

2009 Buick LaCrosse CXL

2009 ENGINE Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse

2009 ENGINE**Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****Fastener Tightening Specifications**

Application	Specifications	
	Metric	English
A/C Compressor Bracket Bolt	50 N.m	37 lb ft
A/C Compressor Nut	30 N.m	22 lb ft
Balance Shaft Driven Gear Bolt		
• First Pass	22 N.m	16 lb ft
• Final Pass	70 degrees	
Balance Shaft Retainer Bolt	30 N.m	22 lb ft
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Camshaft Sprocket Bolt		
• First Pass	100 N.m	74 lb ft
• Final Pass	90 degrees	
Camshaft Thrust Plate Bolt	15 N.m	11 lb ft
Connecting Rod Bearing Cap Bolts		
• First Pass	27 N.m	20 lb ft
• Final Pass	50 degrees	
Crankshaft Balancer Bolt		
• First Pass	150 N.m	111 lb ft
• Final Pass	76 degrees	
Crankshaft Main Bearing Cap Bolt		
• First Pass	40 N.m	30 lb ft
• Final Pass	110 degrees	
Crankshaft Main Bearing Cap Bolt - Side		
• First Pass	15 N.m	11 lb ft
• Final Pass	45 degrees	
Crankshaft Position Sensor Stud	30 N.m	22 lb ft
Crankshaft Rear Oil Seal Housing Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	
Cylinder Head Bolt		

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• First Pass	50 N.m	37 lb ft
• Final Pass	120 degrees	
Drive Belt Tensioner Bolt/Nut	50 N.m	37 lb ft
Drive Belt Tensioner Bracket Stud	17 N.m	12 lb ft
EGR Valve Adapter to Cylinder Head Bolt/Stud	50 N.m	37 lb ft
EGR Valve Inlet Pipe to Exhaust Manifold Bolt	29 N.m	21 lb ft
EGR Valve Nut	29 N.m	21 lb ft
EGR Valve Outlet Pipe Bolt/Nut	29 N.m	21 lb ft
EGR Valve Wiring Harness Heat Shield Bolt/Nut	10 N.m	89 lb in
Engine Coolant Temperature Sensor	25 N.m	18 lb ft
Engine Flywheel Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	
Engine Front Cover Bolt/Stud		
• First Pass	20 N.m	15 lb ft
• Final Pass	40 degrees	
Engine Lift Bracket Bolt/Nut/Stud	30 N.m	22 lb ft
Engine Mount Bracket Bolt	102 N.m	75 lb ft
Engine Mount Nut - Lower	47 N.m	35 lb ft
Engine Mount Nut - Upper	47 N.m	35 lb ft
Engine Mount Strut Bolt	48 N.m	35 lb ft
Engine Mount Strut Bracket Bolt - Lower - to Upper Strut Mount	50 N.m	37 lb ft
Engine Mount Strut Bracket Bolt - to Cylinder Head	50 N.m	37 lb ft
Engine Mount Strut Bracket Bolt - to Radiator Support	28 N.m	21 lb ft
Engine Mount Strut Bracket Nuts - Right	50 N.m	37 lb ft
Engine Mount Strut Nut	48 N.m	35 lb ft
Engine Mount Strut Bracket Nut - Lower - to Exhaust Stud	25 N.m	18 lb ft
Engine to Transaxle Bolt/Stud	75 N.m	55 lb ft
Engine Wiring Harness Ground Nut	35 N.m	26 lb ft
Engine Wiring Harness Heat Shield Bolt/Nut	10 N.m	89 lb in
EVAP Purge Valve Bolt	12 N.m	106 lb in
Exhaust Manifold Bolt/Nut	30 N.m	22 lb ft
Exhaust Manifold Heat Shield Bolt	10 N.m	89 lb in
Exhaust Manifold Heat Shield Nut	25 N.m	18 lb ft
Exhaust Manifold Pipe Stud Nut	32 N.m	24 lb ft
Exhaust Manifold Stud	10 N.m	89 lb in
Frame Bolts	180 N.m	133 lb ft
Fuel Injector Rail Assembly Nut	10 N.m	89 lb in
Fuel Injector Rail Stud	25 N.m	18 lb ft

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Fuel Injector Sight Shield Bracket Nut	30 N.m	22 lb ft
Generator Brace Bracket Bolt	50 N.m	37 lb ft
Generator Bracket Bolt	50 N.m	37 lb ft
Heated Oxygen Sensor	42 N.m	31 lb ft
Idler Pulley Bolt	50 N.m	37 lb ft
Idler Pulley Bracket Bolt	30 N.m	22 lb ft
Ignition Control Module Bracket Stud	17 N.m	12 lb ft
Ignition Control Module Assembly Bracket Bolt	30 N.m	22 lb ft
Ignition Control Module Assembly Bracket Nut	50 N.m	37 lb ft
Ignition Control Module Assembly Nut	8 N.m	71 lb in
Knock Sensor	18 N.m	13 lb ft
Knock Sensor Heat Shield Bolt	50 N.m	37 lb ft
Lower Engine Mount Strut Bracket Bolt	50 N.m	37 lb ft
Lower Engine Mount Strut Bracket Nut	30 N.m	22 lb ft
Lower Intake Manifold Bolt	15 N.m	11 lb ft
MAP/ BARO Sensor Bracket Bolt	30 N.m	22 lb ft
Motor Mount to Frame Bolts	47 N.m	35 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Adapter Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass	50 degrees	
Oil Gallery Plug	30 N.m	22 lb ft
Oil Level Indicator Tube Stud/Nut	19 N.m	14 lb ft
Oil Level Sensor Bolt	20 N.m	15 lb ft
Oil Level Sensor Wiring Harness Bolt	10 N.m	89 lb in
Oil Pan Bolt	14 N.m	125 lb in
Oil Pan Drain Plug	30 N.m	22 lb ft
Oil Pressure Sensor	16 N.m	12 lb ft
Oil Pump Cover Screw	11 N.m	98 lb in
Oil Pump Pipe and Screen Bolt	15 N.m	11 lb ft
Positive Battery Cable	15 N.m	11 lb ft
Positive Crankcase Ventilation (PCV) Valve Access Bolt	10 N.m	89 lb in
Power Steering Bolts	34 N.m	25 lb ft
Right Engine Mount Strut Bracket Nut/Stud	50 N.m	37 lb ft
Spark Plug	15 N.m	11 lb ft
Starter Motor Heat Shield Bolt	30 N.m	22 lb ft
Supercharger Bolt/Stud	23 N.m	17 lb ft
Supercharger Bypass Valve Nut	8 N.m	71 lb in
Supercharger Oil Plug	10 N.m	89 lb in
Throttle Body Bolt/Nut	10 N.m	89 lb in
Timing Chain Dampener Bolt	22 N.m	16 lb ft

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Upper Intake Manifold Bolt	10 N.m	89 lb in
Upper Intake Manifold Cover Nut	3 N.m	27 lb in
Valve Lifter Guide Retainer Bolt	30 N.m	22 lb ft
Valve Rocker Arm Bolt		
• First Pass	15 N.m	11 lb ft
• Final Pass	90 degrees	
Valve Rocker Arm Cover Bolt	10 N.m	89 lb in
Water Outlet Housing Bolt	27 N.m	20 lb ft
Water Pump Bolts		
• Long Bolts First Pass	20 N.m	15 lb ft
• Long Bolts Final Pass	40 degrees	
• Short Bolts First Pass	15 N.m	11 lb ft
• Short Bolts Final Pass	80 degrees	
Water Pump Pulley Bolt	13 N.m	116 lb in
Wiring Harness Retainer Bolt	10 N.m	89 lb in

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General Data		
• Engine Type	90 degrees V-6	
• Displacement	3.8L	231 cu in
• RPO	L26, L32	
• VIN	2, 4	
• Bore	96.52 mm	3.8 in
• Stroke	86.36 mm	3.4 in
• Compression Ratio VIN K - @ 4 Compression Strokes	9.4:1	
• Compression Ratio VIN 1 - @ 4 Compression Strokes	8.5:1	
• Firing Order	1-6-5-4-3-2	
• Spark Plug Gap	1.52 mm	0.60 in
Balance Shaft		
• Bearing Bore Diameter - Front	51.973-51.999 mm	2.0462-2.0472 in
• Bearing Bore Diameter-Rear-In Block	47.584-47.612 mm	1.8735-1.8745 in
• Bearing Inside Diameter - Rear	38.117-38.194 mm	1.5007-1.5037 in
• Bearing Journal Diameter - Rear	38.072-38.105 mm	1.4989-1.5002 in

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• Bearing Clearance - Rear	0.0127-0.1219 mm	0.0005-0.0048 in
• End Play	0.0-0.171 mm	0.0-0.0067 in
• Gear Lash	0.050-0.125 mm	0.002-0.0049 in
Block		
• Balance Shaft Bearing Bore Diameter - Front	51.973-51.999 mm	2.0462-2.0472 in
• Balance Shaft Bearing Inside Diameter - Rear	38.118-38.194 mm	1.5007-1.5037 in
• Balance Shaft Bearing Bore Diameter - Rear, In Block	47.584-47.612 mm	1.8735-1.8745 in
• Camshaft Bearing Inside Diameter - Front and Rear	46.970-46.934 mm	1.8428-1.8492 in
• Camshaft Bearing Inside Diameter - Middle #2, #3	46.977-46.942 mm	1.8481-1.8495 in
• Crankshaft Main Bearing Bore Diameter	68.249-68.270 mm	2.6870-2.6878 in
• Cylinder Bore Diameter	98.5 mm	3.8 in
• Cylinder Bore Out-of-Round - Diametral	0.0254 mm	0.001 in
• Cylinder Bore Taper	0.0254 mm	0.001 in
• Cylinder Head Deck Height	216.459 mm	8.522 in
• Cylinder Head Deck Surface Flatness - Overall	0.0762 mm	0.003 in
• Valve Lifter Bore Diameter	21.424-21.450 mm	0.8435-0.8445 in
Camshaft		
• Camshaft Bearing Inside Diameter - 1 and 4	46.970-46.934 mm	1.8478-1.8492 in
• Camshaft Bearing Inside Diameter 2 and 3	46.977-46.942 mm	1.8481-1.8495 in
• Camshaft Journal Diameter	47.655-46.858 mm	1.8462-1.8448 in
• Camshaft Journal Out-of-Round	0.00635 mm	0.00025 in
• Camshaft Journal to Bearing Clearance	0.041-0.119 mm	0.0016-0.0047 in
• Camshaft Lobe Duration - Exhaust	330 Crankshaft degrees	
• Camshaft Lobe Duration - Intake	320 Crankshaft degrees	
• Camshaft Lobe Lift - Exhaust	6.56 mm	0.258 in
• Camshaft Lobe Lift - Intake	6.56 mm	0.258 in
• Camshaft Lobe Overlap	96 Crankshaft degrees	
Connecting Rod		
• Connecting Rod Bearing Clearance	0.0127-0.0660 mm	0.0005-0.0026 in
• Connecting Rod Bore Diameter	60.295-60.312 mm	2.37378-2.3745 in
• Connecting Rod Length - Center to Center - S/C	143.205-143.307 mm	5.638-5.642 in
• Connecting Rod Length - Center to Center - Non S/C	145.796-145.898 mm	5.740-5.744 in
• Connecting Rod Side Clearance	0.102-0.508 mm	0.004-0.0200 in
Crankshaft		

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• Connecting Rod Journal Diameter	57.1170-57.1475 mm	2.2487-2.2499 in
• Connecting Rod Journal Out-of-Round	0.00508 mm	0.00020 in
• Connecting Rod Journal Taper	0.00889 mm	0.00035 in
• Crankshaft End Play	0.076-0.276 mm	0.003-0.011 in
• Crankshaft Main Bearing Clearance - #1	0.0178-0.0406 mm	0.0007-0.0016 in
• Crankshaft Main Bearing Clearance - #2, 3 and 4	0.0229-0.0457 mm	0.0009-0.0018 in
• Crankshaft Main Journal Diameter	63.470-63.495 mm	2.4988-2.4998 in
• Crankshaft Main Journal Out-of-Round	0.00635 mm	0.00025 in
• Crankshaft Main Journal Taper	0.00889 mm	0.00035 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Runout - from Main 2 & 3 to 1 & 4	0.076 mm	0.003 in
Cylinder Head		
• Combustion Chamber Depth - at Measurement Point	3.9166-5.4356 mm	0.154-0.214 in
• Cylinder Head Height/Thickness	103.492-104.178 mm	4.0745-4.1015 in
• Surface Finish	0.0032 mm	0.000125 in
• Surface Flatness - Block Deck	0.1016 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.1016 mm	0.004 in
• Surface Flatness - Intake Manifold Deck	0.1016 mm	0.004 in
• Valve Guide Bore - Exhaust	8.001-8.0213 mm	0.3150-0.3158 in
• Valve Guide Bore - Intake	8.001-8.0213 mm	0.3150-0.3158 in
Exhaust Manifold		
• Surface Flatness - Maximum	0.5 mm	0.02 in
Lubrication System		
• Oil Capacity - with Filter	4.3L	4.5 qts
• Oil Capacity - without Filter	3.76L	4 qts
• Oil Pressure - @ 1850 RPM	414 kPa	60 psi
Oil Pump		
• Gear Pocket - Depth	11.71-11.75 mm	0.461-0.4625 in
• Gear Pocket - Diameter	89.10-89.20 mm	3.508-3.512 in
• Inner Gear Tip Clearance	0.152 mm	0.006 in
• Relief Valve-to-Bore Clearance	0.038-0.076 mm	0.0015-0.003 in
Piston Ring End Gap		
• First Compression Ring	0.25-0.46 mm	0.010-0.018 in
• Second Compression Ring	0.58-0.84 mm	0.023-0.033 in

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• Oil Control Ring	0.254-0.762 mm	0.010-0.030 in
Piston Ring to Groove Clearance		
• First Compression Ring	0.033-0.079 mm	0.0013-0.0031 in
• Second Compression Ring	0.033-0.079 mm	0.0013-0.0031 in
• Oil Control Ring	0.023-0.201 mm	0.0009-0.0079 in
Piston Ring Thickness		
• First Compression Ring	1.176-1.197 mm	0.0463-0.0471 in
• Second Compression Ring	1.476-1.497 mm	0.0581-0.0589 in
• Oil Control Ring	1.854-2.007 mm	0.073-0.079 in
Pistons and Pins - Piston		
• Piston Diameter - Production - S/C	96.489-96.528 mm	3.7988-3.8003 in
• Piston Diameter - Production - Non S/C	96.482-96.497 mm	3.7985-3.7991 in
• Piston Diameter - Service Limit - Minimum - S/C	96.434 mm	3.7966 in
• Piston Diameter - Service Limit - Minimum - Non S/C	96.442 mm	3.7969 in
• Piston Pin Bore Diameter - S/C	23.0065-23.0105 mm	0.9058-0.9059 in
• Piston Pin Bore Diameter - Non S/C	22.0060-22.0110 mm	0.8664-0.8666 in
• Piston to Bore Clearance - New - VIN K	0.010-0.051 mm	0.0004-0.0020 in
• Piston to Bore Clearance - Used - VIN K	0.050-0.091 mm	0.0020-0.0036 in
• Piston to Bore Clearance - New - VIN 1	-0.0207-0.0437 mm	-0.0008-0.0018 in
• Piston to Bore Clearance - Used VIN 1	0.0193-0.0997 mm	0.0008-0.0039 in
Pistons and Pins - Pin		
• Piston Pin Clearance to Connecting Rod Bore - Clearance - VIN 2	0.0066-0.0217 mm	0.0003-0.0009 in
• Piston Pin Clearance to Piston Pin Bore - VIN K	0.0020-0.0130 mm	0.00008-0.00051 in
• Piston Pin Diameter - Clearance - VIN 4	21.9950-22.000 mm	0.8659-0.8661 in
• Piston Pin Clearance to Connecting Rod Bore - Press Fit - VIN 1	0.0073-0.0225 mm	0.00029-0.00089 in
• Piston Pin Clearance to Piston Pin Bore - VIN 1	0.0065-0.0155 mm	0.00061-0.00026 in
• Piston Pin Diameter - VIN 1	22.995-23.000 mm	0.90531-0.90551 in
Valves		
• Valve Face Angle	46 degrees	
• Valve Face Runout	0.0508 mm	0.002 in
• Valve Head Diameter - Intake	46.37-46.63 mm	1.826-1.836 in
• Valve Head Diameter - Exhaust	38.481-38.735 mm	1.515-1.525 in

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• Valve Length	119.464-119.972 mm	4.7033-4.7233 in
• Valve Seat Angle	45 degrees	
• Valve Seat Runout	0.050 mm	0.002 in
• Valve Seat Width - Intake	1.53-2.03 mm	0.060-0.080-in
• Valve Seat Width - Exhaust	2.29-2.79 mm	0.090-0.110 in
• Valve Stem Diameter	7.948-7.965 mm	0.3129-0.3136 in
• Valve Stem-to-Guide Clearance - Intake	0.031-0.071 mm	0.0012-0.0028 in
• Valve Stem-to-Guide Clearance - Exhaust	0.036-0.074 mm	0.0014-0.0029 in
Valve Lifters/Push Rods		
• Push Rod Length - Intake, Yellow	178.13 mm	7.013 in
• Push Rod Length - Exhaust, Green	178.13 mm	7.013 in
• Valve Lifter Diameter	21.387-21.405 mm	0.842-0.843 in
Valve Rocker Arms		
• Valve Rocker Arm Ratio	1.66:1	
Valve Springs		
• Valve Spring Free Length	49.78 mm	1.960 in
• Valve Spring Installed Height	42.93-44.45 mm	1.690-1.750 in
• Valve Spring Load - Closed	334 N @ 43.69 mm	75 lb @ 1.72 in
• Valve Spring Load - Open	1014 N @ 32.4 mm	228 lb @ 1.277 in
• Valve Spring Total Munber of Coils	6.6	

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Crankshaft Position Sensor Bolt/Stud Threads	Threadlock	12345382	10953489
Crankshaft Side Main Bolt Threads	Threadlock	12345493	10953488
Engine Block Coolant Drain Plug Threads	Sealant	12346004	10953480
Engine Block Oil Gallery Plug Threads	Sealant	12346004	10953480
Engine Front Cover Bolt Threads	Sealant	12346004	10953480
EOS Engine Assembly Prelube	Lubricant	1052367	992869
Exhaust Manifold Bolt and Stud Threads	Threadlock	12345493	10953488
Intake Manifold Bolt Threads -Lower	Threadlock	12345493	10953488
Intake Manifold Coolant Pipe	Sealant	12345493	10953488
Intake Manifold to Engine Block Mating Surface	Sealant	12378521	88901148
Knock Sensor Threads	Sealant	12346004	10953480

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Oil Filter Bypass Hole Plug Threads	Sealant	12346004	10953480
Oil Pan	Sealant	12378521	88901148
Oil Pan Bolt Threads	Threadlock	12345382	10953489
Oil Pressure Switch Threads	Sealant	12346004	10953480
Piston and Piston Pin	Oil-5W-30	12345610	729389
Rear Crankshaft Main Bearing Cap	Sealant	12378521	88901148
Supercharger Oil	Lubricant	12345982	10953513
Valve Lifter and Camshaft Prelube	Lubricant	12345501	992704
Valve Rocker Arm Cover Bolt Threads	Threadlock	12345382	10953489
Valve Rocker Arm Bolt Threads	Threadlock	12345493	10953488
Valve Train Component Prelube, except valve lifter/camshaft face	Lubricant	1052367	992869

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE MECHANICAL SCHEMATICS

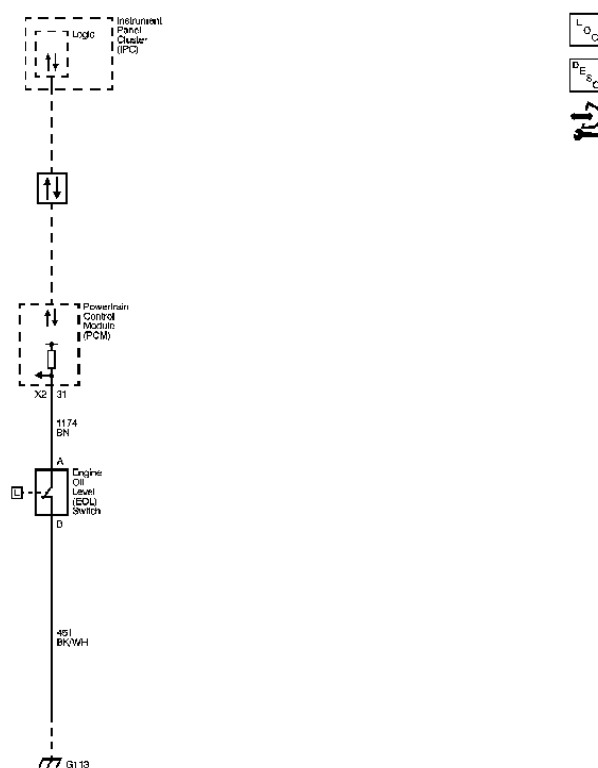


Fig. 1: Engine Oil Level (EOL) Switch Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

DISASSEMBLED VIEWS

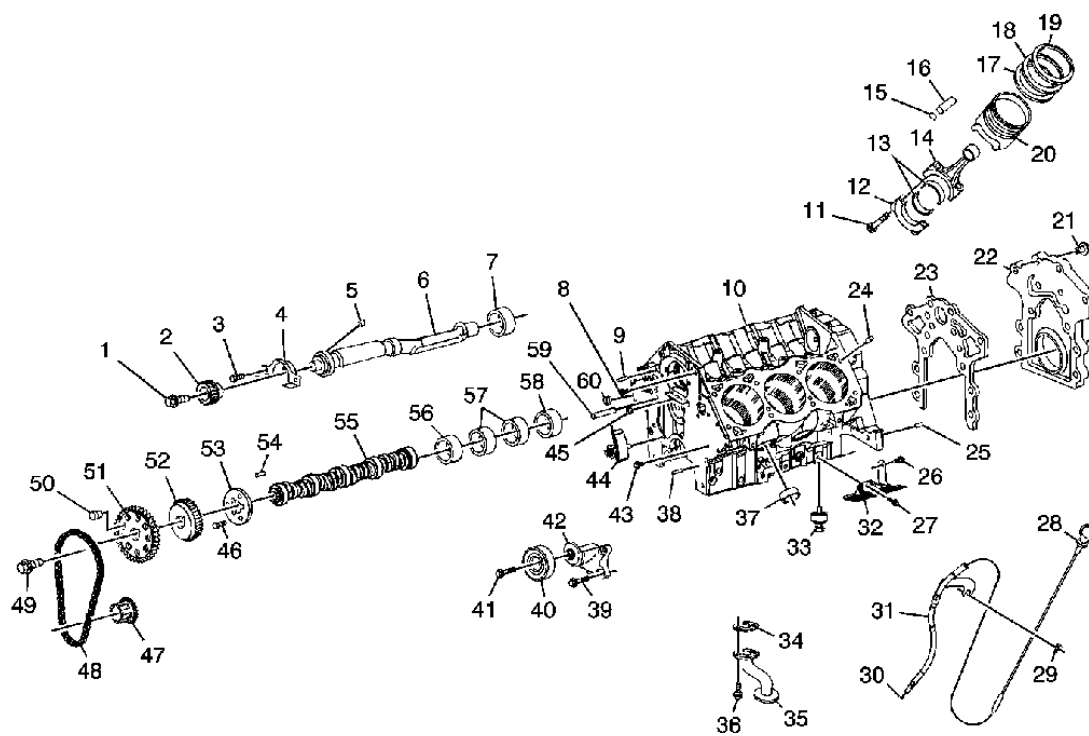


Fig. 2: Engine Block and Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Balance Shaft Gear Bolt
2	Balance Shaft Driven Gear
3	Balance Shaft Retainer Bolt
4	Balance Shaft Retainer
5	Balance Shaft Gear Pin
6	Balance Shaft
7	Balance Shaft Rear Bushing
8	Engine Mount Strut Access Hole Plug
9	Engine Front Cover Location Pin
10	Engine Block
11	Connecting Rod Bolt
12	Connecting Rod Bearing Cap
13	Connecting Rod Bearing
14	Connecting Rod
15	Piston Pin Retainer
16	Piston Pin

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17	Piston Oil Ring
18	Piston Compression Lower Ring
19	Piston Compression Upper Ring
20	Piston
21	Crankshaft Rear Oil Seal Housing Bolt
22	Crankshaft Rear Oil Seal Housing
23	Crankshaft Rear Oil Seal Housing Gasket
24	Cylinder Head Location Pin
25	Transmission Locating Pin
26	Starter Motor Heat Shield Bolt
27	Starter Motor Heat Shield Bolt
28	Oil Level Indicator
29	Oil Level Indicator Tube Nut
30	Oil Level Indicator Tube Seal
31	Oil Level Indicator Tube
32	Starter Motor Heat Shield
33	Knock Sensor
34	Oil Pump Screen Seal
35	Oil Pump Screen
36	Oil Pump Screen Bolt
37	Engine Block Expansion Plug
38	Engine Front Cover Location Pin
39	Drive Belt Idler Pulley Bracket Bolt
40	Drive Belt Idler Pulley
41	Drive Belt Idler Pulley Bolt
42	Drive Belt Idler Pulley Bracket
43	Engine Block Coolant Drain Hole Plug
44	Timing Chain Dampener
45	Engine Block Oil Gallery Plug
46	Camshaft Thrust Plate Bolt
47	Crankshaft Sprocket
48	Timing Chain
49	Camshaft Sprocket Bolt
50	Camshaft Position Sensor Magnet
51	Camshaft Sprocket
52	Balance Shaft Drive Gear
53	Camshaft Thrust Plate
54	Camshaft Key
55	Camshaft
56	Camshaft Bearing
57	Camshaft Bearing

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15	Crankshaft Rear Oil Seal
16	Flywheel
17	Flywheel Bolt
18	Crankshaft Lower No. 4 Bearing
19	Crankshaft Lower No. 3 Bearing
20	Crankshaft Lower No. 2 Bearing
21	Crankshaft Lower No. 1 Bearing
22	Crankshaft No. 1 Bearing Cap
23	Crankshaft Bearing Cap Bolt
24	Crankshaft Bearing Cap Bolt
25	Crankshaft No. 2 Bearing Cap
26	Crankshaft No. 3 Bearing Cap
27	Crankshaft No. 4 Bearing Cap
28	Oil Level Indicator Switch
29	Oil Level Indicator Switch Seal
30	Oil Pan Bolt
31	Oil Pan Drain Plug Seal
32	Oil Pan Drain Plug
33	Oil Pan
34	Oil Pan Gasket
35	Oil Pump Gear Set
36	Engine Front Cover Gasket
37	Engine Front Cover
38	Crankshaft Position Sensor
39	Crankshaft Position Sensor Stud
40	Crankshaft Front Oil Seal
41	Crankshaft Position Sensor Seal
42	Crankshaft Balancer
43	Crankshaft Balancer Bolt
44	Water Pump
45	Water Pump Bolt
46	Water Pump Pulley Bolt
47	Water Pump Pulley
48	Water Pump Bolt
49	Water Pump Gasket
50	Engine Oil Filter Bypass Valve
51	Engine Oil Filter Fitting
52	Engine Oil Filter
53	Engine Oil Pressure Relief Valve Spring
54	Engine Front Cover Stud
55	Engine Front Cover Bolt

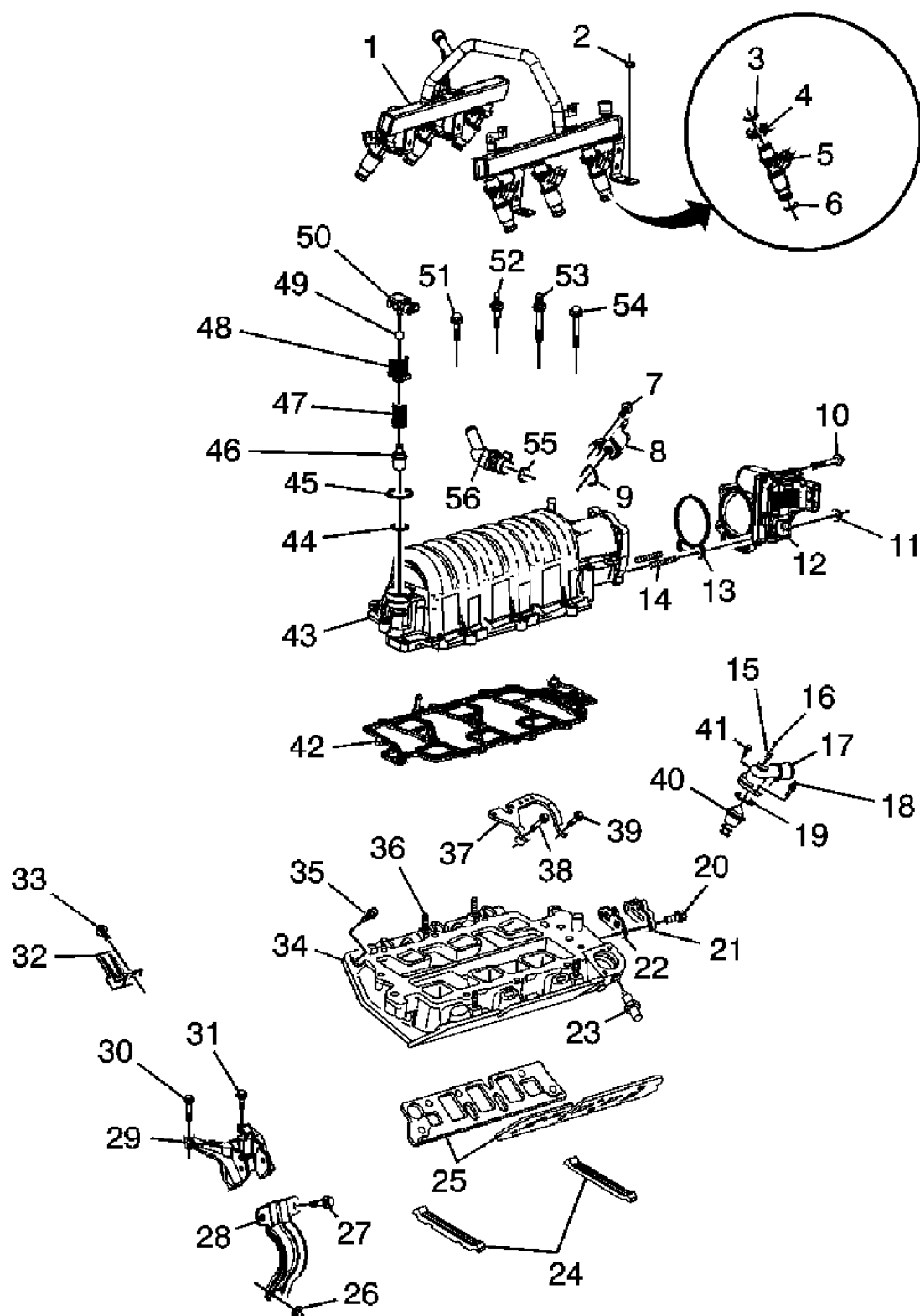


Fig. 4: Intake Manifold and Components
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
1	Sequential Multiport Fuel Injection Fuel Rail
2	Sequential Multiport Fuel Injection Fuel Rail Nut
3	Fuel Injector Seal
4	Fuel Injector Retaining Ring
5	Sequential Multiport Fuel Injector
6	Fuel Injector Seal
7	EVAP Purge Valve Bolt
8	EVAP Purge Valve
9	EVAP Purge Valve Seal
10	Throttle Body Bolt
11	Throttle Body Nut
12	Throttle Body
13	Throttle Body Seal
14	Throttle Body Stud
15	Engine Coolant Bleed Valve Fitting
16	Engine Coolant Bleed Valve
17	Water Outlet Housing
18	Water Outlet Housing Stud
19	Engine Coolant Thermostat Seal
20	Engine Coolant Manifold Bolt
21	Engine Coolant Manifold
22	Engine Coolant Manifold Seal
23	Engine Coolant Temperature Sensor
24	Lower Intake Manifold Seal
25	Lower Intake Manifold Gasket
26	Engine Mount Strut Bracket Nut
27	Engine Mount Strut Bracket Bolt
28	Engine Mount Strut Bracket
29	Engine Mount Strut Bracket
30	Engine Mount Strut Bracket Bolt
31	Engine Mount Strut Bracket Bolt
32	EVAP Purge Valve Bracket
33	EVAP Purge Valve Bracket Bolt
34	Lower Intake Manifold
35	Lower Intake Manifold Bolt
36	Lower Intake Manifold Stud
37	Generator Brace Bracket
38	Generator Brace Bracket Bolt
39	Generator Brace Bracket Bolt
40	Engine Coolant Thermostat
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	Water Outlet Housing Bolt
42	Upper Intake Manifold Gasket
43	Upper Intake Manifold
44	Positive Crankcase Ventilation Valve Seal
45	Positive Crankcase Ventilation Valve Seal
46	Positive Crankcase Ventilation Valve
47	Positive Crankcase Ventilation Valve Spring
48	Positive Crankcase Ventilation Valve Retainer
49	MAP Sensor Seal
50	MAP Sensor
51	Upper Intake Manifold Bolt
52	Upper Intake Manifold Stud
53	Upper Intake Manifold Stud
54	Upper Intake Manifold Bolt
55	Vacuum Manifold Seal
56	Vacuum Manifold

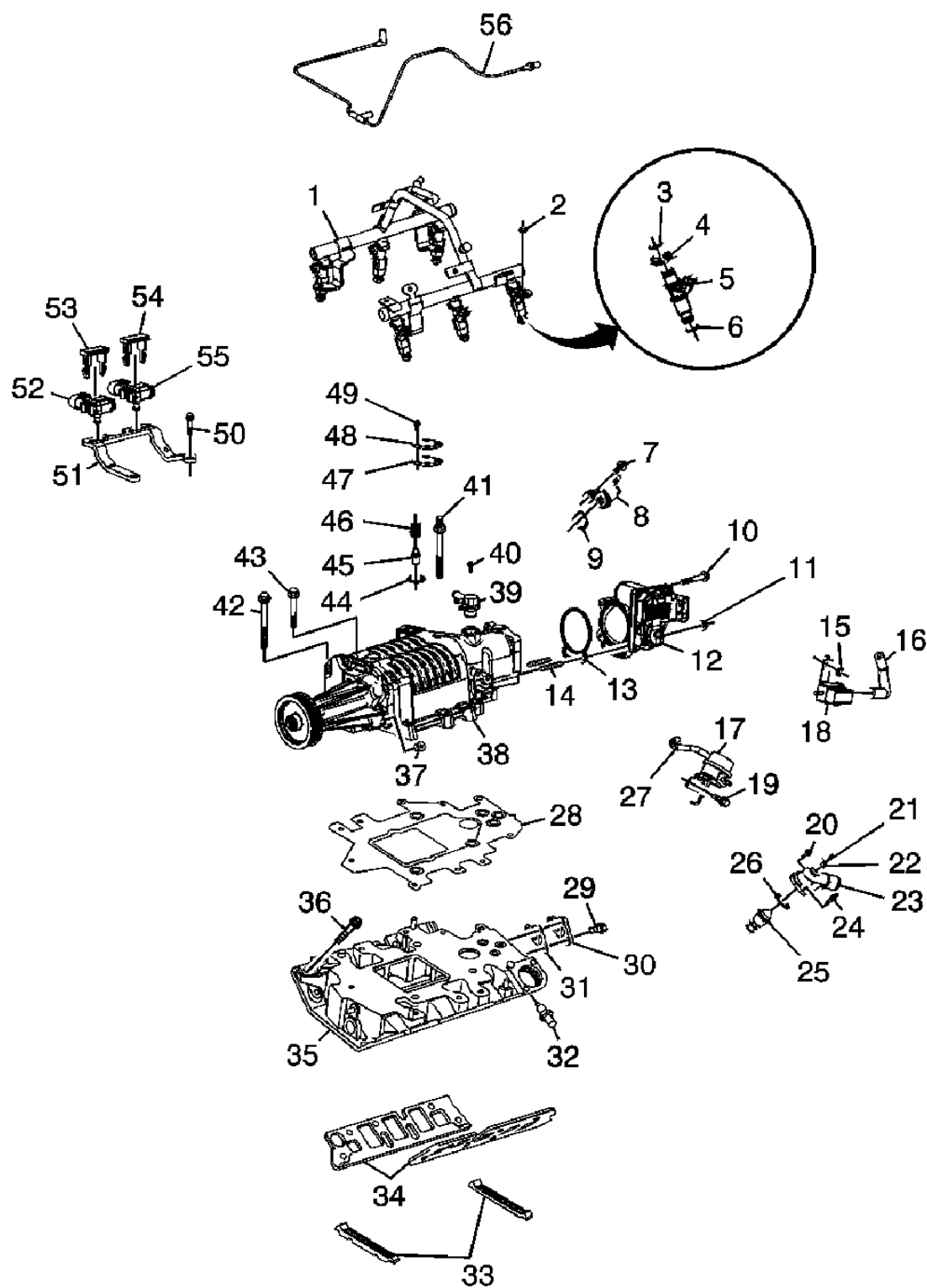


Fig. 5: Supercharger and Components
 Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
1	Sequential Multiport Fuel Injection Fuel Rail
2	Sequential Multiport Fuel Injection Fuel Rail Nut
3	Fuel Injector Seal
4	Fuel Injector Retaining Ring
5	Sequential Multiport Fuel Injector
6	Fuel Injector Seal
7	EVAP Purge Valve Bolt
8	EVAP Purge Valve
9	EVAP Purge Valve Seal
10	Throttle Body Bolt
11	Throttle Body Nut
12	Throttle Body
13	Throttle Body Seal
14	Throttle Body Stud
15	Supercharger Bypass Valve Nut
16	Supercharger Bypass Valve Hose
17	Wastegate Valve
18	Supercharger Bypass Valve
19	Wastegate Valve Bolt
20	Water Outlet Housing Bolt
21	Engine Coolant Bleed Valve
22	Engine Coolant Bleed Valve Fitting
23	Water Outlet Housing
24	Water Outlet Housing Stud
25	Engine Coolant Thermostat
26	Engine Coolant Thermostat Seal
27	Vacuum Source Manifold Tube
28	Upper Intake Manifold Gasket
29	Engine Coolant Manifold Bolt
30	Engine Coolant Manifold
31	Engine Coolant Manifold Seal
32	Engine Coolant Temperature Sensor
33	Lower Intake Manifold Seal
34	Lower Intake Manifold Gasket
35	Lower Intake Manifold
36	Lower Intake Manifold Bolt
37	Supercharger Oil Fill Plug
38	Upper Intake Manifold
39	Vacuum Source Manifold
40	Vacuum Source Manifold Bolt
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	Supercharger Stud
42	Supercharger Bolt
43	Supercharger Bolt
44	Positive Crankcase Ventilation Valve Seal
45	Positive Crankcase Ventilation Valve
46	Positive Crankcase Ventilation Valve Spring
47	Positive Crankcase Ventilation Valve Retainer Seal
48	Positive Crankcase Ventilation Valve Retainer
49	Positive Crankcase Ventilation Valve Retainer Bolt
50	MAP/BARO Sensor Bracket Bolt
51	MAP/BARO Sensor Bracket
52	BARO Sensor
53	MAP/BARO Sensor Retainer Clip
54	MAP/BARO Sensor Retainer Clip
55	MAP Sensor
56	Supercharger Bypass Valve Harness

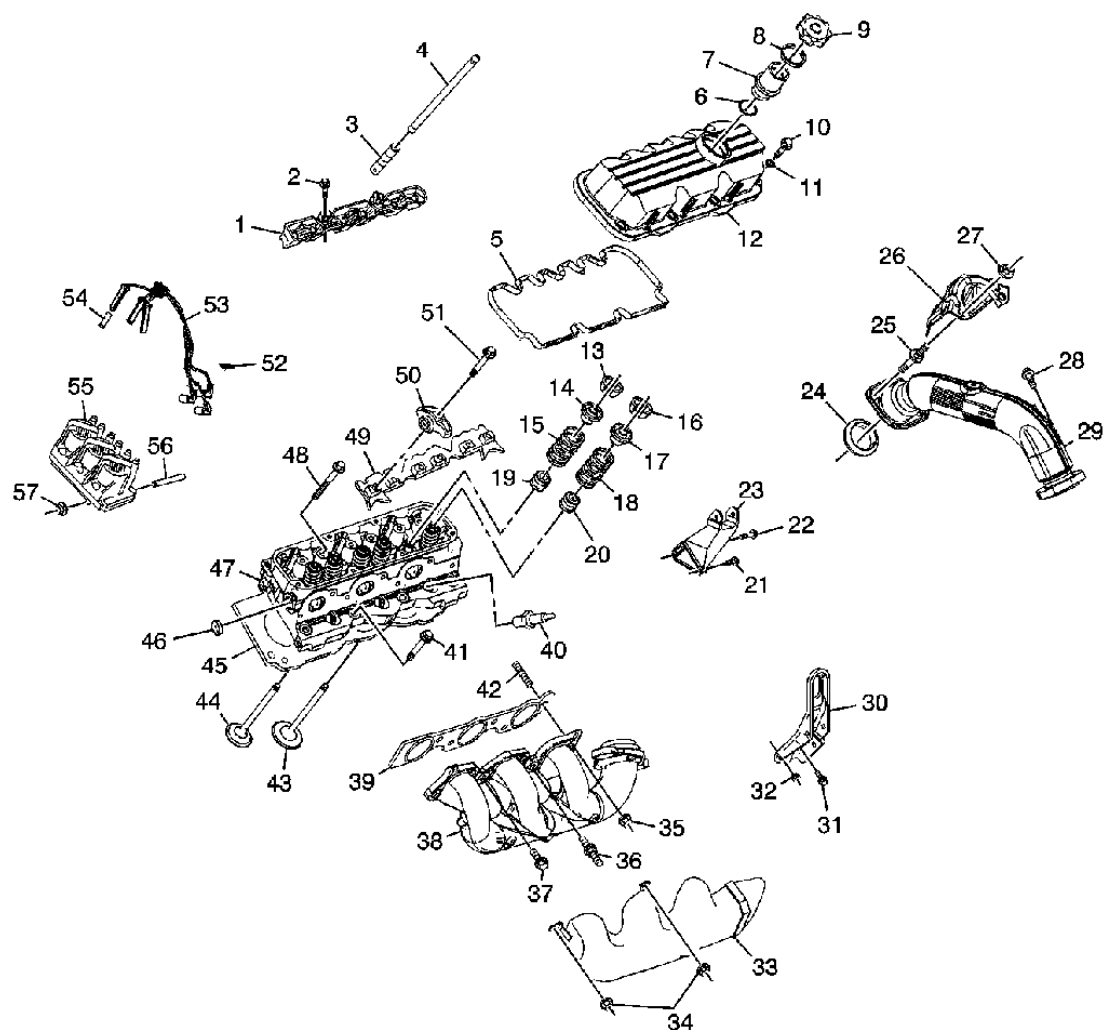


Fig. 6: Cylinder Head and Components - Left - L26
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Valve Lifter Guide
2	Valve Lifter Guide Bolt
3	Valve Lifter
4	Valve Push Rod
5	Valve Rocker Arm Cover Gasket
6	Oil Filler Tube Seal
7	Oil Filler Tube
8	Oil Filler Cap Seal
9	Oil Filler Cap
10	Valve Rocker Arm Cover Bolt
11	Valve Rocker Arm Cover Bolt Grommet

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12	Valve Rocker Arm Cover
13	Valve Stem Key
14	Valve Stem Cap
15	Valve Spring
16	Valve Stem Key
17	Valve Stem Cap
18	Valve Spring
19	Valve Lifter Guide
20	Valve Stem Oil Seal
21	Engine Mount Strut Bracket Bolt
22	Engine Mount Strut Bracket Bolt
23	Engine Mount Strut Bracket
24	Exhaust Crossover Pipe Seal
25	Exhaust Crossover Pipe Stud
26	Brake Booster Heat Shield
27	Brake Booster Heat Shield Nut
28	Exhaust Crossover Pipe Bolt
29	Exhaust Crossover Pipe
30	Engine Lift Bracket
31	Engine Lift Bracket Bolt
32	Engine Lift Bracket Nut
33	Exhaust Manifold Head Shield
34	Exhaust Manifold Heat Shield Nut
35	Exhaust Manifold Nut
36	Exhaust Manifold Bolt
37	Exhaust Manifold Bolt
38	Exhaust Manifold
39	Exhaust Manifold Gasket
40	Spark Plug
41	Cylinder Head Bolt
42	Exhaust Manifold Stud
43	Exhaust Valve
44	Intake Valve
45	Cylinder Head Gasket
46	Cylinder Head Core Hole Plug
47	Cylinder Head
48	Cylinder Head Bolt
49	Valve Rocker Arm Retainer
50	Valve Rocker Arm
51	Valve Rocker Arm Bolt
52	Spark Plug Wire Support Clip
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	Spark Plug Wire Harness
54	Spark Plug Heat Shield
55	Ignition Coil
56	Ignition Coil Stud
57	Ignition Coil Nut

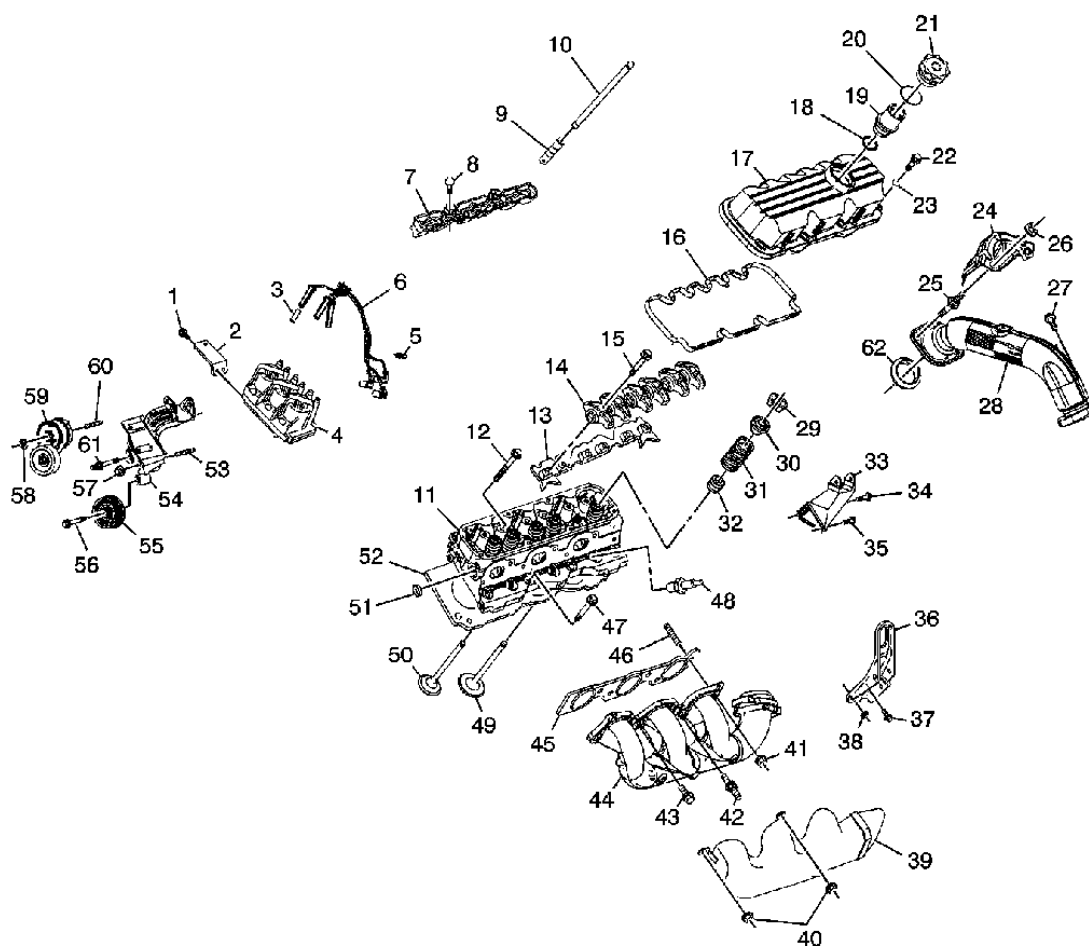


Fig. 7: Cylinder Head and Components - Left - L32
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Spark Plug Wire Support Bolt
2	Spark Plug Wire Support
3	Spark Plug Heat Shield
4	Ignition Coil
5	Spark Plug Wire Support Clip
6	Spark Plug Wire Harness
7	Valve Lifter Guide

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8	Valve Lifter Guide Bolt
9	Valve Lifter
10	Valve Push Rod
11	Cylinder Head
12	Cylinder Head Bolt
13	Valve Rocker Arm Retainer
14	Valve Rocker Arm
15	Valve Rocker Arm Bolt
16	Valve Rocker Arm Cover Gasket
17	Valve Rocker Arm Cover
18	Valve Rocker Arm Cover Bolt
19	Oil Filler Tube
20	Oil Filler Tube Seal
21	Oil Filler Cap
22	Valve Rocker Arm Bolt
23	Valve Rocker Arm Cover O-ring
24	Brake Booster Heat Shield
25	Exhaust Crossover Pipe Stud
26	Brake Booster Heat Shield Nut
27	Exhaust Crossover Pipe Bolt
28	Exhaust Crossover Pipe
29	Valve Stem Key
30	Valve Stem Cap
31	Valve Spring
32	Valve Stem Oil Seal
33	Engine Mount Strut Bracket
34	Engine Mount Strut Bracket Bolt
35	Engine Mount Strut Bracket Bolt
36	Engine Lift Bracket
37	Engine Lift Bracket Bolt
38	Engine Lift Bracket Nut
39	Exhaust Manifold Head Shield
40	Exhaust Manifold Heat Shield Nut
41	Exhaust Manifold Nut
42	Exhaust Manifold Stud
43	Exhaust Manifold Bolt
44	Exhaust Manifold
45	Exhaust Manifold Gasket
46	Exhaust Manifold Stud
47	Cylinder Head Bolt
48	Spark Plug

	Exhaust Valve
50	Intake Valve
51	Cylinder Head Core Hole Plug
52	Cylinder Head Gasket
53	Engine Mount Strut Bracket Stud
54	Engine Mount Strut Bracket
55	Drive Belt Idler Pulley
56	Drive Belt Idler Pulley Bolt
57	Engine Mount Strut Bracket Nut
58	Drive Belt Tensioner Nut
59	Drive Belt Tensioner
60	Drive Belt Tensioner Stud
61	Generator Brace Stud
62	Exhaust Crossover Pipe Seal

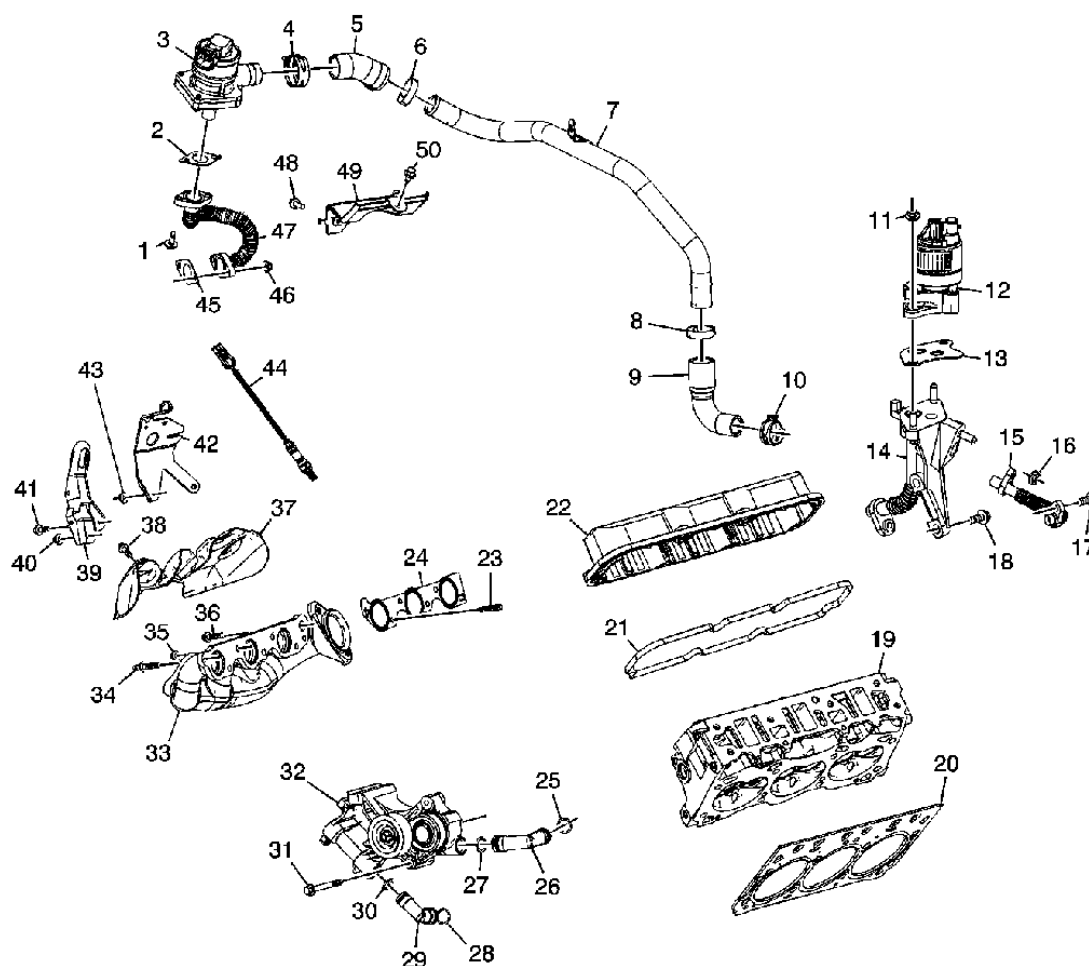


Fig. 8: Cylinder Head and Components - Right - L26/L32

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Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Secondary Air Injection Pipe Bolt
2	Secondary Air Injection Pipe Gasket
3	Secondary Air Injection Valve
4	Secondary Air Injection Hose Clamp
5	Secondary Air Injection Hose
6	Secondary Air Injection Hose Clamp
7	Secondary Air Injection Pipe
8	Secondary Air Injection Hose Clamp
9	Secondary Air Injection Hose Clamp
10	Secondary Air Injection Hose Clamp
11	Exhaust Gas Recirculation Valve Nut
12	Exhaust Gas Recirculation Valve
13	Exhaust Gas Recirculation Valve Gasket
14	Exhaust Gas Recirculation Valve Adapter
15	Exhaust Gas Recirculation Valve Outlet Pipe
16	Exhaust Gas Recirculation Valve Outlet Pipe Nut
17	Exhaust Gas Recirculation Valve Outlet Pipe Bolt
18	Exhaust Gas Recirculation Valve Adapter Bolt
19	Cylinder Head
20	Cylinder Head Gasket
21	Valve Rocker Arm Cover Gasket
22	Valve Rocker Arm Cover
23	Exhaust Manifold Stud
24	Exhaust Manifold Gasket
25	Engine Coolant Thermostat Bypass Pipe Seal
26	Engine Coolant Thermostat Bypass Pipe
27	Engine Coolant Thermostat Bypass Pipe Seal
28	Engine Coolant Thermostat Bypass Pipe Seal
29	Engine Coolant Thermostat Bypass
30	Engine Coolant Thermostat Bypass Pipe Seal
31	Drive Belt Tensioner Bolt
32	Drive Belt Tensioner
33	Exhaust Manifold
34	Exhaust Manifold Stud
35	Exhaust Manifold Nut
36	Exhaust Gas Recirculation Valve Adapter Pipe Bolt
37	Exhaust Manifold Heat Shield
38	Exhaust Manifold Heat Shield Bolt

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39	Engine Lift Bracket
40	Engine Lift Bracket Nut
41	Engine Lift Bracket Bolt
42	Engine Sight Shield Bracket
43	Engine Sight Shield Bracket Nut
44	Oxygen Sensor
45	Secondary Air Injection Pipe Gasket
46	Secondary Air Injection Pipe Nut
47	Secondary Air Injection Pipe
48	Secondary Air Injection Valve Mounting Bracket Bolt
49	Secondary Air Injection Valve Mounting Bracket
50	Secondary Air Injection Valve Bolt

ENGINE IDENTIFICATION

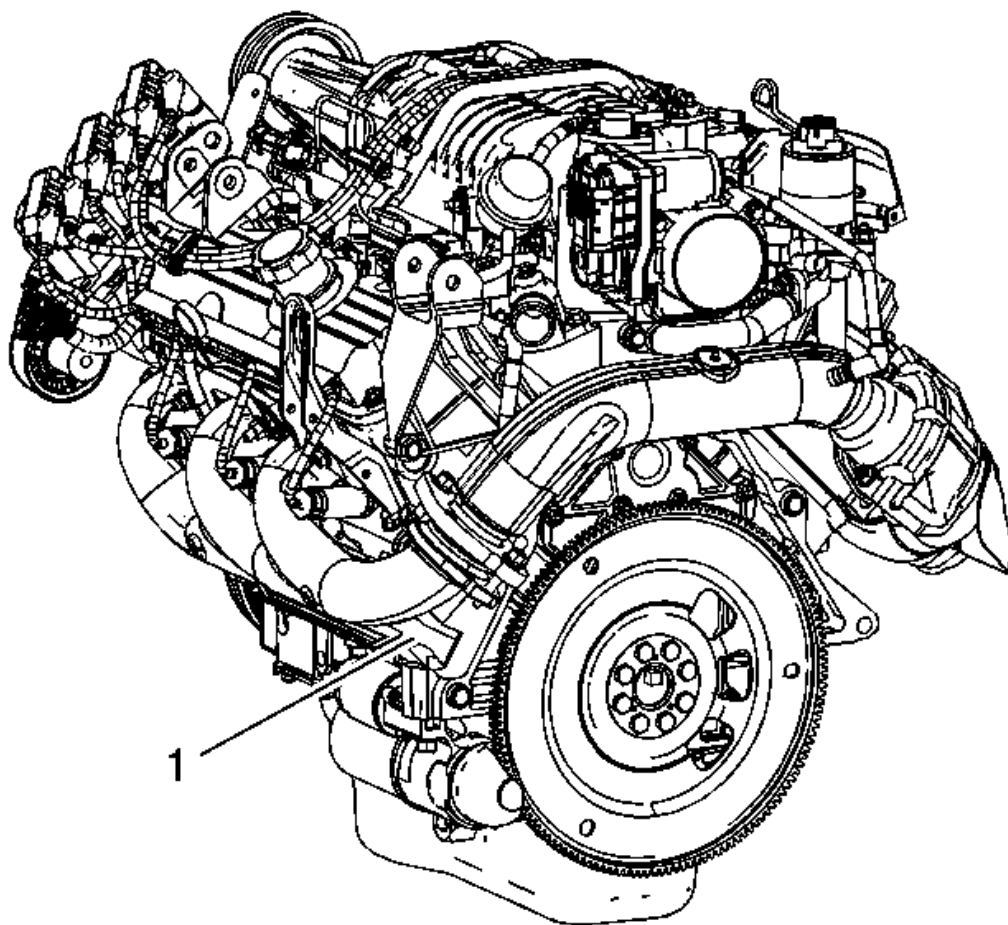


Fig. 9: Primary VIN

Courtesy of GENERAL MOTORS CORP.

The primary Vehicle Identification Number - VIN derivative for the 3800 - L26 and 3800 - L32 is stamped or laser etched on the left side of the engine block above the starter motor (1).

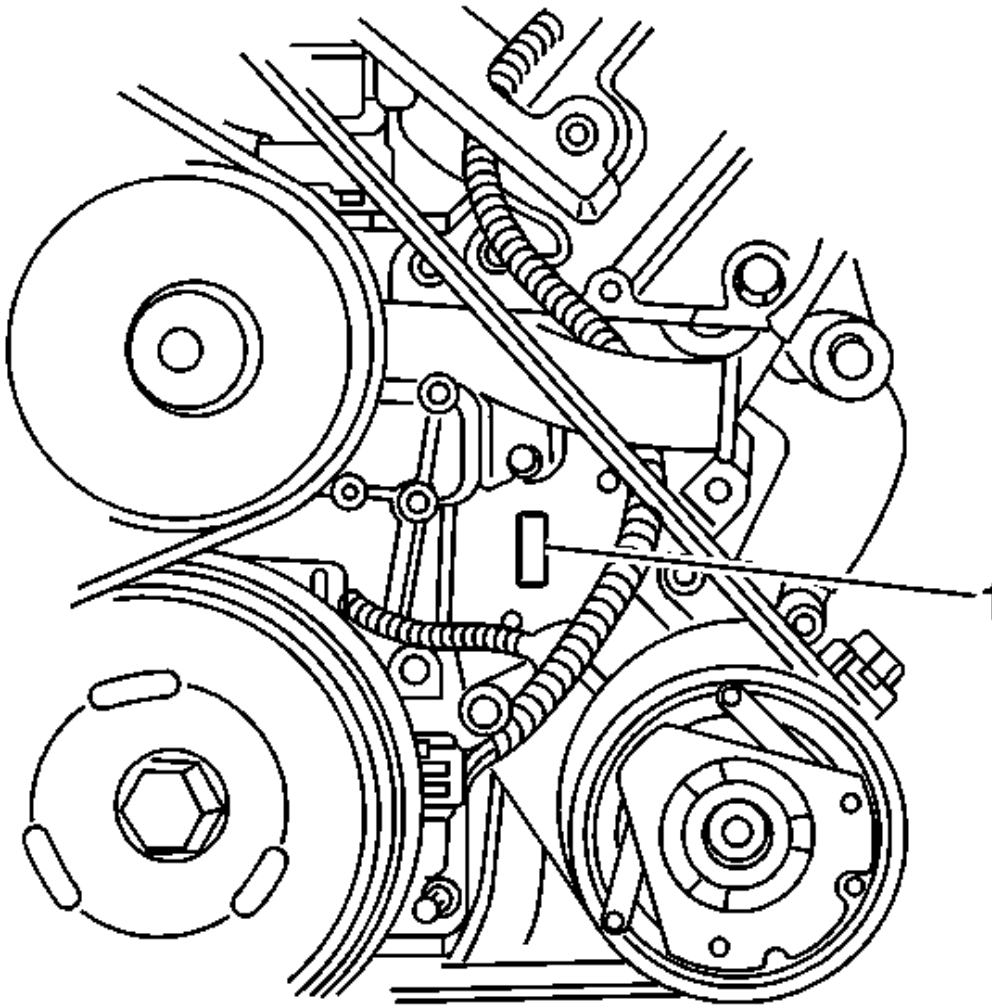


Fig. 10: Locating Secondary Vehicle Identification Number - VIN
Courtesy of GENERAL MOTORS CORP.

The secondary Vehicle Identification Number - VIN, derivative for the 3800 - L26 and 3800 - L32 is stamped or laser etched below the water pump on the engine block (1). The Vehicle Identification Number - derivative is nine digits long and can be used to determine if a vehicle contains the original engine.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digit are the last six of the Vehicle Identification Number - VIN.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the **Disassembled Views**, **Engine Component Description**, **Drive Belt System Description**, **Lubrication Description**, and **New Product Information**. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform A Diagnostic System Check in Engine Controls before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views**, **Engine Component Description**, **Drive Belt System Description**, **Lubrication Description**, and **New Product Information**.

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 problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Strategy Based Diagnosis**.

Visual/Physical Inspection

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check 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 Compression Test
- 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
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement (L26)</u> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement</u> .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.

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Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position	Replace the valve rocker arms as required.
Worn or bent pushrods	Replace the pushrods.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>Diagnostic Starting Point - Engine Cooling</u> . Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> . • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <u>Drive Belt Replacement (L26)</u> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or	Repair or replace the flywheel and/or balancer as

crankshaft balancer A misfire code may be present without an actual misfire condition.	required. Refer to <u>Engine Flywheel Replacement</u> or <u>Crankshaft Balancer Replacement</u> .
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	- Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . - Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.
Worn Crankshaft Thrust Bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

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

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to <u>Diagnostic Starting Point - Engine Cooling</u> . Coolant consumption may or may not cause the engine to overheat.	- Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> . - Perform a cylinder leak down test. - Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. - Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	- Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . - Repair or replace as required.
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	- Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . - Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.

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 oil. - Install the correct viscosity oil.
Worn crankshaft thrust bearing	- Inspect the thrust bearing and crankshaft. - Repair or replace as required.
High valve lifter leak down rate	Replace the lifters as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer <u>Oil Pressure Diagnosis and Testing</u>. - Repair or replace as required.
Loose and/or worn valve rocker arm attachments	- Inspect the valve rocker arm stud, nut, or bolt. - Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Bent or damaged push rod	Inspect the following components, and replace as required: - The valve rocker arm - The valve push rod - The valve lifter
Improper lubrication to the valve rocker arms	Inspect the following components, and repair or

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	replace as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn and/or damaged valve rotators	Replace the valve rotators as required.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn timing chain tensioner, if applicable	Replace the timing chain tensioners as required.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lifters as required.
Damaged, broken, or dirty, balance shaft sprocket teeth, if applicable	Inspect the following components, and repair as required: • The balance shaft gear • The camshaft gear • The balance shaft rear bushing
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
Stuck Valves Carbon on the valve stem or valve seat may cause the valve to stay open	Inspect the following components, and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn accessory drive components	

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Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	• Inspect the accessory drive system. • Repair or replace as required.
Loose or damaged crankshaft balancer	• Inspect the crankshaft balancer. • Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the Knock Sensor System. Refer to <u>Electronic Ignition (EI) System Diagnosis</u> .
Loose torque converter bolts	• Inspect the torque converter bolts and flywheel. • Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	• Inspect the oil pan. • Inspect the oil pump screen • Repair or replace as required.
Oil pump screen loose, damaged or restricted	• Inspect the oil pump screen. • Repair or replace as required.
Excessive piston-to-cylinder bore clearance	• Inspect the piston and cylinder bore. • Repair as required.
Excessive piston pin-to-bore clearance	• Inspect the piston, piston pin, and the connecting rod. • Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin and connecting rod installation Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	• Verify the pistons, piston pins and connecting rods are installed correctly. • Repair as required.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. - Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the Knock Sensor System. Refer to <u>Electronic Ignition (EI) System Diagnosis</u> .
Loose torque converter bolts	- Inspect the torque converter bolts and flywheel. - Repair as required.
Cracked flywheel, automatic transmission	- Inspect the flywheel bolts and flywheel. - Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: - The connecting rod bearings - The connecting rods - The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: - The crankshaft bearings - The crankshaft journals - The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	- Remove accessory drive belt or belts. - Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder - Coolant/antifreeze in cylinder - Oil in cylinder - Fuel in cylinder	- Remove spark plugs and check for fluid. - Inspect for broken head gasket or gaskets. - Inspect for cracked engine block or cylinder head. - Inspect for a sticking fuel injector and/or leaking fuel regulator.
Seized automatic transmission torque converter	- Remove the torque converter bolts. - Rotate crankshaft by hand at the balancer or

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	flywheel location.
Broken timing chain and/or timing chain gears	1. Inspect timing chain and gears. 2. Repair as required.
Seized balance shaft bearing if equipped	1. Inspect balance shaft bearings. 2. Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage.	
• A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>. • Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. • Inspect by performing a <u>Cylinder Leakage Test</u>. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. • Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>.	
Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket.

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	Refer to <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	
- Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u>. - Inspect by performing a <u>Cylinder Leakage Test</u>. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. - Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>.	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Tools Required

J 38722 Compression Tester. See **Special Tools**.

A compression pressure test of the engine cylinders determines the condition of the rings, the valves, and the head gasket.

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge.

2. Turn the engine OFF.

IMPORTANT: Remove the Powertrain Control Module (PCM) and the ignition fuses from the I/P fuse block. Refer to Electrical Center Identification Views .

3. Disable the ignition.
4. Disable the fuel systems.
5. Remove the spark plugs from all the cylinders.
6. Remove the air duct from the throttle body.
7. Block the throttle plate in the open position.

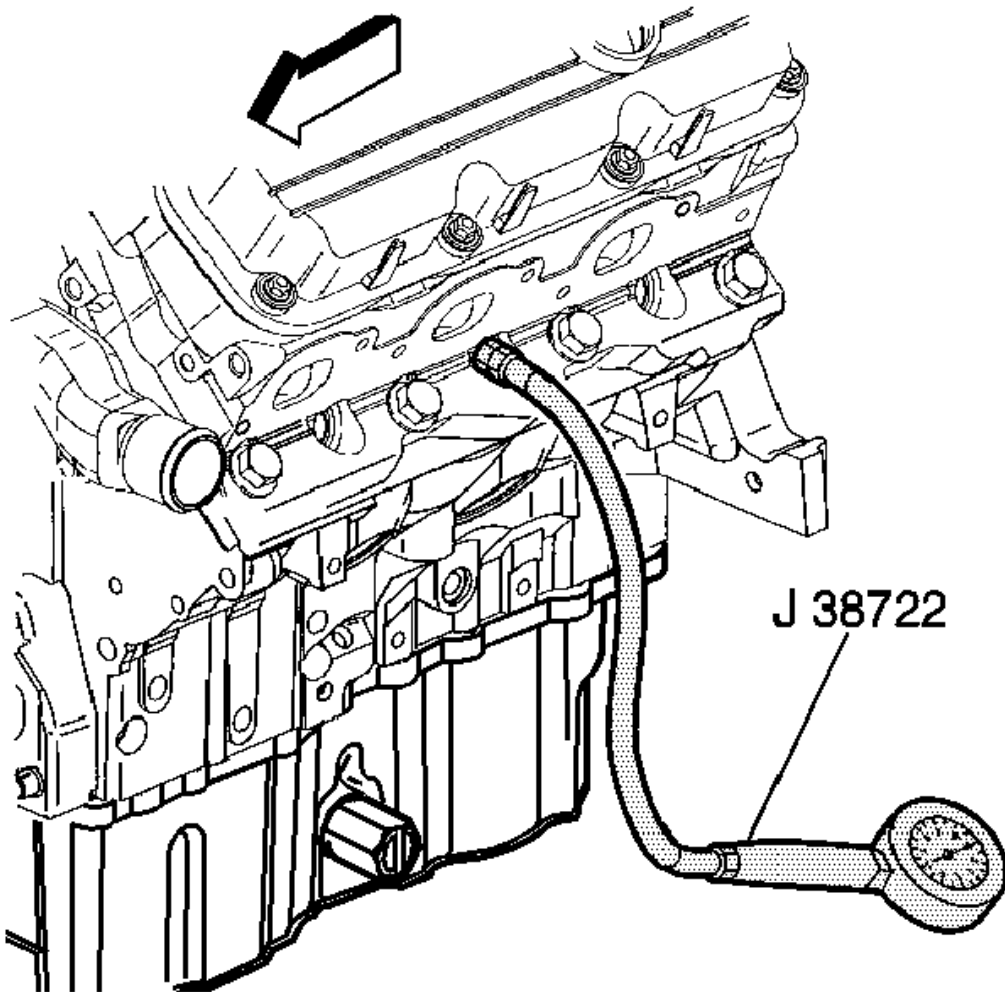


Fig. 11: Measuring Engine Compression
Courtesy of GENERAL MOTORS CORP.

8. Measure the engine compression, using the following procedure:
 1. Firmly install **J 38722** to the spark plug hole. See **Special Tools**.
 2. Have an assistant crank the engine through at least four compression strokes in the testing cylinder.
 3. Check and record the readings on **J 38722** at each stroke. See **Special Tools**.
 4. Disconnect **J 38722** . See **Special Tools**.
 5. Repeat the compression test for each cylinder.
9. Record the compression readings from all of the cylinders.
 - The lowest reading should not be less than 70 percent of the highest reading.
 - No cylinder reading should be less than 689 kPa (100 psi).
10. The following are examples of the possible measurements:
 - When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.
 - When the compression is low on the first stroke and tends to build up on the following strokes, but does not reach the normal compression, or if the compression improves considerably with the addition of three squirts of oil, the piston rings may be the cause.
 - When the compression is low on the first stroke and does not build up in the following strokes, or the addition of oil does not affect the compression, the valves may be the cause.
 - When the compression is low on two adjacent cylinders, or coolant is present in the crankcase, the head gasket may be the cause.
11. Remove the block from the throttle plate.
12. Install the air duct to the throttle body.
13. Install the spark plugs.
14. Install the Powertrain Control Module (PCM) fuse.
15. Install the ignition fuse to the I/P fuse block.

CYLINDER LEAKAGE TEST

Special Tools

J 35667-A: Cylinder Head Leakdown Tester

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

With the use of air pressure, a cylinder leakage test will aid in the diagnosis. The cylinder leakage test may be used in conjunction with the engine compression test, to isolate the cause of leaking cylinders.

WARNING: Refer to **Battery Disconnect Warning** .

1. Remove the battery ground - negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .
3. Install the **J 35667-A**: tester.

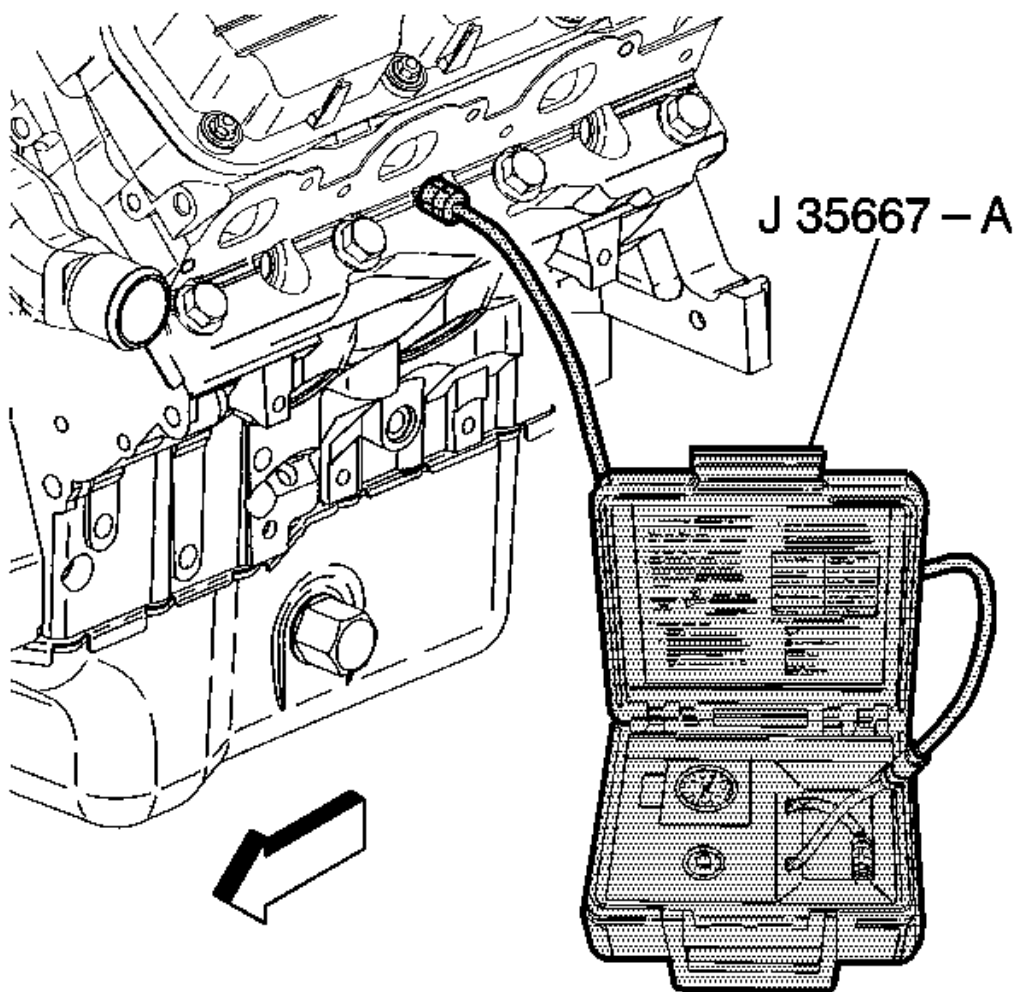


Fig. 12: Measuring Cylinder Leakage
Courtesy of GENERAL MOTORS CORP.

4. Measure each cylinder on the compression stroke, with both valves closed.

NOTE: It may be necessary to hold the crankshaft balancer bolt, to prevent piston movement.

5. Apply air pressure, using the **J 35667-A**: tester. Refer to the manufacturer's instructions.
6. Record the cylinder leakage readings for each cylinder.

NOTE:

- **Normal cylinder leakage is from 12-18 percent.**
- **Make a note of any cylinder with more leakage than the other cylinders.**
- **Any cylinder with 30 percent leakage or more requires service.**

7. Inspect the four primary areas, to properly diagnose a leaking cylinder.
8. If air is heard from the intake or exhaust system, perform the following procedure:
 - Remove the valve rocker arm cover of the suspect cylinder head.
 - Ensure that both valves are closed.
 - Inspect the cylinder head for a broken valve spring.
 - Remove the suspect cylinder head and inspect. Refer to **Cylinder Head Cleaning and Inspection** .
9. If air is heard from the crankcase system at the crankcase, oil filler tube, perform the following procedure:
 - Remove the piston from the suspect cylinder.
 - Inspect the piston and connecting rod assembly. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection** .
 - Inspect the engine block. Refer to **Engine Block Cleaning and Inspection** .
10. If bubbles are found in the radiator, perform the following procedure:
 - Remove both cylinder heads and inspect. Refer to **Cylinder Head Cleaning and Inspection** .
 - Inspect the engine block. Refer to **Engine Block Cleaning and Inspection** .
11. Remove the **J 35667-A**: tester.
12. Install the spark plugs. Refer to **Spark Plug Replacement** .
13. Install the battery ground - negative cable.

OIL CONSUMPTION DIAGNOSIS

An engine that has excessive oil consumption uses 0.9 L (1 qt) of oil, or more, within 3 200 km (2,000 mi). The following list indicates the conditions and corrections of excessive oil consumption:

- An improperly read oil level indicator - dipstick
 - Inspect the oil level while the vehicle is parked on a level surface.
 - Allow adequate drain-down time.
- Improper oil viscosity
 - Use the recommended SAE viscosity for prevailing temperatures.
 - Refer to **Maintenance Schedule (North American Emissions)** for the proper oil viscosity specifications.
- Continuous high-speed driving
- Severe hauling, such as a trailer. This causes decreased oil mileage.

- A malfunctioning crankcase ventilation system
- External oil leaks
 - Tighten the bolts, as needed.
 - Replace the gaskets and seals, as needed.
- Worn or omitted valve guides and/or valve stem seals
 - Ream the guides.
 - Install oversized service valves and/or new valve stem seals.
- Broken or worn piston rings
- Improperly installed or unseated piston rings
- Improperly installed or improperly fitted piston
- Plugged cylinder head gasket oil drain holes
- Damaged intake gaskets

OIL PRESSURE DIAGNOSIS AND TESTING

Low or No Oil Pressure

The following can cause low or no oil pressure:

- Low oil level - fill to the full mark on the oil level indicator.
- Slow idle speed
- Incorrect or malfunctioning oil pressure switch - replace the oil pressure switch.
- Incorrect or malfunctioning oil pressure gage - replace the oil pressure gage.
- Improper oil viscosity or diluted oil
 - Install oil of proper viscosity for expected temperature.
 - Install new oil if it is diluted.
- The oil pump is worn or dirty - clean or replace the oil pump.
- The oil filter is plugged - replace the oil filter.
- The oil pickup screen is loose or plugged - replace the oil pickup screen.
- A hole in the oil pickup tube - replace the oil pickup tube.
- Excessive bearing clearance - replace the bearings.
- Cracked, porous, or plugged oil galleries - repair or replace the engine block.
- The gallery plugs are missing or improperly installed - install or repair as necessary.
- The pressure regulator valve is stuck.
 - Check the pressure regulator valve for sticking in the bore.
 - Check the bore for scoring and burrs.
- The camshaft is worn or poorly machined - replace the camshaft.
- Worn valve guides - repair as needed.

Oil Pressure Testing

Tools Required**J 25087-C Oil Pressure Tester**

If the vehicle has low oil pressure perform the following tests.

1. Check the oil level.
2. Raise the vehicle and remove the oil filter.
3. Assemble the plunger valve in the large hole of **J 25087-C** base and the hose in the small hole of **J 25087-C** base. Connect the gage to the end of the hose.
4. Insert the flat side of the rubber plug in the bypass valve without depressing the bypass valve itself.
5. Install **J 25087-C** on the filter mounting pad.

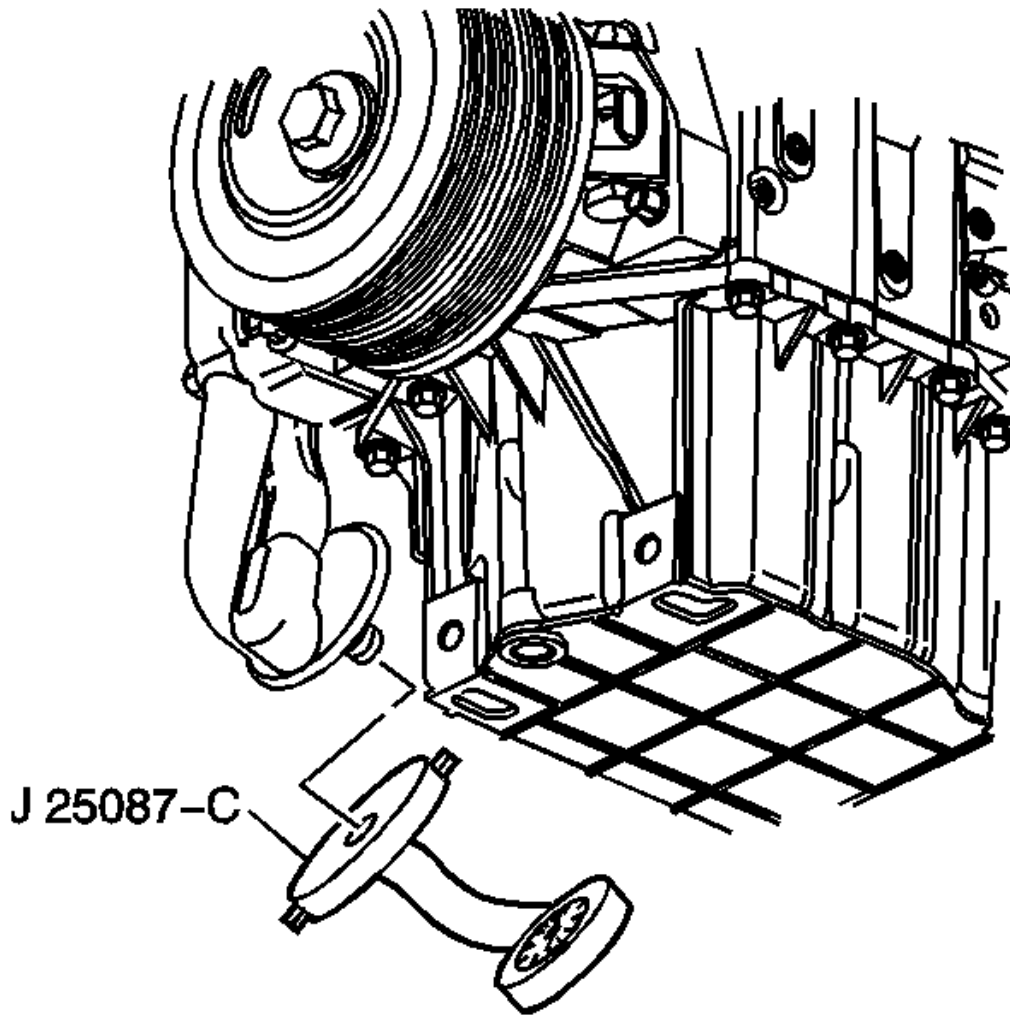


Fig. 13: Measuring Oil Pressure

Courtesy of GENERAL MOTORS CORP.

6. Start the engine and check the overall oil pressure, the oil pressure switch, and for noisy lifters. The engine should be at operating temperature before checking the oil pressure. The oil pressure should be approximately 414 kPa (60 psi) at 1850 RPM using 10W30 engine oil.
7. If adequate oil pressure is indicated, check the oil pressure switch.
8. If a low reading is indicated, press the valve on the tester base to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time indicates a good pump and the previous low pressure was due to worn bearings, etc. A low reading while pressing the valve would indicate a faulty pump.

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
IMPORTANT: 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 cause of the leak as well as the leak itself.			
1	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations:		

5	• Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. 3. Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use the J 28428-E high intensity black light kit in order to identify the type of fluid, and the approximate location of the leak. See Special Tools. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate		

	location of the leak?	Go to Step 10	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Concern	Action
External oil leak	Inspect for any of the following conditions: • Plugged positive crankcase ventilation (PCV) valve. • Plugged or kinked PCV hoses. • Damaged or incorrectly installed PCV valve or hoses. • Excessive crankcase pressure.
Rough Idle	Inspect for any of the following conditions: • Plugged PCV valve. • Plugged or kinked PCV hoses. • Leaking or damaged PCV valve or hoses.
Stalling or slow idle speed	Inspect for any of the following conditions: • Plugged PCV valve.

	• Plugged or kinked PCV hoses. • Leaking or damaged PCV valve or hoses.
High idle speed	Inspect for a leaking or damaged PCV valve or hoses.
Sludge in the engine	Inspect for any of the following conditions: • Plugged PCV valve. • Plugged or kinked PCV hoses.

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.

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.			
DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.			
DEFINITION: The following items are indications of drive belt whine: • A high pitched continuous noise. • The noise may be caused by an accessory drive component failed bearing.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids

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

14	to Drive Belt Tensioner Diagnosis . Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to Drive Belt Replacement (L26) . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

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

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

4: Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating

and may be seen at the edge of the belt our felt as a lump in the belt.

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

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

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

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

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the	Go to <u>Symptoms - Engine Mechanical</u>	

	remaining belt(s).	or Go to <u>Vibration Analysis - Engine</u>	
	Does the rumbling or vibration still exist?		Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement (L26)</u> . Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement (L26)</u> . Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Refer to <u>Water Pump Replacement (RPOs L26/L32)</u> . Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to

fall off the pulleys. Verify the accessory drive components operate properly.

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

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

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

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

Test Description

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

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

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

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

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

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

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

14: The installation of a drive belt that is 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.

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			

2009 Buick LaCrosse CXL

2009 ENGINE Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse

DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. **DEFINITION:** Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to Drive Belt Replacement (L26) . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	CAUTION: Refer to Fastener Caution . 1. Tighten any loose fasteners. Refer to Fastener Tightening Specifications . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to Drive Belt Tensioner Diagnosis . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Refer to Drive Belt Replacement (L26) . Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness.		Go to Diagnostic

	Did you find and repair the condition?	Go to Step 17	Aids
16	Replace the drive belt. Refer to <u>Drive Belt Replacement (L26)</u> . Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

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

REPAIR INSTRUCTIONS - ON VEHICLE

FUEL INJECTOR SIGHT SHIELD REPLACEMENT

Removal Procedure

1. Clean the area around the tube/oil fill cap before removing the tube/oil fill cap in order to prevent contaminants from falling into the valve rocker arm cover opening.

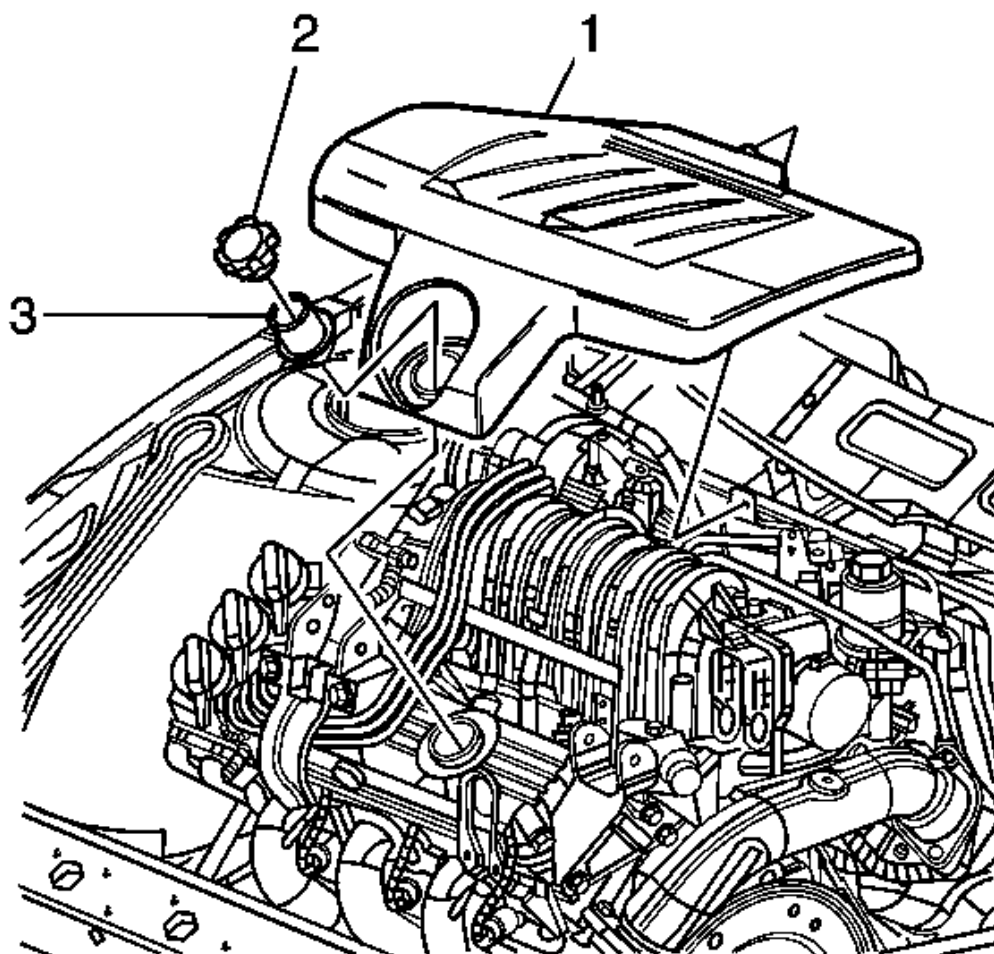


Fig. 14: Oil Fill Cap, Oil Fill Tube & Fuel Injector Sight Shield (L26)
Courtesy of GENERAL MOTORS CORP.

2. Twist counterclockwise to unlock the oil fill tube from the valve rocker arm cover (3).
3. Lift and remove the fuel injector sight shield (1).
4. Install the oil fill tube (3) and the oil fill cap (2).

Installation Procedure

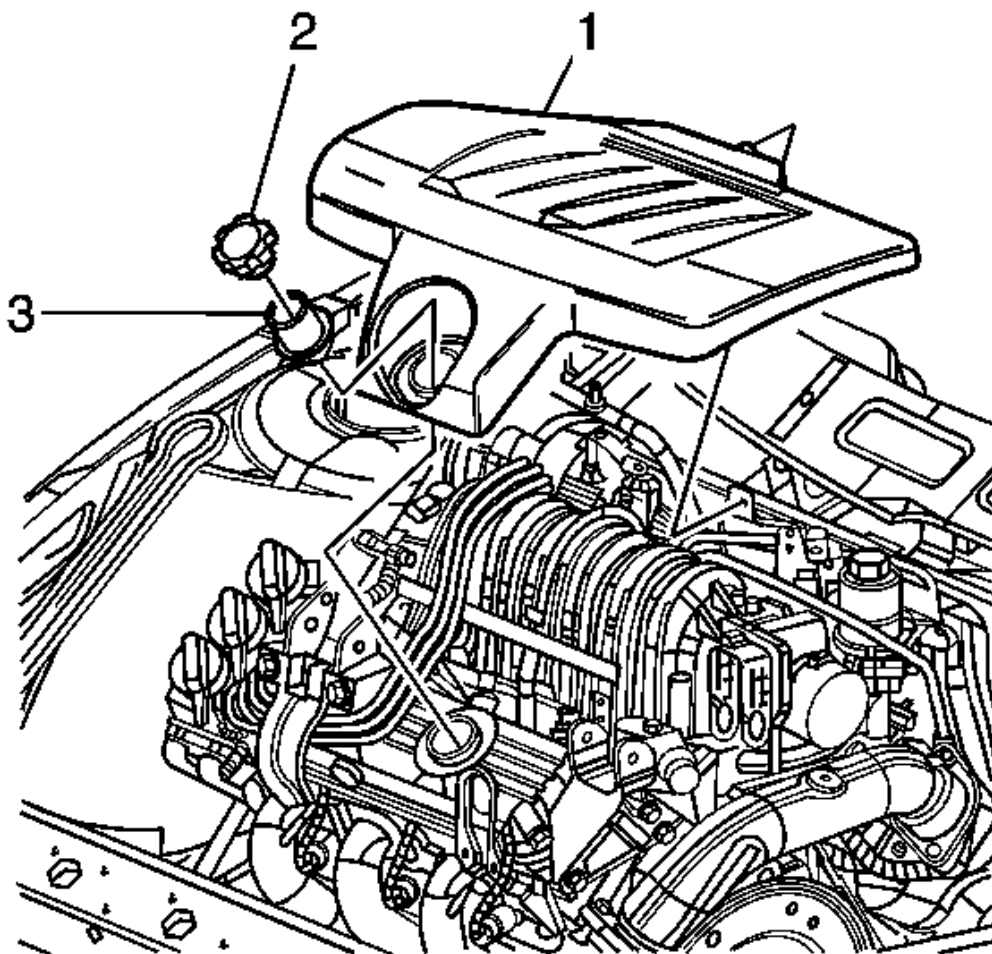


Fig. 15: Oil Fill Cap, Oil Fill Tube & Fuel Injector Sight Shield (L26)
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill cap (2) and the oil fill tube (3).
2. Insert the tab of the fuel injector sight shield under the fuel injector sight shield bracket.
3. Place the hole of the fuel injector sight shield (1) onto the oil fill neck of the valve rocker arm cover.
4. Install the oil fill tube (3) and the oil fill cap (2).

DRIVE BELT REPLACEMENT (L26)

Removal Procedure

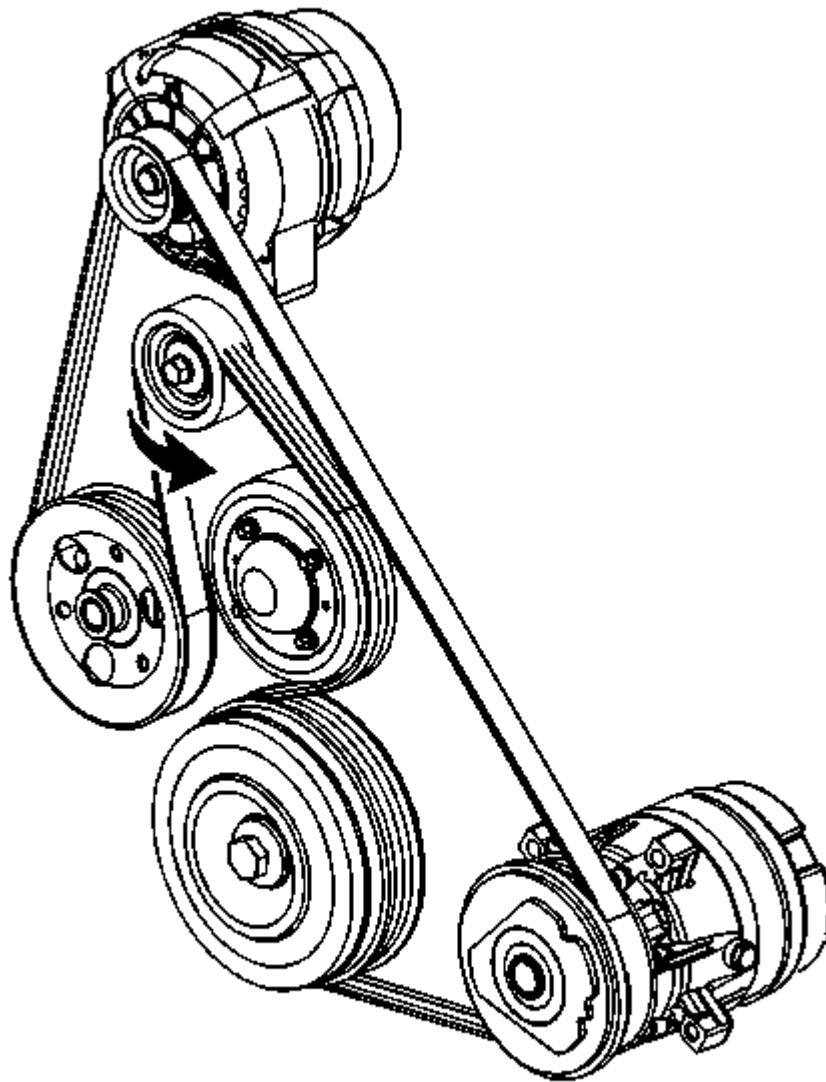


Fig. 16: View Of Drive Belt Routing (L26)
Courtesy of GENERAL MOTORS CORP.

1. Lift or rotate the drive belt tensioner using a 15 mm box end wrench on the pulley nut.
2. Remove the drive belt.

Installation Procedure

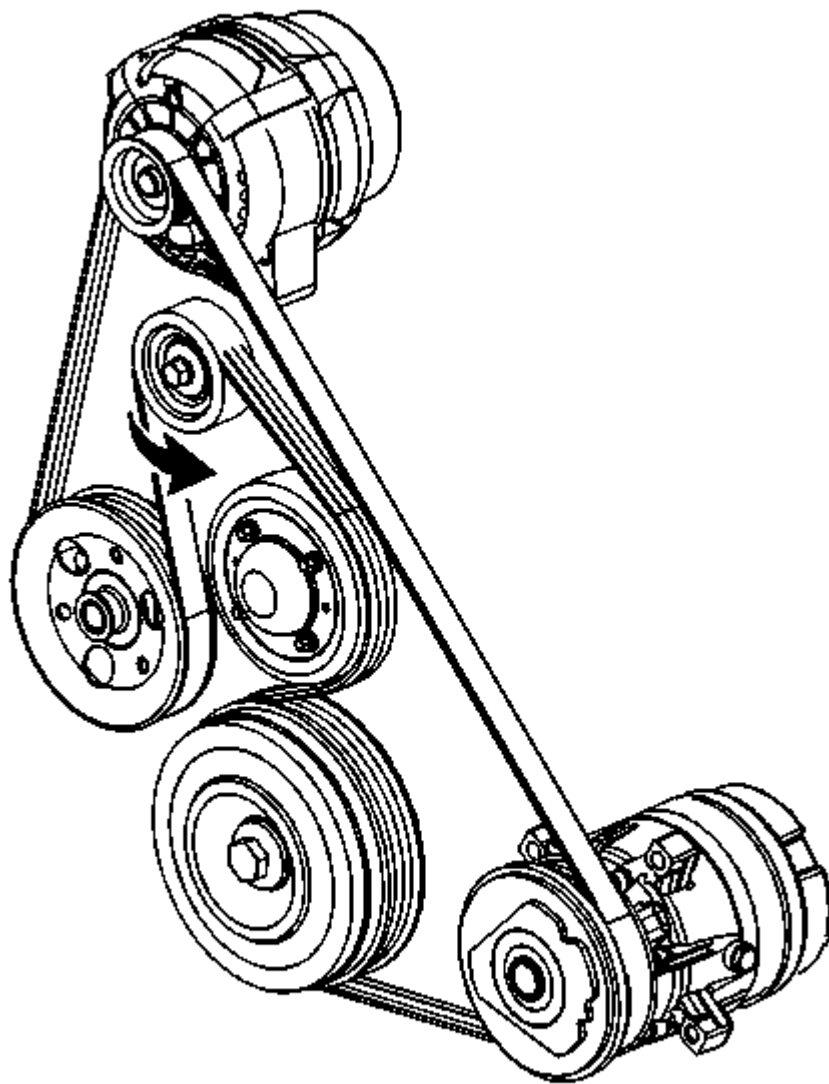


Fig. 17: View Of Drive Belt Routing (L26)
Courtesy of GENERAL MOTORS CORP.

1. Lift or rotate the drive belt tensioner using a 15 mm box end wrench on the pulley nut.
2. Install the drive belt.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
3. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement (L26)** .
4. Remove the drive belt. Refer to **Drive Belt Replacement (L26)**.
5. Remove the generator. Refer to **Generator Replacement (L26)** .
6. Remove the heater hose adapters with the heater hoses from the drive belt tensioner. Refer to **Heater Inlet Hose Replacement (L26)** and to **Heater Outlet Hose Replacement (L26)** .

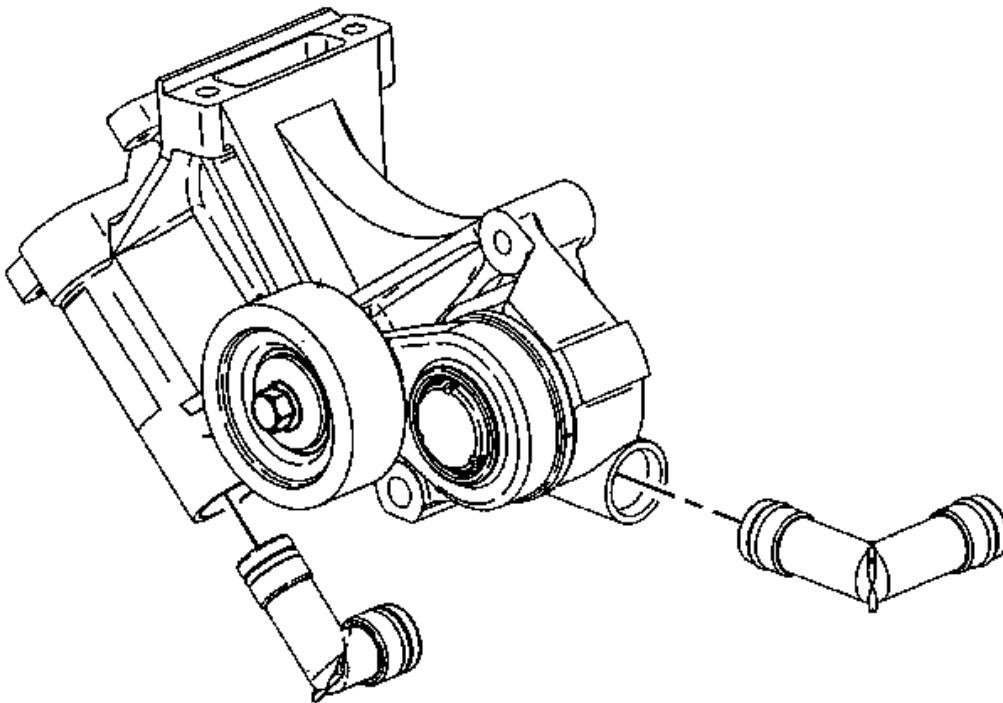


Fig. 18: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Remove the drive belt tensioner bolts.
8. Remove the drive belt tensioner.
9. If replacing the drive belt tensioner, remove the thermostat bypass upper and lower pipe assemblies.

Installation Procedure

1. If replacing the drive belt tensioner, lubricate the thermostat bypass upper and lower pipe assembly seals with engine coolant and install the upper and lower pipe assemblies.

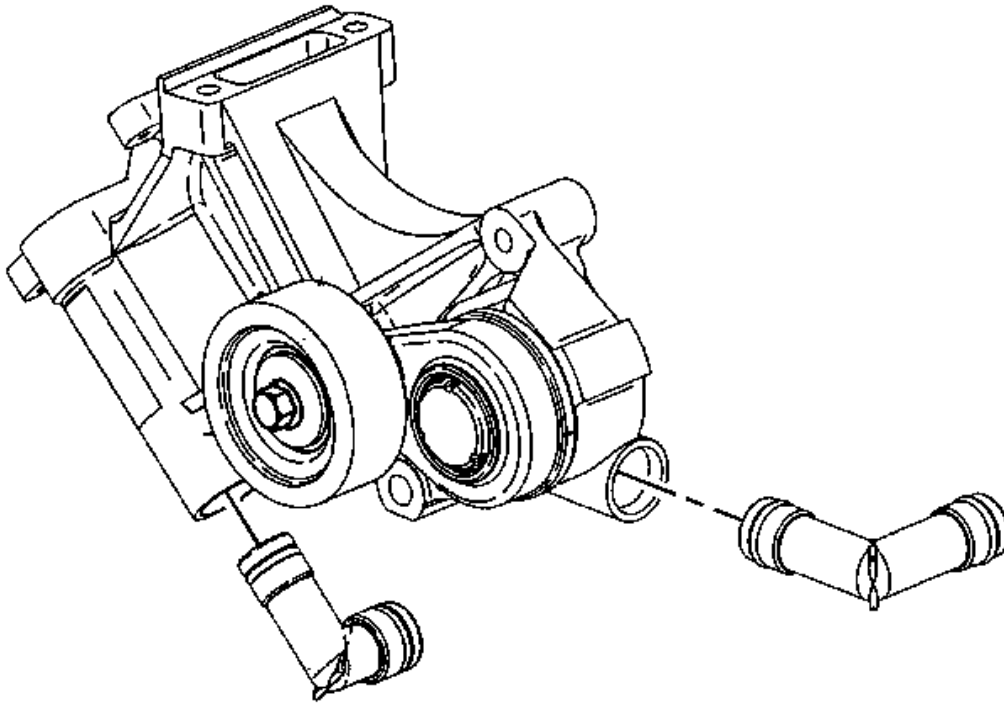


Fig. 19: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Install the drive belt tensioner.

CAUTION: Refer to Fastener Caution .

3. Install the drive belt tensioner bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

4. Install the heater hose adapters with the heater hoses to the drive belt tensioner. Refer to **Heater Inlet Hose Replacement (L26)** and to **Heater Outlet Hose Replacement (L26)** .
5. Install the generator. Refer to **Generator Replacement (L26)** .
6. Install the drive belt. Refer to **Drive Belt Replacement (L26)**.

7. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement (L26)** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .

DRIVE BELT IDLER PULLEY REPLACEMENT - UPPER

Removal Procedure

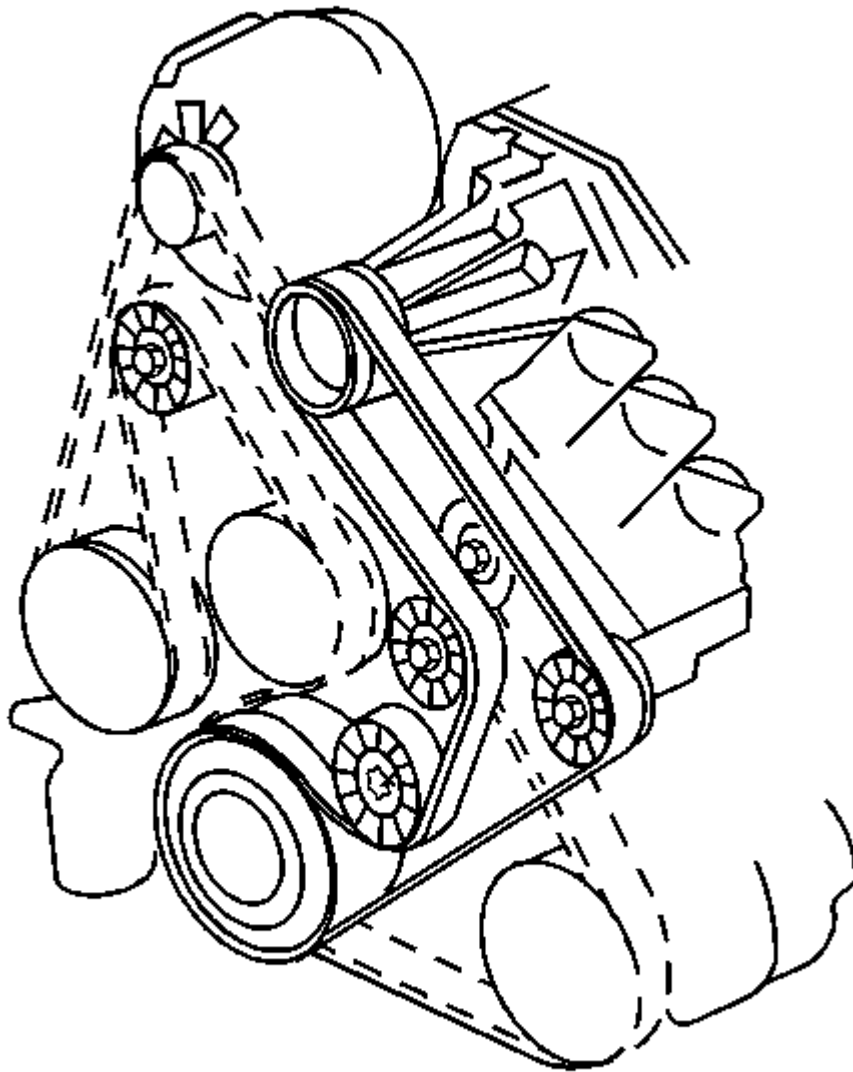


Fig. 20: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

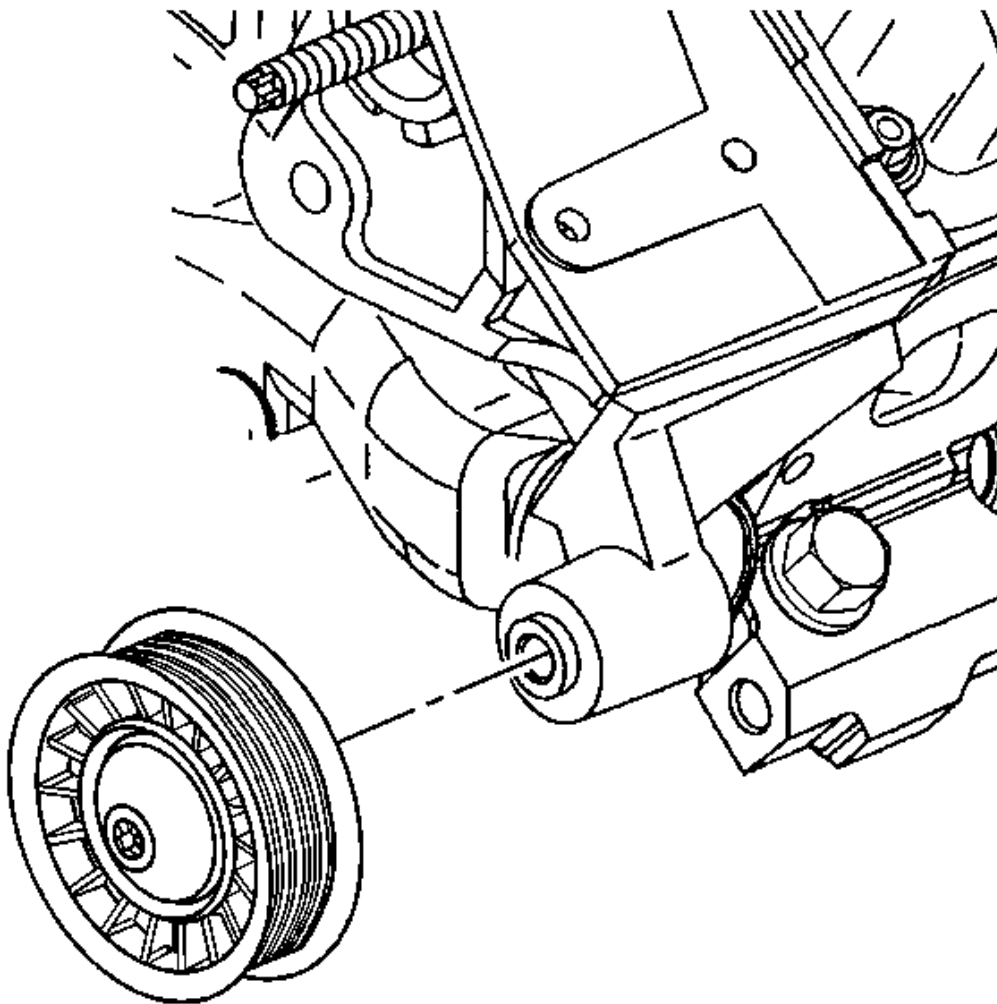


Fig. 21: Removing/Installing Upper Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

2. Remove the idler pulley bolt.
3. Remove the drive belt idler pulley.

Installation Procedure

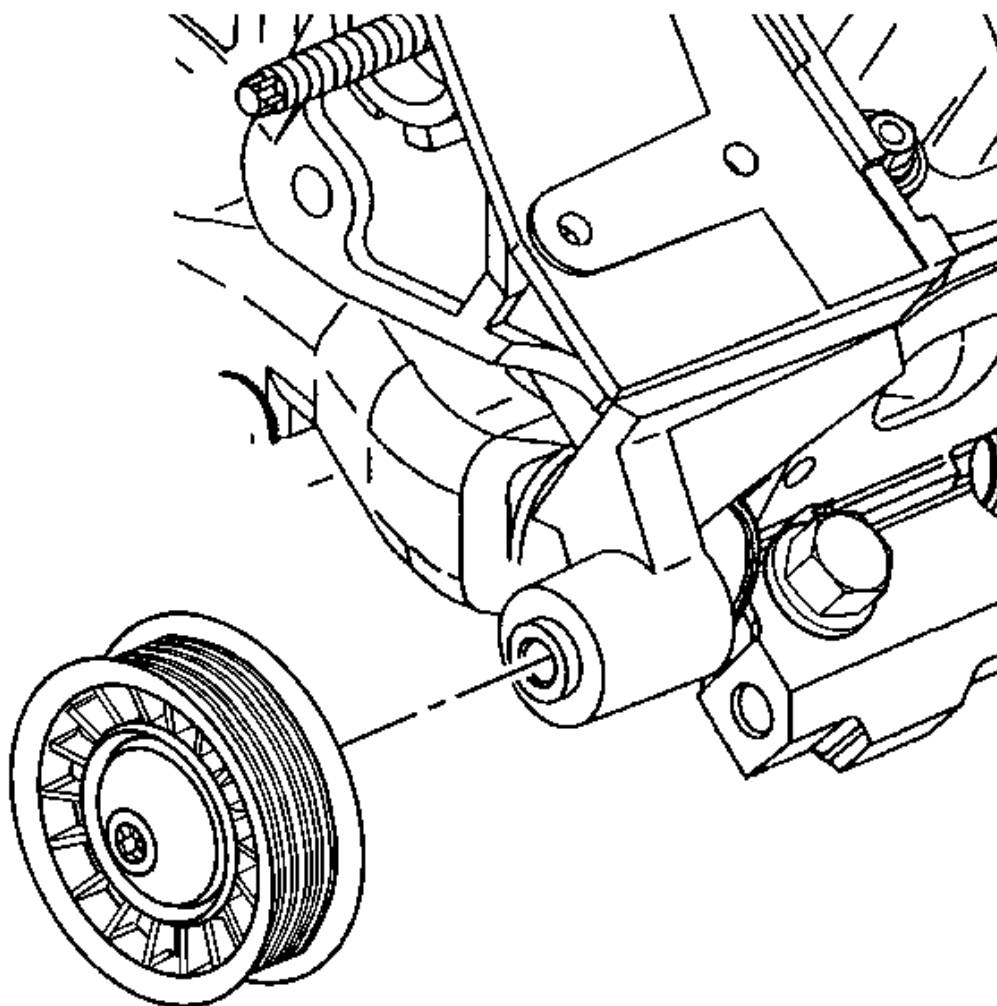


Fig. 22: Removing/Installing Upper Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.

CAUTION: Refer to Fastener Caution .

2. Install the idler pulley bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

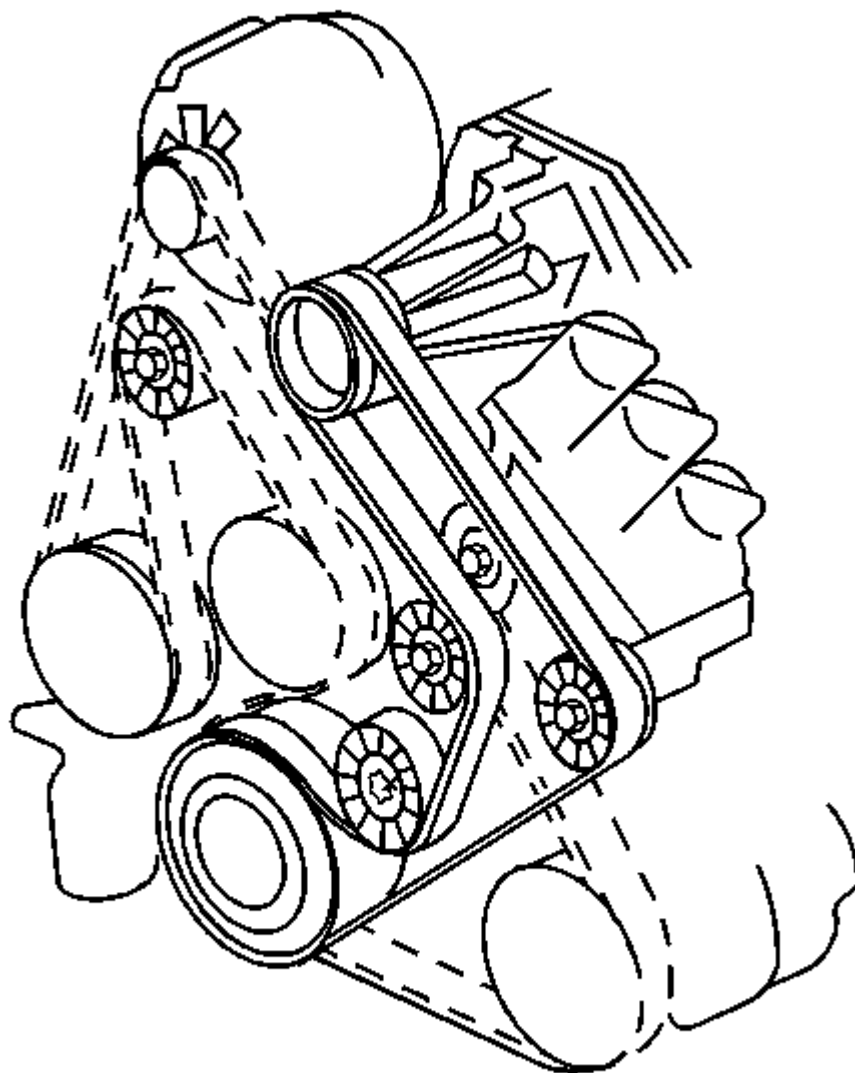


Fig. 23: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

3. Install the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

DRIVE BELT IDLER PULLEY REPLACEMENT - LOWER

Removal Procedure

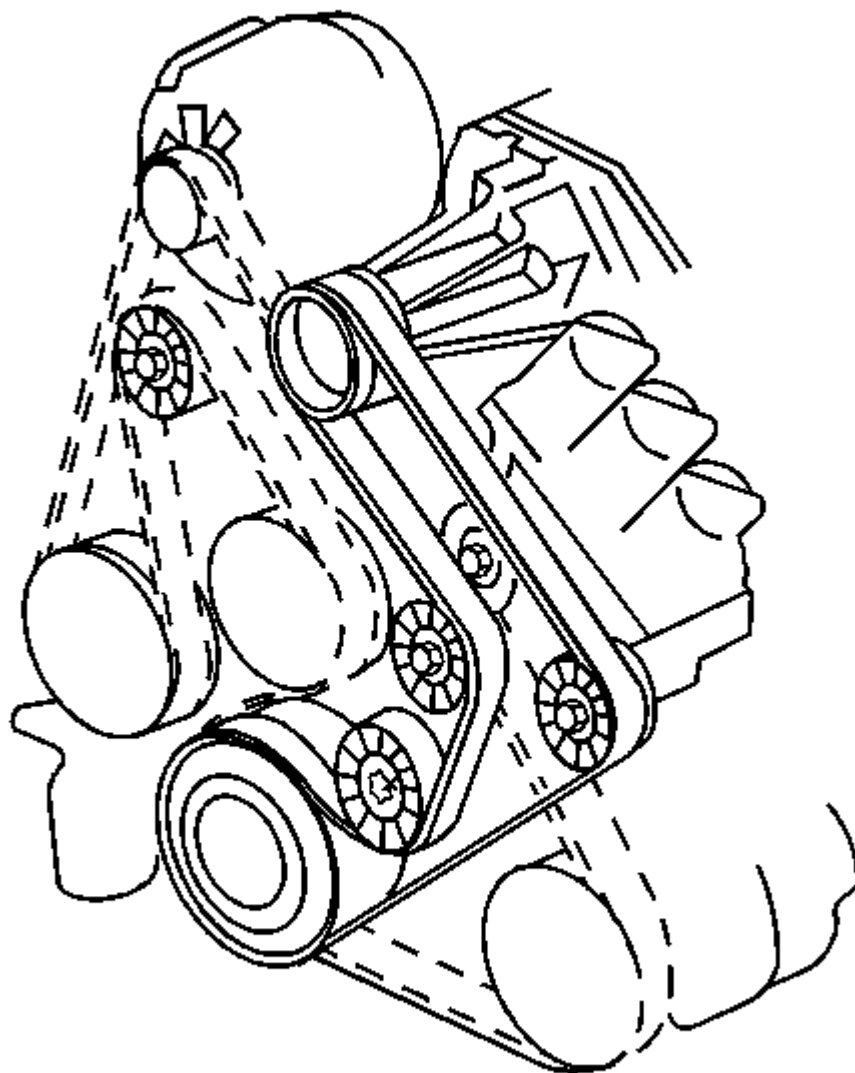


Fig. 24: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

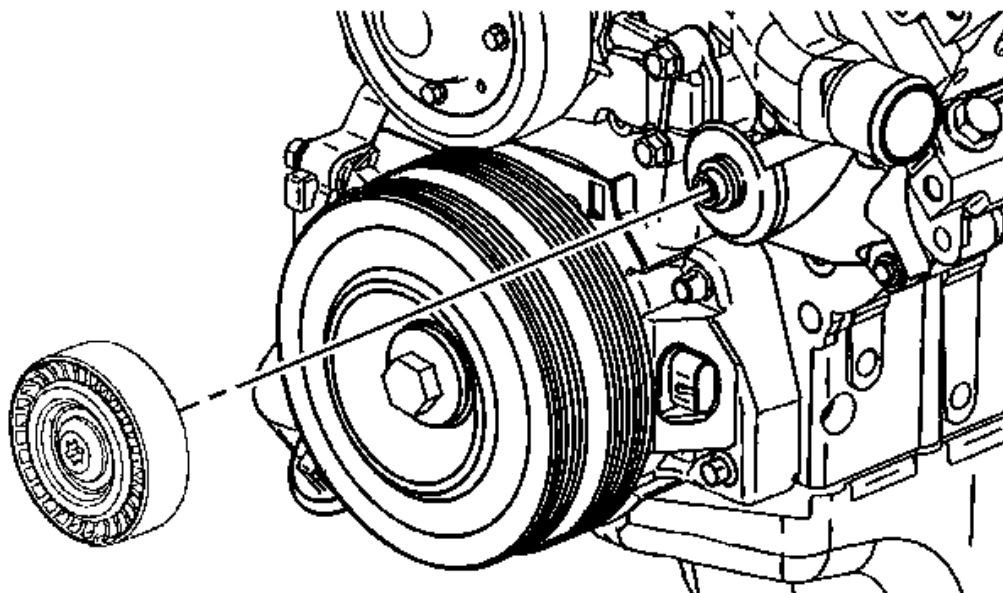


Fig. 25: Identifying Drive Belt Idler Pulley - Lower
Courtesy of GENERAL MOTORS CORP.

2. Remove the idler pulley bolt.
3. Remove the drive belt idler pulley.

Installation Procedure

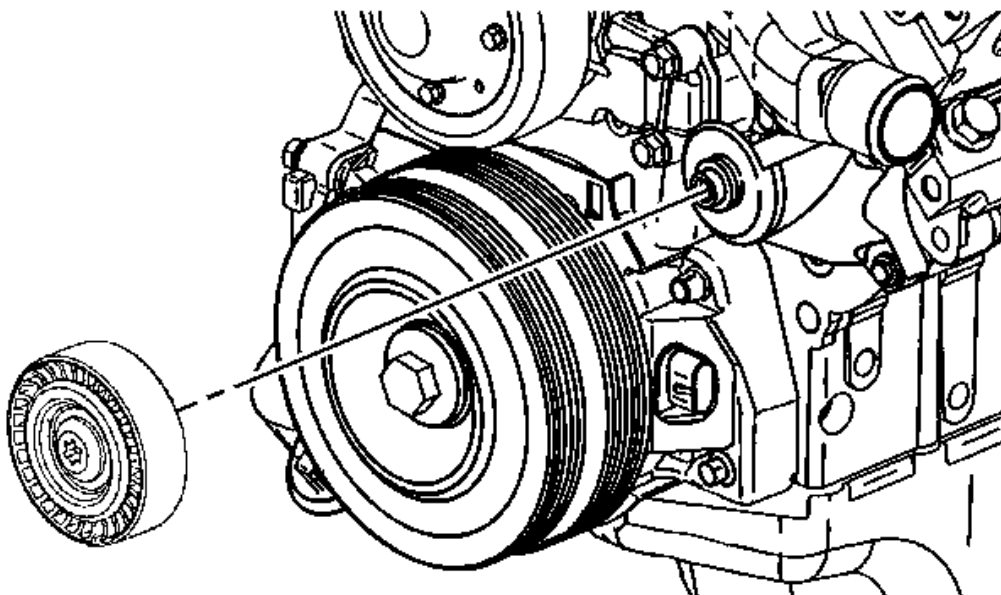


Fig. 26: Identifying Drive Belt Idler Pulley - Lower
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.

CAUTION: Refer to Fastener Caution .

2. Install the idler pulley bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

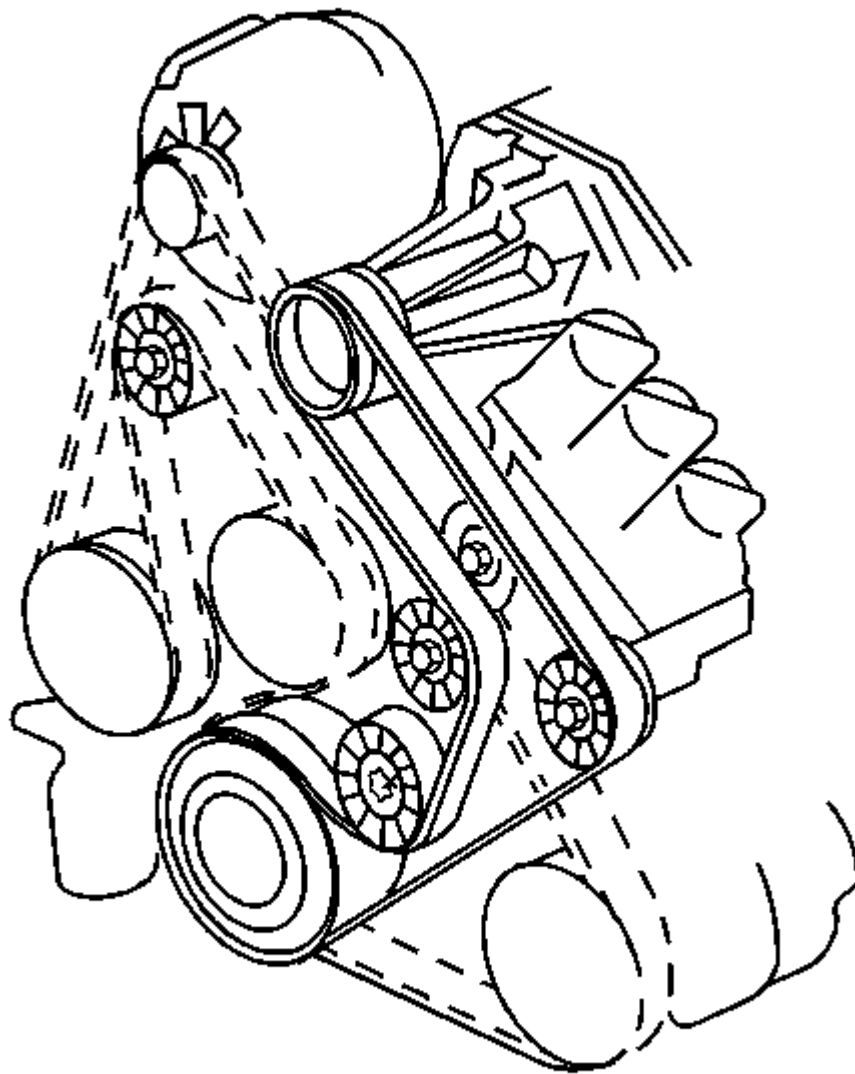


Fig. 27: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

3. Install the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

DRIVE BELT IDLER PULLEY BRACKET REPLACEMENT

Removal Procedure

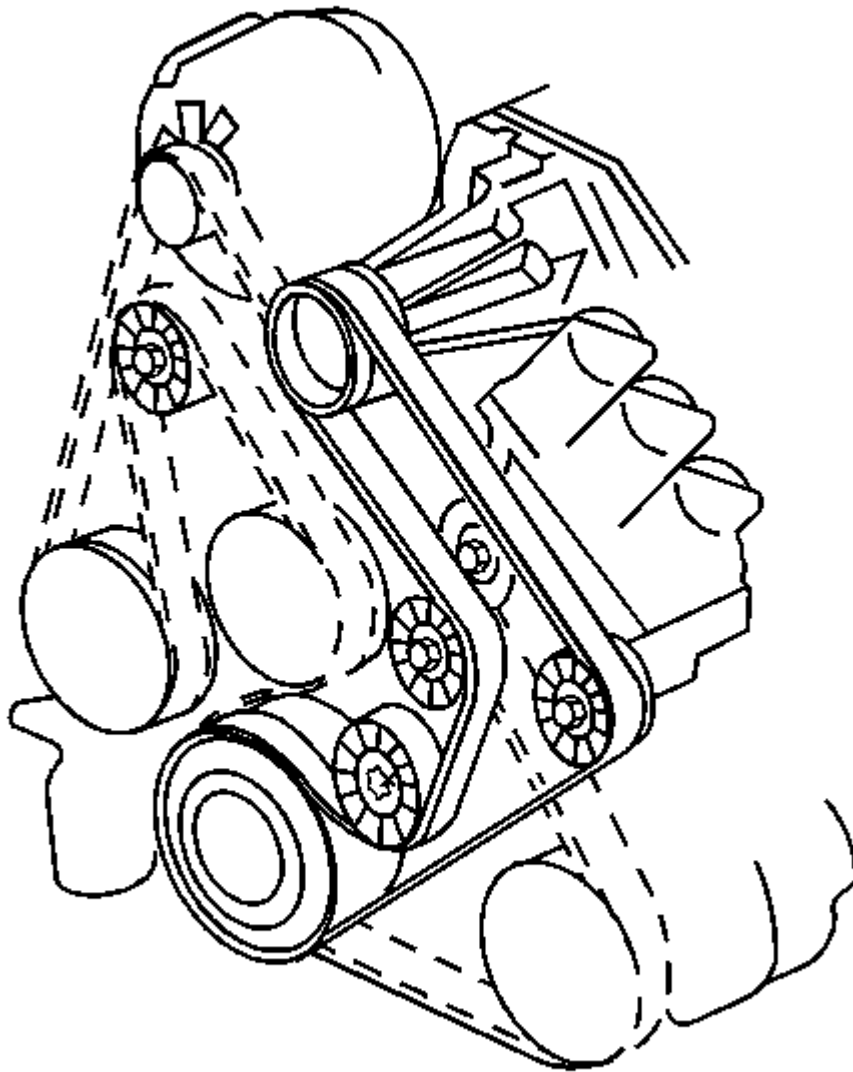


Fig. 28: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

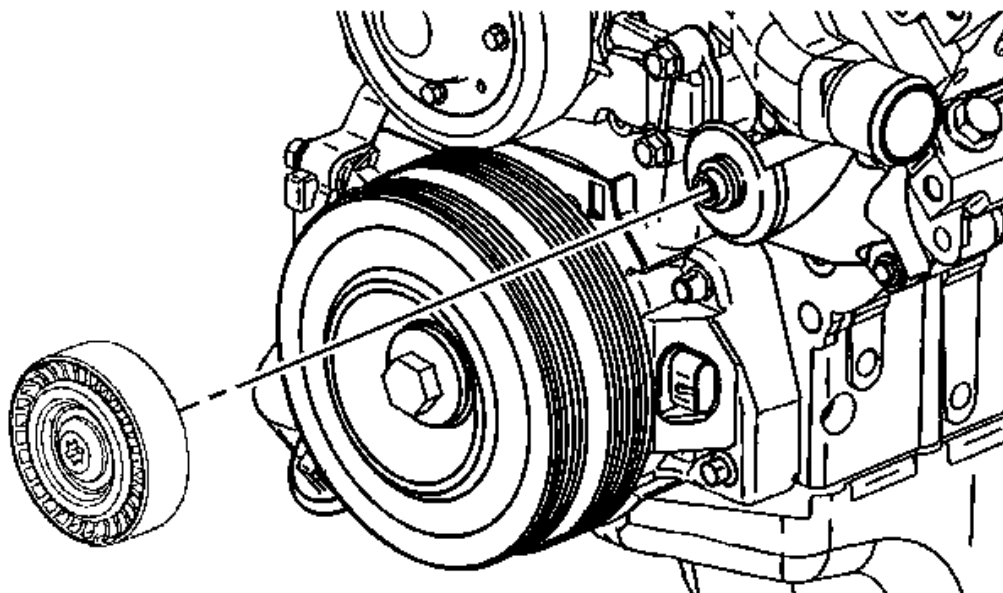


Fig. 29: Identifying Drive Belt Idler Pulley - Lower
Courtesy of GENERAL MOTORS CORP.

2. Remove the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley.

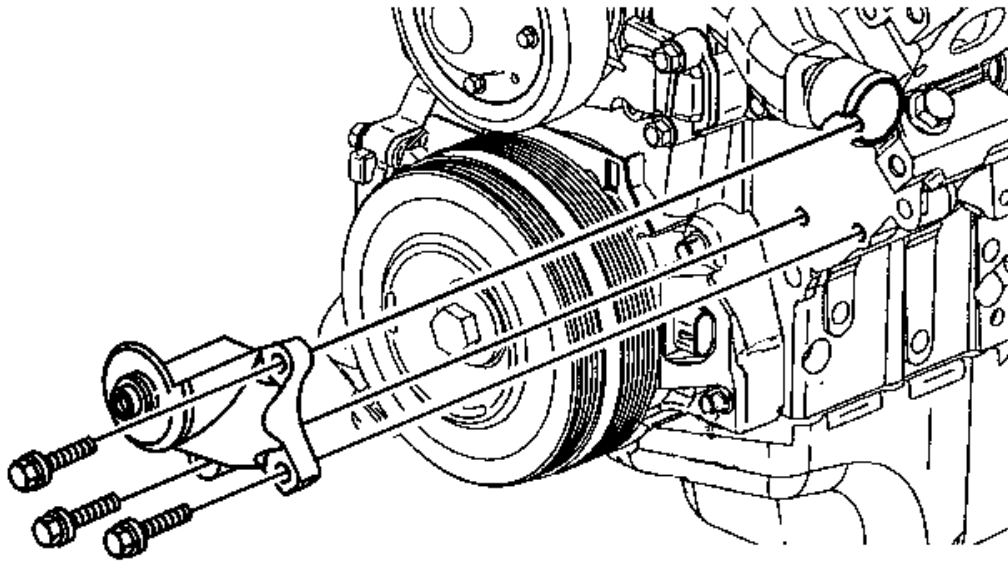


Fig. 30: Idler Pulley Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the idler pulley bracket bolts.
5. Remove the idler pulley bracket.

Installation Procedure

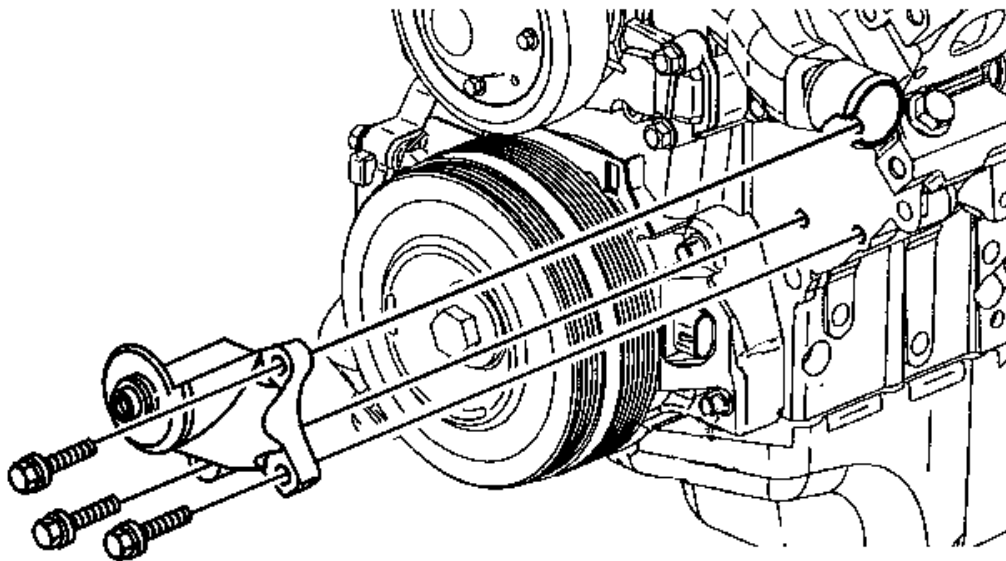


Fig. 31: Idler Pulley Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley bracket.

CAUTION: Refer to Fastener Caution .

2. Install the idler pulley bracket bolts.

Tighten: Tighten the bolts to 30 N.m (22 lb ft).

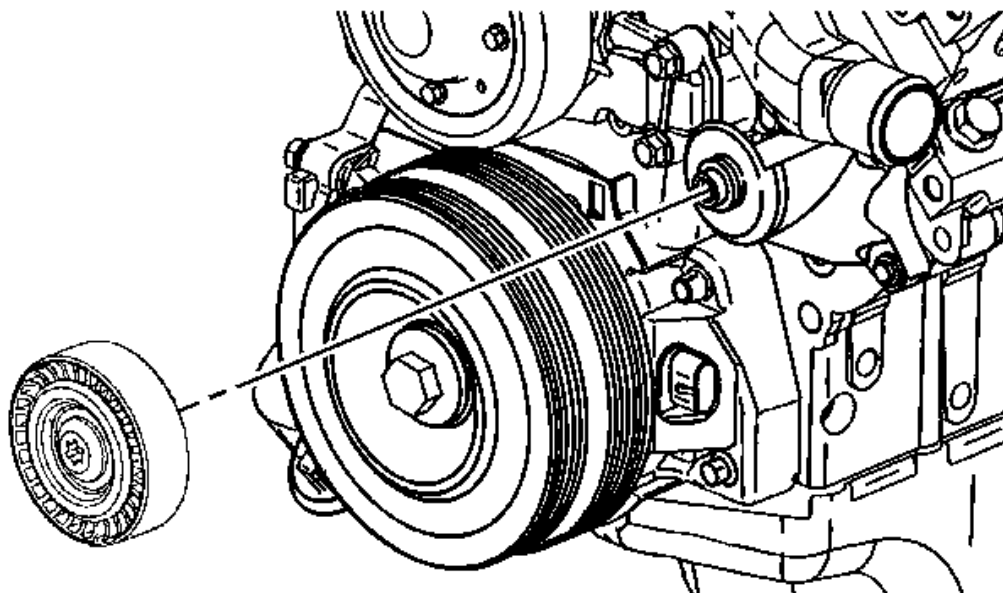


Fig. 32: Identifying Drive Belt Idler Pulley - Lower
Courtesy of GENERAL MOTORS CORP.

3. Install the drive belt idler pulley.
4. Install the drive belt idler pulley bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

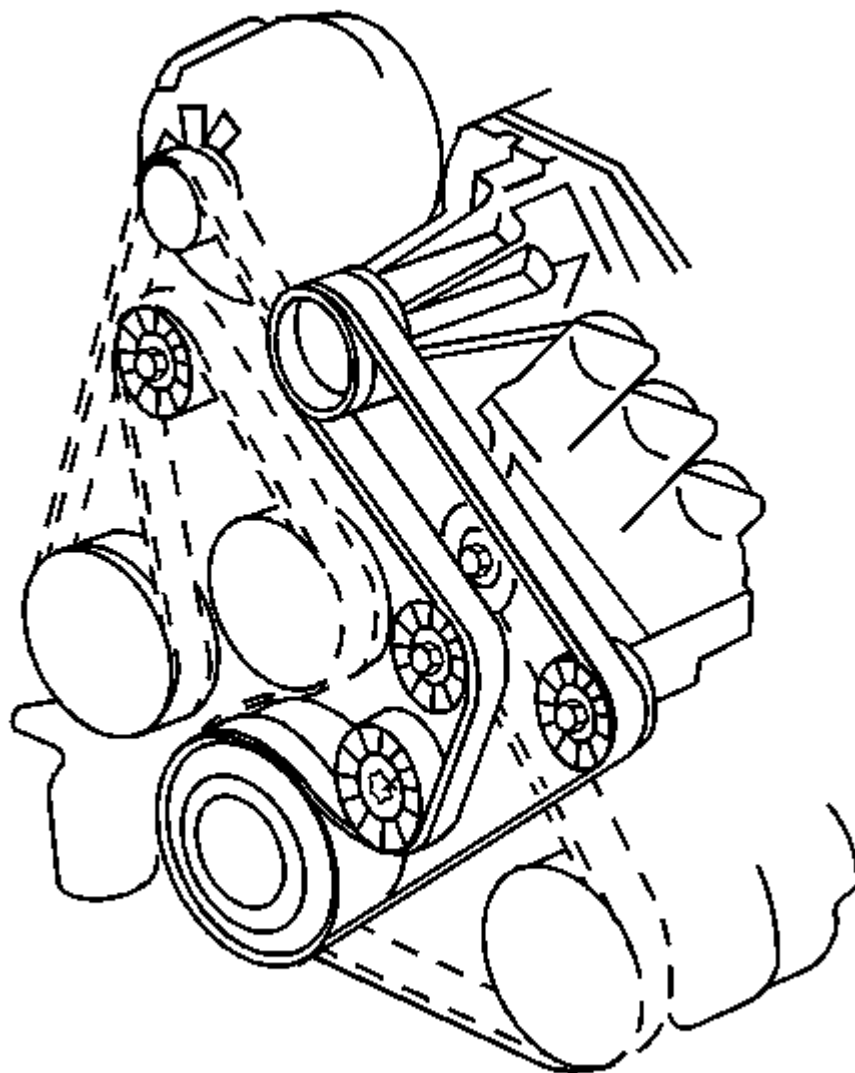


Fig. 33: View Of Supercharger Drive Belt
Courtesy of GENERAL MOTORS CORP.

5. Install the supercharger drive belt. Refer to **Drive Belt Replacement (L26)**.

ENGINE SUPPORT FIXTURE

Special Tools

- **J 28467-B** Universal Engine Support Fixture
 - **J 36462-A** Engine Support Adapter Leg Set. See Special Tools.
 - **J-28467-501** Engine Support Fixture Adapters
1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (L26).

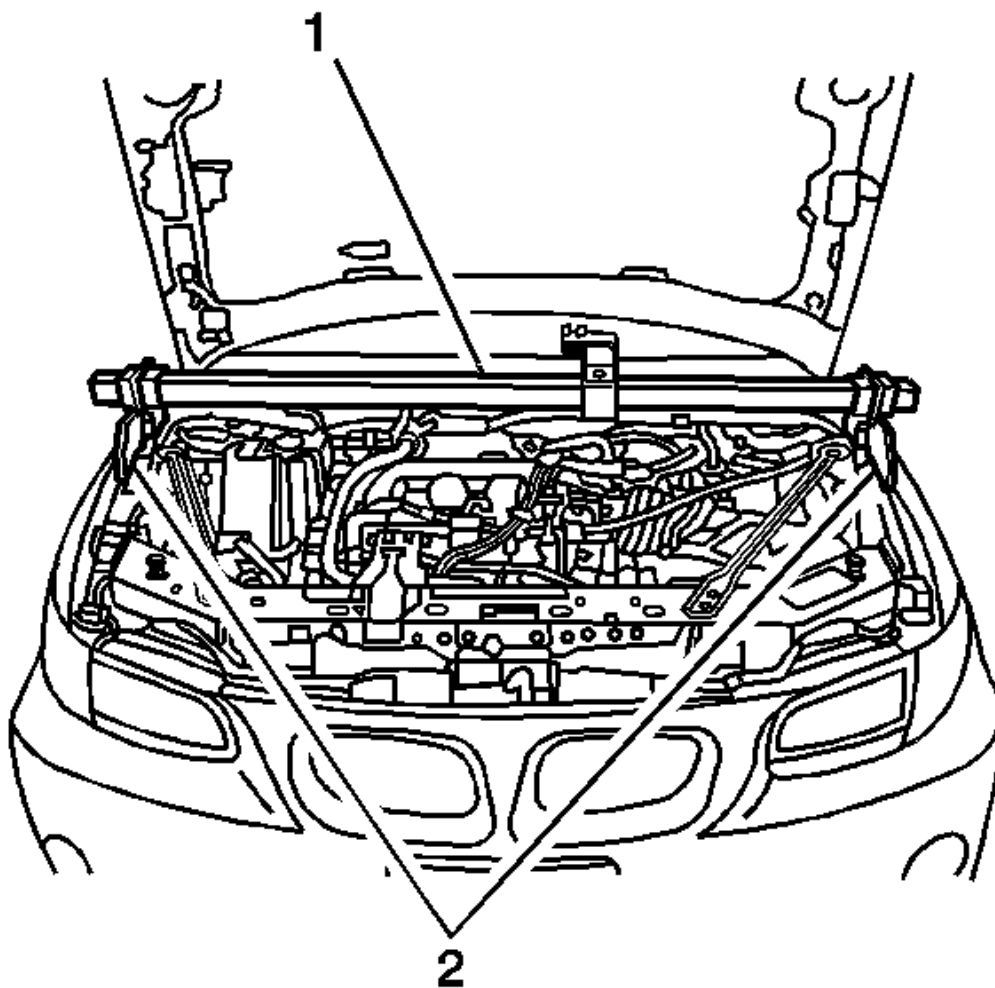


Fig. 34: View Of J-28467-501 & J 28467-B Cross Bar Installed On Engine
Courtesy of GENERAL MOTORS CORP.

2. Remove the left engine mount strut and the bracket from the upper radiator support. Refer to Engine Mount Strut Bracket Replacement - Upper Radiator Support.

3. Install an engine lift hook to the engine, if not previously installed.
4. Assemble the **J-28467-501** (2) to the **J 28467-B** cross bar (1).
5. Install the **J 28467-B** (1) and the **J-28467-501** (2) to the fender rails.

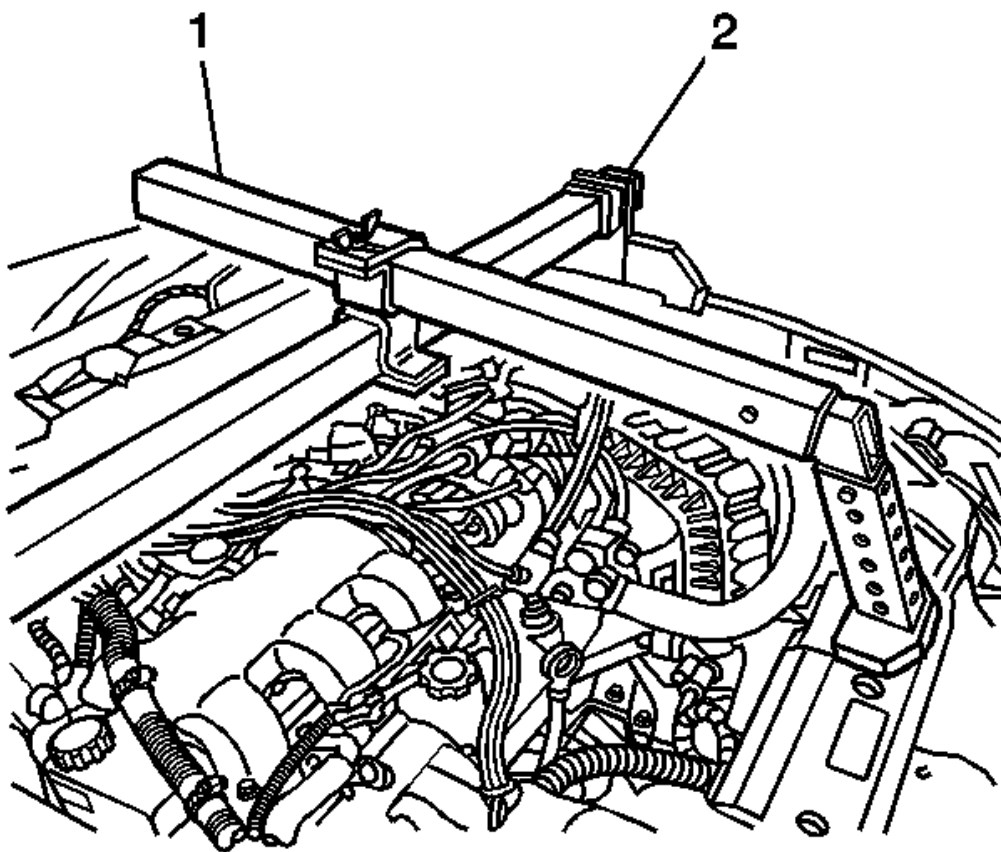


Fig. 35: Installing J 36462-A To Cross Bar
 Courtesy of GENERAL MOTORS CORP.

6. Install the **J 36462-A** (1) to the cross bar (2). See Special Tools.

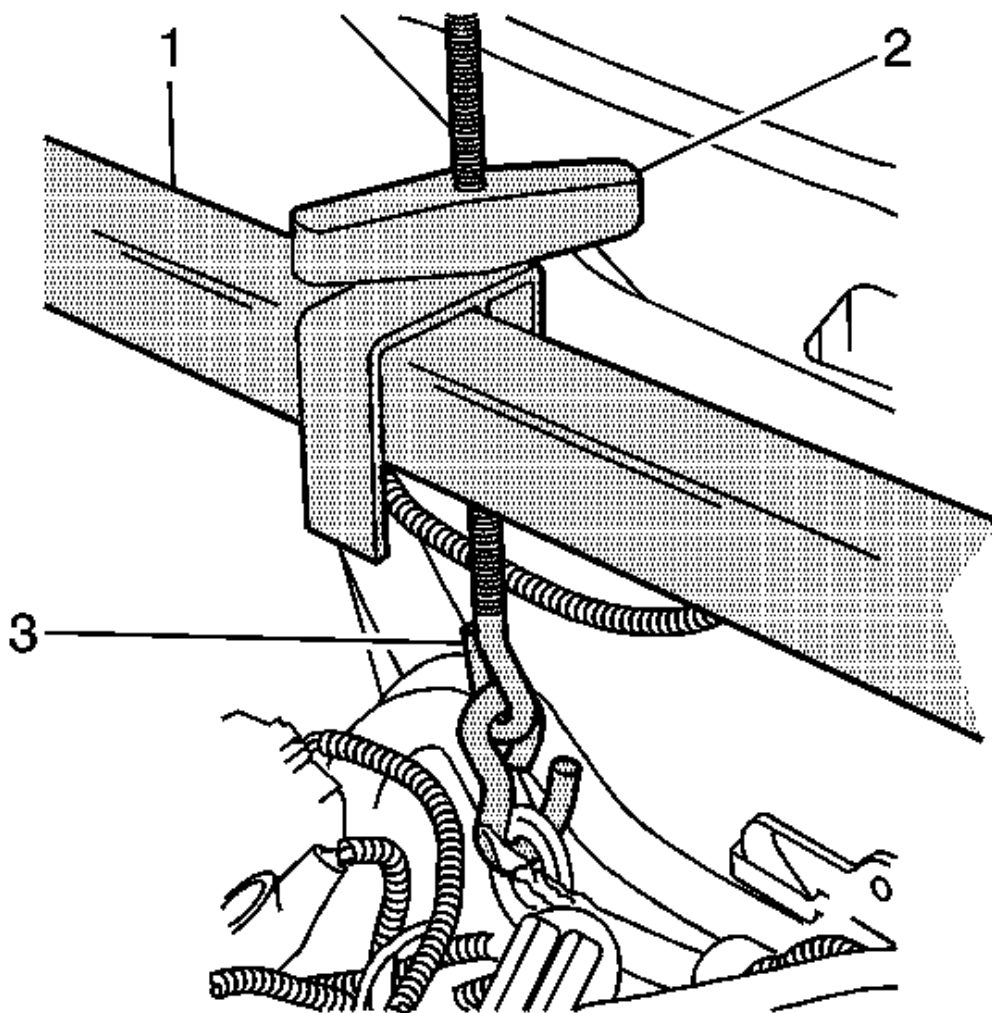


Fig. 36: Support Lift Hook & Cross Bar
Courtesy of GENERAL MOTORS CORP.

7. Install the support lift hook (2) to the cross bar (1).
8. Install the support hook (1) to the right engine lift hook (3).

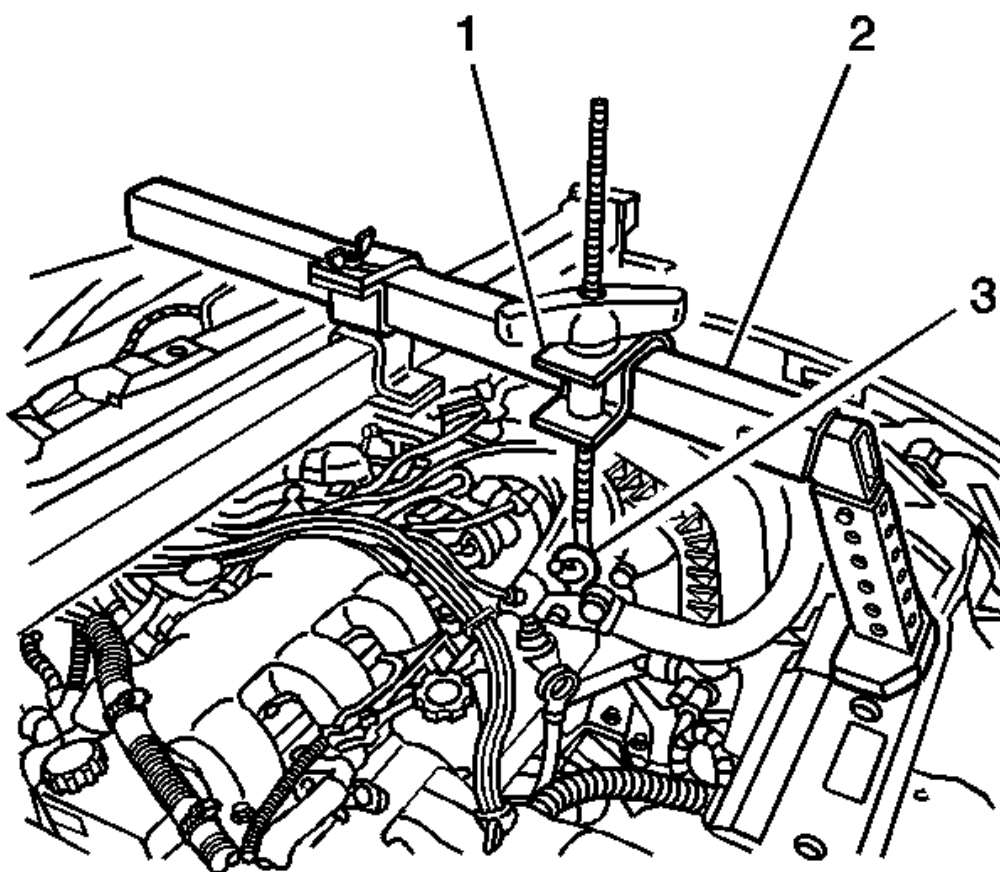


Fig. 37: Installing Support Hook To Left Engine Lift Hook
Courtesy of GENERAL MOTORS CORP.

9. Install the support hook (1) to the J 36462-A (2). See **Special Tools**.
10. Install the support hook (1) to the left engine lift hook (3).

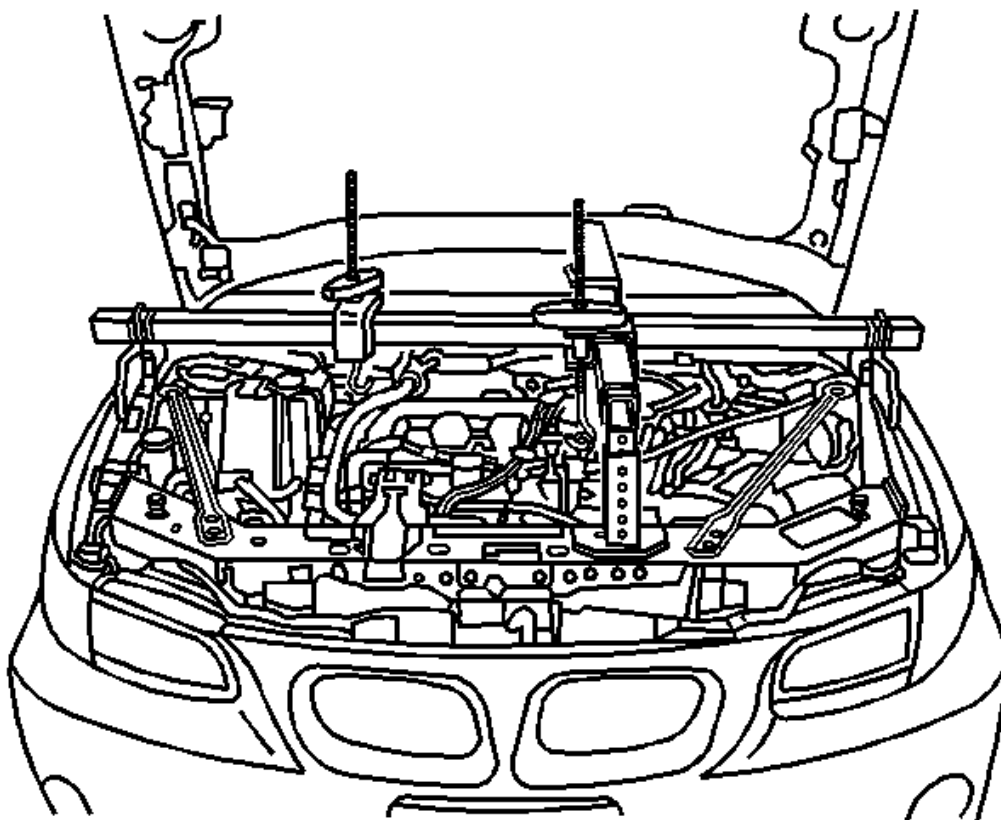


Fig. 38: Releasing Pressure Off Of Engine Mounts
Courtesy of GENERAL MOTORS CORP.

11. Raise the engine to release the pressure off of the engine mounts.

ENGINE FRONT MOUNT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the engine splash shield.

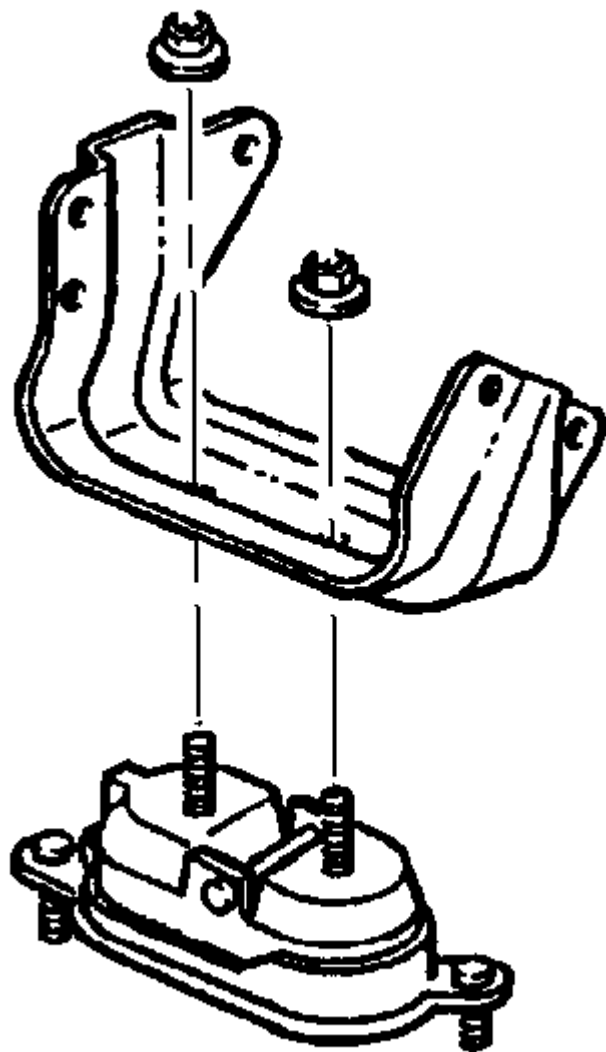


Fig. 39: Engine Mount To Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the motor mount to motor mount bracket nuts.

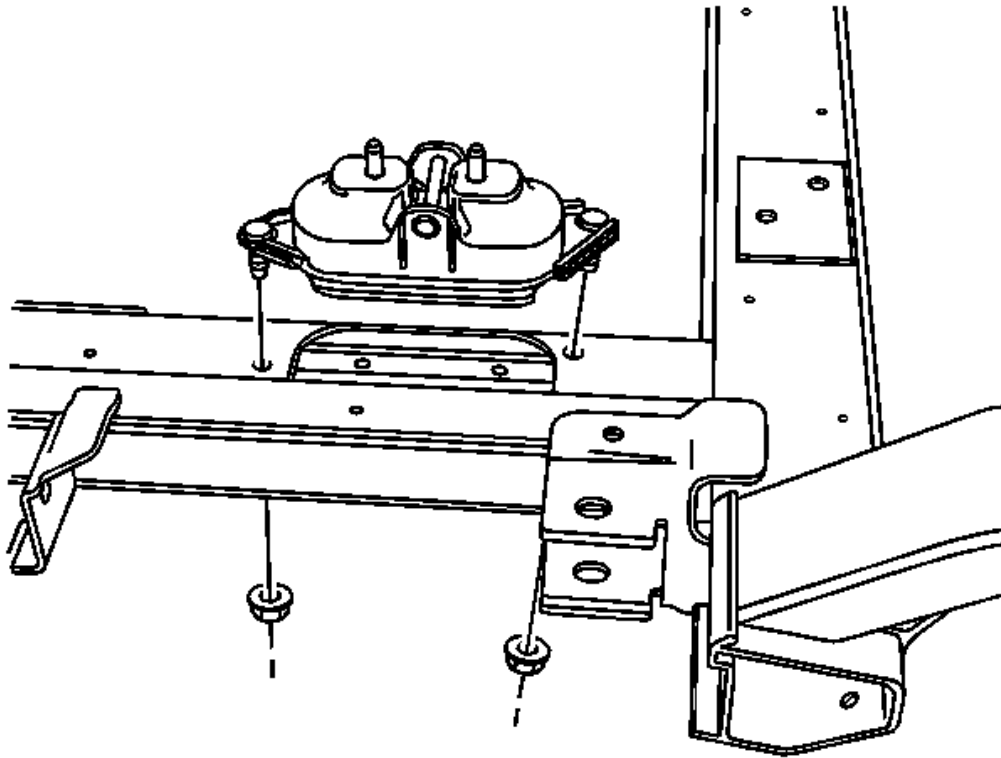


Fig. 40: Motor Mount & Frame Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the motor mount to frame nuts.
6. Using a suitable jackstand, raise the engine.
7. Remove the motor mount from the vehicle.

Installation Procedure

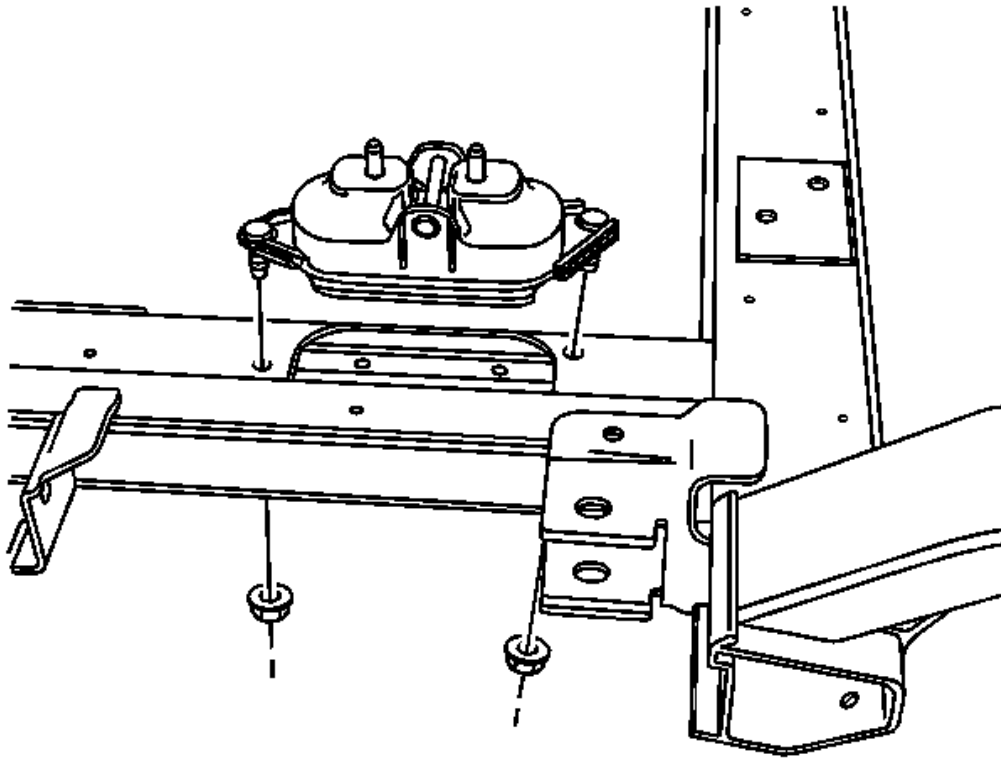


Fig. 41: Motor Mount & Frame Nuts
Courtesy of GENERAL MOTORS CORP.

1. Position the motor mount on the frame
2. Use the jackstand to lower the motor mount bracket on to the motor mount.

CAUTION: Refer to Fastener Caution .

3. Install the motor mount to frame bolts.

Tighten: Tighten the nuts to 47 N.m (35 lb ft).

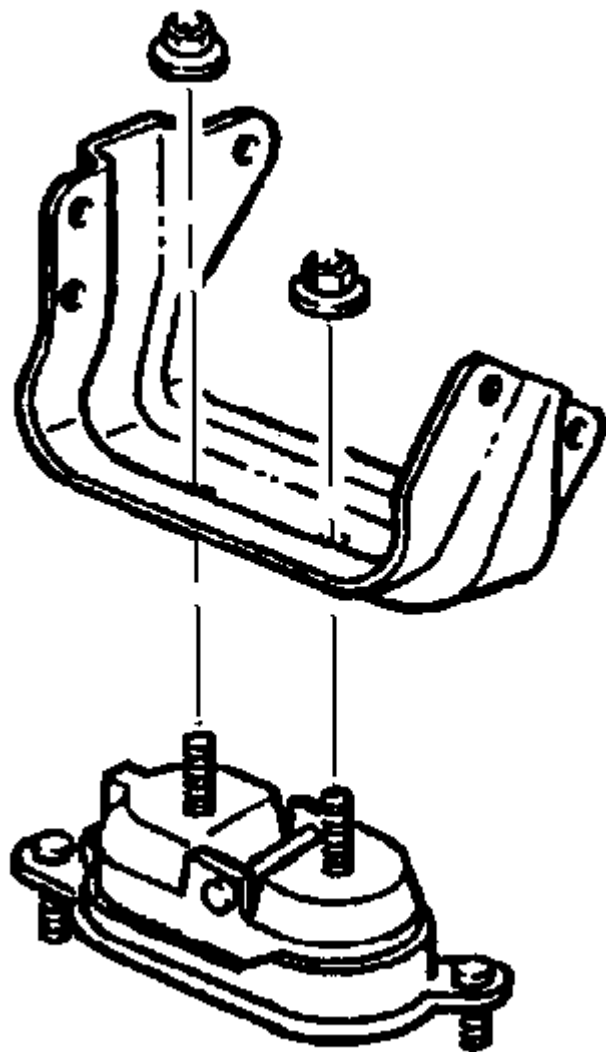


Fig. 42: Engine Mount To Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the motor mount to motor mount bracket nuts.

Tighten: Tighten the nuts to 47 N.m (35 lb ft).

5. Install the engine splash shield.
6. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

7. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Removal Procedure

WARNING: Refer to **Battery Disconnect Warning** .

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Disconnect the intake air temperature (IAT) sensor electrical connector.
4. Remove the air inlet duct from the throttle body.
5. Remove the right and left engine mount struts. Refer to **Engine Mount Strut Replacement - Right Side** and **Engine Mount Strut Replacement - Left Side**.
6. Remove the drive belt. Refer to **Drive Belt Replacement (L26)**.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
8. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

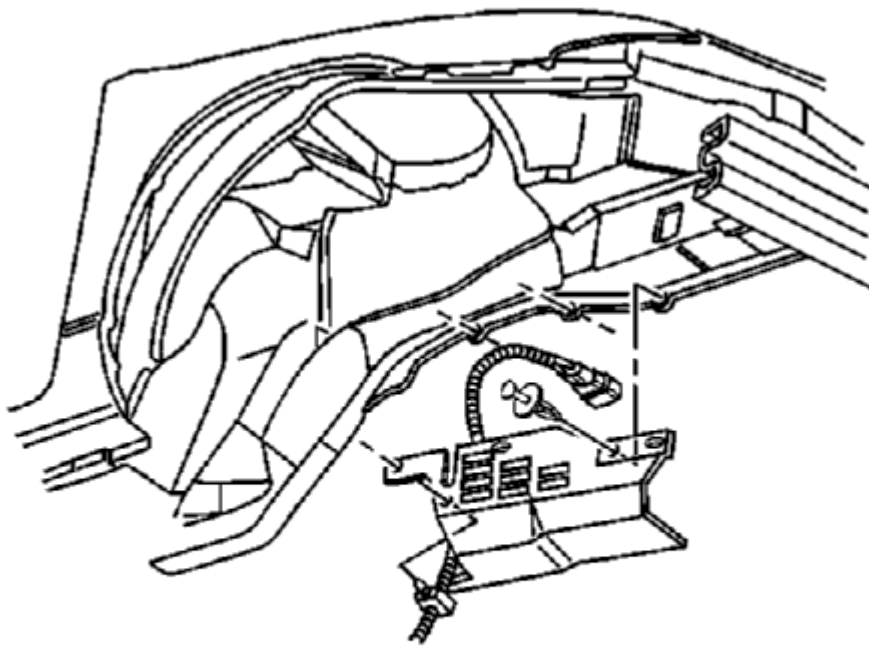


Fig. 43: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS CORP.

9. Remove the right engine splash shield.
10. Remove the power steering oil cooler pipe brackets from the frame.

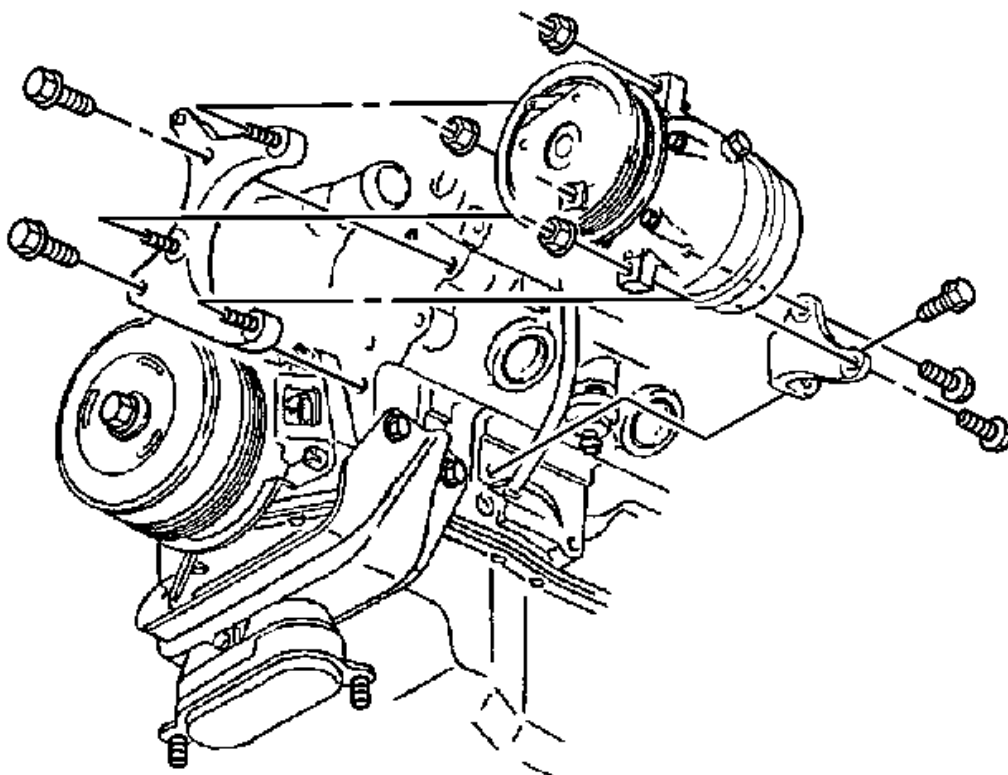


Fig. 44: View Of A/C Compressor
Courtesy of GENERAL MOTORS CORP.

11. Remove the A/C compressor and the A/C compressor bracket. DO NOT discharge the A/C system. Secure the compressor.

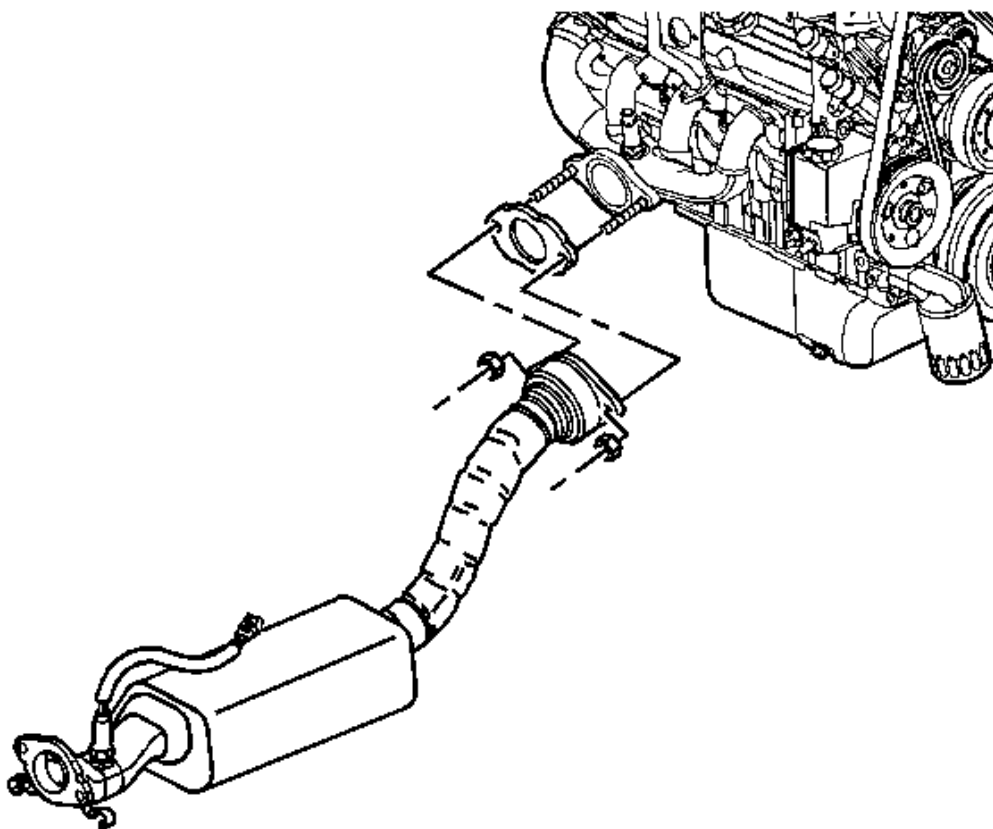


Fig. 45: View Of Catalytic Converter & Exhaust Manifold Pipe Stud Nuts
Courtesy of GENERAL MOTORS CORP.

12. Remove the right exhaust manifold pipe stud nuts from the catalytic converter.

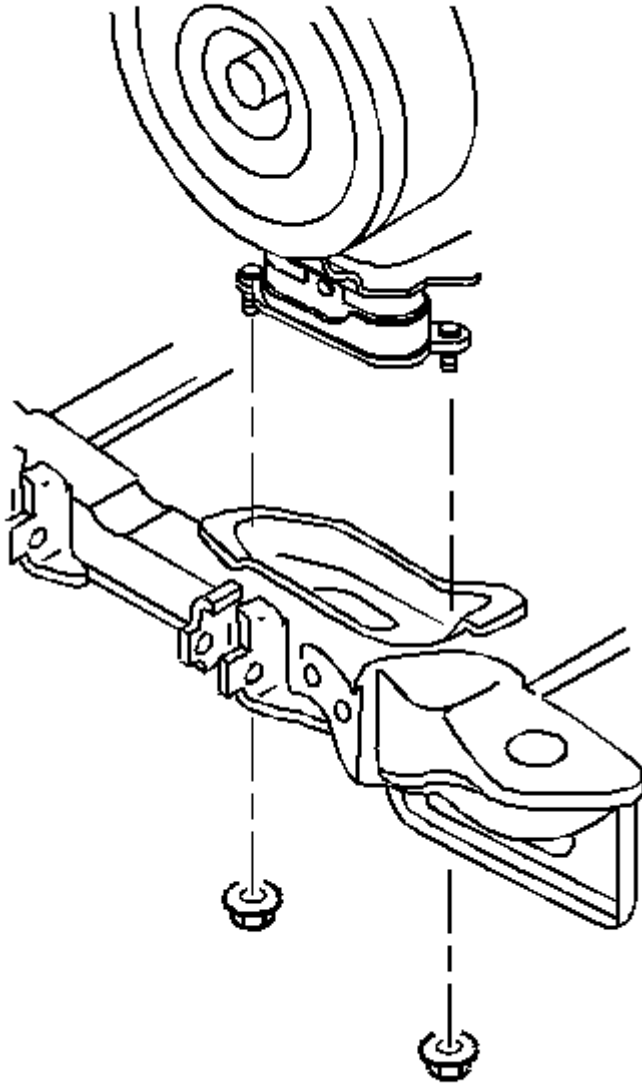


Fig. 46: Engine Mount Lower Nuts
Courtesy of GENERAL MOTORS CORP.

13. Remove the engine mount lower nuts from the frame.
14. Lower the vehicle.
15. Install the engine support fixture. Refer to **Engine Support Fixture**.
16. Use the engine support fixture to raise the engine.
17. Raise the vehicle.

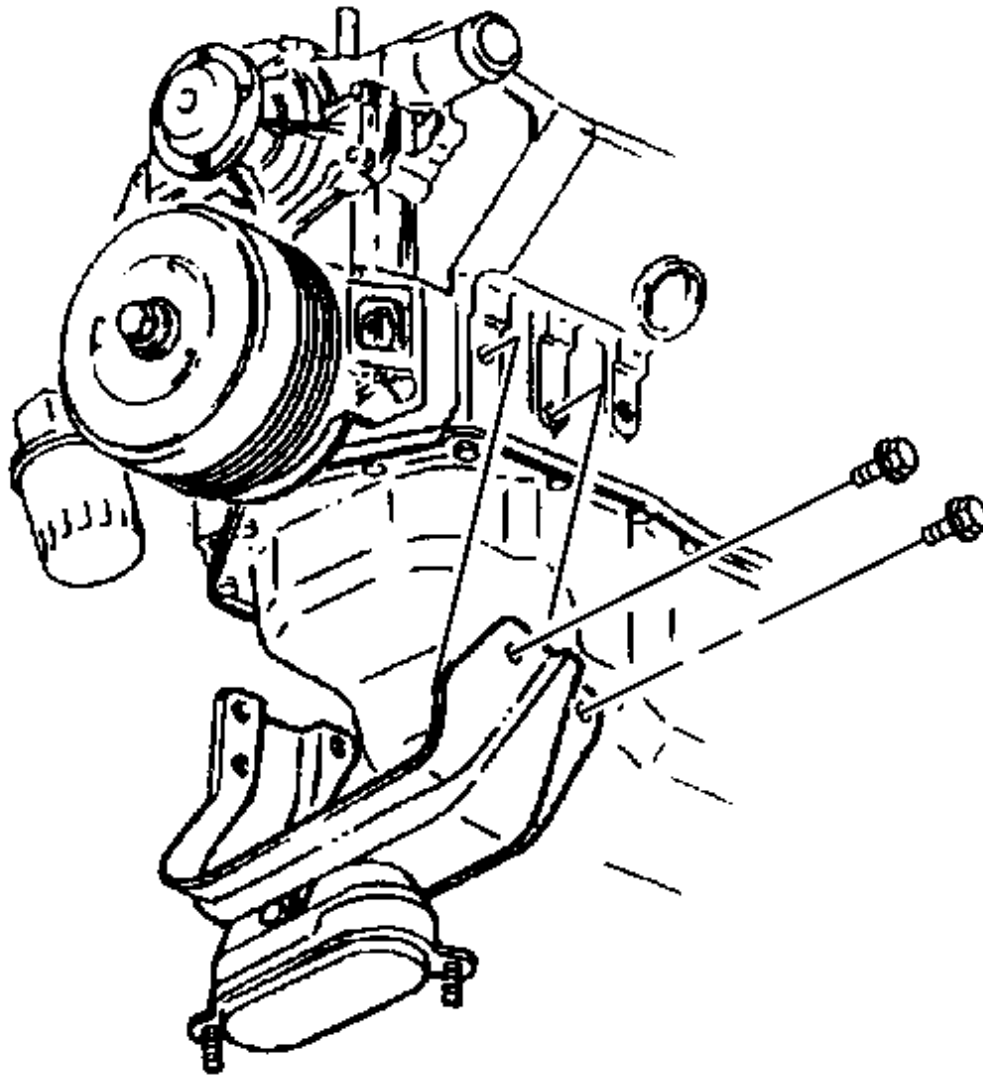


Fig. 47: Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the left engine mount bracket bolts from the engine.

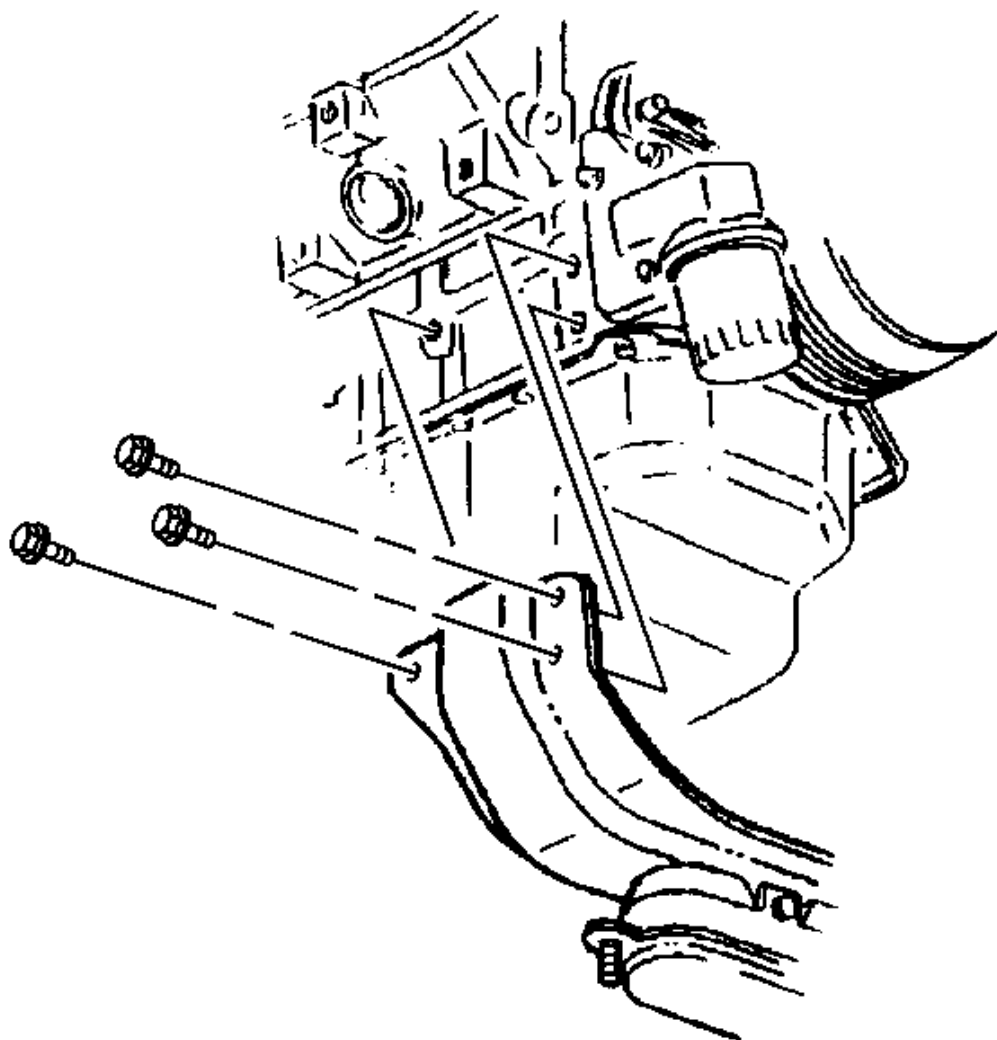


Fig. 48: Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

19. Remove the right engine mount bracket bolts from the engine.
20. Support the frame with jackstands.
21. Loosen the left side frame bolts. Remove the right side frame bolts. Using the jackstands lower the frame for engine mount bracket removal.
22. Remove the engine mount bracket with the engine mount from the engine.

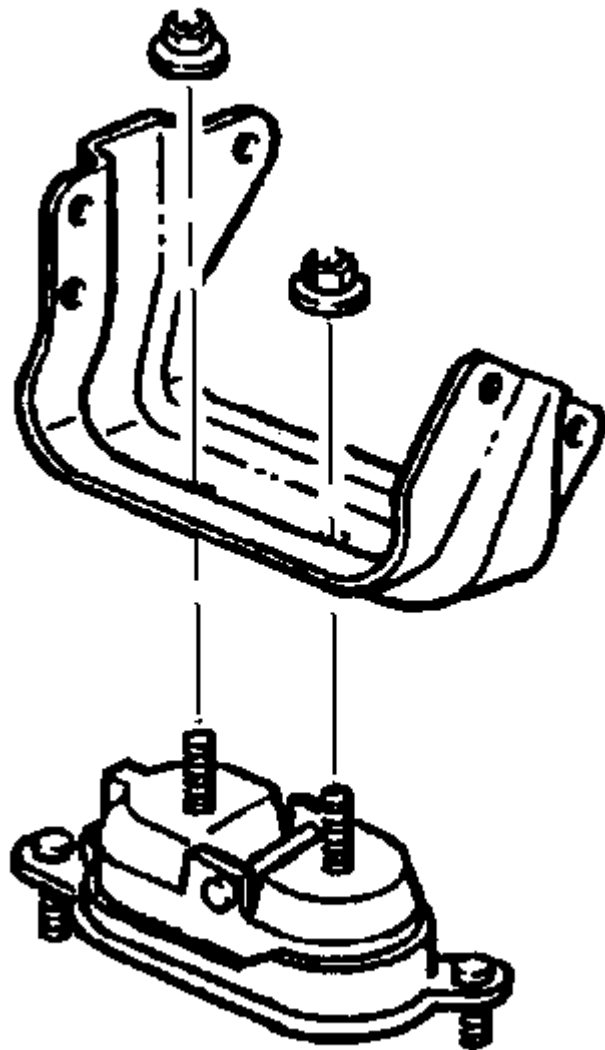


Fig. 49: Engine Mount To Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

23. Remove the engine mount upper nuts.
24. Remove the engine mount from the engine mount bracket.

Installation Procedure

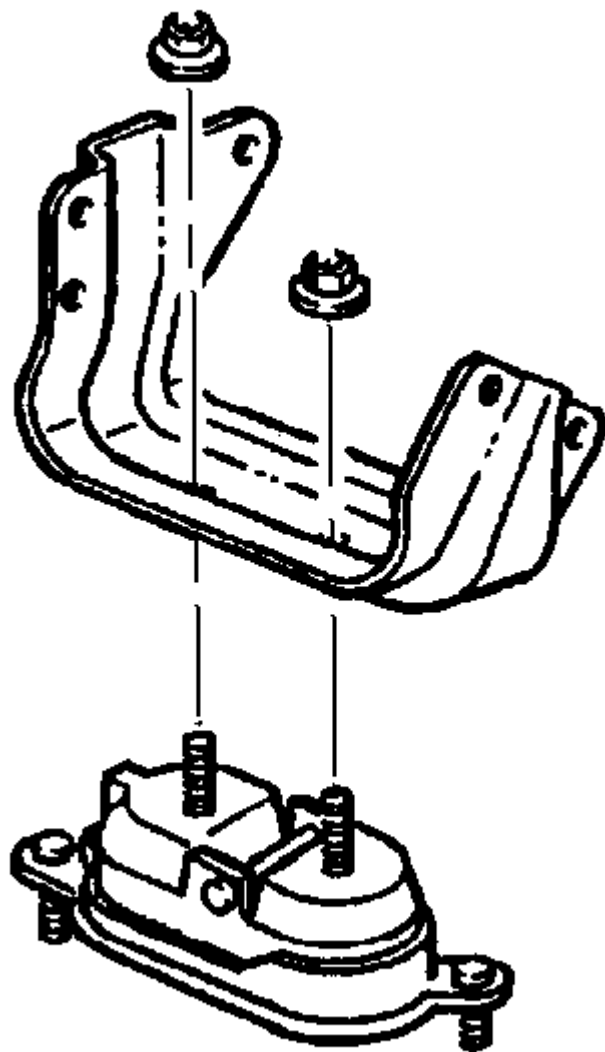


Fig. 50: Engine Mount To Engine Mount Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount to the engine mount bracket.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount upper nuts to the engine mount and the engine mount bracket.

Tighten: Tighten the engine mount upper nuts to 43 N.m (32 lb ft).

3. Install the engine mount bracket with the engine mount to the engine.

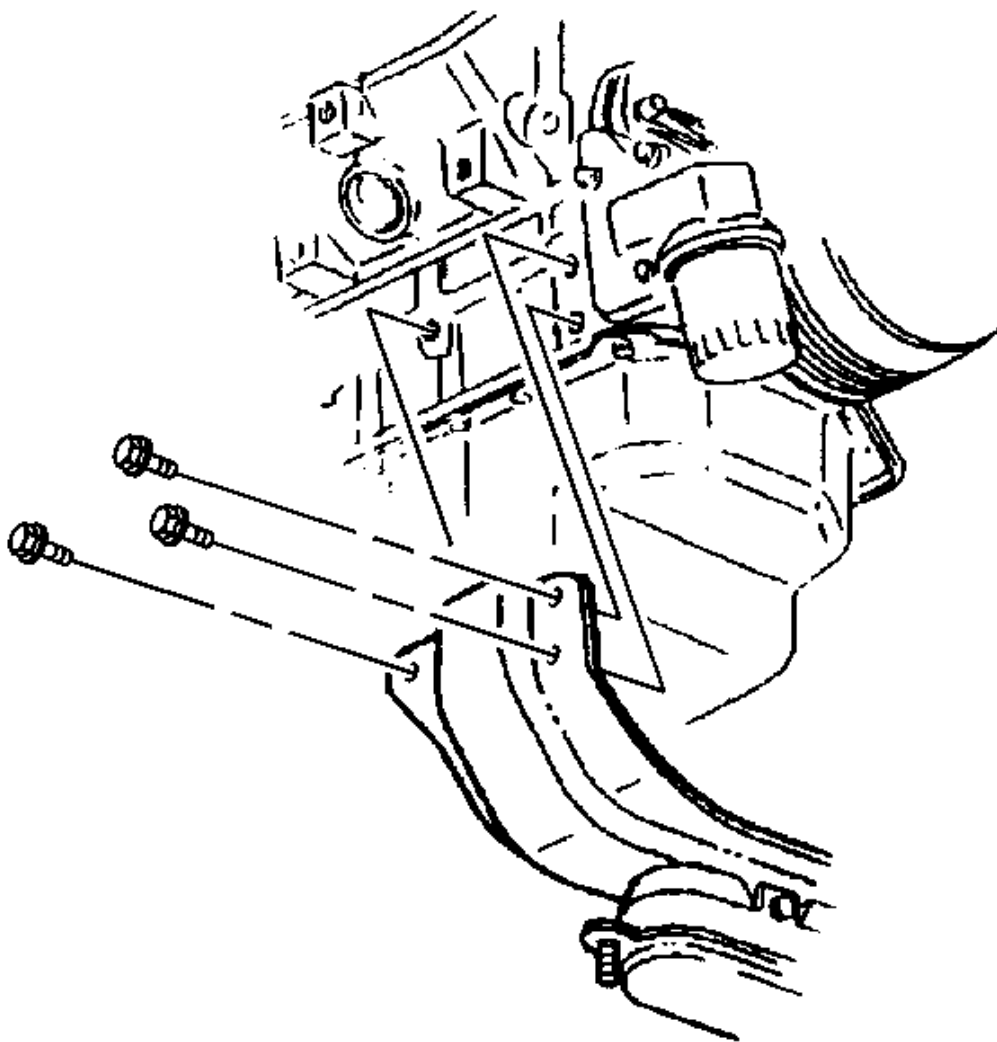


Fig. 51: Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Loosely install the right engine mount bracket bolts to the engine.

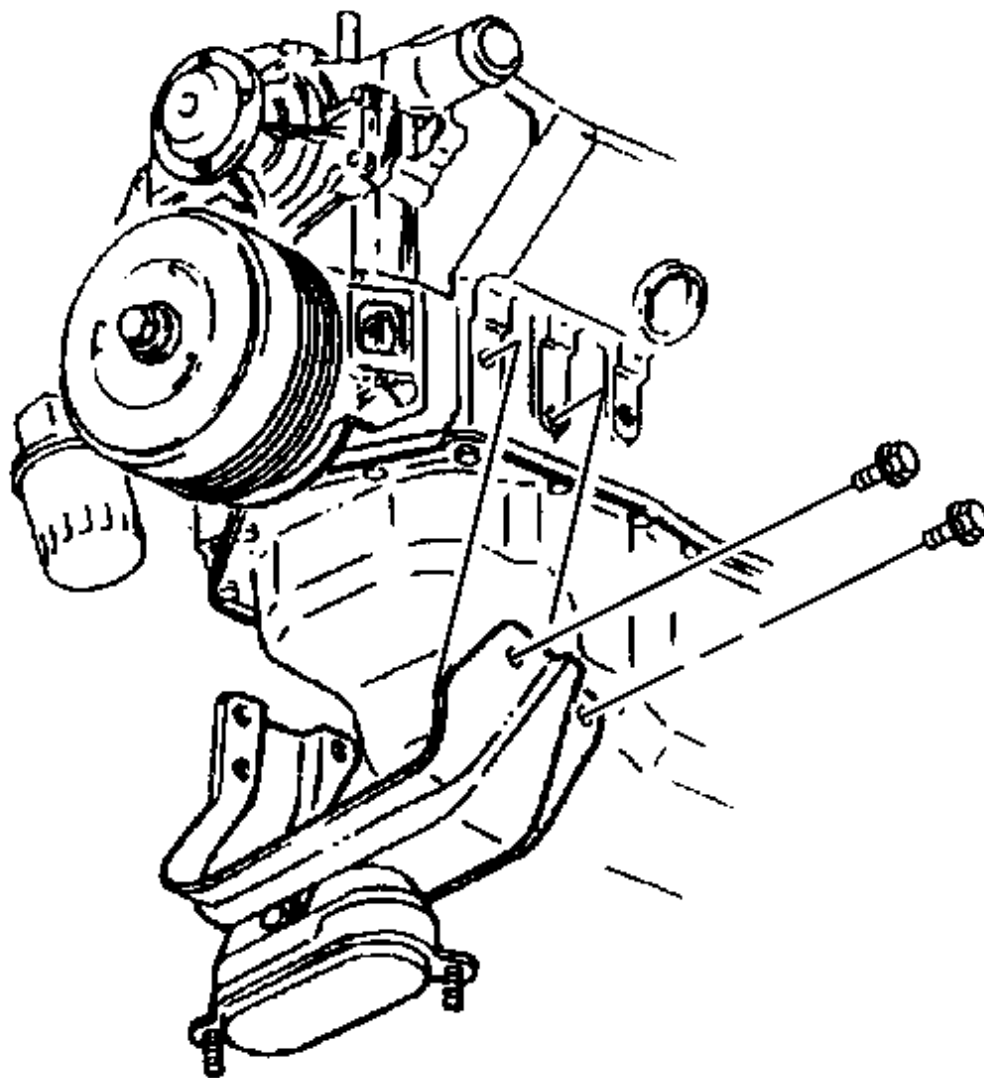


Fig. 52: Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

5. Loosely install the left engine mount bracket bolts to the engine.

Tighten: Tighten the left and the right engine mount bracket bolts to 102 N.m (75 lb ft).

6. Using the jackstands raise the frame to the original position.
7. Install the right side frame bolts.

Tighten: Tighten the right and the left side frame bolts to 180 N.m (133 lb ft).

8. Lower the vehicle.
9. Use the engine support fixture to lower the engine.
10. Raise the vehicle.

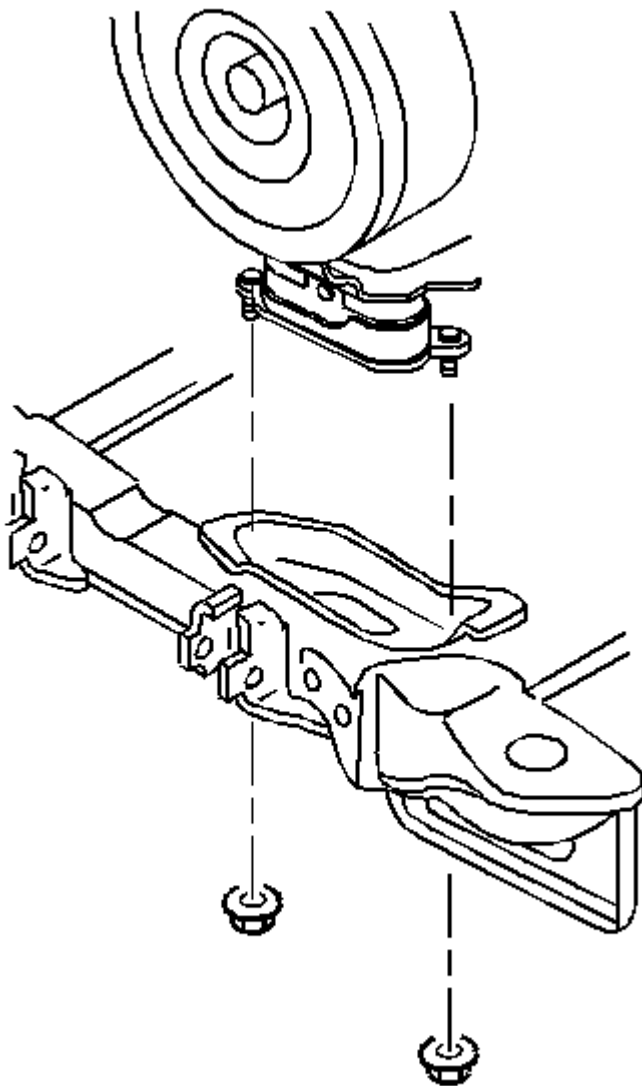


Fig. 53: Engine Mount Lower Nuts
Courtesy of GENERAL MOTORS CORP.

11. Install the engine mount lower nuts to the frame.

Tighten: Tighten the engine mount lower nuts to 43 N.m (32 lb ft).

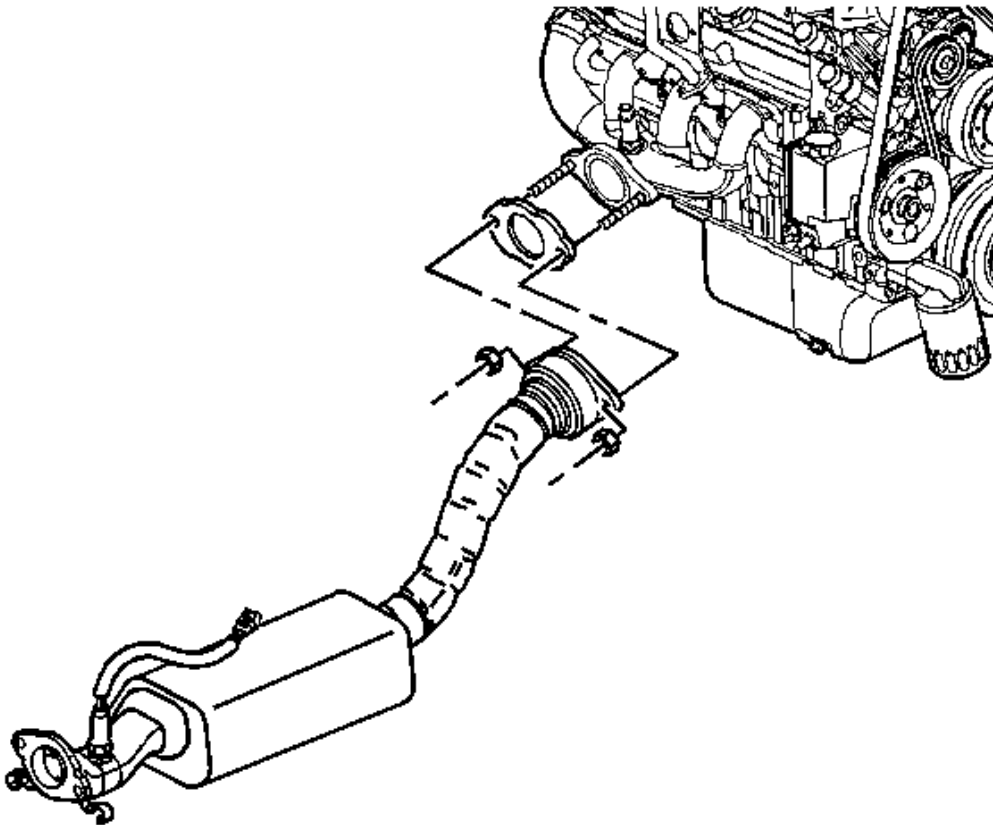


Fig. 54: View Of Catalytic Converter & Exhaust Manifold Pipe Stud Nuts
Courtesy of GENERAL MOTORS CORP.

12. Install the catalytic converter to the right exhaust manifold.
13. Install the right exhaust manifold pipe stud nuts

Tighten: Tighten the right exhaust manifold pipe stud nuts to 30 N.m (22 lb ft).

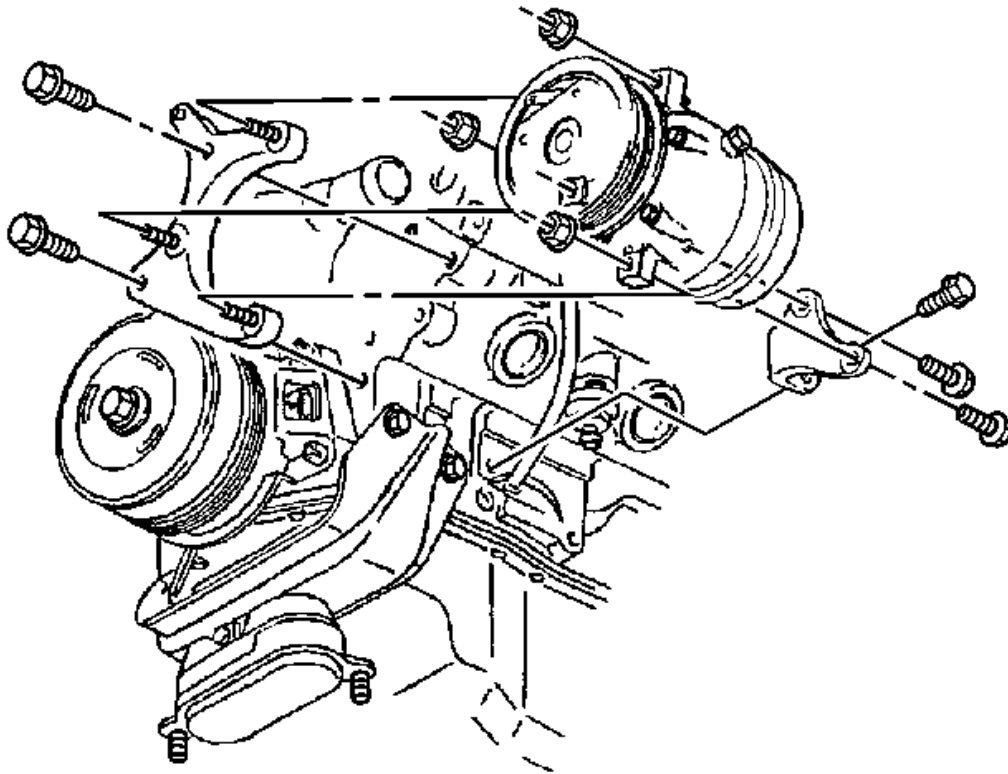


Fig. 55: View Of A/C Compressor
 Courtesy of GENERAL MOTORS CORP.

14. Install the A/C compressor bracket and the A/C compressor bracket bolts.

Tighten: Tighten the A/C compressor bracket bolts to 50 N.m (37 lb ft).

15. Install the A/C compressor and the A/C compressor nuts.

Tighten: Tighten the A/C compressor nuts to 30 N.m (22 lb ft).

16. Install the power steering oil cooler pipe brackets to the frame.

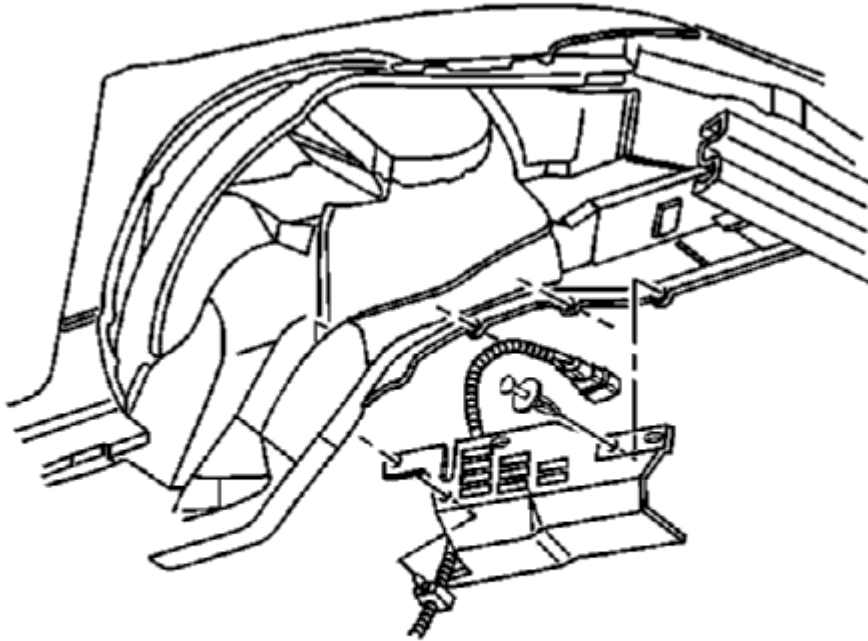


Fig. 56: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS CORP.

17. Install the right engine splash shield.
18. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
19. Lower the vehicle.
20. Remove the engine support fixture.
21. Install the right and left engine mount struts. Refer to **Engine Mount Strut Replacement - Right Side** and **Engine Mount Strut Replacement - Left Side**.
22. Install the air inlet duct to the throttle body.
23. Connect the intake air temperature (IAT) sensor electrical connector.
24. Install the drive belt. Refer to **Drive Belt Replacement (L26)**.
25. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
26. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .

ENGINE FRONT MOUNT BRACKET REPLACEMENT

Removal Procedure

1. Remove the transmission. Refer to **Transmission Replacement** .
2. Remove the drive belt. Refer to **Drive Belt Replacement (L26)**.

NOTE: **Do not discharge the air conditioning system.**

3. Remove the A/C compressor from the engine. Refer to **Air Conditioning Compressor Replacement (L26)** .
4. Secure the compressor away from the bracket area.
5. Remove the engine mount. Refer to **Engine Front Mount Replacement**.
6. Remove the engine knock sensor shield and disconnect the sensor harness. Refer to **Knock Sensor 2 Replacement** .

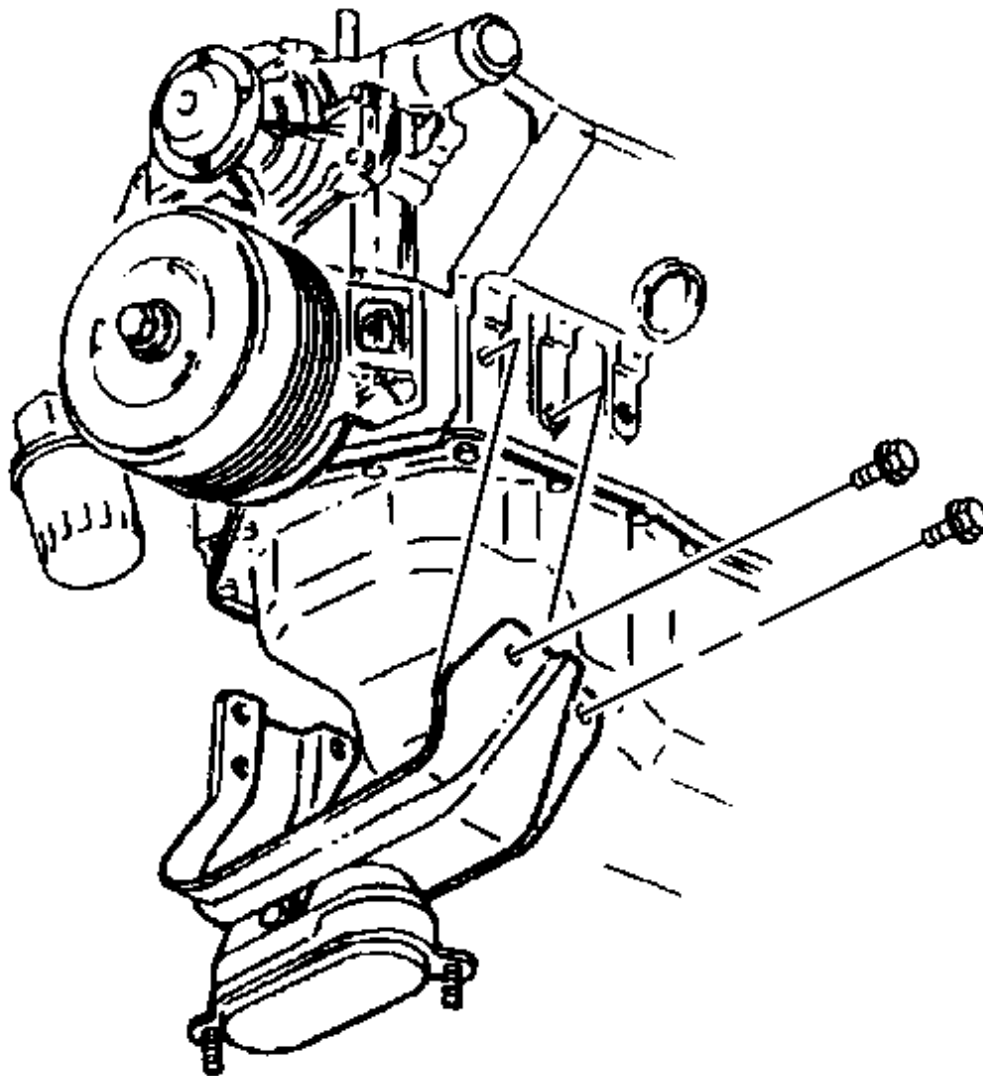


Fig. 57: Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the front engine mount bracket bolts from the engine.

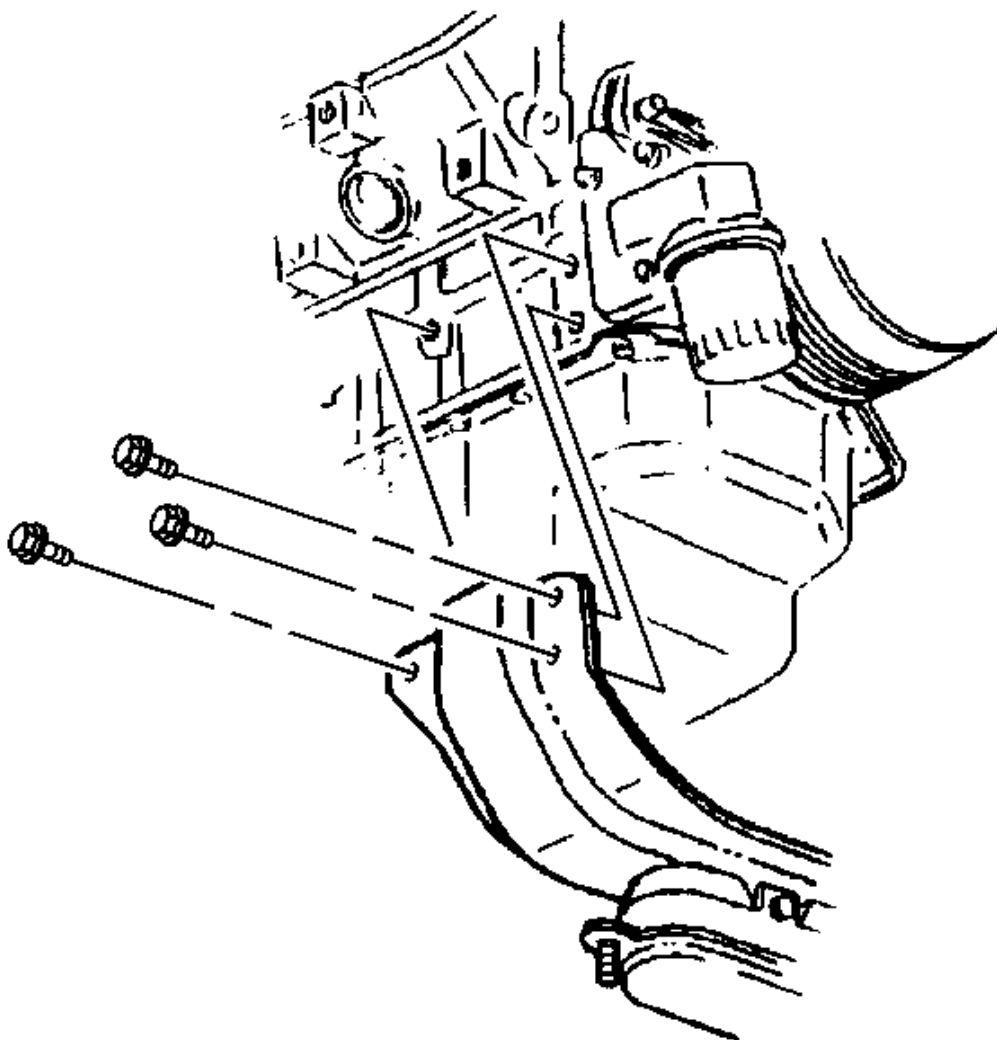


Fig. 58: Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the rear engine mount bracket bolts from the engine.
9. Remove the engine mount bracket from the vehicle.

Installation Procedure

1. Position the engine mount bracket to the engine.
2. Connect the knock sensor harness connector and install the shield. Refer to **Knock Sensor 2 Replacement** .

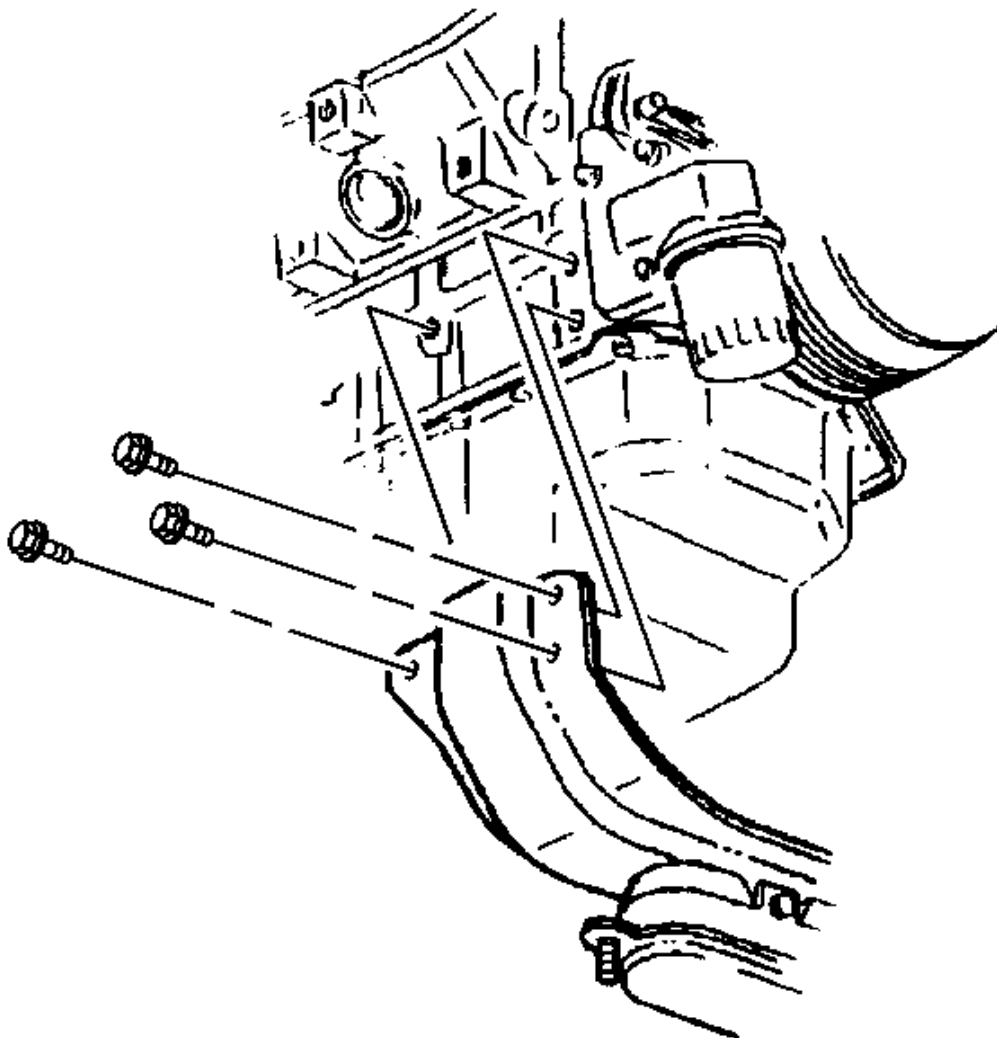


Fig. 59: Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the rear engine mount bracket bolts to the engine. Hand tighten the bolts at this time.

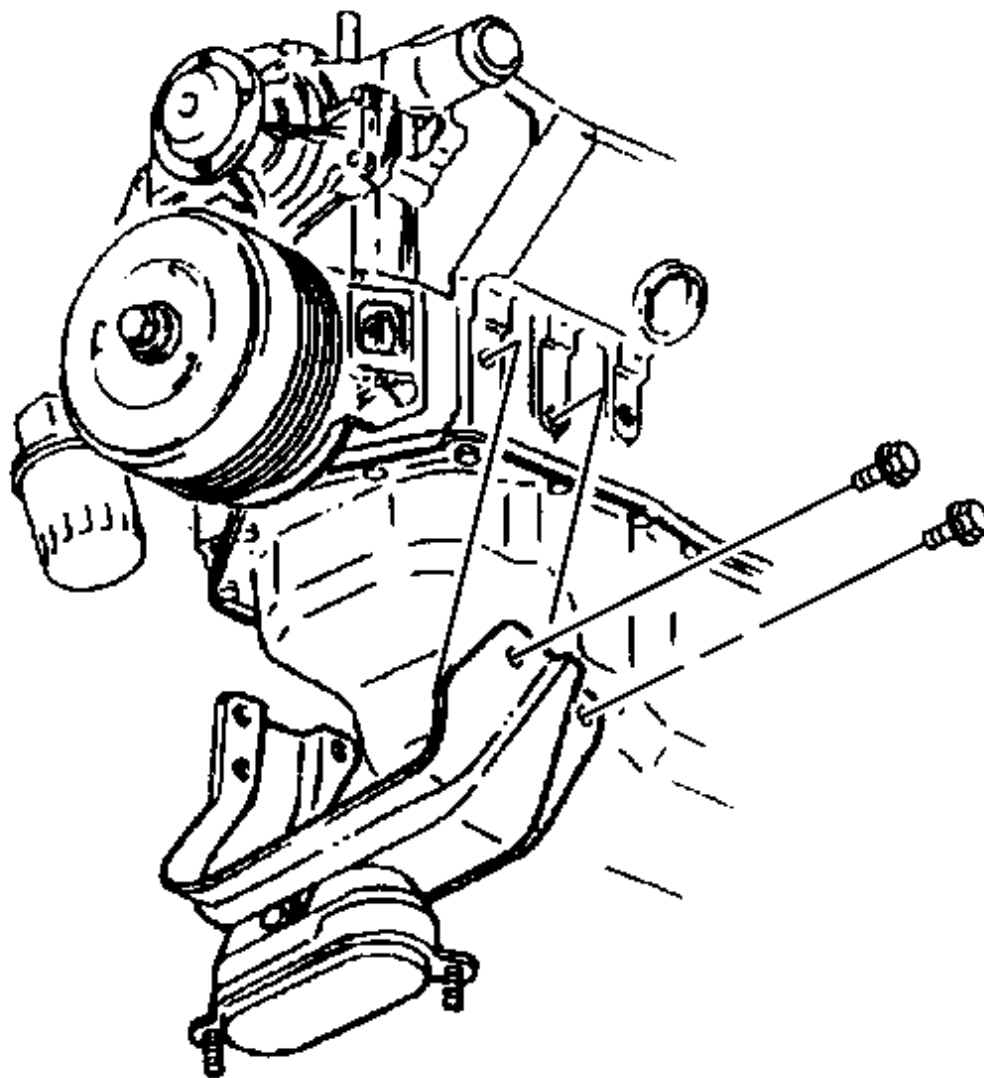


Fig. 60: Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the front engine mount bracket bolts to the engine. Hand tighten the bolts at this time.

CAUTION: Refer to Fastener Caution .

5. Install the engine mount bracket bolts.

Tighten: Tighten the bolts to 102 N.m (75 lb ft).

6. Install the engine mount. Refer to **Engine Front Mount Replacement**.
7. Install the A/C compressor to the engine. Refer to **Air Conditioning Compressor Replacement (L26)**.
8. Install the drive belt. Refer to **Drive Belt Replacement (L26)**.
9. Install the transmission. Refer to **Transmission Replacement**.

ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE

Removal Procedure

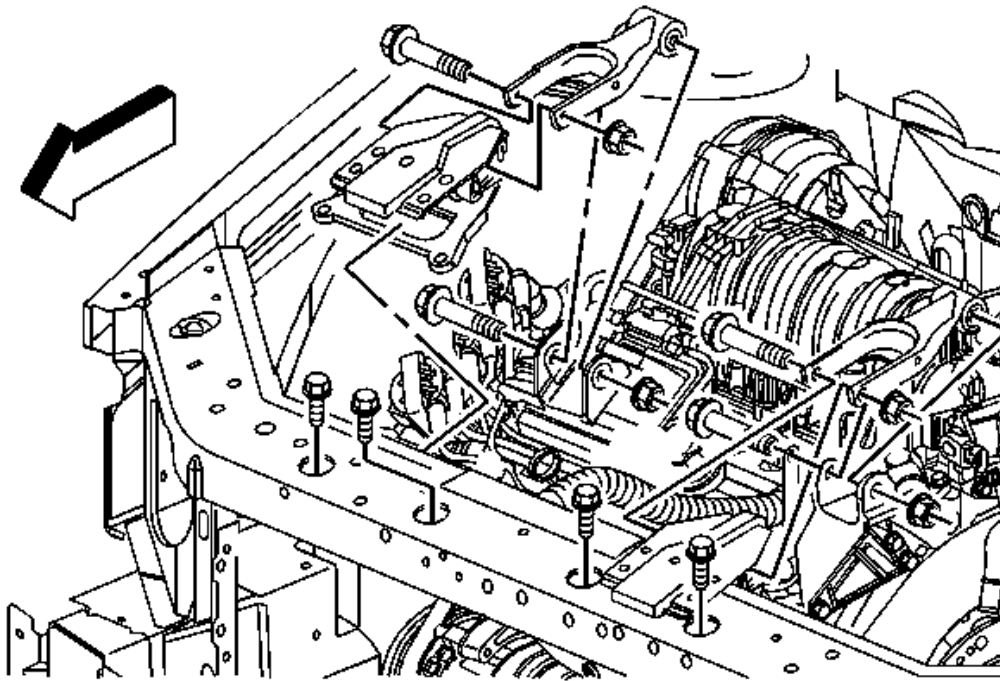


Fig. 61: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

1. If equipped with a L26 engine, remove the bolt and the nut from the right engine mount strut at the right engine mount strut bracket on the engine.

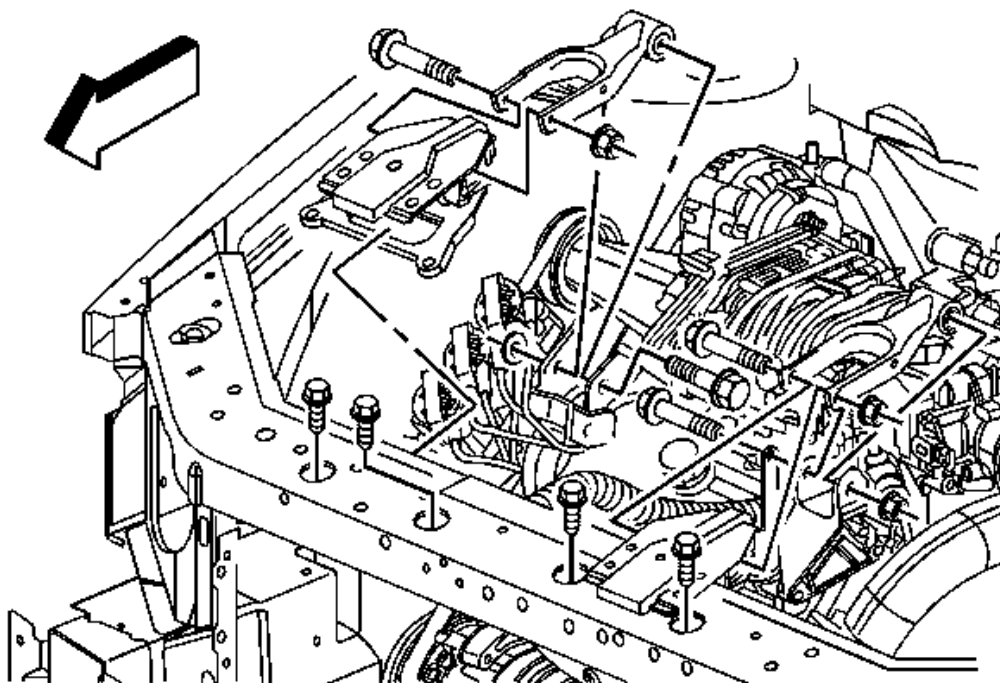


Fig. 62: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

2. If equipped with a L32 engine, remove the bolt and the nut from the right engine mount strut at the right engine mount strut bracket on the engine.

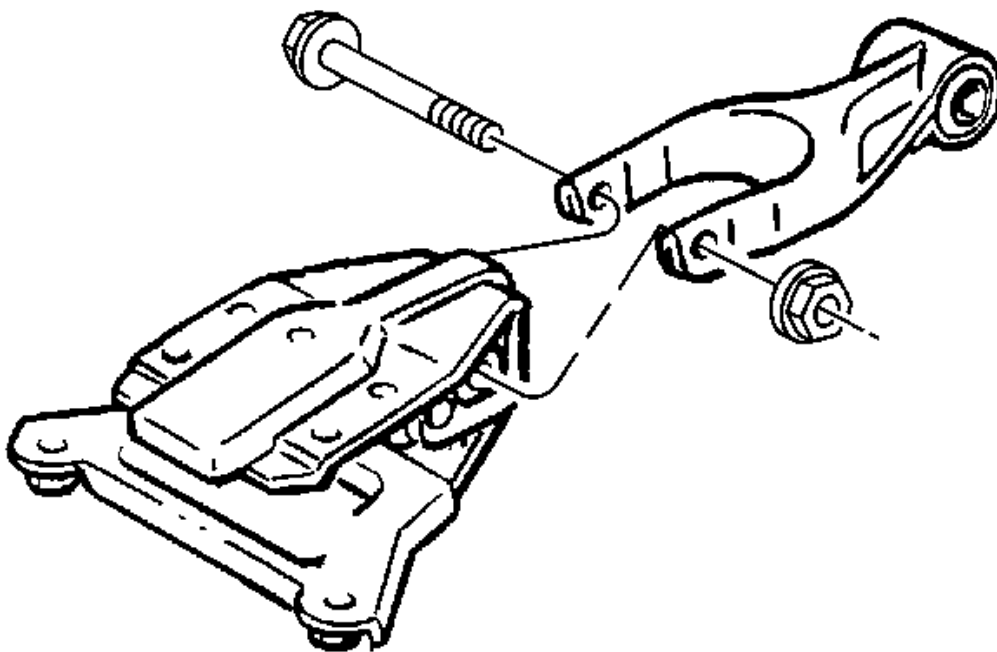


Fig. 63: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

3. Remove the bolt and the nut from the right engine mount strut at the right engine mount strut bracket on the upper radiator support.
4. Remove the engine mount strut.
5. Inspect the rubber in the engine mount strut for the following conditions:
 - Hardness
 - Splitting
 - Cracking

Installation Procedure

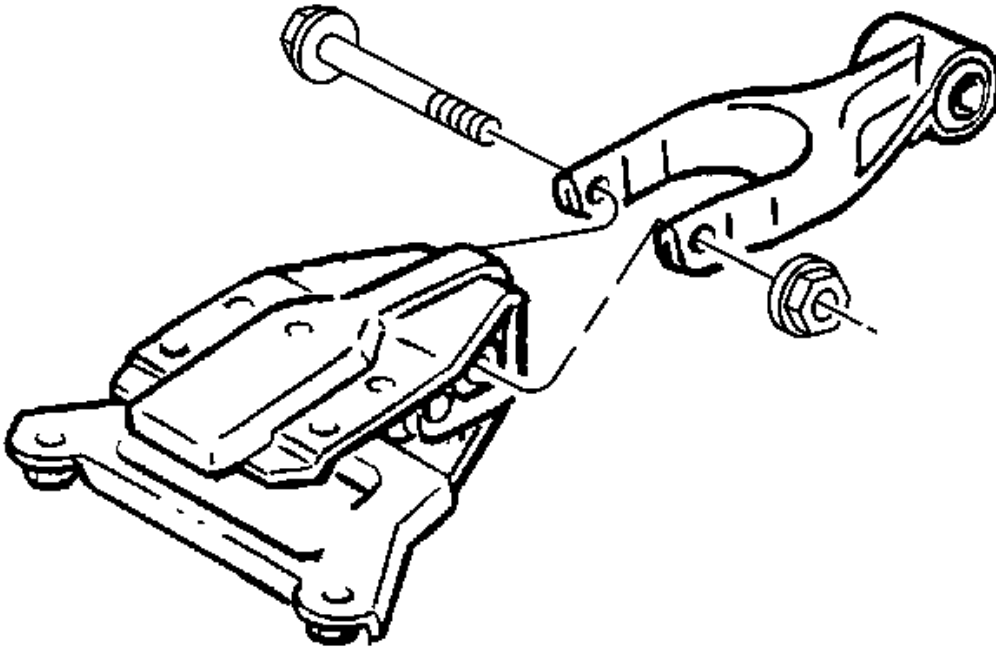


Fig. 64: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut.

CAUTION: Refer to Fastener Caution .

2. Install the bolt and the nut to the right engine mount strut at the right engine mount strut bracket on the upper radiator support.

Tighten: Tighten the engine mount strut bolt to 48 N.m (35 lb ft).

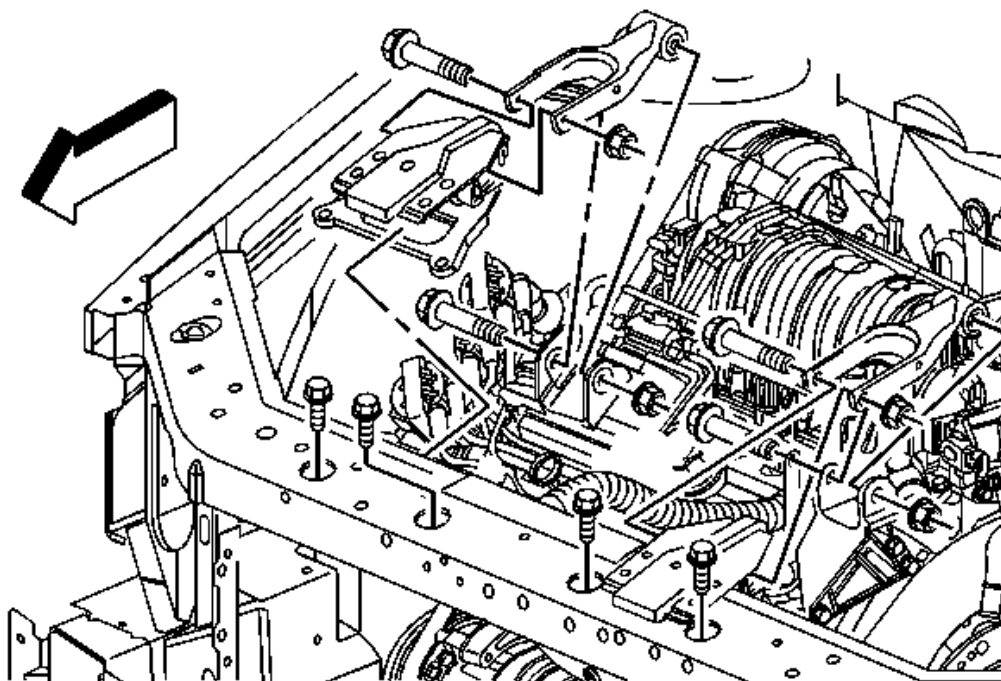


Fig. 65: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. With a L26 Engine, install the bolt and the nut to the right engine mount strut at the right engine mount strut bracket on the engine.

Tighten: Tighten the engine mount strut nut to 48 N.m (35 lb ft).

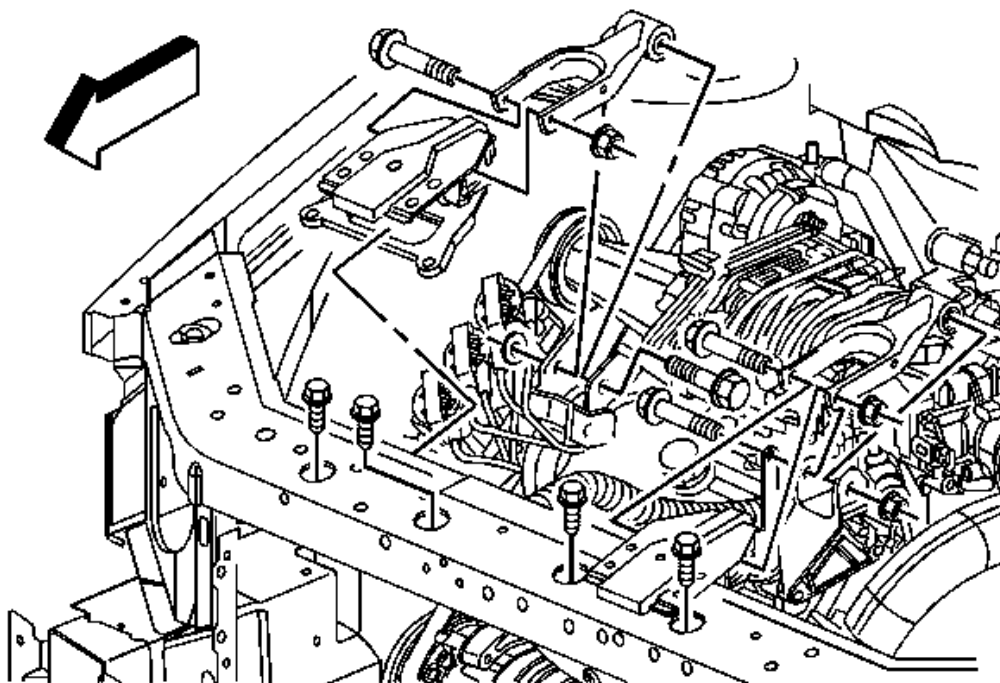


Fig. 66: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

4. With a L32 Engine, install the bolt and the nut to the right engine mount strut at the right engine mount strut bracket on the engine.

Tighten: Tighten the engine mount strut nut to 48 N.m (35 lb ft).

ENGINE MOUNT STRUT REPLACEMENT - LEFT SIDE

Removal Procedure

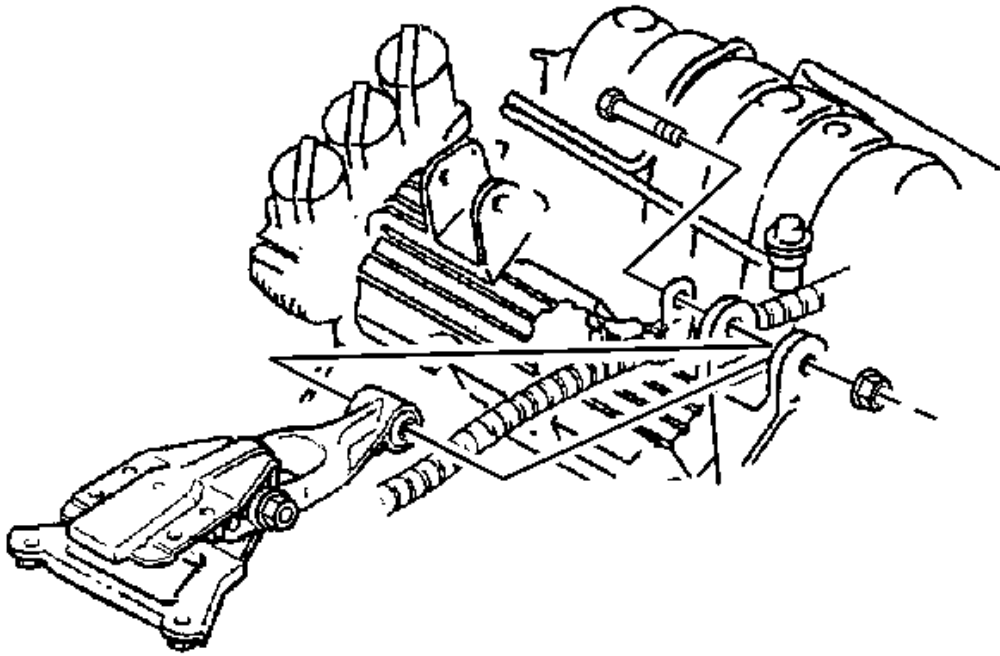


Fig. 67: Left Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the bolt and the nut from the left engine mount strut at the left engine mount strut bracket on the engine.

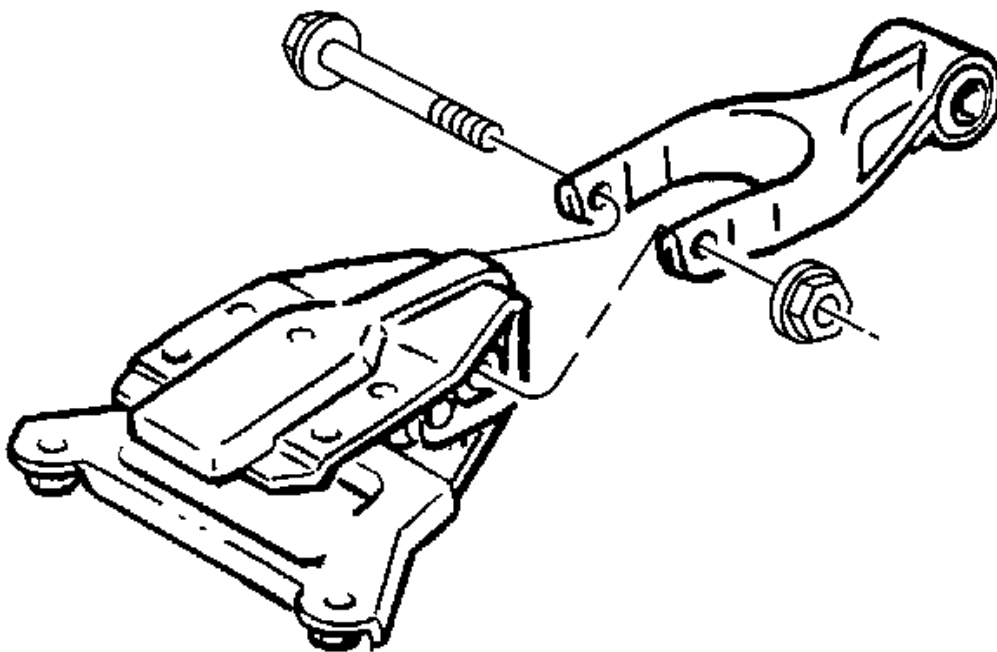


Fig. 68: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

2. Remove the bolt and the nut from the left engine mount strut at the left engine mount strut bracket on the upper radiator support.
3. Remove the engine mount strut.
4. Inspect the rubber in the engine mount strut for the following conditions:
 - Hardness
 - Splitting
 - Cracking

Installation Procedure

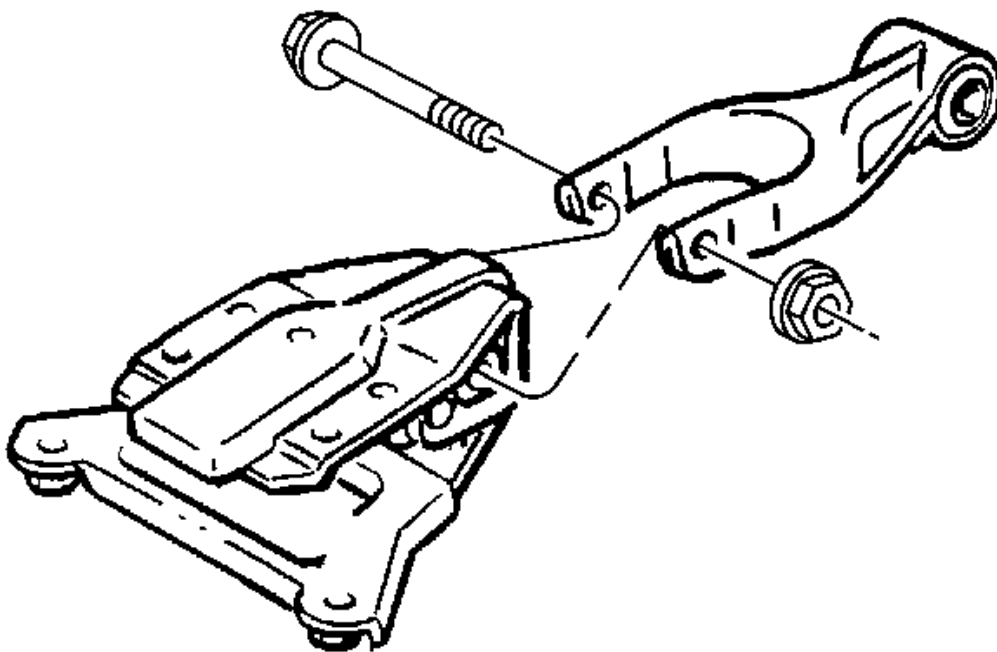


Fig. 69: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut.

CAUTION: Refer to Fastener Caution .

2. Install the bolt and the nut to the left engine mount strut at the left engine mount strut bracket on the upper radiator support.

Tighten: Tighten the engine mount strut bolt to 48 N.m (35 lb ft).

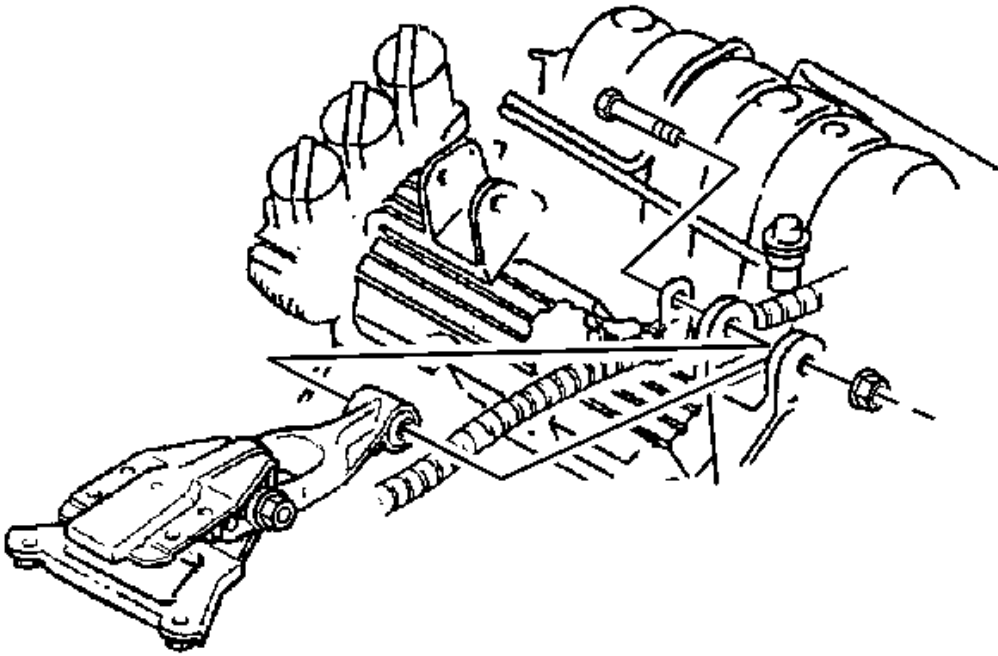


Fig. 70: Left Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. Install the bolt and the nut to the left engine mount strut at the left engine mount strut bracket on the engine.

Tighten: Tighten the engine mount strut nut to 48 N.m (35 lb ft).

ENGINE MOUNT STRUT BRACKET REPLACEMENT - LEFT SIDE

Removal Procedure

1. Drain the engine coolant from the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
2. Remove the engine coolant temperature sensor. Refer to **Engine Coolant Temperature Sensor Replacement** .

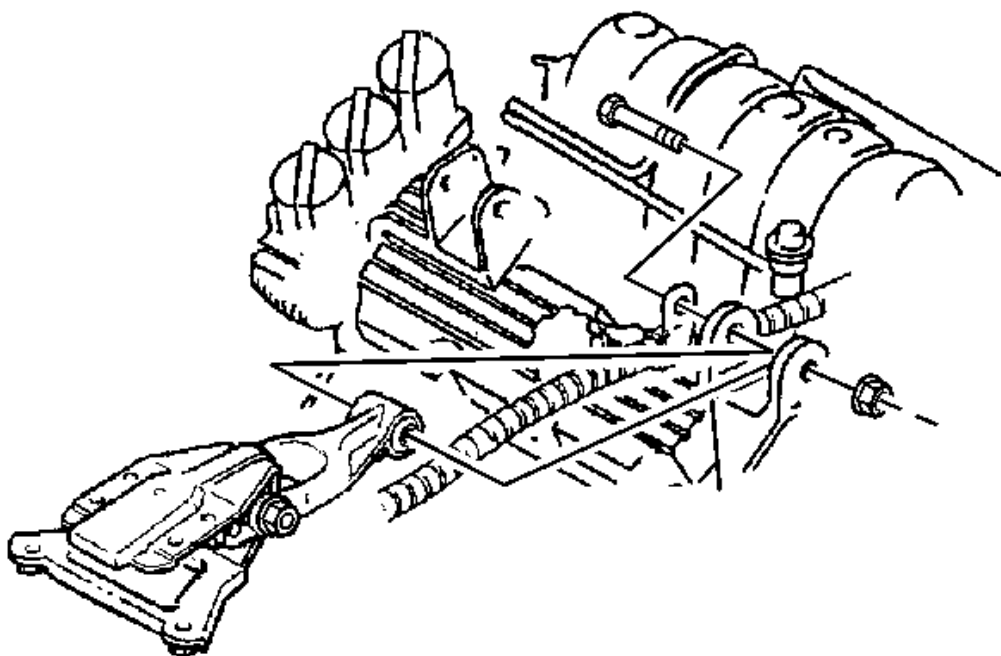


Fig. 71: Left Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount strut at the left engine mount strut bracket. Refer to **Engine Mount Strut Replacement - Left Side** and **Engine Mount Strut Replacement - Right Side**.

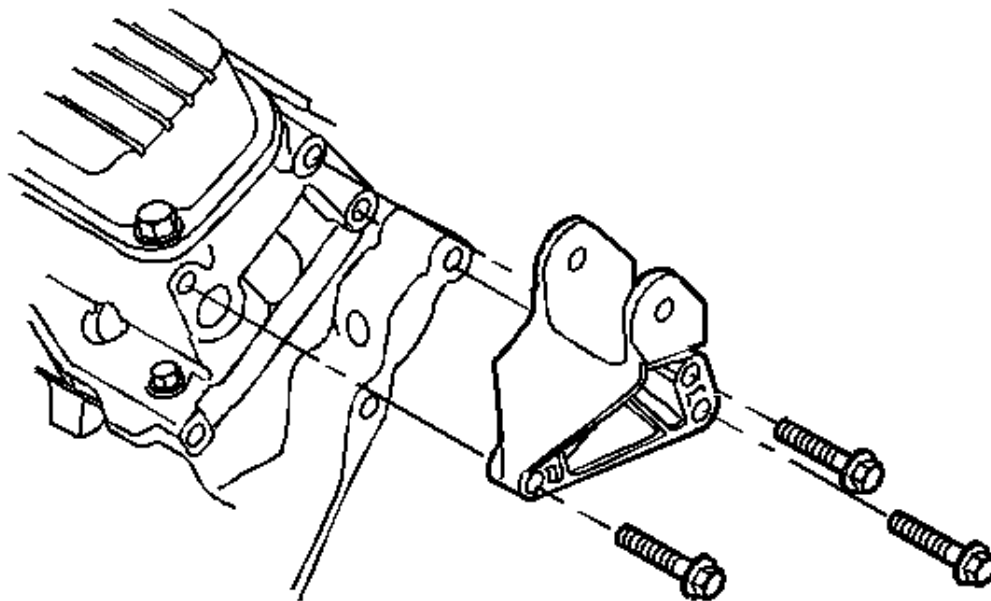


Fig. 72: Left Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine mount strut bracket bolts.
5. Remove the engine mount strut bracket.

Installation Procedure

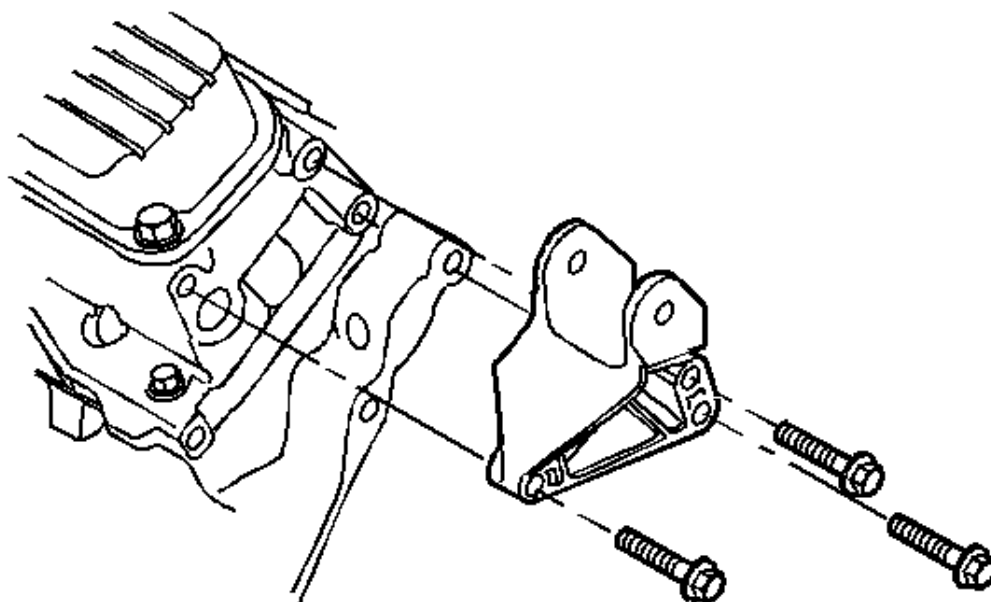


Fig. 73: Left Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount strut bracket to the head.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount strut bracket bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

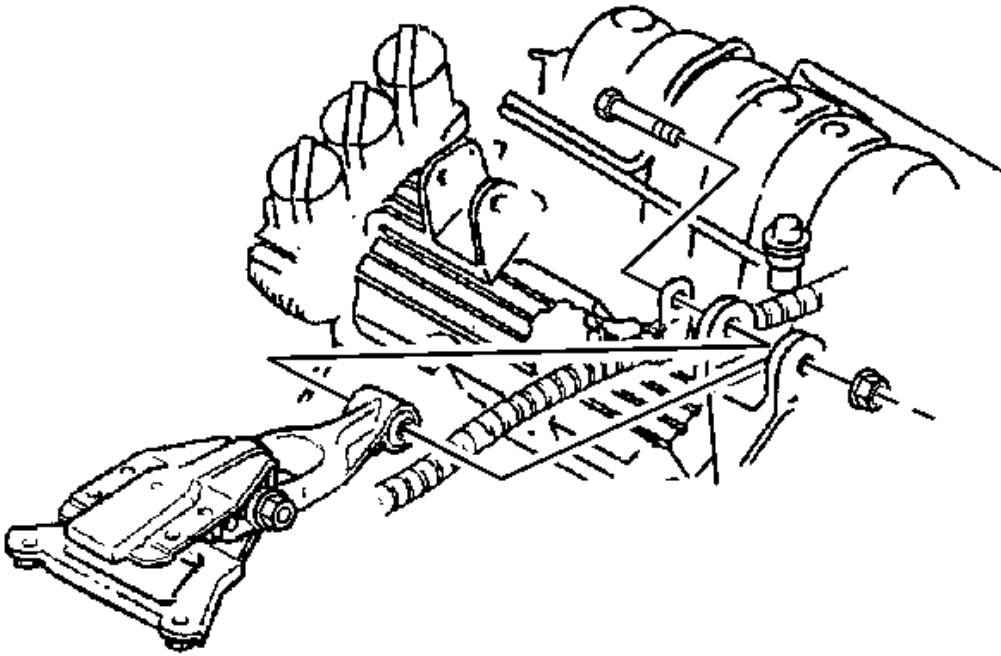


Fig. 74: Left Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount strut to the left engine mount strut bracket. Refer to **Engine Mount Strut Replacement - Left Side** and **Engine Mount Strut Replacement - Right Side**.
4. Install the engine coolant temperature sensor. Refer to **Engine Coolant Temperature Sensor Replacement**.
5. Fill the cooling system with engine coolant. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)**.

ENGINE MOUNT STRUT BRACKET REPLACEMENT - RIGHT SIDE (L26)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.

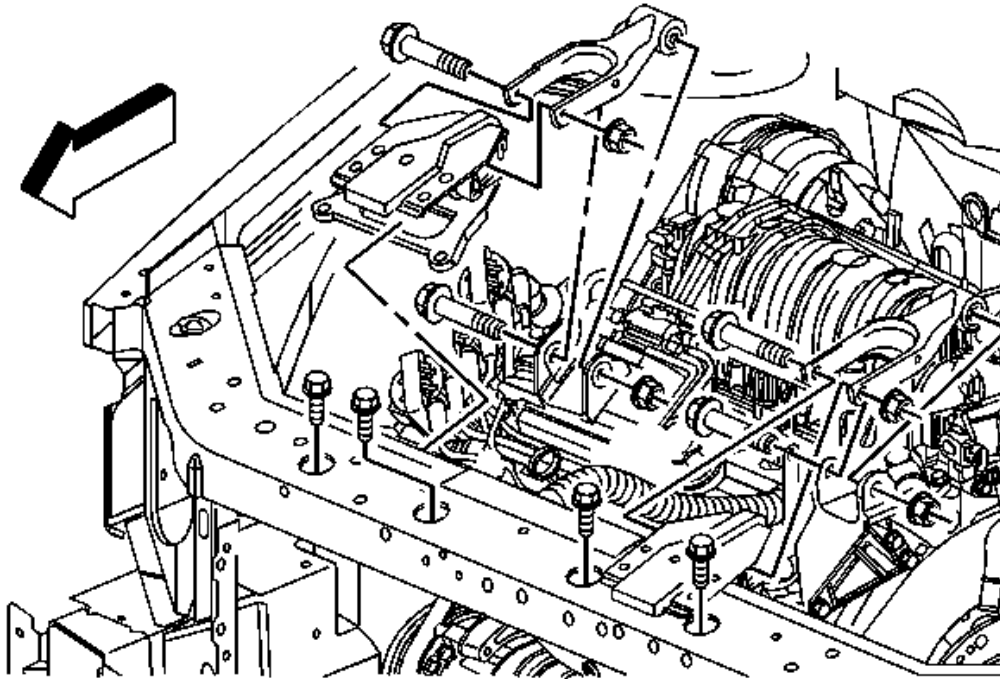


Fig. 75: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

2. Remove the right engine mount strut at the upper engine mount strut bracket. Refer to **Engine Mount Strut Replacement - Left Side** and **Engine Mount Strut Replacement - Right Side**.

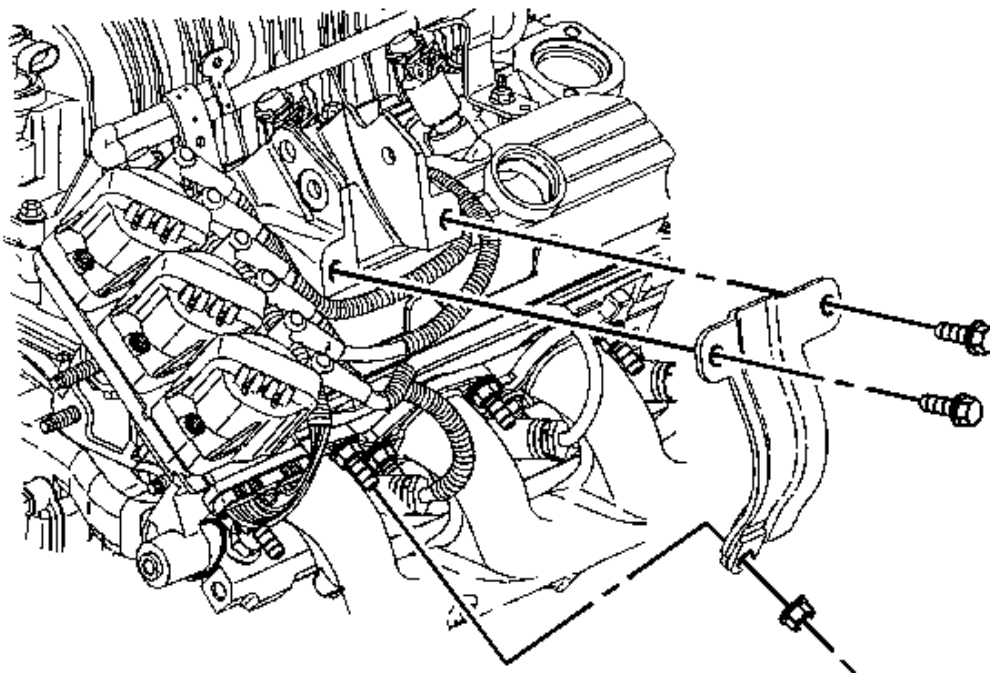


Fig. 76: View Of Lower Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

3. Loosen the lower engine mount strut bracket nut.
4. Remove the lower engine mount strut bracket bolts.

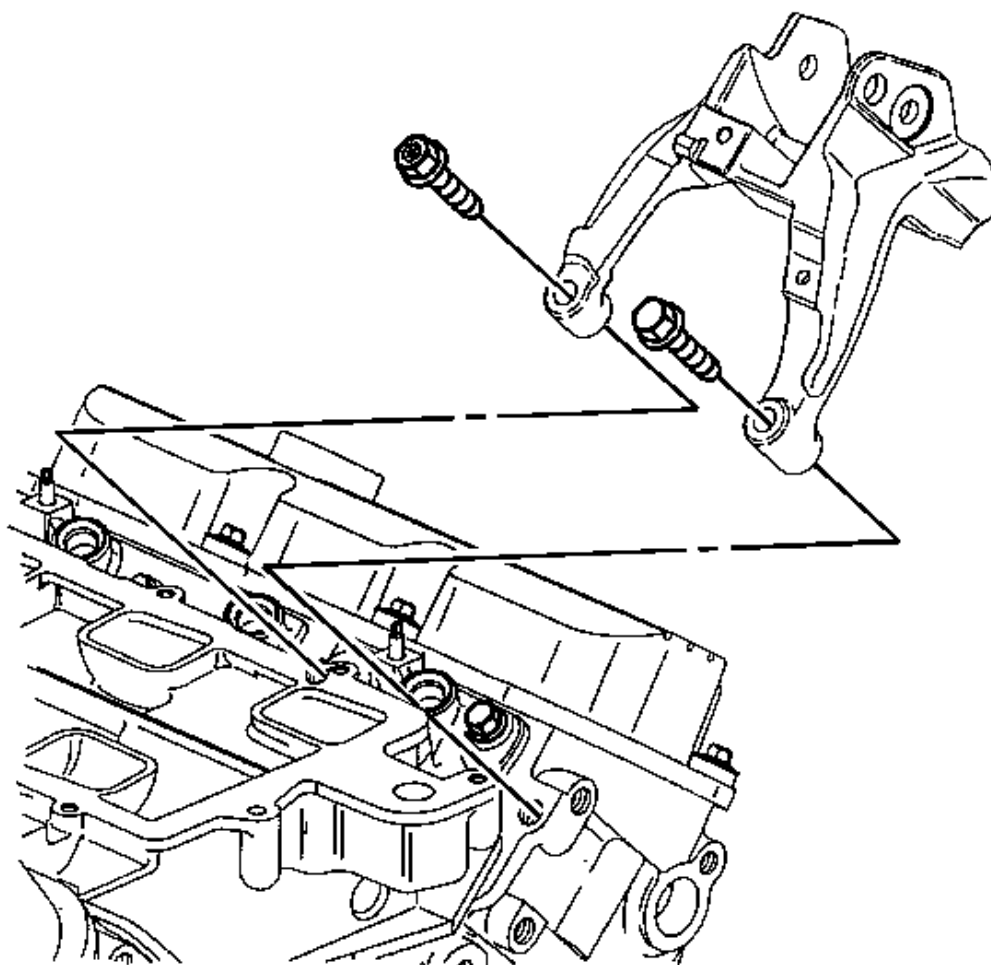


Fig. 77: Upper Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the upper engine mount strut bracket bolts.
6. Remove the upper engine mount strut bracket.

Installation Procedure

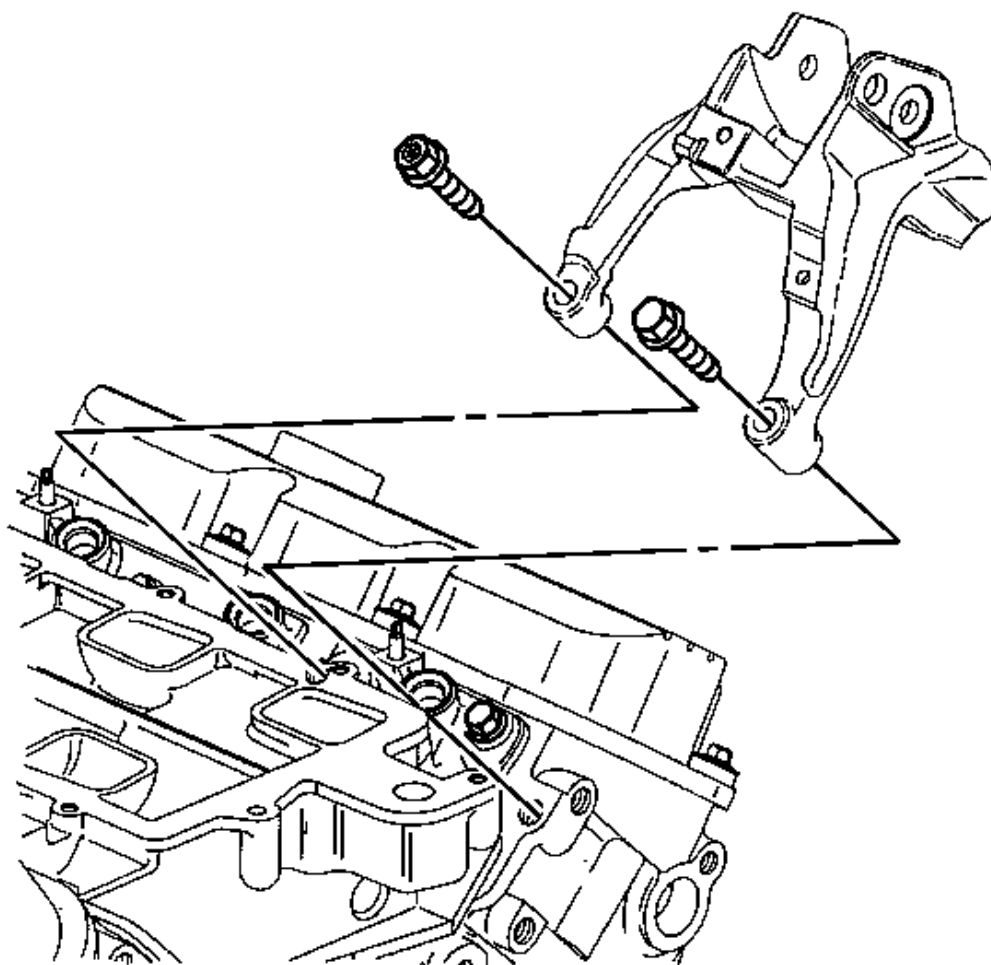


Fig. 78: Upper Engine Mount Strut Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the upper engine mount strut bracket.

CAUTION: Refer to Fastener Caution .

2. Install the upper engine mount strut bracket bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

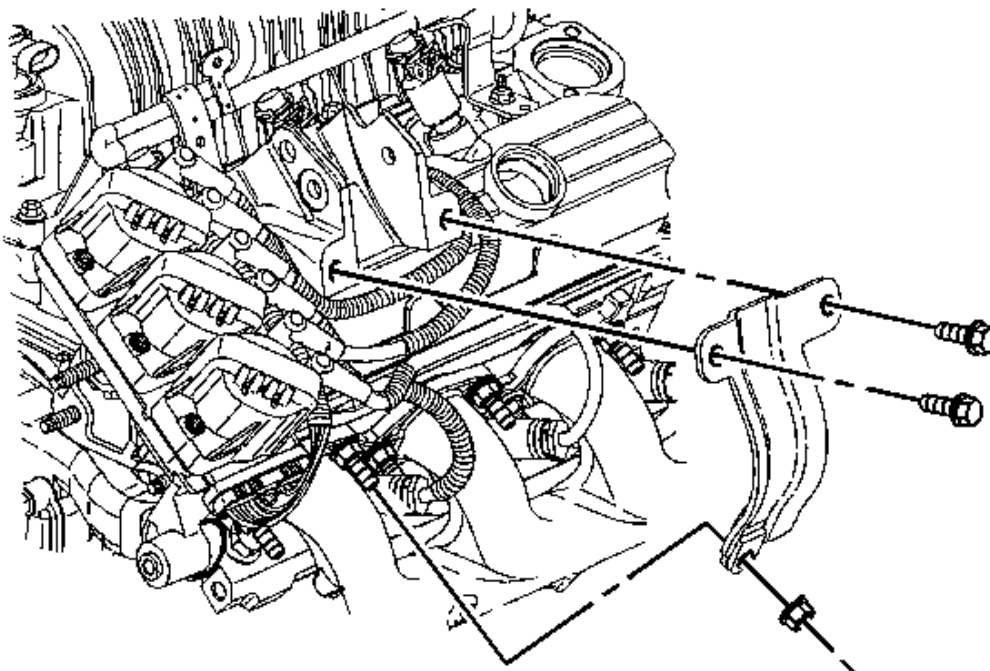


Fig. 79: View Of Lower Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

3. Install the lower engine mount strut bracket bolts.
 - Tighten the lower engine mount strut bracket nut.
Tighten: Tighten the nut to 30 N.m (22 lb ft).
 - Tighten the lower engine mount strut bracket bolts.
Tighten: Tighten the bolts to 50 N.m (37 lb ft).

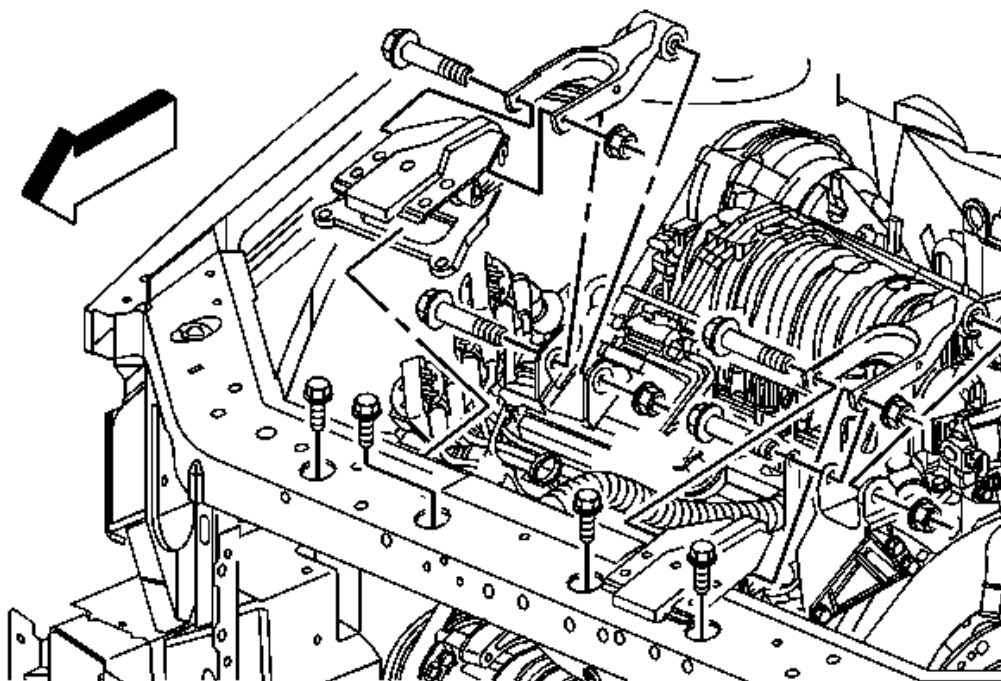


Fig. 80: Right Engine Mount Strut Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the right engine mount strut at the upper engine mount strut bracket. Refer to **Engine Mount Strut Replacement - Left Side** and **Engine Mount Strut Replacement - Right Side**.
5. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.

ENGINE MOUNT STRUT BRACKET REPLACEMENT - UPPER RADIATOR SUPPORT

Removal Procedure

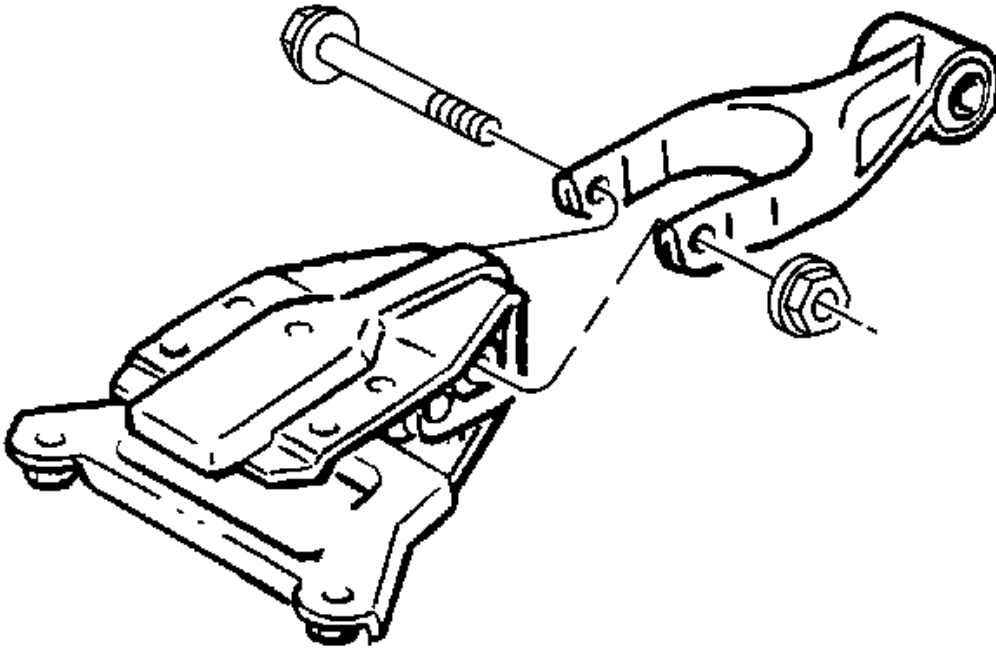


Fig. 81: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount struts from the engine mount strut brackets at the upper radiator support. Refer to **Engine Mount Strut Replacement - Left Side** and/or **Engine Mount Strut Replacement - Right Side**.

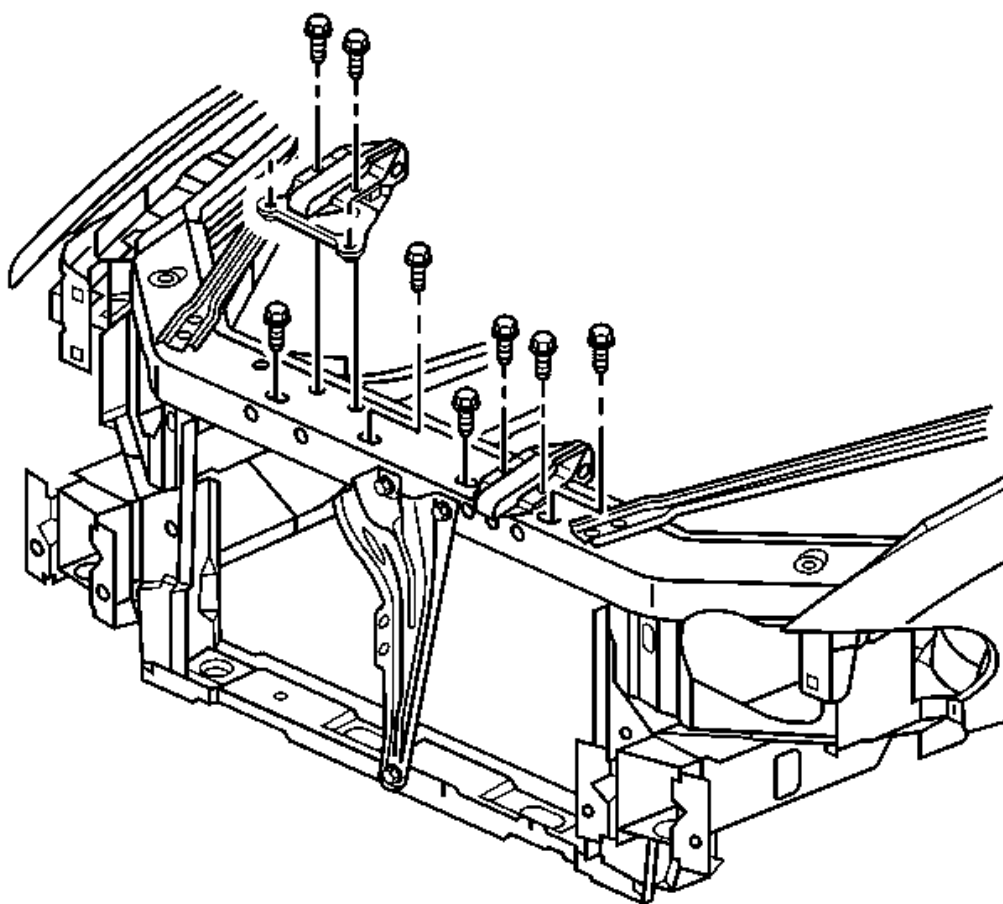


Fig. 82: Engine Mount Strut Bracket & Upper Radiator Support
Courtesy of GENERAL MOTORS CORP.

2. Remove the 4 bolts from the engine mount strut bracket to the upper radiator support.
3. Remove the engine mount strut bracket from the upper radiator support.

Installation Procedure

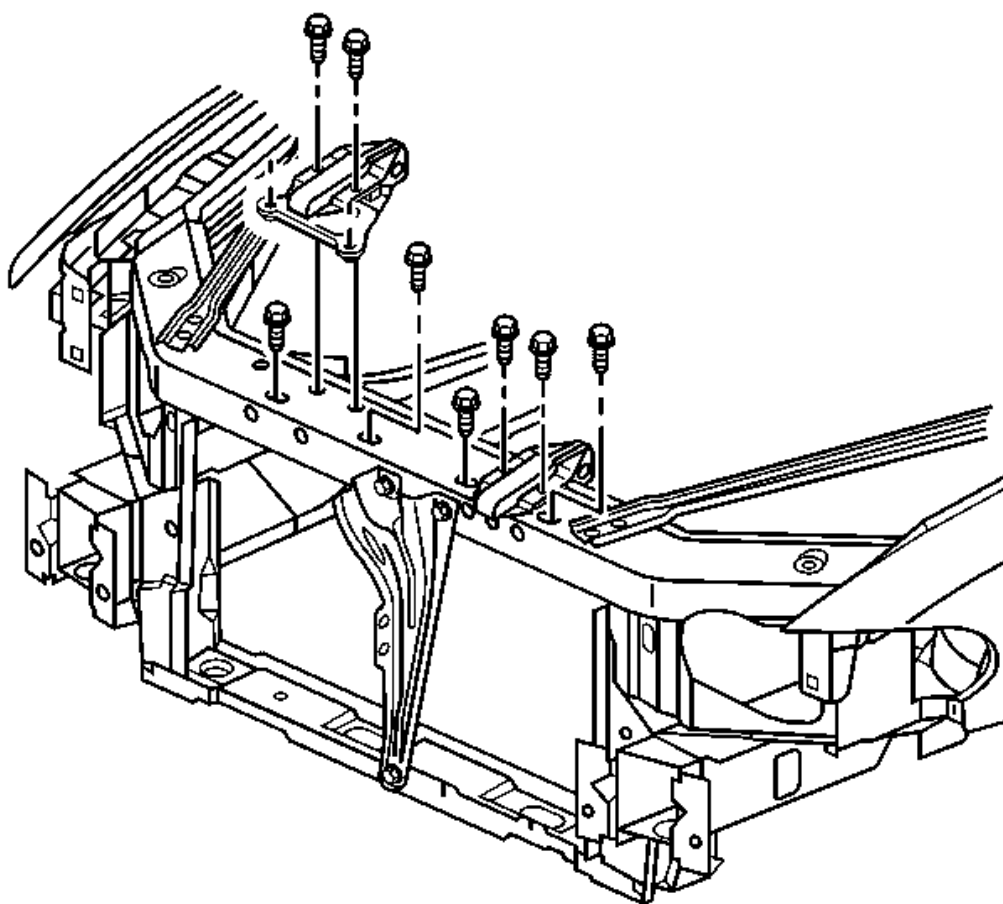


Fig. 83: Engine Mount Strut Bracket & Upper Radiator Support
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount strut bracket over the upper radiator support so the engine mount strut bracket and the engine mount strut are aligned. Align the engine mount strut bracket with the proper holes of the upper radiator support.

CAUTION: Refer to Fastener Caution .

2. Install the 4 bolts through the engine mount strut bracket to the upper radiator support.

Tighten: Tighten the bolts to 28 N.m (21 lb ft).

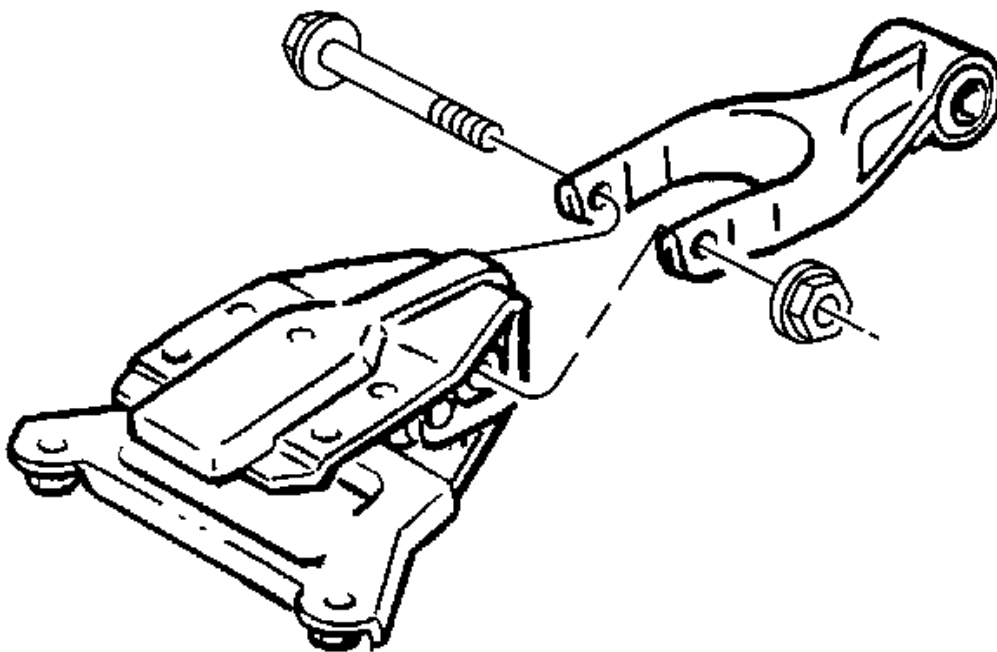


Fig. 84: Identifying Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount strut(s) to the engine mount strut bracket(s) at the upper radiator support. Refer to **Engine Mount Strut Replacement - Left Side** and/or **Engine Mount Strut Replacement - Right Side**.

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (L26)

Removal Procedure

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

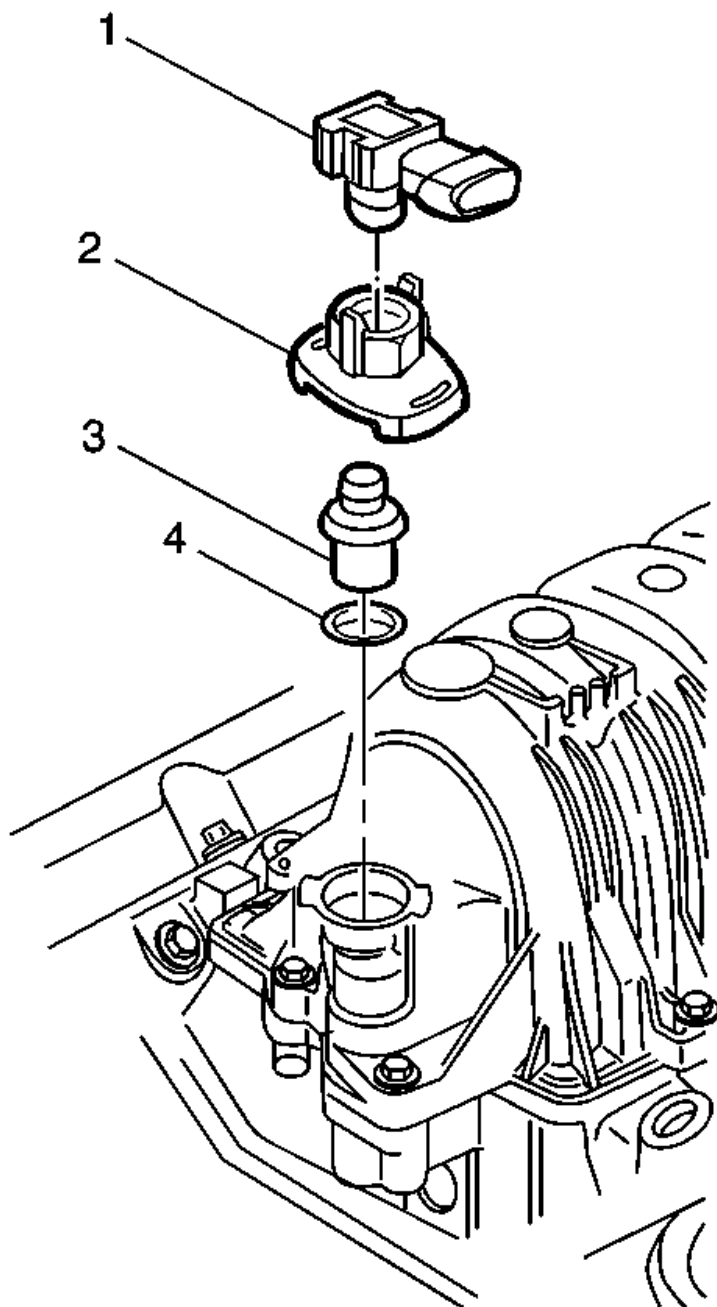


Fig. 85: Identifying PVC Valve & Related Components
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the MAP sensor electrical connector.
3. Remove the MAP sensor (1).

4. Use a 16 mm (5/8 in) socket to press the access cover (2) down and rotate 1/4 turn counterclockwise.
5. Remove the access cover.
6. Remove the PCV valve (3) and the O-ring (4) from the intake manifold.

Installation Procedure

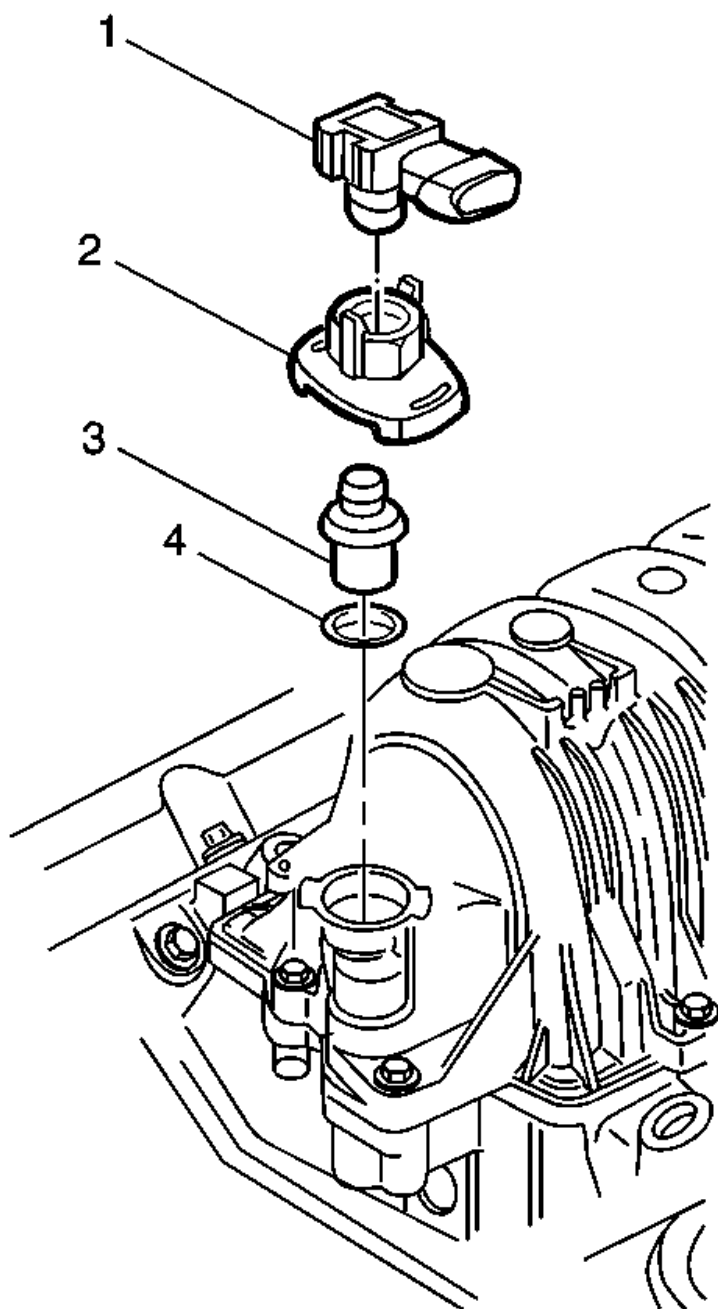


Fig. 86: Identifying PVC Valve & Related Components
Courtesy of GENERAL MOTORS CORP.

1. Install the new O-ring (4) and the PCV valve (3).
2. Install the access cover (2).

3. Install the MAP sensor (1).
4. Connect the MAP sensor electrical connector.
5. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

Removal Procedure

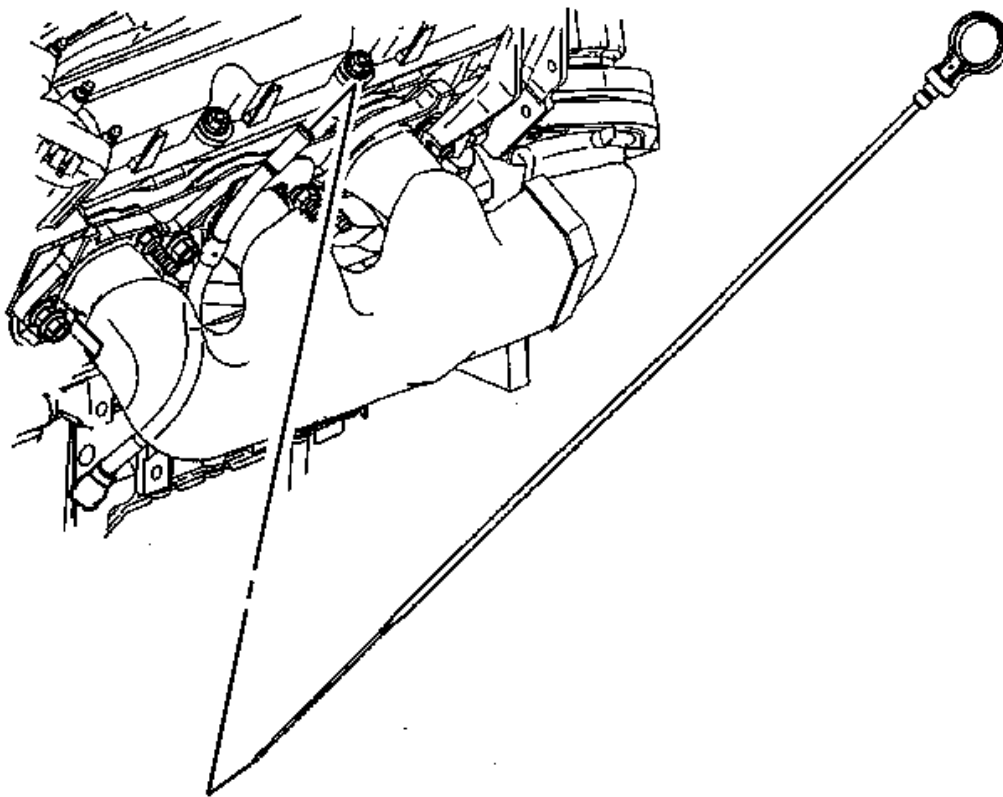


Fig. 87: Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Loosen the nut holding the oil level indicator tube bracket to the exhaust manifold stud.
3. Remove the oil level indicator tube. Pull upward.

Installation Procedure

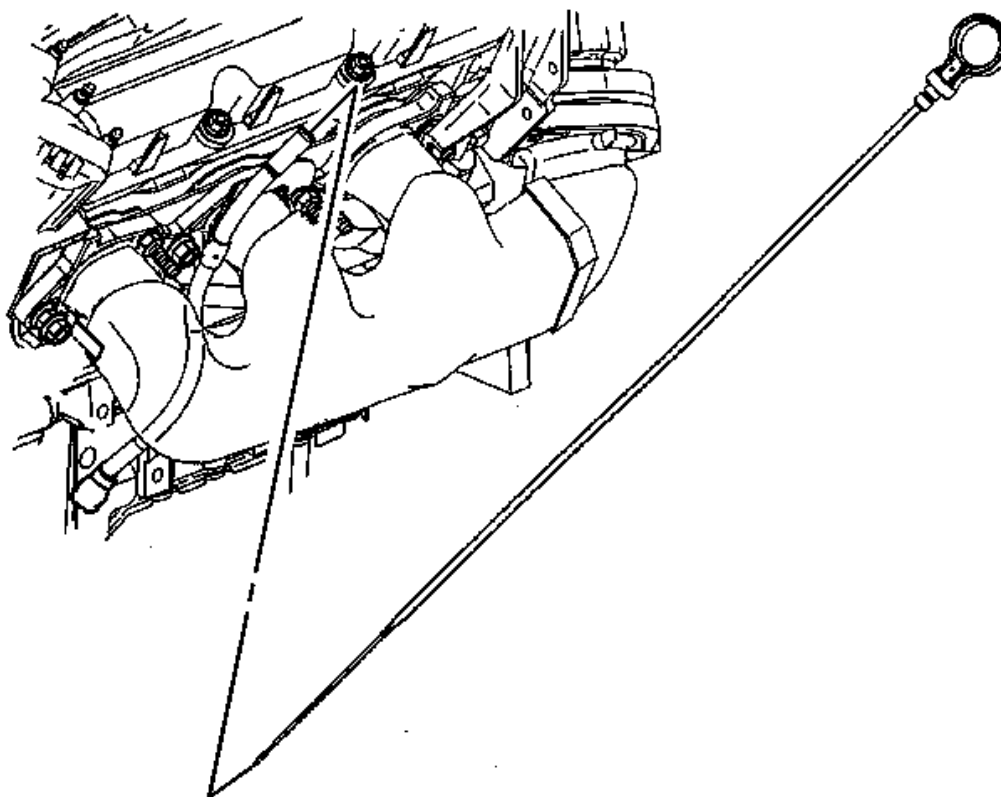


Fig. 88: Oil Level Indicator

Courtesy of GENERAL MOTORS CORP.

1. Install the oil indicator tube to the engine. Ensure that the O-ring is in place. Ensure that the oil level indicator tube is fully seated in the engine.
2. Slide the oil indicator tube bracket onto the exhaust manifold stud.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bracket nut on the exhaust manifold stud.

Tighten: Tighten the nut to 19 N.m (14 lb ft).

4. Install the oil level indicator.

UPPER INTAKE MANIFOLD REPLACEMENT

Removal Procedure

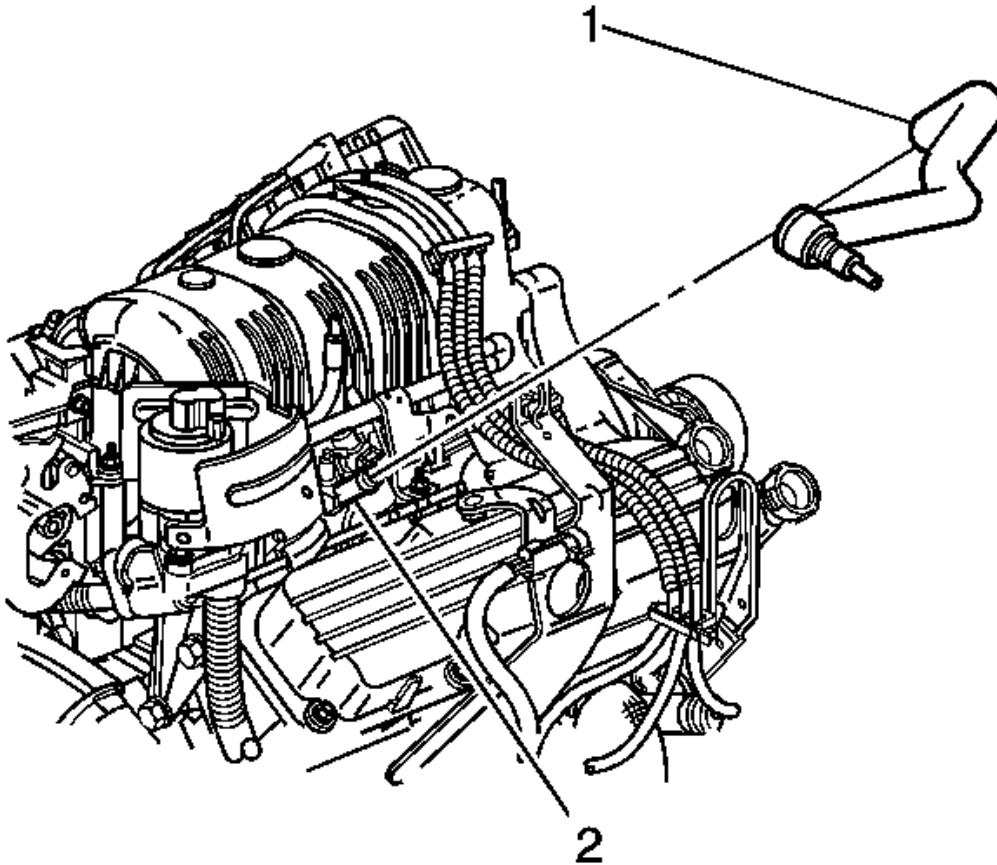


Fig. 89: Brake Booster Hose & Vacuum Source Manifold
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (L26) .
2. Remove the fuel injector sight shield. Refer to Fuel Injector Sight Shield Replacement .
3. Remove the air cleaner intake duct. Refer to Air Cleaner Inlet Duct Replacement .
4. Drain the cooling system. Refer to Cooling System Draining and Filling (L26 Static Fill) or Cooling System Draining and Filling (L26 GE 47716 Fill) .
5. Remove the right spark plug wires from the ignition control module and the upper intake manifold and reposition the wires. Refer to Spark Plug Wire Replacement .
6. Relieve the fuel pressure. Refer to Fuel Pressure Relief (Without CH 48027) or Fuel Pressure Relief (With CH 48027) .

7. Remove the brake booster hose (1) from the vacuum source manifold (2).
8. Disconnect the electrical connectors from the following:
 - Electronic throttle control (ETC)
 - Evaporative emission (EVAP) purge solenoid
 - Manifold absolute pressure (MAP) sensor
 - Mass air flow (MAF) sensor

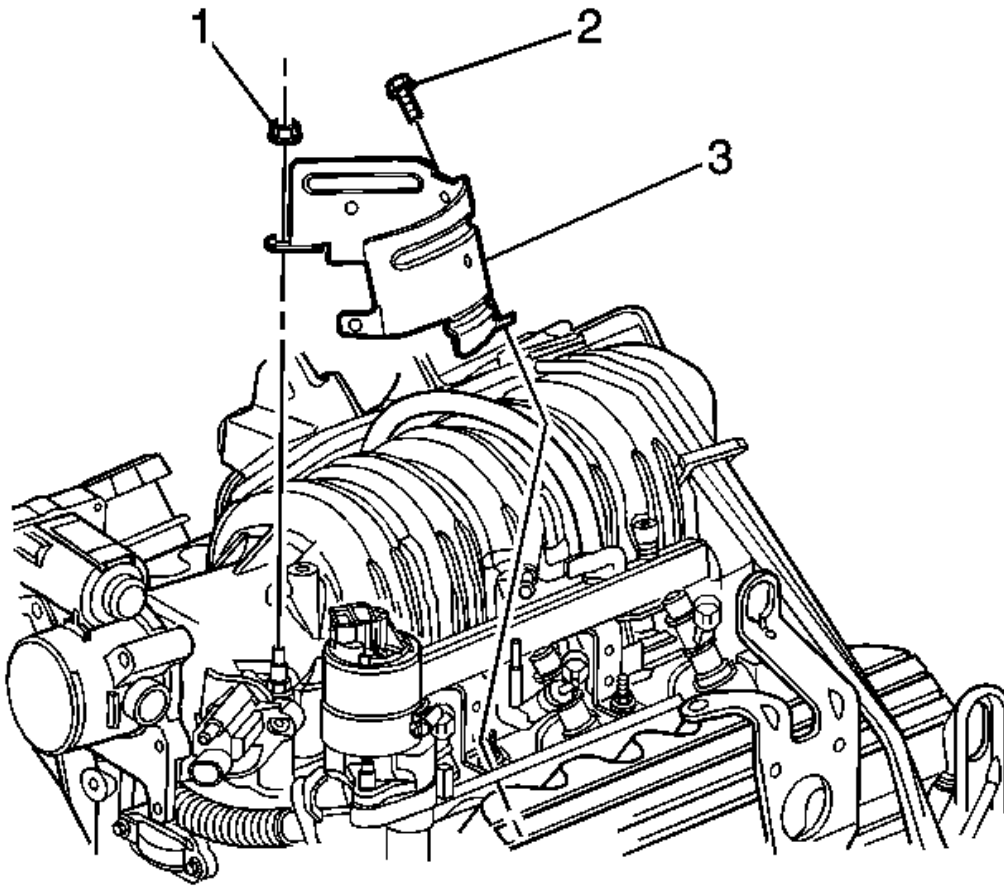


Fig. 90: EGR Valve Wiring Harness Heat Shield Nut & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the exhaust gas recirculation (EGR) valve wiring harness heat shield nut (1), bolt (2) and the EGR heat shield (3).
10. Disconnect the EVAP purge solenoid pipe quick connect fitting. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.

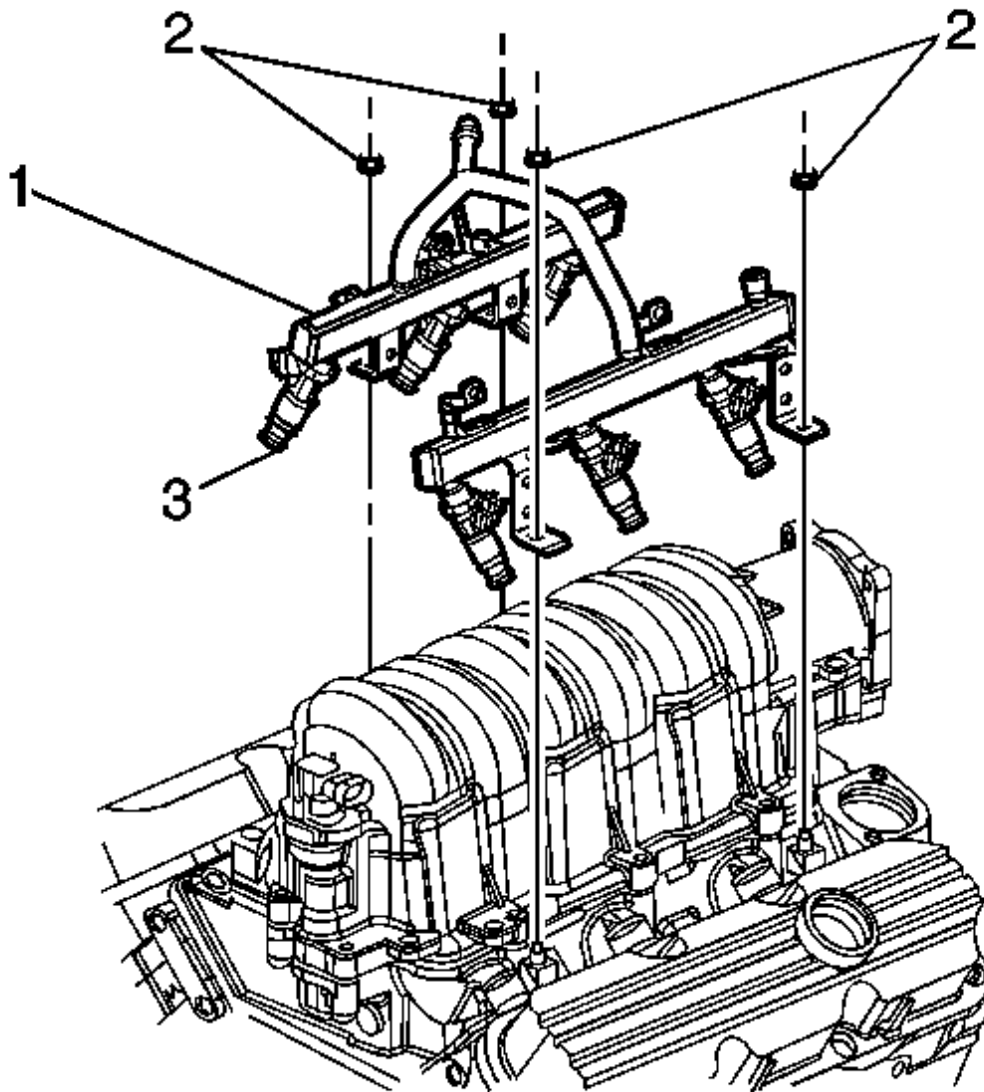


Fig. 91: Fuel Rail Assembly & Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

11. Remove the fuel rail assembly nuts (2).
12. Remove the fuel rail assembly (1) with the fuel injectors (3).

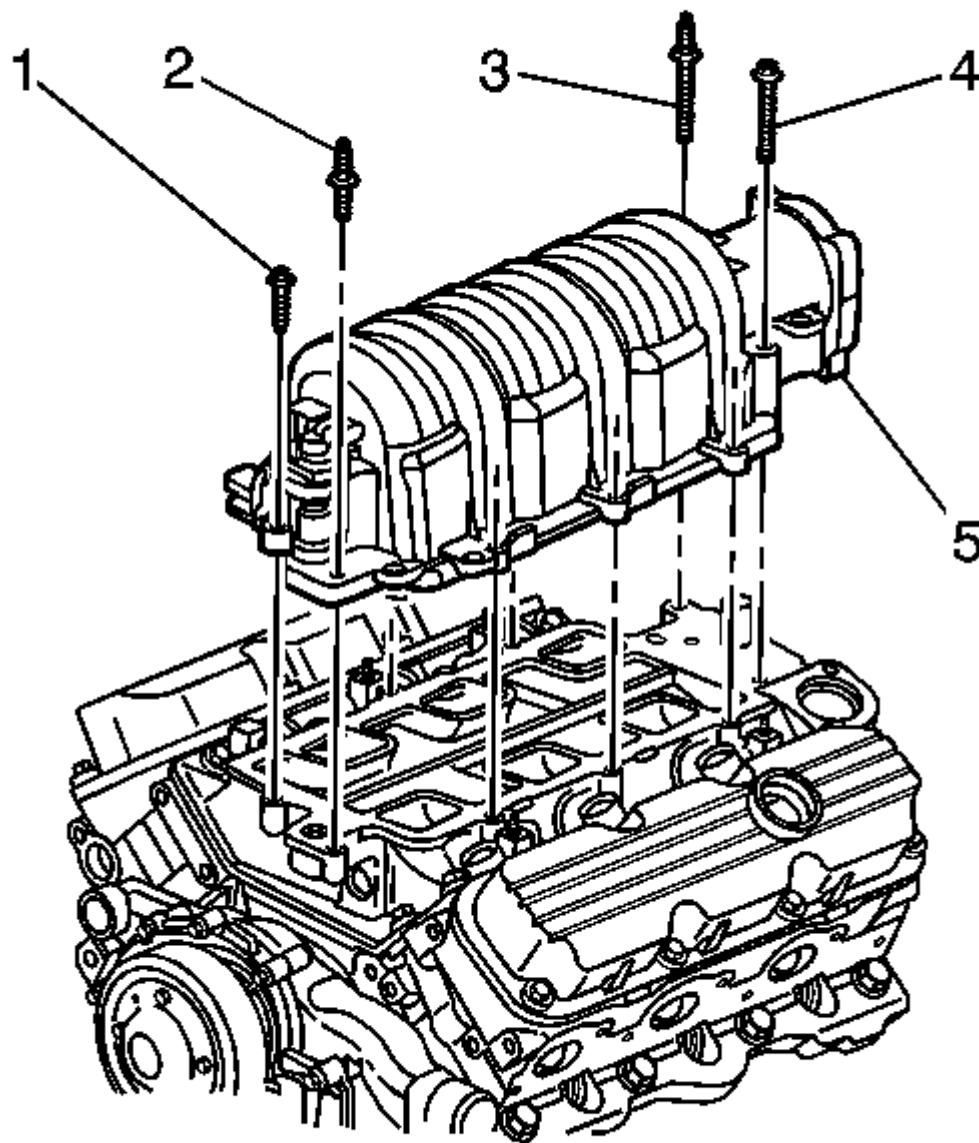


Fig. 92: Upper Intake Manifold Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

13. Remove the upper intake manifold bolts (1, 4) and the studs (2, 3).
14. Clean the upper intake manifold bolt threads.
15. Remove the upper intake manifold.

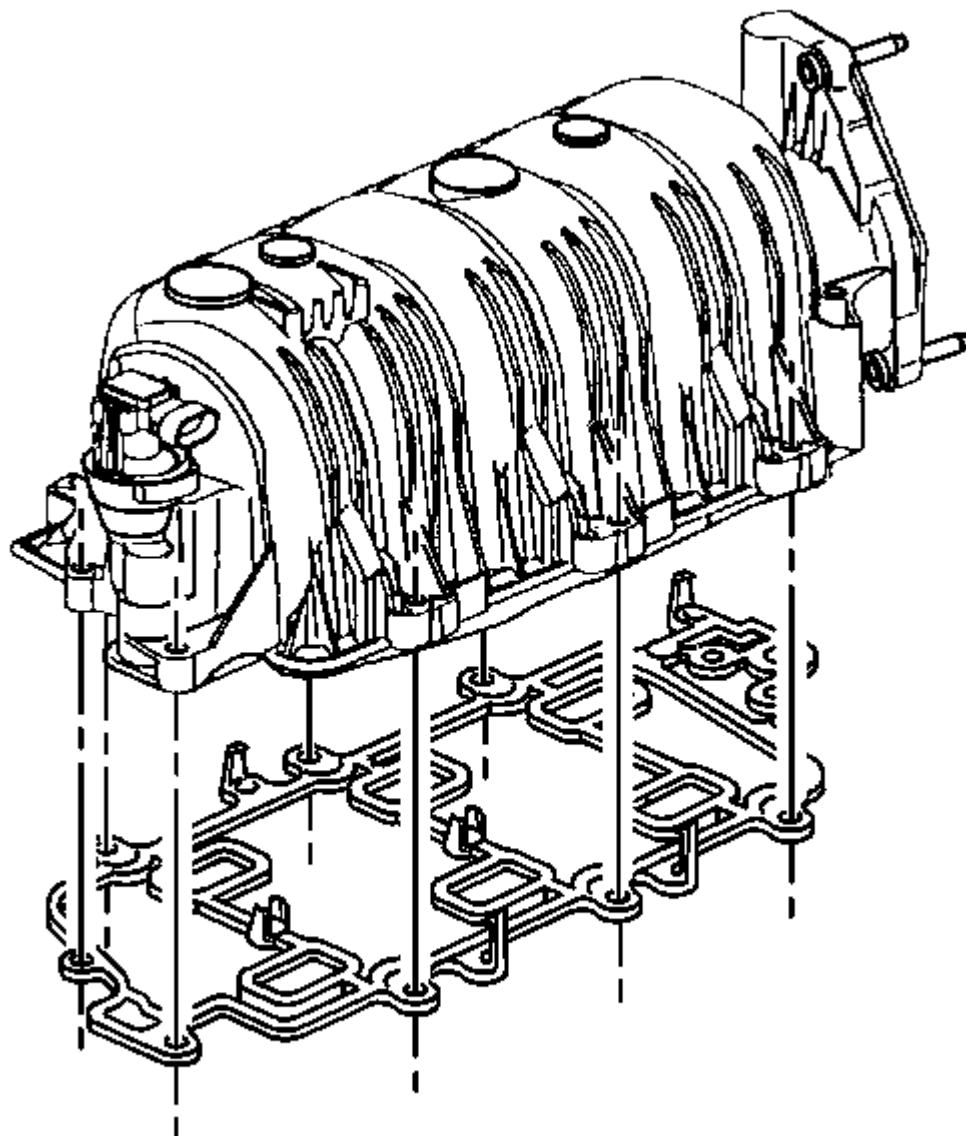


Fig. 93: Upper-To-Lower Intake Manifold Carrier Gasket
Courtesy of GENERAL MOTORS CORP.

16. Remove the upper-to-lower intake manifold carrier gasket from the upper intake manifold.
17. If the upper intake manifold is being replaced, remove the following:
 - Throttle body
 - MAP sensor

- Positive crankcase ventilation (PCV) valve
- Vacuum source manifold

Installation Procedure

1. If the manifold was replaced install the following:
 - Vacuum source manifold
 - PCV valve
 - MAP sensor
 - Throttle body

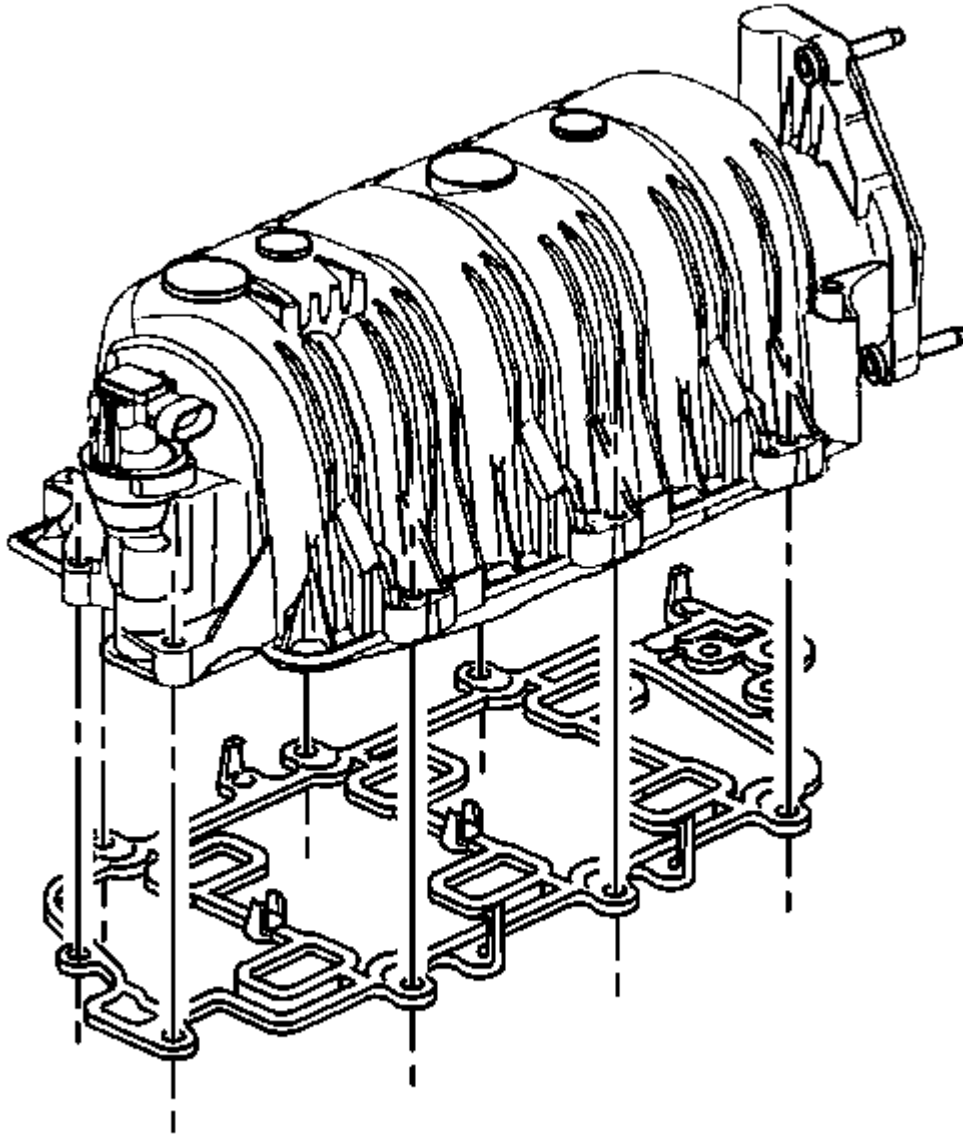


Fig. 94: Upper-To-Lower Intake Manifold Carrier Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the upper-to-lower intake manifold carrier gasket to the upper intake manifold.

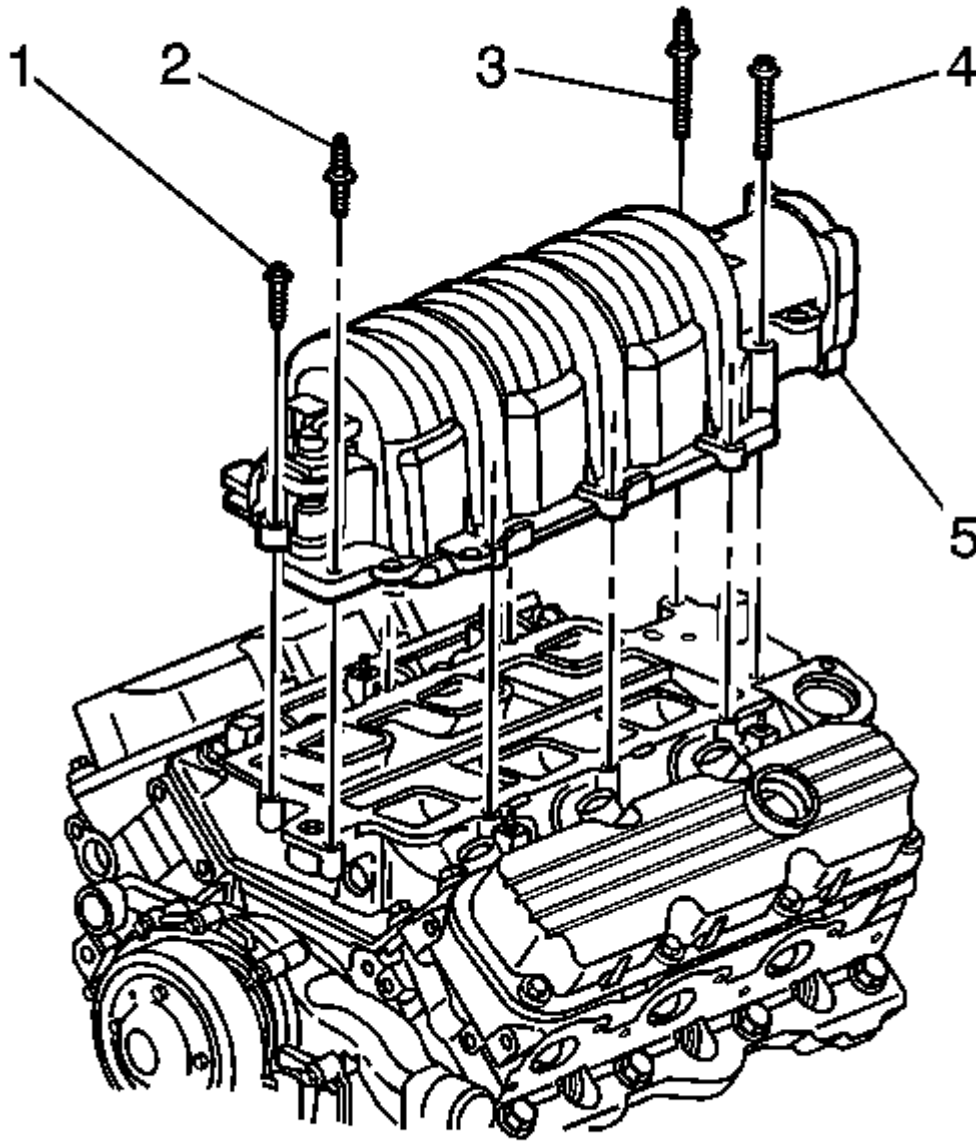


Fig. 95: Upper Intake Manifold Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the upper intake manifold (5) onto the lower intake manifold. Ensure that the alignment pins in the upper intake manifold align with the holes in the lower intake manifold.
4. Apply threadlock compound to the threads of the bolts (1, 4) and the studs (2, 3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

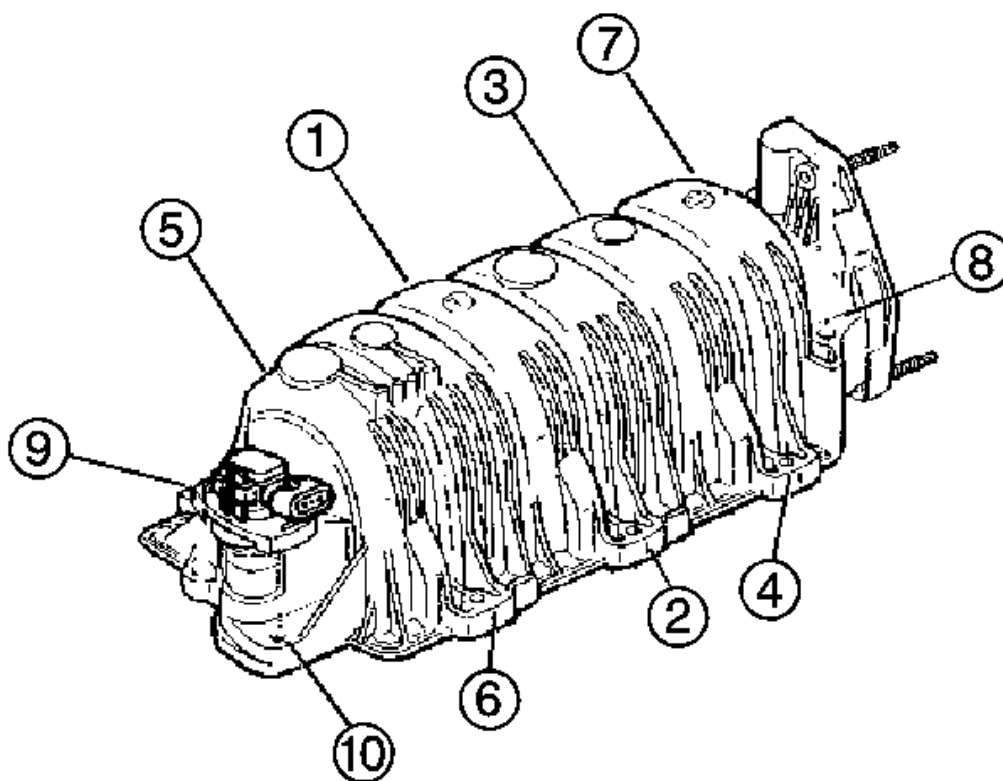


Fig. 96: Installing Upper Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Install the upper intake manifold bolts and the studs (1-10).

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

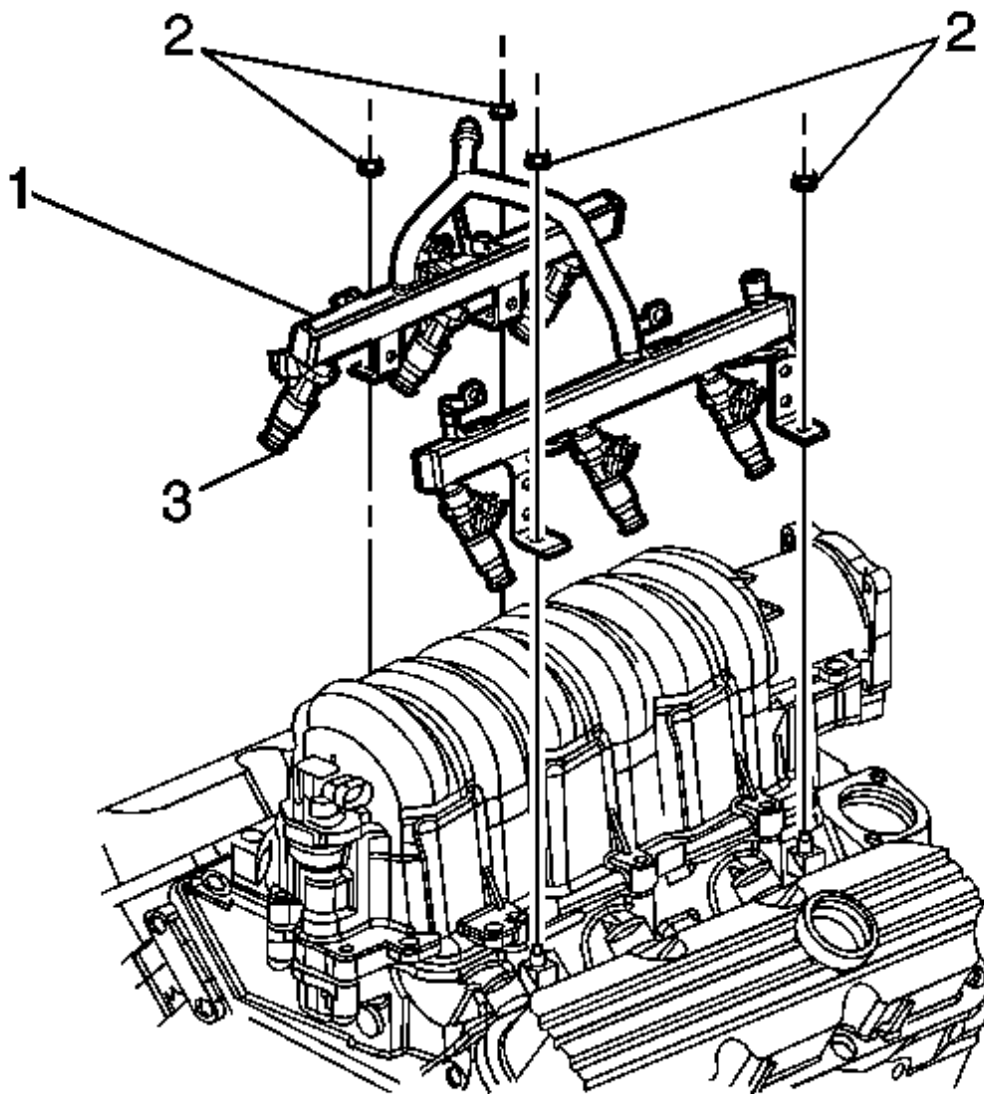


Fig. 97: Fuel Rail Assembly & Fuel Injectors
Courtesy of GENERAL MOTORS CORP.

6. Lightly coat the fuel injectors (3) with clean engine oil.

NOTE: Ensure the fuel rail is fully seated in the lower intake manifold assembly.

7. Install the fuel rail assembly (1) to the lower intake assembly.

8. Install the fuel rail nuts (2).

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

9. Connect the EVAP purge solenoid pipe quick connect fitting. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.

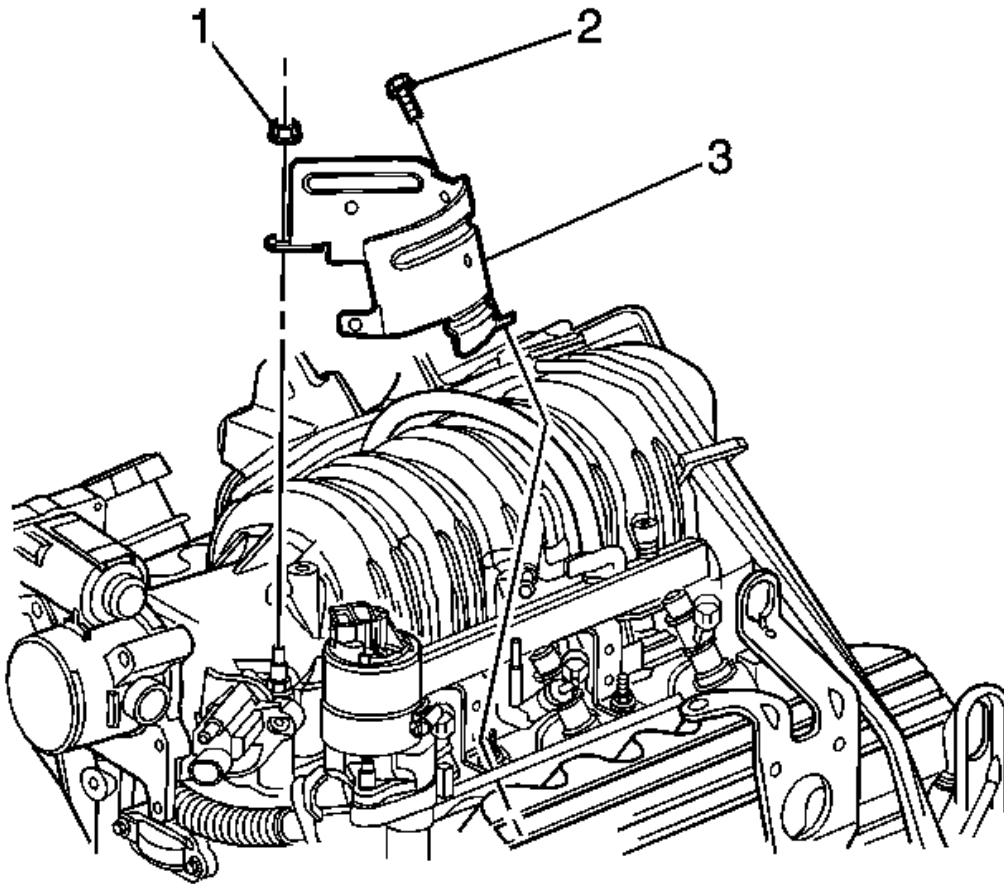


Fig. 98: EGR Valve Wiring Harness Heat Shield Nut & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the EGR valve wiring harness heat shield (3), the nut (1) and the bolt (2).

Tighten: Tighten the nut and the bolt to 10 N.m (89 lb in).

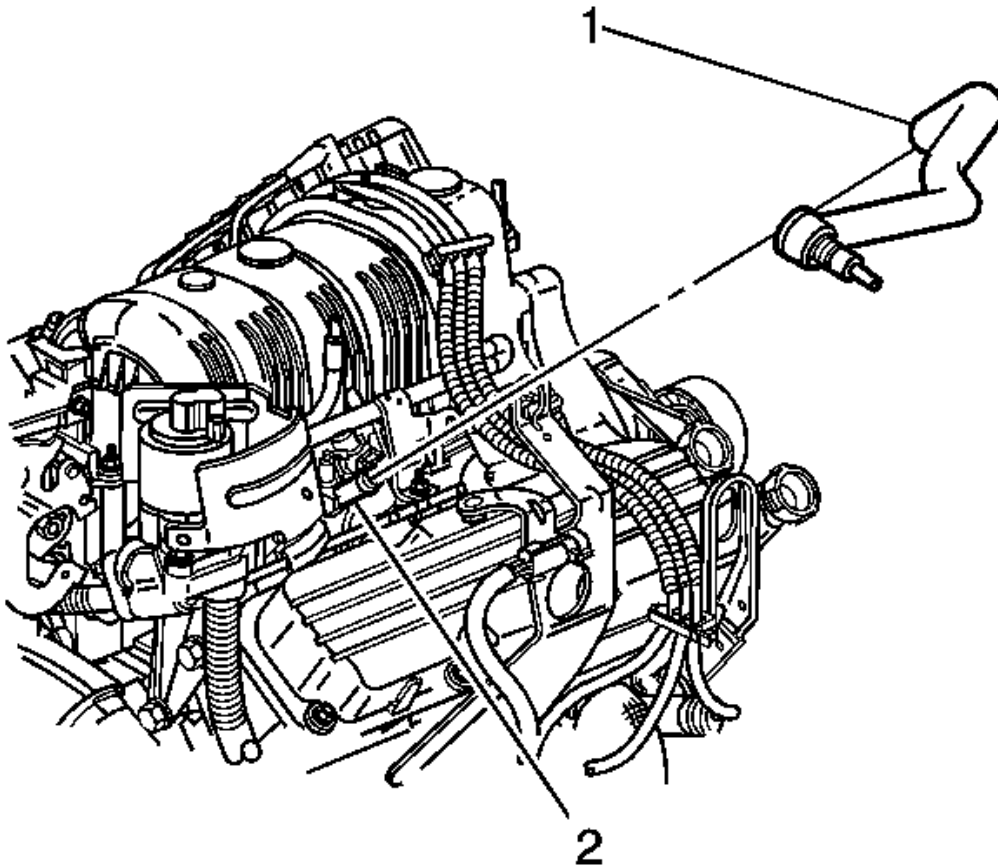


Fig. 99: Brake Booster Hose & Vacuum Source Manifold
Courtesy of GENERAL MOTORS CORP.

11. Install the brake booster hose (1) to the vacuum source manifold (2).
12. Connect the electrical connectors to the following:
 - MAF sensor
 - MAP sensor
 - EVAP purge solenoid
 - ETC
13. Install the right spark plug wires to the ignition control module and the upper intake manifold. Refer to **Spark Plug Wire Replacement** .
14. Install the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
15. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
16. Fill the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling**

System Draining and Filling (L26 GE 47716 Fill) .

17. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26) .**
18. Inspect for fluid or vacuum leaks.

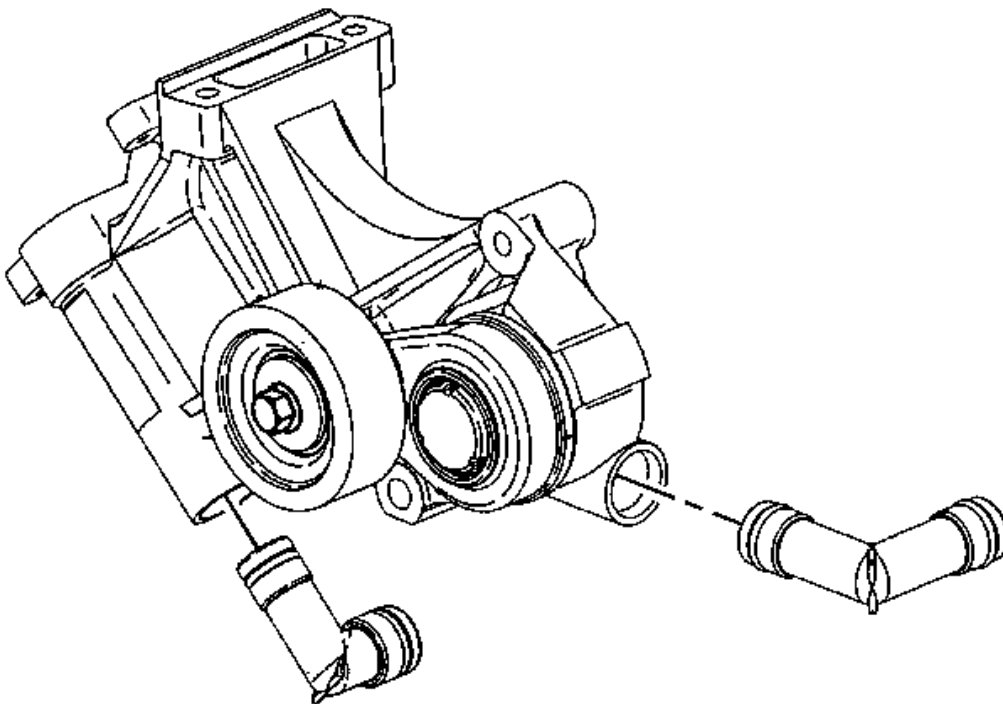
LOWER INTAKE MANIFOLD REPLACEMENT**Removal Procedure**

Fig. 100: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

CAUTION: When installing the seal, ensure the seal lip is firmly seated against the case bore surface. Do not allow the seal lip to be crushed, or a leak may result.

1. Remove the upper intake manifold. Refer to **Upper Intake Manifold Replacement**.
2. Remove the generator brace. Refer to **Generator Brace Replacement (L26) .**
3. Remove the drive belt tensioner with the heater water bypass inlet pipe. Refer to **Drive Belt Tensioner Replacement**.

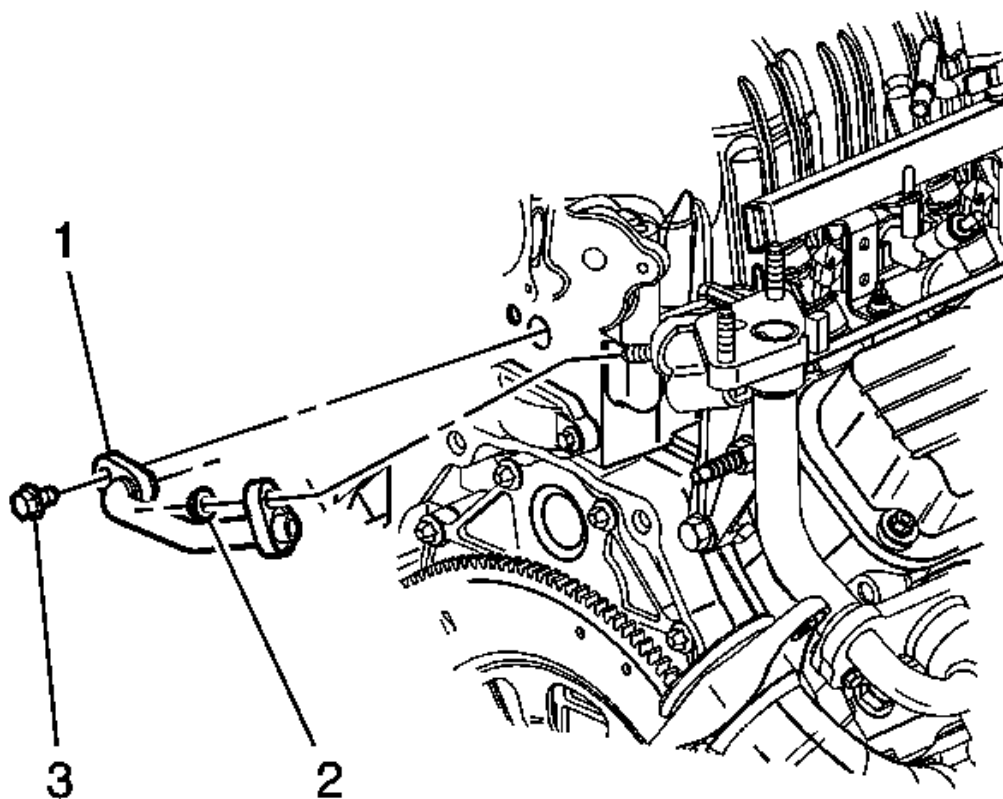


Fig. 101: EGR Outlet Pipe & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust gas recirculation (EGR) outlet pipe bolt (2) from the lower intake manifold.
5. Remove the EGR outlet pipe (1) from the lower intake manifold.

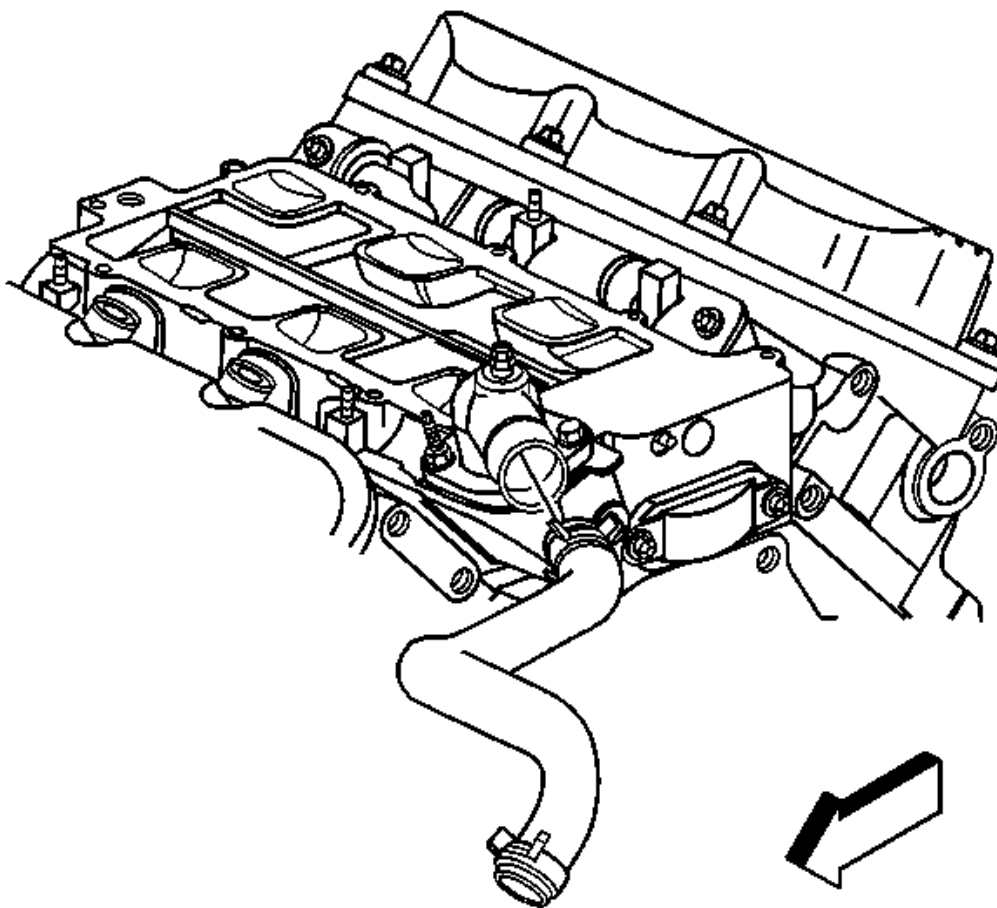


Fig. 102: Radiator Inlet Hose

Courtesy of GENERAL MOTORS CORP.

6. Remove the radiator inlet hose from the water outlet housing. Refer to **Radiator Inlet Hose Replacement (L26)**.

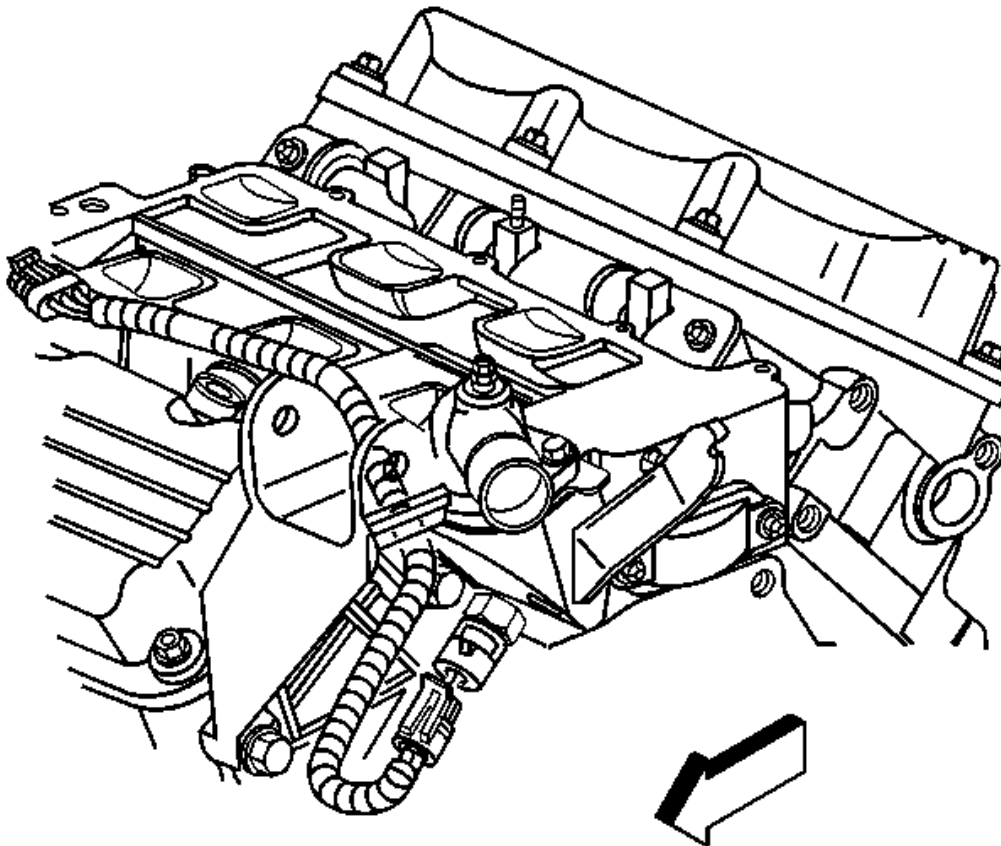


Fig. 103: ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the engine coolant temperature (ECT) sensor electrical connector.

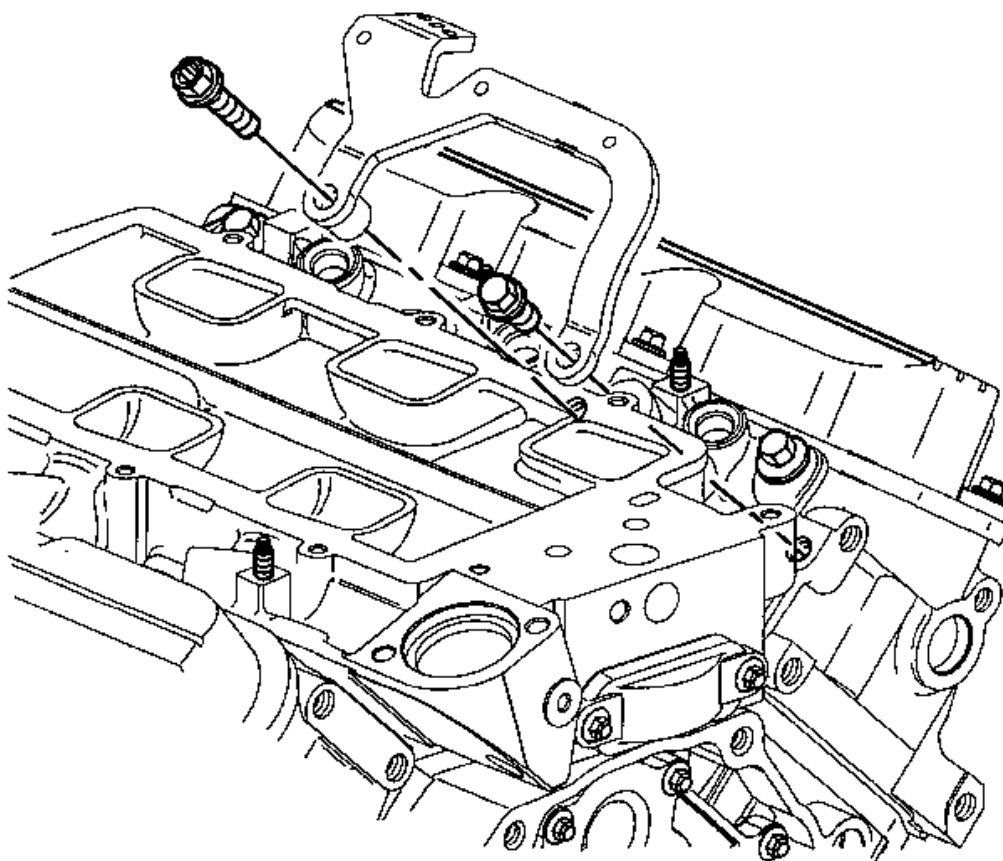


Fig. 104: Generator Brace Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the generator brace bracket bolts.
9. Remove the generator brace bracket.

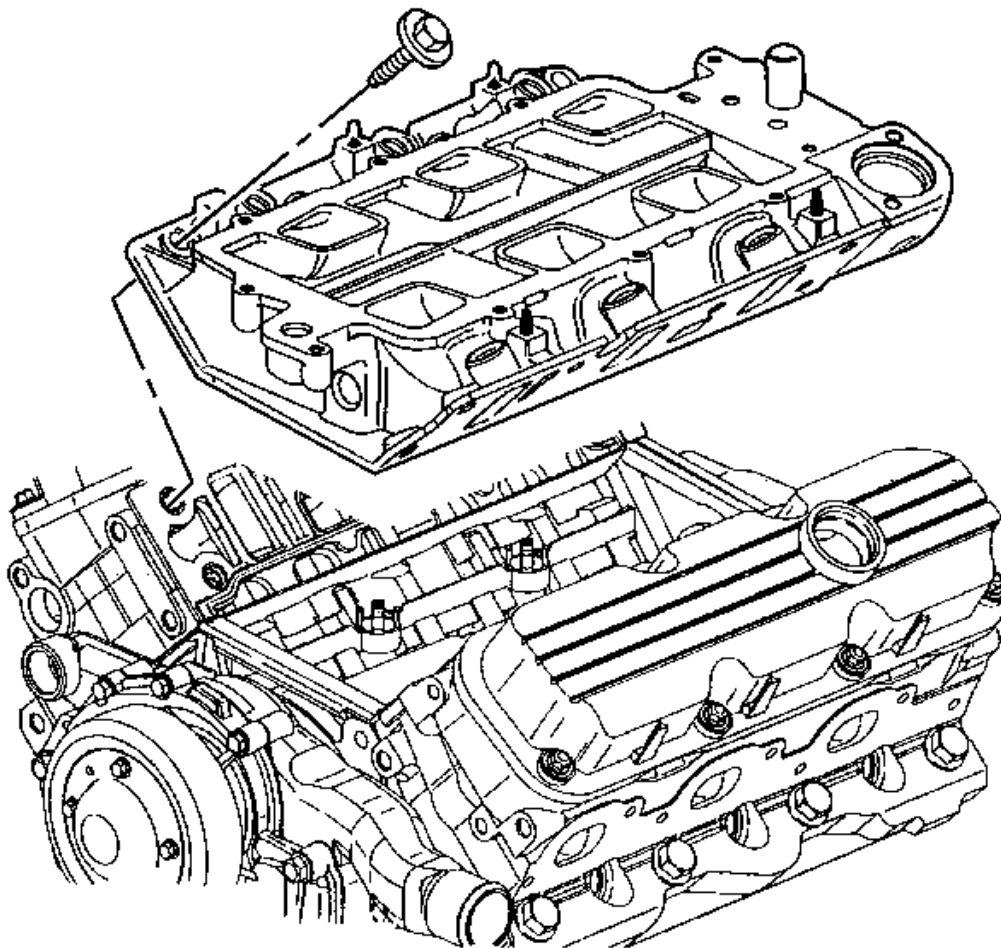


Fig. 105: Lower Intake Manifold & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the lower intake manifold bolts.
11. Remove the lower intake manifold.

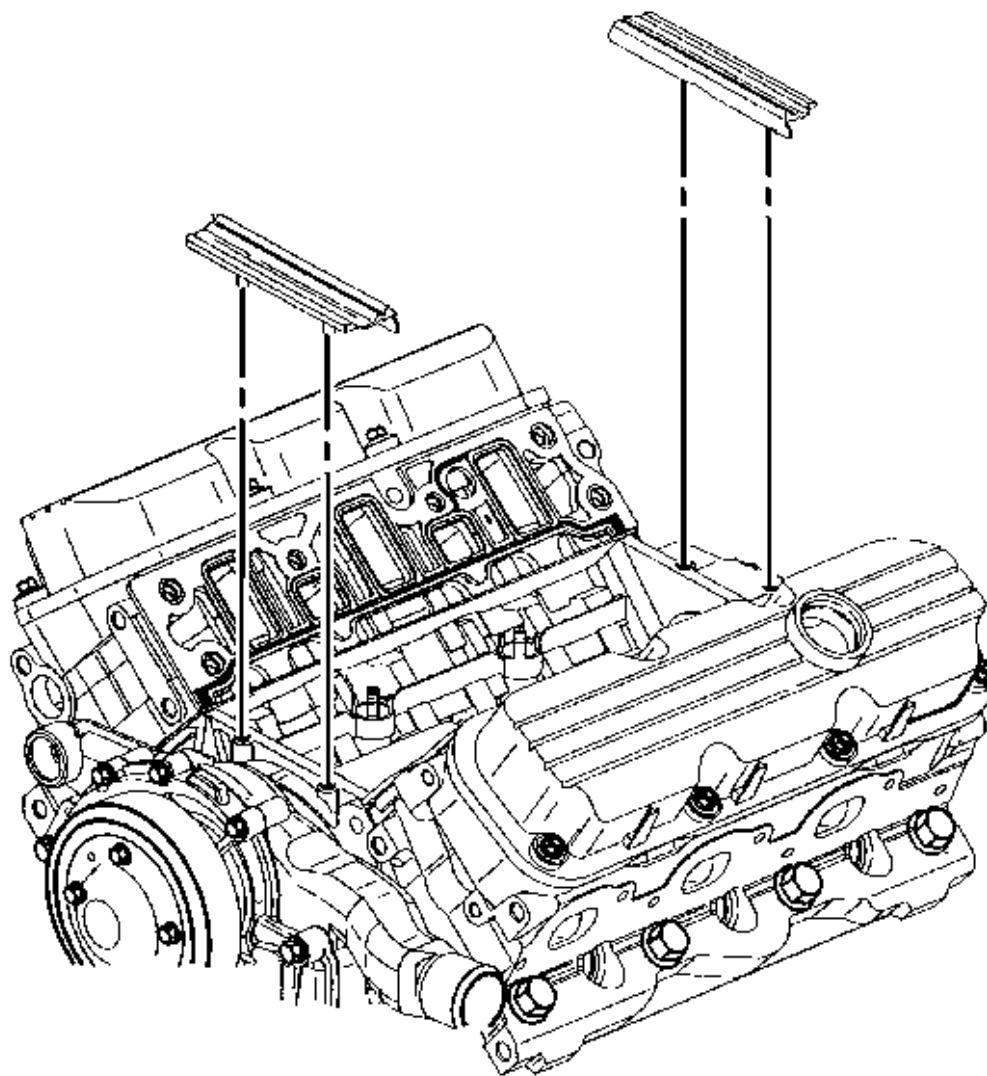


Fig. 106: Lower Intake Manifold Seals
Courtesy of GENERAL MOTORS CORP.

12. Remove the lower intake manifold seals.

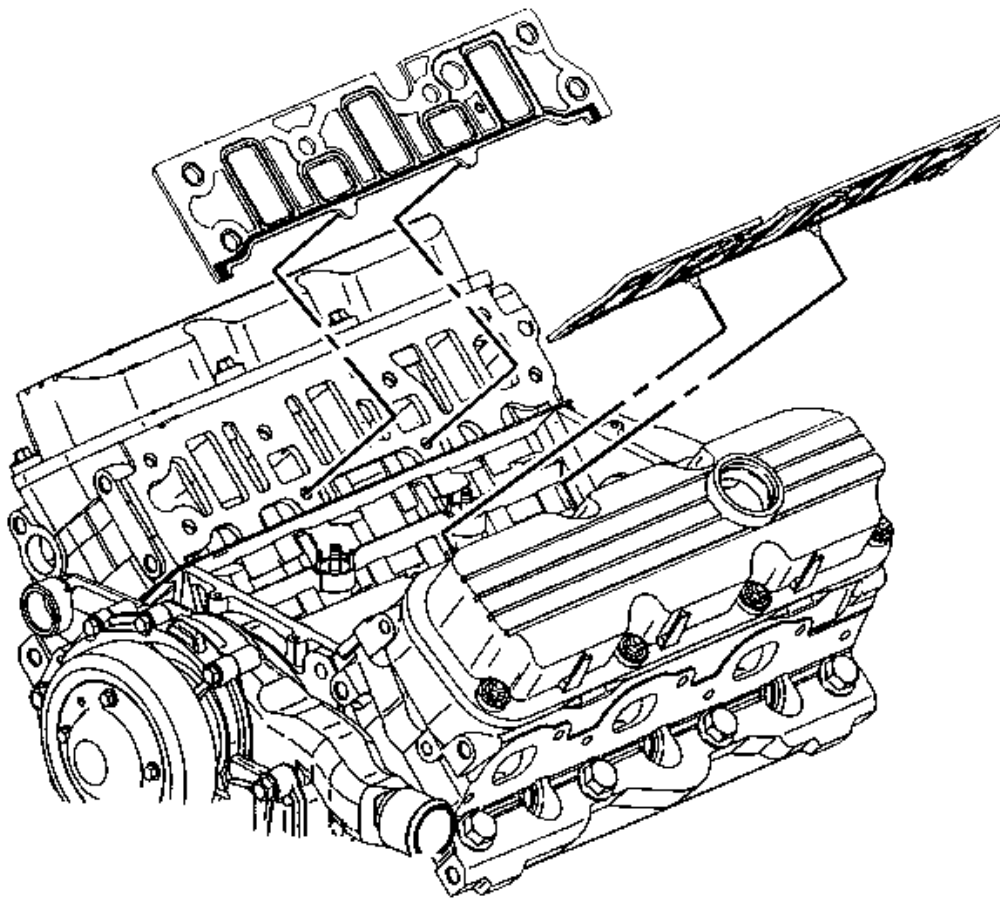


Fig. 107: Lower Intake Manifold Gaskets
Courtesy of GENERAL MOTORS CORP.

13. Remove the lower intake manifold gaskets.

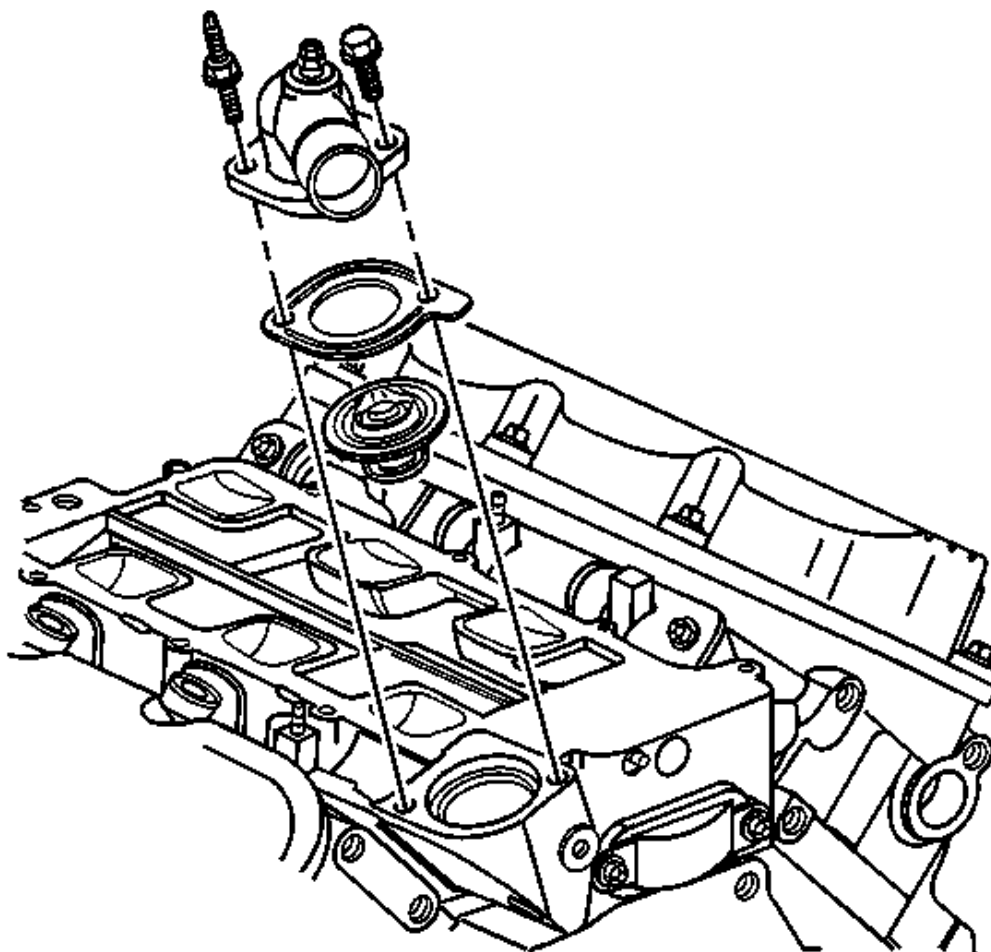


Fig. 108: Water Outlet Housing, Bolt & Stud
Courtesy of GENERAL MOTORS CORP.

14. If replacing the lower intake manifold, remove the water outlet housing bolt, stud and the water outlet housing.
15. If replacing the lower intake manifold, remove the ECT sensor.
16. Inspect the flatness of the inlet flanges.
17. Clean the intake manifold gasket mating surfaces.
18. Clean the intake manifold bolts and bolt holes of adhesive compound.

Installation Procedure

CAUTION: Refer to Fastener Caution .

1. If removed, install the ECT sensor.

Tighten: Tighten the sensor to 25 N.m (18 lb ft).

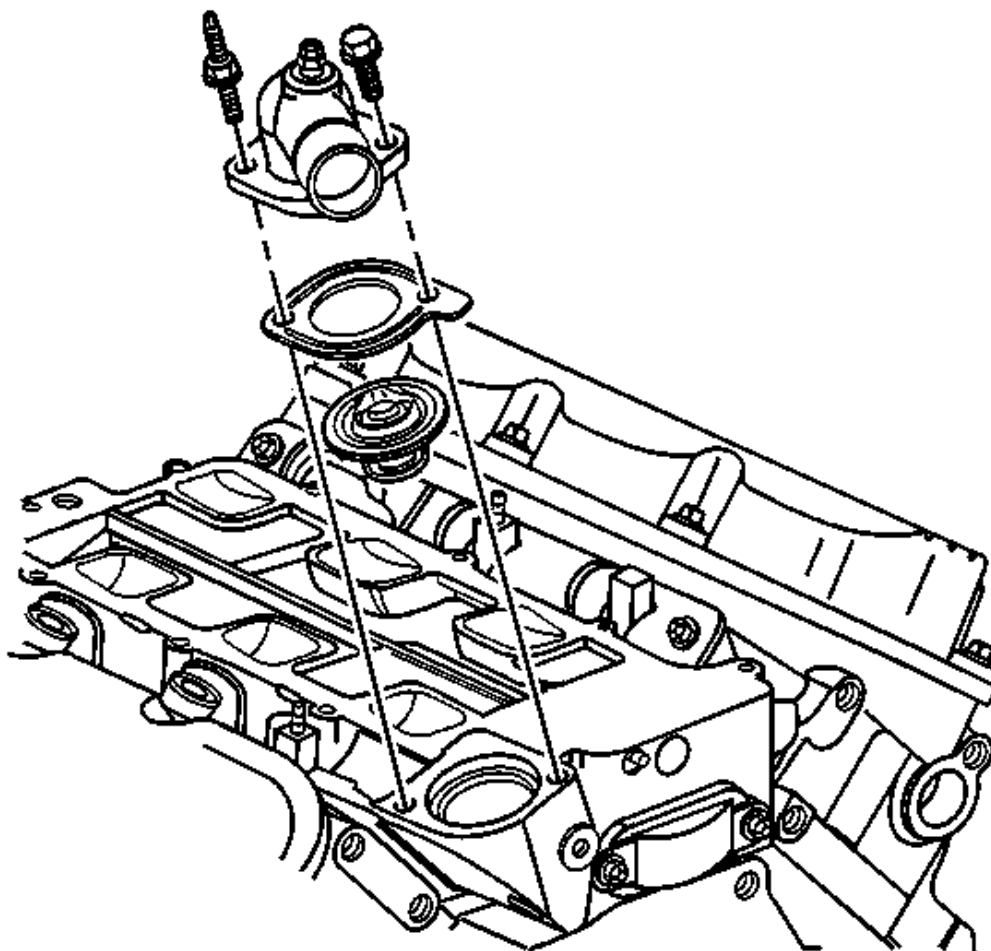


Fig. 109: Water Outlet Housing, Bolt & Stud
Courtesy of GENERAL MOTORS CORP.

2. If removed, install the thermostat, the gasket, and the water outlet housing.
3. Install the water outlet housing bolt and the stud.

Tighten: Tighten the bolt and the stud to 27 N.m (20 lb ft).

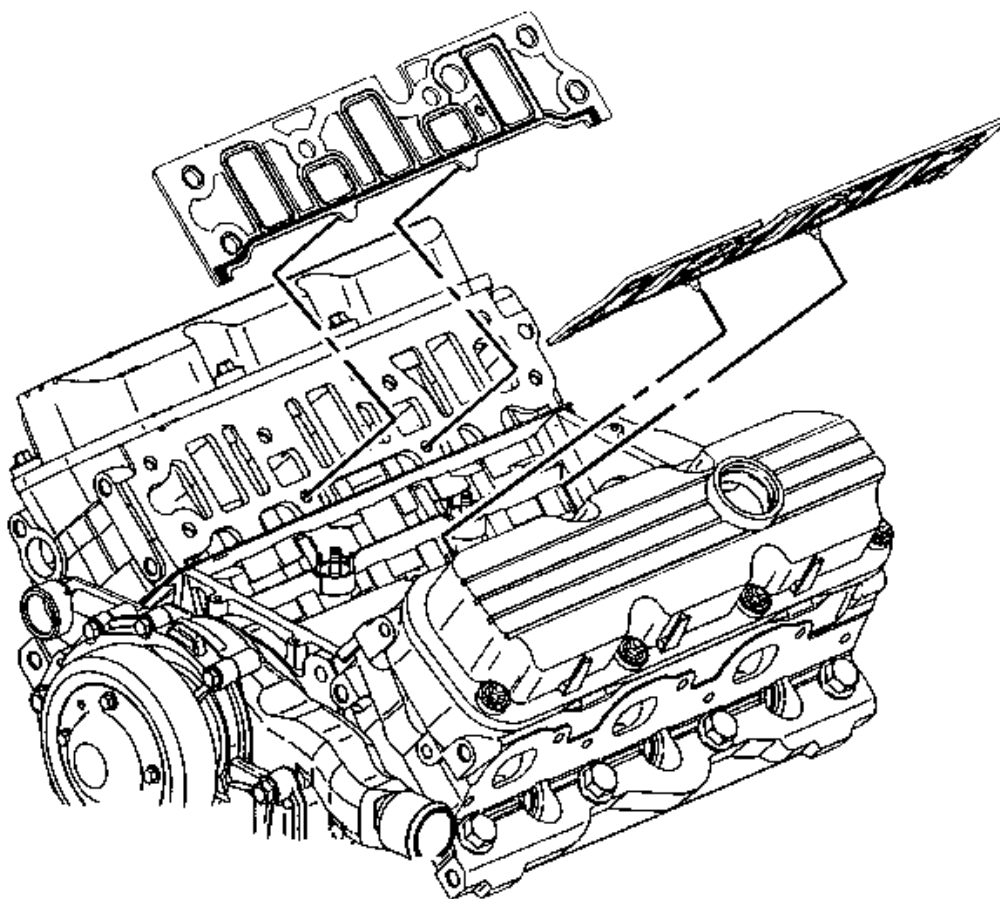


Fig. 110: Lower Intake Manifold Gaskets
Courtesy of GENERAL MOTORS CORP.

4. Install the lower intake manifold gaskets.

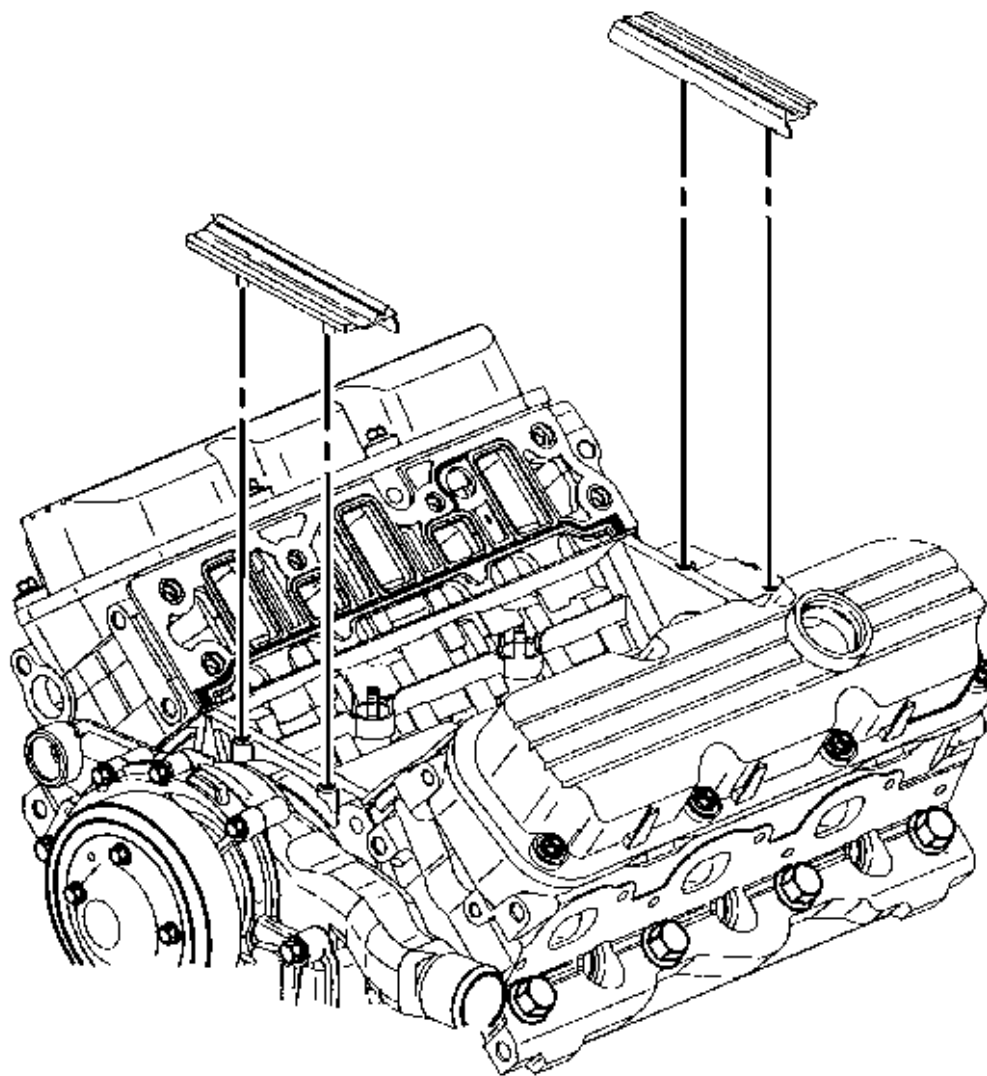


Fig. 111: Lower Intake Manifold Seals
Courtesy of GENERAL MOTORS CORP.

5. Apply sealer to the ends of the intake manifold seals. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Install the lower intake manifold seals.

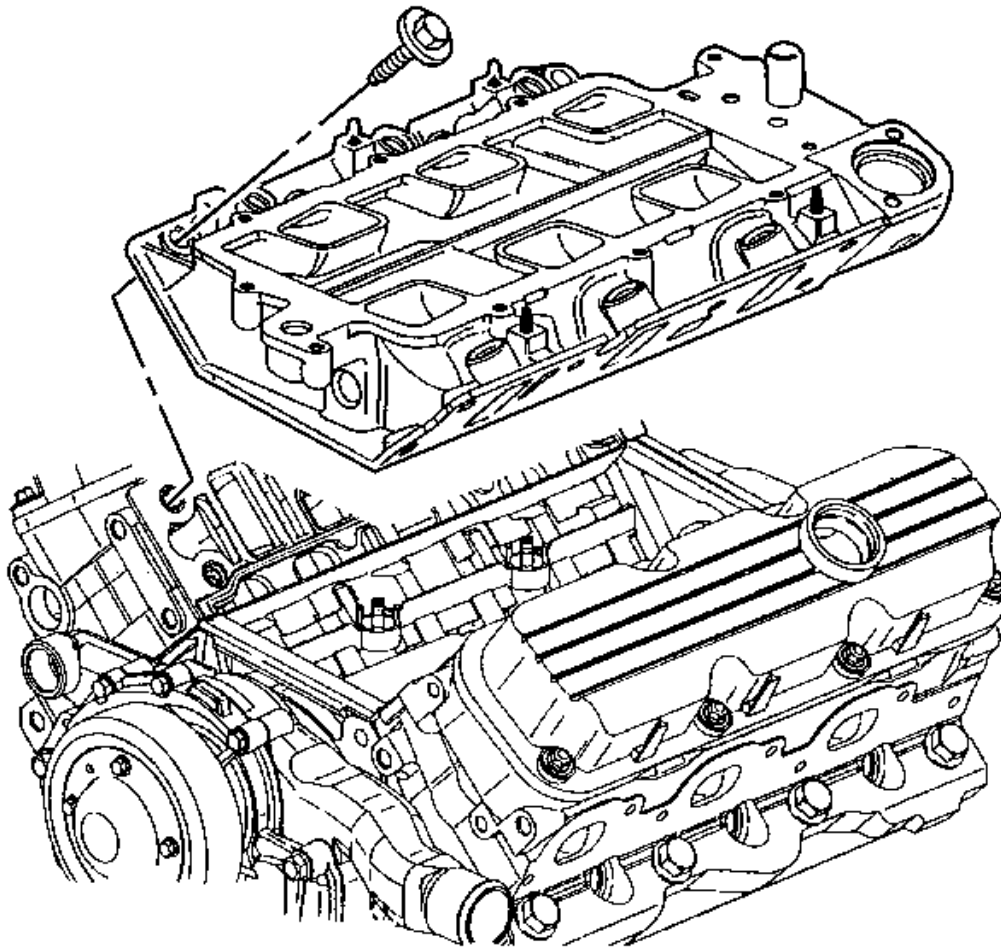


Fig. 112: Lower Intake Manifold & Bolts
 Courtesy of GENERAL MOTORS CORP.

CAUTION: The two bolts which fasten the lower intake manifold to the cylinder head are accessible only after the upper intake is removed. The bolts are located in the right front and left rear corners of the lower intake manifold. Remove the upper intake manifold to service the lower intake.

7. Install the lower intake manifold.
8. Apply threadlock compound to the two hidden bolts. Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number.

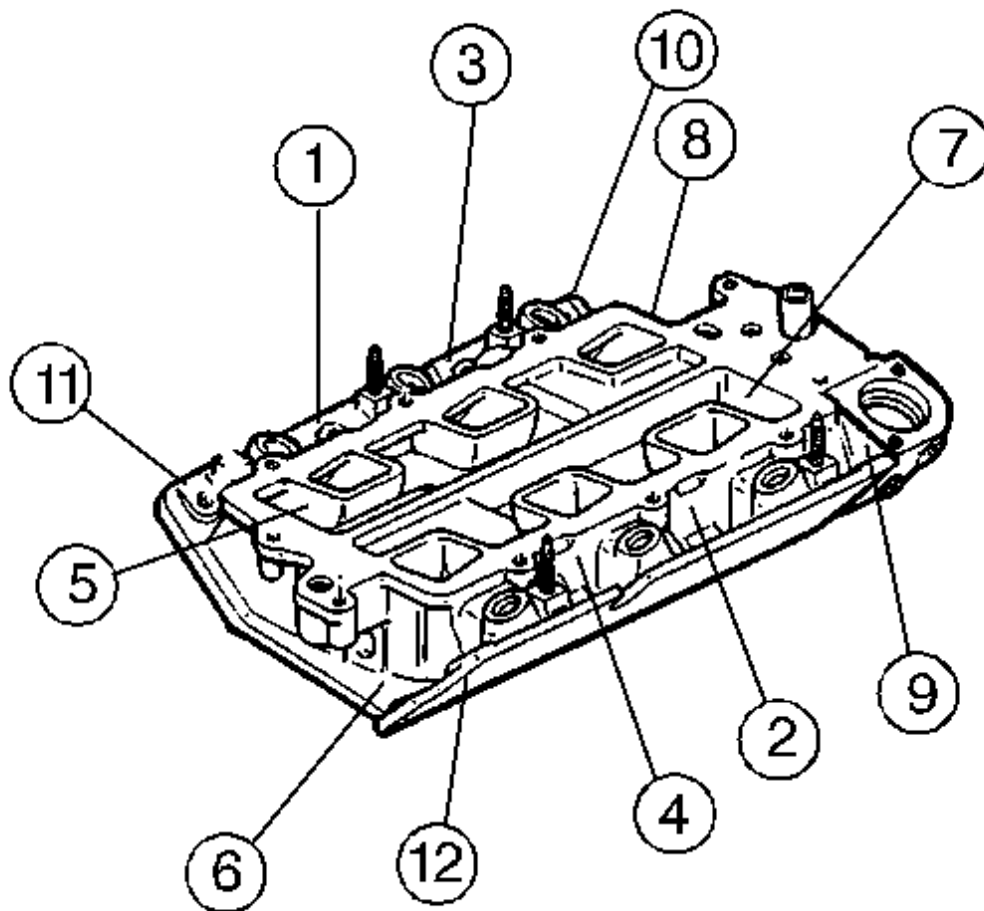


Fig. 113: Identifying Lower Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

9. Install the lower intake manifold bolts (1-12).

Tighten: Tighten the lower intake manifold bolts in sequence to 15 N.m (11 lb ft).

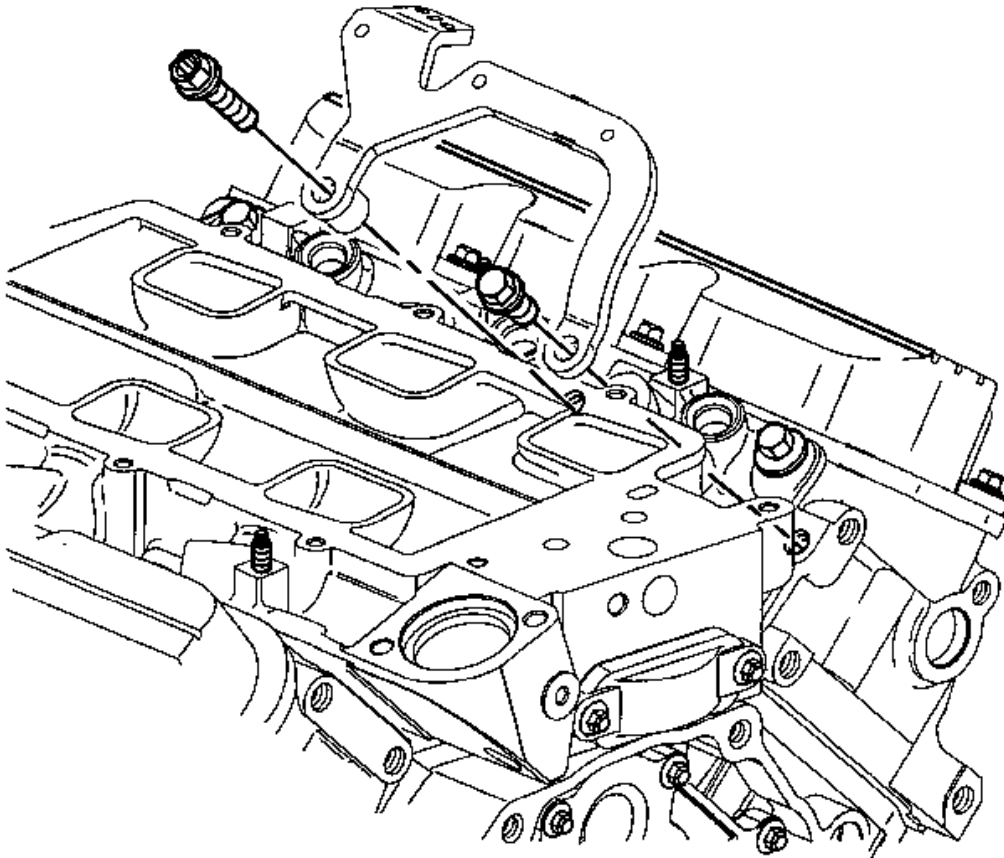


Fig. 114: Generator Brace Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Install the generator brace bracket.
11. Install the generator brace bracket bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

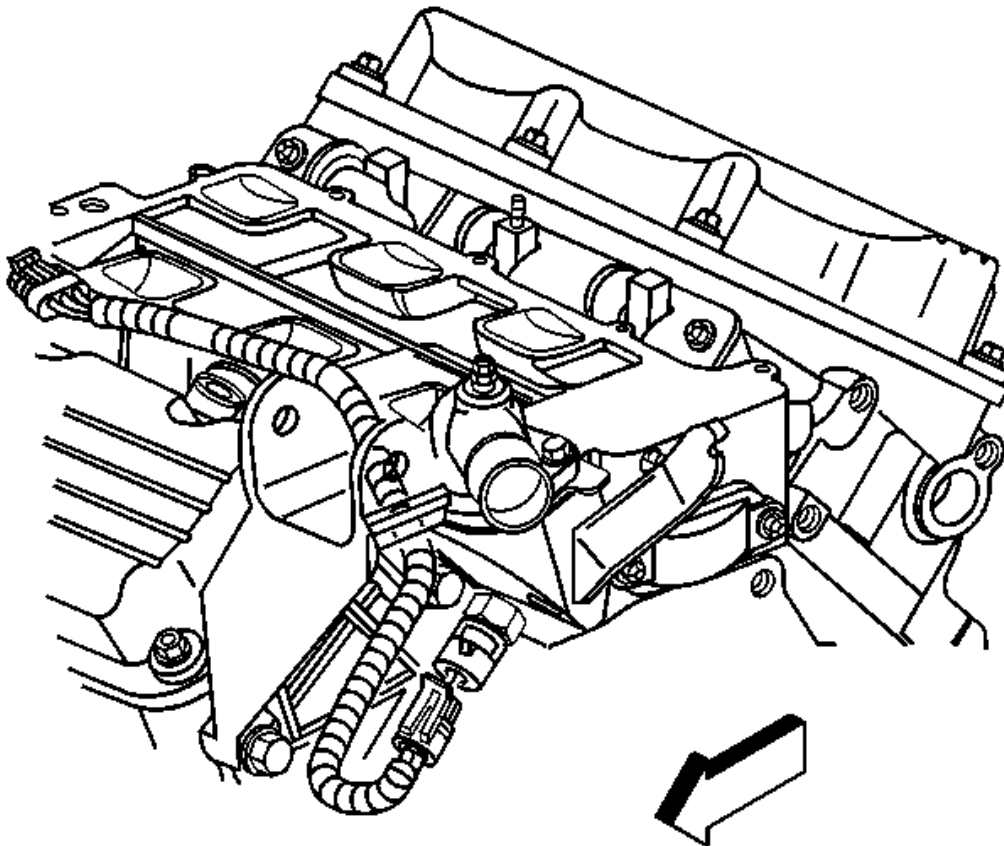


Fig. 115: ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Connect the ECT sensor electrical connector.

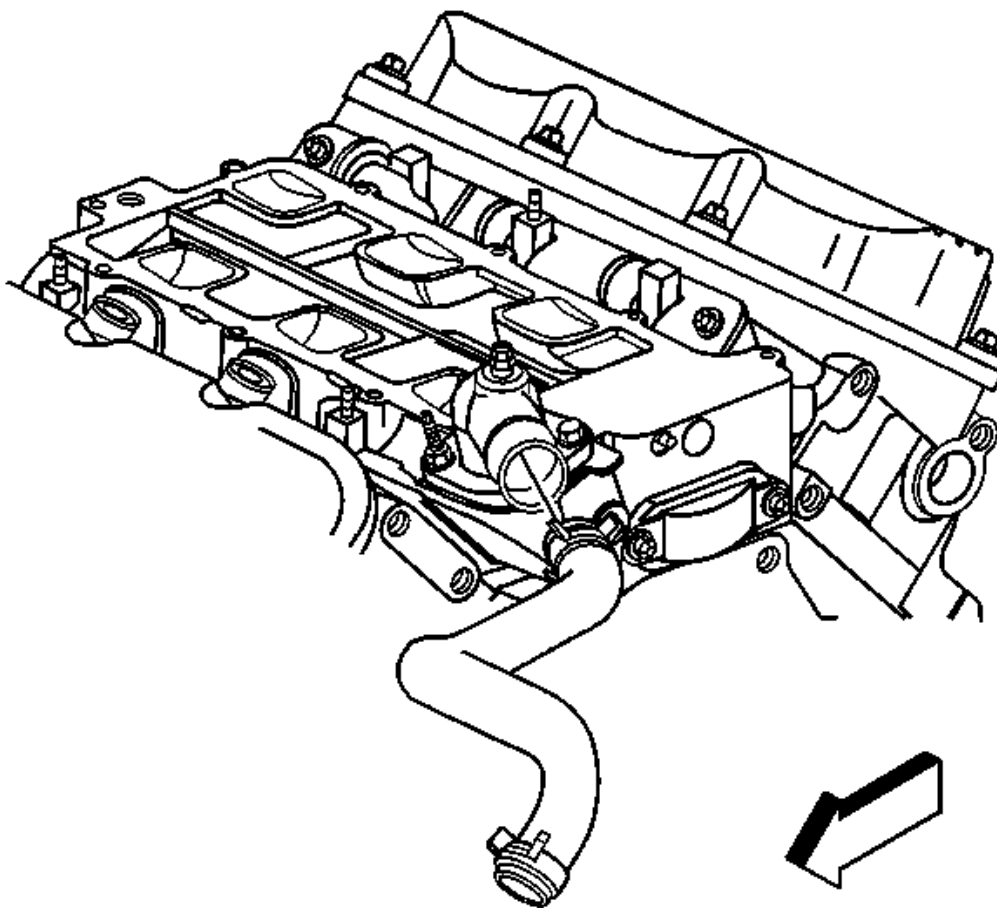


Fig. 116: Radiator Inlet Hose
Courtesy of GENERAL MOTORS CORP.

13. Install the radiator inlet hose to the water outlet housing. Refer to **Radiator Inlet Hose Replacement (L26)**.

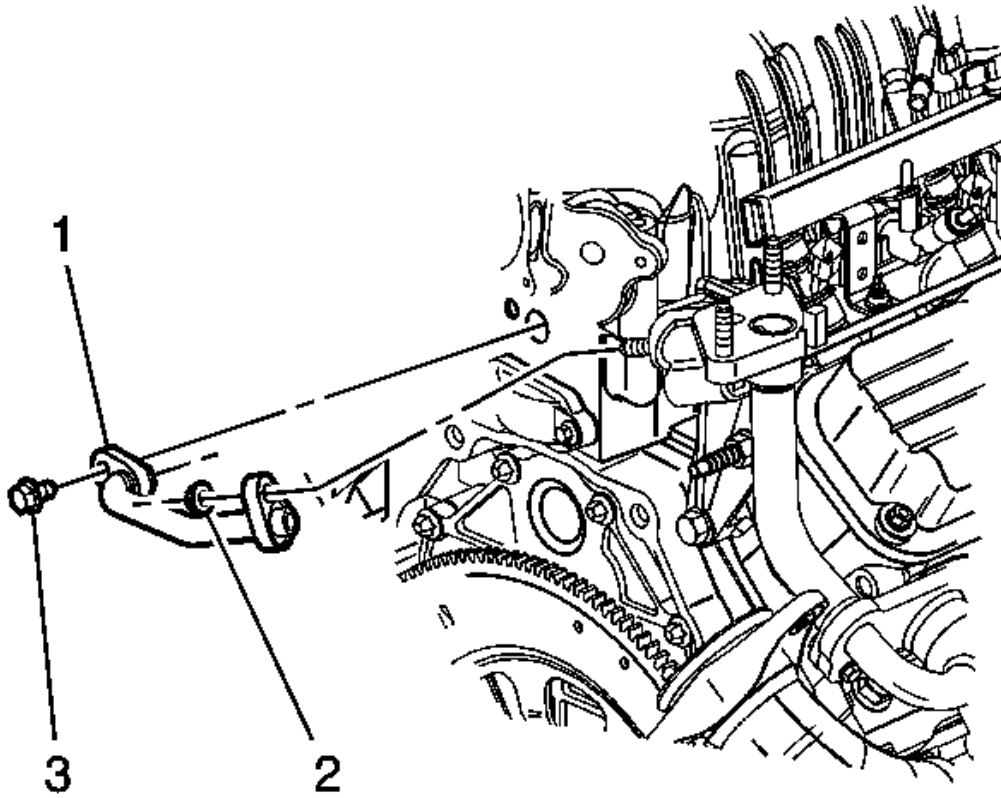


Fig. 117: EGR Outlet Pipe & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

14. Install the EGR outlet pipe (1) to the lower intake manifold.
15. Install the EGR outlet pipe bolt (2) to the lower intake manifold.

Tighten: Tighten the bolt to 29 N.m (21 lb ft).

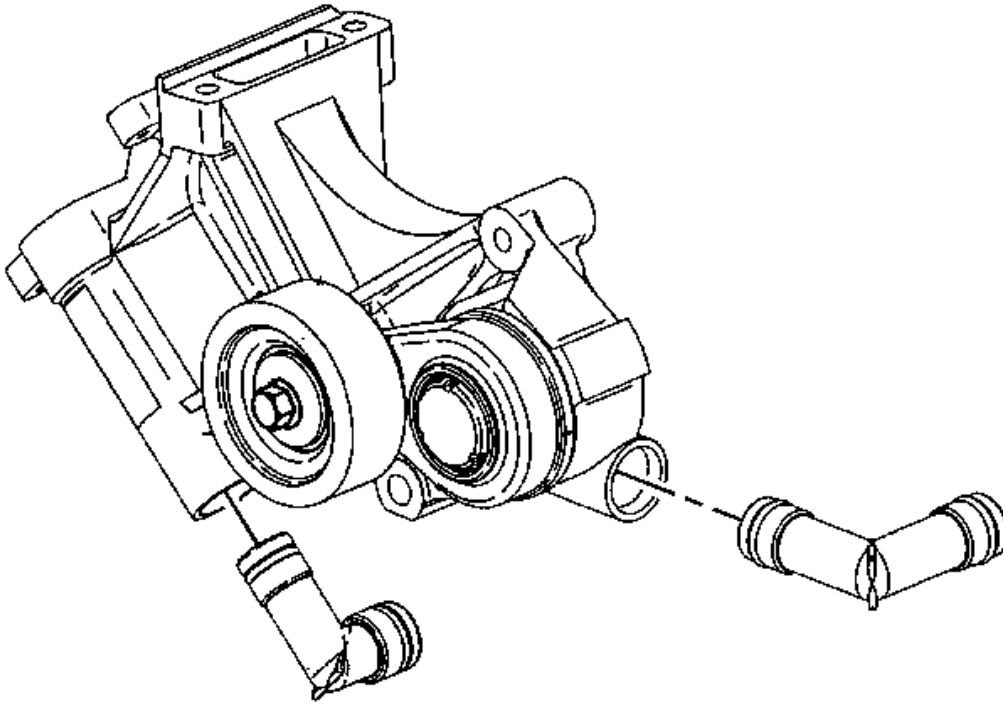


Fig. 118: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

16. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
17. Install the generator brace. Refer to **Generator Brace Replacement (L26)**.
18. Install the upper intake manifold. Refer to **Upper Intake Manifold Replacement**.
19. Inspect for fluid or vacuum leaks.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.

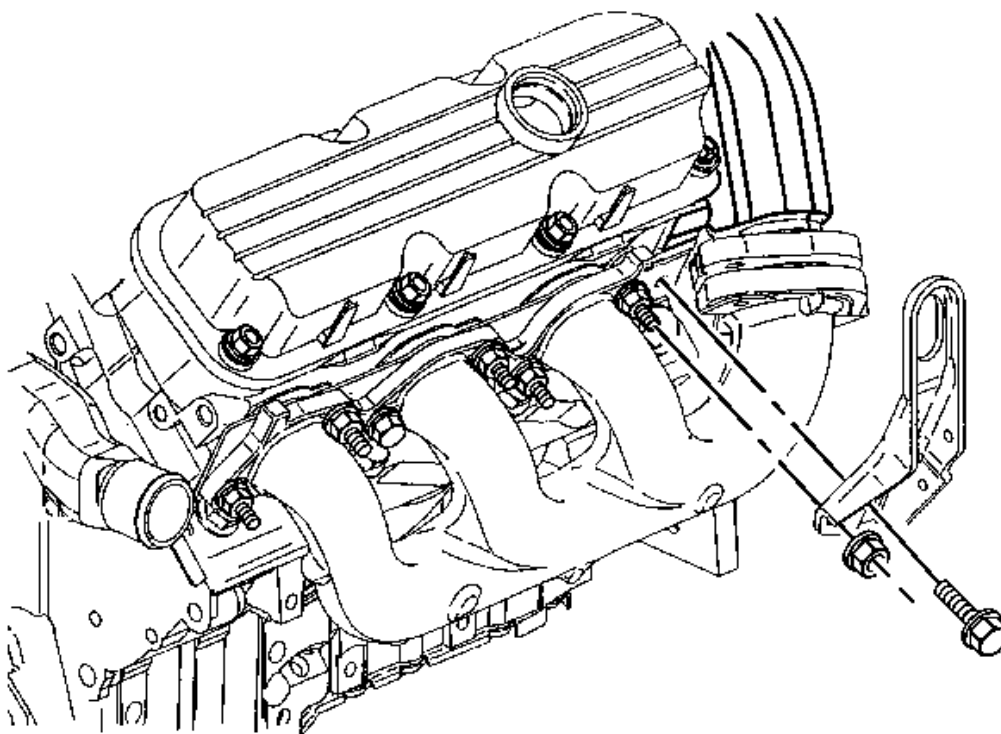


Fig. 119: Left Engine Lift Bracket (3.8L)
Courtesy of GENERAL MOTORS CORP.

2. Remove the left engine lift bracket bolt and nut from the engine lift bracket.
3. Remove the left engine lift bracket from the cylinder head.
4. Remove the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side (L26)**.
5. Remove the left spark plug wires from the left spark plugs. Refer to **Spark Plug Wire Replacement**.
6. Remove the left spark plug wire cover from the left valve rocker arm cover.

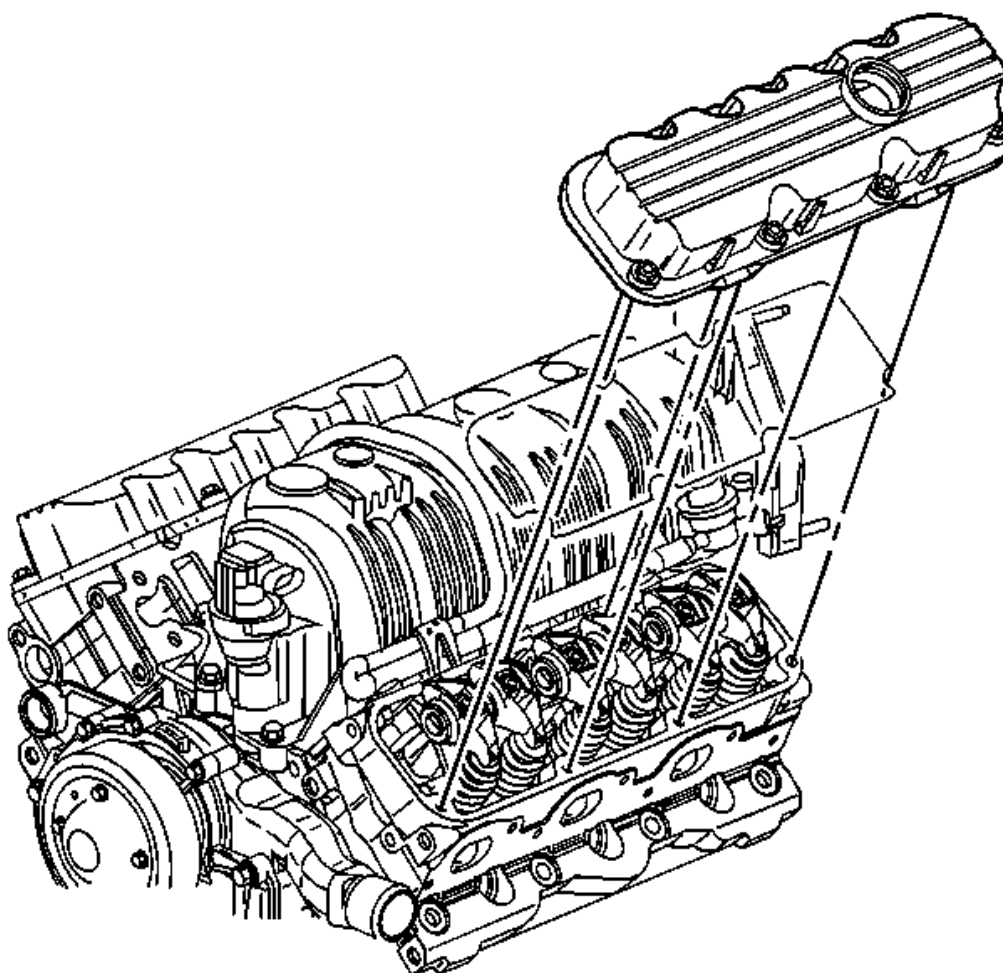


Fig. 120: Left Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

7. Remove the left valve rocker arm cover bolts.

NOTE: If the valve rocker arm cover adheres to the cylinder head, remove the valve rocker arm cover by bumping the end of the valve rocker arm cover with palm of hand or with a soft rubber mallet.

8. Remove the left valve rocker arm cover.
9. Remove the left valve rocker arm cover gasket.
10. Clean the valve rocker arm mating surfaces.

11. Clean the valve rocker arm cover bolts of all thread locking adhesive.

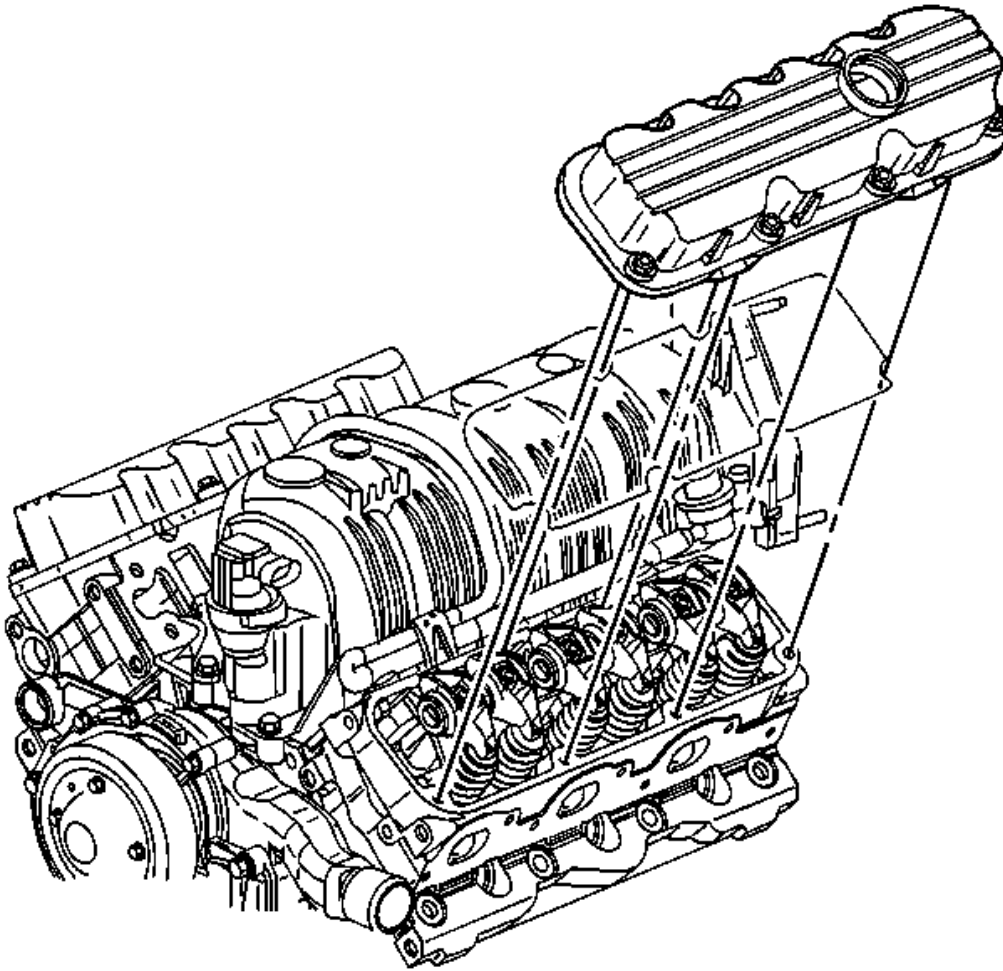
Installation Procedure

Fig. 121: Left Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Install the new valve rocker arm cover gasket. Make sure that valve rocker arm cover gasket is seated properly in the valve rocker arm cover groove.
2. Install the left valve rocker arm cover.
3. Apply threadlock compound to the valve rocker arm cover bolt threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

4. Install the left valve rocker arm cover bolts.

Tighten: Tighten the left valve rocker arm cover bolts to 10 N.m (89 lb in).

5. Install the left spark plug wire cover to the left valve rocker arm cover.
6. Install the left spark plug wires to the spark plugs. Refer to **Spark Plug Wire Replacement** .
7. Install the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side (L26)**.

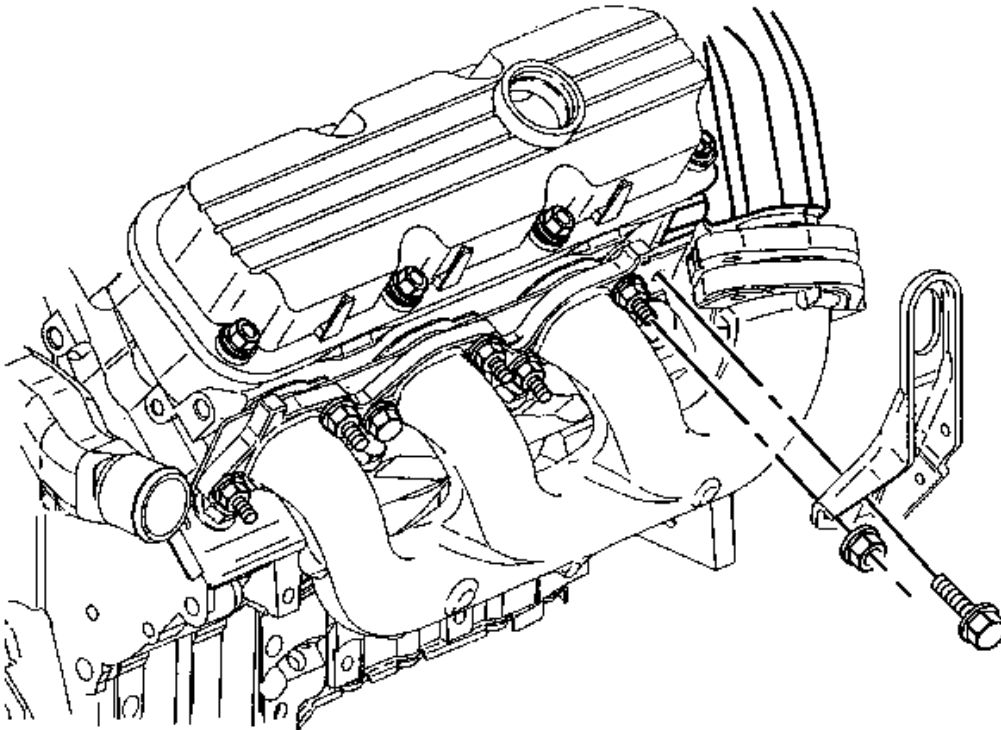


Fig. 122: Left Engine Lift Bracket (3.8L)
Courtesy of GENERAL MOTORS CORP.

8. Install the left engine lift bracket to the cylinder head.
9. Install the left engine lift bracket bolt and the nut.

Tighten: Tighten the engine lift bracket bolt and the nut to 30 N.m (22 lb ft).

10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
11. Check and fill the crankcase as necessary.
12. Inspect for oil leaks.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

Removal Procedure

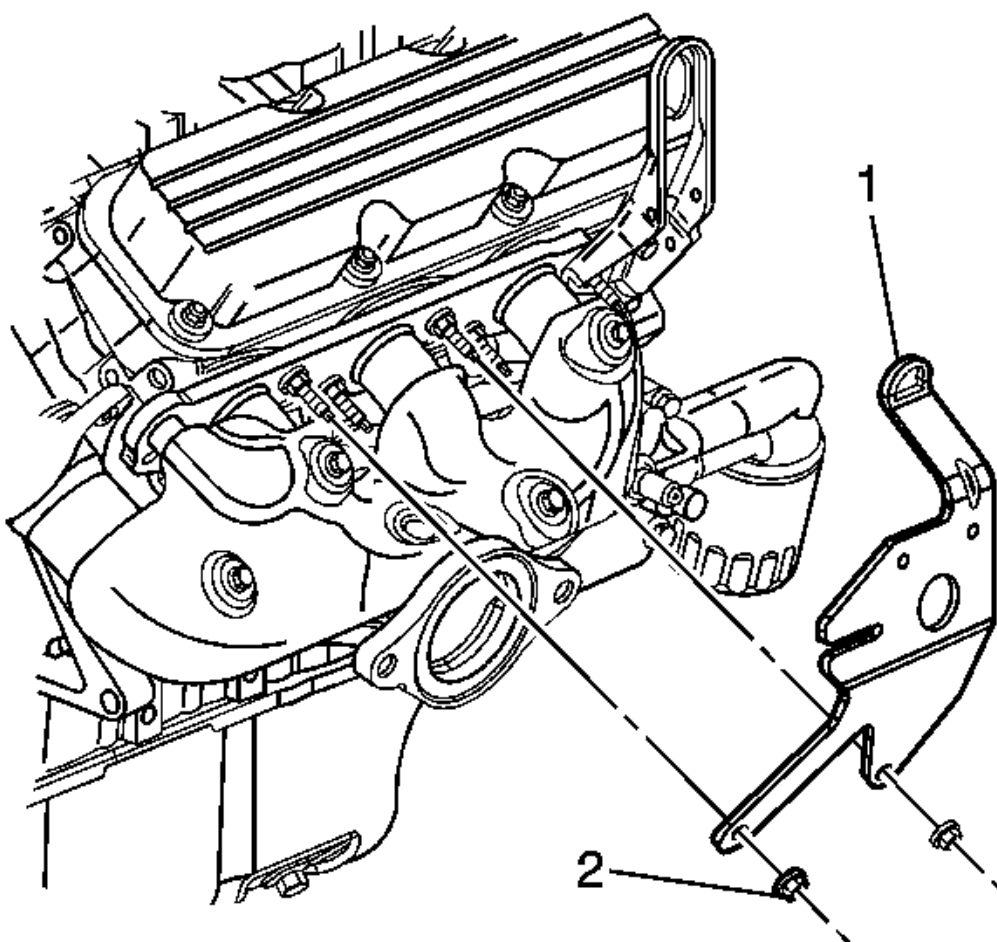


Fig. 123: Fuel Injector Sight Shield Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**

(L26) .

2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
4. Remove the right spark plug wires from the right spark plugs. Refer to **Spark Plug Replacement** .
5. Remove the fuel injector sight shield bracket nuts (2).
6. Remove the fuel injector sight shield bracket (1).

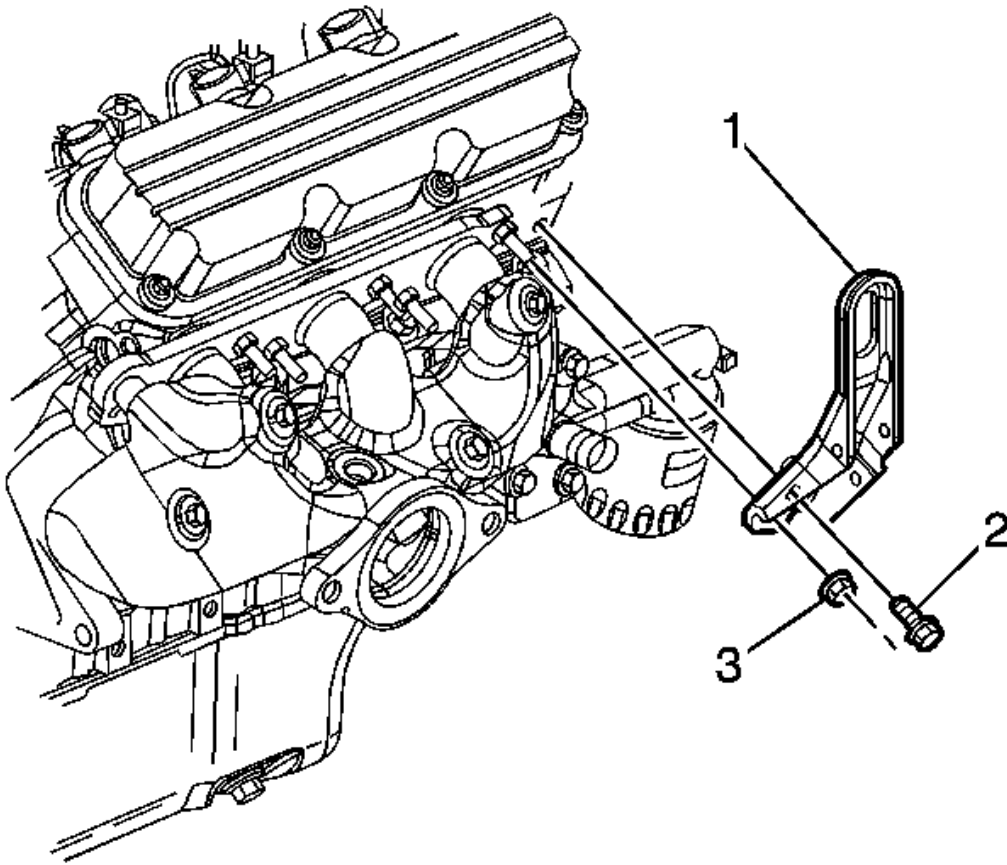


Fig. 124: Right Engine Lift Bracket Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the right engine lift bracket bolt (2) and the nut (3) from the engine lift bracket.
8. Remove the right engine lift bracket (1) from the exhaust manifold.

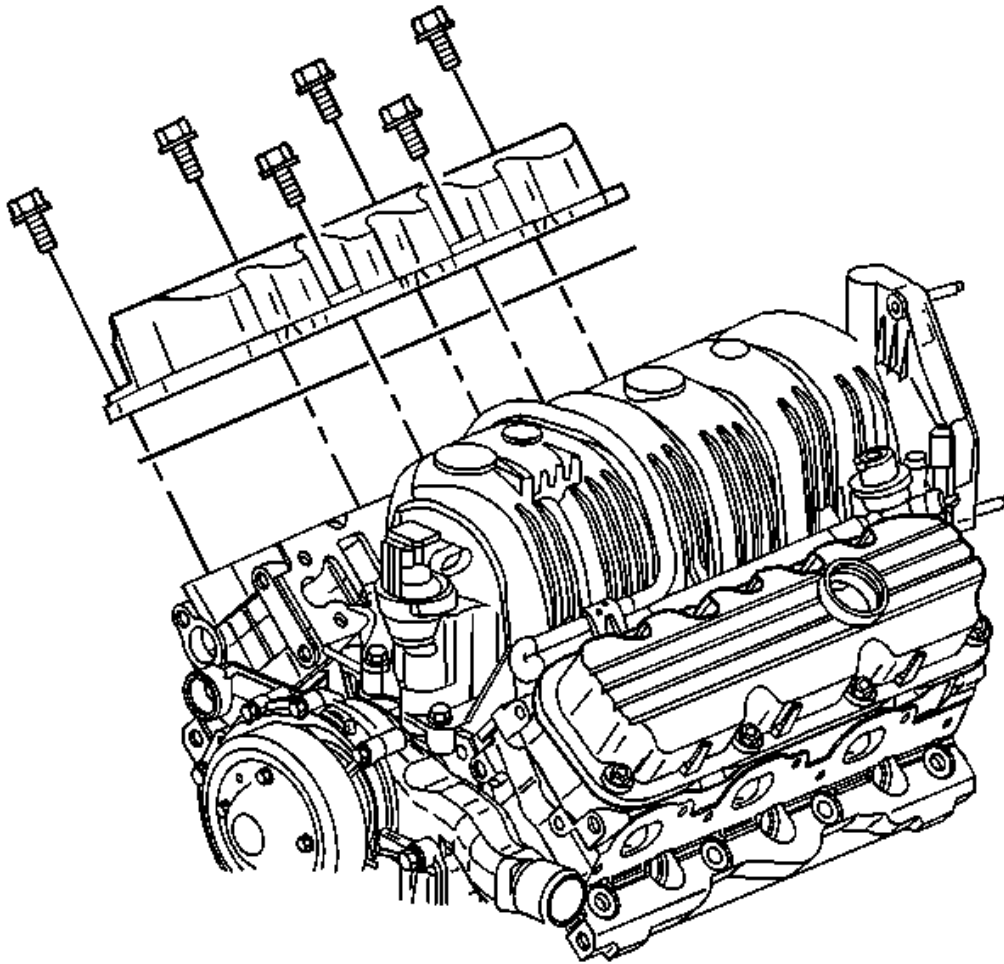


Fig. 125: View Of Right Side Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

9. Remove the right valve rocker arm cover bolts.

NOTE: If the valve rocker arm cover adheres to the cylinder head, remove the valve rocker arm cover by bumping the end of the valve rocker arm cover with the palm of your hand or a soft rubber mallet.

10. Remove the right valve rocker arm cover.
11. Remove the right valve rocker arm cover gasket.
12. Clean the valve rocker arm cover gasket mating surfaces.
13. Clean the valve rocker arm cover bolts of all thread locking adhesive.

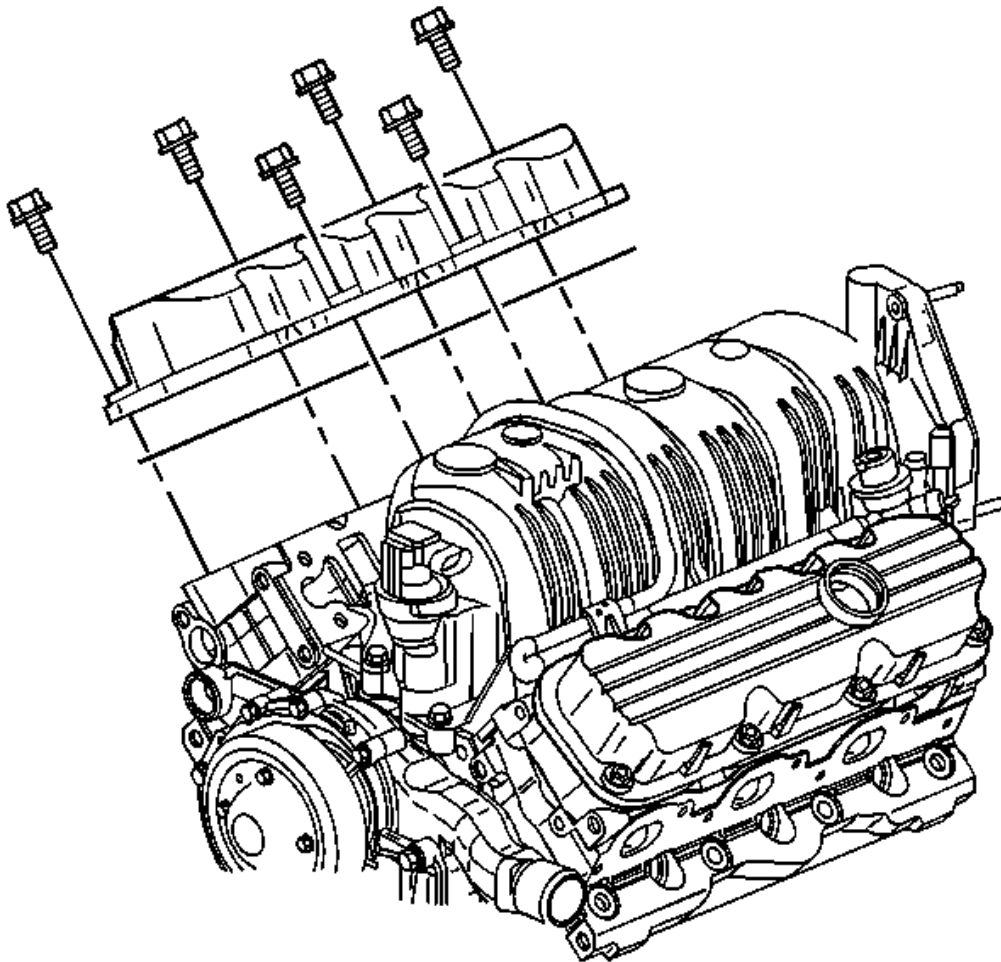
Installation Procedure

Fig. 126: View Of Right Side Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the valve rocker arm cover gasket is seated properly in the valve rocker arm cover groove.

1. Install the new valve rocker arm cover gasket.
2. Install the right valve rocker arm cover.
3. Apply threadlock compound to the valve rocker arm cover bolt threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

4. Install the right valve rocker arm cover bolts.

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

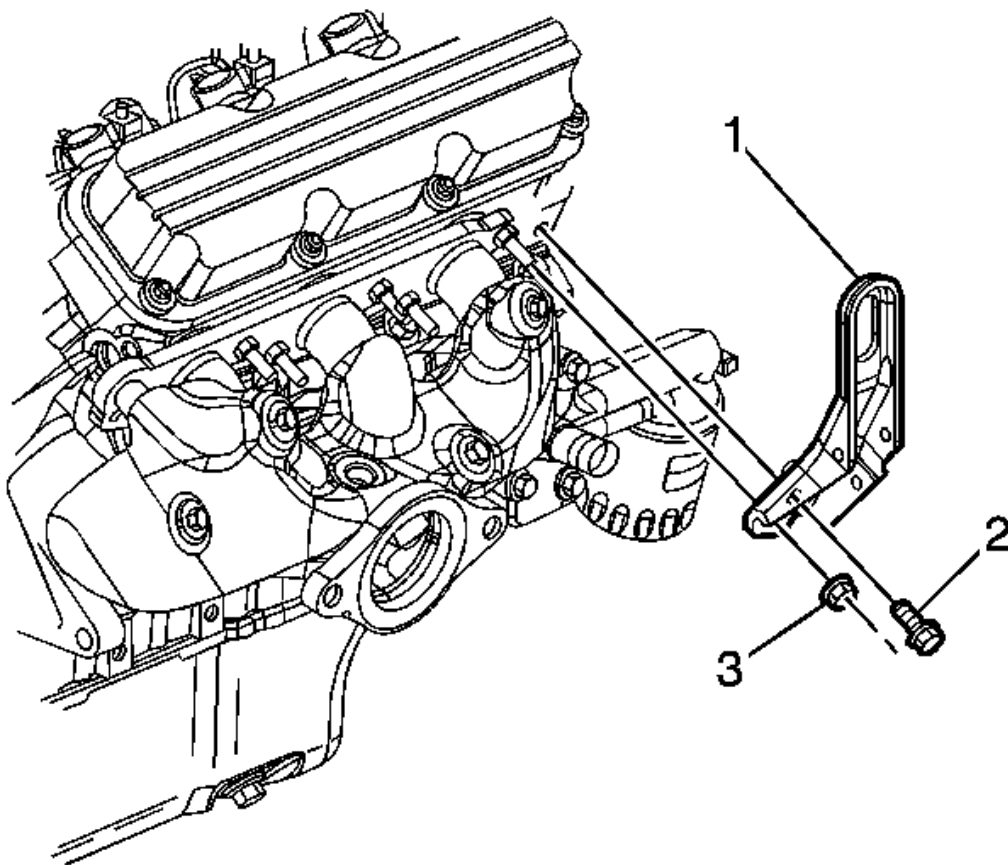


Fig. 127: Right Engine Lift Bracket Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

5. Install the right engine lift bracket (1) to the exhaust manifold.
6. Install the right engine lift bracket bolt (2) and the nut (3).

Tighten: Tighten the bolt and the nut to 30 N.m (22 lb ft).

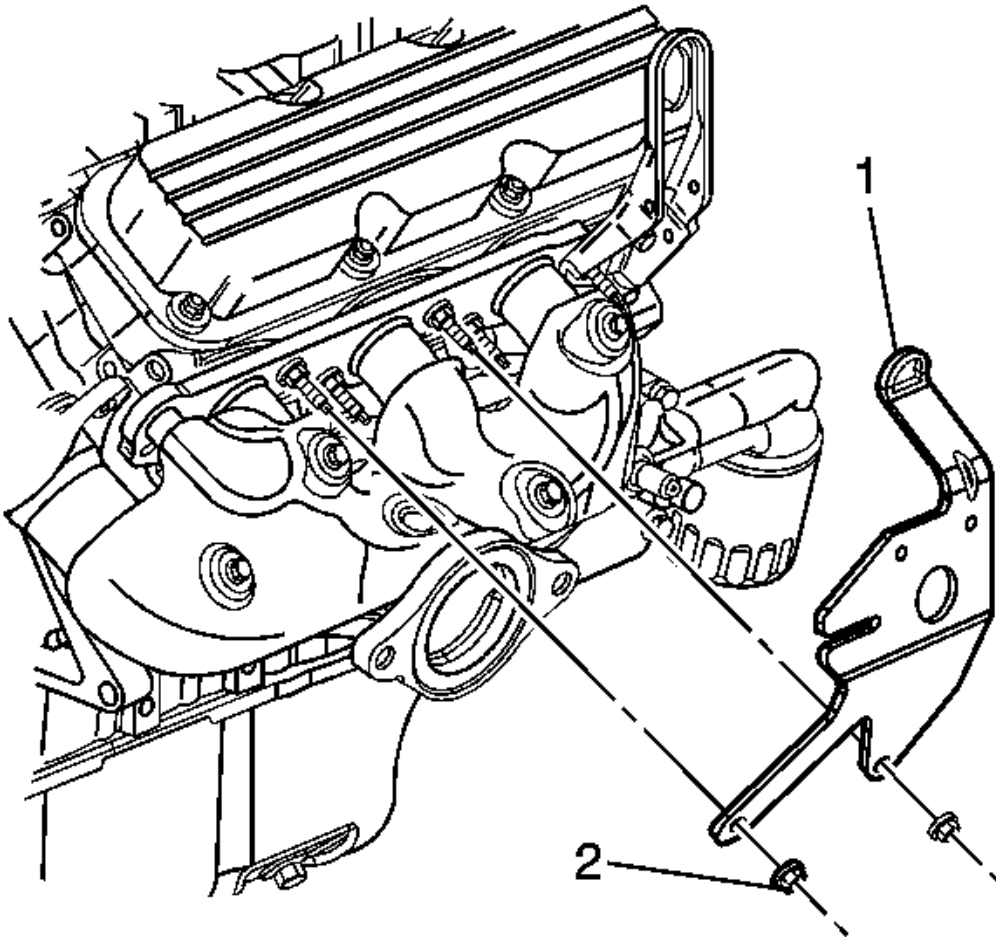


Fig. 128: Fuel Injector Sight Shield Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Install the fuel injector sight shield bracket (1) to the exhaust manifold.
8. Install the fuel injector sight shield bracket nuts (2).

Tighten: Tighten the nuts to 30 N.m (22 lb ft).

9. Install the right spark plug wires to the right spark plugs. Refer to **Spark Plug Replacement** .
10. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
11. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .

13. Check and fill the crankcase as necessary.
14. Inspect for oil leaks.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

Special Tools

J 45059 Electronic Torque Angle Meter

Removal Procedure

1. Remove the left or the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

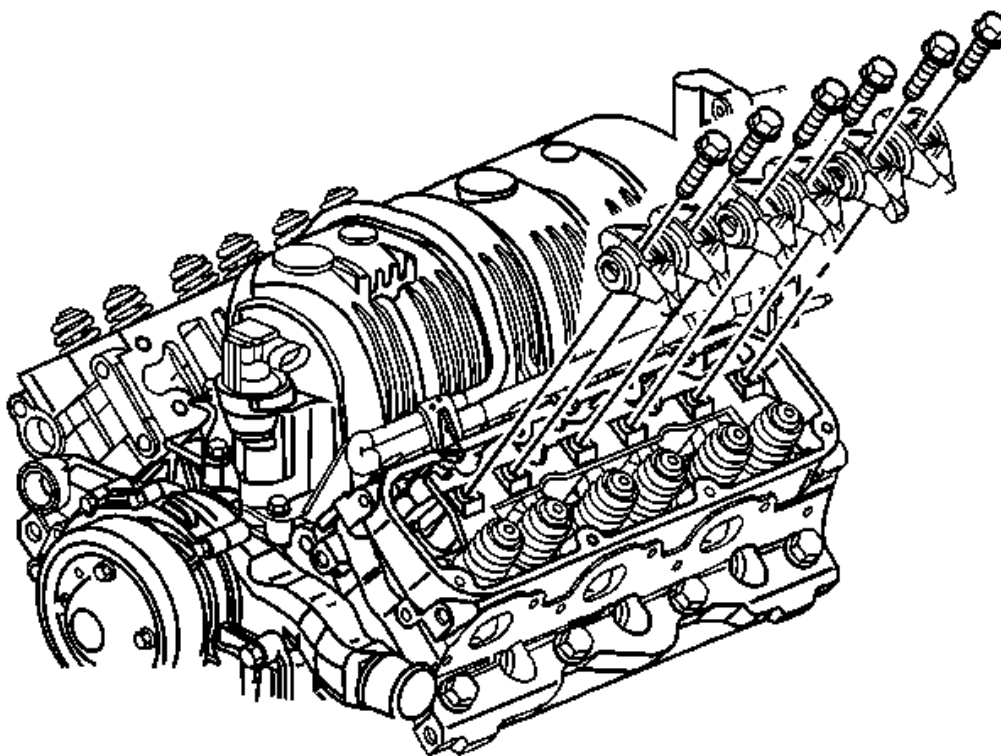


Fig. 129: Rocker Arm & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arm bolts.

NOTE: Place the parts on a clean surface. Store the components in order so they can be reassembled in the same location and with the same mating surfaces as when removed.

3. Remove the valve rocker arms.

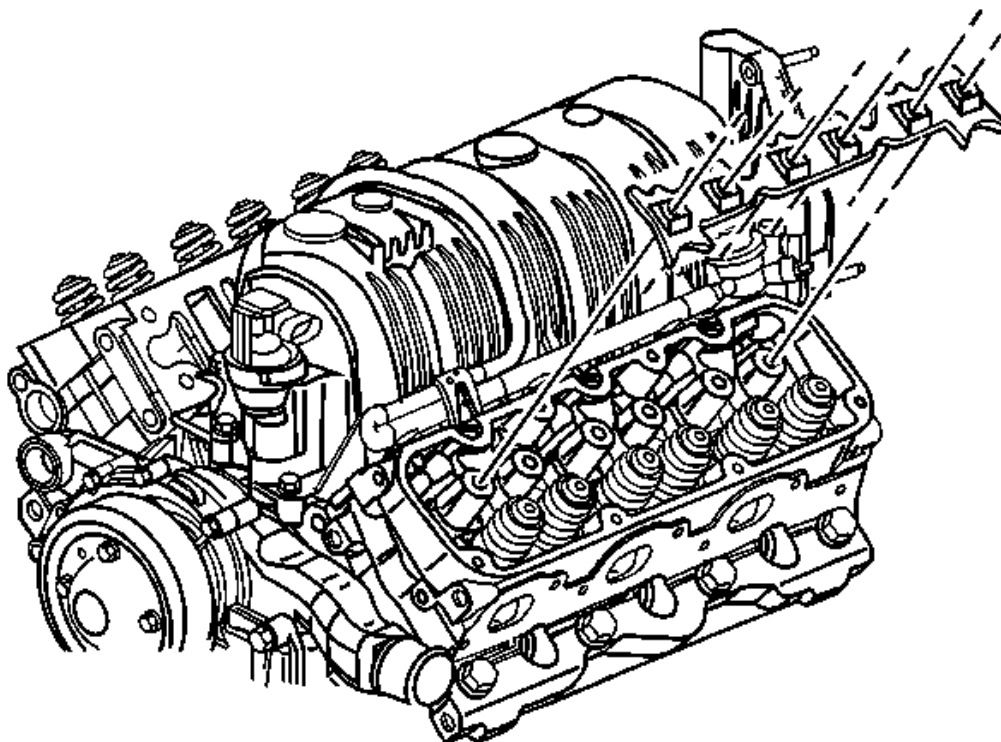


Fig. 130: Push Rod Guide Plates
Courtesy of GENERAL MOTORS CORP.

4. Remove the push rod guide plates if all the valve rocker arms are removed.

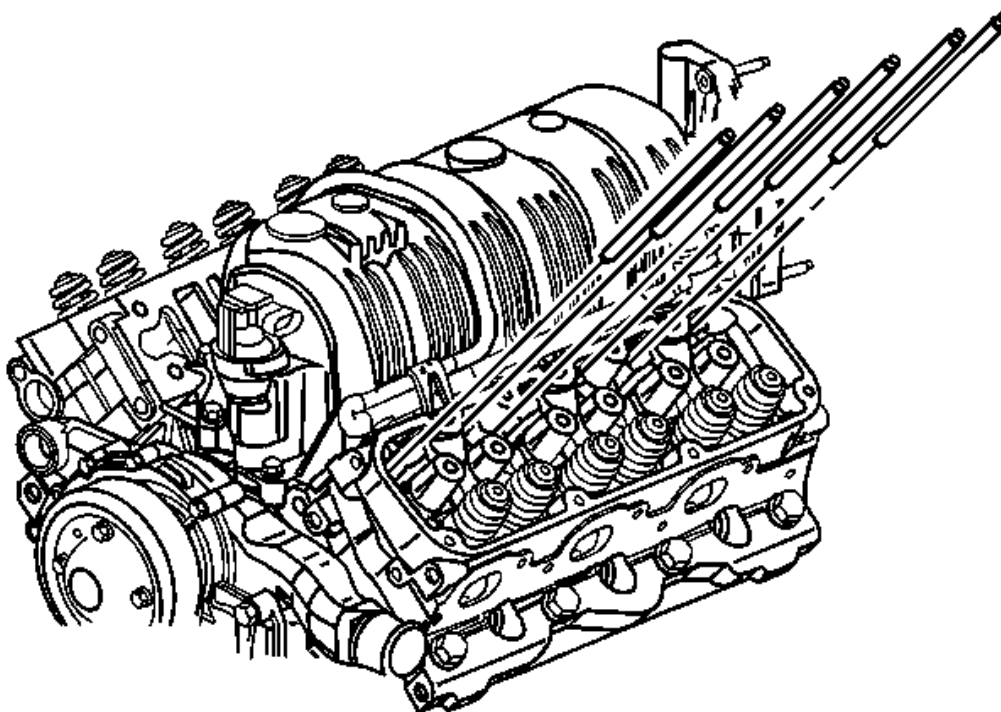


Fig. 131: Push Rods

Courtesy of GENERAL MOTORS CORP.

5. Remove the push rods.
6. Clean the push rods, the valve rocker arms, the bolts, and the guide plates.
7. Clean the valve rocker arm bolts of all thread adhesive.

Installation Procedure

1. Use compressed air in order to blow oil out of the tapped holes in the cylinder head.

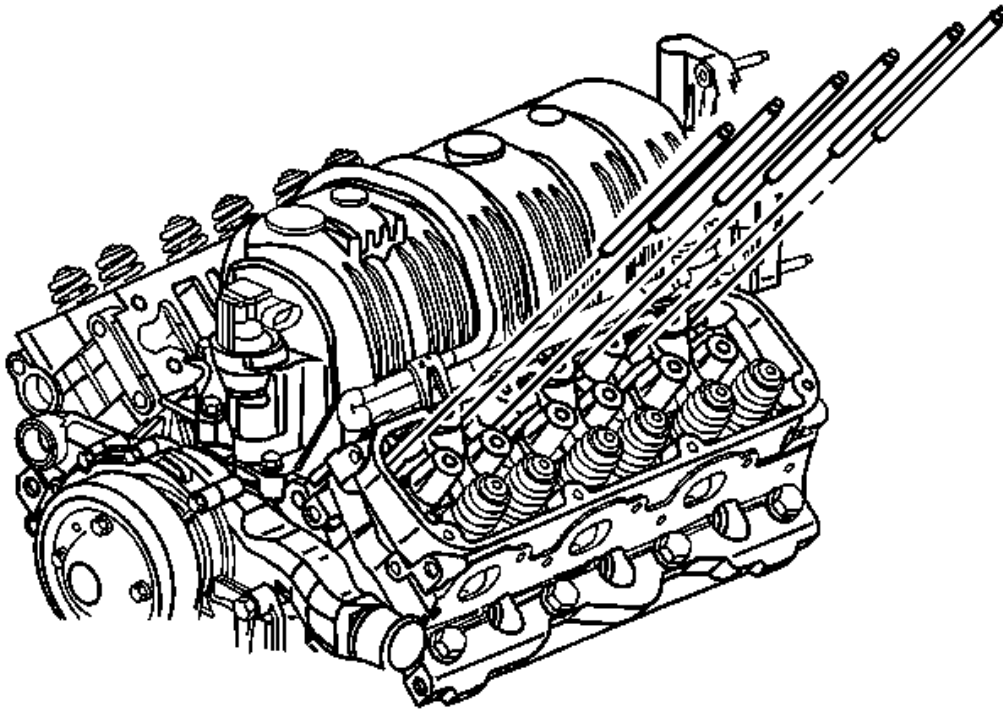


Fig. 132: Push Rods

Courtesy of GENERAL MOTORS CORP.

2. Lubricate the ends of the push rods with new engine oil.
3. Install the push rods to the same position on the cylinder head.

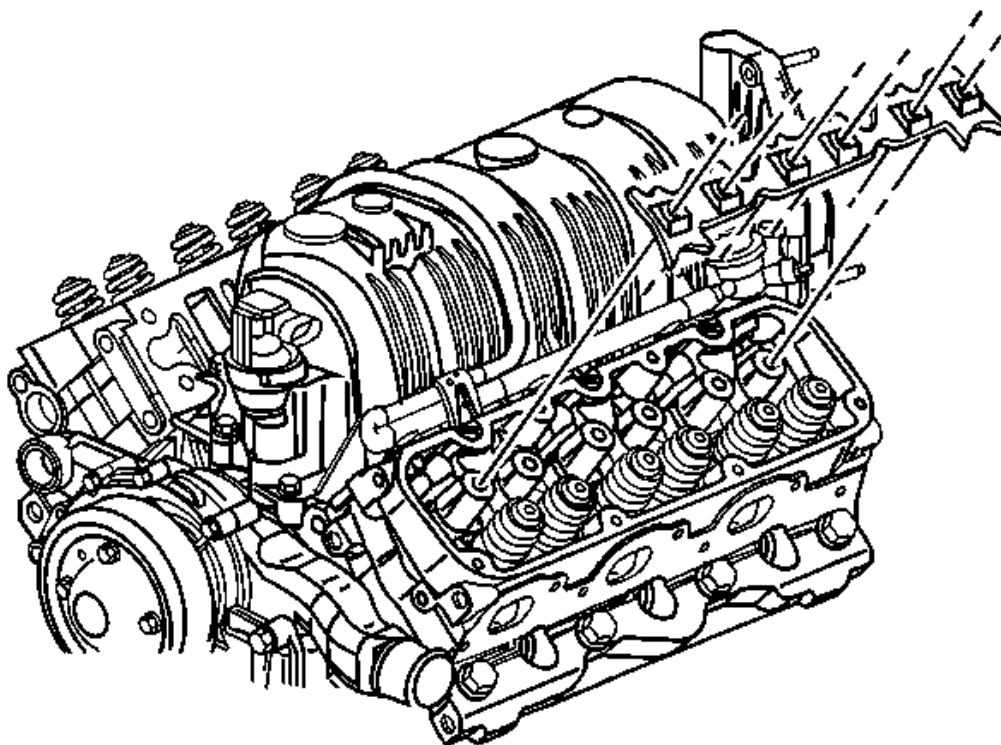


Fig. 133: Push Rod Guide Plates
Courtesy of GENERAL MOTORS CORP.

4. Install the push rod guide plates.

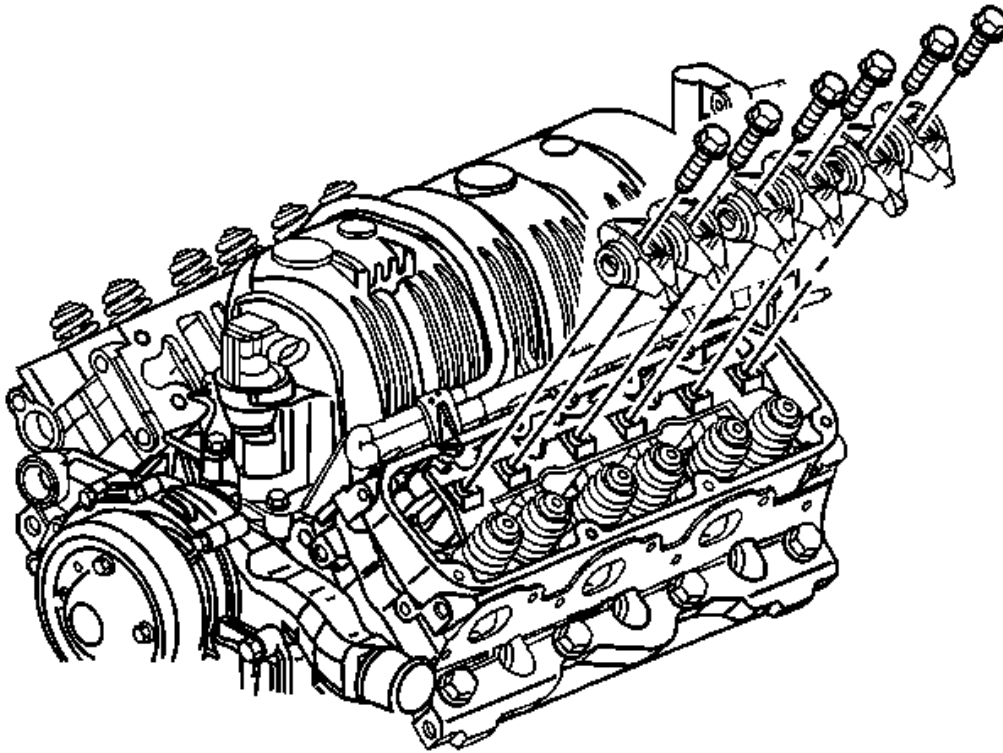


Fig. 134: Rocker Arm & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the valve rocker arms.

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

6. Apply threadlocker to the rocker arm bolt threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to **Fastener Caution** .

7. Install the valve rocker arm bolts.

Tighten:

1. Tighten the bolts to 15 N.m (11 lb ft).
 2. Use the **J 45059** to rotate the bolts an additional 90 degrees.
8. Install the left or the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.
 9. Inspect the valve train for noise.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT**Tools Required**

- **J 23590** Spark Plug Port Adapter. See **Special Tools**.
- **J 38606** Valve Spring Compressor
- **J 42863** Valve Stem Seal Installation Tool. See **Special Tools**.

Removal Procedure

1. Remove the left or the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

IMPORTANT: Rotate the engine so that the piston in the cylinder being worked on is at top dead center before removing the valve locks. This will eliminate the possibility of the valve accidentally falling inside the cylinder.

2. Remove the valve rocker arms and the push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Remove the spark plug. Refer to **Spark Plug Replacement**.

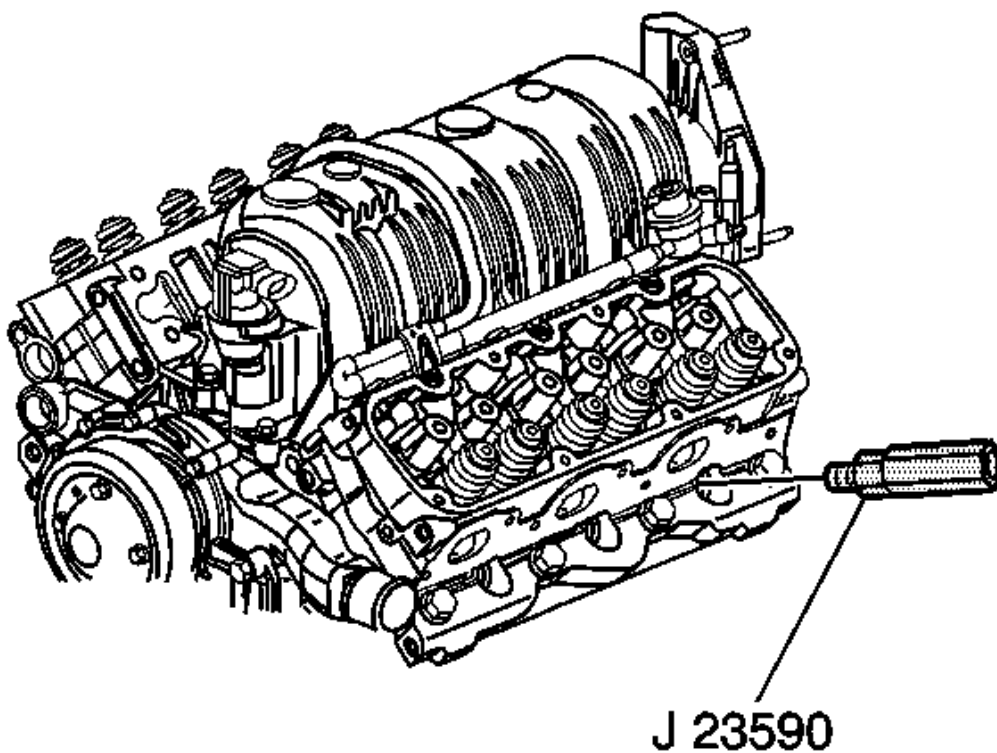


Fig. 135: J 23590 At Spark Plug Port
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 23590** to the spark plug port and apply compressed air in order to hold the valves closed. See Special Tools.

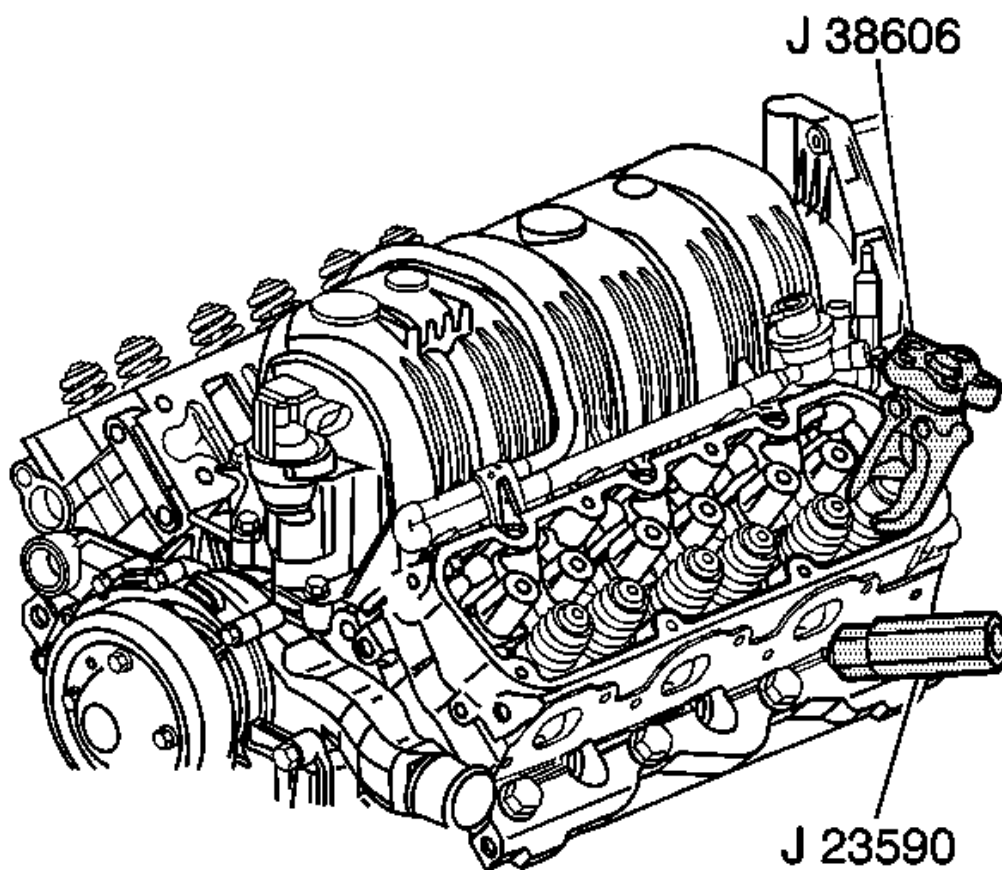


Fig. 136: J 38606 Installed On Valve Spring
Courtesy of GENERAL MOTORS CORP.

5. Install the **J 38606** on the valve spring.

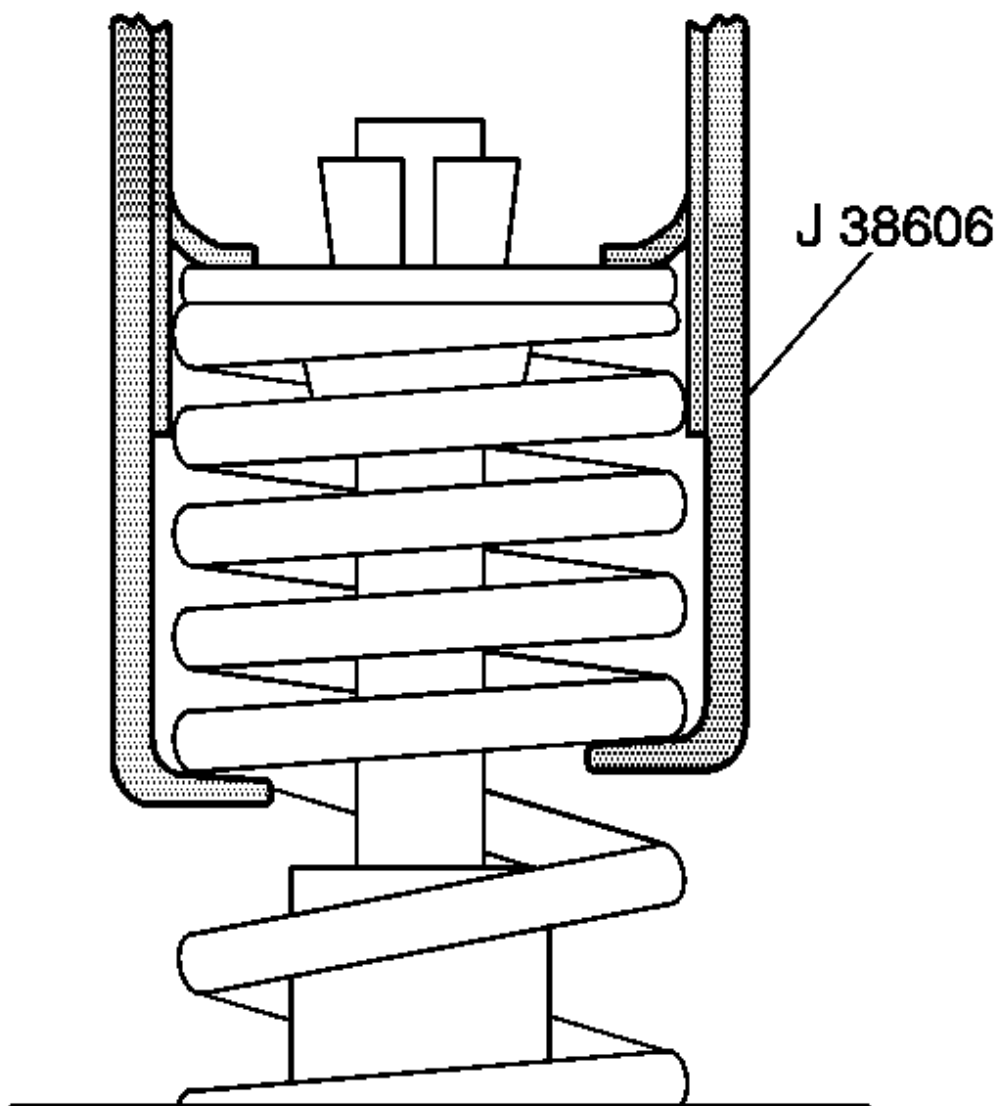


Fig. 137: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

6. Compress the valve spring using the **J 38606** .
7. Remove the valve locks.
8. Remove the valve spring and cap.

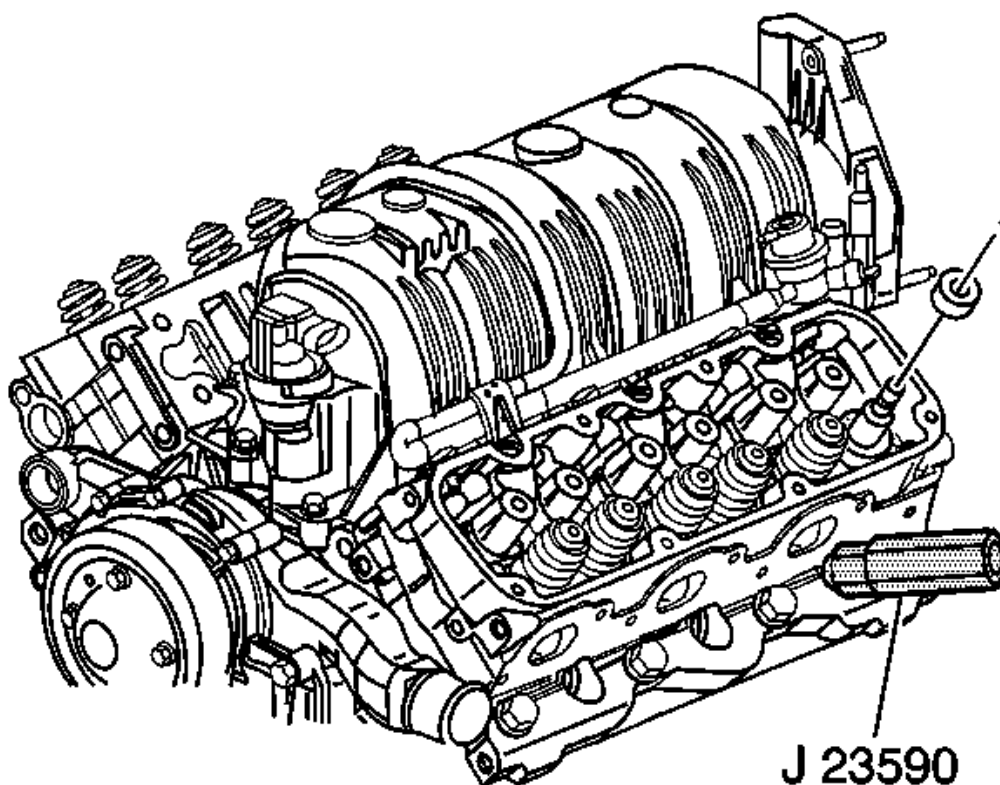


Fig. 138: Removing Valve Stem Oil Seal
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve stem oil seal.
10. Inspect the valve spring for bent, cracked, or broken parts. Replace the valve spring if damaged. Refer to Cylinder Head Cleaning and Inspection.

Installation Procedure

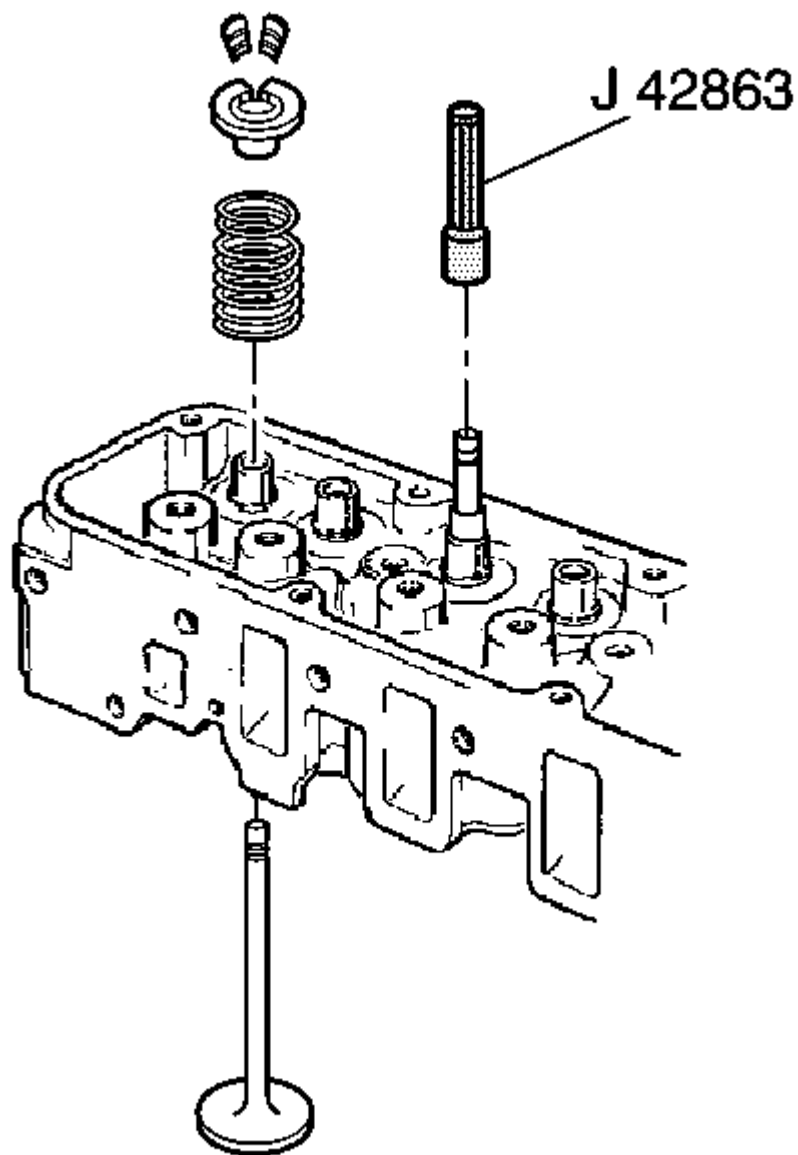


Fig. 139: Installing Valve Stem Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Use hand pressure to install the valve stem oil seal.
- The color of the replacement seal may not be the same color as the original seal. Install the seals in their correct location based on GM

part and package description. Make sure that the seal is fully seated on the valve guide.

1. Place the oil seal over the stem until the seal begins to contact the valve guide.
2. Use the **J 42863** to install the valve stem oil seal over the valve guide. See **Special Tools**.

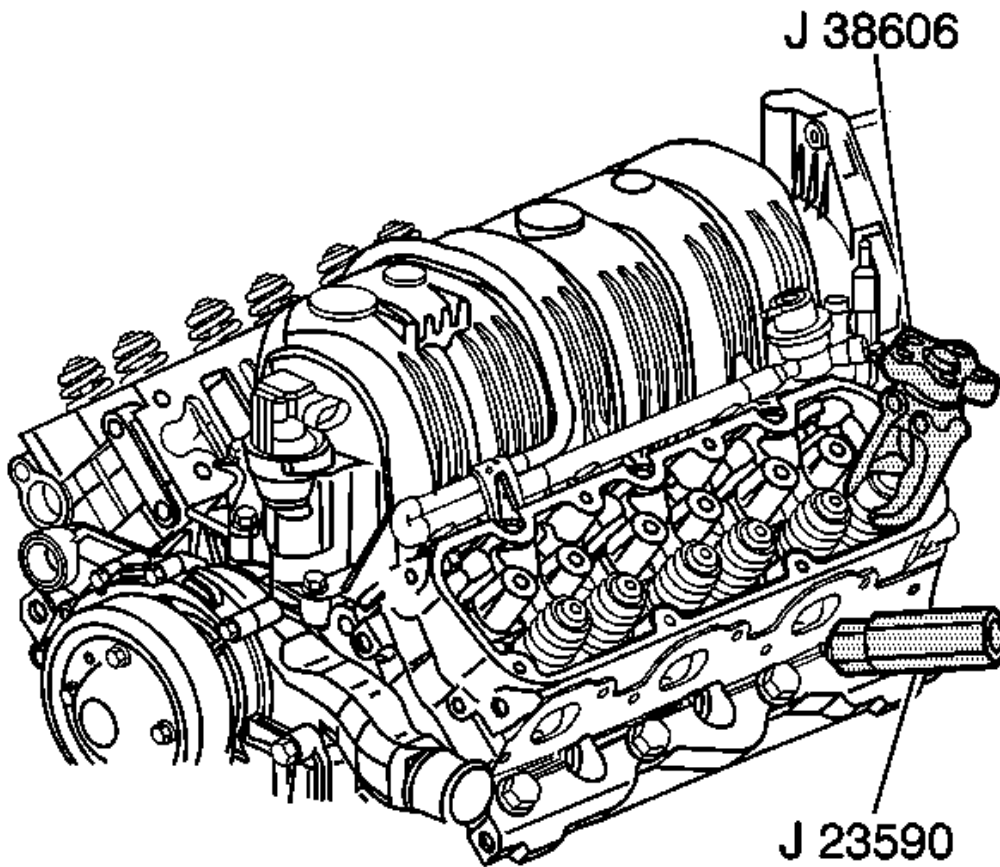


Fig. 140: J 38606 Installed On Valve Spring
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 38606** on the valve spring.

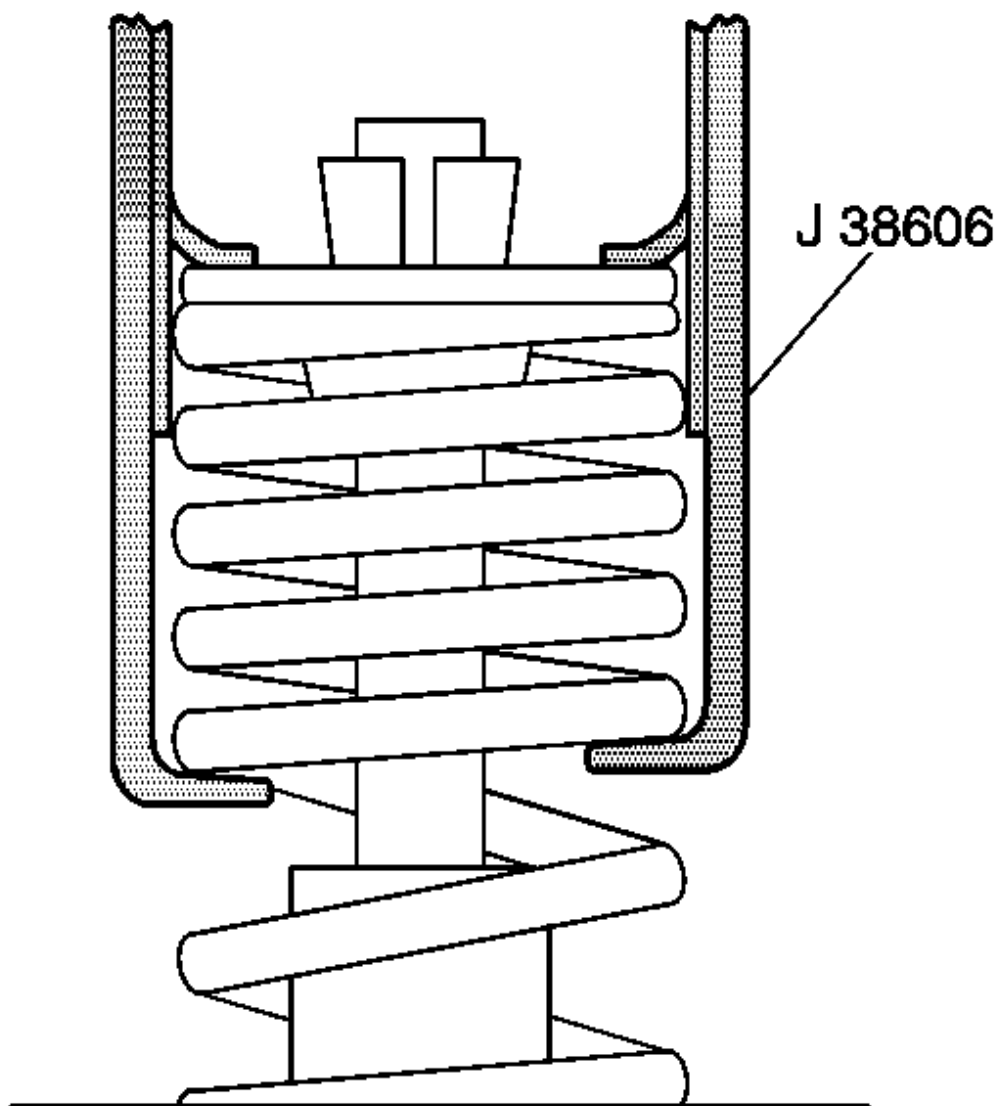


Fig. 141: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

4. Compress the valve spring using the **J 38606** . See **Special Tools**.
5. Install the valve spring and cap.
6. Install the valve locks.
7. Release the valve spring.

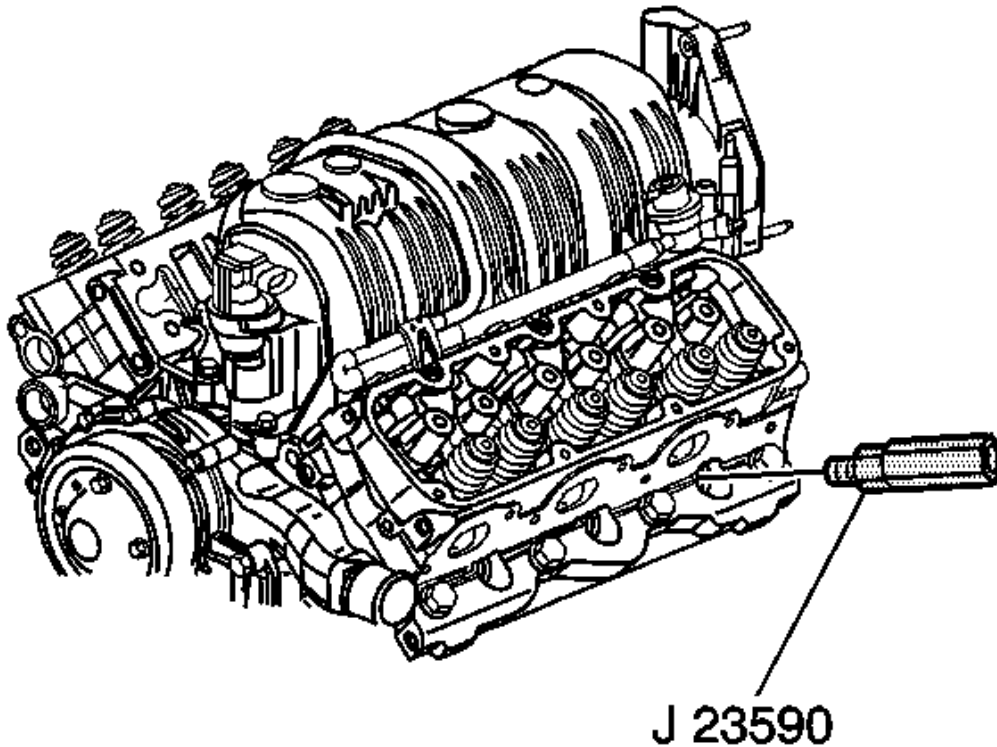


Fig. 142: J 2359 At Spark Plug Port
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure that the valve locks are seated.

8. Release the air pressure, and remove the **J 2359** . See Special Tools.
9. Install the spark plug. Refer to Spark Plug Replacement .
10. Install the push rods and the valve rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement.
11. Install the left or the right valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.

VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the left or the right valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left Side or Valve Rocker Arm Cover Replacement - Right Side.

2. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.

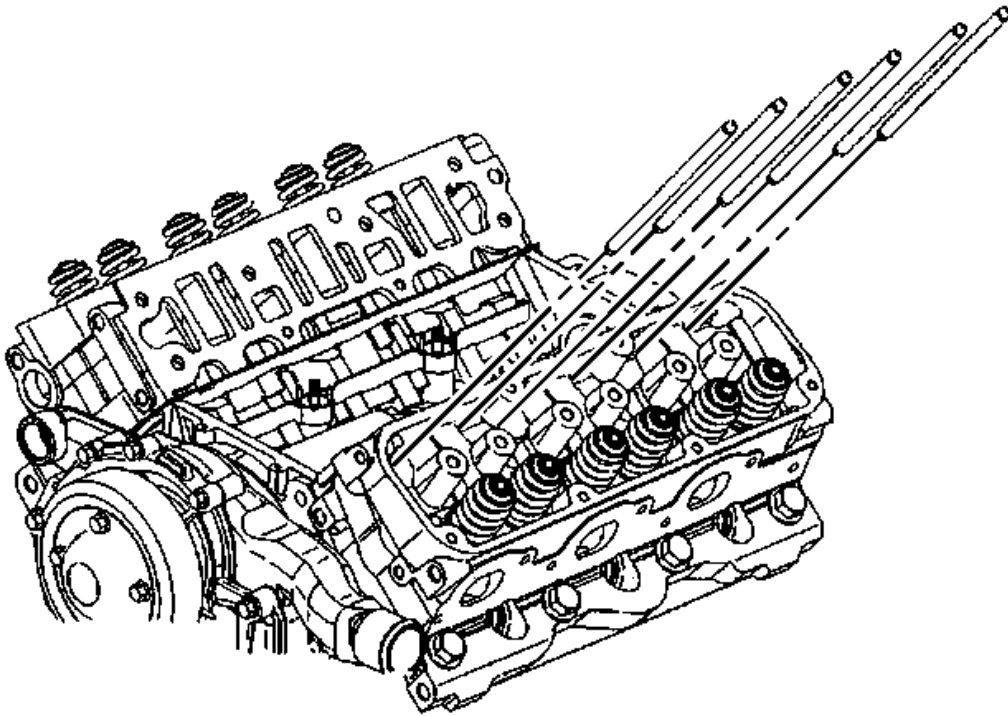


Fig. 143: Push Rods

Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that all the valve train parts are kept in order so that they can be reinstalled in their original locations and with the same mating surfaces as when removed.

3. Remove the rocker arm bolts, the valve rocker arms, the push rods and the push rod guide plates. Refer to **Valve Rocker Arm and Push Rod Replacement**.

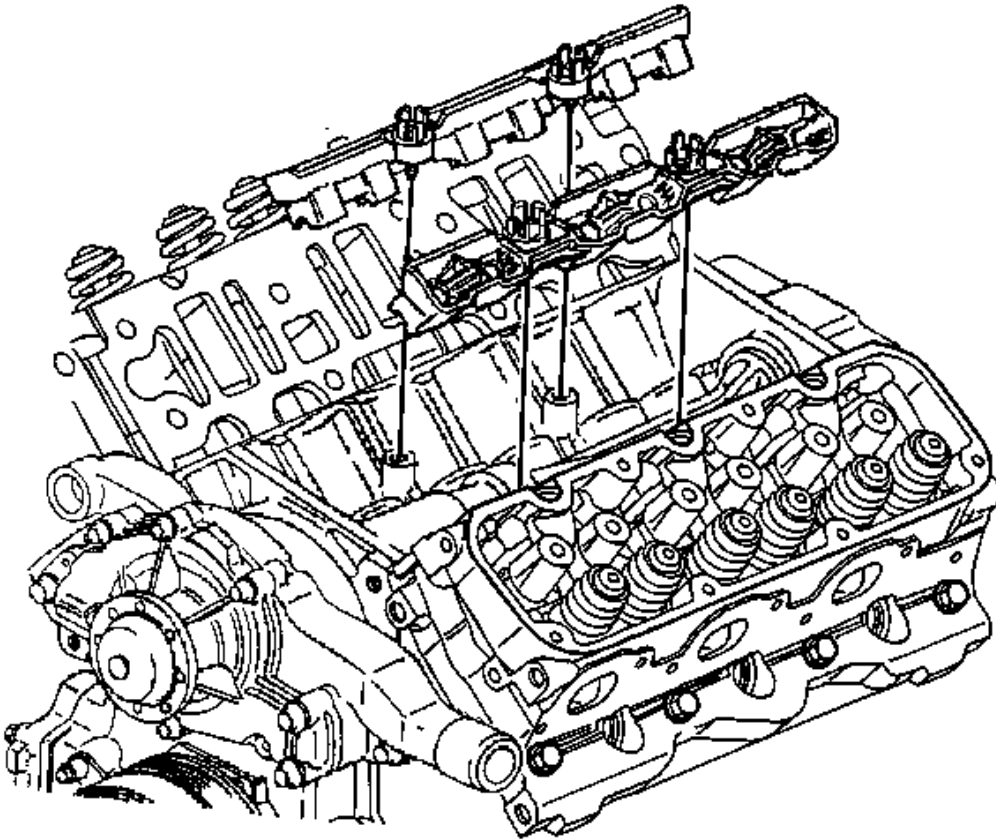


Fig. 144: Valve Lifter Guides
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve lifter guide bolts.
5. Remove the valve lifter guides.
6. Remove the valve lifters.
7. Clean all the gasket mating surfaces.
8. Clean the valve train parts.

Installation Procedure

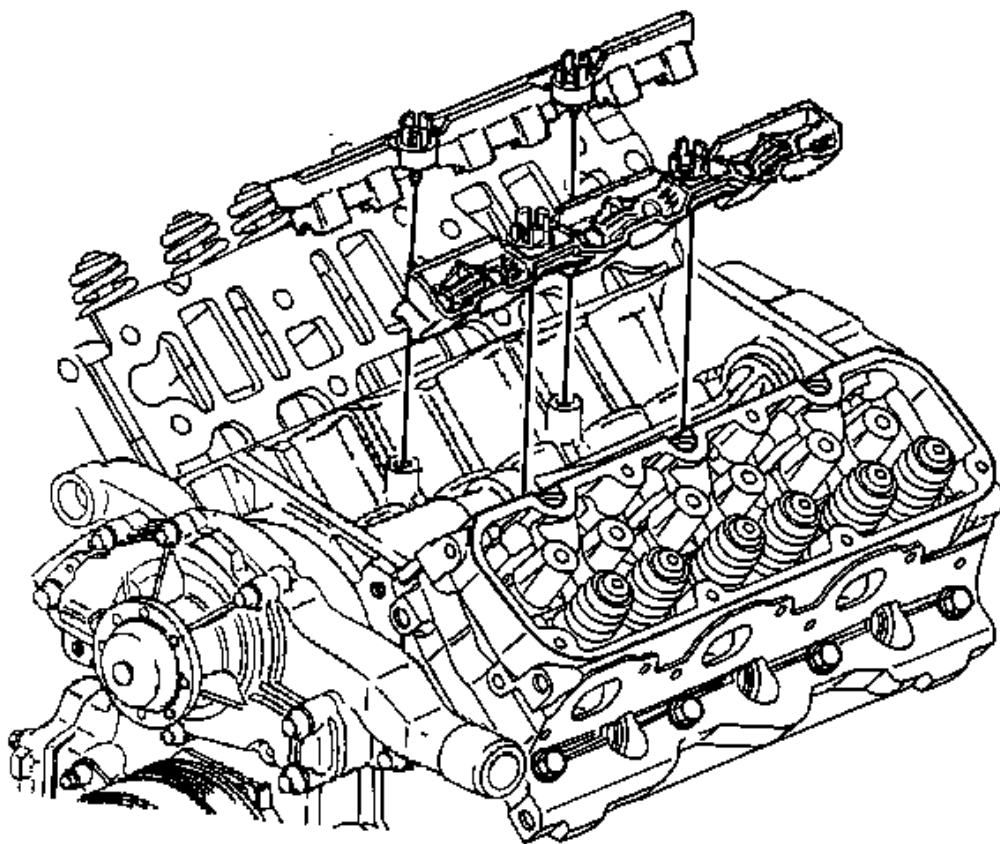


Fig. 145: Valve Lifter Guides

Courtesy of GENERAL MOTORS CORP.

1. Dip the valve lifters in prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
2. Install the valve lifters to the same position the valve lifters were removed.
3. Install the valve lifter guides.

CAUTION: Refer to **Fastener Caution** .

4. Install the valve lifter guide bolts.

Tighten: Tighten the bolts to 30 N.m (22 lb ft).

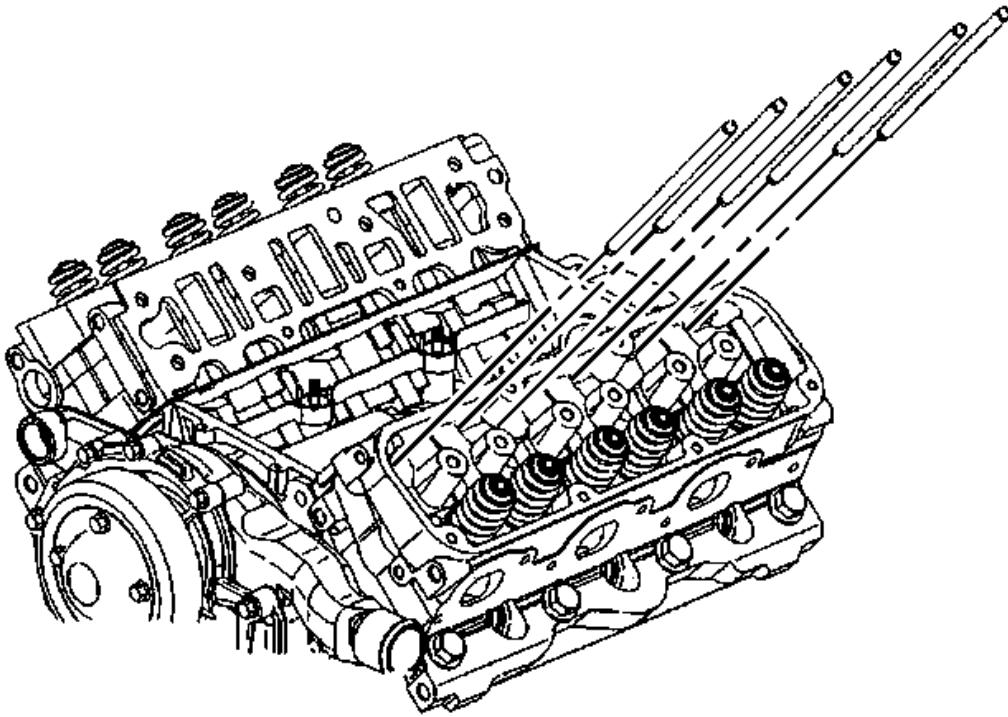


Fig. 146: Push Rods

Courtesy of GENERAL MOTORS CORP.

5. Install the push rod guide plates, the push rods, the valve rocker arms, and the bolts. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
7. Install the left or the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **J 37096** Flywheel Holder. See **Special Tools**.
- **J 38197-A** Crankshaft Balancer Remover. See **Special Tools**.
- **J 45059** Electronic Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**

(L26) .

2. Remove the drive belt. Refer to **Drive Belt Replacement (L26)**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

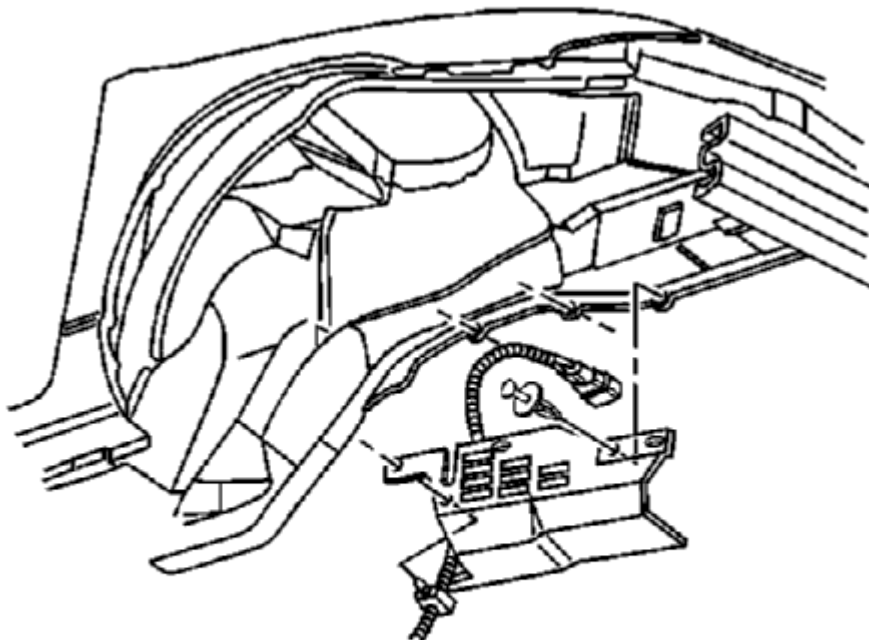


Fig. 147: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS CORP.

5. Remove the right engine splash shield retainers and the engine splash shield.
6. Remove the torque converter covers. Refer to **Torque Converter Cover Replacement** .

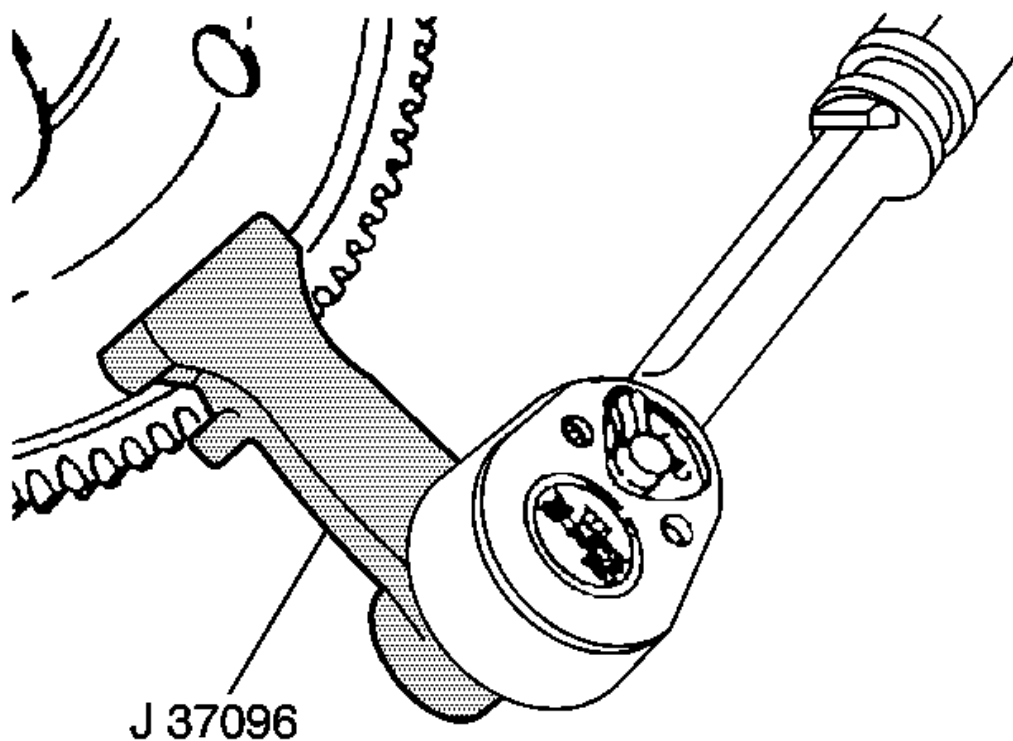


Fig. 148: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

7. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools**.

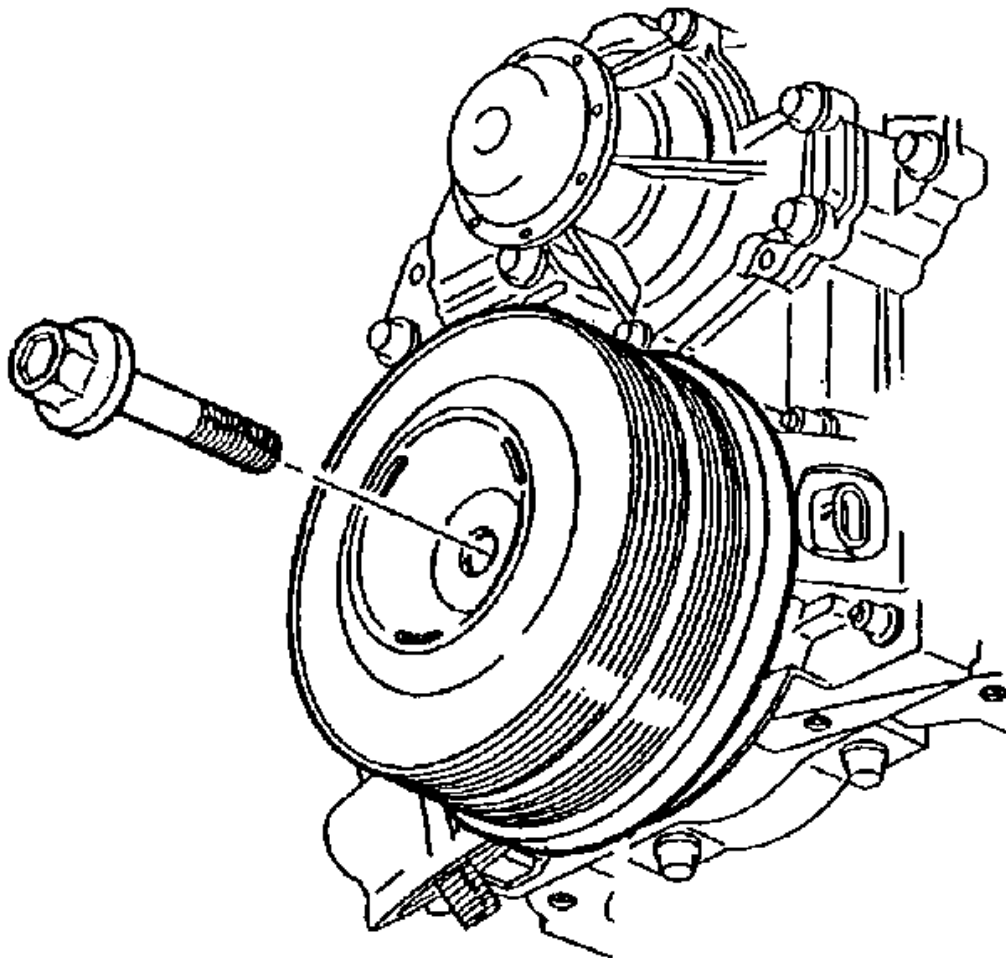


Fig. 149: Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft balancer bolt and discard the balancer bolt.

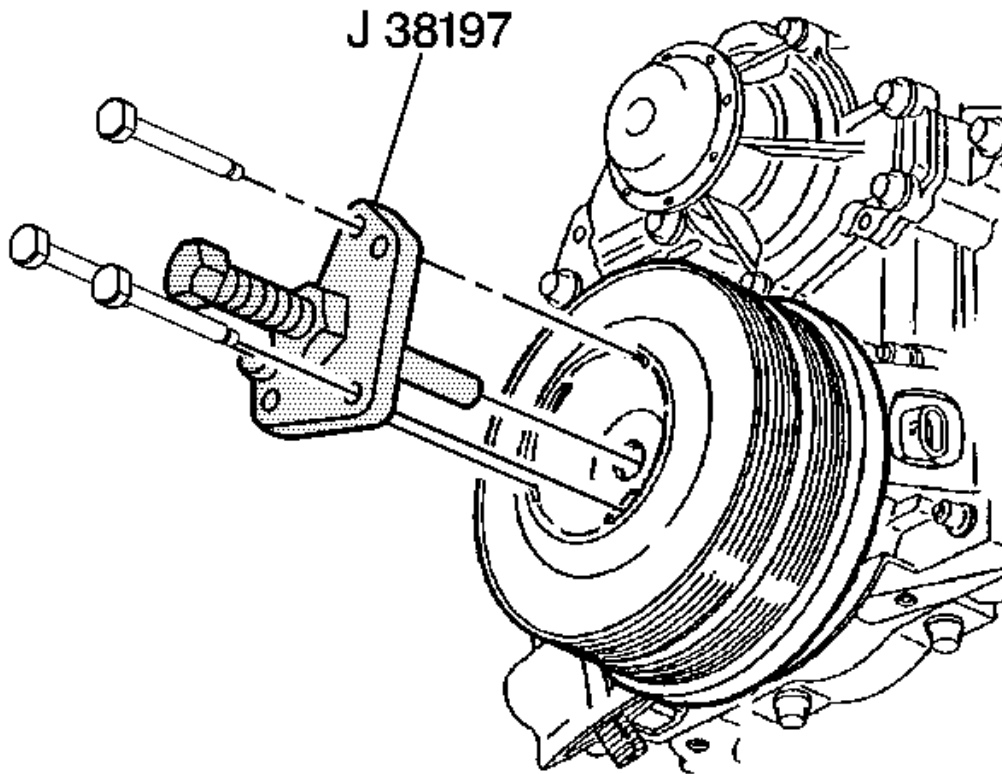


Fig. 150: Removing Crankshaft Balancer Using J 38197-A
Courtesy of GENERAL MOTORS CORP.

NOTE:

**Do not separate the crankshaft pulley from the crankshaft balancer.
Service the crankshaft pulley and the crankshaft balancer as an assembly.**

9. Install the **J 38197-A** . See Special Tools.
10. Remove the crankshaft balancer.
11. Remove the **J 38197-A** . See Special Tools.

Installation Procedure

1. Coat the engine front cover seal contact area on the crankshaft balancer, and the seal surface with engine oil.

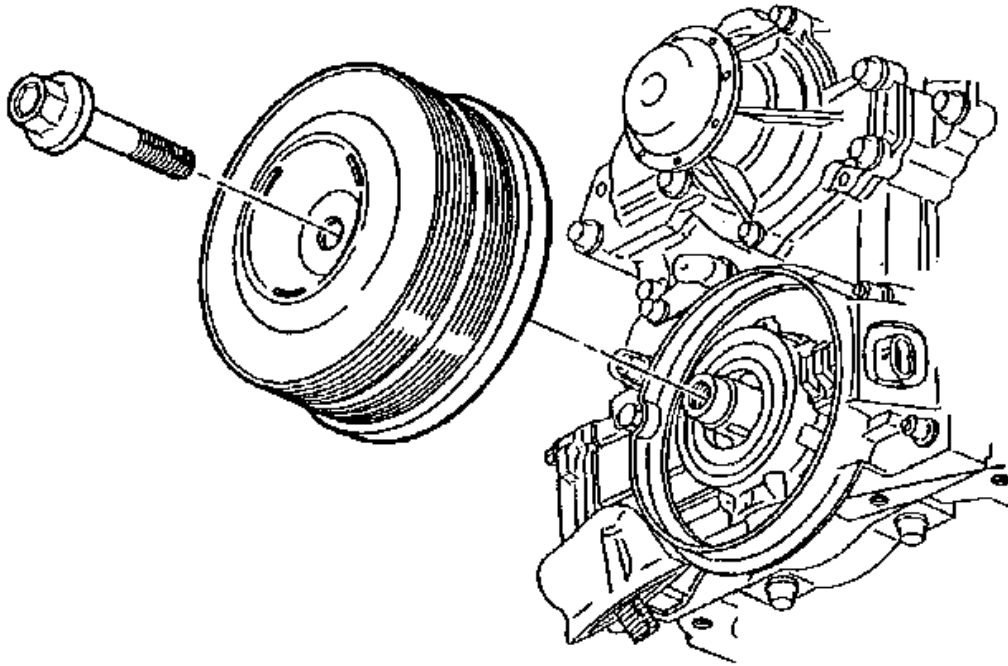


Fig. 151: Installing Crankshaft Balancer Using J 37096
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft balancer.
3. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools**.

CAUTION: Refer to **Fastener Caution** .

4. Install the new crankshaft balancer bolt.

Tighten:

1. Tighten the bolt to 150 N.m (111 lb ft).
 2. Use the **J 45059** to rotate the bolt an additional 76 degrees.
5. Remove the **J 37096** . See **Special Tools**.
 6. Install the torque converter covers. Refer to **Torque Converter Cover Replacement** .

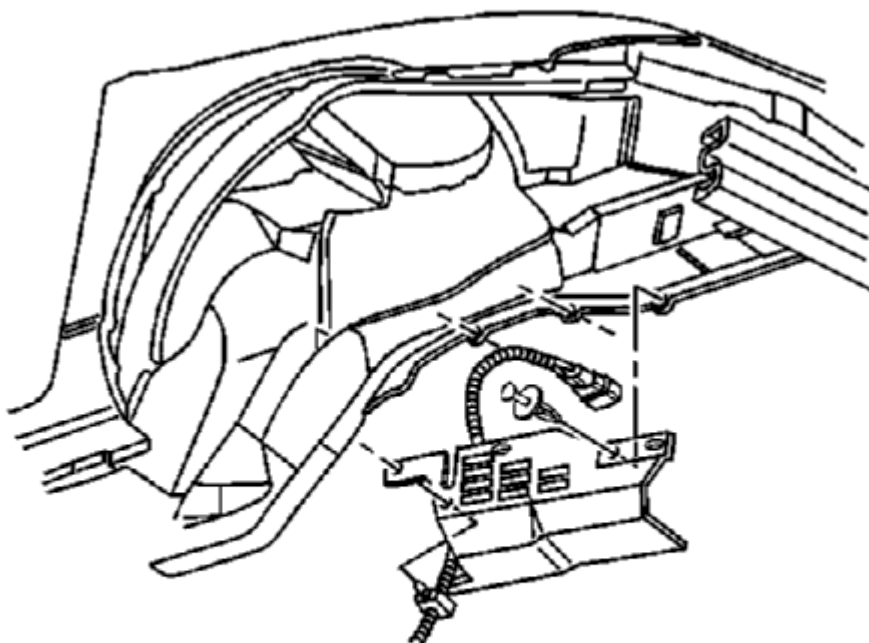


Fig. 152: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS CORP.

7. Install the right engine splash shield and the engine splash shield retainers.
8. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.
10. Install the drive belt. Refer to **Drive Belt Replacement (L26)**.
11. Perform the CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

J 35354-A Seal Installer. See **Special Tools**.

Removal Procedure

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

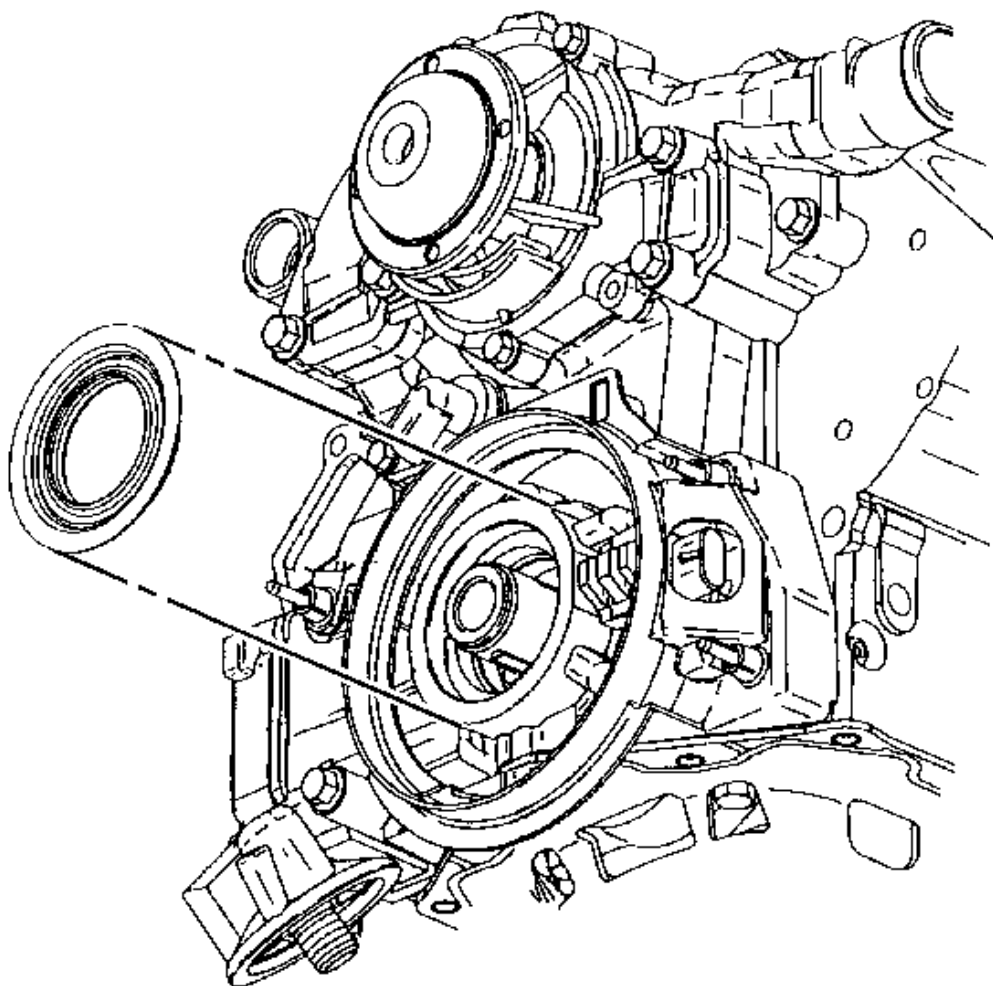


Fig. 153: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be careful not to damage the crankshaft.

2. Pry out the crankshaft front oil seal with a flat bladed tool such as a large screwdriver. Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.
3. Inspect the crankshaft balancer and engine front cover for scratches.

Installation Procedure

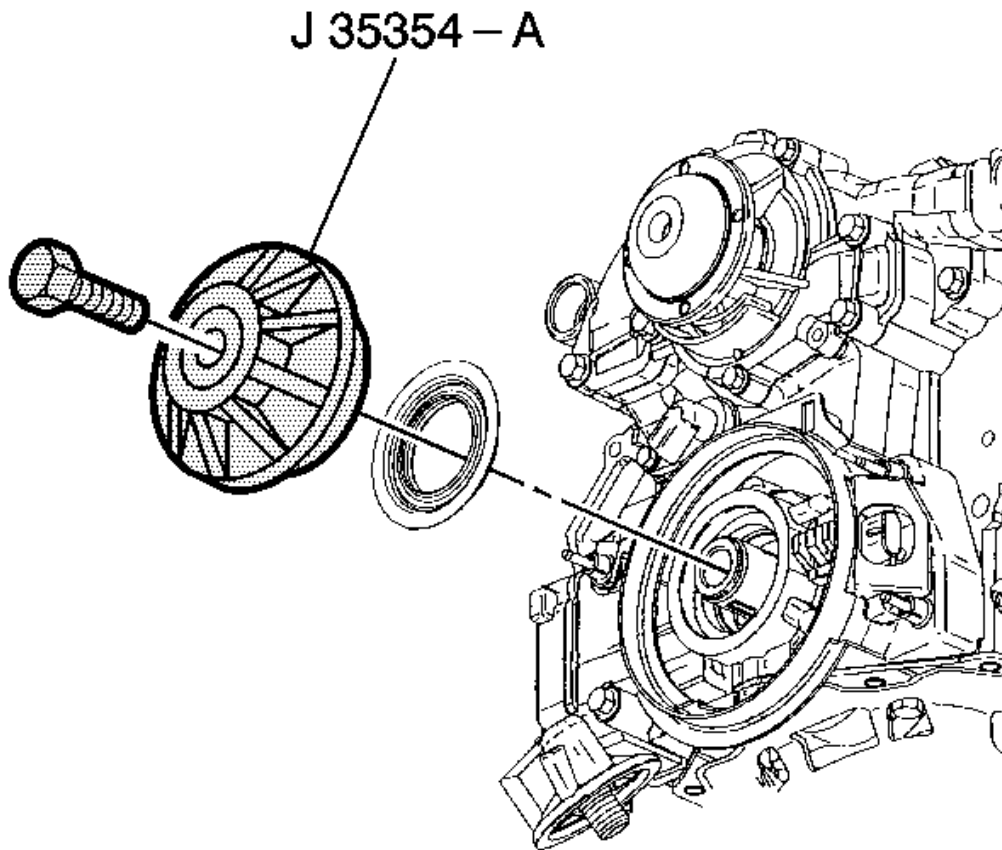


Fig. 154: Installing Crankshaft Front Oil Seal Using J 35354-A
 Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft front oil seal in the engine front cover using the **J 35354-A** . See **Special Tools**.
2. Tighten the bolt until the crankshaft front oil seal is seated in the engine front cover.
3. Remove the **J 35354-A** . See **Special Tools**.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
5. Inspect for leaks.
6. Perform the CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

ENGINE FRONT COVER REPLACEMENT

Special Tools

J 35354-A Seal Installer. See **Special Tools**.

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
5. Lower the vehicle.
6. Loosen the water pump pulley bolts.
7. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
8. Remove the water pump pulley.

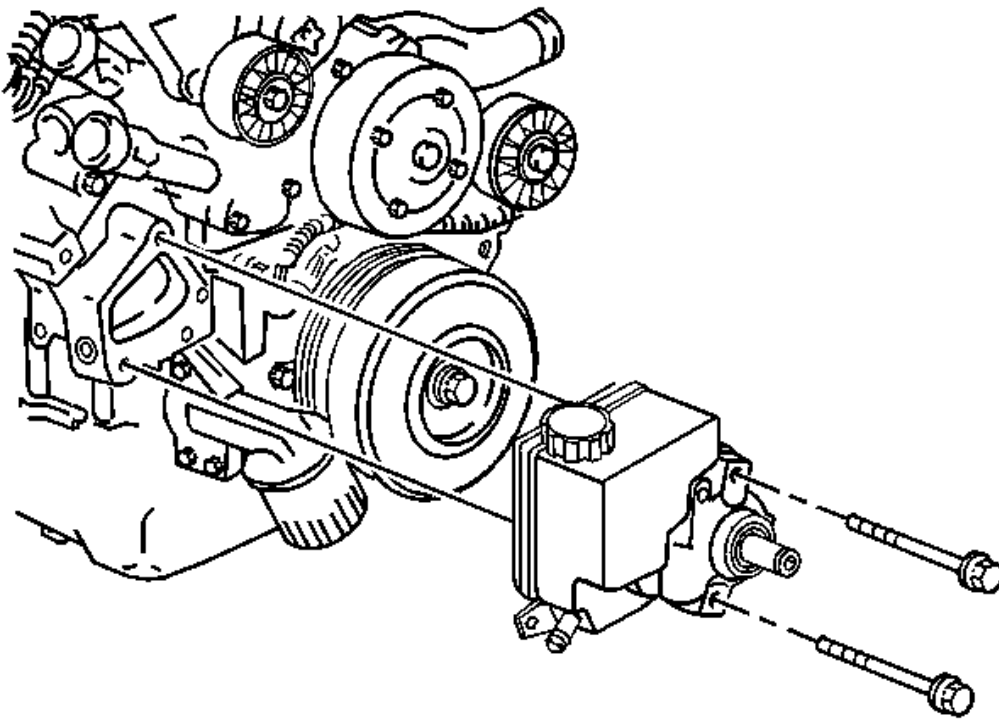


Fig. 155: View Of Power Steering Pump And Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the power steering pump bolts and reposition the pump.
10. Raise the vehicle.

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

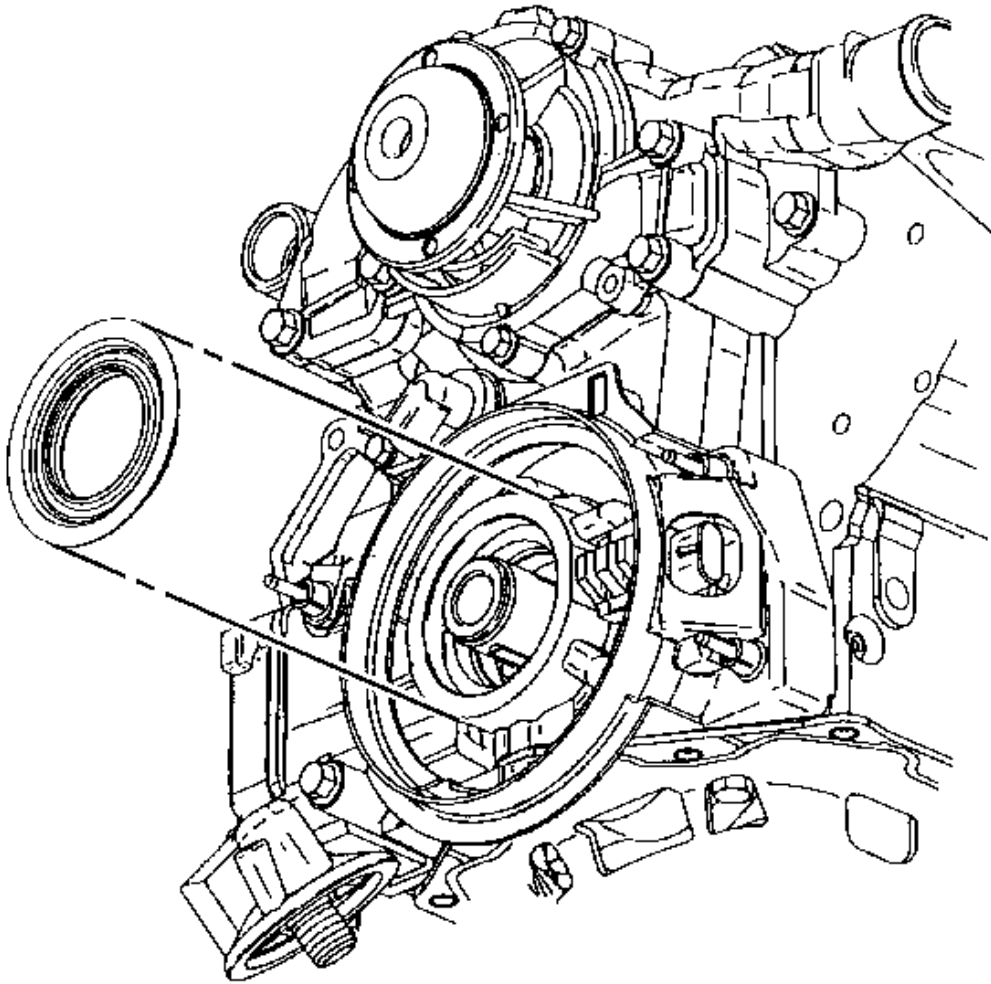


Fig. 156: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the crankshaft.

12. Pry out the crankshaft front oil seal with a flat-bladed tool such as a large screwdriver. Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.
13. Disconnect the electrical connectors from the following:
- Camshaft position (CMP) sensor

- Crankshaft position (CKP) sensor
- Oil pressure sensor

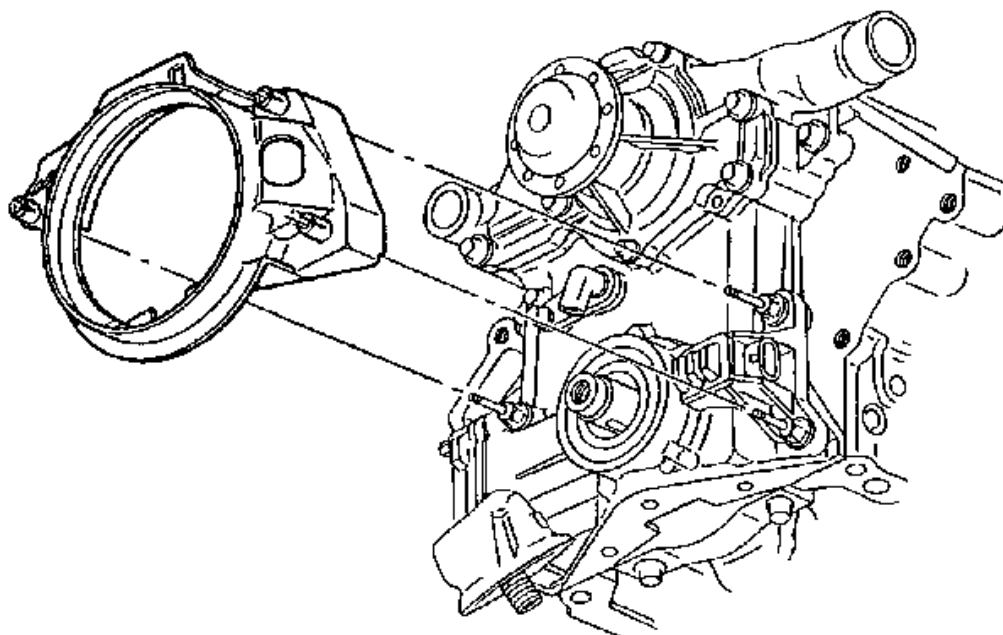


Fig. 157: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS CORP.

14. Remove the crankshaft position sensor shield.
15. Remove the radiator outlet hose from the water pump. Refer to **Radiator Outlet Hose Replacement (L26)**.
16. Lower the vehicle.
17. Install the engine support fixture. Refer to **Engine Support Fixture**.
18. Raise the vehicle.

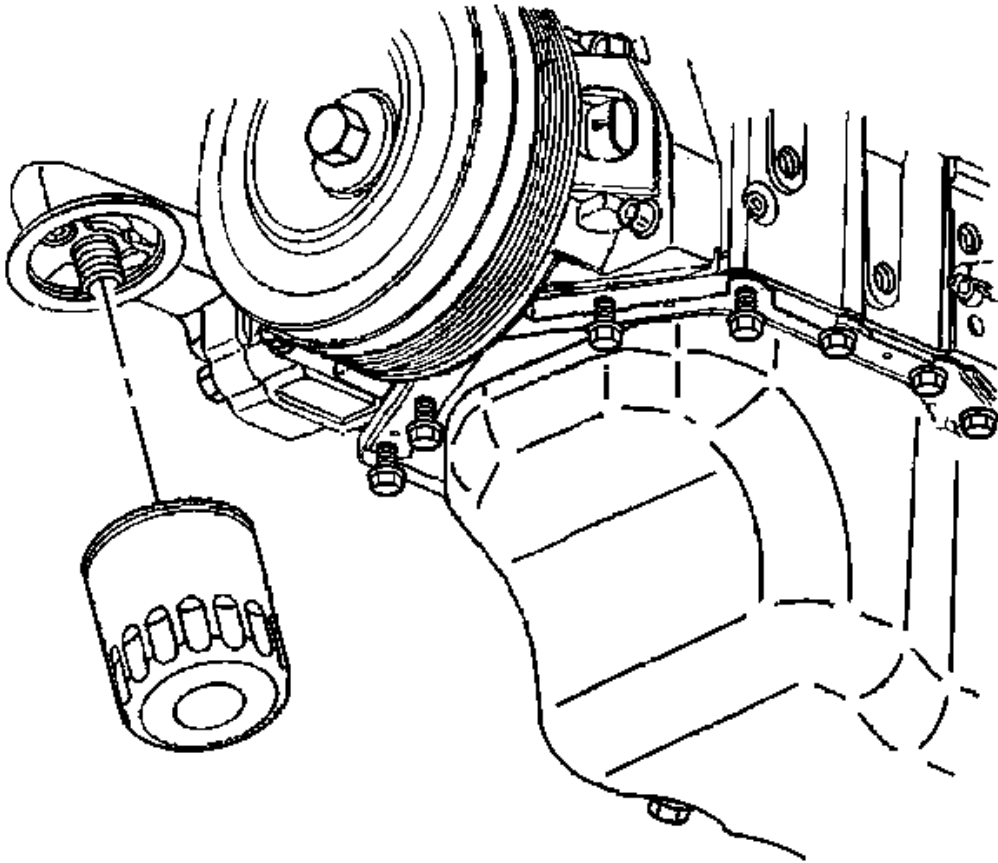


Fig. 158: Oil Filter

Courtesy of GENERAL MOTORS CORP.

NOTE: The oil pan can be dropped slightly for engine front cover clearance if all pan bolts are loosened and the oil level sensor is removed.

19. Remove the oil filter.
20. Remove the engine mount bracket for oil pan access. Refer to **Engine Front Mount Bracket Replacement**.
21. Disconnect the oil level sensor electrical connector.
22. Remove the oil level sensor.
23. Remove the oil pan-to-engine front cover bolts.
24. Loosen the remaining oil pan bolts to gain access for the engine front cover removal. DO NOT remove the remaining oil pan bolts.

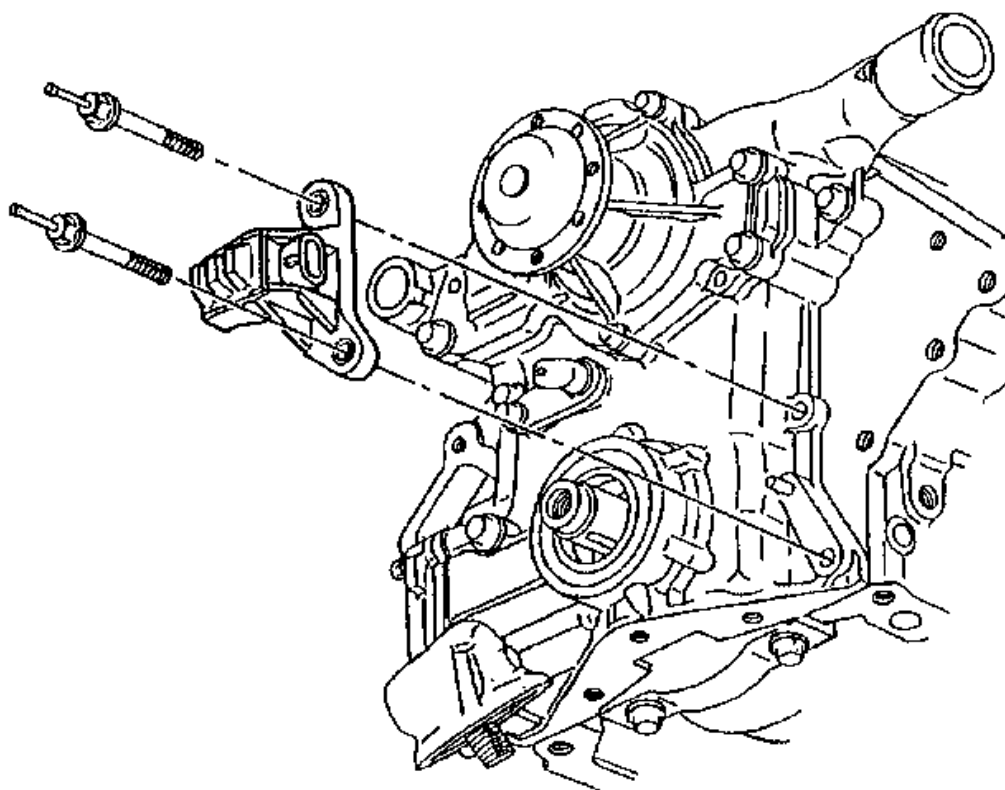


Fig. 159: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

25. Remove the crankshaft position sensor.

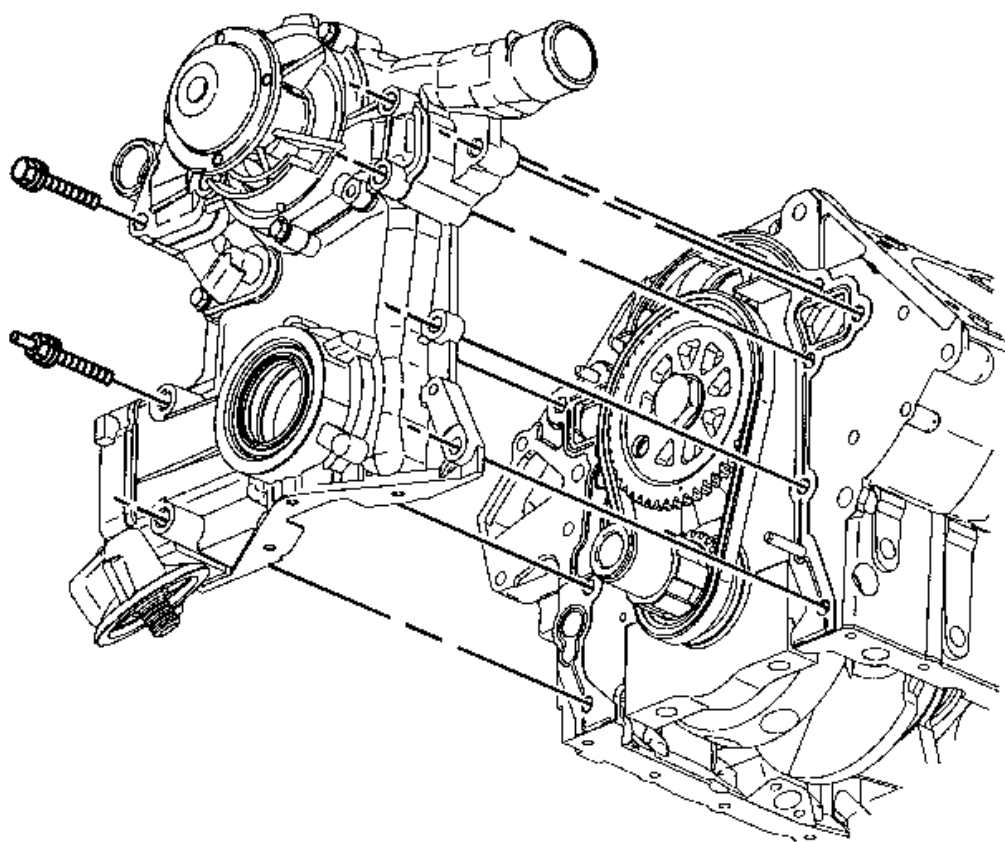


Fig. 160: Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

26. Remove the engine front cover bolts.
27. Remove the engine front cover with the oil filter adapter as one assembly.

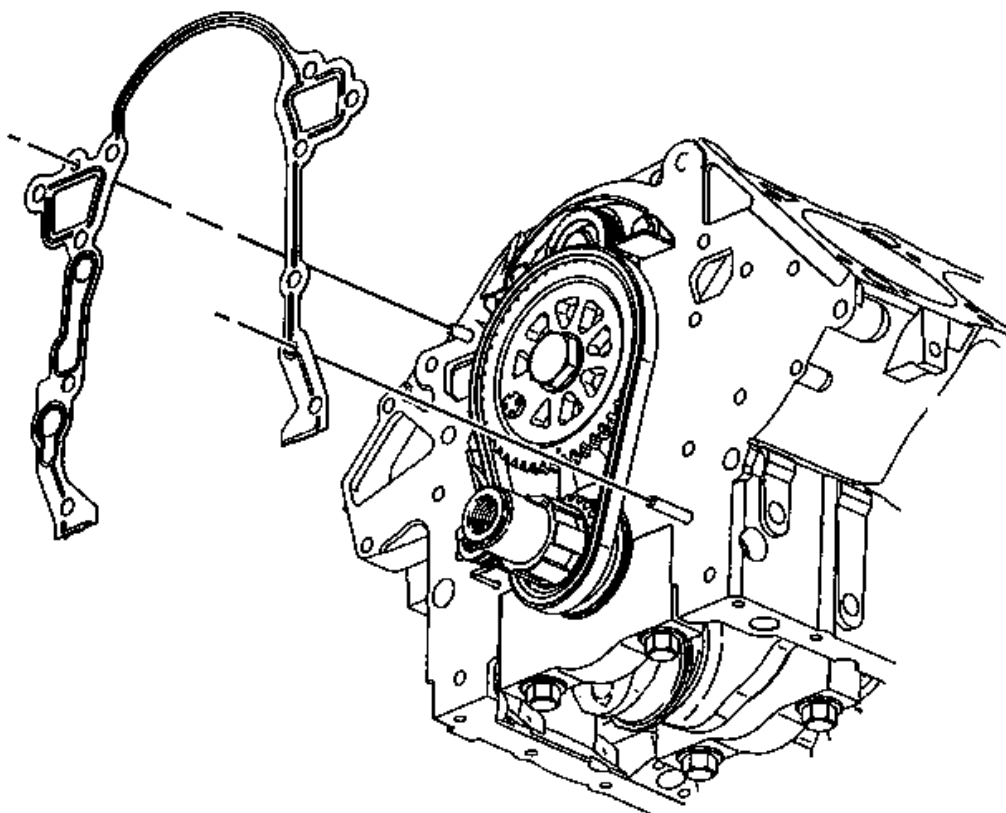


Fig. 161: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

28. Remove the engine front cover gasket.

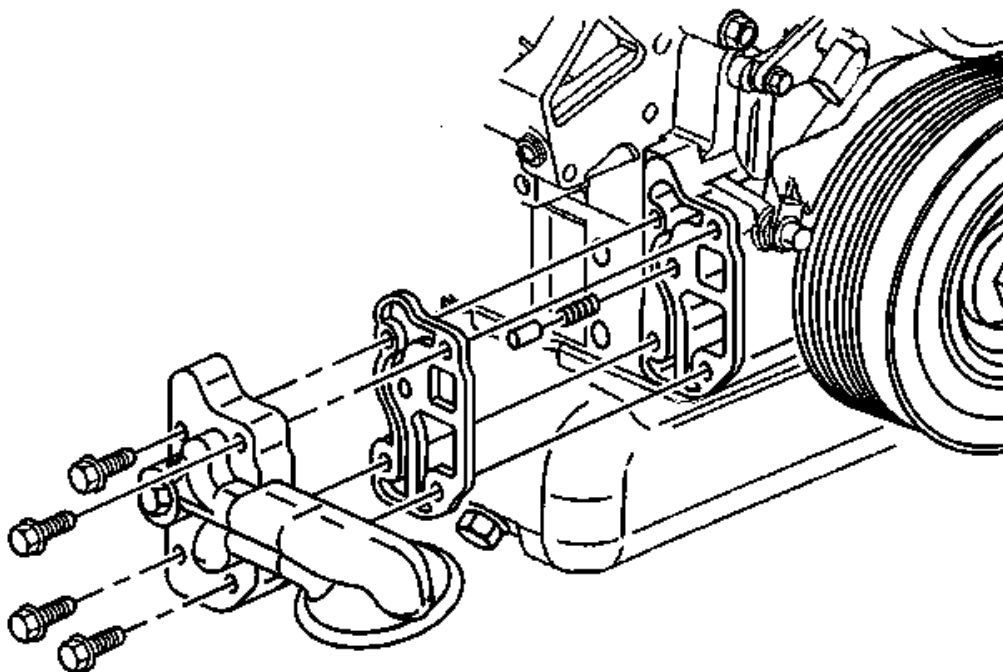


Fig. 162: Identifying Oil Filter Adapter & Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

29. If replacing the engine front cover, remove the oil filter adapter and pressure relief valve from the engine front cover.

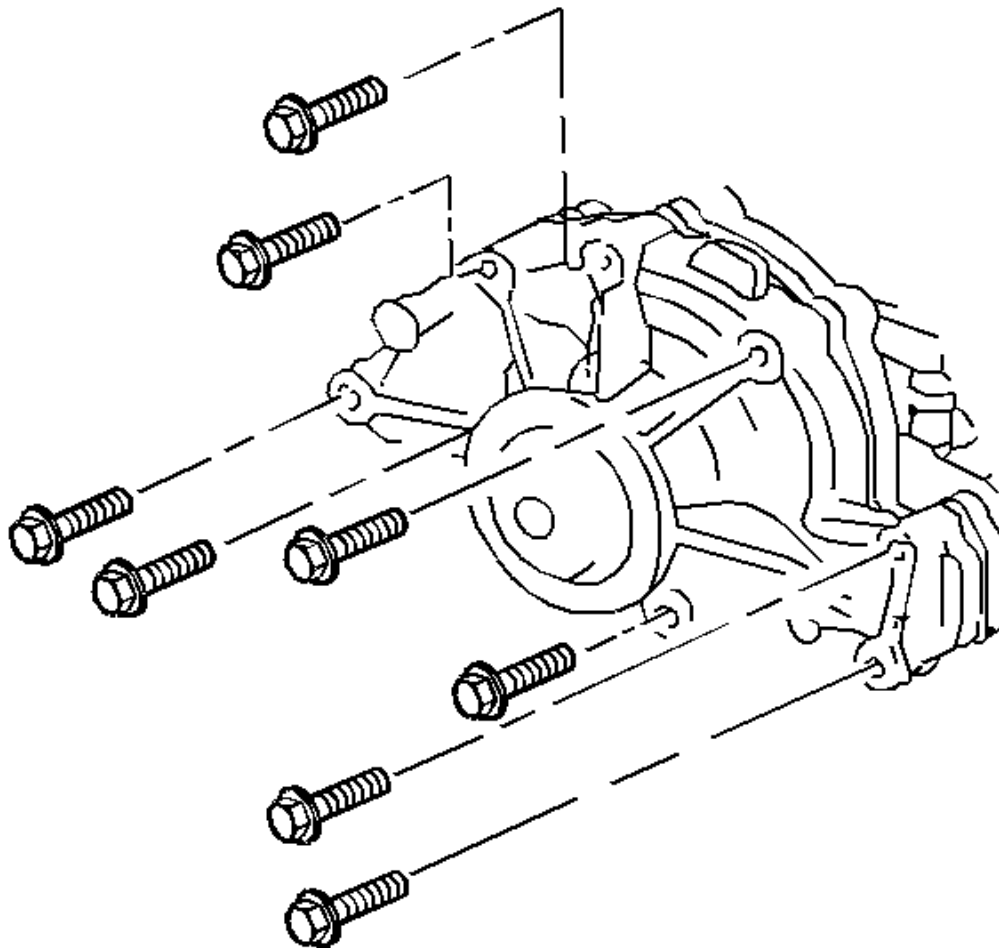


Fig. 163: Locating Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

30. If replacing the engine front cover, remove the water pump from the engine front cover.

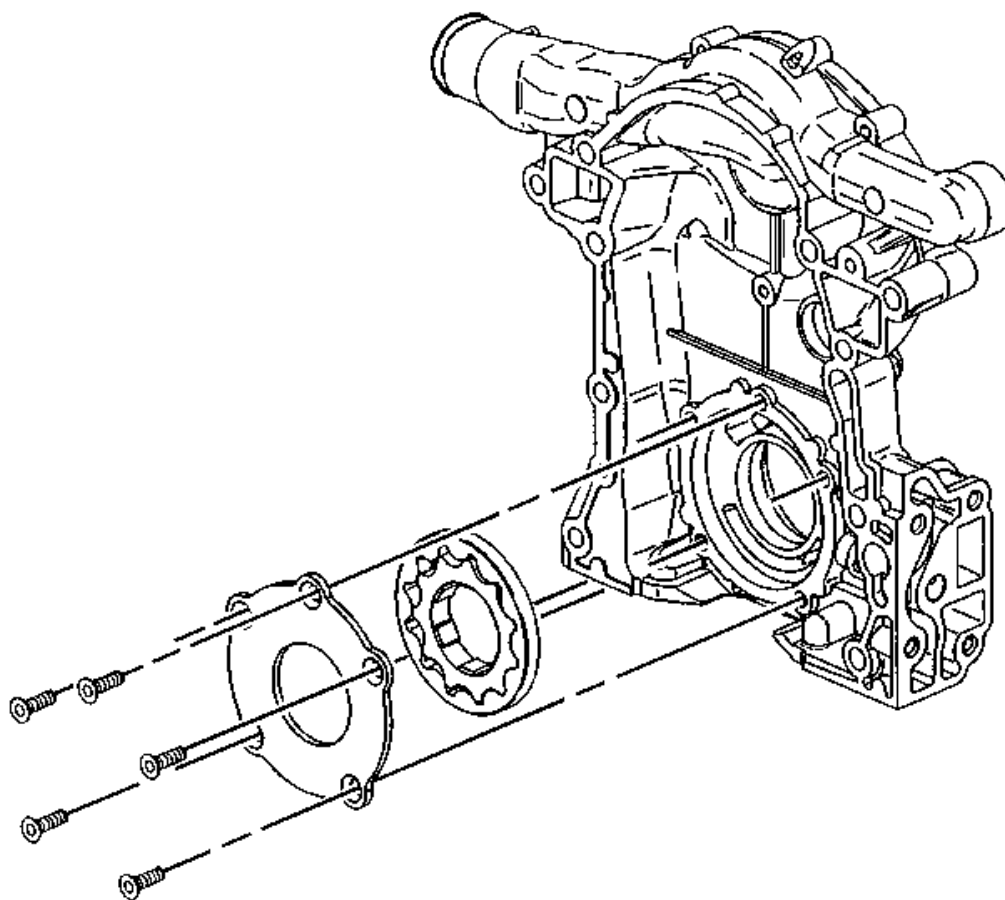


Fig. 164: Identifying Oil Pump Cover & Gear Set
Courtesy of GENERAL MOTORS CORP.

31. If replacing the engine front cover, remove the oil pump cover and gear set from the engine front cover. Refer to **Oil Pump Cover and Gear Set Replacement**.
32. Inspect the oil pump cover and gear set. Refer to **Oil Pump Cleaning and Inspection**.

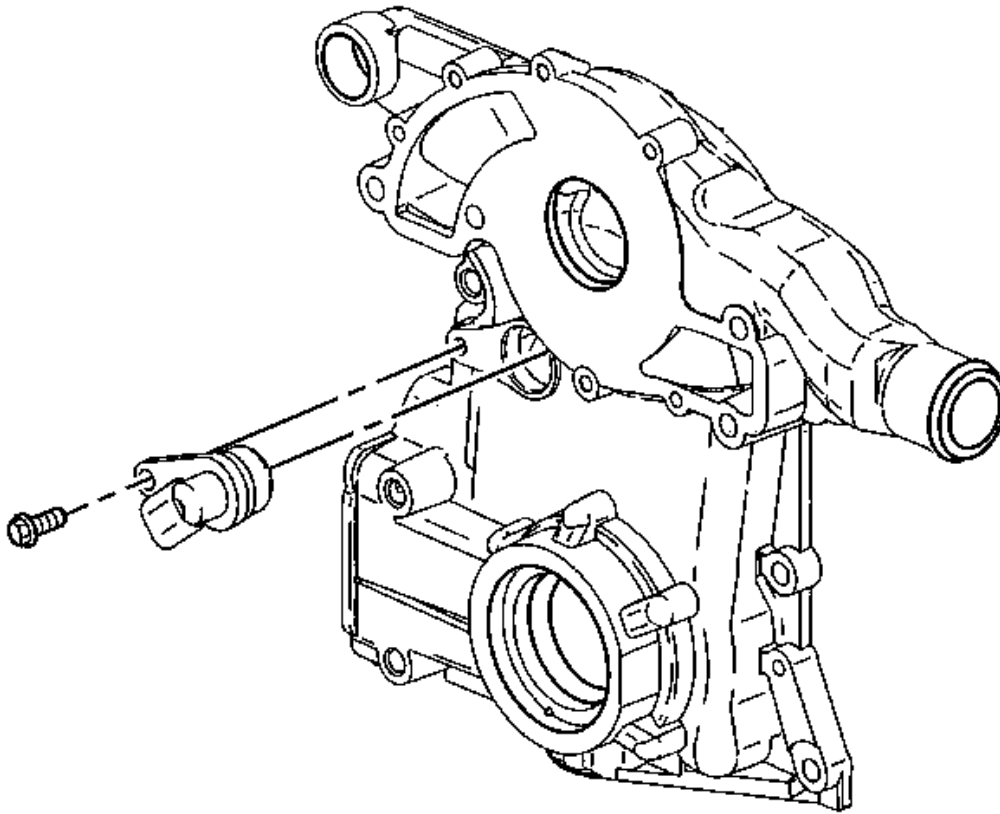


Fig. 165: Camshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

33. If replacing the engine front cover, remove the camshaft position sensor from the engine front cover.
34. Inspect the timing chain for overall in and out movement. Maximum movement is 25.4 mm (1 in). Refer to **Camshaft Timing Chain and Sprocket Cleaning and Inspection (L26)**.
35. Inspect the sprockets for wear.
36. Inspect the oil pan gasket. Replace the oil pan gasket if necessary.
37. Clean the engine front cover mating surfaces.

Installation Procedure

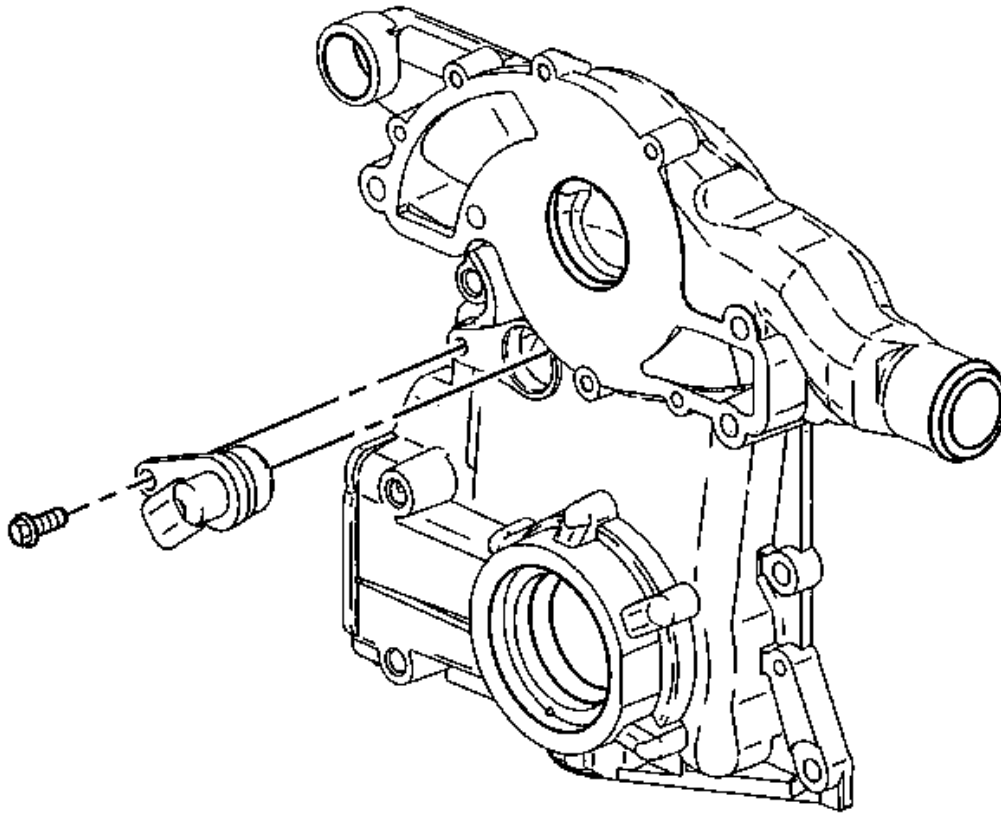


Fig. 166: Camshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

1. If replacing the engine front cover, install the camshaft position sensor to the engine front cover.

CAUTION: Refer to **Fastener Caution** .

2. Install the camshaft position sensor bolt.

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

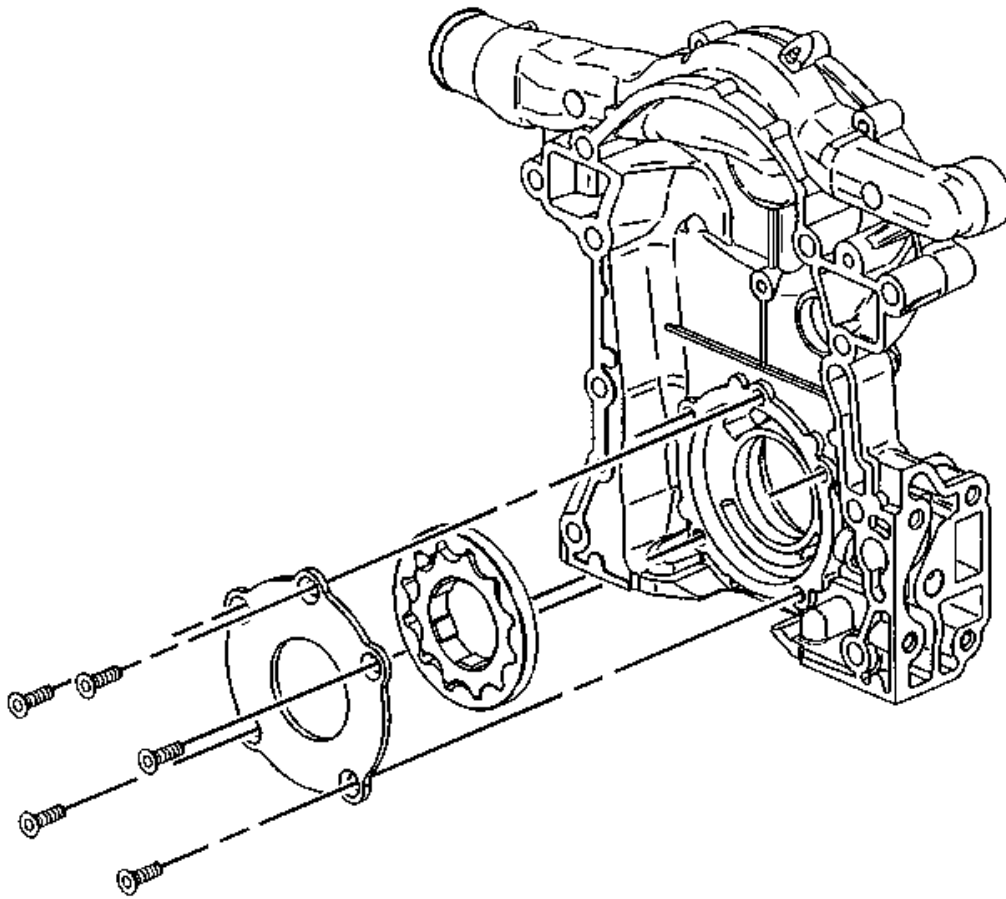


Fig. 167: Identifying Oil Pump Cover & Gear Set
Courtesy of GENERAL MOTORS CORP.

3. If replacing the engine front cover, install the oil pump cover and gear set to the engine front cover. Refer to **Oil Pump Cover and Gear Set Replacement**.

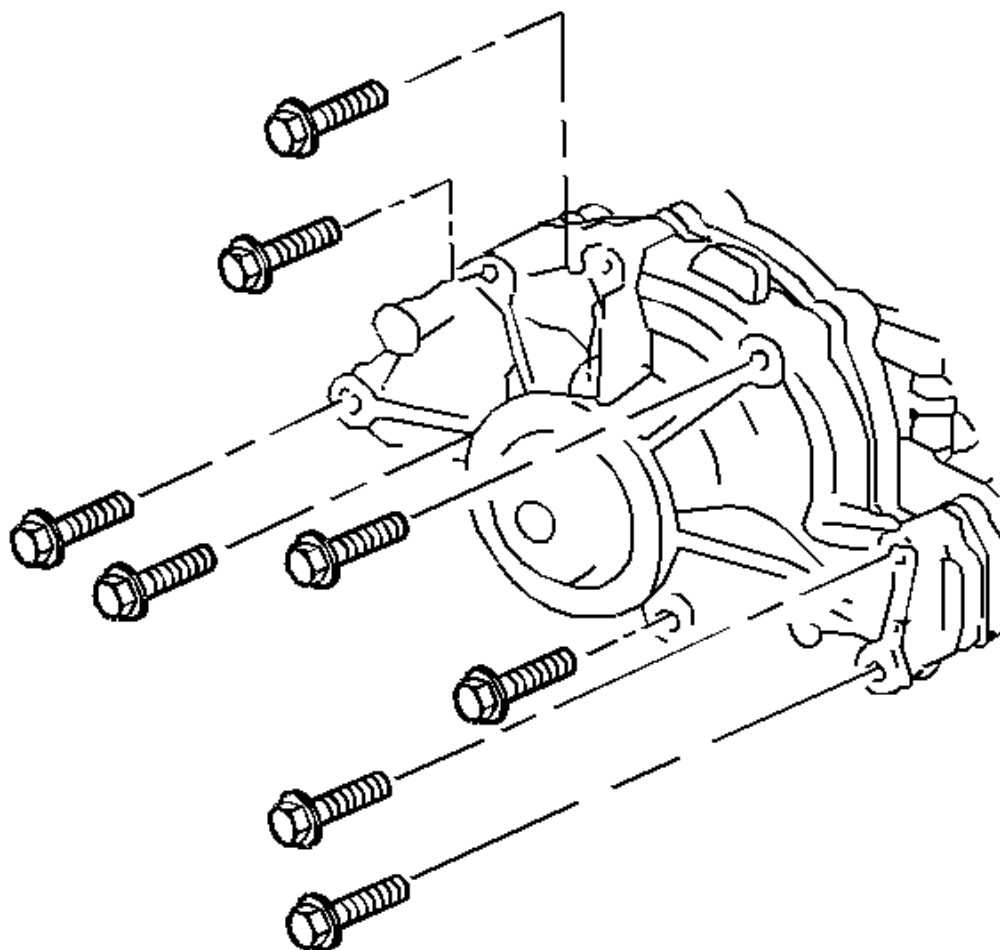


Fig. 168: Locating Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

4. If replacing the engine front cover, install the water pump.
5. Install and tighten the water pump bolts.

Tighten:

- Tighten the long water pump bolts to 34 N.m (25 lb ft).
- Tighten the short water pump bolts to 22 N.m (16 lb ft).

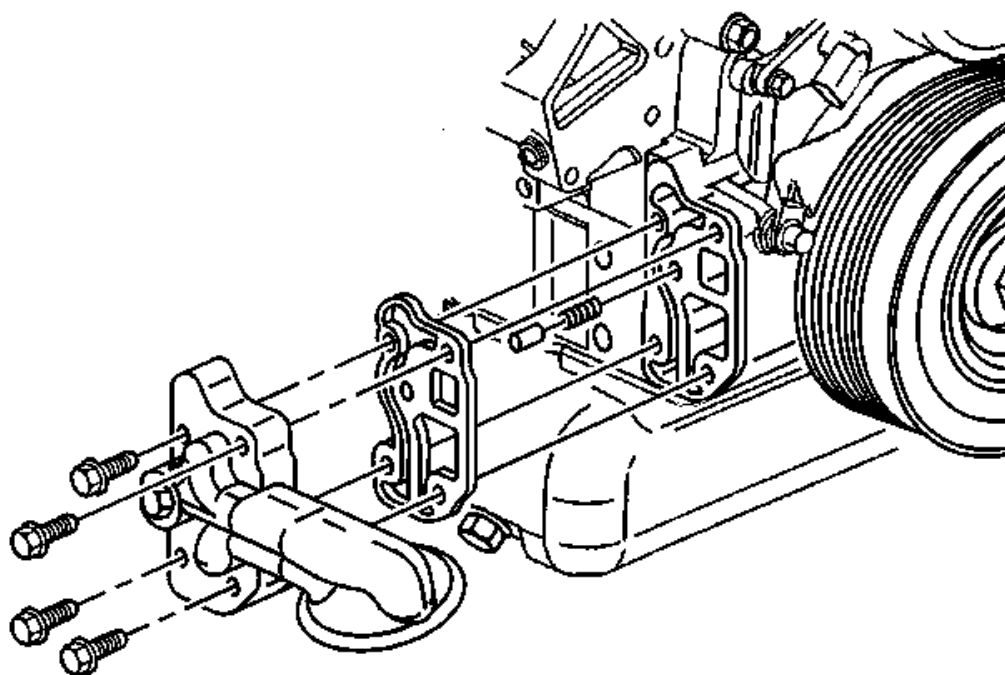


Fig. 169: Identifying Oil Filter Adapter & Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

6. If replacing the engine front cover, install the pressure relief valve, the oil filter adapter and the oil filter adapter bolts to the engine front cover.

Tighten:

1. Tighten the bolts to 15 N.m (11 lb ft).
2. Use the **J 45059** to rotate the bolt an additional 50 degrees.

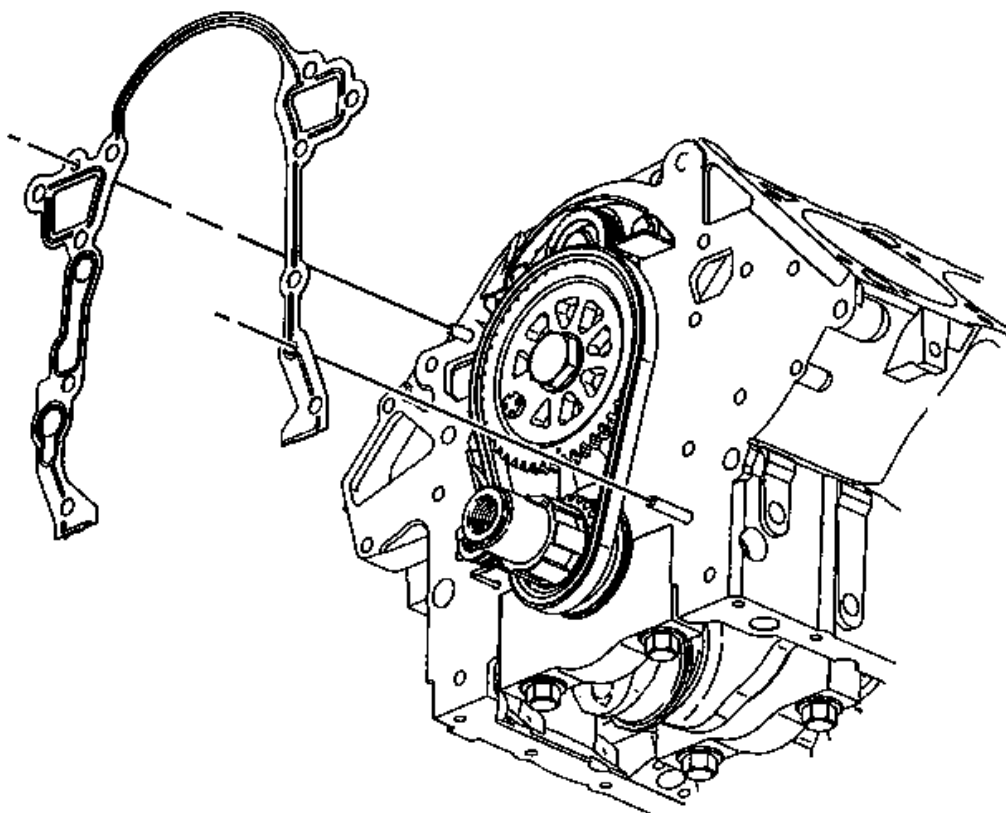


Fig. 170: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

7. Install the new engine front cover gasket. Ensure that the sealing surfaces are not damaged.
8. Apply sealer to the bolt threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

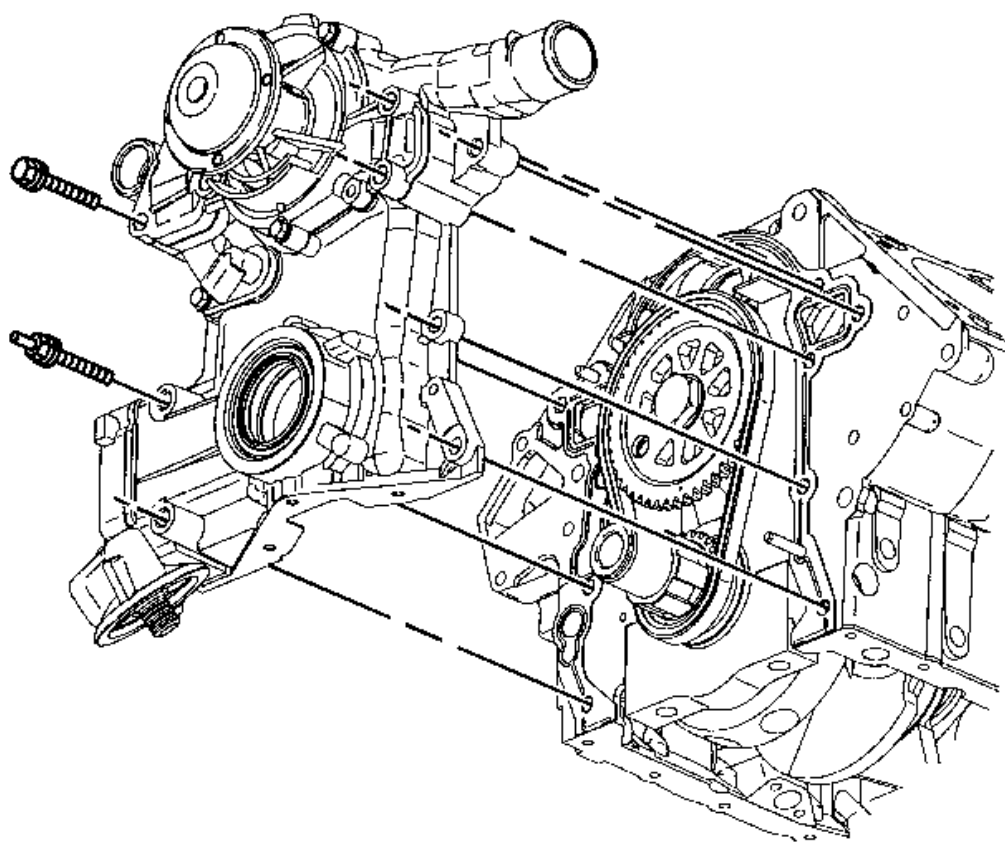


Fig. 171: Engine Front Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Align the cogs on the crankshaft sprocket with the cogs on the oil pump gear set in the engine front cover.
10. Install the engine front cover to the engine.

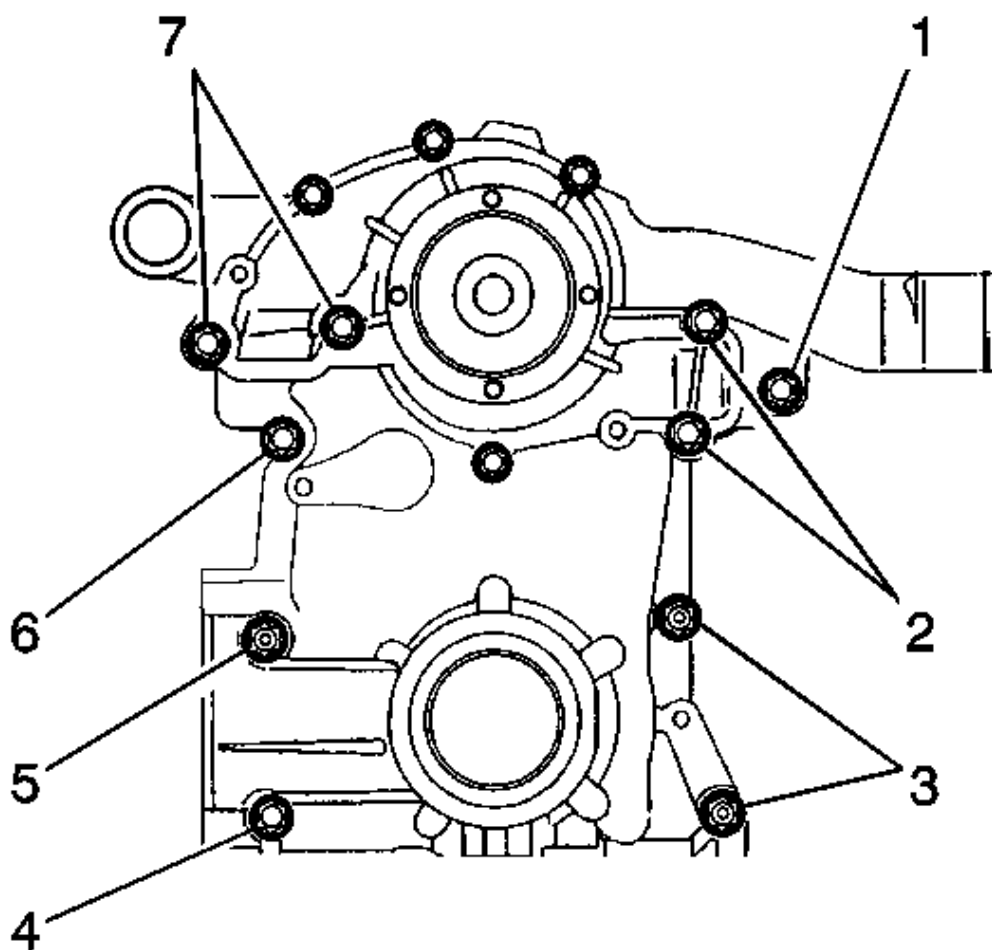


Fig. 172: Engine Front Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

11. Install the engine front cover bolts (1-7).

Tighten:

1. Tighten the bolts to 20 N.m (15 lb ft).
2. Use the **J 45059** to rotate the bolt an additional 40 degrees.

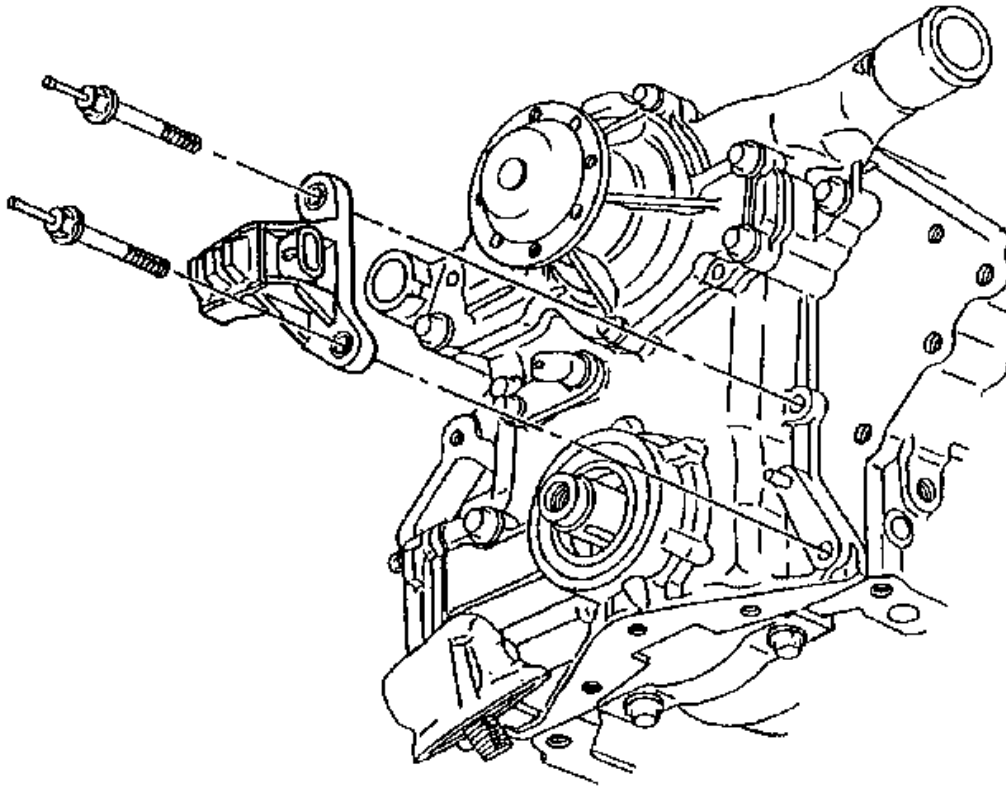


Fig. 173: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

12. Install the crankshaft position sensor.
13. Install the crankshaft position sensor studs.

Tighten: Tighten the studs to 30 N.m (22 lb ft).

14. Install the oil pan-to-engine front cover bolts.

Tighten: Tighten the oil pan bolts to 14 N.m (125 lb in).

15. Install the oil level sensor.

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

16. Connect the oil level sensor electrical connector.
17. Install the engine mount bracket. Refer to **Engine Front Mount Bracket Replacement**.

18. Install the water pump pulley and bolts.

Tighten: Tighten the bolts to 13 N.m (116 lb in).

19. Install the radiator outlet hose to the water pump. Refer to **Radiator Outlet Hose Replacement (L26)**.

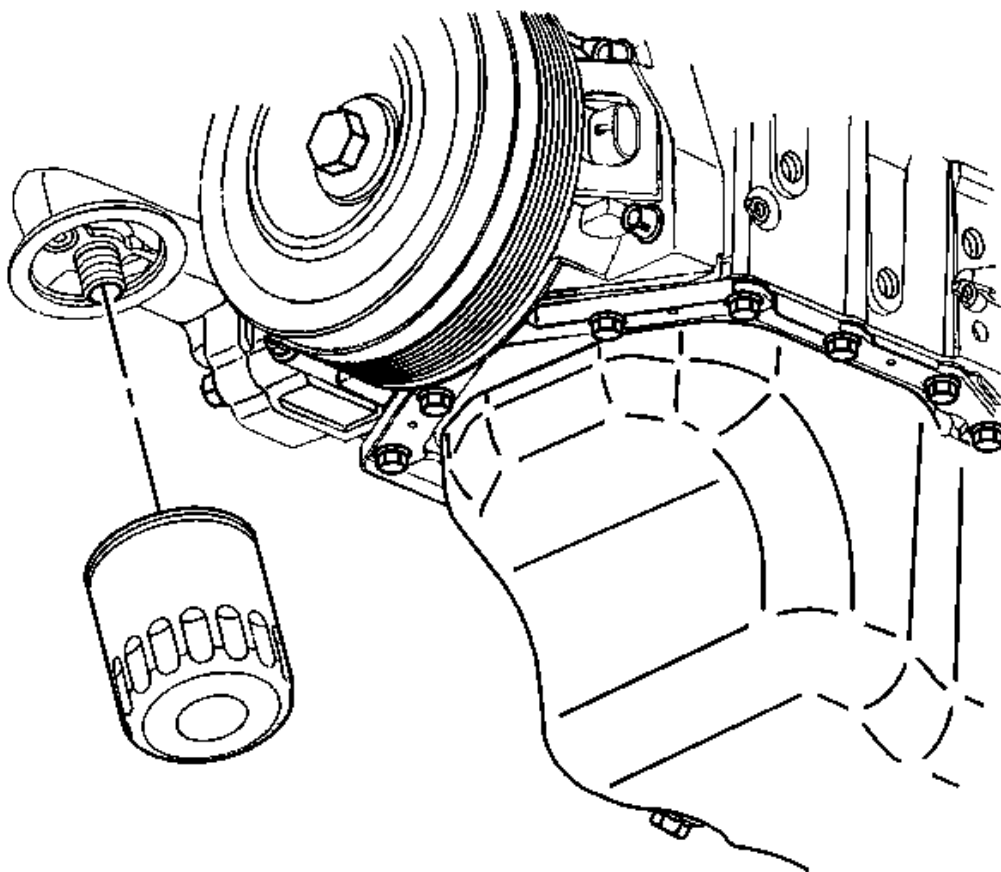


Fig. 174: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

20. Install the oil filter. Install the engine oil pan drain plug. Refer to **Engine Oil and Oil Filter Replacement**.

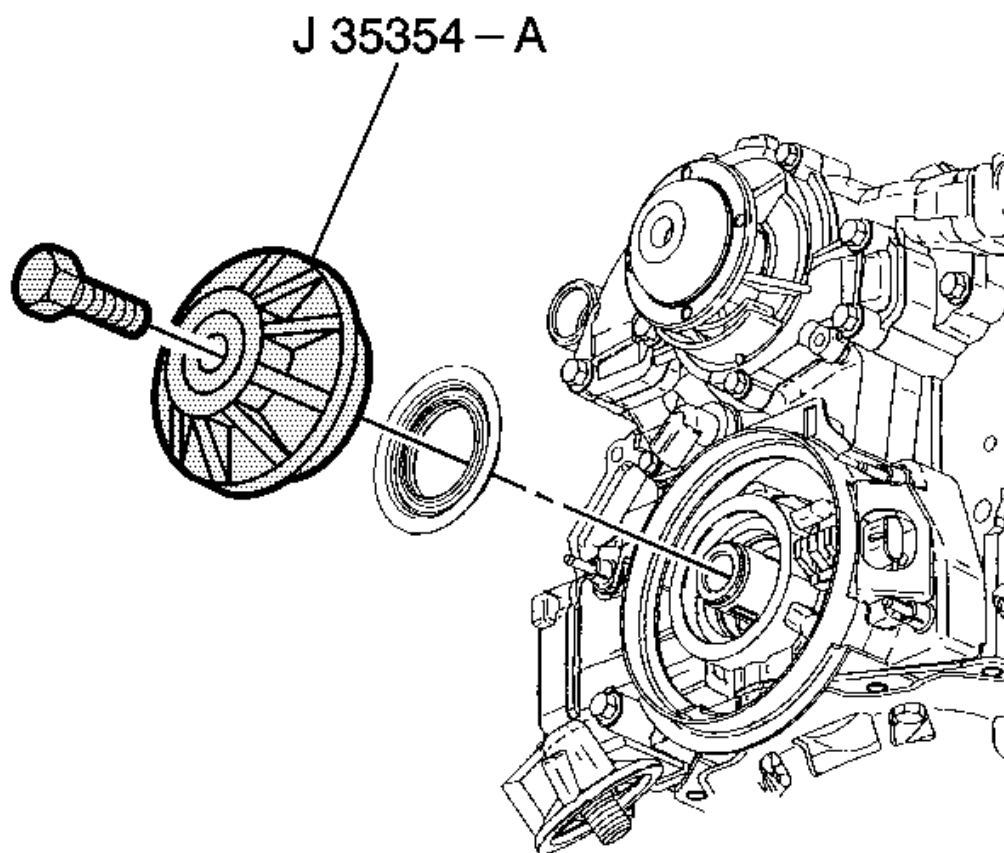


Fig. 175: Installing Crankshaft Front Oil Seal Using J 35354-A
Courtesy of GENERAL MOTORS CORP.

21. Install the new engine front cover seal using **J 35354** . See **Special Tools**.
22. Tighten the bolt until the crankshaft front oil seal is seated in the engine front cover.
23. Remove the **J 35354** . See **Special Tools**.

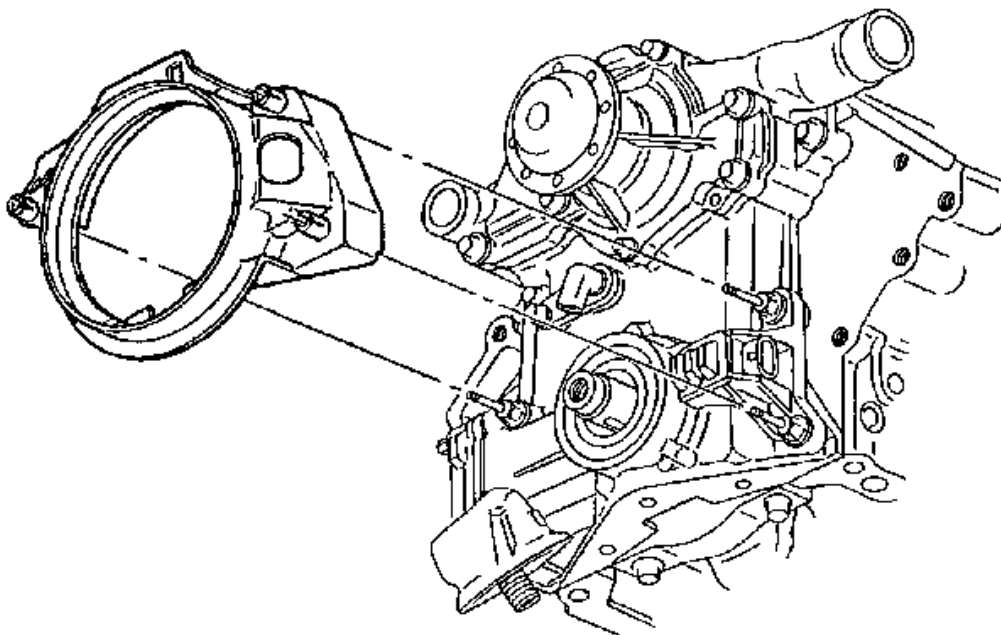


Fig. 176: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS CORP.

24. Install the crankshaft position sensor shield.
25. Connect the electrical connectors to the following:
 - Oil pressure sensor
 - Crankshaft position (CKP) sensor
 - Camshaft position (CMP) sensor
26. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
27. Lower the vehicle.

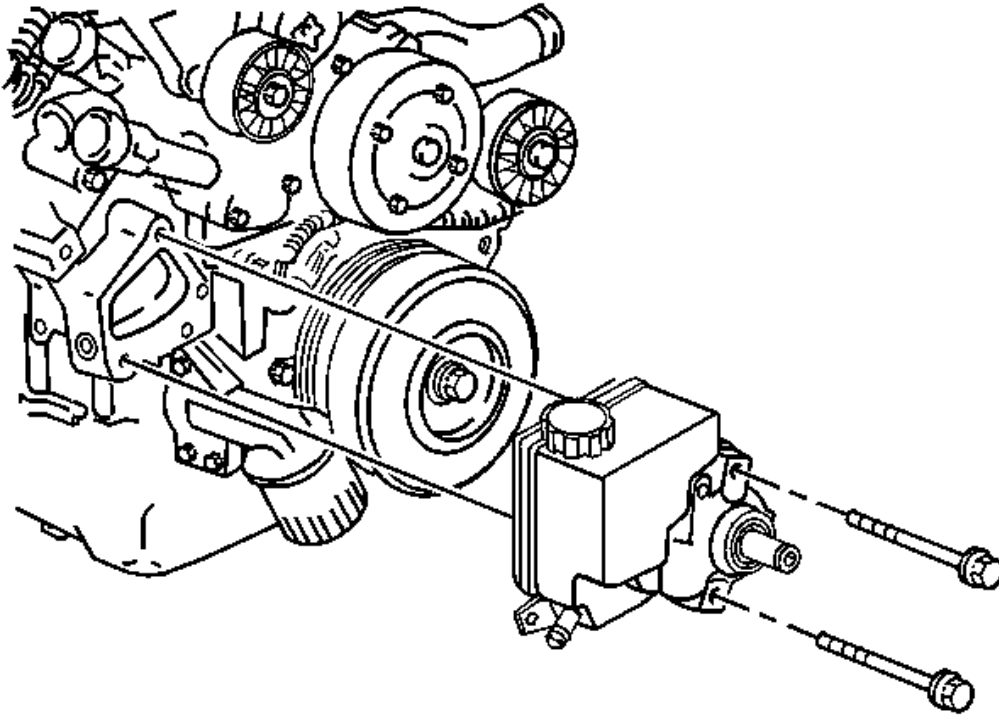


Fig. 177: View Of Power Steering Pump And Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

28. Install the power steering pump and the bolts.

Tighten: Tighten the bolts to 34 N.m (25 lb ft).

29. Remove the engine support fixture.
30. Install the drive belt tensioner. Refer to [Drive Belt Tensioner Replacement](#).
31. Fill the cooling system. Refer to [Cooling System Draining and Filling \(L26 Static Fill\)](#) or [Cooling System Draining and Filling \(L26 GE 47716 Fill\)](#) .
32. Fill the crankcase with engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
33. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection \(L26\)](#) .
34. Inspect for leaks.
35. Perform the CKP system variation learn procedure. Refer to [Crankshaft Position System Variation Learn](#) .

OIL PUMP COVER AND GEAR SET REPLACEMENT

Removal Procedure

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

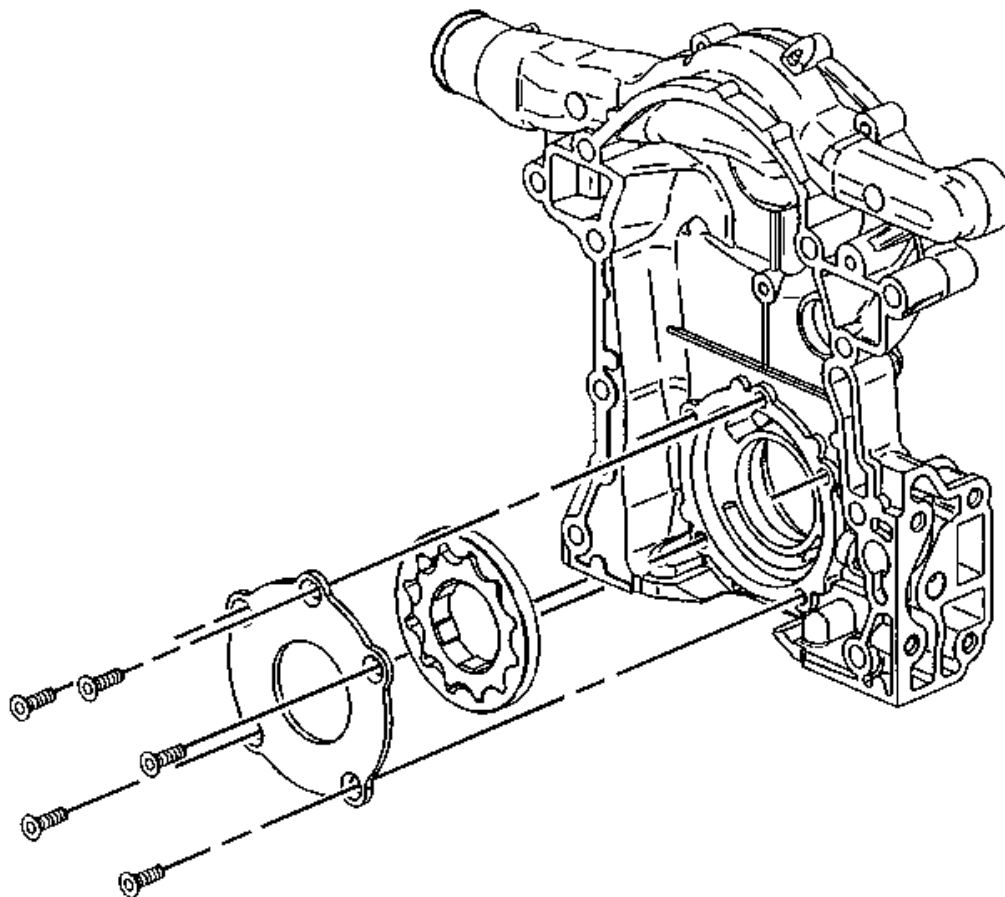


Fig. 178: Identifying Oil Pump Cover & Gear Set
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pump cover screws.
3. Remove the oil pump cover.
4. Remove the oil pump gear set.
5. Inspect the oil pump gear set and housing. Refer to **Oil Pump Cleaning and Inspection**.

Installation Procedure

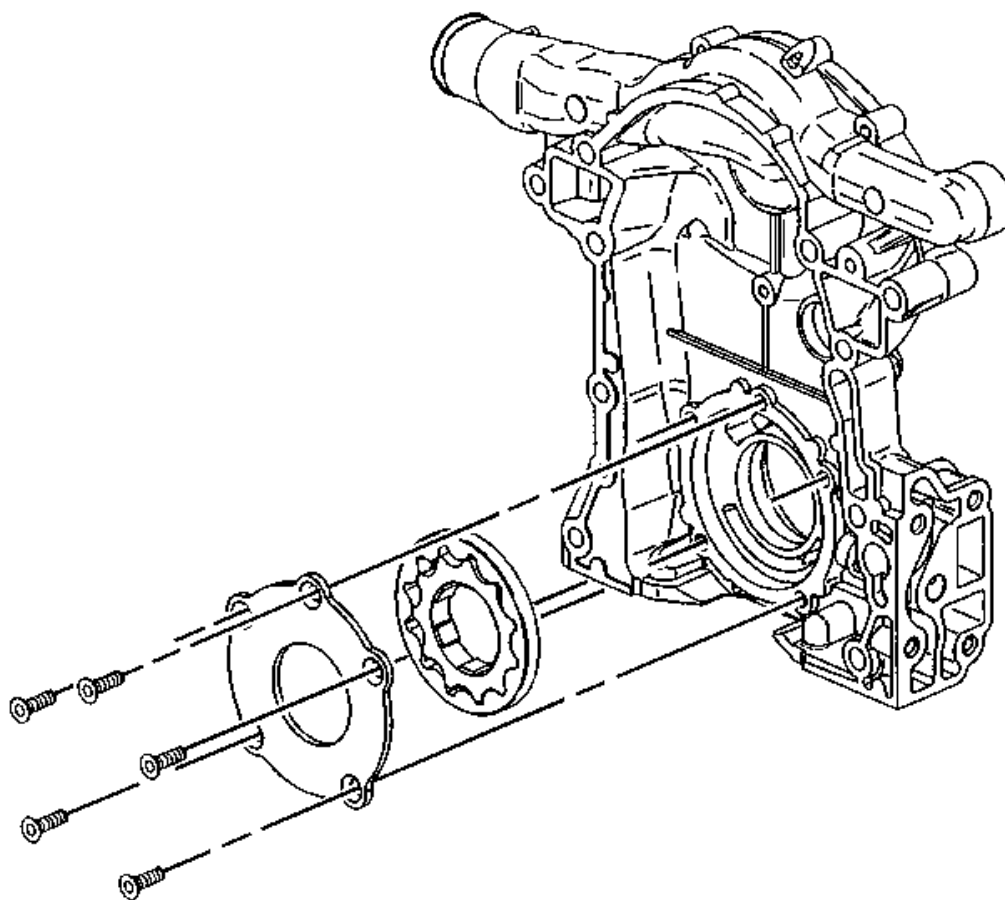


Fig. 179: Identifying Oil Pump Cover & Gear Set
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil pump gear set with petroleum jelly.
2. Install the oil pump gear set.
3. Pack the oil pump gears with petroleum jelly.
4. Install the oil pump cover.

CAUTION: Refer to Fastener Caution .

5. Install the oil pump cover screws.

Tighten: Tighten the screws to 11 N.m (98 lb in).

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

CAUTION: Do not run the engine until the oil pressure is tested. Running the engine without measurable oil pressure will cause extensive damage.

CAUTION: Stop the engine and remove the oil pan if the oil pressure does not build up immediately. Check the oil pump pipe and the screen for a clogged screen, damaged pipe, or a damaged gasket. Running the engine without measurable oil pressure will cause extensive damage.

7. Inspect the oil pressure.
8. Inspect for leaks.

OIL FILTER ADAPTER AND BYPASS VALVE ASSEMBLY REPLACEMENT

Special Tools

J 45059 Electronic Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
3. Remove the right side wheel drive shaft. Refer to **Wheel Drive Shaft Replacement**.
4. Disconnect the oil pressure sensor electrical connector.

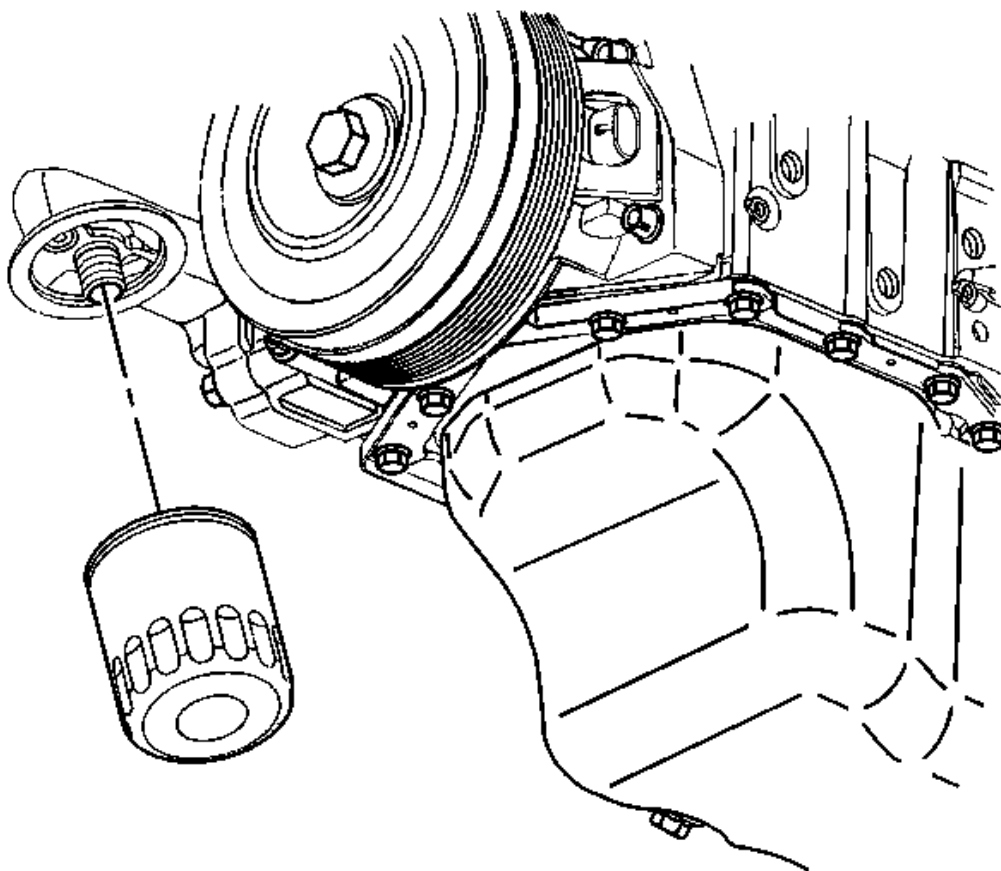


Fig. 180: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil filter and drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

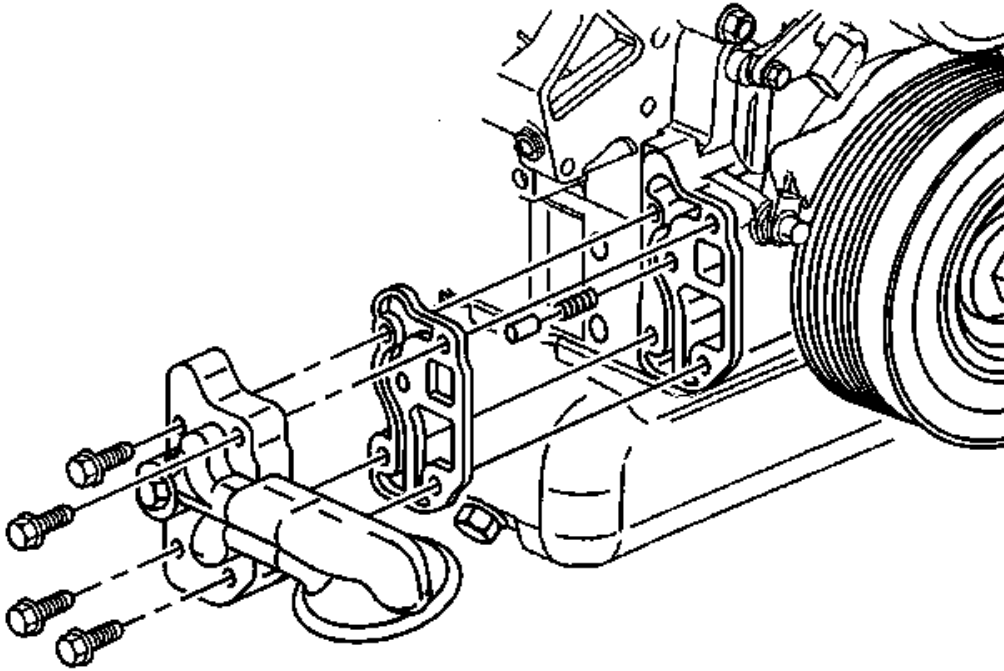


Fig. 181: Identifying Oil Filter Adapter & Pressure Relief Valve
 Courtesy of GENERAL MOTORS CORP.

6. Remove the four bolts holding the oil filter adapter to the engine front cover.
7. Remove the following components:
 - Oil filter adapter
 - Gasket
 - Oil pressure valve and spring
8. Clean the parts in a suitable solvent. Dry the parts.
9. Clean the oil filter adapter gasket mating surfaces.
10. Inspect the following areas:
 - The oil pressure valve and the valve bore for burrs
 - The spring for loss of tension-Replace the spring if necessary.

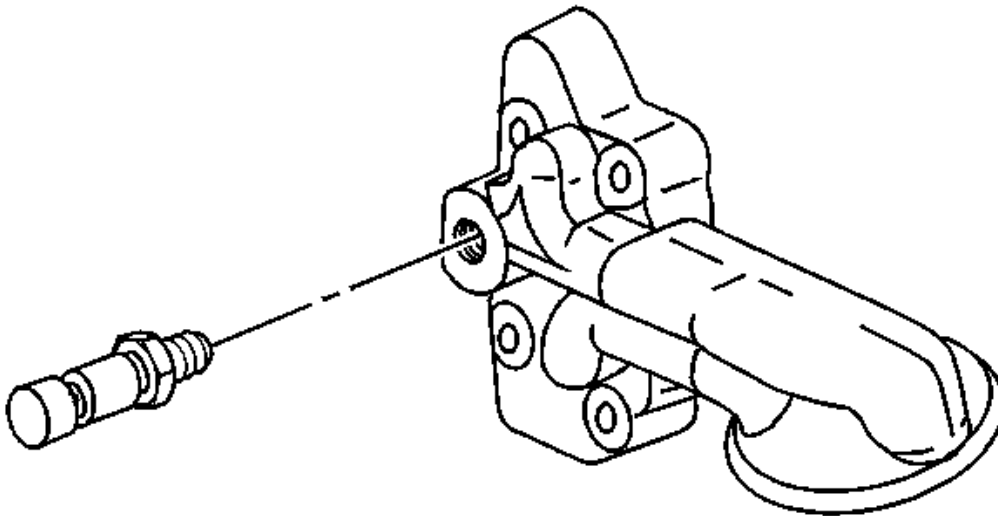


Fig. 182: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

11. If replacing the oil filter adapter and valve assembly, remove the engine oil pressure sensor from the oil filter adapter and valve assembly.

Installation Procedure

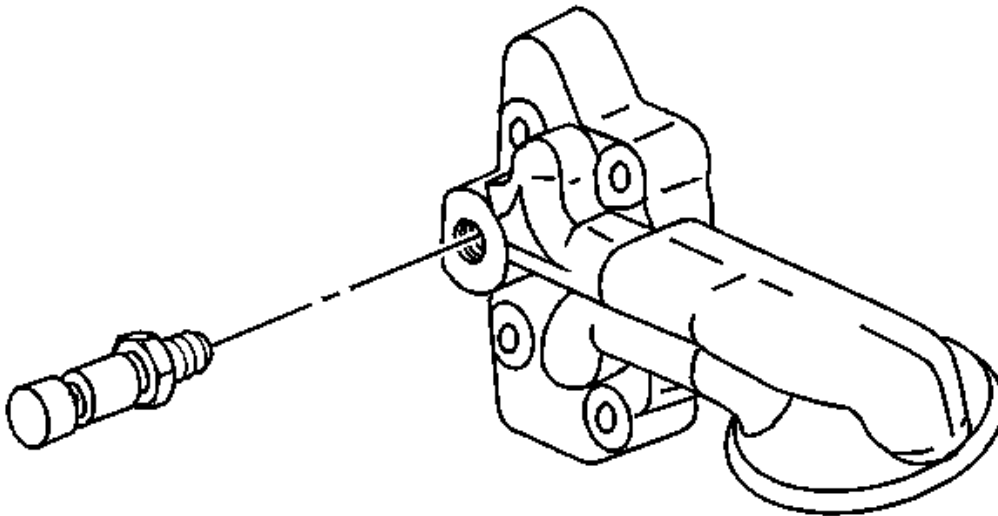


Fig. 183: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. If replacing the oil filter adapter and valve assembly, install the engine oil pressure sensor to the oil filter adapter and valve assembly.

Tighten: Tighten the engine oil pressure sensor to 16 N.m (12 lb ft).

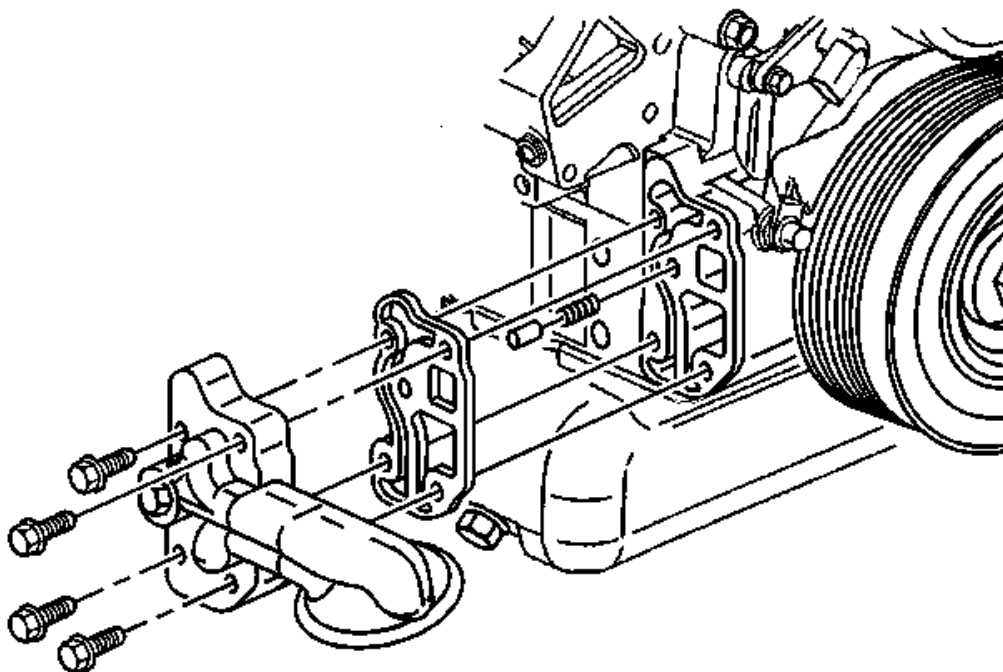


Fig. 184: Identifying Oil Filter Adapter & Pressure Relief Valve
Courtesy of GENERAL MOTORS CORP.

2. Install the spring into the engine front cover.
3. Install the oil pressure valve into the engine front cover.
4. Install the oil filter adapter and a new gasket.
5. Install the oil filter adapter attaching bolts.

Tighten:

1. Tighten the oil filter adapter bolts to 15 N.m (11 lb ft).
2. Use the **J 45059** to rotate the bolt an additional 50 degrees.

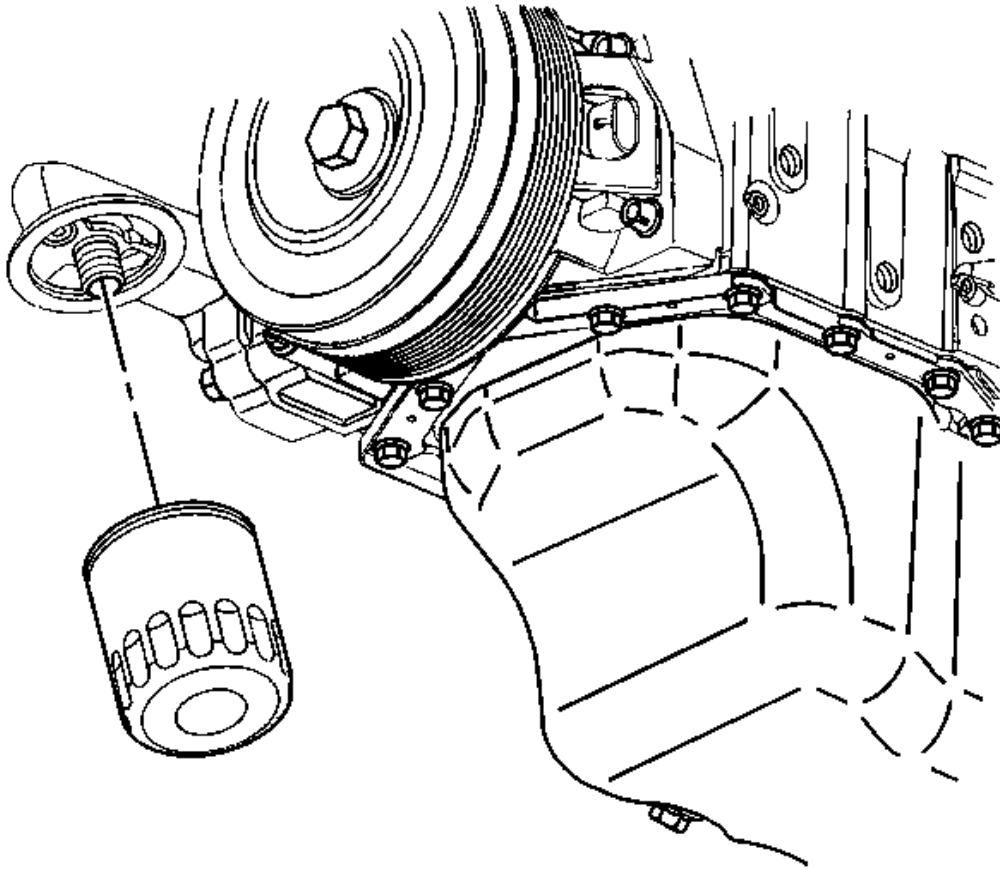


Fig. 185: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

6. Install the engine oil filter and the engine oil drain plug. Refer to **Engine Oil and Oil Filter Replacement**.
7. Connect the oil pressure sensor electrical connector.
8. Install the right side wheel drive shaft. Refer to **Wheel Drive Shaft Replacement**.
9. Lower the vehicle.
10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
11. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
12. Inspect for proper oil pressure.
13. Inspect for leaks.

CAMSHAFT TIMING CHAIN AND SPROCKET REPLACEMENT**Special Tools**

J 45059 Electronic Torque Angle Meter

Removal Procedure

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

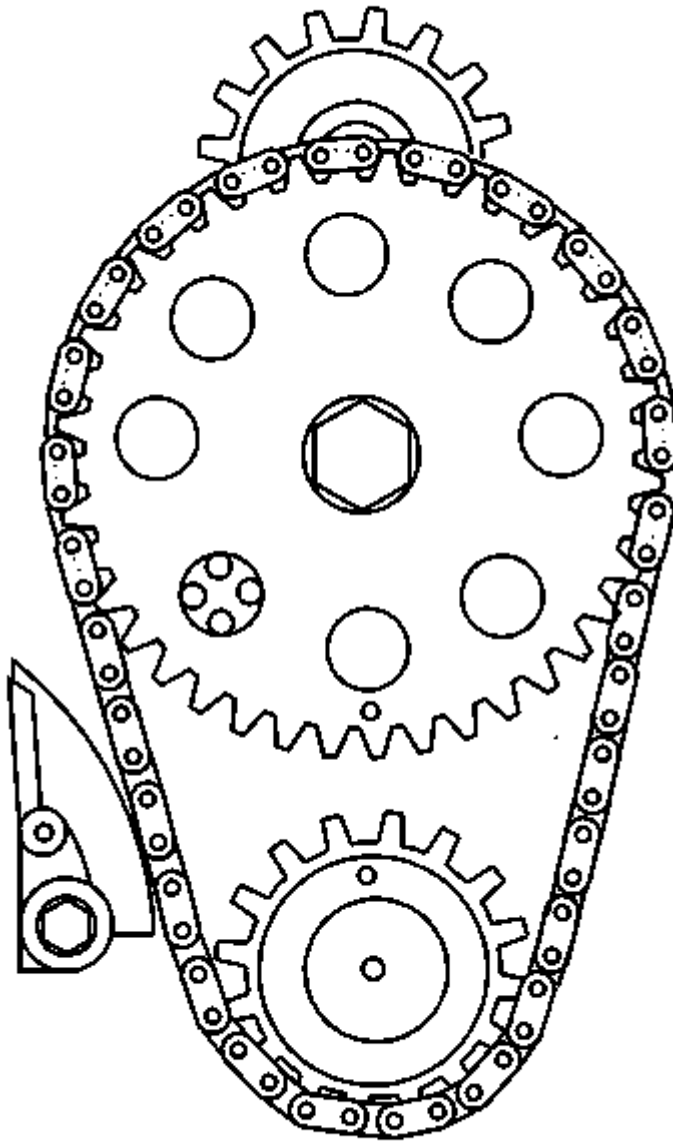


Fig. 186: Aligning Timing Chain & Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

2. Align the timing marks on the sprockets so that they are as close as possible.

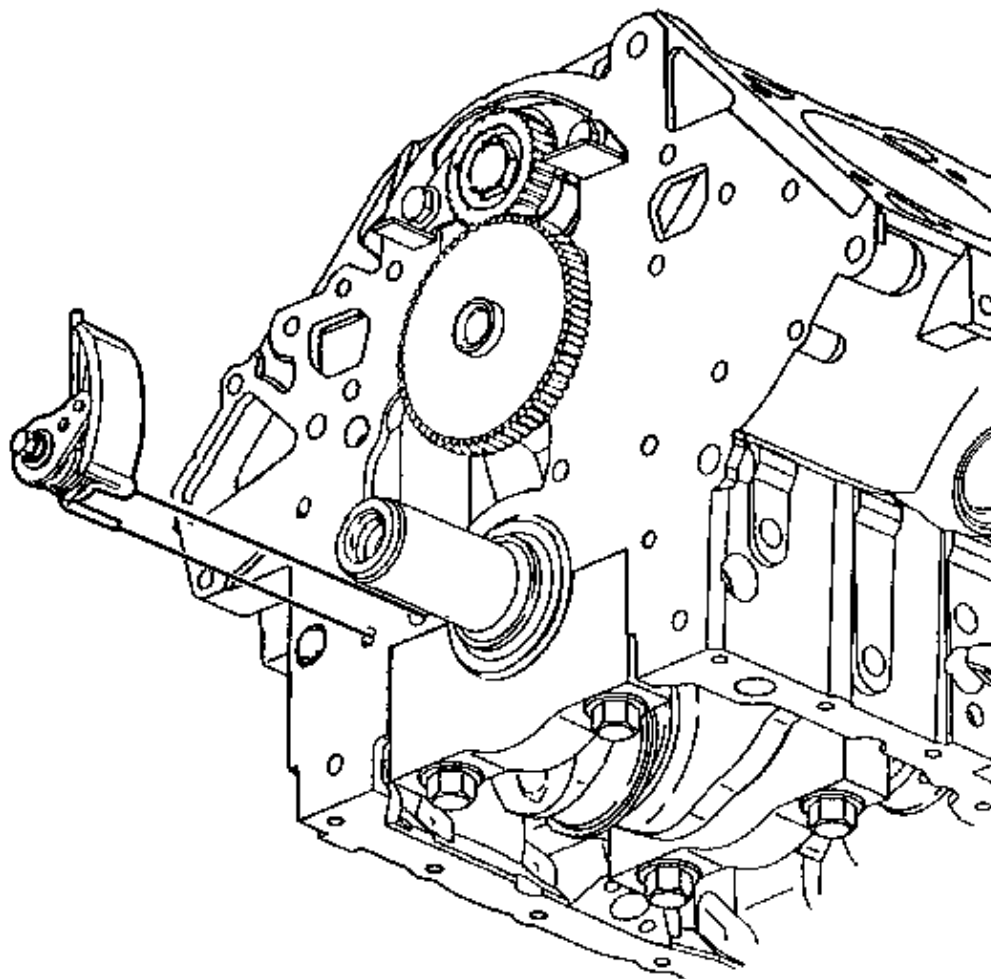


Fig. 187: Timing Chain Damper & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the timing chain damper bolt.
4. Remove the timing chain damper.

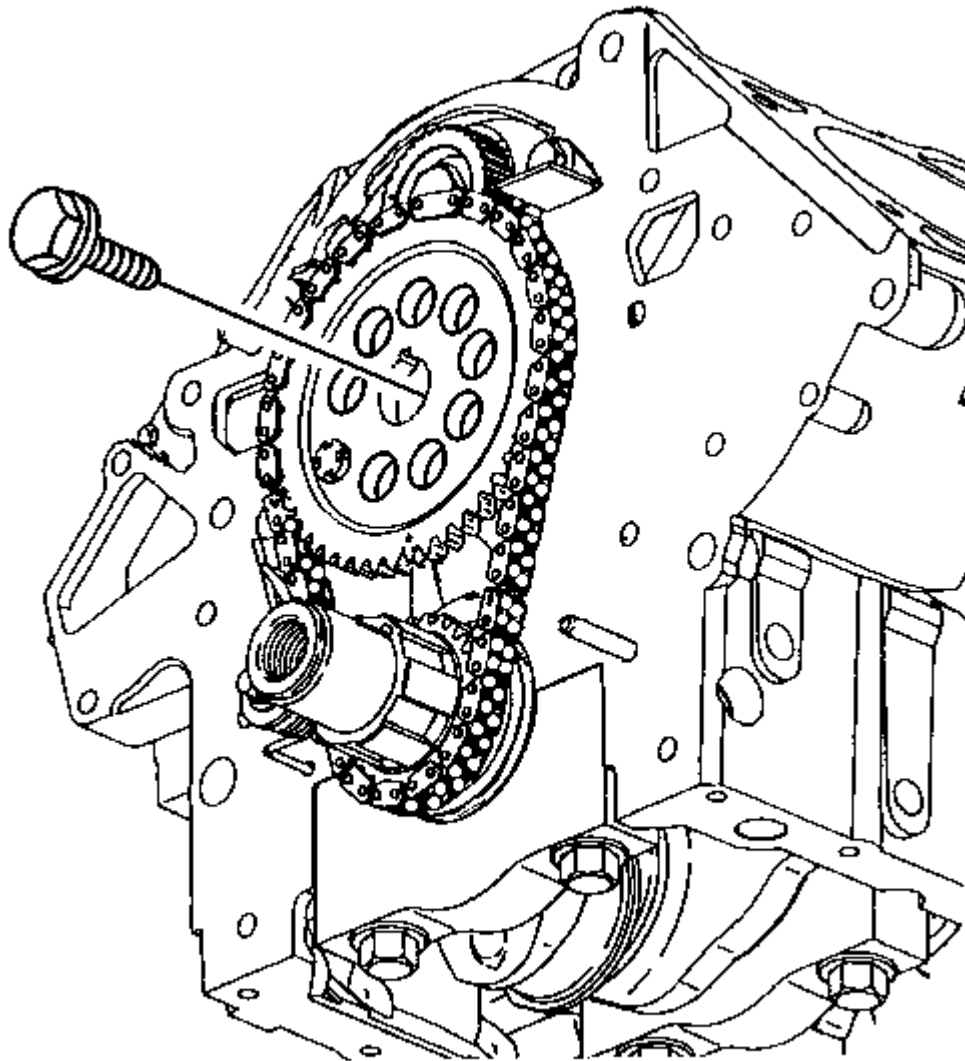


Fig. 188: Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket bolt.

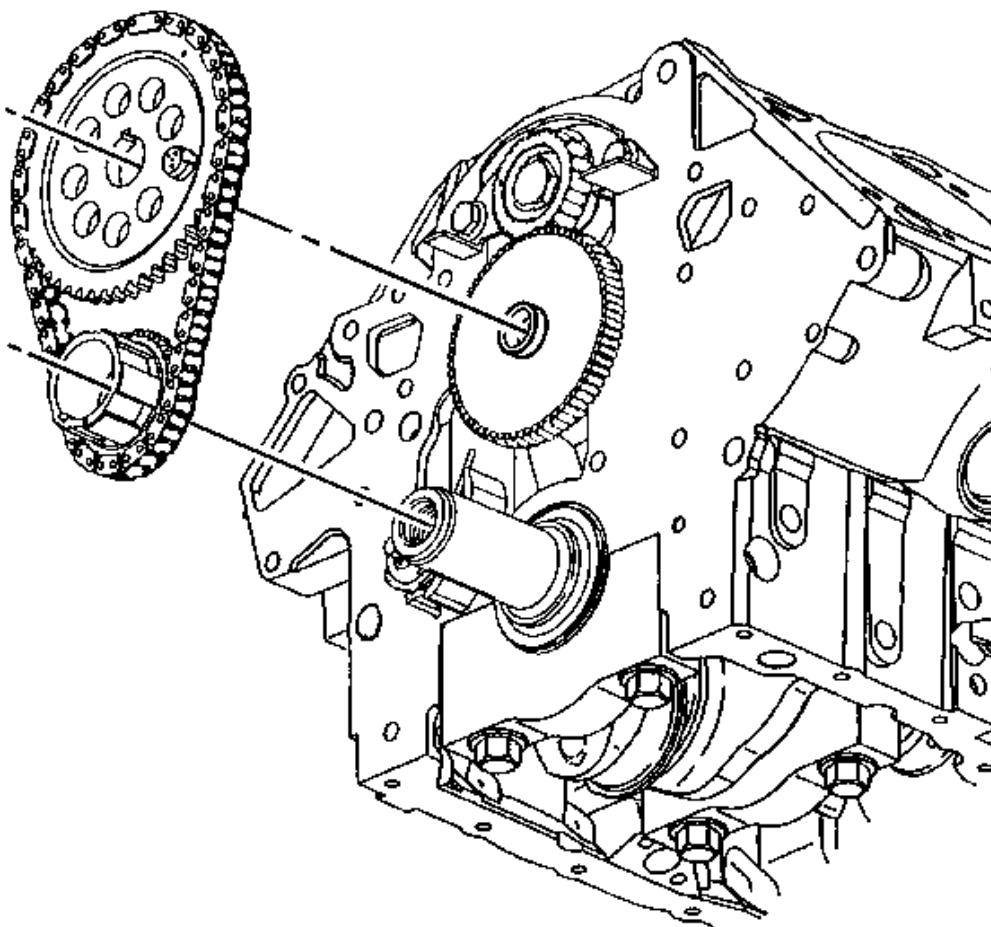


Fig. 189: Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft sprocket and the timing chain.

IMPORTANT: If the sprocket does not come off easily, a light blow on the lower edge of the sprocket with a plastic mallet should dislodge the sprocket.

7. Remove the crankshaft sprocket.

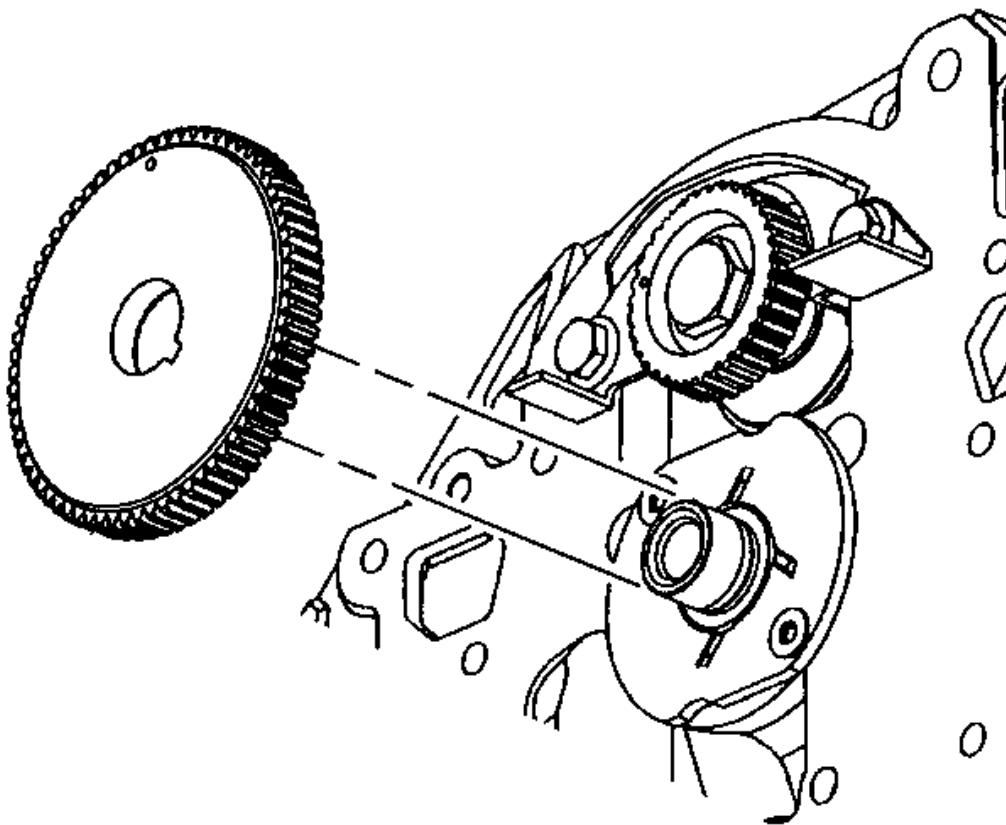


Fig. 190: Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

8. Remove the balance shaft drive gear in order to access the camshaft thrust plate.

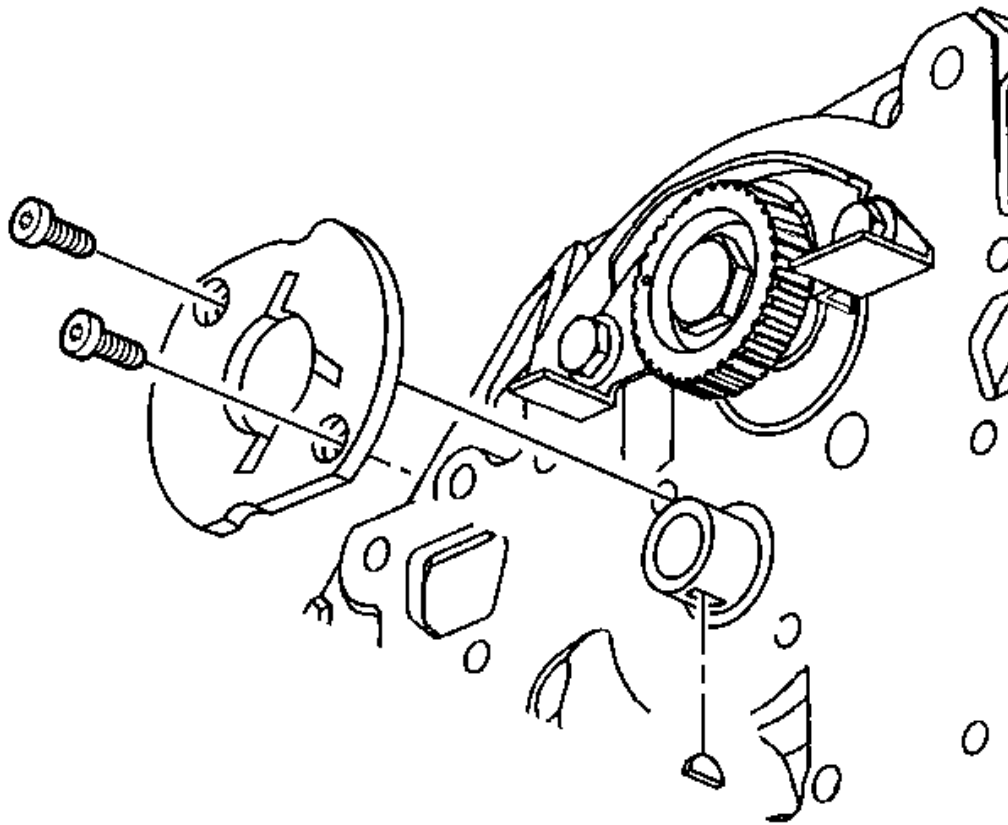


Fig. 191: Camshaft Thrust Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft thrust plate bolts, if required.
10. Remove the camshaft thrust plate, if required.

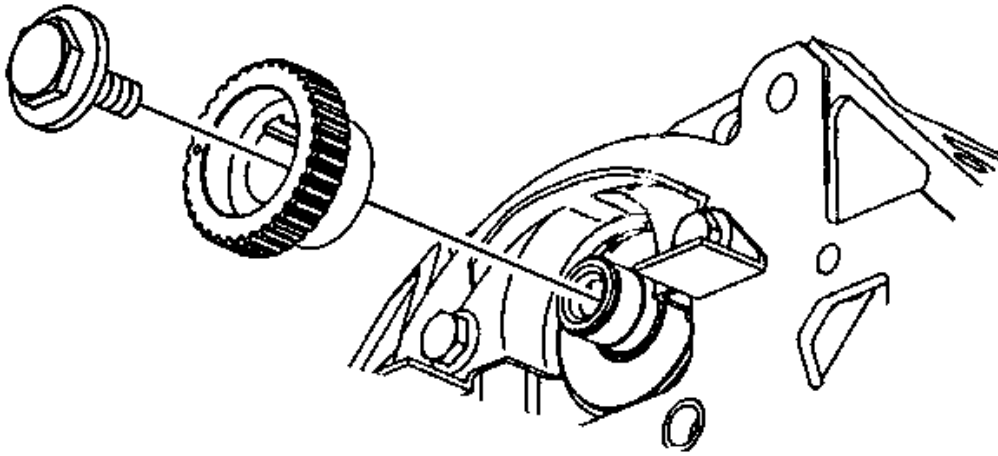


Fig. 192: Balance Shaft Driven Gear & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the balance shaft driven gear bolt, if required.
12. Remove the balance shaft driven gear, if required.
13. Clean and inspect all of the timing components for wear and damage. Refer to **Camshaft Timing Chain and Sprocket Cleaning and Inspection (L26)**.
14. If the pistons have been moved in the engine, use the following procedure:
 1. Turn the crankshaft so that the number one piston is at top dead center.
 2. Turn the camshaft so that, with the sprocket temporarily installed, the timing mark is straight down.

Installation Procedure

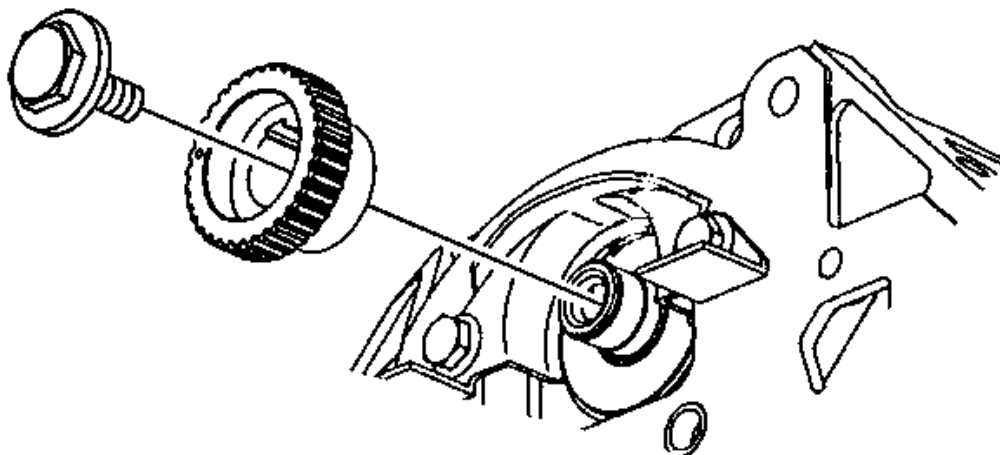


Fig. 193: Balance Shaft Driven Gear & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the balance shaft driven gear, if required.

CAUTION: Refer to Fastener Caution .

2. Prevent the balance shaft from rotating and install the balance shaft driven gear bolt.

Tighten:

1. Tighten the balance shaft driven gear bolt to 22 N.m (16 lb ft).
2. Use the **J 45059** to rotate the bolt an additional 70 degrees.

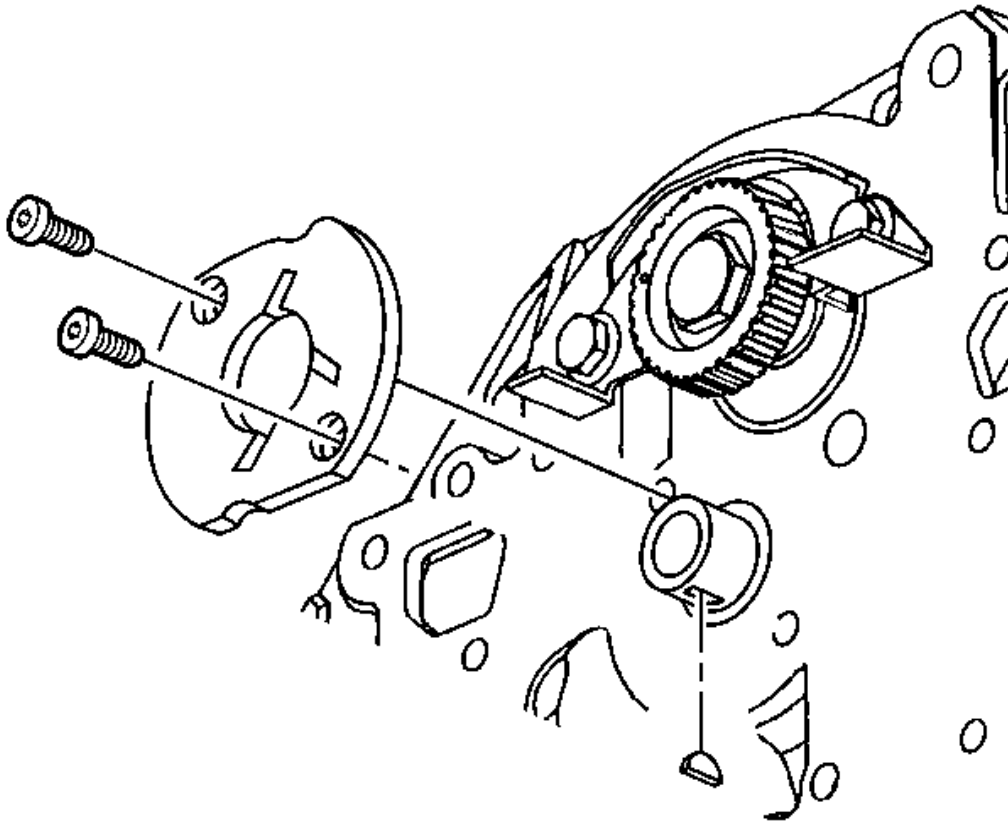


Fig. 194: Camshaft Thrust Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the camshaft thrust plate, if required.
4. Install the camshaft thrust plate bolts, if required.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

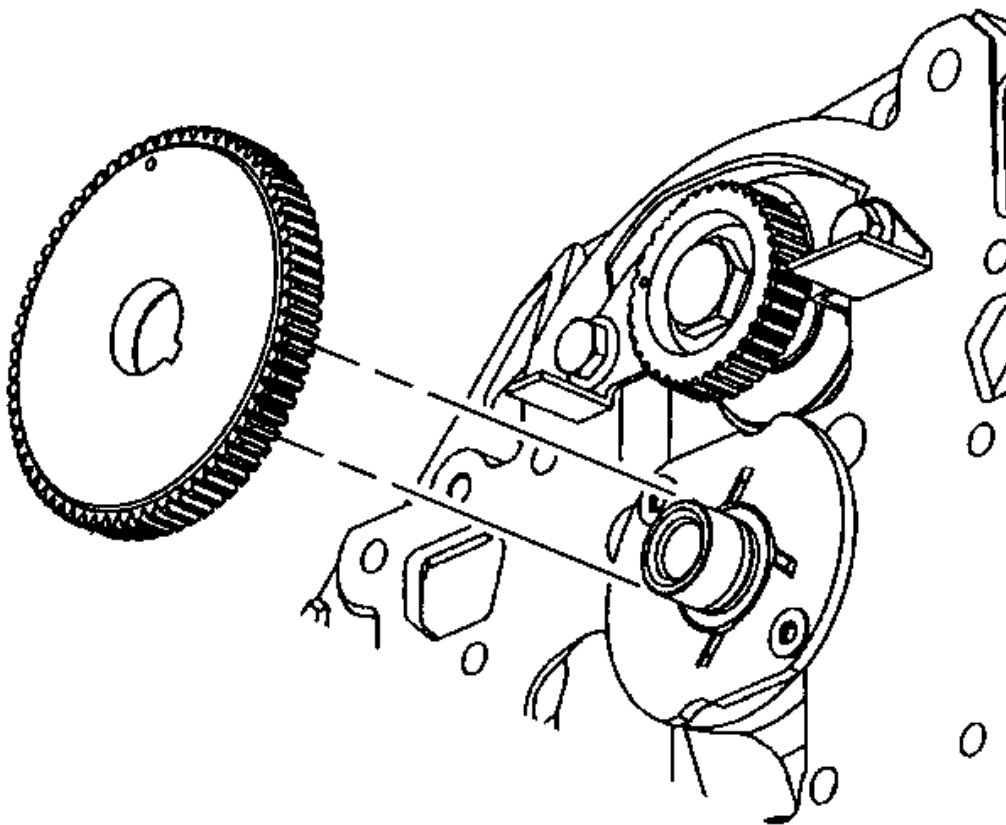


Fig. 195: Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

5. Install the balance shaft drive gear.

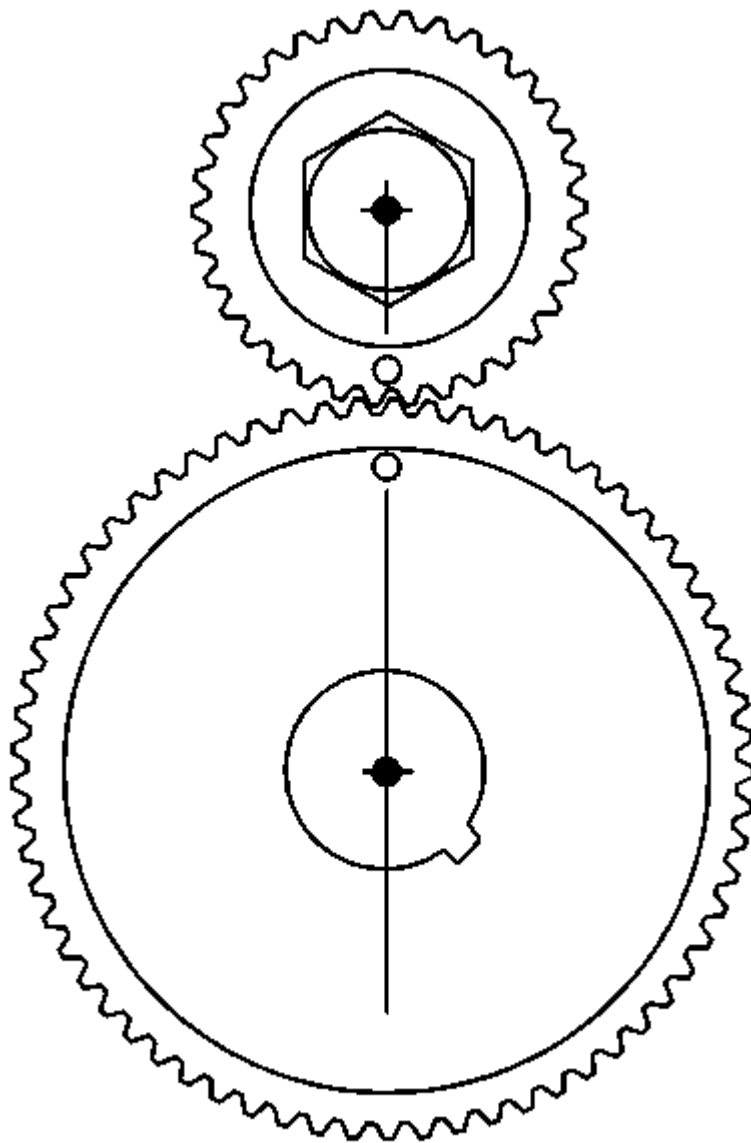


Fig. 196: Balance Shaft Drive Gear & Balance Shaft Driven Gear Timing Marks
Courtesy of GENERAL MOTORS CORP.

6. Align the timing marks on the balance shaft drive gear and the balance shaft driven gear.

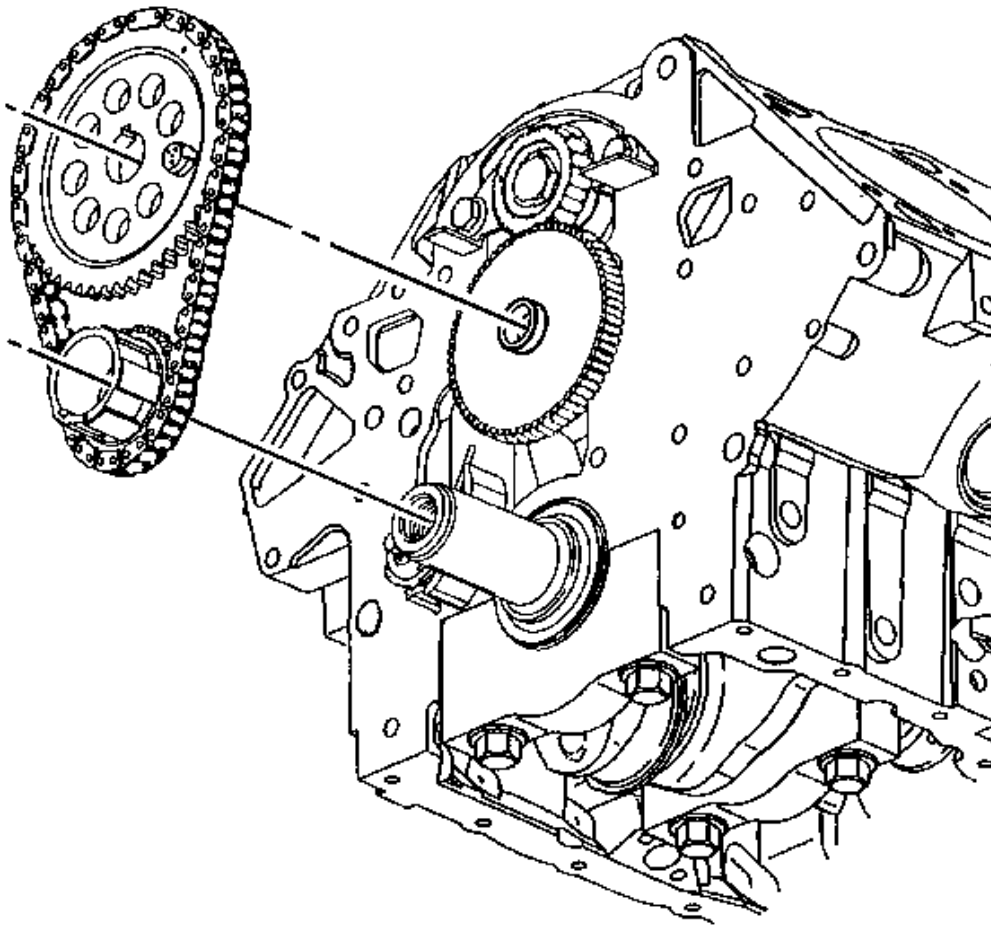


Fig. 197: Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

7. Install the crankshaft sprocket.
8. Install the timing chain and the camshaft sprocket.

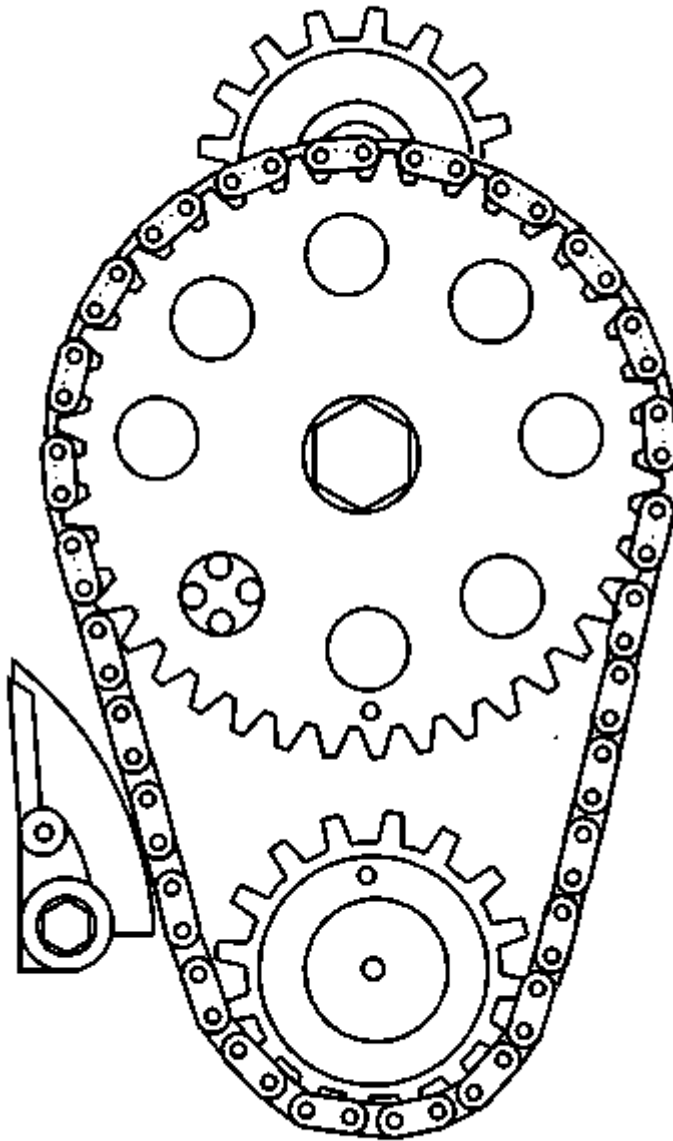


Fig. 198: Aligning Timing Chain & Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

9. Assemble the timing chain on the sprockets with the timing marks as close together as possible.

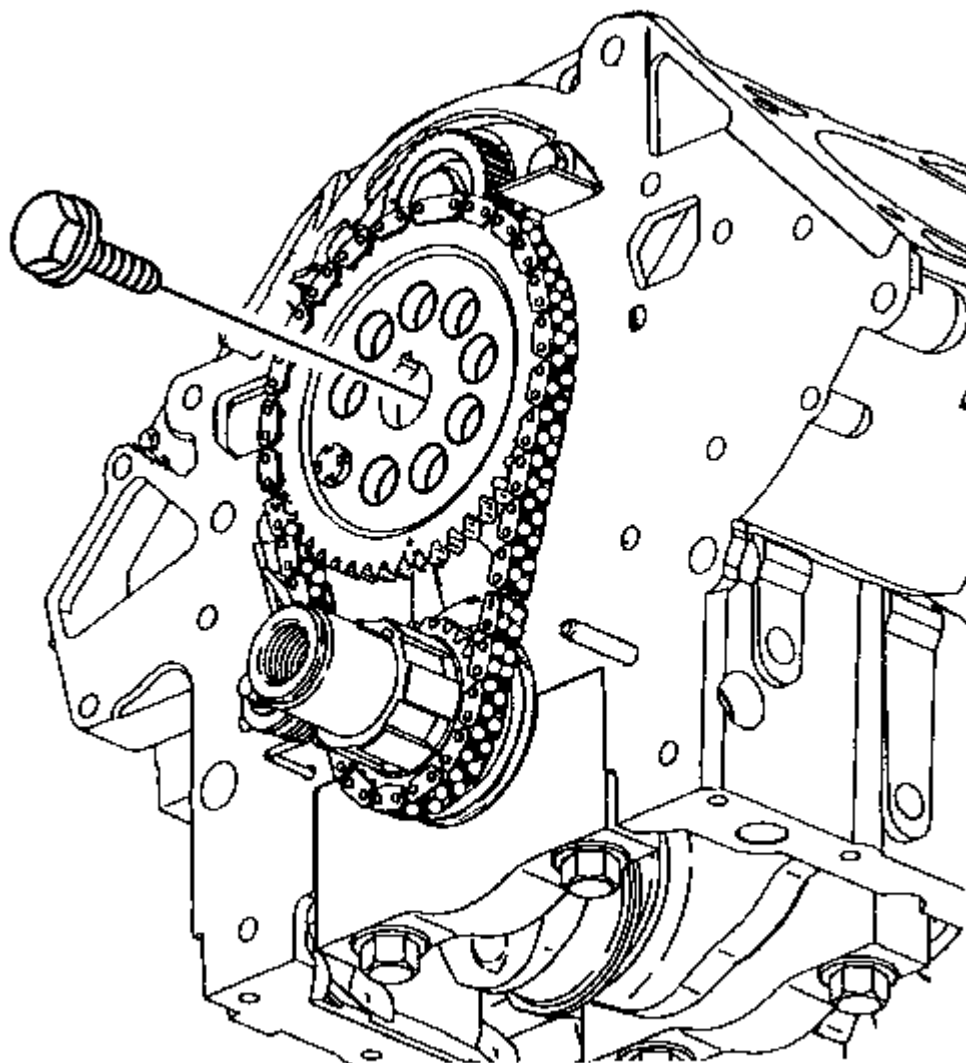


Fig. 199: Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the camshaft sprocket bolt.

Tighten:

1. Tighten the camshaft sprocket bolt to 100 N.m (74 lb ft).
2. Use the **J 45059** to rotate the bolt an additional 90 degrees.

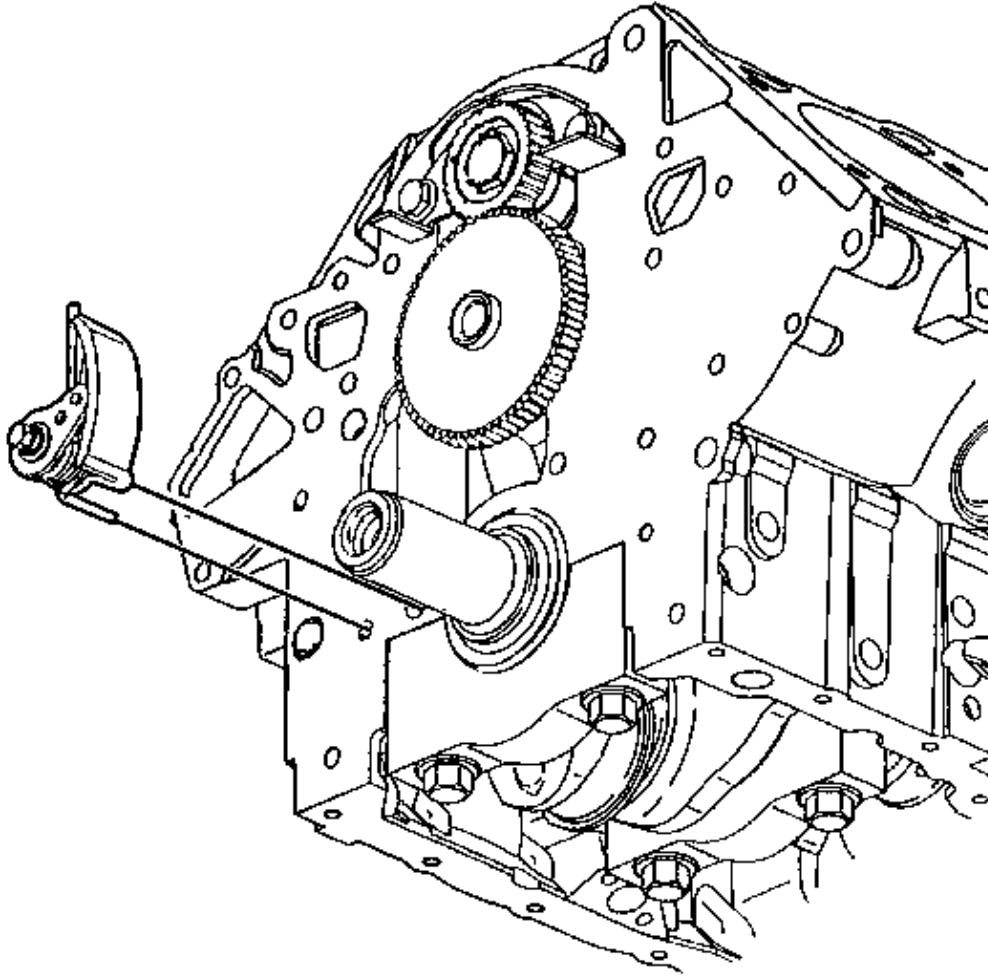


Fig. 200: Timing Chain Damper & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Install the timing chain damper.
12. Install the timing chain damper bolt.

Tighten: Tighten the bolt to 22 N.m (16 lb ft).

NOTE: Rotate the engine two revolutions and check the timing marks. Ensure that the marks are aligned.

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

CYLINDER HEAD REPLACEMENT - LEFT SIDE**Special Tools**

J 45059 Electronic Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
5. Lower the vehicle.
6. Remove the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
7. Remove the ignition control module and the bracket from the left cylinder head. Refer to **Ignition Control Module Replacement** .
8. Remove the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side (L26)**.
9. Remove the left engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Left Side**.
10. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
11. Remove the left spark plugs from the left cylinder head. Refer to **Spark Plug Replacement** .
12. Remove the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (L26)** .
13. Remove the left valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side**.
14. Remove the left rocker arms and the push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

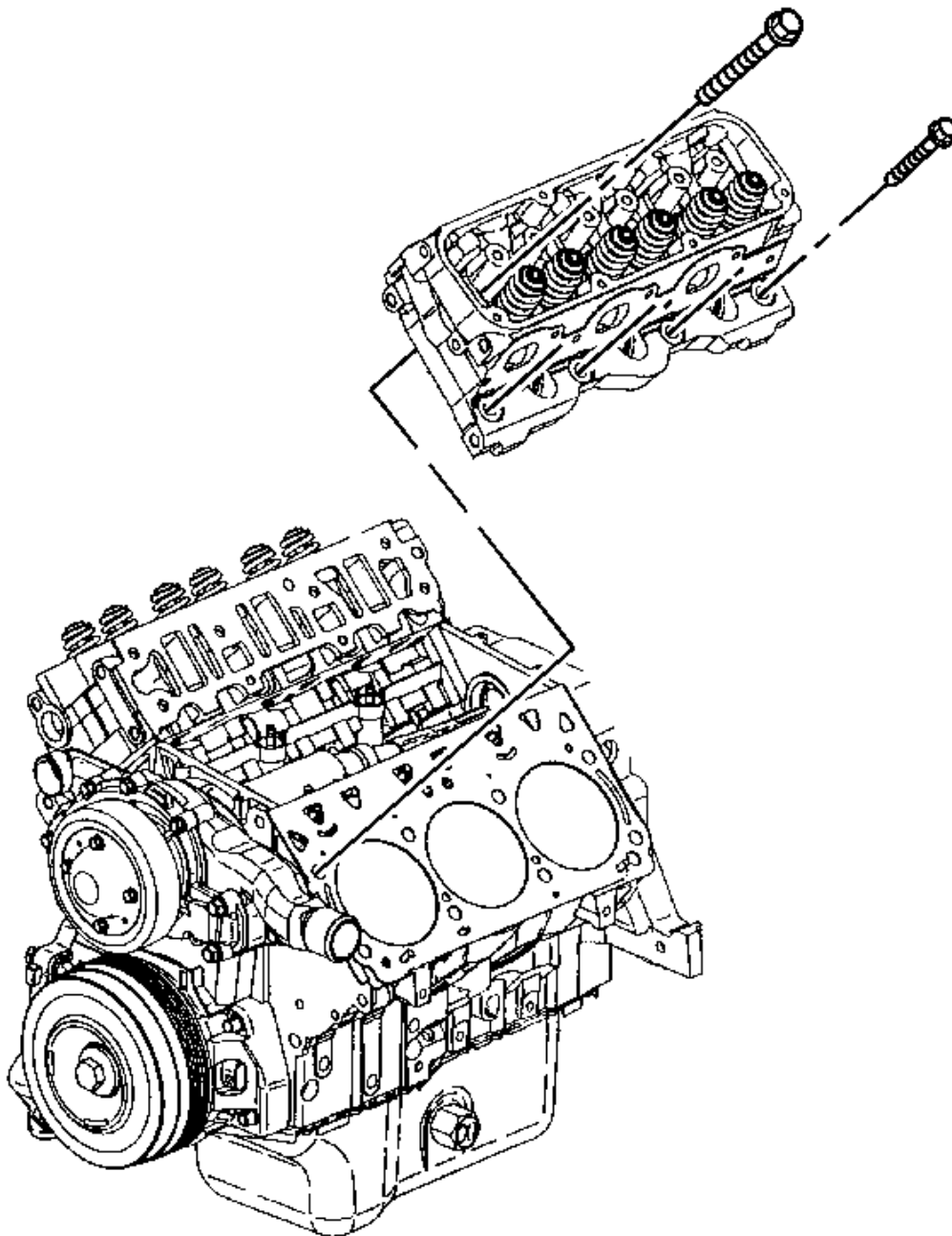


Fig. 201: Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the left cylinder head bolts. Discard the cylinder head bolts.

16. Remove the left cylinder head.

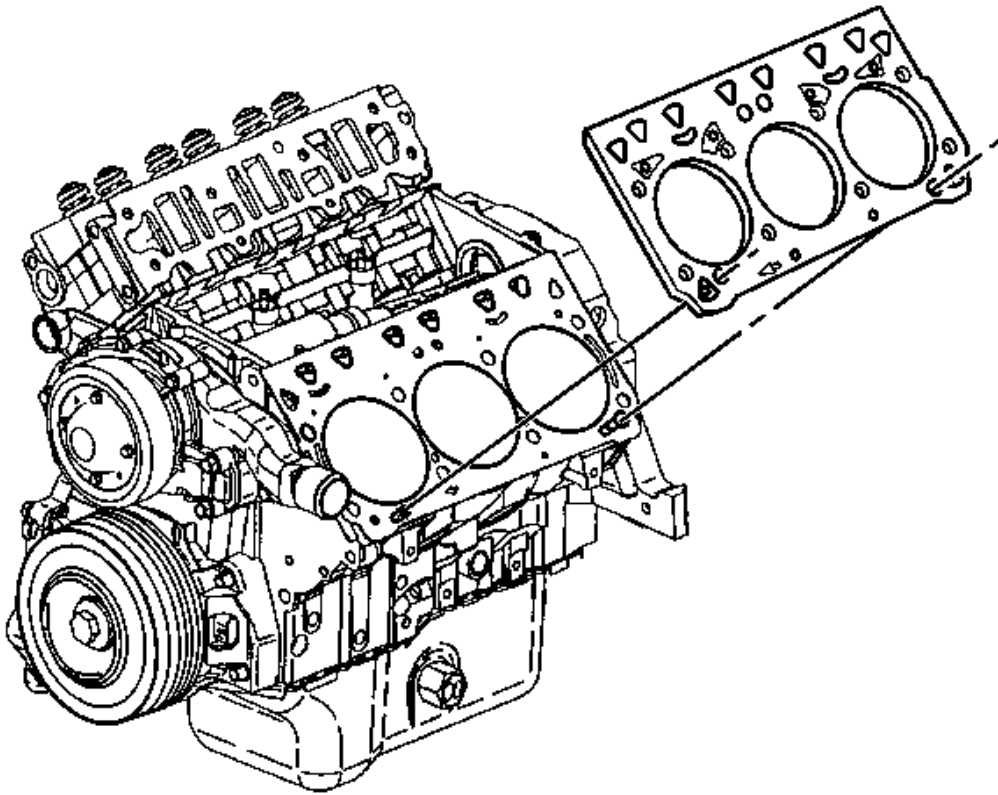


Fig. 202: Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

17. Remove the cylinder head gasket.
18. Remove the caps, the springs, the valves and the seals from the cylinder head. Refer to **Cylinder Head Disassemble**.
19. Clean the gasket mating surfaces on the cylinder head, the cylinder block and the intake manifold.
20. Clean the cylinder block bolt hole threads.
21. Inspect the engine block. Refer to **Engine Block Cleaning and Inspection**.
22. Inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection**.

Installation Procedure

1. Install the valves, the seals, the springs and the caps to the cylinder head. Refer to **Cylinder Head Assemble**.

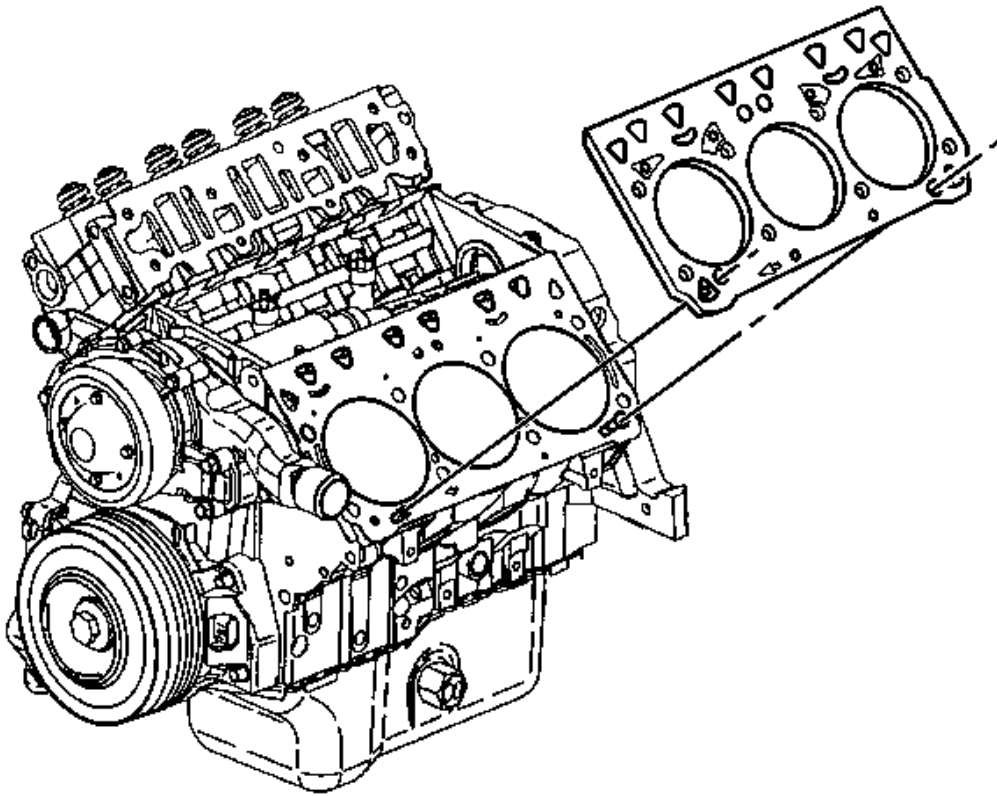


Fig. 203: Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Head gaskets are not interchangeable. The head gasket must be installed with the arrow pointing to the front of the engine. Installing the head gasket in any other direction will cause gasket failure and possible engine failure.

2. Position the head gasket with the arrow pointing to the front of the engine.

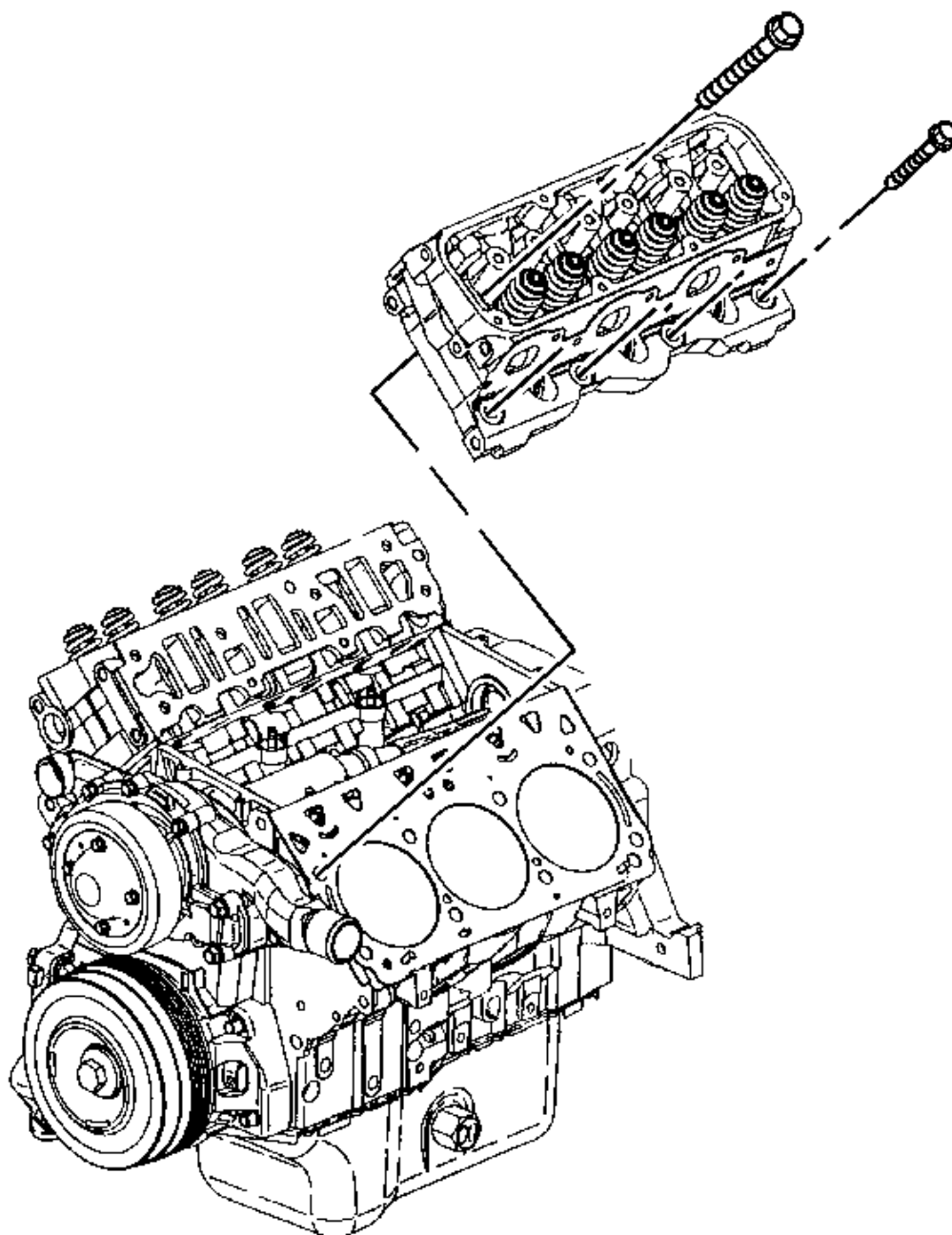


Fig. 204: Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the cylinder head.

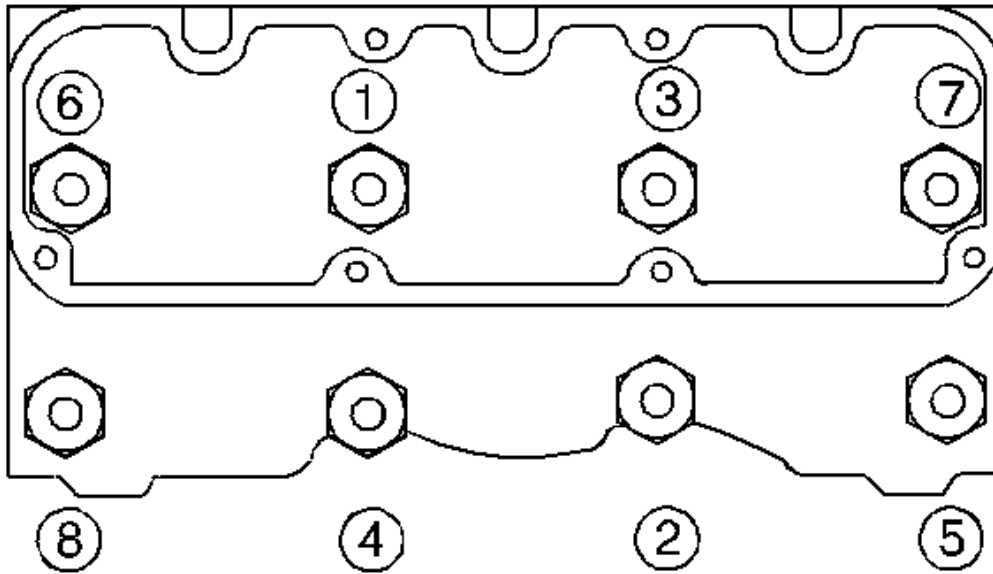


Fig. 205: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

CAUTION: This engine uses special torque to yield head bolts. This design bolt requires a special tightening procedure. Failure to follow the given procedure will cause head gasket failure and possible engine damage.

CAUTION: Refer to Fastener Caution .

4. Install the new cylinder head bolts (1-8).

Tighten:

1. Tighten the cylinder head bolts (1-8) in the following sequence to 50 N.m (37 lb ft).

2. Use the **J 45059** to rotate the cylinder head bolts in the following sequence (1-8) an additional 120 degrees.
5. Install the left push rods and rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Install the left valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side**.
7. Install the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (L26)**.
8. Install the left spark plugs to the left cylinder head. Refer to **Spark Plug Replacement**.
9. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
10. Install the left engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Left Side**.
11. Install the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement - Right Side (L26)**.
12. Install the ignition control module bracket and the ignition control module to the left cylinder head. Refer to **Ignition Control Module Replacement**.
13. Install the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement**.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)**.
15. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
17. Inspect for leaks.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

- **J 41131** Engine Tilt Strap. See **Special Tools**.
- **J 45059** Electronic Torque Angle Meter

Removal Procedure

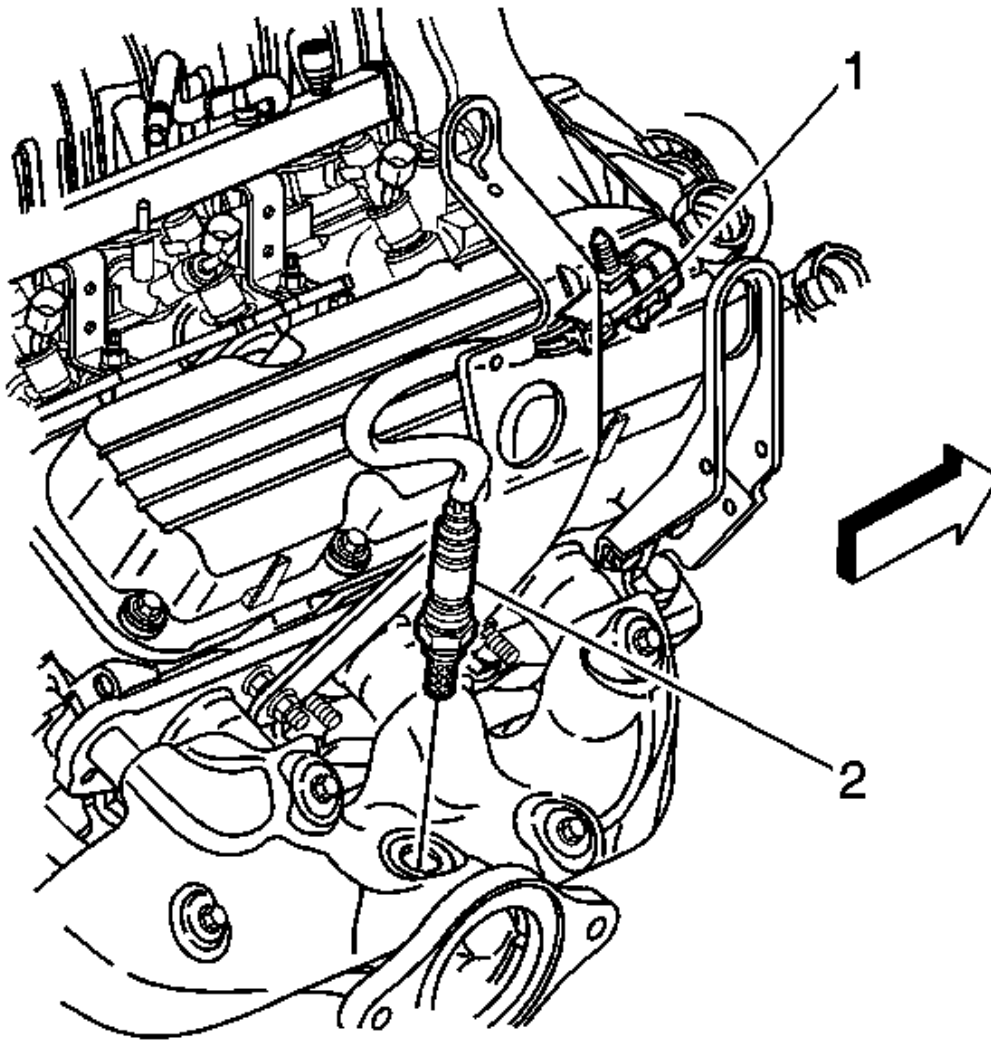


Fig. 206: HO2S Electrical Connector & Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Disconnect the heated oxygen sensor (HO2S) electrical connector (1).
4. Remove the HO2S (2) from the right exhaust manifold.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
6. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling**

System Draining and Filling (L26 GE 47716 Fill) .

7. Drain the engine oil.
8. Remove the catalytic converter from the right exhaust manifold. Refer to **Catalytic Converter Replacement (V6) .**

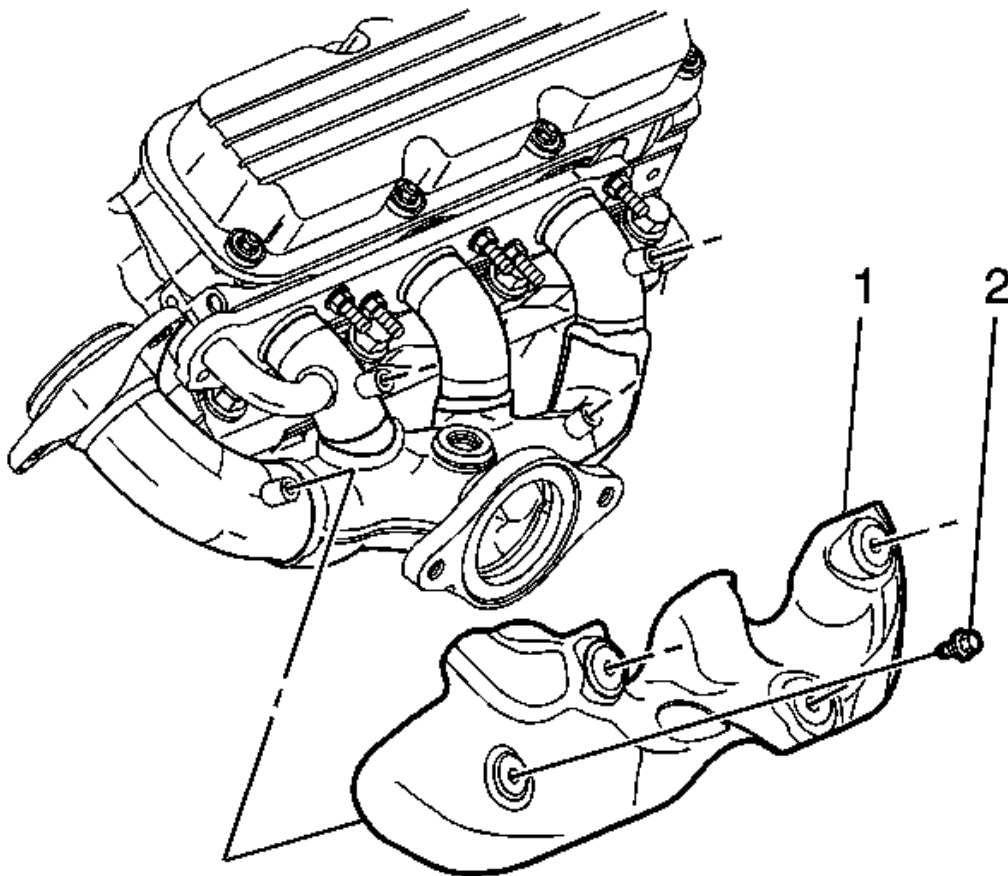


Fig. 207: Right Exhaust Manifold Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the right exhaust manifold heat shield bolts (2).
10. Remove the right exhaust manifold heat shield (1).

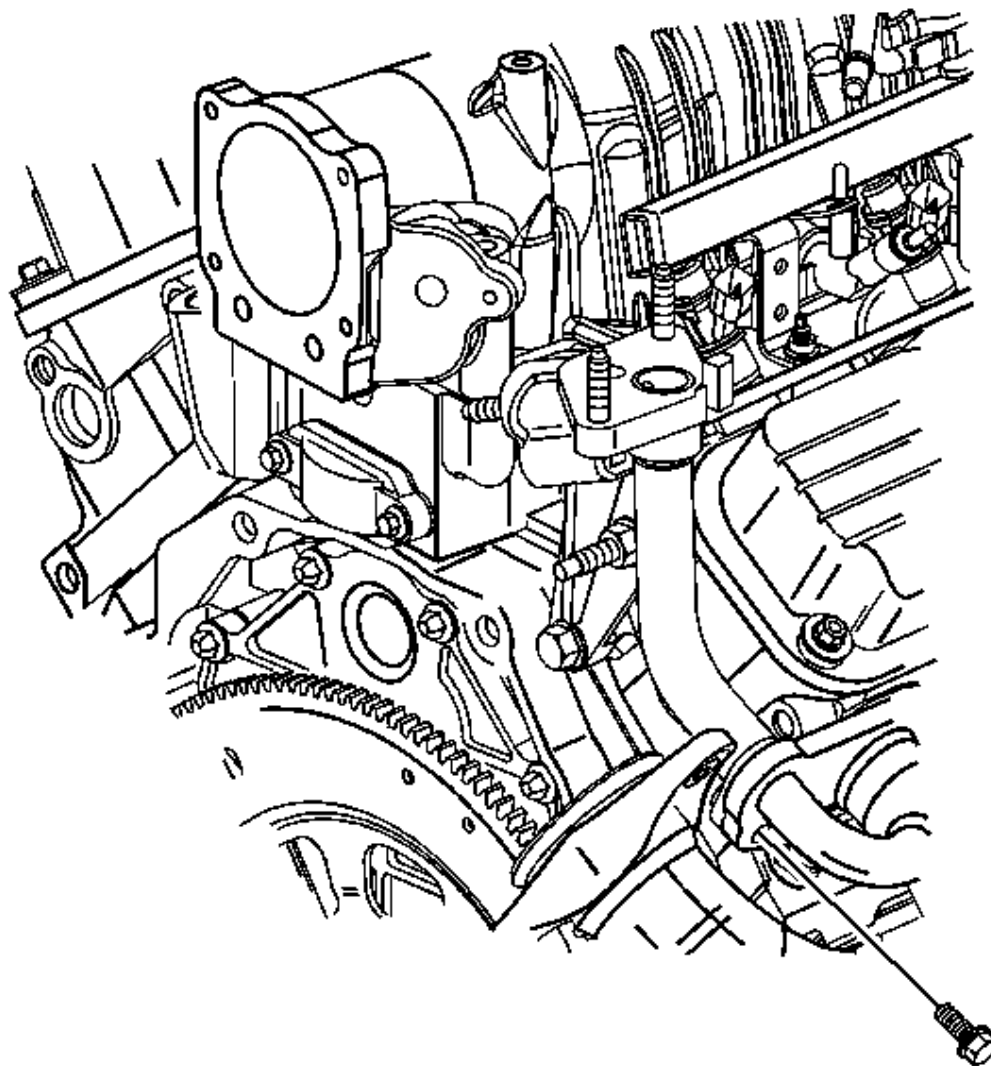


Fig. 208: EGR Valve Adapter Bolt & Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

11. Remove the exhaust gas recirculation (EGR) valve adapter bolt from the right exhaust manifold.
12. Lower the vehicle.
13. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

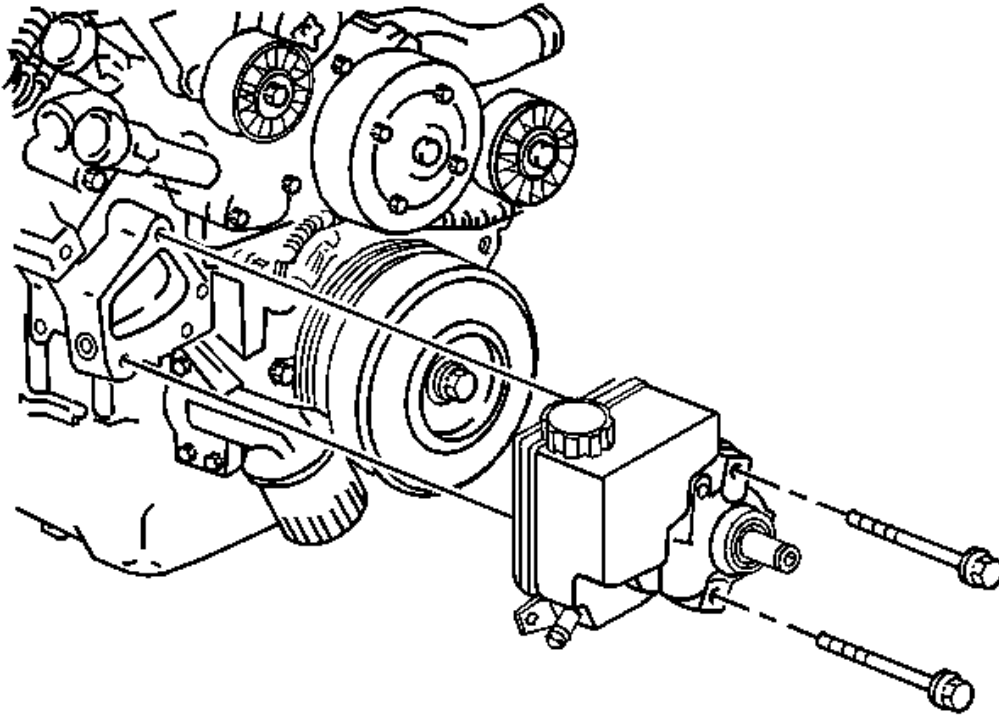


Fig. 209: View Of Power Steering Pump And Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the power steering pump bolts and reposition the power steering pump.
15. Rotate the engine to access the right cylinder head. Refer to **Rotating the Engine for Service Access**.
16. Remove the right spark plugs from the right cylinder head. Refer to **Spark Plug Replacement**.
17. Remove the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
18. Remove the EGR valve inlet adapter pipe from the right cylinder head. Refer to **Exhaust Gas Recirculation Inlet Pipe Replacement**.
19. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (3.8L)**.
20. Remove the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Right Side**.
21. Remove the right rocker arms and push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

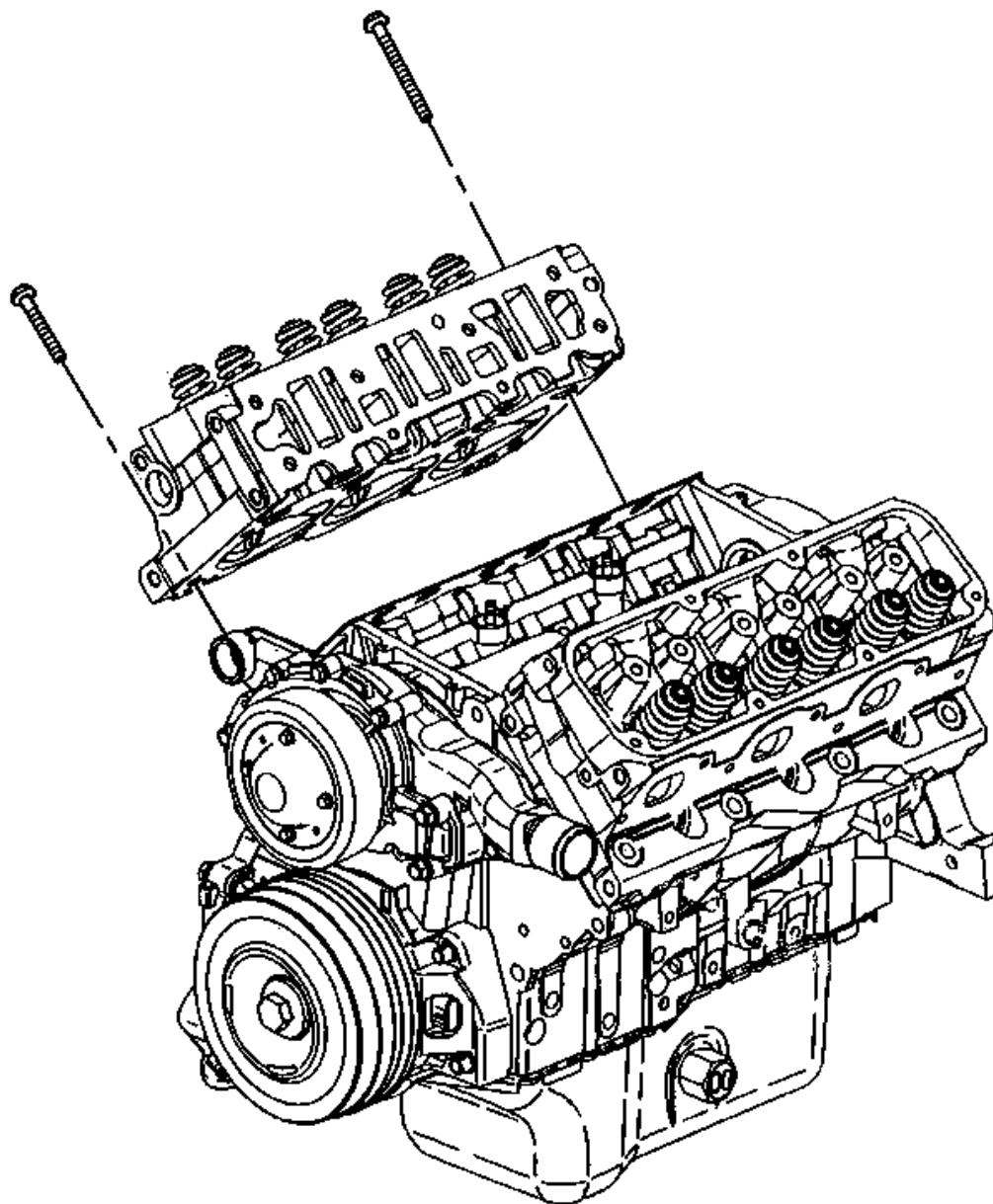


Fig. 210: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

22. Remove the right cylinder head bolts. Discard the cylinder head bolts.
23. Remove the right cylinder head.

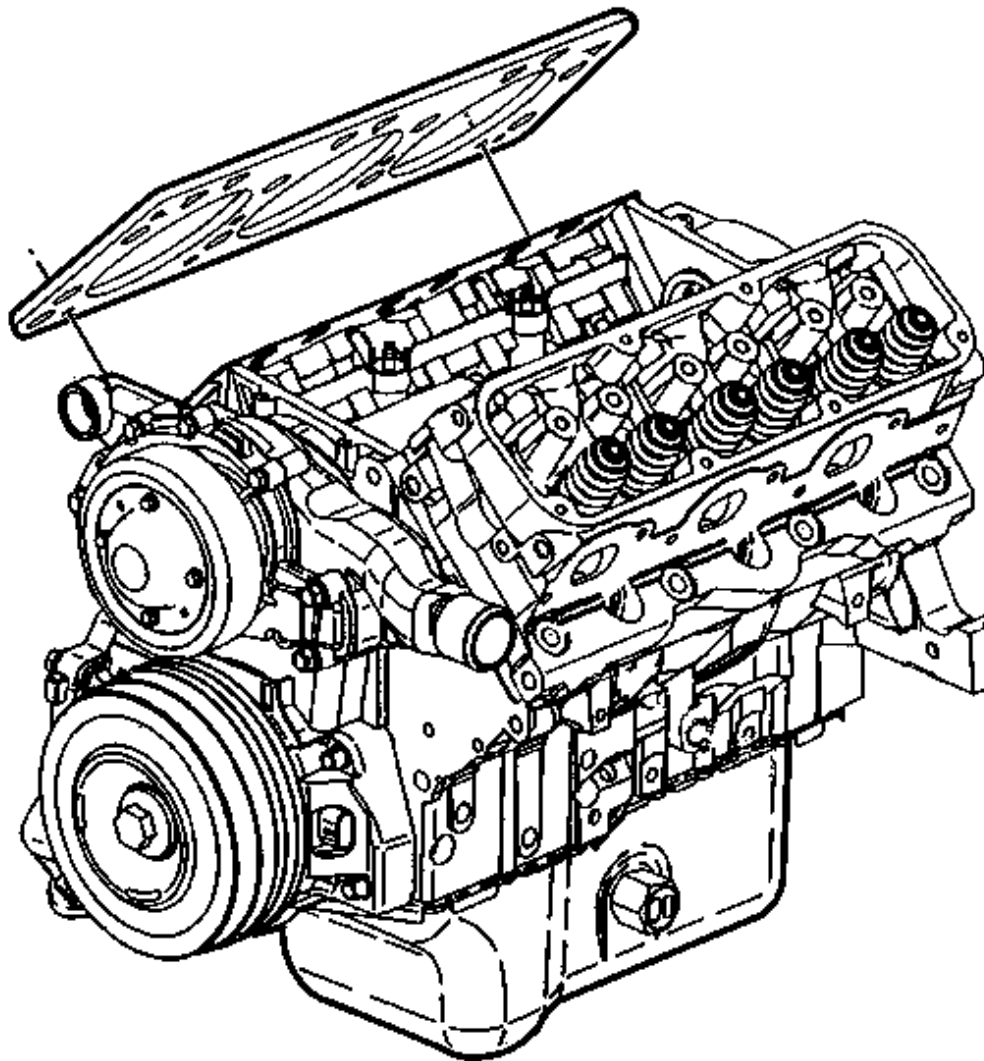


Fig. 211: Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

24. Remove the cylinder head gasket.
25. Remove the caps, the springs, the valves and the seals from the cylinder head. Refer to **Cylinder Head Disassemble**.
26. Clean the gasket mating surfaces on the cylinder head, the engine block and the intake manifold.
27. Clean the cylinder block bolt hole threads.
28. Inspect the engine block. Refer to **Engine Block Cleaning and Inspection**.

29. Inspect the cylinder head. Refer to Cylinder Head Cleaning and Inspection.

Installation Procedure

1. Install the valves, the seals, the springs and the caps to the cylinder head. Refer to Cylinder Head Assemble.

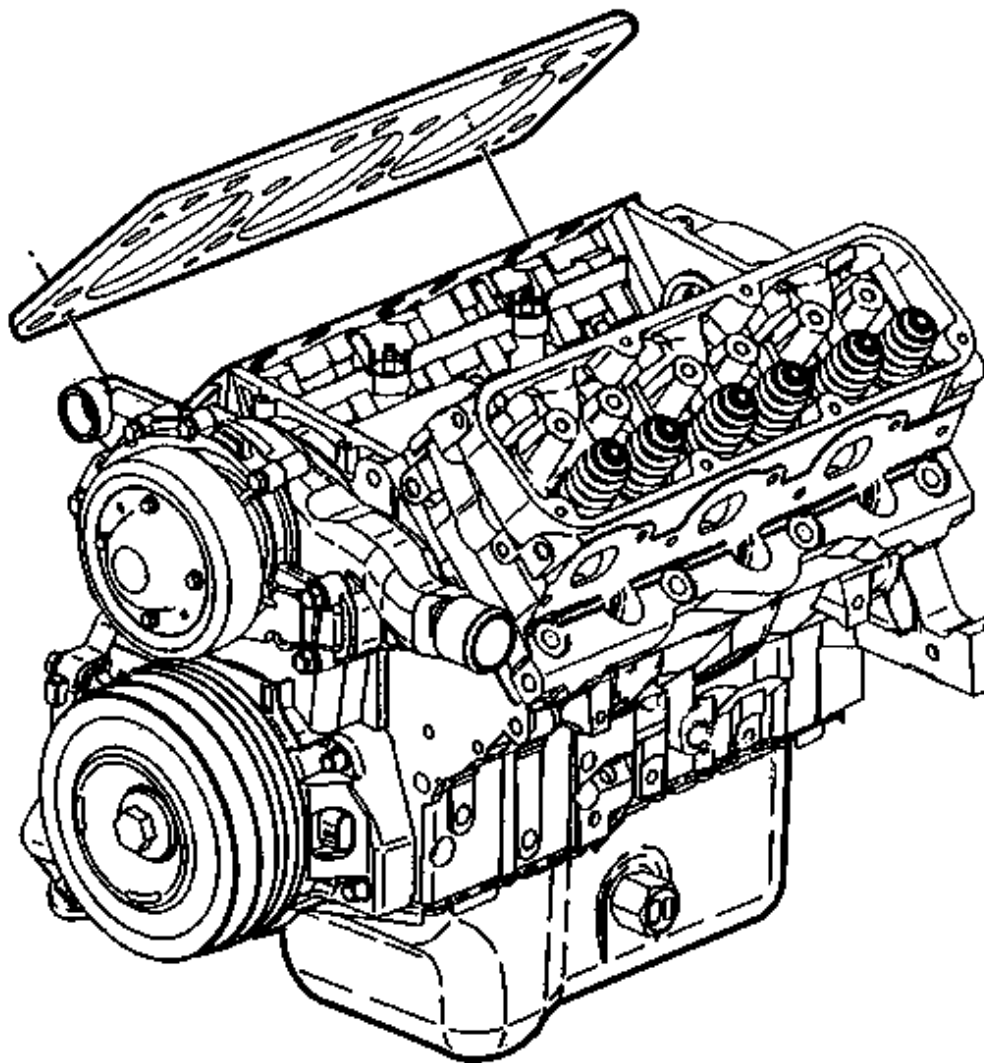


Fig. 212: Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Head gaskets are not interchangeable. The head gasket must be installed with the arrow pointing to the front of the engine. Installing the head gasket in any other direction will cause gasket failure and possible engine failure.

2. Position the head gasket with the arrow pointing to the front of the engine.

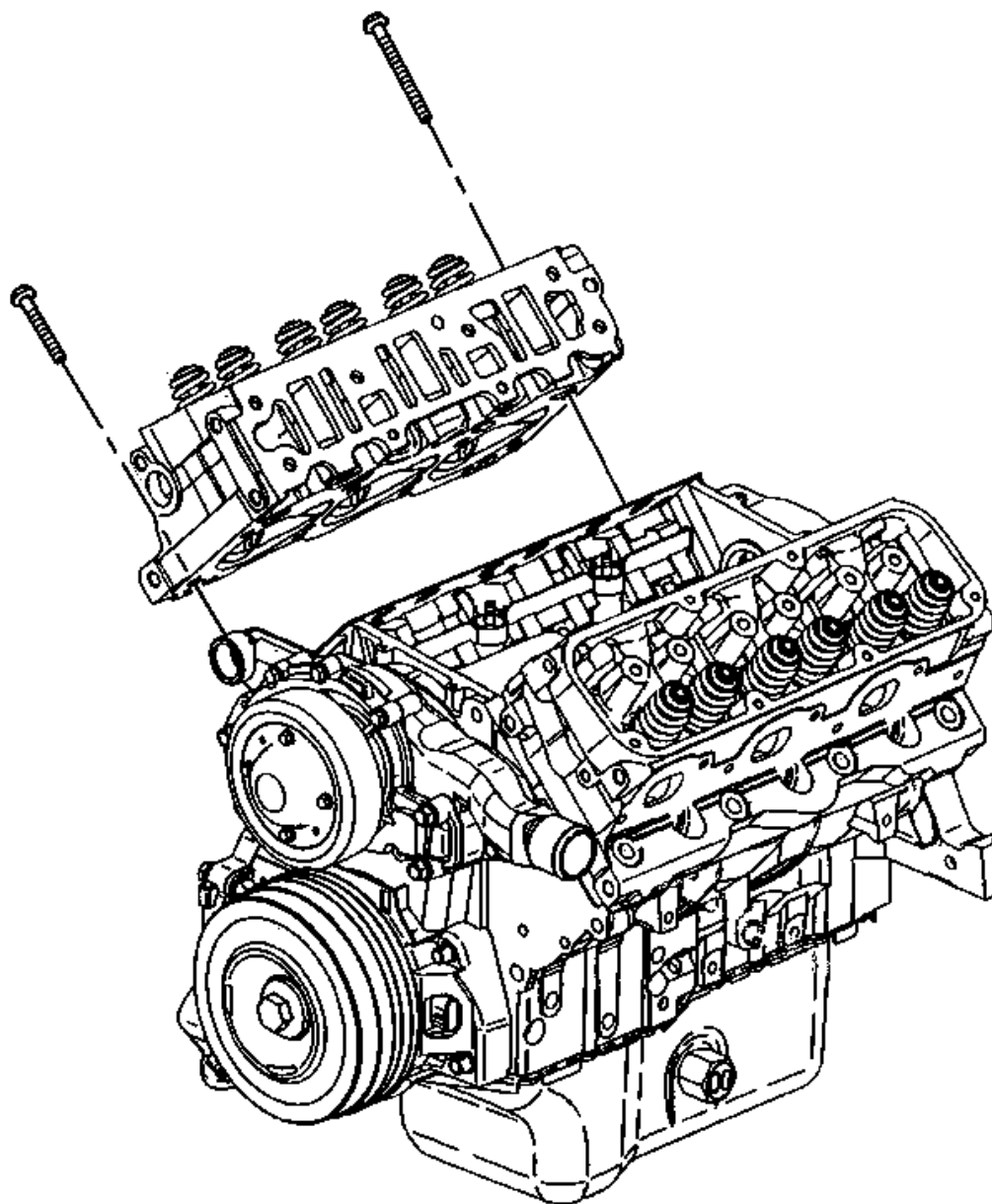


Fig. 213: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the cylinder head.

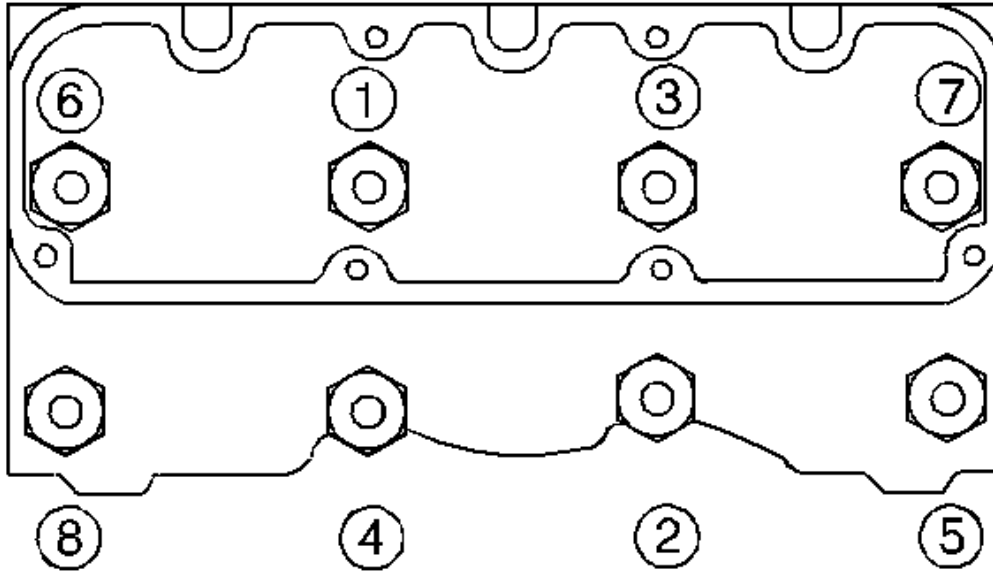


Fig. 214: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the components may be damaged.

CAUTION: This engine uses special torque to yield head bolts. This design bolt requires a special tightening procedure. Failure to follow the given procedure will cause head gasket failure and possible engine damage.

CAUTION: Refer to Fastener Caution .

4. Install the new cylinder head bolts (1-8).

Tighten:

1. Tighten the cylinder head bolts in the following sequence (1-8) to 50 N.m (37 lb ft).
2. Use the **J 45059** to rotate the cylinder head bolts in the following sequence (1-8) an additional 120 degrees.
5. Install the right push rods and rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Install the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Right Side**.
7. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (3.8L)**.
8. Install the EGR valve inlet adapter pipe to the right cylinder head. Refer to **Exhaust Gas Recirculation Inlet Pipe Replacement**.
9. Install the lower intake manifold. Refer to **Lower Intake Manifold Replacement**.
10. Install the right spark plugs to the right cylinder head. Refer to **Spark Plug Replacement**.
11. Carefully release the **J 41131** and return the engine to the original position. See **Special Tools**.

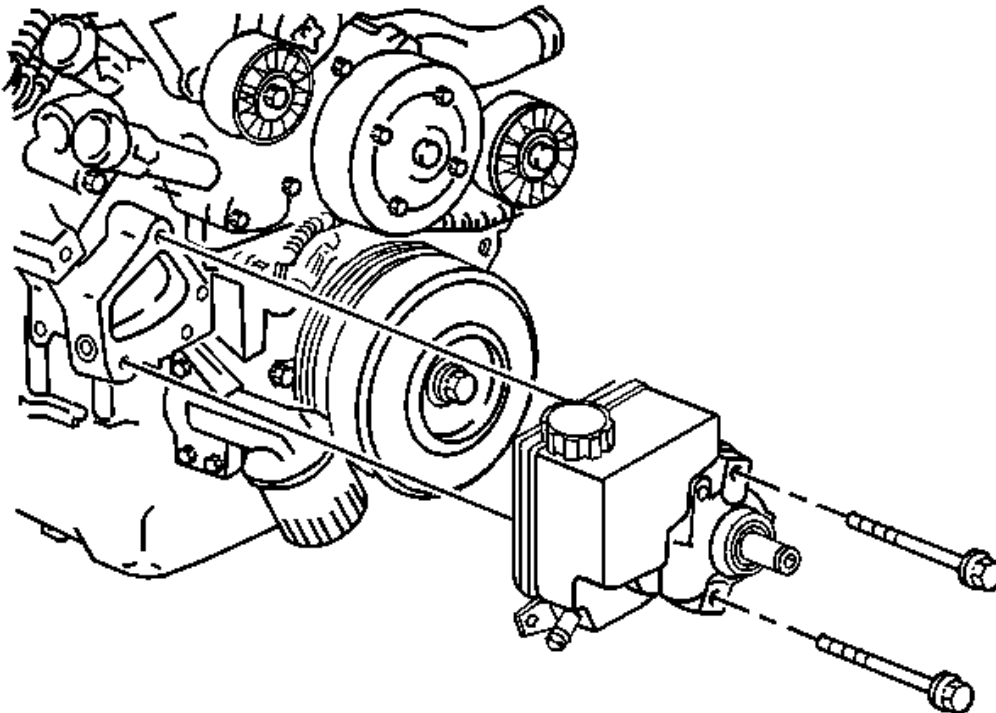


Fig. 215: View Of Power Steering Pump And Mounting Bolts
 Courtesy of GENERAL MOTORS CORP.

12. Install the power steering pump.
13. Install the power steering pump bolts.

Tighten: Tighten the bolts to 34 N.m (25 lb ft).

14. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
15. Install the left and the right engine mount struts. Refer to **Engine Mount Strut Replacement - Right Side** and **Engine Mount Strut Replacement - Left Side**.
16. Raise the vehicle.

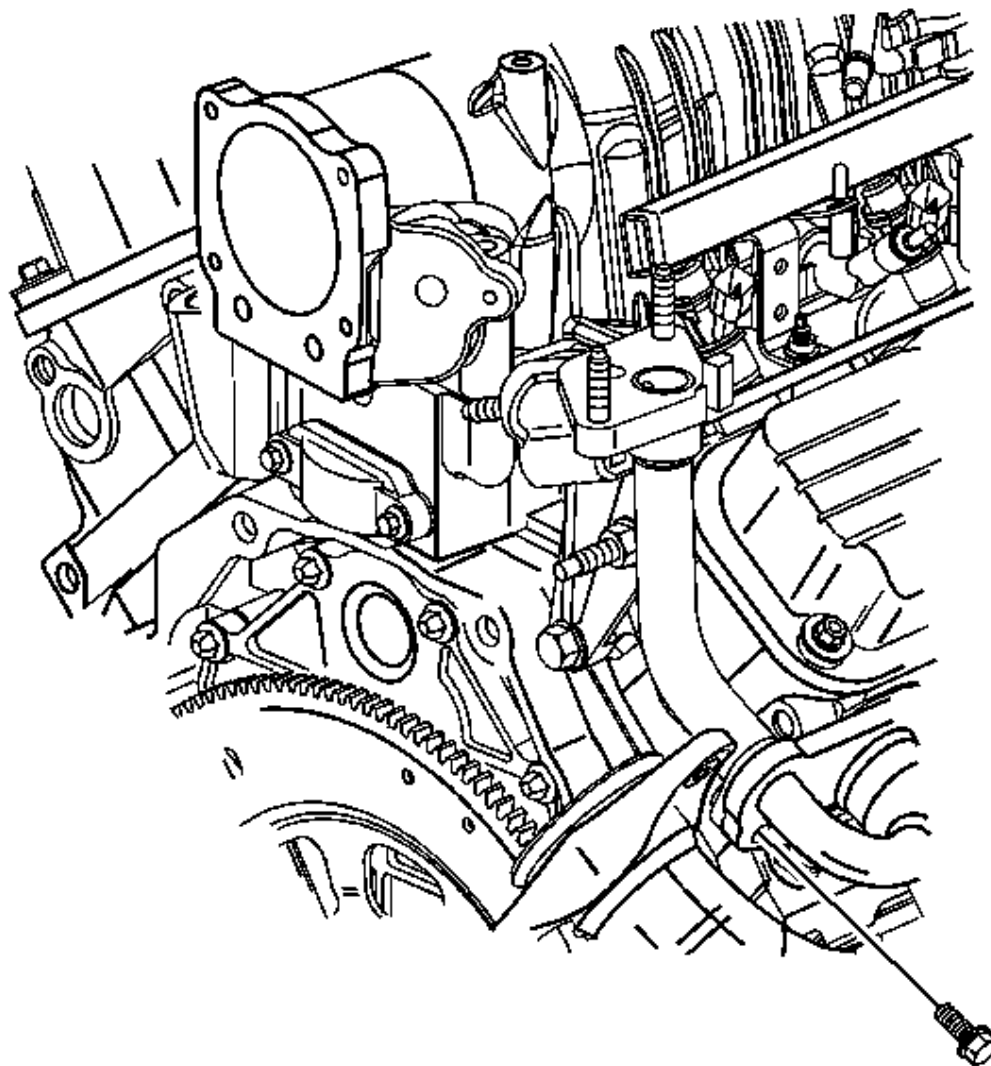


Fig. 216: EGR Valve Adapter Bolt & Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

17. Install the exhaust gas recirculation (EGR) valve adapter bolt to the right exhaust manifold.

Tighten: Tighten the bolt to 29 N.m (21 lb ft).

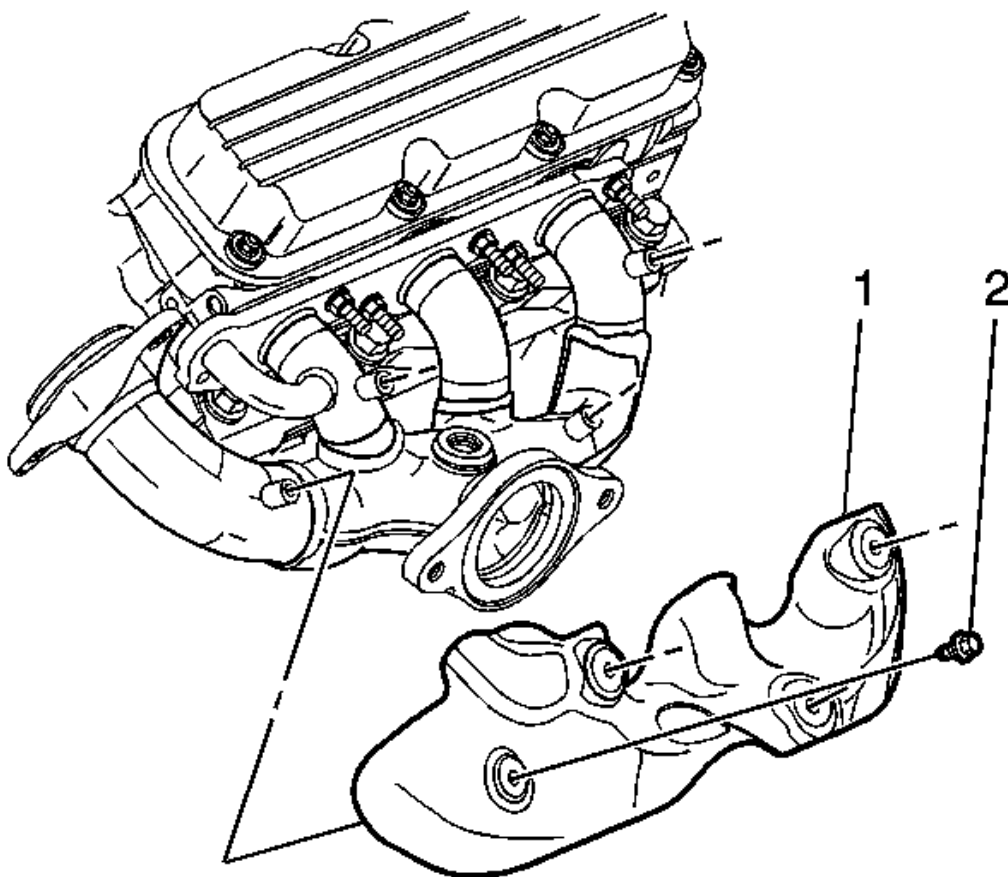


Fig. 217: Right Exhaust Manifold Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

18. Install the right exhaust manifold heat shield (1).
19. Install the right exhaust manifold heat shield bolts (2).

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

20. Install the catalytic converter to the right exhaust manifold. Refer to Catalytic Converter Replacement (V6).
21. Lower the vehicle.

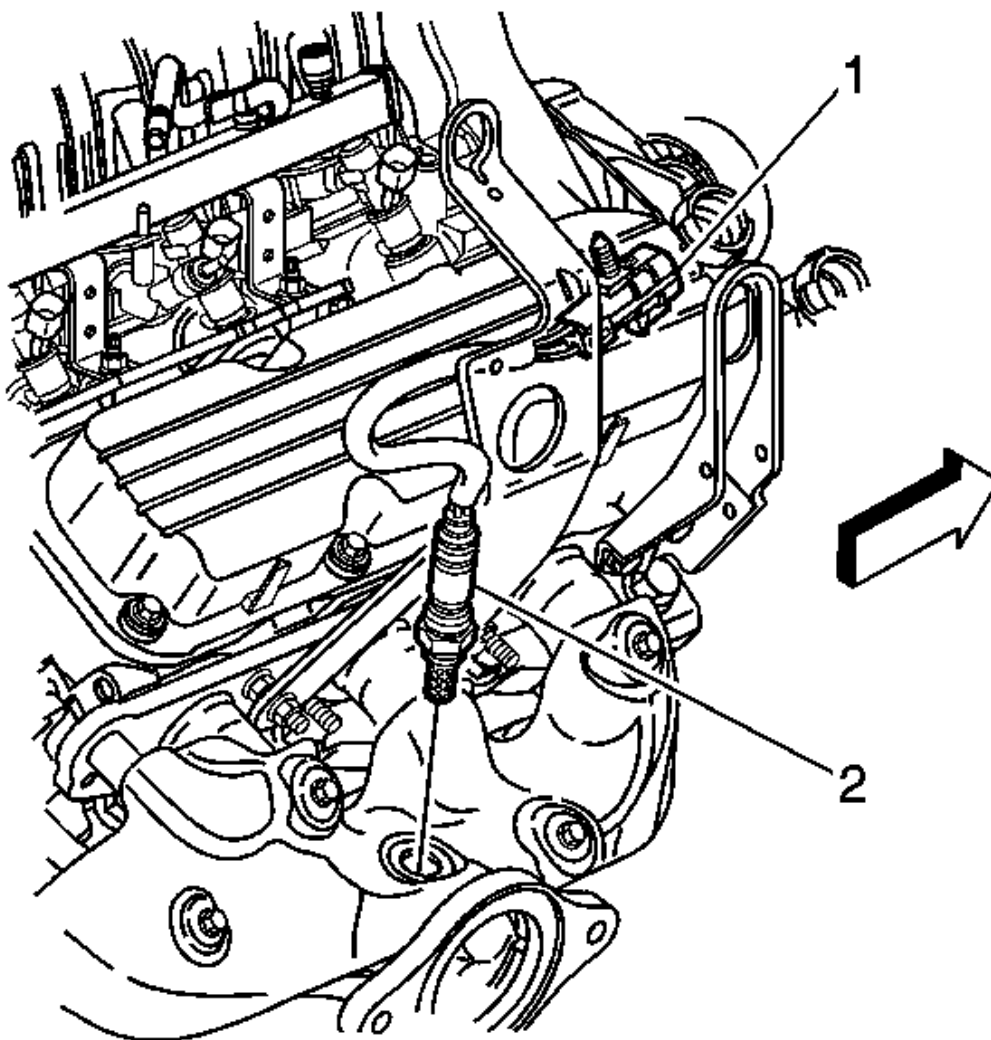


Fig. 218: HO2S Electrical Connector & Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

22. Install the HO2S (2) to the right exhaust manifold.

Tighten: Tighten the HO2S to 42 N.m (31 lb ft).

23. Connect the HO2S electrical connector (1).
24. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
25. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

26. Fill the cooling system. Refer to Cooling System Draining and Filling (L26 Static Fill) or Cooling System Draining and Filling (L26 GE 47716 Fill).
27. Connect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (L26).
28. Inspect for leaks.

OIL PAN REPLACEMENT

Removal Procedure

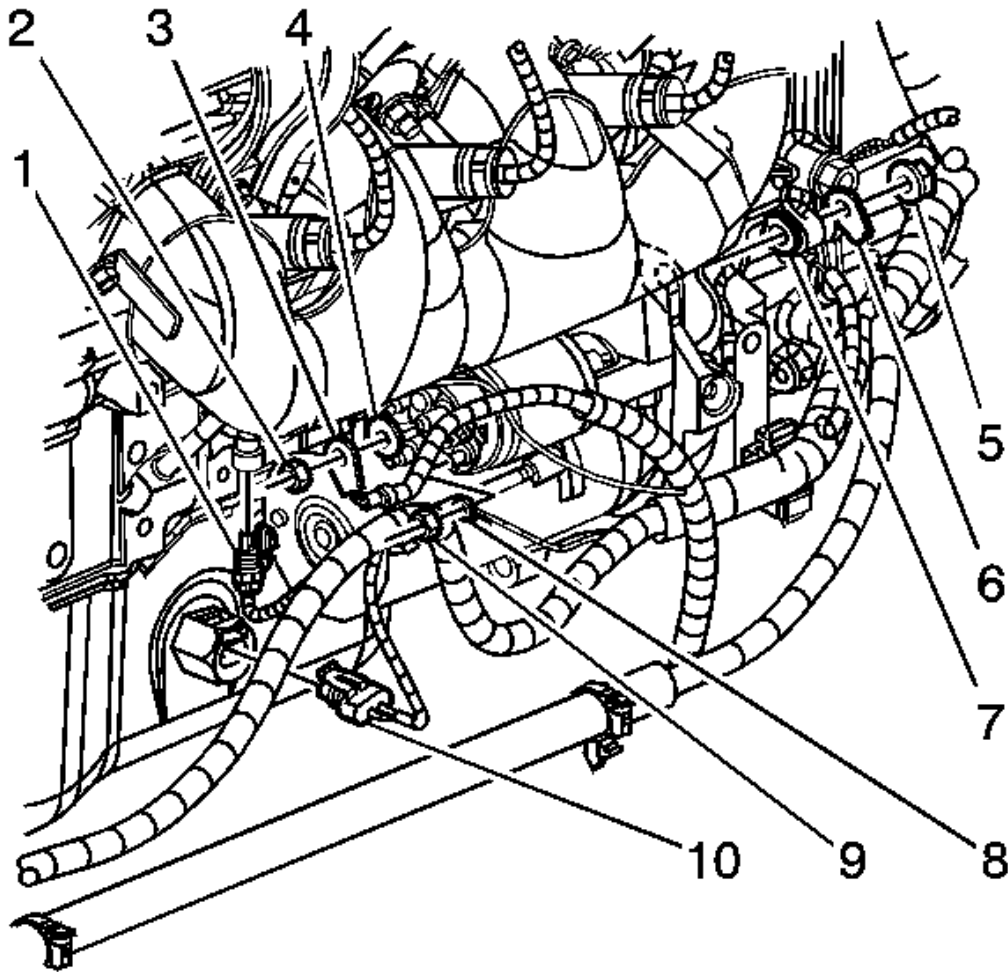


Fig. 219: View Of Engine Electrical Connectors (Left Side)
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
3. Remove the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement**.
4. Install the engine support fixture. Refer to **Engine Support Fixture**.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
6. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
7. Remove the power steering oil cooler pipe brackets from the frame.
8. Disconnect the oil level sensor electrical connector (10).
9. Remove the oil level sensor wiring harness bolt and reposition the oil level sensor wiring harness.

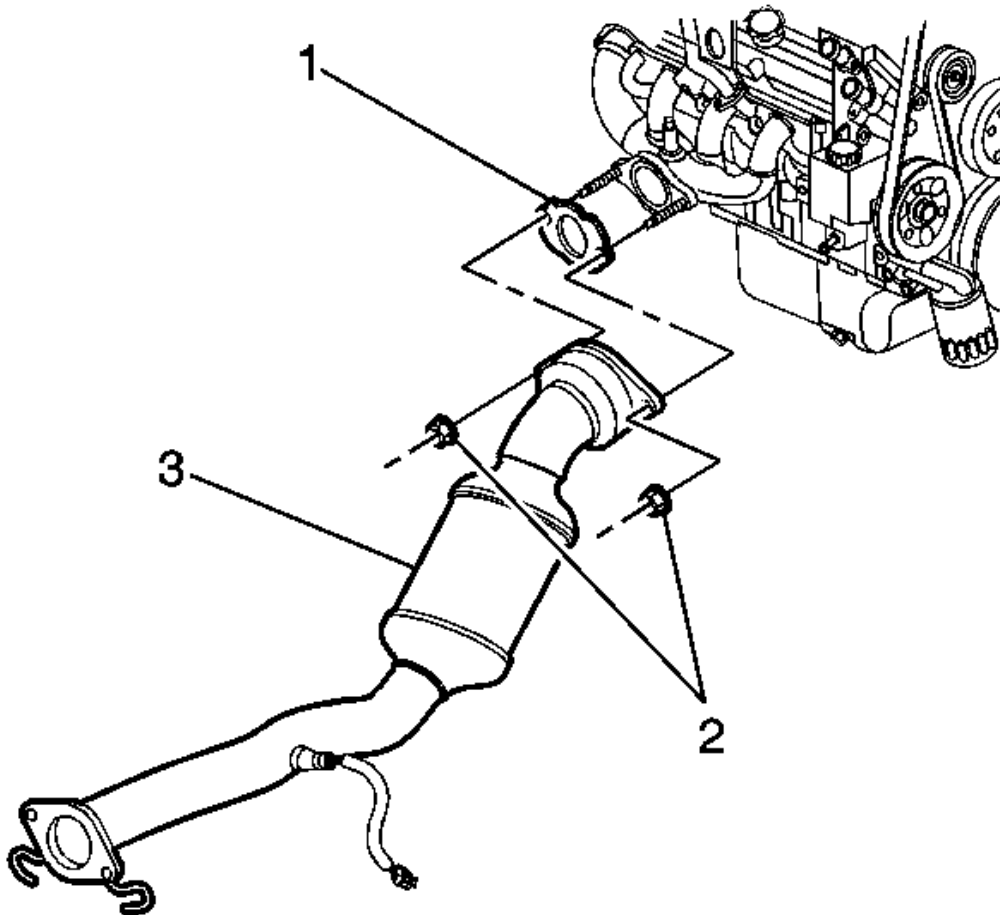


Fig. 220: Right Exhaust Manifold & Catalytic Converter Pipe
Courtesy of GENERAL MOTORS CORP.

10. Remove the catalytic converter (3) to the right exhaust manifold pipe stud nuts (2) and reposition the catalytic converter.
11. Remove the left engine mount strut. Refer to Engine Mount Strut Replacement - Left Side.
12. Remove the right engine mount strut. Refer to Engine Mount Strut Replacement - Right Side.
13. Remove the torque converter covers. Refer to Torque Converter Cover Replacement.
14. Lower the vehicle.
15. Using the engine support fixture raise the engine to gain access for the oil pan removal.
16. Raise the vehicle.

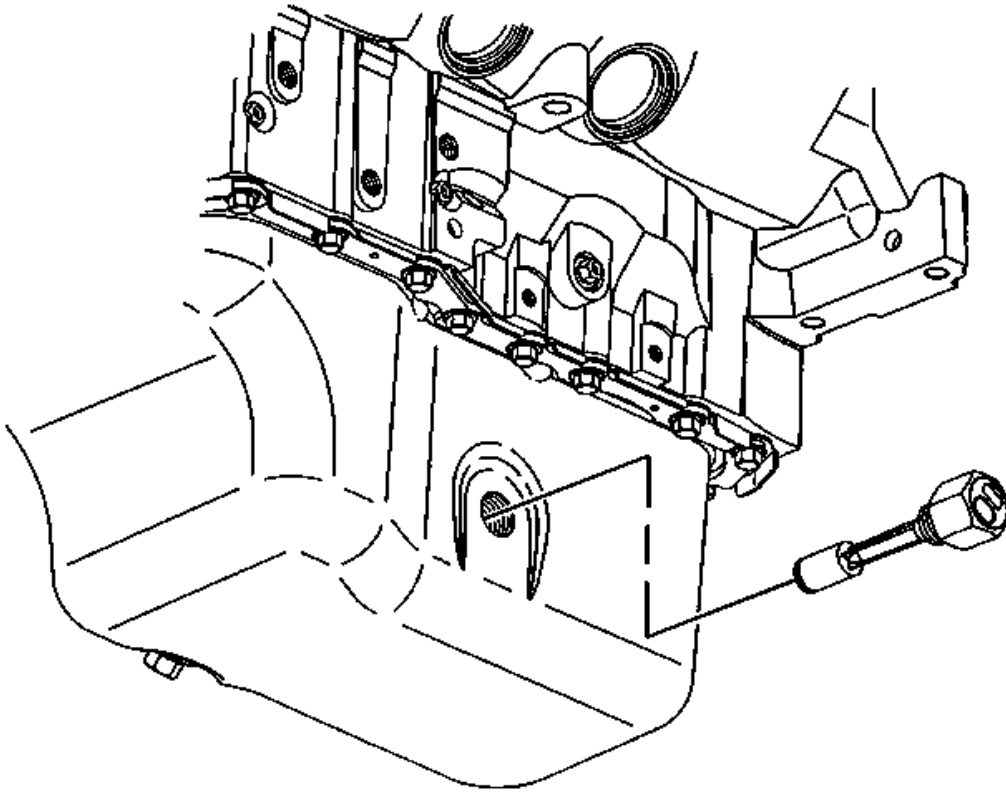


Fig. 221: Oil Level Sensor

Courtesy of GENERAL MOTORS CORP.

CAUTION: Remove the oil level sensor, located in the oil pan, before the oil pan is removed. The sensor may be damaged if the oil pan is removed first.

17. Remove the oil level sensor.

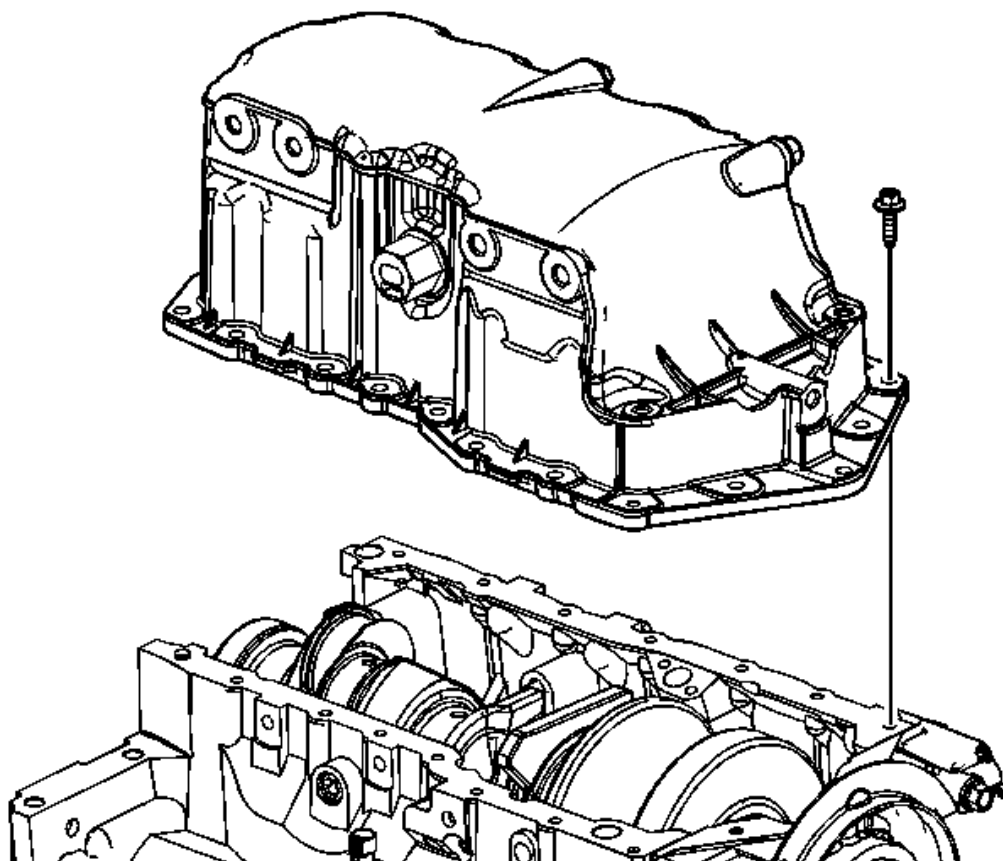


Fig. 222: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the oil pan bolts.
19. Remove the oil pan.

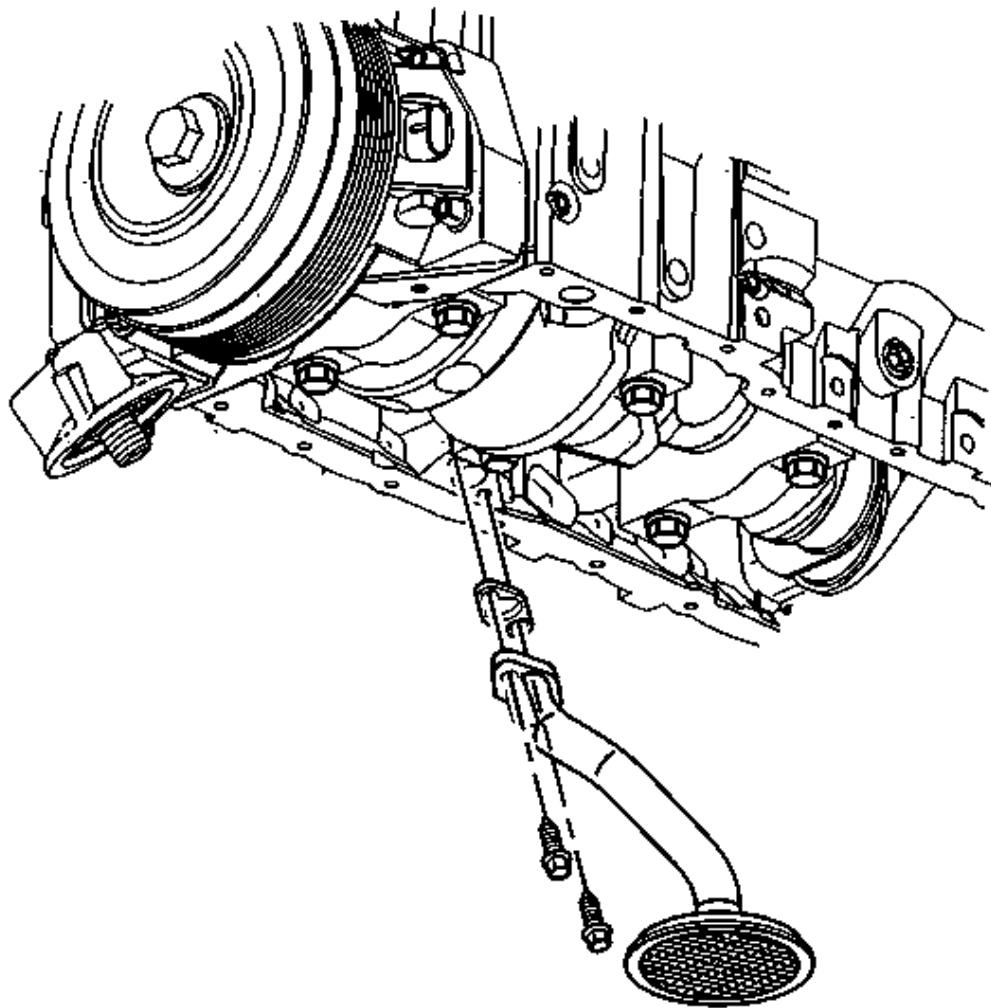


Fig. 223: Oil Pump Screen & Bolts
Courtesy of GENERAL MOTORS CORP.

20. Remove the oil pump pipe screen assembly.
21. Clean the following parts:
 - Oil pump screen mating surfaces
 - Oil pan flanges
 - Oil pan rail
 - Front cover
 - Rear main bearing cap

- Threaded holes

Installation Procedure

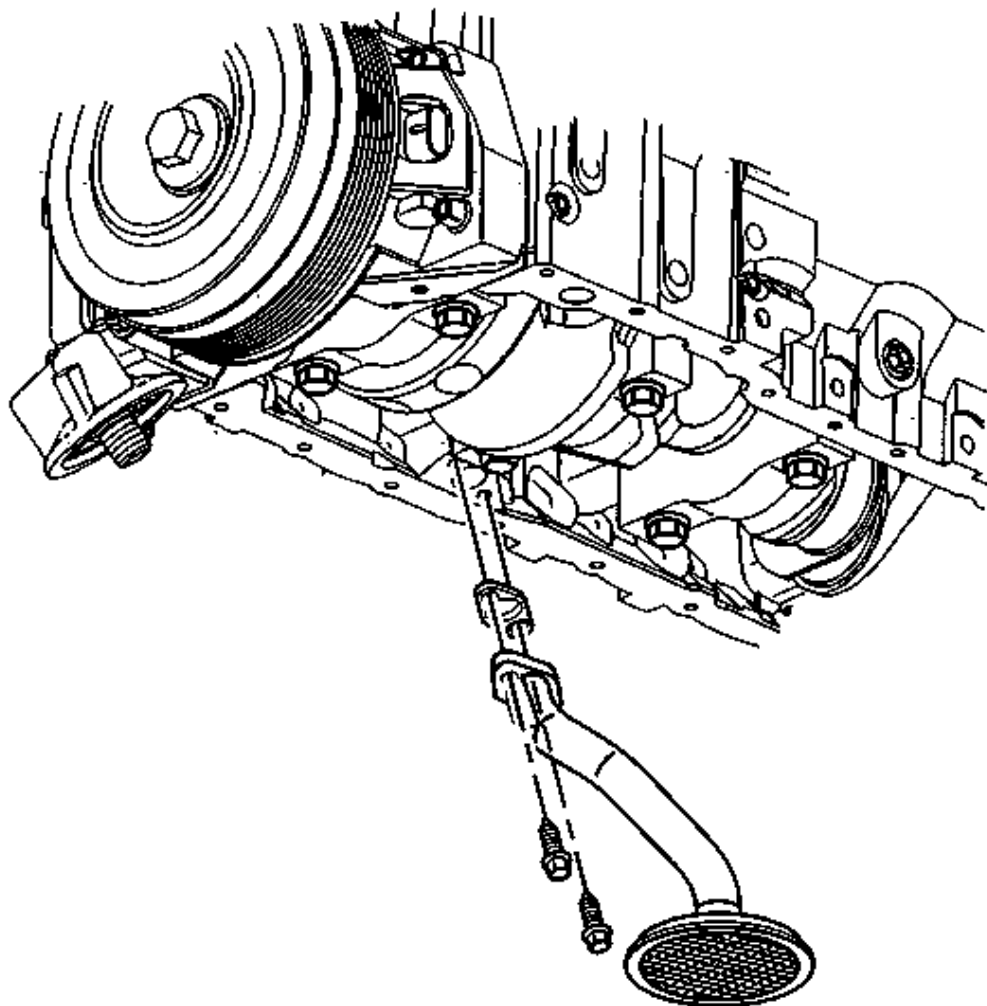


Fig. 224: Oil Pump Screen & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump pipe screen assembly and gasket.

CAUTION: Refer to Fastener Caution .

2. Install the oil pump pipe screen bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

3. Apply a continuous bead 3.0 mm (0.19 in) thick of RTV sealer to the oil pan flange on the block as well as an additional drop to all four corners of the block where the front and rear covers meet. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

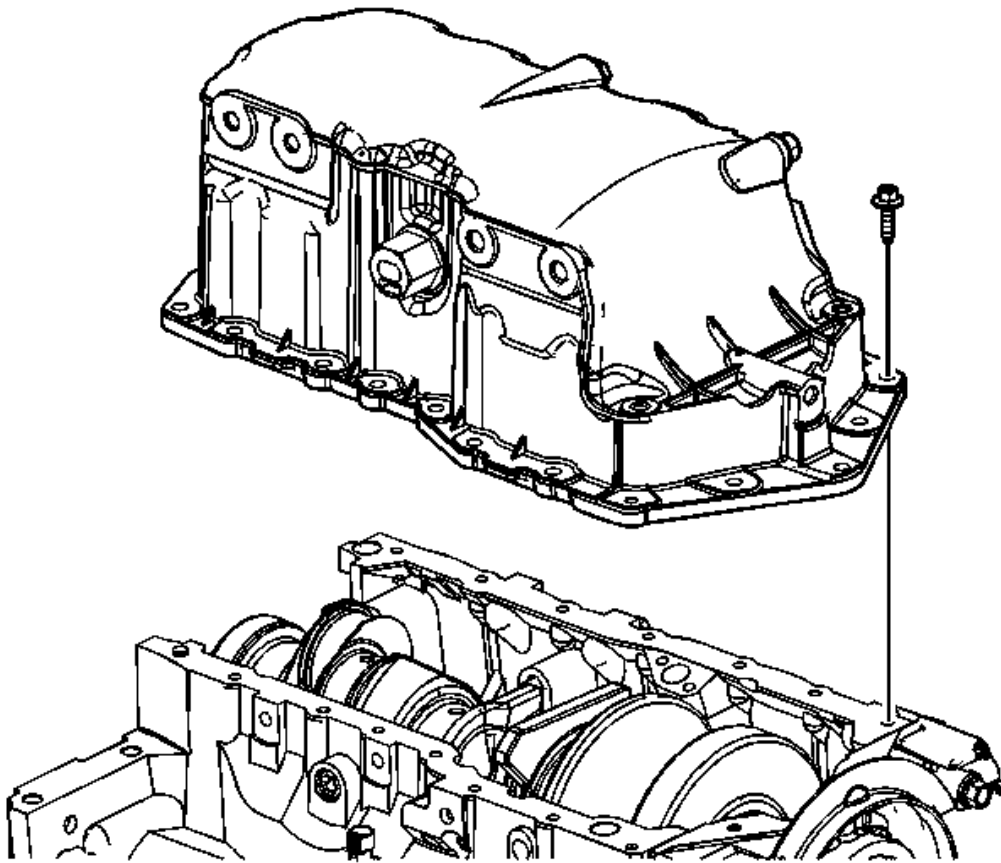


Fig. 225: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Install the oil level sensor, located in the oil pan, after the oil pan is installed. The sensor may be damaged if the oil level sensor is installed first.

4. Install the oil pan.

5. Clean the oil pan bolts and apply one drop of threadlock compound to the oil pan bolt threads. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
6. Install the oil pan bolts.

Tighten: Tighten the oil pan bolts to 14 N.m (125 lb in).

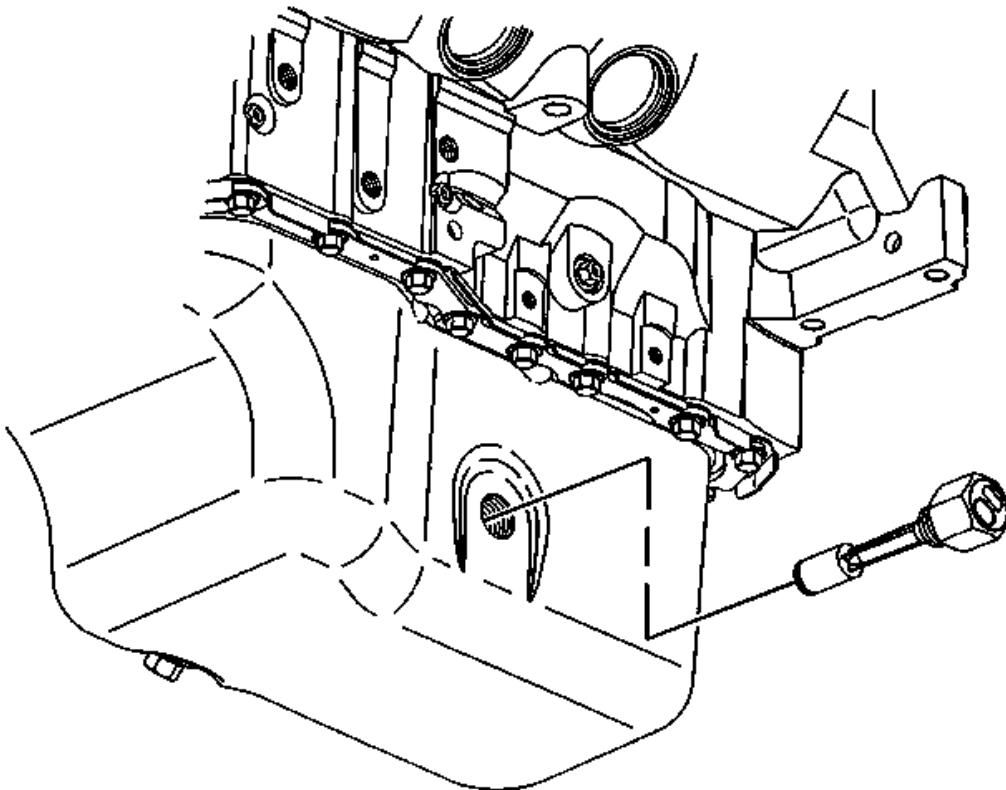


Fig. 226: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

7. Install the oil level sensor.

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

8. Install the torque converter covers. Refer to **Torque Converter Cover Replacement** .
9. Install the engine mount and the engine mount bracket. Refer to **Engine Front Mount Replacement** and **Engine Front Mount Bracket Replacement**.

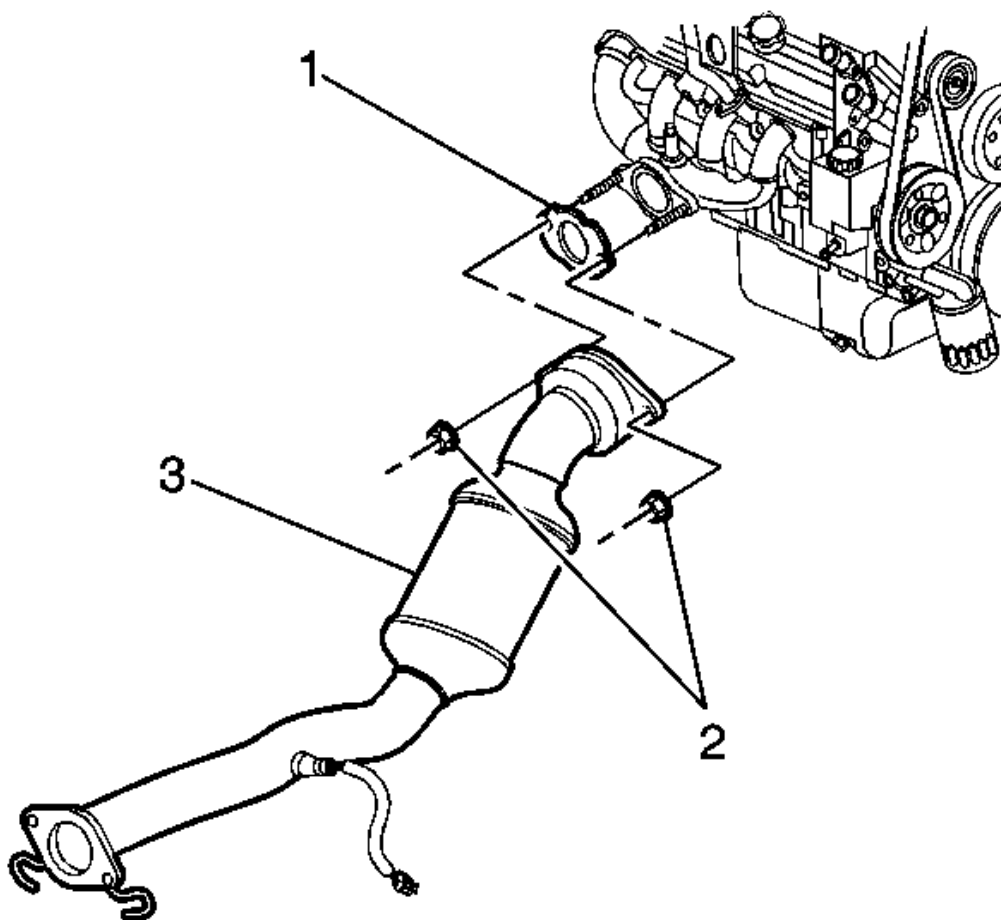


Fig. 227: Right Exhaust Manifold & Catalytic Converter Pipe
Courtesy of GENERAL MOTORS CORP.

10. Install the catalytic converter (3) to the right exhaust manifold.
11. Install the catalytic converter pipe stud nuts (2).

Tighten: Tighten the nuts to 32 N.m (24 lb ft).

12. Install the oil level sensor wiring harness and the oil level sensor wiring harness bolt to the engine.

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

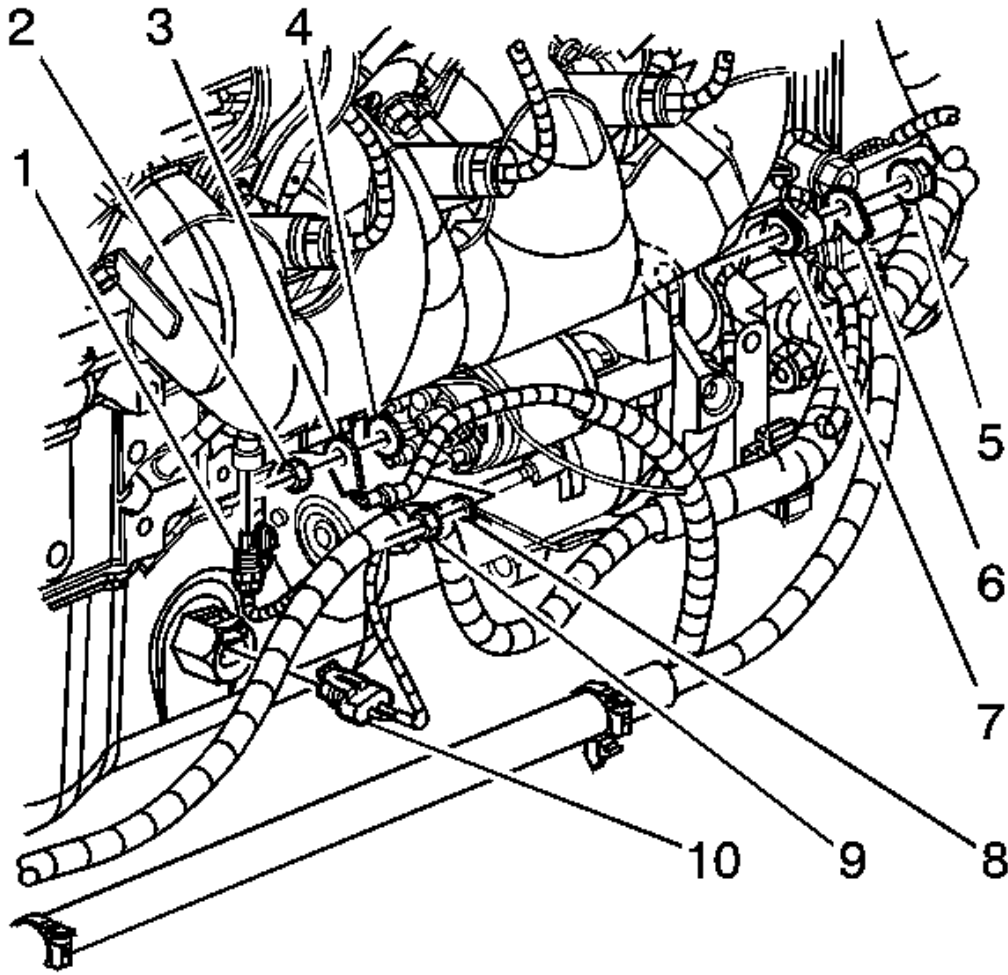


Fig. 228: View Of Engine Electrical Connectors (Left Side)
Courtesy of GENERAL MOTORS CORP.

13. Connect the oil level sensor electrical connector (10).
14. Install the power steering oil cooler pipe brackets to the frame.
15. Install the engine oil filter.
16. Lower the vehicle.
17. Remove the engine support fixture.
18. Install the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side.**
19. Install the left engine mount strut. Refer to **Engine Mount Strut Replacement - Left Side.**
20. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement.**

21. Install the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
22. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
23. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
24. Inspect for leaks.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

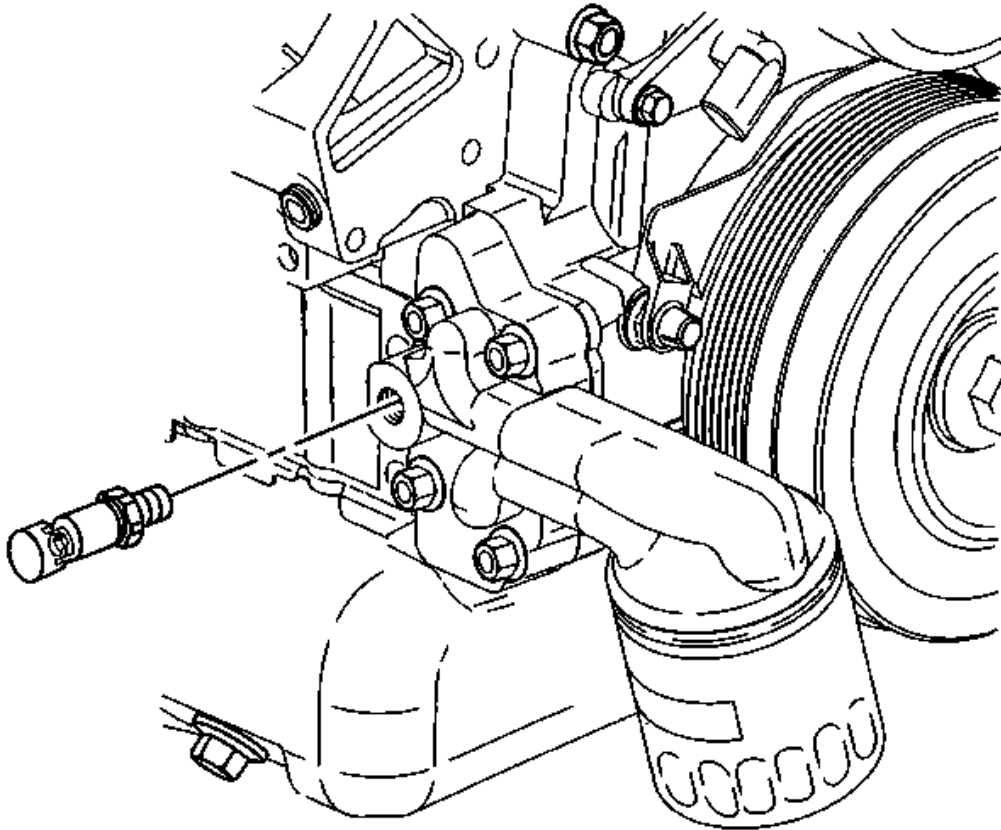


Fig. 229: Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the engine oil pressure sensor electrical connector.
3. Remove the engine oil pressure sensor.

Installation Procedure

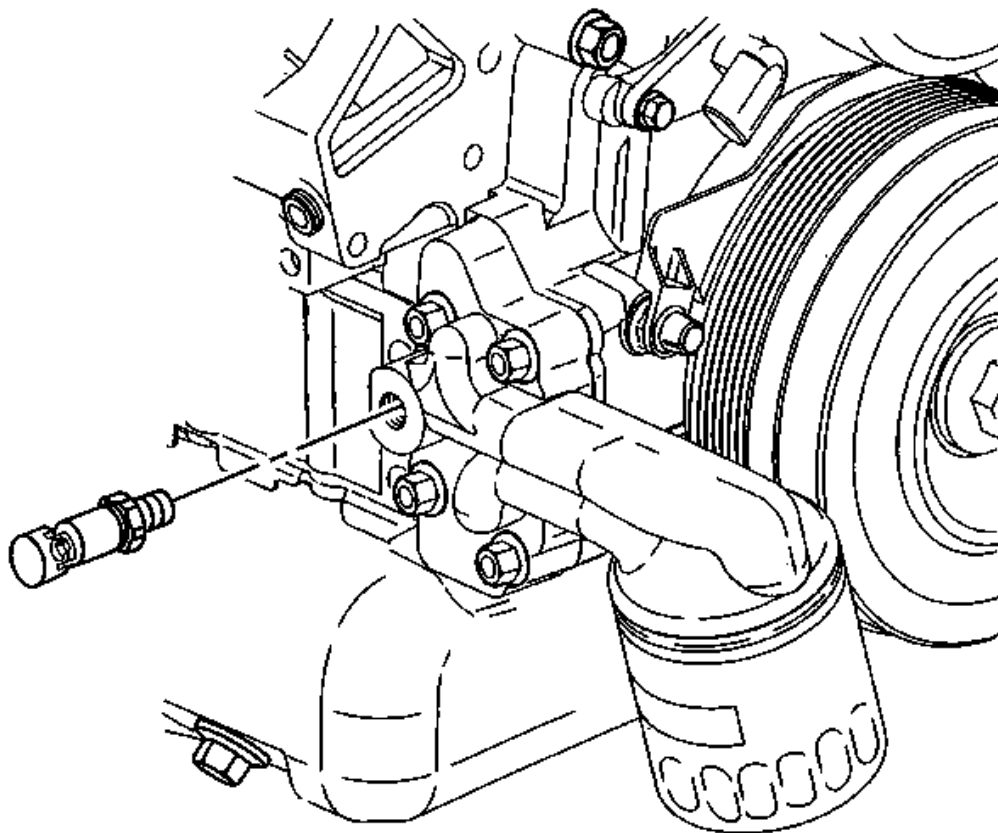


Fig. 230: Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil pressure sensor.

Tighten: Tighten the engine oil pressure sensor to 16 N.m (12 lb ft).

2. Connect the engine oil pressure sensor electrical connector.
3. Lower the vehicle.
4. Fill the crankcase as necessary. Refer to Engine Oil and Oil Filter Replacement.

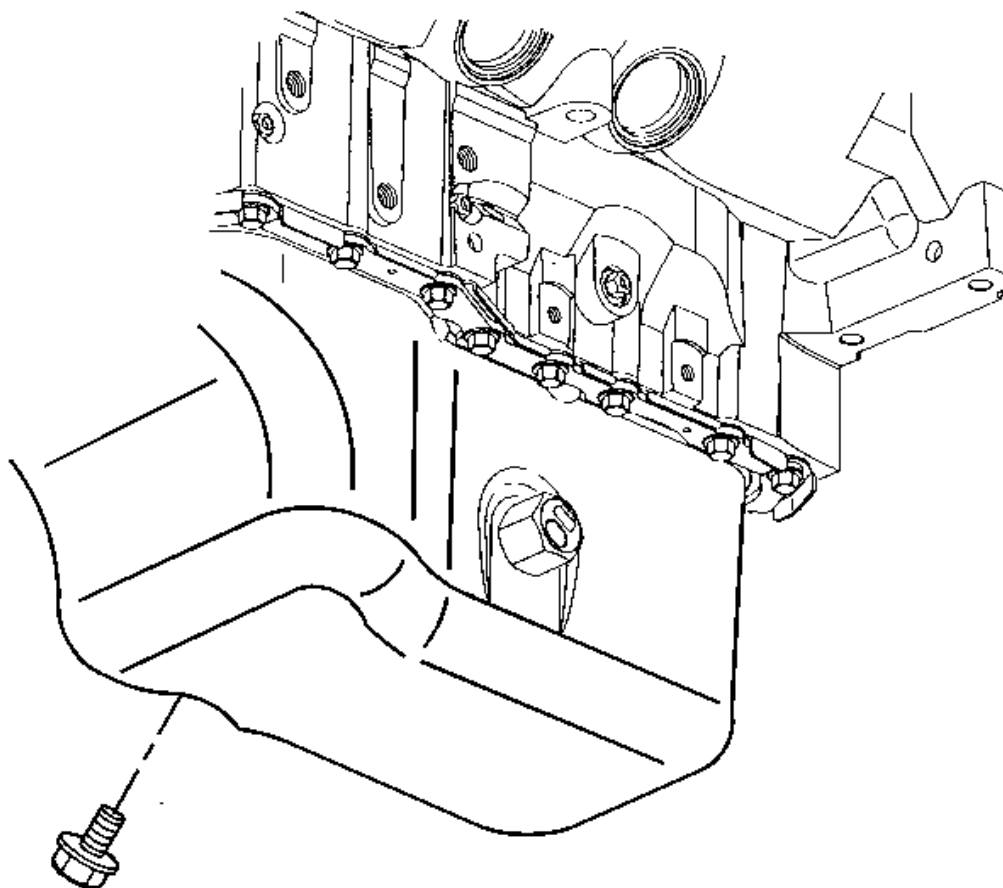
ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT**Removal Procedure**

Fig. 231: Locating Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the engine oil drain plug in order to drain the engine oil.

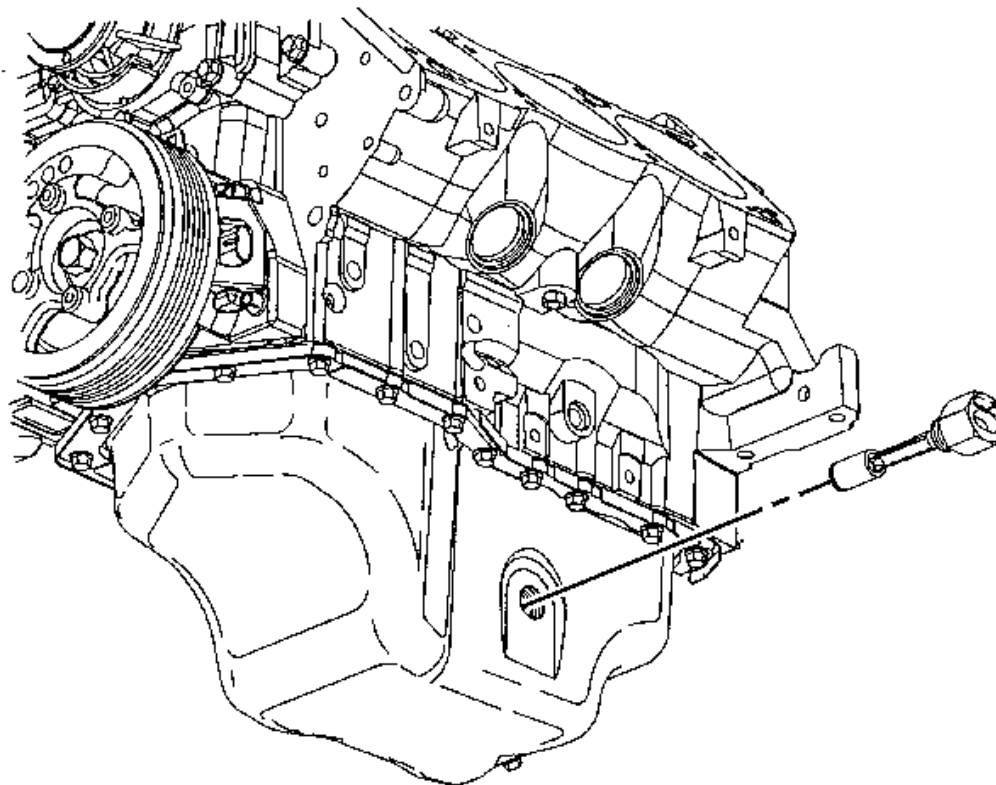


Fig. 232: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the oil level sensor electrical connector.
4. Remove the engine oil level sensor from the oil pan.

Installation Procedure

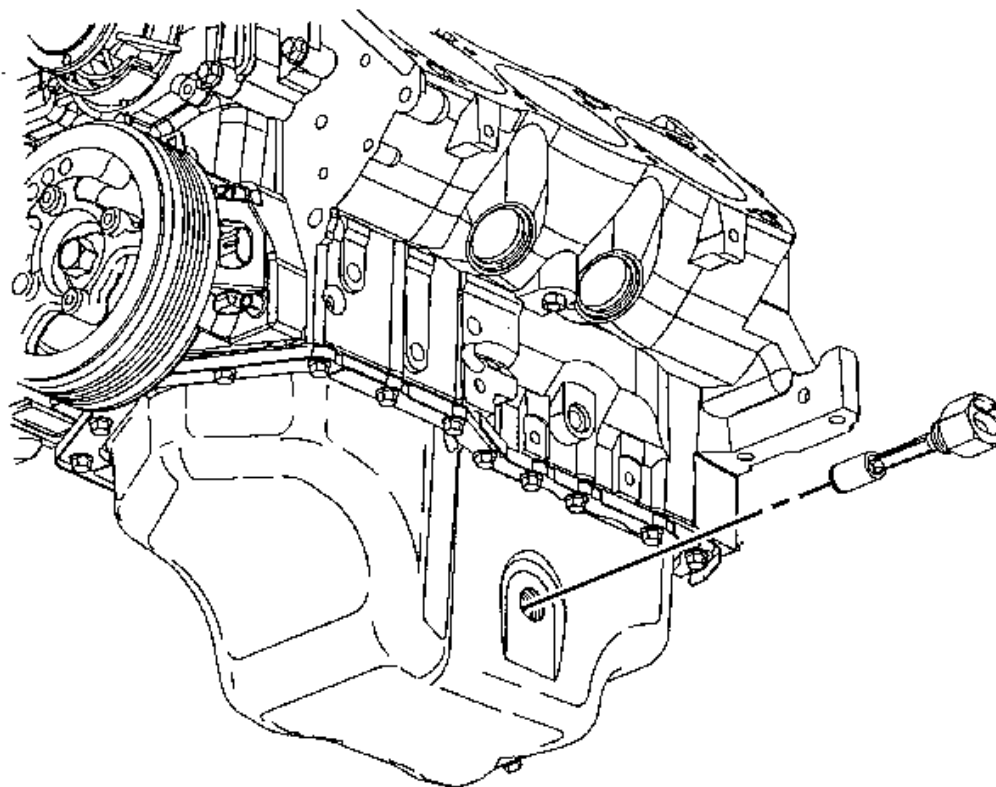


Fig. 233: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil level sensor to the oil pan.

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

2. Connect the oil level sensor electrical connector.

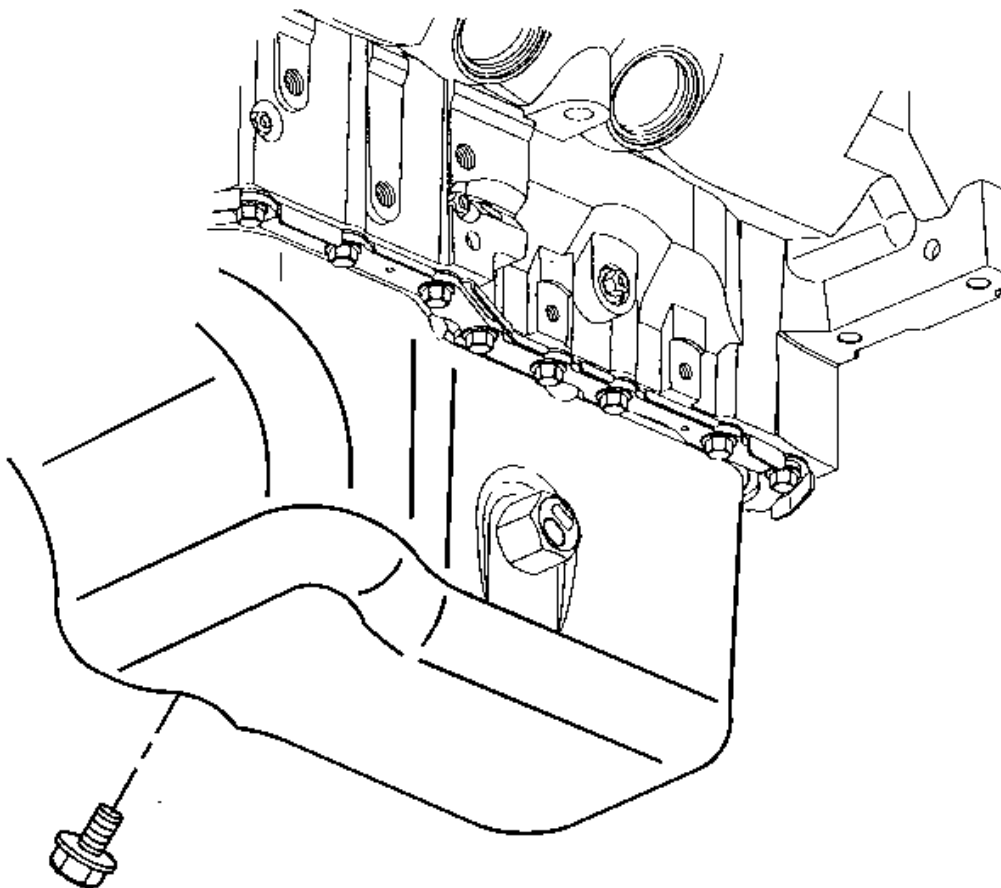


Fig. 234: Locating Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the engine oil drain plug.

Tighten: Tighten the plug to 30 N.m (22 lb ft).

4. Lower the vehicle.
5. Fill the crankcase with engine oil. Refer to Engine Oil and Oil Filter Replacement.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

CAUTION: Remove the oil level sensor, located in the oil pan, before the oil pan

is removed. The sensor may be damaged if the oil pan is removed first.

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

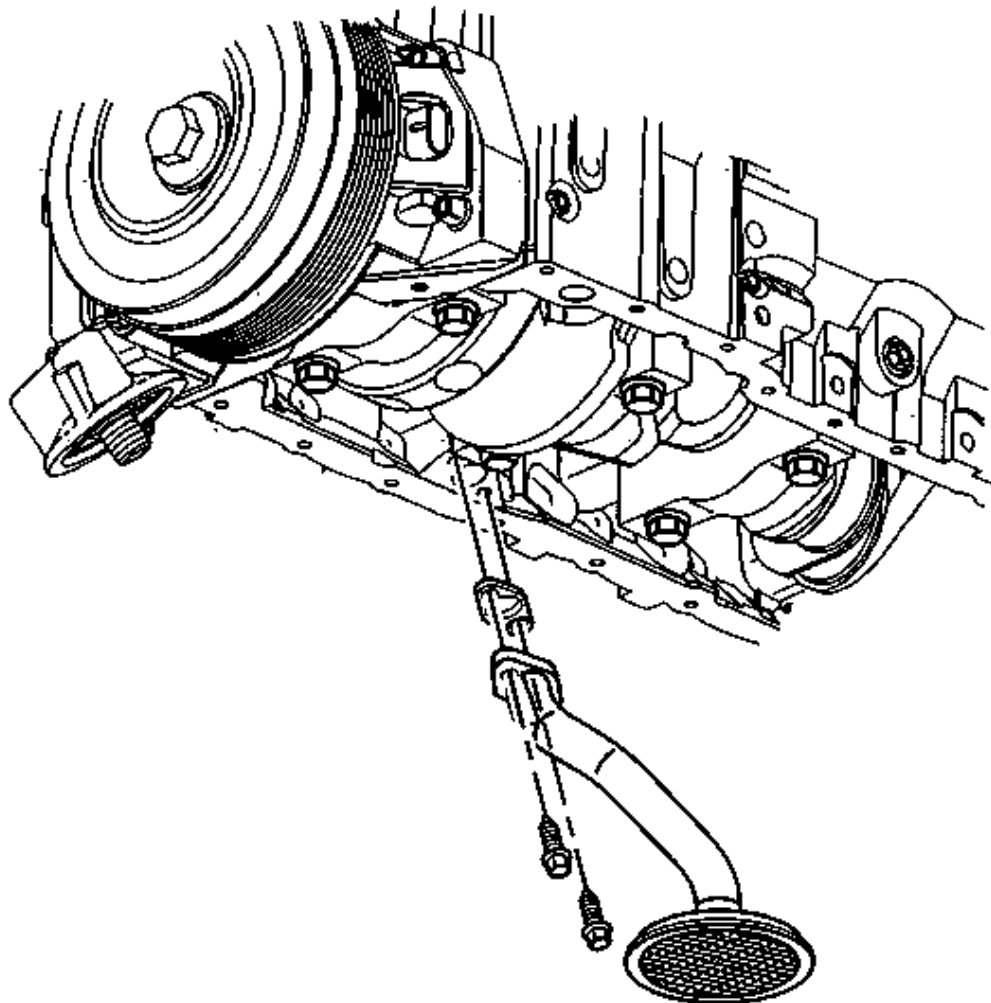


Fig. 235: Oil Pump Screen & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pump screen bolts.
3. Remove the oil pump pipe and screen.
4. Remove the oil pump pipe and screen gasket.

5. Clean the screen and housing with solvent, and blow dry.
6. Inspect the oil pump pipe and screen, replace if necessary.
7. Clean the gasket mating surface on the pipe flange and cylinder block.

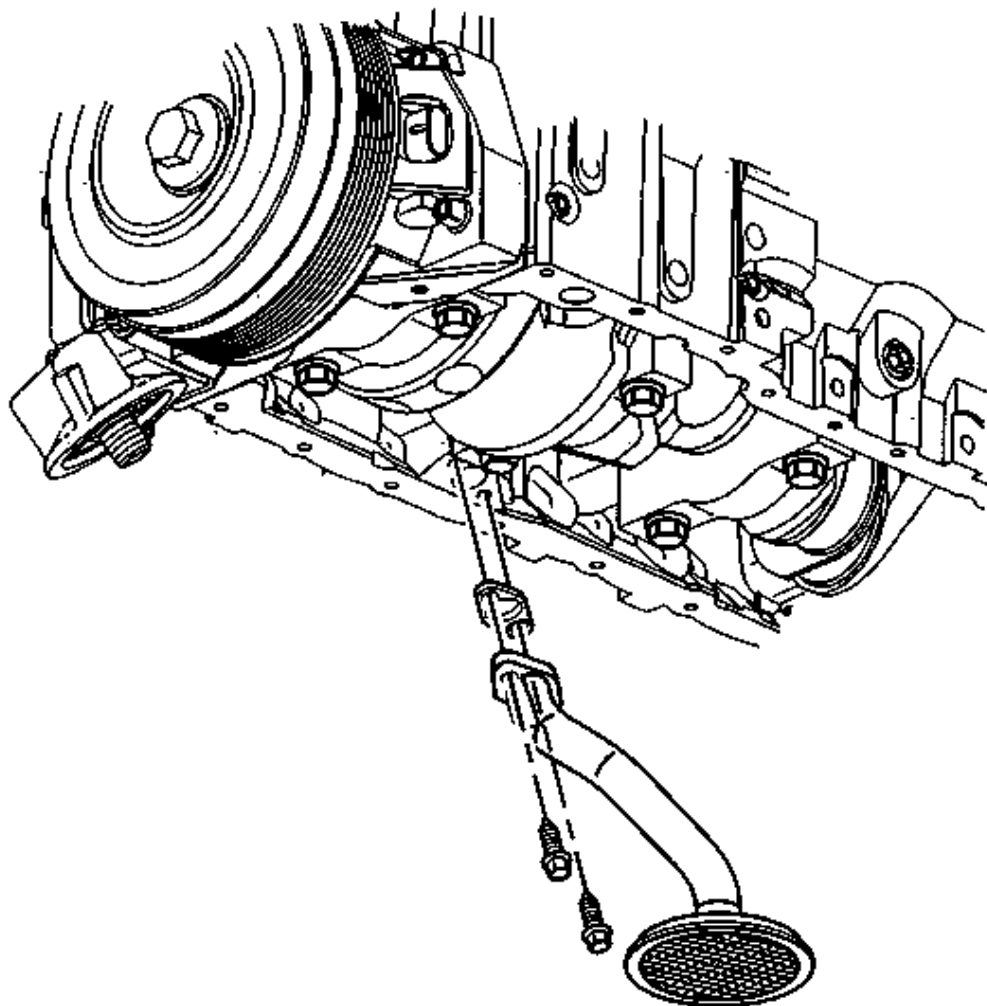
Installation Procedure

Fig. 236: Oil Pump Screen & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The oil pan gasket must be installed before the oil pump pipe and screen assembly.

1. Install the new oil pump pipe and screen gasket.
2. Install the oil pan gasket.
3. Install the oil pump pipe and screen.

CAUTION: Refer to Fastener Caution .

4. Install the oil pump screen bolts.

Tighten: Tighten the oil pump screen bolts to 15 N.m (11 lb ft).

5. Install the oil pan. Refer to Oil Pan Replacement.

CAUTION: Do not run the engine until the oil pressure is tested. Running the engine without measurable oil pressure will cause extensive damage.

CAUTION: Stop the engine and remove the oil pan if the oil pressure does not build up immediately. Check the oil pump pipe and the screen for a clogged screen, damaged pipe, or a damaged gasket. Running the engine without measurable oil pressure will cause extensive damage.

6. Inspect and verify that the oil pressure is within specifications.

CONNECTING ROD BEARING REPLACEMENT

Special Tools

- **J 41507** Connecting Rod Assembly Guide. See Special Tools.
- **J 45059** Electronic Torque Angle Meter

Removal Procedure

1. Remove the oil pan. Refer to Oil Pan Replacement.
2. Remove the spark plugs from the cylinders that is being serviced. Refer to Spark Plug Replacement .
3. Position the connecting rod to be serviced to Bottom Dead Center (BDC) by rotating the crankshaft.

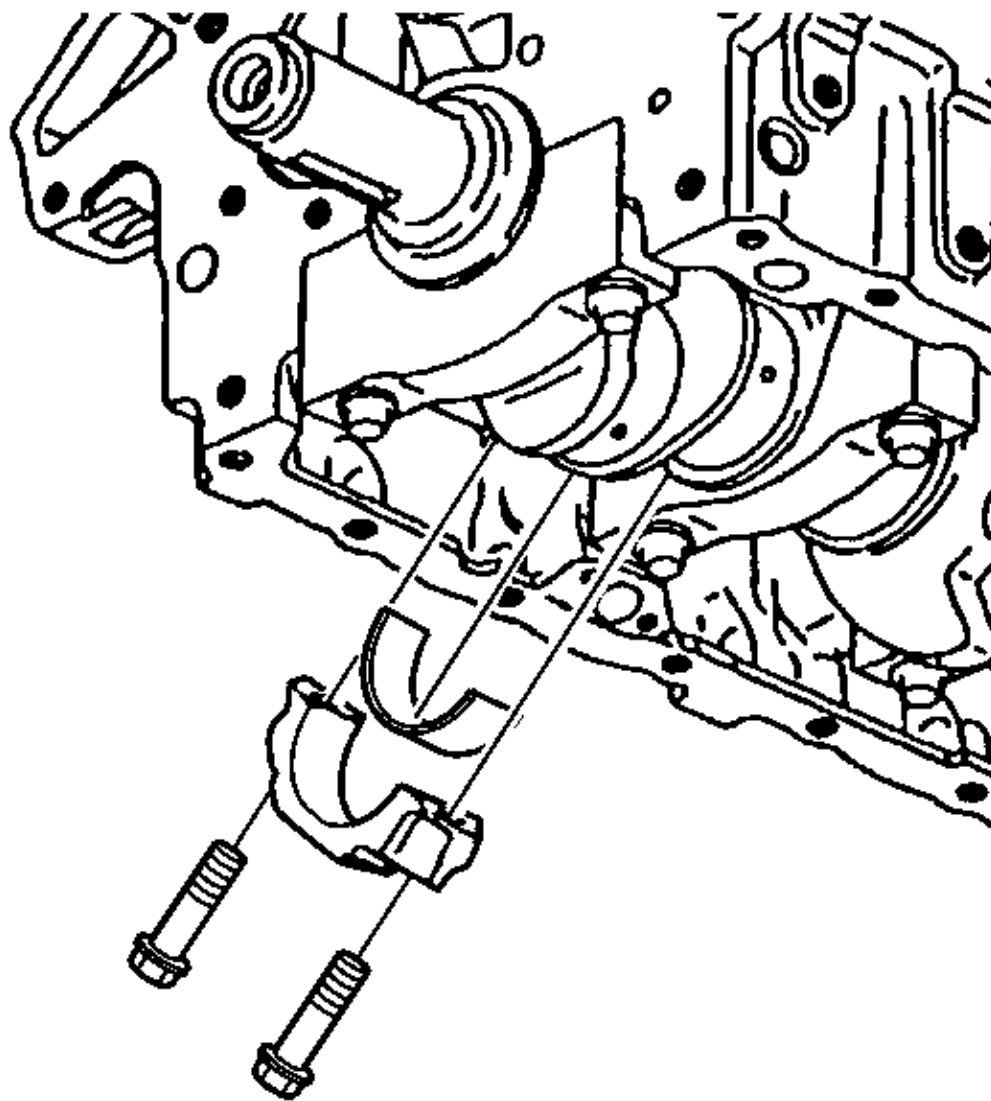


Fig. 237: Connecting Rod Cap And Lower Connecting Rod Bearing
Courtesy of GENERAL MOTORS CORP.

4. Remove the connecting rod cap bolts.
5. Remove the connecting rod cap and lower connecting rod bearing.

NOTE: Keep the bearings with the original connecting rod and cap. Do this in order to reassemble the connecting rod.

6. Remove the lower connecting rod bearing from the connecting rod cap.

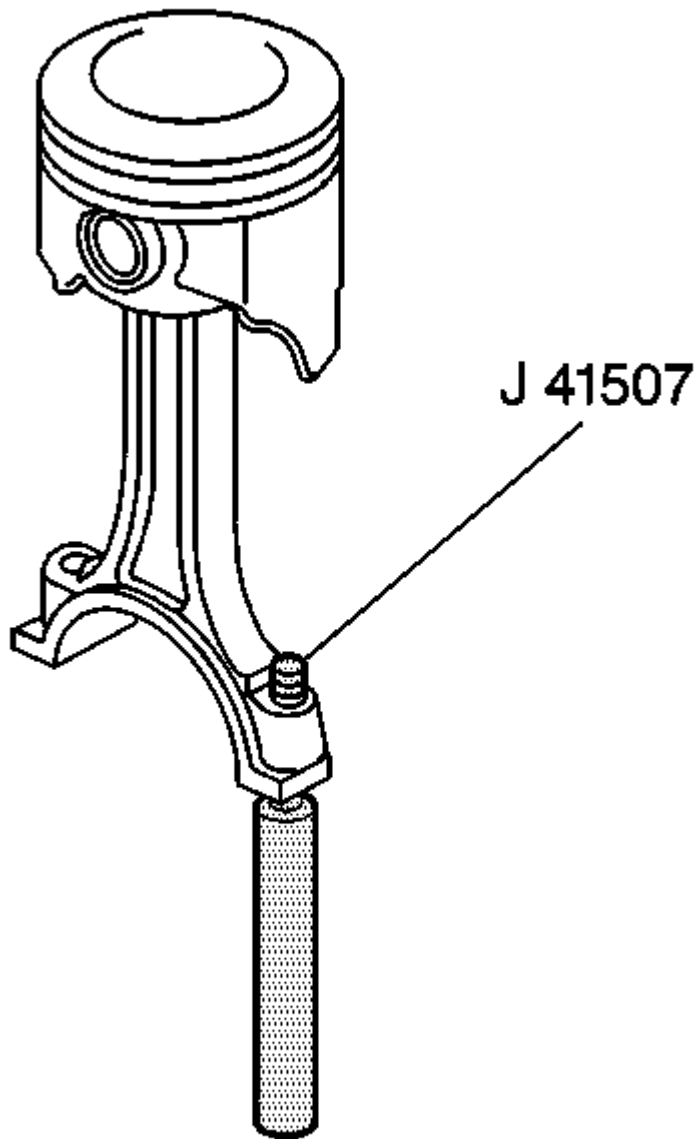


Fig. 238: Installing J 41507 To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 41507** to the connecting rod. See **Special Tools**.
8. Use the **J 41507** , in order to push up the connecting rod and piston and access the upper connecting rod

bearing. See **Special Tools**.

9. Remove the upper connecting rod bearing.
10. Wipe the oil from the bearings.
11. Inspect the connecting rod bearings. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection**.
12. Measure the bearing clearance. Refer to **Engine Mechanical Specifications**.

Installation Procedure

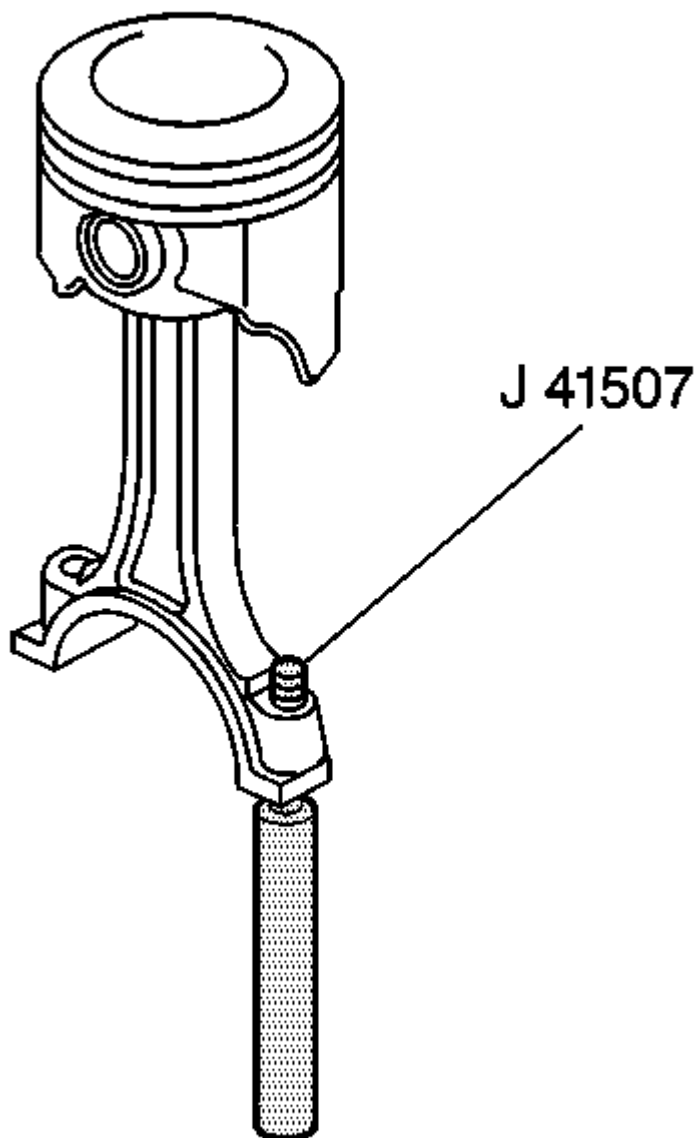


Fig. 239: Installing J 41507 To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not scrape, shim, or file bearing inserts. If the bearing surface of the insert is touched with bare fingers, the skin oil and acids will etch the bearing surface.

NOTE: **Make sure that the connecting rod cap bolt holes and the connecting rod cap mating surfaces are clean and dry.**

1. Dip the connecting rod cap bolts in clean engine oil.
2. Use clean engine oil in order to lubricate the bearing surface.
3. Install the upper connecting rod bearing.
4. Use the **J 41507** , in order to pull down the piston, connecting rod and upper connecting rod bearing. See **Special Tools**.
5. Remove the **J 41507** . See **Special Tools**.

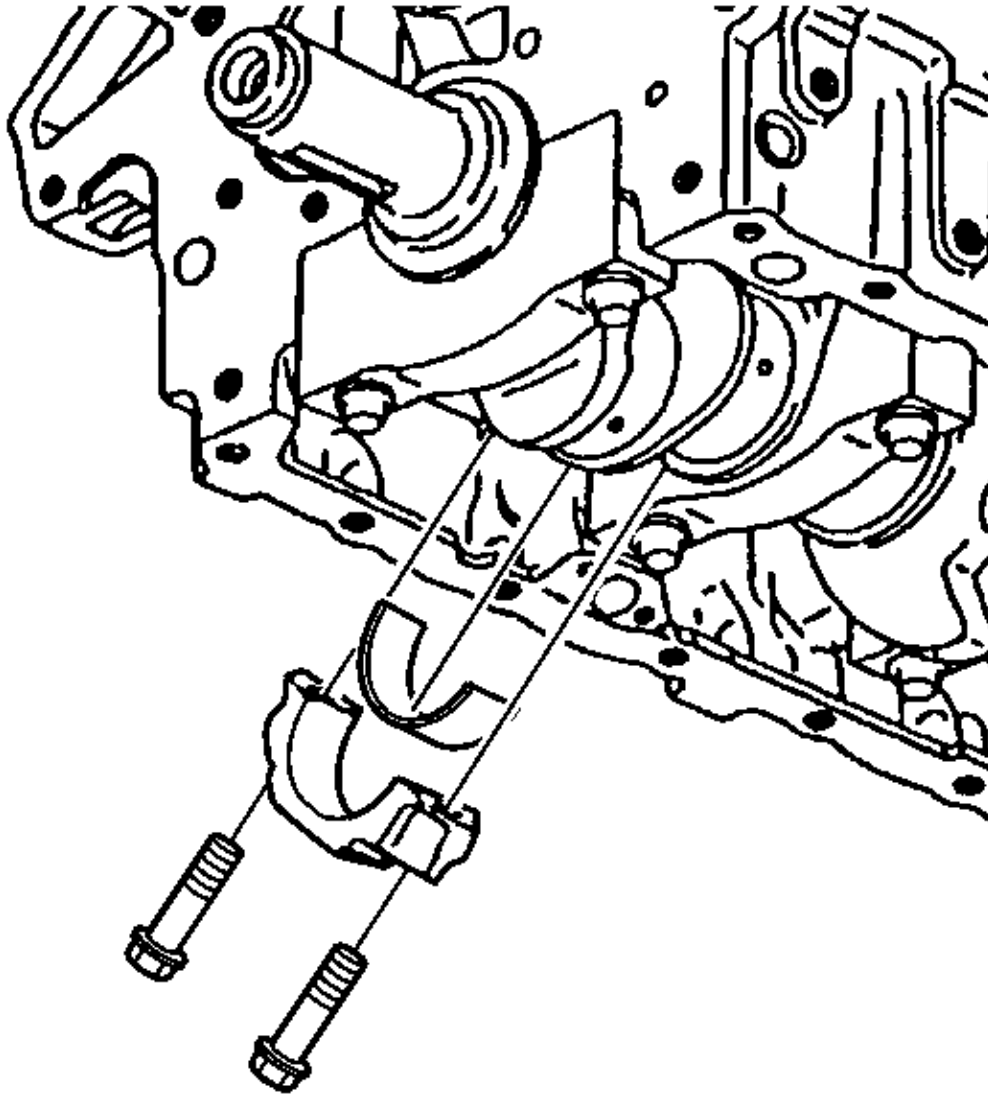


Fig. 240: Connecting Rod Cap And Lower Connecting Rod Bearing
Courtesy of GENERAL MOTORS CORP.

6. Install the lower connecting rod bearing to the connecting rod cap.
7. Install the connecting rod cap.

CAUTION: Refer to **Fastener Caution** .

8. Install the connecting rod cap bolts.

Tighten:

1. Tighten the connecting rod cap bolts to 27 N.m (20 lb ft).
 2. Use the **J 45059** to rotate the connecting rod cap bolts an additional 50 degrees.
9. Pry the connecting rod back and forth in order to check for binding. If necessary, loosen and then retighten the connecting rod cap bolts.

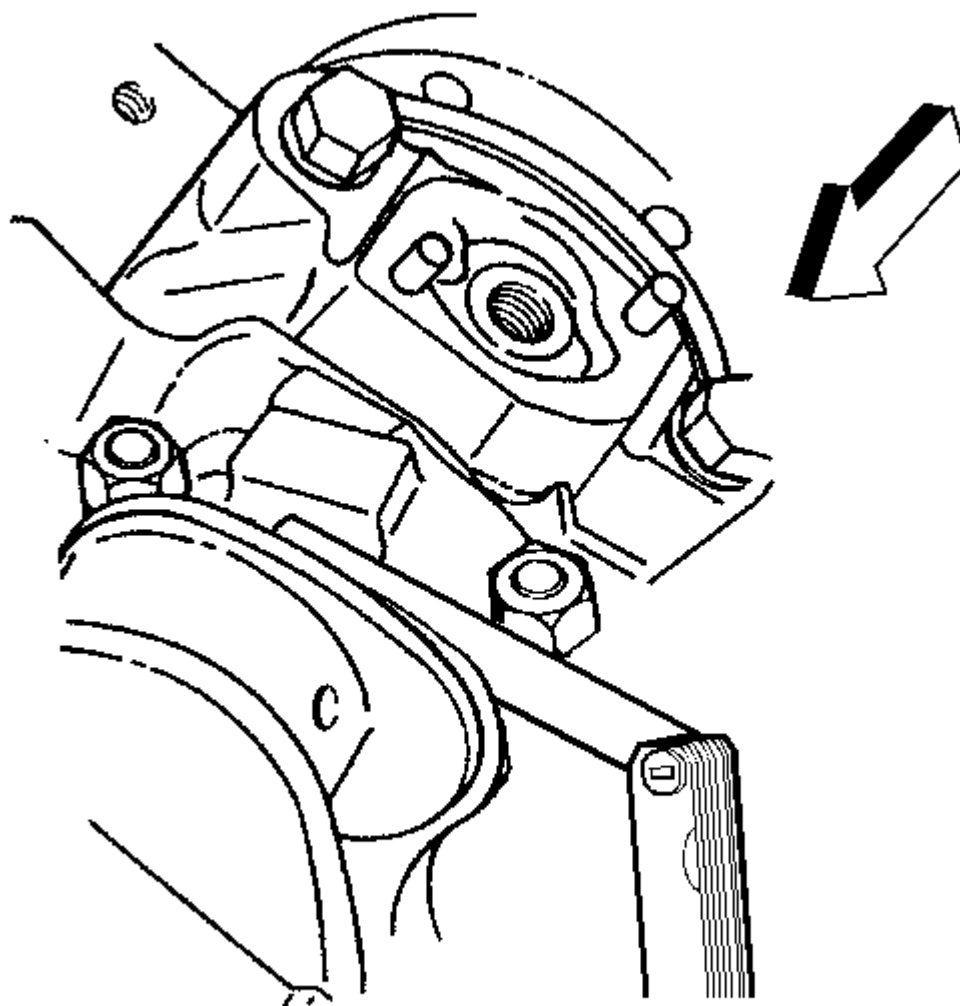


Fig. 241: Measuring Connecting Rod Side Clearance

Courtesy of GENERAL MOTORS CORP.

10. Measure the connecting rod side clearance. Refer to Engine Mechanical Specifications.
11. Install the spark plugs to the cylinders. Refer to Spark Plug Replacement.
12. Install the oil pan. Refer to Oil Pan Replacement.
13. Inspect for proper oil pressure.
14. Inspect for leaks.

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- **J 37096** Flywheel Holder. See Special Tools.
- **J 45059** Electronic Torque Angle Meter

Removal Procedure

1. Remove the transaxle. Refer to Transmission Replacement.

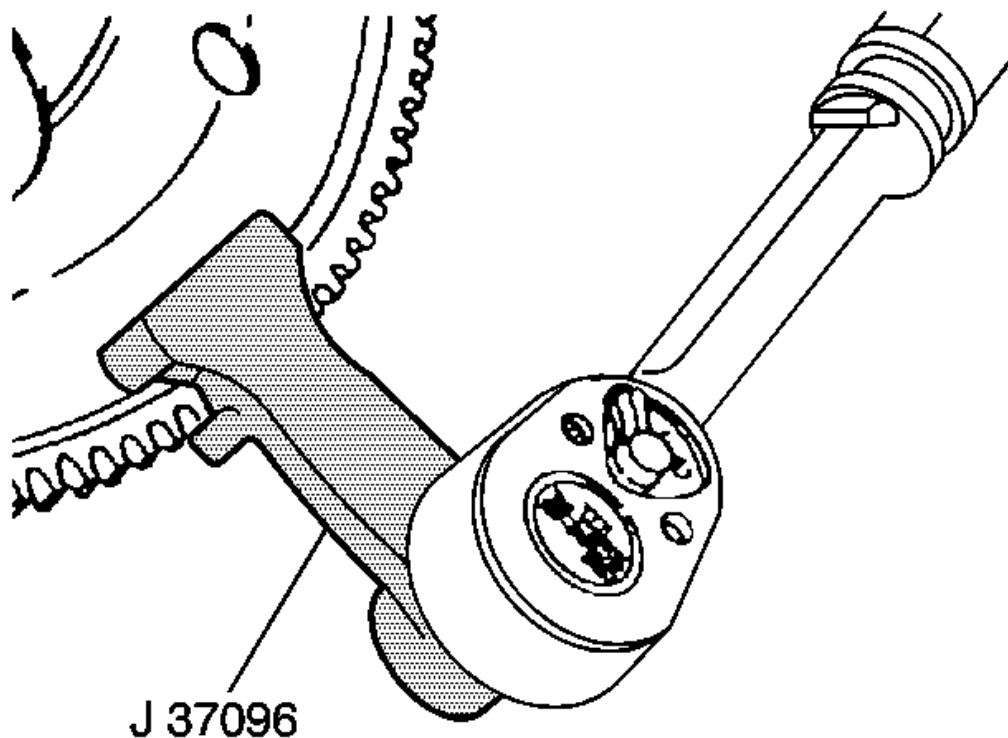
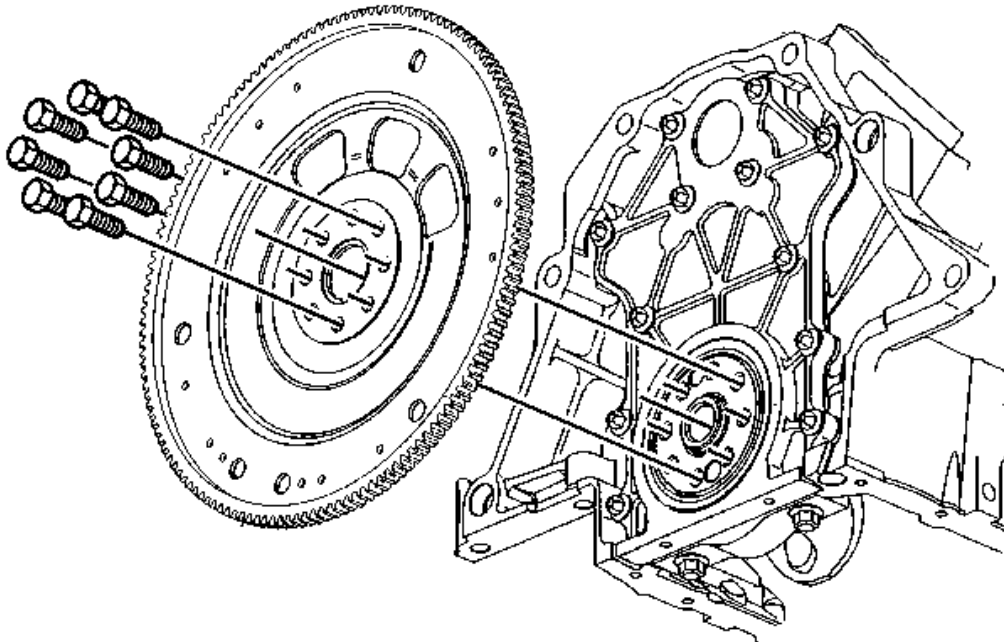


Fig. 242: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

2. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools**.

**Fig. 243: View Of Engine Flywheel & Bolts**

Courtesy of GENERAL MOTORS CORP.

3. Loosen the 8 engine flywheel bolts.
4. Remove 7 of the 8 engine flywheel bolts, leaving one bolt at the top of the crankshaft rotation.
5. Firmly grasp the engine flywheel and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.
6. Remove the engine flywheel.

Installation Procedure

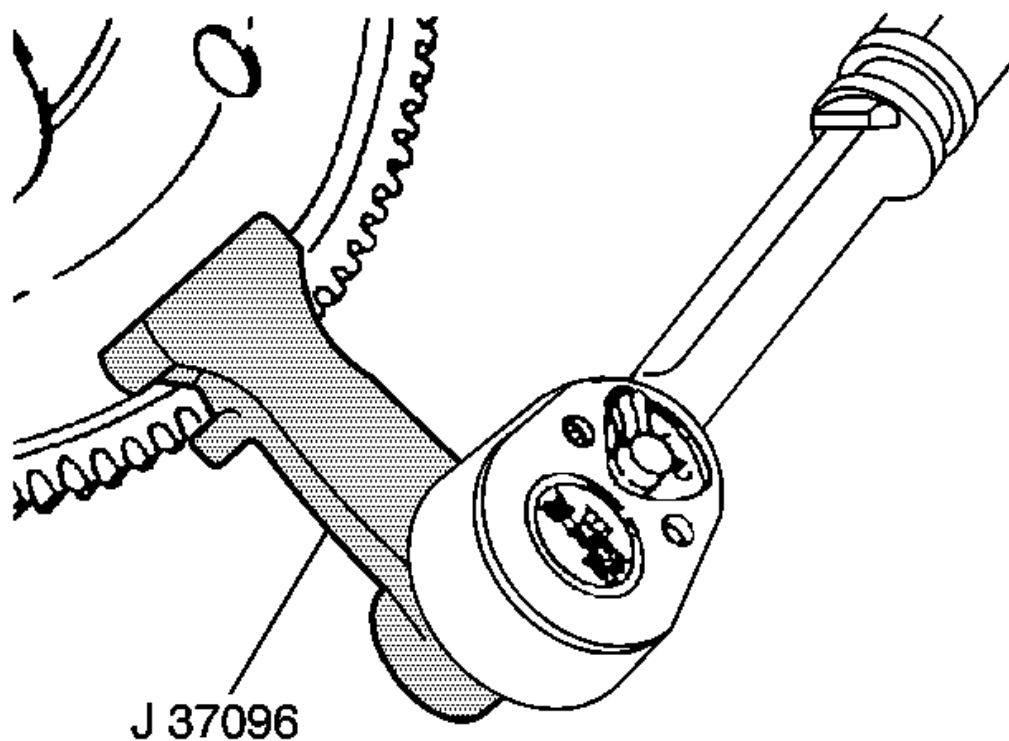


Fig. 244: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

1. Install the engine flywheel.
2. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools**.

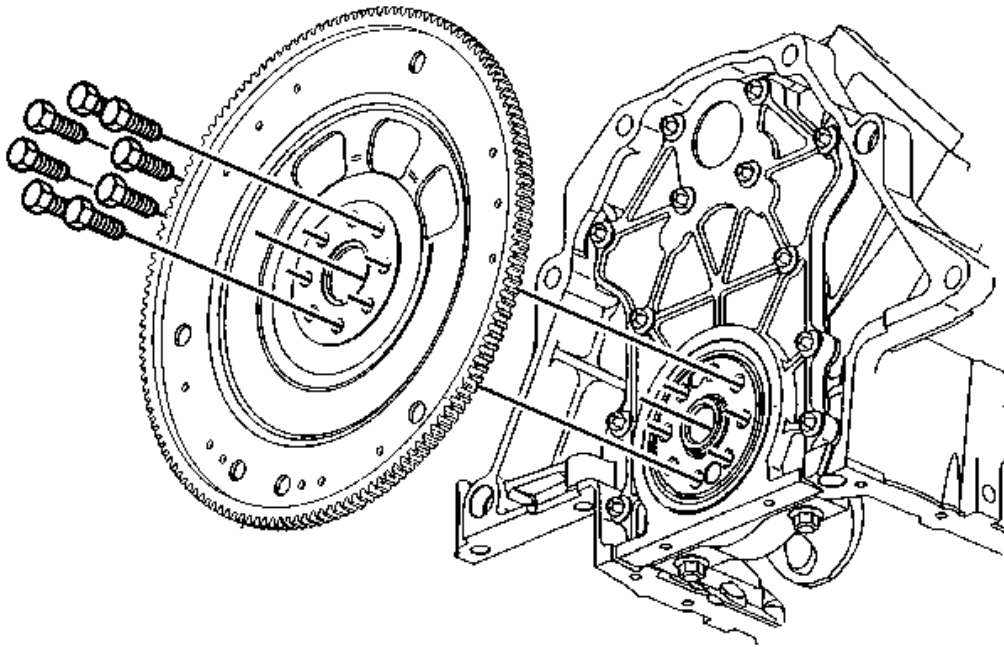


Fig. 245: View Of Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the new engine flywheel bolts.

Tighten:

1. Tighten the engine flywheel bolts to 15 N.m (11 lb ft).
 2. Use the **J 45059** to rotate the engine flywheel bolts an additional 50 degrees.
4. Measure the engine flywheel runout:
 1. Install a dial indicator on the engine block and check the engine flywheel runout at three attaching bosses. Refer to **Engine Mechanical Specifications**.
 2. If the condition cannot be corrected, replace the engine flywheel.
 5. Install the transaxle. Refer to **Transmission Replacement** .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Special Tools

- **EN-47623** Rear Main Seal Installer. See Special Tools.
- **J 8092** Drive Handle. See Special Tools.
- **J 45059** Torque Angle Meter

Removal Procedure

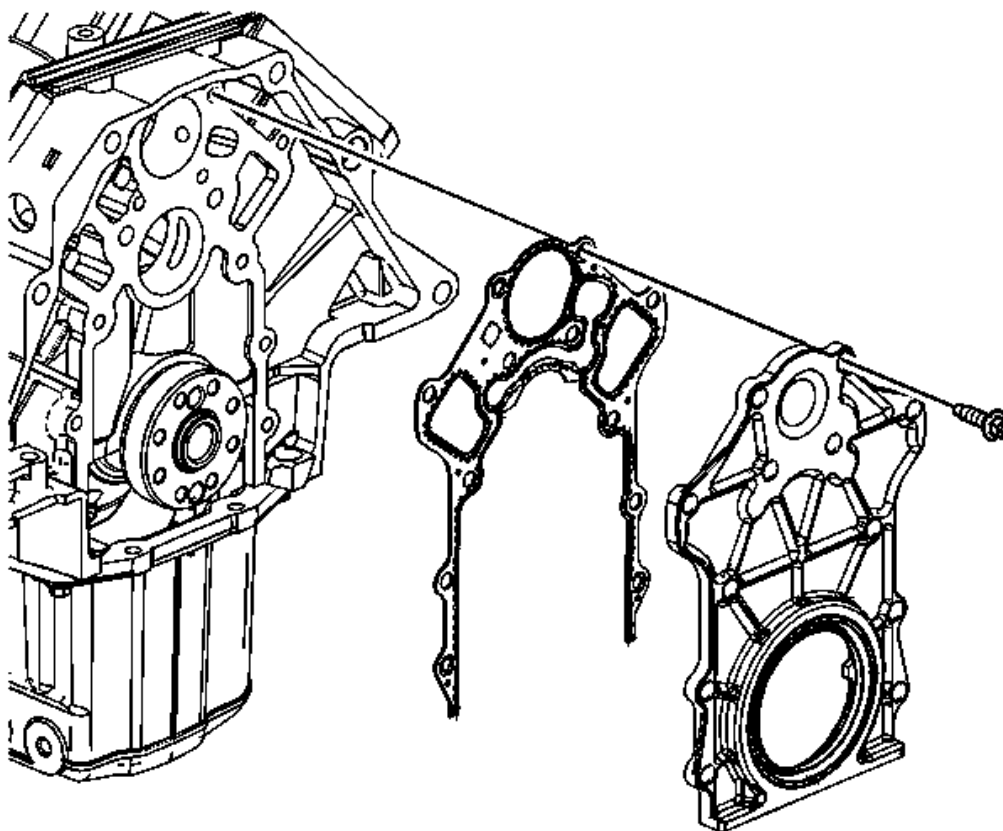


Fig. 246: Crankshaft Rear Oil Seal & Housing (Second Design)
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to Cooling System Draining and Filling (L26 Static Fill) or Cooling System Draining and Filling (L26 GE 47716 Fill).
2. Remove the engine flywheel. Refer to Engine Flywheel Replacement.
3. Remove the oil pan. Refer to Oil Pan Replacement.

NOTE: Ensure not to damage the crankshaft outside diameter surface with any tool.

4. Remove the crankshaft rear oil seal housing bolts.
5. Remove the crankshaft rear oil seal housing and gasket.

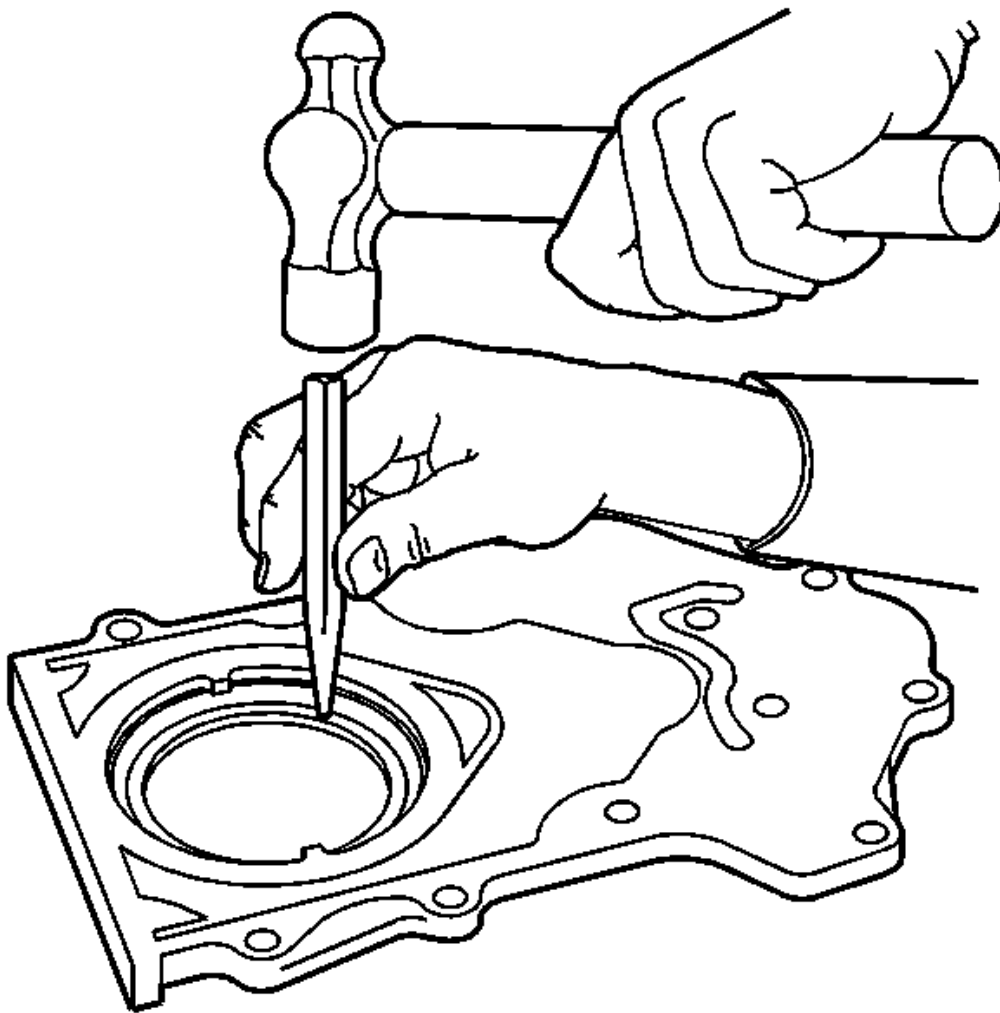


Fig. 247: Locating Crankshaft Rear Oil Seal In Housing
Courtesy of GENERAL MOTORS CORP.

6. Place the crankshaft rear oil seal housing face down on a clean surface and support with blocks of wood.
7. Use a suitable driving tool and hammer and lightly tap around the outer edge of the seal to remove it.

8. Inspect the crankshaft for nicks or burrs on the surface that contacts the seal.
9. Repair or replace the crankshaft, if necessary.

Installation Procedure

CAUTION: Do not apply or use any oil lubrication on the crankshaft rear oil seal, or the seal installer. Do not touch the sealing lip of the oil seal once the protective sleeve is removed. Doing so will damage/deform the seal.

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

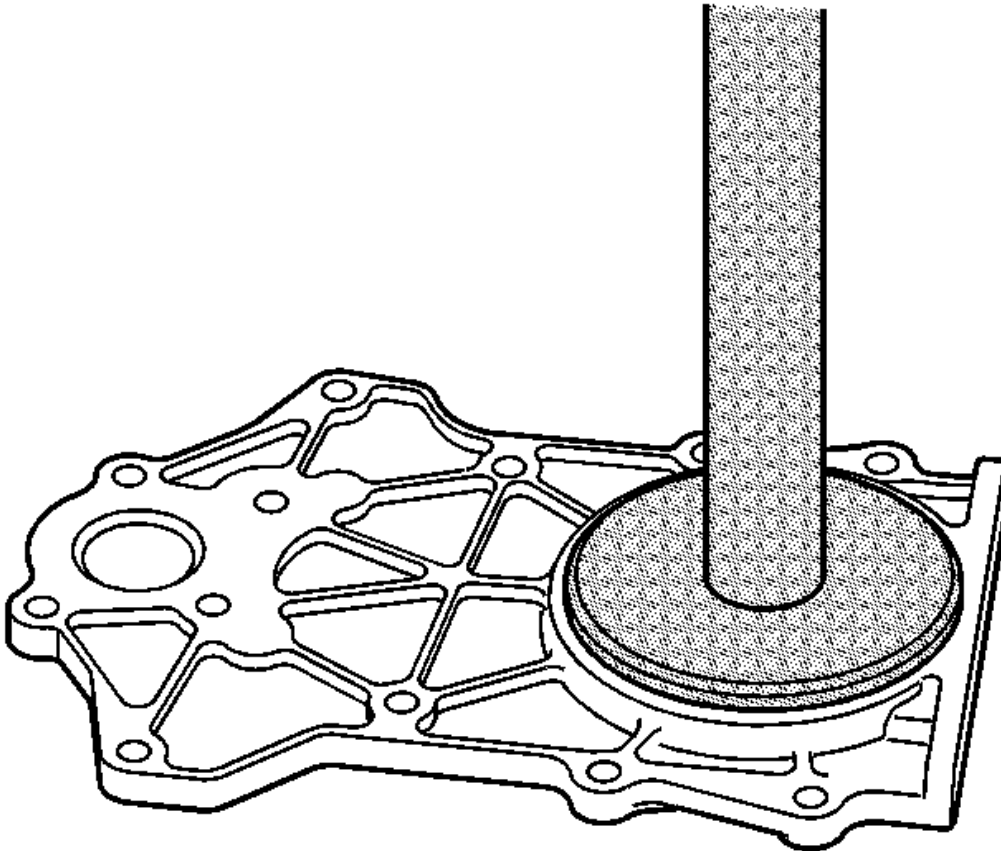


Fig. 248: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Clean and inspect the crankshaft rear oil seal housing making sure it is free of any foreign material.
2. With all bolts removed from the housing, place it face up on a flat clean surface.
3. Carefully remove the protection sleeve from the NEW rear oil seal.
4. Install the seal onto **EN-47623** by placing the seal on an angle and using a twisting motion until it is fully seated. See **Special Tools**.
5. Place **EN-47623** along with **J 8092** onto the housing as shown and apply a constant downward force until the seal is fully seated. See **Special Tools**.

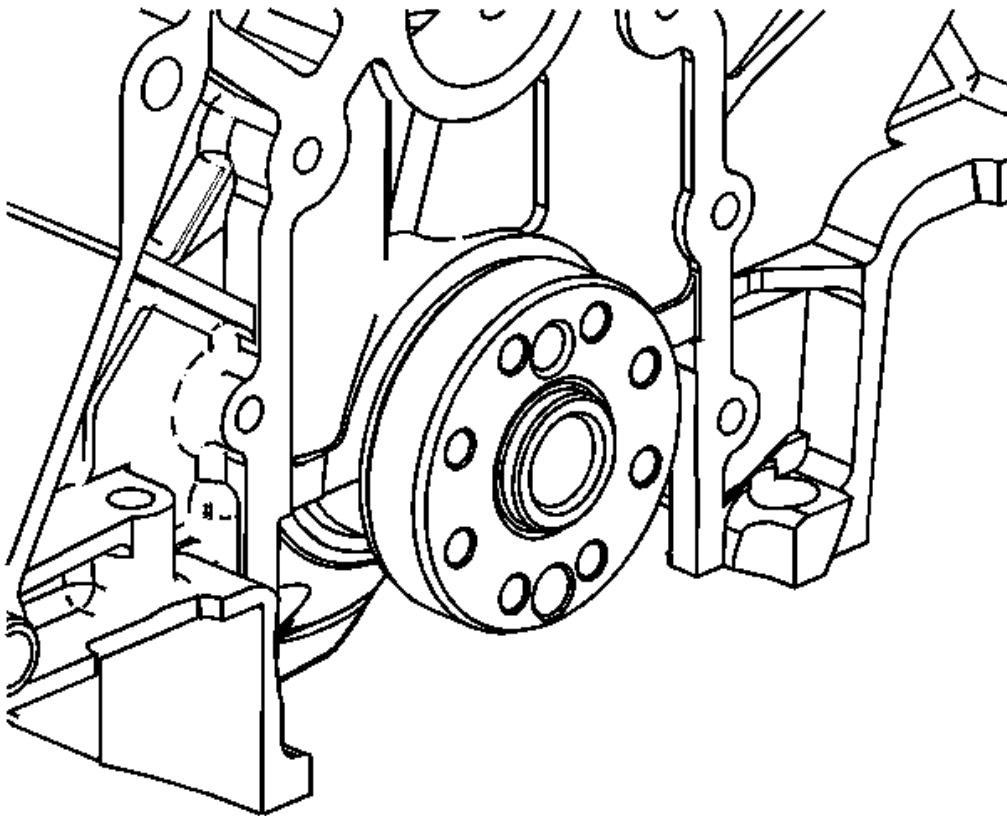


Fig. 249: View Of Crankshaft Sealing Surface
Courtesy of GENERAL MOTORS CORP.

6. Clean the crankshaft sealing surface with a clean, lint free towel. Inspect the crankshaft sealing surface and leading edge of the crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove any burrs or sharp edges with crocus cloth prior to proceeding.

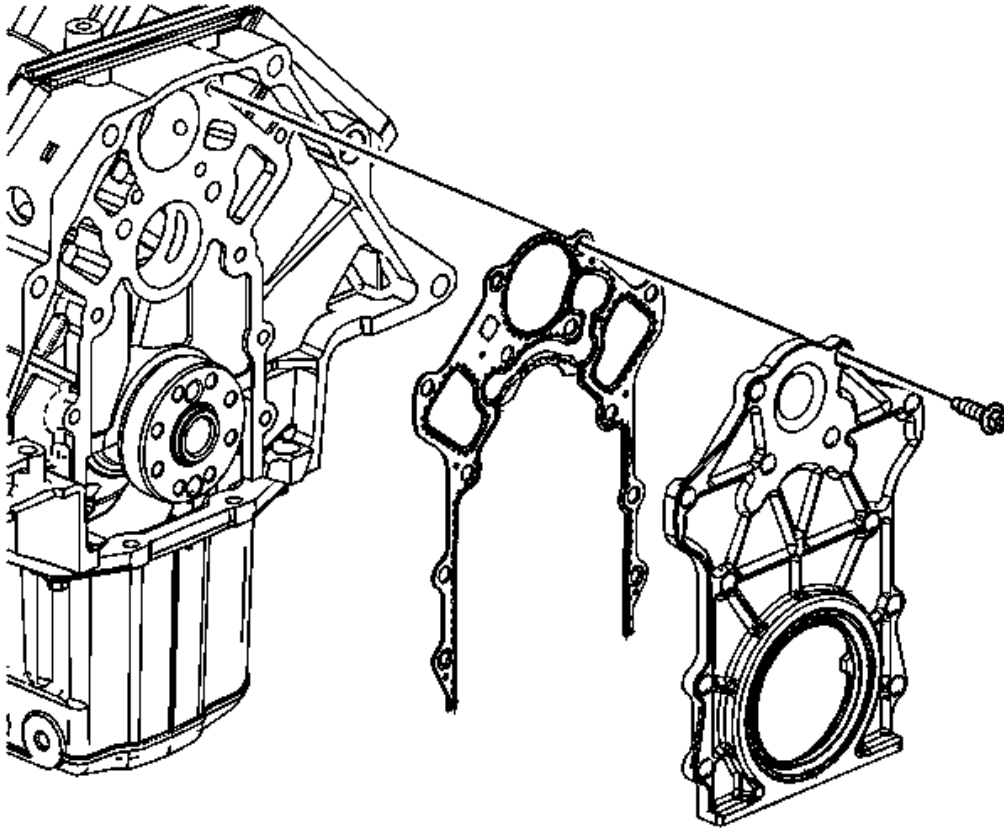


Fig. 250: Crankshaft Rear Oil Seal & Housing (Second Design)

Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not use a sealant or adhesive when installing this component. Use of a sealant or adhesive can cause improper sealing. A component that is not sealed properly can leak leading to extensive engine damage.

NOTE: Always install a NEW crankshaft rear oil seal housing gasket. This gasket may be installed backward. Install the gasket ensuring that all oil passage openings and gasket openings are in alignment.

7. Install a NEW crankshaft rear oil seal housing gasket and the housing onto the engine.

NOTE: The plastic inserts found in the rear oil seal housing retaining bolts are used to aid production assembly only. The inserts are not required for

service.

8. Install the crankshaft rear oil seal housing bolts finger tight.

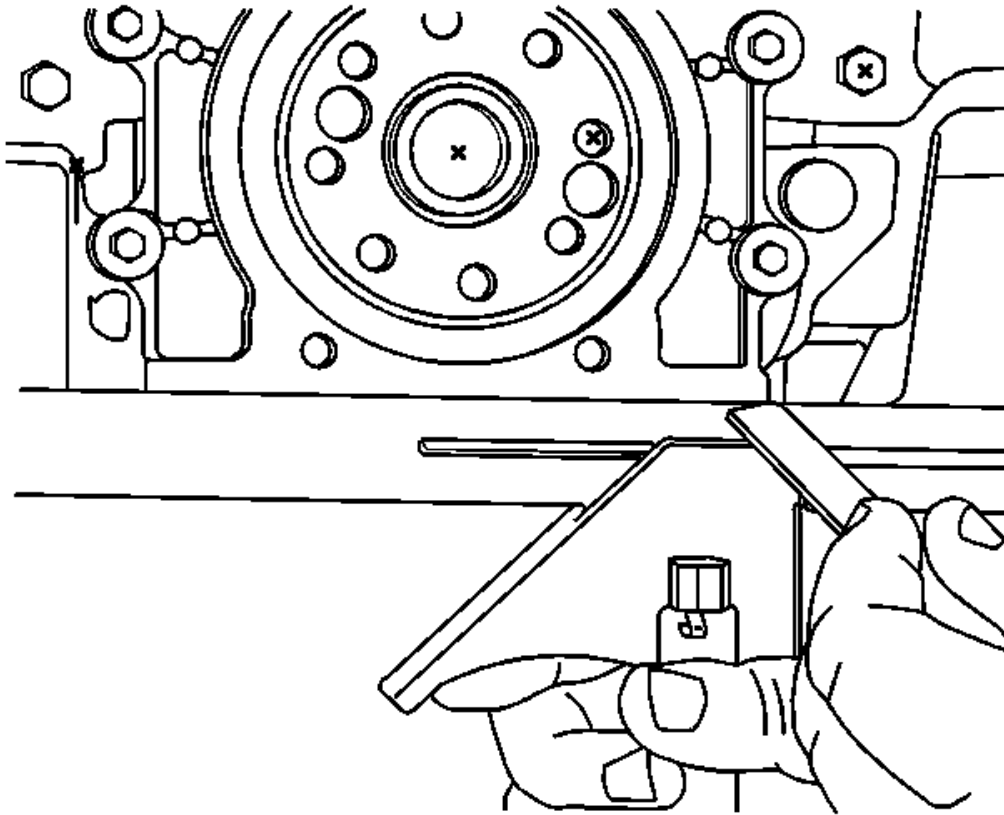


Fig. 251: Measuring Cylinder Block Oil Pan Flange & Rear Oil Seal Housing Flange
Courtesy of GENERAL MOTORS CORP.

9. Place a straight edge on the engine block oil pan flange and the crankshaft rear oil seal housing flange. Use a feeler gage to ensure there is no more than 0.10 mm (0.004 in) step on each side. If necessary, gently rotate the crankshaft rear oil seal housing to make the step equal on each side.

CAUTION: Refer to Fastener Caution .

10. Tighten the crankshaft rear oil seal housing bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft) plus an additional 50 degrees using **J 45059** .

11. Recheck the step height on each side to ensure the crankshaft rear oil seal housing did not move. If the step height is beyond specification, reinstall the crankshaft rear oil seal housing and measure the step again. Replace the crankshaft rear oil seal housing if the clearance is still beyond specification.
12. Install the oil pan. Refer to **Oil Pan Replacement**.
13. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)**.

ENGINE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)**.
2. Remove the hood. Refer to **Hood Replacement**.
3. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
6. Drain the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)**.
7. Remove the torque converter covers. Refer to **Torque Converter Cover Replacement**.

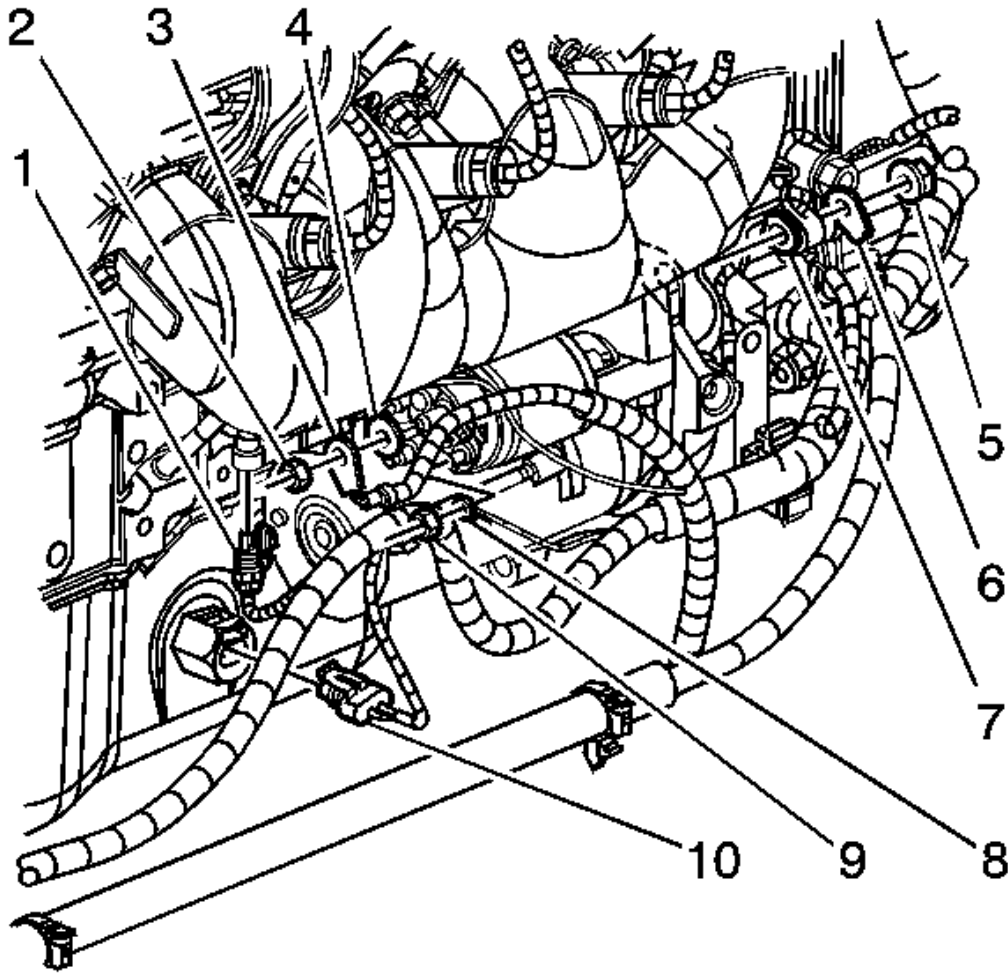


Fig. 252: View Of Engine Electrical Connectors (Left Side)
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine ground nut (5) and the engine ground wire (6) from the transaxle stud.
9. Remove the oil level sensor harness retainer bolt.
10. Remove the oil level harness retainer from the engine.
11. Disconnect and reposition the electrical connectors from the following components:
 - Vehicle speed sensor (VSS)
 - Oil pressure sensor
 - Oil level sensor (10)
 - Knock sensors

- Heated oxygen sensor (H02S)
12. Remove the starter motor. Refer to **Starter Motor Replacement (L26)** .
 13. Remove the engine flywheel-to-torque converter bolts. Refer to **Flywheel to Torque Converter Bolt Replacement** .
 14. Scribe the torque converter to the flywheel for installation.
 15. Remove the transaxle brace. Refer to **Transmission Brace Replacement** .
 16. Remove the engine mount lower nuts.

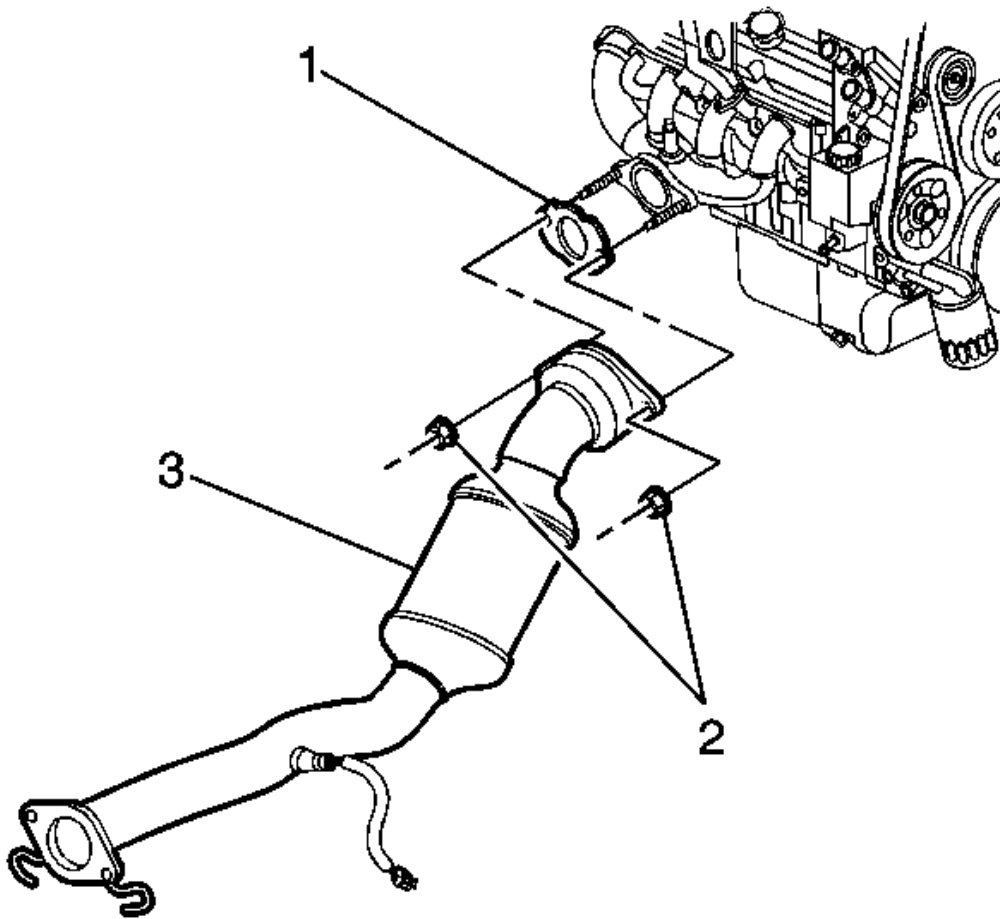


Fig. 253: Right Exhaust Manifold & Catalytic Converter Pipe
 Courtesy of GENERAL MOTORS CORP.

17. Remove the exhaust manifold pipe stud nuts (2) and reposition the catalytic converter from the exhaust manifold.

18. Remove the oil filter adapter housing. Refer to **Oil Filter Adapter and Bypass Valve Assembly Replacement**.

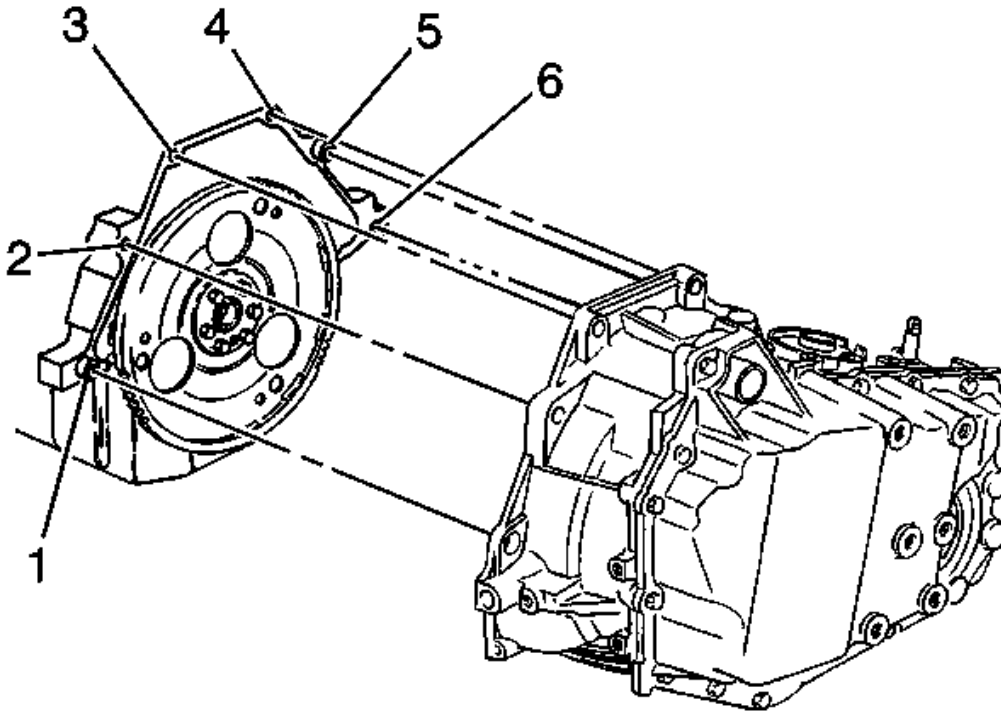


Fig. 254: View of Transaxle To Engine Mounting
Courtesy of GENERAL MOTORS CORP.

19. Remove the lower transaxle to the engine bolt (6) and the stud (1).
20. Lower the vehicle while supporting the transaxle.
21. Remove the air cleaner assembly. Refer to **Air Cleaner Element Replacement** .
22. Disconnect the fuel line from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
23. Disconnect the fuel vapor line. Refer to **Metal Collar Quick Connect Fitting Service** .

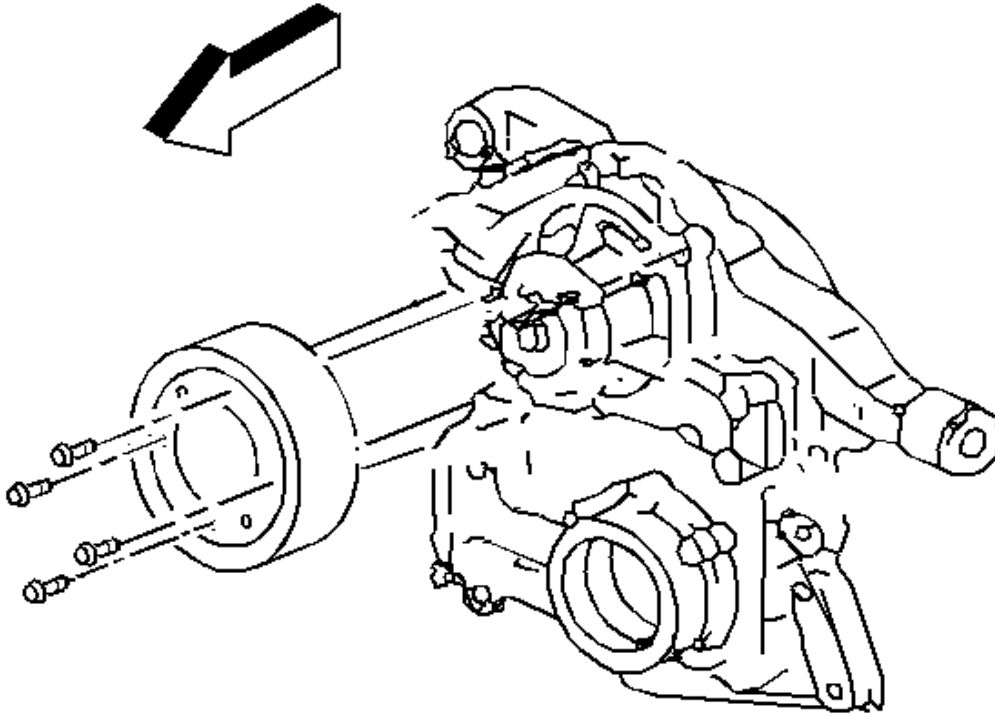


Fig. 255: View Of Water Pump Pulley And Bolts
 Courtesy of GENERAL MOTORS CORP.

24. Loosen the water pump pulley bolts.
25. Remove the drive belt. Refer to **Drive Belt Replacement (L26)**.
26. Remove the water pump pulley bolts and the water pump pulley.
27. Remove the right and the left engine mount struts. Refer to **Engine Mount Strut Replacement - Right Side** and **Engine Mount Strut Replacement - Left Side**.
28. Remove the engine mount brackets from the radiator support. Refer to **Engine Front Mount Bracket Replacement**.
29. Disconnect the positive battery cable.
30. Remove the engine cooling fans. Refer to **Engine Coolant Fan Motor Replacement (L26)**.
31. Remove the vacuum booster hose from the engine. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement**.
32. Disconnect the A/C vacuum hose from the engine.

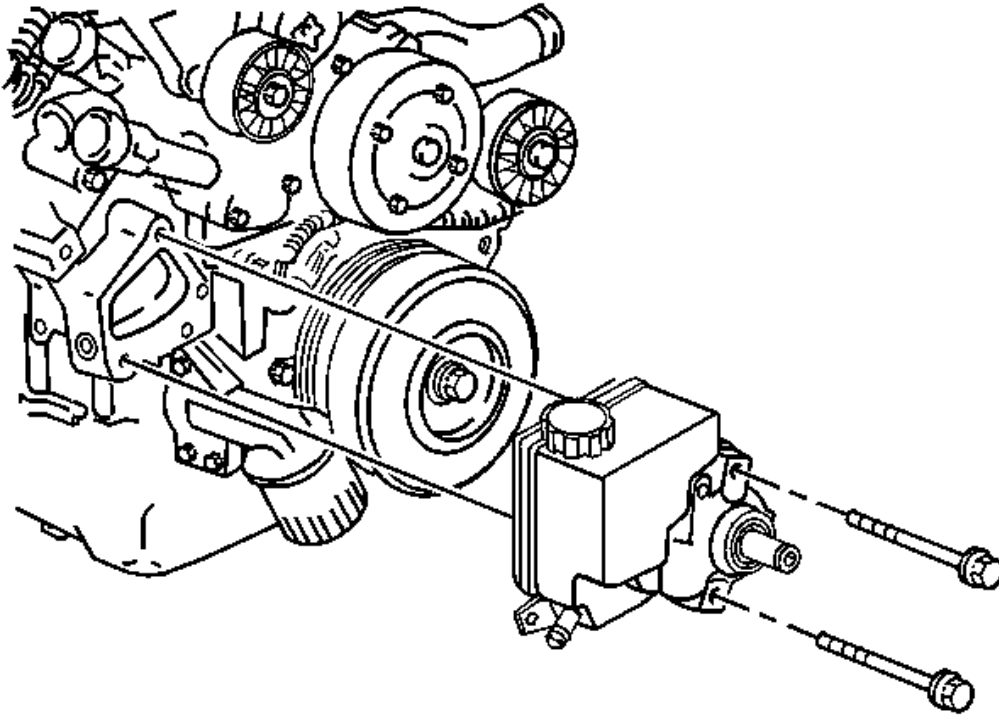


Fig. 256: View Of Power Steering Pump And Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

33. Remove the power steering pump bolts and pump from the engine. Lay the power steering pump aside.
34. Disconnect the upper engine electrical connectors from the following components:
 - Electronic throttle control (ETC)
 - Fuel injectors
 - EVAP purge solenoid
 - Exhaust gas recirculation (EGR) valve
 - Manifold absolute pressure (MAP) sensor
 - BARO sensor, if equipped

NOTE: **Note the position of the engine wiring harness during removal.**

35. Remove upper engine wiring harness from the retaining clips and reposition the engine wiring harness for engine removal.
36. Remove the radiator inlet hose from the engine. Refer to **Radiator Inlet Hose Replacement (L26)** .
37. Remove the radiator outlet hose from the engine. Refer to **Radiator Outlet Hose Replacement (L26)** .

38. Remove the heater hoses from the drive belt tensioner. Refer to **Heater Inlet Hose Replacement (L26)** and to **Heater Outlet Hose Replacement (L26)**.
39. Remove the A/C compressor from the engine. Refer to **Air Conditioning Compressor Replacement (L26)**. DO NOT discharge the A/C system. Secure the compressor to the frame.
40. Install the engine lifting device.

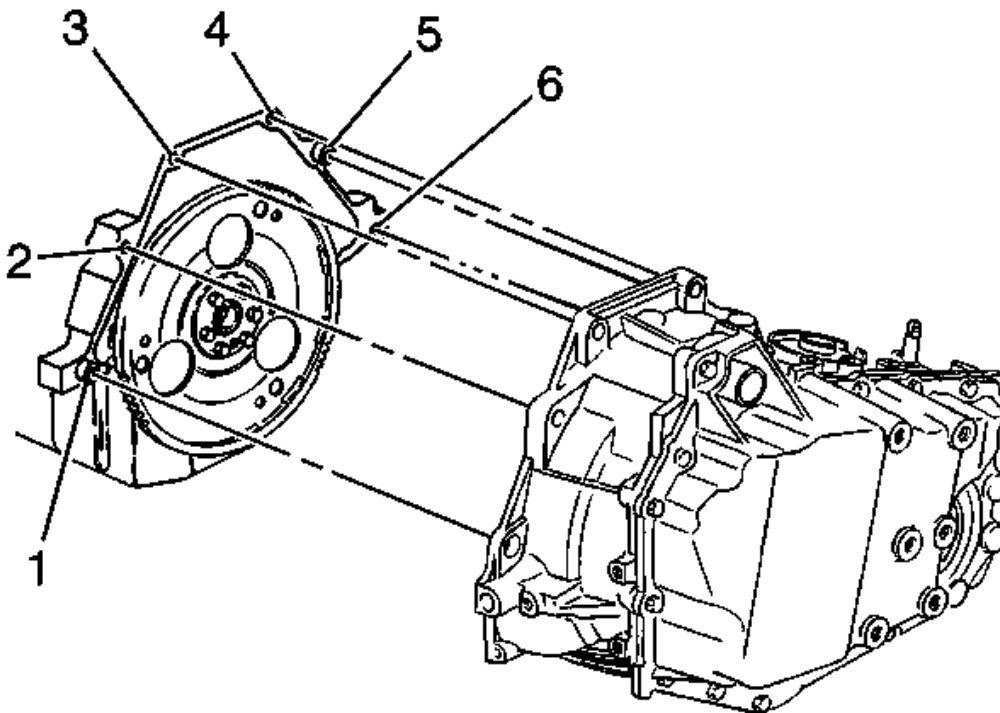


Fig. 257: View of Transaxle To Engine Mounting
Courtesy of GENERAL MOTORS CORP.

41. Remove the upper transaxle to the engine bolts (2, 3, 4, 5).
42. With the aid of an assistant, remove the engine from the vehicle.
43. Remove the flywheel. Refer to **Engine Flywheel Replacement**.
44. Install the engine to the engine stand.

Installation Procedure

1. Remove the engine from the engine stand.
2. Install the flywheel. Refer to **Engine Flywheel Replacement**.
3. With the aid of an assistant, install the engine to the vehicle.

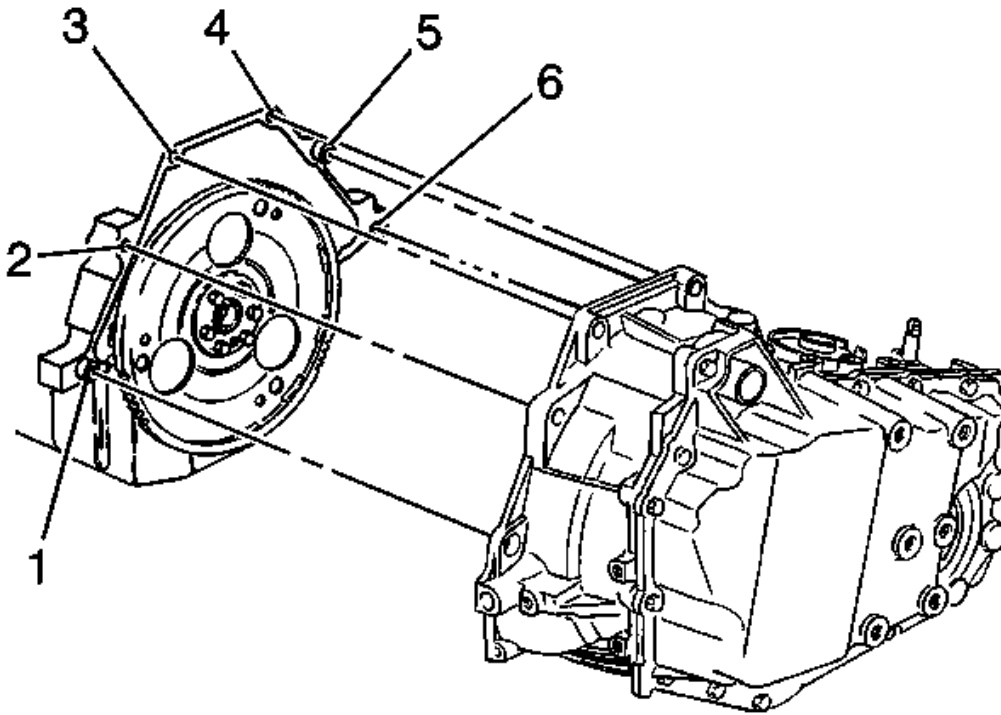


Fig. 258: View of Transaxle To Engine Mounting
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the upper transaxle to the engine bolts (2, 3, 4, 5).

Tighten: Tighten the bolts to 75 N.m (55 lb ft).

5. Remove the engine lifting device.
6. Install the A/C compressor to the engine. Refer to Air Conditioning Compressor Replacement (L26) .
7. Install the heater hoses to the drive belt tensioner. Refer to Heater Inlet Hose Replacement (L26) and Heater Outlet Hose Replacement (L26) .
8. Install the radiator outlet hose to the engine. Refer to Radiator Outlet Hose Replacement (L26) .
9. Install the radiator inlet hose to the engine. Refer to Radiator Inlet Hose Replacement (L26) .
10. Reposition and install the engine wiring harness to the engine as noted during removal.
11. Connect the upper engine electrical connectors to the following components:

- BARO sensor, if equipped
- MAP sensor
- EGR valve
- EVAP purge solenoid
- Fuel injectors
- Electronic throttle control (ETC)

12. Install the upper engine wiring harness to the retaining clips.

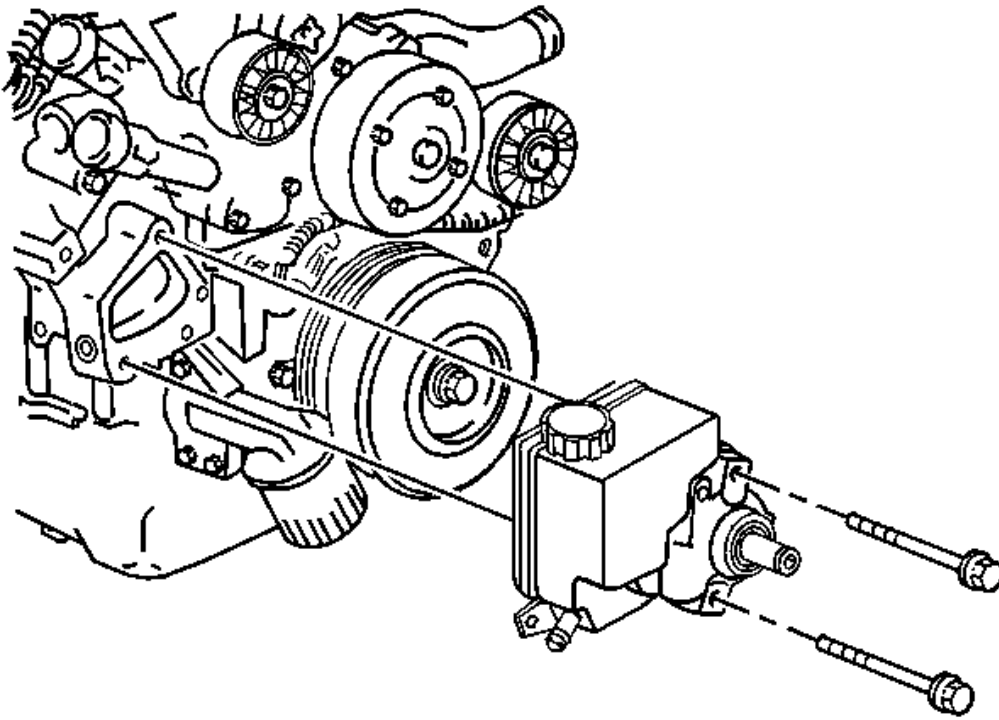


Fig. 259: View Of Power Steering Pump And Mounting Bolts
 Courtesy of GENERAL MOTORS CORP.

13. Install the power steering pump to the engine.
14. Install the power steering pump bolts.

Tighten: Tighten the bolts to 34 N.m (25 lb ft).

15. Connect the A/C vacuum hose to the engine.
16. Install the vacuum booster hose to the engine. Refer to **Power Brake Booster Vacuum Check Valve**

and Hose Replacement .

17. Install the engine cooling fans. Refer to **Engine Coolant Fan Motor Replacement (L26)** .
18. Connect the positive battery cable.

Tighten: Tighten the cable terminal bolt to 15 N.m (11 lb ft).

19. Install the engine mount brackets to the upper radiator support. Refer to **Engine Front Mount Bracket Replacement**.
20. Install the engine mount struts to the engine mount strut brackets. Refer to **Engine Mount Strut Replacement - Right Side** and **Engine Mount Strut Replacement - Left Side**.

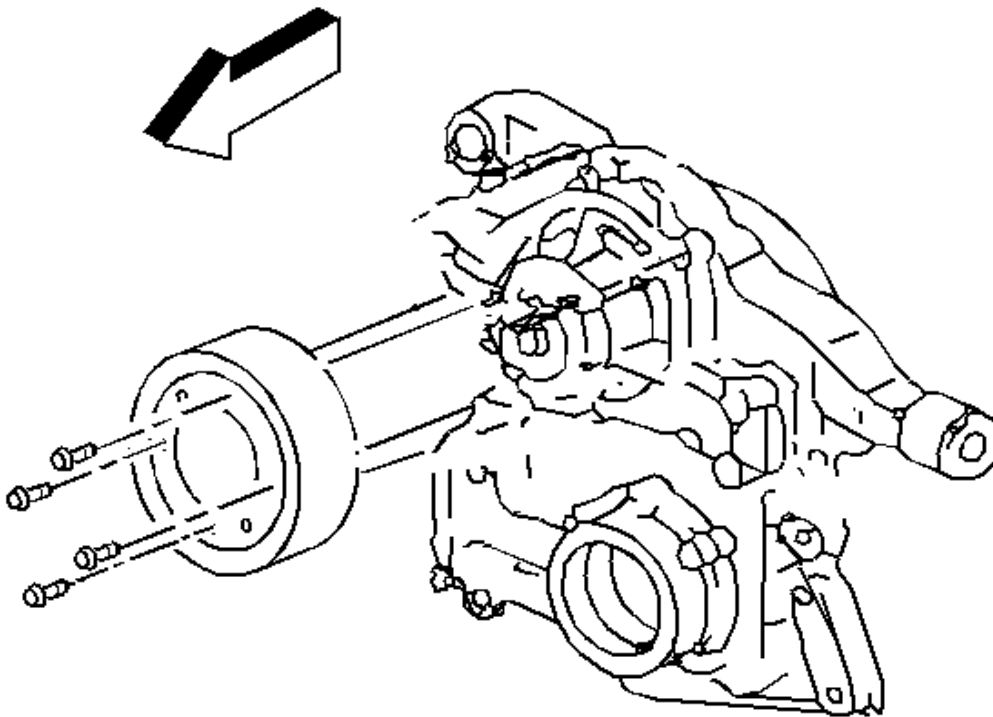


Fig. 260: View Of Water Pump Pulley And Bolts
Courtesy of GENERAL MOTORS CORP.

21. Install the water pump pulley.
22. Install the water pump pulley bolts.

Tighten: Tighten the pulley bolts to 13 N.m (116 lb in).

23. Install the drive belt. Refer to **Drive Belt Replacement (L26)**.
24. Connect the fuel vapor line. Refer to **Metal Collar Quick Connect Fitting Service**.
25. Connect the fuel line to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
26. Install the air cleaner assembly. Refer to **Air Cleaner Element Replacement**.
27. Raise the vehicle and remove the transaxle support.

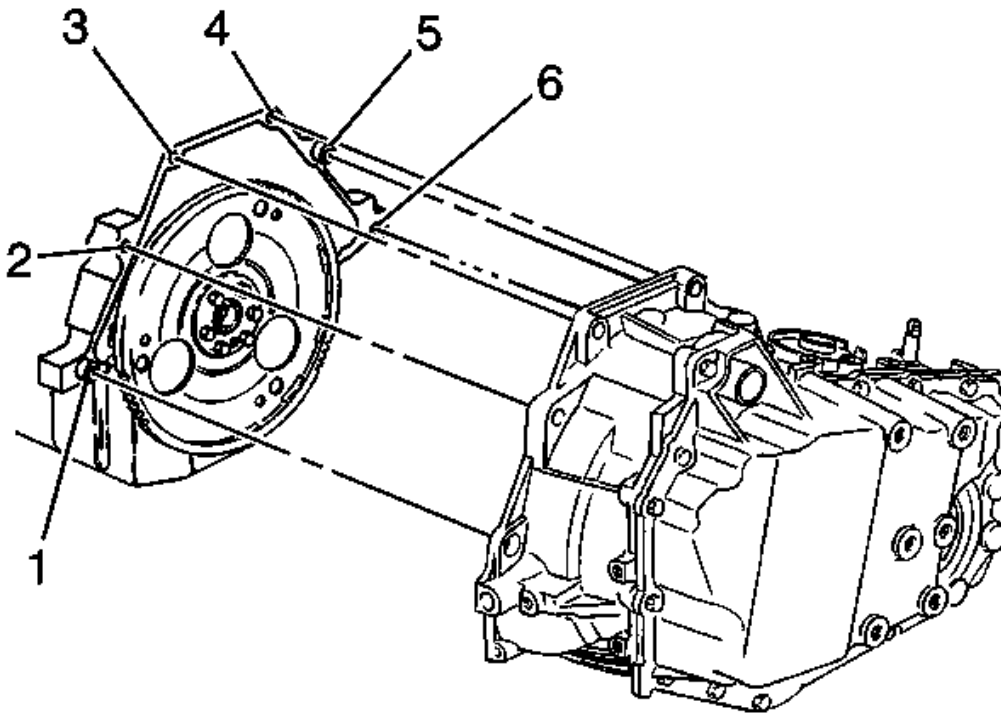


Fig. 261: View of Transaxle To Engine Mounting
Courtesy of GENERAL MOTORS CORP.

28. Install the lower transaxle to the engine bolt (6) and the stud (1).

Tighten: Tighten the bolt and the stud to 75 N.m (55 lb ft).

29. Install the oil filter adapter housing. Refer to **Oil Filter Adapter and Bypass Valve Assembly Replacement**.

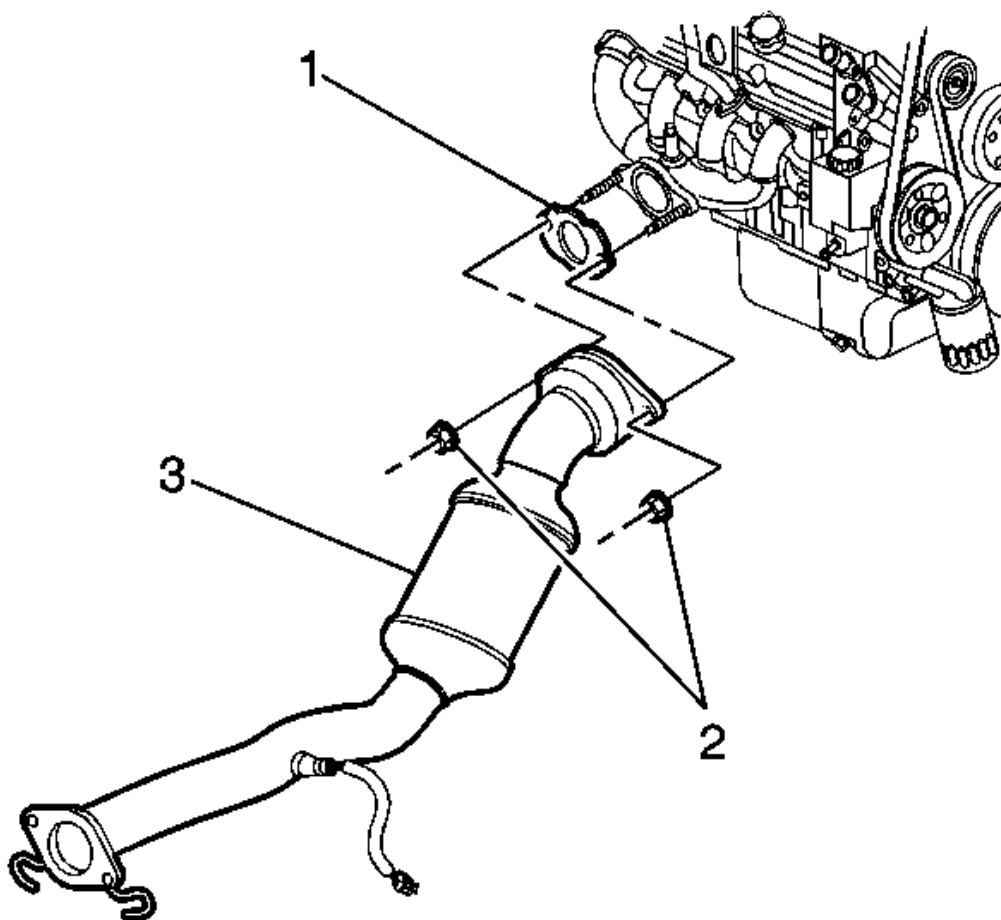


Fig. 262: Right Exhaust Manifold & Catalytic Converter Pipe
Courtesy of GENERAL MOTORS CORP.

30. Install a new gasket (1) and the catalytic converter (3) to the right exhaust manifold.
31. Install the exhaust manifold pipe stud nuts (2).

Tighten: Tighten the nuts to 35 N.m (26 lb ft).

32. Install the engine mount lower nuts.

Tighten: Tighten the nuts to 47 N.m (35 lb ft).

33. Install the transaxle brace. Refer to **Transmission Brace Replacement** .
34. Install the engine flywheel-to-torque converter bolts. Refer to **Flywheel to Torque Converter Bolt**

Replacement .

35. Install the starter motor. Refer to **Starter Motor Replacement (L26)** .

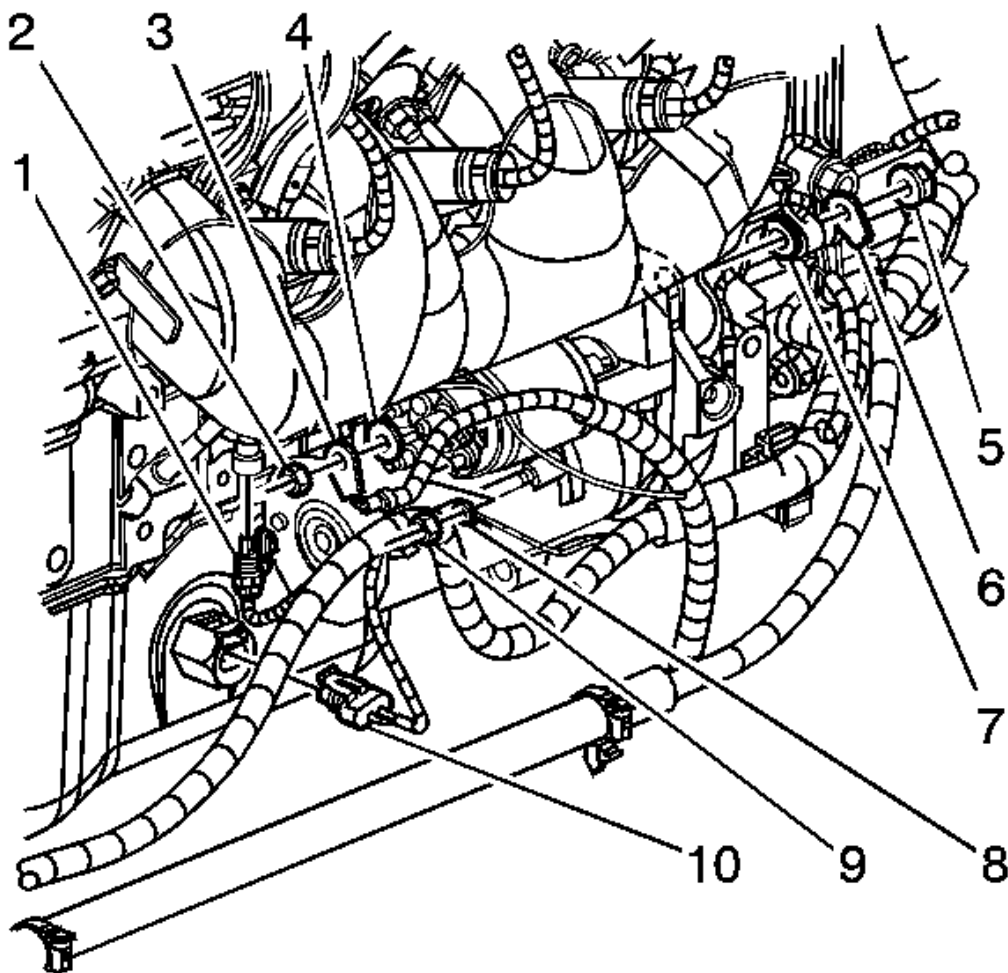


Fig. 263: View Of Engine Electrical Connectors (Left Side)
Courtesy of GENERAL MOTORS CORP.

36. Reposition and connect the electrical connectors to the following components:
- HO2S
 - Knock sensors
 - Oil level sensor (10)
 - Oil pressure sensor
 - VSS

37. Install the oil level sensor harness retainer to the engine.
38. Install the oil level sensor harness retainer bolt.

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

39. Install the engine ground wire (6) and the engine ground wire nut (5) to the transaxle stud.

Tighten: Tighten the nut to 35 N.m (26 lb ft).

40. Install the torque converter covers. Refer to **Torque Converter Cover Replacement** .
41. Lower the vehicle.
42. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement**.
43. Install the hood. Refer to **HOOD REPLACEMENT** .
44. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (L26)** .
45. Fill the crankcase with engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
46. Fill the cooling system. Refer to **Cooling System Draining and Filling (L26 Static Fill)** or **Cooling System Draining and Filling (L26 GE 47716 Fill)** .
47. Inspect for leaks.
48. Perform the CKP system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position the oil drain pan under the engine oil drain plug.

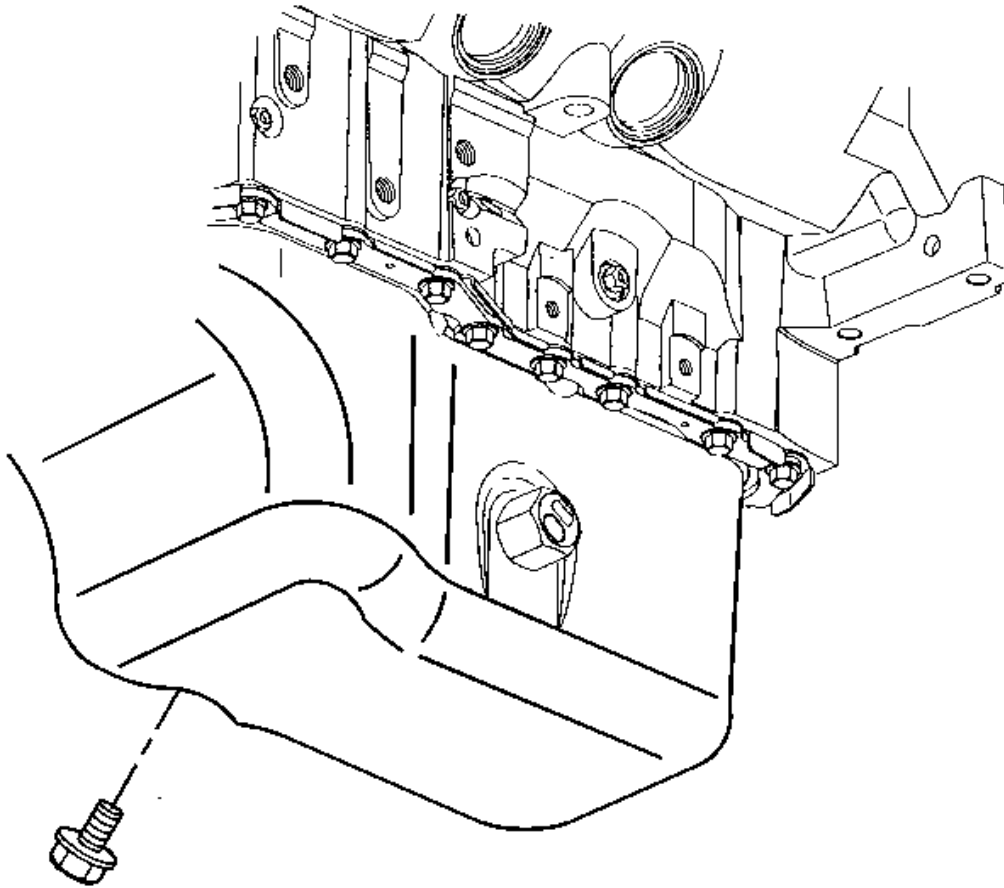


Fig. 264: Locating Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil drain plug.
4. Clean and inspect the engine oil drain plug, repair or replace if necessary.
5. Clean and inspect the engine oil drain plug sealing surface on the oil pan, repair or replace oil pan if necessary.

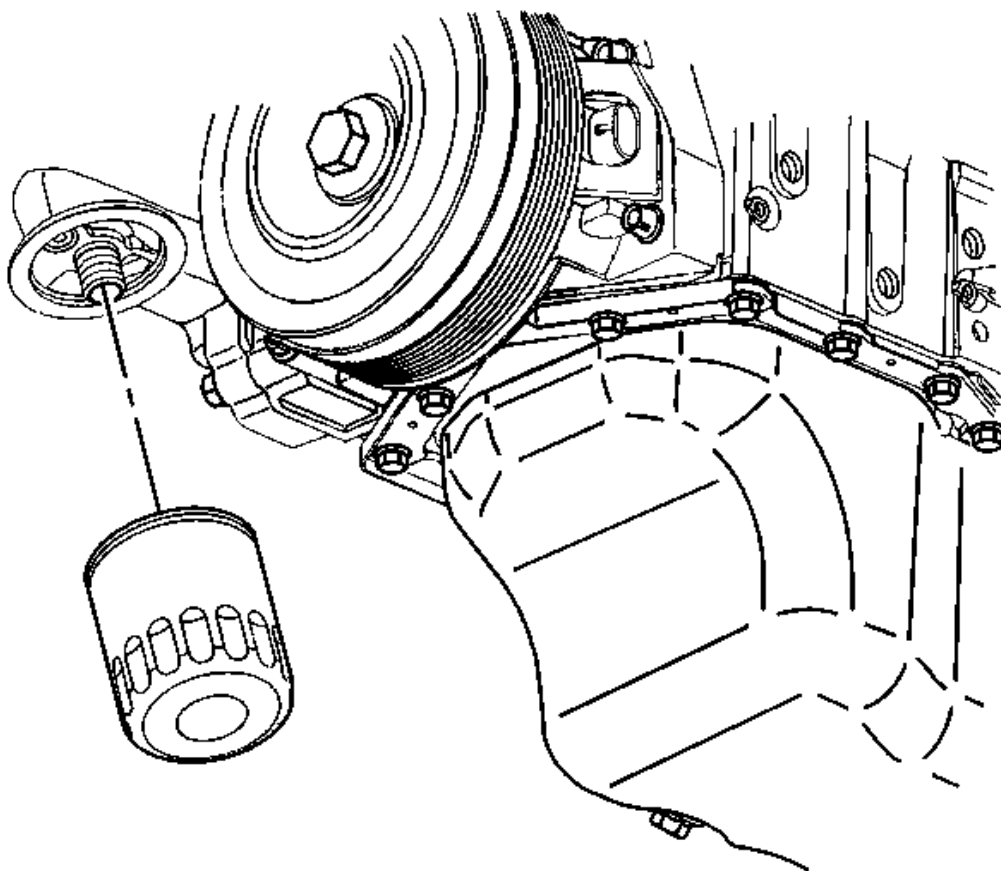


Fig. 265: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil filter.
7. Clean and inspect the oil filter sealing area on the oil filter adapter, repair or replace if necessary. Refer to **Oil Filter Adapter and Bypass Valve Assembly Replacement**.

Installation Procedure

1. Lightly oil the replacement oil filter gasket with clean oil and install the new oil filter.

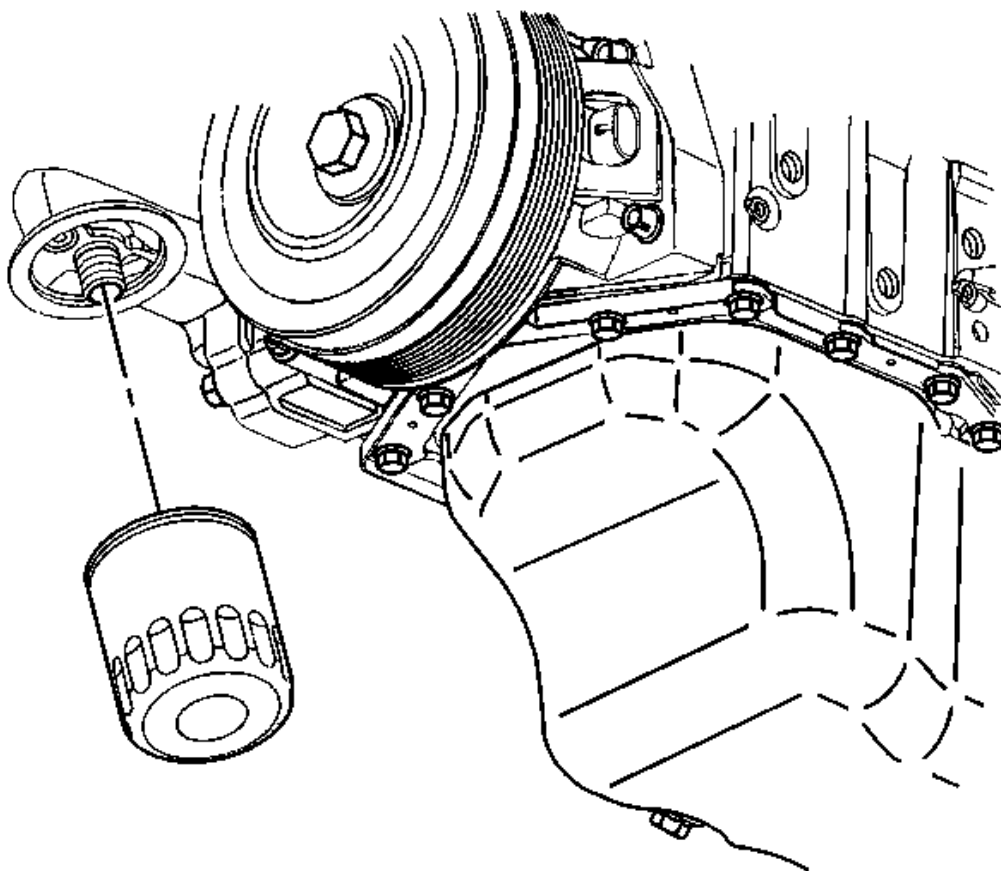


Fig. 266: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the new oil filter. Refer to Maintenance Items .

Tighten: Tighten the new oil filter to 3/4 to 1 full turn, after the oil filter gasket contacts the oil filter mounting surface.

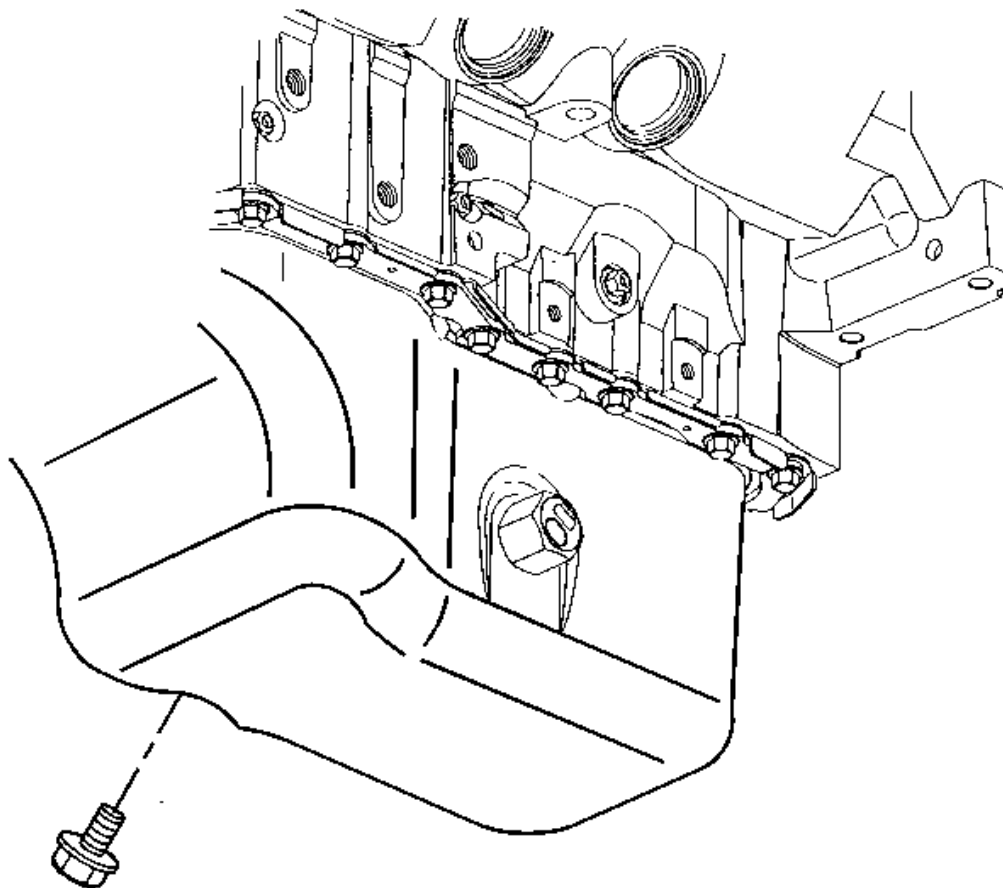


Fig. 267: Locating Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the engine oil drain plug.

Tighten: Tighten the plug to 30 N.m (22 lb ft).

4. Remove the oil drain pan.
5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations**.
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.

10. Remove the oil level indicator from the oil indicator tube.
11. Clean off the indicator end of the oil level indicator with a clean paper towel or cloth.
12. Install the oil level indicator into the oil level indicator tube until the oil level indicator handle contacts the top of the oil level indicator tube.
13. Again, remove the oil level indicator from the oil level indicator tube keeping the tip of the oil level indicator down.
14. Check the level of the engine oil on the oil level indicator.
15. If necessary, readjust the oil level by adding or draining the engine oil.
16. Check for oil leaks.

ROTATING THE ENGINE FOR SERVICE ACCESS

Tools Required

J 41131 Engine Tilt Strap. See **Special Tools**.

1. Remove the air cleaner intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
2. Apply the parking brake.
3. Put the transaxle in the Neutral position.
4. Remove the engine mount struts. Refer to **Engine Front Mount Bracket Replacement** and **Engine Front Mount Replacement**.

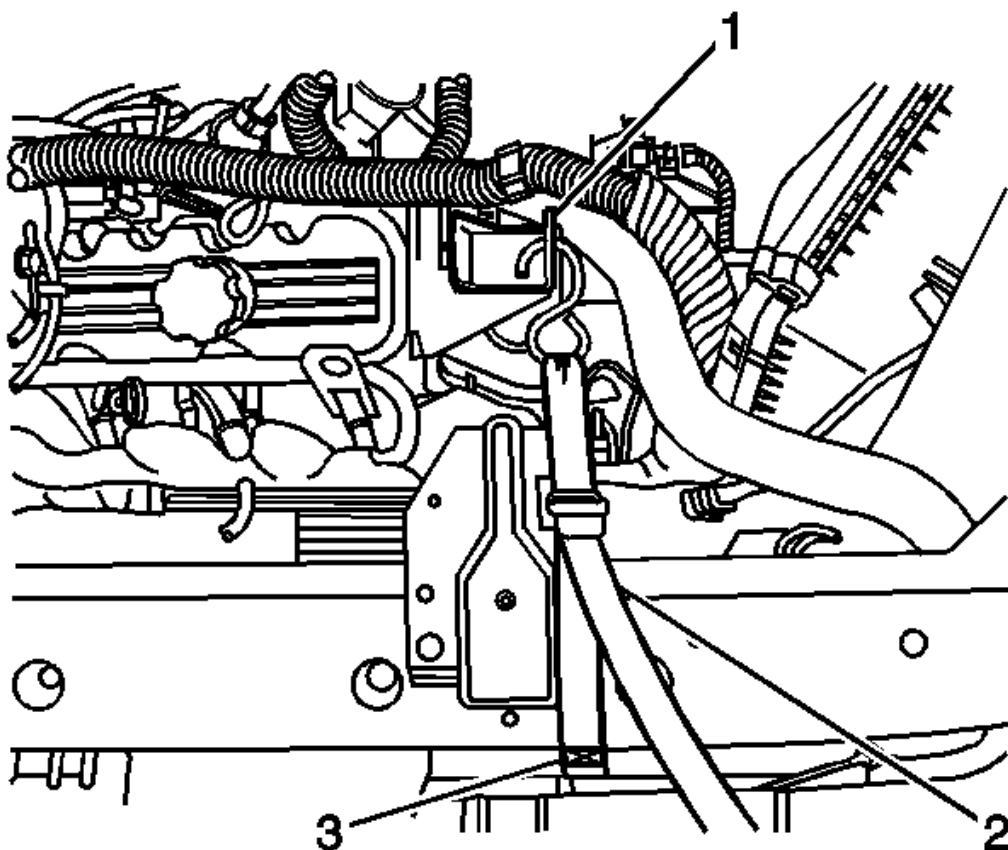


Fig. 268: J 41131, Engine Mount Strut Bracket & Upper Radiator Support
Courtesy of GENERAL MOTORS CORP.

5. Install the J 41131 (2) to the engine mount strut bracket (1) and the upper radiator support (3). See **Special Tools**.
6. Rotate the engine forward for component access.

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

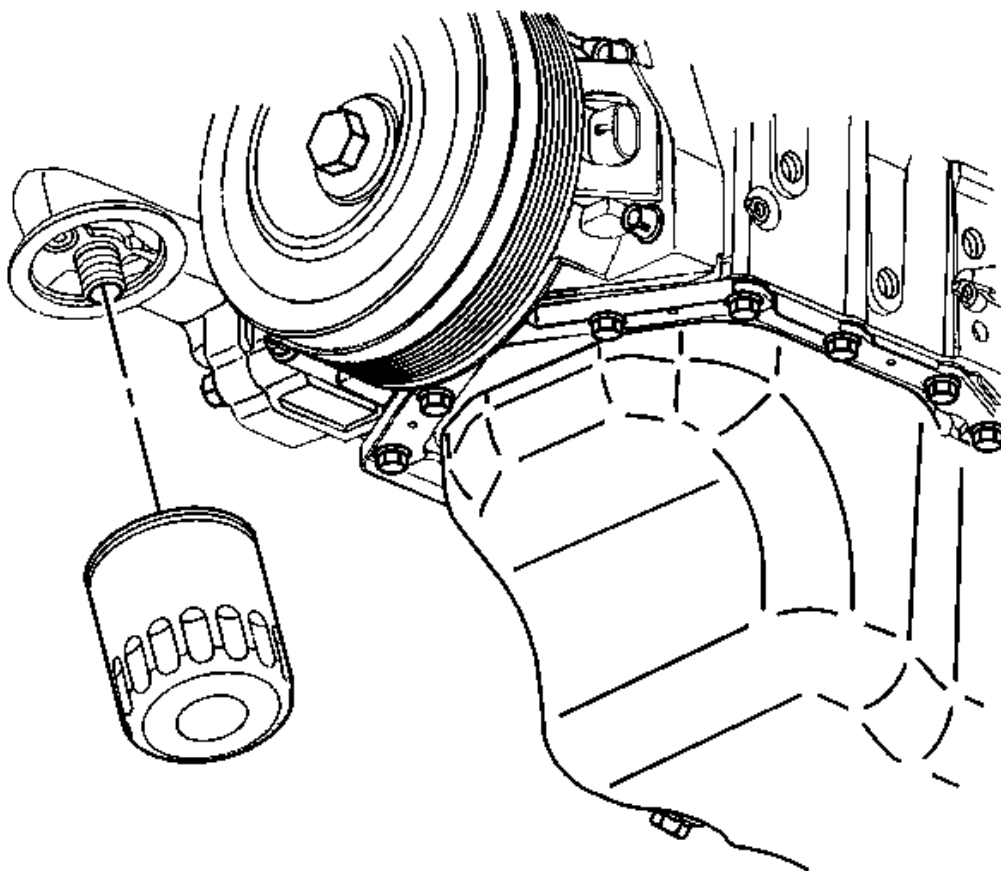


Fig. 269: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil drain plug.
2. Drain the engine oil.
3. Remove the oil filter.

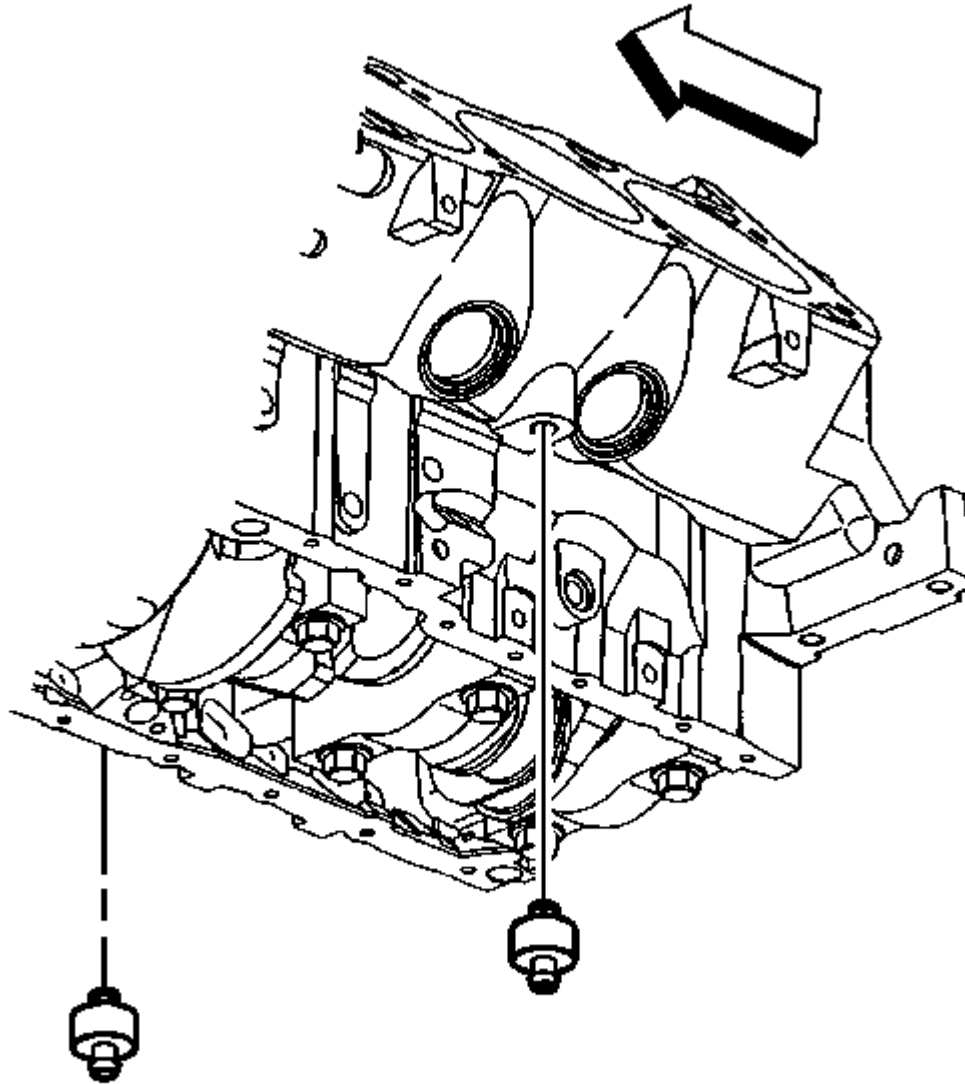


Fig. 270: Identifying Knock Sensors
Courtesy of GENERAL MOTORS CORP.

4. Remove the knock sensor heat shield bolts and heat shield, if applicable.
5. Remove the knock sensor.
6. Drain the coolant.

CRANKSHAFT BALANCER REMOVAL

Tools Required

- **J 37096** Flywheel Holder. See **Special Tools**.
- **J 38197-A** Crankshaft Balancer Remover. See **Special Tools**.

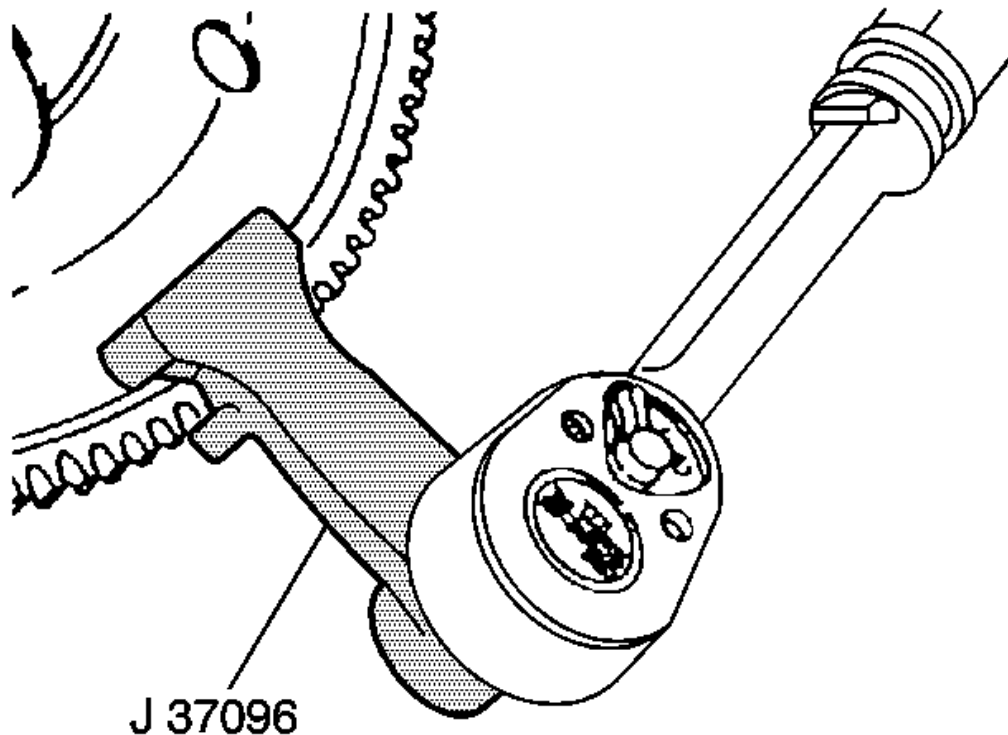


Fig. 271: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

1. Use **J 37096** in order to hold the flywheel. See **Special Tools**.

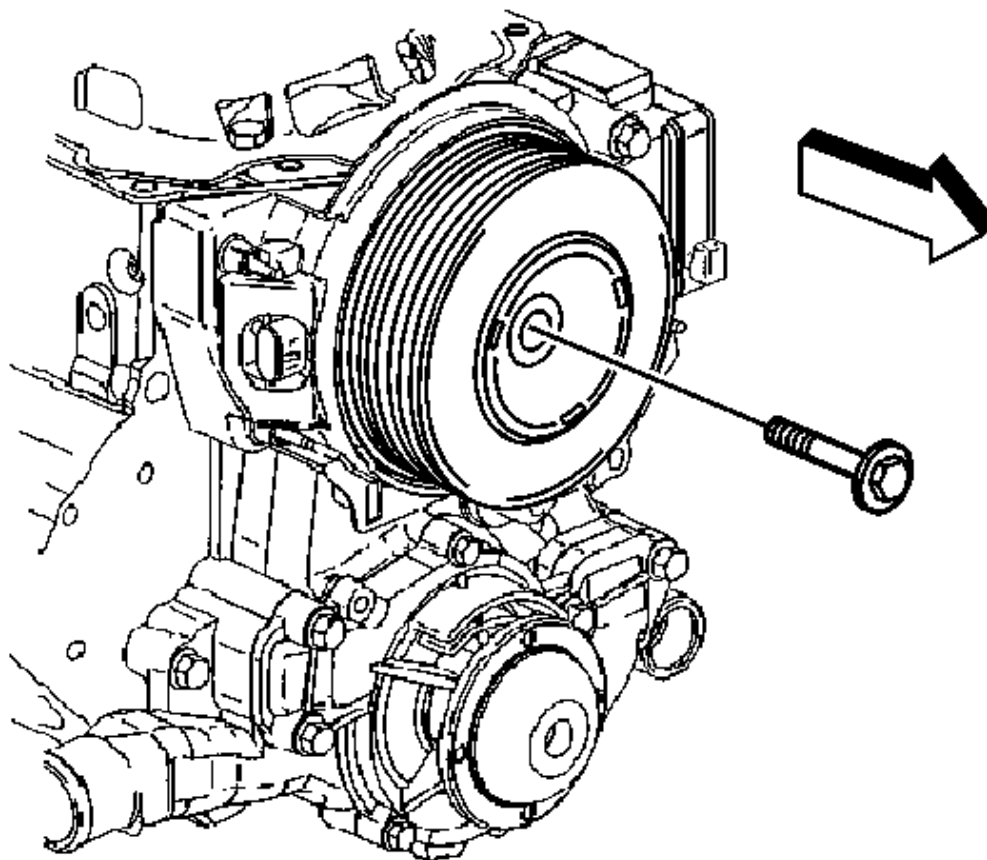


Fig. 272: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt.

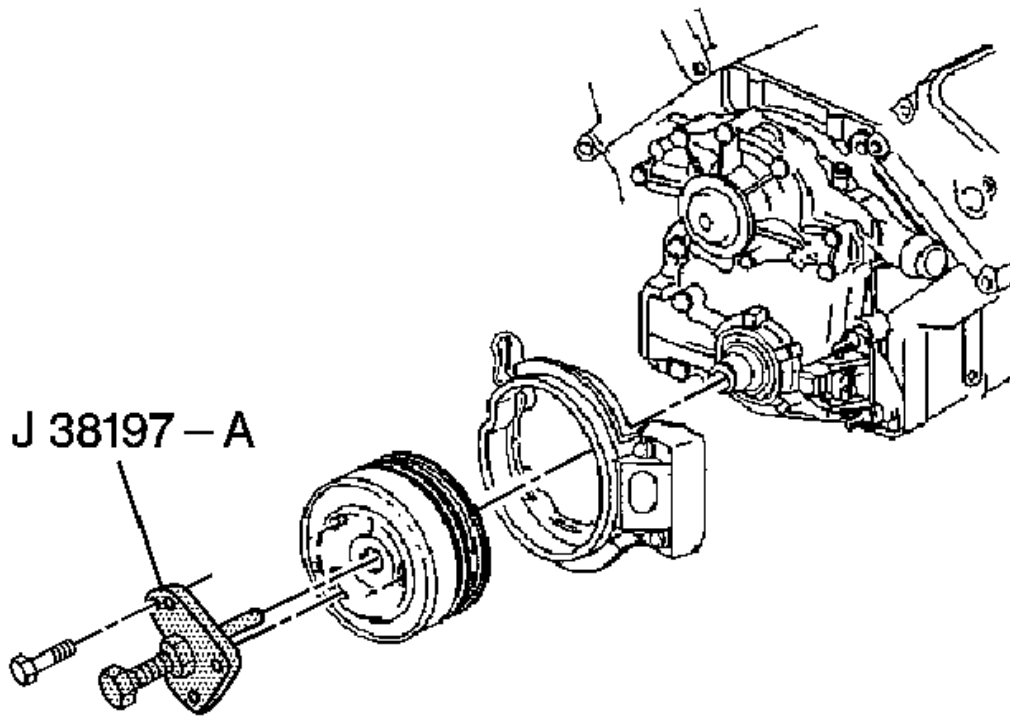


Fig. 273: Removing Crankshaft Balancer
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not separate the crankshaft pulley from the crankshaft balancer.
 Service the crankshaft pulley and the crankshaft balancer as an assembly.

3. Use the **J 38197-A** in order to remove the crankshaft balancer. See Special Tools.
 1. Invert J 38197-2 so the leg of the tool is facing away from the crankshaft balancer.
 2. Install the silver screws J 38197-4 to the crankshaft balancer.
 3. Turn J 38197-1 to remove the crankshaft balancer from the crankshaft.
 4. Remove J 38197-1, J 38197-2, and J 38197-4 from the crankshaft balancer.

ENGINE FLYWHEEL REMOVAL

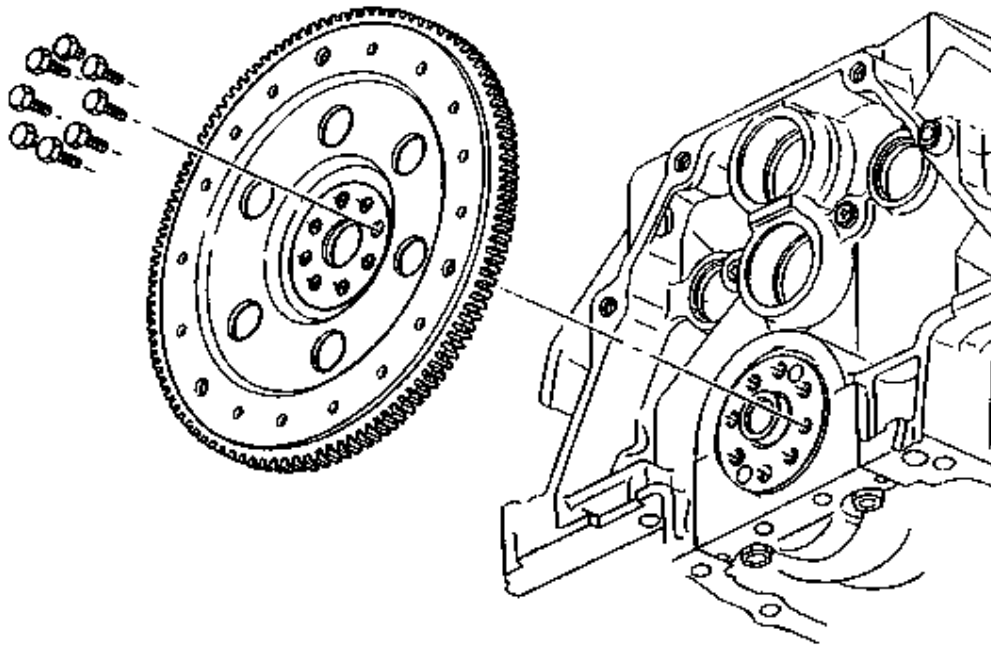


Fig. 274: Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel bolts. Discard the bolts.
2. Remove the flywheel.

DRIVE BELT TENSIONER REMOVAL

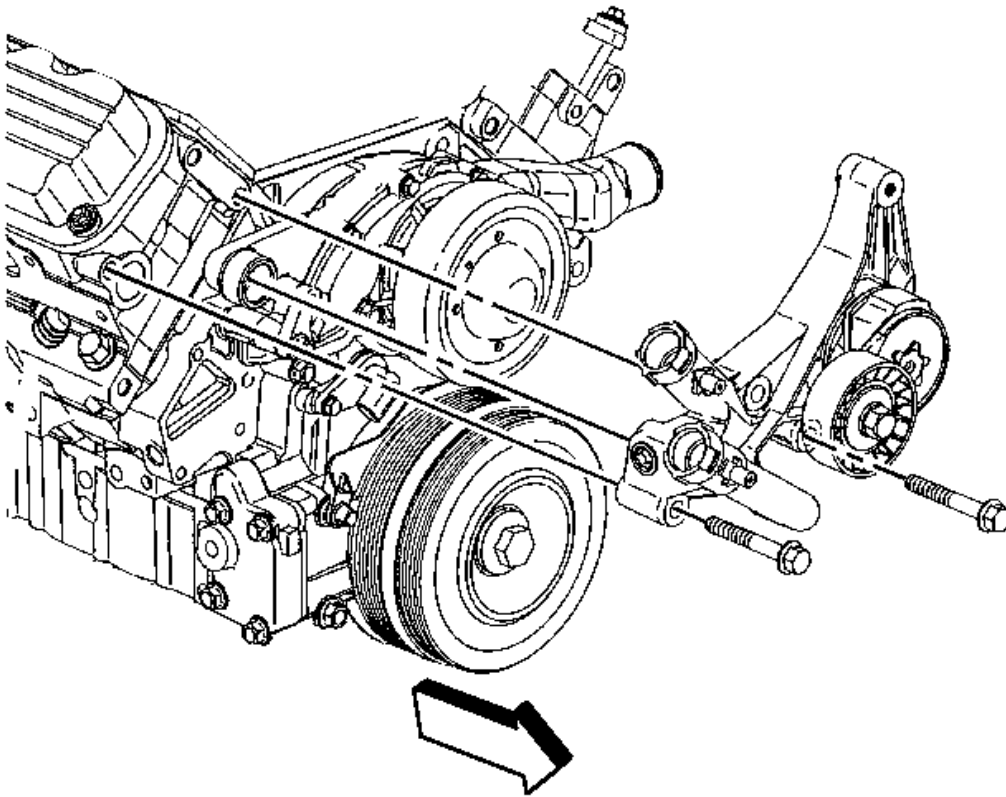


Fig. 275: Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt tensioner bracket bolts.
2. Remove the drive belt tensioner bracket.

DRIVE BELT IDLER PULLEY REMOVAL

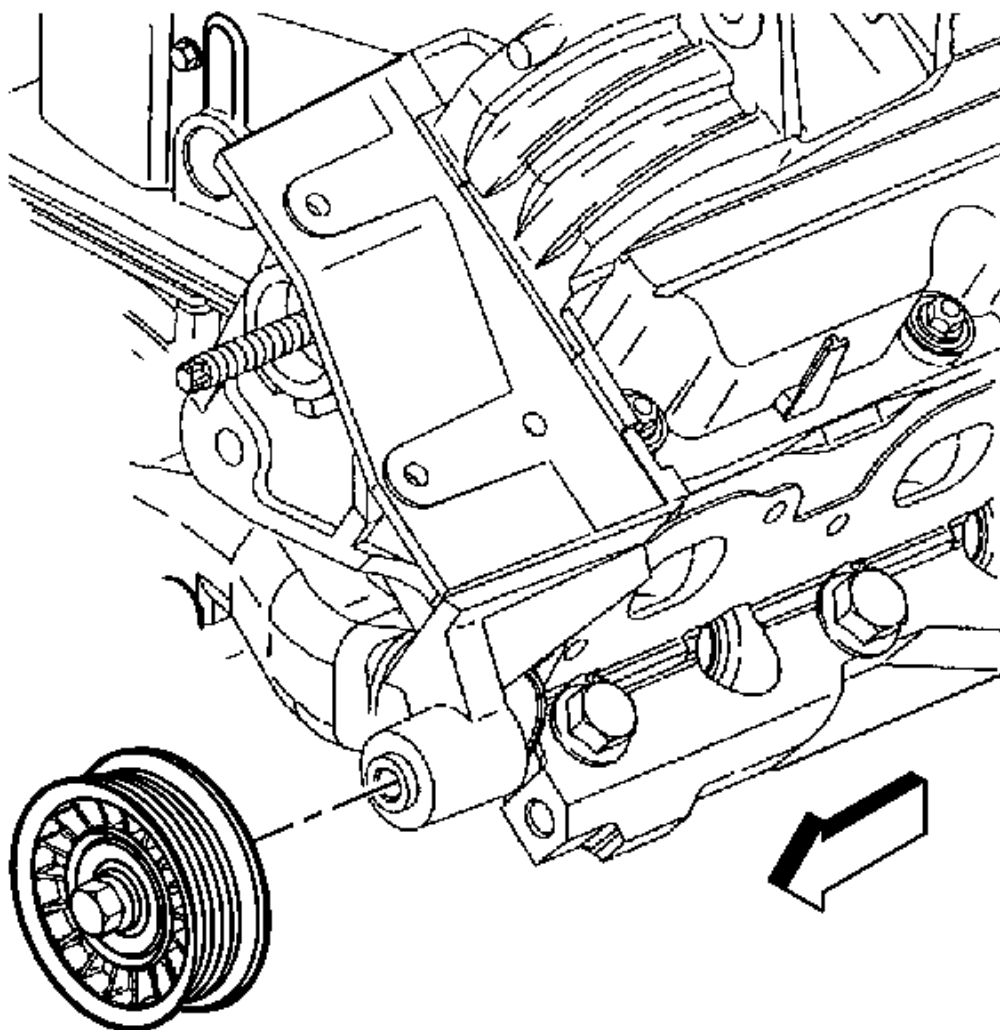


Fig. 276: Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt idler pulley bolt.
2. Remove the drive belt idler pulley.

OIL LEVEL INDICATOR AND TUBE REMOVAL

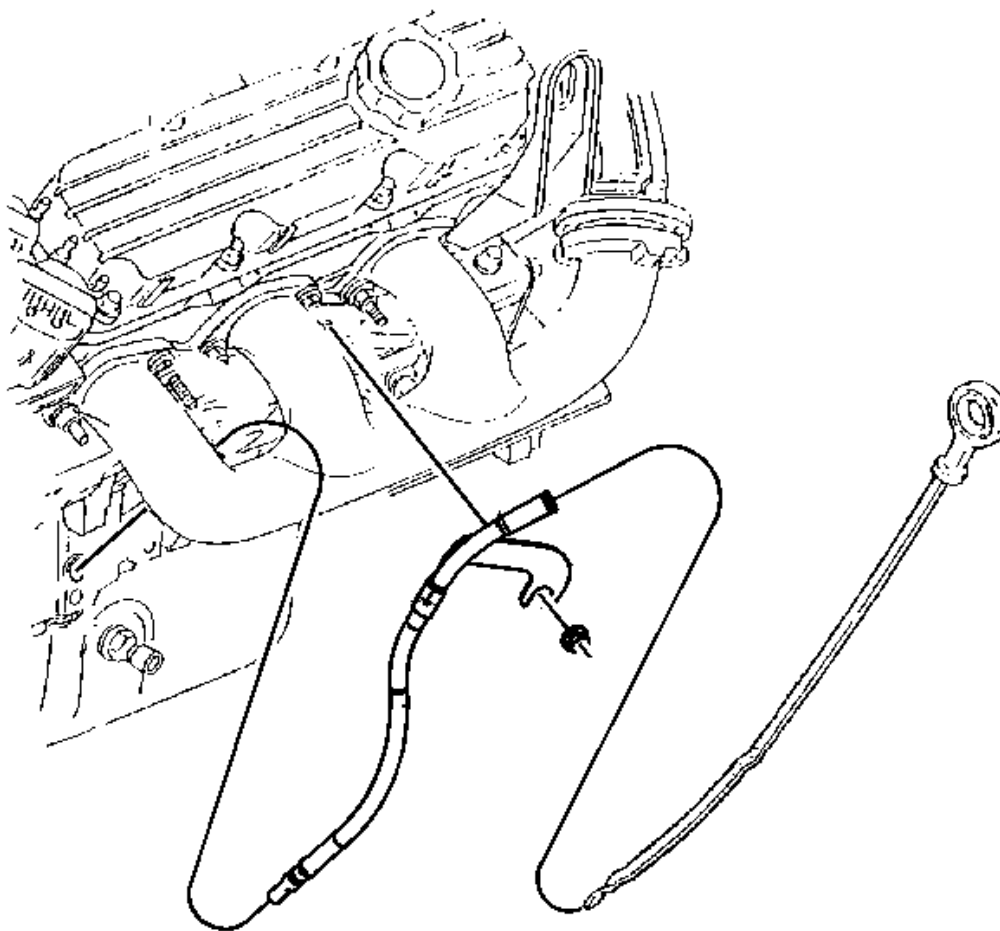


Fig. 277: Oil Level Indicator, Tube & Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the oil level indicator tube nut.
3. Remove the oil level indicator tube.

WATER OUTLET AND ENGINE COOLANT THERMOSTAT REMOVAL (L26)

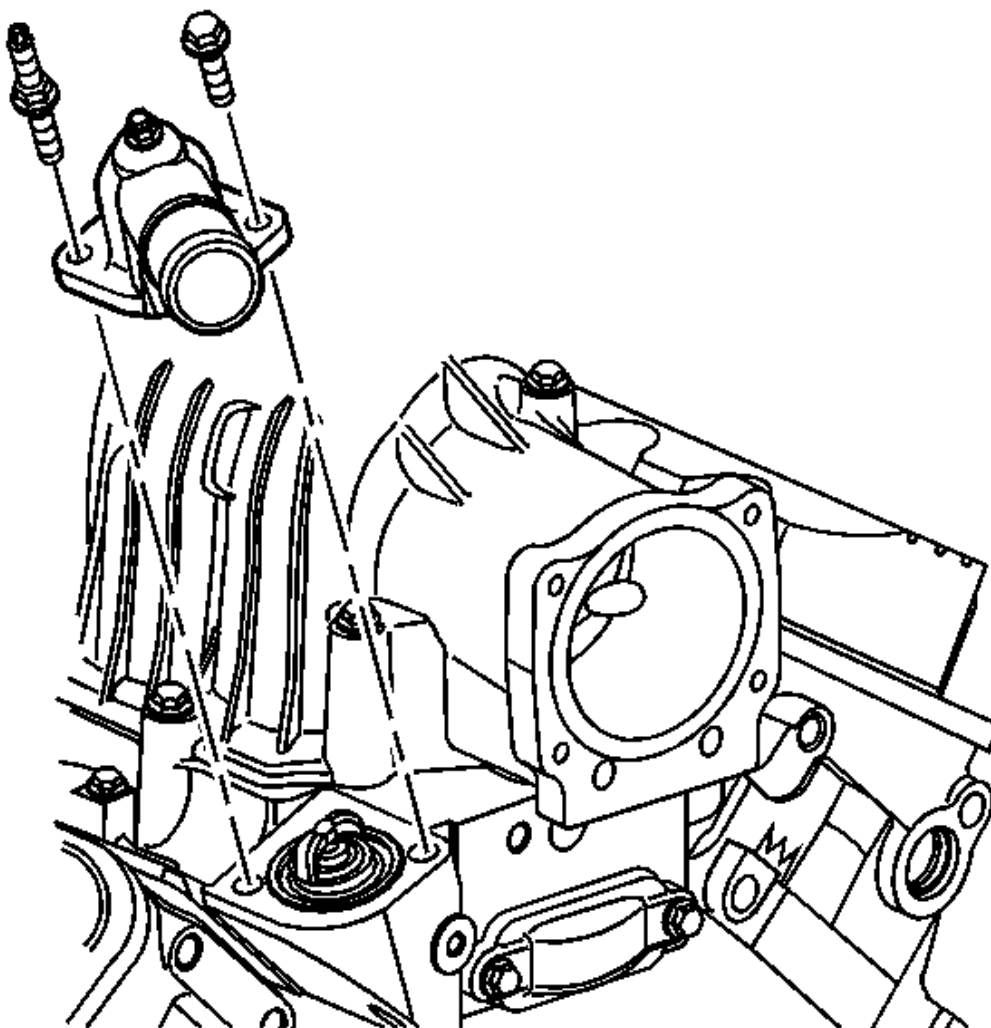


Fig. 278: Thermostat, Water Outlet Bolt & Stud (L26)
Courtesy of GENERAL MOTORS CORP.

1. Remove the water outlet bolt and stud.
2. Remove the water outlet.
3. Remove the thermostat.

WATER PUMP REMOVAL

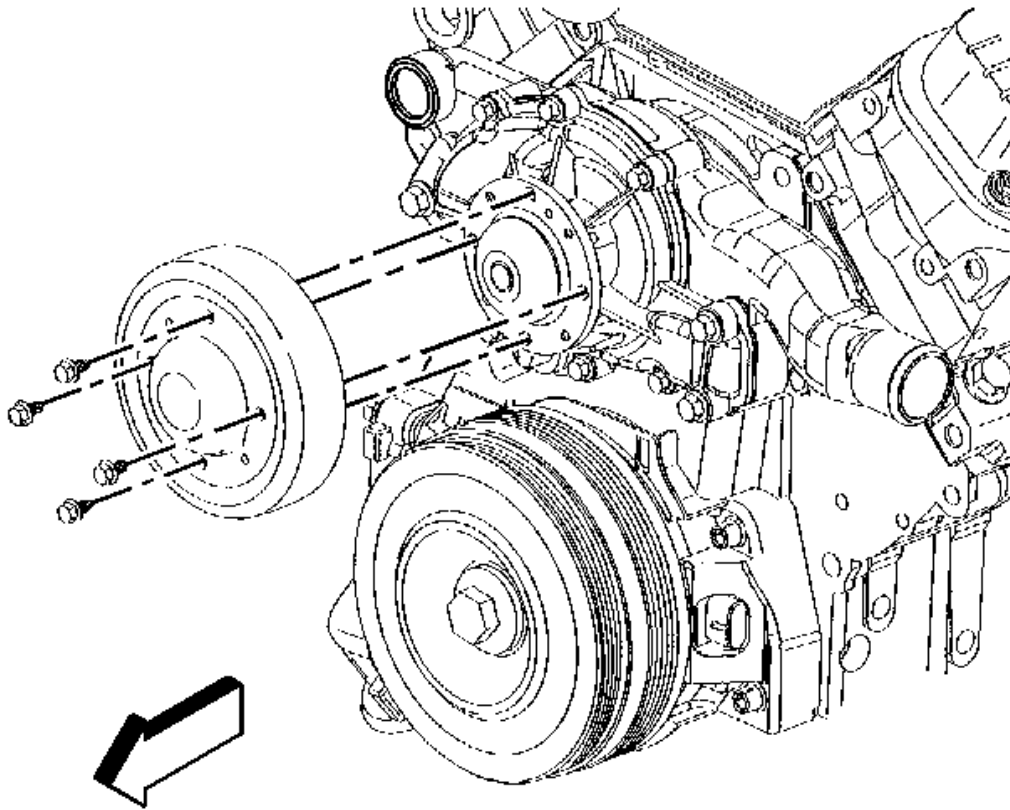


Fig. 279: Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump pulley bolts.
2. Remove the water pump pulley.

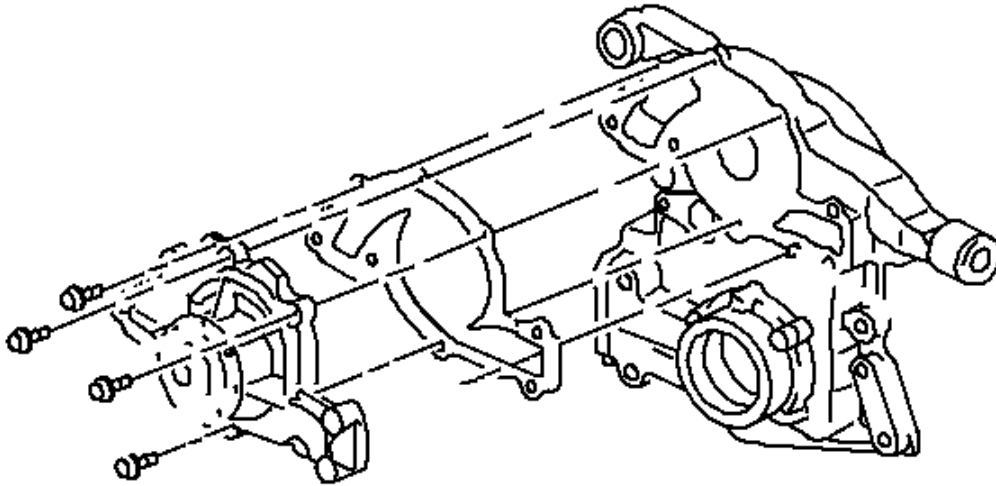


Fig. 280: Identifying Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the water pump bolts.
4. Remove the water pump.
5. Remove the water pump gasket.

UPPER INTAKE MANIFOLD REMOVAL

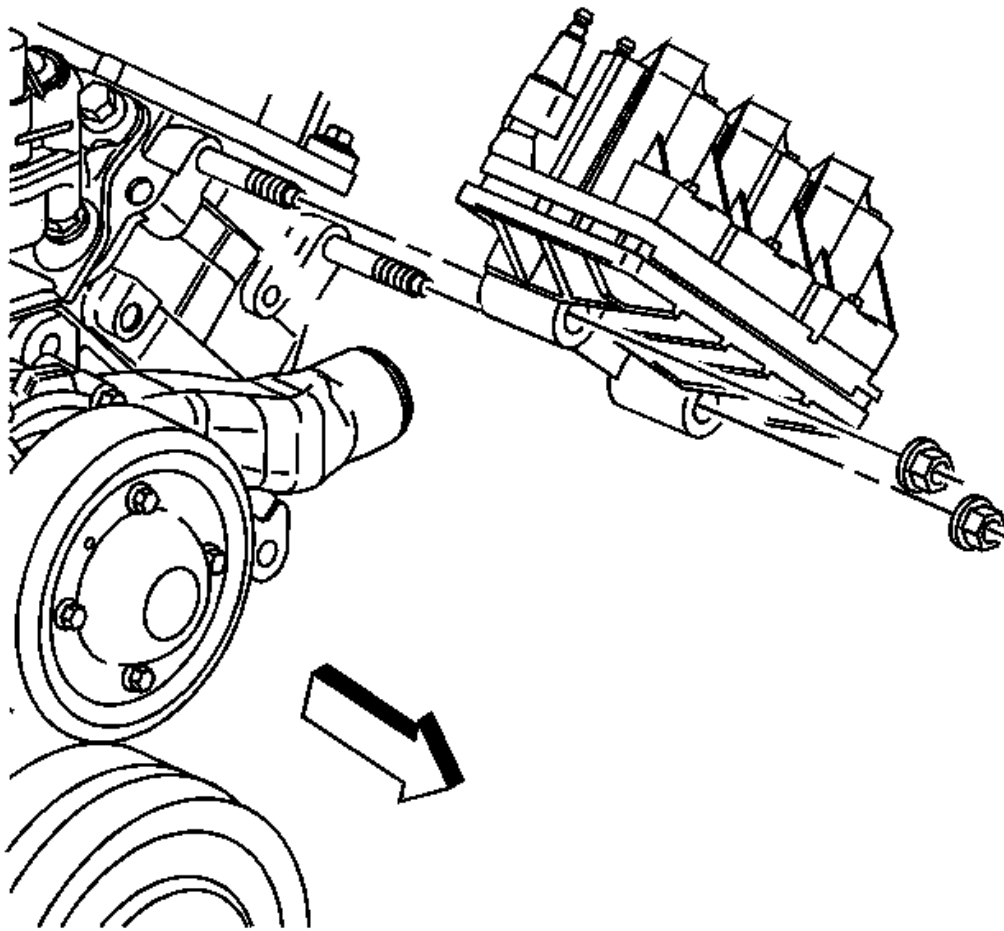


Fig. 281: Ignition Control Module Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires from spark plugs and retaining clips.
2. Remove the wiring harness from fuel rail.
3. Disconnect the ignition control module connector from the ignition control module assembly.
4. Remove the ignition control module assembly nuts.
5. Remove the ignition control module assembly.

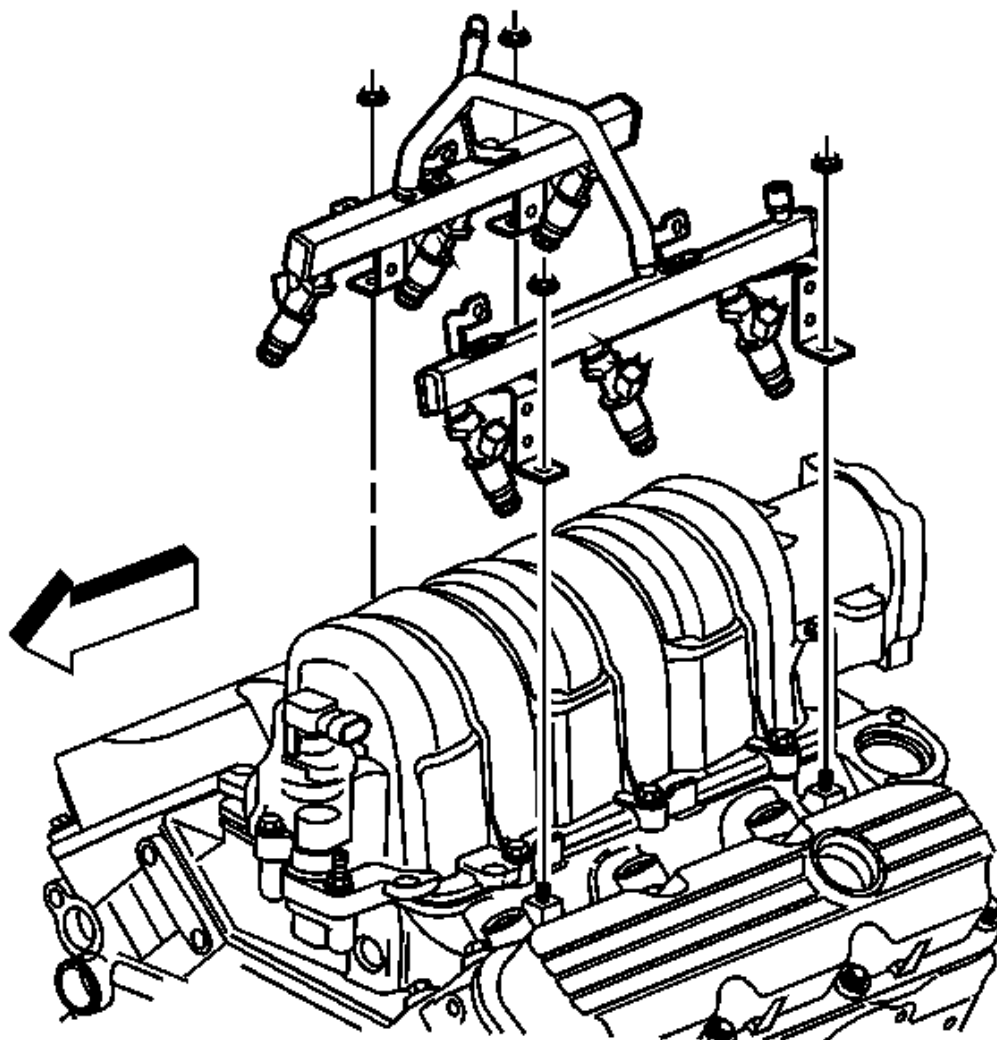


Fig. 282: Fuel Injector Rail

Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel injector rail nuts.
7. Remove the fuel injector rail.

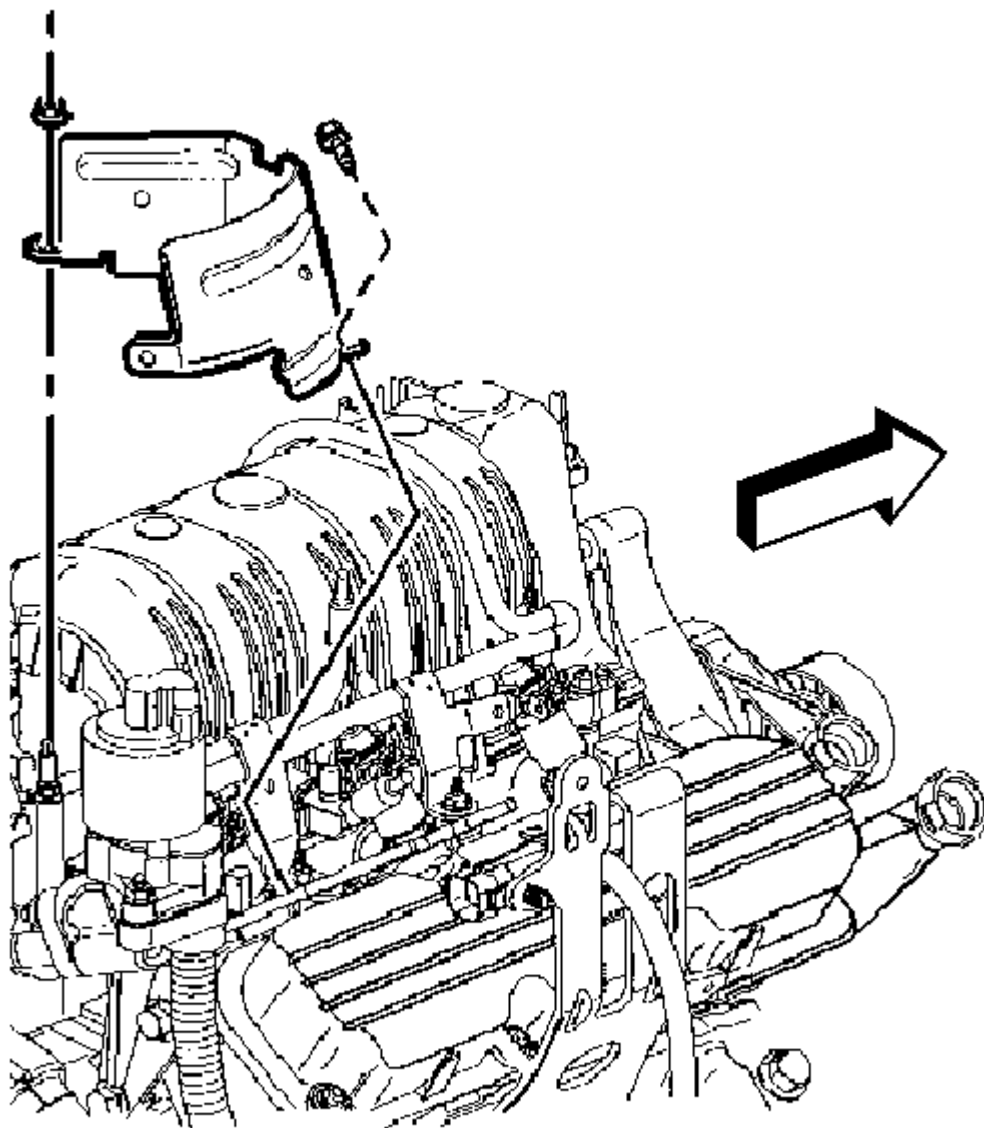


Fig. 283: Engine Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine wiring harness heat shield bolt and nut.
9. Remove the engine wiring harness heat shield.

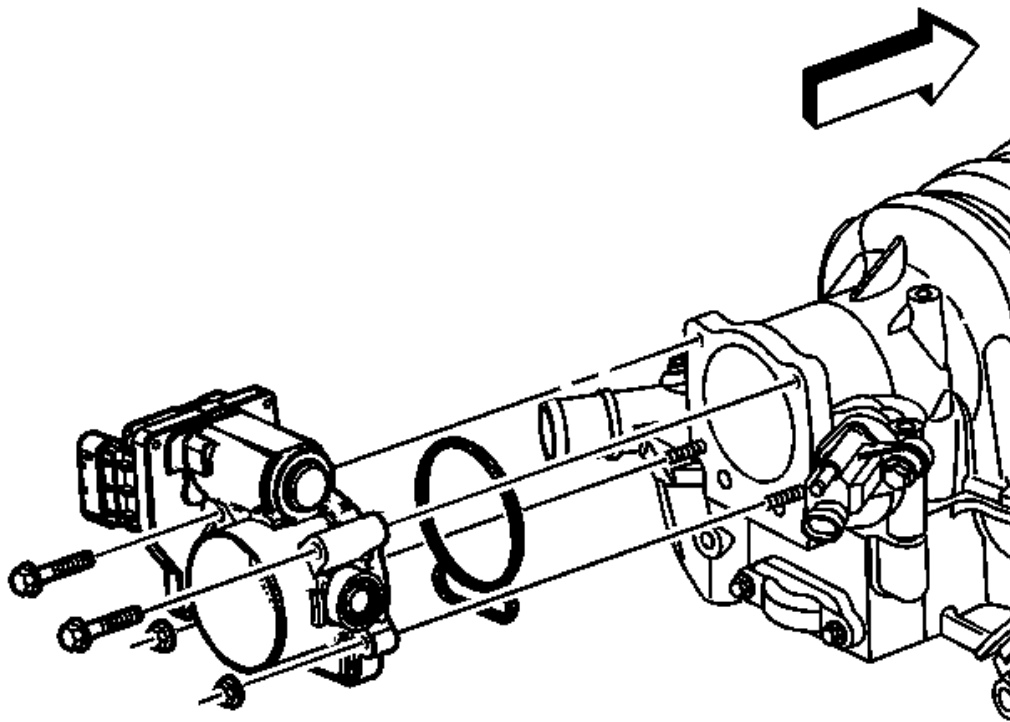


Fig. 284: Throttle Body & Seal
Courtesy of GENERAL MOTORS CORP.

10. Remove the throttle body nuts and bolts.
11. Remove the throttle body.
12. Remove the throttle body seal.

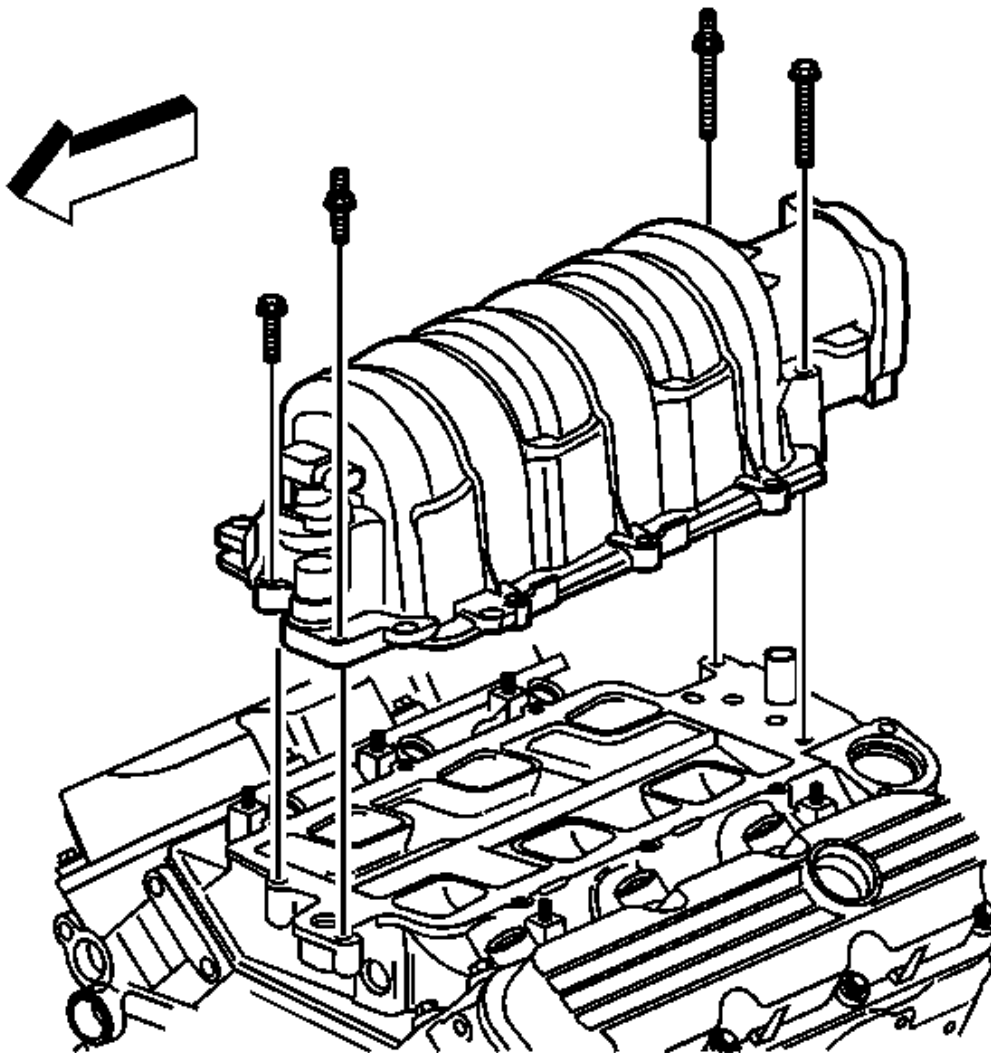


Fig. 285: Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

13. Remove the upper intake manifold bolts and studs.
14. Remove the upper intake manifold.

EXHAUST GAS RECIRCULATION VALVE AND PIPE REMOVAL

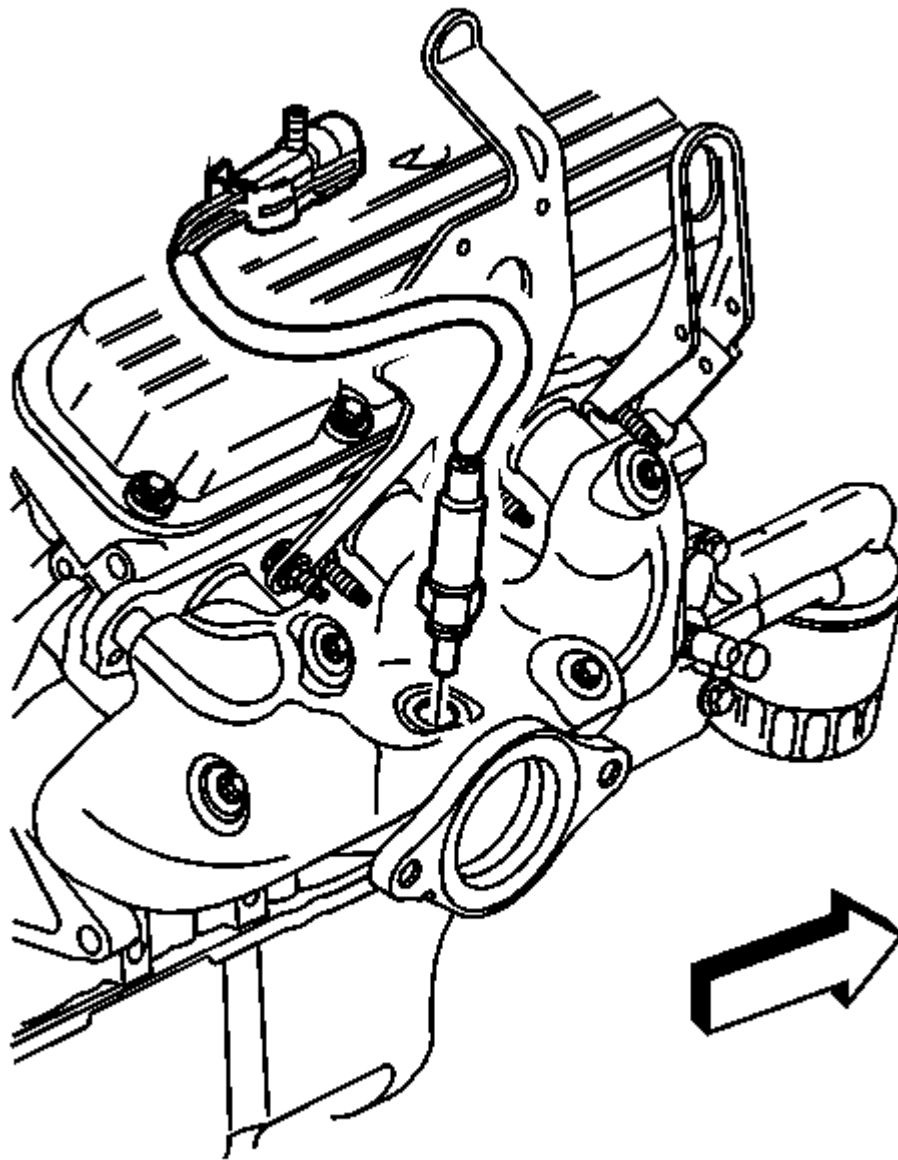


Fig. 286: Heated Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the heated oxygen sensor.

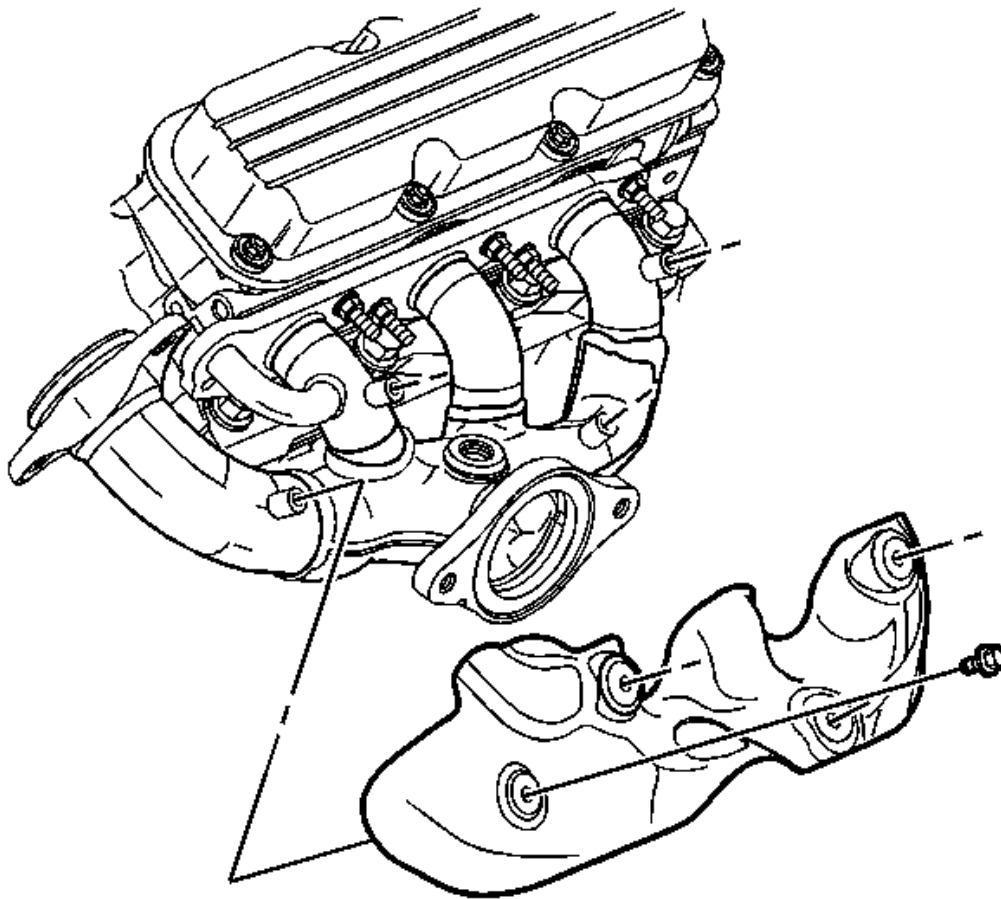


Fig. 287: Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

2. Remove the exhaust manifold heat shield bolts.
3. Remove the exhaust manifold heat shield.

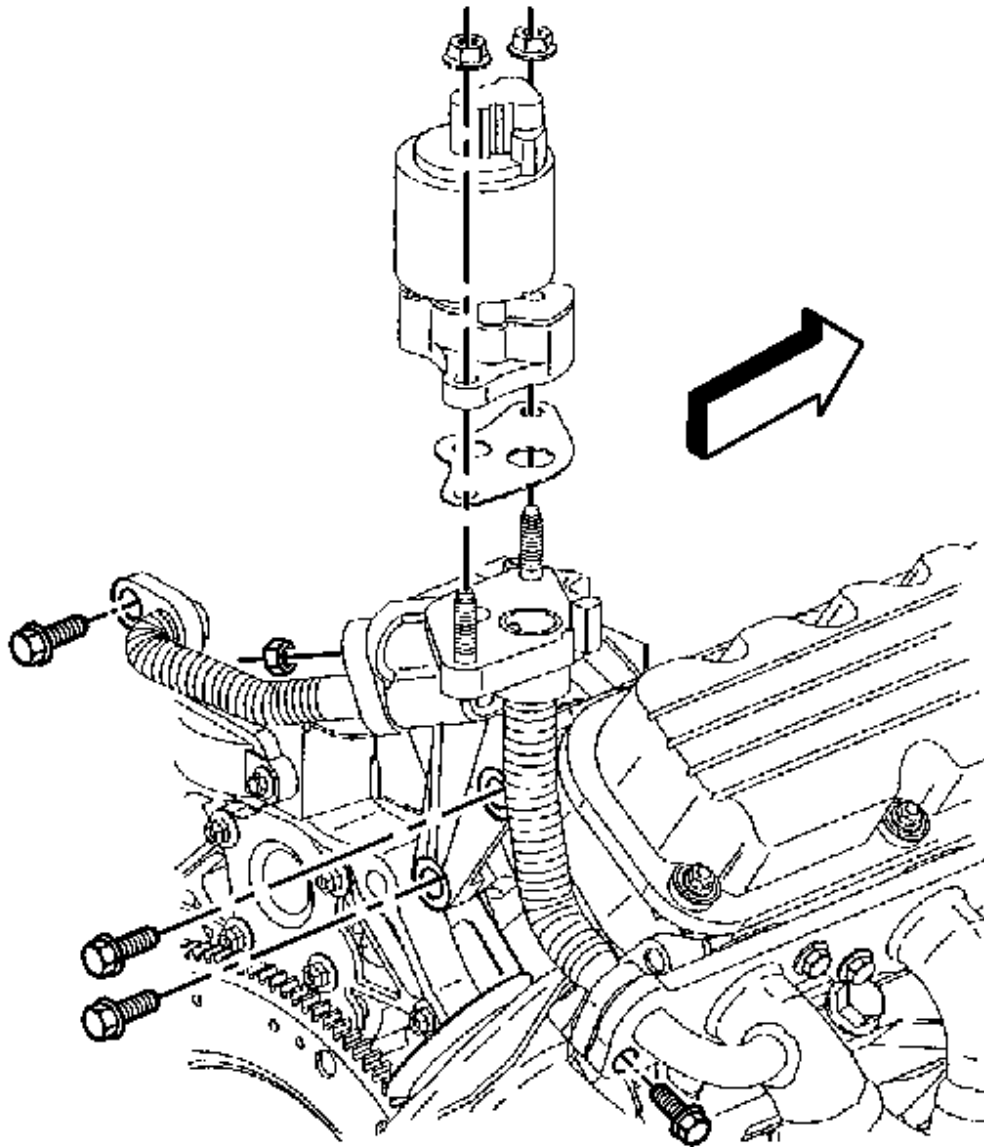


Fig. 288: View Of EGR Valve Adapter Assembly
 Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust gas recirculation (EGR) valve nuts, EGR valve and gasket.
5. Remove the EGR valve adapter inlet pipe bolt from the RH exhaust manifold.
6. Remove the EGR valve outlet pipe bolt, nut and pipe from the lower intake manifold and the EGR valve adapter assembly.

7. Remove the EGR valve adapter assembly bolts.
8. Remove the EGR valve adapter assembly from the cylinder head.

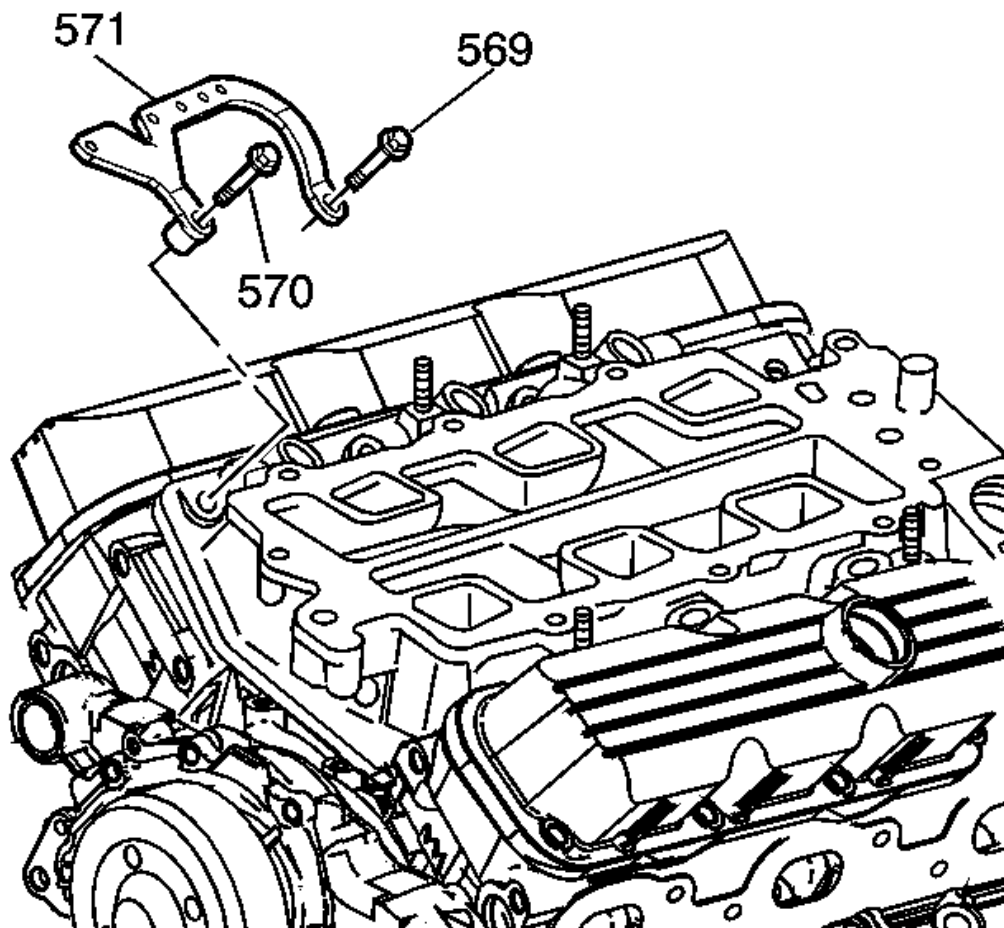
LOWER INTAKE MANIFOLD REMOVAL (L26)

Fig. 289: Generator Brace Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator brace bracket bolts (569, 570).
2. Remove the generator brace bracket (571).

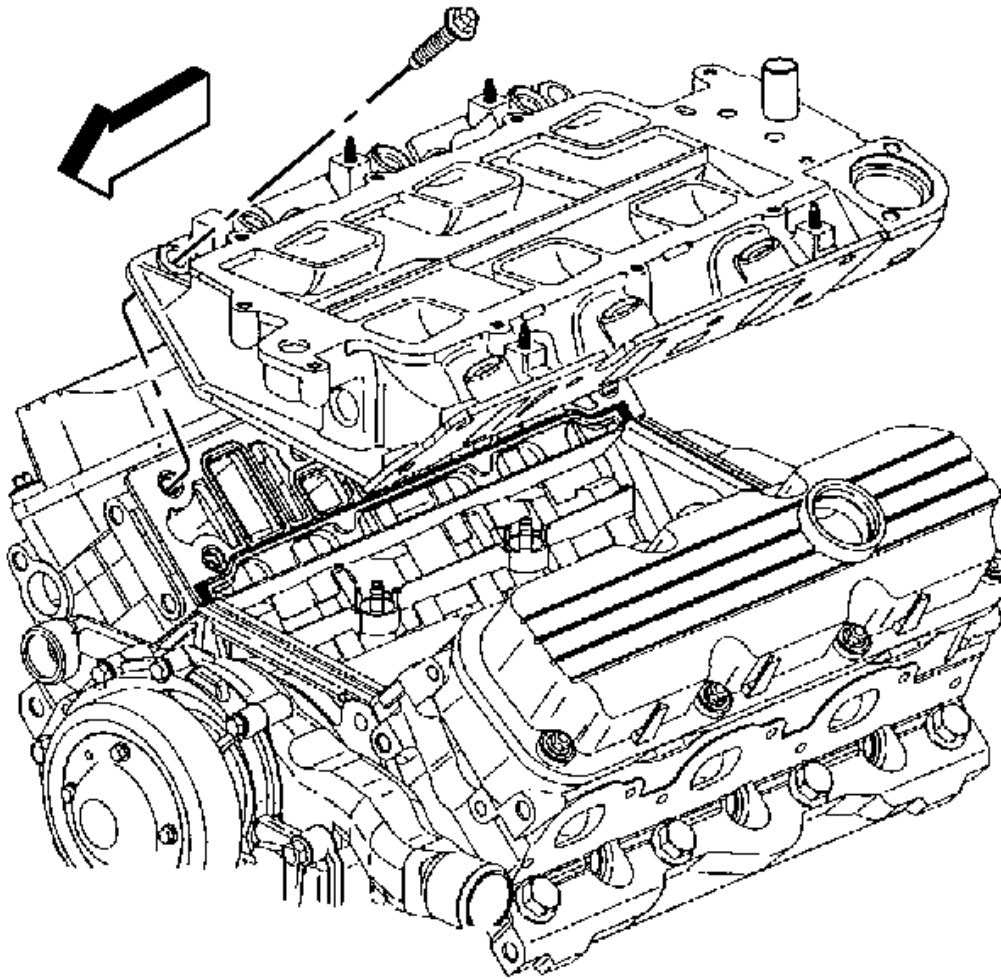


Fig. 290: Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Bolts which fasten the lower intake manifold to the cylinder head are accessible only after the upper intake is removed. The bolts are located in the right front and left rear corners of the lower intake manifold. Remove the upper intake manifold to service the lower intake.

3. Remove the lower intake manifold bolts.
4. Remove the lower intake manifold.
5. Remove the lower intake manifold gasket.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

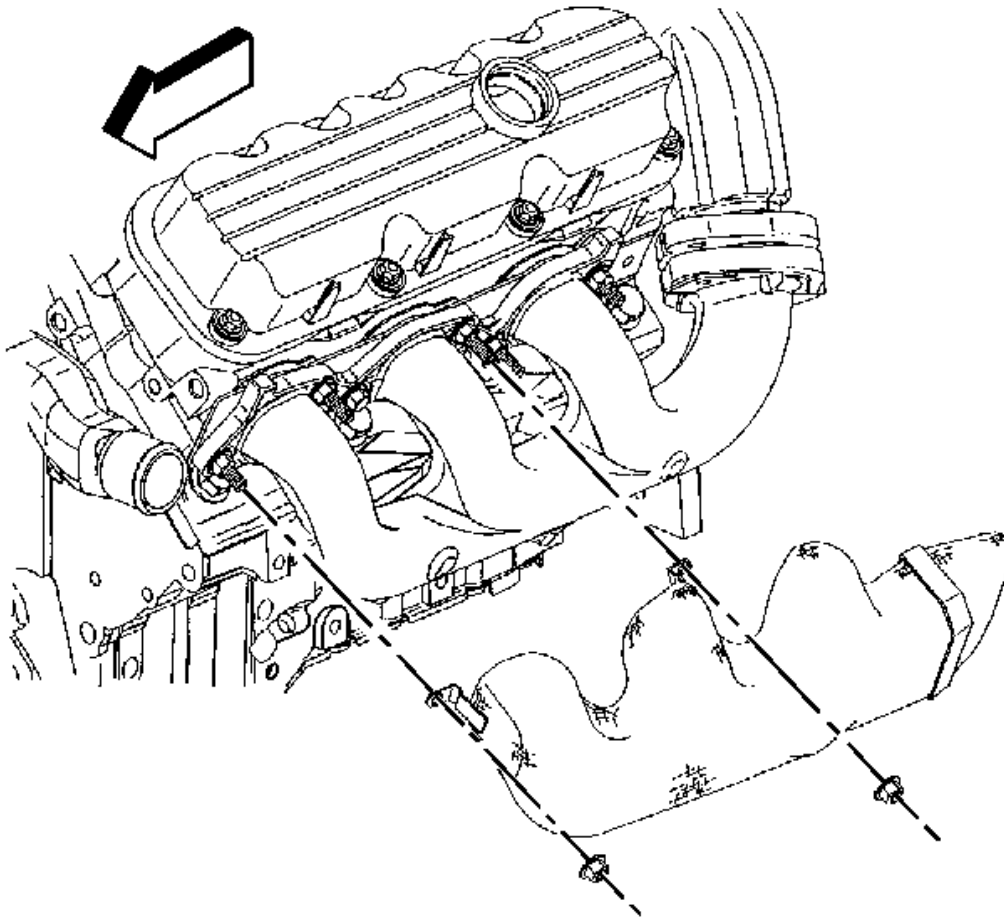


Fig. 291: Exhaust Manifold Heat Shield & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust manifold heat shield nuts.
2. Remove the exhaust manifold heat shield.

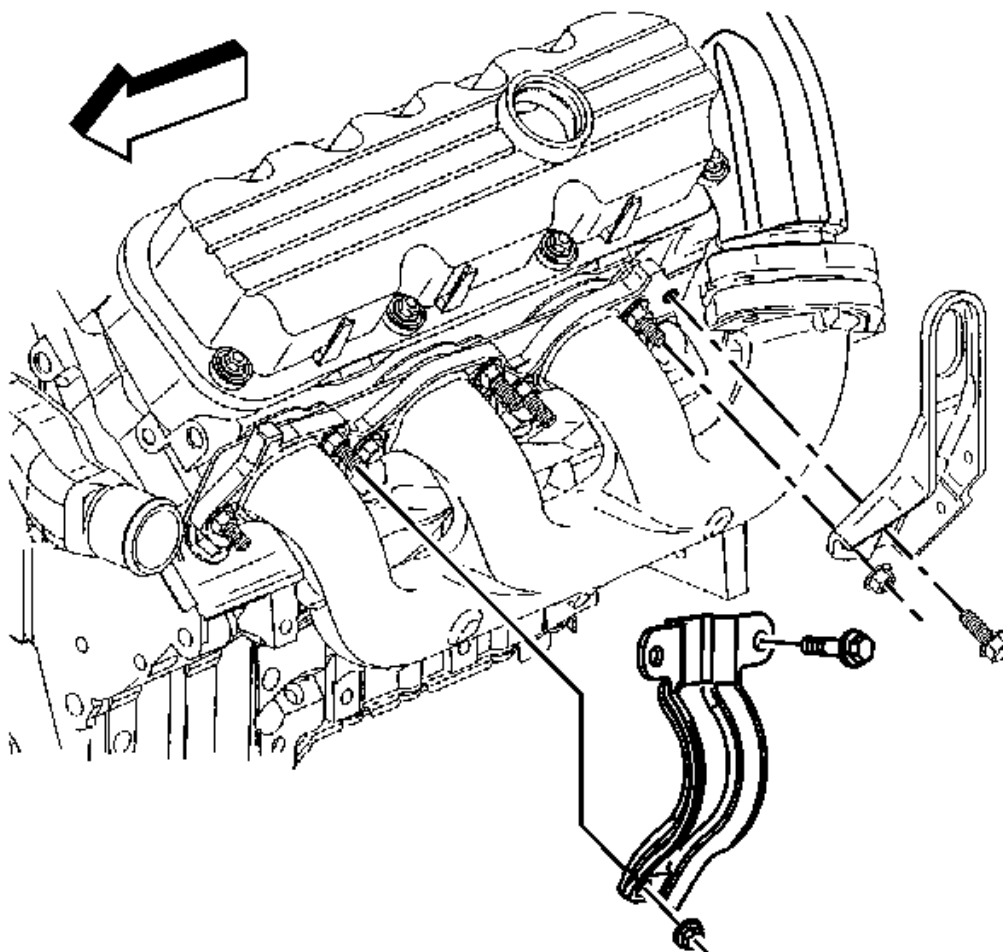


Fig. 292: Left Engine Lift Hook & Mount Strut Lower Bracket
Courtesy of GENERAL MOTORS CORP.

3. Remove the left engine lift hook nut and bolt.
4. Remove the left engine lift hook.
5. Remove the engine mount strut lower bracket nut and bolts.
6. Remove the engine mount strut lower bracket.
7. Remove the left side spark plugs.

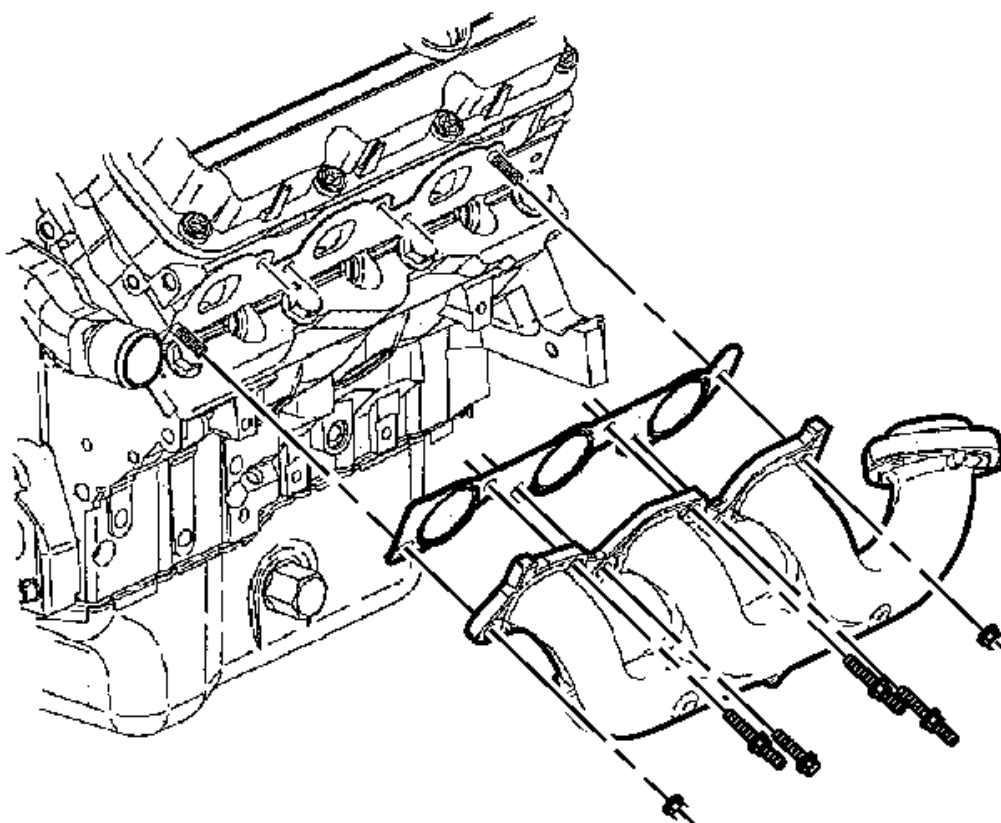


Fig. 293: Identifying Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

8. Remove the exhaust manifold bolt and studs.
9. Remove the exhaust manifold.
10. Remove the exhaust manifold gasket.

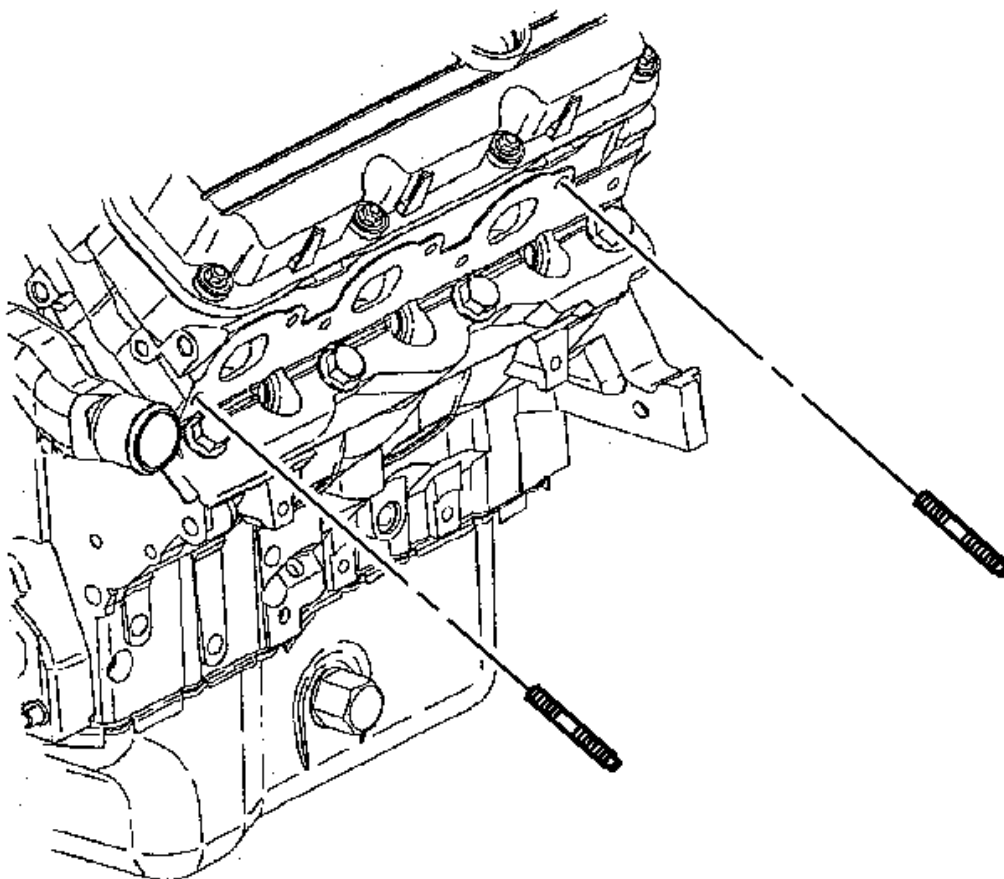


Fig. 294: Left Exhaust Manifold Studs
Courtesy of GENERAL MOTORS CORP.

11. Remove the exhaust manifold studs.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE (WITHOUT SECONDARY AIR INJECTION-SAI)

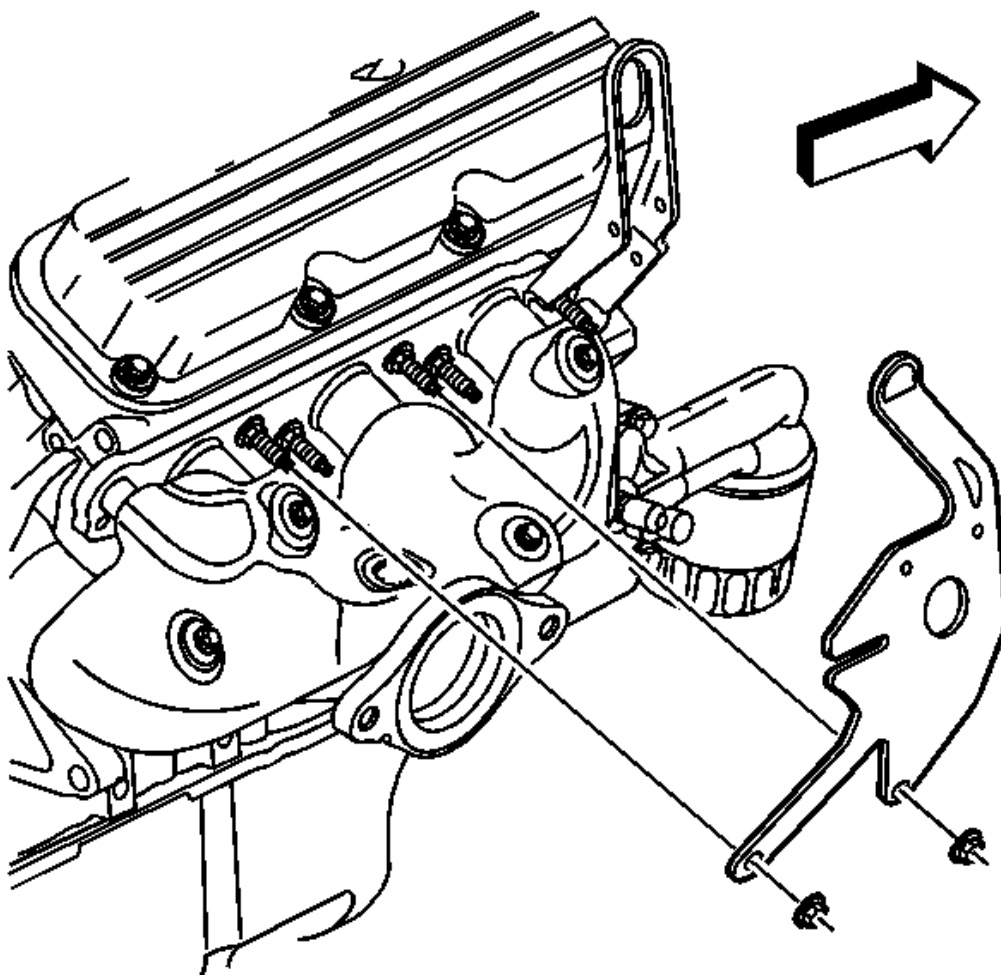


Fig. 295: Fuel Injector Sight Shield Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injector sight shield mounting bracket nuts.
2. Remove the fuel injector sight shield mounting bracket.

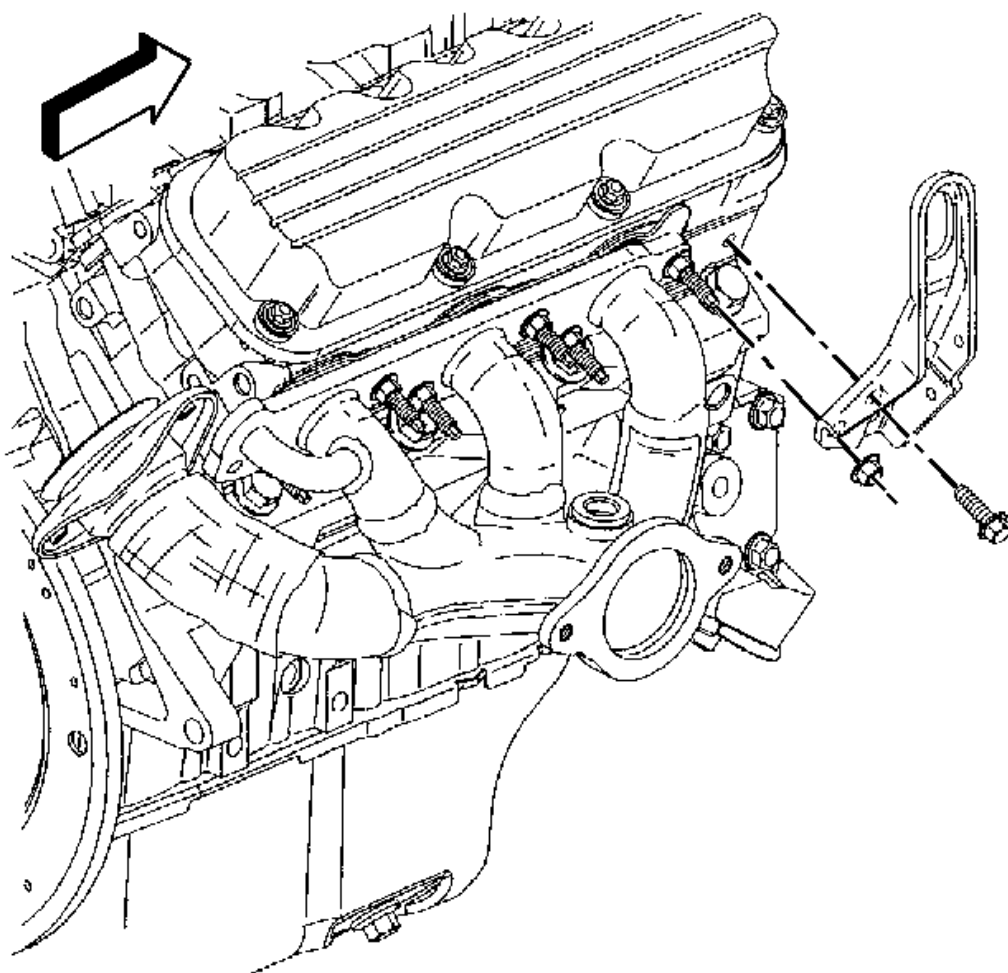


Fig. 296: Identifying Right Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

3. Remove the right engine lift hook nut and bolt.
4. Remove the right engine lift hook bracket.
5. Remove the right side spark plugs.

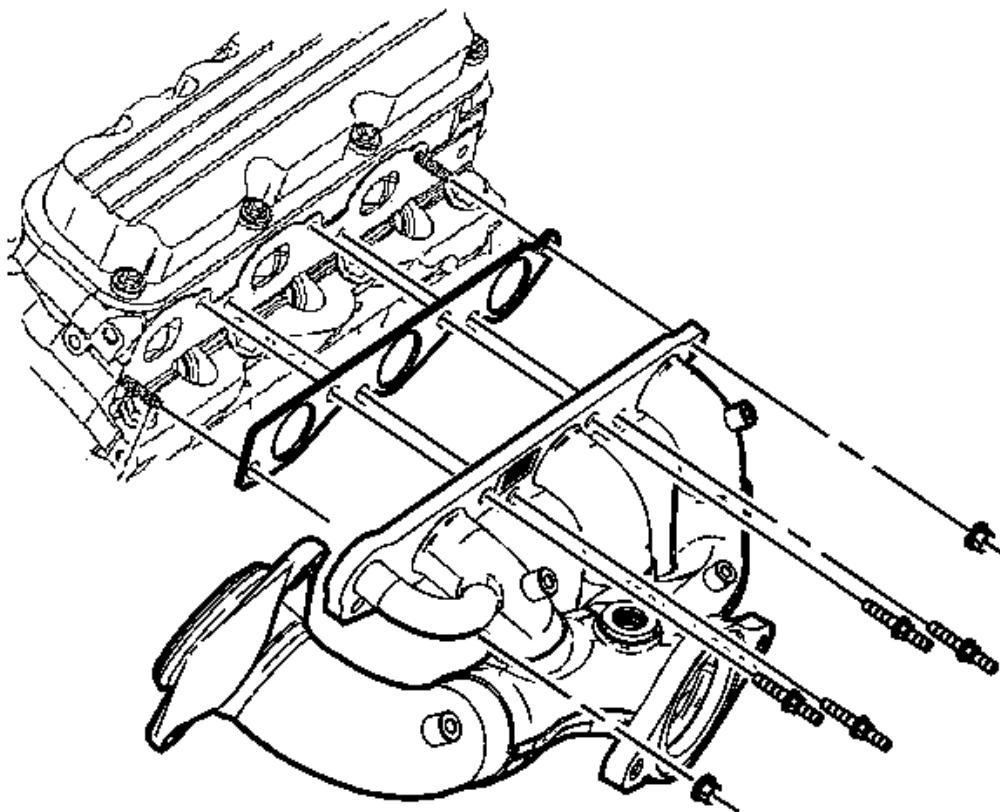


Fig. 297: Right Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the exhaust manifold studs.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket.

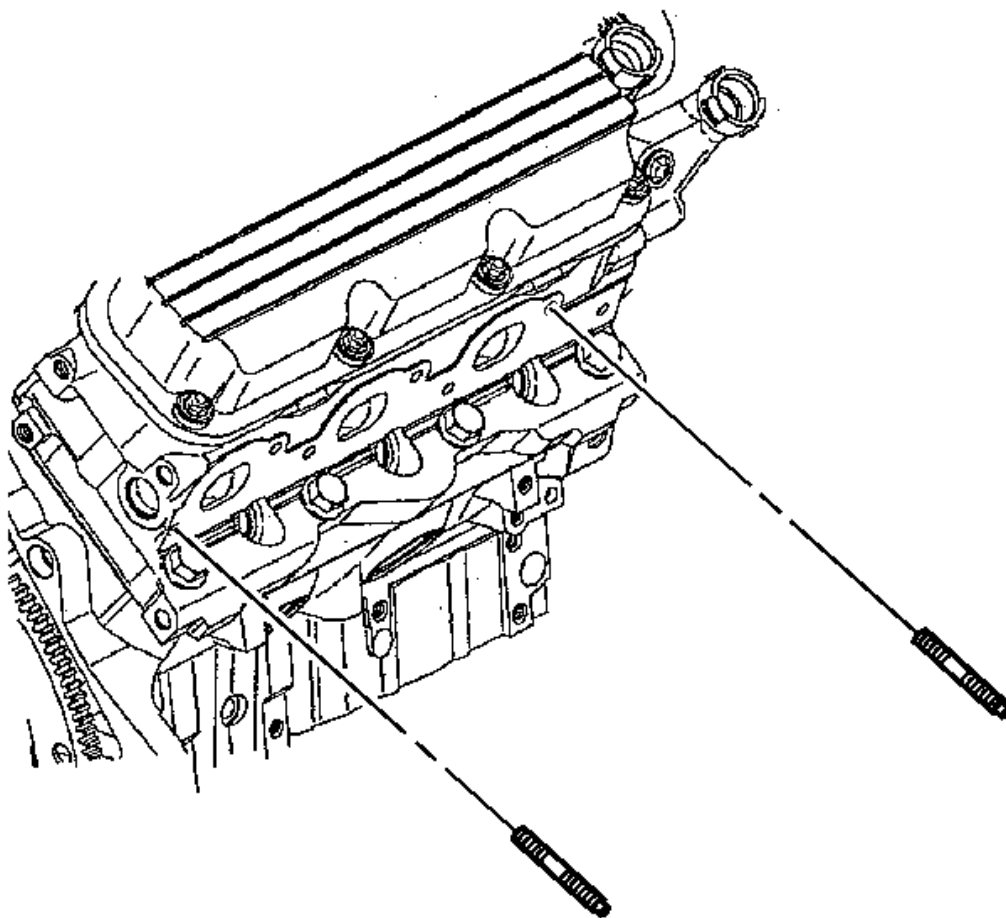


Fig. 298: Identifying Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

9. Remove the exhaust manifold studs.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE (WITH SECONDARY AIR INJECTION-SAI)

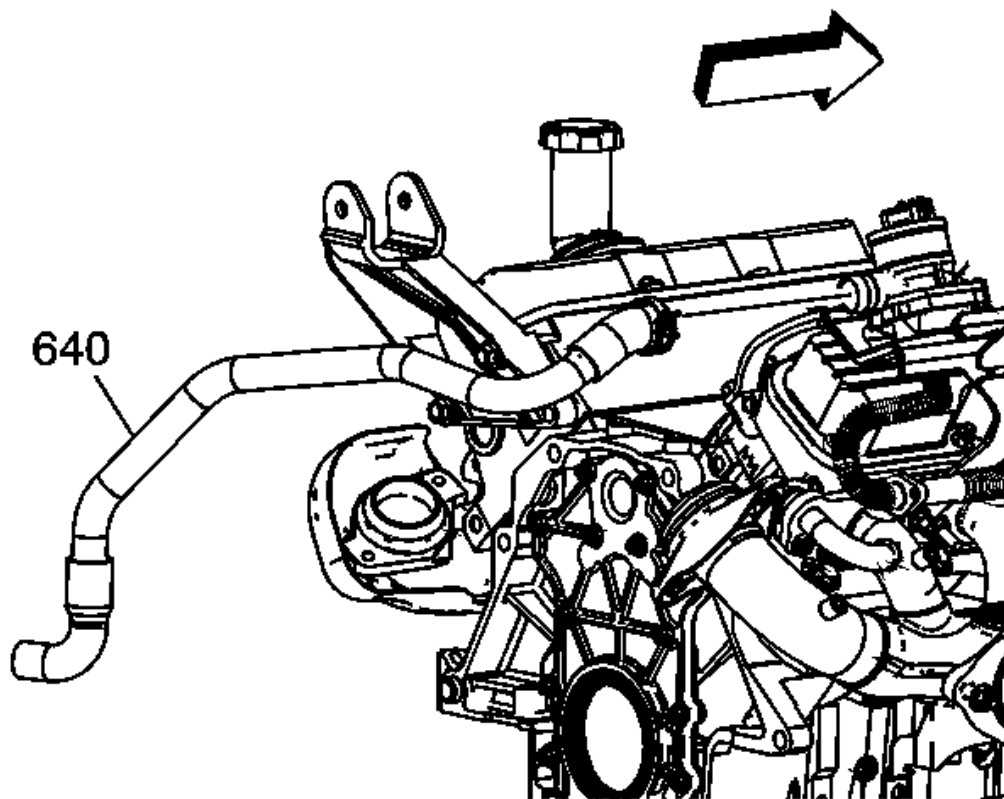


Fig. 299: Secondary Air Injection Pipe
Courtesy of GENERAL MOTORS CORP.

1. Loosen the hose clamp and remove the secondary air injection pipe (640) from the valve.

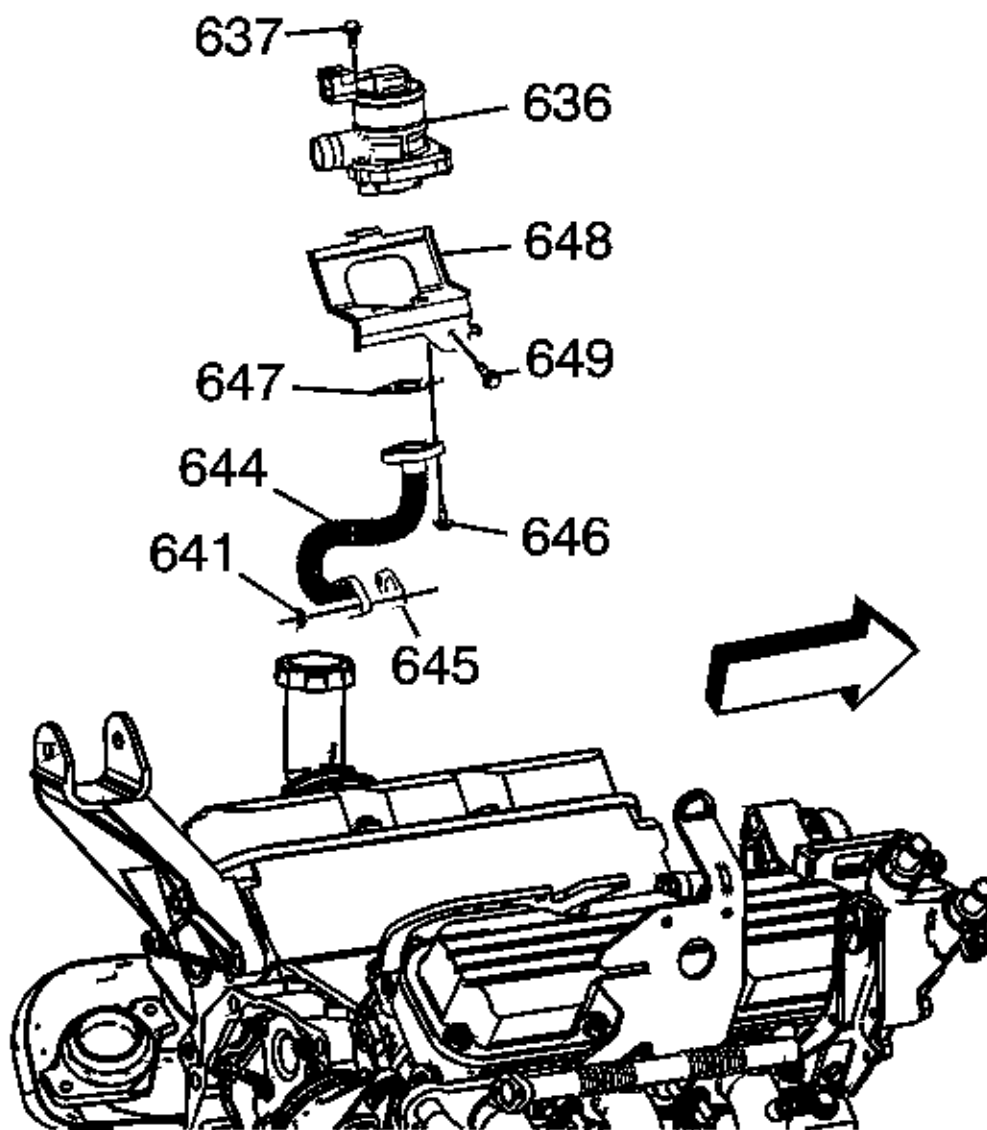


Fig. 300: Secondary Air Injection Assembly
Courtesy of GENERAL MOTORS CORP.

2. Remove nuts (641), gasket (645) and bolts (637, 649) from the secondary air injection assembly and remove from the engine.
3. If necessary, remove bolts (646), gasket (647), pipe (644) and separate from bracket (648) and injection pump (636).

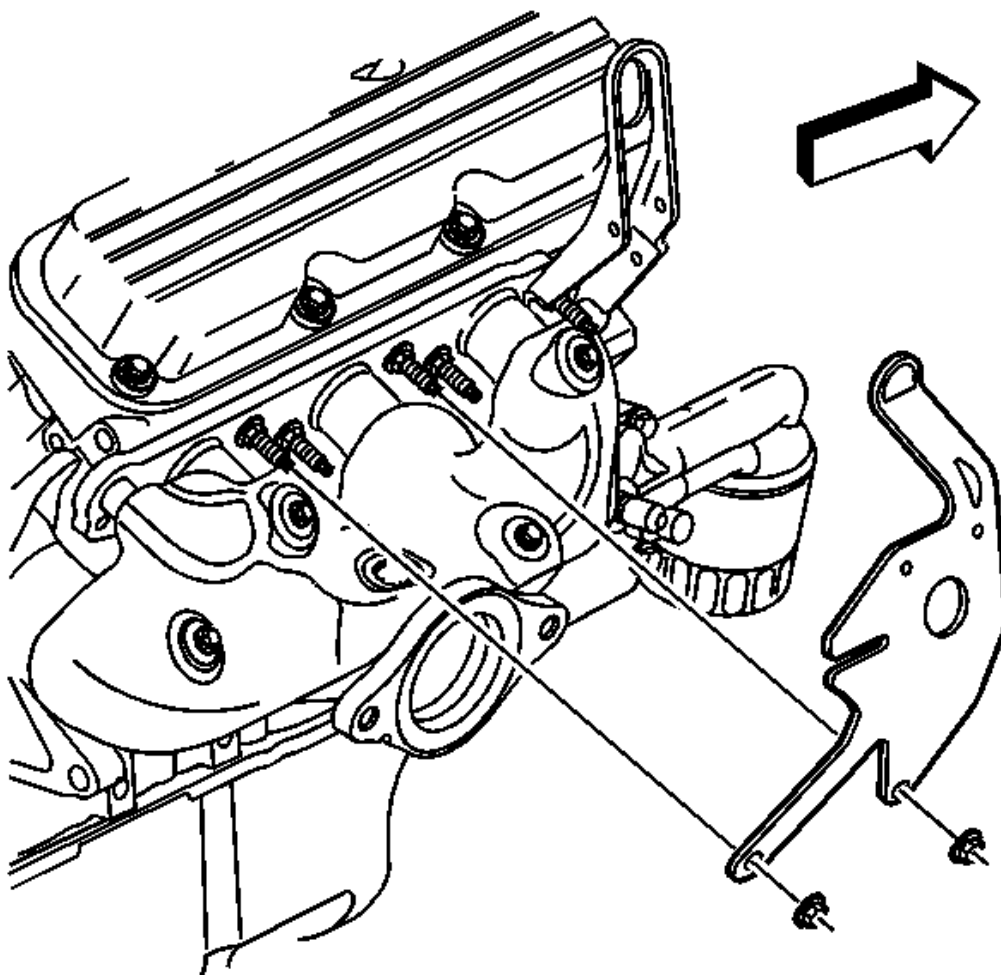


Fig. 301: Fuel Injector Sight Shield Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

4. Remove the fuel injector sight shield mounting bracket nuts.
5. Remove the fuel injector sight shield mounting bracket.

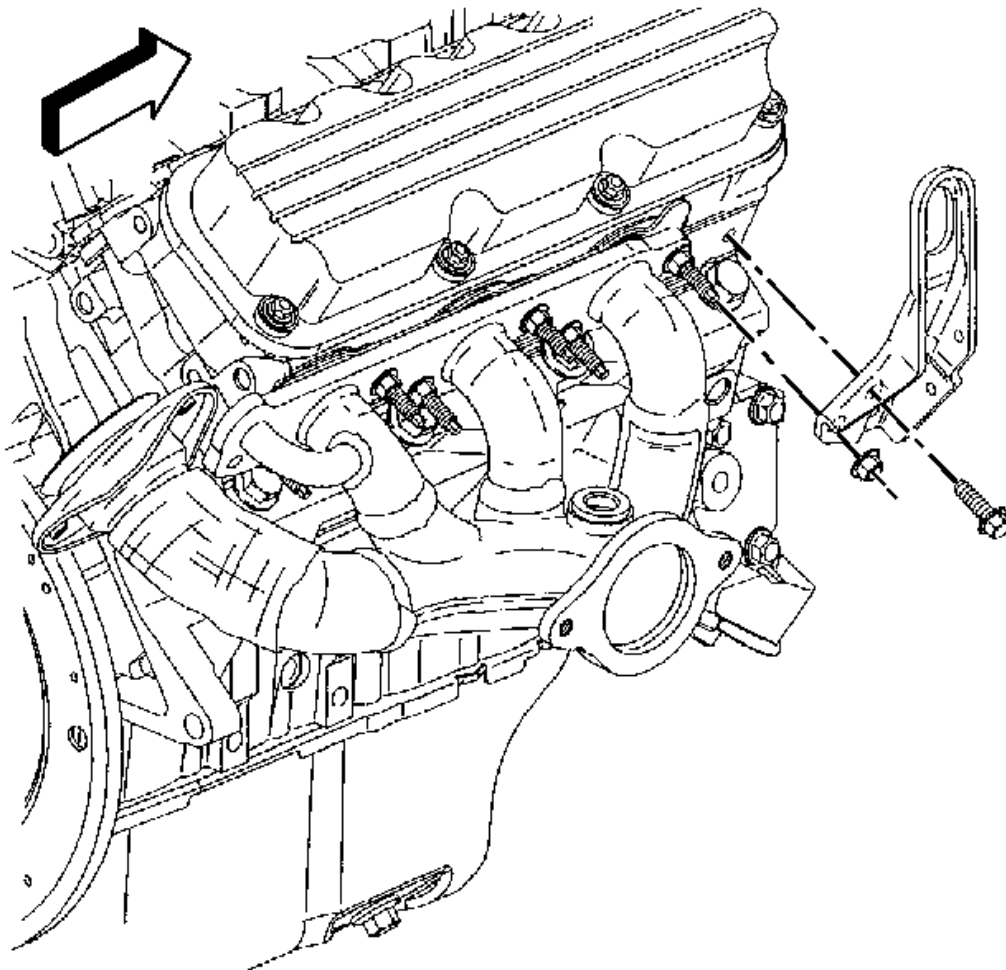


Fig. 302: Identifying Right Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

6. Remove the right engine lift hook nut and bolt.
7. Remove the right engine lift hook bracket.
8. Remove the right side spark plugs.

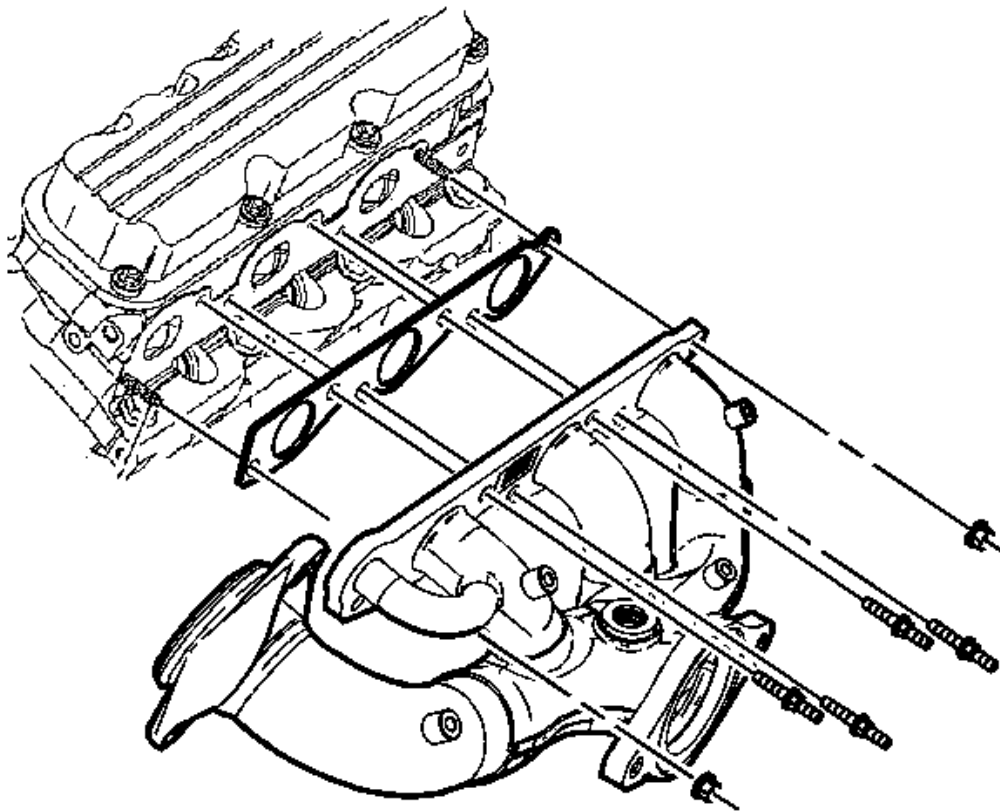


Fig. 303: Right Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

9. Remove the exhaust manifold studs.
10. Remove the exhaust manifold.
11. Remove the exhaust manifold gasket.

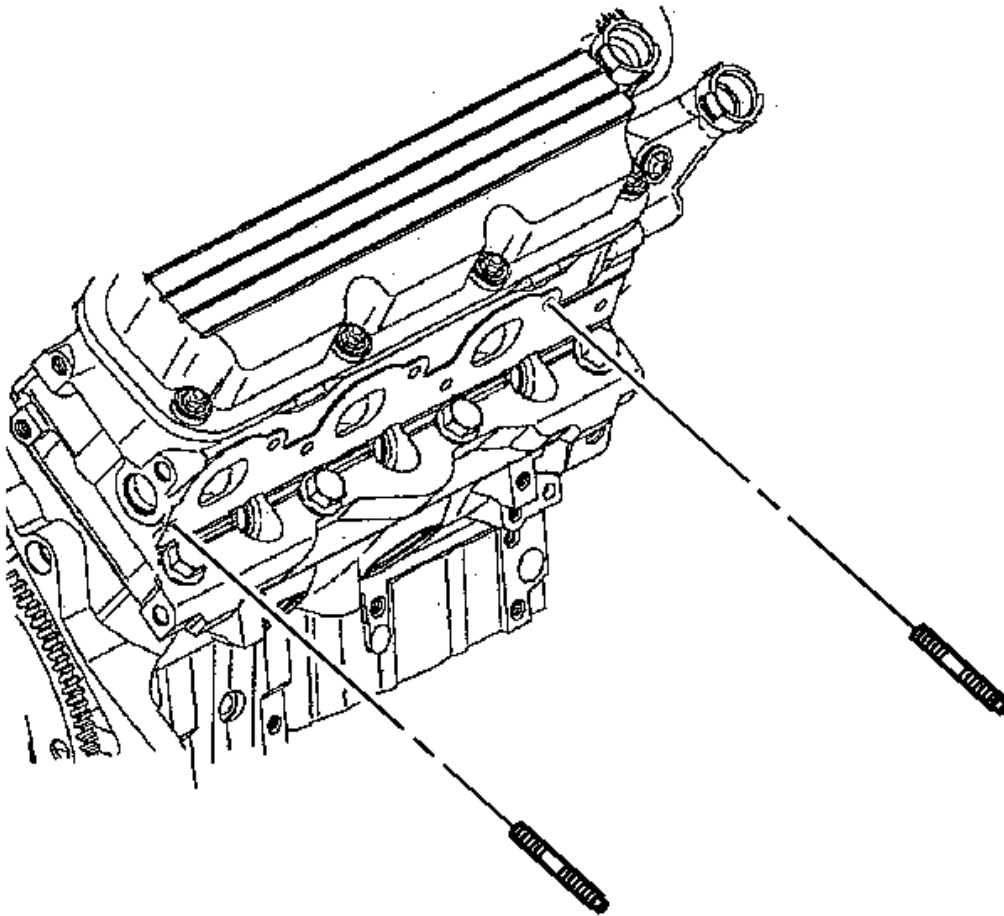


Fig. 304: Identifying Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

12. Remove the exhaust manifold studs.

VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE

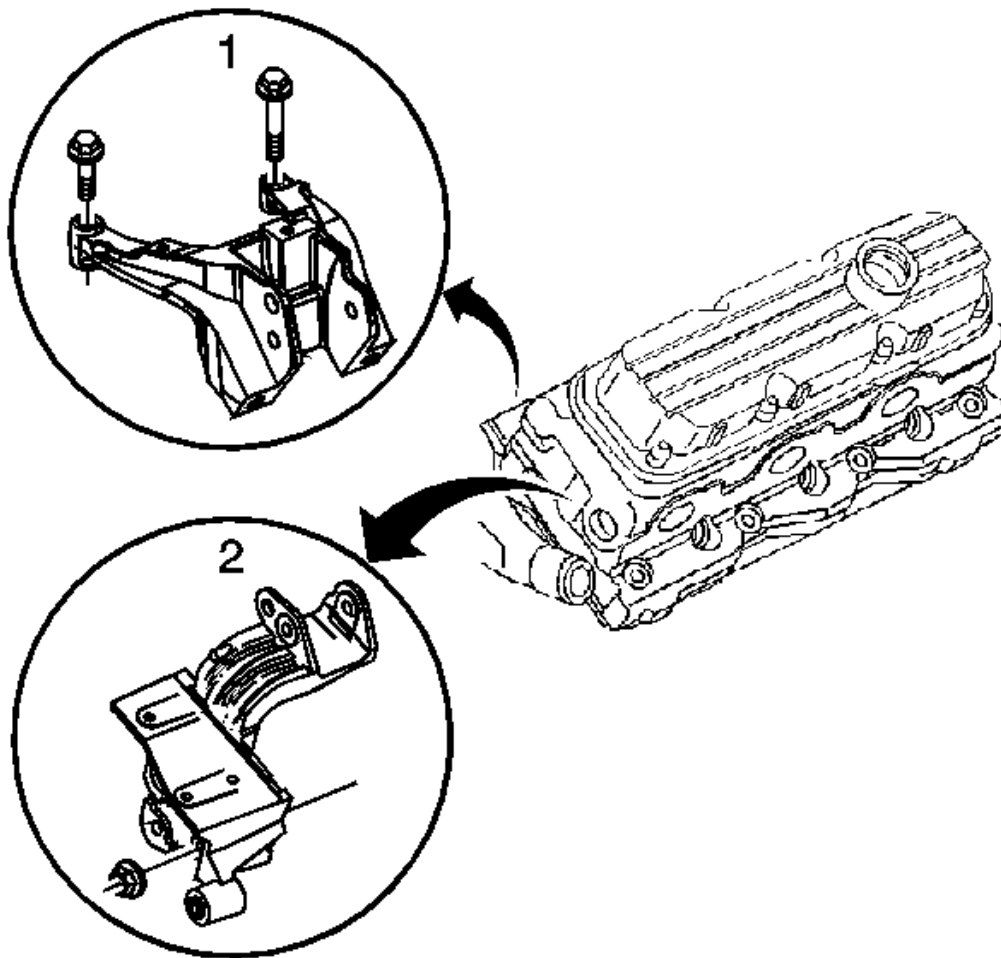


Fig. 305: View of Engine Mount Strut Upper Bracket Bolts
 Courtesy of GENERAL MOTORS CORP.

1. Remove the engine mount strut bracket nuts and bracket (2), if applicable.
2. Remove the engine mount strut upper bracket bolts and bracket (1), if applicable.

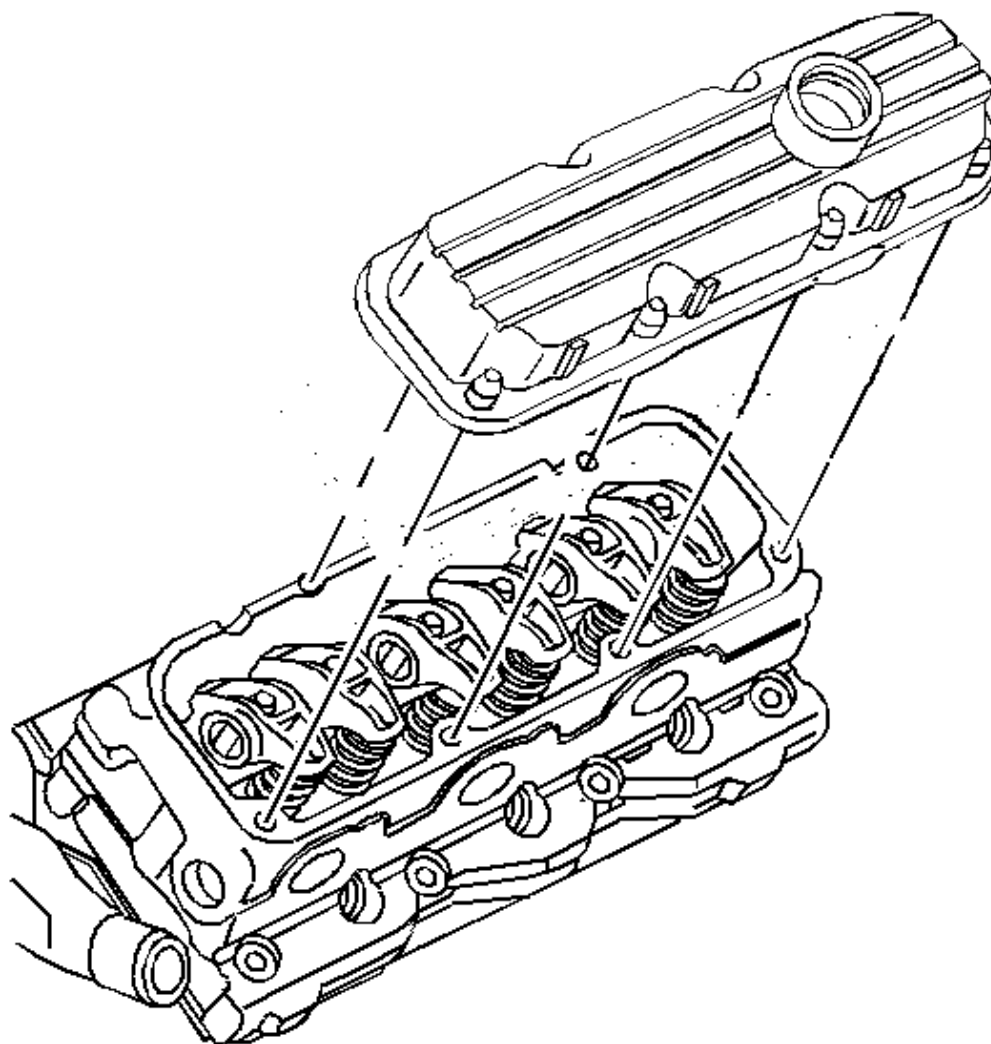


Fig. 306: Left Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve rocker arm cover bolts.
4. Remove the valve rocker arm cover.
5. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE

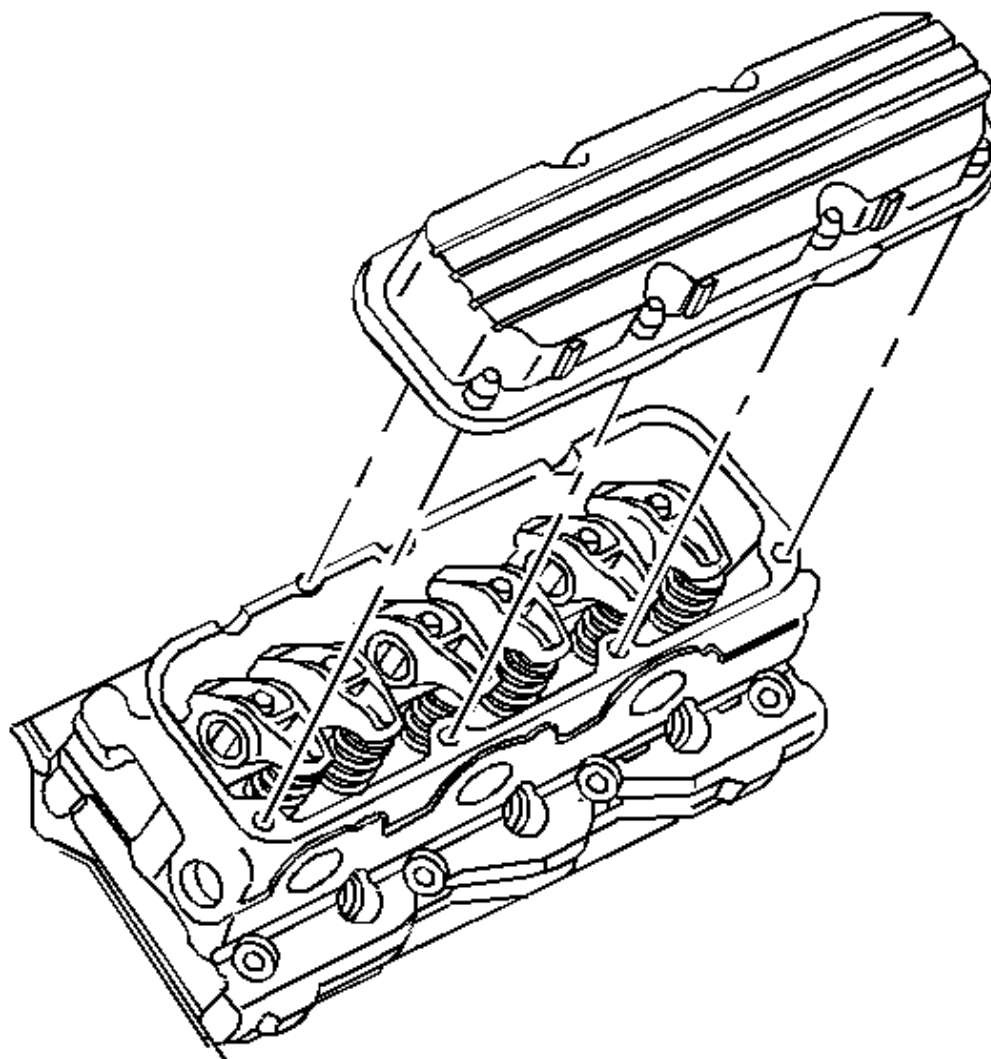


Fig. 307: Right Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm cover bolts.
2. Remove the valve rocker arm cover.
3. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

VALVE ROCKER ARM AND PUSH ROD REMOVAL

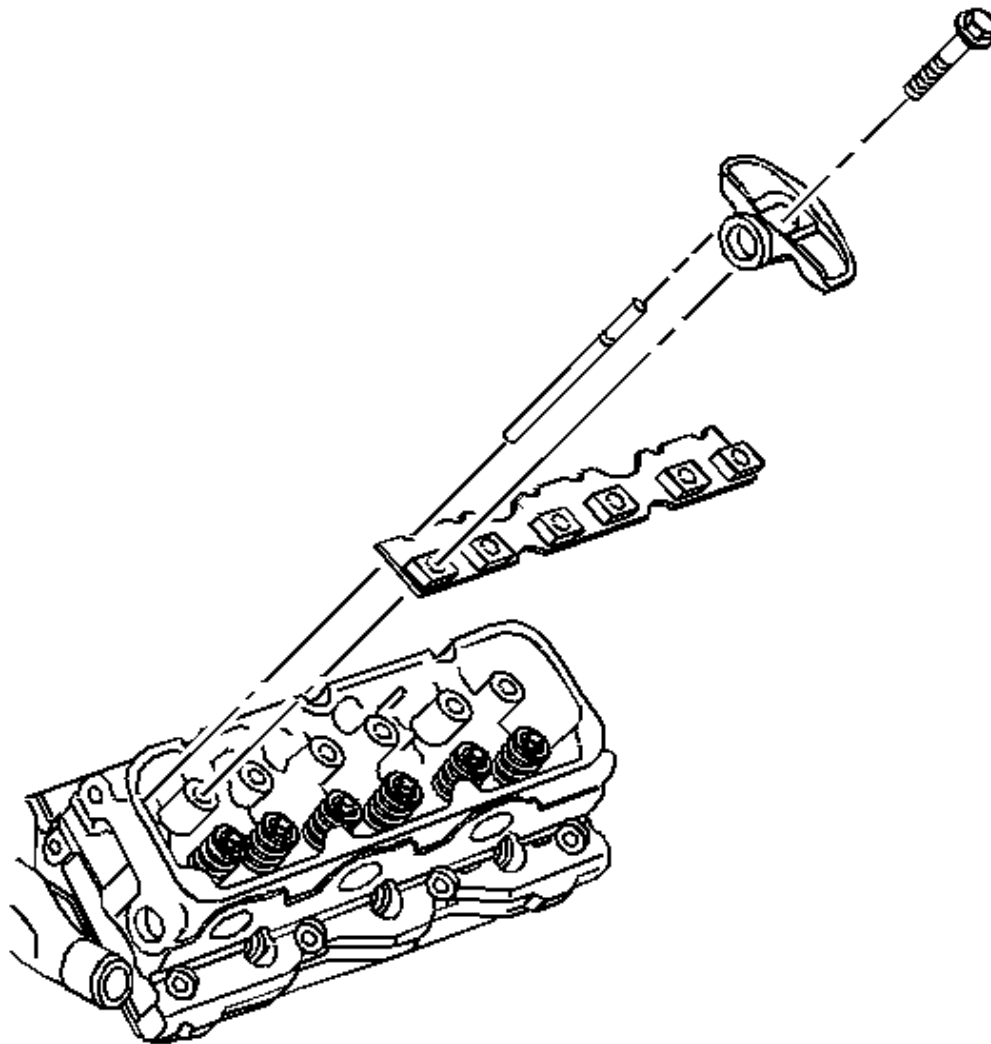


Fig. 308: View Of Valve Rocker Arm, Bolt, Push Rod & Push Rod Guide Plate
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arm.
3. Remove the push rods.
4. Remove the push rod guide plate.

CYLINDER HEAD REMOVAL - LEFT SIDE

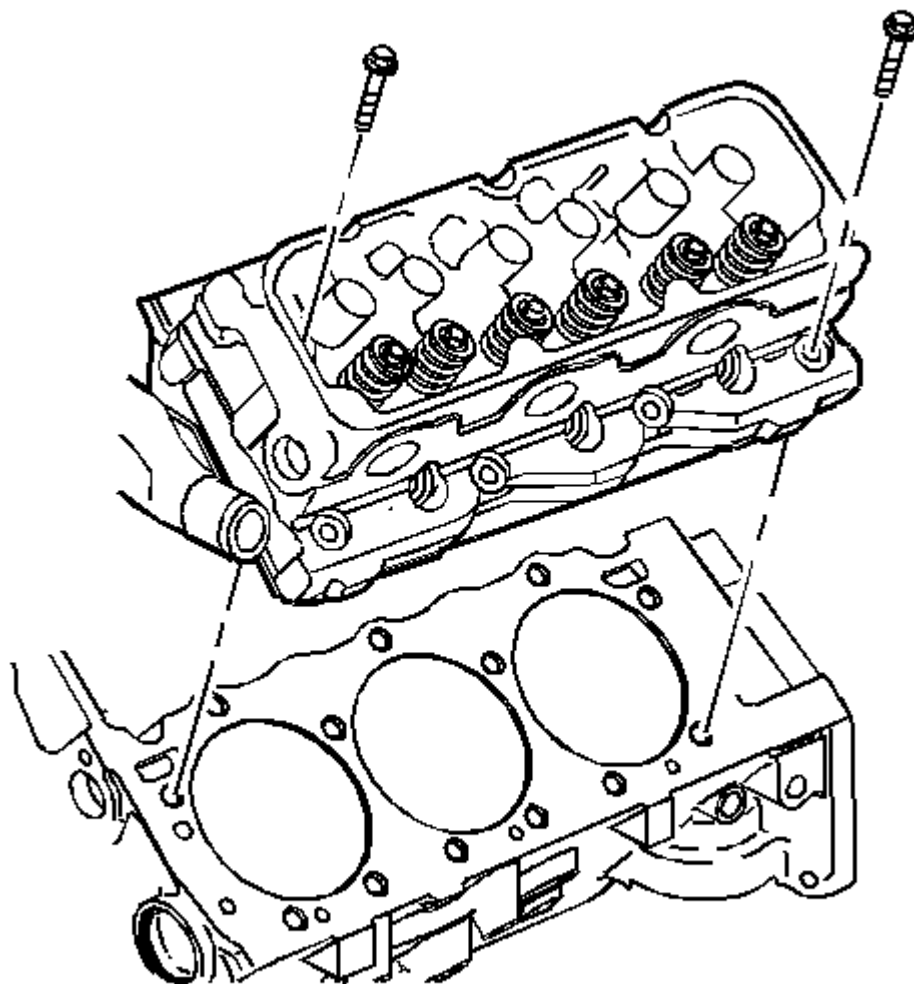


Fig. 309: Identifying Cylinder Head & Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head bolts.
2. Discard the cylinder head bolts.
3. Remove the cylinder head.
4. Remove the cylinder head gasket.

CYLINDER HEAD REMOVAL - RIGHT SIDE

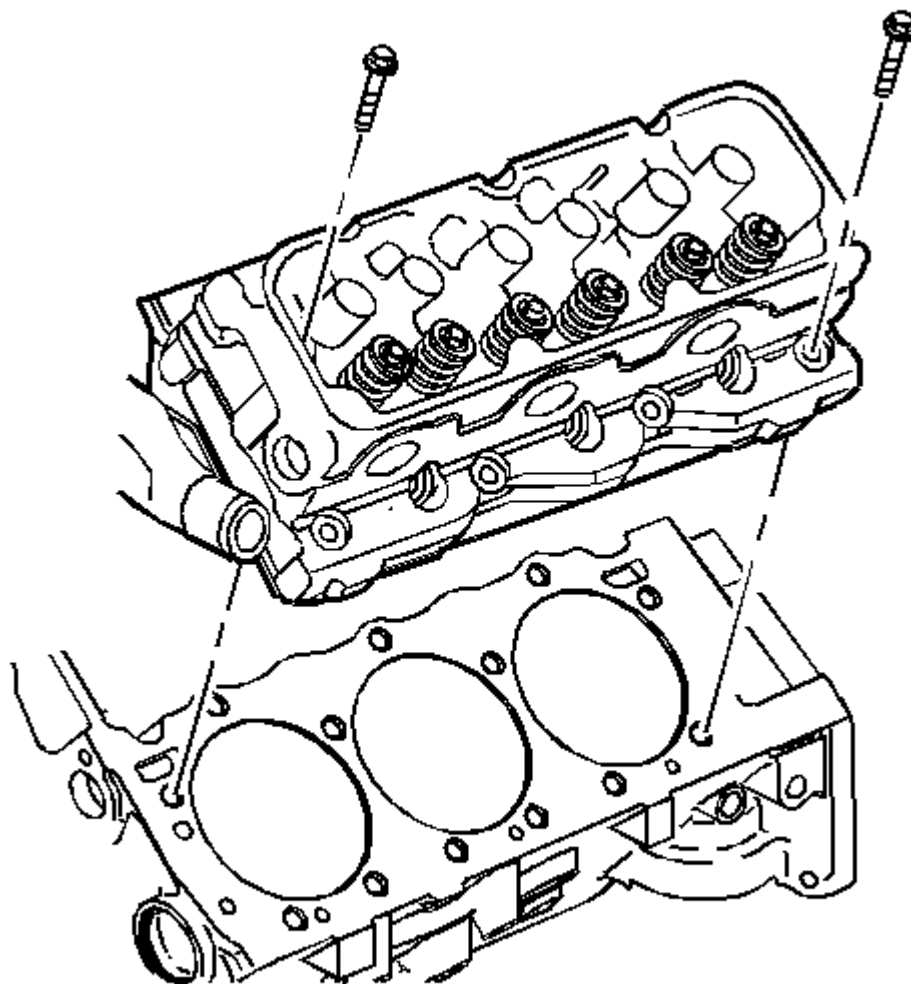


Fig. 310: Identifying Cylinder Head & Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head bolts.
2. Discard the cylinder head bolts.
3. Remove the cylinder head.
4. Remove the cylinder head gasket.

VALVE LIFTER REMOVAL

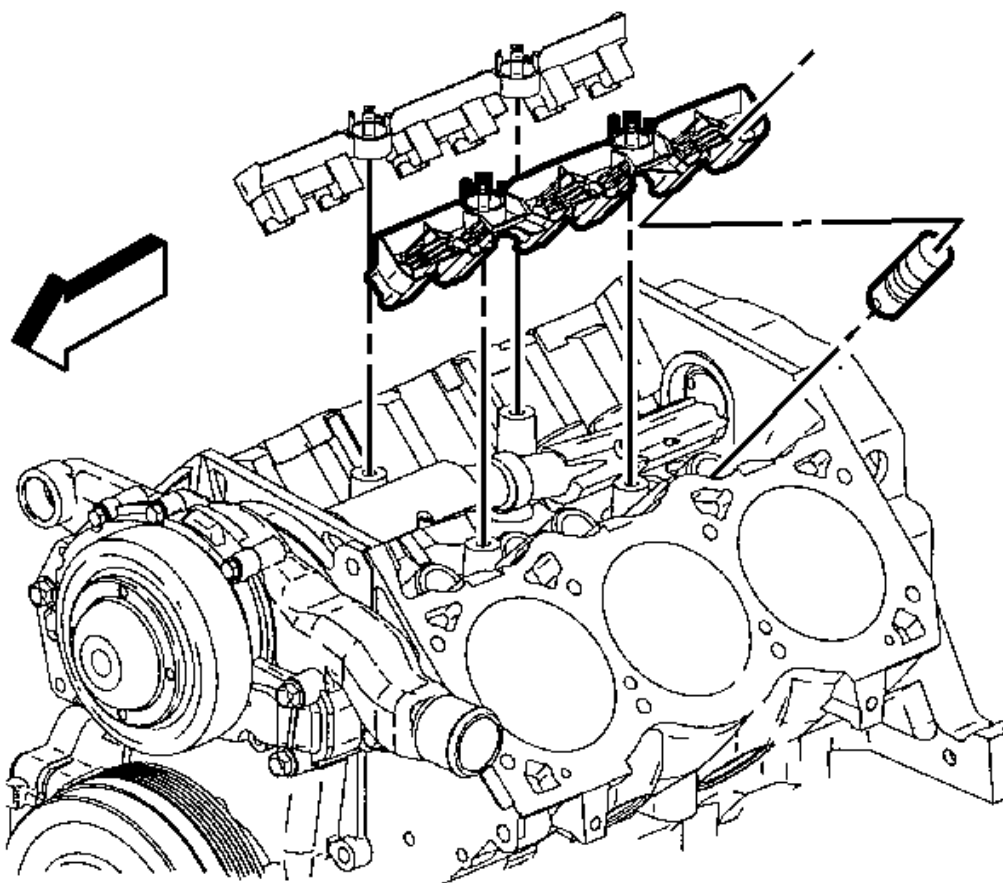


Fig. 311: Identifying Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve lifter guide retainer bolts.
2. Remove the valve lifter guide retainers.
3. Remove the valve lifters.

OIL PAN REMOVAL

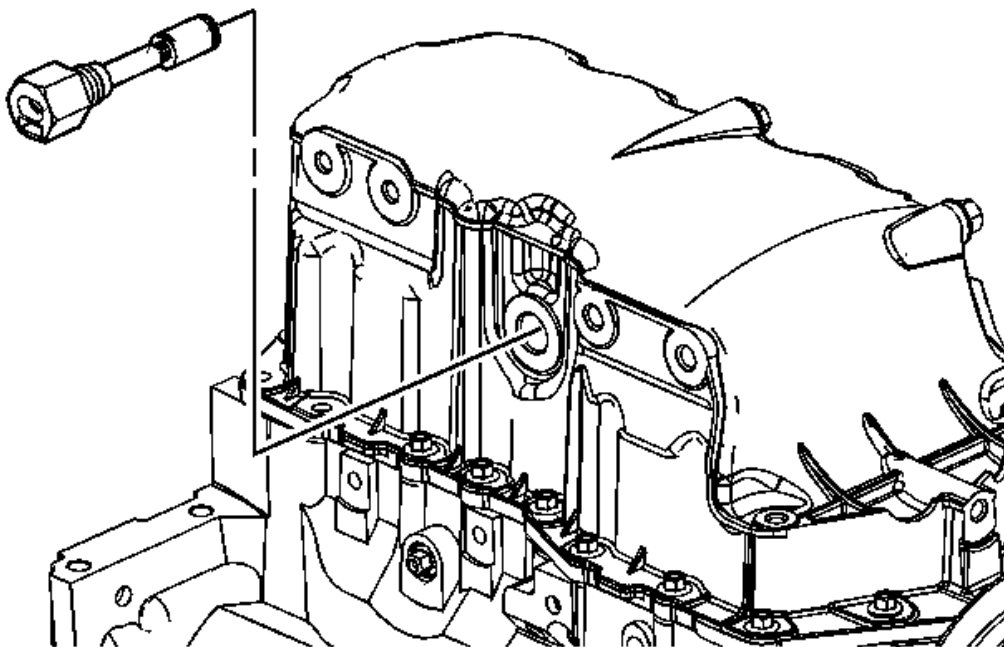


Fig. 312: Identifying Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Remove the oil level sensor, located in the oil pan, before the oil pan is removed. The sensor may be damaged if the oil pan is removed first.

1. Remove the oil level sensor.

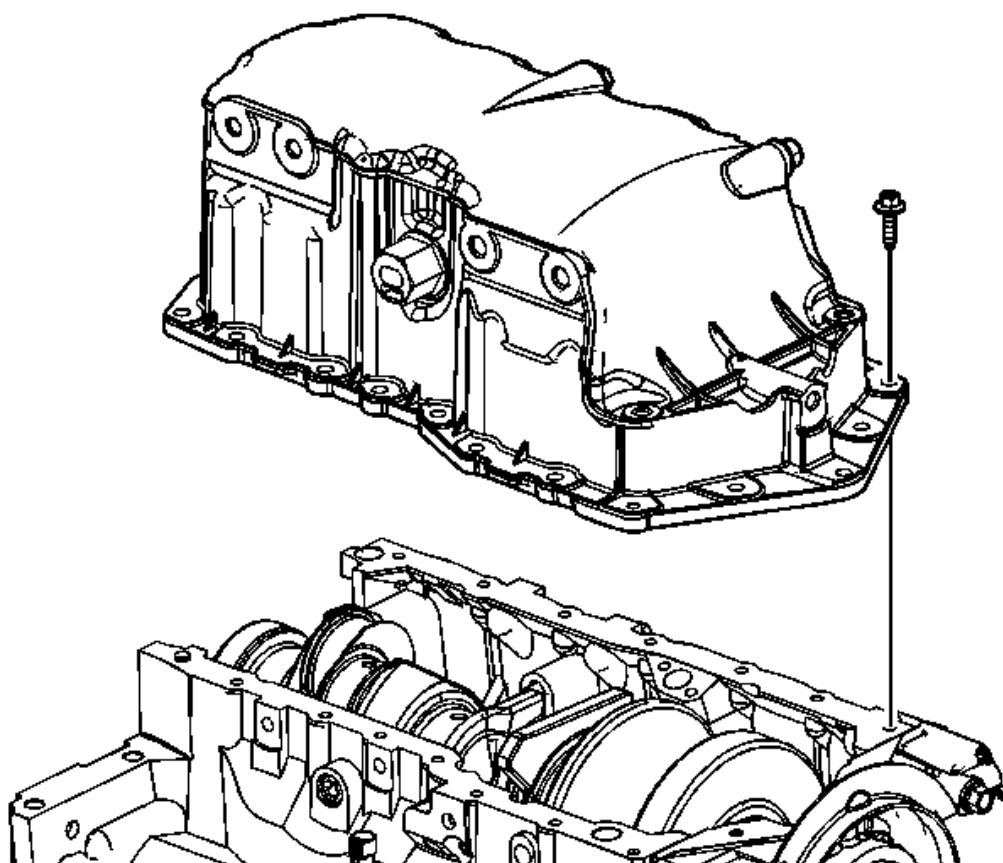


Fig. 313: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan bolts.
3. Remove the oil pan using pry points between the pan and engine block if required.
4. Remove the oil pan gasket if required.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REMOVAL

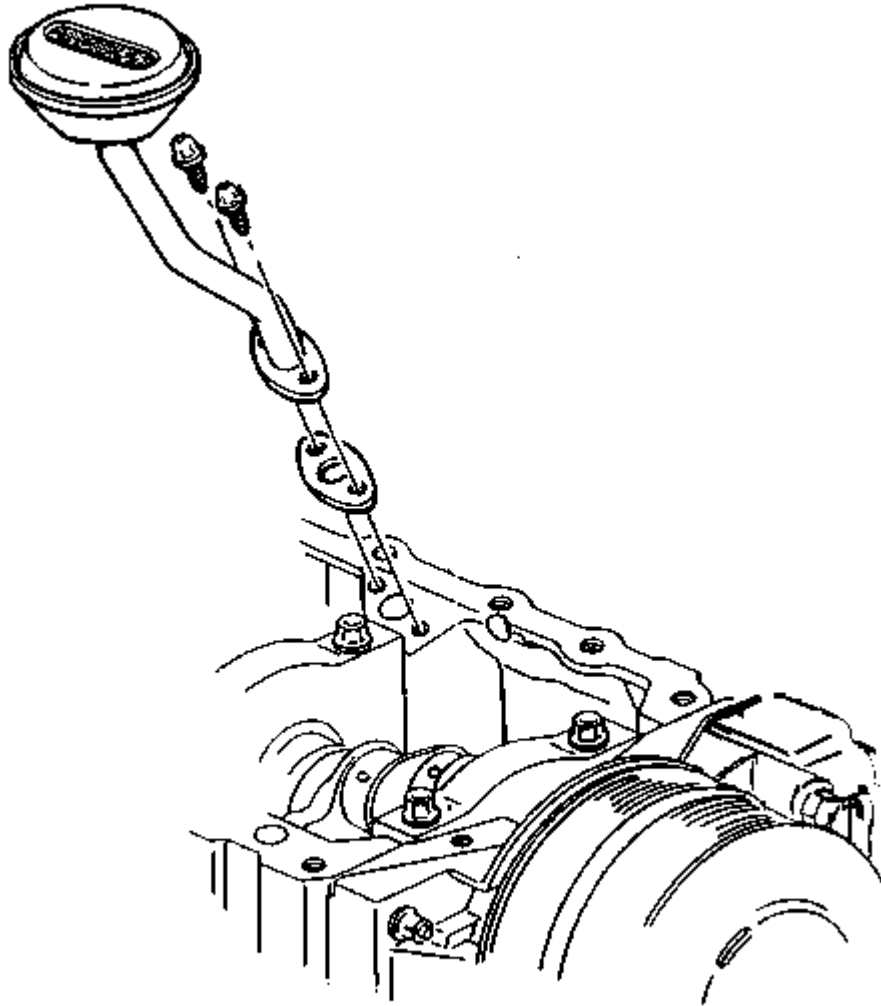


Fig. 314: View Of Oil Pump Pipe & Screen Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump pipe and screen assembly bolts.
2. Remove the oil pump pipe and screen assembly.
3. Remove the oil pump pipe and screen assembly gasket.
4. Use solvent to clean the oil pump pipe and screen.

CRANKSHAFT FRONT OIL SEAL REMOVAL

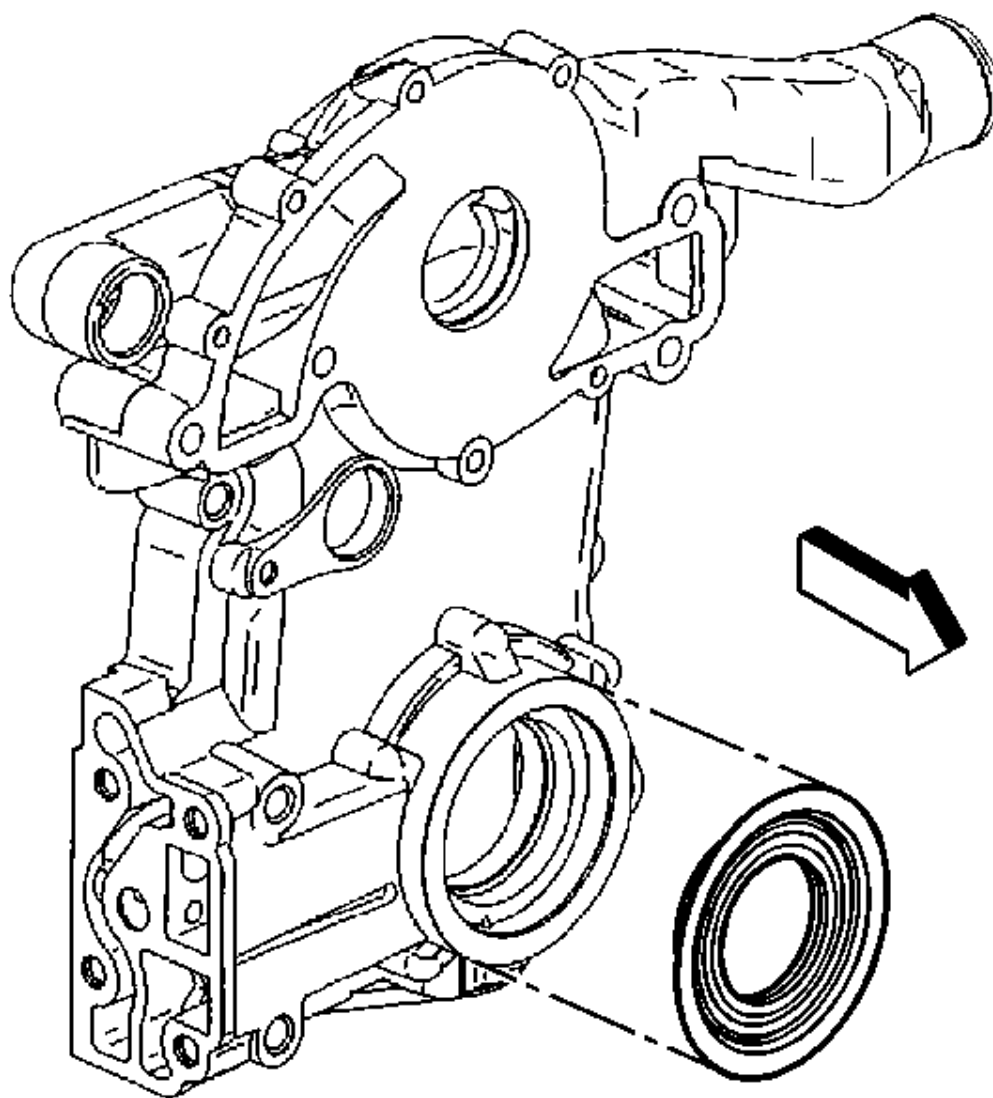


Fig. 315: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the seal bore or the contact surfaces.

Use a screwdriver to pry out the crankshaft front oil seal.

ENGINE FRONT COVER REMOVAL

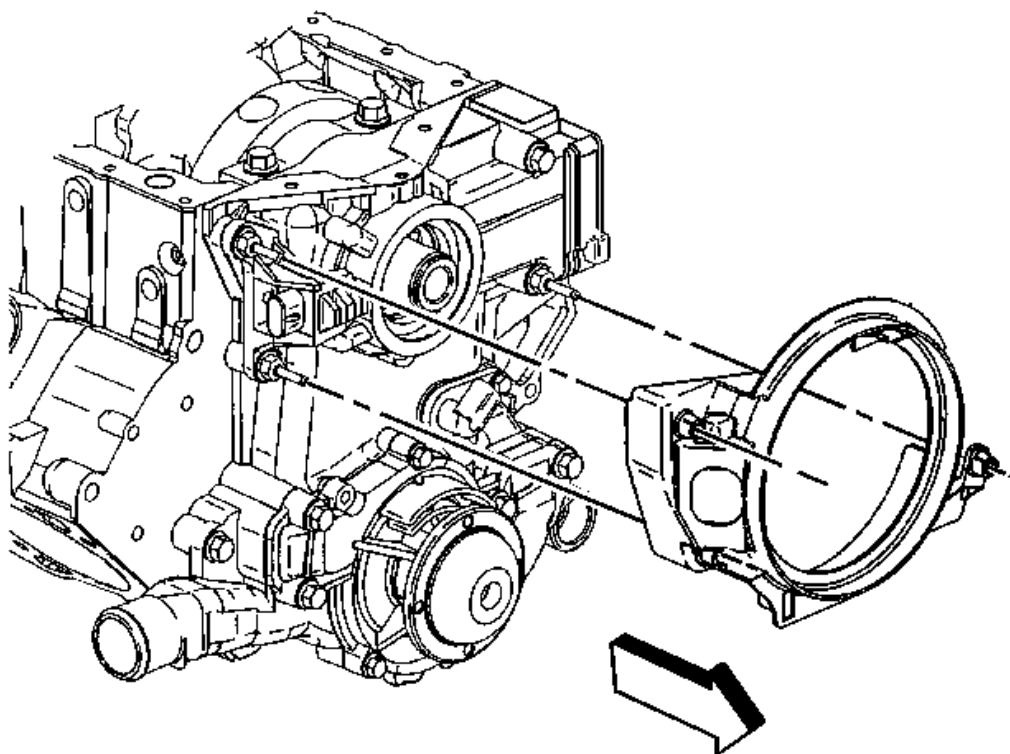


Fig. 316: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft position sensor shield.

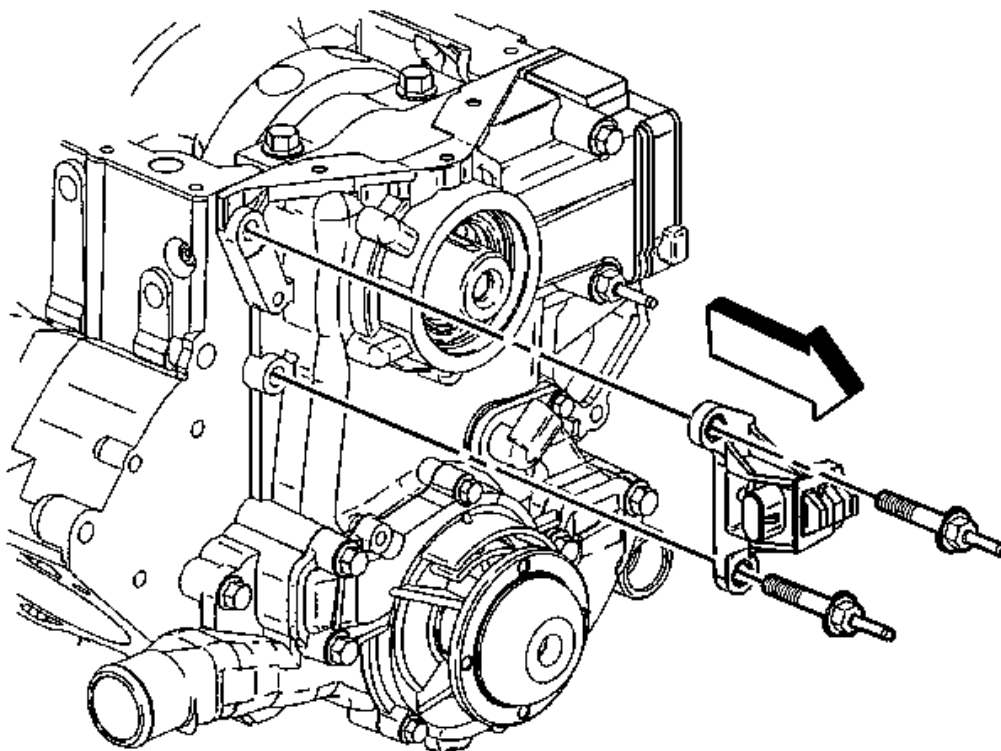


Fig. 317: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft position sensor studs.
3. Remove the crankshaft position sensor.

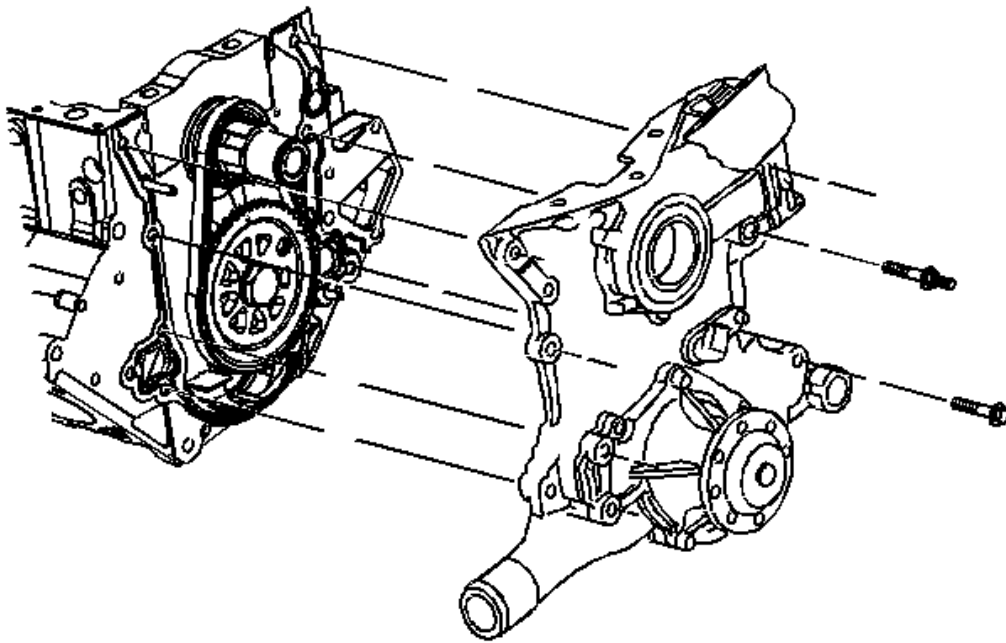


Fig. 318: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine front cover bolts and stud.
5. Remove the engine front cover.

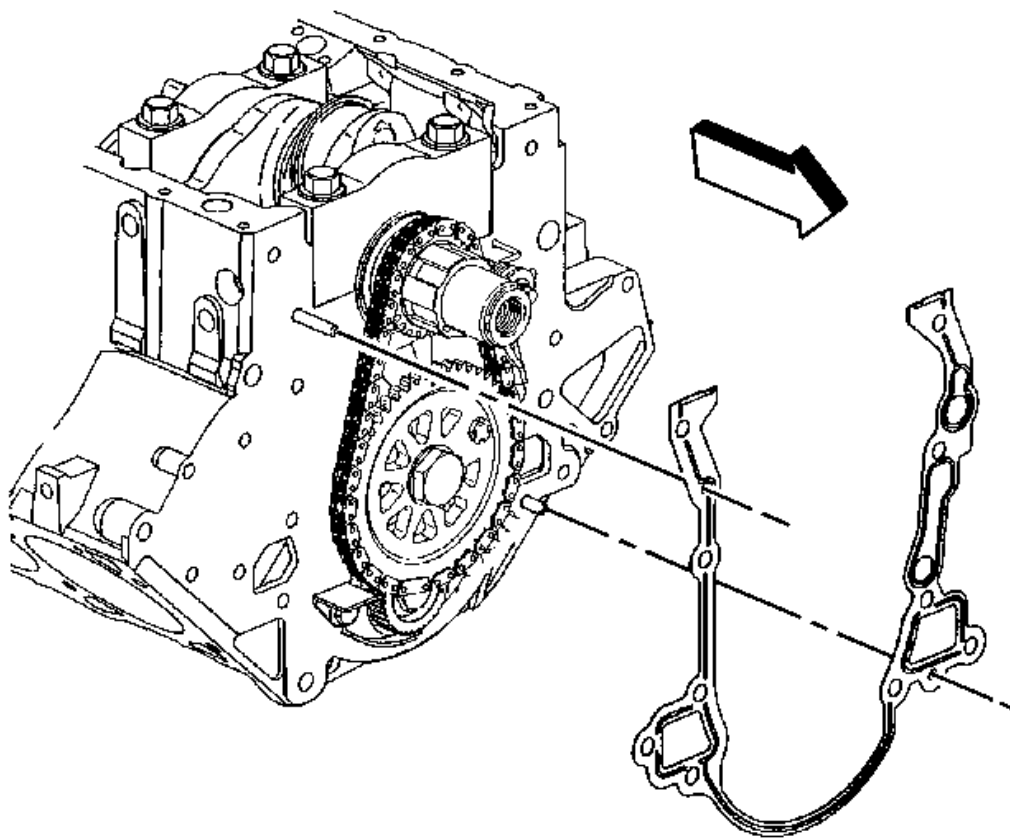


Fig. 319: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine front cover gasket.

OIL FILTER ADAPTER REMOVAL

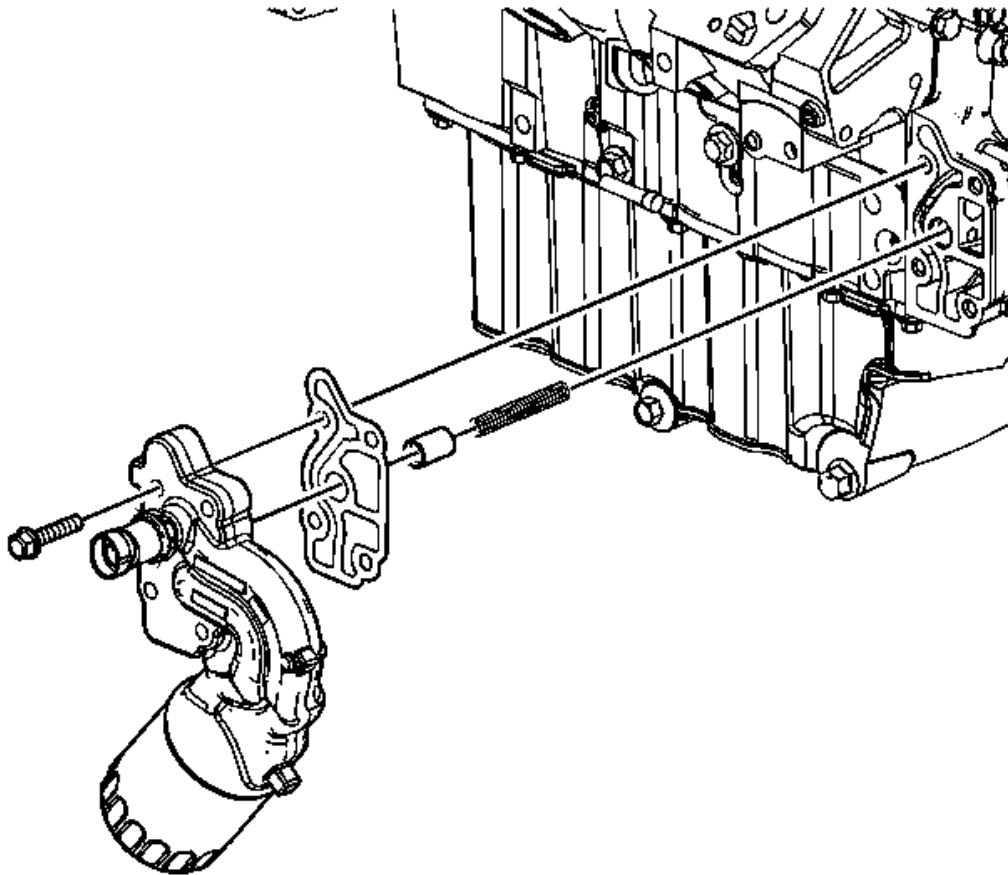


Fig. 320: Identifying Oil Filter Adapter
 Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter adapter bolts from the engine front cover.
2. Remove the oil filter adapter.
3. Remove the oil filter adapter gasket.
4. Remove the oil pressure relief valve.
5. Remove the oil pressure relief valve spring.

TIMING CHAIN AND SPROCKET REMOVAL (L26)

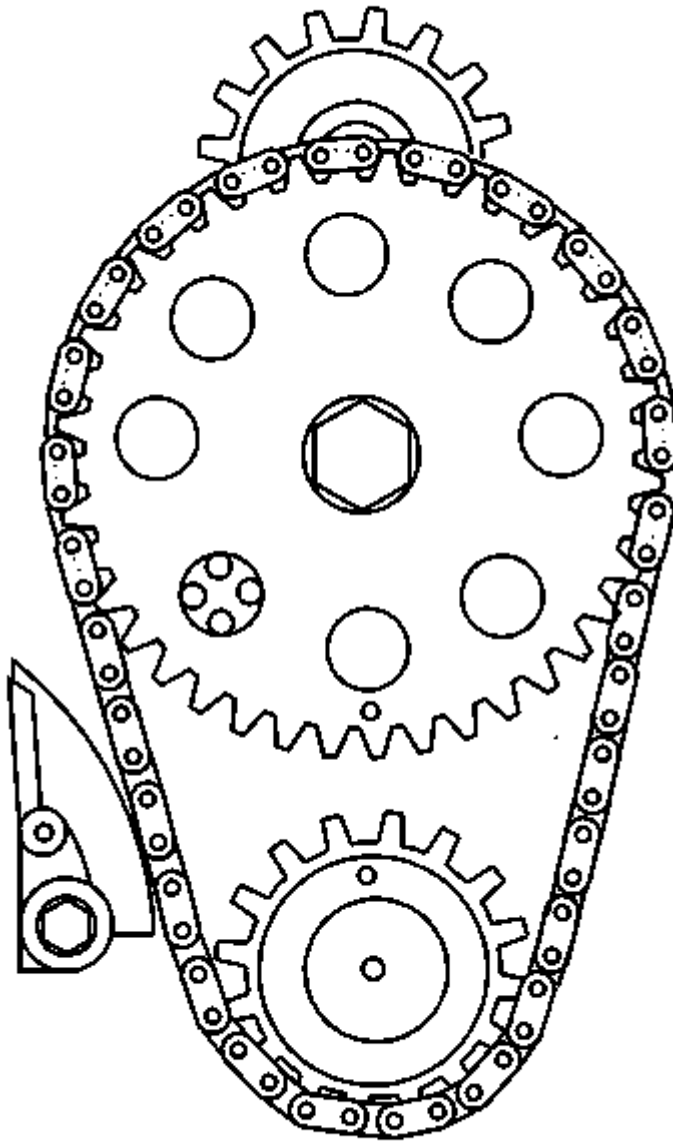


Fig. 321: Aligning Timing Chain & Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

1. Align the timing marks on the sprockets.

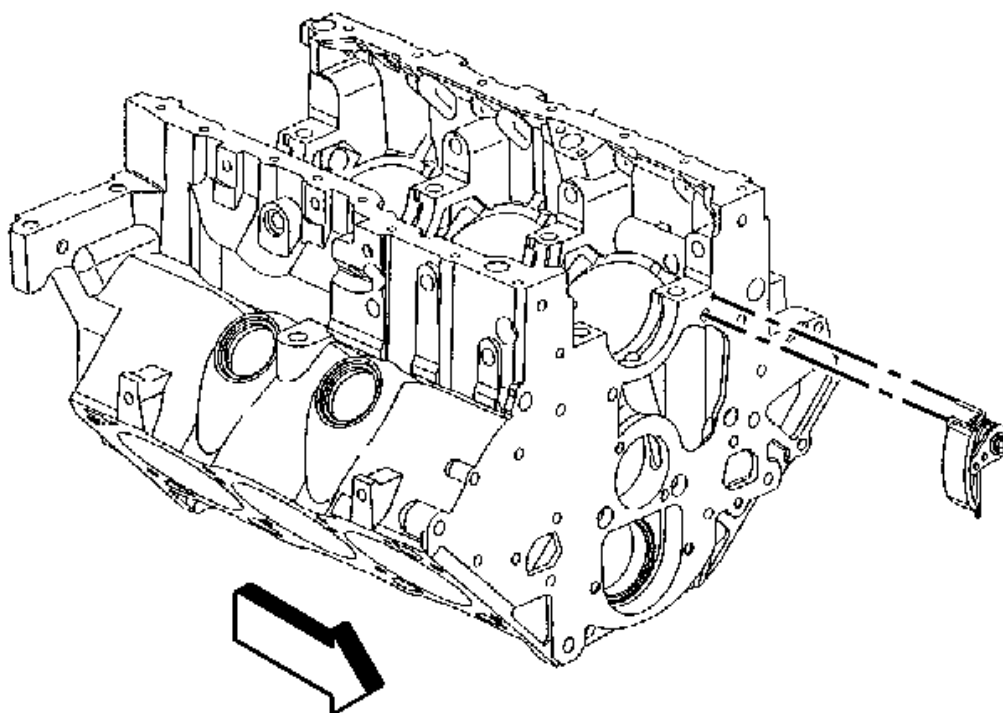


Fig. 322: View Of Timing Chain Dampener
Courtesy of GENERAL MOTORS CORP.

2. Remove the timing chain dampener.

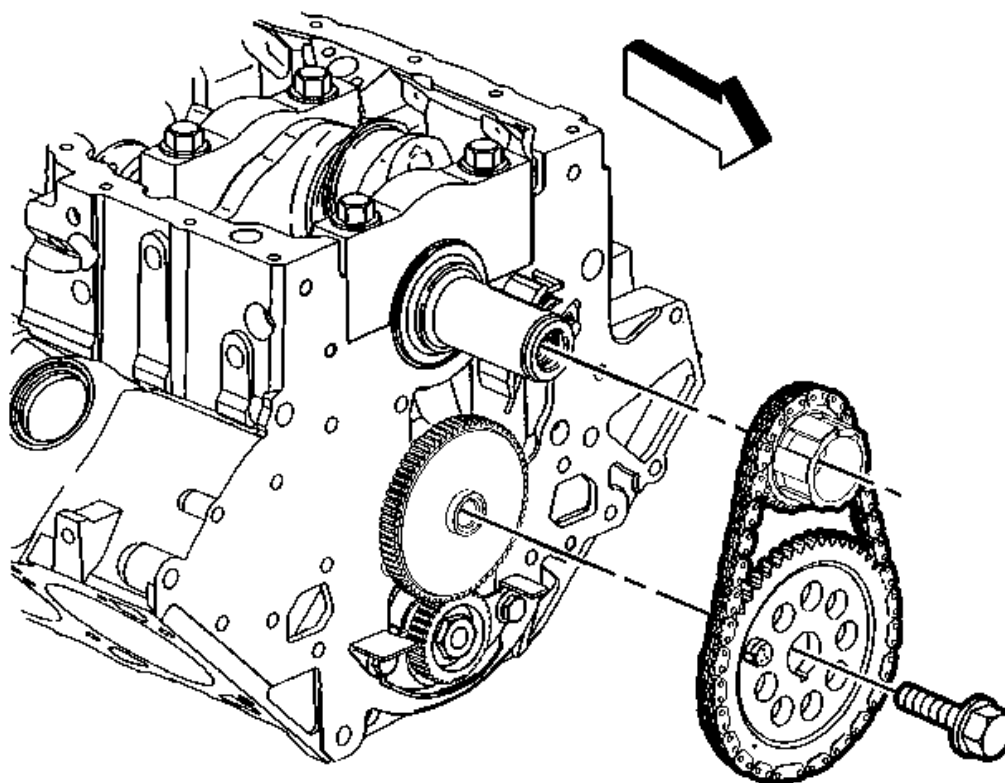


Fig. 323: Timing Chain, Crankshaft Sprocket & Camshaft Sprocket (L26)
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft sprocket bolt.
4. Remove the camshaft sprocket.
5. Remove the timing chain.
6. Remove the crankshaft sprocket.
7. Remove the crankshaft balancer key.

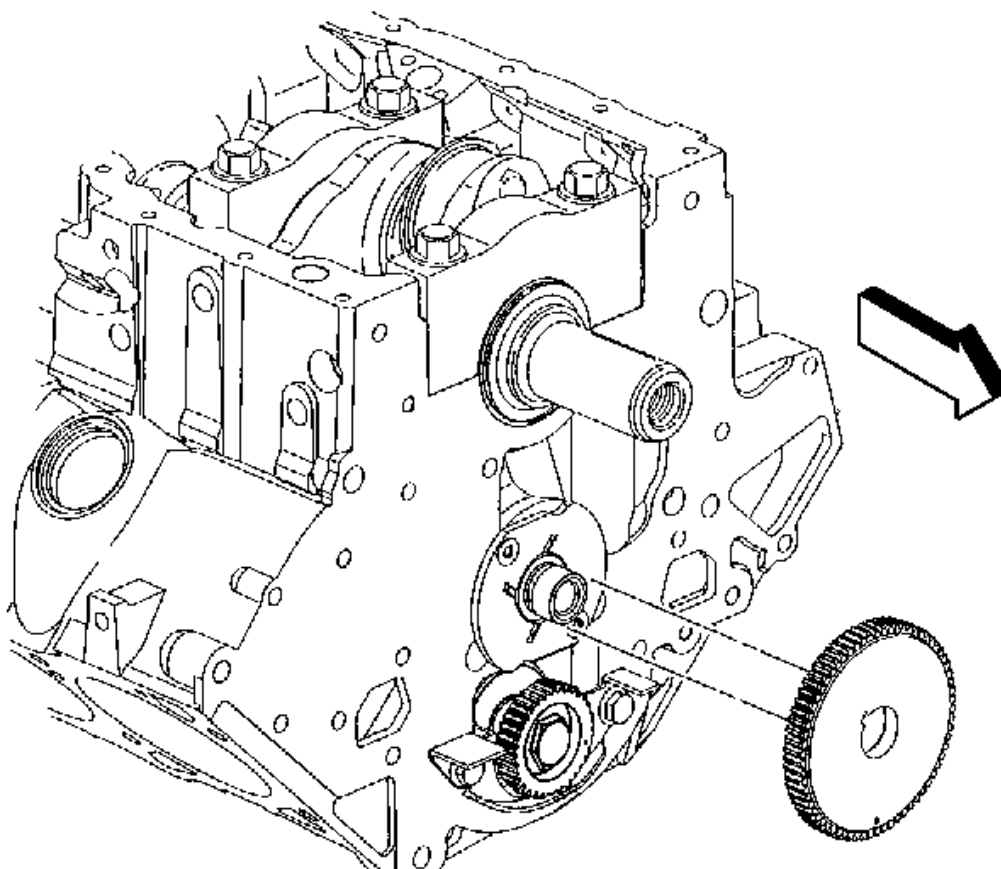


Fig. 324: Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

8. Remove the balance shaft drive gear.

BALANCE SHAFT REMOVAL

Tools Required

J 6125-1B Slide Hammer. See **Special Tools**.

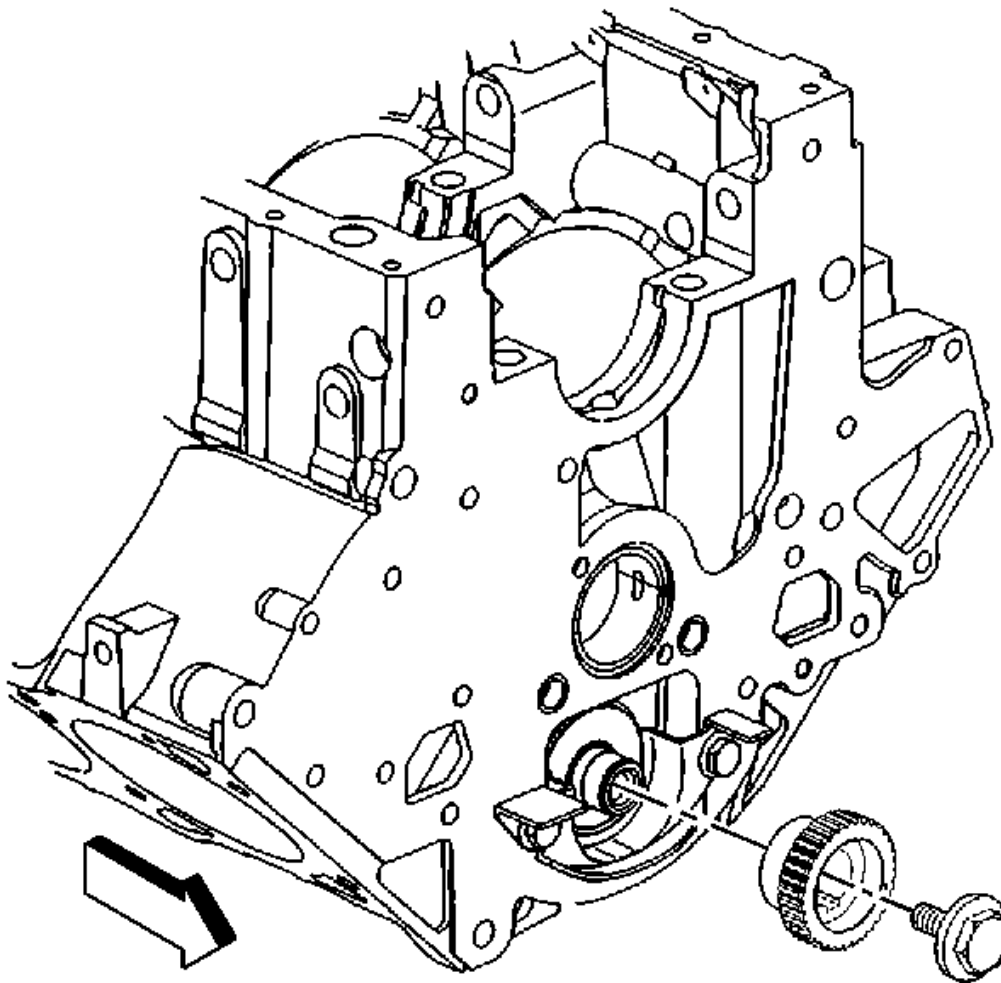


Fig. 325: Locating Balance Shaft Driven Gear & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the balance shaft driven gear bolt.
2. Remove the balance shaft driven gear.

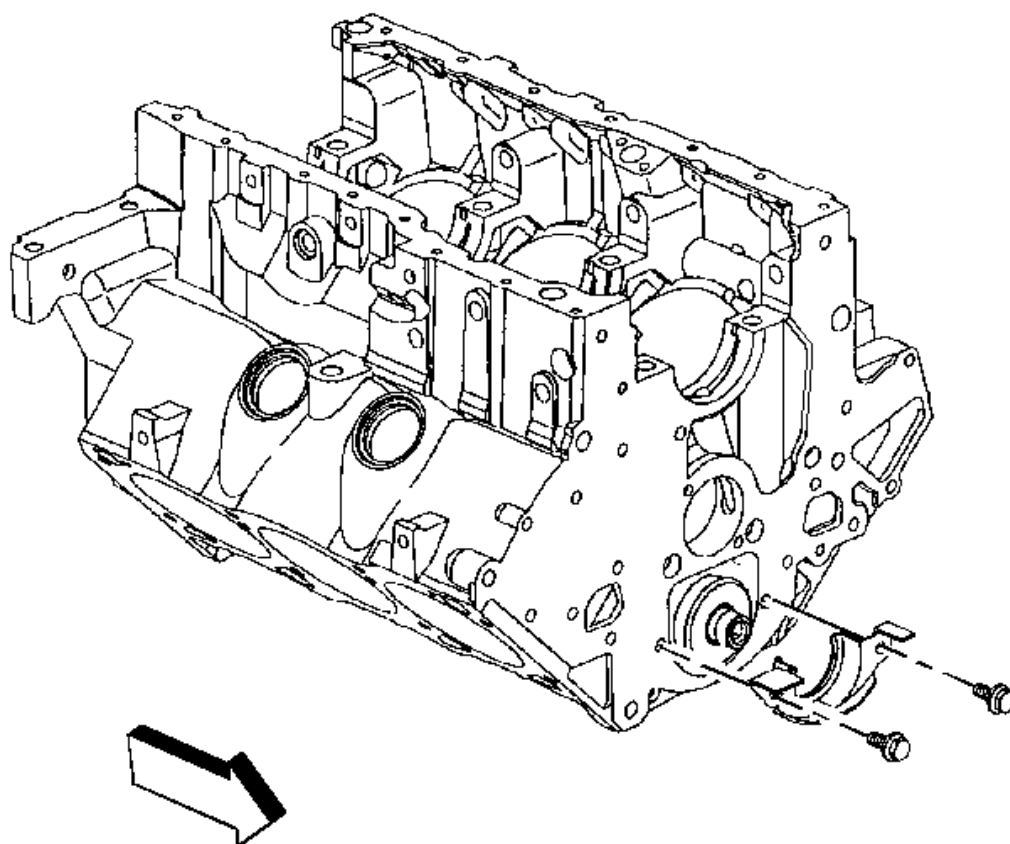


Fig. 326: View Of Balance Shaft Retainer
Courtesy of GENERAL MOTORS CORP.

3. Remove the balance shaft retainer bolts.
4. Remove the balance shaft retainer.

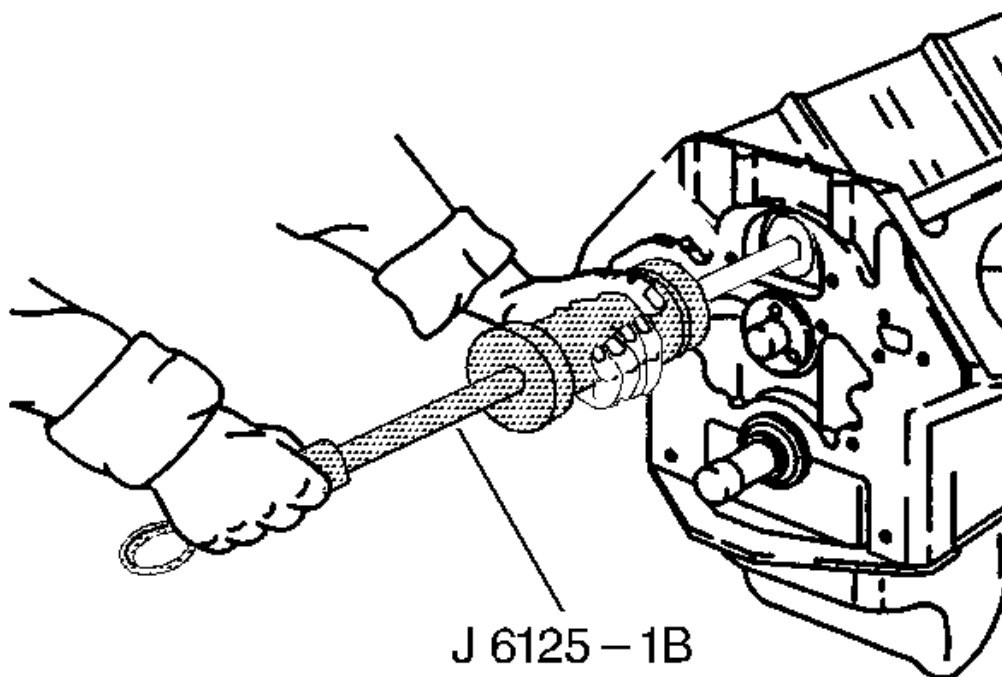


Fig. 327: Removing Balance Shaft
Courtesy of GENERAL MOTORS CORP.

5. Use **J 6125-1B** to remove the balance shaft. See **Special Tools**.

CAMSHAFT REMOVAL

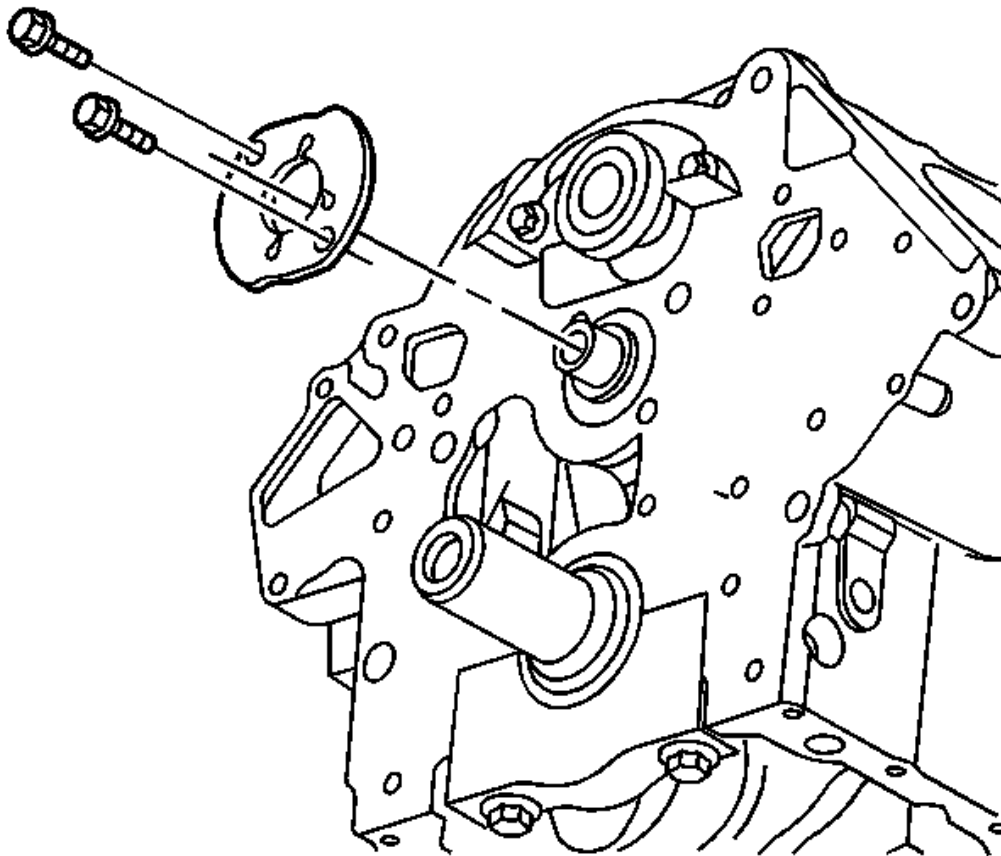


Fig. 328: Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft thrust plate screws.
2. Remove the camshaft thrust plate.

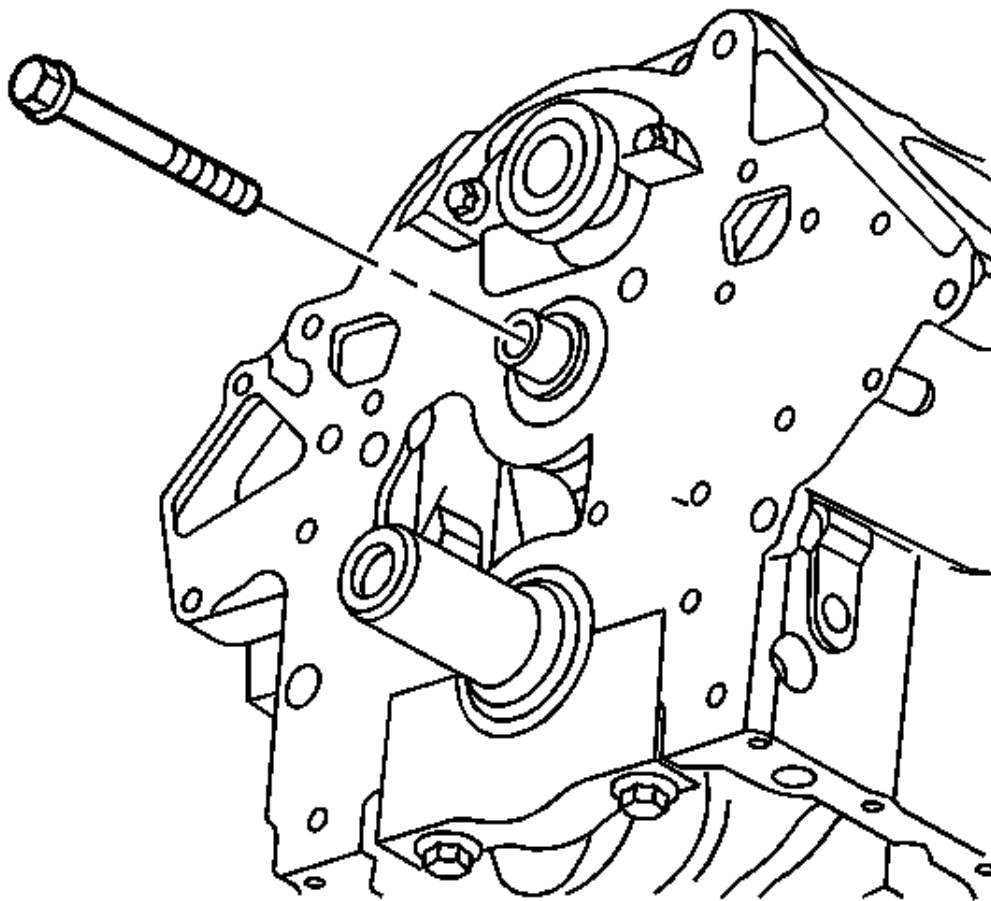


Fig. 329: Camshaft Front Bolt Hole & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install one 1/2-20 x 6.0 inch bolt in the camshaft front bolt hole.

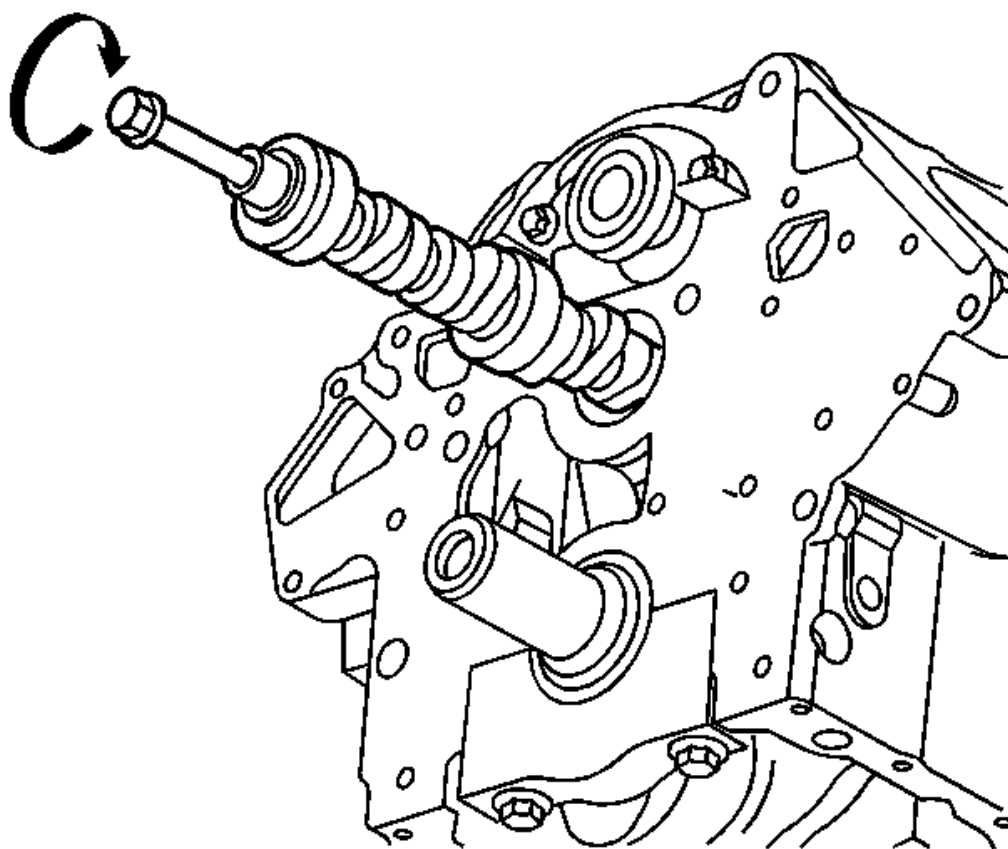


Fig. 330: Removing Camshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: All camshaft journals are the same diameter, so care must be used in removing the camshaft to avoid damage to the bearings.

4. Carefully rotate and pull the camshaft out of the bearings.

CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL (SECOND DESIGN)

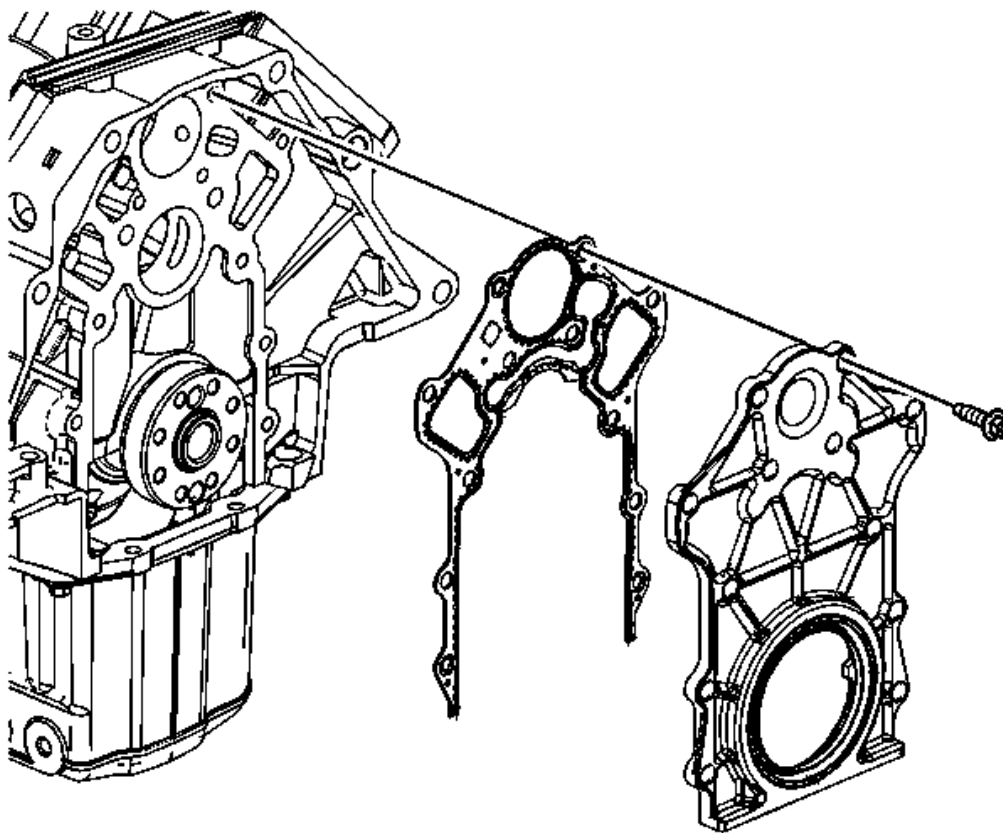


Fig. 331: Crankshaft Rear Oil Seal & Housing (Second Design)
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft rear oil seal housing bolts.
2. Remove the crankshaft rear oil seal housing and gasket.

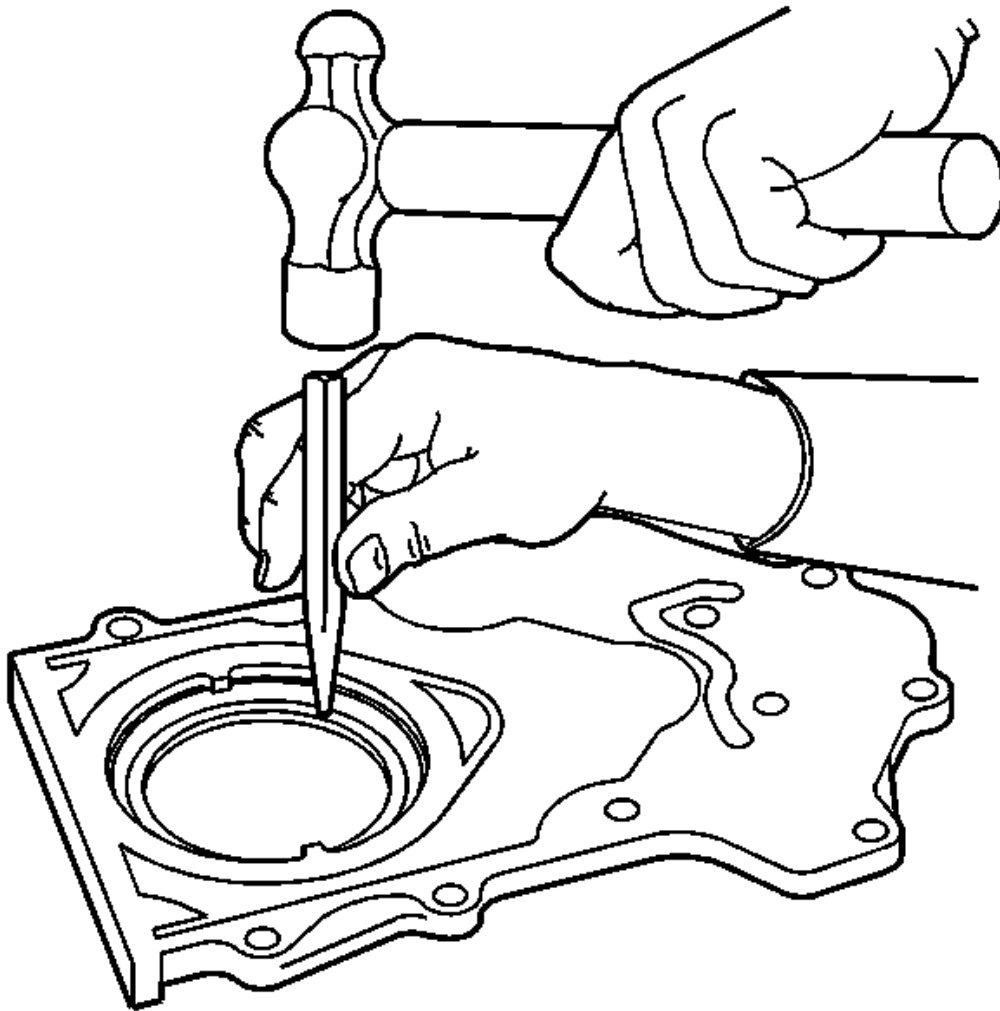


Fig. 332: Locating Crankshaft Rear Oil Seal In Housing
Courtesy of GENERAL MOTORS CORP.

3. Place the crankshaft rear oil seal housing face down on a clean surface and support with blocks of wood.
4. Use a suitable driving tool and hammer and lightly tap around the outer edge of the seal to remove it.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

- **J 24270:** Cylinder Ridge Reamer
- **J 41507:** Connecting Rod Guide Assembly

For equivalent regional tools, refer to Special Tools.

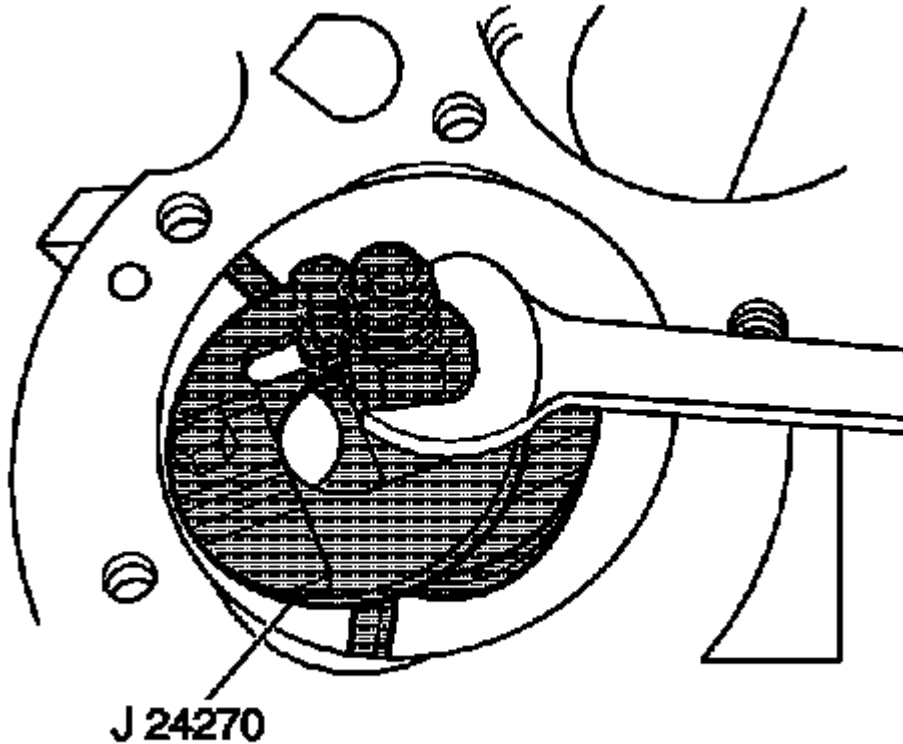


Fig. 333: Removing Cylinder Bore Ring Ridge
Courtesy of GENERAL MOTORS CORP.

1. Mark the connecting rod cap and the connecting rod for proper installation.

CAUTION: If there is a pronounced ridge at the top of the piston travel, the ridge must be removed with a ridge reamer before the piston and connecting rod assembly are removed. Applying force may break the piston rings or damage the piston.

2. Use the **J 24270**: reamer to remove the cylinder bore ring ridge.
 1. Turn the crankshaft until the piston is at the bottom of the stroke.
 2. Cover the piston with a cloth.
 3. Remove the cylinder ring ridge.
 4. Turn the crankshaft until the piston is at the top of the stroke.
 5. Remove the cloth.
 6. Remove the metal shavings from the cylinder and piston.

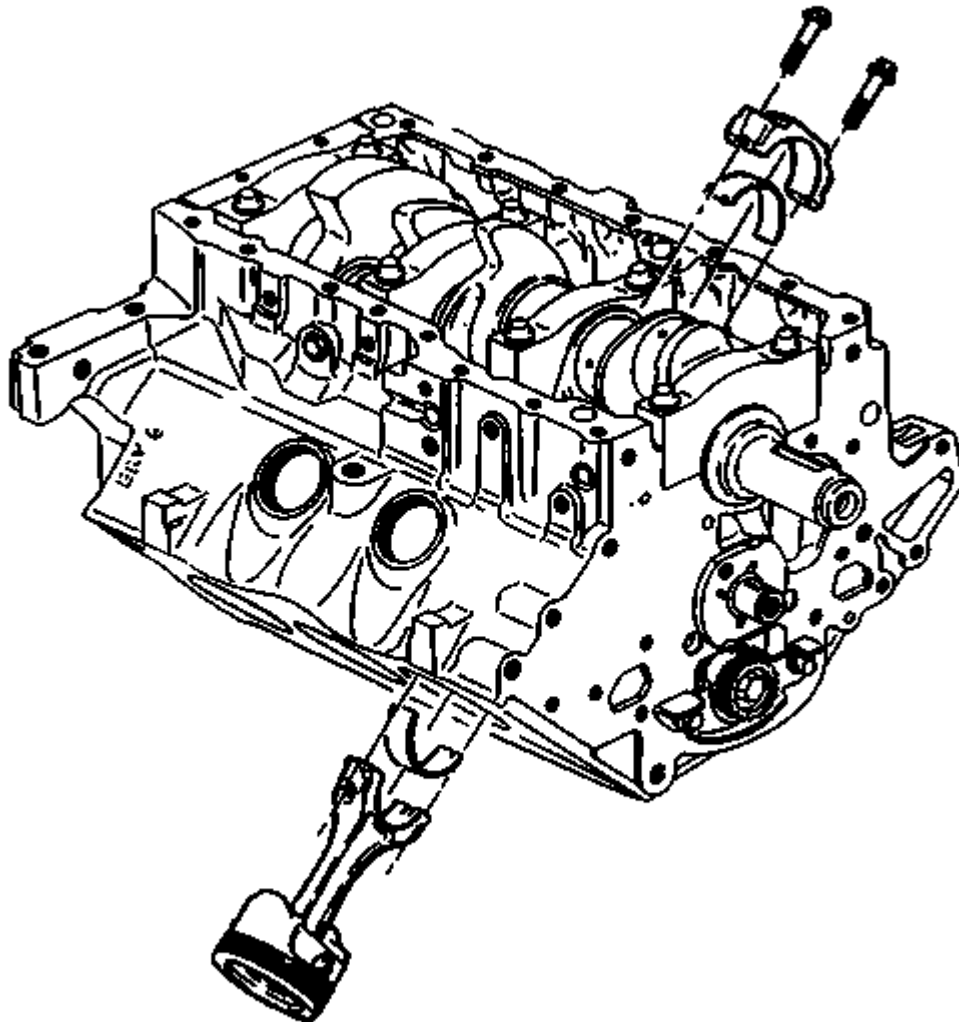


Fig. 334: Connecting Rod Bolts & Cap
Courtesy of GENERAL MOTORS CORP.

3. Remove the connecting rod bolts.
4. Remove the connecting rod cap.

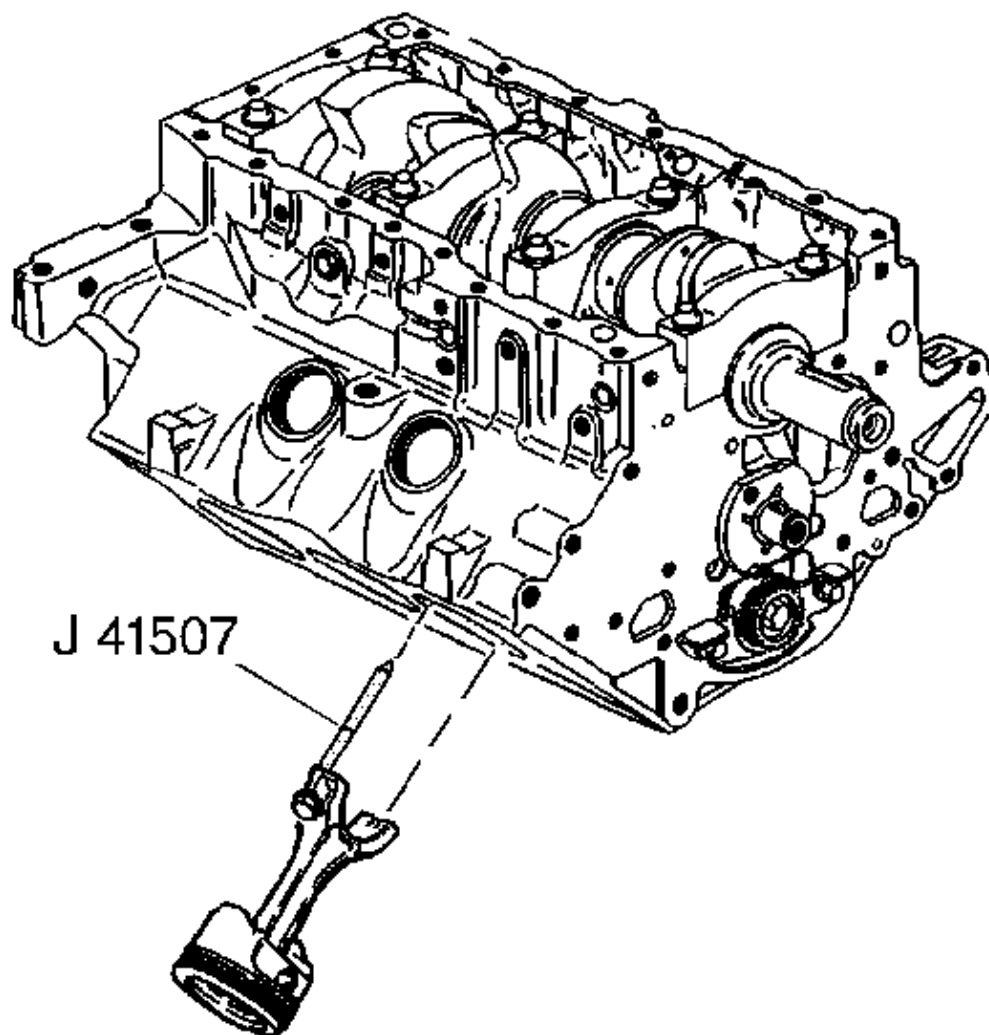


Fig. 335: Installing J 41507 To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Install **J 41507**: assembly to the connecting rod. Hand tighten the tool to the connecting rod.
6. Use hand pressure on **J 41507**: assembly to push the connecting rod towards the top of the cylinder.

NOTE: Mark the piston with the number of the cylinder from which it was removed. Mark the piston as to what is the front for proper reassembly.

7. Remove the piston, the connecting rod, and the connecting rod bearings.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

- **J 6125-1B:** Slide Hammer
- **J 41348:** Main Bearing Cap Puller

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

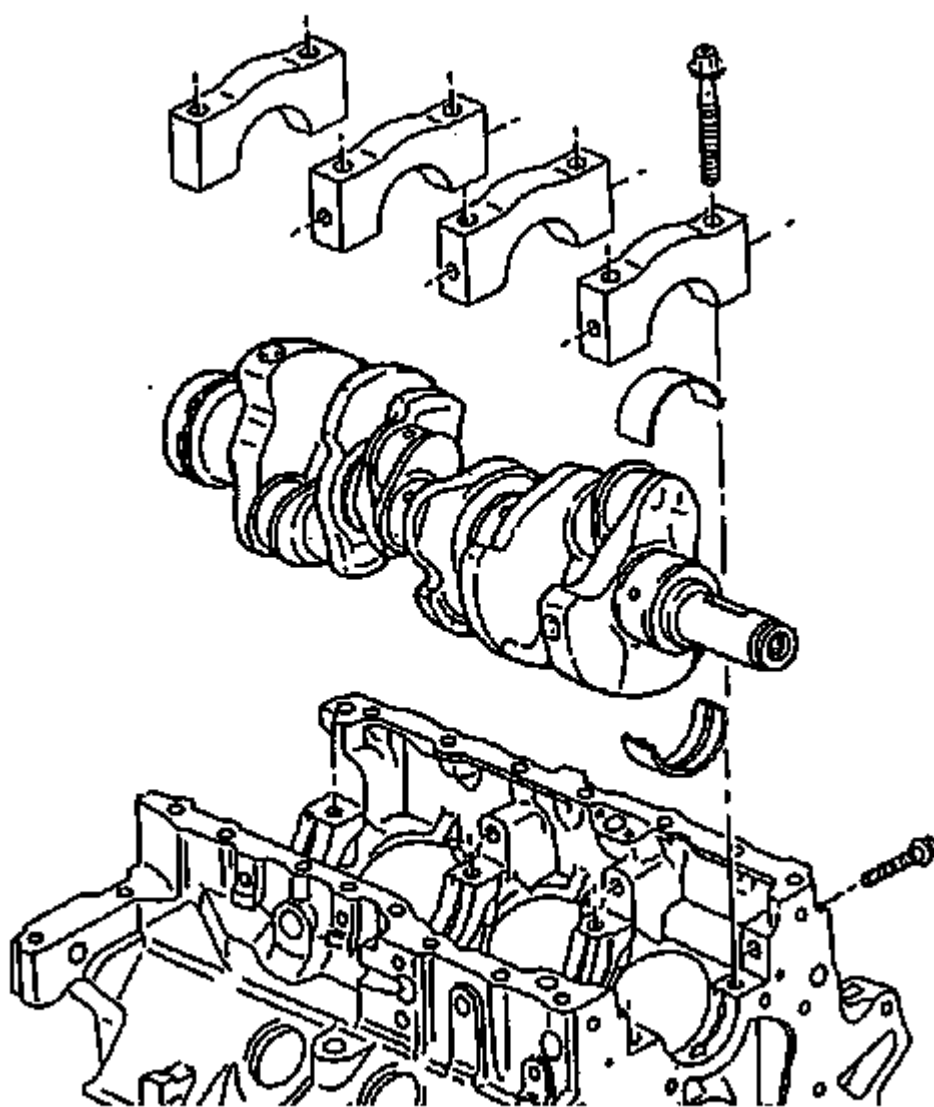


Fig. 336: View Of Crankshaft, Bearings And Bearing Caps
Courtesy of GENERAL MOTORS CORP.

NOTE: This engine has side bolts on all of the main caps except the rear cap. These bolts must be removed to service the caps.

1. Remove the crankshaft main bearing cap side bolts.
2. Remove the crankshaft main bearing cap bolts.

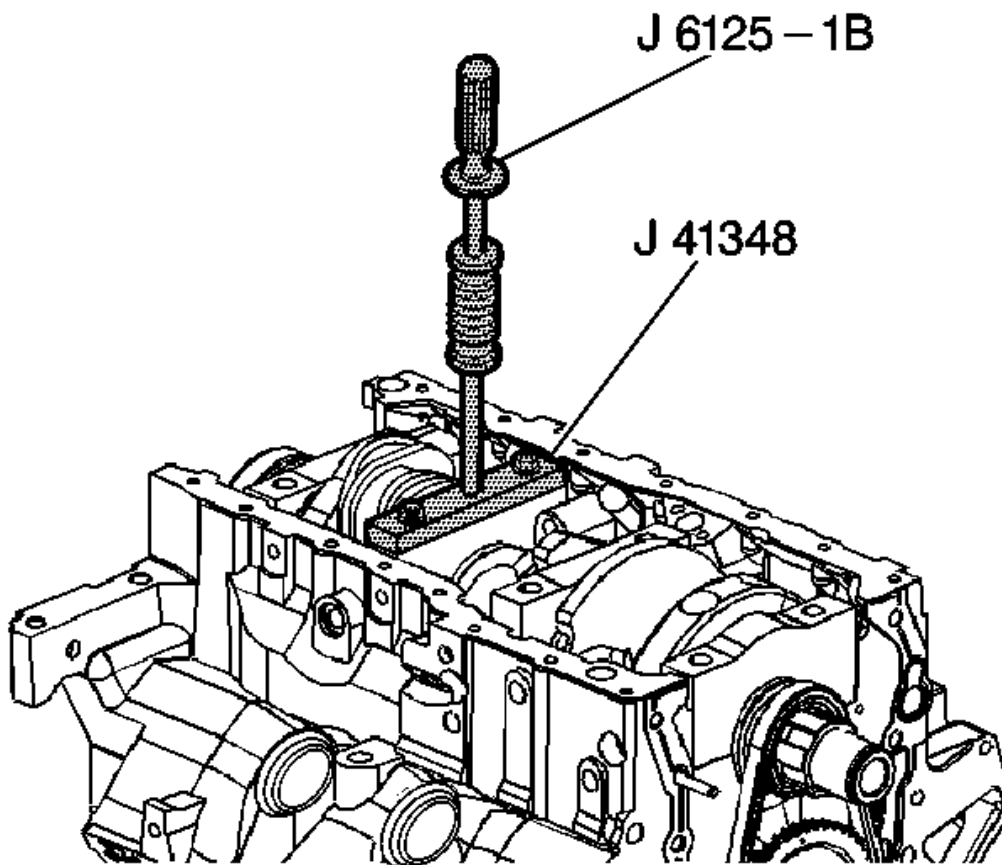


Fig. 337: Removing Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

CAUTION: Main bearing caps are press fit. Remove the caps carefully for service. J 41348 has been designed to work with J 6125-B in order to prevent damage to the bearing and cap. J 41348 **MUST** be installed properly into the bolt holes of the caps and J 6125-B attached to J

41348 in order to properly remove the main cap without damaging the bearing or the cap. Any deviation from this procedure may cause damage to the cap and the bearing and may result in future engine damage.

CAUTION: Refer to Fastener Caution .

3. Install **J 41348:** puller into the crankshaft main bearing cap bolt holes and tighten the bolts on **J 41348:** puller to 12 N.m (100 lb in).
4. Install **J 6125-1B:** hammer to **J 41348:** puller.
5. Use **J 6125-1B:** hammer to remove the crankshaft main lower bearing caps.

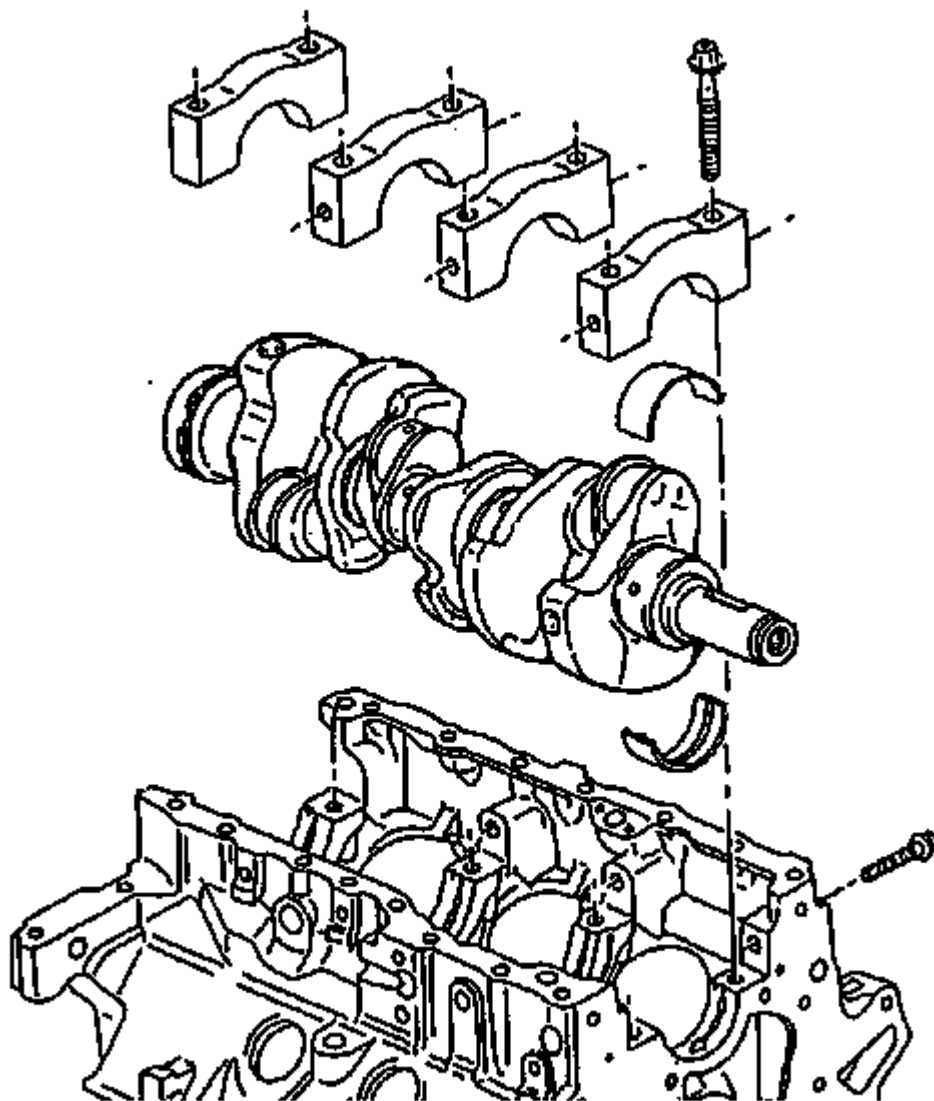


Fig. 338: View Of Crankshaft, Bearings And Bearing Caps
 Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft.
7. Remove the upper main bearings from the engine block.

ENGINE BLOCK PLUG REMOVAL

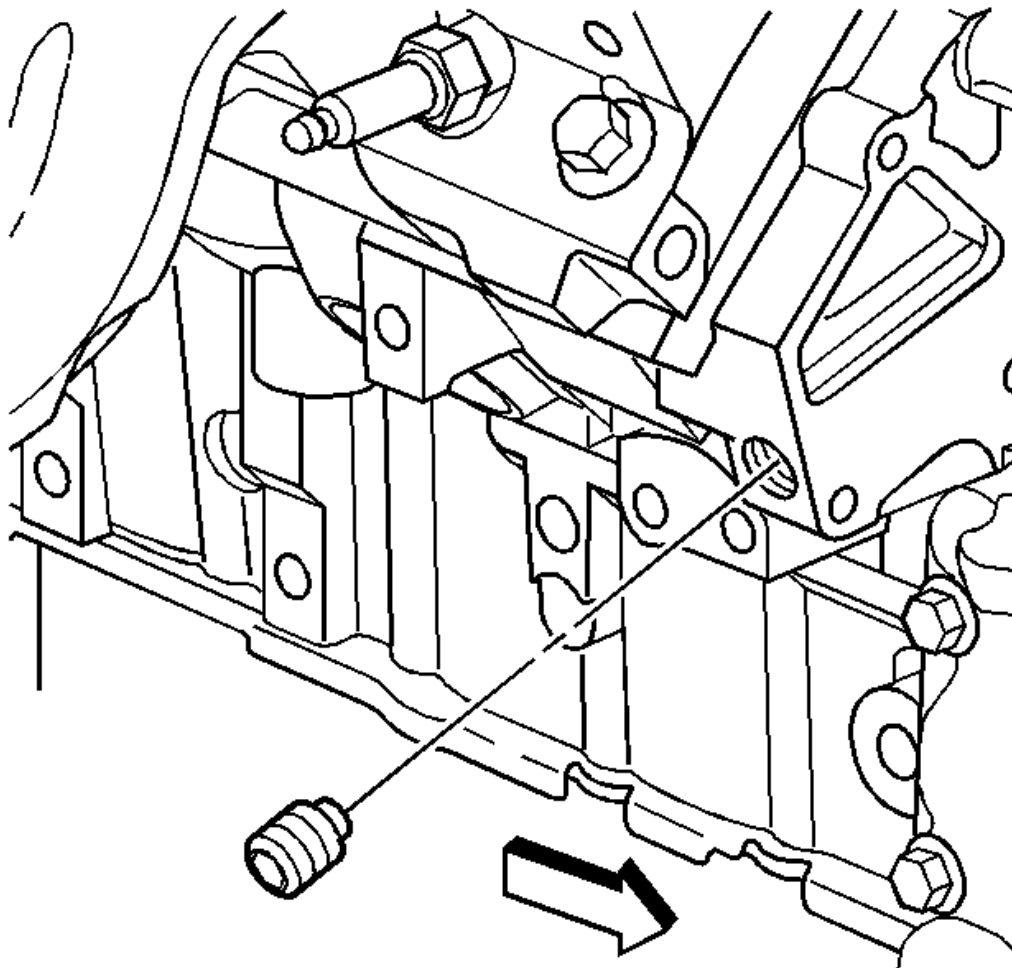


Fig. 339: Locating Threaded Gallery Plugs
Courtesy of GENERAL MOTORS CORP.

1. Remove the threaded coolant jacket plugs.

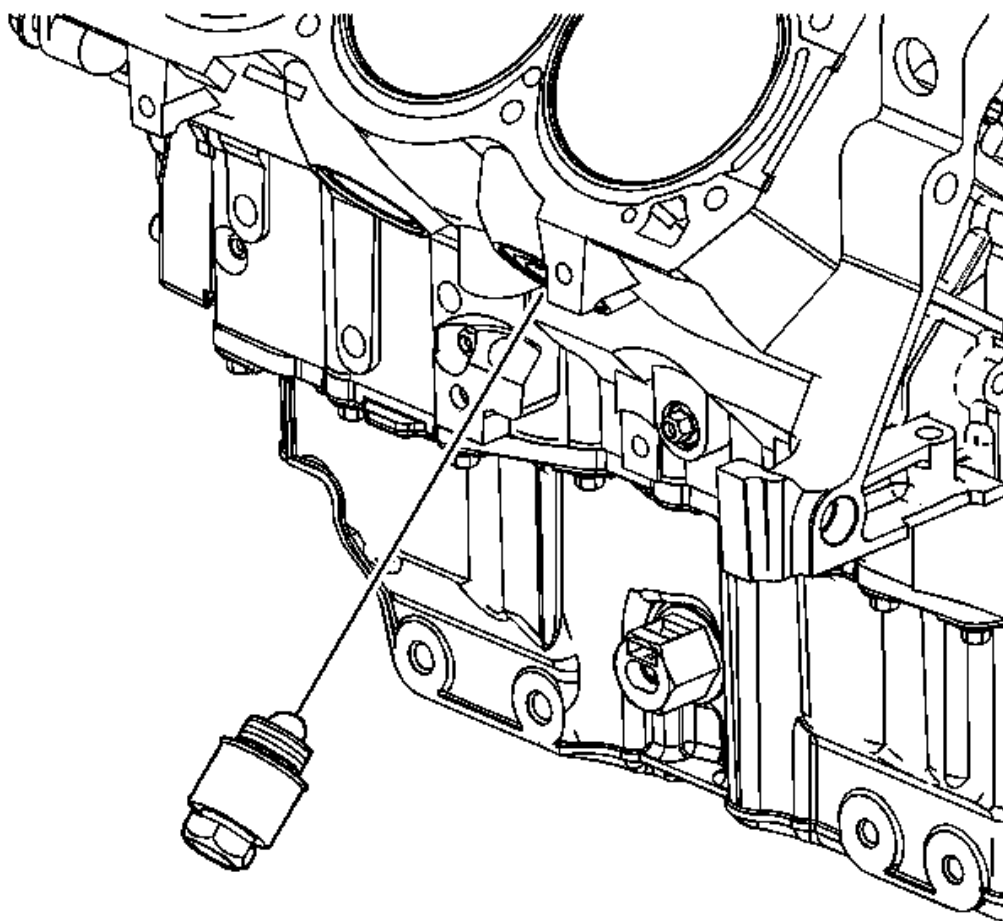


Fig. 340: Threaded Engine Block Heater
Courtesy of GENERAL MOTORS CORP.

2. Remove the threaded engine block heater.

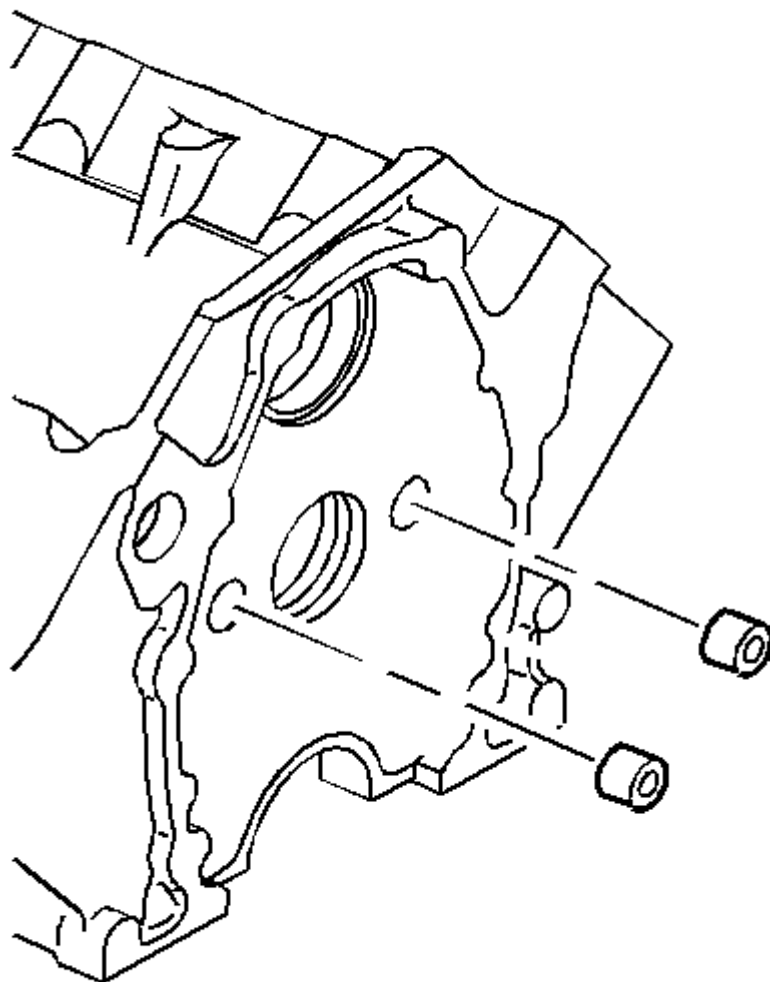
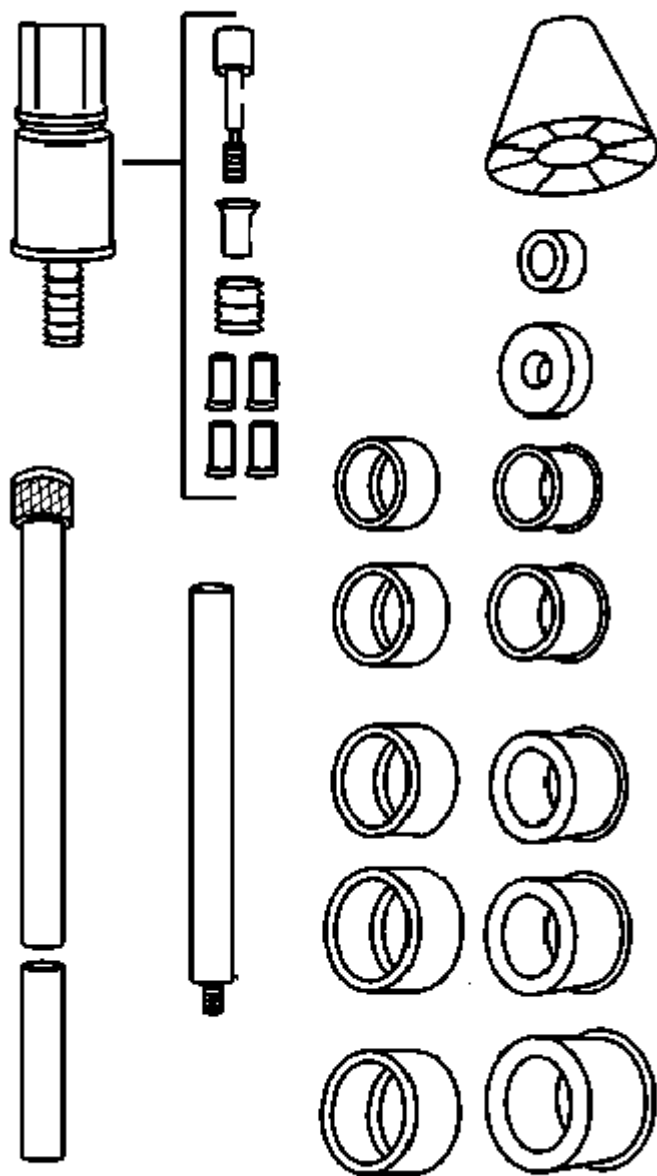


Fig. 341: Locating Engine Block Plugs
Courtesy of GENERAL MOTORS CORP.

3. Remove the remaining plugs using the following procedure.
 1. Obtain a suitable self-threading screw.
 2. Drill a hole into the plug.
 3. Install the self-threading screw.
 4. Use the screw to pry out the plug.

CAMSHAFT BEARING REMOVAL

J 33049 Camshaft Bearing Remover/Installer. See Special Tools.



1. Select the expander assembly and driving washer.
2. Assemble **J 33049** . See **Special Tools**.

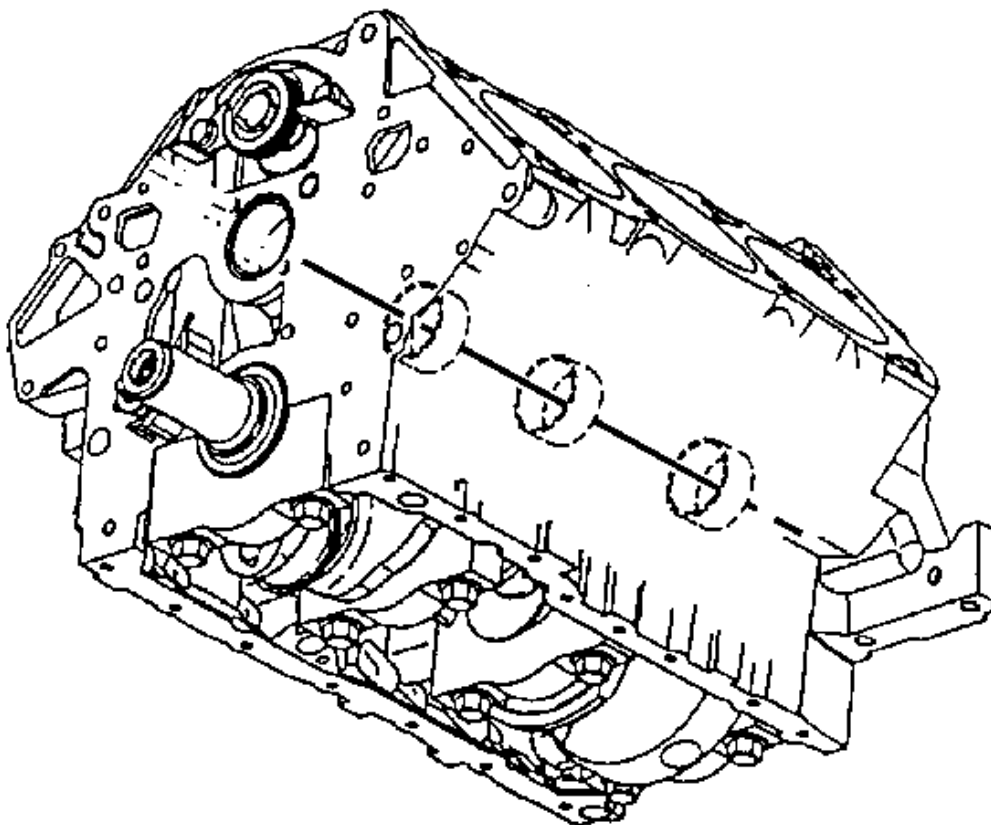


Fig. 343: Identifying Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

3. Drive out the camshaft bearings.

BALANCER SHAFT BEARING REMOVAL

Tools Required

J 36995 Balance Shaft Bearing Remover/Installer. See **Special Tools**.

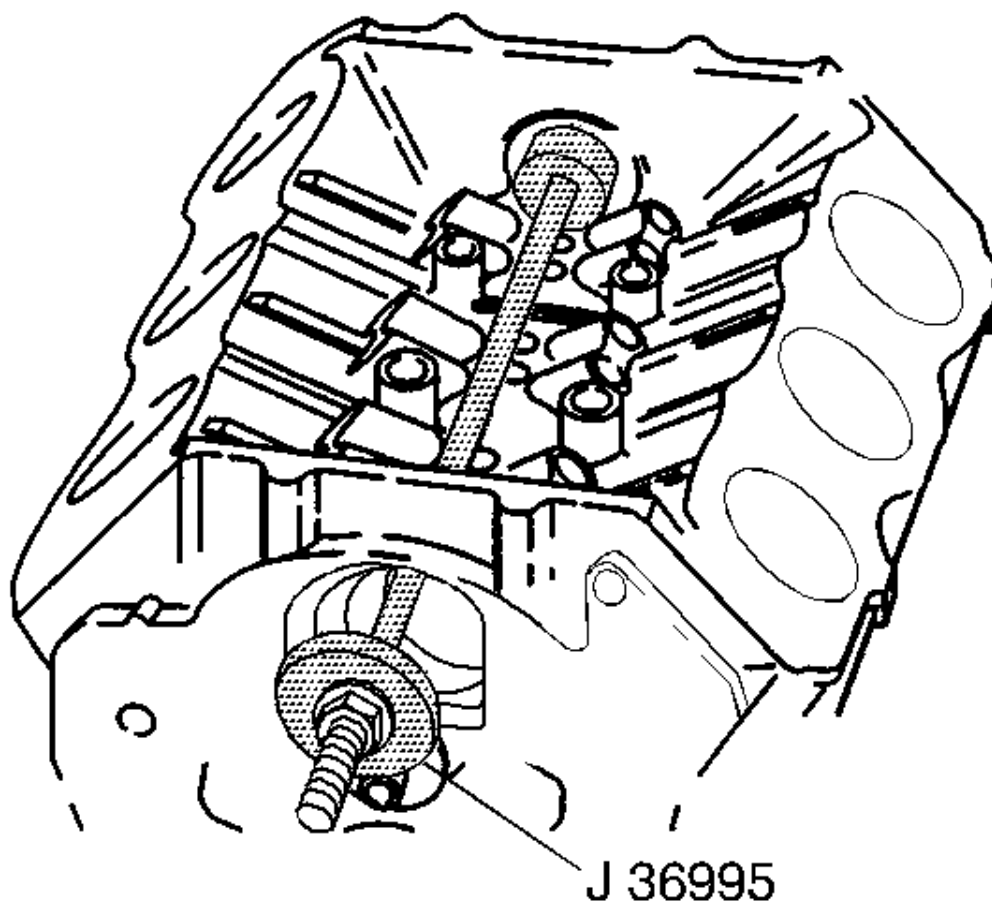


Fig. 344: Removing Balance Shaft Bearing And/Or Bushing
Courtesy of GENERAL MOTORS CORP.

1. Use **J 36995** to remove the balance shaft bearing. See **Special Tools**.
2. Use **J 36995** to remove the balance shaft bushing. See **Special Tools**. It may take a considerable amount of force to loosen the bushing from the block bore.

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **J 8001:** Dial Indicator Set
- **J 8087:** Cylinder Bore Gage

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

1. Clean the sealing material from the gasket mating surfaces.
2. Boil the engine block in caustic solution.
3. Flush the engine block with clean water or steam.
4. Clean the oil passages.
5. Clean the blind holes.
6. Spray the cylinder bores and the machined surfaces with engine oil.
7. Inspect the threaded holes. Clean the holes with a tap. If necessary, drill out the holes and install thread inserts. Refer to **Thread Repair**.

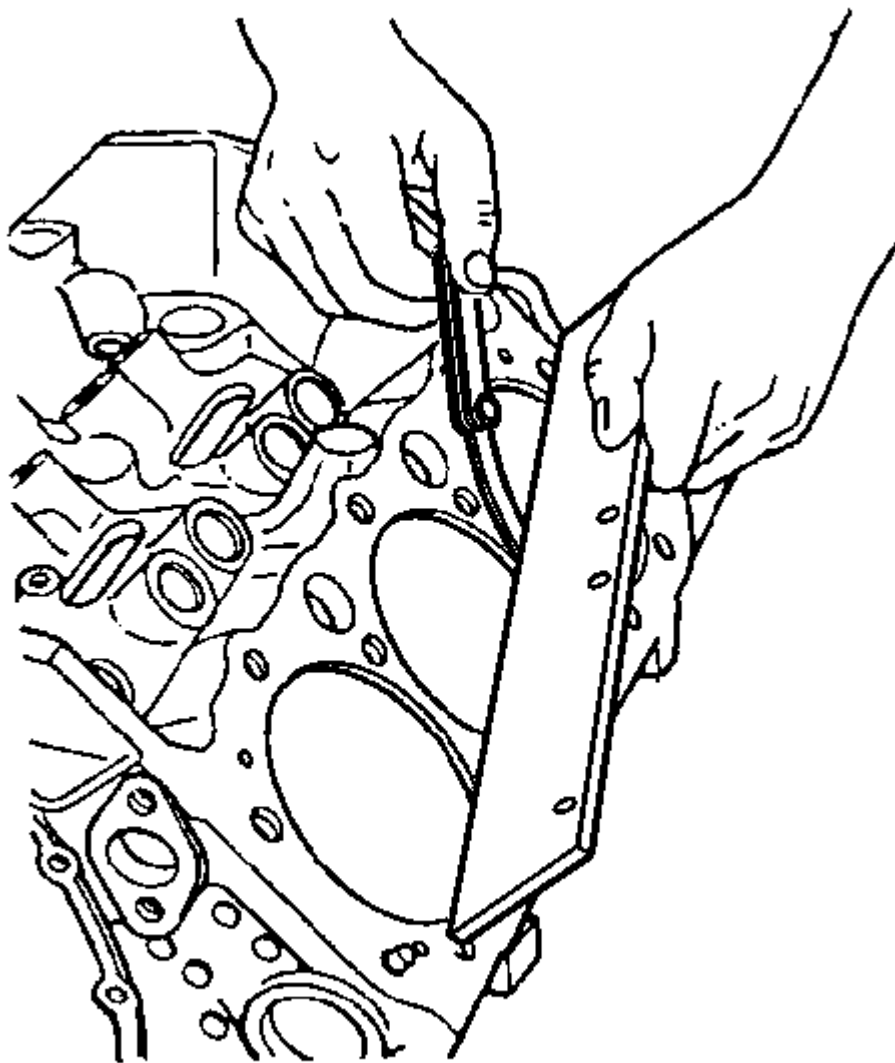


Fig. 345: Testing Block Deck Surface For Flatness
Courtesy of GENERAL MOTORS CORP.

8. Use a straight edge and a feeler gage to check the deck surface for flatness. Carefully machine minor irregularities. Replace the block if more than 0.254 mm (0.010 in) must be removed.
9. Inspect the oil pan rail for nicks. Inspect the front cover attaching area for nicks. Use a flat mill file to remove any nicks.

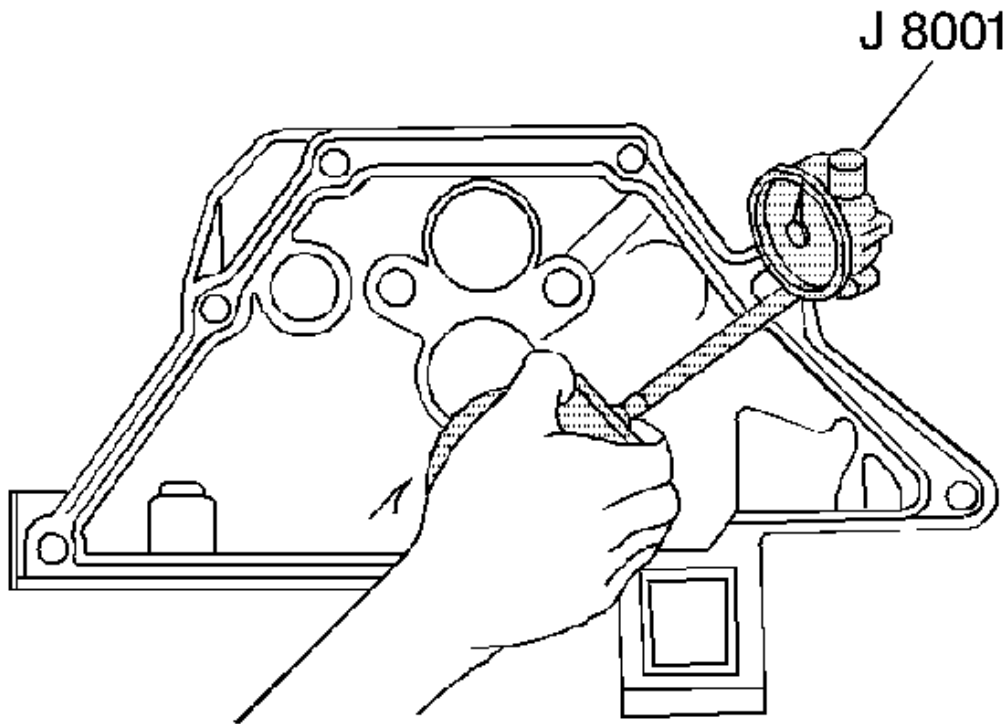


Fig. 346: Inspecting Mating Surfaces Of Transmission Case
Courtesy of GENERAL MOTORS CORP.

10. Inspect the mating surfaces of the transmission case.

CAUTION: A broken flywheel may result if the transmission case mating surface is not flat.

11. Use the following procedure to measure the engine block flange runout at the six mounting bolt hole bosses:
 1. Temporarily install the crankshaft. Measure the crankshaft flange runout.
 2. Hold the gauge plate flat against the crankshaft flange.
 3. Place **J 8001**: set on the transmission mounting bolt hole boss. Set the indicator to 0.
 4. Record the readings obtained from all of the bolt hole bosses. The measurements should not vary more than 0.254 mm (0.010 in).
 5. Recheck the crankshaft flange runout if the readings vary more than 0.254 mm (0.010 in).

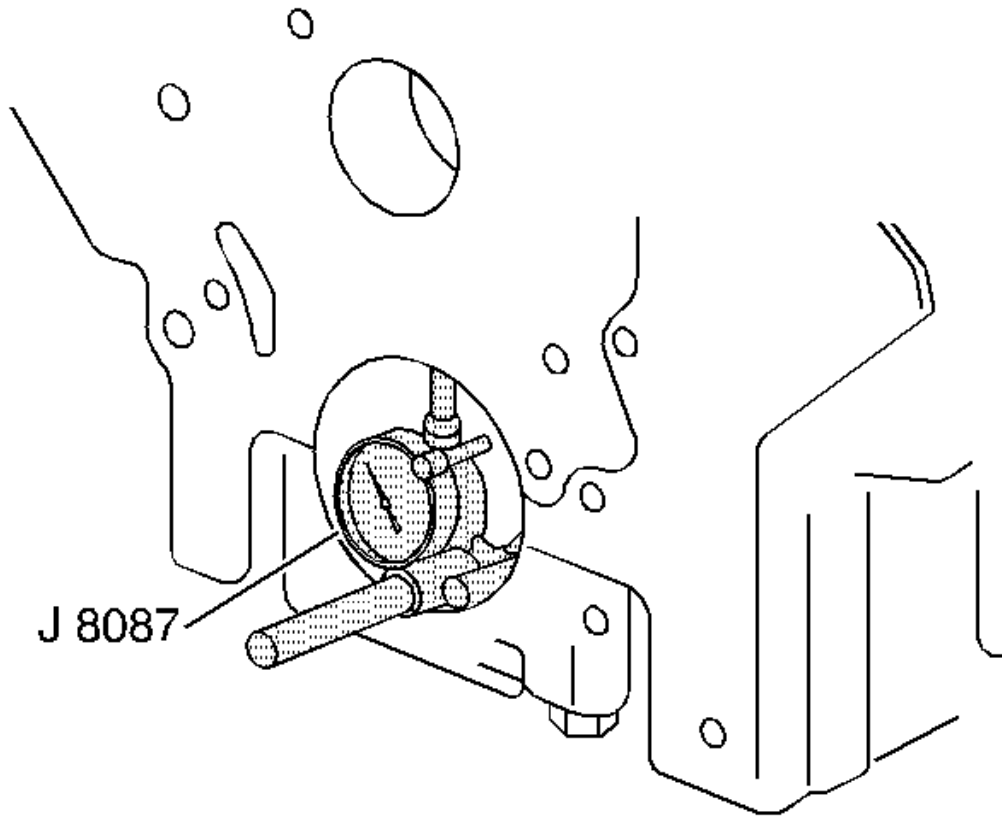


Fig. 347: Inspecting Crankshaft Main Bearing Bores
Courtesy of GENERAL MOTORS CORP.

12. Inspect the crankshaft main bearing bores. Use **J 8087**: gage to measure the bearing bore concentricity and alignment at the following locations:
 - The camshaft
 - The crankshaft

NOTE: **Recondition the engine block with the crankshaft main bearing caps and the crankshaft main bearing cap side bolts installed and tightened to specification.**

13. Ensure that the crankshaft main bearing caps are installed correctly. The arrows should point toward the front of the engine.
14. Replace the engine block if the bores are out of specification.

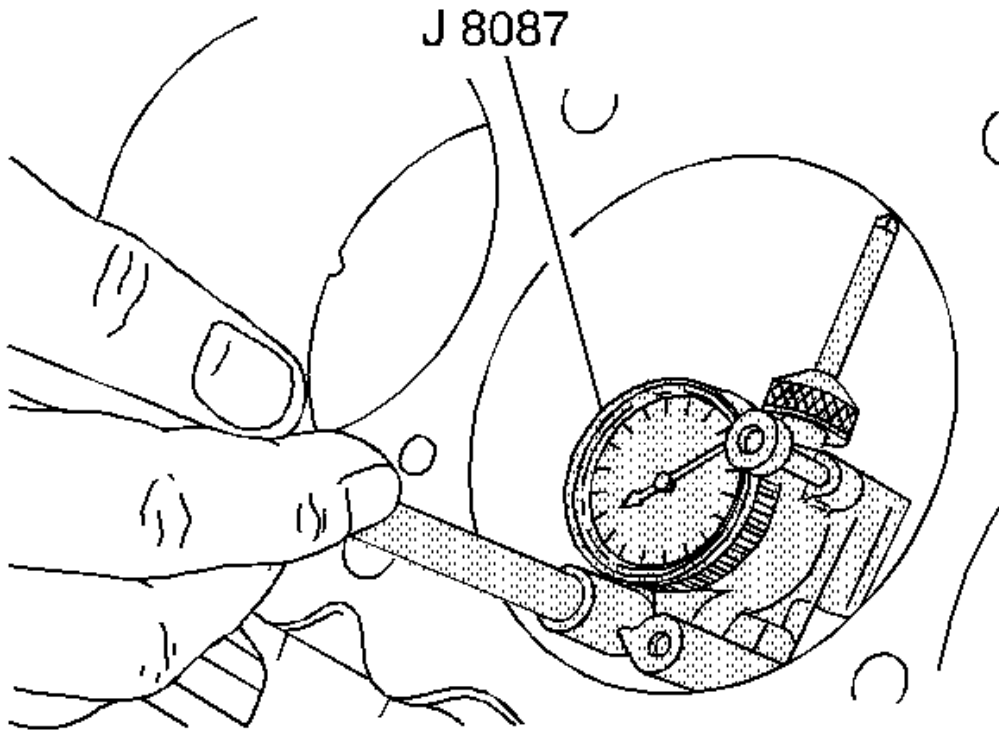


Fig. 348: Inspecting Cylinder Bores
Courtesy of GENERAL MOTORS CORP.

15. Use **J 8087**: gage to inspect the cylinder bores. Inspect for the following items:

- Wear
- Taper
- Run-out
- Ridging

NOTE: If the bore is worn beyond the limits, refit the bore with oversized pistons. Select the smallest available oversize piston. Refer to Cylinder Boring and Honing.

16. Leave sufficient material to allow honing when fitting the piston.

CYLINDER BORING AND HONING

Boring Procedure

1. Before honing or boring, measure all of the new pistons. Select the smallest piston for the piston fitting. Slightly varied pistons in a set may provide correction, if the first piston is too loosely fitted.
2. Before using any type of boring bar, file the top of the engine block to remove any dirt or burrs. If the cylinder block is not straight, the boring bar may be tilted, causing the bored cylinder wall to have incorrect right angles to the crankshaft.
3. Carefully follow the instructions furnished by the manufacturer regarding use of equipment.
4. Install all crankshaft main bearing caps to specification when boring cylinders. Cover or tape the crankshaft bearings and other internal parts to protect these parts during the boring or honing operation.
5. Leave 0.03 mm (0.001 in) on the diameter for finish honing when performing the final cut with a boring bar. Carefully perform the honing and boring operation to maintain the specified clearances between pistons, rings, and cylinder bores.

Honing Procedure

1. Follow the manufacturer's recommendations for use, cleaning, and lubrication when honing the cylinders. Use only clean, sharp stones of the proper grade for the amount of material to be removed. Dull, dirty stones cut unevenly and generate excessive heat. When using coarse or medium-grade stones, leave sufficient metal so all stone marks may be removed with the fine stones used for finishing to provide the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Check for the correct piston fit.
3. Make full strokes in the cylinder to eliminate taper. Repeatedly check the measurement at the top, the middle, and the bottom of the cylinder bore.

CAUTION: Handle the pistons with care. Do not force the pistons through the cylinder until you hone the cylinder to the correct size. The piston can be distorted through careless handling.

NOTE: The finish marks should be clean but not sharp. The finish marks should be free from imbedded particles and torn or folded metal.

4. When finish honing a cylinder bore to fit a piston, move the hone up and down at a sufficient speed to obtain a fine and uniform surface finish in a cross hatch pattern.
5. Determine the finish hone cylinder measurement by measuring the piston to be installed, and by adding the average of the clearance specification. Measure the block and the piston at normal room temperature.
6. True up the refinished cylinder bores. Final hone each cylinder bore to remove all stone or cutter marks.
7. After final honing and before the piston is checked for fit, clean the bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material will wear the new rings, the cylinder bores, and the bearings lubricated by the contaminated oil. After washing dry the bore.
8. Permanently mark the piston for the cylinder to which the piston has been fitted.
9. Apply clean engine oil to each bore to prevent rusting.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools**J 8087:** Cylinder Bore Gage

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

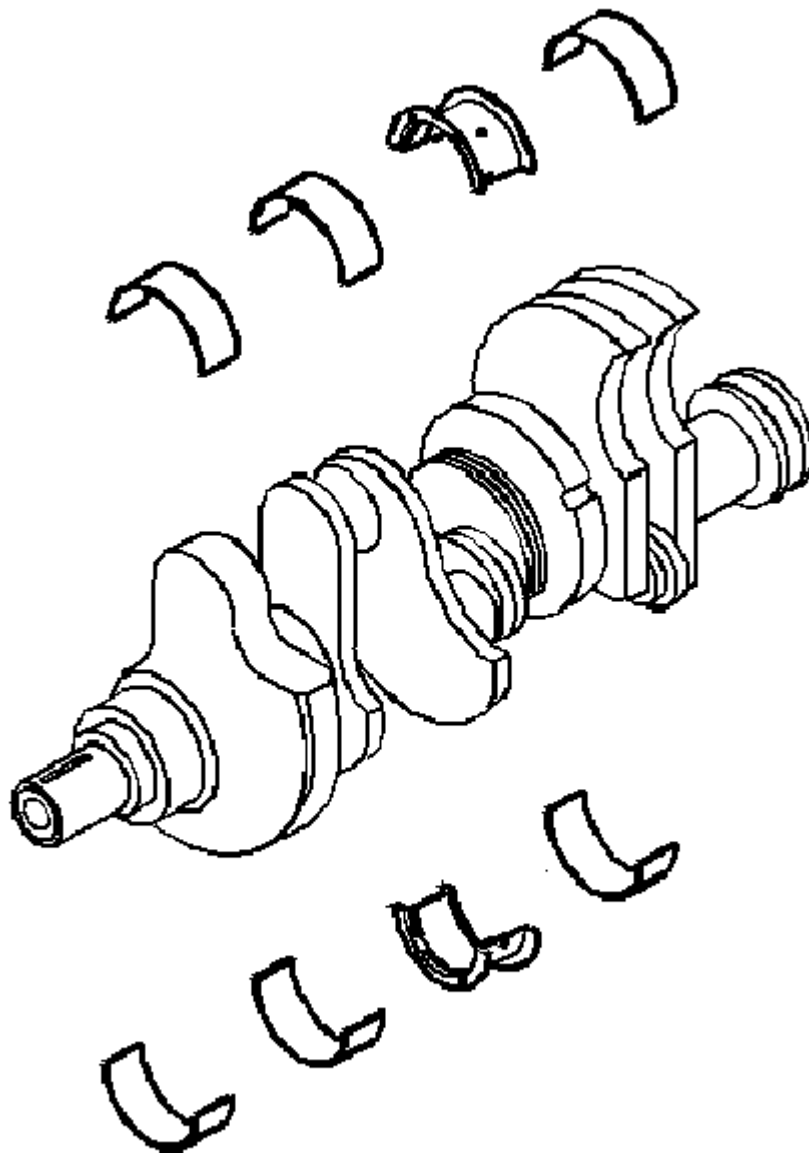


Fig. 349: View Of Crankshaft & Bearings

Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft of the following elements:
 - Oil
 - Sludge
 - Carbon
2. Inspect the crankshaft oil passages for obstructions.
3. Inspect the crankshaft keyway for nicks or wear.
4. Inspect the crankshaft threads.

NOTE: **If cracks, severe gouges or burned spots are found, the crankshaft must be replaced. Slight roughness may be removed with a fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.**

5. Inspect the crankshaft bearing journals and the crankshaft thrust surfaces for the following conditions:
 - Cracks
 - Chips
 - Gouges
 - Roughness
 - Grooves
 - Overheating, discoloration
6. Inspect the corresponding crankshaft bearings for embedded foreign material and determine the source.

NOTE: **Note the location of the crankshaft main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.**

7. Inspect the crankshaft bearings for uneven side-to-side wear. This may indicate a bent crankshaft or a tapered bearing journal.

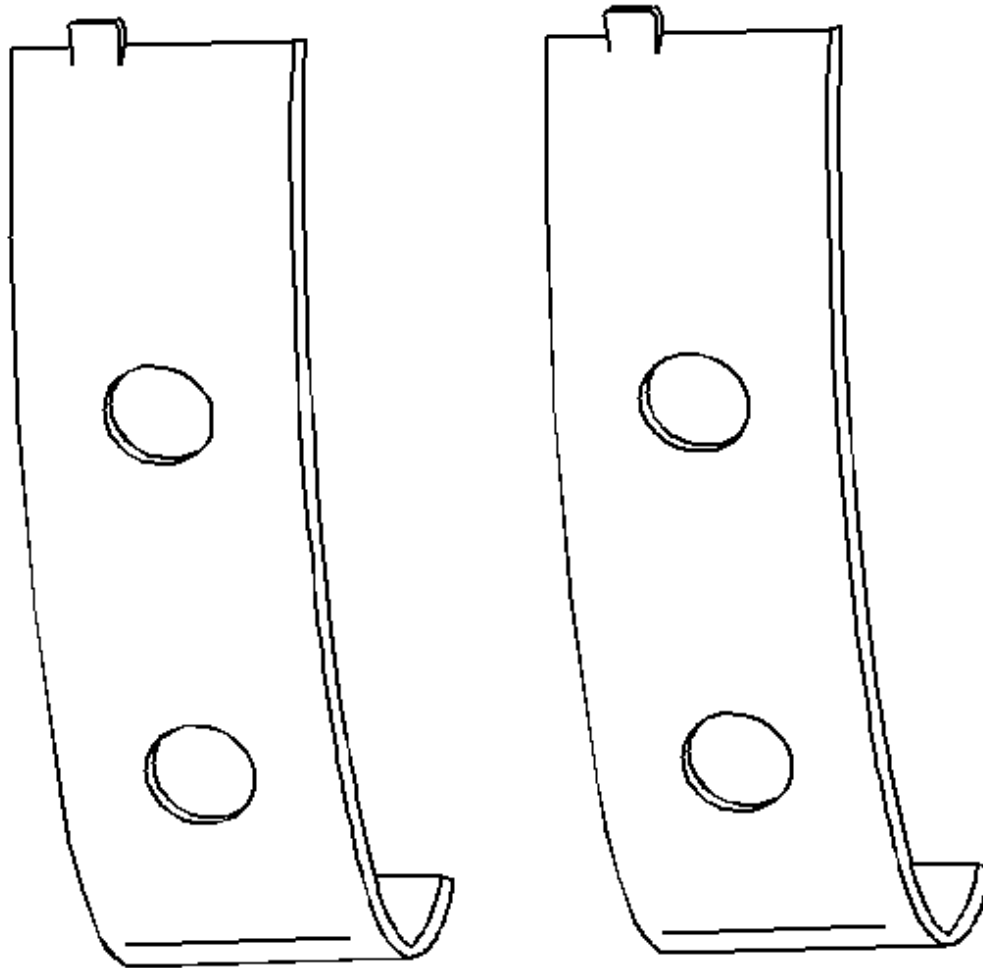


Fig. 350: View Of Crankshaft Bearings
Courtesy of GENERAL MOTORS CORP.

NOTE: The crankshaft bearings are the precision insert type. The crankshaft bearings are available in standard and various undersizes.

8. Inspect the outer surfaces of the crankshaft bearings for the following conditions:
 - Wear - surface wear indicates either movement of the insert or high spots in the surrounding material, spot wear.
 - Overheating or discoloration
 - Looseness or rotation indicated by flattened tangs and wear grooves

9. Inspect the thrust surfaces of the main thrust bearing for the following conditions:
- Wear
 - Grooving, grooves are caused by irregularities of the crankshaft thrust surface.

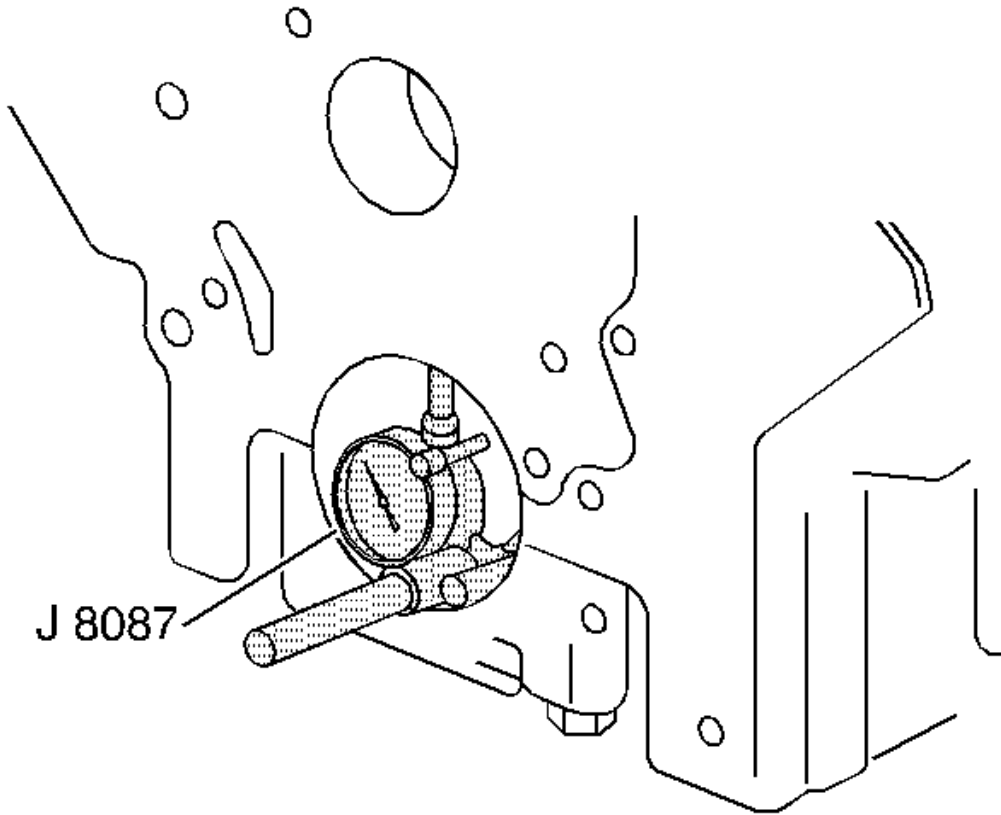


Fig. 351: Inspecting Crankshaft Main Bearing Bores
Courtesy of GENERAL MOTORS CORP.

NOTE: If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.

10. Using the **J 8087**: gage inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure:
1. Tighten the bearing cap to specification.
 2. Measure the bearing bore using **J 8087**: gage for taper and out-of-round.
 3. No taper or out-of-round should exist.

Bearing Selection

Measure the bearing clearance to determine the correct replacement bearing insert size. There are two methods to measure bearing clearance. Method A gives more reliable results and is preferred.

- Method A yields measurement from which the bearing clearance can be computed.
- Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

Method A

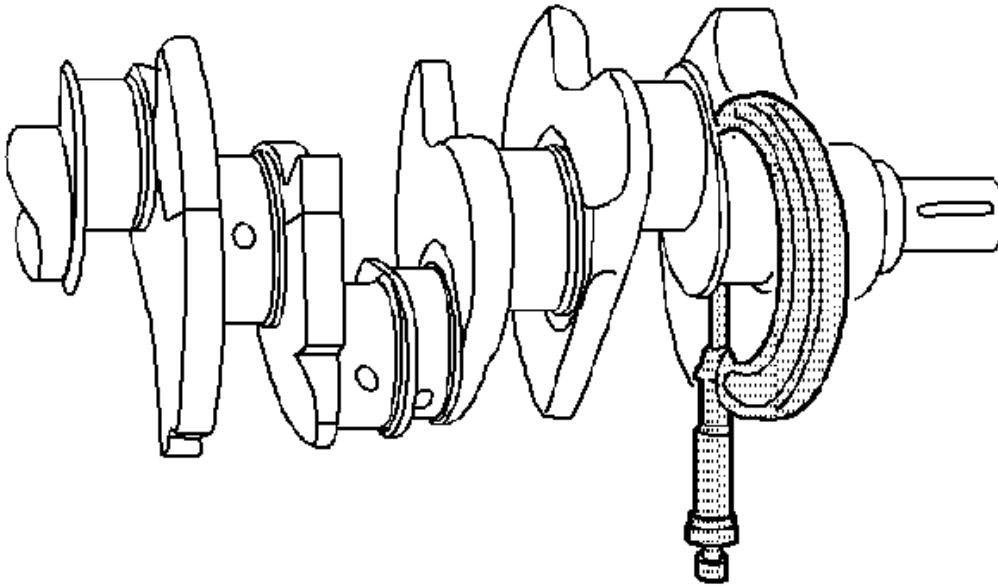


Fig. 352: Measuring Crankshaft Bearing Journal Diameter
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not mix inserts of different nominal size in the same bearing bore.

1. Measure the crankshaft bearing journal diameter with a micrometer in several places, 90 degrees apart. Average the measurements.
2. Measure the crankshaft bearing journal taper and runout.
3. Install the crankshaft bearing inserts. Tighten the bearing cap bolts to specification.
4. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
5. Measure the crankshaft main bearing inside diameter with an inside micrometer.

6. Select a set of bearing inserts that will produce the desired clearance.
7. If the specified clearances cannot be met, the crankshaft journals must be reconditioned and undersized bearing inserts installed.

Method B

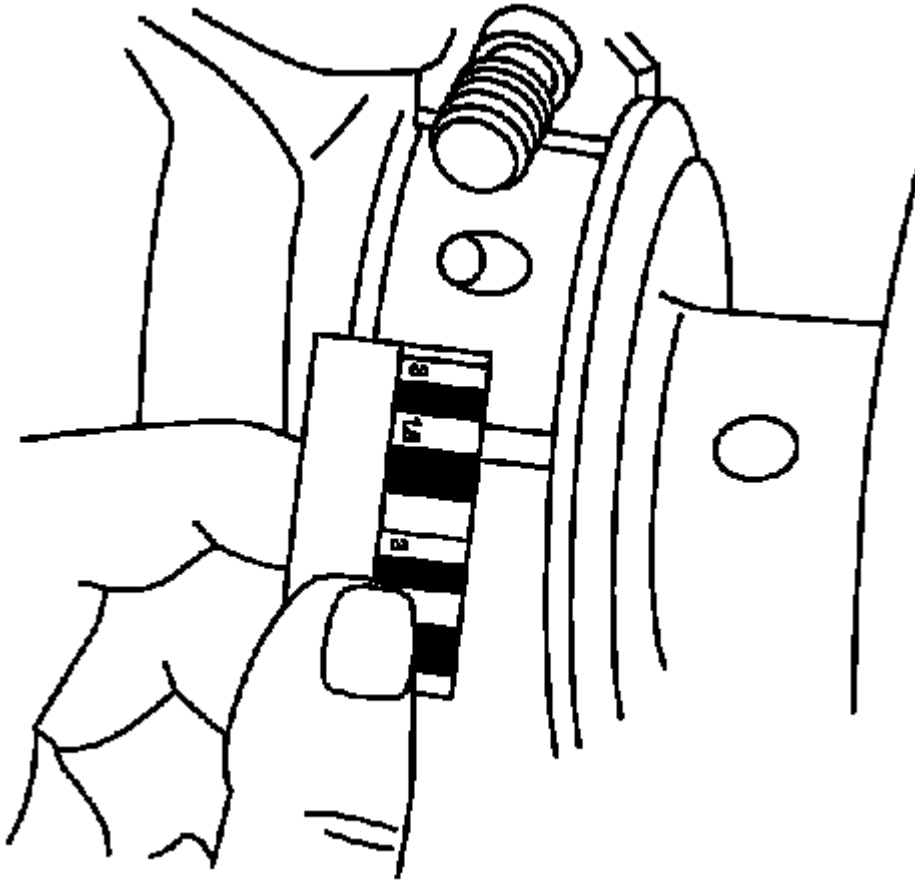


Fig. 353: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not mix inserts of different nominal size in the same bearing bore.

1. Clean the used bearing inserts.
2. Install the used bearing inserts.
3. Place a piece of gaging plastic across the entire bearing width.
4. Install the bearing caps.

CAUTION: In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before

the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

5. Install the bearing cap bolts to specification.

NOTE: Do not rotate the crankshaft.

6. Remove the bearing cap, leaving the gaging plastic in place. It does not matter whether the gaging plastic adheres to the journal or to the bearing cap.
7. Measure the gaging plastic at its widest point with the scale printed on the gaging plastic package.
8. Remove the gaging plastic.
9. Select a set of bearing inserts that will produce the desired clearance.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

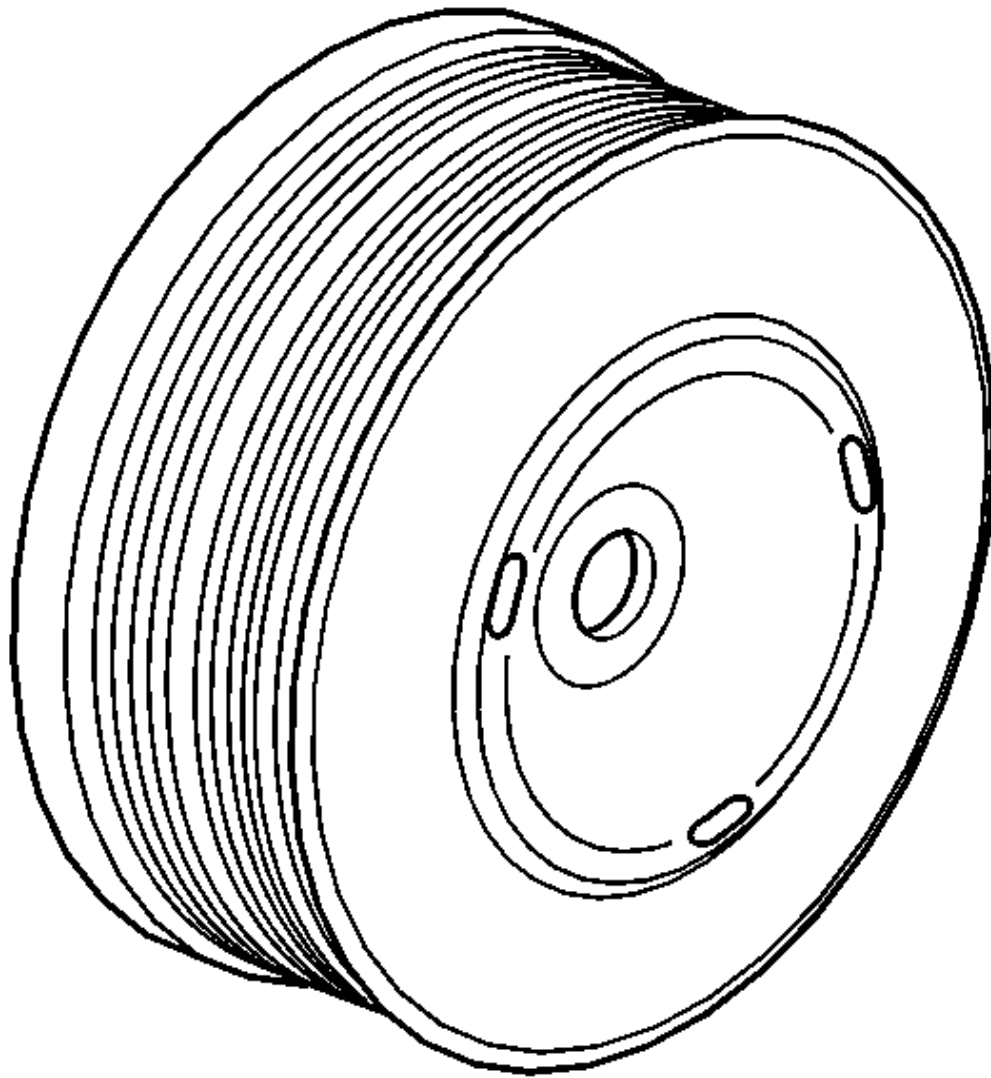


Fig. 354: Inspecting Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

- Inspect the crankshaft balancer for damage.
- Inspect the outside of the crankshaft balancer mounting shaft for grooves.
- Replace the crankshaft balancer if grooves are present and appear to be causing an oil leak.

ENGINE FLYWHEEL CLEANING AND INSPECTION

IMPORTANT: In order to maintain the proper component balance, contact surface taper and heat transfer, manual transmission flywheels are NOT to be machined.

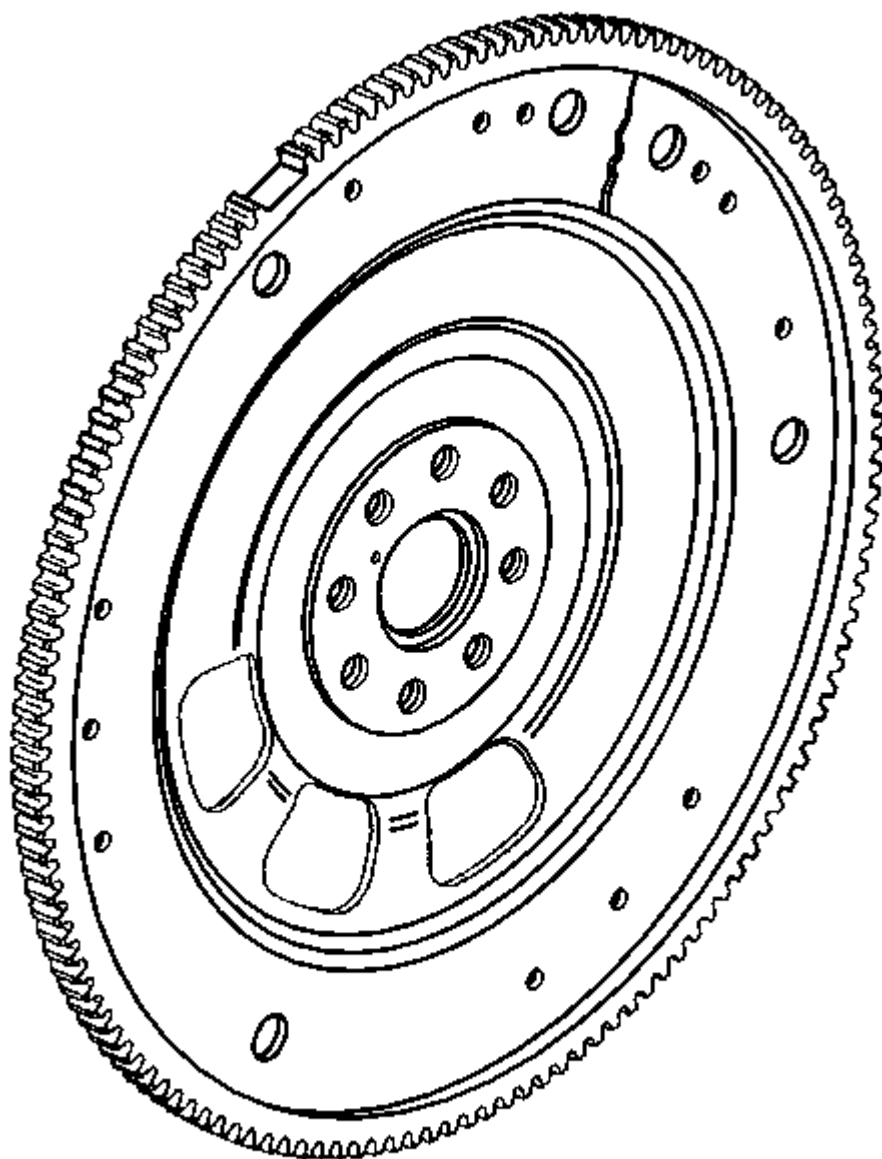


Fig. 355: Inspecting Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

1. Clean the flywheel.
2. Inspect the engine flywheel for damage and cracks.
3. Inspect the engine flywheel ring gear for damaged teeth.
4. Replace the flywheel if any damage is found.

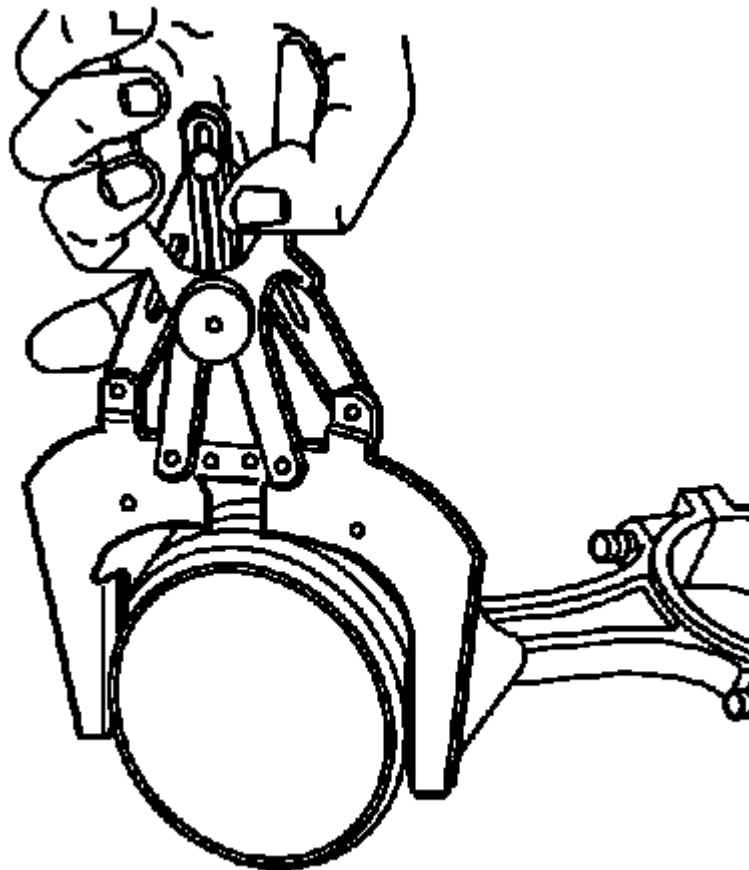
PISTON AND CONNECTING ROD DISASSEMBLE

Fig. 356: Cleaning Piston Ring Grooves
Courtesy of GENERAL MOTORS CORP.

WARNING: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

1. Remove the piston rings. Use a suitable tool to expand the rings. Piston rings must not be reused.

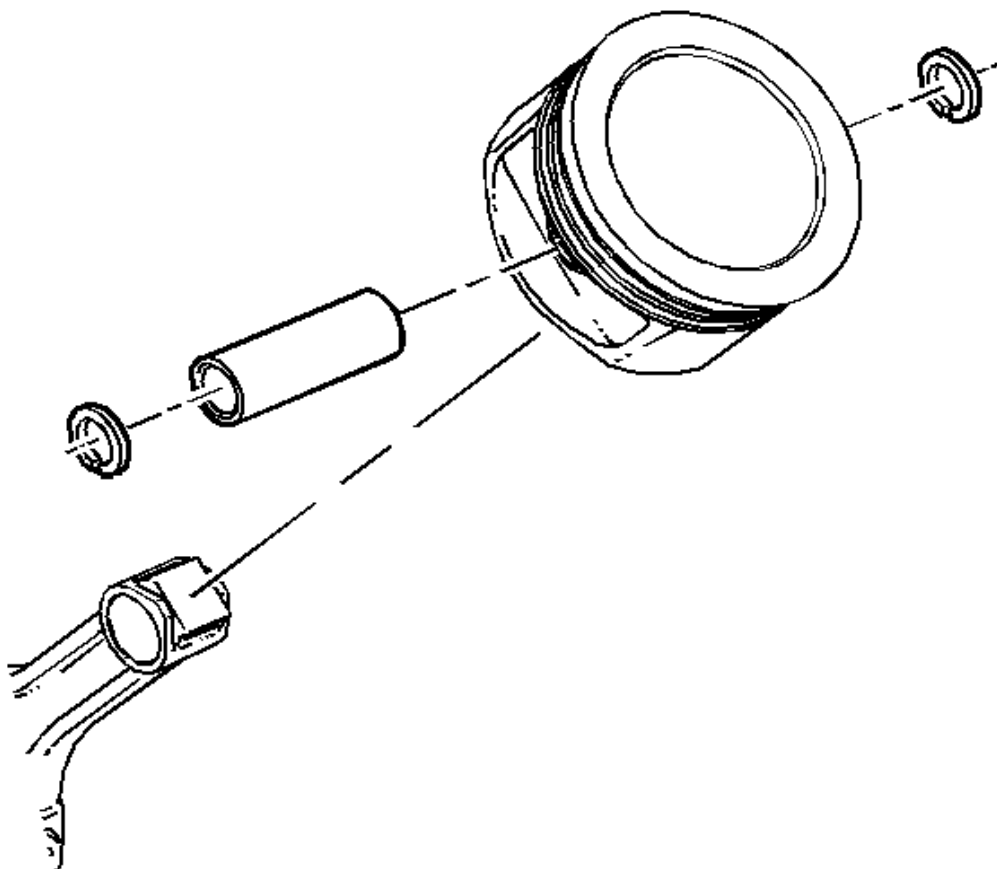


Fig. 357: View Of Piston Pin, Piston, Clips & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

CAUTION: When removing or installing the piston pin retainer and piston pin do not damage the piston or the retaining groove in the piston. Damage to the piston or retaining groove can lead to severe engine damage.

2. Remove the piston pin retaining clips.
3. Remove the piston pin.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

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

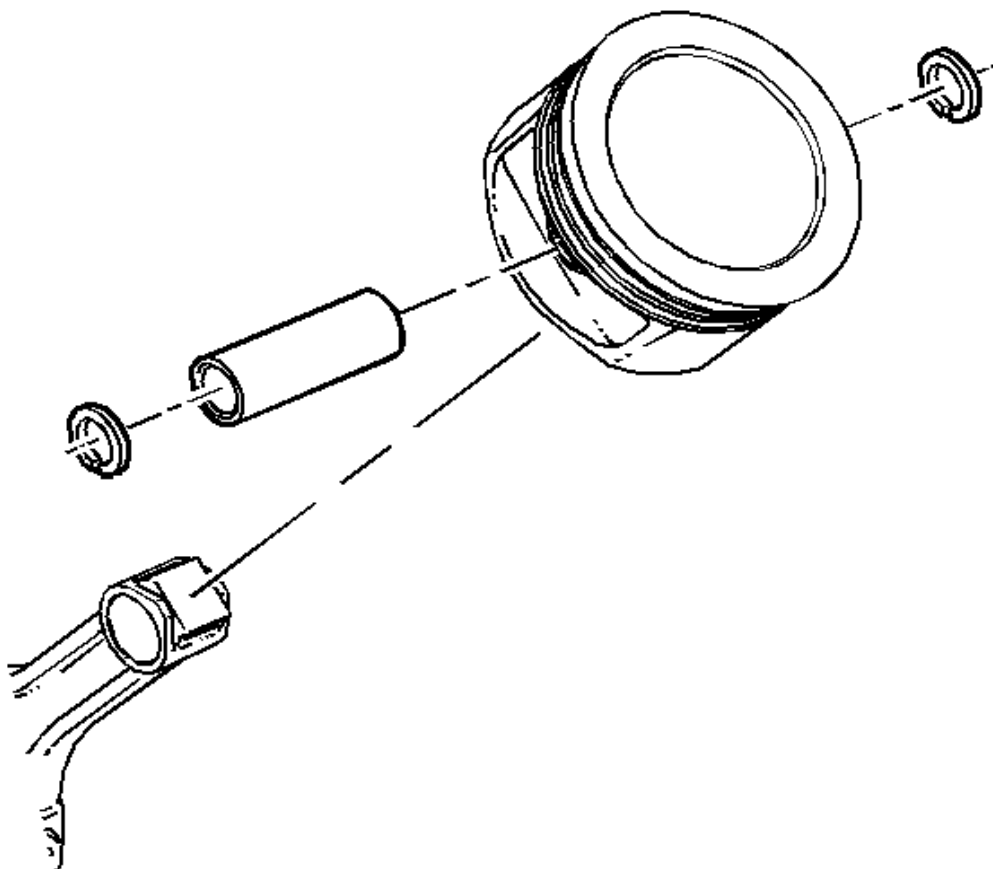


Fig. 358: View Of Piston Pin, Piston, Clips & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

1. Clean the piston and connecting rod in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the components with compressed air.

CAUTION: The piston ring groove must only be cleaned with a ring groove cleaning tool. Proper engine performance and durability depends on the straightness and smoothness of the ring groove. Cleaning the piston ring groove with an improper tool can damage the piston ring groove and effect the performance and durability of the engine.

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

CAUTION: The oil lubrication holes/slots must be cleaned with a suitable tool. Proper engine performance and durability depends on the cleanliness and smoothness of the holes/slots. Cleaning the oil lubrication holes/slots with an improper tool may damage the oil lubrication holes/slots and effect the performance and durability of the engine.

4. Clean the piston oil lubrication holes and slots.

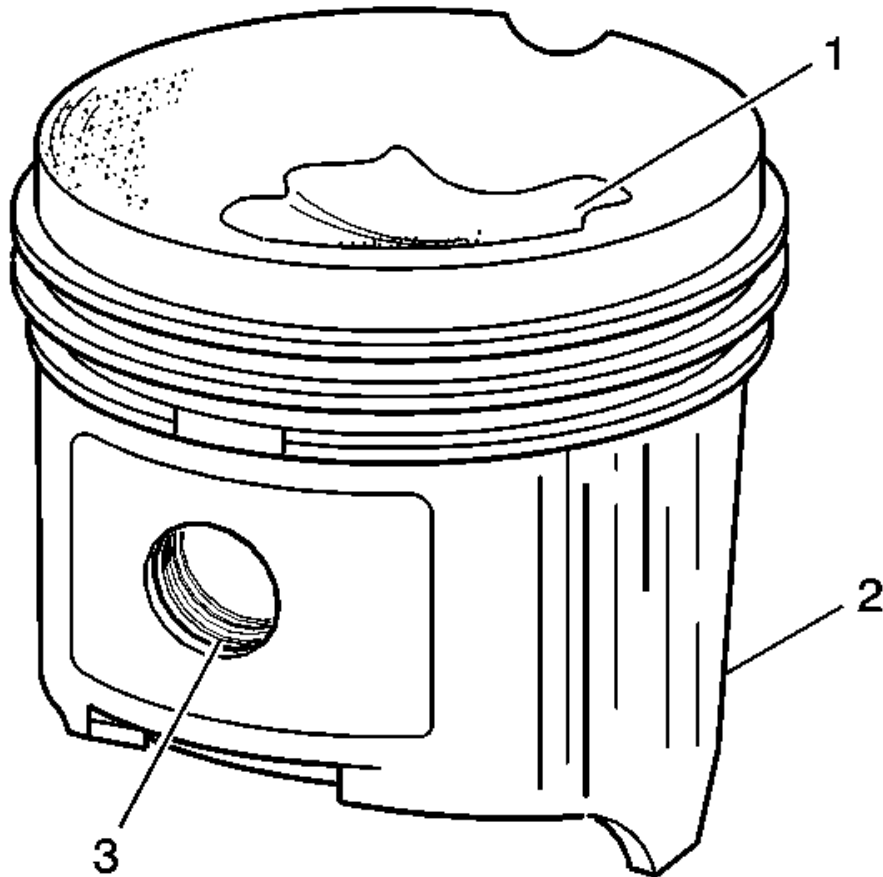


Fig. 359: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS CORP.

5. Inspect the piston for the following conditions:
 - Eroded areas (1) on top of the piston
 - Scuffed or damaged skirt (2)

- Damage to the pin bore (3)
 - Cracks in the piston ring lands, the piston skirt, or the pin bosses
 - Piston ring grooves for nicks, burrs, or other warpage which may cause the piston ring to bind.
6. Inspect the piston for scoring, wear or other damage.

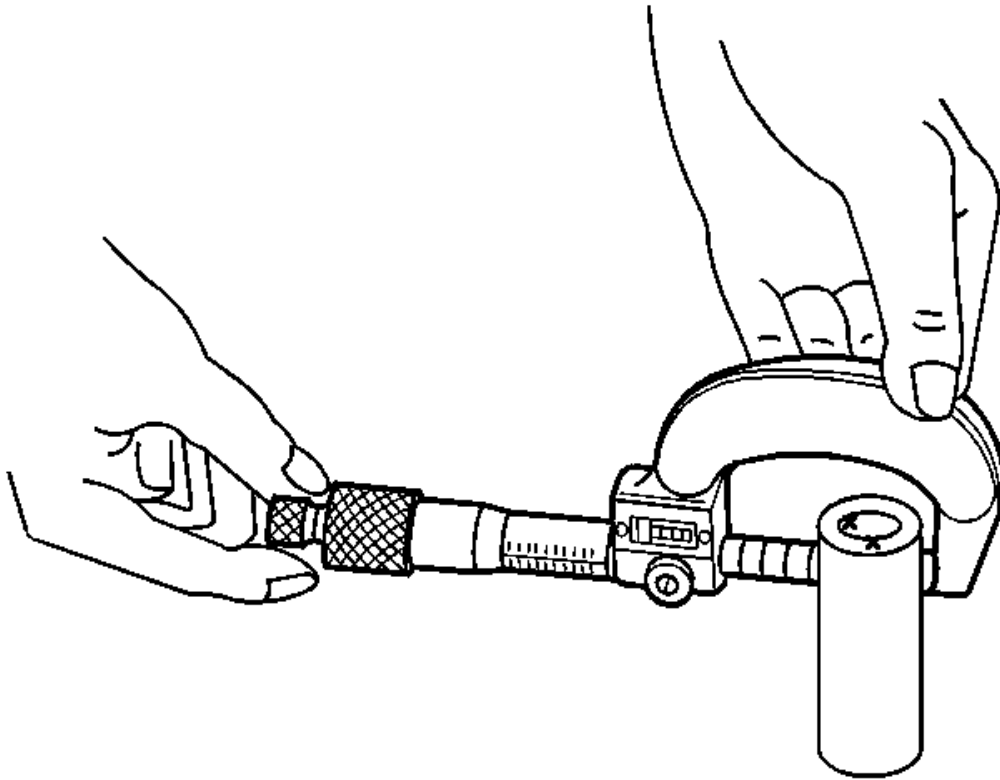


Fig. 360: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

7. To determine the piston-to bore clearance, use a micrometer and measure the piston pin.

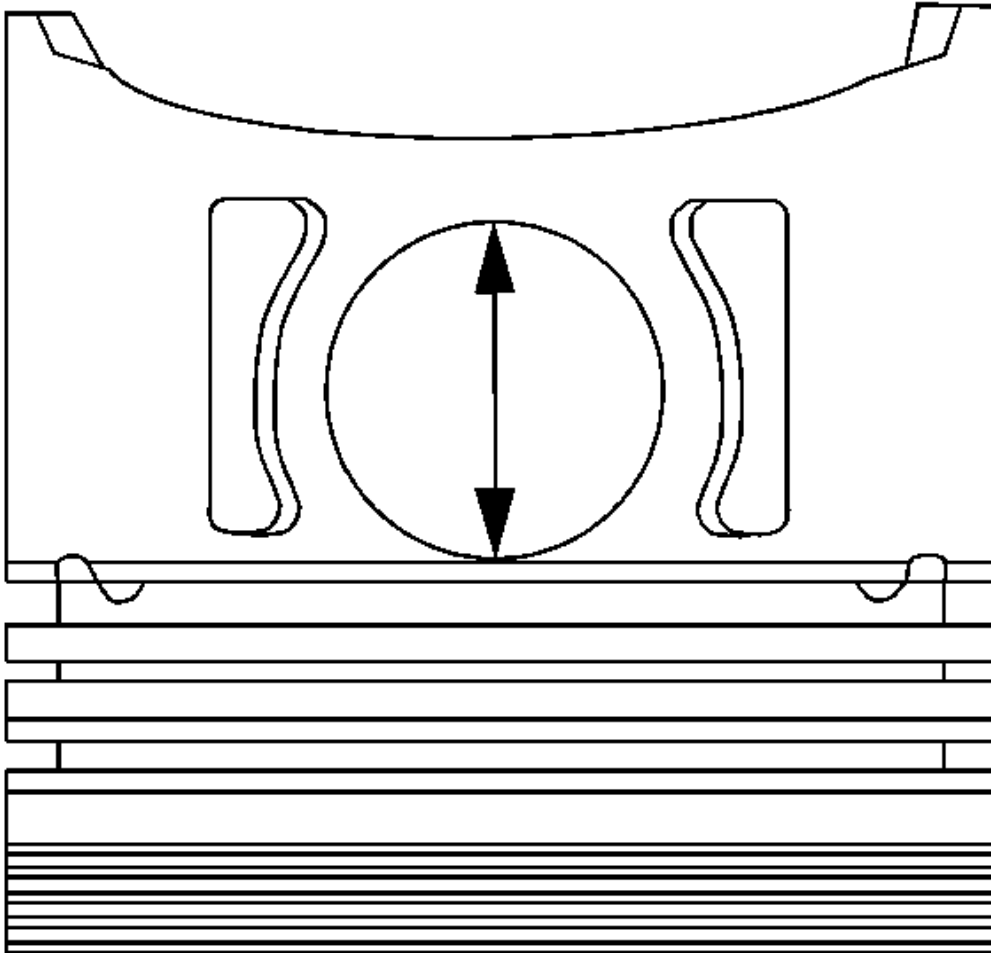


Fig. 361: Using Inside Micrometer & Measuring Piston Pin Bore
Courtesy of GENERAL MOTORS CORP.

8. To determine the piston pin-to bore clearance, use an inside micrometer and measure the piston pin bore.
9. To determine the piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter.

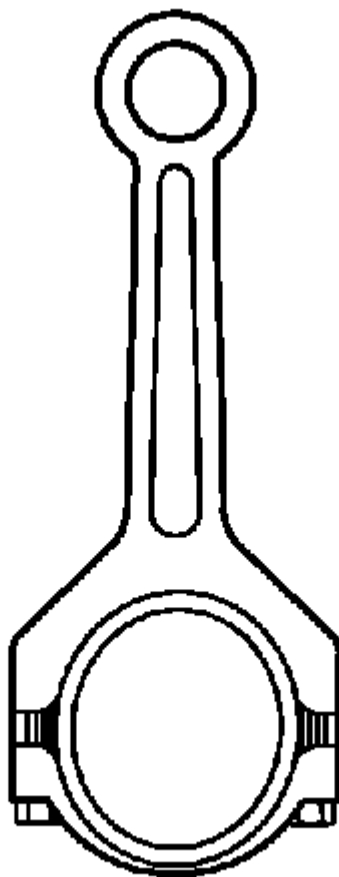


Fig. 362: View Of Connecting Rod
Courtesy of GENERAL MOTORS CORP.

10. Inspect the connecting rod for an out-of-round bearing bore.

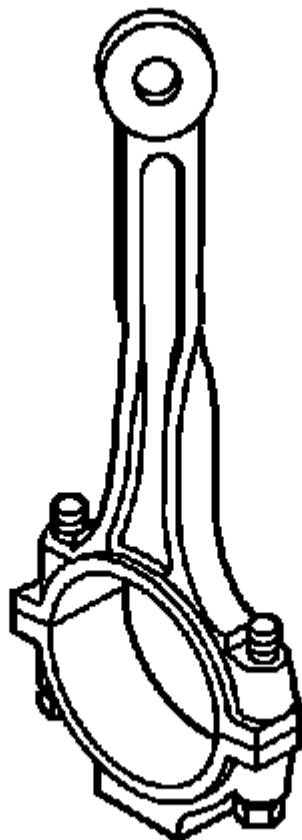


Fig. 363: Identifying Twisted Connecting Rod
Courtesy of GENERAL MOTORS CORP.

11. Inspect the connecting rod for twisting.

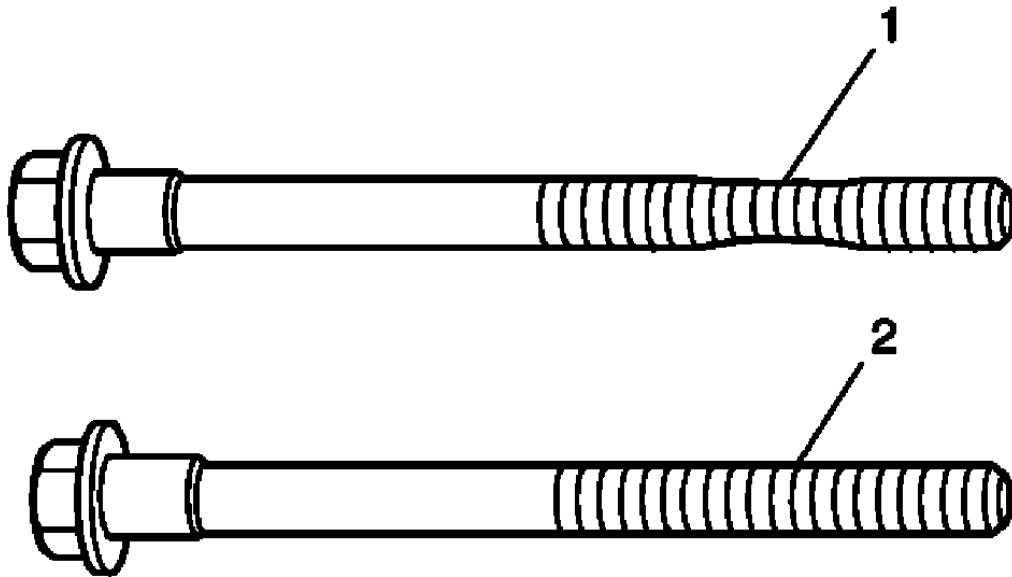


Fig. 364: Inspecting Connecting Rod Cap Bolts
Courtesy of GENERAL MOTORS CORP.

12. Inspect the connecting rod cap bolts for stretch (compare to known good bolt) (1) is a stretched bolt, (2) is a new or good bolt.

PISTON AND CONNECTING ROD ASSEMBLE

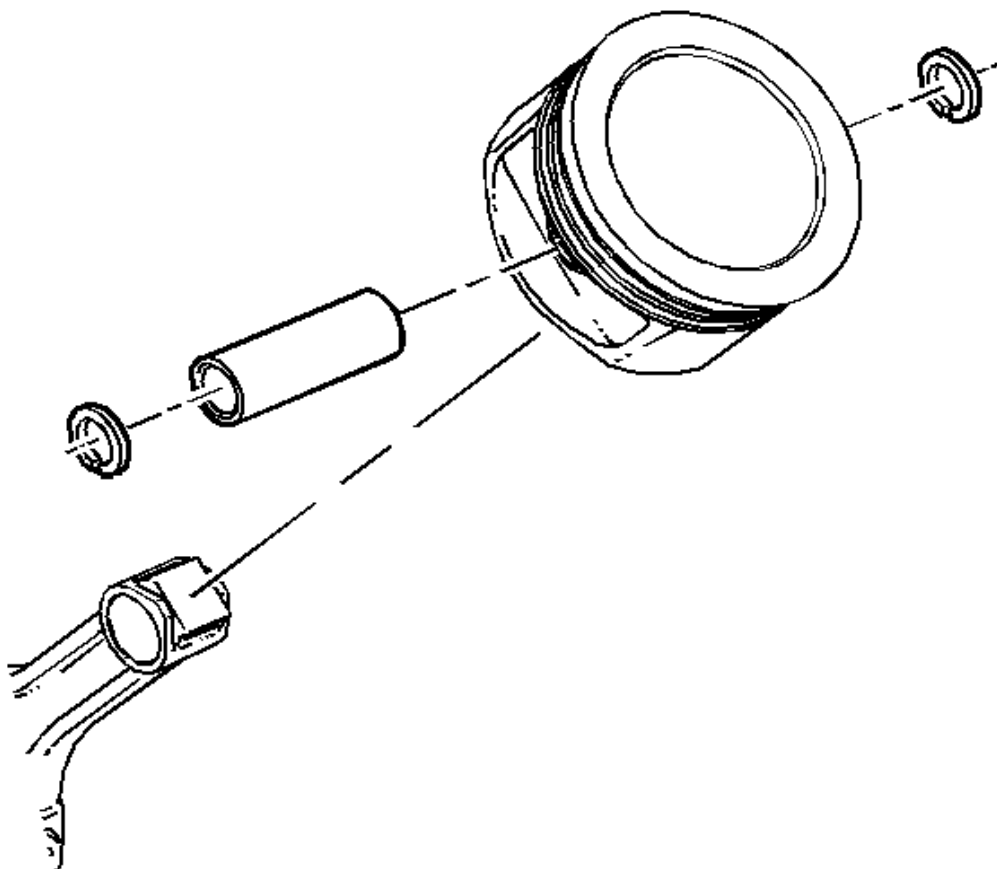


Fig. 365: View Of Piston Pin, Piston, Clips & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

1. Coat the piston pin with oil.
2. Install one piston pin retainer into the retaining groove.
3. Install the connecting rod and piston pin. The connecting rod can be installed in either direction. Push the piston pin in until it bottoms against the installed piston pin retainer.
4. Install the second piston pin retainer.
5. Ensure the piston pin moves freely.



Fig. 366: Exploded View Of Piston Rings
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

NOTE: To provide an effective compression and oil seal, the ring gaps must be staggered a minimum of 90 degrees.

6. Using the piston ring pliers, install the piston rings onto the piston.
 1. Install the oil control ring spacer into the bottom groove of the piston.
 2. Install the lower oil control ring.

The oil control rings do not have a dimple or orientation mark and may be installed in either direction.

3. Install the upper oil control ring.
4. Install the middle compression ring with the dot facing up.
5. Install the top compression ring in either direction. The ring has no orientation markings.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

Tools Required

J 7872 Magnetic Base Indicator Set. See Special Tools.

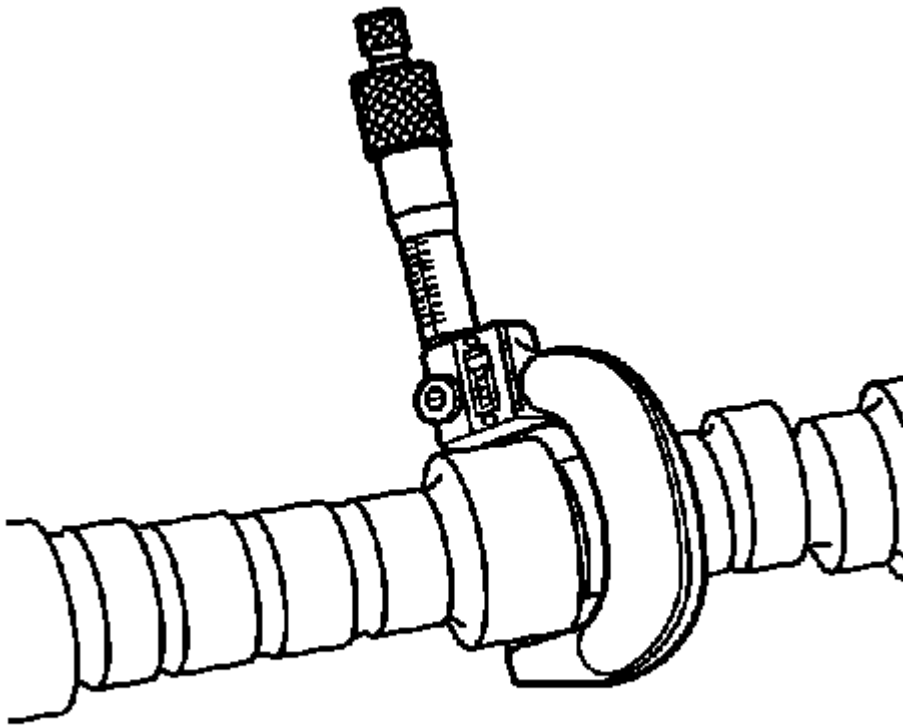


Fig. 367: Measure Camshaft Journals With Micrometer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The camshaft and lifters become mated to each other through both normal and premature wear. If the camshaft must be replaced, **ALL** lifters must be replaced as well.

1. Measure the camshaft journals with a micrometer.

If the camshaft journals are not within specifications, replace the camshaft. The measurement should be 47.655-46.858 mm (1.8462-1.8448 in). If the measurement is not within specifications the engine camshaft must be replaced.

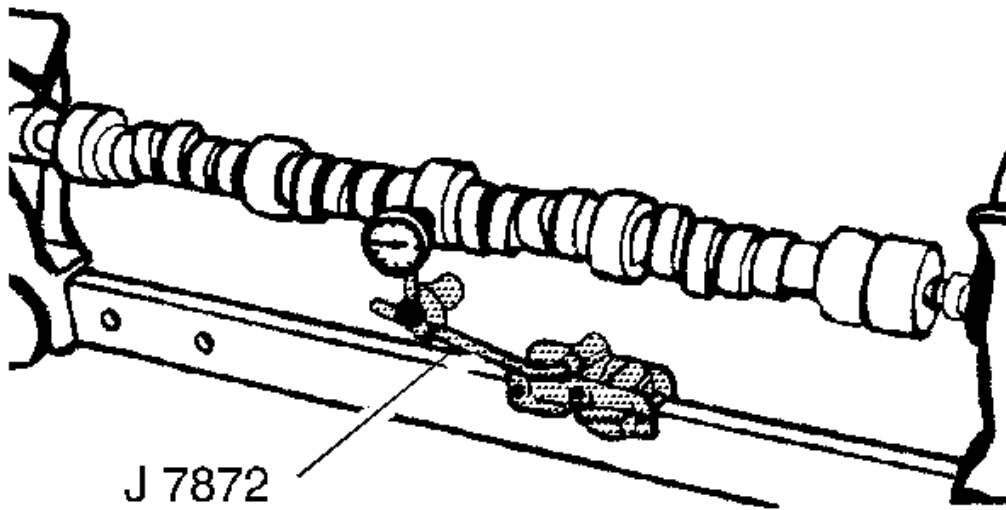


Fig. 368: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

2. Measure the camshaft runout using **J 7872** . See **Special Tools**.
 1. Mount the camshaft in V-blocks between centers.
 2. Use **J 7872** to check the intermediate camshaft journal. See **Special Tools**.
3. If the runout exceeds specifications, the camshaft is bent and should be replaced. If the camshaft journals are more than 0.025 mm (0.0010 in) out-of-round, then replace the engine camshaft.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION (L26)

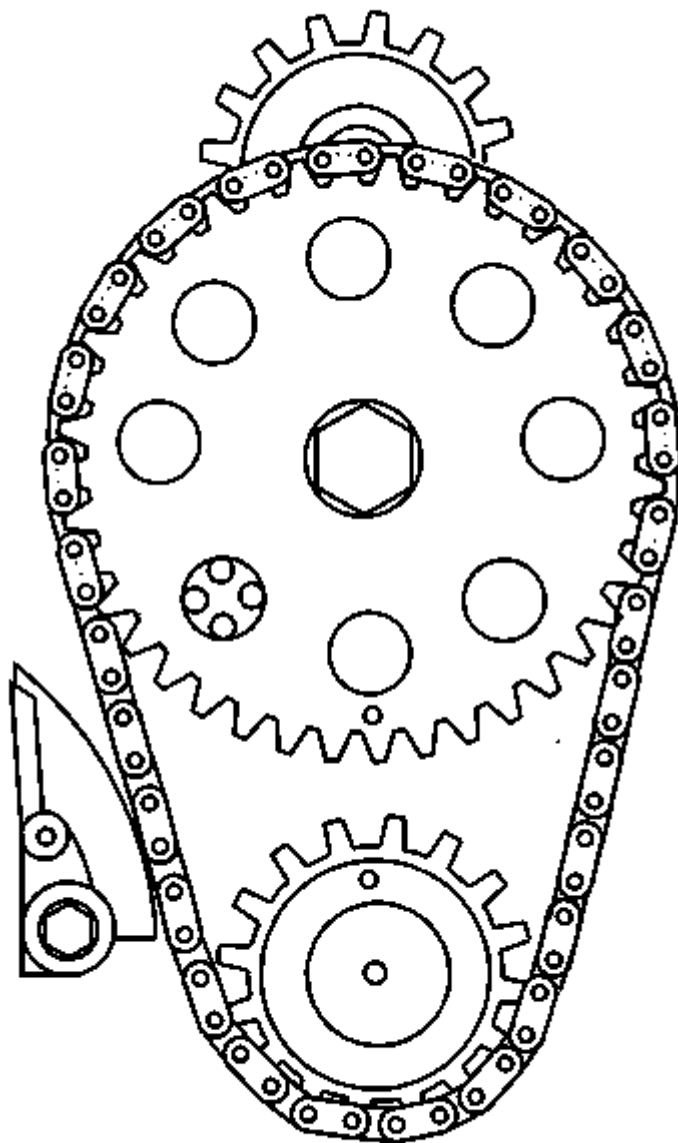


Fig. 369: Aligning Timing Chain & Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

1. Inspect the timing chain and sprockets for damage.
2. Inspect the timing chain for overall in and out movement. Movement should not exceed 25 mm (1 in).
3. Inspect the sprockets for wear.

VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

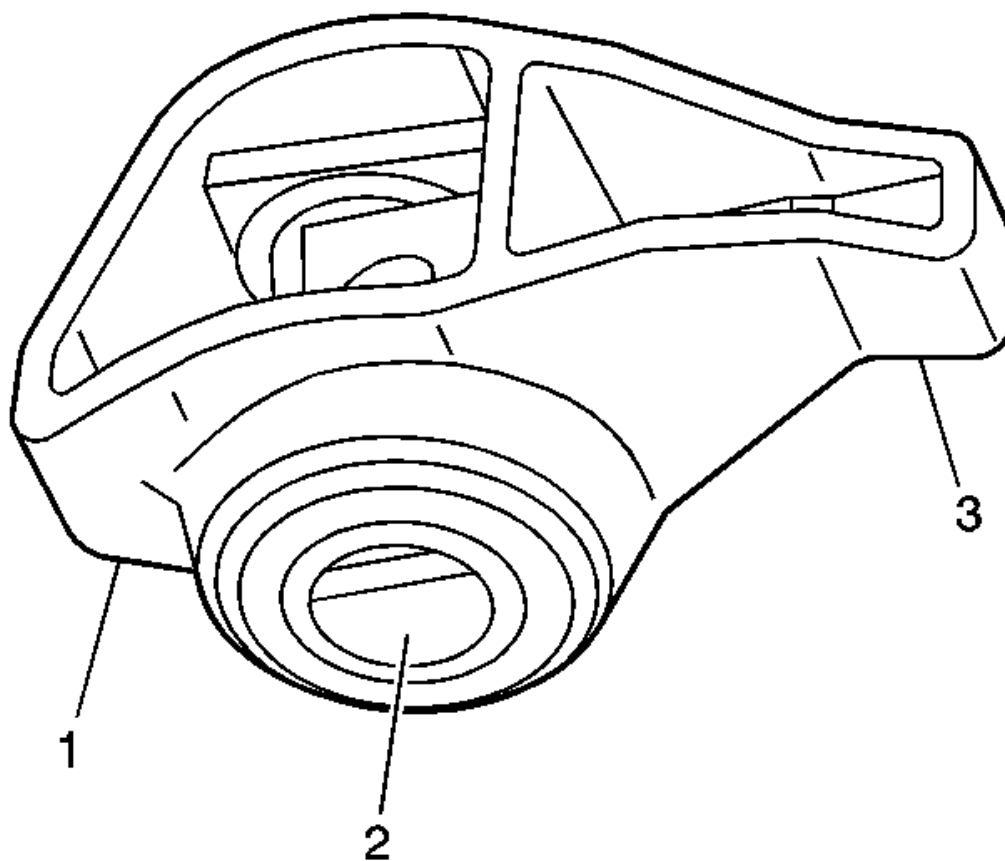


Fig. 370: Cleaning & Inspecting Rocker Arm
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Cleaning Solvent Warning .

WARNING: Refer to Safety Glasses and Compressed Air Warning .

NOTE: Parts that are to be reused must be marked, sorted, and organized for assembly.

- Clean the components with cleaning solvent.

- Dry the components with compressed air.
- Inspect the valve rocker components for the following:
 - Valve rocker arm valve pushrod socket contact surface (1)

The contact surface must be smooth with no scoring or excessive wear.

- Valve rocker arm roller pivot for binding or damage (2)
- Valve rocker arm valve stem contact surface (3)

The contact surface should be smooth with no scoring or excessive wear.

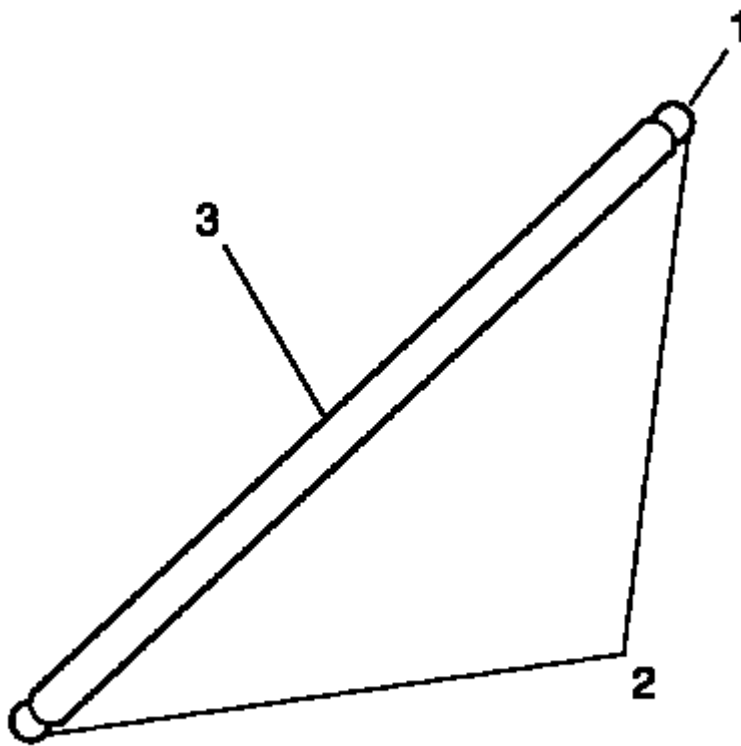


Fig. 371: Pushrod Inspection Areas
 Courtesy of GENERAL MOTORS CORP.

- Inspect the valve pushrods for the following:
 - Restriction of the oil passage (1)
 - Wear or scoring of the end contact surfaces (2)

The end contact surfaces must be smooth with no scoring or excessive wear.

- Shaft for bends (3)

Roll the valve pushrod on a flat surface to determine if the valve pushrod is bent.

VALVE LIFTER AND GUIDE CLEANING AND INSPECTION

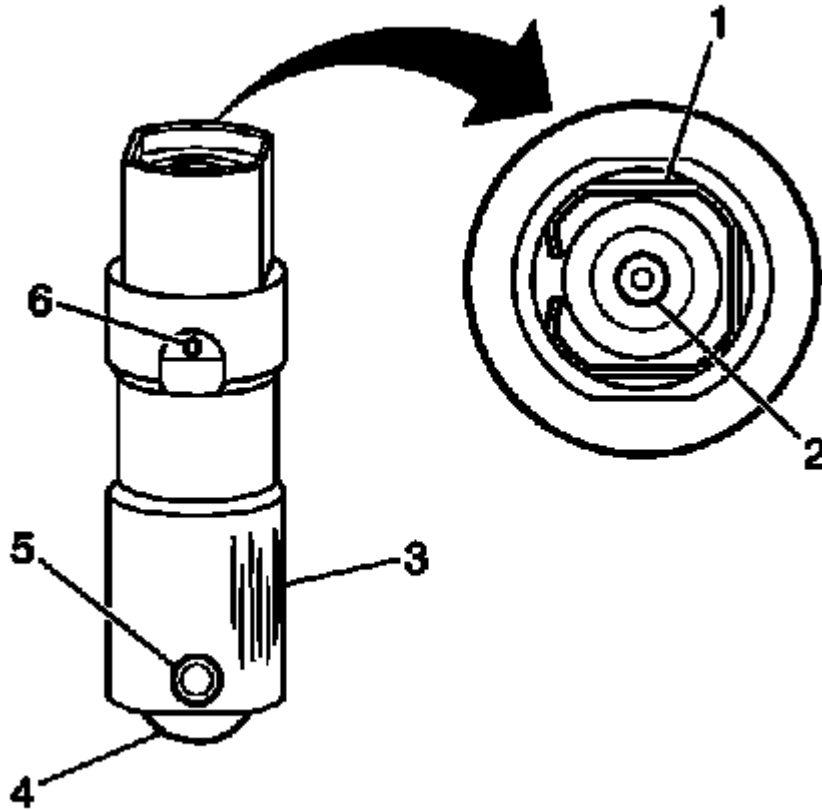


Fig. 372: Identifying Valve Lifter Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Keep the valve lifters in order so they can be installed in their original position.

IMPORTANT: When new valve lifters are installed, coat the valve lifters with camshaft and lifter prelube GM P/N United States 12345501, GM P/N Canada 992704 or the equivalent.

2. Inspect the following areas of the valve lifters:
 - The retaining clip (1)
 - The push rod socket for wear (2)
 - The valve lifter body for wear and scuffing (3)
 - The valve lifter bore for wear
 - The valve lifter roller assembly for wear (4)

- The valve lifter roller pin for damage (5)
 - The oil hole for plugging (6)
3. Inspect the valve lifter guides for cracks or damage.

CYLINDER HEAD DISASSEMBLE

Tools Required

J 38606 Valve Spring Compressor

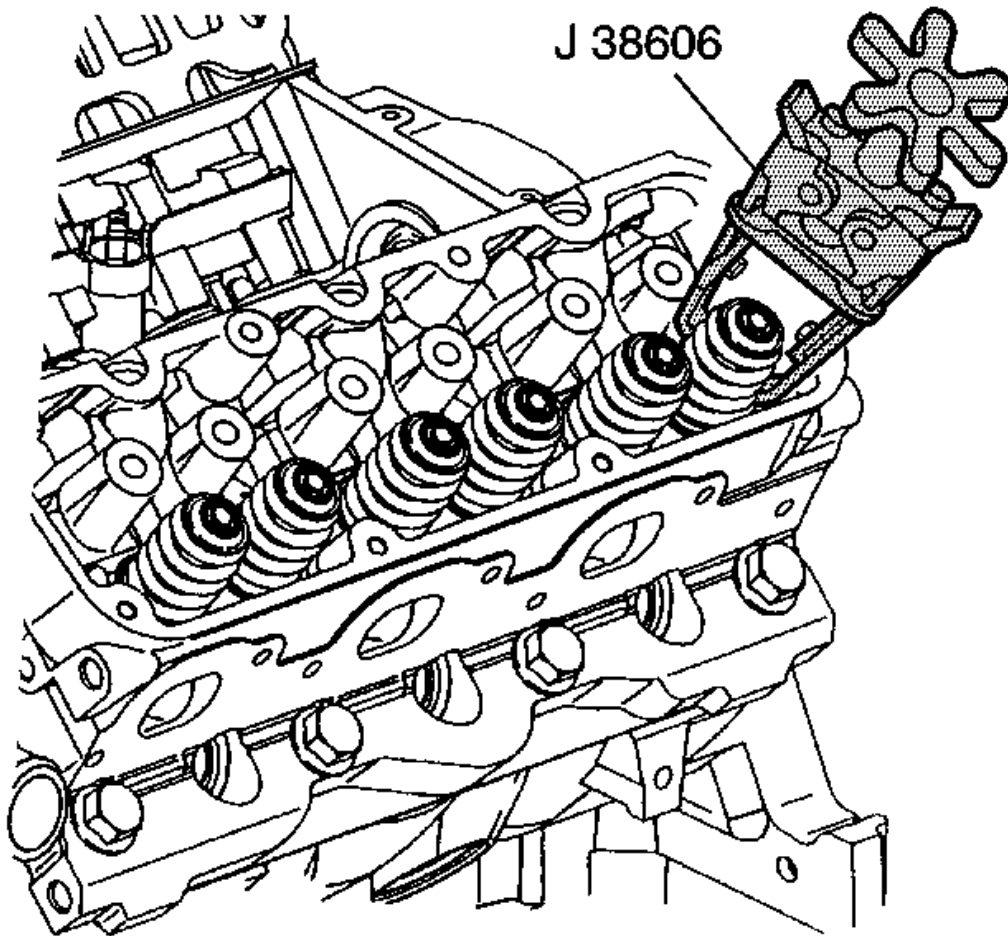


Fig. 373: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: During disassembly, ensure the valve train components are kept together and identified so they can be reinstalled in their original locations and with the same mating surfaces as when removed.

1. Use **J 38606** to compress the valve spring.

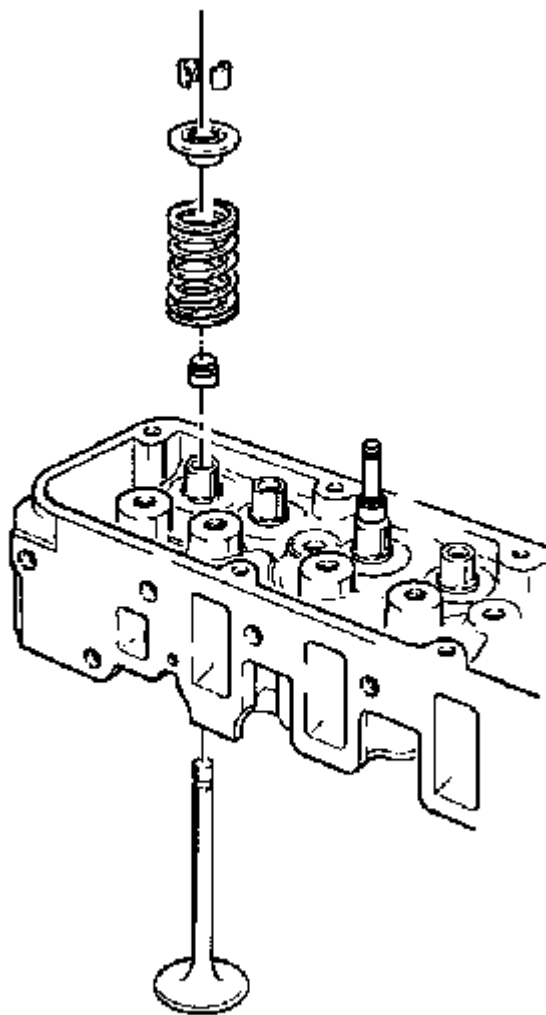


Fig. 374: View Of Valve In Cylinder Head
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve keys.

3. Remove the valve cap and spring.
4. Remove the valve stem oil seal by prying up on the bottom.

CYLINDER HEAD CLEANING AND INSPECTION

Tools Required

J 9666 Valve Spring Tester. See **Special Tools**.

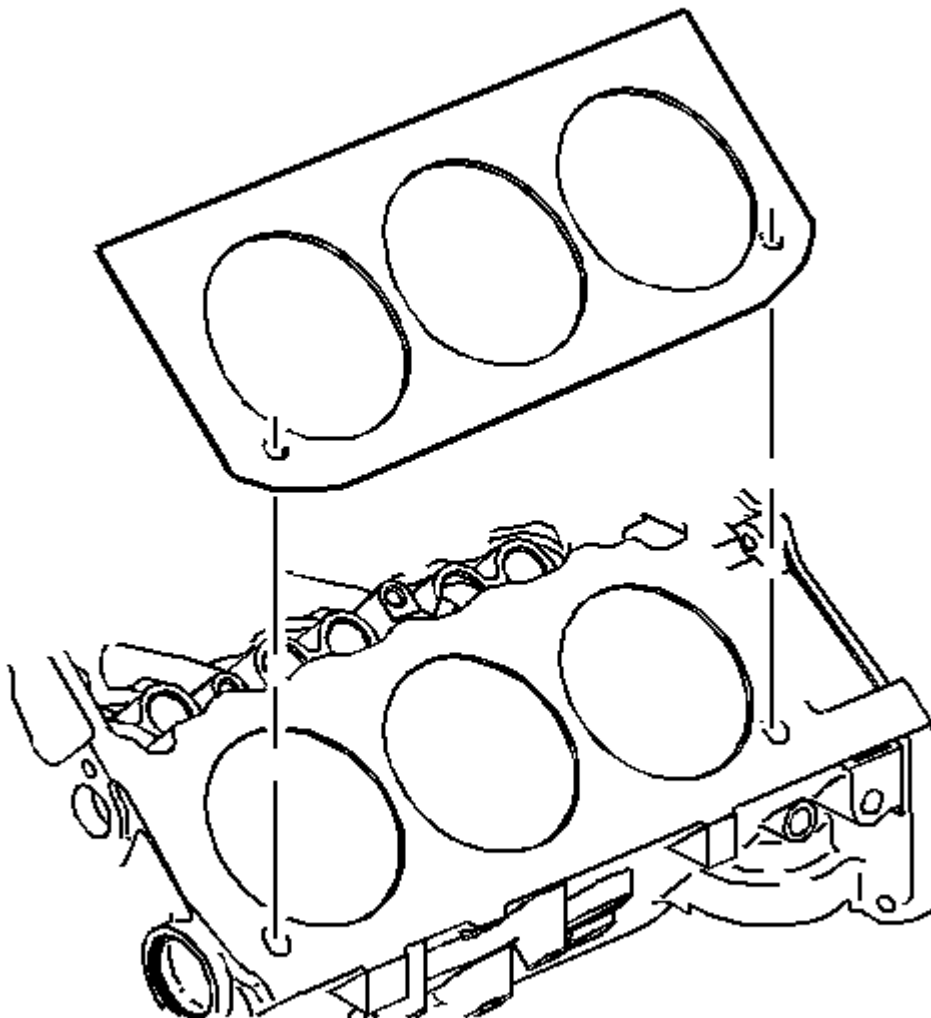


Fig. 375: View Of Cylinder Head Gasket

Courtesy of GENERAL MOTORS CORP.

1. Inspect the cylinder head gasket and the mating surfaces for leaks, corrosion, and blowby.
2. If the gasket failed, determine the cause. Gasket failure is caused by the following conditions:
 - Improper installation
 - A loose or warped cylinder head
 - Missing dowel pins
3. Clean the cylinder head of all foreign material. Do not use a motorized wire brush on any gasket sealing surface.
4. Clean the threaded holes.
5. Inspect the cylinder head for cracks typically between the valve seats and inside of the exhaust ports.

IMPORTANT: Do not attempt to weld the cylinder head. If the cylinder head is damaged, replace the cylinder head.

6. Inspect the cylinder head deck for corrosion.

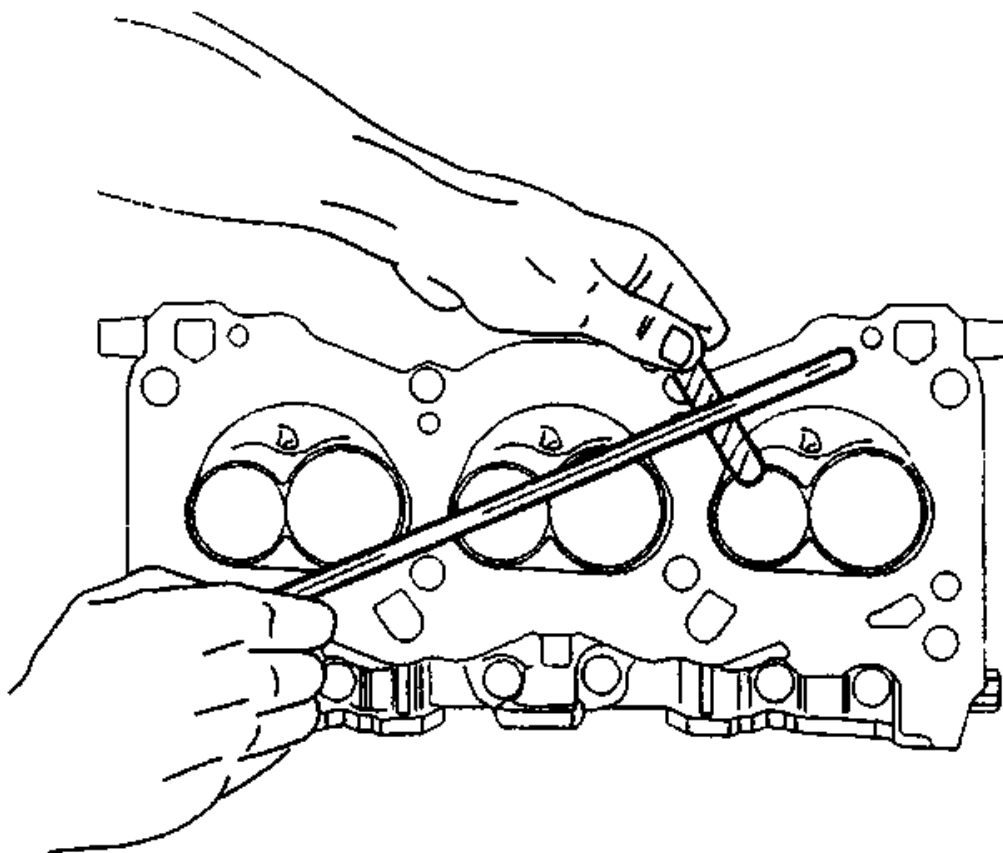


Fig. 376: Inspecting Cylinder Head Mating Surfaces For Flatness
Courtesy of GENERAL MOTORS CORP.

7. Inspect the following locations for flatness:
 - The cylinder head deck
 - The intake manifold mating surface
 - The exhaust manifold mating surface
8. Recondition the surfaces by parallel grinding. Replace the cylinder head if more than 0.254 mm (0.010 in) is removed.

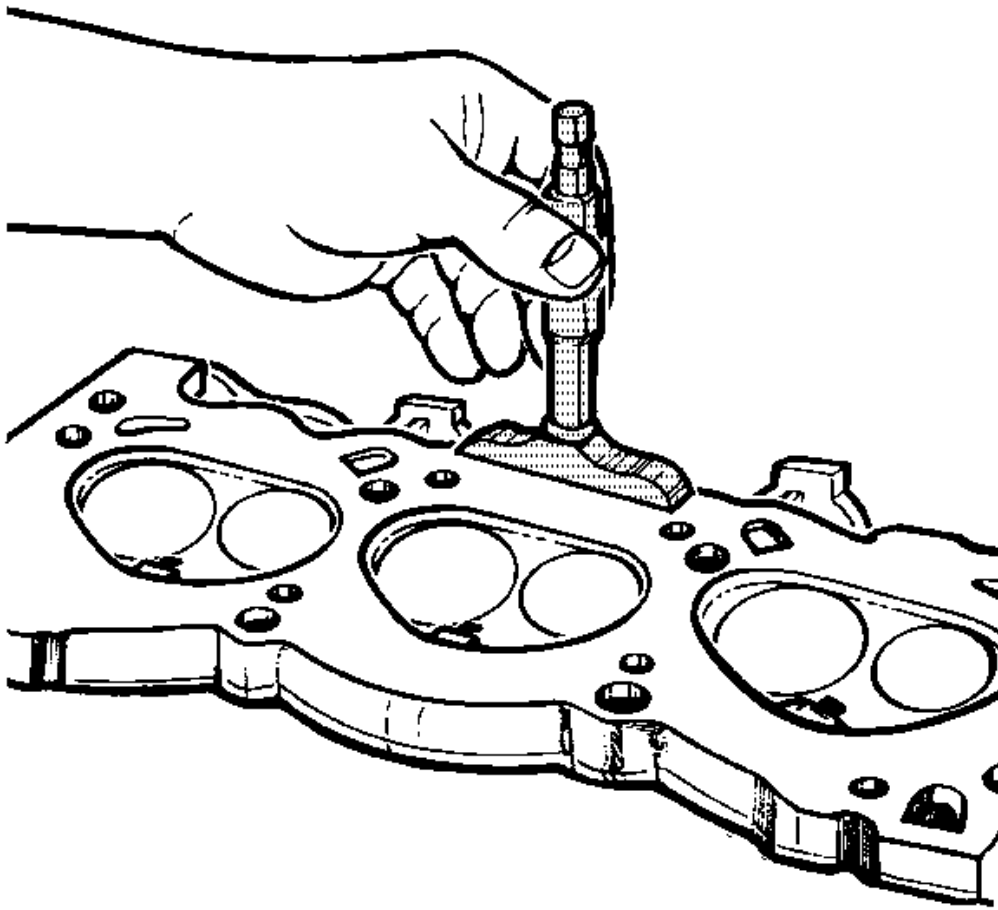


Fig. 377: Measuring Cylinder Head Height From deck Surface To Cast Pads
Courtesy of GENERAL MOTORS CORP.

9. Measure the height from the deck surface to the cast pads. Do this to determine if the cylinder head has sufficient deck surface thickness to resurface.

New cylinder heads measure from 1.372-1.676 mm (0.054-0.066 in). If the cylinder head does not meet the minimum thickness after resurfacing, replace the cylinder head.

10. Inspect all of the threaded holes for damage. Repair the threaded holes, if necessary.
11. Inspect the valve seating surfaces.
12. Inspect the cooling jacket plugs.
13. Inspect the valve guides for wear. Clean the valve guides.
14. Inspect the valve seats for excessive wear and hot spots.

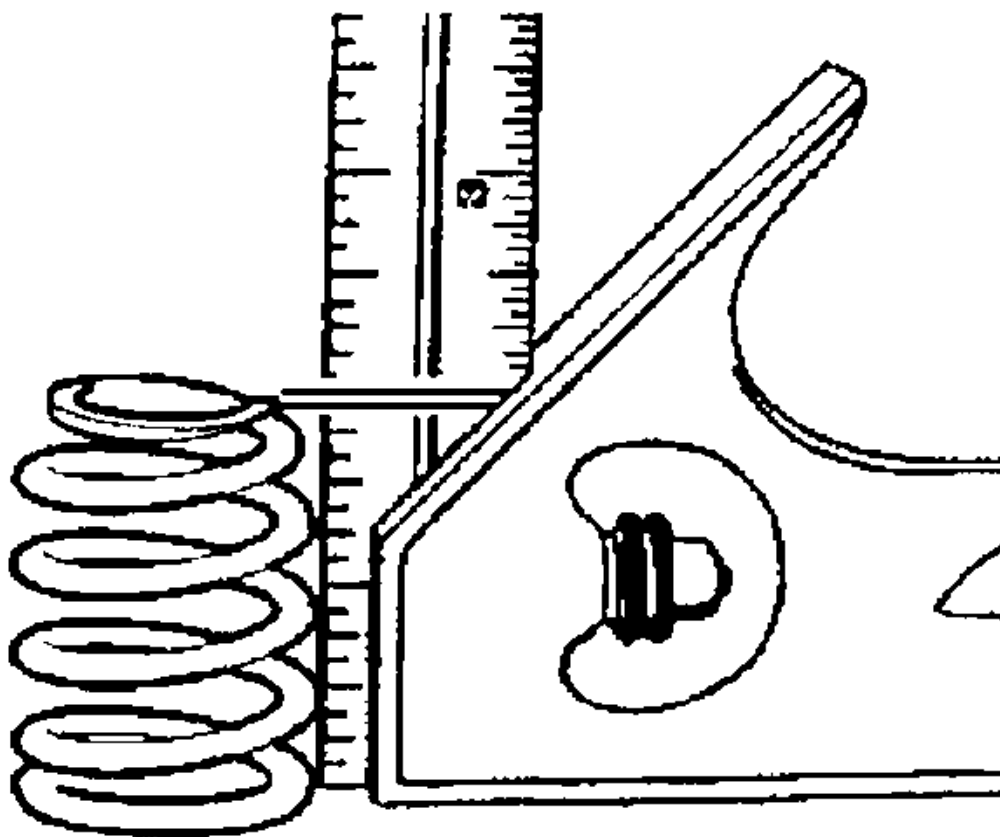


Fig. 378: Measuring Valve Springs For Squareness
Courtesy of GENERAL MOTORS CORP.

15. Inspect the valve springs for squareness.
16. Inspect the valve spring ends. If the valve spring ends are not parallel, the valve spring is bent. Replace the bent valve spring.

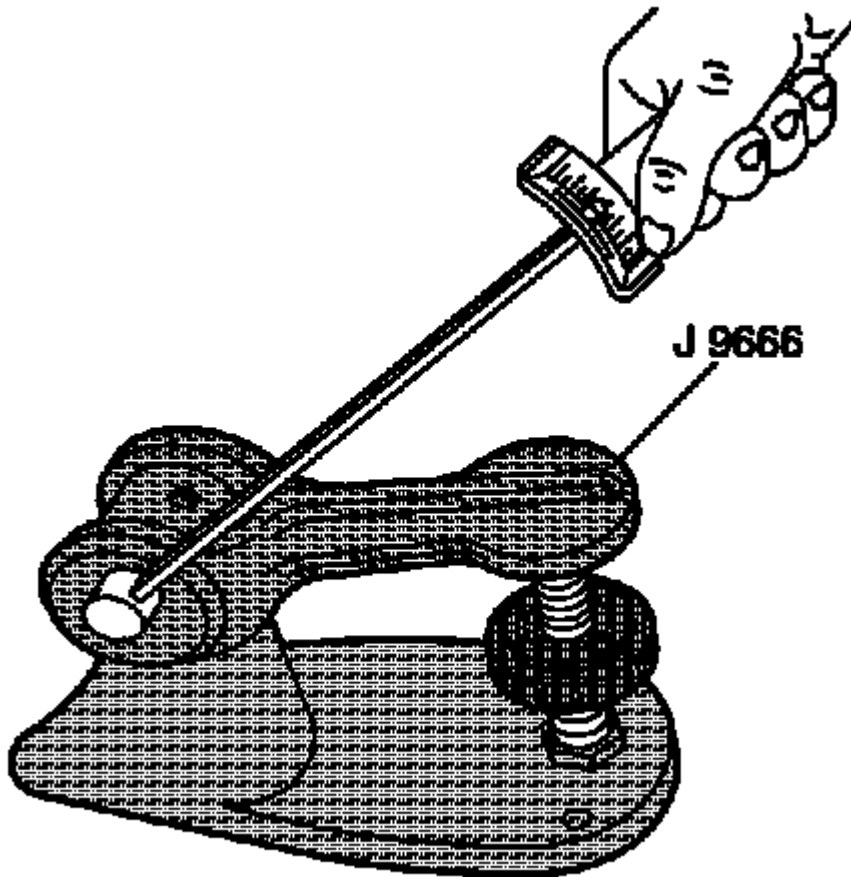


Fig. 379: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS CORP.

17. Using the **J 9666** test the valve spring load. See **Special Tools**. Replace the spring if the valve spring load is less than 334 N.m at 43.69 mm (75 lb at 1.72 in).
18. Inspect the valve spring seating surface of the valve spring retainers for wear or gouging. If the seating surface is damaged, replace the valve spring retainers.
19. Use the following procedure to measure the valve seat concentricity:
 1. Lift the valve off its seat.
 2. Apply a dab of blue dye to the valve face.
 3. Seat and rotate the valve.

The blue dye traces transferred to the valve seat are an indication of concentricity of the valve seat.

20. Use the following procedure to measure the valve runout:
 1. Clean off the blue dye.
 2. Apply blue dye to the valve seat.
 3. Seat and rotate the valve.

The traces of blue dye transferred to the valve indicates valve runout.

4. Recondition the valve seat or valve face, if needed.

VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING

Special Tools

J 8001: Dial Indicator Set

For equivalent regional tools, refer to Special Tools.

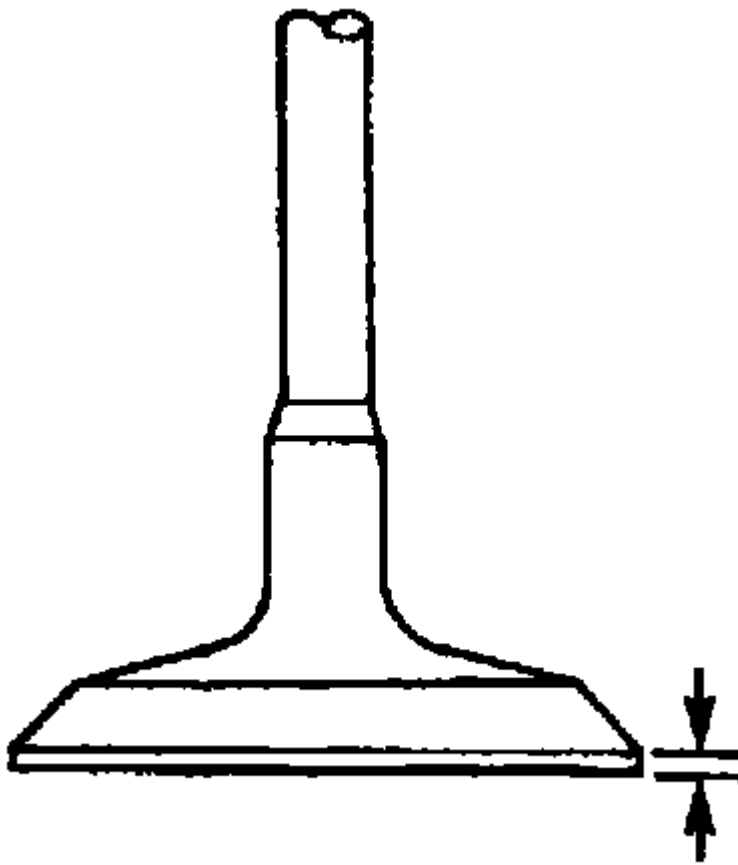


Fig. 380: Inspecting Valve Margin
Courtesy of GENERAL MOTORS CORP.

1. Recondition the valve seats by grinding. Use an oscillating type valve seat grinder. Follow the grinder manufacturer's instructions. If the valve seat is too wide after grinding, use a 20 degree stone or a 70 degree stone in order to narrow the valve seat. The 20 degree stone will lower the seat. The 70 degree stone will raise the seat. Replace or recondition the valves if the seats are reconditioned.
2. After grinding the valves, measure the valve margin. Replace the valve if less than the minimum recommended specification (0.79 mm (0.031 in)).

WARNING: Refer to Cleaning Solvent Warning .

CAUTION: Clean the valve guides before reaming. Packing of chips or carbon may result in the reamer jamming into the valve guide or broken reamer flutes.

3. Clean any foreign material from the valves. Use a wire brush to remove carbon. Do not scratch the valve stem. Soak the valves in cleaning solvent to remove varnish.
4. Use a suitable tool to clean the valve guides.
5. Follow the grinder manufacturer's instructions. Ensure that the new surface is perpendicular to the valve stem.

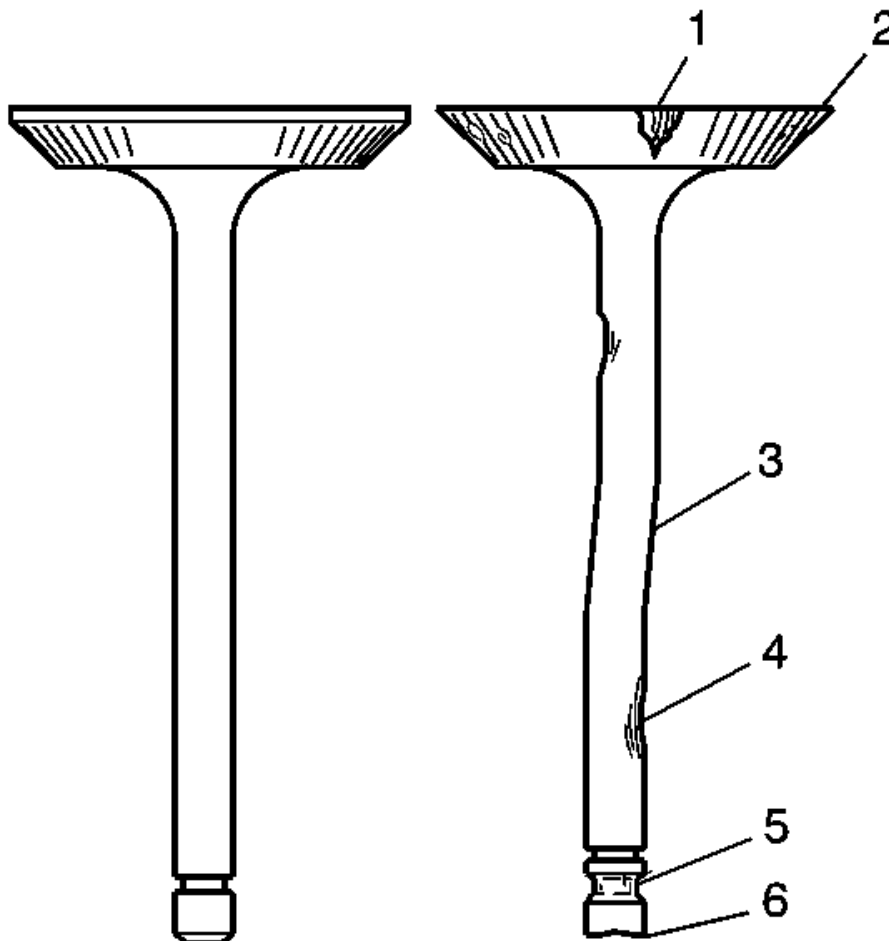


Fig. 381: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS CORP.

6. Inspect the valve key grooves for chipped or worn lands (5). Replace the valve if the valve key groove is damaged.
7. Inspect the valve stem tip for wear (6). Recondition the valve stem tip by grinding.
8. Inspect the valve stem for burrs and scratches (4). Use an oil stone to remove burrs and minor scratches.
9. Inspect the valve stem for straightness (3). Use V blocks to inspect the valve head for bending or distortion. Replace any bent or distorted valves.
10. Inspect the valve face for grooving (1, 2). If the groove is so deep that refacing the valve face would result in a knife edge, replace the valve.

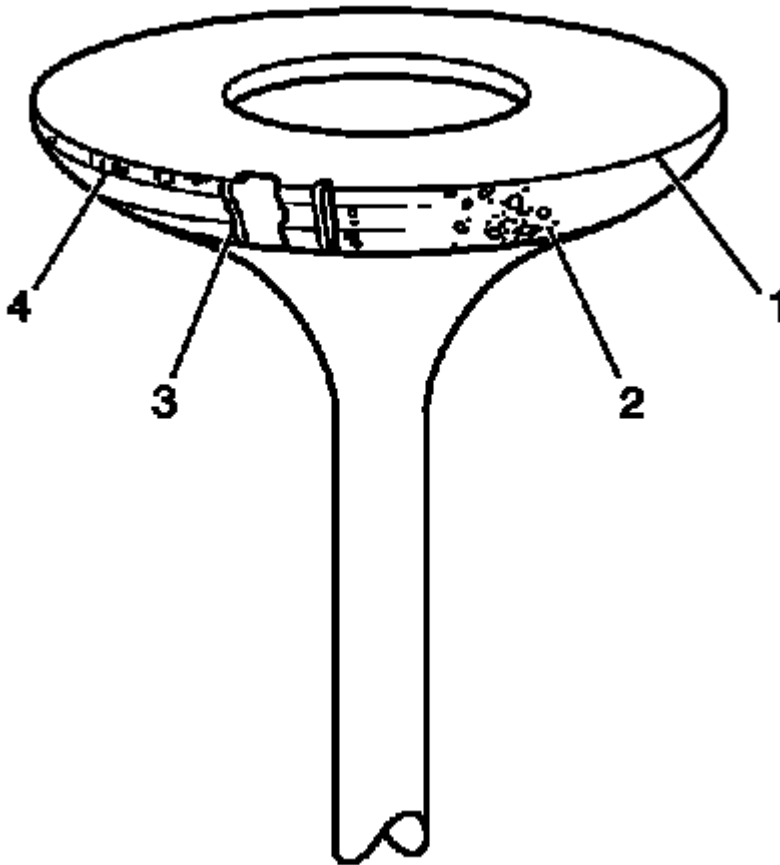


Fig. 382: Inspecting Valve Face For Burning, Pitting & Cracking
Courtesy of GENERAL MOTORS CORP.

11. Inspect the valve face for burning, pitting, or cracking (1, 2, 3, 4). If pieces of the valve face are broken off, replace the valve and inspect the corresponding piston and cylinder head area for damage.

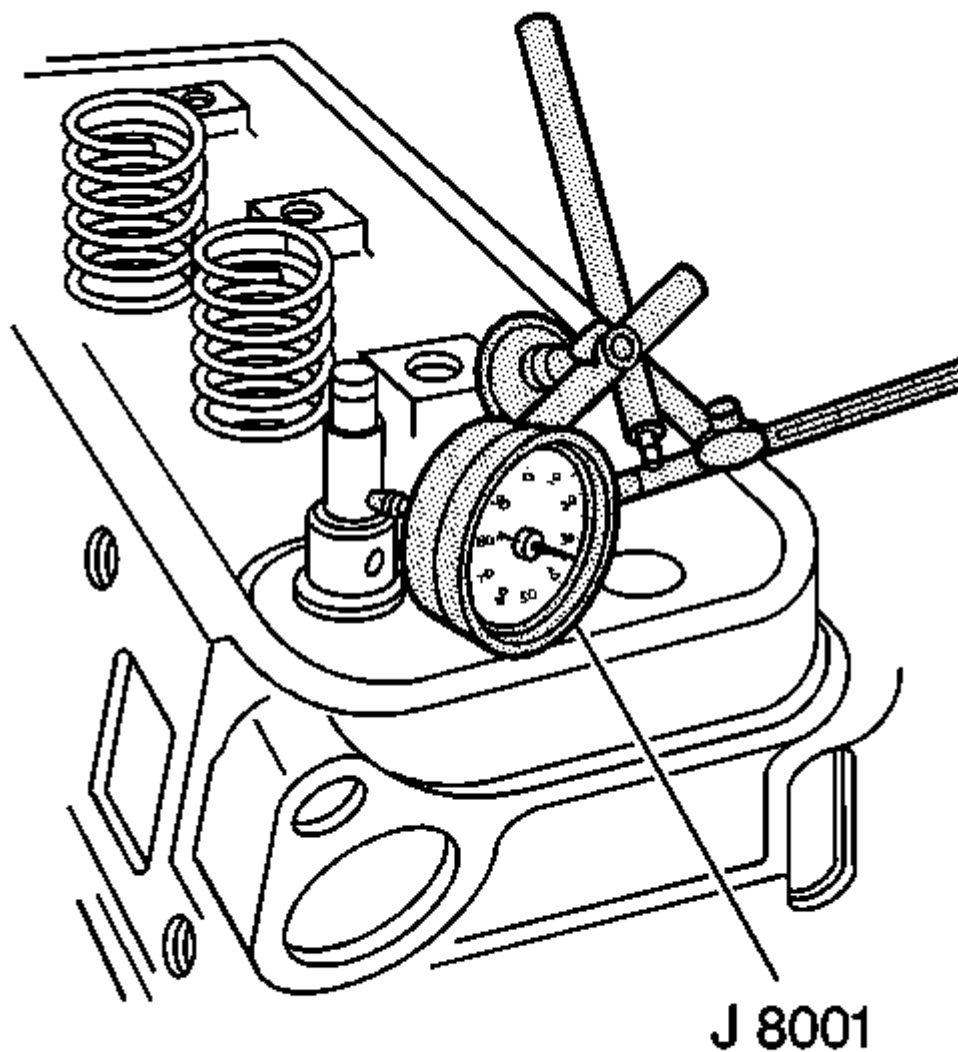


Fig. 383: Measuring Valve Stem Clearance
Courtesy of GENERAL MOTORS CORP.

12. Measure the valve stem clearance:
 1. Insert the valve into the guide.
 2. Lift the valve 2 mm (1/8 in) off of the seat.
 3. Move the valve from side to side.
 4. Use **J 8001**: set to measure the amount of movement.

The intake valve stem clearance should be between 0.031-0.071 mm (0.0012-0.0028 in).

The exhaust valve stem clearance should be between 0.036-0.074 mm (0.0014-0.0029 in).

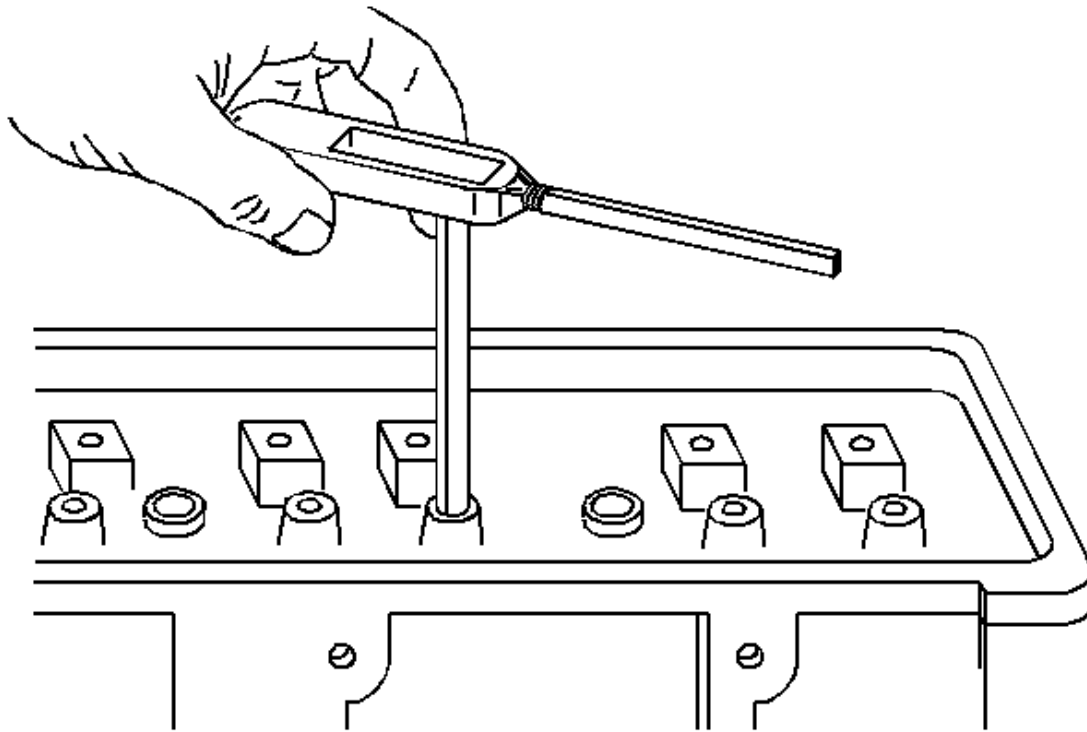


Fig. 384: Reaming Valve Guides For Oversize Valves
Courtesy of GENERAL MOTORS CORP.

NOTE: Clean the valve guide before reaming to avoid breaking the reamer flutes.
Do not push down on the reamer.

13. Ream the valve guides for oversize valves if the clearance exceeds the specifications.
14. Ream the valve guide bores for the oversize valves.
15. Recondition the valve seats after reaming the valve guide bores or installing the new valve guides.

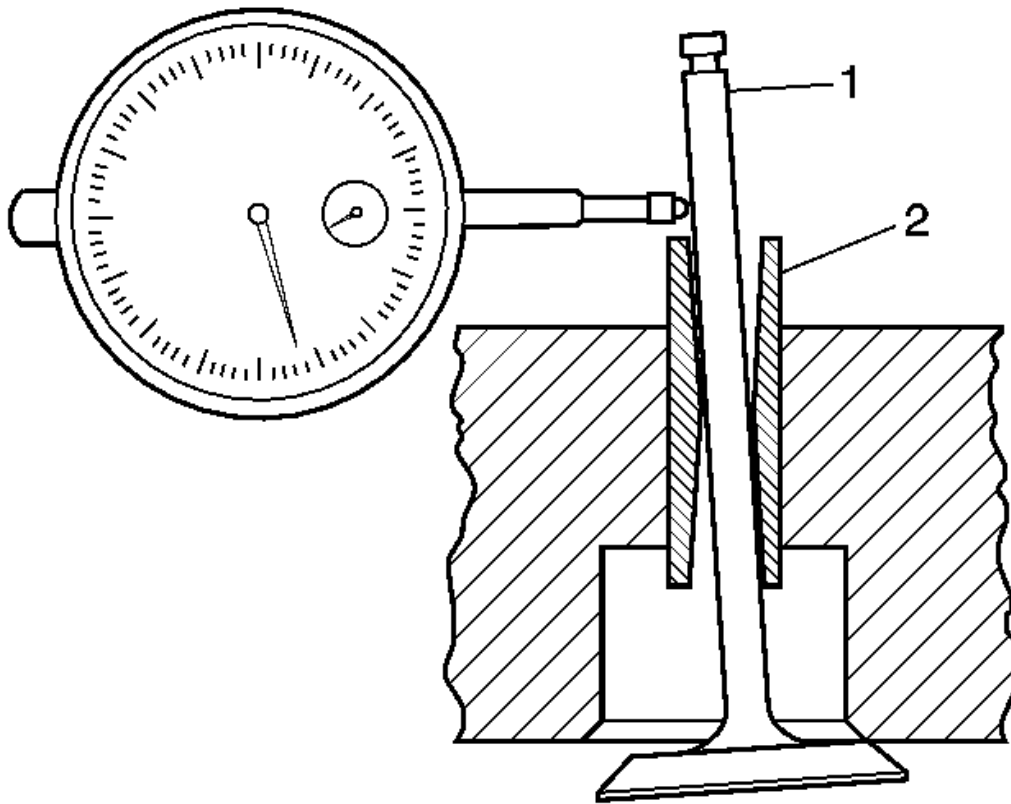


Fig. 385: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS CORP.

16. Inspect the valve stem for straightness. Use V blocks to inspect the valve head for bending or distortion. Replace any bent or distorted valves.

- It is essential that the valve guide bores are free of carbon or dirt to ensure the proper centering of the pilot in the guide.

The valve seats should be concentric to within 0.05 mm (0.031 in) total indicator reading.

- Reface pitted valves on a valve refacing machine to ensure the correct relationship between the valve head and the valve stem.
- Replace the valve if the valve stem is warped (2), or if the valve stem shows signs of excessive wear.
- Inspect the valve key area (1) for damage and carbon build up.
- Replace the valve if the edge of the head is less than 0.79 mm (0.031 in) thick after grinding.
- Use the manufacturer's recommendations of equipment for the proper results.

CYLINDER HEAD ASSEMBLE

Special Tools

- **J 38606:** Valve Spring Compressor
- **J 42863:** Valve Seal Installer

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

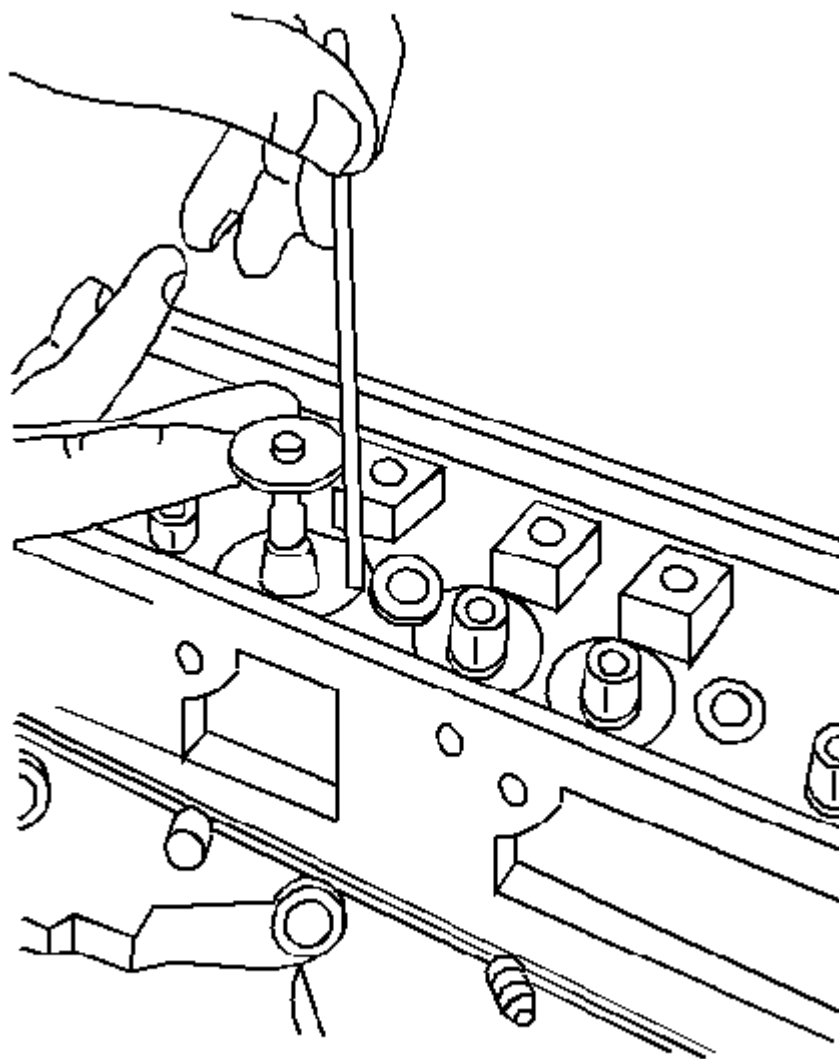


Fig. 386: Measuring Valve Stem Height

Courtesy of GENERAL MOTORS CORP.

1. Install the valves. The valves are available in standard size and 0.381 mm (0.015 in) oversize. Use oversize valve seals if oversized valves are used.
2. Use the following procedure to measure the valve stem height:
 1. Place the valve on the guide. Hold the valve in the closed position.
 2. Use a valve stem height gauge to measure the valve stem height.
 3. The measurement should be 49-50 mm (1.93-1.97 in).

CAUTION: Use hand pressure only when installing the valve seal using J 42863. Using too much force may cause damage to the oil seal and possibly lead to excessive oil consumption.

3. Use the following procedure to measure the valve spring installed height:
 1. Place the valve in the valve guide.
 2. Install the valve spring cap and the valve cap keys.
 3. Seat the valve spring retainer by pulling up.
 4. Use a steel machinists' rule to measure the distance from the spring seat to the bottom of the valve spring cap.
 5. The measurement should be 42-44 mm (1.69-1.75 in).

If the measurement is not within specifications add shims under the valve spring.

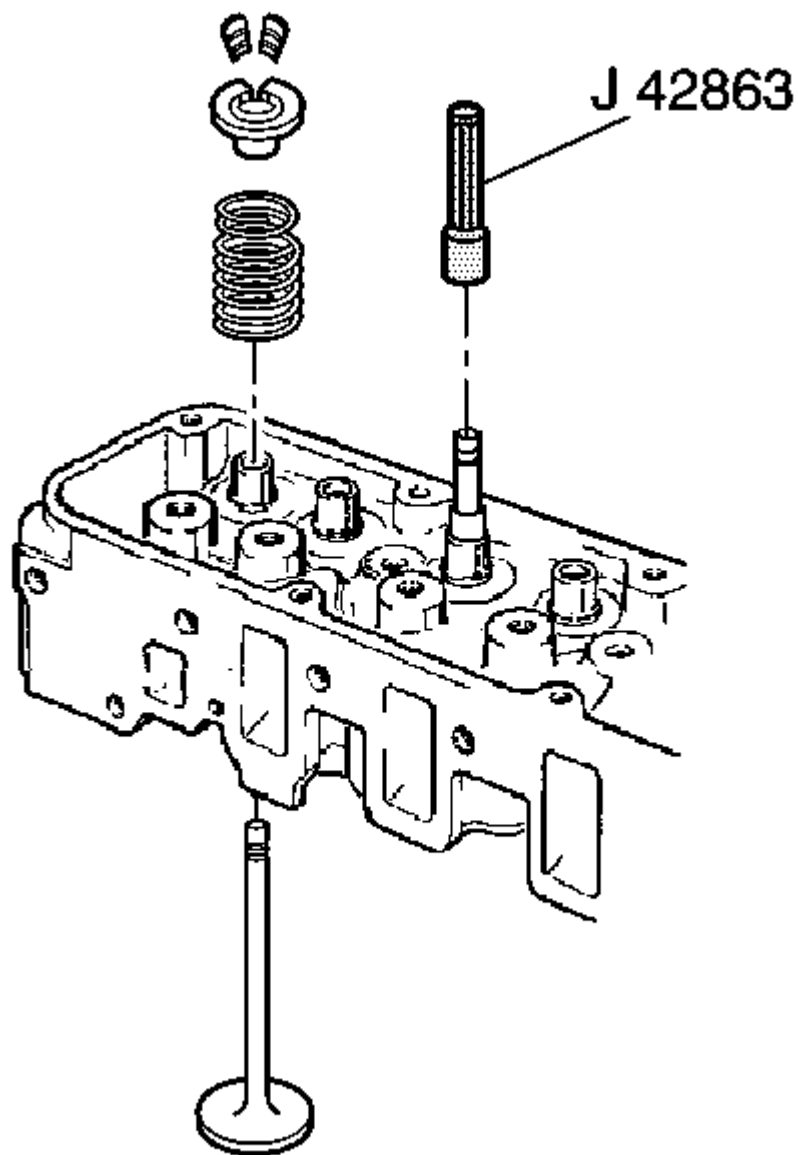


Fig. 387: Installing Valve Stem Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Use hand pressure only when installing the valve seal using J 42863: installer. Using too much force may cause damage to the oil seal and possibly lead to excessive oil consumption.

4. Place the valve stem oil seal over the valve stem so the seal begins to contact the valve guide.
5. Use **J 42863**: installer to push the valve stem oil seal over the valve guide.

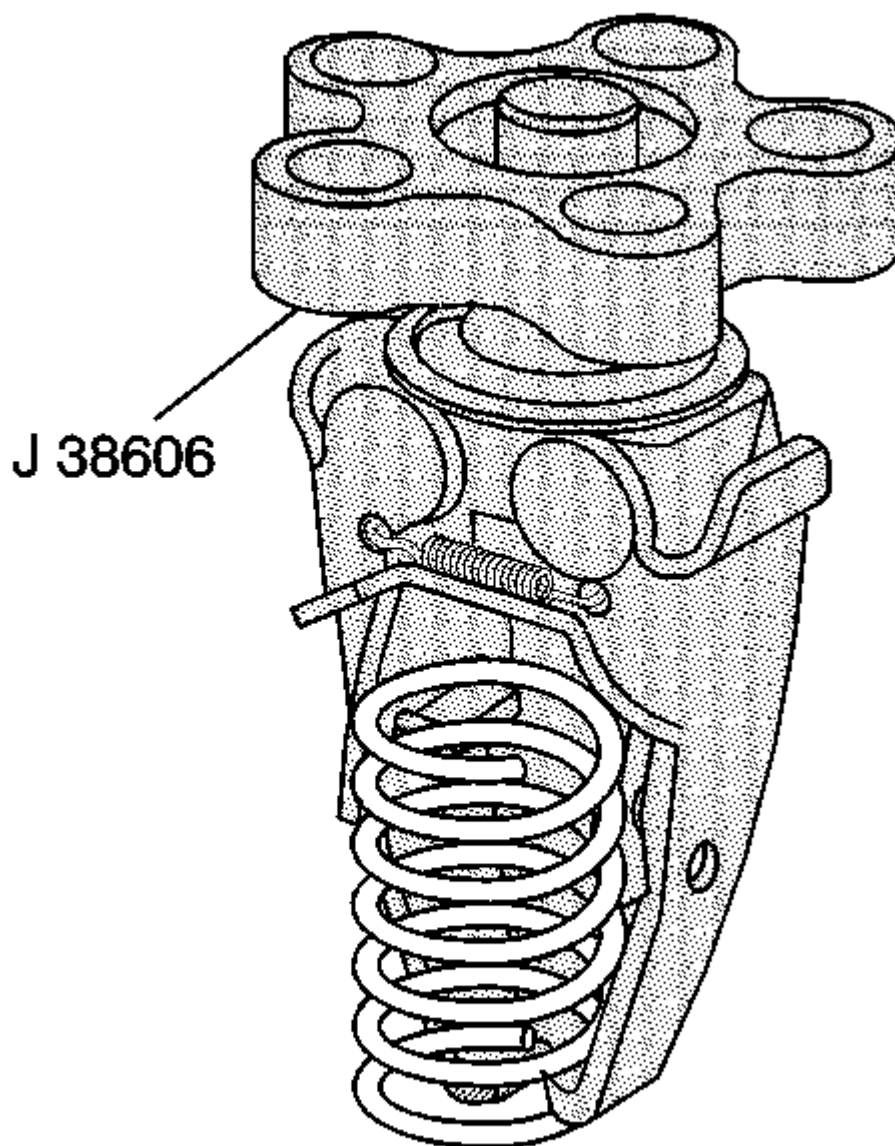


Fig. 388: Installing Valve Spring
Courtesy of GENERAL MOTORS CORP.

6. Use **J 38606**: compressor to install the valve spring and the valve cap.

7. Install the valve keys.

OIL PUMP DISASSEMBLE

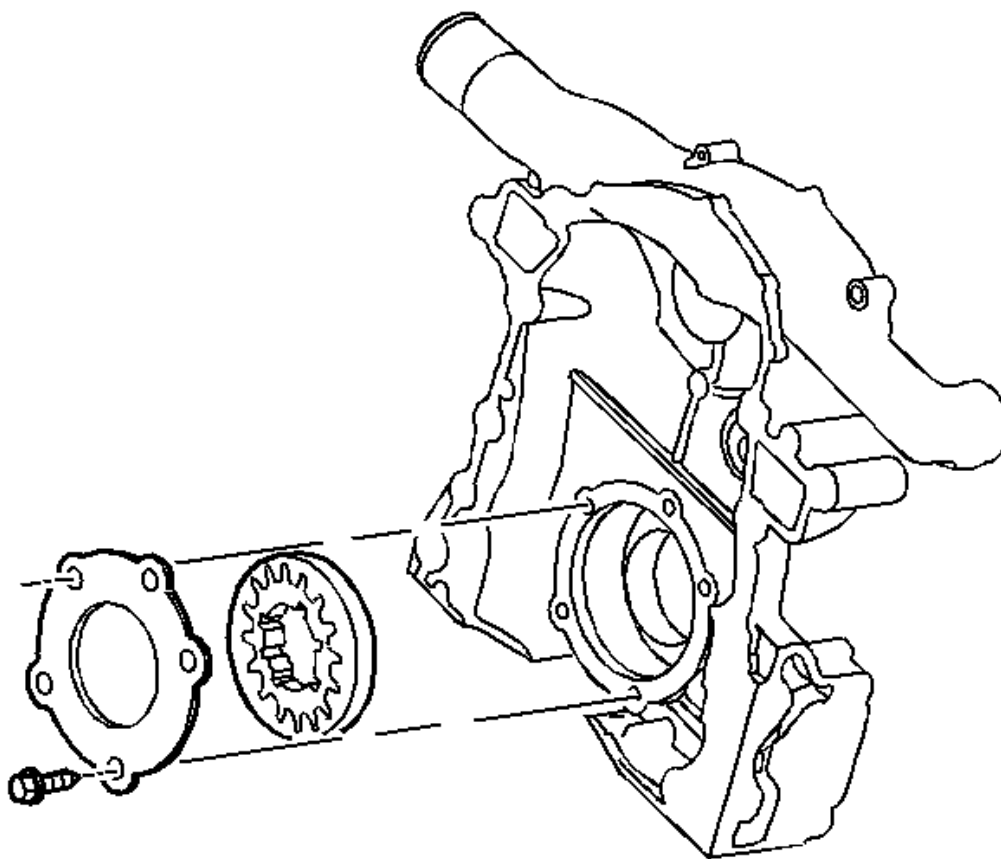


Fig. 389: Exploded View Of Oil Pump Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump cover screws.
2. Remove the oil pump cover.
3. Remove the oil pump gears.

OIL PUMP CLEANING AND INSPECTION

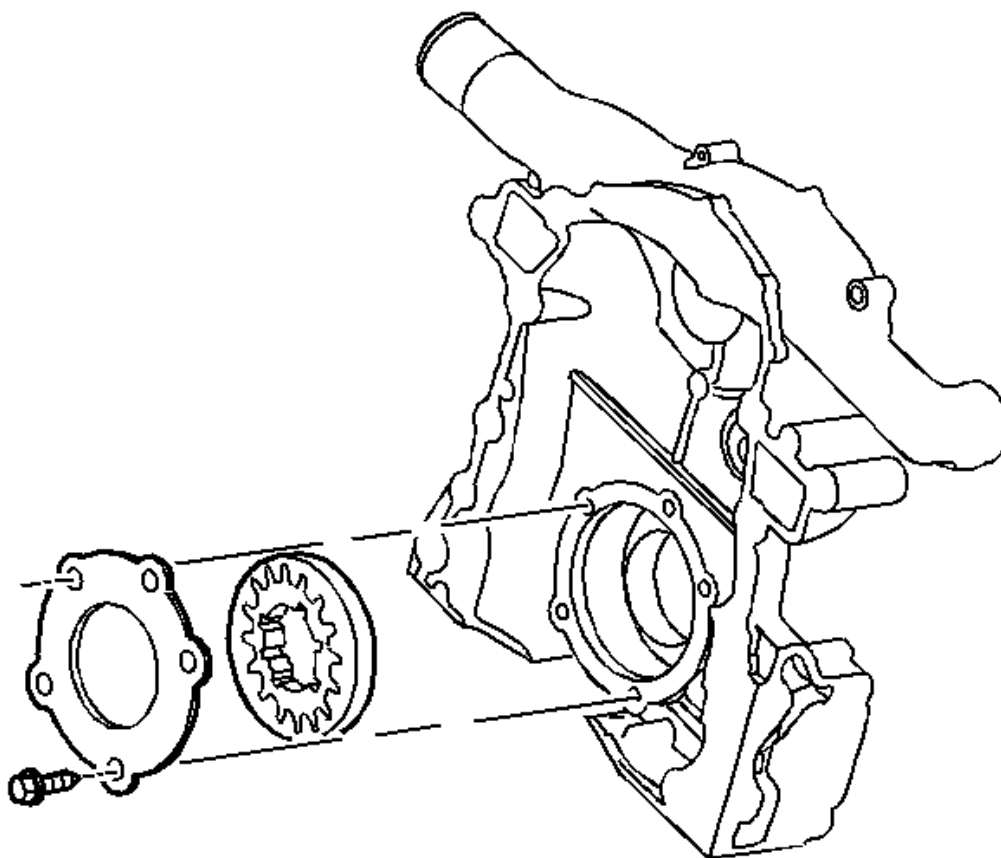


Fig. 390: Exploded View Of Oil Pump Components
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Cleaning Solvent Warning .

1. Use a suitable solvent to clean the oil pump.
2. Remove all old gasket material from the engine front cover and from the engine block.
3. Inspect the oil pump cover and the engine front cover for the following damage:
 - Cracks
 - Scoring
 - Porous or damaged casting
 - Damaged threads
 - Excessive wear

4. Inspect the pressure regulator valve for the following damage:
 - Scoring
 - Sticking in the bore
 - Burrs
 - Foreign material
5. Inspect the pressure regulator spring for loss of tension or bending. Replace the pressure regulator spring if damaged.
6. Inspect the oil pump gears for the following conditions:
 - Chipping
 - Galling
 - Scoring
 - Excessive wear

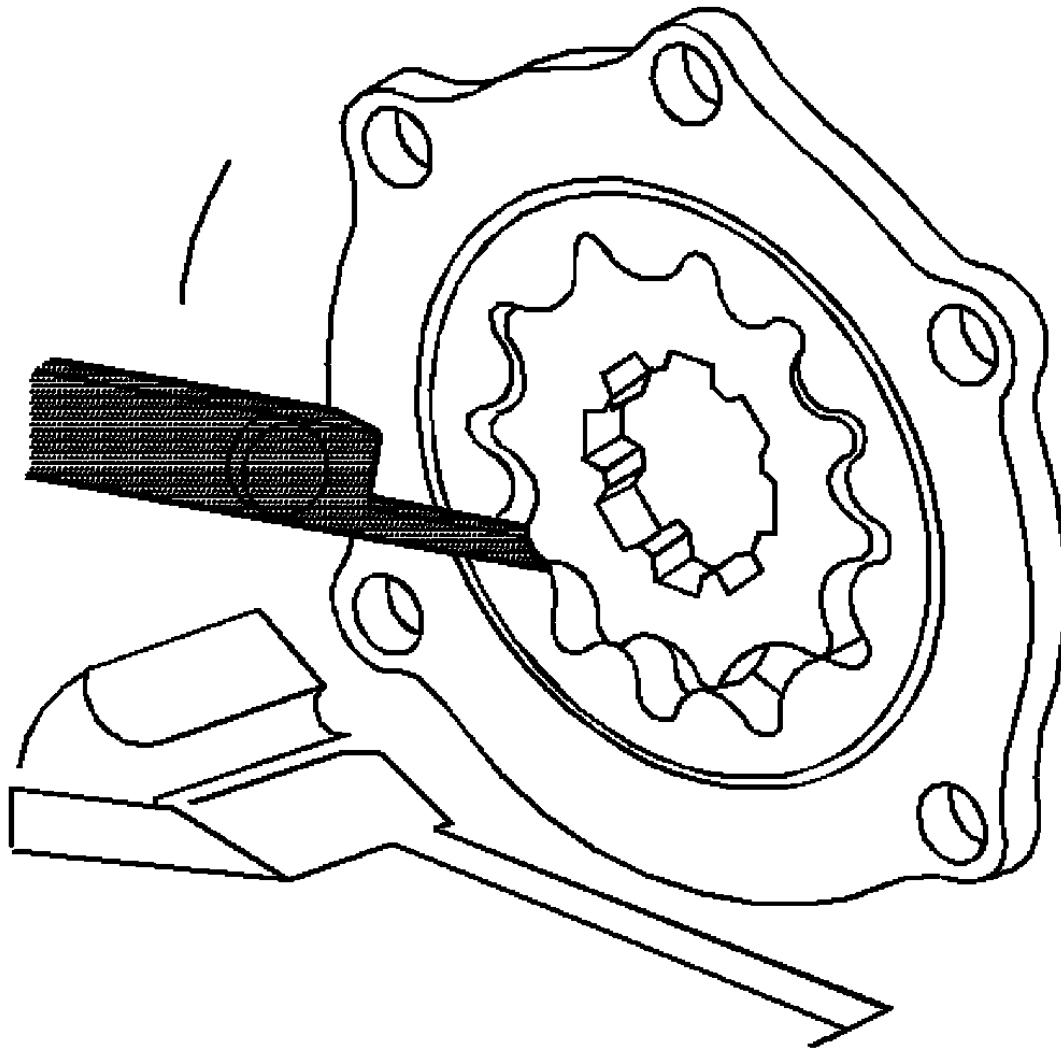


Fig. 391: Measuring Inner Oil Pump Gear Tip Clearance
Courtesy of GENERAL MOTORS CORP.

7. Measure the inner oil pump gear tip clearance.

If the clearance for the inner oil pump gear tip is greater than 0.152 mm (0.006 in) the oil pump must be replaced.

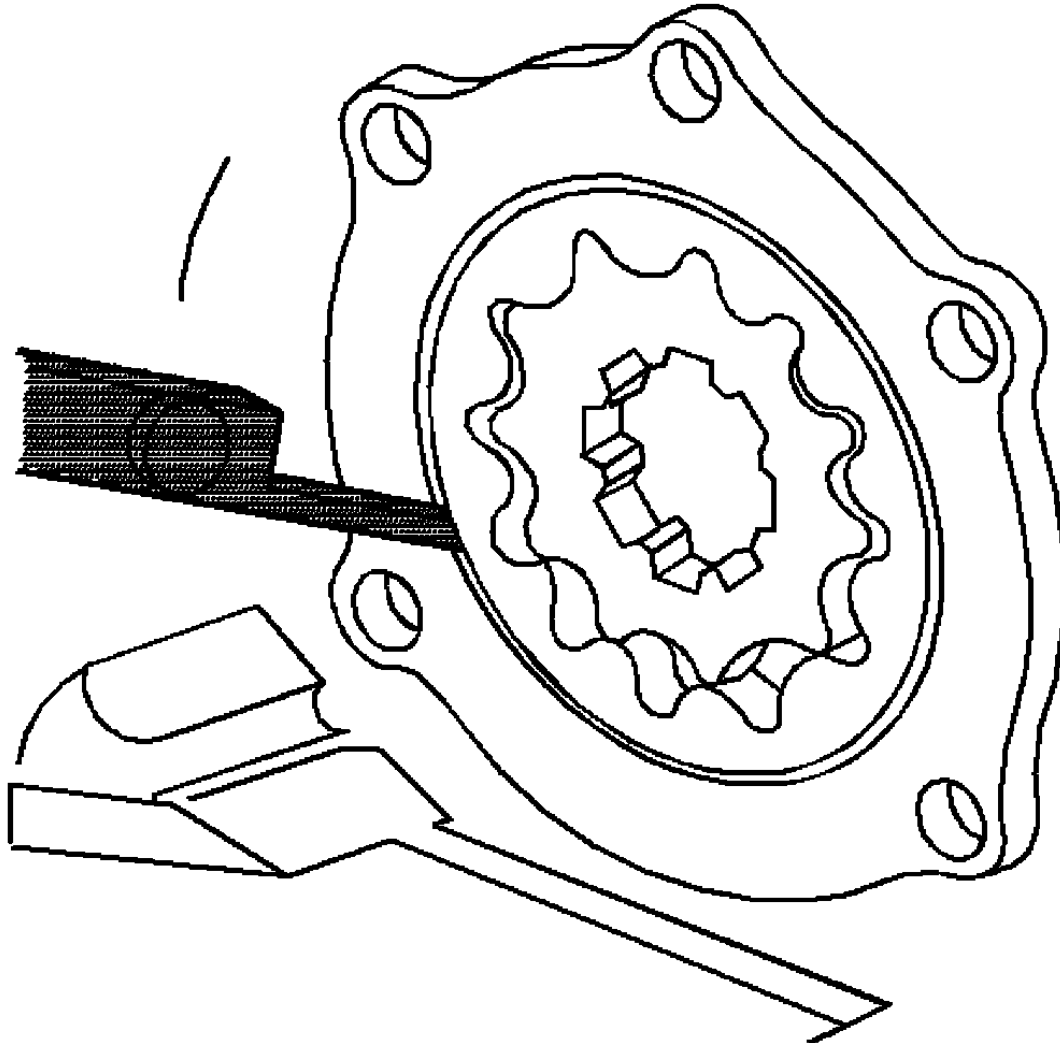


Fig. 392: Measuring Outer Oil Pump Gear Diameter Clearance
Courtesy of GENERAL MOTORS CORP.

8. Measure the outer oil pump gear diameter clearance.

If the outer oil pump gear diameter clearance is greater than 0.381 mm (0.015 in) the oil pump must be replaced.

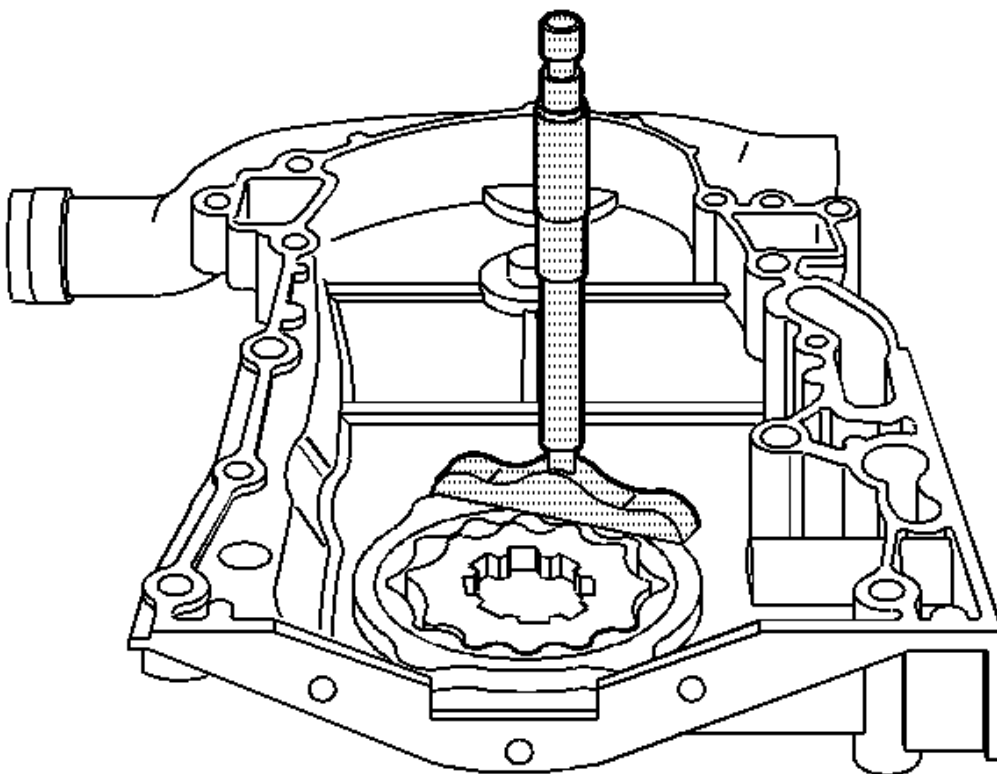


Fig. 393: Measuring Outer Oil Pump Gear End Clearance
Courtesy of GENERAL MOTORS CORP.

9. Measure the oil pump gear end clearance.
10. Measure the pressure regulator valve-to-bore clearance.

If the pressure regulator valve-to-bore clearance is greater than 0.076 mm (0.003 in) the oil pump must be replaced.

ENGINE FRONT COVER CLEANING AND INSPECTION

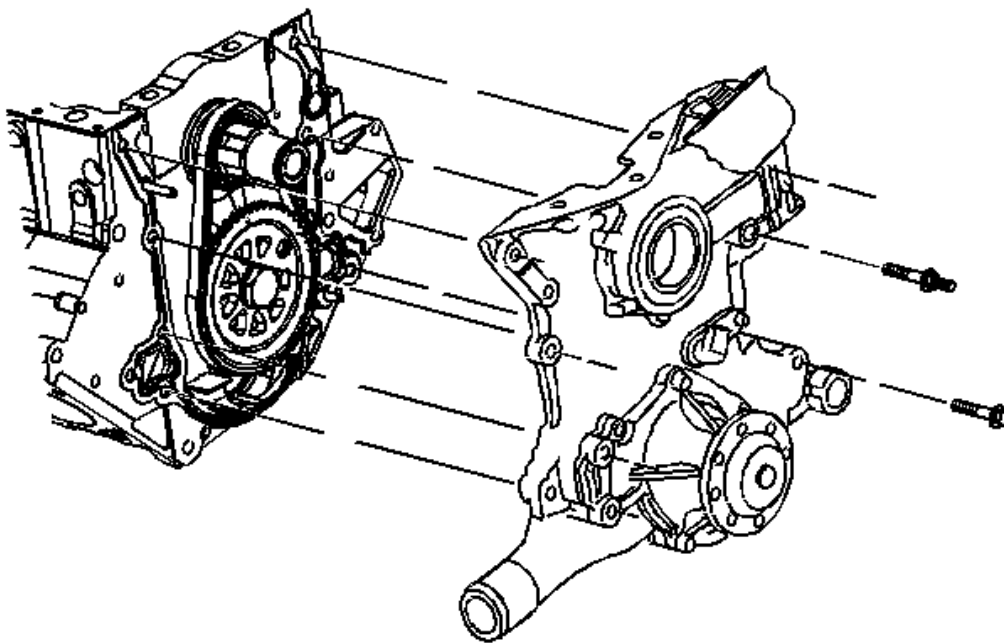


Fig. 394: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine front cover mating surface.
2. Clean the engine front cover.
3. Inspect the engine front cover threaded holes.
4. Inspect the engine front cover for damage.
5. Inspect the engine front cover mating surfaces for nicks.
6. Repair or replace the engine front cover as necessary.

OIL PUMP ASSEMBLE

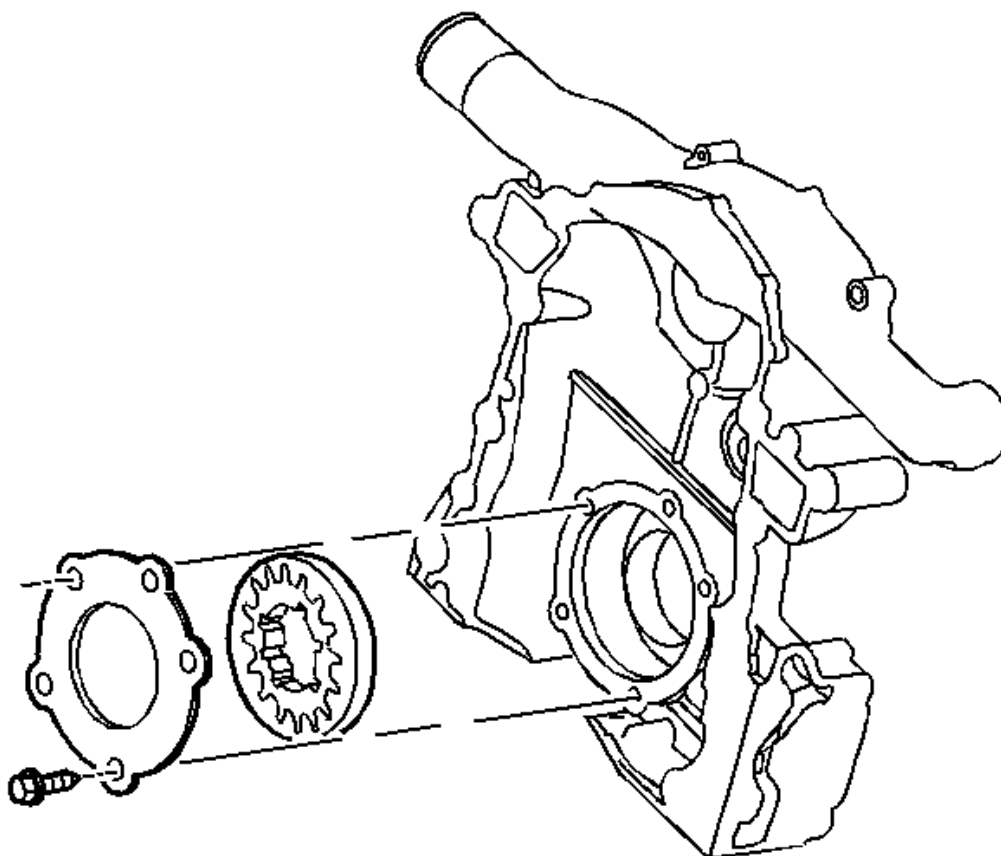


Fig. 395: Exploded View Of Oil Pump Components
 Courtesy of GENERAL MOTORS CORP.

1. Lubricate the oil pump gears with petroleum jelly.
2. Install the oil pump gears.
3. Pack the oil pump cavity with petroleum jelly.
4. Install the oil pump cover.

CAUTION: Refer to Fastener Caution .

5. Install the oil pump cover screws and tighten to 11 N.m (98 lb in).

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

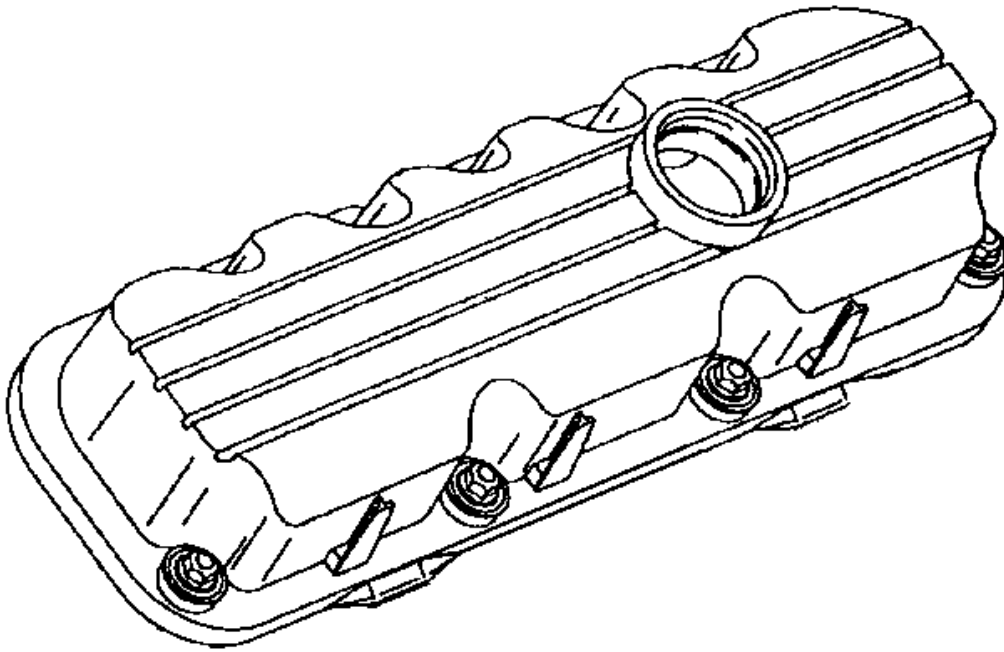


Fig. 396: Cleaning/Inspecting Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Clean the valve rocker arm cover mating surface.
2. Clean the valve rocker arm cover. Remove all the sludge and the oil deposits.
3. Inspect the valve rocker arm cover for damage. Replace the valve rocker arm cover if any damage is found.

OIL PAN CLEANING AND INSPECTION

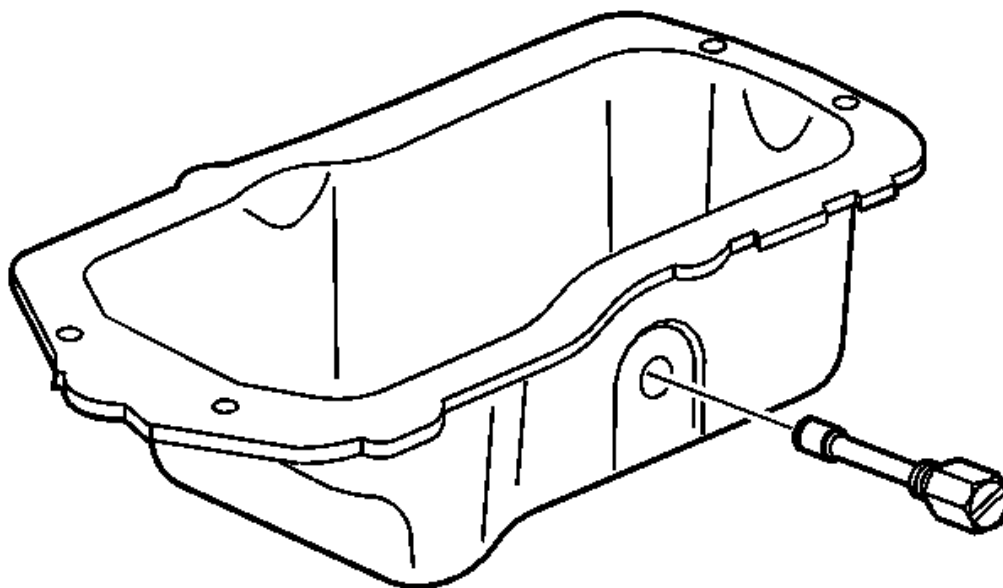


Fig. 397: Oil Pan & Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

1. Clean the oil pan sealing surface.
2. Clean the oil pan. Remove all the sludge oil deposits, and sealer.
3. Inspect the threads for the oil level sensor and the engine oil drain plug.
4. Inspect the oil pan for dents, cracks, or distortion.
5. Repair or replace the oil pan as necessary.

UPPER INTAKE MANIFOLD CLEANING AND INSPECTION

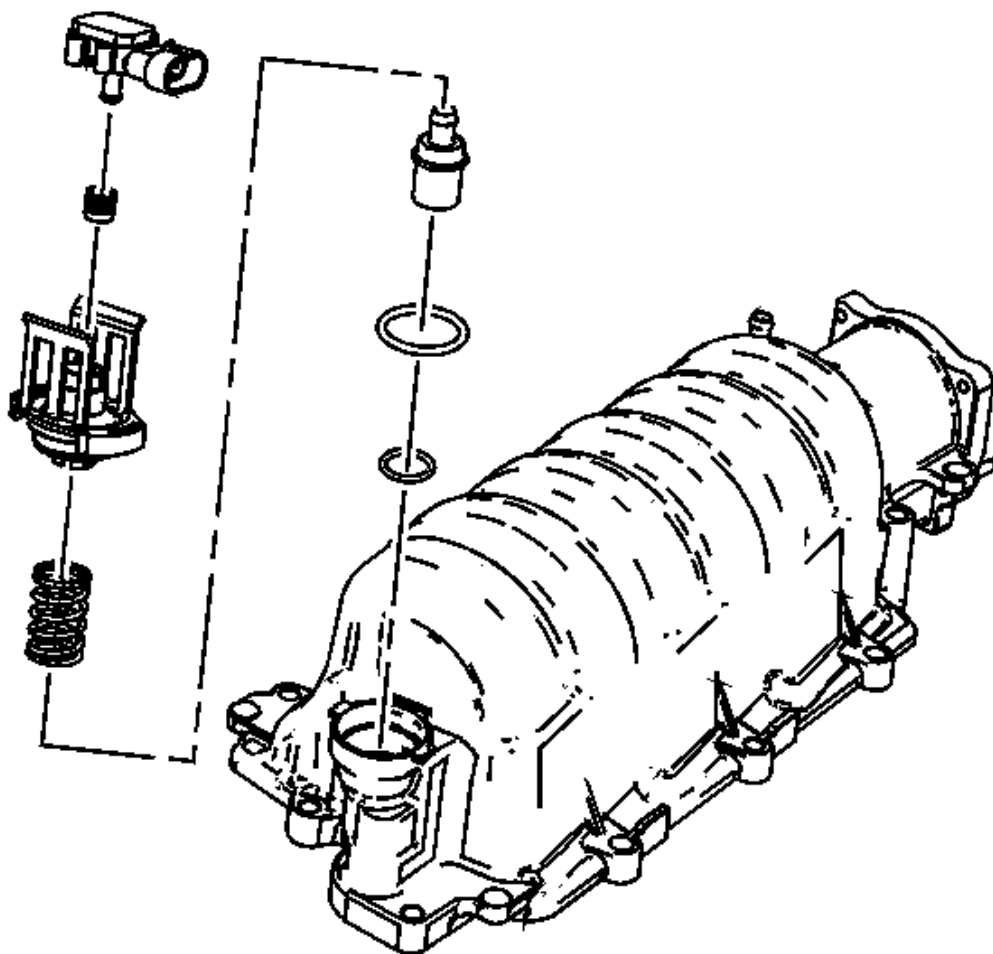


Fig. 398: Cleaning Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Clean the upper intake manifold mating surfaces.
2. Clean the upper intake manifold.
3. Inspect the upper intake manifold for damage.
4. Clean and inspect the PCV valve and components, replace as necessary.
5. Replace the upper intake manifold as necessary.

LOWER INTAKE MANIFOLD CLEANING AND INSPECTION (L26)

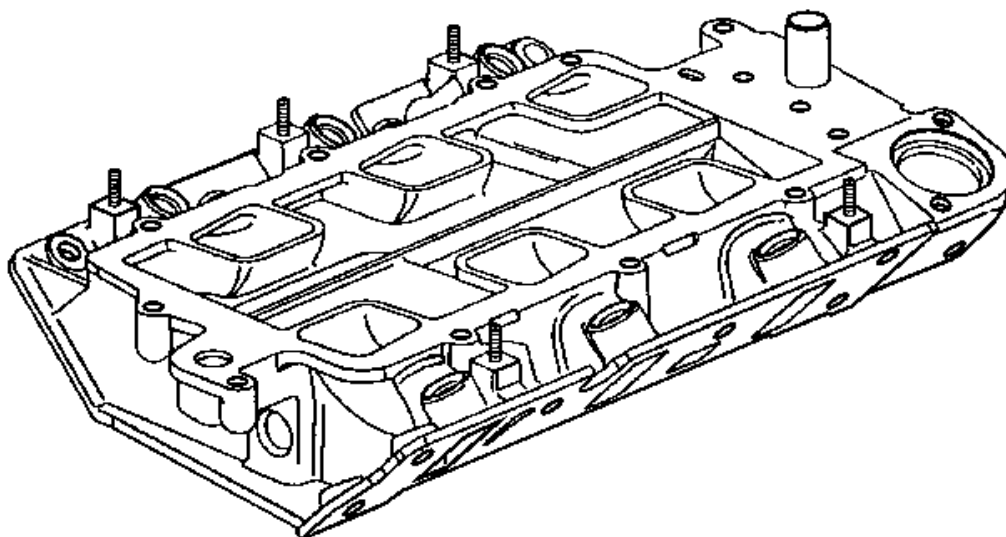


Fig. 399: Cleaning/Inspecting Lower Intake Manifold (L26)
Courtesy of GENERAL MOTORS CORP.

1. Clean the lower intake manifold mating surfaces.
2. Clean the lower intake manifold.
3. Inspect the threaded holes for damage.
4. Inspect the lower intake manifold for damage or nicks in the mating surfaces.
5. Replace or repair the lower intake manifold as necessary.

EXHAUST MANIFOLD CLEANING AND INSPECTION

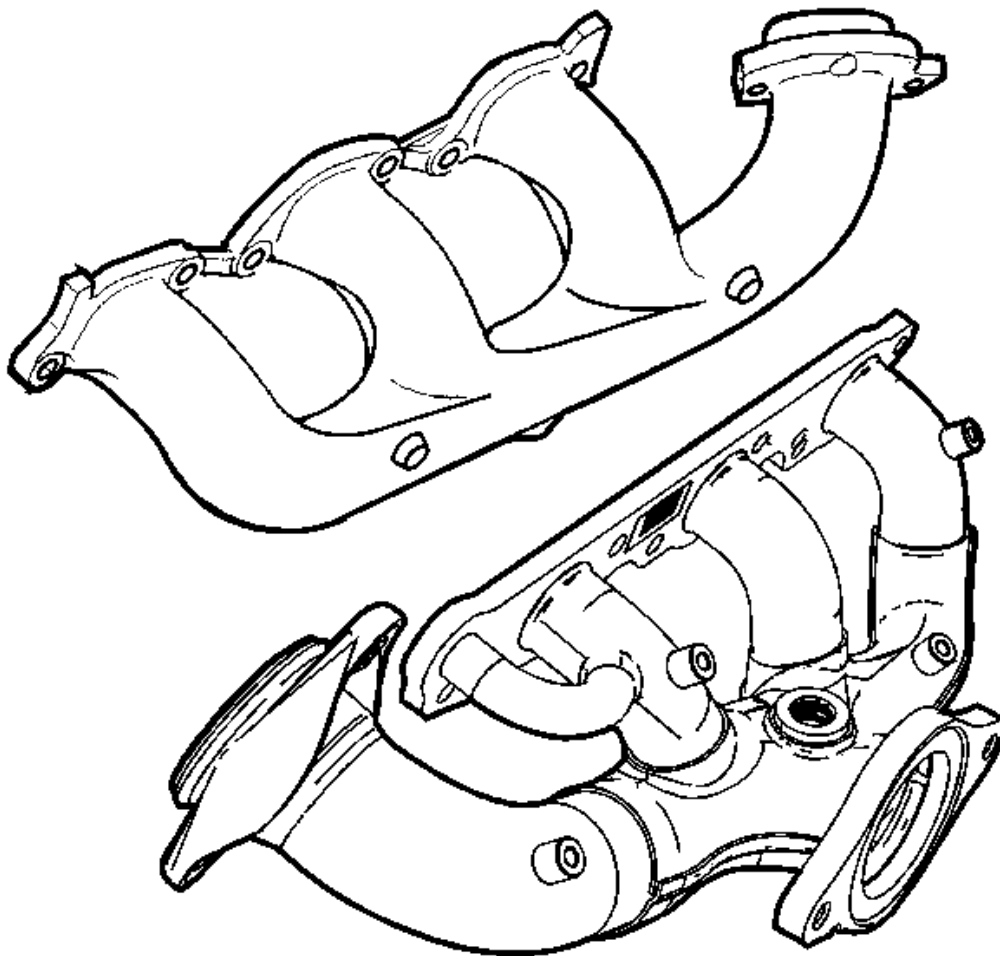


Fig. 400: Cleaning Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Clean the exhaust manifold mating surfaces.
2. Clean the exhaust manifold.
3. Inspect the exhaust manifold mating surfaces for damage.

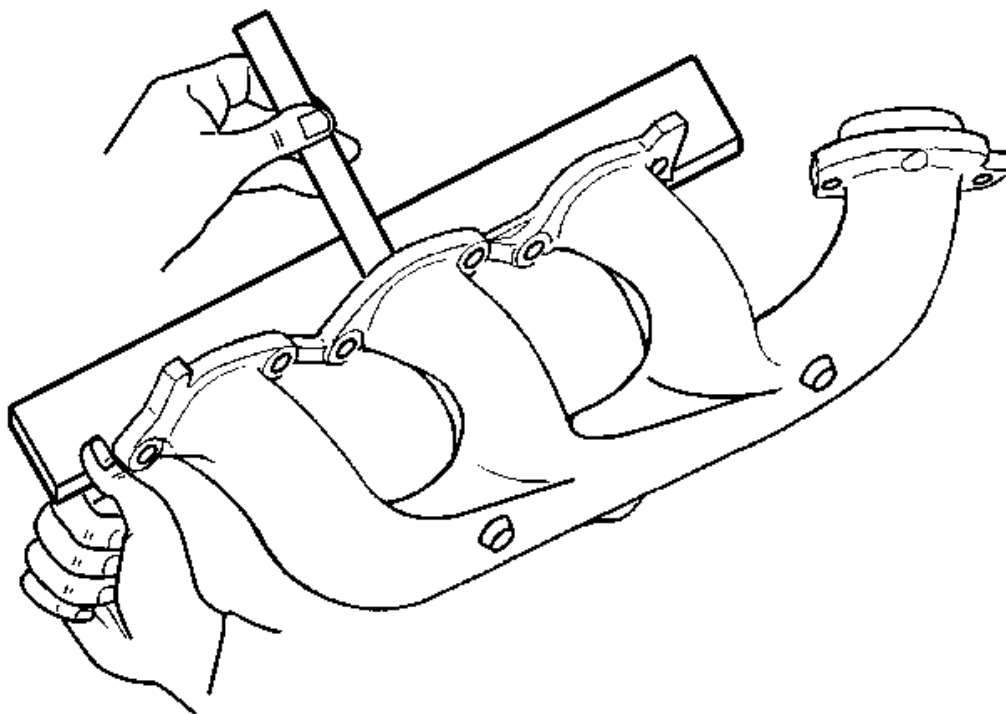


Fig. 401: Cleaning/Inspecting Exhaust Manifold Flange
Courtesy of GENERAL MOTORS CORP.

4. Inspect the exhaust manifold flange for straightness, using a straight edge and a feeler gage.
5. If the exhaust manifold flange is warped more than 0.05 mm (0.002 in) replace the exhaust manifold.

WATER PUMP CLEANING AND INSPECTION

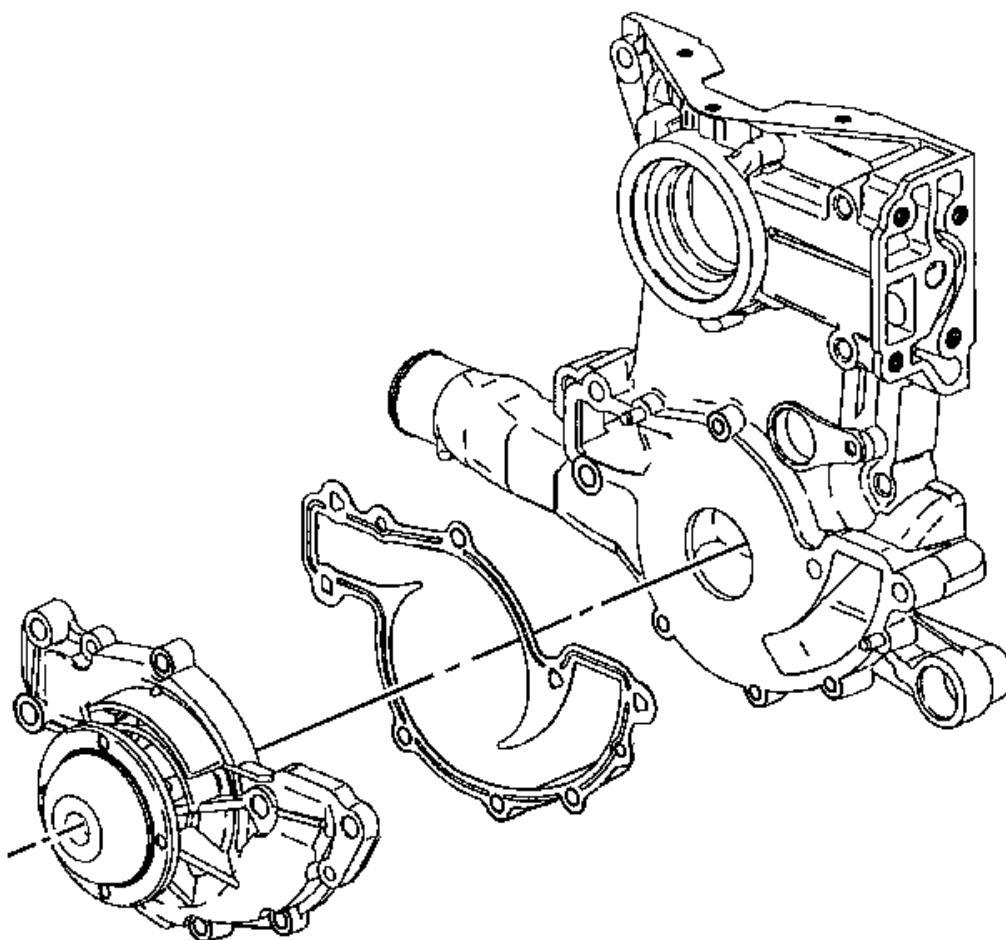


Fig. 402: Water Pump & Components
Courtesy of GENERAL MOTORS CORP.

1. Clean the water pump mating surface.
2. Clean the water pump.
3. Inspect the water pump shaft for looseness.
4. Inspect the water pump vanes for damage.
5. Inspect the water pump mating surfaces for nicks.
6. Repair or replace the water pump as necessary.

BALANCE SHAFT CLEANING AND INSPECTION

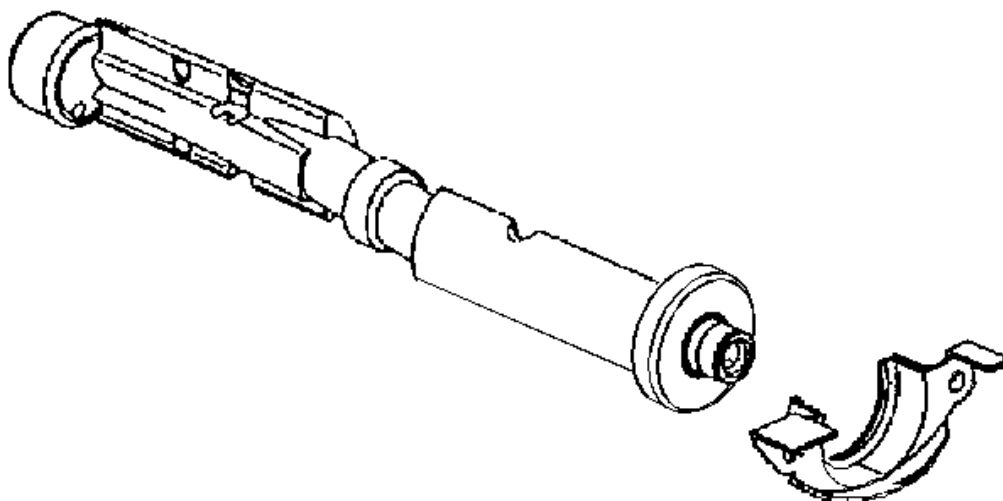


Fig. 403: Cleaning/Inspecting Balance Shaft
Courtesy of GENERAL MOTORS CORP.

1. Clean the balance shaft.
2. Inspect the balance shaft bearing/bushing journals for excessive wear.
3. Inspect the balance shaft driven gear and the balance shaft drive gear for nicks and burrs.
4. Inspect the balance shaft retainer for damage.
5. Inspect the balance shaft threads for damage.
6. Repair or replace the balance shaft components as necessary.

THREAD REPAIR

General purpose thread repair kits are available commercially.

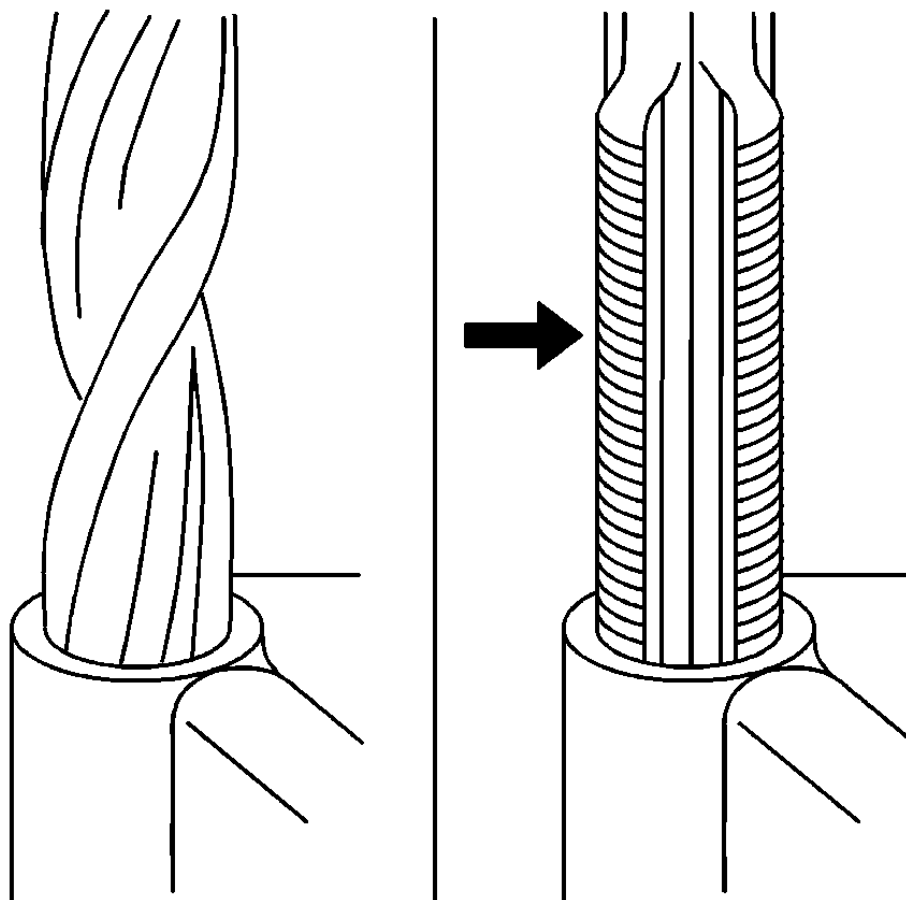


Fig. 404: Drilling & Tapping Damaged Threads
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and which tap to use.
Always avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread.
2. Adjust the stop collars on the cutting tool as needed. Tap the stop collars to the required depth.
3. Drill out the damaged thread.
4. Remove the chips.
5. Apply clean engine oil to the top thread.

6. Use the tap in order to cut new thread.
7. Clean the thread.

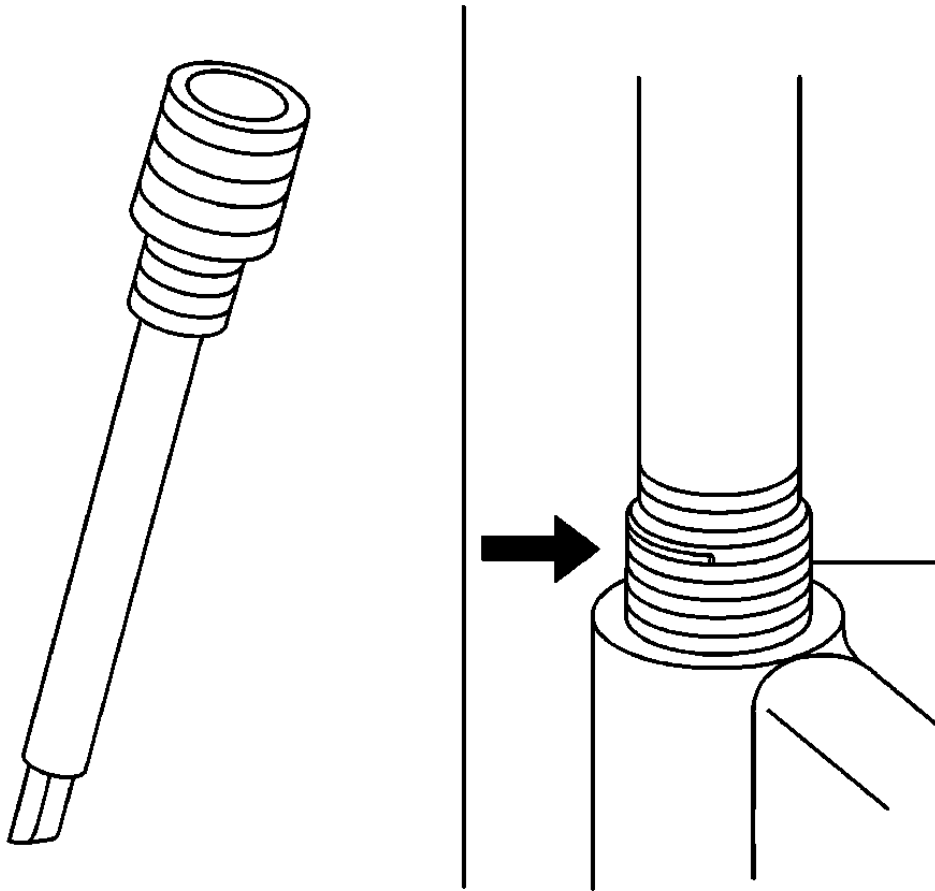


Fig. 405: View Of Thread Insert
Courtesy of GENERAL MOTORS CORP.

8. Screw the thread insert onto the mandrel of the thread insert installer. Engage the tang of the thread insert onto the end of the mandrel.

NOTE: The thread insert should be flush to 1 turn below the surface.

9. Lubricate the thread insert with clean engine oil - except when installing in aluminum - and install the thread insert.
10. If the tang of the thread insert does not break off when backing out the thread insert installer, break off the tang using a drift punch.

SERVICE PRIOR TO ASSEMBLY

Dirt will cause premature wear of the rebuilt engine. Clean all of the components. Use the proper tools in order to measure components when inspecting for excessive wear. Repair or replace the components that are not within the manufacturers specification. When components are reinstalled into an engine, return the components to their original location, position, and direction. During assembly, lubricate all of the moving parts with clean engine oil or engine assembly lubricant unless otherwise specified. This will provide initial lubrication when the engine is first started.

BALANCER SHAFT BEARING INSTALLATION

Tools Required

- **J 21465-13** Drive Handle Extension. See **Special Tools**.
- **J 36995** Balance Shaft Bearing Remover/Installer. See **Special Tools**.

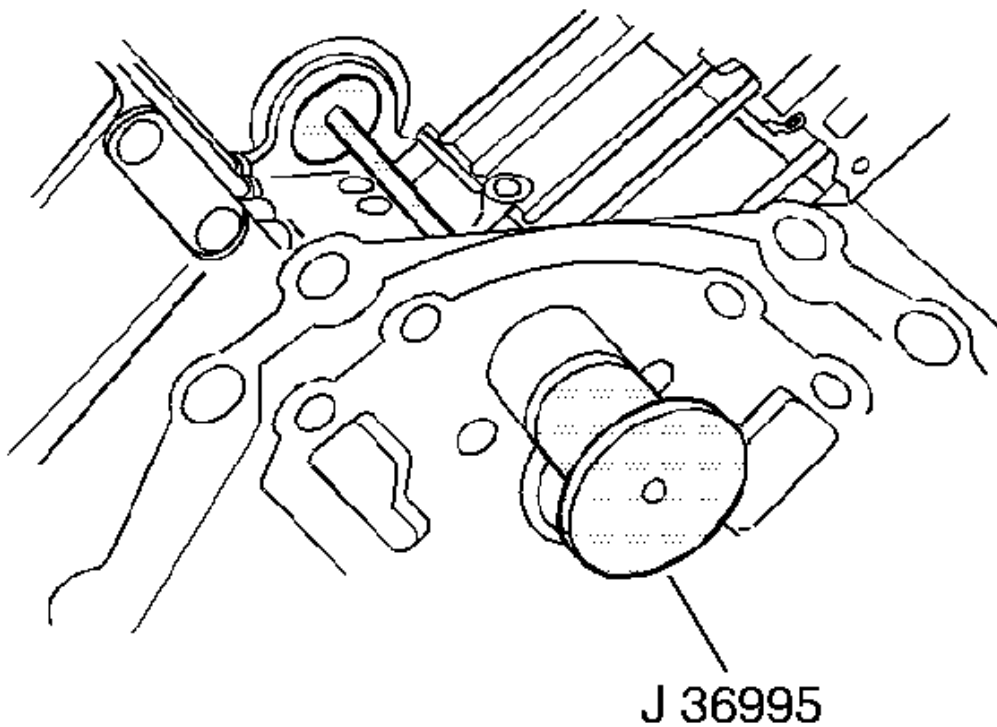


Fig. 406: Installing Balance Shaft Bushing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The J 36995 installs the balance shaft bushing to the correct depth. See **Special Tools**. The balance shaft bushing is properly installed when J

36995 fully contacts the balance shaft bore or the engine block/transaxle mounting flange. See Special Tools.

1. Dip the balance shaft bushing in clean engine oil.
2. Use the balance shaft bushing installers to install the balance shaft bushing.
3. Remove **J 36995** . See Special Tools.

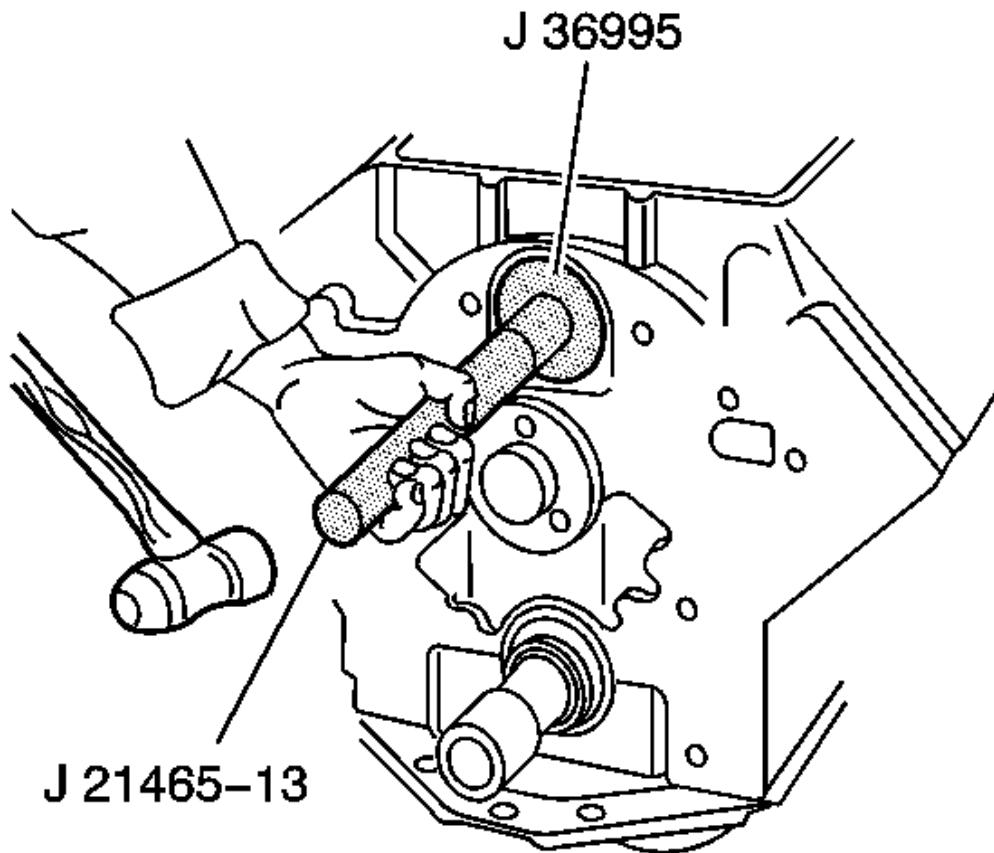


Fig. 407: Installing Balance Shaft Bearing
Courtesy of GENERAL MOTORS CORP.

4. Dip the balance shaft bearing into clean engine oil.
5. Use **J 21465-13** and **J 36995** to install the balance shaft bearing into the engine block. See Special Tools.

CAMSHAFT BEARING INSTALLATION

Special Tools**J 33049:** Camshaft Bearing Service Set

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

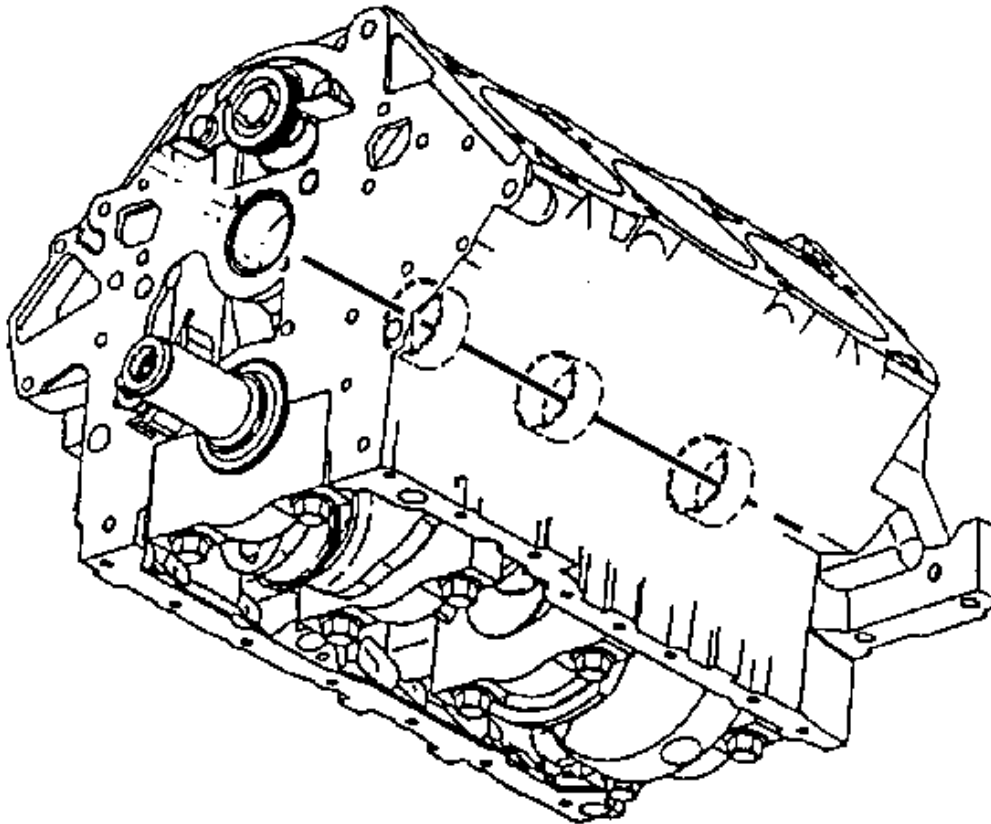
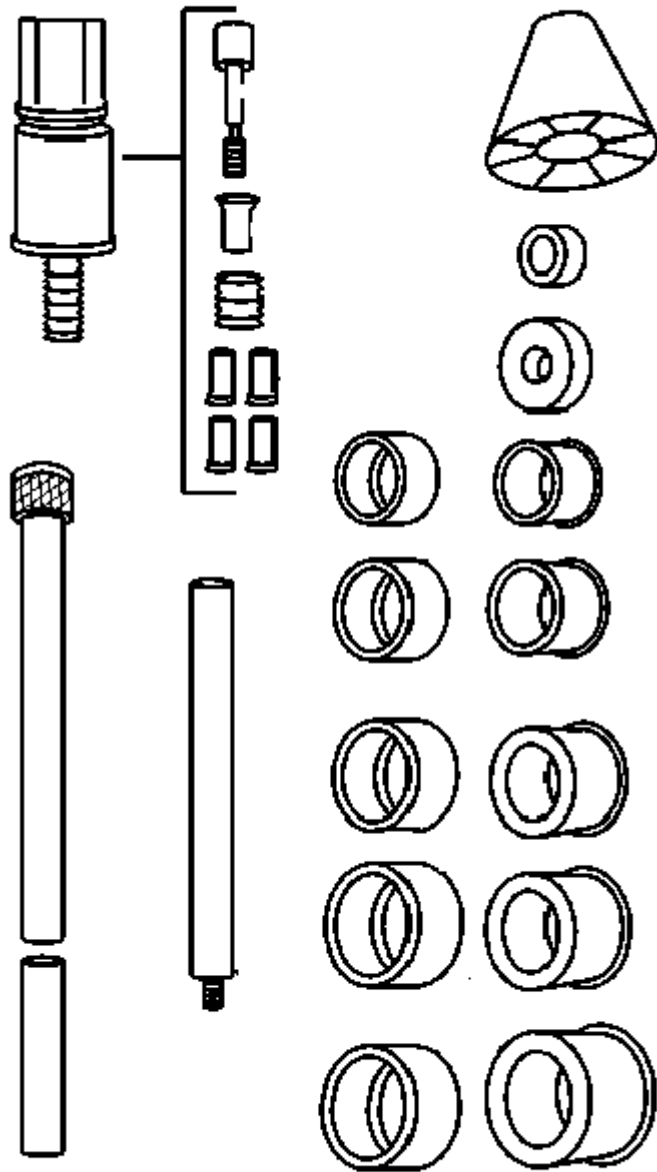


Fig. 408: Identifying Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

1. Select the camshaft bearings.



2. Use the following procedure to install the camshaft bearings:
 1. Assemble **J 33049**: set according to the manufacturer's instructions.
 2. Place the bearing on the tool.

CAUTION: Severe engine damage may result if the oil holes are not correctly aligned.

3. Index the bearing oil holes with the engine block oil passages.

ENGINE BLOCK PLUG INSTALLATION

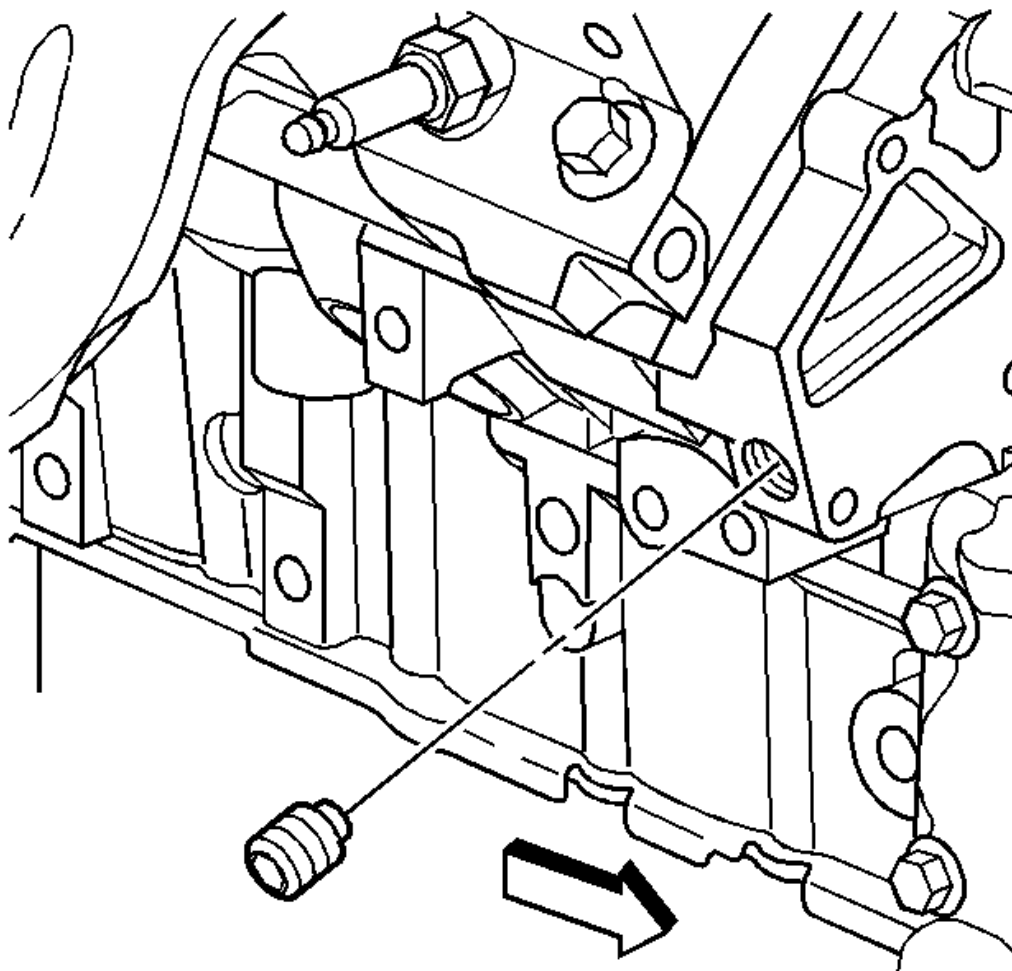


Fig. 410: Locating Threaded Gallery Plugs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

1. Install the threaded oil gallery plugs.

Tighten: Tighten the oil gallery plugs to 30 N.m (22 lb ft).

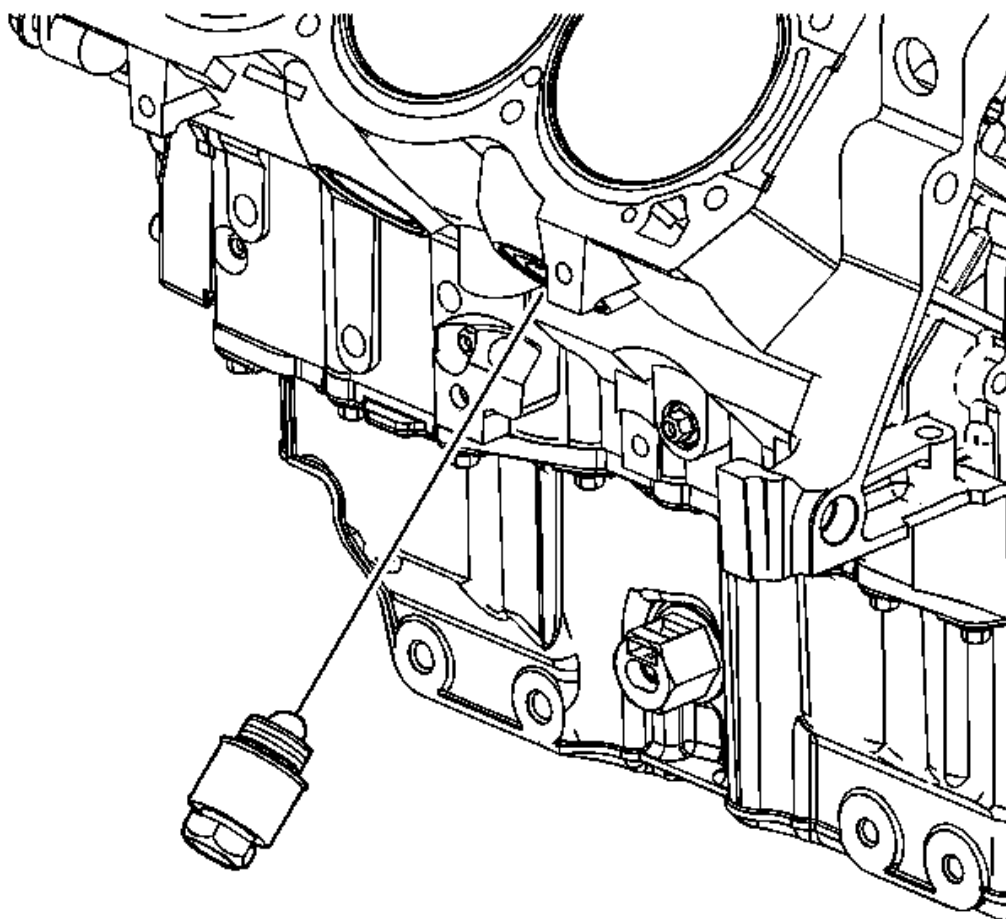


Fig. 411: Threaded Engine Block Heater
Courtesy of GENERAL MOTORS CORP.

2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the threads of the engine block heater.
3. Install the engine block heater.

Tighten: Tighten to 50 N.m (37 lb ft).

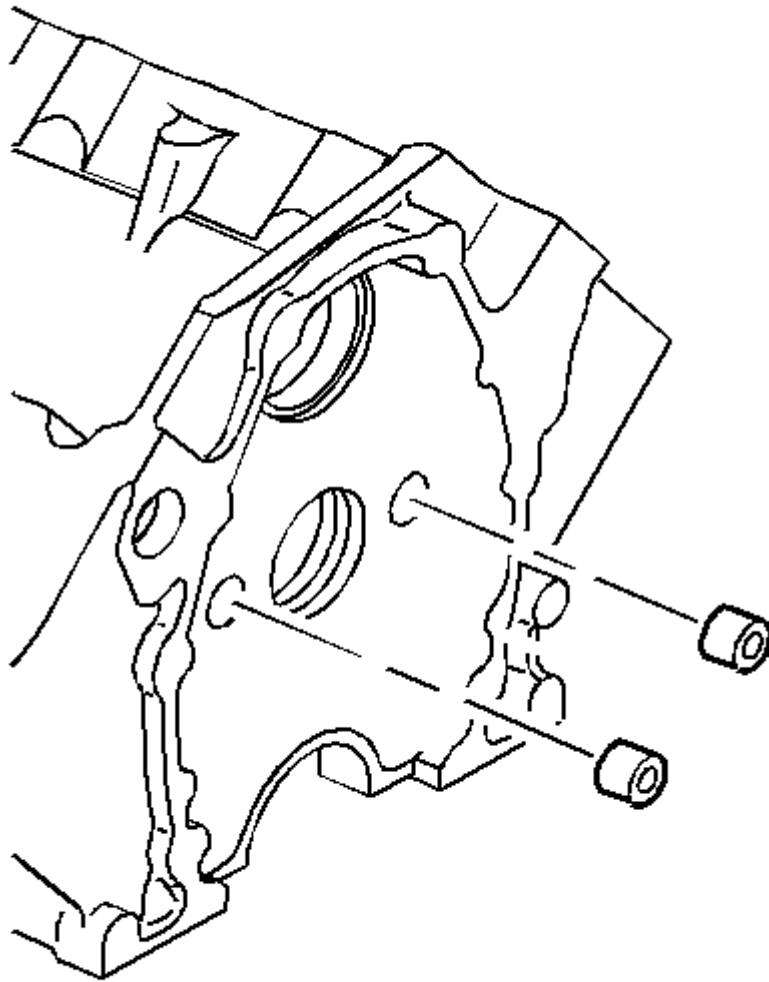


Fig. 412: Locating Engine Block Plugs
Courtesy of GENERAL MOTORS CORP.

4. Install the remaining oil gallery plugs using GM P/N 12346004 (Canadian P/N 10953480) or the equivalent.

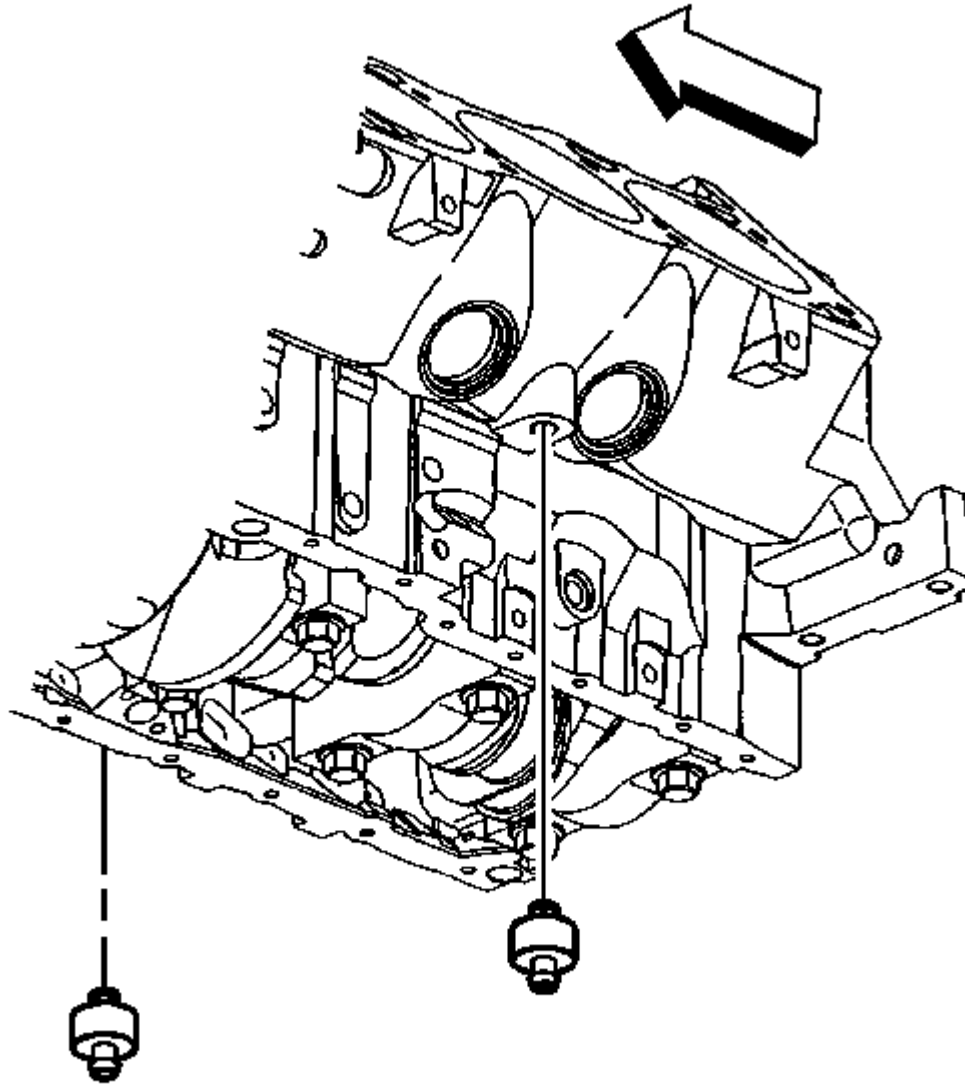


Fig. 413: Identifying Knock Sensors
Courtesy of GENERAL MOTORS CORP.

5. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or the equivalent to the threads of the knock sensor.
6. Install the knock sensors.

Tighten: Tighten the knock sensors to 18 N.m (13 lb ft).

7. Install the knock sensor heat shield and bolts, if applicable.

Tighten: Tighten the knock sensor heat shield bolts to 50 N.m (37 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

J 45059: Angle Meter

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

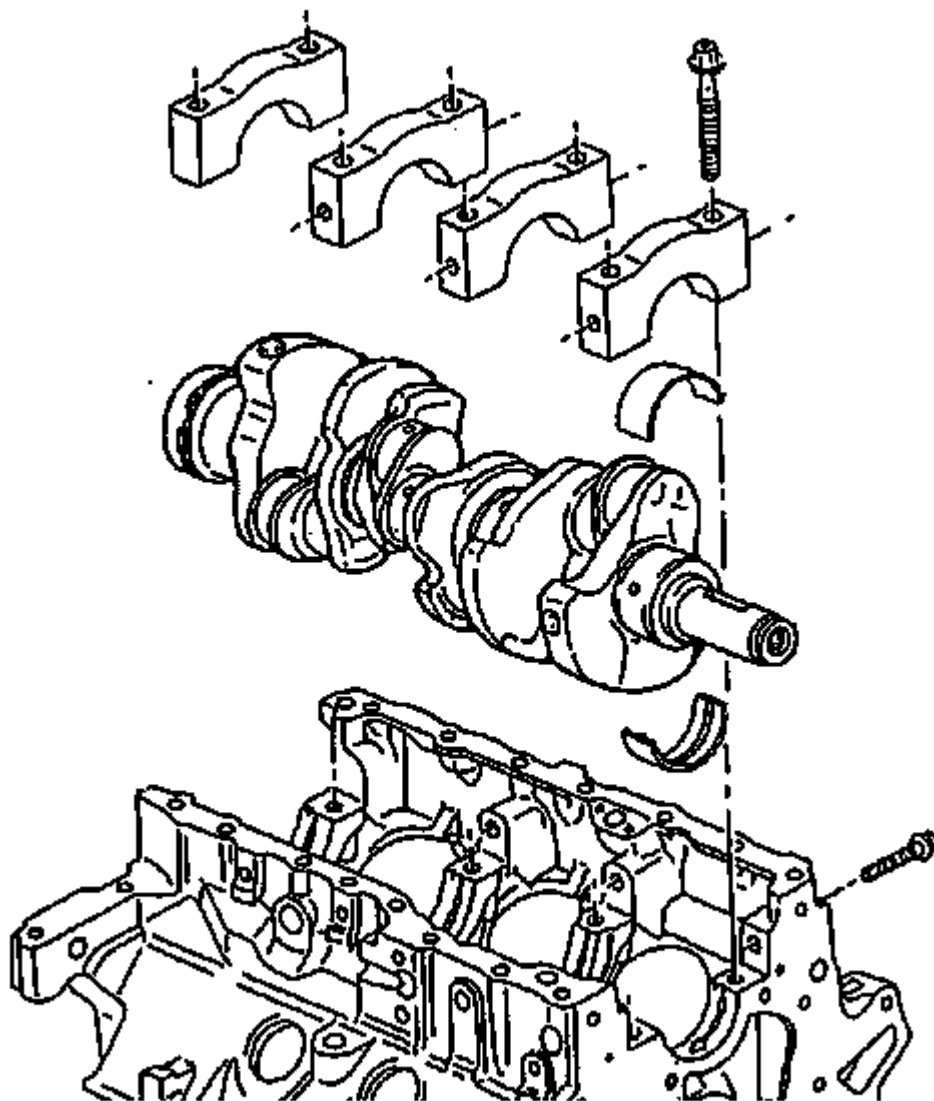


Fig. 414: View Of Crankshaft, Bearings And Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Install the upper crankshaft main bearings.
2. Install the crankshaft. Lubricate the crankshaft to crankshaft main bearing contact areas with engine oil or engine assembly lubricant.

CAUTION: In order to prevent the possibility of cylinder block or crankshaft

bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.

3. Install the lower crankshaft main bearings into the main bearing caps.

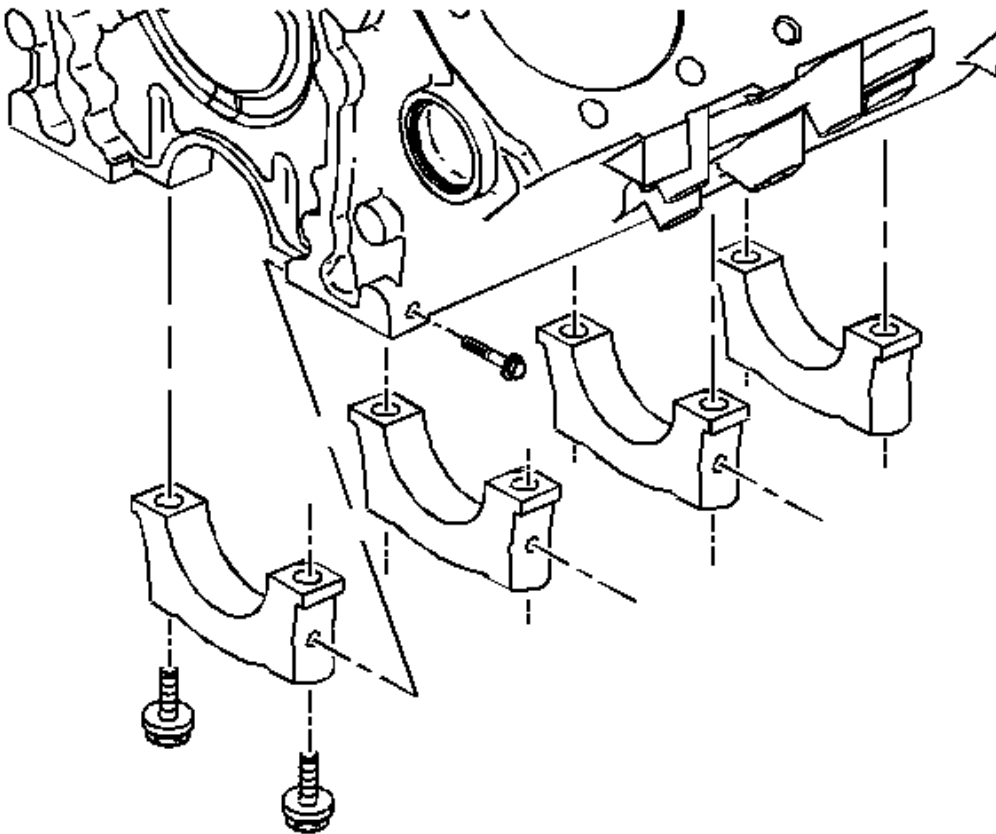


Fig. 415: Crankshaft Main Bearing Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: This bolt is designed to permanently stretch when tightened, and therefore **MUST** be replaced anytime it is removed. The correct part number fastener must be used to replace this type of fastener. Do not use a bolt that is stronger in this application. If the correct bolt is not used, the parts will not be tightened correctly. The system or the

components may be damaged.

CAUTION: Refer to Fastener Caution .

4. Install the crankshaft main bearing cap bolts. Start the crankshaft main bearing cap bolts by hand. Ensure the bottom of the crankshaft main bearing cap is parallel to the bottom of the channel.
 - Tighten the crankshaft main bearing cap bolts in equal increments. Do not completely tighten one bolt at a time to prevent the cap from being cocked.
 - Tighten the bolts to 70 N.m (52 lb ft) to fully seat the crankshaft main bearing caps. Loosen the bolts 360 degrees counterclockwise.
 - Tighten the bolts to 20 N.m (15 lb ft) , then 40 N.m (30 lb ft) .
 - Use **J 45059**: meter to tighten the bolts in steps: 35 degrees + 35 degrees + 40 degrees for a total of 110 degrees .
5. Install the side main bolts. Apply GM P/N United States 12345493, GM P/N Canada 10953488 or the equivalent to the side main bolts and tighten the side crankshaft main bearing cap bolts to 15 N.m (11 lb ft). Use **J 45059**: meter to tighten the bolts an additional 45 degrees.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **J 8037**: Piston Ring Compressor
- **J 41507**: Connecting Rod Guide Assembly
- **J 45059**: Angle Meter

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

1. Position the crankshaft so the connecting rod journal is opposite the piston and connecting rod assembly being installed. This will aid in the installation of the connecting rod assembly.
2. Lubricate the cylinder wall with engine oil.
3. Install the connecting rod bearing inserts.
4. Lubricate the connecting rod bearing insert surface with engine oil.

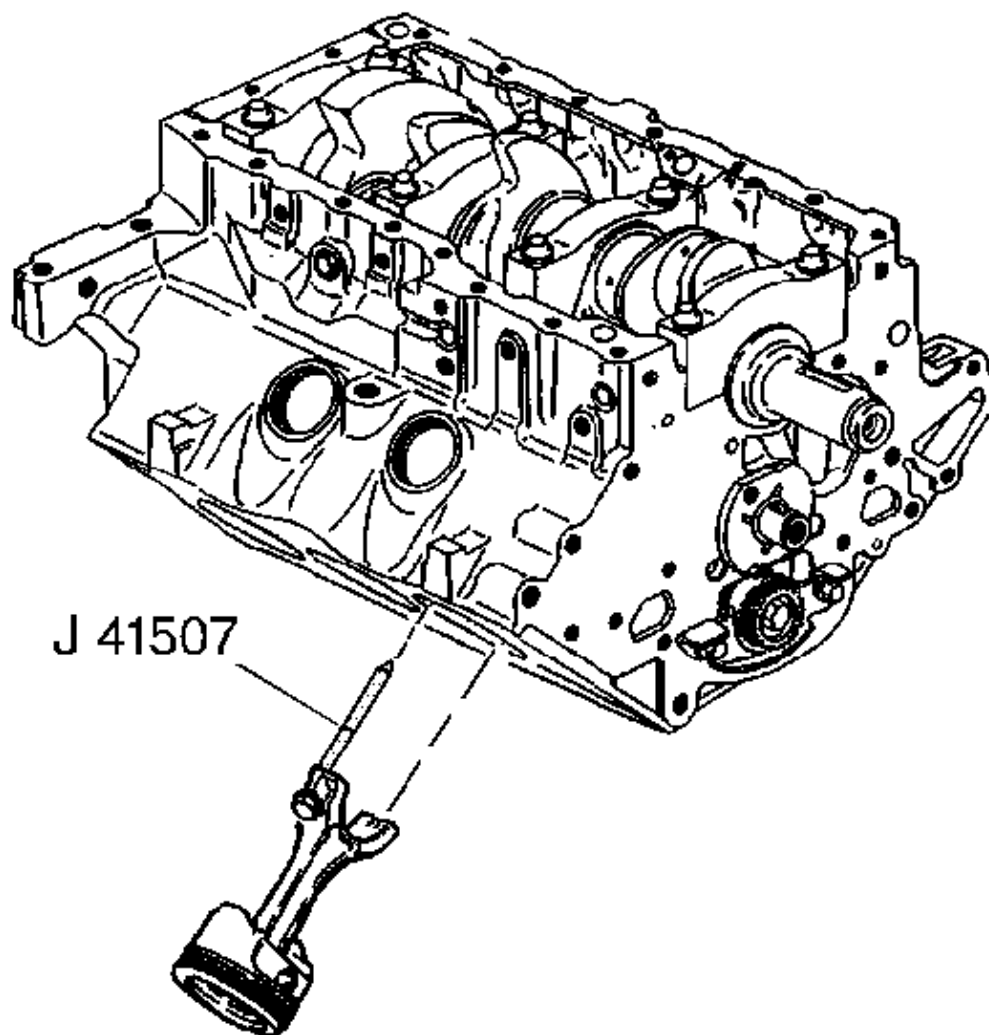


Fig. 416: Installing J 41507 To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Install **J 41507**: assembly to the connecting rod. Hand tighten the tool to the connecting rod.
6. Install **J 8037**: compressor to the piston.

CAUTION: Guide the lower connecting rod end carefully to avoid damaging the crankshaft journal.

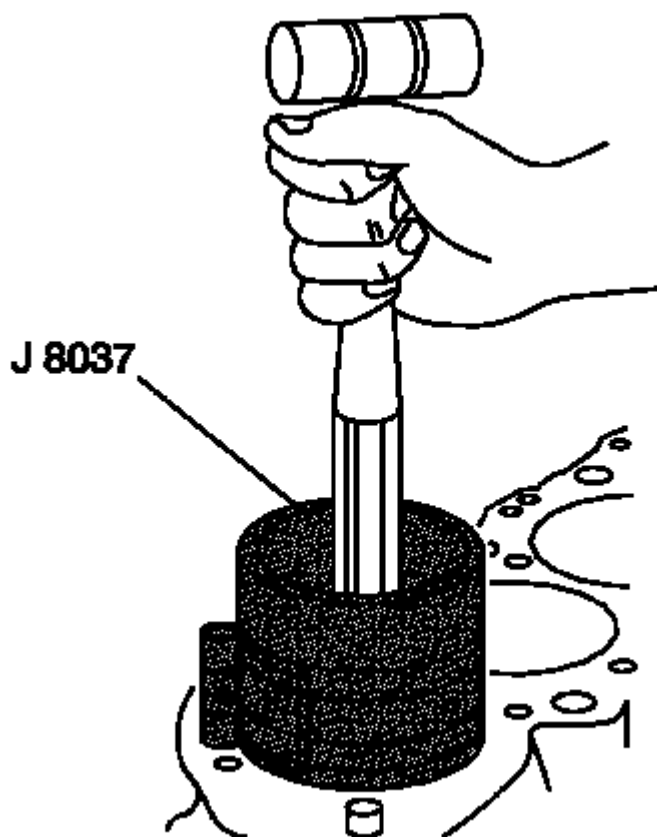


Fig. 417: Installing Piston & Connecting Rod Assembly Into Engine
Courtesy of GENERAL MOTORS CORP.

7. Use **J 8037**: compressor to compress the piston rings for installation of the piston and connecting rod assembly.
8. Install the piston and connecting rod assembly into the engine.

NOTE: **Ensure the arrow on top of the piston or the markings made during removal face towards the front of the engine or are in the same location as when removed.**

9. Use **J 41507**: assembly to pull the connecting rod into place.
10. Remove **J 41507**: assembly.

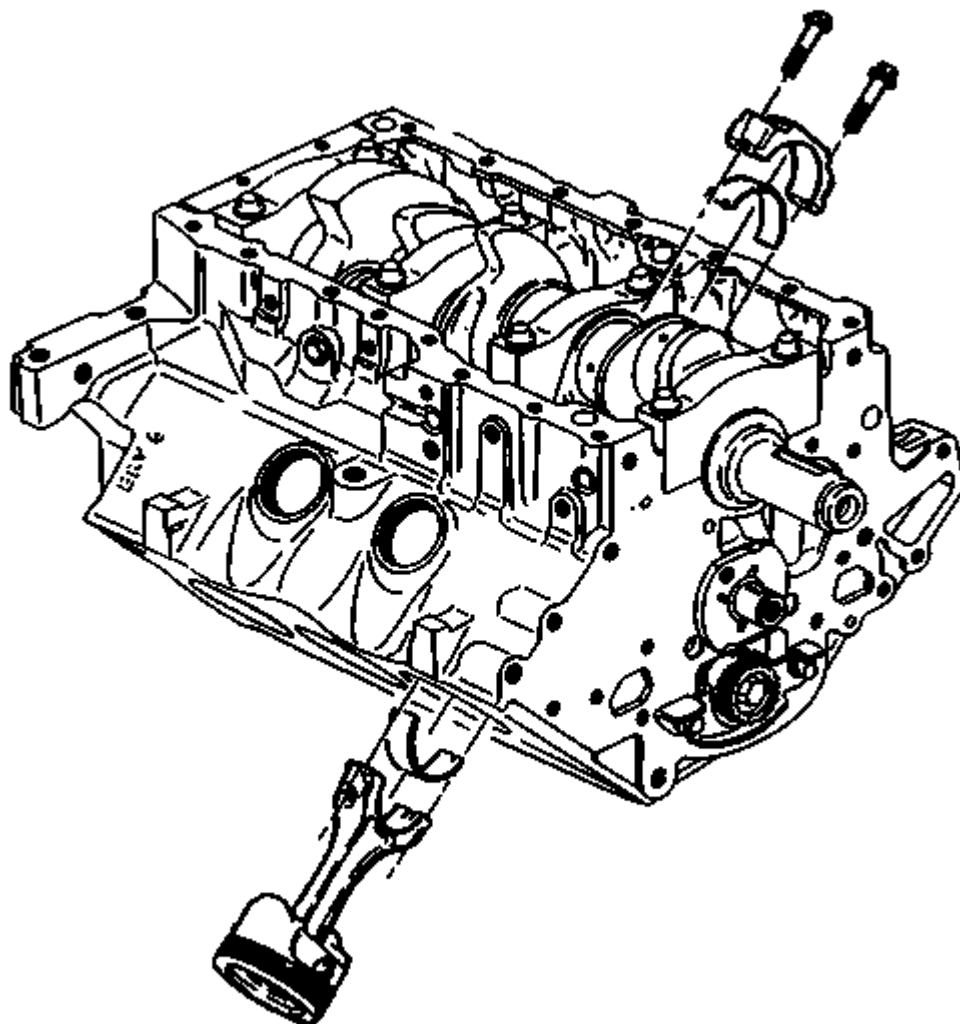


Fig. 418: Connecting Rod Bolts & Cap
Courtesy of GENERAL MOTORS CORP.

11. Install the connecting rod bearing cap.

CAUTION: Refer to Special Fastener Caution .

CAUTION: Refer to Fastener Caution .

12. Install the connecting rod bearing cap bolts and tighten the connecting rod bearing cap bolts to 27 N.m (20 lb ft) + 50 degrees using **J 45059**: meter.
13. Pry the connecting rod back and forth and check for binding. If necessary loosen and retighten the connecting rod bearing cap.

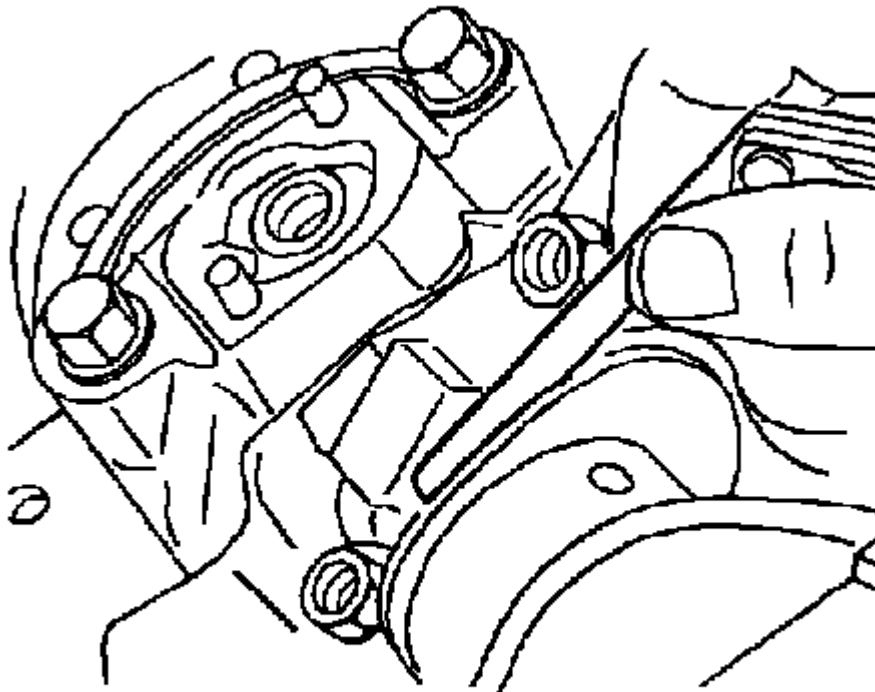


Fig. 419: Measuring Connecting Side Clearance
Courtesy of GENERAL MOTORS CORP.

14. Measure the connecting rod side clearance.

CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION

Special Tools

- **EN-47623**: Rear Main Seal Installer
- **J 8092**: Drive Handle
- **J 45059**: Angle Meter

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

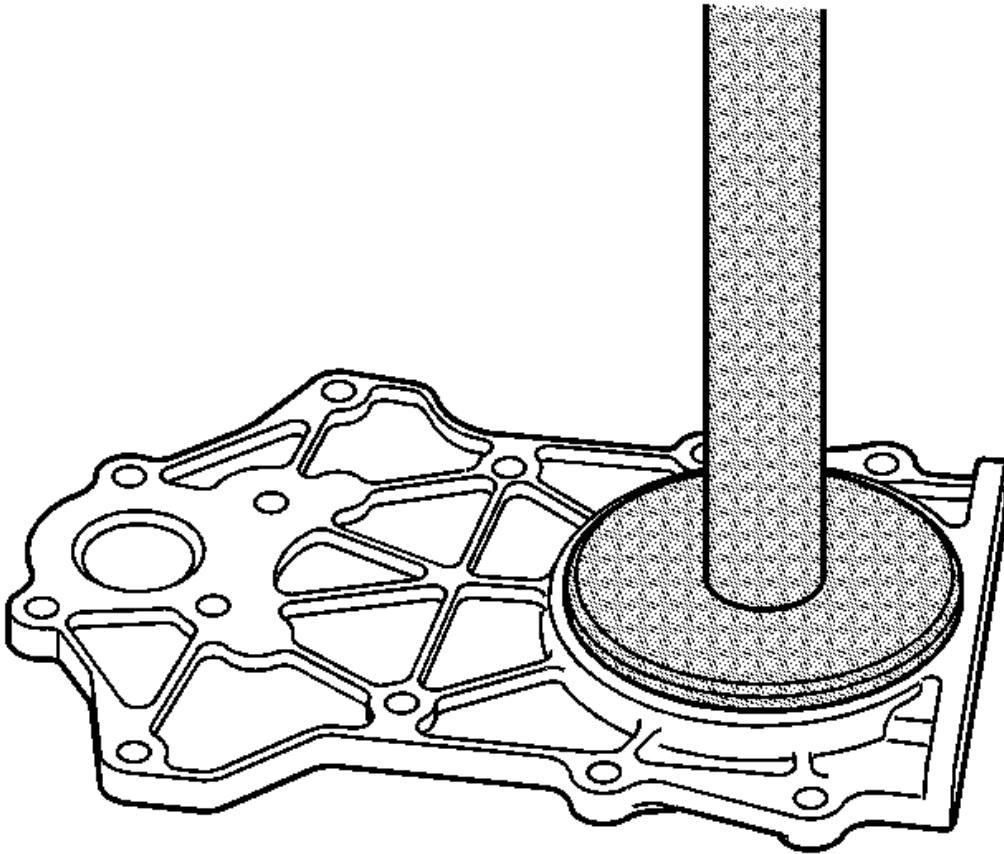


Fig. 420: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not apply or use any oil lubrication on the crankshaft rear oil seal, or the seal installer. Do not touch the sealing lip of the oil seal once the protective sleeve is removed. Doing so will damage/deform the seal.

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

1. Clean and inspect the crankshaft rear oil seal housing making sure it is free of any foreign material.
2. With all bolts removed from the housing, place it face up on a flat clean surface.
3. Carefully remove protection sleeve from the new rear oil seal assembly.

4. Install the seal onto **EN-47623**: installer by placing the seal on an angle and using a twisting motion until it is fully seated.
5. Place **EN-47623**: installer along with **J 8092**: handle onto the housing as shown and apply a constant downward force until the seal is fully seated.

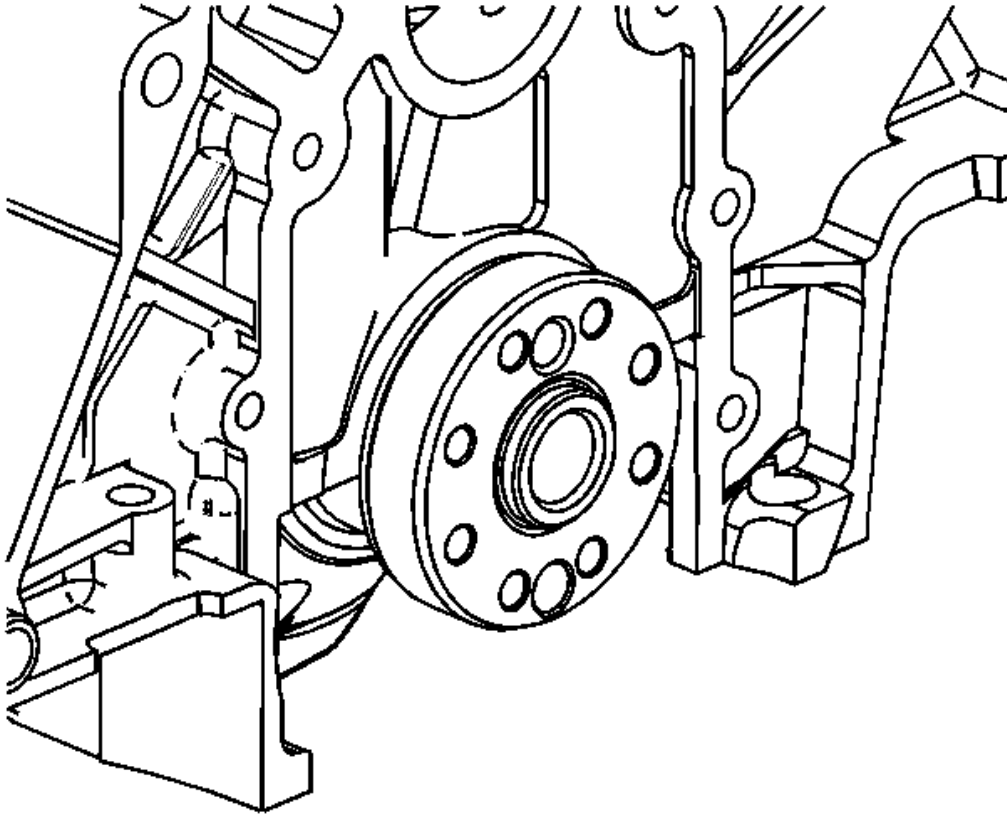


Fig. 421: View Of Crankshaft Sealing Surface
Courtesy of GENERAL MOTORS CORP.

6. Clean the crankshaft sealing surface with a clean, lint free towel. Inspect the crankshaft sealing surface and leading edge of the crankshaft for burrs/sharp edges that could damage the rear main oil seal. Remove any burrs or sharp edges with crocus cloth before proceeding.

CAUTION: Do not use a sealant or adhesive when installing this component. Use of a sealant or adhesive can cause improper sealing. A component that is not sealed properly can leak leading to extensive engine damage.

NOTE: Always install a new crankshaft rear oil seal housing gasket.

7. Install a new crankshaft rear oil seal housing gasket and the housing onto the engine.

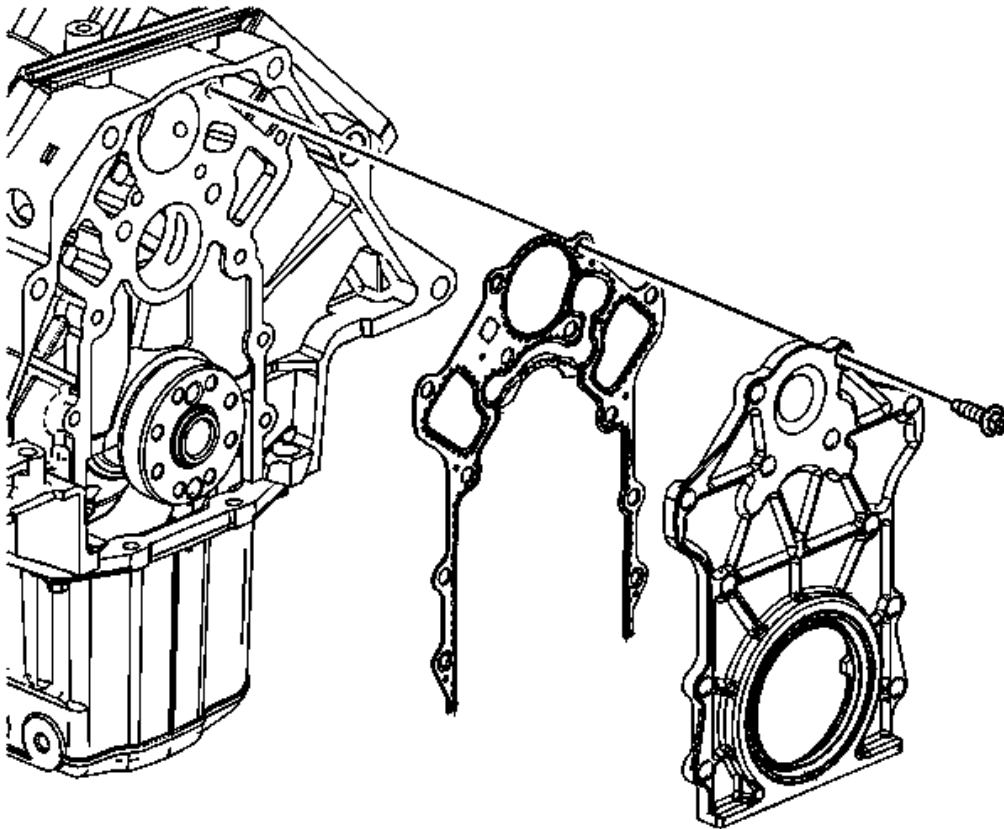


Fig. 422: Crankshaft Rear Oil Seal & Housing (Second Design)
Courtesy of GENERAL MOTORS CORP.

NOTE: The plastic inserts found on the rear oil seal housing retaining bolts are used to aid production assembly only. The inserts are not required for service.

8. Install the crankshaft rear oil seal housing gasket and housing.
9. Install the crankshaft rear oil seal housing bolts.

CAUTION: Refer to Fastener Caution .

10. Tighten the crankshaft rear oil seal housing bolts to Tighten the crankshaft rear oil seal housing bolts to 15 N.m (11 lb ft). Use **J 45059**: meter to tighten the bolts an additional 50 degrees.

CAMSHAFT INSTALLATION

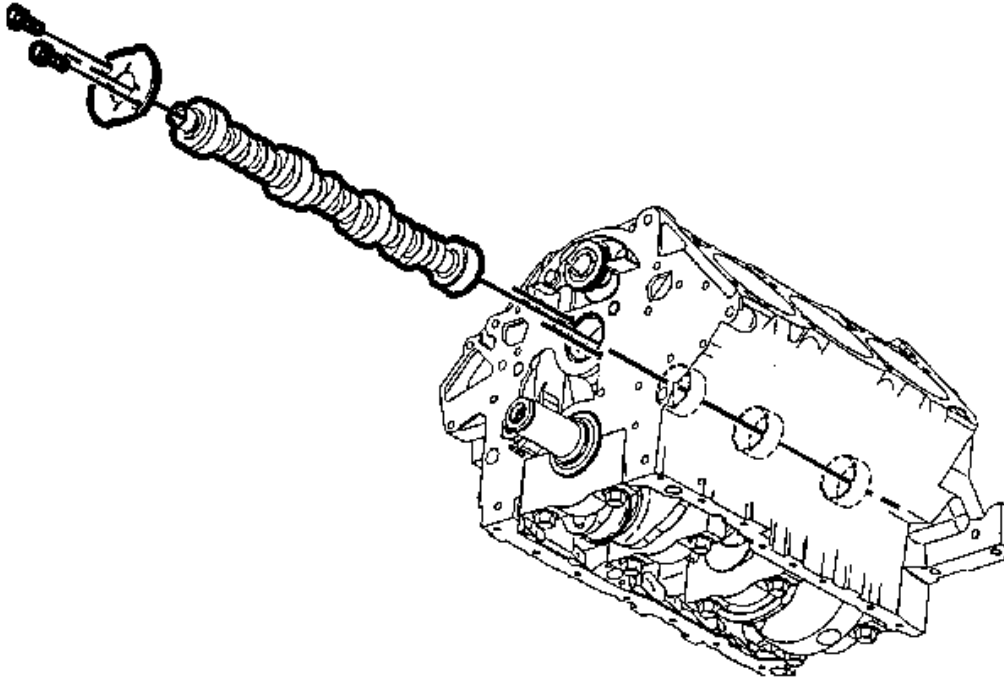


Fig. 423: Installing Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Coat the camshaft with prelube GM P/N 12345501 (Canadian P/N 992704) or the equivalent.
2. Install the camshaft.
3. Install the camshaft thrust plate.

NOTE: Refer to **FASTENER CAUTION** .

4. Install the camshaft thrust plate bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

BALANCE SHAFT INSTALLATION

Special Tools

- **J 8001:** Dial Indicator Set
- **J 21465-13:** Drive Handle Extension
- **J 36996:** Balance Shaft Installer
- **J 45059:** Angle Meter

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

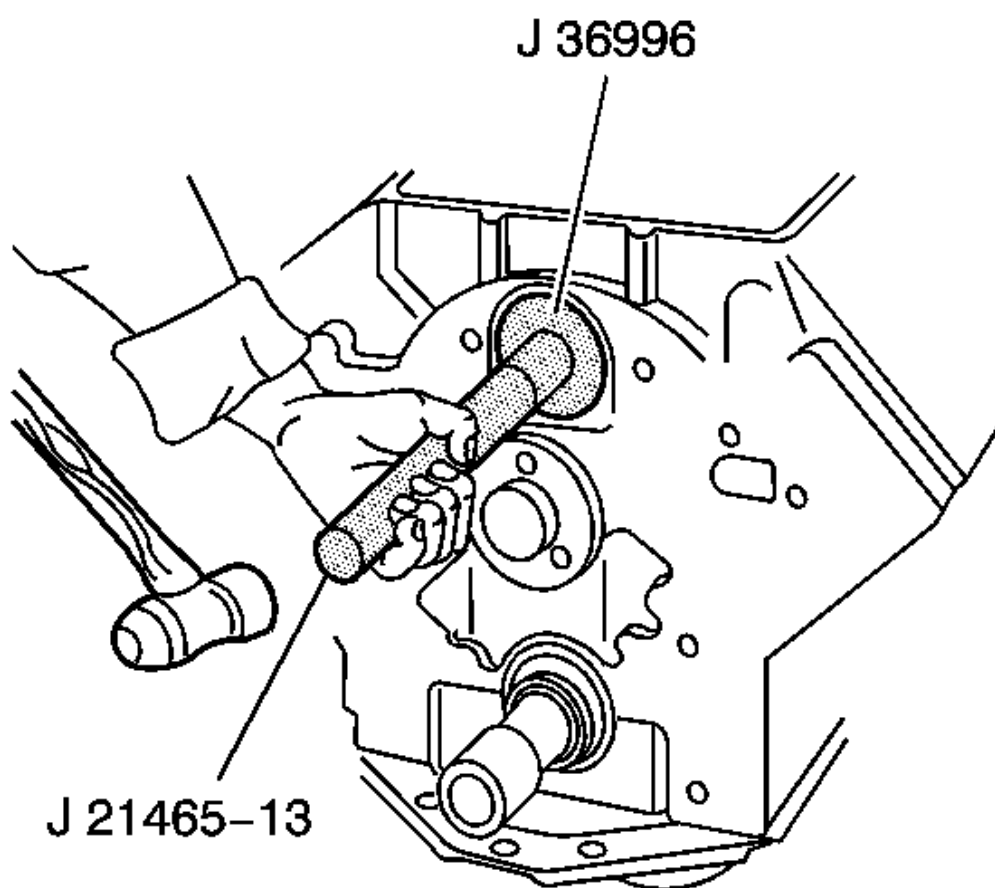


Fig. 424: Installing Balance Shaft
Courtesy of GENERAL MOTORS CORP.

1. Use **J 21465-13:** extension and **J 36996:** installer to install the balance shaft into the engine block.

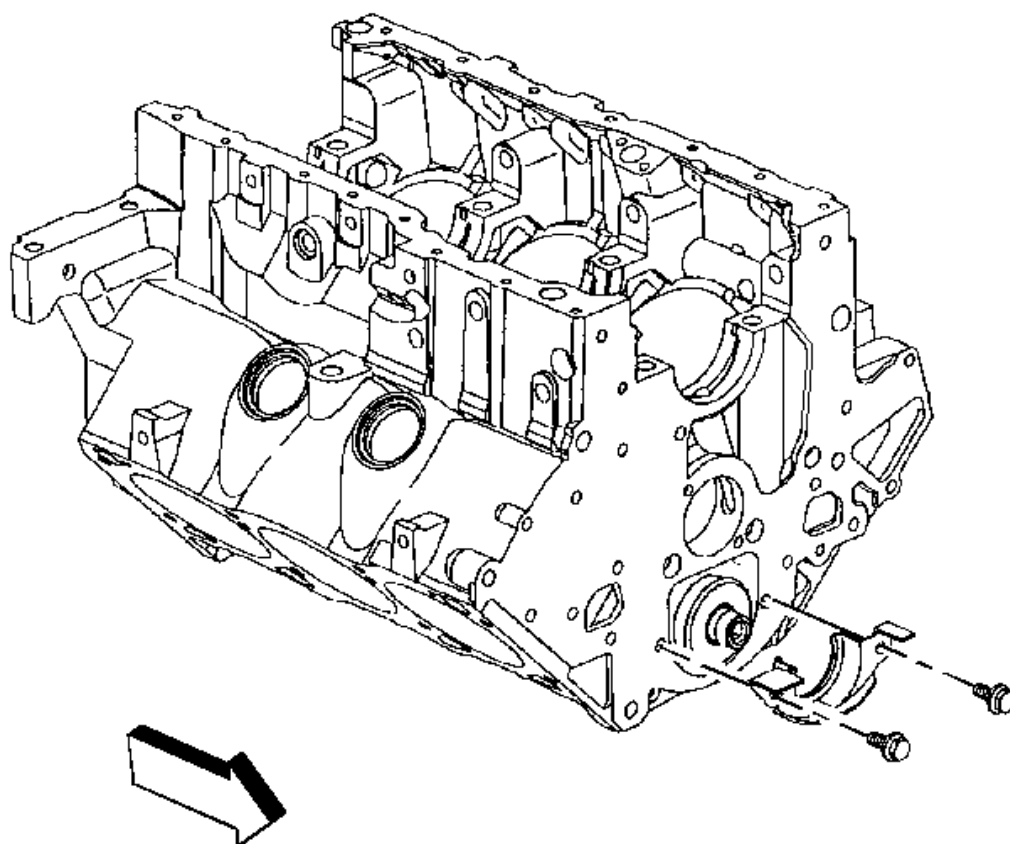


Fig. 425: View Of Balance Shaft Retainer
Courtesy of GENERAL MOTORS CORP.

2. Install the balance shaft retainer.

CAUTION: Refer to Fastener Caution .

3. Install the balance shaft retainer bolts and tighten to 30 N.m (22 lb ft).

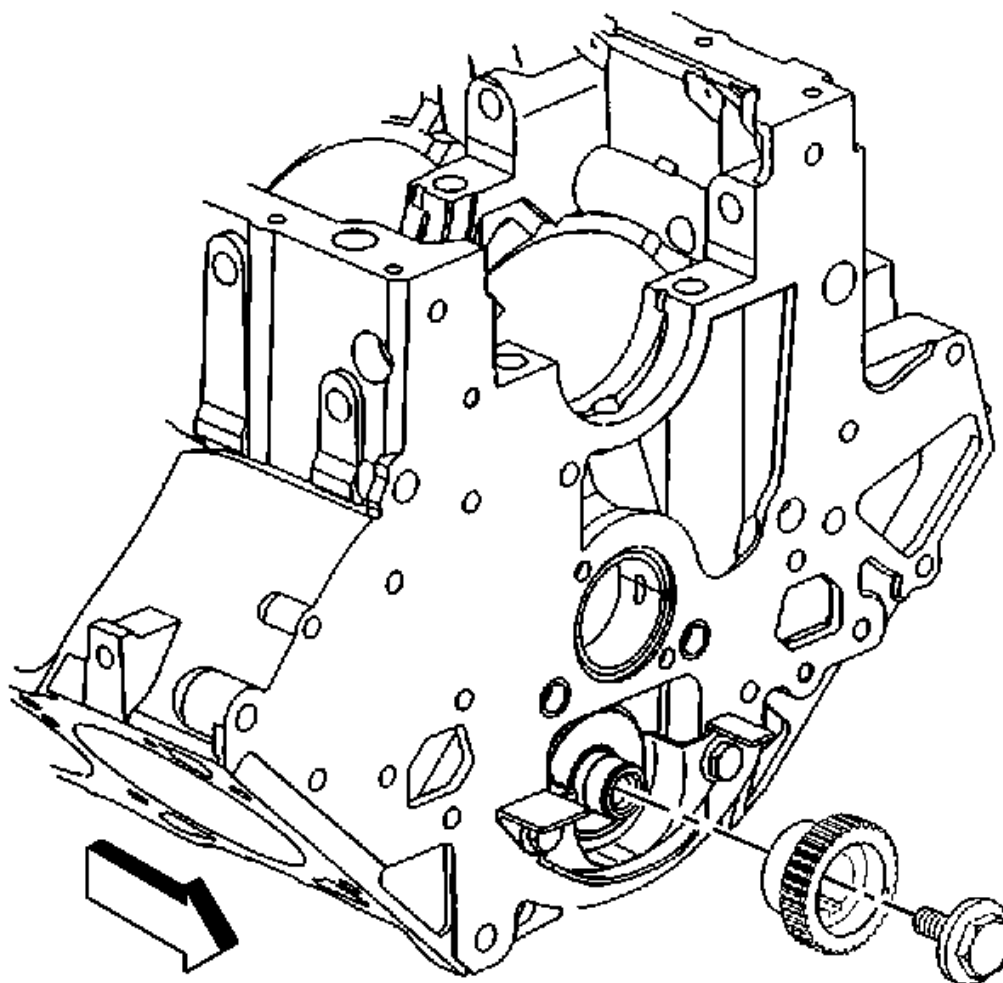


Fig. 426: Locating Balance Shaft Driven Gear & Bolt
 Courtesy of GENERAL MOTORS CORP.

4. Install the balance shaft driven gear.

CAUTION: Refer to Special Fastener Caution .

5. Install the balance shaft driven gear bolt and Tighten the balance shaft driven gear bolt to 22 N.m (16 lb ft). Use **J 45059**: meter to tighten the bolt an additional 70 degrees.

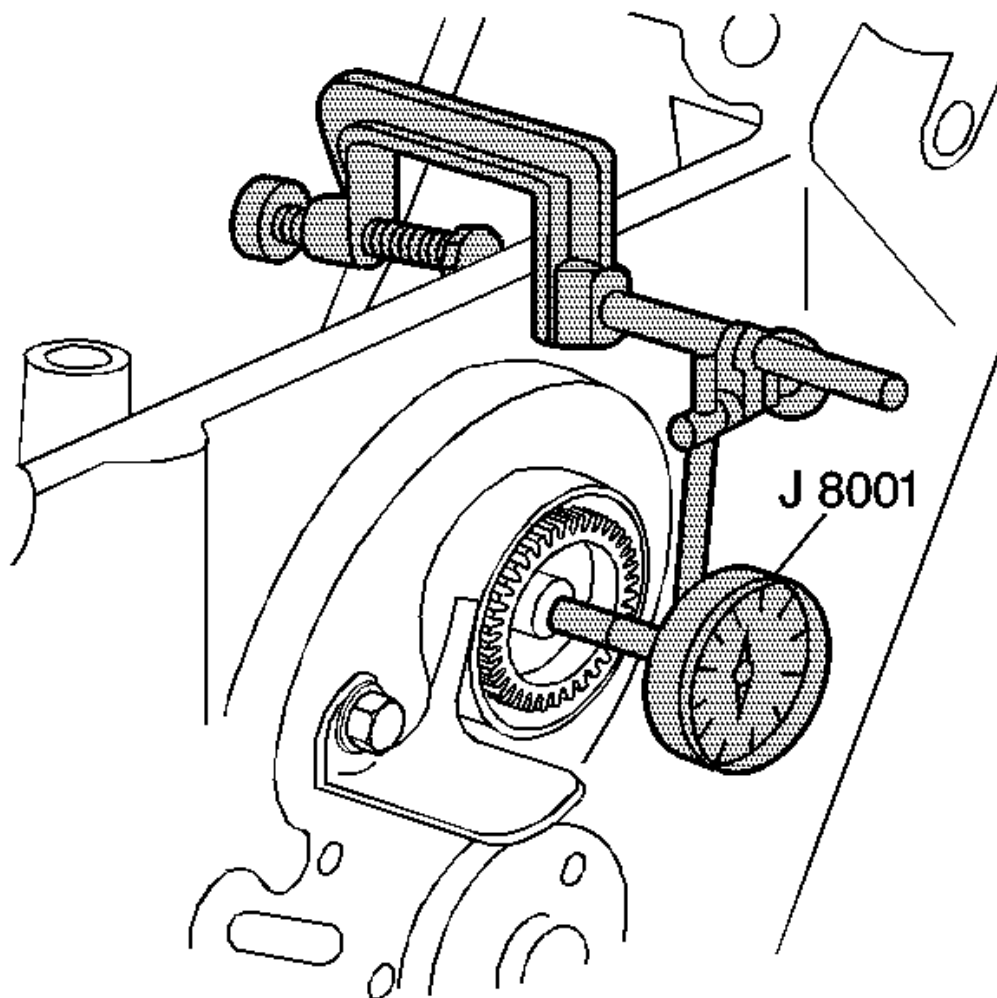


Fig. 427: Measuring Balance Shaft End Play
Courtesy of GENERAL MOTORS CORP.

6. Using **J 8001**: set measure the balance shaft end play. End play must not exceed 0.028 mm (0.008 in).

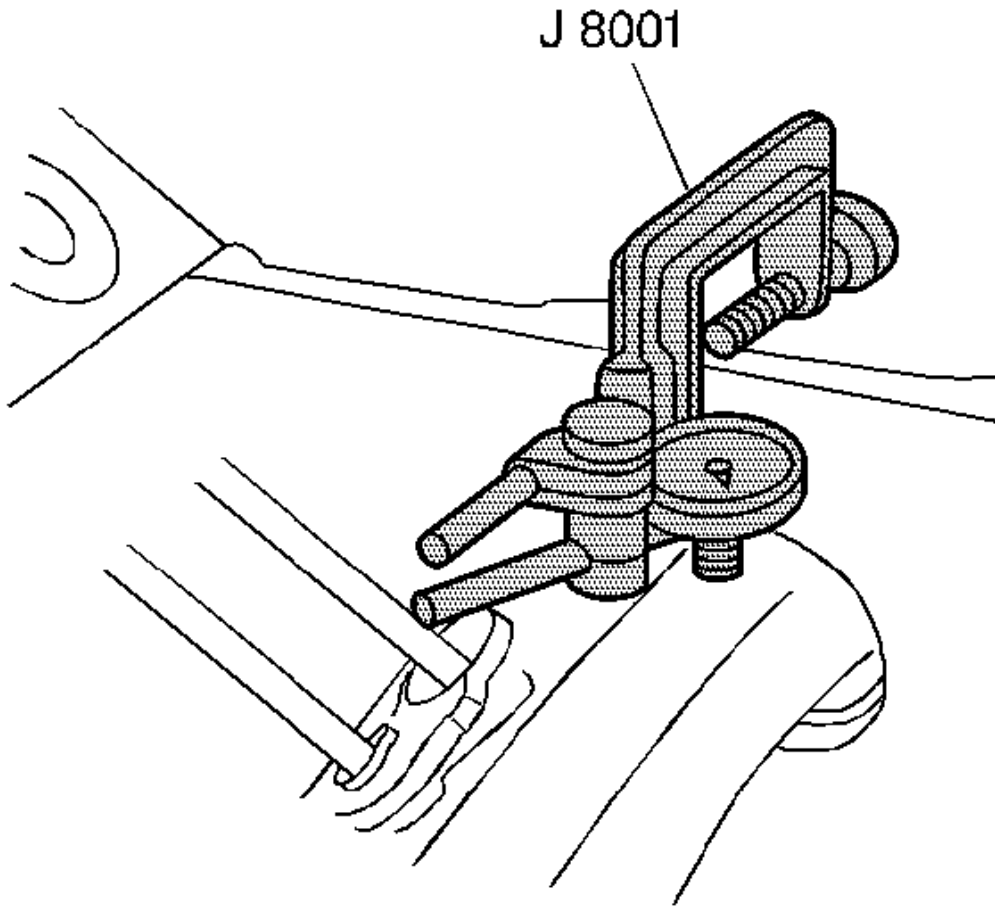


Fig. 428: Measuring Balance Shaft Radial Play
Courtesy of GENERAL MOTORS CORP.

7. Using **J 8001**: set measure the balance shaft radial play at the rear. Radial play must be between 0.0127-0.119 mm (0.0005-0.0047 in).
8. Install the balance shaft drive gear.
9. Install the camshaft sprocket.
10. Turn the camshaft so the timing mark on the camshaft sprocket is straight down.
11. Remove the camshaft sprocket and balance shaft drive gear.
12. Turn the balance shaft so the timing mark on the balance shaft driven gear points straight down.
13. Partially install the balance shaft drive gear so the gear teeth are not engaged.
14. Align the marks on the balance shaft driven gear and the balance shaft drive gear. Do this by turning the balance shaft.

15. Once marks are aligned, fully seat balance shaft drive gear and engage gear teeth.
16. Turn the crankshaft so the number one piston is at top dead center.
17. Install the timing chain and camshaft sprocket.

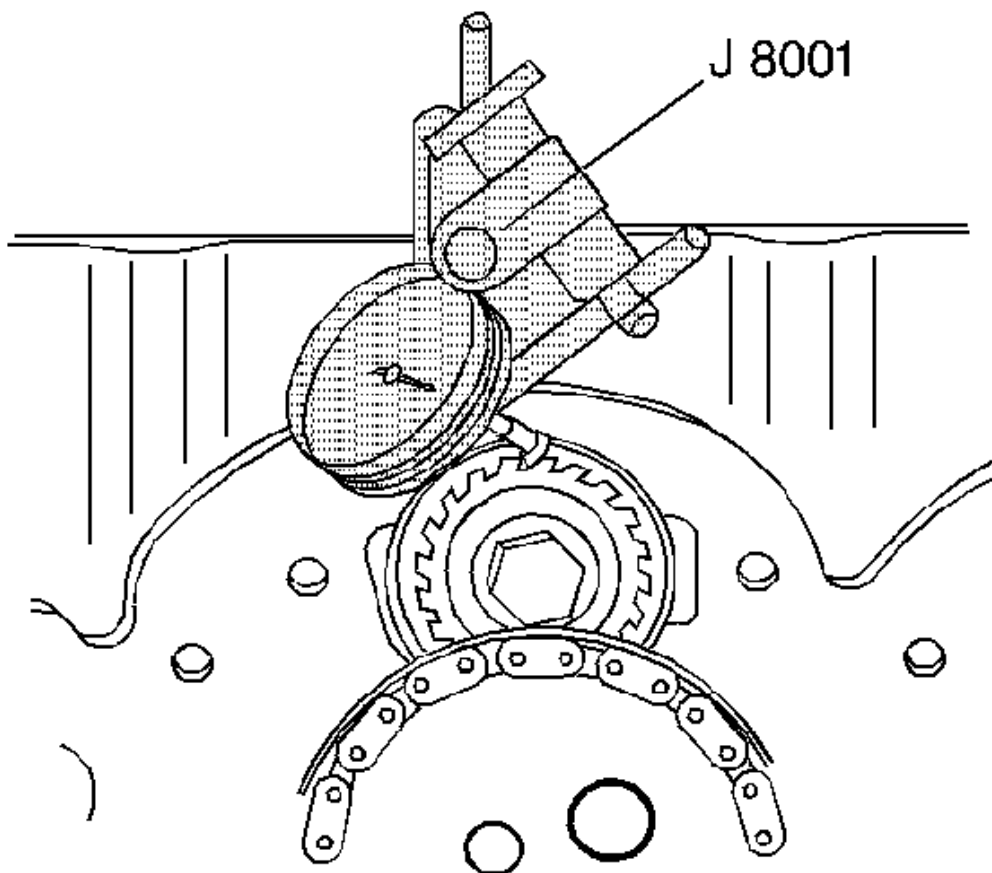


Fig. 429: Measuring Balance Shaft Gear Lash
Courtesy of GENERAL MOTORS CORP.

18. Using **J 8001**: set measure the gear lash at four places. Measure every quarter turn. Gear lash must be between 0.050-0.127 mm (0.002-0.005 in).

TIMING CHAIN AND SPROCKET INSTALLATION (L26)

Special Tools

J 45059: Angle Meter

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

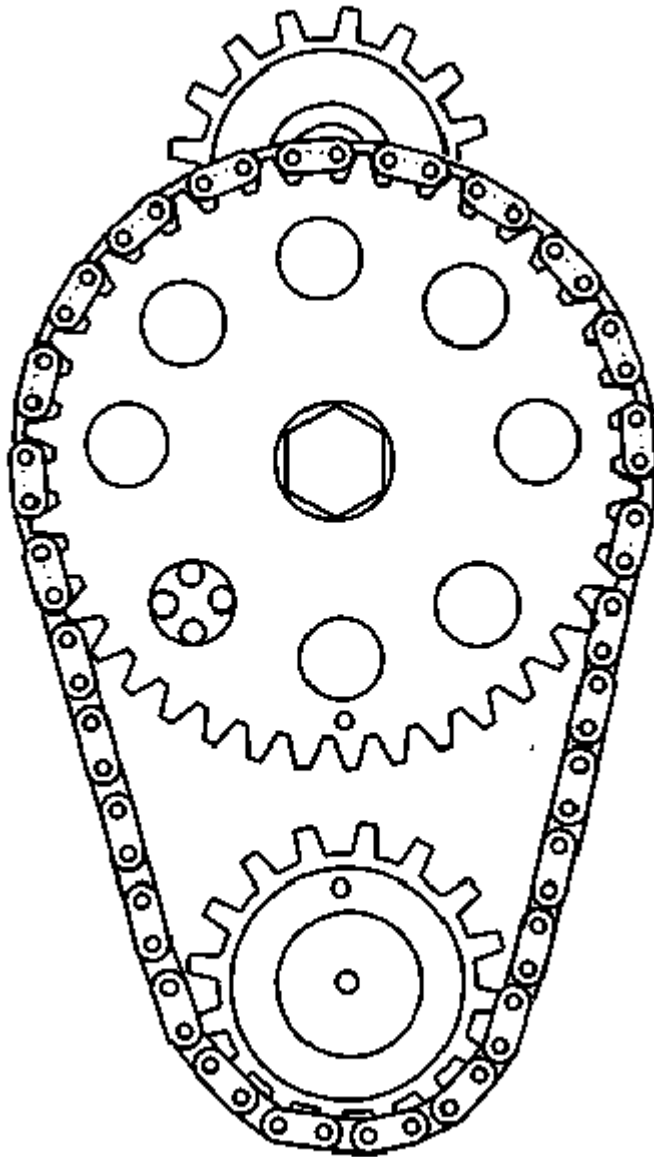


Fig. 430: Aligning The Timing Marks
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer key into the crankshaft keyway.

The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.

2. Install the timing chain on the sprockets. Align the timing marks.

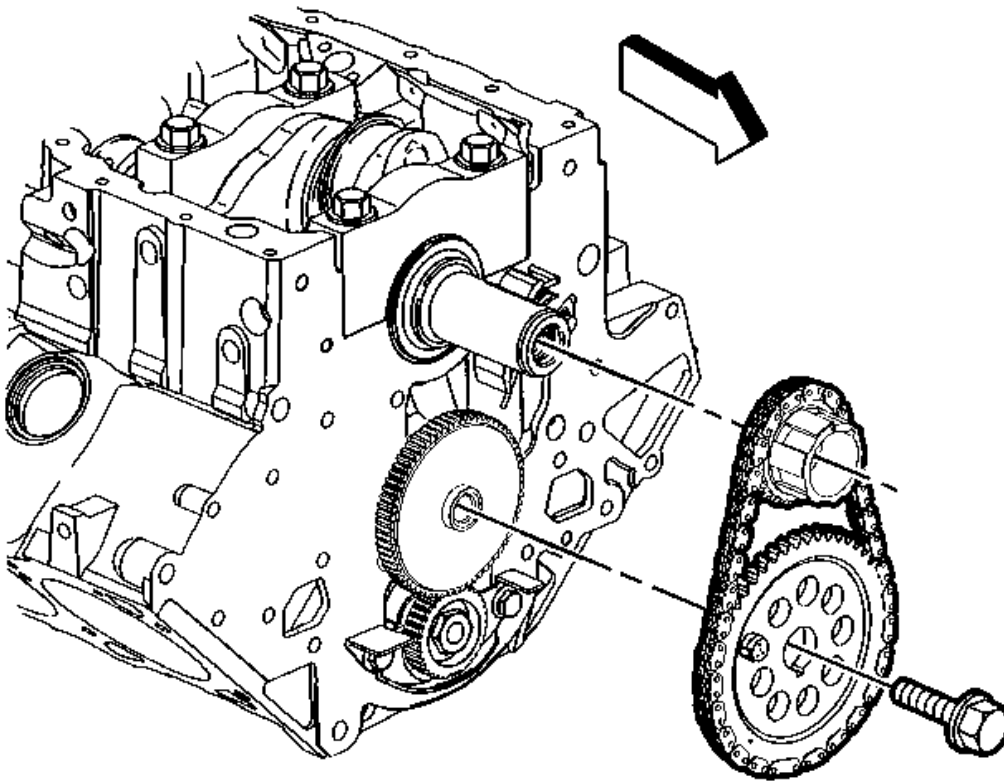


Fig. 431: Timing Chain, Crankshaft Sprocket & Camshaft Sprocket (L26)
Courtesy of GENERAL MOTORS CORP.

3. Install the timing chain, the crankshaft sprocket, and the camshaft sprocket.

CAUTION: Refer to Special Fastener Caution .

CAUTION: Refer to Fastener Caution .

4. Install the camshaft sprocket bolt and tighten the camshaft sprocket bolt to 100 N.m (74 lb ft). Use **J 45059** meter to tighten the camshaft sprocket bolt an additional 90 degrees.

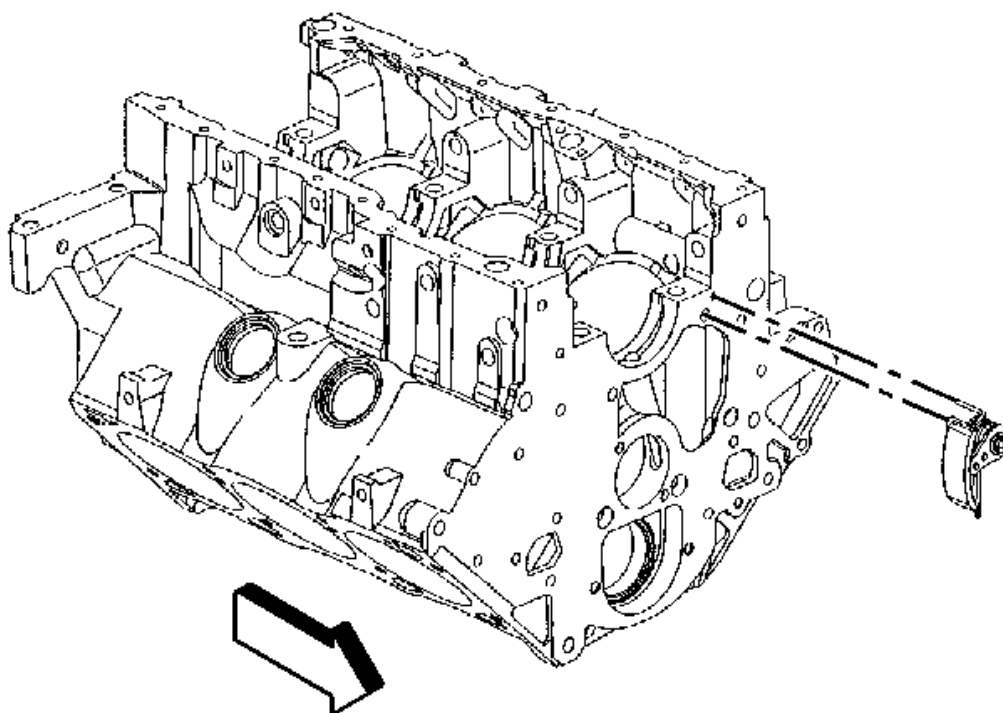


Fig. 432: View Of Timing Chain Dampener
Courtesy of GENERAL MOTORS CORP.

5. Install the timing chain dampener and tighten the timing chain dampener bolt to 22 N.m (16 lb ft).

ENGINE FRONT COVER INSTALLATION

Tools Required

J 45059 Angle Meter

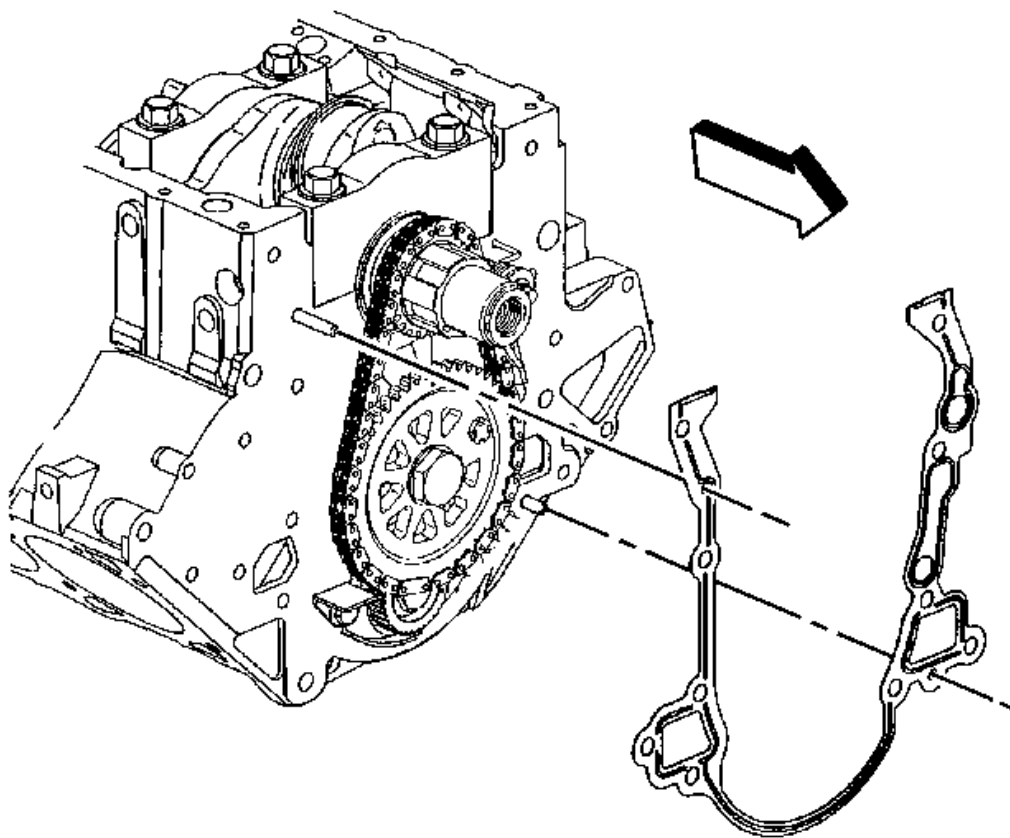


Fig. 433: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the engine front cover gasket.

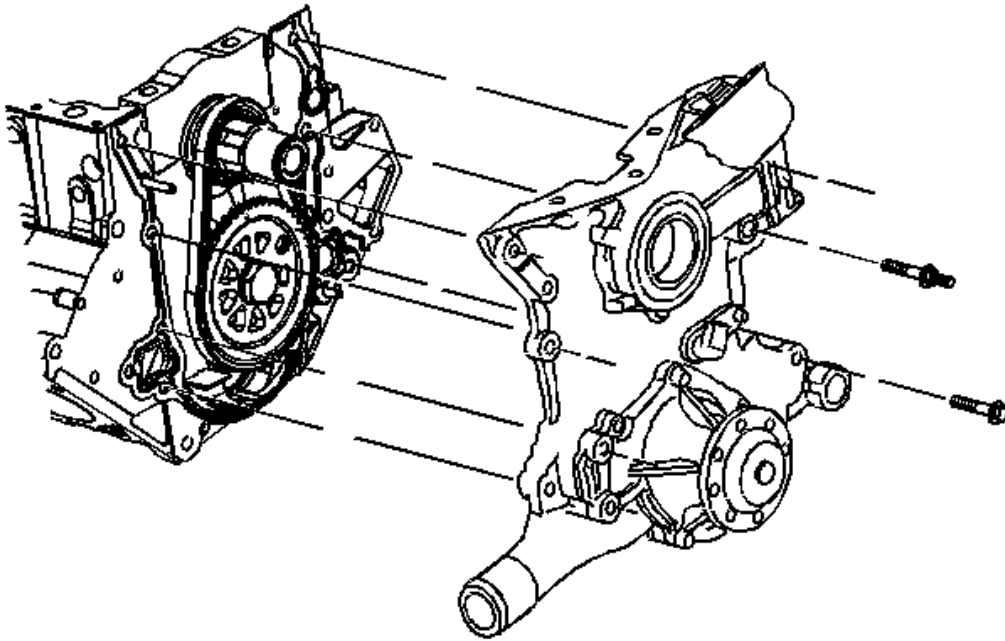


Fig. 434: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the engine front cover.

Align the cogs on the crankshaft sprocket with the cogs on the oil pump in the engine front cover.

3. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or the equivalent to the engine front cover bolt threads.

NOTE: Refer to **FASTENER CAUTION** .

4. Install the engine front cover bolts.

Tighten: Tighten the engine front cover bolts to 20 N.m (15 lb ft). Use the **J 45059** to tighten the engine front cover bolts an additional 40 degrees.

5. Install the oil filter.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

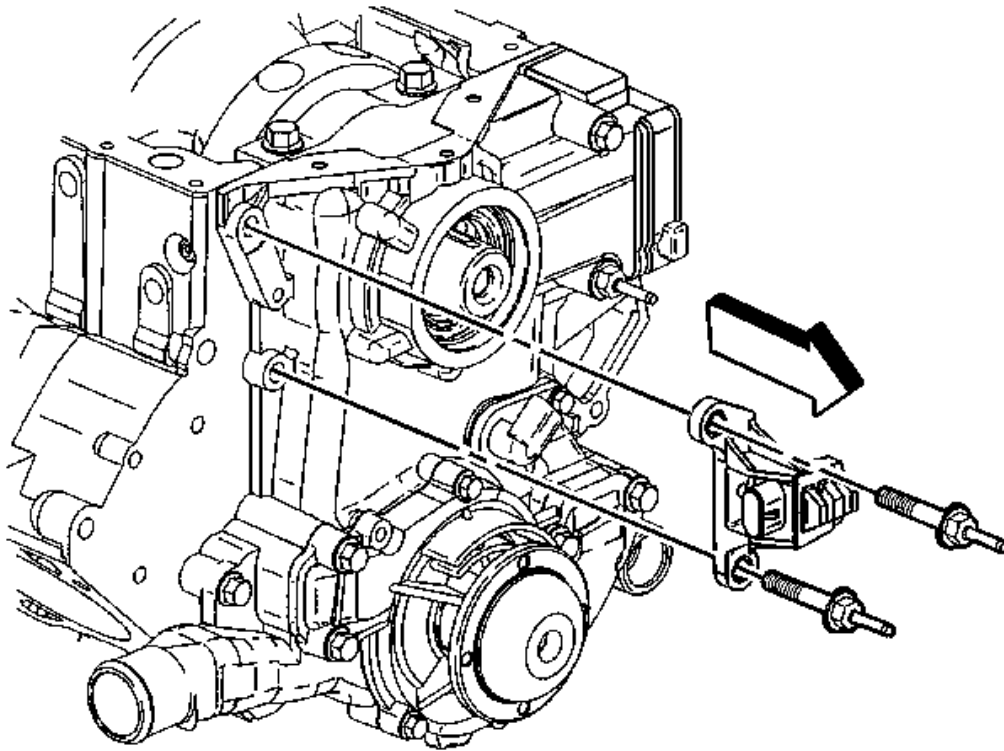


Fig. 435: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

6. Install the crankshaft position sensor.

Tighten: Tighten the crankshaft position sensor studs to 30 N.m (22 lb ft).

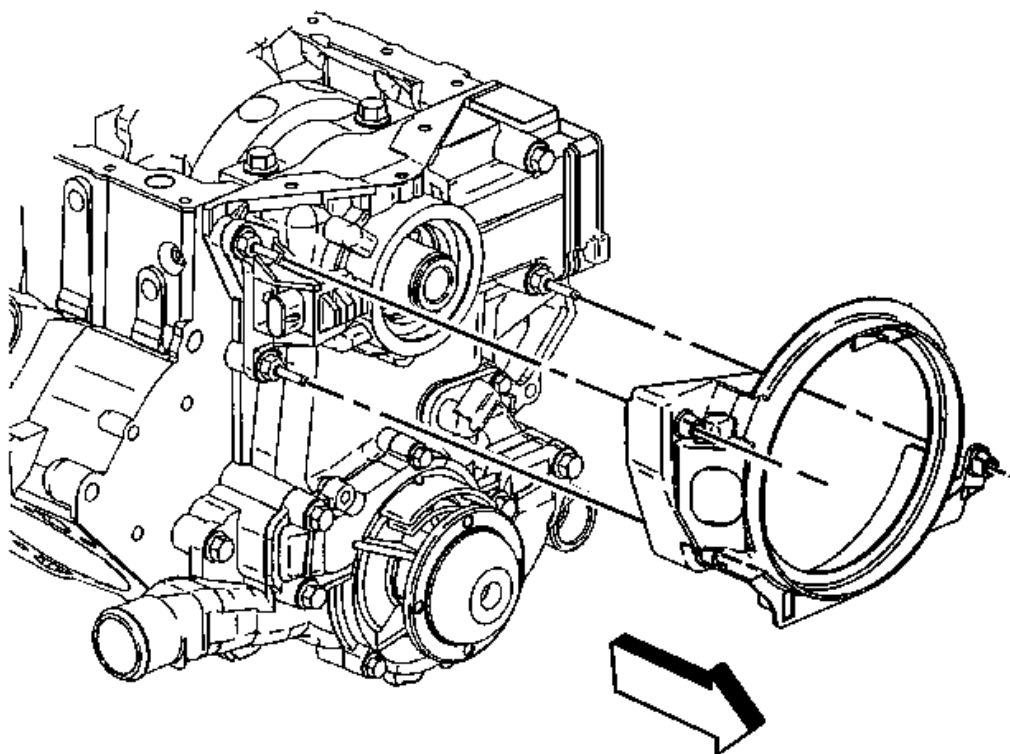


Fig. 436: Crankshaft Position Sensor Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the crankshaft position sensor shield.

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Tools Required

J 35354 Seal Installer. See **Special Tools**.

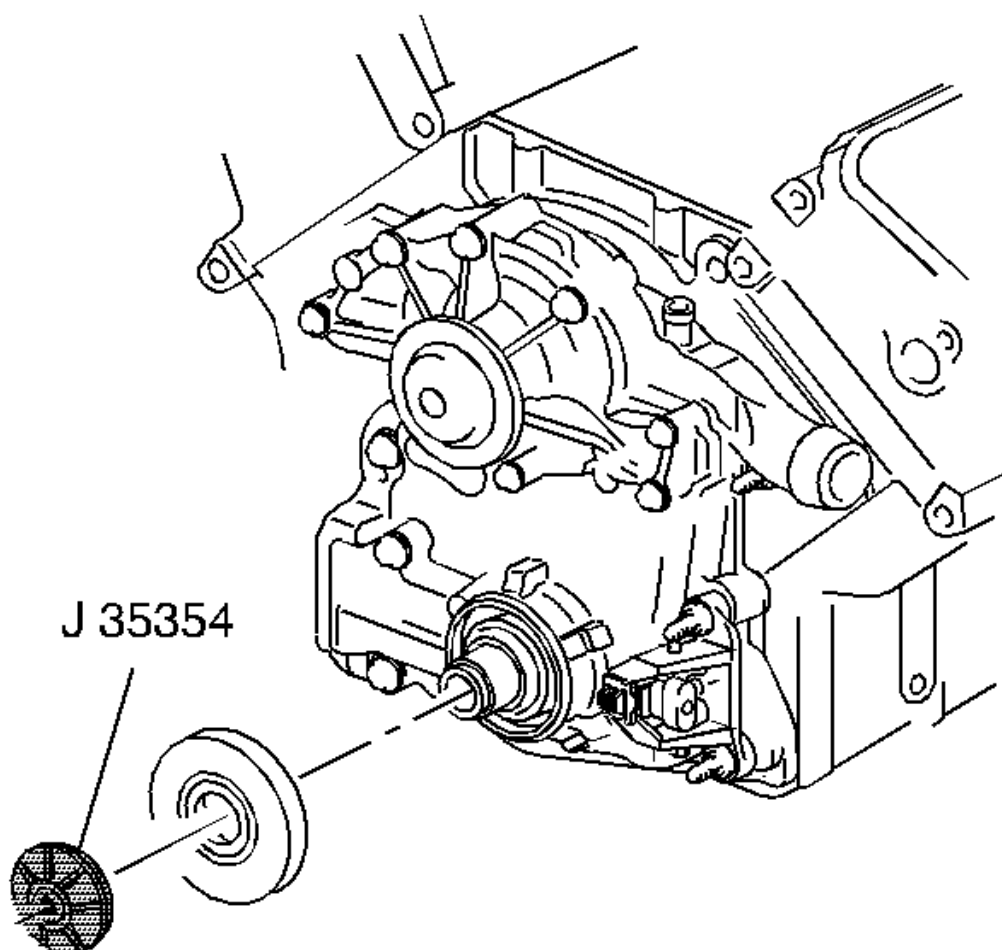


Fig. 437: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Coat the inside diameter of the crankshaft front oil seal with lubricant GM P/N 12345616 (Canadian P/N 993182) or the equivalent.
2. Use **J 35354** and a soft faced hammer to install the crankshaft front oil seal. See **Special Tools**.
3. Remove **J 35354** . See **Special Tools**.

OIL FILTER ADAPTER INSTALLATION

Tools Required

J 45059 Angle Meter

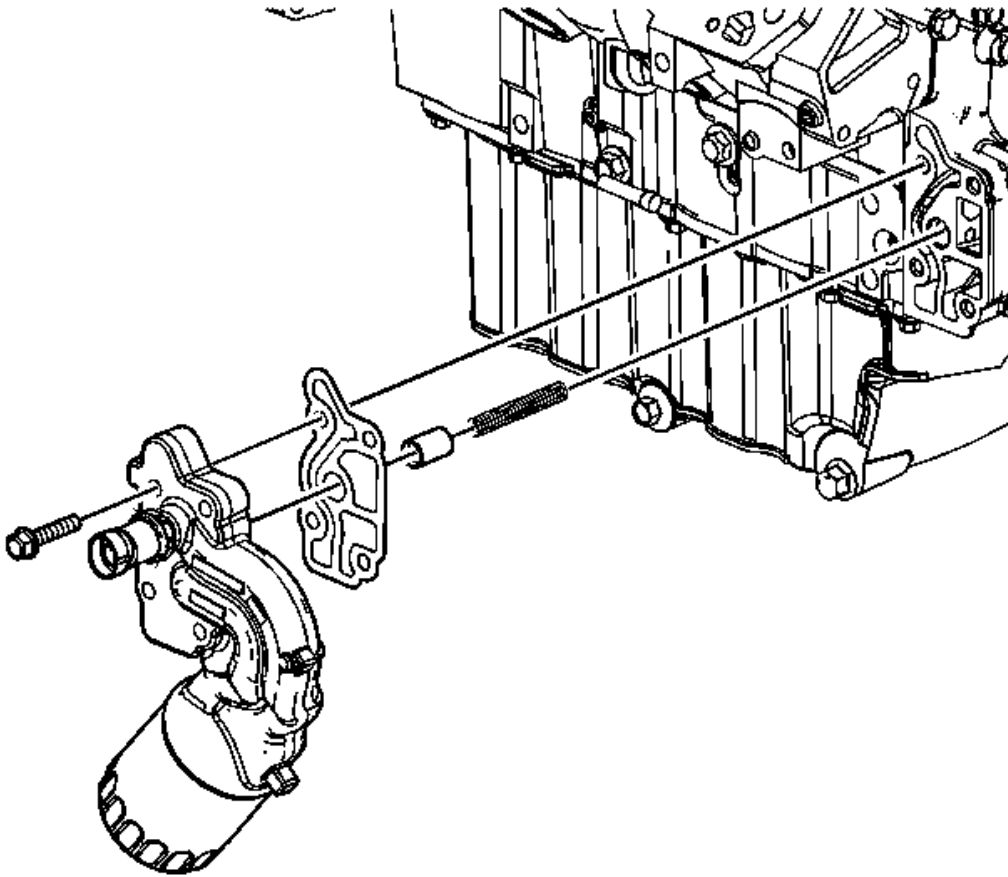


Fig. 438: Identifying Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pressure relief valve spring into the engine front cover.
2. Install the oil pressure relief valve into the engine front cover.
3. Install a new oil filter adapter gasket.
4. Install the oil filter adapter.

NOTE: Refer to **FASTENER CAUTION** .

5. Install the oil filter adapter bolts.

Tighten: Tighten the oil filter adapter bolts to 15 N.m (11 lb ft).

Using **J 45059** rotate each bolt an additional 50 degrees.

6. Install the oil filter.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY INSTALLATION

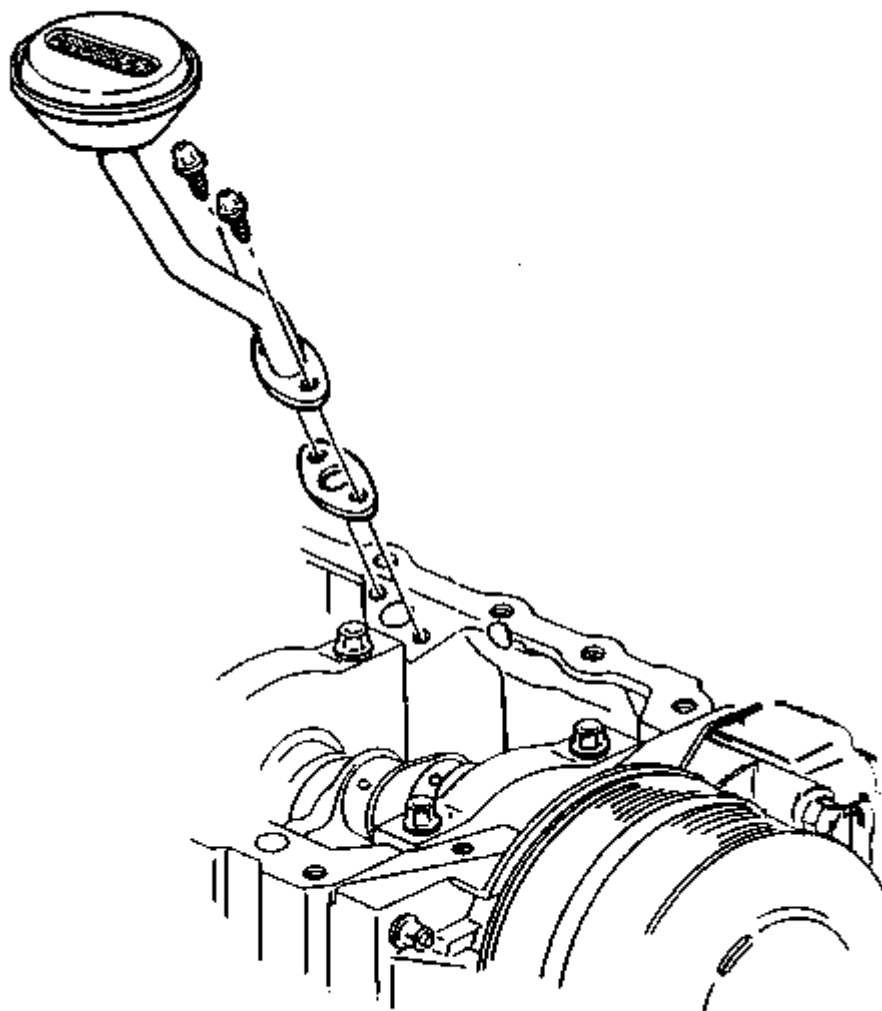


Fig. 439: View Of Oil Pump Pipe & Screen Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump pipe and screen assembly gasket.

IMPORTANT: The oil pan gasket must be installed before the oil pump pipe and screen assembly.

2. Install the oil pan gasket.
3. Install the oil pump pipe and screen assembly.

NOTE: Refer to FASTENER CAUTION .

4. Install the oil pump pipe and screen assembly bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft).

OIL PAN INSTALLATION

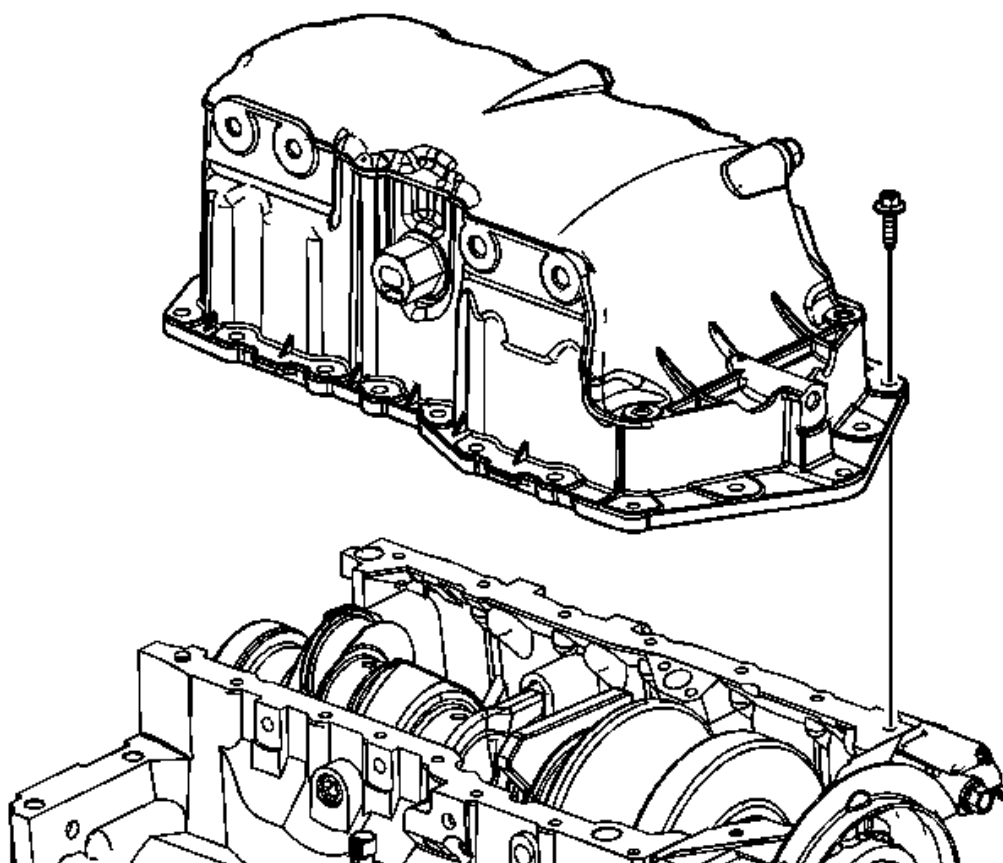


Fig. 440: View Of Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Apply a continuous bead 3.0 mm (0.19 in) thick of RTV GM P/N 12378521 (Canadian P/N 88901148), or equivalent to the oil pan flange on the block as well as an additional drop to all four corners of the block where the front and rear covers meet.
2. Install the oil pan.
3. Clean the oil pan bolts.
4. Apply one drop of GM P/N 12345382 (Canadian P/N 10953489), to each bolt.

CAUTION: Refer to Fastener Caution .

5. Install the oil pan bolts and tighten to 14 N.m (10 lb ft).

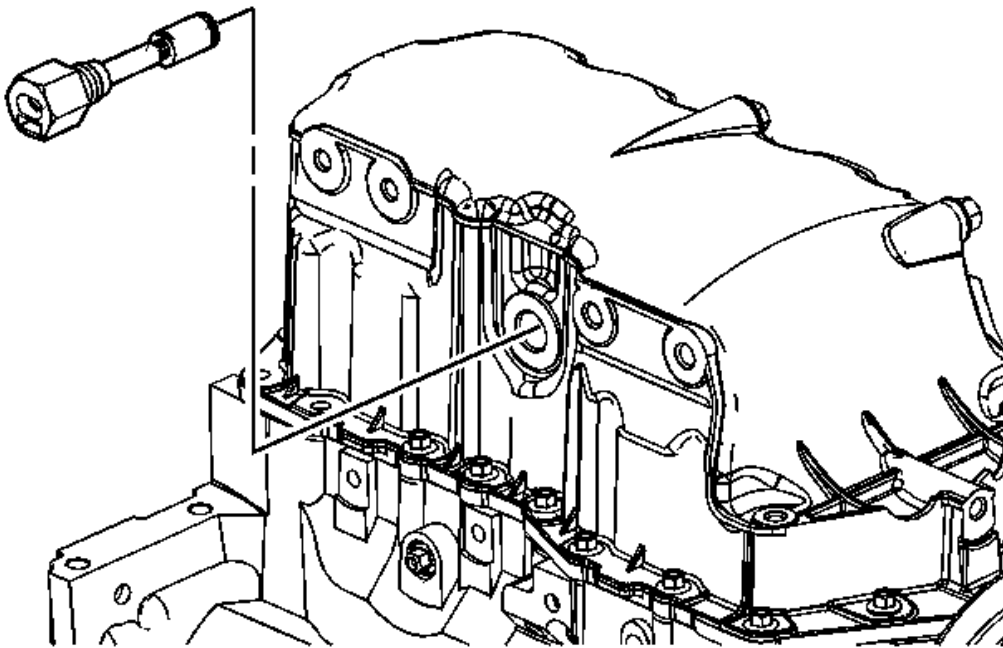


Fig. 441: Identifying Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Install the oil level sensor, located in the oil pan, after the oil pan is installed. The sensor may be damaged if the oil level sensor is installed first.

6. Install the oil level sensor and tighten to 20 N.m (15 lb ft).

VALVE LIFTER INSTALLATION

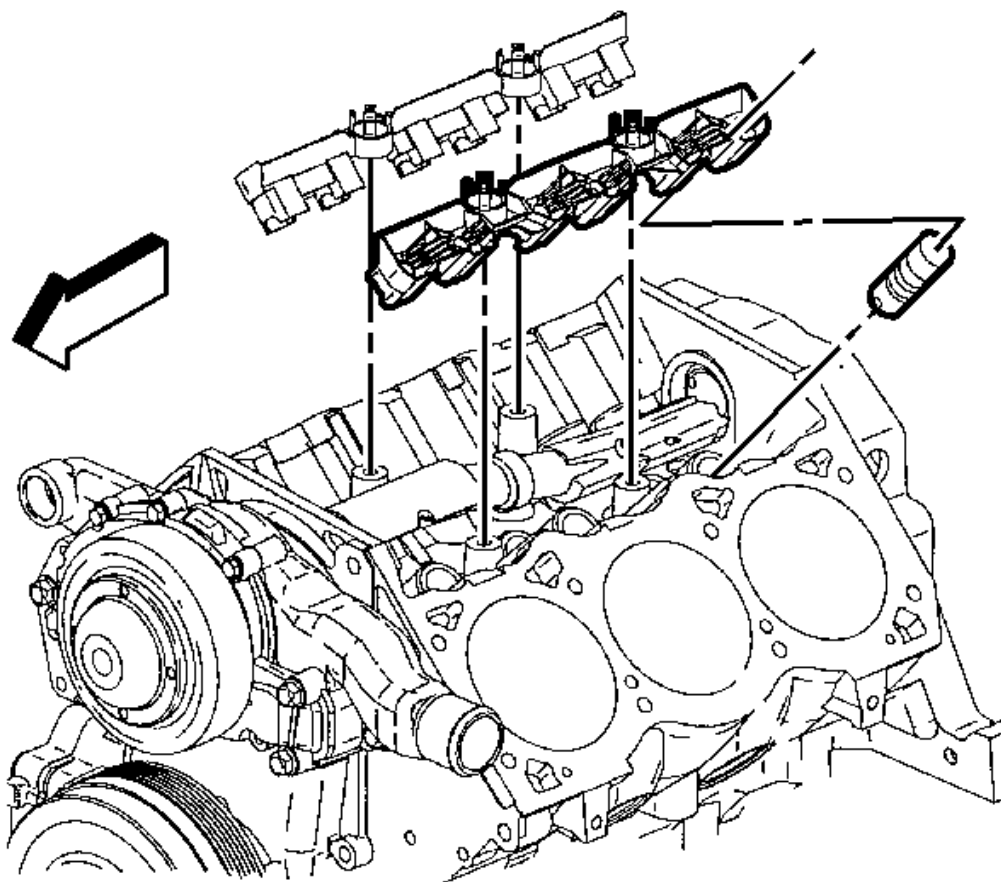


Fig. 442: Identifying Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

1. Dip the valve lifters in prelube GM P/N 12345501 (Canadian 992704) or the equivalent.
2. Install the valve lifters.
3. Install the valve lifter guides.

NOTE: Refer to **FASTENER CAUTION** .

4. Install the valve lifter guide bolts.

Tighten: Tighten the valve lifter guide bolts to 30 N.m (22 lb ft).

CYLINDER HEAD INSTALLATION - RIGHT SIDE**Special Tools**

J 45059: Angle Meter

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

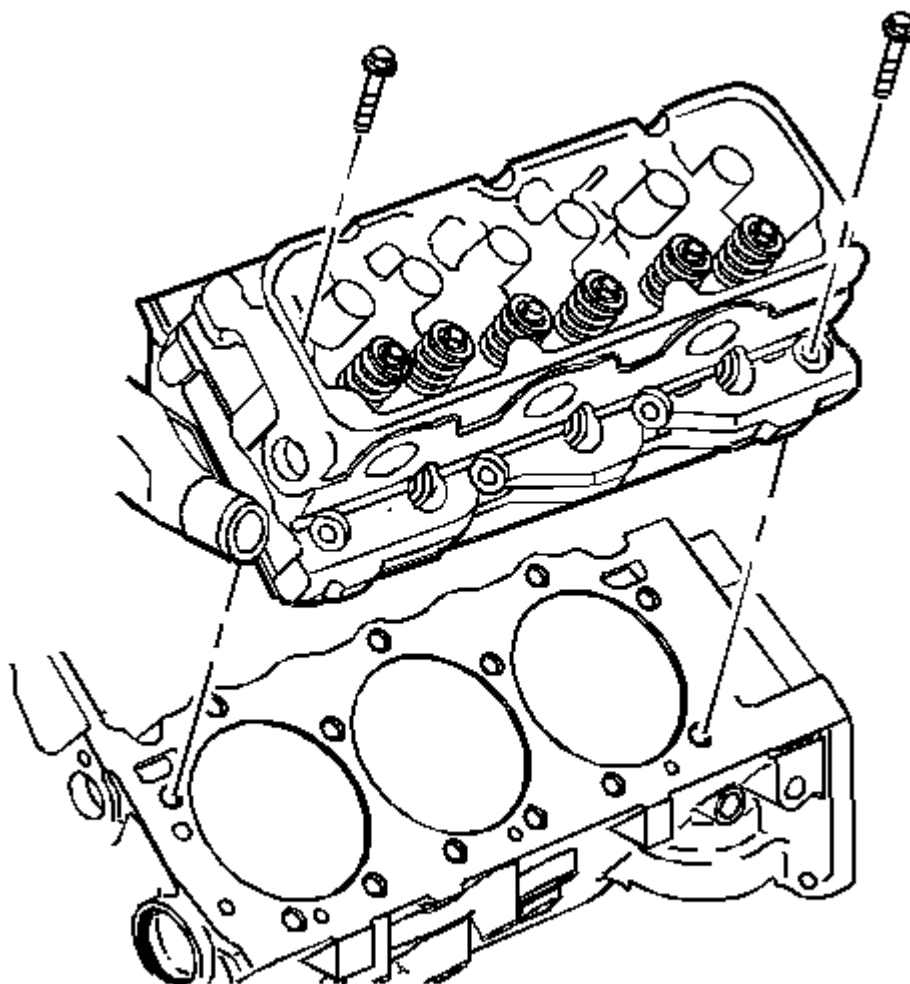


Fig. 443: Identifying Cylinder Head & Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder head gasket. Ensure the arrows point towards the front of the engine. The right

cylinder head gasket has the letter R stamped next to the arrow.

CAUTION: Refer to Special Fastener Caution .

2. Install the cylinder head.

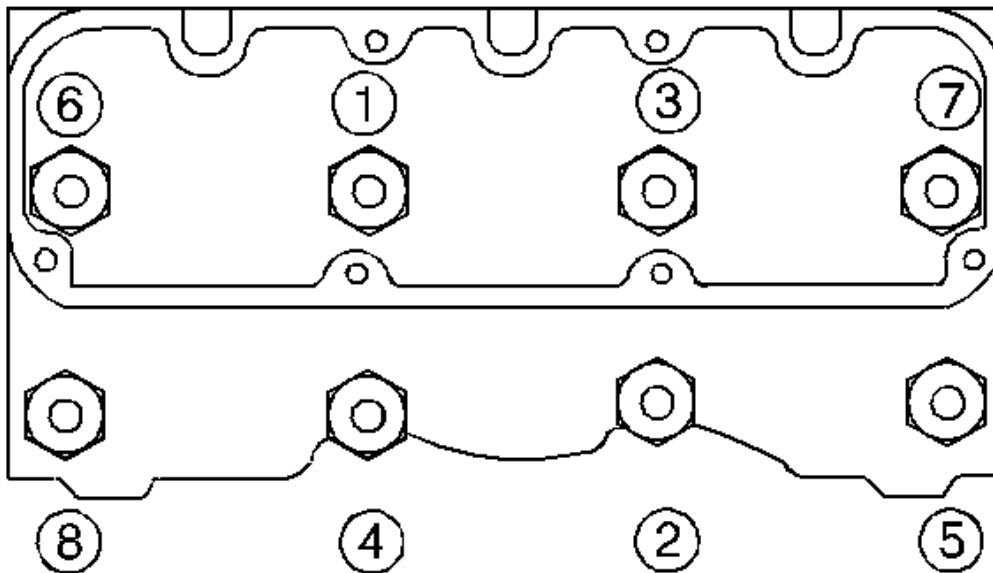


Fig. 444: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install new cylinder head bolts and tighten the cylinder head bolts to 50 N.m (37 lb ft) in sequence. Using **J 45059**: meter rotate each cylinder head bolt an additional 120 degrees.

CYLINDER HEAD INSTALLATION - LEFT SIDE

Special Tools

J 45059: Angle Meter

For equivalent regional tools, refer to Special Tools.

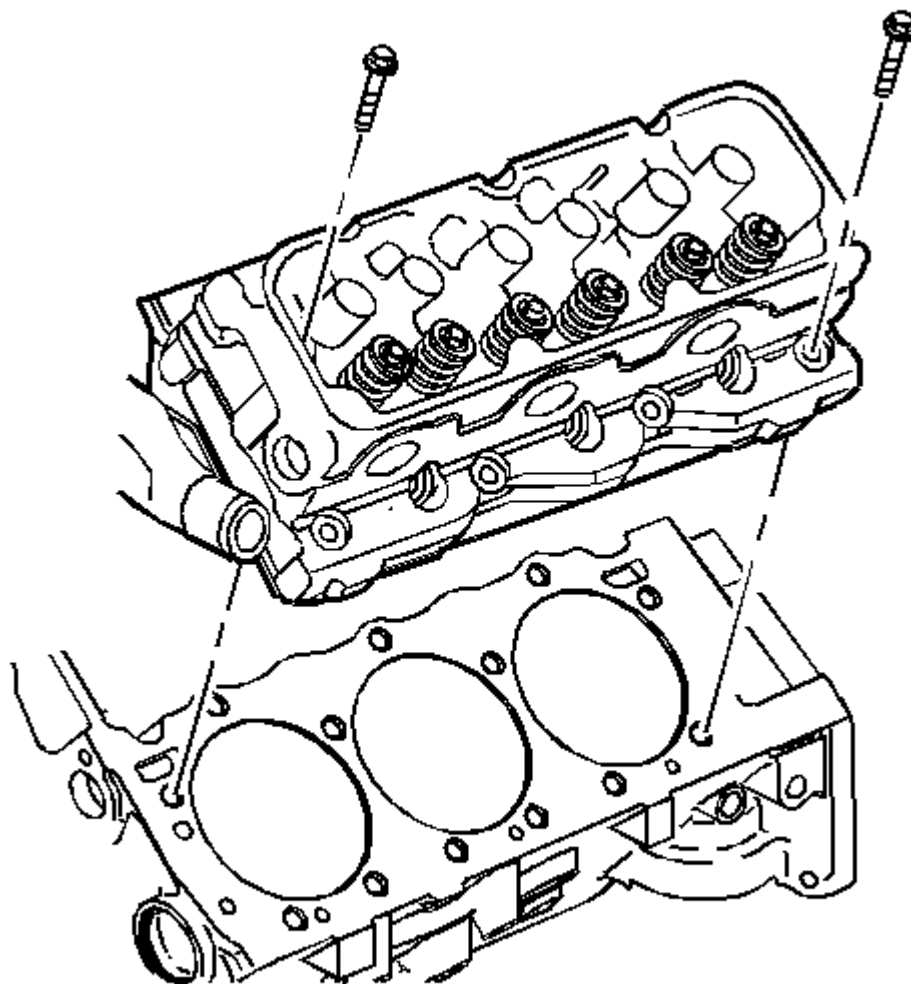


Fig. 445: Identifying Cylinder Head & Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder head gasket. Ensure the arrows point towards the front of the engine. The left cylinder head gasket has the letter L stamped next to the arrow.

CAUTION: Refer to Special Fastener Caution .

2. Install the cylinder head.

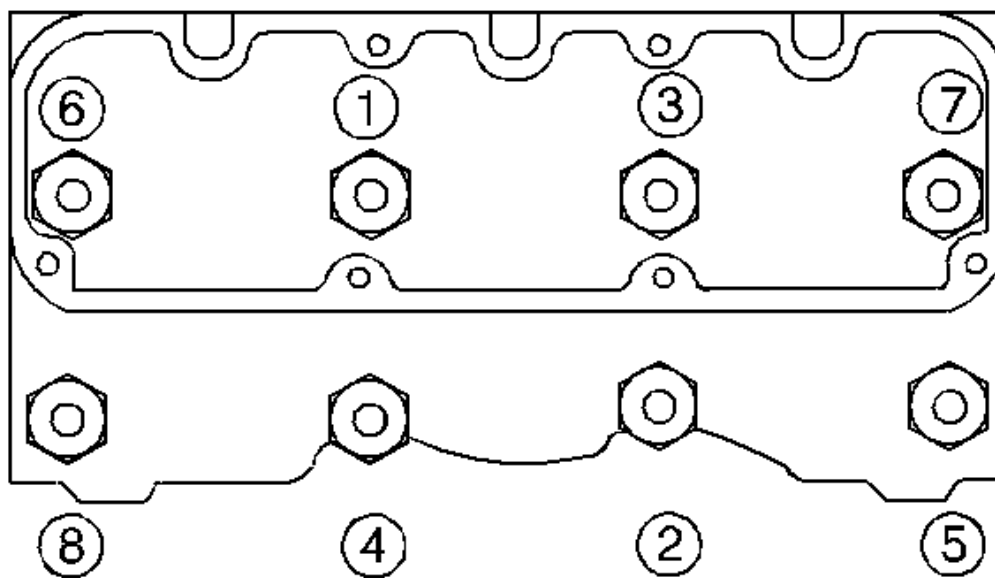


Fig. 446: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install new cylinder head bolts and tighten the cylinder head bolts to 50 N.m (37 lb ft) in sequence. Using **J 45059**: meter rotate each cylinder head bolt an additional 120 degrees.

VALVE ROCKER ARM AND PUSH ROD INSTALLATION

Tools Required

J 45059 Angle Meter

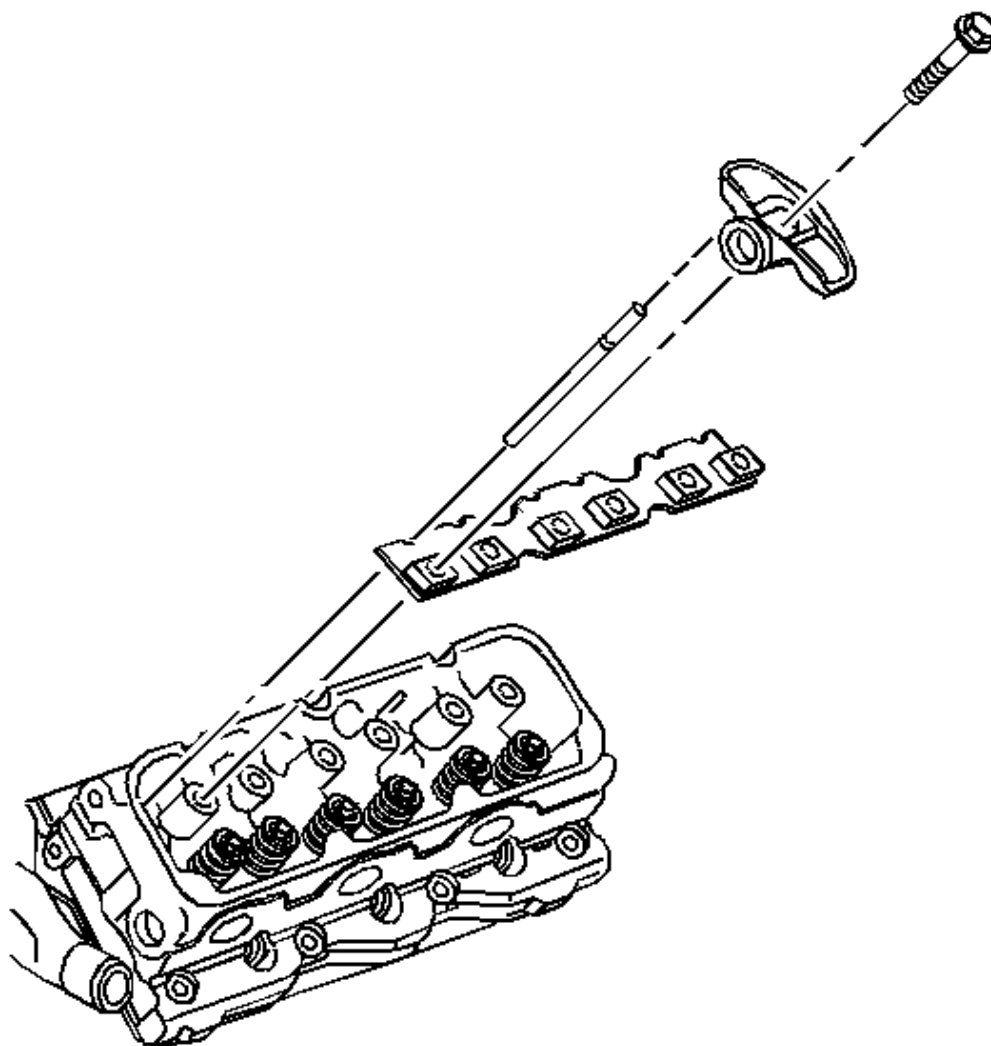


Fig. 447: View Of Valve Rocker Arm, Bolt, Push Rod & Push Rod Guide Plate
Courtesy of GENERAL MOTORS CORP.

1. Install the pushrod guide plate.
2. Install the push rods.
3. Install the valve rocker arm bearing retainer.
4. Coat the valve stem tip and pushrod tip with prelube GM P/N 1052367 (Canadian P/N 992869) or the equivalent.
5. Install the valve rocker arms.

6. Apply GM P/N 12345493 (Canadian P/N 10953488) threadlocker or the equivalent to the valve rocker arm bolt threads.

NOTE: Refer to **FASTENER CAUTION** .

7. Install the valve rocker arm bolts.

Tighten: Tighten the valve rocker arm bolts to 15 N.m (11 lb ft) + 90 degrees using **J 45059** .

VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE

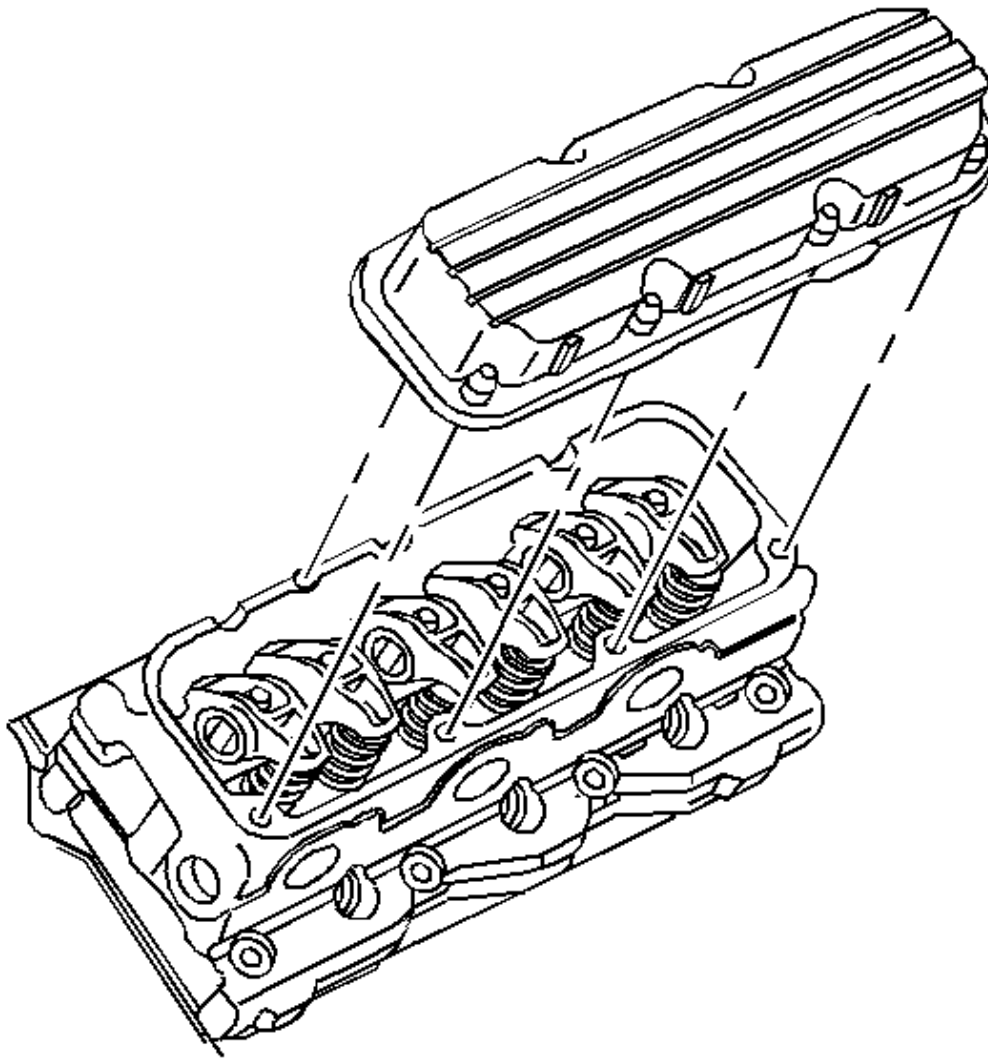


Fig. 448: Right Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Install NEW valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.
2. Install NEW valve rocker arm cover gasket.
3. Install the valve rocker arm cover.

NOTE: Refer to **FASTENER CAUTION** .

4. If reusing bolts that are not fastened to the NEW grommets, apply GM P/N 12345382 (Canadian P/N 10953489) threadlocker or the equivalent to threads and install the valve rocker arm cover bolts.

Tighten: Tighten the valve rocker arm cover bolts to 10 N.m (89 lb in).

VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

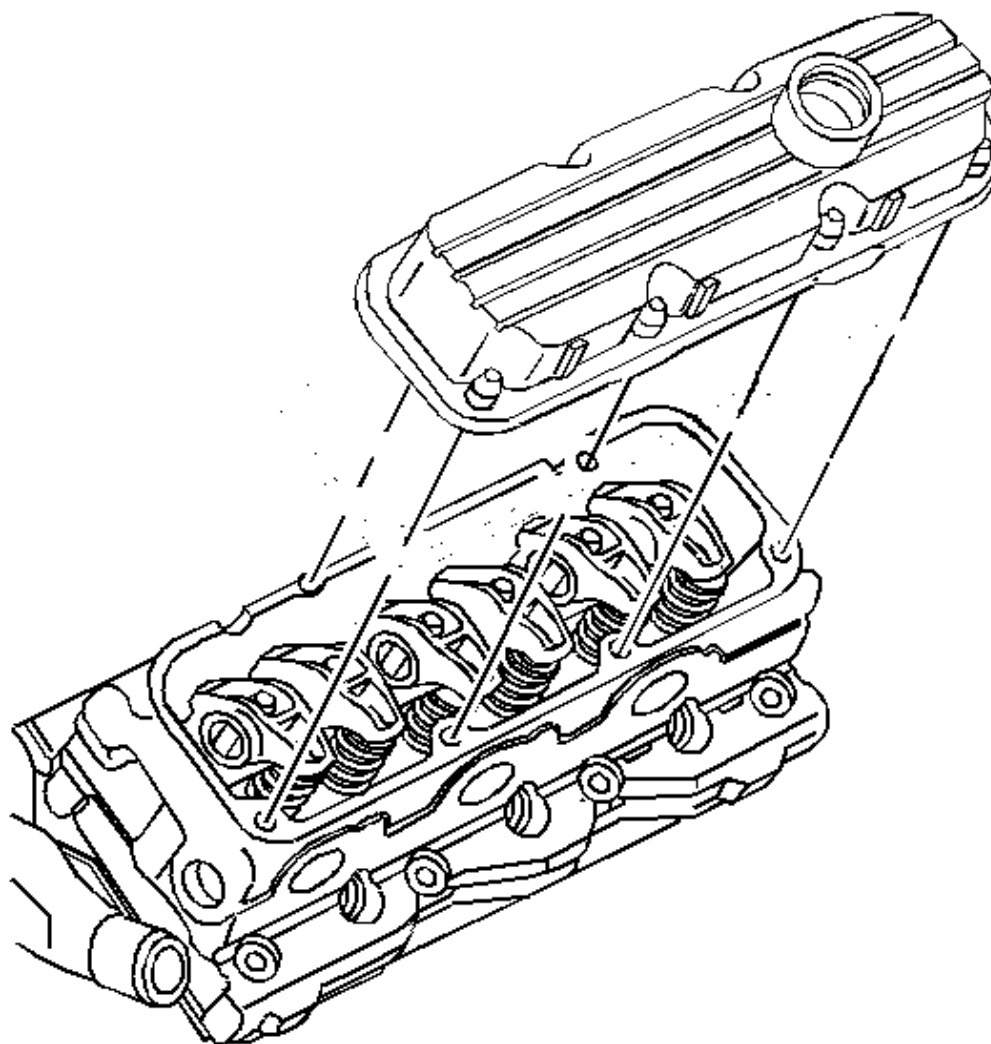


Fig. 449: Left Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Install NEW valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.
2. Install NEW valve rocker arm cover gasket.
3. Install the valve rocker arm cover.

NOTE: Refer to FASTENER CAUTION .

4. If reusing bolts that are not fastened to the NEW grommets, apply GM P/N 12345382 (Canadian P/N 10953489) threadlocker or the equivalent to threads and install the valve rocker arm cover bolts.

Tighten: Tighten the valve rocker arm cover bolts to 10 N.m (89 lb in).

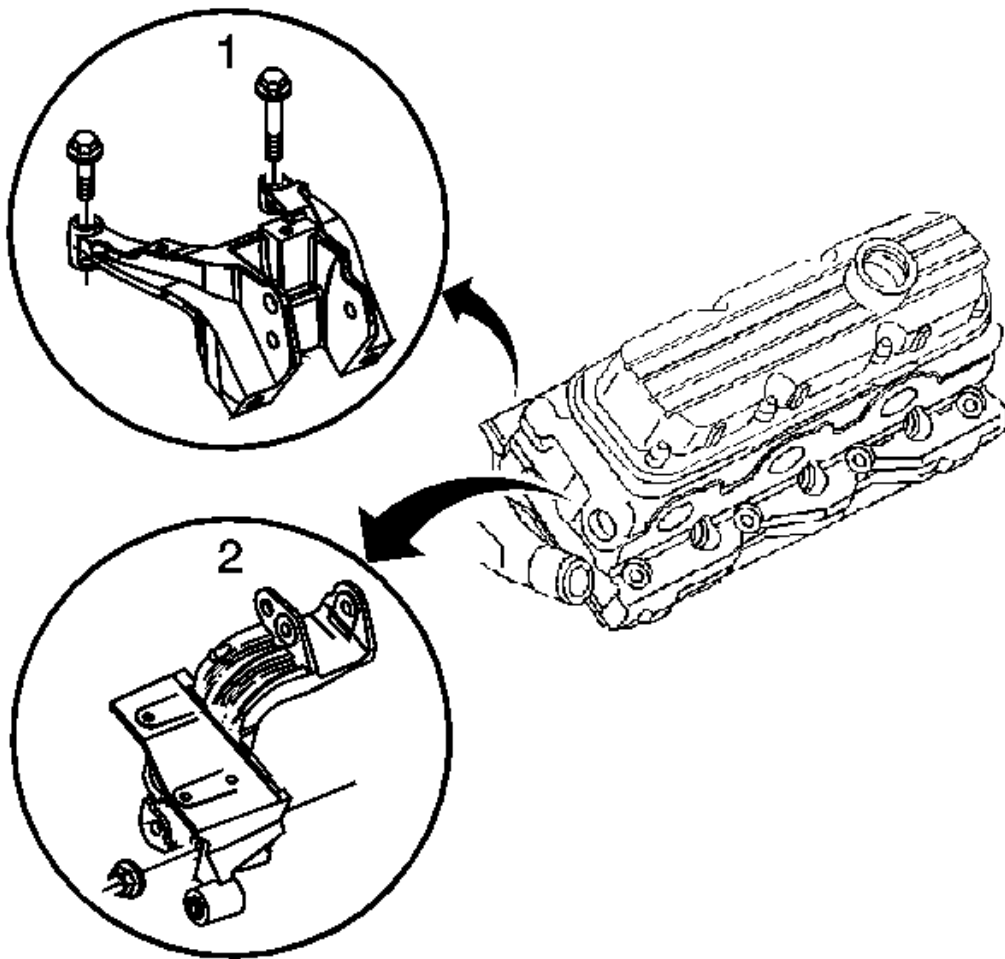


Fig. 450: View of Engine Mount Strut Upper Bracket Bolts

Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount strut upper bracket bolts (1) if applicable.

Tighten: Tighten the engine mount strut upper bracket bolts (1) to 50 N.m (37 lb ft).

6. Install the engine mount strut bracket and nuts (2), if applicable.

Tighten: Tighten the engine mount strut bracket and nuts (2) to 50 N.m (37 lb ft).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE (WITHOUT SECONDARY AIR INJECTION-SAI)

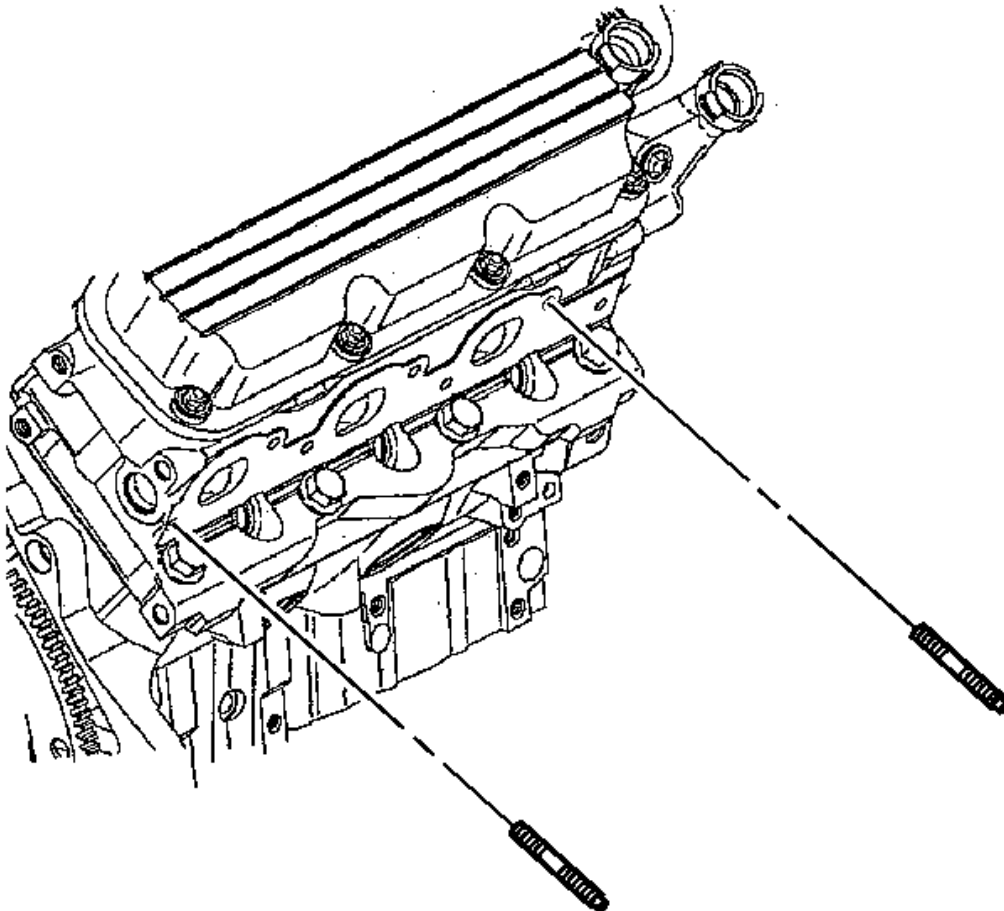


Fig. 451: Identifying Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

CAUTION: When replacing the HO2S perform a code clear with a scan tool, regardless of whether or not a DTC is set. Performing a code clear will reset the HO2S resistance learned value. Failure to perform a code clear may result in an HO2S failure.

1. Install the exhaust manifold studs and tighten to 10 N.m (89 lb in).

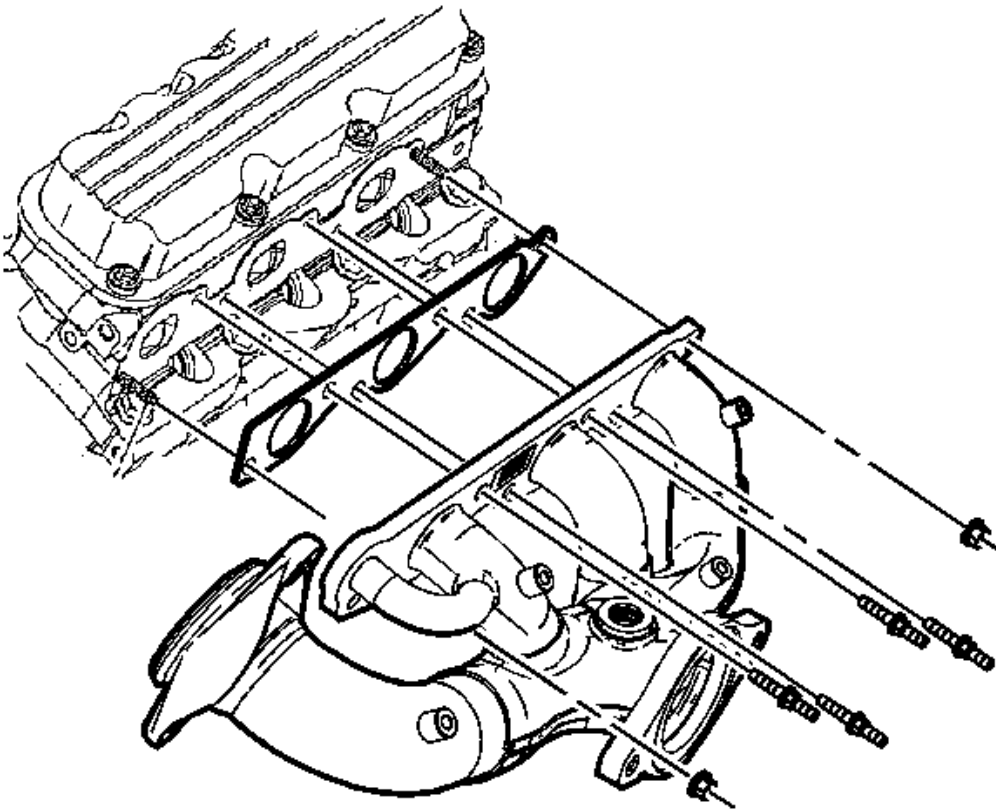


Fig. 452: Right Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold bolts and nuts and tighten to 30 N.m (22 lb ft).

5. Install the right side spark plugs and tighten to 15 N.m (11 lb ft).

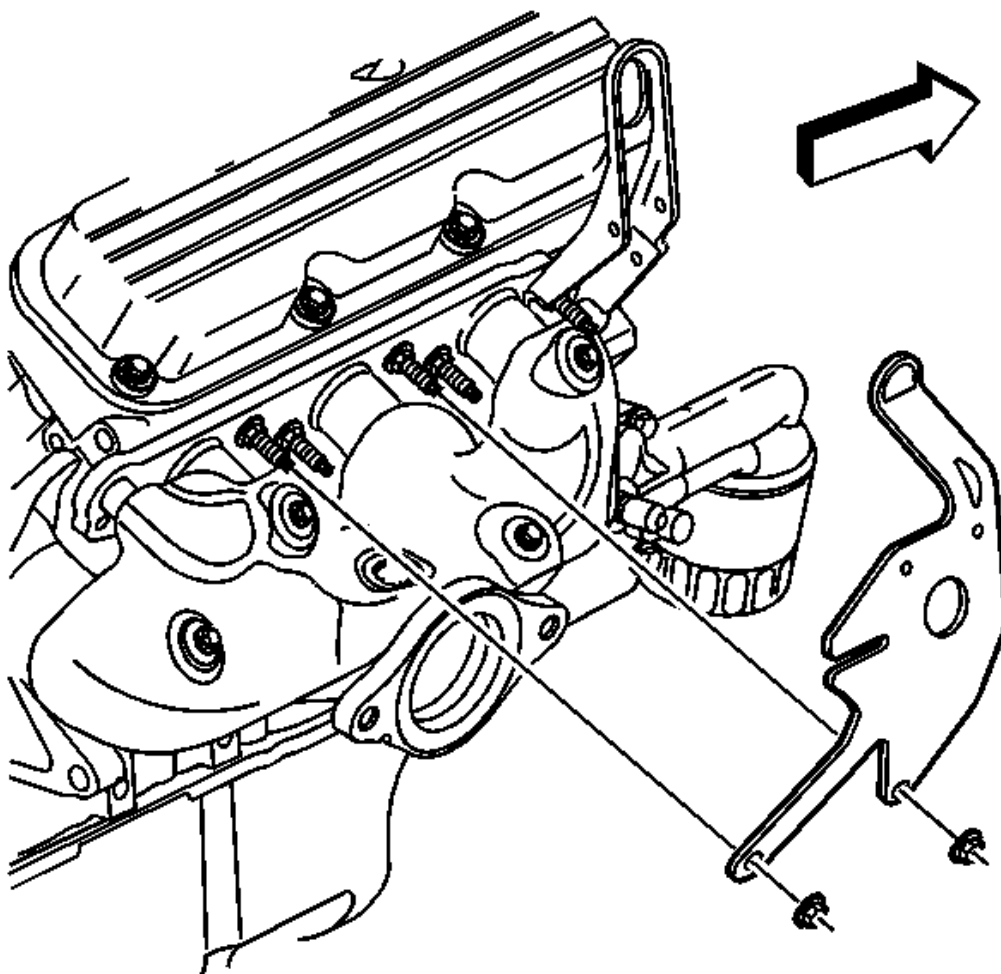


Fig. 453: Fuel Injector Sight Shield Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel injector sight shield cover bracket.
7. Install the fuel injector sight shield cover bracket nuts and tighten to 30 N.m (22 lb ft).

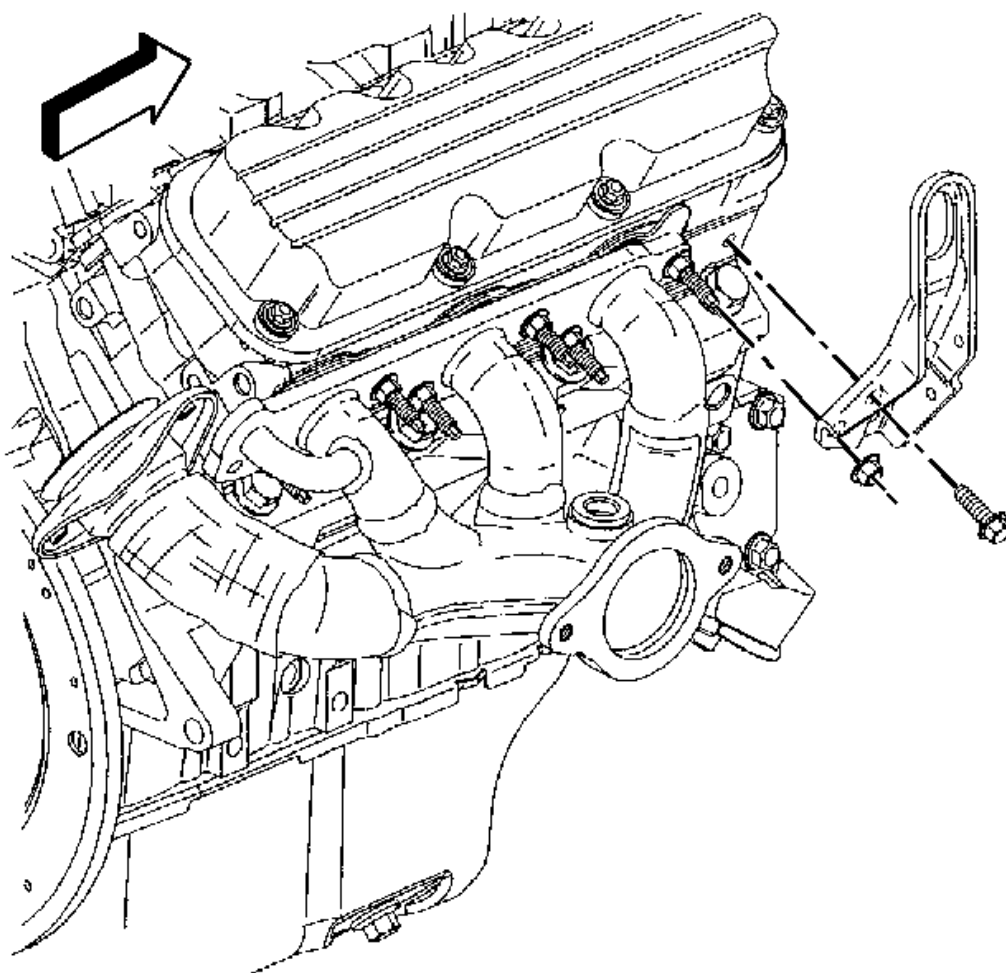


Fig. 454: Identifying Right Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

8. Install the right engine lift hook.
9. Install the right engine lift hook nut and bolt and tighten to 30 N.m (22 lb ft).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE (WITH SECONDARY AIR INJECTION-SAI)

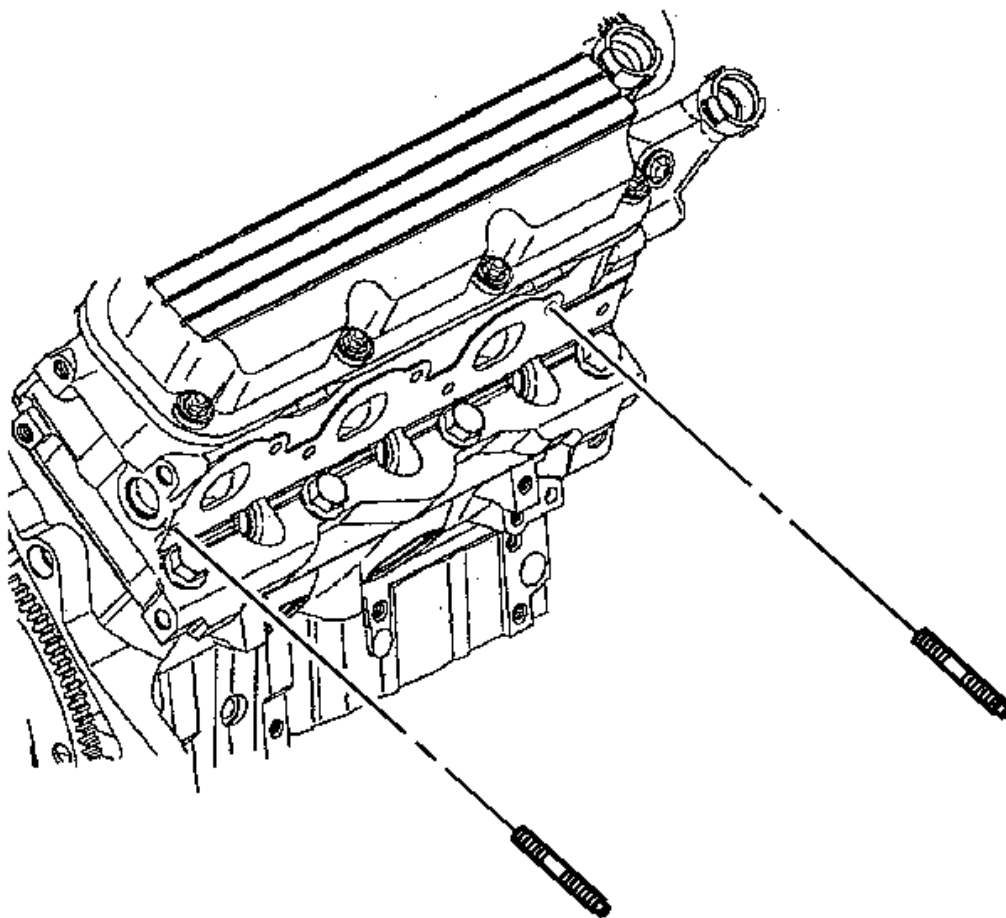


Fig. 455: Identifying Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

CAUTION: When replacing the HO₂S perform a code clear with a scan tool, regardless of whether or not a DTC is set. Performing a code clear will reset the HO₂S resistance learned value. Failure to perform a code clear may result in an HO₂S failure.

1. Install the exhaust manifold studs and tighten to 10 N.m (89 lb in).

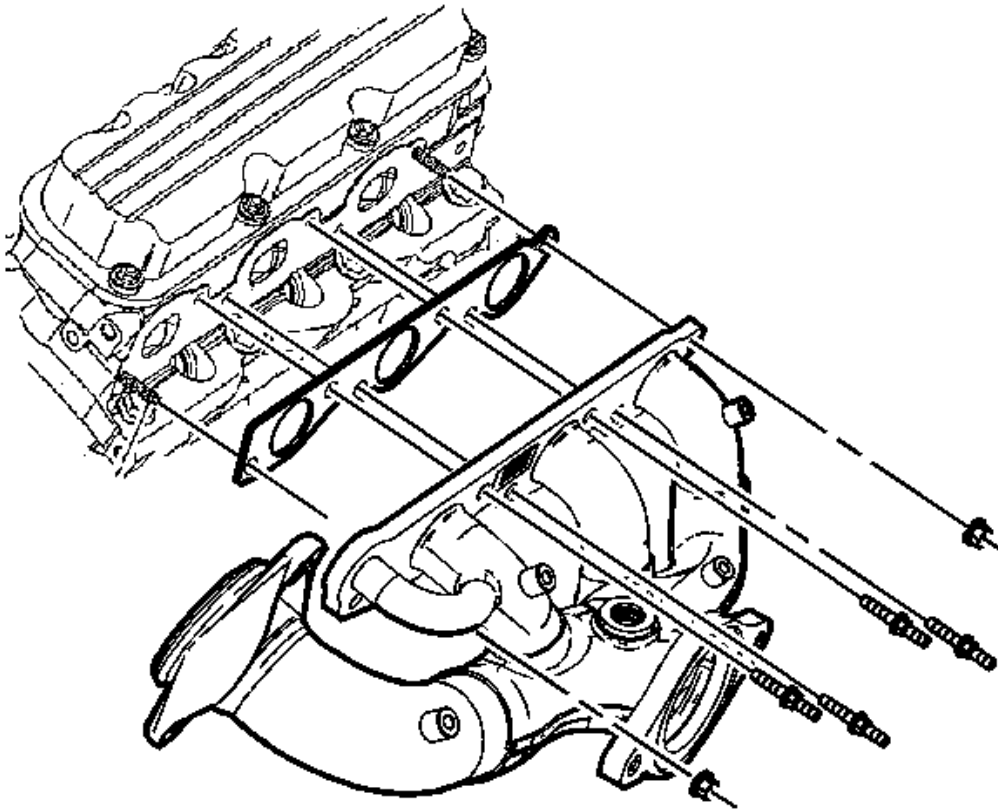


Fig. 456: Right Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold bolts and nuts and tighten to 30 N.m (22 lb ft).
5. Install the right side spark plugs and tighten to 15 N.m (11 lb ft).

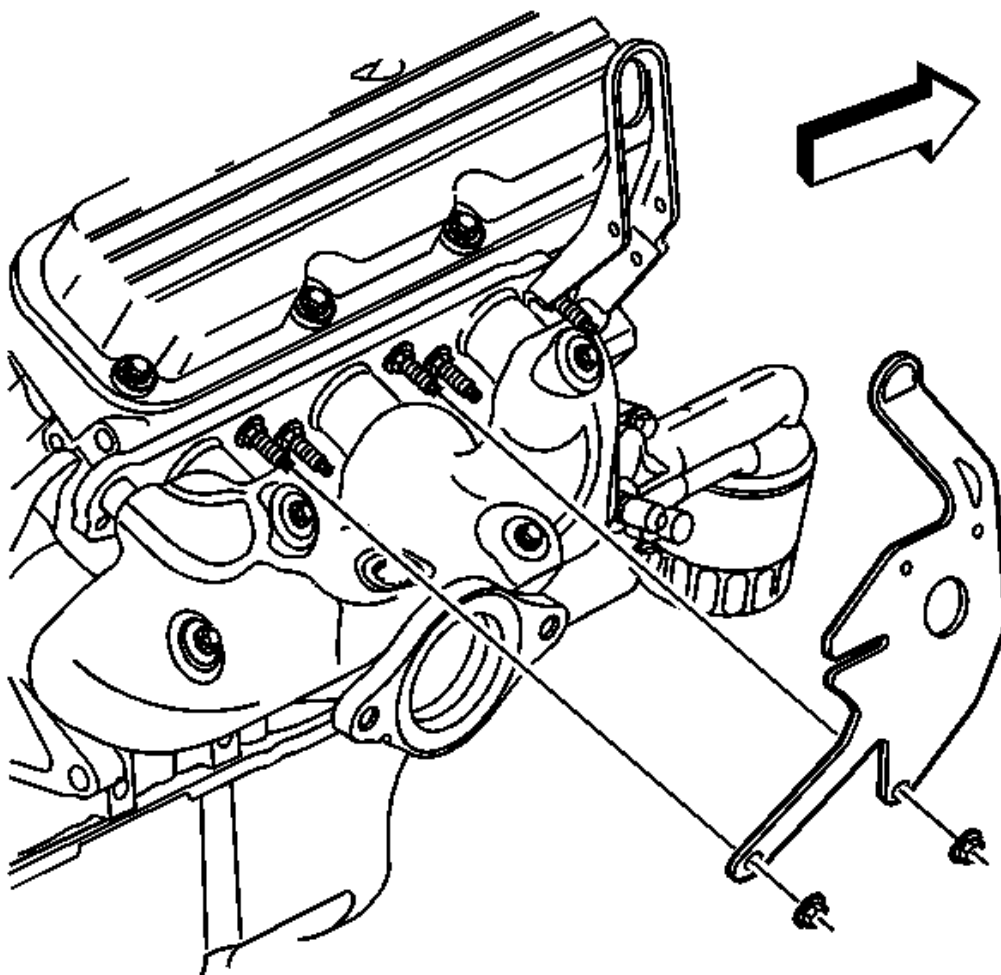


Fig. 457: Fuel Injector Sight Shield Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the fuel injector sight shield cover bracket.
7. Install the fuel injector sight shield cover bracket nuts and tighten to 30 N.m (22 lb ft).

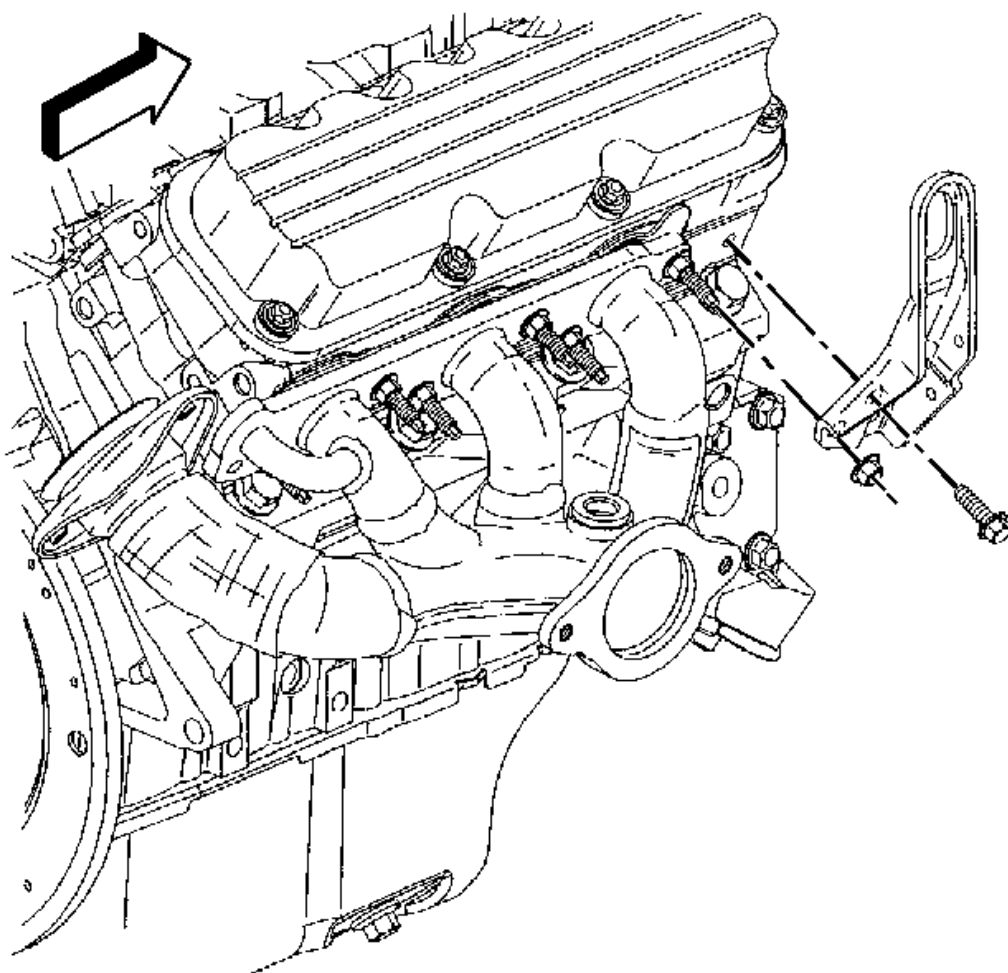


Fig. 458: Identifying Right Engine Lift Hook Bracket
Courtesy of GENERAL MOTORS CORP.

8. Install the right engine lift hook.
9. Install the right engine lift hook nut and bolt and tighten to 30 N.m (22 lb ft).

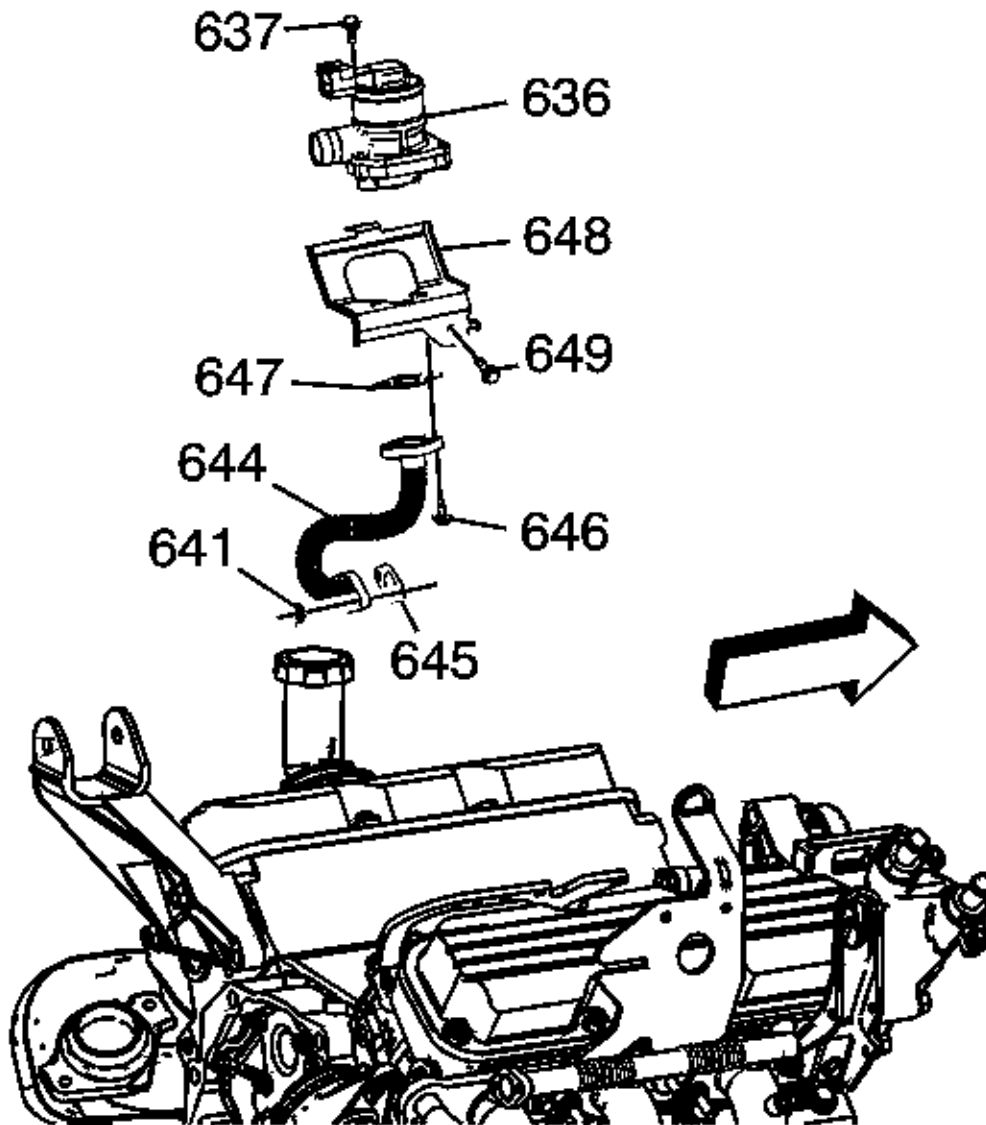


Fig. 459: Secondary Air Injection Assembly
Courtesy of GENERAL MOTORS CORP.

10. If necessary, install the secondary air pipe (644), gasket (647), and bolts (646) and assemble the injection pump (636) onto bracket (648) and tighten the secondary air injection pump pipe bolts to 10 N.m (89 lb in).
11. Install gasket (645), secondary air injection pump assembly and nuts (641) onto the engine and tighten to 10 N.m (89 lb in).

12. Install the secondary air injection pump assembly mounting bolts (637, 649) and tighten to 10 N.m (89 lb in).

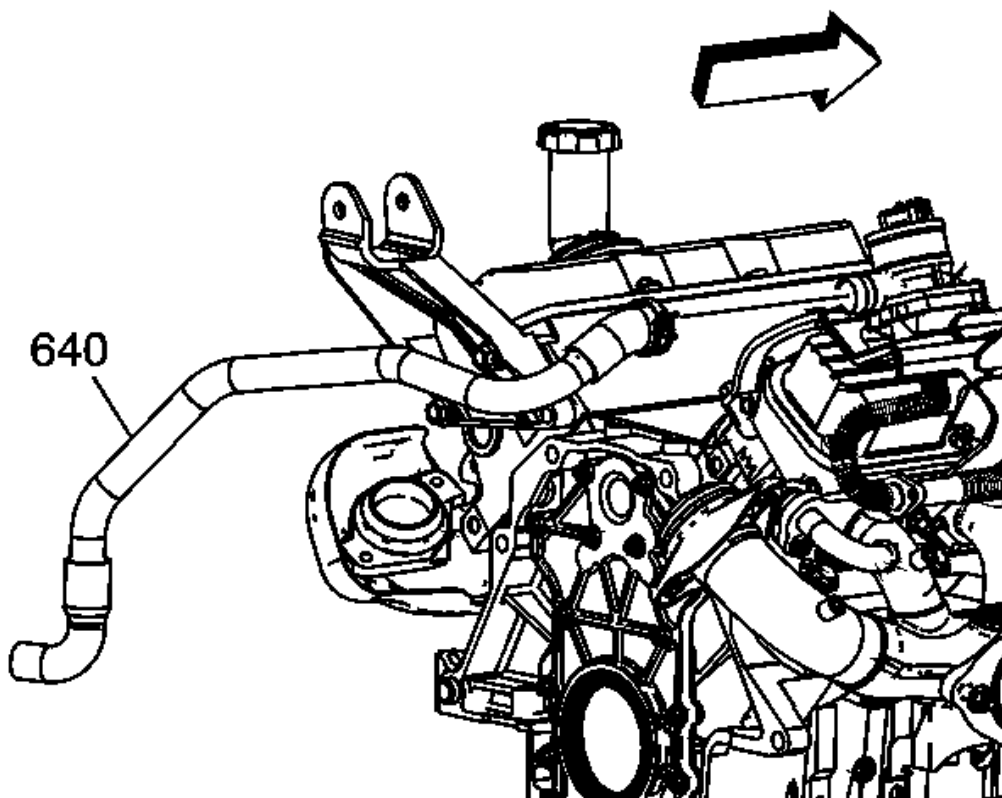


Fig. 460: Secondary Air Injection Pipe
Courtesy of GENERAL MOTORS CORP.

13. Loosen the hose clamp and install the secondary air injection pipe (640) onto the valve and reinstall the hose clamp.

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

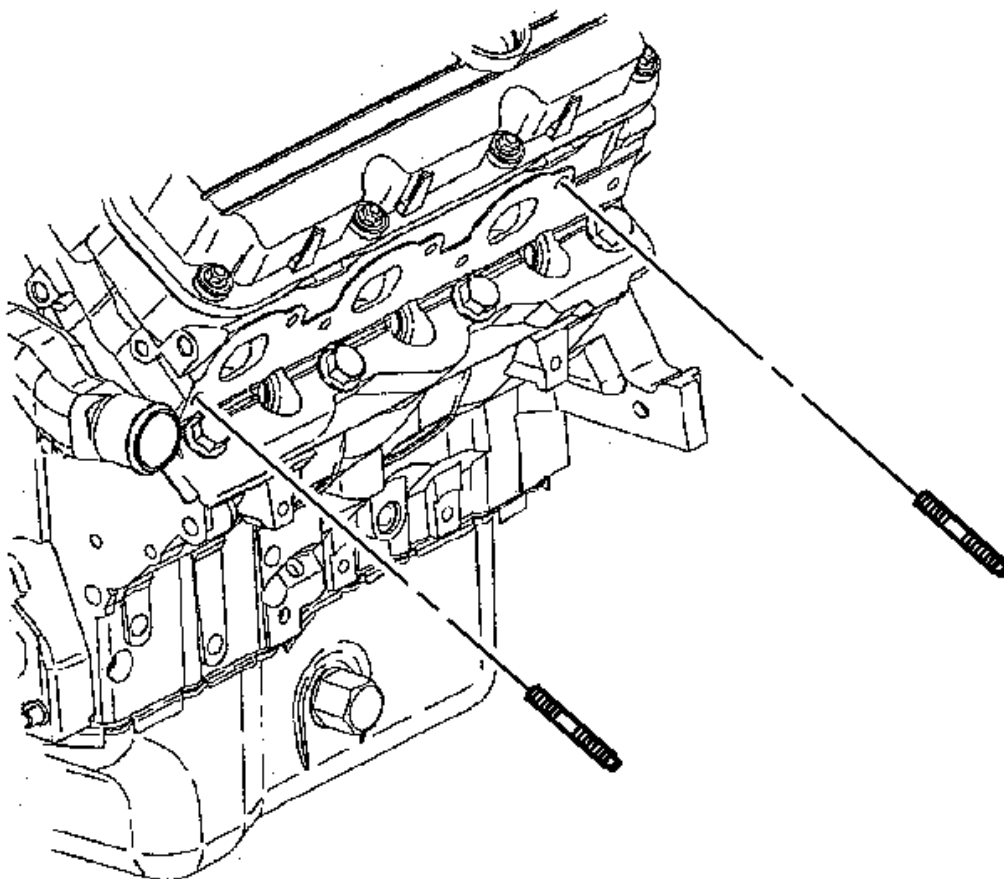


Fig. 461: Left Exhaust Manifold Studs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

1. Install the exhaust manifold studs.

Tighten: Tighten the exhaust manifold studs to 10 N.m (89 lb in).

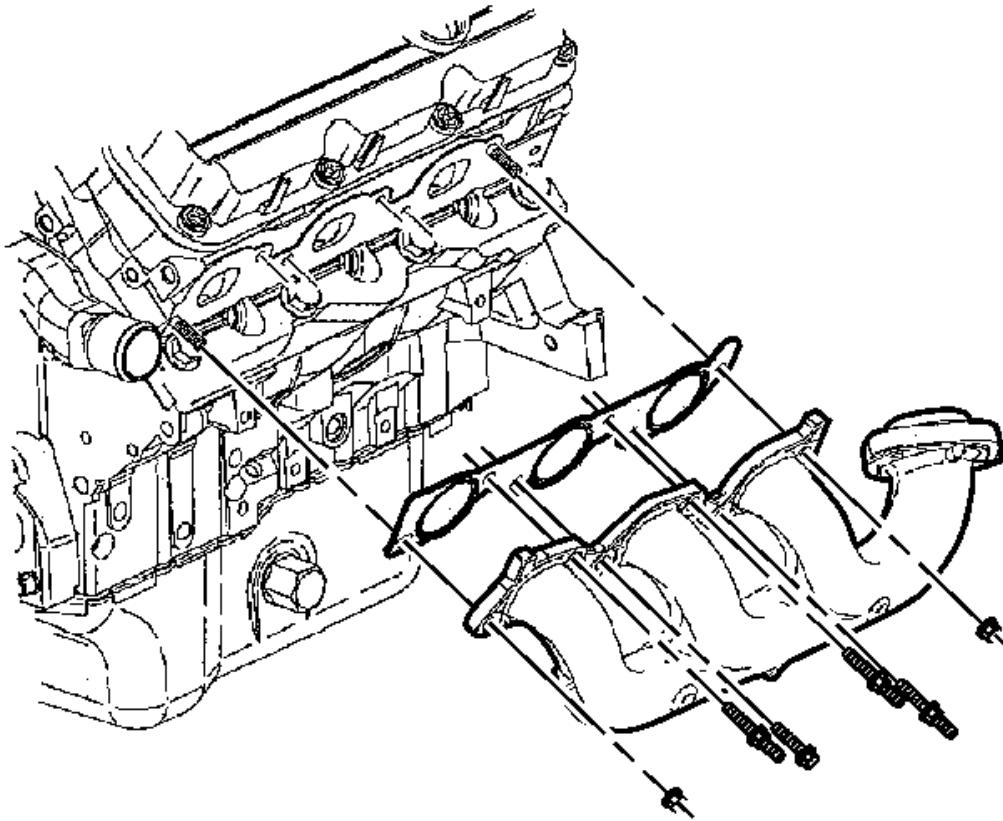


Fig. 462: Identifying Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust manifold gasket.
3. Install the exhaust manifold.
4. Install the exhaust manifold bolts and nuts.

Tighten: Tighten the exhaust manifold bolts and nuts to 30 N.m (22 lb ft).

5. Install the left side spark plugs.

Tighten: Tighten the spark plugs to 15 N.m (11 lb ft).

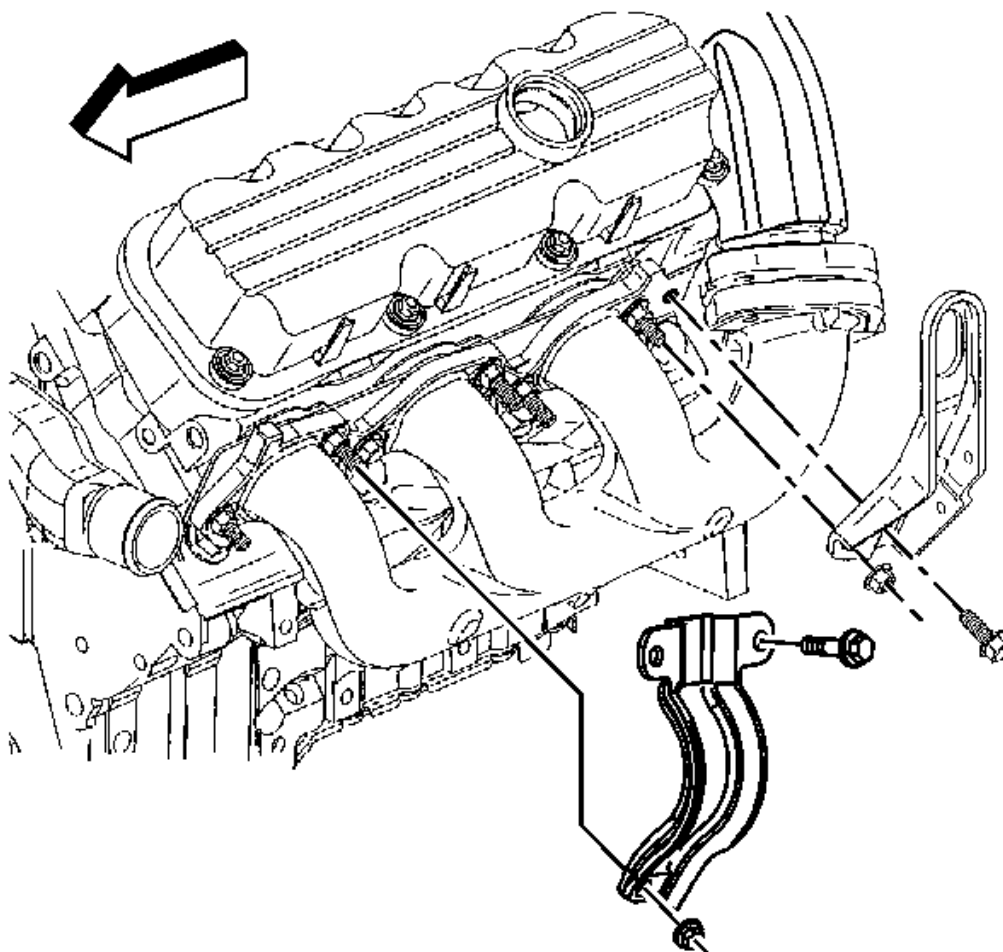


Fig. 463: Left Engine Lift Hook & Mount Strut Lower Bracket
Courtesy of GENERAL MOTORS CORP.

6. Install the left engine lift hook.
7. Install the left engine lift hook nut and bolt.

Tighten: Tighten the left engine lift hook nut and bolt to 30 N.m (22 lb ft).

8. Install the engine mount strut lower bracket.
9. Install the engine mount strut lower bracket nut and bolts.

Tighten:

- Tighten the engine mount strut lower bracket bolts to 50 N.m (37 lb ft).

- Tighten the engine mount strut lower bracket nut to 25 N.m (18 lb ft)

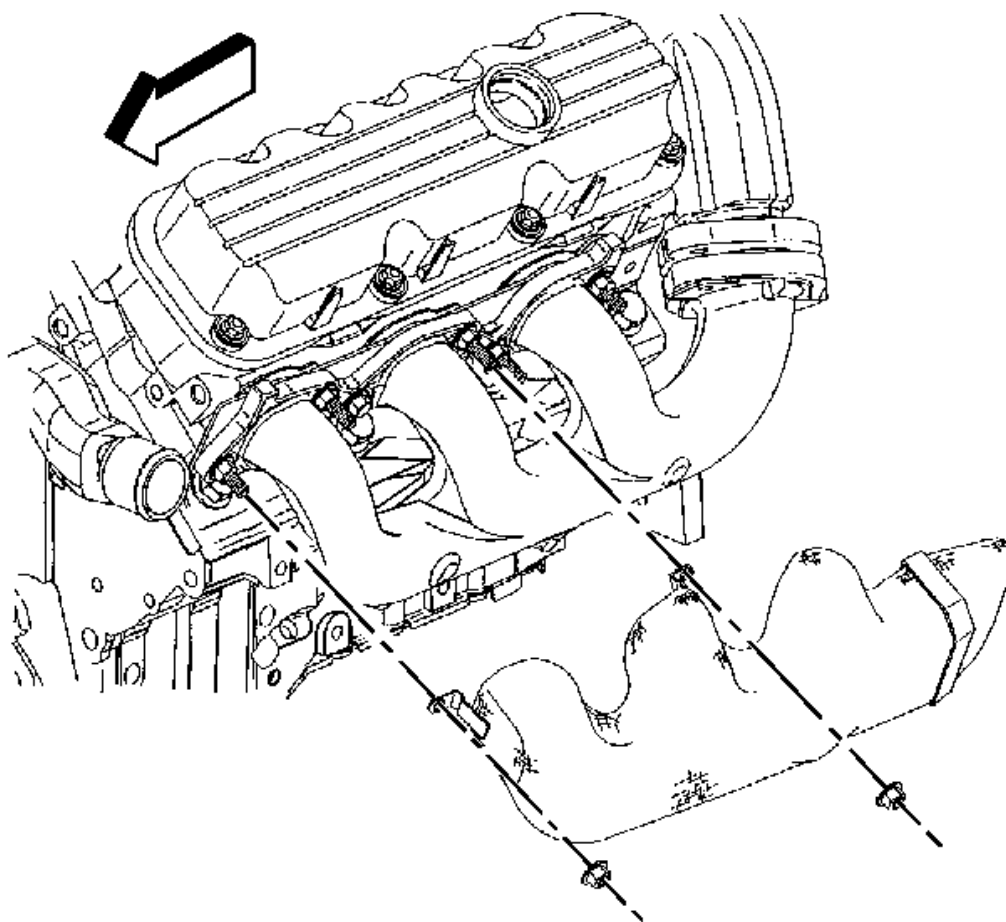


Fig. 464: Exhaust Manifold Heat Shield & Nuts
Courtesy of GENERAL MOTORS CORP.

10. Install the left exhaust manifold heat shield.
11. Install the left exhaust manifold heat shield nuts.

Tighten: Tighten the left exhaust manifold heat shield nuts to 20 N.m (15 lb ft).

LOWER INTAKE MANIFOLD INSTALLATION (L26)

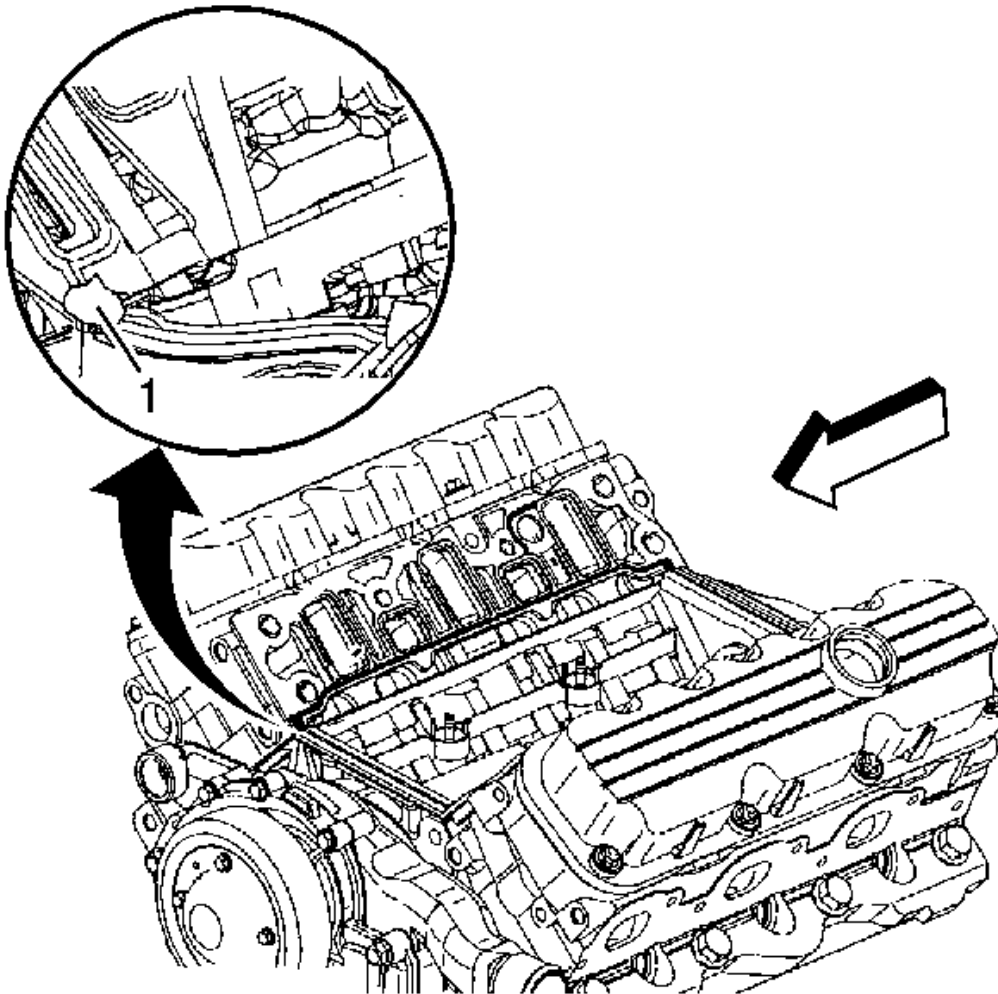


Fig. 465: Identifying Lower Intake Manifold sealing Points
Courtesy of GENERAL MOTORS CORP.

1. Clean the lower intake manifold sealing surface using GM P/N 12346139 (Canadian P/N 10953463) or equivalent prior to installing any seals or gaskets.
2. Install the lower intake manifold gaskets and seals.
3. With gaskets and seals in place, apply a small drop 8-10 mm (0.31-0.39 in) of RTV sealer GM P/N 12378521 (Canadian P/N 88901148) or equivalent, to the 4 corners of the intake manifold to block joints (1).
4. Install the lower intake manifold.
5. Apply threadlocker 272 GM P/N 12345493, (Canadian P/N 10953488) or the equivalent to the bolt threads.

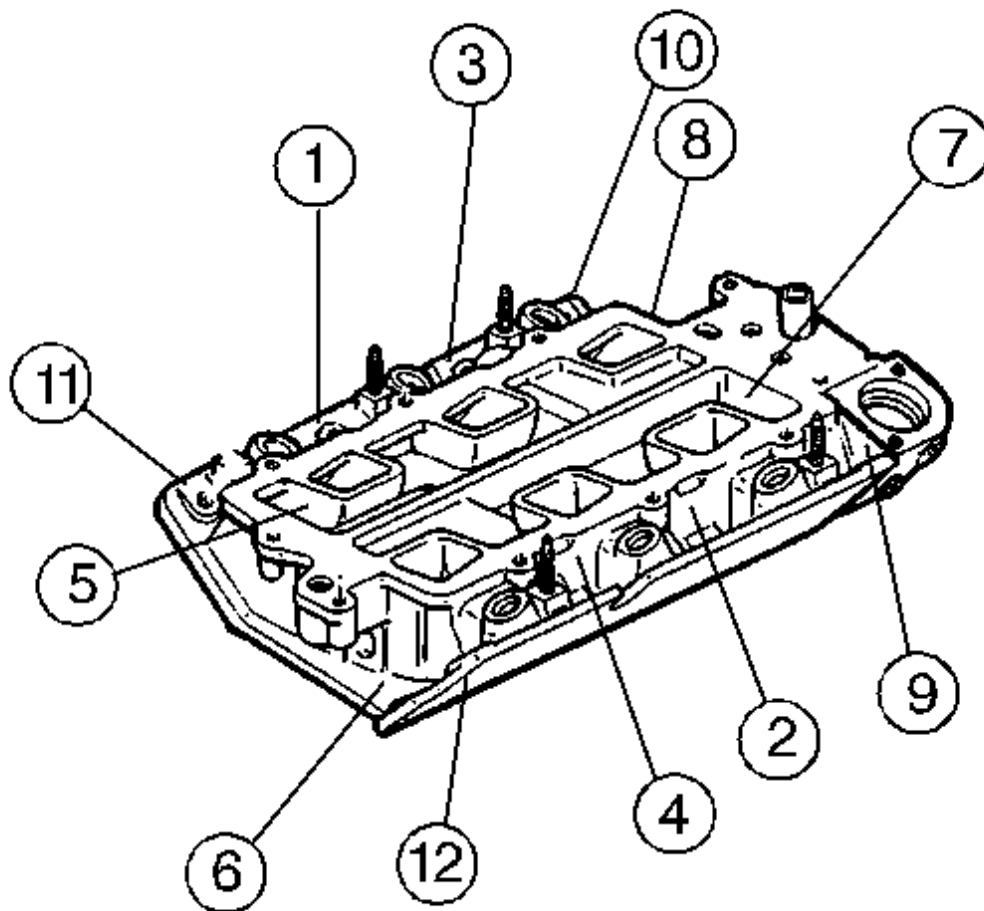


Fig. 466: Identifying Lower Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

6. Install the lower intake manifold bolts.

Tighten: Tighten the lower intake manifold bolts in sequence to 15 N.m (11 lb ft).

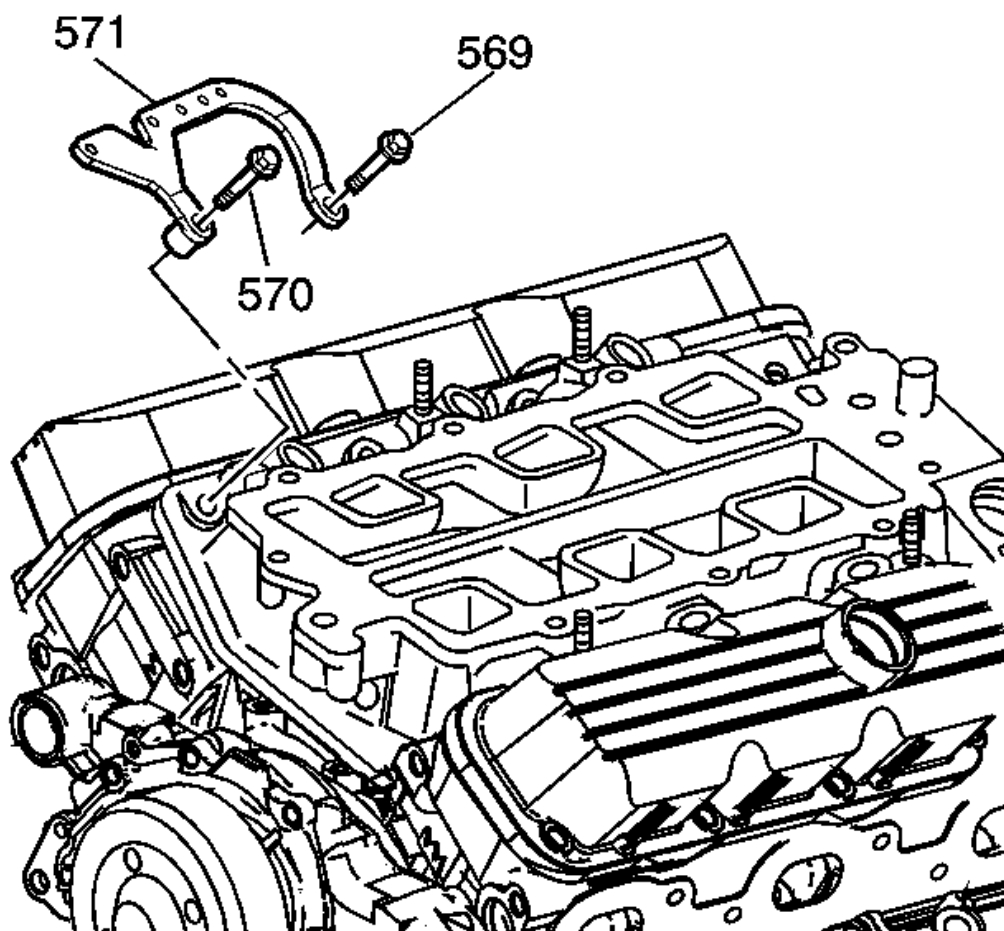


Fig. 467: Generator Brace Bracket
Courtesy of GENERAL MOTORS CORP.

7. Install the generator brace bracket (571).
8. Install the generator brace bracket bolts (569, 570).

Tighten: Tighten the generator brace bracket bolts to 50 N.m (37 lb ft).

EXHAUST GAS RECIRCULATION VALVE AND PIPE INSTALLATION

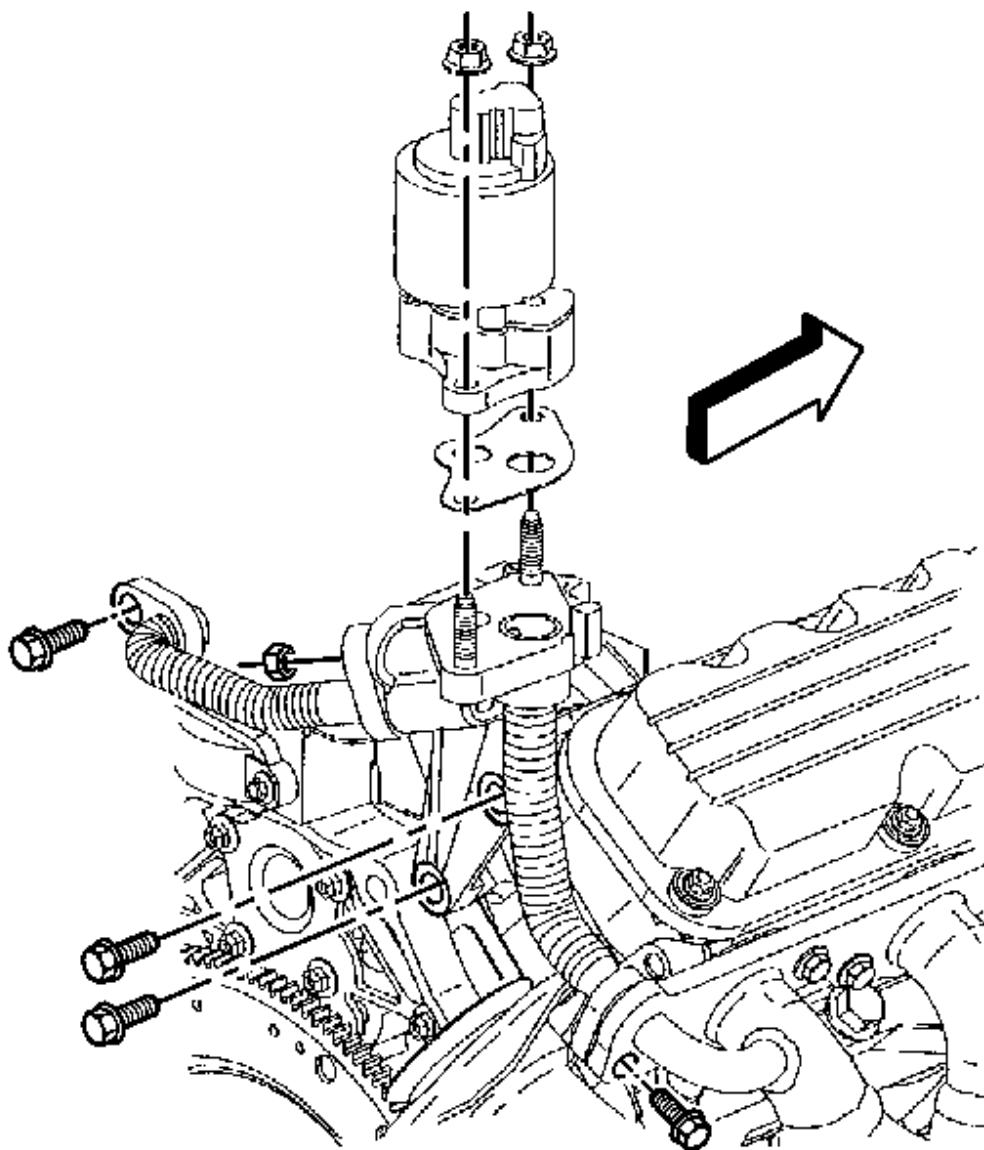


Fig. 468: View Of EGR Valve Adapter Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Inspect the exhaust gas recirculation (EGR) inlet/outlet pipes for leaks before installation. If cracks, deformations or any visible signs of leaking are present, replace the appropriate part.

1. Install the EGR inlet pipe into the RH exhaust manifold as the EGR valve adapter assembly is installed onto the cylinder head.

NOTE: Refer to **FASTENER CAUTION** .

2. Install the EGR valve adapter assembly to cylinder head bolts and the EGR inlet pipe to RH exhaust manifold bolt.

Tighten:

- Tighten the EGR valve adapter assembly to cylinder head bolts to 50 N.m (37 lb ft).
- Tighten the EGR inlet pipe to RH exhaust manifold bolt to 29 N.m (21 lb ft).

3. Install the EGR valve outlet pipe to the lower intake and the EGR valve adapter assembly.
4. Install the EGR valve outlet pipe bolt and nut.

Tighten: Tighten the EGR valve outlet pipe bolt and nut to 29 N.m (21 lb ft).

5. Install the EGR valve gasket and EGR valve.
6. Install the EGR valve nuts.

Tighten: Tighten the EGR valve nuts to 29 N.m (21 lb ft).

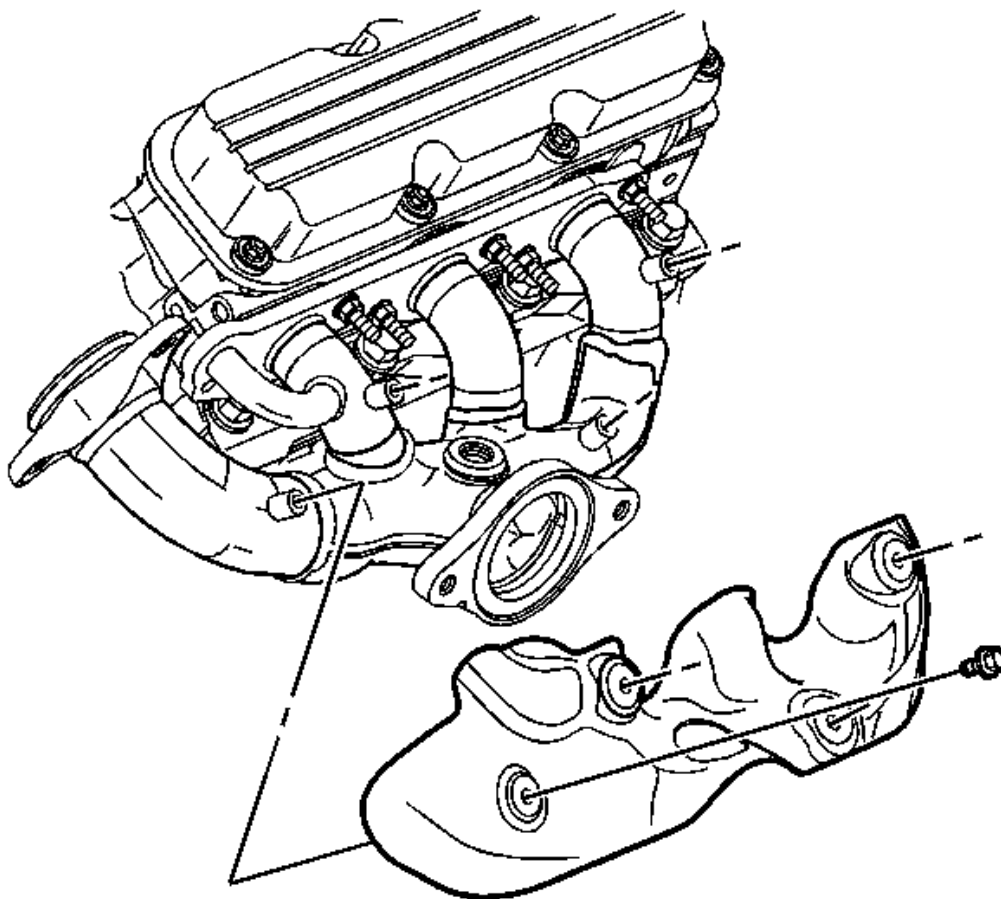


Fig. 469: Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust manifold heat shield.
8. Install the exhaust manifold heat shield bolts.

Tighten: Tighten the exhaust manifold heat shield bolts to 10 N.m (89 lb in).

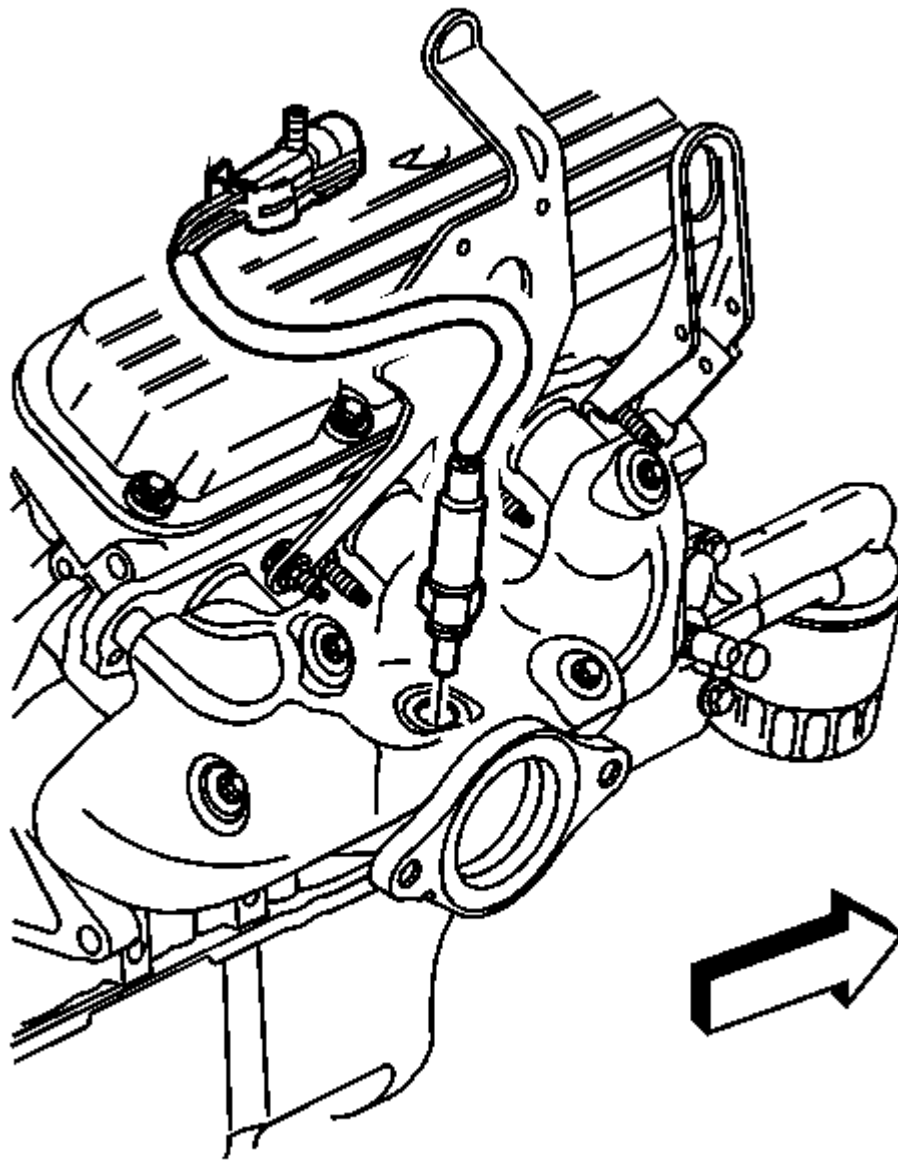


Fig. 470: Heated Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

9. Install the heated oxygen sensor.

Tighten: Tighten the heated oxygen sensor to 42 N.m (31 lb ft).

UPPER INTAKE MANIFOLD INSTALLATION

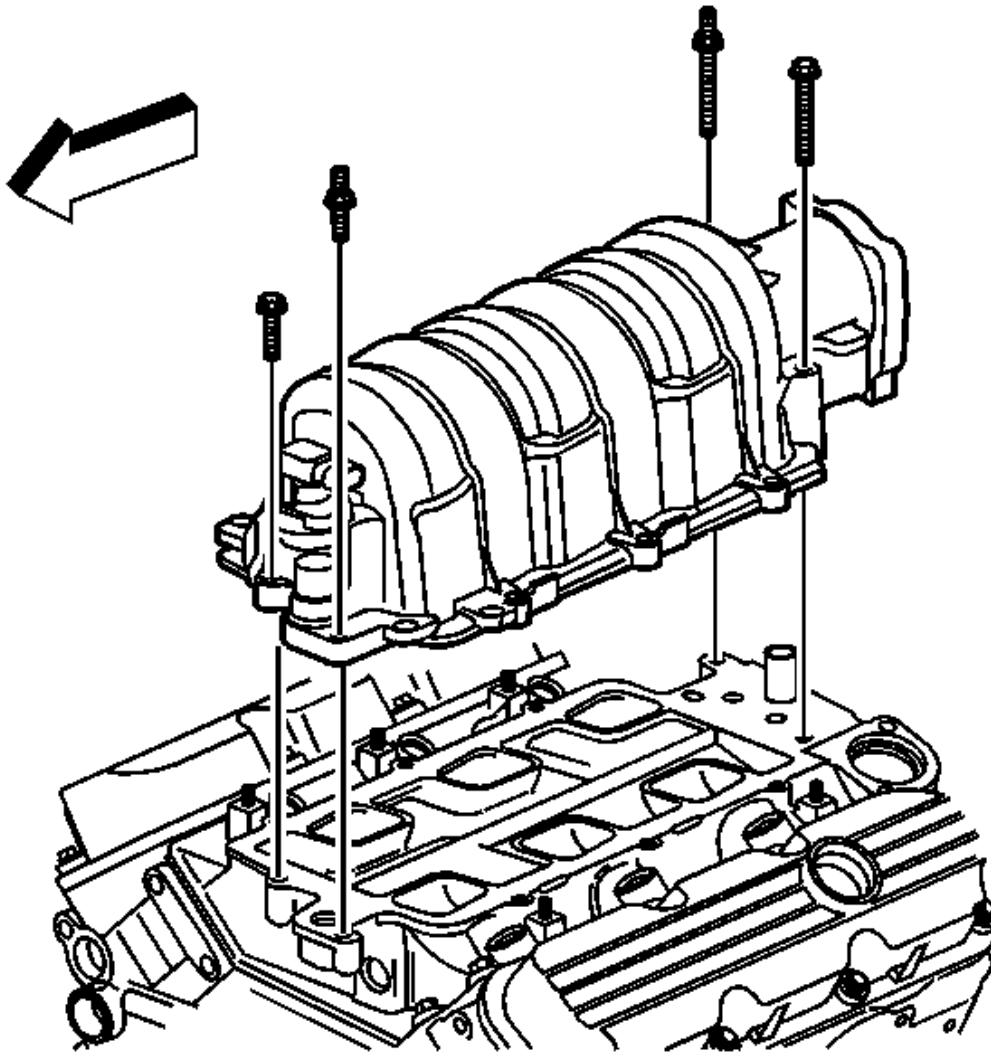


Fig. 471: Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Install the upper intake manifold gasket.
2. Install the upper intake manifold.

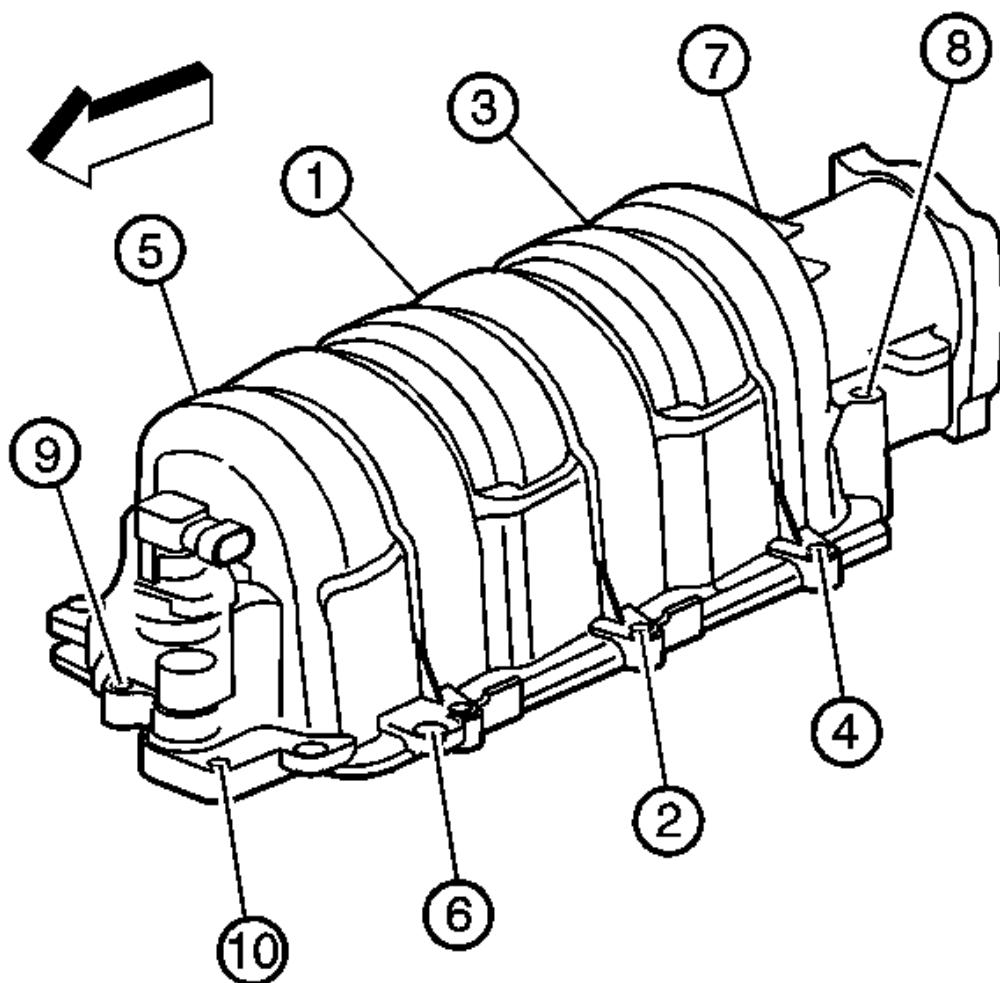


Fig. 472: Upper Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER CAUTION .

3. Install the upper intake manifold bolts and studs.

Tighten: Tighten the upper intake manifold bolts and studs in sequence to 10 N.m (89 lb in).

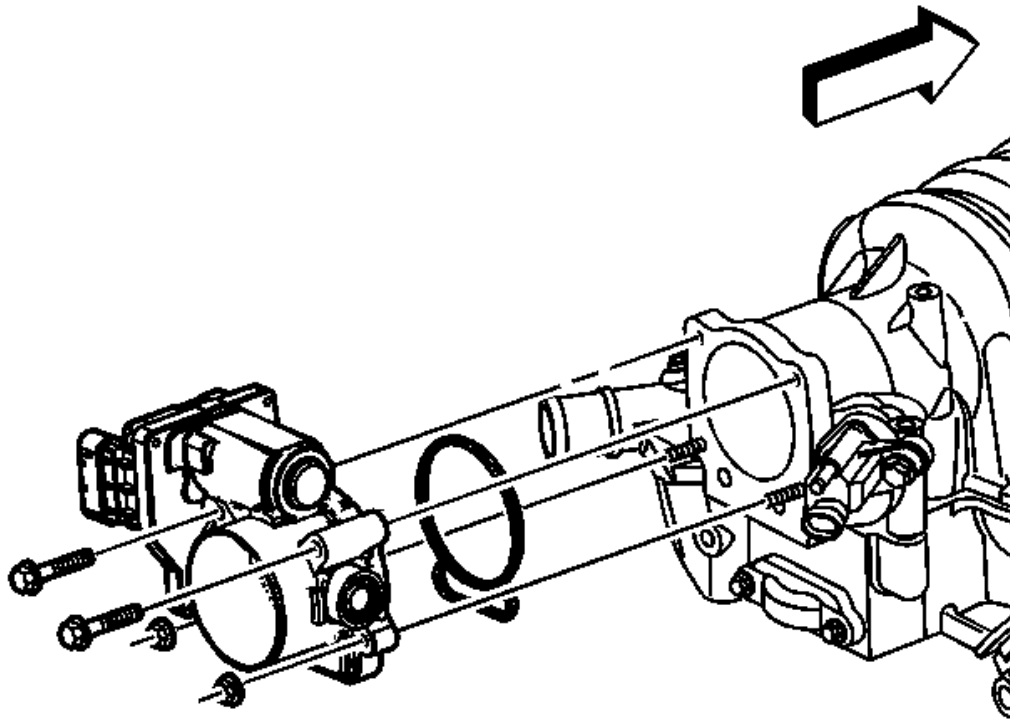


Fig. 473: Throttle Body & Seal
Courtesy of GENERAL MOTORS CORP.

4. Install the throttle body gasket.
5. Install the throttle body.
6. Install the throttle body nuts and bolts.

Tighten: Tighten the throttle body nuts and bolts to 10 N.m (89 lb in).

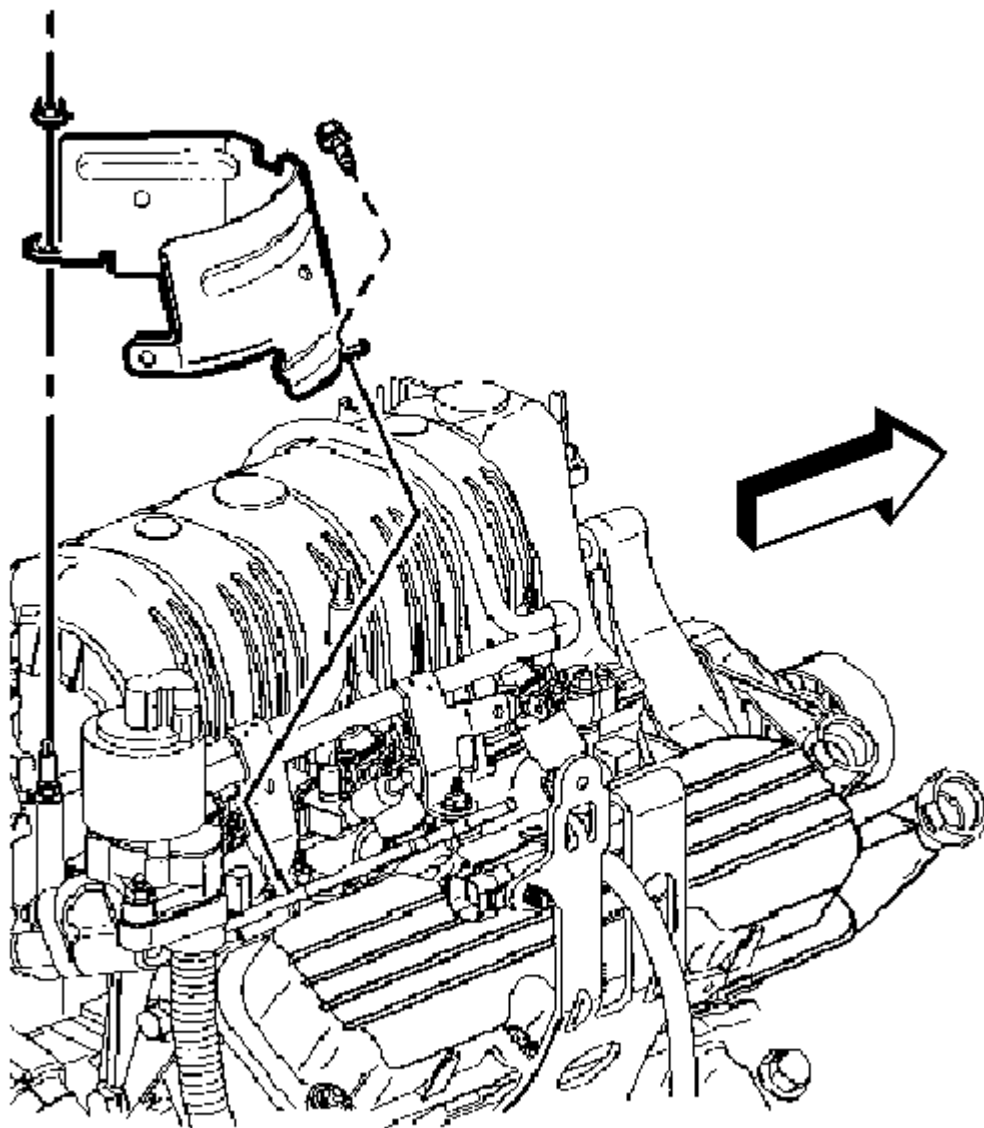


Fig. 474: Engine Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Install the engine wiring harness heat shield.
8. Install the engine wiring harness heat shield bolt and nut.

Tighten: Tighten the engine wiring harness heat shield bolt and nut to 10 N.m (89 lb in).

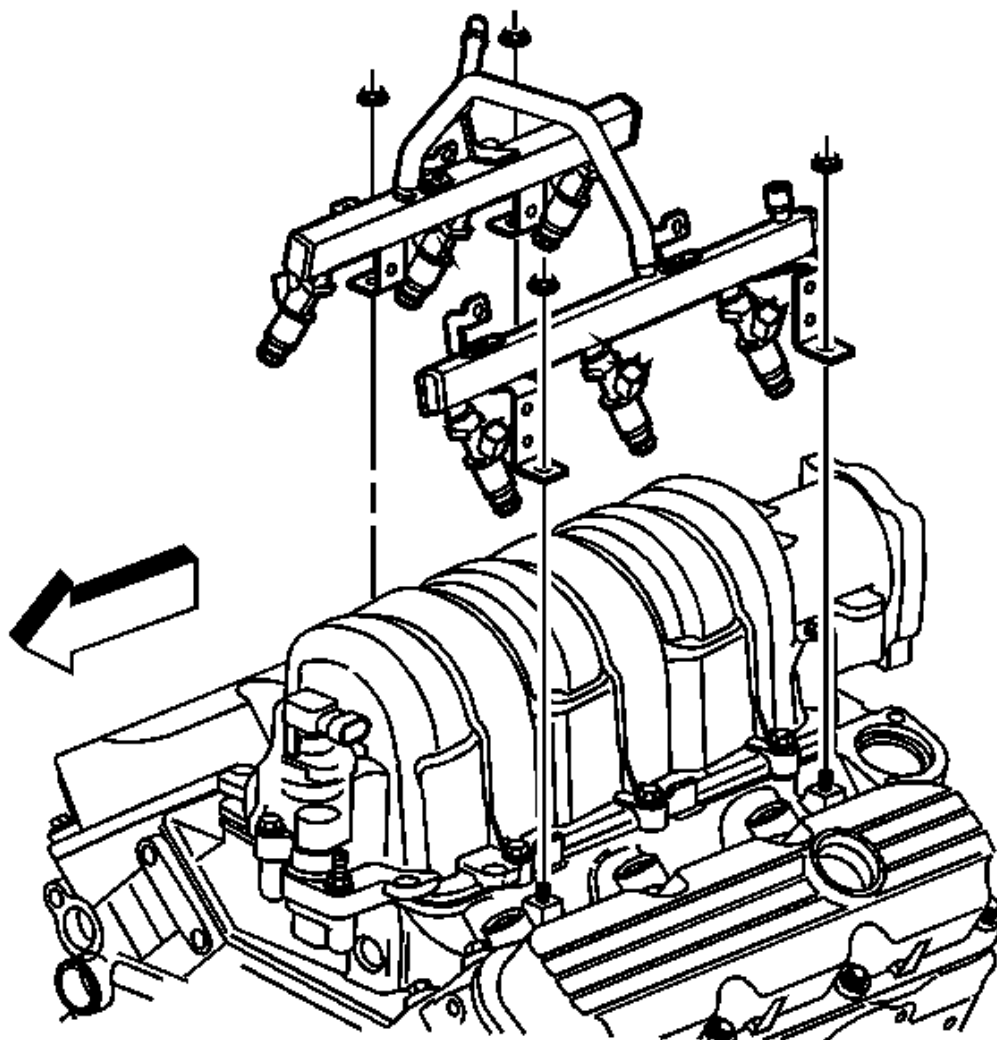


Fig. 475: Fuel Injector Rail

Courtesy of GENERAL MOTORS CORP.

9. Install the fuel injector rail.
10. Install the fuel injector rail nuts.

Tighten: Tighten the fuel injector rail nuts to 10 N.m (89 lb in).

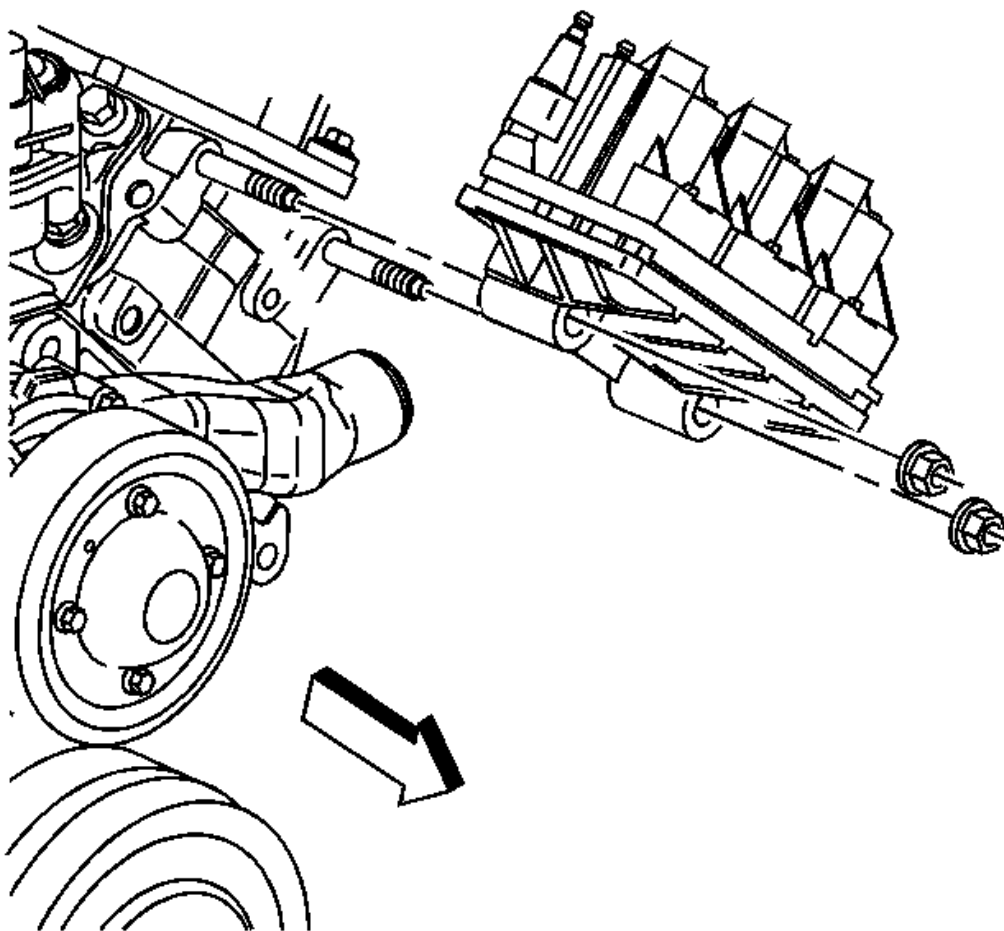


Fig. 476: Ignition Control Module Assembly
Courtesy of GENERAL MOTORS CORP.

11. Install the ignition control module assembly.
12. Install the ignition control module assembly bracket nuts.

Tighten: Tighten the ignition control module assembly bracket nuts to 50 N.m (37 lb ft).

13. Connect the ignition control module connector to the ignition control module assembly.
14. Install the wiring harness to the fuel rail.
15. Install the spark plug wires to the retaining clips and spark plugs.

WATER PUMP INSTALLATION

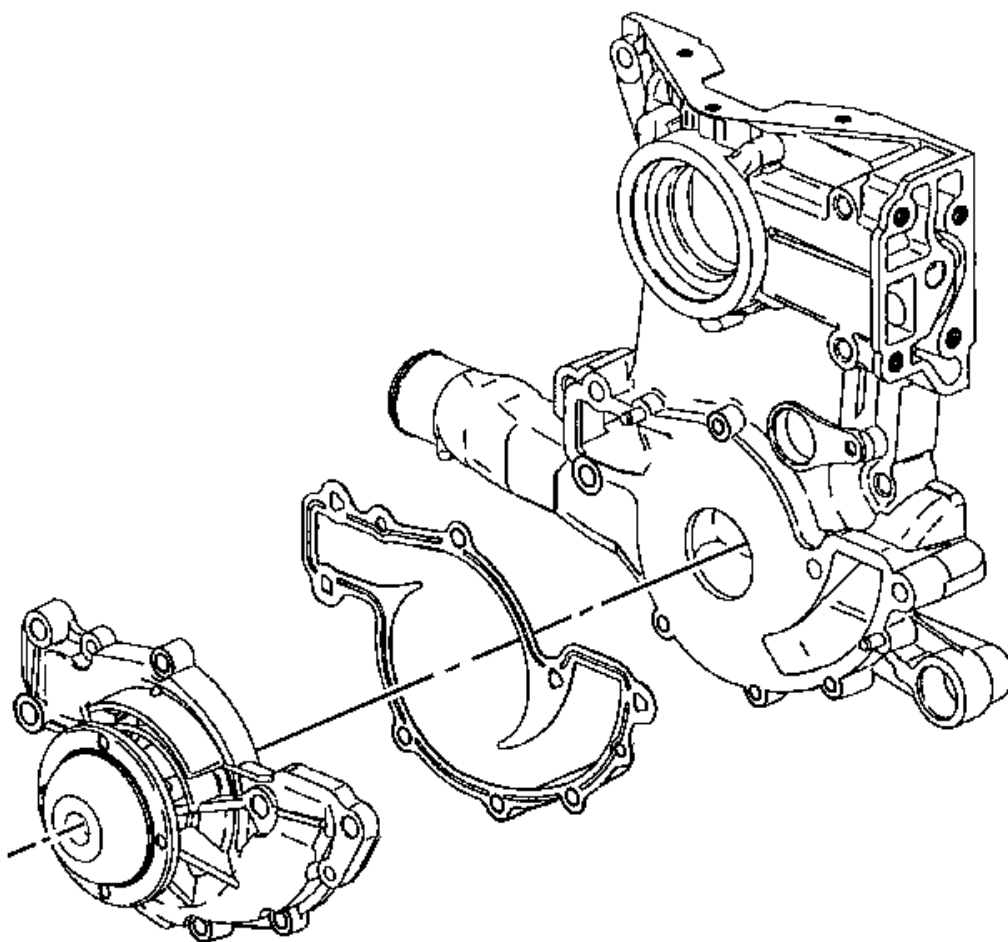


Fig. 477: Water Pump & Components
Courtesy of GENERAL MOTORS CORP.

1. Install the water pump gasket.
2. Install the water pump.

NOTE: Refer to **FASTENER CAUTION** .

3. Install the water pump bolts.

Tighten:

- Tighten the small water pump bolts to 22 N.m (16 lb ft).
- Tighten the large water pump bolts to 34 N.m (25 lb ft).

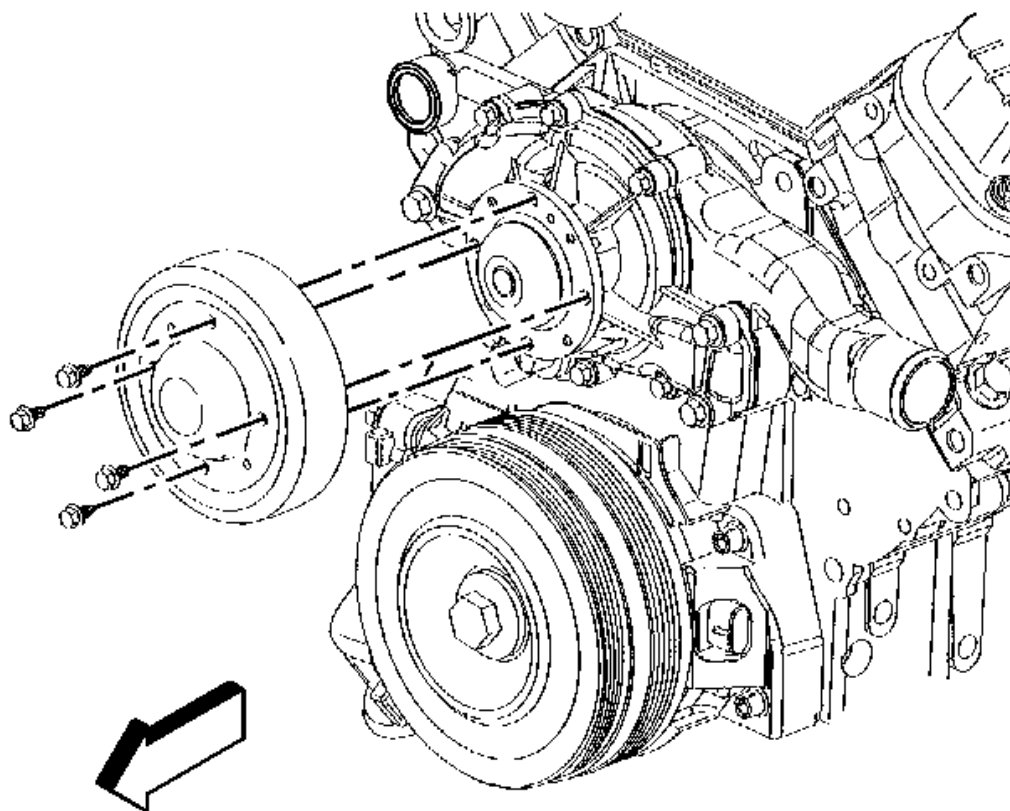


Fig. 478: Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

4. Install the water pump pulley.
5. Install the water pump pulley bolts.

Tighten: Tighten the water pump pulley bolts to 13 N.m (116 lb in).

WATER OUTLET AND ENGINE COOLANT THERMOSTAT INSTALLATION (L26)

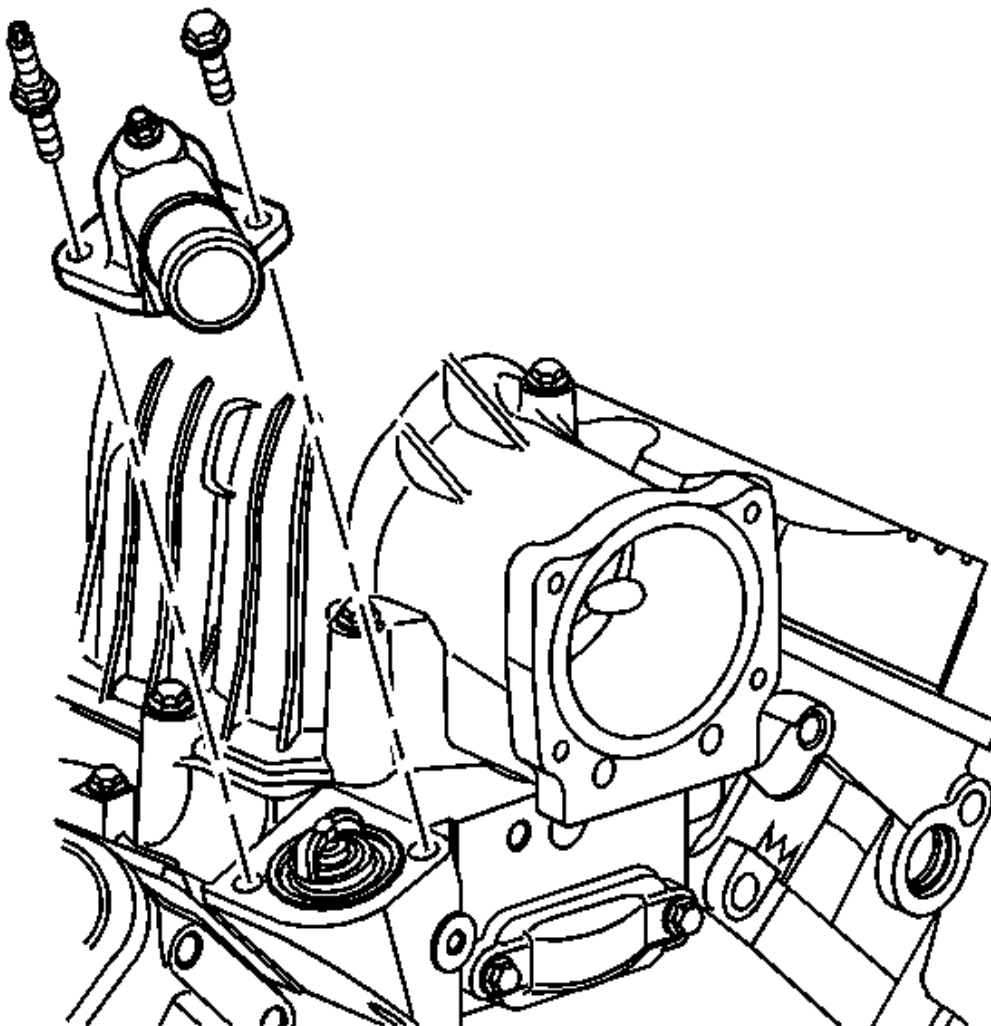


Fig. 479: Thermostat, Water Outlet Bolt & Stud (L26)
 Courtesy of GENERAL MOTORS CORP.

1. Install the thermostat.
2. Install the water outlet.

NOTE: Refer to FASTENER CAUTION .

3. Install the water outlet bolt and stud.

Tighten: Tighten the water outlet bolt and stud to 27 N.m (20 lb ft).

OIL LEVEL INDICATOR AND TUBE INSTALLATION

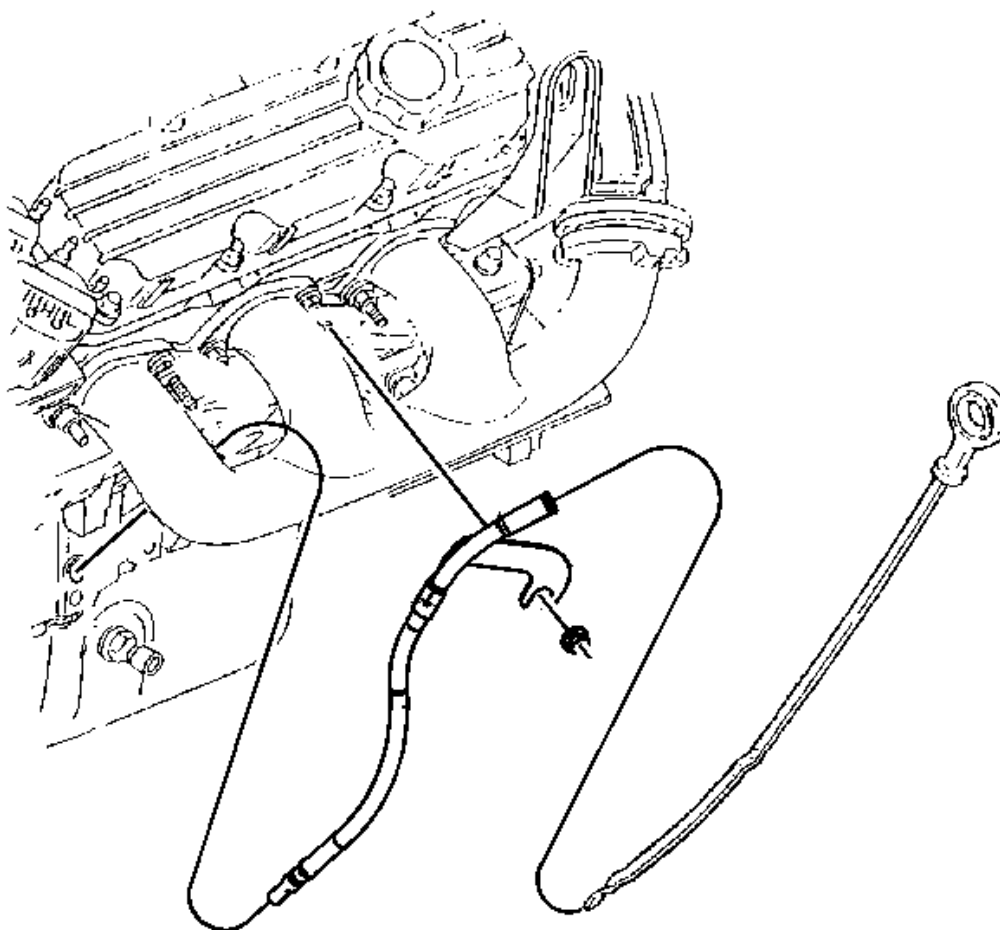


Fig. 480: Oil Level Indicator, Tube & Nut
Courtesy of GENERAL MOTORS CORP.

1. Install the oil level indicator tube.
 - Lubricate the O-ring with engine oil and make sure it is in place.
 - Make sure the assembly is fully seated in the engine block.

NOTE: Refer to FASTENER CAUTION .

2. Install the oil level indicator tube nut.

Tighten: Tighten the nut to 19 N.m (14 lb ft).

3. Install the oil level indicator.

DRIVE BELT IDLER PULLEY INSTALLATION

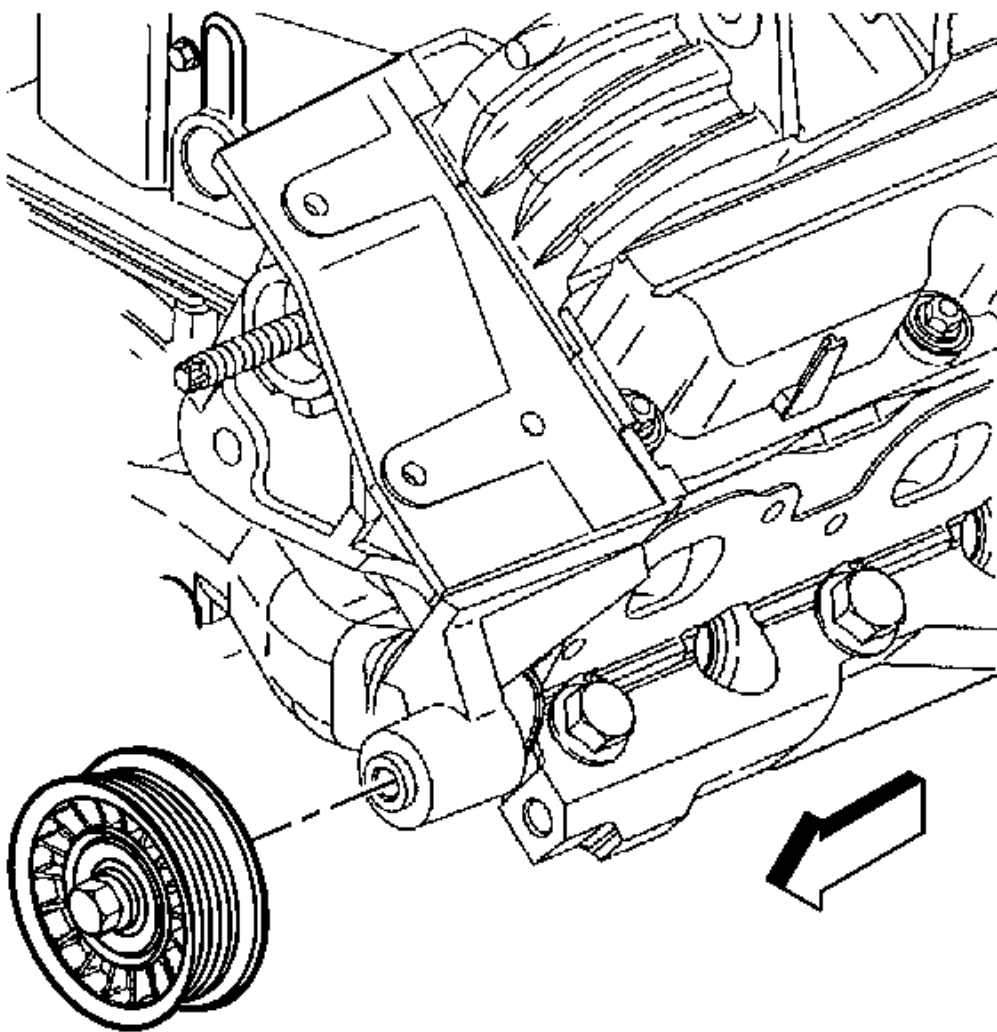


Fig. 481: Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.

NOTE: Refer to **FASTENER CAUTION** .

2. Install the drive belt idler pulley bolt.

Tighten: Tighten the drive belt idler pulley bolt to 50 N.m (37 lb ft).

DRIVE BELT TENSIONER INSTALLATION

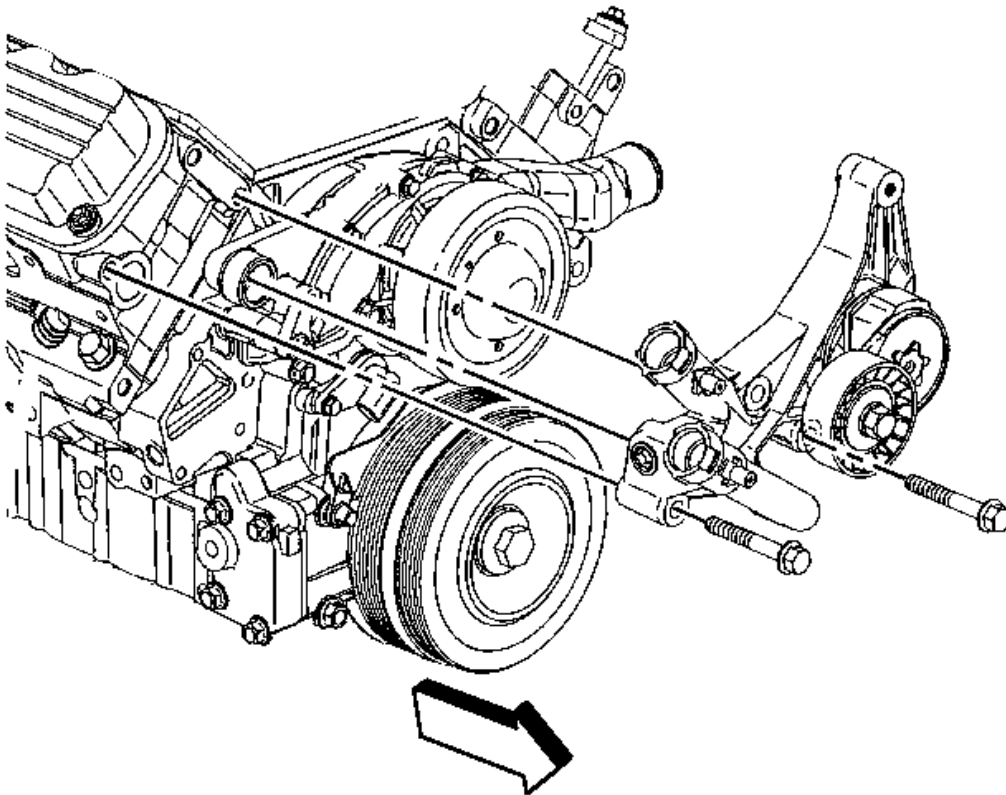


Fig. 482: Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner bracket.

NOTE: Refer to FASTENER CAUTION .

2. Install the drive belt tensioner bracket bolts.

Tighten: Tighten the drive belt tensioner bolts to 50 N.m (37 lb ft).

ENGINE FLYWHEEL INSTALLATION

Tools Required

- **J 37096** Flywheel Holder. See **Special Tools**.
- **J 45059** Angle Meter

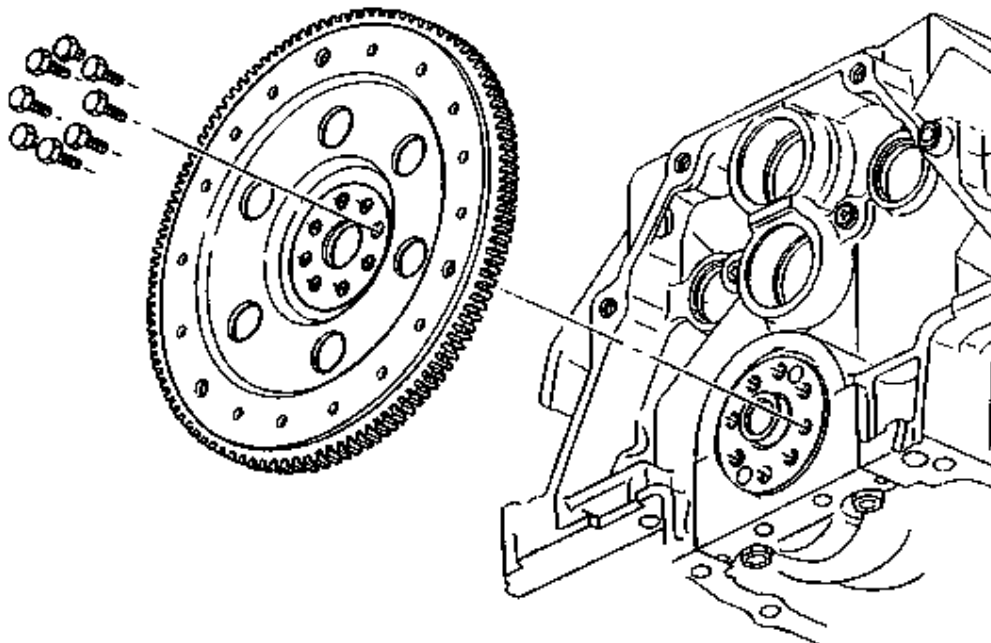


Fig. 483: Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel.

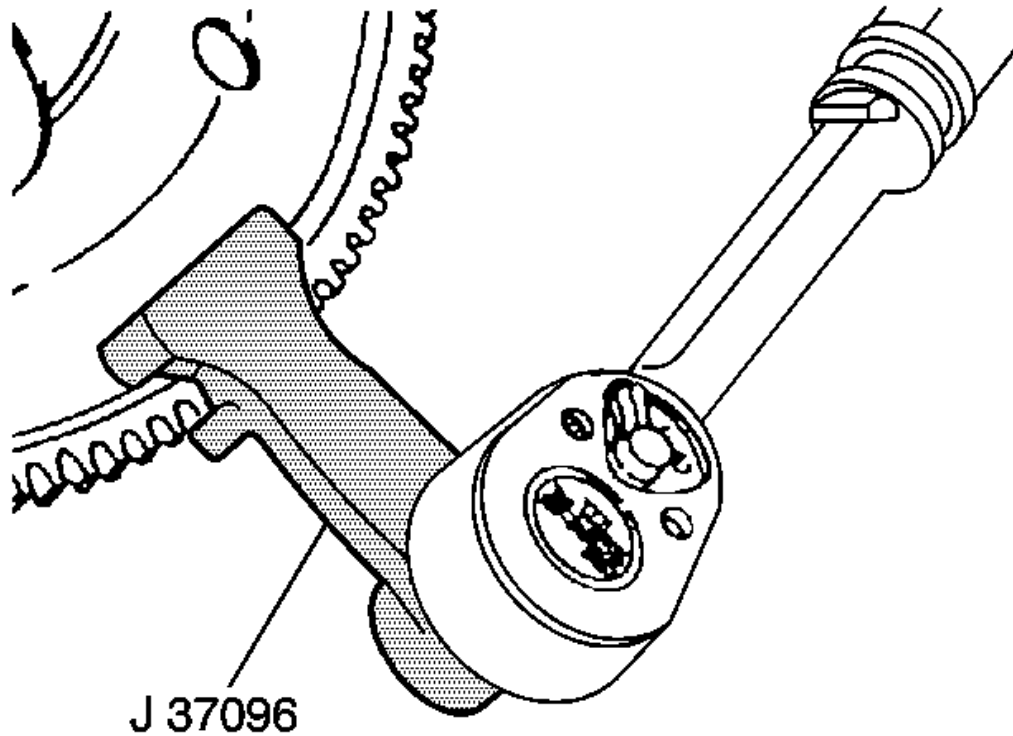


Fig. 484: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

2. Use the **J 37096** to secure the flywheel in order to prevent the crankshaft from rotating. See **Special Tools**.

NOTE: Refer to **FASTENER CAUTION** .

3. Install the new flywheel bolts.

Tighten: Tighten the bolts to 15 N.m (11 lb ft). Use the **J 45059** to tighten the bolts an additional 50 degrees.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **J 37096:** Flywheel Holder
- **J 45059:** Angle Meter

For equivalent regional tools, refer to Special Tools.

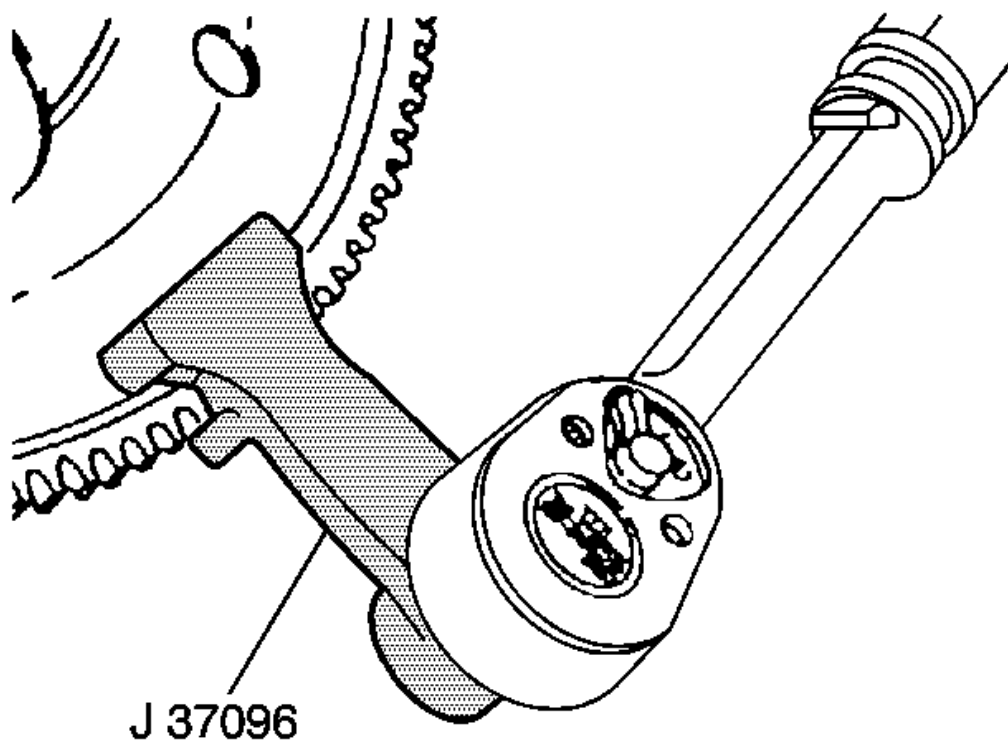


Fig. 485: Holding Flywheel

Courtesy of GENERAL MOTORS CORP.

1. Lubricate the seal surface of the crankshaft balancer with engine oil.

NOTE: The crankshaft position sensor system variation learn procedure must be completed whenever the crankshaft is replaced.

2. Install the crankshaft balancer.
3. Use **J 37096**: holder to hold the flywheel.

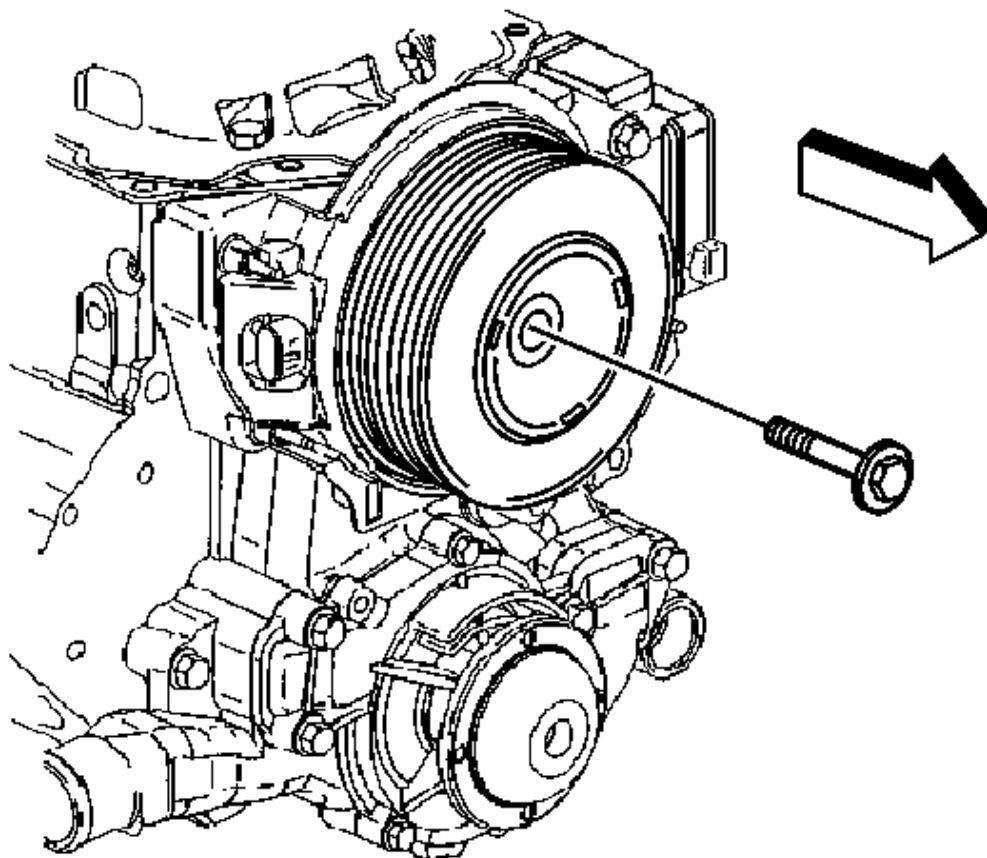


Fig. 486: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Special Fastener Caution .

CAUTION: Refer to Fastener Caution .

4. Install the crankshaft balancer bolt and Tighten the crankshaft balancer bolt to 150 N.m (111 lb ft). Use **J 45059**: meter to tighten the crankshaft balancer bolt an additional 76 degrees.

ENGINE PRELUBING

Tools Required

J 45299 Engine Preluber. See **Special Tools**.

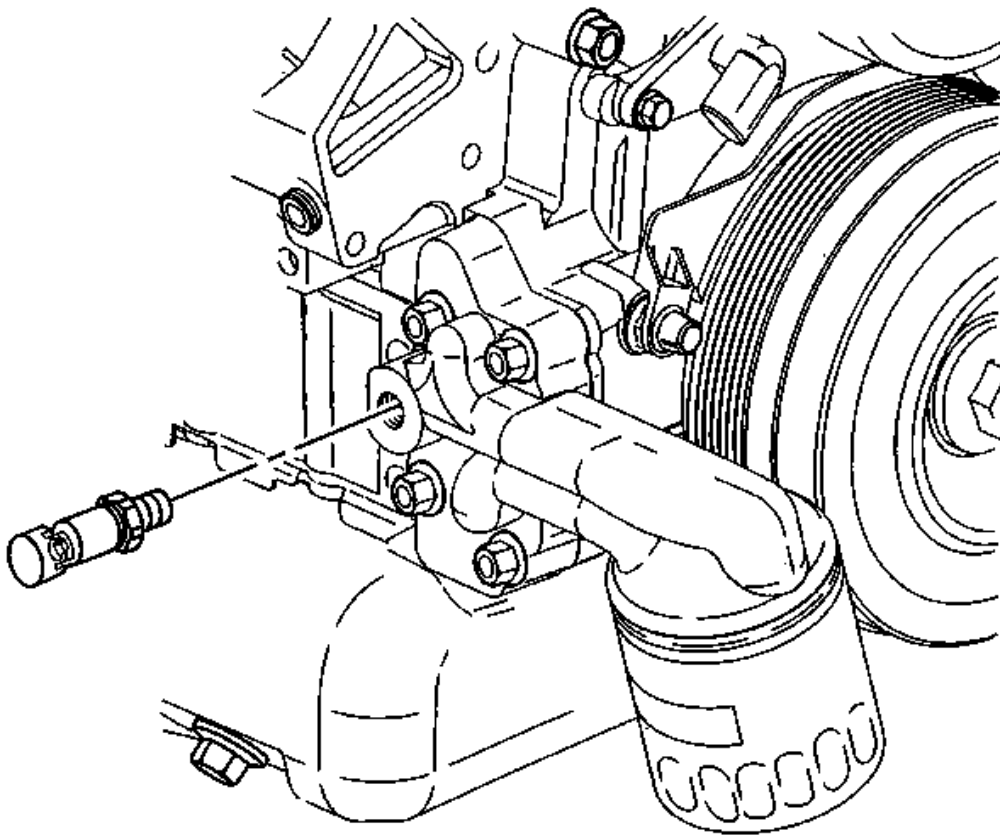


Fig. 487: Oil Pressure Switch

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: A constant/continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter, fill with clean engine oil.

NOTE: Refer to **FASTENER CAUTION** .

2. Install the oil filter.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

3. Locate the oil pressure sensor on left side of engine and remove.
4. Install the 1/4 inch adapter P/N 509373.

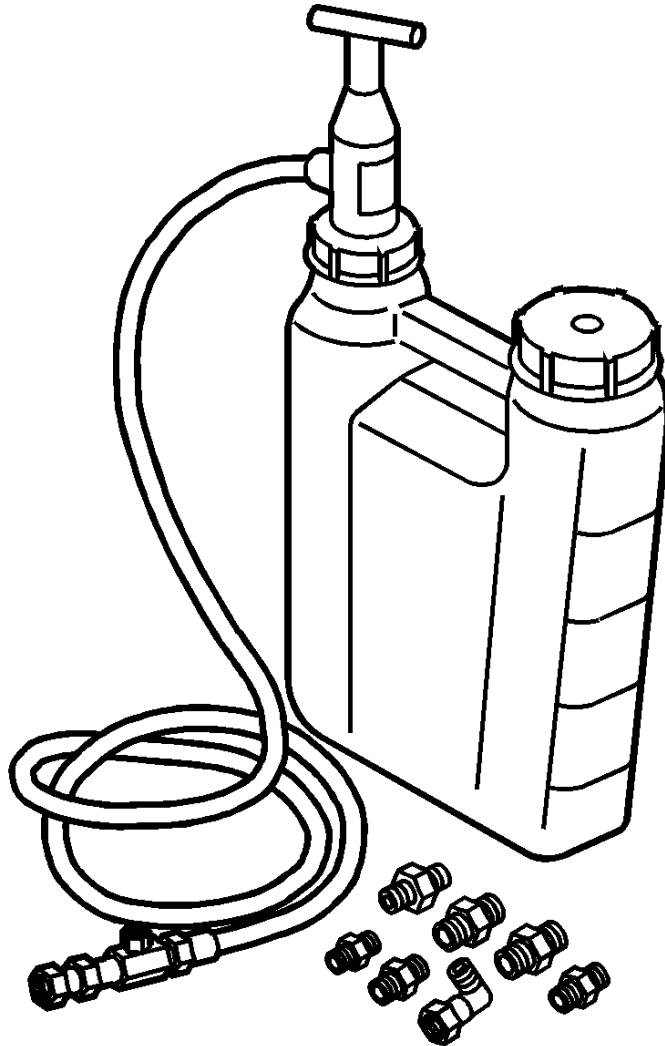


Fig. 488: View Of Engine Preluber
Courtesy of GENERAL MOTORS CORP.

5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on **J 45299** to flow a minimum of 1-2 quarts of engine oil. See **Special Tools**. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the oil pressure sensor.

Tighten: Tighten the oil pressure sensor to 16 N.m (12 lb ft).

9. Top off the engine oil to the proper level.

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

Inspection/Description

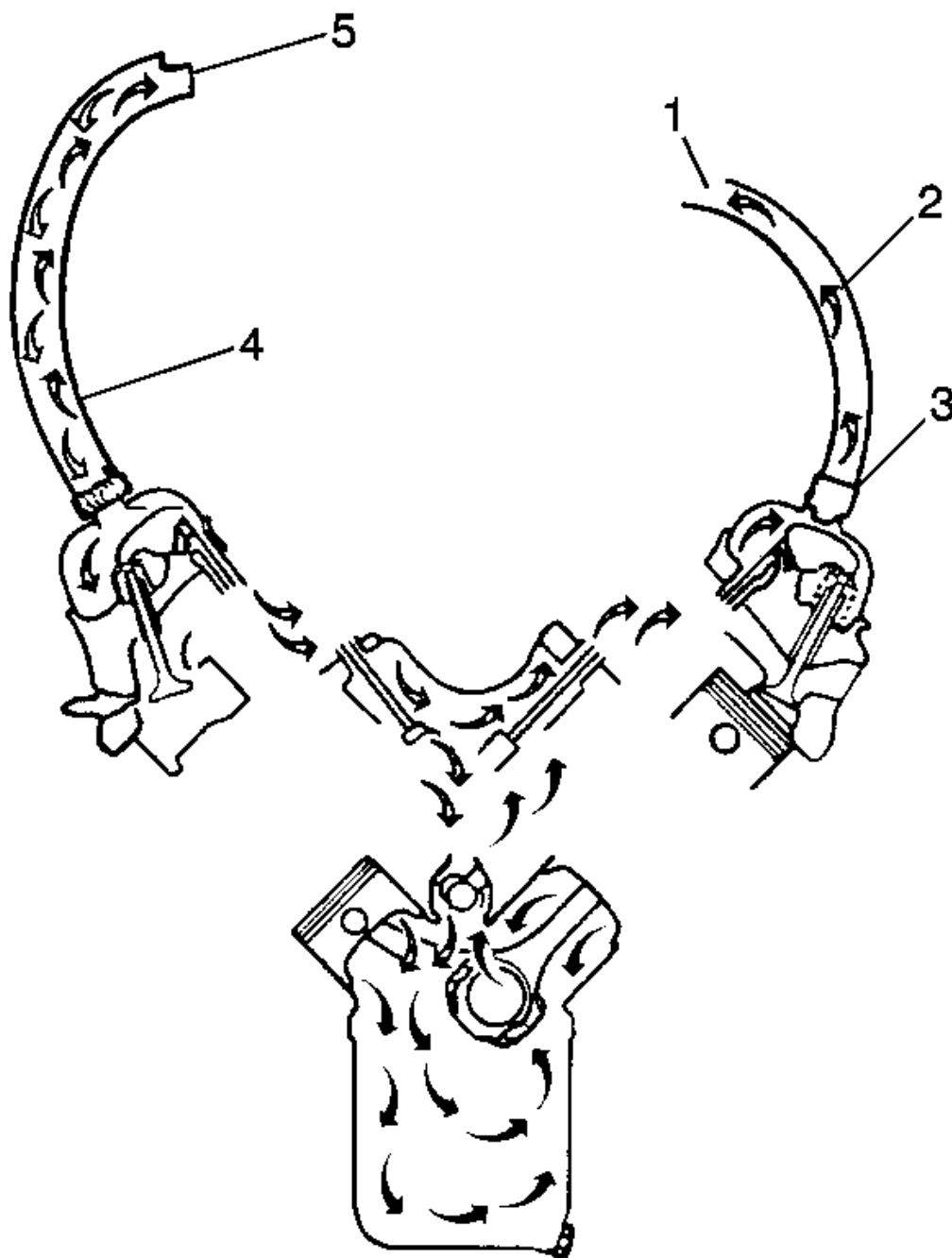


Fig. 489: Crankcase Ventilation System Flow Diagram
Courtesy of GENERAL MOTORS CORP.

The Crankcase Ventilation System is used to consume crankcase vapors (1) in the combustion process instead of venting them to atmosphere. Fresh air from the throttle body is supplied to the crankcase, mixed with blow-by gases and then passed through a crankcase ventilation valve into the supercharger inlet (L67) or the intake manifold (L26).

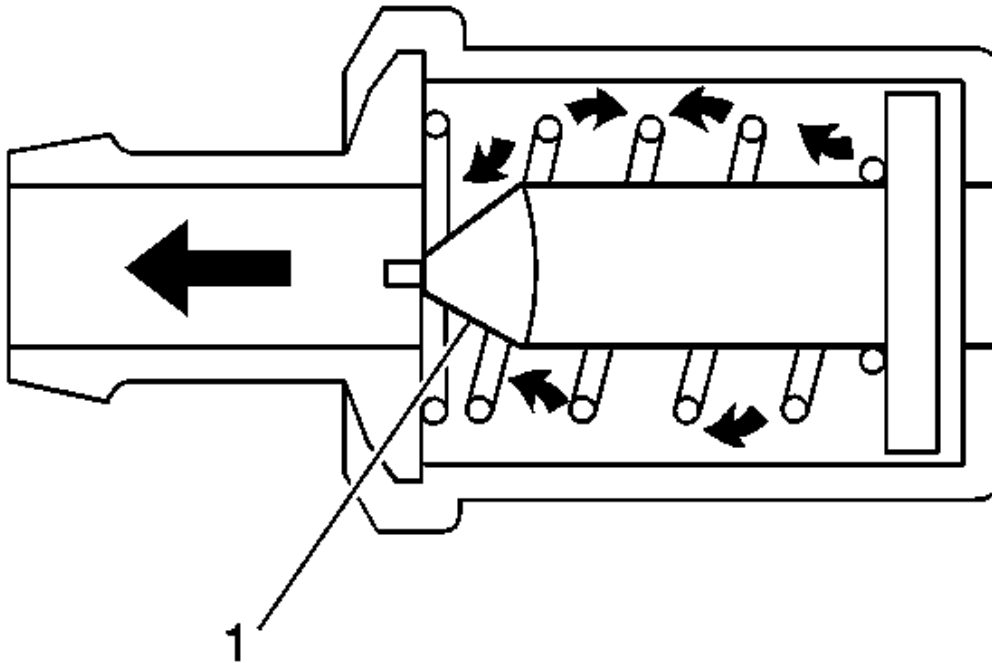


Fig. 490: Crankcase Ventilation
Courtesy of GENERAL MOTORS CORP.

The primary control is through the crankcase ventilation valve (1) which meters the flow at a rate depending on inlet vacuum. To maintain idle quality, the crankcase ventilation valve restricts the flow when inlet vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent into the throttle body to be consumed by normal combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- Drive belt
- Drive belt tensioner
- Drive belt idler pulley
- Supercharger drive belt

- Supercharger drive belt tensioner
- Supercharger drive belt idler pulleys
- Crankshaft balancer pulley
- Accessory drive component mounting brackets
- The accessory drive components:
 - Power steering pump
 - Generator
 - A/C compressor
 - Water pump

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

ENGINE COMPONENT DESCRIPTION

Engine Construction

Starting at the front of the engine, the cylinders of the left bank are numbered 1-3-5 and the cylinders of the right bank are numbered 2-4-6. The crankshaft is supported in the engine block by four bearings. The crankshaft is counterbalanced by the flywheel, the crankshaft balancer, and the weights cast into the crankshaft. Additional counterbalancing is obtained from the balance shaft which rides in the engine block above the camshaft and is driven by the camshaft. All 3800 engines are even-firing, the cylinders fire at equal 120 degree intervals of crankshaft rotation. The location of the crankshaft journals has been offset by 30 degrees to fire the cylinders at 120 degree intervals of crankshaft rotation. The camshaft lobes and timing also reflect the 120 degree intervals. The even firing crankshaft provides an equal interval of 120 degrees between ignition of each of the cylinders throughout the firing order. The firing order is 1-6-5-4-3-2. The aluminum alloy pistons have slipper skirts and are cam turned. Four drilled holes or casted slots in the oil ring grooves permit drain back of the oil collected by the oil ring. The camshaft is supported by four bearings in the engine block and is driven by the crankshaft through sprockets and a timing chain. The cylinder heads are cast iron and incorporate integral valve stem guides. Right and left cylinder heads are identical and are interchangeable, but it is good practice to reinstall the cylinder heads on the side from which they are removed. The intake manifold is bolted to the inner faces of both

cylinder heads so it connects with all inlet ports.

Each exhaust and intake valve has a valve spring to insure positive seating throughout the operating speed range. The valve rocker arms for each bank of the cylinders pivot on pedestals bolted to the cylinder head. Hydraulic roller valve lifters and tubular push rods are used to operate overhead rocker arms and valves of both banks of the cylinders from a single camshaft. This system requires no lash adjustment at the time of assembly or service.

In addition to its normal function of a cam follower, each valve lifter also serves as an automatic adjuster which maintains zero lash in the valve train under all operating conditions. By eliminating all lash in the valve train and also providing a cushion of oil to absorb operating shocks, the valve lifter promotes quiet valve operation. It also eliminates the need for periodic valve adjustment to compensate for wear of parts. Oil is supplied to the valve lifter through a hole in the side of the valve lifter body which indexes with a groove and a hole in the valve lifter plunger. Oil is then metered past the oil metering valve in the valve lifter, through the push rods to the valve rocker arms. When the valve lifter begins to move up the camshaft lobe, the check ball is held against its seat in the plunger by the check ball spring which traps the oil in the base of the valve lifter body below the plunger.

The plunger and the valve lifter body then raise as a unit, pushing up the push rod to open the valve. The force of the valve spring which is exerted on the plunger through the valve rocker arm and push rod, causes a slight amount of leakage between the plunger and the valve lifter body. This leakage allows a slow escape of trapped oil in the base of the valve lifter body. As the valve lifter rolls down the other side of the camshaft lobe and reaches the base circle or valve closed position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the check ball to open against the ball spring, and any oil inside the plunger is drawn into the base of the valve lifter. This restores the valve lifter to the zero lash.

NEW PRODUCT INFORMATION

The purpose of New Product Information is to highlight or indicate important product changes from the previous model year.

Changes may include one or more of the following items:

- A component comparison from the previous year
- Fastener changes
- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required

Component Comparison

- New upper and lower intake
- ETC (Electronic Throttle Control) throttle body

- Returnless fuel system
- Oil Level indicator tube
- New MAP and BARO Sensors
- New MAP and BARO sensor bracket and retainer clips
- Direct mount EVAP purge valve

Fastener Changes

EVAP Purge Valve bolt has been added 16 N.m (12 lb ft).

Torque Values and/or Fastener Tightening Strategies

No torque value changes for 2007.

Changed Engine Specifications

No engine specification changes for 2007.

New Sealants and/or Adhesives

No new sealants and or adhesives for 2007.

Disassembly and Assembly Procedure Revisions

- Supercharger Removal/Installation procedures have been revised - L32.
- Intake Manifold Removal/Installation Procedures have been revised - L26.

Engine Mechanical Diagnostic Procedure Revisions

No engine diagnostic procedure revisions for 2007.

New Special Tools Required

J 45059 Angle Meter has replaced the J 36660-A Torque Angle Meter.

LUBRICATION DESCRIPTION

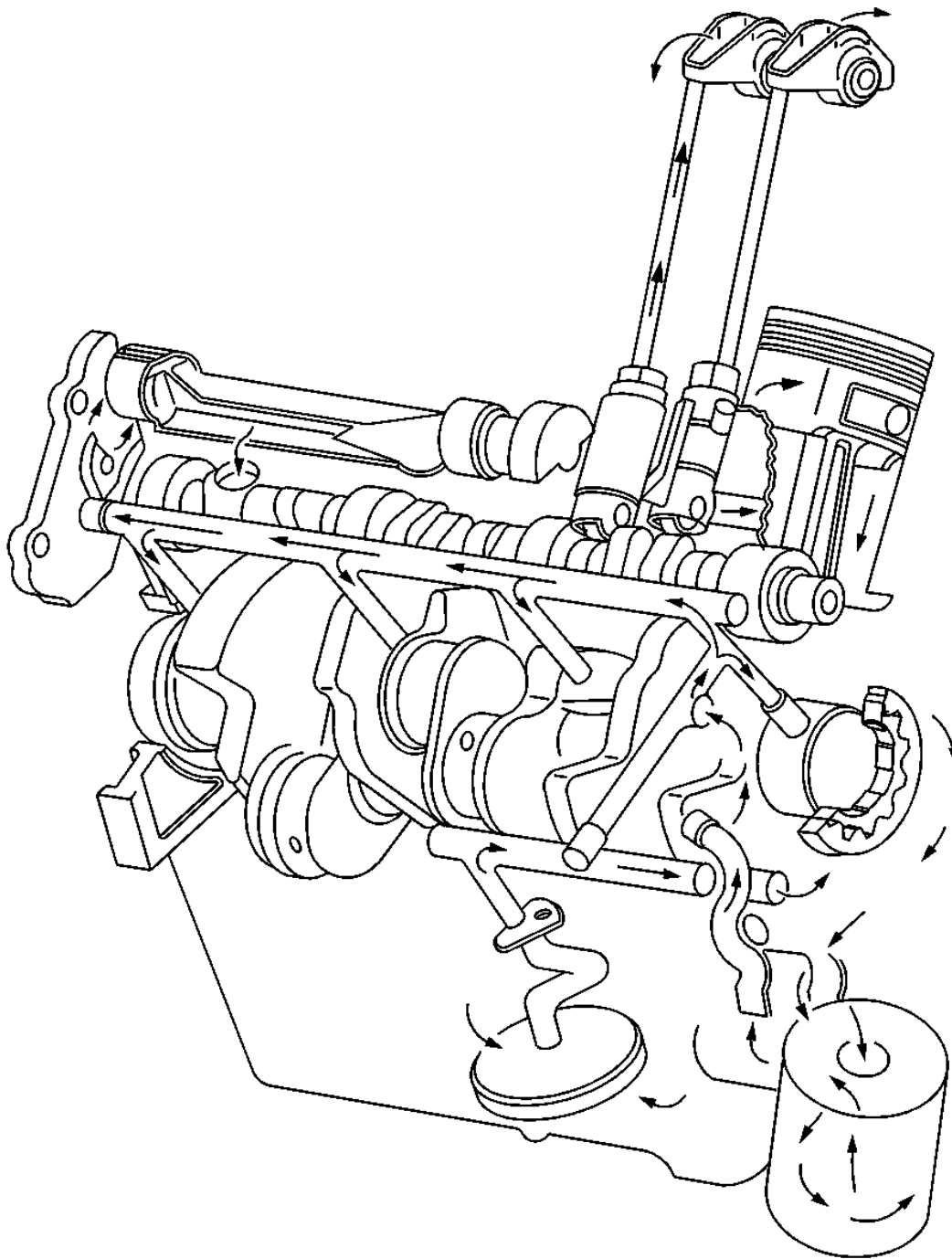


Fig. 491: Identifying Engine Lubrication System
Courtesy of GENERAL MOTORS CORP.

The engine lubrication system is of the force-feed type. The oil is supplied under full pressure to the crankshaft,

connecting rods, valve lifters, camshaft, and rear balance shaft bearing. A controlled volume of oil is supplied to the valve rocker arms and push rods. All other moving parts are lubricated by gravity flow or splash. The engine oil is stored in the lower crankcase (oil pan) which is filled through a filler opening in the valve rocker arm cover. A removable oil level indicator, on the left side of the engine block, is provided to check the oil level. The oil pump is located in the engine front cover and is driven by the crankshaft. It is a gerotor-style pump which is a combination of a gear and a rotor pump. It is connected by a passage in the cylinder block to an oil screen and pipe assembly. The screen is submerged in the oil supply and has ample volume for all operating conditions. If the screen becomes clogged, oil may be drawn into the system through the oil pressure relief valve in the oil filter adapter. Oil is drawn into the pump through the screen and pipe assembly, and a passage in the crankcase, connecting to the passages in the engine front cover. Oil is discharged from the oil pump to the oil filter adapter. The oil filter adapter consists of an oil filter bypass valve and a nipple for installation of an oil filter. The spring-loaded oil pressure relief valve, located in the engine front cover, limits the oil pressure. The oil filter bypass valve opens when the oil filter is restricted to approximately 68.95 kPa (10 psi) of pressure difference between the oil filter inlet and discharge. The oil will then bypass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine. A full-flow oil filter is externally mounted to the oil filter adapter on the lower right front side of the engine. If the filter element becomes restricted, not allowing engine oil to pass through, a spring-loaded bypass valve opens. The main oil galleries run the full length of the engine block and cut into the valve lifter guide holes to supply oil at full pressure to the valve lifters. Holes, drilled from the crankshaft bearings to the main oil gallery, intersect the camshaft bearing bores to supply oil to the cam bearings.

Oil is transferred from the crankshaft bearings to the connecting rod bearings through holes drilled in the crankshaft. Pistons, piston pins, and cylinder walls are lubricated by oil splash from the crankshaft and connecting rods.

Each valve rocker arm and valve is supplied with oil through the tubular push rod. The oil comes from the inside of the valve lifter passing around the metering valve and through a hole in the push rod seat. Oil from the push rod passes through a hole in the push rod seat, and emerges on top of the push rod seat boss.

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.

CAUTION: Engine damage may result if an abrasive paper, pad, or motorized wire brush is used to clean any engine gasket surfaces.

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.

SEPARATING PARTS

The components of an internal combustion engine develop wear patterns with their mating components. During disassembly of the engine, parts should be separated and kept in order so they may be reinstalled in the same location from which they were removed.

REPLACING ENGINE GASKETS

1. Do not reuse any gasket unless otherwise specified. Reusable gaskets will be identified in the service procedure. Do not apply sealant to any gasket or sealing surface unless called out in the service procedure.
2. Use a rubber mallet in order to separate components. Bump the part sideways in order to loosen the components. Perform the bumping at the bends or at the reinforced areas in order to prevent the distortion of components.

IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a components.

Do not use the following items in order to clean the gasket surfaces:

- Abrasive pads
- Sand paper
- Power tools

These methods of cleaning may damage the component.

Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.

3. Remove all of the gasket and the sealing material from the component using a plastic or a wood scraper. Do not gouge or scrape the sealing surfaces.

IMPORTANT: Do not allow the sealant to enter any blind threaded holes. The sealant may cause the following conditions:

- Prevent you from properly seating the bolt
- Cause damage when you tighten the bolt

4. When assembling components, use only the sealant specified in the service procedure. Ensure that the sealing surfaces are clean and free of debris or oil. When applying sealant to a component, apply a bead size as specified in the service procedure.
5. Tighten the bolts to the specifications.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

The following 2 types of sealer are commonly used in engines:

- The RTV sealer
- The anaerobic gasket eliminator sealer

Follow the service procedure instructions. Use the correct sealer in the proper place in order to prevent oil leaks. Do not interchange the 2 types of sealers. Use the sealer recommended in the service procedure.

Applying RTV Sealer

- Do not use the room temperature vulcanizing (RTV) sealant in areas where extreme temperatures are expected. These areas include the following locations:
 - The exhaust manifold
 - The head gasket
 - The other surfaces where gasket eliminator is specified
- Use a rubber mallet in order to separate the components sealed with RTV sealant. Bump the part sideways in order to shear the RTV sealer. Perform the bumping at the bends or the reinforced areas in order to prevent distortion of the components. The RTV sealant is weaker in shear (lateral) strength than in tensile (vertical) strength.

IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a component.

- Do not use the following items in order to clean the gasket surfaces:
 - Abrasive pads
 - Sand Paper
 - Power tools

These methods of cleaning may damage the part.

Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.

- Remove all of the gasket material from the component using a plastic or a wood scraper. Use Loctite® brand gasket remover P/N 4MA or the equivalent. Follow all of the safety recommendations and the directions that are on the container.

IMPORTANT: Do not allow the sealer to enter the blind threaded holes. The sealer may cause the following conditions:

- Prevent you from properly seating the bolt
- Cause damage when you tighten the bolt
- Apply the RTV sealant to a clean surface. Use a bead size as specified in the procedure. Apply the bead to the inside of any bolt holes.
- Assemble the components while the RTV sealant is still wet (within 3 minutes). Do not wait for the RTV sealant to skin over.

IMPORTANT: Do not overtighten the bolts.

- Tighten the bolts to specifications.

Applying Anaerobic Sealer

The anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where 2 rigid parts (such as castings) are assembled together. When 2 rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.

IMPORTANT: Do not use any other method or technique in order to remove the gasket material from a component.

Do not use the following items in order to clean the gasket surfaces:

- Abrasive pads
- Sand paper
- Power tools

These methods of cleaning may damage the part.

Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil. This grit is abrasive and may cause internal engine damage.

- Remove all of the gasket material from the component using a plastic or a wood scraper. Use Loctite® brand gasket remover P/N 4MA or the equivalent. Follow all of the safety recommendations and the directions that are on the container.
- Apply a continuous bead of the gasket eliminator to 1 flange. Clean and dry any surfaces that you will reseal.

IMPORTANT: Anaerobic sealed joints that are partially torqued and allowed to cure more than 5 minutes may result in incorrect shimming and sealing of the joint.

- Do not allow the sealer to enter the blind threaded holes. The sealer may cause the following conditions:

- Prevent you from properly seating the bolt
- Cause damage when you tighten the bolt
- Spread the sealer evenly in order to get a uniform coating on the sealing surface.
- Tighten the bolts to the specifications.
- Remove the excess sealer from the outside of the joint.

TOOLS AND EQUIPMENT

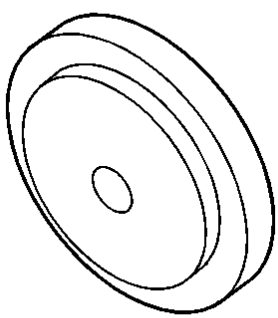
Work in a clean and well-lit area. Have the following components available before you begin to work:

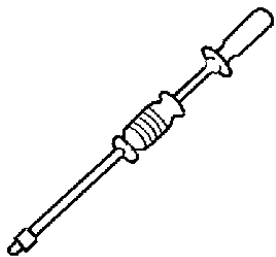
- A suitable parts cleaning tank
- A compressed air supply
- Trays, in order to keep the parts and the fasteners organized
- An adequate set of hand tools

An approved engine repair stand will prevent personal injury or damage to the engine components. The special tools are designed in order to quickly and safely accomplish the operations for which the tools are intended. Using the tools will minimize possible damage to the engine components. Precision measuring tools are required for the inspection of certain critical components. Torque wrenches are needed for the correct assembly of various parts.

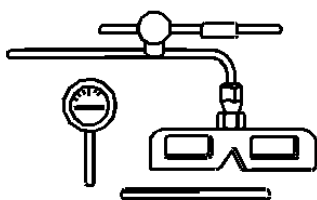
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

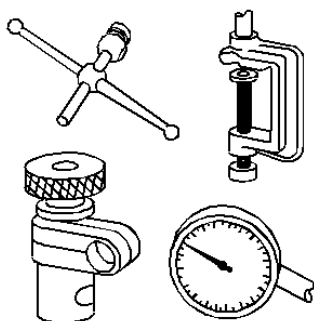
Illustration	Tool Number/Description
	EN 47623 Anchor Bolt Socket
	J 6125-1B



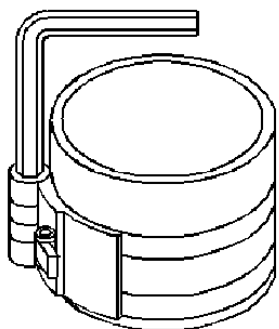
Slide Hammer



J 7872
Magnetic Base Dial Indicator Set



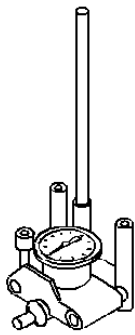
J 8001
Dial Indicator Set



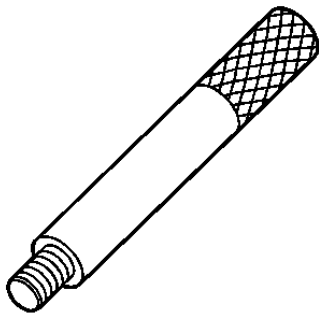
J 8037
Ring Compressor

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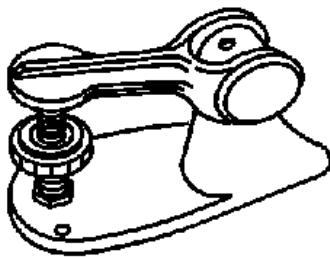
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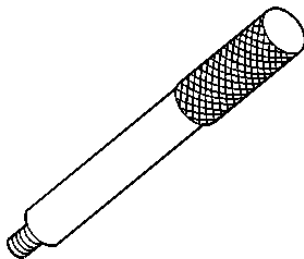
J 8087
Cylinder Bore Gage



J 8092
Drive Handle



J 9666
Valve Spring Tester

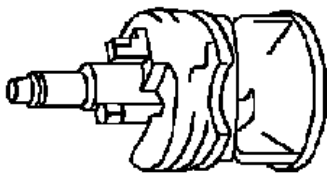
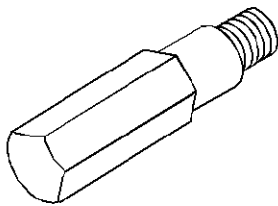


J 21465-13
Drive Handle Extension

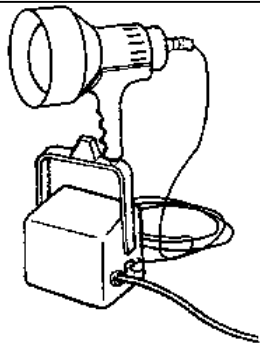
J 23590
Spark Plug Port Adapter

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J 24270
Cylinder Bore Ridge Reamer



J 28428-E
High Intensity Black Light

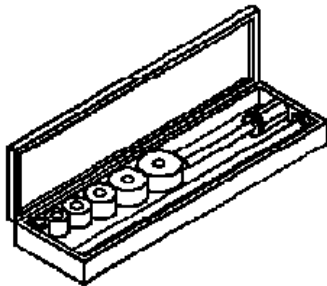
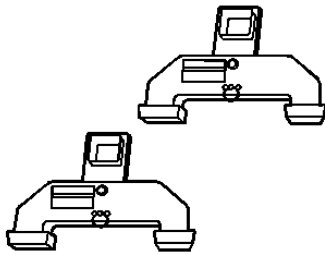


J 28467-B
Universal Engine Support Fixture

J 28467-501
Engine Support Fixture Adapter

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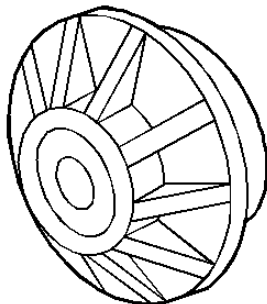
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J 33049
Camshaft Bearing Service Set



J 33049
Camshaft Bearing Remover/Installer Set

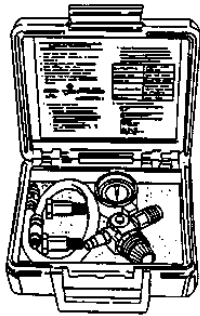
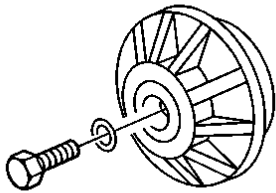


J 35354
Seal Installer

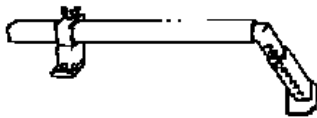
J 35354-A
Front Cover Seal Installer

2009 Buick LaCrosse CXL

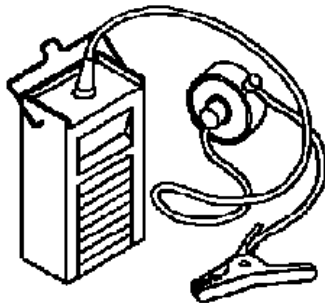
2009 ENGINE Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse



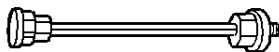
J 35667-A
Cylinder Head Leakdown Tester



J 36462-A
Engine Support Adapter Leg Set



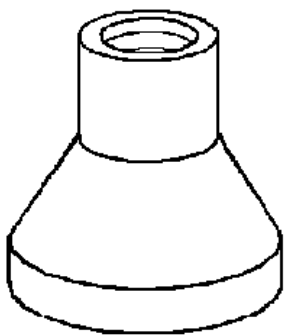
J 36660-A
Torque Angle Meter



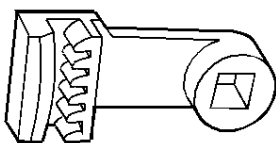
J 36995
Balance Shaft Remover

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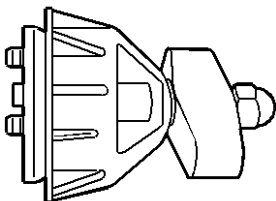
2009 ENGINE Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse



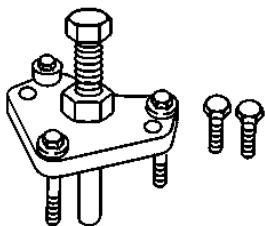
J 36996
Balance Shaft Installer



J 37096
Flywheel Holder



J 38196
Rear Crankshaft Seal Installer

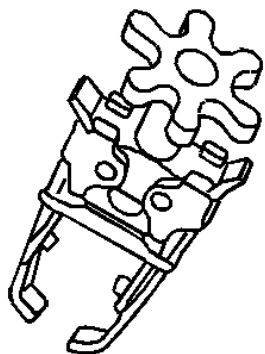


J 38197-A
Crankshaft Balancer Remover

J 38606
Valve Spring Compressor

2009 Buick LaCrosse CXL

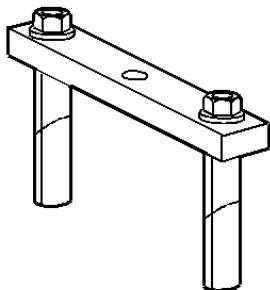
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J 38722
Compression Tester



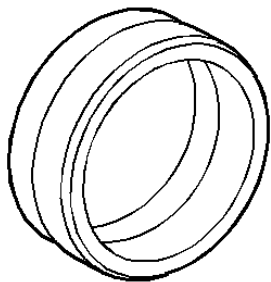
J 41131
Engine Tilt Strap



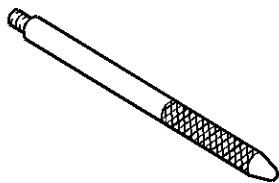
J 41348
Bearing Cap Puller

2009 Buick LaCrosse CXL

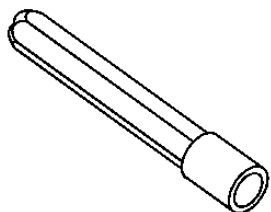
2009 ENGINE Engine Mechanical - 3.8L - Allure (Canadian) & LaCrosse



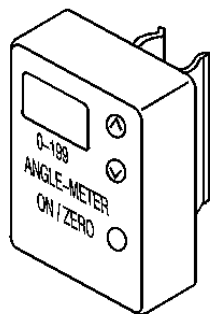
J 41349
Crankshaft Rear Main Oil Seal Housing Aligning
Tool



J 41507
Connecting Rod Assembly Guide



J 42863
Valve Stem Seal Installer



J 45059
Angle Meter

J 45299
Engine Preluber

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