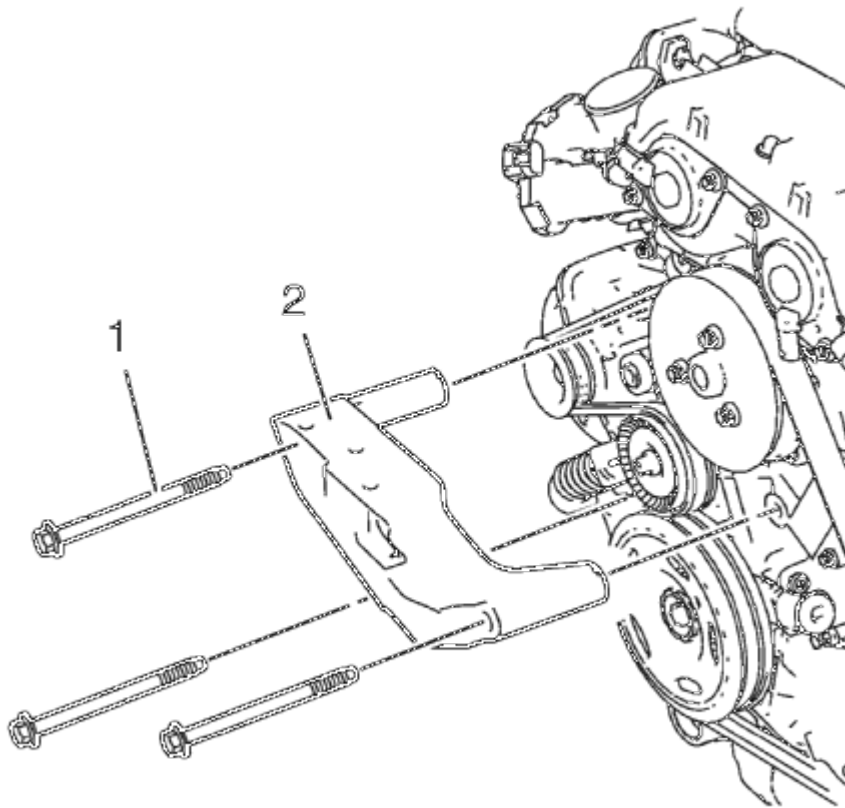
**Fig. 229: Engine Support Fixture Components**  
 Courtesy of GENERAL MOTORS COMPANY

### Engine Support Fixture

Callout	Component Name
<b>Preliminary Procedure</b> Remove the radiator opening upper cover. Refer to <u><b>Radiator Opening Upper Cover Replacement</b></u>	
<b>Special Tools</b> <ul style="list-style-type: none"> <li>• EN-28467-300 Engine Support Fixture Adapter</li> <li>• J-28467-518 Main Support Beam</li> <li>• J-28467-1A Cross Bracket</li> <li>• J-28467-5A Strut Tower Support Assembly</li> <li>• J-28467-2A Radiator Tube Shelf Assembly</li> <li>• J-36857 Engine Lift Bracket</li> <li>• J-28467-8A Hook Assembly</li> </ul>	
For equivalent regional tools, refer to <u><b>Special Tools</b></u> .	
1	Engine Support Fixture Adapter Leg (Qty: 2) <b>Procedure</b> Install the bracket to fender frame. Do not install on top of fender lip.
2	Main Support Beam

3	Cross Bracket
4	Strut Tower Support Assembly <b>Procedure</b> Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly
6	Hook Assembly <b>Procedure</b> Use a grade 10.9 bolt to install the engine lift bracket. <b>TIP:</b> If the engine is not equipped with engine lift bracket, install J-36857 in place.

## ENGINE MOUNT BRACKET REMOVAL



**Fig. 230: Engine Mount Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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

## CAMSHAFT TIMING CHAIN INSPECTION

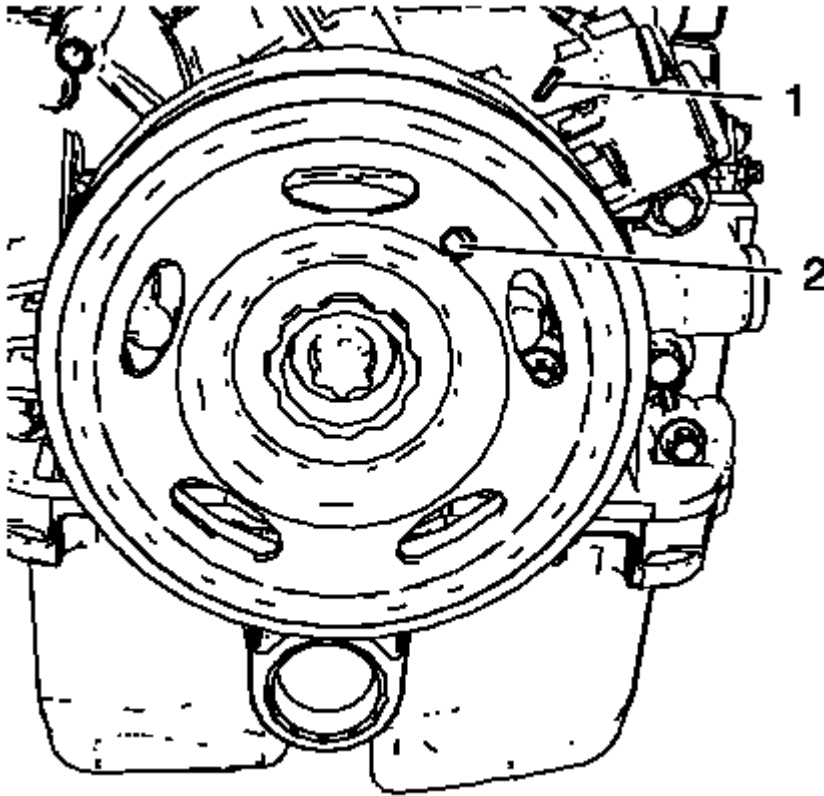
### Special Tools



- **EN-952** Fixing Pin
- **EN-953-A** Fixing Tool
- **EN-49977-100** Transmitter Disc Fixation

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

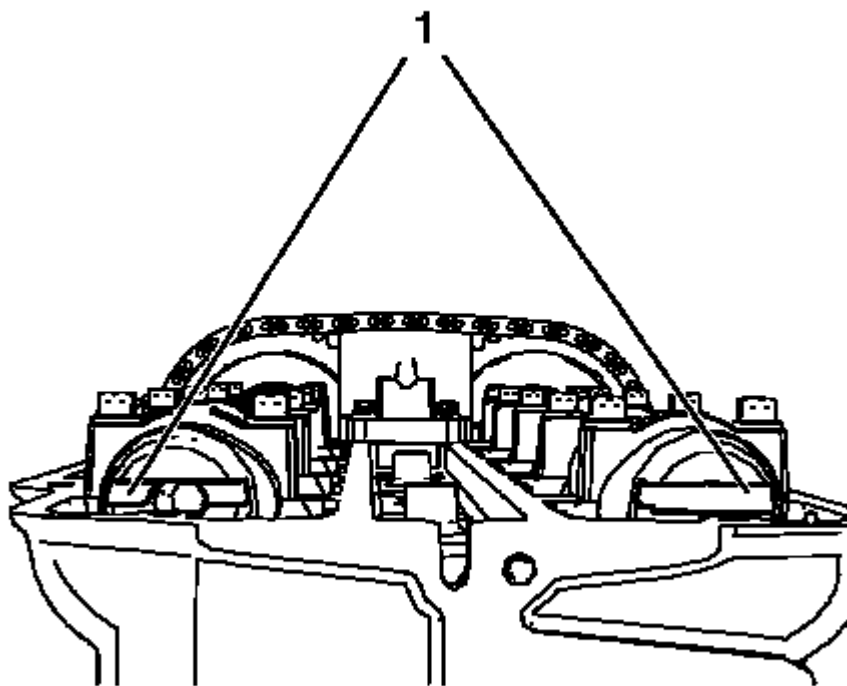
1. Remove the ignition coil. Refer to **Ignition Coil Replacement** .
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.



**Fig. 231: Bore And Mark**

Courtesy of GENERAL MOTORS COMPANY

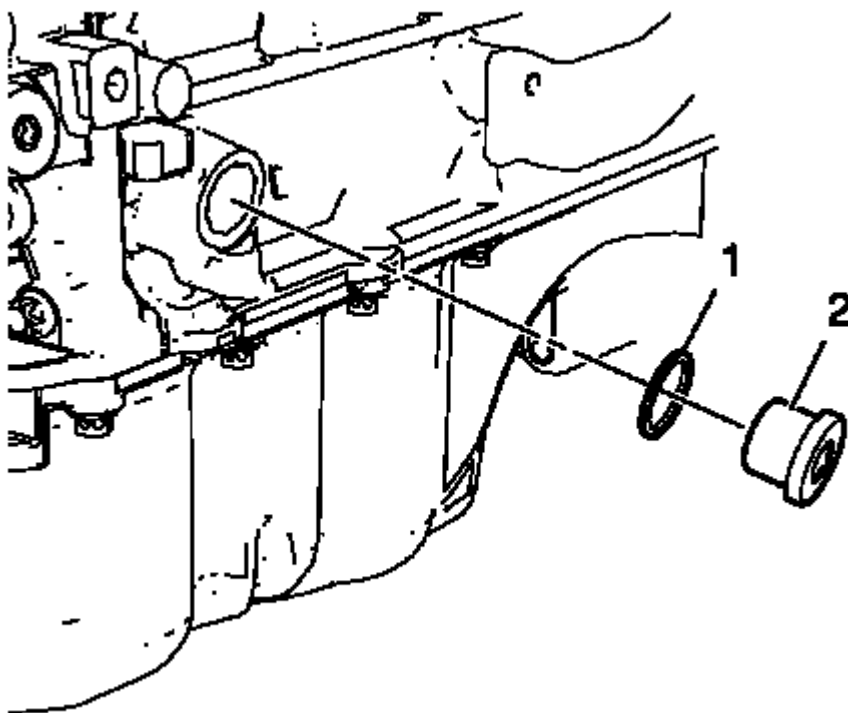
3. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement (Rear)** , **Front Wheelhouse Liner Replacement (Front)**
4. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.



**Fig. 232: Camshaft Grooves**

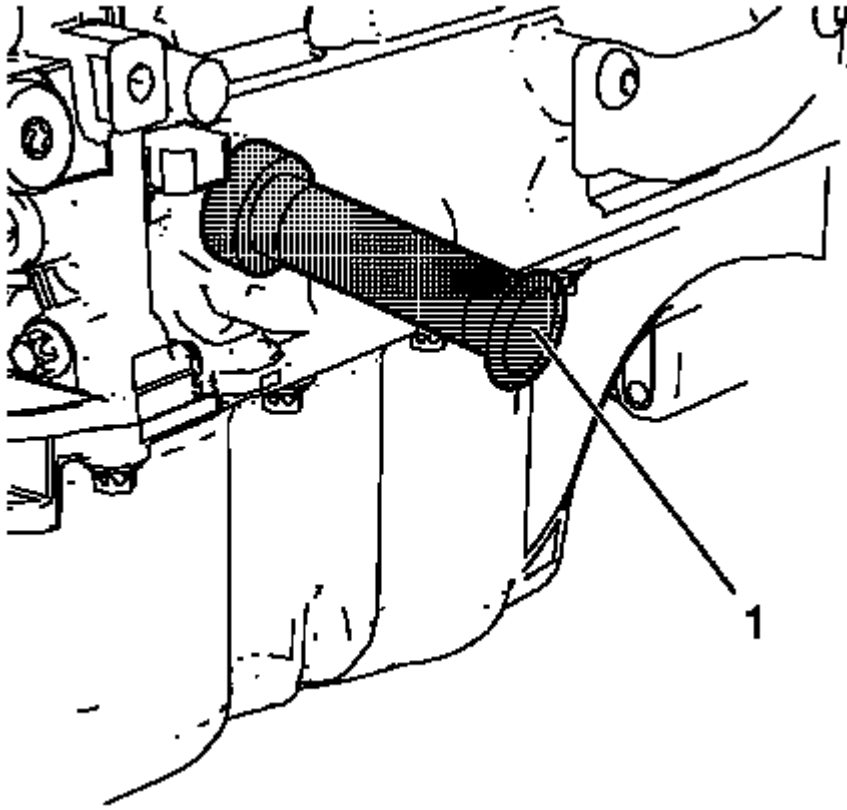
**Courtesy of GENERAL MOTORS COMPANY**

5. Examine that the camshaft grooves (1) are visible as shown. If the camshaft grooves are not visible rotate the crankshaft 360°.



**Fig. 233: Crankshaft Bearing Cap Tie Plate Hole Plug And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

6. Remove the crankshaft bearing cap tie plate hole plug (2) and the seal ring (1).

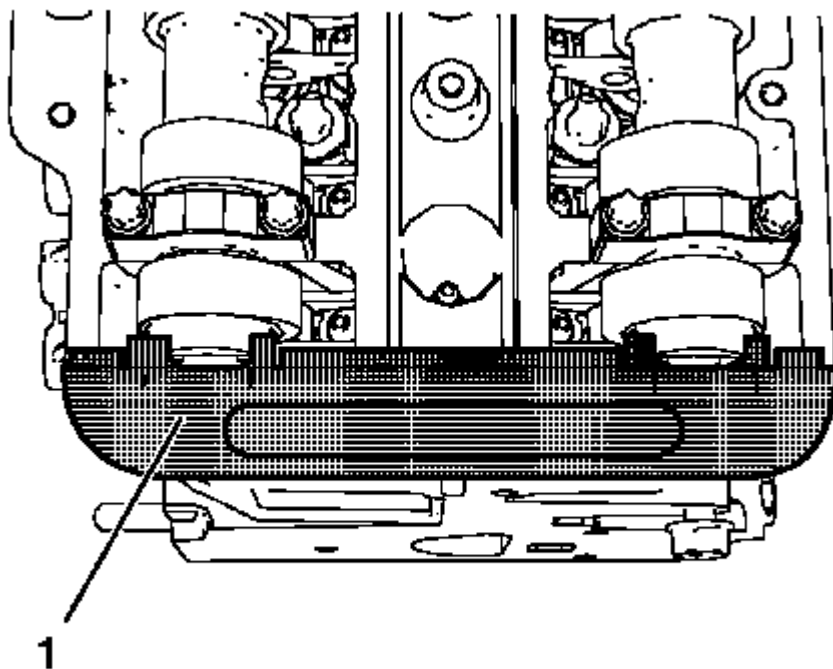


**Fig. 234: Fixing Pin**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** To ensure proper crankshaft top dead center (TDC) alignment, the retention pin should fit easily through the bore in the crankshaft tie plate and into the crankshaft. Binding of the retention pin could affect proper engine timing.

7. Install **EN-952** fixing pin (1) to hold the crankshaft in TDC position.

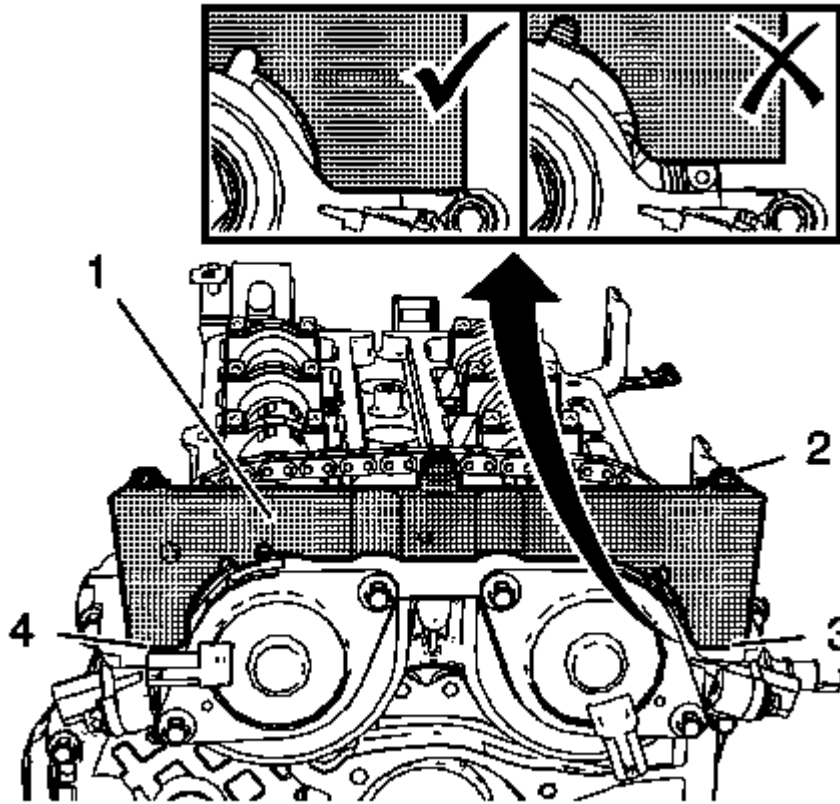


**Fig. 235: Fixing Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The fixing tool should be installed completely to both camshaft grooves without high effort.

8. Install EN-953-A fixing tool (1) to the camshafts.



**Fig. 236: Transmitter Disc Fixation And Bolts**  
 Courtesy of GENERAL MOTORS COMPANY

**NOTE:** A wrong installation position is possible. Make sure that the fixation tool is installed without clearance to the cylinder head in areas (3) and (4).

9. Install EN-49977-100 transmitter disc fixation (1) to inspect the correct position of the camshaft position exciter wheels.
10. Tighten the bolts (2) of EN-49977-100 transmitter disc fixation.
11. If EN-953-A fixing tool or EN-49977-100 transmitter disc fixation can not be installed, refer to Camshaft Timing Chain Adjustment.
12. Remove EN-49977-100 transmitter disc fixation.
13. Remove EN-953-A fixing tool.
14. Remove EN-952 fixing pin.

**CAUTION:** Refer to Fastener Caution .

15. Install crankshaft bearing cap tie plate hole plug and seal ring and tighten to 40 N.m (30 lb ft).
16. Install the right front wheelhouse liner. Refer to Front Wheelhouse Liner Replacement (Rear) , Front

**Wheelhouse Liner Replacement (Front)**

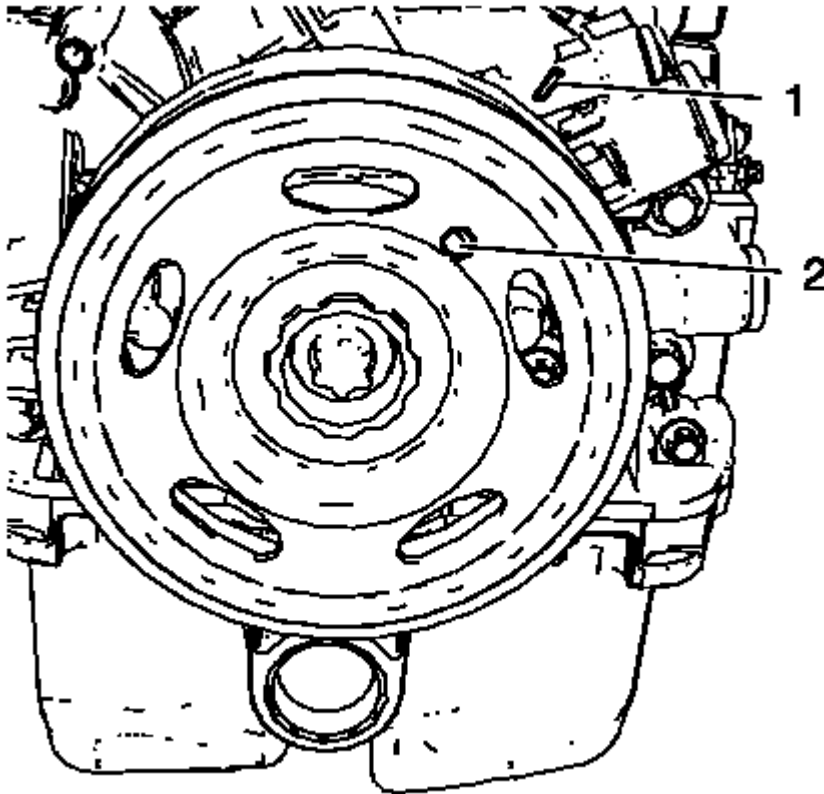
17. Install the camshaft cover. Refer to **Camshaft Cover Installation**.
18. Install the ignition coil. Refer to **Ignition Coil Installation**.

**CAMSHAFT TIMING CHAIN ADJUSTMENT****Special Tools**

- **EN-952** Fixing Pin
- **EN-953-A** Fixing Tool
- **EN-49977-100** Fixation Sensor Discs

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

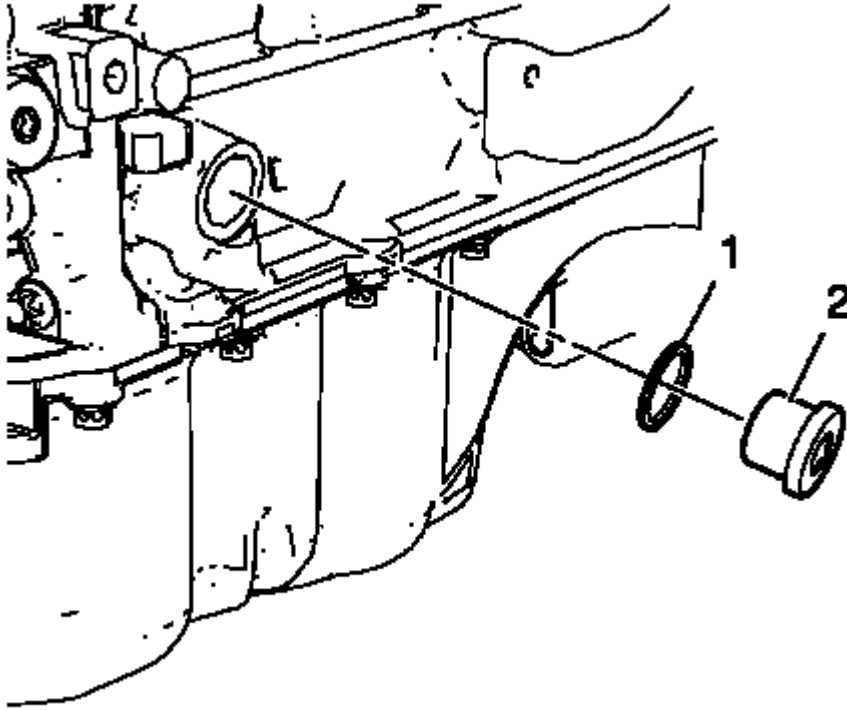
1. Remove the ignition coil. Refer to **Ignition Coil Replacement**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement**.
3. Remove the camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement**.
4. Remove the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement (Rear)**, **Front Wheelhouse Liner Replacement (Front)**.



**Fig. 237: Bore And Mark**

Courtesy of GENERAL MOTORS COMPANY

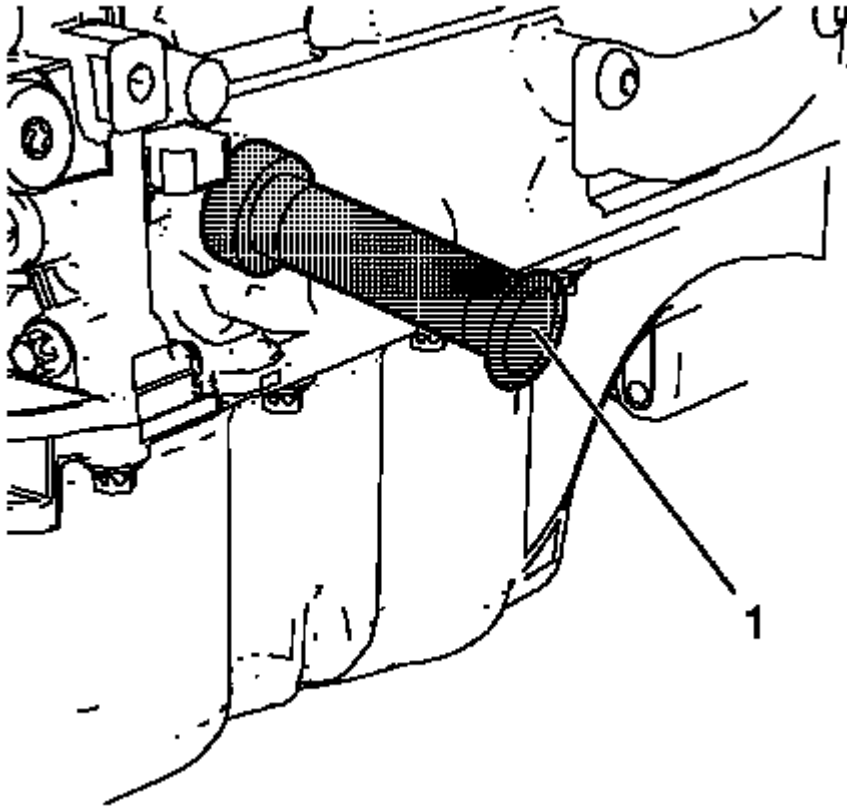
5. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.

**Fig. 238: Crankshaft Bearing Cap Tie Plate Hole Plug And Seal Ring**

Courtesy of GENERAL MOTORS COMPANY

6. Remove the crankshaft bearing cap tie plate hole plug (2) and the seal ring (1).



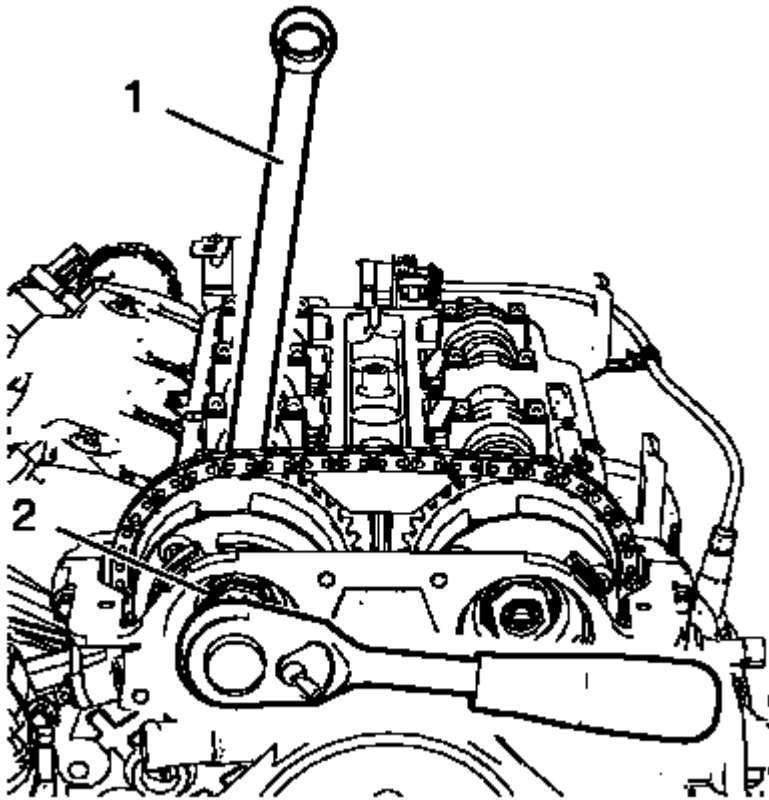


**Fig. 239: Fixing Pin**

Courtesy of GENERAL MOTORS COMPANY

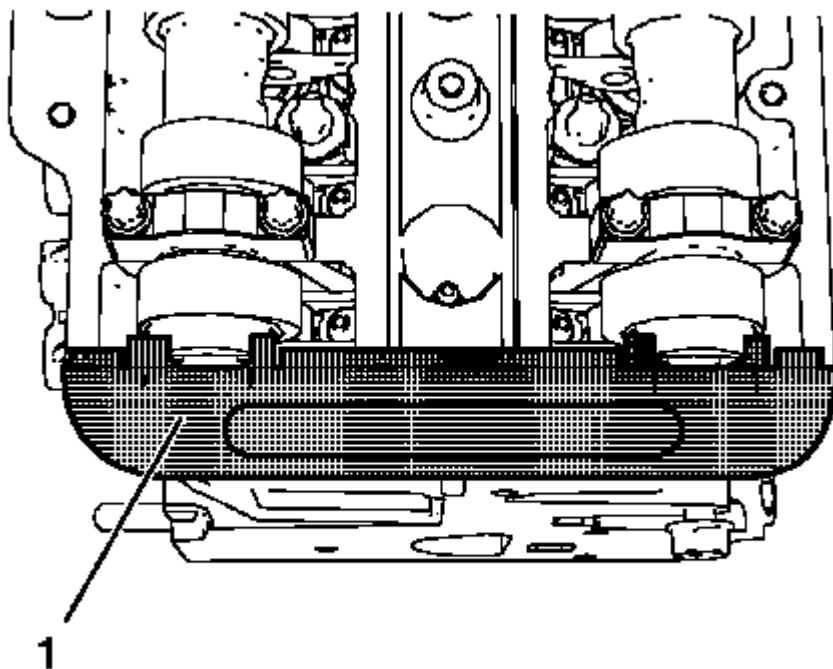
**CAUTION:** To ensure proper crankshaft top dead center (TDC) alignment, the retention pin should fit easily through the bore in the crankshaft tie plate and into the crankshaft. Binding of the retention pin could affect proper engine timing.

7. Install the **EN-952** fixing pin (1) to hold the crankshaft in TDC position.



**Fig. 240: Intake Camshaft Sprocket Bolt And Wrench**  
Courtesy of GENERAL MOTORS COMPANY

8. Loosen the intake camshaft sprocket bolt (2) while holding the hexagon of the intake camshaft with a wrench (1) until the camshaft position exciter wheel is clearly rotatable.
9. Loosen the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft with a wrench until the camshaft position exciter wheel is clearly rotatable.

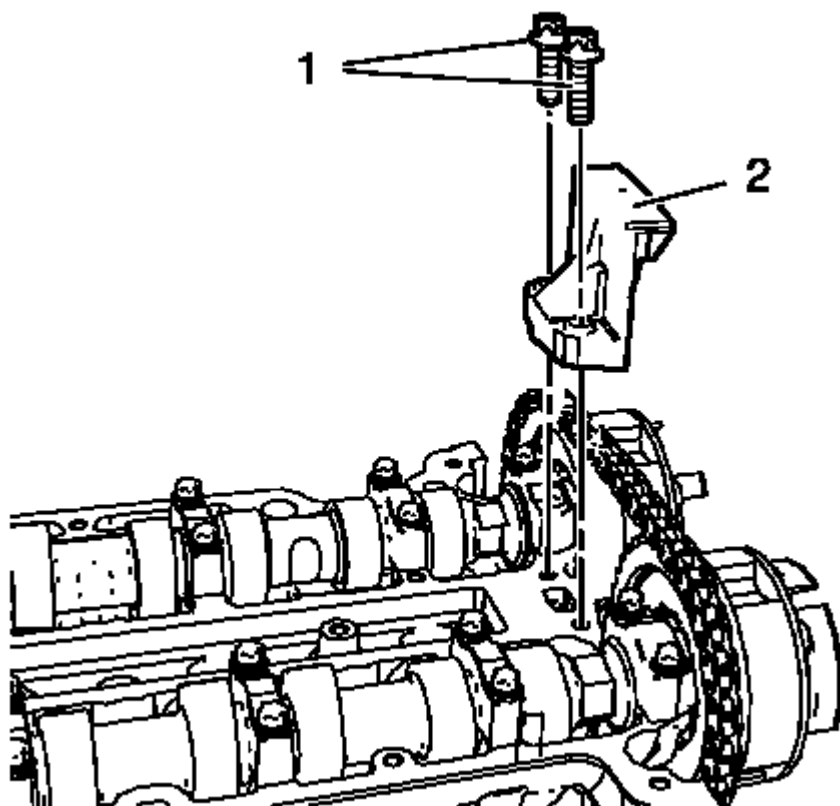


**Fig. 241: Fixing Tool**

Courtesy of GENERAL MOTORS COMPANY

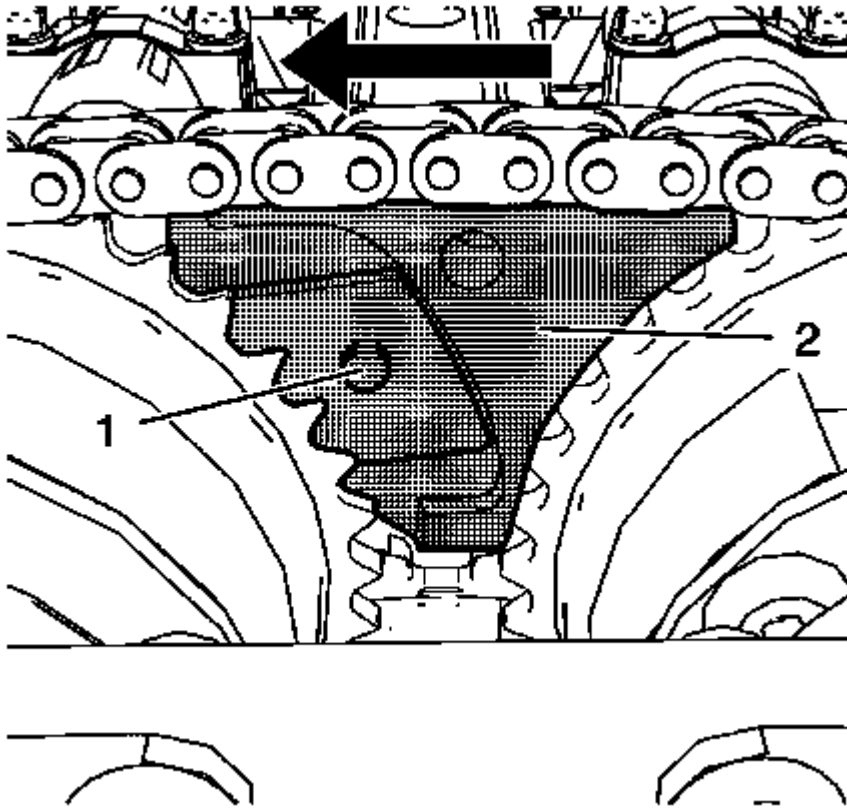
**NOTE:** The fixing tool should be installed completely to both camshaft grooves without high effort.

10. Adjust the camshafts so that the **EN-953-A** fixing tool (1) can be installed.



**Fig. 242: Upper Timing Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

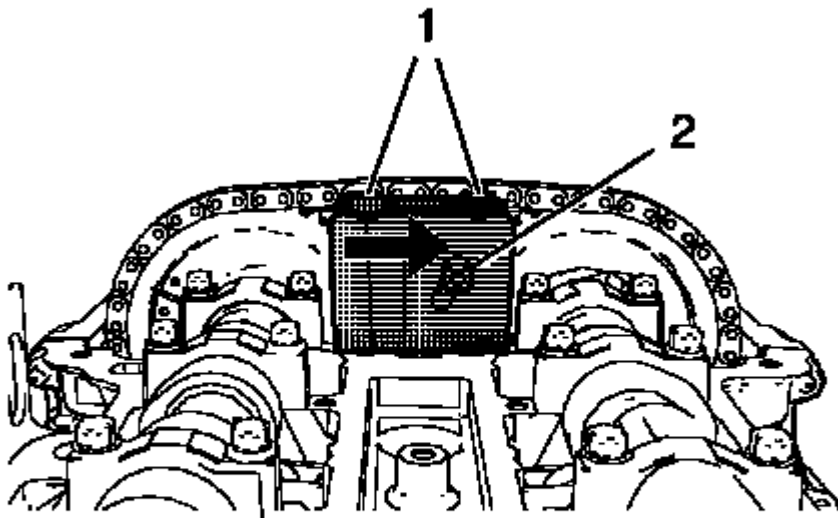
11. Remove the 2 upper timing chain guide bolts (1).
12. Remove the upper timing chain guide (2).



**Fig. 243: Intake Camshaft Sprocket Gearing And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Push the fixing tool in the direction of the arrow to ensure it engages without clearance.

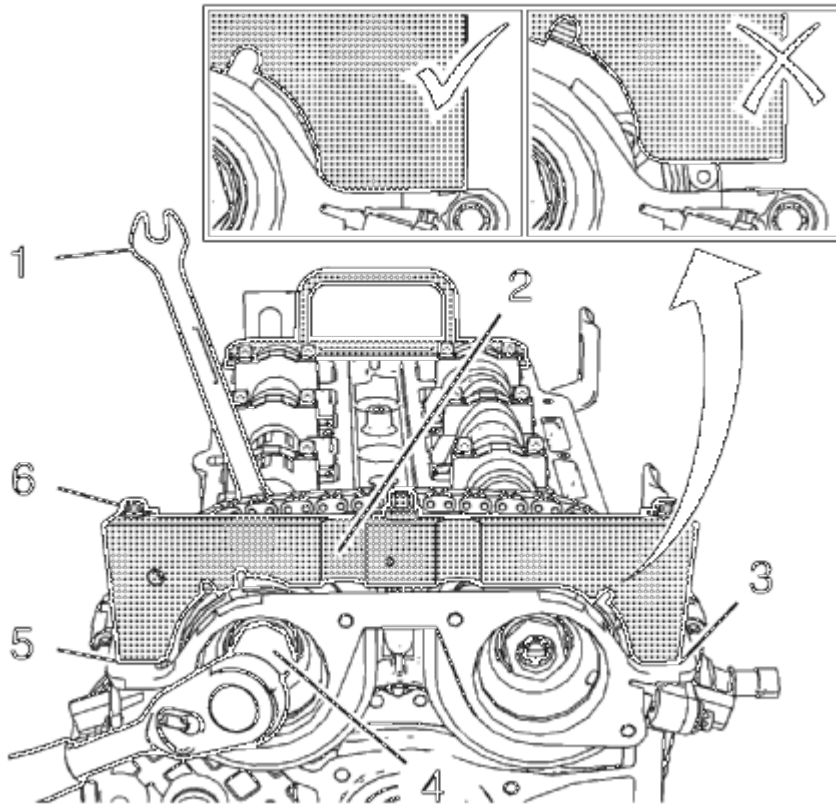
13. Install the **EN-49977-200** fixing tool (2) and adjust the gearing of the fixing tool so it engages with the intake camshaft sprocket gearing (1).



**Fig. 244: Adjuster Bolt And Fastening Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

14. Tighten the 2 fastening bolts (1) of the **EN-49977-200** fixing tool while pushing the fixing tool in direction of the arrow.
15. Tighten the adjuster bolt (2).



**Fig. 245: Fastening Bolts And Fixation Tool**  
Courtesy of GENERAL MOTORS COMPANY

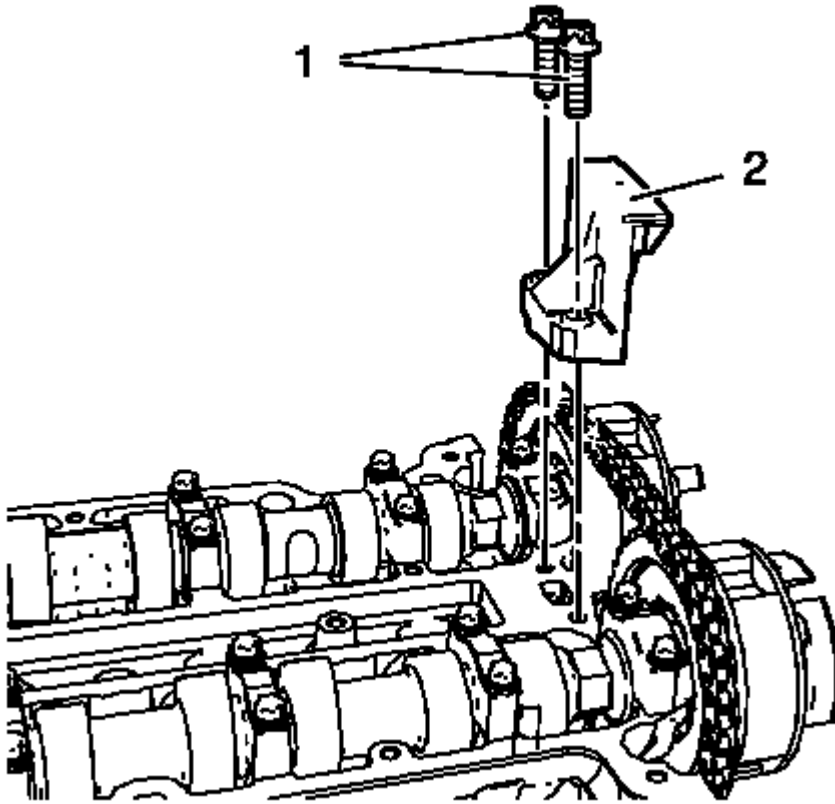
**NOTE:** A wrong installation position is possible. Make sure that the fixation tool is installed without clearance to the cylinder head in areas (3) and (5).

16. Install the **EN-49977-100** fixation (2) to find and hold the camshaft position exciter wheels in the correct position.
17. Tighten the 2 fastening bolts (6) of the **EN-49977-100** fixation.

**CAUTION:** Refer to Fastener Caution .

18. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to 50 N.m (37 lb ft).
19. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft an additional 60°.
20. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to 50 N.m (37 lb ft).
21. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft an additional 60°.

22. Remove the **EN-49977-100** fixation and the **EN-49977-200** fixing tool.

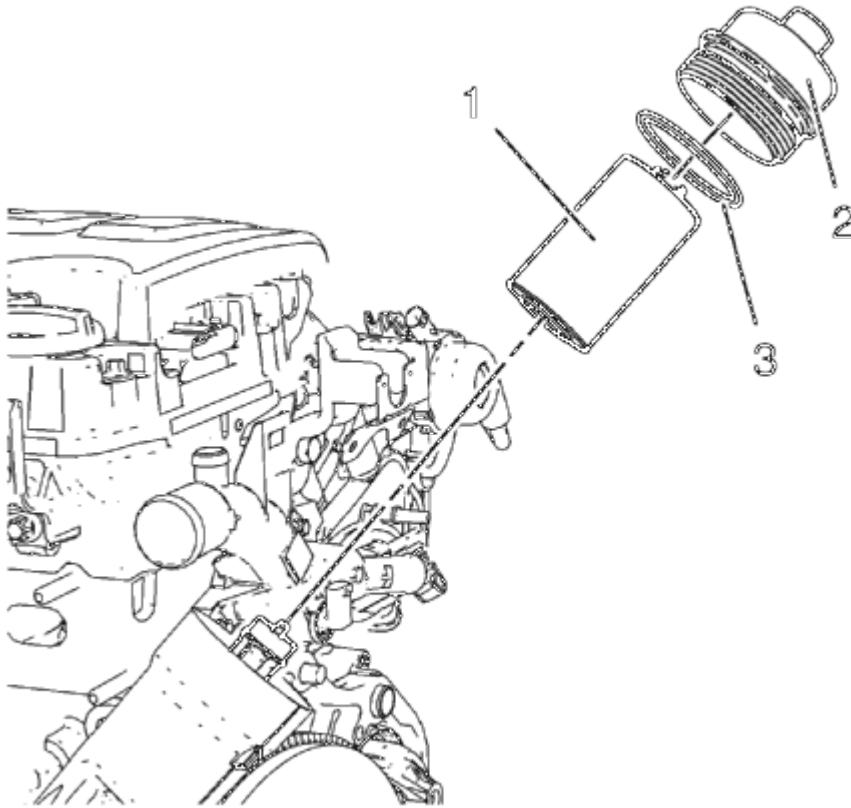


**Fig. 246: Upper Timing Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

23. Install the upper timing chain guide (2).
24. Install the 2 upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).
25. Remove the **EN-953-A** fixing tool.
26. Remove the **EN-952** fixing pin.
27. Rotate the crankshaft for 720° and check the engine timing again. Repeat the adjustment procedure if necessary.
28. Install the crankshaft bearing cap tie plate hole plug and seal ring and tighten to 40 N.m (30 lb ft).
29. Install the right front wheelhouse liner. Refer to **Front Wheelhouse Liner Replacement (Rear)** , **Front Wheelhouse Liner Replacement (Front)**
30. Install the camshaft position actuator solenoid valves. Refer to **Camshaft Position Actuator Solenoid Valve Replacement** .
31. Install the camshaft cover. Refer to **Camshaft Cover Replacement**.
32. Install the ignition coil. Refer to **Ignition Coil Replacement** .

## DRAINING FLUIDS AND OIL FILTER REMOVAL



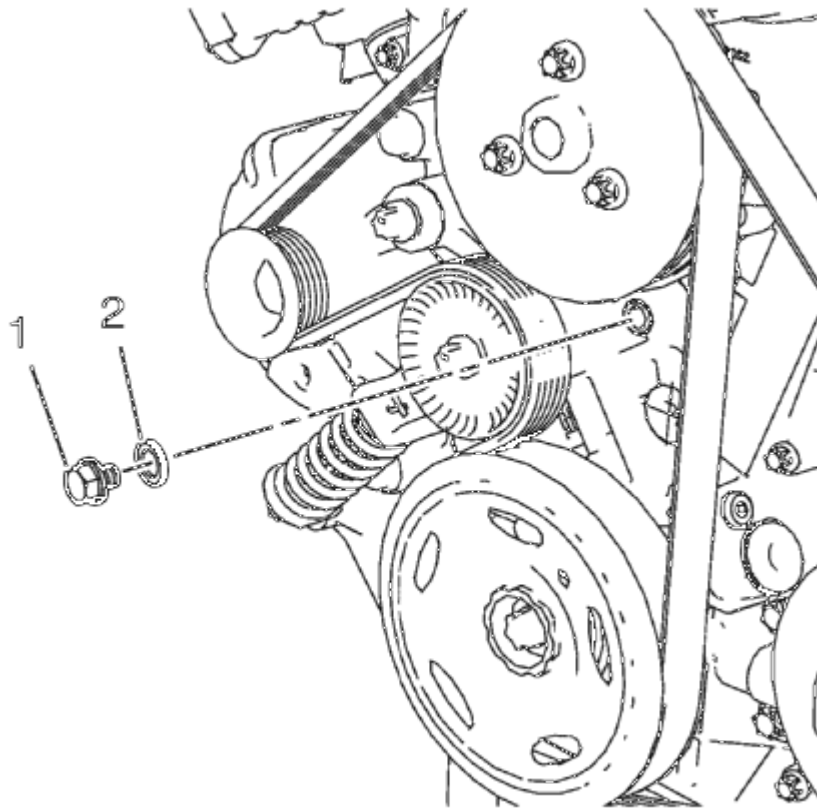


**Fig. 247: Engine Oil Filter Element, Cap And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil filter cap (2) along with the engine oil filter cap seal ring (3) and the oil filter element (1).
2. Remove the oil pan drain plug and allow the oil to drain out.

**CAUTION: Refer to Fastener Caution .**

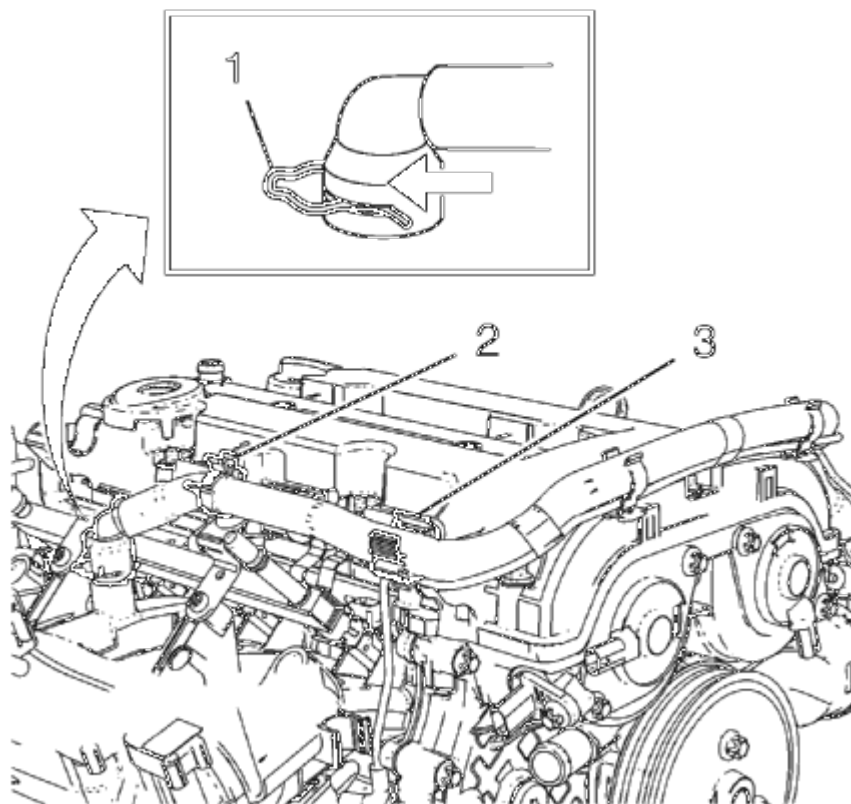
3. Install the oil pan drain plug and a NEW seal ring and tighten to 14 N.m (124 lb in).
4. Install the engine oil filter cap along with a NEW engine oil filter cap seal ring and a NEW oil filter element.
5. Tighten the engine oil filter cap to 25 N.m (18 lb ft).



**Fig. 248: Water Pump Drain Plug And Seal Ring**  
**Courtesy of GENERAL MOTORS COMPANY**

6. Remove the water pump drain plug (1) and the water pump drain plug seal ring (2) and allow the remaining coolant to drain out.
7. Install the water pump drain plug and a NEW seal ring and tighten to 15 N.m (11 lb ft).

#### **POSITIVE CRANKCASE VENTILATION PIPE REMOVAL**

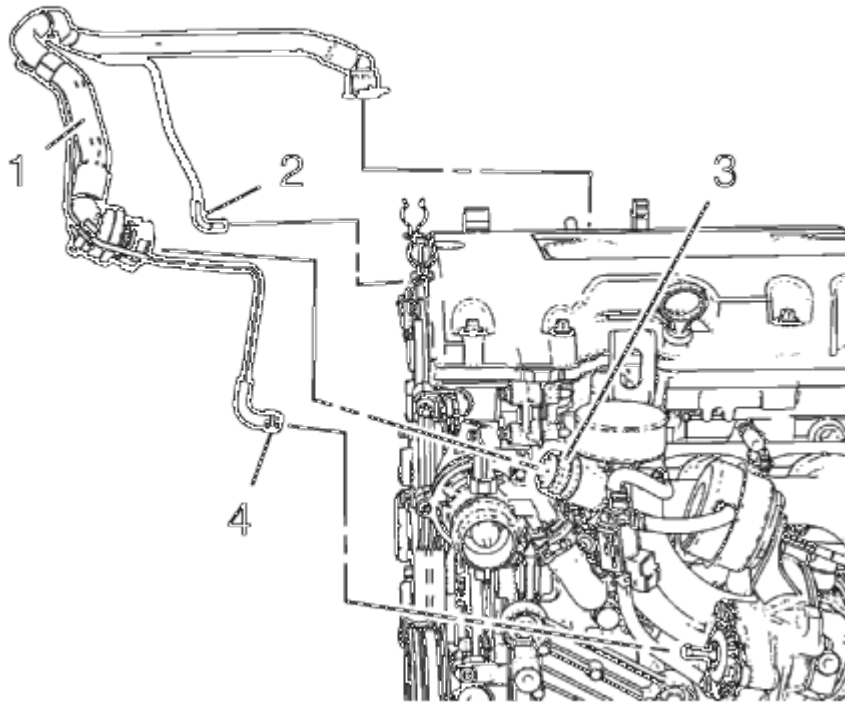


**Fig. 249: Positive Crankcase Ventilation Pipe Retainer Clips And Retainer Clamp**  
Courtesy of GENERAL MOTORS COMPANY

1. Open the 2 positive crankcase ventilation pipe retainer clips (2) and (3).

**NOTE:** Move retainer clamp (1) in direction of the arrow.

2. Remove the positive crankcase ventilation pipe from the intake manifold.

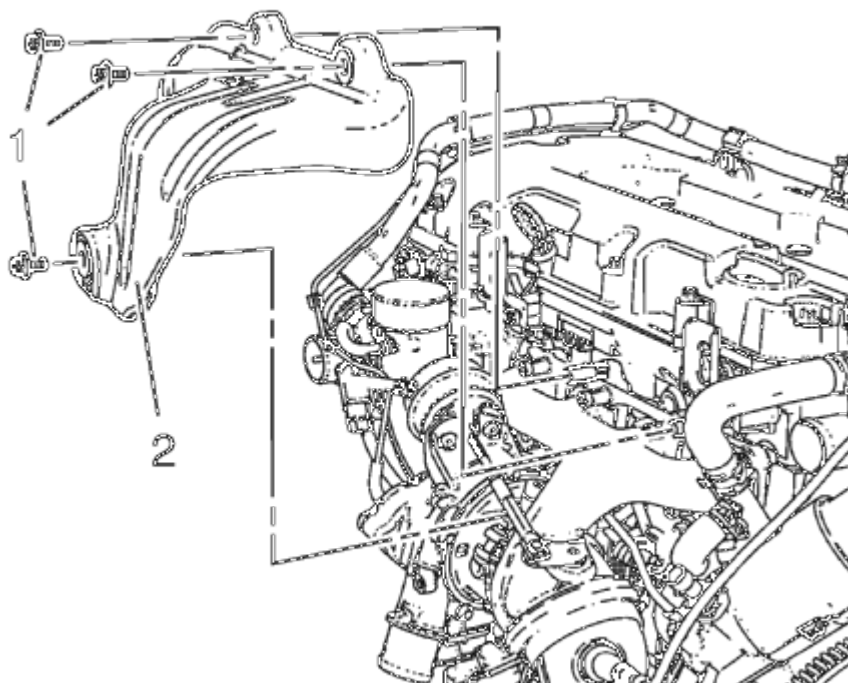


**Fig. 250: Turbocharger, Positive Crankcase Ventilation Pipe Assembly And Charger Air Bypass Valve Pipe**

Courtesy of GENERAL MOTORS COMPANY

3. Loosen the charger air bypass valve pipe clamp (4).
4. Remove the charger air bypass valve pipe from turbocharger.
5. Remove the charger air bypass valve pipe (2) from turbo charger waste regulator solenoid valve.
6. Disconnect the positive crankcase ventilation pipe from turbocharger (3).
7. Unclip and remove the positive crankcase ventilation pipe assembly (1) from the camshaft cover retainer clips.

## EXHAUST MANIFOLD HEAT SHIELD REMOVAL (1.4L LUV)

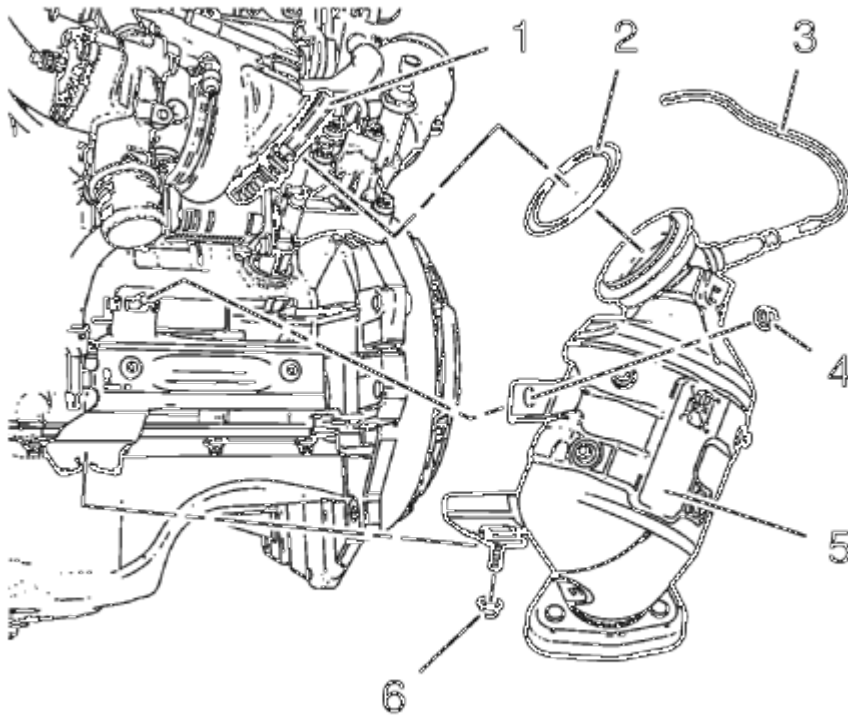


**Fig. 251: Exhaust Manifold Heat Shield**

**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the 3 exhaust manifold heat shield bolts (1) and the washers.
2. Remove the exhaust manifold heat shield (2).

### **WARM UP THREE-WAY CATALYTIC CONVERTER REMOVAL (1.4L LUV)**



**Fig. 252: Locating Catalytic Converter Components**  
 Courtesy of GENERAL MOTORS COMPANY

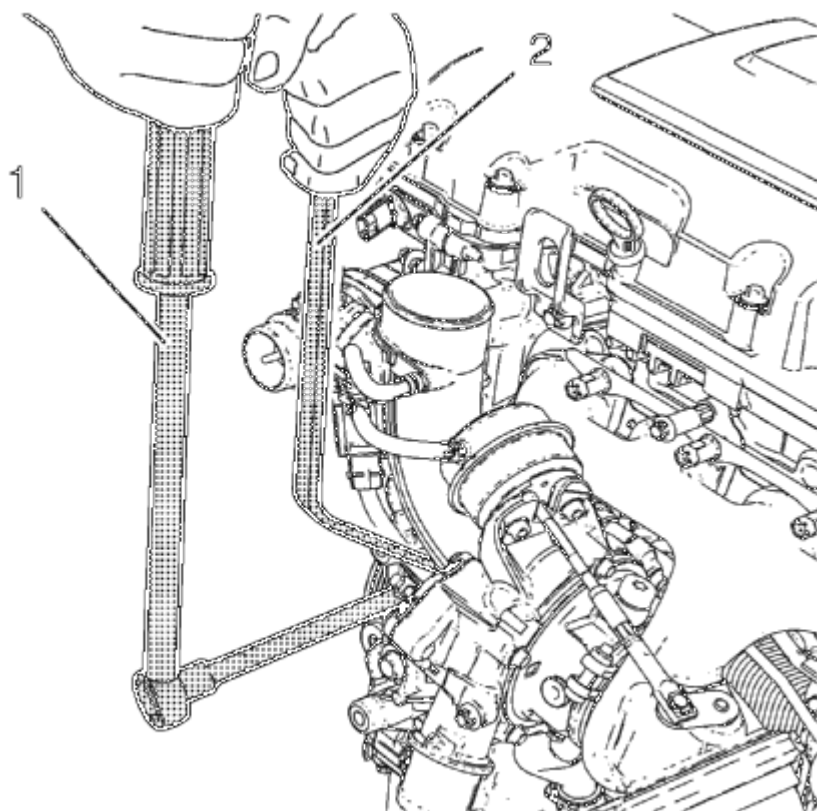
1. Disconnect the heated oxygen sensor wiring harness (3) from retainer clip.
2. Remove the 2 catalytic converter to catalytic converter bracket nuts (4) and (6).
3. Loosen the three way warm up catalytic converter V-clamp (1).
4. Remove the three way warm up catalytic converter (5) and the catalytic converter seal (2).

## TURBOCHARGER REMOVAL

### Special Tool

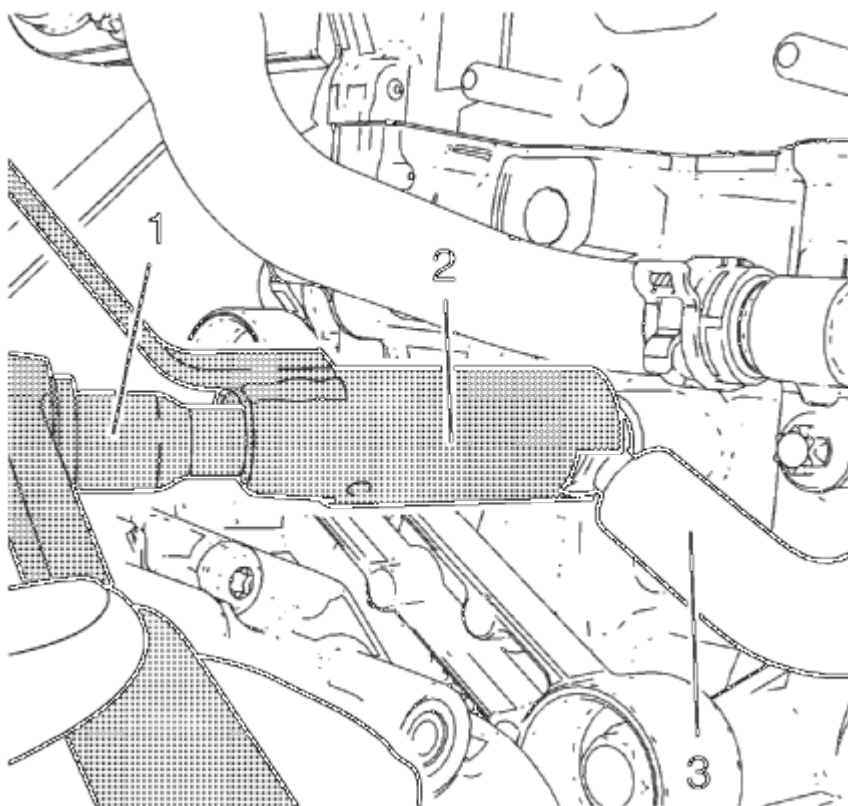
**EN-49942** Holding Wrench

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



**Fig. 253: Holding Wrench And Ratchet Wrench**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-49942** holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through **EN-49942** holding wrench to the turbocharger coolant feed pipe hollow screw.

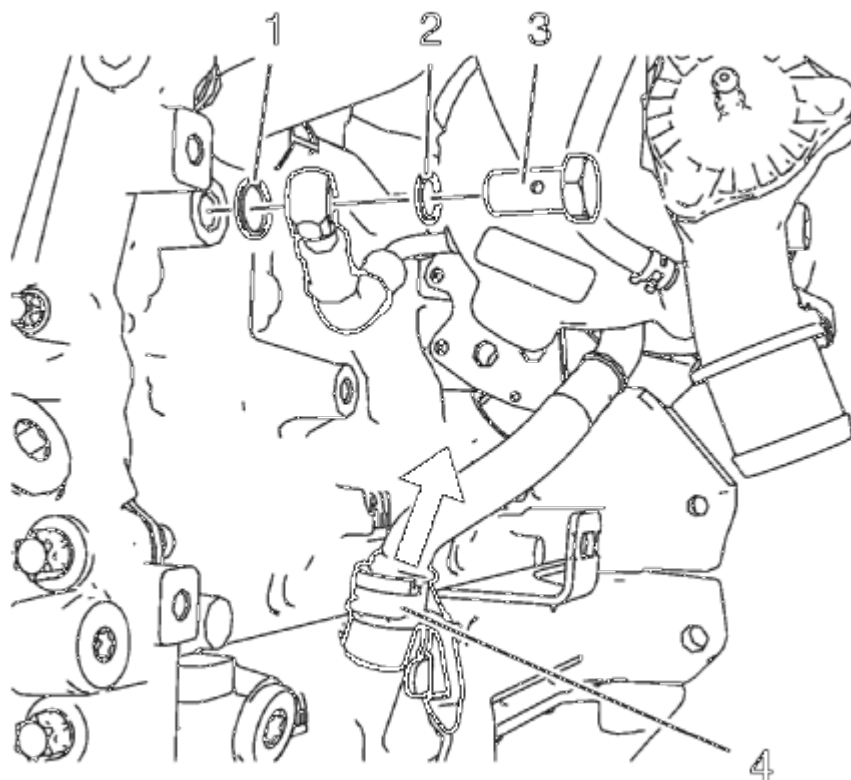


**Fig. 254: Ratchet Wrench, Holding Wrench And Coolant Feed Pipe**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** EN-49942 holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the loosening procedure.

2. Loosen the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1).

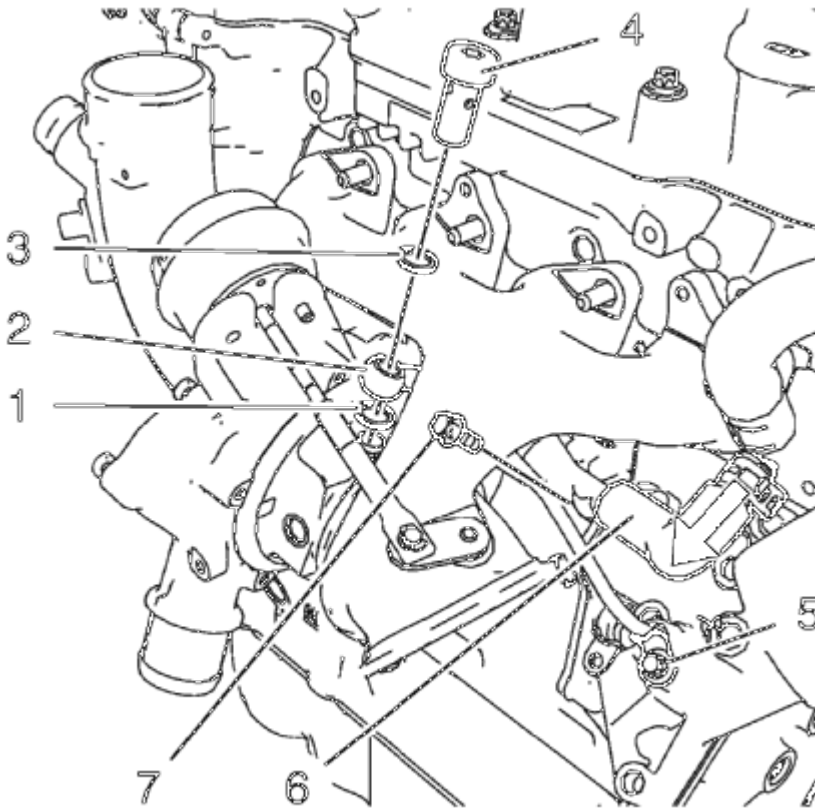




**Fig. 255: Turbocharger Oil Return Pipe**

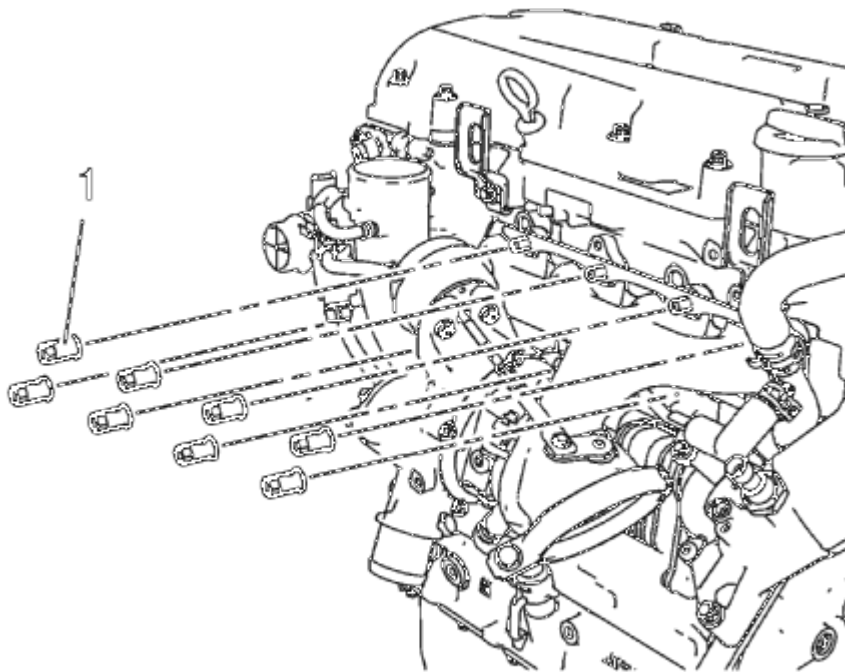
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove the turbocharger coolant feed pipe hollow screw (3) and the 2 seal rings (1) and (2).
4. Disconnect the turbocharger oil return pipe (4) from the engine block.



**Fig. 256: Turbocharger Oil Feed Pipe Components**  
 Courtesy of GENERAL MOTORS COMPANY

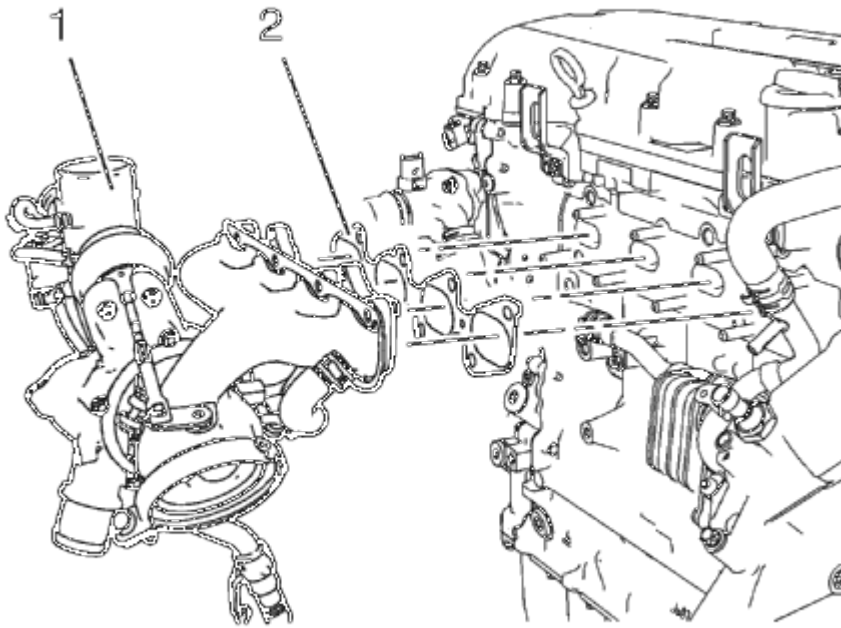
5. Remove the turbocharger oil feed pipe bolt (5) from the oil cooler.
6. Remove the turbocharger oil feed pipe hollow screw (4) and the 2 seal rings (1) and (3) and close the screw bore in the turbocharger.
7. Remove the turbocharger oil feed pipe (2) and the rubber seal ring.
8. Disconnect the turbocharger coolant return hose (6) from the oil cooler coolant inlet pipe and remove the turbocharger coolant return pipe bolt (7) from the oil cooler.



**Fig. 257: Turbocharger Nuts**

**Courtesy of GENERAL MOTORS COMPANY**

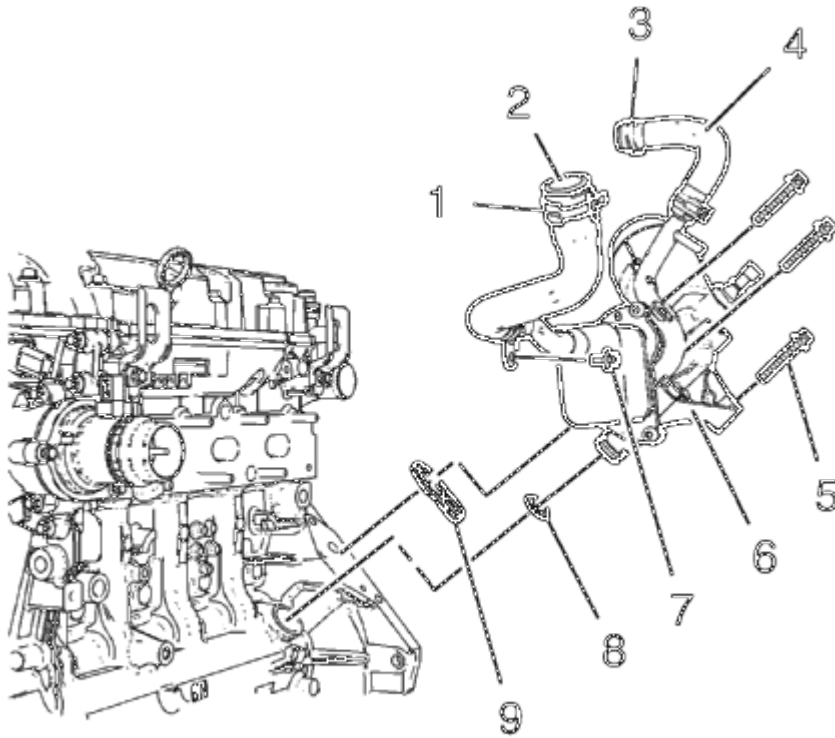
9. Remove the 8 turbocharger nuts (1).



**Fig. 258: Turbocharger Assembly And Turbocharger Gasket**  
Courtesy of GENERAL MOTORS COMPANY

10. Remove the turbocharger assembly (1) and the turbocharger gasket (2).

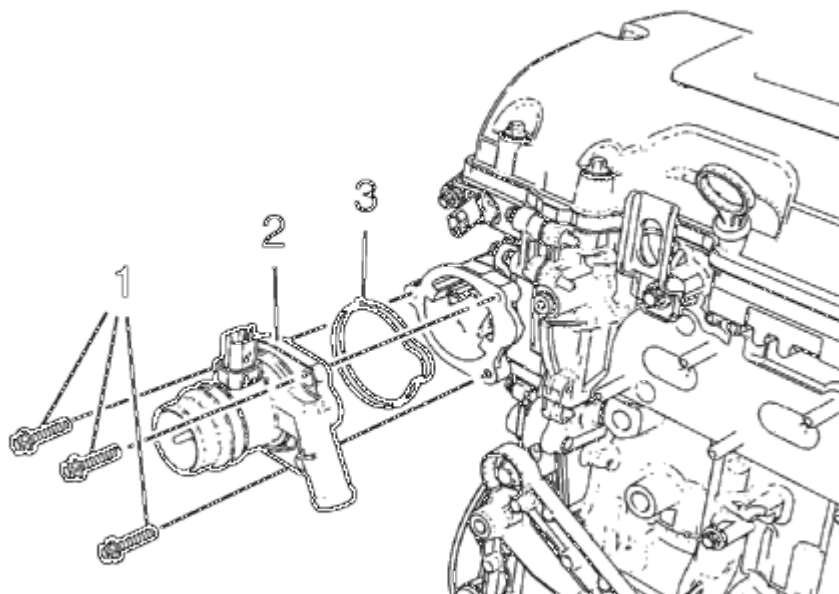
#### **ENGINE OIL COOLER REMOVAL**



**Fig. 259: Locating Engine Oil Cooler Components**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil cooler coolant outlet hose clamp (1).
2. Remove the oil cooler coolant outlet hose (2) from engine coolant thermostat housing.
3. Remove the oil cooler coolant inlet hose clamp (3).
4. Remove the oil cooler coolant inlet hose (4) from water outlet.
5. Remove the oil cooler coolant outlet pipe bolt (7).
6. Remove the 3 oil cooler bolts (5).
7. Remove the engine oil cooler assembly (6) and the 2 oil cooler sealings (8) and (9).

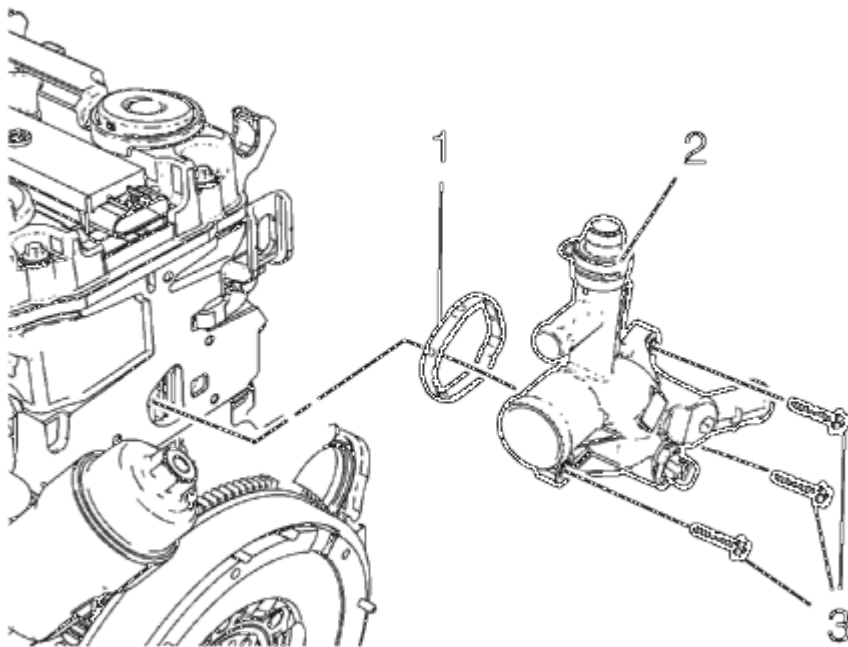
#### **ENGINE COOLANT THERMOSTAT HOUSING REMOVAL (1.4L LUV)**



**Fig. 260: Engine Coolant Thermostat Housing**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the 3 engine coolant thermostat housing bolts (1).
2. Remove the engine coolant thermostat housing (2) and the engine coolant thermostat housing seal ring (3).

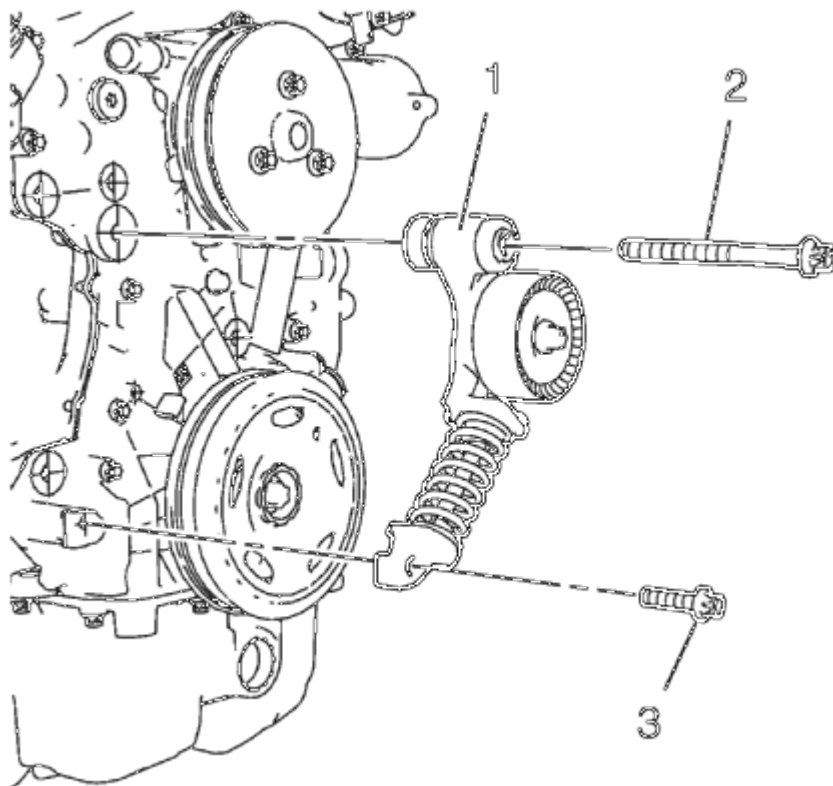
#### **WATER OUTLET REMOVAL (1.4L LUV)**



**Fig. 261: Water Outlet, Bolts And Seal Ring**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the 3 water outlet bolts (3).
2. Remove the water outlet (2) and the water outlet seal ring (1).

## **DRIVE BELT TENSIONER REMOVAL**



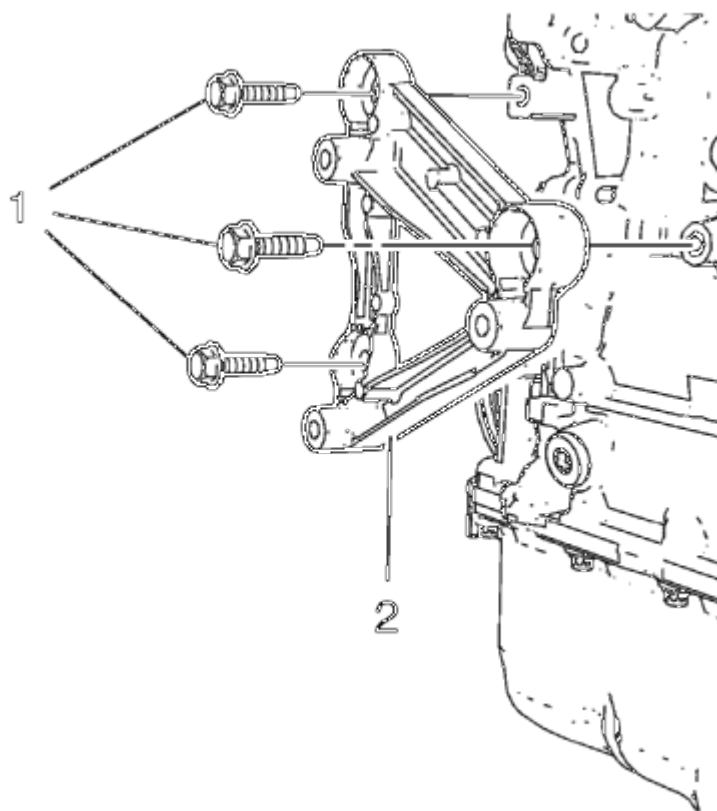
**Fig. 262: Drive Belt Tensioner And Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

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

#### **AIR CONDITIONING COMPRESSOR BRACKET REMOVAL**

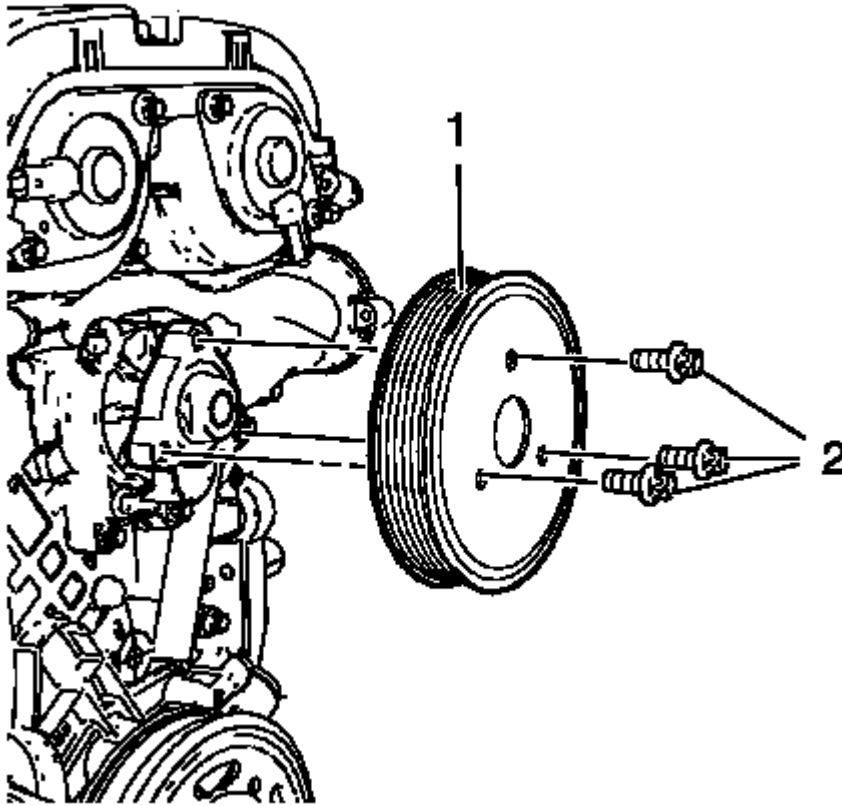




**Fig. 263: Power Steering Pump Bracket/Air Conditioning Compressor Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 air conditioning compressor and power steering pump bracket bolts (1).
2. Remove the air conditioning compressor and power steering pump bracket (2).

## **WATER PUMP PULLEY REMOVAL**



**Fig. 264: Water Pump Pulley**

Courtesy of GENERAL MOTORS COMPANY

1. Loosen the 3 water pump pulley bolts (2) while holding up the water pump pulley hub with a wrench.
2. Remove the 3 water pump pulley bolts (2).
3. Remove the water pump pulley (1).

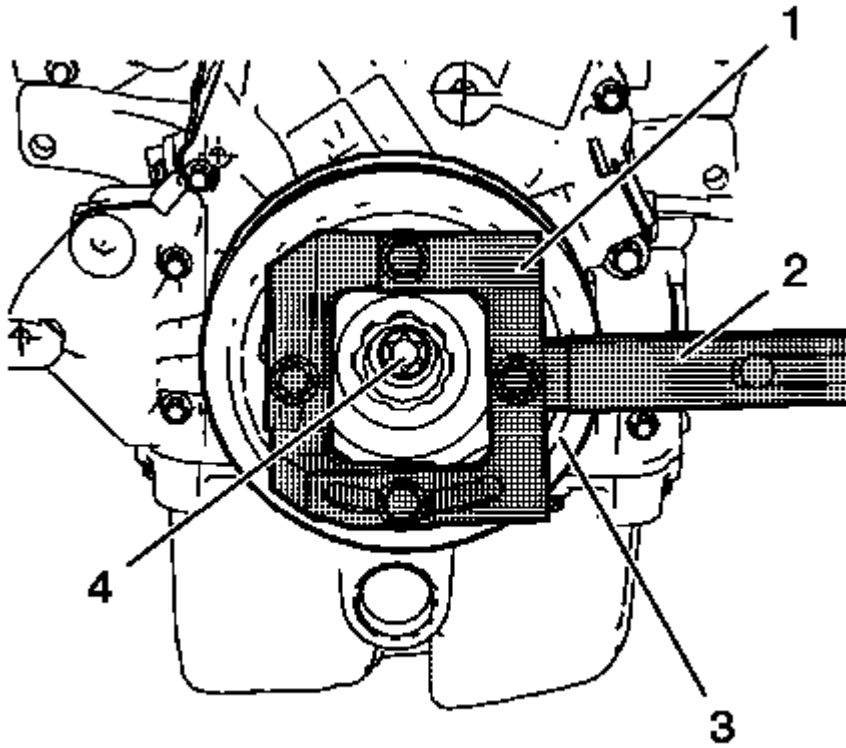
## CRANKSHAFT BALANCER REMOVAL

### Special Tools

- **EN-956-1** Extension
- **EN-49979** Crankshaft Shock Mount Retainer

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

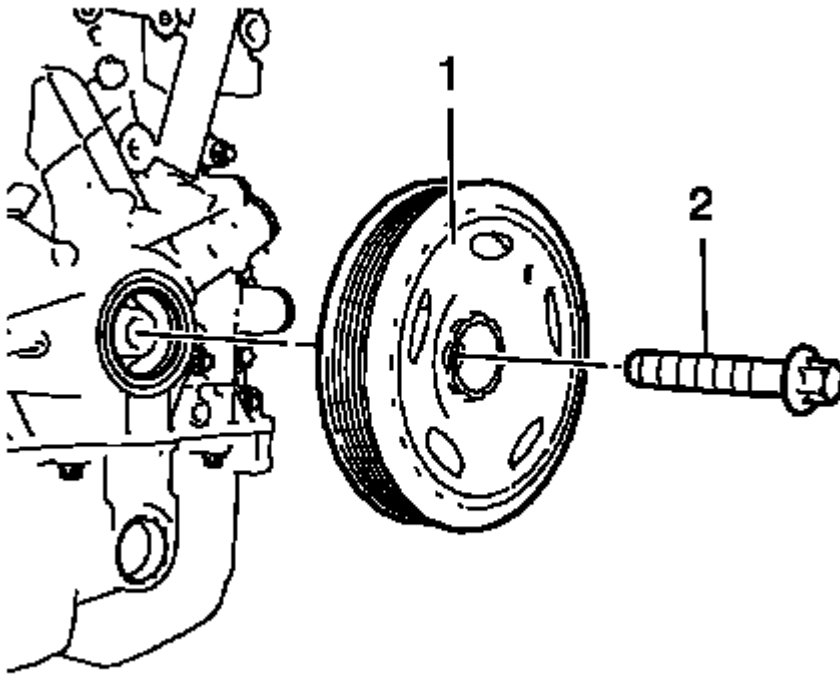
1. Install **EN-49979** retainer to **EN-956-1** extension.



**Fig. 265: Crankshaft Balancer, Retainer And Extension**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The crankshaft balancer can be incorrectly installed 180° from the required position. Be sure to note the location of the alignment hole on the crankshaft balancer prior to removing the crankshaft balancer from the engine.

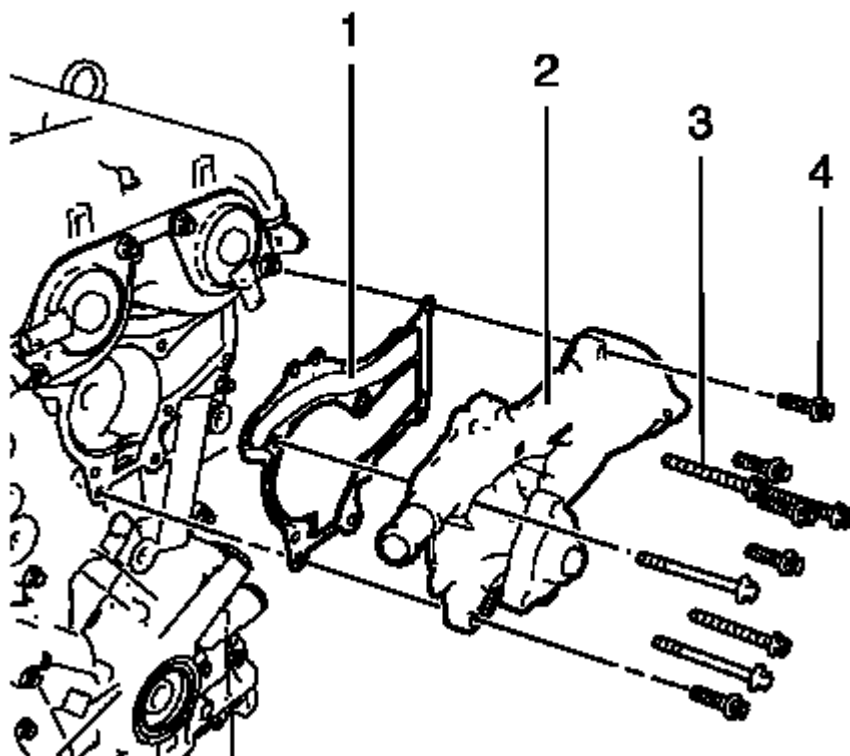
2. Loosen the crankshaft balancer bolt (4) while fixing the crankshaft balancer (3) with **EN-49979** retainer (1) and **EN-956-1** extension (2).



**Fig. 266: Crankshaft Balancer And Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

3. Remove and DISCARD the crankshaft balancer bolt (2).
4. Remove the crankshaft balancer (1).

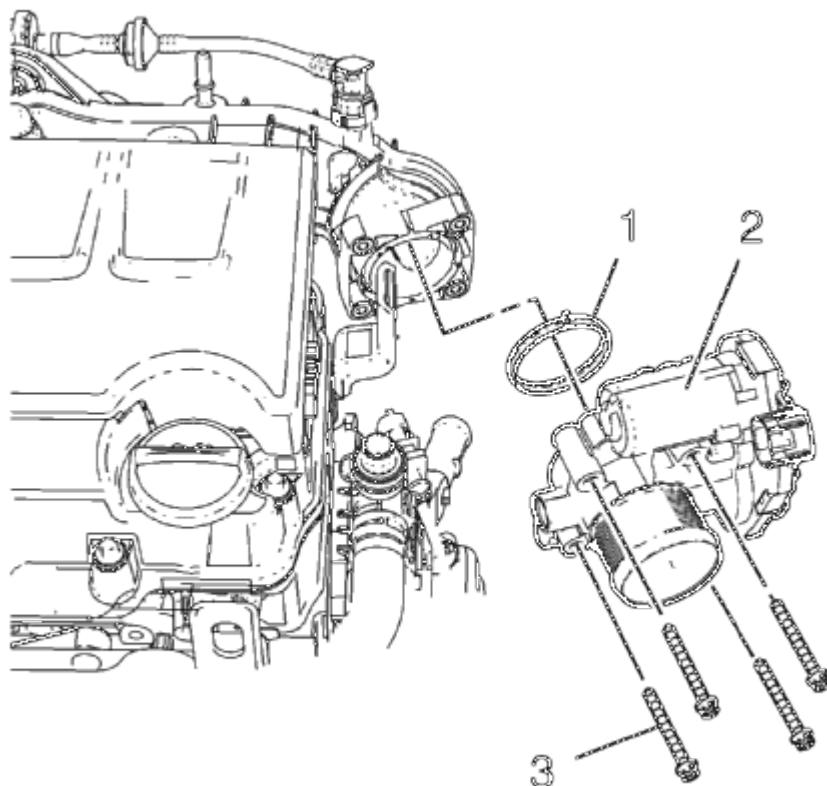
## **WATER PUMP REMOVAL**



**Fig. 267: Water Pump, Gasket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 5 short water pump bolts (4) and the 5 long water pump bolts (3).
2. Remove the water pump (2).
3. Remove the water pump gasket (1).

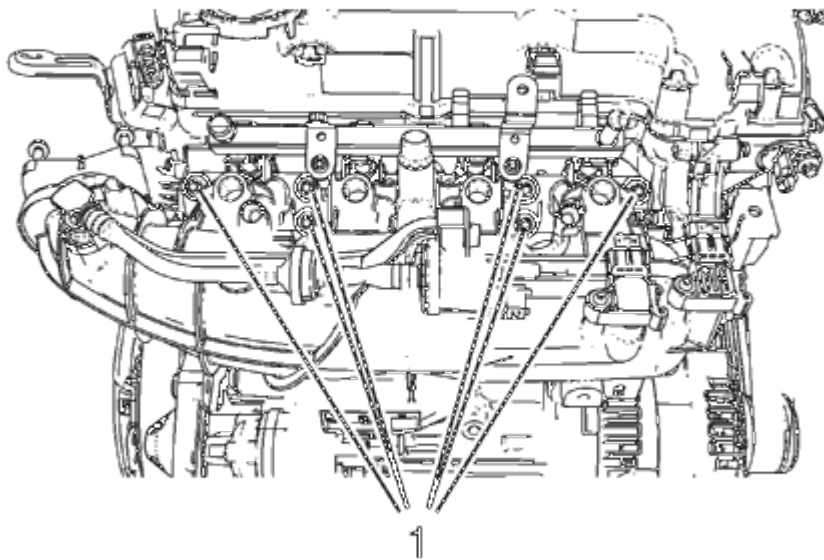
#### **THROTTLE BODY REMOVAL (1.4L LUV)**

**Fig. 268: Throttle Body And Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 throttle body bolts (3).
2. Remove the throttle body (2) and the throttle body seal ring (1).

### **INTAKE MANIFOLD REMOVAL (1.4L LUV)**

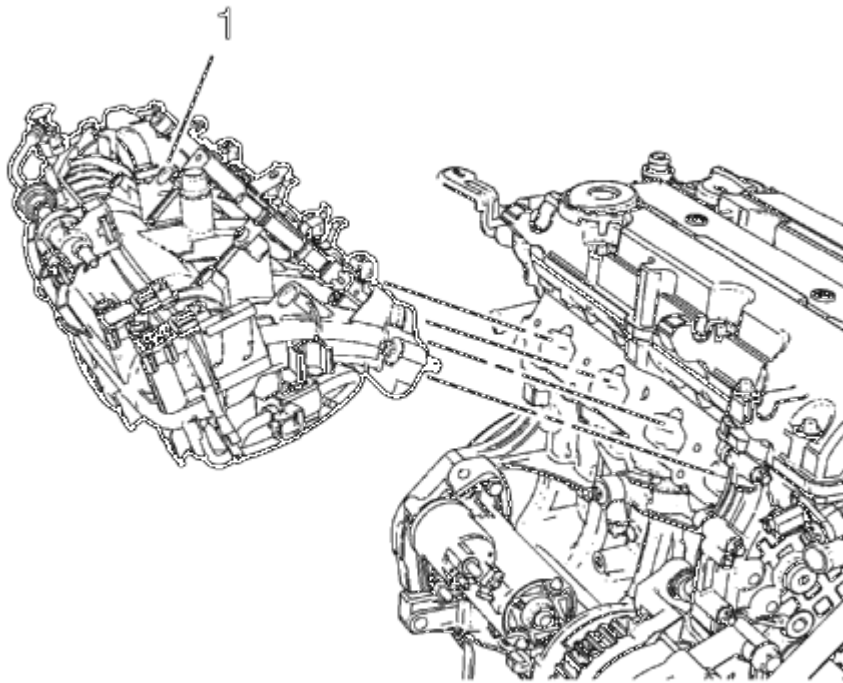


**Fig. 269: Intake Manifold Bolts**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Intake manifold bolts remain in intake manifold screw bores.

1. Remove the 6 intake manifold bolts (1).



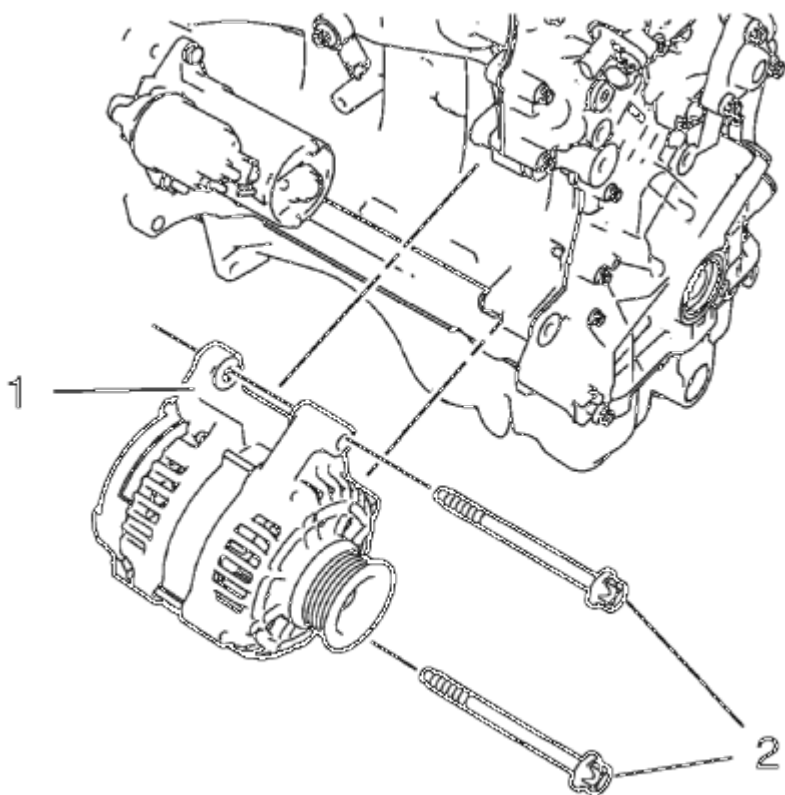
**Fig. 270: Intake Manifold**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold (1) along with the intake manifold gasket.

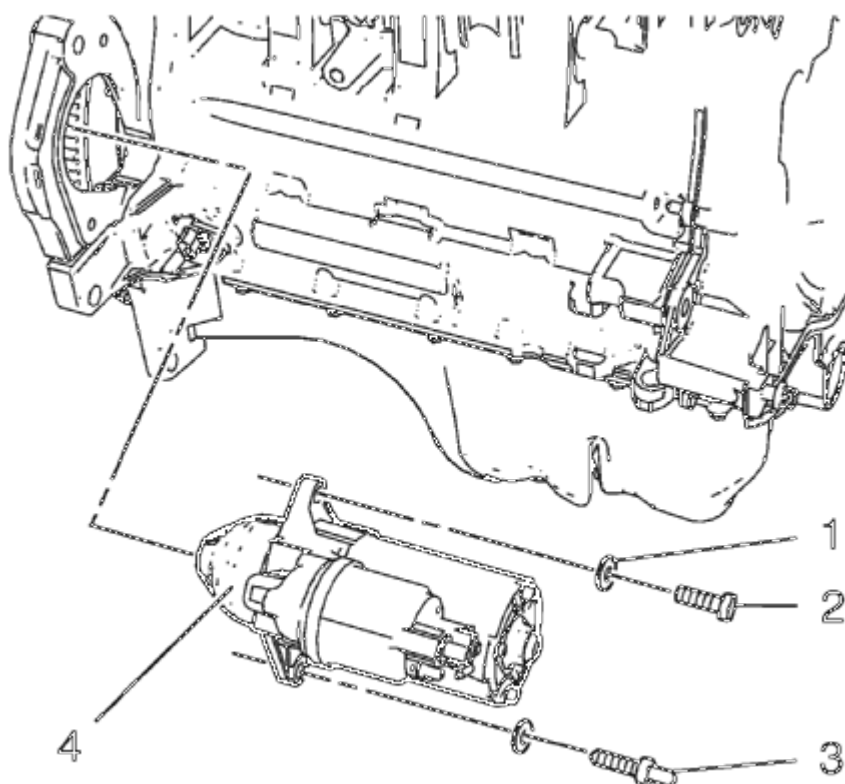
## GENERATOR REMOVAL



**Fig. 271: Generator And Bolts****Courtesy of GENERAL MOTORS COMPANY**

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

**STARTER REMOVAL**



**Fig. 272: Starter, Bolt, Stud And Washer**  
Courtesy of GENERAL MOTORS COMPANY

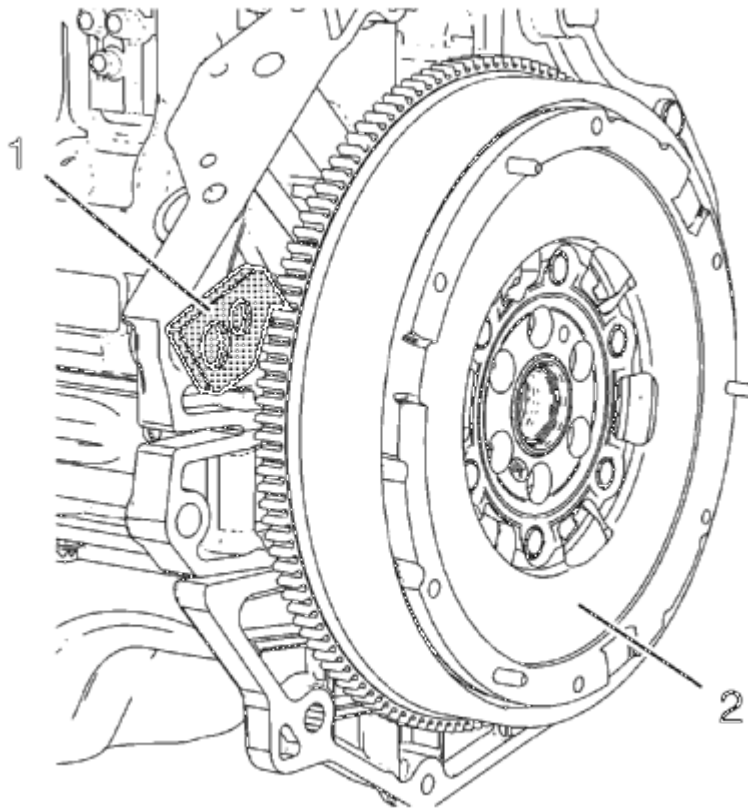
1. Remove the upper starter bolt (2) and the washer (1).
2. Remove the lower starter bolt stud (3) and the washer.
3. Remove the starter (4).

## ENGINE FLYWHEEL REMOVAL (1.4L LUV)

### Special Tools

**EN-652** Flywheel Holder

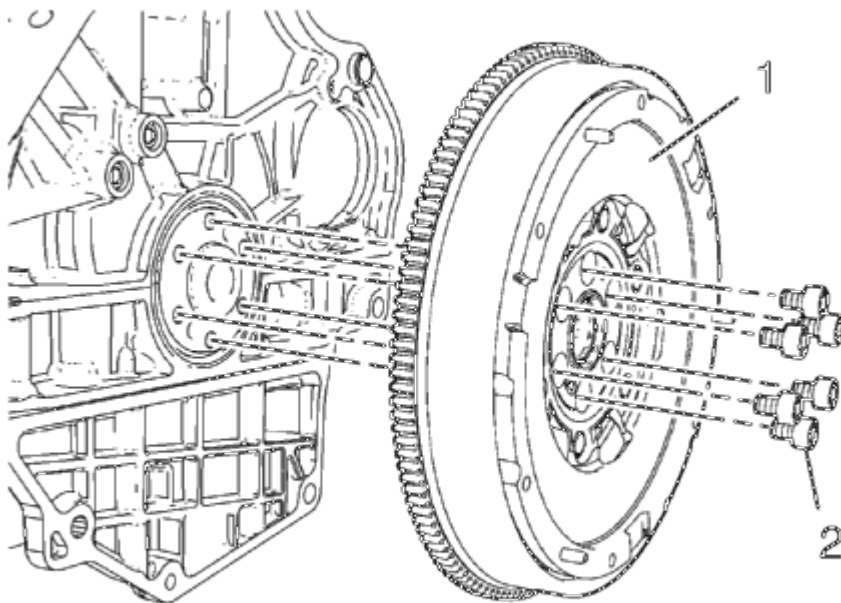
For equivalent regional tools, refer to **Special Tools**.



**Fig. 273: Engine Flywheel And Holder**

Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-652** holder (1) to hold the engine flywheel (2).



**Fig. 274: Engine Flywheel And Bolts**

Courtesy of GENERAL MOTORS COMPANY

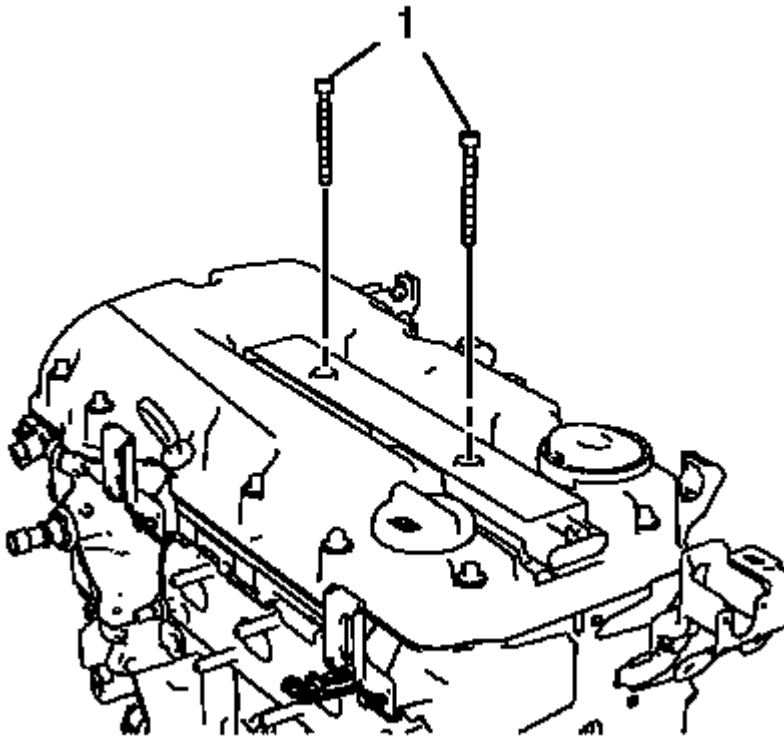
2. Remove and DISCARD the 6 engine flywheel bolts (2).
3. Remove the engine flywheel (1).

## IGNITION COIL REMOVAL

### Special Tools

**EN-6009** Remover and Installer Ignition Module

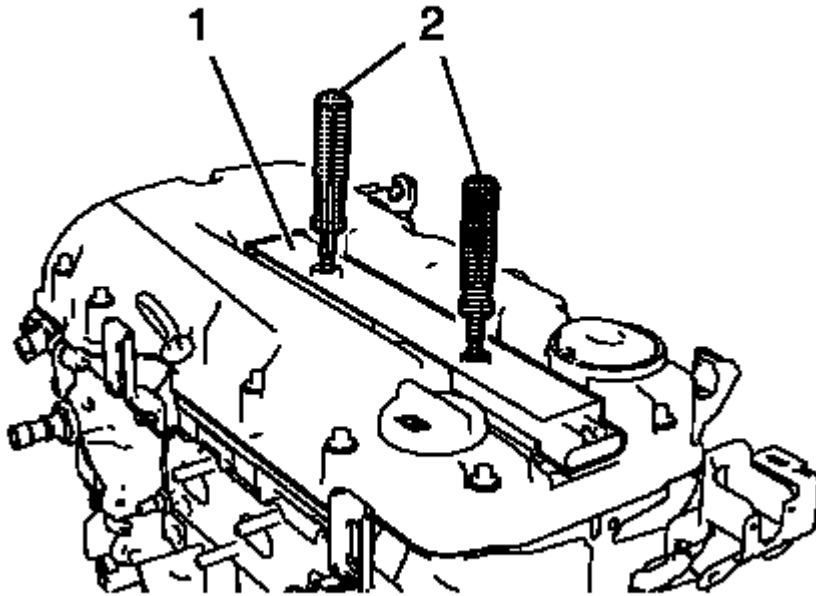
For equivalent regional tools, refer to **Special Tools**.



**Fig. 275: Ignition Coil Bolts**

Courtesy of GENERAL MOTORS COMPANY

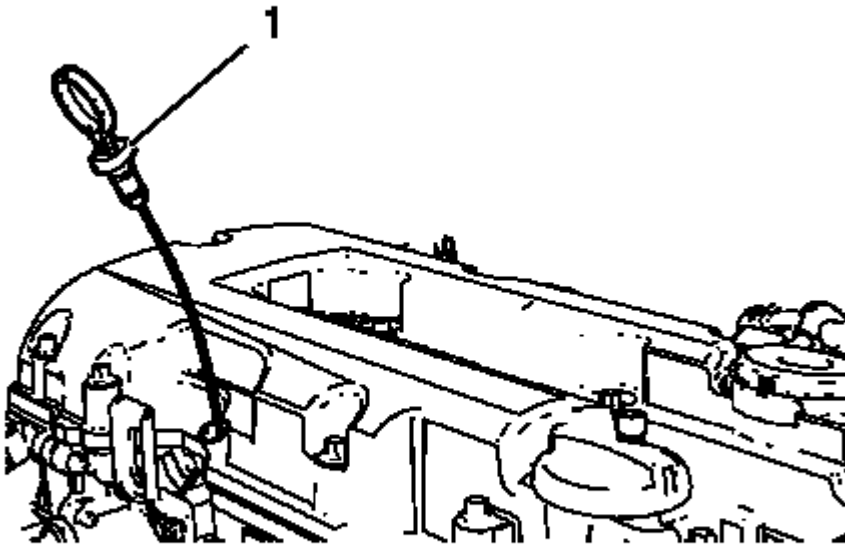
1. Remove the 2 ignition coil bolts (1).



**Fig. 276: Ignition Coil And Remover/Installer**  
**Courtesy of GENERAL MOTORS COMPANY**

2. Install **EN-6009** remover and installer (2) and remove the ignition coil (1).

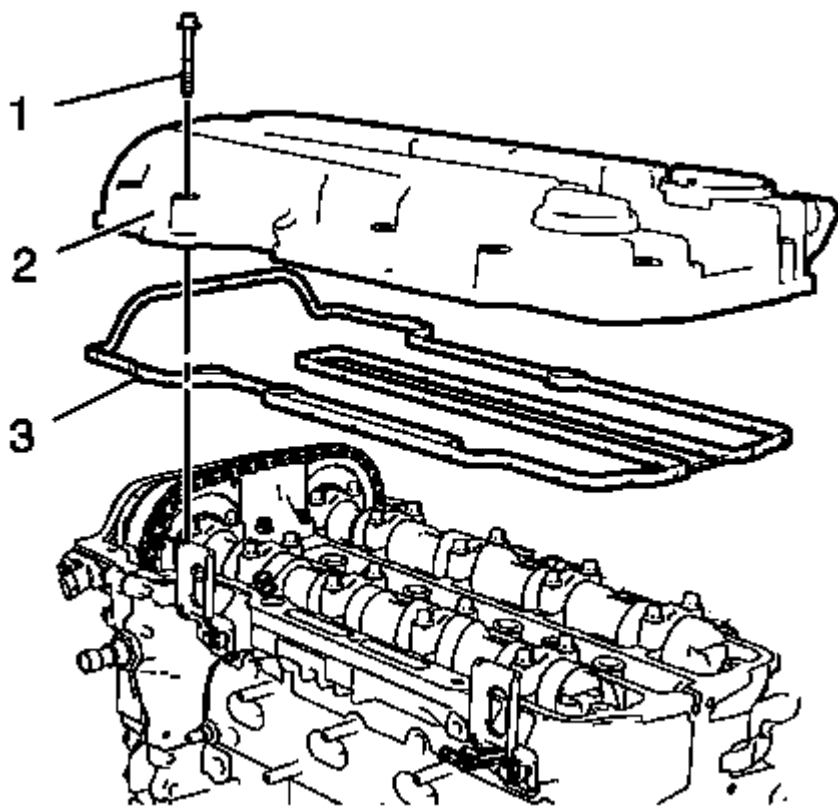
#### **CAMSHAFT COVER REMOVAL**



**Fig. 277: Engine Oil Level Indicator**

**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the oil level indicator (1).



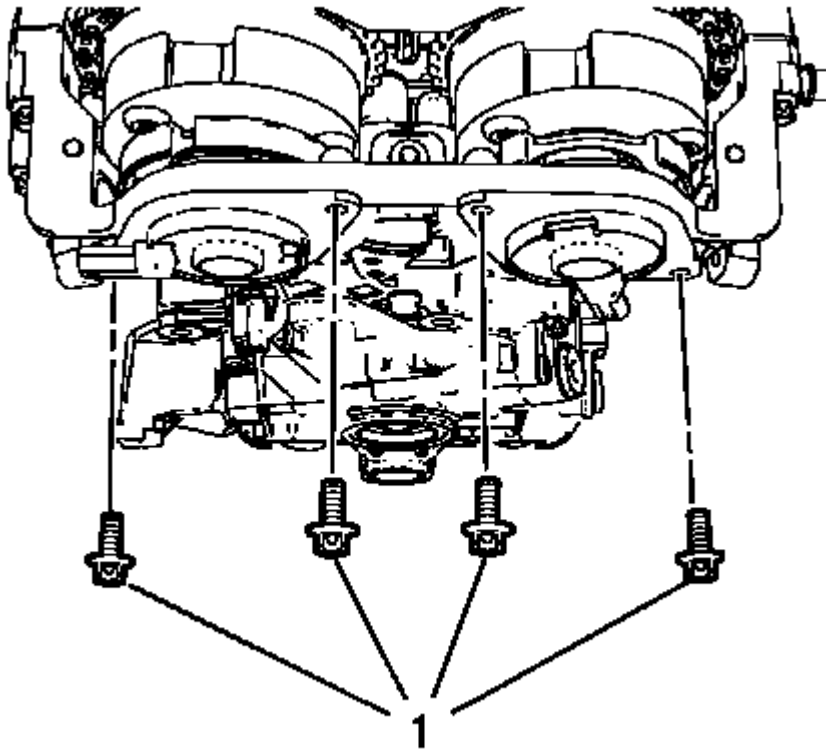
**Fig. 278: Camshaft Cover And Gasket**

Courtesy of GENERAL MOTORS COMPANY

2. Remove the 15 camshaft cover bolts (1).
3. Remove the camshaft cover (2) and the camshaft cover gasket (3).

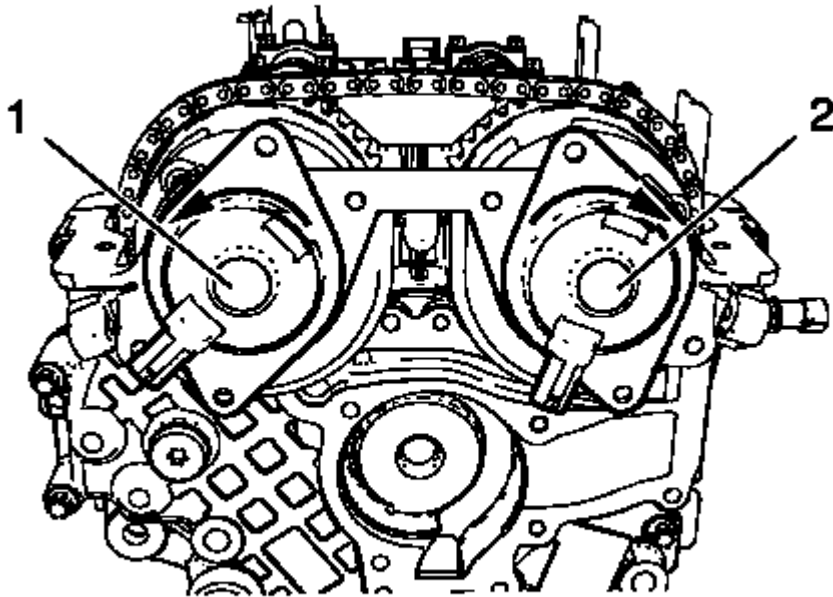
#### **CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REMOVAL**





**Fig. 279: Camshaft Position Actuator Solenoid Valve Bolts**  
Courtesy of GENERAL MOTORS COMPANY

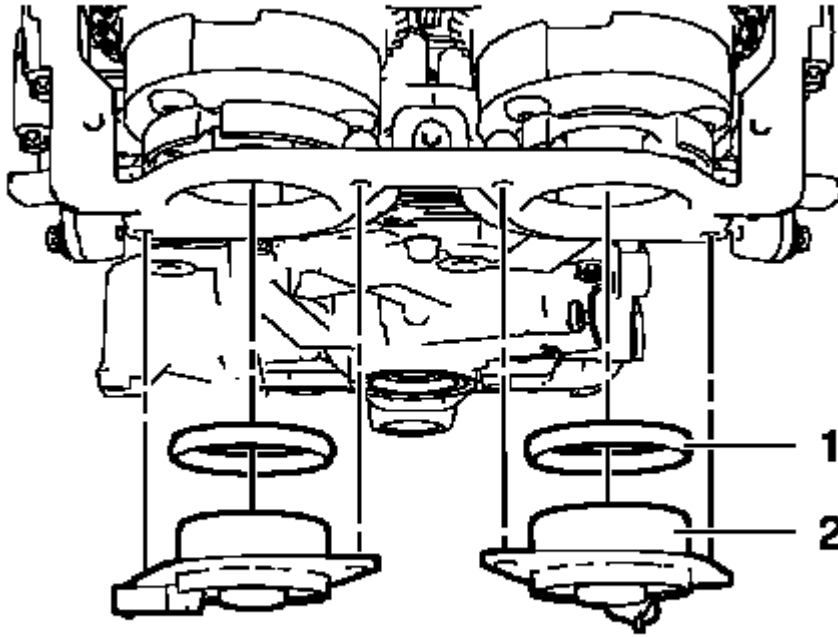
1. Remove the 4 camshaft position actuator solenoid valve bolts (1).



**Fig. 280: Intake Camshaft Position Actuator Solenoid Valve And Exhaust Camshaft Position Actuator Solenoid Valve**

Courtesy of GENERAL MOTORS COMPANY

2. Move the intake camshaft position actuator solenoid valve (1) carefully counter clockwise in the position shown.
3. Move the exhaust camshaft position actuator solenoid valve (2) carefully clockwise in the position shown.

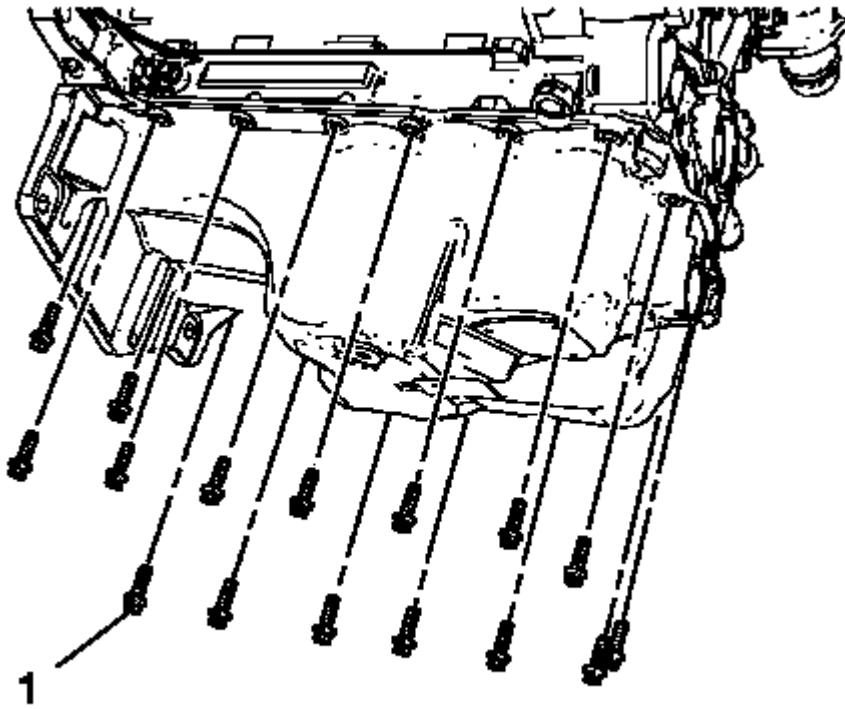


**Fig. 281: Camshaft Position Actuator Solenoid Valves And Seal Rings**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** The camshaft position actuator solenoid valves must be kept parallel to the engine front cover during removal and installation. The camshaft position actuator solenoid valves can be damaged if they become wedged or stuck during this process.

4. Carefully remove the 2 camshaft position actuator solenoid valves (2) and the seal rings (1).

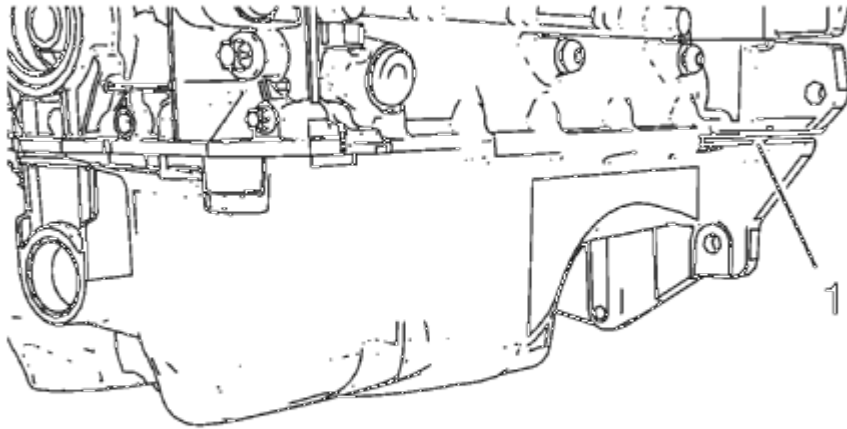
## OIL PAN REMOVAL



**Fig. 282: Oil Pan Bolts**

Courtesy of GENERAL MOTORS COMPANY

1. Remove the 16 oil pan bolts (1).

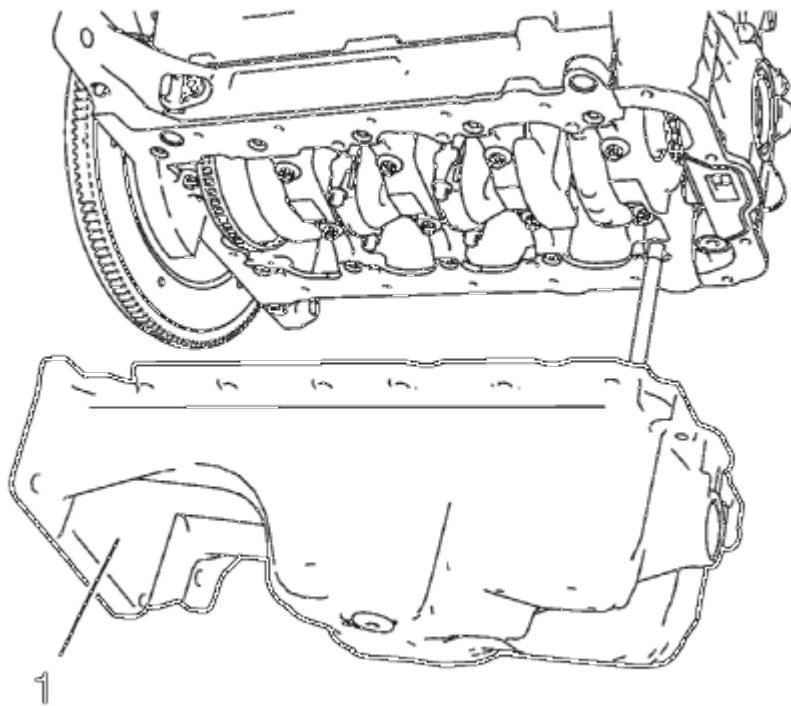


**Fig. 283: Oil Pan Prying Area**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Pry the oil pan carefully in order to prevent damage to the transaxle case or the oil pan sealing surfaces.**

2. Place a suitable prying tool to the area shown (1) and carefully pry the oil pan loose.



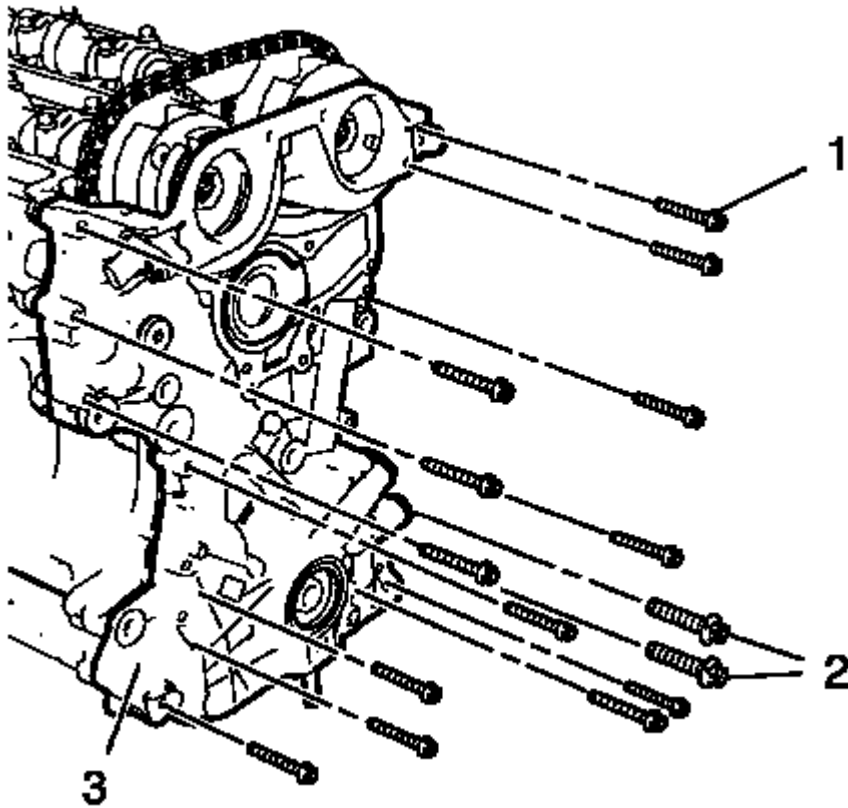
**Fig. 284: Oil Pan**

Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan (1).

#### **ENGINE FRONT COVER AND OIL PUMP REMOVAL**

1. Set engine to TDC. Refer to **Camshaft Timing Chain Inspection.**



**Fig. 285: M6, M10 Front Cover Bolts And Engine Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 13 engine front cover bolts M6 (1).
3. Remove the 2 engine front cover bolts M10 (2).
4. Remove the engine front cover.

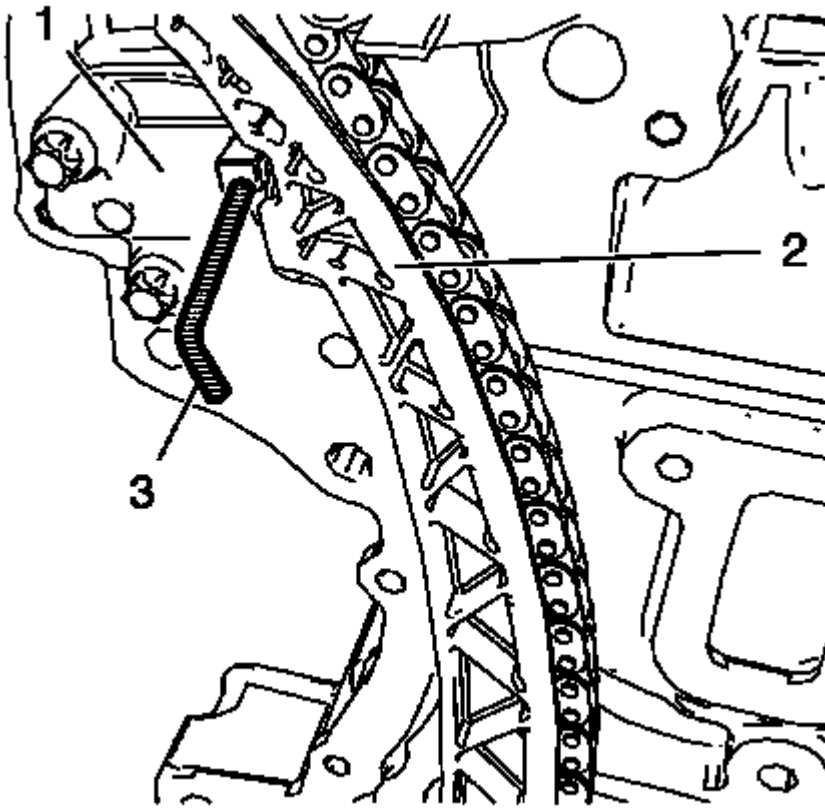
## CAMSHAFT TIMING CHAIN REMOVAL

### Special Tools

- EN-952 Fixing Pin
- EN-953-A Fixing Tool
- EN-955-1 Fixing Pin from EN-955 Kit

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

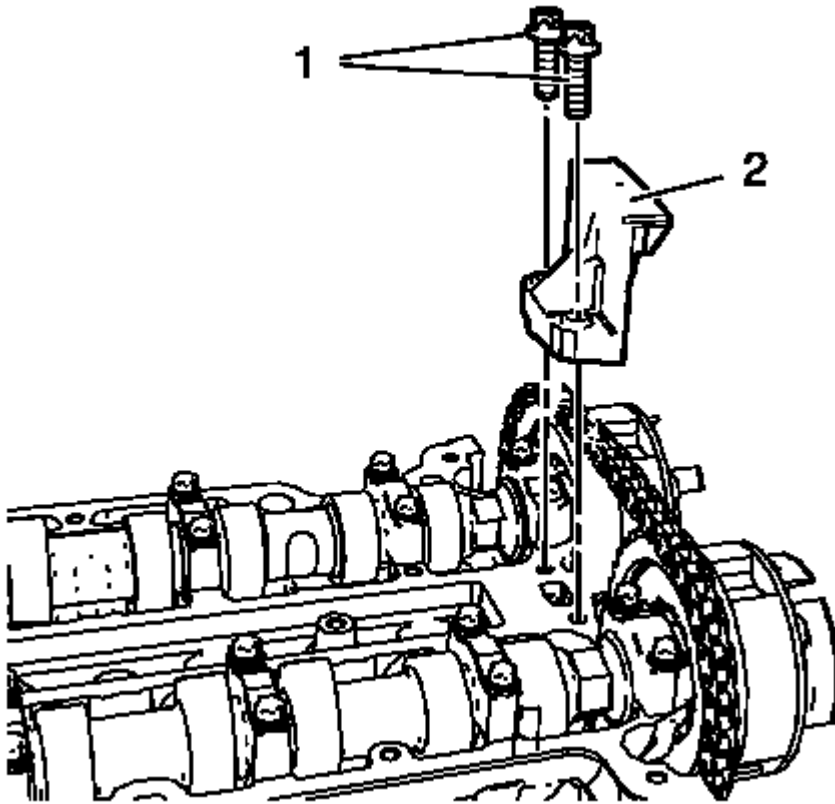
1. The engine should be adjusted to TDC.
2. The crankshaft should be fixed with **EN-952** fixing pin.
3. The camshaft should be fixed with **EN-953-A** fixing tool.



**Fig. 286: Timing Chain And Timing Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

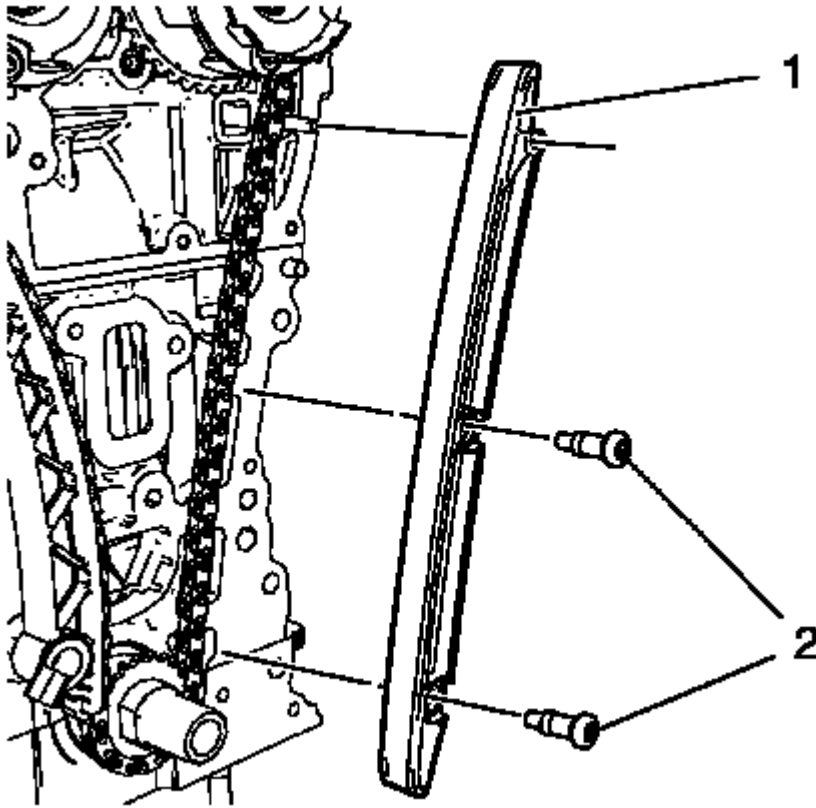
4. Push the timing chain (2) in direction to the timing chain tensioner (1) and fix the tensioner with **EN-955-1** fixing pin (3).





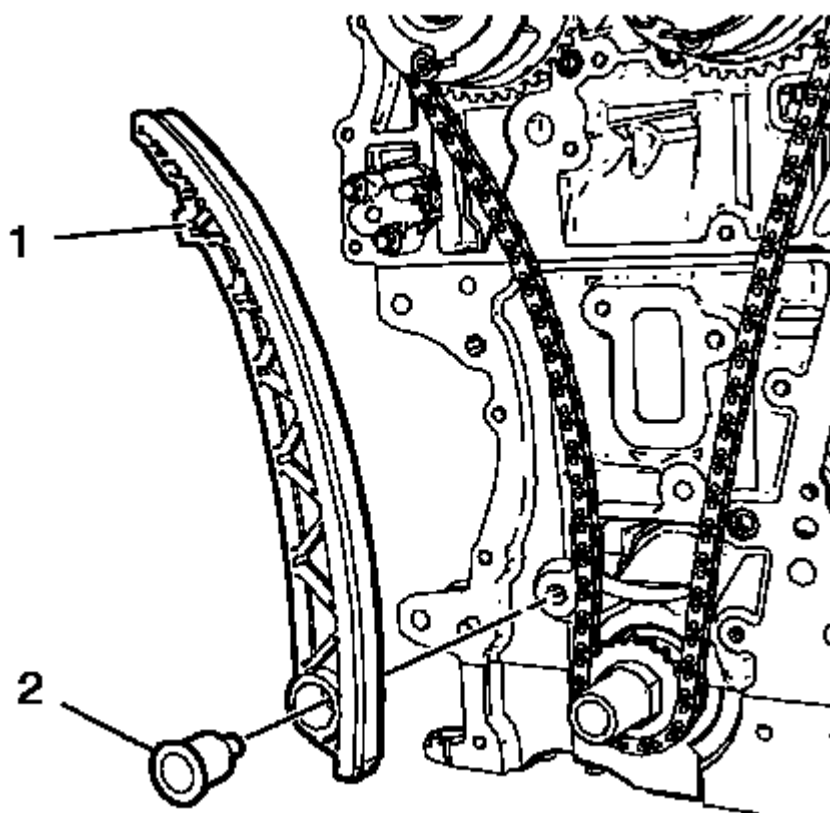
**Fig. 287: Upper Timing Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 upper timing chain guide bolts (1).
6. Remove the upper timing chain guide (2).



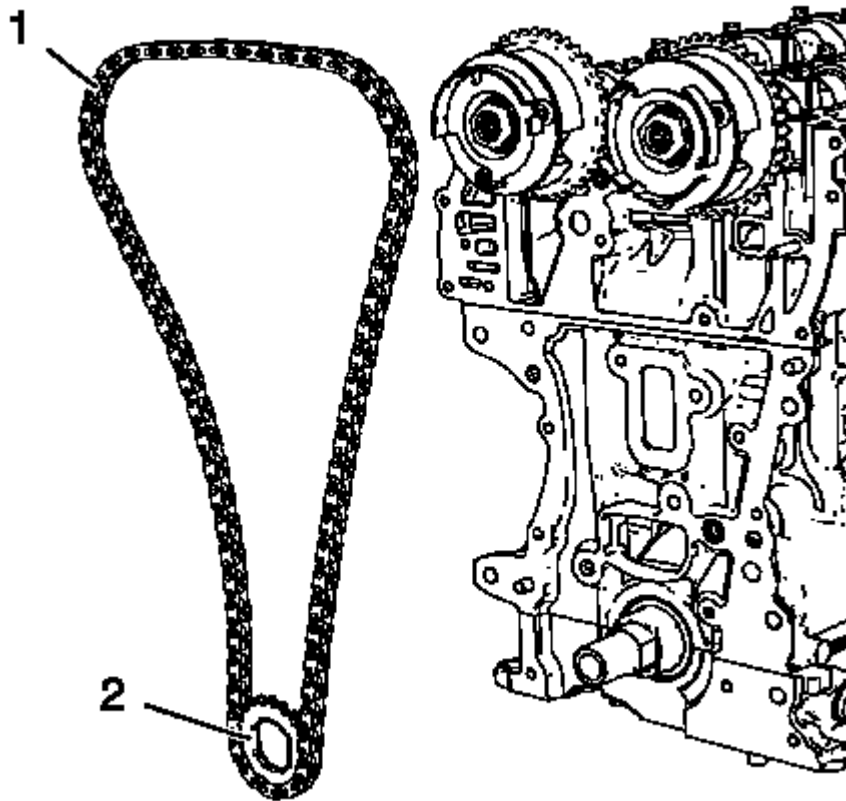
**Fig. 288: Timing Chain Guide Right Side**  
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 timing chain guide right side bolts (2).
8. Remove the timing chain guide right side (1).



**Fig. 289: Timing Chain Tensioner Shoe And Bolt**  
**Courtesy of GENERAL MOTORS COMPANY**

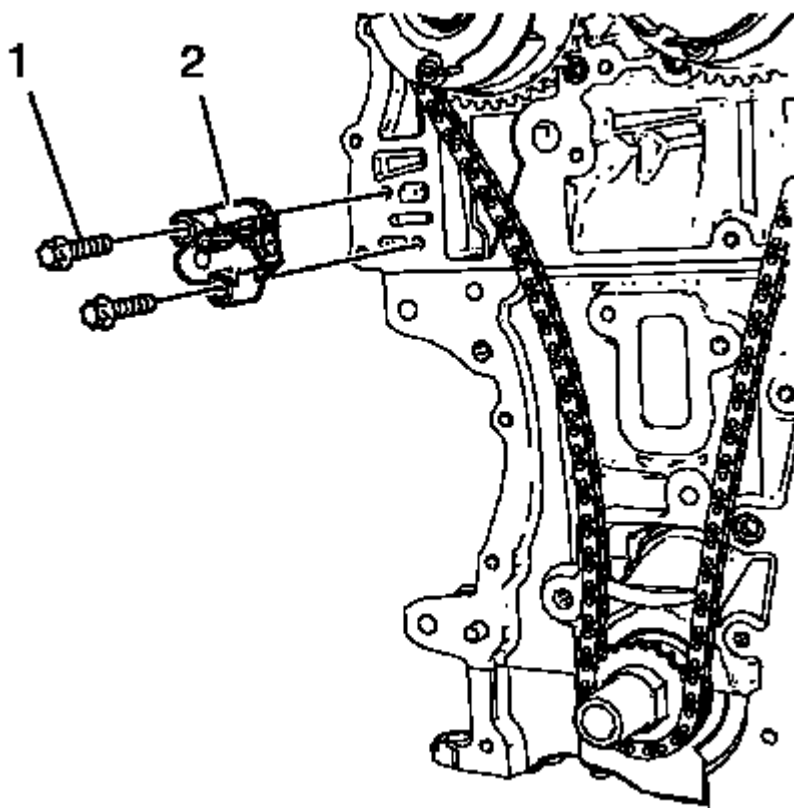
9. Remove the timing chain tensioner shoe bolt (2).
10. Remove the timing chain tensioner shoe (1).



**Fig. 290: Timing Chain And Crankshaft Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

11. Remove the timing chain (1) in compound with the crankshaft sprocket (2).

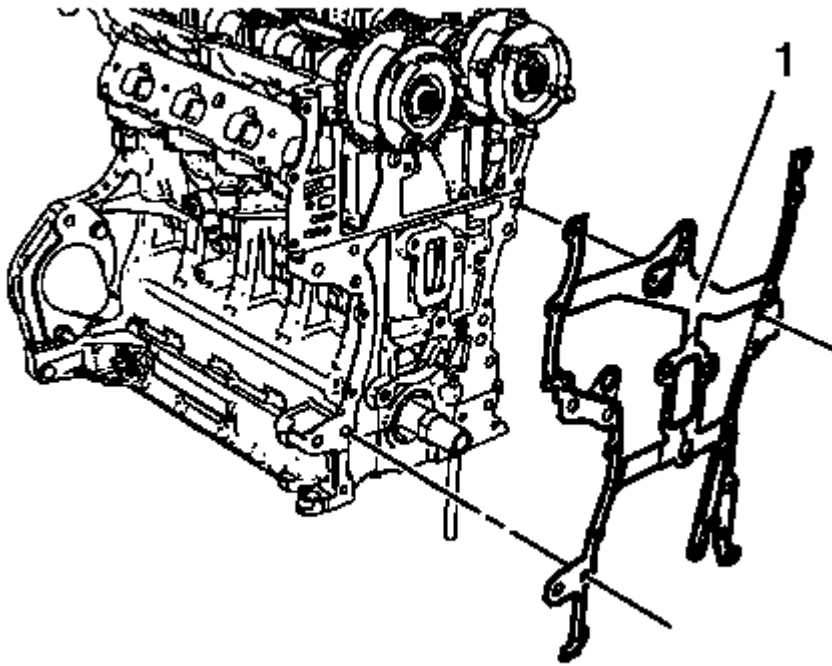
#### **TIMING CHAIN TENSIONER REMOVAL**



**Fig. 291: Timing Chain Tensioner And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 timing chain tensioner bolts (1).
2. Remove the timing chain tensioner (2).

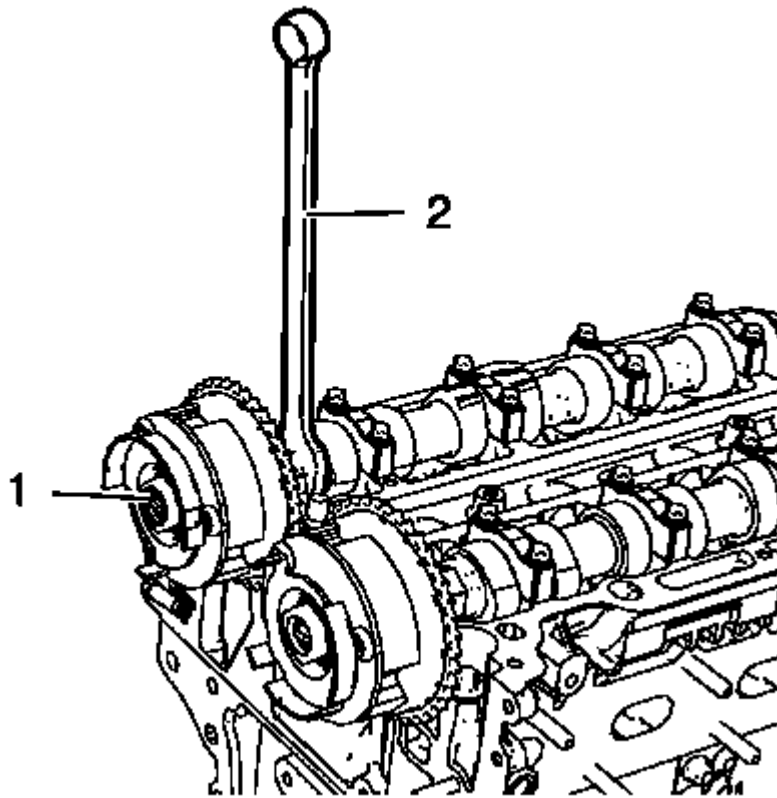
#### **ENGINE FRONT COVER GASKET REMOVAL**



**Fig. 292: Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS COMPANY

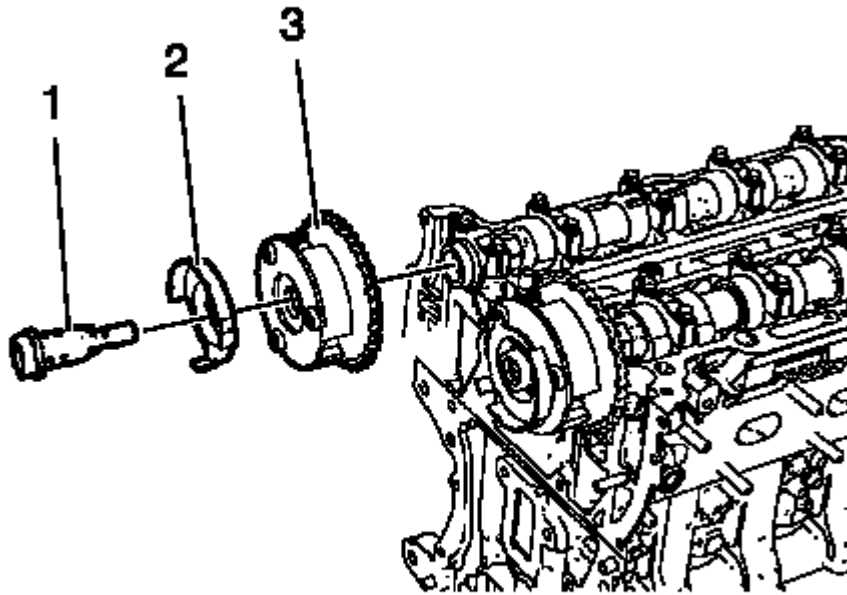
Remove the engine front cover gasket (1).

### **CAMSHAFT SPROCKET REMOVAL**



**Fig. 293: Intake Camshaft And Intake Camshaft Sprocket Bolt**  
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the intake camshaft sprocket bolt (1) while holding the hexagon of intake camshaft (2) with a wrench.

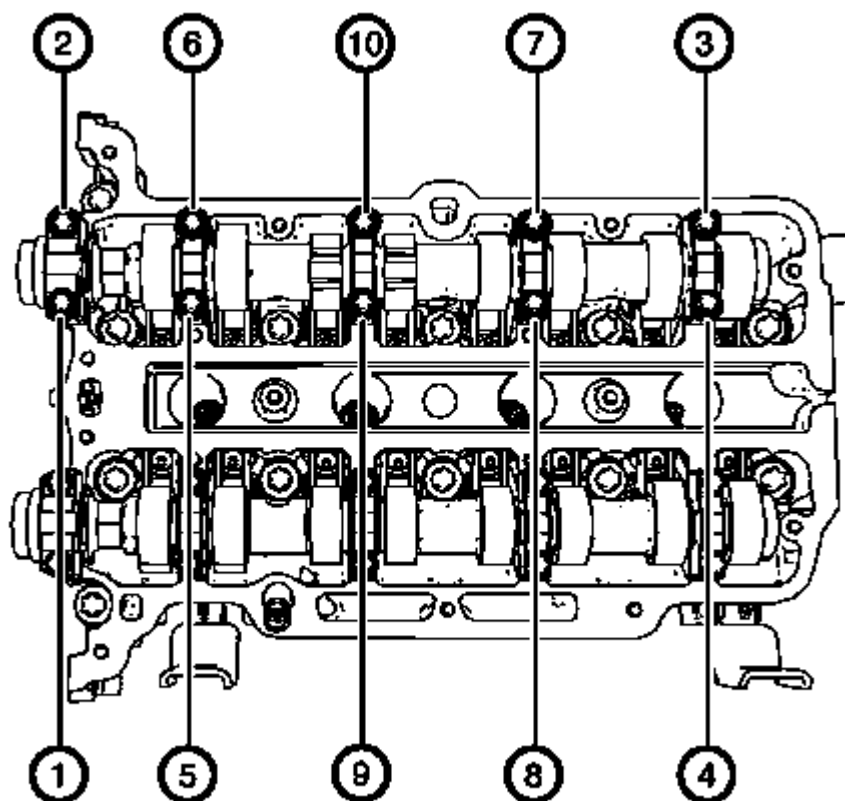


**Fig. 294: Intake Camshaft Sprocket, Bolt And Intake Camshaft Position Exciter Wheel**  
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake camshaft sprocket bolt (1) and the intake camshaft position exciter wheel (2).
3. Remove the intake camshaft sprocket (3).
4. Loosen the exhaust camshaft sprocket bolt while holding the hexagon of exhaust camshaft with a wrench.
5. Remove the exhaust camshaft sprocket bolt and the exhaust camshaft position exciter wheel.
6. Remove the exhaust camshaft sprocket.

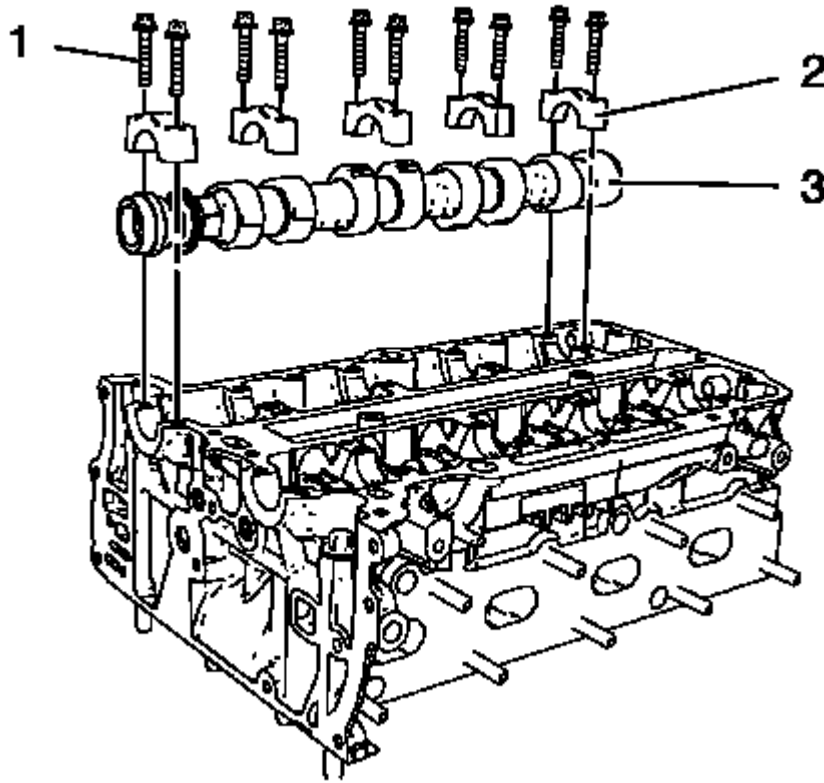
## INTAKE CAMSHAFT REMOVAL





**Fig. 295: Intake Camshaft Bearing Cap Bolts Removal Sequence**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft bearing cap bolts in a spiral sequence as shown one turn at a time until there is no spring tension pushing on the camshaft.

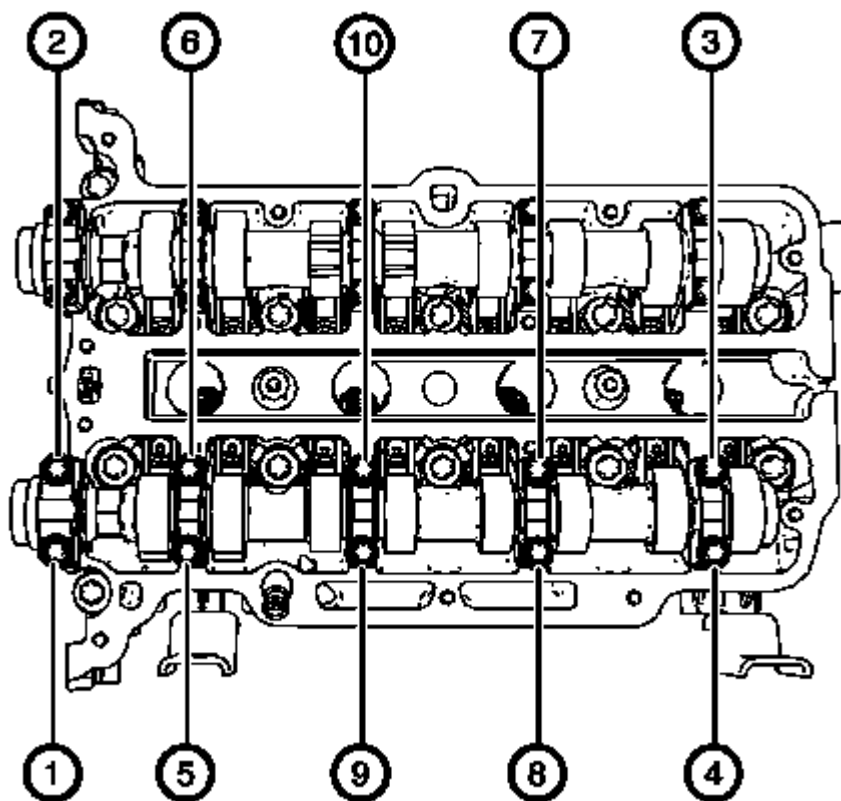


**Fig. 296: Intake Camshaft, Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the markings on the camshaft bearing caps to ensure they will be installed in the same position.

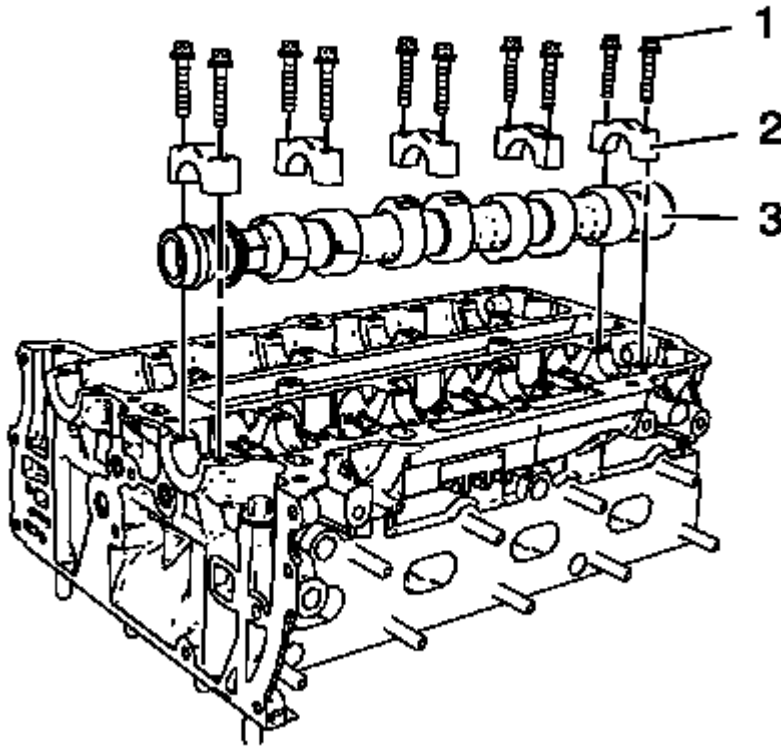
2. Remove the 10 camshaft bearing cap bolts (1).
3. Remove the 5 camshaft bearing caps (2).
4. Remove the intake camshaft (3).

#### EXHAUST CAMSHAFT REMOVAL



**Fig. 297: Exhaust Camshaft Bearing Cap Bolts Removal Sequence**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft bearing cap bolts in a spiral sequence as shown one turn at a time until there is no spring tension pushing on the camshaft.

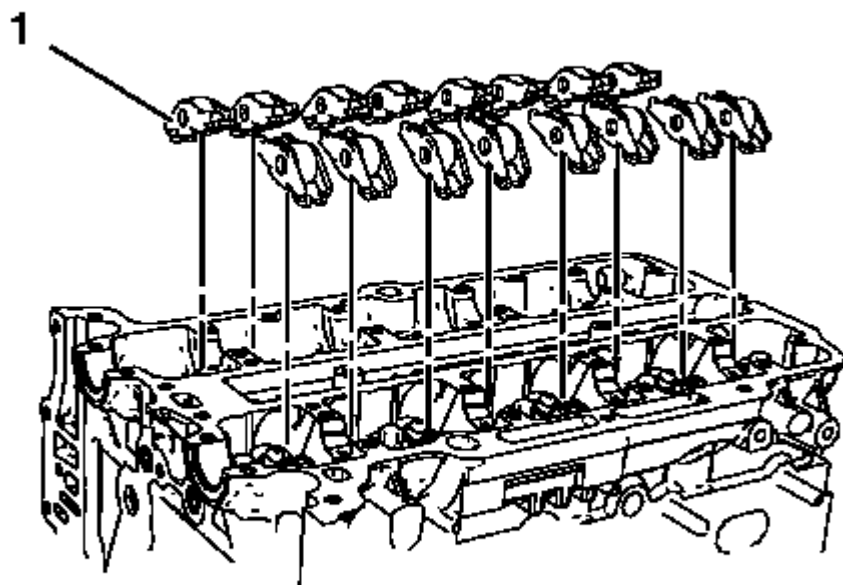


**Fig. 298: Exhaust Camshaft, Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the markings on the camshaft bearing caps to ensure they will be installed in the same position.

2. Remove the 10 camshaft bearing cap bolts (1).
3. Remove the 5 camshaft bearing caps (2).
4. Remove the exhaust camshaft (3).

#### HYDRAULIC VALVE LASH ADJUSTER ARM REMOVAL

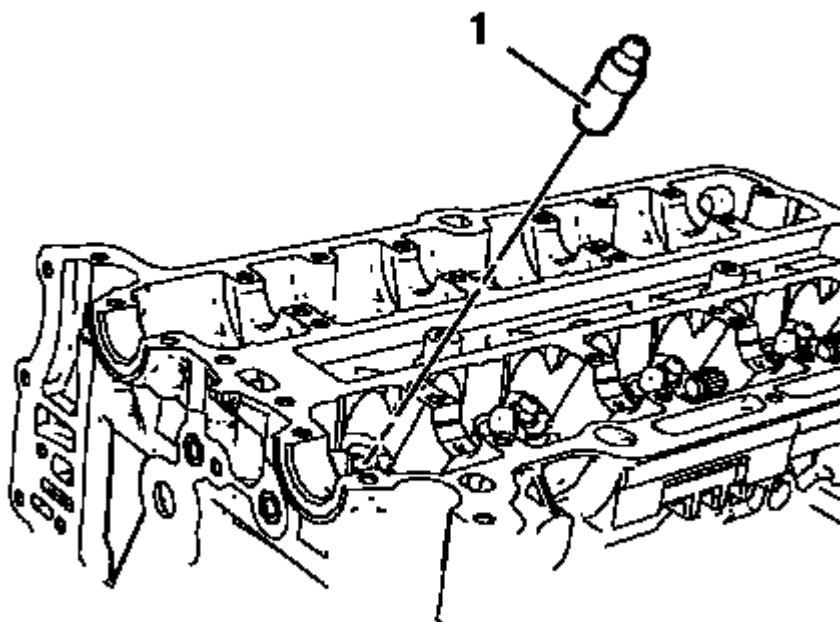


**Fig. 299: Hydraulic Valve Lash Adjuster Arms**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the installation position of the hydraulic valve lash adjuster arms.

Remove the 16 hydraulic valve lash adjuster arms (1).

#### **HYDRAULIC VALVE LASH ADJUSTER REMOVAL**

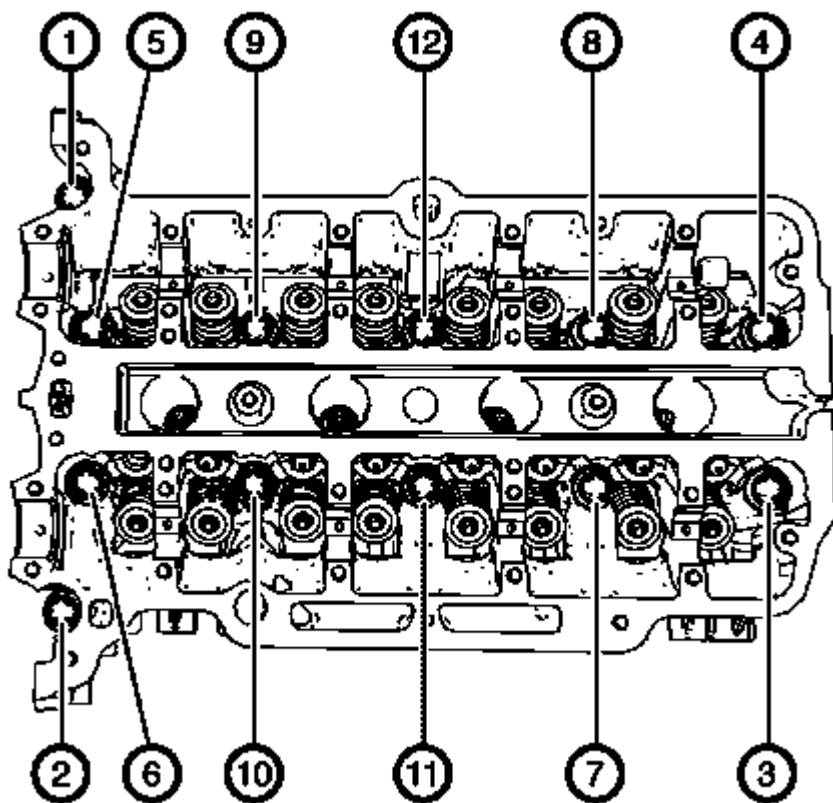


**Fig. 300: Hydraulic Valve Lash Adjusters**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the installation position of the hydraulic valve lash adjusters.

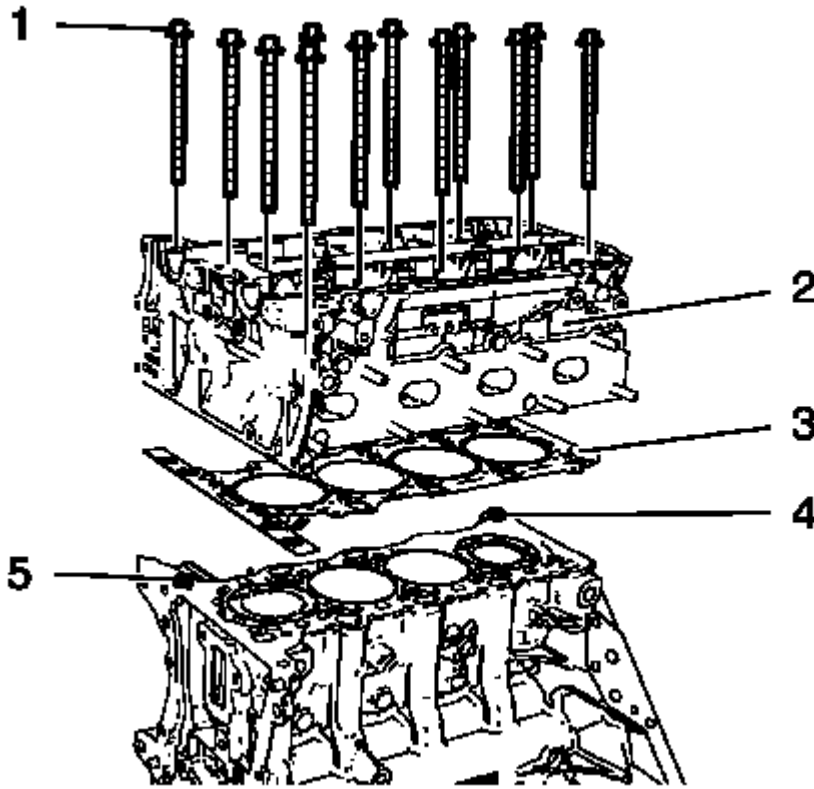
Remove the 16 hydraulic valve lash adjusters (1).

#### **CYLINDER HEAD REMOVAL**



**Fig. 301: Cylinder Head Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the 12 cylinder head bolts in the sequence as shown. Use the following procedure:
  1. Loosen the cylinder head bolts 90 degrees.
  2. Loosen the cylinder head bolts 180 degrees.



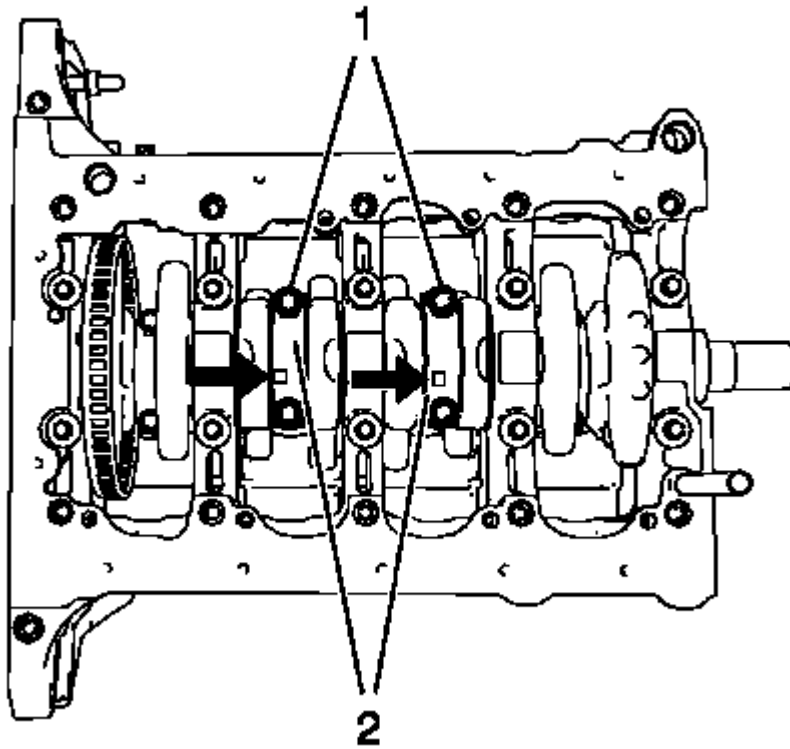
**Fig. 302: Cylinder Head, Gasket, Bolts And Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Do not damage the guide sleeves (4) and (5).

2. Remove the 12 cylinder head bolts (1).
3. Remove the cylinder head (2).
4. Remove the cylinder head gasket (3).

#### **PISTON, CONNECTING ROD, AND BEARING REMOVAL**

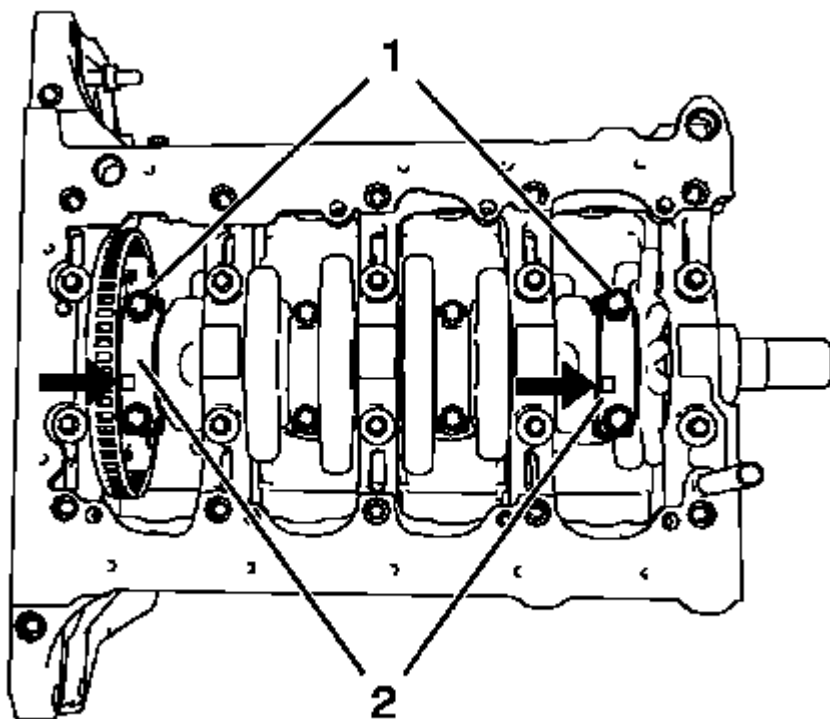




**Fig. 303: Connecting Rod Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

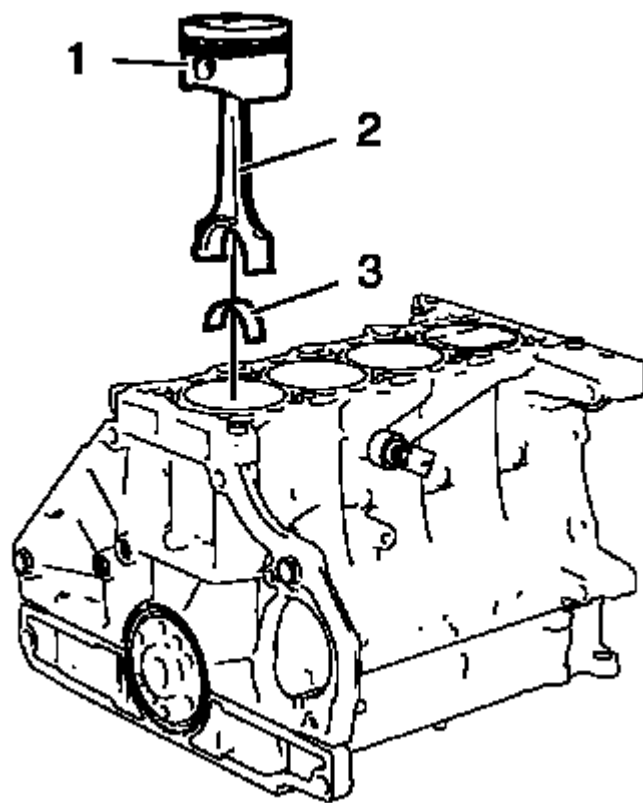
**NOTE:** Mark the installation position of the connecting rod bearing caps. The connecting rod bearings and bearing caps must not be interchanged with other connecting rods.

1. Remove the 4 connecting rod bearing cap bolts (1) of cylinder 2 and 3.
2. Remove the 2 connecting rod bearing caps (2) and the 2 connecting rod bearings of cylinder 2 and 3.
3. Rotate the crankshaft 180 degrees.



**Fig. 304: Connecting Rod Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

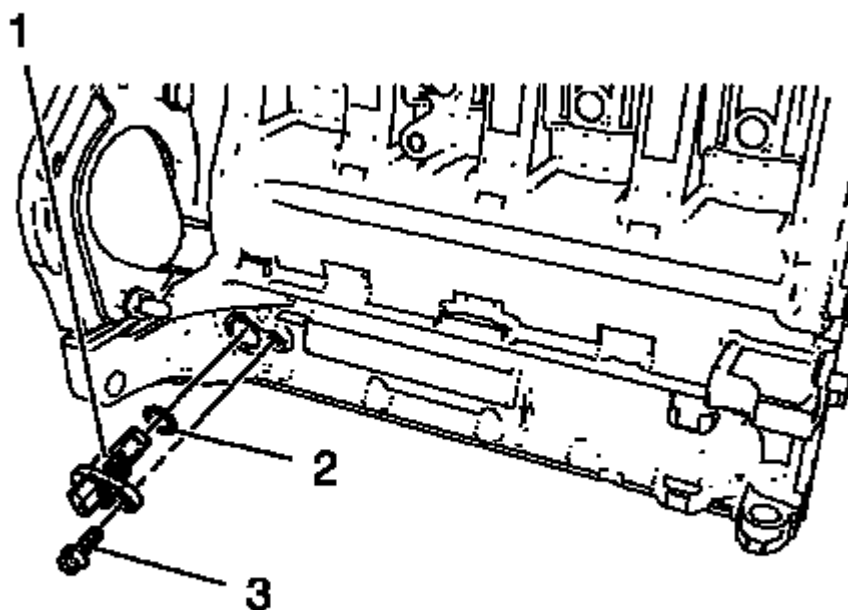
4. Remove the 4 connecting rod bearing cap bolts (1) of cylinder 1 and 4.
5. Remove the 2 connecting rod bearing caps (2) and the 2 connecting rod bearings of cylinder 1 and 4.



**Fig. 305: Pistons, Connecting Rods And Bearings**  
**Courtesy of GENERAL MOTORS COMPANY**

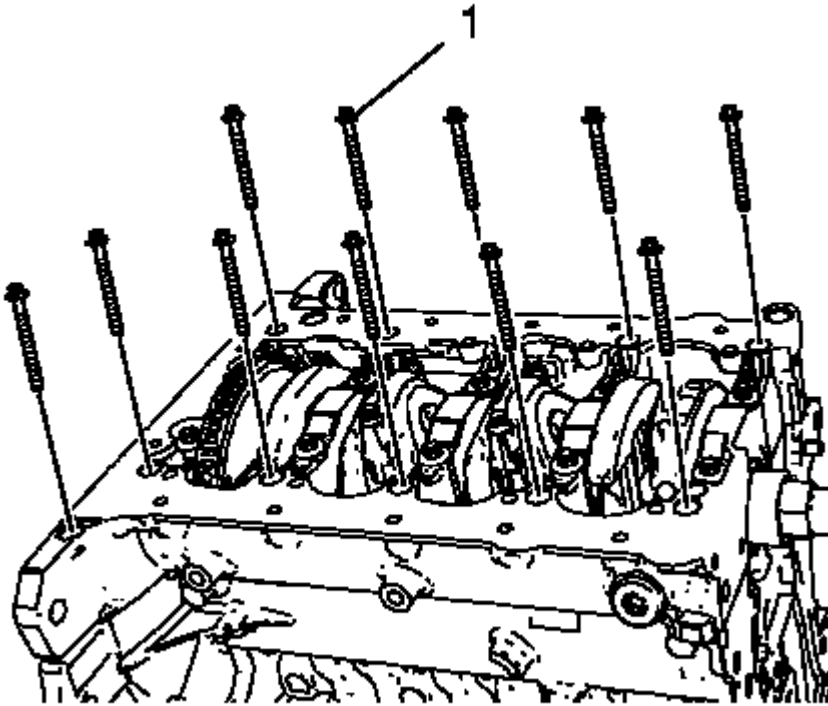
6. Remove the 4 pistons (1) and connecting rods (2) and the 4 upper connecting rod bearings (3) from the cylinder block.

## CRANKSHAFT AND BEARING REMOVAL



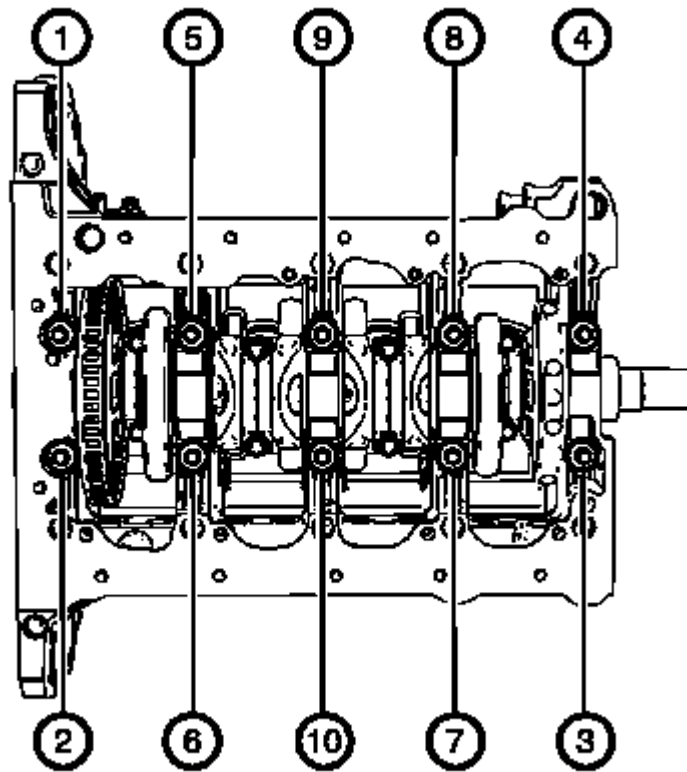
**Fig. 306: Crankshaft Position Sensor, Bolt And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft position sensor bolt (3).
2. Remove the crankshaft position sensor (1) and the crankshaft position sensor seal ring (2).



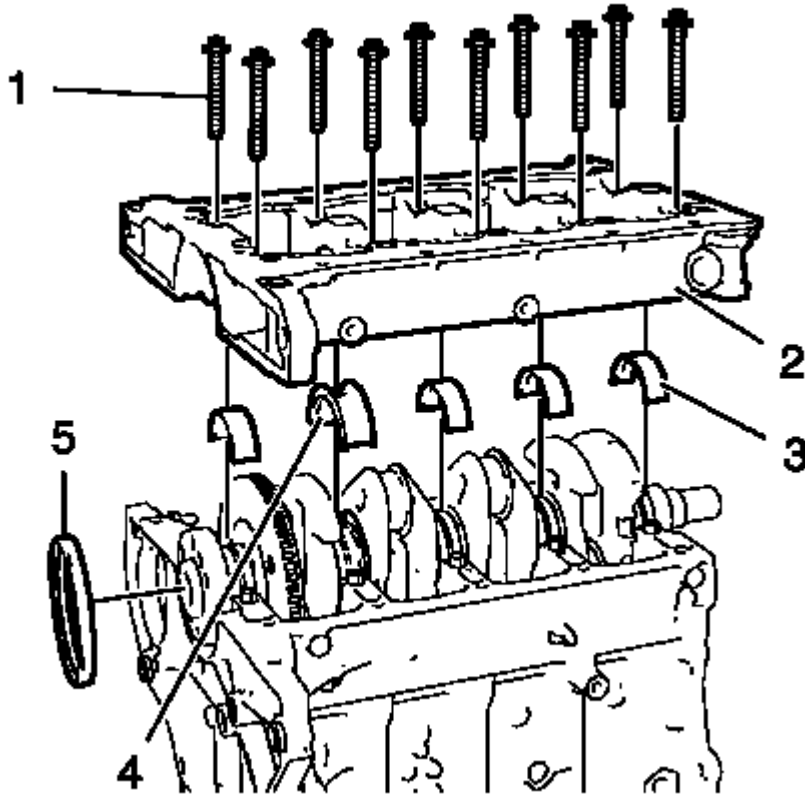
**Fig. 307: Outer Crankshaft Bearing Cap Tie Plate Bolts**  
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 12 outer crankshaft bearing cap tie plate bolts (1).



**Fig. 308: Inner Crankshaft Bearing Cap Tie Plate Bolts Loosening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the 10 inner crankshaft bearing cap tie plate bolts in a sequence as shown.

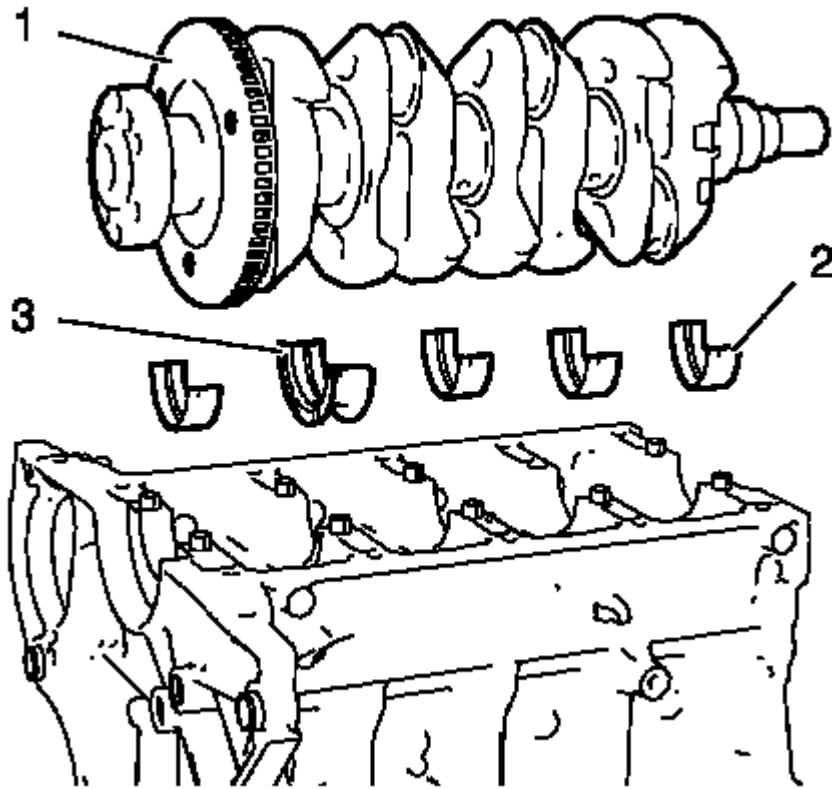


**Fig. 309: Crankshaft Bearing Cap Tie Plate, Bolts, Lower Crankshaft Bearings, Lower Crankshaft Thrust Bearing And Crankshaft Rear Oil Seal**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the 10 crankshaft bearing cap tie plate bolts (1)

Remove the crankshaft bearing cap tie plate (2).

6. Remove the 4 lower crankshaft bearings (3) and the lower crankshaft thrust bearing (4).
7. Remove the crankshaft rear oil seal (5).



**Fig. 310: Crankshaft, Upper Crankshaft Bearings And Upper Crankshaft Thrust Bearing**  
Courtesy of GENERAL MOTORS COMPANY

8. Remove the crankshaft (1), the 4 upper crankshaft bearings (2) and the upper crankshaft thrust bearing (3).

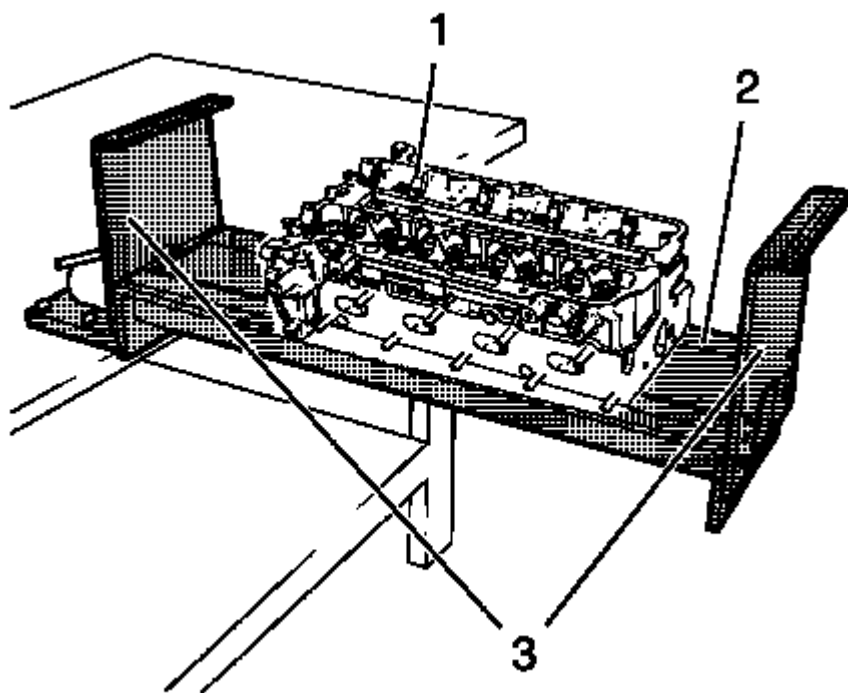
## CYLINDER HEAD DISASSEMBLE

### Special Tools

- EN-840 Pliers / Remover
- EN-849 Assembly Tray
- EN-6086 Spring And Wedge Replacer Kit
- EN-6167 Support Set
- EN-6171 Release Tool
- EN-6215 Mounting Equipment

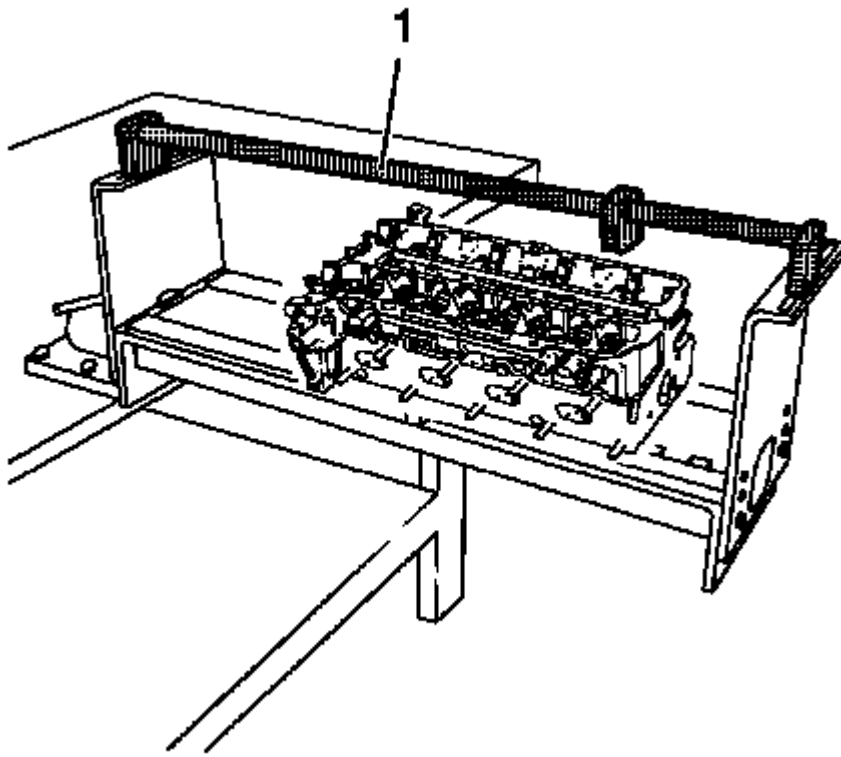
For equivalent regional tools, refer to **Special Tools**.





**Fig. 311: Cylinder Head, Mounting Table And Support**  
Courtesy of GENERAL MOTORS COMPANY

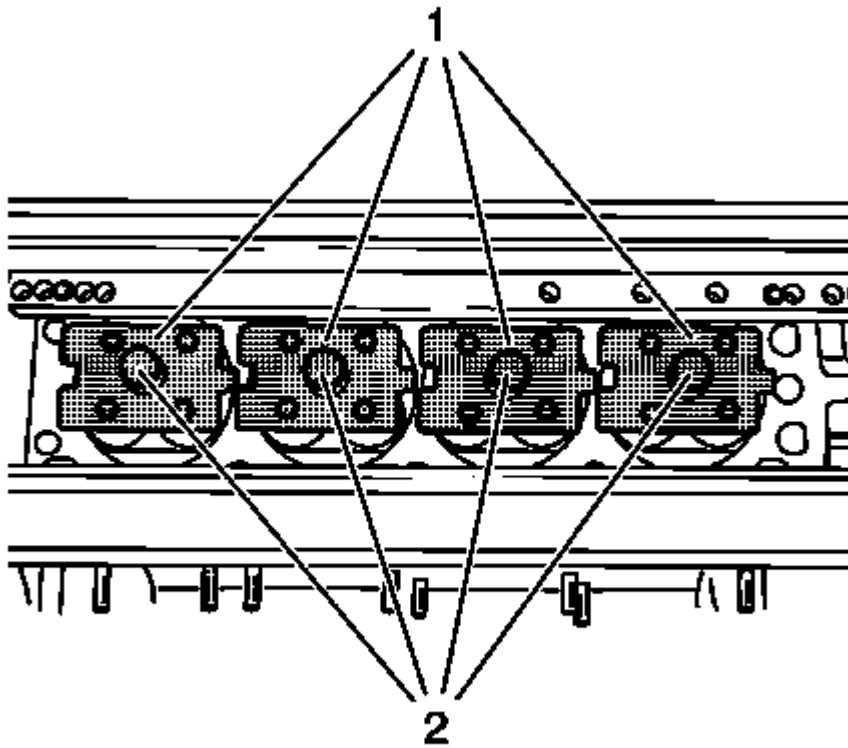
1. Install the cylinder head (1) to EN-6215-1 mounting table (2) along with EN-6215-5 support (3). Hold the cylinder head with the appropriate short bolts.



**Fig. 312: Handle**

Courtesy of GENERAL MOTORS COMPANY

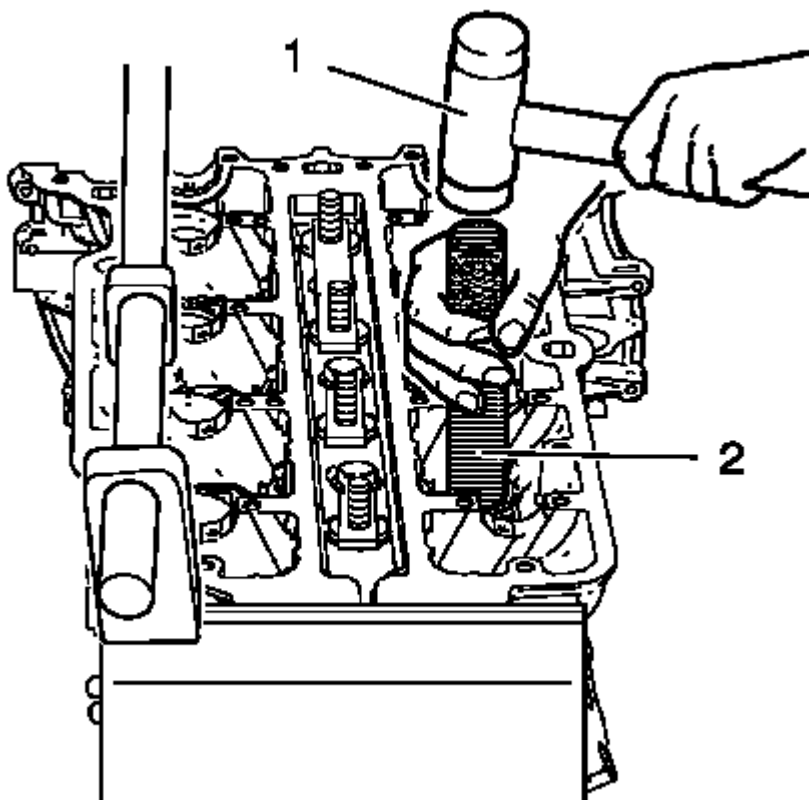
2. Install **EN-6215-4** handle (1) to **EN-6215-1** mounting table.
3. Turn the cylinder head 180 degrees.
4. Rework the spark plug threads.



**Fig. 313: Brace And Bolts**

Courtesy of GENERAL MOTORS COMPANY

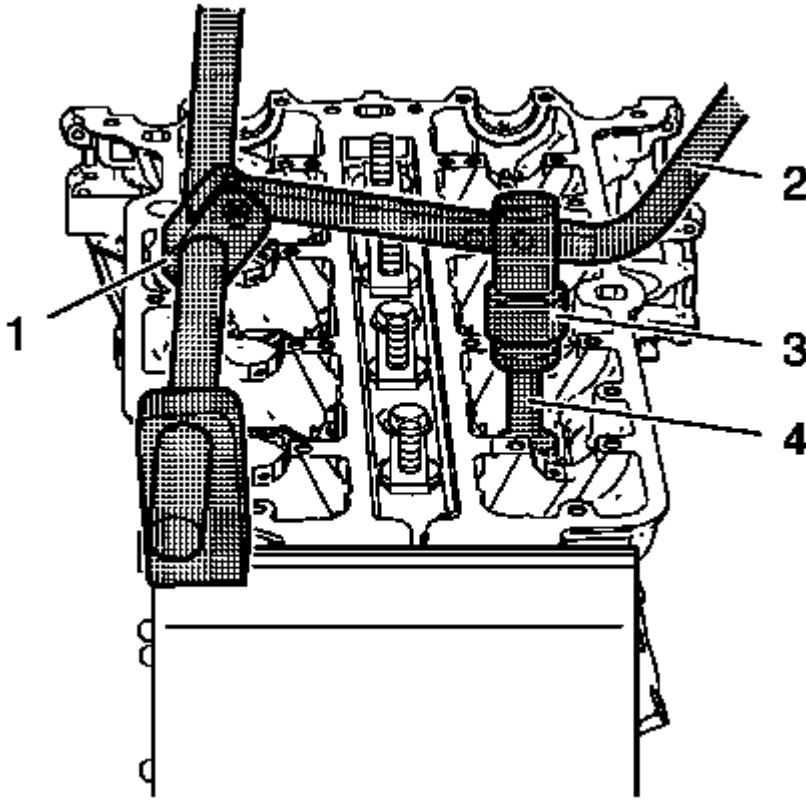
5. Install 4 **EN-6167-1** brace (1) and hold with **EN-6167-5** bolts (2) to support the valves.



**Fig. 314: Rubber Mallet And Release Tool**

Courtesy of GENERAL MOTORS COMPANY

6. Tap the valve spring retainers with an soft hammer hit. Use a rubber mallet (1) and **EN-6171** release tool (2).



**Fig. 315: Handle, Lever Arm, Adapter And Demounting Piece**  
Courtesy of GENERAL MOTORS COMPANY

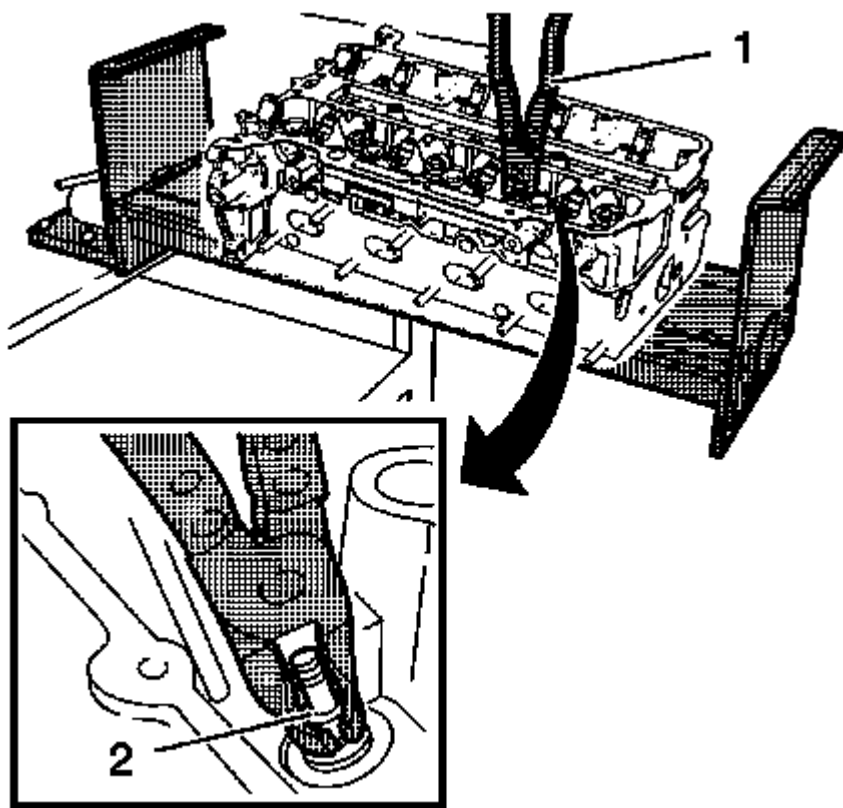
7. Install **EN-6086-7** lever arm (2) to the handle (1).
8. Install **EN-6086-11** demounting piece (4) along with **EN-6086-1** adapter (3) to the lever.

**NOTE:** The demounting piece must be applied parallel to the valve spring retainers to prevent damage to the tools or the valve train components.

9. Press down on the valve springs and the upper valve spring retainers until the valve keys are discharged from spring load. Remove the valve keys.

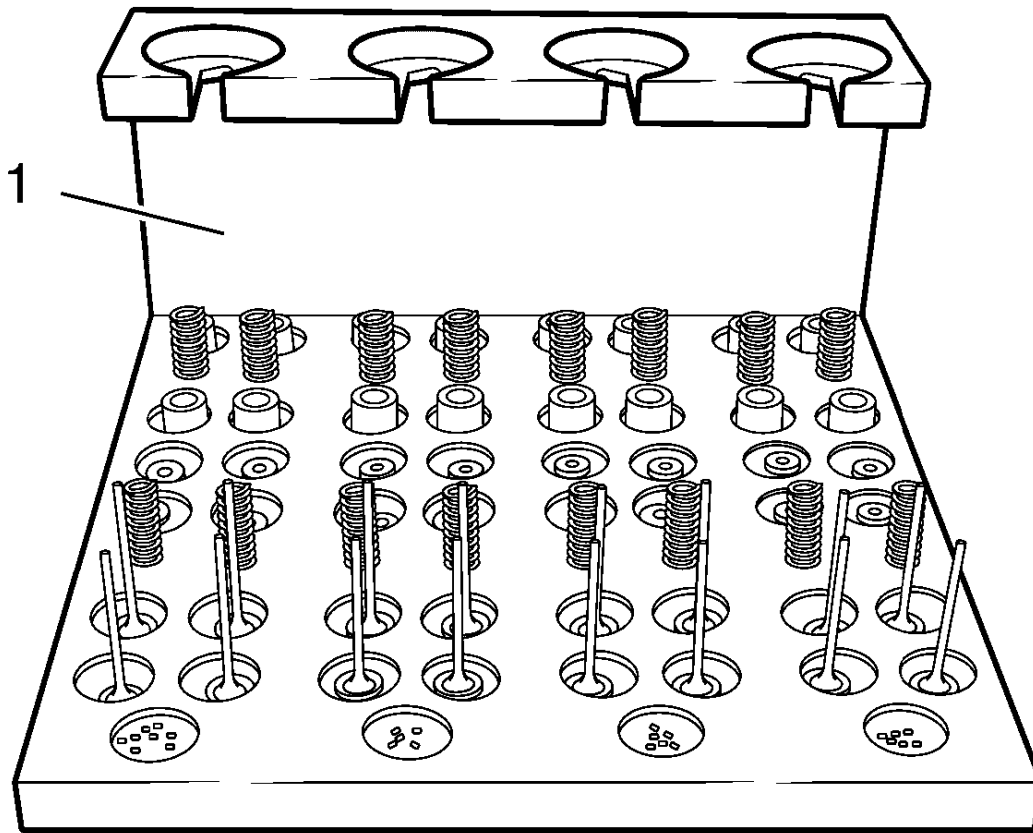
**NOTE:** Mind the installation position of valve springs, valve spring retainers and valve keys

10. Remove valve springs and valve spring retainers and place in the **EN-849** assembly tray to ensure they will be installed in their original position.



**Fig. 316: Removing Valve Stem Oil Seals Using Pliers**  
Courtesy of GENERAL MOTORS COMPANY

11. Remove the valve stem oil seals (2). Use **EN-840** pliers (1).
12. Remove **EN-6167-5** bolts and **EN-6167-1** brace.



**Fig. 317: Assembly Tray**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the installation position of the valves.

13. Remove the valves and place to **EN-849** assembly tray (1) to ensure they will be installed in their original position

## CYLINDER HEAD CLEANING AND INSPECTION

### Special Tools

- **EN-6216** Gauge
- **EN-6216-200/300/400** Gauge Instruments

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

**Cleaning Procedure**

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all cylinder head surfaces with non-corrosive sealant.

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

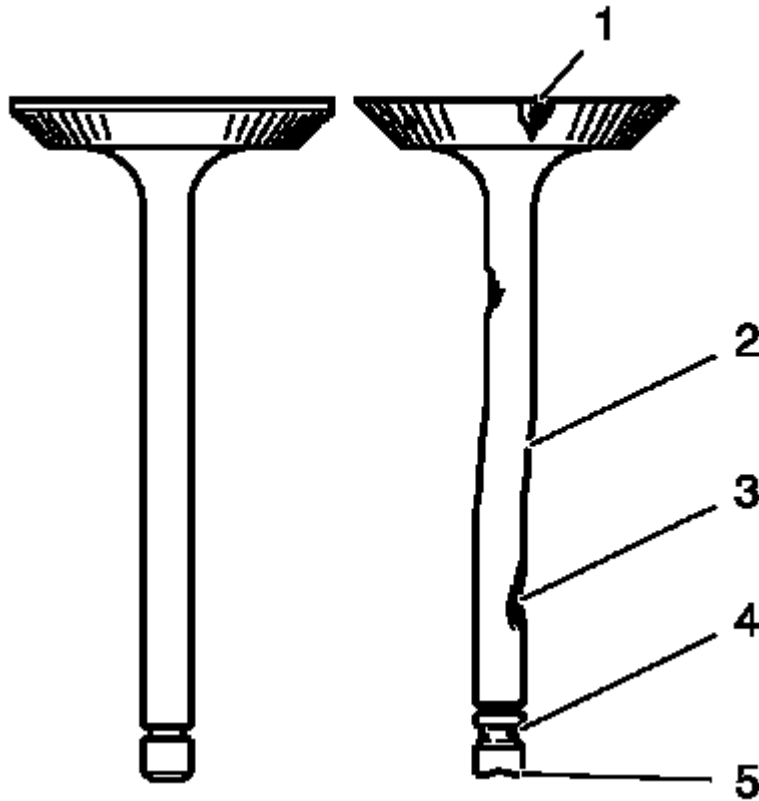
3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chamber.

**Visual Inspection**

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
  - Excessive scoring or pitting
  - Discoloration from overheating
  - Deformation from excessive wear
  - 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 war page as described under cylinder head measurement - deck flatness inspection.
  - Damage to any gasket surfaces.
  - 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 allowed.

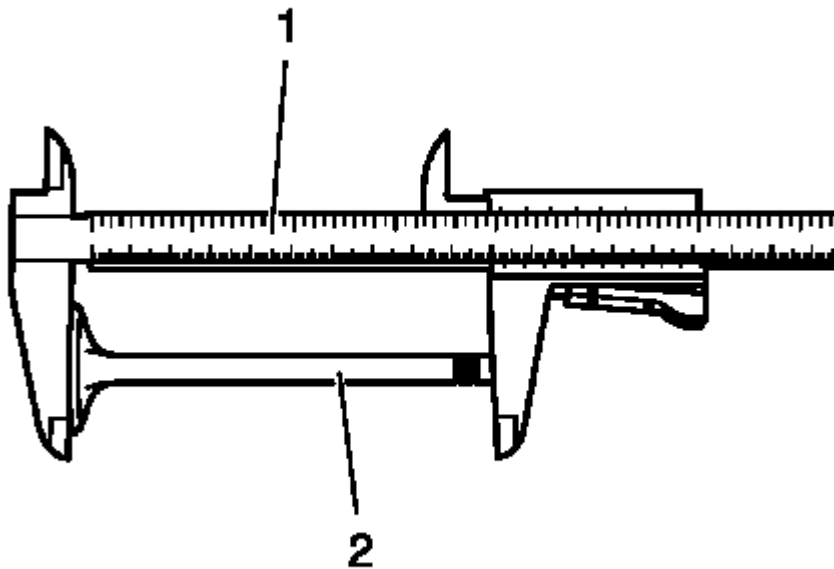
**Valve Inspection And Measurement**





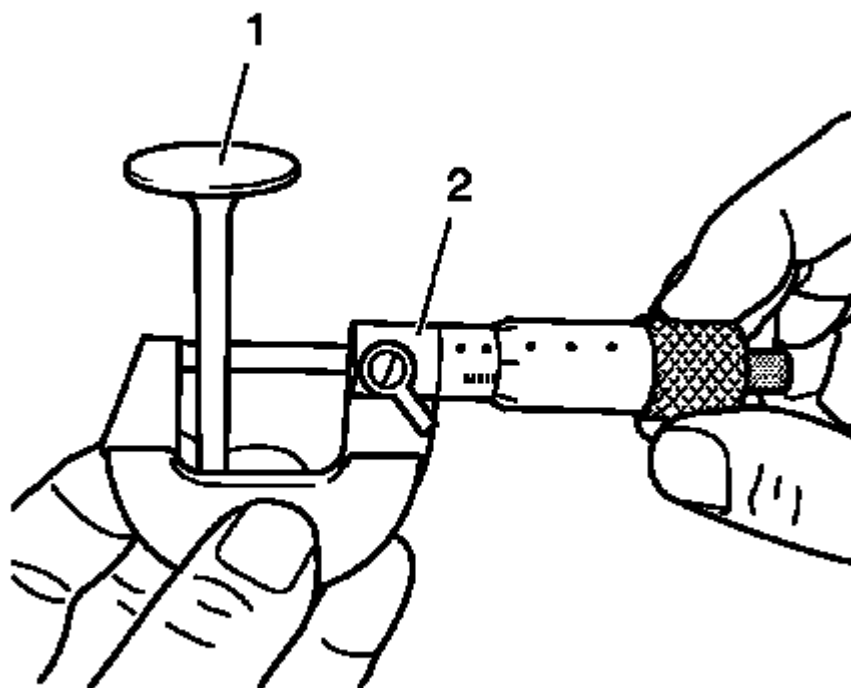
**Fig. 318: Valve Inspection And Measurement**  
Courtesy of GENERAL MOTORS COMPANY

1. Clean the valves of carbon and oil. Carbon can be removed with a wire brush.
2. Inspect the valves for the following conditions:
  1. Inspect the valve faces for burning and cracking (1). If pieces are broken, replace the valve and inspect the corresponding piston and cylinder head area for damage.
  2. Inspect the valve for straightness and distortion (2). Distorted valve must be replaced.
  3. Inspect the valve stem for wear (3).
  4. Inspect the valve key grooves for chipping and wear (5). Replace the valve if chipped or worn.



**Fig. 319: Measuring Valve Length Using Slide Gauge**  
Courtesy of GENERAL MOTORS COMPANY

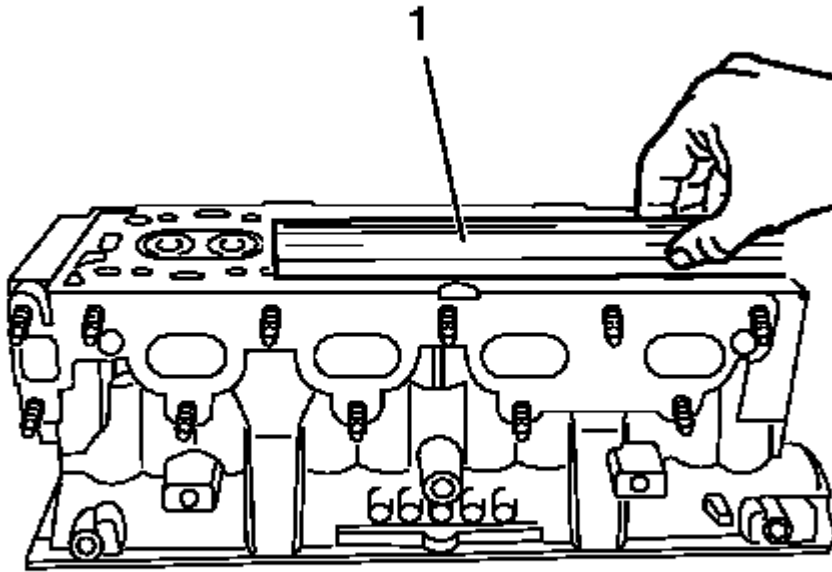
3. Measure the valve length (2). Use a slide gauge (1). Refer to **Engine Mechanical Specifications** to find the permitted values.



**Fig. 320: Measuring Valve Stem Diameter Using Micrometer Gauge**  
Courtesy of GENERAL MOTORS COMPANY

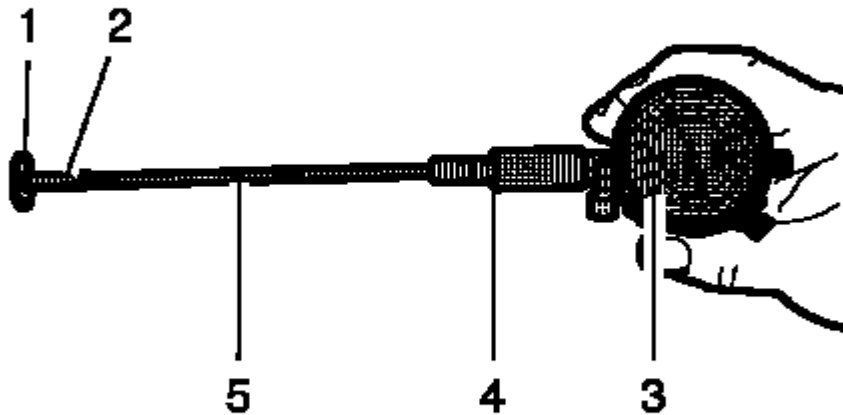
4. Measure the valve stem diameter. Use a micrometer gauge (2). Refer to **Engine Mechanical Specifications** to find the permitted values. Note the measurement results.

#### Cylinder Head Measurement



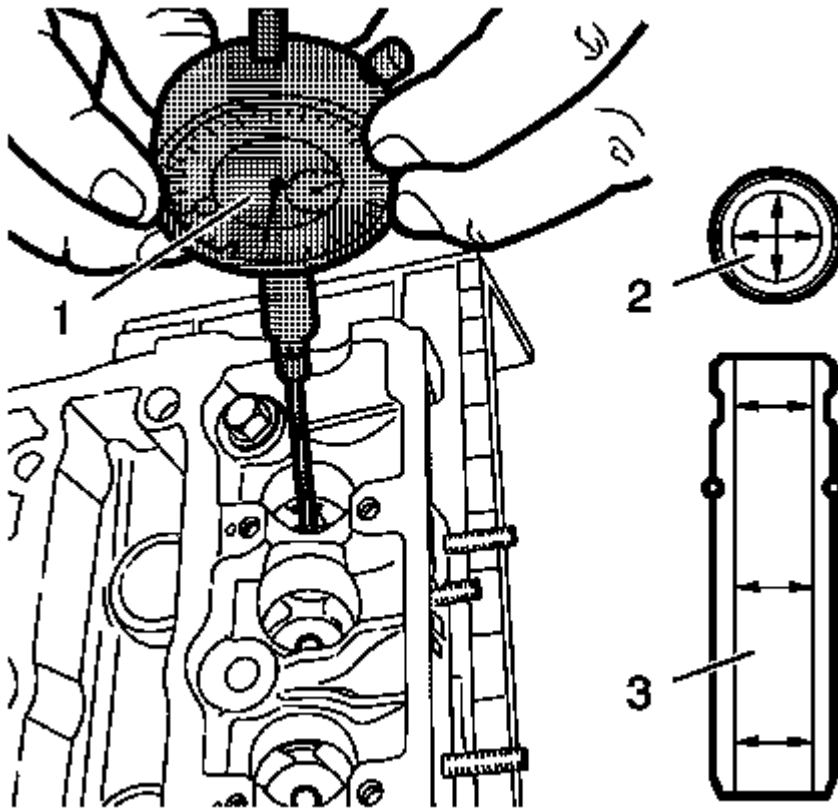
**Fig. 321: Using Straightedge To Inspect Cylinder Head Sealing Surface For Flatness**  
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the cylinder head sealing surface for flatness. Use a straightedge (1).



**Fig. 322: Checking Valve Stem To Guide Clearance Measurement**  
Courtesy of GENERAL MOTORS COMPANY

2. Prepare the gauge for valve stem to guide clearance measurement. Assemble the **EN-6216** gauge and the **EN-6216-200/300/400** gauge instruments as followed:
  1. Install the extension (5) to the support (4).
  2. Install the inside caliper (2) to the extension (5).
  3. Install the gauge (3) to the support (4) and pretension to 1 mm (0.0394 in).
  4. Install the calibration washer (1) as shown to justify the gauge.
  5. Adjust the gauge to 0 mm (0 in) by rotating the instrument dial.
  6. Cautious remove the calibration washer (1).



**Fig. 323: Measuring Valve Guide Inner Diameter**  
Courtesy of GENERAL MOTORS COMPANY

3. Measure the valve guide inner diameter (2) as shown in different areas (3). Use **EN-6216** gauge (1) and gauge instruments. Note the measurement results. Refer to **Engine Mechanical Specifications** to find the permitted values.
4. Subtract the valve stem diameter from valve guide inner diameter to calculate the valve stem to guide clearance. Refer to **Engine Mechanical Specifications** to find the permitted values.
5. Turn the cylinder head upside down.

## CYLINDER HEAD ASSEMBLE

### Special Tools

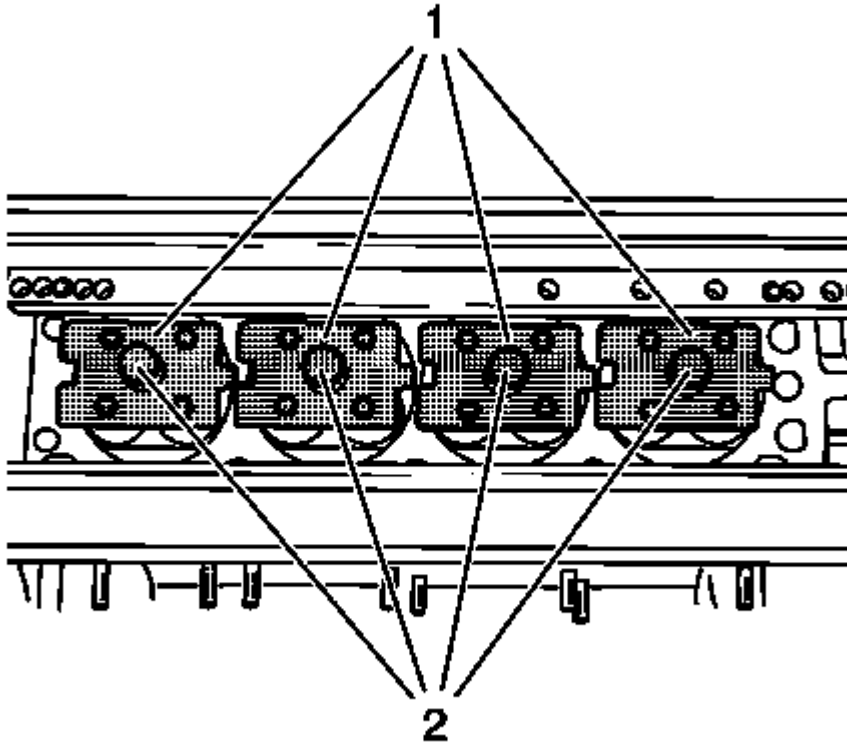
- **EN-6215** Mounting Equipment
- **EN-6167** Support Set
- **EN 6086** Spring And Wedge Replacer Kit
- **EN-840** Pliers / Remover
- **EN-835-A** Installer

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

**NOTE:** Lubricate the valve guides and the valve stems with engine oil.

**NOTE:** Ensure that the valves will be installed in their original position.

1. Install the 16 valves to the cylinder head.



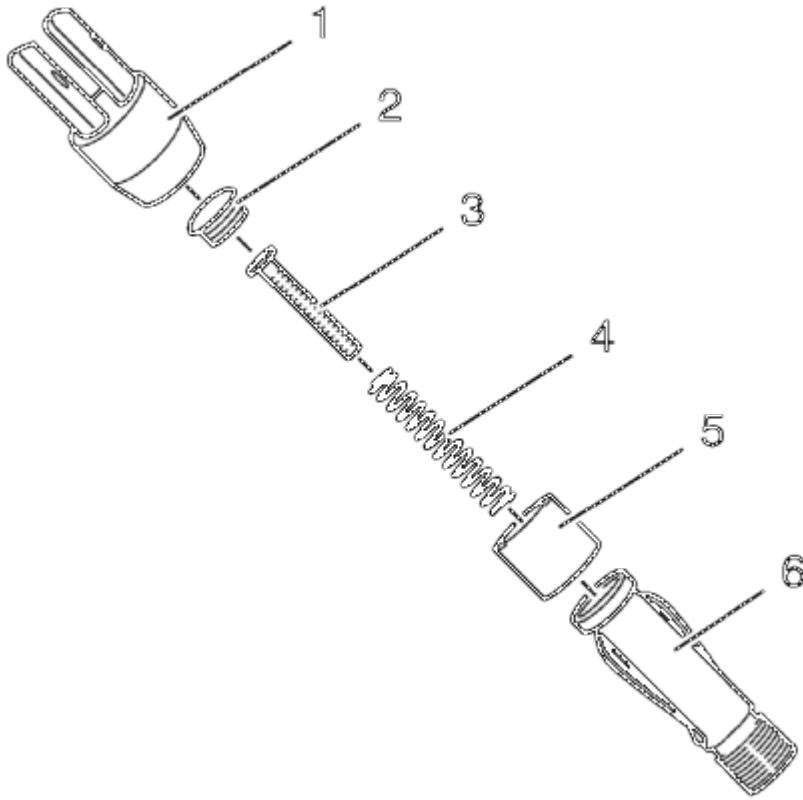
**Fig. 324: Brace And Bolts**

Courtesy of GENERAL MOTORS COMPANY

2. Install **EN-6167-1** braces (1) and hold with **EN-6167-5** bolts (2) to support the valves.
3. Install the 16 valve stem oil seals. Use **EN-835-A** installer to push down the valve stem oil seals.

**NOTE:** Ensure that the valve springs and the valve spring retainers are installed in their original position.

4. Install the 16 valve springs and the 16 valve spring retainers.

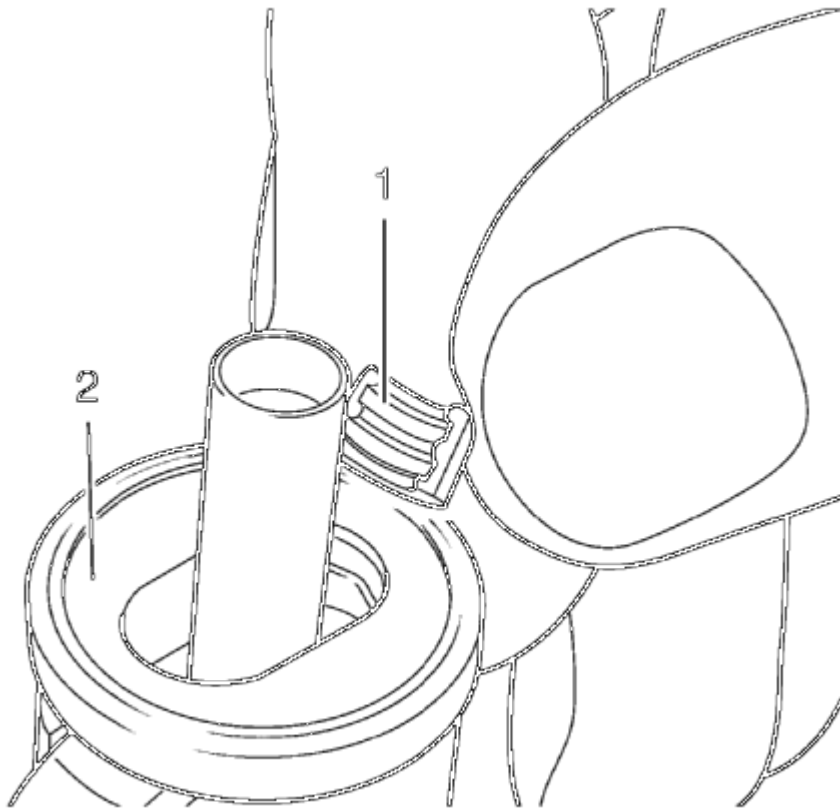


**Fig. 325: Valve Key Installation Mounting Piece Components**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Use the correct combination of mounting piece and plunger as shown above to ensure a proper function.

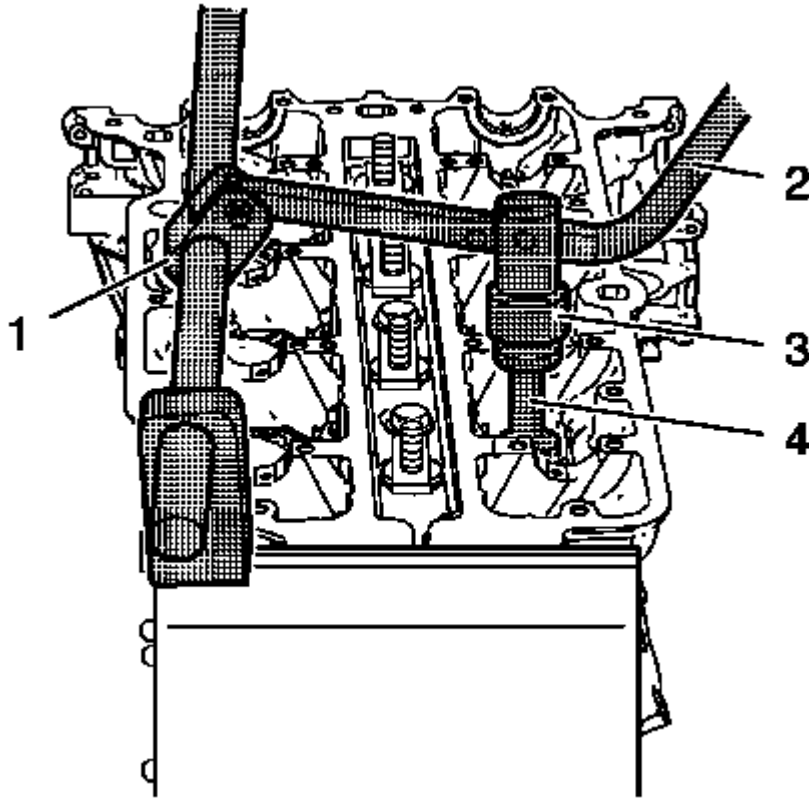
5. Prepare **EN-6086-200-1** mounting piece for the valve key installation. The mounting piece must be assembled in the following order:
  1. Support (6)
  2. Bushing (5)
  3. Spring (4)
  4. **EN-6086-200-10** plunger (3)
  5. Screw connection (2)
  6. Lever adapter (1)





**Fig. 326: Valve Keys And Mounting Piece**  
**Courtesy of GENERAL MOTORS COMPANY**

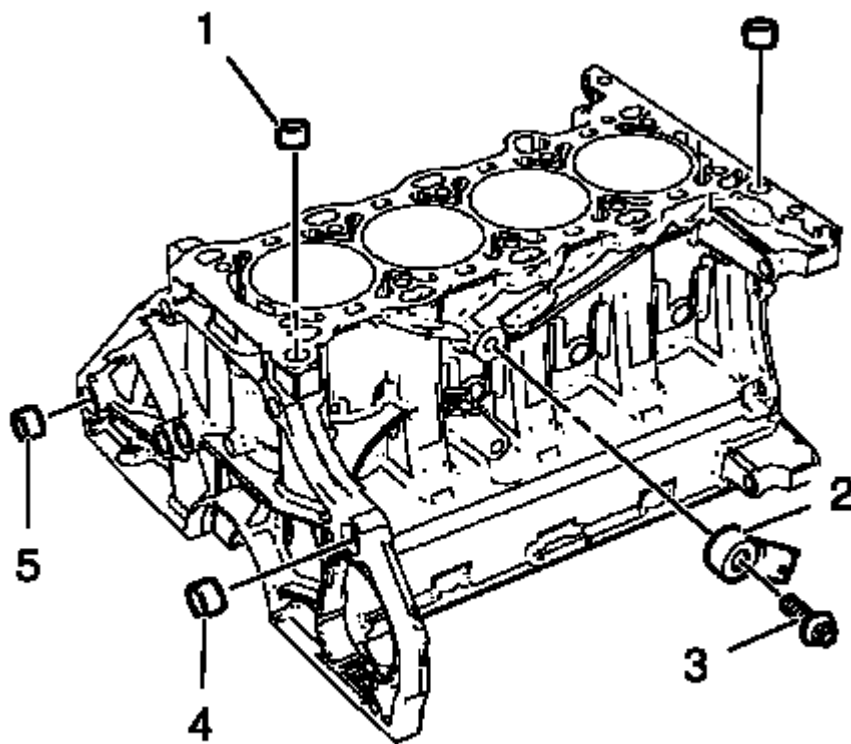
6. Install the valve keys (1) to the mounting piece (2) as shown and hold them with the bushing.



**Fig. 327: Handle, Lever Arm, Adapter And Demounting Piece**  
Courtesy of GENERAL MOTORS COMPANY

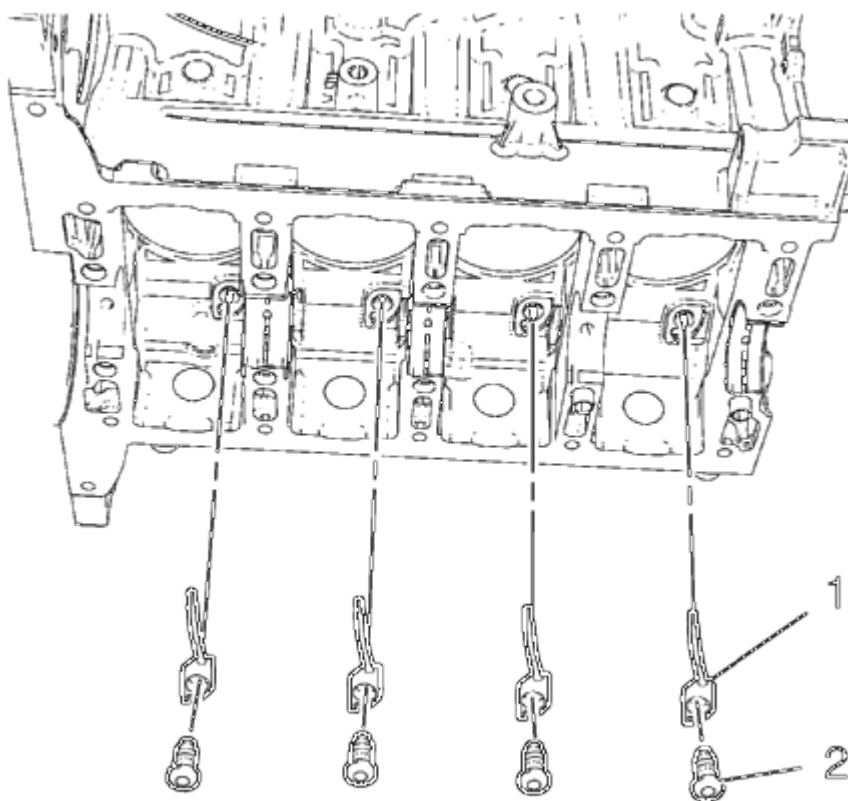
7. Install **EN-6086-7** lever (2) along with the lever adapter (3) and the mounting piece (4) to the handle (1).
8. Push the mounting piece slightly down until the valve keys are audible engaged.
9. Repeat the procedure on the remaining 15 valves.
10. Remove **EN-6167-1** braces and **EN-6167-5** bolts.
11. Remove the cylinder head from the **EN-6215-1** mounting table.

#### **ENGINE BLOCK DISASSEMBLE (1.4L LUV)**



**Fig. 328: Knock Sensor, Bolt, Cylinder Head Guide Sleeves And Transmission Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the knock sensor bolt (3).
2. Remove the knock sensor (2).
3. Remove the 2 cylinder head guide sleeves (1). Use suitable pliers.
4. Remove the 2 transmission guide sleeves (4) and (5). Use suitable pliers.

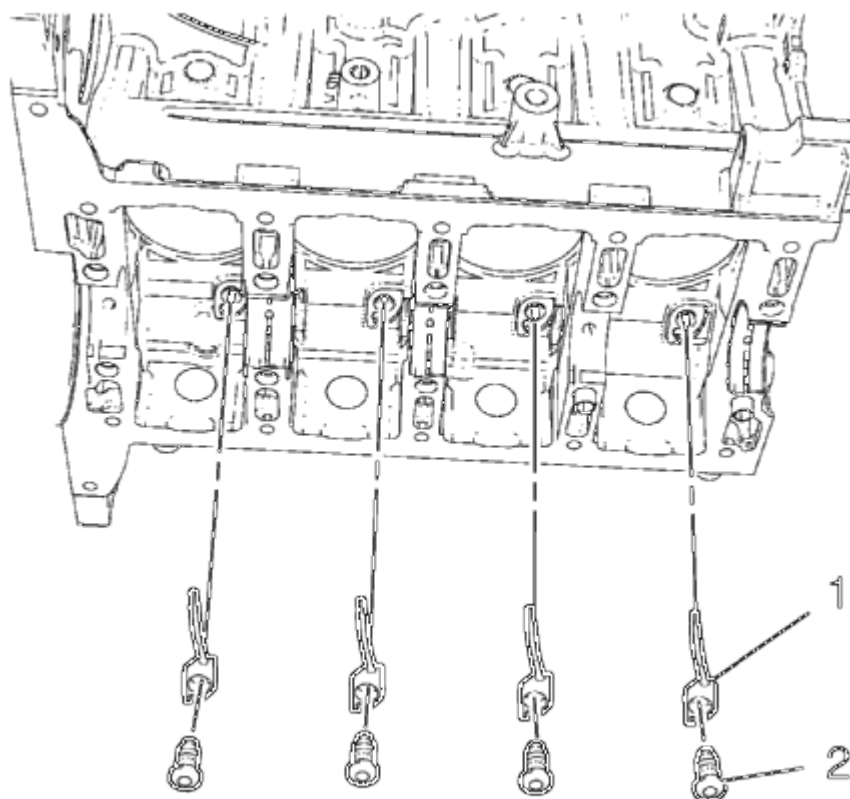


**Fig. 329: Piston Oil Nozzles And Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

5. Remove the 4 piston oil nozzle bolts (2).
6. Remove the 4 piston oil nozzles (1).

**ENGINE BLOCK ASSEMBLE (1.4L LUV)**



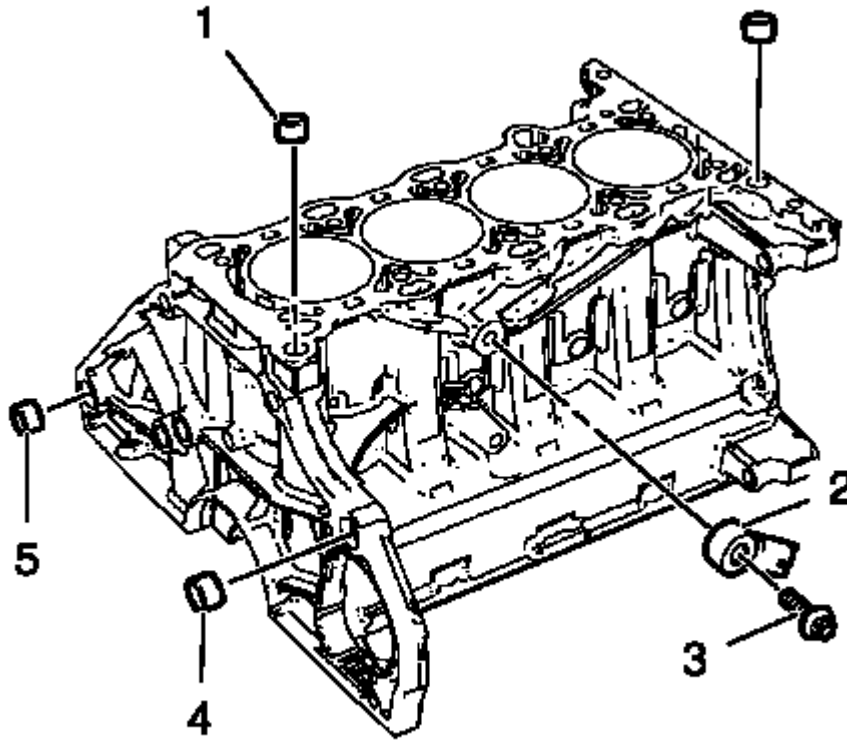
**Fig. 330: Piston Oil Nozzles And Bolts**

Courtesy of GENERAL MOTORS COMPANY

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

**CAUTION: Refer to Fastener Caution .**

2. Install the 4 piston oil nozzle bolts (2) and tighten to 25 N.m (18 lb ft).



**Fig. 331: Knock Sensor, Bolt, Cylinder Head Guide Sleeves And Transmission Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

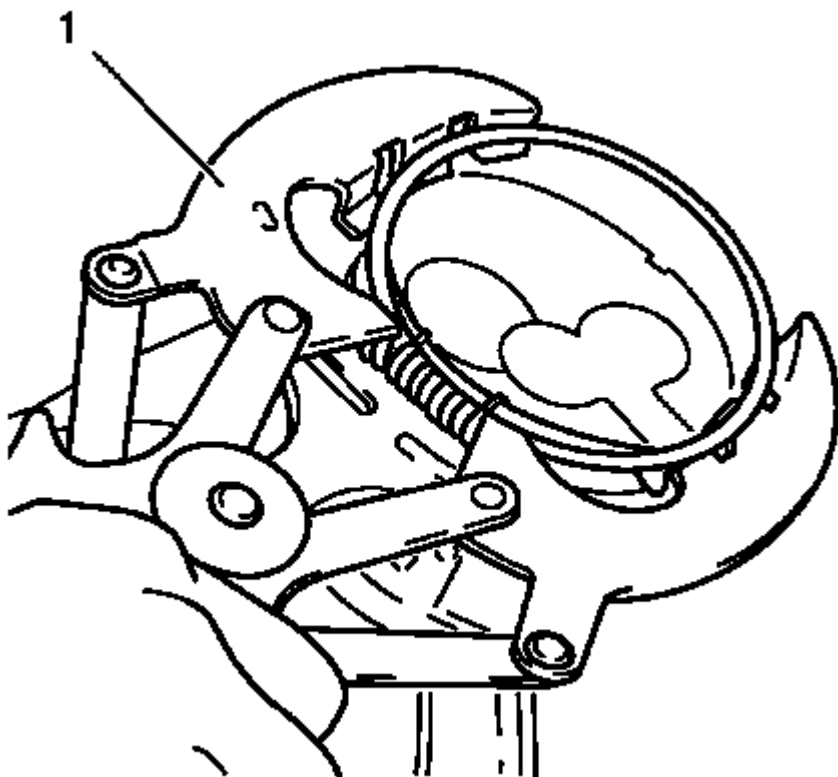
3. Install the knock sensor (2).
4. Install the knock sensor bolt (3) and tighten to 20 N.m (15 lb ft).
5. Install the 2 cylinder head guide sleeves (1). Use a rubber mallet.
6. Install the 2 transmission guide sleeves (4) and (5). Use a rubber mallet.

## PISTON AND CONNECTING ROD DISASSEMBLE (1.4L LUV)

### Special Tool

**EN-49941** Remover / Installer Piston Retainer Ring

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

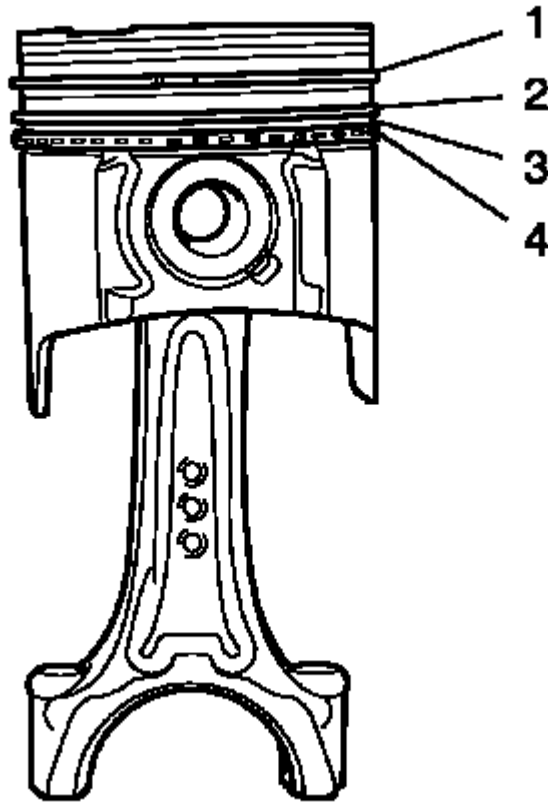


**Fig. 332: Using Piston Ring Pliers**

Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

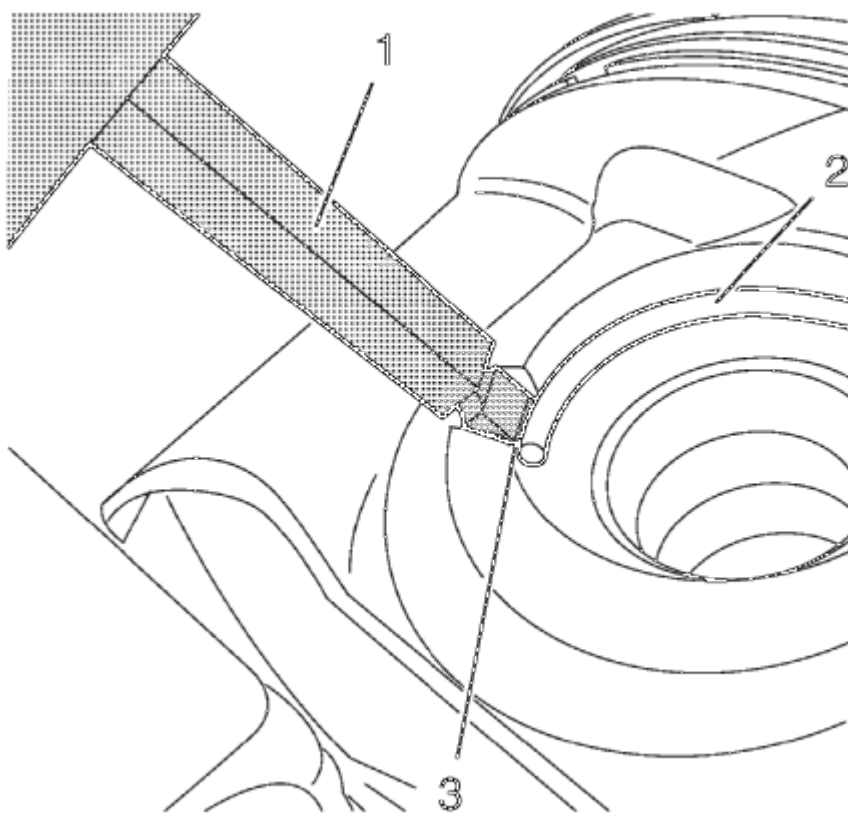
1. Remove the piston rings. Use piston ring pliers (1)



**Fig. 333: Upper Compression Ring, Lower Compression Ring, Oil Rings And Oil Ring Spacer**  
Courtesy of GENERAL MOTORS COMPANY

2. The piston rings are ordered as followed:
  - Upper compression ring (1)
  - Lower compression ring (2)
  - Oil rings and oil ring spacer (3) and (4)
3. Install the piston and connecting rod assembly to a bench vise. Use aluminum braces

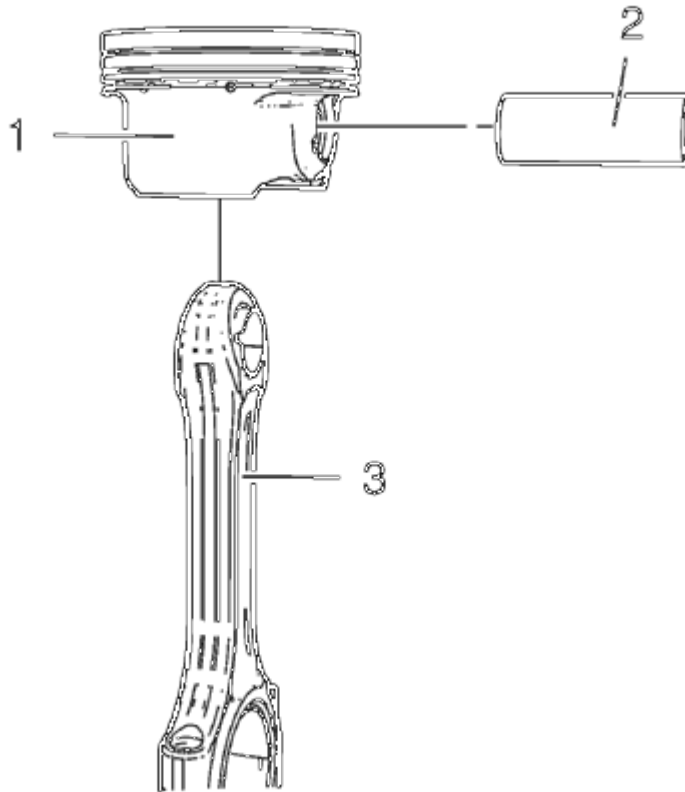




**Fig. 334: Piston Pin Retainer, Remover And Notch**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Use extreme care when removing snap rings. Always wear adequate eye protection in order to avoid personal injury.

4. Apply the **EN-49941** remover (1) in the notch (3) to the piston pin retainer (2) and remove it.



**Fig. 335: Connecting Rod, Piston And Piston Pin**  
Courtesy of GENERAL MOTORS COMPANY

5. Remove the piston pin (2) and the connecting rod (3) from the piston (1).

## PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION (1.4L LUV)

### Special Tools

**EN-470-B** Angular Torque Wrench

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

### Visual Inspection And Cleaning Procedure

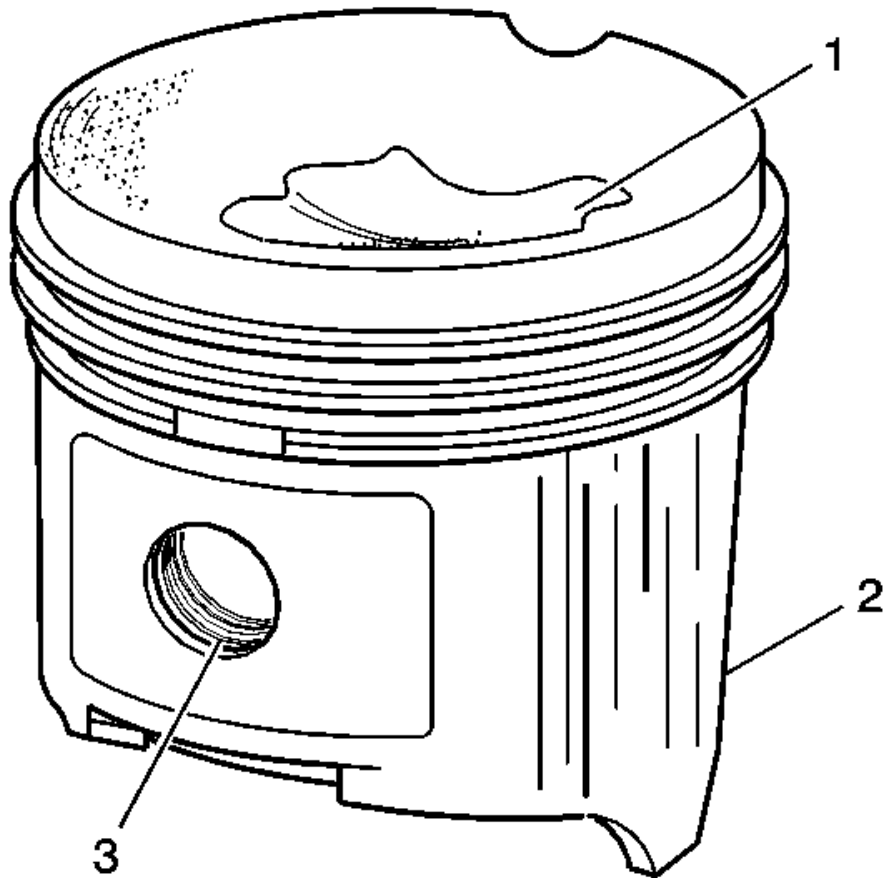
#### Connecting Rod

**WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.**

1. Clean the connecting rods in solvent and dry with compressed air.
2. Inspect the connecting rod for the following:

- Signs of being twisted, bent, nicked or cracked
- Scratches or abrasion on the connecting rod bearing seating surfaces

## Piston



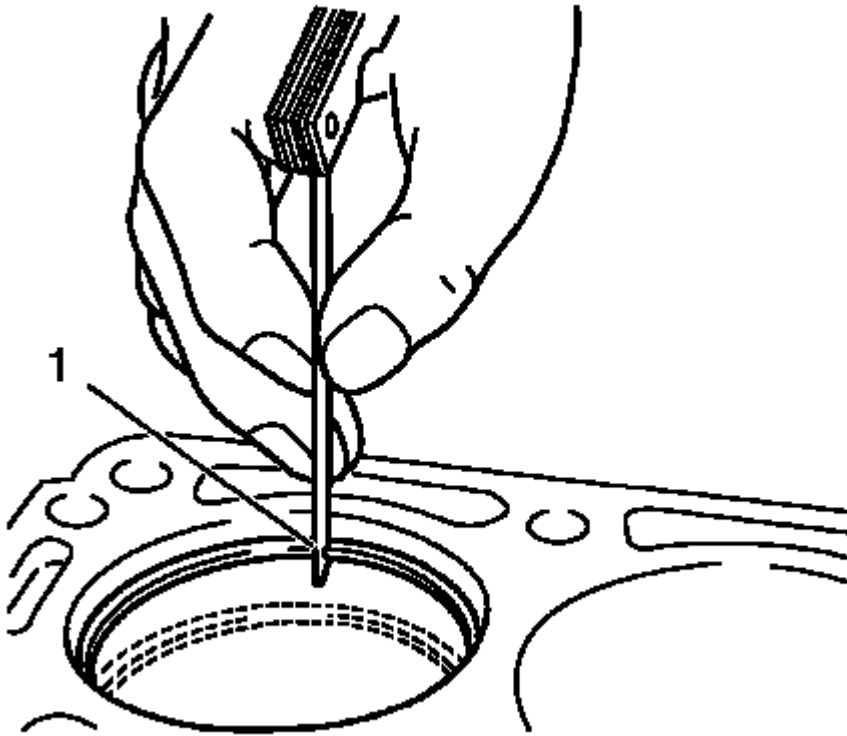
**Fig. 336: Identifying Piston Damage Inspection Areas**  
**Courtesy of GENERAL MOTORS COMPANY**

1. Clean the piston with a cleaning solvent. DO NOT wire brush any parts of the piston.
2. Clean the piston ring grooves.
3. Inspect the piston on the following:
  - Cracked ring lands, skirts or pin bosses
  - Ring grooves for nicks
  - Eroded areas on the top of the piston (1)
  - Scuffed or damaged skirts (2)

- Worn piston pin bores (3)
4. If there is any excessive wear, replace the piston.
  5. Measure the clearance between piston pin and piston bore.

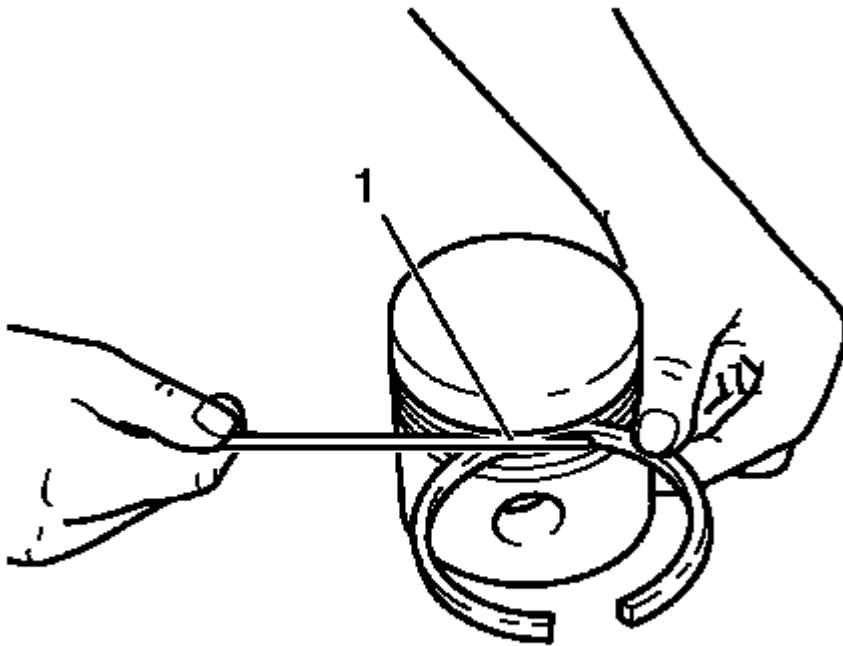
#### Piston And Connecting Rod Measurement Procedure

#### Piston Ring Clearance



**Fig. 337: Installing Piston Rings To Cylinder**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the piston rings to the cylinder as shown (1) and measure the piston ring end gap. Compare the measurements with those provided below:
  - The upper compression ring end gap should be 0.4-0.6 mm (0.0157-0.0236 in).
  - The lower compression ring end gap should be 0.4-0.6 mm (0.0157-0.0236 in).
  - The oil ring end gap should be 0.2-0.9 mm (0.0079-0.0354 in).
2. If the clearance is greater than the provided specifications, the piston rings must be replaced.



**Fig. 338: Measuring Piston Ring Side Clearance**  
Courtesy of GENERAL MOTORS COMPANY

3. Measure the piston ring side clearance as shown (1). Compare the measurements with those provided below:
  - The upper compression ring side clearance should be 0.025-0.07 mm (0.001-0.0028 in).
  - The lower compression ring side clearance should be 0.025-0.07 mm (0.001-0.0028 in).
  - The oil ring side clearance should be 0.04-0.12 mm (0.0016-0.0047 in).
4. If the clearance is greater than the provided specifications, replace the piston rings.
5. If the clearance is still too great, replace the pistons.

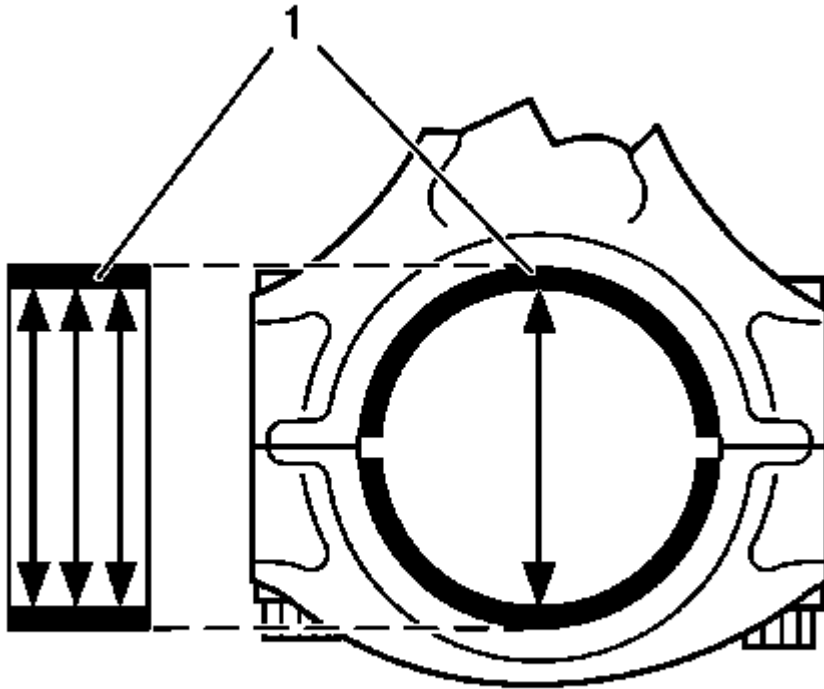
#### **Connecting Rod Bearing Clearance (With Micrometer Gauge Internal Measuring Device)**

1. Install the connecting bearings and the connecting rod bearing caps.
2. Tighten the connecting rod bearing cap bolts in the following sequence:

**CAUTION: Refer to Fastener Caution**

**NOTE:** The old bolts can be reused for the measuring procedure.

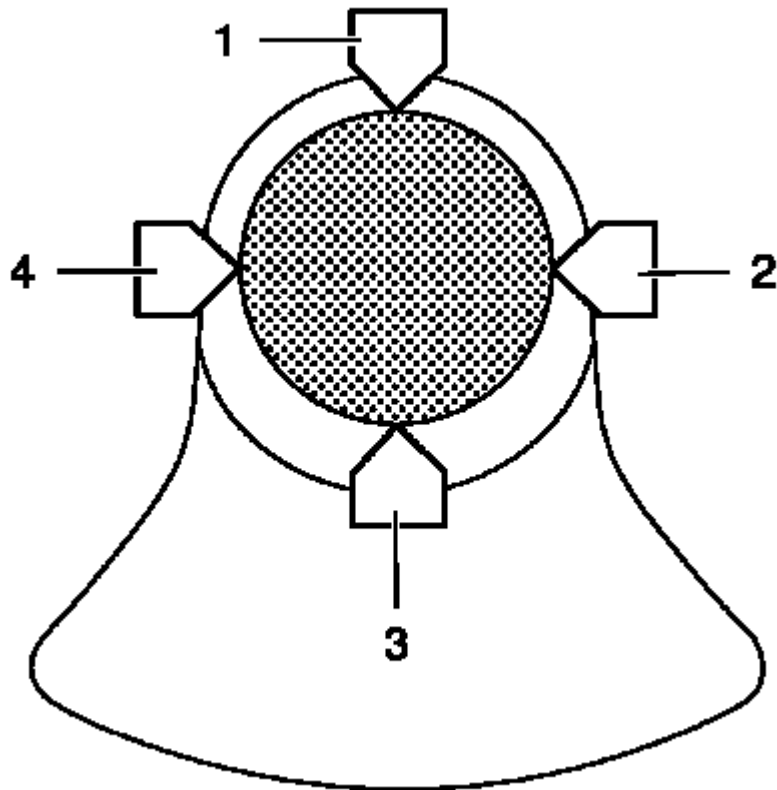
1. Tighten the connecting rod bearing cap bolts to 10 N.m (89 lb in).
2. Tighten the bolts to an additional 60 degrees using **EN-470-B** wrench.
3. Tighten the bolts to an additional 15 degrees using **EN-470-B** wrench.



**Fig. 339: Measuring Connecting Rod Bearing Diameters**  
Courtesy of GENERAL MOTORS COMPANY

3. Measure the connecting rod bearing diameters at 3 points as shown (1). Use a internal measuring device.
4. Calculate the average connecting rod inner diameter.

Formula: 1. result + 2. result + 3. result / 3



**Fig. 340: Connecting Rod Journal Diameter Points**  
Courtesy of GENERAL MOTORS COMPANY

5. Measure the connecting rod journal diameter at 2 points between (1) and (3) and between (2) and (4). Use a micrometer gauge.
6. Calculate the average connecting rod journal diameter.

Formula: 1. result + 2. result / 2.

7. Subtract the average connecting rod journal diameter from the average connecting rod bearing diameter in order to determine the connecting rod bearing clearance.

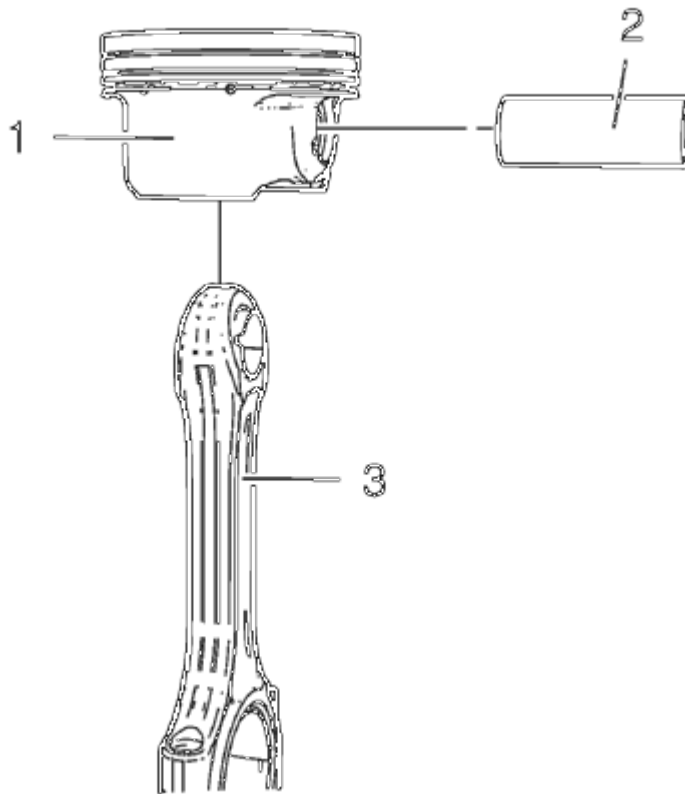
The clearance should be 0.013-0.061 mm (0.0005-0.0024 in).

## PISTON AND CONNECTING ROD ASSEMBLY (1.4L LUV)

### Special Tools

**EN-49941** Remover / Installer Piston Retainer Ring

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

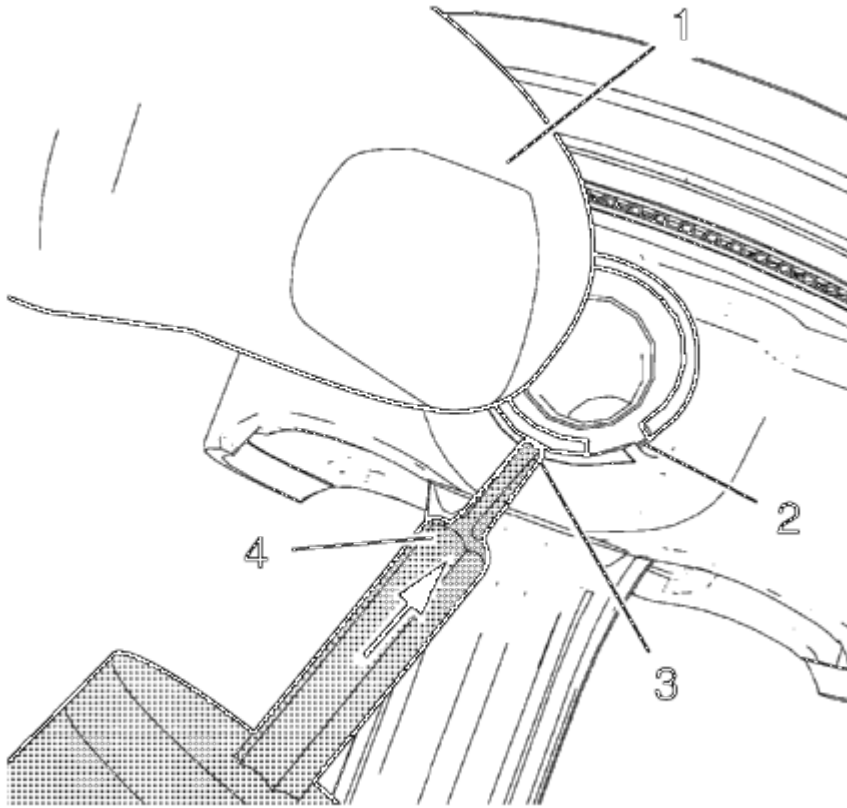


**Fig. 341: Connecting Rod, Piston And Piston Pin**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate the piston pin with clean engine oil.

1. Install the connecting rod (3) and the piston pin (2) to the piston (1).
2. Install the piston and connecting rod assembly to a bench vise. Use aluminum braces.





**Fig. 342: Pushing Piston Pin Retainer Down With Thumb**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Use extreme care when removing snap rings. Always wear adequate eye protection in order to avoid personal injury.

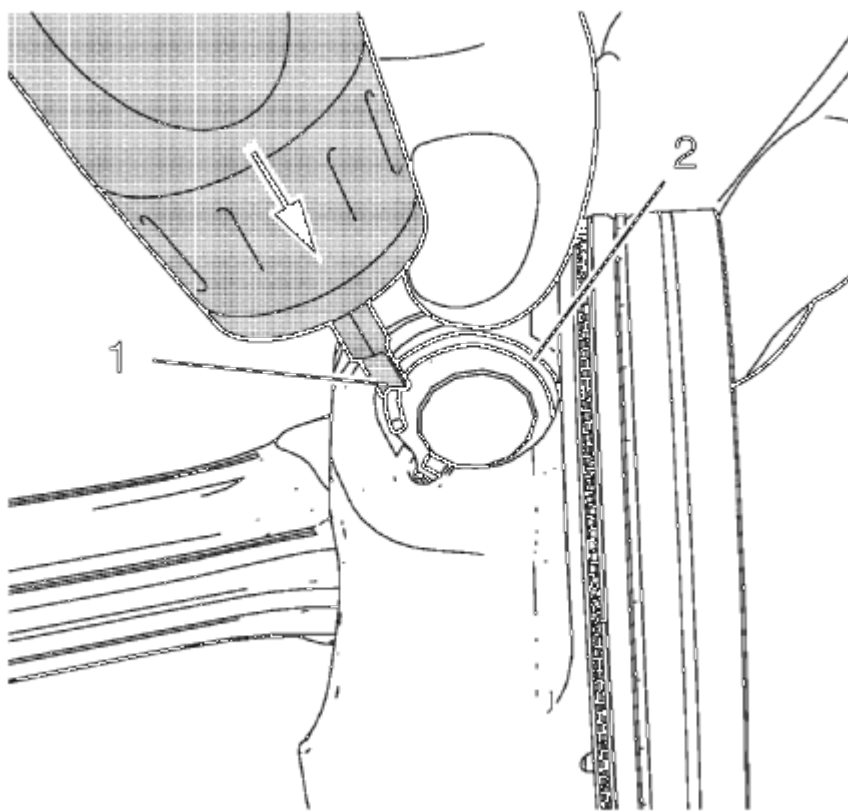
**WARNING:** Use care when removing or installing the piston retainer ring. Ensure the EN-49941 remover/installer is installed properly onto the retainer ring and that hands and fingers are kept clear from the front of the tool. Otherwise, bodily injury may occur.

**NOTE:** Notch (2) on right side.

3. Place the piston pin retainer in the piston pin retainer groove so that the ring gap lays on the notch (2).
4. Push the piston pin retainer down with the thumb in the shown position (1) and hold.

**NOTE:** The EN-49941 installer should be applied in a perpendicular position to the piston pin retainer.

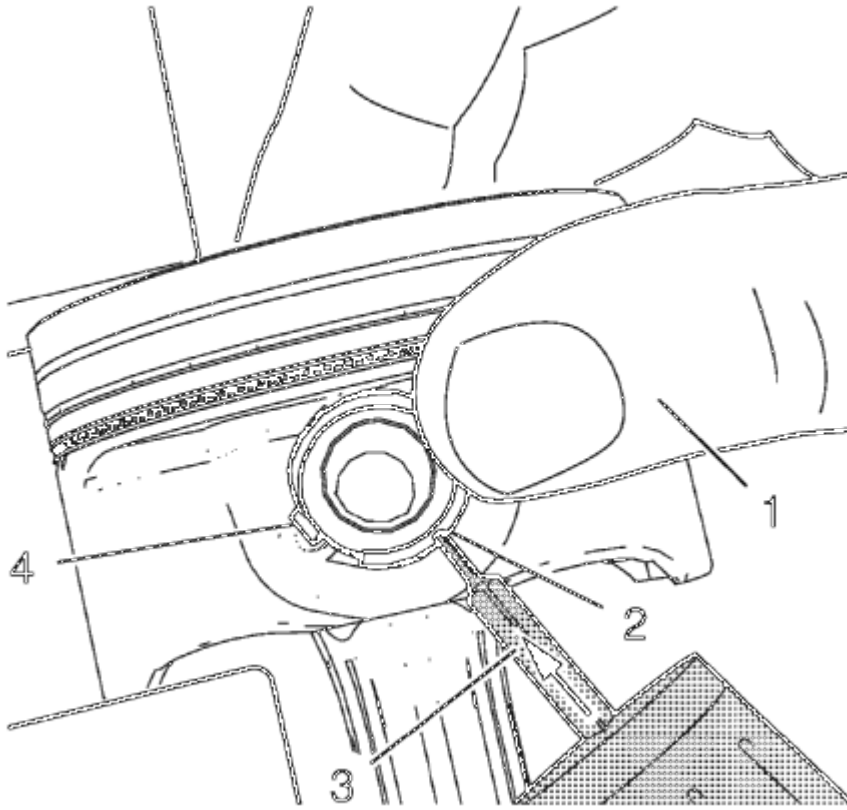
5. Apply the EN-49941 installer (4) to the piston pin retainer in the position shown (3) and push in direction of the arrow while pushing down with the thumb.



**Fig. 343: Pushing Piston Pin Retainer Down**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Push the piston pin retainer down in the position shown (2).

6. Move the **EN-49941** installer (1) carefully to the position shown while pushing in direction of the arrow until the piston pin retainer engages in the piston pin retainer groove.
7. Push down the piston ring retainer to get a proper seat in the groove.



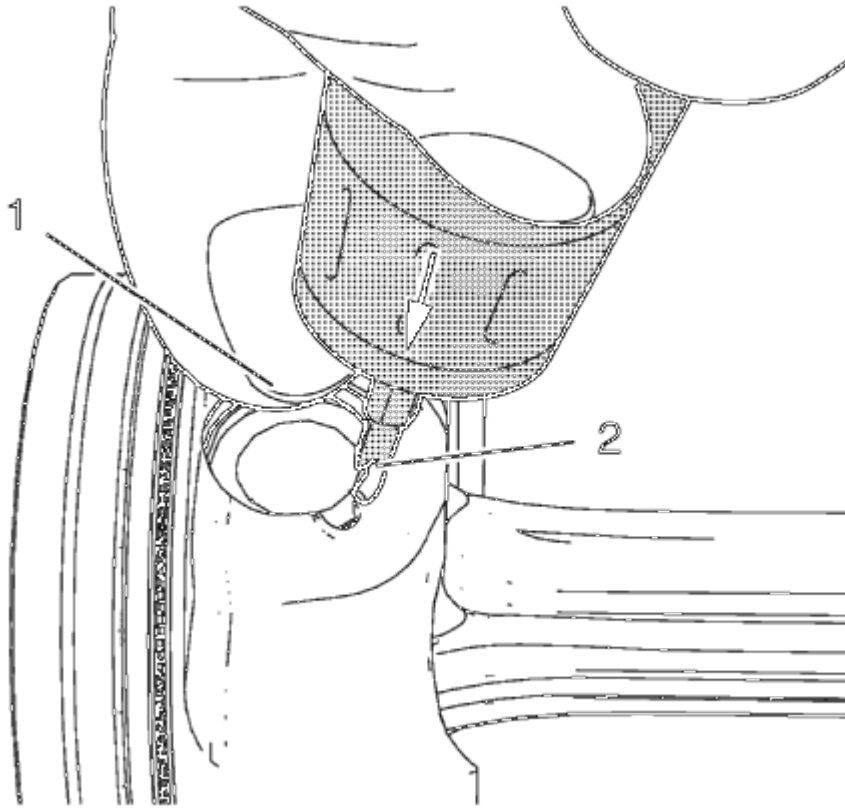
**Fig. 344: Pushing Piston Pin Retainer Down With Thumb**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Notch (4) on left side. EN-49941 installer should be used with left hand.

8. Place the piston pin retainer in the piston pin retainer groove so that the ring gap lays on the notch (4).
9. Push the piston pin retainer down with the thumb in the position shown (1) and hold.

**NOTE:** The EN-49941 installer should be applied in a perpendicular position to the piston pin retainer.

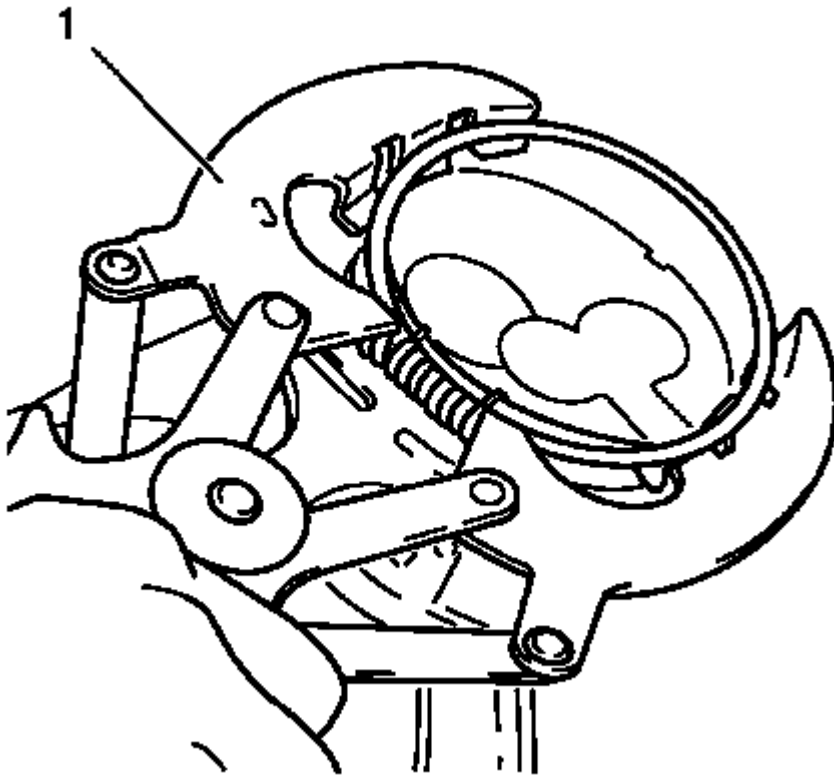
10. Apply the EN-49941 installer (3) to the piston pin retainer in the position shown (2) and push in direction of the arrow while pushing down with the thumb.



**Fig. 345: Pushing Piston Pin Retainer Down**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Push the piston pin retainer down in the position shown (1).

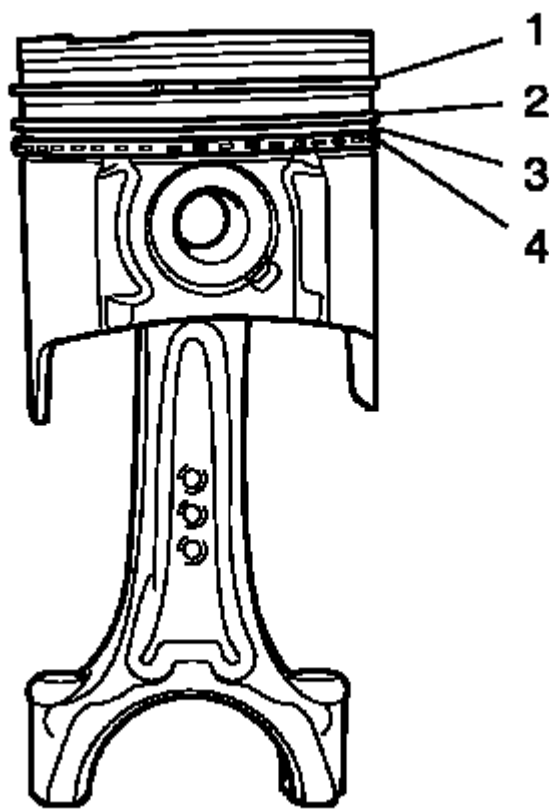
11. Move the **EN-49941** installer (2) carefully to the position shown while pushing in direction of the arrow until the piston pin retainer engages in the piston pin retainer groove.
12. Push down the piston ring retainer to get a proper seat in the groove.
13. Remove the piston and connecting rod assembly from the bench vise.



**Fig. 346: Using Piston Ring Pliers**

Courtesy of GENERAL MOTORS COMPANY

14. Install the piston rings. Use piston ring pliers (1).

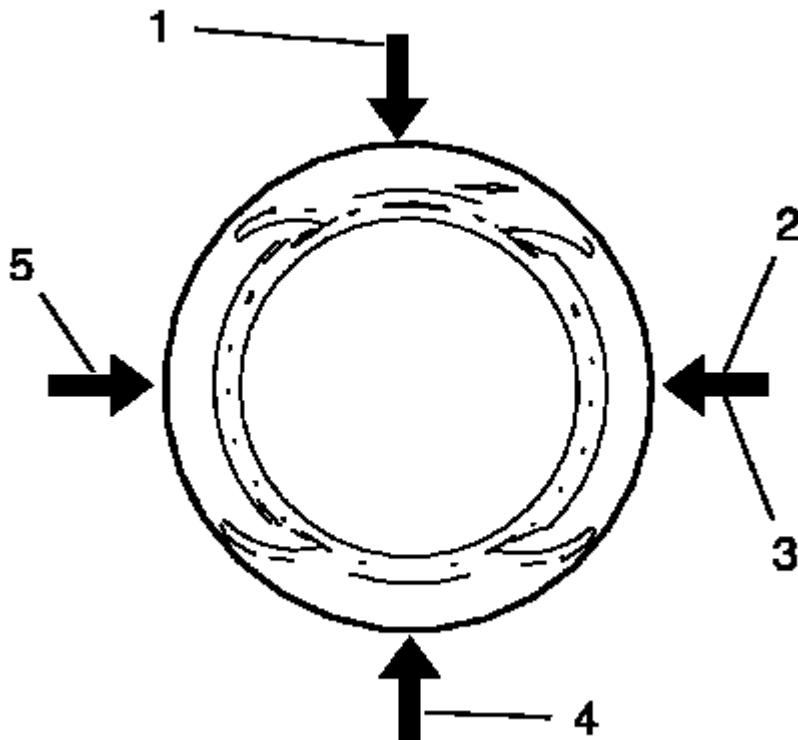


**Fig. 347: Upper Compression Ring, Lower Compression Ring, Oil Rings And Oil Ring Spacer**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the TOP marking on the piston rings.

15. The piston rings must be ordered as followed:

- Upper compression ring (1)
- Lower compression ring (2)
- Piston oil ring with spacer (3), (4)

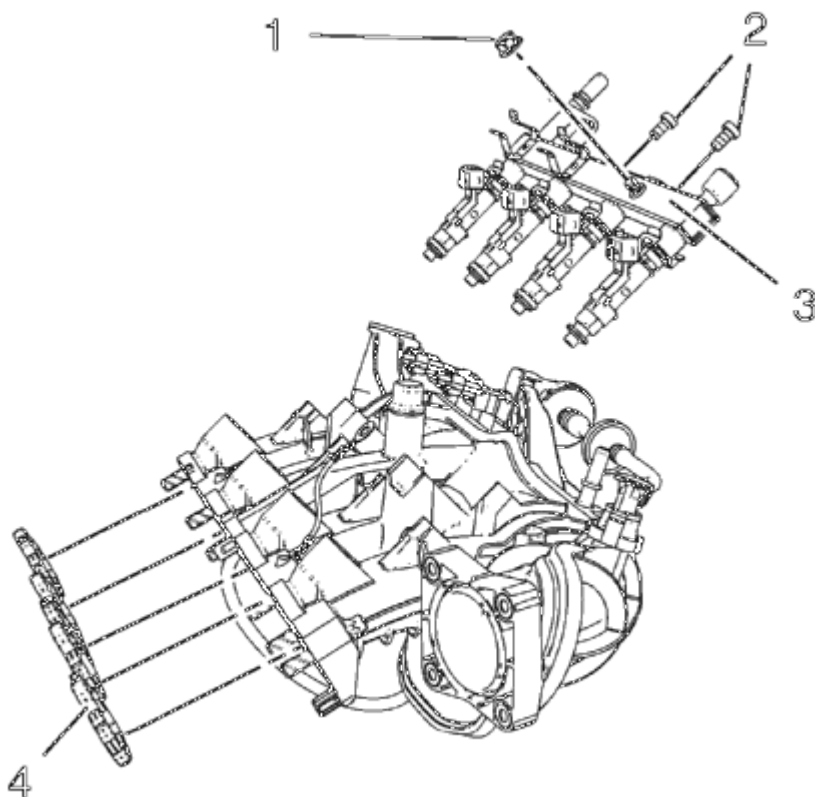


**Fig. 348: Oil Ring Joints, Lower Compression Ring Joint, Upper Compression Ring Joint And Oil Ring Spacer Joint**

Courtesy of GENERAL MOTORS COMPANY

16. The piston ring joints must be positioned 90 degrees to each other.
- Upper compression ring joint (2)
  - Lower compression ring joint (5)
  - Oil ring joint, upper part (1)
  - Oil ring joint, lower part (4)
  - Oil ring spacer joint (3)

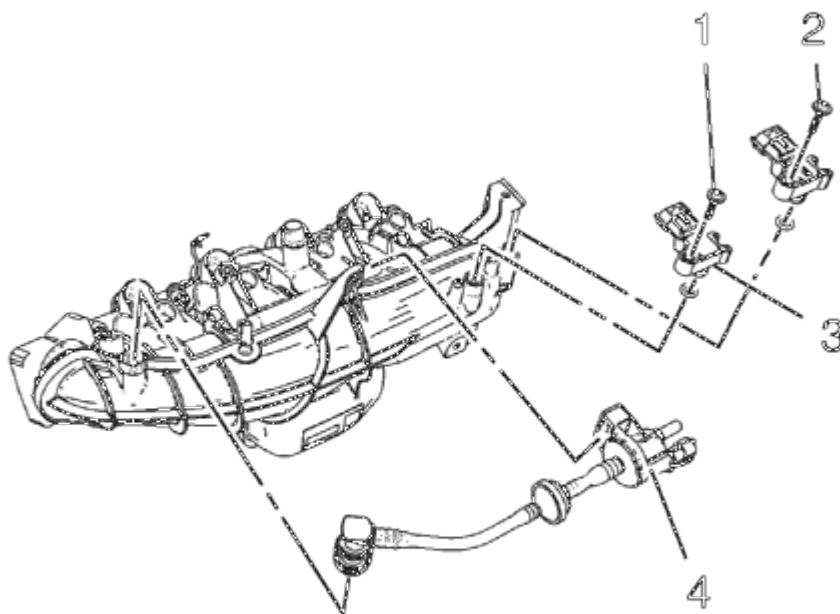
#### **INTAKE MANIFOLD DISASSEMBLE (LUV W. RETURNLESS FUEL SYST.)**



**Fig. 349: Fuel Injection Fuel Rail Assembly And Intake Manifold Gasket**  
 Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel injection rail ground cable nut (1).
2. Remove the 2 fuel injection rail bolts (2).
3. Remove the fuel injection fuel rail assembly (3).
4. Remove the intake manifold gasket (4).



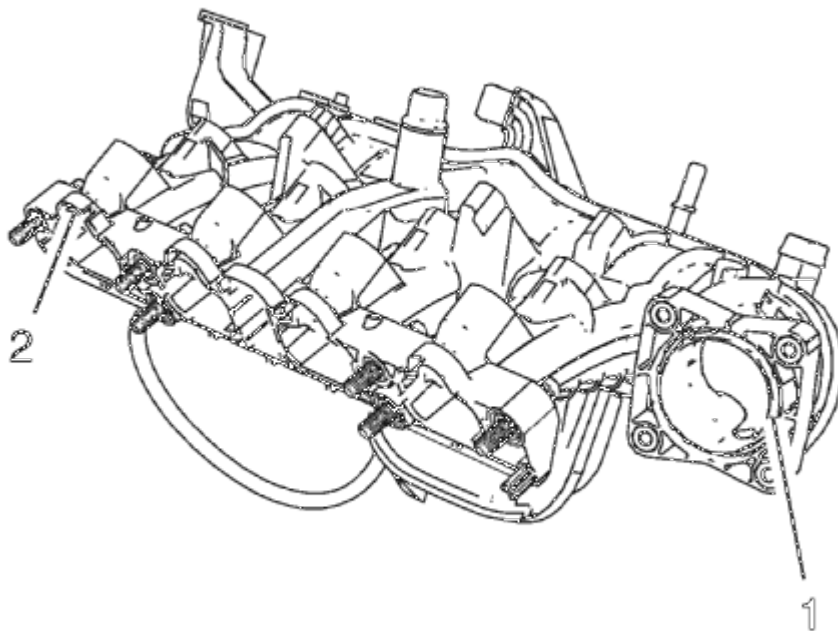


**Fig. 350: Evaporative Emission Canister Purge Solenoid Valve And Manifold Absolute Pressure Sensors**

Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 manifold absolute pressure sensor bolts (1).
6. Remove the 2 manifold absolute pressure sensors (2).
7. Remove the evaporative emission canister purge solenoid valve (3).

#### **INTAKE MANIFOLD CLEANING AND INSPECTION**

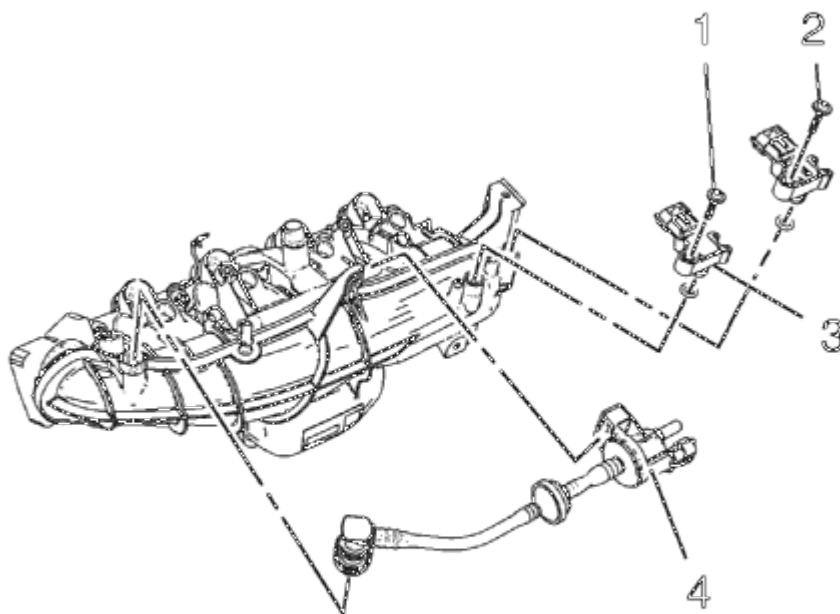


**Fig. 351: Intake Manifold Sealing Surfaces**

**Courtesy of GENERAL MOTORS COMPANY**

1. Clean the sealing surfaces (1) and (2).
2. Inspect the intake manifold for cracks and fractures.

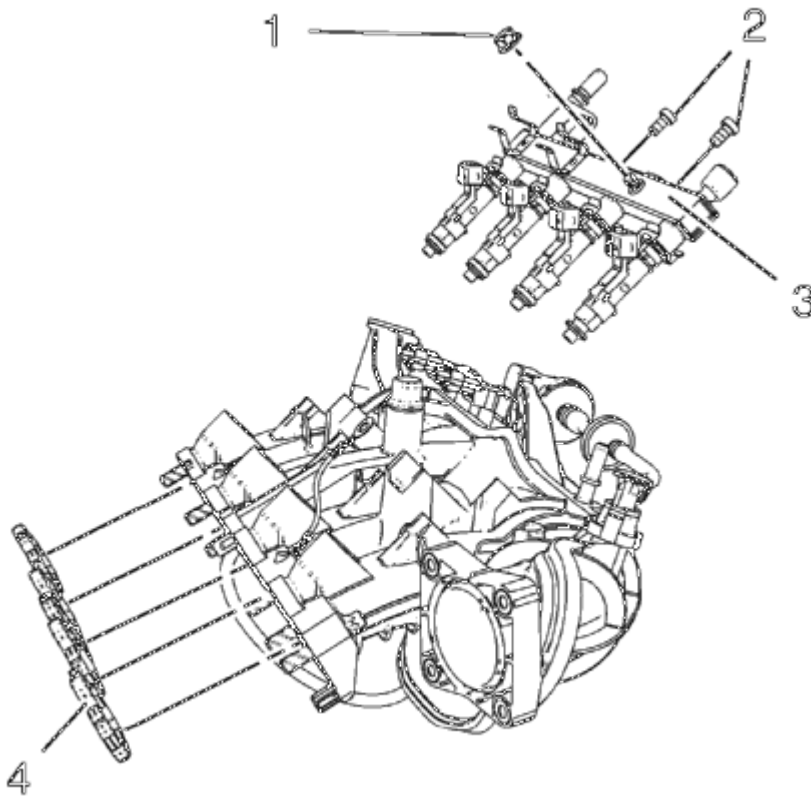
**INTAKE MANIFOLD ASSEMBLY (LUV W. RETURNLESS FUEL SYST.)**



**Fig. 352: Evaporative Emission Canister Purge Solenoid Valve And Manifold Absolute Pressure Sensors**

Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister purge solenoid valve (3).
2. Install the 2 manifold absolute pressure sensors (2).
3. Install the 2 manifold absolute pressure sensor bolts (1) and tighten.



**Fig. 353: Fuel Injection Fuel Rail Assembly And Intake Manifold Gasket**  
 Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel injection fuel rail assembly (3).

**CAUTION:** Refer to Fastener Caution .

5. Install the 2 fuel injection rail bolts (2) and tighten to 8 N.m (71 lb in).
6. Install the fuel injection rail ground cable nut (1) and tighten.
7. Install a NEW intake manifold gasket (4).

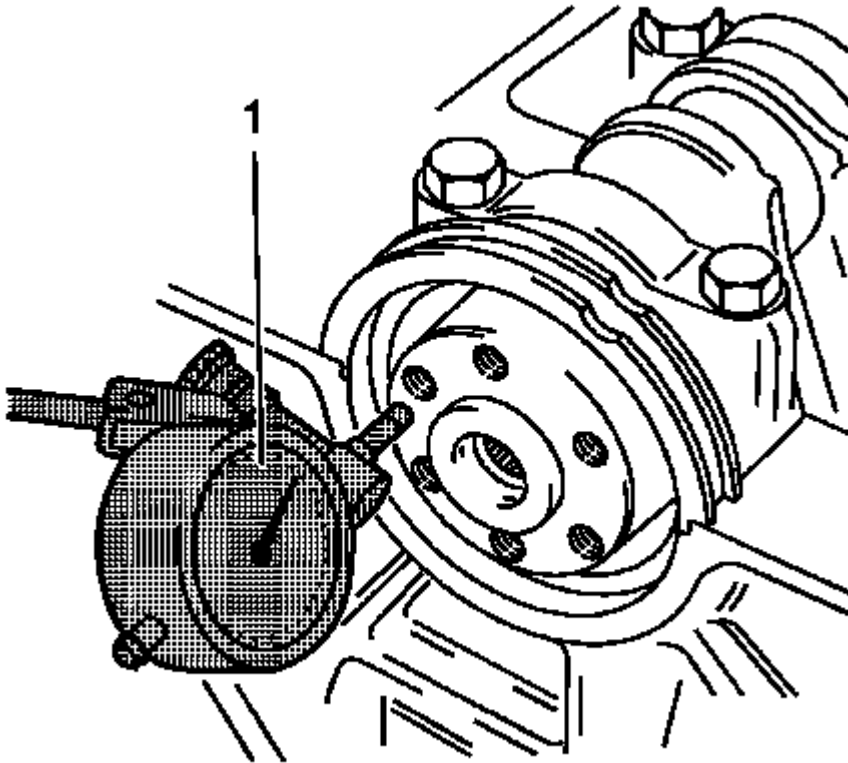
## CRANKSHAFT AND BEARING CLEANING AND INSPECTION

### Special Tools

- EN-470-B Angular Torque Wrench
- GE-571-B Dial Gauge

For equivalent regional tools, refer to Special Tools.

### Crankshaft End Play, Check



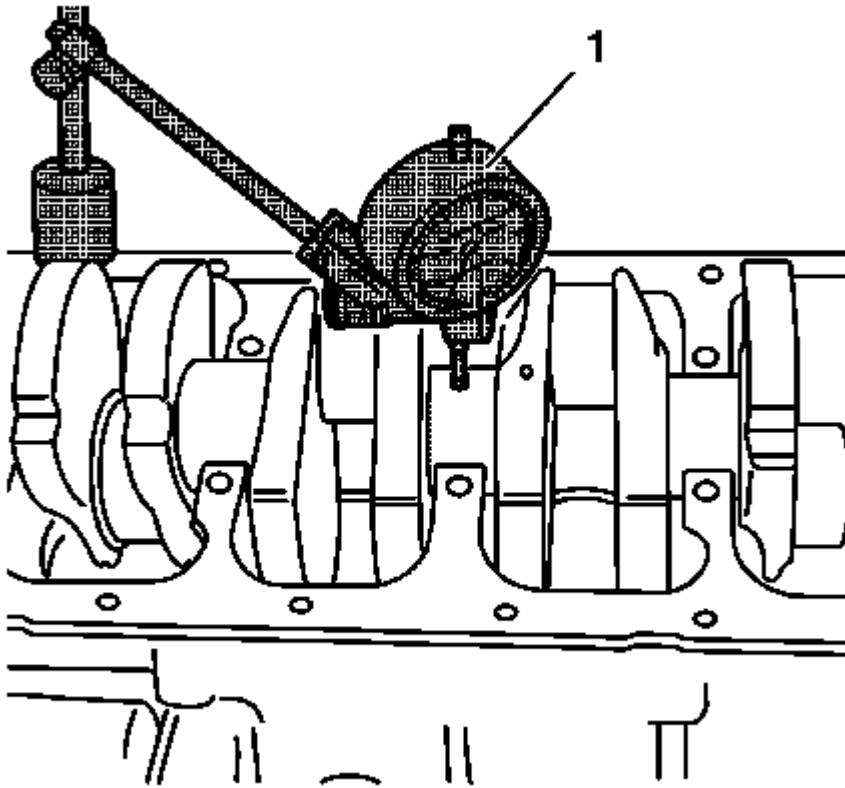
**Fig. 354: Dial Gauge Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Crankshaft attached with crankshaft bearing caps.

1. Install the **GE-571-B** gauge (1).
  - Install the holder on the front of the engine block.
  - Place the dial gauge plunger against the crankshaft and adjust.
2. Measure the longitudinal play of the crankshaft.
  - Move the crankshaft in the longitudinal direction.
  - Permissible crankshaft end play 0.100-0.202 mm (0.0039-0.0080 in).
3. Remove the **GE-571-B** gauge.

**Crankshaft Out-of-Round, Check**



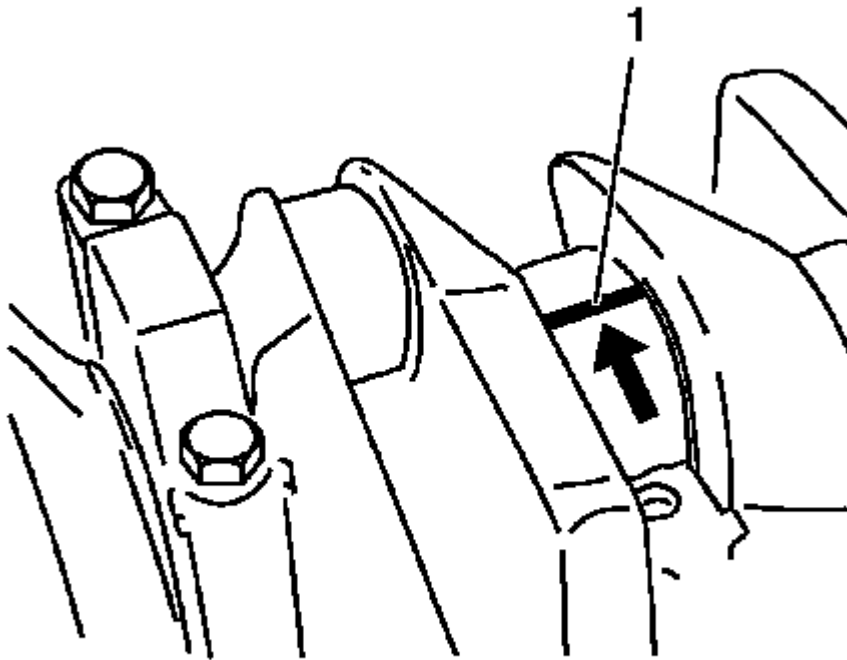
**Fig. 355: Dial Gauge Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE: Crankshaft removed.**

1. Insert the crankshaft in the engine block.
2. Install the **GE-571-B** gauge (1).
  - Attach holder to the engine block.
  - Place the dial gauge plunger against the crankshaft bearing journal and adjust.
3. Check the rotational play of the crankshaft.
  - Turn the crankshaft evenly.
  - Maximum permissible rotational play 0.03 mm (0.001 in).
4. Remove the **GE-571-B** gauge.

**Check Crankshaft Bearing Clearance (With Plastigage)**



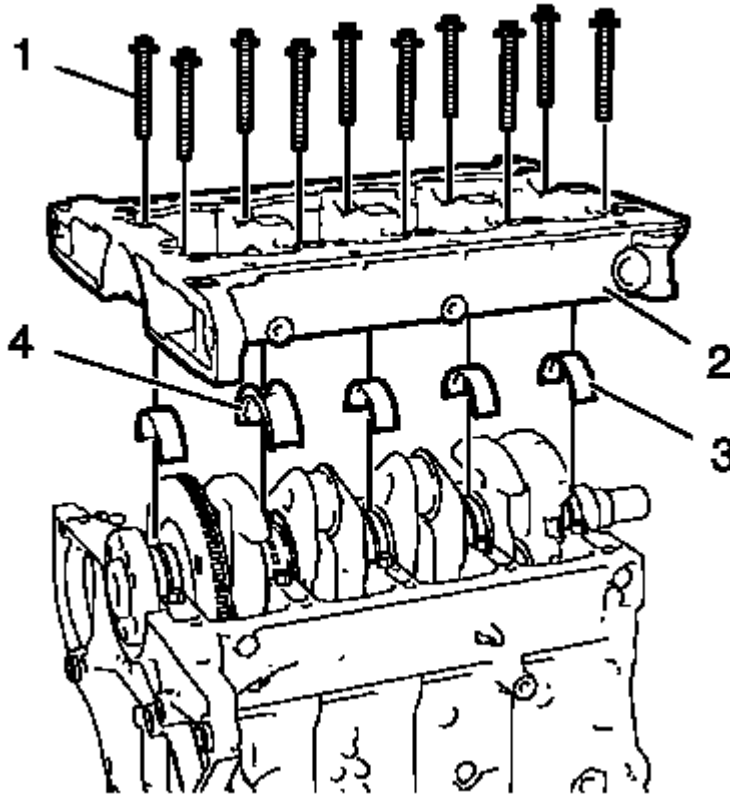
**Fig. 356: Plastigage On Bearing Journal**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:**

- Crankshaft removed.
- Do not rotate the crankshaft.

1. Lay out plastigage.

Lay out plastigage (flexible plastic thread) around the entire width of the crankshaft bearing journal (1).

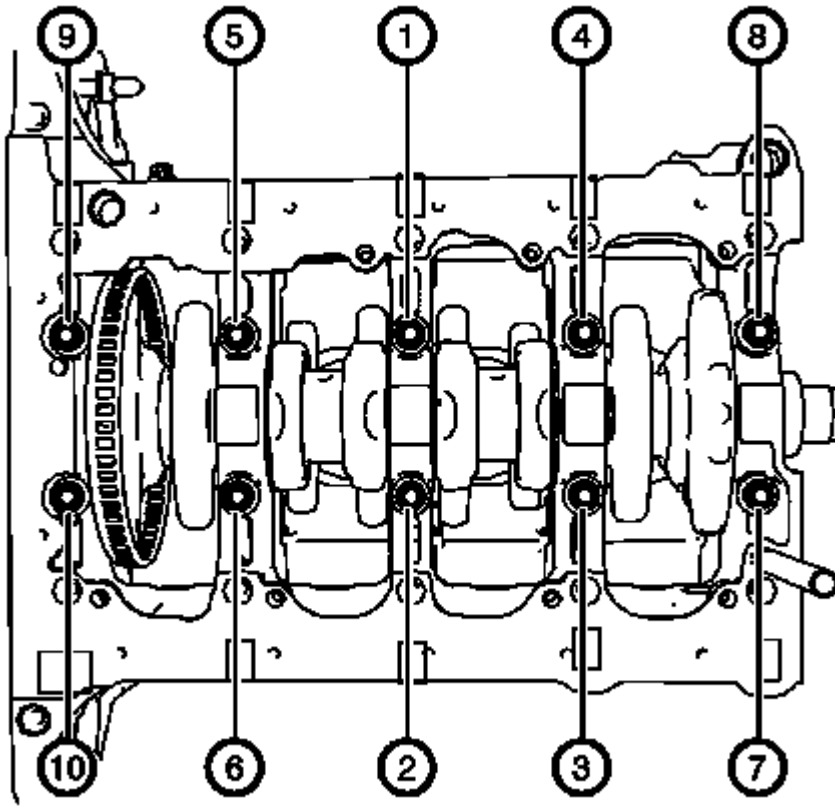


**Fig. 357: Crankshaft Bearing Cap Tie Plate**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The bolts can be reused for checking the crankshaft bearing play.

2. Install the 4 lower crankshaft bearings (3) and the lower crankshaft thrust bearing (4).
3. Install the crankshaft bearing cap tie plate (2).
4. Install the 10 inner crankshaft bearing cap tie plate bolts (1).

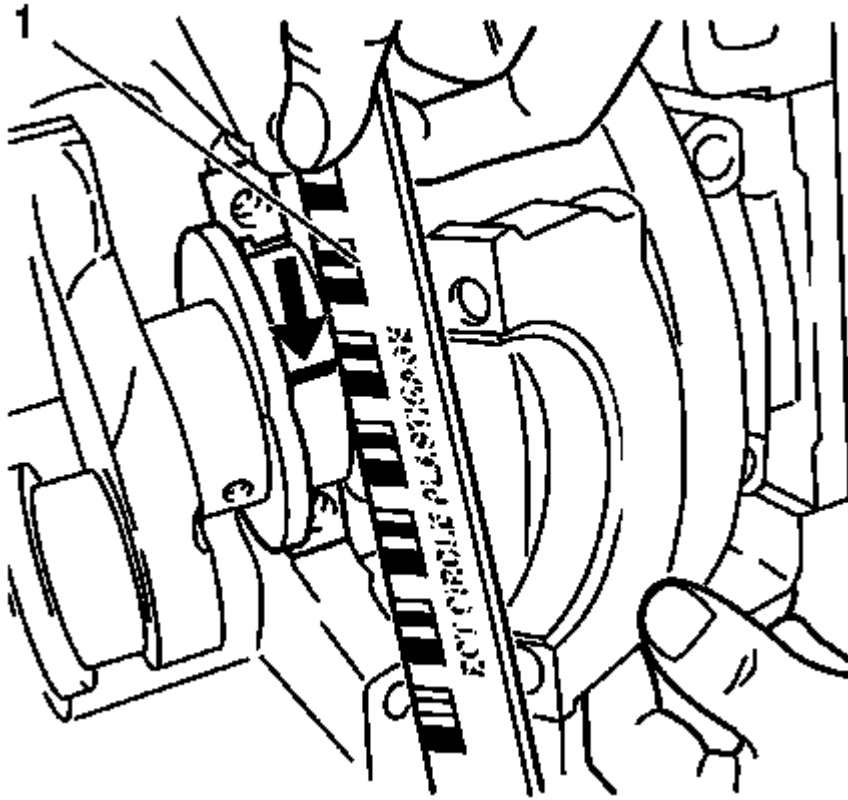




**Fig. 358: Inner Crankshaft Bearing Cap Tie Plate Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

5. Tighten the 10 inner crankshaft bearing cap tie plate bolts in a sequence as shown and in the following order:
  1. Tighten the inner crankshaft bearing cap tie plate bolts to 25 N.m (18 lb ft).
  2. Tighten the inner crankshaft bearing cap tie plate bolts an additional 60°. Use **EN-470-B** wrench.
  3. Tighten the inner crankshaft bearing cap tie plate bolts an additional 15°. Use **EN-470-B** wrench.
6. Remove the crankshaft bearing cap tie plate bolts and the crankshaft bearing cap tie plate.



**Fig. 359: Measuring Crankshaft Bearing Play Using Measuring Scale**  
Courtesy of GENERAL MOTORS COMPANY

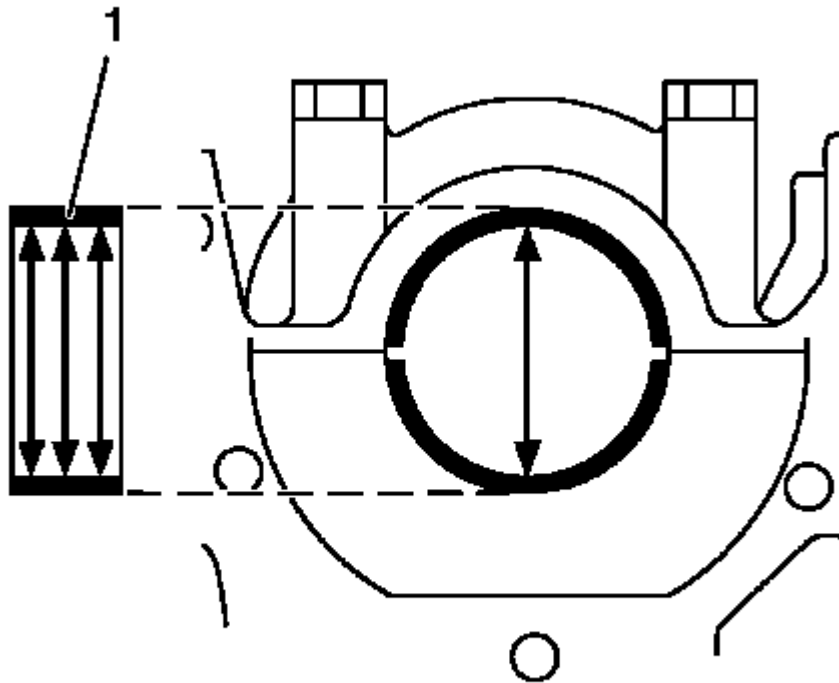
**NOTE:** When reading the value, do not confuse millimeters and inches on the measuring scale.

7. Measure the crankshaft bearing play.
  - Compare the width of the flattened plastic thread (arrow) to the measuring scale (1).
  - The crankshaft bearing play should be 0.007-0.031 mm (0.00028-0.00122 in).

**Check Crankshaft Bearing Clearance (With Micrometer Gauge Internal Measuring Device)**

**NOTE:** The bolts can be reused for checking the crankshaft bearing play.

1. Install and tighten the crankshaft bearing cap tie plate and the crankshaft bearings as shown above.



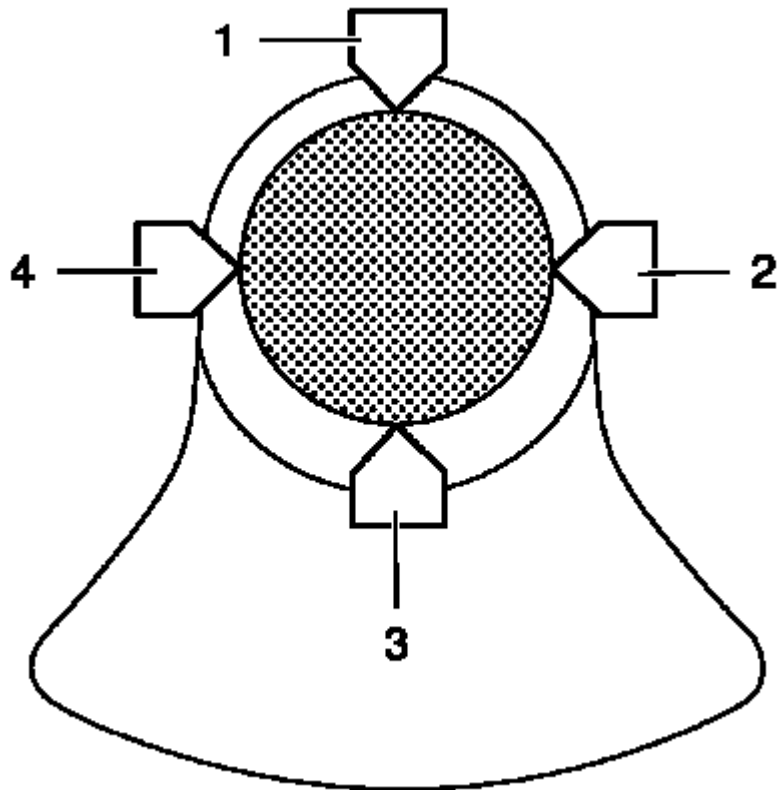
**Fig. 360: Crankshaft Bearing Diameter Measuring Points**  
Courtesy of GENERAL MOTORS COMPANY

2. Measure the crankshaft bearing diameter at 3 points.

Measure in areas as shown (1) with an internal measuring device.

Calculate the average crankshaft bearing diameter.

Formula: 1. result + 2. result + 3. result / 3.



**Fig. 361: Connecting Rod Journal Diameter Points**  
Courtesy of GENERAL MOTORS COMPANY

3. Measure the crankshaft bearing journal diameter at 2 points between (1) and (3) and between (2) and (4) with the micrometer gauge.
4. Calculate the average crankshaft bearing journal diameter.

Formula: 1. result + 2. result / 2.

5. Determine the crankshaft bearing play.

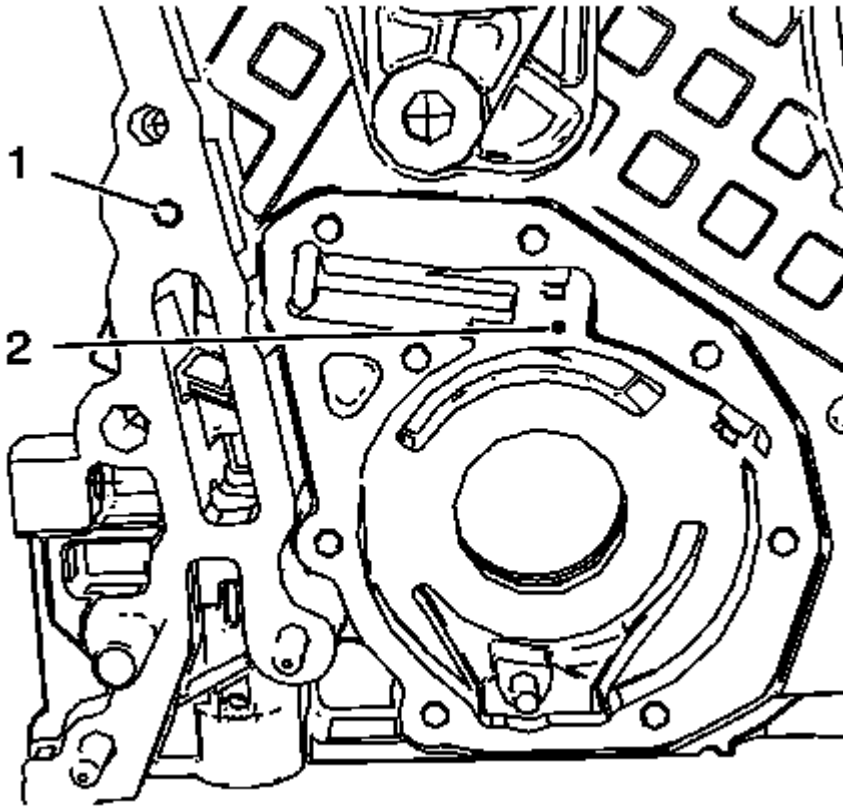
Calculation formula: average crankshaft bearing diameter minus average crankshaft bearing journal diameter.

6. The crankshaft bearing play should be 0.007-0.031 mm (0.00028-0.00122 in).

## ENGINE FRONT COVER AND OIL PUMP CLEANING AND INSPECTION

### Engine Front Cover Cleaning Procedure

1. Clean the engine front cover sealing surface.



**Fig. 362: Oil Gallery Bores**

Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Wear safety glasses when using compressed air in order to prevent eye injury.

**CAUTION:** To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

2. Clean the shown oil gallery with solvent and compressed air. Blow compressed air from bore (2) to bore (1).

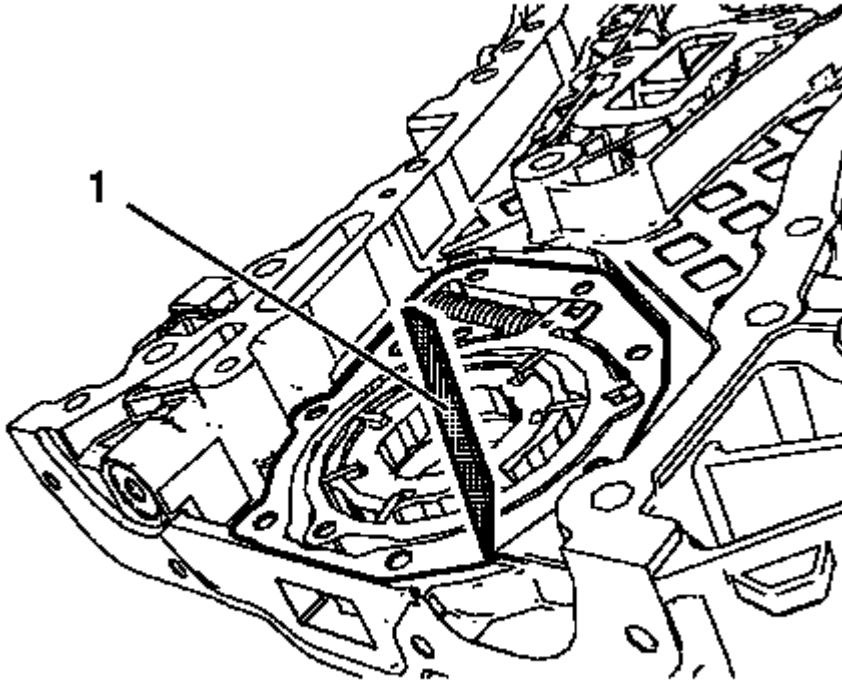
#### Engine Front Cover Visual Inspection

Inspect the engine front cover for cracks, scratches and damage.

#### Oil Pump Visual Inspection and Measurement

1. Inspect the oil pump cover and the engine front cover for flatness.
2. Inspect the oil pump vanes, the oil pump vane rotor, the oil pump vane rings and the oil pump slide for localized flatting.

3. Inspect the oil pump slide pivot pin for firm seat.

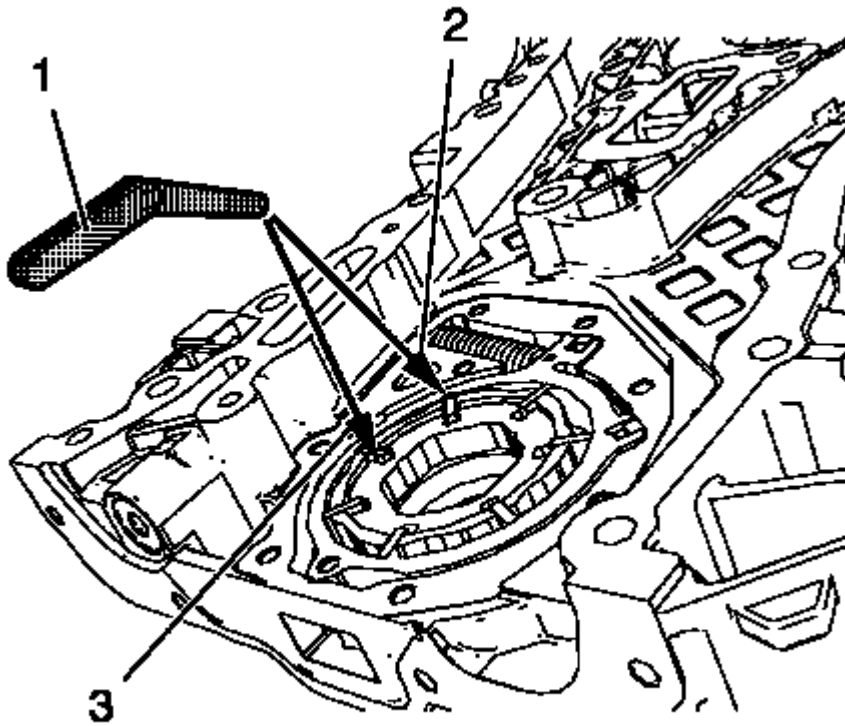


**Fig. 363: Straight Edge Tool**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Oil pump components are installed.

4. Measure the oil pump axial clearances. Use a straight edge (1) and a feeler gauge.
  1. The maximal axial clearance between engine front cover and oil pump vane rotor should be 0.1 mm (0.004 in).
  2. The maximal axial clearance between engine front cover and oil pump vane should be 0.09 mm (0.0035 in).
  3. The maximal axial clearance between engine front cover and oil pump vane ring should be 0.4 mm (0.016 in).
  4. The maximal axial clearance between engine front cover and oil pump slide should be 0.08 mm (0.0031 in).
  5. The maximal axial clearance between engine front cover and oil pump slide seal should be 0.09 mm (0.0035 in).



**Fig. 364: Feeler Gauge, Oil Pump Slide And Oil Pump Vane**  
Courtesy of GENERAL MOTORS COMPANY

5. Measure the oil pump radial clearance. Use a feeler gauge (1). Measure the clearance between oil pump vane rotor and oil pump vane (3).

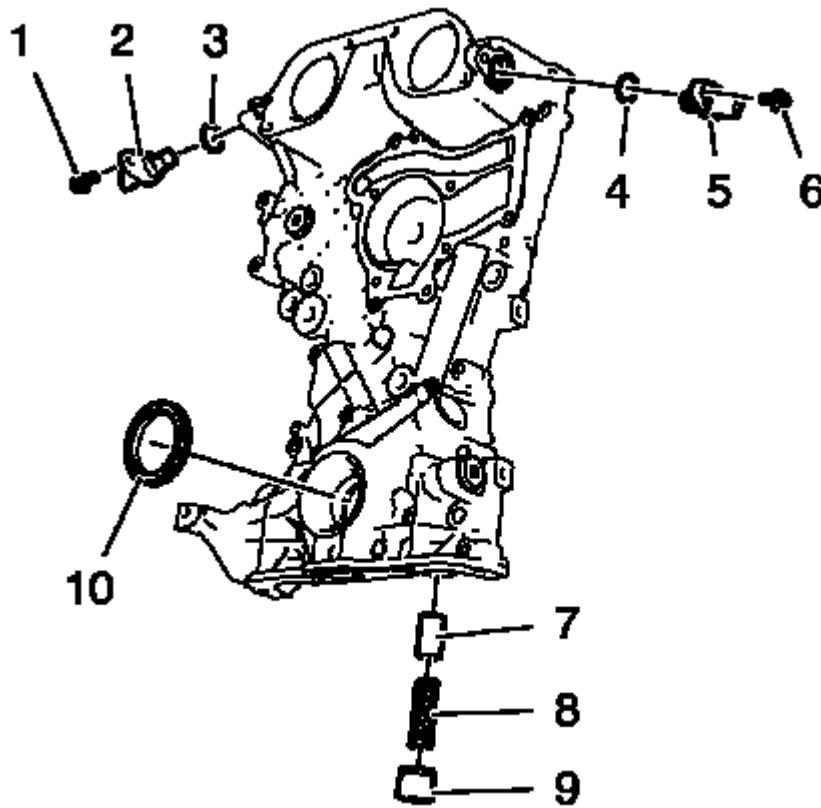
The maximal clearance should be 0.05 mm (0.002 in).

6. Measure the clearance between oil pump vane and oil pump slide (2).

The maximal clearance should be 0.2 mm (0.008 in).

## ENGINE FRONT COVER AND OIL PUMP DISASSEMBLE

### Engine Front Cover Disassemble

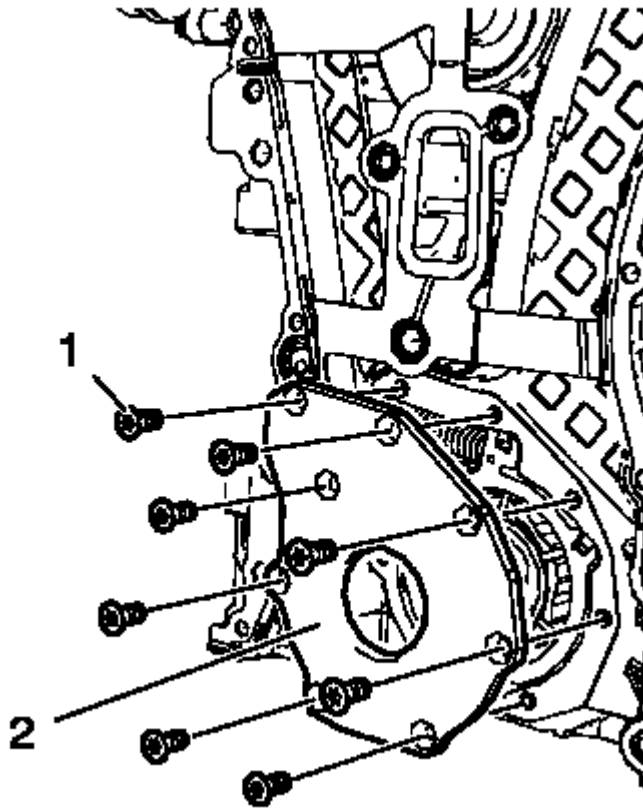


**Fig. 365: Locating Engine Front Cover Components**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake camshaft position sensor bolt (1).
2. Remove the intake camshaft position sensor (2) and the seal ring (3).
3. Remove the exhaust camshaft position sensor bolt (6).
4. Remove the exhaust camshaft position sensor (5) and the seal ring (4).
5. Remove the oil pressure relief valve (7, 8 and 9)
6. Remove the crankshaft front oil seal (10).

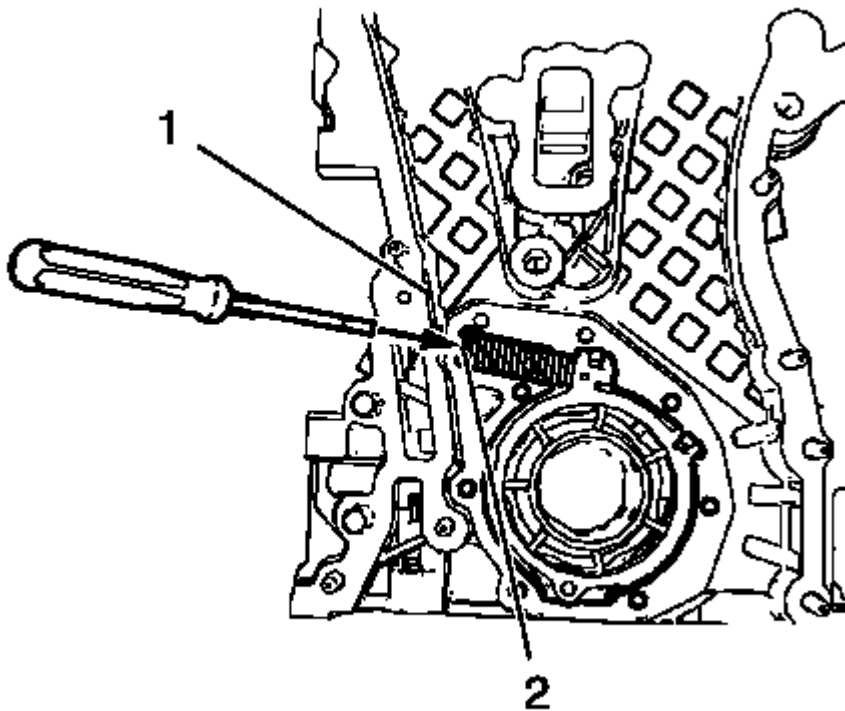
#### Oil Pump Removal





**Fig. 366: Engine Oil Pump Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 8 oil pump cover bolts (1).
2. Remove the oil pump cover (2).

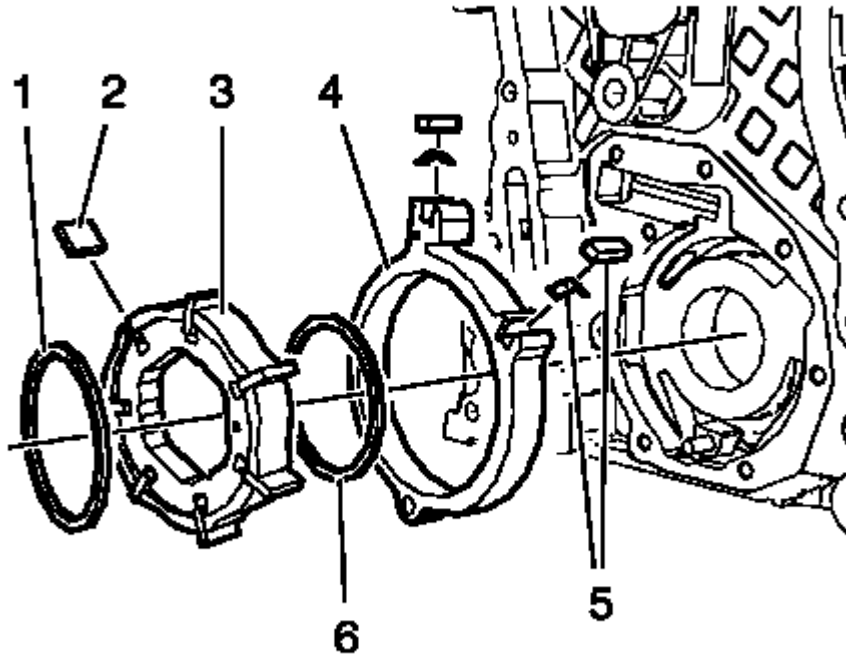


**Fig. 367: Oil Pump Slide Spring Windings And Engine Front Cover Edge**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Before removing the spring, cover the spring with a towel to prevent the spring from flying and possibly causing damage or personal injury.

**NOTE:** Position a screw driver between the oil pump slide spring windings (2).

3. Protect the engine front cover edge (1) with a suitable piece of plastic.
4. Compress the oil pump slide spring with a screw driver and remove the oil pump slide spring along with the oil pump slide spring pin.



**Fig. 368: Locating Engine Oil Pump Components**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the installation position of the oil pump components.

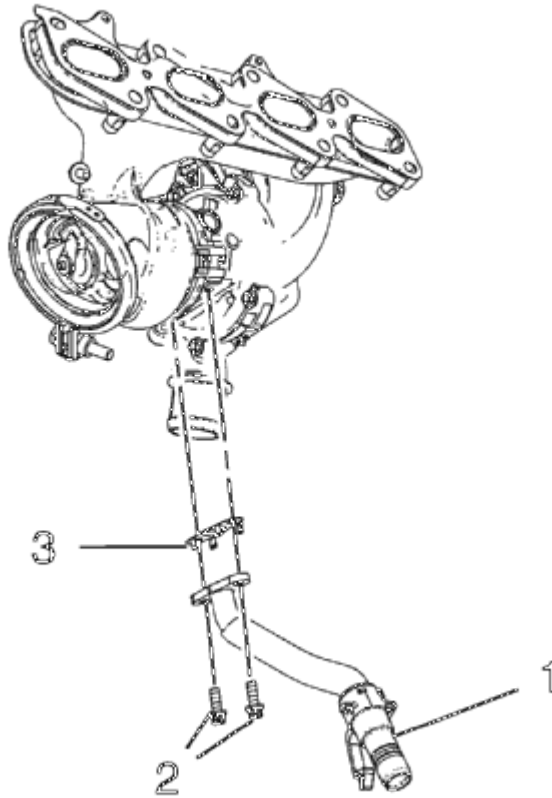
5. Remove the oil pump components in the following order:
  1. Outer oil pump vane ring (1).
  2. Oil pump vane rotor (3) and the 7 oil pump vanes (2).
  3. Inner oil pump vane ring (6).
  4. Oil pump slide (4) and the 2 oil pump slide seals with the 2 oil pump slide seal springs (5).

## TURBOCHARGER DISASSEMBLE

### Special Tool

**EN-49940** Remover Quick Connector

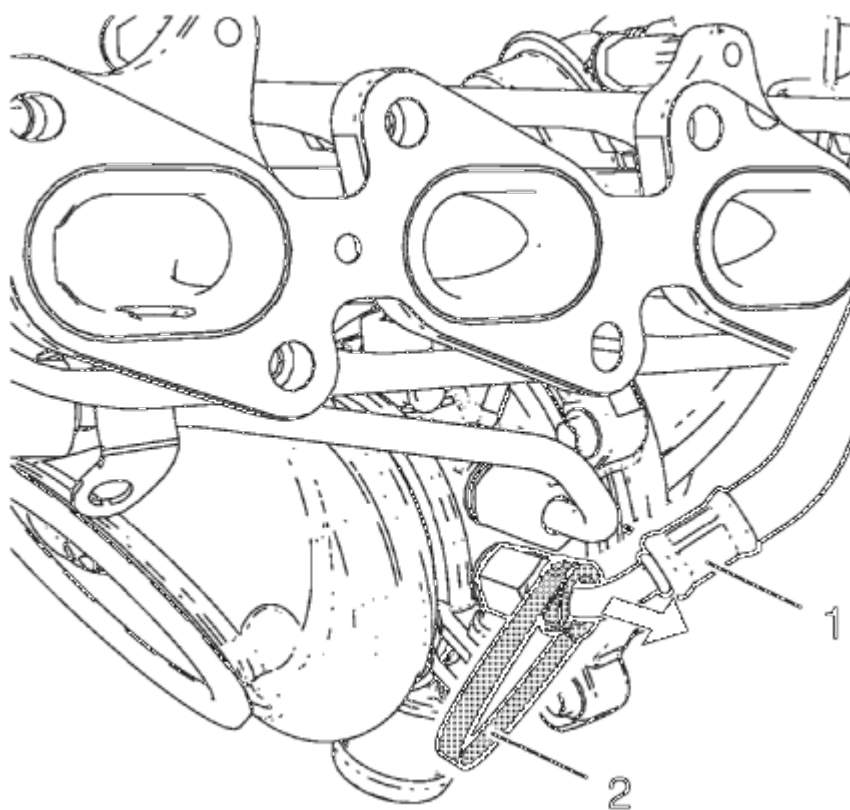
For equivalent regional tools, refer to **Special Tools**.



**Fig. 369: Turbocharger Oil Return Pipe**

**Courtesy of GENERAL MOTORS COMPANY**

1. Remove the 2 turbocharger oil return pipe bolts (2).
2. Remove the turbocharger oil return pipe (1) and the sealing (3) from the turbocharger.

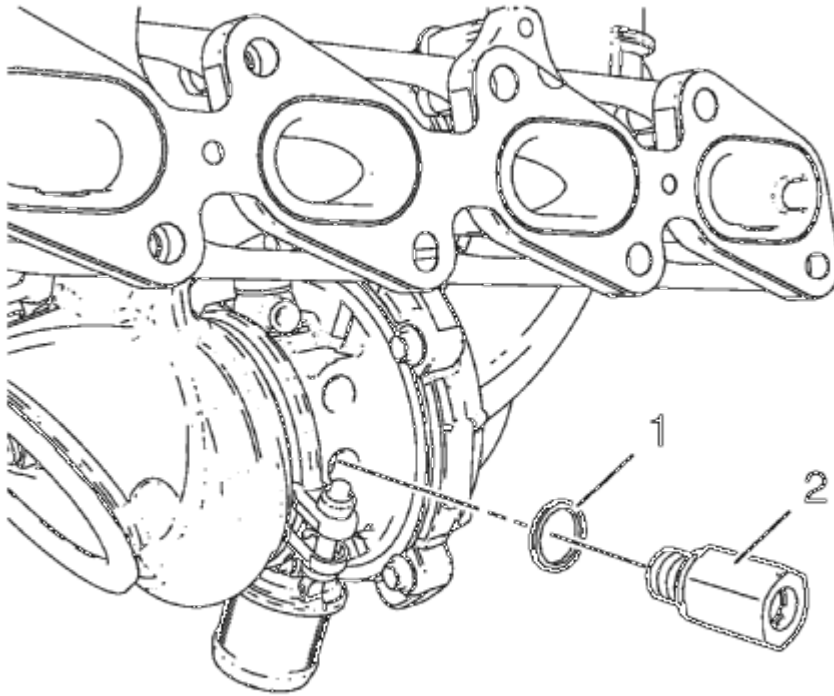


**Fig. 370: Turbocharger Coolant Feed Pipe**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The quick fitting connectors should be always replaced when the turbocharger coolant pipes are removed

3. Install the **EN-49940** remover (2) to the turbocharger coolant feed pipe (1) and the quick fitting connector as shown.
4. Compress the **EN-49940** remover and remove the turbocharger coolant feed pipe direction of the arrow.



**Fig. 371: Quick Fitting Connector And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

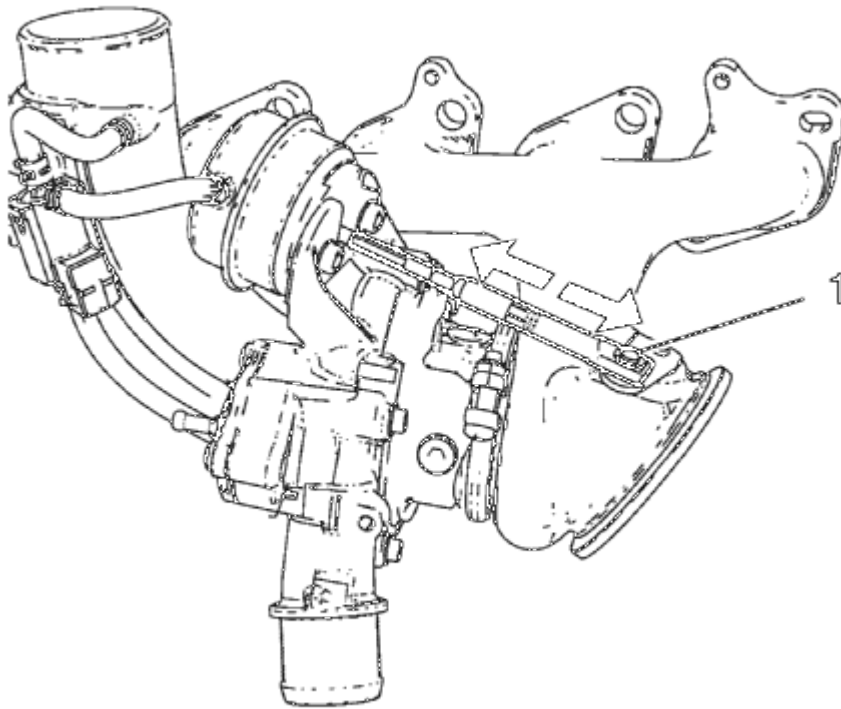
5. Remove the quick fitting connector (2) and the seal ring (1).
6. Use the same procedure for the turbocharger coolant return pipe and the turbocharger coolant return pipe quick fitting connector.

## **TURBOCHARGER CLEANING AND INSPECTION**

### **Cleaning Procedure**

1. Clean all sealing surfaces.
2. Clean all threads if necessary.

### **Inspection Procedure**

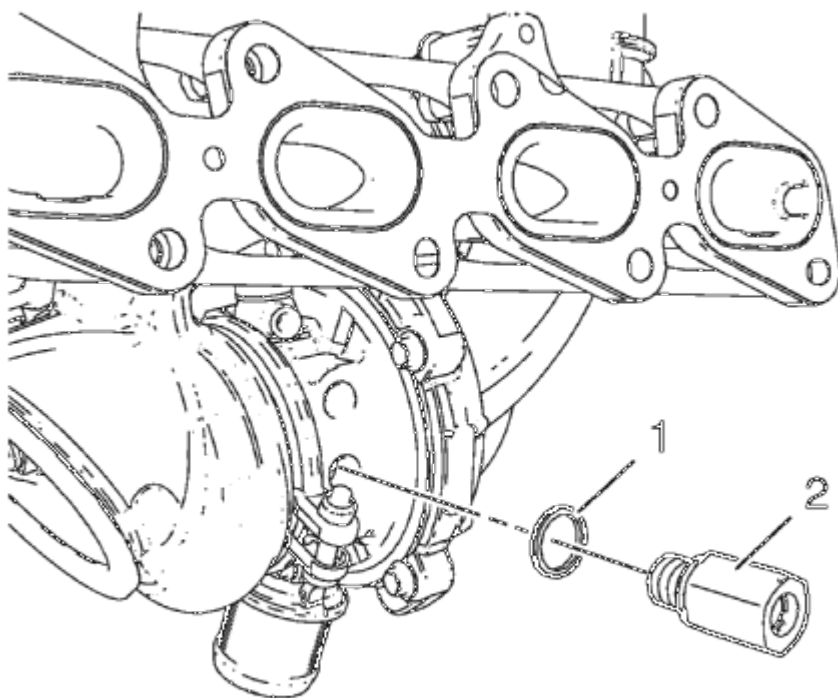


**Fig. 372: Wastegate Regulator Mechanism**

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the wastegate regulator mechanism (1) for functionality.
2. Inspect the turbine blades for damage or foreign material.
3. Inspect the turbocharger wastegate regulator vacuum hoses for damage.
4. Inspect the exhaust manifold and the turbocharger for cracks or other damage.
5. Inspect the exhaust manifold mating surface for flatness.

## **TURBOCHARGER ASSEMBLE**

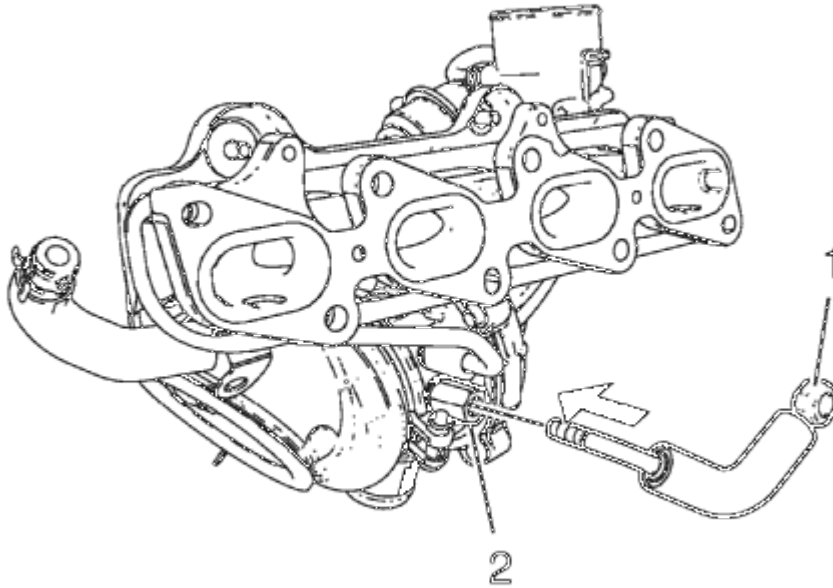


**Fig. 373: Quick Fitting Connector And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

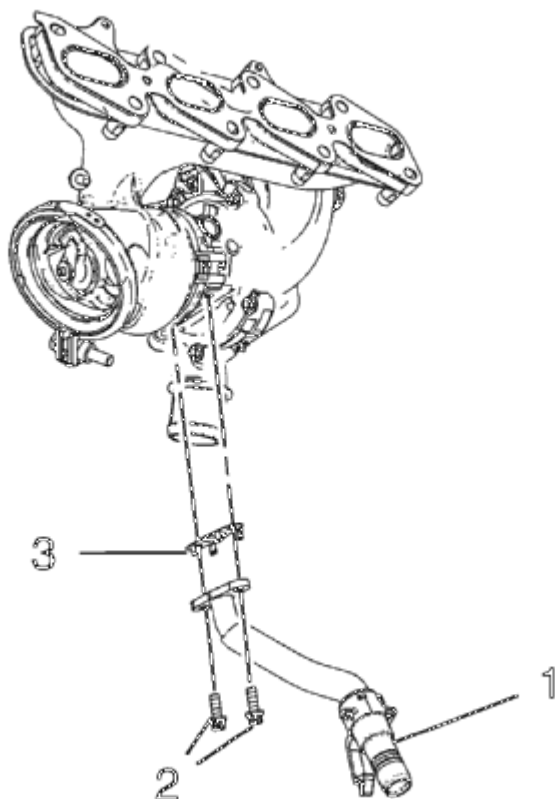
1. Install the NEW quick fitting connector (2) and a NEW seal ring (1) to the turbocharger and tighten to 20 N.m (15 lb ft).





**Fig. 374: Turbocharger Coolant Feed Pipe And Quick Fitting Connector**  
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the turbocharger coolant pipes for ridges and damage.
3. Install the turbocharger coolant feed pipe (1) to the quick fitting connector (2) by pushing in direction of the arrow until an audible click is heard.
4. Use the same procedure for the turbocharger coolant return pipe and the turbocharger coolant return pipe quick fitting connector.

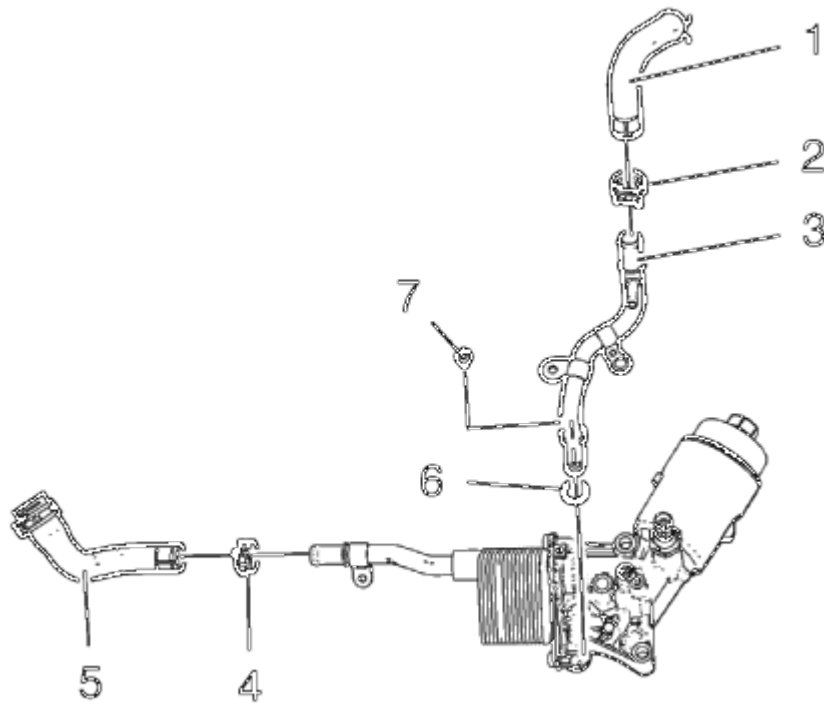


**Fig. 375: Turbocharger Oil Return Pipe**

**Courtesy of GENERAL MOTORS COMPANY**

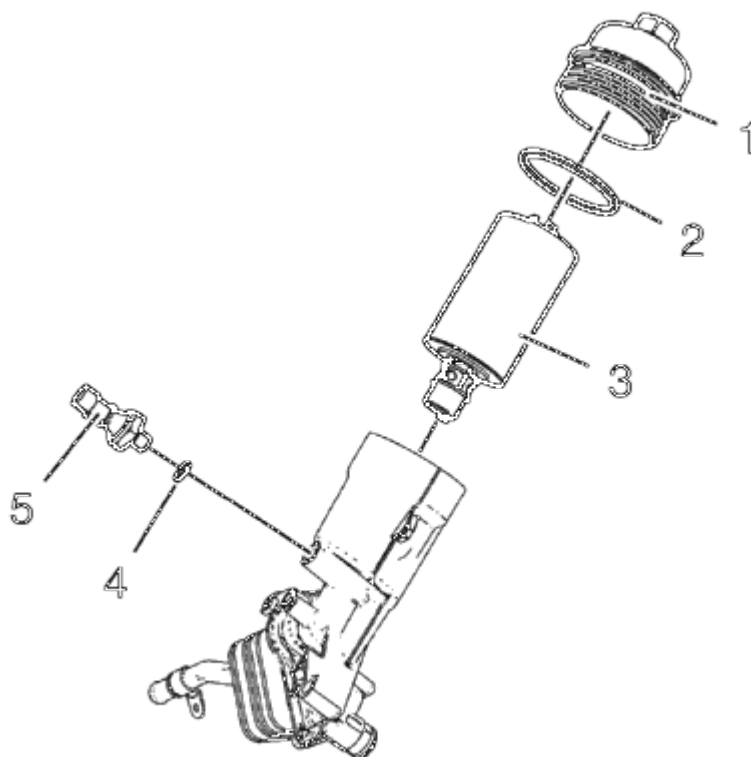
5. Install the turbocharger oil return pipe (1) and a NEW sealing (3) to the turbocharger.
6. Install the 2 turbocharger oil return pipe bolts (2) and tighten to 8 N.m (71 lb in).

## **ENGINE OIL COOLER DISASSEMBLE**



**Fig. 376: Locating Engine Oil Cooler Components**  
Courtesy of GENERAL MOTORS COMPANY

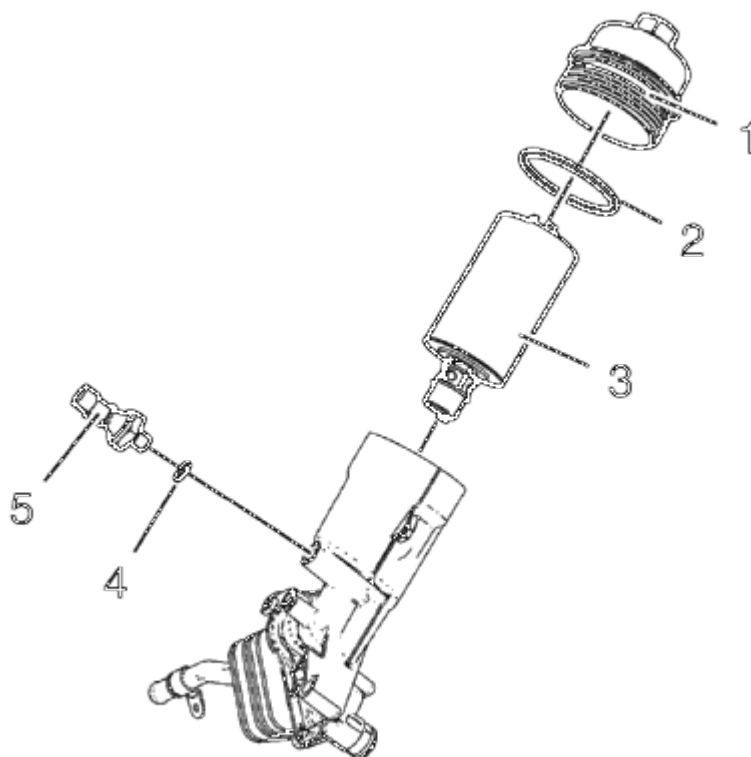
1. Remove the oil cooler coolant inlet hose clamp (2).
2. Remove the oil cooler coolant inlet hose (1).
3. Remove the oil cooler coolant inlet pipe bolt (7)
4. Remove the oil cooler coolant inlet pipe (3) and the seal ring (6).
5. Remove the oil cooler coolant outlet hose clamp (4).
6. Remove the oil cooler coolant outlet hose (5).



**Fig. 377: Engine Oil Pressure Indicator Switch, Oil Filter Cap And Oil Filter Element**  
 Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine oil pressure indicator switch (5) and the seal ring (4).
8. Remove the engine oil filter cap (1) along with the seal ring (2) and the oil filter element (3).

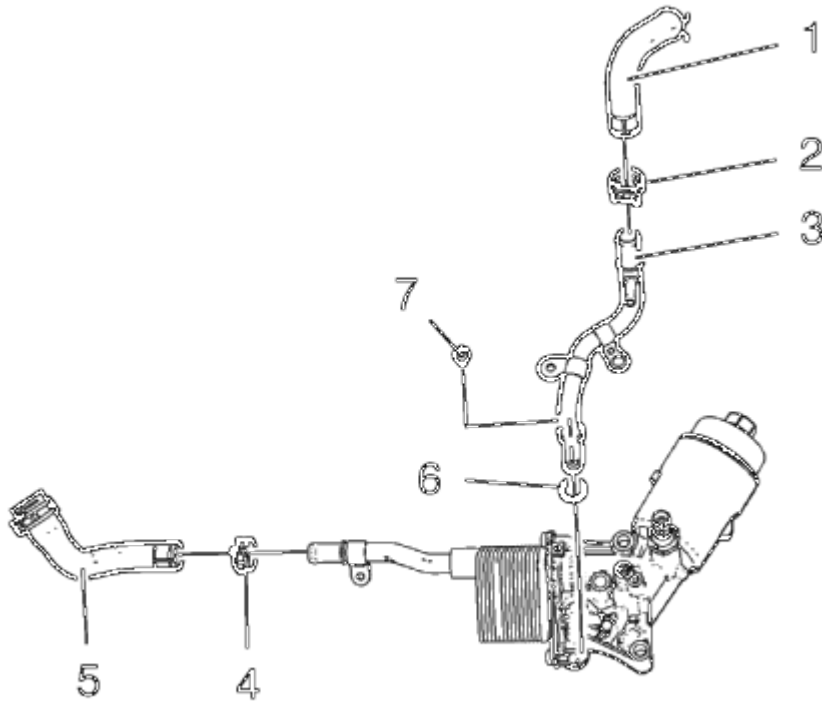
## ENGINE OIL COOLER ASSEMBLE



**Fig. 378: Engine Oil Pressure Indicator Switch, Oil Filter Cap And Oil Filter Element**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

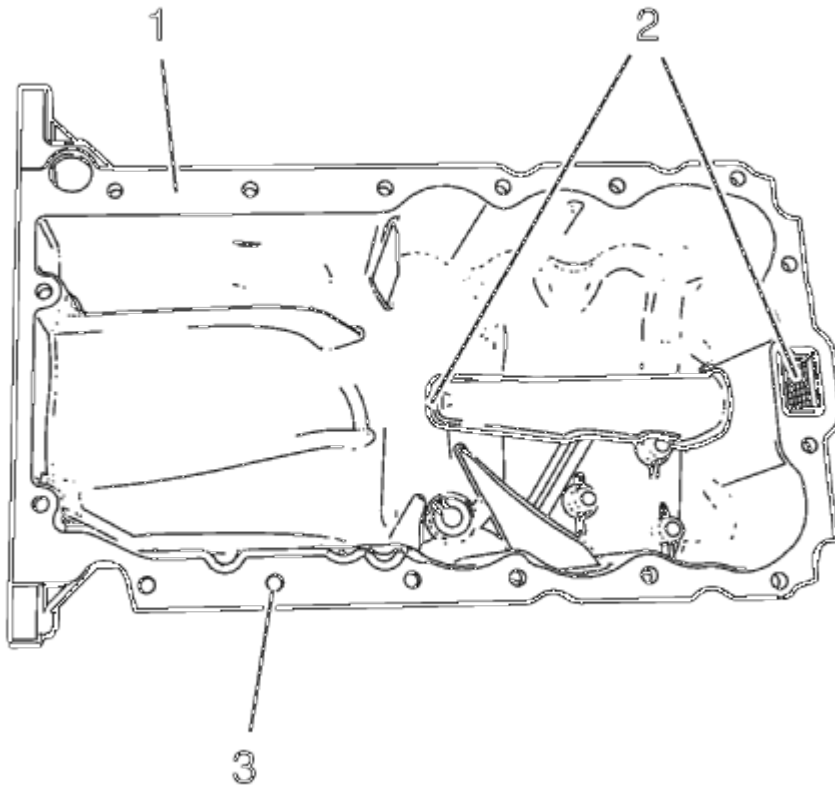
1. Install the engine oil filter cap (1) along with a NEW seal ring (2) and a NEW oil filter element (3) and tighten to 25 N.m (18 lb ft).
2. Install the engine oil pressure indicator switch (5) and NEW seal ring (4) and tighten to 20 N.m (15 lb ft).



**Fig. 379: Locating Engine Oil Cooler Components**  
 Courtesy of GENERAL MOTORS COMPANY

3. Install the oil cooler coolant outlet hose (5)
4. Install the oil cooler coolant outlet hose clamp (4).
5. Install the oil cooler coolant inlet pipe (3) and a NEW seal ring (6).
6. Install the oil cooler coolant inlet pipe bolt (7) and tighten to 10 N.m (89 lb in).
7. Install the oil cooler coolant inlet hose (1).
8. Install oil cooler coolant inlet hose clamp (2).

## OIL PAN CLEANING AND INSPECTION



**Fig. 380: Oil Suction Gallery, Sealing Surface And Screw Bores**  
Courtesy of GENERAL MOTORS COMPANY

**WARNING:** Wear safety glasses when using compressed air in order to prevent eye injury.

**CAUTION:** To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

1. Clean the oil suction gallery (2) with compressed air. Be sure to remove all dirt and old gasket material from the suction gallery (2).
2. Remove all remaining old gasket material from sealing surface (1) and screw bores (3).
3. Clean the sealing surfaces from dirt and grease.
4. Inspect the sealing surface for cracks and damage.

## CRANKSHAFT AND BEARING INSTALLATION

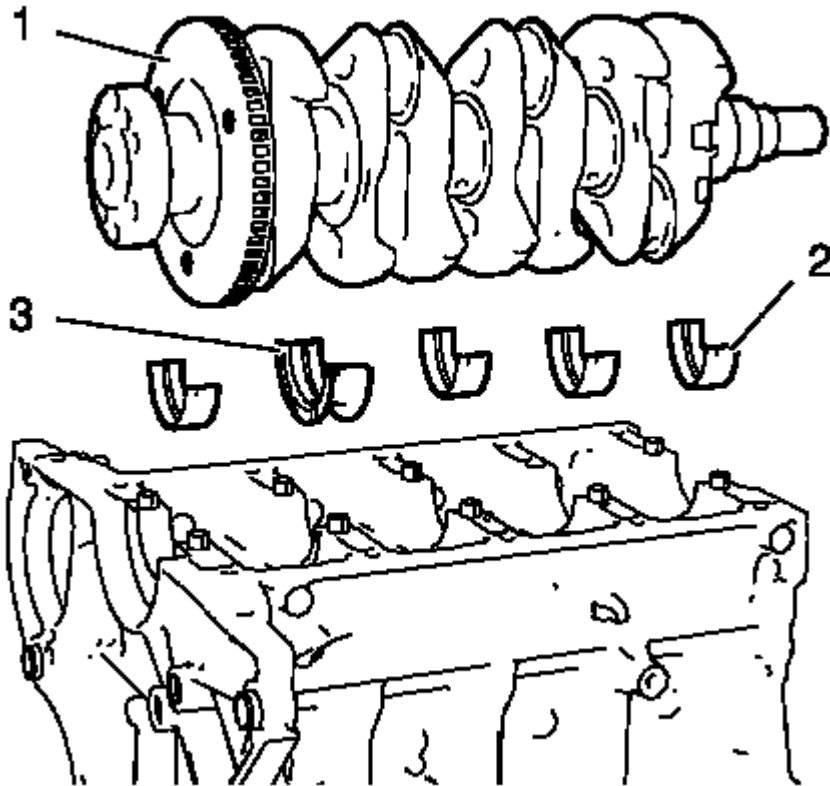
### Special Tools

- EN-235-6 Installer from EN-235-D Kit.

- **EN-470-B** Angular Torque Wrench
- **EN-658-1** Installer from **EN-658** Kit.

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

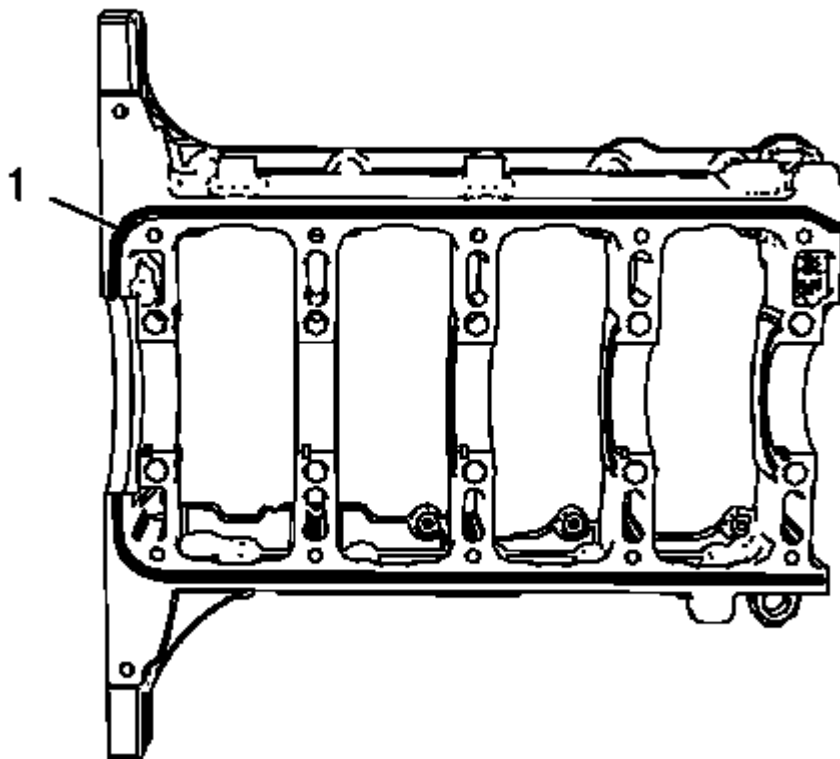
1. Lubricate crankshaft, crankshaft bearings and crankshaft bearing cap tie plate with engine oil.



**Fig. 381: Crankshaft, Upper Crankshaft Bearings And Upper Crankshaft Thrust Bearing**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the 4 upper crankshaft bearings (2) and the crankshaft thrust bearing (3).
3. Install the crankshaft (1).

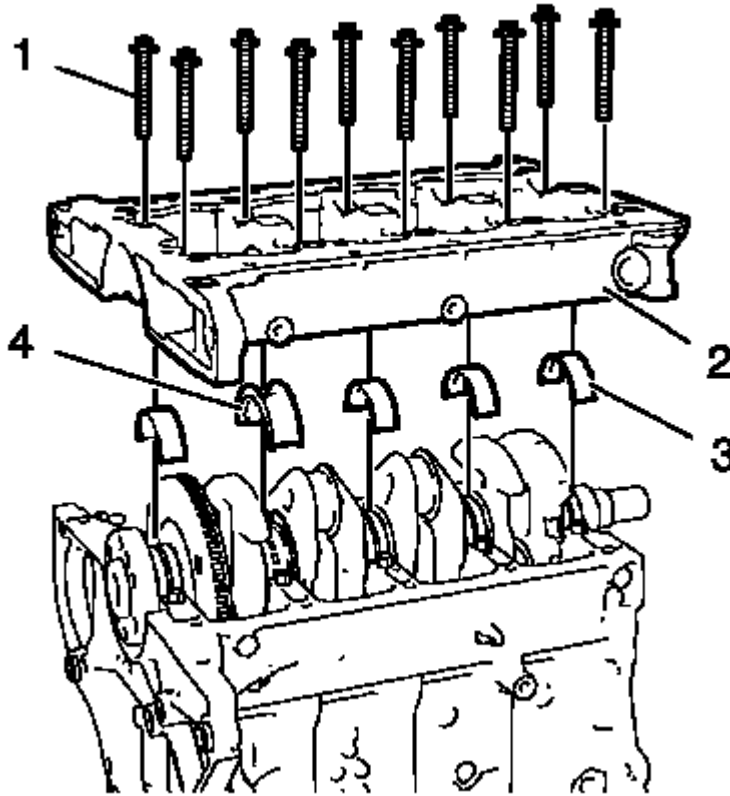




**Fig. 382: Sealing Compound Application Area**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The thickness of the sealing bead should be 2 mm (0.0787 in).

4. Apply sealing compound (1) to the outer rim of the groove on the crankshaft bearing cap tie plate. Refer to Adhesives, Fluids, Lubricants, and Sealers.



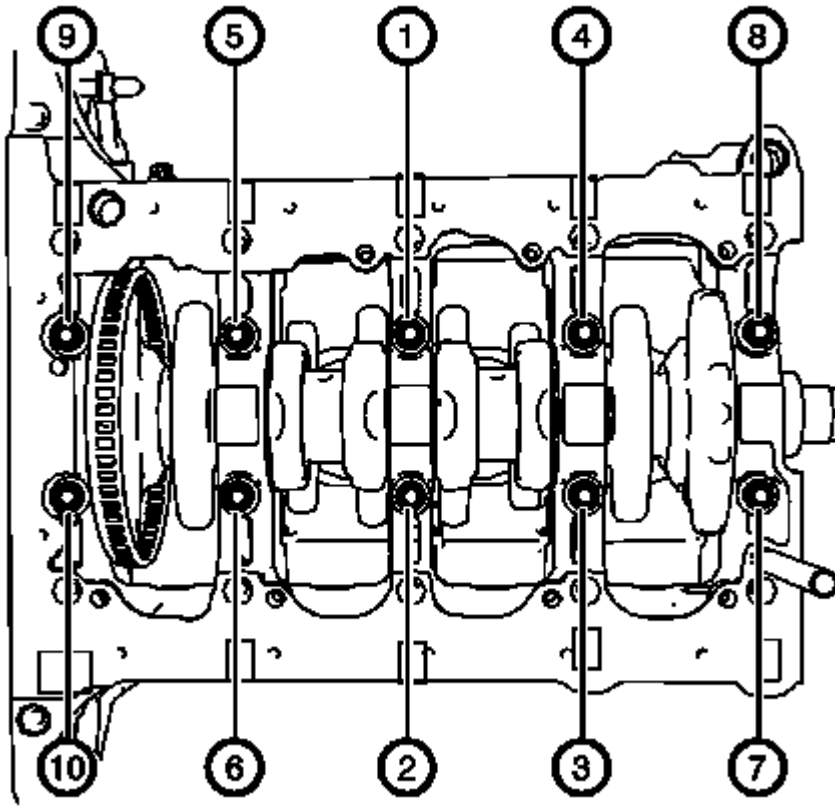
**Fig. 383: Crankshaft Bearing Cap Tie Plate**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The complete installation procedure should not take longer than 10 minutes.

5. Install the 4 lower crankshaft bearings (3) and the lower crankshaft thrust bearing (4).
6. Install the crankshaft bearing cap tie plate (2).

**NOTE:** Do not reuse the old bolts.

7. Install the 10 NEW inner crankshaft bearing cap tie plate bolts (1).

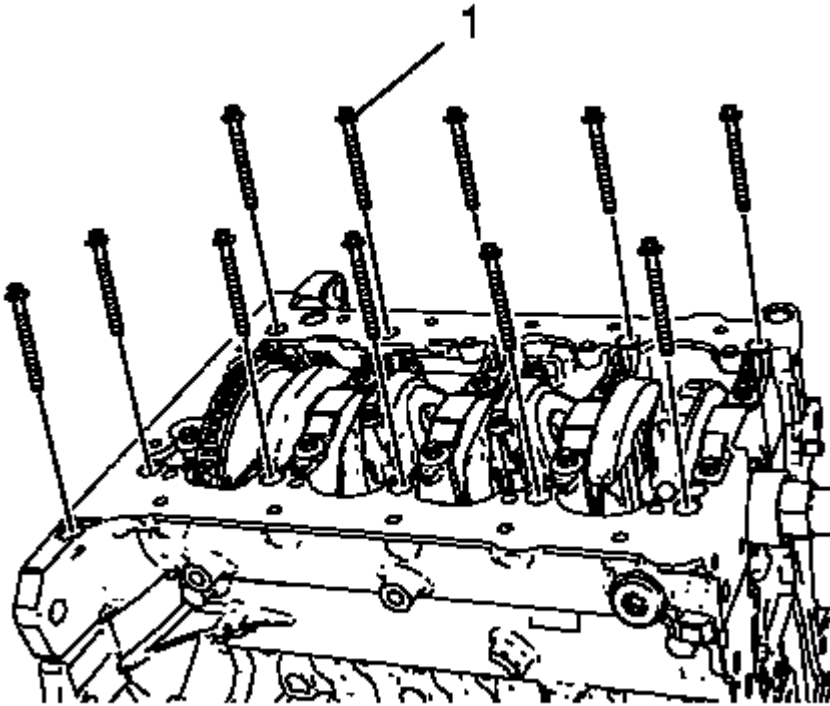


**Fig. 384: Inner Crankshaft Bearing Cap Tie Plate Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

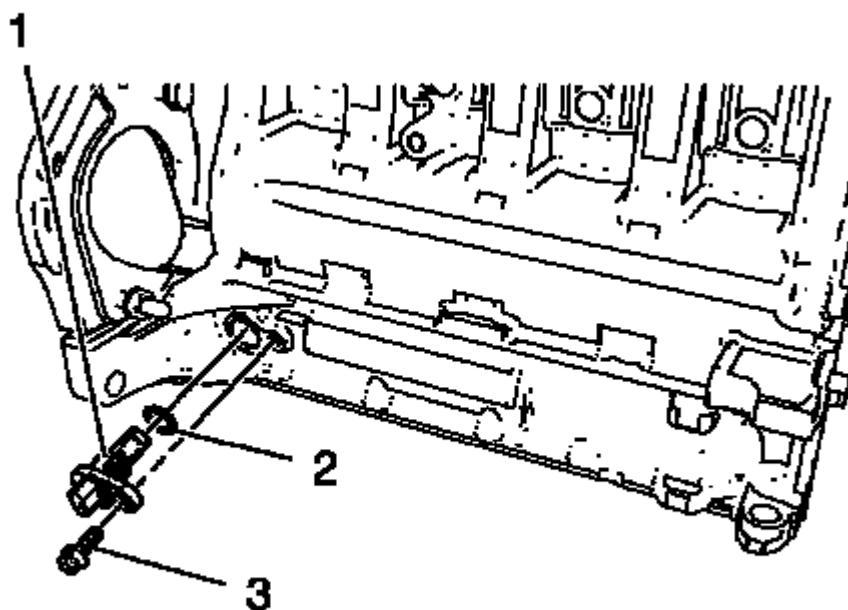
8. Tighten the 10 inner crankshaft bearing cap tie plate bolts in the sequence shown and to the following specifications:
  1. Tighten the inner crankshaft bearing cap tie plate bolts to 25 N.m (18 lb ft).
  2. Tighten the inner crankshaft bearing cap tie plate bolts an additional 60 degrees. Use **EN-470-B** wrench.
  3. Tighten the inner crankshaft bearing cap tie plate bolts an additional 15 degrees. Use **EN-470-B** wrench.



**Fig. 385: Outer Crankshaft Bearing Cap Tie Plate Bolts**  
Courtesy of GENERAL MOTORS COMPANY

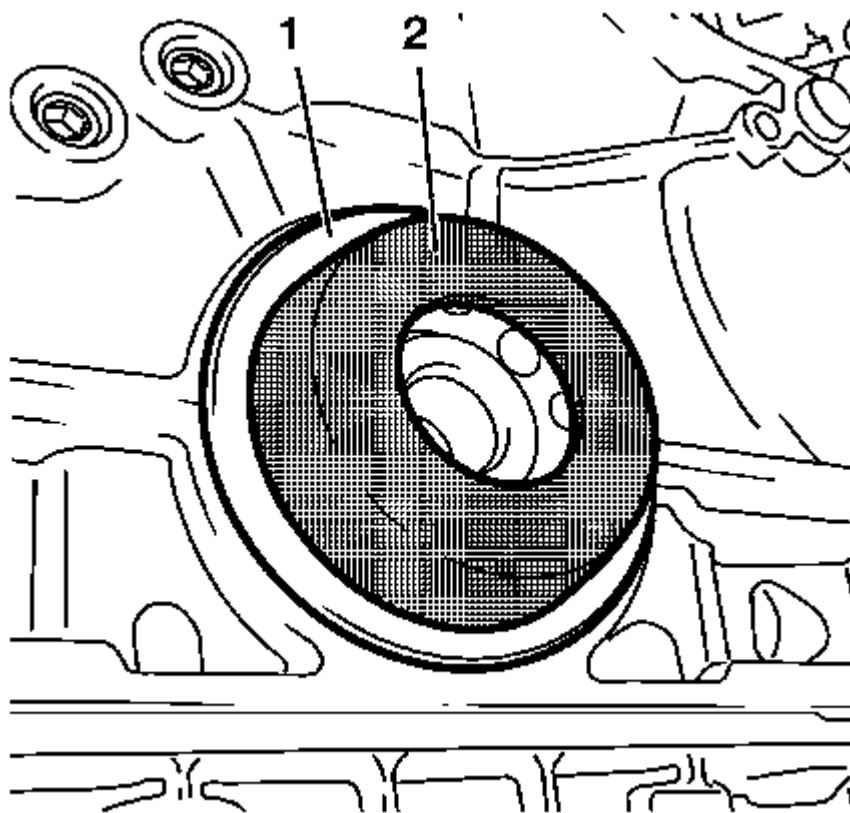
**NOTE:** Do not reuse the old bolts.

9. Install the 12 NEW outer crankshaft bearing cap tie plate bolts (1) and tighten to the following specification:
  1. Tighten the outer crankshaft bearing cap tie plate bolts to 10 N.m (89 lb in).
  2. Tighten the outer crankshaft bearing cap tie plate bolts an additional 60 degrees. Use **EN-470-B** wrench.
  3. Tighten the outer crankshaft bearing cap tie plate bolts an additional 15 degrees. Use **EN-470-B** wrench.



**Fig. 386: Crankshaft Position Sensor, Bolt And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

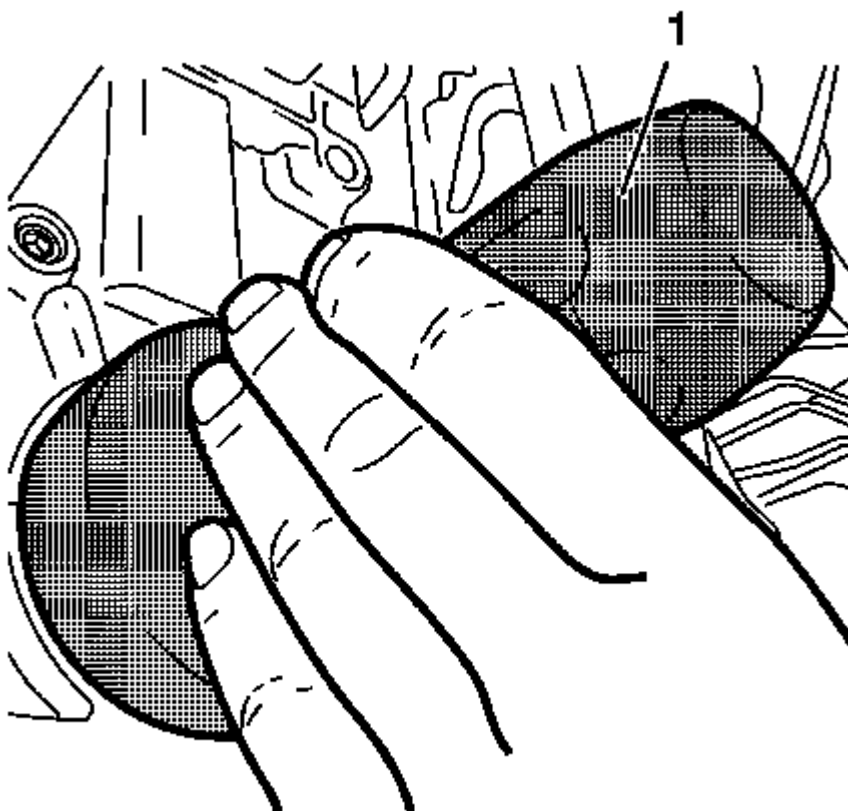
10. Install the crankshaft position sensor (1) and a NEW crankshaft position sensor seal ring (2).
11. Install the crankshaft position sensor bolt (3) and tighten to 8 N.m (71 lb in).



**Fig. 387: Crankshaft Rear Oil Seal And Installer**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Lubricate the crankshaft rear oil seal.

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



**Fig. 388: Installer Tool**

Courtesy of GENERAL MOTORS COMPANY

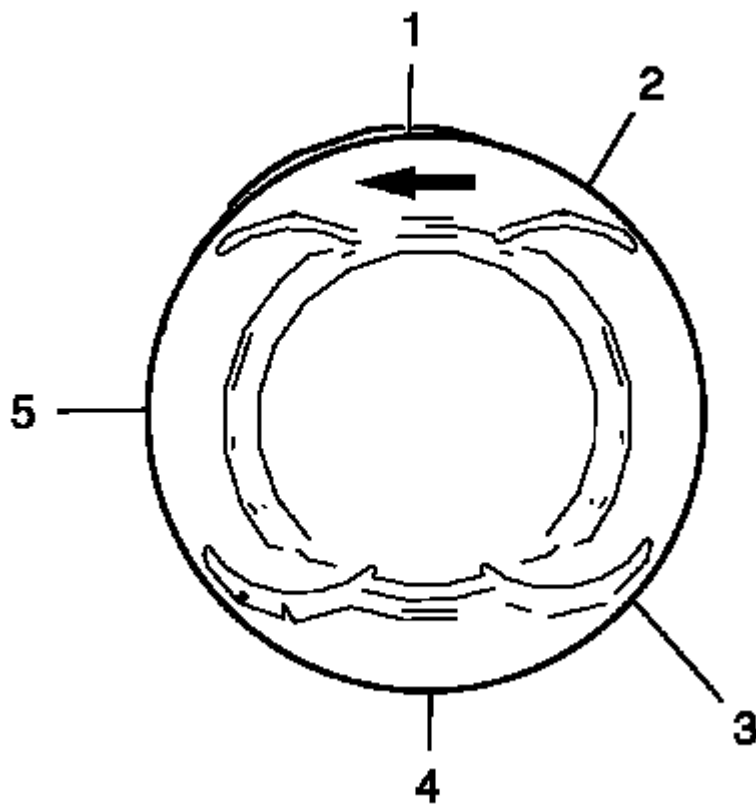
13. Use EN-658-1 installer (1) to strike the crankshaft rear oil seal.

## PISTON, CONNECTING ROD, AND BEARING INSTALLATION

### Special Tools

EN-470-B Angular Torque Wrench

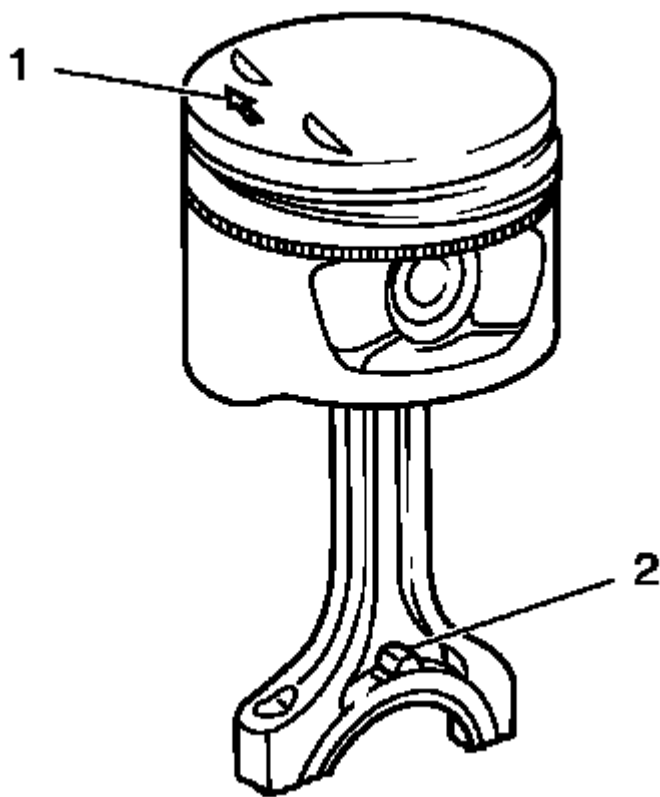
For equivalent regional tools, refer to **Special Tools**.



**Fig. 389: Piston Ring Joint Adjustment Points**  
Courtesy of GENERAL MOTORS COMPANY

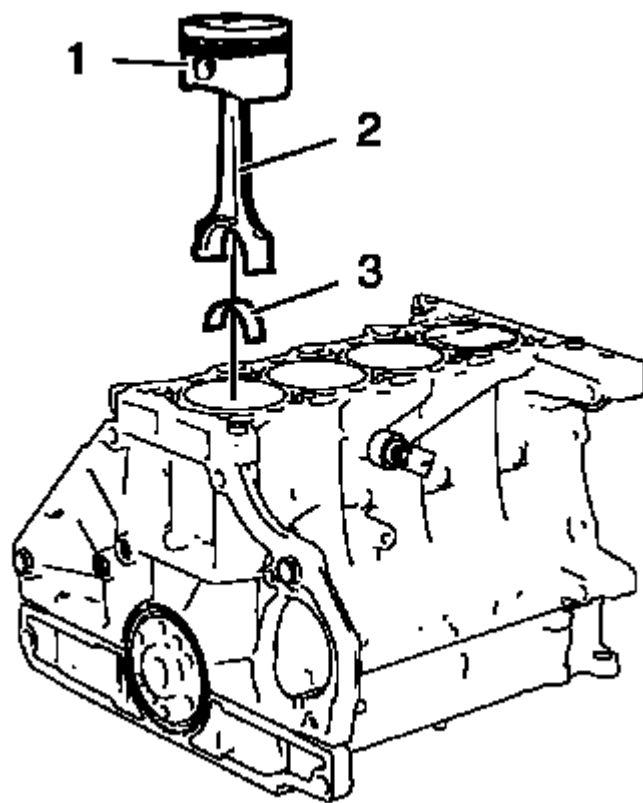
1. Adjust the piston ring joints as follows:
  1. Upper compression ring (1).
  2. Lower compression ring (4).
  3. Oil rings (2) or (3).
  4. Oil ring spacer (5).





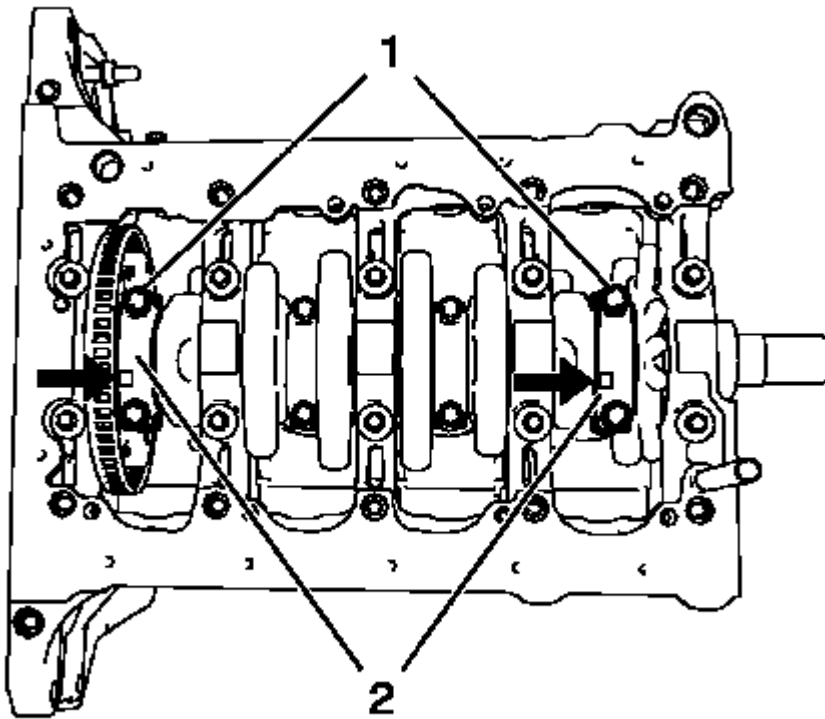
**Fig. 390: Connecting Rods And Arrow On Piston Head**  
Courtesy of GENERAL MOTORS COMPANY

2. The arrow (1) on the piston head must point to the timing side.
3. The markings on the connecting rods (2) must point to the transmission side.



**Fig. 391: Pistons, Connecting Rods And Bearings**  
**Courtesy of GENERAL MOTORS COMPANY**

4. Install a piston ring compressor to compress the piston rings.
5. Install the pistons (1) in along with connecting rods (2) and upper connecting rod bearings (3) to the engine block and to the crankshaft.



**Fig. 392: Connecting Rod Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The flarings (arrows) on the connecting rod bearing caps must point to the transmission side. The connecting rod bearing caps must be installed in their original position.

6. Install the 2 connecting rod bearings and the 2 connecting rod bearing caps (2) of cylinder 1 and 4.

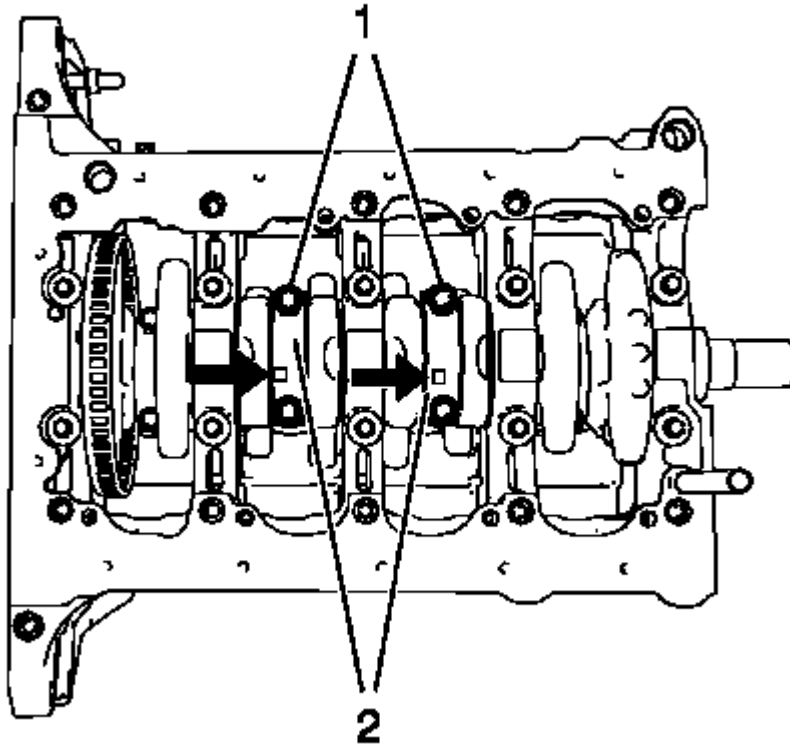
**CAUTION:** Refer to Fastener Caution .

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

**NOTE:** Do not reuse the old bolts.

7. Install the 4 NEW connecting rod bearing cap bolts (1) and tighten in the following sequence:
  1. Tighten the connecting rod bearing cap bolts to 25 N.m (18 lb ft).
  2. Tighten the connecting rod bearing cap bolts an additional 45 degrees. Use **EN-470 B** wrench.

8. Rotate the crankshaft 180 degrees.



**Fig. 393: Connecting Rod Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The flarings (arrows) on the connecting rod bearing caps must point to the transmission side. The connecting rod bearing caps must be installed in their original position.

9. Install the 2 connecting rod bearings and the 2 connecting rod bearing caps (2) of cylinder 3 and 2.

**NOTE:** Do not reuse the old bolts.

10. Install the 4 NEW connecting rod bearing cap bolts (1) and tighten in the following sequence:
  1. Tighten the connecting rod bearing cap bolts to 25 N.m (18 lb ft).
  2. Tighten the connecting rod bearing cap bolts an additional 45 degrees. Use **EN-470-B** wrench.

## CYLINDER HEAD INSTALLATION

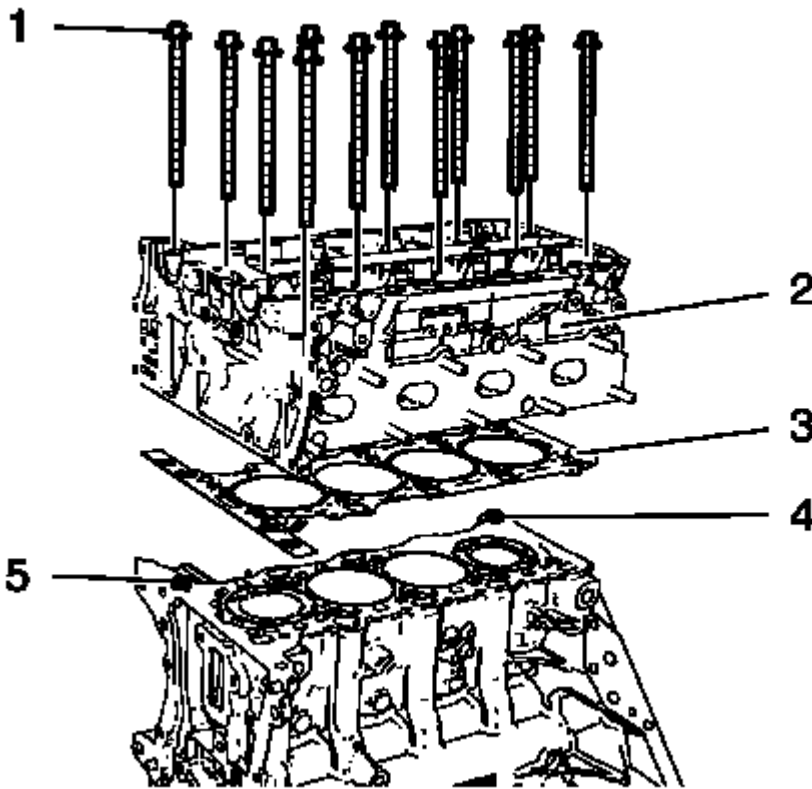
### Special Tools

**EN-470-B** Angular Torque Wrench.

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

**WARNING:** Wear safety glasses when using compressed air in order to prevent eye injury.

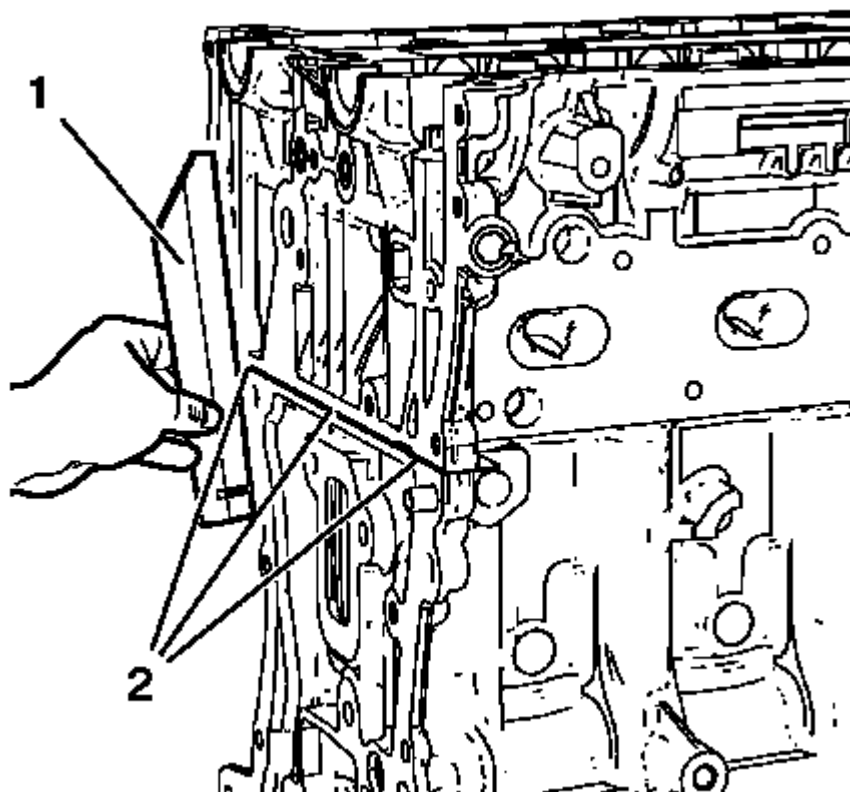
1. Clean the sealing surfaces and remove dirt and old gasket material from thread bores, water galleries and oil galleries.



**Fig. 394: Cylinder Head, Gasket, Bolts And Guide Sleeves**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the guide sleeves (4) and (5).

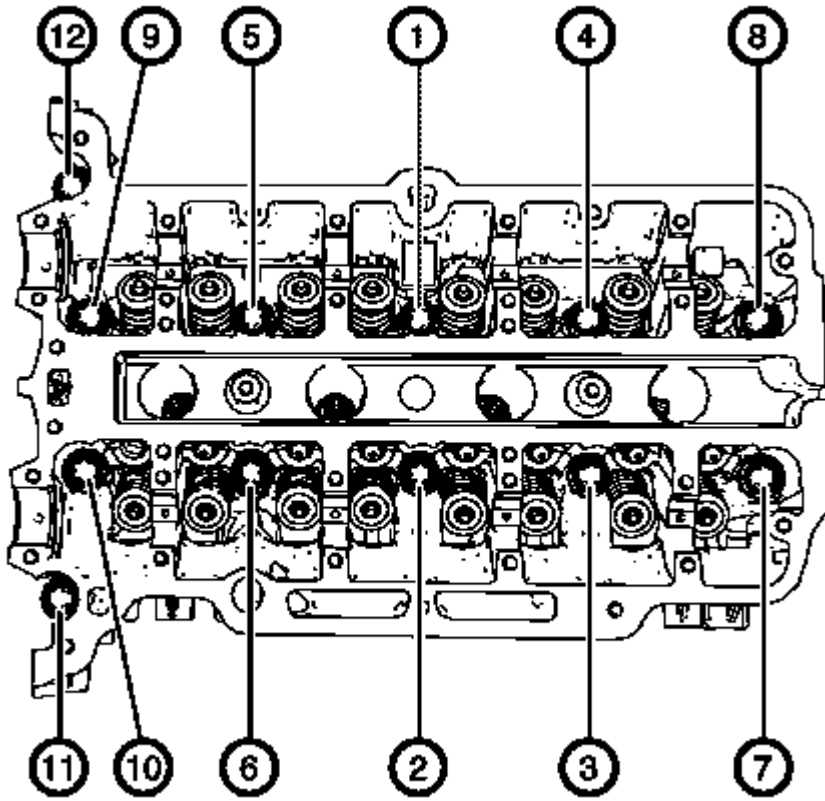
2. Install a NEW cylinder head gasket (3). The marking "Top" should point to the cylinder head.
3. Install the cylinder head (2).
4. Install 12 NEW cylinder head bolts (1) and hand tighten.



**Fig. 395: Straight Edge Tool**

Courtesy of GENERAL MOTORS COMPANY

5. Lay a straight edge (1) against the engine block and cylinder head. Adjust the transition in area (2) until there is no clearance between cylinder head and straight edge, using a rubber mallet.



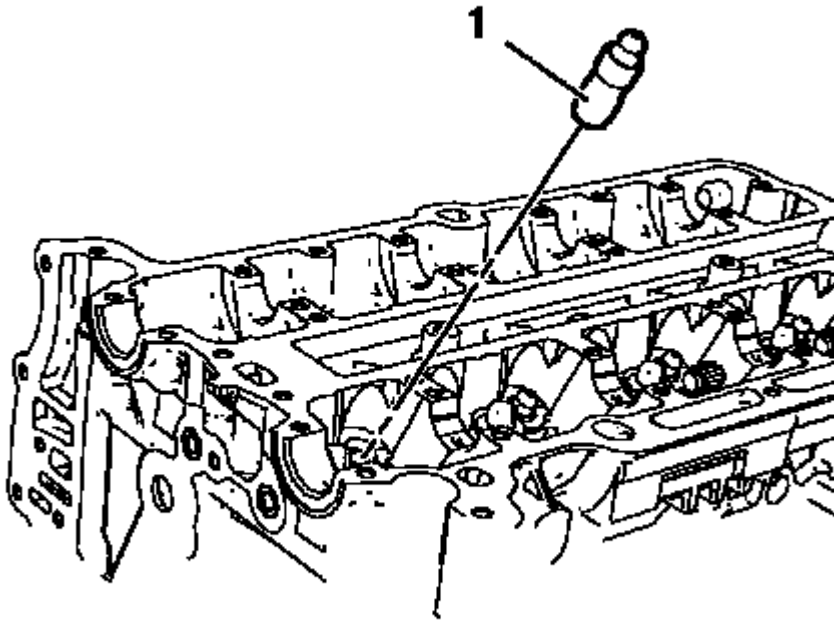
**Fig. 396: Cylinder Head Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution

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

6. Tighten the cylinder head bolts in the sequence shown and to the following specifications:
  1. Tighten the cylinder head bolts to 35 N.m (26 lb ft).
  2. Tighten the cylinder head bolts an additional 180 degrees. Use **EN-470-B** wrench.

#### HYDRAULIC VALVE LASH ADJUSTER INSTALLATION



**Fig. 397: Hydraulic Valve Lash Adjusters**

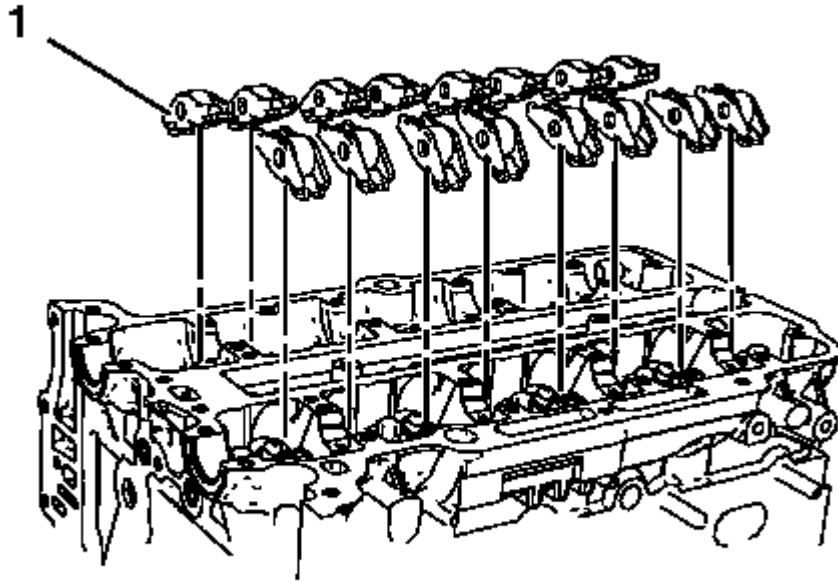
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the installation position of the hydraulic valve lash adjusters.

1. Lubricate the hydraulic valve lash adjusters with engine oil.
2. Install the 16 hydraulic valve lash adjusters (1).

#### HYDRAULIC VALVE LASH ADJUSTER ARM INSTALLATION



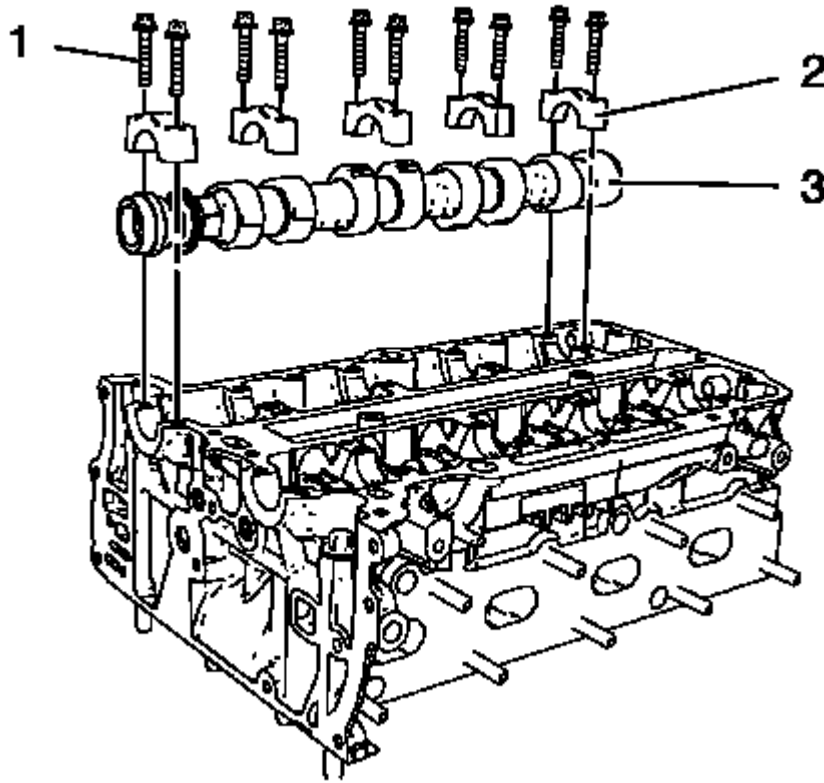


**Fig. 398: Hydraulic Valve Lash Adjuster Arms**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Hydraulic valve lash adjuster arms should be installed in their original position.

1. Lubricate the hydraulic valve lash adjuster arms with engine oil.
2. Install the 16 hydraulic valve lash adjuster arms (1).

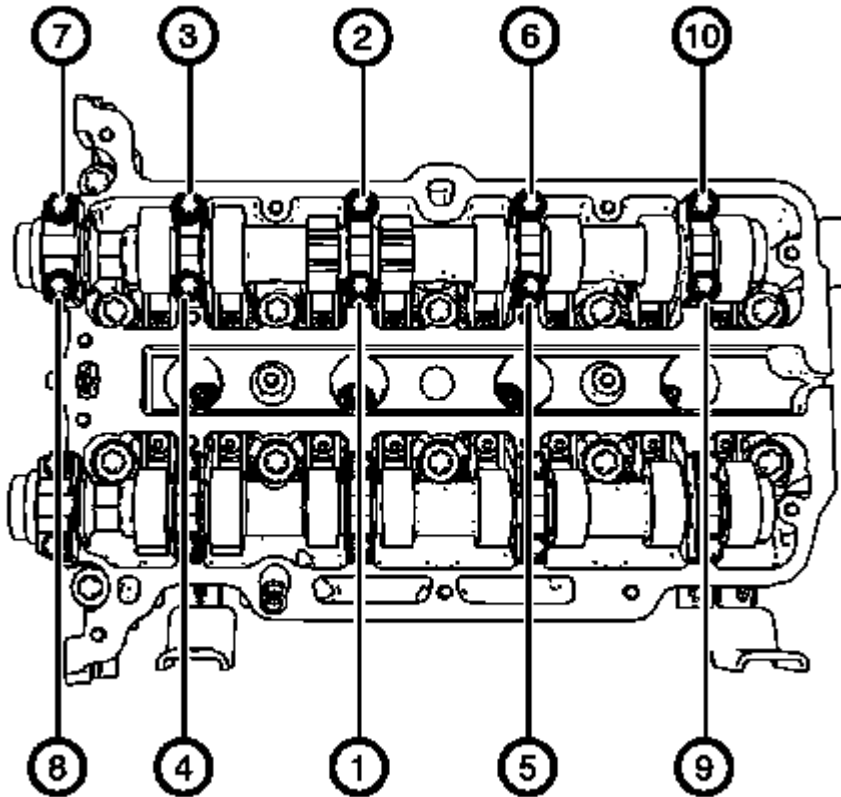
#### **INTAKE CAMSHAFT INSTALLATION**



**Fig. 399: Intake Camshaft, Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the markings on the camshaft bearing caps. Camshaft bearing caps should be installed in their original position.

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the intake camshaft (3).
3. Install the 5 camshaft bearing caps (2).
4. Install the 10 camshaft bearing cap bolts (1) and hand tighten.



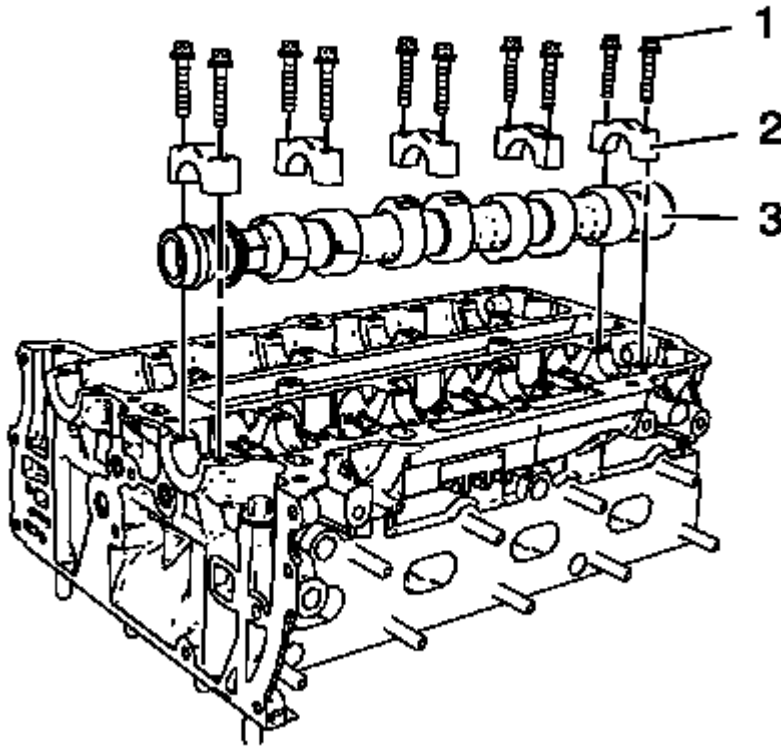
**Fig. 400: Intake Camshaft Bearing Cap Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

**NOTE:** Tighten the camshaft bearing cap bolts one turn at a time in order to avoid shape distortion of the camshaft.

5. Tighten the camshaft bearing cap bolts one turn at a time and in a spiral sequence as shown to 8 N.m (71 lb in).

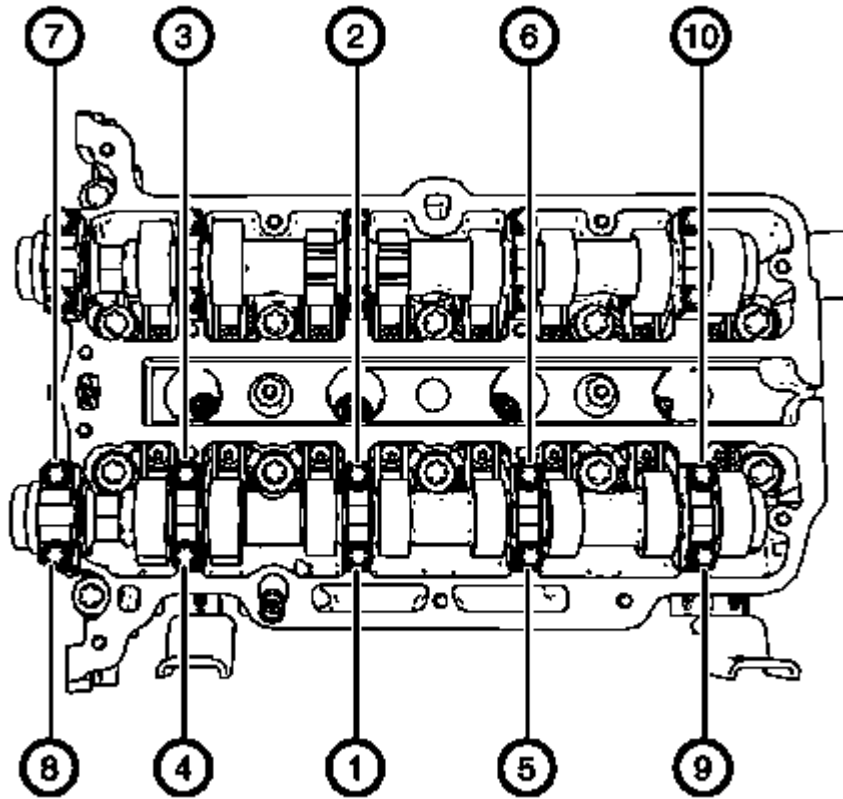
#### EXHAUST CAMSHAFT INSTALLATION



**Fig. 401: Exhaust Camshaft, Camshaft Bearing Caps And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the markings on the camshaft bearing caps. Camshaft bearing caps should be installed in their original position.

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the exhaust camshaft (3).
3. Install the 5 camshaft bearing caps (2).
4. Install the 10 camshaft bearing cap bolts (1) and hand tighten.



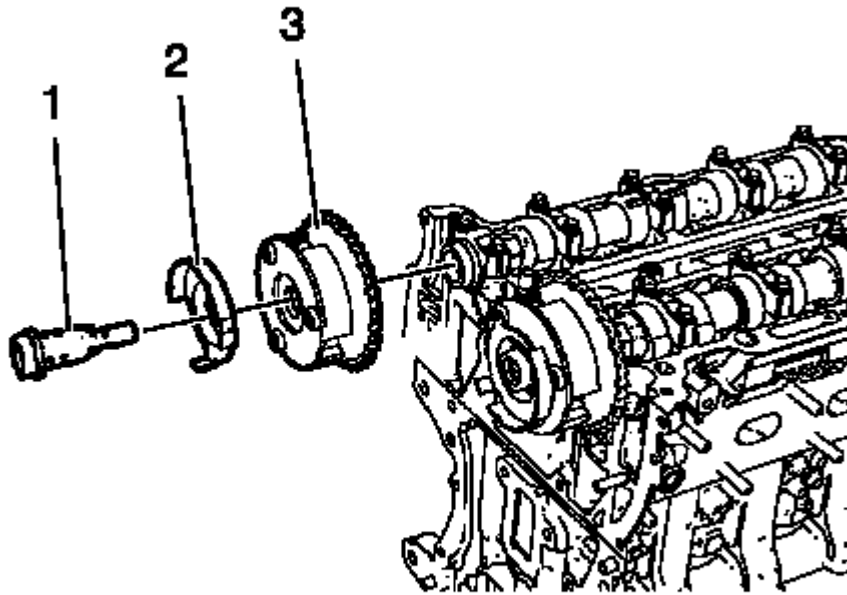
**Fig. 402: Exhaust Camshaft Bearing Cap Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

**NOTE:** Tighten the camshaft bearing cap bolts one turn at a time in order to avoid shape distortion of the camshaft.

5. Tighten the camshaft bearing cap bolts one turn at a time and in a spiral sequence as shown to 8 N.m (71 lb in).

#### CAMSHAFT SPROCKET INSTALLATION



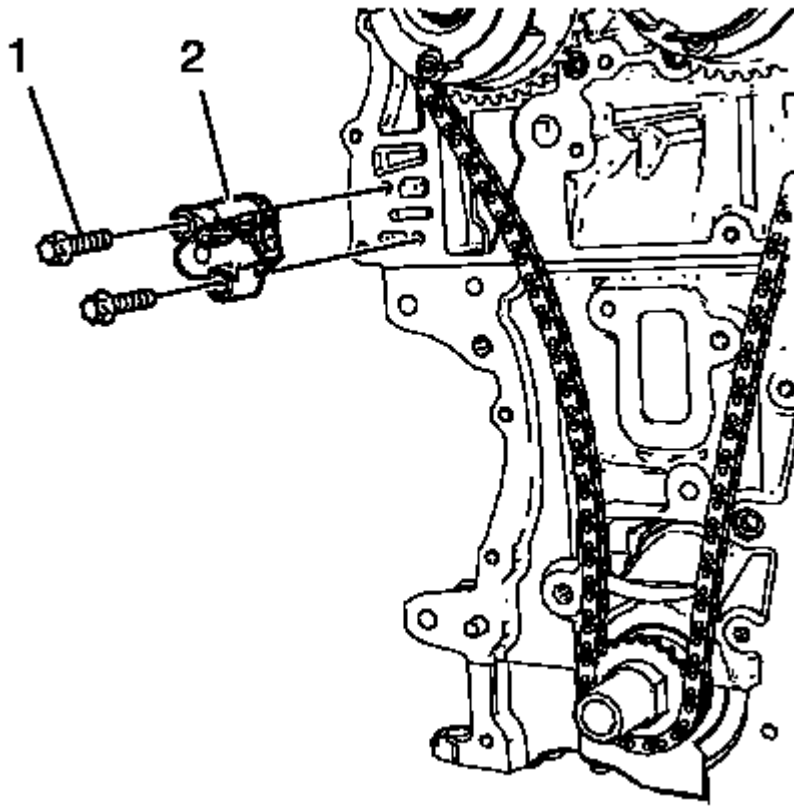
**Fig. 403: Intake Camshaft Sprocket, Bolt And Intake Camshaft Position Exciter Wheel**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft sprocket (3).
2. Install the intake camshaft position sensor exciter wheel (2) and the intake camshaft sprocket bolt (1), but do not tighten yet.
3. Install the exhaust camshaft sprocket.

**NOTE:** Tightening of camshaft sprocket bolts will be done after the engine front cover installation.

4. Install the exhaust camshaft position sensor exciter wheel and the exhaust camshaft sprocket bolt, but do not tighten yet.

#### TIMING CHAIN TENSIONER INSTALLATION



**Fig. 404: Timing Chain Tensioner And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

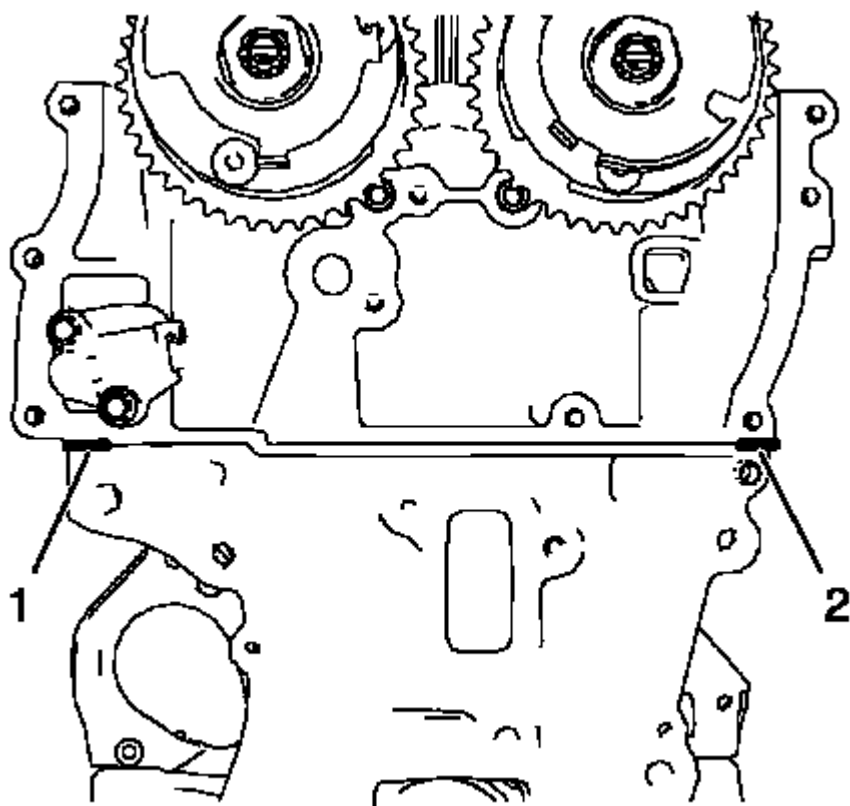
1. Install the timing chain tensioner (2).

**CAUTION:** Refer to Fastener Caution .

2. Install the 2 timing chain tensioner bolts (1) and tighten to 8 N.m (71 lb in).

#### **ENGINE FRONT COVER GASKET INSTALLATION**

1. Clean the sealing surfaces and remove all remains of old sealing compound material.

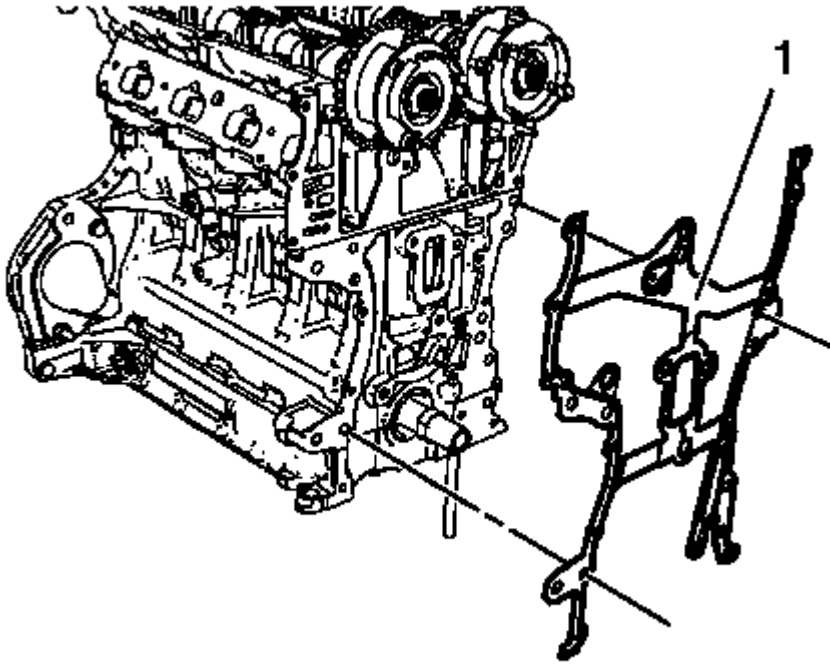


**Fig. 405: Sealing Compound Application Areas**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The thickness of the sealing bead should be 2 mm (0.0787 in).

2. Apply sealing compound to the shown areas (1) and (2). Refer to Adhesives, Fluids, Lubricants, and Sealers.





**Fig. 406: Engine Front Cover Gasket**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the guide sleeves.

3. Install the engine front cover gasket (1).
4. Install the timing chain. Refer to Camshaft Timing Chain Installation.

**NOTE:** The complete installation procedure should not take longer than 10 minutes.

5. Install the engine front cover. Refer to Engine Front Cover and Oil Pump Installation.

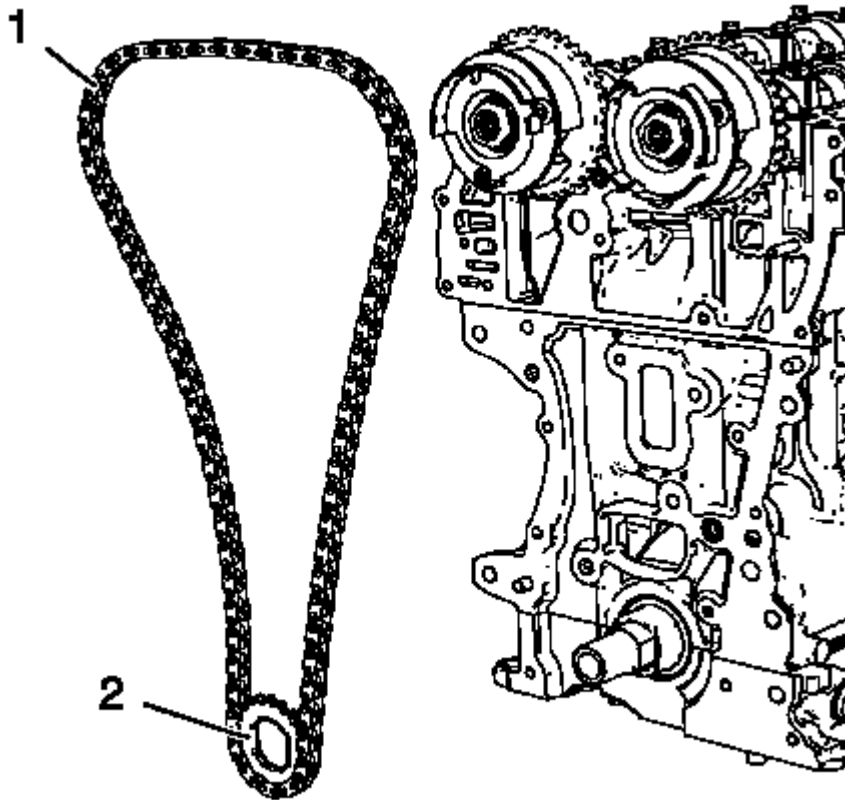
## CAMSHAFT TIMING CHAIN INSTALLATION

### Special Tools

- EN-952 Fixing Pin
- EN-953-A Fixing Tool
- EN-955-1 Fixing Pin from EN-955 Kit

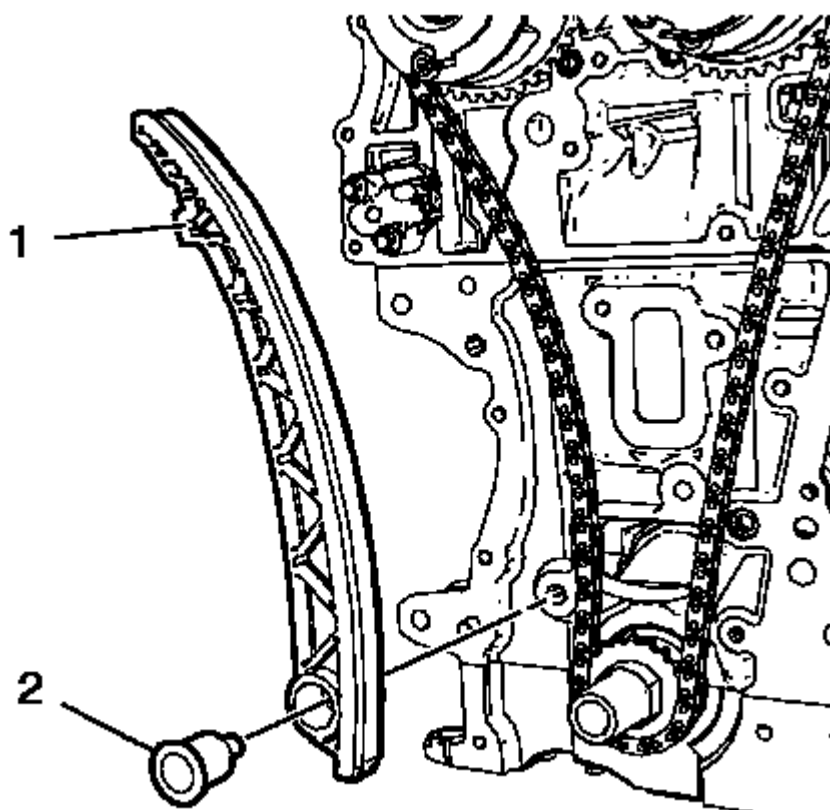
For equivalent regional tools, refer to **Special Tools**.

1. The engine should be adjusted to TDC.
2. The crankshaft should be locked with **EN-952** fixing pin.
3. The camshaft should be locked with **EN-953-A** fixing tool.



**Fig. 407: Timing Chain And Crankshaft Sprocket**  
Courtesy of GENERAL MOTORS COMPANY

4. Install the timing chain (1) along with the crankshaft sprocket (2).

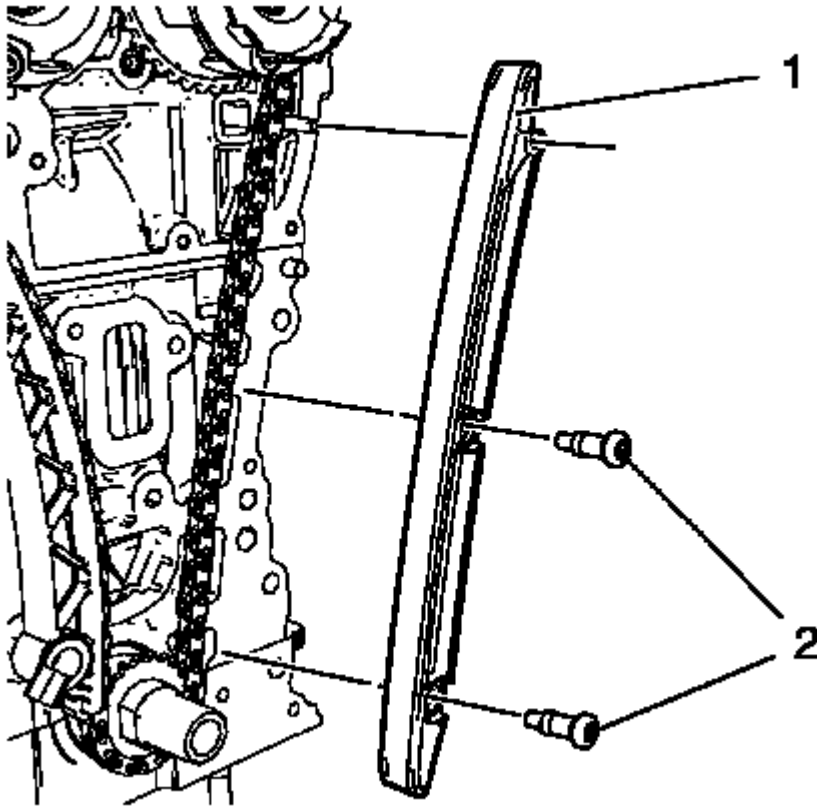


**Fig. 408: Timing Chain Tensioner Shoe And Bolt**  
Courtesy of GENERAL MOTORS COMPANY

5. Install the timing chain tensioner shoe (1).

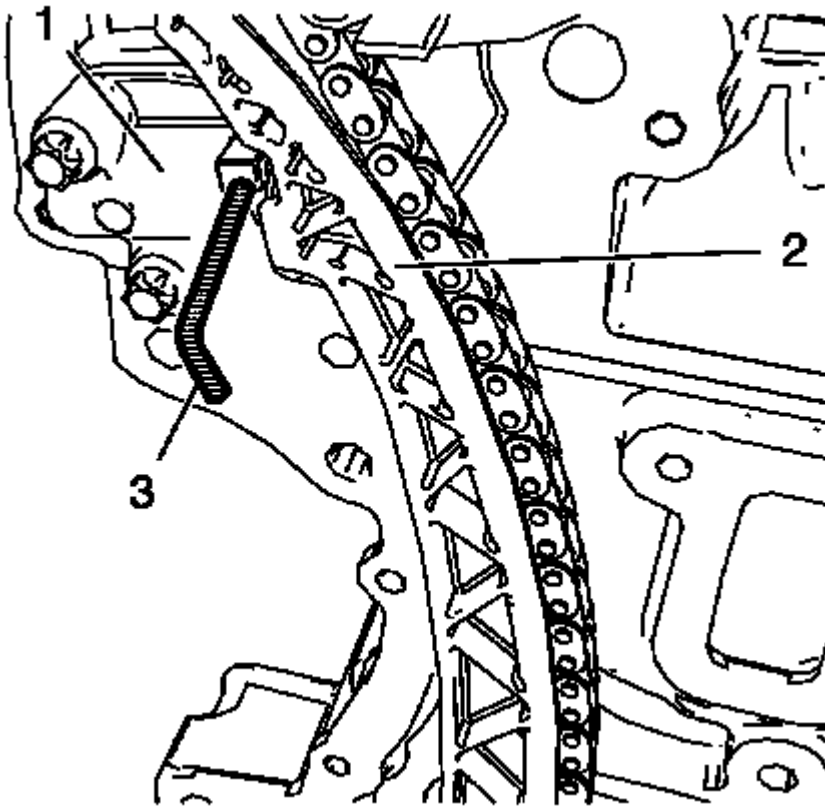
**CAUTION:** Refer to Fastener Caution .

6. Install the timing chain tensioner shoe bolt (2) and tighten to 20 N.m (15 lb ft).



**Fig. 409: Timing Chain Guide Right Side**  
Courtesy of GENERAL MOTORS COMPANY

7. Install the timing chain guide right side (1).
8. Install the 2 timing chain guide right side bolts (2) and tighten to 8 N.m (71 lb in).



**Fig. 410: Timing Chain And Timing Chain Tensioner**  
Courtesy of GENERAL MOTORS COMPANY

9. Push the timing chain (2) in direction to the timing chain tensioner (1) and Remove **EN-955-1** fixing pin (3).

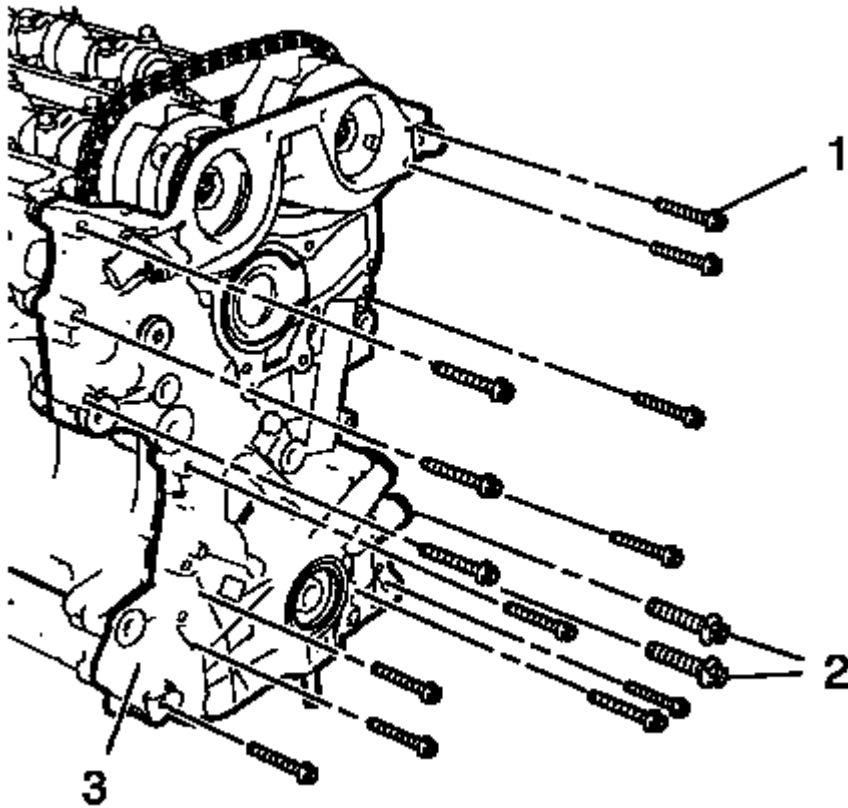
The upper timing chain guide will be installed after the installation of the engine front cover and the fastening of the camshaft sprockets.

## ENGINE FRONT COVER AND OIL PUMP INSTALLATION

### Special Tools

- **EN-952** Fixing Pin
- **EN-953-A** Fixing Tool
- **EN-49977-100** Transmitter Disc Fixation
- **EN-49977-200** Fixing Tool

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



**Fig. 411: M6, M10 Front Cover Bolts And Engine Front Cover**  
Courtesy of GENERAL MOTORS COMPANY

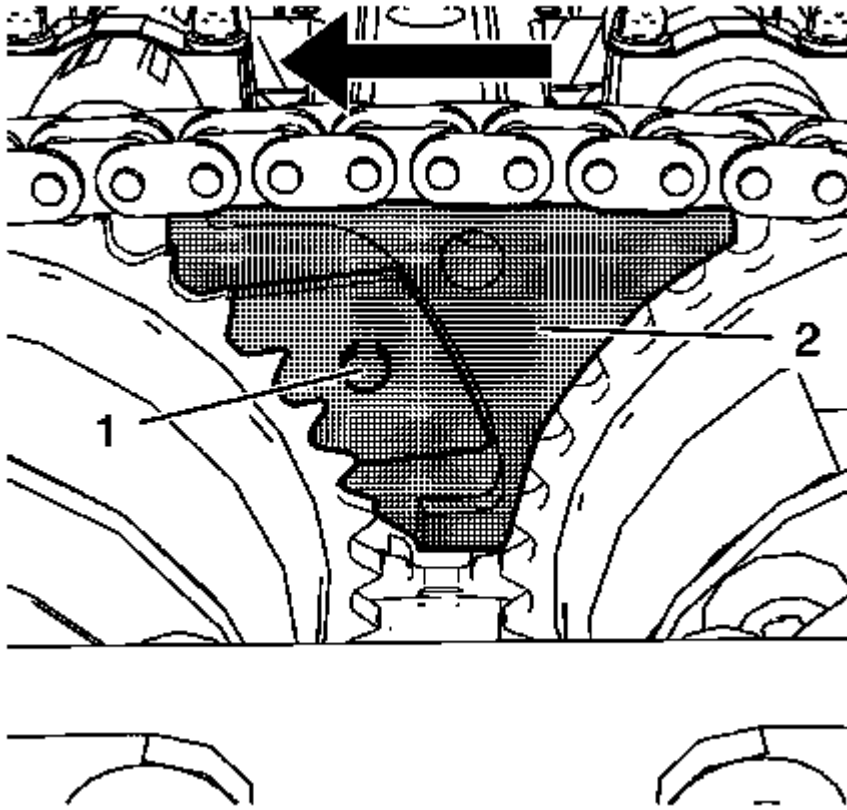
**NOTE:** Mind the guide sleeves when installing engine front cover.

1. Install the engine front cover (3).
2. Install the 13 engine front cover bolts M6 (1).
3. Install the 2 engine front cover bolts M10 (2).

**CAUTION:** Refer to Fastener Caution .

4. Tighten the 13 engine front cover bolts M6 to 8 N.m (71 lb in).
5. Tighten the 2 engine front cover bolts M10 to 35 N.m (26 lb ft).

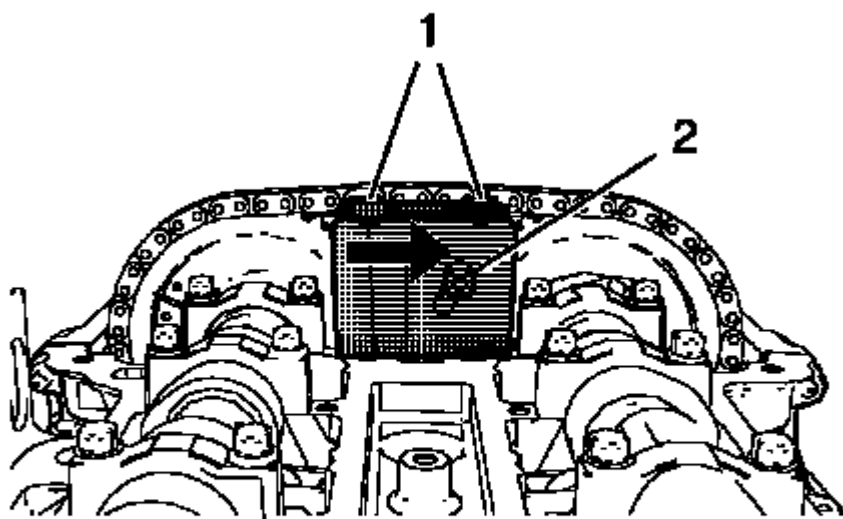
#### Camshaft Sprocket Fastening



**Fig. 412: Intake Camshaft Sprocket Gearing And Special Tool**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Push the fixing tool in the direction of the arrow to ensure it fully engages.

1. Install **EN-49977-200** fixing tool (2) and ensure that the gearing of the fixing tool engages with the intake camshaft sprocket gearing (1).

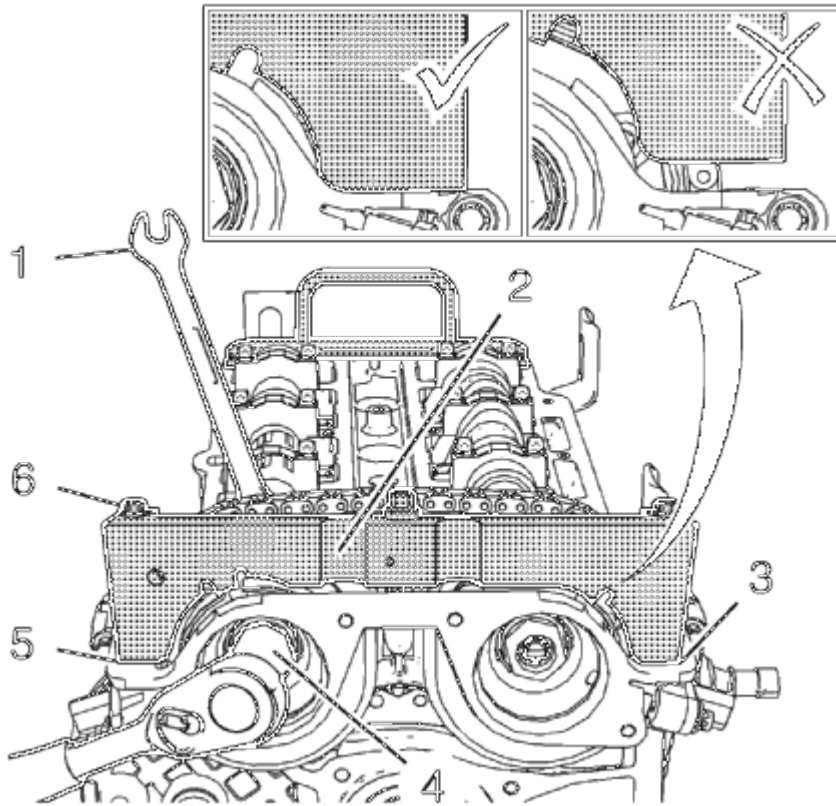


**Fig. 413: Adjuster Bolt And Fastening Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

2. Tighten the 2 fastening bolts (1) of **EN-49977-200** fixing tool while pushing the fixing tool in direction of the arrow.
3. Tighten the adjuster bolt (2).





**Fig. 414: Fastening Bolts And Fixation Tool**  
 Courtesy of GENERAL MOTORS COMPANY

**NOTE:** A wrong installation position is possible. Make sure that the holding tool is fully installed to the cylinder head in areas (3) and (5).

4. Install EN-49977-100 transmitter disc holder (2) to find and hold the correct position of the camshaft position exciter wheels.
5. Tighten the fastening bolts (6) of EN-49977-100 transmitter disc holder.

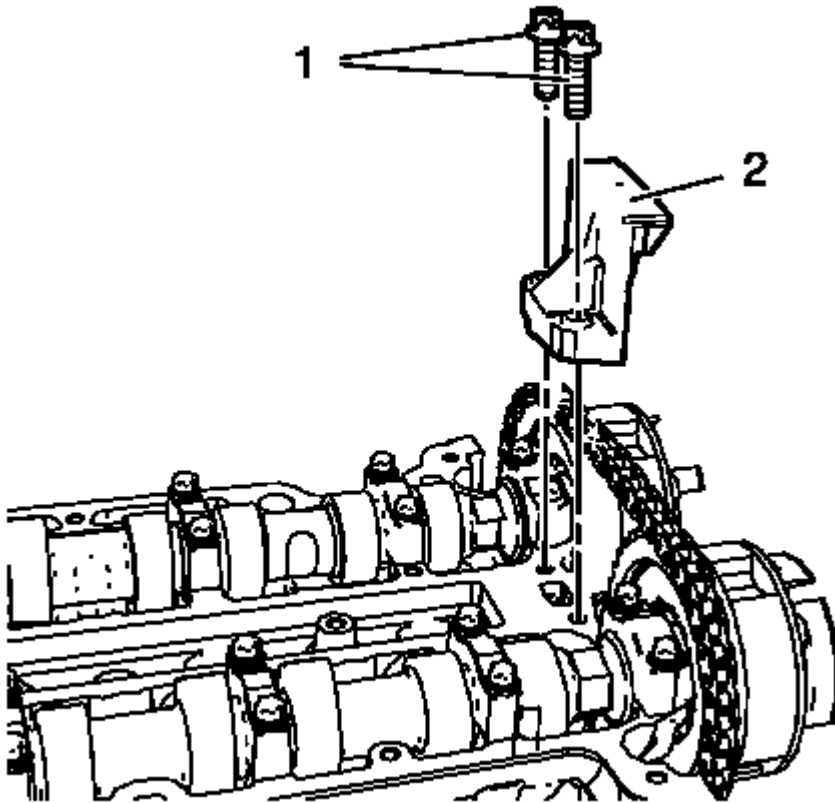
**CAUTION:** Refer to Fastener Caution .

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

6. Tighten the NEW intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to 50 N.m (37 lb ft).
7. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to an additional 60 degrees.

8. Tighten the NEW exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to 50 N.m (37 lb ft).
9. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to an additional 60 degrees.
10. Remove **EN-49977-100** transmitter disc holder and **EN-49977-200** fixing tool.

### Upper Timing Chain Guide Installation



**Fig. 415: Upper Timing Chain Guide And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the upper timing chain guide (2).
2. Install the 2 upper timing chain guide bolts (1) and tighten to 8 N.m (71 lb in).
3. Remove **EN-953-A** fixing tool and **EN-952** fixing pin.
4. Install crankshaft bearing cap tie plate hole plug and seal ring and tighten to 40 N.m (30 lb ft).

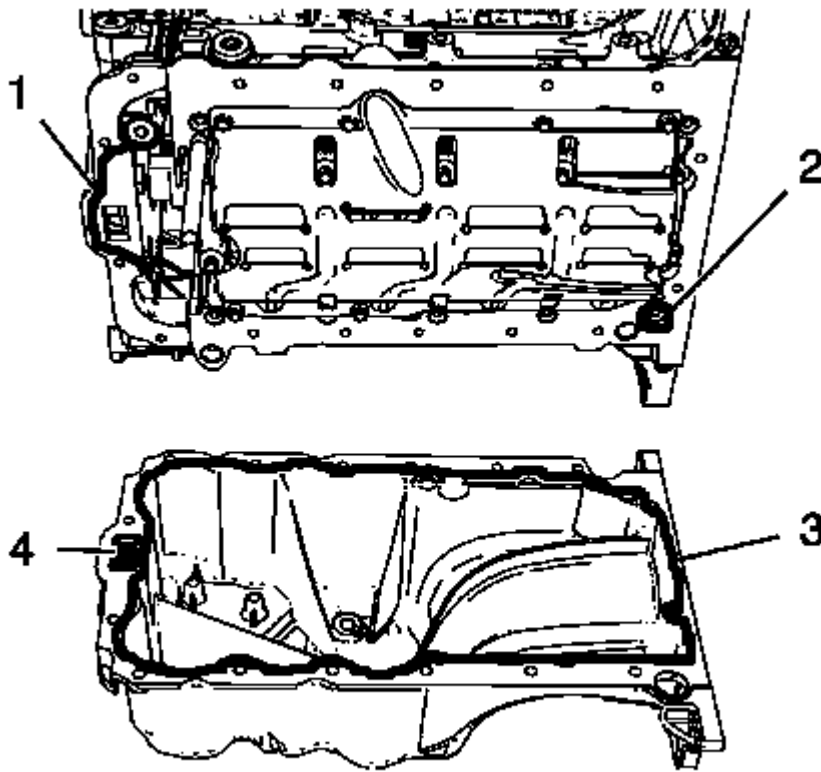
### OIL PAN INSTALLATION

#### Special Tools

**EN-49980** Guidance Pins

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

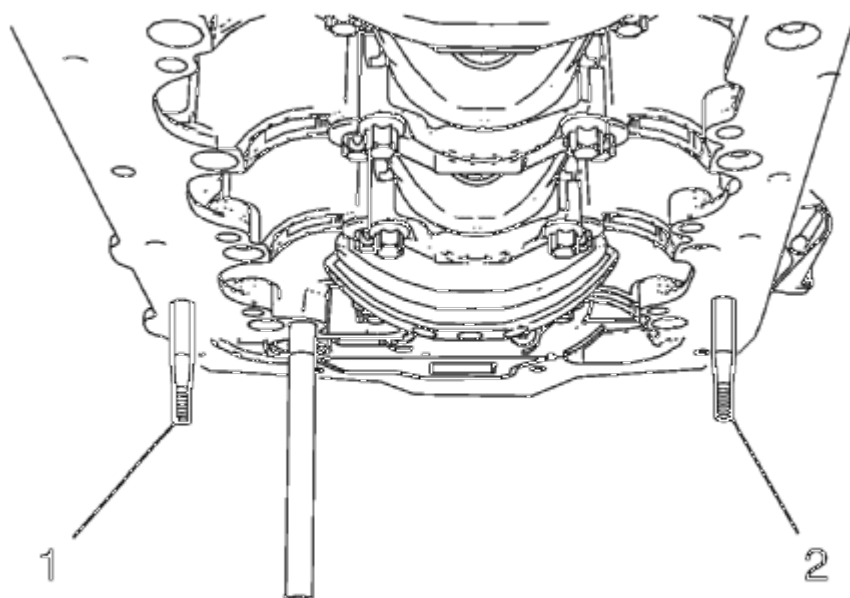
1. Clean the sealing surfaces from old sealing material, dirt, oil and grease.



**Fig. 416: Engine Front Cover, Oil Suction Gallery And Screw Bore**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The sealing bead should be applied close to the inner edge of the oil pan. Take care that the oil suction gallery (4) will not get contaminated with sealing compound or dirt. The thickness of the sealing bead (3) should be 2 mm (0.0787 in).

2. Apply sealing compound to the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Apply sealing compound to the groove of the engine front cover (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Apply sealing compound around the screw bore (2) of the crankshaft bearing cap tie plate.

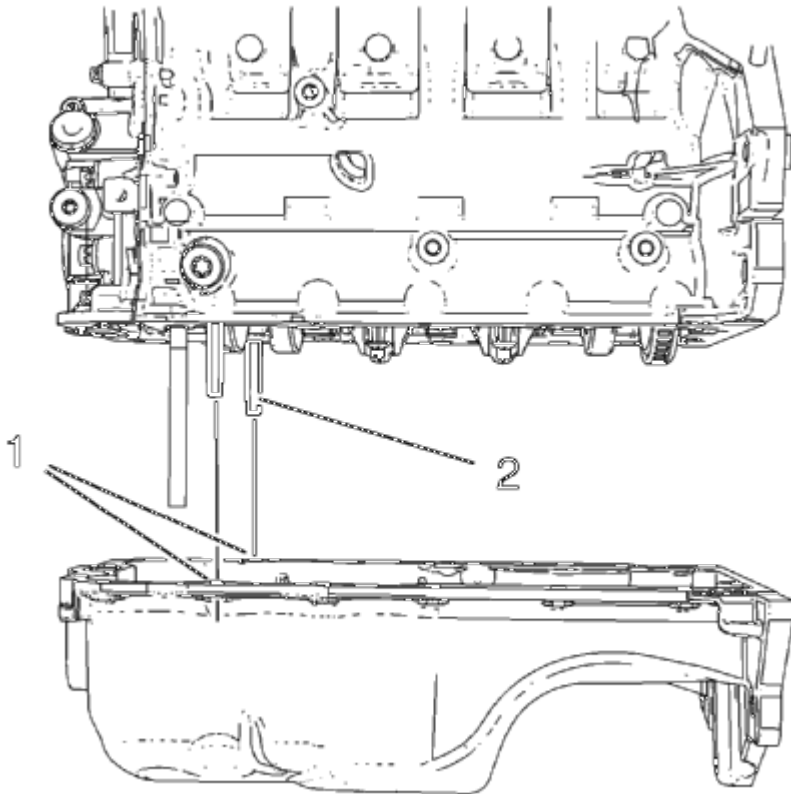


**Fig. 417: Engine Oil Pan Pins**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The complete installation procedure of the oil pan should not take longer than 10 minutes.

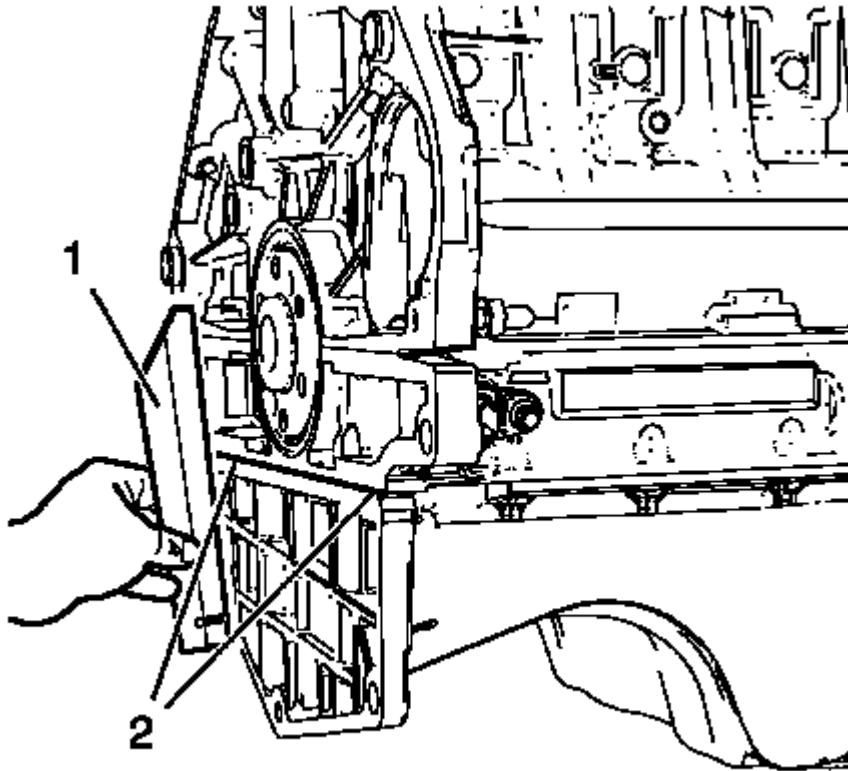
5. Install the 2 **EN-49980** pins (1) and (2) to the shown oil pan screw bores.



**Fig. 418: Engine Oil Pan Pins And Screw Bores**  
 Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Use care when installing the oil pan to prevent disruption of the sealing bead. The sealing bead should remain consistent until the oil pan is mated with the engine. An inconsistent sealing bead can cause an insufficient seal and result in engine damage.

6. Carefully install the oil pan. Guide the oil pan with **EN-49980** pins (2) and the equivalent screw bores (1).
7. Hold the oil pan with 4 oil pan bolts.
8. Remove **EN-49980** pins.
9. Install the remaining 12 oil pan bolts and hand tighten.



**Fig. 419: Straight Edge Tool**

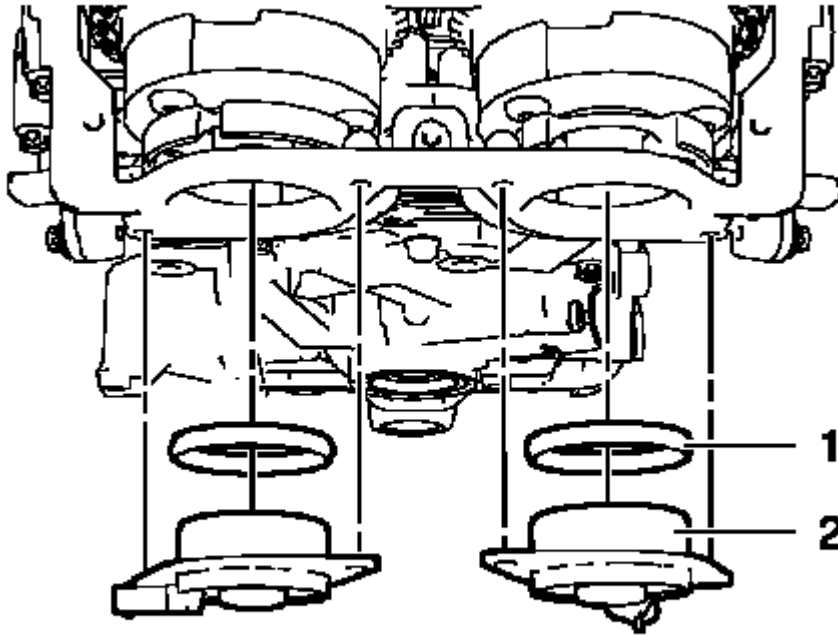
Courtesy of GENERAL MOTORS COMPANY

10. Lay a straight edge (1) against the oil pan and engine block. Using a rubber mallet, adjust the transition in area (2) until there is no clearance between oil pan and the straight edge.

**CAUTION: Refer to Fastener Caution .**

11. Tighten the 16 oil pan bolts to 10 N.m (89 lb in).

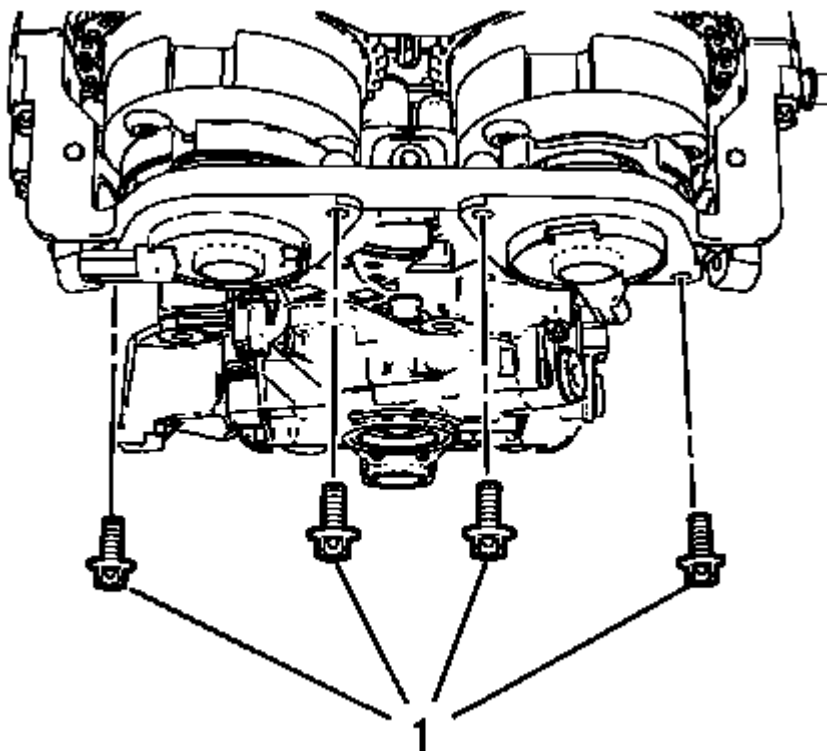
#### **CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSTALLATION**



**Fig. 420: Camshaft Position Actuator Solenoid Valves And Seal Rings**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** The camshaft position actuator solenoid valves must be kept parallel to the engine front cover during removal and installation. The camshaft position actuator solenoid valves can be damaged if they become wedged or stuck during this process.

1. Install the 2 camshaft position actuator solenoid valves (2) and the 2 seal rings (1) by carefully and evenly pressing.

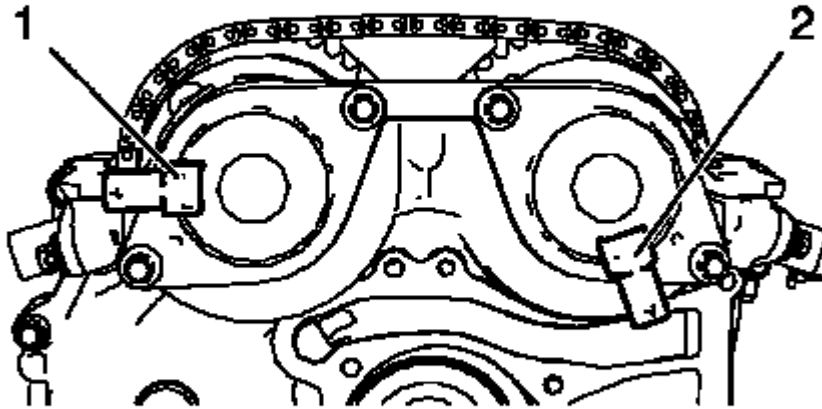


**Fig. 421: Camshaft Position Actuator Solenoid Valve Bolts**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution

2. Install the 4 camshaft position actuator solenoid valve bolts (1) and tighten to 8 N.m (71 lb in).



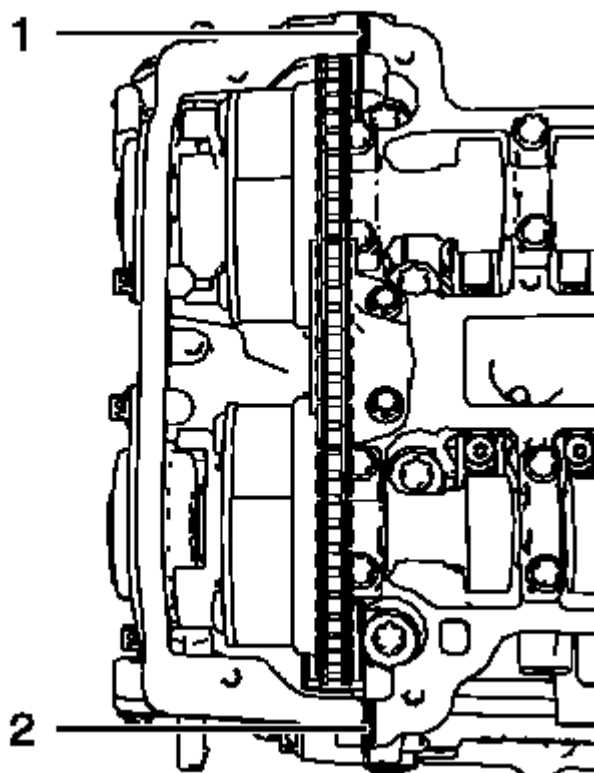


**Fig. 422: Camshaft Position Actuator Solenoid Valves Proper Position**  
Courtesy of GENERAL MOTORS COMPANY

3. The 2 camshaft position actuator solenoid valves should be installed in the position as shown (1) and (2).

### **CAMSHAFT COVER INSTALLATION**

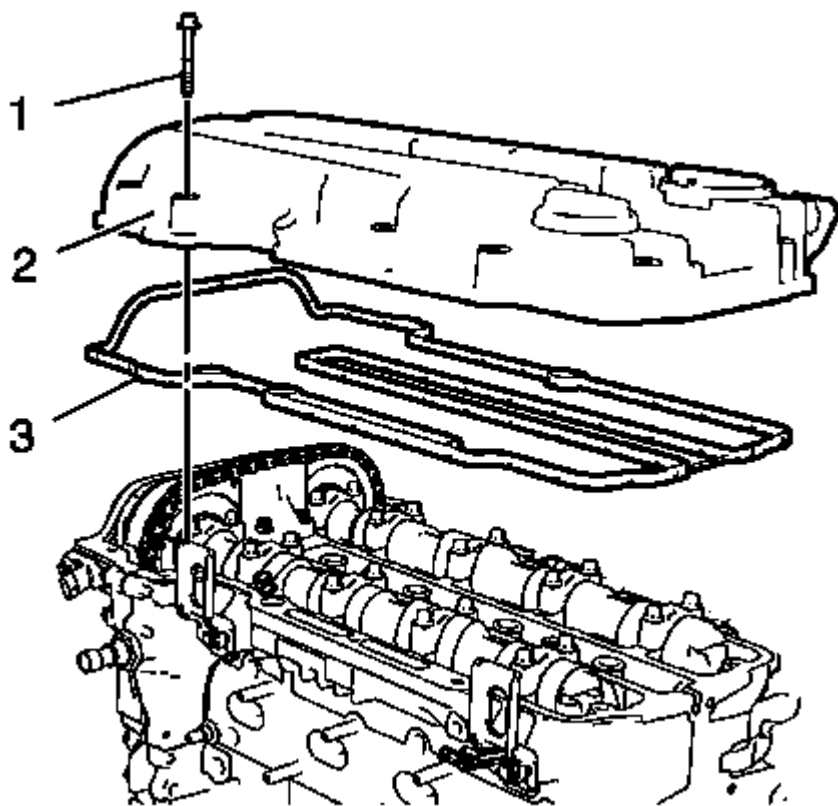
1. Clean the sealing surfaces.



**Fig. 423: Sealing Compound Application Areas**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The thickness of the sealing bead should be 2 mm (0.0787 in).

2. Apply sealing compound to areas (1) and (2). Refer to Adhesives, Fluids, Lubricants, and Sealers.

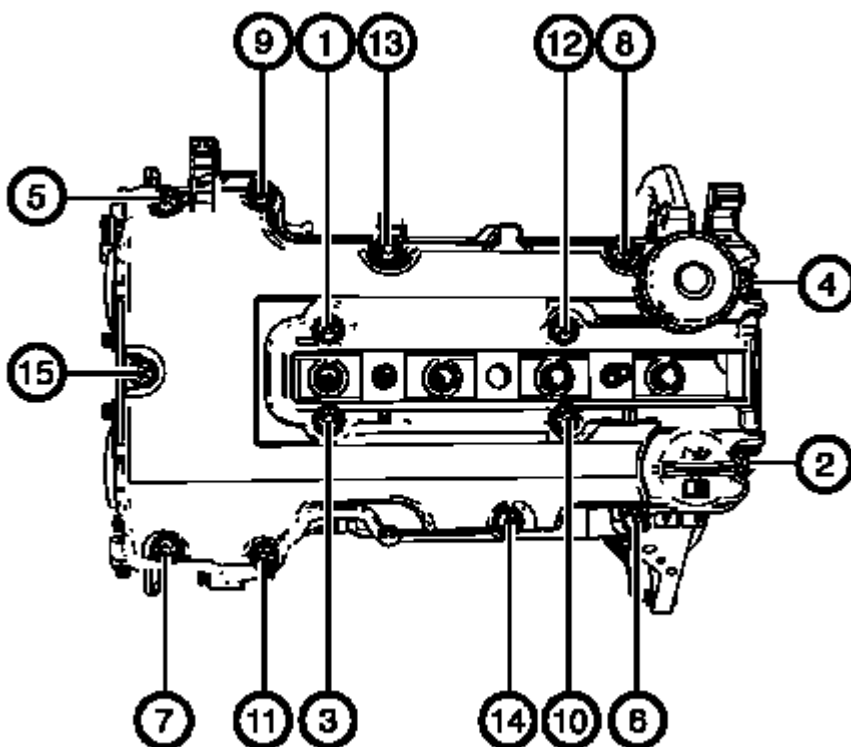


**Fig. 424: Camshaft Cover And Gasket**

Courtesy of GENERAL MOTORS COMPANY

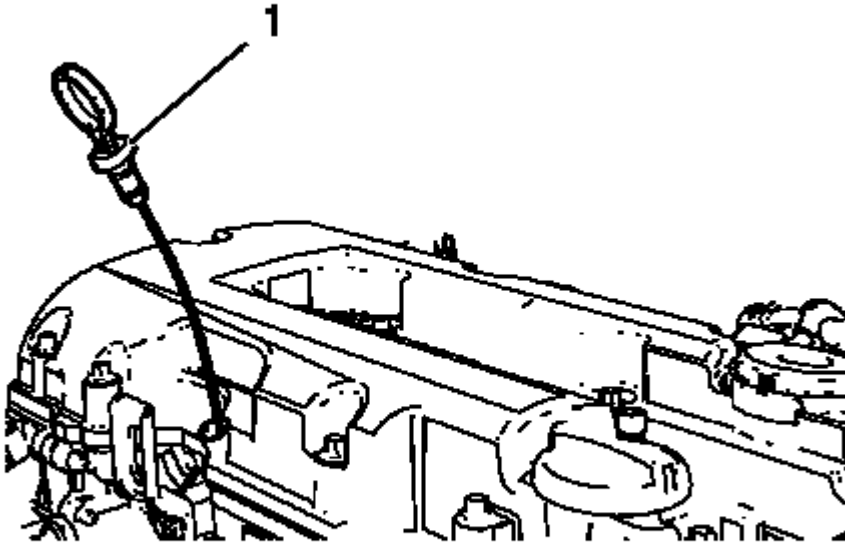
**NOTE:** The installation procedure should not take longer than 10 minutes.

3. Install the camshaft cover (2) and a NEW gasket (3).
4. Install the 15 camshaft cover bolts (1).



**Fig. 425: Camshaft Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the 15 camshaft cover bolts in a sequence as shown to 8 N.m (71 lb in).



**Fig. 426: Engine Oil Level Indicator**

Courtesy of GENERAL MOTORS COMPANY

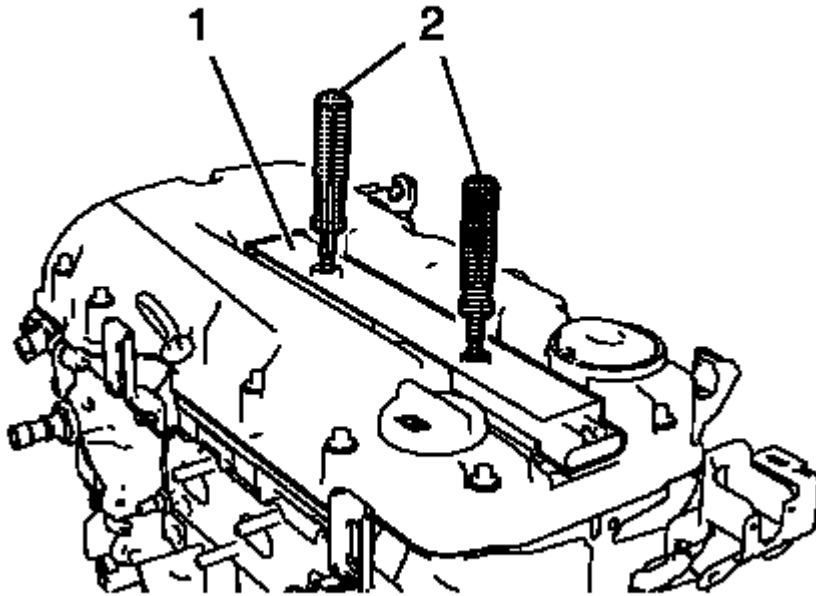
6. Install the oil level indicator (1).

## **IGNITION COIL INSTALLATION**

### **Special Tools**

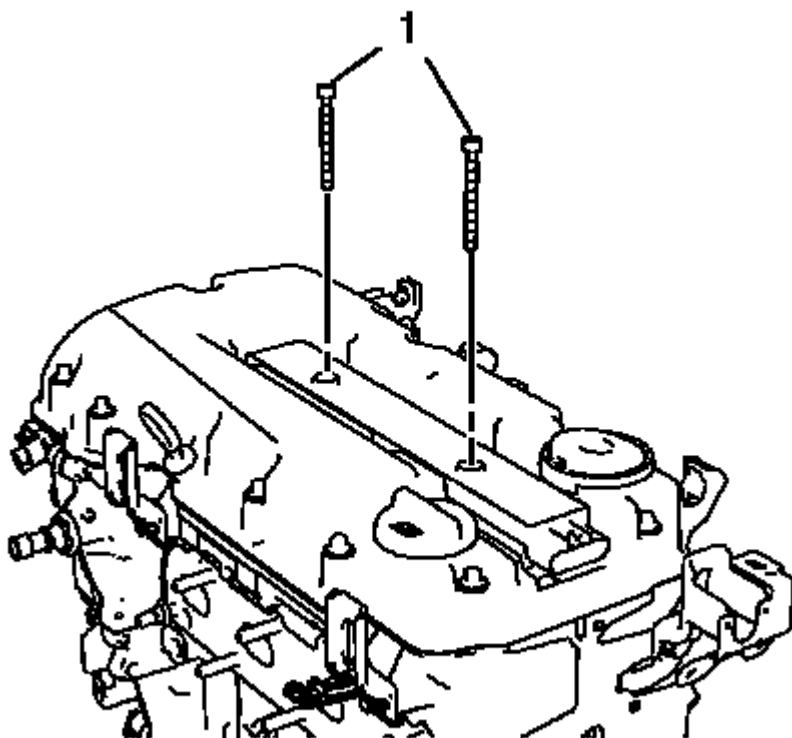
**EN-6009** Remover and Installer Ignition Module

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



**Fig. 427: Ignition Coil And Remover/Installer**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil (1) and remove **EN-6009** remover and installer (2).



**Fig. 428: Ignition Coil Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

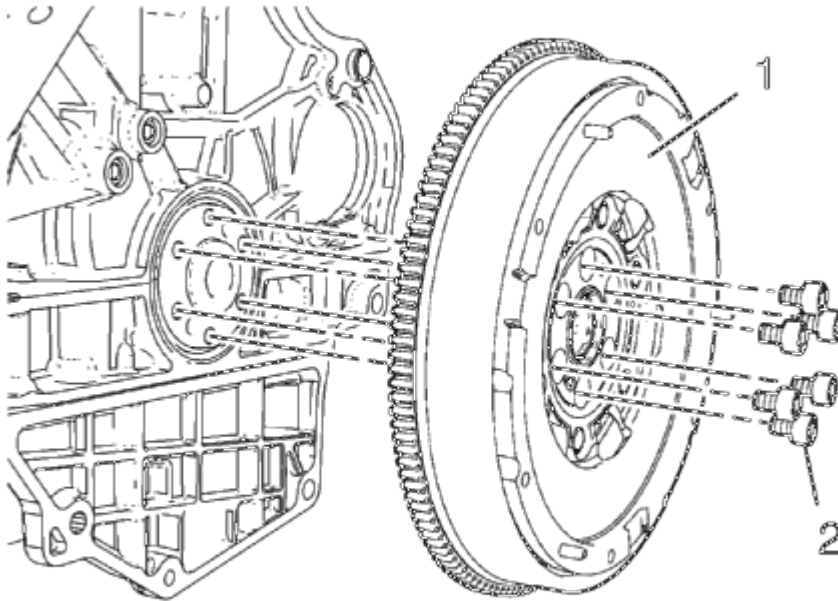
2. Install the 2 ignition coil bolts (1) and tighten to 8 N.m (71 lb in).

## ENGINE FLYWHEEL INSTALLATION (1.4L LUV)

### Special Tools

- **EN-470-B** Angular Torque Wrench
- **EN-652** Flywheel Holder

For equivalent regional tools, refer to Special Tools.

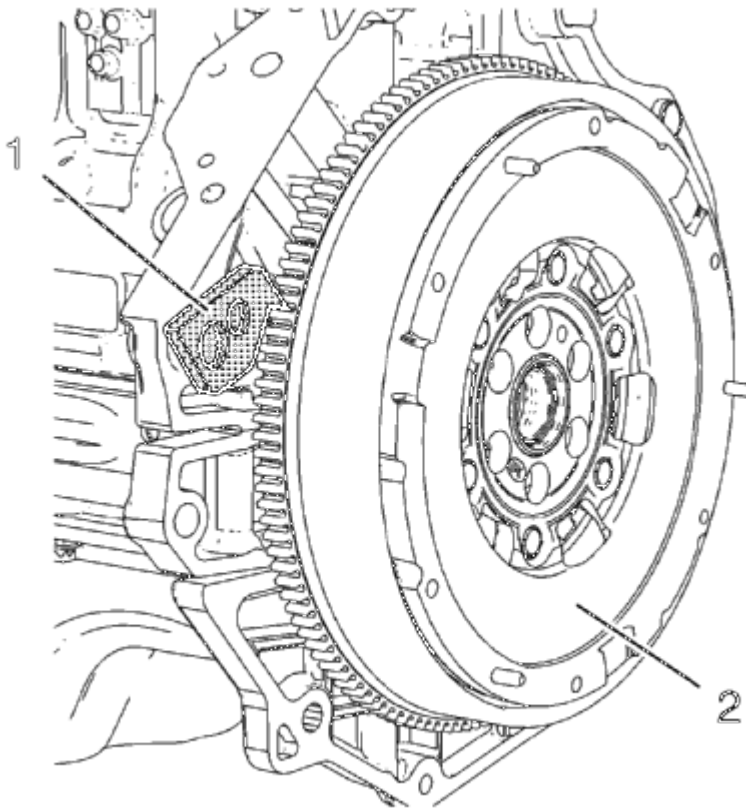


**Fig. 429: Engine Flywheel And Bolts**

**Courtesy of GENERAL MOTORS COMPANY**

1. Install the engine flywheel (1).
2. Install the 6 NEW engine flywheel bolts (2).





**Fig. 430: Engine Flywheel And Holder**  
 Courtesy of GENERAL MOTORS COMPANY

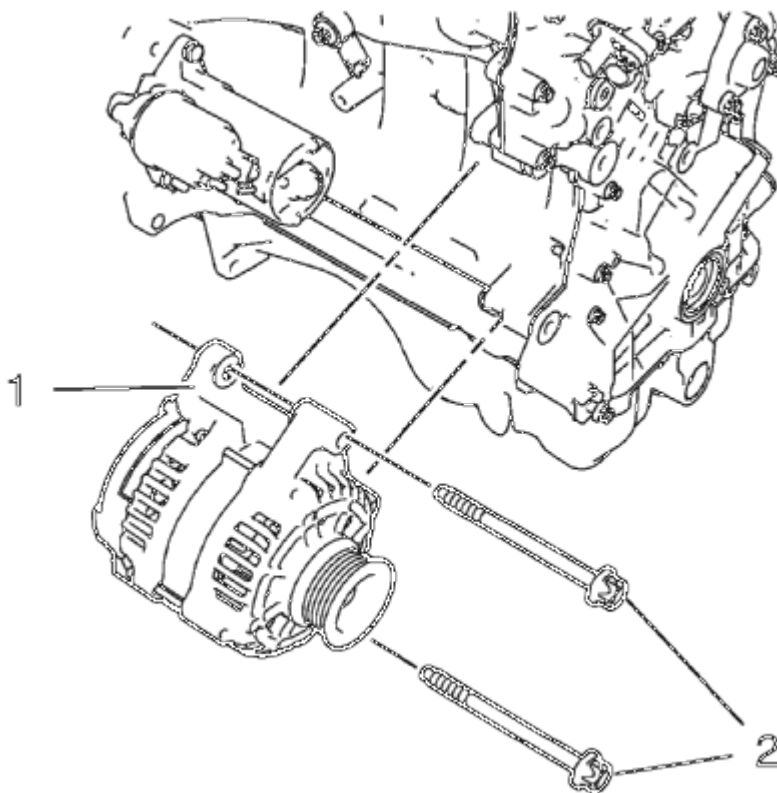
3. Install **EN-652** holder (1) to hold the engine flywheel (2).

**CAUTION: Refer to Fastener Caution .**

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

4. Tighten the 6 engine flywheel bolts in a cross sequence to 60 N.m (44 lb ft).
  1. Tighten the 6 engine flywheel bolts in a cross sequence to an additional 45 degrees. Use **EN-470-B** wrench.
  2. Tighten the 6 engine flywheel bolts in a cross sequence to an additional 15 degrees. Use **EN-470-B** wrench.
5. Remove **EN-652** holder.

## GENERATOR INSTALLATION

**Fig. 431: Generator And Bolts**

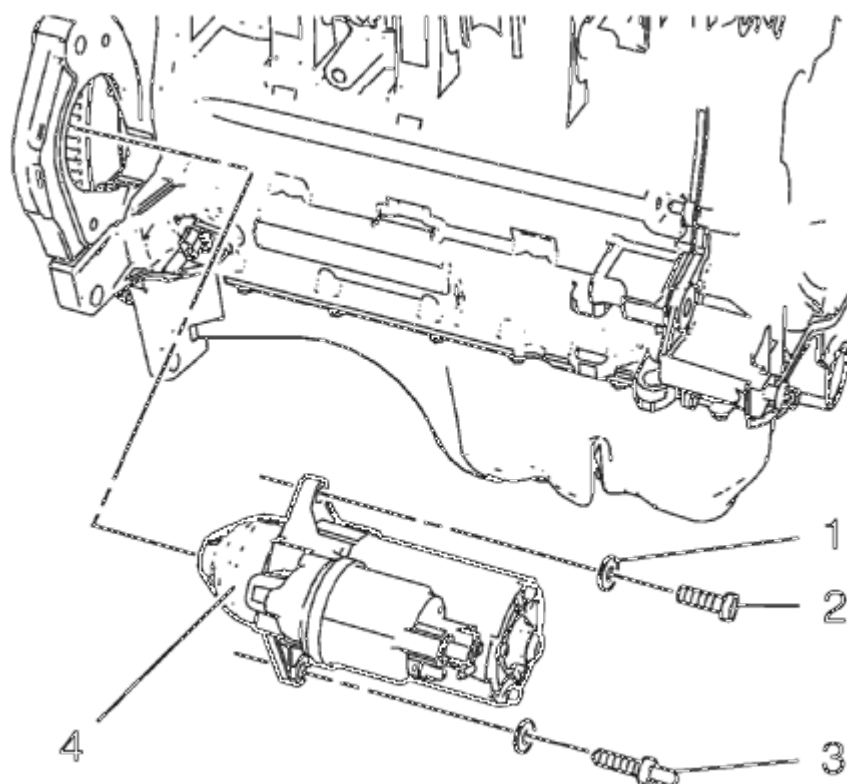
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator (1).

**CAUTION:** Refer to Fastener Caution .

2. Install the 2 generator bolts (2) and tighten to 35 N.m (26 lb ft).

## STARTER INSTALLATION



**Fig. 432: Starter, Bolt, Stud And Washer**  
**Courtesy of GENERAL MOTORS COMPANY**

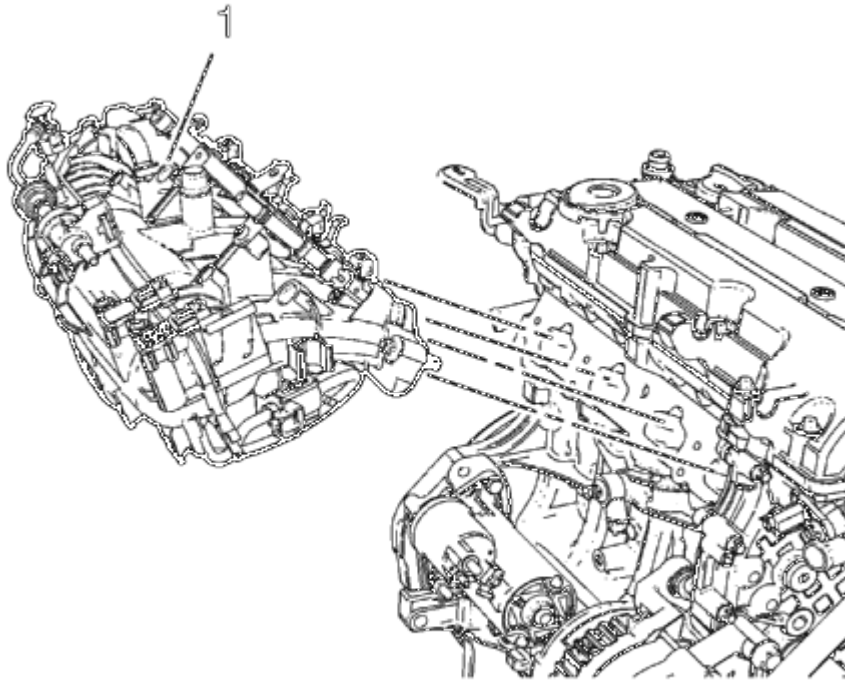
1. Install the starter (4).
2. Install the lower starter bolt stud (3) and the washer.
3. Install the upper starter bolt (2) and the washer (1).

**CAUTION: Refer to Fastener Caution .**

4. Tighten the starter bolt and starter bolt stud to 25 N.m (18 lb ft).

#### **INTAKE MANIFOLD INSTALLATION (1.4L LUV)**

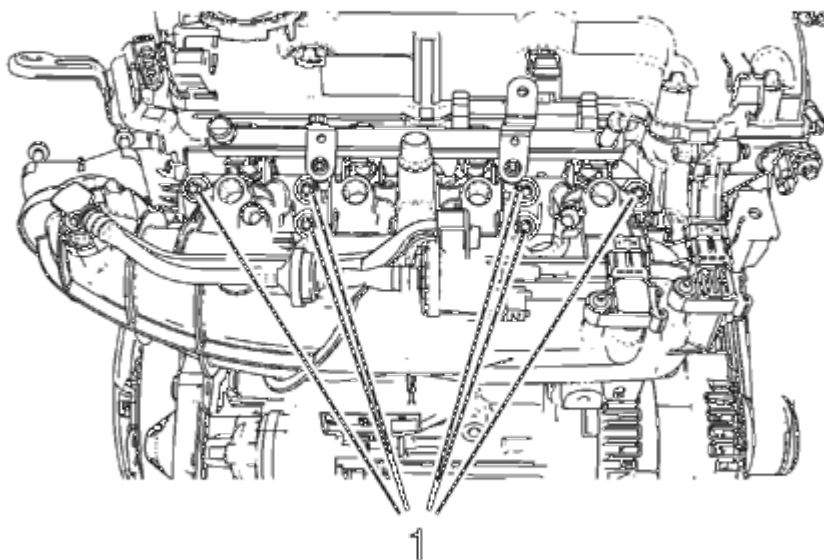
1. Clean the sealing surfaces.



**Fig. 433: Intake Manifold**

**Courtesy of GENERAL MOTORS COMPANY**

2. Install the intake manifold (1) along with a NEW intake manifold gasket.



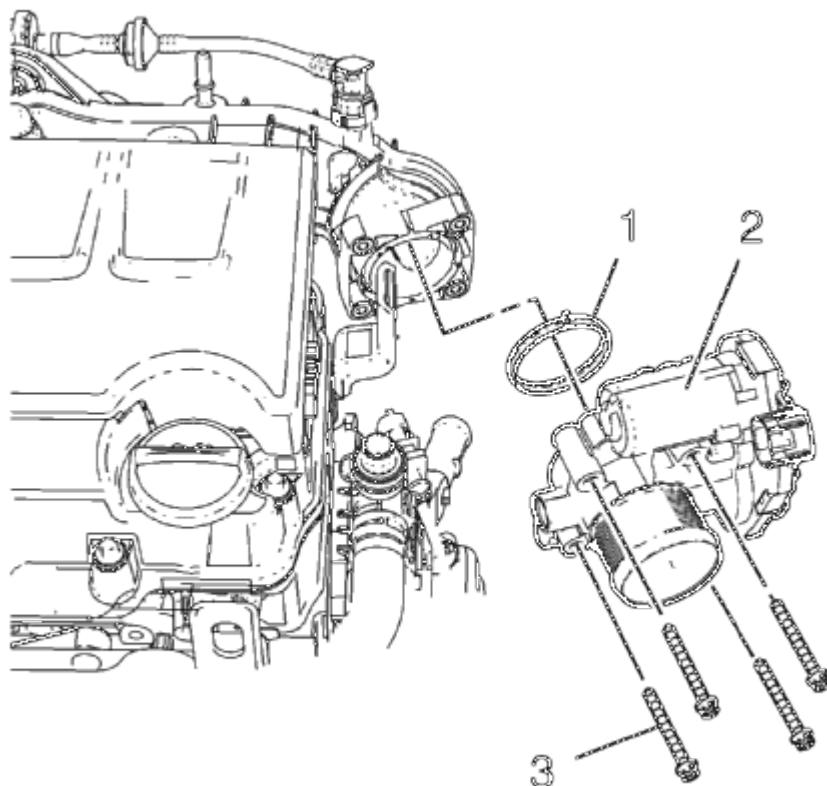
**Fig. 434: Intake Manifold Bolts**

Courtesy of GENERAL MOTORS COMPANY

**CAUTION: Refer to Fastener Caution .**

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

#### **THROTTLE BODY INSTALLATION (1.4L LUV)**



**Fig. 435: Throttle Body And Bolts**

Courtesy of GENERAL MOTORS COMPANY

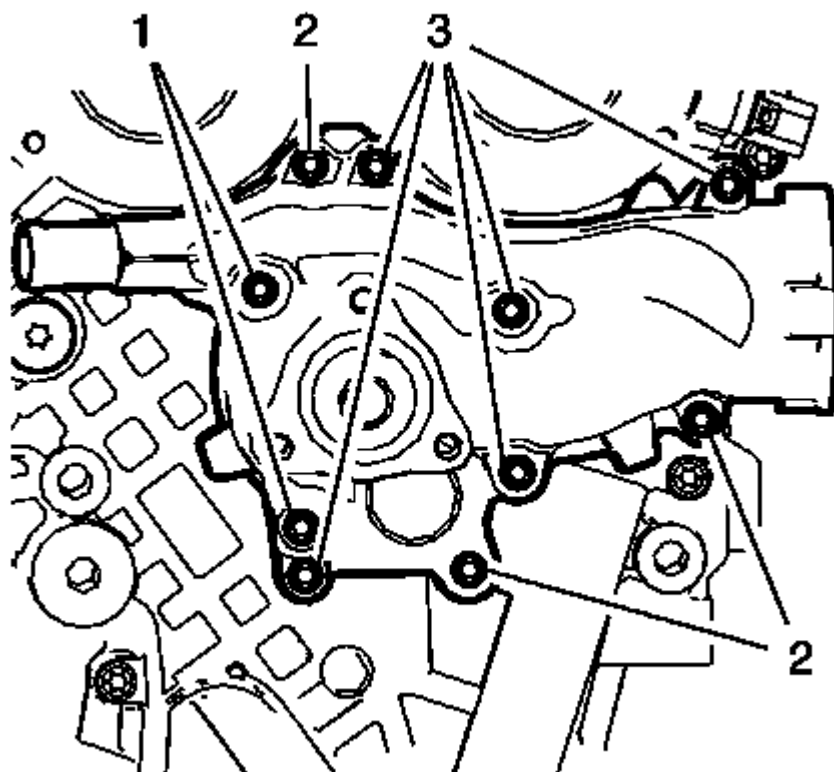
1. Install the throttle body (2) and a NEW throttle body seal ring (1).

**CAUTION:** Refer to Fastener Caution .

2. Install the 4 throttle body bolts (3) and tighten to 8 N.m (71 lb in).

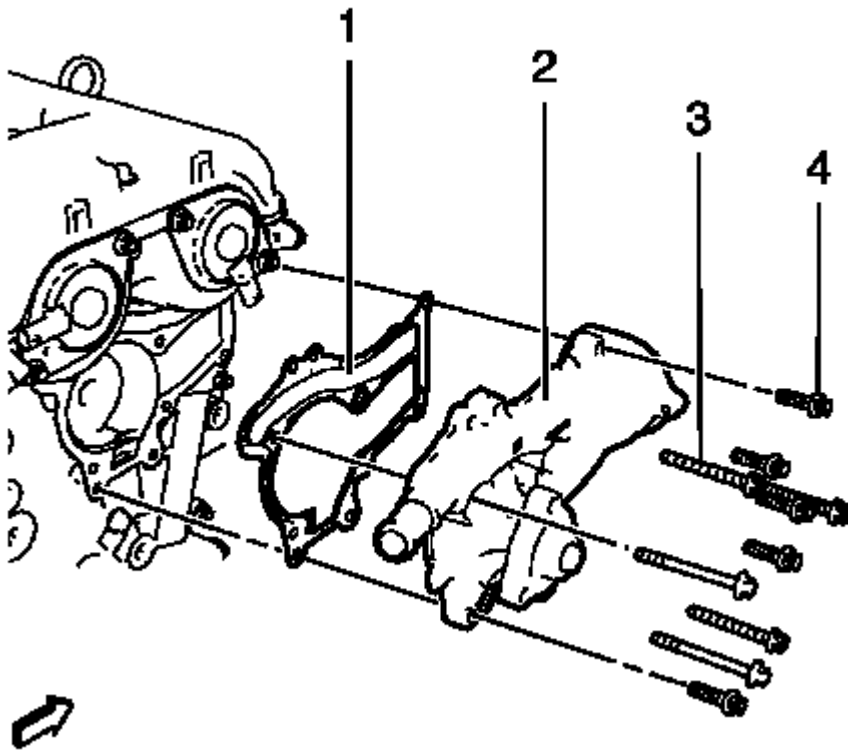
## **WATER PUMP INSTALLATION**

1. Clean the sealing surfaces.



**Fig. 436: Water Pump And Engine Front Cover Bolts**  
Courtesy of GENERAL MOTORS COMPANY

2. The water pump and engine front cover bolts are located as followed:
- Engine front cover special bolt without cone end 60 mm (2.362 in) (1).
  - Engine front cover standard bolt with cone end 52 mm (2.047 in) (2).
  - Water pump bolt 25 mm (0.984 in) (3).



**Fig. 437: Water Pump, Bolts And Gasket**  
Courtesy of GENERAL MOTORS COMPANY

3. Install the water pump (2) and a NEW water pump gasket (1).

**CAUTION:** Refer to Fastener Caution .

4. Install the 5 water pump bolts (4) and the 5 long engine front cover bolts (3) and tighten in a cross sequence to 8 N.m (71 lb in).

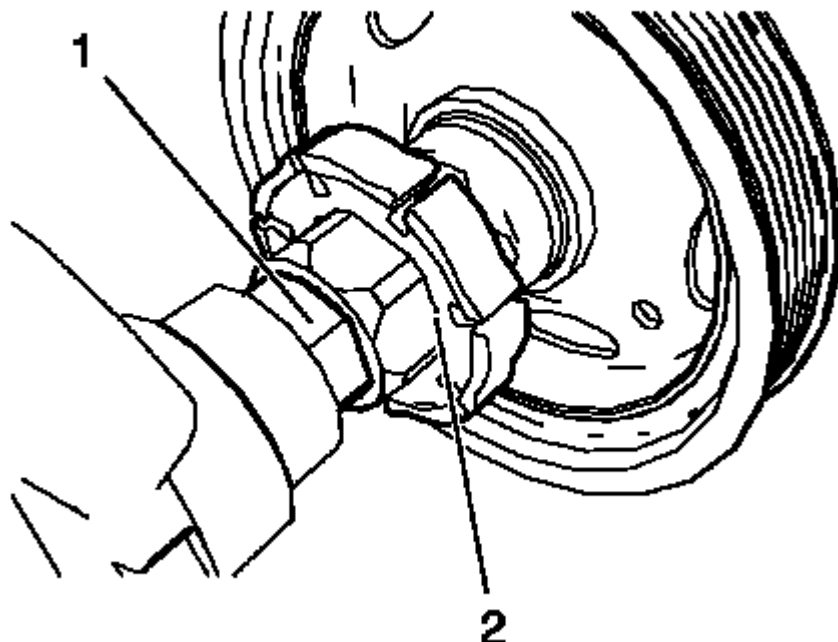
## CRANKSHAFT BALANCER INSTALLATION

### Special Tools

- EN-470-B Angular Torque Wrench
- EN-956-1 Extension
- EN-49979 Crankshaft Shock Mount Retainer

For equivalent regional tools, refer to Special Tools.

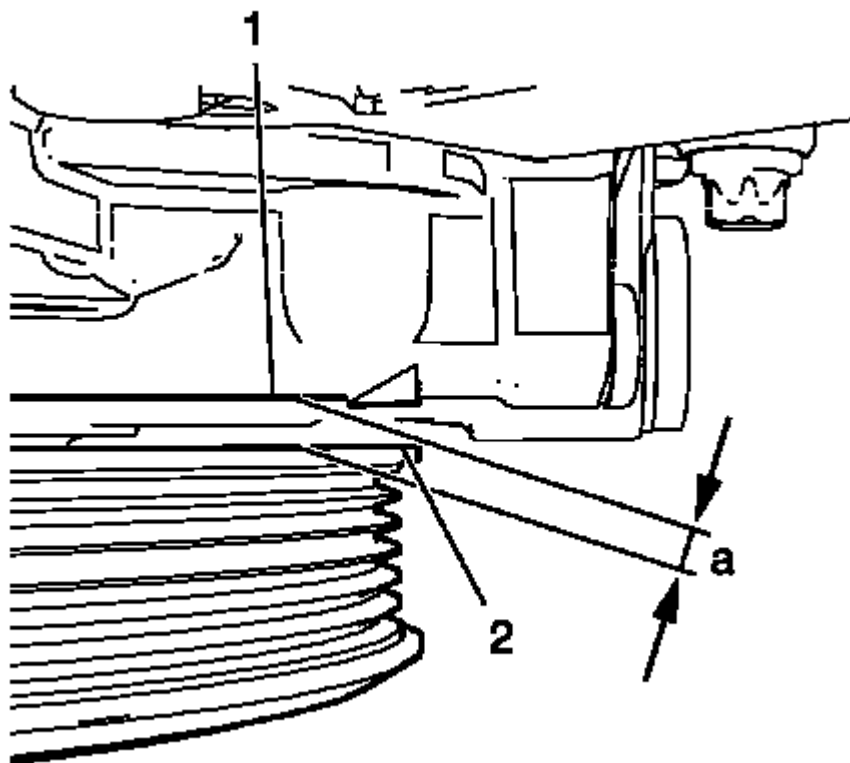




**Fig. 438: Engine Oil Pump Rotor And Crankshaft**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The crankshaft balancer flange must fit to the hexagon of the oil pump rotor (2) and to the two-flat of the crankshaft (1).

1. Install the crankshaft balancer by carefully pressing into position.

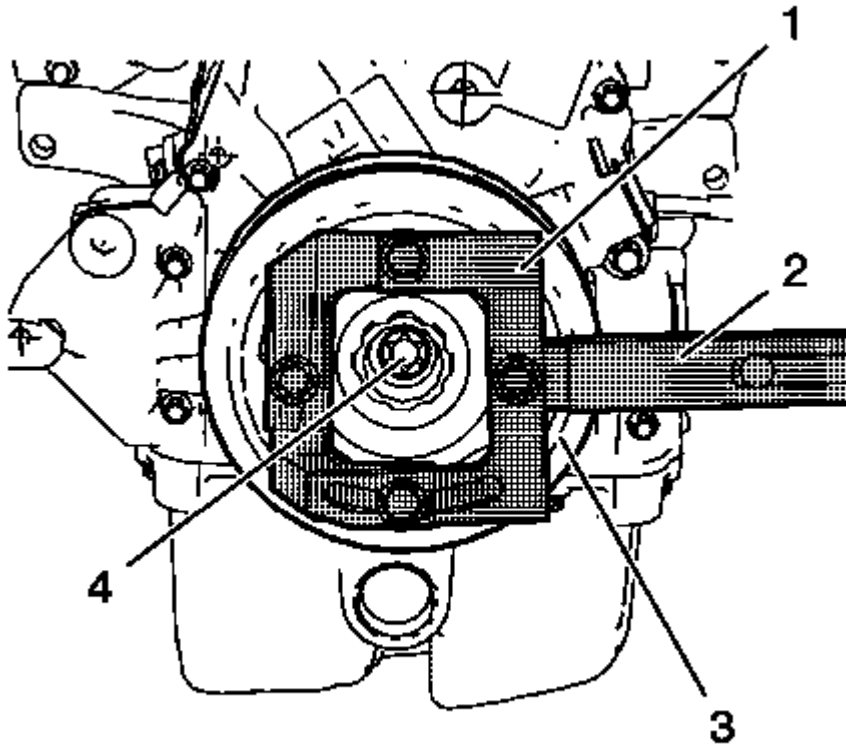


**Fig. 439: Engine Front Cover And Crankshaft Balancer**  
Courtesy of GENERAL MOTORS COMPANY

2. Measure the distance *a* between the crankshaft balancer (2) and the engine front cover (1). The distance *a* should be 5.5 mm (0.21654 in).

**NOTE:**        **Never re-use the crankshaft balancer bolt.**

3. Install a NEW crankshaft balancer bolt.



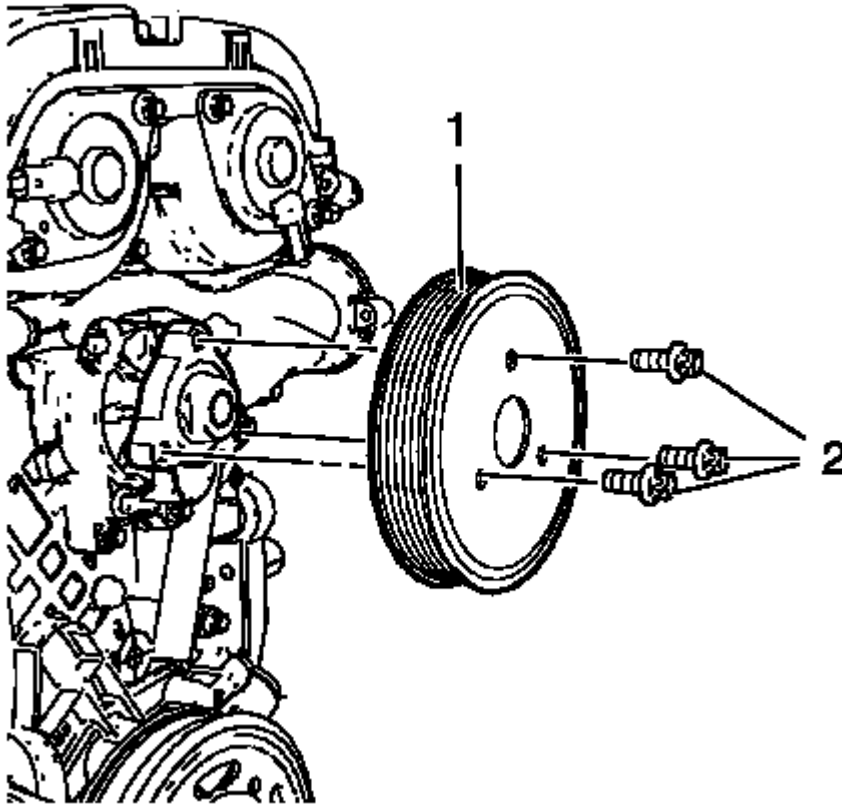
**Fig. 440: Crankshaft Balancer, Retainer And Extension**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

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

4. Tighten the crankshaft balancer bolt (4) while holding the crankshaft balancer (3) with **EN-49979** retainer (1) and **EN-956-1** extension (2) in the following order:
  1. Tighten the crankshaft balancer bolt to 150 N.m (111 lb ft).
  2. Tighten the crankshaft balancer bolt to an additional 60 degrees, using **EN-470-B** wrench.

## WATER PUMP PULLEY INSTALLATION



**Fig. 441: Water Pump Pulley**

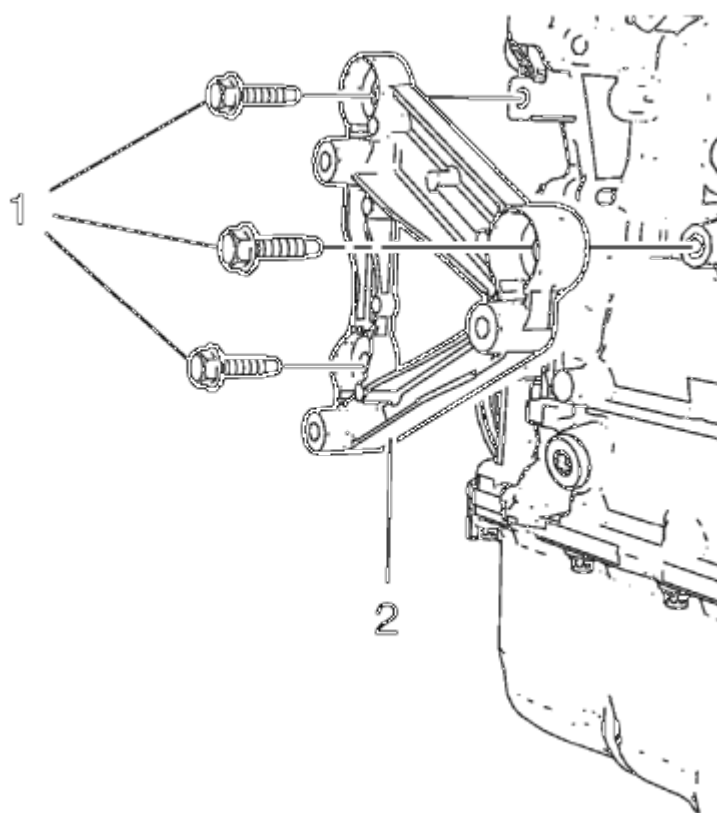
Courtesy of GENERAL MOTORS COMPANY

1. Install the water pump pulley (1).
2. Install the 3 water pump pulley bolts (2).

**CAUTION:** Refer to Fastener Caution .

3. Tighten the 3 water pump pulley bolts (2) to 22 N.m (16 lb ft) while holding up the water pump pulley hub with a wrench.

#### **AIR CONDITIONING COMPRESSOR BRACKET INSTALLATION**



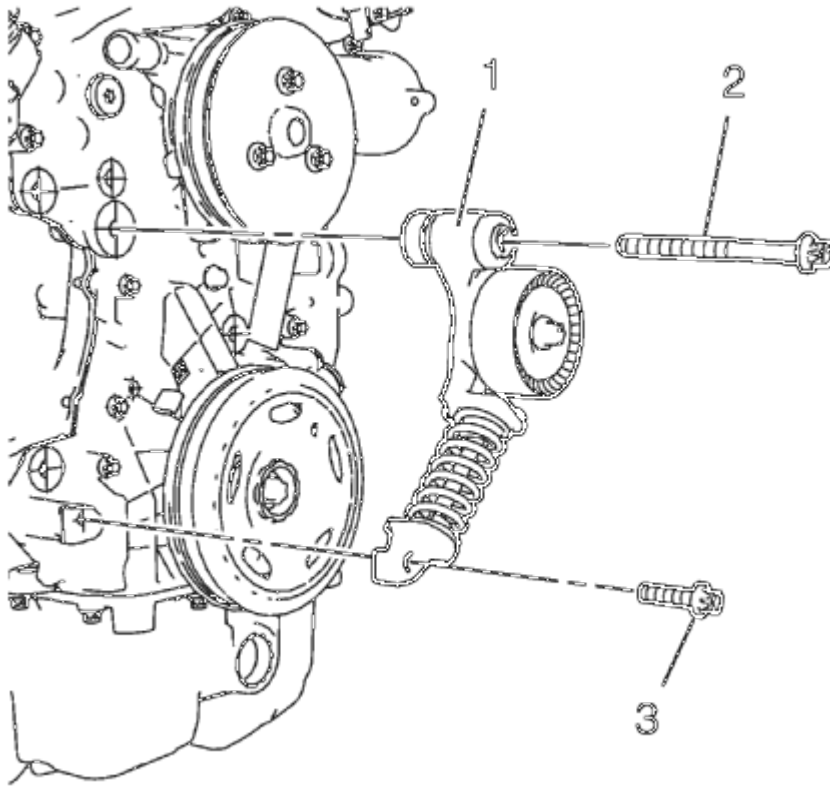
**Fig. 442: Power Steering Pump Bracket/Air Conditioning Compressor Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

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 N.m (16 lb ft).

## DRIVE BELT TENSIONER INSTALLATION



**Fig. 443: Drive Belt Tensioner And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt tensioner (1).
2. Install the upper drive belt tensioner bolt (2).
3. Install the lower drive belt tensioner bolt (3).

**CAUTION:** Refer to Fastener Caution .

4. Tighten the lower drive belt tensioner bolt (M8) to 22 N.m (16 lb ft).
5. Tighten the upper drive belt tensioner bolt to 55 N.m (41 lb ft).

## DRIVE BELT INSTALLATION

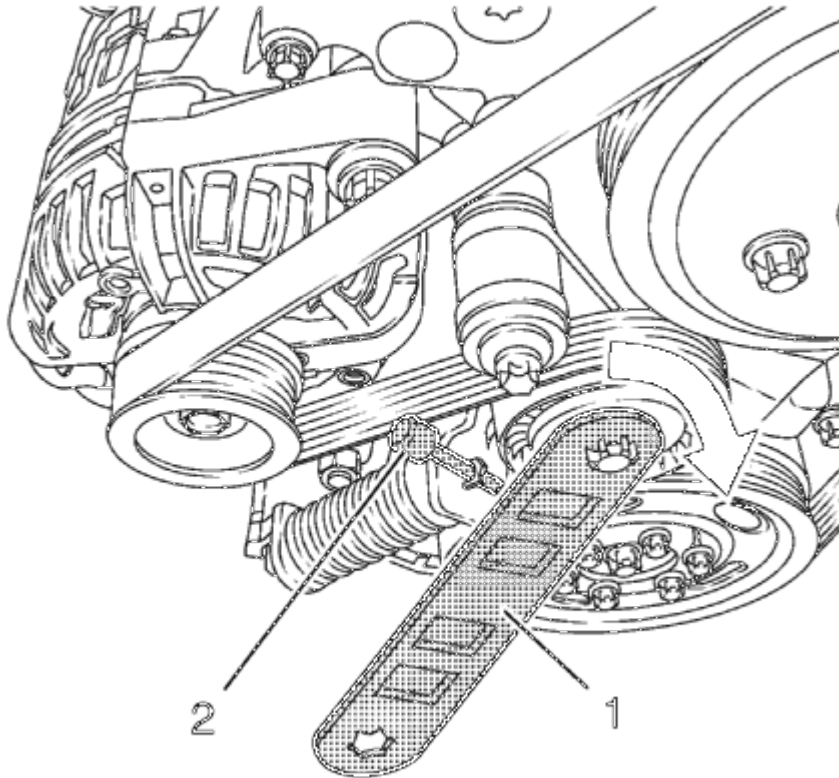
### Special Tools

- **EN-955-2** Locking Pin
- **EN-48488** Holding Wrench

For equivalent regional tools, refer to Special Tools.

**NOTE:** Ensure that the drive belt tensioner is held with EN-955-2 locking pin.

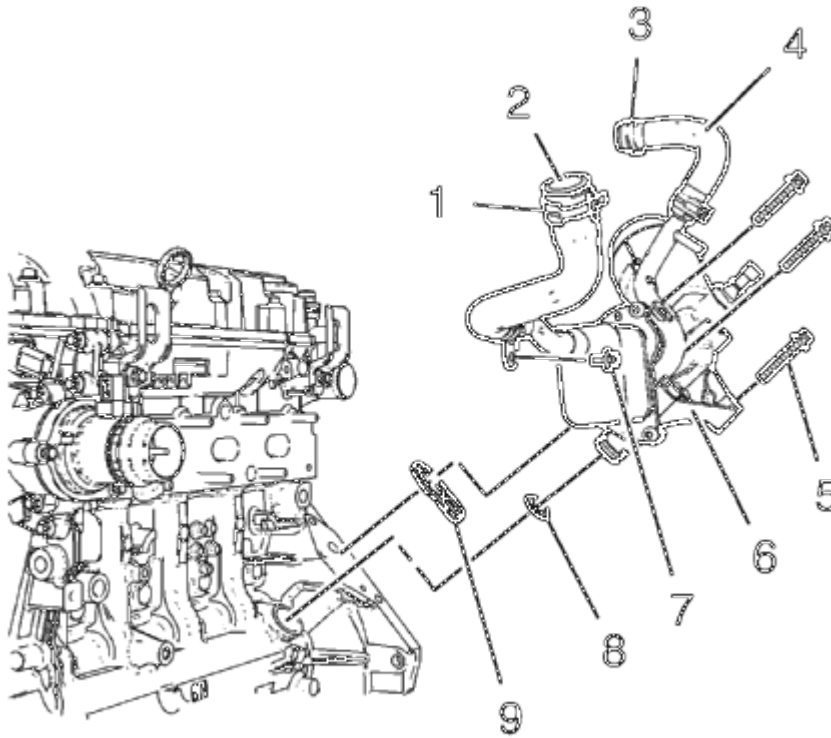
1. Install the drive belt.



**Fig. 444: Locking Pin And Wrench**  
Courtesy of GENERAL MOTORS COMPANY

2. Move the drive belt tensioner clockwise until EN-955-2 locking pin (2) can be removed. Use EN-48488 wrench (1).
3. Remove EN-955-2 locking pin (2) from the drive belt tensioner while holding with EN-48488 wrench (1).
4. Release tension from drive belt tensioner and remove EN-48488 wrench (1).

## ENGINE OIL COOLER INSTALLATION



**Fig. 445: Locating Engine Oil Cooler Components**  
Courtesy of GENERAL MOTORS COMPANY

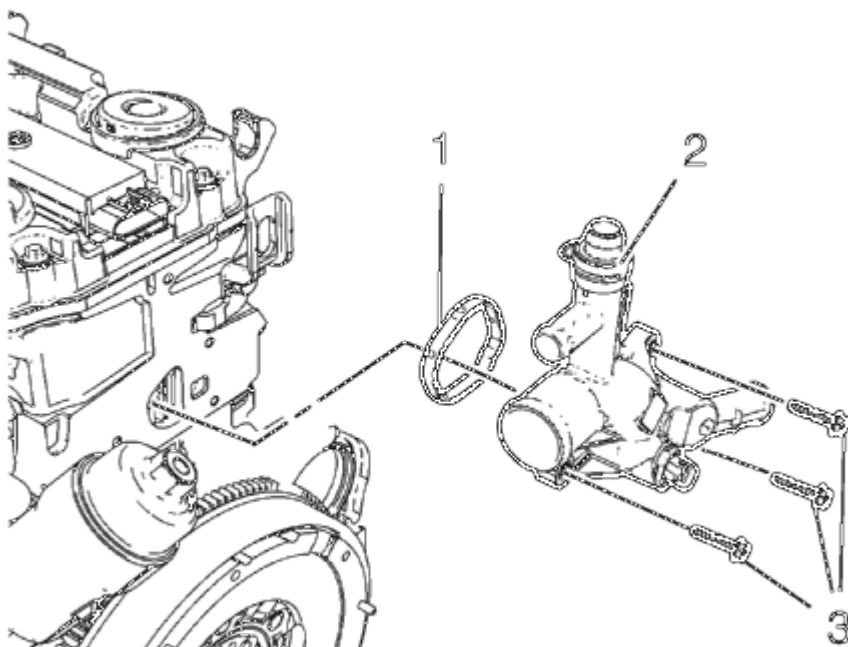
**NOTE:** Lubricate the oil cooler seal (8) with clean engine oil.

1. Install the engine oil cooler assembly (6) along with 2 NEW sealings (8) and (9).
2. Install the 3 oil cooler bolts (5) and tighten to 10 N.m (89 lb in).
3. Install the oil cooler coolant outlet pipe bolt (7) and tighten to 10 N.m (89 lb in).
4. Install the oil cooler coolant outlet hose (2) to the engine coolant thermostat housing.
5. Install the oil cooler coolant outlet hose clamp (1).
6. Install the oil cooler coolant inlet hose (4) to the water outlet.
7. Install the oil cooler coolant inlet hose clamp (3).

#### WATER OUTLET INSTALLATION (1.4L LUV)

1. Clean the sealing surfaces.





**Fig. 446: Water Outlet, Bolts And Seal Ring**  
Courtesy of GENERAL MOTORS COMPANY

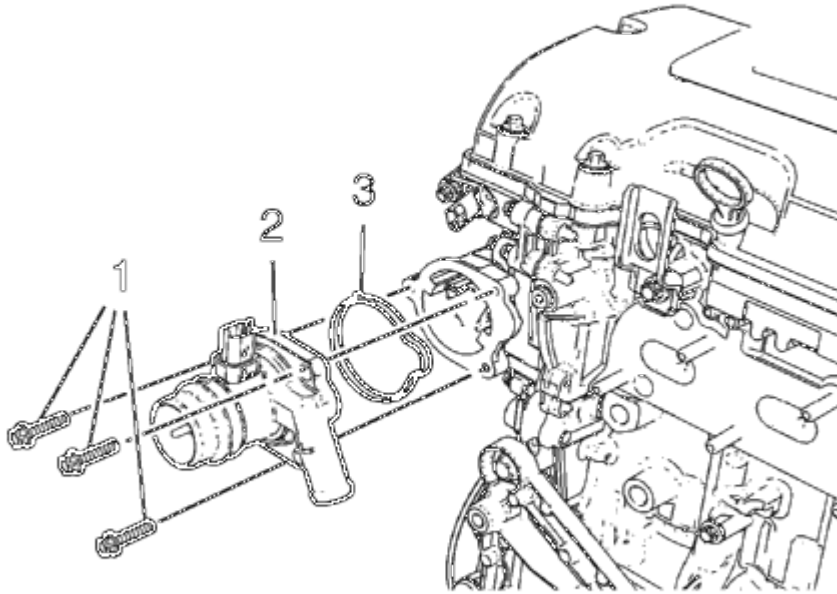
2. Install the water outlet (2) and a NEW water outlet seal ring (1).

**CAUTION:** Refer to Fastener Caution .

3. Install the 3 water outlet bolts (3) and tighten to 8 N.m (71 lb in).

#### **ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION (1.4L LUV)**

1. Clean the sealing surfaces.



**Fig. 447: Engine Coolant Thermostat Housing**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine coolant thermostat housing (2) and a NEW engine coolant thermostat housing seal ring (3).

**CAUTION: Refer to Fastener Caution .**

3. Install the 3 engine coolant thermostat housing bolts (1) and tighten to 8 N.m (71 lb in).

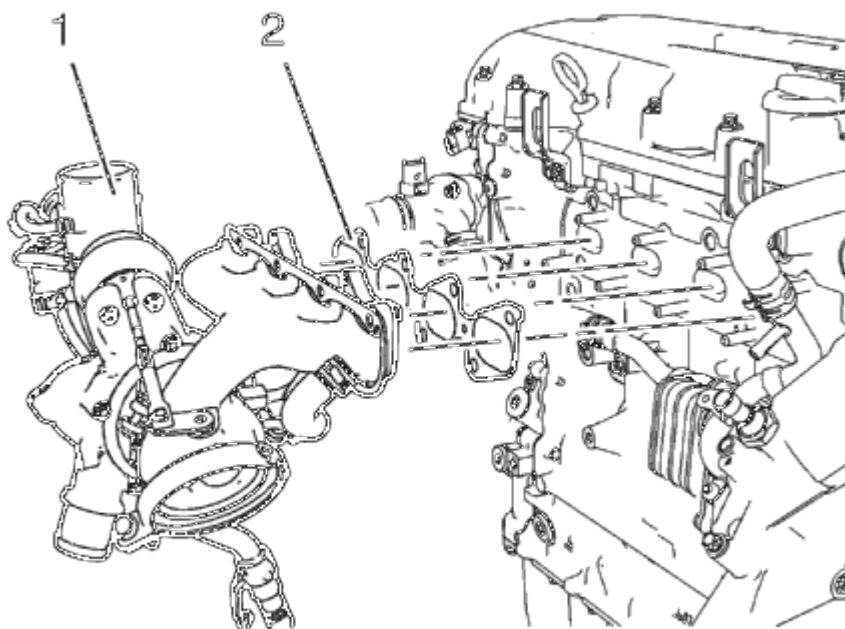
## **TURBOCHARGER INSTALLATION**

### **Special Tool**

**EN-49942** Holding Wrench

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

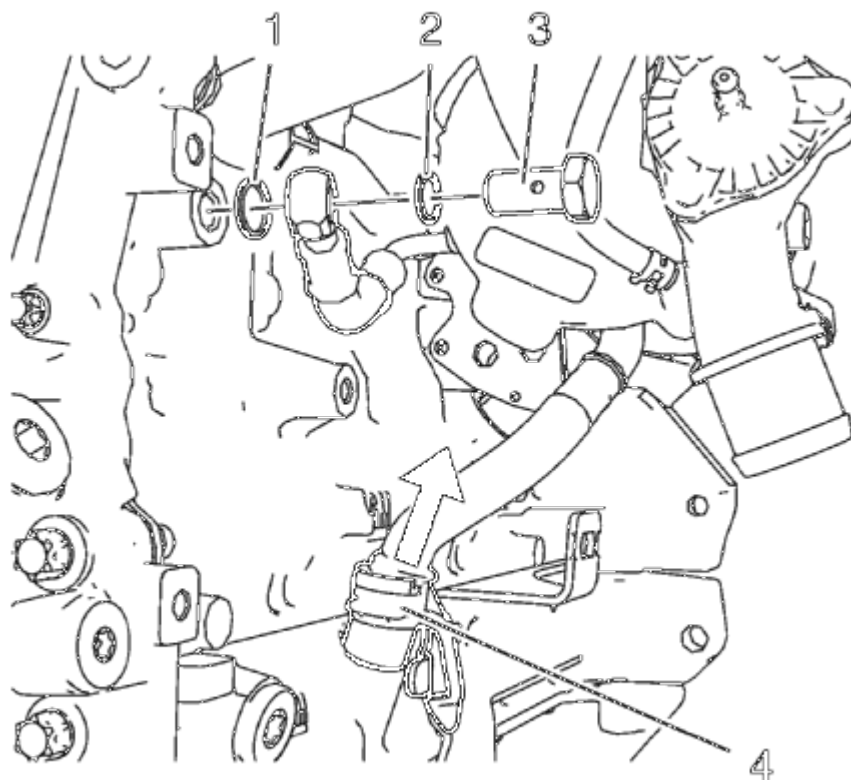
1. Clean the sealing surfaces.
2. Replace the connect fittings on the turbocharger coolant feed pipe and the turbocharger coolant return pipe. Refer to **Turbocharger Disassemble**, and **Turbocharger Assemble**.



**Fig. 448: Turbocharger Assembly And Turbocharger Gasket**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** Mind the turbocharger oil return pipe.

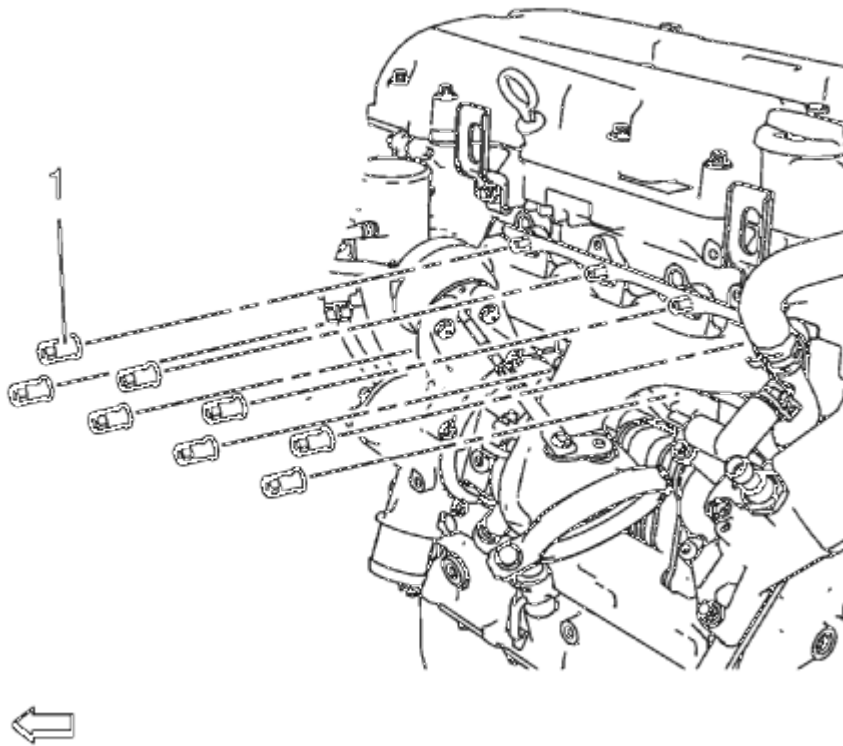
3. Install the turbocharger assembly (1) and a NEW turbocharger gasket (2).



**Fig. 449: Turbocharger Oil Return Pipe**

**Courtesy of GENERAL MOTORS COMPANY**

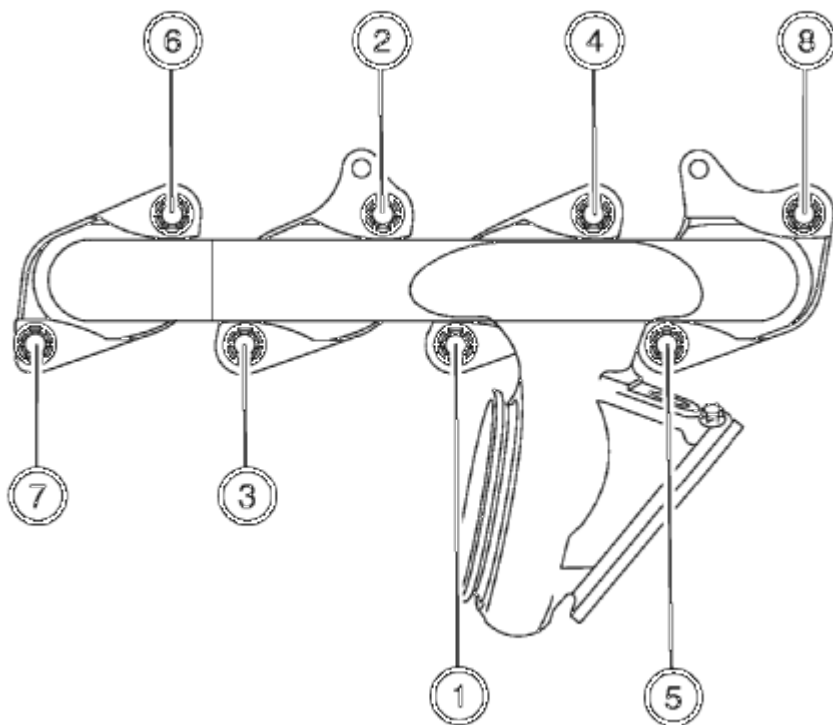
4. Connect the turbocharger oil return pipe to the engine while installing the turbocharger.
5. Install the turbocharger coolant feed pipe hollow screw along with 2 NEW seal rings (1) and (2).



**Fig. 450: Turbocharger Nuts**

**Courtesy of GENERAL MOTORS COMPANY**

6. Install the 8 NEW turbocharger nuts (1).

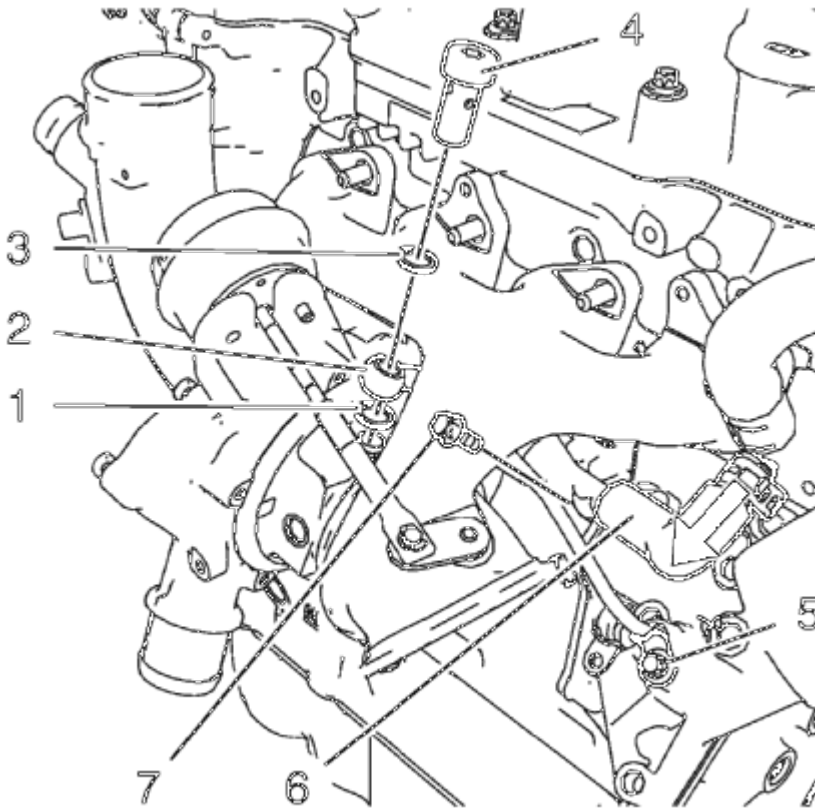


**Fig. 451: Turbocharger Nuts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

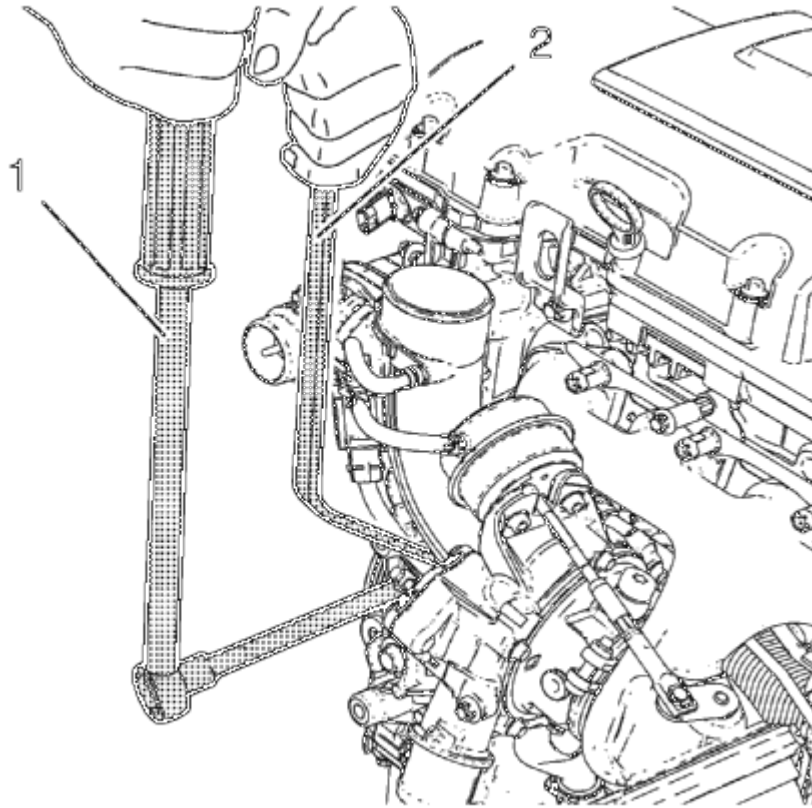
**CAUTION:** Refer to Torque-to-Yield Fastener Caution .

7. Tighten the 8 turbocharger nuts in a sequence as shown to 8 N.m (71 lb in).
8. Repeat the tightening procedure to ensure a proper fastening of the turbocharger nuts.



**Fig. 452: Turbocharger Oil Feed Pipe Components**  
 Courtesy of GENERAL MOTORS COMPANY

9. Connect the turbocharger coolant return hose (6) to the oil cooler coolant inlet pipe and install the turbocharger coolant return pipe bolt (7) to the oil cooler. Tighten the turbocharger coolant return pipe bolt to 8 N.m (71 lb in).
10. Install the turbocharger oil feed pipe (2) along with a NEW rubber seal ring.
11. Install the turbocharger oil feed pipe hollow screw (4) in compound with 2 NEW seal rings (1) and (3).
12. Install the turbocharger oil feed pipe bolt (5) to the oil cooler and tighten to 10 N.m (89 lb in).
13. Tighten the turbocharger oil feed pipe hollow screw to 30 N.m (22 lb ft).

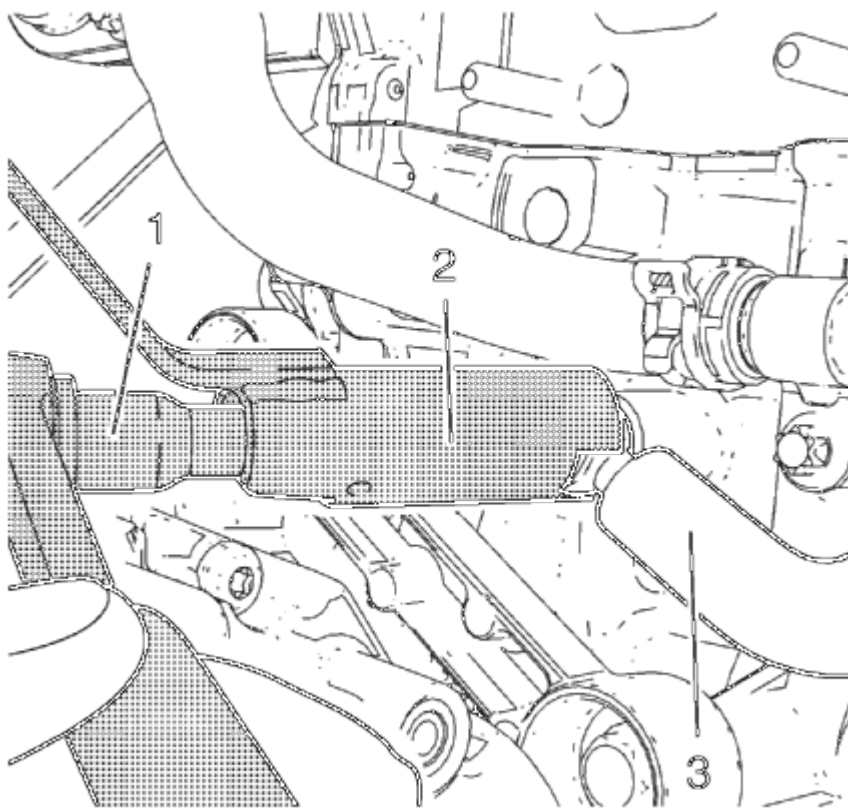


**Fig. 453: Holding Wrench And Ratchet Wrench**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The EN-49942 holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twisting of the turbocharger coolant feed pipe during the fastening procedure.

14. Install the **EN-49942** holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through **EN-49942** holding wrench to the turbocharger coolant feed pipe hollow screw.



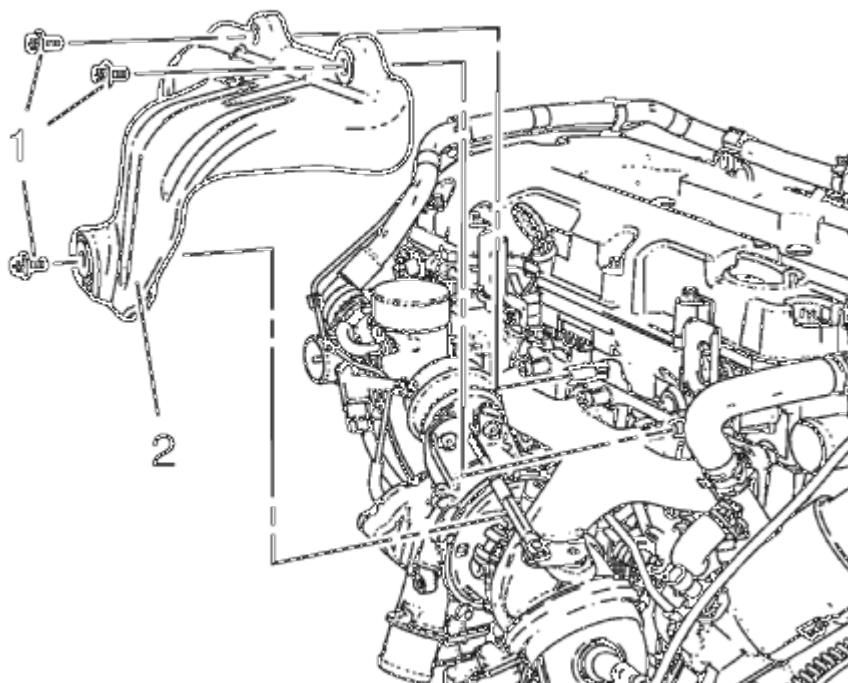


**Fig. 454: Ratchet Wrench, Holding Wrench And Coolant Feed Pipe**  
Courtesy of GENERAL MOTORS COMPANY

**NOTE:** EN-49942 holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe while the fastening procedure.

15. Tighten the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1) to 30 N.m (22 lb ft).

#### **EXHAUST MANIFOLD HEAT SHIELD INSTALLATION (1.4L LUV)**



**Fig. 455: Exhaust Manifold Heat Shield**

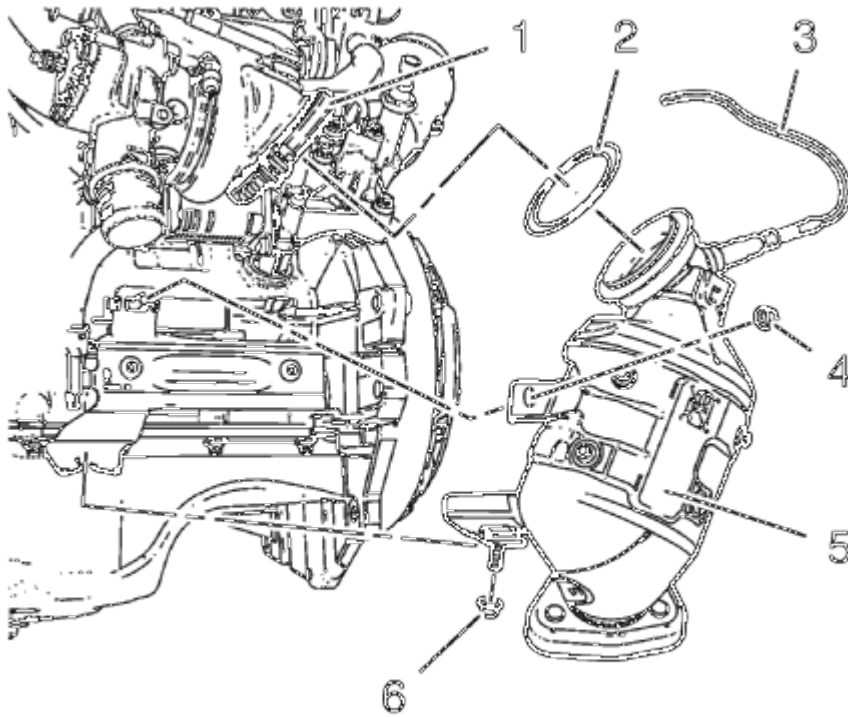
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust manifold heat shield (2).

**CAUTION:** Refer to Fastener Caution .

2. Install the 3 exhaust manifold heat shield bolts (1) and the washers and tighten to 8 N.m (71 lb in).

#### **WARM UP THREE-WAY CATALYTIC CONVERTER INSTALLATION (1.4L LUV)**

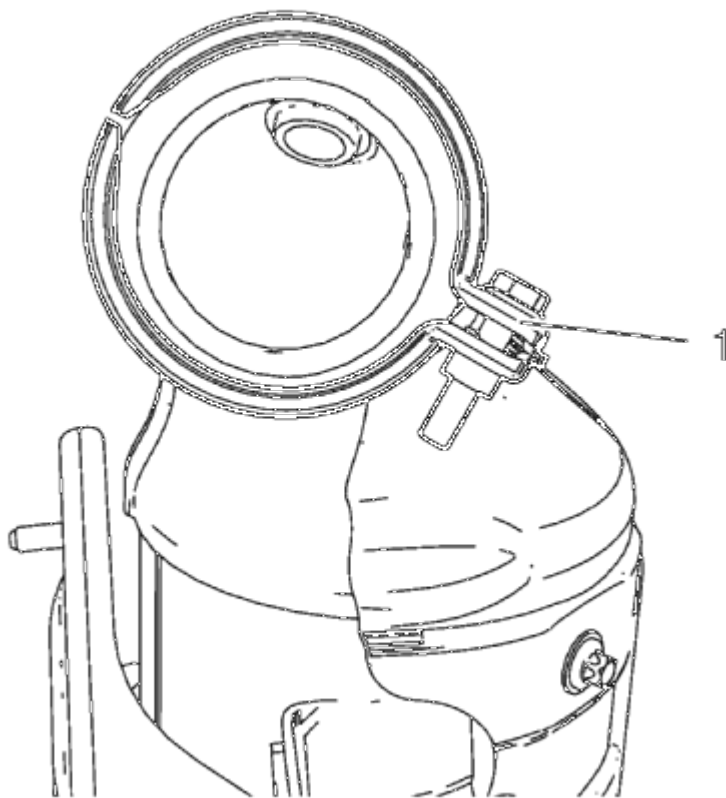


**Fig. 456: Locating Catalytic Converter Components**  
Courtesy of GENERAL MOTORS COMPANY

1. Install the warm up three way catalytic converter (5) to the brackets and the turbocharger. Use a NEW warm up three way catalytic converter seal (2).

**NOTE:**        **Never re-use the V-clamp.**

2. Install a NEW warm up three way catalytic converter V-clamp (1).
3. Install the 2 catalytic converter to catalytic converter bracket nuts (4) and (6) and hand tighten.
4. Hand tighten the catalytic converter V-clamp.
5. Connect the heated oxygen sensor wiring harness (3) to retainer clip.



**Fig. 457: Catalytic Converter V-Clamp**

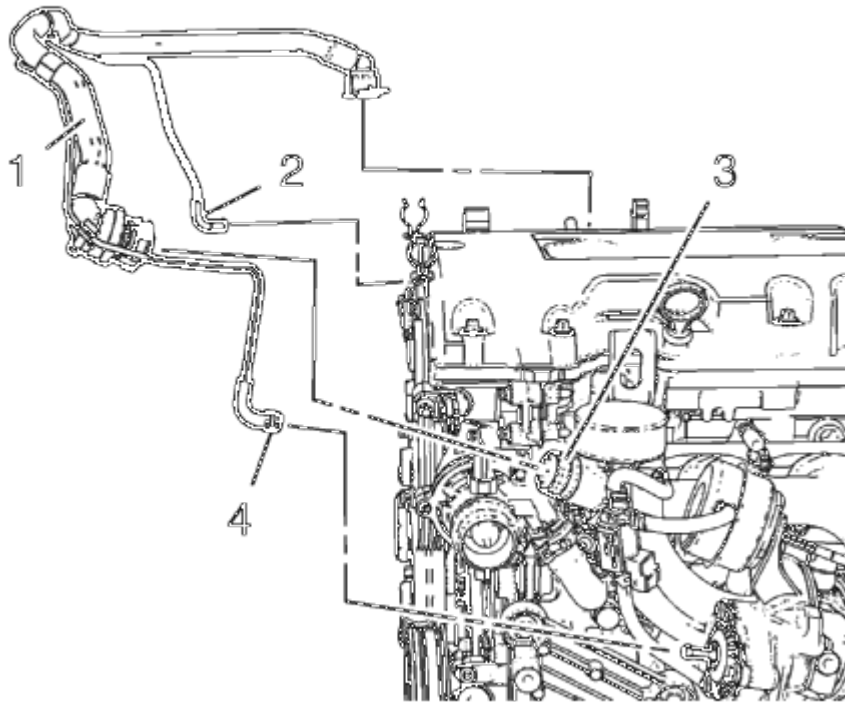
Courtesy of GENERAL MOTORS COMPANY

6. The catalytic converter V-clamp (1) should be installed in the shown position.

**CAUTION: Refer to Fastener Caution .**

7. Tighten the catalytic converter to catalytic converter bracket nuts to 22 N.m (16 lb ft).
8. Tighten the catalytic converter V-clamp to 13 N.m (115 lb in).

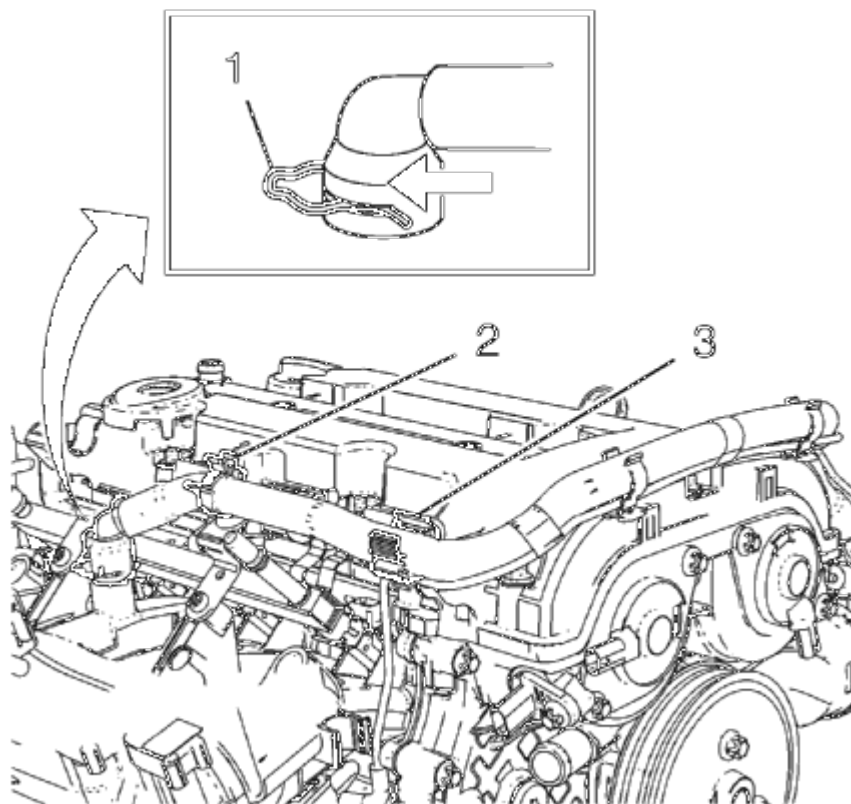
## **POSITIVE CRANKCASE VENTILATION PIPE INSTALLATION**



**Fig. 458: Turbocharger, Positive Crankcase Ventilation Pipe Assembly And Charger Air Bypass Valve Pipe**

Courtesy of GENERAL MOTORS COMPANY

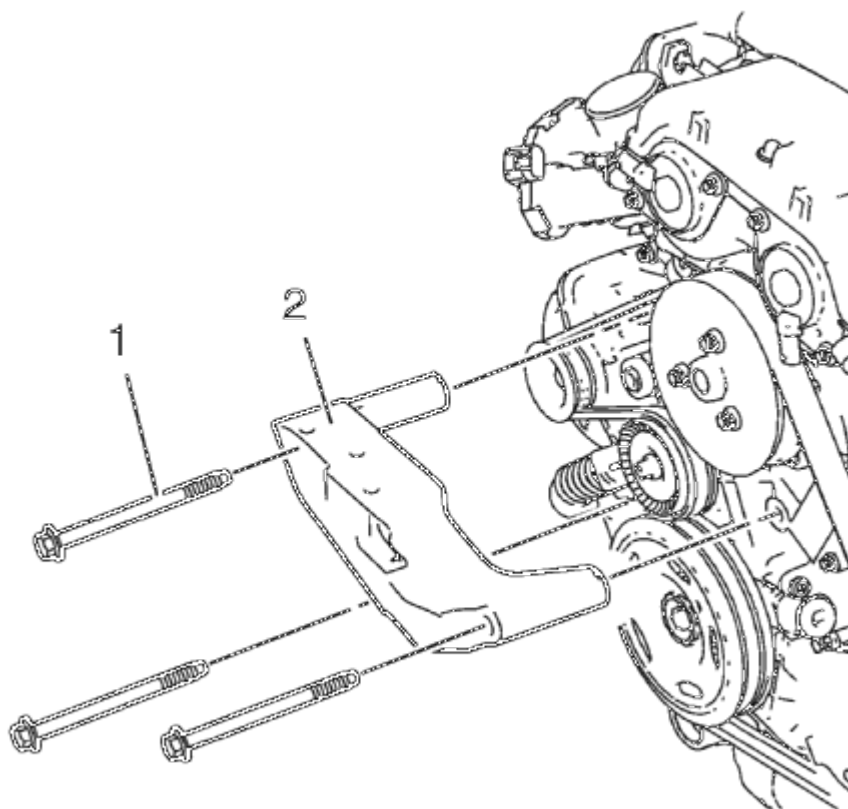
1. Install the positive crankcase ventilation pipe assembly (1) to the camshaft cover retainer clips.
2. Connect the positive crankcase ventilation pipe to turbocharger (3).
3. Install the charger air bypass valve pipe (2) to turbo charger waste regulator solenoid valve.
4. Install the charger air bypass valve pipe to turbocharger.
5. Fasten the charger air bypass valve pipe clamp (4).



**Fig. 459: Positive Crankcase Ventilation Pipe Retainer Clips And Retainer Clamp**  
Courtesy of GENERAL MOTORS COMPANY

6. Install the positive crankcase ventilation pipe to the intake manifold and fix with retainer clamp (1).
7. Clip in the positive crankcase ventilation pipe to the 2 retainer clips (2) and (3).

## ENGINE MOUNT BRACKET INSTALLATION



**Fig. 460: Engine Mount Bracket And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

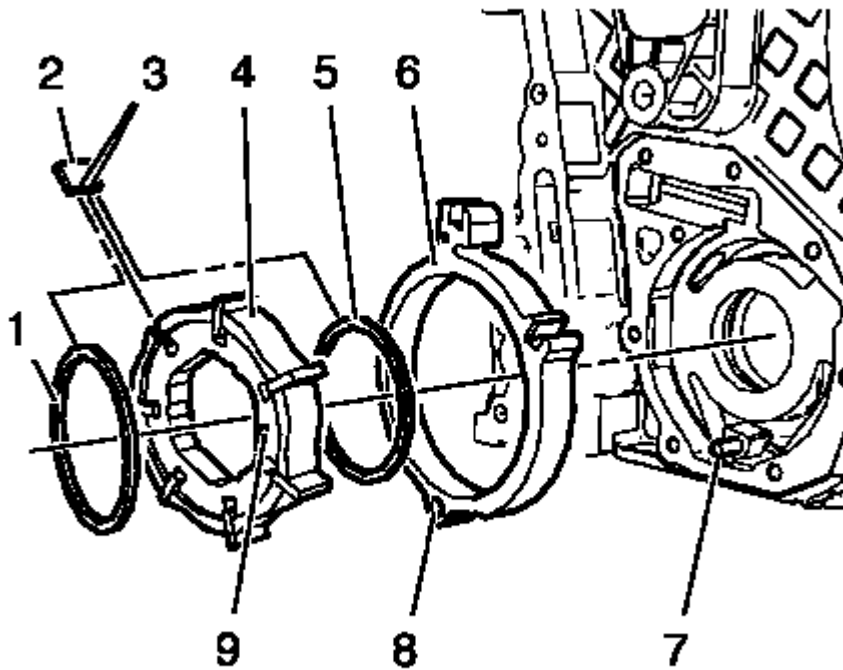
1. Install the engine mount bracket (2).

**CAUTION:** Refer to Fastener Caution .

2. Install the 3 engine mount bracket bolts and tighten to 60 N.m (45 lb ft) + 45-60°.

## ENGINE FRONT COVER AND OIL PUMP ASSEMBLE

### Oil Pump Installation



**Fig. 461: Oil Pump Components**

Courtesy of GENERAL MOTORS COMPANY

**NOTE:** The oil pump slide spring and pin, as well as the slide seal and slide seal spring can be ordered as single parts. All other oil pump components can only be ordered as a replacement kit.

1. Install the oil pump components in the following order:

**NOTE:** The bore (8) in the oil pump slide must fit smooth-running and without clearance to the oil pump slide pivot pin (7).

1. Install the oil pump slide (6).
2. Install the inner oil pump vane ring (5).

**NOTE:** Mind the installation position of the oil pump vane rotor (4). The mark (9) must point to direction of the oil pump cover.

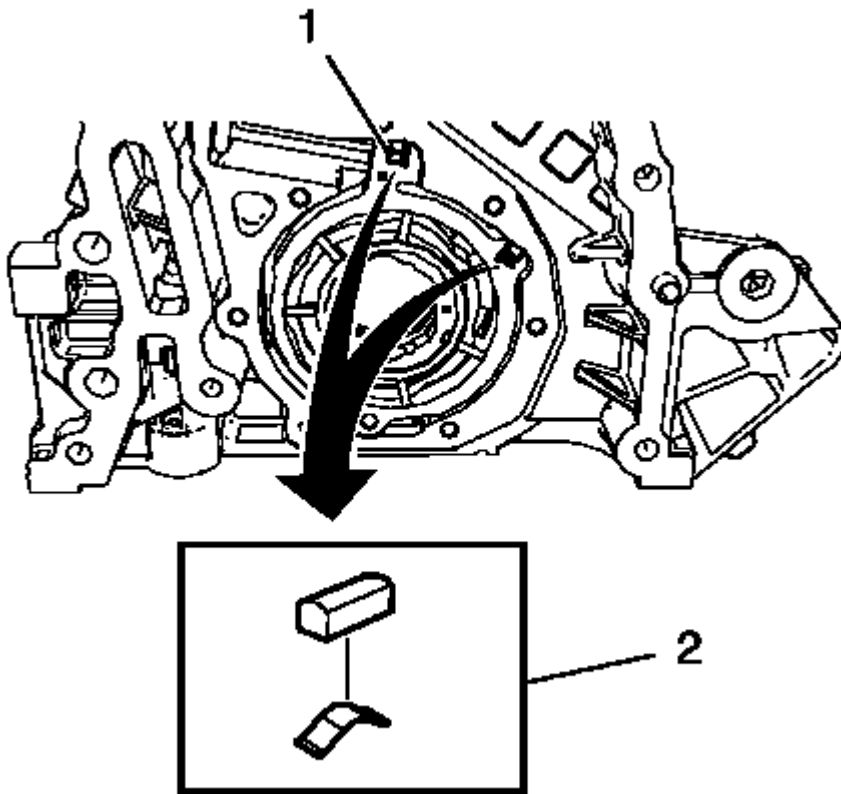
3. Install the oil pump vane rotor (4).

**NOTE:** Mind the localized flats (3) on the oil pump vanes (2) caused by the



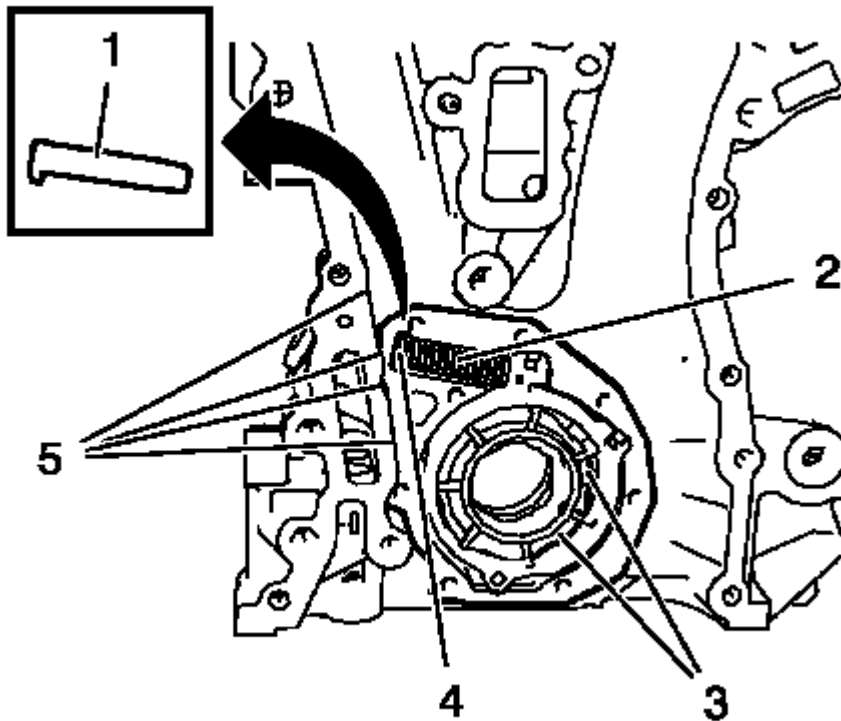
**oil pump vane rings. The localized flats must point to the oil pump vane rotor.**

4. Install the 6 oil pump vanes (2).
5. Install the outer oil pump vane ring (1).



**Fig. 462: Oil Pump Slide Seal Springs And Grooves**  
Courtesy of GENERAL MOTORS COMPANY

2. Install the 2 oil pump slide seals and the 2 oil pump slide seal springs (2) in the position as shown to the 2 grooves (1) of the oil pump slide.

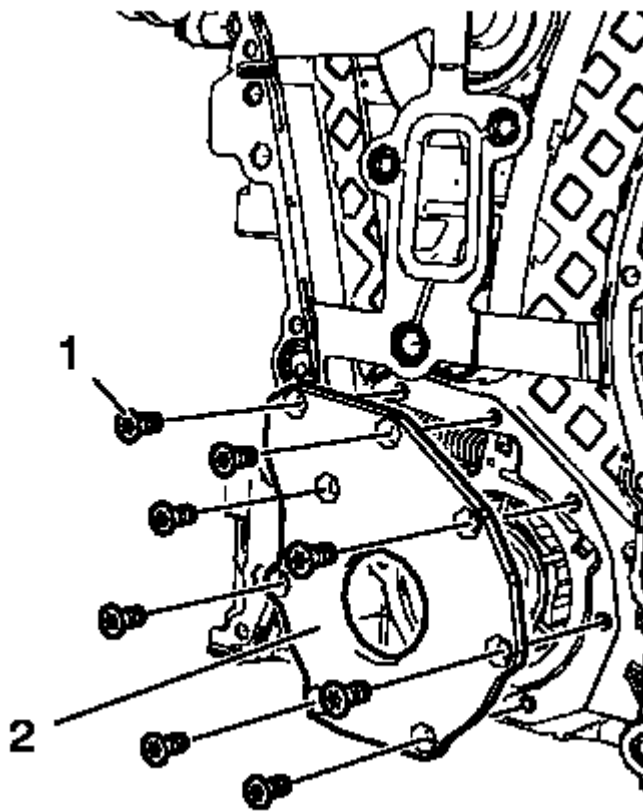


**Fig. 463: Oil Pump Slide Spring, Pin, Chambers And Front Cover Edge**  
Courtesy of GENERAL MOTORS COMPANY

3. Protect the engine front cover edge (5) with a suitable piece of plastic.

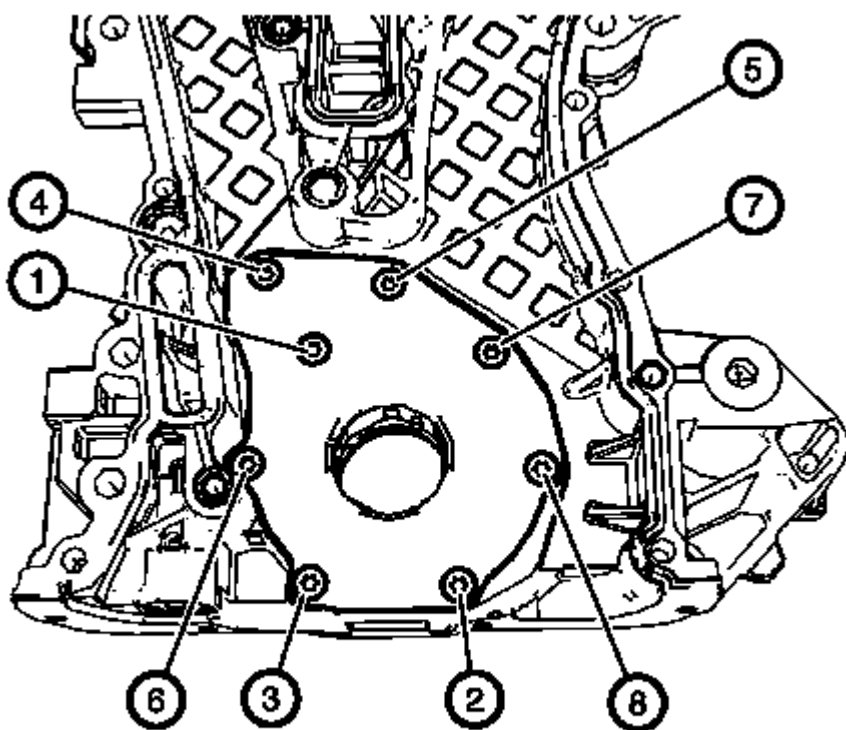
**NOTE:** The length of the removed oil pump slide spring (2) should be 76.5 mm (3.0118 in) for suction engines and 61 mm (2.4016 in) for turbo engines.

4. Install the oil pump slide spring pin along with the oil pump slide spring (4). Use a screwdriver to compress the oil pump slide spring. The flat side of oil pump slide spring pin must face upwards.
5. Measure the oil pump clearances to ensure a correct installation of the oil pump components. Refer to Engine Front Cover and Oil Pump Cleaning and Inspection.
6. Lubricate the oil pump vanes, the oil pump vane rotor, the oil pump slide spring and the area (3) with engine oil.
7. Inspect the oil pump slide spring mechanism for functionality.



**Fig. 464: Engine Oil Pump Cover And Bolts**  
Courtesy of GENERAL MOTORS COMPANY

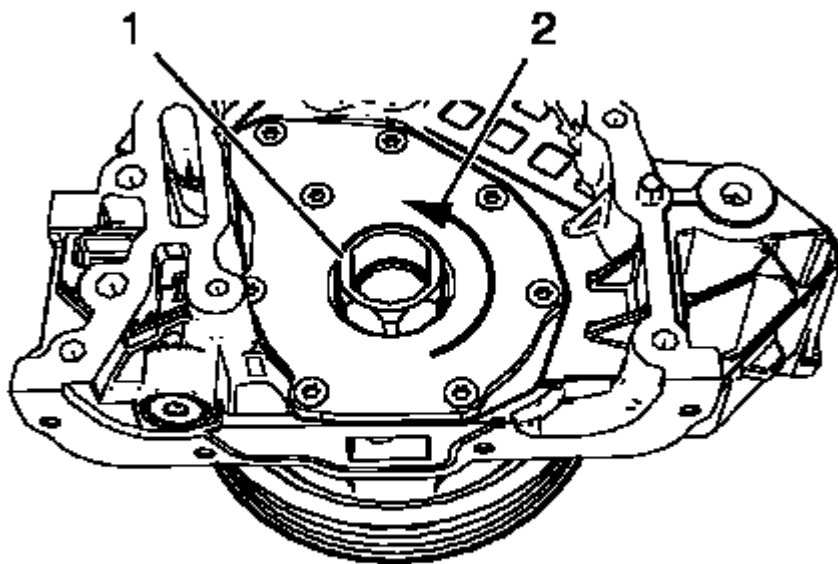
8. Install the oil pump cover (2) and the 8 oil pump cover bolts (1).



**Fig. 465: Oil Pump Cover Bolts Tightening Sequence**  
Courtesy of GENERAL MOTORS COMPANY

**CAUTION:** Refer to Fastener Caution .

9. Tighten the oil pump cover bolts in a sequence as shown to 8 N.m (71 lb in).

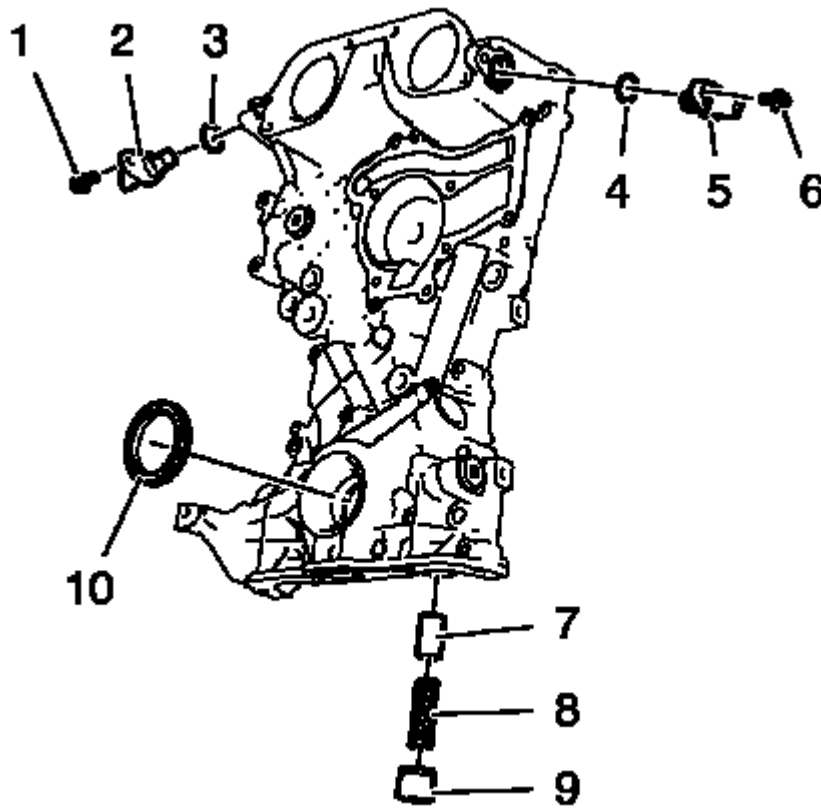


**Fig. 466: Crankshaft Balancer**

**Courtesy of GENERAL MOTORS COMPANY**

10. Install the crankshaft balancer (1) and rotate in the direction shown (2) in order to inspect the function of the oil pump mechanism. The crankshaft balancer should rotate easily.

**Engine Front Cover Assemble**



**Fig. 467: Locating Engine Front Cover Components**  
Courtesy of GENERAL MOTORS COMPANY

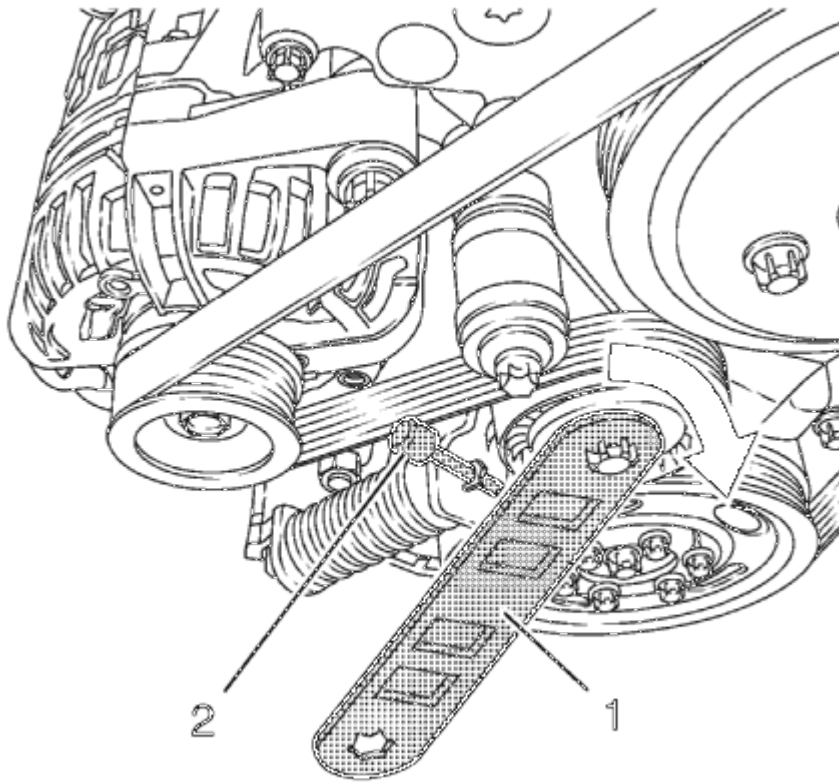
1. Install the crankshaft front oil seal (10).
2. Install the oil pressure relief valve (7), (8) and (9) and tighten to 50 N.m (37 lb ft).
3. Install the exhaust camshaft position sensor (5) and the seal ring (4).
4. Install the exhaust camshaft sensor bolt (6) and tighten to 6 N.m (53 lb in).
5. Install the intake camshaft position sensor (2) and the seal ring (3).
6. Install the intake camshaft sensor bolt (1) and tighten to 6 N.m (53 lb in).

## DRIVE BELT REMOVAL

### Special Tools

- EN-955 Locking Pins
- EN-48488 Holding Wrench

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



**Fig. 468: Locking Pin And Wrench**

Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-48488** wrench (1) to the drive belt tensioner.
2. Move the drive belt tensioner clockwise until the drive belt tensioner can be held with **EN-955-2** locking pin (2).
3. Remove the drive belt.

## ENGINE BLOCK CLEANING AND INSPECTION

### Special Tools

**EN-8087** Cylinder Bore Gauge

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

### Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all the following areas with solvent:
  - Sealing surfaces
  - Cooling passages

- Oil passages
3. Clean all threaded and through holes with solvent.

**WARNING: Wear safety glasses when using compressed air in order to prevent eye injury.**

4. Dry the engine block with compressed air.

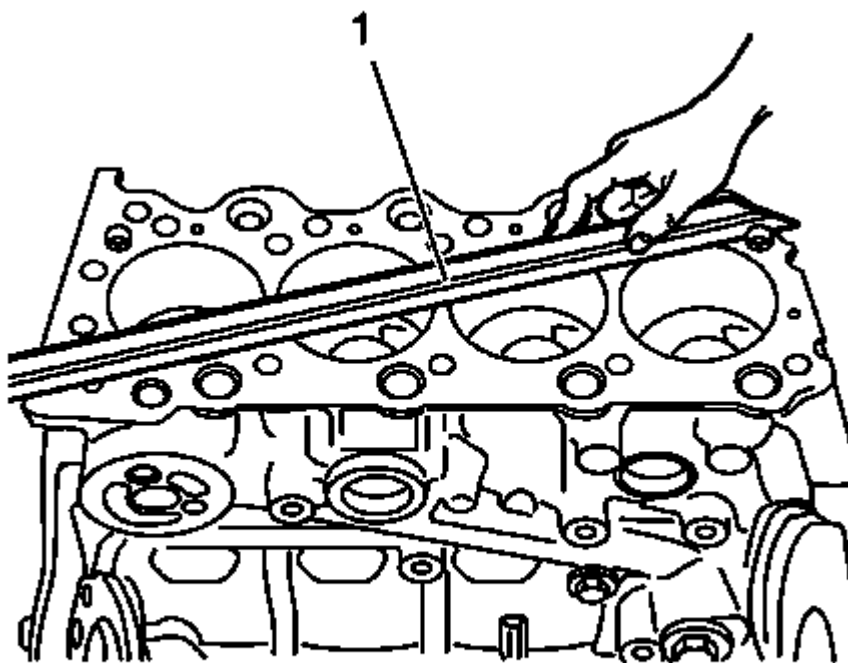
#### **Visual Inspection**

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the engine block assembly must be replaced.
2. Inspect all sealing and mating surfaces for damage, repair or replace the engine block assembly if necessary.
3. Inspect all threaded and through holes for damage or excessive debris.
4. Inspect all bolts for damage, if damaged replace with NEW bolts only.
5. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
6. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.

#### **Measuring Procedure**

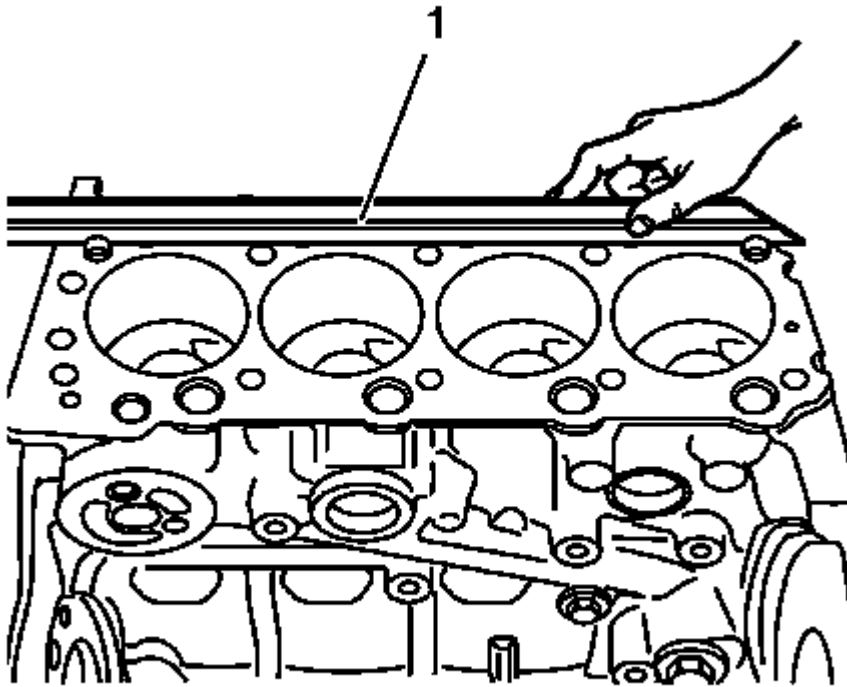
#### **Engine Block Flatness Inspection**





**Fig. 469: Inspecting Engine Block For Distortion Using Straight Edge**  
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the engine block as shown for distortion. Use a straightedge (1).



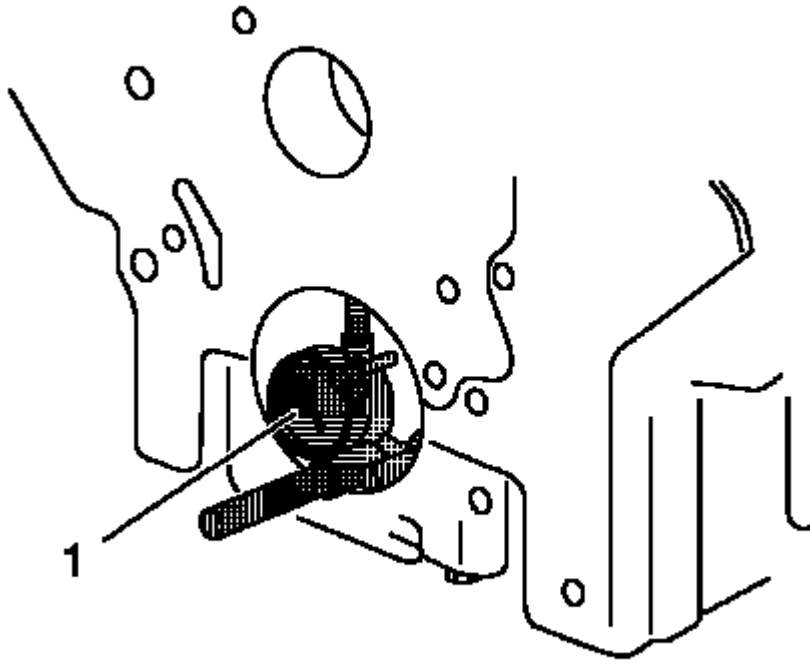
**Fig. 470: Inspecting Engine Block For Deflection Using Straight Edge**  
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the engine block as shown for deflection. Use a straightedge (1).

#### Cylinder bore and crankshaft bearing bore

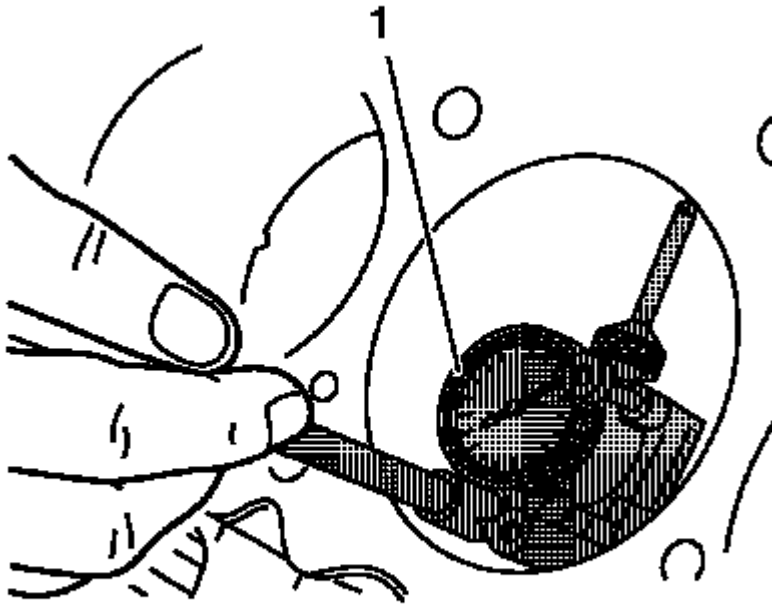
**NOTE:** Old bolts can be used for the measuring procedure.

1. Install the crankshaft bearing cap tie plate and tighten.



**Fig. 471: Measuring Bearing Bore Concentricity And Alignment Using Gauge Tool**  
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the crankshaft main bearing bores. Use the **EN-8087** gauge (1) to measure the bearing bore concentricity and alignment. Refer to **Engine Mechanical Specifications** to find the permitted values.
3. Replace the engine block and crankshaft bearing cap tie plate if the crankshaft bearing bores are out of specification.



**Fig. 472: Inspecting Cylinder Bore**  
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the cylinder bores using the **EN-8087** gauge (1). Inspect for the following items:
  - Wear
  - Taper
  - Runout
  - Ridging
5. Refer to **Engine Mechanical Specifications** to find the permitted values.
6. If the cylinder bores are out of specification, replace the engine block.
7. Remove the crankshaft bearing cap tie plate.

## DESCRIPTION AND OPERATION

### ENGINE COMPONENT DESCRIPTION

#### Cylinder Block

The cylinder hollow frame structured in-line 4 cylinder. 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 lubrication. The 3rd bearing is the thrust bearing which controls the proper axial end play of the crankshaft. A harmonic damper is used to control torsional vibration.

**Oil Pump**

The engine is equipped with a variable oil pump. The oil pump is integrated into the engine front cover and provides different oil pressure values depending on the engine speed.

**Oil Pan**

The oil pan is a structural aluminum oil pan with transmission attachment points. The oil suction gallery for the oil pump is integrated into the oil pan.

**Piston and Connecting Rod**

The pistons are aluminum pistons. The connecting rods are made of fractured steel. The piston pin is floating in piston bore and shrunk in connecting rod.

**Cylinder Head**

This cylinder head is a double over head camshaft (DOHC) type and has 2 camshafts that open 4 valves per cylinder with hydraulic valve lash adjusters and hydraulic valve lash adjuster arms. The cylinder head is made of cast aluminum alloy for better strength and hardness while remaining light weight. The combustion chamber of the cylinder head is designed for increasing of squish and swirl efficiency to help maximize gasoline combustion efficiency.

**Camshaft Drive with Variable Camshaft Timing**

A timing chain is used for camshaft drive. There is a tensioner to control the tension of the chain. The engine is equipped with a variable camshaft timing system. The camshaft adjuster will readjust itself depending on the engine speed. The valve timing readjusts to reduce fuel consumption and provide optimal power and torque.

**Intake Manifold**

The intake manifold provides the air flow passage to the combustion chambers through the throttle body. The intake manifold along with the throttle body have an effect on engine torque, power, noise, driveability, emission, fuel economy and performance. The intake manifold is made of plastic for better strength with maintaining a light weight.

**Turbocharger**

The turbocharger consists of turbine and compressor on a common shaft. The shaft bearing is constructed to higher rotation speed and lubricated by engine oil. The turbocharger is water cooled for improved durability. The turbine wheel is driven by exhaust emissions. The compressor wheel compresses the intake air. A bypass valve (Wastegate) regulates the charging pressure for generating a high pressure at low speed as well. At a

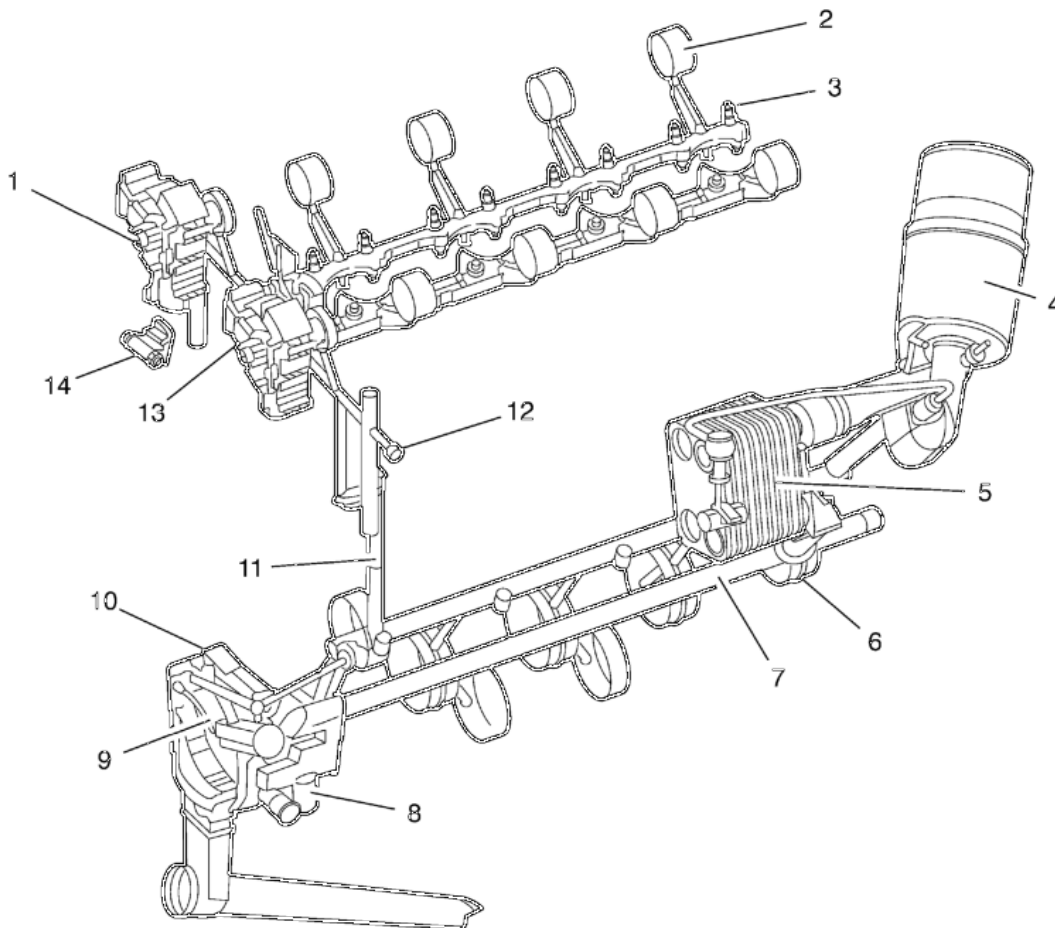
defined charging pressure it regulates the way of the exhaust emission on bypassing the turbine wheel. The Wastegate valve is controlled pneumatic and electric from the pressure in the intake manifold. The pressure of exhaust emission is reduced by opening the Wastegate thereby reducing the intake pressure.

### Positive Crankcase Ventilation

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 intake manifold. The primary control is through the positive crankcase ventilation (PCV) orifice which meters the flow at a rate depending on inlet vacuum. The PCV orifice is an integral part of the camshaft cover. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent into the intake system to be consumed by normal combustion.

## LUBRICATION DESCRIPTION

### General Lubrication Description



**Fig. 473: Lubrication System Components**

**Courtesy of GENERAL MOTORS COMPANY**

Oil is applied under pressure to the crankshaft bearings (6), connecting rod bearings (7), camshaft bearings (2) and hydraulic lash adjusters (3). In addition the variable oil pump (9), variable camshaft phaser (1), and hydraulic chain tensioner (14) are supplied with pressurized oil. Oil is sucked from the oil pan through the fixed screen into the variable vane type oil pump. The pump is integrated in the front cover and directly driven by the crankshaft. Also integrated into the front cover is a pressure relieve valve (8) that opens when the oil pressure is too high at a cold start. When that valve is open some oil flows directly into the oil pan. Normally the pressurized oil passes into the engine oil gallery leading through the oil cooler (5) to the oil filter assembly (4). The oil is cleaned by passing the filter from the outer to the inner side of the filter. Then the oil flows into the main oil gallery. A filter by-pass valve in the oil filter ensures continues oil flow in case the oil filter should be restricted by more than 1.7 bar. From the oil filter the oil is distributed to the crankshaft bearings, oil pump displacement control chamber (10) and cylinder head feed (11). The connecting rod bearings are supplied by oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. In the cylinder head the oil is distributed to the variable camshaft phasers, chain tensioner, oil pressure switch (12) and through the restrictor orifice (13) into the camshaft feed oil gallery. From there the hydraulic valve lifters and camshaft bearings are supplied with oil.

**Variable Oil Pump Description**

The engine is equipped with a variable displacement vane oil pump. It is indirect regulated by the oil pressure out of the main oil gallery. The purpose of this indirect regulation is to keep a defined maximum pressure in the main oil gallery independent of the individual pressure drop between the pump outlet, the main gallery inlet, and the various engine components. The purpose of the variable displacement is to reduce the power consumption of the pump to reduce the overall fuel consumption of the engine. The oil flow of a static displacement oil pump is linear to the speed of the pump. This would lead to a too high oil pressure after a certain engine speed (ca. 1000 rpm at cold oil temperature, ca. 3000 rpm at hot oil temperatures). To reduce that high oil pressure normal pumps have a relieve valve: a portion of the pressurized, already pumped oil is fed back to the intake of the pump. This is waste of power. The oil flow of a Variable Displacement Vane Pump (VDVP) as used in Fam 0 Gen 3 is linear to the speed and to the excentricity of the rotor to the slide. The slide is moveable, so it is possible to reduce the oil flow for a given speed by reducing the excentricity. With a lower flow the oil pressure is reduced; pump oil flow equals now engine oil flow.

**CLEANLINESS AND CARE**

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

**WARNING:** Refer to **Battery Disconnect Warning** .

Disconnect the negative battery cables before you perform any major work on the engine.

## USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

### Pipe Joint Compound

**NOTE:** Three types of sealer are commonly used in engines. These are RTV sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. **DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.**

- Pipe joint compound is a pliable sealer that does not completely harden. This type sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container. To remove the sealant or the gasket material.
- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

## SPECIAL TOOLS AND EQUIPMENT

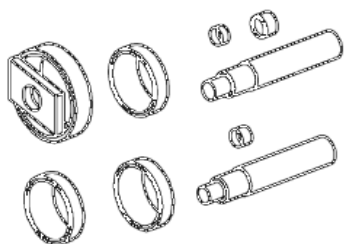
### SPECIAL TOOLS

Illustration	Tool Number/Description
	EN-194-E KM-194-E Spark Plug Key

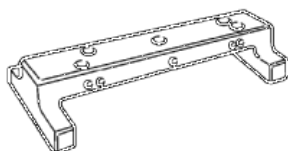


## 2012 Chevrolet Sonic LTZ

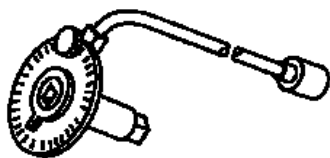
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-235-D  
KM-235-D  
Seal Installer Kit



EN-301  
KM-301  
Measuring Bridge

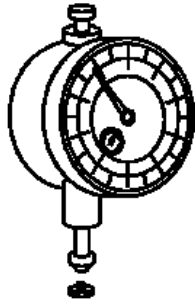
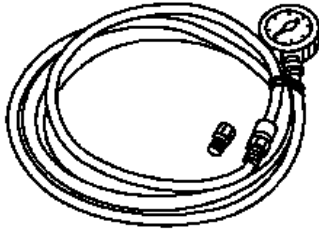


EN-470-B  
KM-470-B  
J-45059  
Angular Torque Wrench

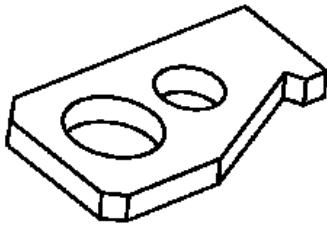
EN-498-B  
KM-498-B  
Pressure Gauge

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GE-571-B  
MKM-571-B  
Dial Gauge



EN-652  
DT-652  
KM-652  
Flywheel Holder

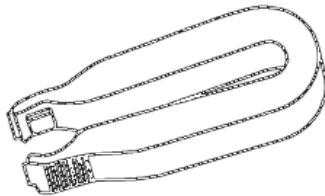
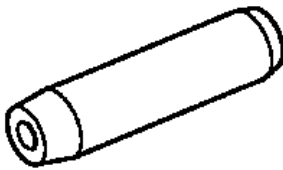


EN-658  
KM-658  
J-35264  
Installer

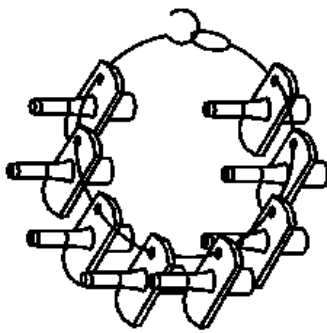
EN-663  
KM-663  
Installer

## 2012 Chevrolet Sonic LTZ

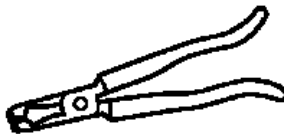
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-796-A  
KM-796-A  
Remover Quick Fitting



CH-807  
KM-807  
Plugs

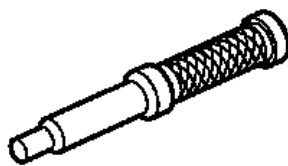
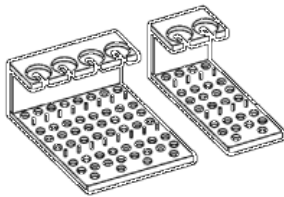


EN-840  
KM-840  
Pliers / Remover

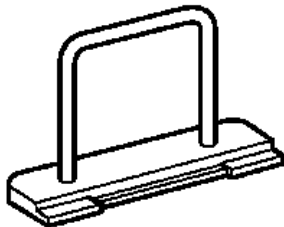
EN-849  
KM-849  
Assembly Tray

## 2012 Chevrolet Sonic LTZ

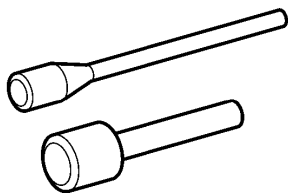
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-952  
KM-952  
Fixing Tool Crankshaft



EN-953-A  
Fixing Tool Camshaft

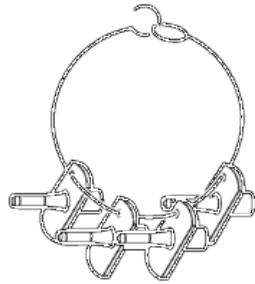
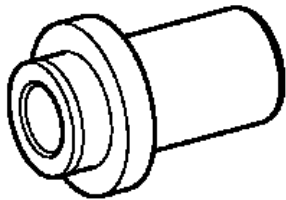
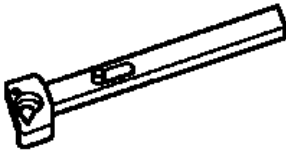


EN-955  
KM-955  
Locking Pins

EN-956-1  
KM-956-1  
Extension

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2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-960  
KM-960  
Installer

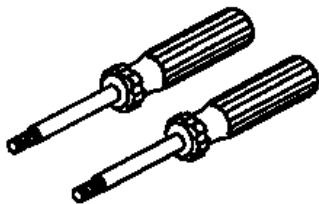
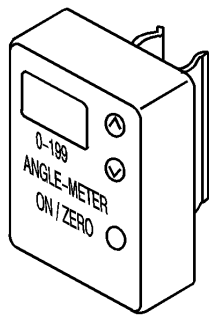
EN-6015  
KM-6015  
Closure Plugs

EN-45000  
KM-J45000  
J-45000  
Remover Oil Seal

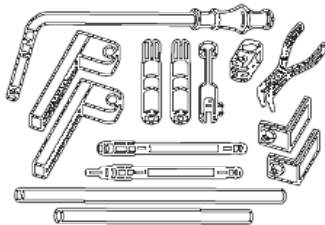
EN-45059  
Angle Meter

## 2012 Chevrolet Sonic LTZ

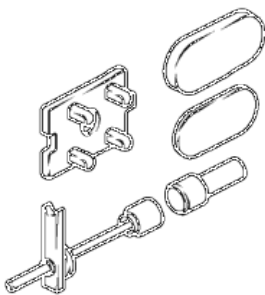
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-6009  
KM-6009  
Remover / Installer



EN-6086  
MKM-6086  
Basic Kit, Spring and Wedge Replacer

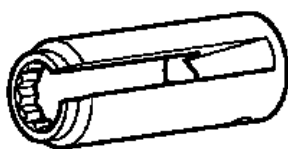
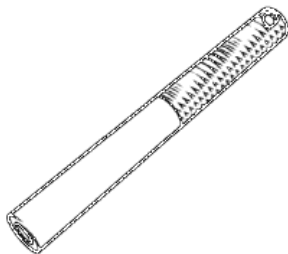


EN-6167  
KM-6167  
Adapter Kit

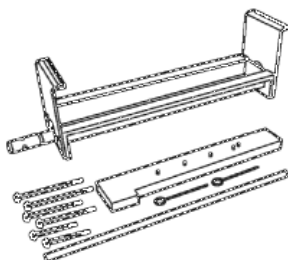
EN-6171  
KM-6171  
Release Tool

## 2012 Chevrolet Sonic LTZ

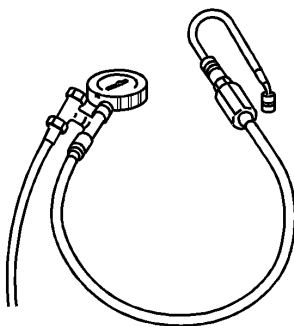
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-6179  
KM-6179  
Installer / Remover



EN-6215  
KM-6215  
Mounting Equipment

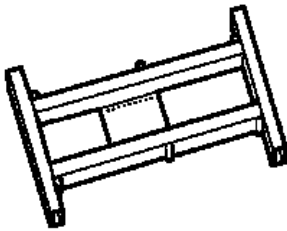
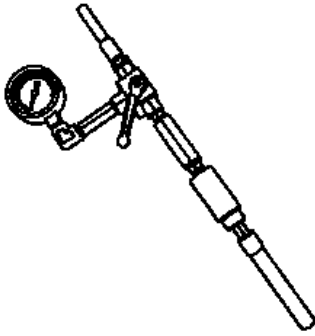


EN-34730-91  
KM-34730-91  
J-34730-91  
Pressure Tester

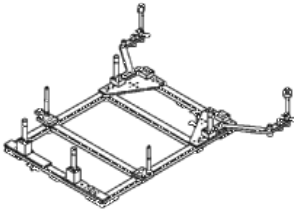
EN-48248  
Cylinder Compression Pressure Gauge

## 2012 Chevrolet Sonic LTZ

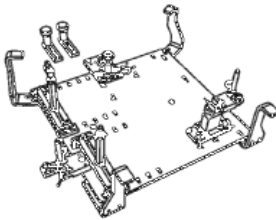
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



CH-904  
Base Frame



CH-49289  
Centering Frame



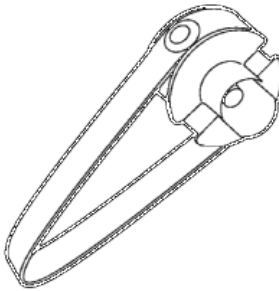
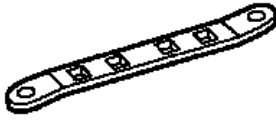
CH-49290  
Engine Support Tool

EN-48488  
KM-956  
Holding Wrench



## 2012 Chevrolet Sonic LTZ

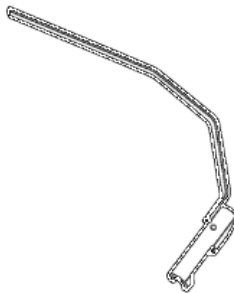
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-49940  
Remover Quick Connector



EN-49941  
Remover / Installer Piston Retainer Ring

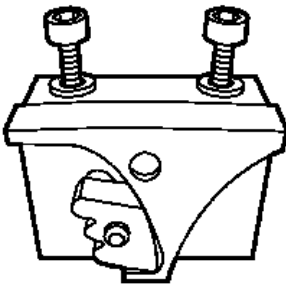
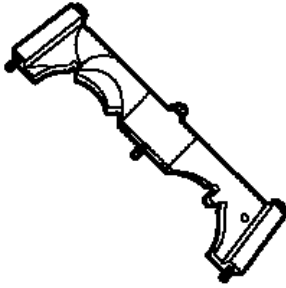


EN-49942  
Holding Wrench

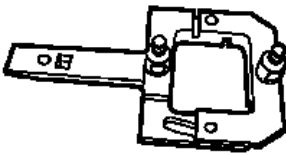
EN-49977-100  
Fixation Sensor Disks and Camshafts

## 2012 Chevrolet Sonic LTZ

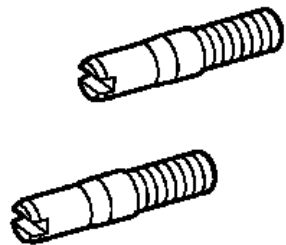
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-49977-200  
Fixing Tool



EN-49979  
Retainer Shock Mount Crankshaft

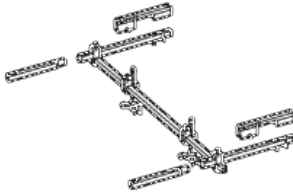
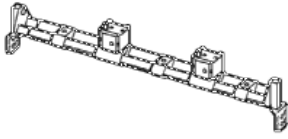


EN-49980  
Guidance Pins Oil Pan

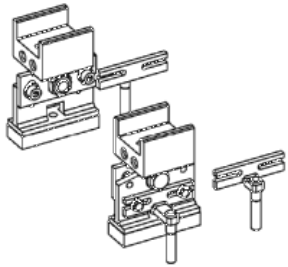
EN-47649  
Engine Bridge

## 2012 Chevrolet Sonic LTZ

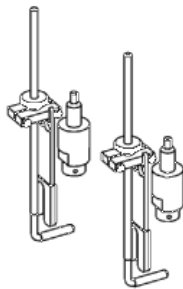
2012 ENGINE Engine Mechanical - 1.4L (LUV) - Sonic



EN-47650  
Retainer Frame



EN-47650-300  
Adapter



EN-47650-200  
Front Adapter