2009 ENGINEEngine

Mechanical - 6.0L

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (L76)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N.m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N.m	106 lb in
CMP Sensor Wire Harness Bolt	12 N.m	106 lb in
Camshaft Retainer Bolts - TORX® Head Bolts	15 N.m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N.m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Connecting Rod Bolts - First Pass	20 N.m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N.m	106 lb in
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N.m	110 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N.m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N.m	18 lb ft
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N.m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N.m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N.m	22 lb ft
Cylinder Head Coolant Plug	20 N.m	15 lb ft
Cylinder Head M8 Bolts - in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Engine Block Coolant Drain Hole Plug	60 N.m	44 lb ft
Engine Block Coolant Heater	50 N.m	37 lb ft
Engine Block Oil Gallery Plug	60 N.m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N.m	37 lb ft

Exhaust Manifold Bolts - First Pass	15 N.m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N.m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N.m	80 lb in
Exhaust Manifold Studs	20 N.m	15 lb ft
Flex Plate Bolts - First Pass	20 N.m	15 lb ft
Flex Plate Bolts - Second Pass	50 N.m	37 lb ft
Flex Plate Bolts - Final Pass	100 N.m	74 lb ft
Front Cover Bolt	25 N.m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N.m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs	12 N.m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N.m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N.m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N.m	89 lb in
J 41798 M8 Bolt	25 N.m	18 lb ft
J 41798 M10 Bolts	50 N.m	37 lb ft
Knock Sensor Bolts	20 N.m	15 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Fitting	55 N.m	40 lb ft
Oil Level Indicator Tube Bolt	25 N.m	18 lb ft
Oil Level Sensor	20 N.m	15 lb ft
Oil Pan Baffle Bolt	12 N.m	106 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N.m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N.m	80 lb in
Oil Pan Cover Bolts	12 N.m	106 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N.m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N.m	18 lb ft
Oil Pressure Sensor	35 N.m	26 lb ft
Oil Pump Cover Bolts	12 N.m	106 lb in
Oil Pump Relief Valve Plug	12 N.m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N.m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N.m	18 lb ft
Spark Plugs	15 N.m	11 lb ft
Throttle Body Bolts	10 N.m	89 lb in
Timing Chain Tensioner Bolts	25 N.m	18 lb ft
Valve Lifter Oil Manifold Bolts	25 N.m	18 lb ft
Valve Lifter Guide Bolts	10 N.m	89 lb in
Valve Rocker Arm Bolts	30 N.m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N.m	106 lb in
Water Inlet Housing Bolts	15 N.m	11 lb ft

Water Pump Bolts - First Pass	15 N.m	11 lb ft
Water Pump Bolts - Final Pass	30 N.m	22 lb ft

FASTENER TIGHTENING SPECIFICATIONS (6.2L LS3)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N.m	20 lb ft
Camshaft Position (CMP) Sensor Bolt	12 N.m	106 lb in
CMP Sensor Wire Harness Bolt	12 N.m	106 lb in
Camshaft Retainer Bolts - Hex Head Bolts	25 N.m	18 lb ft
Camshaft Retainer Bolts - TORX® Head Bolts	15 N.m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N.m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Clutch Pressure Plate Bolts	70 N.m	52 lb ft
Connecting Rod Bolts - First Pass	20 N.m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe and Cover Bolts	12 N.m	106 lb in
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt - First Pass	150 N.m	111 lb ft
Crankshaft Balancer Bolt - Second Pass	Loosen 360 degrees	
Crankshaft Balancer Bolt - Third Pass	50 N.m	37 lb ft
Crankshaft Balancer Bolt - Final Pass	230 degrees	
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N.m	18 lb ft
Crankshaft Oil Deflector Nuts	25 N.m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N.m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N.m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Cylinder Head M8 Bolts - in Sequence	30 N.m	22 lb ft
Cylinder Head Coolant Plug	20 N.m	15 lb ft
Engine Block Coolant Drain Hole Plug	60 N.m	44 lb ft
Engine Block Coolant Heater	50 N.m	37 lb ft
Engine Block Oil Gallery Plug	60 N.m	44 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N.m	37 lb ft

Exhaust Manifold Bolts - First Pass	15 N.m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N.m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N.m	80 lb in
Exhaust Manifold Stud	20 N.m	15 lb ft
Flywheel Bolts - First Pass	20 N.m	15 lb ft
Flywheel Bolts - Second Pass	50 N.m	37 lb ft
Flywheel Bolts - Final Pass	100 N.m	74 lb ft
Front Cover Bolts	25 N.m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N.m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Stud	12 N.m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N.m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N.m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N.m	89 lb in
J 41798 M8 Bolt	25 N.m	18 lb ft
J 41798 M10 Bolts	50 N.m	37 lb ft
Knock Sensor Bolts	20 N.m	15 lb ft
Motor Mount Bracket Bolts	50 N.m	37 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Fitting	55 N.m	40 lb ft
Oil Level Indicator Tube Bolt	25 N.m	18 lb ft
Oil Level Sensor	13 N.m	115 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N.m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N.m	80 lb in
Oil Pan Cover Bolts	12 N.m	106 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N.m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N.m	18 lb ft
Oil Pressure Sensor	35 N.m	26 lb ft
Oil Pump Cover Bolts	12 N.m	106 lb in
Oil Pump Relief Valve Plug	12 N.m	106 lb in
Oil Pump Screen Nuts	25 N.m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N.m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N.m	18 lb ft
Spark Plugs	15 N.m	11 lb ft
Throttle Body Bolts	10 N.m	89 lb in
Timing Chain Tensioner Bolts	25 N.m	18 lb ft
Valley Cover Bolts	25 N.m	18 lb ft
Valve Lifter Guide Bolts	12 N.m	106 lb in
Valve Rocker Arm Bolts	30 N.m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N.m	106 lb in

Water Inlet Housing Bolts	15 N.m	11 lb ft
Water Pump Bolts - First Pass	15 N.m	11 lb ft
Water Pump Bolts - Final Pass	30 N.m	22 lb ft

ENGINE MECHANICAL SPECIFICATIONS (6.2L LS3)

Application	Specification	
	Metric	English
General		
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LS3	
• VIN	W	
• Bore	103.241-103.259 mm	4.0065-4.0065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.7:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.02 mm	0.04 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241-103.259 mm	4.0065-4.0065 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Bearing Diameter	55.063-55.088 mm	2.1678-2.1688 in

• Camshaft Journal-to-Bearing Clearance	0.023-0.098 mm	0.0009-0.0038 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift - Intake	8.24 mm	0.324 in
• Camshaft Lobe Lift - Exhaust	7.77 mm	0.306 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
• Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout - Measured 1.0 mm	0.7 mm	0.028 in

(0.04 in) Below Tooth Diameter		
• Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
• Surface Flatness - Block Deck - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
• Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
• Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
• Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
• Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
• Oil Capacity - with Filter	8.3 liters	8.8 quarts
• Oil Capacity - without Filter	5.4 liters	5.7 quarts
• Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
• Piston Ring End Gap - First Compression Ring -	0.17-0.44 mm	0.0067-0.0173 in

Measured in Cylinder Bore - Service		
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32-0.69 mm	0.0126-0.0272 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22-0.79 mm	0.0086-0.0311 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22-0.85 mm	0.0086-0.0335 in
• Piston Ring to Groove Clearance - First Compression Ring - Production	0.030-0.083 mm	0.0012-0.0033 in
• Piston Ring to Groove Clearance - First Compression Ring - Service	0.030-0.083 mm	0.0012-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040-0.083 mm	0.0016-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040-0.083 mm	0.0016-0.0033 in
• Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013-0.201 mm	0.0005-0.0079 in
• Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013-0.201 mm	0.0005-0.0079 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002-0.01 mm	0.00008-0.0004 in
• Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002-0.015 mm	0.00008-0.0006 in
• Pin - Piston Pin Diameter	23.952-23.955 mm	0.9430-0.9431 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007-0.02 mm	0.00027-0.00078 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007-0.022 mm	0.00027-0.00086 in
• Piston - Piston Diameter - Measured Over Skirt Coating	103.258-103.289 mm	4.0653-4.0665 in
• Piston - Piston to Bore Clearance - Production	-0.048 to +0.001 mm	-0.0019 to +0.000 in
• Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
• Valves - Valve Face Angle	45 degrees	
• Valves - Valve Face Width	1.25 mm	0.05 in
• Valves - Valve Lash	Net Lash - No Adjustment	

• Valves - Valve Lift - Intake	13.97 mm	0.55 in
• Valves - Valve Lift - Exhaust	13.22 mm	0.52 in
• Valves - Valve Seat Angle	46 degrees	
• Valves - Valve Seat Runout	0.05 mm	0.002 in
• Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
• Valves - Seat Width - Intake	1.02 mm	0.04 in
• Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
• Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
• Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
• Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
• Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
• Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
• Valve Springs - Valve Spring Load - Open	1175 N at 33.05 mm	264 lb at 1.30 in

ENGINE MECHANICAL SPECIFICATIONS (L76)

Application	Specification	
	Metric	English
• Engine Type	V8	
• Displacement	5697 cu cm	348 cu in
• RPO	L76	
• Bore	101.618-101.636 mm	4.0007-4.0017 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	9.67:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Active Fuel Management Cylinders	1-4-6-7	
• Spark Plug Gap	1.02 mm	0.04 in
Block		

• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	101.618-101.636 mm	4.0007-4.0017 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift - Exhaust - Non Active Fuel Management Cylinders	7.17 mm	0.282 in
• Camshaft Lobe Lift - Exhaust - Active Fuel Management Cylinders	7.3 mm	0.287 in
• Camshaft Lobe Lift - Intake - Non Active Fuel Management Cylinders	7.08 mm	0.279 in
• Camshaft Lobe Lift - Intake - Active Fuel Management Cylinders	7.2 mm	0.283 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		

• Connecting Rod Journal Diameter - Production	53.318 mm 53.338 mm	2.0991 in 2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out - of - Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out - of - Round - Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Production)	0.005 mm	0.0002 in
• Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Service)	0.02 mm	0.00078 in
• Crankshaft End Play	0.04 mm 0.2 mm	0.0015 in 0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02 mm 0.052 mm	0.0008 in 0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02 mm 0.065 mm	0.0008 in 0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992 mm 65.008 mm	2.558 in 2.559 in
• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out - of - Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out - of - Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below Tooth Diameter)	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14 mm 26.22 mm	1.029 in 1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
• Surface Flatness - Block Deck (Measured within a 152.4 mm (6.0 in) Area)	0.08 mm	0.003 in
• Surface Flatness - Block Deck (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
• Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in

• Valve Guide Installed Height (Measured from the Spring Seat Surface to the Top of the Guide)	17.32 mm	0.682 in
Intake Manifold		
• Surface Flatness (Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings)	0.3 mm	0.118 in
Lubrication System		
• Oil Capacity - with Filter	8.3 Litres	8.8 Quarts
• Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Active Fuel Management Relief Valve Oil Pressure - as Measured at Oil Pressure Sensor Location	379-517 kPa Maximum	55-75 psi Maximum
Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
• Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0 mm 0.5 mm	0.0 in 0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0 mm 0.1 mm	0.0 in 0.004 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Production)	0.20 mm 0.41 mm	0.008 in 0.016 in
• Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Service)	0.20 mm 0.41 mm	0.008 in 0.016 in
• Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Production)	0.37 mm 0.69 mm	0.015 in 0.027 in
• Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Service)	0.37 mm 0.69 mm	0.015 in 0.027 in
• Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Production)	0.22 mm 0.79 mm	0.009 in 0.031 in
• Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Service)	0.22 mm 0.79 mm	0.009 in 0.031 in
• Piston Ring to Groove Clearance - First Compression Ring - Production	0.030 mm 0.10 mm	0.0012 in 0.0040 in
• Piston Ring to Groove Clearance - First Compression Ring - Service	0.030 mm 0.10 mm	0.0012 in 0.0040 in
• Piston Ring to Groove Clearance - Second	0.035 mm 0.078 mm	0.0014 in 0.0031 in

Compression Ring - Production		
• Piston Ring to Groove Clearance - Second Compression Ring - Service	0.035 mm 0.078 mm	0.0014 in 0.0031 in
• Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013 mm 0.201 mm	0.0005 in 0.0079 in
• Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013 mm 0.201 mm	0.0005 in 0.0079 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002 mm 0.01 mm	0.0008 in 0.0004 in
• Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002 mm 0.015 mm	0.0008 in 0.0006 in
• Pin - Piston Pin Diameter	23.952 mm 23.955 mm	0.943 in 0.943 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007 mm 0.02 mm	0.00027 in 0.00078 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm 0.022 mm	0.00027 in 0.00086 in
• Piston - Piston Diameter - Measured Over Skirt Coating	101.611 mm 101.642 mm	4.0 in 4.001 in
• Piston - Piston to Bore Clearance - Production	-0.022 mm 0.08 mm	-0.0009 in 0.0012 in
• Piston - Piston to Bore Clearance (Service Limit with Skirt Coating Worn Off)	0.024 mm 0.08 mm	0.00094 in 0.0031 in
Valve System		
• Valves - Valve Face Angle	45 degrees	
• Valves - Valve Face Width	1.25 mm	0.05 in
• Valves - Valve Lash	Net Lash - No Adjustment	
• Valve Lift - Exhaust - Non Active Fuel Management	12.19 mm	0.480 in
• Valve Lift - Exhaust - Active Fuel Management	12.41 mm	0.489 in
• Valve Lift - Intake - Non Active Fuel Management	12.04 mm	0.474 in
• Valve Lift - Intake - Active Fuel Management	12.24 mm	0.488 in
• Valves - Valve Seat Angle	46 degrees	
• Valves - Valve Seat Runout	0.05 mm	0.002 in
• Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
• Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
• Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
• Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
• Valves - Valve Stem-to-Guide Clearance - Production		

- Exhaust	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
• Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
• Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
• Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs - Valve Spring Load - Closed	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Springs - Valve Spring Load - Open	980 N at 33.55 mm	220 lb at 1.32 in

ENGINE CONTENT SPECIFICATIONS

RPO	VIN	Displacement	Camshaft Position (CMP) Actuator Control System	Active Fuel Management Control System	E85 Capable	Block Material
L76	Y	6.0L	No	Yes	No	Aluminum
LS3	W	6.2L	No	No	No	Aluminum

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plugs	Threadlock	12345382	10953489
Cylinder Head Plug	Threadlock	12345382	10953489
Engine Block Coolant Drain Hole Plug Washer	Sealant	12346004	10953480
Engine Block Oil Gallery Plug - Front	Threadlock	12345382	10953489
Engine Block Oil Gallery Plug Washers	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	729389
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolts	Threadlock	12345493	10953488
Flexplate/Flywheel Bolts	Threadlock	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Ignition Coil Bracket-to-Valve Cover Studs	Threadlock	12345382	10953489

Ignition Coil-to-Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolts	Threadlock	12345382	10953489
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

THREAD REPAIR SPECIFICATIONS

Engine Block - Front/Rear Views

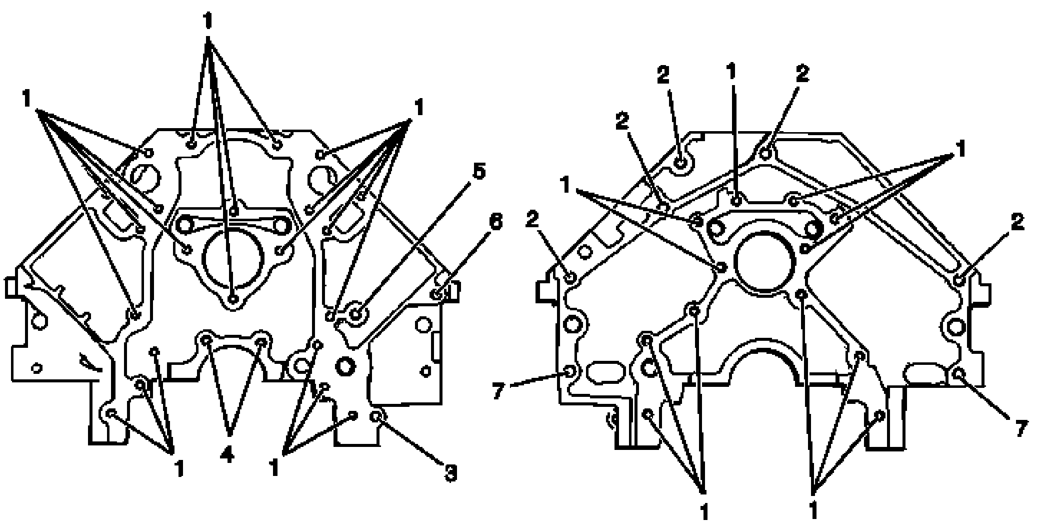


Fig. 1: Engine Block - Front/Rear Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Front/Rear Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	27.5	(1.08)	22.0	(0.866)
	M10 x										

3	1.5	211	212	N/A	213	214	215	Through		Through	
4	M8 x 1.25	206	207	N/A	208	209	210	Through		Through	
5	M10 x 1.5	211	212	N/A	213	214	215	25.0	(0.984)	19.5	(0.767)
6	M10 x 1.5	211	212	N/A	213	214	215	32.5	(1.279)	25.0	(0.984)
7	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
Bolt hole 6 is drilled and tapped for aluminium block applications only.											

Engine Block - Left/Right Side Views

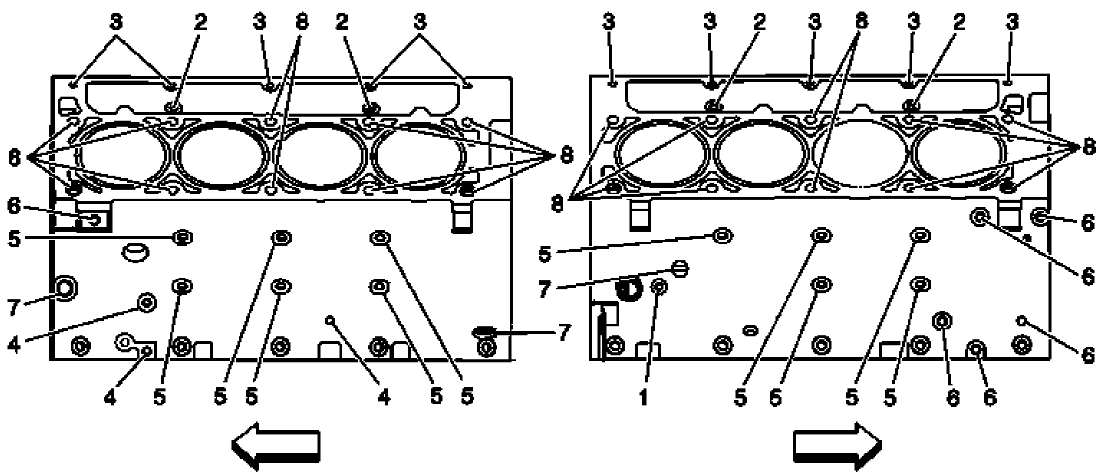


Fig. 2: Engine Block - Left/Right Side Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Left/Right Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	(1.122)	23.0	(0.905)
3	M8 x 1.25	206	207	N/A	208	209	210	21.5	(0.846)	16.0	(0.629)
4	M10 x 1.25	211	212	N/A	213	214	215	29.0	(1.141)	23.0	(0.905)
5	M10 x 1.5	211	212	N/A	213	214	215	27.0	(1.062)	21.5	(0.846)
	M16 x										

6	1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
7	M11 x 2.0	105	N/A	N/A	106	107	108	69.0	(2.72)	60.0	(2.36)
8	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	Through		Through	
Bolt hole 7 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.											

Engine Block - Top/Bottom Views

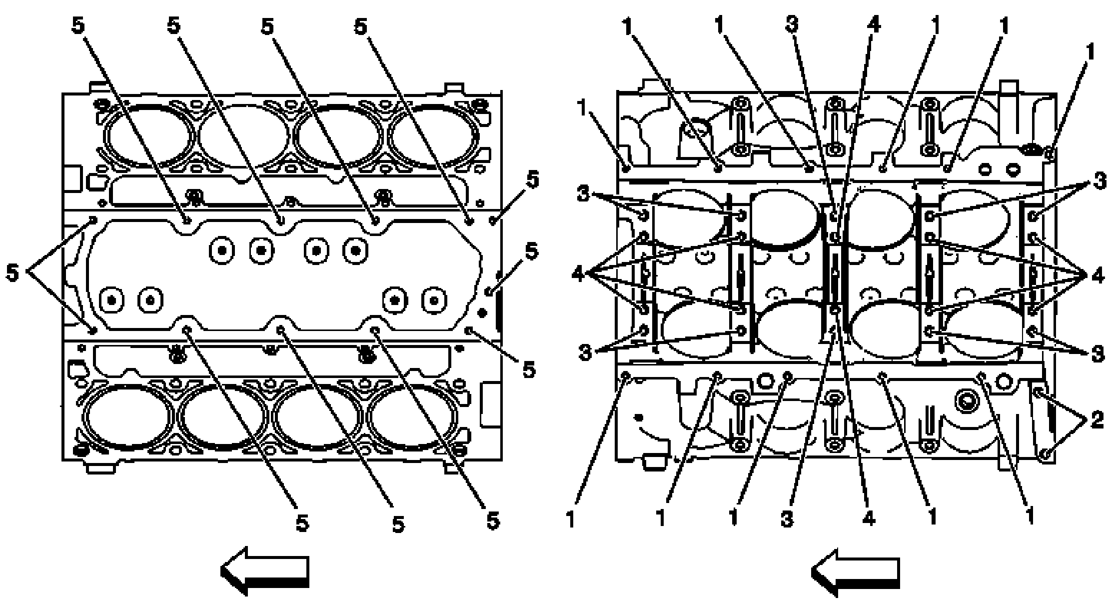


Fig. 3: Engine Block - Top/Bottom Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Top/Bottom Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	42.5	(1.67)	37.0	(1.45)
3	M10 x 2.0	101	N/A	N/A	102	103	104	31.0	(1.22)	25.5	(1.0)
4	M10 x	101	N/A	N/A	102	103	104	53.5	(2.10)	44.0	(1.73)

	2.0										
5	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.043)	19.0	(0.748)
• Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap. • Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap. • Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.											

Cylinder Head - Top/End Views

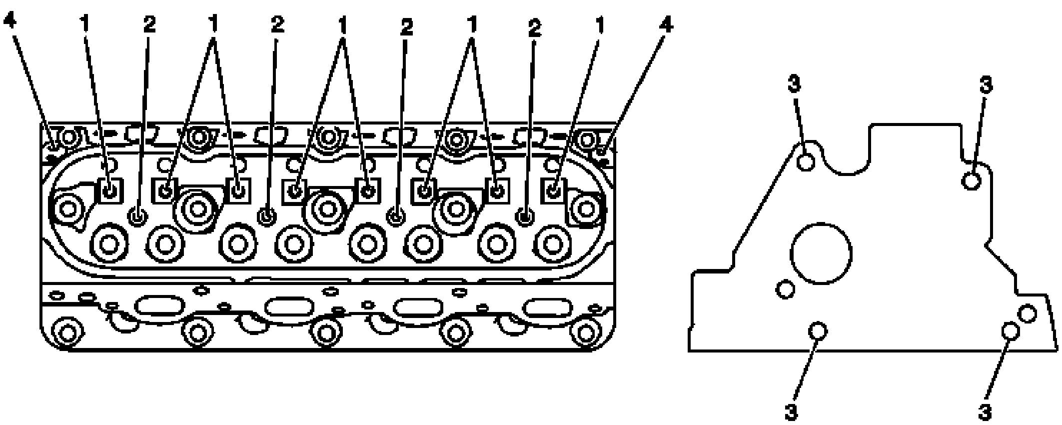


Fig. 4: Cylinder Head - Top/End Views
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Top/End Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.04)	19.0	(0.784)
2	M6 x 1.0	201	202	N/A	203	204	205	20.05	(0.789)	16.05	(0.632)
3	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	(0.885)	15.0	(0.688)

Cylinder Head - Intake/Exhaust Side Views

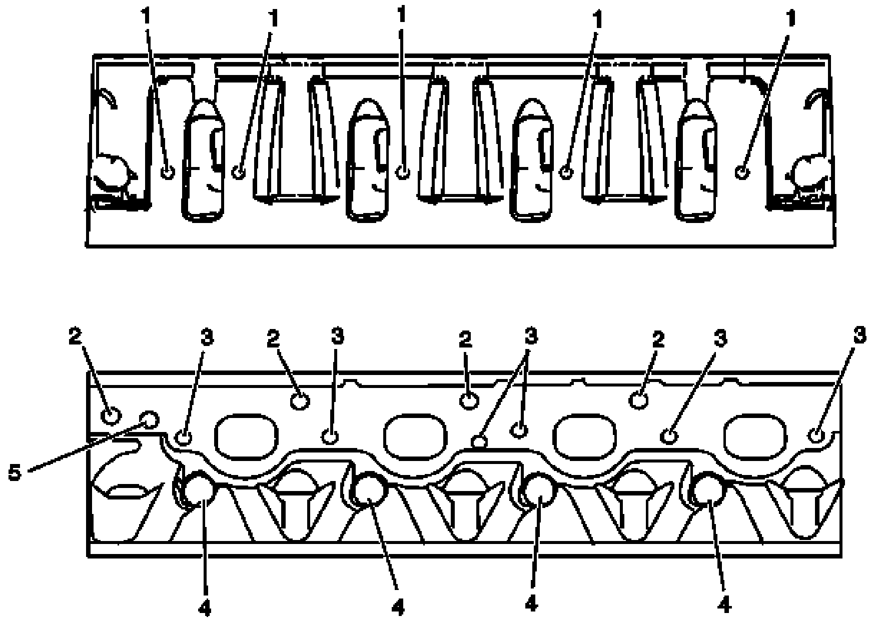


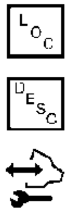
Fig. 5: Cylinder Head - Intake/Exhaust Side Views
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Intake/Exhaust Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
		J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	Through		Through	
2	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
3	M8 x 1.25	206	207	N/A	208	209	210	21.0	(0.826)	16.0	(0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE MECHANICAL SCHEMATICS



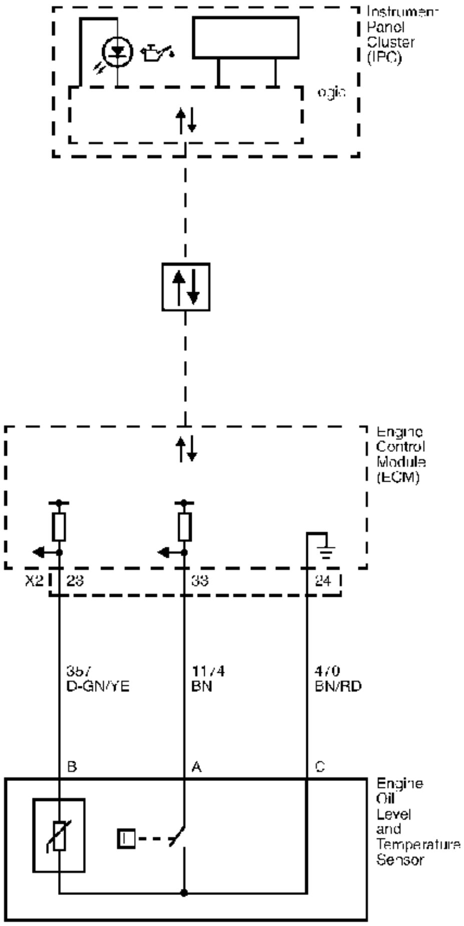


Fig. 6: Identifying Engine Mechanical Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

DISASSEMBLED VIEWS (L76)

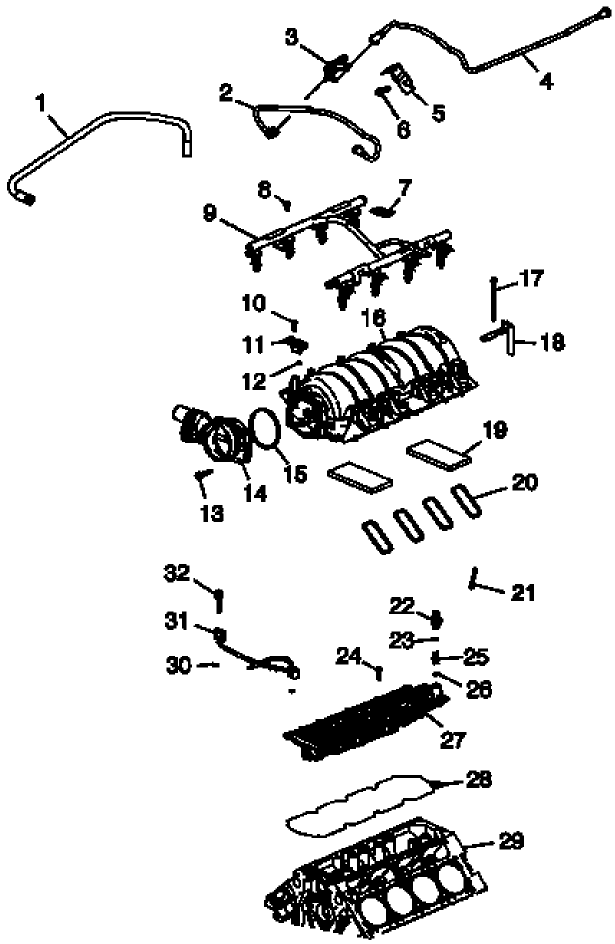


Fig. 7: Intake Manifold/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Positive Crankcase Ventilation (PCV) Tube - Dirty Air
2	Evaporative Emission (EVAP) Canister Purge Tube
3	EVAP Canister Purge Solenoid Valve
4	EVAP Canister Purge Tube
5	EVAP Purge Valve Bracket
6	Bolt
7	Fuel Rail Ground Strap
8	Bolt
9	Fuel Rail with Injectors
10	Manifold Absolute Pressure (MAP) Sensor Bolt
11	Manifold Absolute Pressure (MAP) Sensor
12	Seal
13	Bolt

14	Throttle Body
15	Throttle Body Gasket
16	Intake Manifold
17	Bolt
18	Fuel Injection Fuel Rail Stop Bracket
19	Seal
20	Intake Manifold Gasket
21	Engine Coolant Air Bleed Plug
22	Oil Pressure Sensor
23	Washer
24	Bolt
25	Filter
26	O-Ring
27	Valve Lifter Oil Manifold (VLOM)
28	VLOM Gasket
29	Engine Block
30	Seal
31	Engine Coolant Air Bleed Pipe
32	Bolt

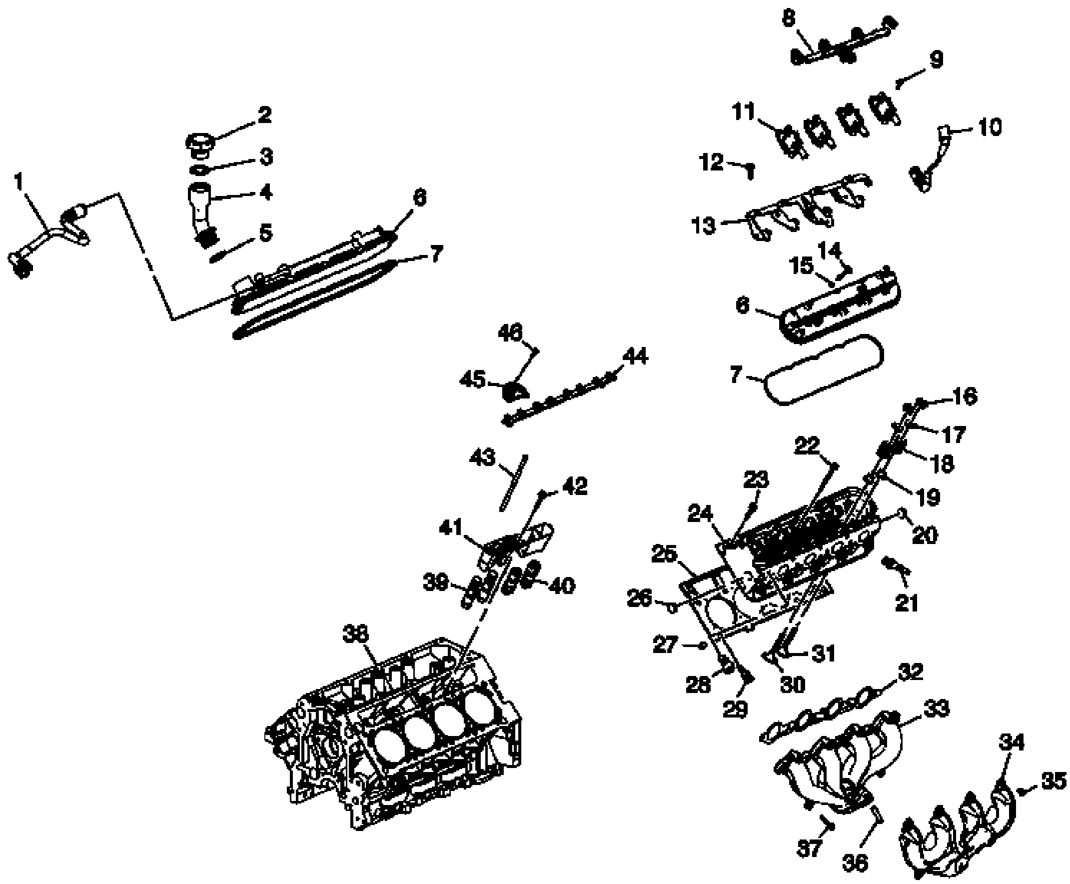


Fig. 8: Cylinder Head/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Positive Crankcase Ventilation (PCV) Hose - Fresh Air
2	Oil Fill Cap
3	O-Ring
4	Oil Fill Tube
5	O-Ring
6	Valve Rocker Arm Cover
6	Valve Rocker Arm Cover
7	Valve Rocker Arm Cover Gasket
7	Valve Rocker Arm Cover Gasket
8	Ignition Coil Wire Harness Assembly
9	Bolt
10	Spark Plug Wire
11	Ignition Coil

12	Bolt
13	Ignition Coil Bracket
14	Plug
15	Bolt
16	Bolt Grommet
17	Valve Stem Key
18	Valve Spring Cap
19	Valve Spring
20	Valve Stem Oil Seal
21	Core Hole Plug
22	Spark Plug
23	Cylinder Head Bolt - M11
24	Cylinder Head Bolt - M8
25	Cylinder Head
26	Cylinder Head Gasket
27	Core Hole Plug
28	Cylinder Head Locating Pin
29	Cylinder Head Plug
30	Coolant Temperature Sensor (CTS)
31	Exhaust Valve
32	Intake Valve
33	Exhaust Manifold Gasket
34	Exhaust Manifold
35	Exhaust Manifold Heat Shield
36	Bolt
37	Stud
38	Bolt
39	Engine Block
40	Valve Lifter - Active Fuel Management
41	Valve Lifter - Non-Active Fuel Management
42	Valve Lifter Guide
43	Bolt
44	Pushrod
45	Valve Rocker Arm Pivot Support
46	Valve Rocker Arm
47	Bolt

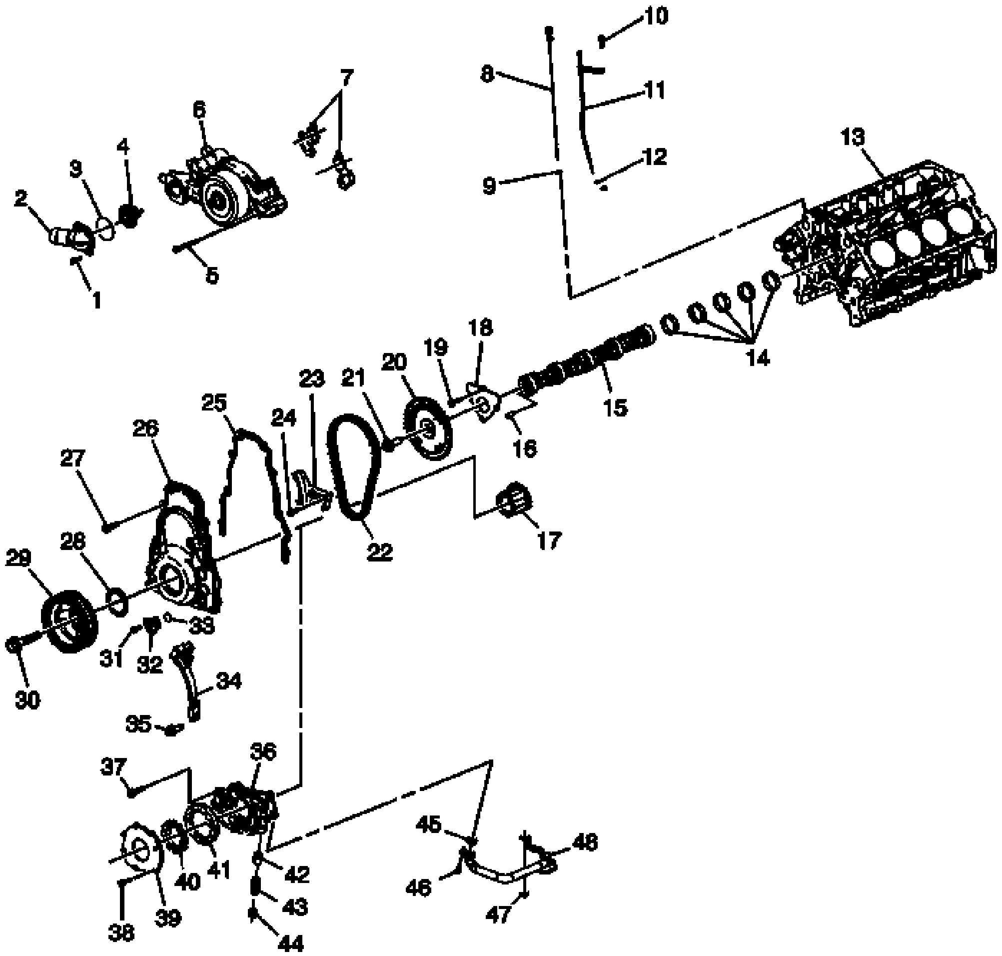


Fig. 9: Front of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt
2	Water Inlet Housing
3	O-Ring
4	Thermostat
5	Bolt
6	Water Pump
7	Water Pump Gasket
8	Oil Level Indicator
9	O-Ring
10	Bolt
11	Oil Level Indicator Tube
12	O-Ring
13	Engine Block

14	Camshaft Bearings
15	Camshaft
16	Camshaft Sprocket Locating Pin
17	Crankshaft Sprocket
18	Camshaft Retainer
19	Bolt
20	Camshaft Sprocket
21	Bolt
22	Timing Chain
23	Timing Chain Tensioner
24	Bolt
25	Engine Front Cover Gasket
26	Engine Front Cover
27	Bolt
28	Crankshaft Front Oil Seal
29	Crankshaft Balancer
30	Crankshaft Balancer Bolt
31	Bolt
32	Camshaft Position (CMP) Sensor
33	O-Ring
34	CMP Sensor Wire Harness
35	Bolt
36	Oil Pump Housing
37	Bolt
38	Bolt
39	Oil Pump Housing Cover
40	Oil Pump Drive Gear
41	Oil Pump Driven Gear
42	Oil Pump Pressure Relief Valve
43	Spring
44	Oil Pump Housing Plug
45	O-Ring
46	Bolt
47	Nut
48	Oil Pump Screen

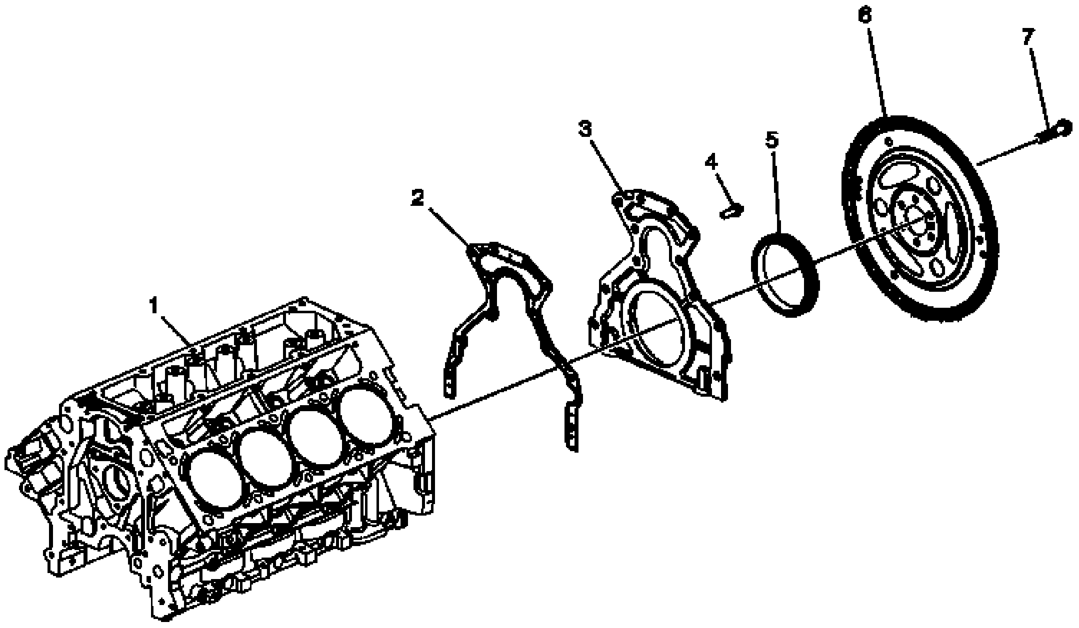


Fig. 10: Rear of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Crankshaft Rear Oil Seal Housing Gasket
3	Crankshaft Rear Oil Seal Housing
4	Crankshaft Rear Oil Seal Housing Bolt
5	Crankshaft Rear Oil Seal
6	Flex Plate - Automatic Transmission
7	Flywheel Bolt

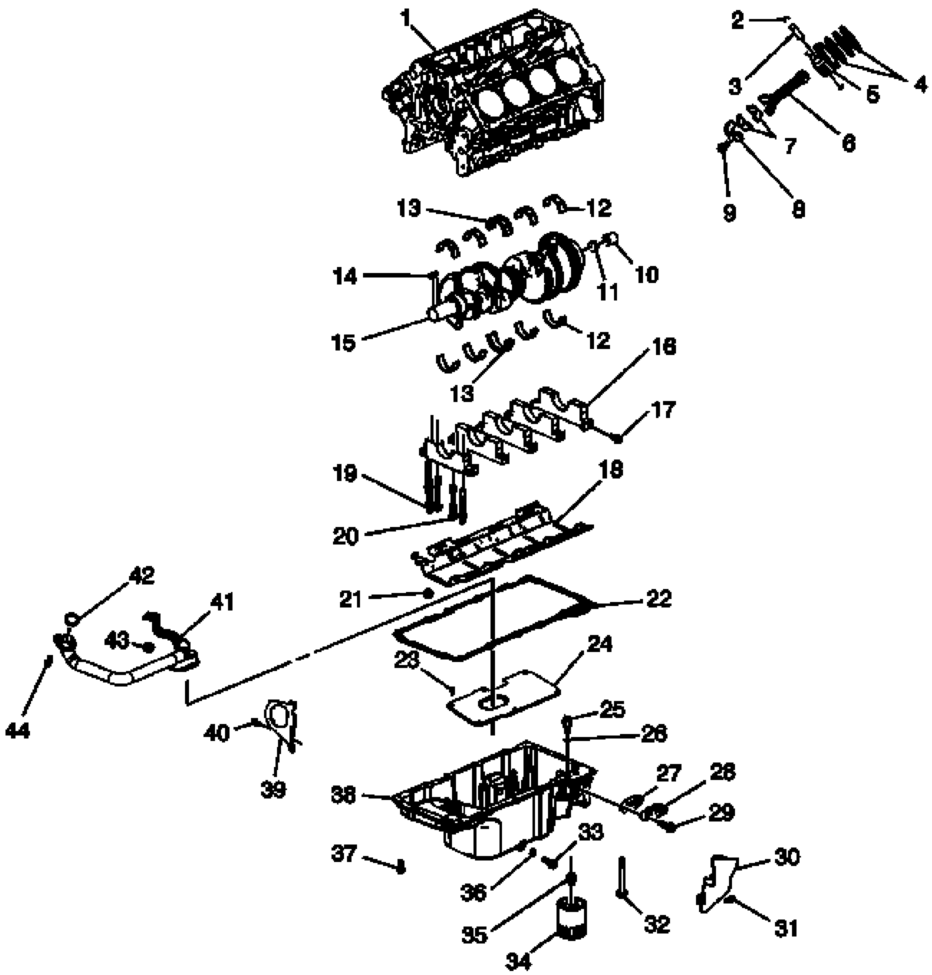


Fig. 11: Lower Engine Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Piston Pin Retainer
3	Piston Pin
4	Piston Ring Set
5	Piston
6	Connecting Rod
7	Connecting Rod Bearings
8	Connecting Rod Cap
9	Connecting Rod Bolt
10	Transmission Pilot Bearing - Manual Transmission
11	Plug
12	Crankshaft Main Bearing
12	Crankshaft Main Bearing

13	Crankshaft Thrust Bearing
13	Crankshaft Thrust Bearing
14	Crankshaft Balancer Key
15	Crankshaft
16	Crankshaft Bearing Cap
17	Crankshaft Bearing Cap Bolt - M8
18	Crankshaft Oil Deflector
19	Crankshaft Oil Deflector Stud - M10
20	Crankshaft Oil Deflector Bolt - M10
21	Nut
22	Oil Pan Gasket
23	Bolt
24	Oil Pan Baffle
25	Active Fuel Management Oil Pressure Relief Valve
26	Washer
27	Oil Pan Cover Gasket
28	Oil Pan Cover
29	Bolt
30	Oil Pan Closeout Cover - Left
31	Bolt
32	Oil Pan Bolt - M6
33	Oil Pan Drain Plug
34	Oil Filter
35	Oil Filter Fitting
36	O-Ring
37	Oil Pan Bolt - M8
38	Oil Pan
39	Engine Closeout Cover - Right
40	Bolt
41	Oil Pump Screen
42	O-Ring
43	Nut
44	Bolt

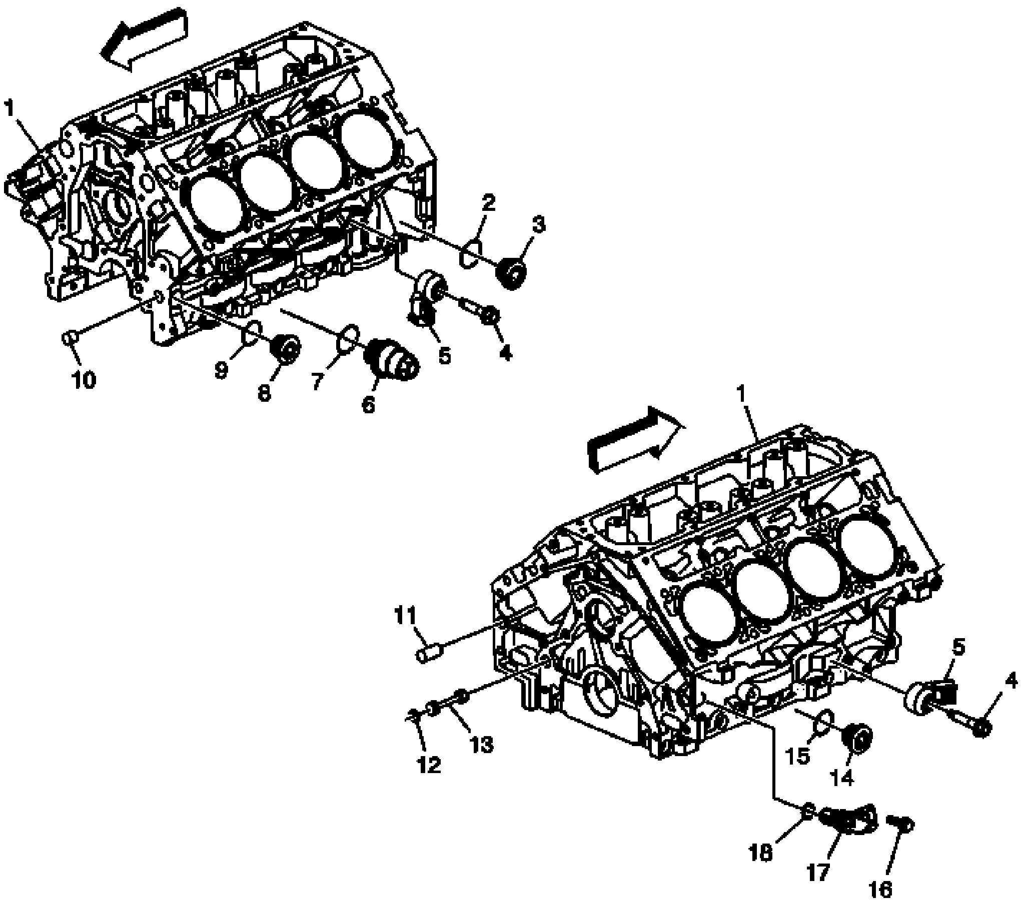


Fig. 12: Engine Block Plugs/Sensors
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
1	Engine Block
2	Washer
3	Oil Gallery Plug - Side
4	Bolt
4	Bolt
5	Knock Sensor
5	Knock Sensor
6	Engine Coolant Heater
7	Washer
8	Oil Gallery Plug - Side
9	Washer
10	Oil Gallery Plug - Front

11	Transmission Housing Locating Pin
12	O-Ring
13	Oil Gallery Plug - Rear
14	Engine Block Coolant Drain Hole Plug
15	Washer
16	CKP Sensor Bolt
17	Crankshaft Position (CKP) Sensor
18	O-Ring

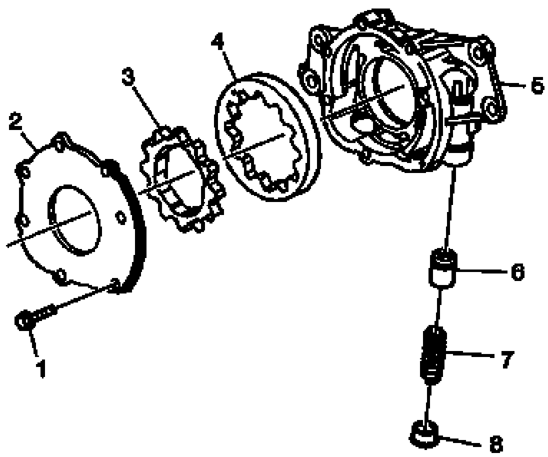


Fig. 13: Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt
2	Oil Pump Housing Cover
3	Oil Pump Drive Gear
4	Oil Pump Driven Gear
5	Oil Pump
6	Oil Pump Pressure Relief Valve
7	Oil Pump Pressure Relief Valve Spring
8	Oil Pump Housing Plug

DISASSEMBLED VIEWS (6.2L LS3)

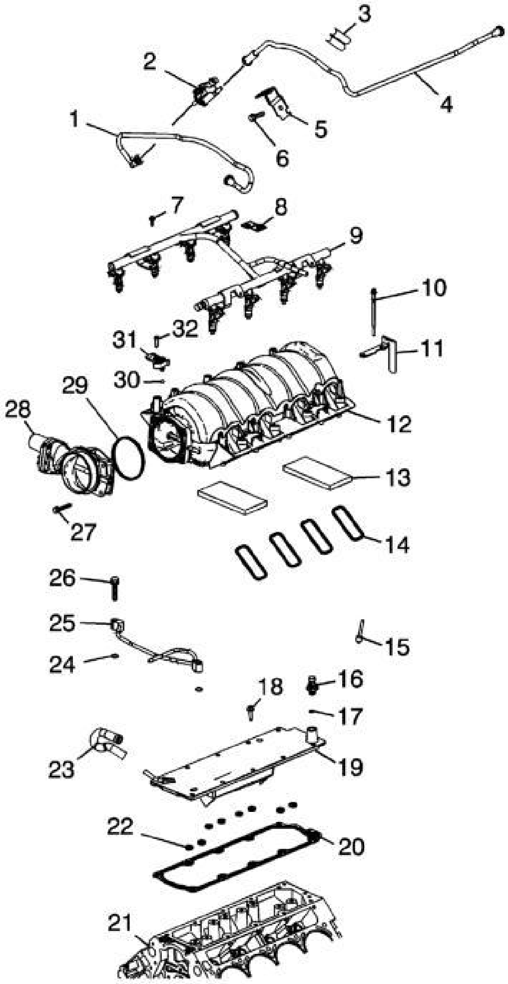


Fig. 14: Intake Manifold/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Evaporative Emission (EVAP) Canister Purge Tube
2	EVAP Canister Purge Solenoid Valve
3	EVAP Tube Clip
4	EVAP Canister Purge Tube
5	EVAP Purge Valve Bracket
6	Bolt
7	Bolt
8	Fuel Rail Ground Strap
9	Fuel Rail with Injectors
10	Bolt
11	Fuel Injection Fuel Rail Stop Bracket
12	Intake Manifold
13	Seal

14	Intake Manifold Gasket
15	Engine Coolant Air Bleed Plug
16	Oil Pressure Sensor
17	Washer
18	Bolt
19	Valley Cover
20	Valley Cover Gasket
21	Engine Block
22	Seal
23	Positive Crankcase Ventilation (PCV) Hose - Dirty Air
24	Seal
25	Engine Coolant Air Bleed Pipe
26	Bolt
27	Bolt
28	Throttle Body
29	Throttle Body Gasket
30	Seal
31	Manifold Absolute Pressure (MAP) Sensor
32	MAP Sensor Bolt

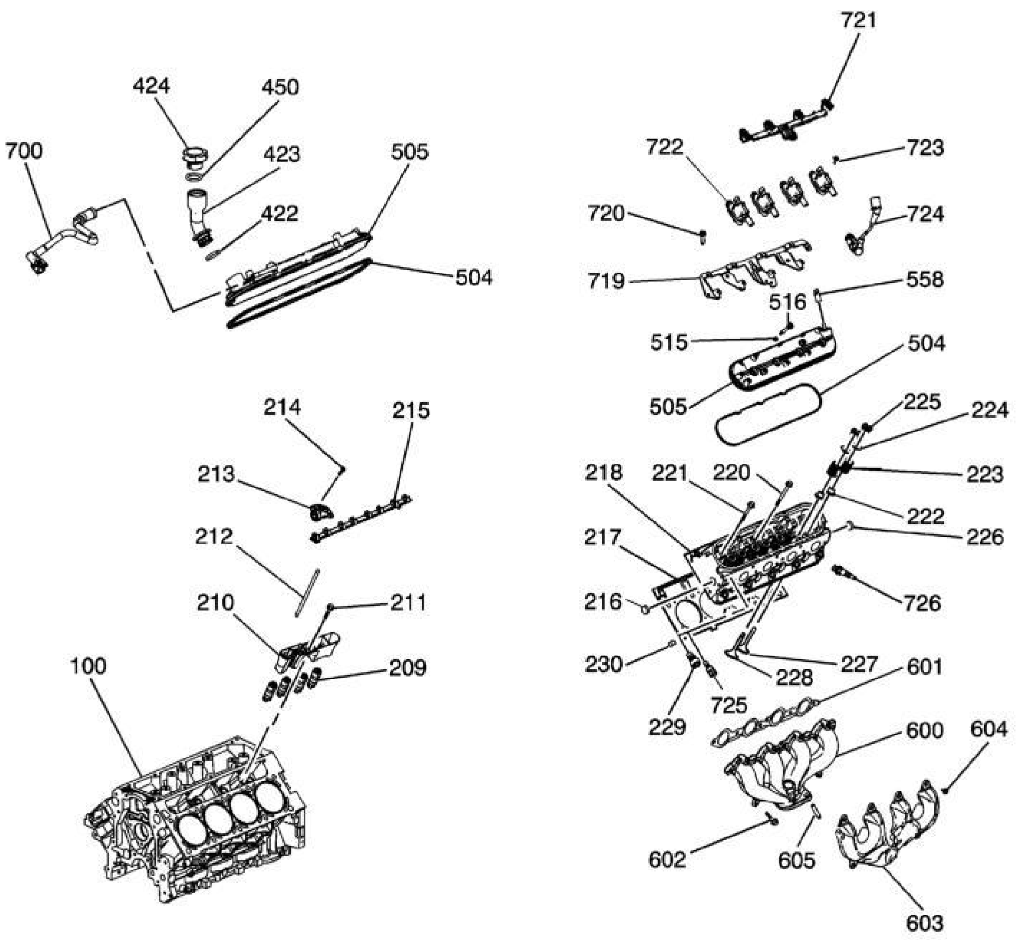


Fig. 15: Cylinder Head/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
209	Valve Lifter
210	Valve Lifter Guide
211	Bolt
212	Pushrod
213	Valve Rocker Arm
214	Bolt
215	Valve Rocker Arm Pivot Support
216	Core Hole Plug
217	Cylinder Head Gasket
218	Cylinder Head
220	Cylinder Head Bolt - M11
221	Cylinder Head Bolt - M8

222	Valve Stem Oil Seal
223	Valve Spring
224	Valve Spring Cap
225	Valve Stem Key
226	Core Hole Plug
227	Intake Valve
228	Exhaust Valve
229	Cylinder Head Plug
230	Cylinder Head Locating Pin
422	O-Ring
423	Oil Fill Tube
424	Oil Fill Cap
450	O-Ring
504	Valve Rocker Arm Cover Gasket
504	Valve Rocker Arm Cover Gasket
505	Valve Rocker Arm Cover
505	Valve Rocker Arm Cover
515	Bolt Grommet
516	Bolt
558	Plug
600	Exhaust Manifold
601	Exhaust Manifold Gasket
602	Bolt
603	Exhaust Manifold Heat Shield
604	Bolt
605	Stud
700	Positive Crankcase Ventilation (PCV) Hose - Fresh Air
719	Ignition Coil Bracket
720	Stud
721	Ignition Coil Wire Harness Assembly
722	Ignition Coil
723	Bolt
724	Spark Plug Wire
725	Coolant Temperature Sensor (CTS)
726	Spark Plug

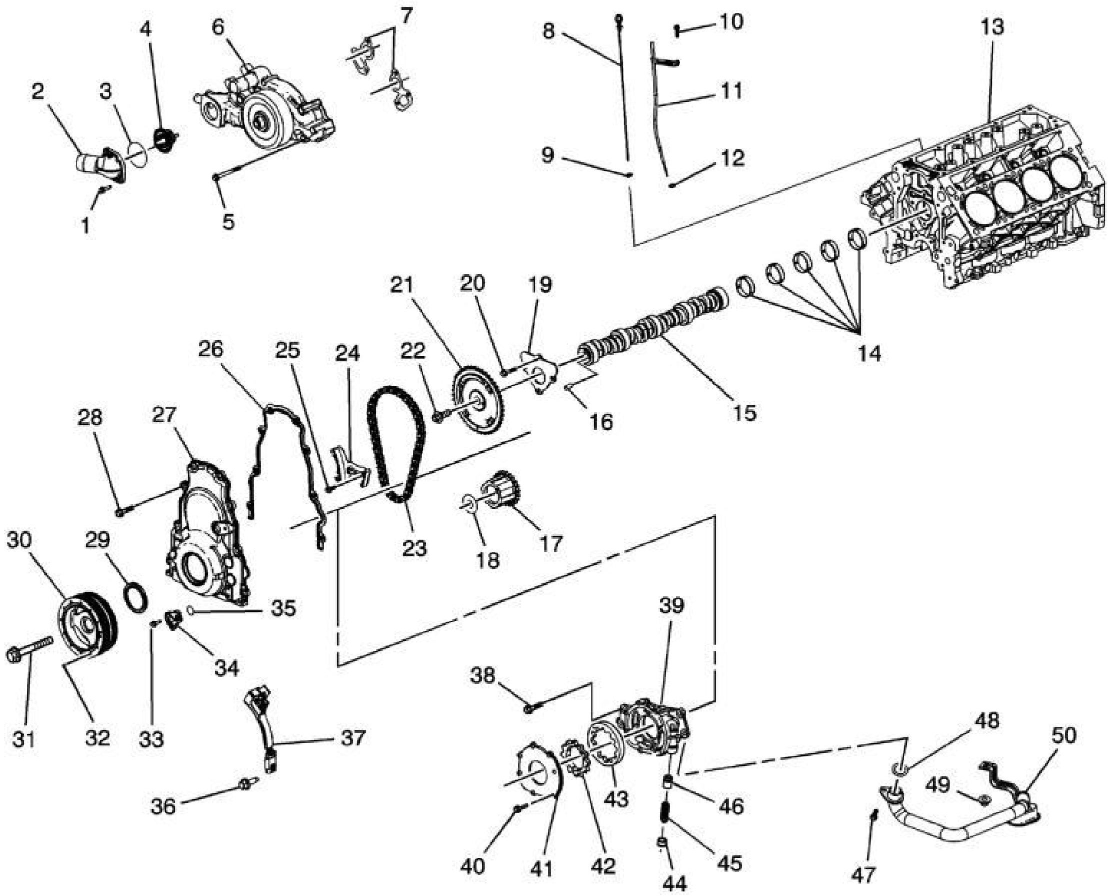


Fig. 16: Front of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt
2	Water Inlet Housing
3	O-Ring
4	Thermostat
5	Bolt
6	Water Pump
7	Water Pump Gasket
8	Oil Level Indicator
9	O-Ring
10	Bolt
11	Oil Level Indicator Tube
12	O-Ring
13	Engine Block

14	Camshaft Bearings
15	Camshaft
16	Camshaft Sprocket Locating Pin
17	Crankshaft Sprocket
18	Crankshaft Balancer Washer
19	Camshaft Retainer
20	Bolt
21	Camshaft Sprocket
22	Bolt
23	Timing Chain
24	Timing Chain Tensioner
25	Bolt
26	Engine Front Cover Gasket
27	Engine Front Cover
28	Bolt
29	Crankshaft Front Oil Seal
30	Crankshaft Balancer
31	Bolt
32	Balance Weight - Crankshaft Balancer
33	Bolt
34	Camshaft Position (CMP) Sensor
35	O-Ring
36	Bolt
37	CMP Sensor Wire Harness
38	Bolt
39	Oil Pump
40	Bolt
41	Oil Pump Housing Cover
42	Oil Pump Drive Gear
43	Oil Pump Driven Gear
44	Oil Pump Housing Plug
45	Oil Pump Pressure Relief Valve Spring
46	Oil Pump Pressure Relief Valve
47	Bolt
48	O-Ring
49	Nut
50	Oil Pump Screen

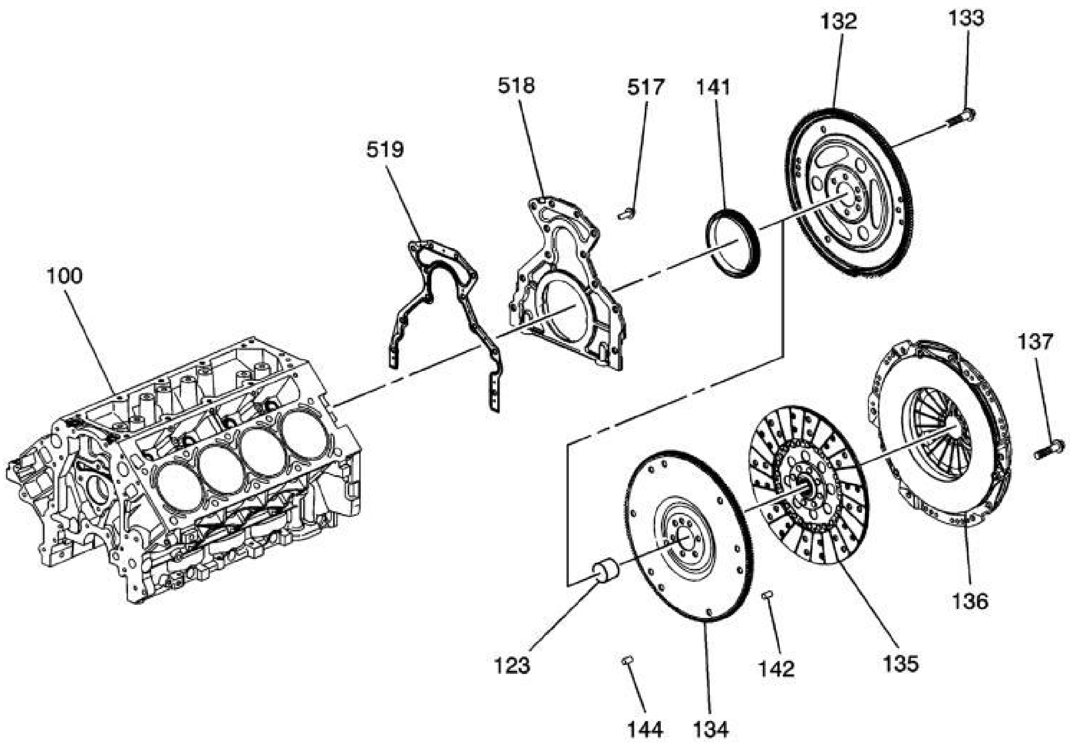


Fig. 17: Rear of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
123	Transmission Pilot Bearing - Manual Transmission
132	Flex Plate - Automatic Transmission
133	Bolt
134	Flywheel - Manual Transmission
135	Clutch Driven Plate - Manual Transmission
136	Clutch Pressure Plate - Manual Transmission
137	Bolt
141	Crankshaft Rear Oil Seal
142	Clutch Pressure Plate Locating Pin - Manual Transmission
144	Balance Weight - Flywheel
517	Bolt
518	Crankshaft Rear Oil Seal Housing

519	Crankshaft Rear Oil Seal Housing Gasket

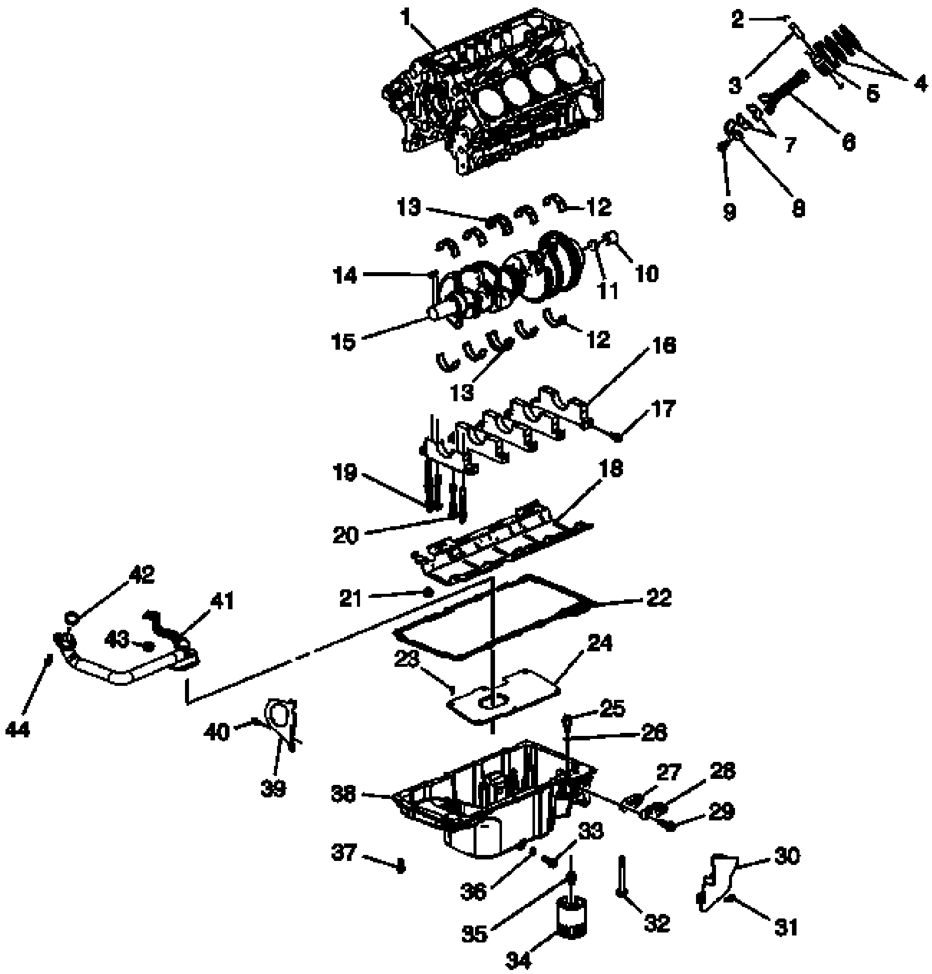


Fig. 18: Lower Engine Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Piston Pin Retainer
3	Piston Pin
4	Piston Ring Set
5	Piston
6	Connecting Rod
7	Connecting Rod Bearings
8	Connecting Rod Cap
9	Connecting Rod Bolt
10	Transmission Pilot Bearing - Manual Transmission
11	Plug

12	Crankshaft Main Bearing
12	Crankshaft Main Bearing
13	Crankshaft Thrust Bearing
13	Crankshaft Thrust Bearing
14	Crankshaft Balancer Key
15	Crankshaft
16	Crankshaft Bearing Cap
17	Crankshaft Bearing Cap Bolt - M8
18	Crankshaft Oil Deflector
19	Crankshaft Oil Deflector Stud - M10
20	Crankshaft Oil Deflector Bolt - M10
21	Nut
22	Oil Pan Gasket
23	Bolt
24	Oil Pan Baffle
25	Active Fuel Management Oil Pressure Relief Valve
26	Washer
27	Oil Pan Cover Gasket
28	Oil Pan Cover
29	Bolt
30	Oil Pan Closeout Cover - Left
31	Bolt
32	Oil Pan Bolt - M6
33	Oil Pan Drain Plug
34	Oil Filter
35	Oil Filter Fitting
36	O-Ring
37	Oil Pan Bolt - M8
38	Oil Pan
39	Engine Closeout Cover - Right
40	Bolt
41	Oil Pump Screen
42	O-Ring
43	Nut
44	Bolt

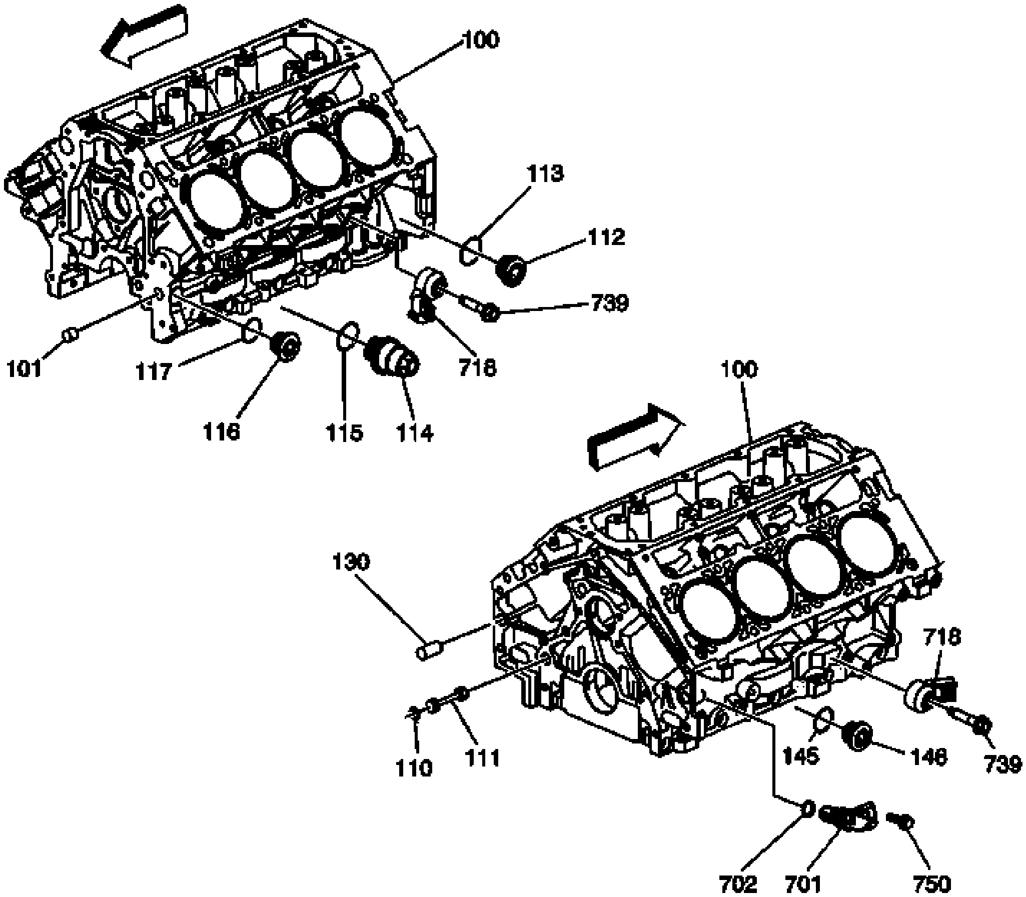


Fig. 19: Exploded View Of Engine Block Plugs/Sensors Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
100	Engine Block
101	Oil Gallery Plug - Front
110	O-Ring
111	Oil Gallery Plug - Rear
112	Oil Gallery Plug - Side
113	Washer
114	Engine Coolant Heater
115	Washer
116	Oil Gallery Plug - Side
117	Washer
130	Transmission Housing Locating Pin
145	Washer

146	Engine Block Coolant Drain Hole Plug
701	Crankshaft Position (CKP) Sensor
702	O-Ring
718	Knock Sensor
718	Knock Sensor
739	Bolt
739	Bolt
750	CKP Sensor Bolt

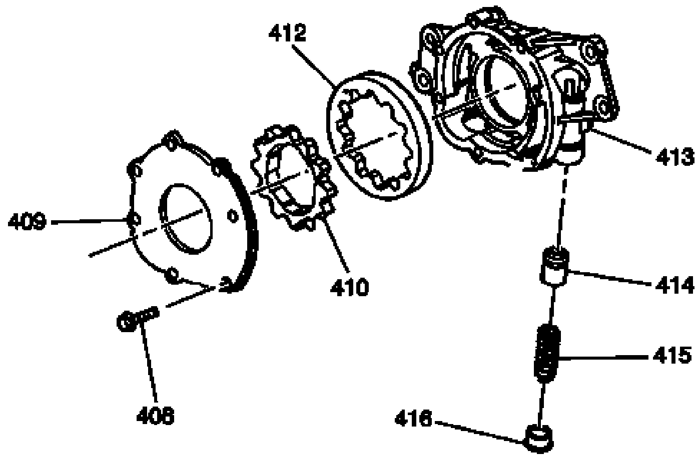


Fig. 20: Exploded View Of Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
408	Bolt
409	Oil Pump Housing Cover
410	Oil Pump Drive Gear
412	Oil Pump Driven Gear
413	Oil Pump
414	Oil Pump Pressure Relief Valve
415	Oil Pump Pressure Relief Valve Spring
416	Oil Pump Housing Plug

ENGINE IDENTIFICATION (6.2L LS3)

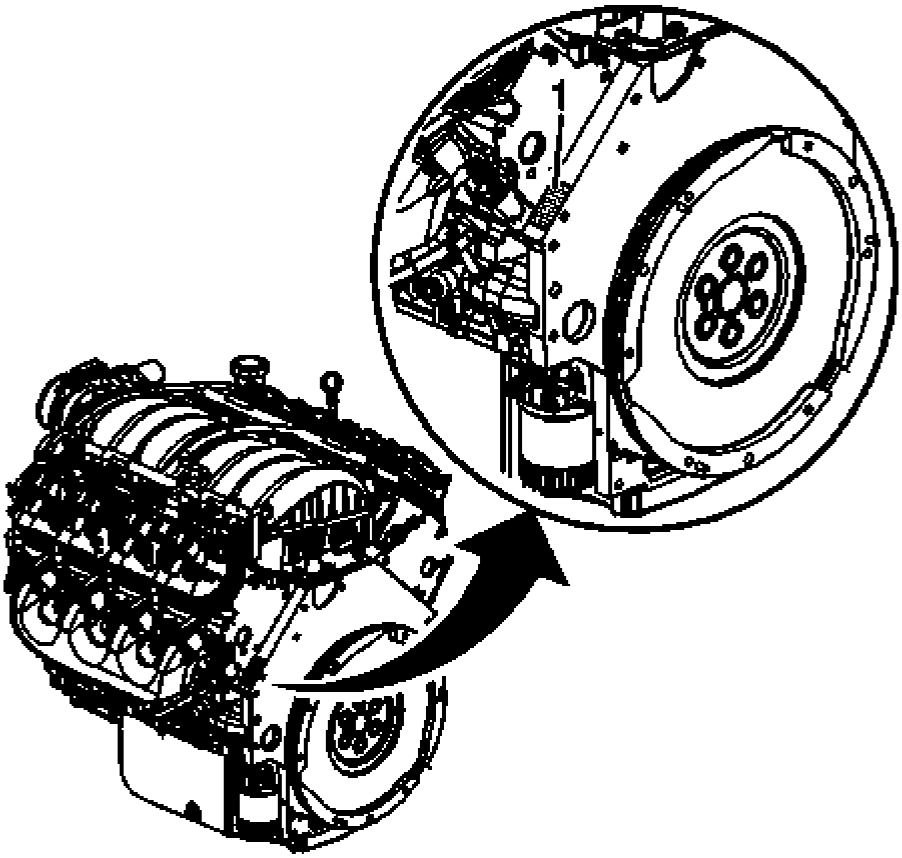


Fig. 21: Locating Engine Identification Number (6.2L LS3)
Courtesy of GENERAL MOTORS CORP.

The vehicle identification number (VIN) (1) is located on the left side rear of the engine block and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the **Disassembled Views (L76)** or **Disassembled Views (6.2L LS3)**, **Engine Component Description (L76)** or **Engine Component Description (6.2L LS3)**, **Lubrication Description (L76)** or **Lubrication Description (6.2L LS3)**, and **Cylinder Deactivation (Active Fuel Management) System Description**. Reviewing the description and operation information helps you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information also helps 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 the Diagnostic System Check - Vehicle before using the symptom tables.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views (L76)** or **Disassembled Views (6.2L LS3)**, **Engine Component Description (L76)** or **Engine Component Description (6.2L LS3)**, **Lubrication Description (L76)** or **Lubrication Description (6.2L LS3)**, and **Cylinder Deactivation (Active Fuel Management) System Description**.

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

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**

- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Coolant in Combustion Chamber**
- **Coolant in Engine Oil**
- **Cylinder Deactivation (Active Fuel Management) System Diagnosis**
- **Engine Compression Test**
- **Cylinder Deactivation (Active Fuel Management) System Compression Test**
- **Cylinder Leakage Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing**
- **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Crankcase Ventilation System Inspection/Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Fuel injector harness connectors are connected to the incorrect fuel injectors/cylinders	Relocate the fuel injector harness connectors, as necessary.
Abnormalities, such as 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 **Drive Belt Replacement - Accessory** .
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 **Engine Flywheel Replacement** or **Crankshaft Balancer Replacement** .

Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace, as required.
Improperly installed or damaged vacuum hoses	Repair or replace, as required.
Improper sealing between the intake manifold and cylinder heads or throttle body	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body, as required.
Improperly installed or damaged manifold absolute pressure (MAP) sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor, as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and the rocker arm in the proper position.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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.	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace the oil pump, as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** . 2. Inspect the cylinder heads, engine block, and/or head gaskets. Refer to **Coolant in Combustion Chamber**. 3. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to identify the cause. Refer to **Cylinder Leakage Test**.

	4. Repair or replace, as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with electronic communications, DIS, or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then sync the crankshaft position. • Systems with electronic communication, DIS, or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and affect fuel and spark delivery to the point of generating a DTC P0300 or DTC P0336.	Replace the sensor and/or crankshaft, as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, such as 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 **Drive Belt Replacement - Accessory** .
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 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 **Engine Flywheel Replacement** or **Crankshaft Balancer Replacement** .
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**.

	3. Perform cylinder leak down and compression testing to determine the cause. Refer to **Cylinder Leakage Test**. 4. 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 be intact within the rocker arm assembly.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace, as required.
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to **Oil Pressure Diagnosis and Testing**.
Improper operation of the active fuel management oil pressure relief valve	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing**.
Improper operation of the active fuel management system - RPO L76	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis**.

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 Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** . 2. Perform a cylinder leak down test. Refer to **Cylinder Leakage Test**. 3. Inspect the cylinder heads and engine block

	for damage to the coolant passages and/or a faulty head gasket. Refer to **Coolant in Combustion Chamber**. 4. Repair or replace, as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to **Cylinder Leakage Test**. 4. 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	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters as required.
Worn crankshaft thrust bearing	1. Check the crankshaft end play. 2. Inspect the thrust bearing and crankshaft. 3. Repair or replace as required.
Faulty oil filter bypass valve. The valve is now internal to the oil filter.	Replace the oil filter as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace, as required.
Loose and/or worn valve rocker arm attachments	1. Inspect the valve rocker arm, bolt, and

	pedestal. 2. Repair or replace, as required.
Worn or damaged valve rocker arm	1. Inspect the rocker arm for wear or missing needle bearings 2. Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve The bypass valve is now internal to the oil filter. • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
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 engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft and valve lifters, as required.
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	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace damaged components, as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	1. Inspect the accessory drive system. 2. Repair or replace, as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flex plate. 2. Repair or replace, as required.
Loose or damaged flywheel or flex plate	Repair or replace the flywheel or flex plate.
Oil pump screen loose, damaged, or restricted	1. Inspect the oil pump screen. 2. Repair or replace, as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair, as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, pin, and connecting rod. 2. Replace the piston and pin as an assembly, 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.	1. Verify the pistons, piston pins and connecting rods are installed correctly. Refer to **Piston, Connecting Rod, and Bearing Installation** . 2. Repair, as required.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flex plate. 2. Repair, as required.
Cracked flex plate - automatic transmission	1. Inspect the flex plate bolts and flex plate. 2. 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	1. Remove the accessory drive belts. 2. Confirm that the engine will rotate. Rotate the

	crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Seized automatic transmission torque converter	1. Remove the torque converter-to-flex plate bolts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Broken timing chain	1. Inspect the timing chain and sprockets. 2. Repair or replace the components, as required.
Seized timing chain or timing sprockets	1. Inspect the timing chain and sprockets for foreign material or a seized chain. 2. Repair or replace the components, as required.
Seized or broken camshaft	1. Inspect the camshaft and the camshaft bearings. 2. Repair or replace the components, as required.
Bent valve in the cylinder head	1. Inspect the valves and the cylinder heads. 2. Repair or replace the components, as required.
Seized oil pump	1. Inspect the oil pump assembly. 2. Repair or replace, as required.
Hydraulically locked cylinder • Coolant/antifreeze in the cylinder • Oil in the cylinder • Fuel in the cylinder	1. Remove the spark plugs and inspect for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to **Coolant in Combustion Chamber**. 2. Inspect for failed/broken head gaskets. 3. Inspect for a cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace the components, as required.
Material in the cylinder	1. Inspect the cylinder for damaged components and/or foreign materials.

• Broken valve • Broken piston rings • Piston material • Foreign material	2. Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Repair or replace the components, as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Replace the piston and pin as an assembly, as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair or replace the components, 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. 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate**. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.	
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Removal - Left Side** and **Cylinder Head Installation - Left Side** , or **Cylinder Head Removal - Right Side** and **Cylinder Head Installation - Right Side** .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
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. 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed**. 2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. 2 cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.	
Faulty external engine oil cooler	Replace the components, as required.
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Removal - Left Side** and **Cylinder Head Installation - Left Side** , or **Cylinder Head Removal - Right Side** and **Cylinder Head Installation - Right Side** .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
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.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DIAGNOSIS

NOTE: Cylinder Deactivation (Active Fuel Management) System Diagnosis is applicable for RPO L76.

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to **Diagnostic System Check - Vehicle** . Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to **Oil Pressure Diagnosis and Testing**.
4. Verify proper operation of the active fuel management system components. Refer to **Cylinder Deactivation (Active Fuel Management) System Compression Test**.

5. Remove the valve lifter oil manifold. Refer to **Valve Lifter Oil Manifold Replacement** .
6. Verify proper operation of the valve lifter oil manifold. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**.
7. Replace the active fuel management valve lifters, as required. Both intake and exhaust lifters should be replaced in pairs. Refer to **Valve Lifter Replacement** .

ENGINE COMPRESSION TEST

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gage at zero and crank the engine through 4 compression strokes, 4 puffs.
8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1 035 x 70% = 725) (150 x 70% = 105).
    - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
    - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
    - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
    - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM COMPRESSION TEST

NOTE: Cylinder Deactivation (Active Fuel Management) System Compression Test is applicable for RPO L76.

The Cylinder Deactivation (Active Fuel Management) System Compression Test is a functional test of the valve lifter oil manifold and valve lifters. Using a compression gage, the technician can monitor the specific cylinders ability to go into and out of active fuel management as commanded by the scan tool. The actual pressure values on the compression gage are not as critical as is observing the on-off switching action of the solenoid and valve lifters.

1. Measure the engine oil level. Fill, as required.

2. Perform the Diagnostic System Check - Vehicle. Refer to **Diagnostic System Check - Vehicle** .
3. Disable the ignition system for the cylinder to be tested, by disconnecting the electrical wire harness to the ignition coil.
4. Disable the fuel injection system for the cylinder to be tested, by disconnecting the electrical wire harness to the fuel injector.
5. Remove the spark plug and wire for the cylinder to be tested.
6. Install a 0-1 378 kPa (0-200 psi) compression gage.
7. Start the engine.
8. Using the scan tool output controls, command the solenoid ON, for the cylinder to be deactivated.
9. Depress the Schrader valve on the compression gage, in order to release the pressure and zero the gage. With the engine running and the cylinder in active fuel management mode, the compression reading should be less than 172 kPa (25 psi).
10. Using the scan tool, de-energize the solenoid while observing the reading on the compression gage. With the engine running and the cylinder NOT in active fuel management mode, the compression gage reading should increase quickly to greater than 345 kPa (50 psi).

NOTE: Only 1 cylinder can be tested at a time. When testing has been completed on a specific cylinder, the wire harness electrical connectors, spark plug, and spark plug wire must be installed prior to testing of each additional cylinder.

11. Test each of the 4 active fuel management cylinders, 1 at a time. If the readings are not within specifications, remove, and test the valve lifter oil manifold, as required. Refer to **Valve Lifter Oil Manifold Replacement** and **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**.
12. If the compression test has been performed and all active fuel management cylinders are operating within specifications, the active fuel management system is performing as designed and no repairs are required.
13. Clear the diagnostic trouble codes (DTCs) with a scan tool.

CYLINDER LEAKAGE TEST

Special Tools

J 35667-A: Cylinder Head Leakdown Tester, or equivalent

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

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

- **Worn or burnt valves**
- **Broken valve springs**
- **Stuck valve lifters**

- **Incorrect valve lash**
- **Damaged piston**
- **Worn piston rings**
- **Worn or scored cylinder bore**
- **Damaged cylinder head gasket**
- **Cracked or damaged cylinder head**
- **Cracked or damaged engine block**

Test

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

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Install the **J 35667-A:** tester, or equivalent.

NOTE: It may be necessary to hold the crankshaft balancer bolt to prevent the crankshaft from rotating.

5. Apply shop air pressure to the **J 35667-A:** tester and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
   - Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
   - Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
   - Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Checks	Causes
Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3 200 kilometers (2,000 miles).	

Preliminary	The causes of excessive oil consumption may include the following conditions: • External oil leaks Refer to **Oil Leak Diagnosis**. • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time, 2-3 minutes, and measure for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components Refer to Crankcase Ventilation System Inspection/Diagnosis. • Worn valve guides and/or valve stems • Worn or improperly installed valve stem oil seals Refer to **Spark Plug Inspection** . • Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to **Cylinder Leakage Test**. • Piston and rings improperly installed or not fitted to the cylinder bore Refer to **Lower Engine Noise, Regardless of Engine Speed**.

OIL PRESSURE DIAGNOSIS AND TESTING

Tools Required

- **EN-47971** Oil Pressure Gage Adapter. See **Special Tools**.
- **J 21867** Pressure Gage

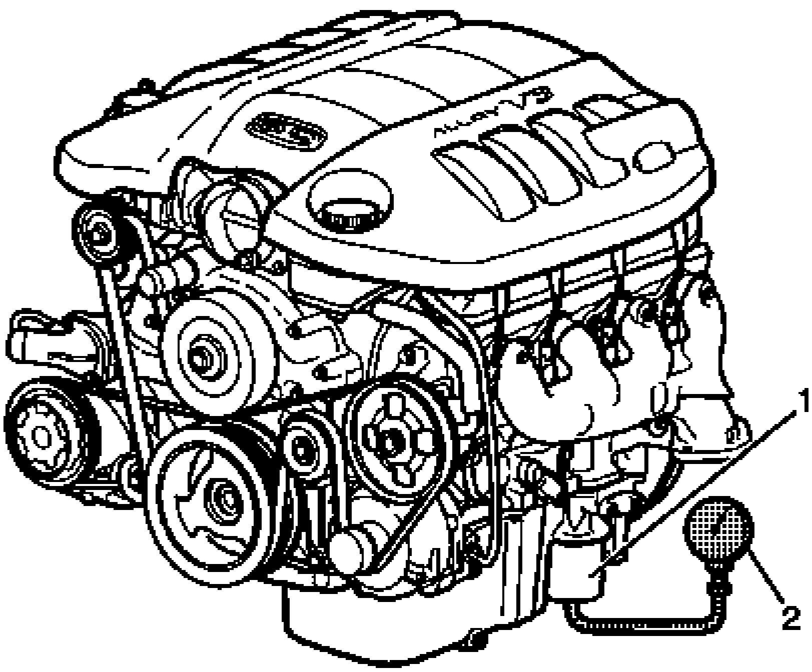


Fig. 22: Locating EN-47971 & J 21867
Courtesy of GENERAL MOTORS CORP.

1. With the vehicle on a level surface, run the vehicle for a few minutes. Allow adequate drain down time, 2-3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gage or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following conditions:
    - Oil diluted by water or glycol antifreeze

      Refer to **Coolant in Engine Oil** .

    - Foamy oil, which may be caused by a cut or damaged oil pump screen O-ring seal
6. Remove the oil filter and install the **EN-47971** (1). See **Special Tools**.
7. Install the **J 21867** (2), or equivalent to the **EN-47971** (1). See **Special Tools**.

8. Run the engine and measure the engine oil pressure.
9. Compare the readings to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (L76)**.
10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
    - Oil pump worn or dirty

      Refer to **Oil Pump Cleaning and Inspection** .

    - Oil pump-to-engine block bolts loose

      Refer to **Oil Pump, Screen and Crankshaft Oil Deflector Installation** .

    - Oil pump screen loose, plugged, or damaged
    - Oil pump screen O-ring seal missing or damaged
    - Malfunctioning oil pump pressure relief valve
    - Excessive bearing clearance
    - Cracked, porous, or restricted oil galleries
    - Oil gallery plugs missing or incorrectly installed

      Refer to **Engine Block Plug Installation** .

    - Improper operation of the active fuel management oil pressure relief valve

      Refer to **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing** .

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OIL PRESSURE RELIEF VALVE DIAGNOSIS AND TESTING

Tools Required

- **EN-47971** Oil Pressure Gage Adapter. See **Special Tools**.
- **J 21867** Pressure Gage
- **J-21867-16** Oil Pressure Adapter. See **Special Tools**.

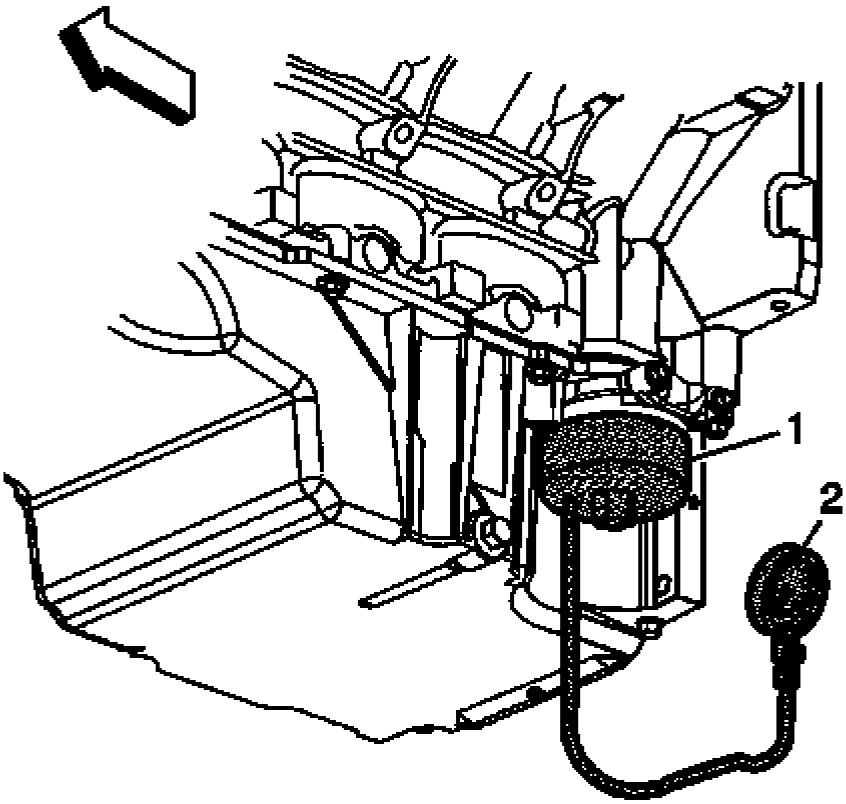


Fig. 23: Using Special Tools EN-47971 & J 21867 To Check Oil Pressure
Courtesy of GENERAL MOTORS CORP.

NOTE: This test is performed to verify the operation of the active fuel management oil pressure relief valve located in the oil pan. Refer to Cylinder Deactivation (Active Fuel Management) System Description and Lubrication Description (L76) or Lubrication Description (6.2L LS3).

1. Remove the oil filter and install the **EN-47971** (1). See **Special Tools**.
2. Install the **J 21867** (2), or equivalent, to the **EN-47971** (1). See **Special Tools**.

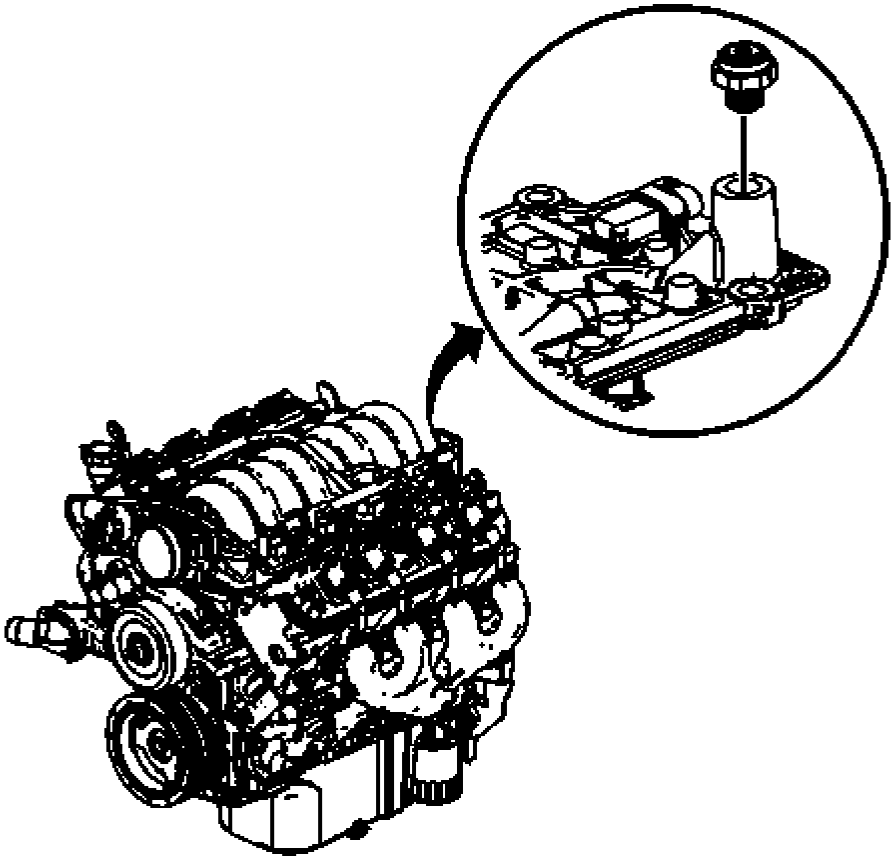


Fig. 24: Locating Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor and install the **J-21867-16** . See **Special Tools**.

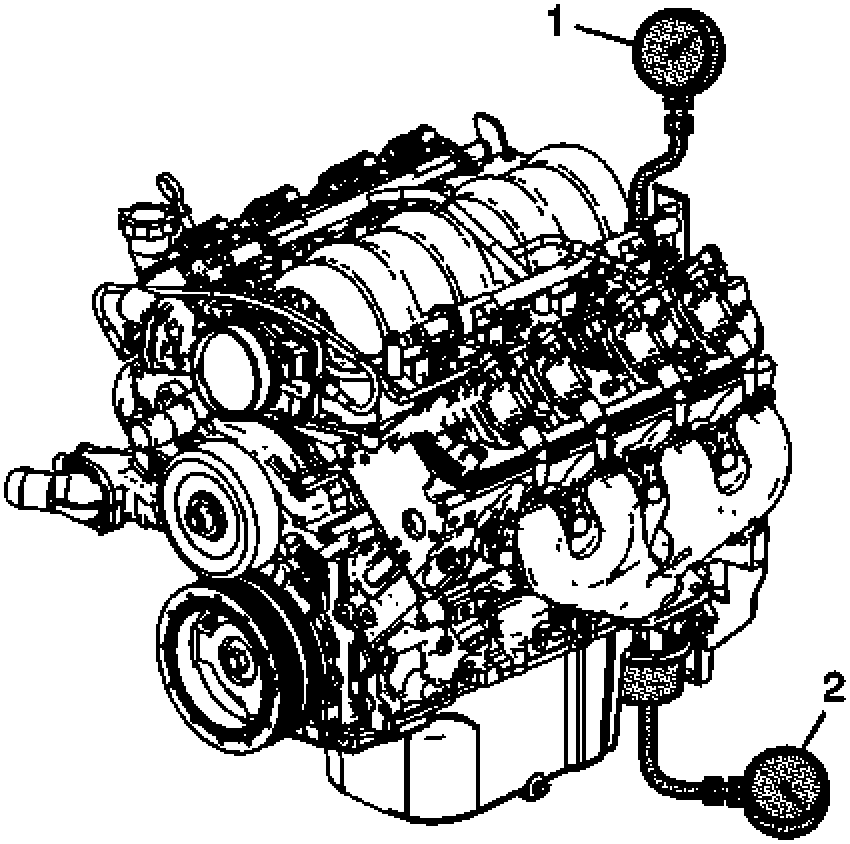


Fig. 25: Testing Oil Pressure
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 21867** (1), or equivalent, to the**J-21867-16** (2). See **Special Tools**.
5. Run the engine and measure the engine oil pressure while observing both gages.

   Operate the throttle, as required, to increase and decrease the engine oil pressure.

   - With the engine running and the lower pressure gage (2) measuring below 379 kPa (55 psi), both gages should display the same pressure reading. If the readings are not the same and the lower gage (2) has a higher reading, the active fuel management oil pressure relief valve is stuck in the open position or the valve lifter oil manifold filter is plugged.
   - With the engine running and the lower pressure gage (2) measuring above 379 kPa (55 psi), the upper gage (1) should display no greater than 379-517 kPa (55-75 psi). If the reading on the upper gage (1) is greater than 517 kPa (75 psi), the active fuel management oil pressure relief valve is stuck in the closed position.
6. Repair, as required.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) VALVE LIFTER OIL MANIFOLD DIAGNOSIS AND TESTING

Special Tools

- **EN-46999:** Active Fuel Management Tester
- **EN-46999-1:** Active Fuel Management Tester Air Adapter
- **EN-46999-5:** Active Fuel Management Tester Harness - Small Block V8

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

NOTE:

- **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing is applicable for RPO L76.**
- **A minimum shop air source of 206 kPa (30 psi) is required for manifold testing.**
- **A water bleed is located on the side of the EN-46999: tester. Occasionally, depress the valve in order to remove excess water from the tool.**

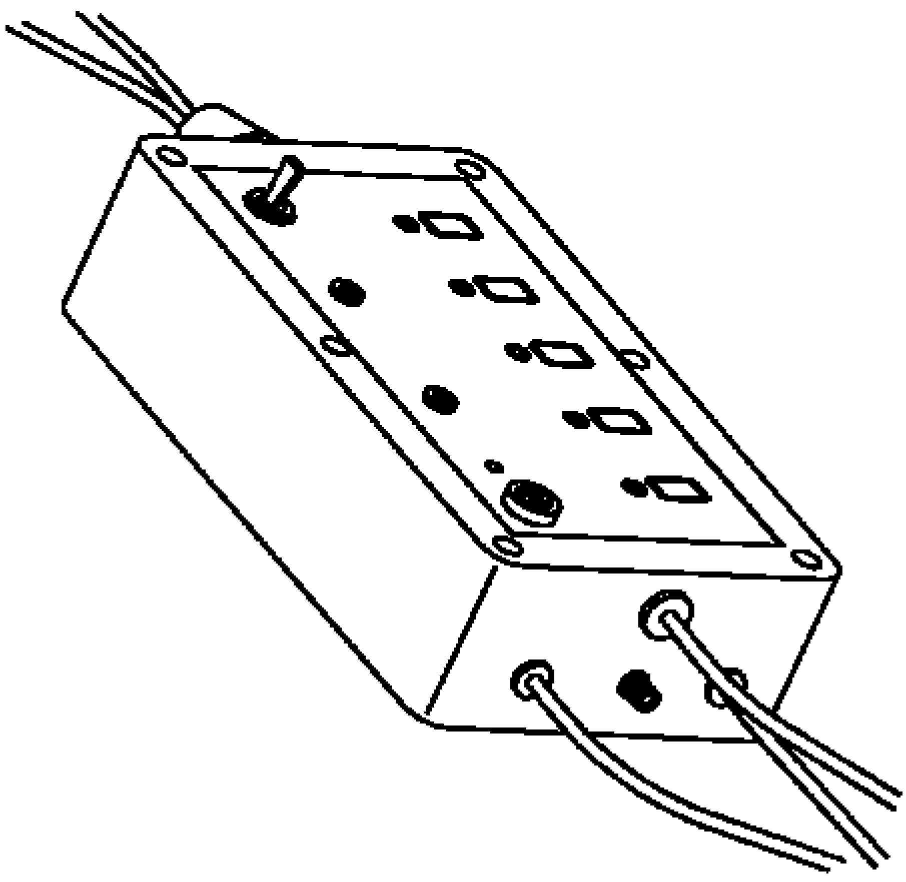


Fig. 26: Identifying Displacement On-Demand Tester
Courtesy of GENERAL MOTORS CORP.

The manifold bench test provides a maximum 206 kPa (30 psi) of filtered shop air to the manifold and will test each solenoid/valve for the following conditions:

- Proper operation
- A stuck open condition - constant air flow
- A stuck closed condition - no air flow
- A flow restriction within the manifold

1. Individually depress each of the buttons 1-4 on the **EN-46999:** tester in order to activate each of the solenoid/valves. When activating each solenoid/valve, a loud click should be heard from the solenoid and an increased amount of air will exit the outlet ports.
   - Button 1 will energize the solenoid/valve 1 for engine cylinder number 1.
   - Button 2 will energize the solenoid/valve 2 for engine cylinder number 4.
   - Button 3 will energize the solenoid/valve 3 for engine cylinder number 6.
   - Button 4 will energize the solenoid/valve 4 for engine cylinder number 7.

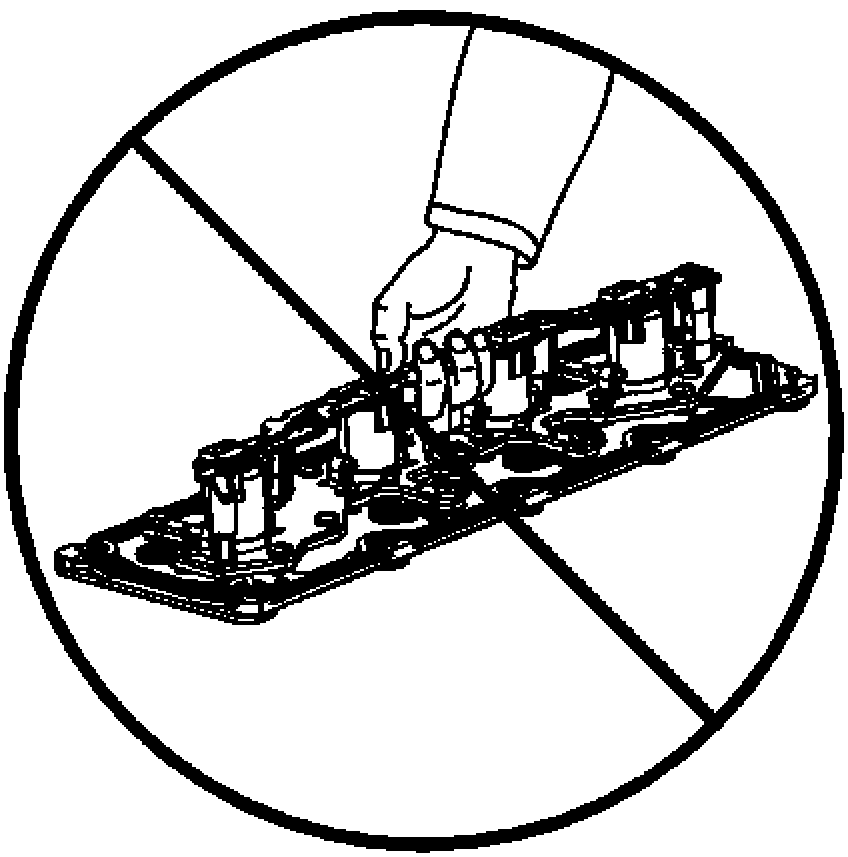


Fig. 27: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

2. Do not lift the manifold assembly by the electrical lead frame.

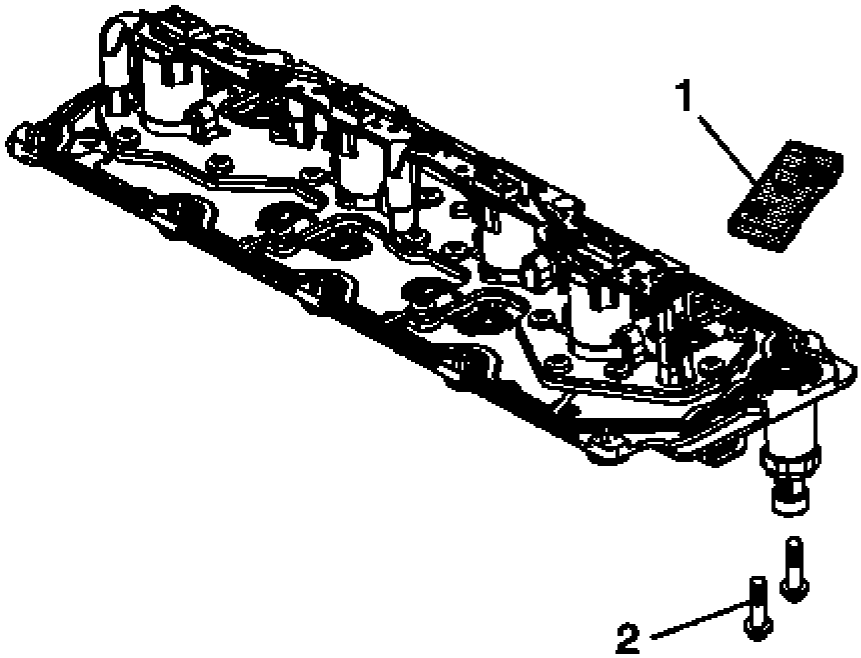


Fig. 28: Displacement-on-Demand Tester Air Adapter
Courtesy of GENERAL MOTORS CORP.

3. Install the **EN-46999-1:** tester air adapter (1) to the manifold.

CAUTION: Refer to Fastener Caution .

4. Install 2 of the manifold bolts (2) to the **EN-46999-1:** tester air adapter. Tighten the bolts to 25 N.m (18 lb ft).

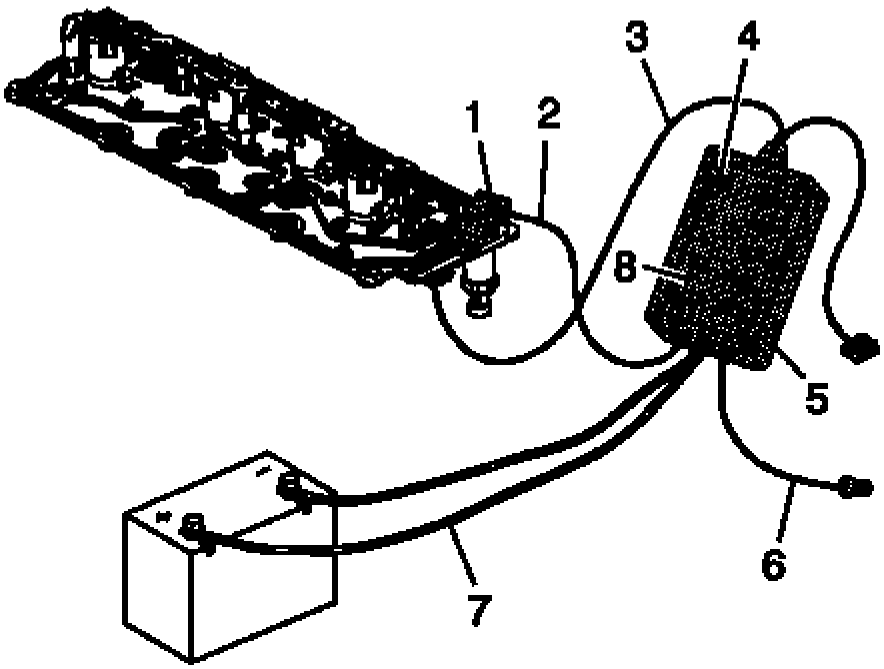


Fig. 29: Connecting Air Out Hose
Courtesy of GENERAL MOTORS CORP.

5. Connect the air out hose (2) of the **EN-46999:** AFM tester (5) to the **EN-46999-1:** tester air adapter (1). Verify the air supply switch (4) is in the off position.
6. Connect the air in hose (6) of the **EN-46999:** AFM tester (5) to a shop air source.
7. Connect the 12-volt power supply connectors (7) of the **EN-46999:** AFM tester (5) to a 12-volt power supply. Verify the Power light (8) on the tool is illuminated. If the light on the tool is not illuminated when connected to a 12-volt power supply, test and/or replace the 3 amp fuse.
8. Connect the **EN-46999-5:** tester harness power cable (3) to the electrical connector of the manifold.

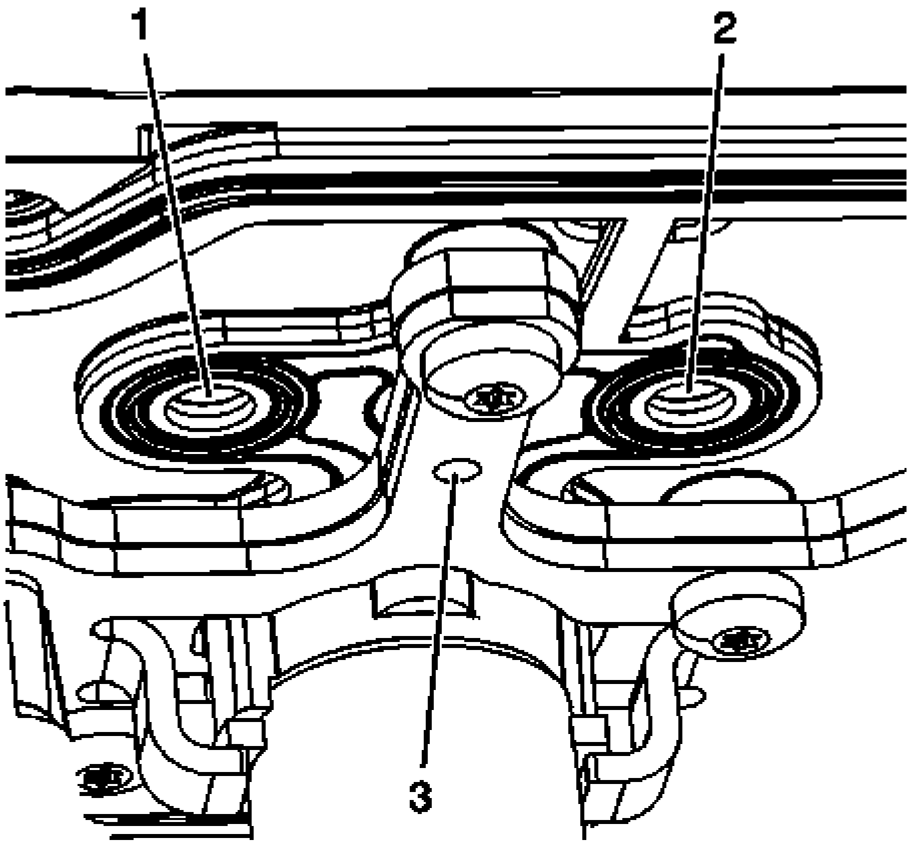


Fig. 30: Bleed Holes & Outlet Ports
Courtesy of GENERAL MOTORS CORP.

9. Turn the air supply switch of the **EN-46999:** AFM tester to the ON position. With the air supply connected to the manifold assembly and the solenoid/valves in the closed position, a limited amount of air will exit each of the bleed holes (3) and outlet ports (1, 2) of the manifold.

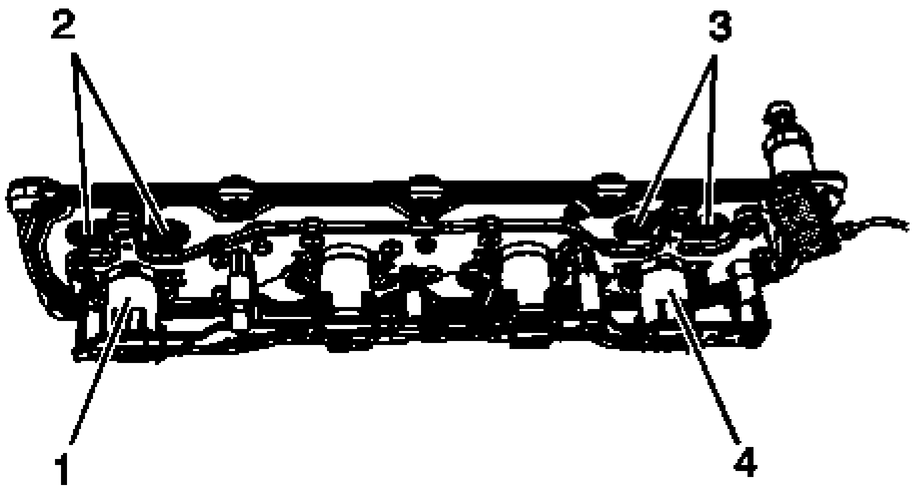


Fig. 31: Testing Solenoid/Valves
Courtesy of GENERAL MOTORS CORP.

NOTE: The manifold must be tested in the proper position to ensure the solenoid/valves operate as designed.

10. Position the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 1 and 4.
11. Depress button number 1 on the tool to activate solenoid/valve 1. With button 1 depressed, the solenoid/valve (1) should open, allowing an increased amount of air to exit the outlet ports (2) of the manifold.
12. Depress button number 4 on the tool to activate solenoid/valve 4. With button 4 depressed, the solenoid/valve (4) should open, allowing an increased amount of air to exit the outlet ports (3) of the manifold.

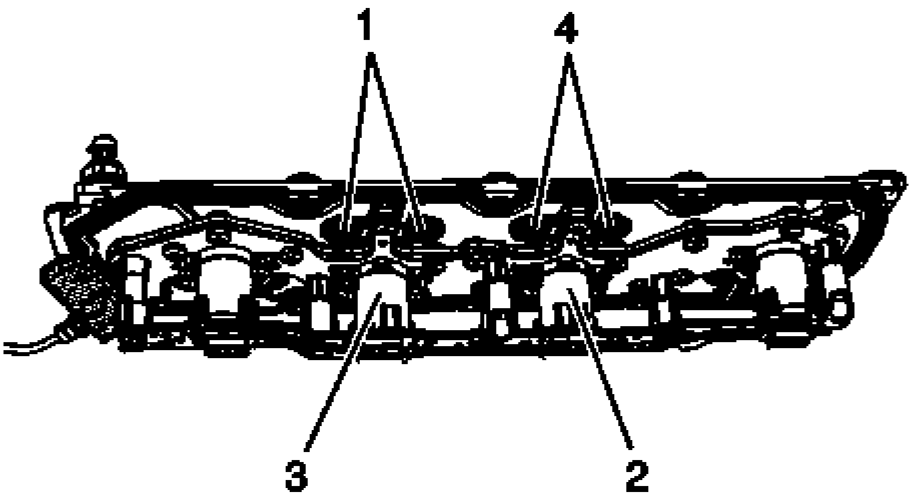


Fig. 32: View Of Solenoid/Valves 2 & 3
Courtesy of GENERAL MOTORS CORP.

13. Reposition the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 2 and 3.
14. Depress button number 2 on the tool to activate solenoid/valve 2. With button 2 depressed, the solenoid/valve (2) should open, allowing an increased amount of air to exit the outlet ports (4) of the manifold.
15. Depress button number 3 on the tool to activate solenoid/valve 3. With button 3 depressed, the solenoid/valve (3) should open, allowing an increased amount of air to exit the outlet ports (1) of the manifold.
16. When the test is completed, turn the air source switch on the **EN-46999:** AFM tester to the off position and disconnect the tool from the 12-volt power supply, shop air source and manifold assembly.
17. If after testing, it has been determined that one or more of the solenoid/valves is not functioning properly, replace the manifold as an assembly.
18. If after testing, it has been determined that the solenoid/valves are functioning properly, replace the valve lifters as required. Both intake and exhaust lifters should be replaced in pairs.

ENGINE OIL LEVEL SENSOR DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Engine Oil Level Sensor Signal	2	1	-	1
Engine Oil Level Sensor Low Reference	-	1	-	-
1. DIC message Engine Oil Level Low Always ON 2. DIC message Engine Oil Level Low Always OFF				

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is a normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC) and a message is displayed on the driver information center (DIC).

The following information determines the message sent from the ECM to the IPC:

- The Engine Oil Level Low message is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.
- The Engine Oil Level Low message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by the ignition ON for less than 1 second.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify proper engine oil level. Add oil as necessary.
2. Ignition ON, observe the scan tool Engine Oil Level parameter. The reading should be OK and change to Low when the oil level sensor/switch harness connector is disconnected.

Circuit/System Testing

NOTE: Verify proper engine oil level before continuing with diagnosis.

1. Ignition OFF, disconnect the harness connector at the engine oil level sensor.
2. Ignition OFF for 90 seconds, test for less than 1 ohms between the low reference circuit terminal C and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool Engine Oil Level parameter reads Low.
   - If the Oil Level parameter reads OK, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.

NOTE: If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.

4. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal C. Verify the scan tool Engine Oil Level parameter reads OK.
   - If the Engine Oil Level parameter reads Low, test the signal circuit terminal A for an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the engine oil level sensor and/or switch.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Oil Level Sensor and/or Switch Replacement**
- **Engine Control Module Replacement**
- **Control Module References** for the ECM replacement, setup, and programming

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**
	1. Completely clean the entire engine and surrounding components.		

4	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**
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: • 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. 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). • Plugged or kinked PCV hose(s). • Damaged or incorrectly installed PCV or hose(s). • Above acceptable crankcase pressure.
Rough Idle.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s). • Leaking (damaged) PCV or hose(s).
Stalling or slow idle speed.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s). • Leaking (damaged) PCV or hose(s).
High idle speed.	Inspect for a leaking (damaged) PCV or hose(s).
Sludge in the engine.	Inspect for any of the following conditions: • Plugged PCV. • Plugged or kinked PCV hose(s).

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Drive Belt Chirping Diagnosis

Diagnostic Aids

The chirping noise may be intermittent due to moisture on the drive belts or the accessory drive pulleys. in order to duplicate the customer concern, It may be necessary to spray a small amount of water onto the drive belts. If spraying water on the drive belts duplicates the symptom, cleaning the accessory drive pulleys may be the most probable solution.

A loose or incorrect installation of a body or suspension component, or other items on the vehicle may cause the chirping noise.

Test Description

The numbers below refer to the steps in the diagnostic table.

2: The chirping 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 in this table.

3: The noise may be an internal engine noise. Remove the drive belts and operate the engine for a few seconds, this will verify if the chirping noise is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4: Inspect the drive belts for signs of pilling. Pilling is the small balls, pills, or strings in the drive belt grooves caused by the accumulation of rubber dust.

6: Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the correct removal and installation procedure for that pulley.

10: Inspection of the fasteners can address the possibility that a incorrect bolt, nut, spacer, or washer was installed.

12: Inspection the accessory drive pulleys should include inspecting for bends, dents or other damage to the pulleys that May prevent the drive belts from seating correctly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belt is used to drive the pulley.

14: Replacing the drive belts when it is not damaged or there is not above acceptable pilling will only be a temporary repair.

Step	Action	Yes	No
CAUTION: Refer to **Belt Dressing Caution** . DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belts or an accessory drive pulley. • Chirping may occur on cold damp start-up conditions and will subside once the vehicle reaches normal operating temperature.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Operate the engine for no longer than 30-40 seconds. Does the chirping noise still exist?	Go to **Engine Noise on Start-Up, but Only Lasting a Few Seconds** or **Upper Engine Noise, Regardless of Engine Speed** or **Lower Engine Noise, Regardless of Engine Speed**.	Go to **Step 4**
4	Inspect for extreme drive belt pilling exceeding 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to **Step 5**	Go to **Step 6**
5	Clean the accessory drive pulleys with a suitable wire brush.		

	Were the accessory drive pulleys cleaned?	Go to **Step 14**	-
6	Inspect for a misaligned accessory drive pulleys. Is there a misaligned accessory drive pulleys?	Go to **Step 7**	Go to **Step 8**
7	Replace and/or repair the misaligned accessory drive pulleys. Refer to **Power Steering Pump Pulley Replacement** . Refer to **Drive Belt Idler Pulley Replacement** or **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** . Were the misaligned accessory drive pulleys replaced and/or repaired?	Go to **Step 15**	-
8	Inspect for a bent or cracked accessory drive brackets. Did you find any bent or cracked accessory drive brackets?	Go to **Step 9**	Go to **Step 10**
9	Replace the bent and/or cracked accessory drive brackets. Refer to **Air Conditioning Compressor Bracket Replacement** . Refer to **Generator Bracket Replacement (3.6L)** or **Generator Bracket Replacement (6.0L)** . Was the bent and/or cracked accessory drive brackets replaced?	Go to **Step 15**	-
10	Inspect for incorrect, loose, and/or missing fasteners. Were there any incorrect, loose, and/or missing fasteners found?	Go to **Step 11**	Go to **Step 12**
11	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (L76)** or **Fastener Tightening Specifications (6.2L LS3)**. Were the fasteners replaced and/or tightened?	Go to **Step 15**	-
12	Inspect for a bent accessory drive pulleys. Refer to **Power Steering Pump Pulley Replacement** . Refer also to **Drive Belt Idler Pulley Replacement** or **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** . Was a bent accessory drive pulleys found?	Go to **Step 13**	Go to **Step 14**
13	Replace the bent accessory drive pulleys. Refer to **Power Steering Pump Pulley Replacement** . Refer also to **Drive Belt Idler Pulley Replacement** or **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** . Was the bent accessory drive pulleys replaced?	Go to **Step 15**	-
	Replace the drive belts. Refer to **Drive Belt**		

14	**Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Was the drive belts replaced?	Go to **Step 15**	-
15	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the chirping noise still exist?	Go to **Step 3**	System OK

Drive Belt Squeal Diagnosis

Diagnostic Aids

A loose or incorrect installation of the body, suspension component, or other items on the vehicle may cause the squealing noise.

If the noise is intermittent, verify that the accessory drive components, by varying their loads, are operating to their maximum capacity. An overcharged air conditioning (A/C) system, power steering system restriction, incorrect fluid, or a failing alternator are suggested items to inspect.

Test Description

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

2: The squeal 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 in this table.

3: The noise may be an internal engine noise. Remove the drive belts and operate the engine for a few seconds; this will verify if the squealing noise is related to the drive belts or an accessory drive component. With the drive belts removed, the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4: This test is to verify that an accessory drive component does not have a seized bearing. With the belts removed, test the bearings in the accessory drive components for smooth operation. Also, test the accessory drive components with the engine operating by varying the load on the accessory drive components to verify that the components are operating correctly.

5: This test is to verify that the drive belt tensioners are operating correctly. If the drive belt tensioners are not operating correctly, correct belt tension may not be achieved to keep the drive belt from slipping, which may cause a belt squeal noise.

6: This test is to verify that the drive belt is not too long, which May prevent the drive belt tensioners from operating correctly. Also, if an incorrect length drive belt was installed, it may not be routed correctly and may be turning an accessory drive component in the incorrect direction.

7: Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves, across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct removal and installation procedure for that pulley.

8: Inspect the accessory drive pulleys to verify that they are the correct diameter or width. Using a known good vehicle, compare the pulley sizes.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by slipping drive belts; this is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belts, such as an air conditioning (A/C) compressor engagement, snapping the throttle, or slipping on a seized pulley, or a faulty accessory drive component.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Verify that there is a squealing noise. Does the engine make the squealing noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Operate the engine for no longer than 30 - 40 seconds. Does the squealing noise still exist?	Go to **Engine Noise on Start-Up, but Only Lasting a Few Seconds** or **Upper Engine Noise, Regardless of Engine Speed** or **Lower Engine Noise, Regardless of Engine Speed**.	Go to **Step 4**
4	Inspect for a seized accessory drive component bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to **Step 9**	Go to **Step 5**
5	Inspect the drive belt tensioner for correct operation. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and correct the condition?	Go to **Step 9**	Go to **Step 6**
6	Check the drive belt is the correct length. Did you find and correct the condition?	Go to **Step 9**	Go to **Step 7**
7	Inspect for a misaligned pulleys. Did you find and correct the condition?	Go to **Step 9**	Go to **Step 8**
8	Inspect for an incorrect size pulley. Did you find and correct the condition?	Go to **Step 9**	-
9	1. Install the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Clear any codes. 3. Run the engine in order to verify the repair. Does the squealing noise still exist?	-	System OK

Drive Belt Whine Diagnosis

Diagnostic Aids

The drive belts will not cause the whine. If the whine is intermittent, verify that it is not the accessory drive components by varying their loads, making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction, or the incorrect fluid, or a failing alternator are suggested items to inspect.

Test Description

The numbers below refer to the steps in the diagnostic table.

3: This test is to verify that the whine is being caused by the accessory drive components. Remove the drive belts and operate the engine for a few seconds, this will verify if the whining noise is related to the accessory drive component. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4: The inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belts may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the correct removal and installation procedure.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Verify that there is a whining noise. Does the engine make the whining noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Operate the engine for no longer than 30 - 40 seconds. Does the whining noise still exist?	Go to **Engine Noise on Start-Up, but Only Lasting a Few Seconds** or **Upper Engine Noise, Regardless of Engine Speed** or **Lower Engine Noise, Regardless of Engine Speed**.	Go to **Step 4**
	1. Inspect for a failed accessory drive component bearing.		

4	2. Install the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Did you find and correct the condition?	Go to **Step 5**	-
5	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the whining still exist?	-	System OK

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Drive Belt Rumbling Diagnosis

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to produce a rumbling noise.

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

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

Test Description

The numbers below refer to the steps in 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 the drive belts are causing the rumbling. Rumbling 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. Operate the engine for a few seconds, this will verify if the rumbling noise is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

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

5: Small amounts of pilling is a normal condition and acceptable. When the pilling is extreme the drive belts does not have a smooth surface for correct operation.

Step	Action	Yes	No

CAUTION:
Refer to Belt Dressing Caution .

DEFINITION:

- A low pitch tapping, knocking, or thumping noise heard at or just above idle.
- Heard once per revolution of the drive belts or pulleys.
- Rumbling may be caused from:
  - Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belts pulley groove.
  - The separation of the drive belts.
  - A damaged drive belt.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Operate the engine for no longer than 30 - 40 seconds. Does the rumbling noise still exist?	Go to **Engine Noise on Start-Up, but Only Lasting a Few Seconds** or **Upper Engine Noise, Regardless of Engine Speed** or **Lower Engine Noise, Regardless of Engine Speed**.	Go to **Step 4**
4	Inspect the drive belts for damage, separation, or sections of missing ribs. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Were any of these conditions found?	Go to **Step 7**	Go to **Step 5**
5	Inspect for extreme pilling of more than 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to **Step 6**	Go to **Step 7**
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Install the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Did you complete the repair?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning**		

	Compressor Belt Replacement . Did you complete the replacement?	Go to **Step 8**	-
8	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the rumbling noise still exist?	-	System OK

Drive Belt Vibration Diagnosis

Diagnostic Aids

The accessory drive components may have an affect on engine vibration. An overcharged air conditioning (A/C) system, a power steering system restriction, or the incorrect fluid, or an extra load placed on the alternator are suggested items to inspect. To help identify an intermittent or an incorrect condition, vary the loads on the accessory drive components.

Test Description

The numbers below refer to the steps in the diagnostic table.

2: This test is to verify that the vibration is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system or the drivetrain.

3: This test is to verify that the drive belts or accessory drive components may be causing the vibration. Remove the drive belts and operate the engine for a few seconds, this will verify if the vibration is related to the drive belts or not. With the drive belts removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belts removed.

4: The drive belts may cause a vibration. While the drive belts are removed this is the best time to inspect the condition of the drive belts.

6: Inspection of the fasteners can address the possibility that a incorrect bolt, nut, spacer, or washer was installed.

9: Inspect the water pump drive shaft for being bent. Also inspect the water pump bearings for smooth operation and above acceptable play. Compare the water pump with a known, good water pump.

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

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** 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 Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . 2. Operate the engine for no longer than 30 - 40 seconds. Does the engine still make the vibration?	Go to **Drive Belt Rumbling and Vibration Diagnosis**.	Go to **Step 4**
4	Inspect the drive belts for wear, damage, debris build-up and missing drive belt ribs. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Were any of these conditions found?	Go to **Step 5**	Go to **Step 6**
5	Install new drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Did you complete the replacement?	Go to **Step 11**	-
6	Inspect for incorrect, loose or missing fasteners. Were any of these conditions found?	Go to **Step 7**	Go to **Step 8**
7	1. Replace the incorrect or missing fasteners. 2. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (L76)** or **Fastener Tightening Specifications (6.2L LS3)**. Were the fasteners replaced and/or tightened?	Go to **Step 11**	-
8	Inspect for a bent water pump drive shaft. Refer to **Water Pump Cleaning and Inspection** . Did you find and correct the condition?	Go to **Step 11**	Go to **Step 9**
9	Inspect for a bent or cracked accessory drive brackets. Did you find and correct the condition?	Go to **Step 10**	-
10	Replace the bent and/or cracked accessory drive brackets. Refer to **Air Conditioning Compressor Bracket Replacement** . Refer to **Generator Bracket Replacement (3.6L)** or **Generator Bracket Replacement (6.0L)** . Was the bent and/or cracked accessory drive brackets replaced?	Go to **Step 11**	-
11	1. Clear any codes. 2. Run the engine in order to verify the repair.		

	Does the vibration still exist?	-	System OK

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Drive Belt Falls Off Diagnosis

Diagnostic Aids

If the drive belts repeatedly fall off the accessory drive pulleys, this may be caused by pulley misalignment.

If the drive belts repeatedly fall off the accessory drive pulleys, this may be caused by pulley misalignment.

If the drive belts are the incorrect length, the drive belt tensioners may not maintain the correct tension on the drive belts.

Test Description

The numbers below refer to the steps in the diagnostic table.

> **2:** This inspection is to verify the condition of the drive belts. Damage may have occurred to the drive belts when the drive belts fell off the pulley. Inspect the drive belts for cuts, tears, sections of ribs missing, or damaged belt plies.
>
> **4:** Misalignment of the accessory drive pulleys may be caused from incorrect mounting or incorrect installation of an accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found, refer to that accessory drive component for the correct removal and installation procedure of that pulley.
>
> **5:** Inspection of the accessory drive pulleys should include inspecting for bends, dents or other damage that May prevent the drive belt from seating correctly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belts are used to drive the pulley.
>
> **6:** Accessory drive component brackets that are bent or cracked will also cause the drive belts to fall off.
>
> **7:** Inspection of the fasteners can address the possibility that an incorrect bolt, nut, spacer, or washer was installed. Missing, loose, or incorrect fasteners may cause pulley misalignment from the accessory drive brackets moving under load. Over tightening the fasteners may cause misalignment of the accessory component brackets.

Step	Action	Yes	No
CAUTION: Refer to **Belt Dressing Caution** . DEFINITION: The drive belts fall off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
	Inspect the drive belts for wear, damage, debris build-		

2	up and missing drive belt ribs. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Was a damaged drive belt found?	Go to **Step 3**	Go to **Step 4**
3	Install new drive belts. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Do the drive belts continue to fall off?	Go to **Step 4**	System OK
4	Inspect for misaligned drive pulleys. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 5**
5	Inspect for a bent or dented accessory drive pulley. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 6**
6	Inspect for a bent or a cracked accessory drive bracket. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 7**
7	Inspect for incorrect, loose or missing fasteners. Were there any incorrect, loose and/or missing fasteners?	Go to **Step 8**	Go to **Step 9**
8	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (L76)** or **Fastener Tightening Specifications (6.2L LS3)**. Does the drive belt continue to fall off?	Go to **Step 9**	System OK
9	Inspect the drive belt tensioner for correct operation. 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 - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** . Does the drive belt continue to fall off?	Go to **Step 11**	System OK
11	Inspect for a failed drive belt idler and drive belt tensioner pulley bearing. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and repair the condition?	Go to **Step 12**	-
12	Run the engine in order to verify the repair. Does the drive belt still fall off?	-	System OK

Drive Belt Excessive Wear Diagnosis

Diagnostic Aids

Above acceptable wear on a drive belt is usually caused by incorrect installation or the wrong drive belts for the application.

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

Major misalignment of the drive belt pulleys will cause above acceptable wear and may also make the drive belts fall off the pulleys.

Test Description

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

2: The inspection is to verify that the drive belts are correctly installed over all of the drive belt pulleys. Wear on the drive belts may be caused by misalignment the drive belts by one groove on a pulley.

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

4: This inspection is to verify the drive belts 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 belts should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: Wear at the outside ribs of the drive belts due to an incorrectly installed drive belts			
1	Did you review the Symptoms - Engine Mechanical diagnostic information and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**.
2	Inspect the drive belts for the correct installation. **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Did you find this condition?	Go to **Step 5**	Go to **Step 3**
3	Inspect for the correct drive belt. Did you find this condition?	Go to **Step 5**	Go to **Step 4**
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to **Step 6**	Go to Diagnostic Aids
5	Replace the drive belt. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** . Did you complete the replacement?	Go to **Step 6**	-
6	Run the engine in order to verify the repair. Is there still above acceptable drive belt wear?	-	System OK

DRIVE BELT TENSIONER DIAGNOSIS

NOTE: Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

IMPORTANT: When the engine is operating, the belt tensioner arm will move. Do not replace the belt tensioner because of movement in the belt tensioner arm.

1. Remove the drive belt. Refer to **Drive Belt Replacement - Accessory** or **Air Conditioning Compressor Belt Replacement** .
2. Position a hex-head socket on the belt tensioner pulley bolt.
3. Move the belt tensioner through its full travel.
    - The movement should feel smooth.
    - There should be no binding.
    - The belt tensioner should return freely.
4. If any binding is observed, replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** .
5. Install the drive belt. Refer to **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Tensioner Replacement - Air Conditioning** .

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

A closed crankcase ventilation system is used in order to provide a more complete scavenging of the crankcase vapors. 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 intake manifold.

The primary control is through the crankcase ventilation valve which meters the flow at a rate depending on manifold vacuum. To maintain idle quality, the crankcase ventilation valve restricts the flow when intake manifold 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 tube into the engine air inlet to be consumed by normal combustion.

Filtered fresh air is routed from up-stream of the throttle blade to the front of the right rocker arm cover via a formed rubber hose. To reduce the potential of oil pullover into the throttle bore area due to back flow of the ventilation system, the fitting in the right rocker arm cover is shielded from the rocker arms. From there fresh air and gases are routed through the crankcase and up to the opposite rocker arm cover where the positive crankcase ventilation (PCV) valve is located. Gases are then routed through a hose to the intake manifold.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets

- The accessory drive components
  - The power steering pump
  - The alternator
  - The A/C compressor
  - The 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. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plies containing either fibre 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 (L76)

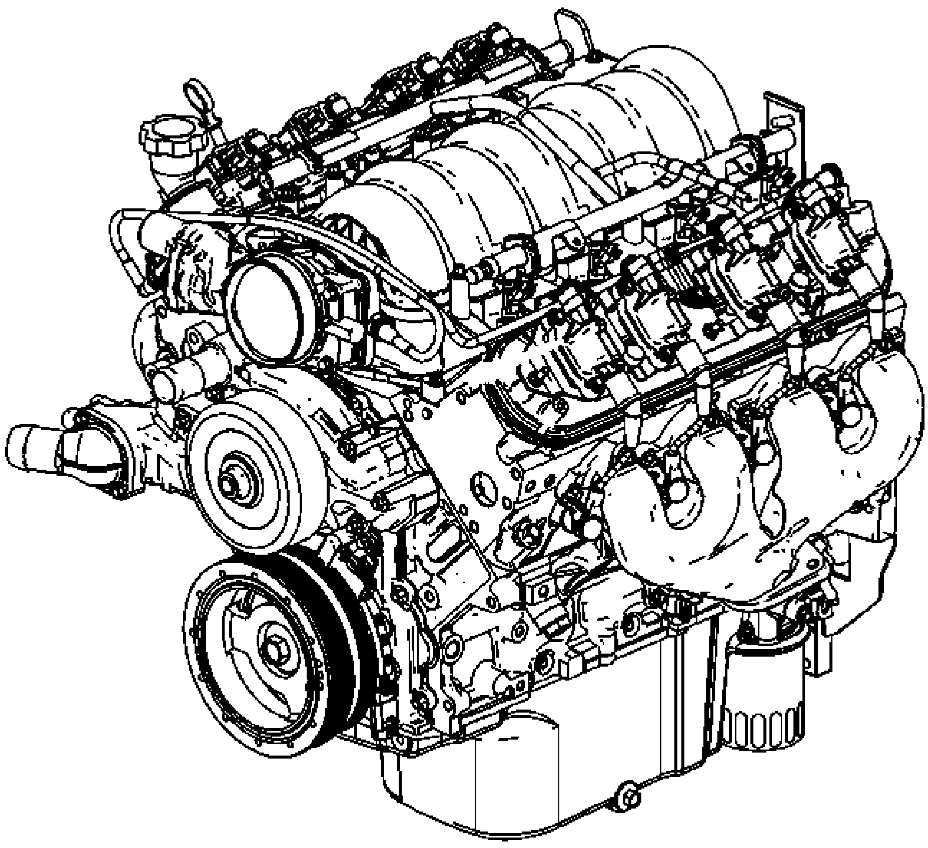


Fig. 33: The 6.0 Liter V8 Engine
Courtesy of GENERAL MOTORS CORP.

The 6.0 liter V8 engine is identified as RPO L76 VIN Y.

Camshaft and Drive System

A billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket, with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps, which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit, mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, drain plug opening, baffle, oil level sensor, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. The active fuel management oil pressure relief valve is also internal to the oil pan. Alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover are the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft, through the hydraulic roller valve lifters and tubular pushrods, to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. The inlet rocker arms are offset 6 mm (0.24 in) to enable more direct intake flow. Valve lash is net build. Cylinders 1, 4, 6, and 7 are Active Fuel Management. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

ENGINE COMPONENT DESCRIPTION (6.2L LS3)

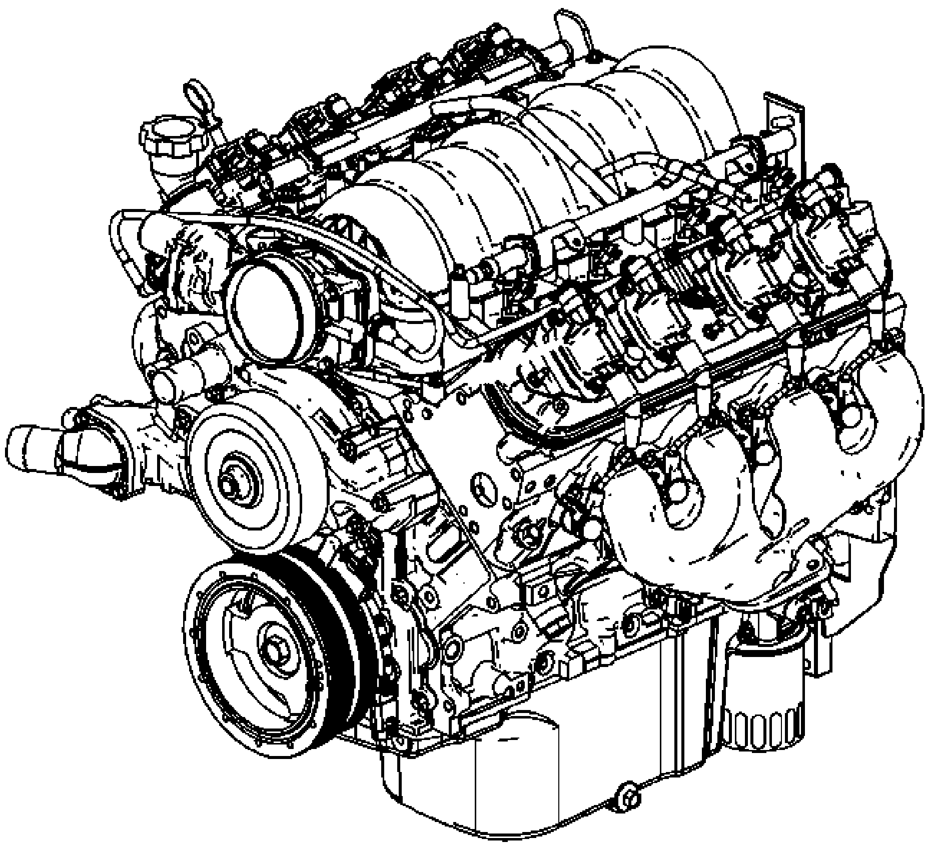


Fig. 34: The 6.2 Liter V8 Engine

Courtesy of GENERAL MOTORS CORP.

The 6.2 Liter V8 engine is identified as RPO LS3 VIN W.

Camshaft and Drive System

A hollow billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts. High-flow cylinder heads, with modified intake and exhaust ports, are used to increase flow.

Engine Block

The new larger bore engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, drain plug opening, baffle, oil level sensor, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. The active fuel management oil pressure relief valve is also internal to the oil pan. Alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The new larger diameter pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover are the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. The inlet rocker arms are offset 6 mm (0.24 in) to enable more direct intake flow. Valve lash is net build.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION

System Operation

General Motors Active Fuel Management engine control system has the ability, under certain light load driving conditions, to provide maximum fuel economy by deactivating 4 of the engines 8 cylinders. The engine will normally operate on 8 cylinders in V8 mode during starting, idling, and medium or heavy throttle conditions. When commanded ON, the engine control module (ECM) will direct the active fuel management system and deactivate cylinders 1 and 7 on the left bank and cylinders 4 and 6 on the right bank, forcing V4 mode. Refer to **Lubrication Description (L76)** or **Lubrication Description (6.2L LS3)** and Cylinder Deactivation (Active Fuel Management) System Description in Engine Controls.

Valve Lifter Oil Manifold Assembly

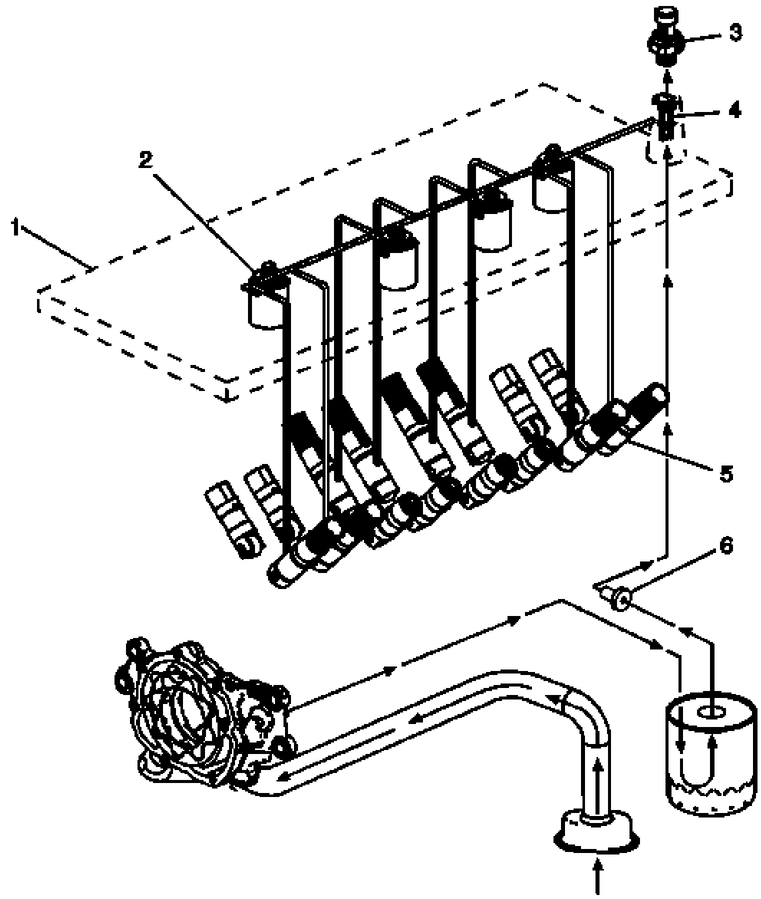


Fig. 35: View Of Engine Oil Flow
Courtesy of GENERAL MOTORS CORP.

The valve lifter oil manifold assembly (1) is bolted to the top of the engine block beneath the intake manifold assembly. The oil manifold consists of 4 electrically operated and normally-closed solenoids (2). Each solenoid directs the flow of pressurized engine oil to the active fuel management intake and exhaust valve lifters (5). The active fuel management oil pressure relief valve (6), located in the oil pan, regulates engine oil pressure to the lubrication system and the oil manifold.

When enabling conditions are met for active fuel management operation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the windings energized, the solenoid valves open and direct pressurized engine oil through the valve lifter oil manifold into 8 vertical passages in the engine block lifter valley. The 8 vertical passages, 2 per cylinder, direct pressurized oil to the valve lifter bores of the cylinders to be deactivated. When vehicle operating conditions require a return to V8 mode, the ECM will turn OFF the ground circuit for the solenoids, allowing the solenoid valves to close. When the solenoid valves are closed, remaining oil pressure is exhausted through the bleed passages of the valve lifter oil manifold into the engine block lifter valley. The housing of the oil manifold incorporates several oil bleed passages that continually purge trapped air from the manifold and engine block.

To help control contamination within the active fuel management hydraulic system, a small replaceable oil filter (4) is located in the valve lifter oil manifold oil inlet passage. The oil pressure sensor (3) monitors engine oil pressure and provides information to the ECM.

Active Fuel Management Valve Lifters

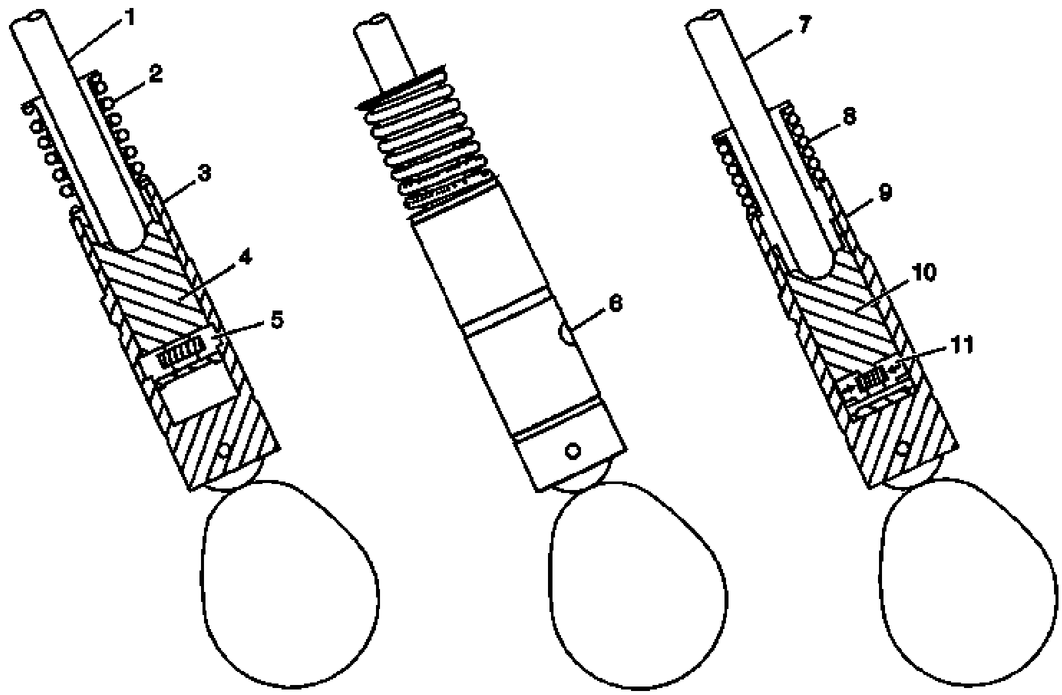


Fig. 36: Displacement On Demand Valve Lifters
Courtesy of GENERAL MOTORS CORP.

When operating in V8 mode, the active fuel management valve lifters function similar to the non-active fuel management valve lifters. The active fuel management oil manifold solenoids are in the closed position, with no pressurized oil directed to the valve lifters. The pushrod (1) travels upward and downward to actuate the rocker arm and valve. The spring loaded locking pins (5) of the lifter are extended outward and mechanically lock the pin housing (4) to the outer body of the valve lifter (3).

When the active fuel management system is commanded ON, the ECM will direct the solenoids of the oil manifold to open and direct pressurized oil to the valve lifters. Oil travels through the valve lifter oil manifold and engine block oil galleries and enters the inlet port (6) of the valve lifter.

When operating in V4 mode, pressurized oil forces the locking pins (11) inward. The pushrod (7) remains in a constant position and does not travel upward and downward. The outer body of the lifter (9) moves upward and downward independently from the pin housing (10). The valve lifter spring (8) retains tension on the valve train components to eliminate valve train noise.

When the active fuel management system is commanded OFF, the ECM directs the solenoids of the oil manifold to close, stopping the flow of pressurized oil to the valve lifters. The oil pressure within the lifter will decrease and the locking pins will move outward to mechanically lock the pin housing and outer body.

Engine Block

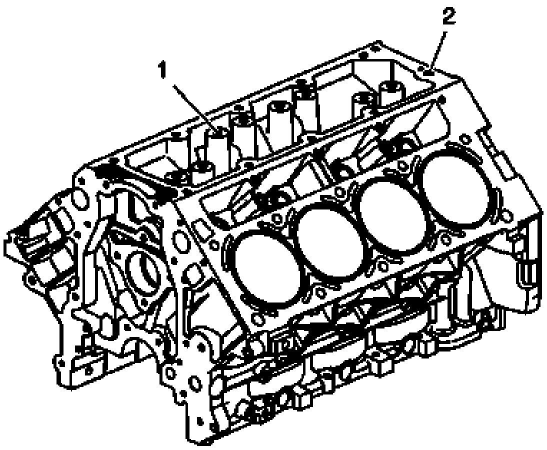


Fig. 37: DOD Engine Block
Courtesy of GENERAL MOTORS CORP.

The active fuel management engine block incorporates additional features to support active fuel management system operation. Engine oil pressure is routed to the valve lifter oil manifold assembly from an oil gallery (2) in the rear of the cylinder block. Cylinders 1, 4, 6, and 7 each have 2 vertical, cast-in-block oil passages (1). The vertical oil passages permit oil flow from the manifold assembly to the valve lifter bores.

Engine Control Module (ECM)

Refer to Cylinder Deactivation (Active Fuel Management) System Description in Engine Controls.

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 1 or more of the following items:

- 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
- A component comparison from the previous year

Changed Engine Specifications

- Engine specifications for the L76 application have been added.

- Engine specifications for the LS3 application have been added.

Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (L76)**.

Torque Values and/or Fastener Tightening Strategies

- Fastener tightening specifications for the L76 application have been added.
- Fastener tightening specifications for the LS3 application have been added.

Refer to **Fastener Tightening Specifications (L76)** or **Fastener Tightening Specifications (6.2L LS3)**.

New Sealants and/or Adhesives

Sealers and adhesives, as required, are identified within the specific service procedures. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

Disassembly and Assembly Procedure Revisions

A variety of new procedures have been added for the L76 and LS3 applications.

Engine Mechanical Diagnostic Procedure Revisions

Diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Diagnostic Starting Point - Engine Mechanical**.

New Special Tools Required

A variety of new tools are required for servicing the L76 and LS3 applications. Refer to **Special Tools**.

A Component Comparison from the Previous Year

- The 6.0L RPO L76 engine has been added
- The 6.2L RPO LS3 engine has been added

LUBRICATION DESCRIPTION (L76)

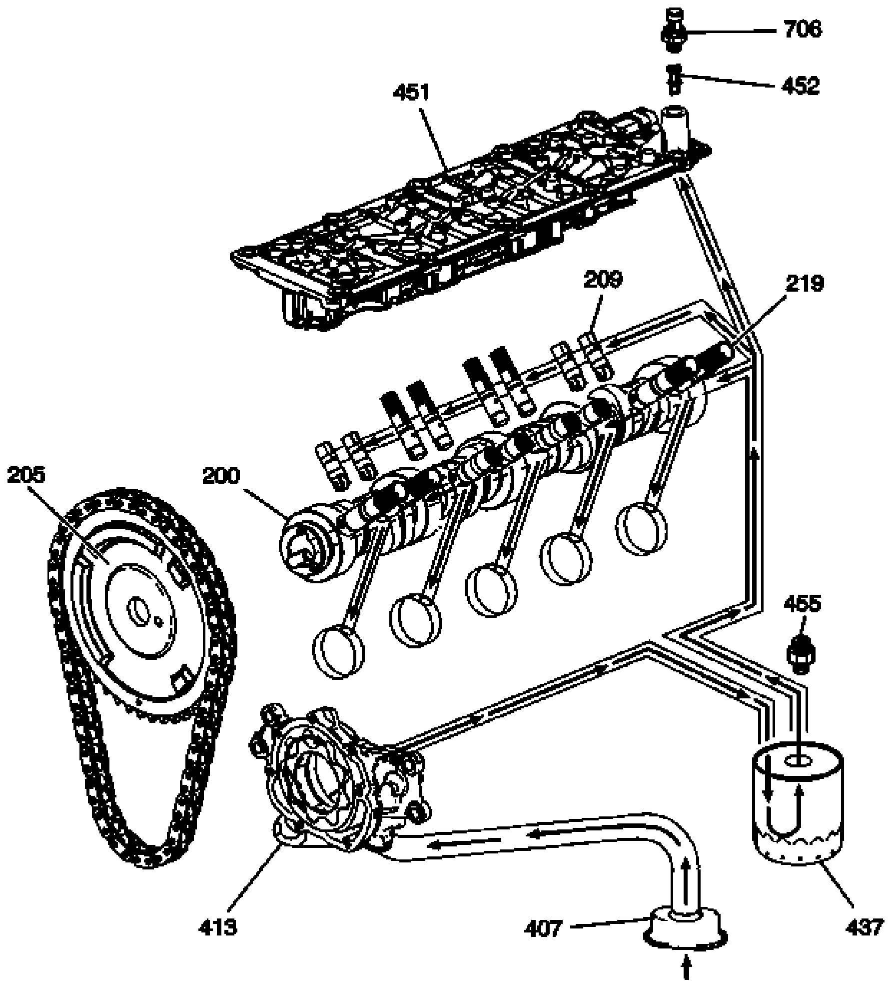


Fig. 38: View Of Lubrication System Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
200	Camshaft
205	Camshaft Sprocket
209	Valve Lifter - Non-Active Fuel Management
219	Valve Lifter - Active Fuel Management
407	Oil Pump Screen
413	Oil Pump
437	Oil Filter
451	Valve Lifter Oil Manifold
452	Valve Lifter Oil Filter
455	Active Fuel Management Oil Pressure Relief Valve
706	Oil Pressure Sensor

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the engine control module (ECM) commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION (6.2L LS3)

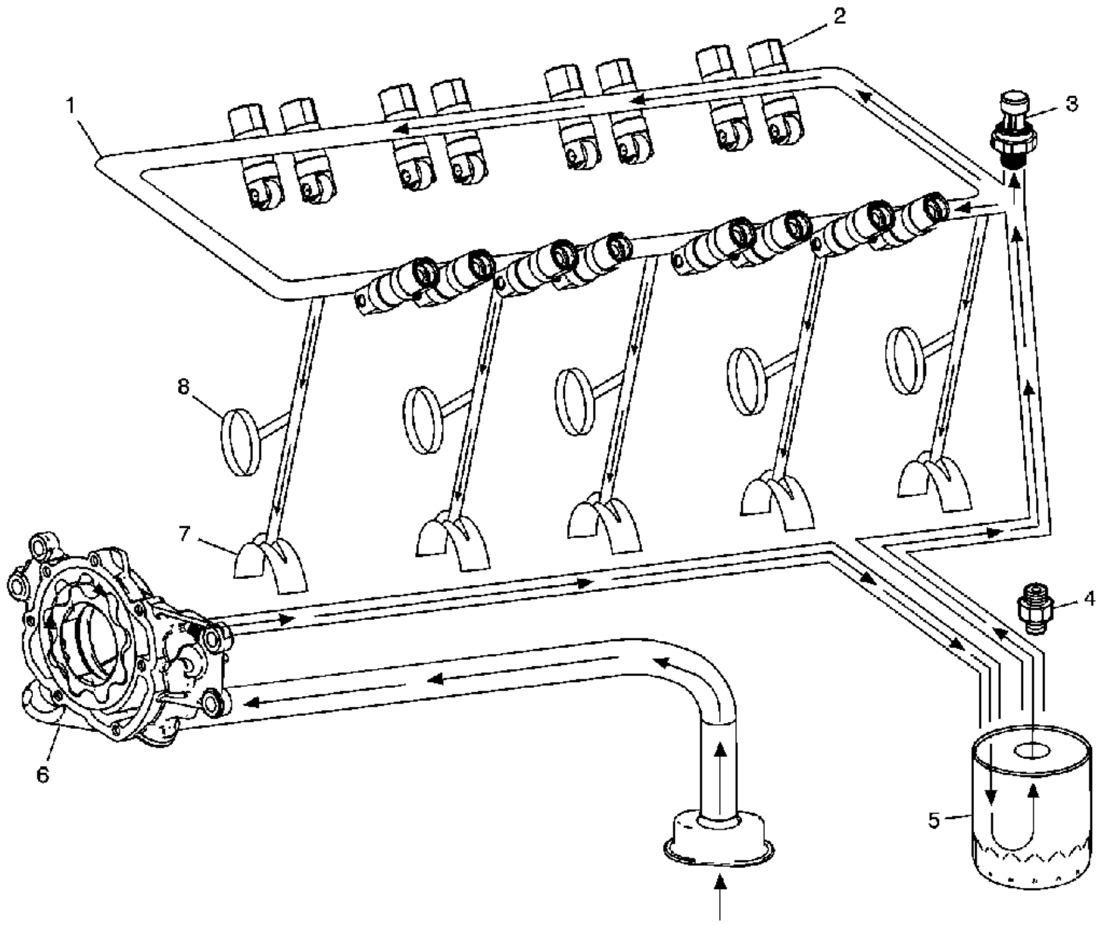


Fig. 39: View Of Lubrication System
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Upper Main Oil Galleries
2	Valve Lifters
3	Oil Pressure Sensor
4	Active Fuel Management Oil Pressure Relief Valve
5	Oil Filter
6	Oil Pump Assembly
7	Crankshaft Bearings
8	Camshaft Bearings

Engine lubrication is supplied by a gerotor type oil pump assembly (6). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (5) where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve (4), is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil into the sump.

Oil is then directed from the filter to the upper main oil galleries (1). Oil from the left upper oil gallery is directed to the crankshaft bearings (7) and camshaft bearings (8). Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies (2) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (3) is located at the top rear of the engine.

LUBRICATION DESCRIPTION - MAIN PRESSURE BELOW 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OFF

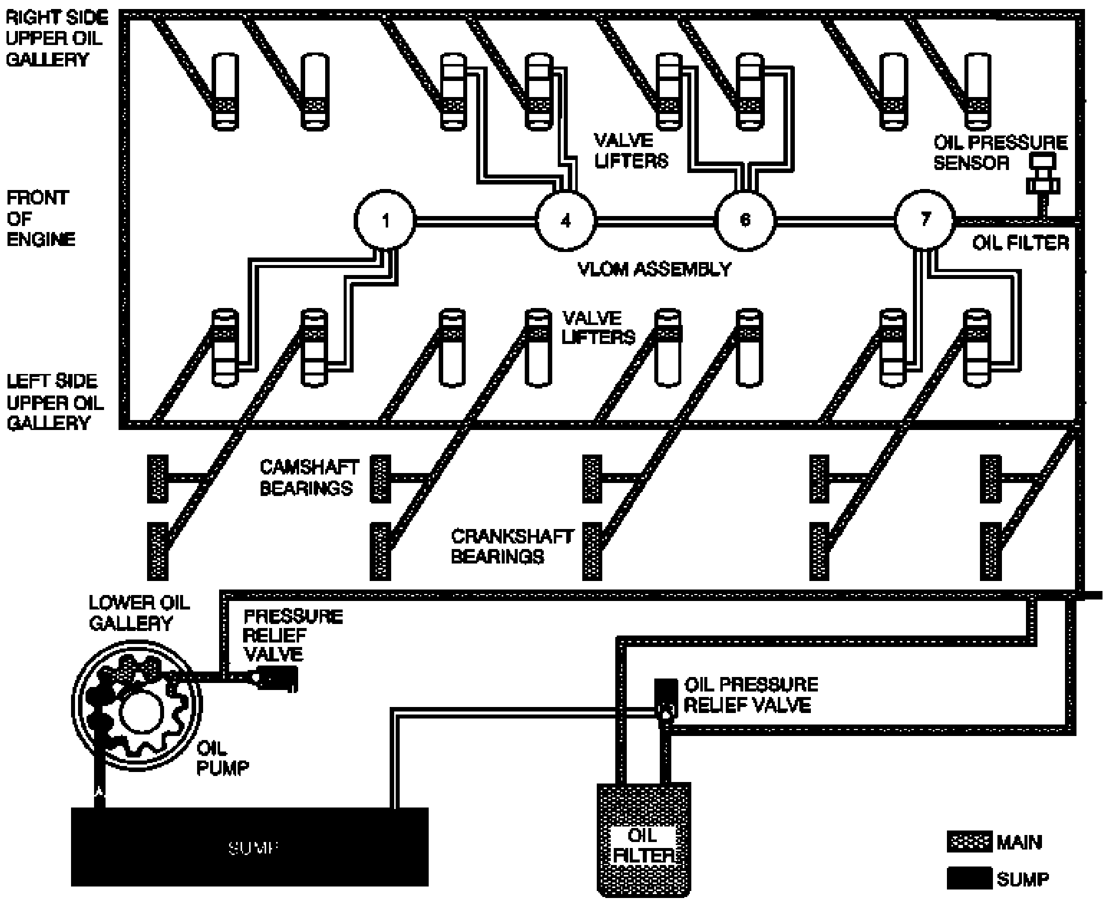


Fig. 40: Lubrication Schematic Below 55 psi (RPO LH6/LMG/LY5/LC9)
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and oil manifold assembly to 379-517 kPa (55-75 psi) maximum.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE ABOVE 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OFF

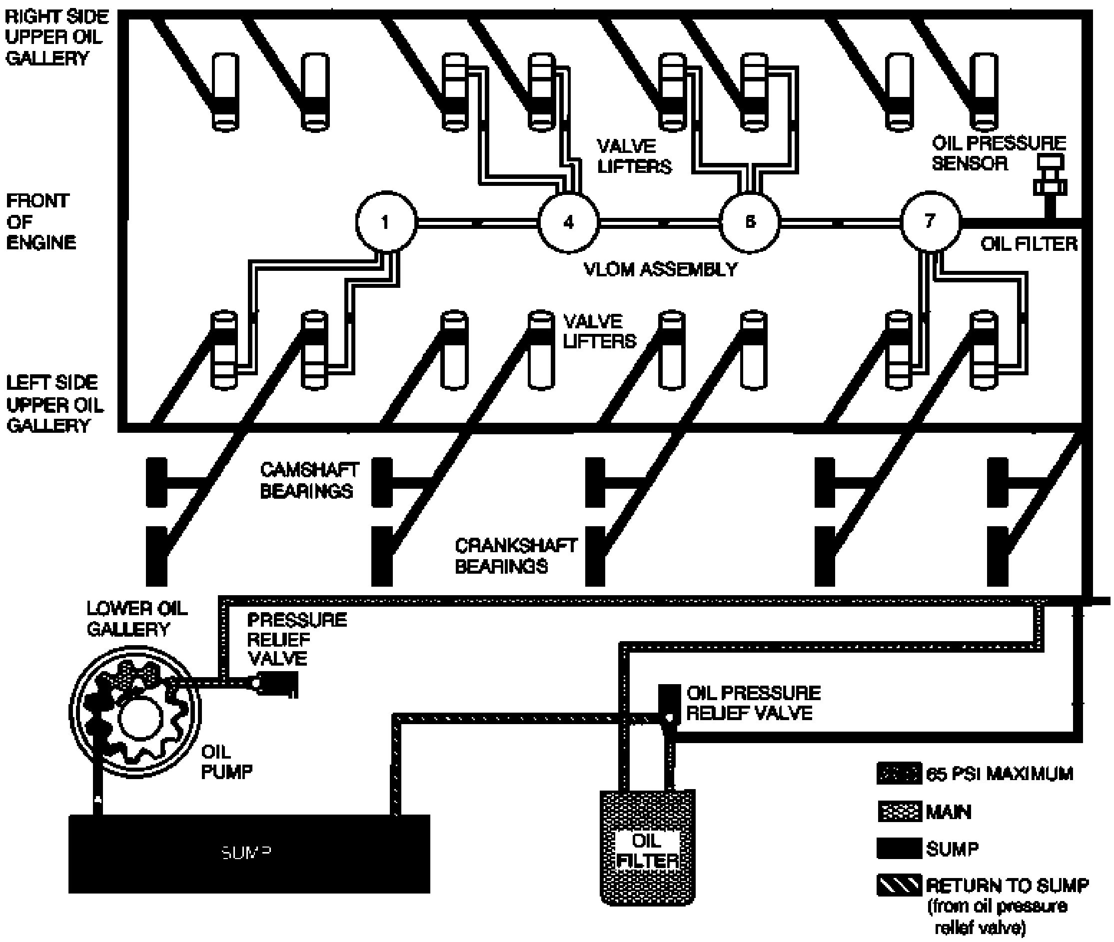


Fig. 41: Lubrication Schematic Above 55 psi (RPO LH6/LMG/LY5/LC9)
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE BELOW 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) ON

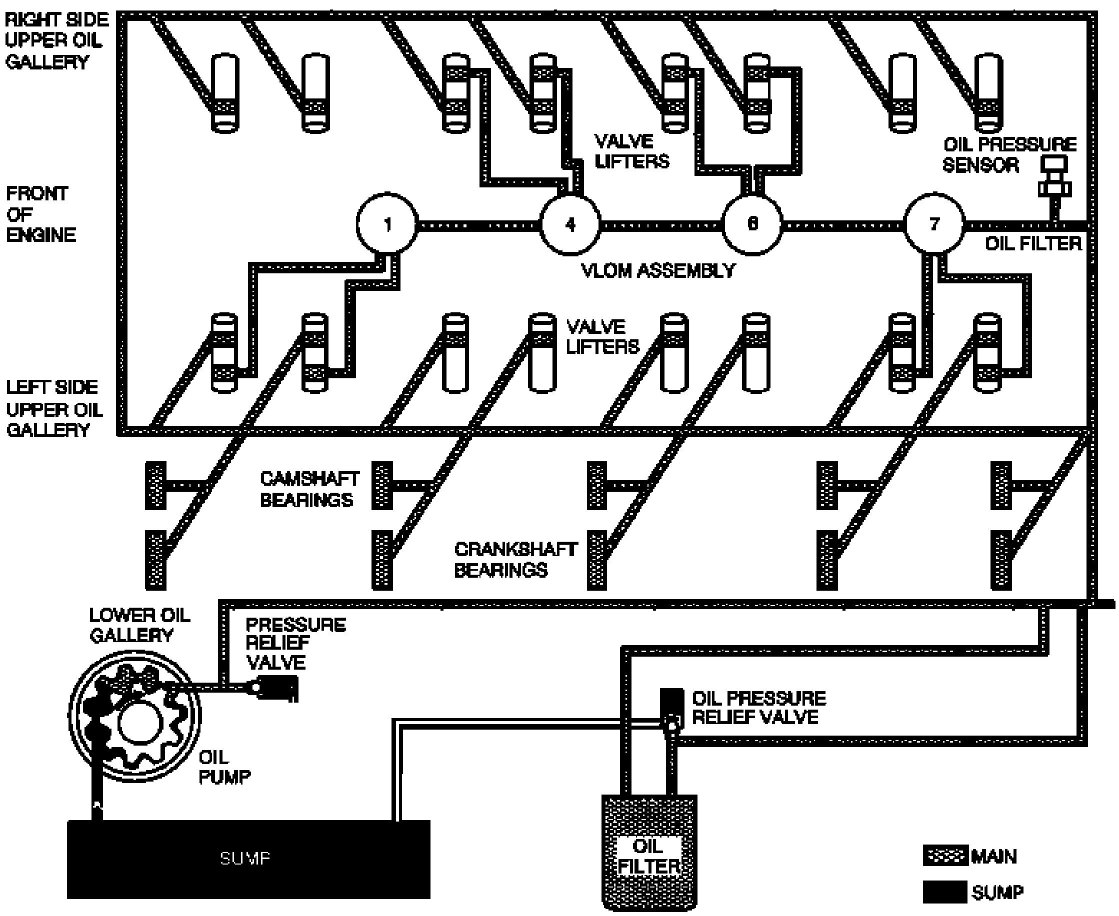


Fig. 42: Lubrication Schematic Below 55 psi (RPO LH6/LMG/LY5/LC9)
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and oil manifold assembly to 379-517 kPa (55-75 psi) maximum.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the engine control module (ECM) commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE ABOVE 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) ON

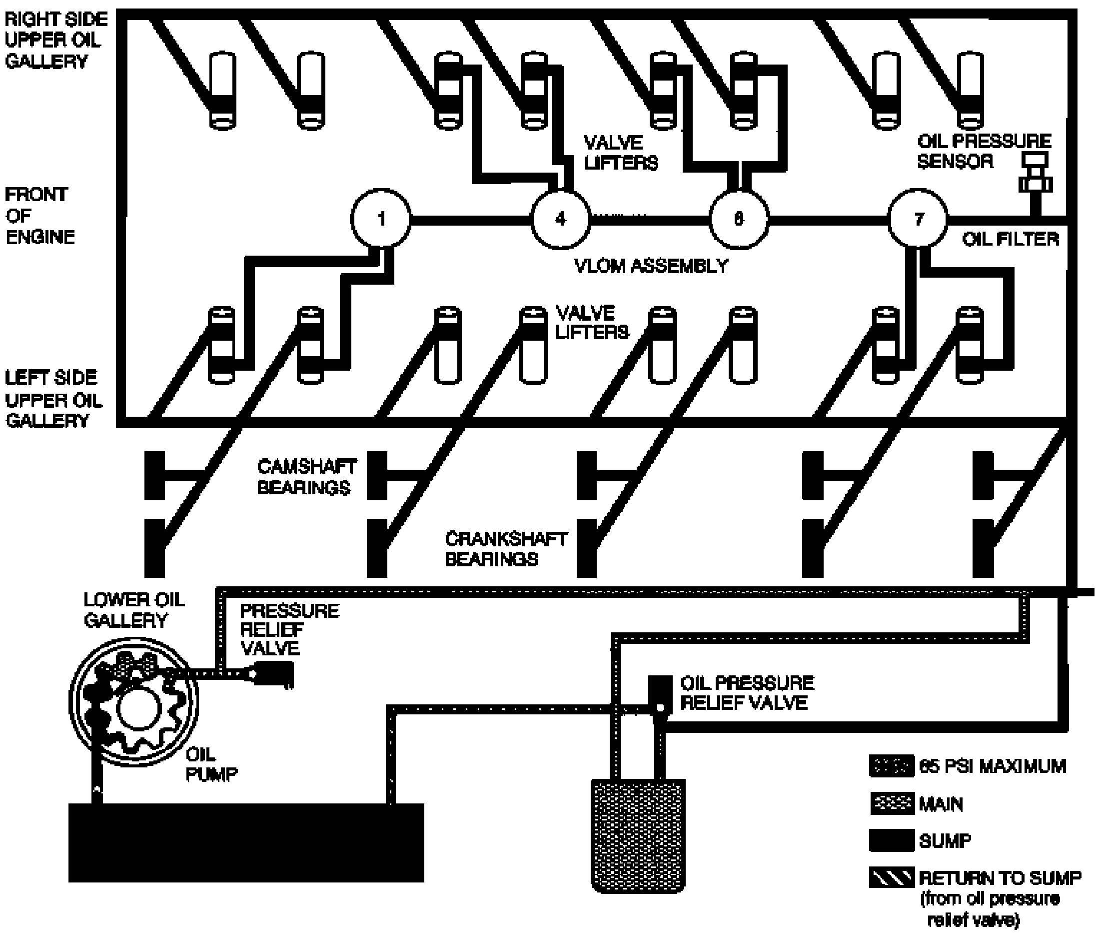


Fig. 43: Lubrication Schematic Above 55 psi (RPO LH6/LMG/LY5/LC9)
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery and through the oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the engine control module (ECM) commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

CLEANLINESS AND CARE

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice, even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to **Separating Parts**.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

SEPARATING PARTS

IMPORTANT:

- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

  A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

J 28410: Gasket Remover

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

Gasket Use and Applying Sealants

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **J 28410:** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.

- These methods of cleaning can cause damage to the component sealing surfaces.
- Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
- This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

CAUTION: Refer to Sealant Caution .

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Pipe Joint Compound

NOTE: 3 types of sealer are commonly used in engines. These are room temperature vulcanizing (RTV) sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include the exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

CAUTION: Refer to Sealant Caution .

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

RTV Sealer

- RTV sealant hardens when exposed to air. This type of sealer is used where 2 non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include the exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

CAUTION: Refer to Sealant Caution .

- Apply RTV sealant to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while the RTV sealant is still wet, within 3 minutes. Do not wait for the RTV sealant to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- 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 two rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

  To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply a continuous bead of gasket eliminator to 1 flange. Surfaces to be sealed must be clean and dry.

CAUTION: Refer to Sealant Caution .

- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

NOTE: 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.

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section.

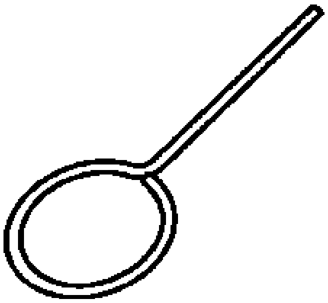
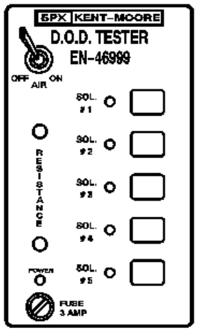
These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

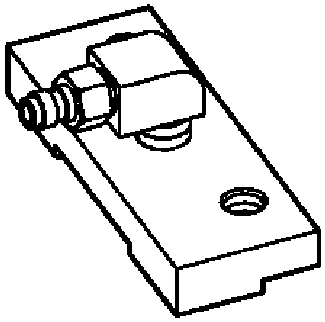
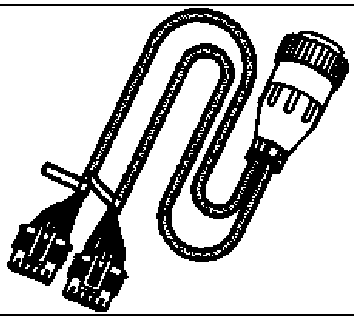
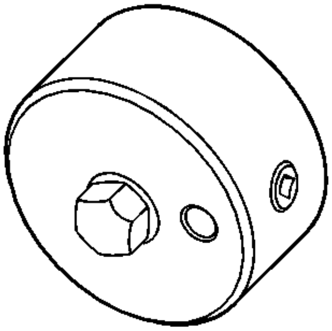
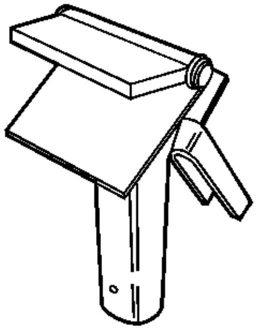
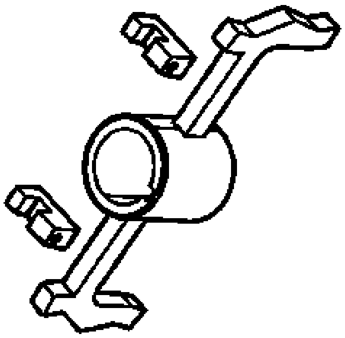
To properly service the engine assembly, the following items should be readily available:

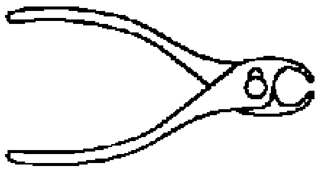
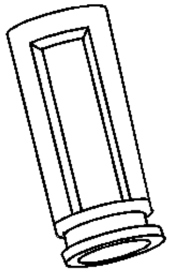
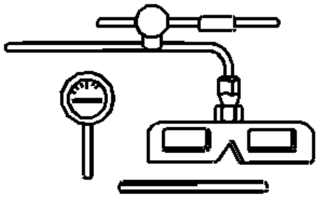
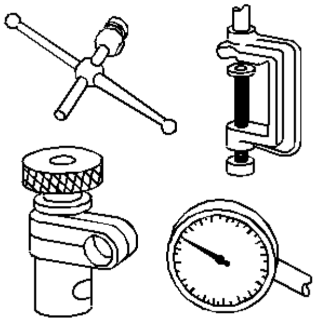
- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

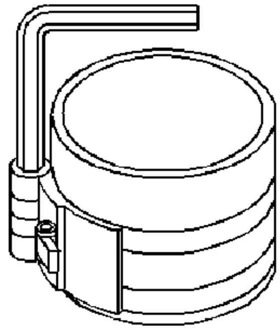
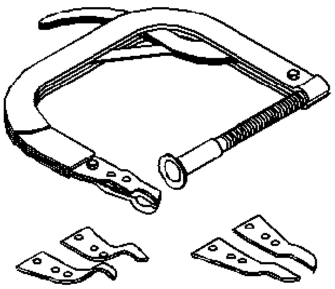
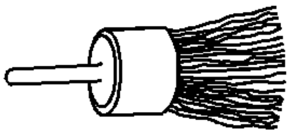
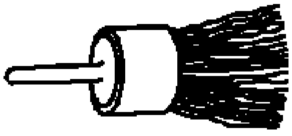
SPECIAL TOOLS AND EQUIPMENT

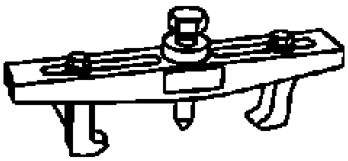
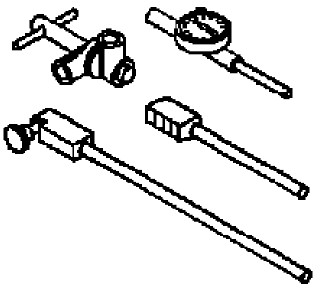
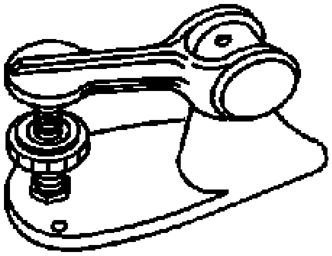
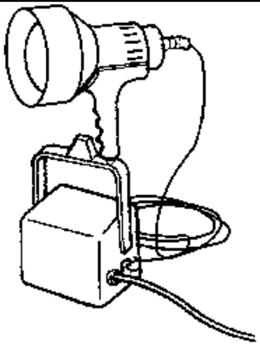
SPECIAL TOOLS

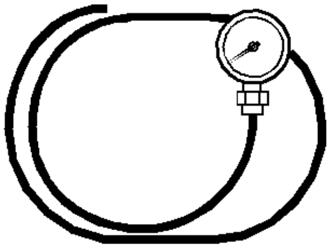
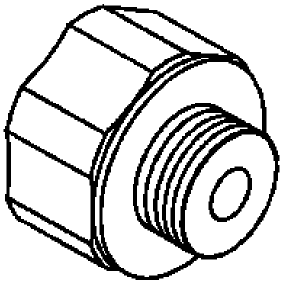
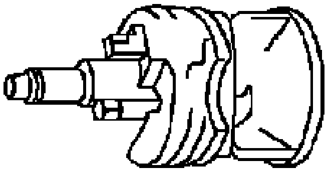
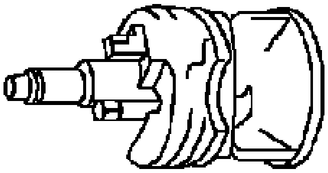
Illustration	Tool Number/Description
	EN-46330 Timing Belt Tensioner Retaining Pin
	EN-46999 Active Fuel Management Tester
	EN-46999-1

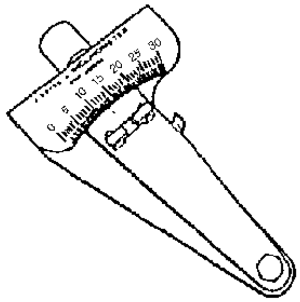
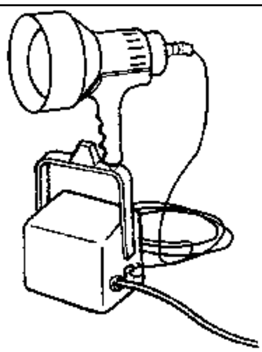
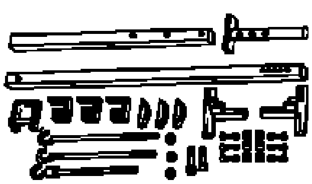
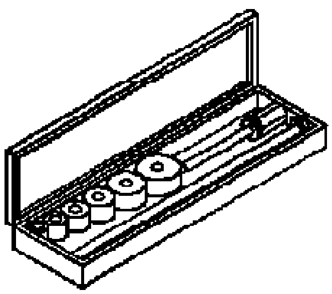
	Active Fuel Management Tester Air Adapter
	EN-46999-5 Active Fuel Management Tester Harness - Small Block V8
	EN-47971 Oil Pressure Gage Adapter
	GE-48326 Sealant Dispenser
	EN-48853 Front Cover Alignment Tool

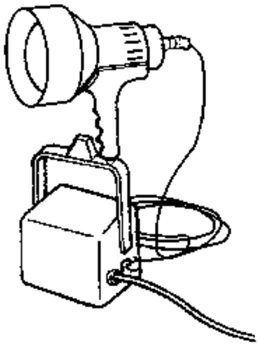
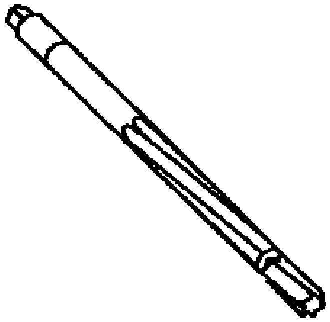
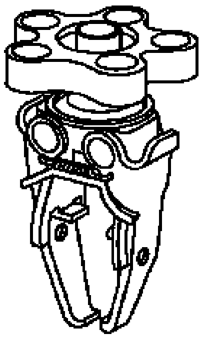
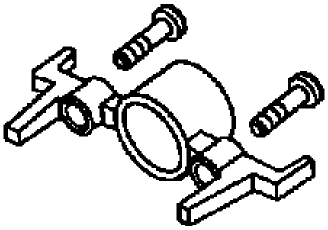
	J 3049-A Valve Lifter Remover
	J 6125-1B Slide Hammer with Adapter
	J 7872 Magnetic Base Dial Indicator Set
	J 8001 Dial Indicator Set
	J 8037 Ring Compressor

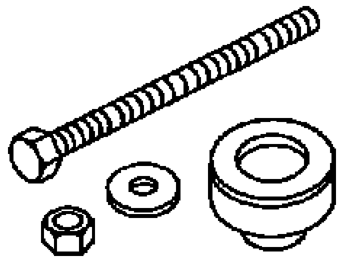
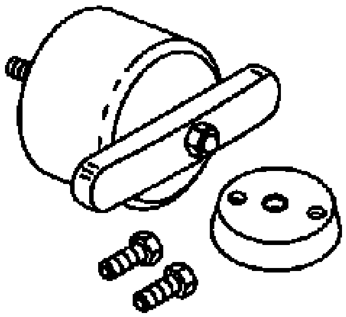
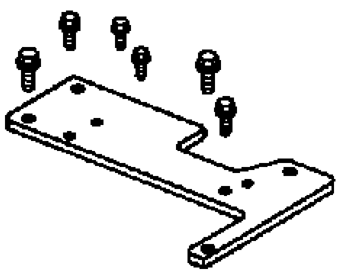
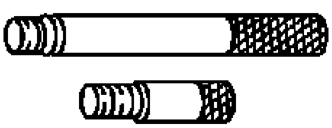
	
	J 8062 Valve Spring Compressor - Head Off
	J 8087 Cylinder Bore Gage
	J 8089 Carbon Removal Brush
	J 8433

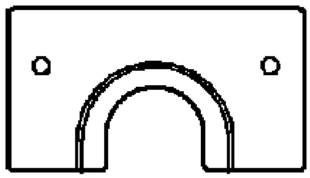
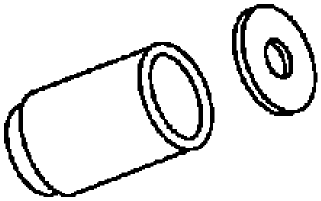
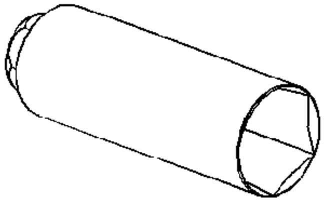
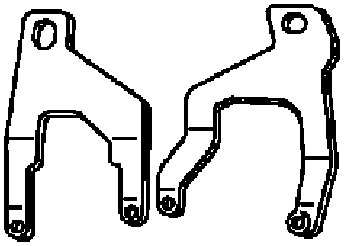
	Two Jaw Puller
	J 8520 Cam Lobe Lift Indicator
	J 9666 Valve Spring Tester
	J 21366 Converter Holding Strap
	J 21867

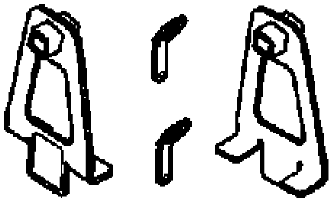
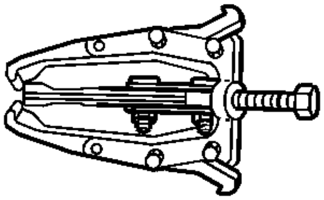
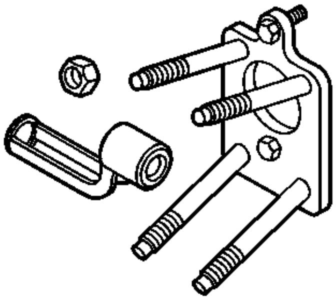
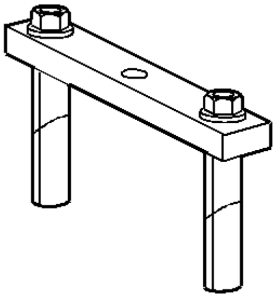
	Pressure Gage
	J-21867-16 Oil Pressure Adapter
	J 22794 Spark Plug Port Adapter
	J 24270 Cylinder Bore Ridge Reamer
	J 28410

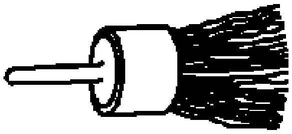
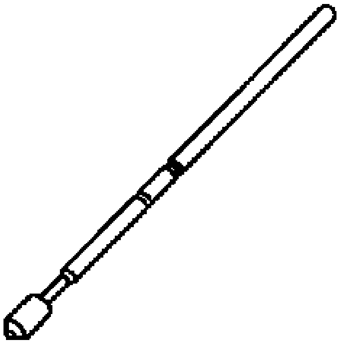
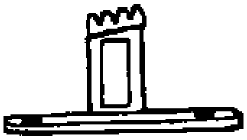
	Gasket Remover
	J 28428-E High-Intensity Black Light Kit
	J 28467-B Universal Engine Support Fixture
	J 33049 Camshaft Bearing Service Set
	J 35667-A Cylinder Head Leakdown Tester

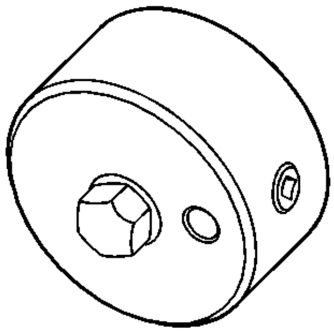
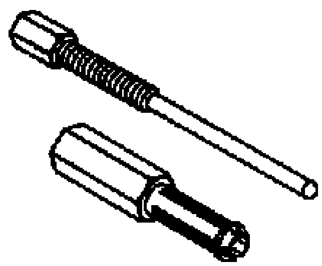
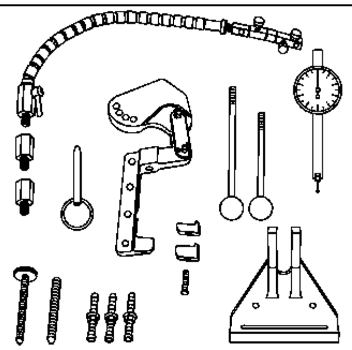
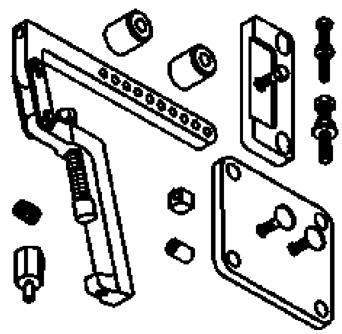
	
	J 37378-1 Valve Guide Reamer
	J 38606 Valve Spring Compressor
	J 41476 Front and Rear Cover Alignment Tool
	J 41478 Crankshaft Front Oil Seal Installer

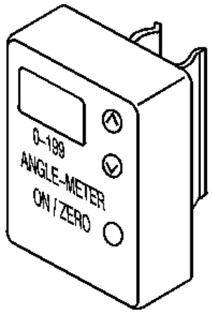
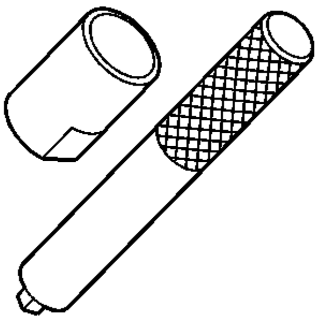
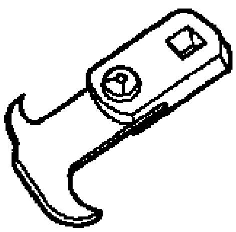
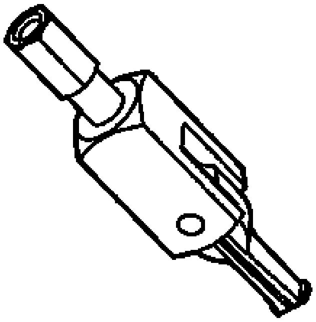
	
	J 41479 Crankshaft Rear Oil Seal Installer
	J 41480 Front and Rear Cover Alignment
	J 41556 Connecting Rod Guide
	J 41558

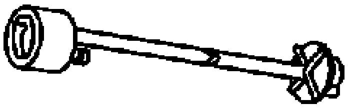
	Crankshaft Sprocket Remover
	J 41665 Crankshaft Balancer and Sprocket Installer
	J 41712 Oil Pressure Switch Socket
	J 41798 Engine Lift Bracket
	J 41803

	Engine Support Fixture
	J 41816-A Crankshaft Balancer Remover
	J 41816-2 Crankshaft End Protector
	J 41818 Crankshaft Bearing Cap Remover
	J 42385-100 Head/Main Bolt Thread Repair Kit

	
	J 42385-200 Common Thread Repair Kit
	J 42385-300 Fixtures and Hardware Kit
	J 42386-A Flywheel Holding Tool
	EN 47971 Oil Pressure Gage Adapter

	
	J 43276 Clutch Pilot Bearing Remover
	J 43690 Rod Bearing Clearance Checking Tool
	J 43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
	J 45059 Angle Meter

	
	J 45299 Engine Preluber
	E 308 Universal Seal Remover
	J 23907 Slide Hammer
	J 41415-40 Fuel Tank Cap Adaptor



2009 ENGINEEngine

Mechanical - 6.0L - G8

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT - ACCESSORY

Removal Procedure

1. Remove the air intake duct. Refer to **Air Cleaner Assembly Replacement** .

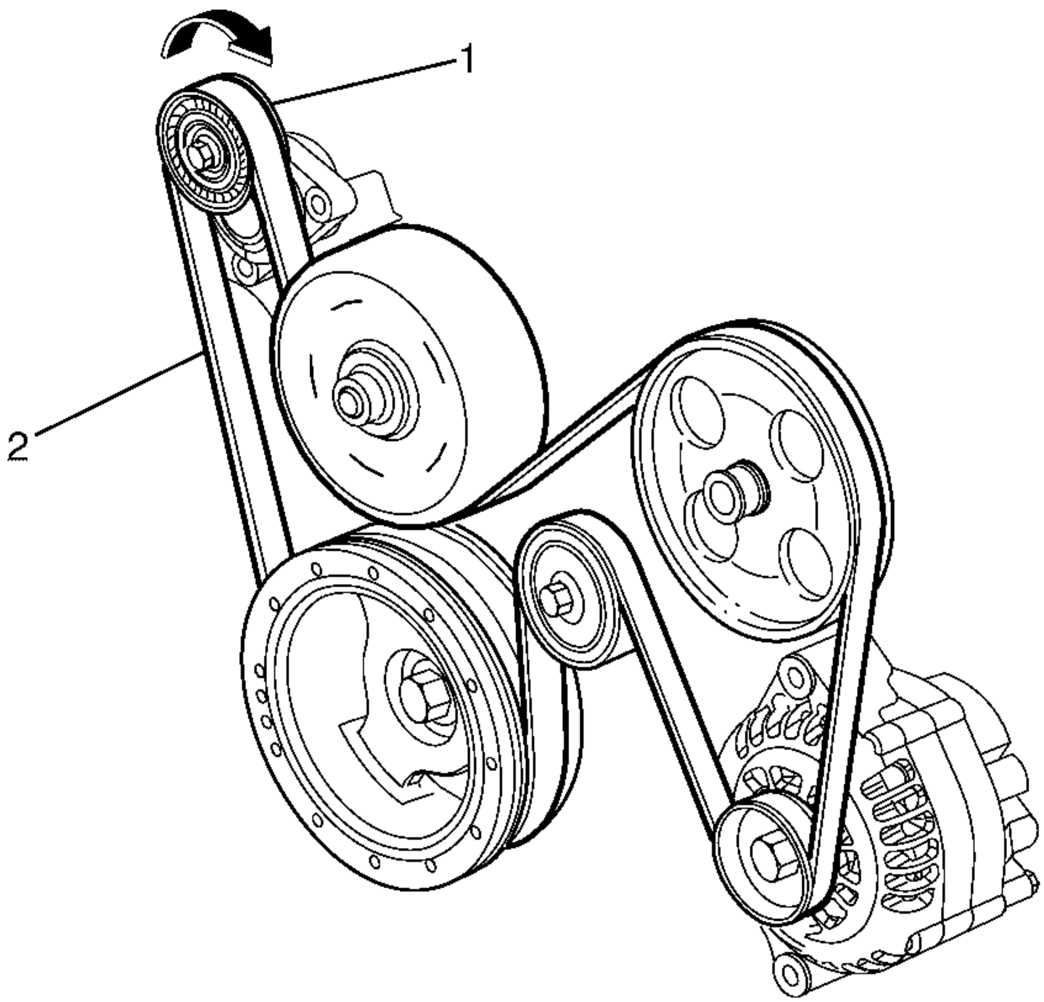


Fig. 1: Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise to relieve the tension on the accessory drive belt (2).

3. Remove the accessory drive belt (2).
4. Slowly release tension on the drive belt tensioner (1).
5. Clean and inspect the drive belt surfaces of all the pulleys.

Installation Procedure

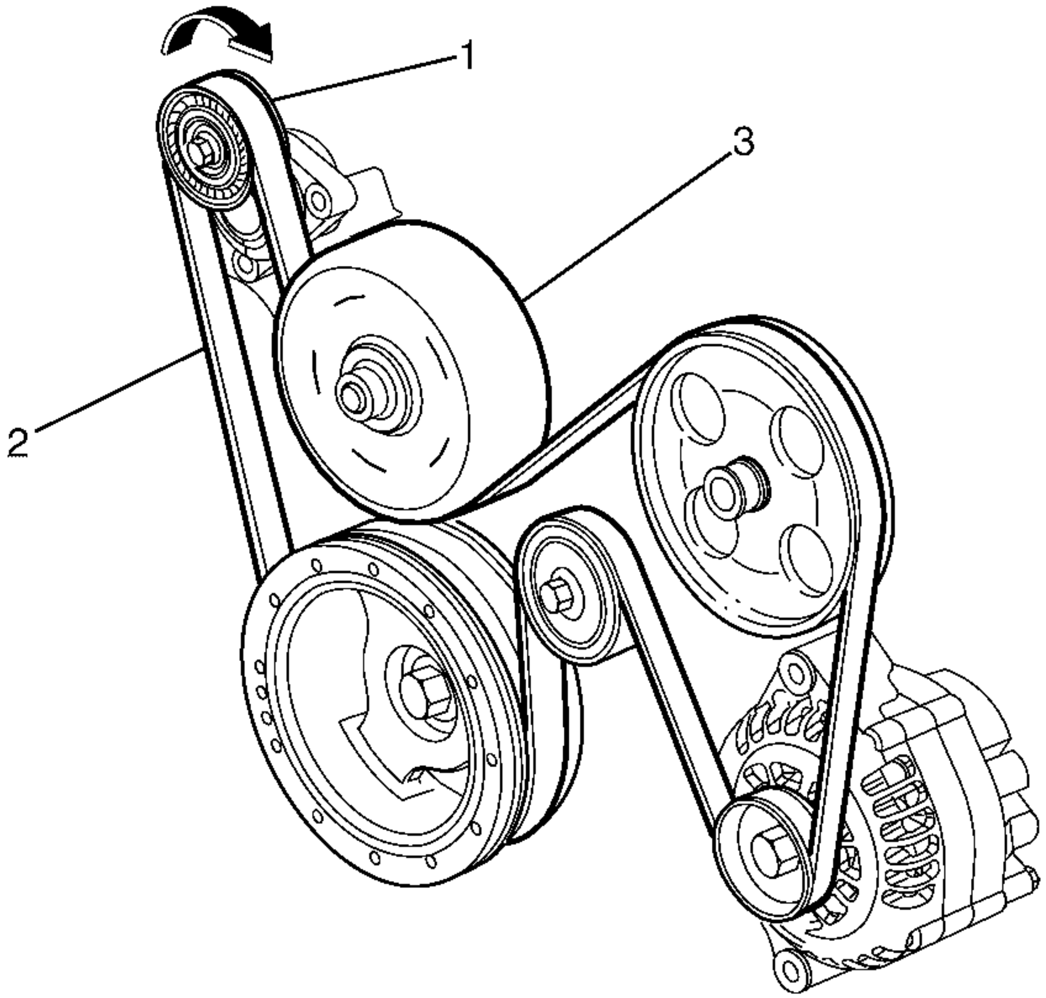


Fig. 2: Identifying Drive Belt Tensioner, Accessory Drive Belt & Water Pump Pulley
Courtesy of GENERAL MOTORS CORP.

1. Route the accessory drive belt (2) around all the pulleys except the water pump pulley (3).
2. Using a suitable tool, rotate the drive belt tensioner (1) clockwise.
3. Install the accessory drive belt under the water pump pulley (3).
4. Slowly release the drive belt tensioner (1).
5. Install the air intake duct. Refer to **Air Cleaner Assembly Replacement** .
6. Inspect the accessory drive belt (2) for correct alignment.

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT

Removal Procedure

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the Front Air Deflector. Refer to **Front Air Deflector Replacement** .

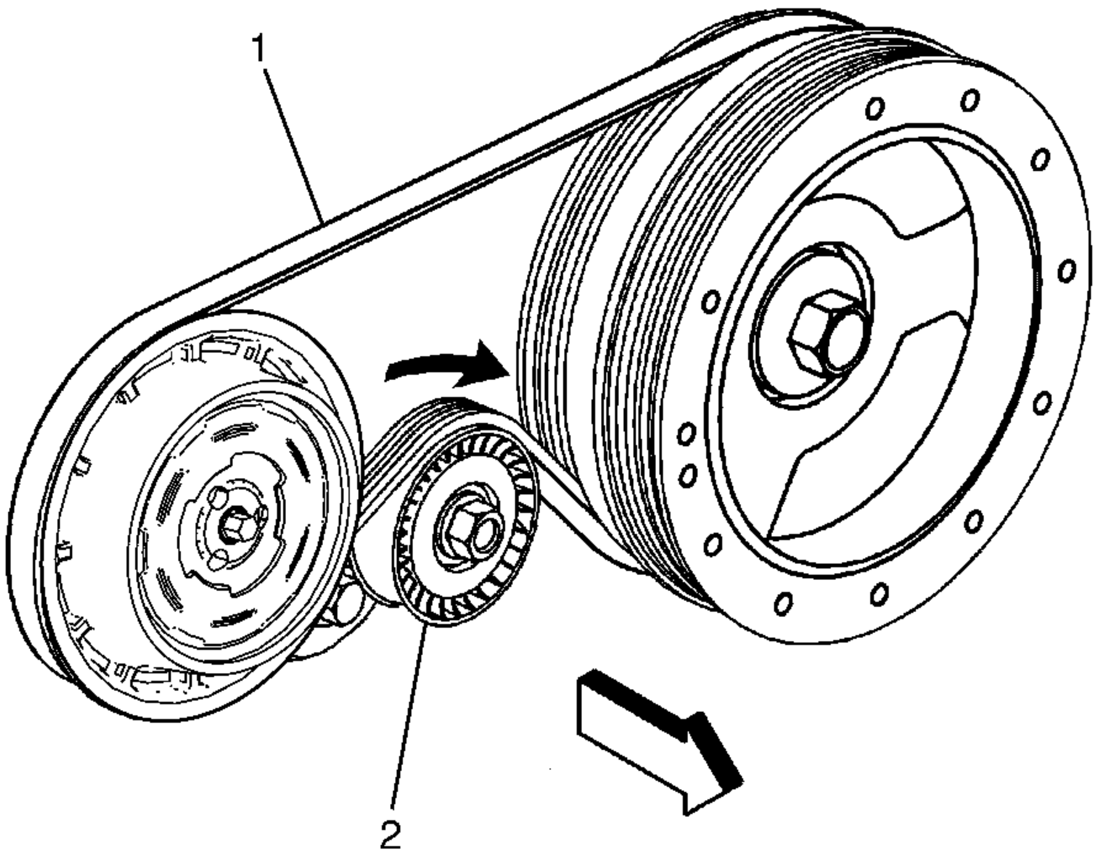


Fig. 3: A/C Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

4. Using a suitable tool, rotate the air conditioner (A/C) belt tensioner (2) clockwise.
5. Remove the A/C belt (1).
6. Slowly release the A/C belt tensioner (2).
7. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure

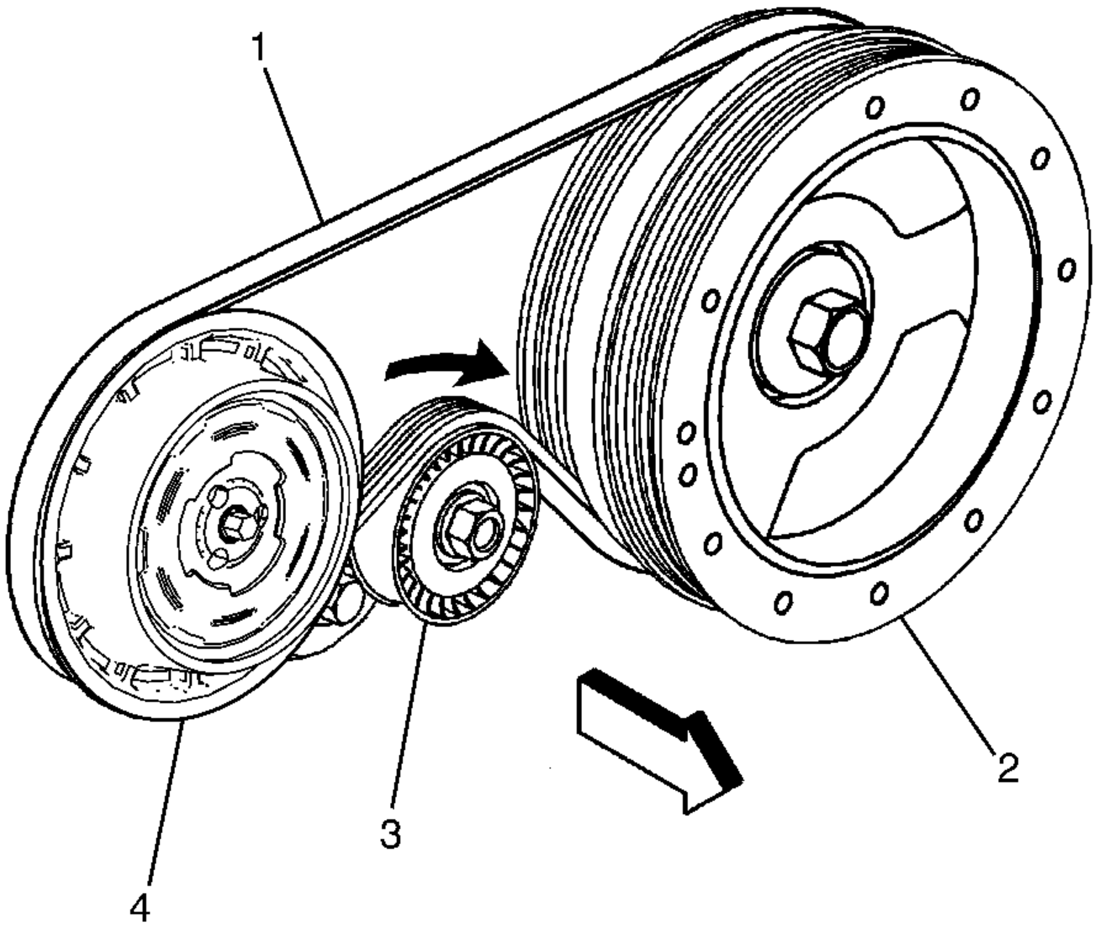


Fig. 4: A/C Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

1. Install the A/C belt (1) around the crankshaft balancer (2).
2. Using a suitable tool, rotate the A/C belt tensioner (3) clockwise.
3. Install the A/C belt (1) over the A/C belt tensioner (3) idler pulley.
4. Install the A/C belt (1) around the A/C compressor pulley (4).
5. Slowly release the tension on the A/C belt tensioner (3).
6. Inspect the A/C belt (1) for correct installation and alignment.
7. Install the Front Air Deflector. Refer to **Front Air Deflector Replacement** .
8. Lower the vehicle.
9. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

1. Remove the air intake duct. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

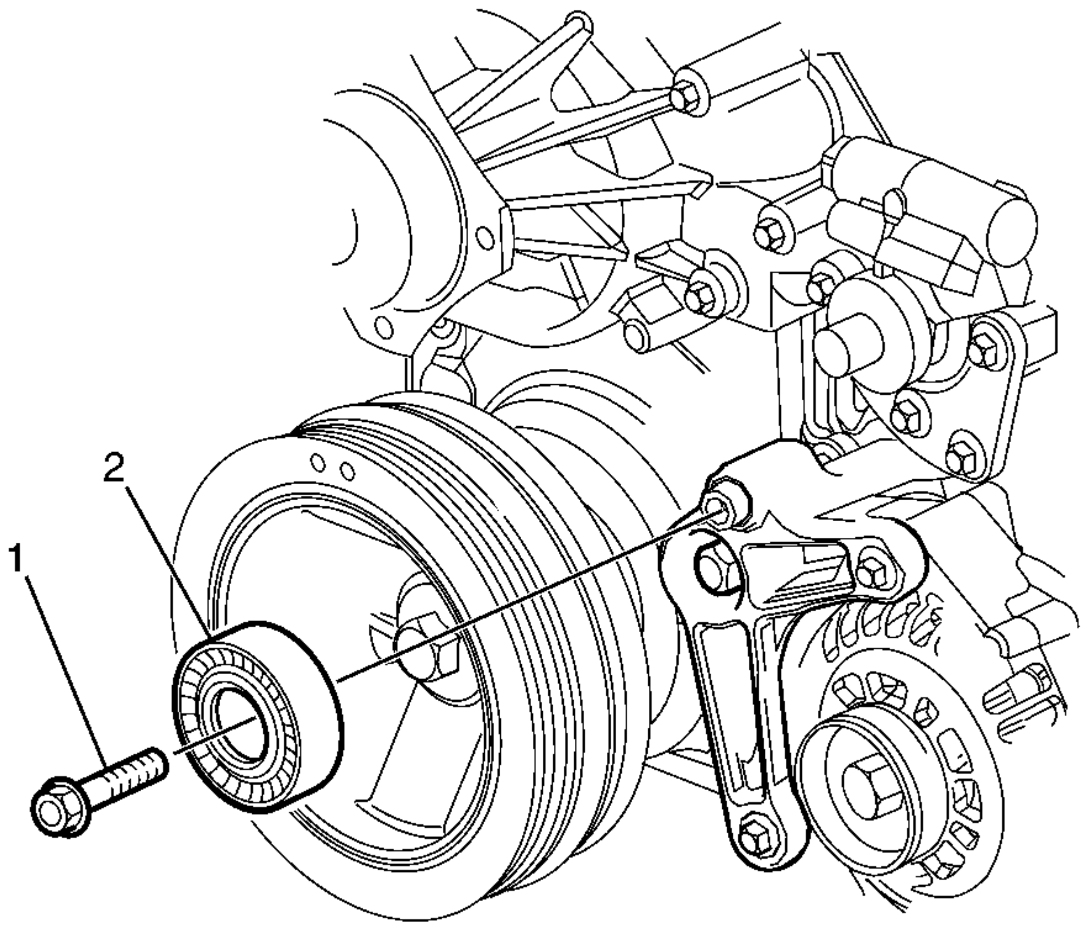


Fig. 5: Identifying Drive Belt Idler Pulley To Alternator Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the drive belt idler pulley to alternator bracket retaining bolt (1).
4. Remove the drive belt idler pulley (2).

Installation Procedure

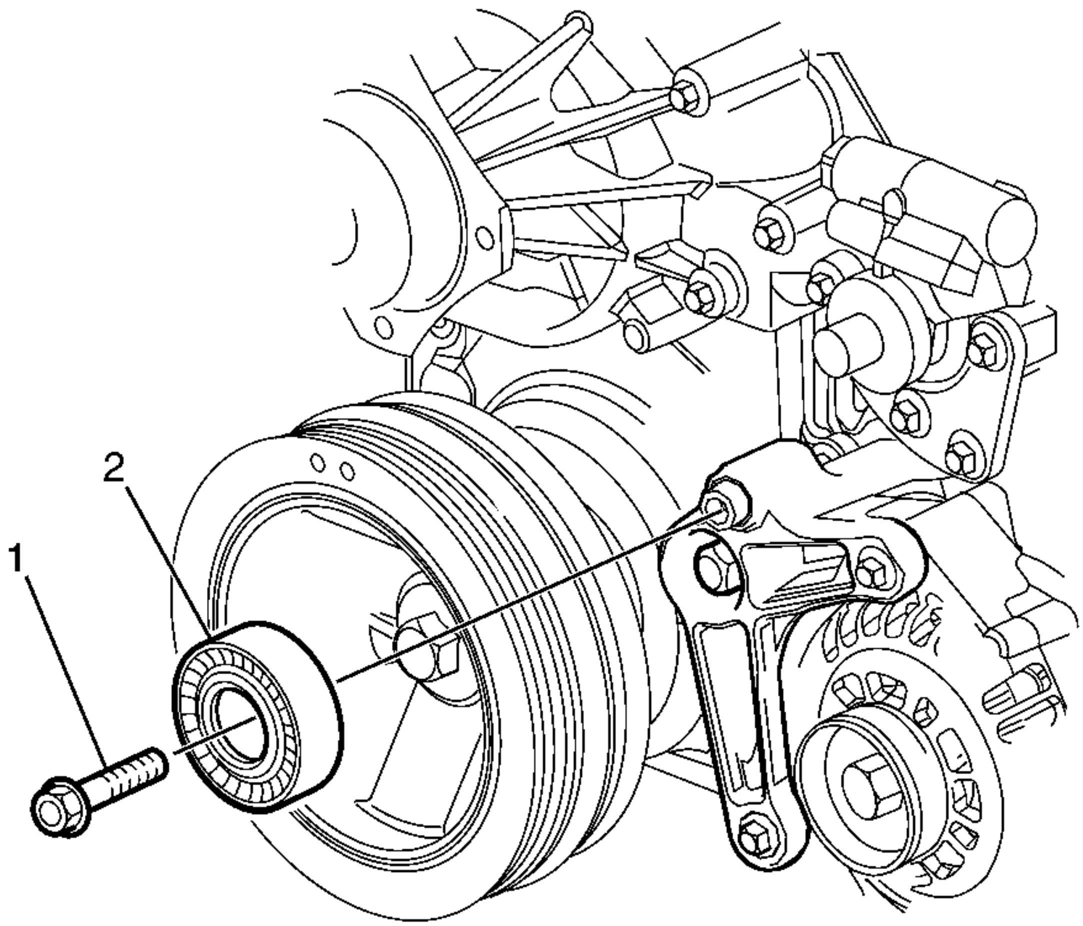


Fig. 6: Identifying Drive Belt Idler Pulley To Alternator Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley (2).
2. Hand tighten the drive belt idler pulley to alternator bracket retaining bolt (1).

CAUTION: Refer to Fastener Caution .

3. Tighten the drive belt idler pulley bolt to 58 N.m (43 lb ft).
4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
5. Install the air intake duct. Refer to **Air Cleaner Assembly Replacement** .

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

Removal Procedure

1. Remove the air intake duct. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

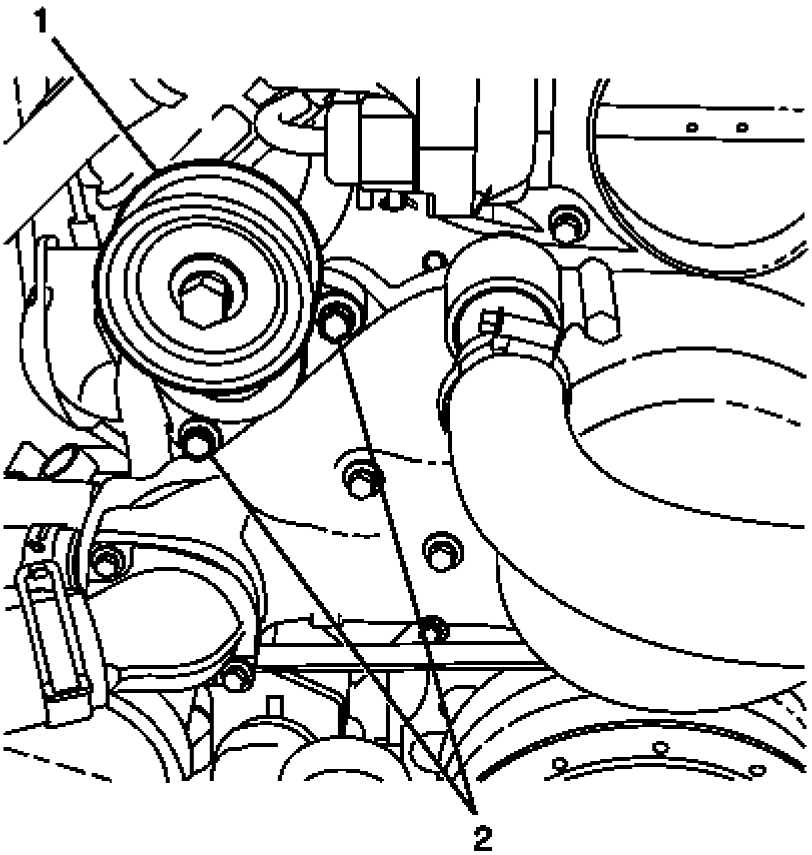


Fig. 7: Identifying Accessory Drive Belt Tensioner To Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the accessory drive belt tensioner to cylinder head retaining bolts (2).
4. Remove the accessory drive belt tensioner (1).

Installation Procedure

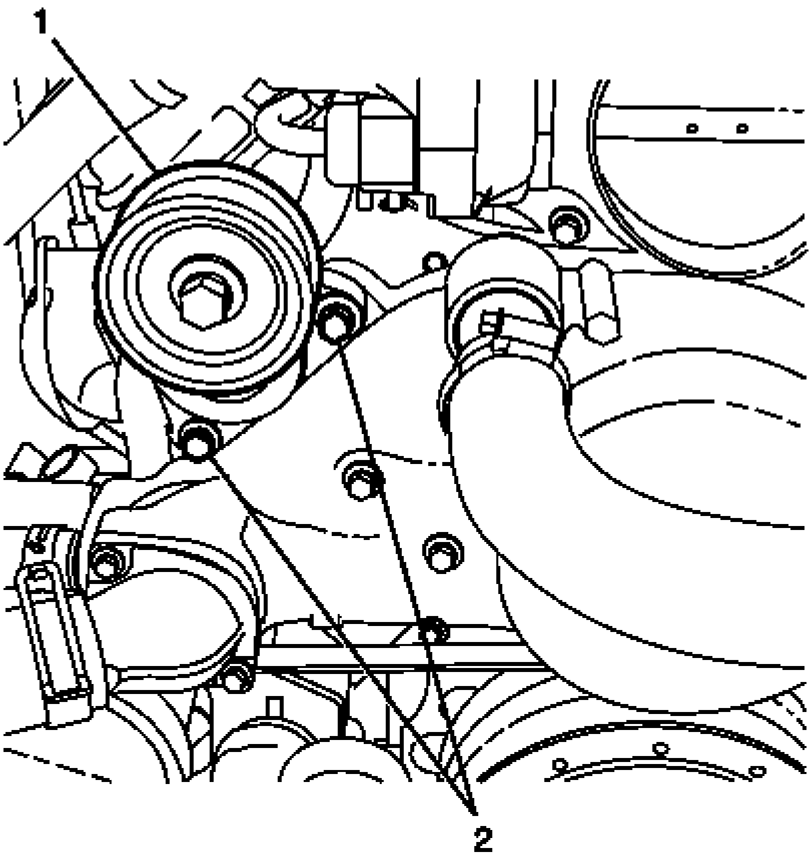


Fig. 8: Identifying Accessory Drive Belt Tensioner To Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the accessory drive belt tensioner (1).

CAUTION: Refer to Fastener Caution .

2. Install the accessory drive belt tensioner to cylinder head retaining bolts (2) and tighten to 58 N.m (43 lb ft).
3. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
4. Install the air intake duct. Refer to **Air Cleaner Assembly Replacement** .

DRIVE BELT TENSIONER REPLACEMENT - AIR CONDITIONING

Removal Procedure

1. Remove the air intake duct. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
3. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.

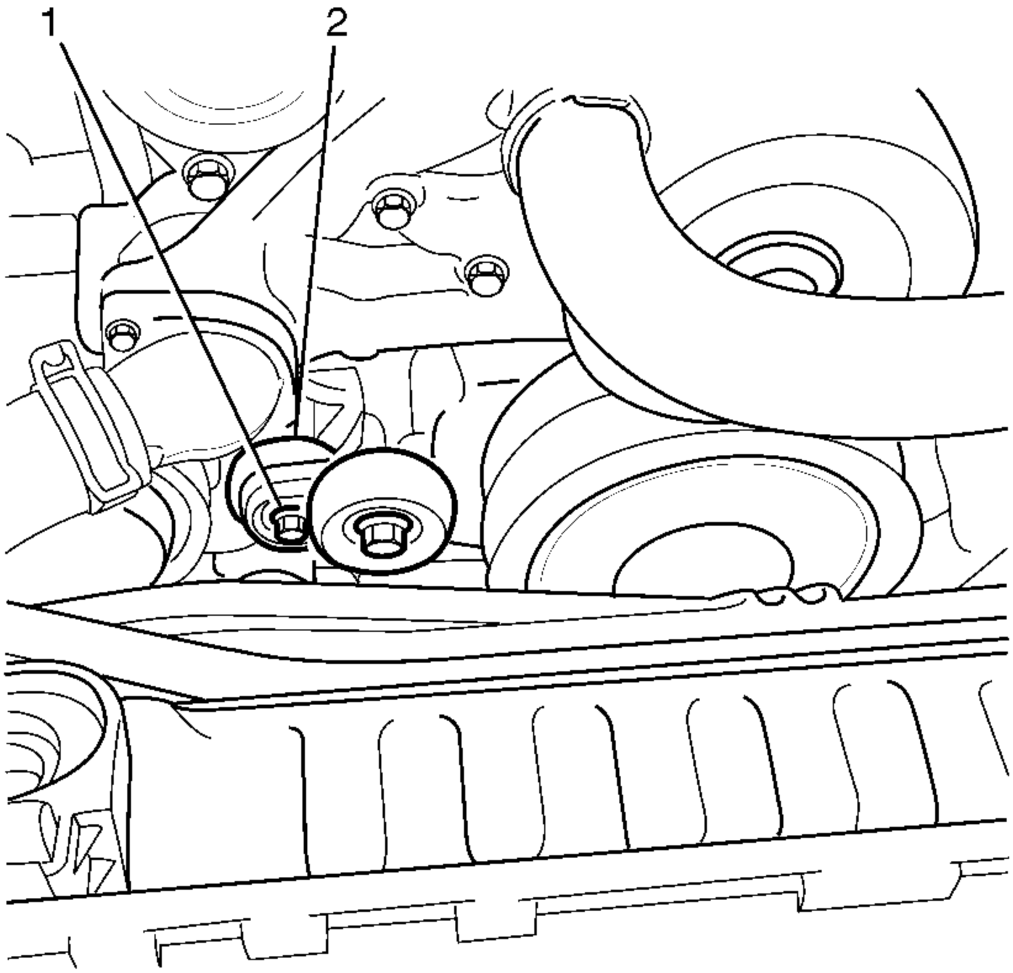


Fig. 9: Identifying A/C Drive Belt Tensioner To A/C Compressor Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1).
5. Remove the A/C drive belt tensioner (2).

Installation Procedure

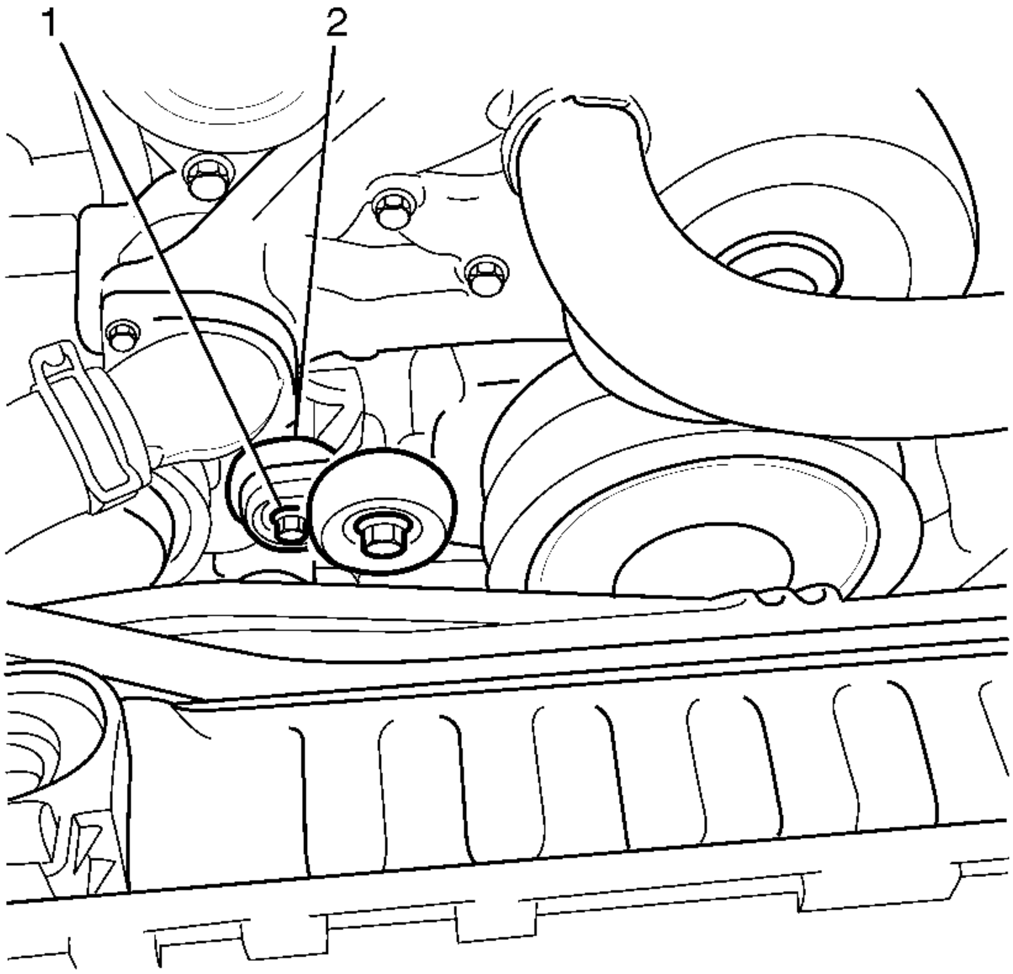


Fig. 10: Identifying A/C Drive Belt Tensioner To A/C Compressor Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the A/C drive belt tensioner (2).

CAUTION: Refer to Fastener Caution .

2. Tighten the A/C drive belt tensioner to A/C compressor bracket retaining bolt (1) to 22 N.m (16 lb ft).
3. Install the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
5. Install the air intake duct. Refer to **Air Cleaner Assembly Replacement** .

ENGINE COVER REPLACEMENT

Removal Procedure

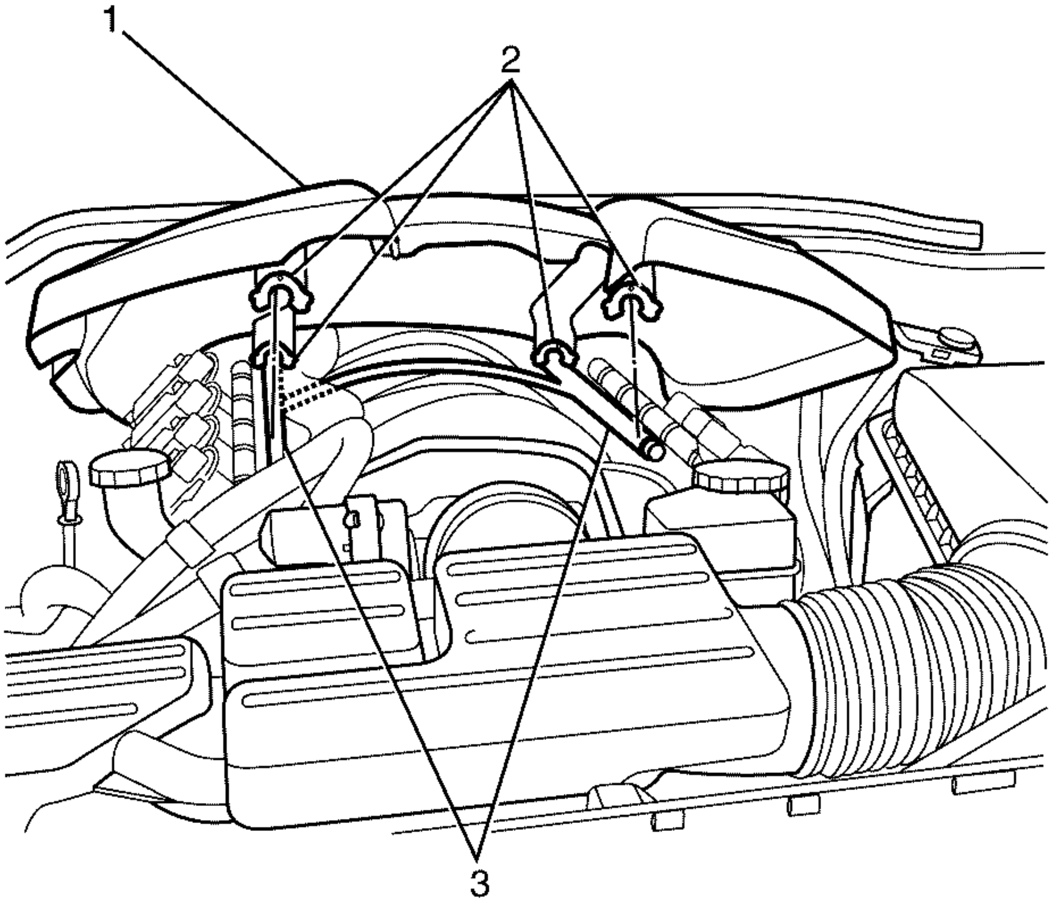


Fig. 11: Identifying Engine Cover To Fuel Injector Rail Retaining Clips
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Pull upward on the front of the engine cover (1) to detach the engine cover to fuel injector rail retaining clips (2).

1. Detach the engine cover (1) from the fuel rail (3).
2. Remove the engine cover (1) from the engine compartment.

Installation Procedure

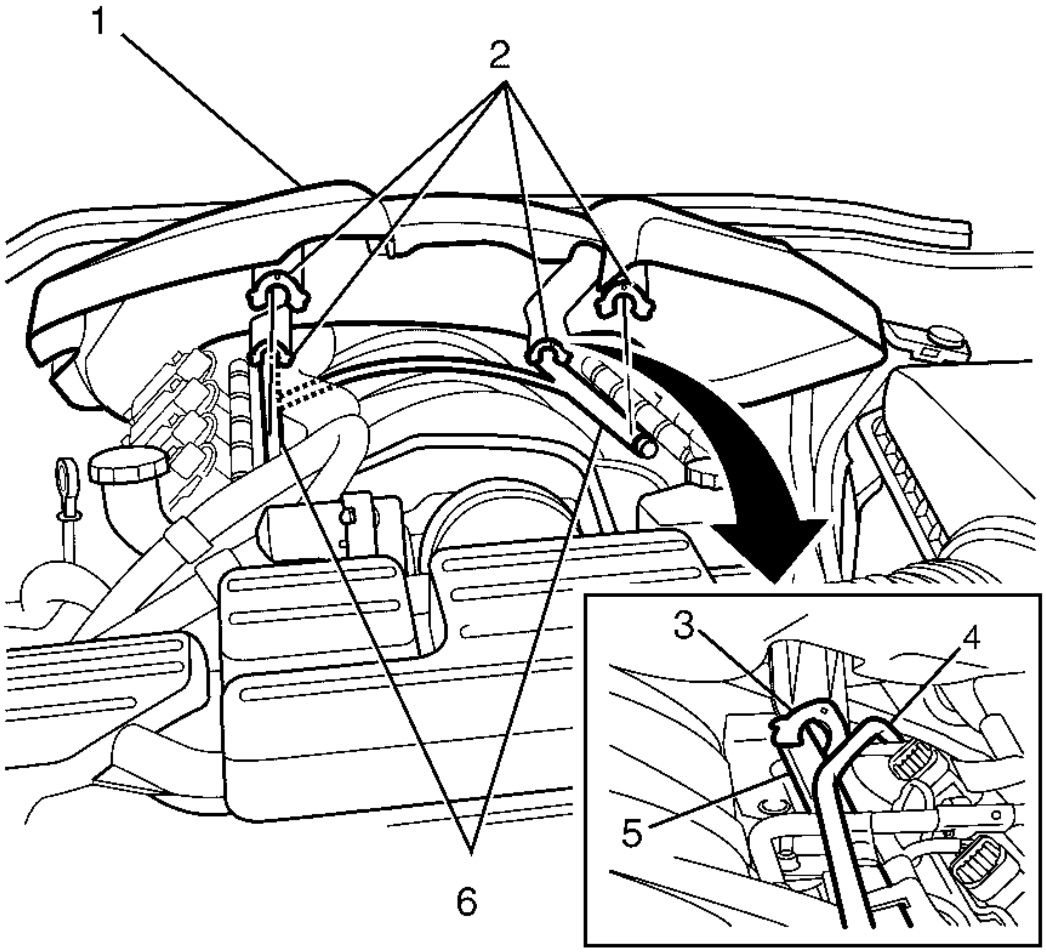


Fig. 12: Locating Engine Cover Retainer, PCV Hose & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lower the rear of the engine cover (1) to the engine and align the engine cover to fuel injector rail retaining clips (2) to the fuel rail (6).

IMPORTANT: Make sure that the engine cover retainer (3) correctly engages the fuel rail (5), clear of the PCV hose (4).

1. Position the engine cover (1) to the fuel rail (6).

IMPORTANT: Press down on the engine cover (1) to ensure the engine cover to fuel injector rail retaining clips (2) are fully engaged to prevent an induced rattle condition.

2. Install the engine cover (1) to the fuel rail (6).

ENGINE MOUNT INSPECTION

CAUTION: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

NOTE: Raising the engine, will remove the weight from the engine mount and create a slight tension in the rubber mount.

1. Use a suitable engine lifting tool to raise the engine until the weight of the engine is removed from the engine mounts.

NOTE: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is actually the engine mount, not the engine or other accessories.

2. Observe the engine mount while raising the engine. Replace the engine mount if the mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.
   - The rubber is split through the centre of the engine mount.
   - The GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Engine Mount Replacement - Left Side** or**Engine Mount Replacement - Right Side**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

Special Tools

- **J 28467-B** Universal Engine Support Fixture
- **J 41803** Engine Support Fixture. See **Special Tools** .
- **J 41798** Engine Lift Bracket. See **Special Tools** .

Removal Procedure

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

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is

supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

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

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .

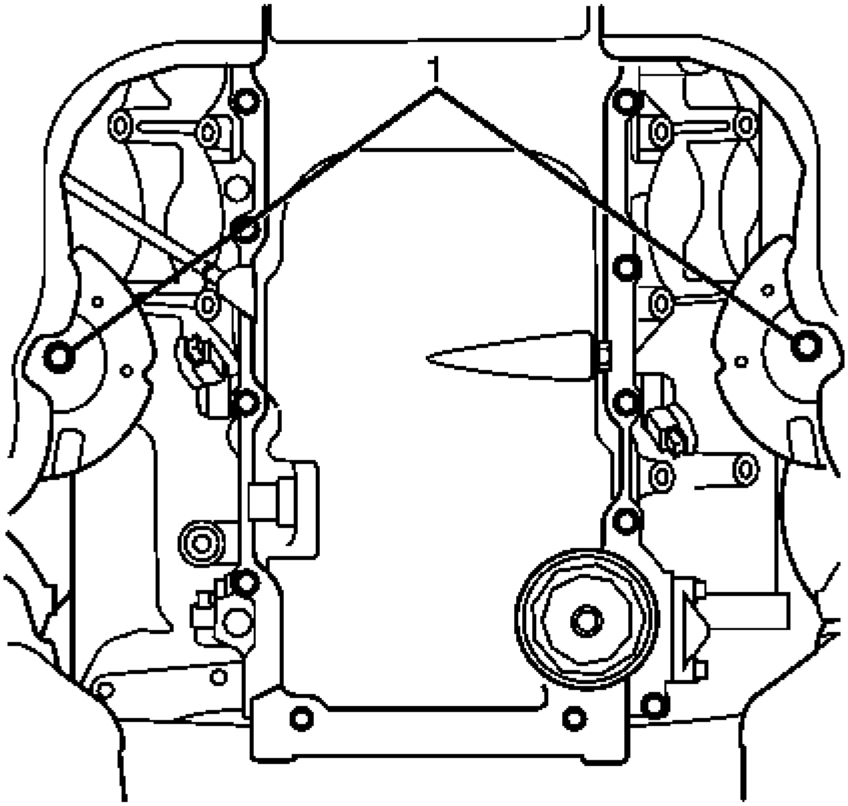


Fig. 13: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

4. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
5. Lower the vehicle.

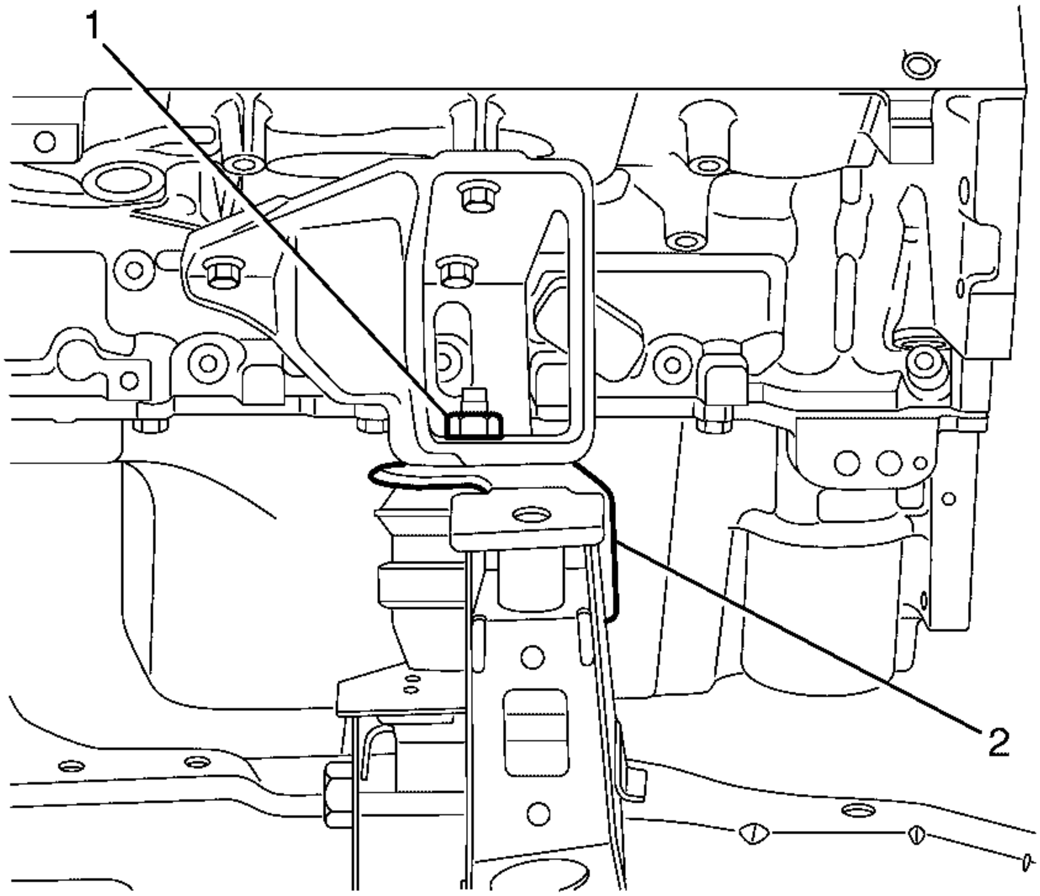


Fig. 14: Identifying Left Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the upper left side engine mount to engine mount bracket retaining nut (1).

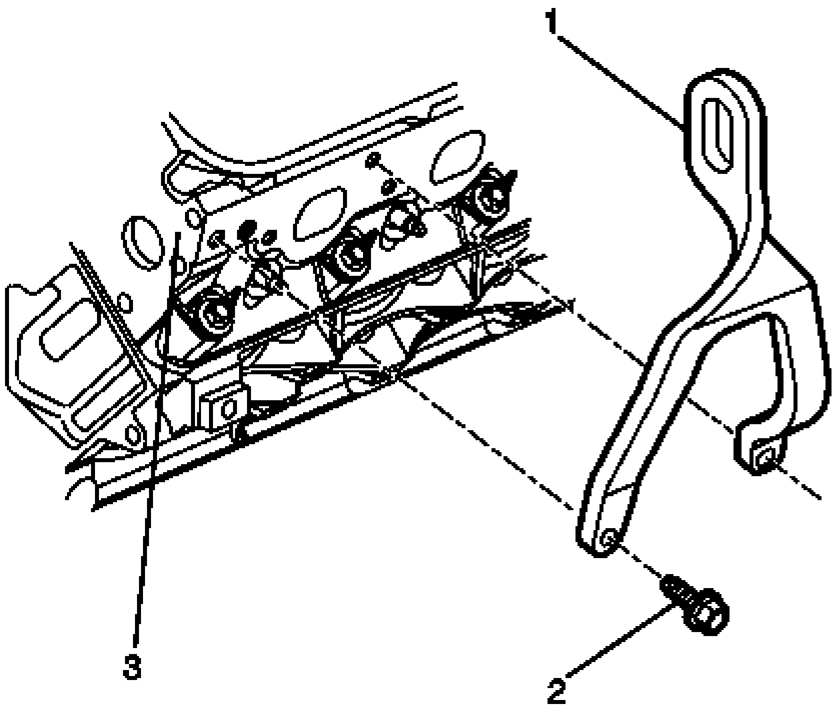


Fig. 15: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

7. Position the **J 41798** (1) on the cylinder head (3). See **Special Tools** .

CAUTION: Refer to Fastener Caution .

8. Install the **J 41798** to cylinder head retaining bolts (2) and tighten to 50 N. See **Special Tools** .m (36 lb ft).

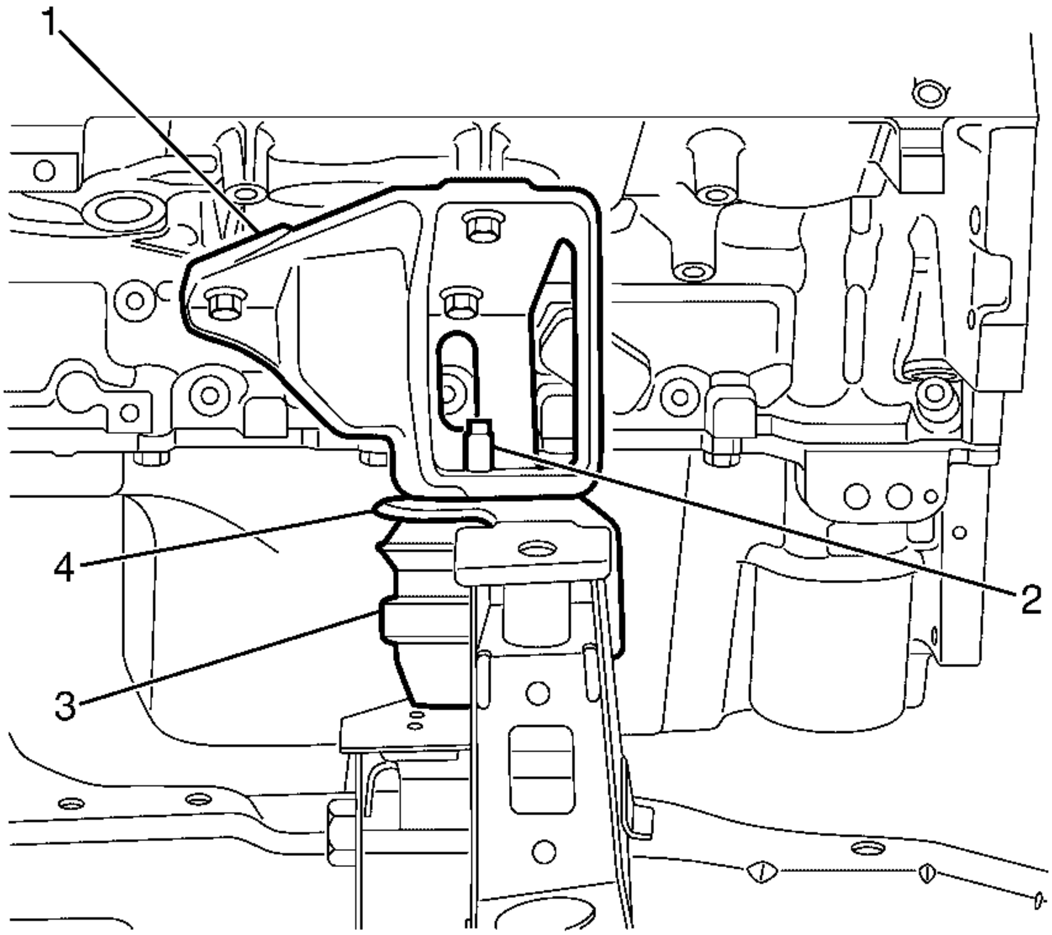


Fig. 16: Locating Cylinder Head Retaining Bolts & J 41798
Courtesy of GENERAL MOTORS CORP.

NOTE: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Install **J 41803** and **J 28467-B** and raise the engine assembly until the left side engine mount bracket (1) is clear of the left side engine mount retaining stud (2).

NOTE: DO NOT bend or distort the right side engine mount heat shield (4).

10. Remove the left side engine mount assembly (3).

Installation Procedure

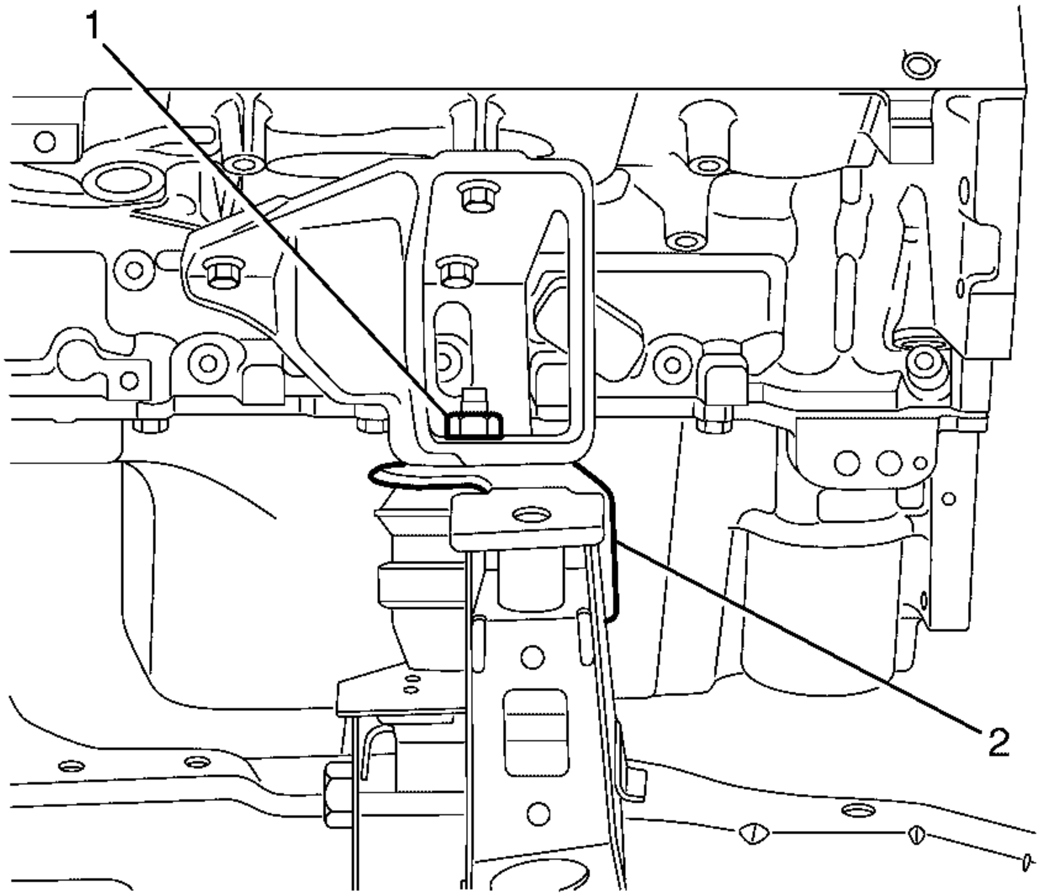


Fig. 17: Identifying Left Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT bend or distort the right side engine mount heat shield (4).

1. Position the left side engine mount assembly (3).
2. Lower the engine and remove **J 41803** , **J 28467-B** and **J 41798** from the engine. See **Special Tools** .

CAUTION: Refer to Fastener Caution .

3. Install the upper engine mount to engine mount bracket retaining nut (1) and tighten to 80 N.m (59 lb ft).

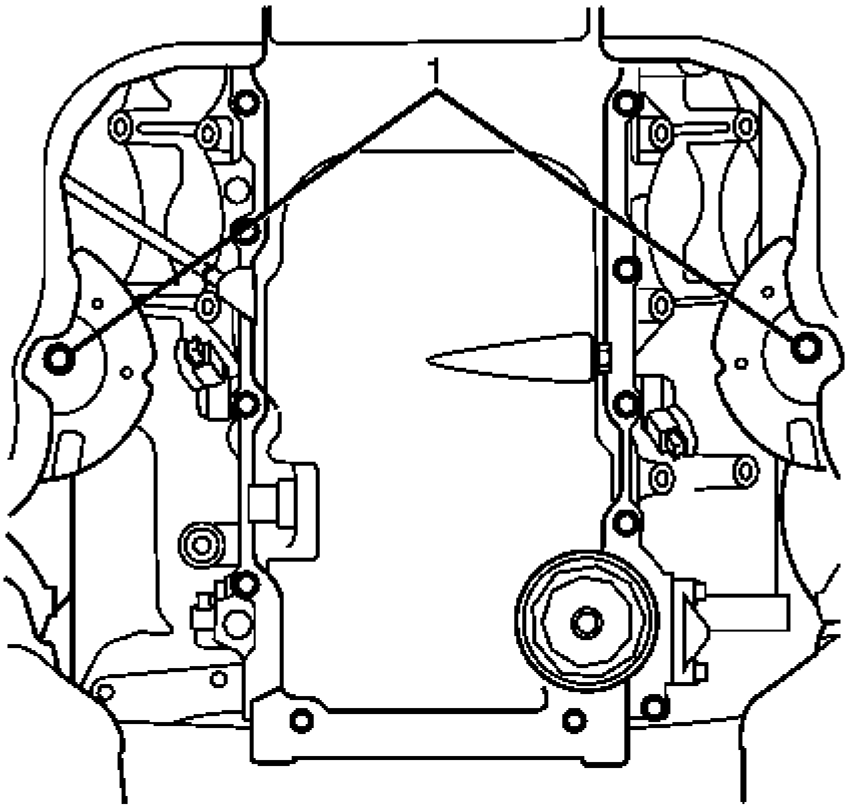


Fig. 18: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.**

4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to 80 N.m (59 lb ft).
6. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
7. Lower the vehicle.
8. Install the engine splash shield. Refer to **Engine Cover Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the left side engine mount. Refer to **Engine Mount Replacement - Left Side**.

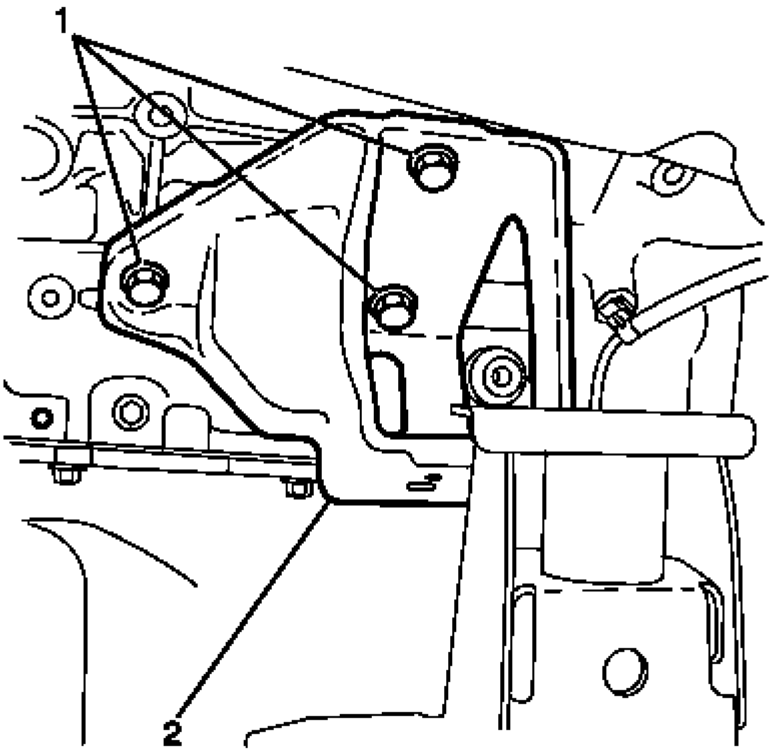


Fig. 19: Identifying Left Side Engine Mount Bracket To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the left side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the left side engine mount bracket (2).

Installation Procedure

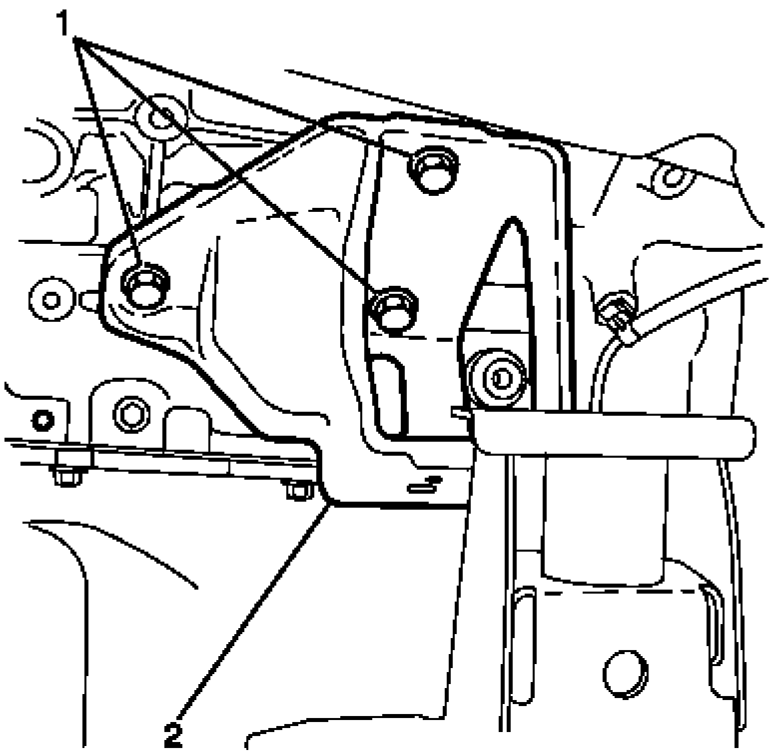


Fig. 20: Identifying Left Side Engine Mount Bracket To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the left side engine mount bracket (2).

CAUTION: Refer to Fastener Caution .

2. Install the left side engine mount bracket to cylinder block retaining bolts (1) and tighten to 50 N.m (37 lb ft).
3. Install the left side engine mount. Refer to **Engine Mount Replacement - Left Side**.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Special Tools

- **J 28467-B** Universal Engine Support Fixture
- **J 41803** Engine Support Fixture. See **Special Tools** .
- **J 41798** Engine Lift Bracket. See **Special Tools** .

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Remove the oil level indicator and tube. Refer to **Oil Level Indicator Tube Replacement**.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .

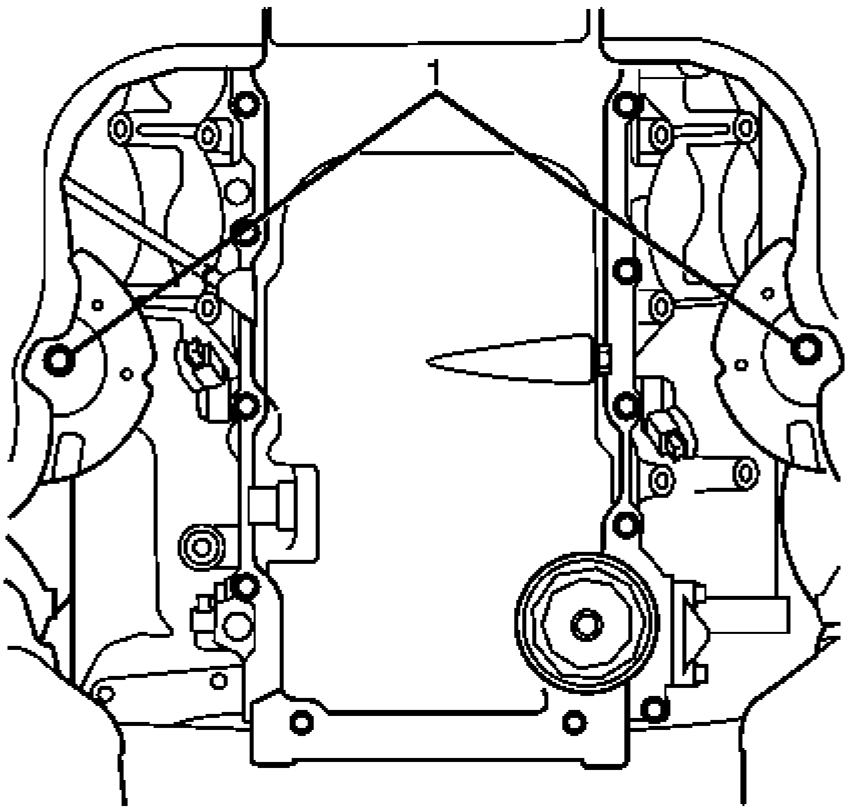


Fig. 21: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
6. Lower the vehicle.

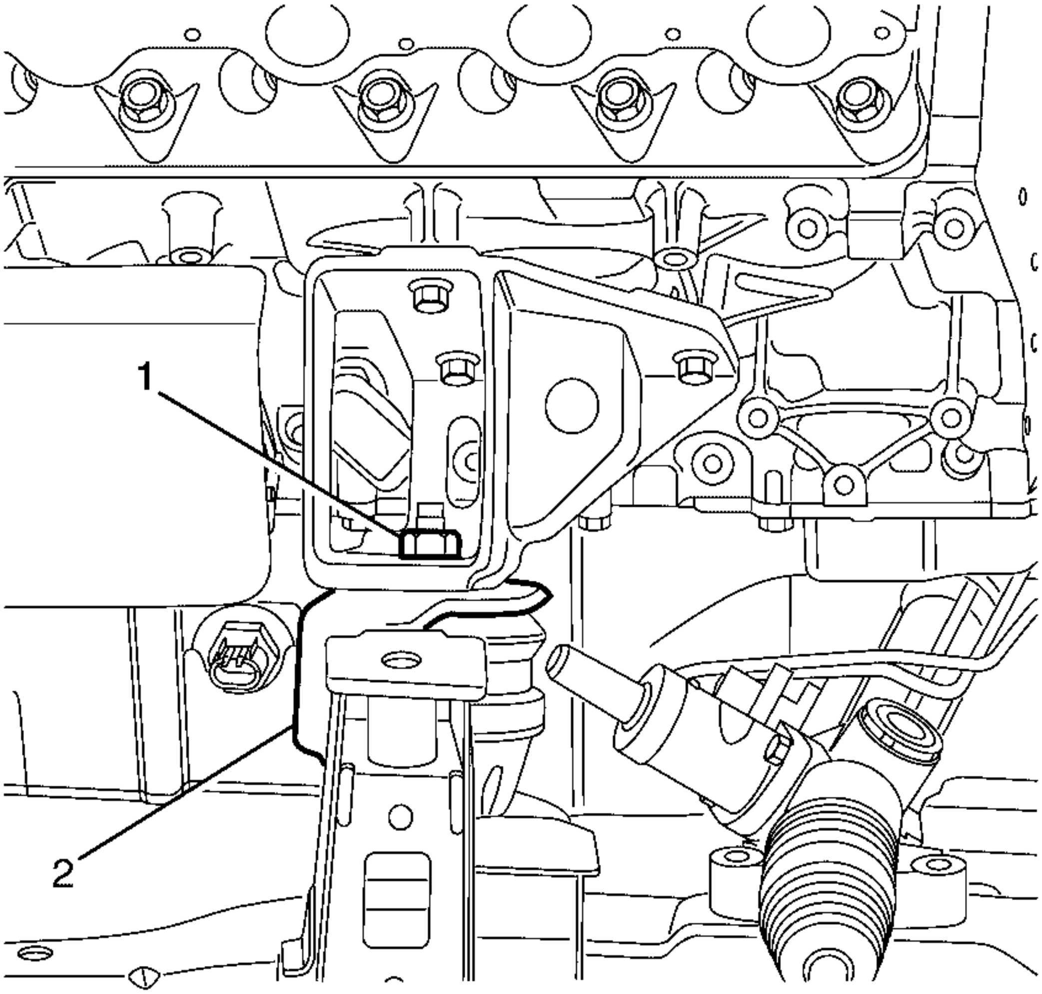


Fig. 22: Identifying Upper Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the upper right side engine mount to engine mount bracket retaining nut 1).

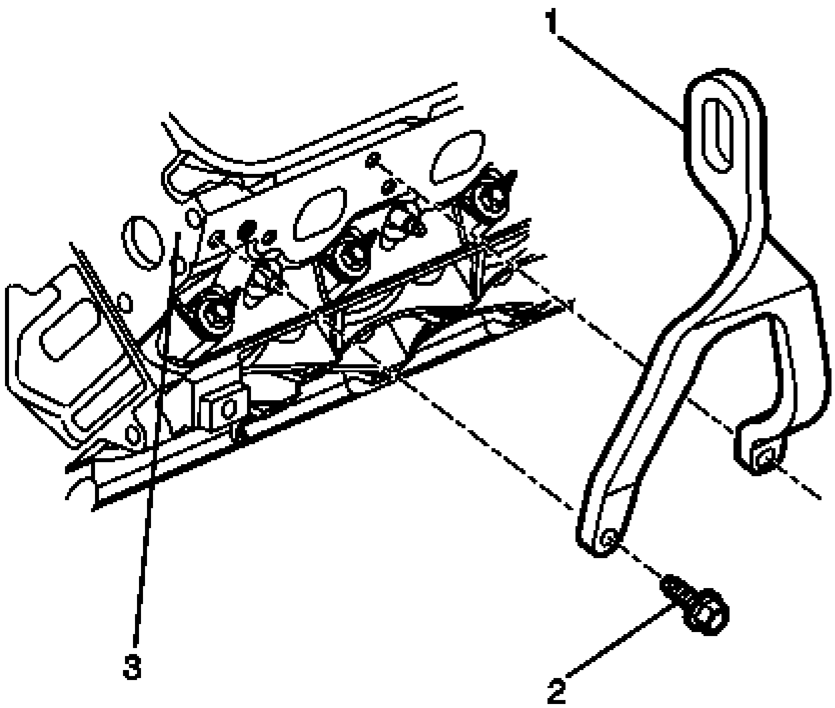


Fig. 23: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

8. Position the **J 41798** (1) on the cylinder head (3). See **Special Tools** .

CAUTION: Refer to Fastener Caution .

9. Install the **J 41798** to cylinder head retaining bolts (2) and tighten to 50 N. See **Special Tools** .m (36 lb ft).

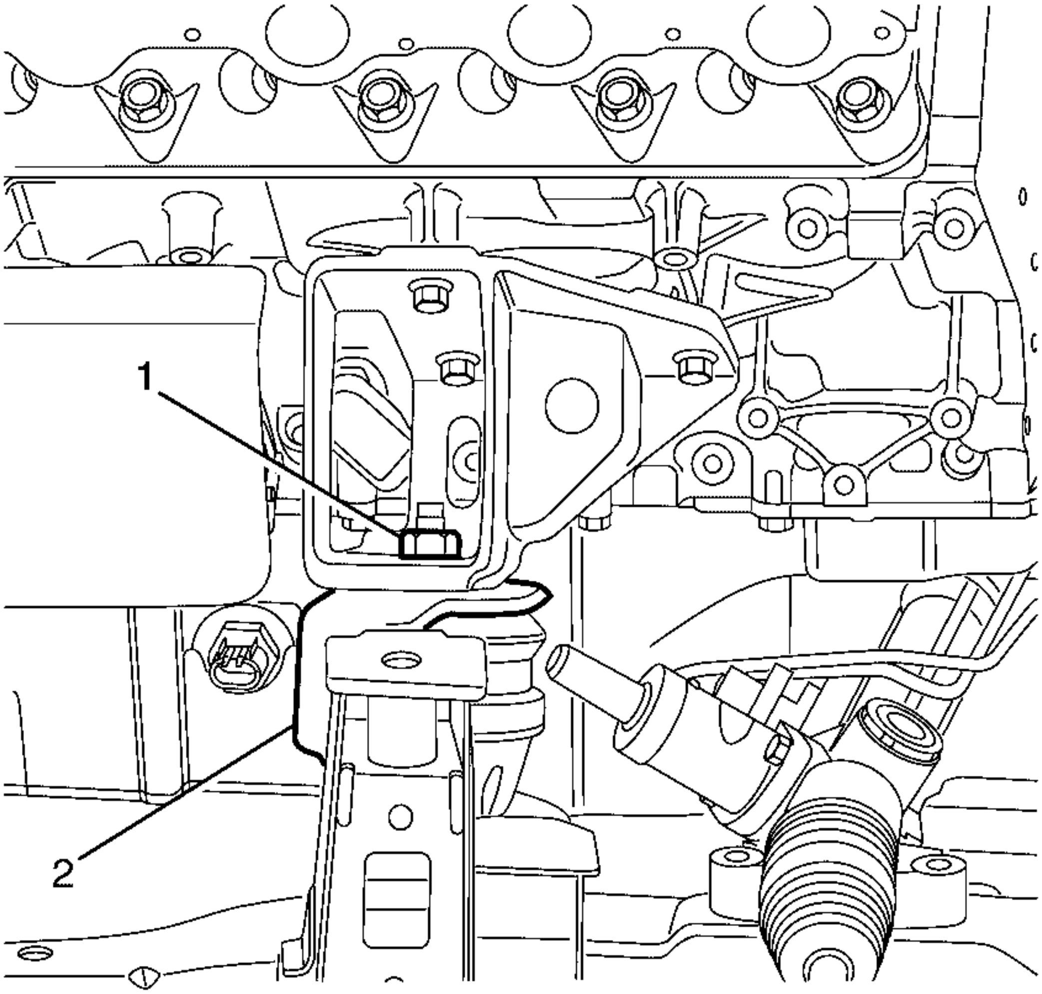


Fig. 24: Identifying Upper Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

10. Install **J 41803** and **J 28467-B** and raise the engine assembly until the right side engine mount bracket (1) is clear of the right side engine mount retaining stud (2).

NOTE: DO NOT bend or distort the right side engine mount heat shield (4).

11. Remove the right side engine mount assembly (3).

Installation Procedure

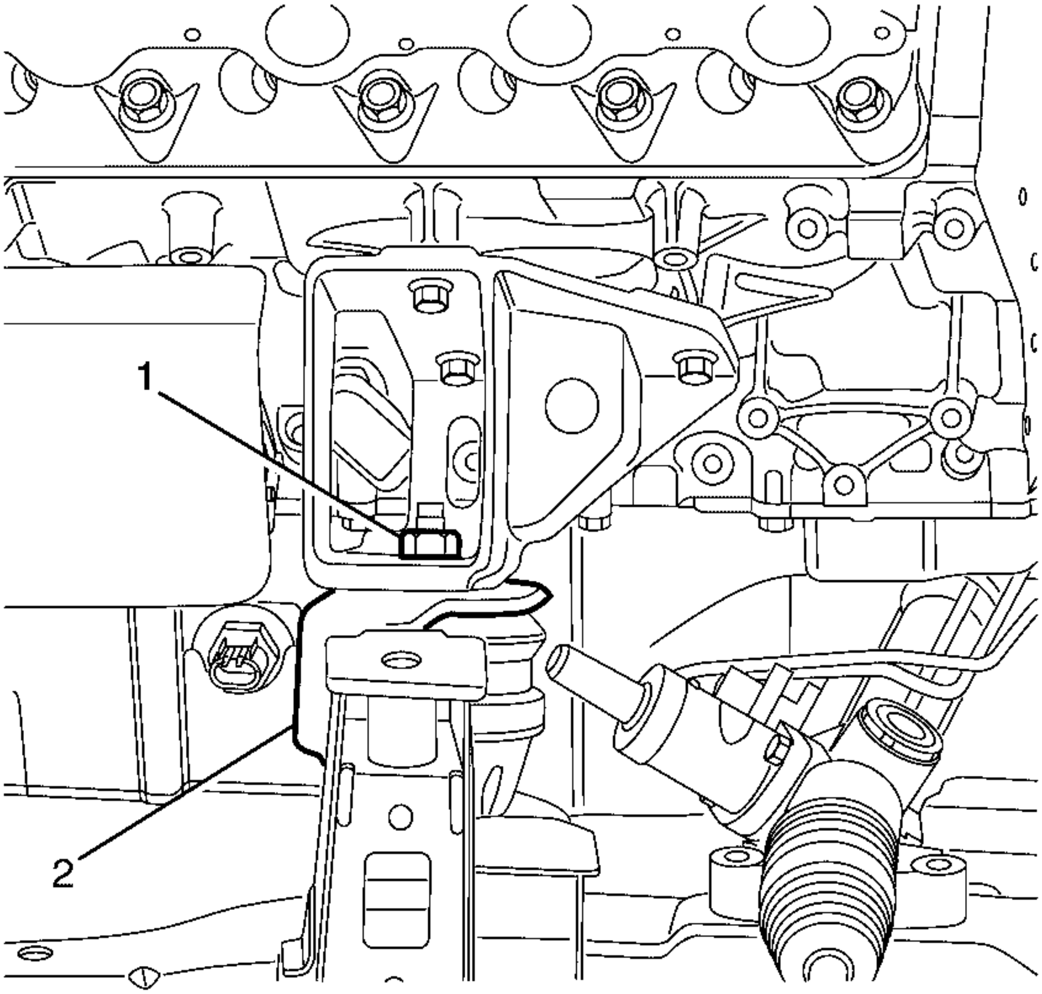


Fig. 25: Identifying Upper Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT bend or distort the right side engine mount heat shield (4).

1. Install the right side engine mount assembly (3).
2. Lower the engine assembly until the right side engine mount retaining stud (2) is installed through the right side engine mount bracket (1).
3. Remove **J 41803** , **J 28467-B** and **J 41798** from the engine. See **Special Tools** .

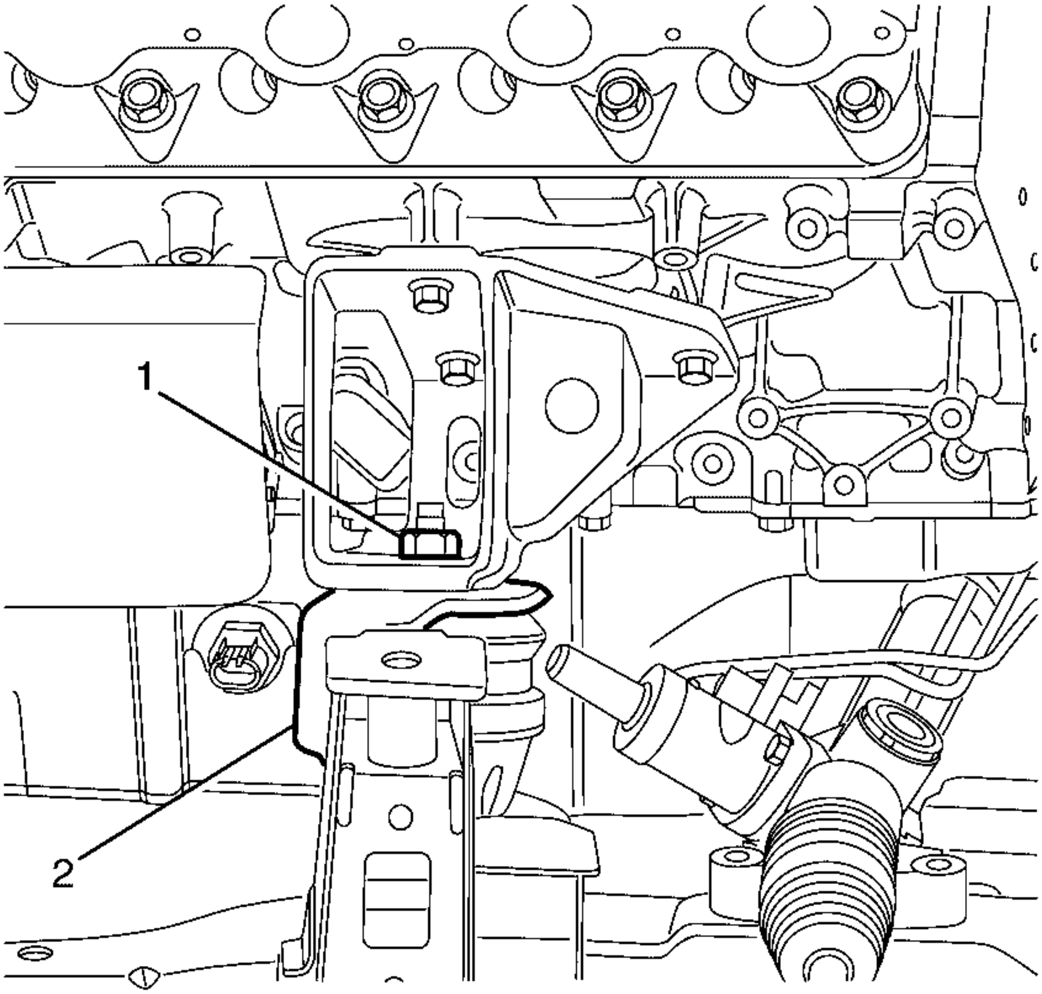


Fig. 26: Identifying Upper Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the upper right side engine mount to engine mount bracket retaining nut (1) and tighten to 80 N.m (59 lb ft).

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

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

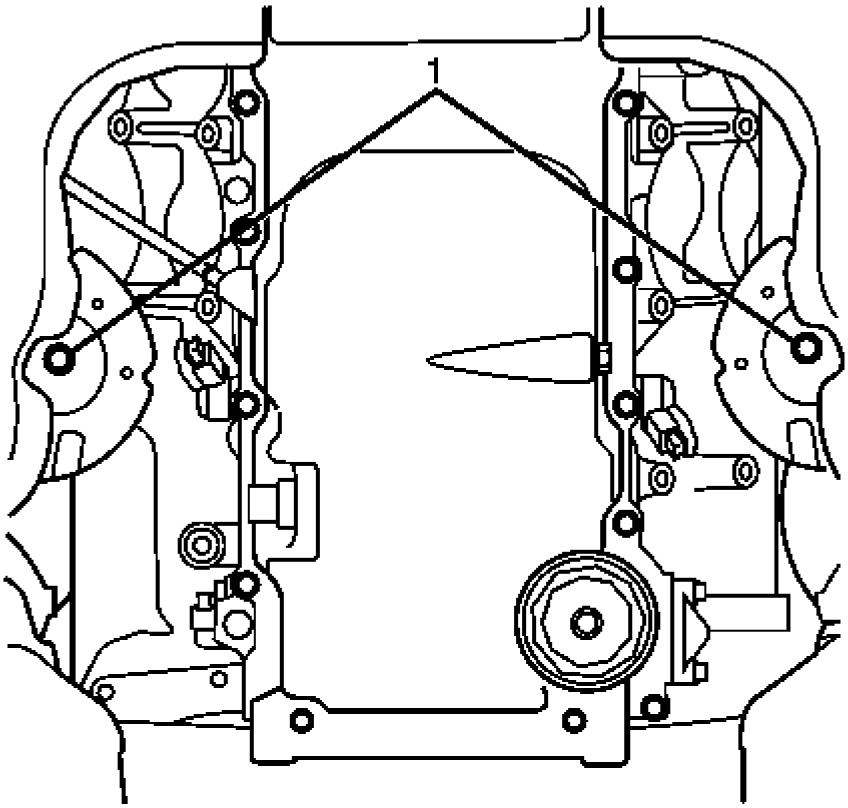


Fig. 27: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

6. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to 80 N.m (59 lb ft).
7. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
8. Lower the vehicle.
9. Install the oil level indicator and tube. Refer to **Oil Level Indicator Tube Replacement**.
10. Install the engine cover. Refer to **Engine Cover Replacement**.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

Special Tools

EN 46114 Engine Lift Brackets

Removal Procedure

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and**

strap the vehicle to the hoist.

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .

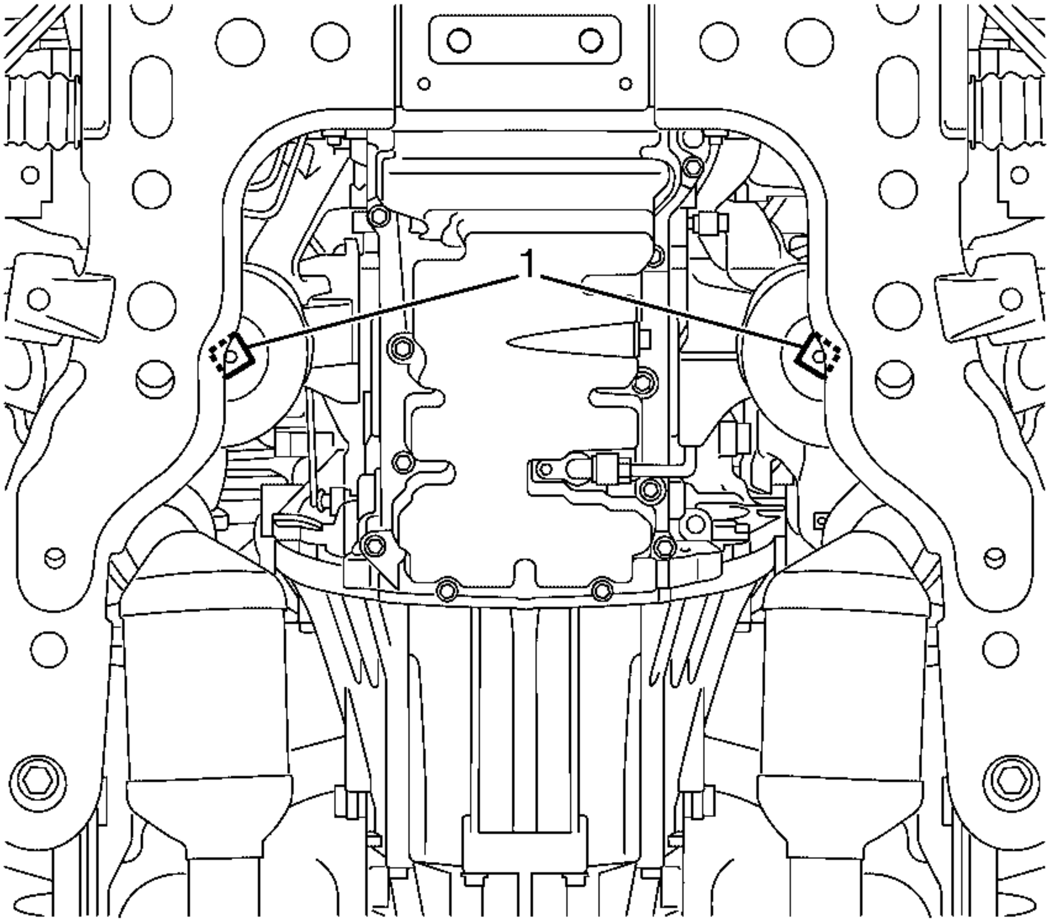


Fig. 28: Identifying Engine Mount To Front Subframe Retaining Nut
Courtesy of GENERAL MOTORS CORP.

3. Remove the lower engine mount retaining nuts (1).
4. Lower the vehicle.

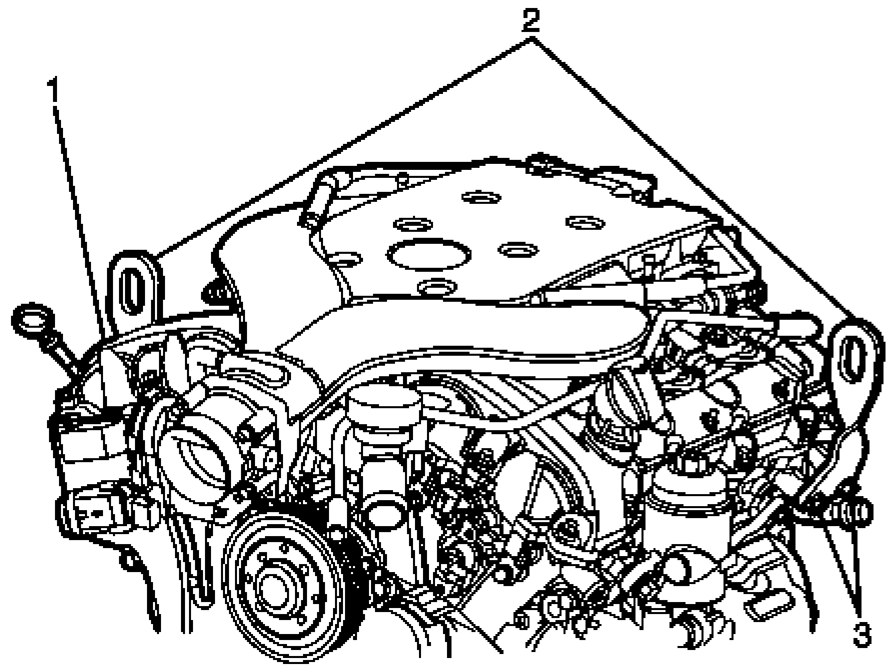


Fig. 29: View Of EN 46114, Engine & Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

5. Position the **EN 46114** (2) on the engine (1).

CAUTION: Refer to Fastener Caution .

6. Install the **EN 46114** to cylinder head retaining bolts (3) and tighten to 50 N.m (36 lb ft).

NOTE: Use a suitable tool to raise the engine.

NOTE: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

7. Raise the engine until the weight of the engine is removed from the right hand engine mount.

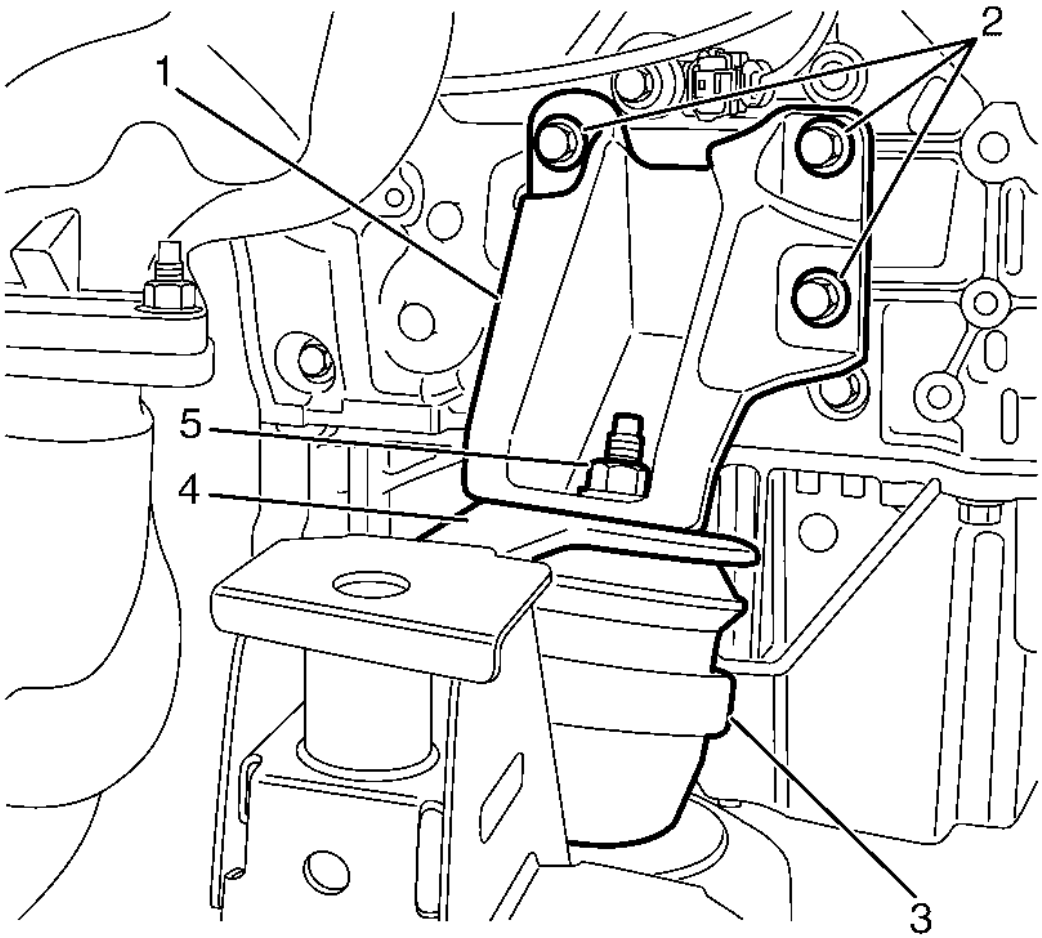


Fig. 30: Identifying Right Hand Engine Mount Bracket To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the right hand engine mount to engine mount bracket retaining nut (5).

IMPORTANT: If required, raise the engine further to provide adequate space.

IMPORTANT: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Remove the right hand engine mount (3) from the right hand engine mount bracket (1).

NOTE: DO NOT distort or bend the right hand engine mount heat shield (4).

10. Remove the right hand engine mount bracket to cylinder block retaining bolts (2).

11. Remove the right hand engine mount bracket (1).

Installation Procedure

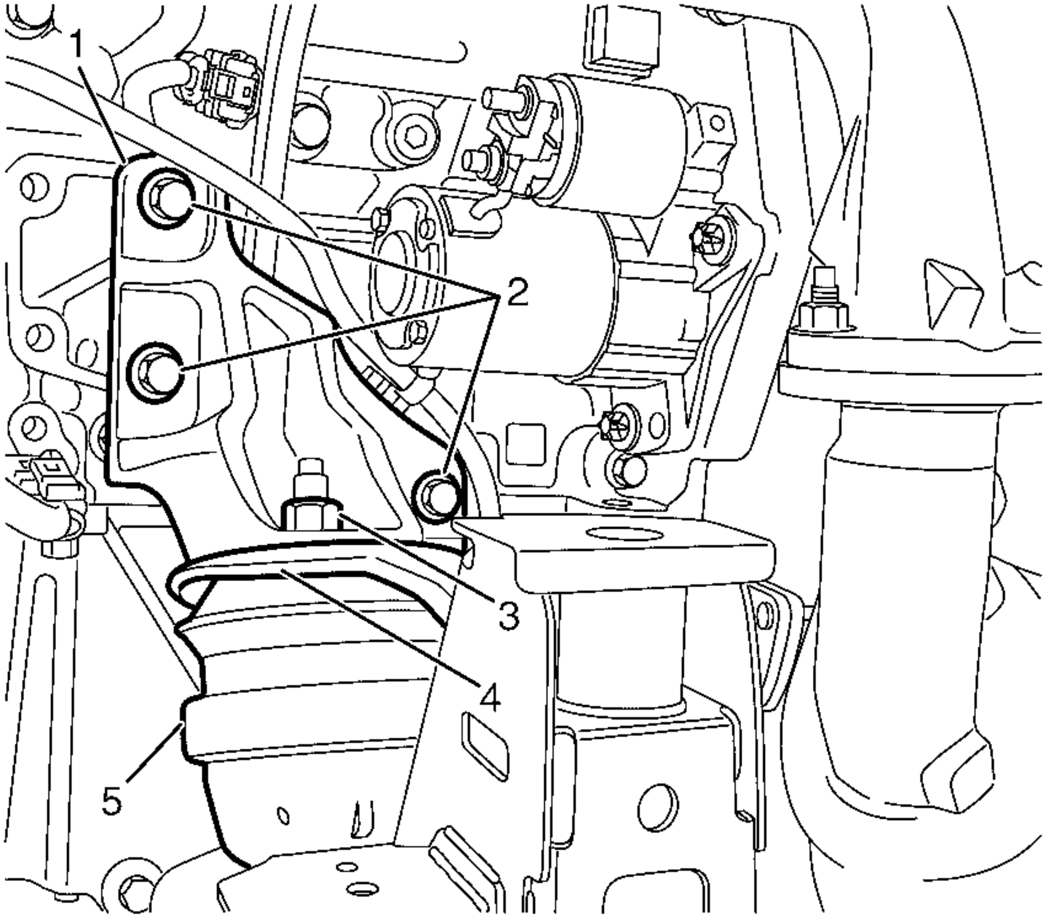


Fig. 31: Identifying Right Hand Engine Mount Bracket To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT distort or bend the right hand engine mount heat shield (4).

1. Install the right hand engine mount bracket (1).

CAUTION: Refer to Fastener Caution .

2. Install the right hand engine mount bracket to cylinder block retaining bolts (2) and tighten to 60 N.m (44 lb ft).

3. Position the right hand engine mount (3) on the right hand engine mount bracket (1).
4. Install the right hand engine mount to engine mount bracket retaining nut (5) and tighten to 80 N.m (59 lb ft).
5. Lower the engine until the weight is resting on the right hand engine mount.

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Safety Glasses Warning .

6. Raise the vehicle.

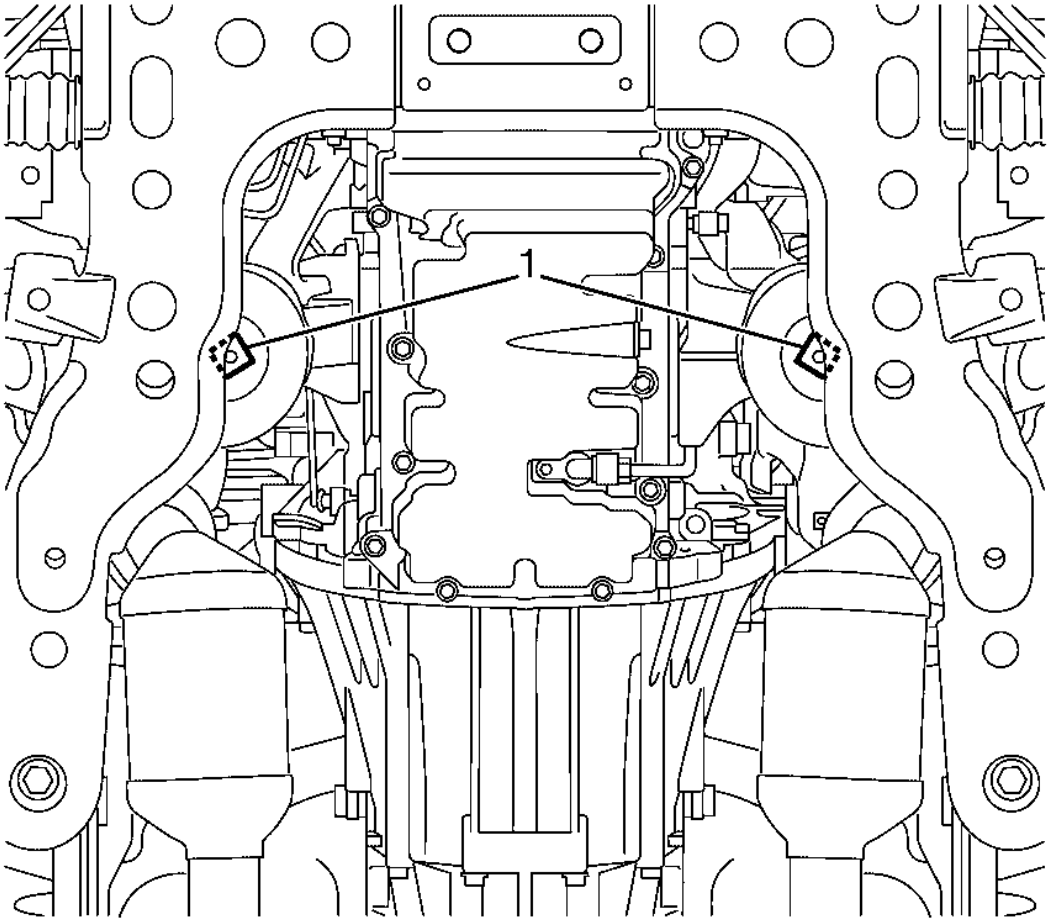


Fig. 32: Identifying Engine Mount To Front Subframe Retaining Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the engine mount to front sub-frame retaining nut (1) and tighten to 80 N.m (59 lb ft).
8. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
9. Lower the vehicle to the ground.

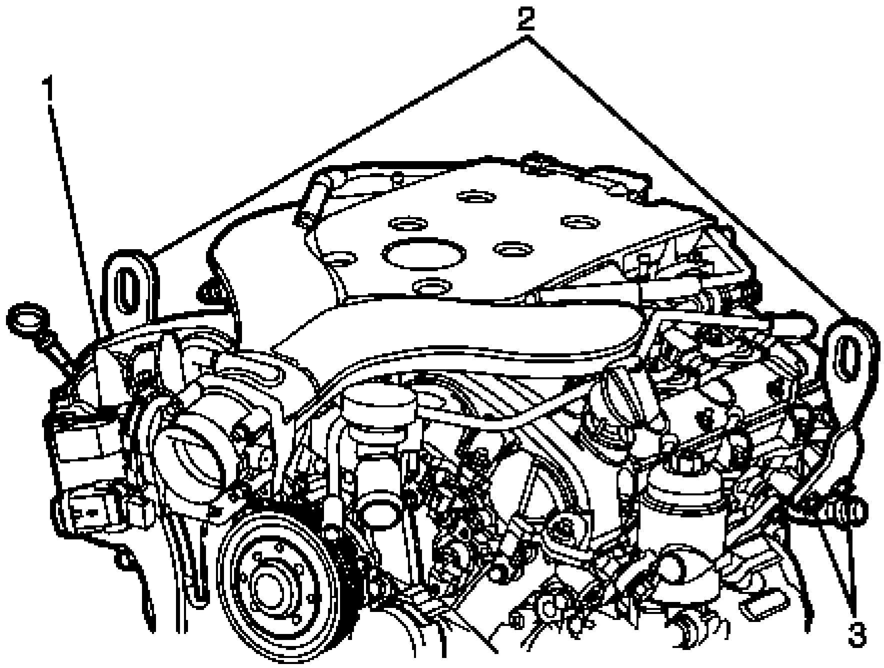


Fig. 33: View Of EN 46114, Engine & Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46114** to cylinder head retaining bolts (3).
11. Remove the **EN 46114** (2) from the engine (1).

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

Removal Procedure

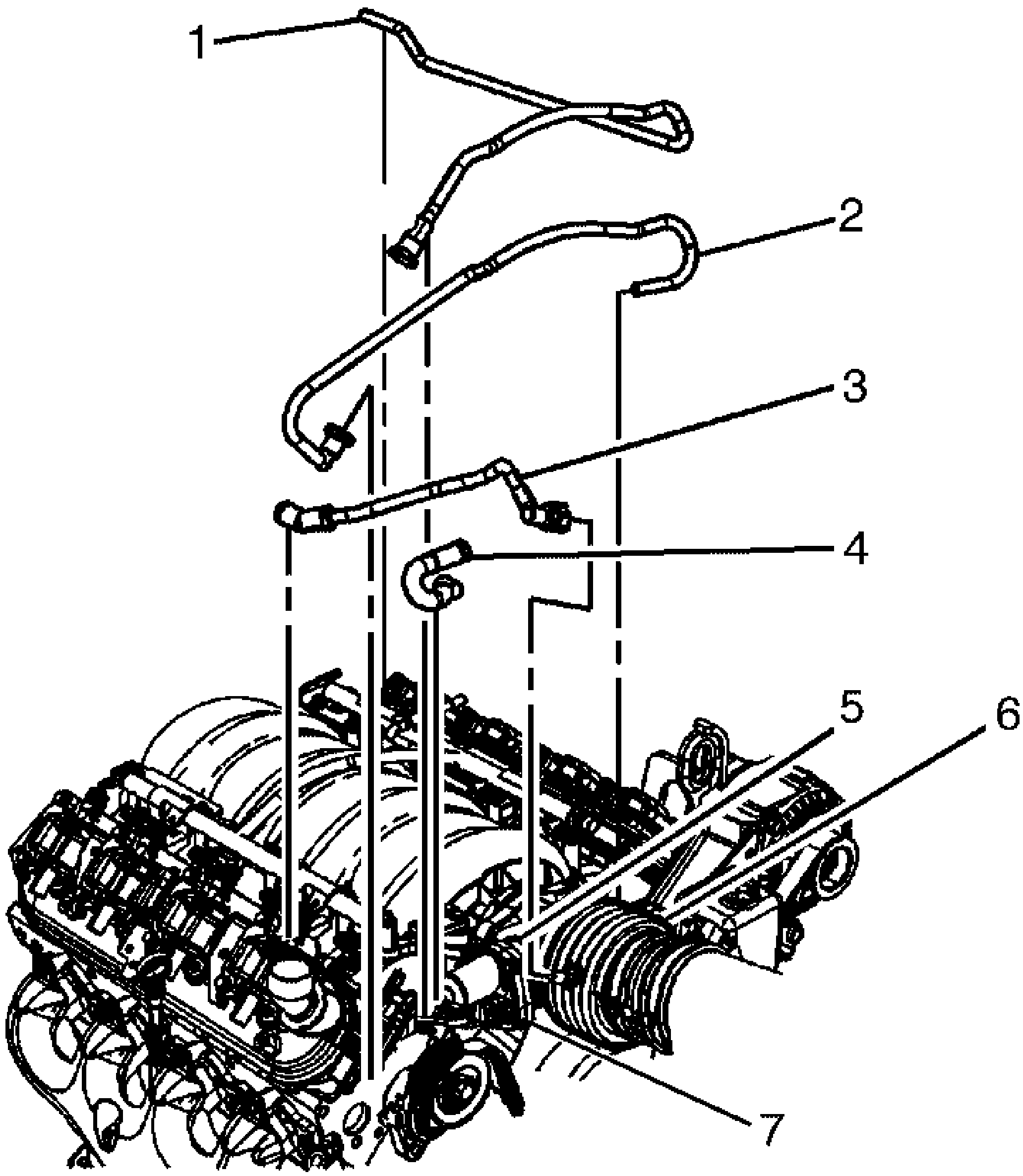


Fig. 34: View Of EVAP Pipes, Emission Canister Purge Valve, Air Intake Duct & Throttle Body
Courtesy of GENERAL MOTORS CORP.

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

IMPORTANT: In the following service procedure, it maybe necessary to remove the evaporative emission (EVAP) valve assembly to gain access to the positive crankcase ventilation hose.

2. Remove the evaporative emission canister purge valve (5). Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
3. Remove the EVAP pipes (1) and (2).
4. Remove the EVAP pipe (3) from the air intake duct (6) and the valve cover.
5. Remove the hose (4) from the throttle body (7) and the engine valley cover.

Installation Procedure

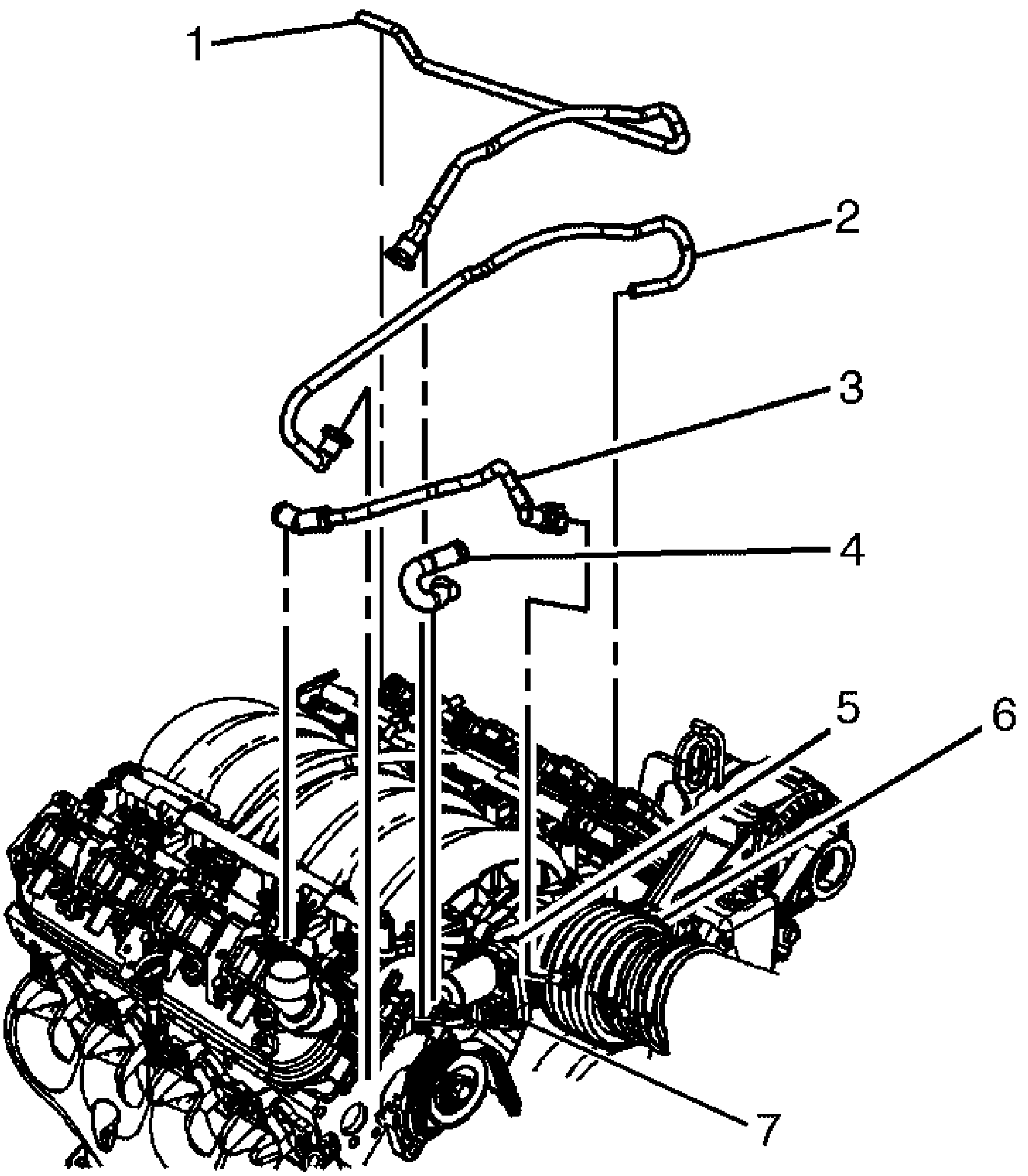


Fig. 35: View Of EVAP Pipes, Emission Canister Purge Valve, Air Intake Duct & Throttle Body
Courtesy of GENERAL MOTORS CORP.

1. Install the hose (4) from the throttle body (7) and the engine valley cover.
2. Install the EVAP pipe (3) from the air intake duct (6) and the valve cover.
3. Install the evaporative emission canister purge valve (5). Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
4. Install the EVAP pipes (1) and (2).
5. Install the engine cover. Refer to **Engine Cover Replacement**.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

IMPORTANT: The intake manifold, throttle body, fuel injection rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Depressurize the fuel system. Refer to **Fuel Pressure Relief** .
3. Disconnect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
5. Remove the air intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .

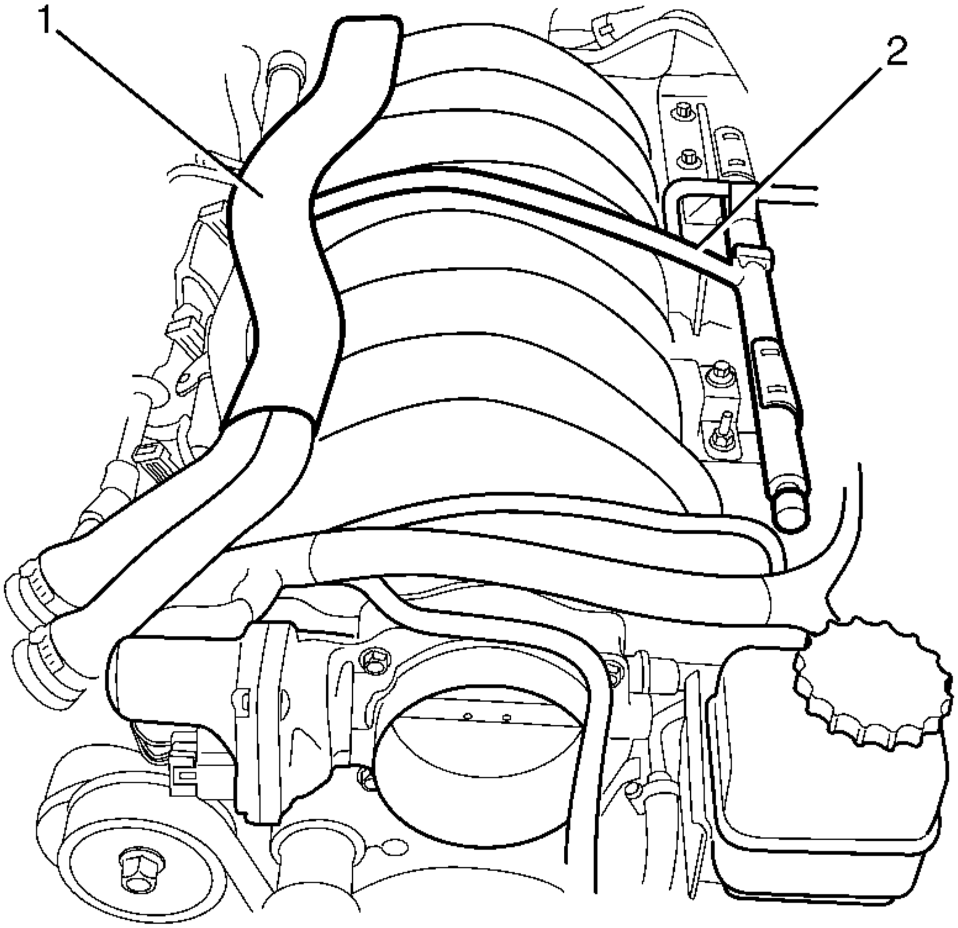


Fig. 36: Identifying Heater Hoses & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

6. Reposition and secure the heater hoses (1) away from the intake manifold (2).

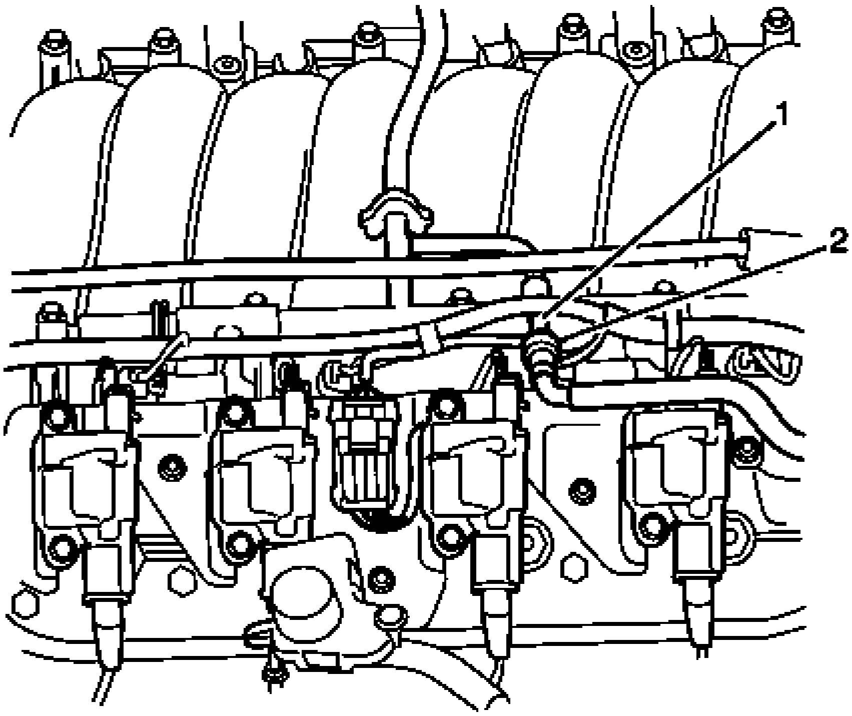


Fig. 37: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

7. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .

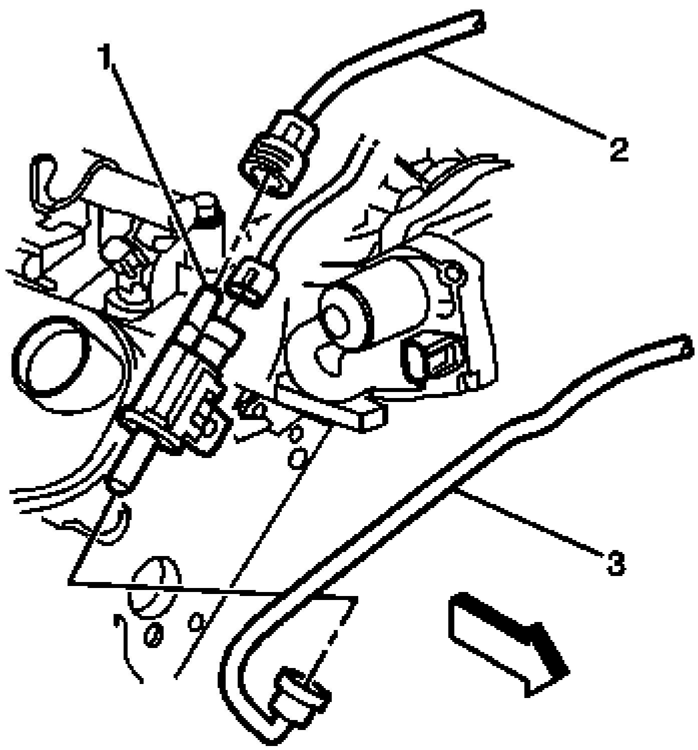


Fig. 38: Locating Fuel Tank Hose, EVAP Purge Valve & Hose
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

8. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

IMPORTANT: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

9. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).

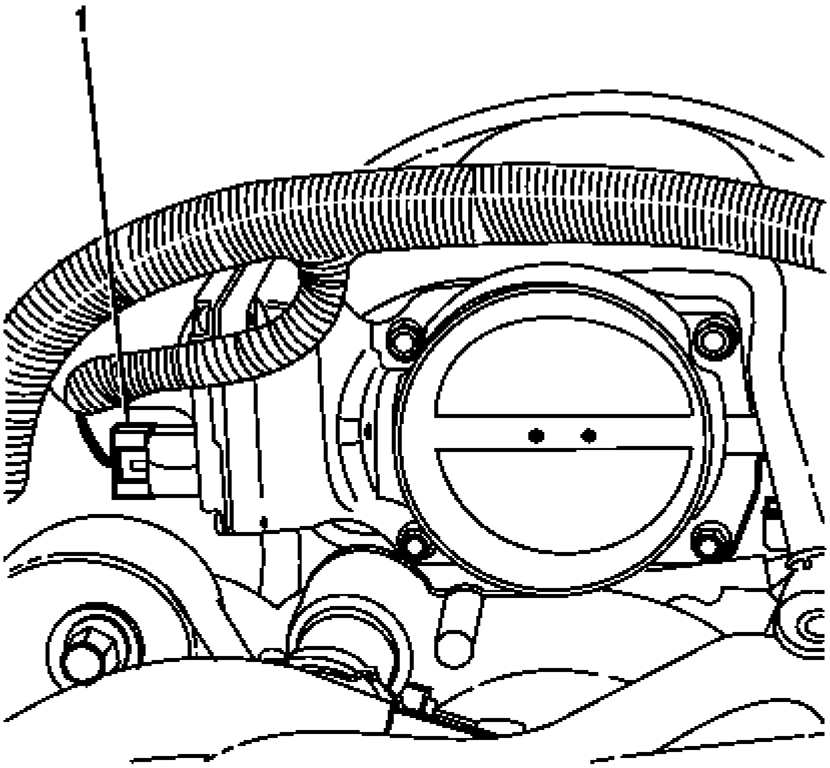


Fig. 39: Identifying Electronic Throttle Body Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the electronic throttle body wiring harness connector (1).

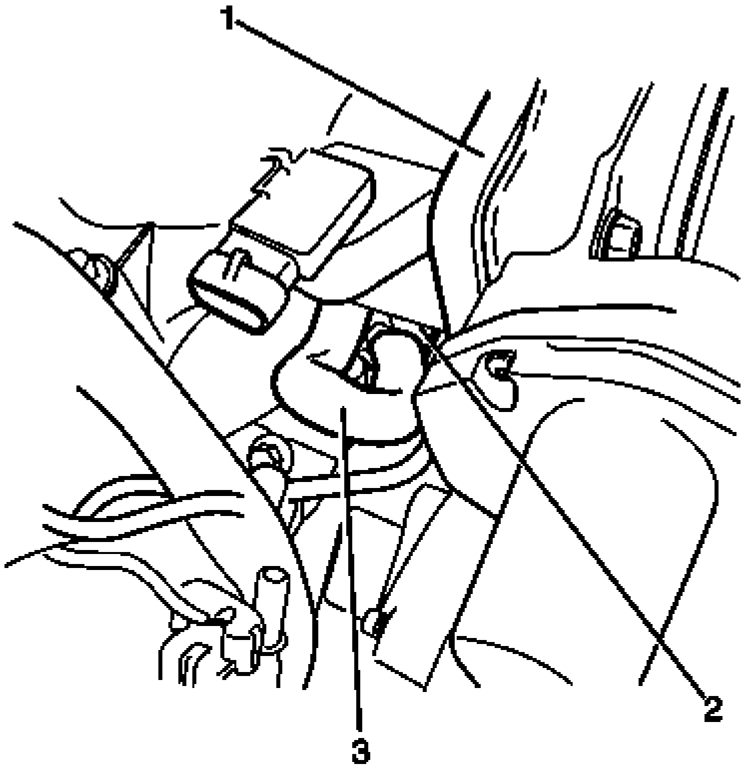


Fig. 40: Locating PCV Hose, Intake Manifold & Valley Cover
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the (PCV) Positive Crankcase Ventilation hose (3) from the intake manifold (1) and the valley cover (2).

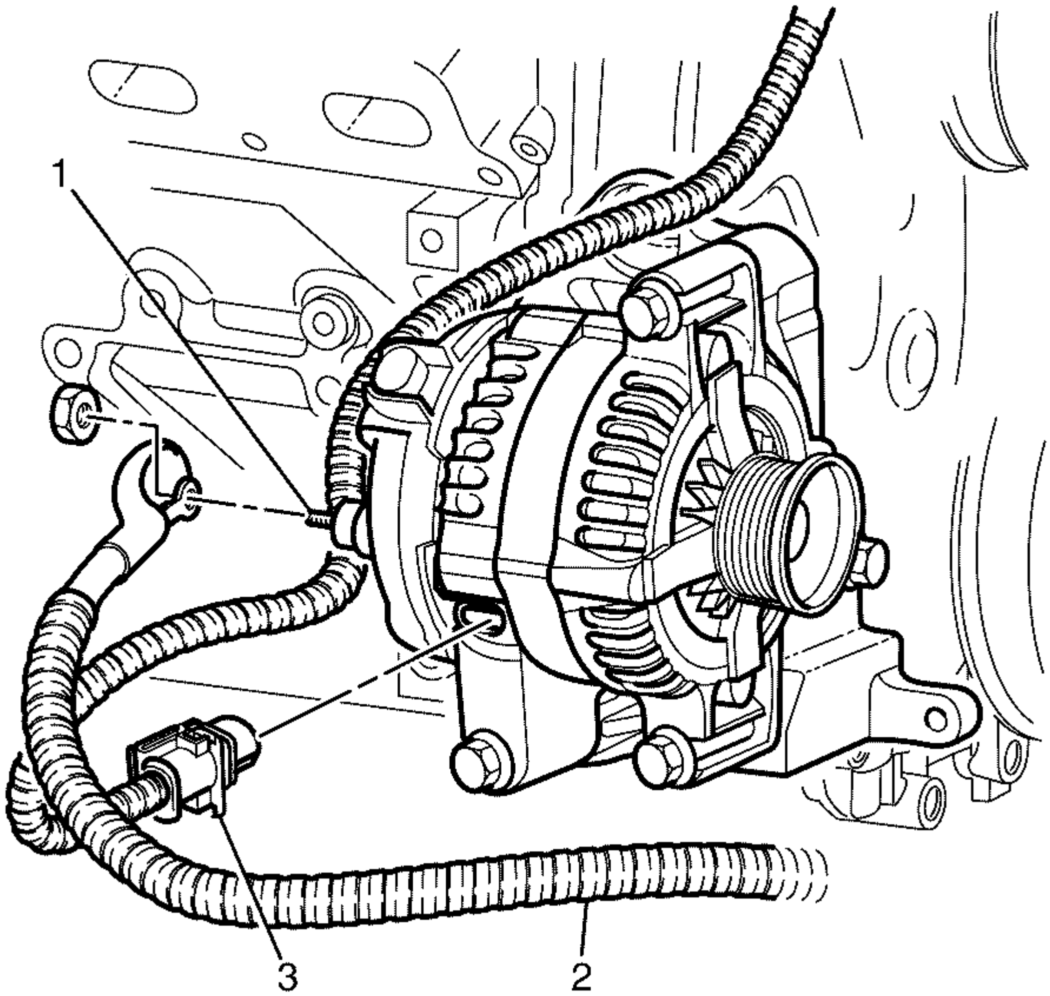


Fig. 41: Identifying Alternator Terminal Nut & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the alternator wiring harness connector (1) from the alternator.

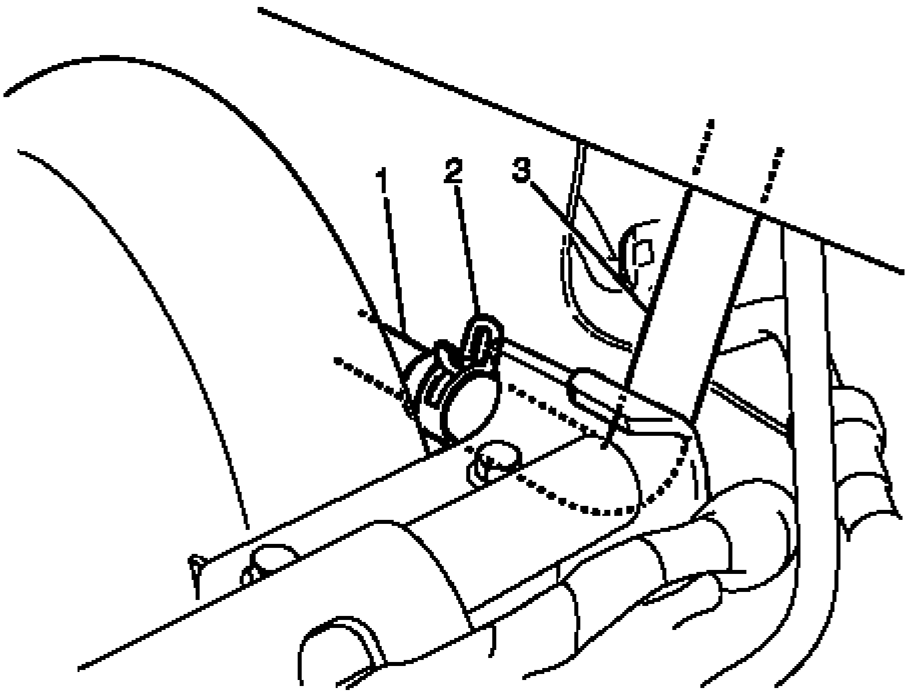


Fig. 42: Identifying Intake Manifold Vacuum Port, Vacuum Hose & Retaining Clamp
Courtesy of GENERAL MOTORS CORP.

13. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
14. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).

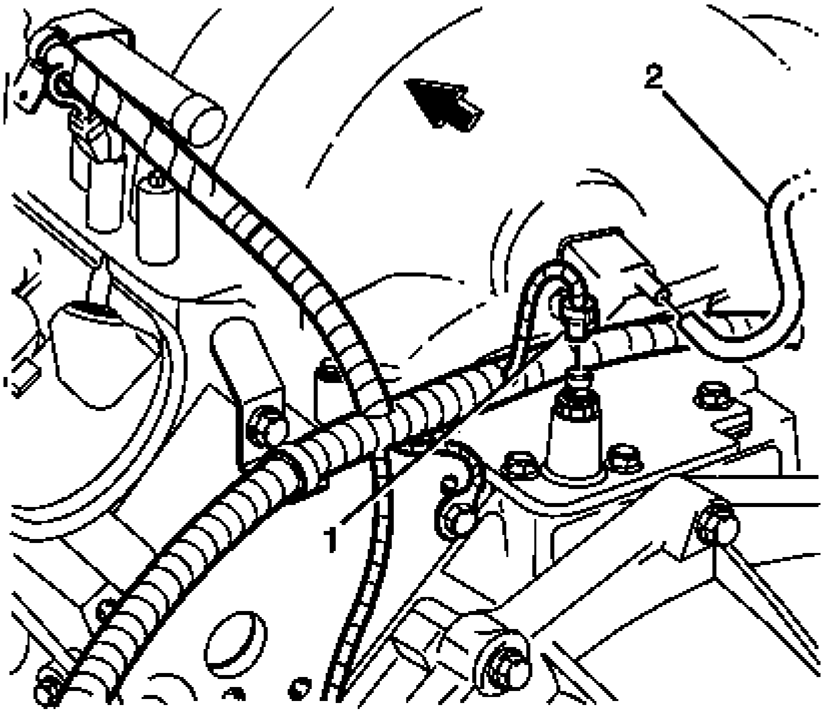


Fig. 43: Identifying HVAC Vacuum Hose & Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the oil pressure sensor wiring harness connector (1) from the oil pressure sensor.
16. Disconnect the HVAC vacuum hose (2) from the intake manifold.

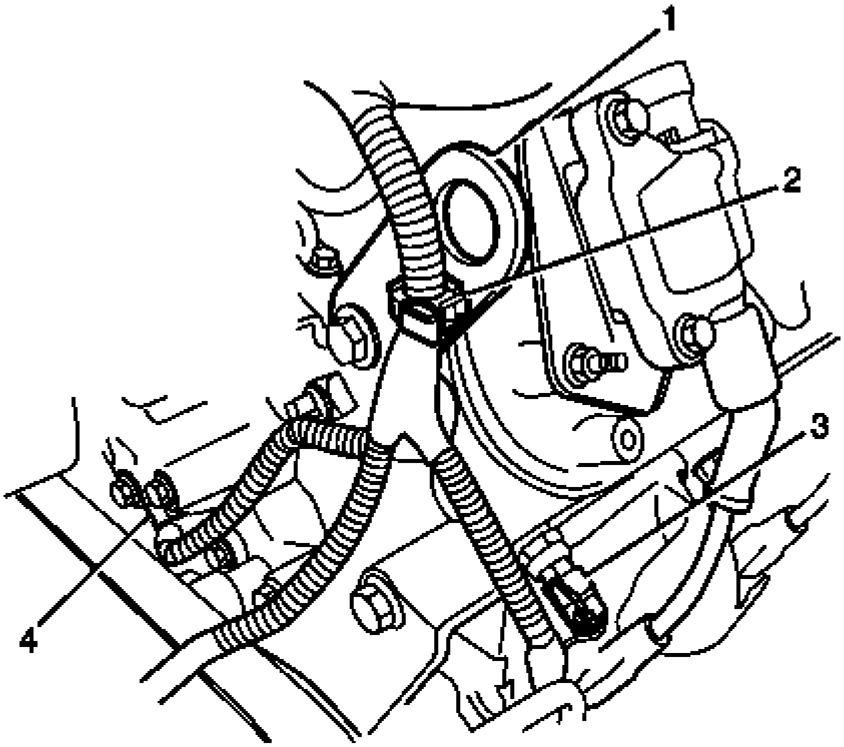


Fig. 44: View Of Camshaft Position Sensor Connector, Coolant Temperature Sensor Connector & Engine Lifting Bracket
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the camshaft position sensor connector (4) from the camshaft position sensor.
18. Disconnect the coolant temperature sensor connector (3) from the coolant temperature sensor.
19. Detach the wiring harness retaining clip (2) from the engine lifting bracket (1).

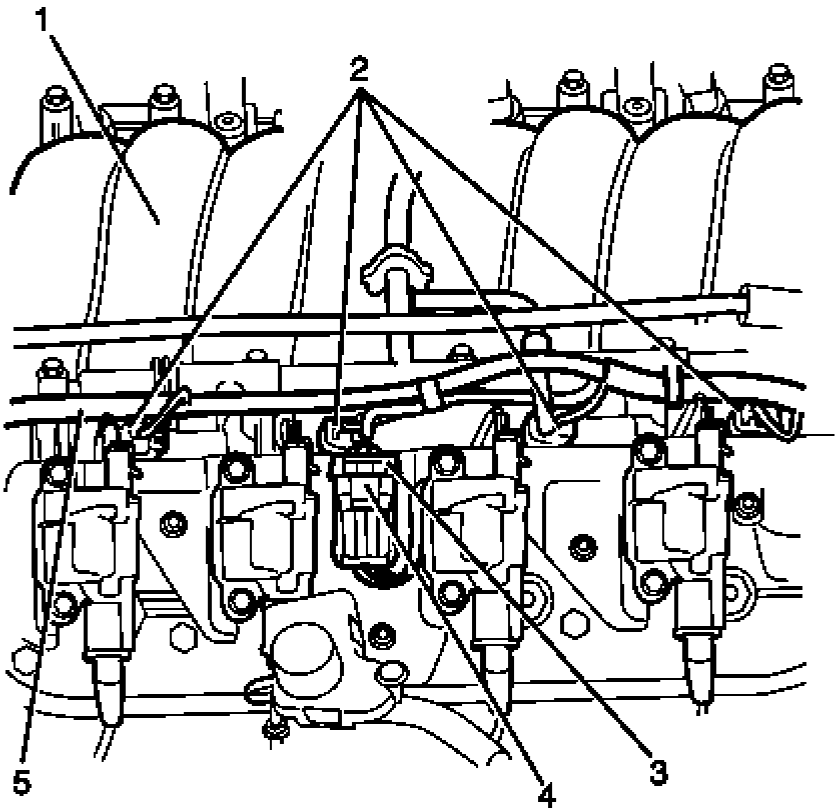


Fig. 45: Identifying Left Side Fuel Injector Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

20. Disconnect the left side fuel injector wiring harness connectors (2) from the fuel injectors.
21. Remove the Connector Position Assurance (CPA) lock (4) from the left side ignition coil main connector (3).
22. Disconnect the left side ignition coil main connector (3) from the ignition coil wiring harness.
23. Reposition and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).

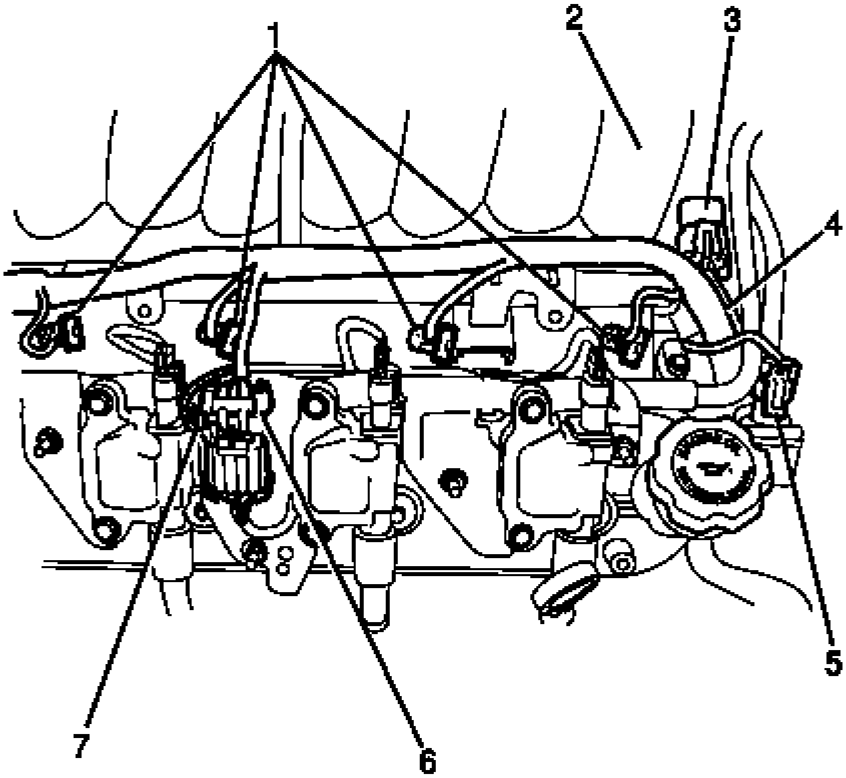


Fig. 46: Identifying Right Side Fuel Injector Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

24. Disconnect the right side fuel injector wiring harness connectors (1) from the fuel injectors.
25. Remove the CPA lock (7) from the right side ignition coil main connector (6).
26. Disconnect the right side ignition coil main connector (6) from the ignition coil wiring harness.
27. Disconnect the canister purge valve (5) wiring harness connector.
28. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (3) from the MAP sensor.
29. Reposition and secure the right side fuel injector wiring harness (4) away from the intake manifold (2).
30. Remove the intake manifold. Refer to **Intake Manifold Removal** .
31. Clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

1. Install the intake manifold. Refer to **Intake Manifold Installation** .

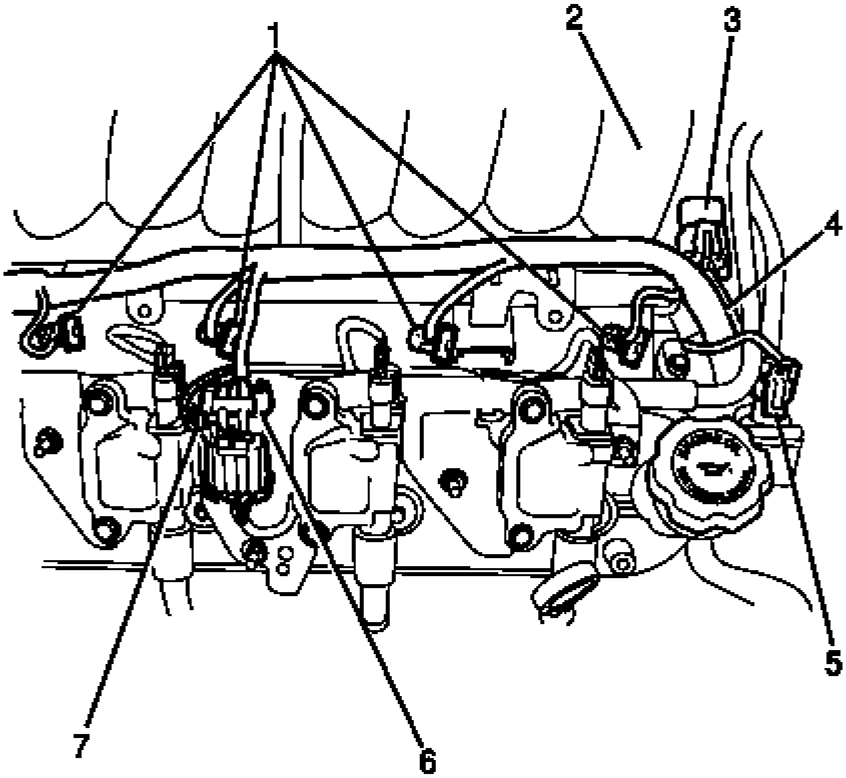


Fig. 47: Identifying Right Side Fuel Injector Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

2. Position the right side fuel injector wiring harness (4) on the intake manifold (2).
3. Connect the Manifold Absolute Pressure (MAP) sensor wiring harness connector (3) to the MAP sensor.
4. Connect the canister purge valve wiring harness connector (5).
5. Connect the right side ignition coil main connector (6) to the ignition coil wiring harness.
6. Install the Connector Position Assurance (CPA) lock (7) from the right side ignition coil main connector (6).
7. Connect the right side fuel injector wiring harness connectors (1) to the fuel injectors.

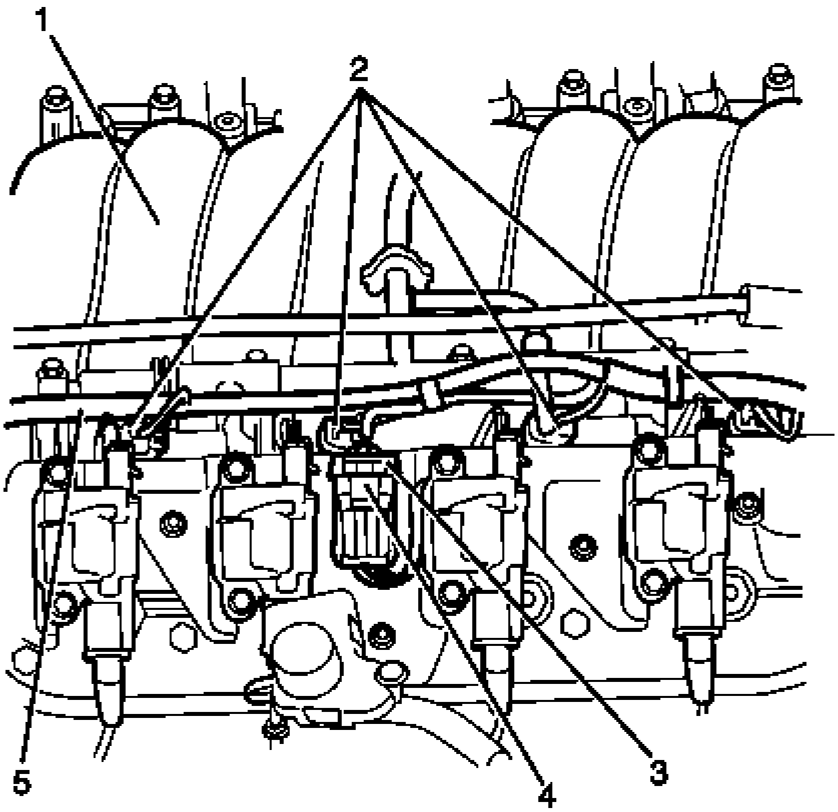


Fig. 48: Identifying Left Side Fuel Injector Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

8. Position the left side fuel injector wiring harness (5) back to its original location the intake manifold (1).
9. Connect the left side ignition coil main connector (3) ignition coil wiring harness.
10. Install the CPA lock (4) from the left side ignition coil main connector (3).
11. Connect the left side fuel injector wiring harness connectors (2) to the fuel injectors.

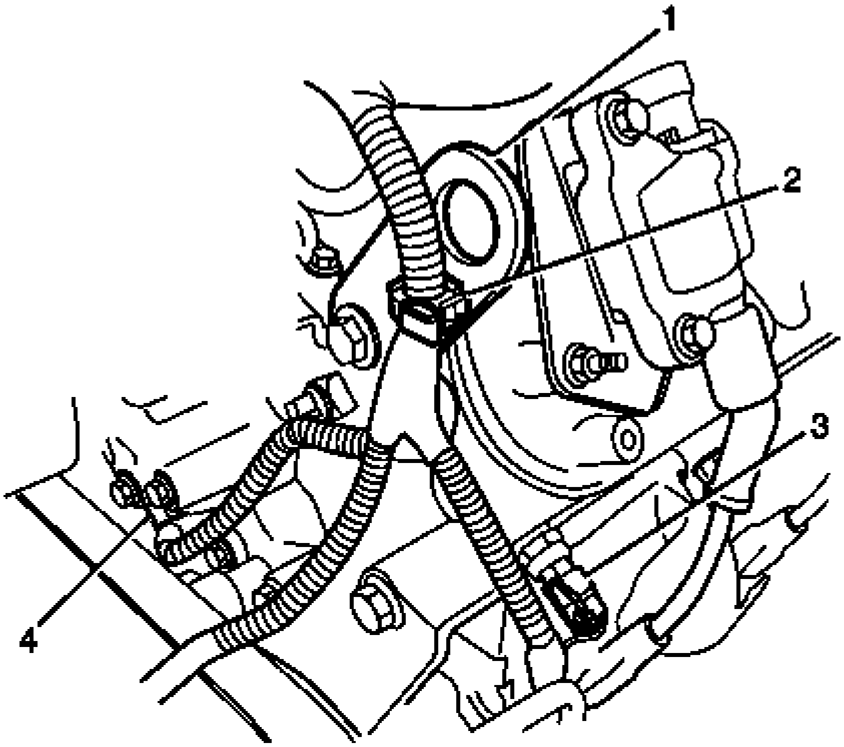


Fig. 49: View Of Camshaft Position Sensor Connector, Coolant Temperature Sensor Connector & Engine Lifting Bracket
Courtesy of GENERAL MOTORS CORP.

12. Connect the camshaft position sensor connector (4) to the camshaft sensor.
13. Connect the coolant temperature sensor connector (3) to the coolant sensor.
14. Attach the wiring harness retaining clip (2) to the engine lifting bracket (1).

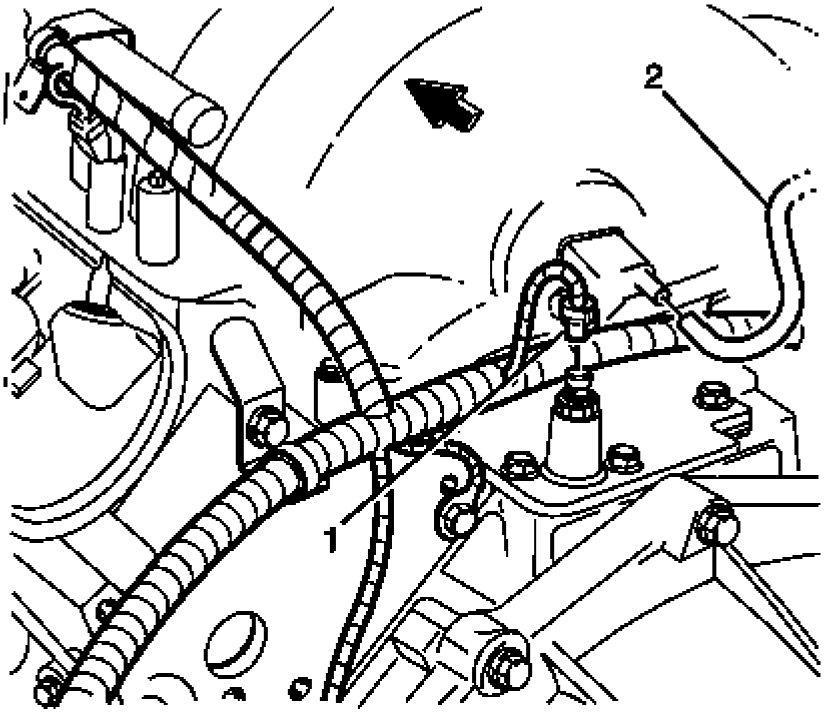


Fig. 50: Identifying HVAC Vacuum Hose & Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

15. Connect the oil pressure sensor wiring harness connector (1) to the oil pressure sensor.
16. Connect the HVAC vacuum hose (2) to the intake manifold.

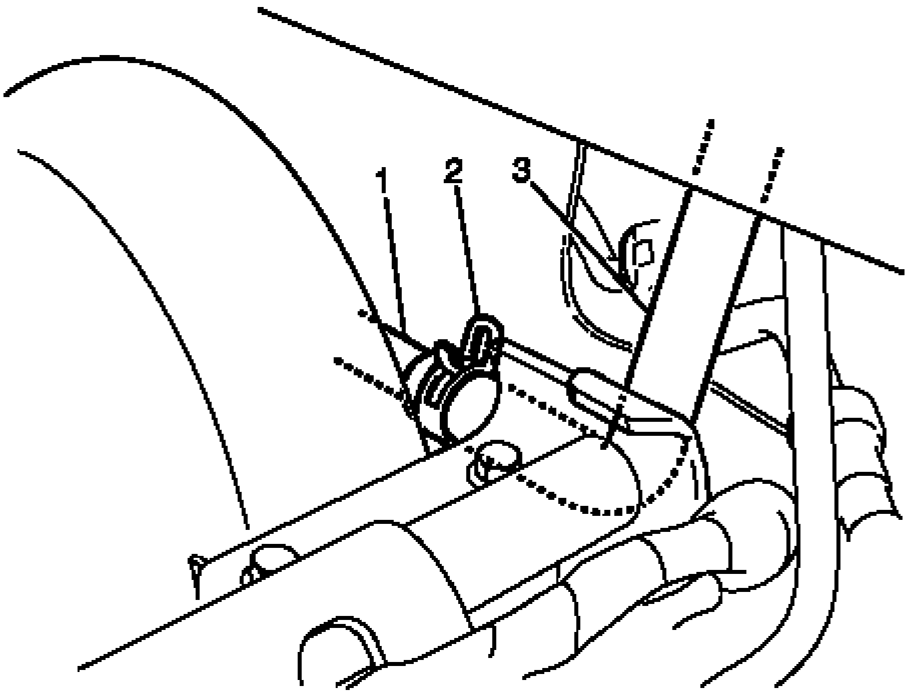


Fig. 51: Identifying Intake Manifold Vacuum Port, Vacuum Hose & Retaining Clamp
Courtesy of GENERAL MOTORS CORP.

17. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
18. Connect the vacuum hose (3) to the intake manifold vacuum port (1).

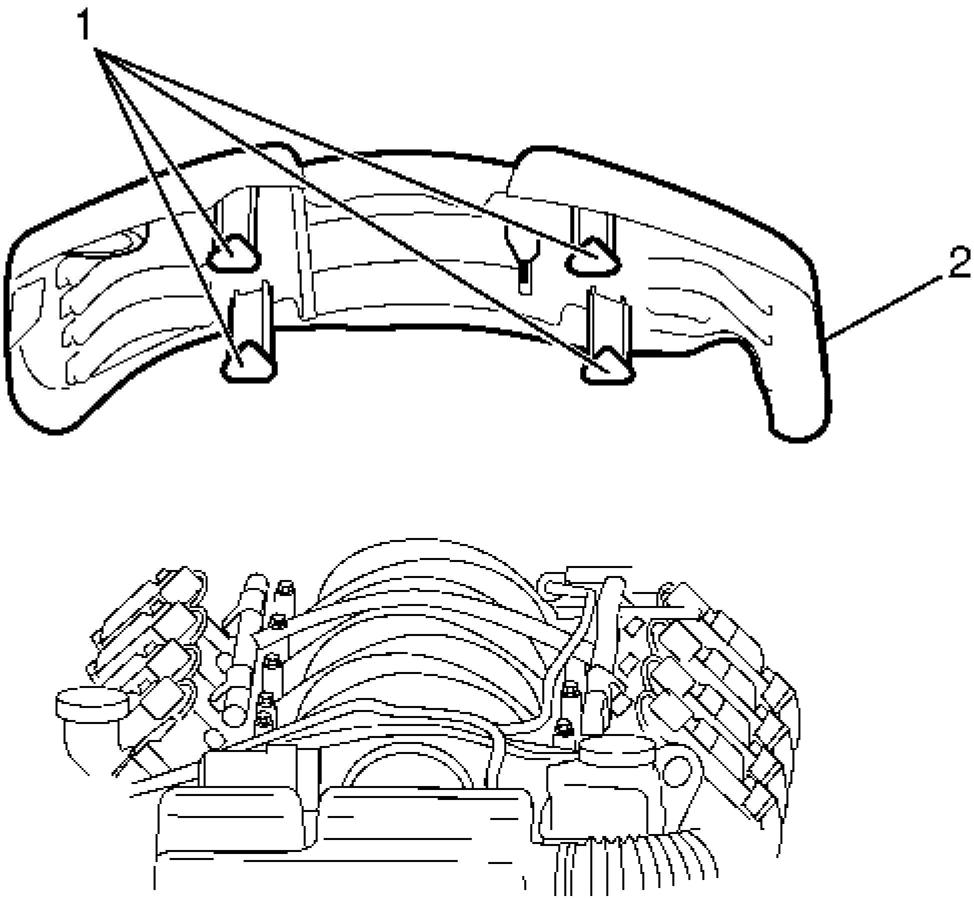


Fig. 52: Identifying Alternator Terminal Nut & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

19. Connect the alternator wiring harness connector (1) to the alternator.

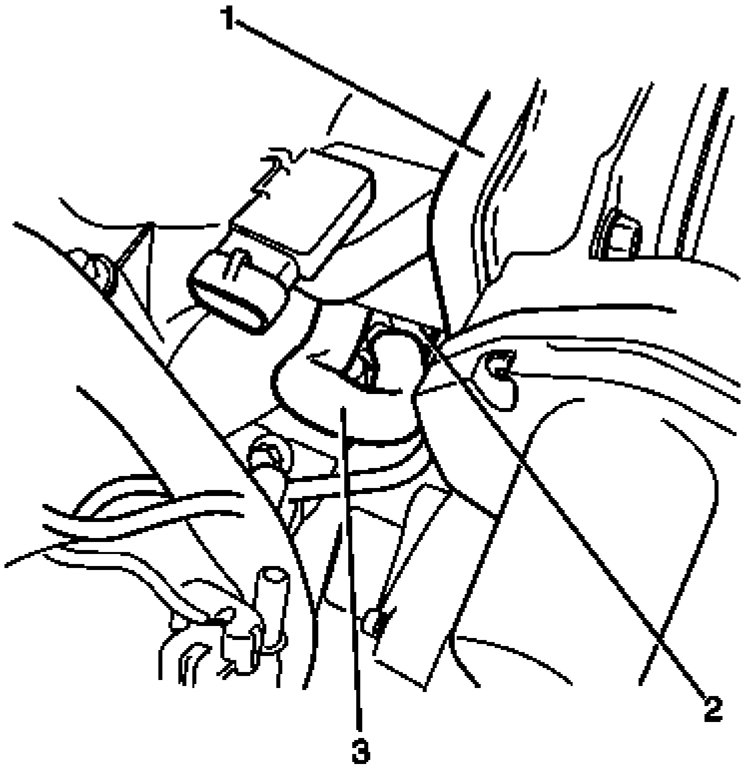


Fig. 53: Locating PCV Hose, Intake Manifold & Valley Cover
Courtesy of GENERAL MOTORS CORP.

20. Connect the PCV hose (3) to the intake manifold (1) and the valley cover (2).

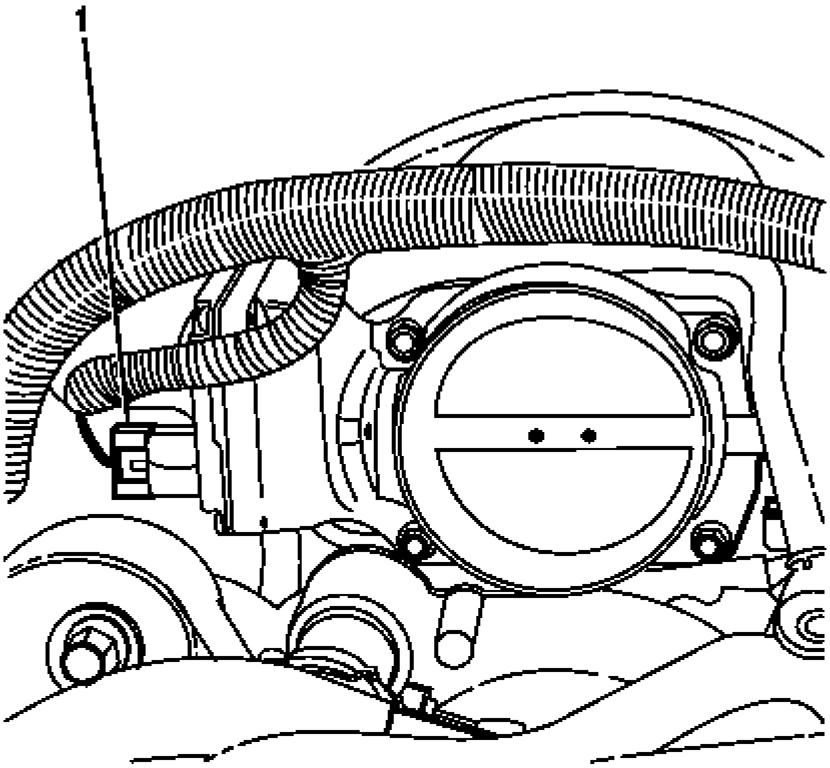


Fig. 54: Identifying Electronic Throttle Body Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

21. Connect the electronic throttle body wiring harness connector (1) to the throttle body.

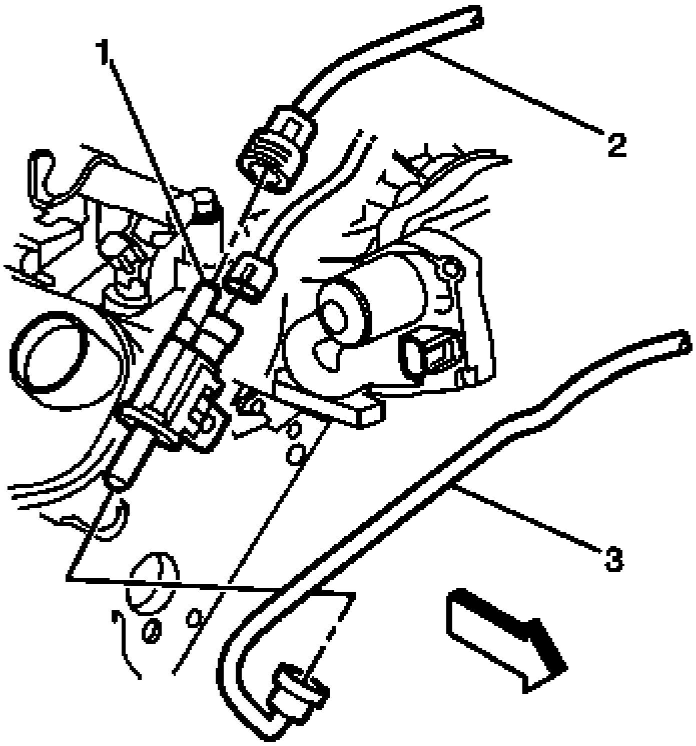


Fig. 55: Locating Fuel Tank Hose, EVAP Purge Valve & Hose
Courtesy of GENERAL MOTORS CORP.

22. Remove the plug on the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends.
23. Connect the throttle body to EVAP purge valve hose (3) to the EVAP purge valve (1).
24. Remove the plug on the throttle body to the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends.
25. Connect the EVAP purge valve to fuel tank hose (2) to the EVAP purge valve (1).

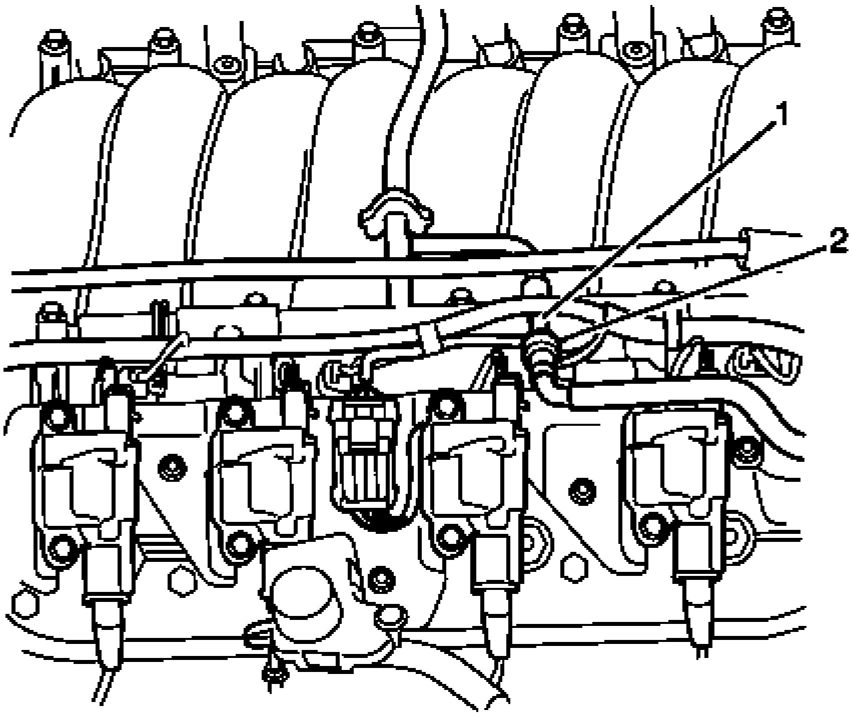


Fig. 56: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

26. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) end.
27. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .

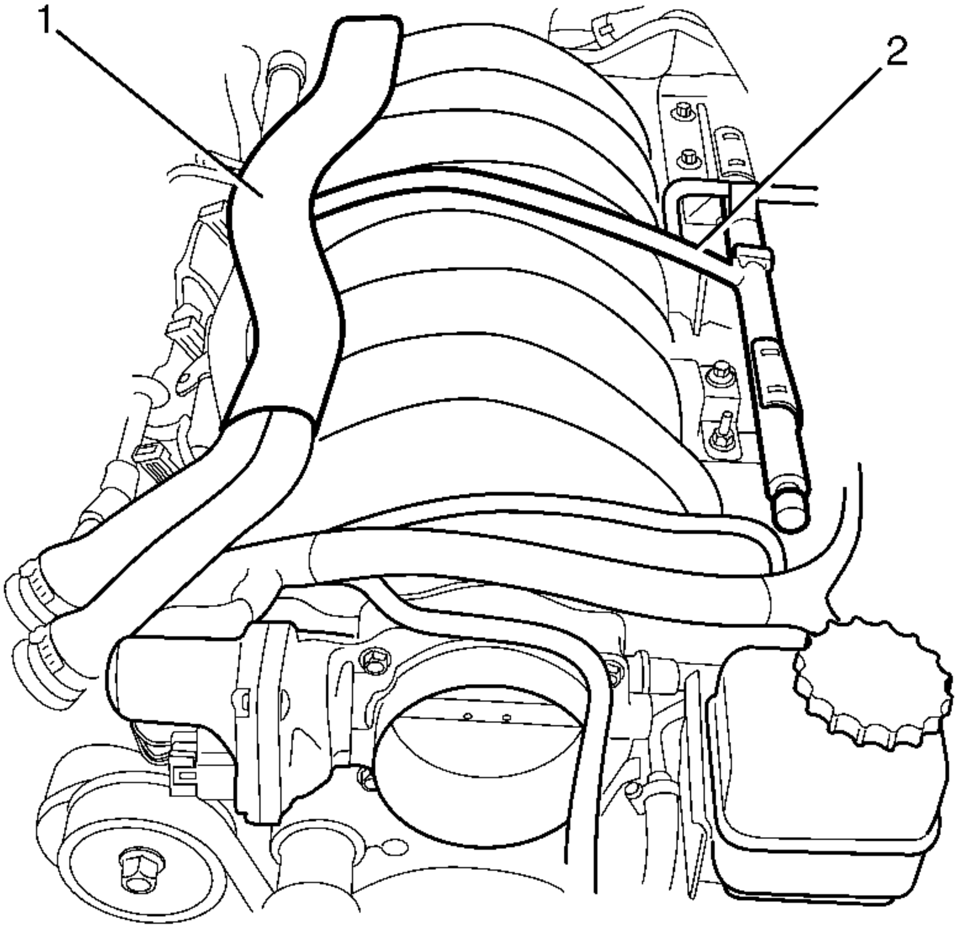


Fig. 57: Identifying Heater Hoses & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

28. Position the heater hoses (1) correctly on the intake manifold (2).
29. Install the air intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
30. Fill the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
31. Connect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .
32. Run engine and check for leaks.
33. Install the engine cover. Refer to **Engine Cover Replacement**.

VALVE LIFTER OIL MANIFOLD REPLACEMENT

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the oil pressure sensor. Refer to **Engine Oil Pressure Sensor and/or Switch Replacement**.

3. Remove the VLOM. Refer to **Valve Lifter Oil Manifold Removal** .

Installation Procedure

1. Install the VLOM. Refer to **Valve Lifter Oil Manifold Removal** .
2. Install the oil pressure sensor. Refer to **Engine Oil Pressure Sensor and/or Switch Replacement**.
3. Install the intake manifold. Refer to **Intake Manifold Replacement**.

VALVE LIFTER OIL FILTER REPLACEMENT

Removal Procedure

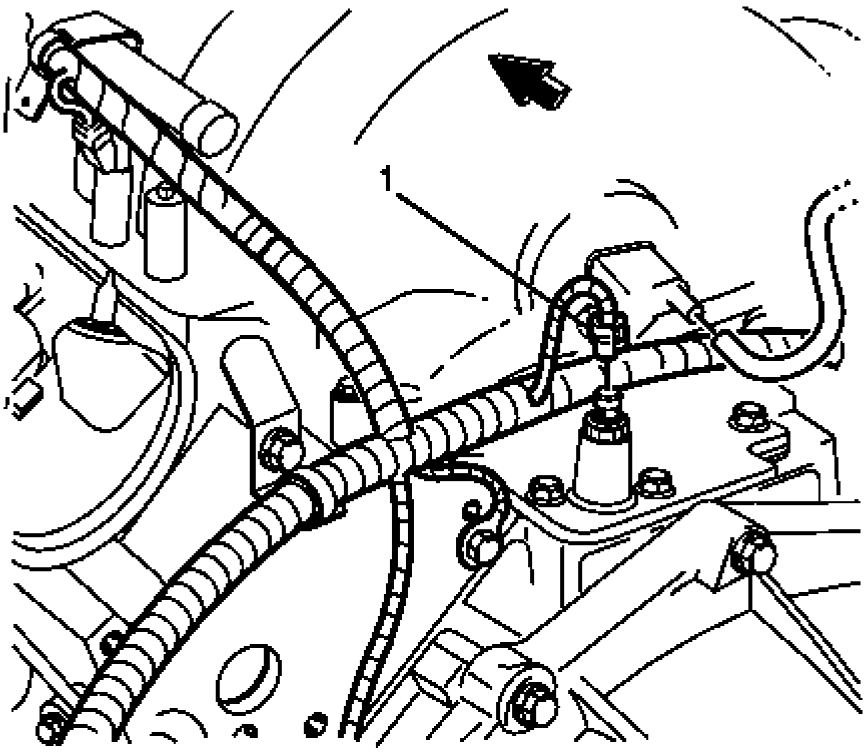


Fig. 58: Identifying Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the oil pressure sensor wiring harness connector (1).
2. Remove the valve lifter oil filter. Refer to **Valve Lifter Oil Filter Removal** .

Installation Procedure

1. Install the valve lifter oil filter. Refer to **Valve Lifter Oil Filter Installation** .

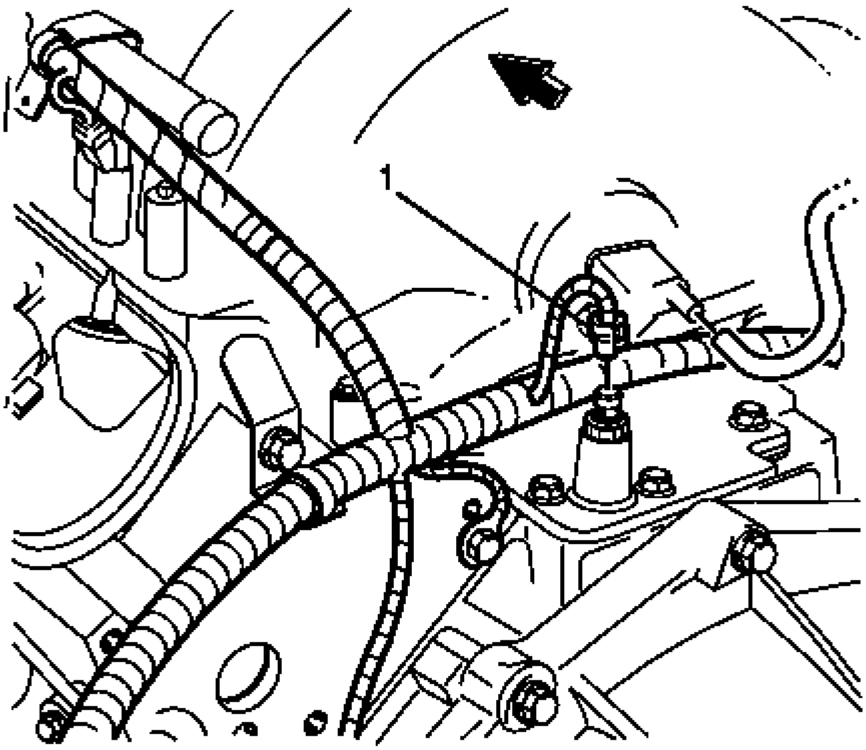


Fig. 59: Identifying Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the oil pressure sensor electrical connector (1).

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the dress engine cover. Refer to **Engine Cover Replacement**.
2. Depressurize the fuel system. Refer to **Fuel Pressure Relief** .
3. Disconnect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .

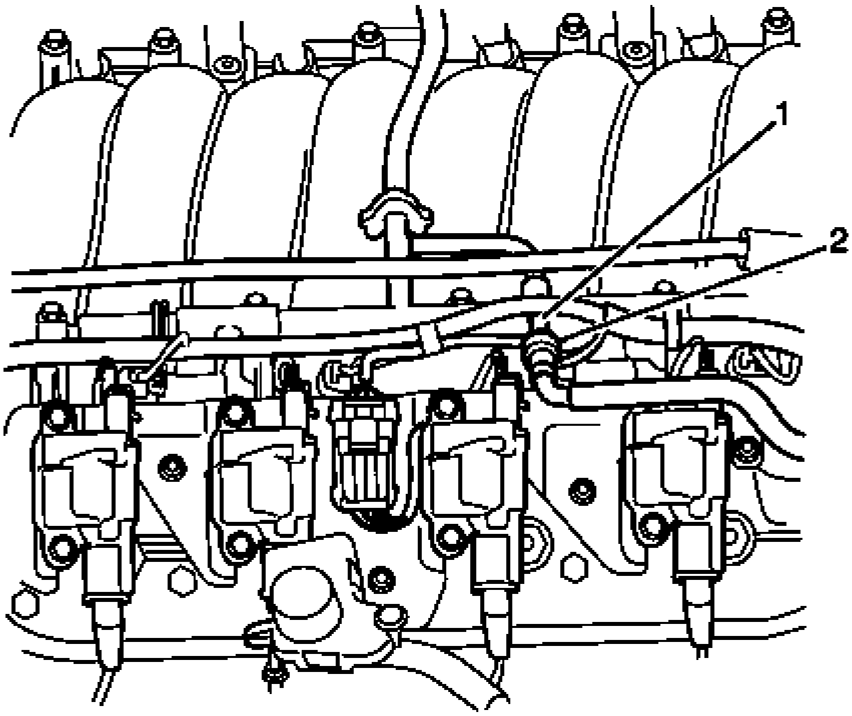


Fig. 60: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.**

4. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .

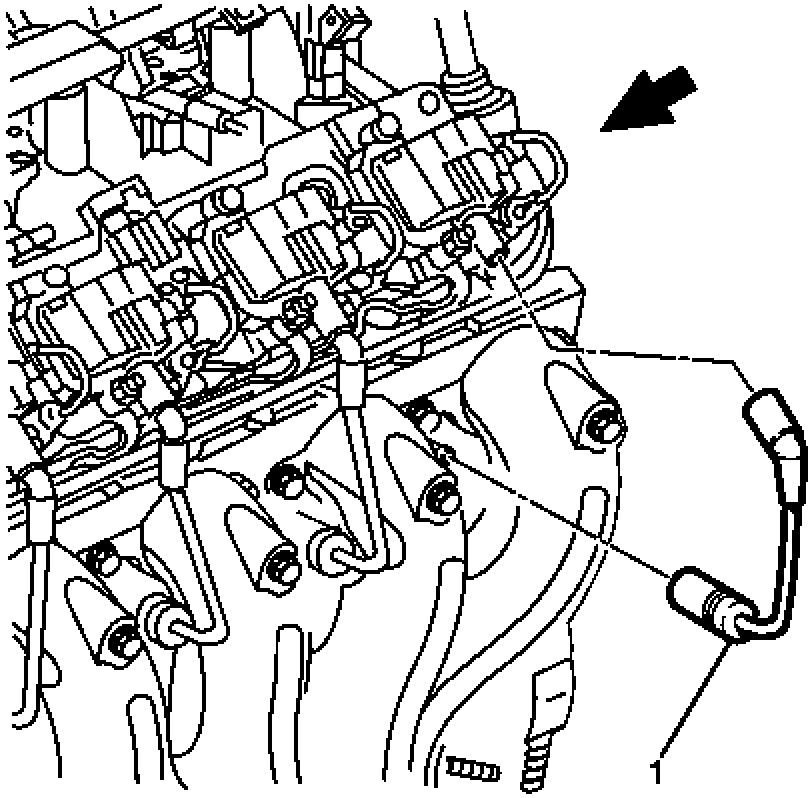


Fig. 61: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

5. Remove the spark plug leads (1).

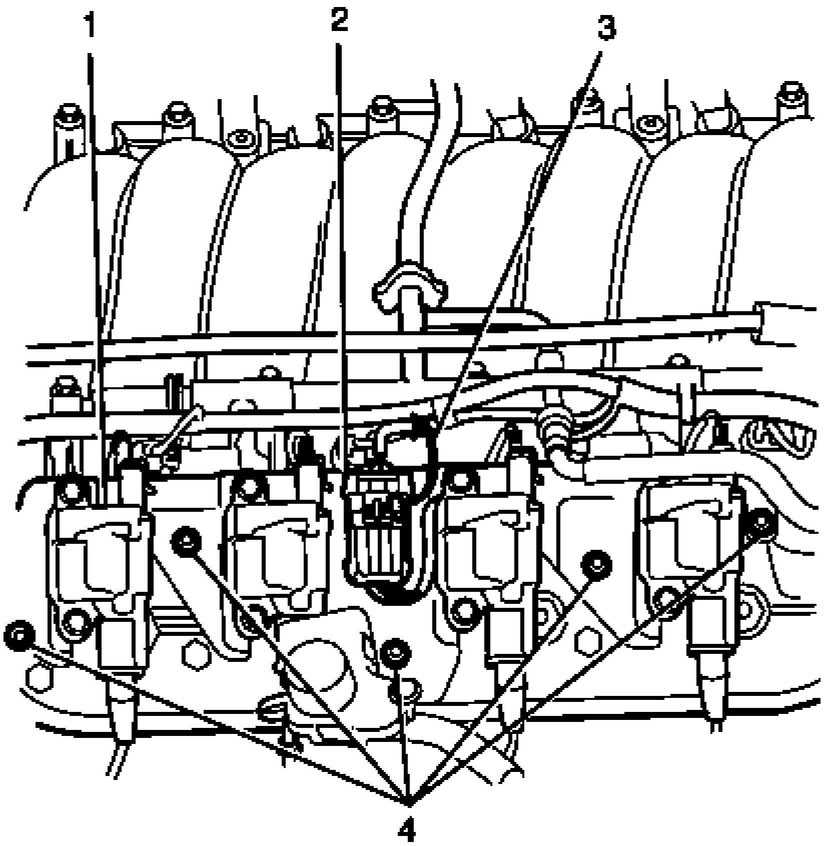


Fig. 62: Identifying Ignition Coil Assembly To Valve Rocker Arm Cover Retaining Studs (Left Side)
Courtesy of GENERAL MOTORS CORP.

6. Remove the connector position assurance (CPA) lock (3) from the ignition coil main connector (2).
7. Disconnect the ignition coil main connector (2).
8. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
9. Remove the ignition coil assembly (1).

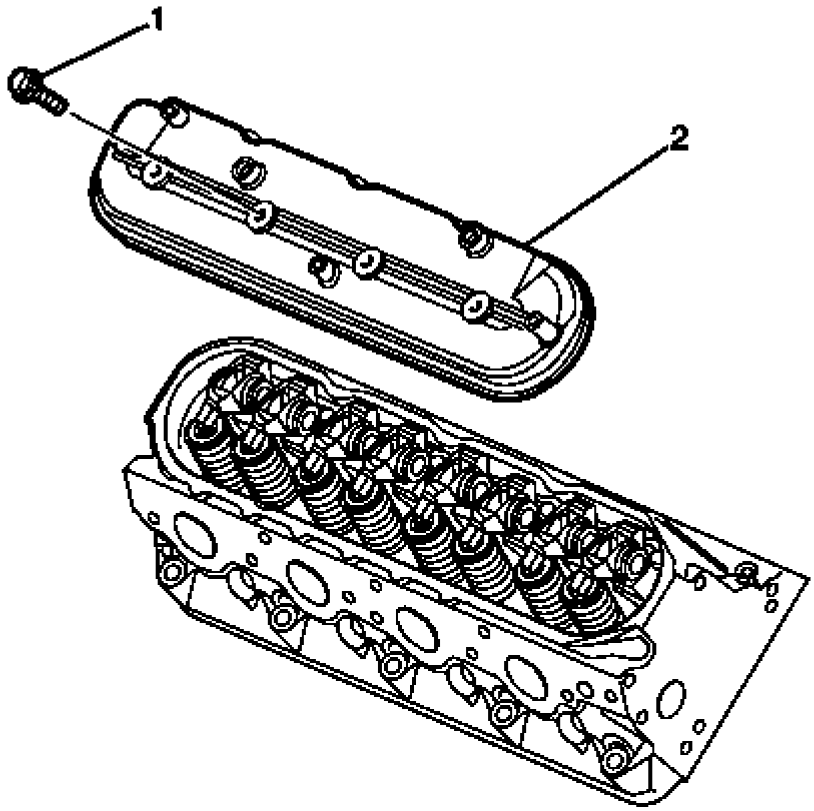


Fig. 63: Identifying Valve Rocker Arm Cover To Cylinder Head Retaining Bolts (Left Side)
Courtesy of GENERAL MOTORS CORP.

10. Loosen the valve rocker arm cover to cylinder head retaining bolts (1).
11. Remove the valve rocker arm cover (2).

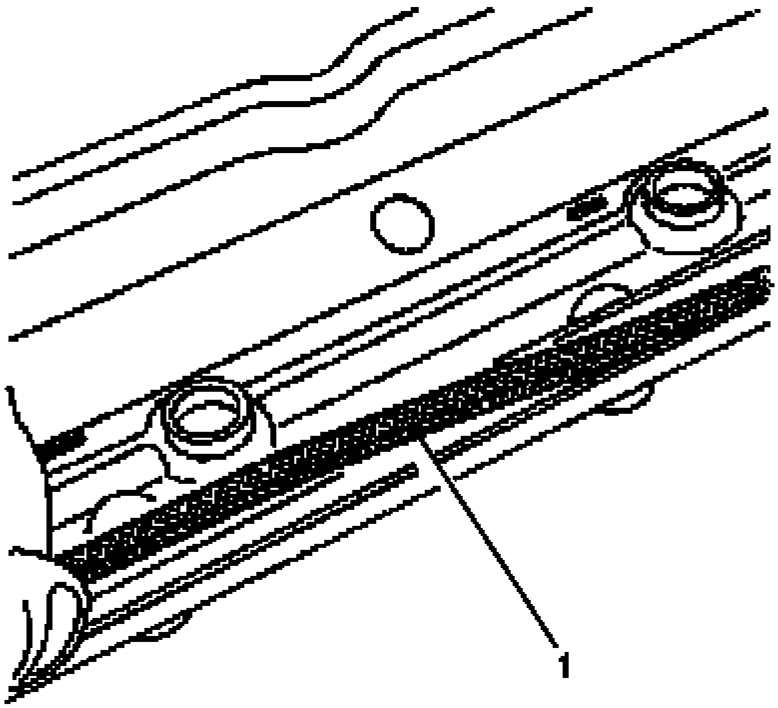


Fig. 64: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: **The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.**

12. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).

Installation Procedure

NOTE:

- **All gasket surfaces should be free of oil and other foreign material during assembly.**
- **DO NOT reuse the valve rocker arm cover gasket.**
- **The valve rocker arm cover bolt grommets may be reused.**
- **If the positive crankcase ventilation (PCV) valve grommet has been removed from the rocker arm cover, install a NEW grommet during assembly.**

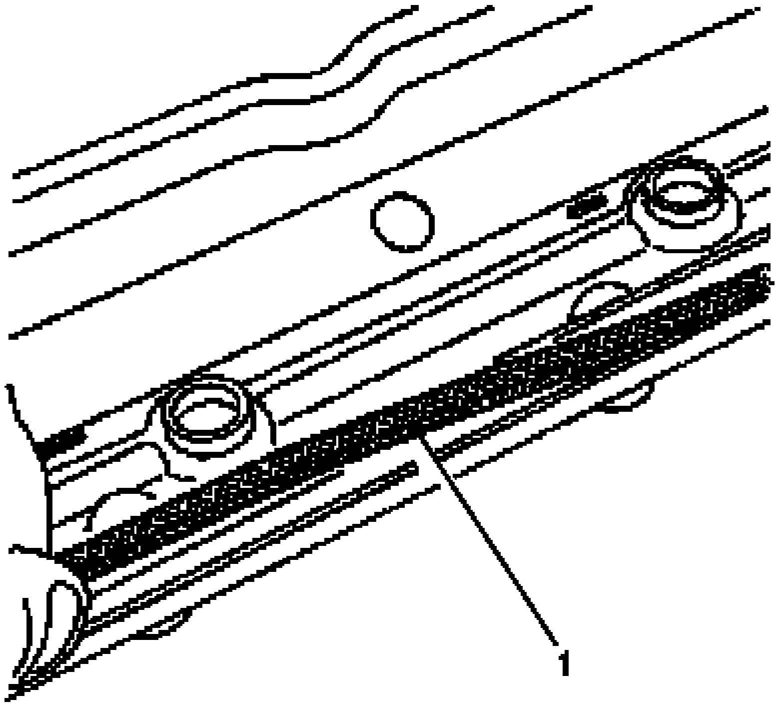


Fig. 65: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve rocker arm cover gasket (1).
2. Install the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Installation - Left Side** .

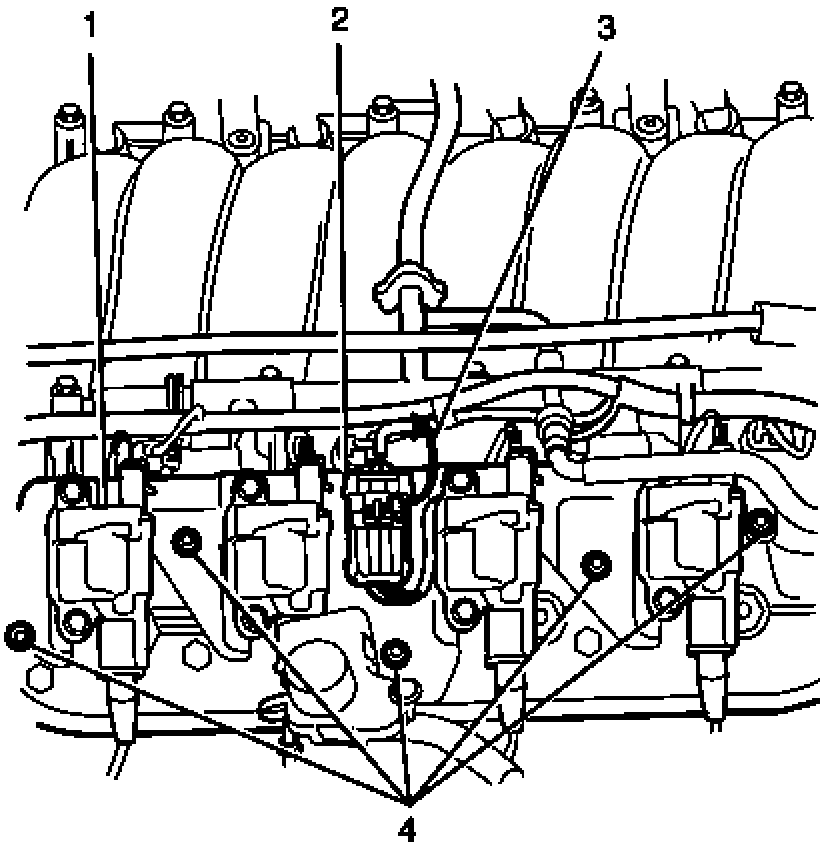


Fig. 66: Identifying Ignition Coil Assembly To Valve Rocker Arm Cover Retaining Studs (Left Side)
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coil assembly (1).

CAUTION: Refer to Fastener Caution .

4. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to 12 N.m (106 lb in).
5. Connect the ignition coil main connector (2).
6. Install the CPA lock (3) from the ignition coil main connector (2).

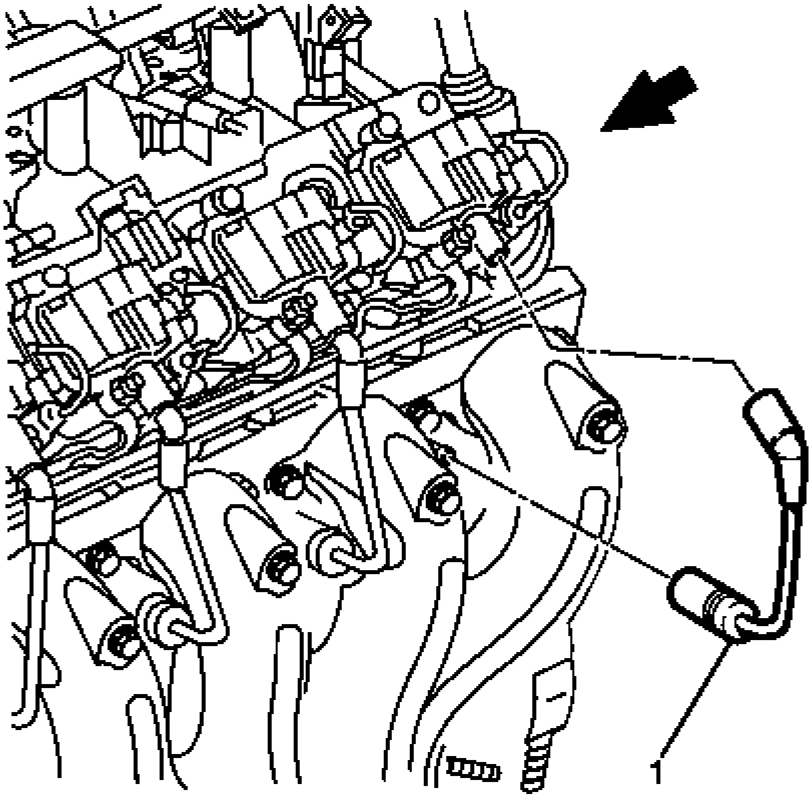


Fig. 67: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

7. Install the spark plug leads (1).

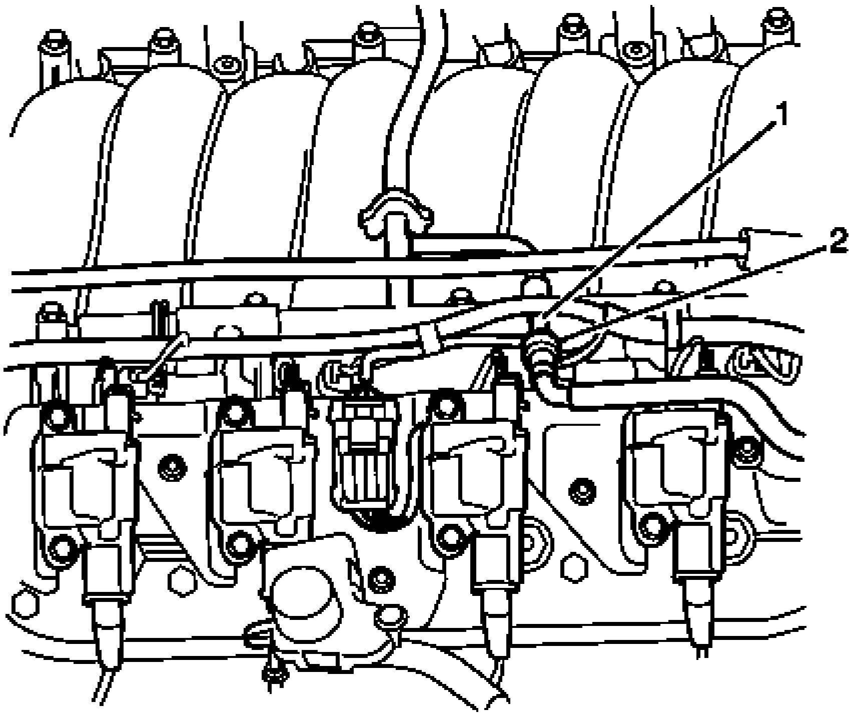


Fig. 68: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

8. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) ends.
9. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .
10. Connect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .
11. Install the dress engine cover. Refer to **Engine Cover Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Disconnect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine cover. Refer to **Engine Cover Replacement**.

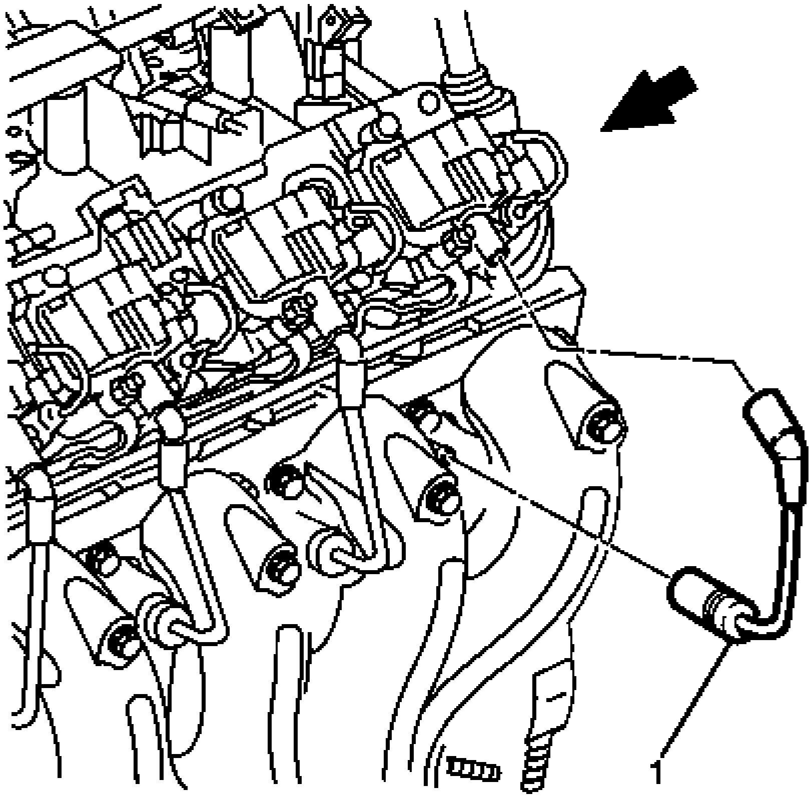


Fig. 69: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

3. Remove the spark plug leads (1).

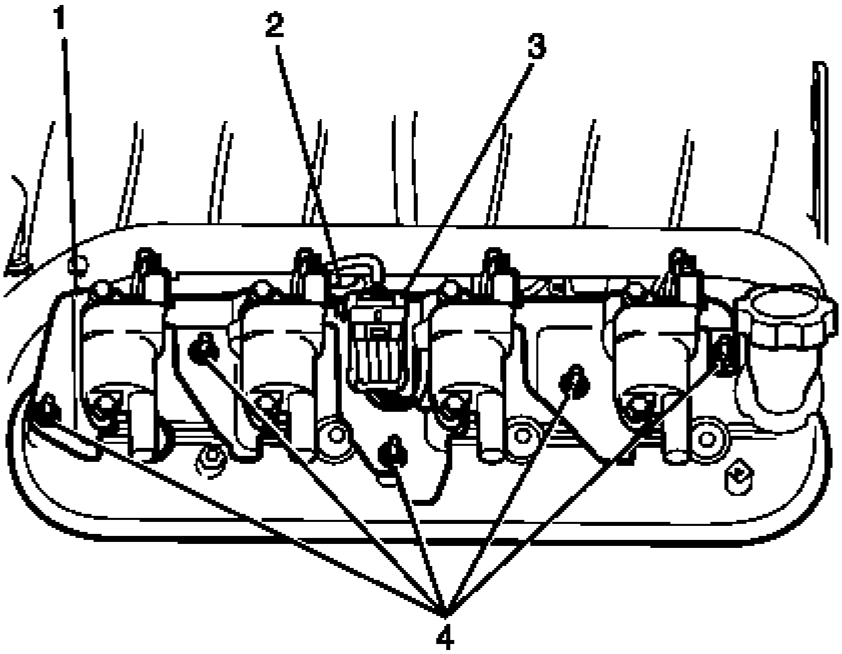


Fig. 70: Identifying Ignition Coil Assembly To Valve Rocker Arm Cover Retaining Studs (Right Side)
Courtesy of GENERAL MOTORS CORP.

4. Remove the CPA lock (2) from the ignition coil main connector (3).
5. Disconnect the ignition coil main connector (3).
6. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
7. Remove the ignition coil assembly (1).

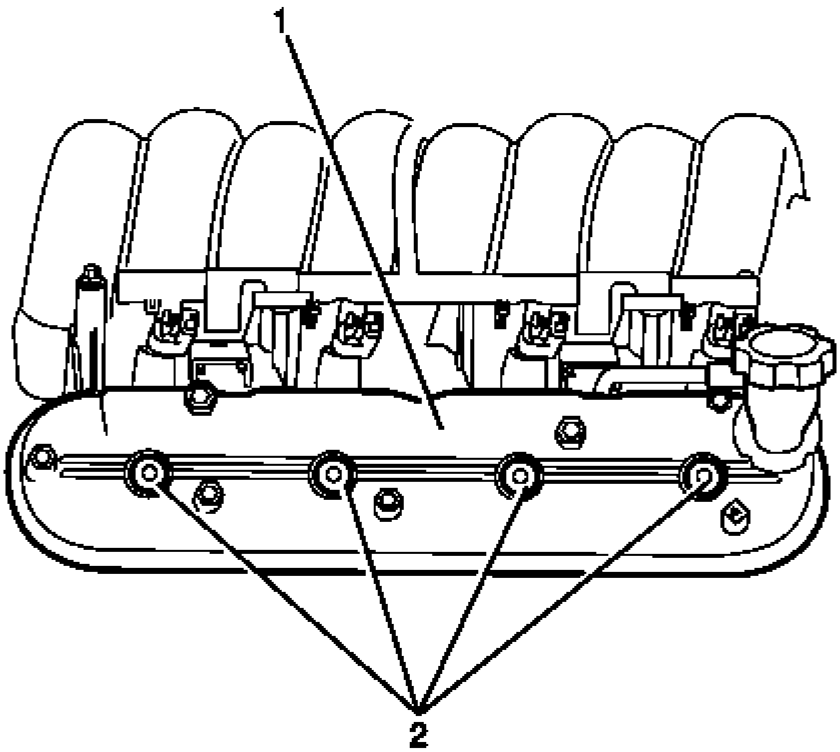


Fig. 71: Identifying Valve Rocker Arm Cover & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve rocker arm cover retaining bolts (2) and valve rocker arm cover (1).
9. Remove the valve rocker arm cover (1). Refer to **Valve Rocker Arm Cover Installation - Right Side** .

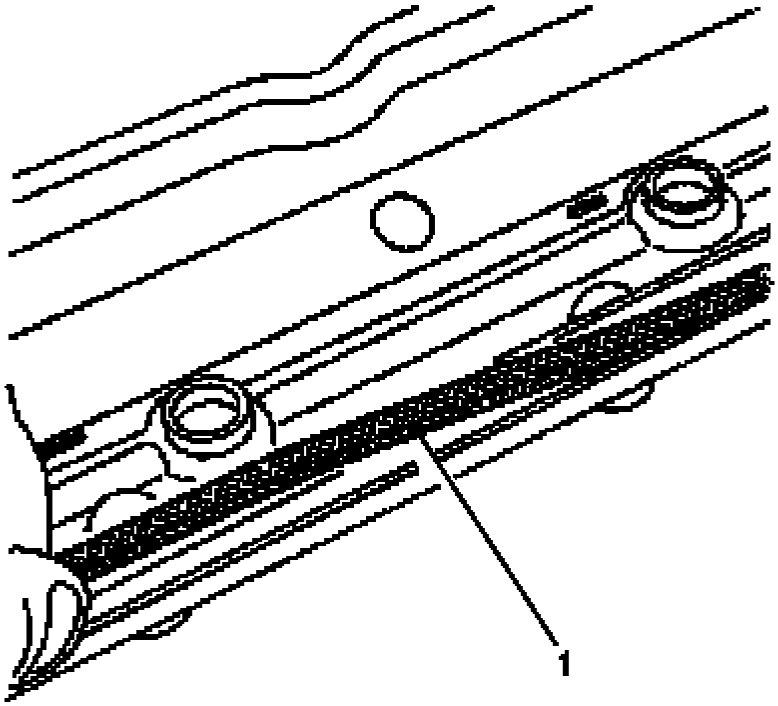


Fig. 72: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: **The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.**

10. Remove the valve rocker arm cover gasket (1).

    Discard the valve rocker arm cover gasket (1).

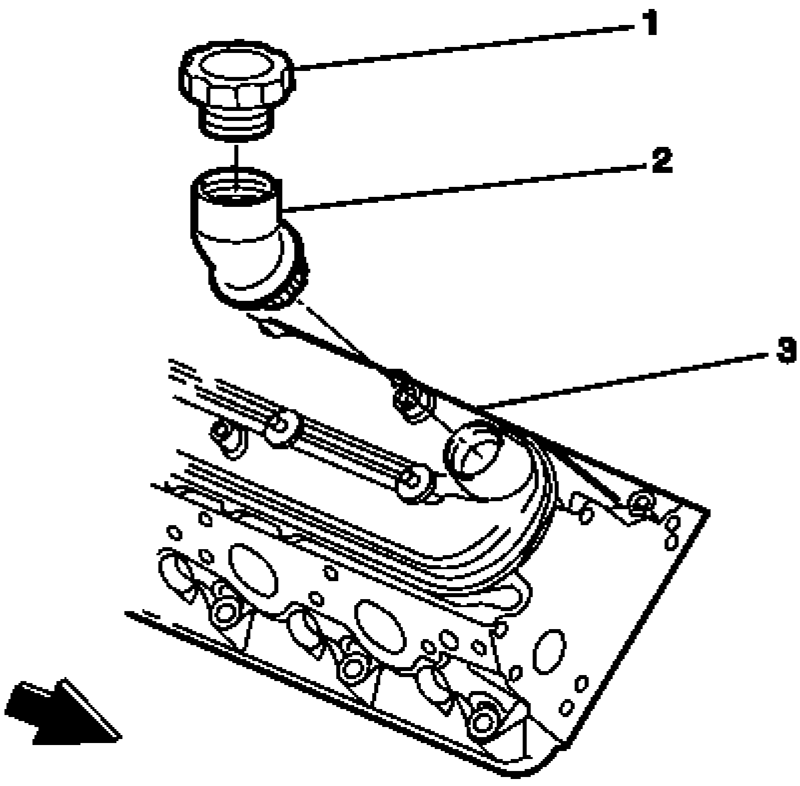


Fig. 73: View Of Valve Rocker Arm Cover, Oil Fill Tube & Cap (Right Side)
Courtesy of GENERAL MOTORS CORP.

11. Remove the oil fill cap (1) from the oil fill tube (2).

NOTE: **Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.**

12. Remove the oil fill tube (2), from the right hand valve rocker arm cover (3) if required.

    Discard the oil fill tube (2).

Installation Procedure

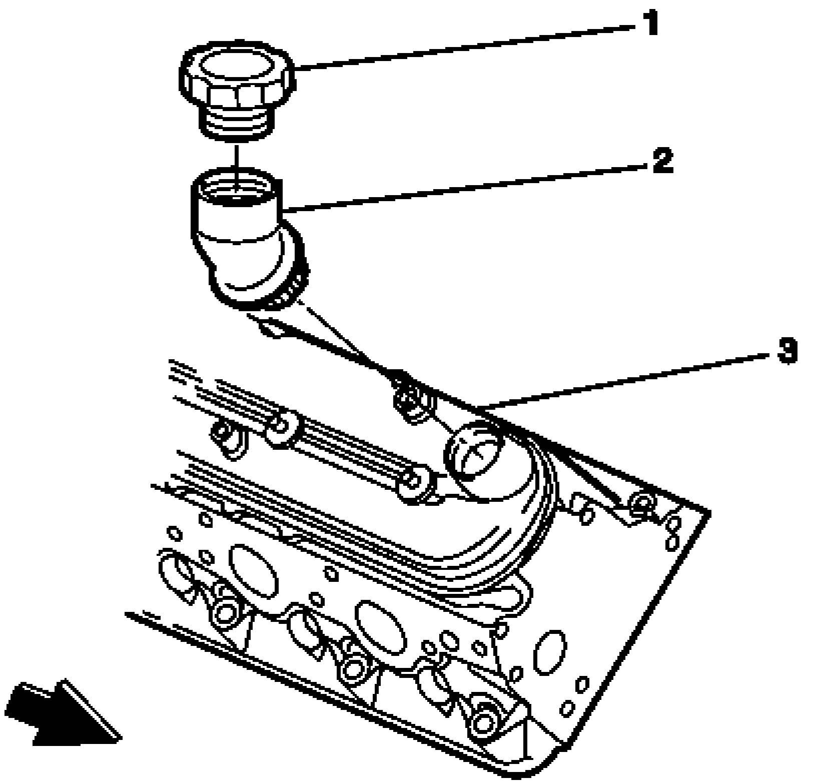


Fig. 74: View Of Valve Rocker Arm Cover, Oil Fill Tube & Cap (Right Side)
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW oil fill tube (2), to the right hand valve rocker arm cover (3) if required.
2. Install the oil fill cap (1) to the oil fill tube (2).

NOTE:

- **All gasket surfaces should be free of oil and other foreign material during assembly.**
- **DO NOT reuse the valve rocker arm cover gasket.**
- **The valve rocker arm cover bolt grommets may be reused.**

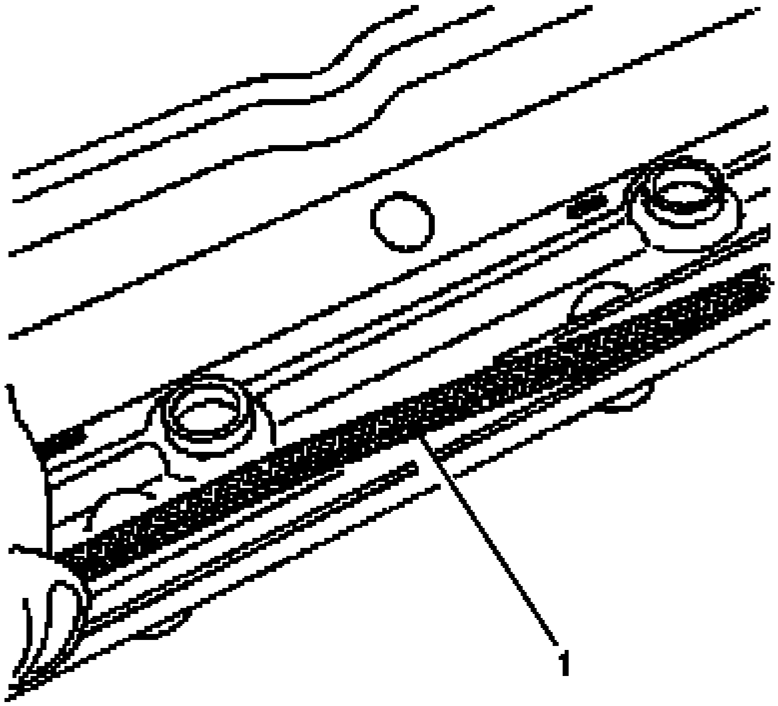


Fig. 75: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW valve rocker arm cover gasket (1).
4. Install the valve rocker arm cover. Refer to **Valve Rocker Arm Cover Installation - Right Side** .

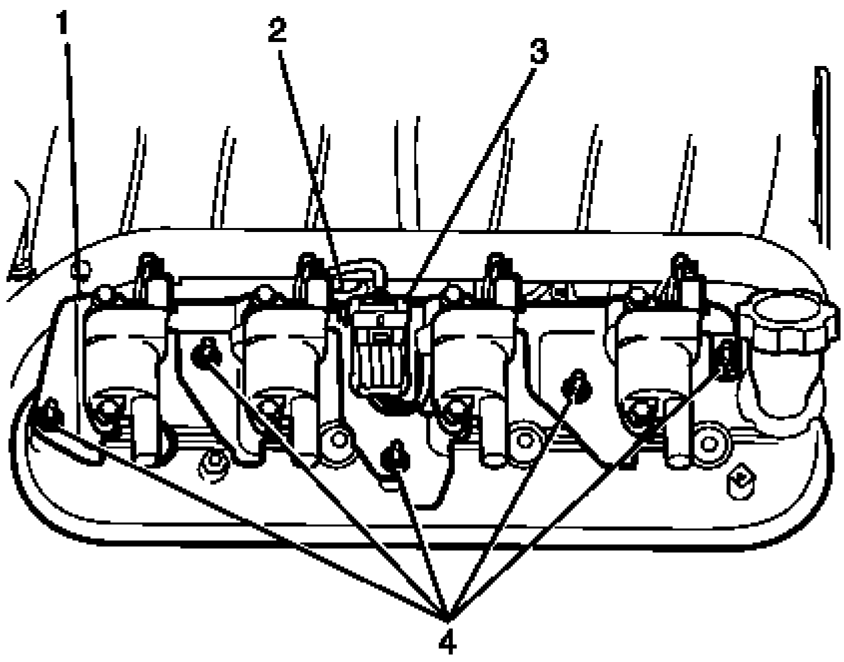


Fig. 76: Identifying Ignition Coil Assembly To Valve Rocker Arm Cover Retaining Studs (Right Side)
Courtesy of GENERAL MOTORS CORP.

5. Install the ignition coil assembly (1).

CAUTION: Refer to Fastener Caution .

6. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to 12 N.m (106 lb in).
7. Connect the ignition coil main connector (3).
8. Install the CPA lock (2) from the ignition coil main connector (3).

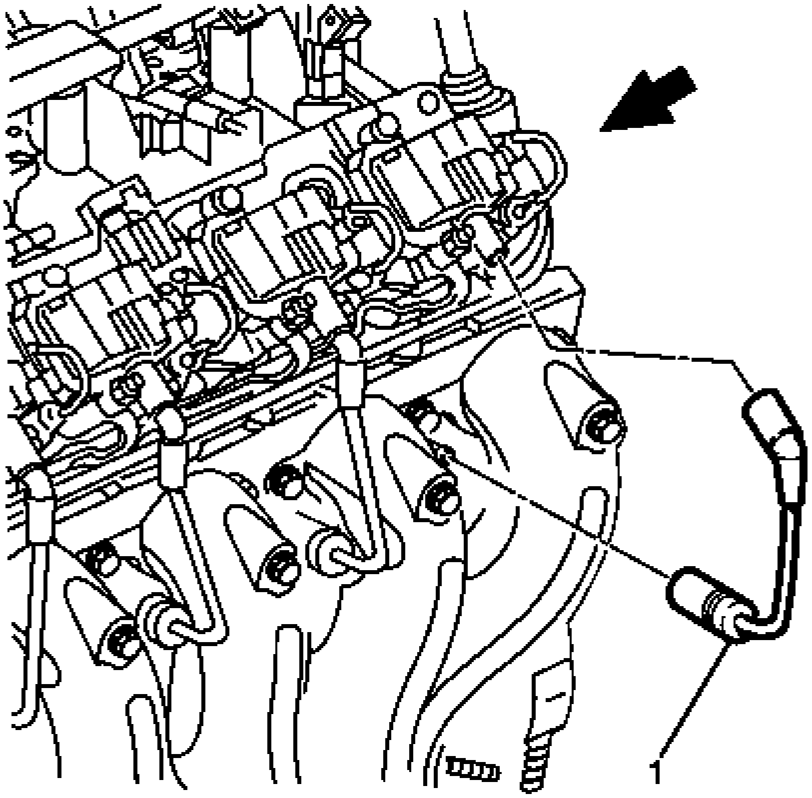


Fig. 77: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plug leads (1).
10. Install the engine cover. Refer to **Engine Cover Replacement**.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

Removal Procedure

1. Remove the valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.
2. Remove the valve rocker arm and push rods. Refer to **Valve Rocker Arm and Push Rod Removal** .
3. Clean and inspect the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

Installation Procedure

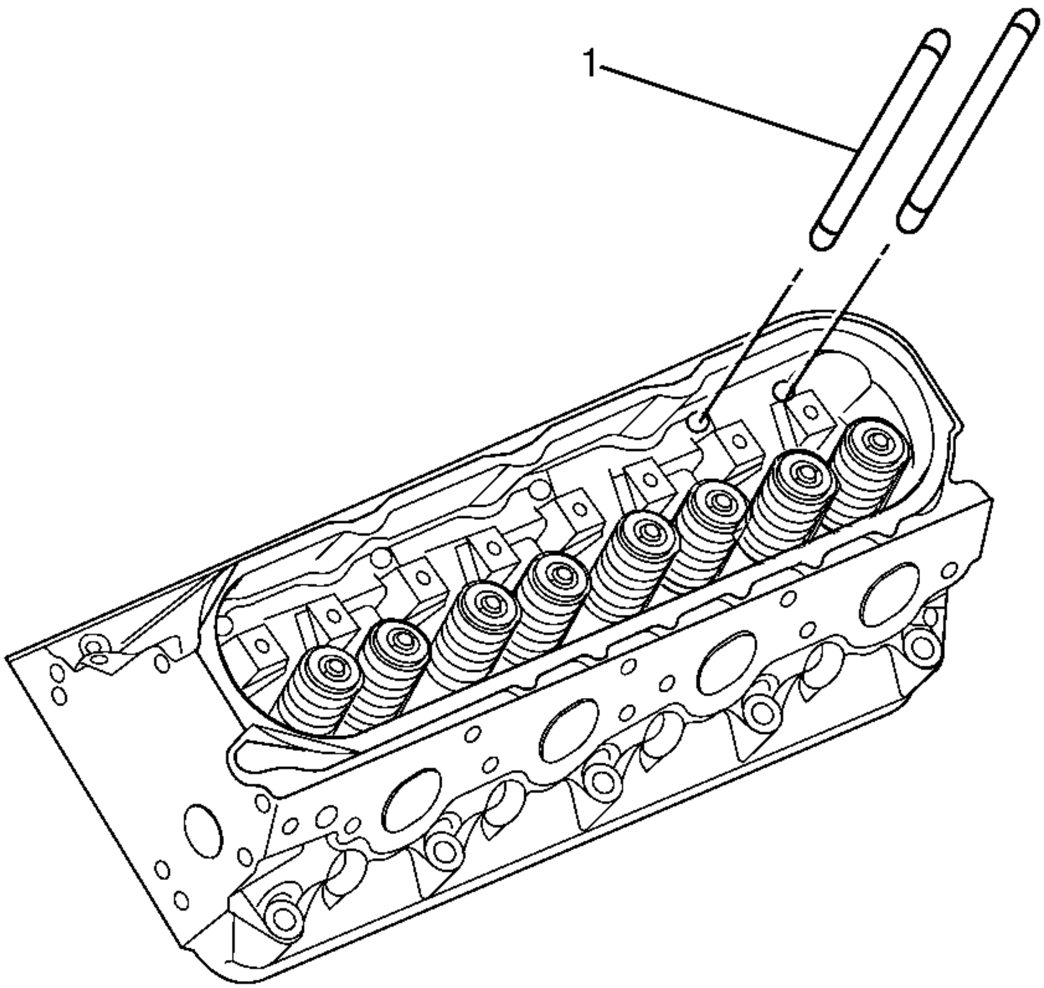


Fig. 78: Identifying Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build, no valve adjustment is required.**

1. Lubricate the pushrods (1) with clean engine oil.

NOTE: **Make sure the pushrods (1) seat correctly to the valve lifter sockets.**

2. Install the pushrods (1).

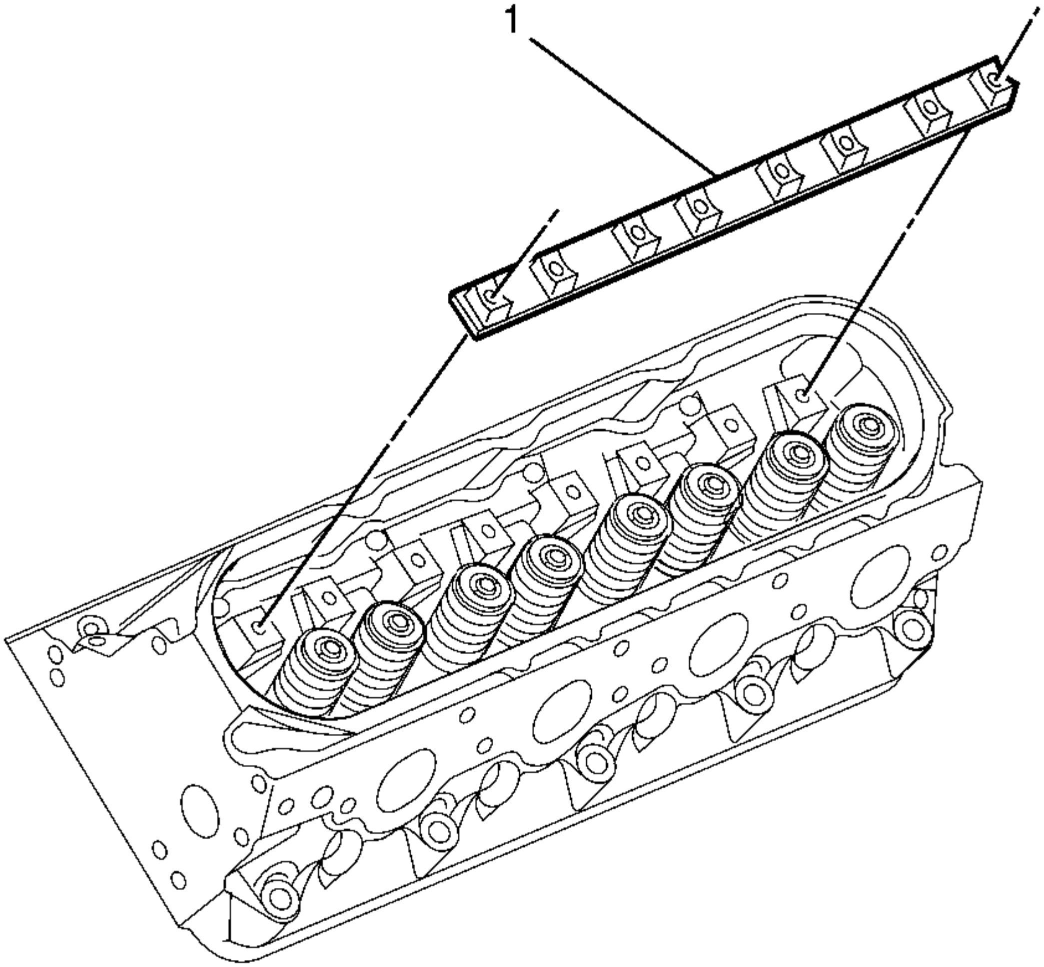


Fig. 79: Identifying Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm pivot support (1).

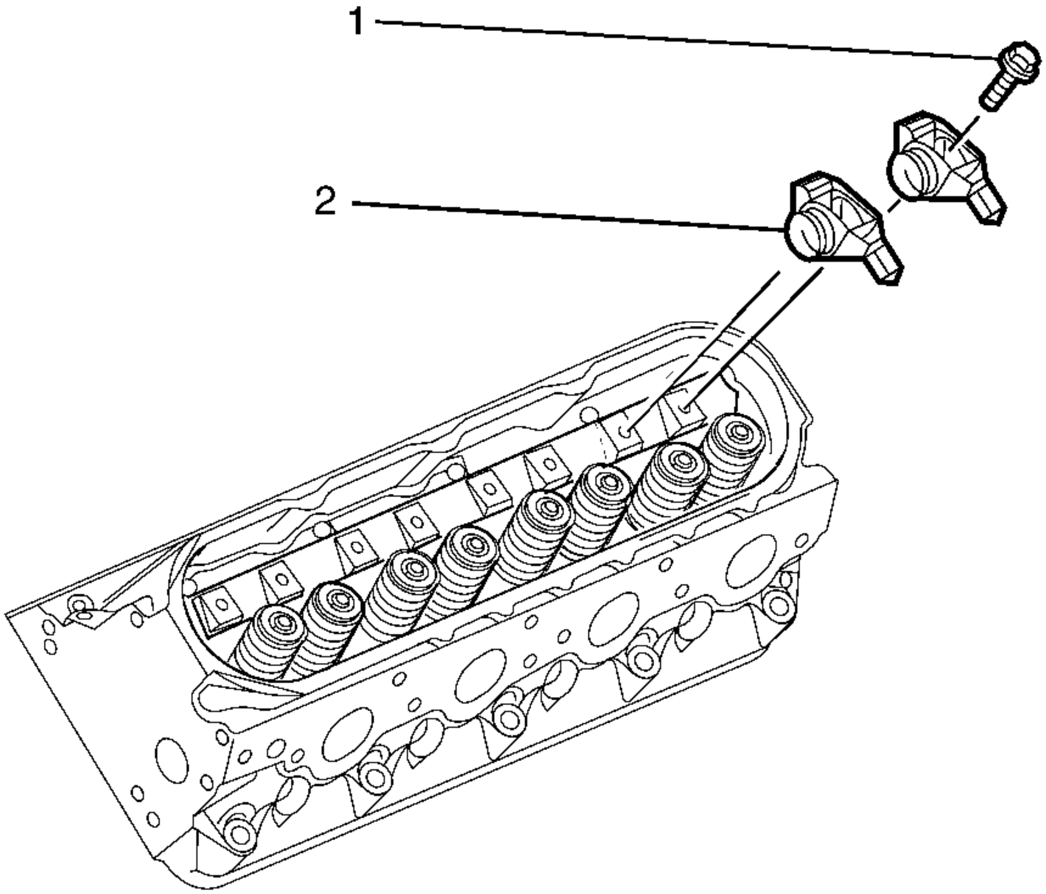


Fig. 80: Identifying Valve Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Lubricate the valve rocker arms (2) and pushrods with clean engine oil.
5. Lubricate the flange of the valve rocker arm bolts (1) with clean engine oil.

NOTE:

- **Make sure the pushrods seat correctly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

6. Install the rocker arms and rocker arm retaining bolts.

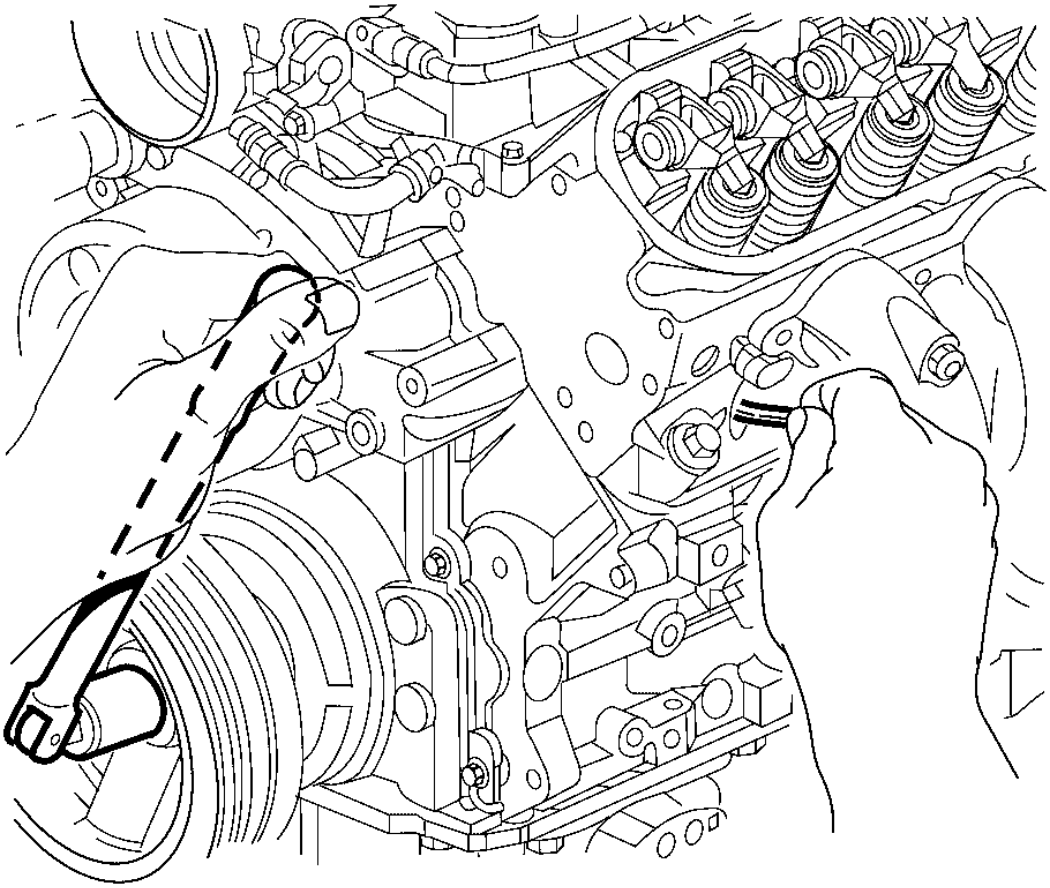


Fig. 81: Locating Socket & Handle On Crankshaft Pulley Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **The Number 1 piston is at the compression stroke when the Number 6 cylinder inlet and exhaust valves are rocking, that is when the exhaust valve is at the end of its upward travel while the intake valve starts its downward movement.**

NOTE: **The engine firing order is 1-8-7-2-6-5-4-3. Cylinder numbers are 1-3-5-7 are on the left bank and 2-4-6-8 are on the right bank.**

7. Rotate the crankshaft until number one piston is at top dead centre of compression stroke.

CAUTION: Refer to **Fastener Caution** **.**

8. With the engine in the number one firing position, tighten the following valve rocker arm retaining bolts.

Tighten exhaust valve rocker arm retaining bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft). Tighten intake valve rocker arm retaining bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).

9. Rotate the crankshaft 360 degrees.
10. Tighten the following valve rocker arm retaining bolts. Tighten exhaust valve rocker arm retaining bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft). Tighten intake valve rocker arm retaining bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft).
11. Install the valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Tools Required

- **J 22794** Spark Plug Port Adapter. See **Special Tools** .
- **J 38606** Valve Spring Compressor (Head-on). See **Special Tools** .

Removal Procedure

IMPORTANT: Store all valve train components in the same order they are removed. Make sure all valve train components are installed in the same location as on removal.

1. Remove the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .
2. Remove the spark plug. Refer to **Spark Plug Replacement** .

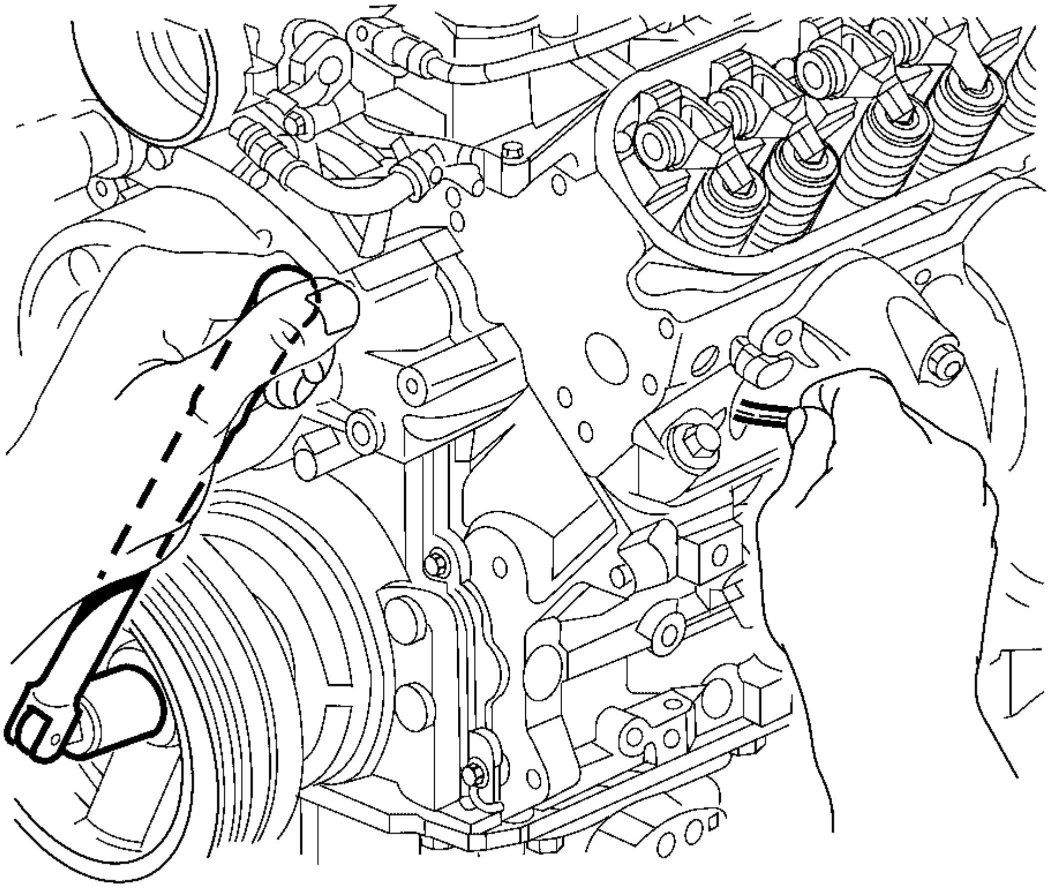


Fig. 82: Locating Socket & Handle On Crankshaft Pulley Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: This operation can be performed with the cylinder at the bottom of its stroke, however with the piston at TDC the valve will not fall into the cylinder if the air supply is accidentally disconnected during the operation.

3. Using a socket and handle on the crankshaft pulley retaining bolt, rotate the crankshaft until the piston of the cylinder being serviced is at the Top Dead Centre (TDC) of the compression stroke.

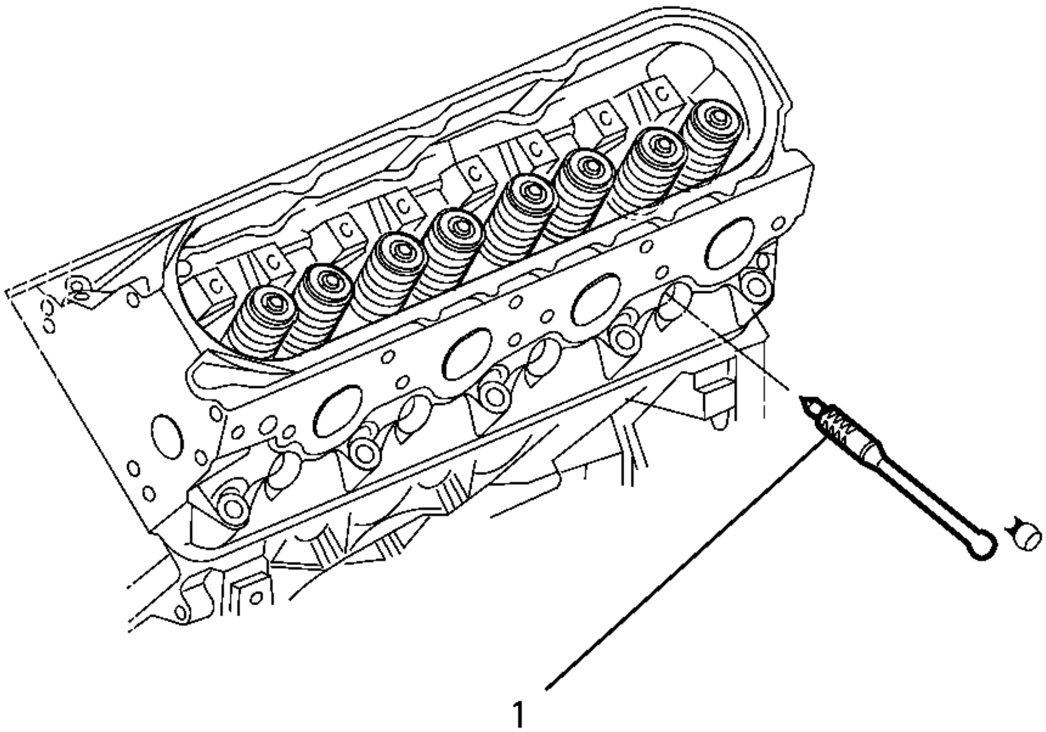


Fig. 83: Locating J 22794
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 22794** (1) or equivalent into the spark plug hole of the cylinder being serviced. See **Special Tools** .
5. Attach a compressed air line to **J 22794** (1) and apply a constant supply of air pressure to the cylinder being serviced. See **Special Tools** .
6. Tap the end of the valve stem with a soft face hammer in order to dislodge the valve spring cap retaining collets.

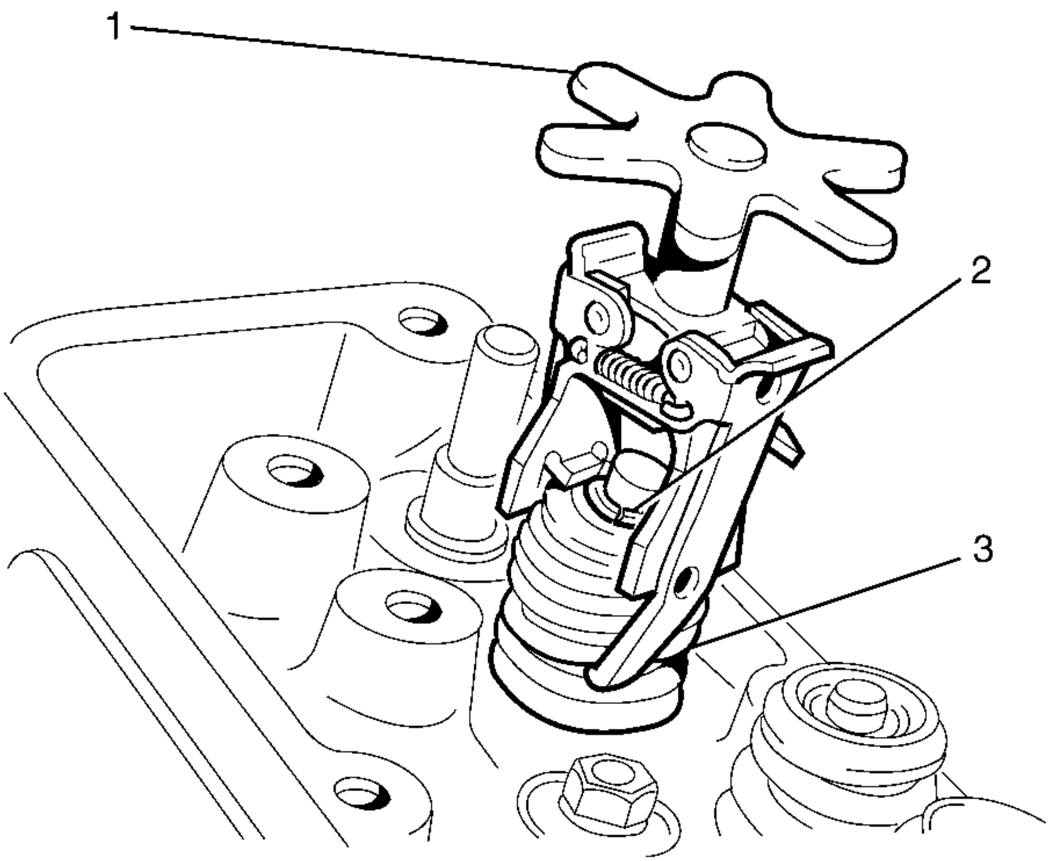


Fig. 84: Locating J 38606, Valve Spring Retaining Cap Collets & Valve Spring
Courtesy of GENERAL MOTORS CORP.

7. Use **J 38606** (1) in order to compress the valve spring (3). See **Special Tools** .
8. Remove the valve spring retaining cap collets (2).
9. Carefully release the valve spring (3) tension.
10. Remove the **J 38606** (1). See **Special Tools** .

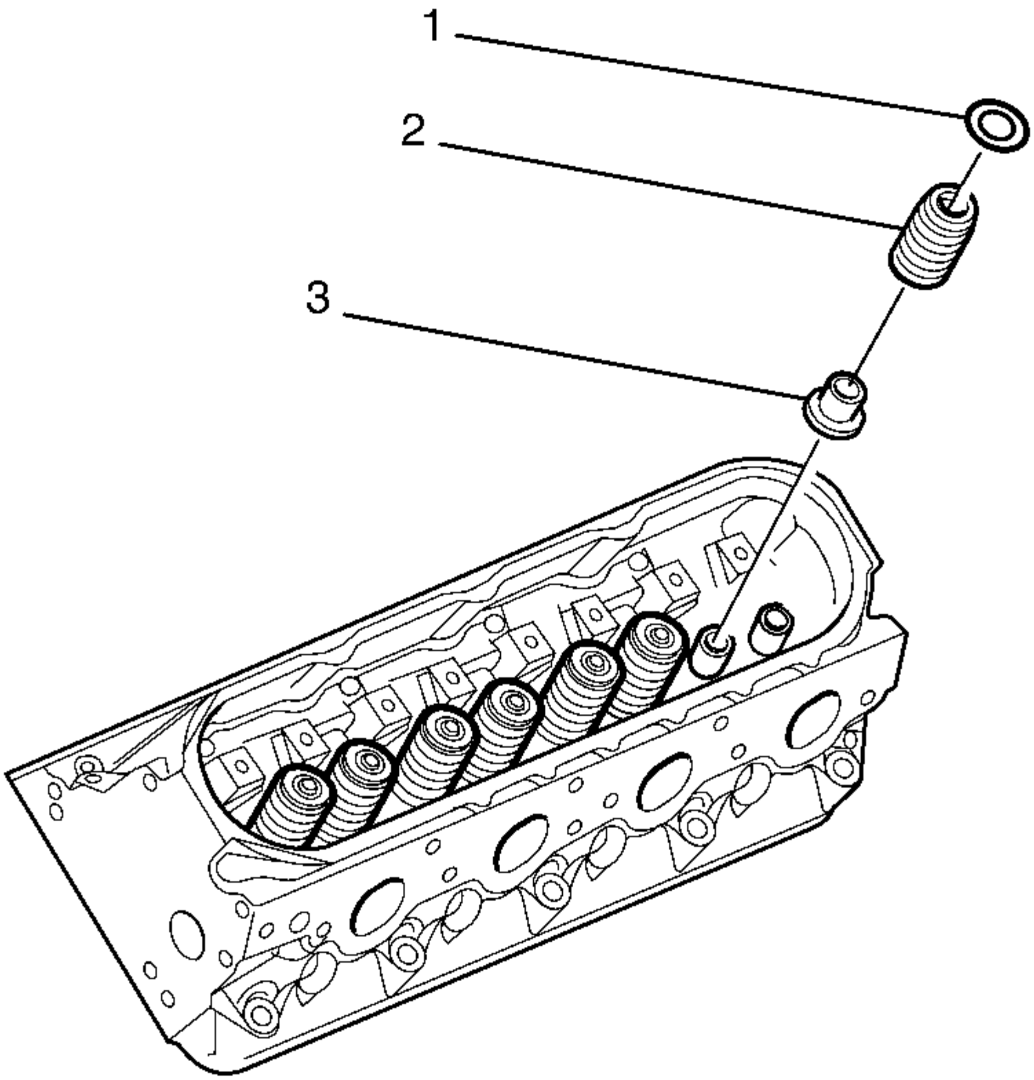


Fig. 85: Locating Valve Stem Oil Seal, Valve Spring & Cap
Courtesy of GENERAL MOTORS CORP.

11. Remove the valve spring cap (1).
12. Remove the valve spring (2).
13. Remove the valve stem oil seal (3).

Installation Procedure

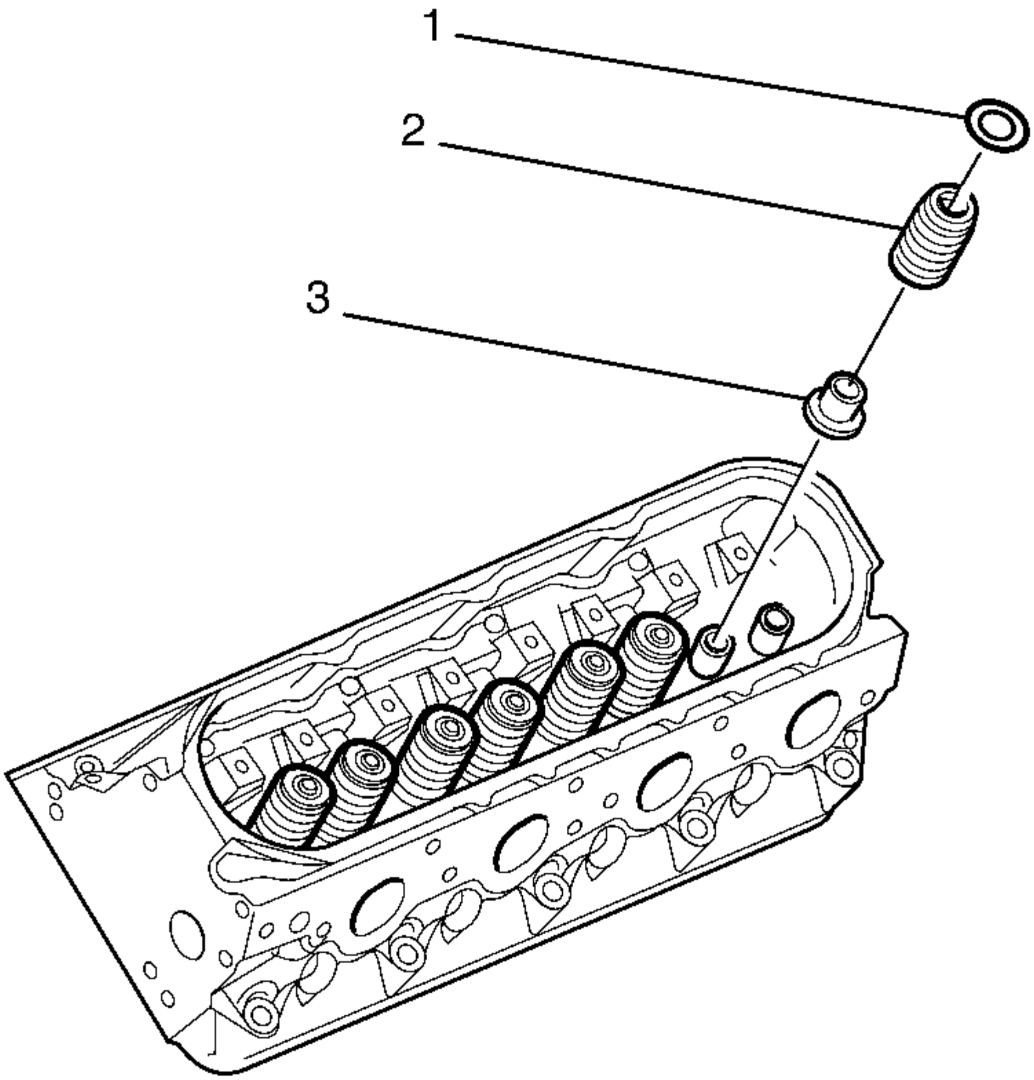


Fig. 86: Locating Valve Stem Oil Seal, Valve Spring & Cap
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring seat and/or shim area.

IMPORTANT: The valve stem oil seal alignment and position on the valve guide is critical. An incorrectly installed valve stem oil seal may lead to above acceptable oil consumption and increased vehicle emissions.

2. Install the valve stem oil seal (3). onto the guide.
3. Install the valve spring (2).

4. Install the valve spring cap (1).

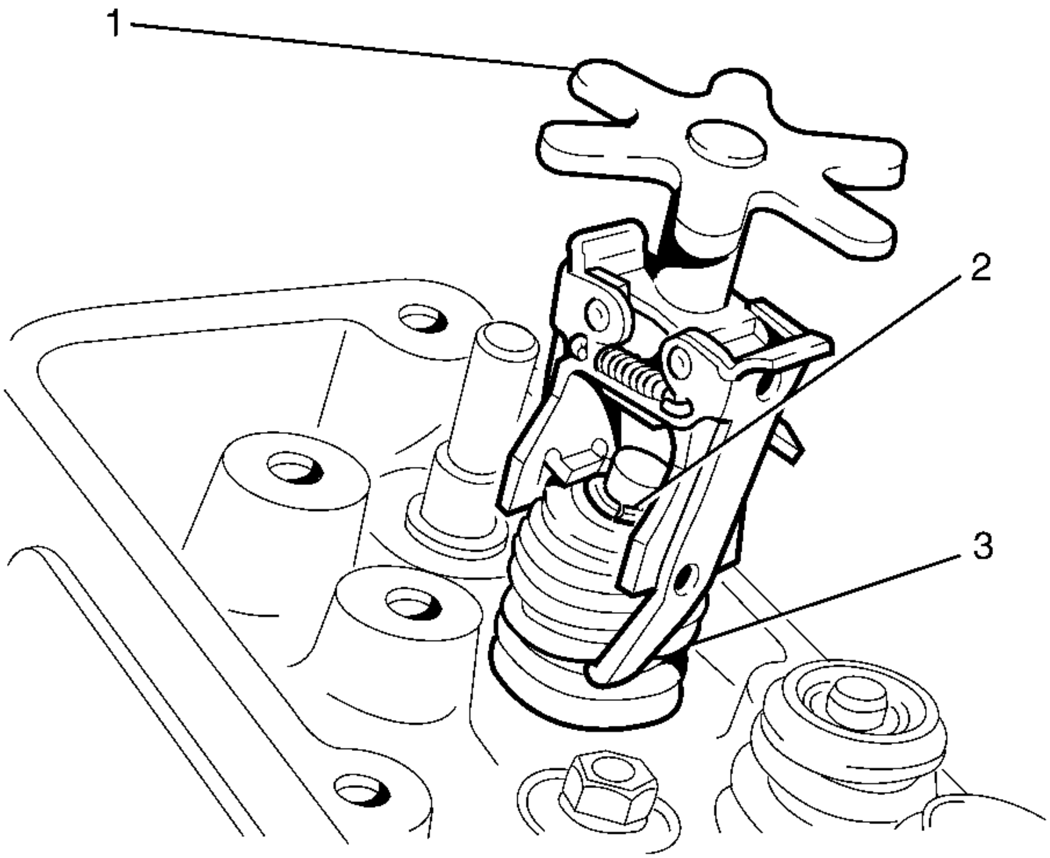


Fig. 87: Locating J 38606, Valve Spring Retaining Cap Collets & Valve Spring
Courtesy of GENERAL MOTORS CORP.

5. Use **J 38606** (1) in order to compress the valve spring (3). See **Special Tools** .
6. Compress the valve spring using the **J 38606** (1). See **Special Tools** .

IMPORTANT: Use clean grease or petroleum jelly to retain the valve spring retaining collets (2)

7. Install the valve spring retaining collets (2).
8. Release the **J 38606** (1) making sure both valve spring retaining collets have seated correctly. See **Special Tools** .
9. Lightly tap the valve stem with a soft faced hammer to seat the valve stem collets.

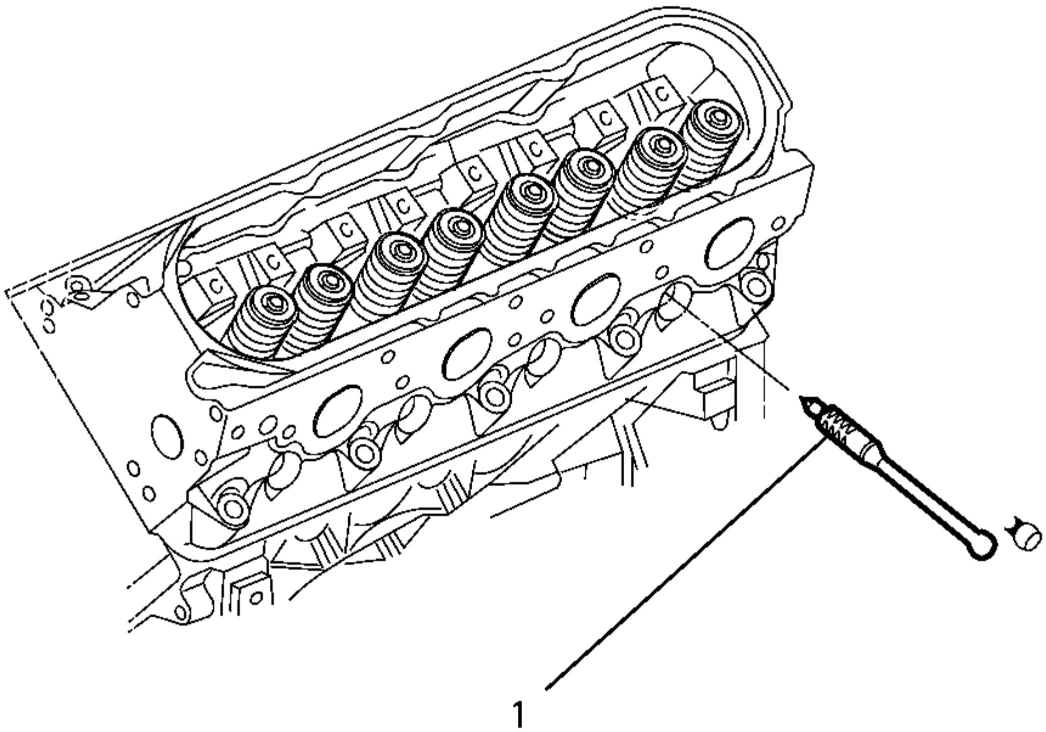


Fig. 88: Locating J 22794
Courtesy of GENERAL MOTORS CORP.

10. Disconnect and remove the compressed air supply from the **J 22794** (1). See **Special Tools** .
11. Remove the **J 22794** (1) from the spark plug hole. See **Special Tools** .

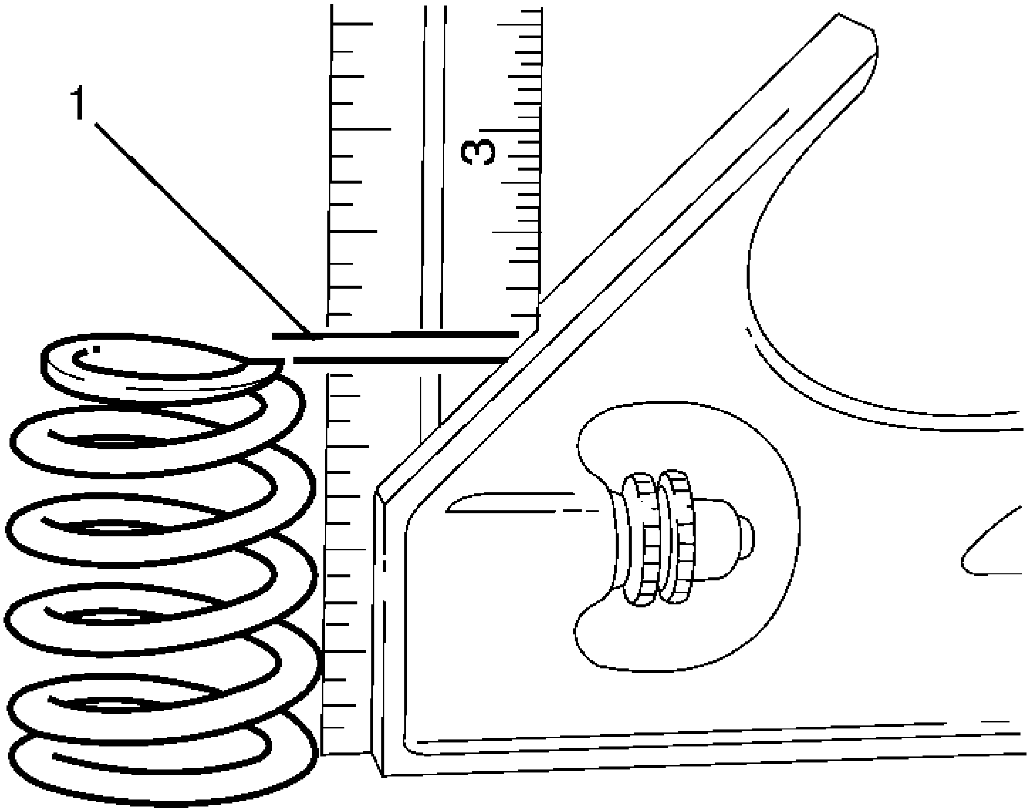


Fig. 89: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Measure the valve spring installed height using a ruler.

    Measure from the base of the valve spring to the top of the valve spring.

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.

      Do not assemble the components without a spring shim on the cylinder head.

13. Install the spark plug. Refer to **Spark Plug Replacement** .
14. Install the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

OIL LEVEL INDICATOR TUBE REPLACEMENT

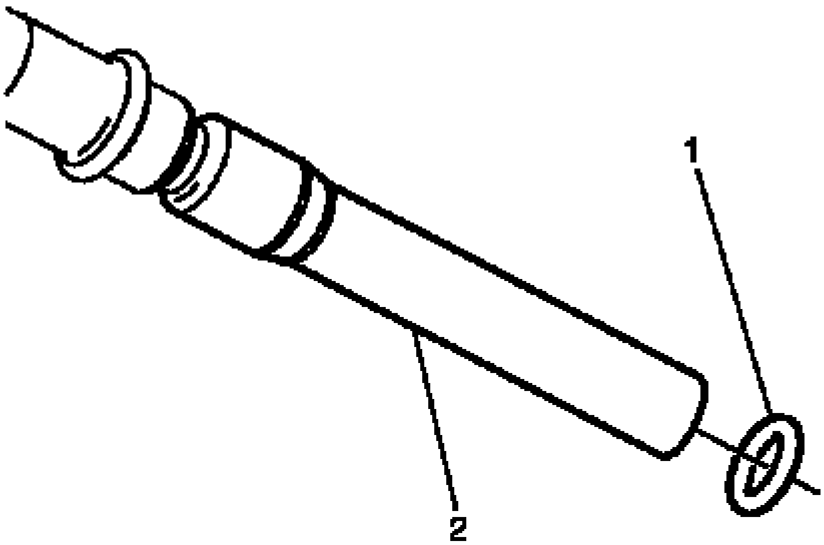


Fig. 90: Identifying Oil Level Indicator Tube & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Inspect the O-ring seal (1) for cuts or damage. If the O-ring seal (1) is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal (1) with clean engine oil.
3. Install the O-ring seal (1) onto the oil level indicator tube (2).

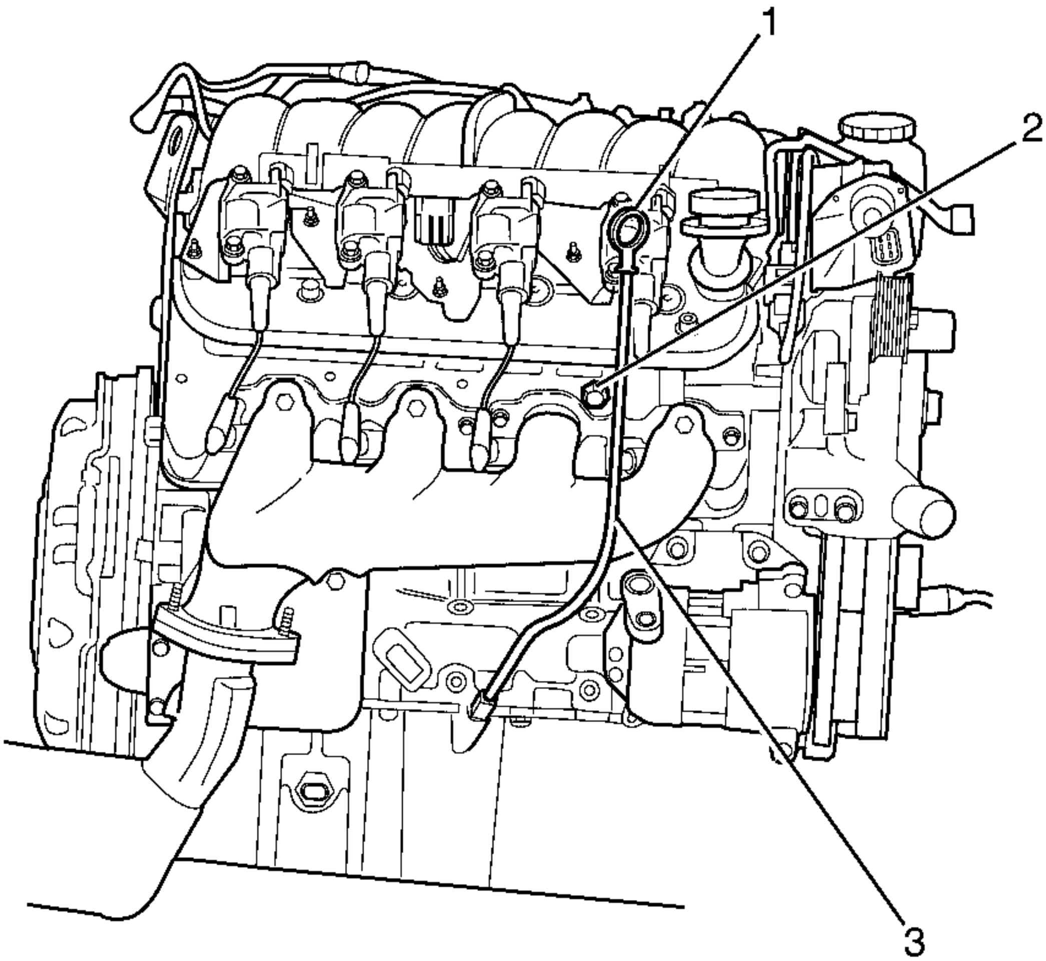


Fig. 91: Identifying Oil Level Indicator Tube To Cylinder Head Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the oil level indicator tube (2) to the engine and rotate into correct position.

CAUTION: Refer to Fastener Caution .

5. Install oil level indicator tube to cylinder head bracket retaining bolt (3) and tighten to 25 N.m (18 lb ft).
6. Install the oil level indicator (1) to the oil level indicator tube (2).

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

- **J 42385-100** Head/Main Bolt Thread Repair Kit. See **Special Tools** .
- **J 45059** Angle Meter

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Depressurize the fuel system. Refer to **Fuel Pressure Relief** .

WARNING: Refer to Battery Disconnect Warning .

3. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
5. Remove the intake manifold assembly. Refer to **Intake Manifold Replacement**.
6. Remove the engine coolant air bleed pipe and cover. Refer to **Engine Coolant Air Bleed Hose Replacement (6.0L)** .
7. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
8. Remove the left side ignition coils. Refer to **Ignition Coil Replacement** .
9. Remove the spark plugs. Refer to **Spark Plug Replacement** .
10. Remove the left side exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (V8)** .

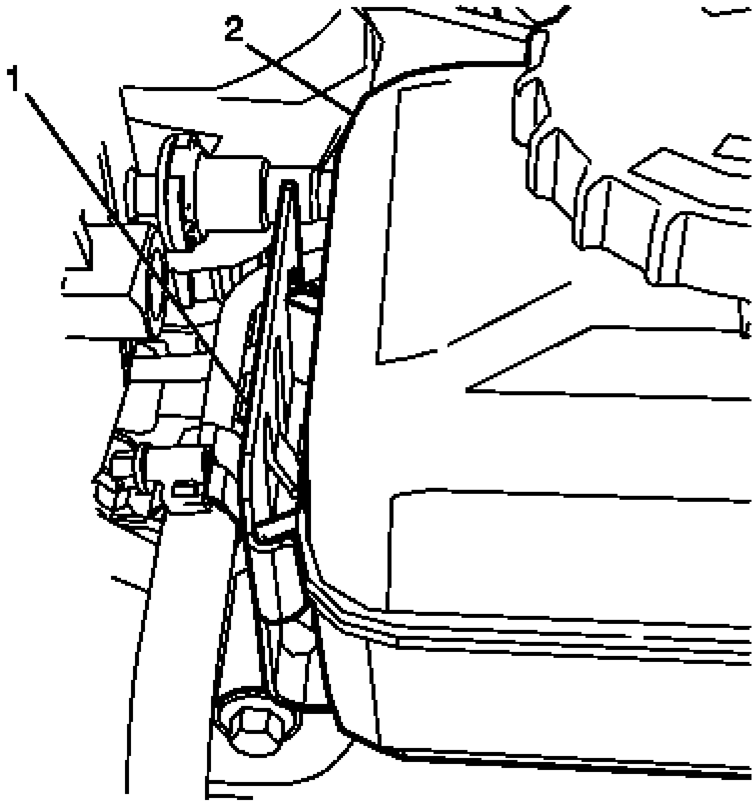


Fig. 92: Identifying Power Steering Reservoir & Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: **The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).**

11. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.

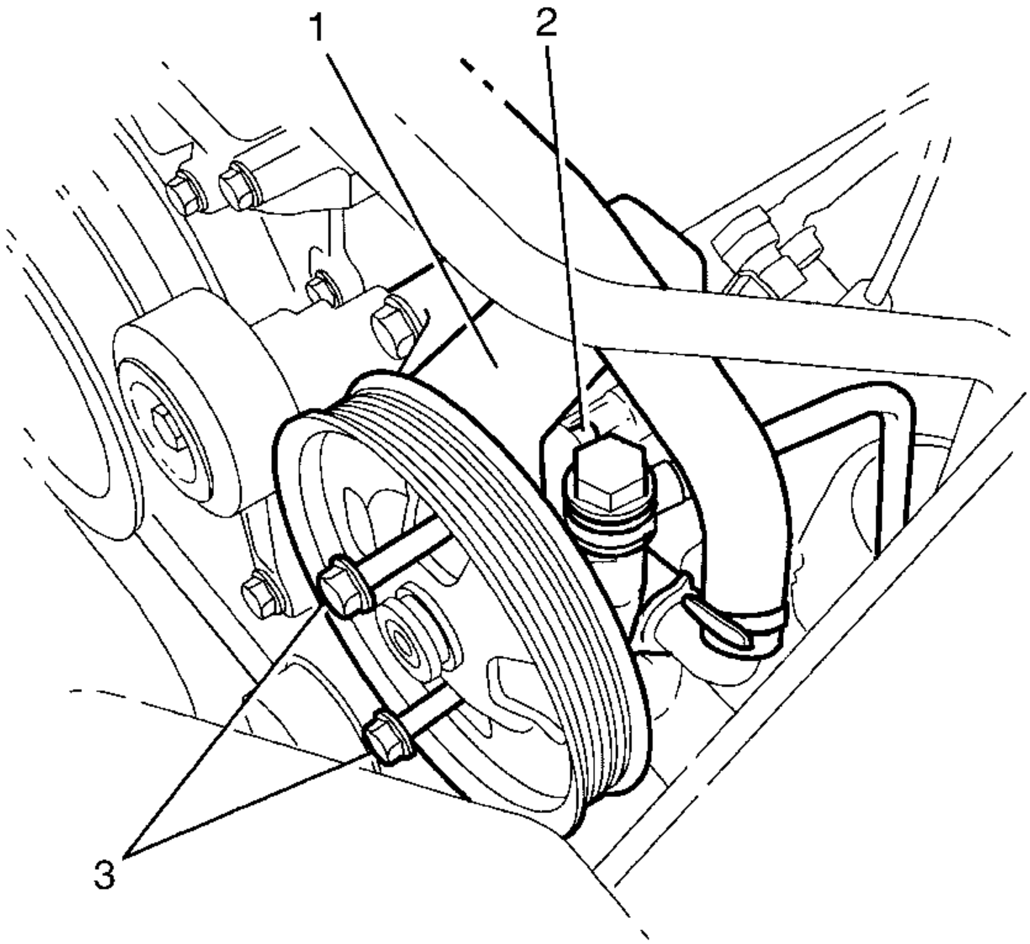


Fig. 93: Identifying Power Steering Pump, Bracket & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the power steering pump (2) to power steering pump bracket retaining bolts (3) and position the power steering pump (2) away from the power steering pump bracket (1).

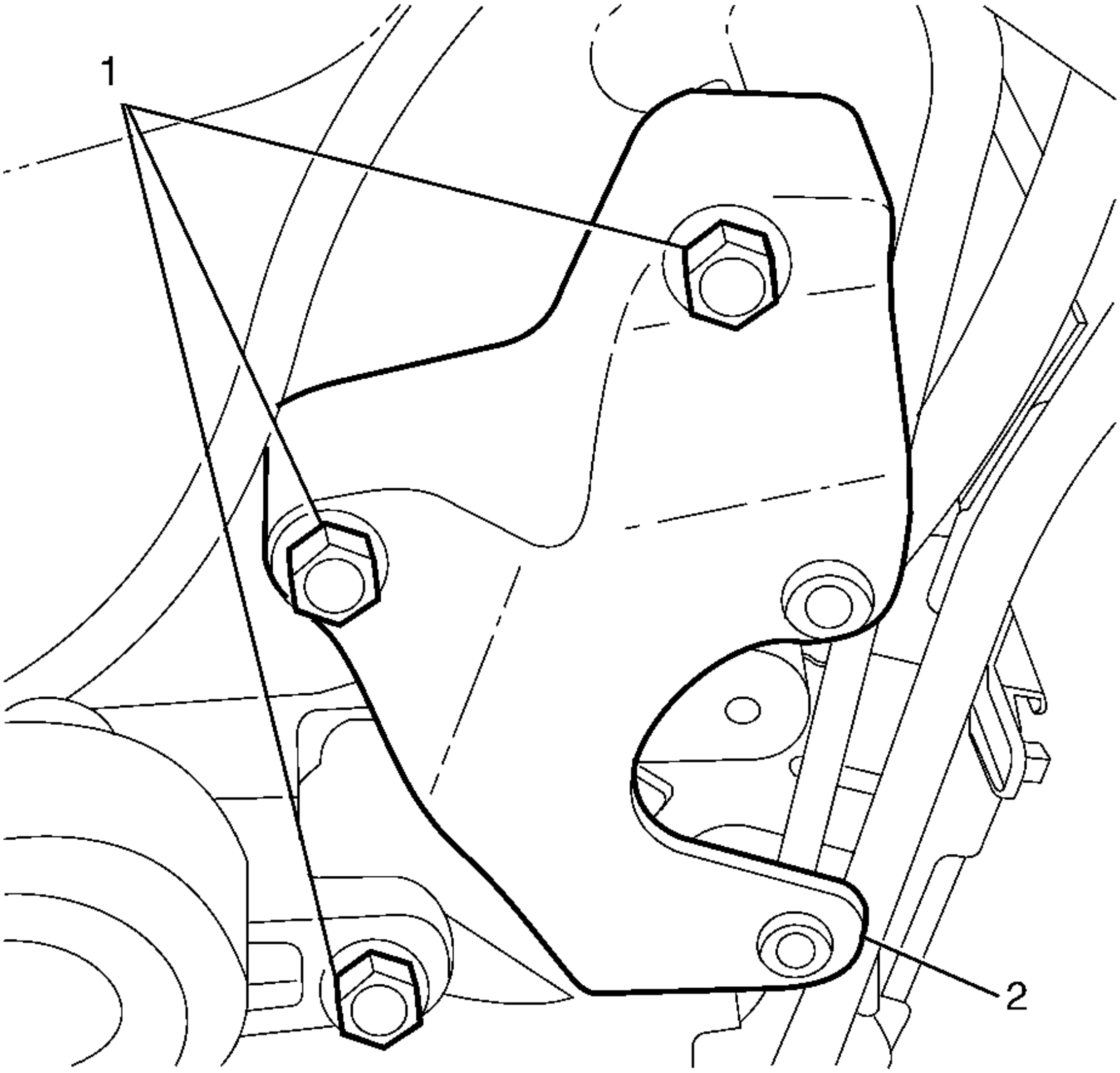


Fig. 94: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

13. Remove the power steering pump bracket to engine retaining bolts (1).
14. Remove the power steering pump bracket (2).

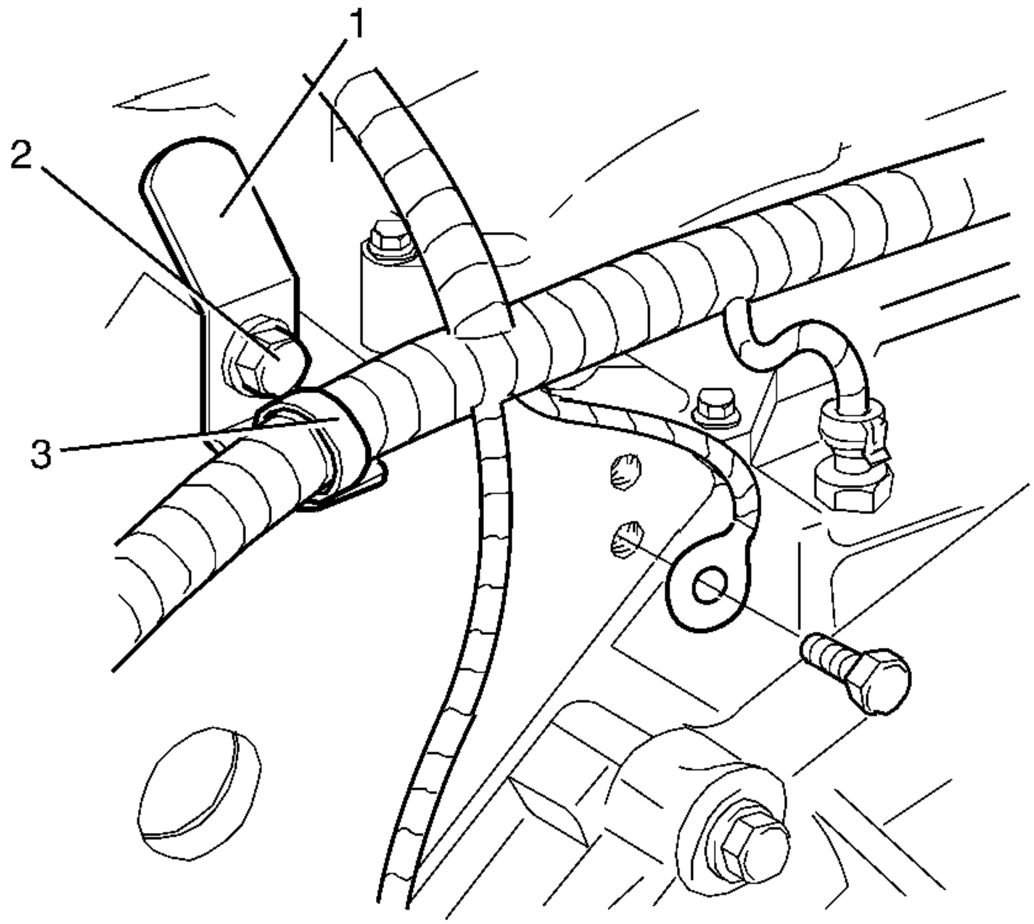


Fig. 95: Identifying Engine Wiring Harness Ground Connector To Cylinder Head Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

15. Detach the powertrain wiring harness strap (3) from the rear cylinder head bracket (1).
16. Remove the powertrain wiring harness ground cable to cylinder head retaining bolt (2).

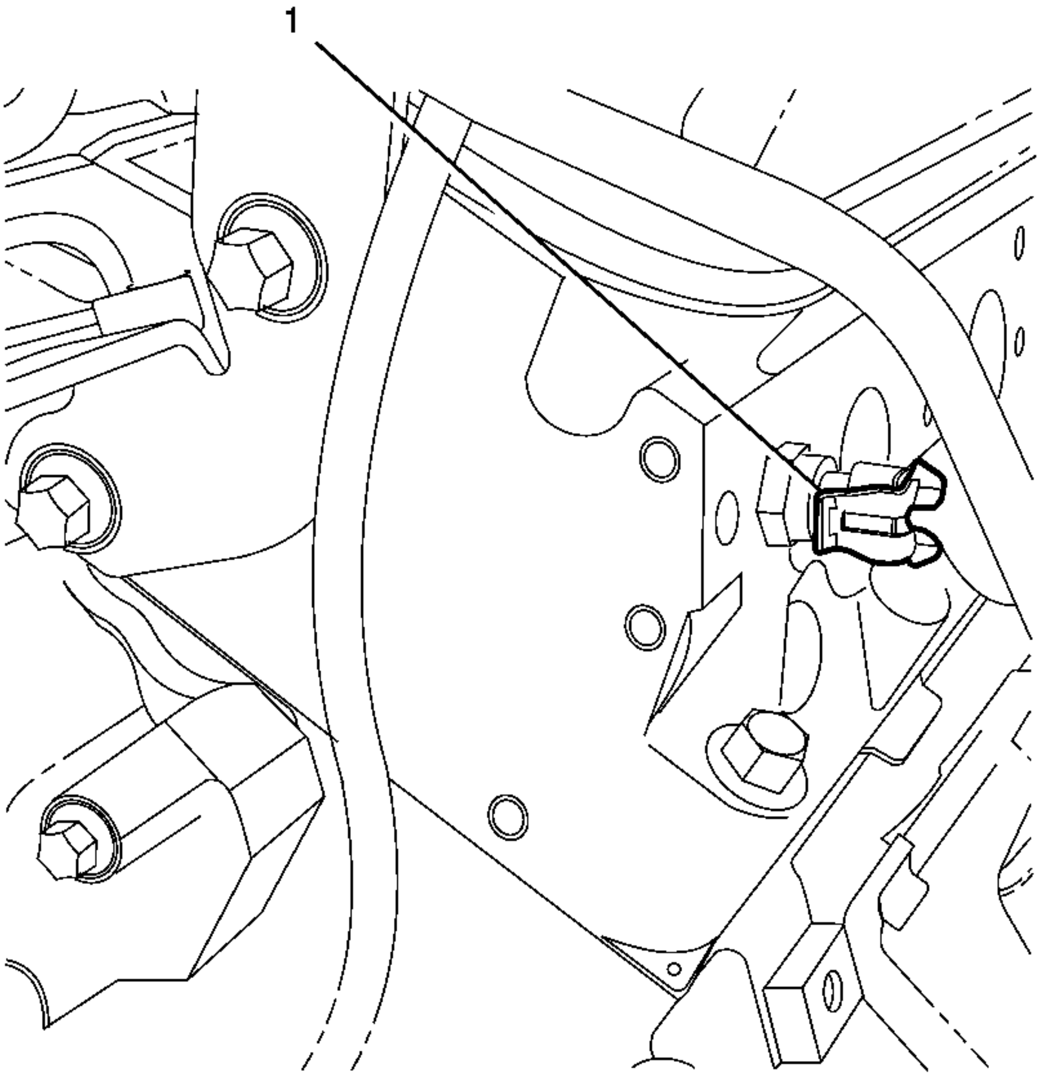


Fig. 96: Identifying Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the coolant temperature sensor electrical connector (1).
18. Remove the left side valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side**.
19. Remove the left side valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

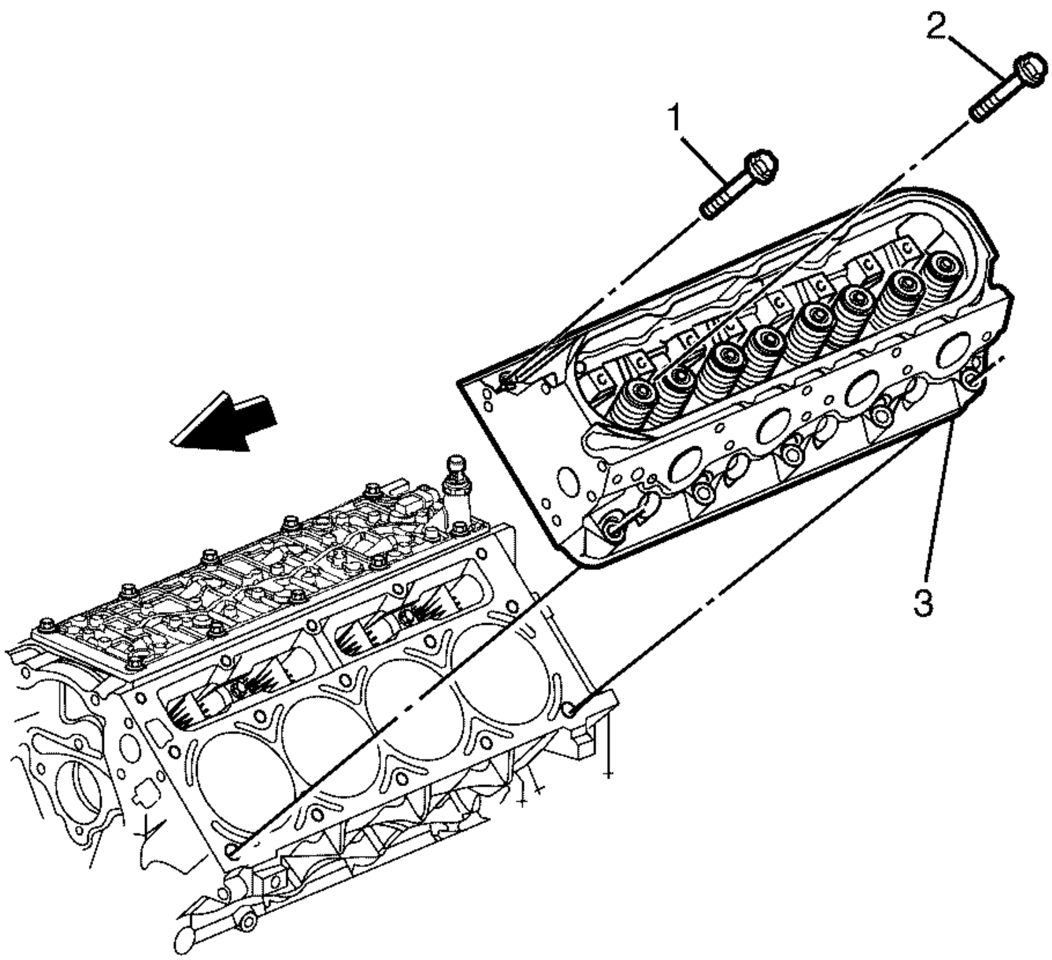


Fig. 97: Identifying Cylinder Head & Bolts (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **The cylinder head bolts are torque to yield bolts and are single use only fasteners.**

20. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

    Discard the bolts.

NOTE: **After removal, place the cylinder head on 2 wooden blocks in order to prevent damage to the sealing surfaces.**

21. Remove the cylinder head (3).

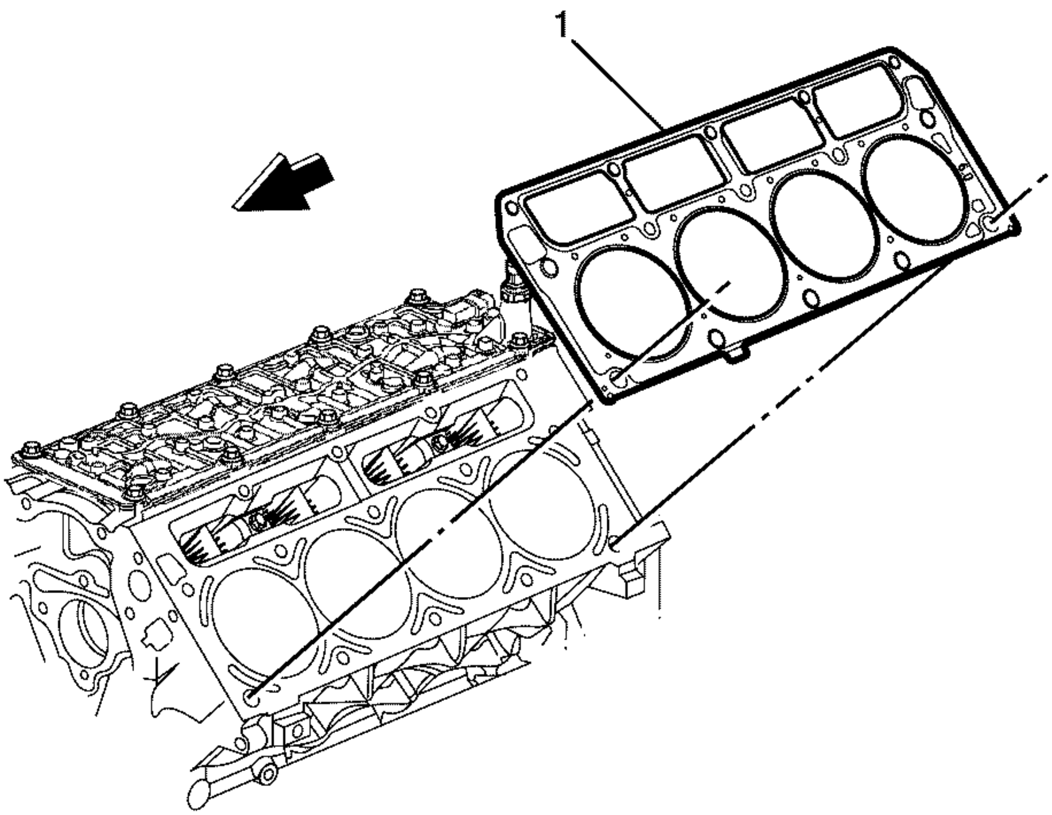


Fig. 98: Identifying Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

22. Remove the cylinder head gasket (1).

    Discard the gasket.

23. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection** .
24. If necessary, disassemble the cylinder head. Refer to **Cylinder Head Disassemble** .

Installation Procedure

1. If necessary, assemble the cylinder head. Refer to **Cylinder Head Assemble** .

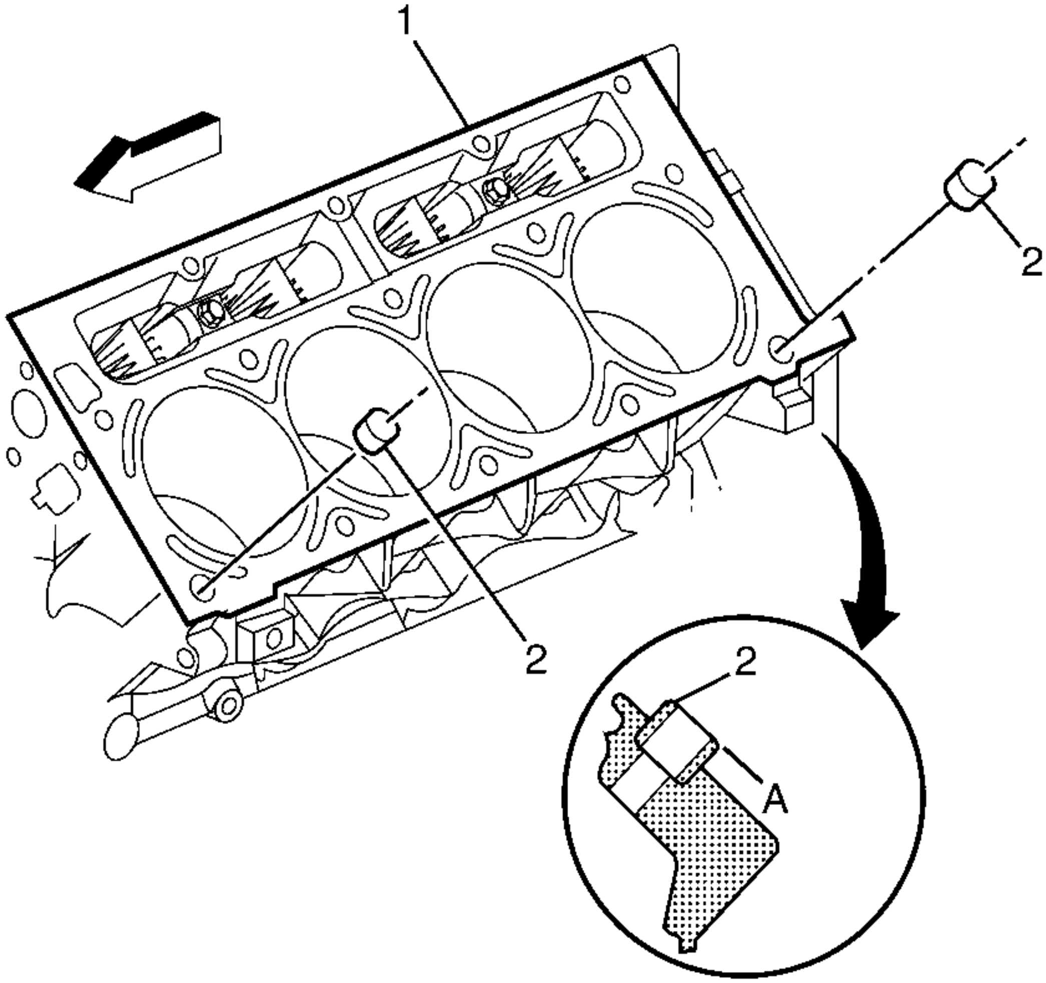


Fig. 99: Identifying Cylinder Block & Locating Sleeves (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).**

2. Install the locating sleeves (2) into the cylinder block (1).

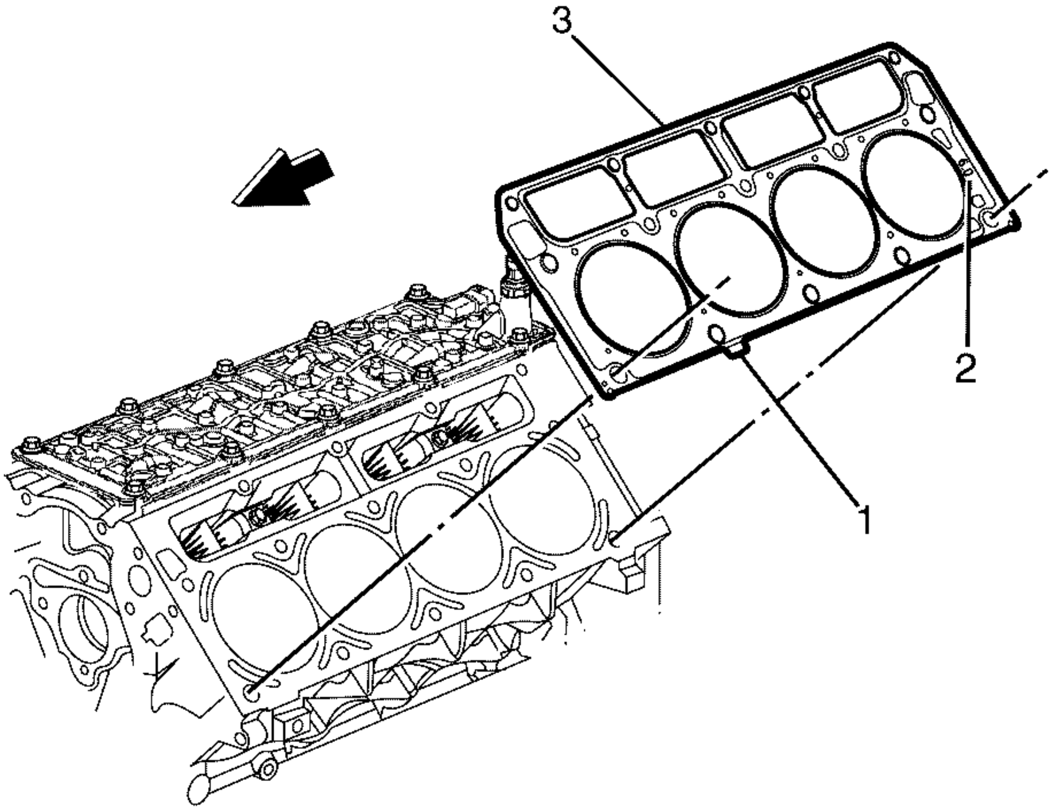


Fig. 100: Identifying Cylinder Head Gasket (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE:	**The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.**

NOTE:	**Do not use any type of sealant on the cylinder head gasket (3), unless specified.**

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.
4. Install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side** .
5. Install the left side valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Install the left side valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Left Side**.

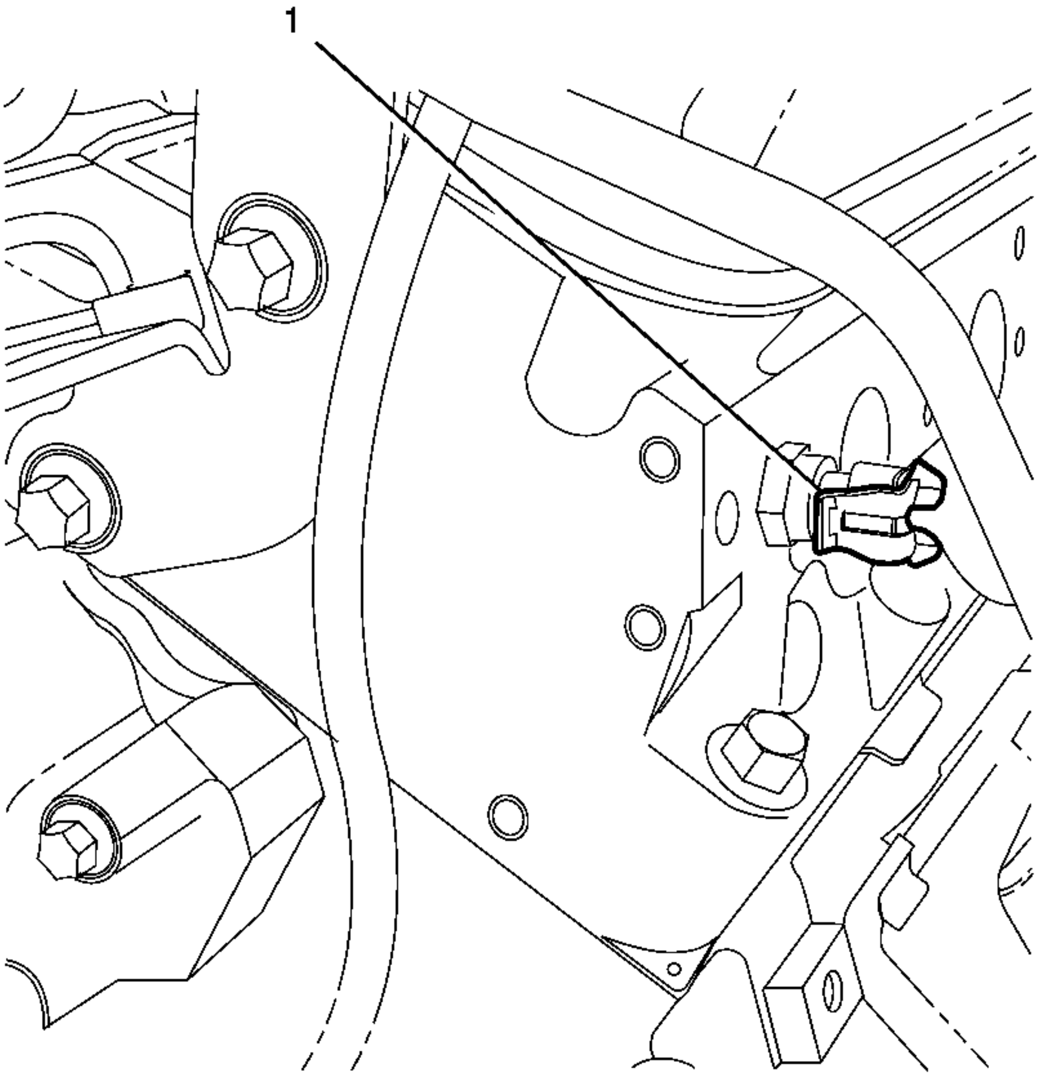


Fig. 101: Identifying Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Connect the coolant temperature sensor electrical connector (1).

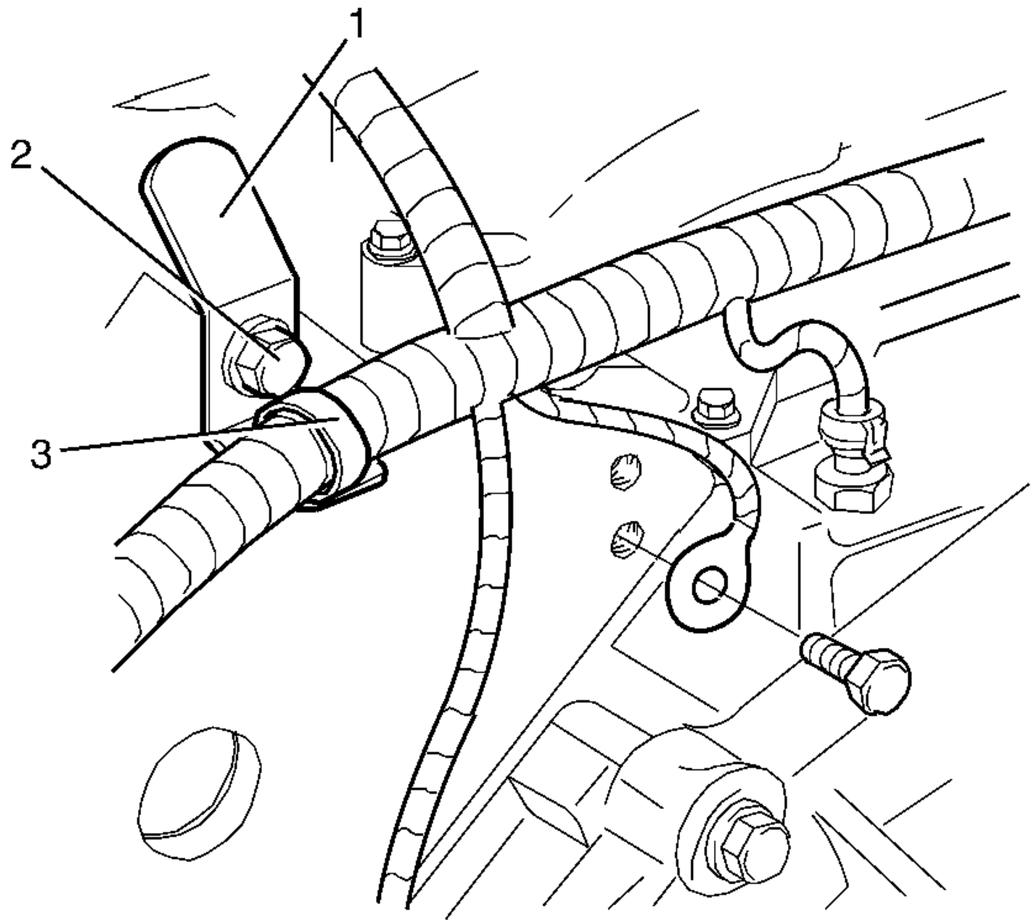


Fig. 102: Identifying Engine Wiring Harness Ground Connector To Cylinder Head Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Install the engine wiring harness ground connector to cylinder head retaining bolt (2) and tighten to 10 N.m (89 lb in).
9. Attach the powertrain wiring harness strap (3) to the rear cylinder head bracket (1).

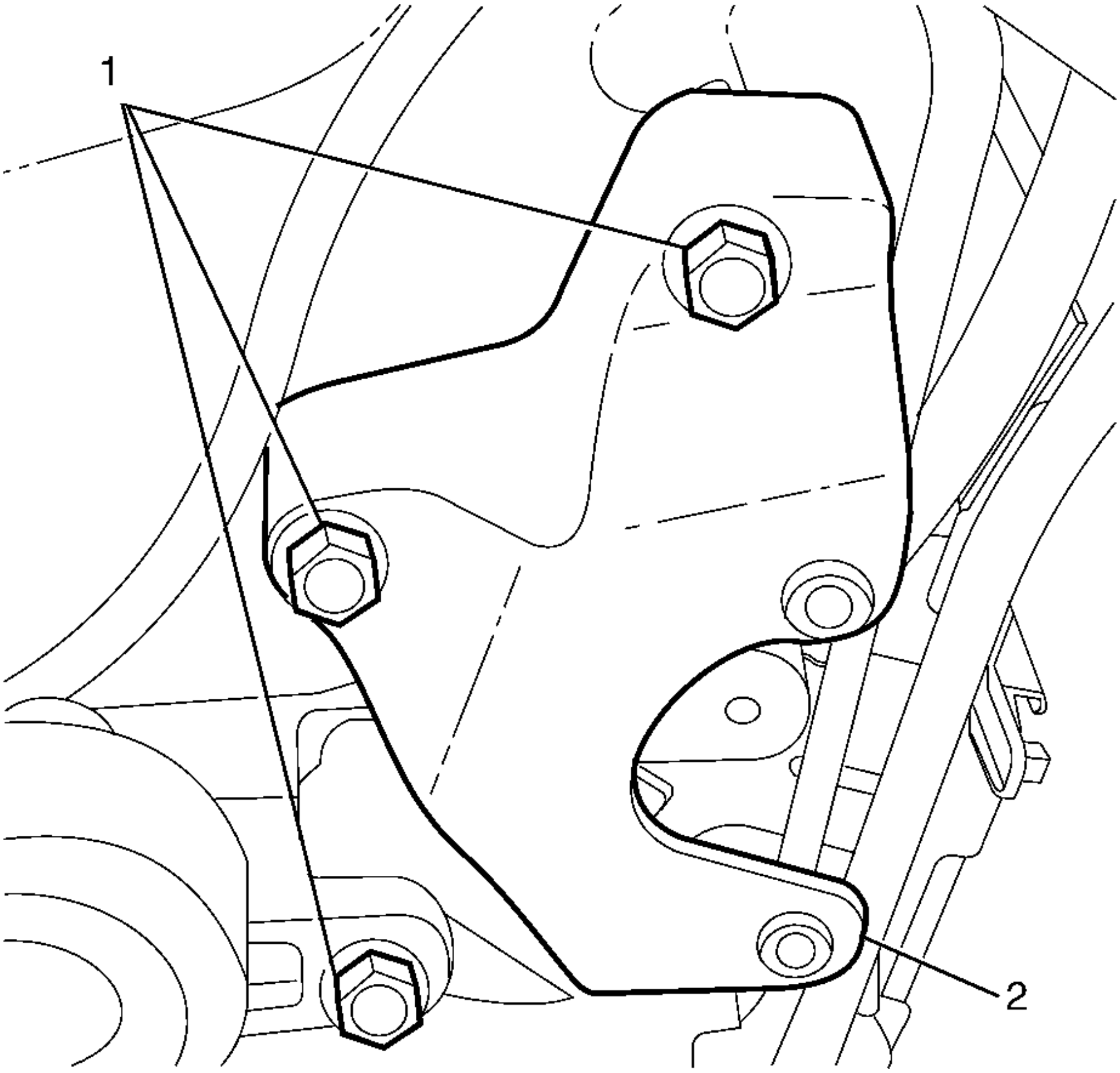


Fig. 103: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

10. Install the power steering pump bracket (2).
11. Install the power steering pump bracket to engine retaining bolts (1) and tighten to 58 N.m (43 lb ft).

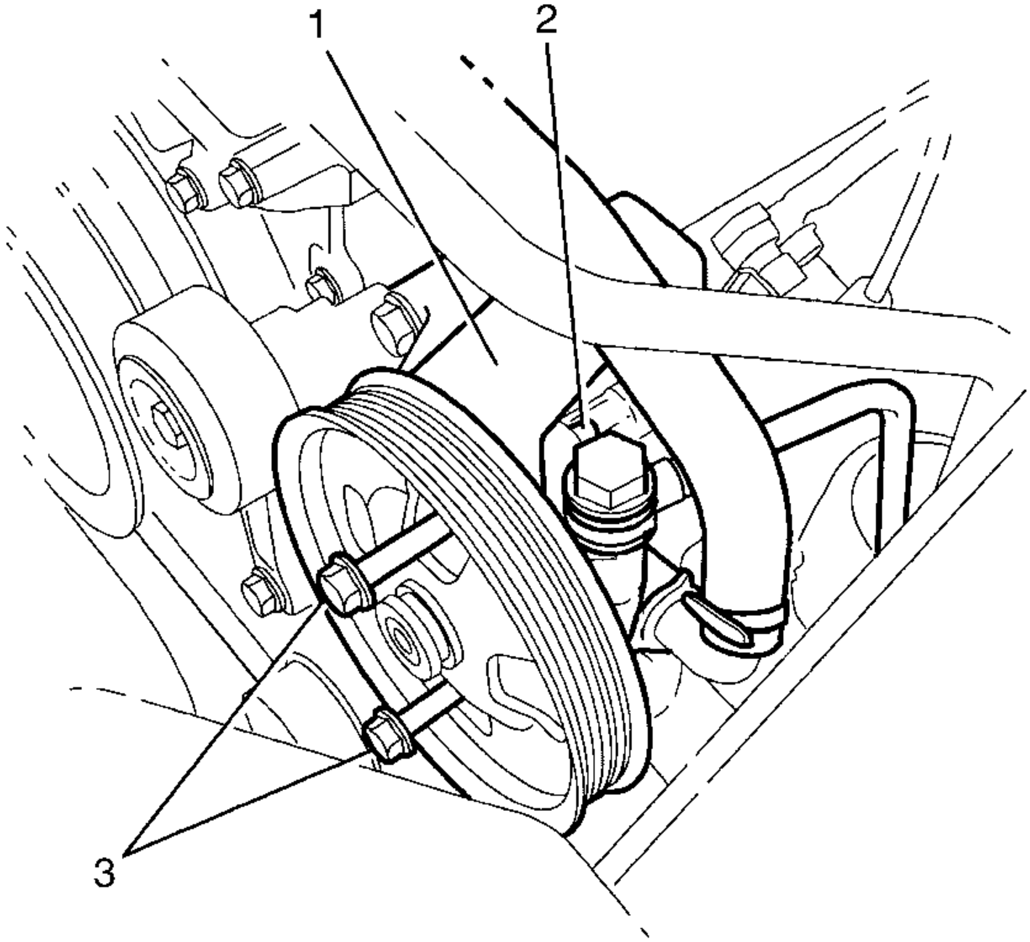


Fig. 104: Identifying Power Steering Pump, Bracket & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

12. Position the power steering pump (2) on the power steering pump bracket (1).
13. Install the power steering pump to power steering pump bracket retaining bolts (3) and tighten to 30 N.m (22 lb ft).

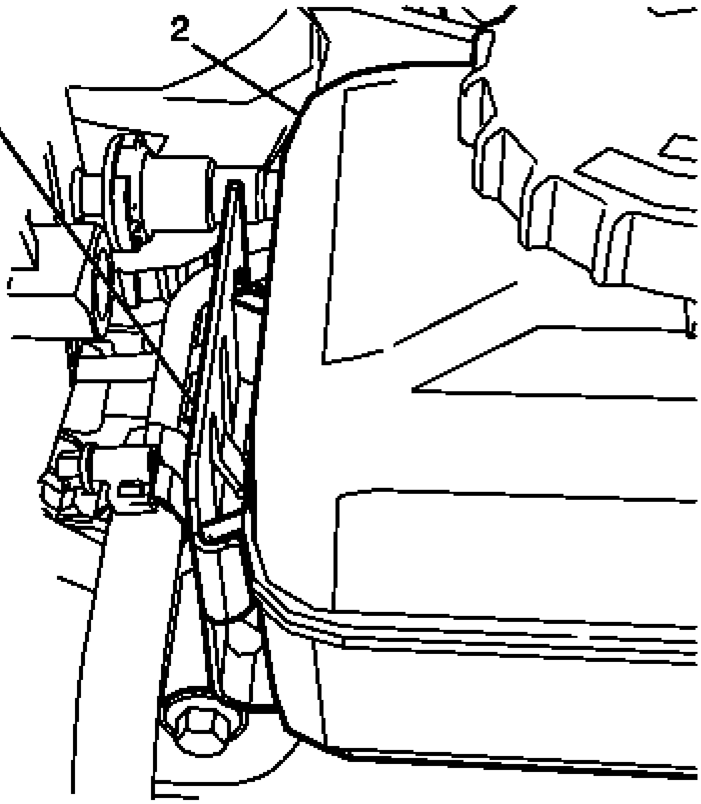


Fig. 105: Identifying Power Steering Reservoir & Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: **Make sure the power steering reservoir (2) and the locking tang on the power steering reservoir bracket (1) are engaged to avoid an induced rattle condition.**

14. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).
15. Install the left side exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (V8)** .
16. Install the spark plugs. Refer to **Spark Plug Replacement** .
17. Install the left side ignition coils. Refer to **Ignition Coil Replacement** .
18. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
19. Install the engine coolant air bleed pipe and cover. Refer to **Engine Coolant Air Bleed Hose Replacement (6.0L)** .
20. Install the intake manifold assembly. Refer to **Intake Manifold Replacement**.
21. Refill the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
22. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
23. Install the engine cover. Refer to **Engine Cover Replacement**.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

- **J 42385-100** J-42385-100. See **Special Tools** .
- **J 45059** J-45059

Removal Procedure

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Depressurize the fuel system. Refer to **Fuel Pressure Relief** .

WARNING: Refer to Battery Disconnect Warning .

3. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Drain the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
5. Remove the intake manifold assembly. Refer to **Intake Manifold Replacement**.
6. Remove the engine coolant air bleed pipe and cover. Refer to **Engine Coolant Air Bleed Hose Replacement (6.0L)** .
7. Remove the right side ignition coils. Refer to **Ignition Coil Replacement** .
8. Remove the spark plugs. Refer to **Spark Plug Replacement** .
9. Remove the oil level indicator and tube. Refer to **Oil Level Indicator Tube Replacement**.

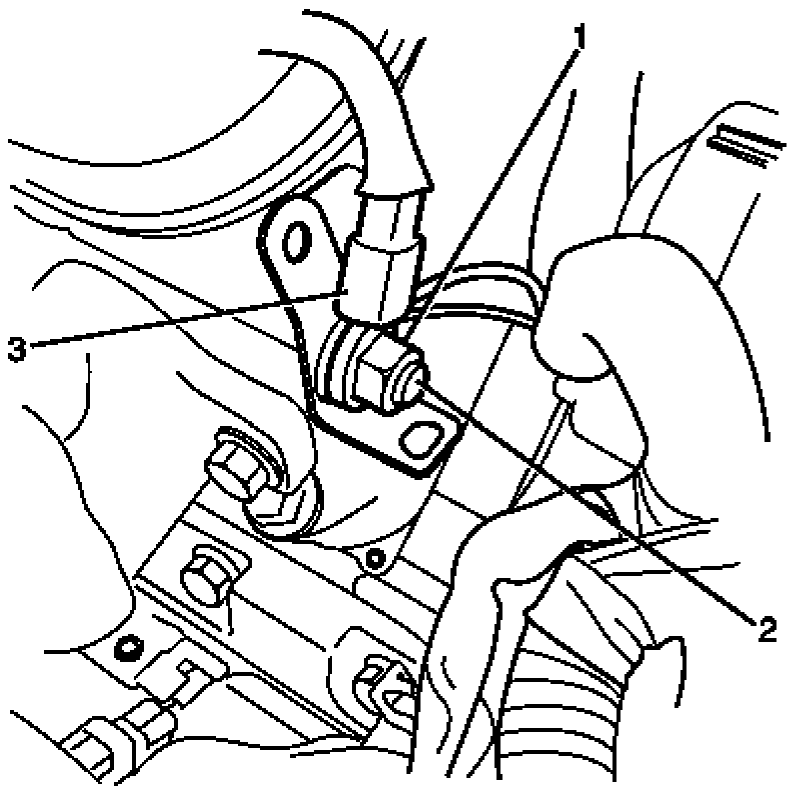


Fig. 106: Identifying Vehicle Body Ground Cable To Cylinder Head Retaining Nut
Courtesy of GENERAL MOTORS CORP.

10. Remove the vehicle body ground cable to cylinder head retaining nut (1).
11. Remove the vehicle body ground cable (3) from the cylinder head stud (2).

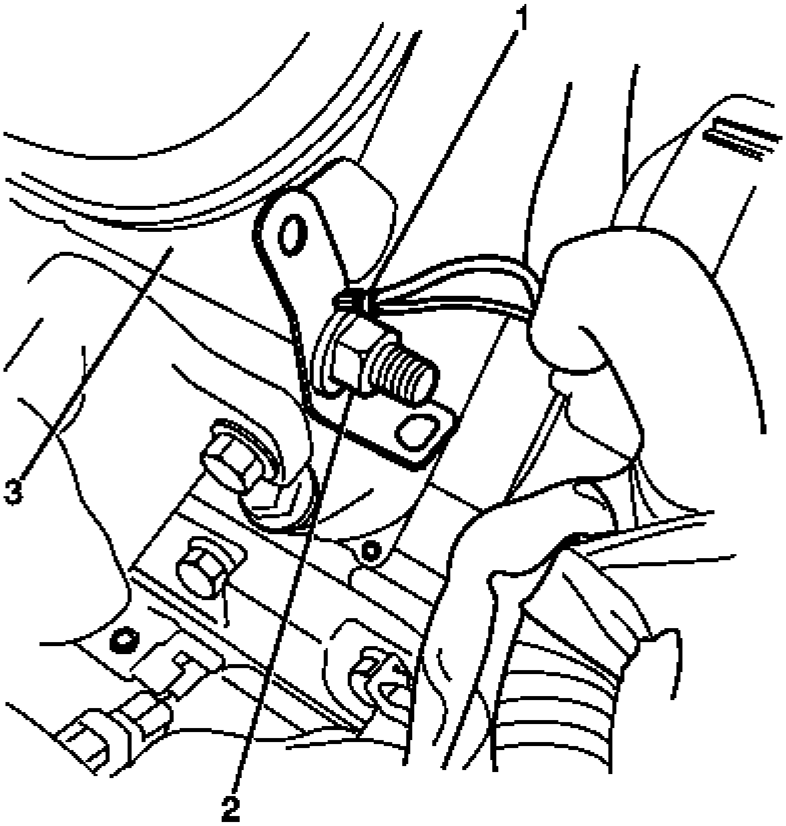


Fig. 107: Locating Wiring Harness Ground, Cylinder Head & Stud
Courtesy of GENERAL MOTORS CORP.

12. Remove the cylinder head stud (3) from the cylinder head (2) and secure the wiring harness ground (1) away from the cylinder head (2).
13. Remove the right side exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (V8)** .
14. Remove the right side valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Right Side**.
15. Remove the right side valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

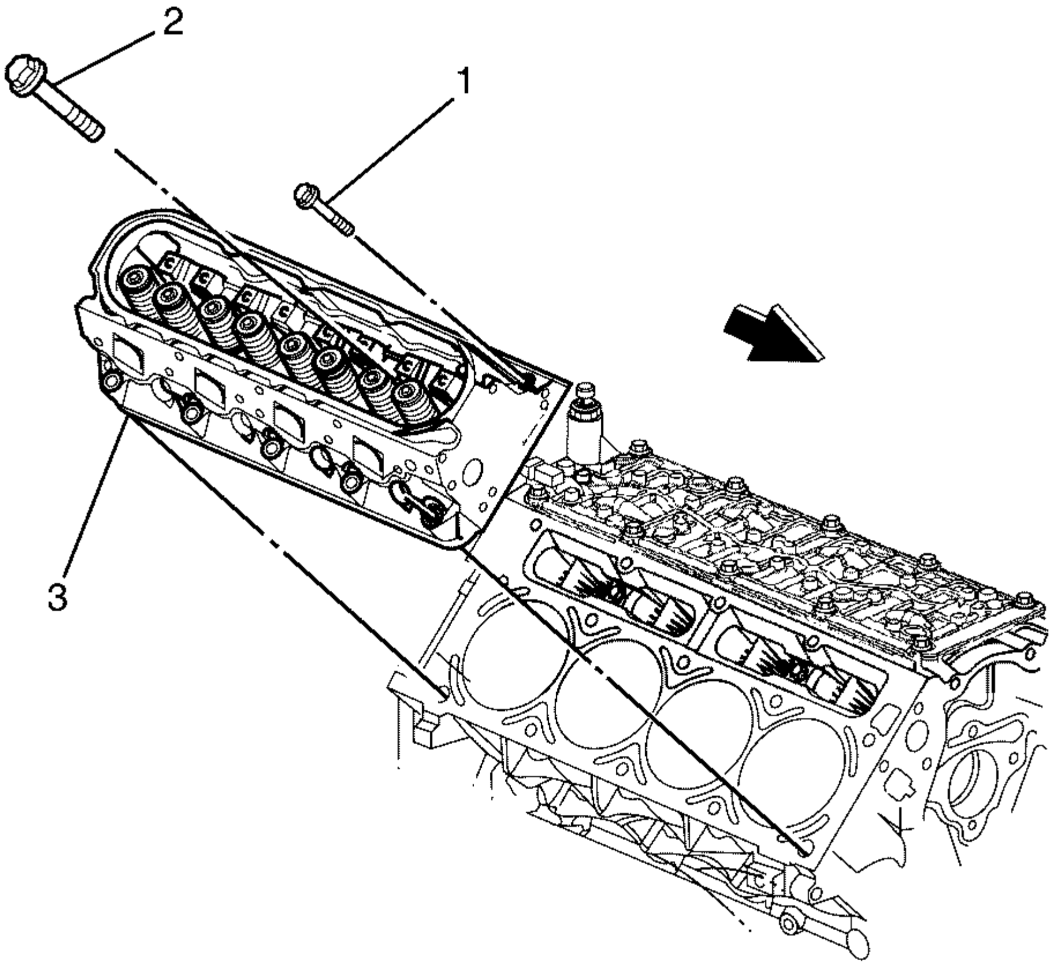


Fig. 108: Identifying Cylinder Head & Bolts (Right Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

16. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

    Discard the bolts.

NOTE: After removal, place the cylinder head on 2 wooden blocks in order to prevent damage to the sealing surfaces.

17. Remove the cylinder head (3).

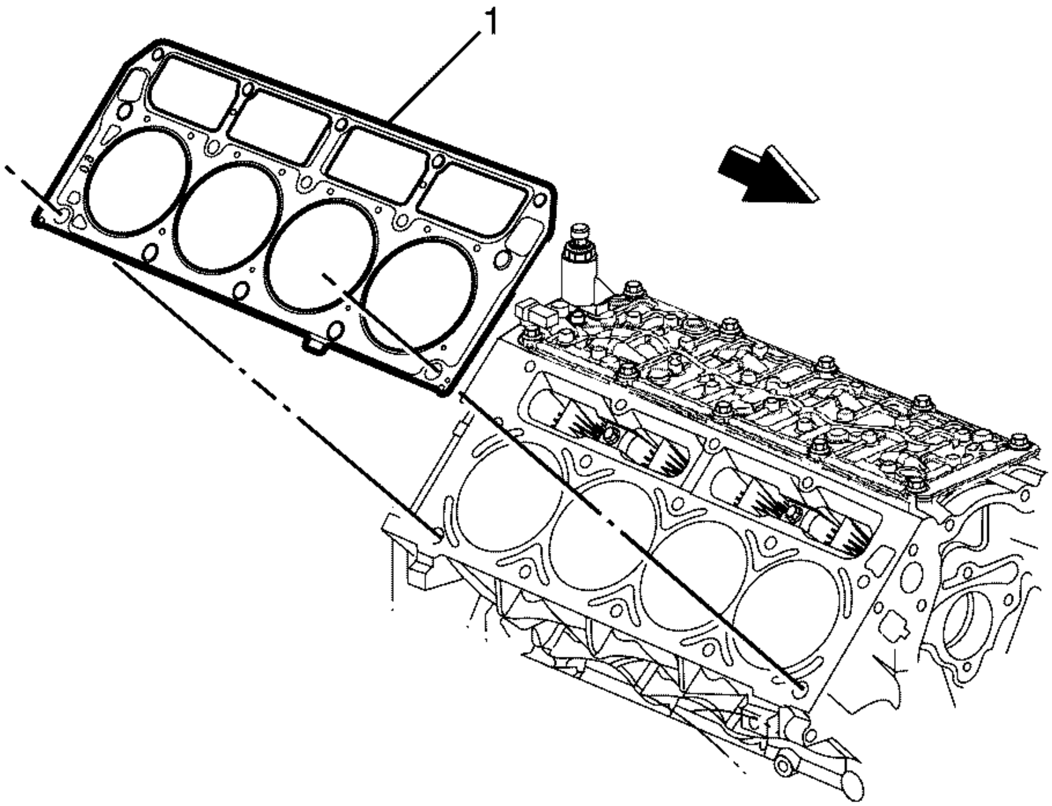


Fig. 109: Identifying Cylinder Head Gasket (Right Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.**

18. Remove the cylinder head gasket (1).

    Discard the gasket.

19. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection** .
20. If necessary, disassemble the cylinder head. Refer to **Cylinder Head Disassemble** .

Installation Procedure

1. If necessary, assemble the cylinder head. Refer to **Cylinder Head Assemble** .

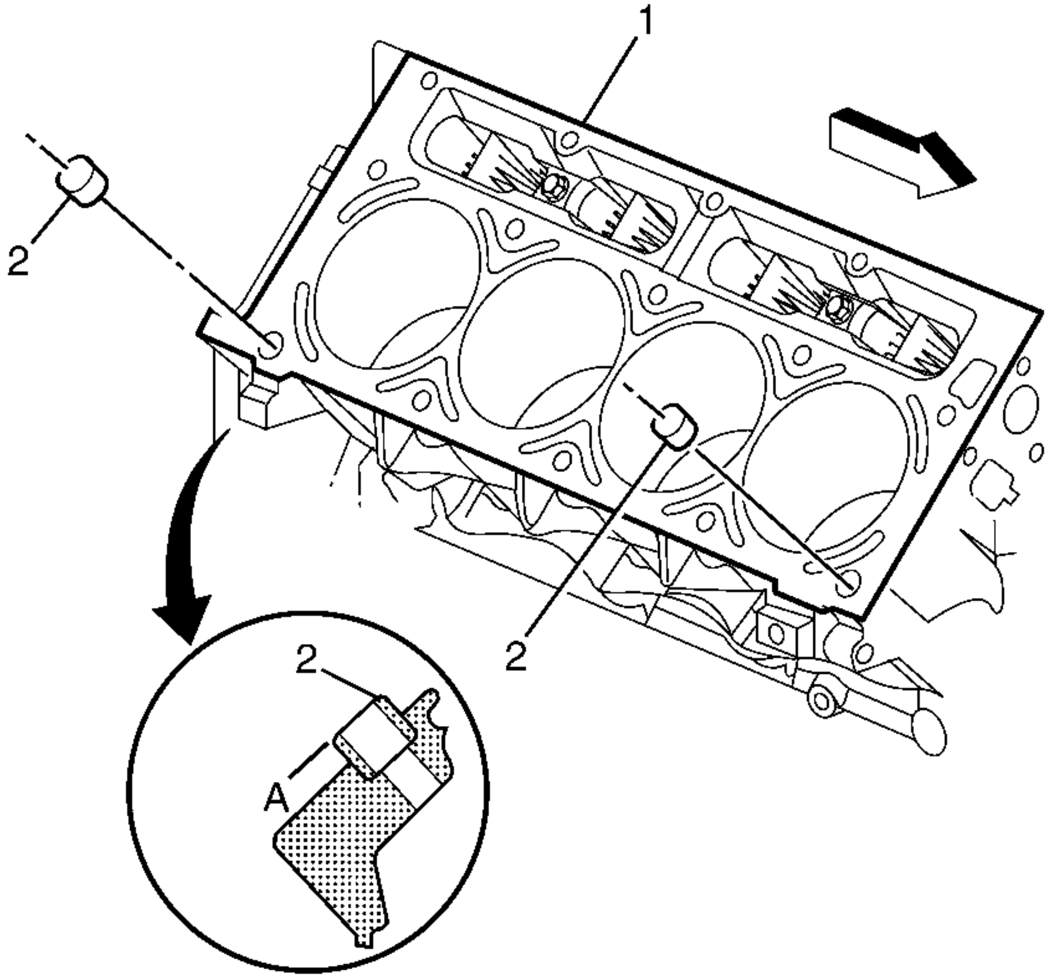


Fig. 110: Identifying Cylinder Block & Locating Sleeves (Right Side)
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Make sure the locating sleeves (2) are correctly installed to the maximum height (A) of 8.3 mm (0.33 in).**

2. Install the locating sleeves (2) into the cylinder block (1).

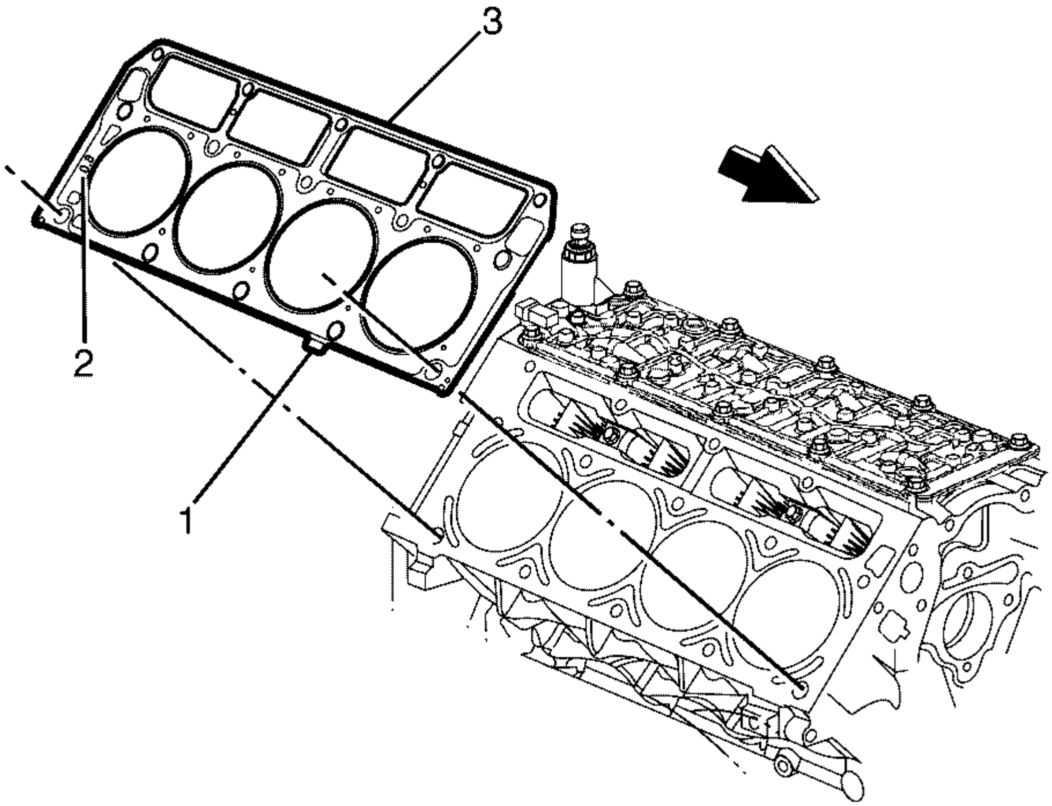


Fig. 111: Locating Cylinder Head Gasket (Right Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **The cylinder head gasket (3) will fit on either side of the engine. Make sure the tab on the cylinder head gasket (1) is located towards the front half point and the stamping FRONT on the cylinder head gasket (2) is facing the front of the engine.**

NOTE: **Do not use any type of sealant on the cylinder head gasket (1), unless specified.**

3. Install the NEW cylinder head gasket (3) correctly over the locating sleeves.
4. Install the cylinder head with the exhaust manifold to the engine. Refer to **Ignition Coil Replacement** .
5. Install the right side valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Install the right side valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Right Side**.
7. Install the right side exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (V8)** .

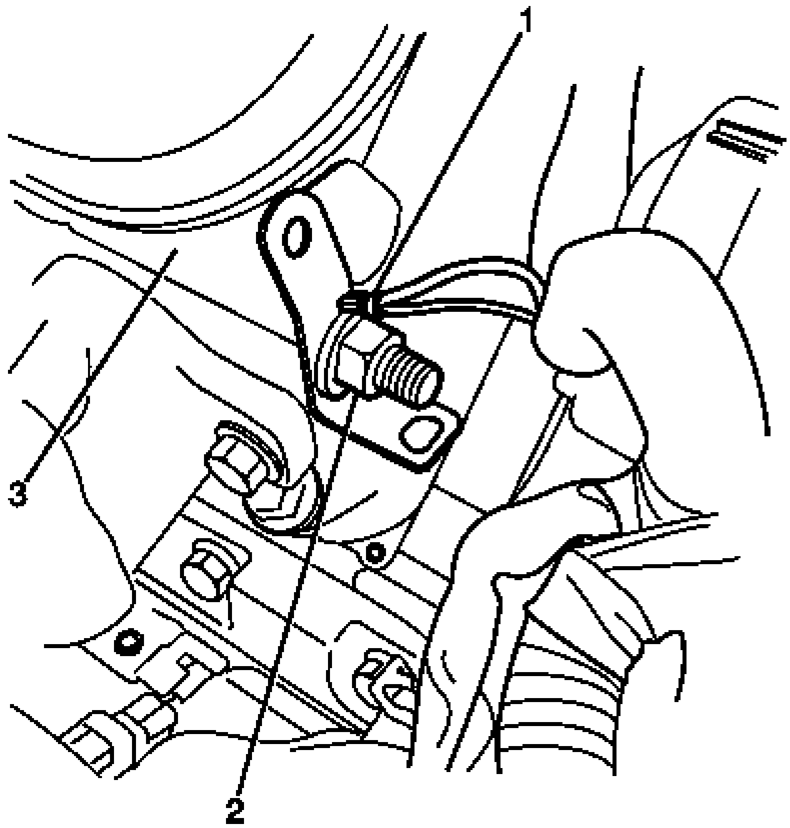


Fig. 112: Locating Wiring Harness Ground, Cylinder Head & Stud
Courtesy of GENERAL MOTORS CORP.

8. Position the wiring harness ground (1) on the cylinder head (2).

CAUTION: Refer to Fastener Caution .

9. Install the cylinder head stud (3) to the cylinder head (2) and tighten to 30 N.m (22 lb ft).

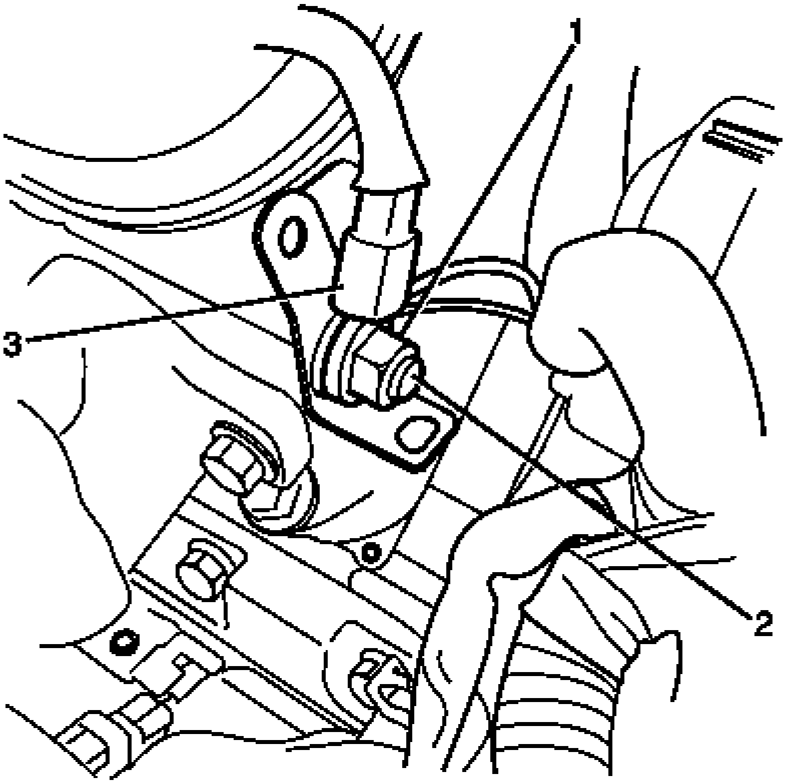


Fig. 113: Identifying Vehicle Body Ground Cable To Cylinder Head Retaining Nut
Courtesy of GENERAL MOTORS CORP.

10. Position the vehicle body ground cable (3) on the cylinder head stud (2).
11. Install the vehicle body ground cable to cylinder head retaining nut (1) and tighten to 12 N.m (106 lb ft).
12. Install the oil level indicator and tube. Refer to **Oil Level Indicator Tube Replacement**.
13. Install the spark plugs. Refer to **Spark Plug Replacement** .
14. Install the right side ignition coils. Refer to **Ignition Coil Replacement** .
15. Install the engine coolant air bleed pipe and cover. Refer to **Engine Coolant Air Bleed Hose Replacement (6.0L)** .
16. Install the intake manifold assembly. Refer to **Intake Manifold Replacement**.
17. Refill the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
18. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
19. Install the engine cover. Refer to **Engine Cover Replacement**.

VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head**

Replacement - Right Side.

2. Remove the valve lifters. Refer to **Valve Lifter Removal** .

Installation Procedure

1. Install the valve lifters. Refer to **Valve Lifter Installation** .
2. Install the cylinder head. Refer to **Cylinder Head Installation - Left Side** or**Cylinder Head Installation - Right Side** .

CRANKSHAFT BALANCER REPLACEMENT

Tools Required

- **J 41816-A** Crankshaft Balancer Remover. See **Special Tools** .
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .

Removal Procedure

1. Disconnect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the radiator. Refer to **Radiator Replacement** .
3. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
4. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
5. Remove the starter motor. Refer to **Starter Replacement (6.0L)** .
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal (6.0L L76)** or **Crankshaft Balancer Removal (6.2L LS3)**.

Installation Procedure

1. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation (6.0L L76)** or **Crankshaft Balancer Installation (6.2L LS3)** .
2. Install the starter motor. Refer to **Starter Replacement (6.0L)** .
3. Install the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
5. Install the radiator. Refer to **Radiator Replacement** .
6. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .

- **E-308** Crankshaft Front Oil Seal Remover.

Removal Procedure

1. Disconnect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the radiator. Refer to **Radiator Replacement** .
3. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
4. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
5. Remove the starter motor. Refer to **Starter Replacement (6.0L)** .
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal (6.0L L76)** or **Crankshaft Balancer Removal (6.2L LS3)**.

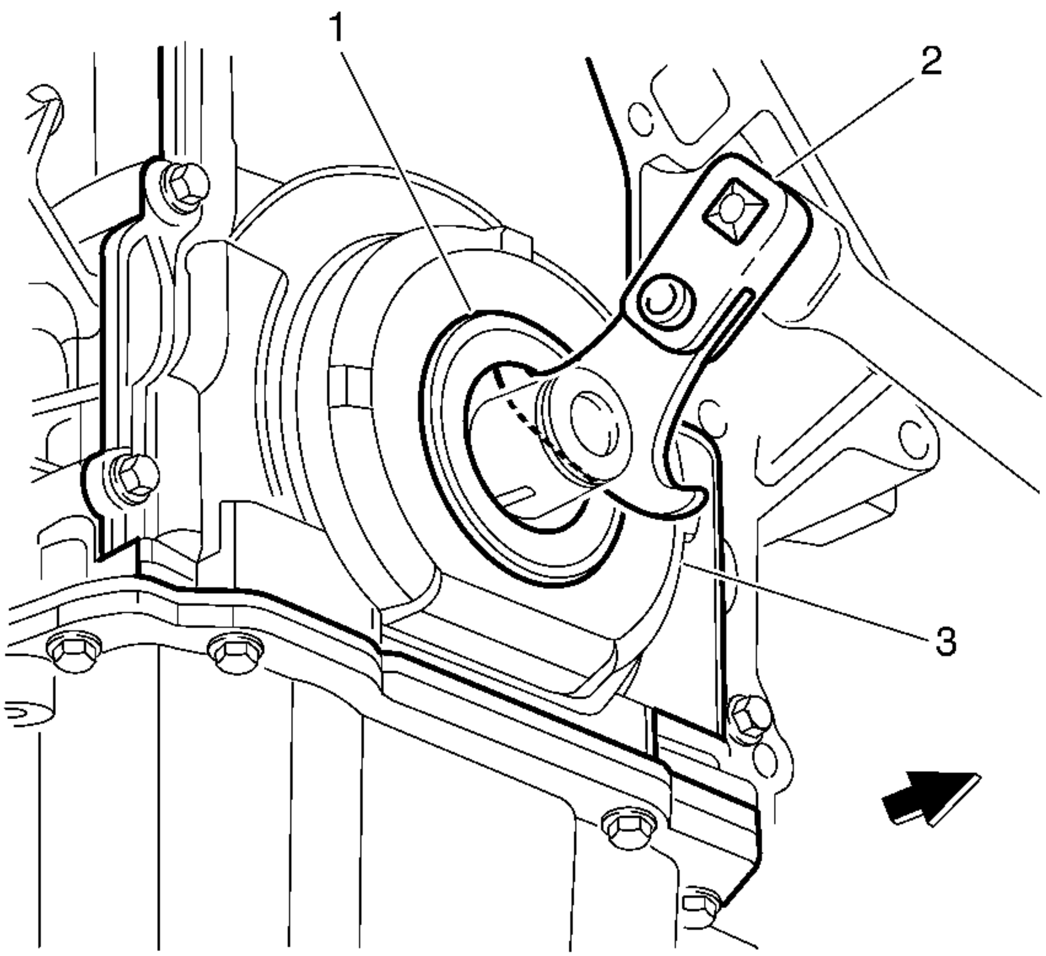


Fig. 114: Locating Front Engine Cover, E-308 & Crankshaft Oil Seal
Courtesy of GENERAL MOTORS CORP.

7. Using tool **E-308** (2) gently pry the crankshaft oil seal (1) from the front engine cover (3).

Installation Procedure

1. Install the crankshaft front oil seal installation. Refer to **Crankshaft Front Oil Seal Installation** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation (6.0L L76)** or **Crankshaft Balancer Installation (6.2L LS3)** .
3. Install the starter motor. Refer to **Starter Replacement (6.0L)** .
4. Install the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
5. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
6. Install the radiator. Refer to **Radiator Replacement** .
7. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE FRONT COVER REPLACEMENT

Tools Required

- **J 41480** Front and Rear Cover Alignment. See **Special Tools** .
- **J 41476** Front and Rear Cover Alignment Tool. See **Special Tools** .

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal (6.0L L76)** or **Crankshaft Balancer Removal (6.2L LS3)**.

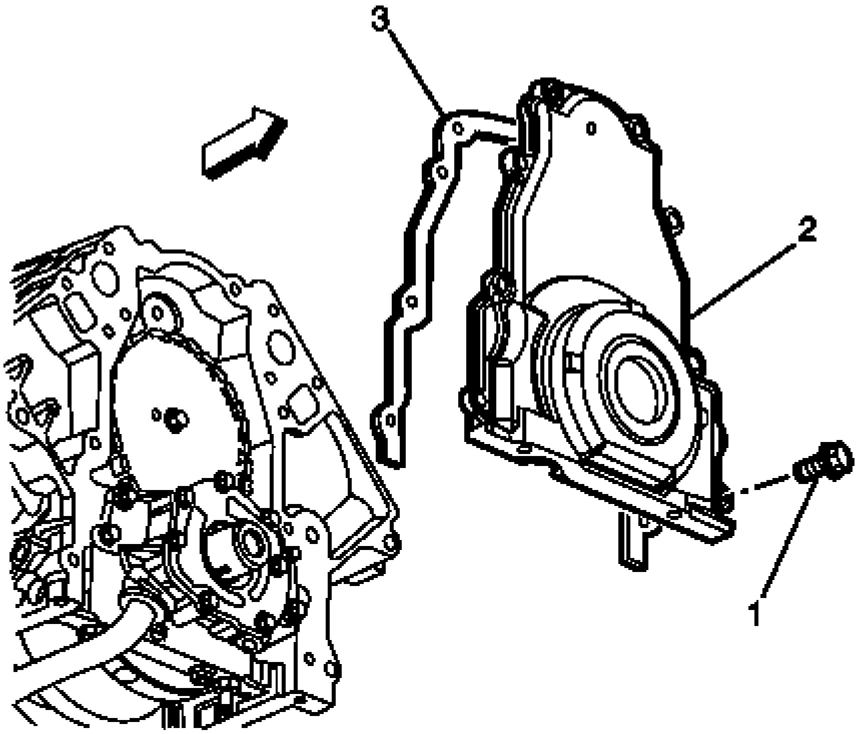


Fig. 115: Identifying Engine Front Cover To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine front cover to cylinder block retaining bolts (1).

IMPORTANT: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

4. Remove the engine front cover (2) and gasket (3).
5. Remove the engine front cover gasket (3).

   Discard the engine front cover gasket (3).

6. Clean and inspect the engine front cover. Refer to **Engine Front Cover Cleaning and Inspection** .

Installation Procedure

1. Install the engine front cover. Refer to **Engine Front Cover Installation** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Removal (6.0L L76)** or **Crankshaft Balancer Removal (6.2L LS3)**.
3. Install the oil pan. Refer to **Oil Pan Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Tools Required

J 41479 Crankshaft Rear Oil Seal Installer. See **Special Tools** .

Removal Procedure

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.

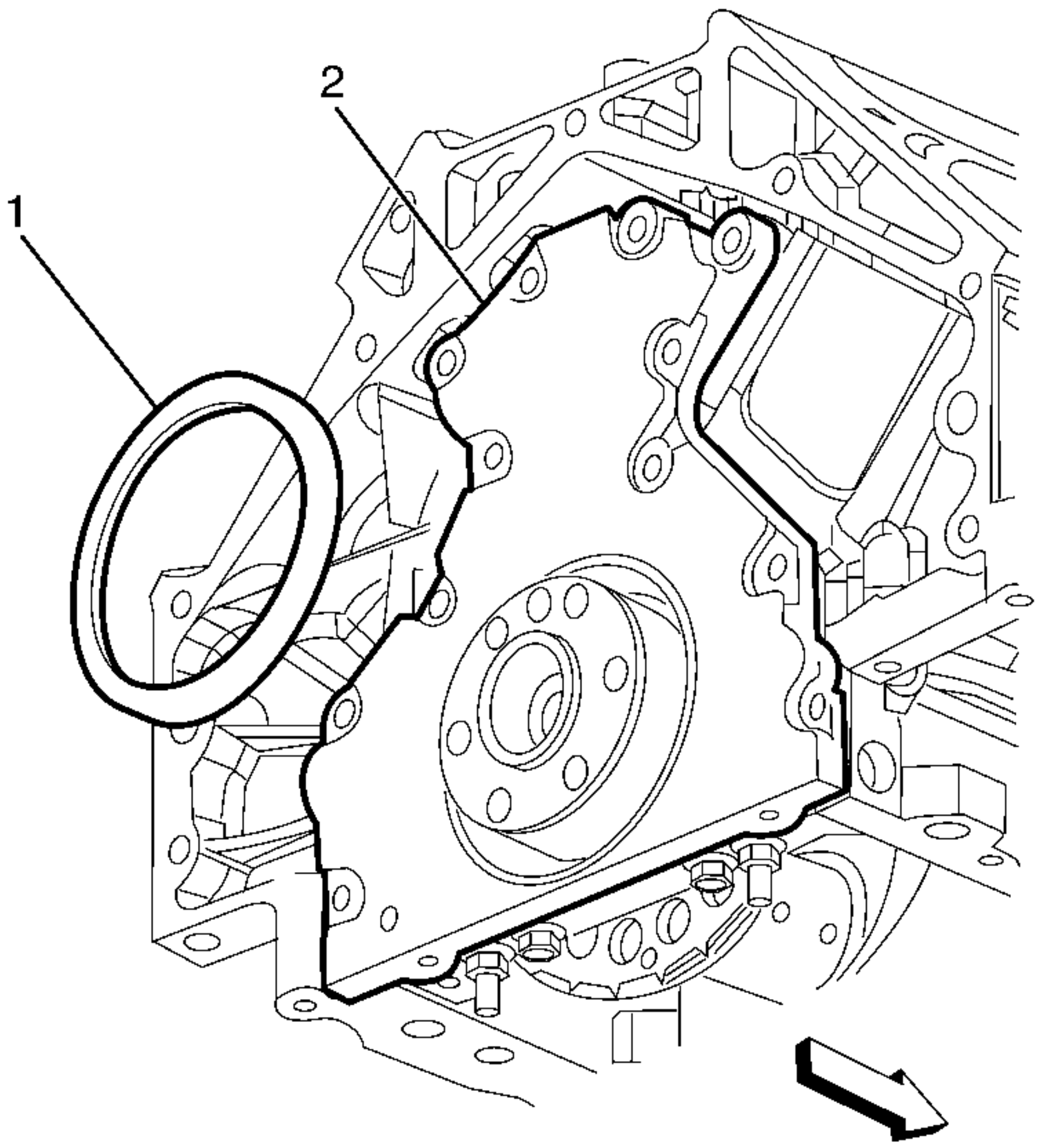


Fig. 116: Identifying Crankshaft Rear Cover & Oil Seal
Courtesy of GENERAL MOTORS CORP.

2. Gently pry the crankshaft rear oil seal (1) from the rear cover (2).

Installation Procedure

1. Install the crankshaft rear seal. Refer to **Crankshaft Rear Oil Seal Installation** .
2. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

Tools Required

- **J 41476** . See **Special Tools** .
- **J 41479** . See **Special Tools** .

Removal Procedure

1. Remove the transmission assembly. Refer to **Transmission Replacement** .
2. Remove the flywheel assembly. Refer to **Engine Flywheel Removal**.

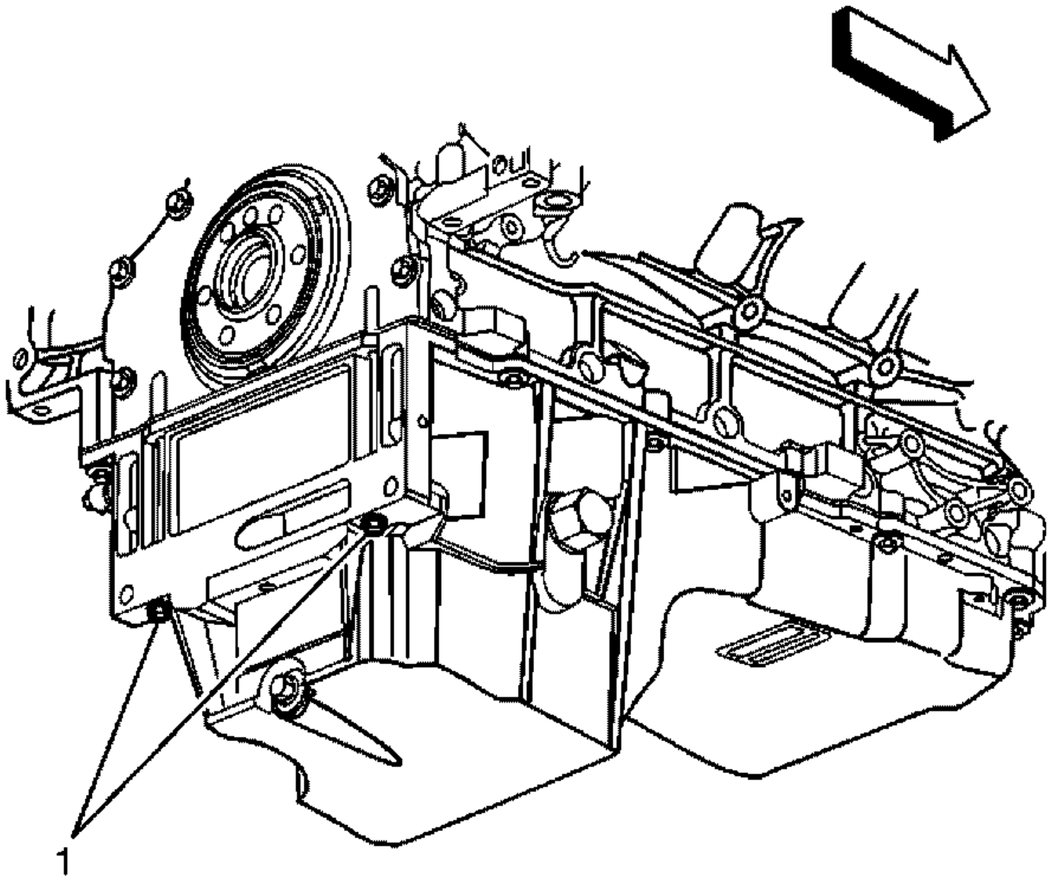


Fig. 117: Identifying Oil Pan To Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan to rear oil seal housing bolts (1).

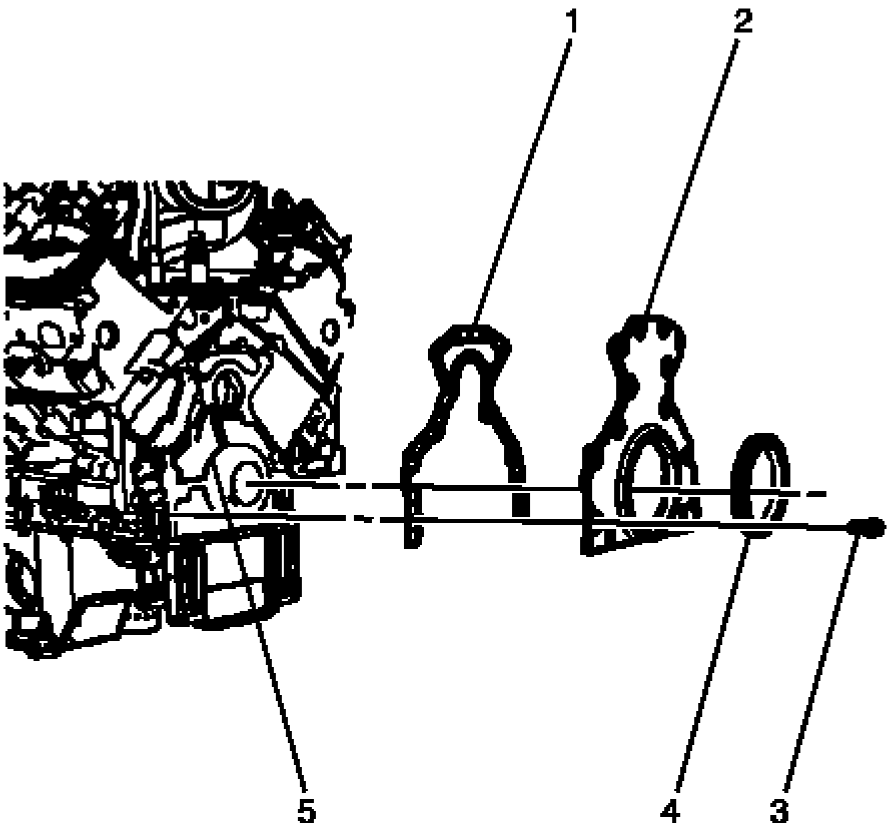


Fig. 118: Identifying Rear Oil Seal Housing To Engine Block Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the rear oil seal housing to engine block bolts (3).
5. Remove the rear oil seal housing (2) from the engine block (5).
6. Remove the rear oil seal housing gasket (1) from the engine block (5).

   Discard the rear oil seal housing gasket (1).

7. Remove the rear crankshaft oil seal (4) from the rear oil seal housing (2).

   Discard the rear oil seal (4).

Installation Procedure - Cover with Seal

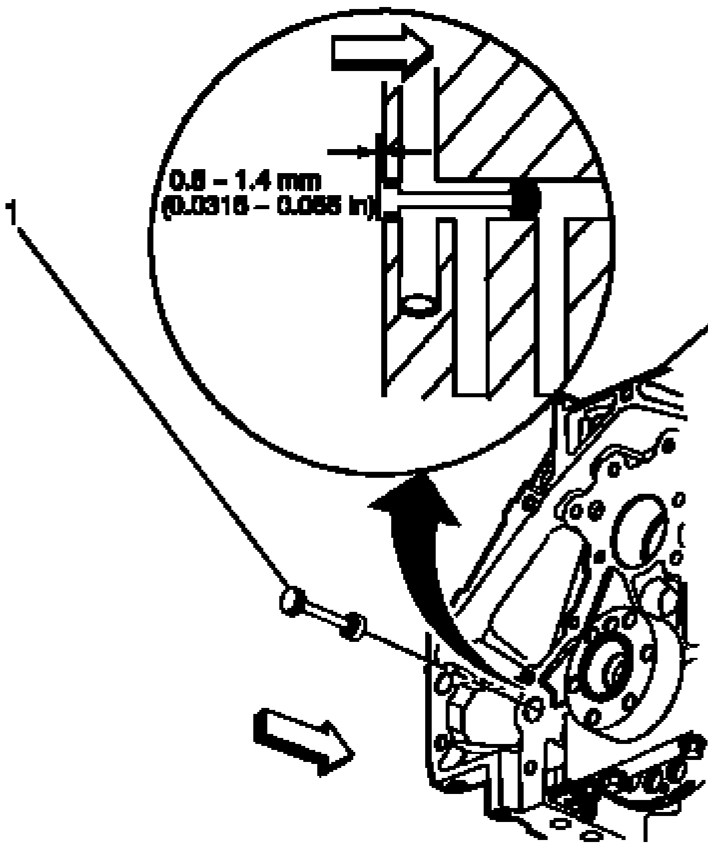


Fig. 119: Identifying Rear Oil Gallery Plug & Engine Block
Courtesy of GENERAL MOTORS CORP.

1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).

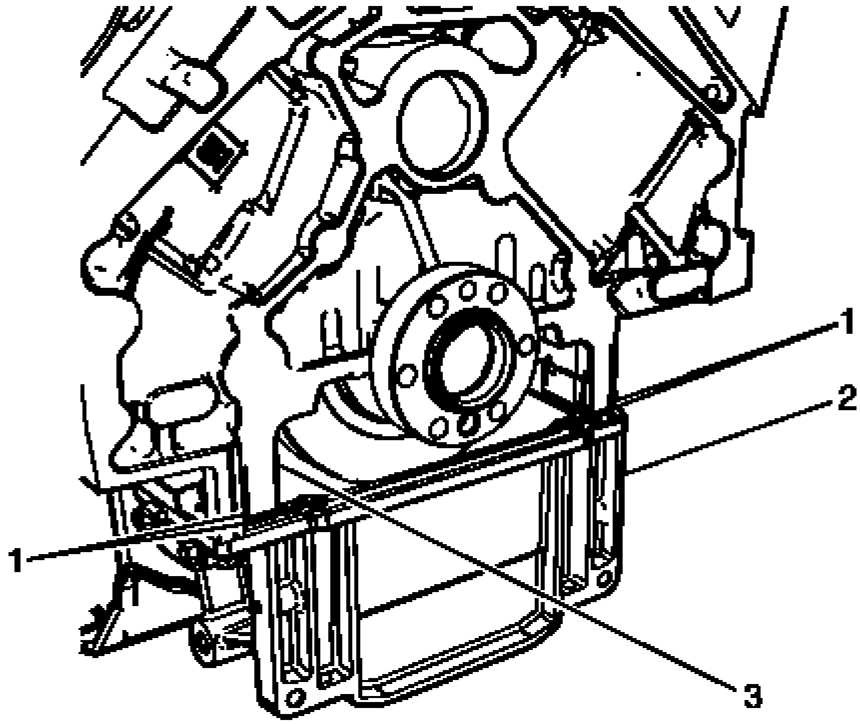


Fig. 120: Locating Surfaces Of Oil Pan & Engine Block
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).

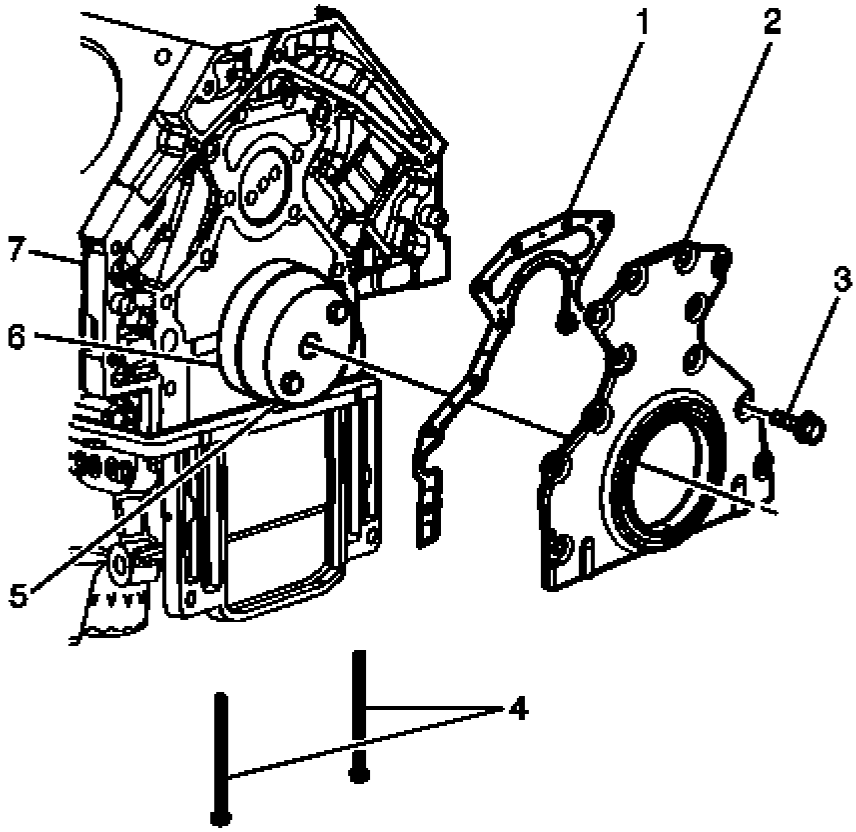


Fig. 121: Identifying J 41479 & Crankshaft
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 41479** (5) to the crankshaft (6). See **Special Tools** .

NOTE: **Install a new rear oil seal housing gasket (1). Failure to comply may lead to an oil leak.**

NOTE: **Make sure that the rear oil seal housing gasket contact surfaces are clean and dry. Failure to comply may lead to an oil leak.**

4. Install the new rear oil seal housing gasket (1) to the engine block (7).

NOTE: **The rear oil seal housing must be aligned with J 41479 . See Special Tools . Failure to comply may cause the rear crankshaft seal to wear prematurely.**

5. Install the rear oil seal housing (2) to the engine block (7).

CAUTION: **Refer to Fastener Caution .**

6. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.
7. Install the oil pan to rear oil seal housing bolts (4) and tighten to 12 N.m (106 lb. in).
8. Tighten the rear oil seal housing to engine block bolts (3) and tighten to 30 N.m (22 lb. ft).
9. Remove the **J 41479** (5) from the crankshaft (6). See **Special Tools** .
10. Install the engine flywheel assembly. Refer to **Engine Flywheel Replacement**.
11. Install the transmission assembly. Refer to **Transmission Replacement** .

Installation Procedure - Cover without Seal

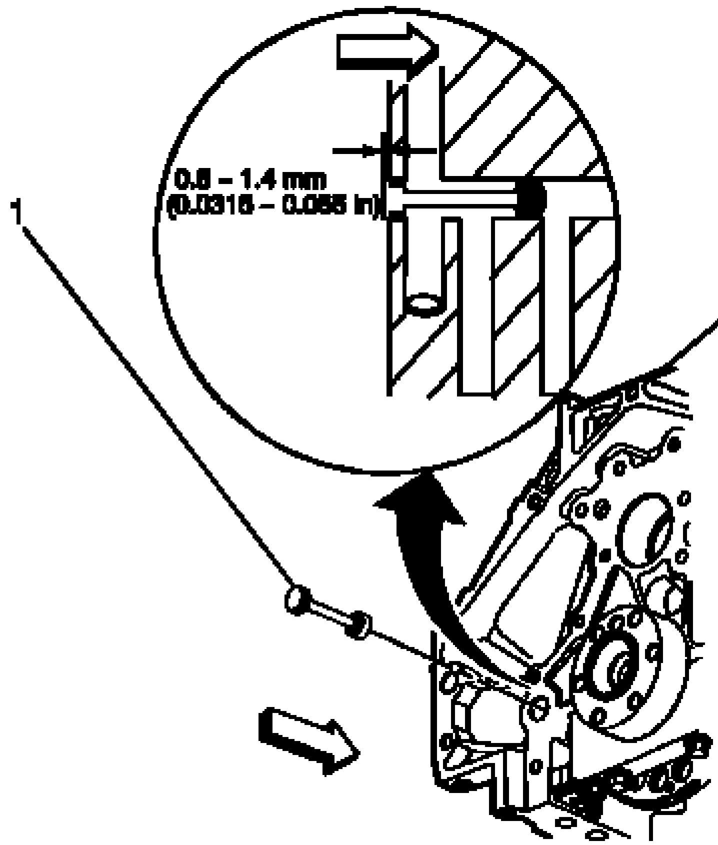


Fig. 122: Identifying Rear Oil Gallery Plug & Engine Block
Courtesy of GENERAL MOTORS CORP.

1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).

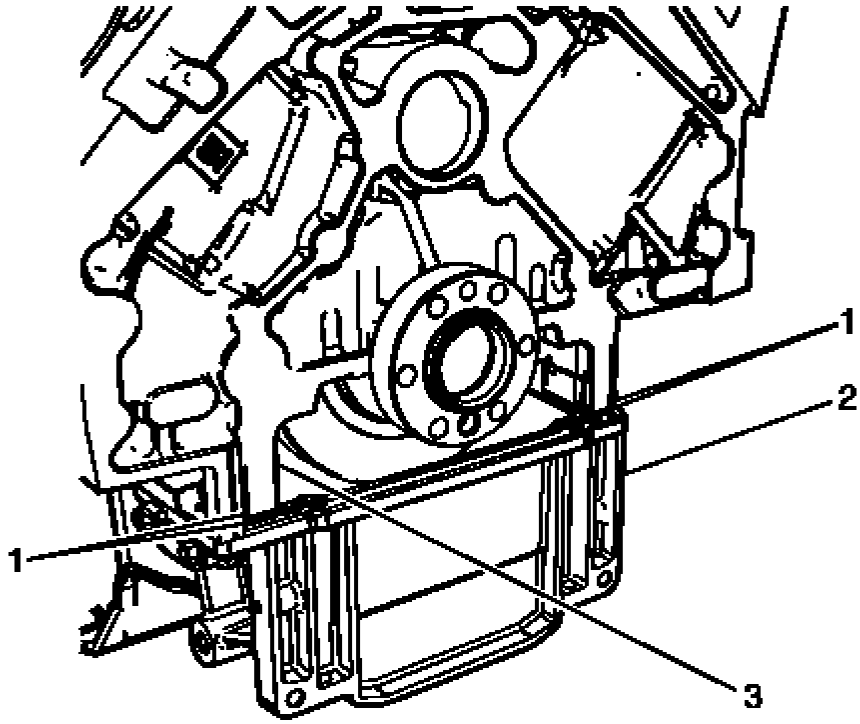


Fig. 123: Locating Surfaces Of Oil Pan & Engine Block
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).

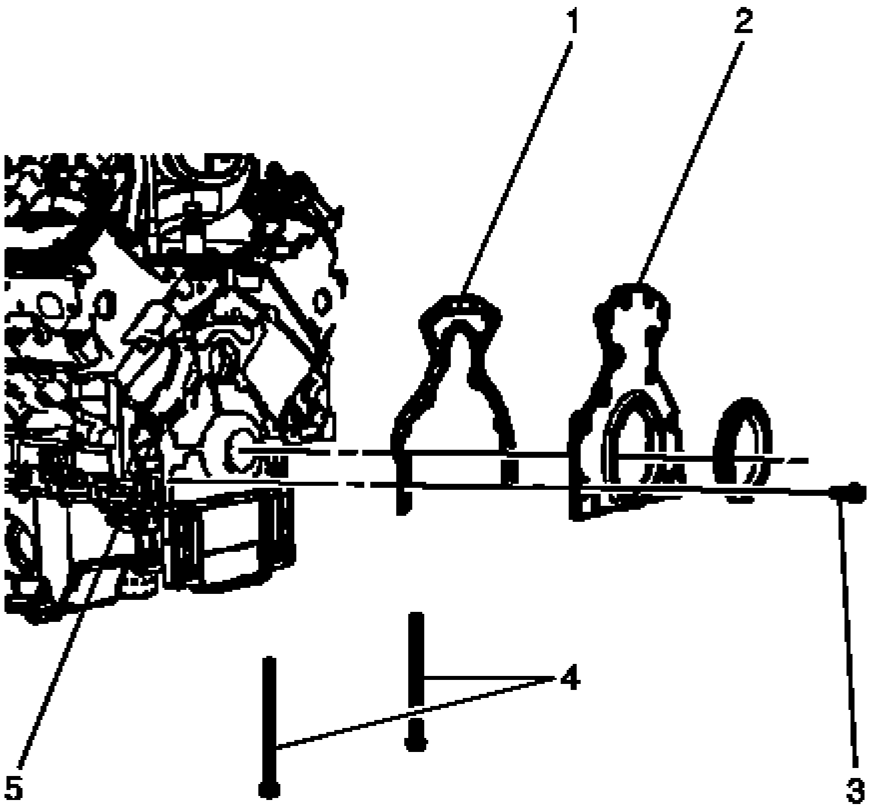


Fig. 124: Identifying Rear Oil Seal Housing To Engine Block Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure that the rear oil seal housing gasket contact surfaces are clean and dry.

3. Install the new rear oil seal housing gasket (1) to the engine block (5).
4. Install the rear oil seal housing (2) to the engine block (5).

CAUTION: Refer to Fastener Caution .

5. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.
6. Install the oil pan to rear housing bolts (4). Finger tighten only at this stage.

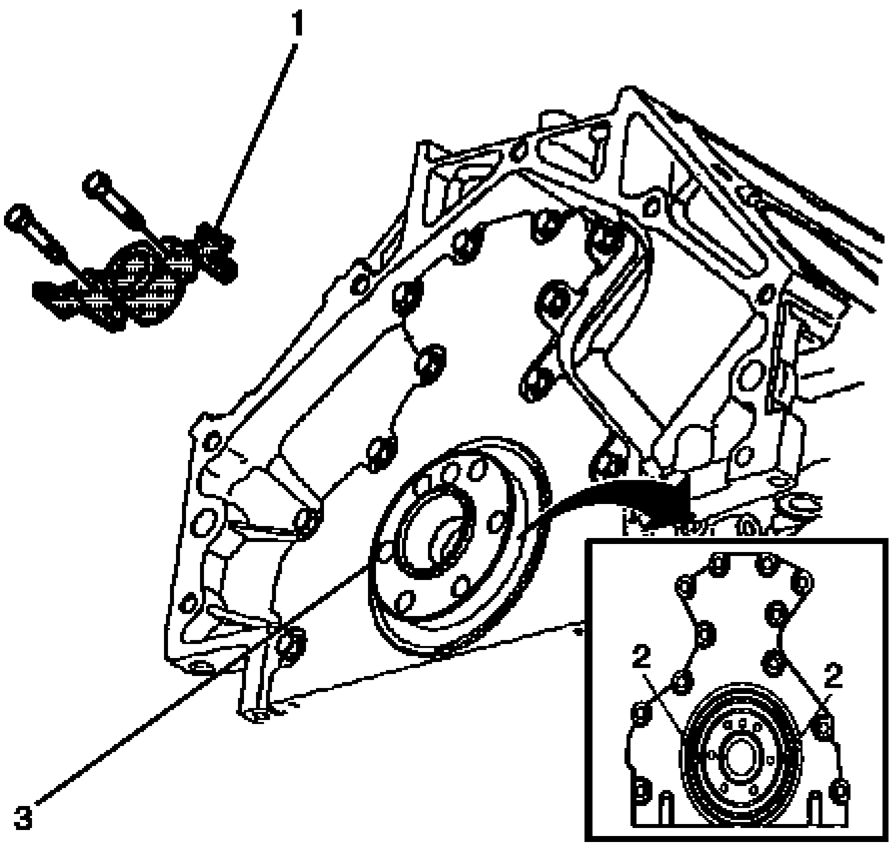


Fig. 125: Locating J 41476, Slots & Crankshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **The rear oil seal housing MUST be aligned to the crankshaft using J 41476 (1). See Special Tools . Failure to comply may cause the rear crankshaft seal to wear prematurely.**

NOTE: **Align the J 41476 I (1) with the slots (2). See Special Tools .**

NOTE: **The legs of the J 41476 (1) must enter the oil seal bore. See Special Tools .**

7. Install the **J 41476** (1) to the crankshaft (3). See **Special Tools** .

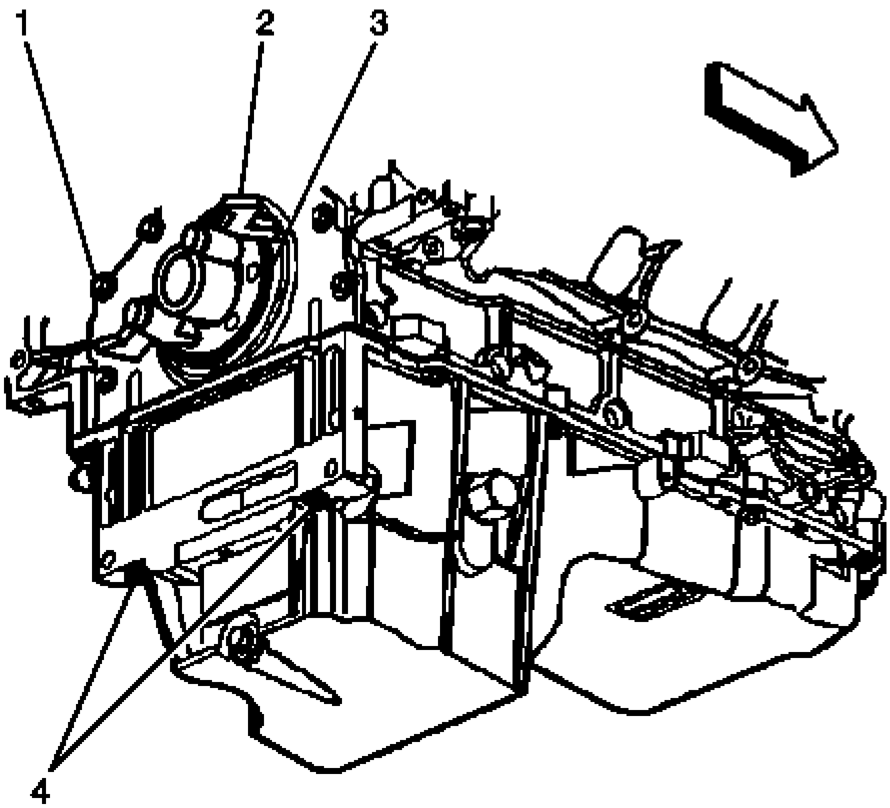


Fig. 126: Identifying Oil Pan To Rear Housing Bolts
Courtesy of GENERAL MOTORS CORP.

8. Tighten the oil pan to rear housing bolts (4) and tighten to 12 N.m (106 lb. in).
9. Tighten the rear oil seal housing to engine block bolts (1) and tighten to 30 N.m (22 lb. ft).
10. Remove the **J 41476** (2) from the crankshaft (3). See **Special Tools** .
11. Install a new crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
12. Install the engine flywheel assembly. Refer to **Engine Flywheel Replacement**.
13. Install the transmission assembly. Refer to **Transmission Replacement** .

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

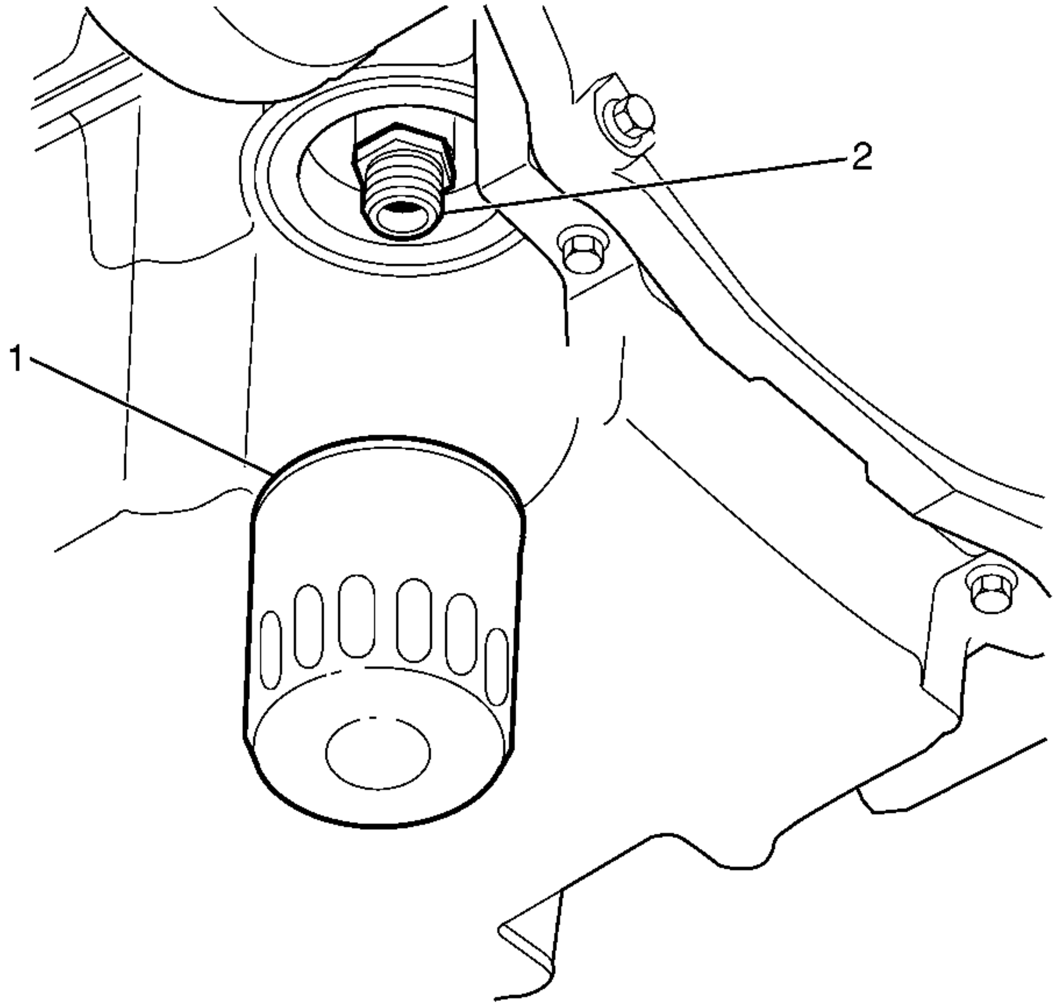


Fig. 127: Identifying Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter (1).
2. Remove the oil filter adapter (2).

Installation Procedure

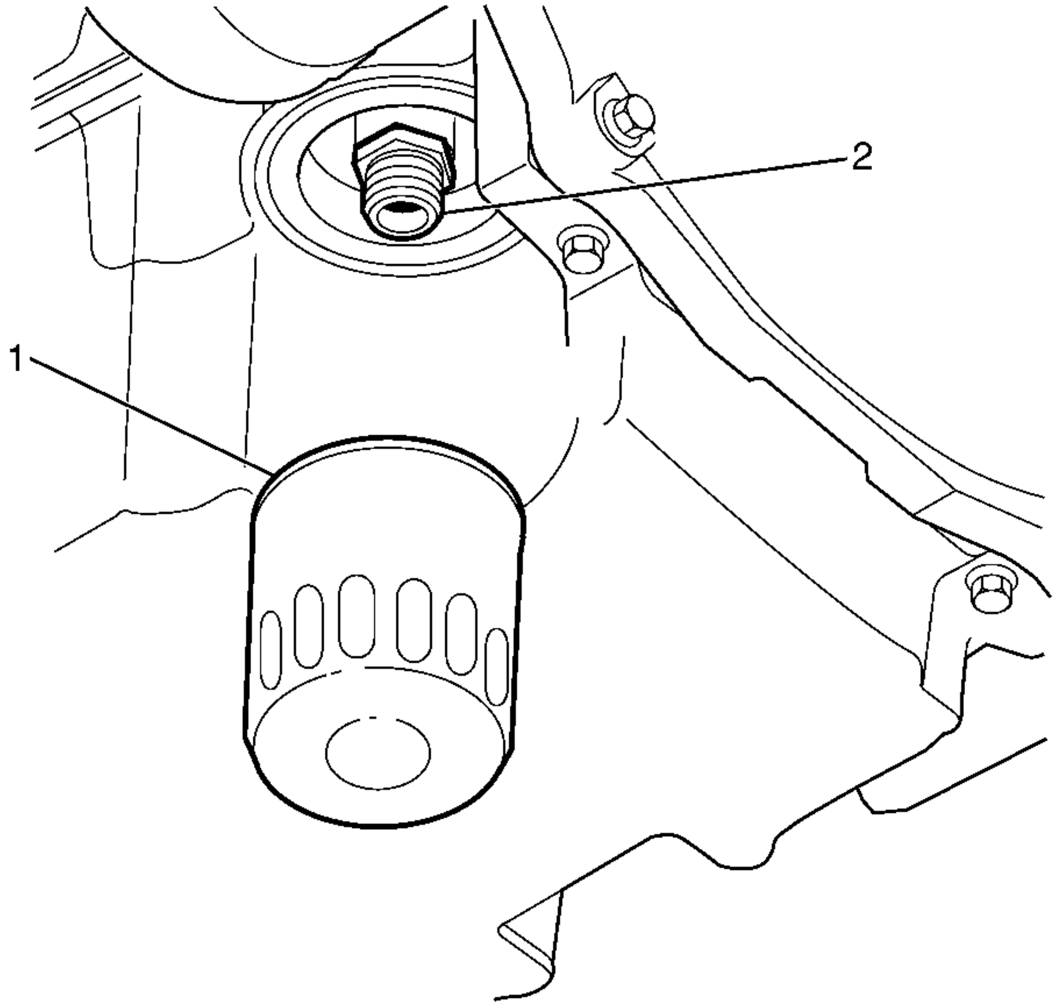


Fig. 128: Identifying Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil filter adapter (2) and tighten to 55 N.m (40 lb ft).
2. Install the oil filter (1) and tighten to 30 N.m (22 lb ft).

OIL PAN COVER REPLACEMENT

Removal Procedure

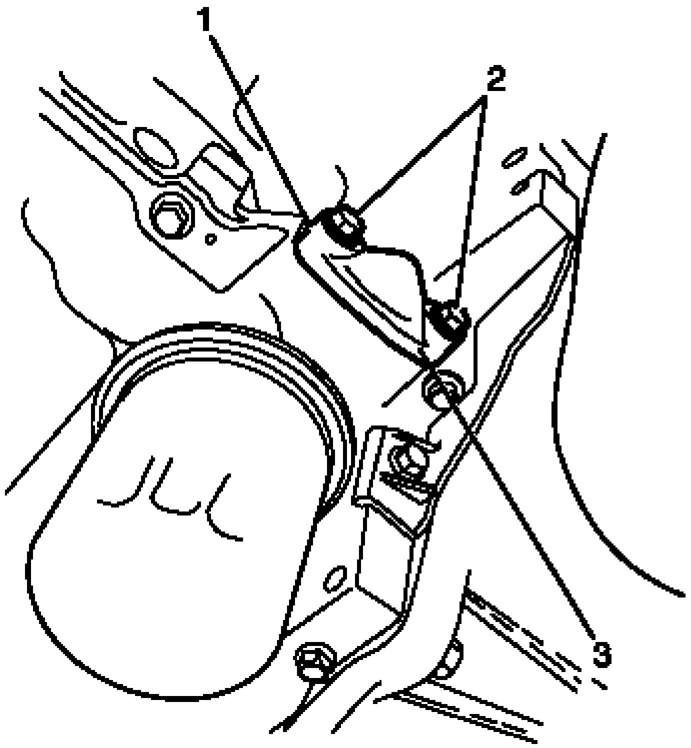


Fig. 129: Identifying Oil Pan Cover To Oil Pan Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the oil pan cover to oil pan retaining bolts (2).
3. Remove the cover (1).
4. Remove the gasket (3).

Installation Procedure

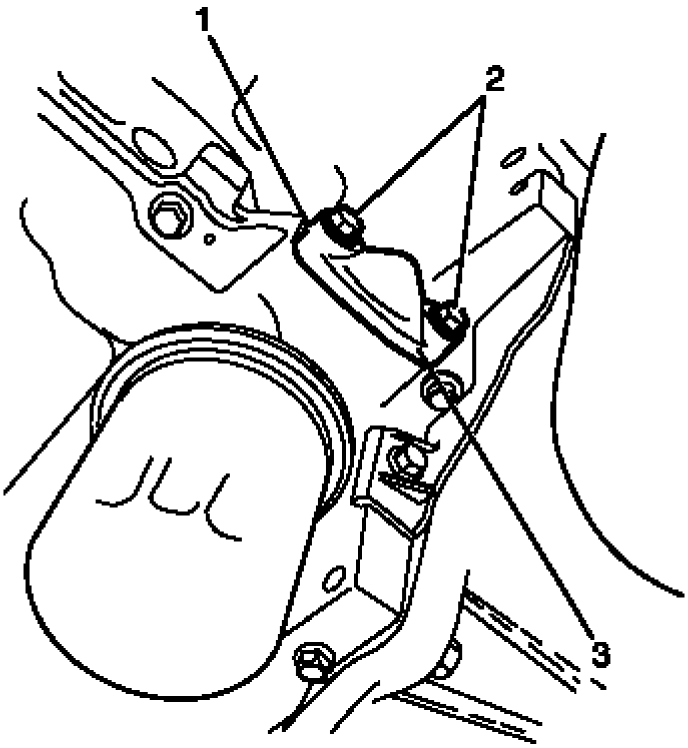


Fig. 130: Identifying Oil Pan Cover To Oil Pan Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the gasket (3) and cover (1) on the engine block.

CAUTION: Refer to Fastener Caution .

2. Install the retaining bolts (2) for the cover and tighten to 12 N.m (106 lb in).
3. Lower the vehicle.

OIL PAN REPLACEMENT

Removal Procedure

WARNING: Refer to Battery Disconnect Warning .

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

WARNING: To avoid any vehicle damage, serious personal injury or death when

major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

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

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the air deflector. Refer to **Front Air Deflector Replacement** .
4. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
5. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .
6. Remove the starter motor. Refer to **Starter Replacement (6.0L)** .

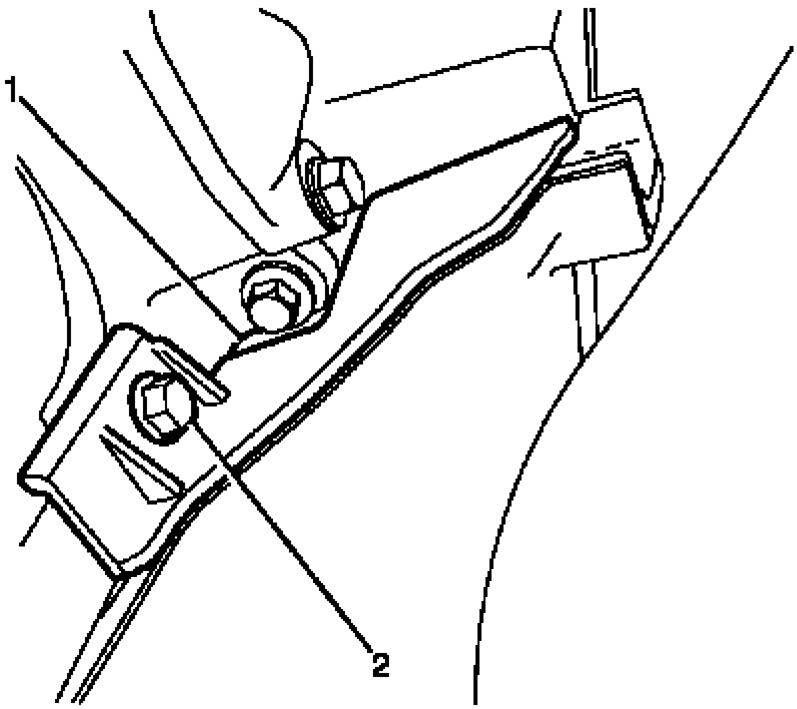


Fig. 131: Identifying Left Side Close Out Cover To Cylinder Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the left side close out cover to cylinder block retaining bolt (2).
8. Remove the left side close out cover (1).

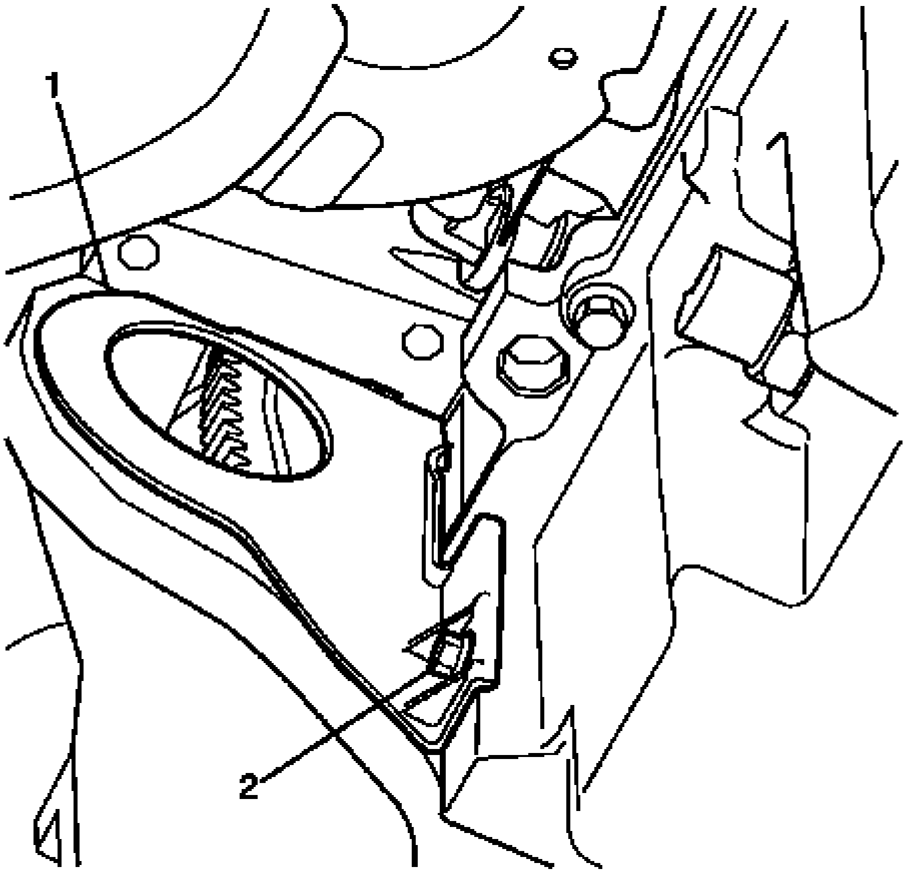


Fig. 132: Identifying Right Transmission Cover & Engine Oil Pan Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the right side close out cover to cylinder block retaining bolt (2).
10. Remove the right side close out cover (1).

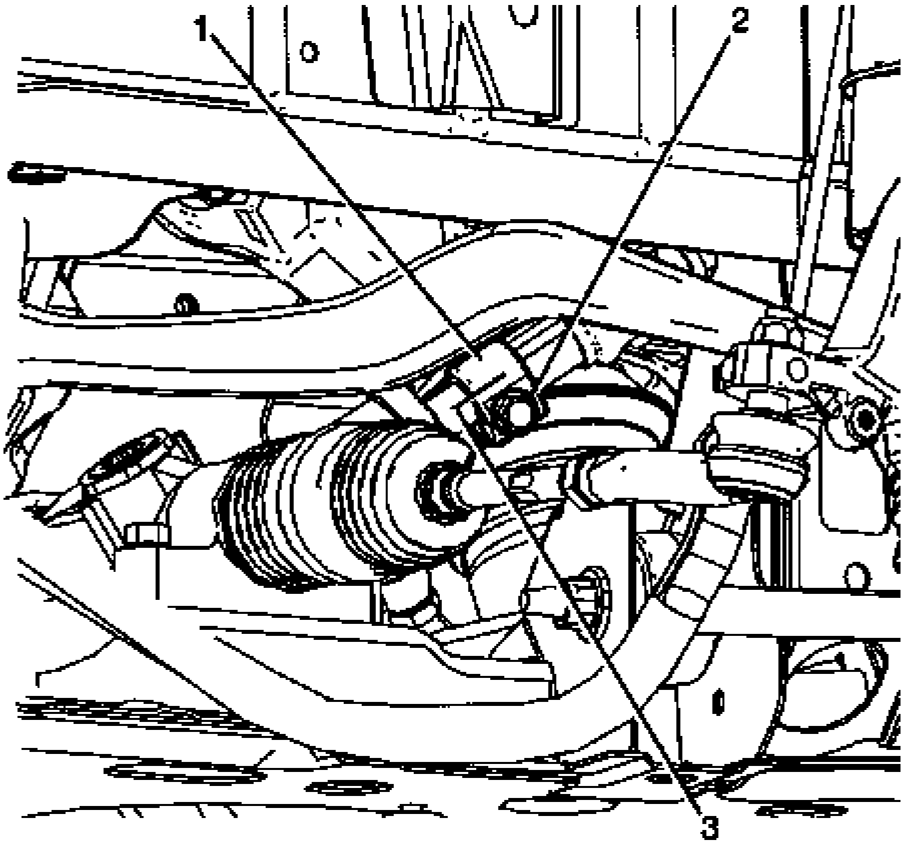


Fig. 133: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimize the potential of incorrect steering column assembly alignment.**

11. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).

NOTE: **Secure the steering wheel to prevent rotation otherwise damage to the SIR coil will occur.**

NOTE: **Bolts with micro-encapsulated thread sealant must be discarded after removal.**

12. Remove the intermediate steering shaft to pinion shaft retaining bolt (2) and discard.

    Discard the bolt.

13. Disconnect the intermediate shaft (2) from the pinion shaft (3).

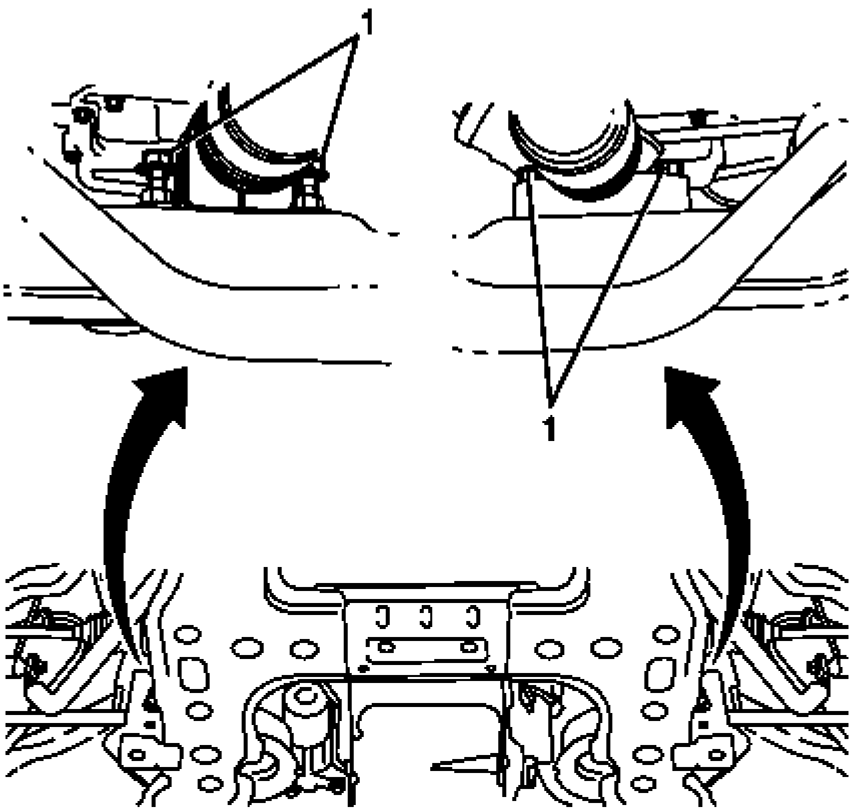


Fig. 134: Identifying Steering Gear To Subframe Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the steering gear to sub-frame retaining bolts (1).
15. Slide the steering gear forward to gain full access to the sump.

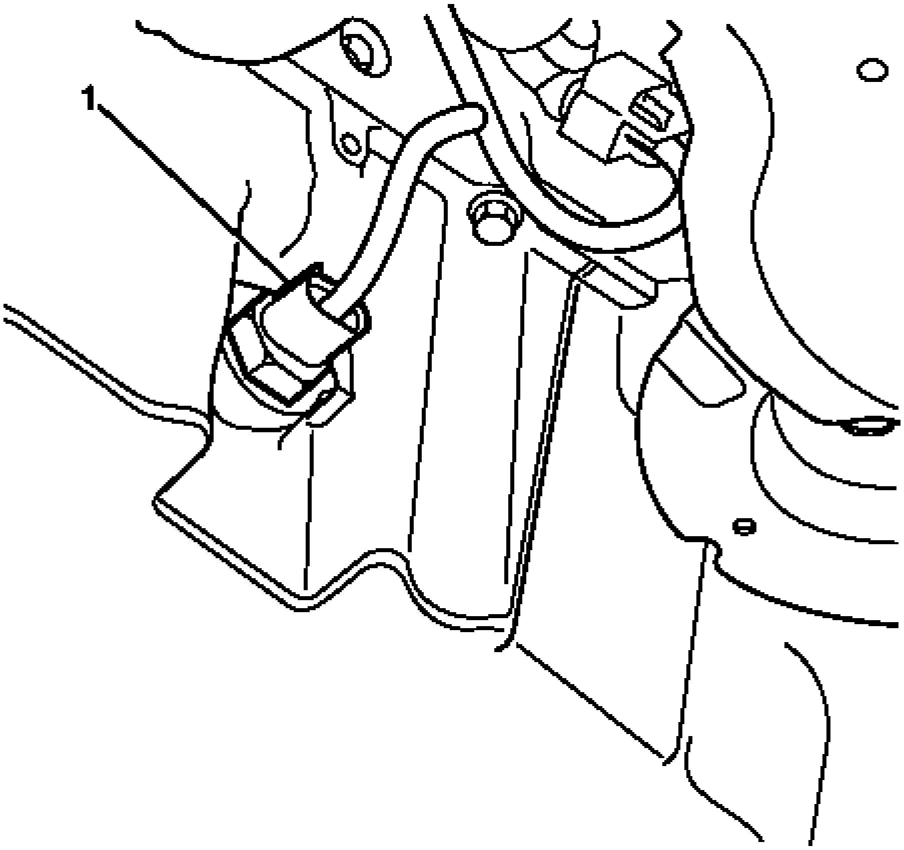


Fig. 135: Identifying Oil Level/Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

16. Disconnect the oil level/temperature sensor electrical connector (1) from the oil level/temperature sensor.

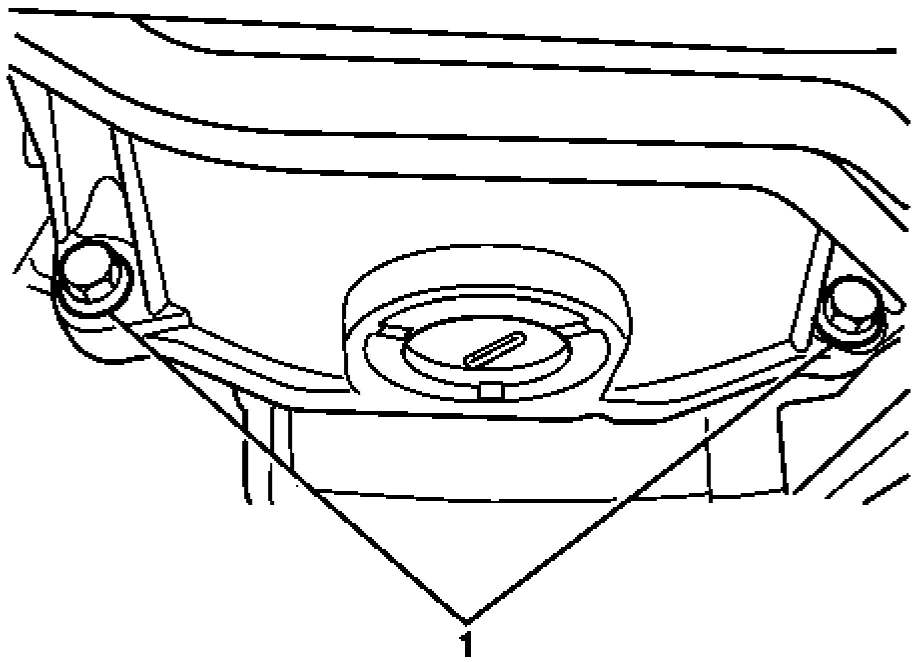


Fig. 136: Identifying Transmission To Oil Pan Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the transmission to oil pan retaining bolts (1).

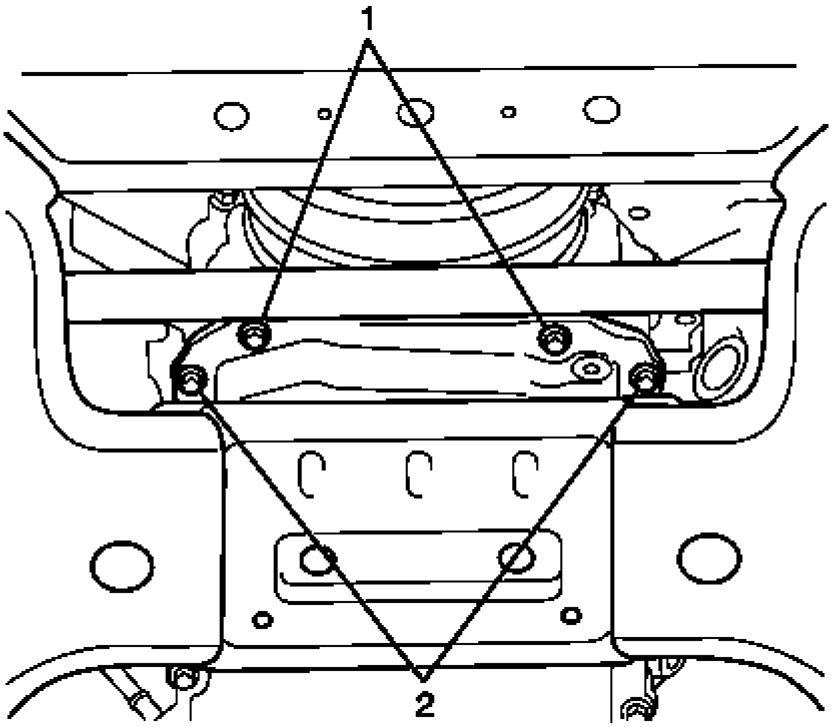


Fig. 137: Identifying Oil Pan To Front Cover & Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

18. Remove the oil pan to front cover retaining bolts (1).
19. Remove the oil pan to cylinder block front retaining bolts (2).
20. Lower the vehicle.

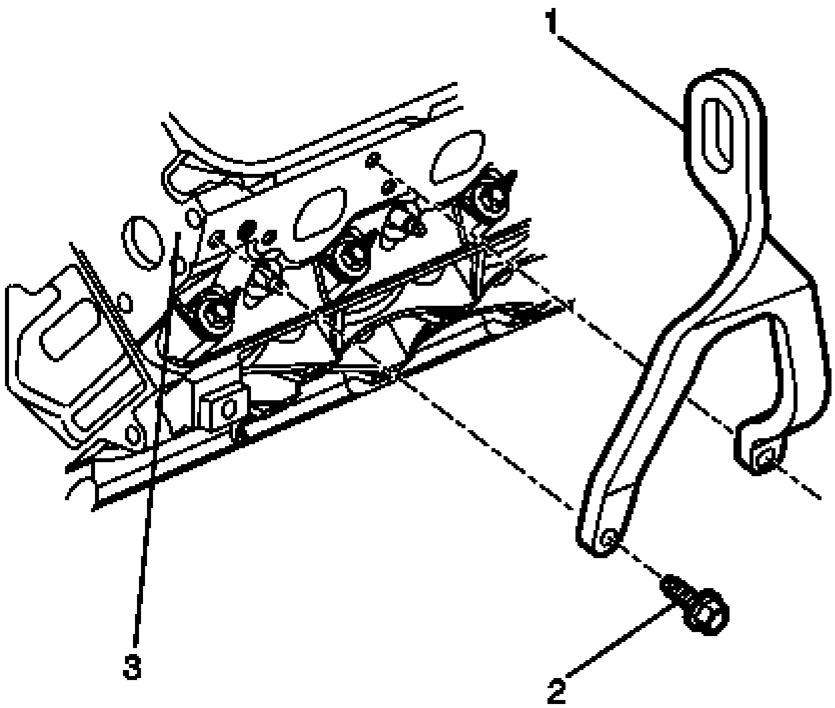


Fig. 138: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

21. Position the **J 41798** (1) on the cylinder head (3). See **Special Tools** .

CAUTION: Refer to Fastener Caution .

22. Install the **J 41798** to cylinder head retaining bolts (2) and tighten to 50 N. See **Special Tools** .m (36 lb ft).

NOTE: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

23. Install **J 41803** J-41803 and **J 28467-B** and raise the engine assembly 20 mm. See **Special Tools** .
24. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

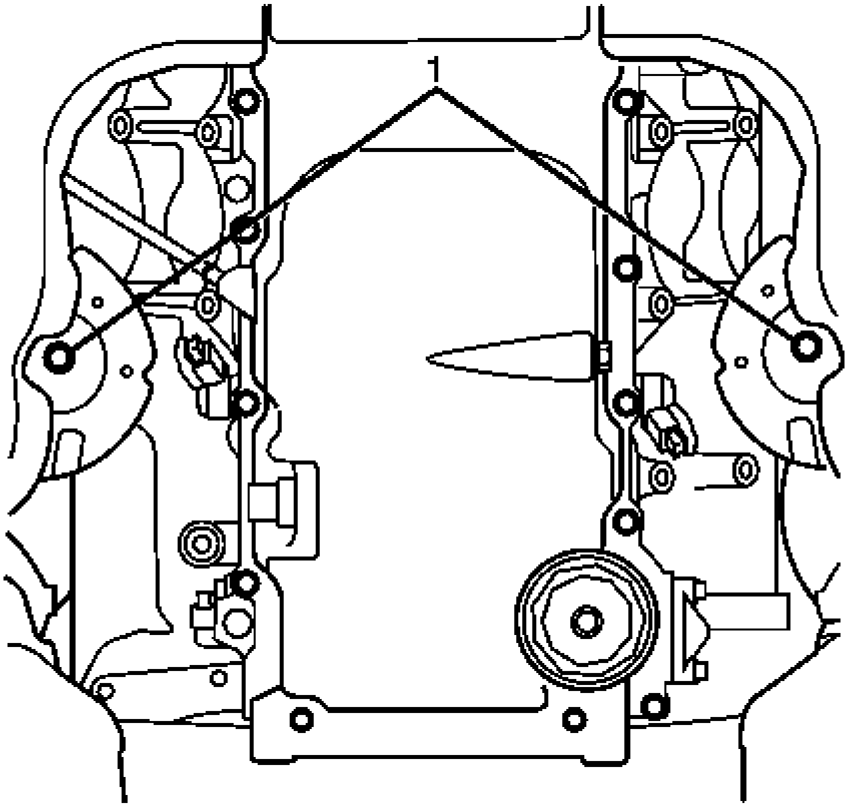


Fig. 139: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

25. Remove the lower engine mount to crossmember retaining nut (1) from both engine mounts.

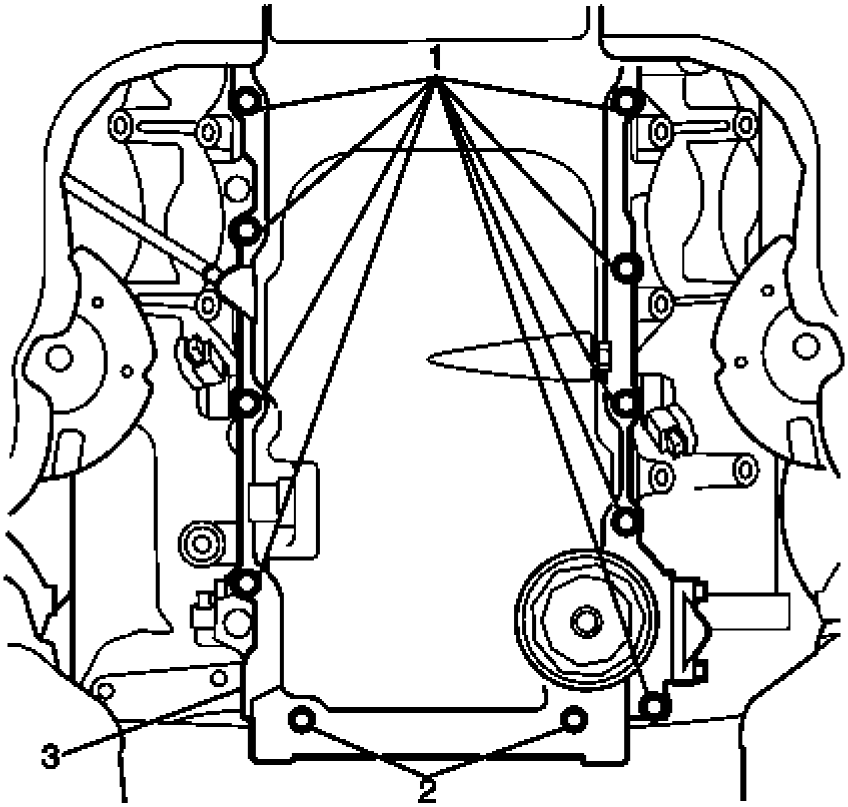


Fig. 140: Identifying Oil Pan To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

26. Remove the oil pan to engine rear cover retaining bolts (2).
27. Remove the oil pan to cylinder block retaining bolts (1).
28. Remove the oil pan (3).

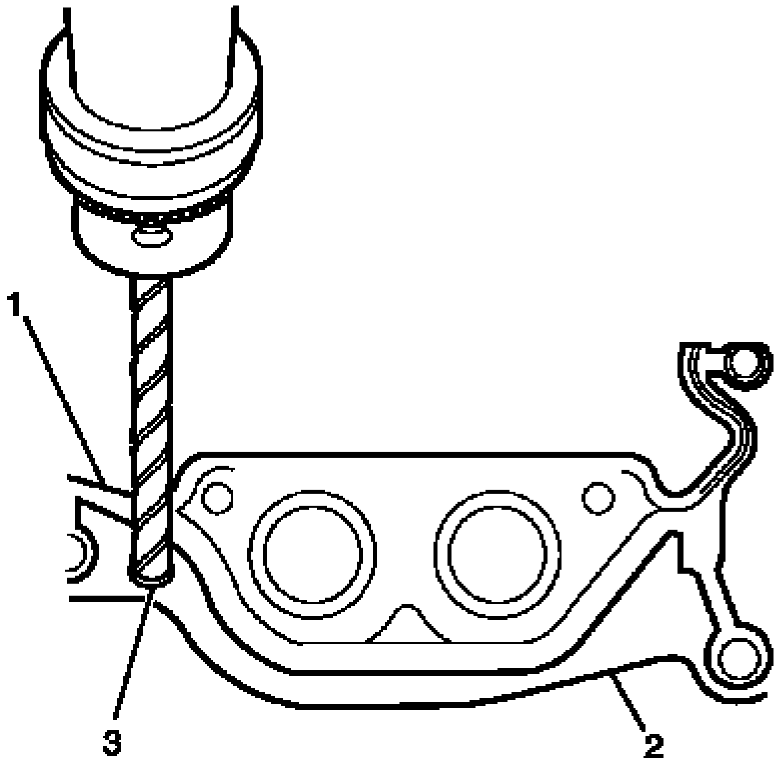


Fig. 141: Identifying Retaining Rivets (Drilling Out)
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT allow foreign material to enter the oil passages of the oil pan, cap, or cover the openings, as required.

NOTE: Take care not to gouge, score, or damage the oil pan sealing surface.

29. Drill out the retaining rivets (3) from the oil pan, if required.

NOTE: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

30. Remove the oil pan gasket (1) from the oil pan (2).

    Discard the gasket and rivets.

31. Clean and inspect the oil pan as necessary. Refer to **Oil Pan Cleaning and Inspection** .

    .

32. Clean the base of the engine block. Refer to **Replacing Engine Gaskets** .

.

Installation Procedure

NOTE: **The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.**

NOTE: **The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.**
It is not necessary to rivet the NEW gasket to the oil pan.

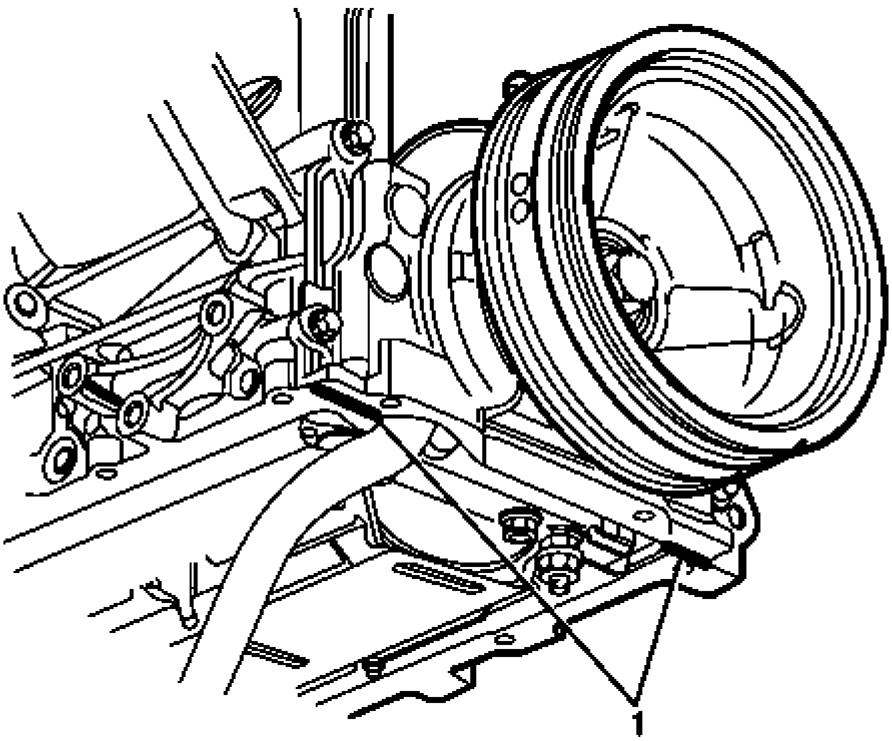


Fig. 142: Identifying Engine Block Sealant Application Area (Front Cover Gasket)
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

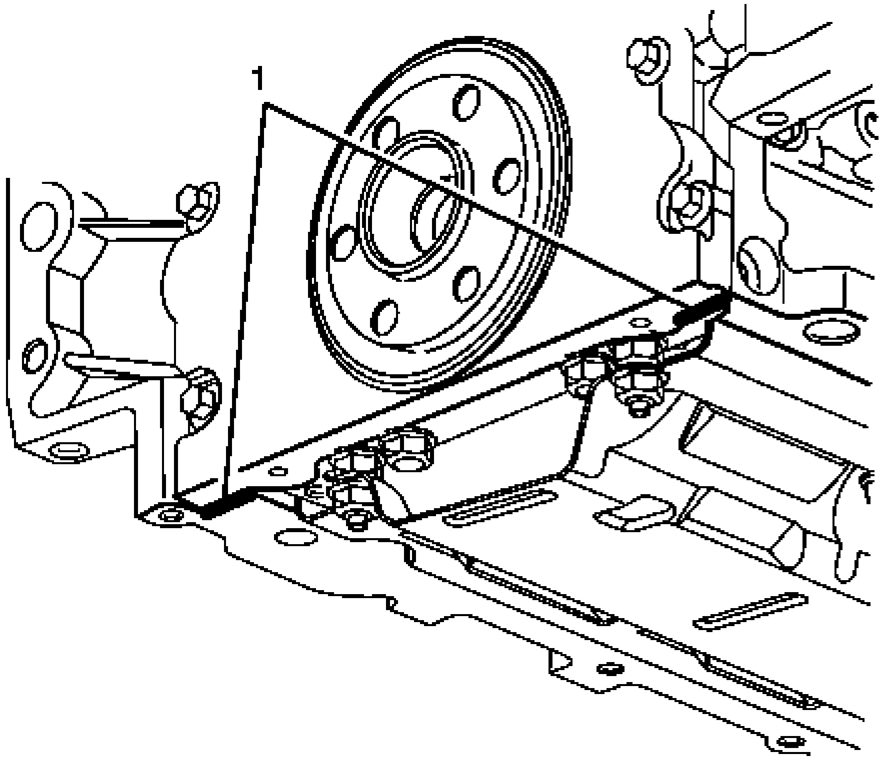


Fig. 143: Identifying Engine Block Sealant Application Area (Rear Cover Gasket)
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

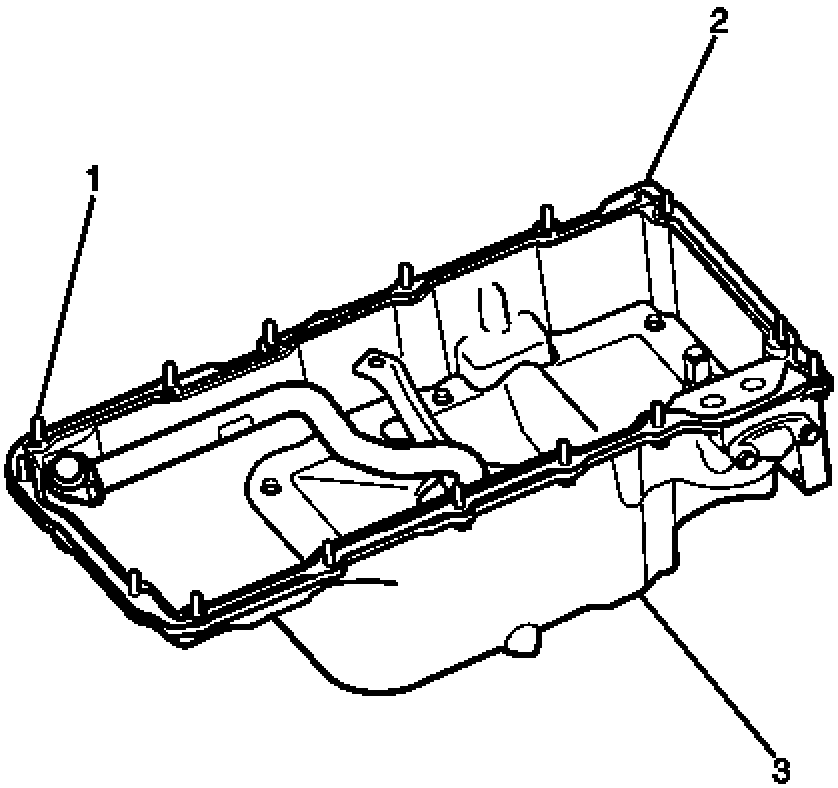


Fig. 144: Identifying Oil Pan, Gasket & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure to align the oil gallery passages in the oil pan and engine block correctly, with the oil pan gasket.

3. Preassemble the oil pan gasket (2) to the oil pan (3).
    1. Install the oil pan gasket (2) to the oil pan (3).
    2. Install the oil pan retaining bolts (1) to the oil pan (3) and through the oil pan gasket (2).

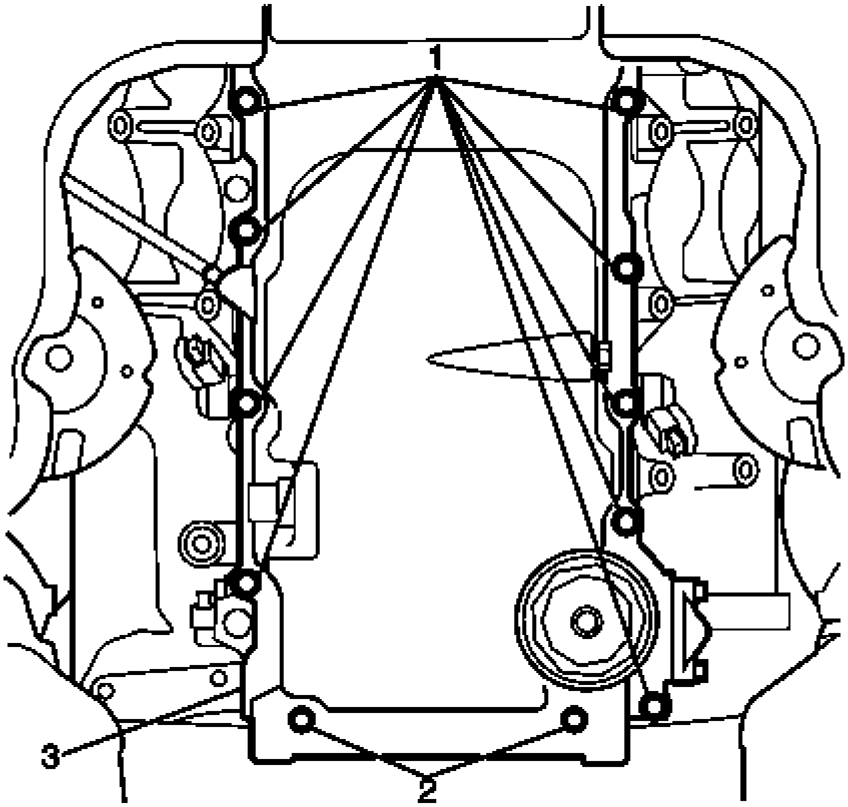


Fig. 145: Identifying Oil Pan To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan assembly (3).
5. Install the oil pan to cylinder block retaining bolts (1) finger tight. Do not over tighten.
6. Install the oil pan to engine rear cover retaining bolts (2) finger tight. Do not over tighten.
7. Lower the vehicle.
8. Lower the engine to engage the engine mounts to the front sub-frame.

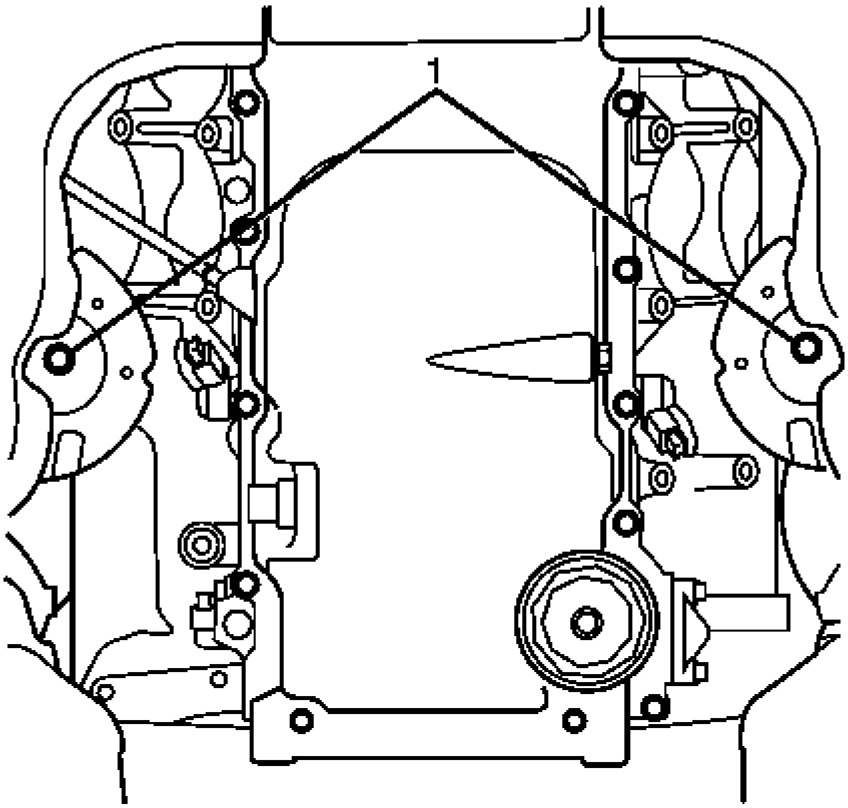


Fig. 146: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

9. Raise the vehicle.

CAUTION: Refer to Fastener Caution .

10. Install the lower engine mount to front sub-frame retaining nuts (1) on both engine mounts and tighten to 80 N.m (59 lb ft).
11. Lower the vehicle.
12. Remove **J 41803** and **J 28467-B** from the engine. See **Special Tools** .

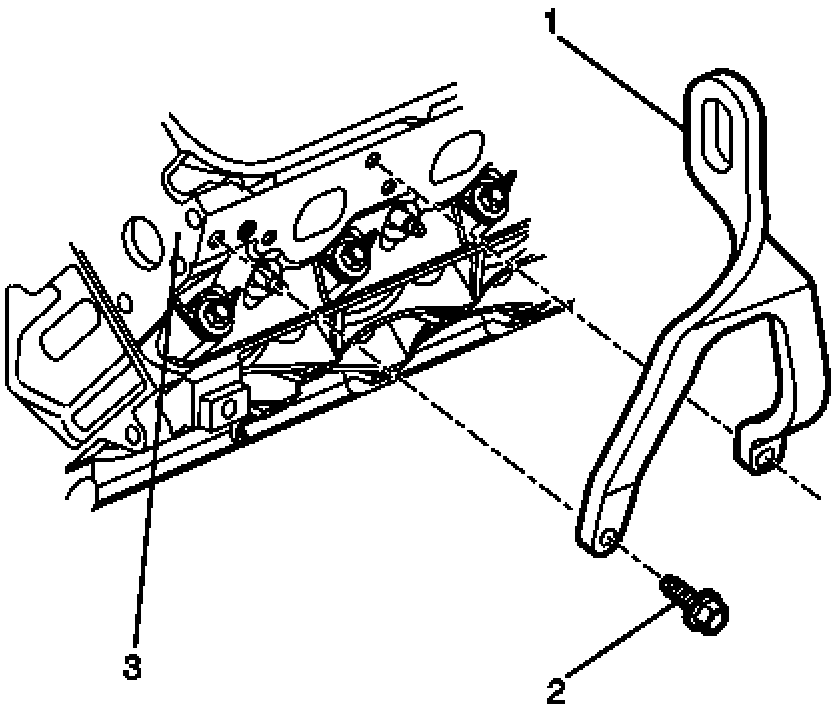


Fig. 147: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the **J 41798** to cylinder head retaining bolts (2). See **Special Tools** .
14. Remove the **J 41798** (1) from the cylinder head (3). See **Special Tools** .

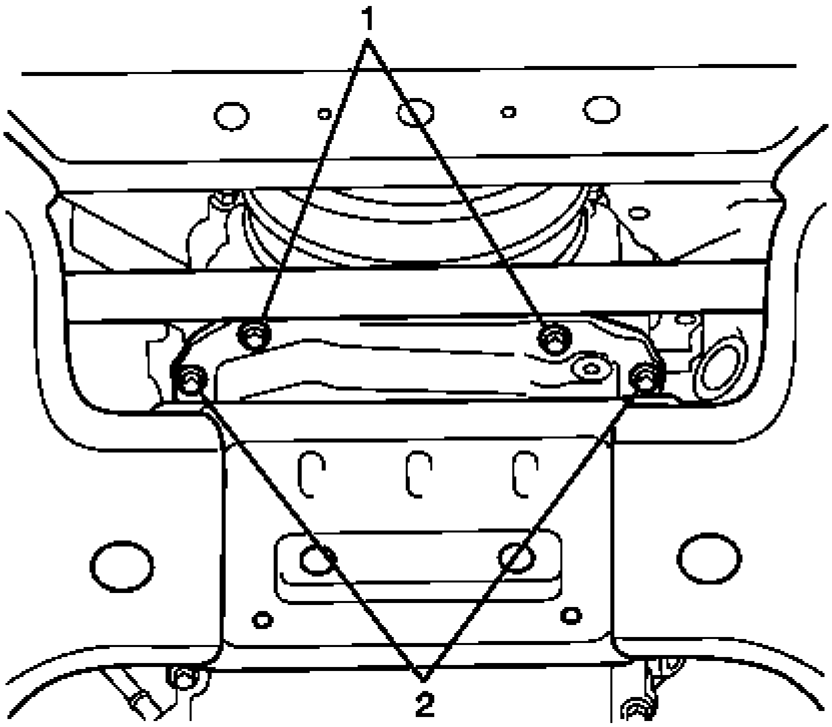


Fig. 148: Identifying Oil Pan To Front Cover & Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

15. Install the oil pan to front cover retaining bolts (1) finger tight. Do not over tighten.
16. Install the oil pan to cylinder block retaining bolts (2) finger tight. Do not over tighten.
17. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
18. Align the oil pan until the rear of engine block and the rear of oil pan are flush or even.
19. Measure the oil pan-to-engine block alignment.
    1. Place a straight edge across the rear of the engine block and rear of the oil pan at the transmission housing mounting surfaces.

       NOTE: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

    2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and the straight edge.
    3. If the oil pan alignment is not within specifications, remove the oil pan and repeat procedures 17-19.

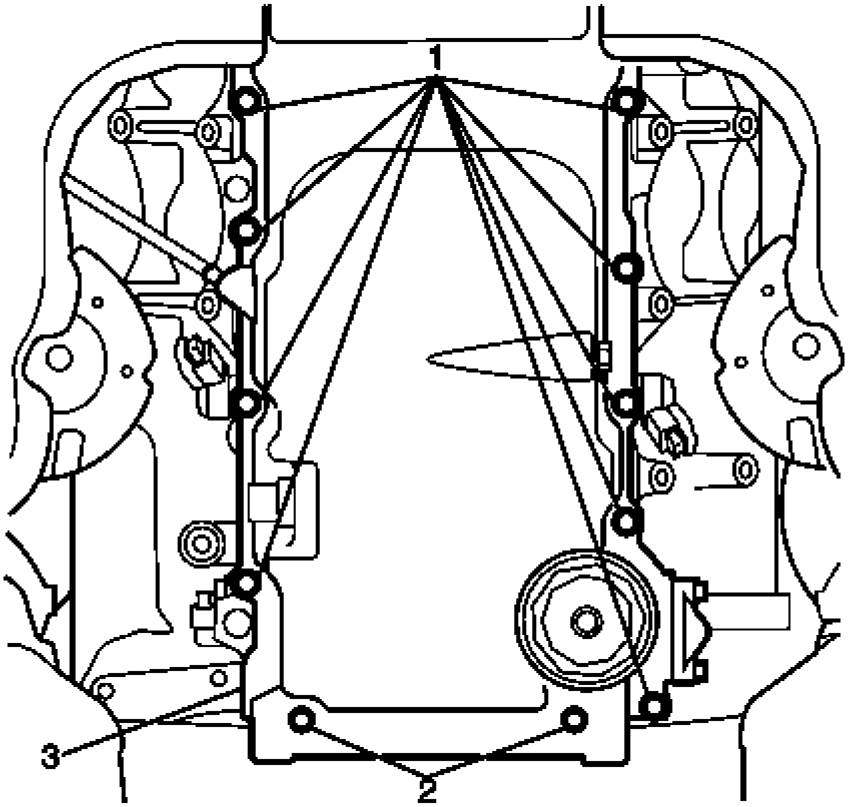


Fig. 149: Identifying Oil Pan To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

20. Tighten the oil pan to cylinder block retaining bolts (1) to 25 N.m (18 lb ft).
21. Tighten the oil pan to engine rear oil seal housing retaining bolts (2) to 12 N.m (106 lb in).

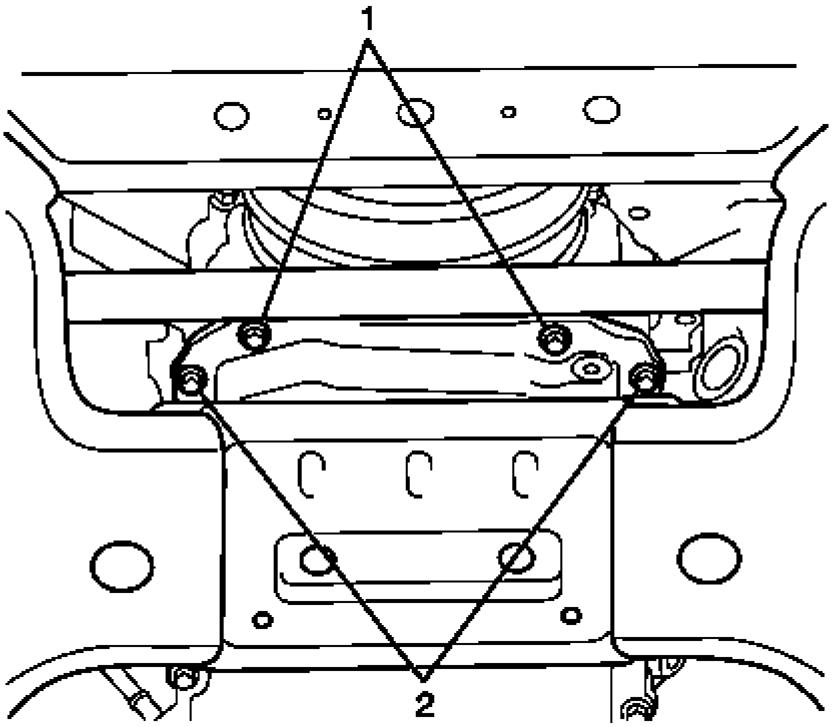


Fig. 150: Identifying Oil Pan To Front Cover & Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

22. Tighten the oil pan to cylinder block retaining bolts (2) to 25 N.m (18 lb ft).
23. Tighten the oil pan to front cover retaining bolts (1) to 25 N.m (18 lb ft).
24. Position the steering gear in the correct location.

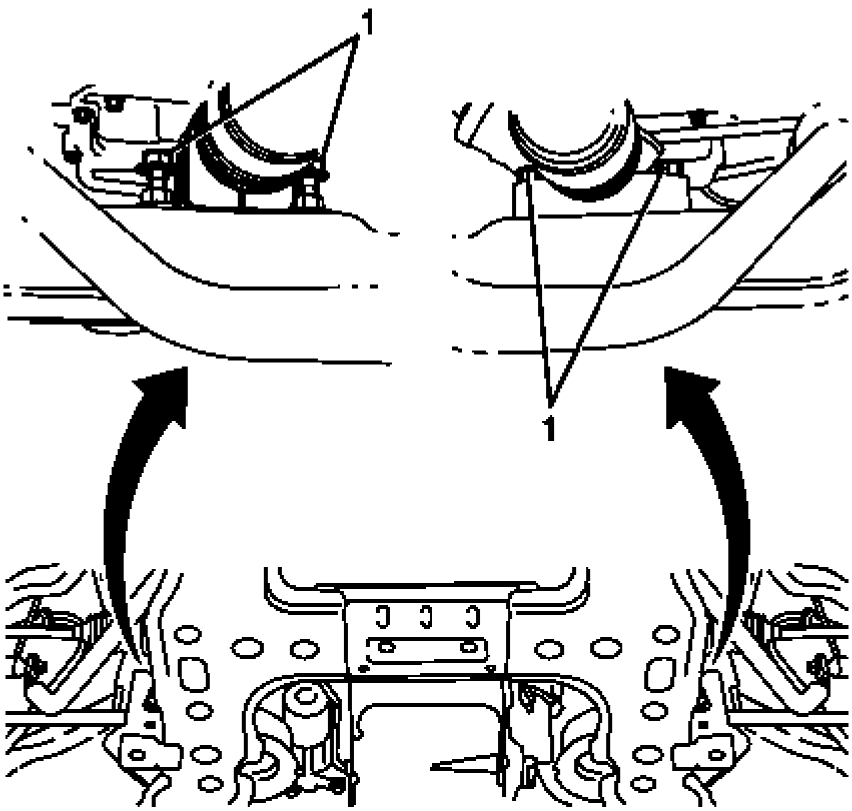


Fig. 151: Identifying Steering Gear To Subframe Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the steering gear to sub-frame retaining bolts (1) and tighten to 65 N.m (48 lb ft).

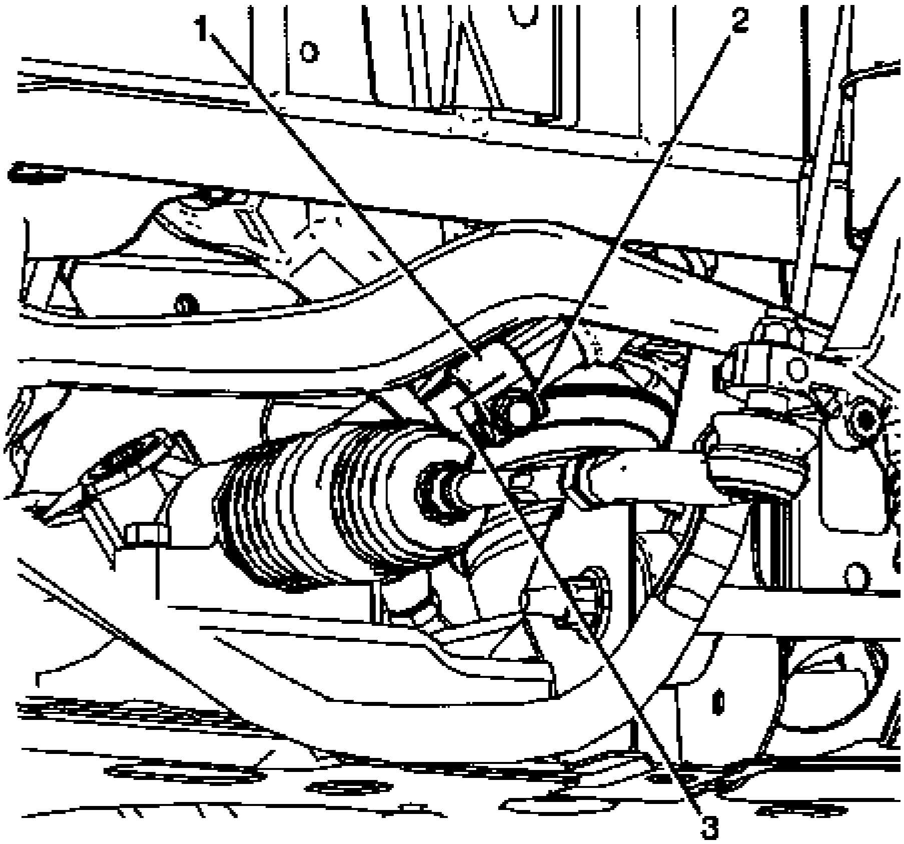


Fig. 152: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.**

26. Connect the intermediate steering shaft (1) to the pinion shaft (3).
27. Install the intermediate steering shaft to pinion shaft NEW retaining bolt (2) and tighten to 25 N.m (18 lb ft).

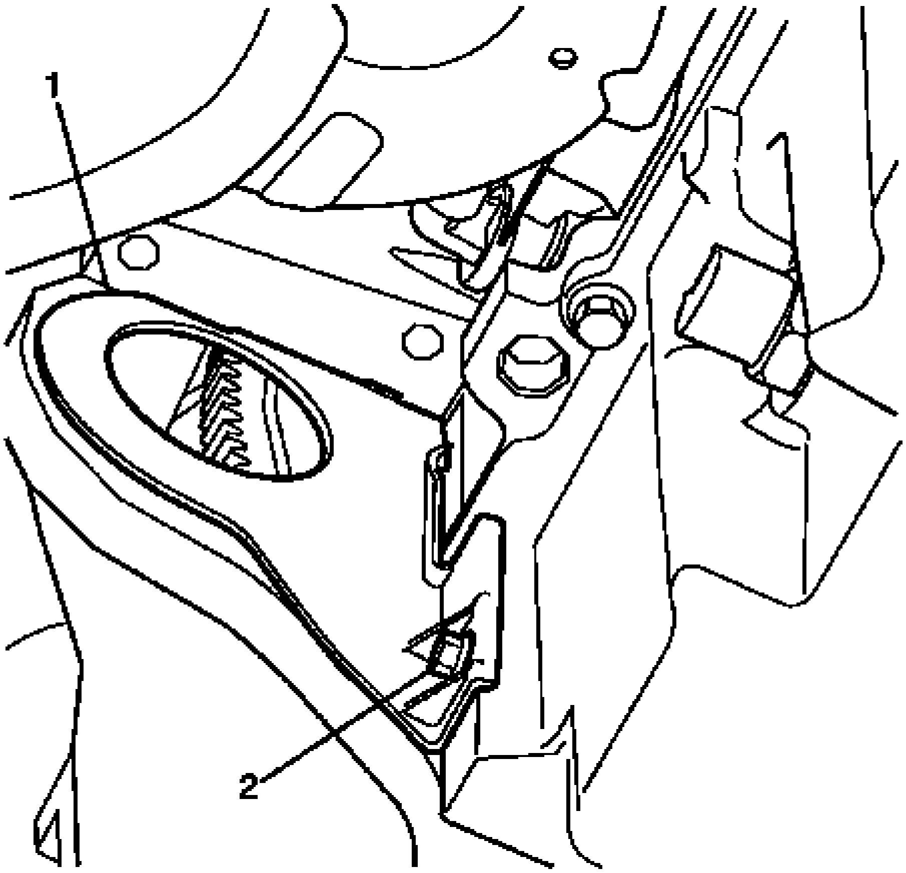


Fig. 153: Identifying Right Transmission Cover & Engine Oil Pan Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

28. Install the right side close out cover (1).
29. Install the right side close out cover to cylinder block retaining bolt (2) and tighten to 12 N.m (106 lb in).

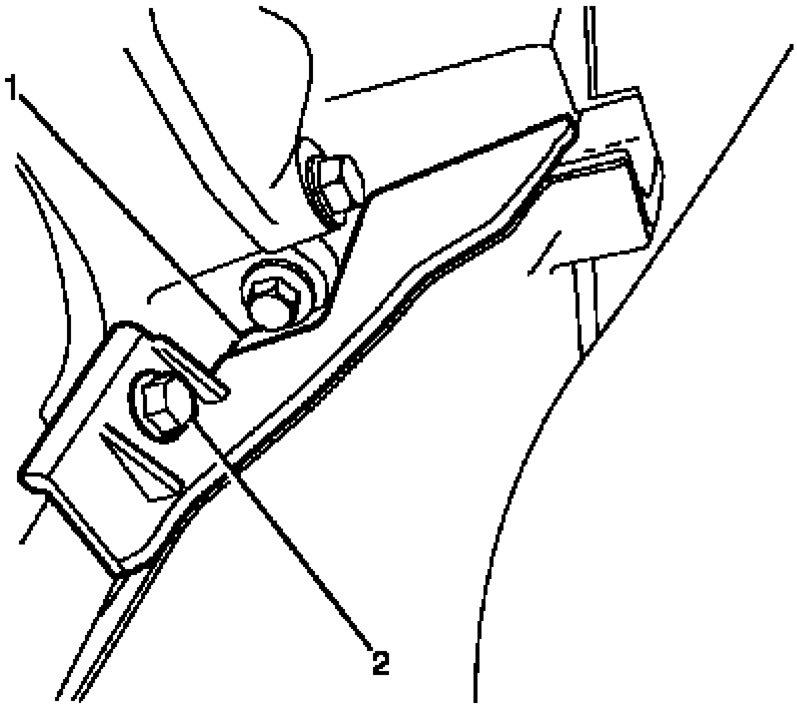


Fig. 154: Identifying Left Side Close Out Cover To Cylinder Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

30. Install the left side close out cover (1).
31. Install the left side close out cover to cylinder block retaining bolt (2) and tighten to 12 N.m (106 lb in).

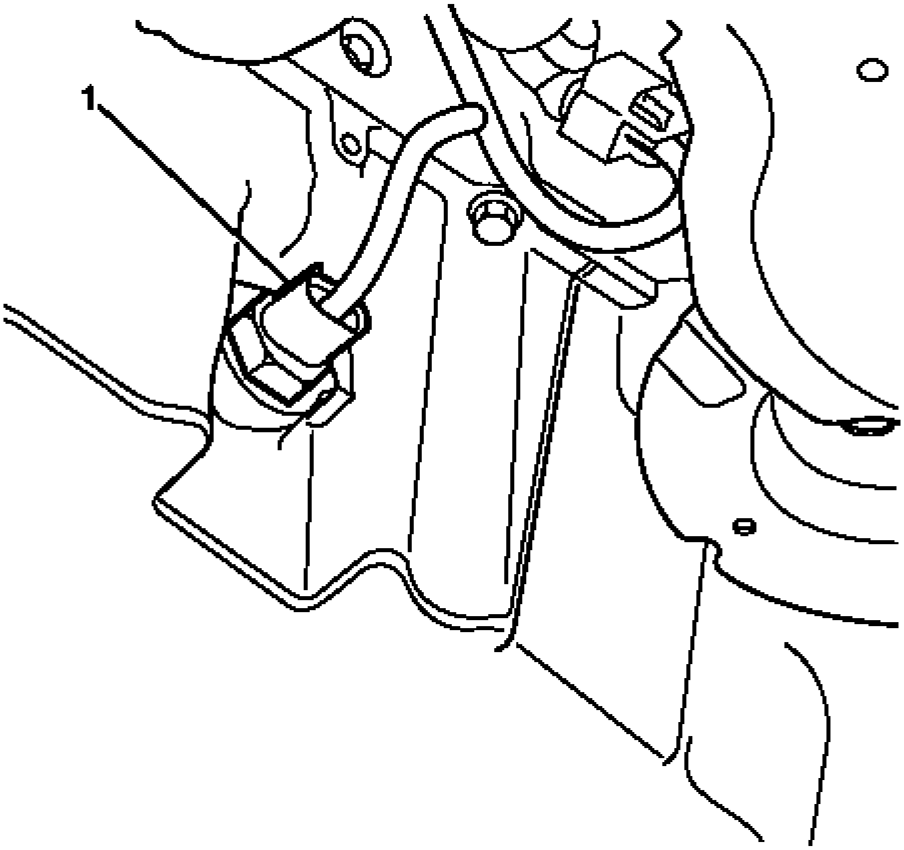


Fig. 155: Identifying Oil Level/Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

32. Connect the oil level/temperature sensor electrical connector (1) to the oil level/temperature sensor.
33. Install the starter motor. Refer to **Starter Replacement (6.0L)** .
34. Install the air deflector. Refer to **Front Air Deflector Replacement** .
35. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
36. Lower the vehicle to the ground
37. Connect the battery ground cable. Refer to **Battery Negative Cable Disconnection and Connection** .
38. Replace the engine oil and oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required

J 41712 Oil Pressure Switch Socket

Removal Procedure

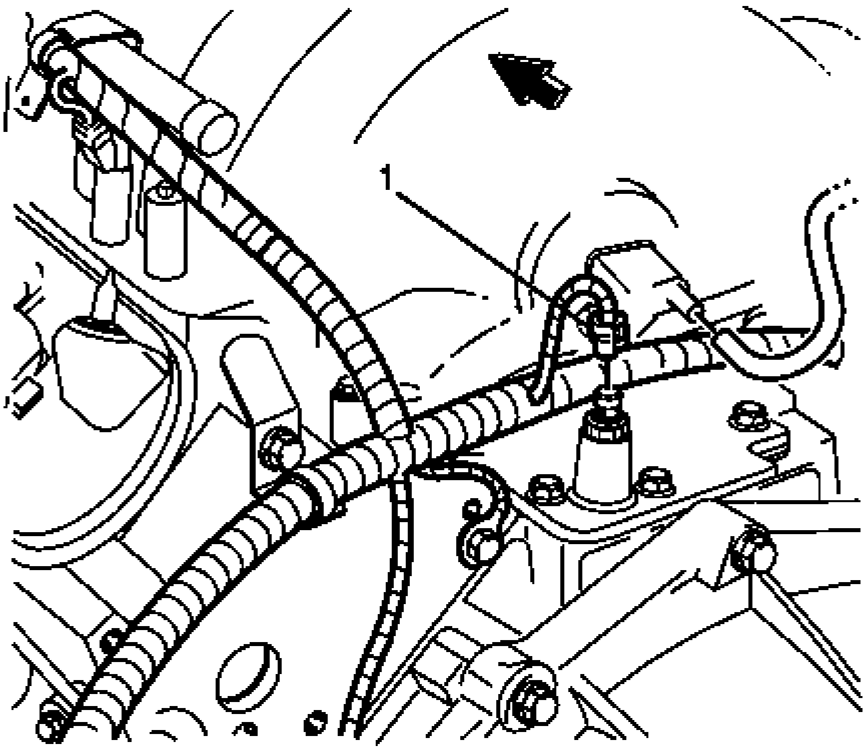


Fig. 156: Identifying Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the oil pressure sensor wiring harness connector (1).

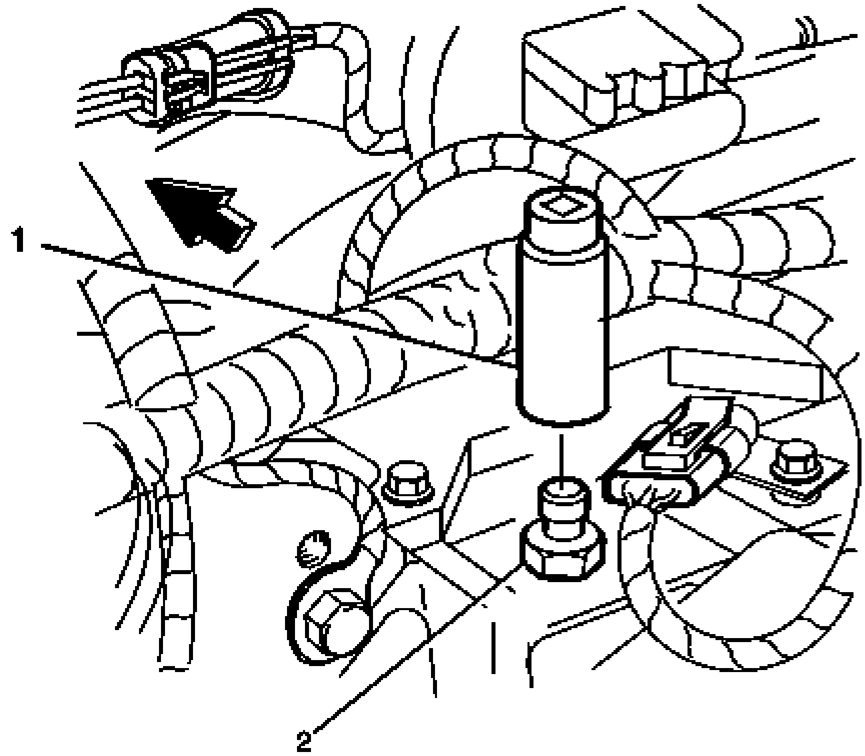


Fig. 157: Identifying Oil Pressure Sensor & J 41712
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Clean the area around the oil pressure sensor (2) before removal. This prevents debris from entering the engine.**

2. Use the **J 41712** (1) to remove the oil pressure sensor (2).

Installation Procedure

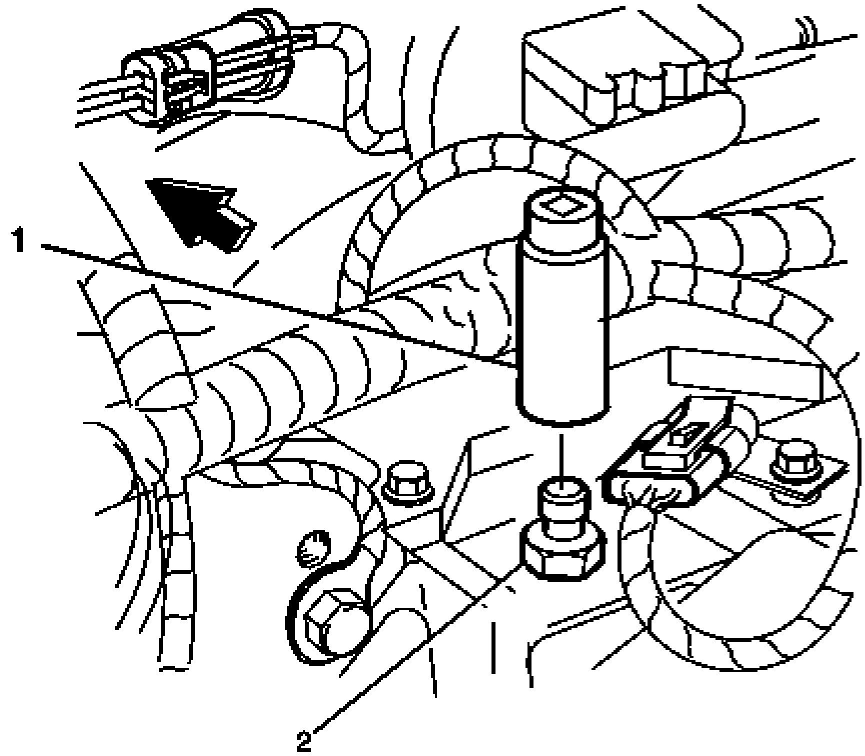


Fig. 158: Identifying Oil Pressure Sensor & J 41712
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: If installing the old oil pressure sensor (2), apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the cleaned oil pressure sensor (2) thread.

1. Install the oil pressure sensor (2) using the **J 41712** (1) and tighten to 35 N.m (26 lb ft).

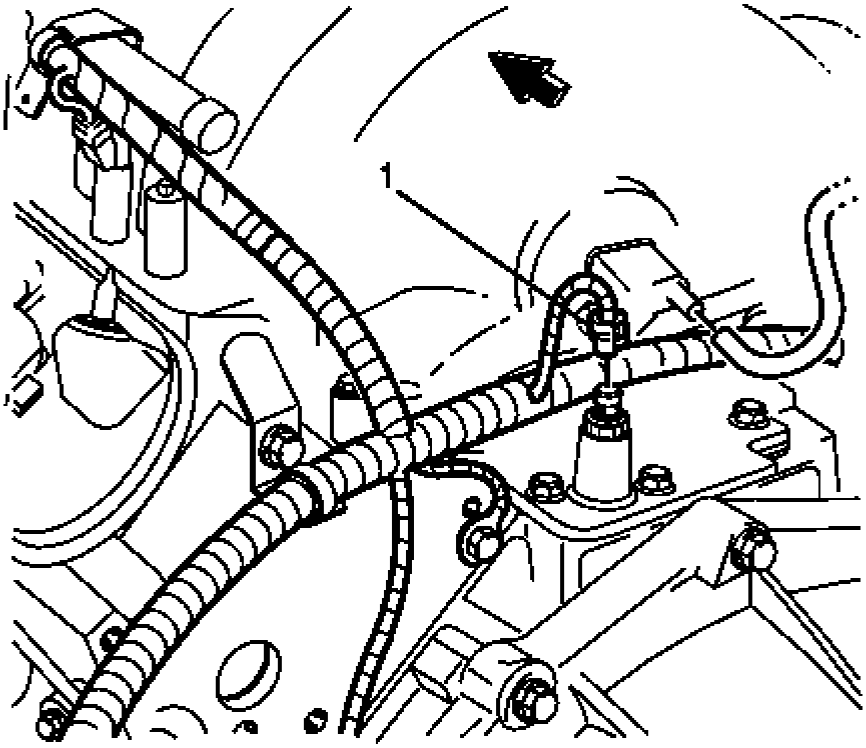


Fig. 159: Identifying Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the oil pressure sensor electrical connector (1).

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

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

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

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.**

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

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**.

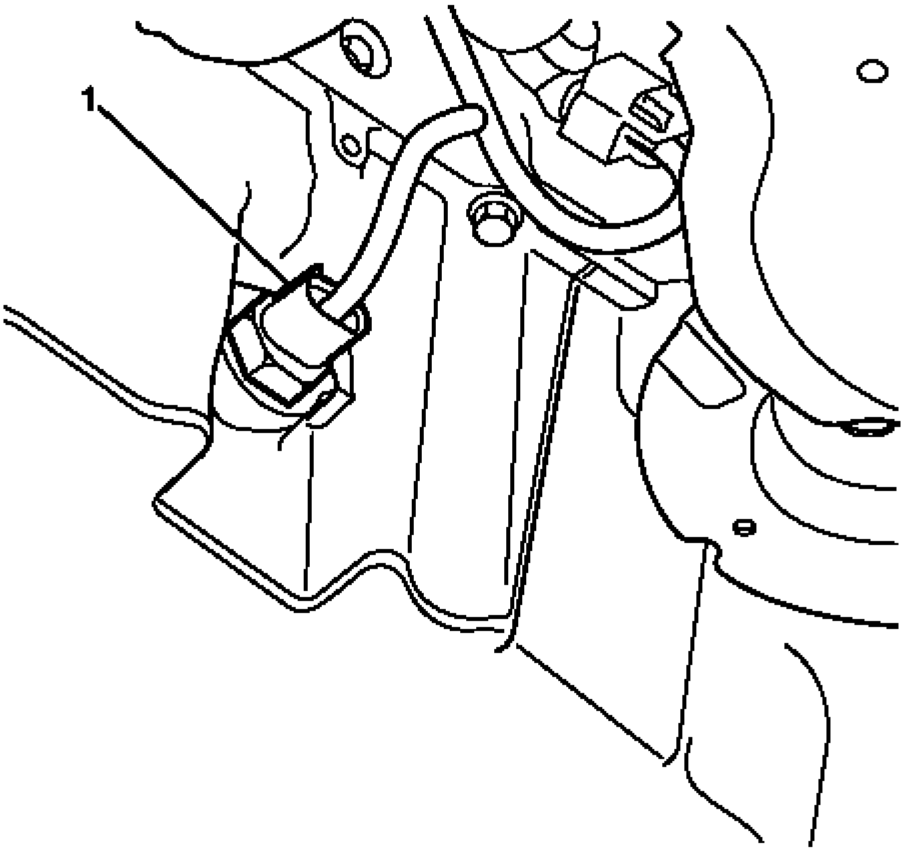


Fig. 160: Identifying Oil Level/Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the oil level/temperature sensor electrical connector (1).

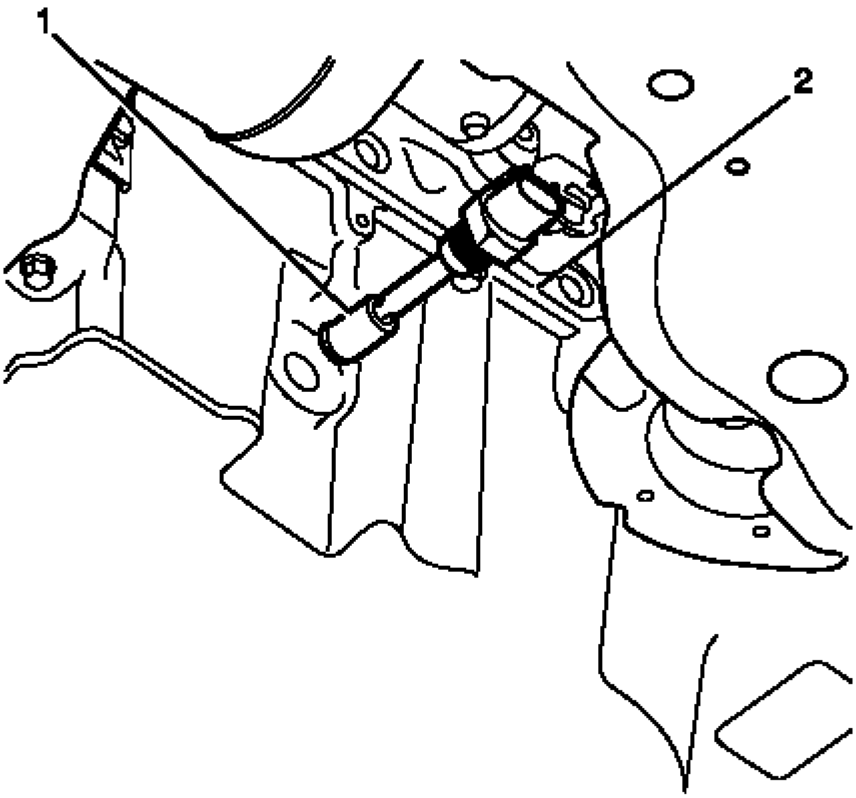


Fig. 161: Identifying Engine Oil Lever Sensor & Oil Pan
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine oil lever sensor (1) from the oil pan (2).

Installation Procedure

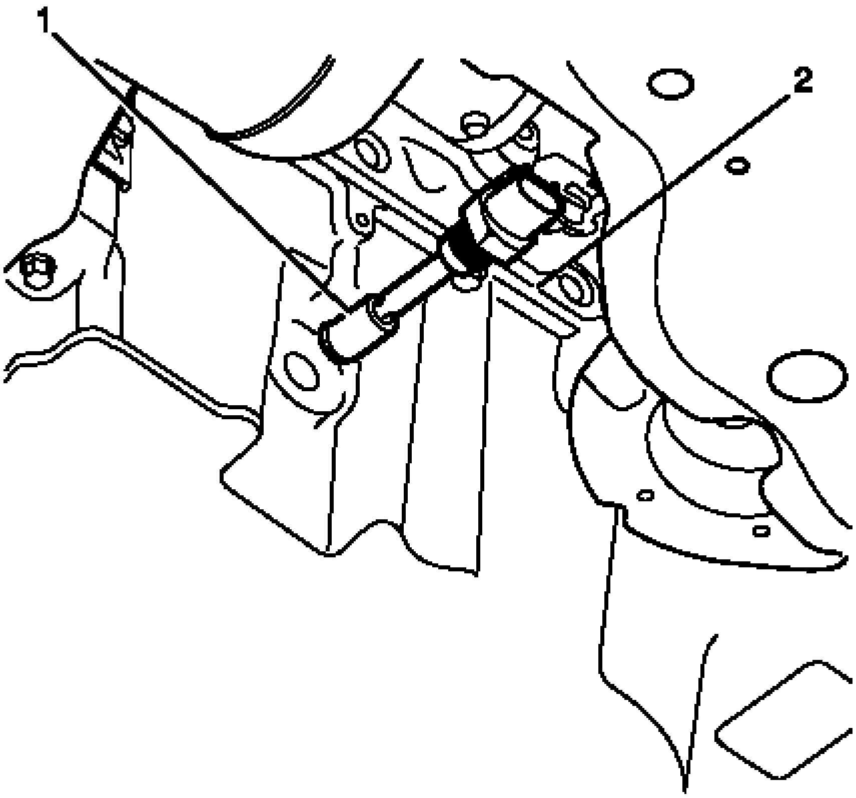


Fig. 162: Identifying Engine Oil Lever Sensor & Oil Pan
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine oil level sensor (1) to the oil pan (2) and tighten to 20 N.m (15 lb ft).

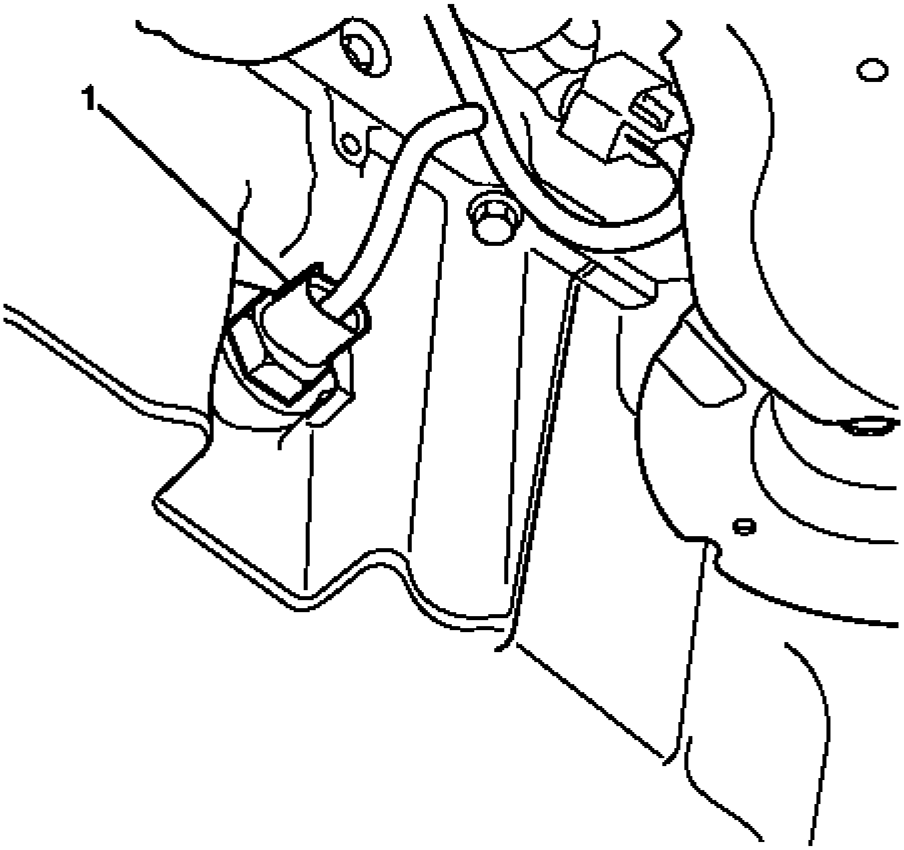


Fig. 163: Identifying Oil Level/Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Connect the oil level/temperature sensor electrical connector (1).
3. Lower the vehicle.
4. Replace the engine oil and oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
5. Reset the GM Oil Life System. Refer to **GM Oil Life System Resetting** .

OIL PUMP, SCREEN, AND CRANKSHAFT OIL DEFLECTOR REPLACEMENT

Removal Procedure

1. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

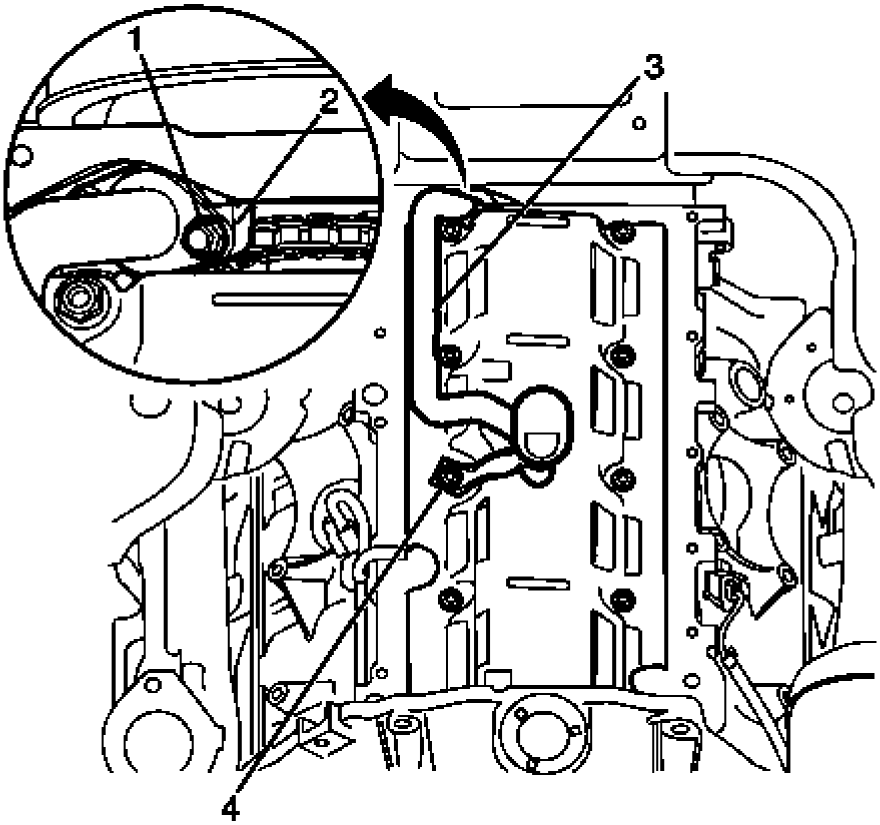


Fig. 164: Identifying Oil Pump Screen & Tube Assembly To Oil Pump Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
4. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
5. Remove the oil pump screen and tube assembly (3) from the oil pump (2).

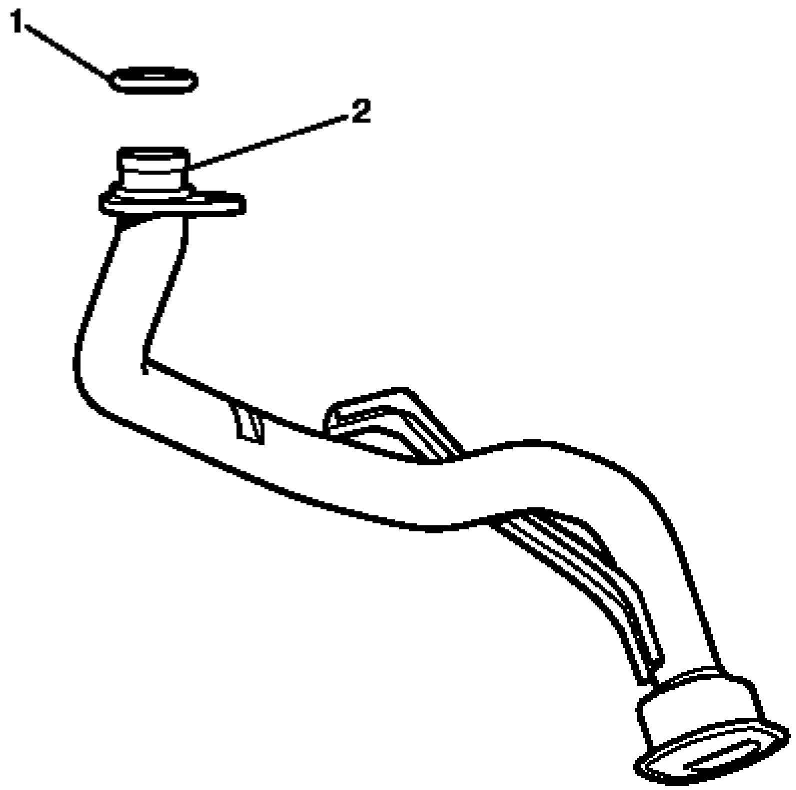


Fig. 165: Identifying Oil Pump Screen & Tube Assembly O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

NOTE:	**The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.**

6. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

   Discard the oil pump screen and tube assembly O-ring seal (1).

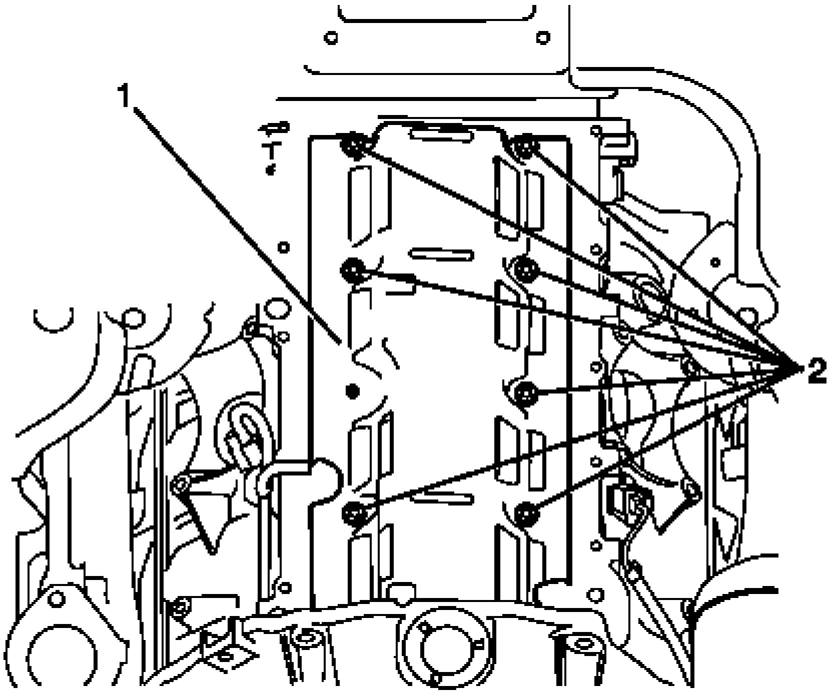


Fig. 166: Identifying Crankshaft Oil Deflector Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the remaining crankshaft oil deflector retaining nuts (2).
8. Remove the crankshaft oil deflector (1).

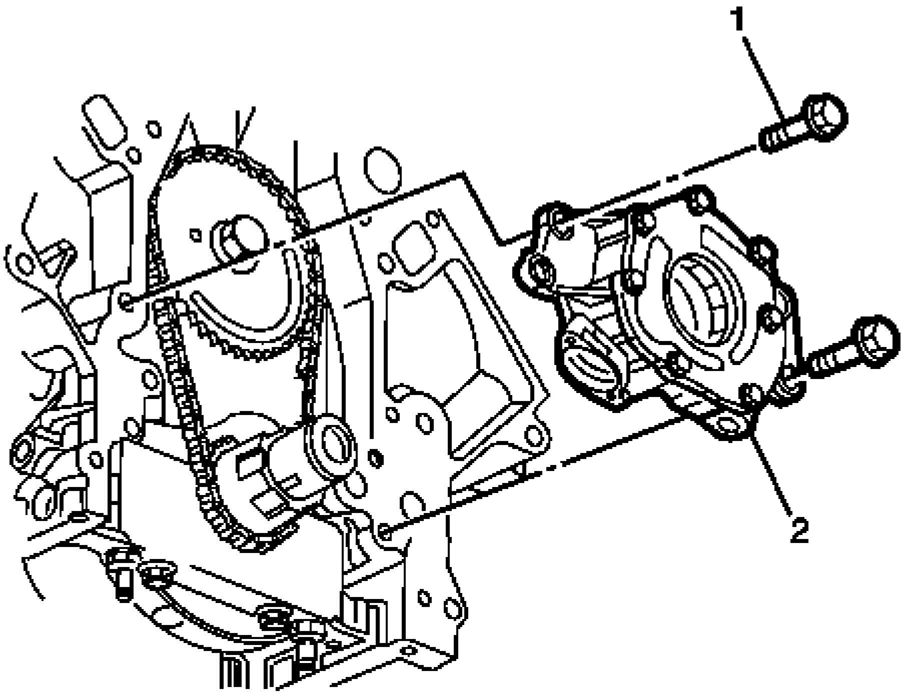


Fig. 167: Identifying Oil Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow dirt or debris to enter the oil pump. Cap the ends as necessary.

9. Remove the oil pump bolts (1).
10. Remove the oil pump (2).
11. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

Installation Procedure

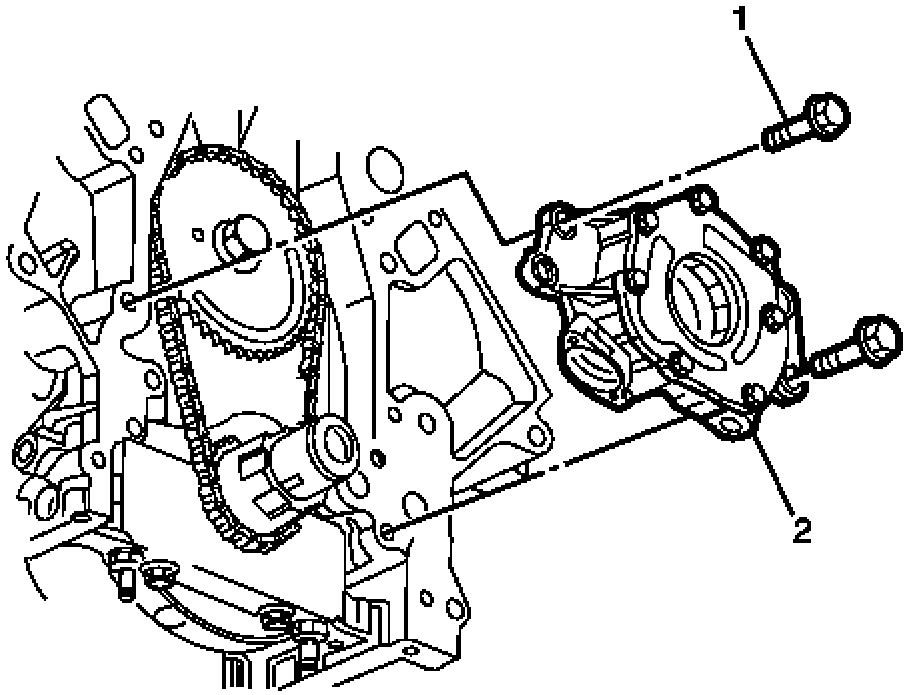


Fig. 168: Identifying Oil Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.**

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (1).

   CAUTION: Refer to Fastener Caution .

2. Install the oil pump to engine block retaining bolts (2) and tighten to 25 N.m (18 lb ft).

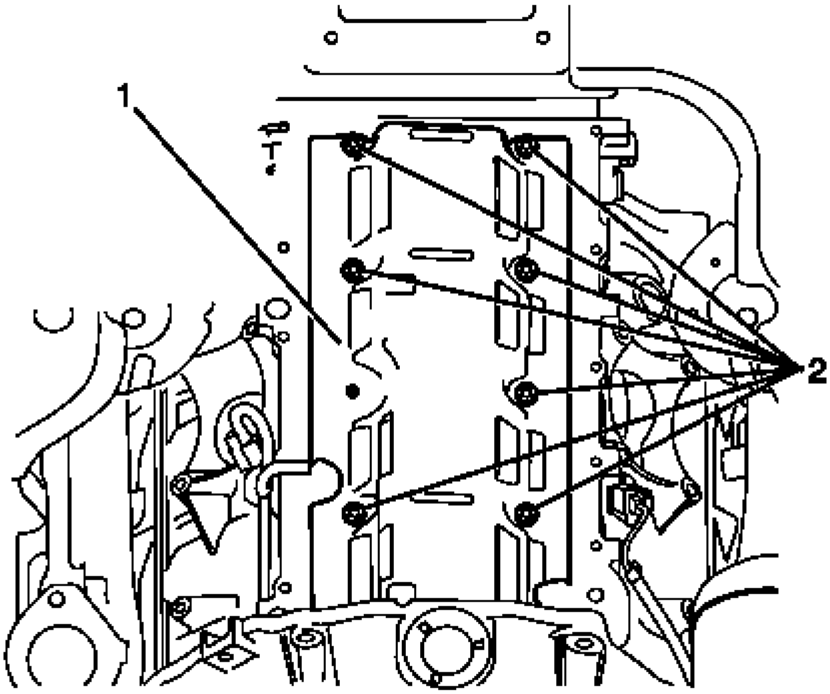


Fig. 169: Identifying Crankshaft Oil Deflector Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft oil deflector (1).
4. Install the crankshaft oil deflector retaining nuts (2) and tighten to 25 N.m (18 lb ft).

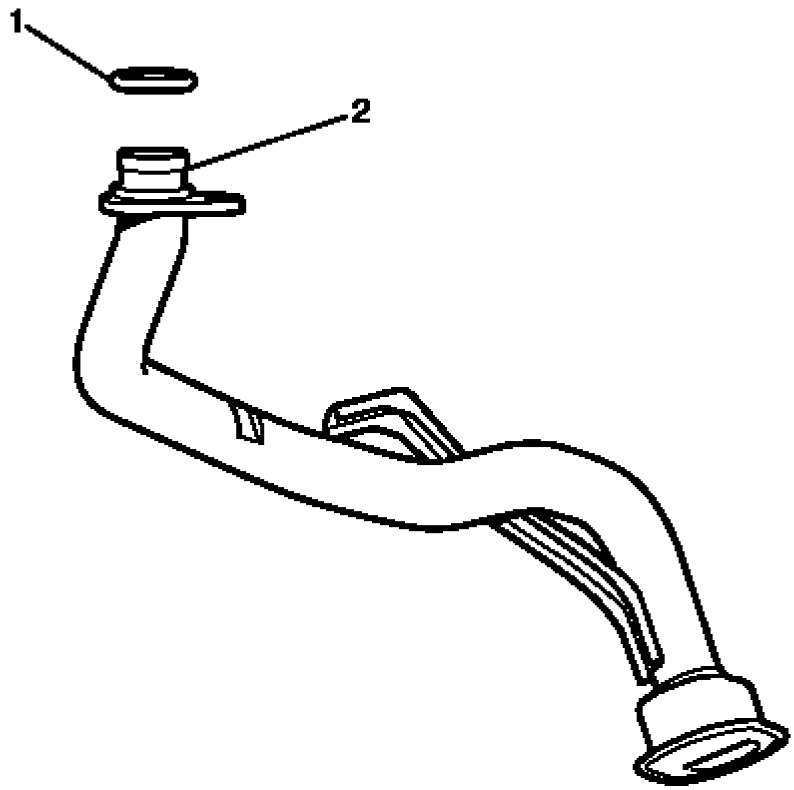


Fig. 170: Identifying Oil Pump Screen & Tube Assembly O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen and tube assembly O-ring seal (1) with clean engine oil.
6. Install the NEW oil pump screen and tube assembly O-ring seal (1) onto the oil pump screen and tube assembly (2).

NOTE: **Push the oil pump screen and tube assembly (3) completely into the oil pump (2) prior to tightening the oil pump screen and tube assembly to oil pump retaining bolt (1). Do not allow the oil pump screen and tube assembly to oil pump retaining bolt (1) to pull the oil pump screen and tube assembly (3) into the oil pump (2).**

NOTE: **Align the oil pump screen brackets with the correct crankshaft bearing cap studs.**

7. Install the oil pump screen and tube assembly (3).
8. Install the oil pump screen and tube assembly to oil pump retaining bolt (1) and tighten to 12 N.m (106 lb in).
9. Install the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4) and tighten to 25 N.m (18 lb ft).

10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
11. Install the engine oil pan. Refer to **Oil Pan Replacement**.

CAMSHAFT TIMING CHAIN AND SPROCKET REPLACEMENT

Special Tools

- **EN 46330** EN-46330 Timing Chain Tensioner Retaining Pin. See **Special Tools** .
- **J 8433-1** Puller Bar
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41558** Crankshaft Sprocket Remover. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer. See **Special Tools** .
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .
- **J 45059** Angle Meter

Removal Procedure

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

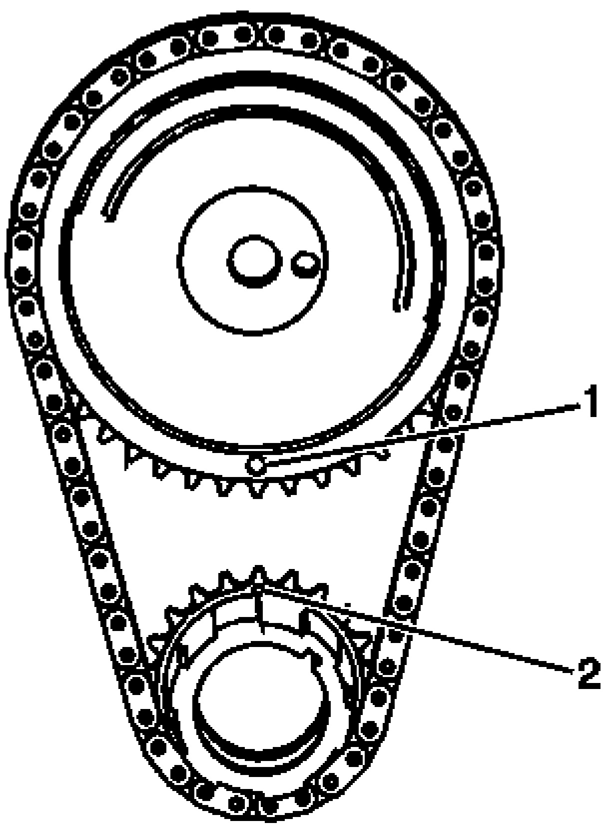


Fig. 171: Identifying Camshaft & Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

4. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.
5. Remove the timing chain and sprockets. Refer to **Timing Chain and Sprocket Removal** .

Installation Procedure

1. Install the timing chain and sprockets. Refer to **Timing Chain and Sprocket Installation** .
2. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT REPLACEMENT

Special Tools

J 41476 J-41476 Front and Rear Cover Alignment Tool. See **Special Tools** .

Removal Procedure

1. Remove the engine assembly. Refer to **Engine Replacement**.
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator and Tube Removal** .
3. Remove the left and right exhaust manifolds. Refer to **Exhaust Manifold Replacement - Left Side (V8)** and **Exhaust Manifold Replacement - Right Side (V8)** .
4. Remove the intake manifold. Refer to **Intake Manifold Removal** .
5. Remove the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement** .
6. Remove the left and right valve rocker arm covers. Refer to **Valve Rocker Arm and Push Rod Replacement** and **Valve Stem Oil Seal and Valve Spring Replacement**.
7. Remove the valve rocker arms and push rods. Refer to **Oil Level Indicator Tube Replacement**.
8. Remove the left and right cylinder heads. Refer to **Cylinder Head Replacement - Left Side** and **Cylinder Head Replacement - Right Side**.
9. Remove the valve lifters. Refer to **Valve Lifter Replacement**.
10. Remove the water pump. Refer to **Water Pump Removal**.
11. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal (6.0L L76)** or **Crankshaft Balancer Removal (6.2L LS3)**.
12. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

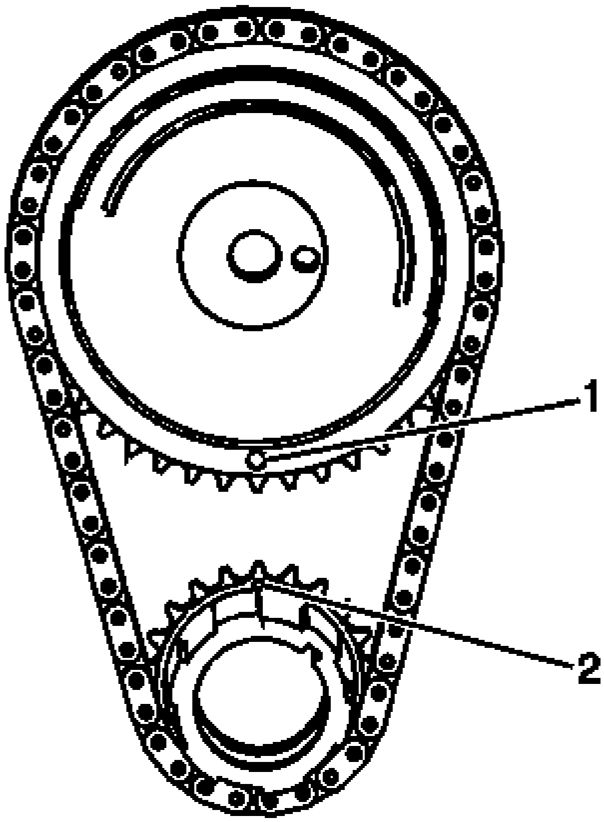


Fig. 172: Identifying Camshaft & Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS CORP.

13. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

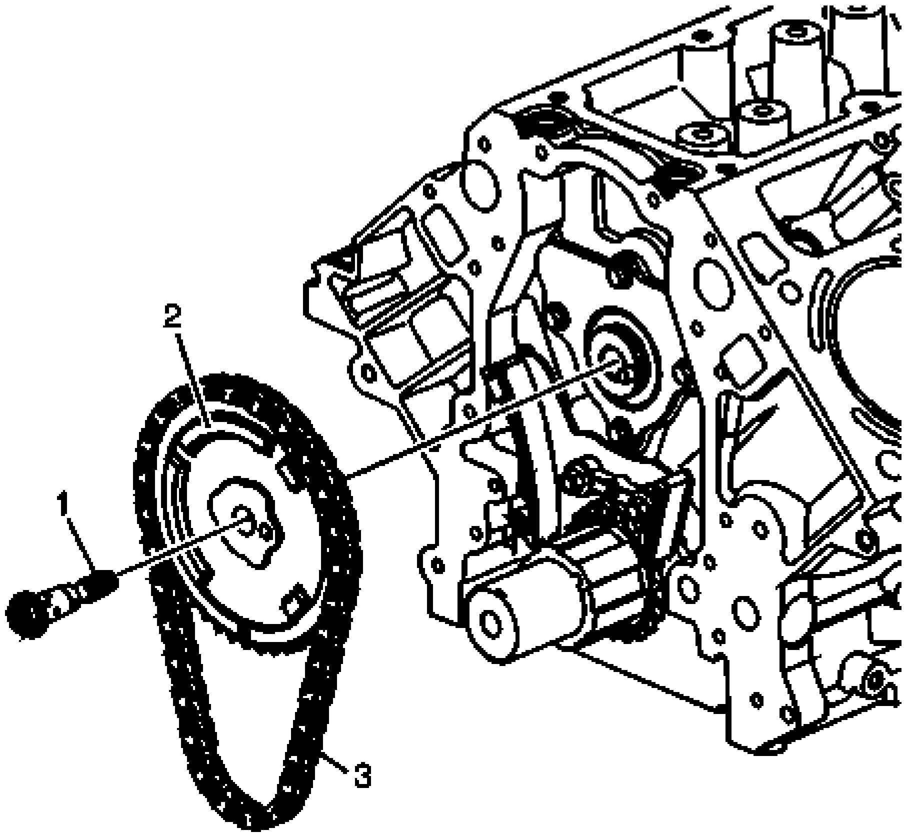


Fig. 173: Identifying Timing Chain, Camshaft Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

14. Remove the camshaft sprocket bolt (1).
15. Remove the camshaft sprocket (2) and timing chain (3).
16. Remove the camshaft. Refer to **Camshaft Removal** .

Installation Procedure

NOTE: If camshaft replacement is required, the valve lifters must also be replaced.

1. Install the camshaft. Refer to **Camshaft Installation** .

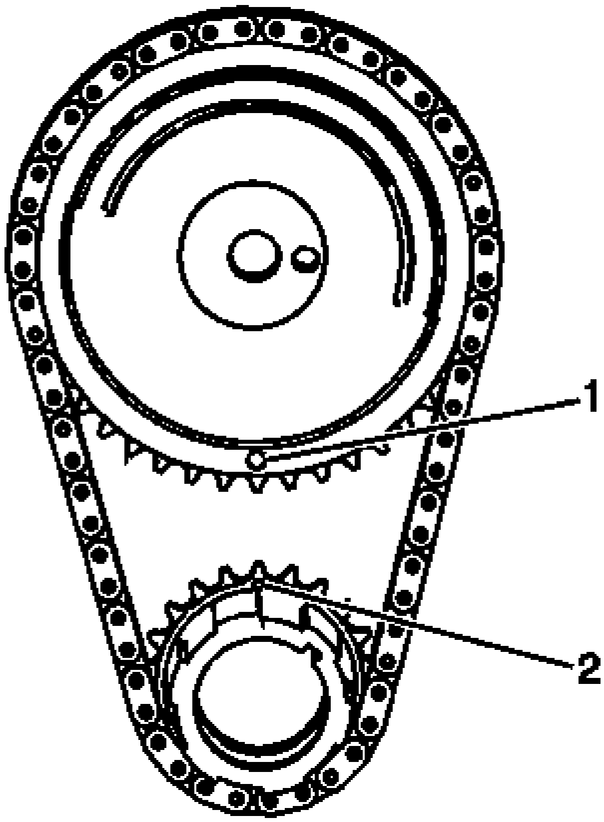


Fig. 174: Identifying Camshaft & Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS CORP.

2. Align the camshaft sprocket alignment mark (1, 2), in the 6 o'clock position.

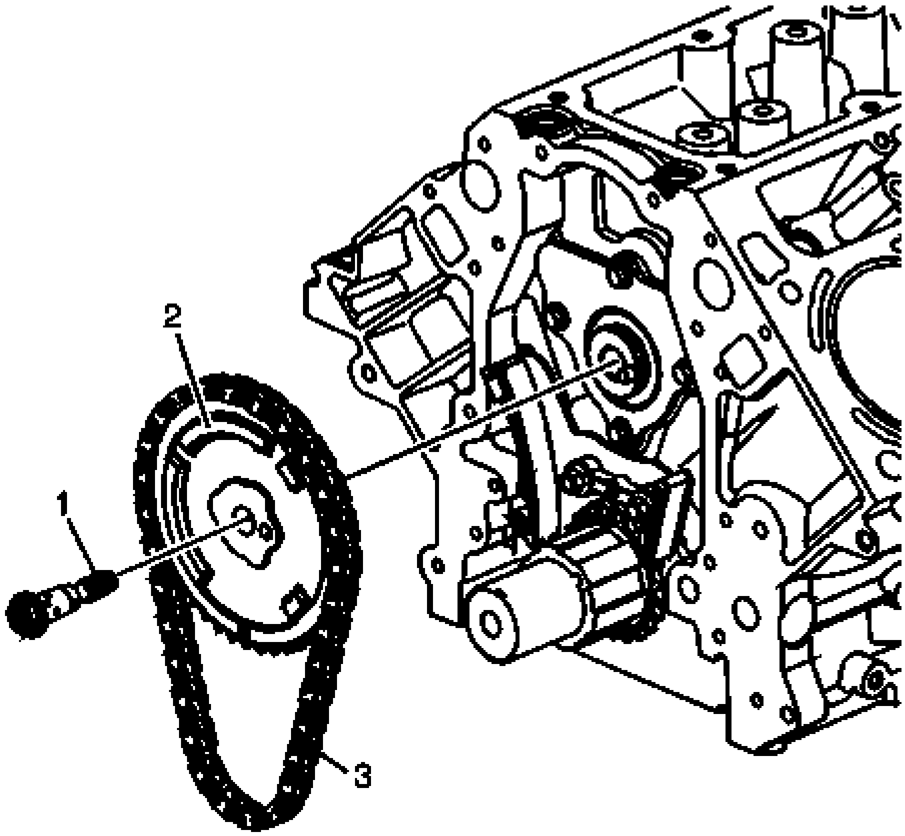


Fig. 175: Identifying Timing Chain, Camshaft Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the camshaft sprocket (1) and timing chain (2).

CAUTION: Refer to Fastener Caution .

4. Install the camshaft sprocket to camshaft retaining bolt (1) and tighten to 25 N.m (18 lb ft).
5. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
6. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Installation** .
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation (6.0L L76)** or **Crankshaft Balancer Installation (6.2L LS3)** .
8. Install the valve lifters. Refer to **Valve Lifter Replacement**.
9. Install the right side and left side cylinder heads. Refer to **Cylinder Head Installation - Left Side** and **Cylinder Head Installation - Right Side** .
10. Install the valve rocker arms and push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the right and left valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Left Side** and **Valve Rocker Arm Cover Replacement - Right Side**.
12. Install the coolant air bleed pipe. Refer to **Engine Coolant Air Bleed Pipe Replacement** .

13. Install the intake manifold. Refer to **Intake Manifold Installation** .
14. Install the water pump. Refer to **Water Pump Installation** .
15. Install the left and right exhaust manifolds. Refer to **Exhaust Manifold Replacement - Left Side (V8)** and **Exhaust Manifold Replacement - Right Side (V8)** .
16. Install the oil level indicator tube. Refer to **Oil Level Indicator and Tube Installation** .
17. Install the engine assembly. Refer to **Engine Replacement**.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

1. Remove the automatic transmission. Refer to **Transmission Replacement** .
2. Remove the engine flywheel. Refer to **Engine Flywheel Removal**.

Installation Procedure

1. Install the engine flywheel. Refer to **Engine Flywheel Installation** .
2. Install the automatic transmission. Refer to **Transmission Replacement** .

ENGINE REPLACEMENT

Tools Required

J 41798 Engine Lifting Brackets. See **Special Tools** .

Removal Procedure

1. Turn the ignition key to the LOCK position.

WARNING: Refer to Battery Disconnect Warning .

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the engine cover. Refer to **Engine Cover Replacement**.
4. Remove the radiator air baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .
5. Recover the air conditioning (A/C) refrigerant. Refer to **Refrigerant Recovery and Recharging** .
6. Remove the air intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
7. Depressurize the fuel system. Refer to **Fuel Pressure Relief** .
8. Drain the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
9. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (6.0L)** .

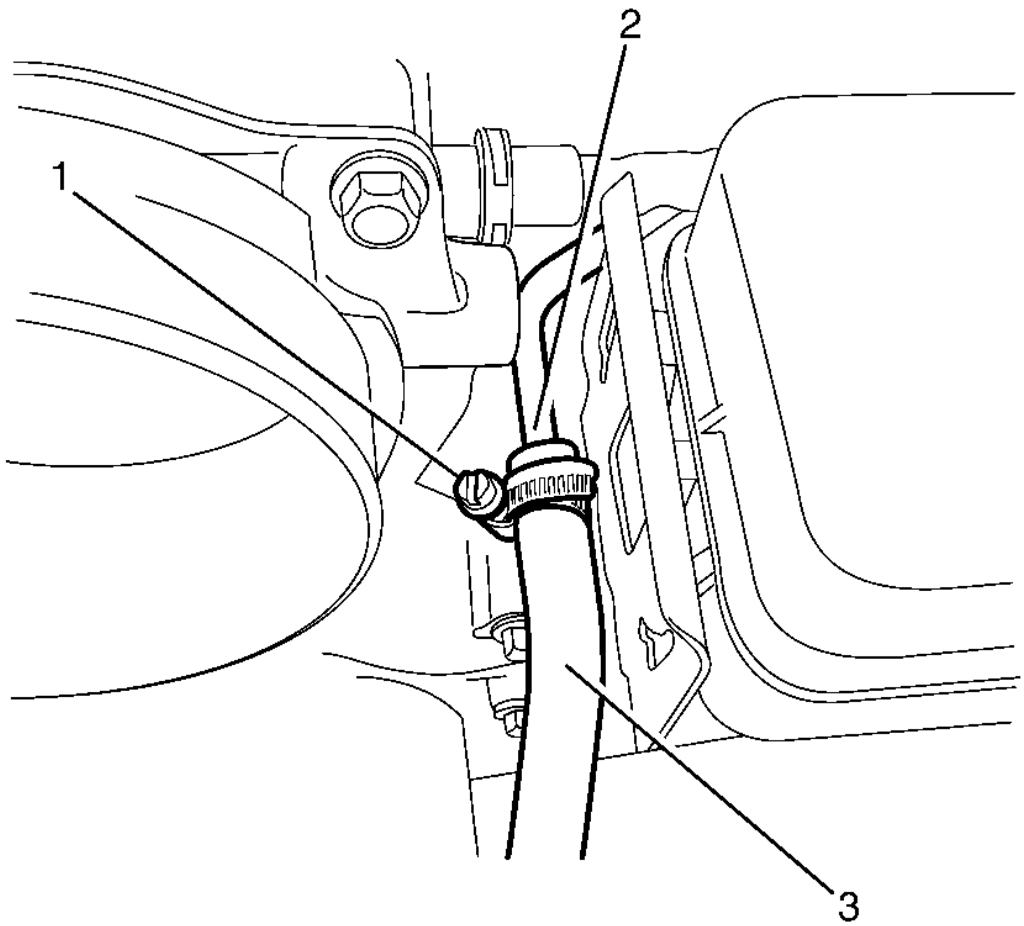


Fig. 176: View Of Coolant Bleed Hose Retaining Clamp, Coolant Air Bleed Hose & Coolant Bleed Pipe
Courtesy of GENERAL MOTORS CORP.

10. Loosen the coolant bleed hose retaining clamp (1) at the cylinder head end and slide 50 mm (2 in) along the coolant bleed hose (3).
11. Disconnect the coolant air bleed hose (3) from the coolant bleed pipe (2).

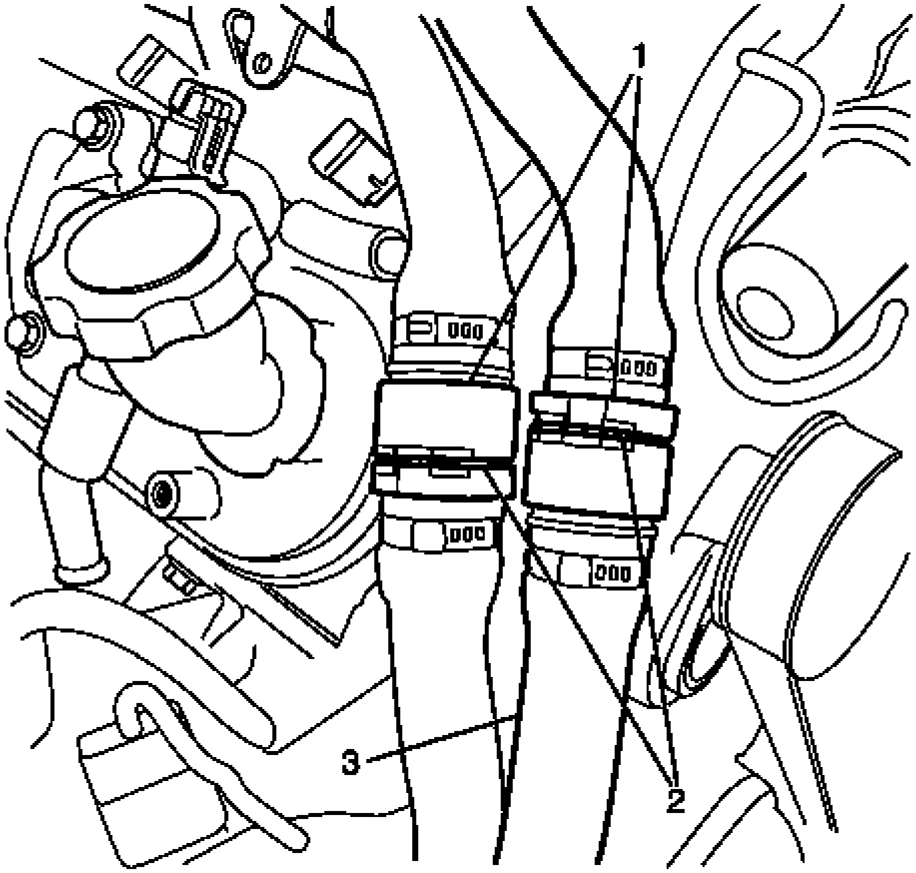


Fig. 177: Identifying Heater Hose Assembly Quick Connect Fittings & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

NOTE: **Disconnect the heater hose assembly quick connect fittings (1) by releasing the retaining clips (2) using a suitable tool.**

12. Disconnect the inlet and outlet heater hoses (3) from the heater hose assembly quick connect fittings (1).

CAUTION: **Do not touch the connector pins or soldered components on the circuit board in order to prevent possible electrostatic discharge (ESD) damage to the PCM.**

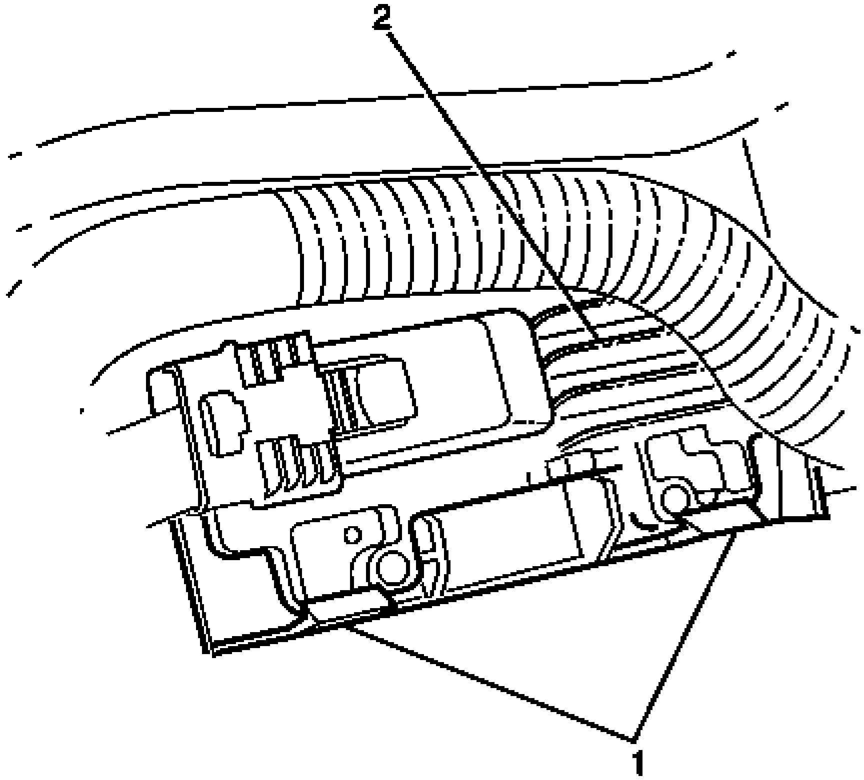


Fig. 178: Identifying ECM & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

13. Release the ECM retaining clips (1) and detach the ECM (2).

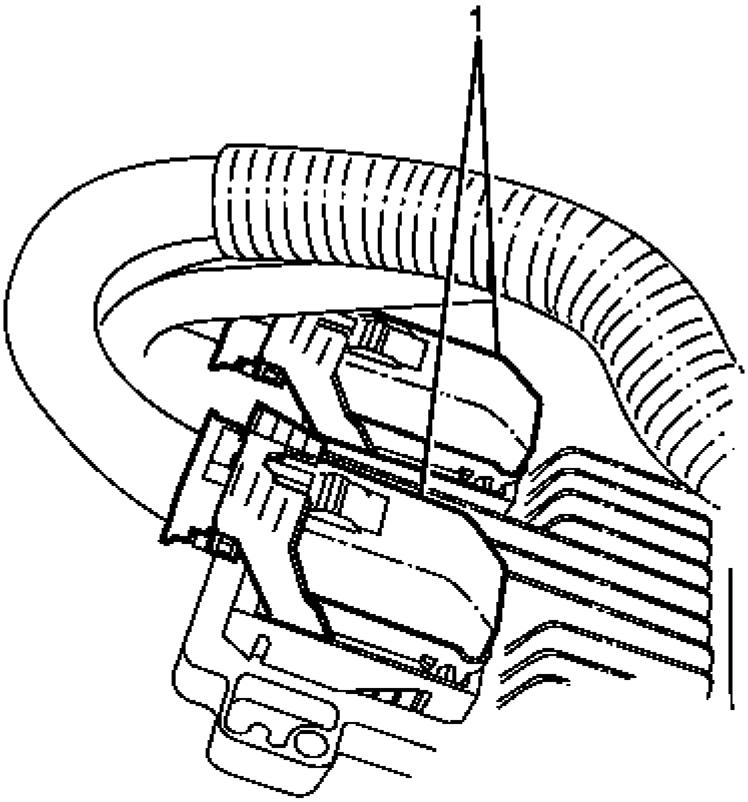


Fig. 179: Identifying ECM Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

14. Move the connector lock levers to the unlock position and disconnect the ECM electrical connectors (1).

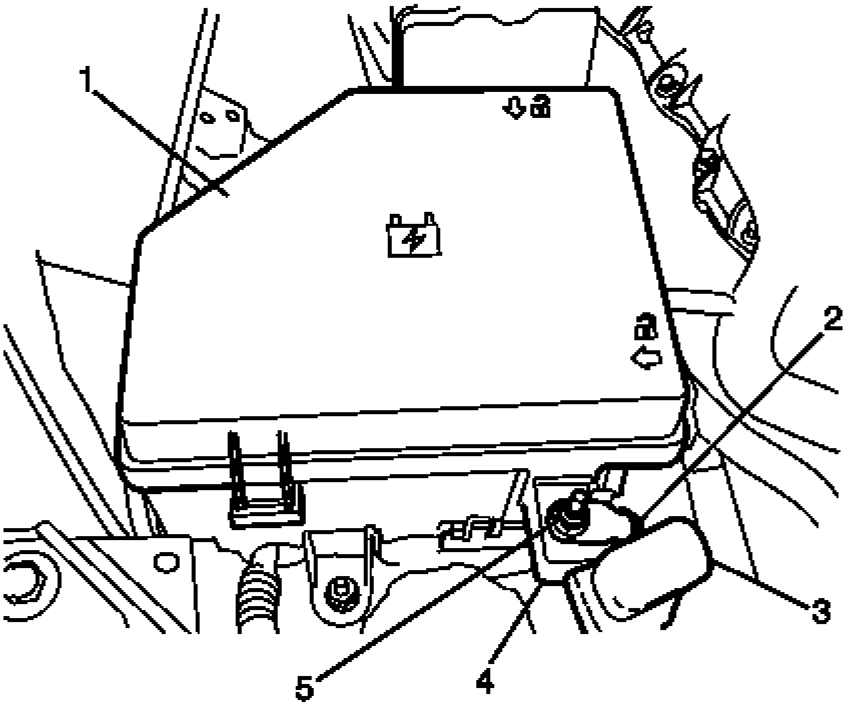


Fig. 180: Identifying Positive Cable To Under Hood BEC Plate Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

15. Remove the under hood Body Electrical Centre (BEC) cover (1).
16. Remove the positive cable protective cover (3).
17. Remove the positive cable to under hood BEC plate retaining bolt (5).
18. Disconnect the positive cable (2) from the upper under hood BEC plate (4).

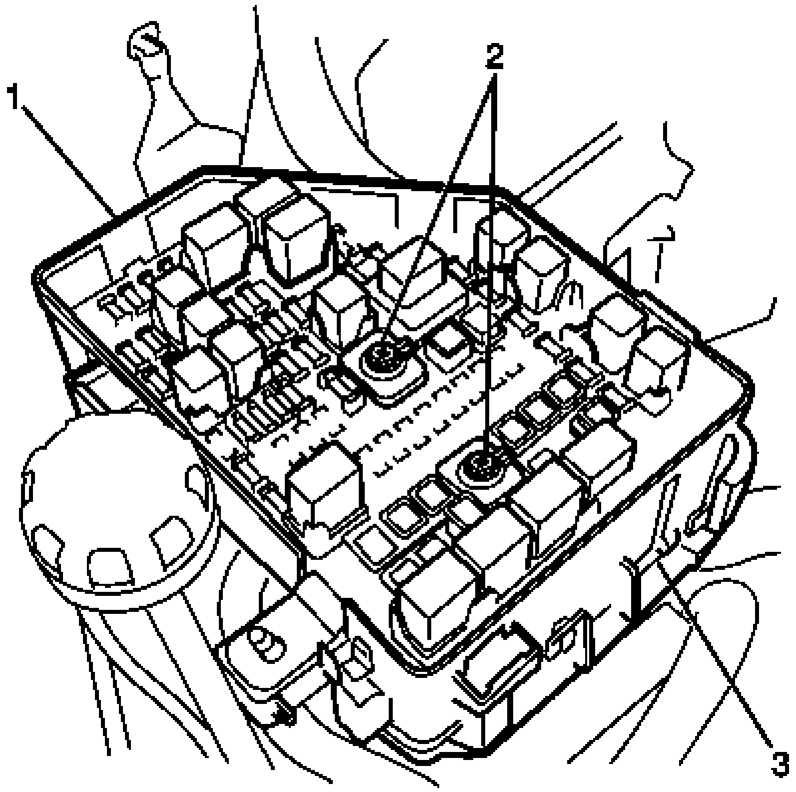


Fig. 181: Identifying Under Hood BEC Upper Plate To Lower Plate Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

19. Remove the under hood BEC upper plate to lower plate retaining bolts (2).
20. Raise the upper under hood BEC plate (1) from the lower under hood BEC plate (3).

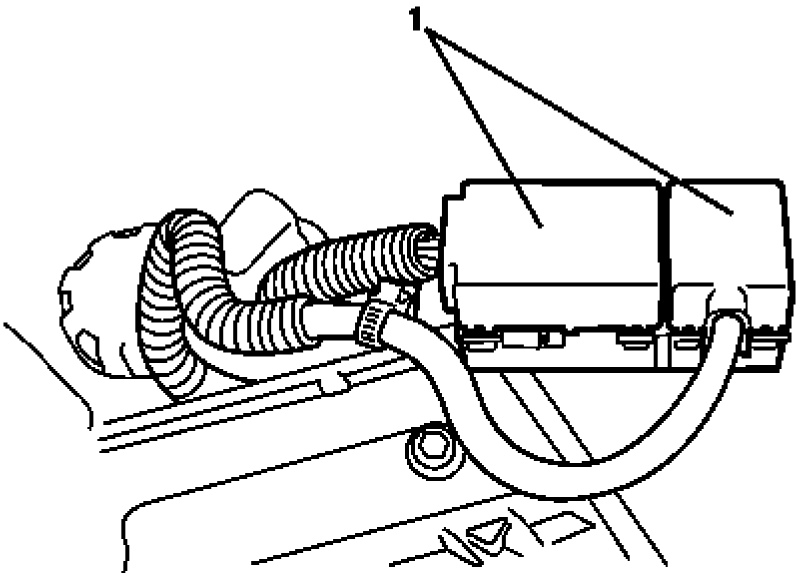


Fig. 182: Identifying Protector
Courtesy of GENERAL MOTORS CORP.

21. Detach the protector (1) from the base of the under hood BEC connector (2).

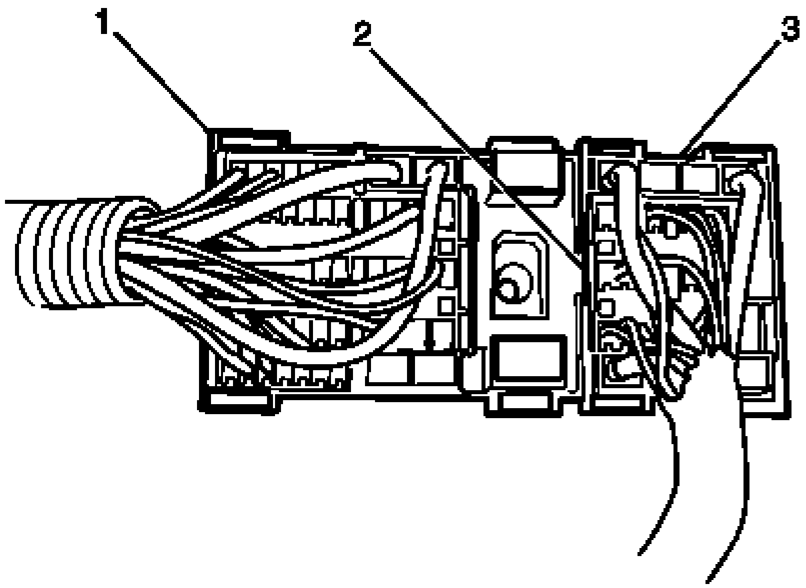


Fig. 183: Identifying Engine Connector, Locking Tang & Body Harness Connector
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Use a suitable tool to depress the connector locking tang (2), then pull the body harness connector (1) upward and the engine connector (3) downward to separate the body harness connector (1) from the engine connector (3).**

22. Separate the body harness connector (1) from the engine connector (3).
23. Reposition and secure the engine wiring harness and connector (3) on the engine.

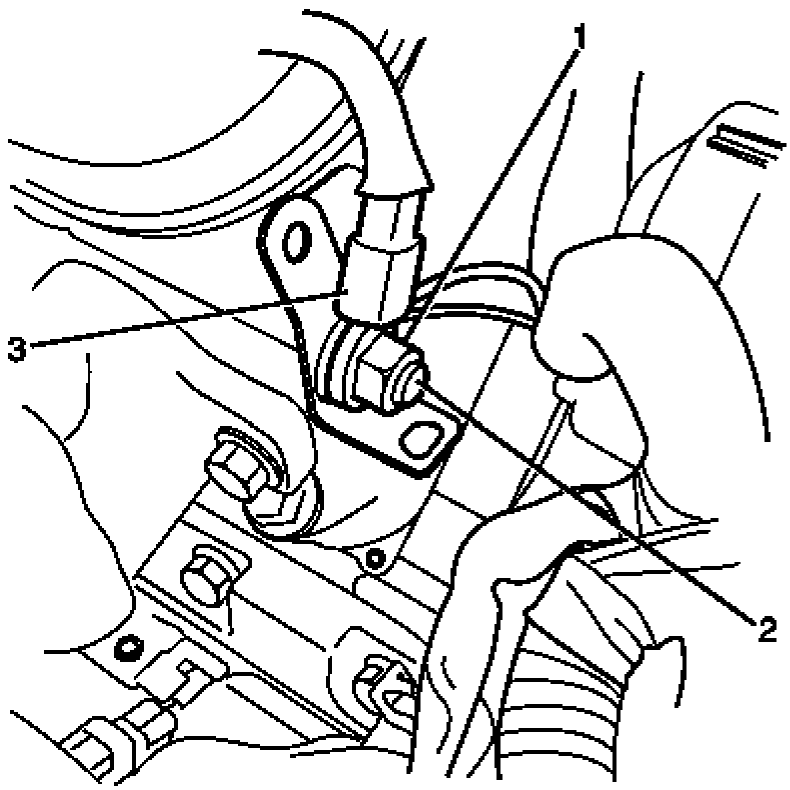


Fig. 184: Identifying Vehicle Body Ground Cable To Cylinder Head Retaining Nut
Courtesy of GENERAL MOTORS CORP.

24. Remove the vehicle body ground cable to cylinder head retaining nut (1).
25. Remove the vehicle body ground cable (3) from the cylinder head stud (2).

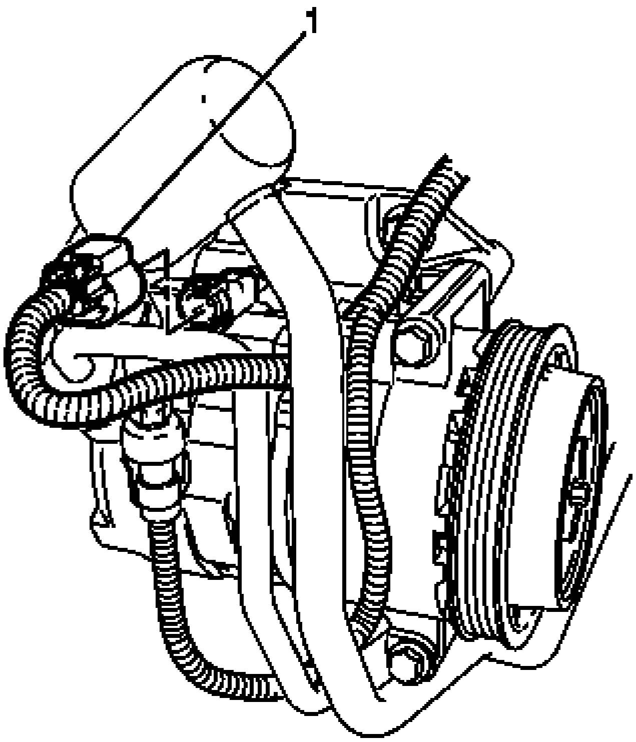


Fig. 185: Identifying Compressor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

26. Disconnect the A/C electrical connector (1) from the A/C compressor.

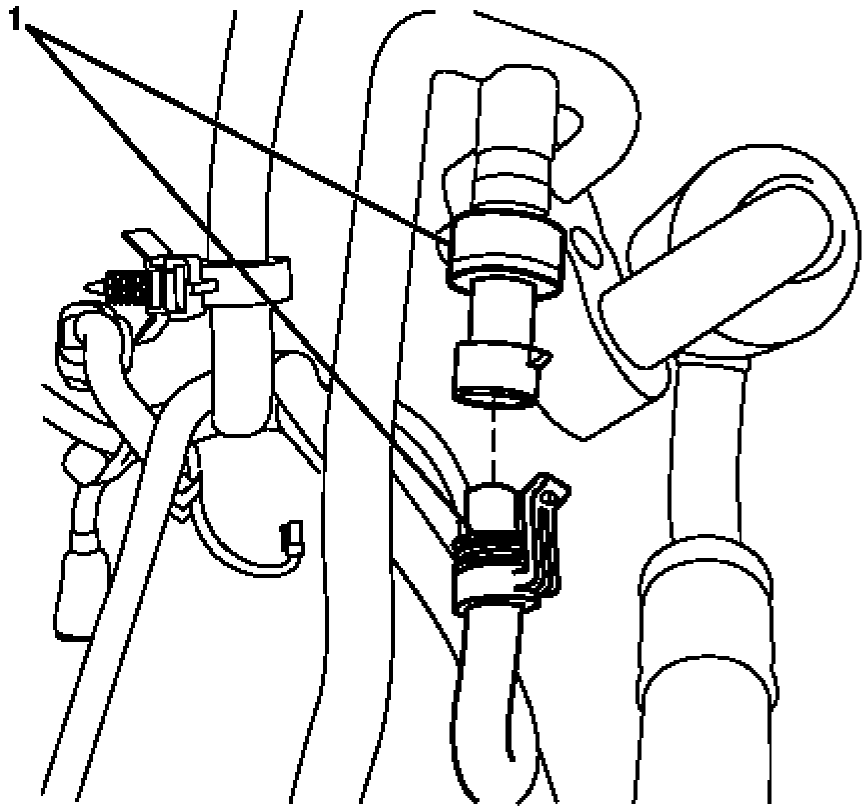


Fig. 186: Identifying A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

27. Disconnect the electrical connector from the A/C Refrigerant Pressure Sensor (1).

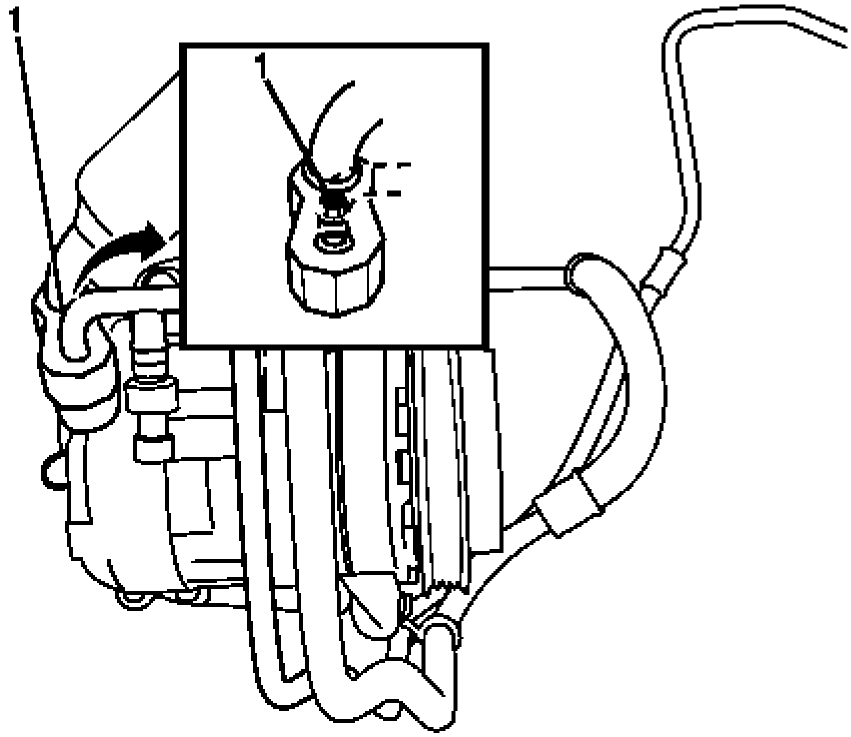


Fig. 187: Identifying Suction/Discharge Pipe To Compressor Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

28. Remove the suction/discharge pipes pad (1) to compressor retaining bolt (2).

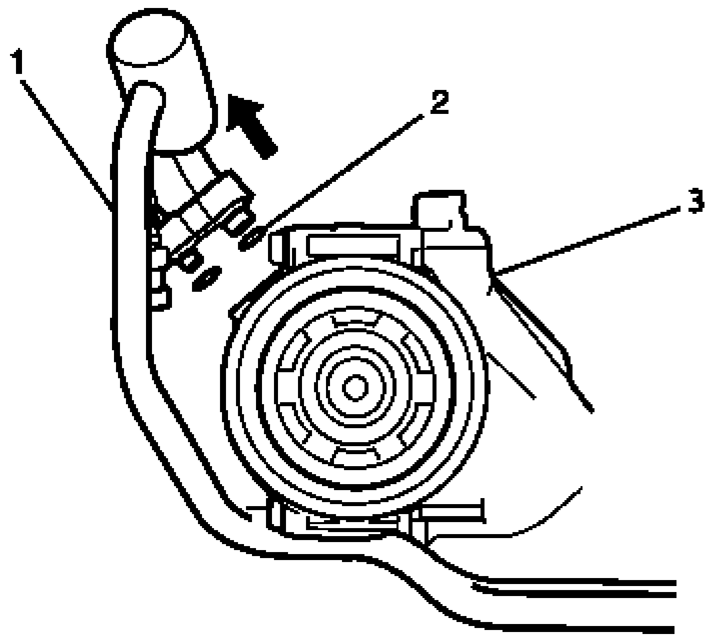


Fig. 188: Identifying Suction/Discharge Pipes & Compressor
Courtesy of GENERAL MOTORS CORP.

29. Disconnect the suction/discharge pipes (1) from the compressor (3).

NOTE:	**Sealing washers are single use and must be discarded after use.**

NOTE:	**Seal pipes immediately to prevent absorption of moisture from the atmosphere.**

NOTE:	**The plugs for A/C compressor ports must be sufficient to stop oil escaping when tilting A/C compressor for removal.**

30. Remove and discard the port sealing washers (2).

    Discard the port sealing washers (2).

NOTE:	**Cap or plug the ports immediately to prevent absorption of moisture from the atmosphere.**

31. Cap or plug the A/C compressor (3) ports.

32. Cap or plug the A/C hoses (1).
33. Remove the engine coolant heater cord if fitted. Refer to **Coolant Heater Cord Replacement (6.0L)** .

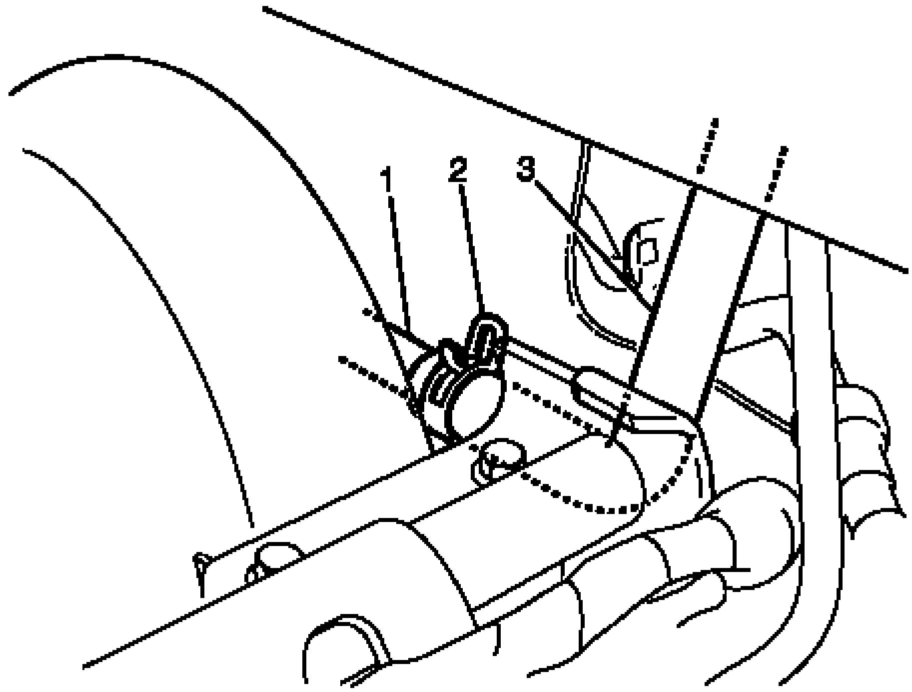


Fig. 189: Identifying Intake Manifold Vacuum Port, Vacuum Hose & Retaining Clamp
Courtesy of GENERAL MOTORS CORP.

34. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
35. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).

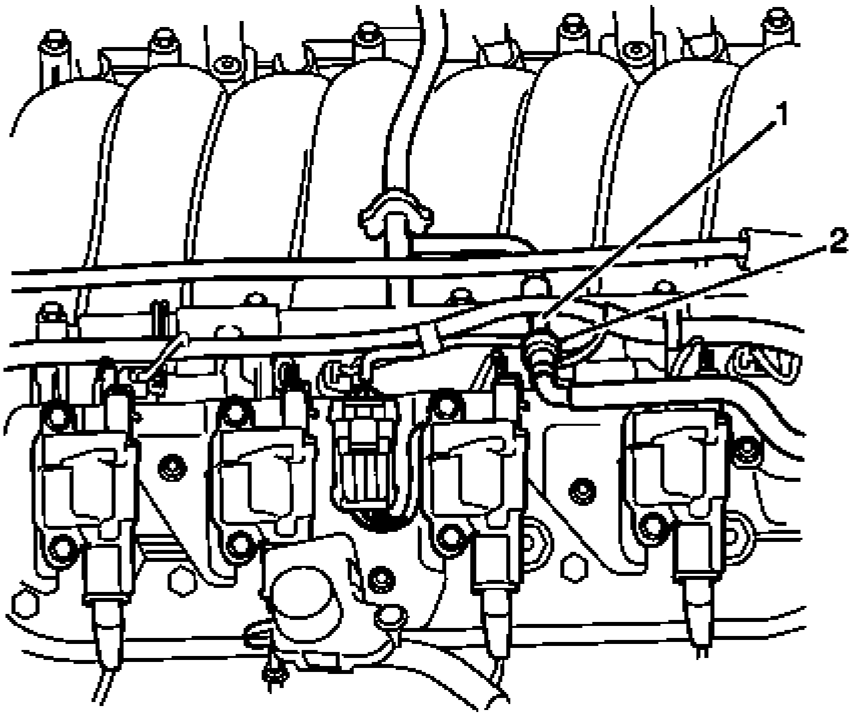


Fig. 190: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.**

36. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .

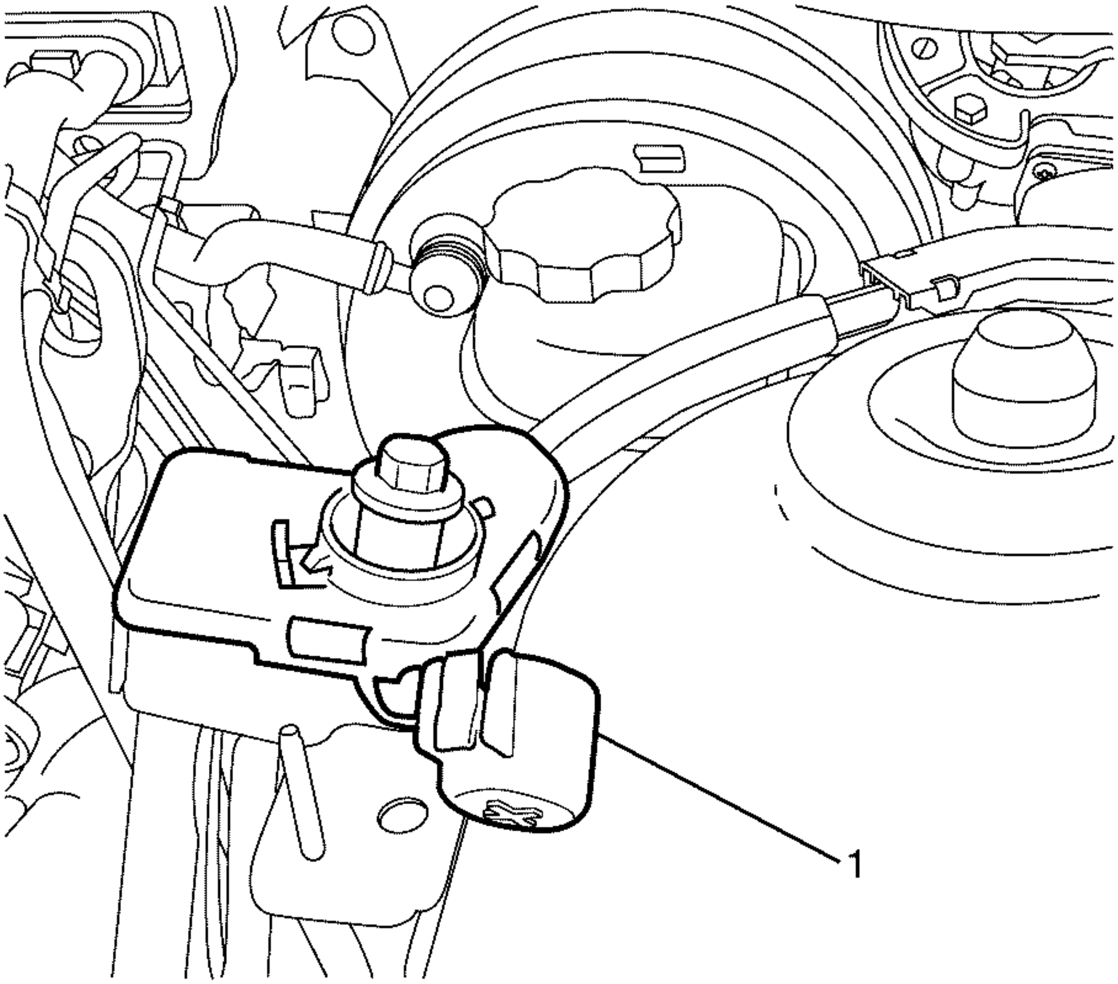


Fig. 191: Identifying Remote Battery Positive Post Cover
Courtesy of GENERAL MOTORS CORP.

37. Remove the remote positive battery post cover (1) from the remote positive battery post.

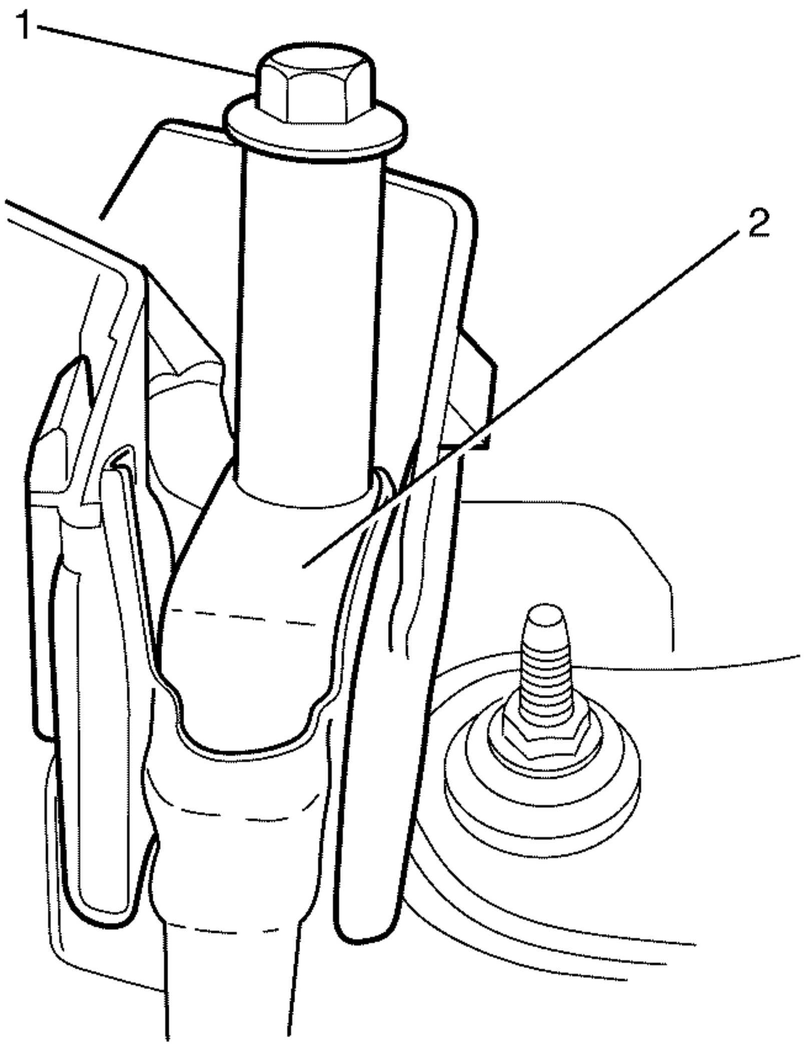


Fig. 192: Identifying Remote Battery Positive Post To Wiring Harness Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

38. Remove the remote positive battery post to wiring harness retaining bolt (1).
39. Remove the wiring harness (2) from the remote positive battery post.

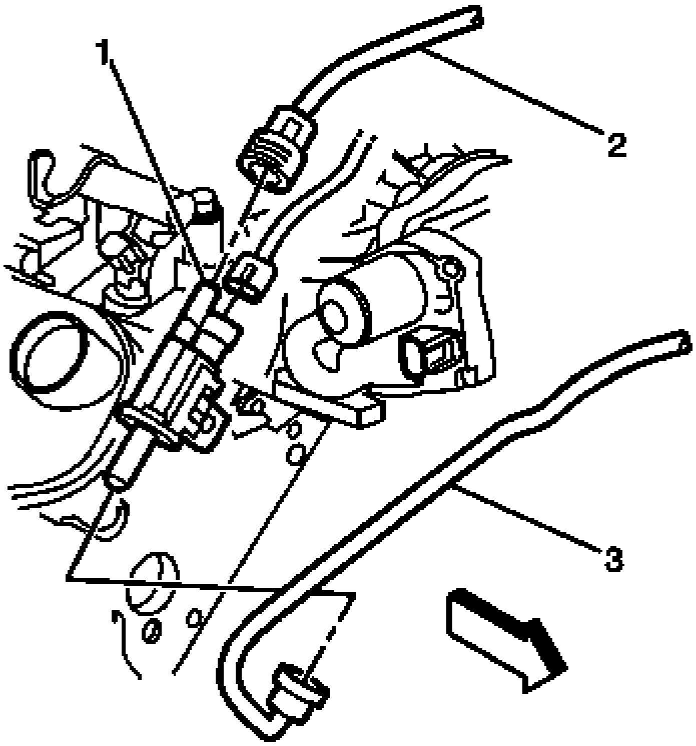


Fig. 193: Locating Fuel Tank Hose, EVAP Purge Valve & Hose
Courtesy of GENERAL MOTORS CORP.

NOTE: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

40. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

NOTE: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

41. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).

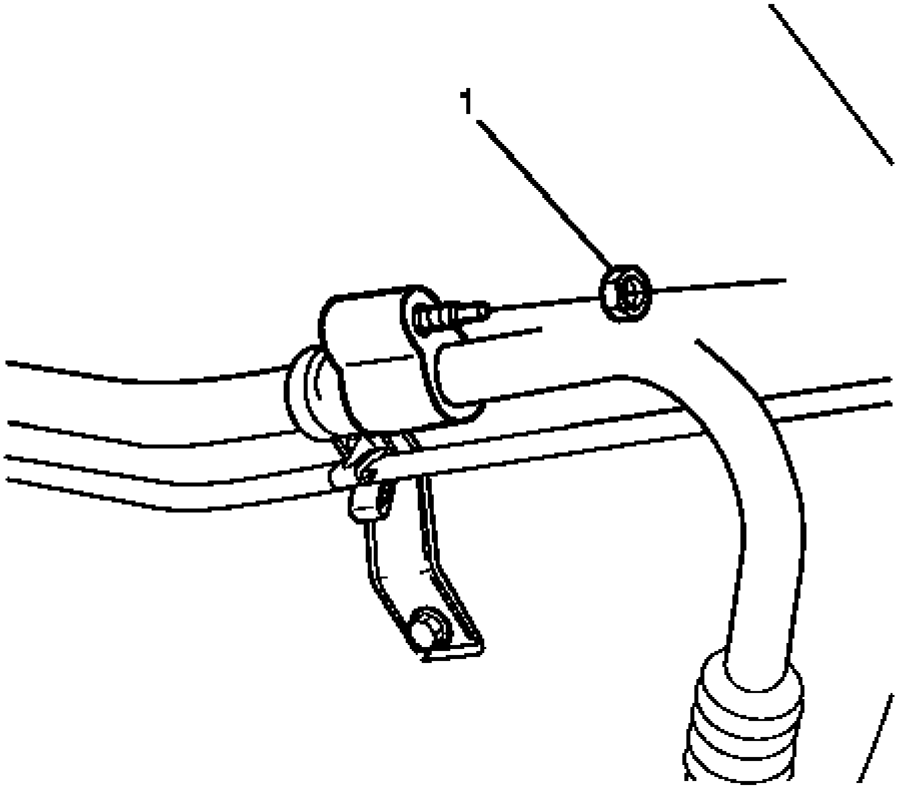


Fig. 194: Identifying A/C Suction Pipe Pad To Lower A/C Suction Pipe Retaining Nut
Courtesy of GENERAL MOTORS CORP.

42. Remove the A/C suction pipe pad to lower A/C suction pipe retaining nut (1).

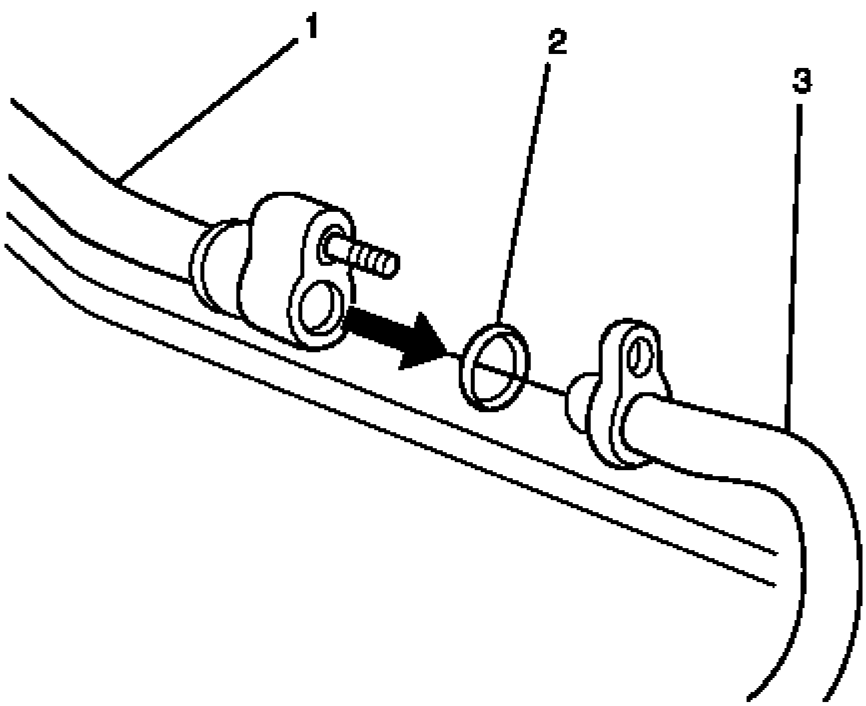


Fig. 195: Identifying Upper & Lower A/C Suction Pipe With Sealing O-Ring
Courtesy of GENERAL MOTORS CORP.

43. Disconnect the upper A/C suction pipe (1) from the lower A/C suction pipe (3).

NOTE: **Plug or cap the A/C suction pipe ends (1 and 3) immediately to prevent contamination and absorption of moisture from the atmosphere.**

44. Plug or cap the A/C suction pipe ends.

NOTE: **The A/C suction pipe sealing O-ring (2) is a single use component and will not reseal. Install a NEW A/C suction pipe sealing O-ring (2) whenever the upper A/C suction pipe (1) is removed from the lower A/C suction pipe (3).**

45. Remove and discard the A/C suction pipesealing O-ring (2).

    Discard the A/C suction pipe sealing O-ring (2).

46. Reposition and retain the A/C suction/discharge pipes away from the engine.

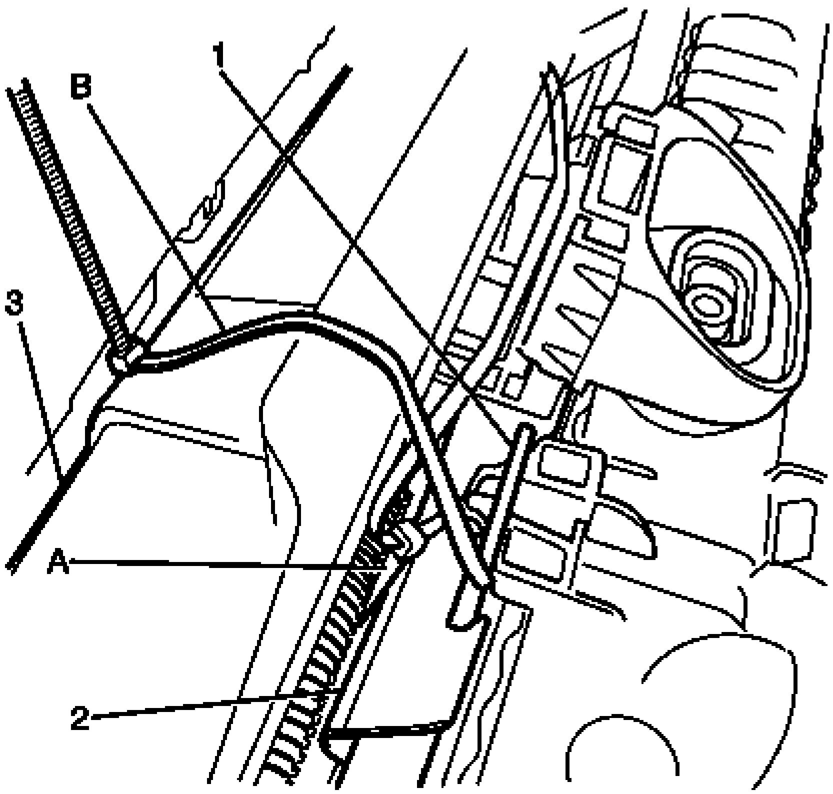


Fig. 196: Identifying Front End, Radiator & Condenser Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: **It is necessary to secure the radiator and condenser assembly (2) to the front end assembly (3) as the radiator and condenser assembly is supported to the subframe.**

NOTE: **Thread zip tie A around the front end assembly and zip tie B through the radiator and condenser mount (1). Insert zip tie A into the retainer of zip tie B and insert zip tie B into the retainer of zip tie A.**

47. Secure radiator and condenser assembly (2) to the front end assembly (3) with large zip ties or equivalent.

NOTE: **The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.**

NOTE: **When removal is complete plug hose openings with a clean lint free cloth to prevent foreign matter entry.**

48. Place a suitable container beneath the radiator and engine.

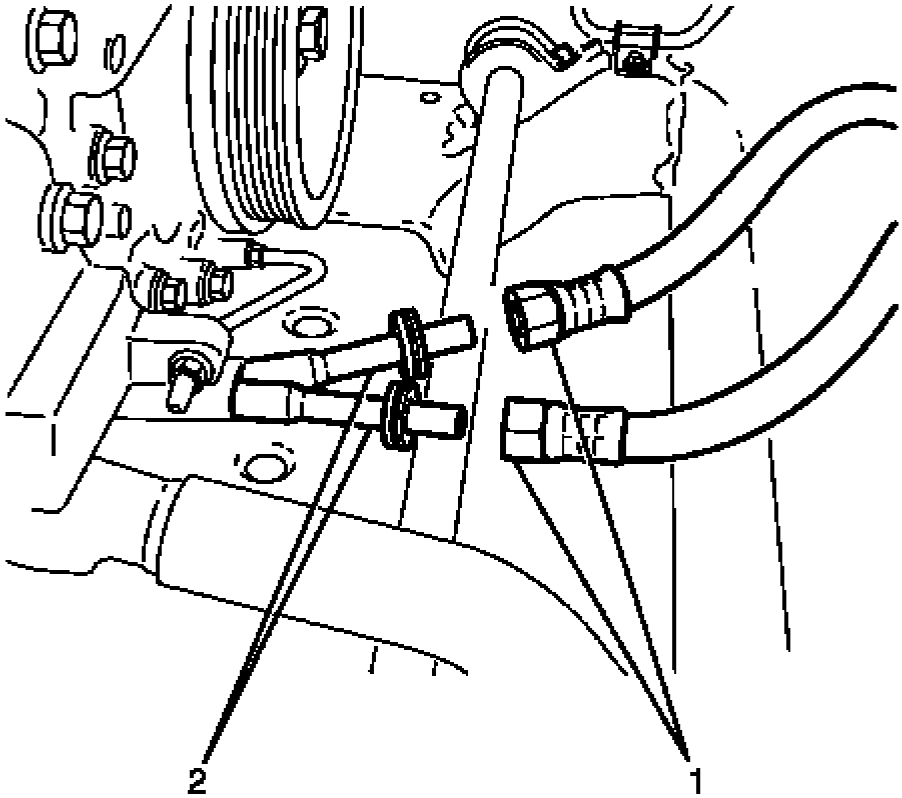


Fig. 197: Identifying Transmission Cooler Lines & Flexible Hoses
Courtesy of GENERAL MOTORS CORP.

49. Disconnect the automatic transmission cooler pipe (2) from the flexible hose (1) at the quick connect fitting using tool. AU525.
    - Open release tool AU525 then close and clip around the hose to be disconnected.
    - While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
    - Repeat for the second fitting if required.
50. Reposition and secure the flexible hoses (1) away from the engine and subframe.

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

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.**

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

52. Remove the front air deflector. Refer to **Front Air Deflector Replacement** .
53. Remove the engine splash shield. Refer to **Engine Splash Shield Replacement** .

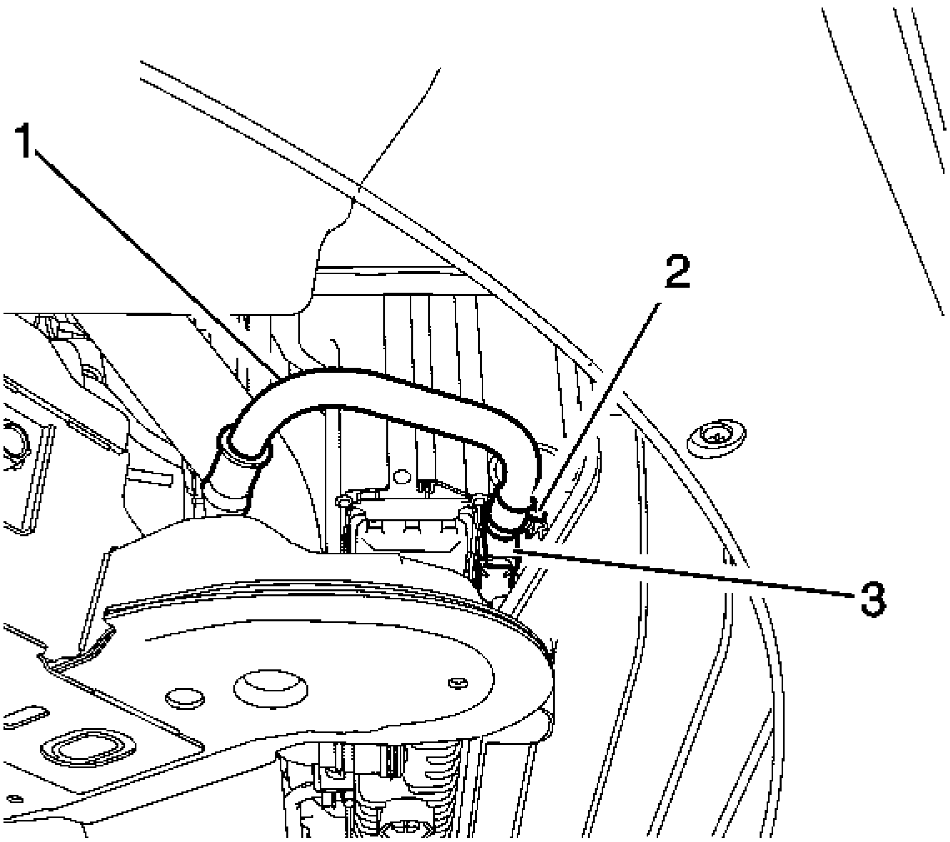


Fig. 198: View Of Power Steering Cooler & Power Steering Gear Outlet Pipe/Hose With Spring Clamp
Courtesy of GENERAL MOTORS CORP.

54. Place a suitable container under the power steering cooler.

NOTE: The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.

55. Release the power steering gear outlet hose spring clamp (2) and disconnect the power steering gear outlet hose (1) from the power steering cooler (3).

Plug the power steering cooler (3) and power steering gear outlet hose (1).

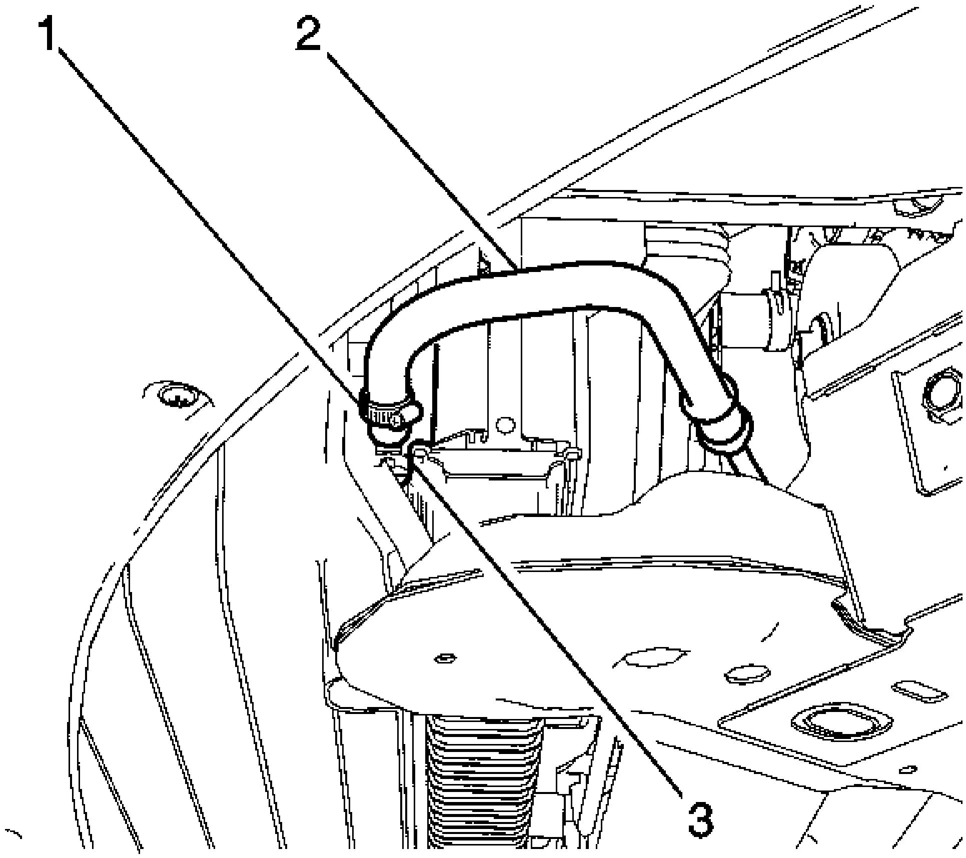


Fig. 199: View Of Power Steering Cooler & Power Steering Fluid Reservoir Inlet Pipe/Hose & Spring Clamp
Courtesy of GENERAL MOTORS CORP.

NOTE:	**The power steering cooler (3) must be plugged to prevent the entry of foreign particles into the power steering system.**

56. Release the power steering reservoir inlet hose spring clamp (1) and disconnect the power steering reservoir inlet hose (2) from the power steering cooler (3).

    Plug the power steering cooler (3) and power steering reservoir inlet hose (2).

57. Remove the exhaust system. Refer to **Exhaust System Replacement (V8 - For Access)** or **Exhaust System Replacement (V8 - Complete)** .
58. Remove the centre heat shield. Refer to **Exhaust Heat Shield Replacement - Center** .
59. Remove the propeller shaft. Refer to **Propeller Shaft Replacement** .
60. Remove the starter. Refer to **Starter Replacement (6.0L)** .

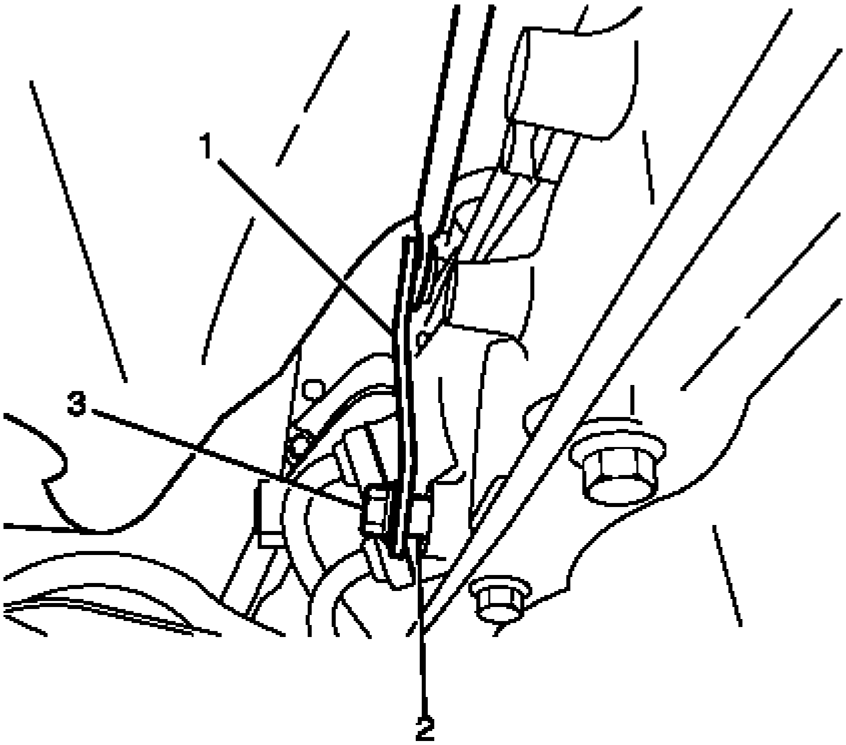


Fig. 200: Identifying Shift Selector Linkage Rod To Shift Selector Shaft Retaining Nut
Courtesy of GENERAL MOTORS CORP.

61. Remove the shift selector linkage rod to shift selector shaft retaining nut (3).
62. Remove the shift selector linkage rod (1) from the shift selector shaft (2).
63. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation** .

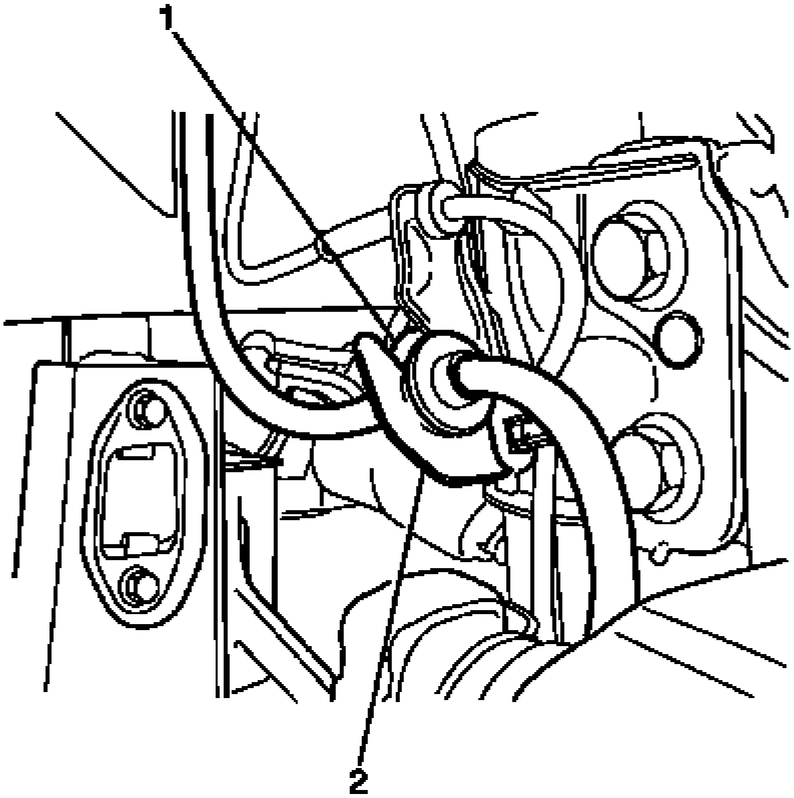


Fig. 201: Identifying Front Brake Hose & Strut Mounted Brake Hose Retaining Bracket
Courtesy of GENERAL MOTORS CORP.

64. Detach the front brake hose (1) from the front strut mounted brake hose retaining bracket (2). Repeat for opposite side.

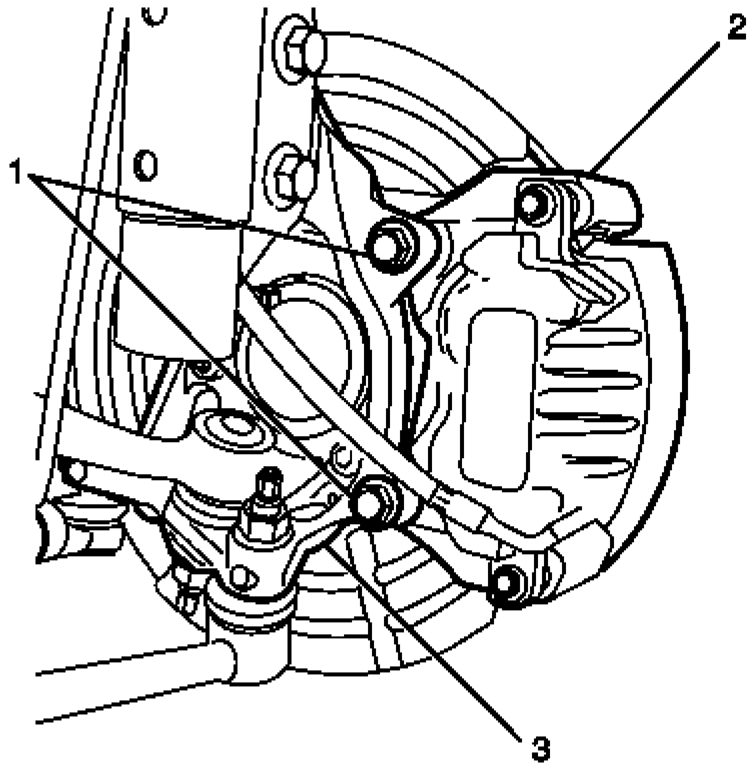


Fig. 202: Identifying Front Brake Caliper Anchor Plate To Front Steering Knuckle Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Nuts with micro-encapsulated thread sealant must be discarded after removal.**

65. Remove the front brake caliper anchor plate to knuckle retaining bolts (1). Repeat for opposite side.

    Discard the bolts.

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

66. Remove the front brake caliper (2) from the front steering knuckle (3). Repeat for opposite side.

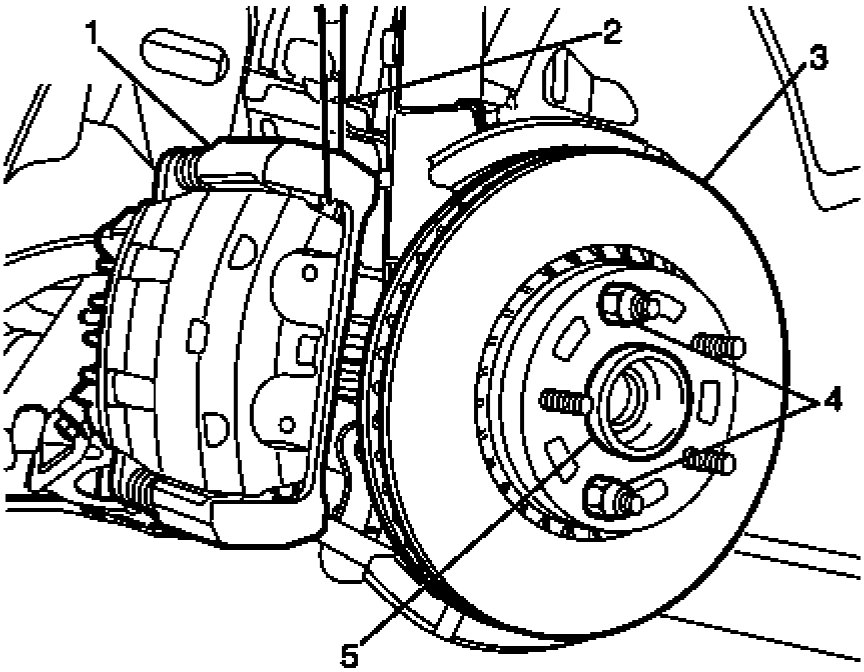


Fig. 203: View Of Hub, Wheel Nuts, Front Brake Disc, Heavy Mechanic's Wire & Front Brake Caliper
Courtesy of GENERAL MOTORS CORP.

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

67. Support the front brake caliper (1) with heavy mechanic's wire, or equivalent (2). Repeat for opposite side.
68. Remove the two wheel nuts (4) retaining the front brake disc (3) to the hub (5). Repeat for opposite side.

Fig. 204: Identifying Front Wheel Speed Sensor Jumper Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

69. Disconnect the front wheel speed sensor jumper harness electrical connector (1) and secure away from the front subframe and suspension components. Repeat for opposite side.

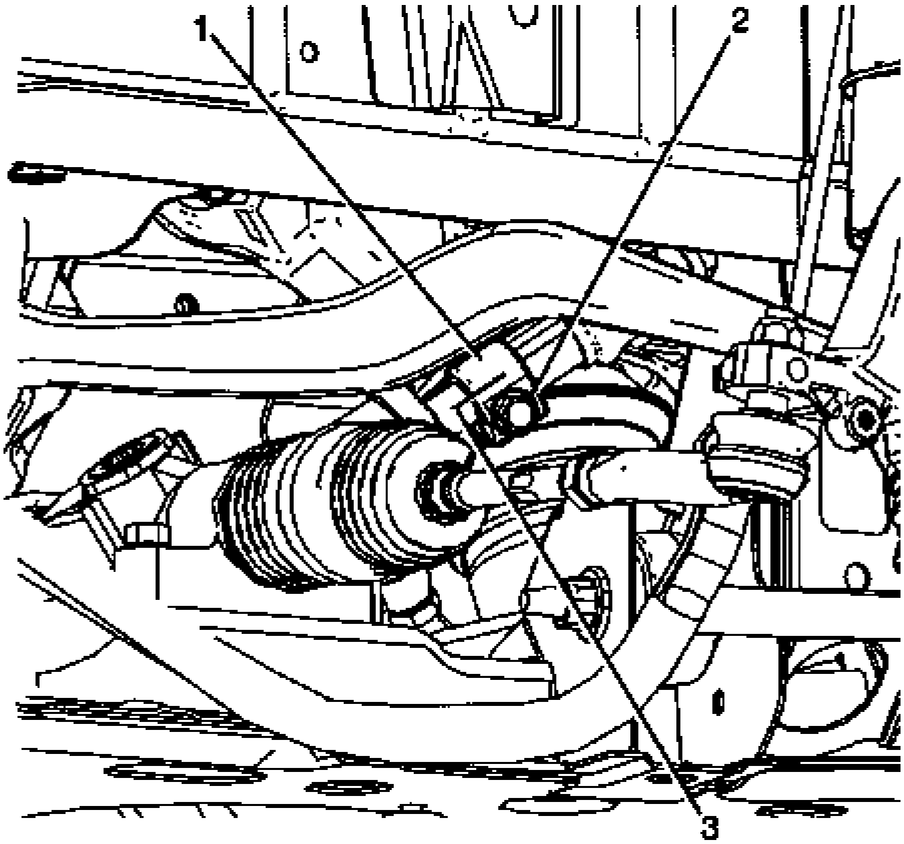


Fig. 205: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **The front wheels of the vehicle must be maintained in the straight ahead position and the steering column must be in the LOCK position before disconnecting the steering column or intermediate shaft. If these procedures are not followed incorrect alignment of some components during installation will result and damage to the SIR coil assembly will occur.**

NOTE: **Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimise the potential of incorrect steering column assembly alignment.**

70. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).
71. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

NOTE: **Bolts with micro-encapsulated thread sealant must be discarded after removal.**

72. Disconnect the intermediate shaft (2) from the pinion shaft (3).

Discard the bolt.

73. Lower the vehicle.

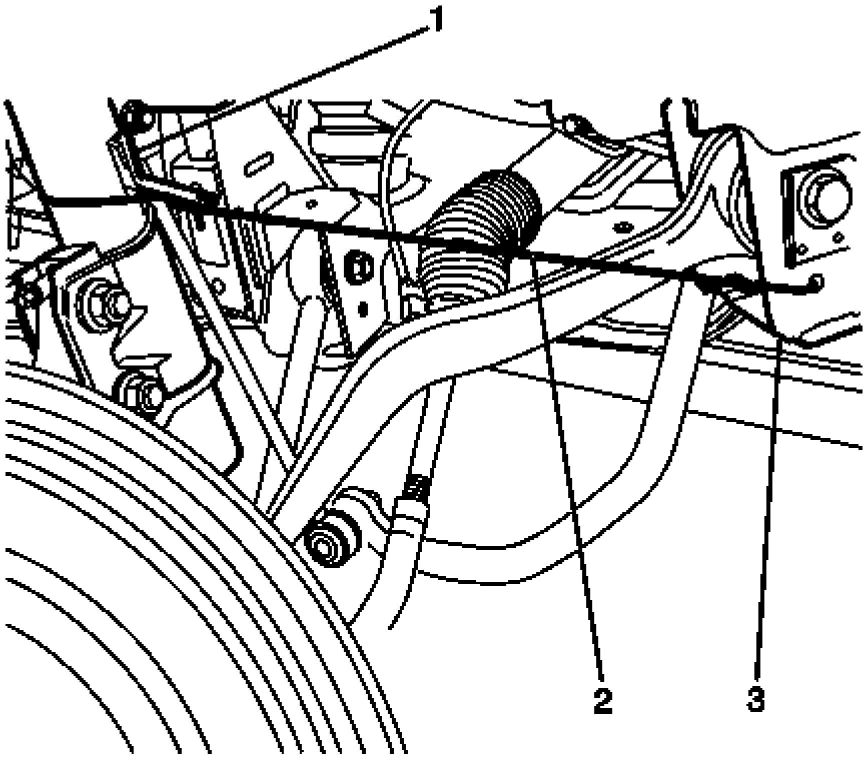


Fig. 206: View Of Subframe, Heavy Mechanic's Wire & Strut Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: **The strut assembly (1) must be secured to the subframe (3) to prevent damage to the front wheelhouse liner, fenders and suspension components.**

74. Retain the front strut assembly (1) to the front subframe (3) using heavy mechanics wire or equivalent (2). Repeat for opposite side.

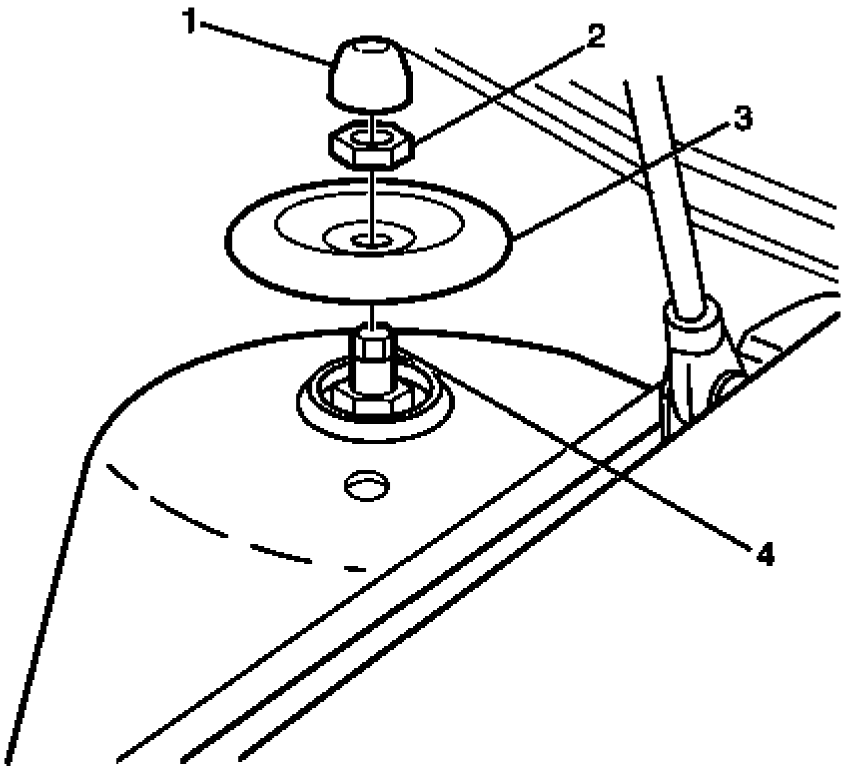


Fig. 207: View Of Strut Piston Shaft, Stud Dust Cover, Front Wheelhouse Retaining Plate & Nut
Courtesy of GENERAL MOTORS CORP.

75. Remove the stud dust cover (1) from the strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side.

NOTE: **The strut assembly (4) must be supported from underneath before the strut assembly to body retaining nut (2) is removed.**

76. Remove the strut assembly to front wheelhouse retaining nut (2) while holding the strut piston shaft (4). Repeat for opposite side.

    Discard the nut.

77. Remove the strut assembly to front wheelhouse retaining plate (3). Repeat for opposite side.
78. Position a suitable powertrain and/or engine lift table below the frame, engine and transmission.
79. Raise the lift table and/or lower the vehicle to support the frame, engine and transmission.

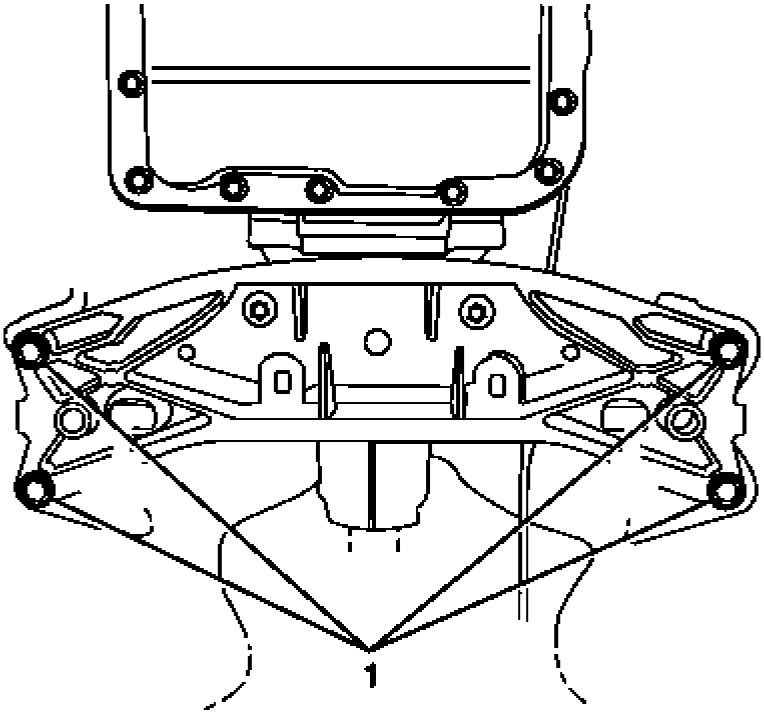


Fig. 208: Identifying Transmission Support To Body Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

80. Remove the transmission support to body retaining bolts (1).

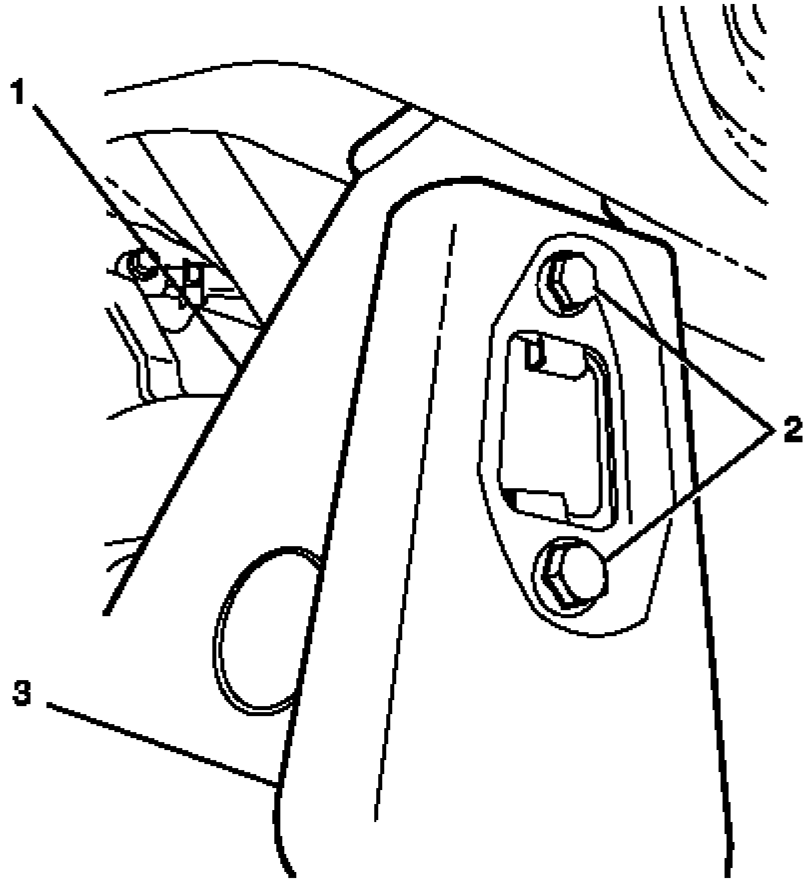


Fig. 209: Identifying Subframe Reinforcement Plate To Subframe Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

81. Remove the front subframe reinforcement plate to front subframe retaining bolts (2).
82. Remove the front subframe reinforcement plate (3) from the front subframe (1).

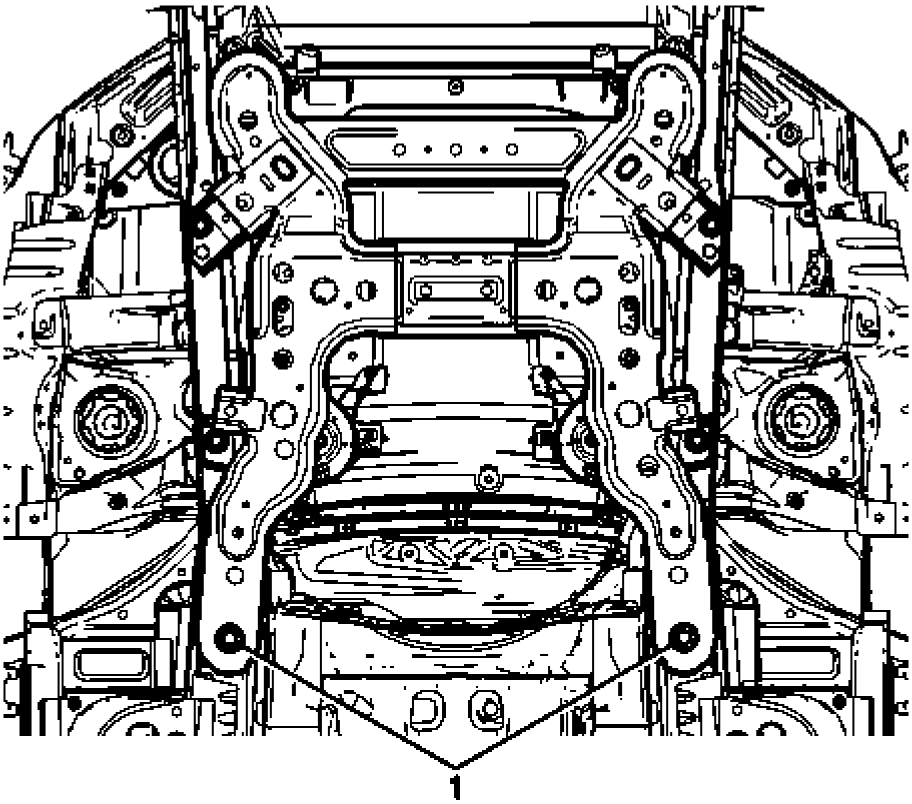


Fig. 210: Identifying Subframe To Body Rear Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

83. Remove the front subframe to body rear retaining bolts (1).

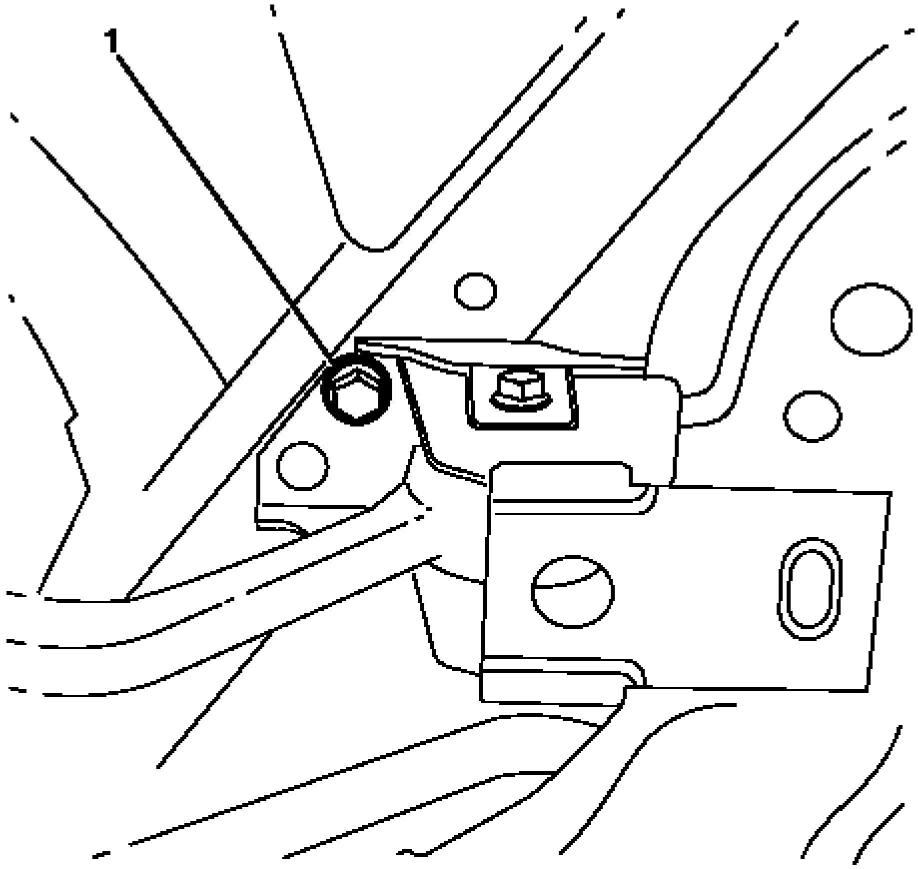


Fig. 211: Identifying Subframe To Body Front Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Only right side depicted in graphic, left side similar.

84. Remove the front subframe to body front retaining bolt (1). Repeat for opposite side.

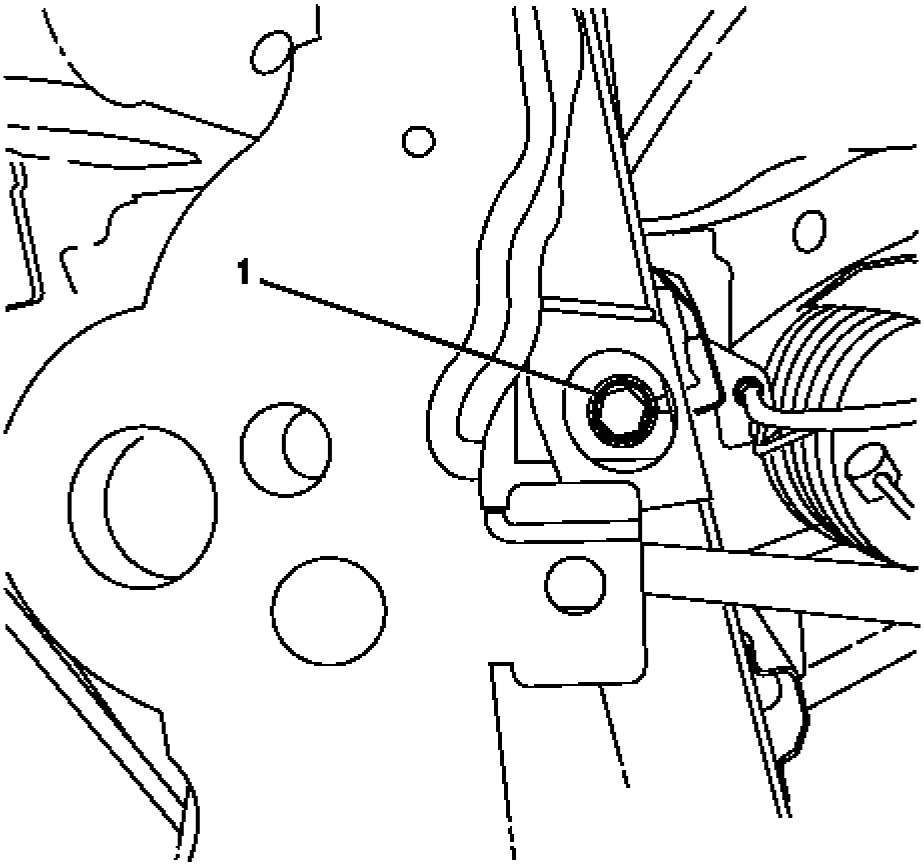


Fig. 212: Identifying Subframe To Body Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Only right side depicted in graphic, left side similar.

85. Remove the front subframe to body retaining bolt (1). Repeat for opposite side.

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

86. With the aid of an assistant, lower the table and/or raise the vehicle to remove the engine, transmission, front suspension and subframe assembly from the vehicle.
87. Remove the engine and transmission wiring harness and related components. Refer to **Engine Wiring Harness Assembly Removal** .

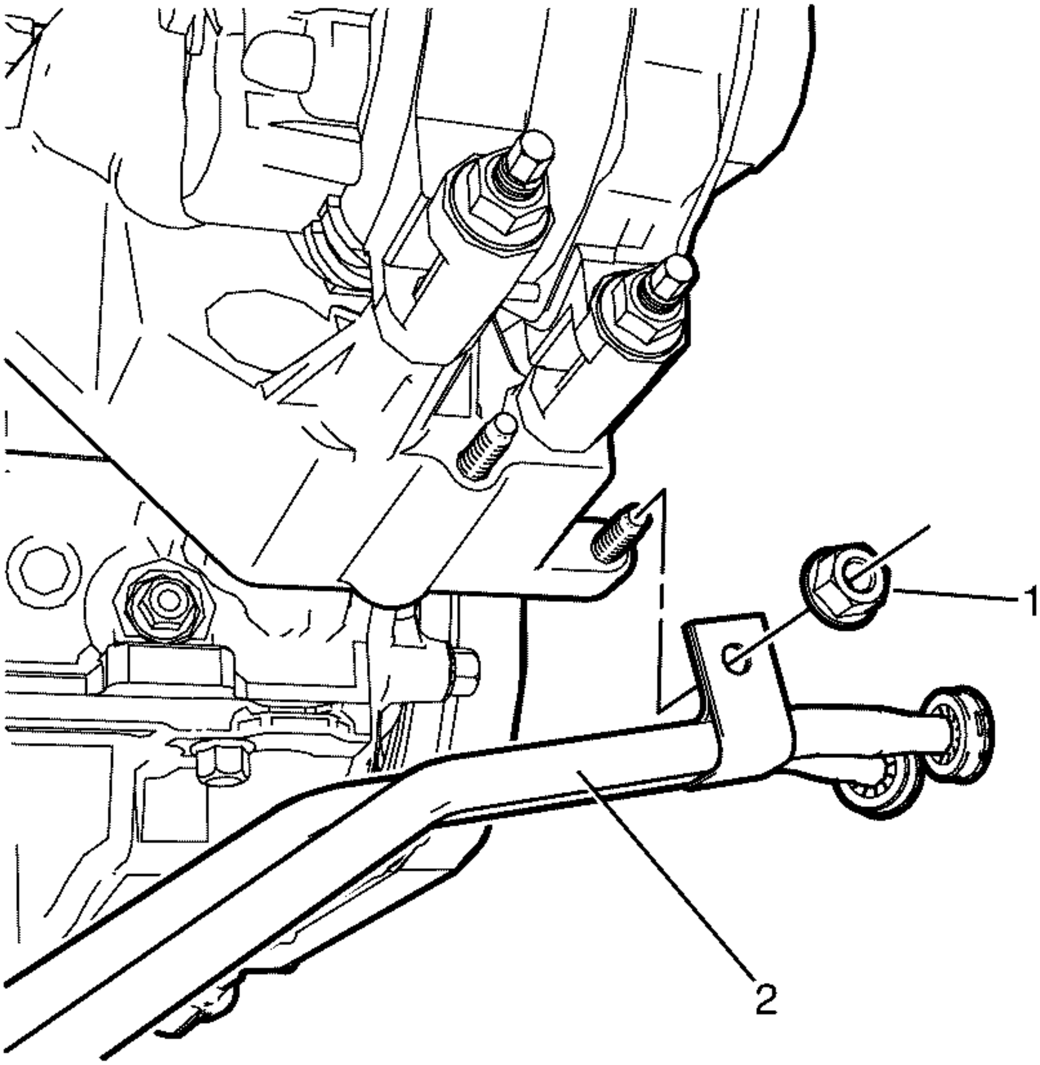


Fig. 213: Identifying A/T Cooler Pipe Clamp To A/C Bracket Nut
Courtesy of GENERAL MOTORS CORP.

88. Remove the automatic transmission cooler pipe clamp to A/C bracket nut (1) and position the automatic transmission cooler pipes (2) aside.
89. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.
90. Position a second powertrain lift table below the transmission.
91. Remove the transmission. Refer to **Transmission Replacement** .
92. Remove the engine flywheel. Refer to **Engine Flywheel Removal**.
93. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

94. Remove the A/C drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.

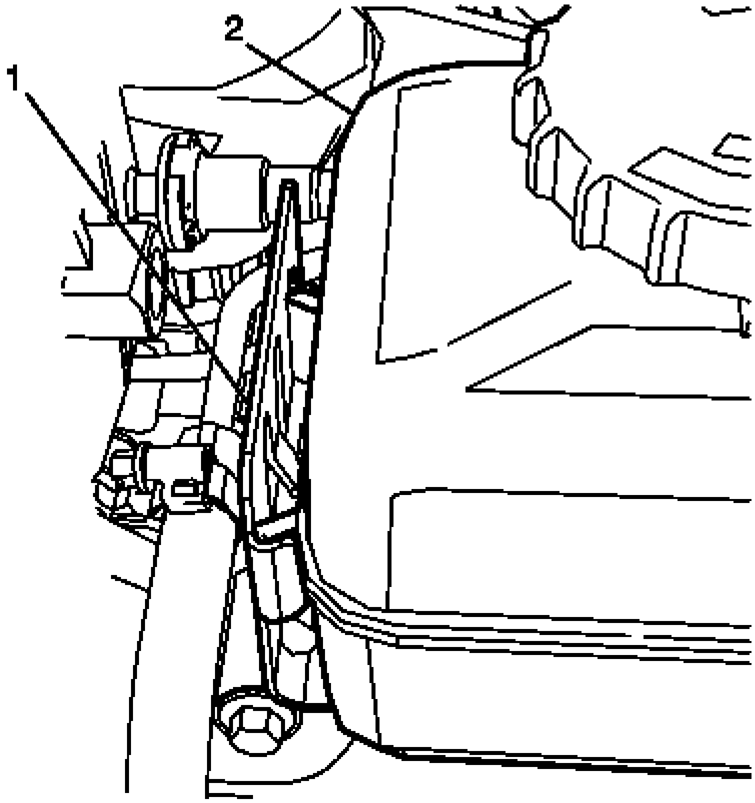


Fig. 214: Identifying Power Steering Reservoir & Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).

95. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.

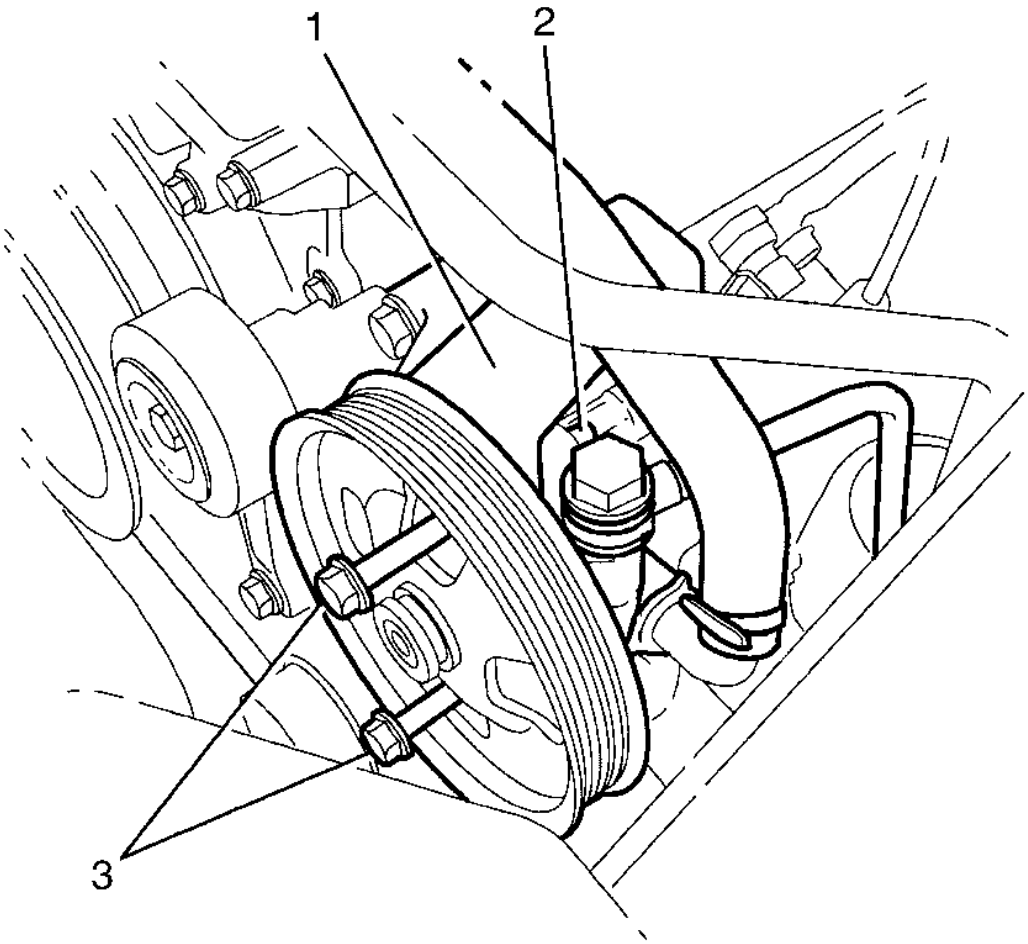


Fig. 215: Identifying Power Steering Pump, Bracket & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

96. Remove the power steering pump (2) to power steering pump bracket retaining bolts (3) and position the power steering pump (2) away from the power steering pump bracket (1).

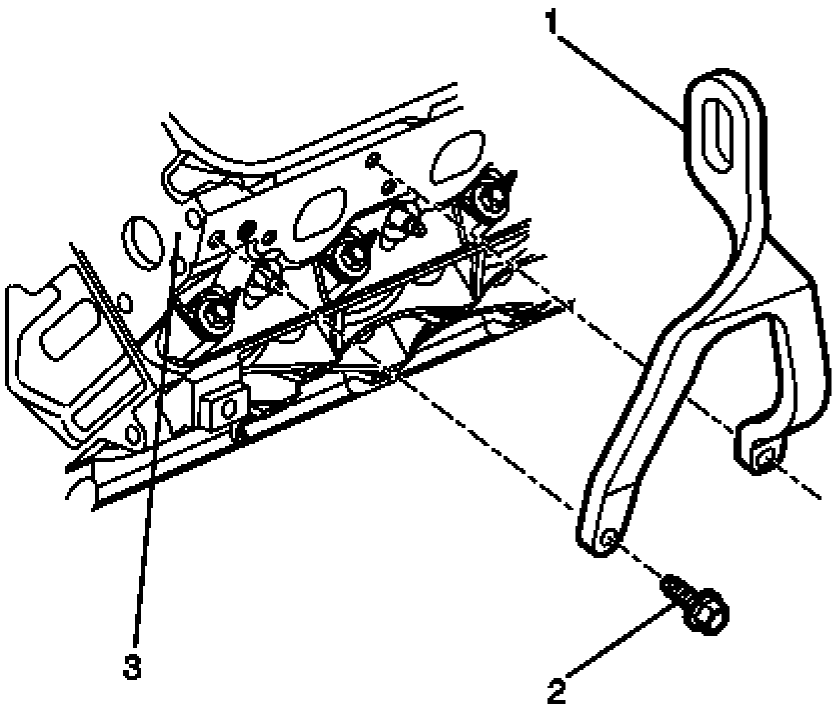


Fig. 216: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

97. Position the **J 41798** (1) on the cylinder head (3). See **Special Tools** .

CAUTION: Refer to Fastener Caution .

98. Install the **J 41798** to cylinder head retaining bolts (2) and tighten to 50 N. See **Special Tools** .m (36 lb ft).
99. Attach a suitable lifting chain and hooks to the engine lifting brackets (1).

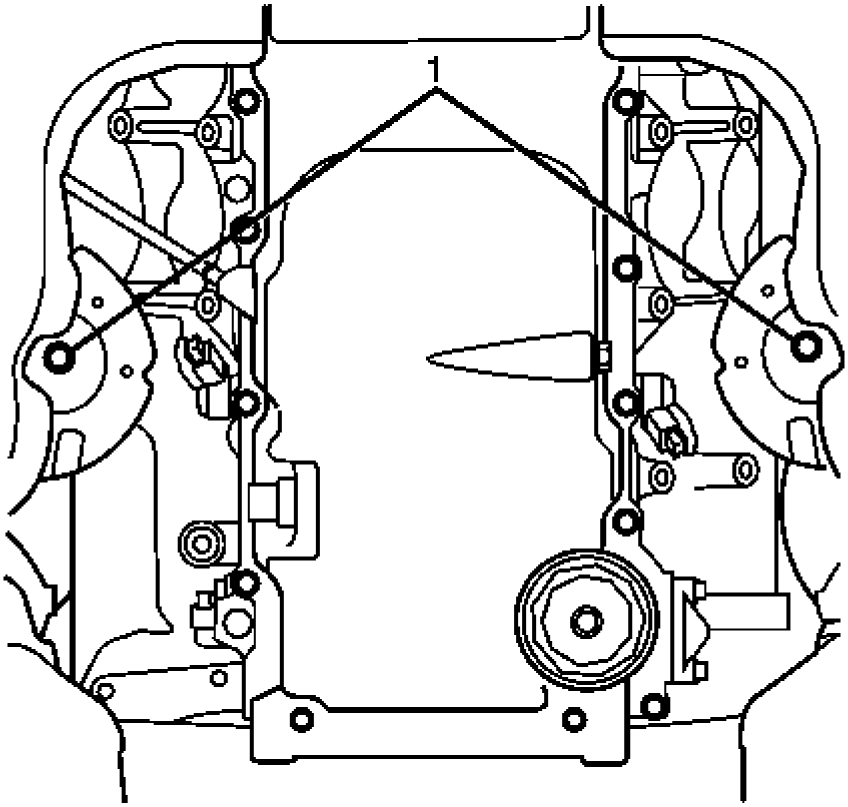


Fig. 217: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

100. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
101. Using a suitable lifting crane, raise the engine to clear the engine mount stud.
102. Remove the engine from the subframe

     If required mount the engine on a suitable engine stand.

103. Remove the left side spark plug leads. Refer to **Spark Plug Wire Replacement** .
104. Remove the left side spark plugs from the cylinder head. Refer to **Spark Plug Replacement** .

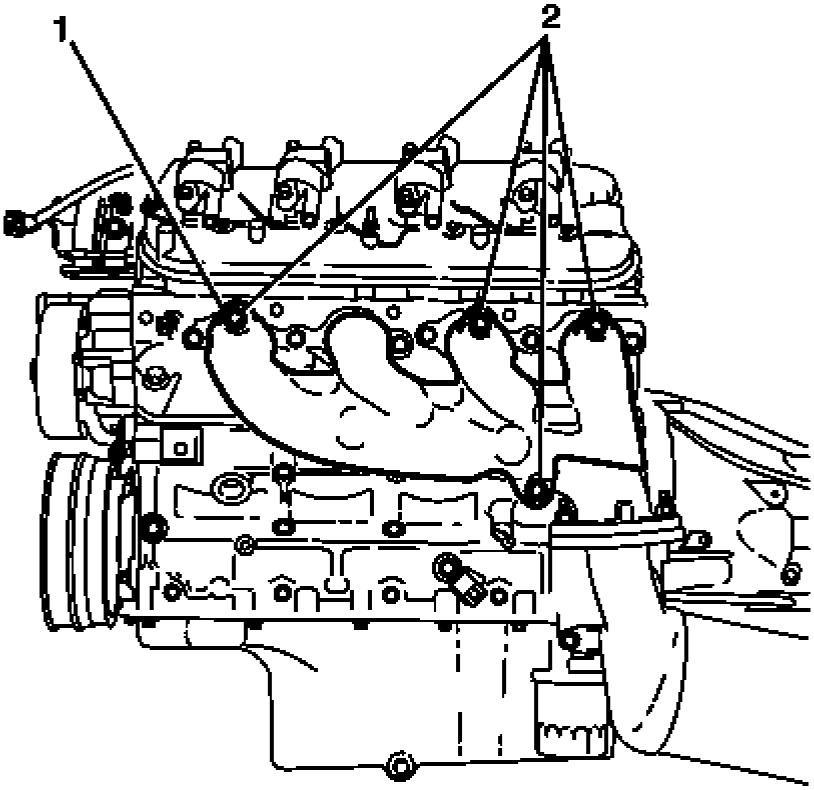


Fig. 218: Identifying Left Side Exhaust Manifold Heat Shield To Left Side Exhaust Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Exhaust Service Warning .

WARNING: Refer to Protective Goggles and Glove Warning .

105. Remove the left side exhaust manifold heat shield to left side exhaust manifold retaining bolts (2).
106. Remove the left side exhaust manifold heat shield (1).

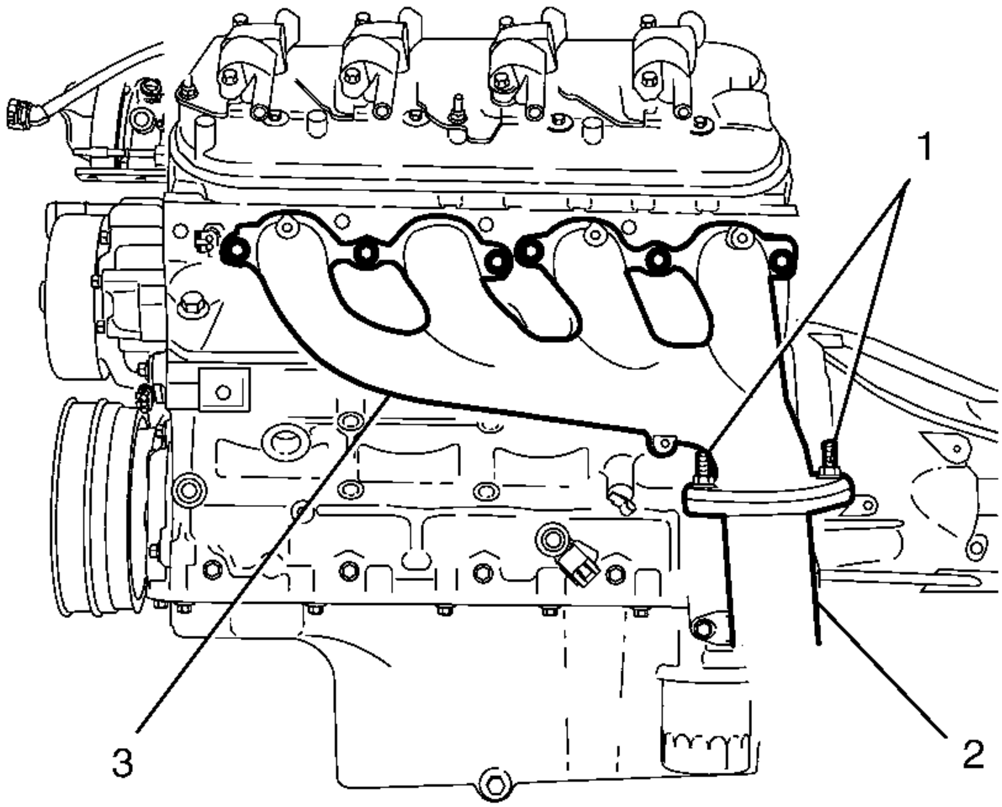


Fig. 219: Identifying Left Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: The left side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

107. Remove the left side catalytic converter to exhaust manifold retaining nuts (1).

     Discard the nuts.

108. Disconnect the left side catalytic converter (2) from the exhaust manifold (3).

     Discard the gasket.

109. Remove the right side spark plug leads. Refer to **Spark Plug Wire Replacement** .
110. Remove the right side spark plugs from the cylinder head. Refer to **Spark Plug Replacement** .

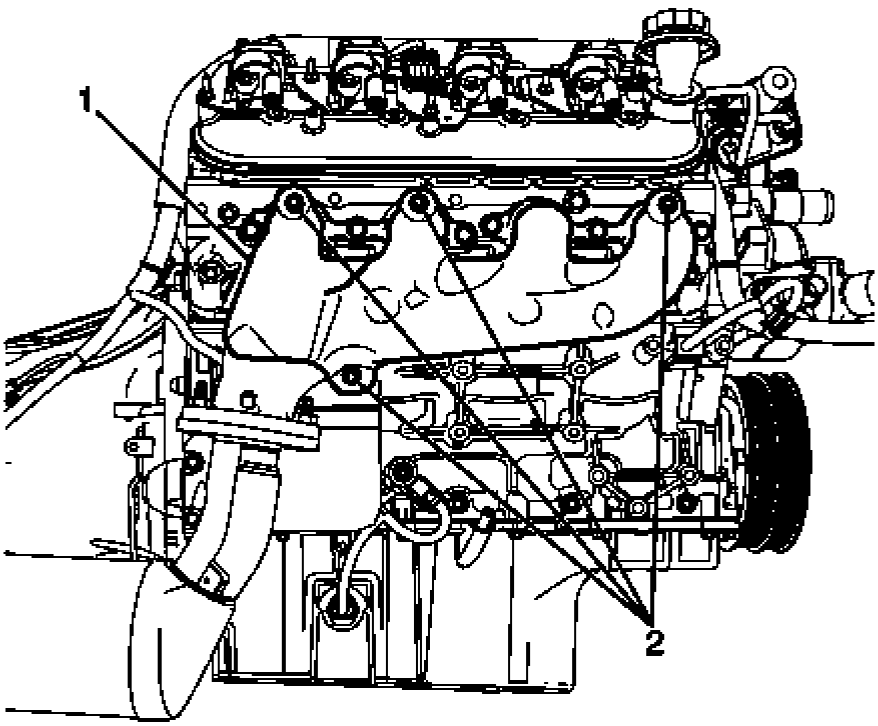


Fig. 220: Identifying Right Side Exhaust Manifold Heat Shield To Right Side Exhaust Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

111. Remove the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2).
112. Remove the right side exhaust manifold heat shield (1).

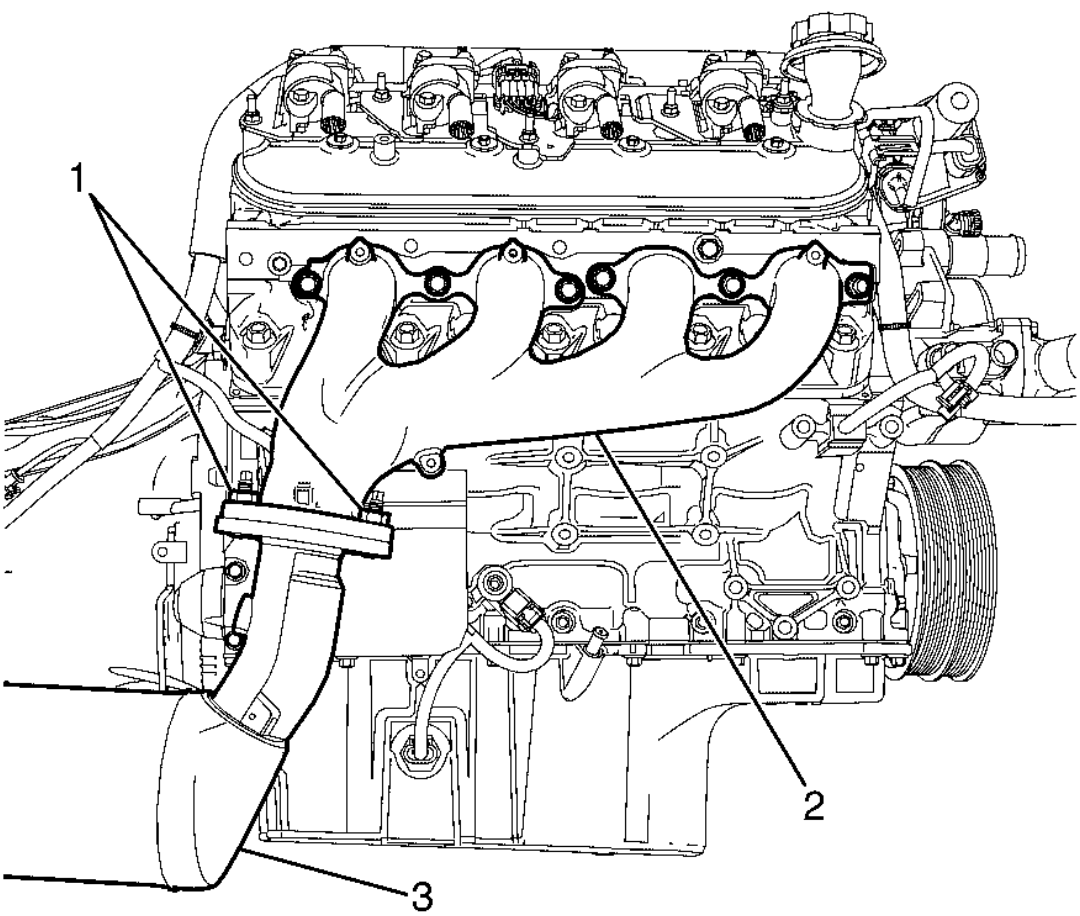


Fig. 221: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: The right side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

113. Remove the right side catalytic converter to exhaust manifold retaining nuts (1).

   Discard the nuts.

114. Disconnect the right side catalytic converter (3) from the exhaust manifold (2).

   Discard the gasket.

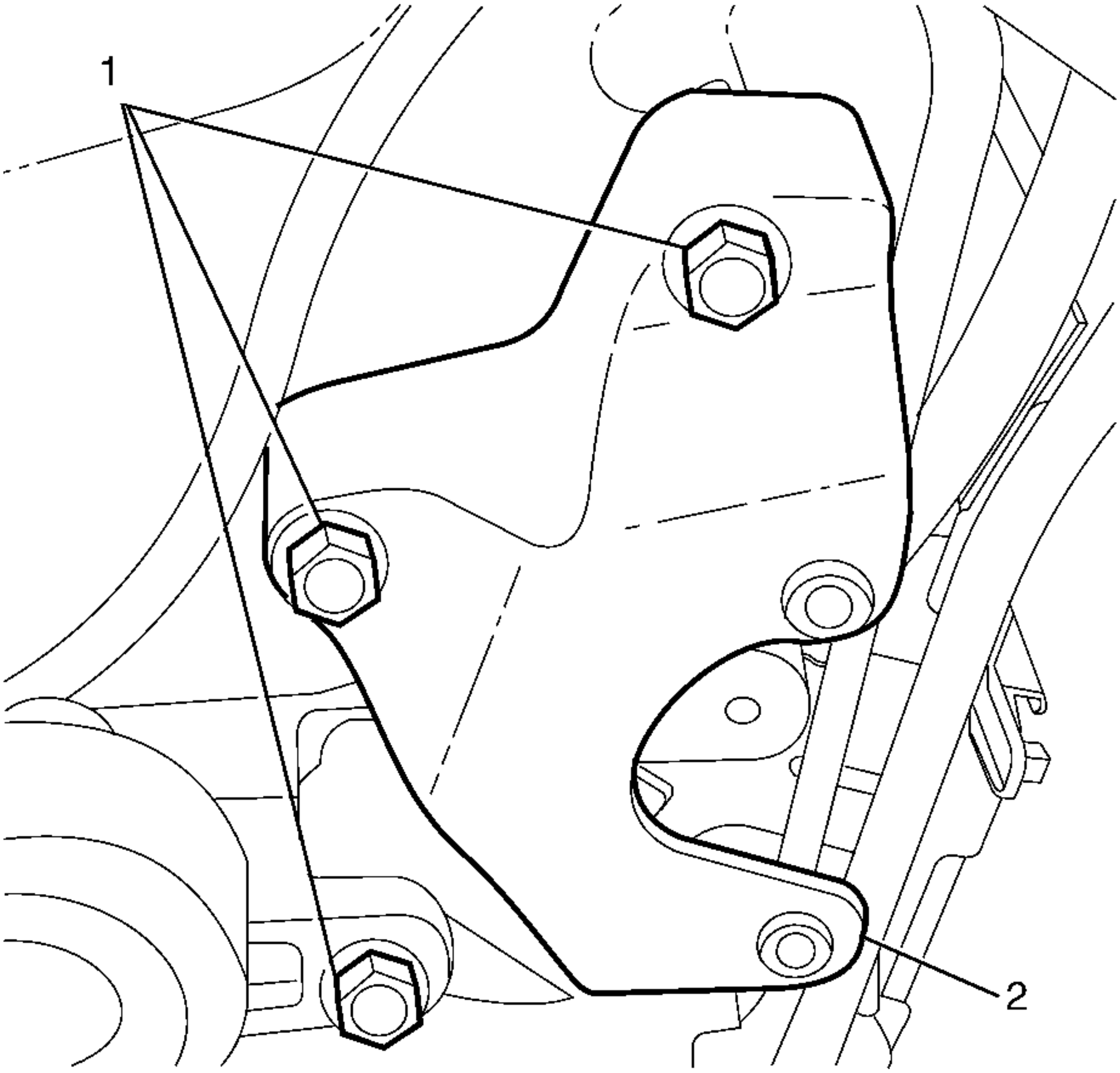


Fig. 222: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

115. Remove the power steering pump bracket to engine retaining bolts (1).
116. Remove the power steering pump bracket (2).

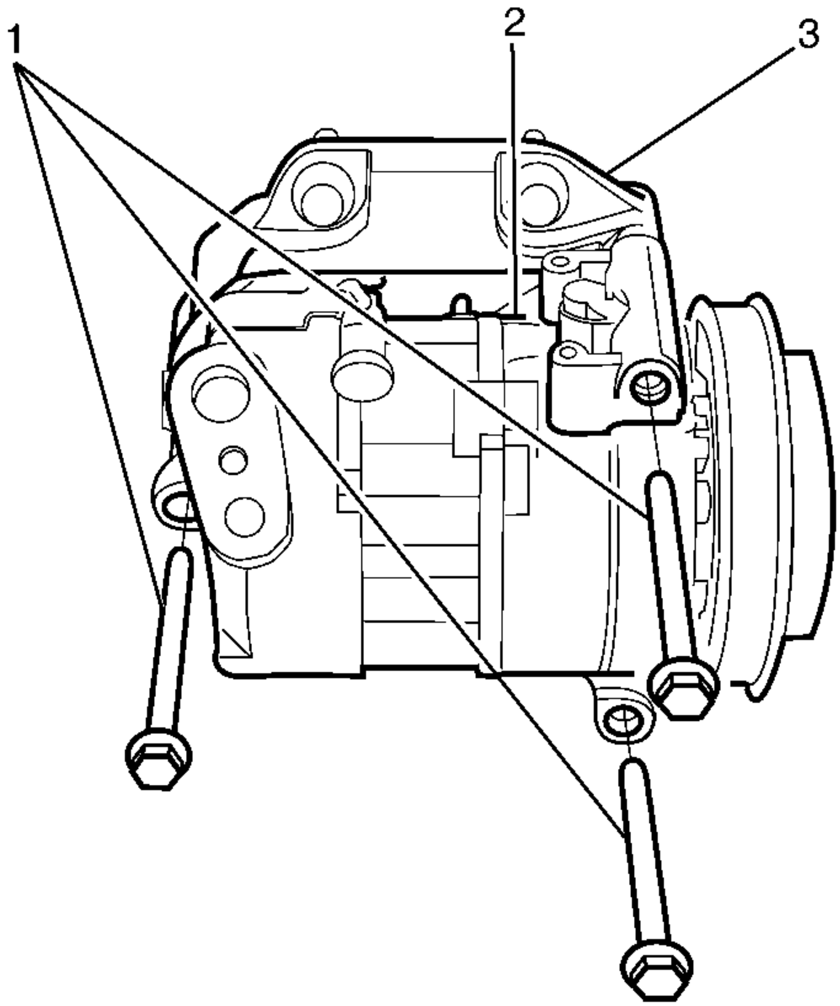


Fig. 223: Identifying A/C Compressor To A/C Compressor Bracket Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

117. Remove the compressor to A/C compressor mounting bracket retaining bolts (1).
118. Remove the compressor (2) to the A/C compressor bracket (3).

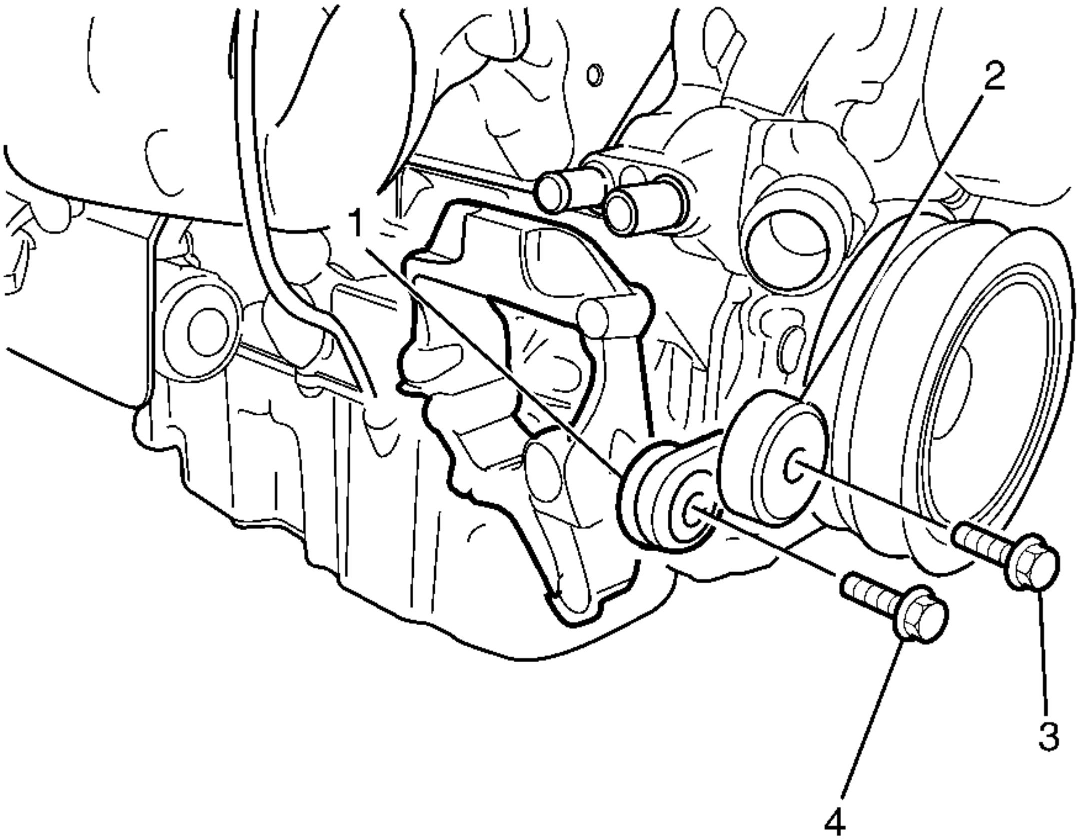


Fig. 224: Identifying A/C Drive Belt Tensioner To A/C Compressor Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

119. Remove the A/C tensioner pulley to A/C tensioner retaining bolt (3).
120. Remove the A/C tensioner pulley (2).
121. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4).
122. Remove the A/C drive belt tensioner (1).

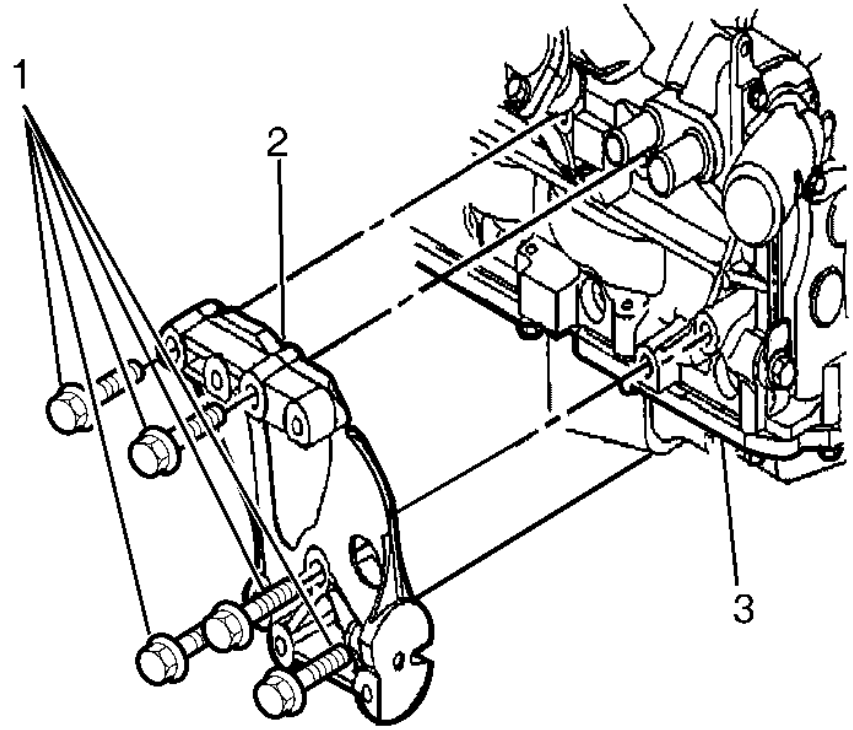


Fig. 225: Identifying A/C Compressor Bracket To Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

123. Remove the A/C compressor bracket to cylinder head retaining bolts (1).
124. Remove the A/C compressor bracket (2).

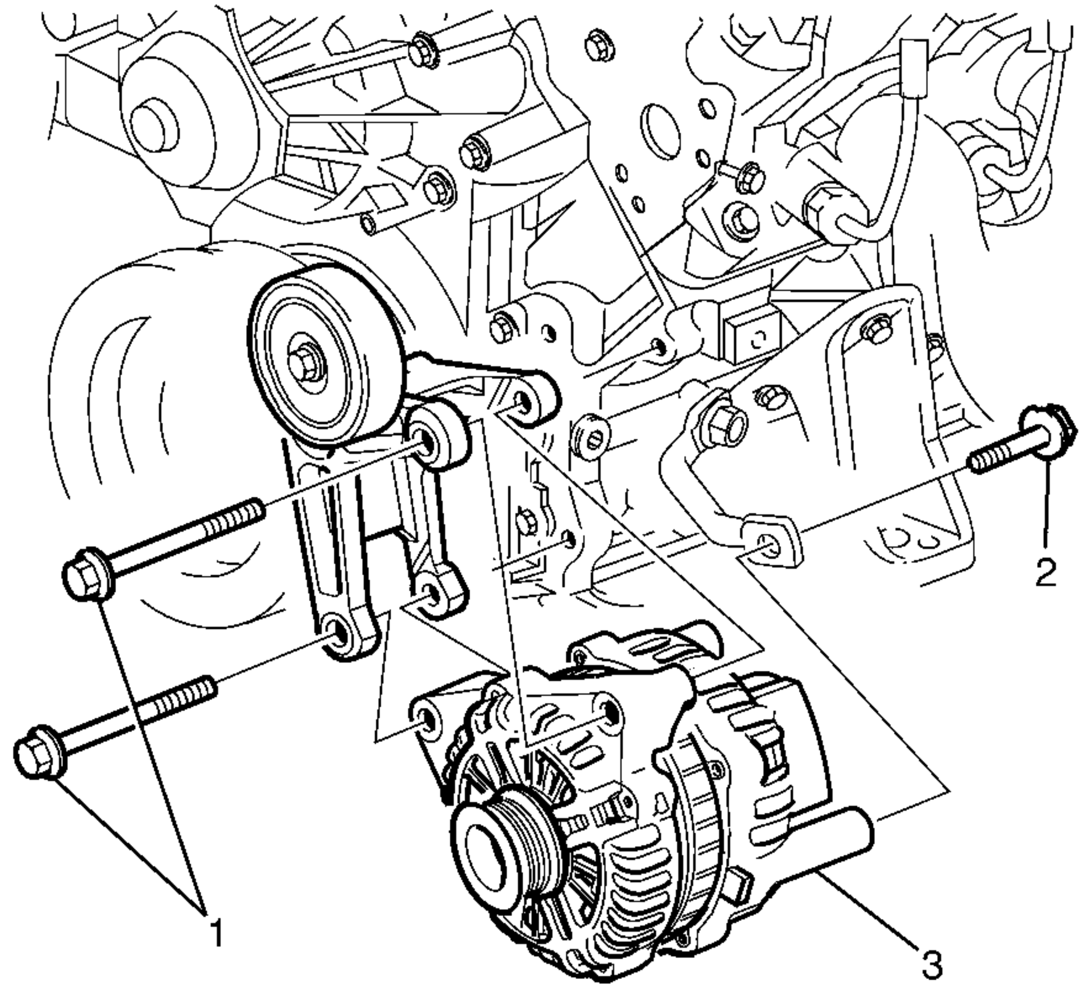


Fig. 226: Identifying Alternator To Alternator Bracket Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

125. Remove alternator to alternator bracket retaining bolts (1 and 2).
126. Remove the alternator (3) from the alternator bracket.

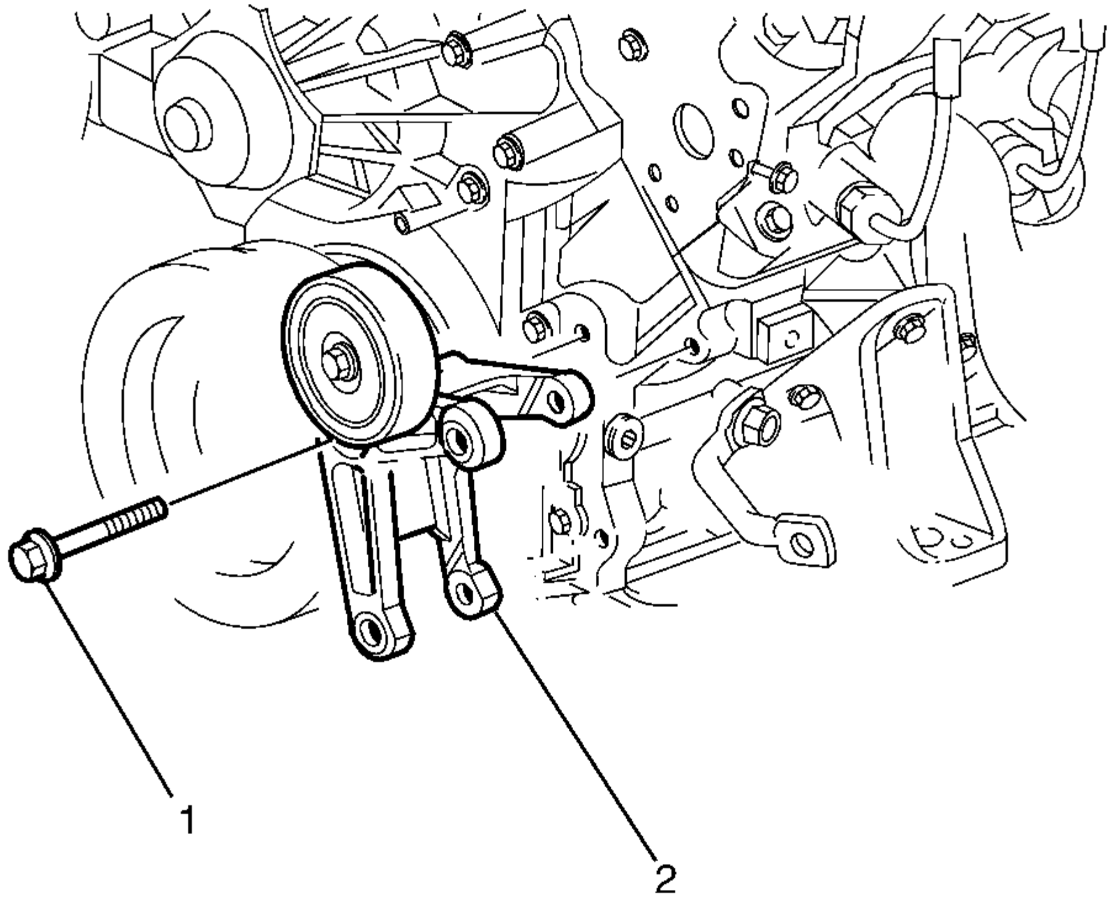


Fig. 227: Identifying Alternator Bracket To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

127. Remove the alternator bracket to engine block retaining bolt (1).
128. Remove the alternator bracket (2) from the engine.

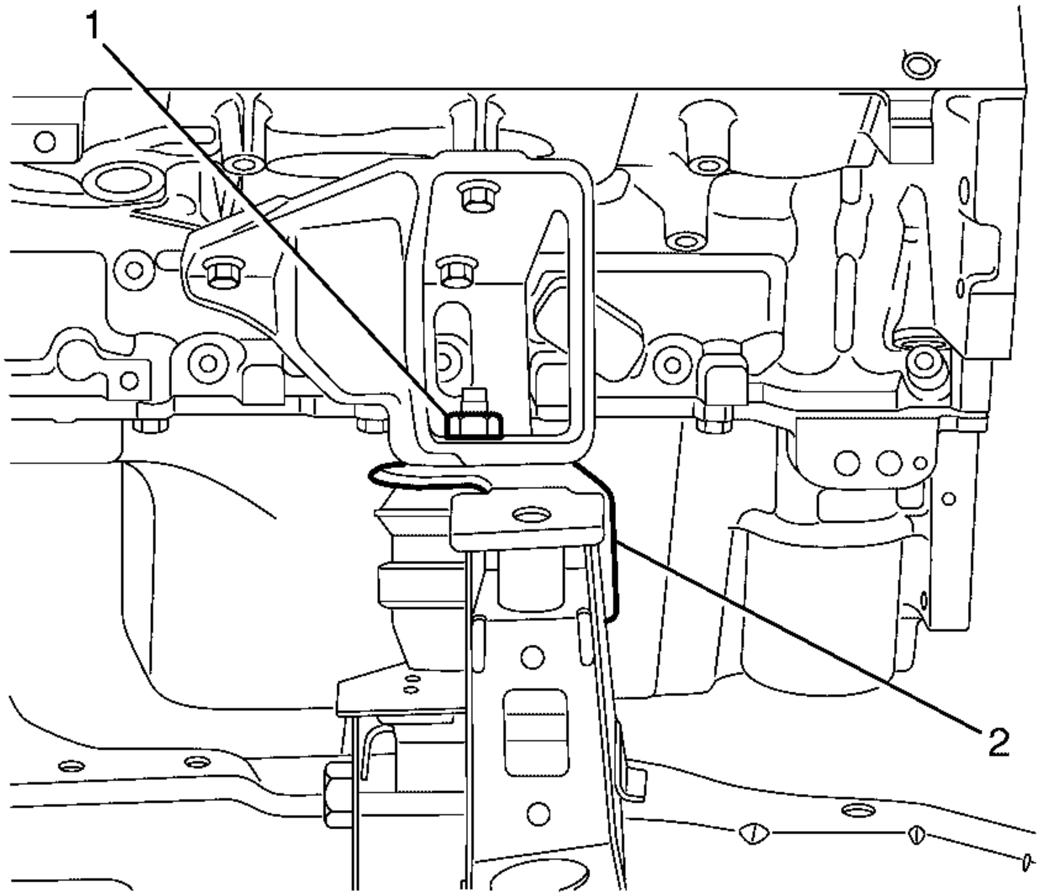


Fig. 228: Identifying Left Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT bend or distort the left side engine mount heat shield (2).

129. Remove the left side engine mount to engine mount bracket retaining nut (1).

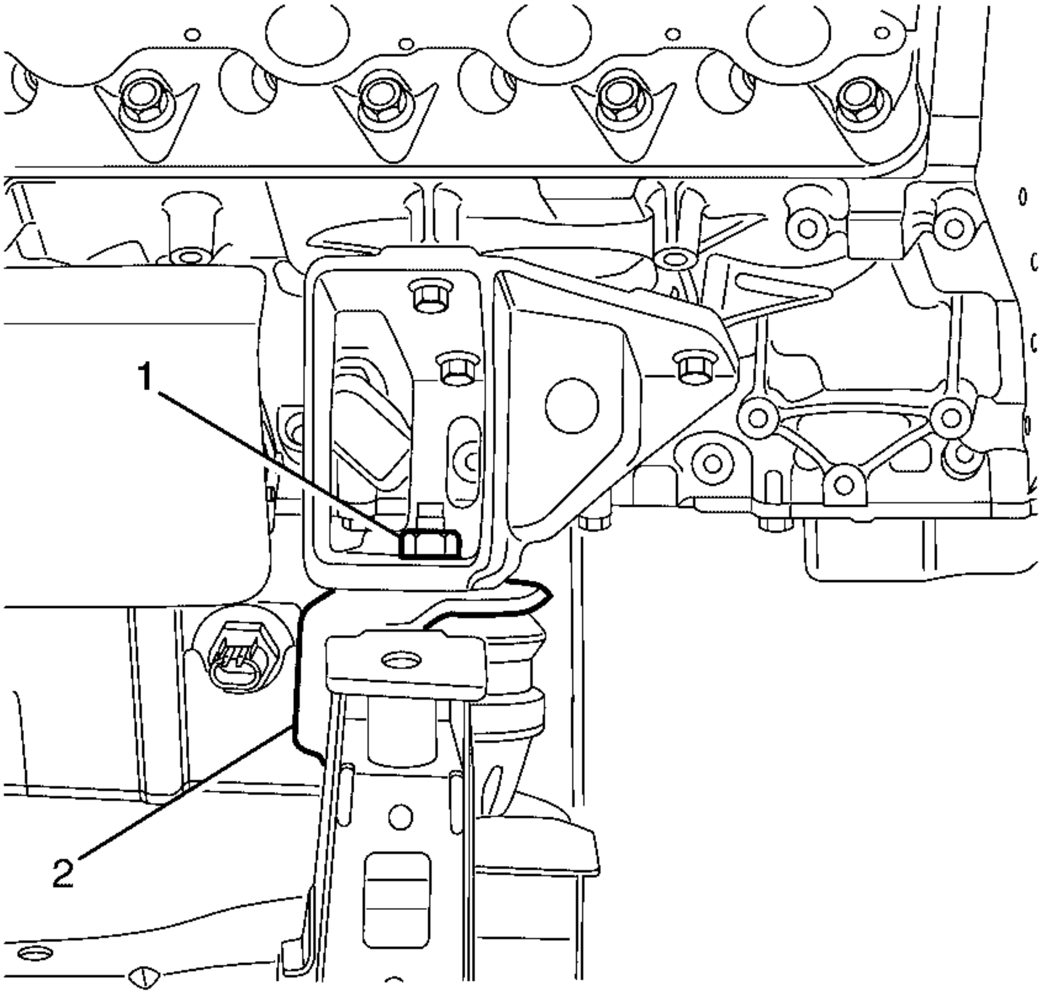


Fig. 229: Identifying Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT bend or distort the left side engine mount heat shield (2).

130. Remove the right side engine mount to engine mount bracket retaining nut (1).
131. Attach a suitable lifting chain and hooks to the 2 **J 41798** , engine lifting brackets. See **Special Tools** .
132. Using a suitable lifting crane, remove the engine from the subframe.

     If required, mount engine to a suitable engine stand.

133. Remove the lifting equipment as required.

Installation Procedure

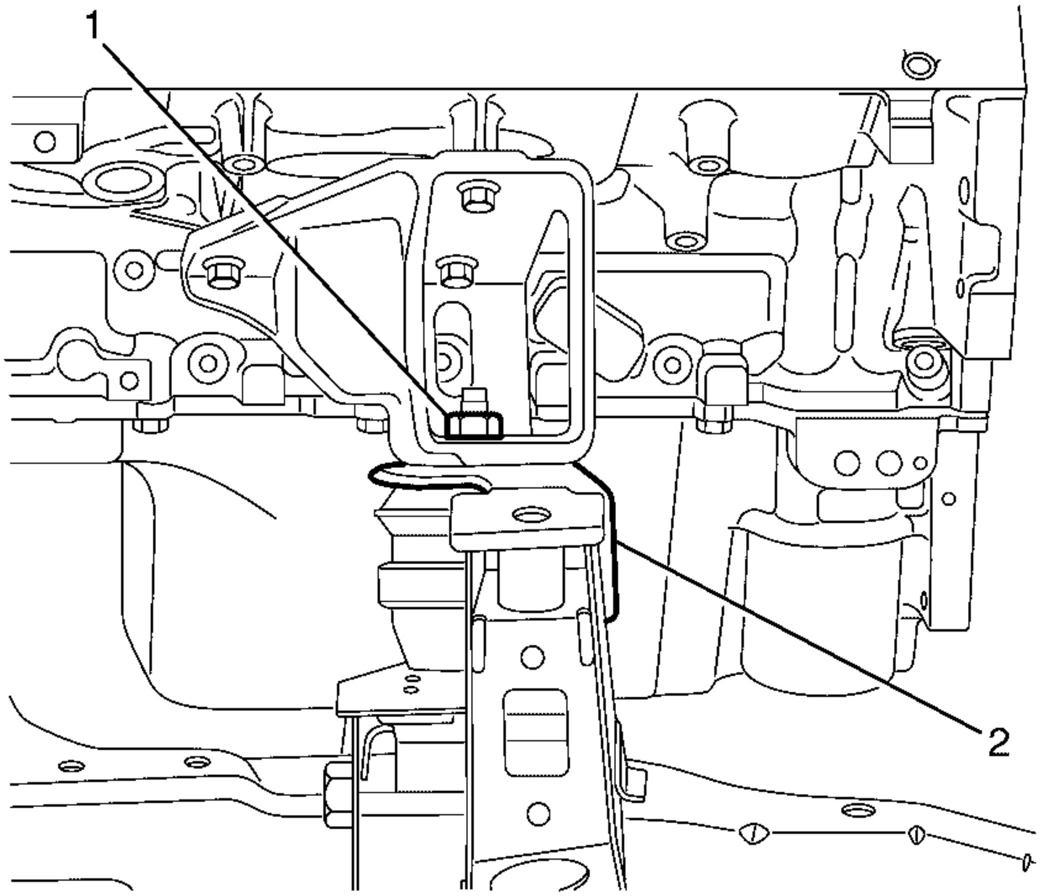


Fig. 230: Identifying Left Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: DO NOT bend or distort the left side engine mount heat shield (2).

1. Install the left side engine mount to engine mount bracket retaining nut (1) and tighten to 80 N.m (59 lb ft).

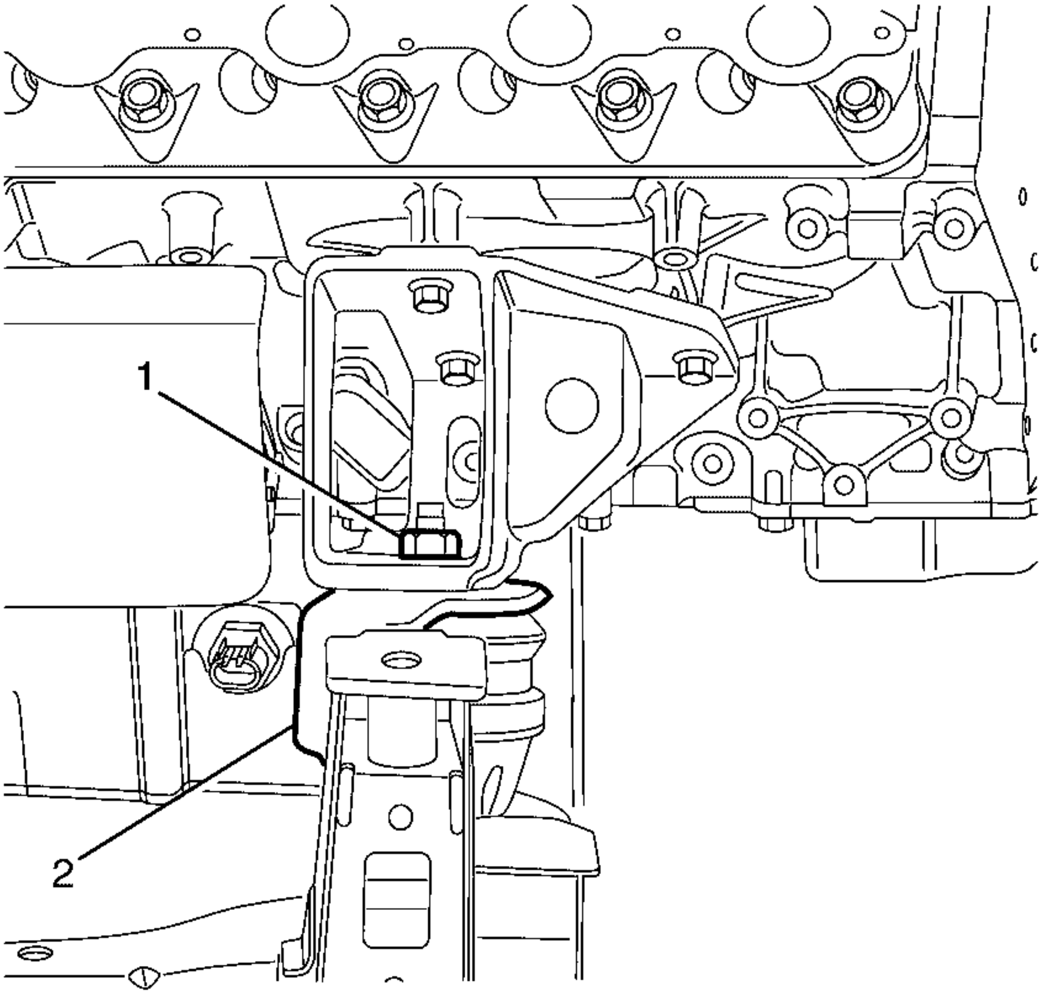


Fig. 231: Identifying Right Side Engine Mount To Engine Mount Bracket Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT bend or distort the right side engine mount heat shield (2).

2. Install the right side engine mount to engine mount bracket retaining nut (1) and tighten to 80 N.m (59 lb ft).
3. Remove the lifting equipment as required and the **J 41798** from the cylinder heads. See **Special Tools** .

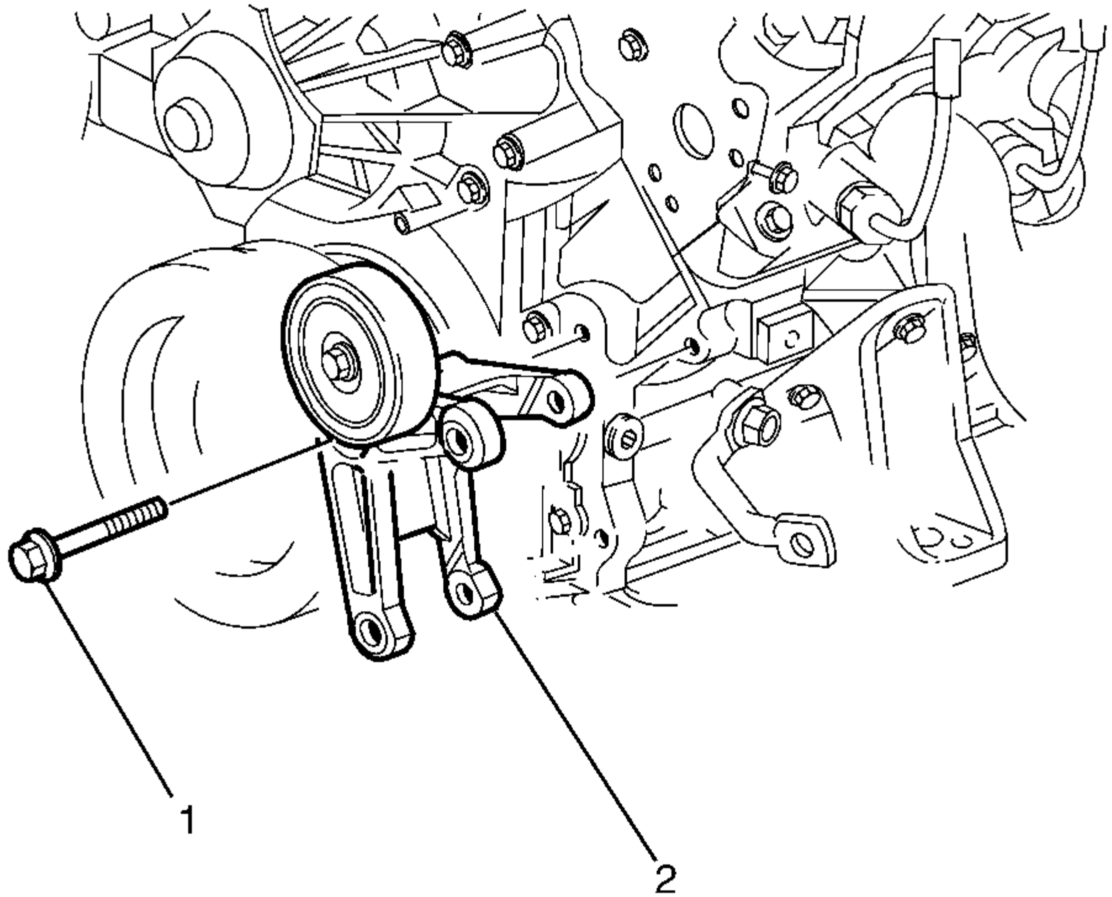


Fig. 232: Identifying Alternator Bracket To Engine Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the alternator bracket (2) to the engine.
5. Install the alternator bracket to engine block retaining bolt (1) and tighten to 50 N.m (37 lb ft).

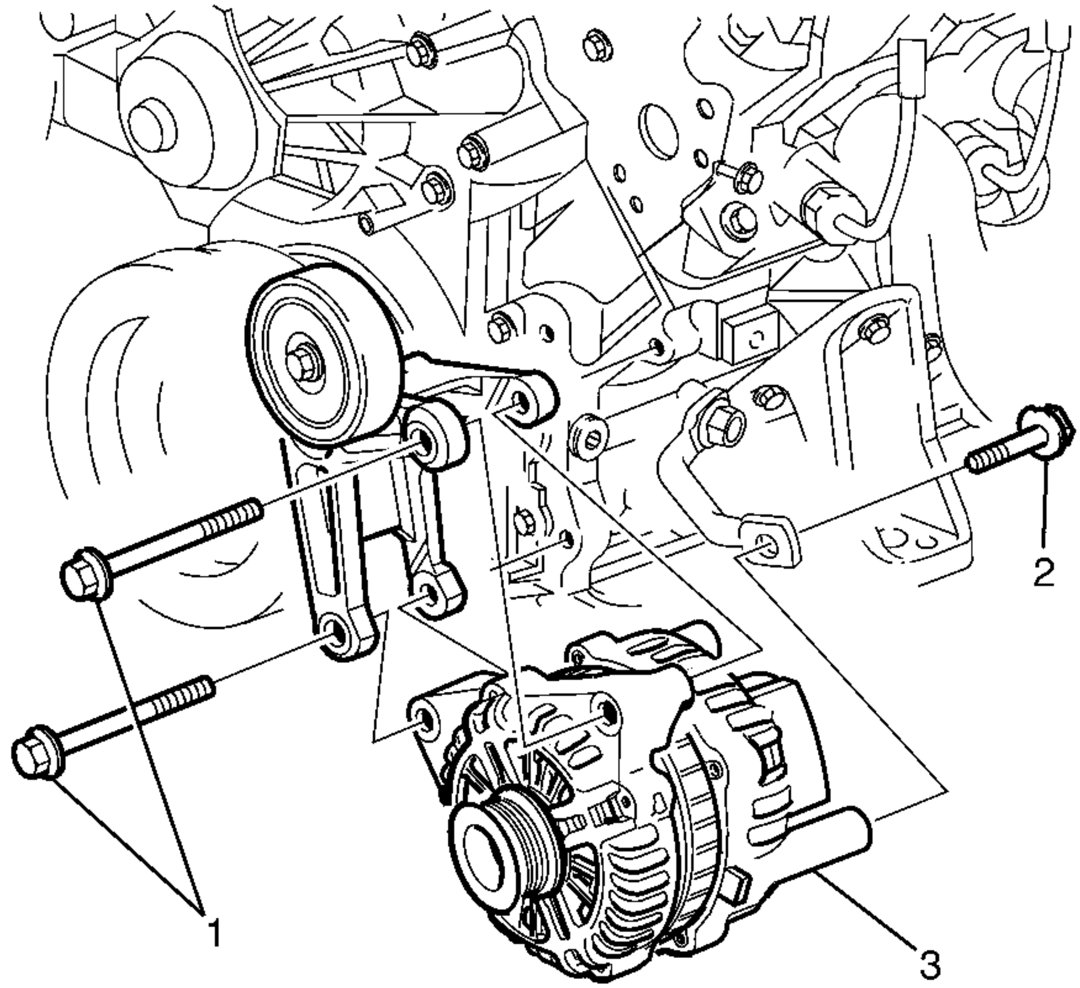


Fig. 233: Identifying Alternator To Alternator Bracket Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the alternator (3) to the alternator bracket.
7. Install alternator to alternator bracket retaining bolts (1 and 2) and tighten to 34 N.m (25 lb in).

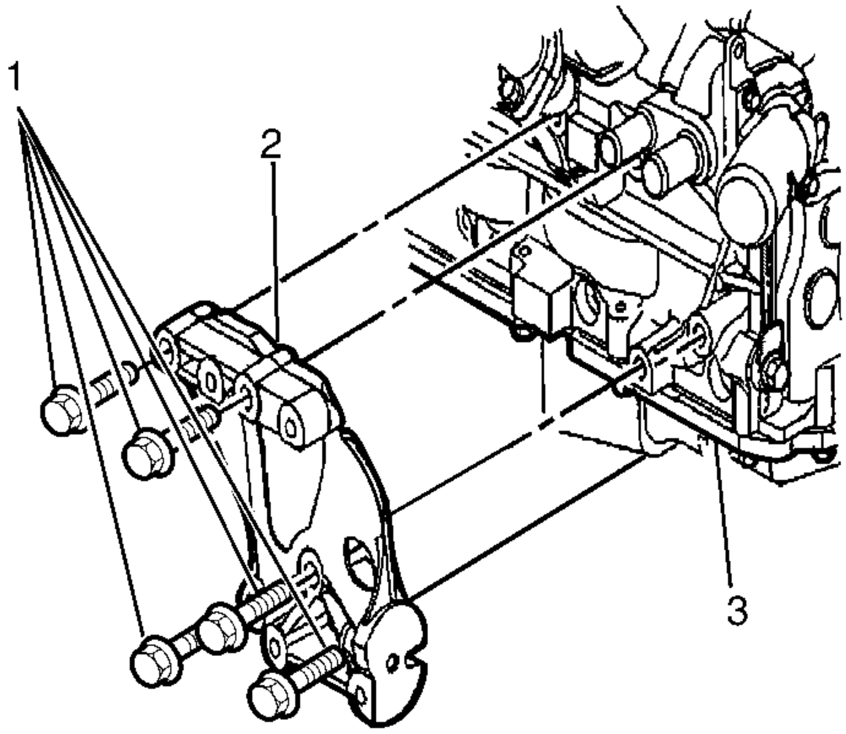


Fig. 234: Identifying A/C Compressor Bracket To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the A/C compressor bracket (2) to the engine.
9. Install the A/C compressor bracket to the cylinder block retaining bolts (1) and tighten to 58 N.m(43 lb ft).

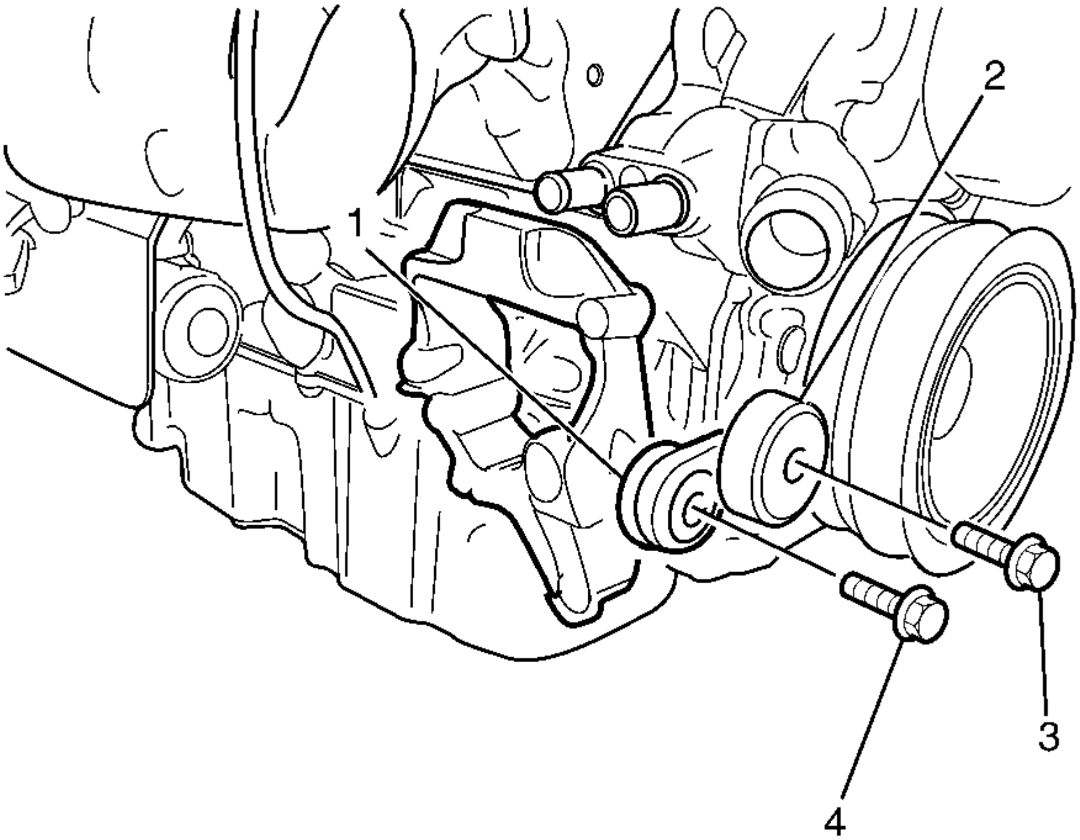


Fig. 235: Identifying A/C Drive Belt Tensioner To A/C Compressor Bracket Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the A/C drive belt tensioner (1) to the engine.
11. Install the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4) and tighten to 22 N.m (16 lb ft).
12. Install the A/C tensioner pulley (2) to the A/C tensioner.
13. Install the A/C tensioner pulley to A/C tensioner retaining bolt (3) and tighten to 50 N.m (37 lb ft).
14. If you are replacing the compressor, balance the compressor oil. Refer to **Air Conditioning Compressor Oil Balancing** .

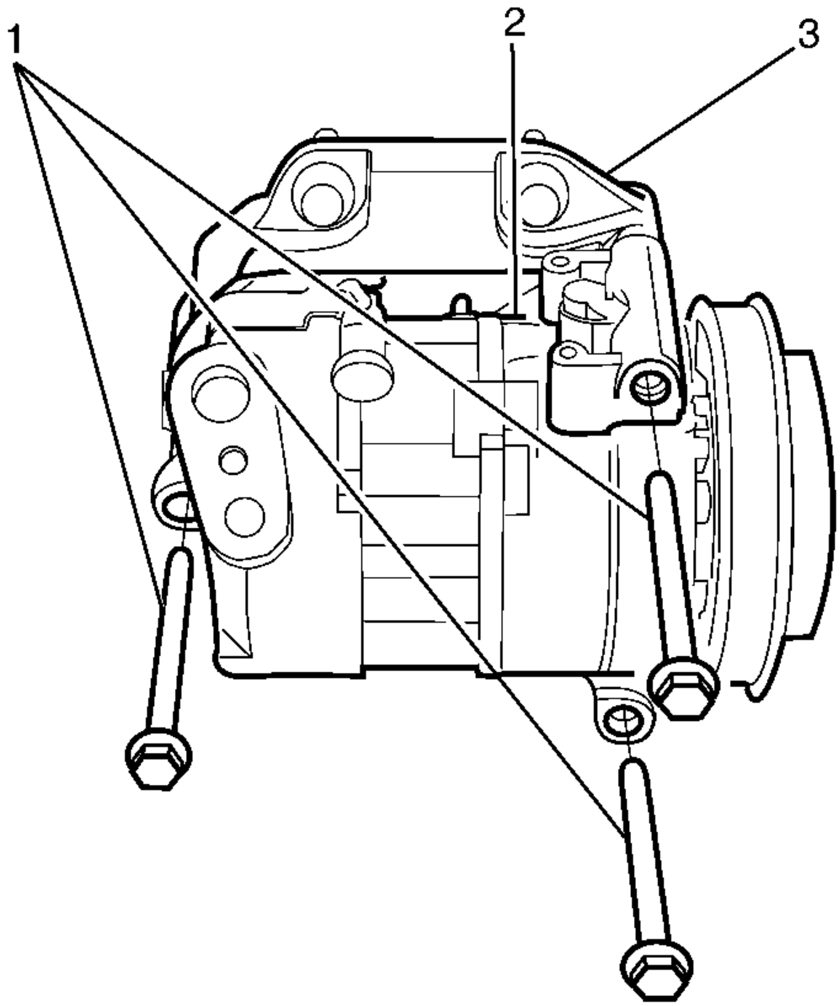


Fig. 236: Identifying A/C Compressor To A/C Compressor Bracket Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

15. Install the A/C compressor (2) to the A/C compressor bracket (3).
16. Install the A/C compressor to A/C compressor bracket retaining bolts (1) and tighten to 22 N.m (16 lb ft).

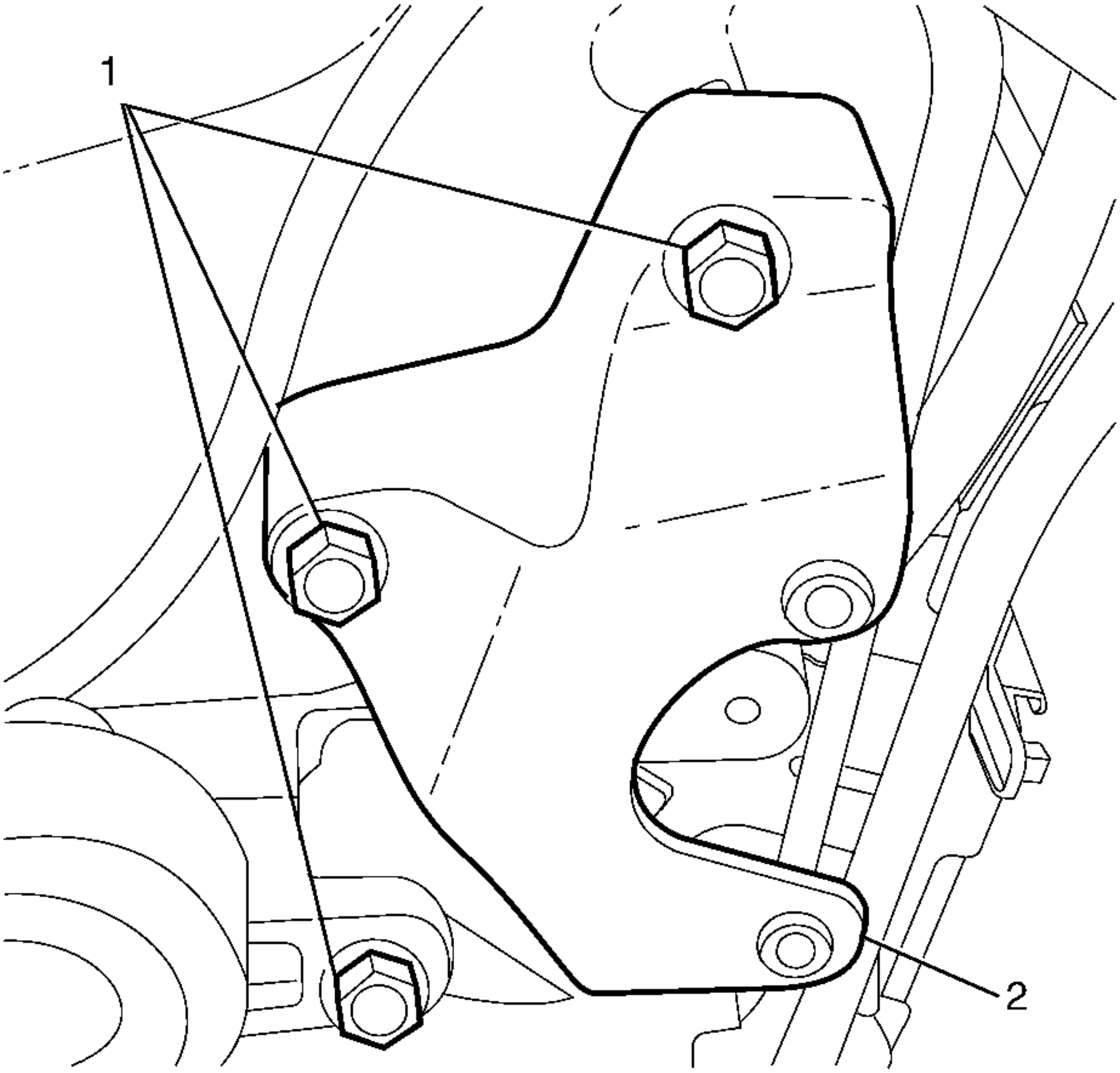


Fig. 237: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

17. Install the power steering pump bracket (2) to the engine.
18. Install the power steering pump bracket to engine retaining bolts (1) and tighten to 58 N.m (43 lb ft).

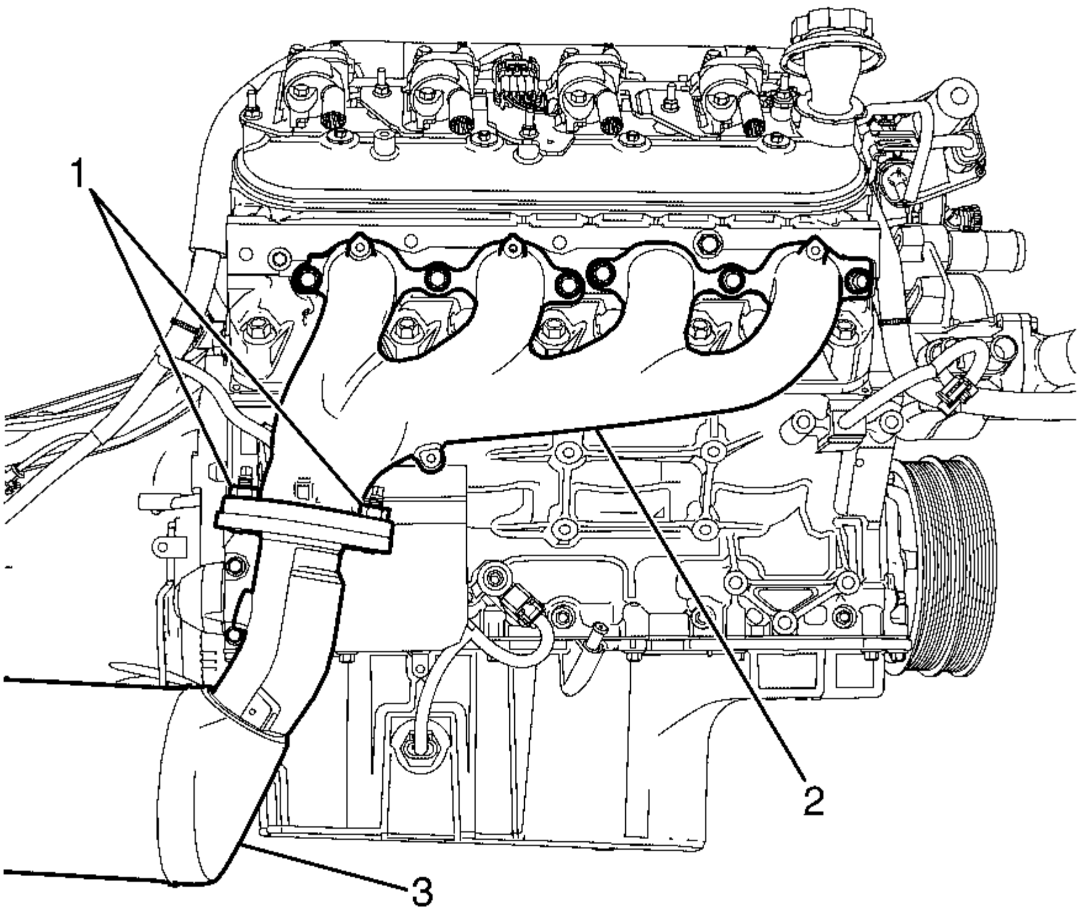


Fig. 238: Identifying Right Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.**

19. Install a NEW sealing ring to the right side catalytic converter.
20. Connect the right side catalytic converter (3) to the right side exhaust manifold (2).
21. Install the right side catalytic converter to right side exhaust manifold retaining nuts (1) and tighten to 45 N.m (33 lb ft).

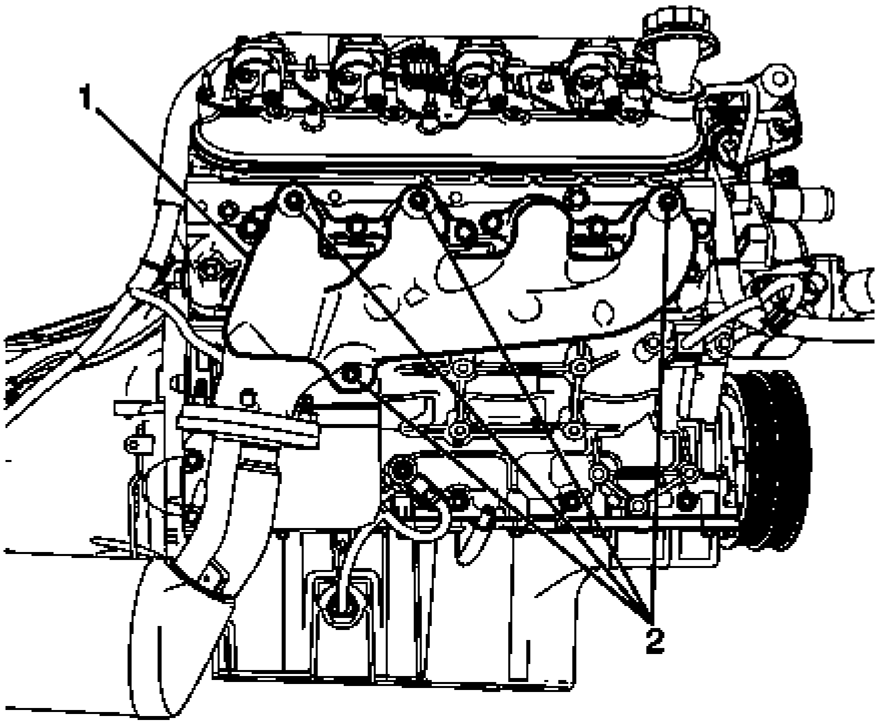


Fig. 239: Identifying Right Side Exhaust Manifold Heat Shield To Right Side Exhaust Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

22. Install the right side exhaust manifold heat shield (1) to the right side exhaust manifold.
23. Install the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2) and tighten to 10 N.m (89 lb in).
24. Install the right side spark plugs to the cylinder head. Refer to **Spark Plug Replacement** .
25. Install the right side spark plug leads. Refer to **Spark Plug Wire Replacement** .

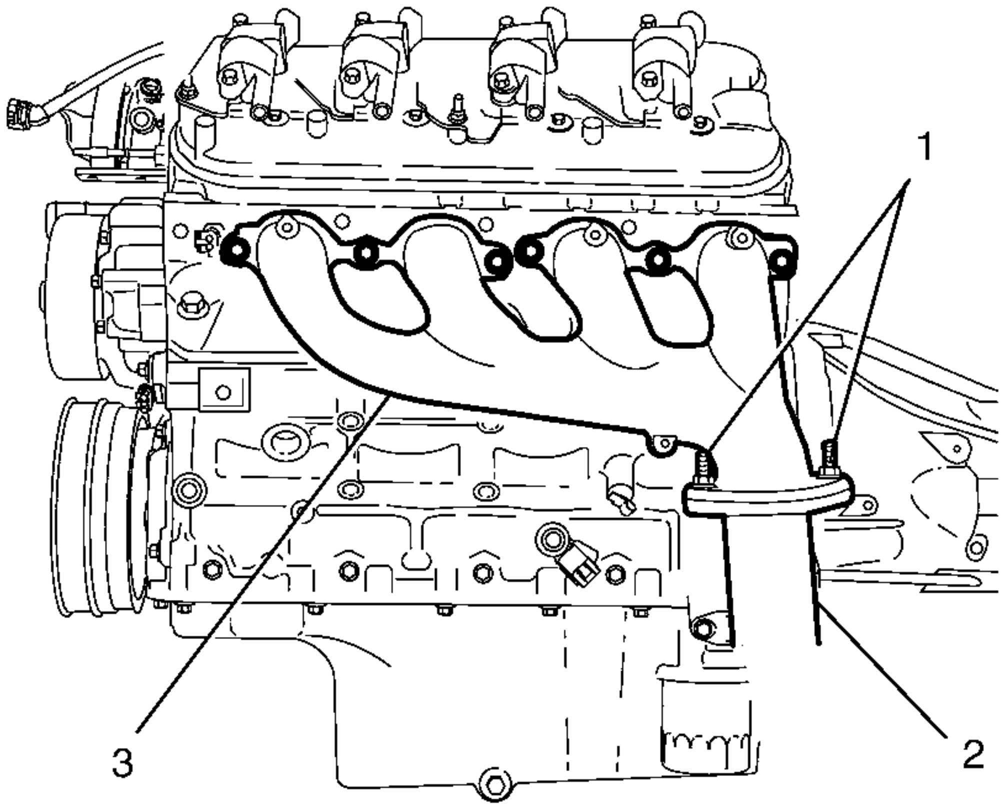


Fig. 240: Identifying Left Side Catalytic Converter To Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.

26. Install a NEW sealing ring to the left side catalytic converter.
27. Connect the left side catalytic converter (2) to the left side exhaust manifold (3).
28. Install the left side catalytic converter to left side exhaust manifold retaining nuts (1) and tighten to 45 N.m (33 lb ft).

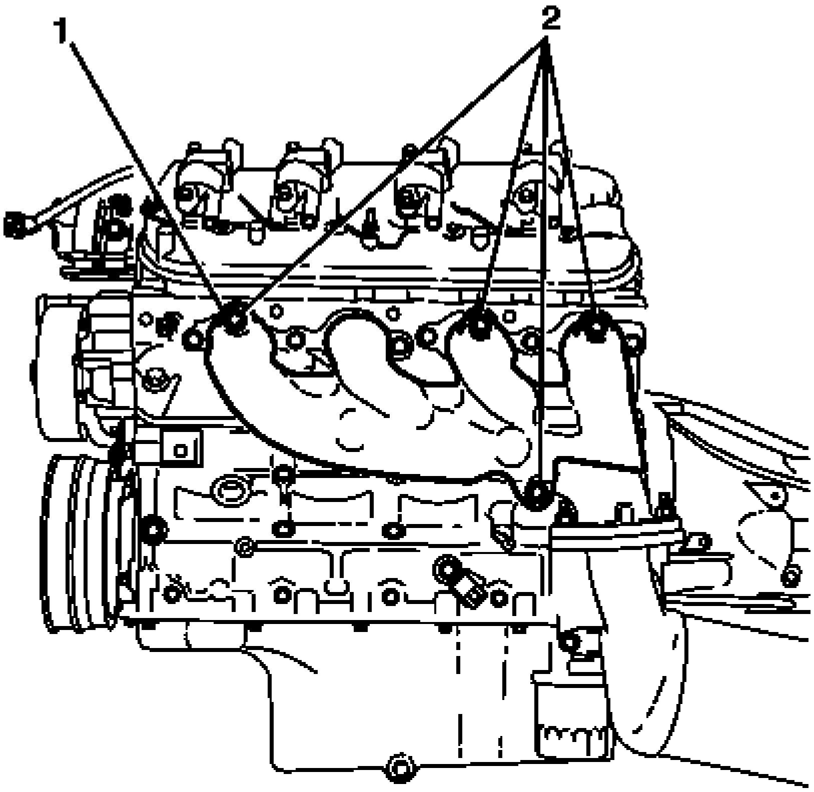


Fig. 241: Identifying Left Side Exhaust Manifold Heat Shield To Left Side Exhaust Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

29. Install the left side exhaust manifold heat shield (1) to the left side exhaust manifold.
30. Install the left side exhaust manifold heat shield to left side exhaust manifold retaining bolts (2) and tighten to 10 N.m (89 lb in).
31. Install the left side spark plugs to the cylinder head. Refer to **Spark Plug Replacement** .
32. Install the left side spark plug leads. Refer to **Spark Plug Wire Replacement**

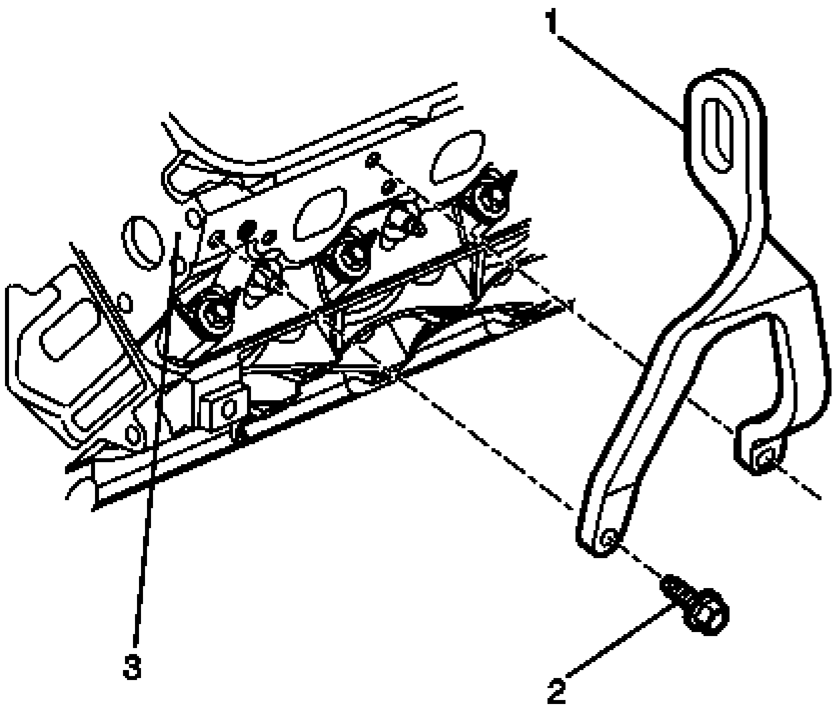


Fig. 242: View Of EN 46114, Cylinder Head & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

33. Position the **J 41798** (1) on the cylinder heads (3). See **Special Tools** .
34. Install the **J 41798** to cylinder head retaining bolts (2) and tighten to 50 N. See **Special Tools** .m (36 lb ft).
35. Using a suitable lifting crane and the **J 41798** raise the engine slightly. See **Special Tools** .
36. Remove the engine from the engine stand.
37. Lower the engine onto the front subframe.
38. Position the engine mounts to the front subframe.

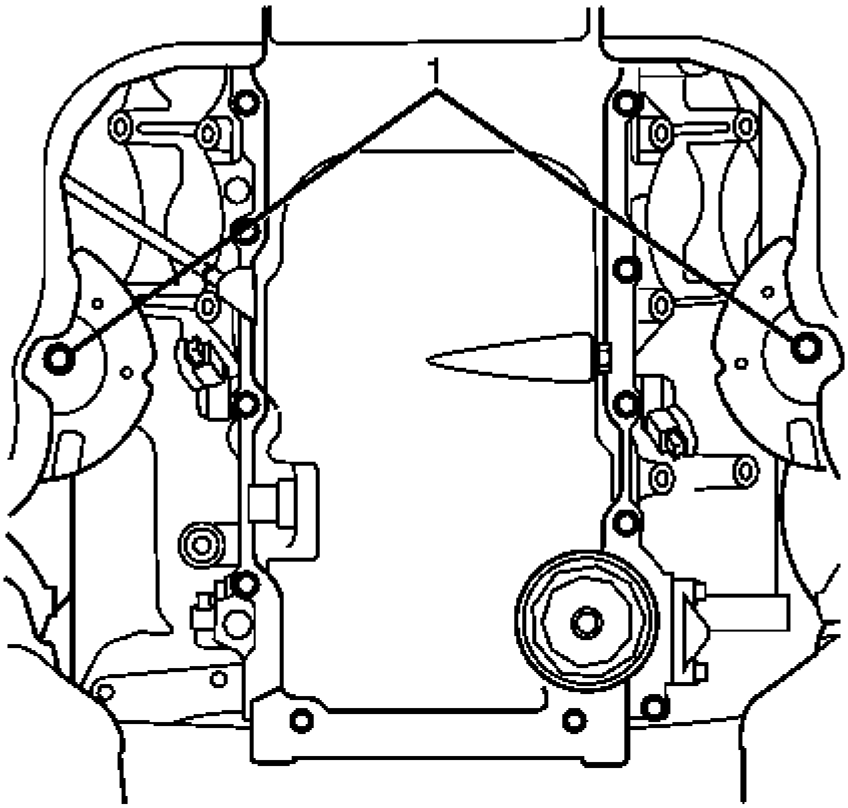


Fig. 243: Identifying Lower Engine Mount To Front Subframe Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

39. Install the lower engine mount to front subframe retaining nuts (1) on both engine mounts and tighten to 80 N.m (59 lb ft).

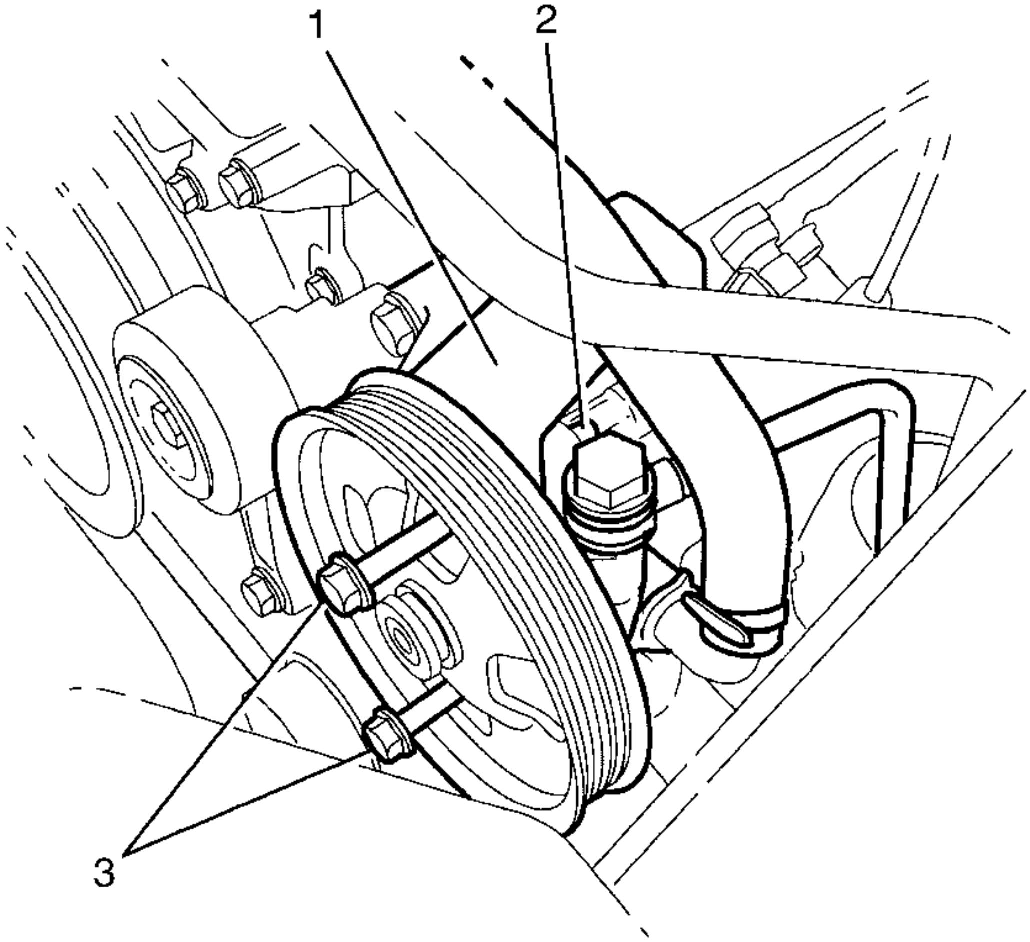


Fig. 244: Identifying Power Steering Pump, Bracket & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

40. Position the power steering pump (2) to the power steering pump bracket (1).
41. Install NEW power steering pump to power steering pump bracket retaining bolts (3) and tighten to 30 N.m (23 lb ft).

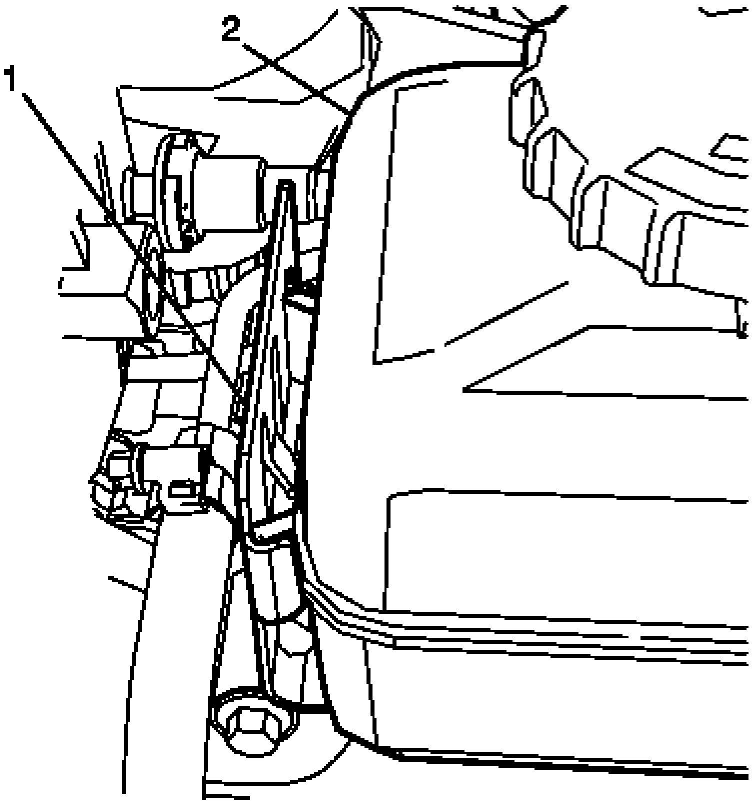


Fig. 245: Identifying Power Steering Reservoir & Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure the power steering reservoir (2) and the power steering reservoir bracket locking tang (1) are engaged to avoid an induced rattle condition.

42. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).
43. Install the A/C drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
44. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
45. Install the engine flywheel. Refer to **Engine Flywheel Installation** .
46. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.
47. Install the transmission. Refer to **Transmission Replacement** .

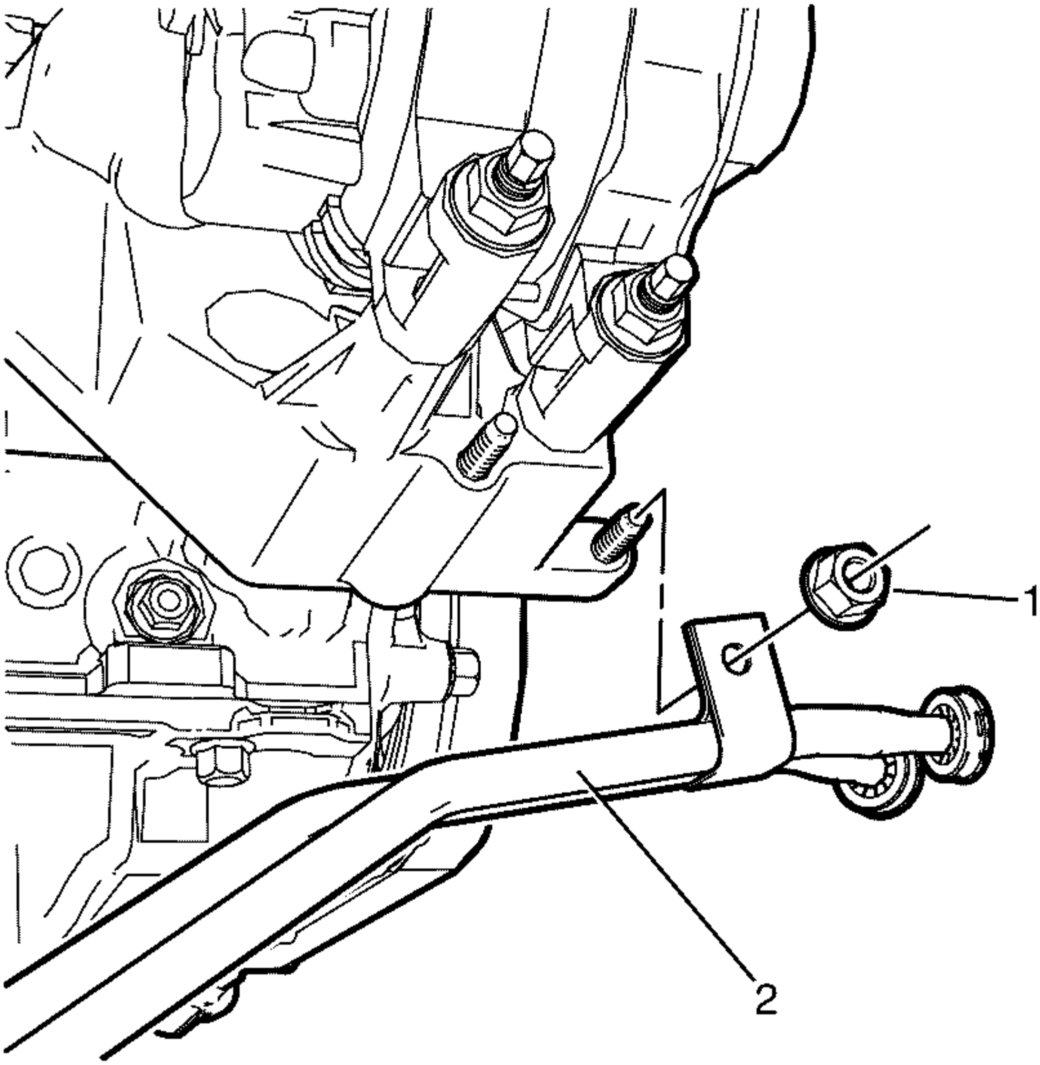


Fig. 246: Identifying A/T Cooler Pipe Clamp To A/C Bracket Nut
Courtesy of GENERAL MOTORS CORP.

48. Position the automatic transmission cooler pipes (2) to the engine.
49. Install the automatic transmission cooler pipe clamp to A/C bracket retaining nut (1) and tighten to 22 N.m (16 lb ft).
50. Install the engine and transmission wiring harness and related components. Refer to **Engine Wiring Harness Assembly Removal** .

NOTE:	**Make sure that all the hoses, wires, pipes and shock modules clear the vehicle during the installation process.**

51. With the aid of an assistant, raise the table and/or lower the vehicle to install the engine, transmission, front suspension and subframe assembly to the vehicle.

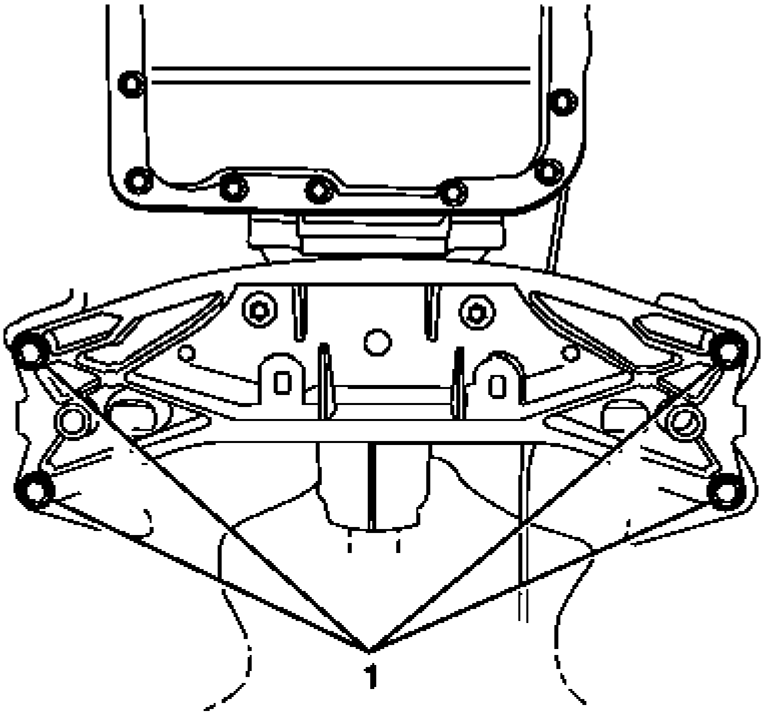


Fig. 247: Identifying Transmission Support To Body Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

52. Install the transmission support to body retaining bolts (1) and tighten to 58 N.m (42 lb ft).

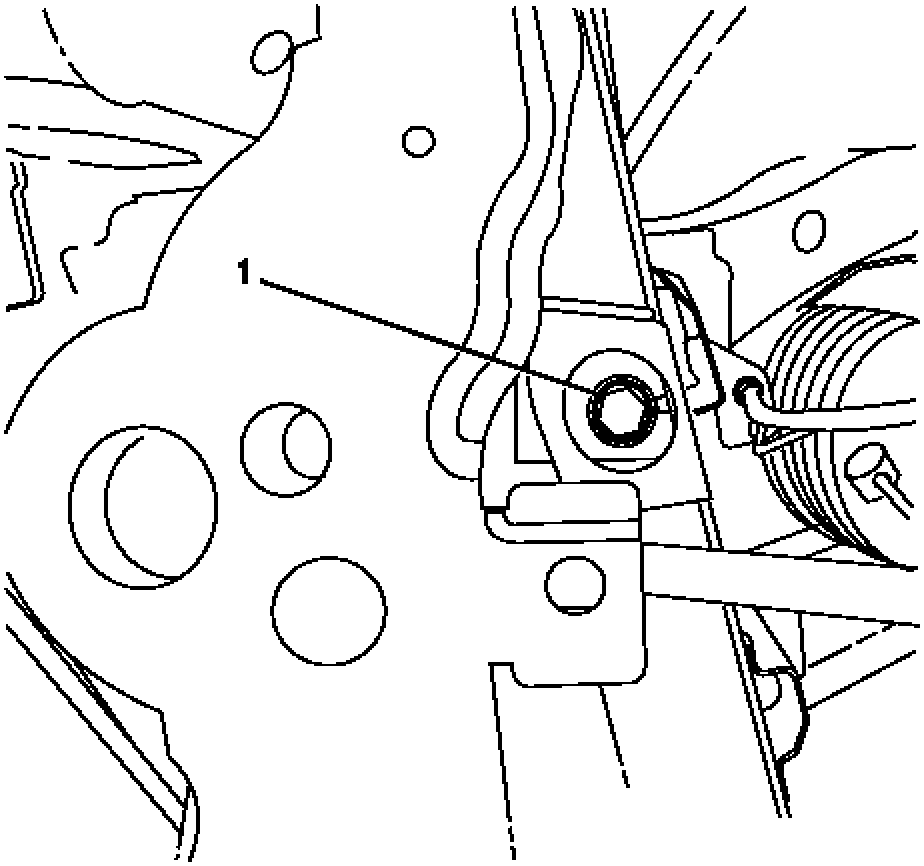


Fig. 248: Identifying Subframe To Body Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

53. Install the front subframe to body centre retaining bolt (1) and tighten to 160 N.m (118 lb ft). Repeat for opposite side.

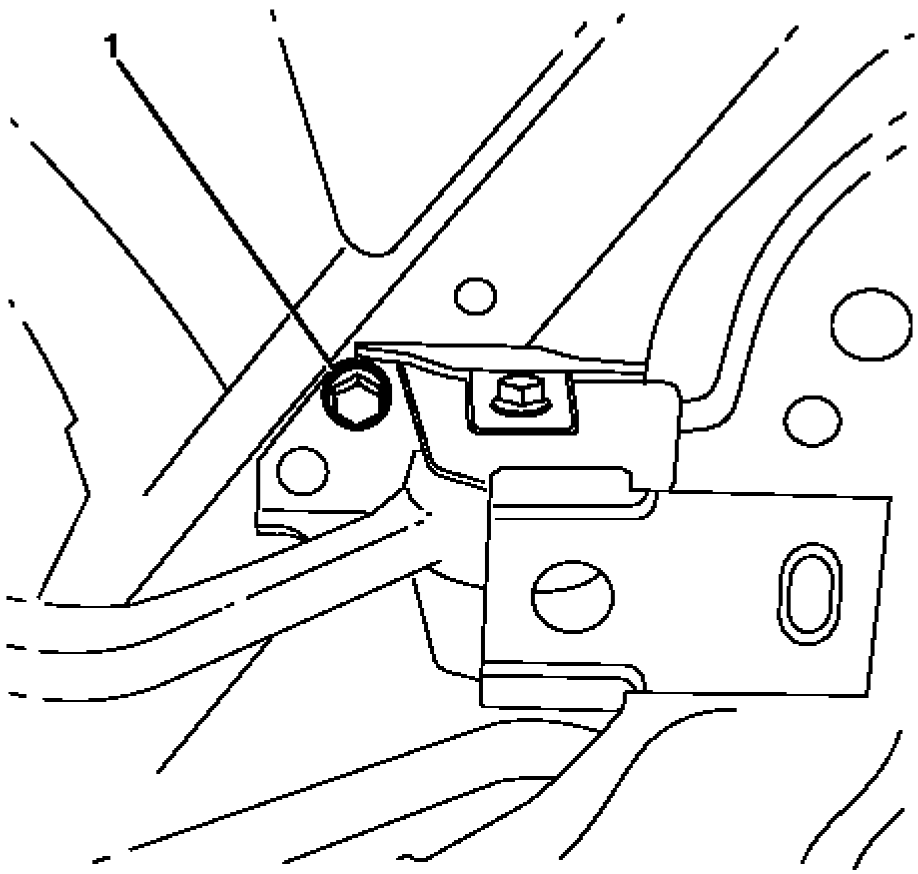


Fig. 249: Identifying Subframe To Body Front Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

54. Install the front subframe to body front retaining bolt (1) and tighten to 160 N.m (118 lb ft). Repeat for opposite side.

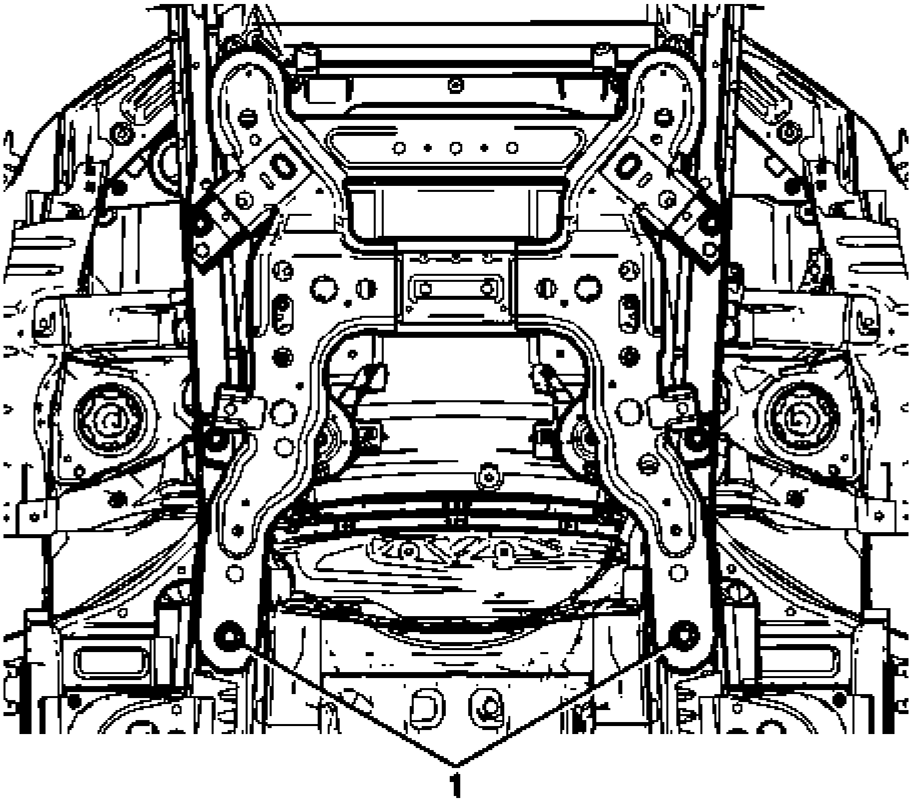


Fig. 250: Identifying Subframe To Body Rear Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

55. Install the front subframe to body rear retaining bolts (1) and tighten to 240 N.m (178 lb ft).

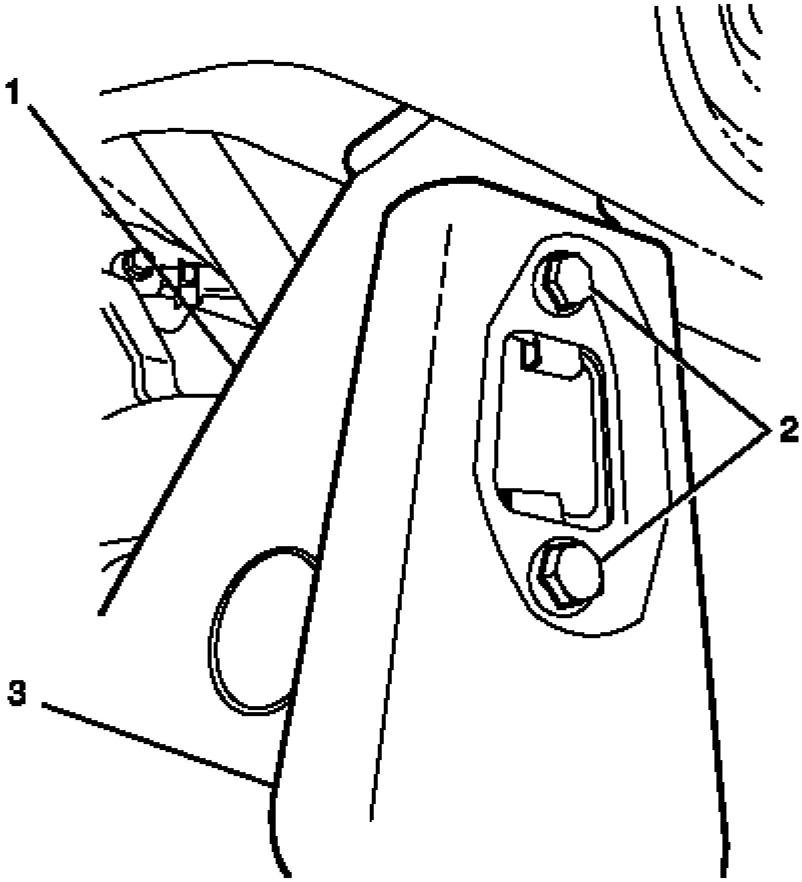


Fig. 251: Identifying Subframe Reinforcement Plate To Subframe Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

56. Install the front subframe reinforcement plate (3) to the subframe (1).
57. Install the front subframe reinforcement plate to front subframe retaining bolts (2) and tighten to 17 N.m (11 lb ft).
58. Lower the lift table and/or raise the vehicle to remove the support from the frame, engine and transmission.
59. Remove the powertrain and/or engine lift table from the frame, engine and transmission.
60. Lower the vehicle.

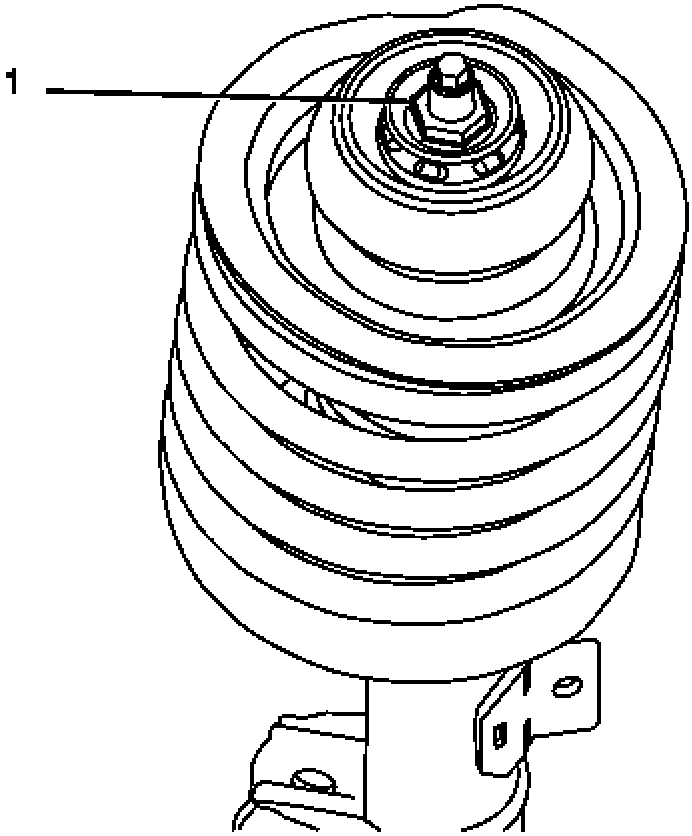


Fig. 252: Identifying Strut Assembly Retaining Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: **The strut assembly retaining nut (1) must be checked for correct torque before installing the strut assembly into the vehicle. The strut assembly retaining nut torque must be 75 N.m (55 lb ft)).**

61. Check the torque of the strut assembly retaining nut (1), correct if necessary. Repeat for opposite side.

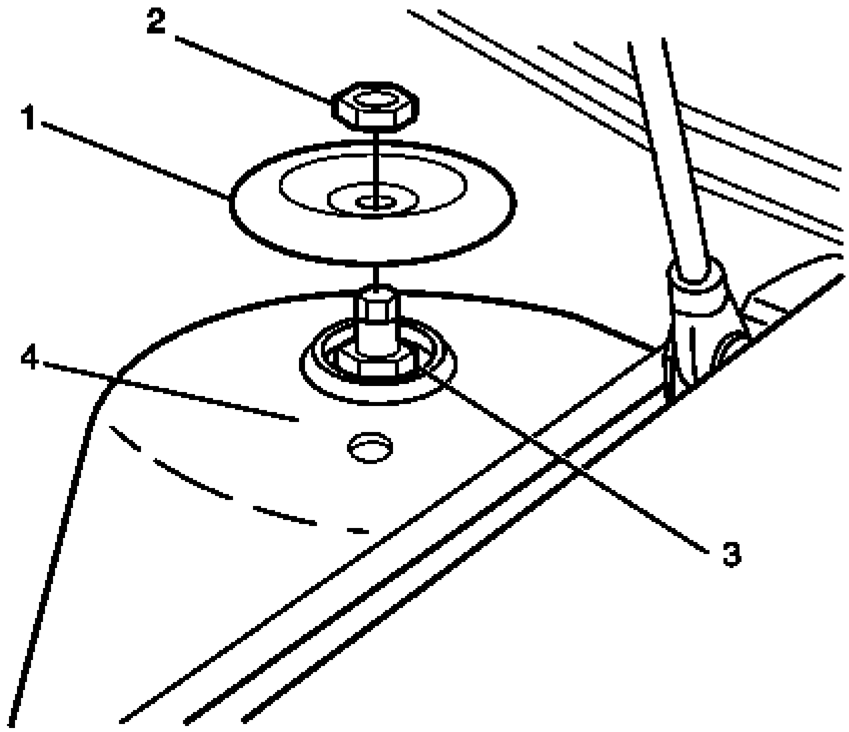


Fig. 253: Identifying Front Strut Assembly To Front Wheelhouse Retaining Nut
Courtesy of GENERAL MOTORS CORP.

62. Install the front strut assembly (3) to the front wheelhouse (4). Repeat for opposite side.
63. Install front strut assembly to front wheelhouse retaining plate (1). Repeat for opposite side.
64. Install the NEW front strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side and tighten to 55 N.m (41 lb ft).

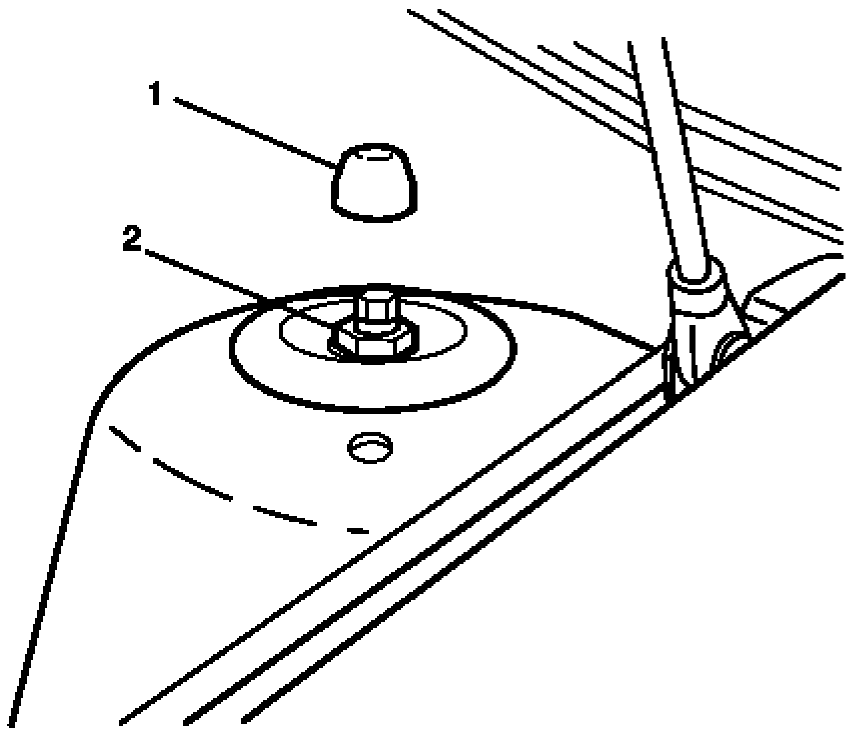


Fig. 254: Identifying Front Strut Assembly To Front Wheelhouse Retaining Nut With Dust Cover
Courtesy of GENERAL MOTORS CORP.

65. Install the dust cover (1) to the front strut assembly to front wheelhouse retaining nut (2).
66. Raise the vehicle.

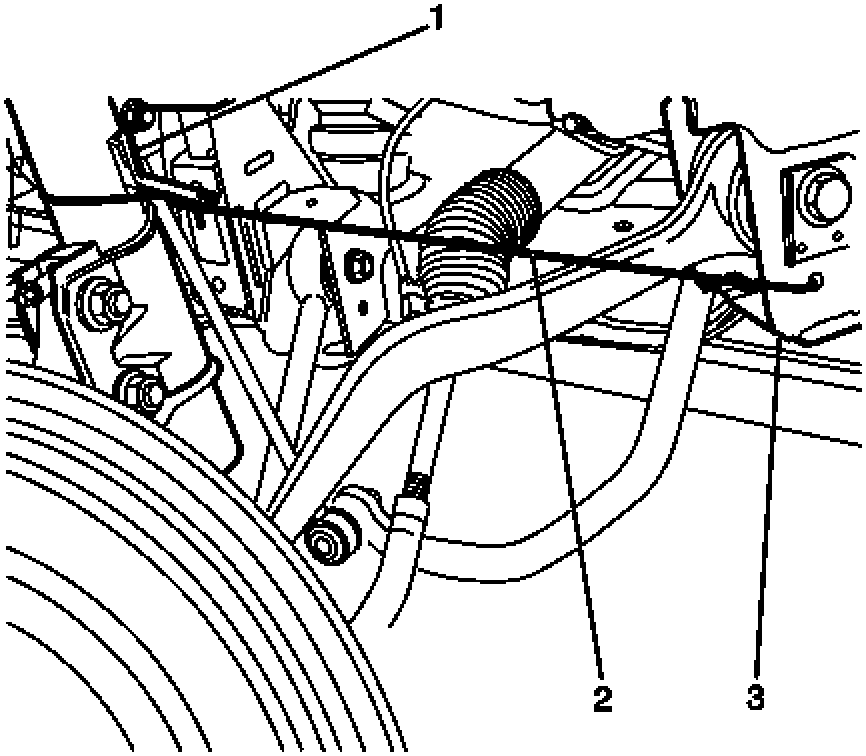


Fig. 255: View Of Subframe, Heavy Mechanic's Wire & Strut Assembly
Courtesy of GENERAL MOTORS CORP.

67. Remove the heavy mechanics wire or equivalent (2) retaining the front strut assembly (1) to the front subframe (3).

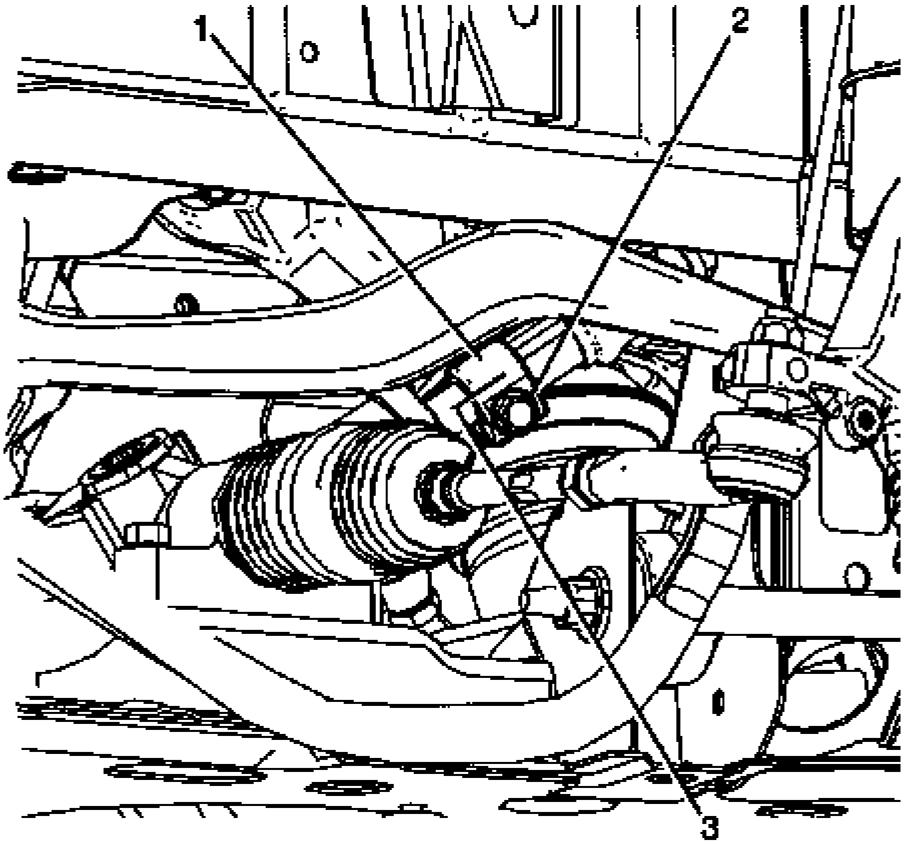


Fig. 256: Identifying Intermediate Steering Shaft To Pinion Shaft Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.**

68. Connect the intermediate steering shaft (1) to the pinion shaft (3).
69. Install NEW the intermediate steering shaft to pinion shaft retaining bolt (2) and tighten to 25 N.m (18 lb ft).

Fig. 257: Identifying Front Wheel Speed Sensor Jumper Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

70. Connect the front wheel speed sensor jumper harness electrical connector (1) to the front wheel speed sensor. Repeat for opposite side.

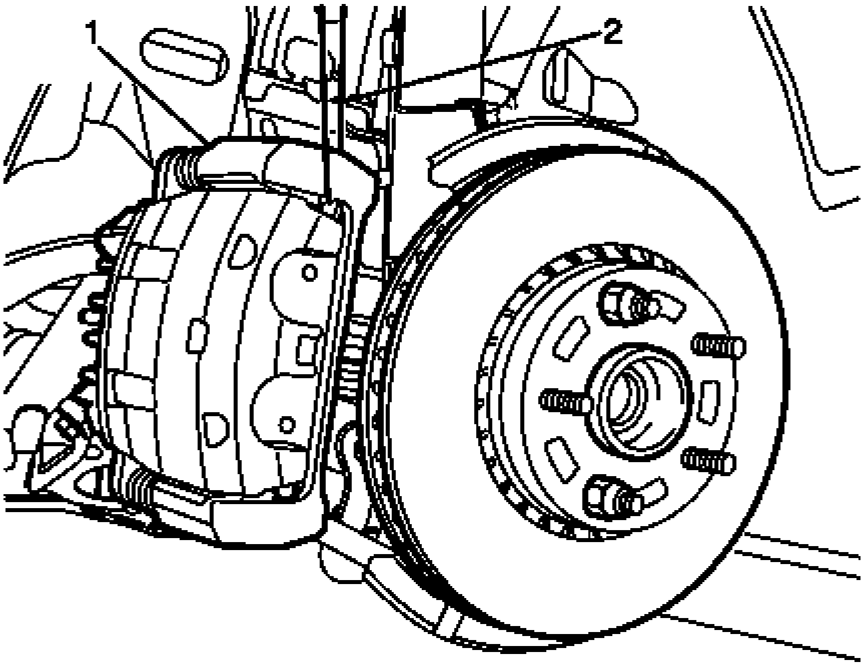


Fig. 258: Locating Brake Caliper & Heavy Mechanic's Wire
Courtesy of GENERAL MOTORS CORP.

71. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1). Repeat for opposite side.

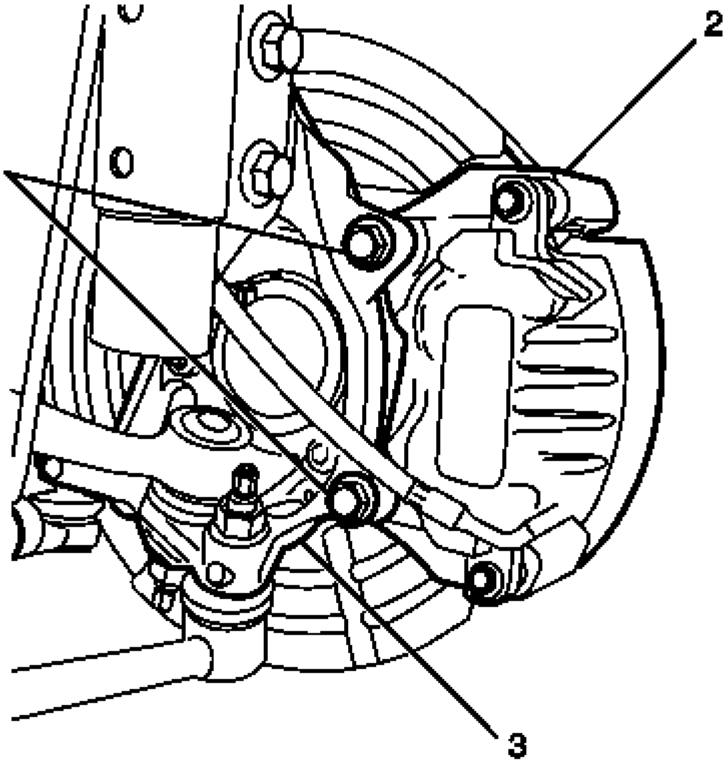


Fig. 259: Identifying Front Brake Caliper Anchor Plate To Front Steering Knuckle Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

72. Install the front brake caliper assembly (2) to the front steering knuckle (3). Repeat for opposite side.
73. Install the NEW front brake caliper anchor plate to front steering knuckle retaining bolts (1) and tighten to 60 N.m +120° (44 lb in +120°).

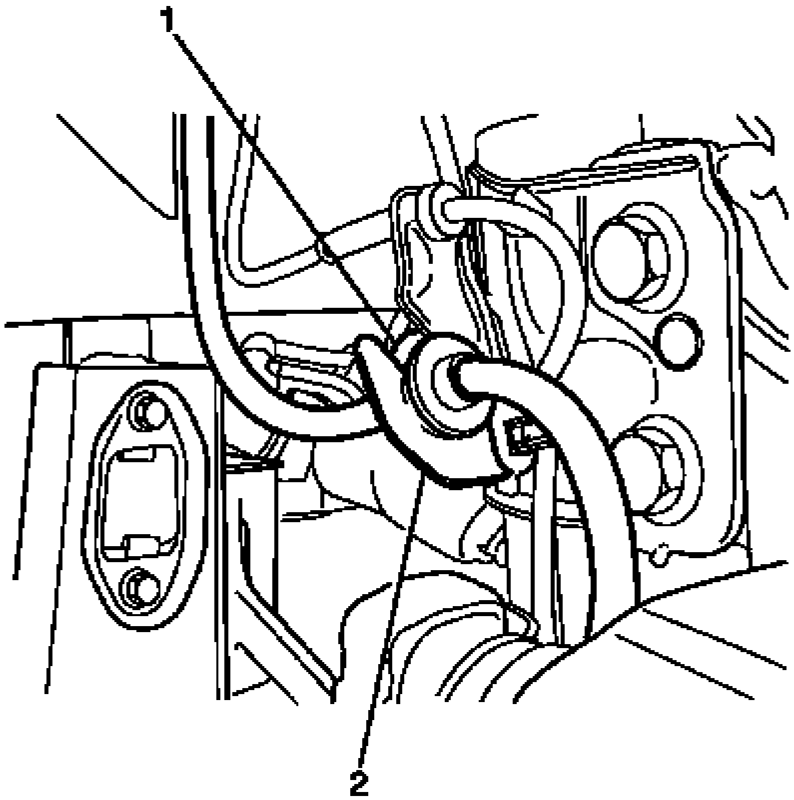


Fig. 260: Identifying Front Brake Hose & Strut Mounted Brake Hose Retaining Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

74. Attach the front brake hose (1) to the strut mounted brake hose retaining bracket (2). Repeat for opposite side.
75. Install the front wheels. Refer to **Tire and Wheel Removal and Installation** .

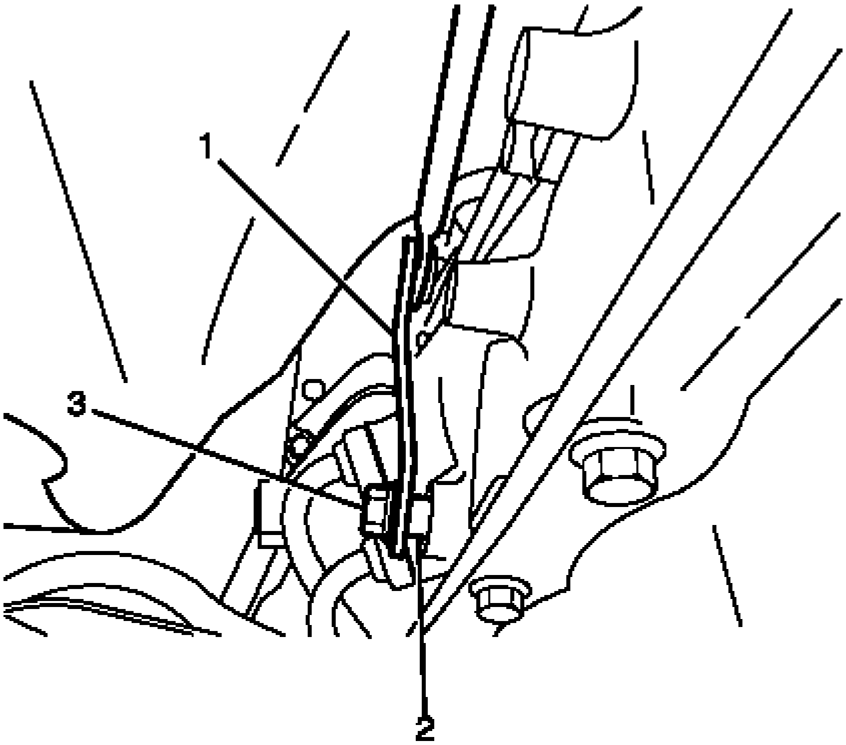


Fig. 261: Identifying Shift Selector Linkage Rod To Shift Selector Shaft Retaining Nut
Courtesy of GENERAL MOTORS CORP.

76. Install the shift selector linkage rod (1) to the shift selector shaft (2).
77. Install the shift selector linkage rod to shift selector shaft retaining nut (3) and tighten to 60 N.m +120° (44 lb in +120°).
78. Install the starter motor. Refer to **Starter Replacement (6.0L)** .
79. Install the propeller shaft. Refer to **Propeller Shaft Replacement** .
80. Install the centre exhaust heat shield. Refer to **Exhaust Heat Shield Replacement - Center** .
81. Install the exhaust system. Refer to **Exhaust System Replacement (V8 - For Access)** or **Exhaust System Replacement (V8 - Complete)** .

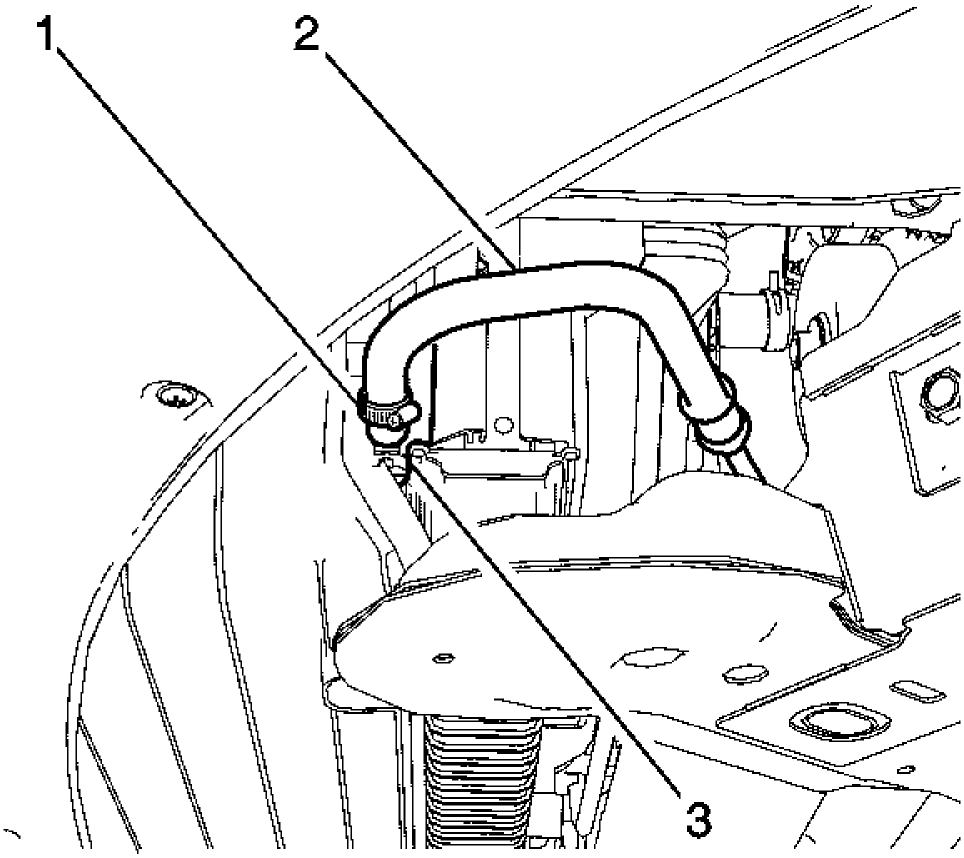


Fig. 262: View Of Power Steering Cooler & Power Steering Fluid Reservoir Inlet Pipe/Hose & Spring Clamp
Courtesy of GENERAL MOTORS CORP.

82. Remove the plug from the power steering cooler (3) and power steering reservoir inlet hose (2).
83. Connect the power steering reservoir inlet hose (2) to the power steering cooler (3).
84. Install the power steering reservoir inlet hose spring clamp (1) to its original location

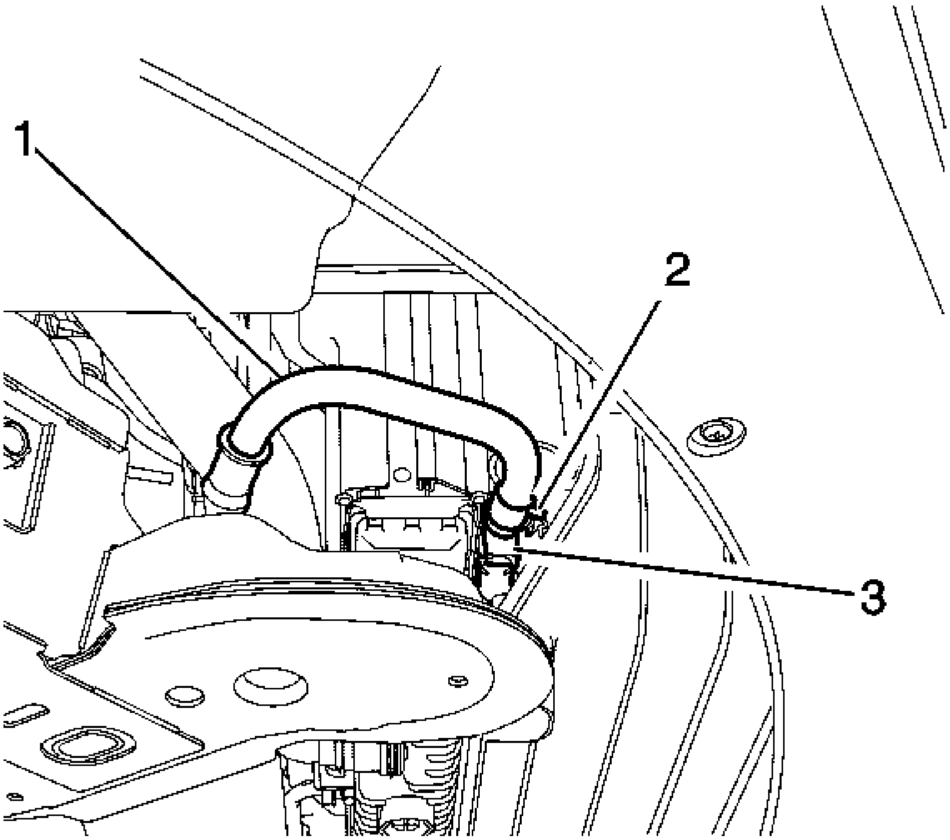


Fig. 263: View Of Power Steering Cooler & Power Steering Gear Outlet Pipe/Hose With Spring Clamp
Courtesy of GENERAL MOTORS CORP.

85. Remove the plug from the power steering cooler (3) and power steering reservoir inlet hose (1).
86. Connect the power steering reservoir inlet hose (1) to the power steering cooler (3).
87. Install the power steering reservoir inlet hose spring clamp (2) to its original location
88. Install the engine splash shield. Refer to **Engine Splash Shield Replacement** .
89. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
90. Lower the vehicle.

NOTE: **Ignore steps 94 through to 97 for vehicles equipped with a manual transmission.**

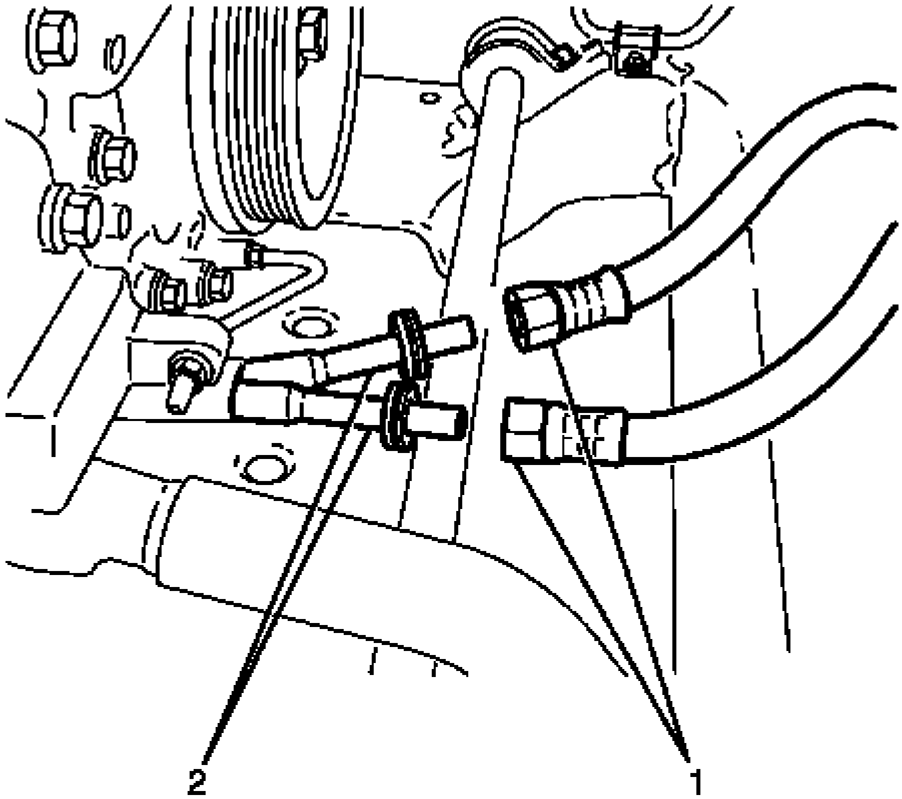


Fig. 264: Identifying Transmission Cooler Lines & Flexible Hoses
Courtesy of GENERAL MOTORS CORP.

91. Remove the clean lint free cloth at the automatic transmission cooler pipes (2) and the flexible hoses (1).

NOTE: **The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.**

92. Align both flexible hose's with both steel cooler lines.

NOTE: **Listen for an audible click to confirm fitting.**

93. Hold the cooler line (2) and connect the flexible hose (1) by pushing together. Repeat procedure for other hose.

NOTE: **When adding or changing transmission fluid use only recommend automatic transmission fluid.**

94. Check and top up transmission fluid level if required. Refer to **Transmission Fluid Check** .

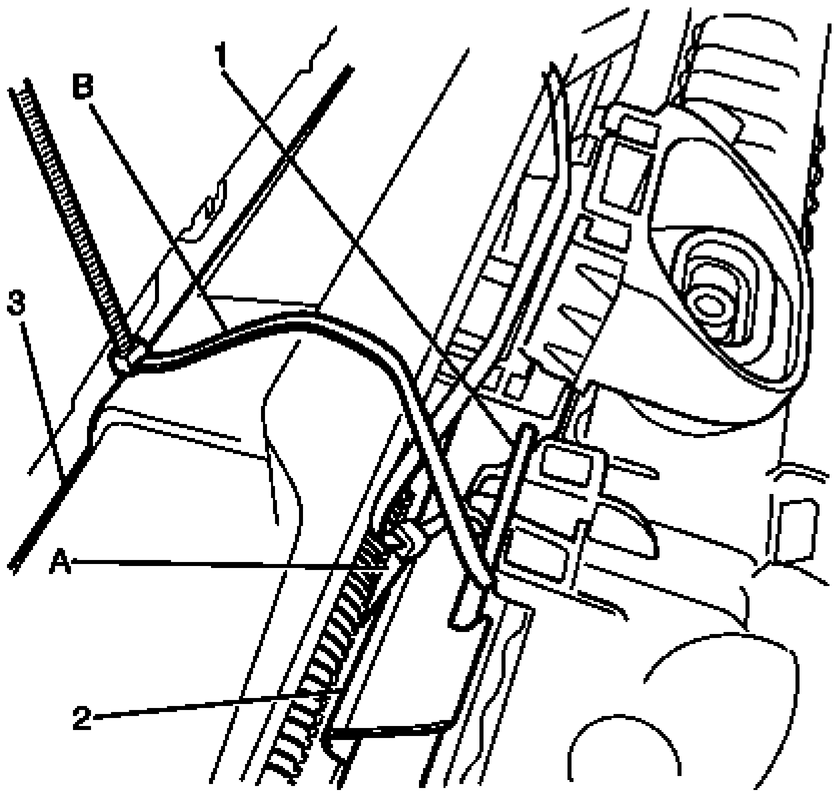


Fig. 265: Identifying Front End, Radiator & Condenser Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Cut zip tie A and zip tie B and remove from around the front end assembly (3) and the radiator and condenser mount (1).

95. Remove the large zip ties or equivalent securing the radiator and condenser assembly (2) to the front end assembly (3).

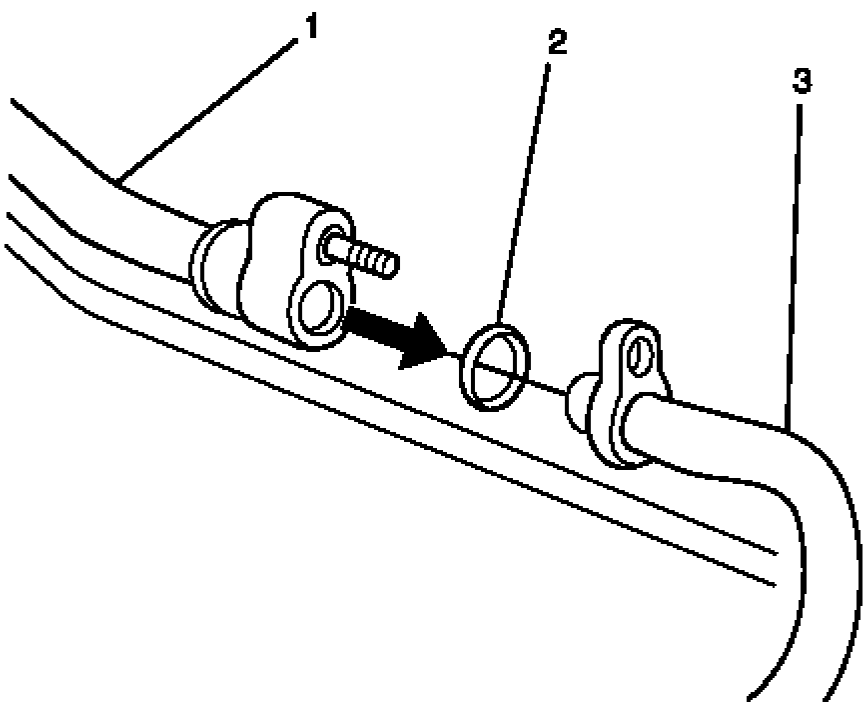


Fig. 266: Identifying Upper & Lower A/C Suction Pipe With Sealing O-Ring
Courtesy of GENERAL MOTORS CORP.

96. Remove the plug or cap at the A/C suction pipe ends (1 and 3)

NOTE: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

97. Fit the NEW A/C suction pipe sealing O-ring (2) to the suction pipe.
98. Install the upper A/C suction pipe (1) to the lower A/C suction pipe (3).

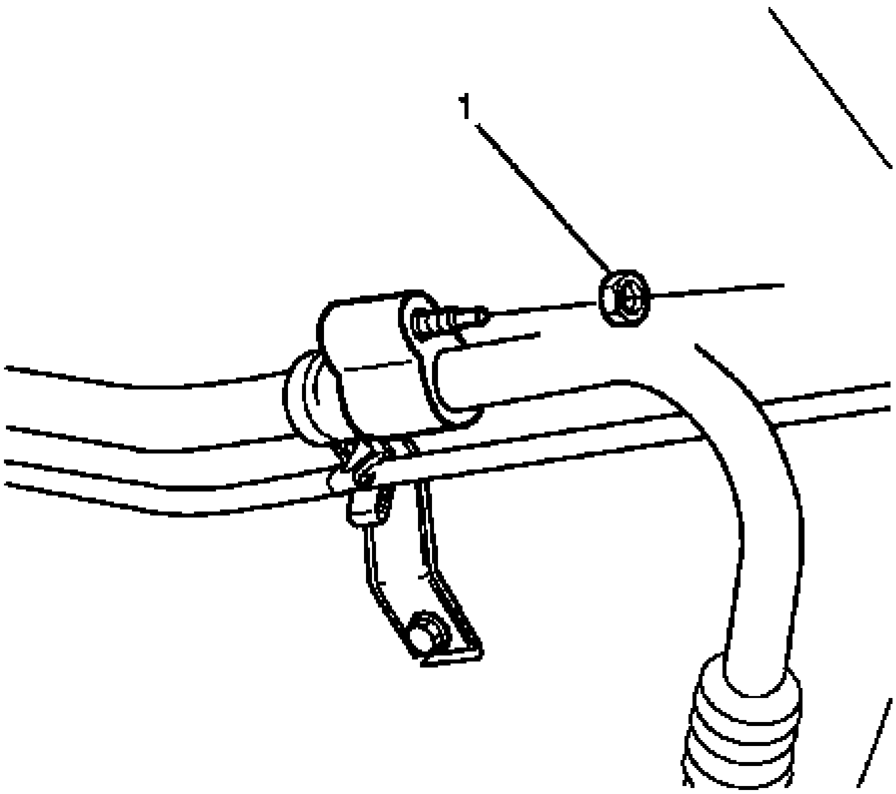


Fig. 267: Identifying Suction Pipe Upper To Suction Pipe Lower Retaining Nut
Courtesy of GENERAL MOTORS CORP.

99. Install the A/C suction pipe pad to A/C suction pipe retaining nut (1) and tighten to 22 N.m(16 lb ft).

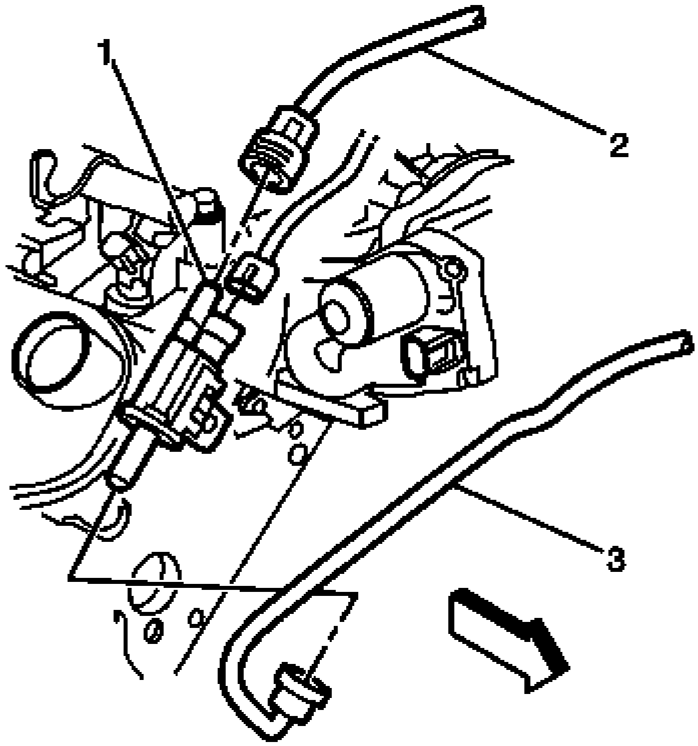


Fig. 268: Locating Fuel Tank Hose, EVAP Purge Valve & Hose
Courtesy of GENERAL MOTORS CORP.

100. Remove the plug from the throttle body to EVAP purge valve tube (3) and EVAP purge valve (1) ends.
101. Connect the throttle body to EVAP purge valve tube (3) to the EVAP purge valve (1).
102. Remove the plug from the EVAP purge valve to fuel tank tube (2) and EVAP purge valve (1) ends.
103. Connect the EVAP purge valve to fuel tank tube (2) to the EVAP purge valve (1).

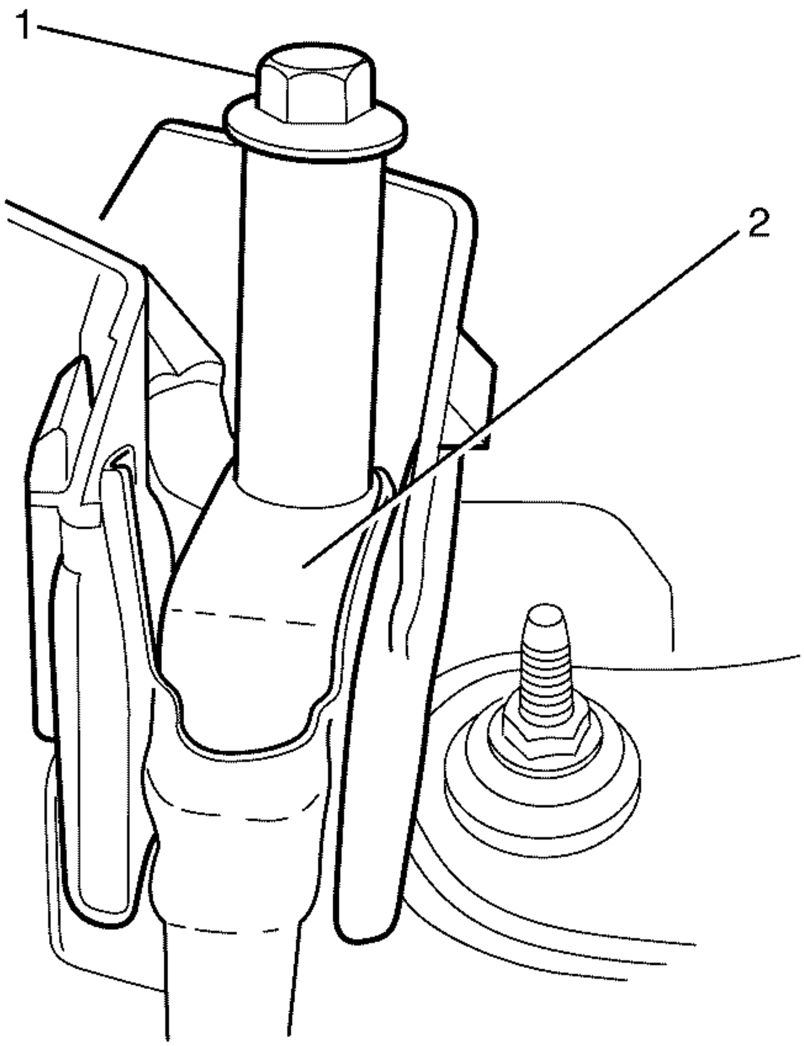


Fig. 269: Identifying Remote Battery Positive Post To Wiring Harness Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

104. Install the wiring harness (2) to the remote positive battery post.
105. Install the remote positive battery post to wiring harness retaining bolt (1) and tighten to 15 N.m (11 lb ft).

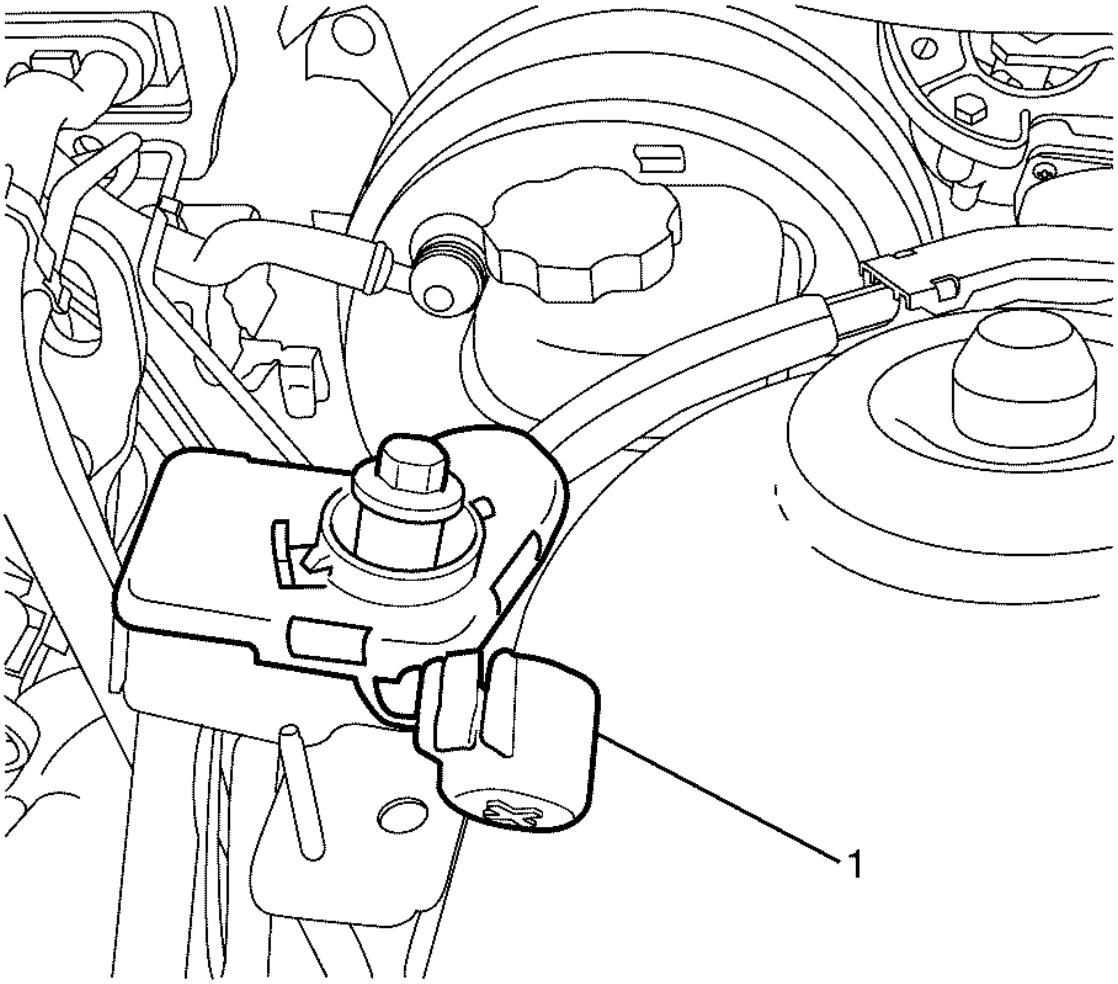


Fig. 270: Identifying Remote Battery Positive Post Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure the clips on the remote positive battery post cover (1) are engaged to avoid an induced rattle condition.

106. Install the remote positive battery post cover (1).

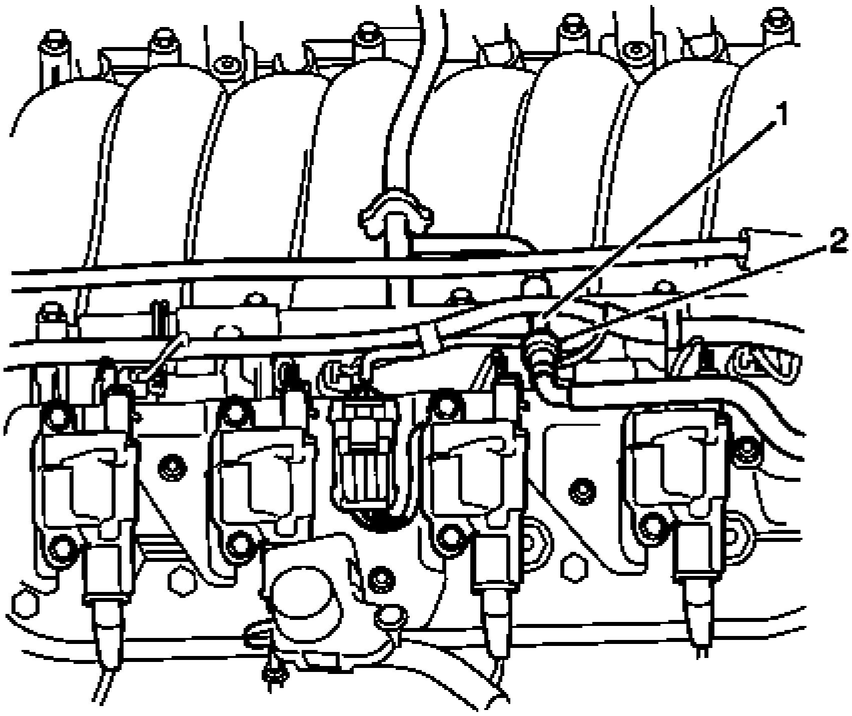


Fig. 271: Identifying Fuel Rail Tube & Feed Pipe (Left Side)
Courtesy of GENERAL MOTORS CORP.

107. Remove the plug from the fuel feed pipe (2) and fuel rail pipe (1) ends.
108. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to **Metal Collar Quick Connect Fitting Service** or **Plastic Collar Quick Connect Fitting Service** .
109. Install the engine coolant heater cord if fitted. Refer to **Coolant Heater Cord Replacement (6.0L)** .

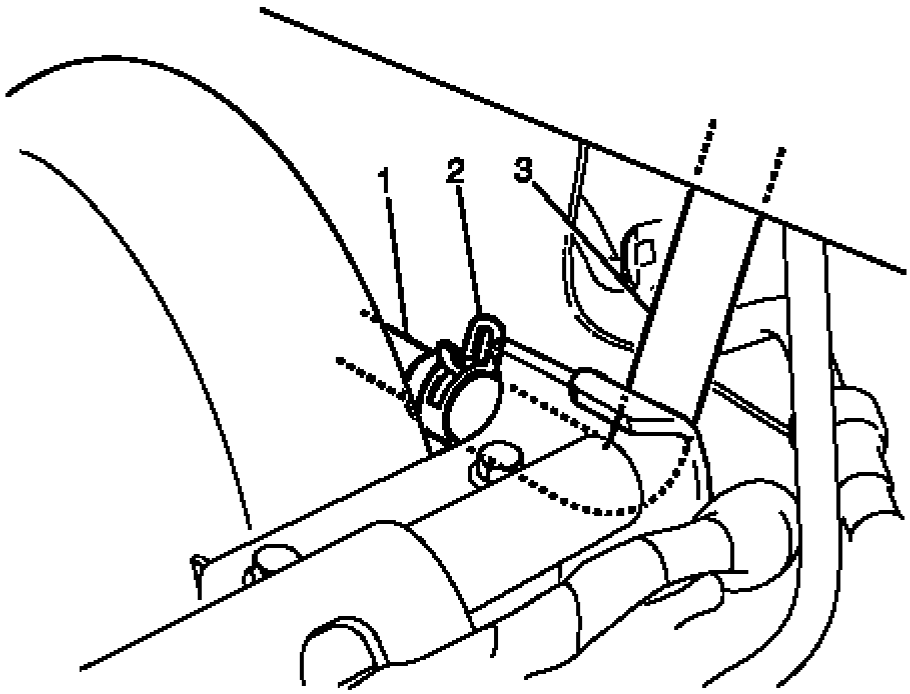


Fig. 272: Identifying Intake Manifold Vacuum Port, Vacuum Hose & Retaining Clamp
Courtesy of GENERAL MOTORS CORP.

110. Connect the vacuum brake booster hose (3) from the intake manifold vacuum port (1).
111. Compress the vacuum brake booster hose retaining clamp (2) and return to its original position on the vacuum brake booster hose (3).

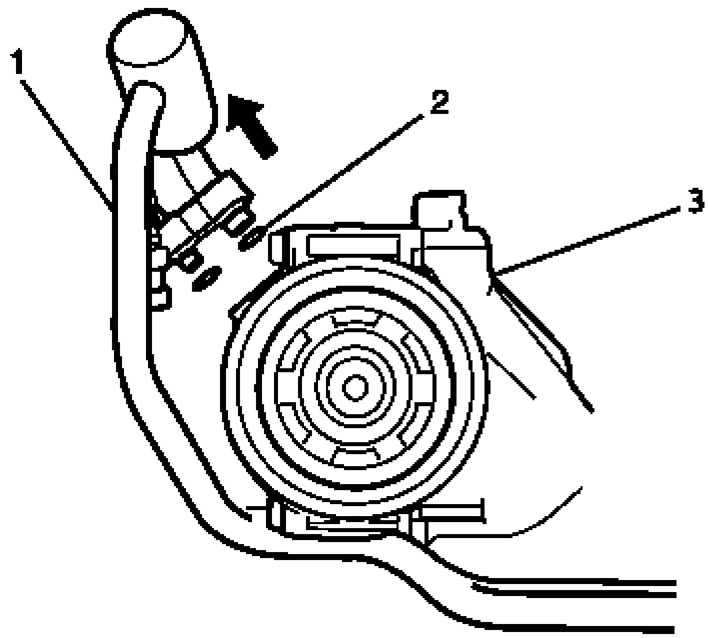


Fig. 273: Identifying Suction/Discharge Pipes & Compressor
Courtesy of GENERAL MOTORS CORP.

112. Remove the plug from the compressor (3) ports.
113. Remove the plug from the pipes (1).

NOTE: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

114. Fit the NEW A/C suction/discharge pipe O-rings (2) to the suction/discharge pipes (1).
115. Connect the A/C suction/discharge line pad (1) to the A/C compressor (3).

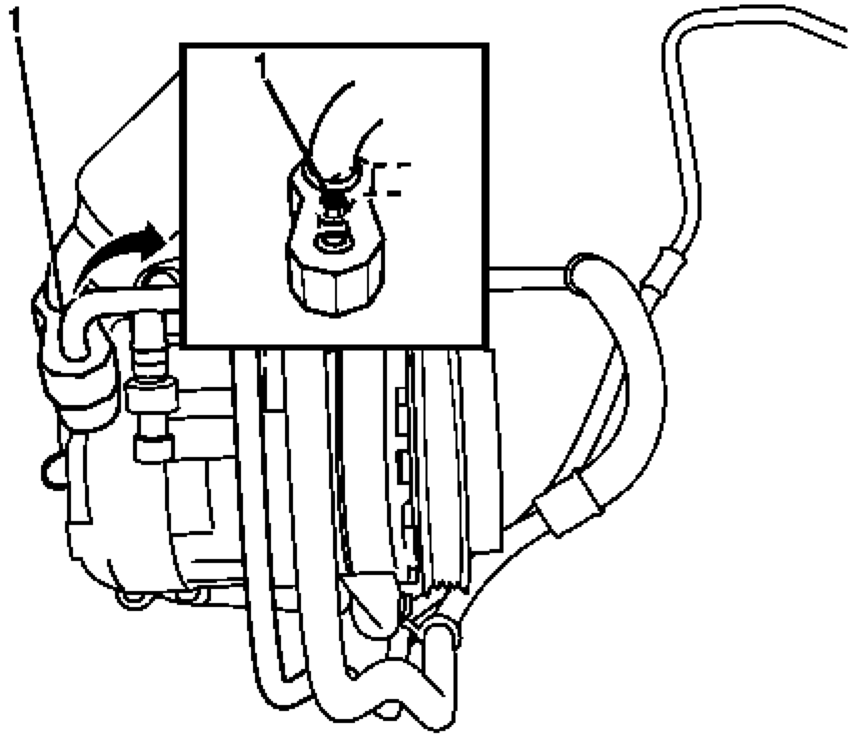


Fig. 274: Identifying Suction/Discharge Pipe To Compressor Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

116. Install the suction/discharge line pad (1) to compressor and tighten the retaining bolt (1) to the correct torque specification and tighten to 22 N.m(16 lb ft).

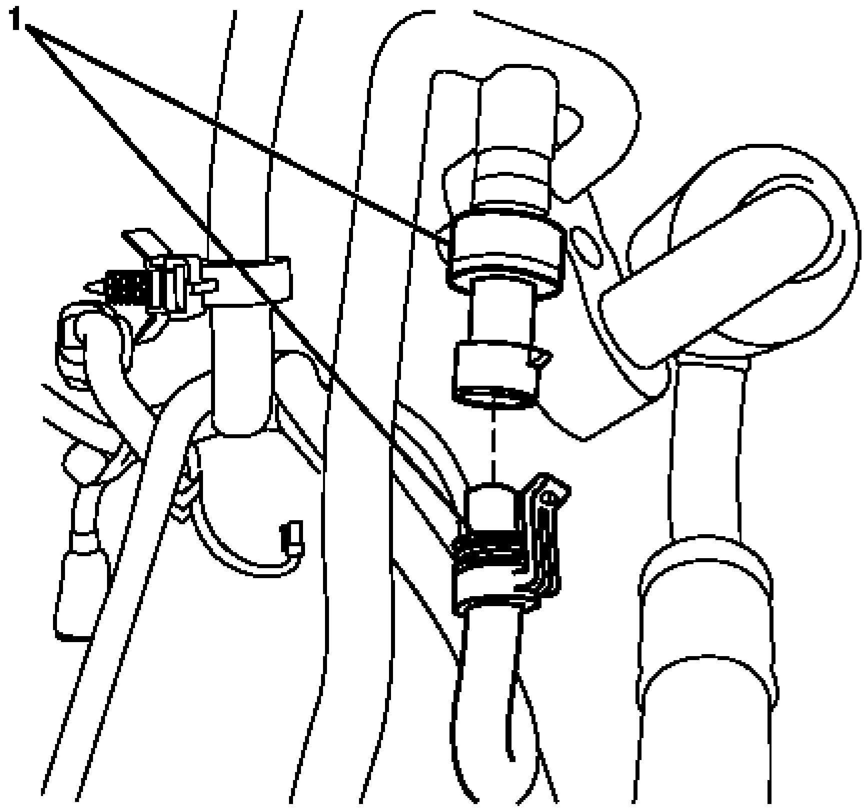


Fig. 275: Identifying A/C Refrigerant Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

117. Connect the electrical connector to the A/C Refrigerant Pressure Sensor (1) to the A/C refrigerant sensor.

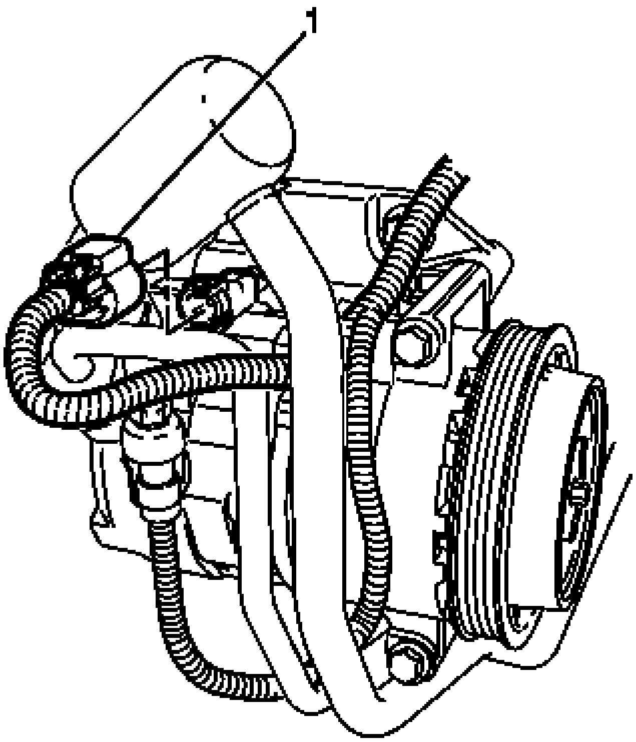


Fig. 276: Identifying Compressor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

118. Connect the A/C electrical connector (1) to the A/C compressor.

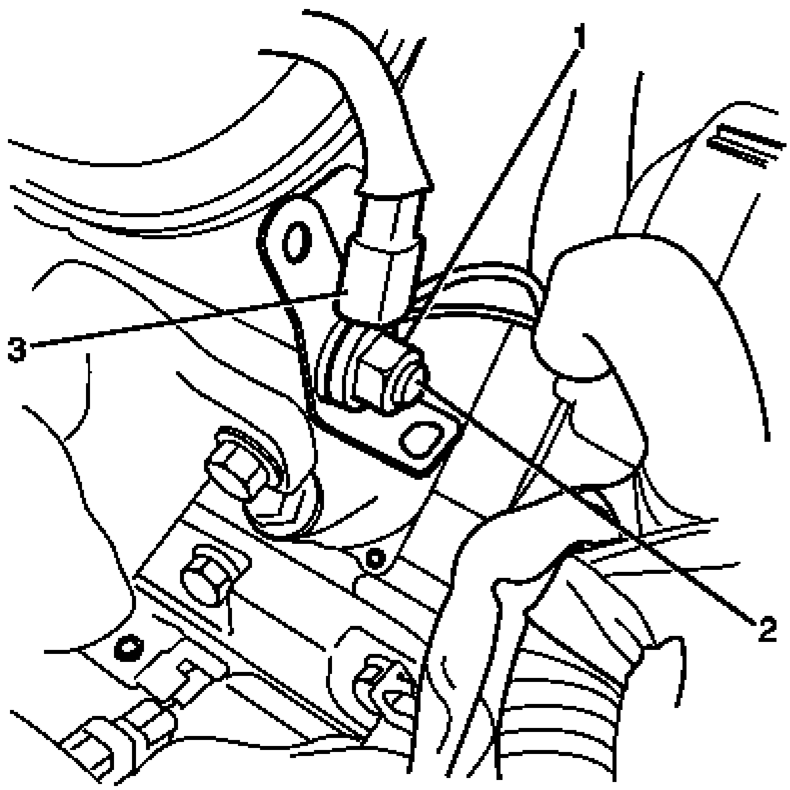


Fig. 277: Identifying Vehicle Body Ground Cable To Cylinder Head Retaining Nut
Courtesy of GENERAL MOTORS CORP.

119. Install the vehicle body ground cable (3) to the cylinder head stud (2).
120. Install the vehicle body ground cable to cylinder head retaining nut (1) and tighten to 12 N.m(106 lb in).

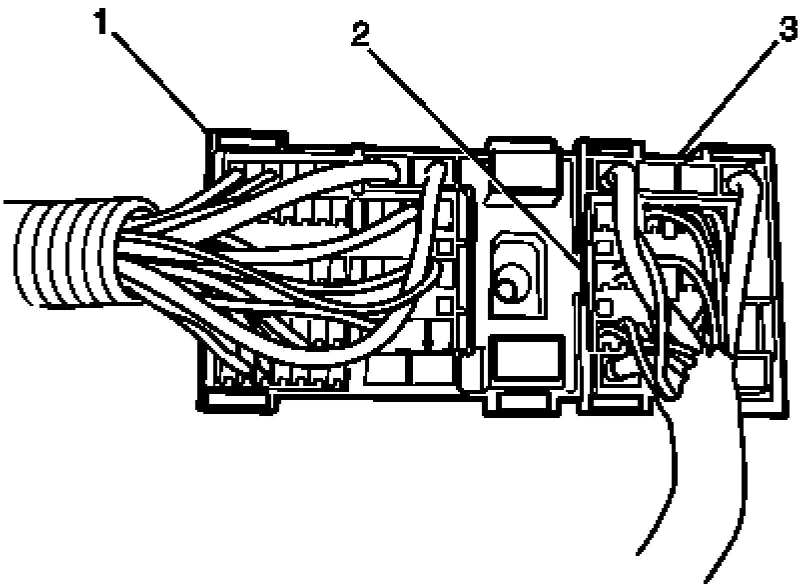


Fig. 278: Identifying Engine Connector, Locking Tang & Body Harness Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: **Listen for a audible click from the locking tang (2) to confirm fitting.**

121. Slide the engine connector (3) into the body harness connector (1) to join.

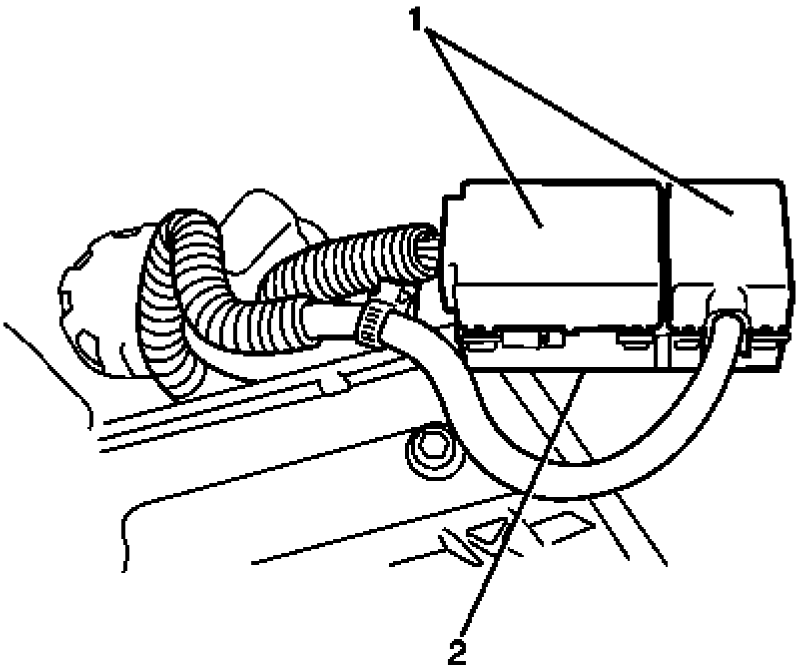


Fig. 279: Identifying Under Hood BEC Connector With Protector
Courtesy of GENERAL MOTORS CORP.

122. Install the protector (1) to the base of the under hood BEC connector (2).

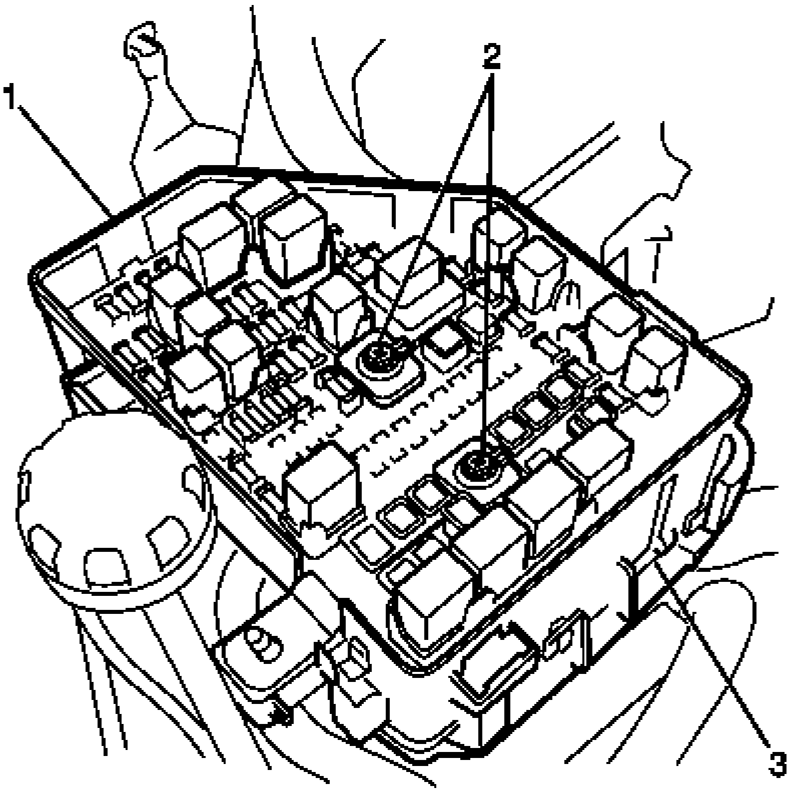


Fig. 280: Identifying Under Hood BEC Upper Plate To Lower Plate Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

123. Install the upper under hood BEC plate (1) to the lower under hood BEC plate (3).

NOTE: **The under hood BEC upper plate to lower plate retaining bolts (2) DO NOT have a torque specification. Listen for an audible clicking sound whilst tightening the under hood BEC upper plate to lower plate retaining bolts (2) to confirm correct fitting.**

124. Install the under hood BEC upper plate to lower plate retaining bolts (2).

Listen for an audible click for correct tension.

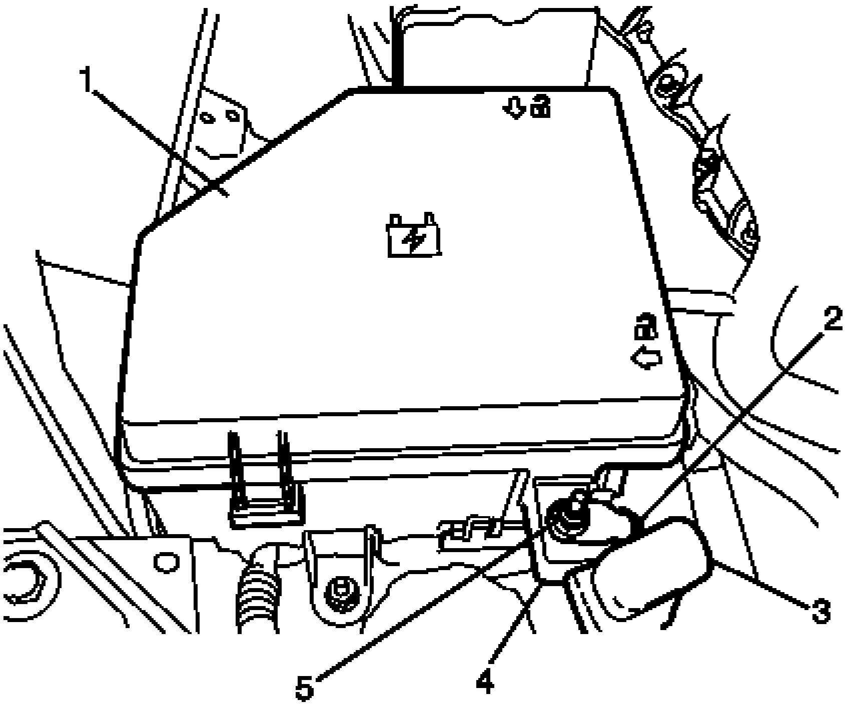


Fig. 281: Identifying Positive Cable To Under Hood BEC Plate Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

125. Connect the positive cable (2) to the upper under hood BEC plate (4).
126. Install the positive cable to under hood BEC plate retaining bolt (5) and tighten to 10 N.m (89 lb ft).
127. Install the positive cable protective cover (3) to the positive cable.
128. Install the under hood body electrical centre (BEC) cover (1).

CAUTION: In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins or the soldered components on the circuit board.

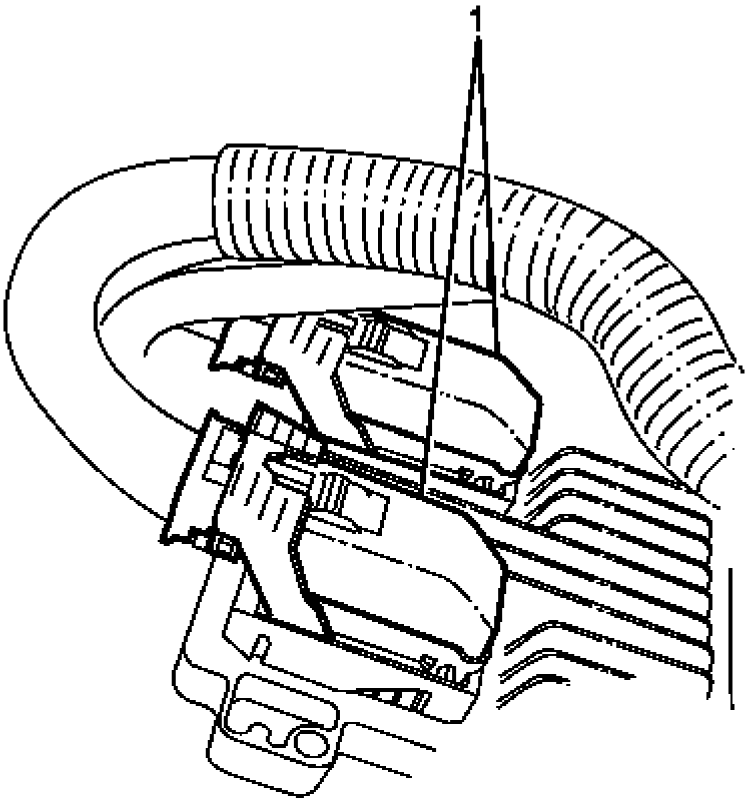


Fig. 282: Identifying ECM Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

129. Connect the ECM electrical connectors (1) to the ECM.

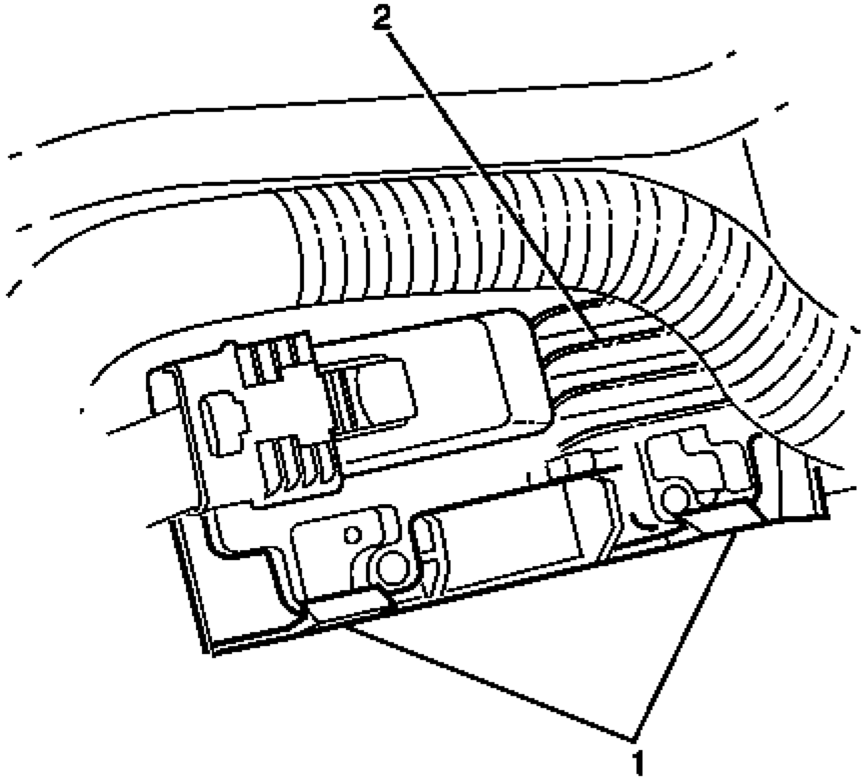


Fig. 283: Identifying ECM & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

130. Engage the ECM retaining clips (1) to secure the ECM (2).

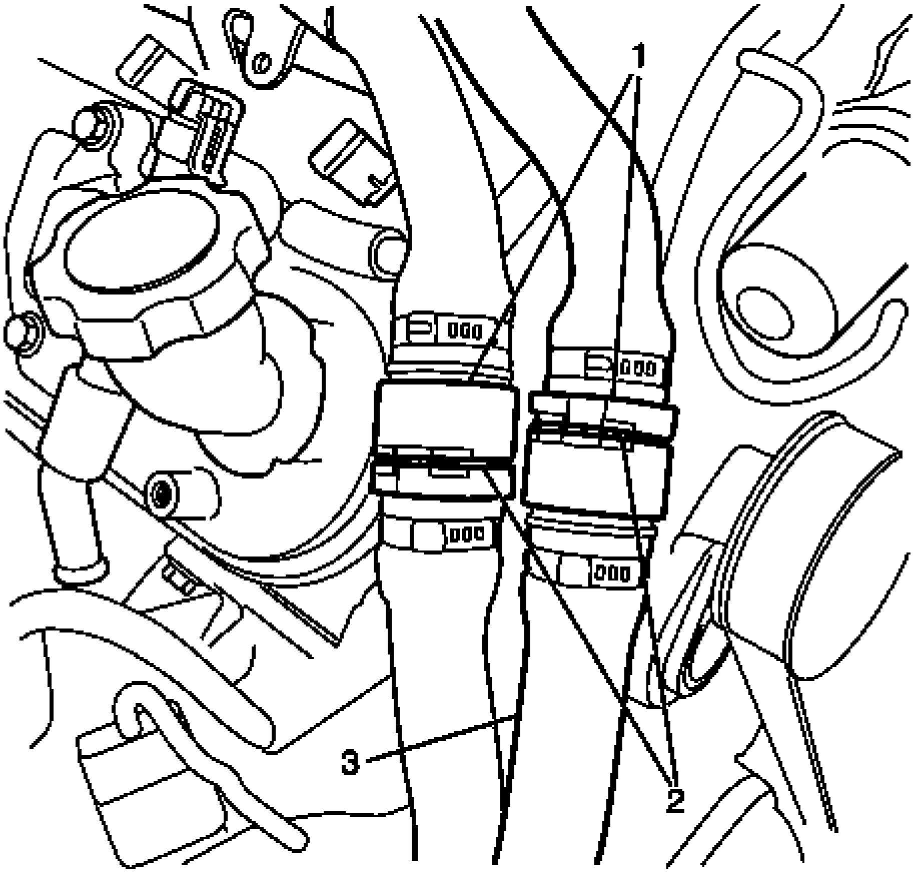


Fig. 284: Identifying Heater Hose Assembly Quick Connect Fittings & Retaining Clips
Courtesy of GENERAL MOTORS CORP.

NOTE: Listen for a audible click to confirm fitting.

131. Connect the inlet and outlet heater hoses (3) at the heater hose assembly quick connect fittings (1).

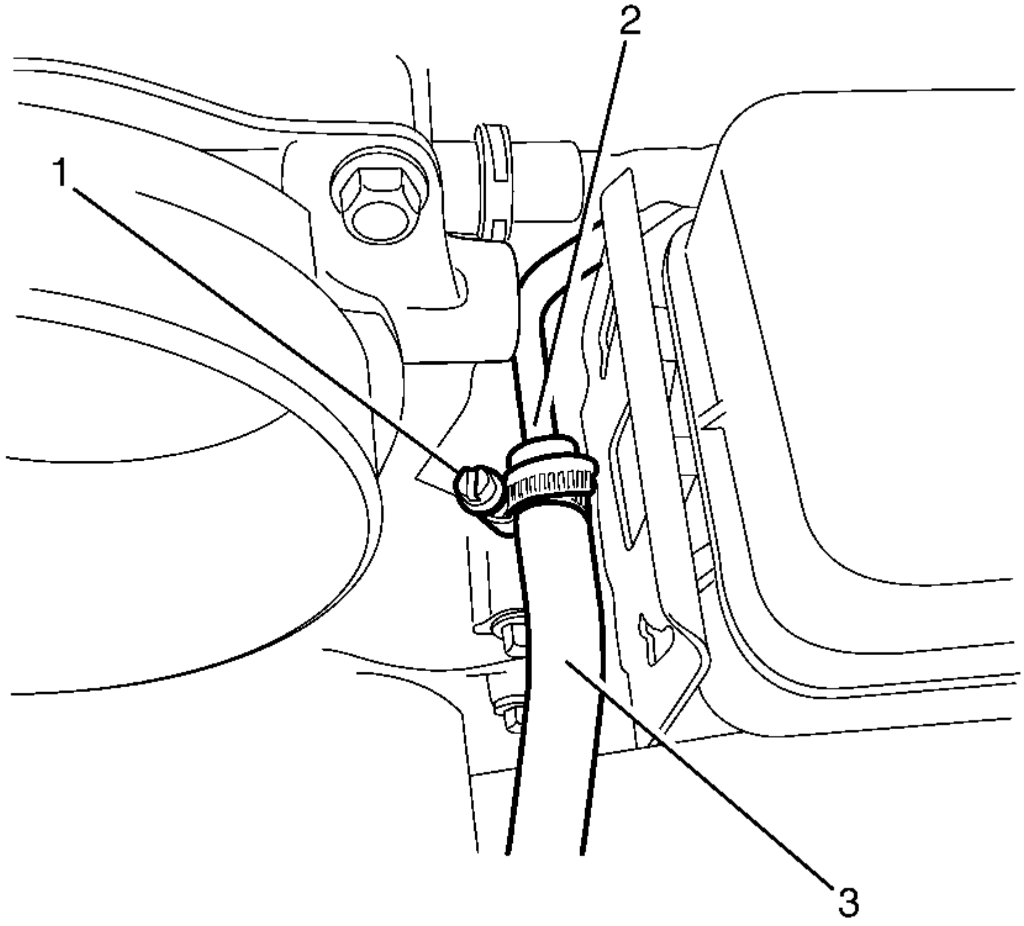


Fig. 285: View Of Coolant Bleed Hose Retaining Clamp, Coolant Air Bleed Hose & Coolant Bleed Pipe
Courtesy of GENERAL MOTORS CORP.

132. Connect the coolant air bleed hose (3) to the coolant bleed pipe (2).
133. Reposition the coolant bleed hose retaining clamp (1) to its original position on the coolant bleed hose (3).
134. Tighten the coolant bleed hose retaining clamp (1).
135. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (6.0L)** .
136. Fill the cooling system. Refer to **Cooling System Draining and Filling (6.0 L)** .
137. Install the air intake duct. Refer to **Air Cleaner Inlet Duct Replacement** .
138. Recharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
139. Install the radiator air baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .
140. Install the engine cover. Refer to **Engine Cover Replacement**.

141. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
142. Disable the ignition system.
143. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
144. Enable the ignition system.
145. Start the engine and listen for unusual noises.
146. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.

     If necessary, install an oil pressure gauge and measure the engine oil pressure.

147. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
148. Listen for sticking lifters and other unusual noises.
149. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Remove the oil fill cap.

   WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

   WARNING: Refer to Safety Glasses Warning .

2. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

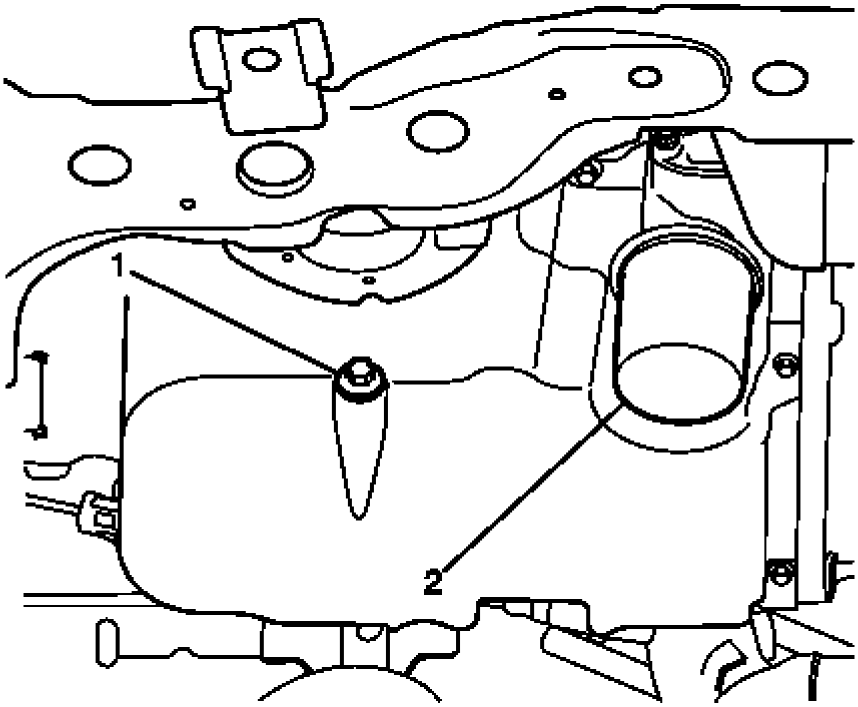


Fig. 286: Identifying Oil Pan Drain Plug & Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan drain plug (1).
4. Drain the engine oil into an appropriate container.
5. Remove the engine oil filter (2).

Installation Procedure

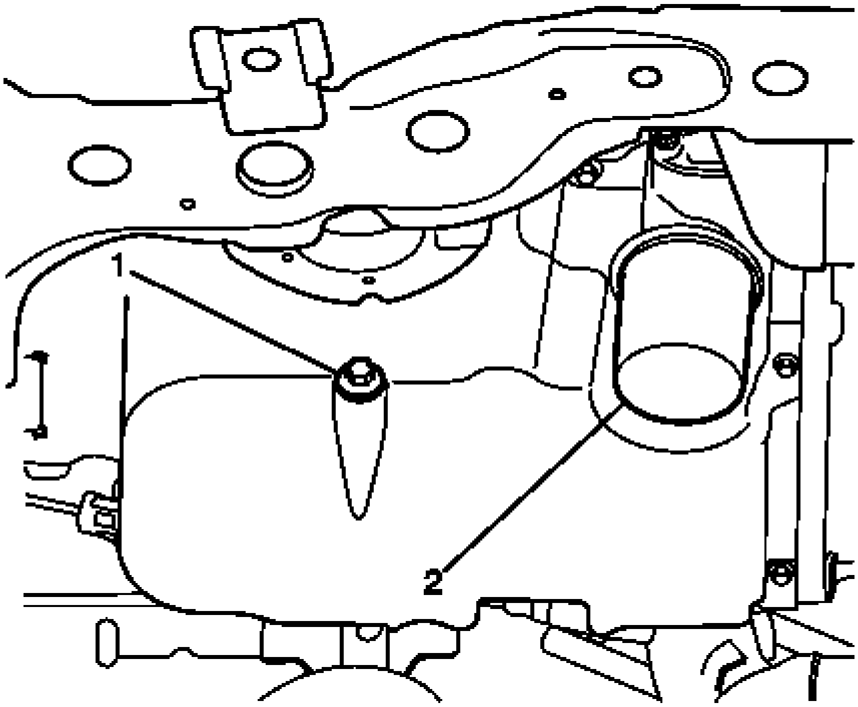


Fig. 287: Identifying Oil Pan Drain Plug & Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Before installing the new oil filter, ensure that the old oil filter gasket has been removed. If not, remove the old gasket.

1. Install the oil filter (2) and tighten to 30 N.m (22 lb ft).
2. Install the oil pan drain plug (1) and tighten to 25 N.m (18 lb ft).
3. Lower the vehicle.
4. Fill the engine with a suitable amount and type of engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations** .
5. Check the oil level.
6. Install the oil fill cap.
7. Reset the service reminder display. Refer to **Service Display Reminders** .

FUEL RAIL AND INJECTORS INSTALLATION

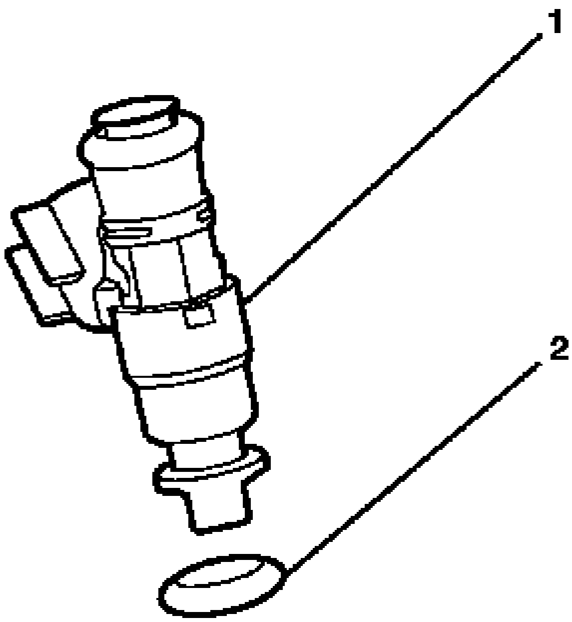


Fig. 288: Identifying Fuel Injector O-Ring Seals
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Rail Stop Bracket Installation Warning .

NOTE: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals with clean engine oil.
2. Install the O-ring seals to the fuel injectors.

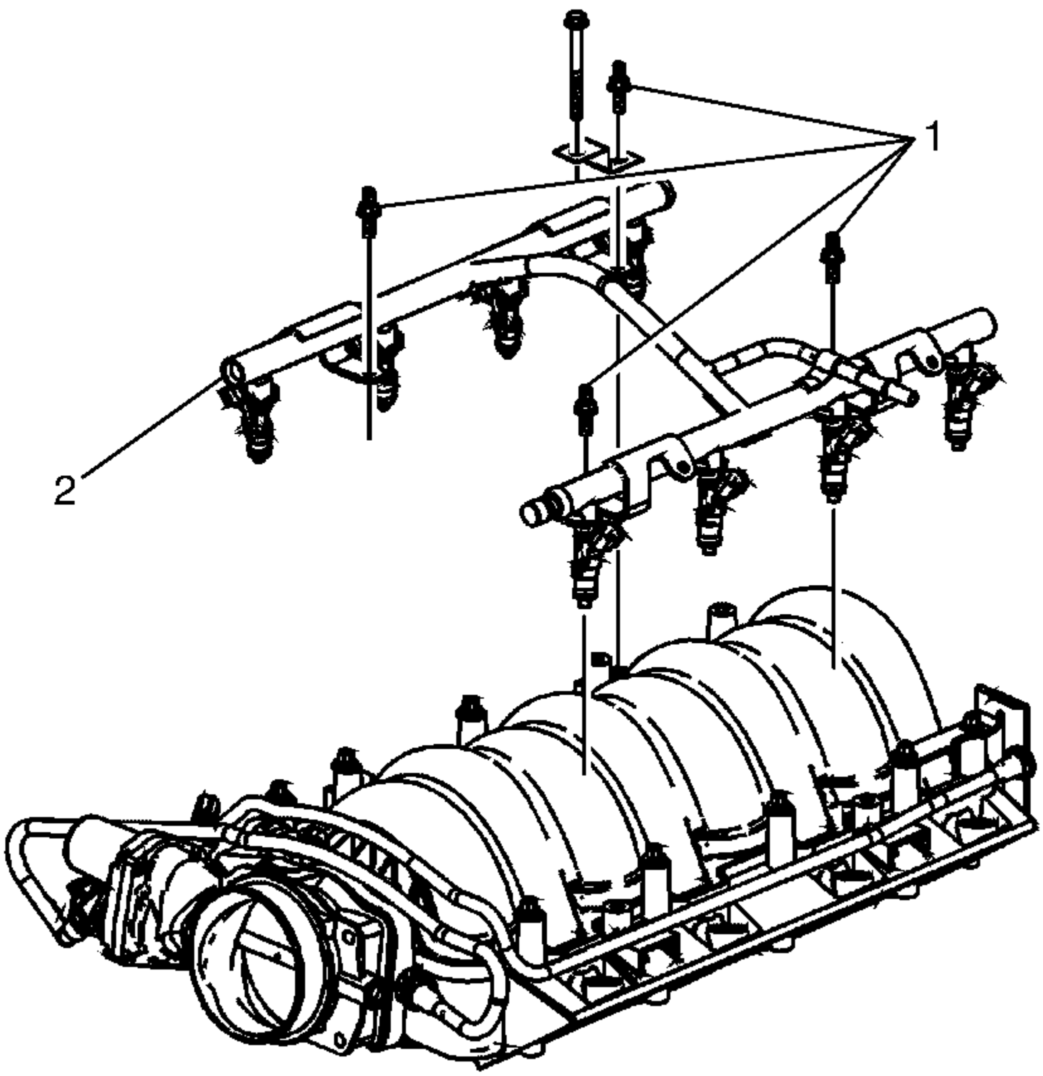


Fig. 289: Identifying Fuel Rail Ground Strap To Intake Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel rail (3) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
4. Apply a 5 mm (0.2 in) band of threadlock to the threads of the fuel rail bolts (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

5. Install the fuel rail bolts (2) and fuel rail ground strap (1) and tighten to 10 N.m (89 lb in).

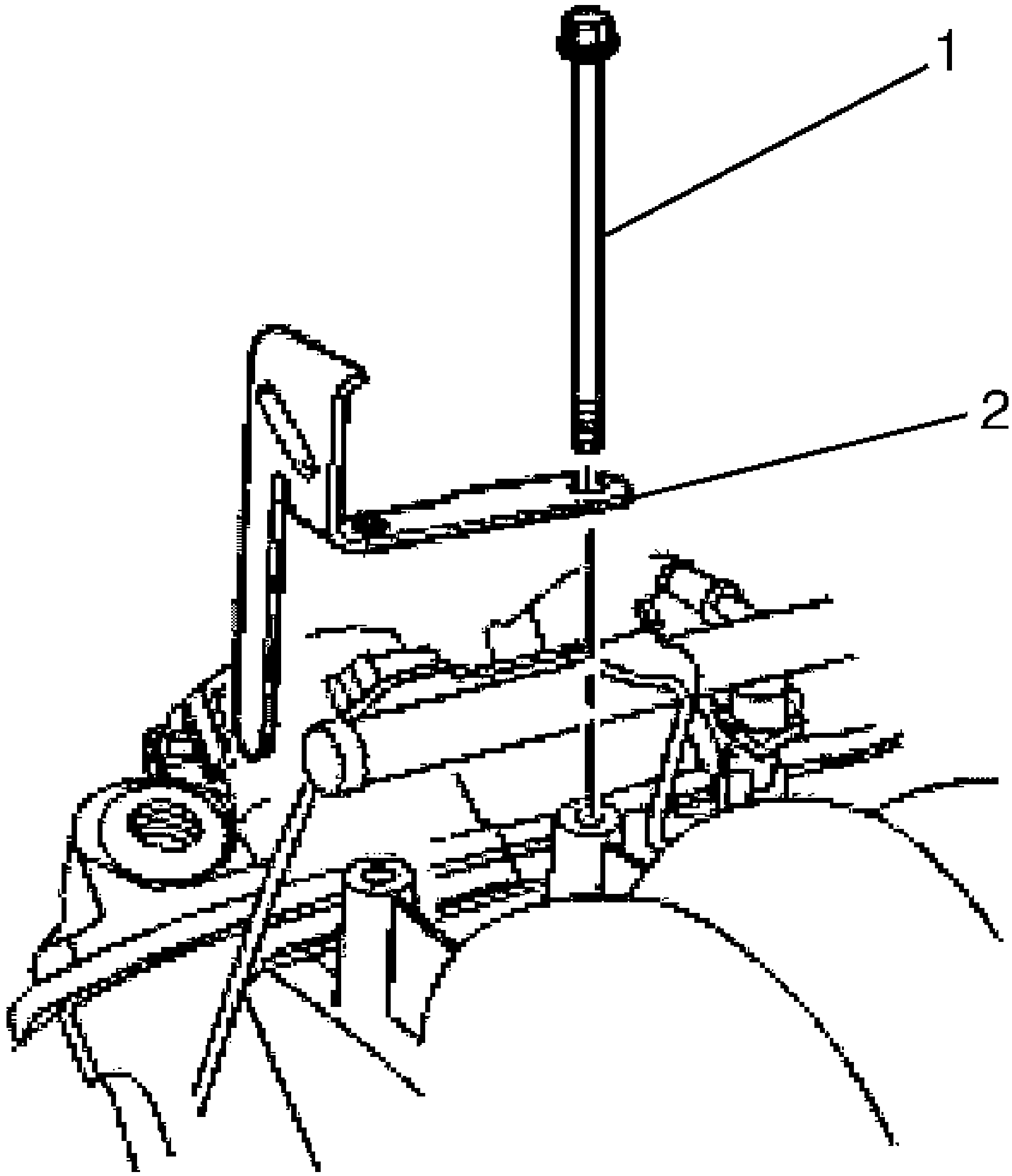


Fig. 290: Identifying Fuel Rail Stop Bracket To Intake Manifold Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **The fuel rail stop bracket (2) must be installed. The fuel rail stop bracket (2) serves as a protective shield in the event of a vehicle frontal collision.**

6. Install the fuel rail stop bracket (2).

7. Install the fuel rail stop bracket to intake manifold retaining bolt (1) and tighten to 10 N.m (89 lb in).

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

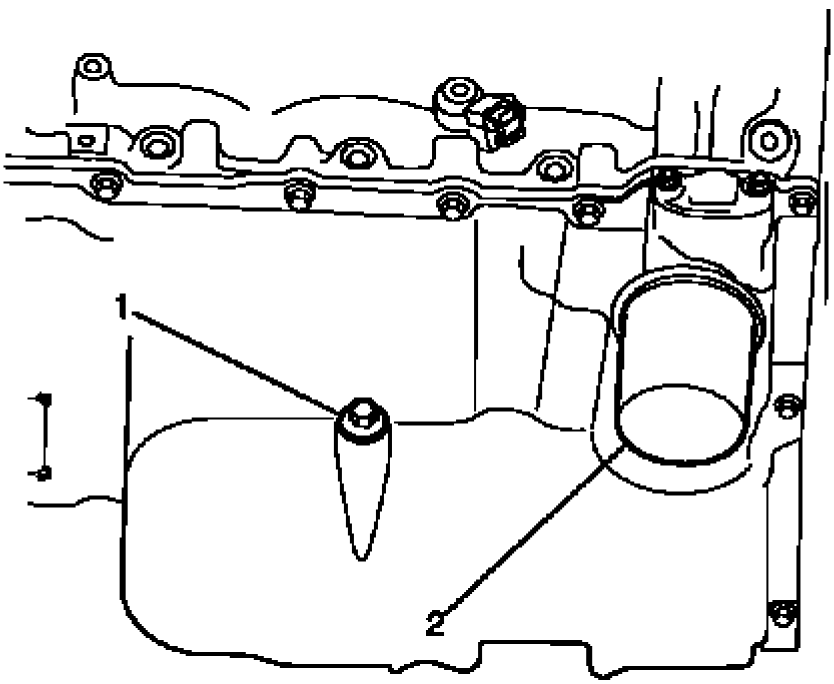


Fig. 291: Identifying Oil Filter & Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan drain plug (1).
2. Drain the engine oil into an appropriate container.
3. Remove the engine oil filter (2).

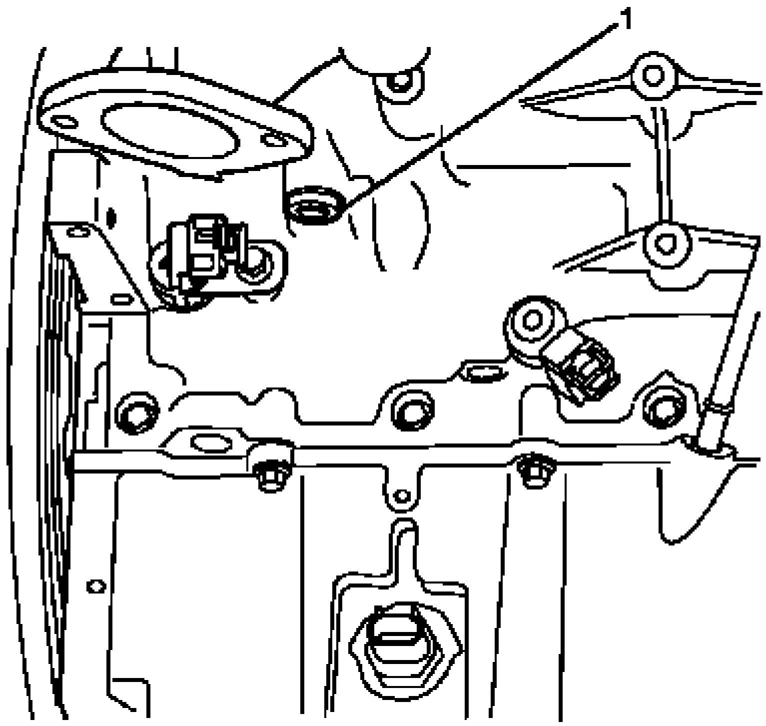


Fig. 292: Identifying Right Side Rear Engine Block Coolant Drain Hole Plug & Washer
Courtesy of GENERAL MOTORS CORP.

4. Remove the right side rear engine block coolant drain hole plug and washer (1).

CRANKSHAFT BALANCER REMOVAL (6.0L L76)

Special Tools

- **J 41816:** Crankshaft Balancer Remover
- **J 41816-2:** Crankshaft End Protector
- **J 42386-A:** Flywheel Holding Tool

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

Removal

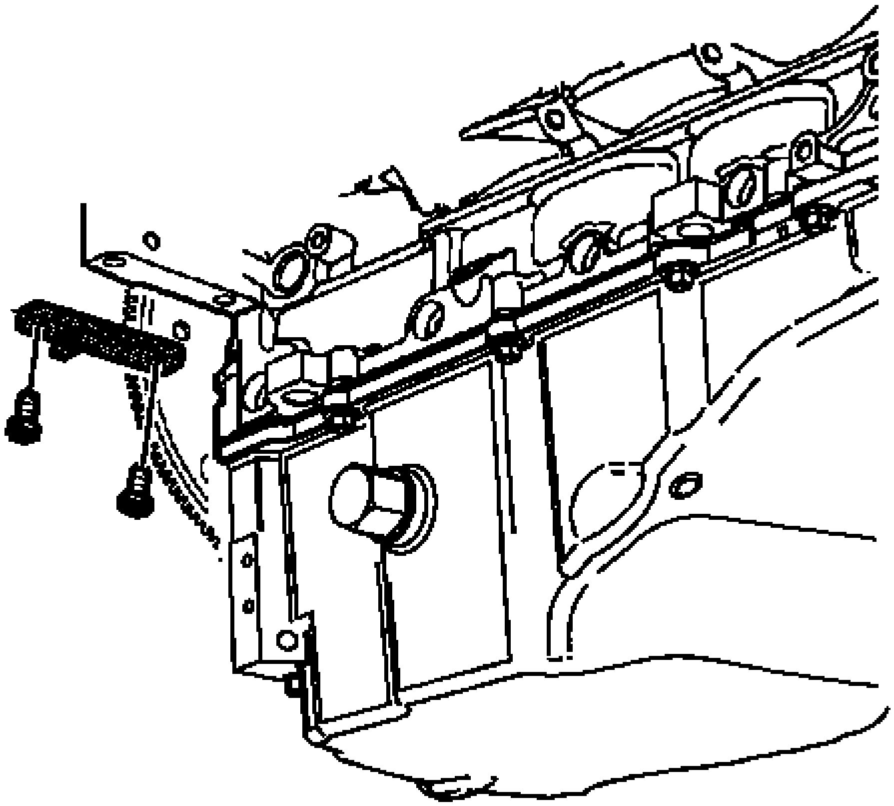


Fig. 293: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the **J 42386-A:** holding tool and bolts.

   Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

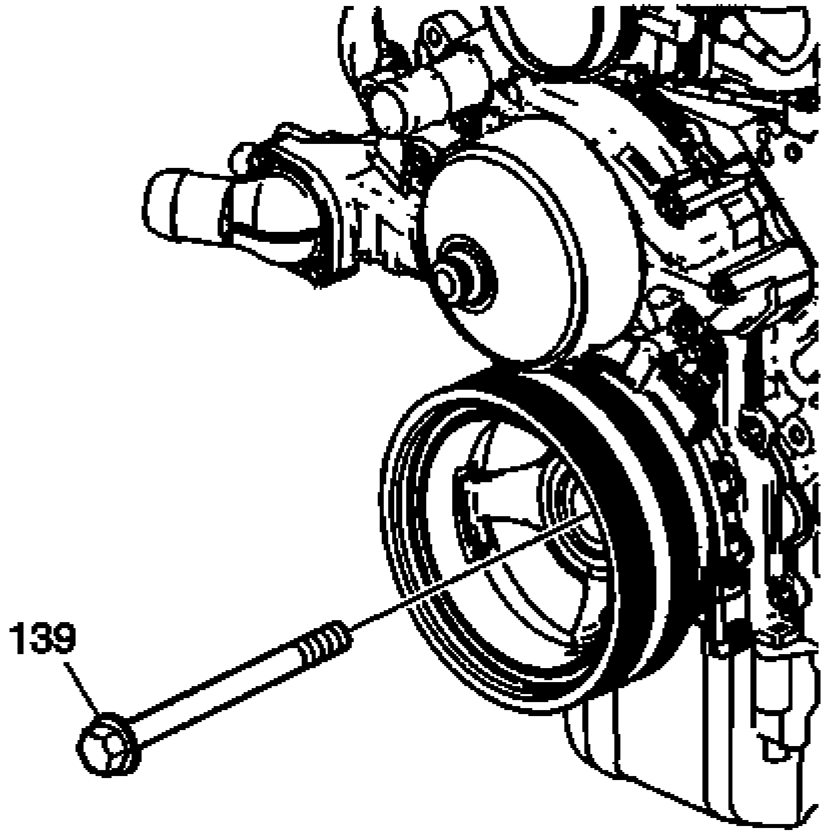


Fig. 294: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt (139).

   Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

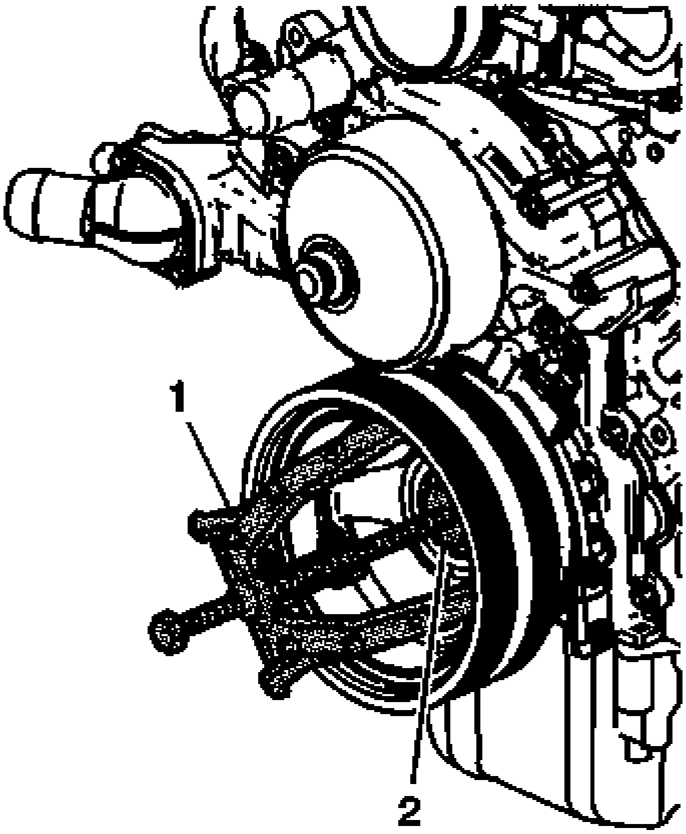


Fig. 295: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 41816:** remover (1) and the **J 41816-2:** protector (2) in order to remove the crankshaft balancer.

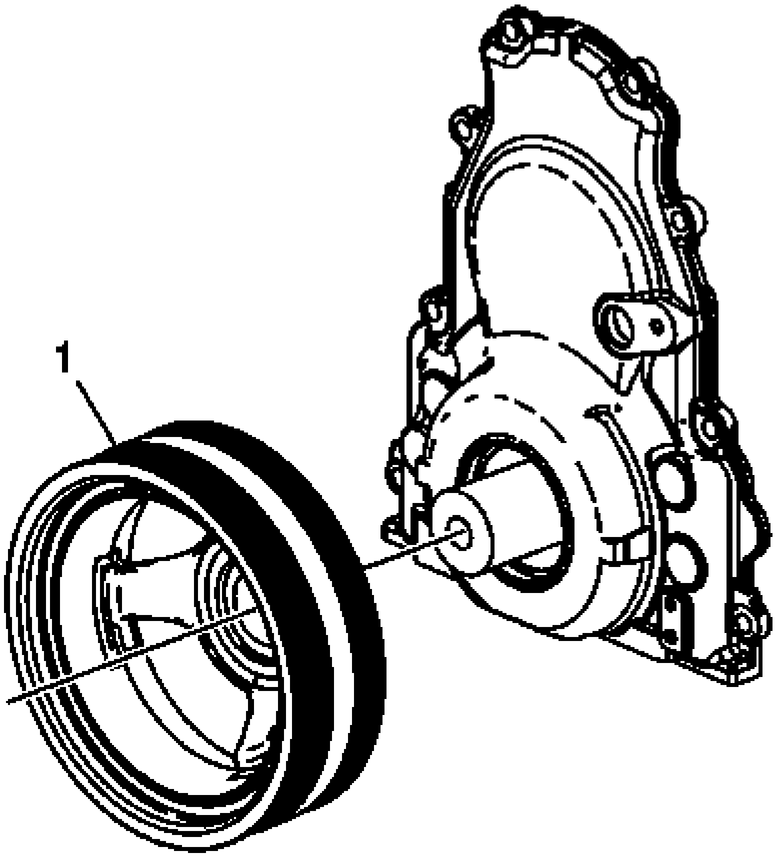


Fig. 296: Balancer
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft balancer (138).
5. Remove the **J 42386-A:** holding tool and bolts.

CRANKSHAFT BALANCER REMOVAL (6.2L LS3)

Special Tools

- **J 41816-A:** Crankshaft Balancer Remover
- **J 41816-2:** Crankshaft End Protector
- **J 42386-A:** Flywheel Holding Tool

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

Removal

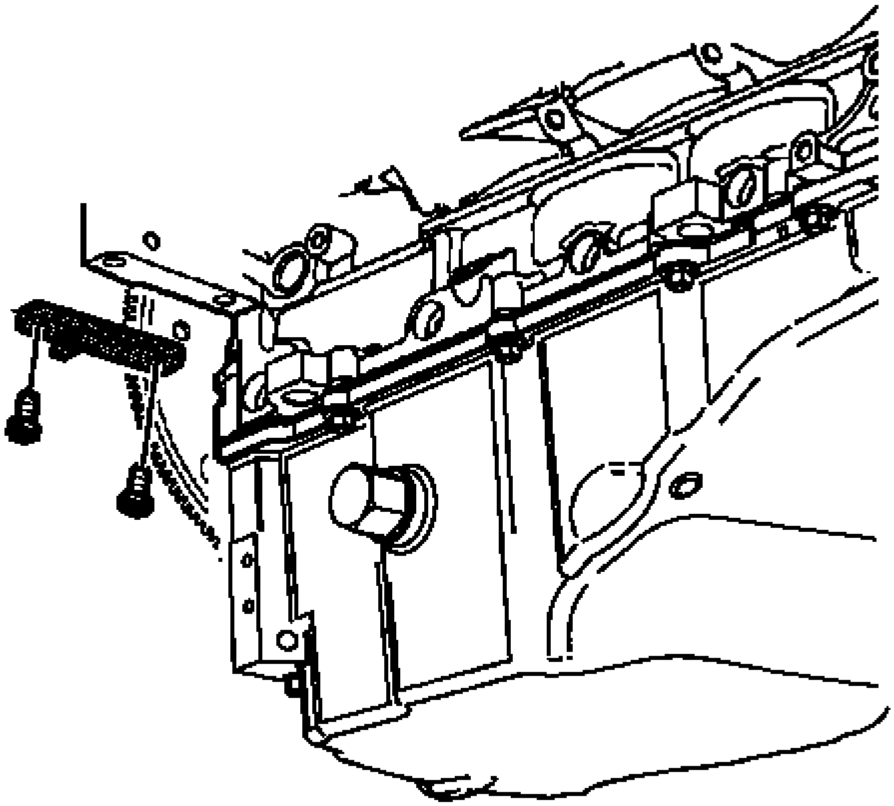


Fig. 297: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the **J 42386-A:** holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

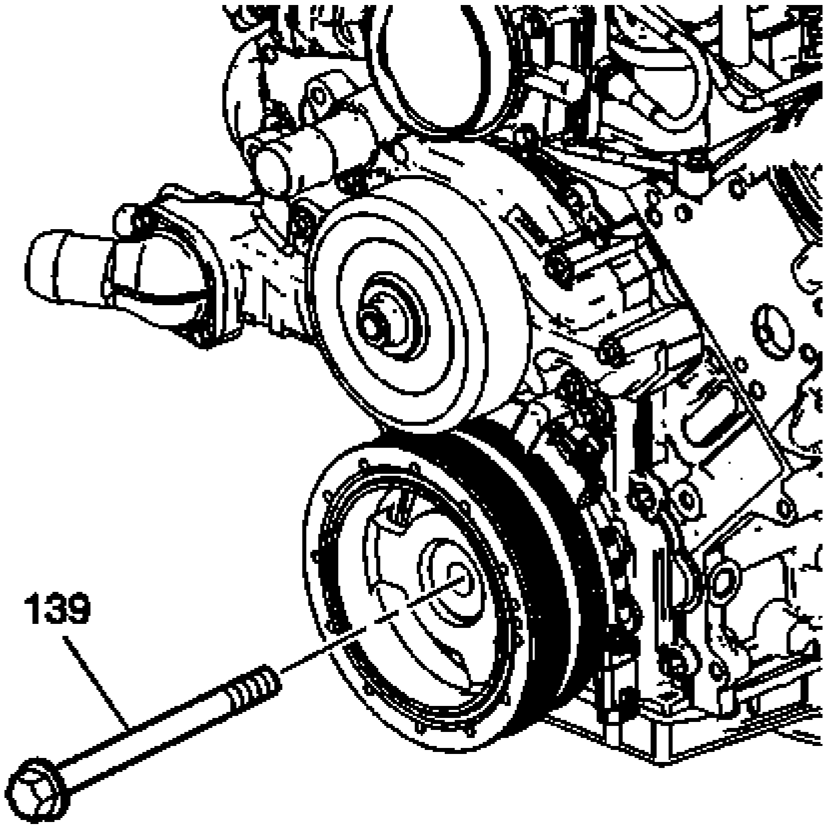


Fig. 298: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt (139).

   Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

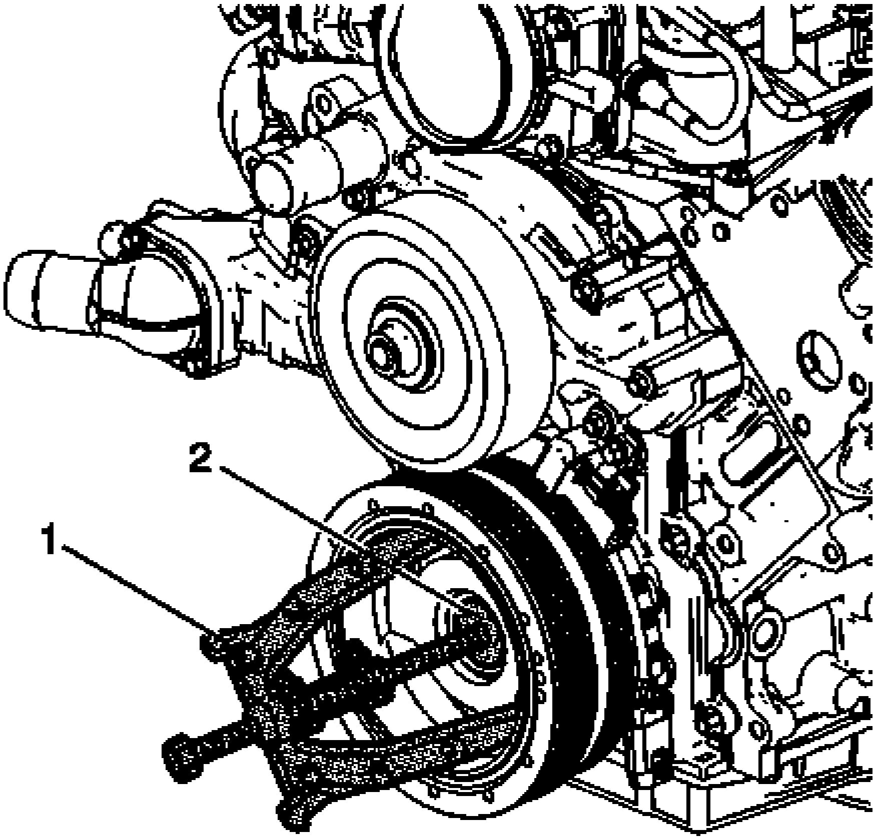


Fig. 299: J 41816 (1) and J 41816-2 (2)
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 41816-A:** remover (1) and the **J 41816-2:** protector (2) in order to remove the crankshaft balancer.

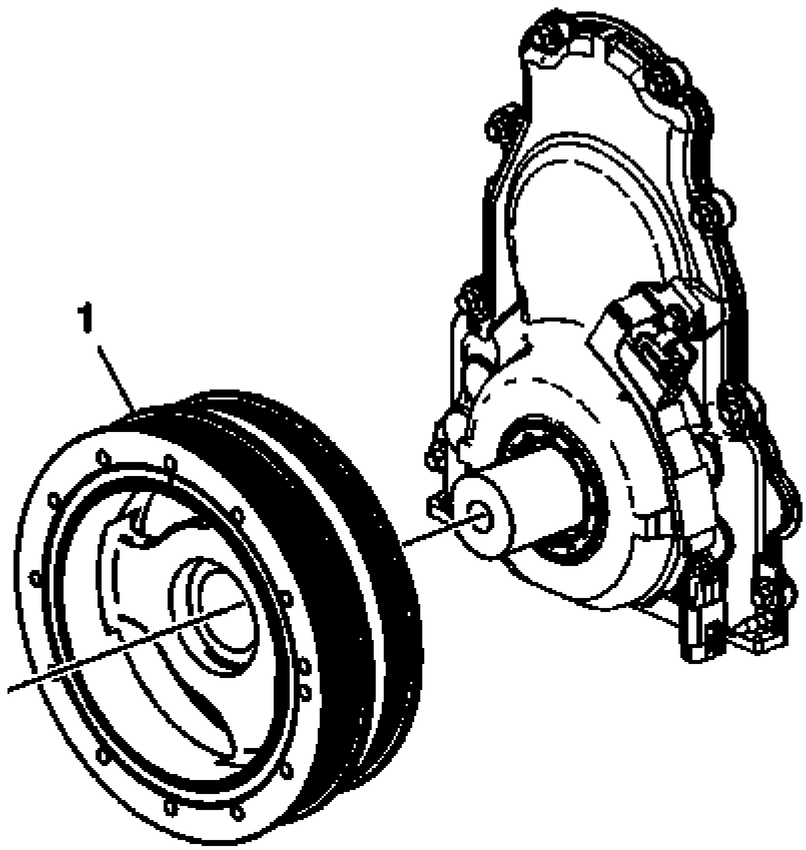


Fig. 300: Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft balancer (1).

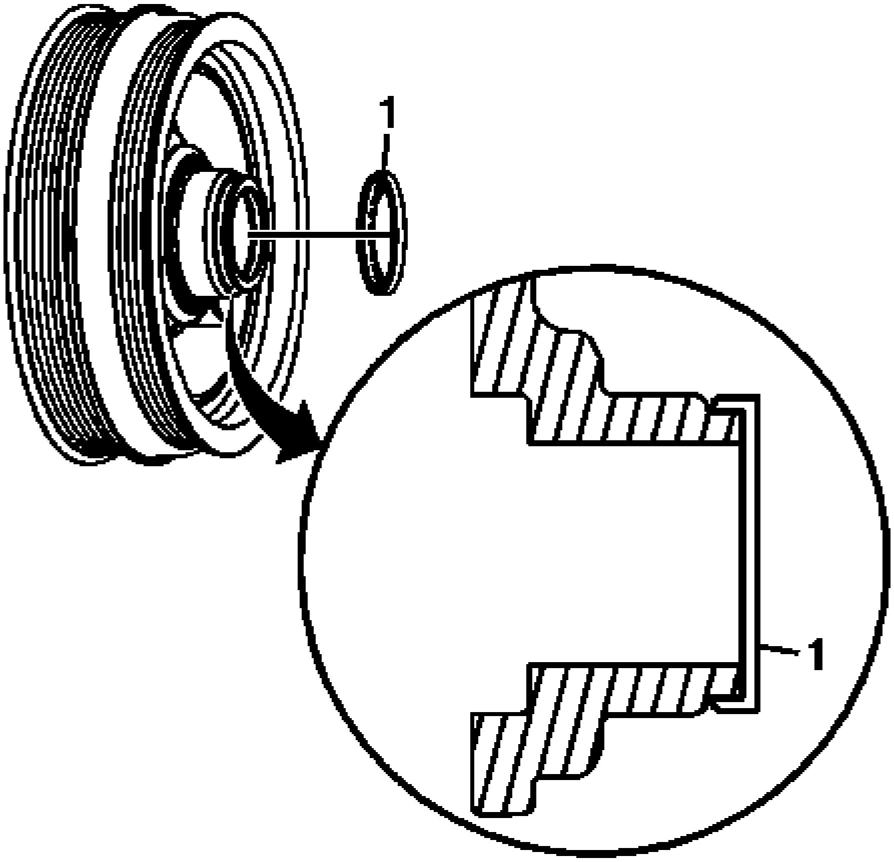


Fig. 301: POA Friction Washer
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft balancer washer (1) from the LS3 balancer as required.

ENGINE FLYWHEEL REMOVAL

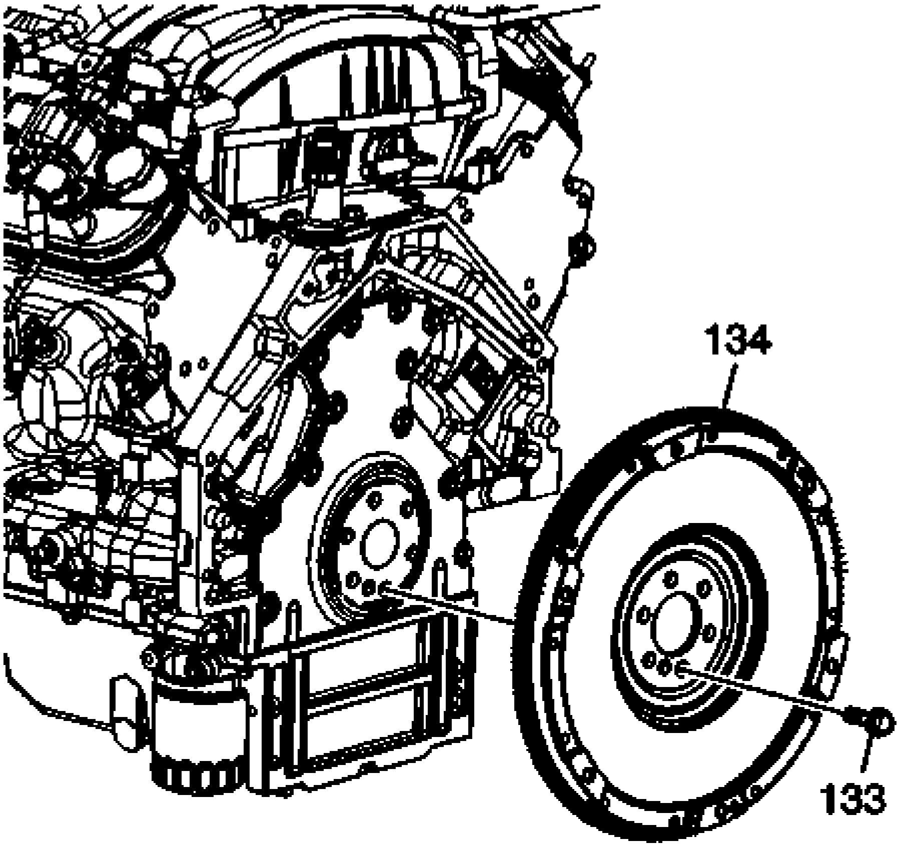


Fig. 302: View Of Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel bolts (133).
2. Remove the manual transmission flywheel (134).

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Removal Procedure

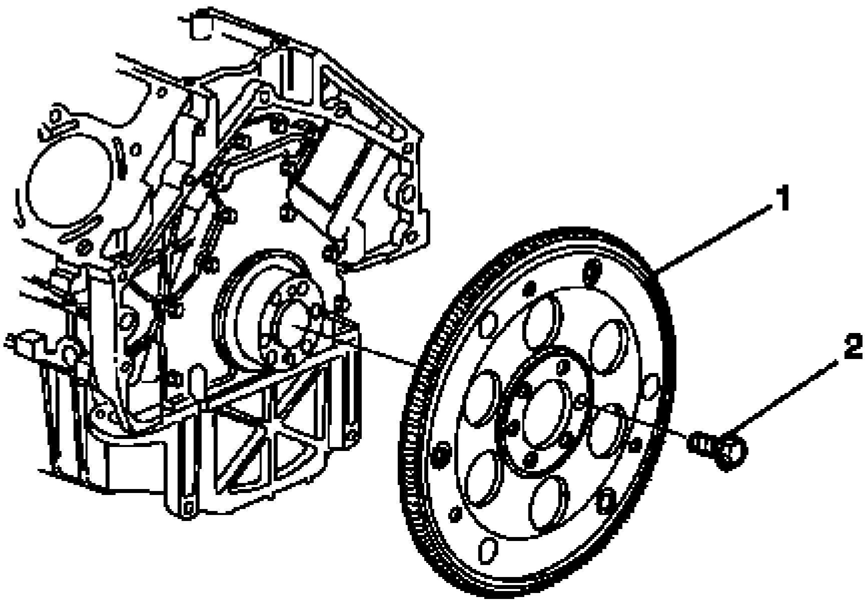


Fig. 303: Identifying Flexplate To Crankshaft Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the position and direction of the flexplate (1) before removal. The flexplate (1) does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flexplate (1) before component removal.

IMPORTANT: The flexplate retaining bolts (2) are single use components only. The flexplate retaining bolts (2) must be replaced upon removal

1. Remove the flexplate to crankshaft retaining bolts (2).
2. Remove the flexplate (1).

CLUTCH PILOT BEARING REMOVAL

Special Tools

- **J 2619-01:** Slide Hammer
- **J 23907:** Slide Hammer with Bearing Adapter

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

Removal

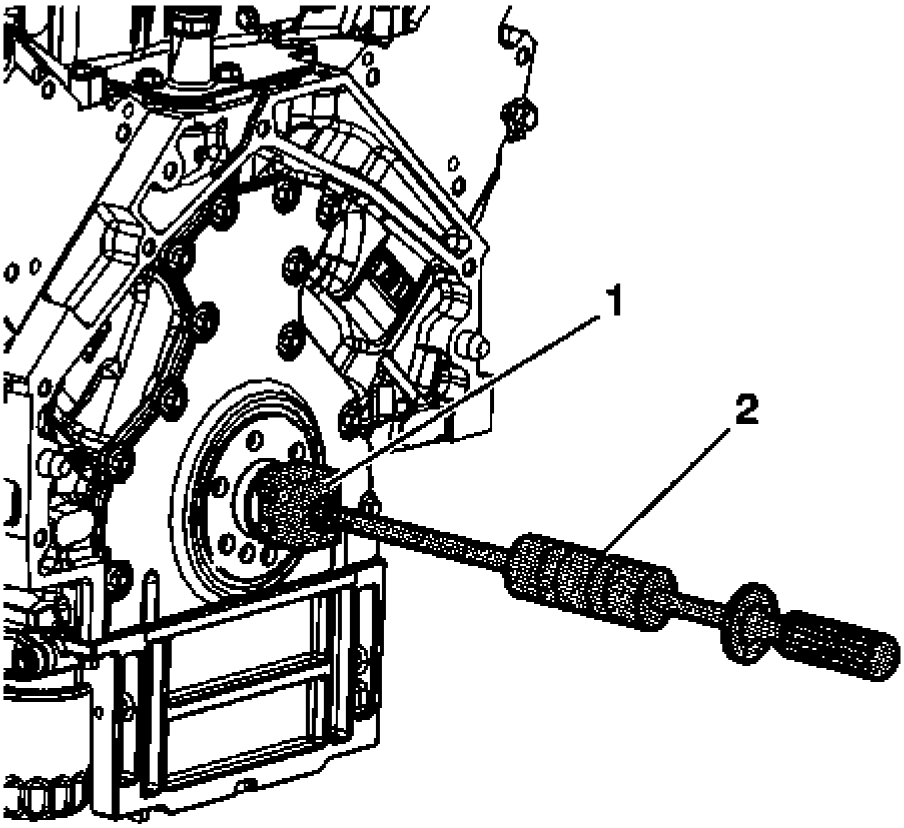


Fig. 304: Removing Clutch Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

1. Remove the clutch pilot bearing using the **J 23907:** slide hammer with bearing adapter (1) and **J 2619-01:** slide hammer (2).
    1. Install the legs of the **J 23907:** slide hammer with bearing adapter (1) into the clutch pilot bearing.
    2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.
    3. Install the **J 2619-01:** slide hammer (2) to the **J 23907:** slide hammer with bearing adapter (1).
    4. Remove the bearing from the rear of the crankshaft.
    5. Remove the **J 23907:** slide hammer with bearing adapter (1) and **J 2619-01:** slide hammer (2) from the bearing.

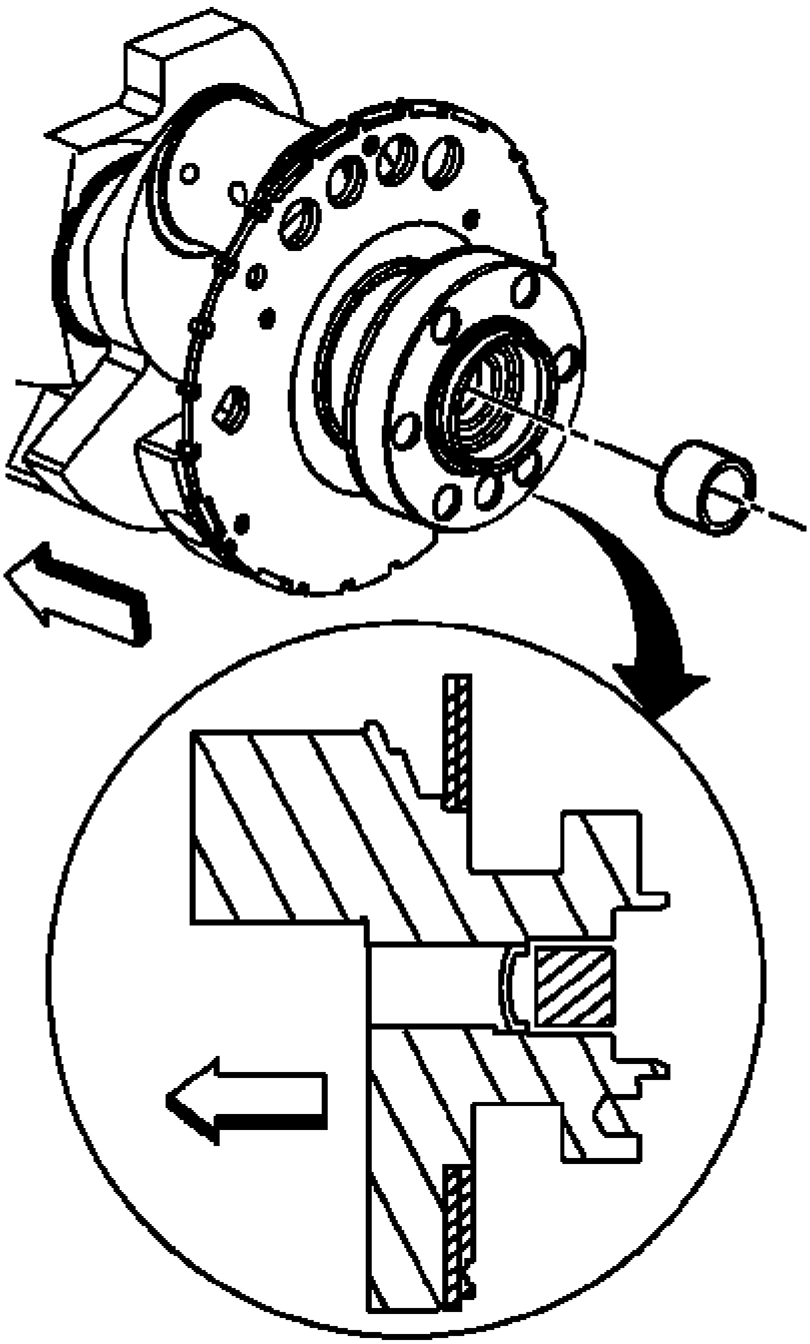


Fig. 305: Locating Clutch Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

2. Discard the bearing.

OIL LEVEL INDICATOR AND TUBE REMOVAL

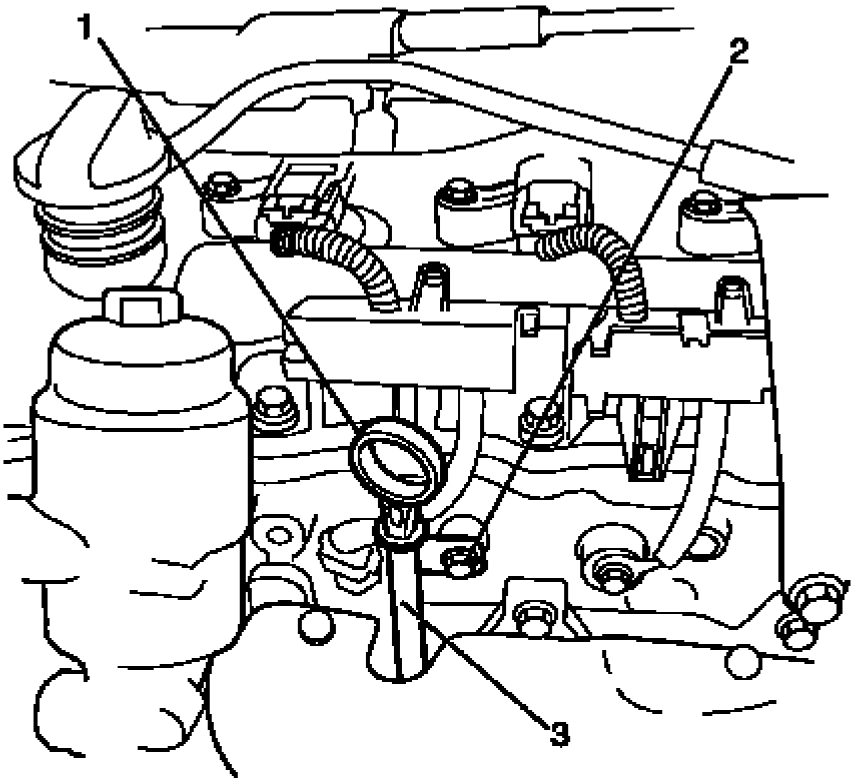


Fig. 306: Identifying Oil Level Indicator Tube Bracket To Cylinder Head Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
2. Remove the oil level indicator (1) from the oil level indicator tube (3).
3. Remove the knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .

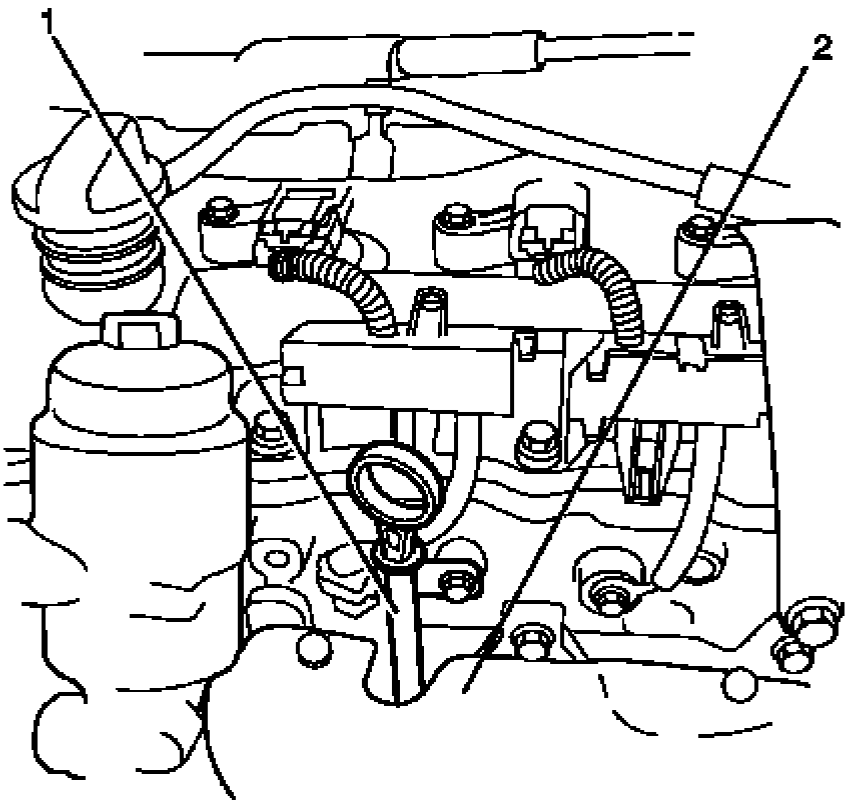


Fig. 307: Identifying Oil Level Indicator Tube & Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level indicator tube (1) up through the exhaust manifold (2).

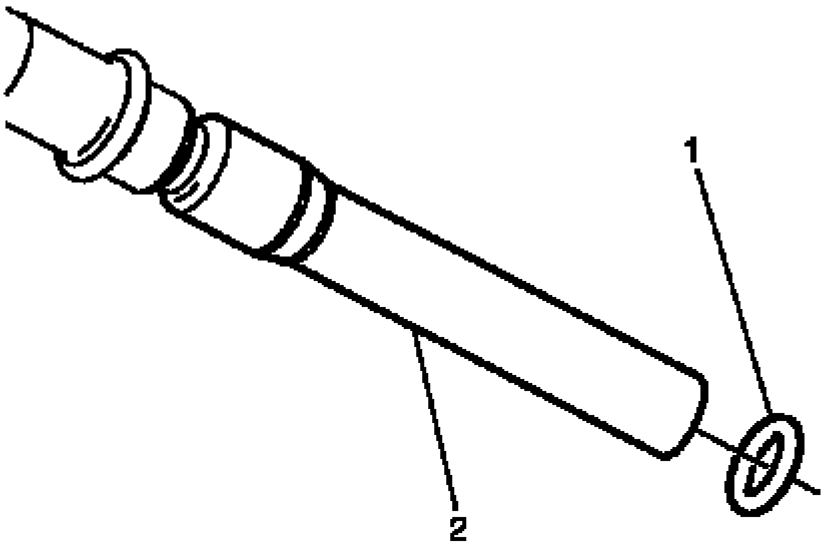


Fig. 308: Identifying Oil Level Indicator Tube & O-Ring
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the O-ring (1) from the oil level indicator tube (2) if damaged.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE (6.2L LS3)

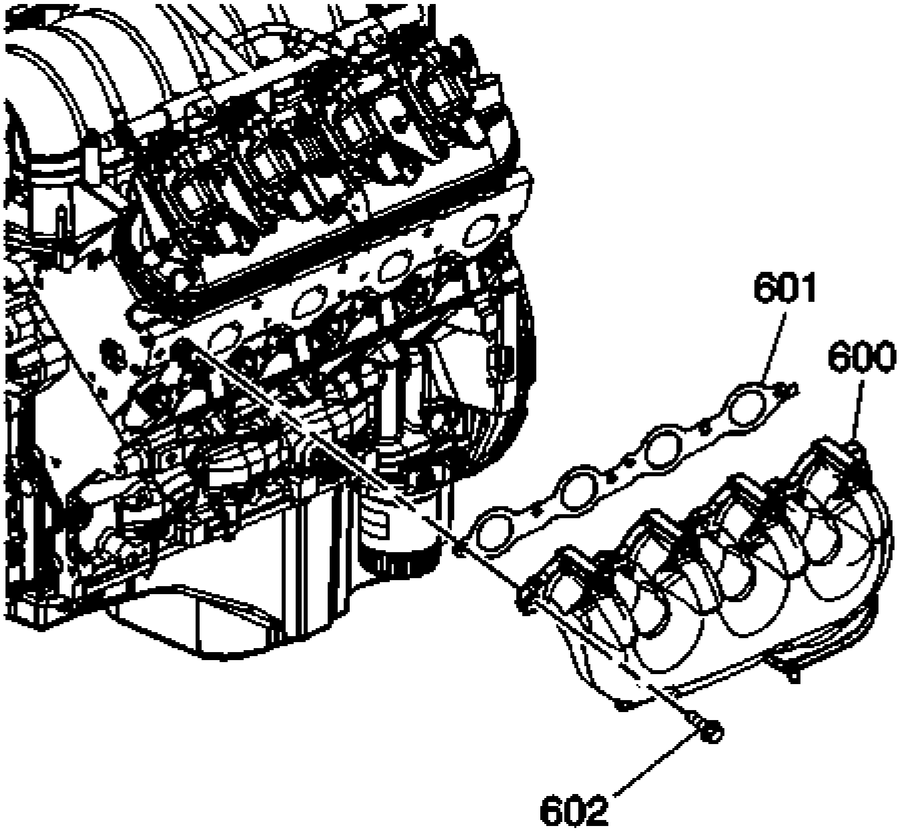


Fig. 309: Exhaust Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.

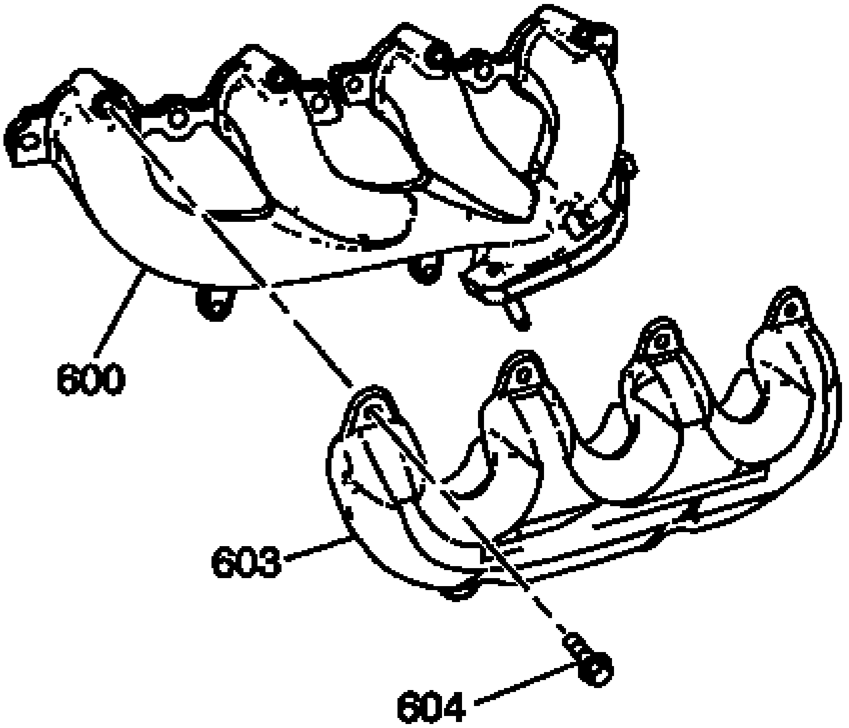


Fig. 310: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

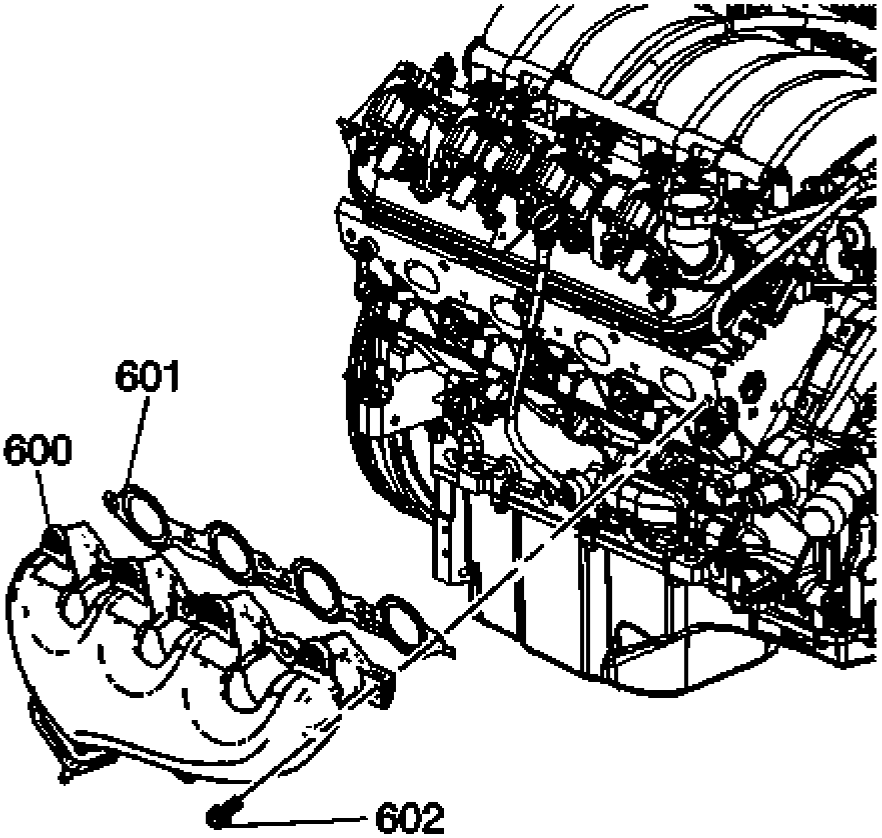


Fig. 311: Exhaust Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.

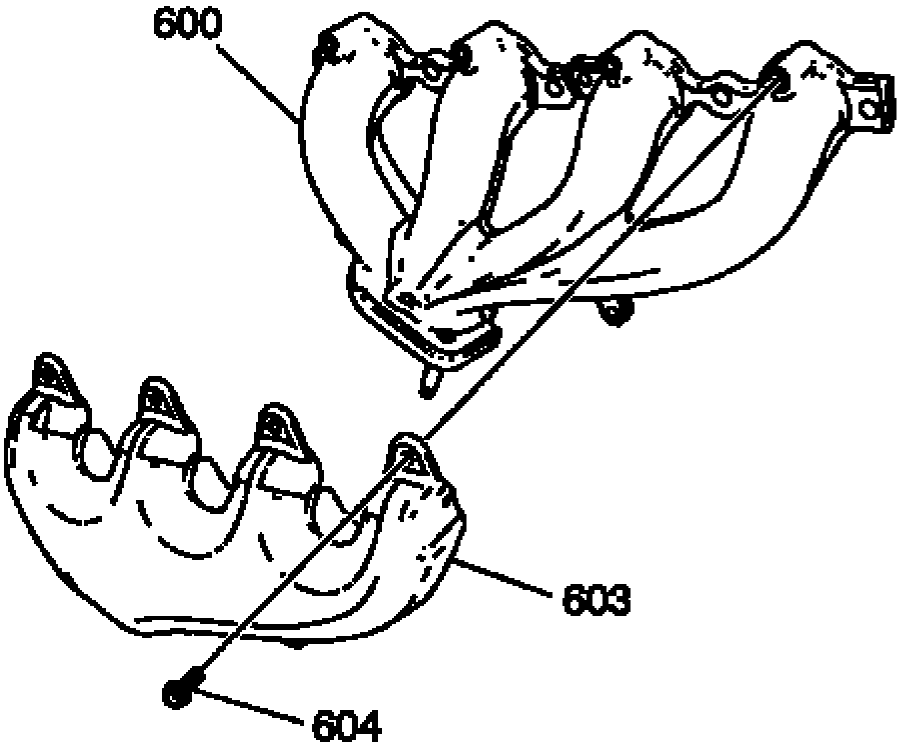


Fig. 312: View Of Heat Shield & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

WATER PUMP REMOVAL

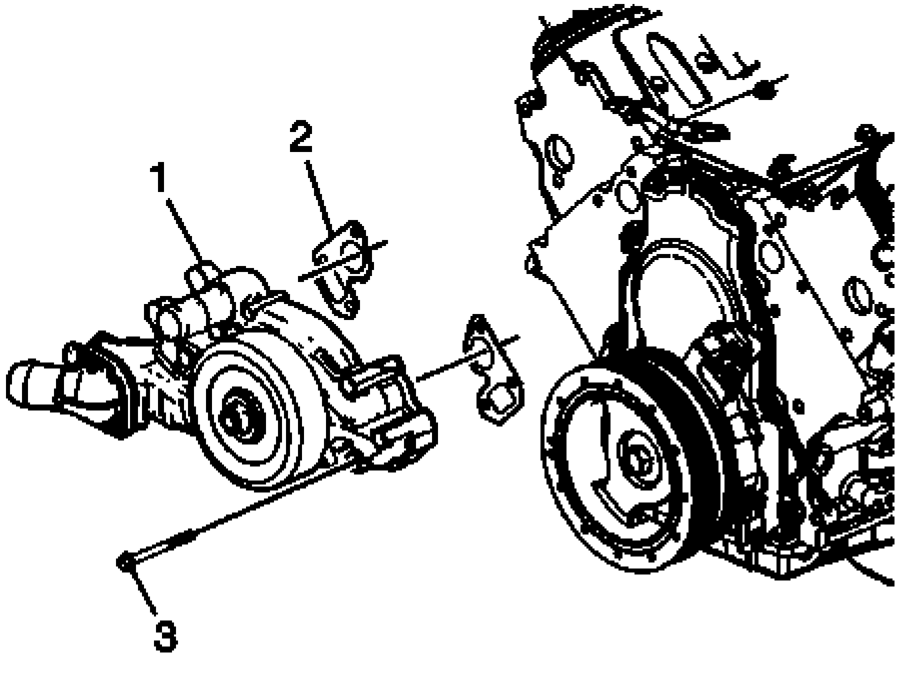


Fig. 313: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump bolts (3).
2. Remove the water pump (1) and gaskets (2).
3. Discard the water pump gaskets.

2009 ENGINEEngine

Mechanical - 6.0L - G8

REPAIR INSTRUCTIONS - OFF VEHICLE

THROTTLE BODY REMOVAL

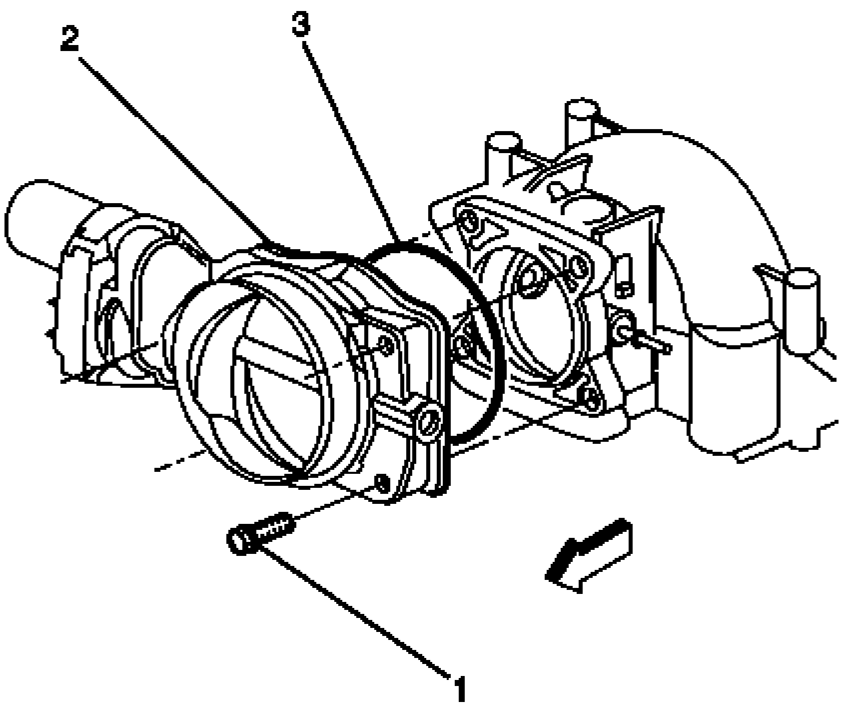


Fig. 1: Identifying Throttle Body To Intake Manifold Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

NOTE: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body to intake manifold retaining bolts (3).

2. Remove the throttle body (1).
3. Remove the throttle body gasket (2).

   Discard the throttle body gasket (2).

FUEL RAIL AND INJECTORS REMOVAL

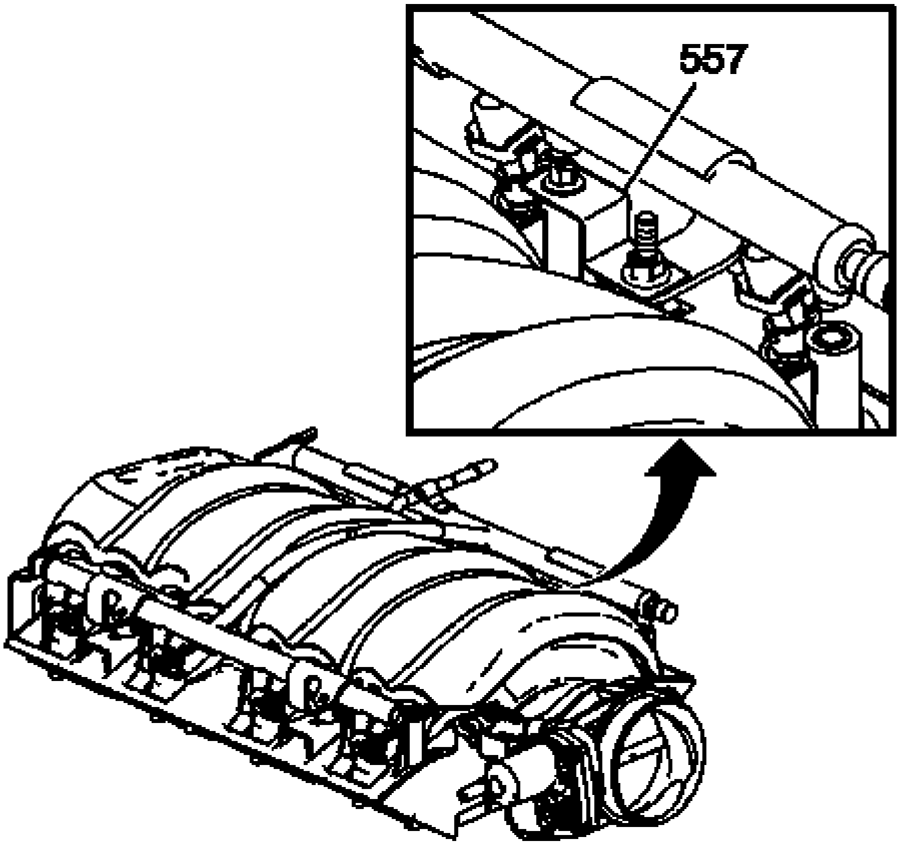


Fig. 2: Fuel Rail Ground Strap
Courtesy of GENERAL MOTORS CORP.

WARNING: **Refer to Fuel Rail Stop Bracket Installation Warning .**

NOTE:

- **The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the intake manifold as a complete assembly.**
- **Do not separate the fuel injectors from the fuel rail unless component service is required.**
- **Use cleanliness and care when handling the fuel system**

components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Note the location of the fuel rail ground strap (557).

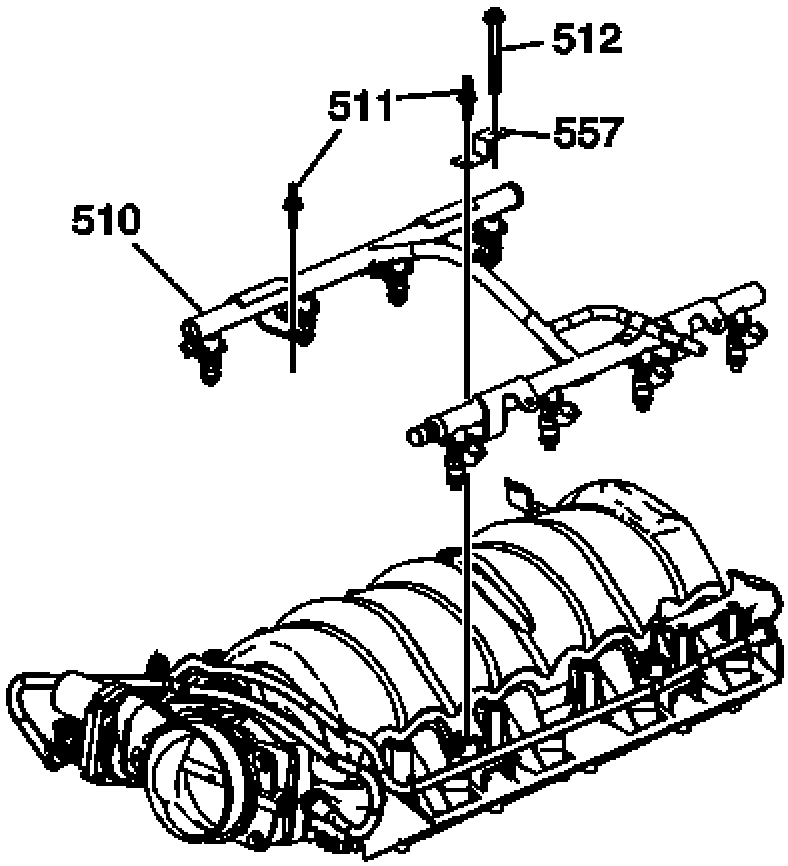


Fig. 3: Fuel Rail Assembly
Courtesy of GENERAL MOTORS CORP.

2. Remove the bolts (511 and 512), ground strap (557), and fuel rail with injectors (510). Lift evenly on both sides of the fuel rail until all injectors have left their bores.

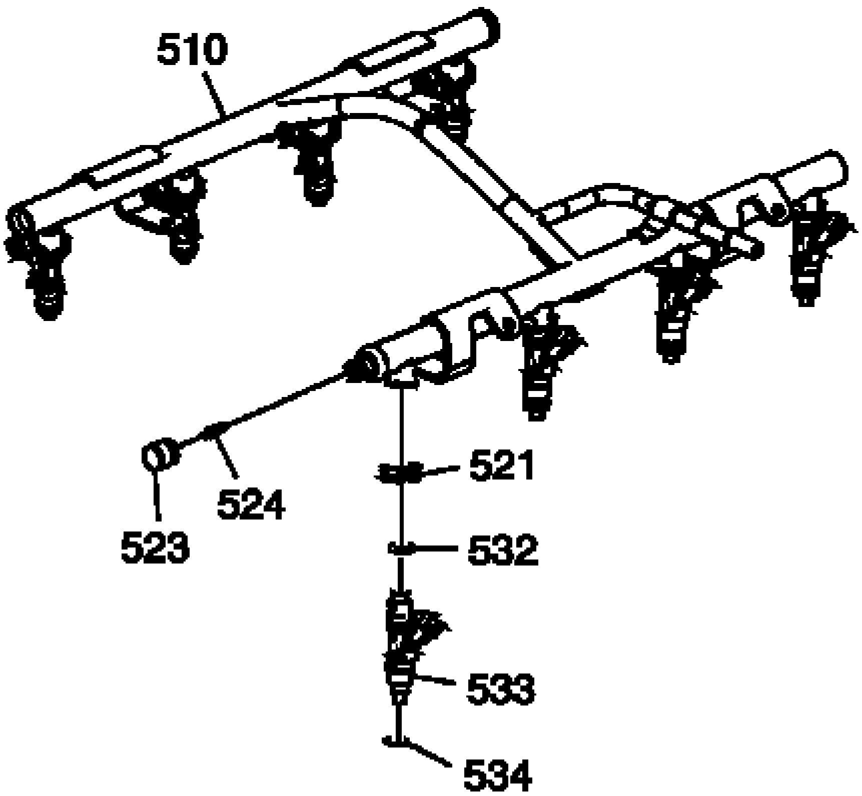


Fig. 4: Fuel Injectors & Retainers
Courtesy of GENERAL MOTORS CORP.

3. Remove the fuel injectors (533) and retainers (521).
4. Remove the O-rings (532 and 534), as required.
5. Remove the cap (523) and service valve (524), as required.

INTAKE MANIFOLD REMOVAL

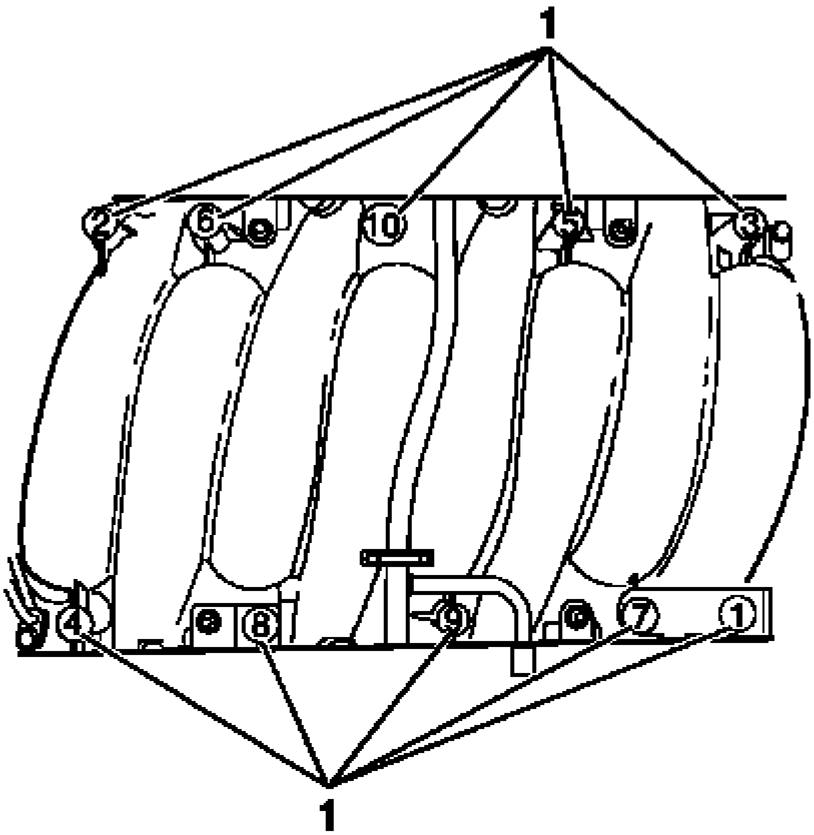


Fig. 5: Identifying Intake Manifold To Cylinder Head Retaining Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: **The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.**

NOTE: **Removal of the intake manifold to cylinder head retaining bolts (1-10) should be performed in sequence. Failing to do so may distort the intake manifold (B).**

1. Remove the intake manifold to cylinder head retaining bolts (A) in sequence.

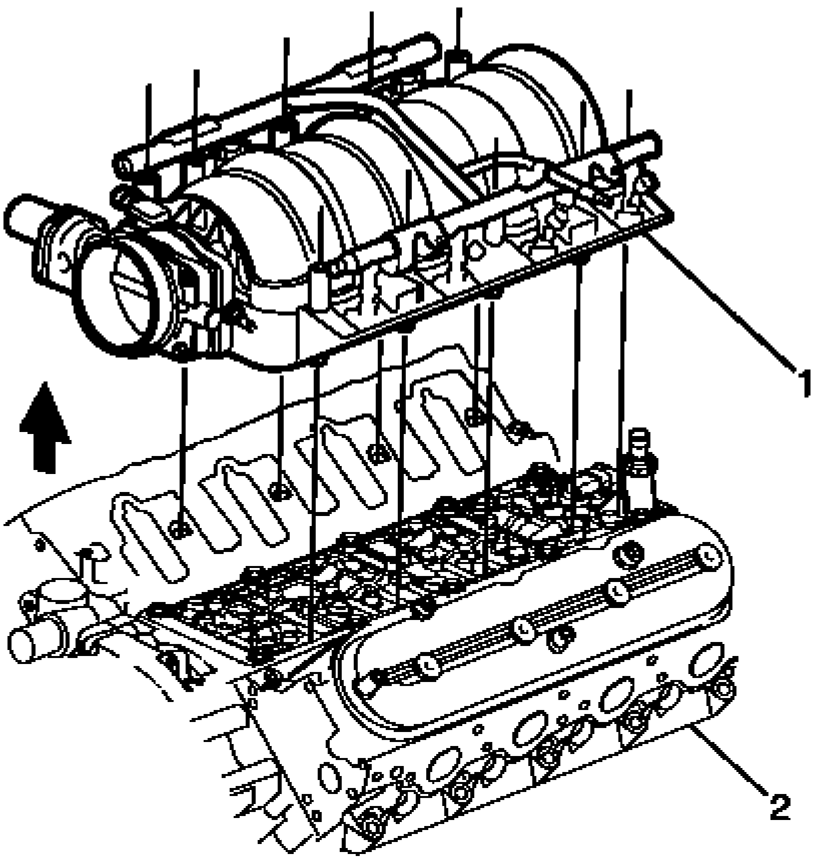


Fig. 6: Locating Intake Manifold & Engine
Courtesy of GENERAL MOTORS CORP.

2. Remove the intake manifold (1) from the engine (2).
3. Plug the engine (2) with a clean lint free cloth.

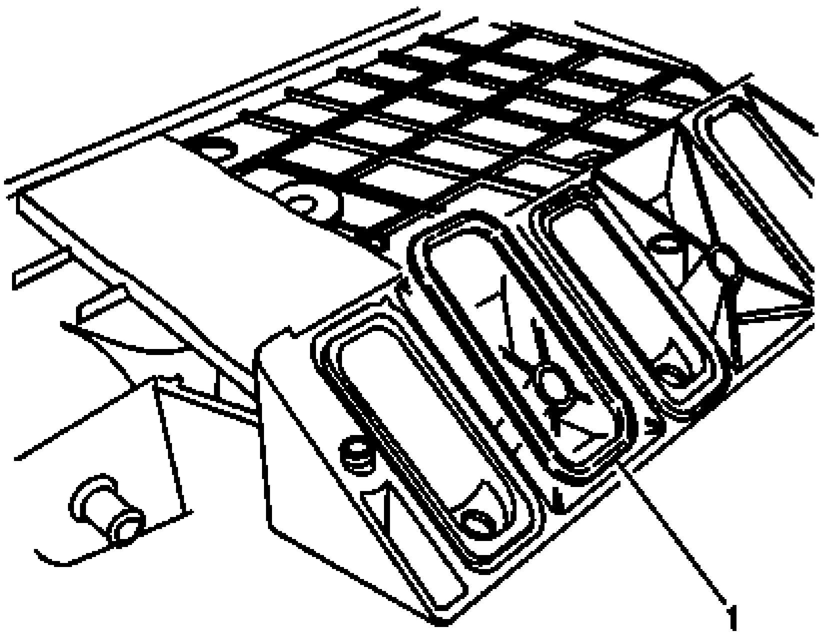


Fig. 7: Identifying Intake Manifold To Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold to cylinder head gaskets (1).

   Discard the intake manifold to cylinder head gaskets (1).

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

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER REMOVAL

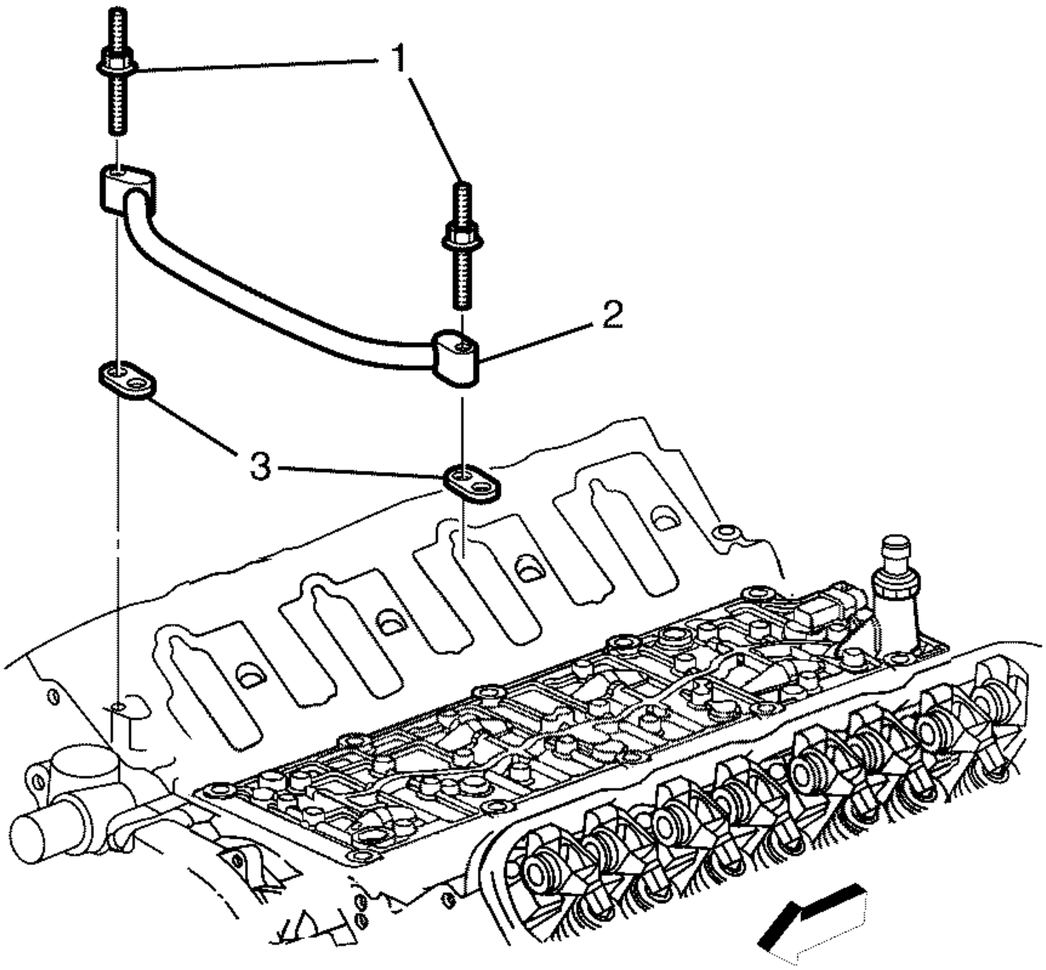


Fig. 8: Identifying Engine Coolant Air Bleed Pipe To Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine coolant air bleed pipe to cylinder head retaining bolts (1).
2. Remove the engine coolant air bleed pipe (2).

IMPORTANT: The engine coolant air bleed pipe seals (3) are single use only components and must be replaced whenever engine coolant air bleed pipe (2) is removed from the engine.

3. Remove the engine coolant air bleed pipe seals (3).

   Discard the engine coolant air bleed pipe seals (3).

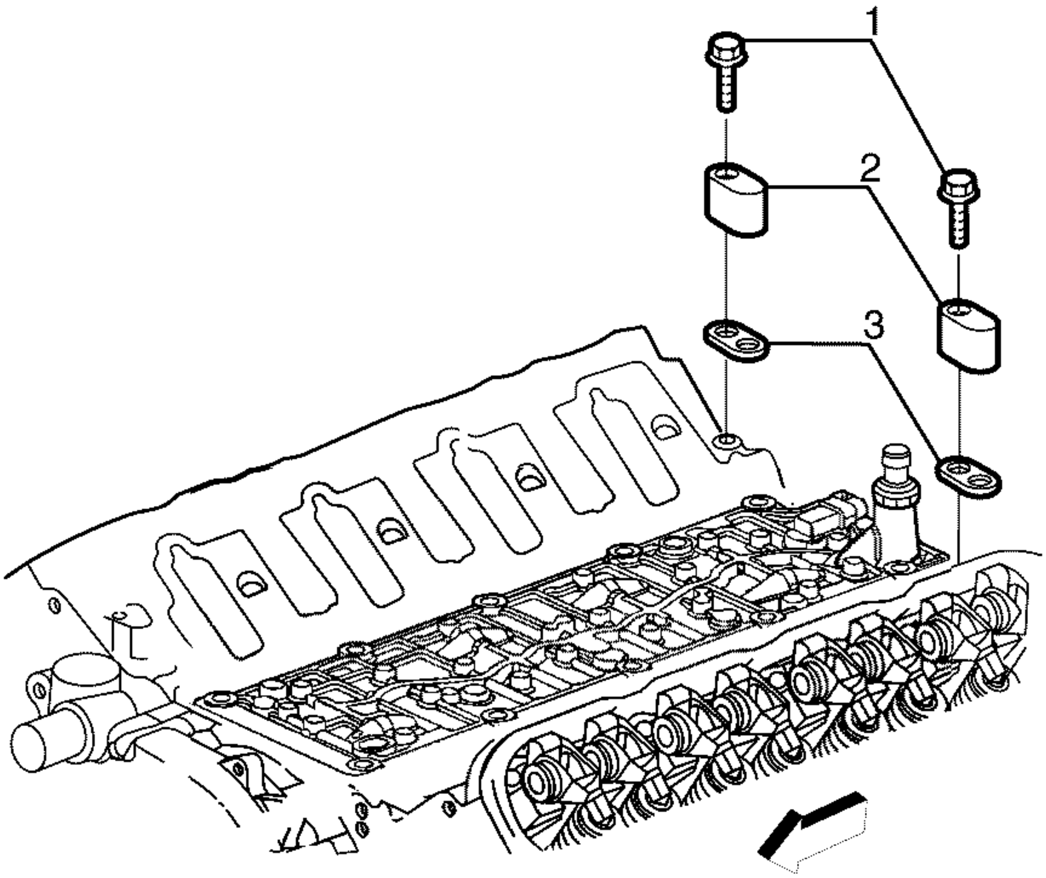


Fig. 9: Identifying Engine Coolant Air Bleed Cover To Cylinder Head Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine coolant air bleed cover to cylinder head retaining bolts (1).
5. Remove the engine coolant air bleed covers (2).

IMPORTANT: The engine coolant air bleed cover seals (3) are single use only components and must be replaced whenever engine coolant air bleed covers (2) are removed from the engine.

6. Remove the engine coolant air bleed cover (2) seals (3).

   Discard the engine coolant air bleed cover seals (3).

ENGINE BLOCK VALLEY COVER REMOVAL

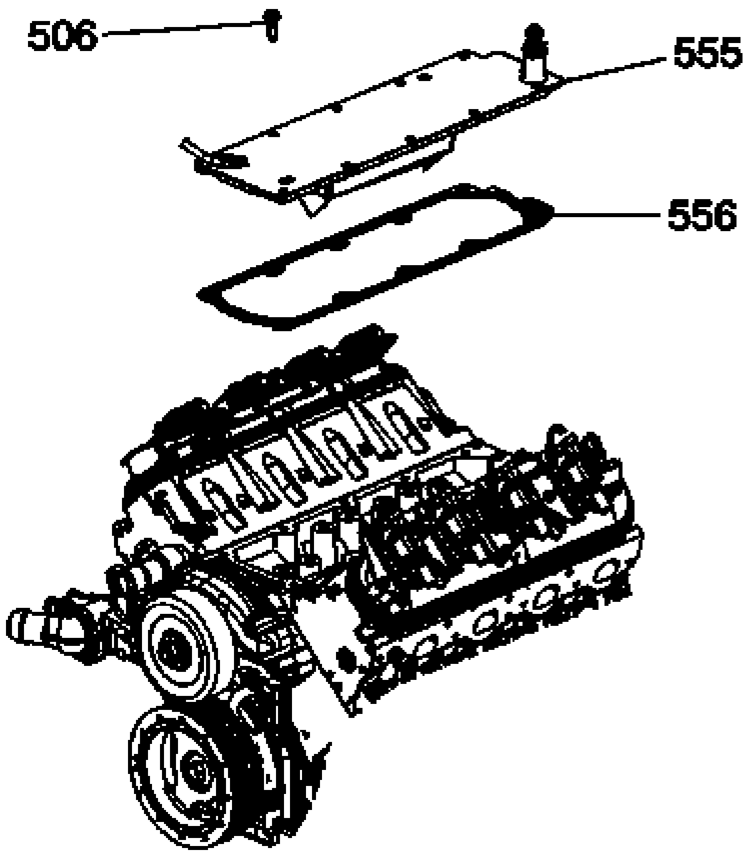


Fig. 10: View Of Engine Valley Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).

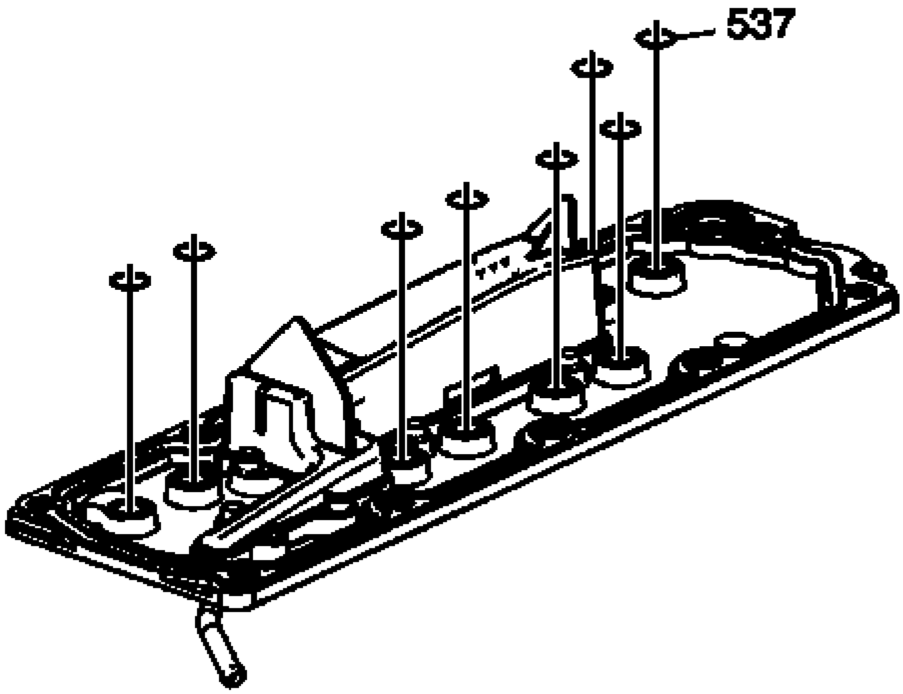


Fig. 11: Valley Cover Seals & Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove the seals (537) from the cover.

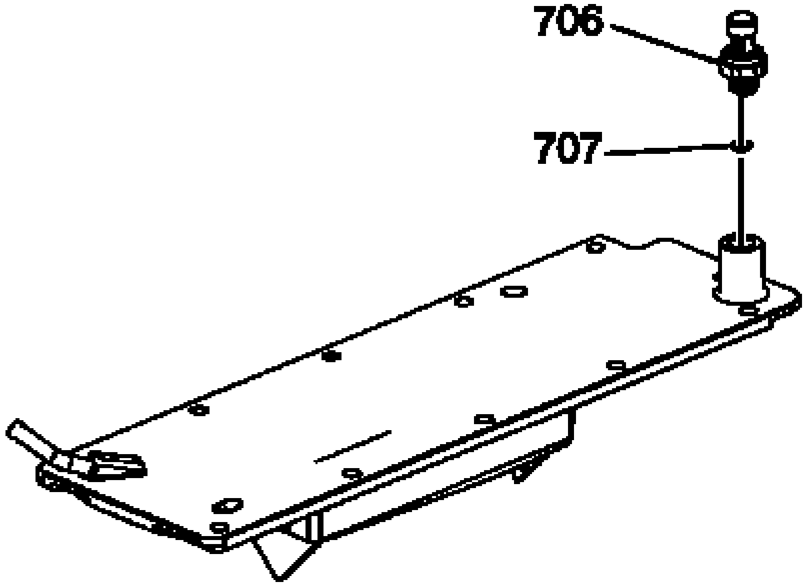


Fig. 12: Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine oil pressure sensor (706) and seal (707), as required.

VALVE LIFTER OIL MANIFOLD REMOVAL

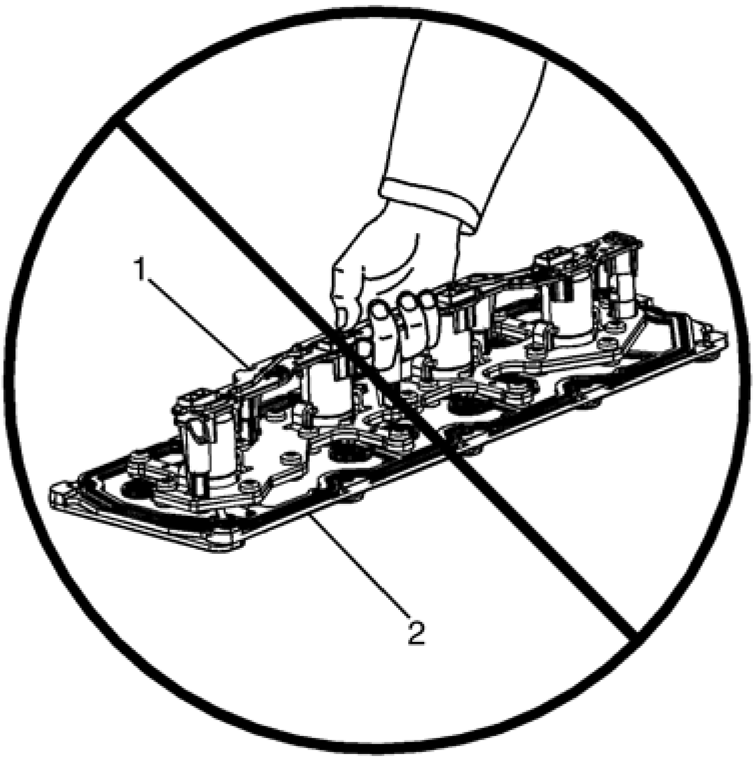


Fig. 13: Identifying Improper Lifting Of VLOM
Courtesy of GENERAL MOTORS CORP.

1. DO NOT lift the Valve Lifter Oil Manifold (VLOM) (2) by the electrical lead frame (1).

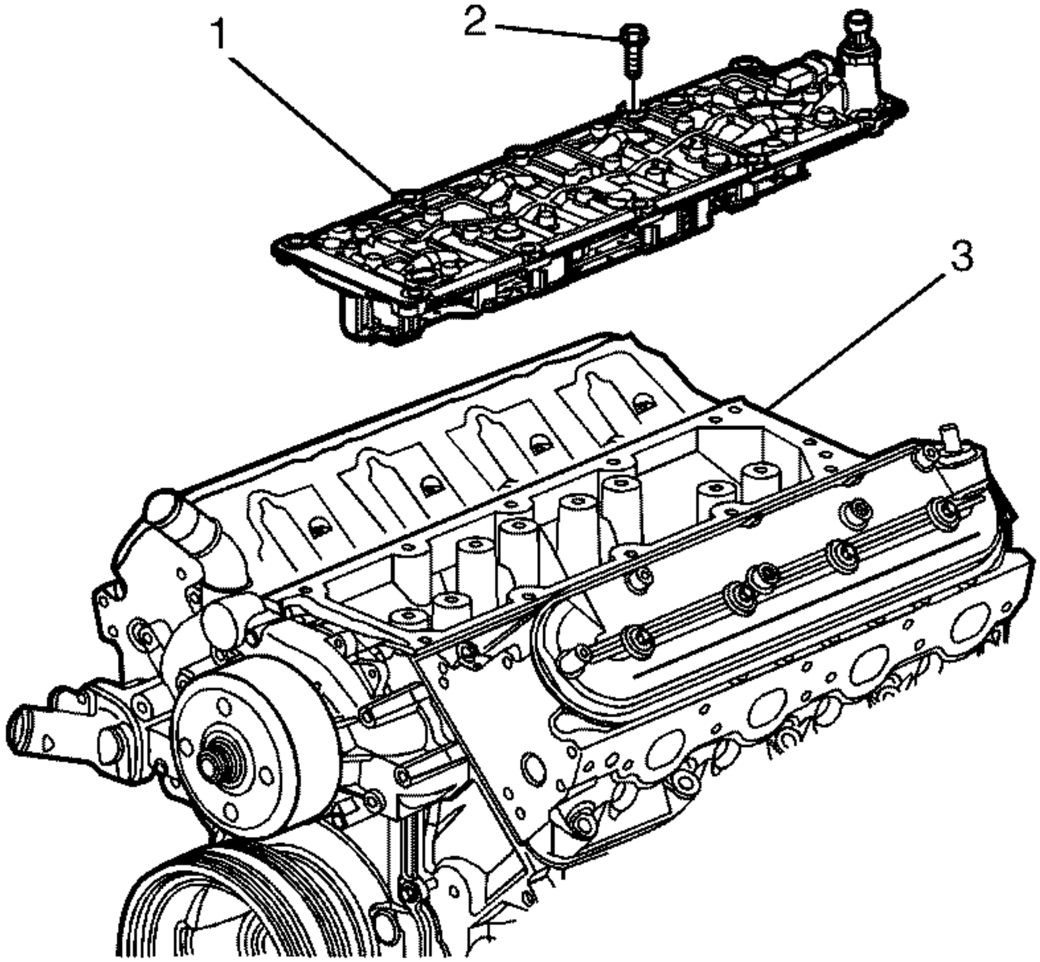


Fig. 14: Identifying VLOM To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the VLOM to cylinder retaining bolts (2).
3. Remove the VLOM (1) from the cylinder block (3).

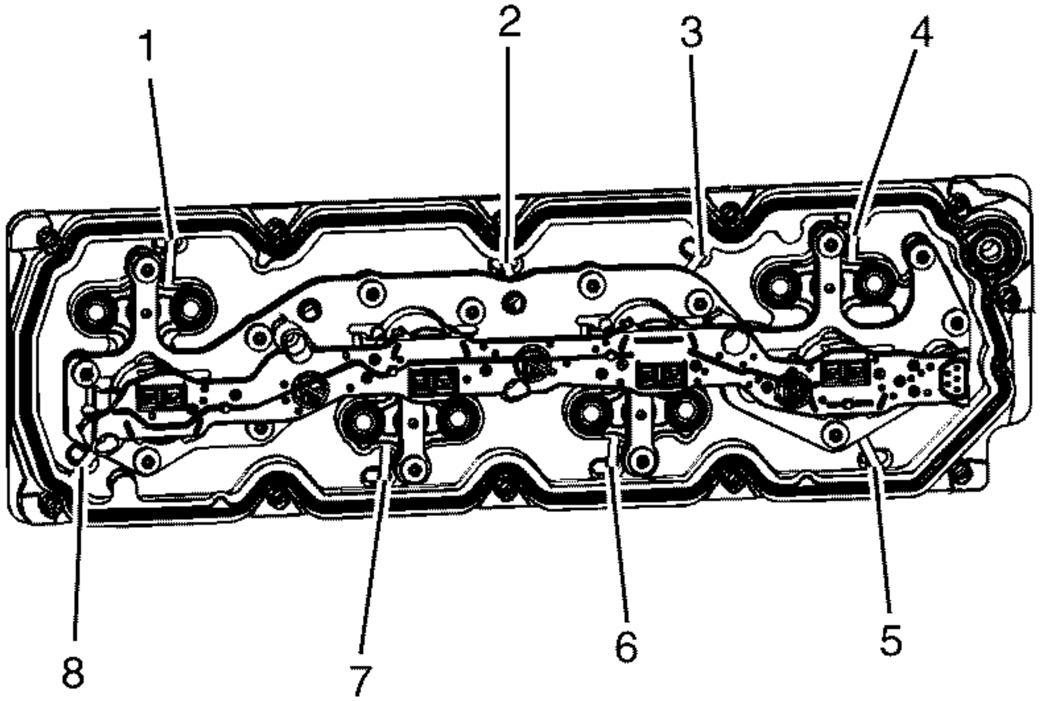


Fig. 15: Identifying VLOM Outer Gasket Retaining Strap Locations
Courtesy of GENERAL MOTORS CORP.

4. Identify the 8 VLOM outer gasket retaining strap locations (1-8).

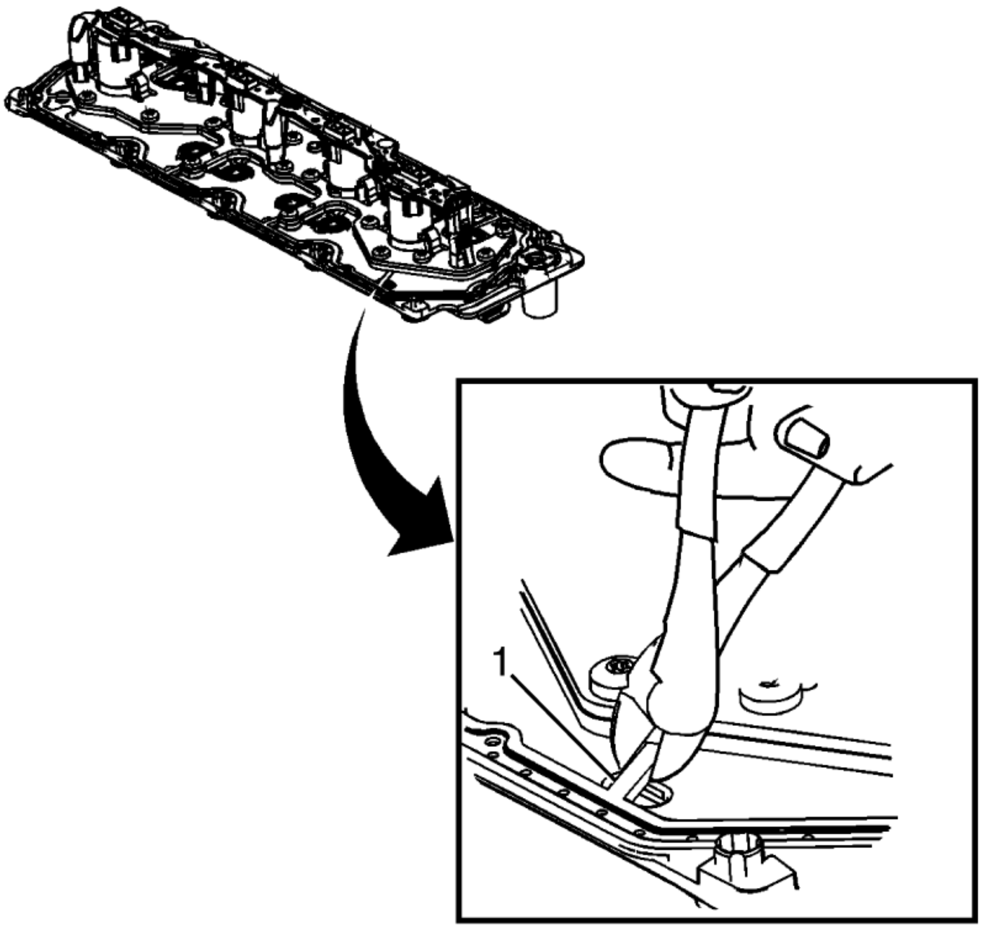


Fig. 16: View Of Cutting VLOM Outer Gasket Retaining Straps
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.**

5. Cut the 8 VLOM outer gasket retaining straps (1).

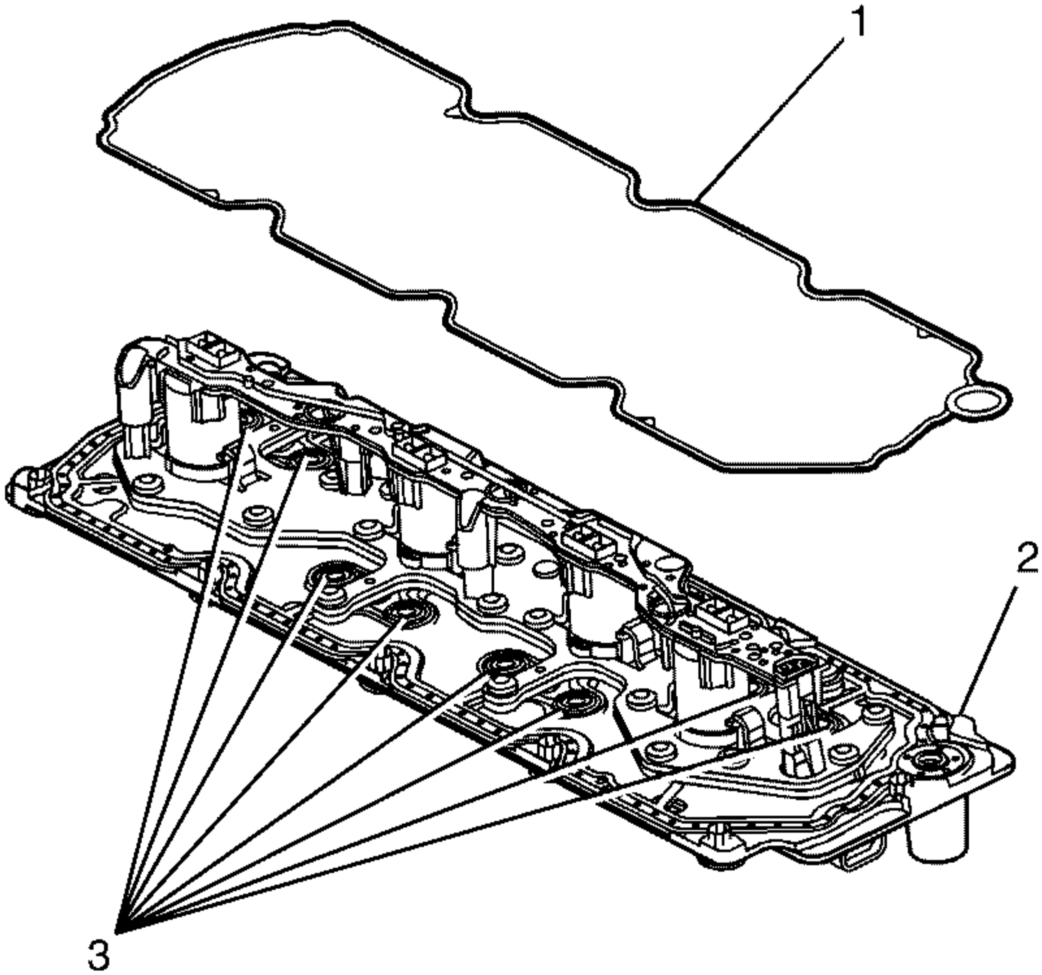


Fig. 17: Identifying VLOM & Outer Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the VLOM outer gasket (1) from the VLOM (2).

VALVE LIFTER OIL FILTER REMOVAL

Tools Required

J 41712 Oil Pressure Switch Socket

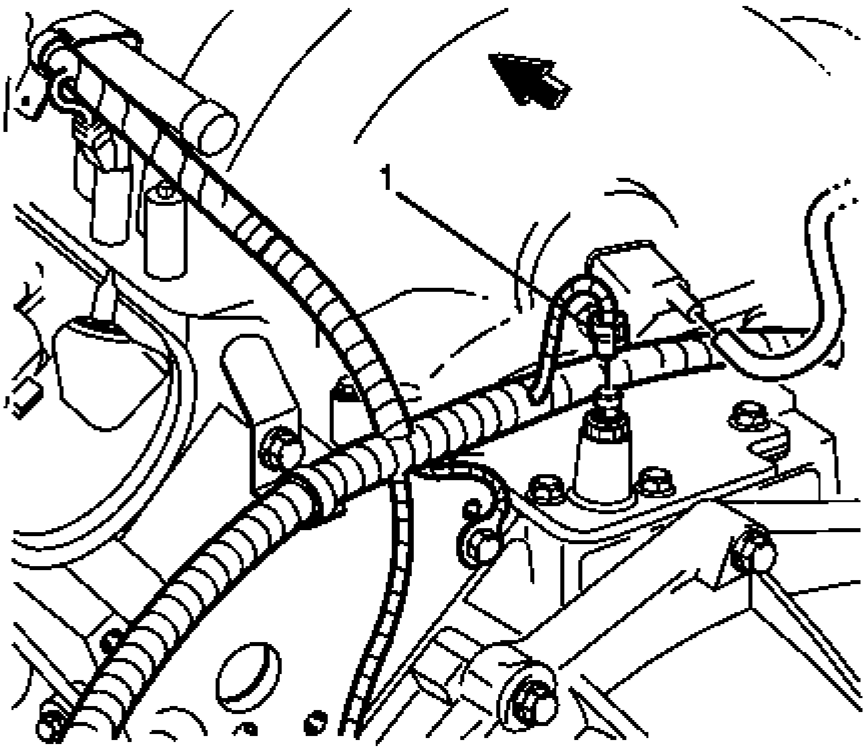


Fig. 18: Identifying Oil Pressure Sensor Wiring Harness Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the oil pressure sensor wiring harness connector (1).

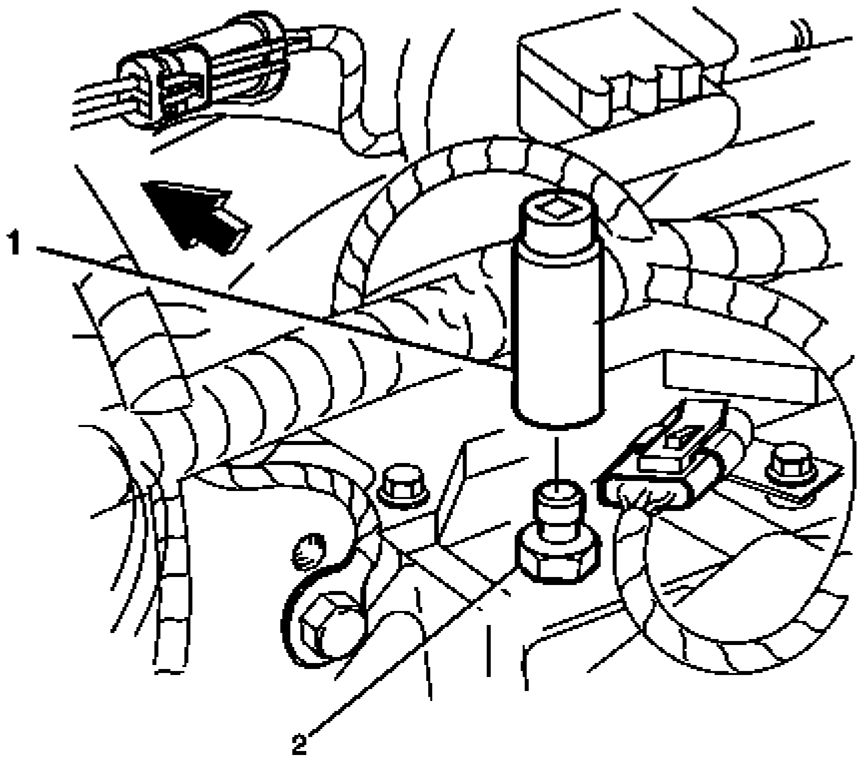


Fig. 19: Identifying Oil Pressure Sensor & J 41712
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Clean the area around the oil pressure sensor (2) before removal. This prevents debris from entering the engine.

2. Use the **J 41712** (1) to remove the oil pressure sensor (2).

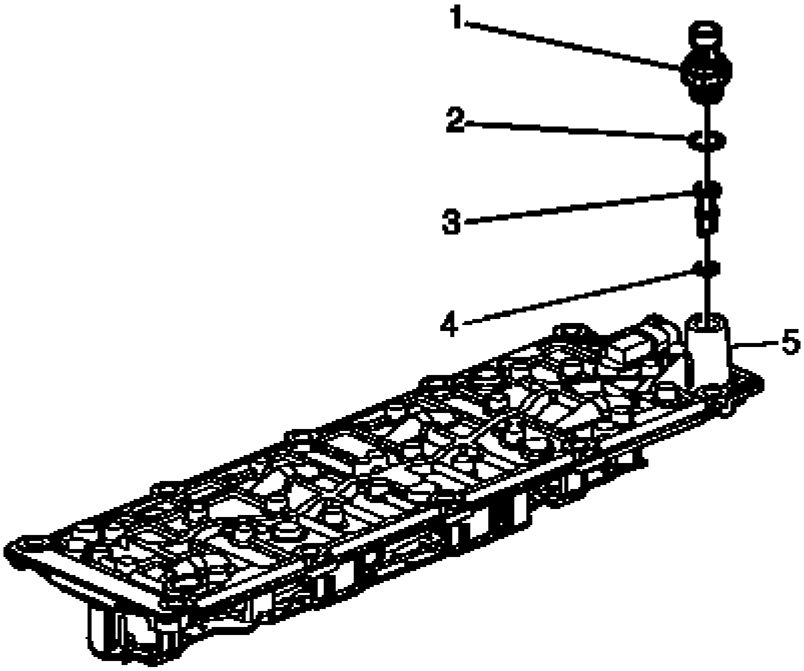


Fig. 20: View Of VLOM, Oil Pressure Sensor, Washer, Valve Lifter Oil Filter & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor (1) and washer (2) from the Valve Lifter Oil Manifold (VLOM) (5).

IMPORTANT: The valve lifter oil filter (3) should be replaced whenever the oil pressure sensor (1) is removed.

4. Remove the valve lifter oil filter (3).

   Discard the filter.

IMPORTANT: The valve lifter oil filter O-ring seal (4) is a single use only part and must be replaced whenever the valve lifter oil filter (3) is removed.

5. Remove and discard the valve lifter oil filter O-ring seal (4).

   Discard the O-ring seal.

VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE

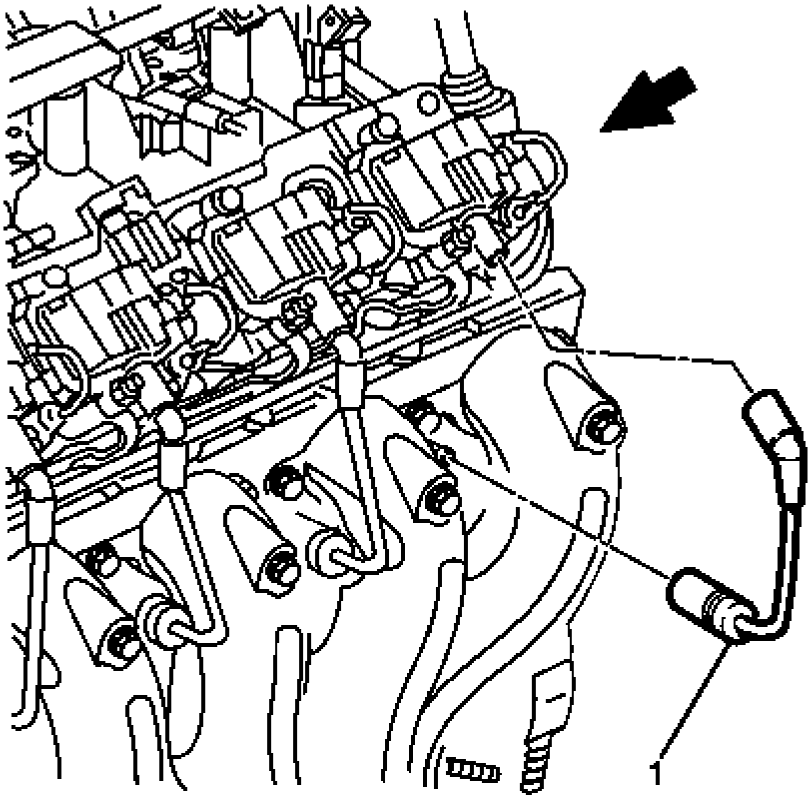


Fig. 21: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug leads (1).

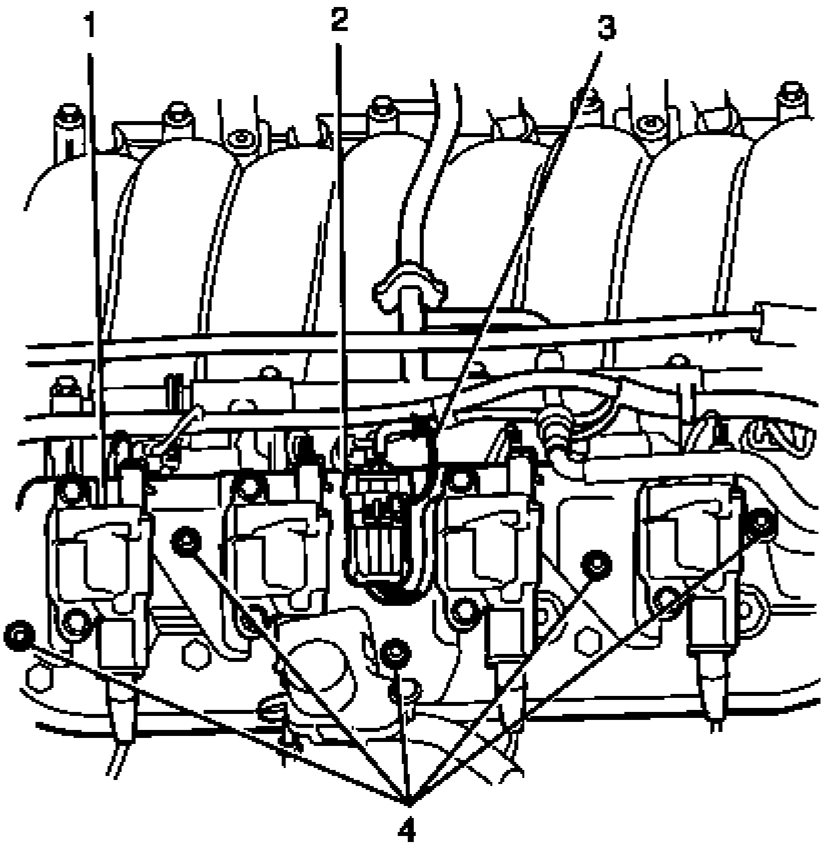


Fig. 22: Identifying Ignition Coil Assembly To Valve Rocker Arm Cover Retaining Studs (Left Side)
Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
3. Remove the ignition coil assembly (1).

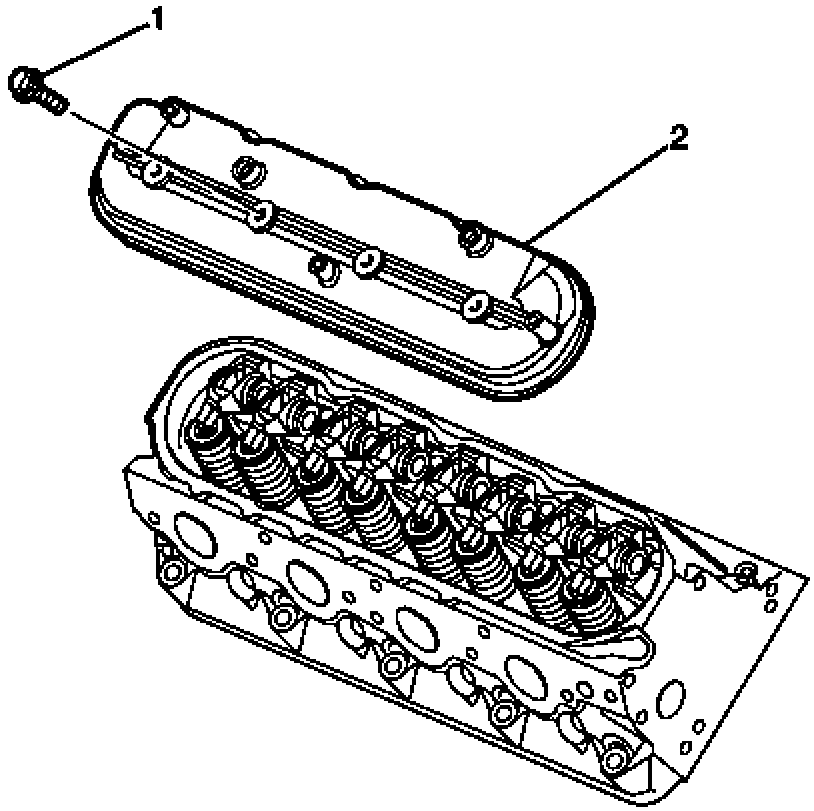


Fig. 23: Identifying Valve Rocker Arm Cover To Cylinder Head Retaining Bolts (Left Side)
Courtesy of GENERAL MOTORS CORP.

4. Loosen the valve rocker arm cover to cylinder head retaining bolts (1).
5. Remove the valve rocker cover (2).
6. 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.

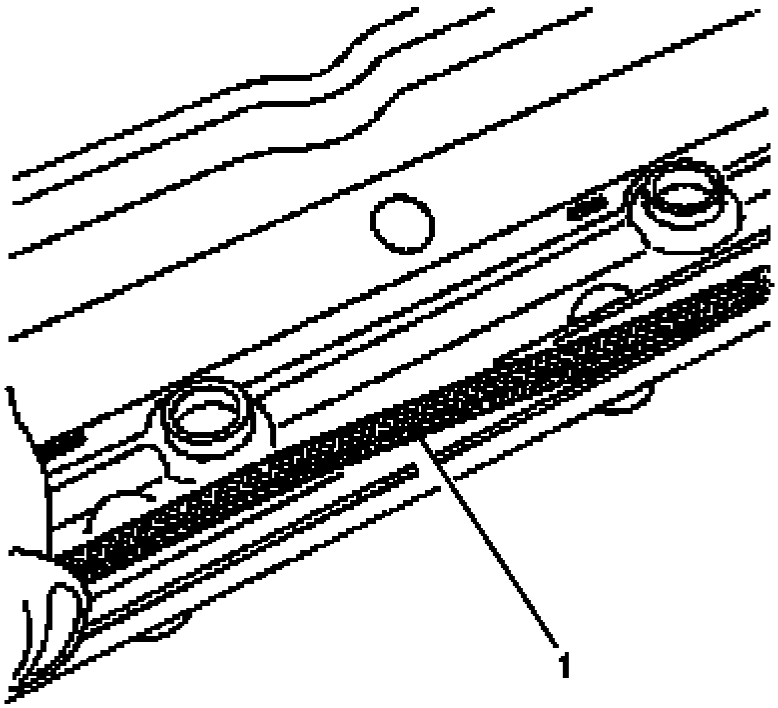


Fig. 24: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

7. Remove the valve rocker arm cover gasket (1).

   Discard the valve rocker arm cover gasket (1).

VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE

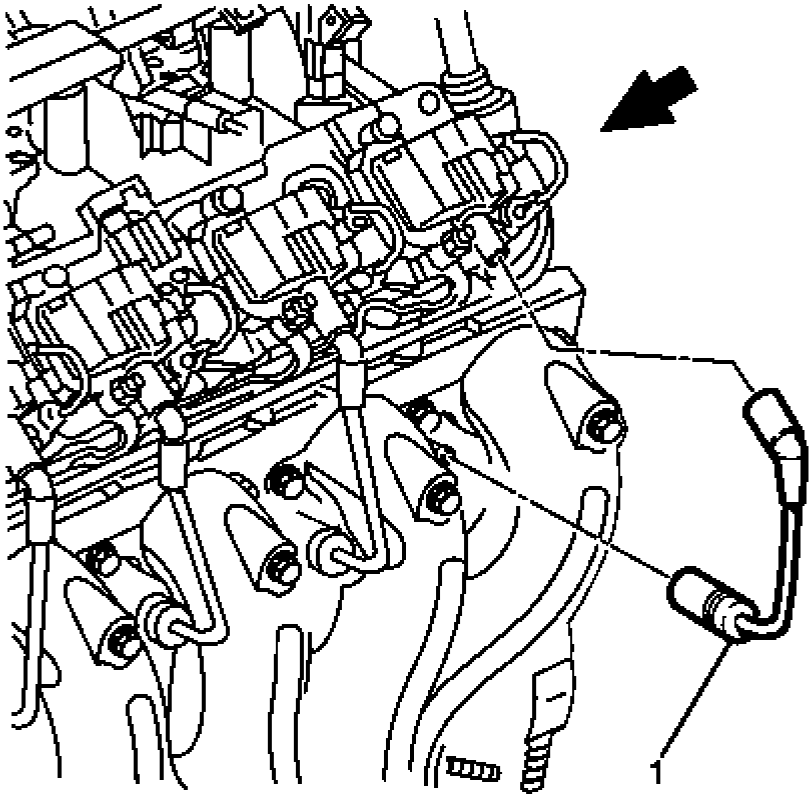


Fig. 25: Locating Spark Plug Leads
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug leads (1).

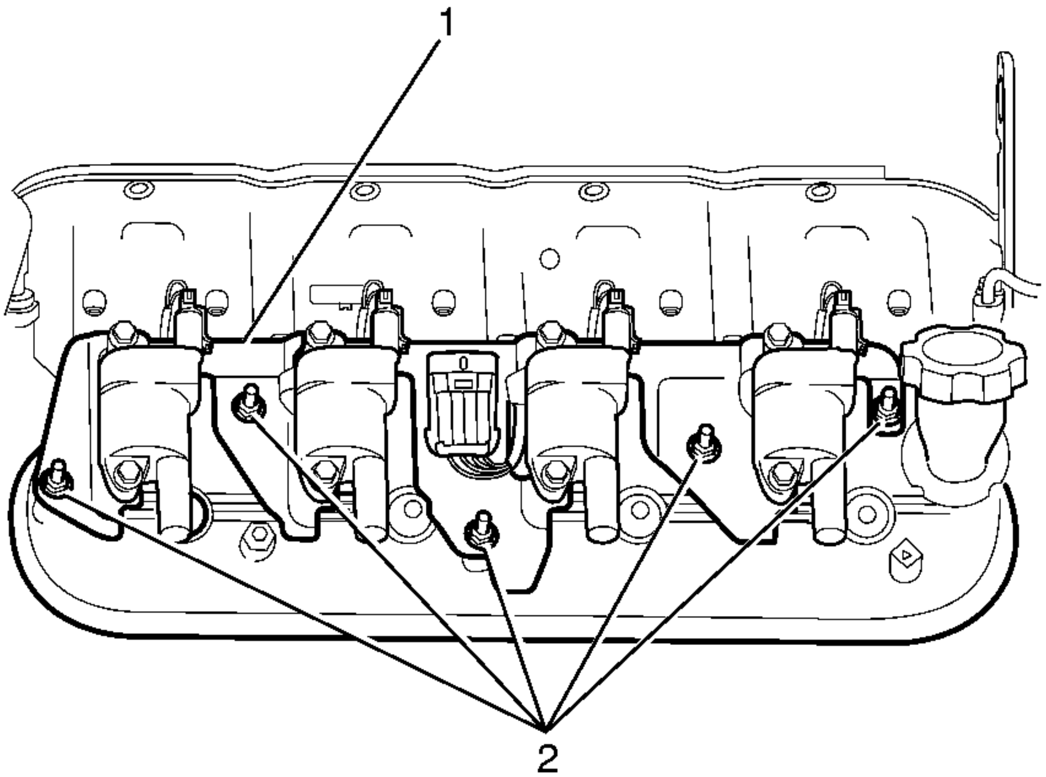


Fig. 26: Identifying Ignition Coil Bracket Retaining Studs
Courtesy of GENERAL MOTORS CORP.

NOTE: **Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.**

2. Remove the ignition coil bracket retaining studs (2).
3. Remove the ignition coil and bracket assembly (1).

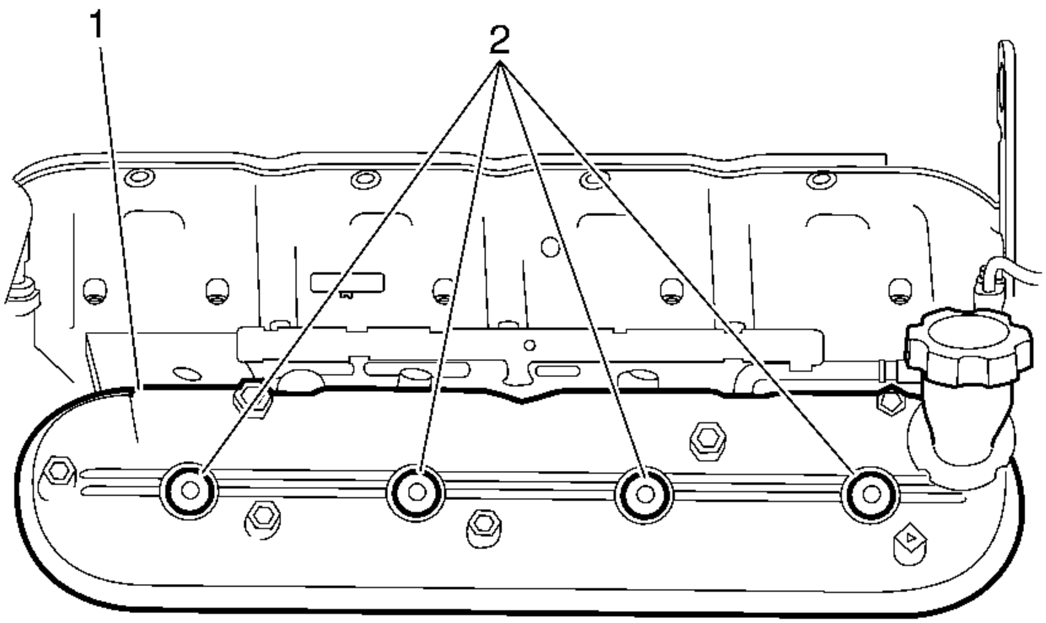


Fig. 27: Identifying Valve Rocker Arm Cover & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve rocker arm cover retaining bolts (2) and valve rocker arm cover (1).
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.

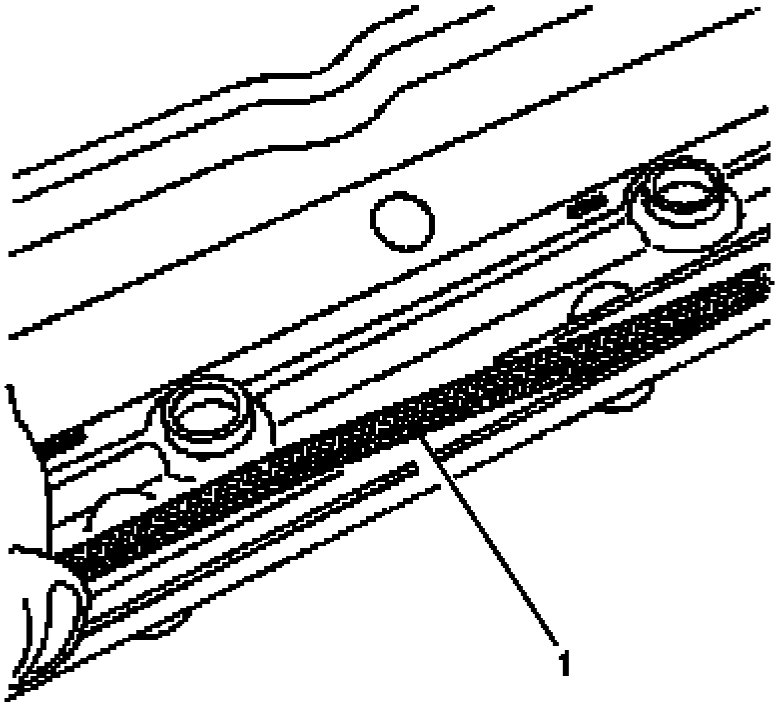


Fig. 28: Identifying Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: **The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.**

6. Remove the valve rocker arm cover gasket (1).

   Discard the valve rocker arm cover gasket (1).

VALVE ROCKER ARM AND PUSH ROD REMOVAL

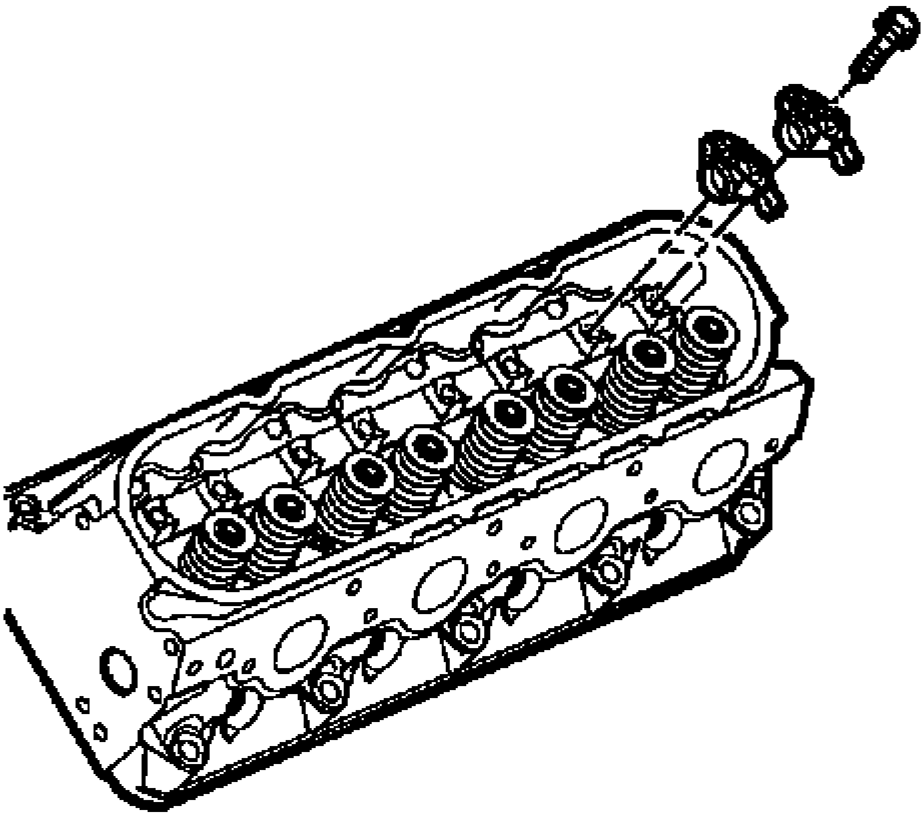


Fig. 29: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Place the valve rocker arms, valve pushrods, and pivot support, in a rack so they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.

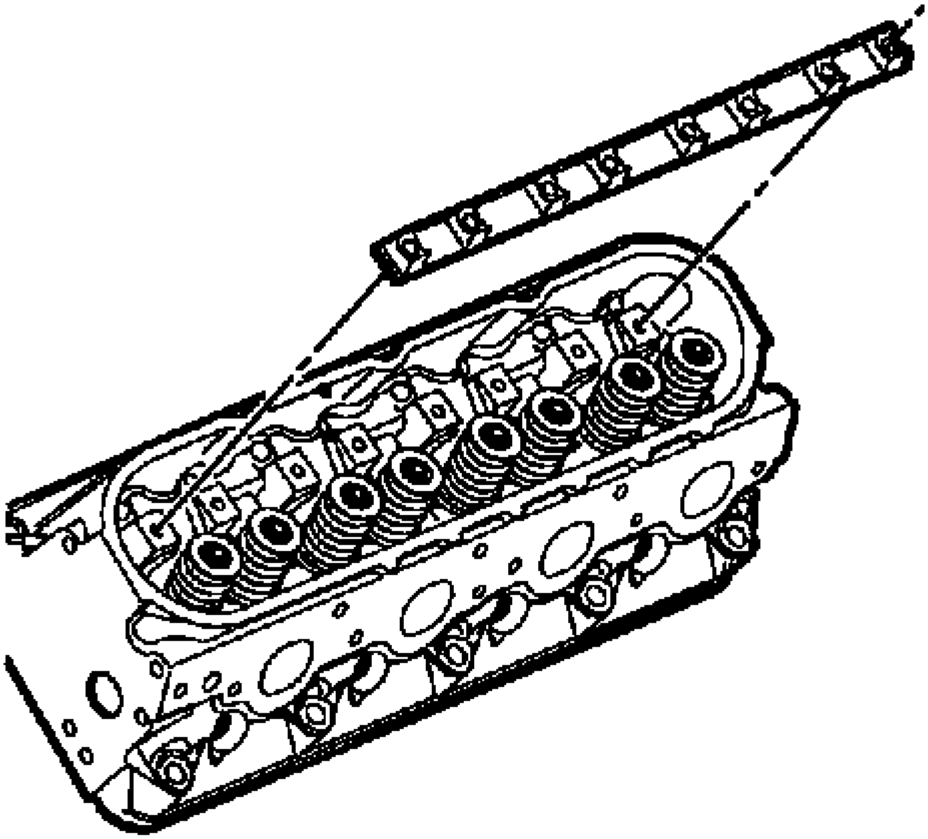


Fig. 30: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve rocker arm pivot support.

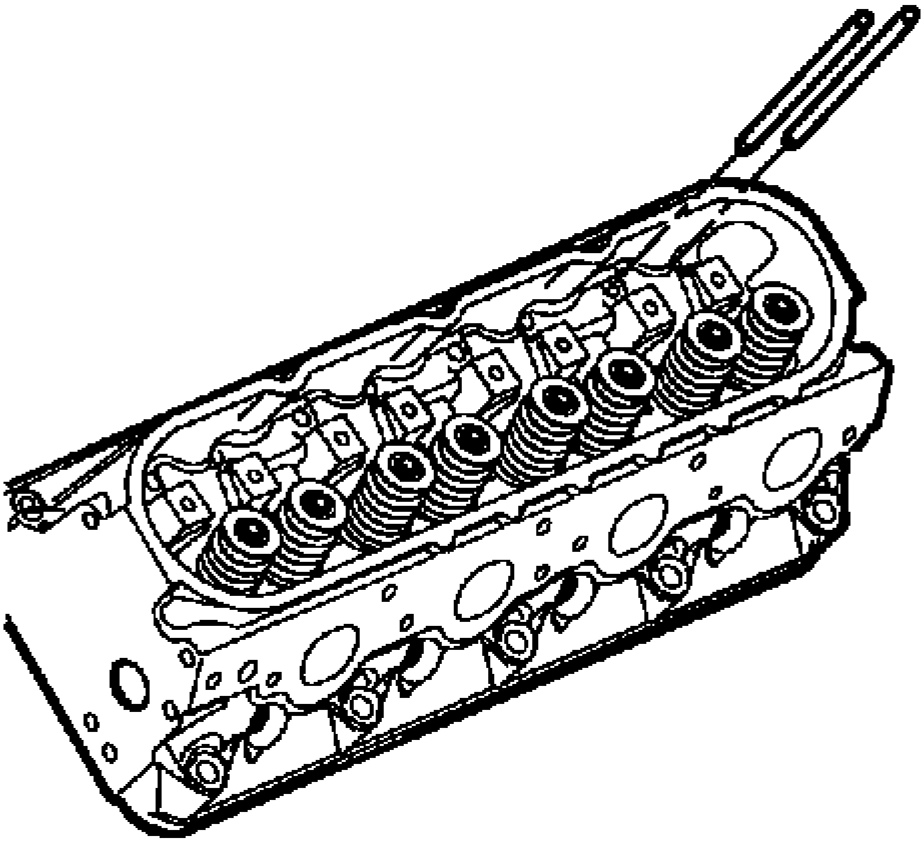


Fig. 31: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

4. Remove the pushrods.

CYLINDER HEAD REMOVAL - LEFT SIDE

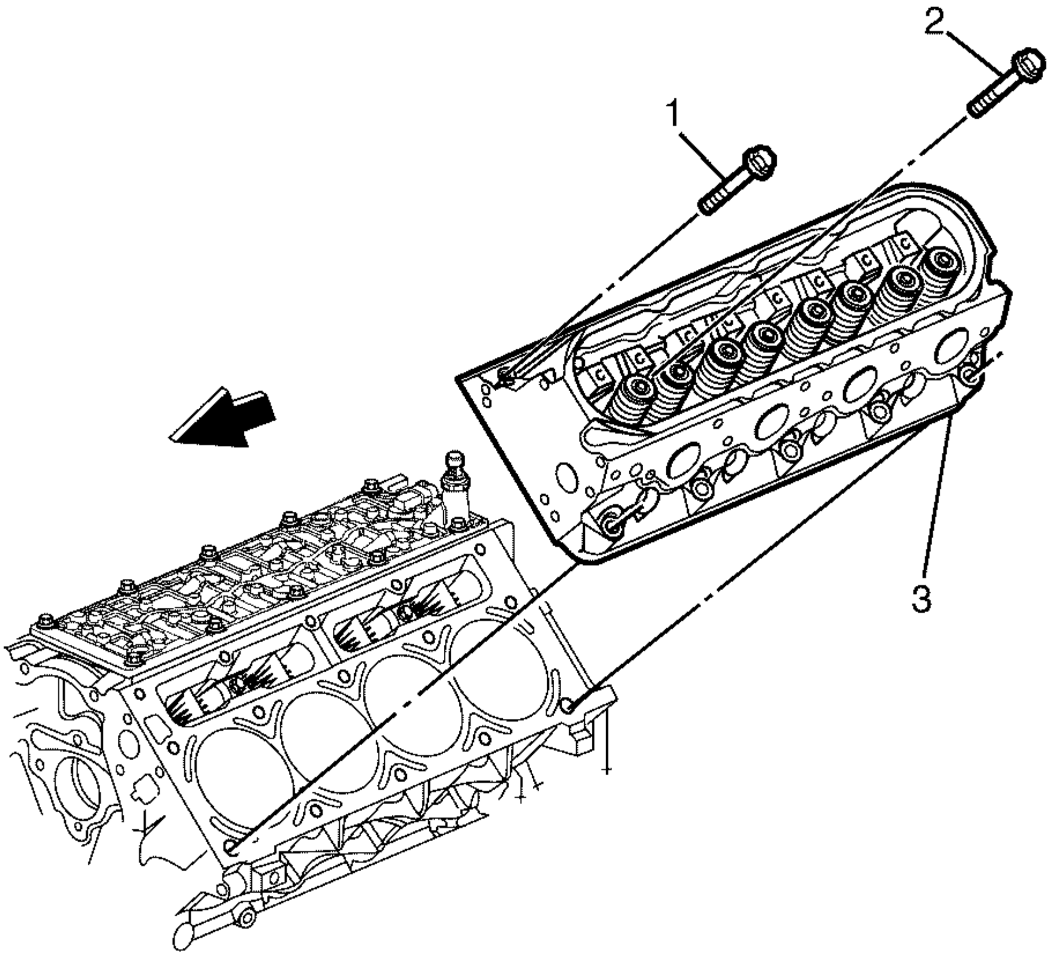


Fig. 32: Identifying Cylinder Head & Bolts (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

1. Remove and discard the cylinder head bolts (1) 10 places and (2) 5 places.

   Discard the bolts.

   CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (3).

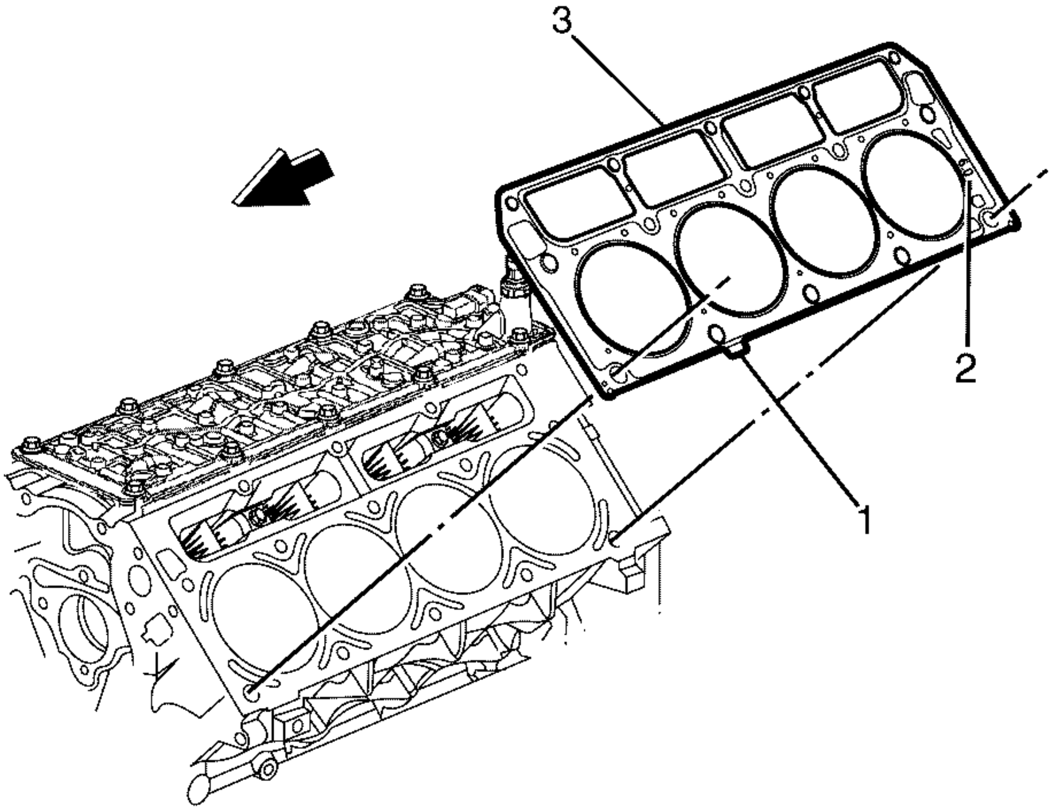


Fig. 33: Identifying Cylinder Head Gasket (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: Cylinder head gaskets must be discarded whenever the cylinder head has been removed from the cylinder block.

3. Remove the cylinder head gasket (1).

   Discard the gasket.

4. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection**.
5. If necessary, disassemble the cylinder head. Refer to **Cylinder Head Disassemble**.

CYLINDER HEAD REMOVAL - RIGHT SIDE

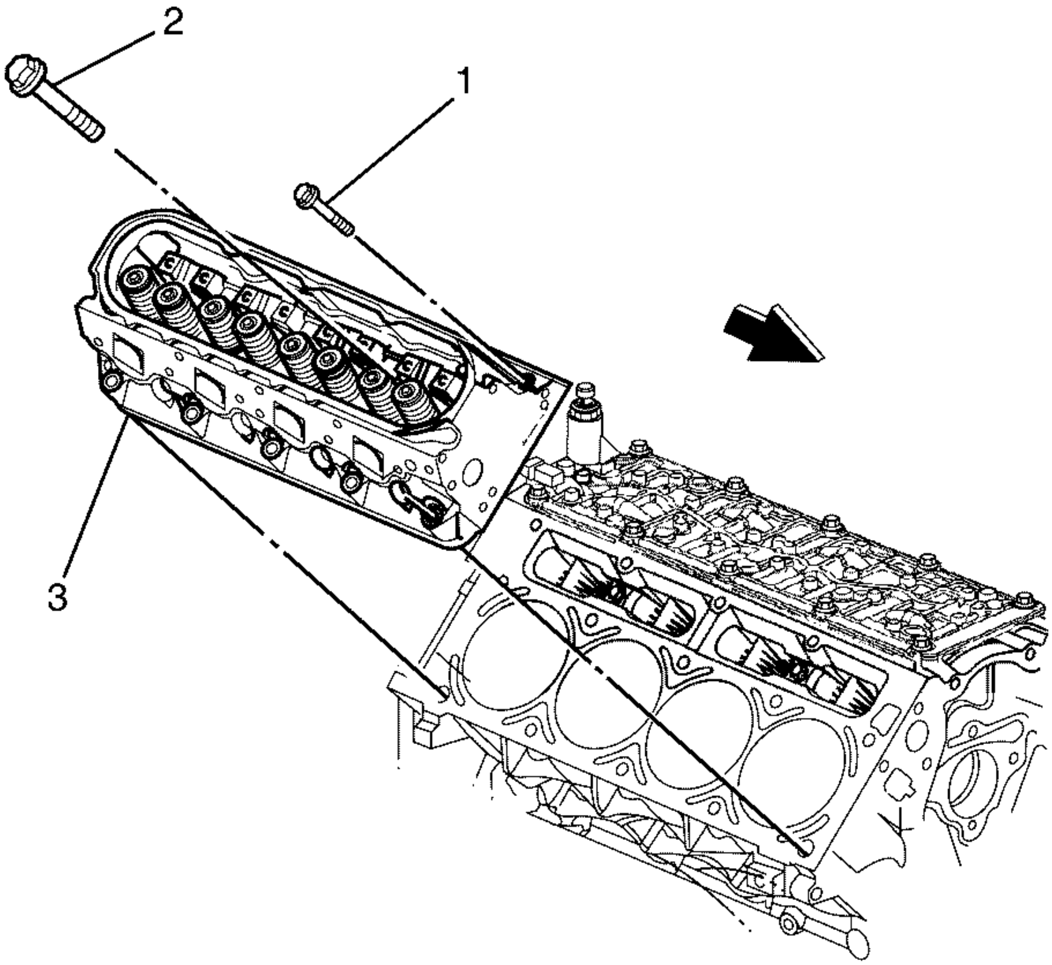


Fig. 34: Identifying Cylinder Head & Bolts (Right Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are torque to yield bolts and are single use only fasteners.

1. Remove and discard the cylinder head bolts (1) 10 places, (2) 5 places.

   Discard the bolts.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (3).

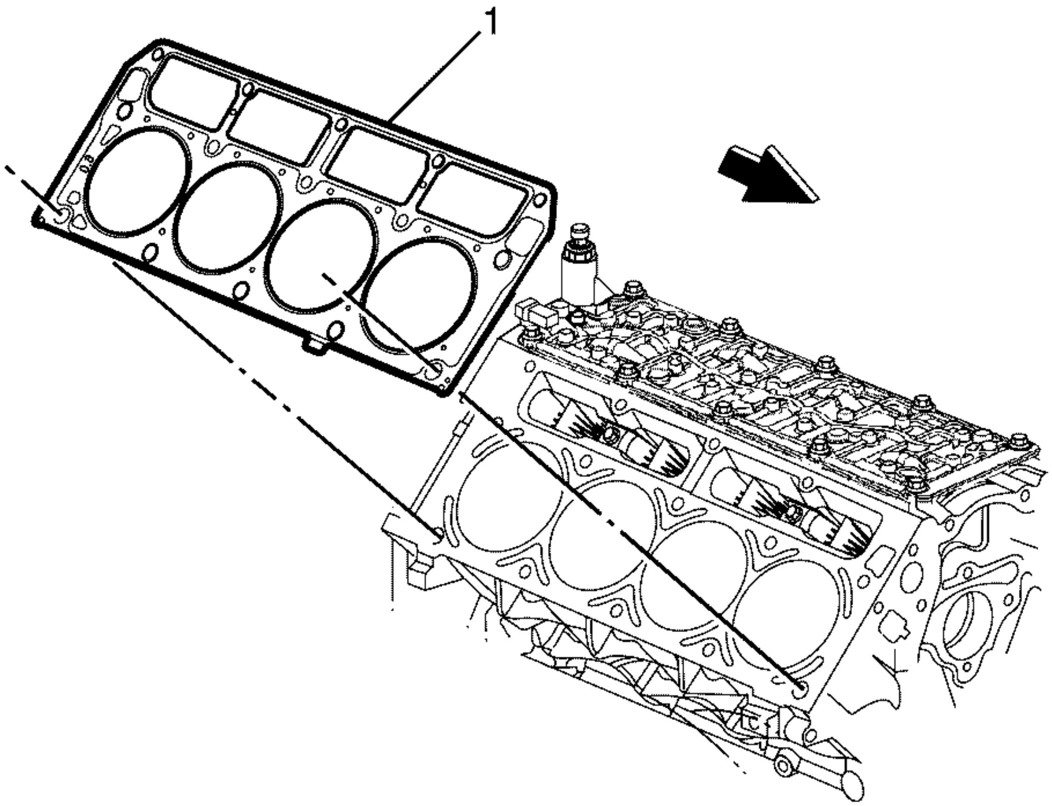


Fig. 35: Identifying Cylinder Head Gasket (Right Side)
Courtesy of GENERAL MOTORS CORP.

3. Remove the cylinder head gasket (1).

   Discard the gasket.

4. Clean and inspect the cylinder head and the cylinder block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection**.
5. If necessary, disassemble the cylinder head. Refer to **Cylinder Head Disassemble**.

VALVE LIFTER REMOVAL

Tools Required

J 3049-A Valve Lifter Remover. See **Special Tools** .

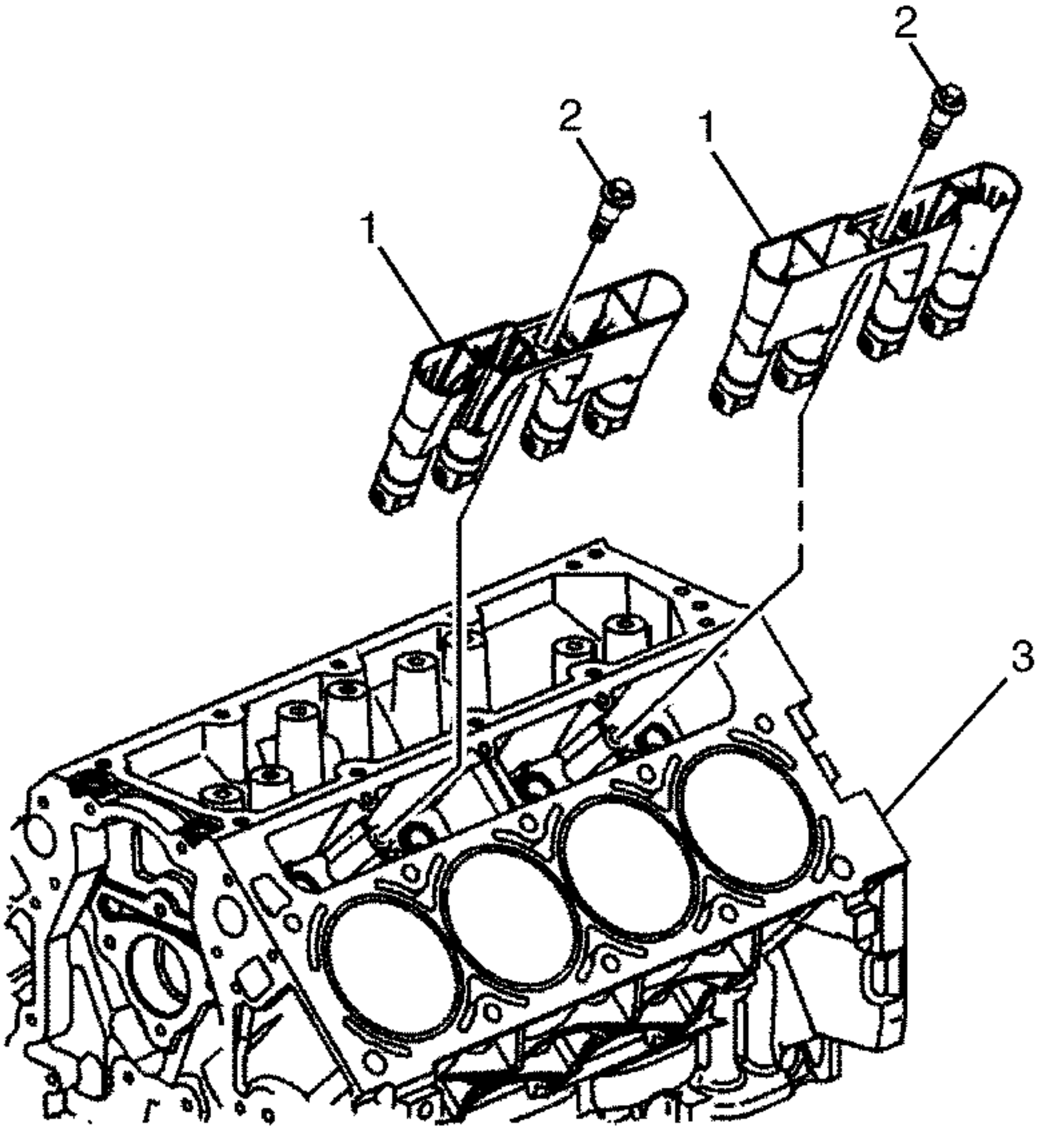


Fig. 36: Identifying Valve Lifter Guide To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the lifter guide to cylinder block retaining bolts (2).

IMPORTANT: Note the installed position of the valve lifter guides (1). The notched area of the valve lifter guides (1) are to align with the locating tab on the cylinder block (3).

2. Remove the valve lifter guides (1) and valve lifters as an assembly from the cylinder block (3).

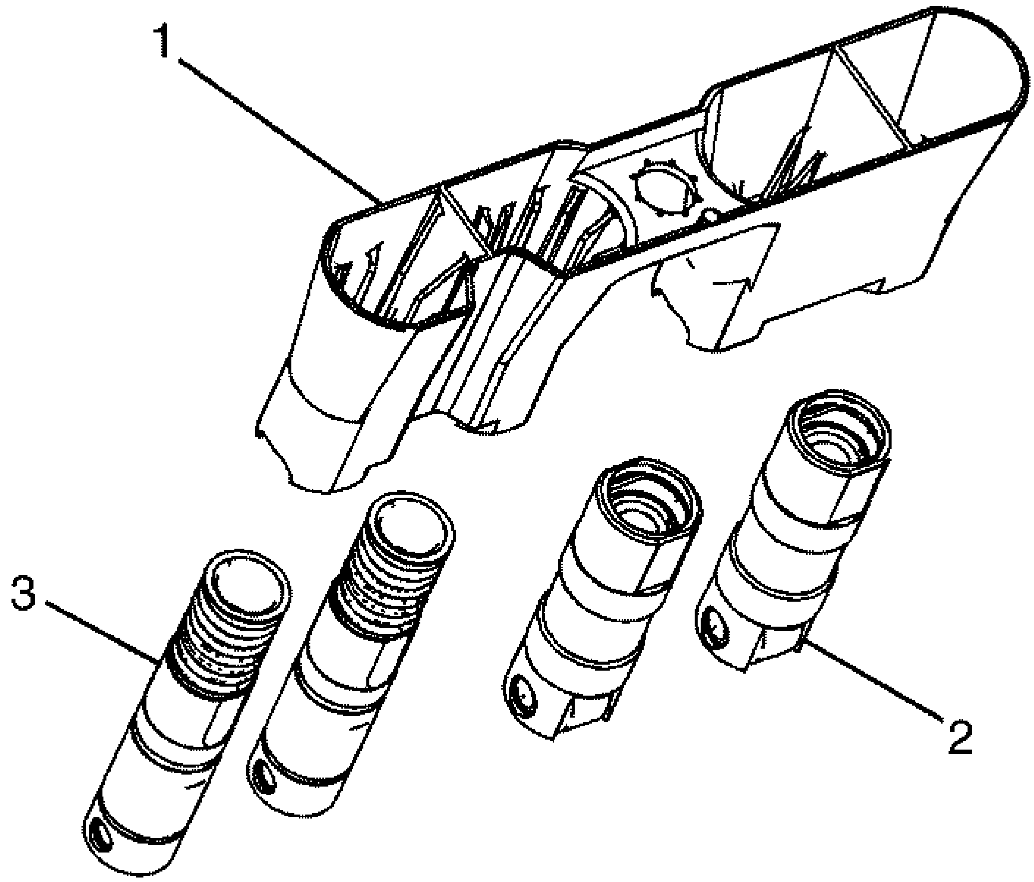


Fig. 37: Identifying Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve lifters (2 and 3) from the valve lifter guide (1).

IMPORTANT: Some valve lifters (2 or 3) may be stuck in their bores because of gum or varnish deposits.

4. Use **J 3049-A** J 3049-A or equivalent in order to remove the valve lifters (2 and 3), if required. See **Special Tools** .

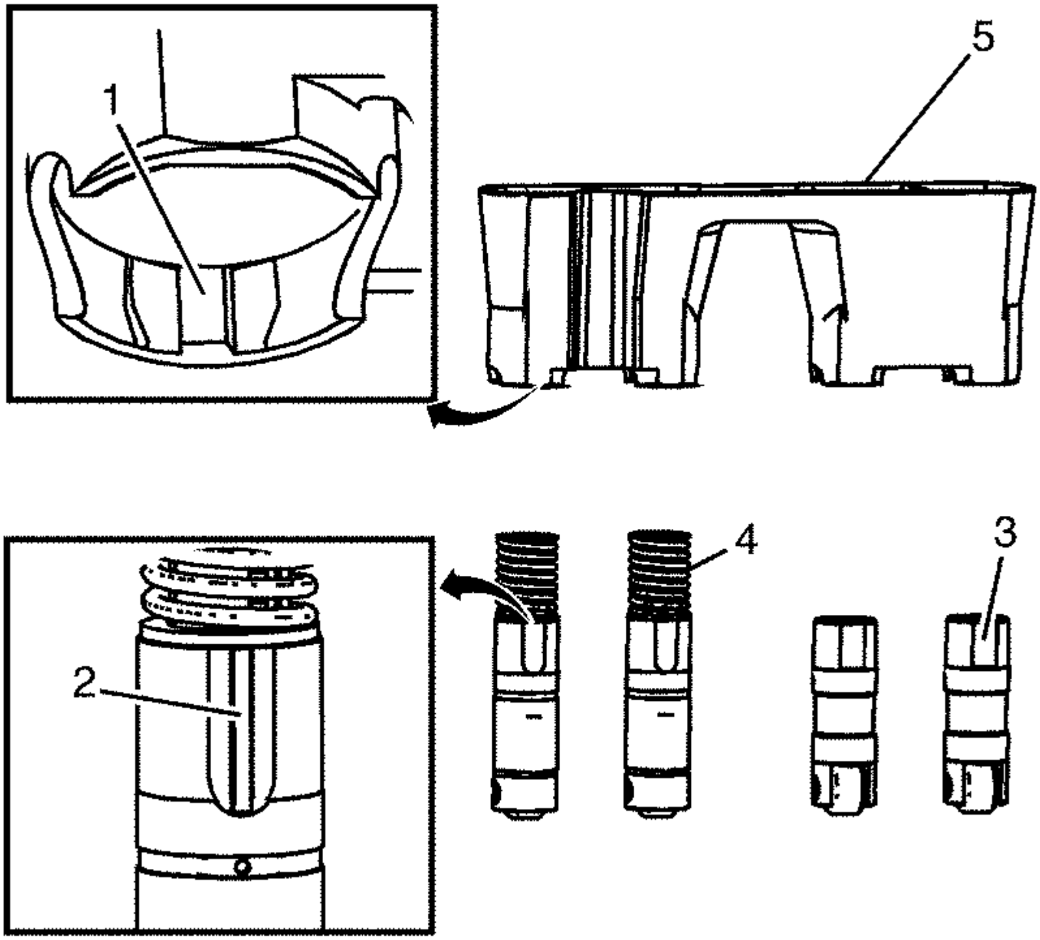


Fig. 38: Identifying Cylinder Deactivation Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The cylinder deactivation lifters (4) are installed into the guide (5) by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2).

5. When using the valve train components again, always install the components to the original location and position. Refer to **Separating Parts** .
6. Clean and inspect the valve lifters (3 and 4), if required. Refer to **Valve Lifter and Guide Cleaning and Inspection**.

OIL FILTER, ADAPTER, AND PAN COVER REMOVAL

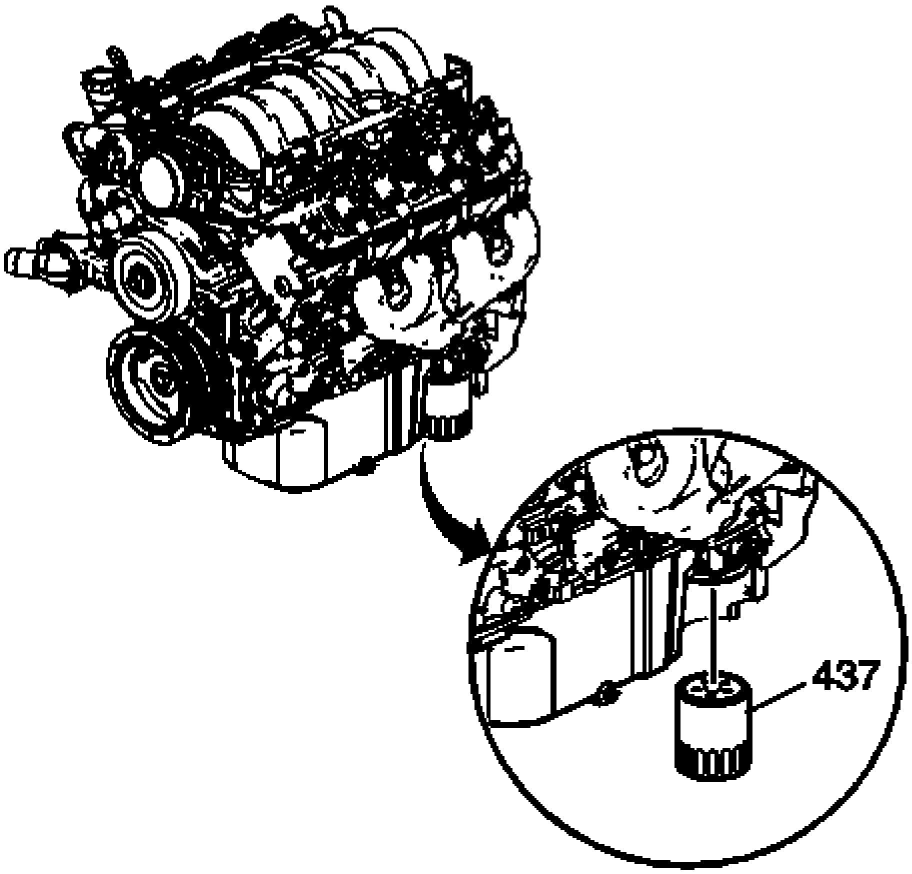


Fig. 39: Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter (437).

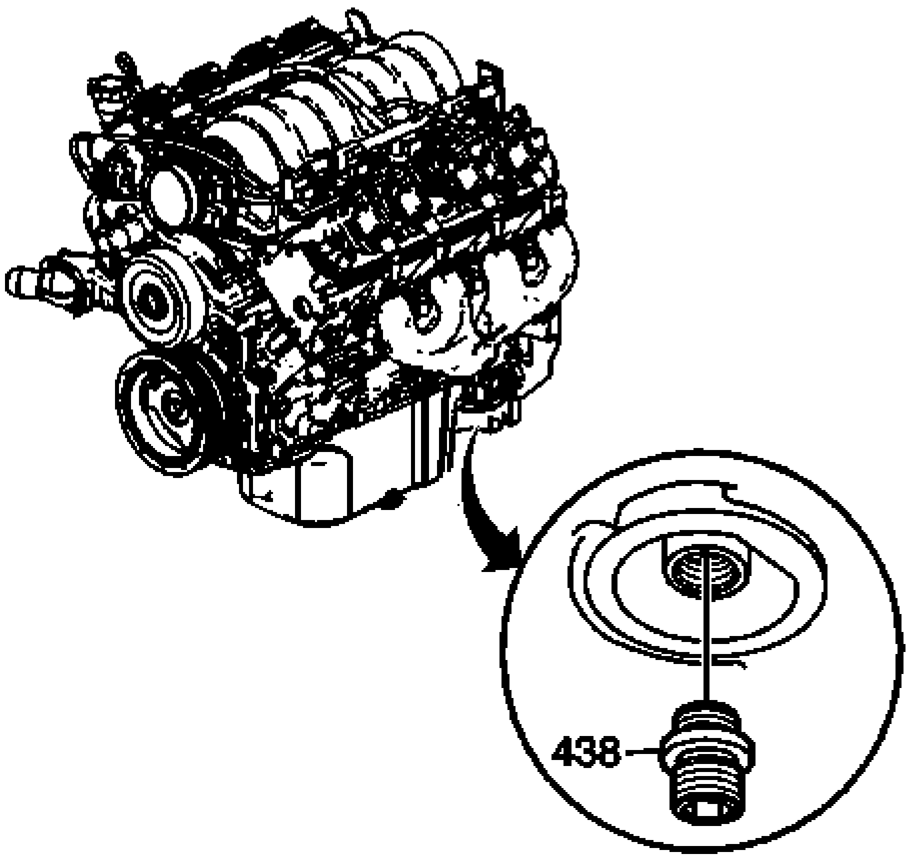


Fig. 40: Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter fitting (438) as required.

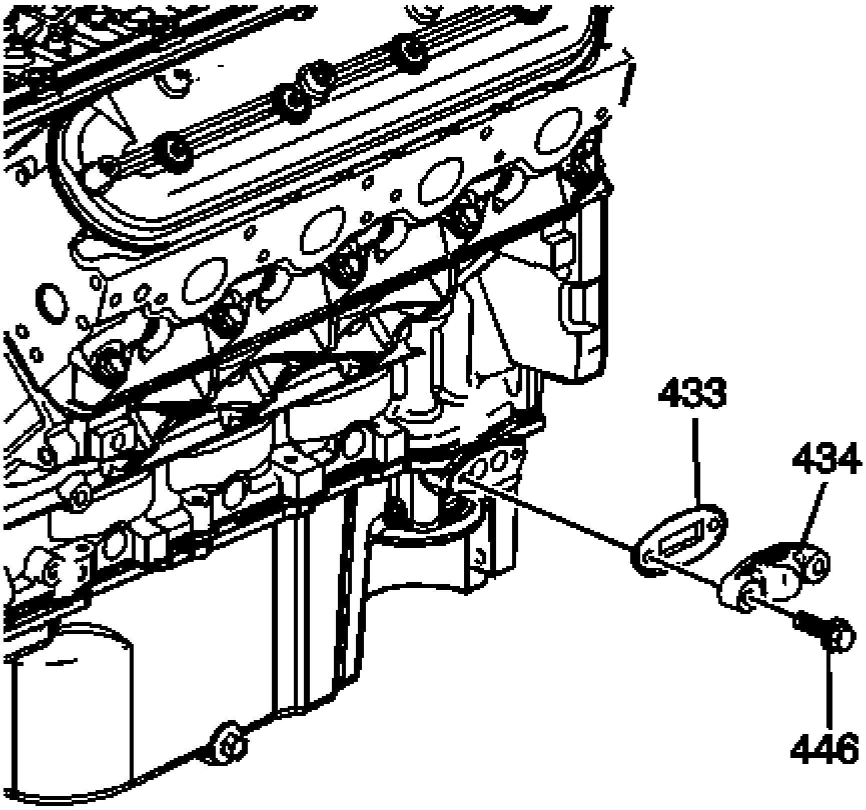


Fig. 41: Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the bolts (446), cover (434), and gasket (433).

OIL PAN REMOVAL

Removal Procedure

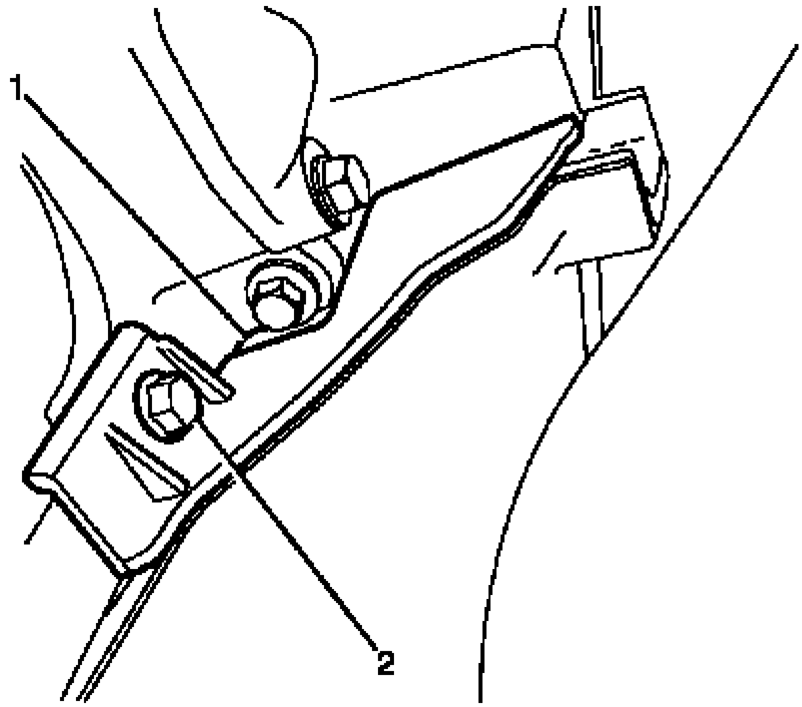


Fig. 42: Identifying Left Side Close Out Cover To Cylinder Block Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.**
- **DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.**

1. Remove the left side close out cover to cylinder block retaining bolt (2).
2. Remove the left side close out (1).

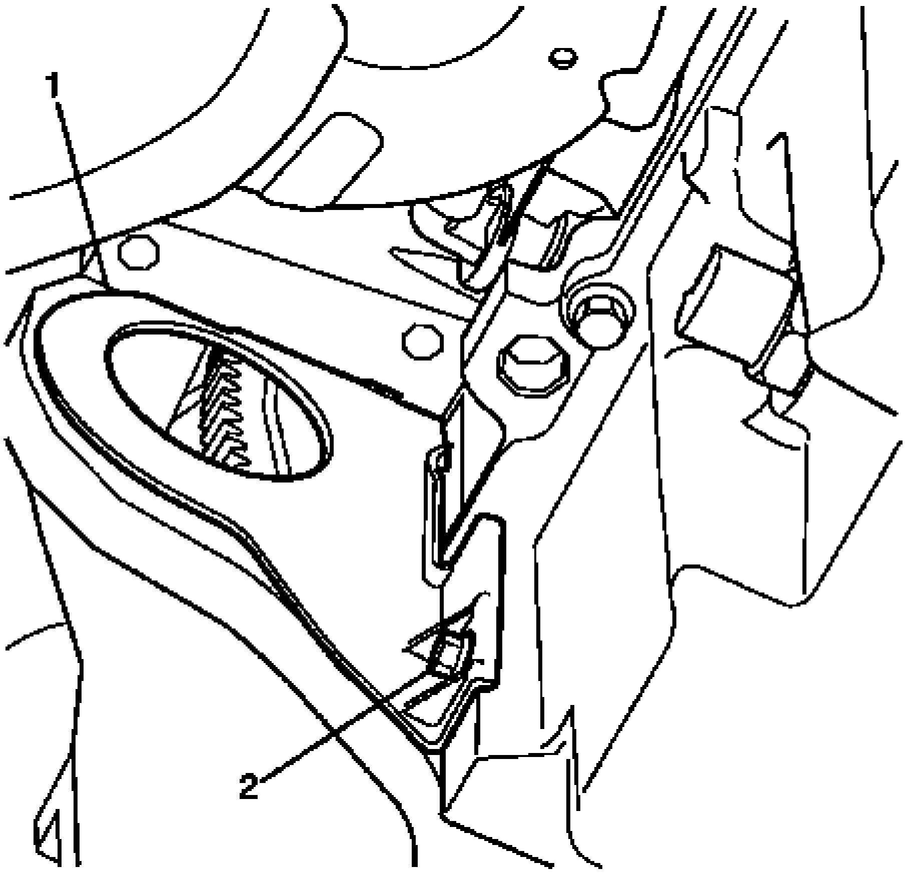


Fig. 43: Identifying Right Transmission Cover & Engine Oil Pan Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the right side close out cover to cylinder block retaining bolt (2).
4. Remove the right side close out (1).

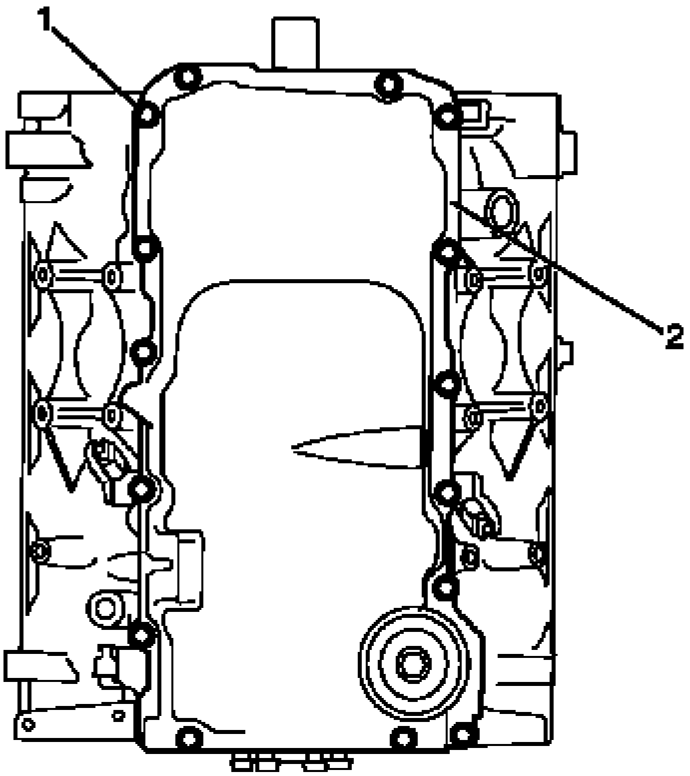


Fig. 44: Identifying Oil Pan To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pan to cylinder block retaining bolts (1 and 3).
6. Remove the oil pan (2).

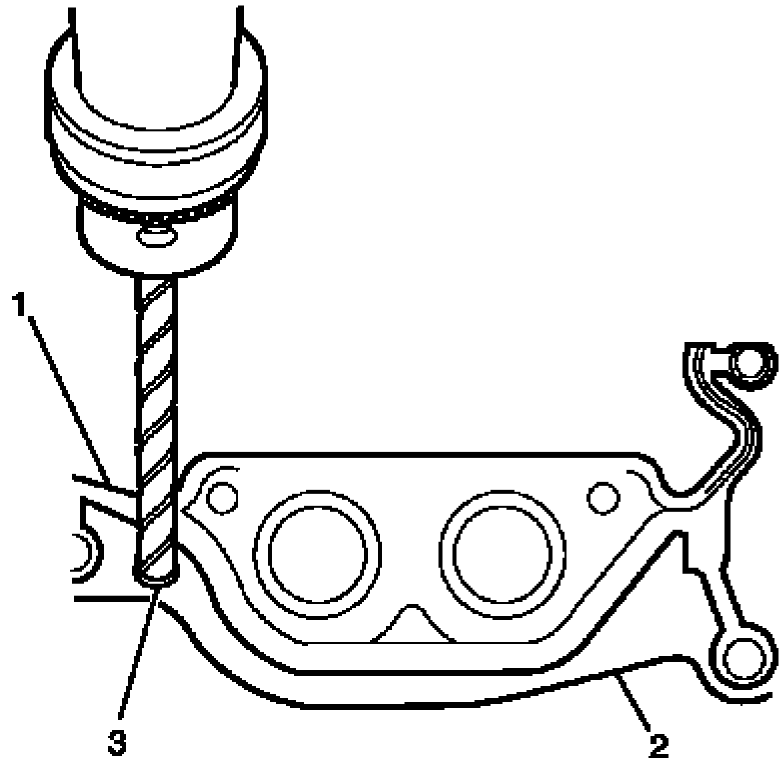


Fig. 45: Identifying Retaining Rivets (Drilling Out)
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.**
- **Use care not to gouge, score, or damage the oil pan sealing surface.**

7. Drill (3) out the retaining rivets, if required.

IMPORTANT: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

8. Remove the oil pan gasket (1) from the oil pan.

   Discard the gasket and rivets.

ENGINE FRONT COVER REMOVAL

1. Remove the camshaft position sensor (CMP). Refer to **Camshaft Position Sensor Replacement** .

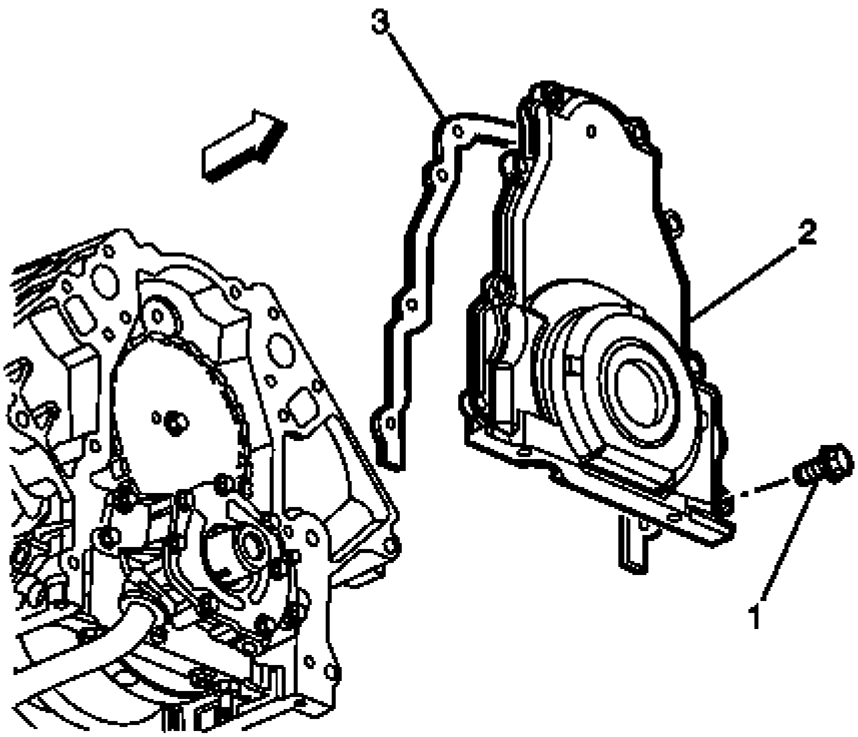


Fig. 46: Identifying Engine Front Cover To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine front cover to cylinder block retaining bolts (1).

IMPORTANT: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

3. Remove the engine front cover (2) and gasket (3).
4. Remove the engine front cover gasket (3).

   Discard the engine front cover gasket (3).

5. Clean and inspect the engine front cover. Refer to **Engine Front Cover Cleaning and Inspection**

CRANKSHAFT REAR OIL SEAL HOUSING REMOVAL

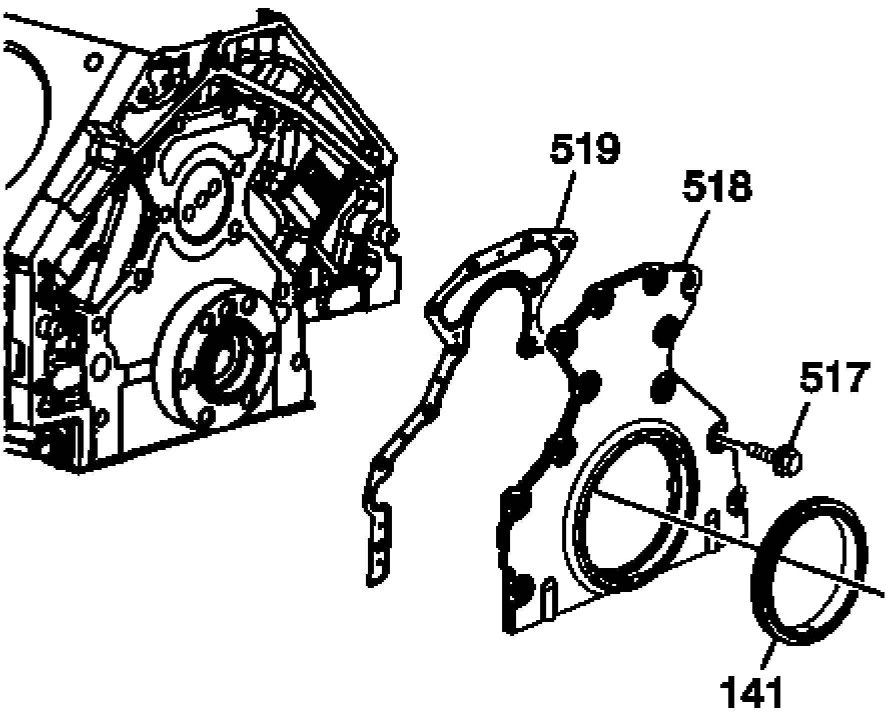


Fig. 47: View of Rear Housing, Gasket and Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the rear oil seal housing bolts (517).
2. Remove the housing (518) and gasket (519).
3. Remove the rear oil seal (141).

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR REMOVAL

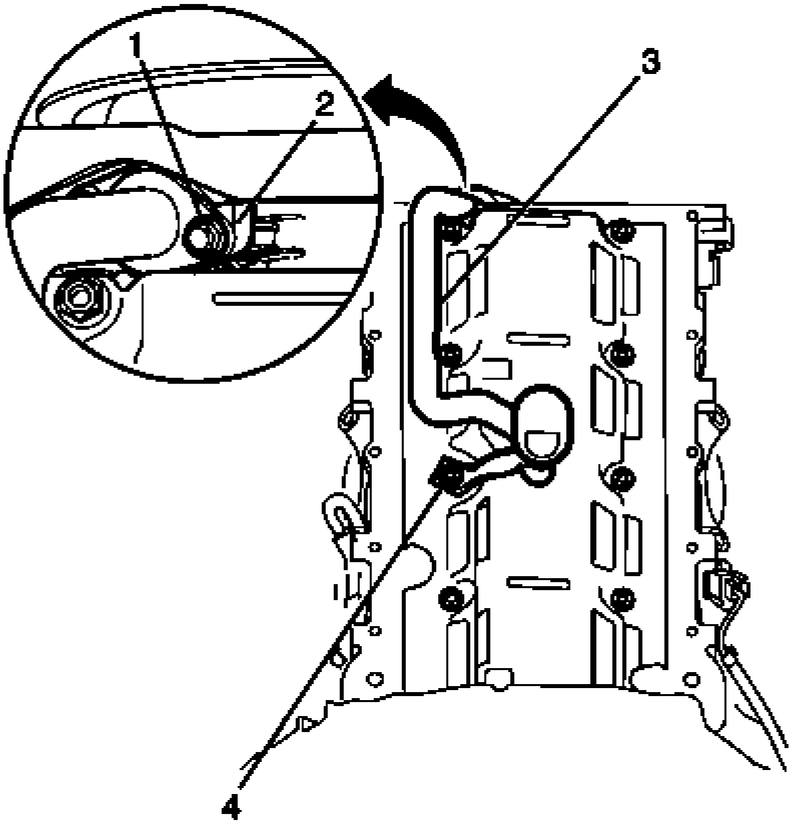


Fig. 48: Identifying Oil Pump Screen & Tube Assembly To Oil Pump Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
2. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
3. Remove the oil pump screen and tube assembly (3) from the oil pump (2).

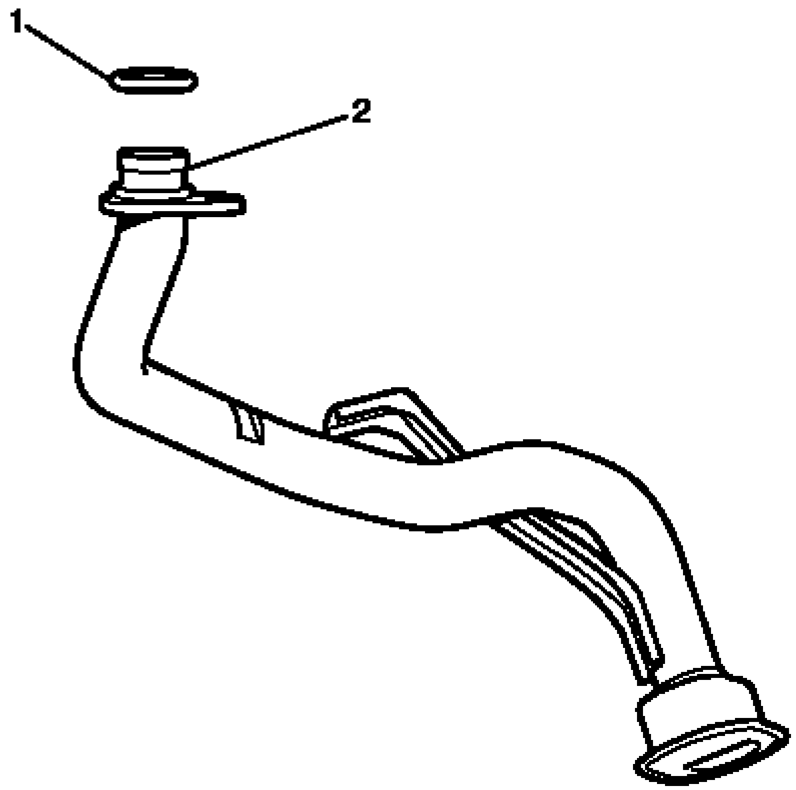


Fig. 49: Identifying Oil Pump Screen & Tube Assembly O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.

4. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

   Discard the oil pump screen and tube assembly O-ring seal (1).

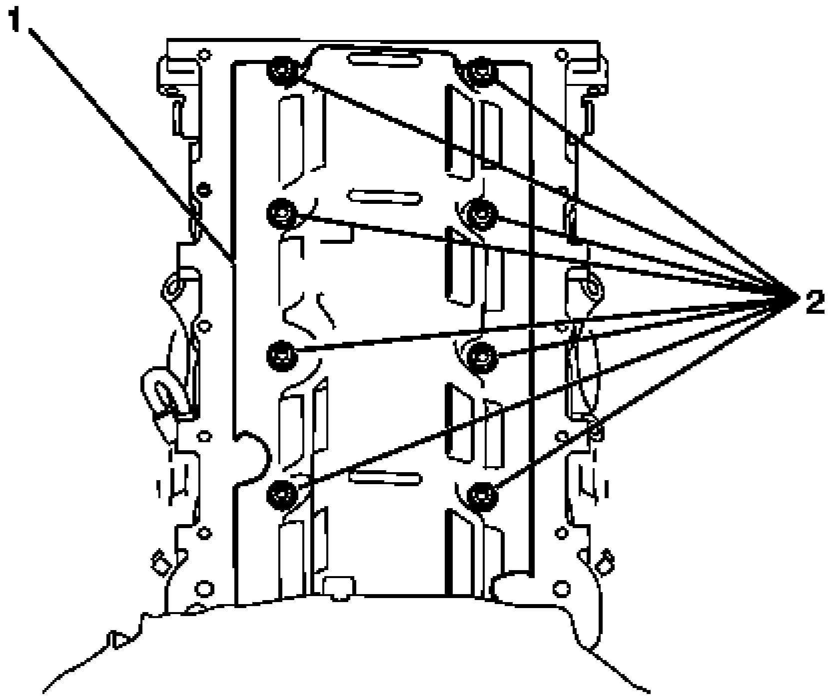


Fig. 50: Identifying Crankshaft Oil Deflector Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the remaining crankshaft oil deflector retaining nuts (2).
6. Remove the crankshaft oil deflector (1).

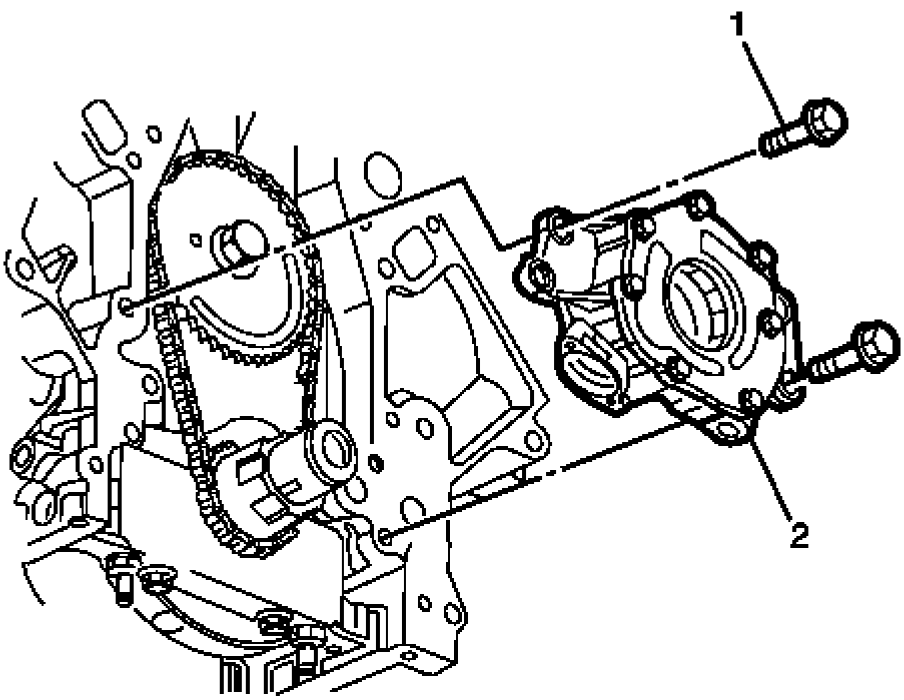


Fig. 51: Identifying Oil Pump Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

7. Remove the oil pump bolt (1).
8. Remove the oil pump (2).
9. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection**.

TIMING CHAIN AND SPROCKET REMOVAL

Special Tools

- **J 8433-1:** Puller Bar
- **J 41558:** Crankshaft Sprocket Remover
- **J 41816-2:** Crankshaft End Protector

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

Removal Procedure

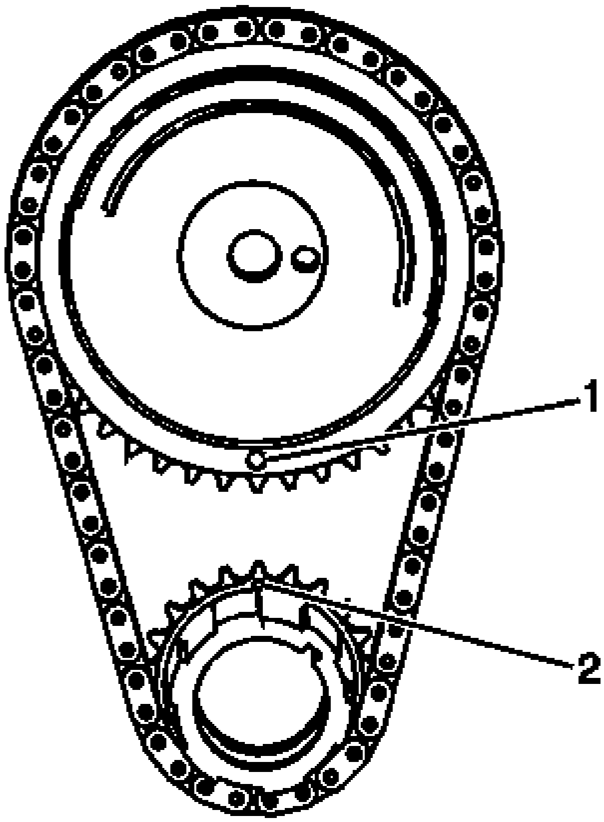


Fig. 52: Identifying Camshaft & Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS CORP.

1. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

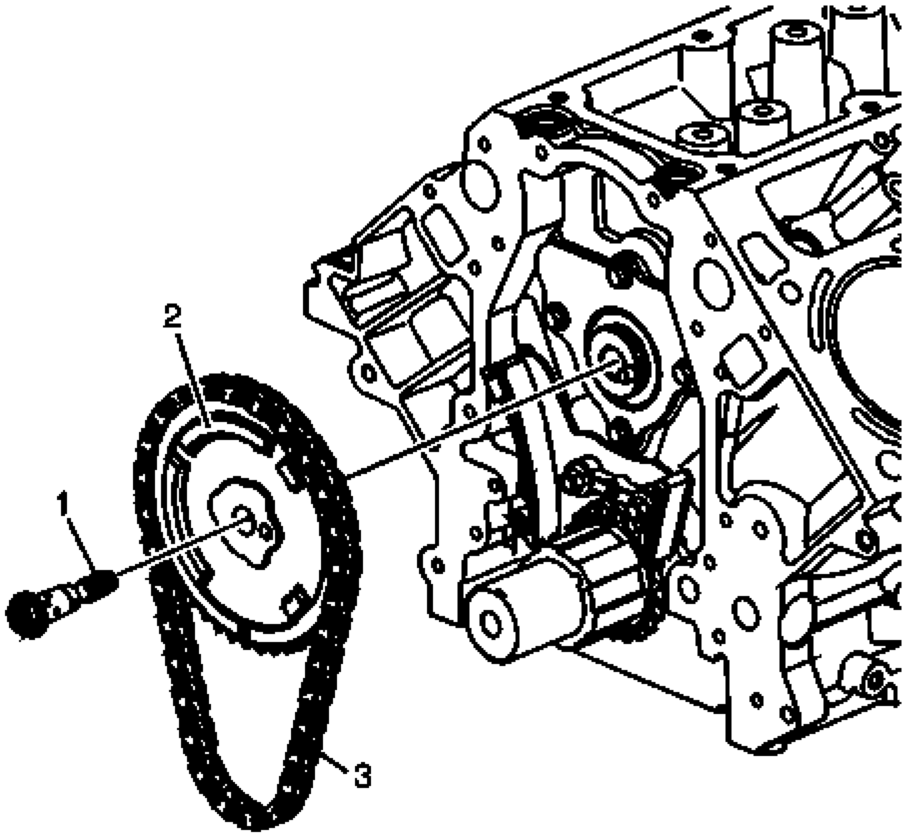


Fig. 53: Identifying Timing Chain, Camshaft Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

2. Remove the camshaft sprocket bolt (1).
3. Remove the camshaft sprocket (2) and timing chain (3).

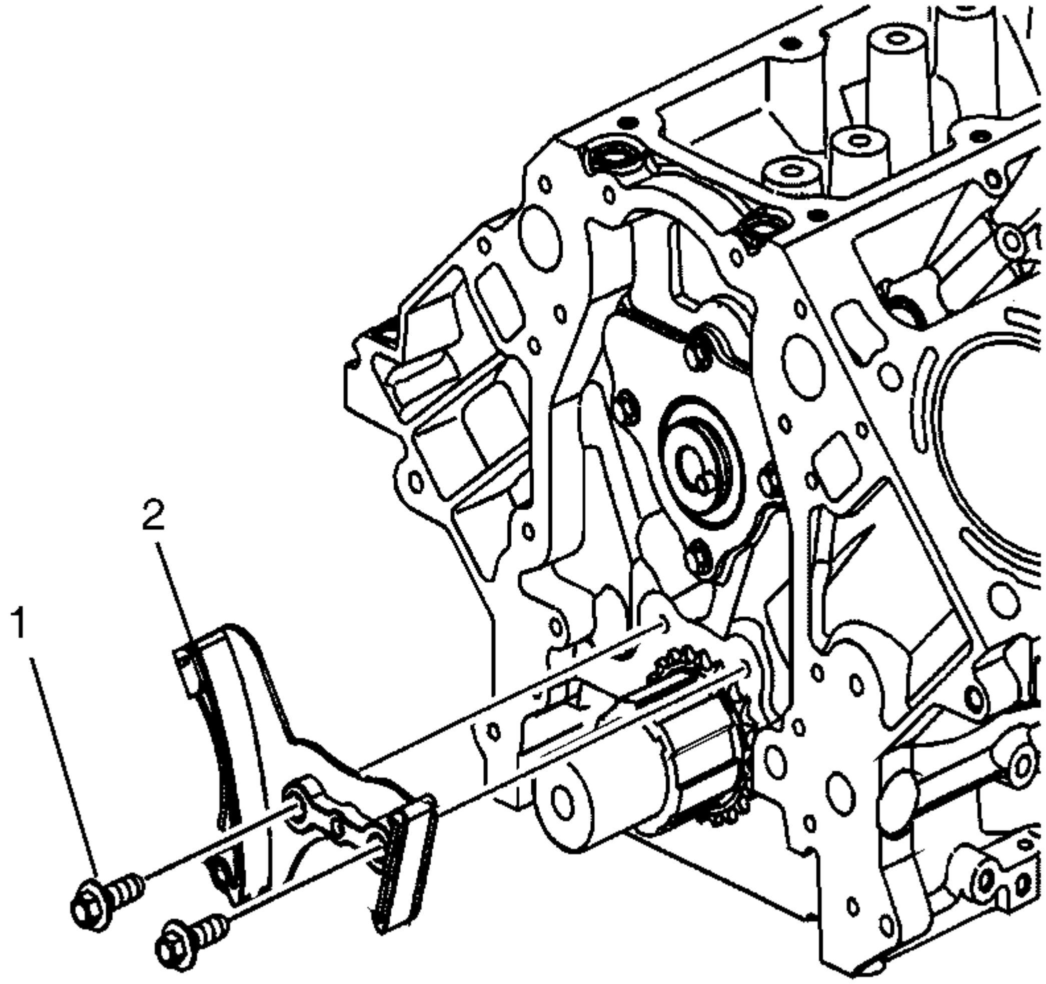


Fig. 54: Identifying Timing Chain Tension Bolts & Tensioner
Courtesy of GENERAL MOTORS CORP.

4. Remove the timing chain tension bolts (1) and tensioner (2).

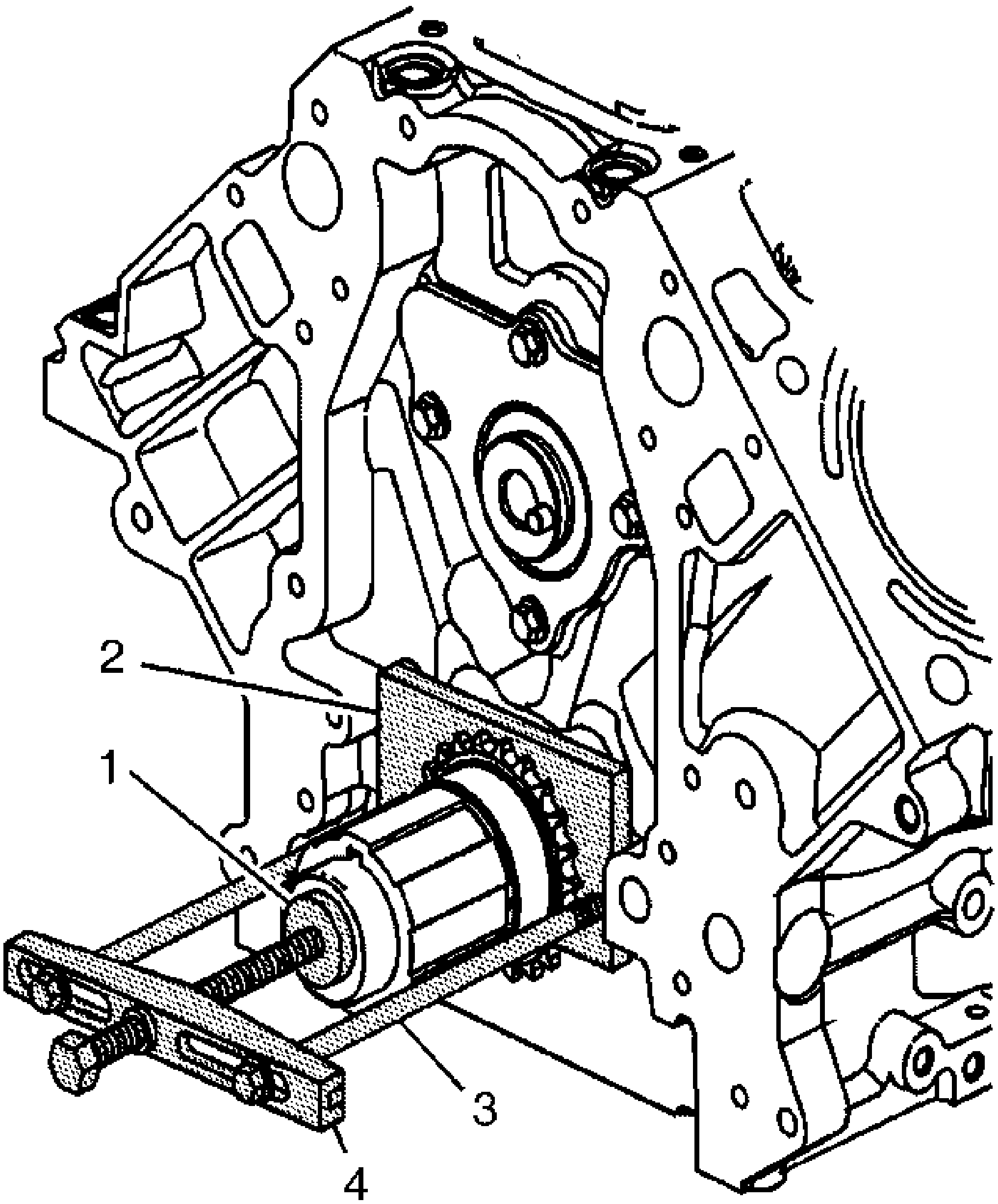


Fig. 55: View Of J 41816-2, J 41558, Bolts & J 8433-1
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 41816-2:** protector (1), the **J 41558:** remover (2), bolts (3) and the **J 8433-1:** puller (4) in order to remove the crankshaft sprocket.

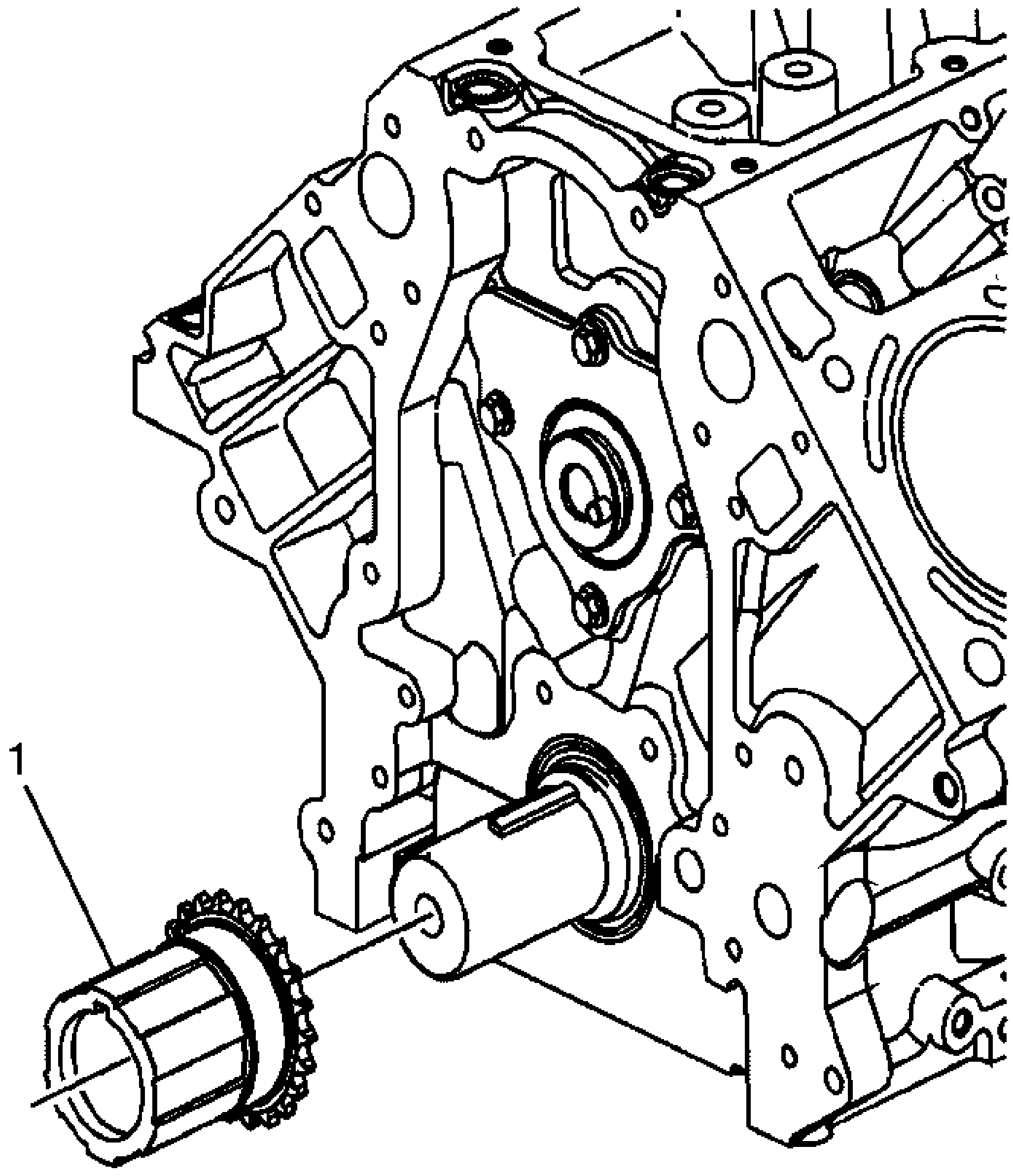


Fig. 56: Identifying Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft sprocket (1).

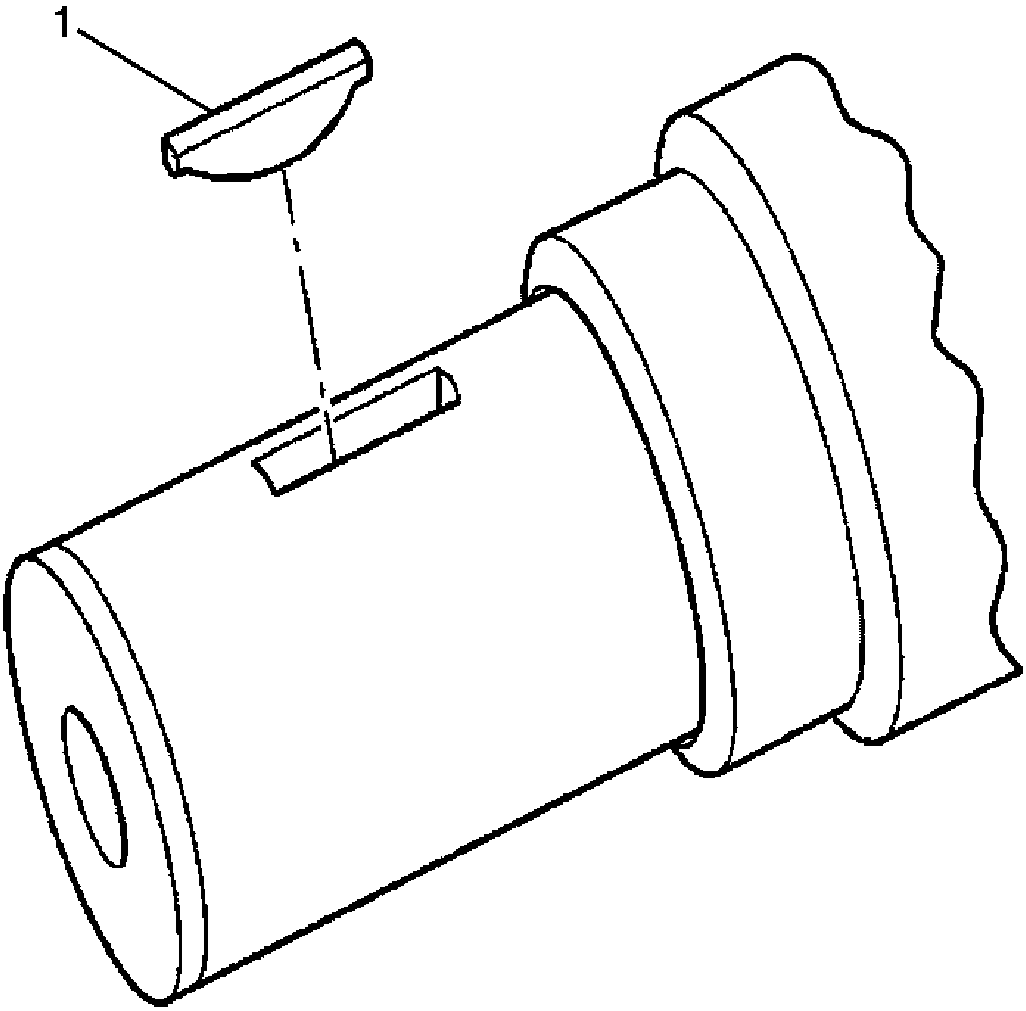


Fig. 57: Identifying Crankshaft Sprocket Key
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket key (1), if required.

CAMSHAFT REMOVAL

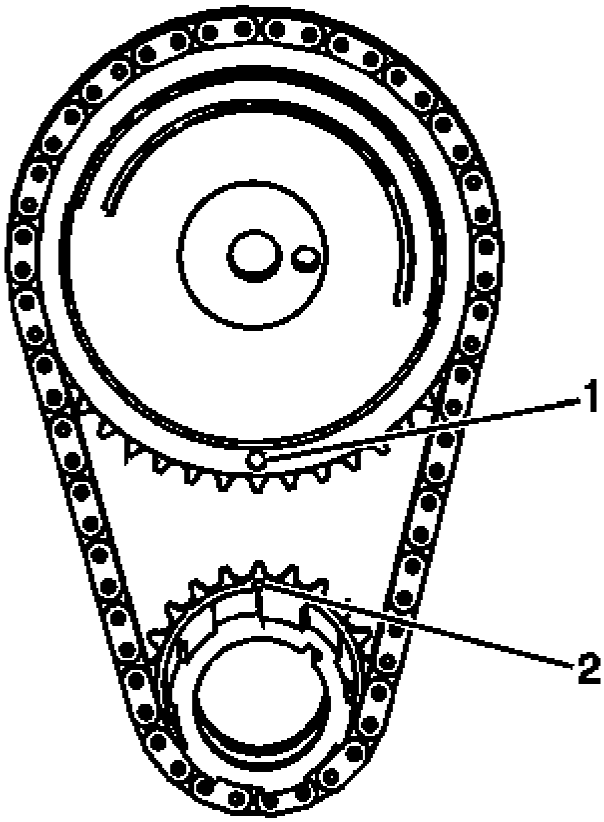


Fig. 58: Identifying Camshaft & Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS CORP.

1. Rotate the engine in order to align the timing marks (1, 2).

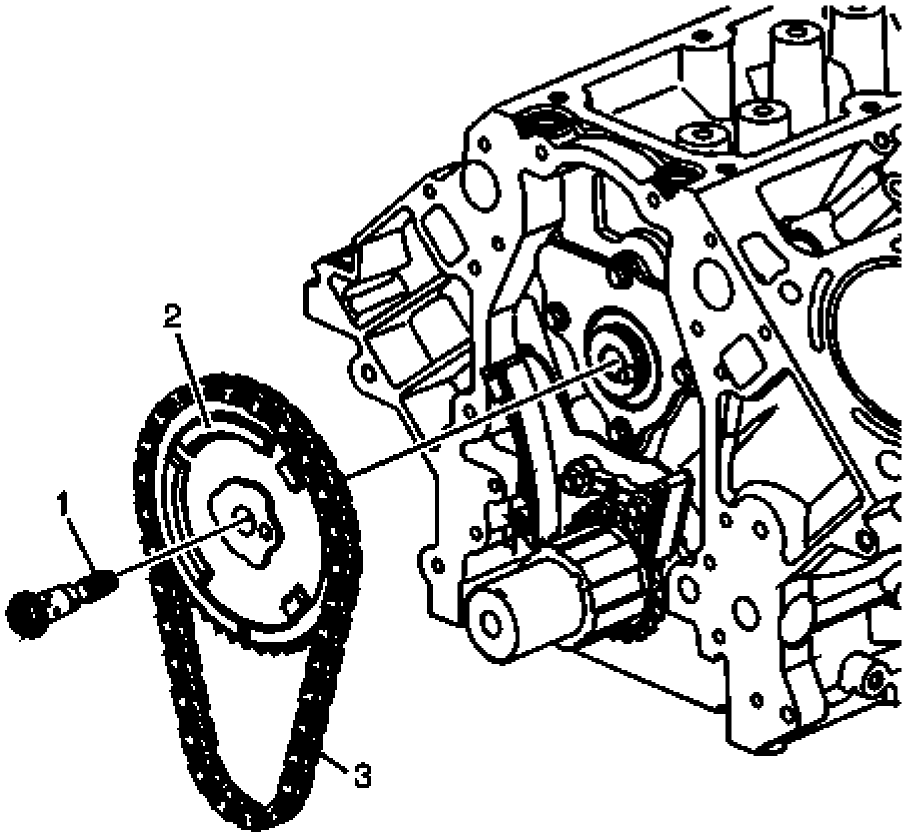


Fig. 59: Identifying Timing Chain, Camshaft Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft sprocket to camshaft retaining bolt (1).
3. Remove the timing chain (3), from the camshaft sprocket (2), and allow the timing chain (3) to rest on the crankshaft sprocket (2).

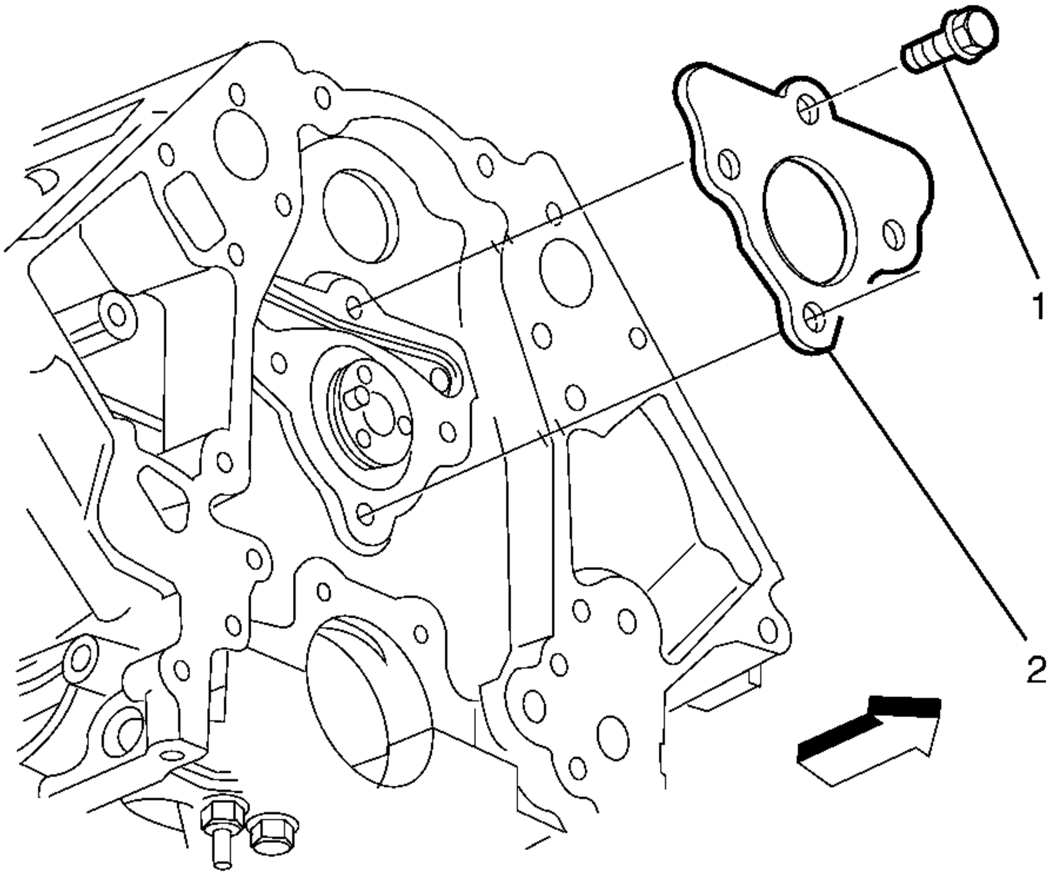


Fig. 60: Identifying Camshaft Retainer To Cylinder Block Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft retainer to cylinder block retaining bolts (1) and remove the camshaft retainer (2).

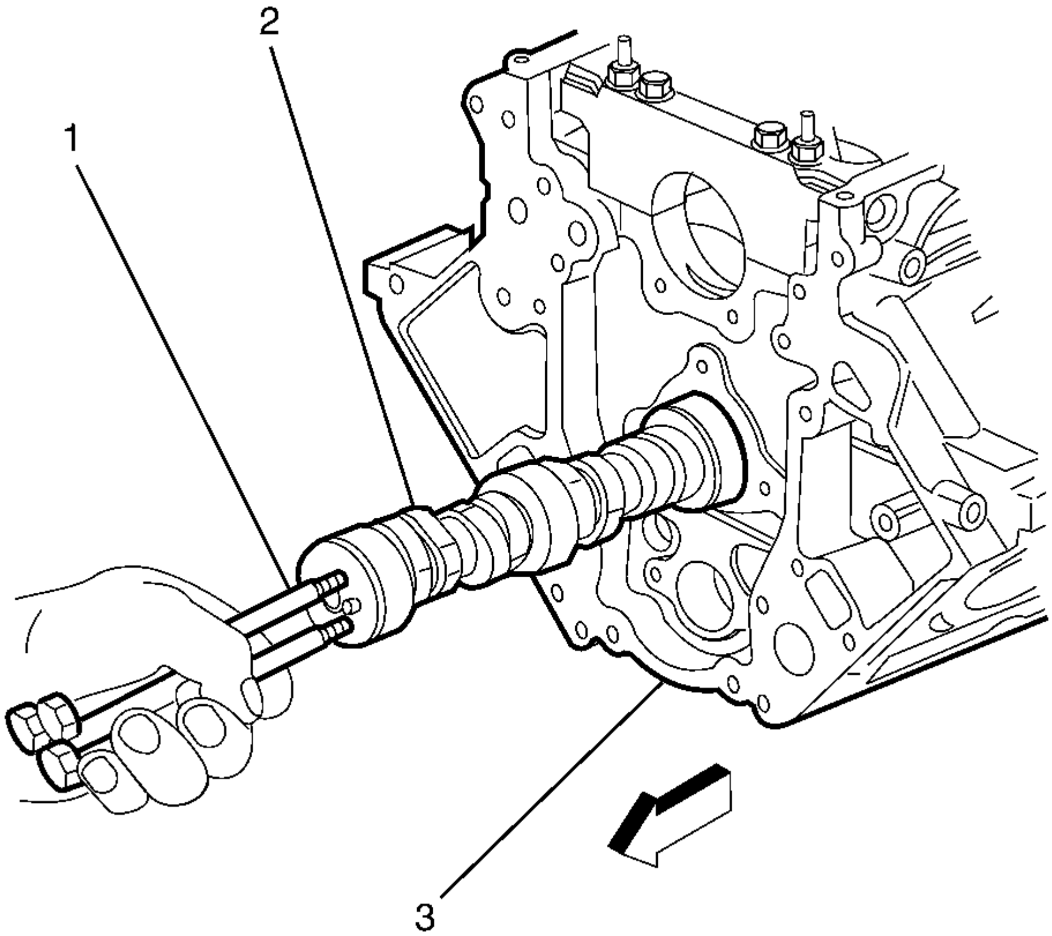


Fig. 61: Locating Cylinder Block, Camshaft & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

5. Remove the camshaft (2).
   1. Install M8 -1.25 x 100 mm (M8 -1.25 x 4.0 in) bolts (1) in the front of the camshaft (2).
   2. Using the bolts (1) as a handle, carefully rotate and pull the camshaft (2) out of the cylinder block (3).
   3. Remove the bolts (1) from the camshaft (3).
6. If required, clean and inspect the camshaft (3) and bearings. Refer to **Camshaft and Bearings Cleaning and Inspection**.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Tools Required

- **J 24270** Cylinder Bore Ridge Reamer. See **Special Tools** .
- **J 41556** Connecting Rod Guide. See **Special Tools** .

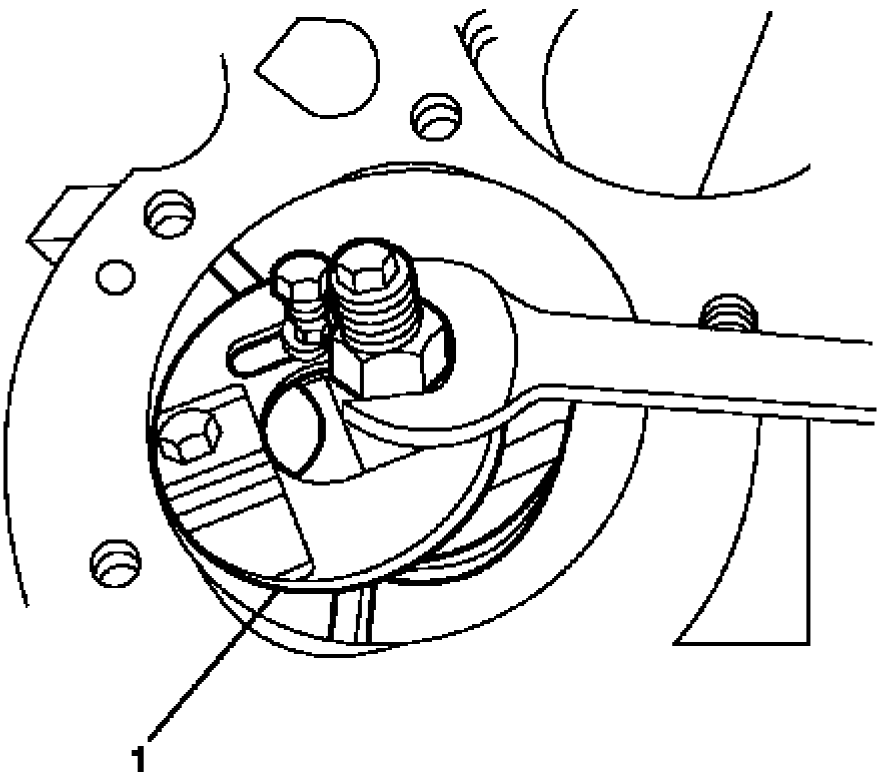


Fig. 62: Locating J 24270
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Follow the manufacturer's operating instructions for the ridge remover being used.

1. Use the **J 24270** or equivalent (1) in order to remove the cylinder bore ring ridge, if required. See **Special Tools** .
    1. Turn the crankshaft until the piston is at the bottom of the stroke.
    2. Place a cloth on top of the piston.
    3. Use the **J 24270** or equivalent (1), in order to remove a cylinder ring ridge. See **Special Tools** .
    4. Turn the crankshaft so the piston is at the top of the stroke.
    5. Remove the cloth.
    6. Remove the cutting debris from the cylinder and piston.

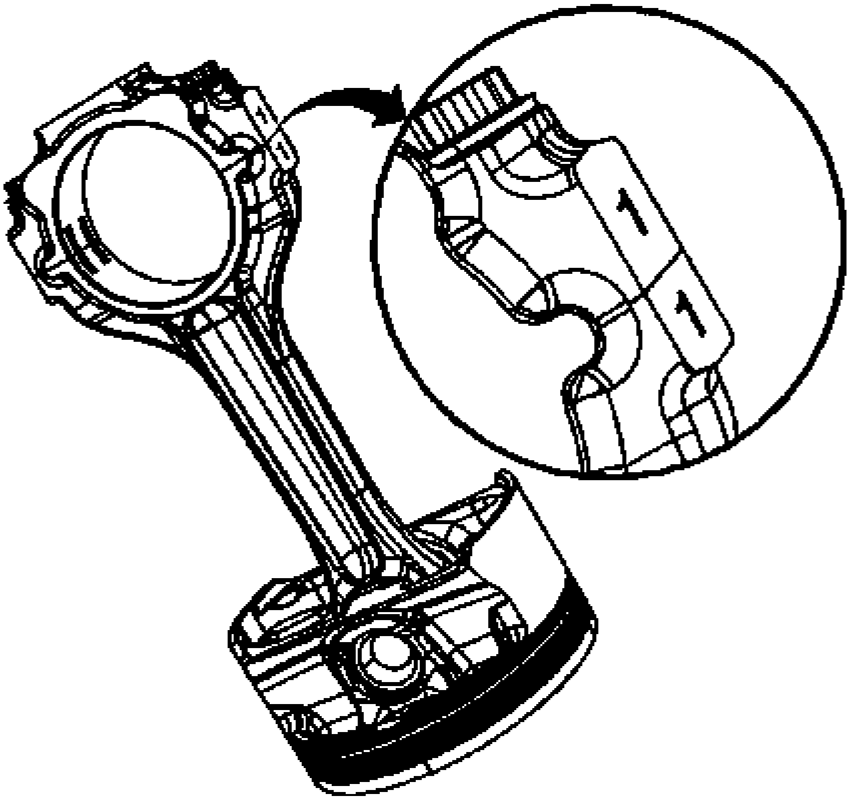


Fig. 63: Identifying Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not apply a stamping mark to any part of the connecting rod and piston assembly, A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.

2. Using a paint stick or etching tool, place match marks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and direction.
3. Mark the top of the piston to the specific cylinder bore.

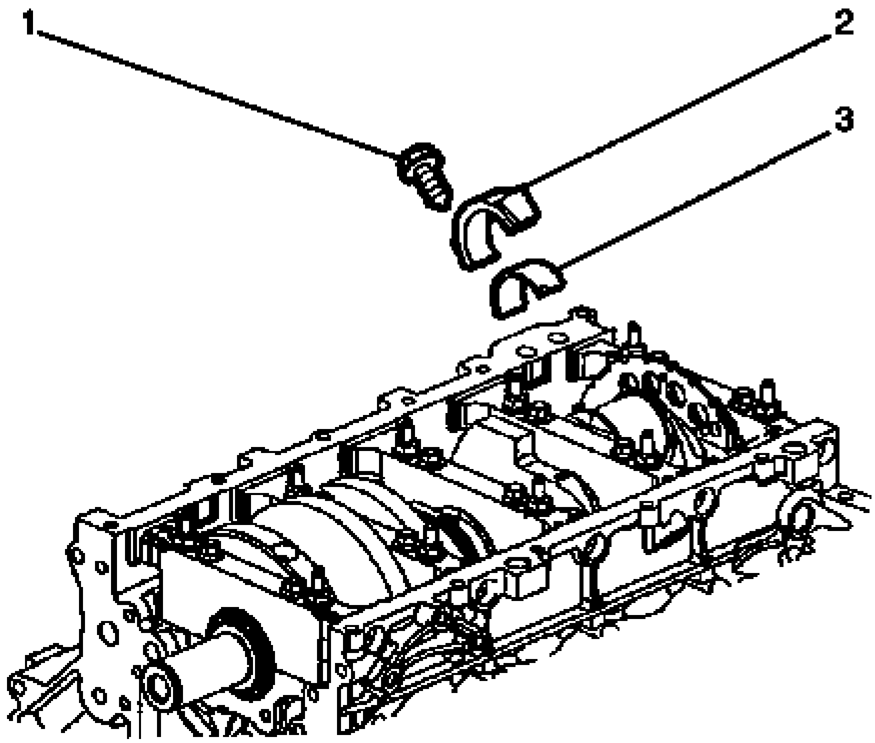


Fig. 64: Identifying Connecting Rod Bolts, Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Mark, sort, or organise the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable. Refer to Separating Parts .

4. Remove the connecting rod bolts (1).
5. Remove the connecting rod bearing cap (2).
6. Remove the connecting rod bearing (3).

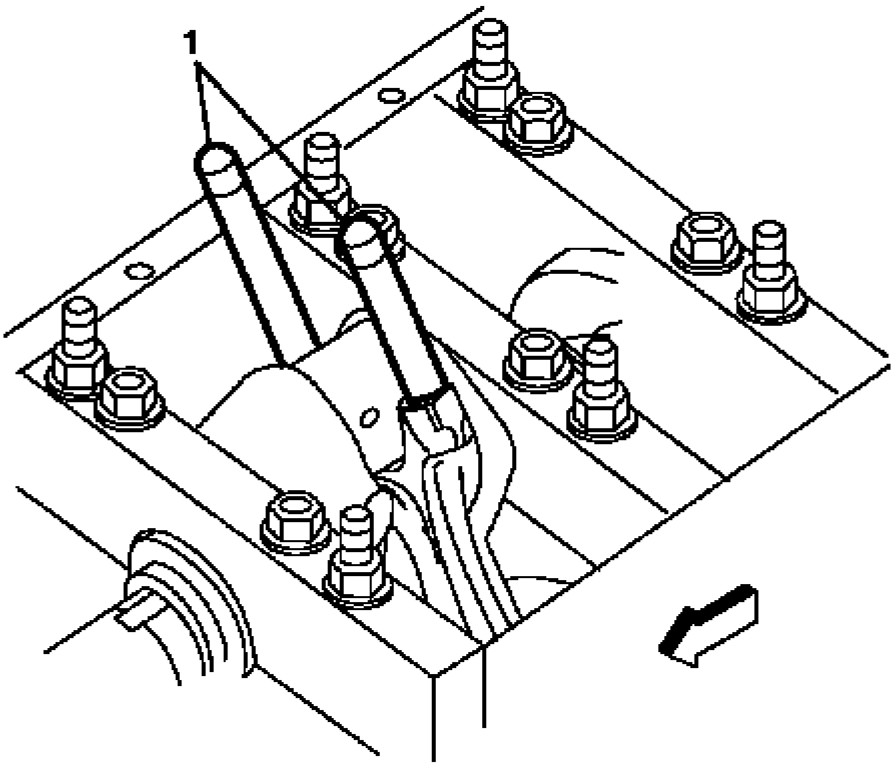


Fig. 65: Locating J 41556
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 41556** (1) to the connecting rod. See **Special Tools** .
8. Using a soft hammer, tap lightly on the end of the **J 41556** (1) in order to remove the piston and connecting rod assembly from the cylinder bore. See **Special Tools** .

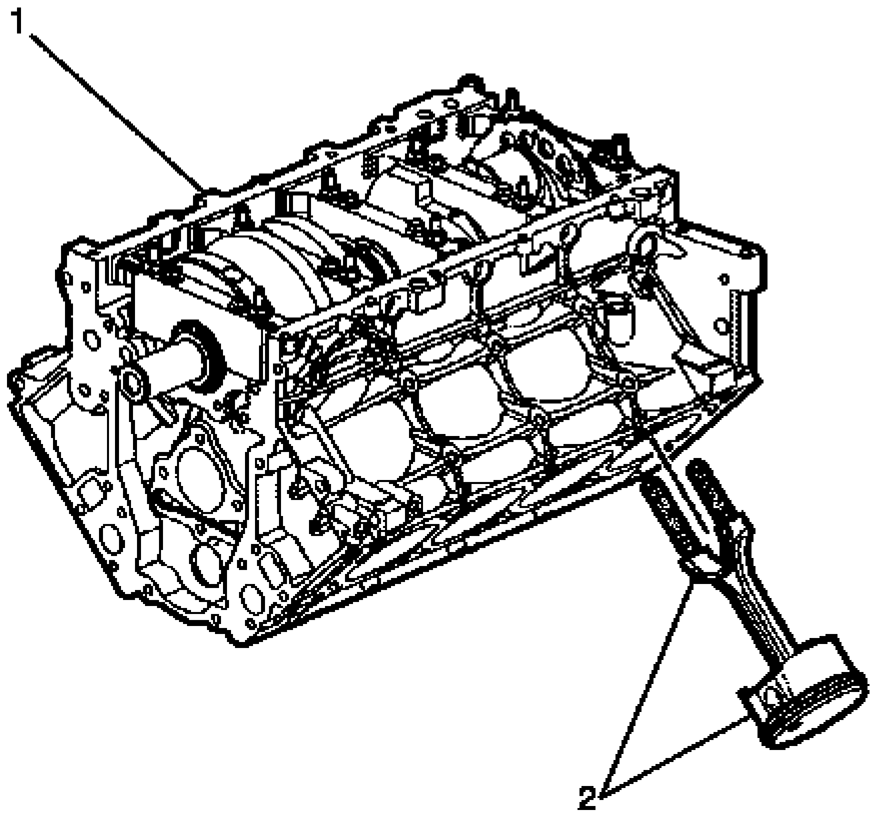


Fig. 66: Identifying Piston & Connecting Rod Assembly With Cylinder Block
Courtesy of GENERAL MOTORS CORP.

9. Remove the piston and connecting rod assembly (2) from the cylinder block (1).
10. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolt onto the matching connecting rod.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

- **J 6125-1B:** Slide Hammer
- **J 41818:** Crankshaft Bearing Cap Remover

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

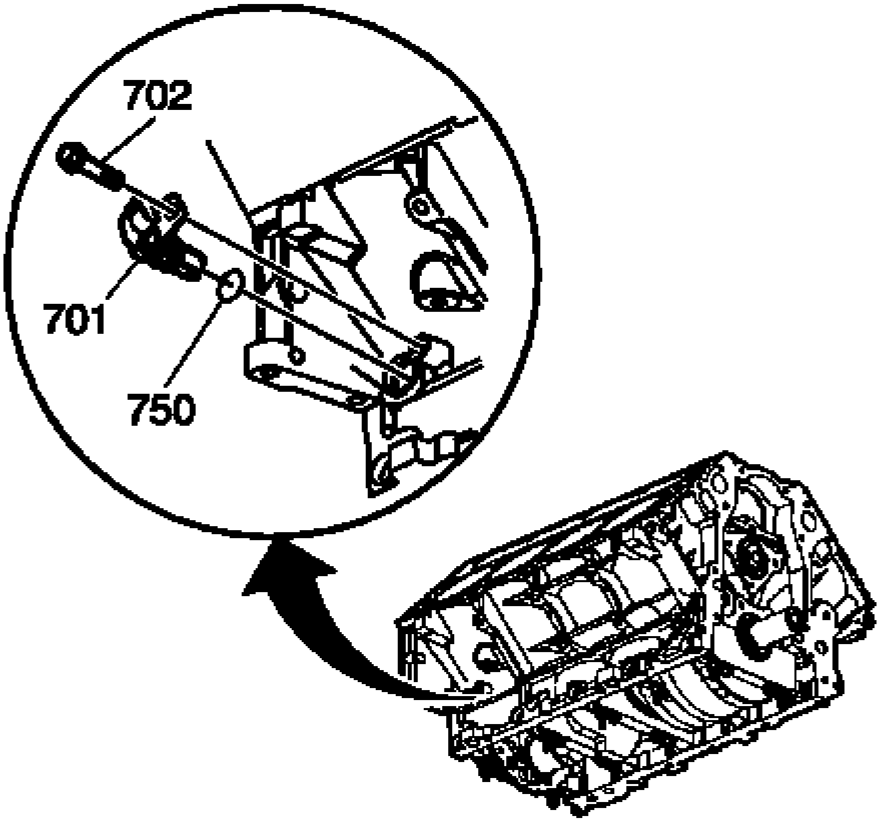


Fig. 67: CKP Sensor, Bolt & O-Ring
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.**
- **Do not use the bearing cap M8 side bolts again.**

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).
3. Remove the O-ring (750) from the sensor, as required.

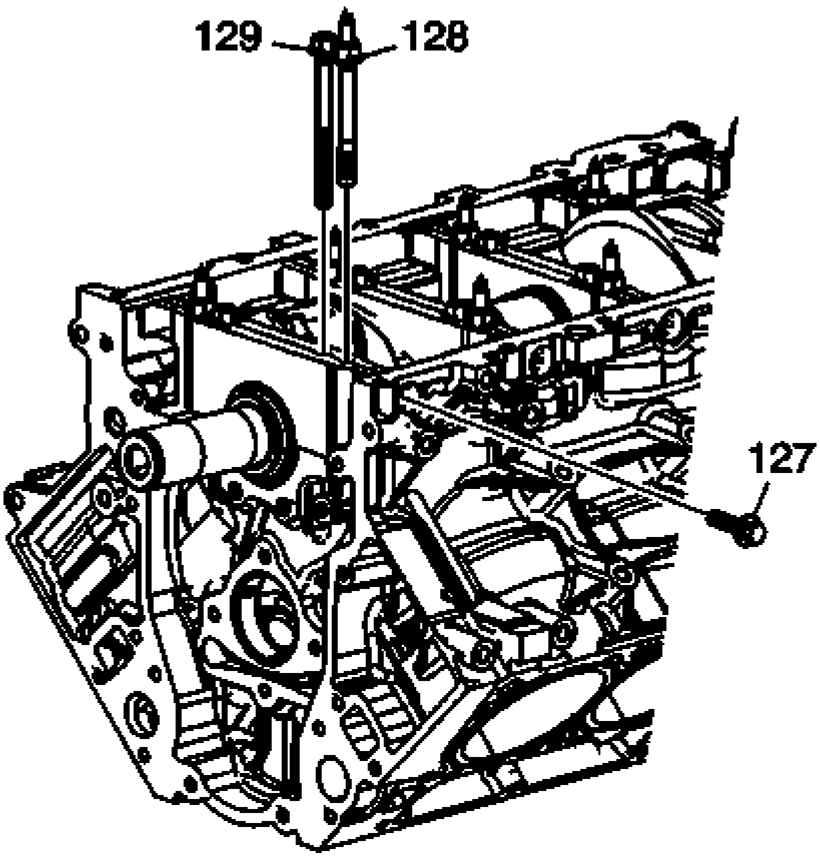


Fig. 68: Identifying Bearing Cap Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft bearing cap M8 bolts (127).
5. Remove the bearing cap M10 bolts (129) and studs (128).

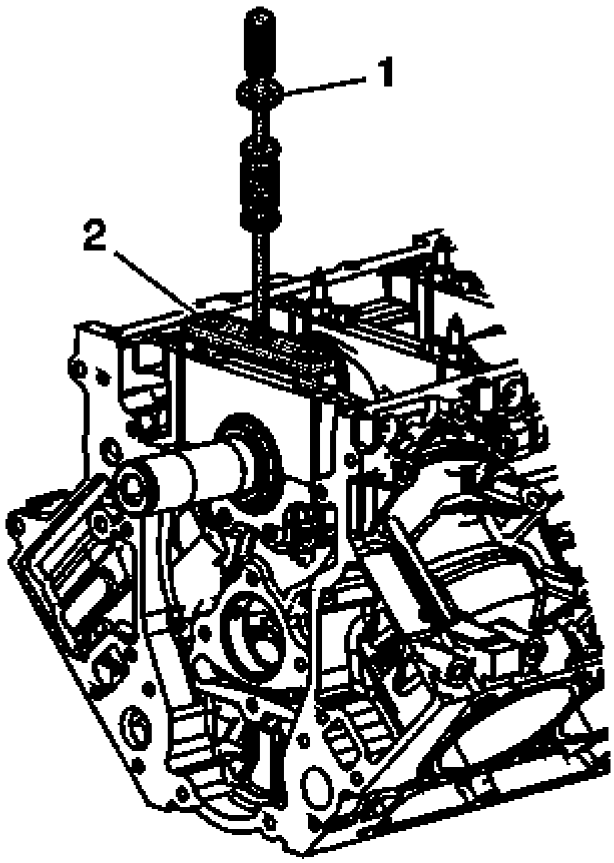


Fig. 69: View Of Crankshaft Bearing Cap Bolts (M10)
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the **J 41818:** remover (2). Tighten the **J 41818:** remover (2) bolts to 11 N.m (100 lb in).
7. Install the **J 6125-1B:** slide hammer (1) to the **J 41818:** remover (2) in order to remove the crankshaft bearing caps.

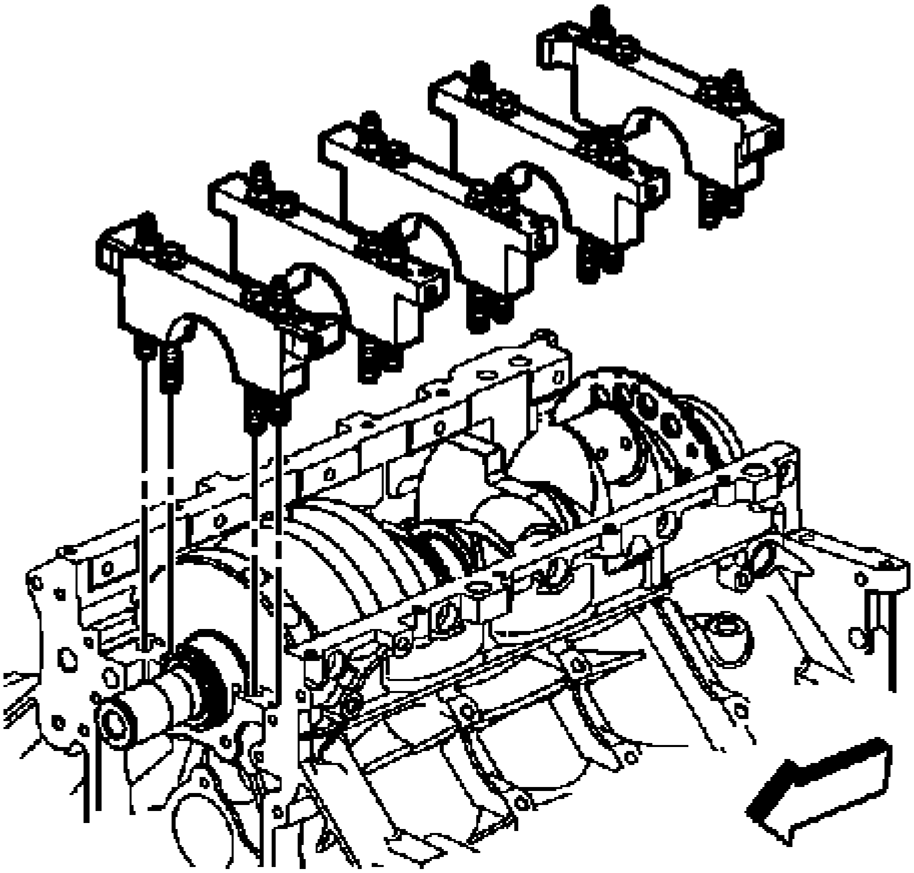


Fig. 70: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Remove the bearing caps.

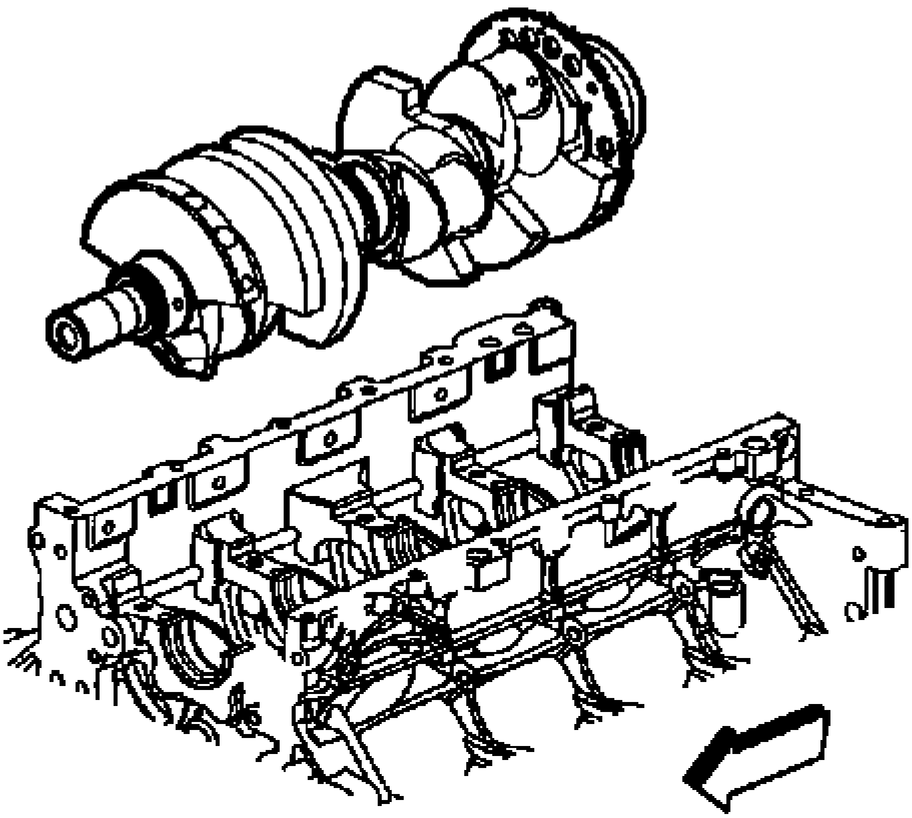


Fig. 71: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

9. Remove the crankshaft.

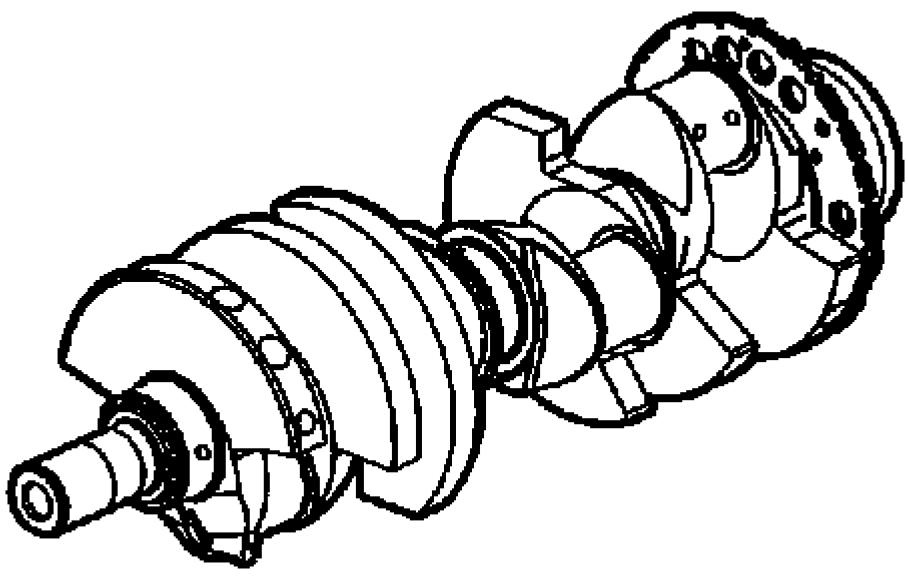


Fig. 72: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect on-board diagnostics (OBD) II system performance.**

10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

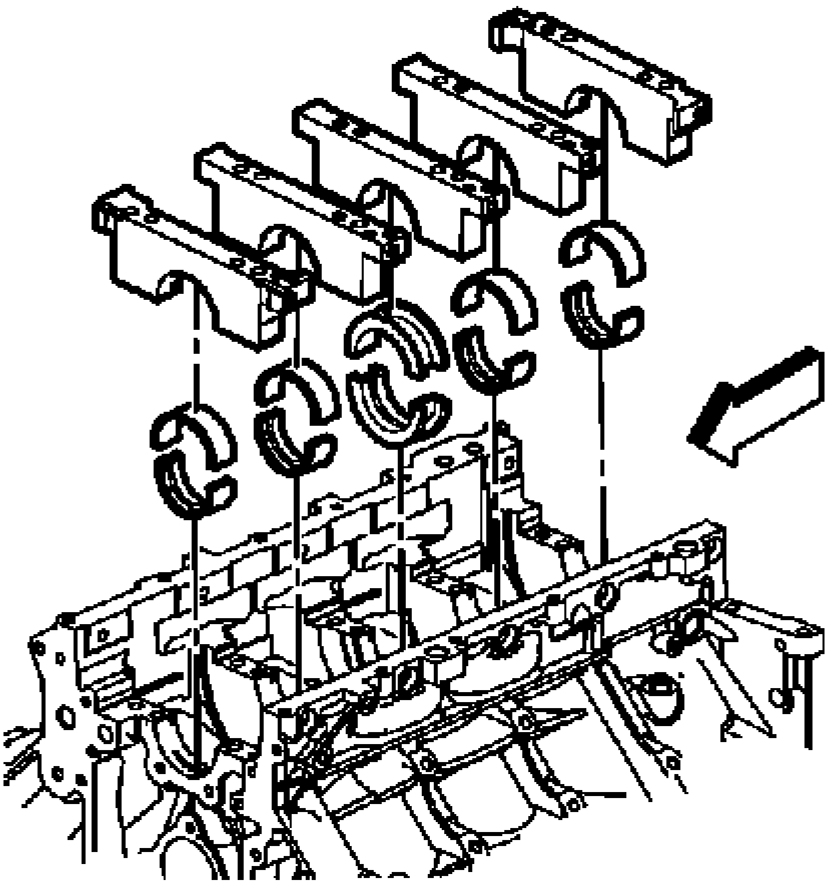


Fig. 73: View Of Crankshaft Bearings & Bearing Caps
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft bearings from the bearing caps and the engine block.
12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to **Separating Parts** .

ENGINE BLOCK PLUG REMOVAL

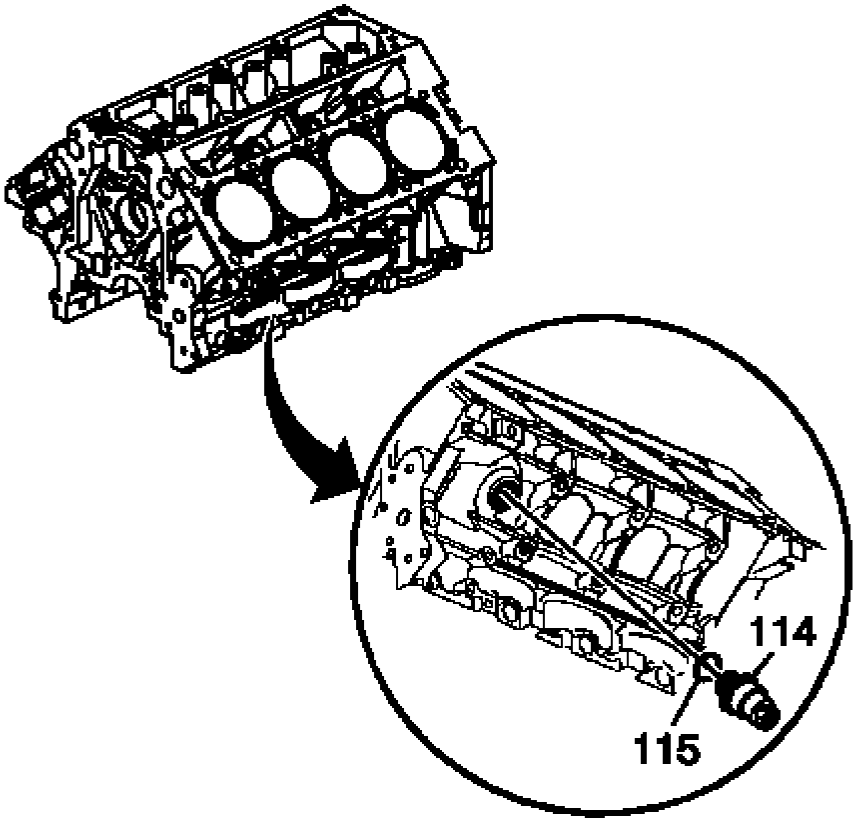


Fig. 74: Identifying Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine block coolant heater (114) and seal (115).

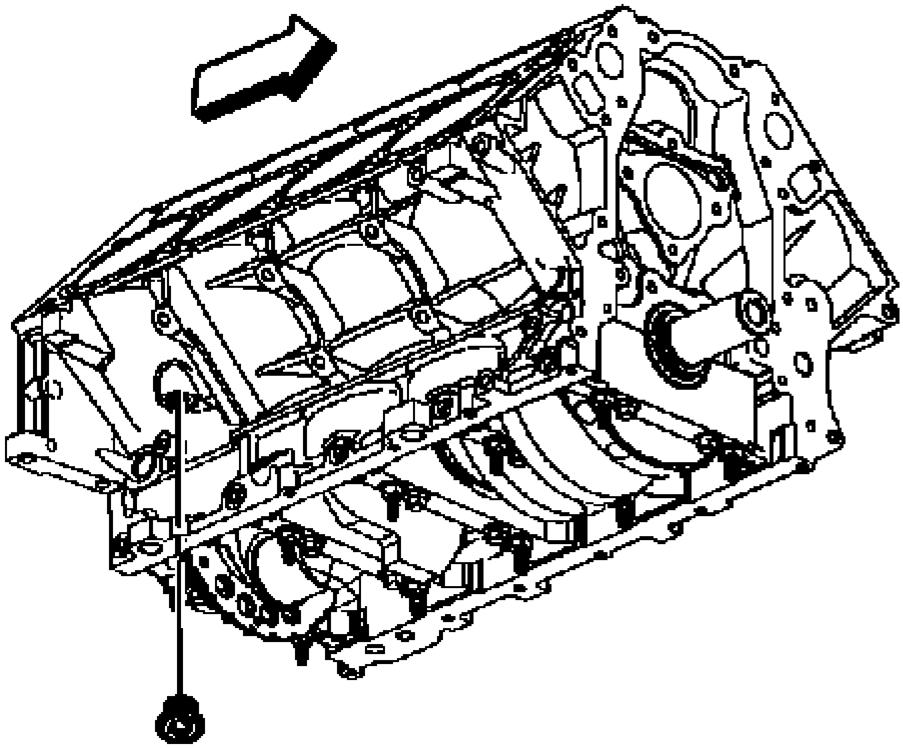


Fig. 75: Identifying Plug Location On Underside Of Block
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine block right rear coolant drain hole plug and seal.

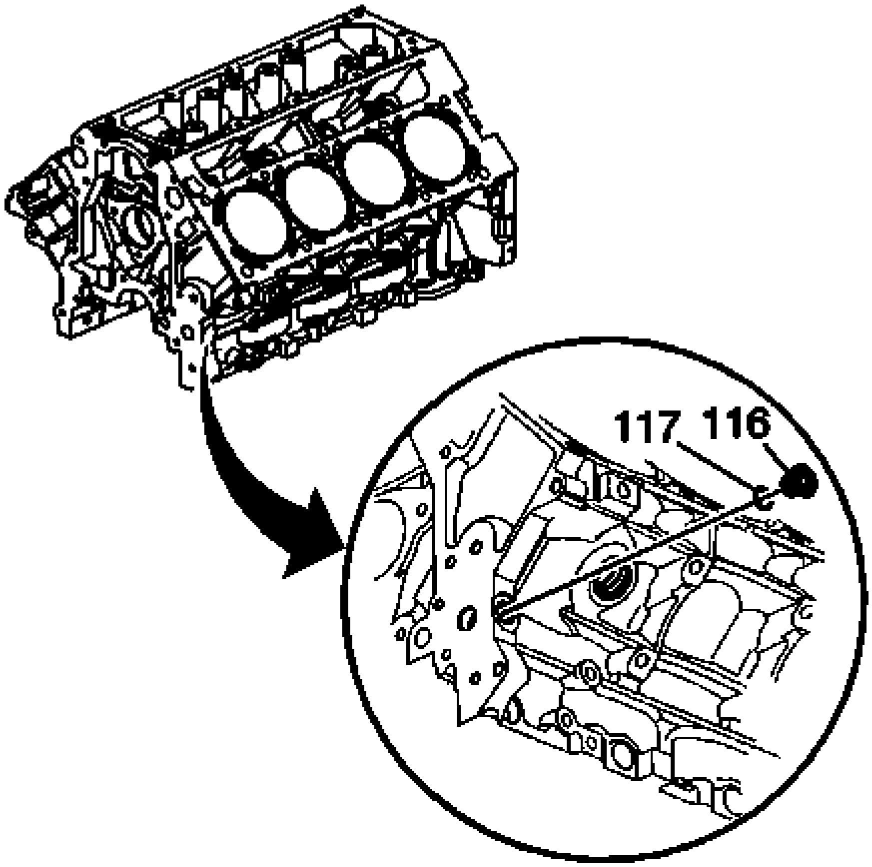


Fig. 76: Locating Engine Block Left Front Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine block left front oil gallery plug (116) and seal (117).

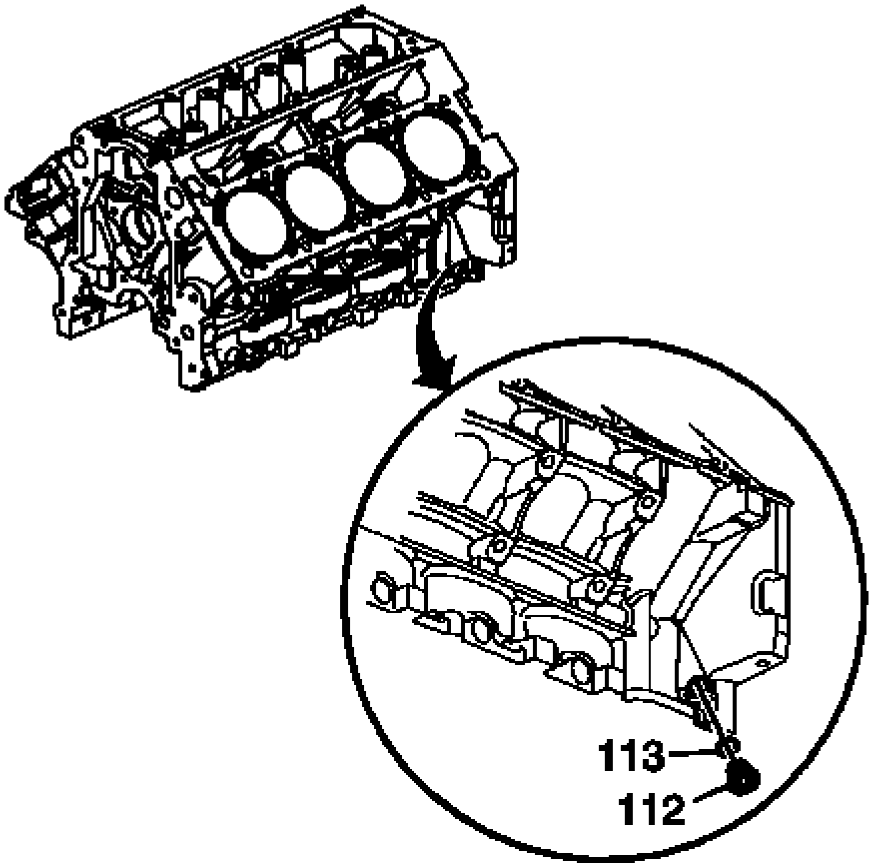


Fig. 77: Locating Engine Block Left Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine block left rear oil gallery plug (112) and seal (113).

   If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.

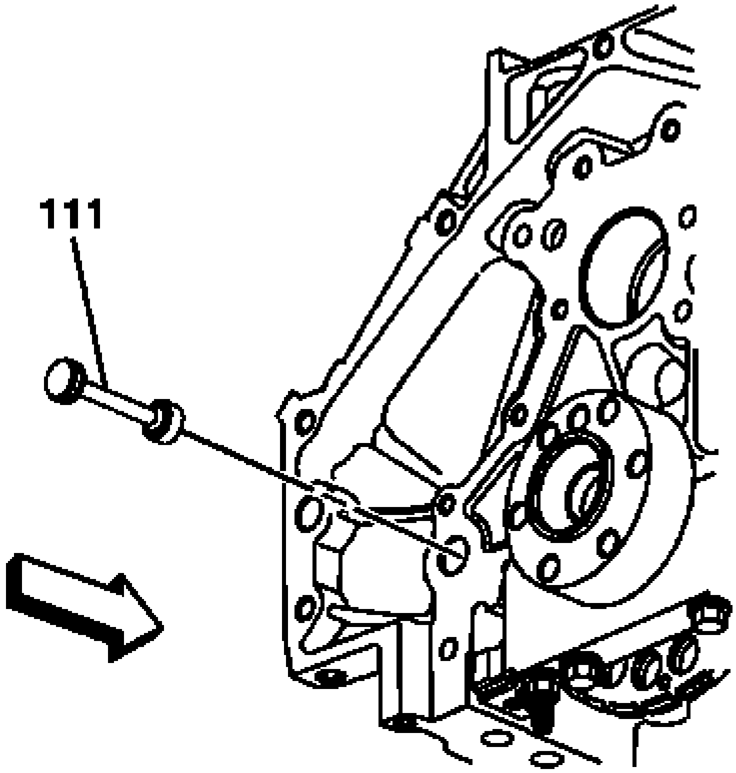


Fig. 78: Identifying Engine Block Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

   If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

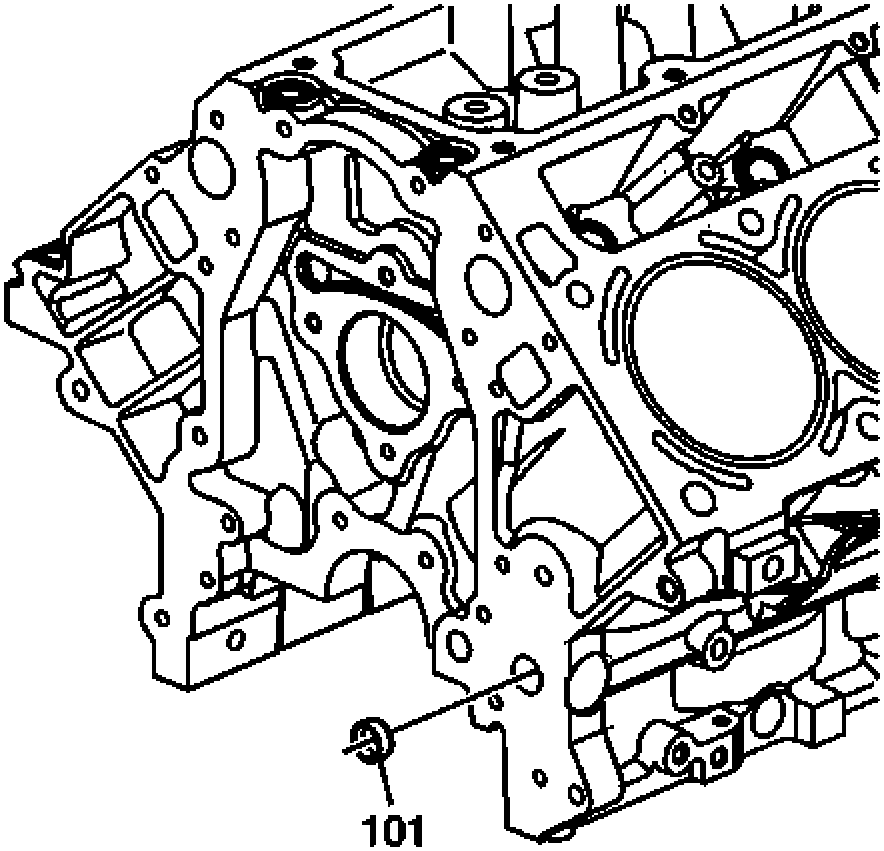


Fig. 79: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

7. Remove the engine block front oil gallery plug (101).

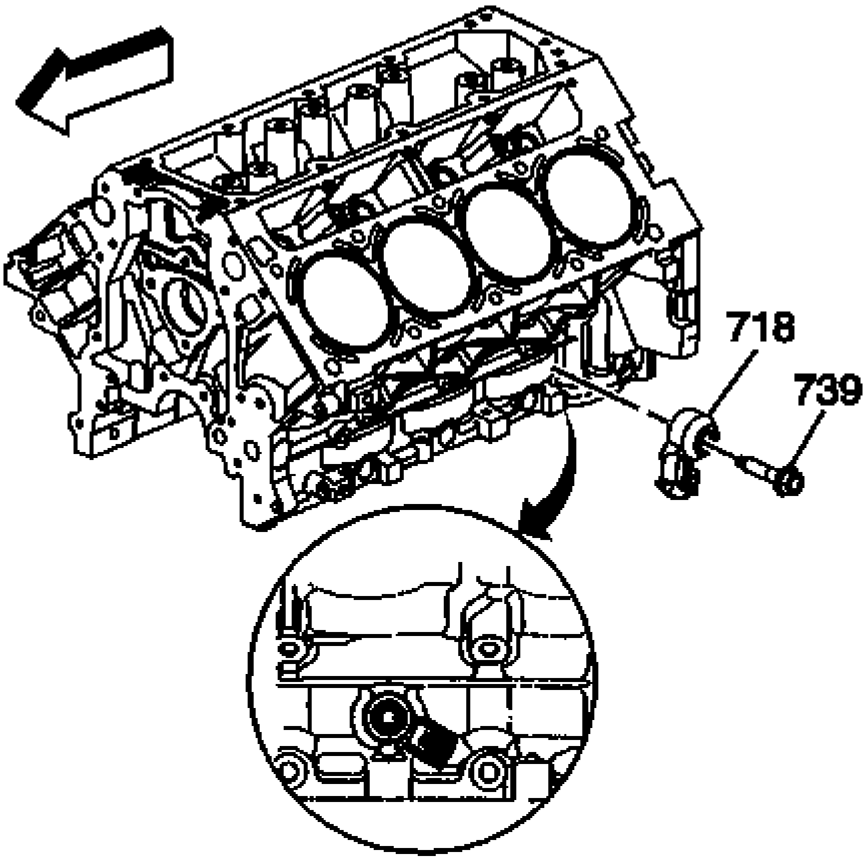


Fig. 80: Left Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the left side knock sensor (718) and bolt (739).

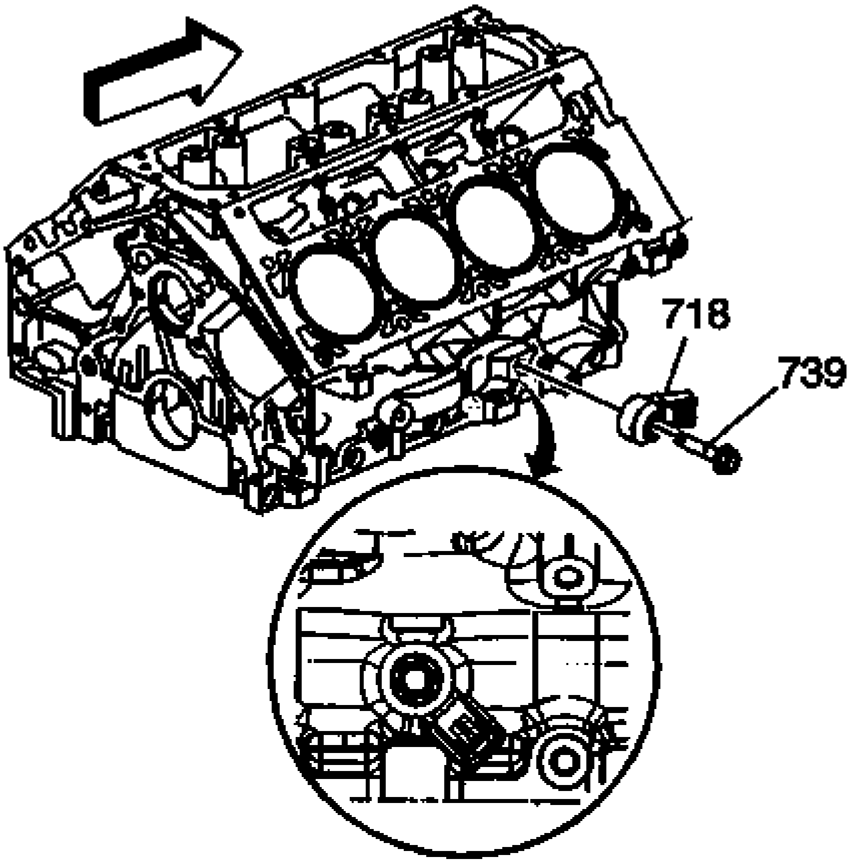


Fig. 81: Right Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the right side knock sensor (718) and bolt (739).

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **J 8087:** Cylinder Bore Gauge
- **J 42385-100:** Head/Main Bolt Thread Repair Kit

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

Cleaning Procedure

CAUTION: Do not use a caustic solution to clean the aluminum engine block.

NOTE: When cleaning the engine block in a thermal type oven, do not exceed 232°C

(450°F).

Clean the following components:

- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to **Cleanliness and Care** .
- Gasket surfaces

  Refer to **Replacing Engine Gaskets** .

- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material

  Thread repair driver tool **J 42385-100:** kit may be used to clean the threads of old threadlocking material.

Inspection Procedure

Inspect the following components:

- Cylinder walls for above acceptable scratches or gouging.
- Cylinder bores for above acceptable ring ridge at the top of the cylinder.
- Coolant jacket for cracks.
- Valve lifter bores for above acceptable scoring or wear.
- Crankshaft bearing webs for cracks.
- Gasket sealing surfaces for above acceptable scratches or gouging.

  Refer to **Replacing Engine Gaskets** .

- Oil galleries for restrictions.
- Threaded bolt holes for damaged threads.

Measuring the Cylinder Deck for Distortion

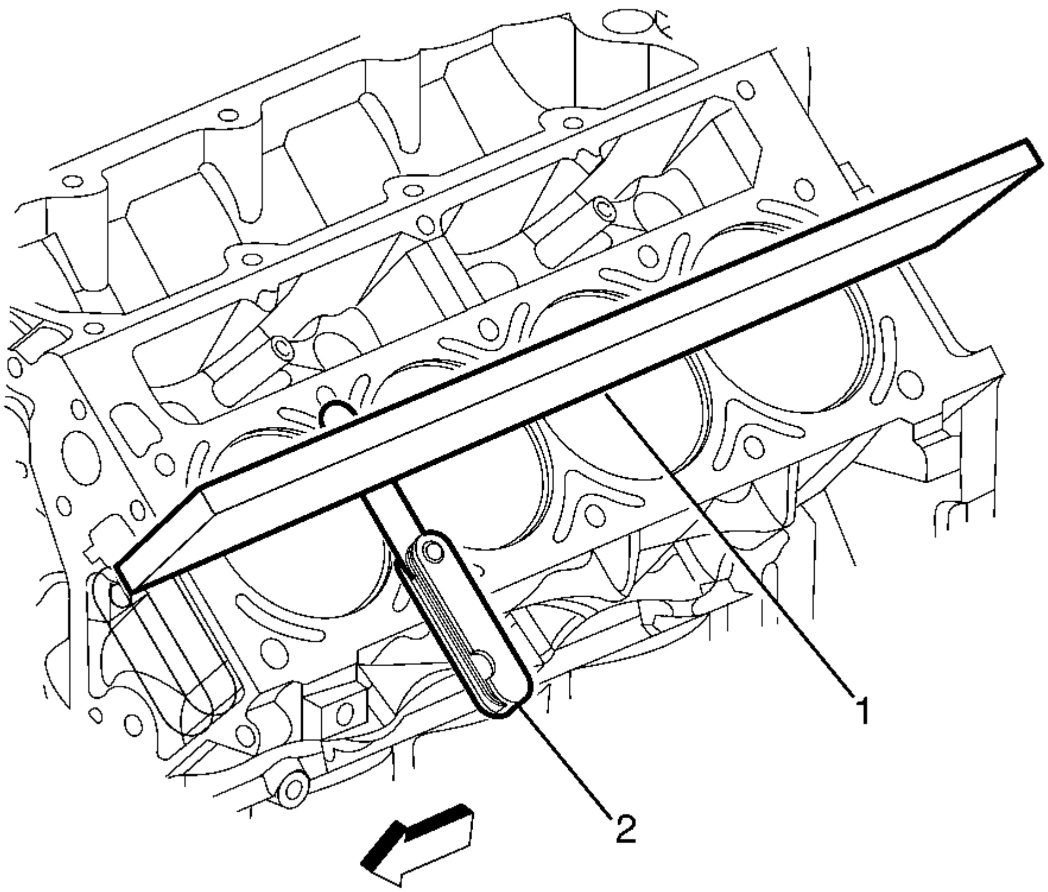


Fig. 82: Locating Straight Edge & Feeler Gauges
Courtesy of GENERAL MOTORS CORP.

1. Measure the cylinder block cylinder head deck using a straight edge (1) and feeler gauges (2).
2. Check the flatness of the cylinder block and cylinder head deck surfaces. If the measurement is not within specification, the cylinder block must be replaced. machining is not recommended. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

Measuring the Cylinder for Oversize

1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

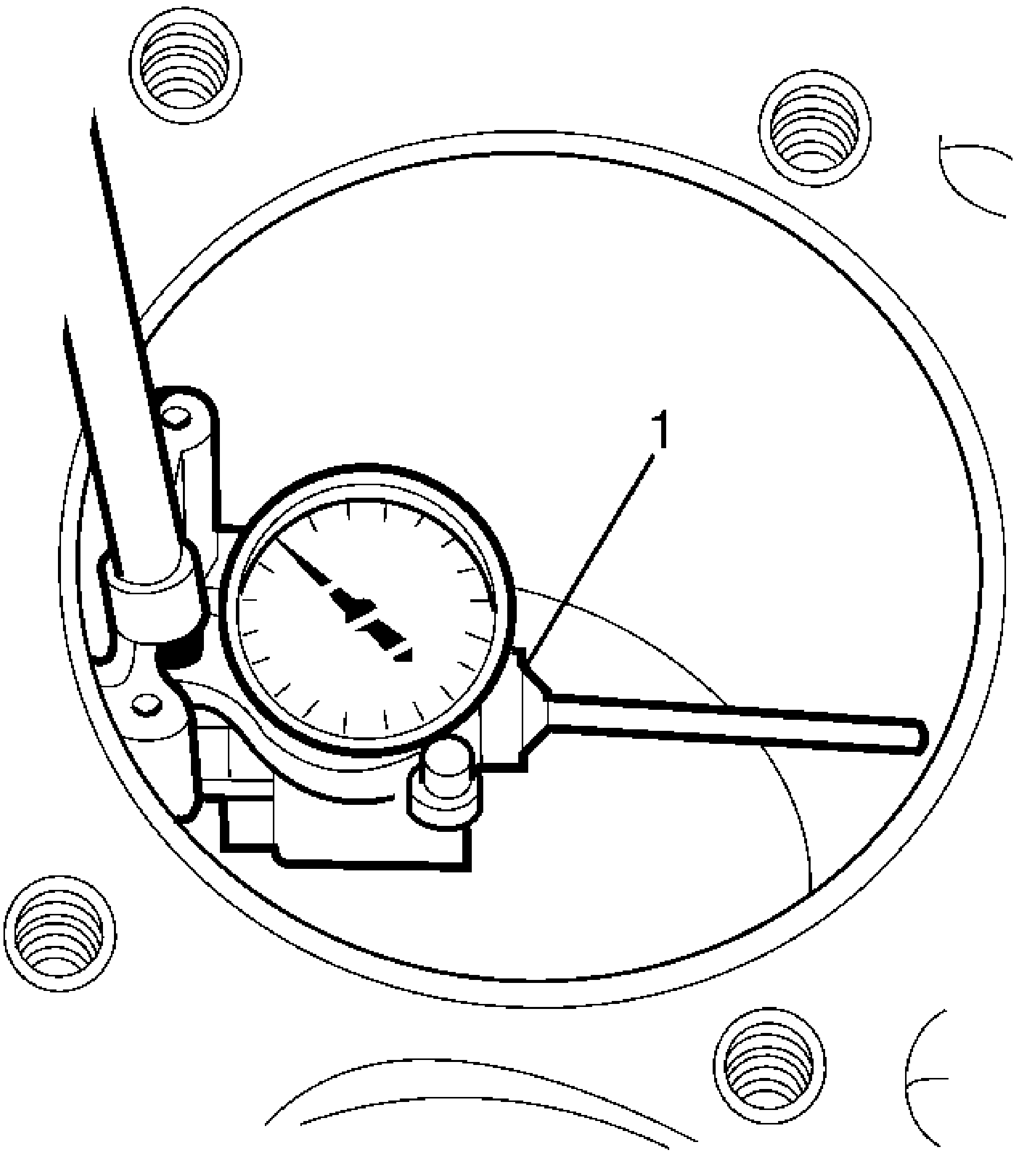


Fig. 83: Locating J 8087 Bore Gauge
Courtesy of GENERAL MOTORS CORP.

2. Insert the **J 8087:** gauge (1) bore gauge into the micrometer and zero the bore gauge dial.
3. Using the **J 8087:** gauge (1), measure the cylinder bore for oversize.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Check the bore both parallel and perpendicular to the centre line of the crankshaft. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to **Engine Mechanical Specifications (6.2L**

LS3) or **Engine Mechanical Specifications (6.0L L76)** .

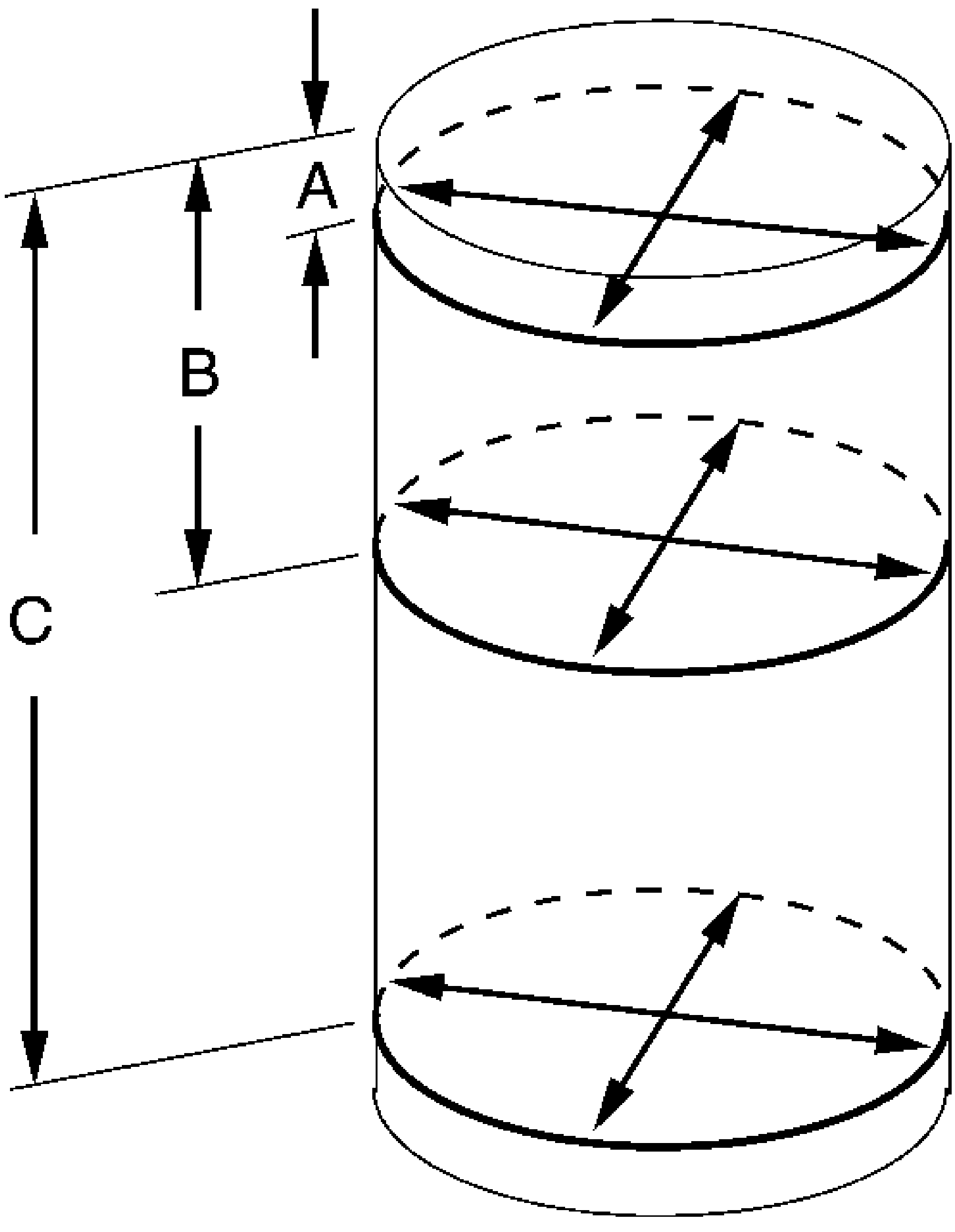


Fig. 84: Identifying Point A, B & C
Courtesy of GENERAL MOTORS CORP.

4. Measure the bore at points (A, B and C), measure at these points both in line with and perpendicular to the crankshaft centre line.
    - Point (A) is 9 mm from the cylinder head surfaces
    - Point (B) is 57 mm from the cylinder head surfaces
    - Point (C) is 127 mm from the cylinder head surfaces
5. Calculate the difference between the two measurements at each location, the results will indicate any out of round bore condition. A cylinder bore that exceeds the maximum out of round condition must be serviced with an oversized piston. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

CYLINDER BORING AND HONING

Boring Procedure

IMPORTANT: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available.

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure

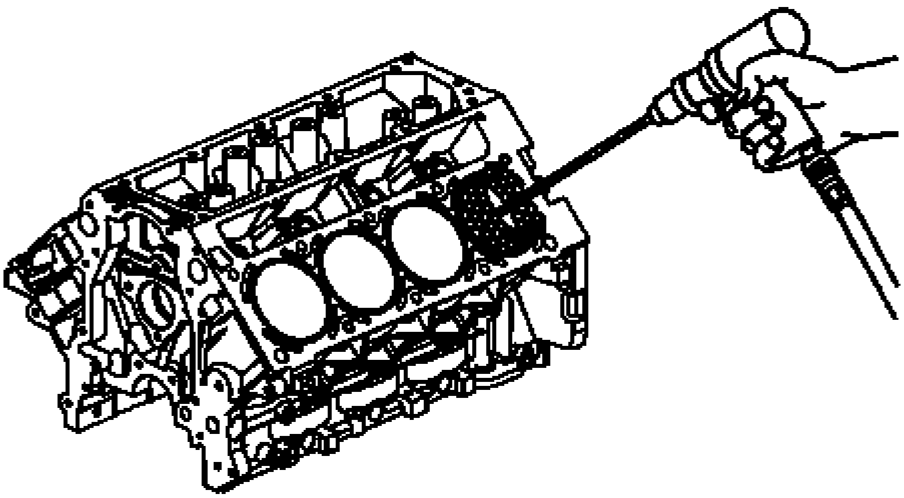


Fig. 85: View Of Honing Of Cylinders
Courtesy of GENERAL MOTORS CORP.

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.
2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

   All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.
4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

   A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder 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 may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

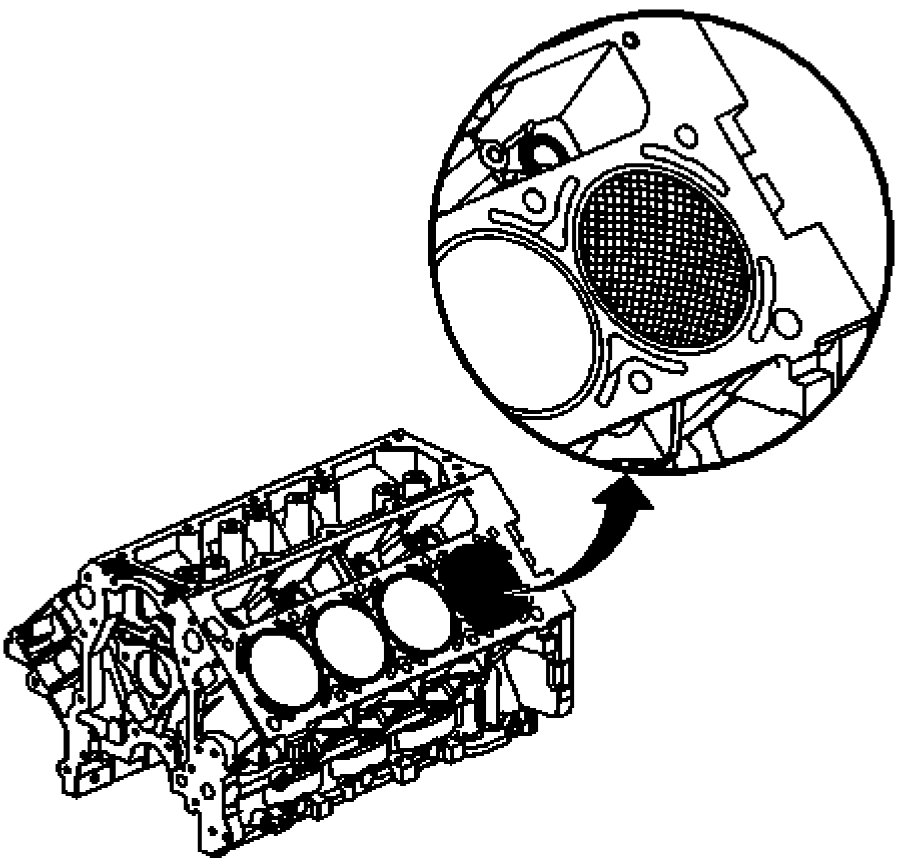


Fig. 86: Illustrating Deglazing Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when performing the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

- **J 7872:** Magnetic Base Dial Indicator Set
- **J 43690:** Rod Bearing Checking Tool
- **J 43690-100:** Rod Bearing Checking Tool - Adapter Kit

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

Cleaning Procedure

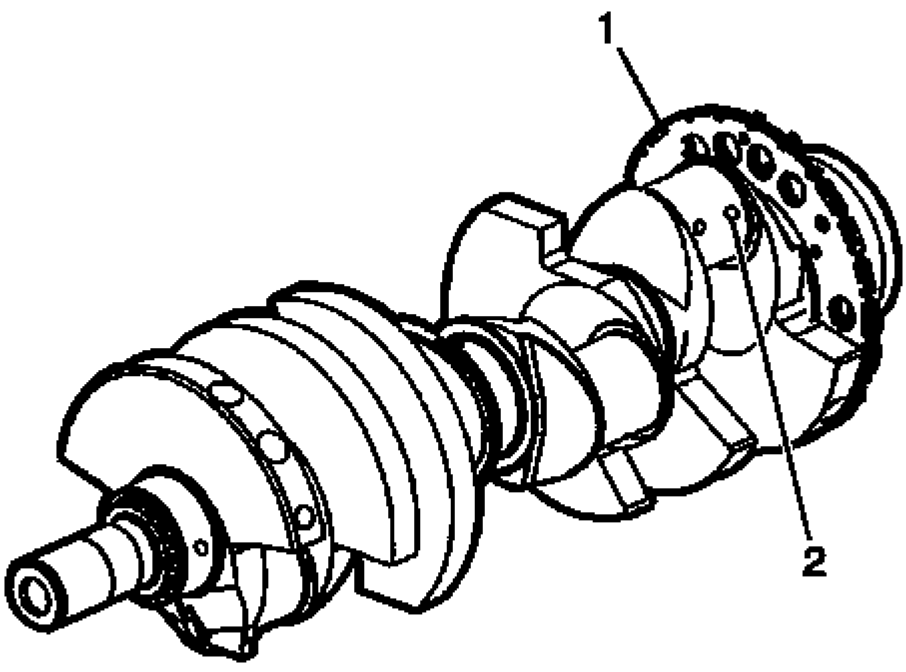


Fig. 87: Oil Passages & CKP Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

NOTE: **Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.**

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

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

3. Dry the crankshaft with compressed air.

Inspection Procedure

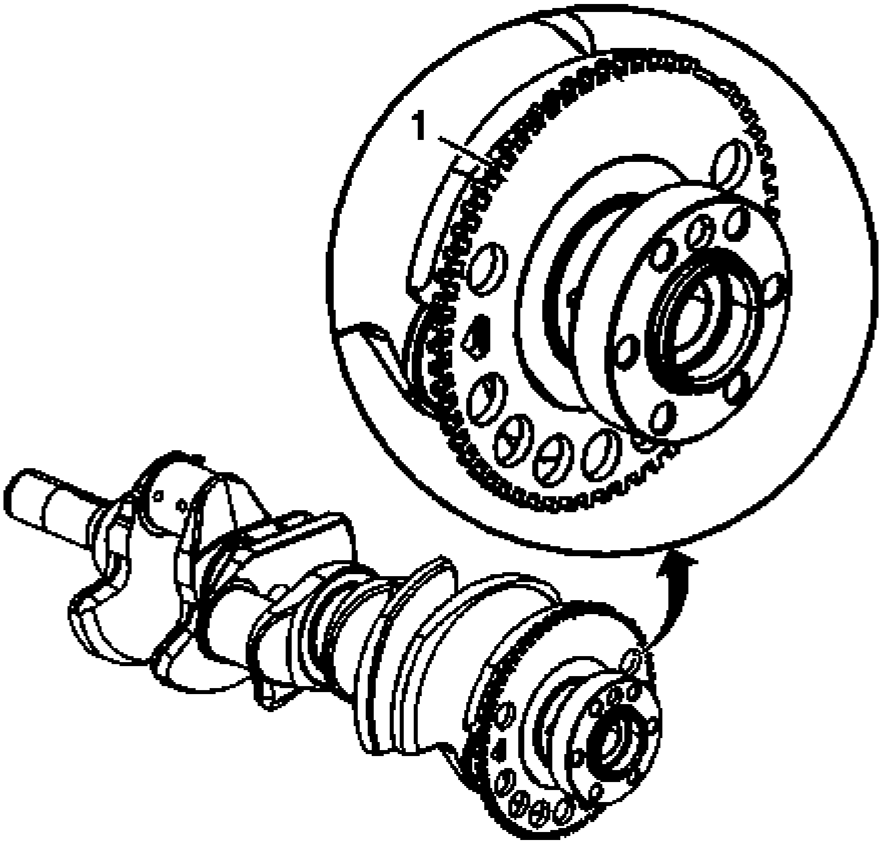


Fig. 88: View Of Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

NOTE: **The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.**

1. Inspect the CKP reluctor ring teeth (1) for damage.

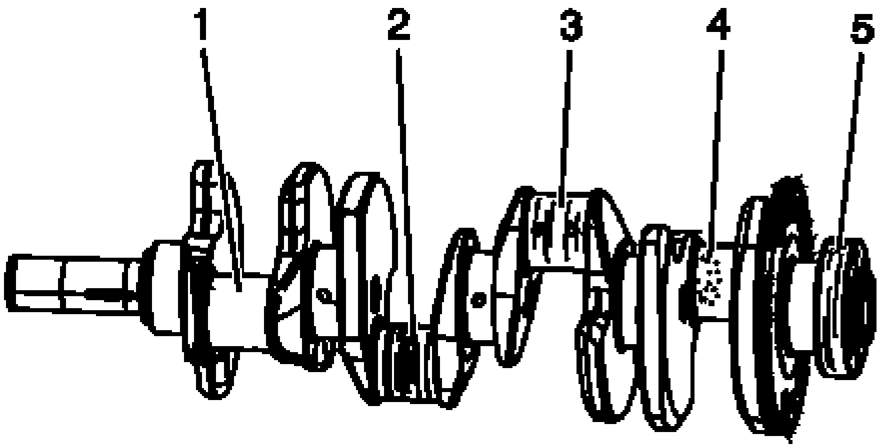


Fig. 89: View Of Crankshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Inspect the crankshaft journals for wear.

   Journals should be smooth (1) with no signs of scoring, wear, or damage.

3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.

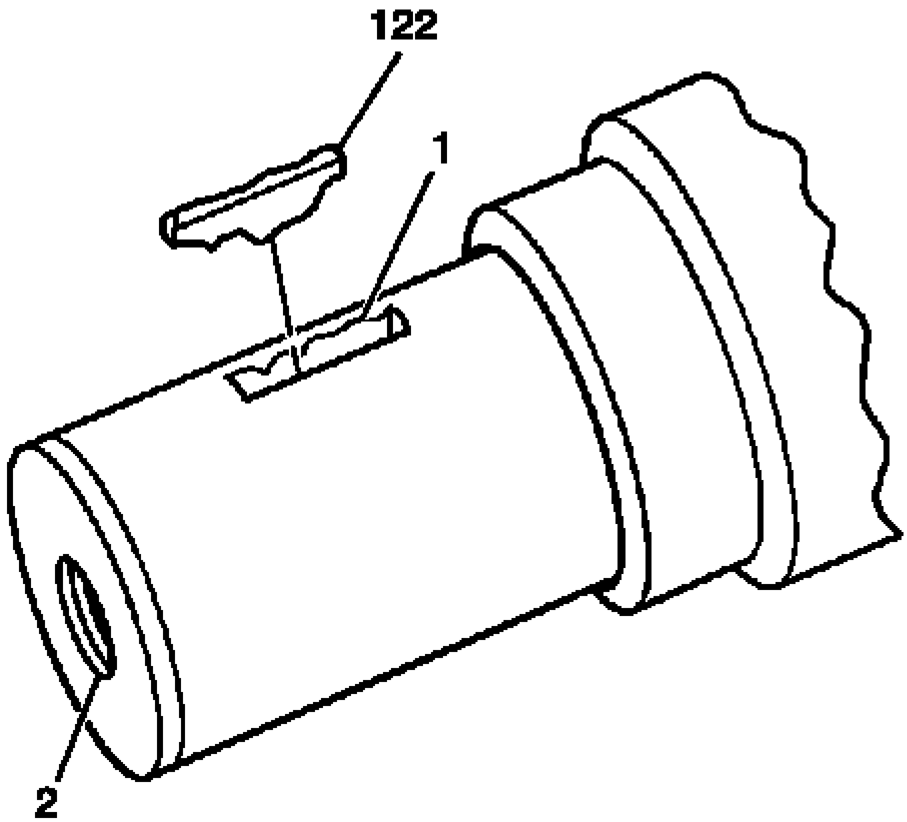


Fig. 90: View Of Crankshaft Key, Keyway & Threaded Hole
Courtesy of GENERAL MOTORS CORP.

7. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

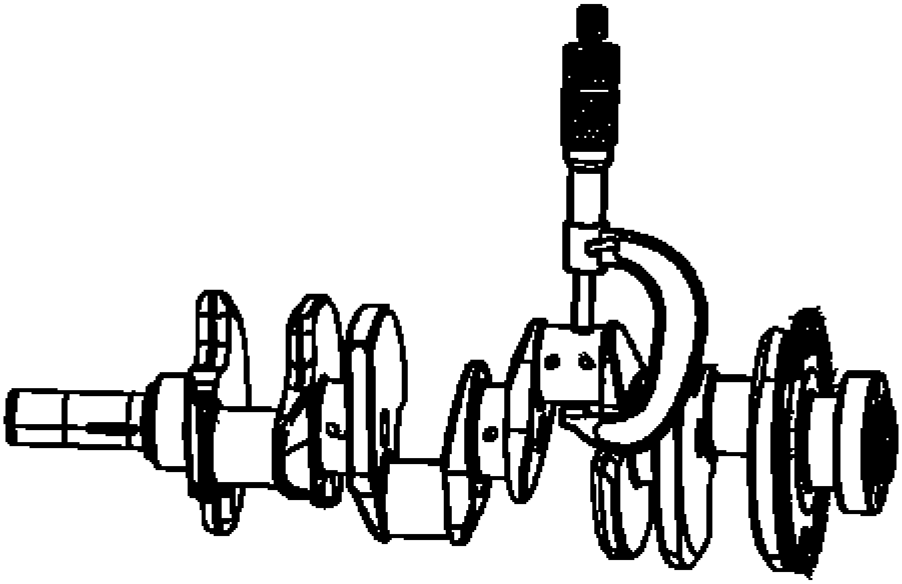


Fig. 91: Measuring Connecting Rod Journals For Out-Of-Round And Taper
Courtesy of GENERAL MOTORS CORP.

8. Measure the connecting rod journals for out-of-round and taper.

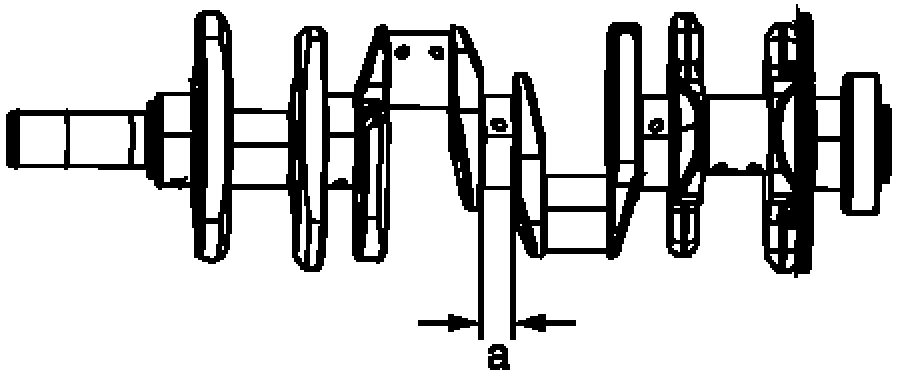


Fig. 92: Measuring Crankshaft Thrust Wall Width
Courtesy of GENERAL MOTORS CORP.

9. Measure the crankshaft thrust wall width.

   A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.

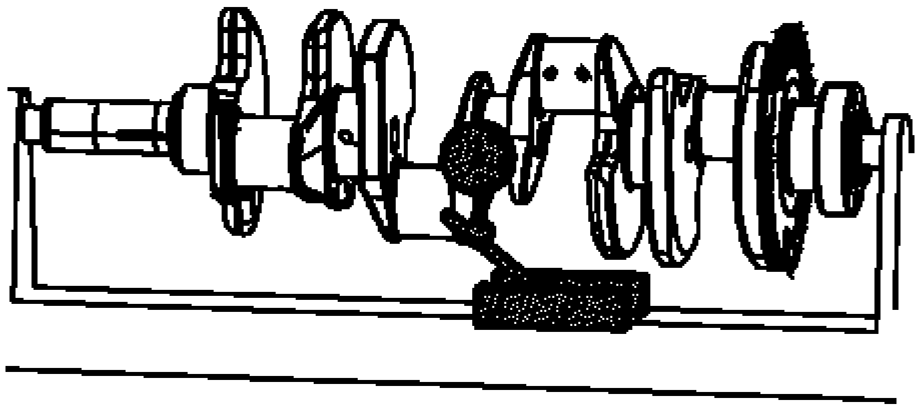


Fig. 93: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS CORP.

10. Measure the crankshaft runout.

    Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

11. Use the **J 7872:** dial indicator set in order to measure the crankshaft runout at the front and rear intermediate journals.
12. Use the **J 7872:** dial indicator set in order to measure the runout of the crankshaft rear flange.
13. Use the **J 7872:** dial indicator set in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

    If the reluctor ring has runout in excess of 0.7 mm (0.028 in), replace the crankshaft.

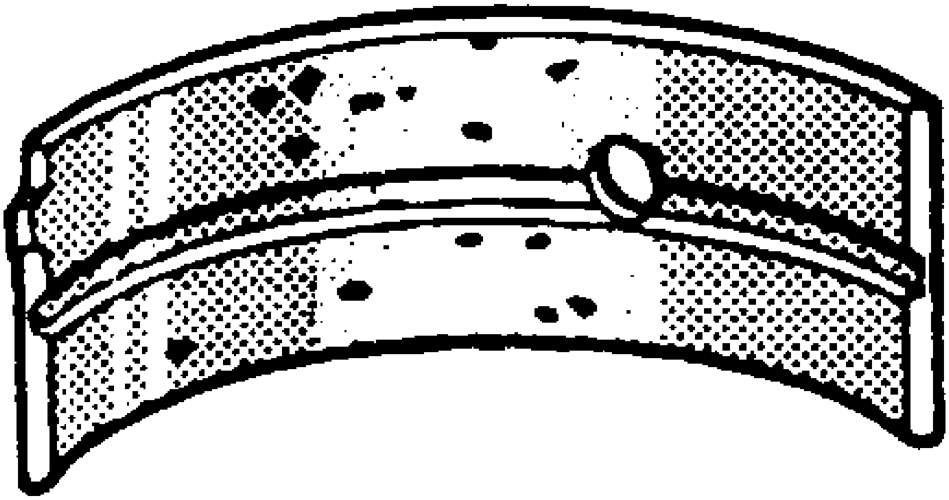


Fig. 94: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

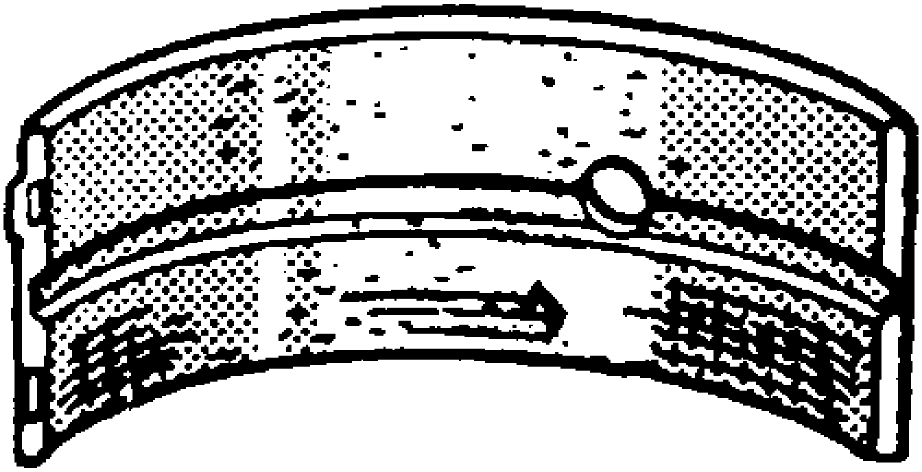


Fig. 95: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

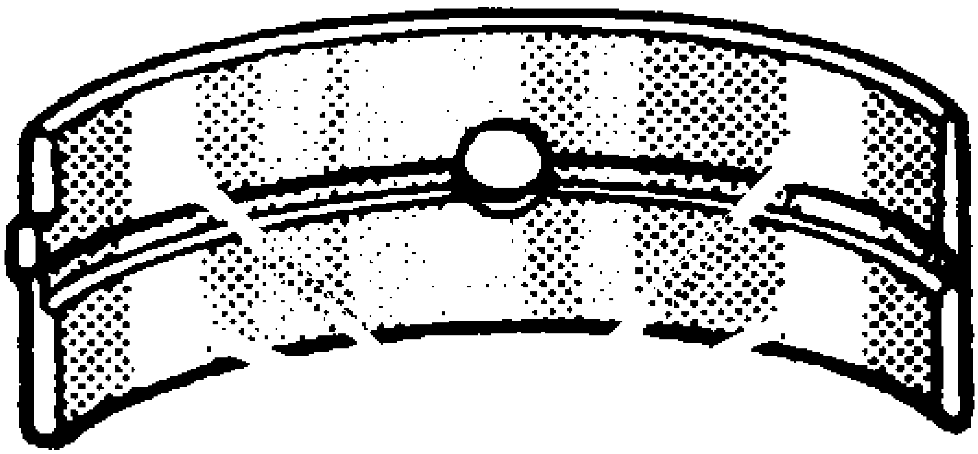


Fig. 96: View Of Improper Seating
Courtesy of GENERAL MOTORS CORP.

17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

Measuring Main Bearing Clearance - Gaging Plastic Method

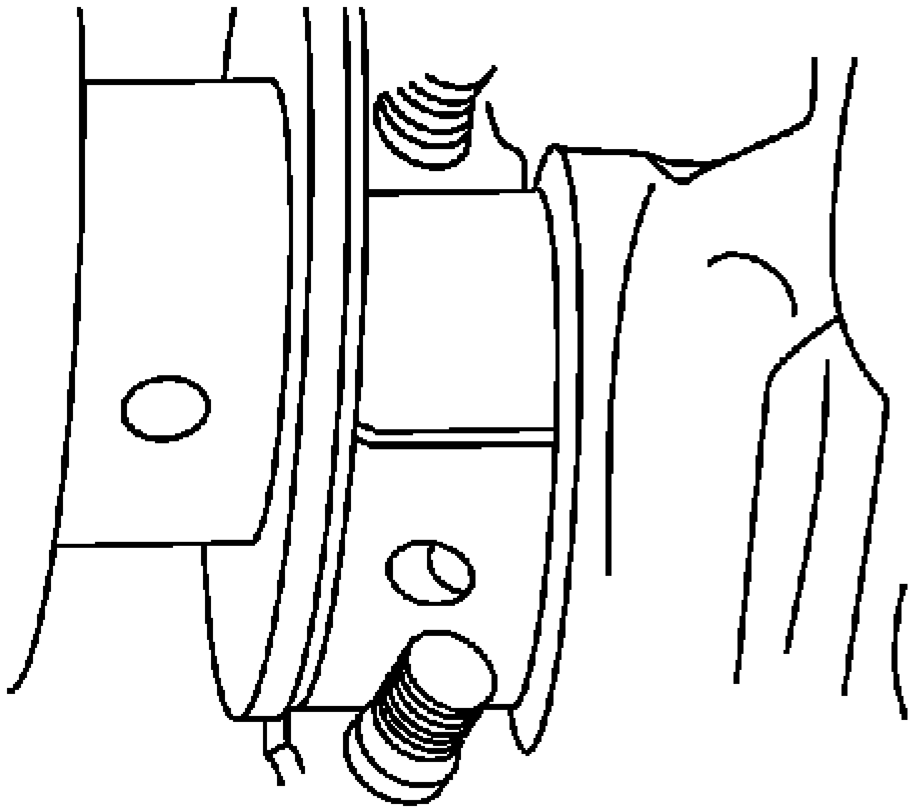


Fig. 97: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**
- **The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect OBD II system operation.**
- **Remove the bearing cap side bolts prior to cap removal.**

1. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Removal**.
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Installation** .

4. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Removal**.

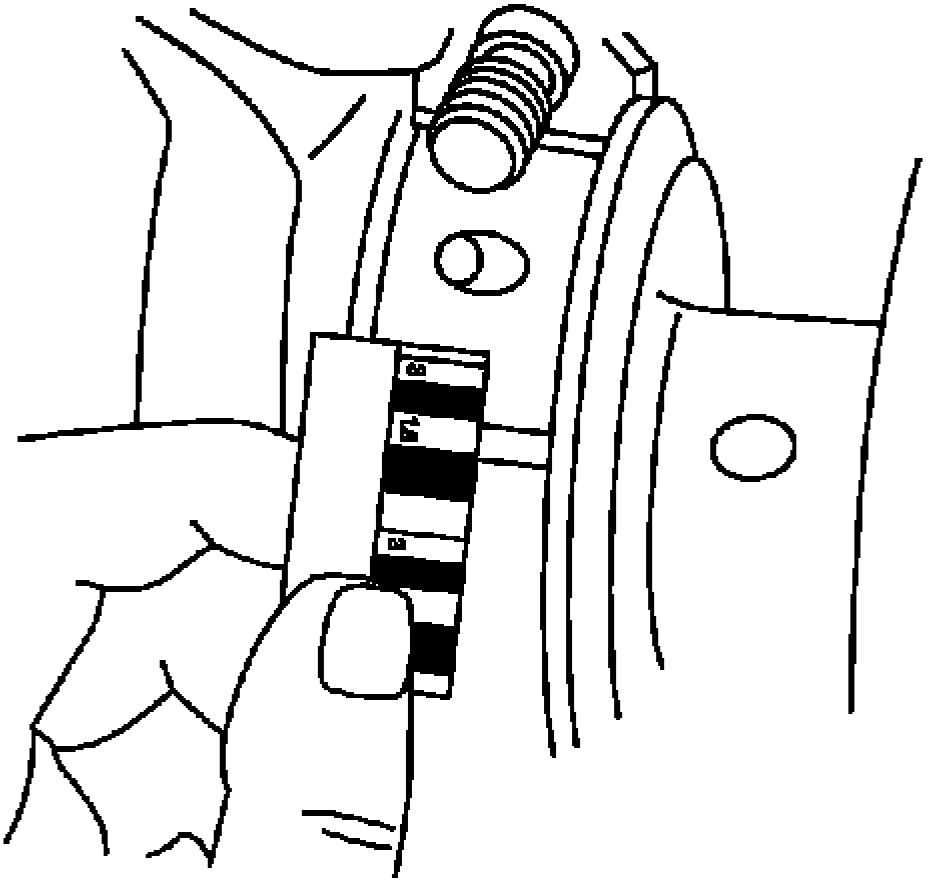


Fig. 98: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
   - If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
   - If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

Measuring Connecting Rod Bearing Clearance - Gaging Plastic Method

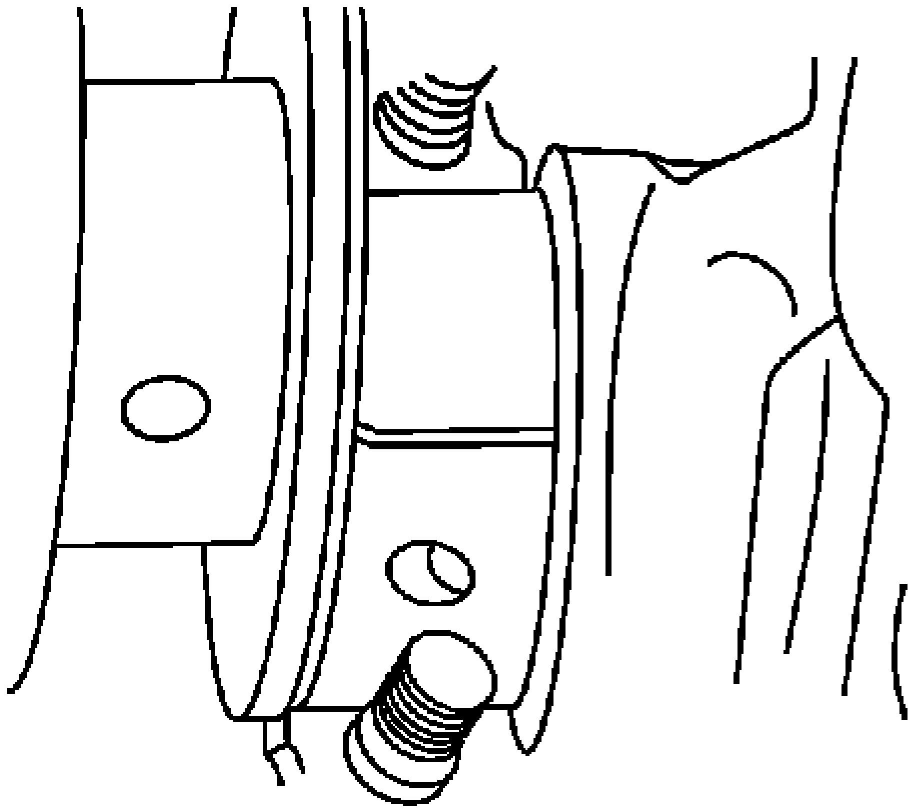


Fig. 99: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**

1. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal**.
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Installation** .
4. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal**.

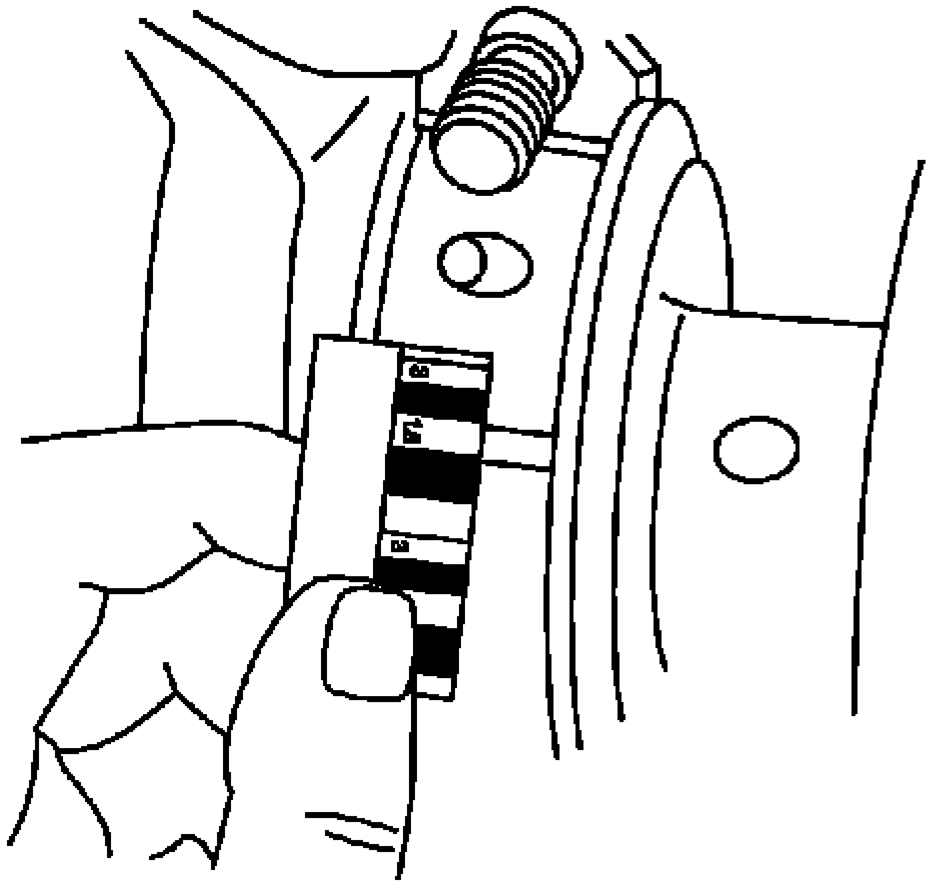


Fig. 100: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

Measuring Connecting Rod Bearing Clearance - Using J 43690/J 43690-100

J 43690: rod bearing checking tool and **J 43690-100:** adapter kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.

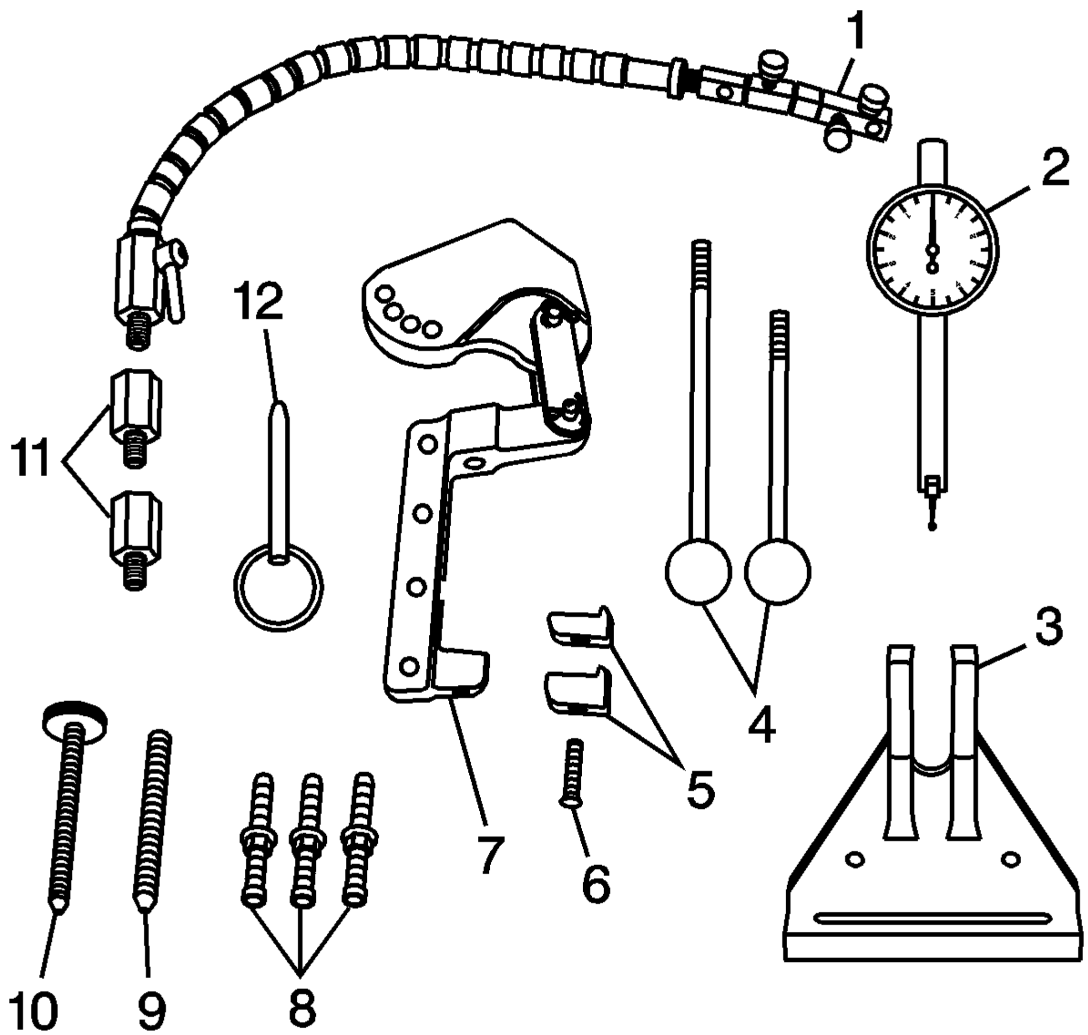


Fig. 101: Identifying Rod Bearing Clearance Checking Tool
Courtesy of GENERAL MOTORS CORP.

J 43690 Rod Bearing Checking Tool

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)

- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)

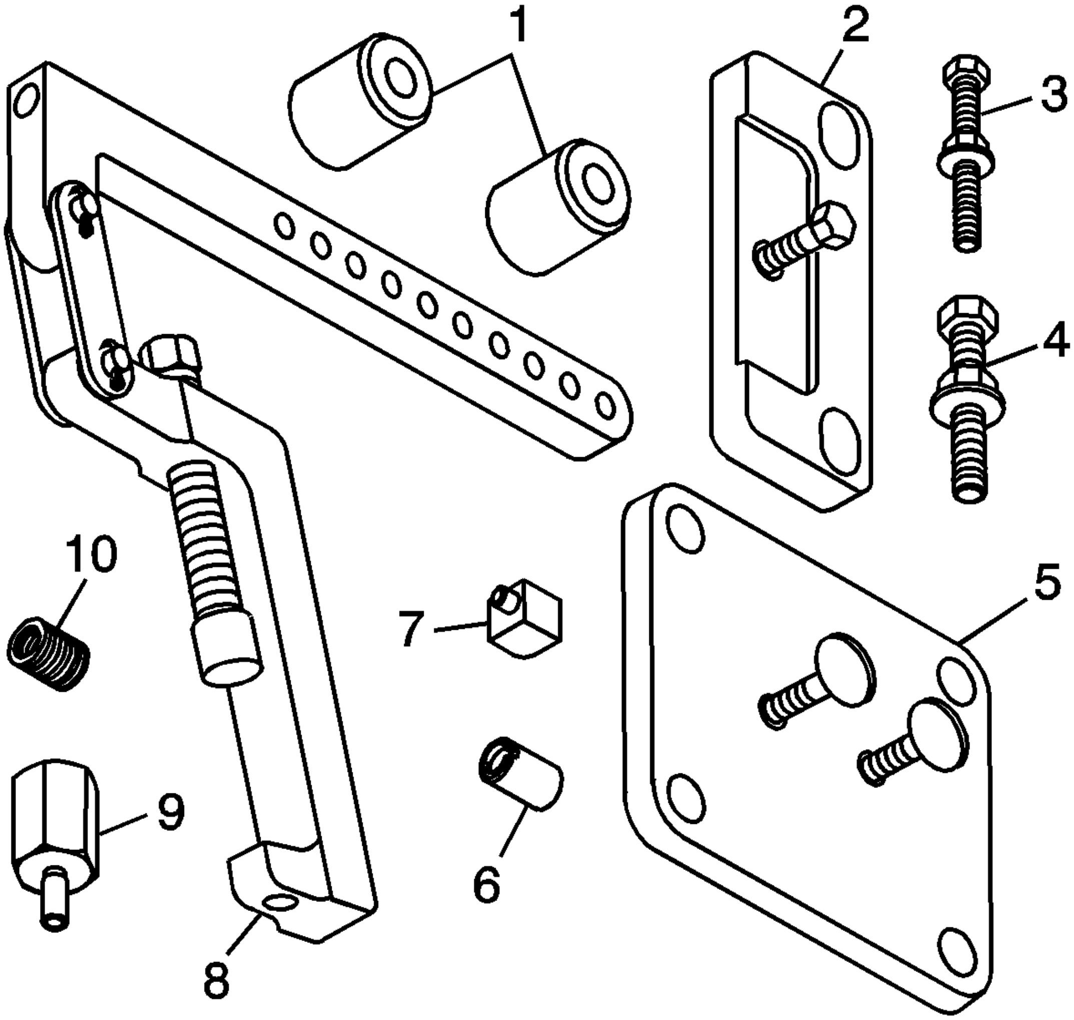


Fig. 102: Identifying Rod Bearing Clearance Tool - Adapter Kit
Courtesy of GENERAL MOTORS CORP.

J 43690-100 Rod Bearing Checking Tool - Adapter Kit

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)

- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)

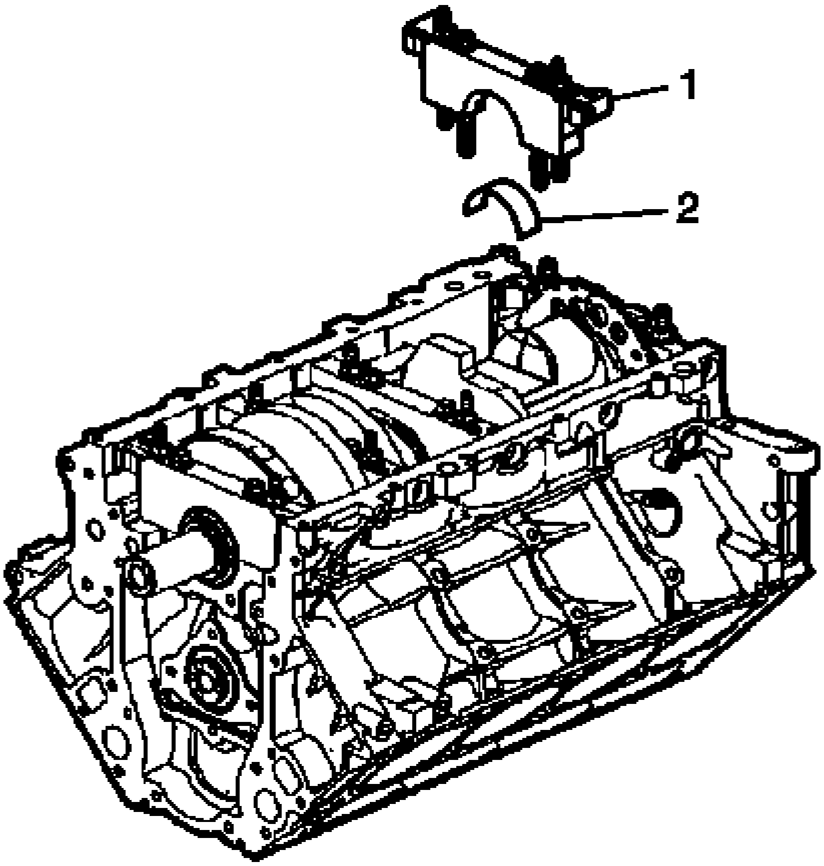


Fig. 103: View Of Bearing Cap, Bolt & Bearing Half
Courtesy of GENERAL MOTORS CORP.

NOTE: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to **Fastener Tightening Specifications (6.0L L76)** or **Fastener Tightening Specifications (6.2L LS3)** .

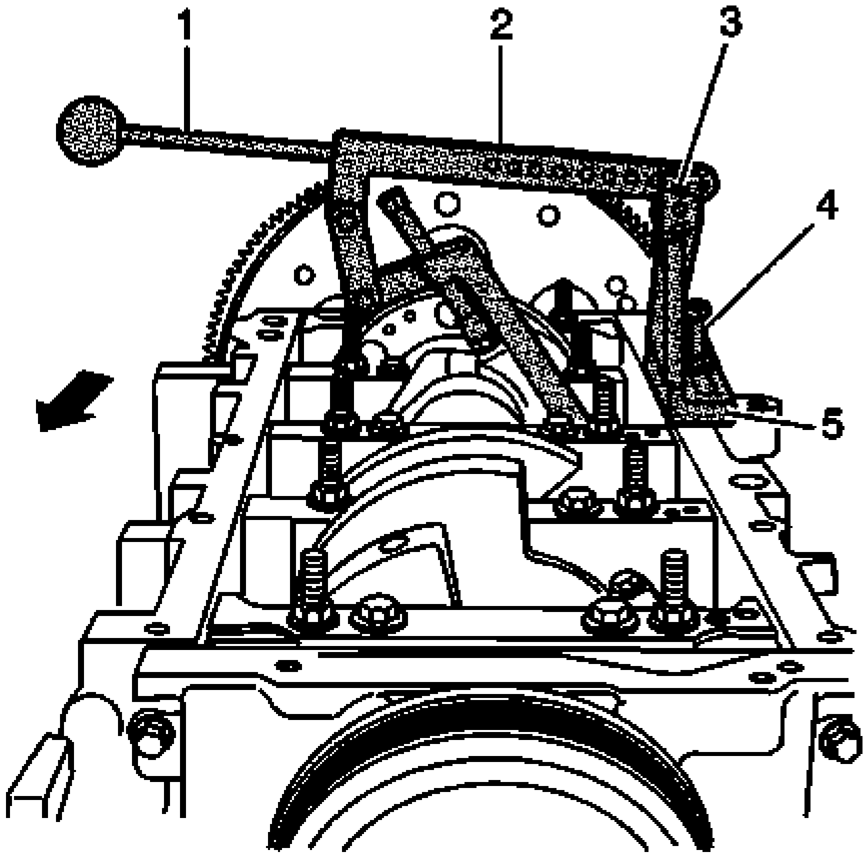


Fig. 104: View Of Special Tool Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

6. Install the following:
   1. J 43690-2 (5)
   2. J 43690-3 (4)
   3. J 43690-101 (2)
   4. 280310 (3)
   5. J 43690-5 (1)

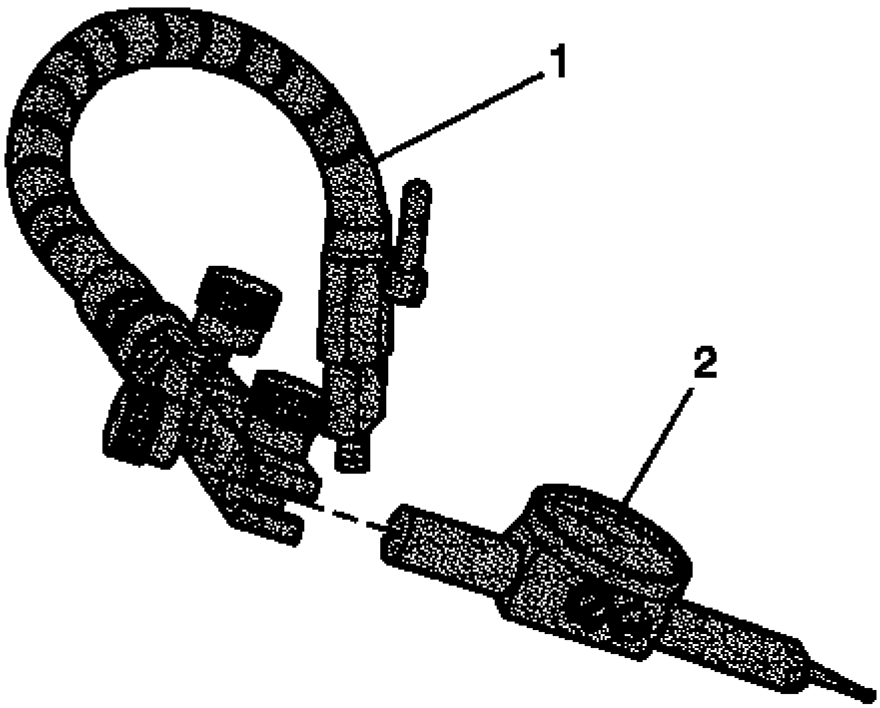


Fig. 105: View Of Swivel Base & Dial Indicator
Courtesy of GENERAL MOTORS CORP.

7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

CRANKSHAFT BALANCER CLEANING AND INSPECTION (L76)

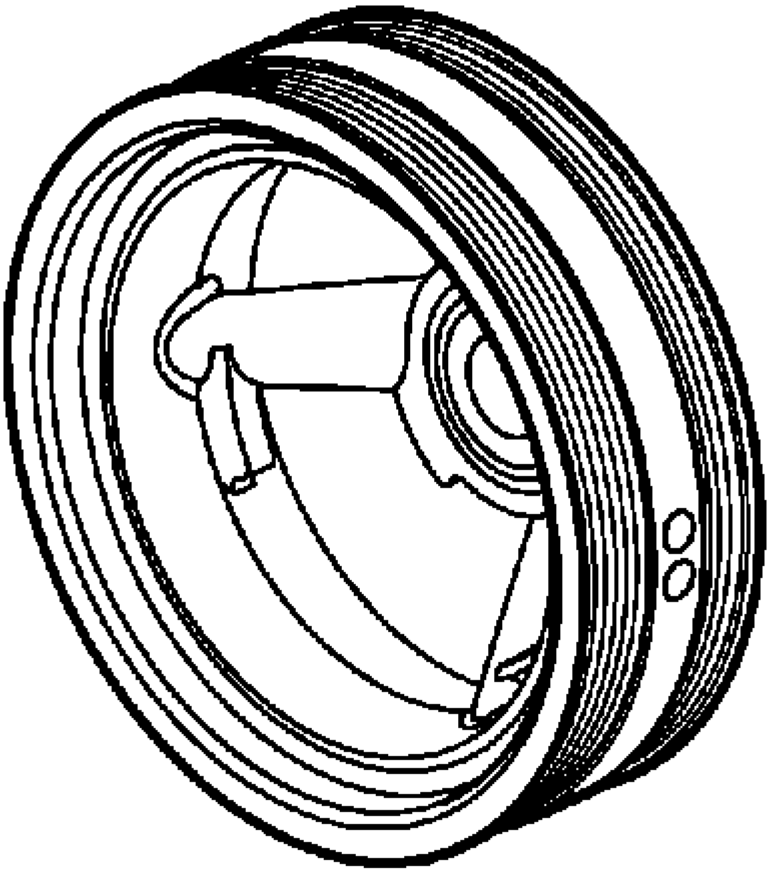


Fig. 106: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
   - Worn, grooved, or damaged hub seal surface

     A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

     Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

     NOTE: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

   - Dirty or damaged belt grooves

The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

Minor imperfections may be removed with a fine file.

- Worn, chunking, or deteriorated rubber between the hub and pulley

CRANKSHAFT BALANCER CLEANING AND INSPECTION (6.2L LS3)

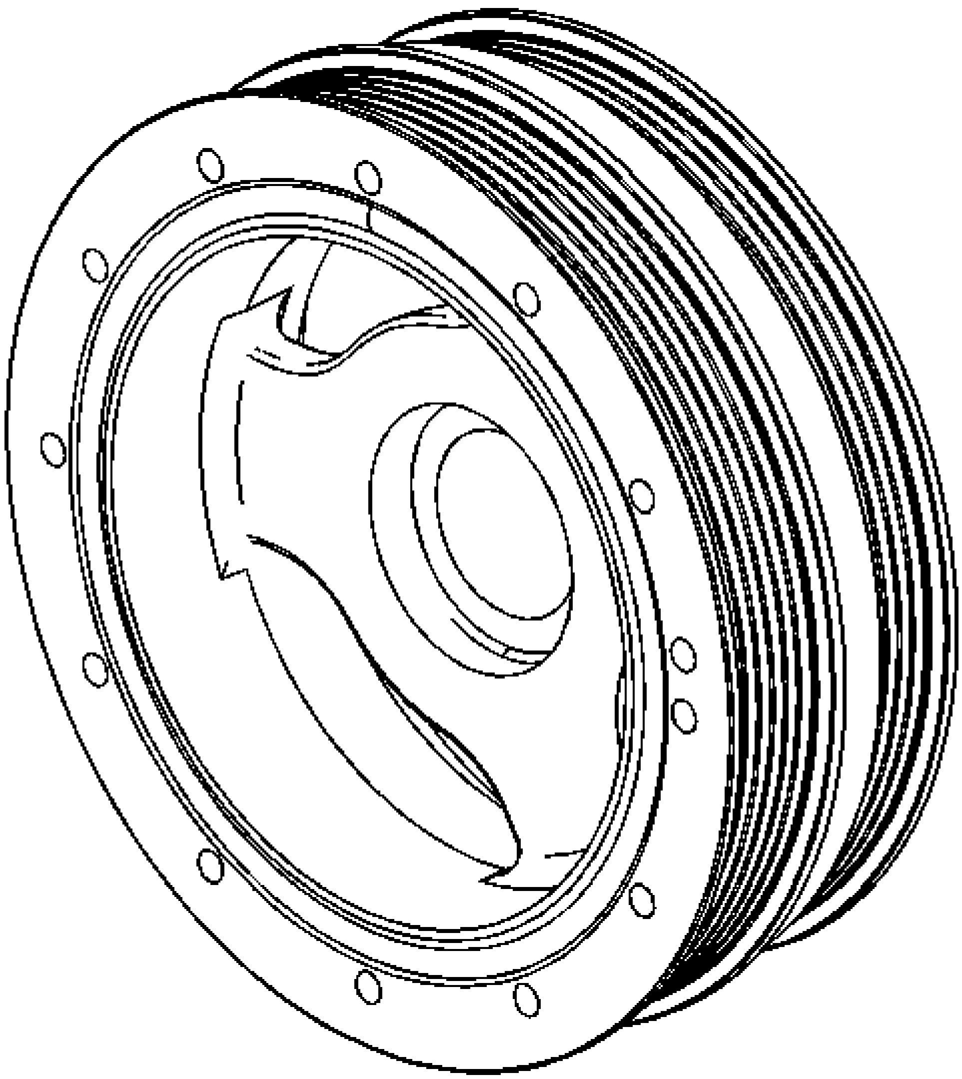


Fig. 107: Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft balancer in solvent.
2. Using a wire brush, clean the belt grooves of all dirt and debris.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
   - Worn, grooved, or damaged hub seal surface

     A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

     Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

     NOTE: In order for the belt to track properly, the belt grooves should be free of all dirt and debris.

   - Dirty or damaged belt grooves

     The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

     Minor imperfections may be removed with a fine file.

   - Worn, chunking or deteriorated rubber between the hub and pulley

ENGINE FLYWHEEL CLEANING AND INSPECTION

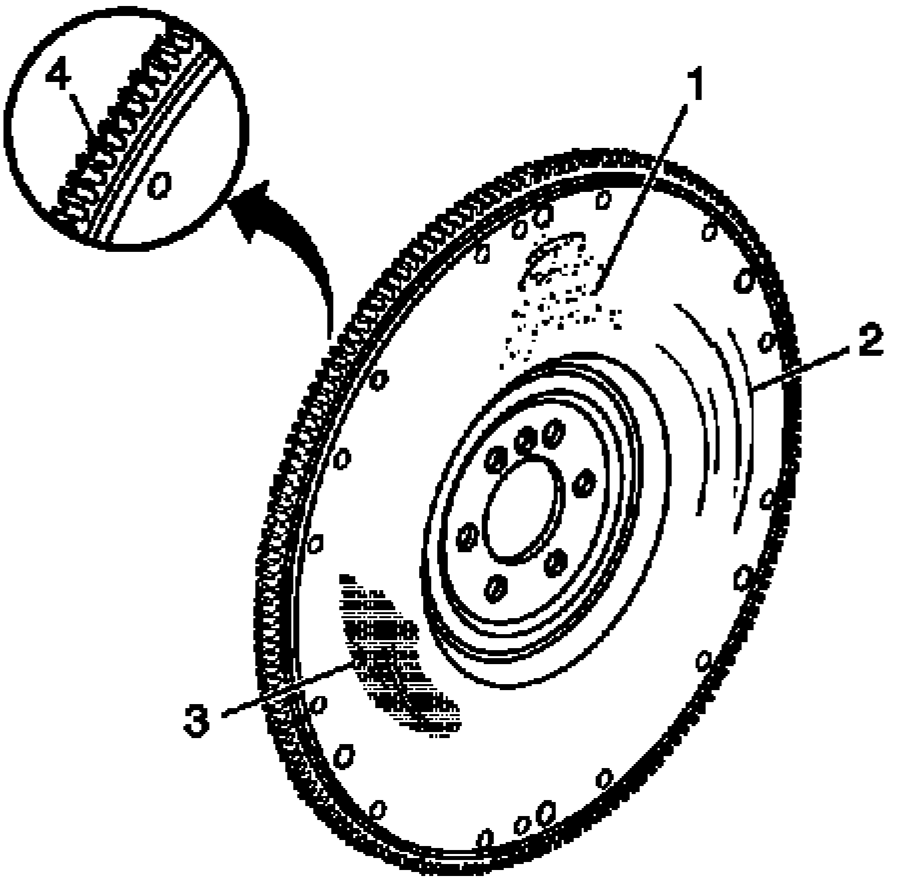


Fig. 108: Flywheel Inspection Areas (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

NOTE: In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission flywheels are NOT to be machined.

Inspect the manual transmission flywheel for the following conditions:

- Pitted surface (1)
- Grooved or scored surface (2)
- Rusted surface (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

  The ring gear has an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.

- Missing, bent or damaged pressure plate locating pins

The 2 locating pins are installed into the flywheel and spaced 170 degrees apart to ensure proper orientation of the clutch pressure plate to the engine flywheel during assembly.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

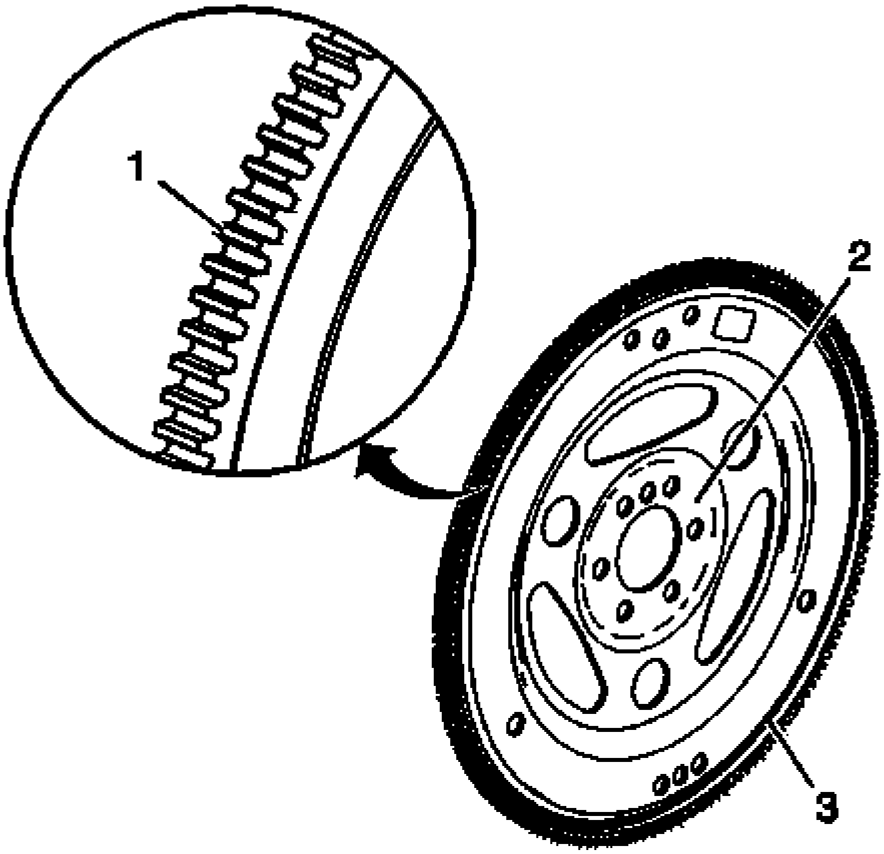


Fig. 109: View Of Ring Gear Teeth
Courtesy of GENERAL MOTORS CORP.

1. Clean the flex plate in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)
   - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

NOTE: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.

- Welded areas (3) that retain the ring gear onto the flex plate for cracking

PISTON AND CONNECTING ROD DISASSEMBLE

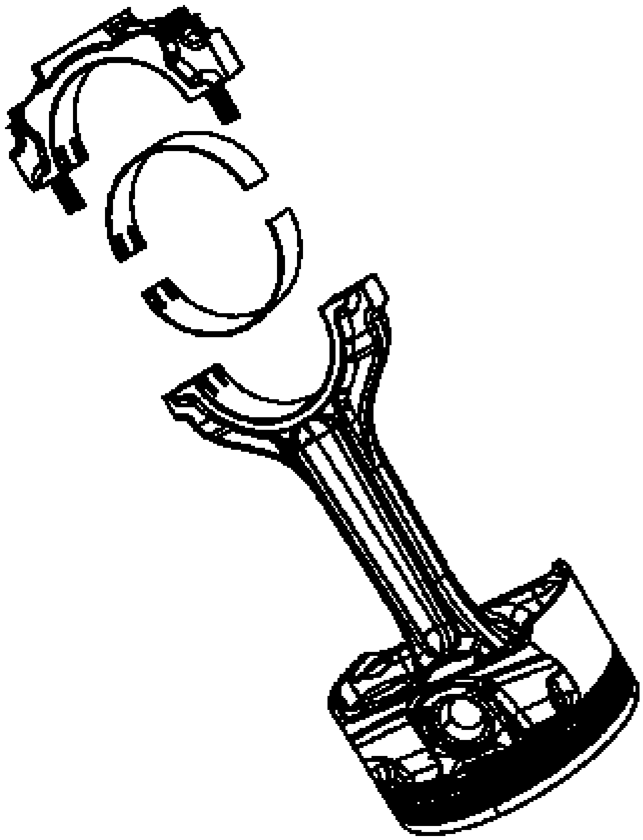


Fig. 110: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the connecting rod bearings from the rod and cap.

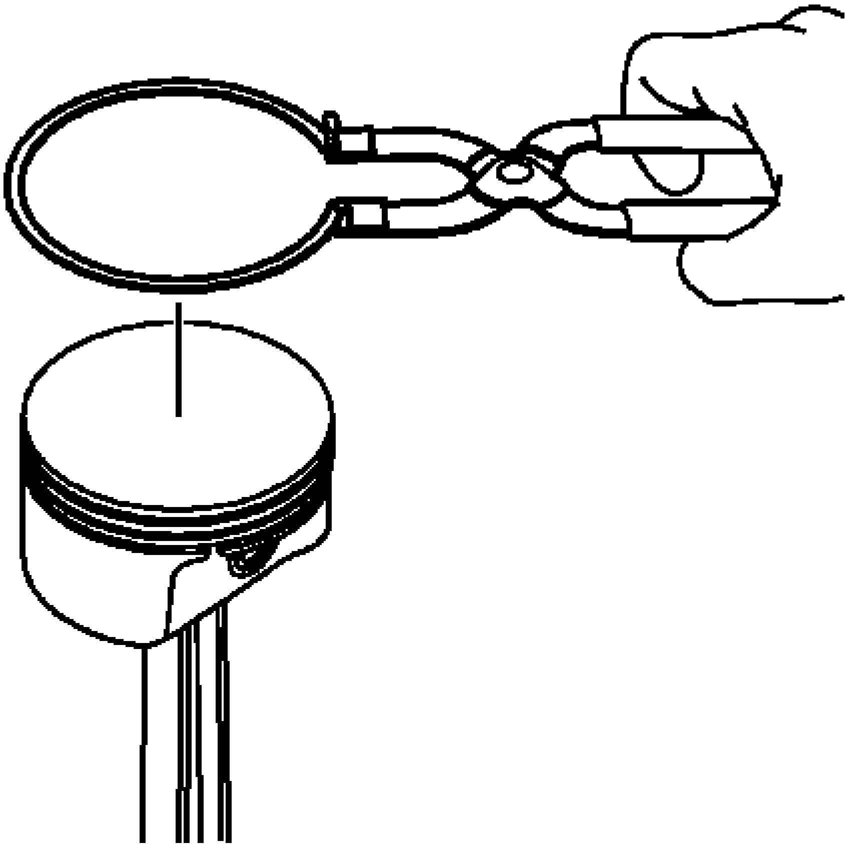


Fig. 111: Removing/Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

2. Using piston ring pliers, remove the piston rings from the piston.

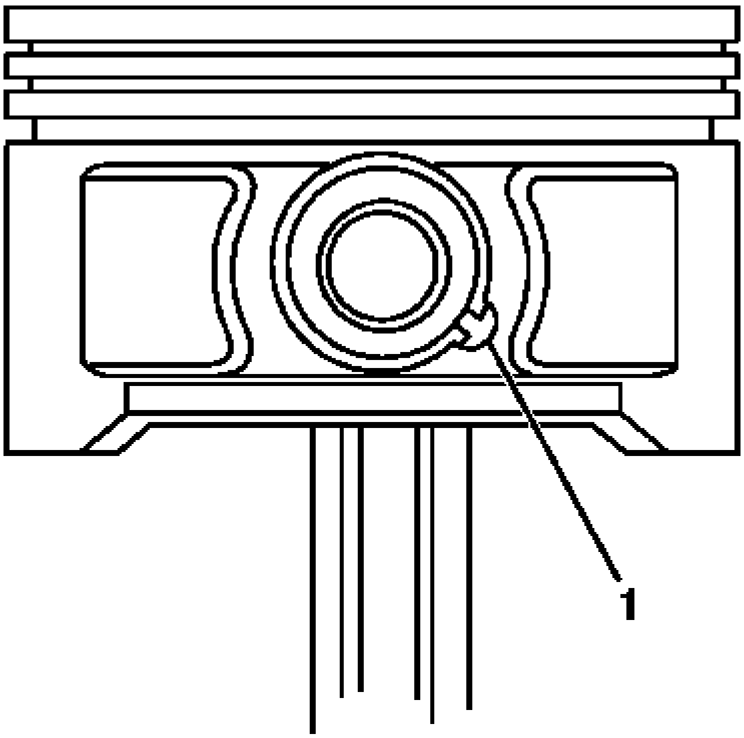


Fig. 112: View Of Piston Pin Retaining Clip & Cutout Area Of Pin Bore
Courtesy of GENERAL MOTORS CORP.

3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.

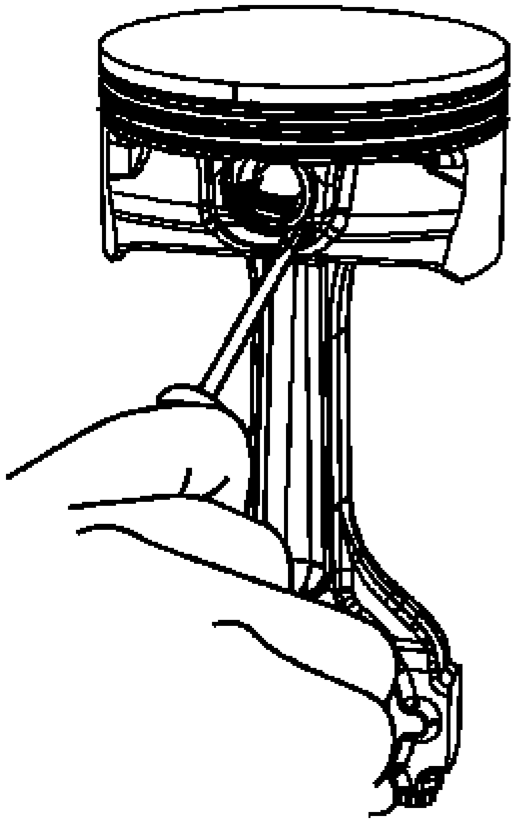


Fig. 113: Piston Pin Retainer
Courtesy of GENERAL MOTORS CORP.

4. Remove the retainers starting in the cutout area of the pin bore.

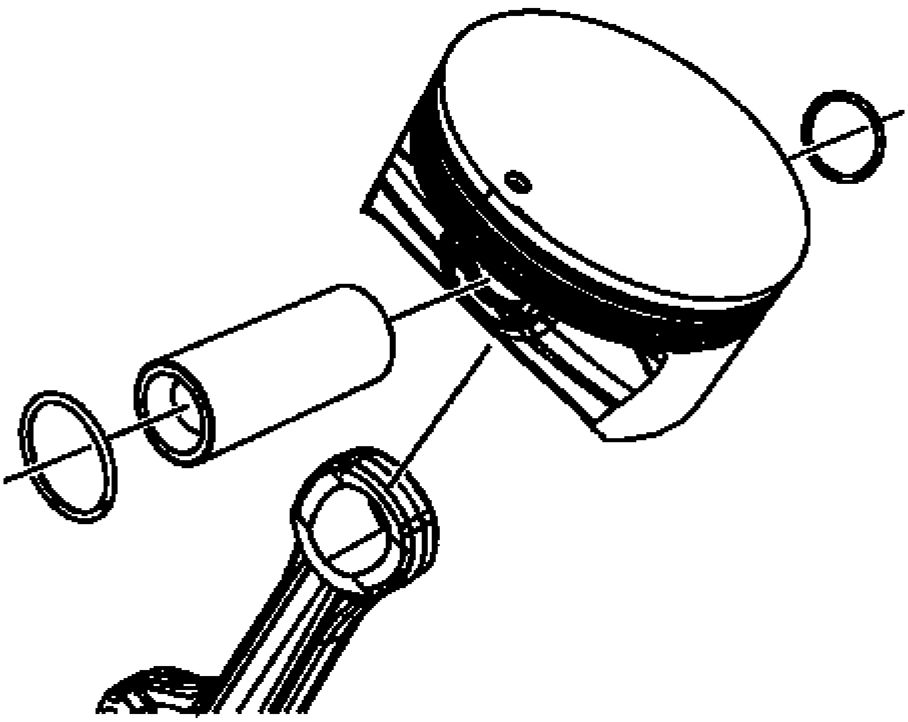


Fig. 114: Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

   Mark, sort, or organize the piston and the matching piston pin.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Piston, Pin, and Piston Rings

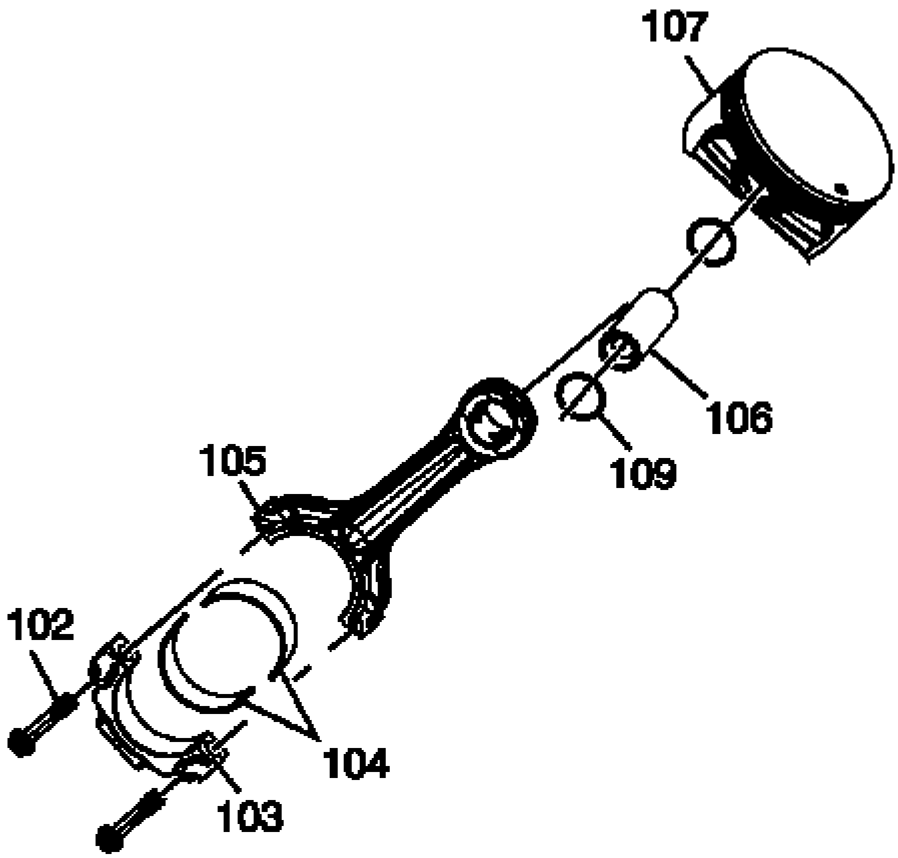


Fig. 115: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.**
- **The piston and pin are to be serviced as an assembly.**
- **Do not wire brush any part of the piston.**
- **Measurement of the components should be taken with the components at normal room temperature.**

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

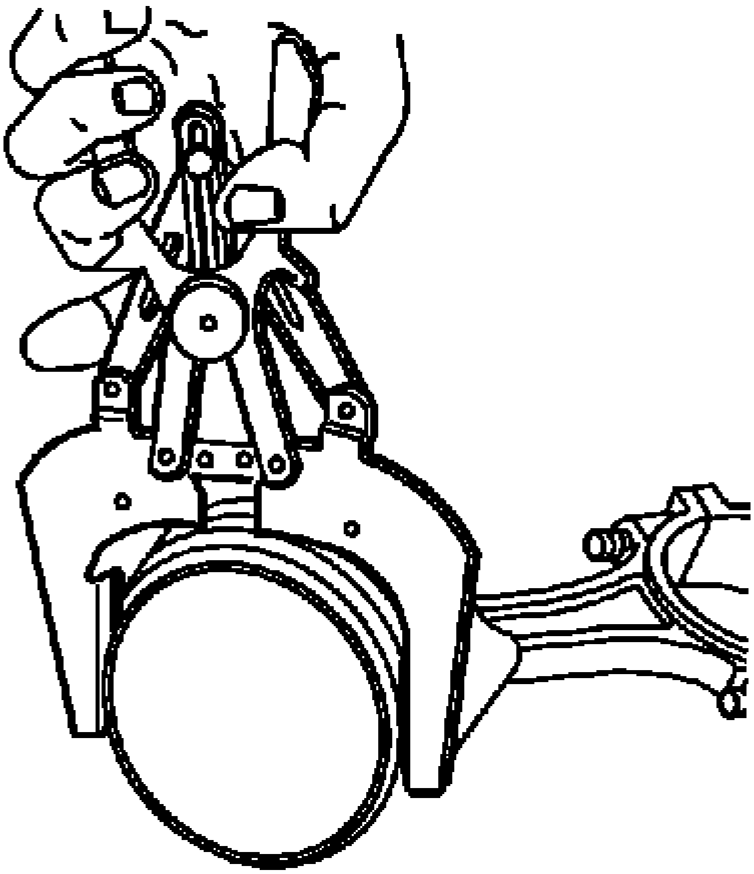
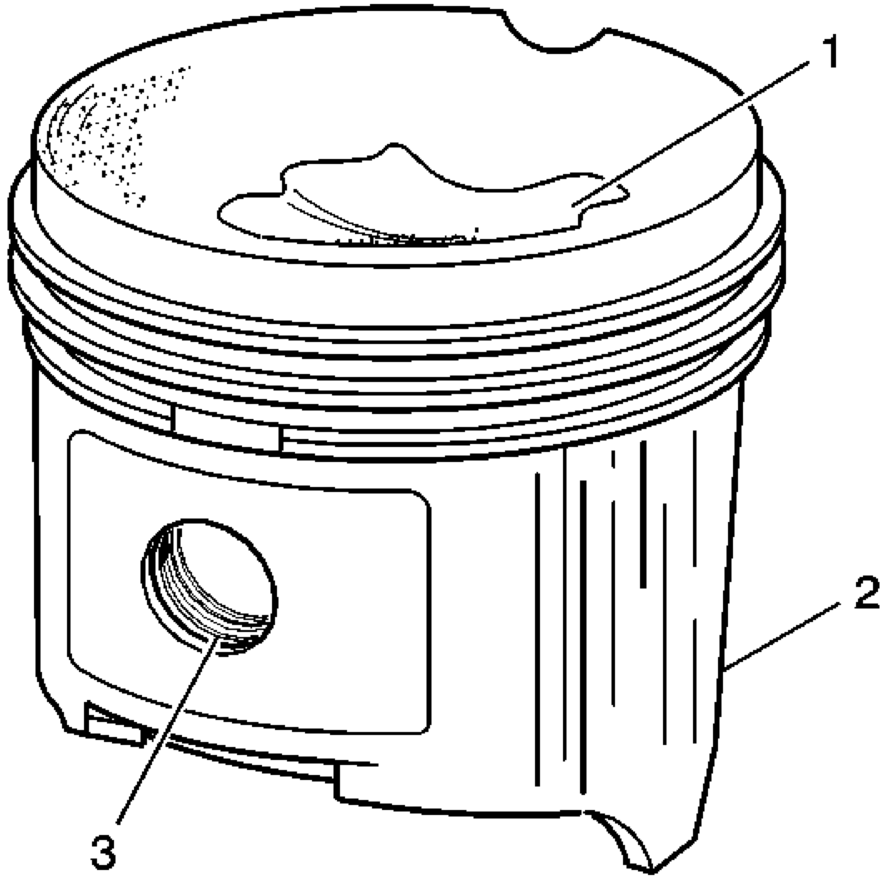


Fig. 116: Cleaning Piston Ring Grooves
Courtesy of GENERAL MOTORS CORP.

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.



<u>Fig. 117: Identifying Piston Damage Inspection Areas</u>
Courtesy of GENERAL MOTORS CORP.

5. Inspect the piston for the following conditions:
   - Cracks in the piston ring lands, the piston skirt, or pin bosses
   - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind

     MINOR imperfections may be removed from the piston with a fine file.

   - Eroded areas at the top of the piston (1)
   - Scuffed or damaged skirts (2)
   - Scoring to the piston pin bore (3) or piston pin

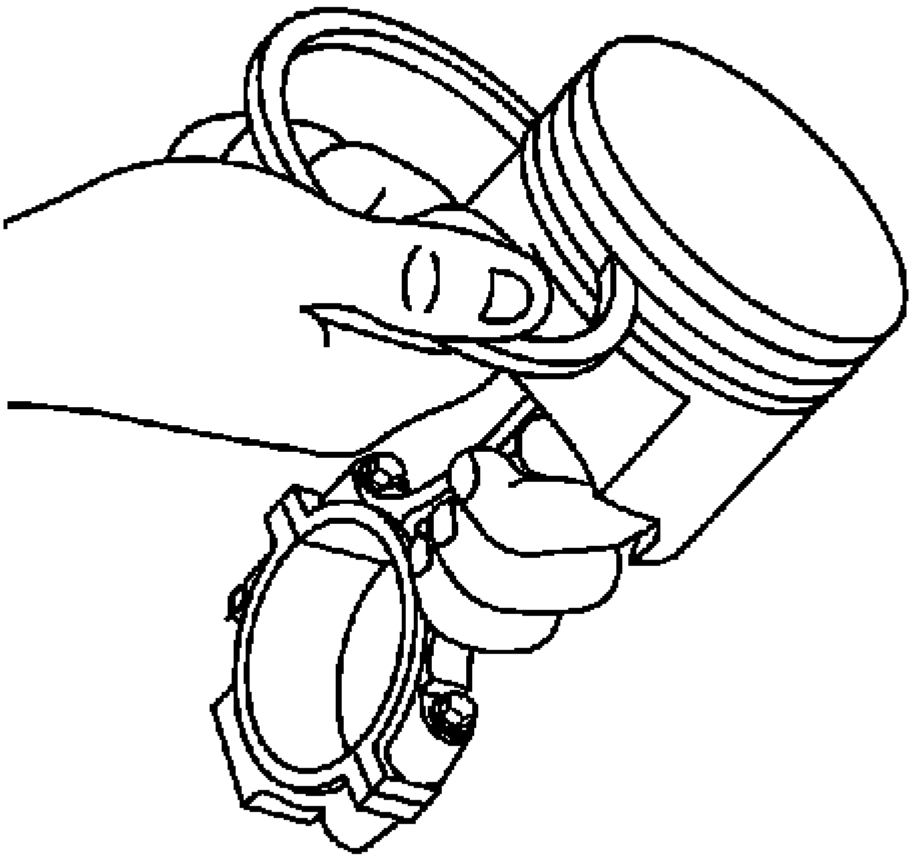


Fig. 118: Inserting Piston Ring Into Ring Groove
Courtesy of GENERAL MOTORS CORP.

6. Insert the edge of the piston ring into the piston ring groove.

   Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.

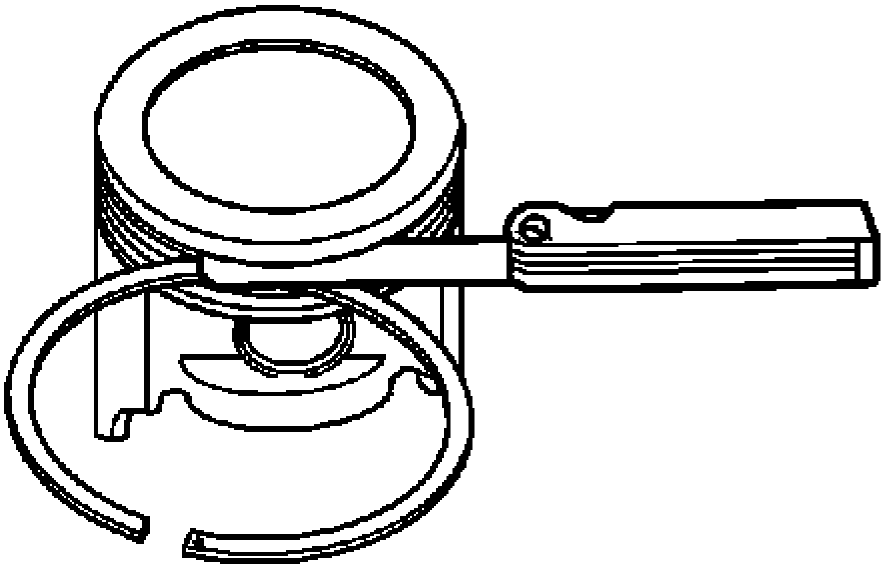


Fig. 119: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

7. Measure the piston ring side clearance with a feeler gage. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

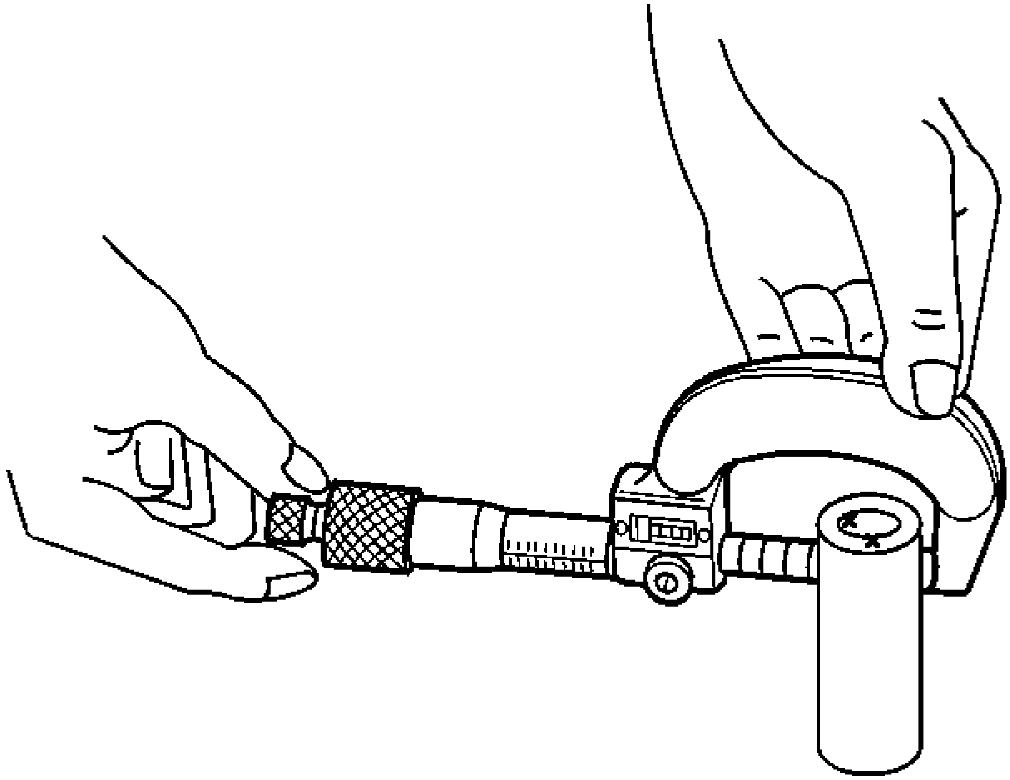


Fig. 120: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

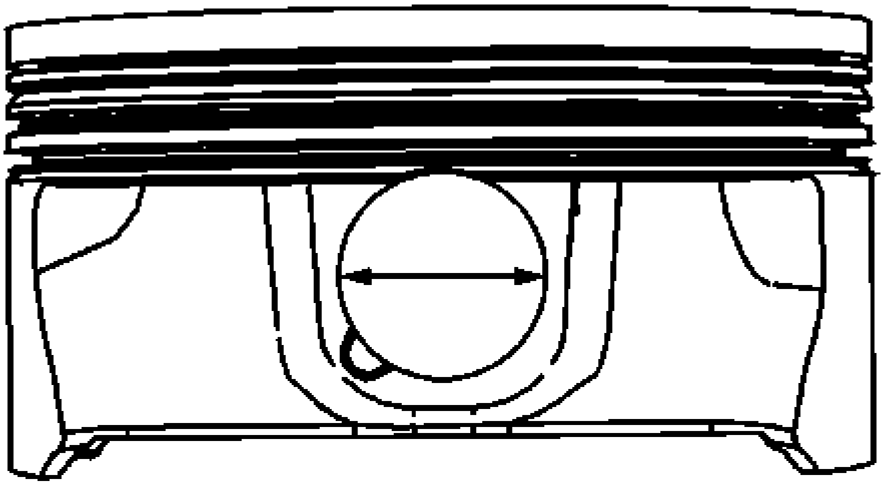


Fig. 121: Measuring Piston Pin-To-Bore Clearance
Courtesy of GENERAL MOTORS CORP.

9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

Measuring Piston Ring End Gap

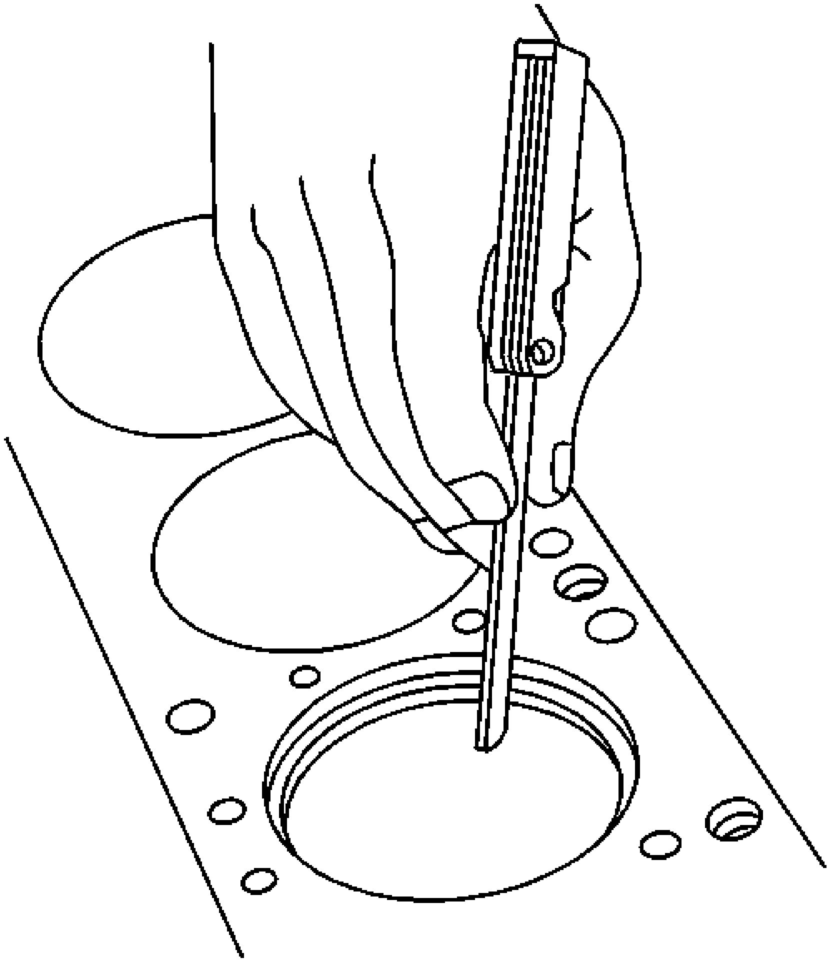


Fig. 122: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.**
- **Measure the piston ring in the cylinder in which it will be used.**

1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gage and measure the piston ring end gap. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

Connecting Rod and Bearings

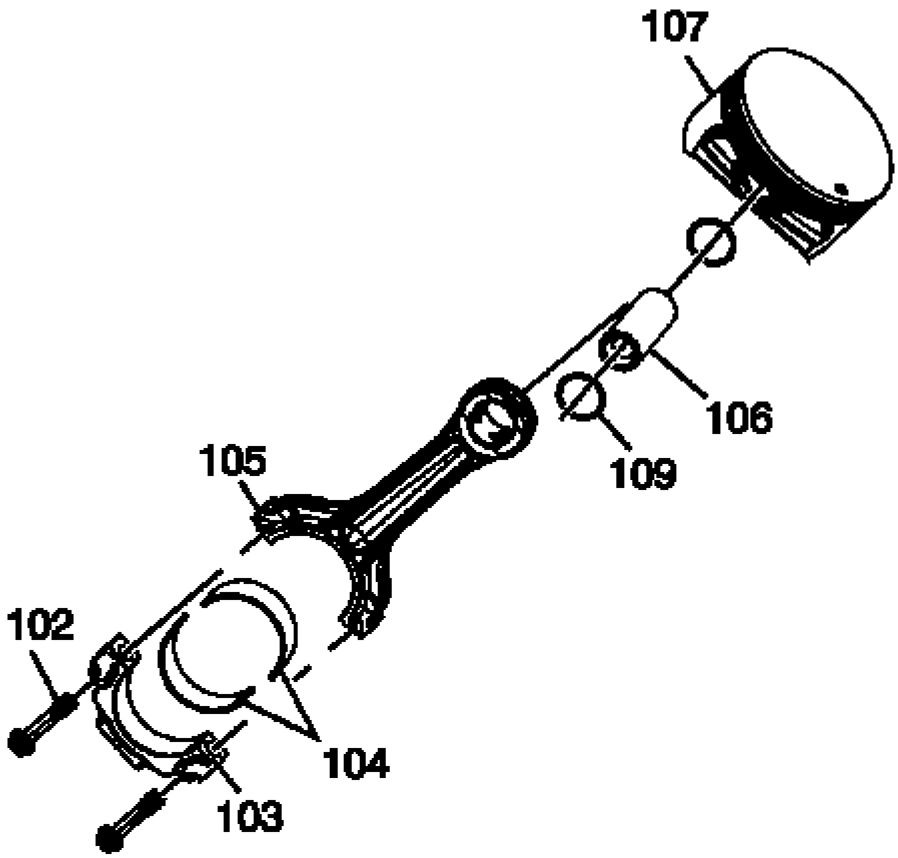


Fig. 123: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.**
- **Do not attempt to repair the bolt hole threads of the connecting rod.**

1. Clean the connecting rod (105) and cap (103) in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

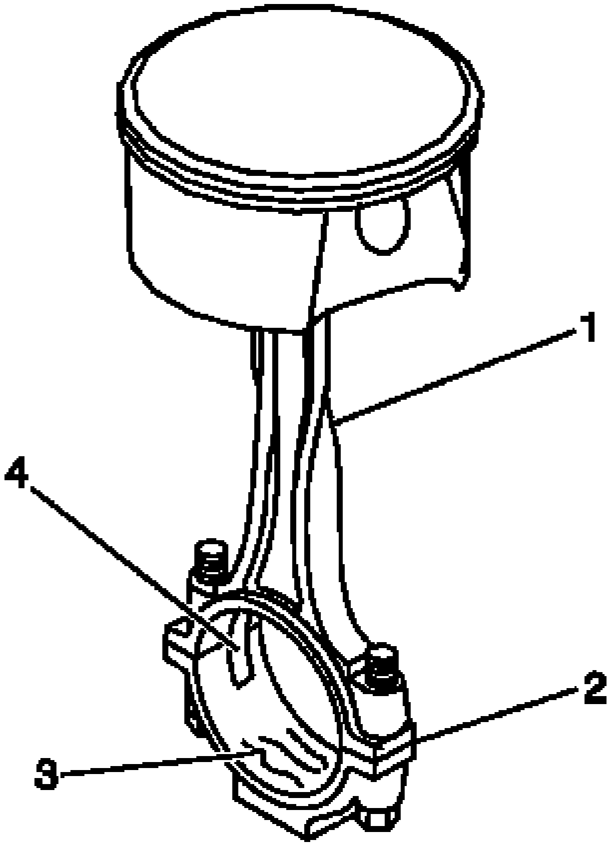


Fig. 124: Identifying Connecting Rod Inspection Areas
Courtesy of GENERAL MOTORS CORP.

3. Inspect the connecting rod for the following conditions:
   - Twisting (1)
   - Proper fit of the connecting rod and cap mating surfaces (2)
   - Nicks or gouges in the bearing bore (3)
   - Damage to the bearing locating slots (4)

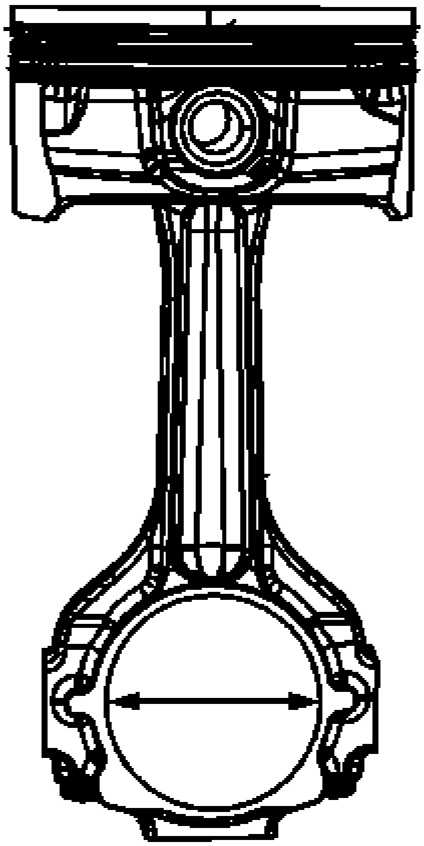


Fig. 125: Identifying Connecting Rod Bearing Bore
Courtesy of GENERAL MOTORS CORP.

4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

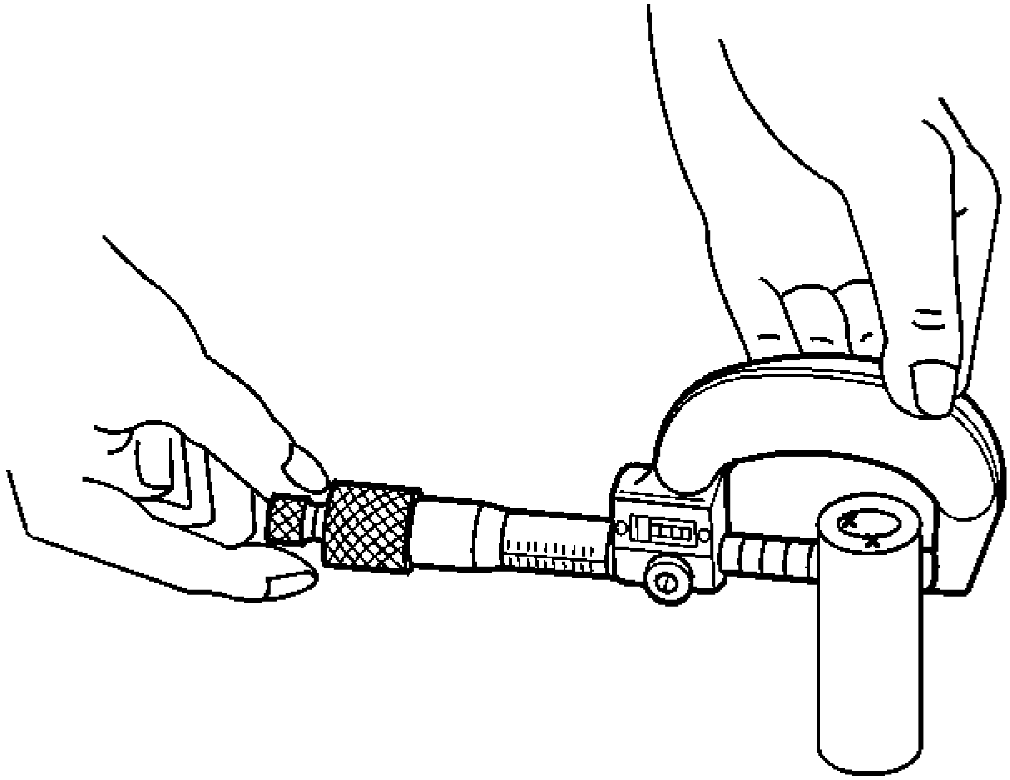


Fig. 126: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.

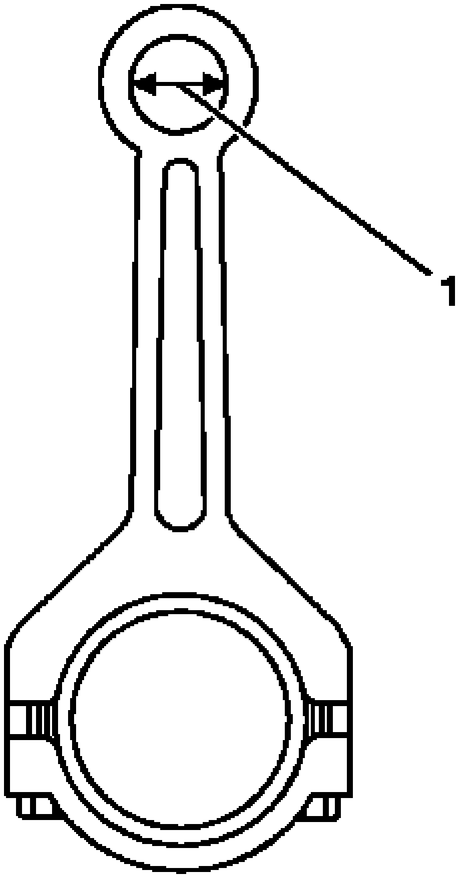


Fig. 127: Measuring Connecting Rod Pin Bore Inside Diameter
Courtesy of GENERAL MOTORS CORP.

6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

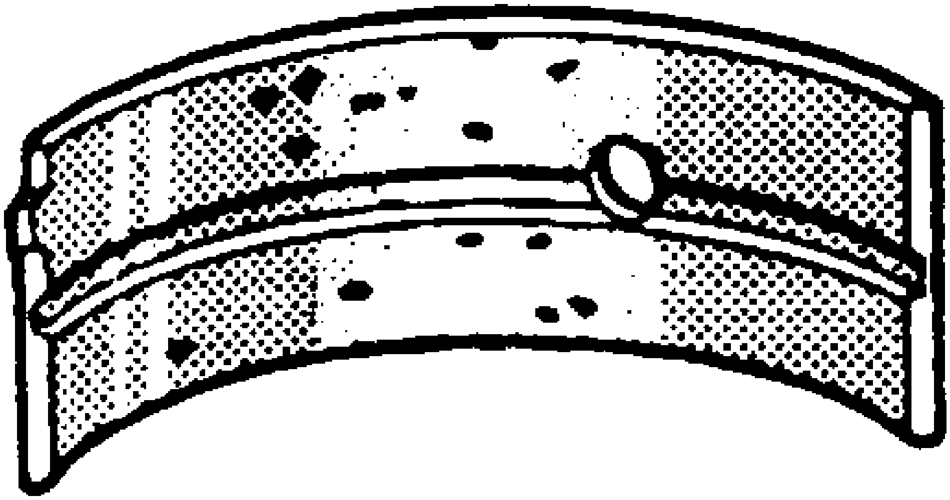


Fig. 128: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

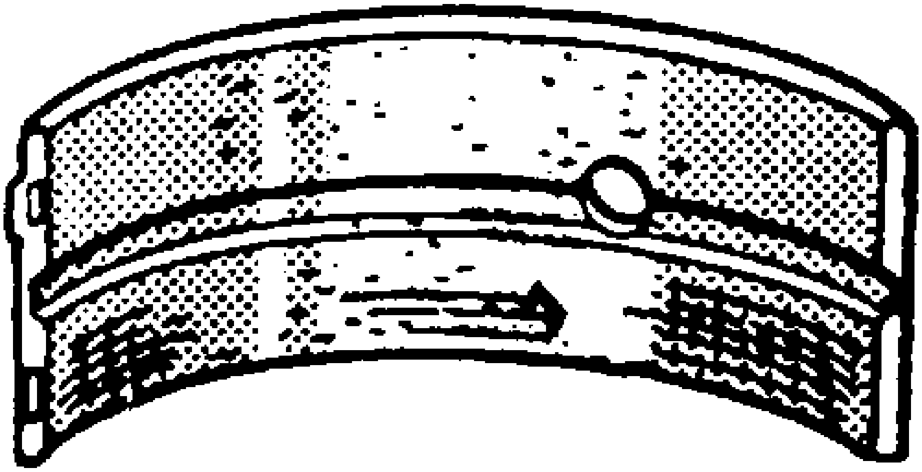


Fig. 129: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

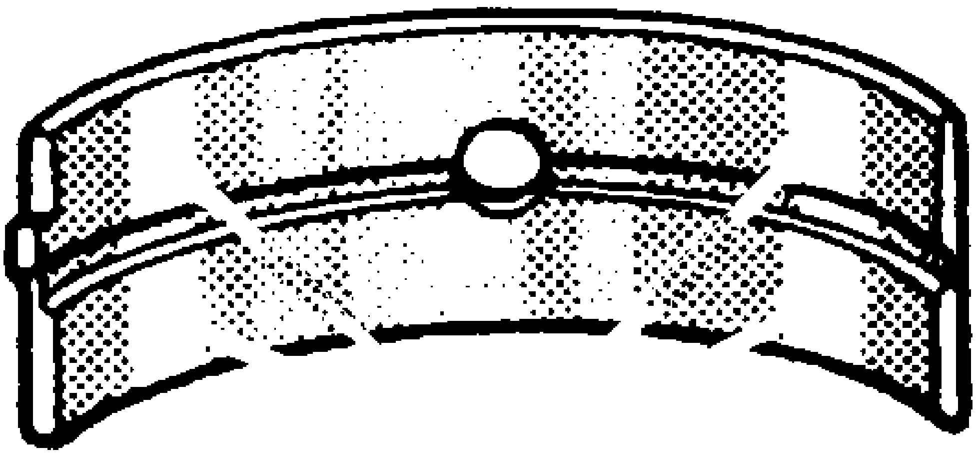


Fig. 130: View Of Improper Seating
Courtesy of GENERAL MOTORS CORP.

11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.
13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

PISTON AND CONNECTING ROD ASSEMBLE

Tools Required

EN 46121 Connecting Rod Guide Pin Set

Piston and Piston Pin Installation Procedure

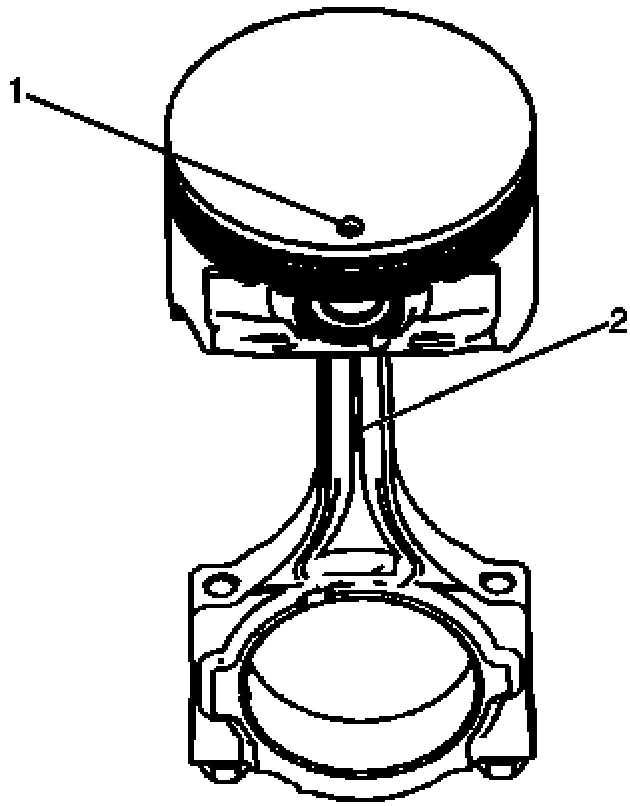


Fig. 131: Identifying Piston Notch & Connecting Rod Painted Mark
Courtesy of GENERAL MOTORS CORP.

1. Assemble the piston and connecting rod with the notch (1) on the piston and the painted mark (2) on the connecting rod facing the front of the engine.

   When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the painted mark (2) on the connecting rod should face the front of the engine.

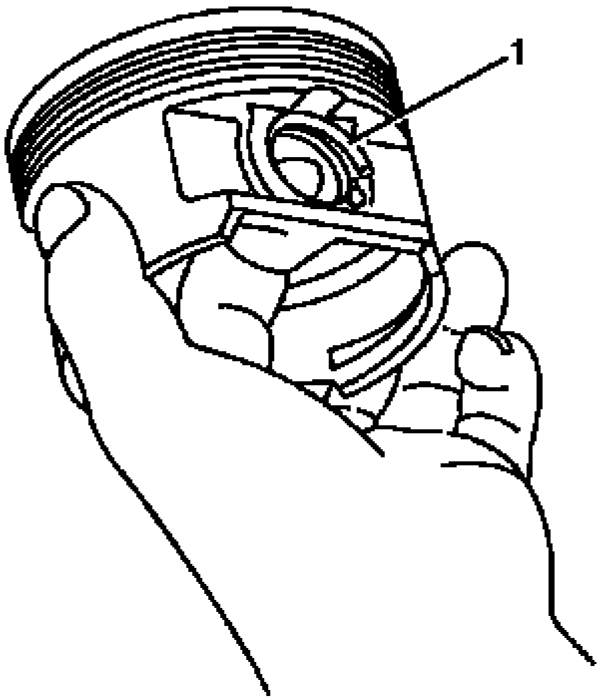


Fig. 132: View Of Retainer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure the retainer (1) is seated in the groove.

2. Install the retainer (1).

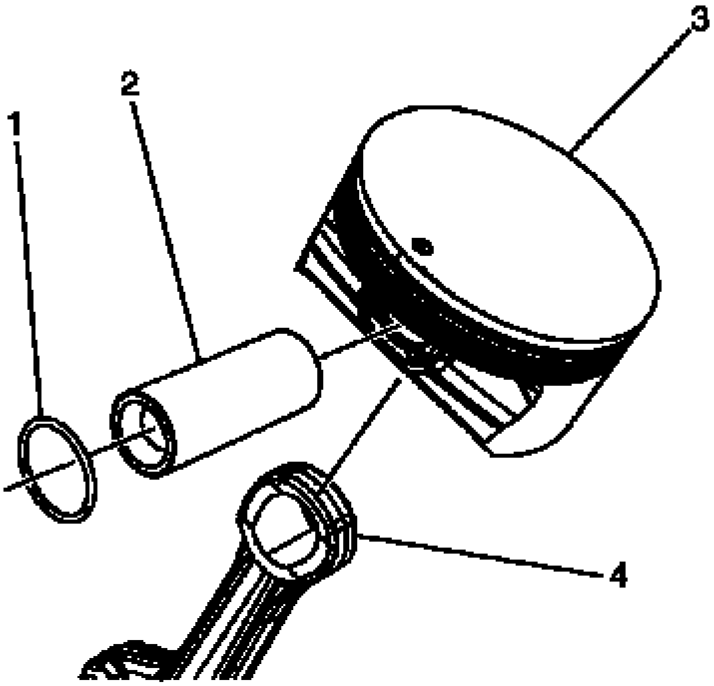


Fig. 133: View Of Retainer, Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

3. Install the piston pin (2) to the piston (3) and connecting rod (4).

IMPORTANT: Make sure the retainer (1) is seated in the groove.

4. Install the retainer (1).

Piston Ring Installation Procedure

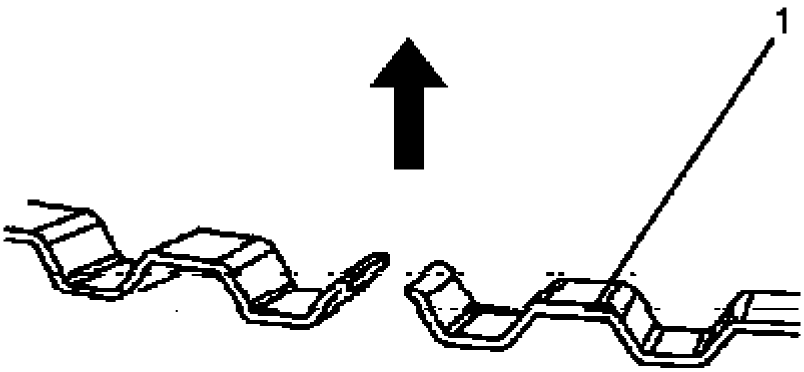


Fig. 134: Identifying Oil Control Ring Expander
Courtesy of GENERAL MOTORS CORP.

1. Correctly orient the oil control ring expander (1) as shown before installation. The ends of the oil control ring expander (1) must be facing toward the top of the piston.

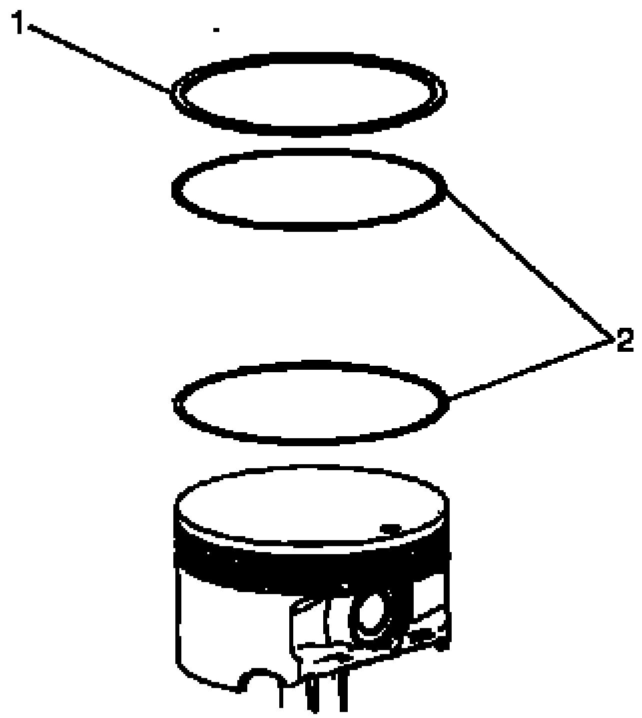


Fig. 135: Identifying Expander & Oil Scraper Rings
Courtesy of GENERAL MOTORS CORP.

2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
    1. Install the expander ring (2).

        IMPORTANT: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

    2. Install the 2 oil scraper rings (1). Expand the rings only enough to clear the piston diameter.

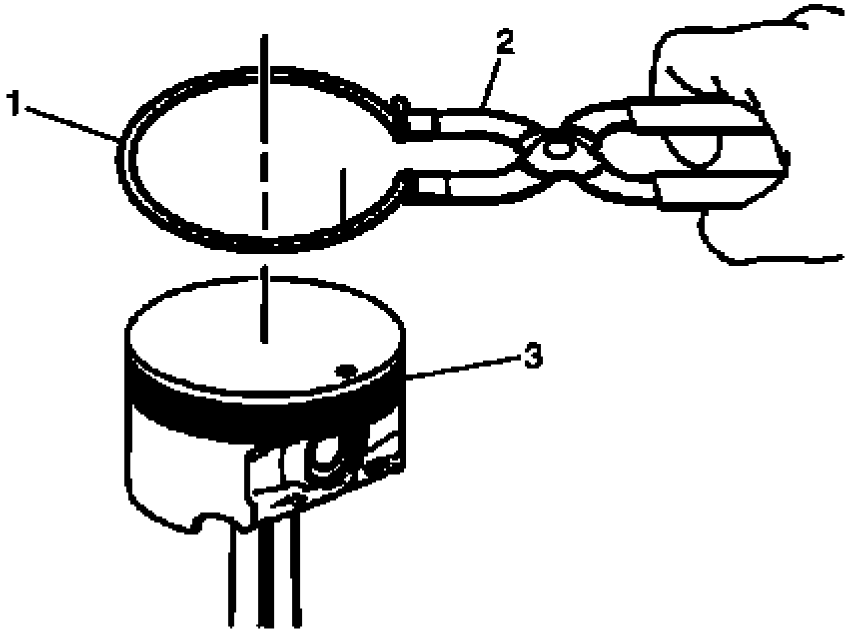


Fig. 136: View Of Ring Expander, Second Piston Ring & Piston
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

IMPORTANT: Install the second piston ring (2) onto the piston (3) using the ring expander (1).

3. Install the second piston ring (2) onto the piston (3).

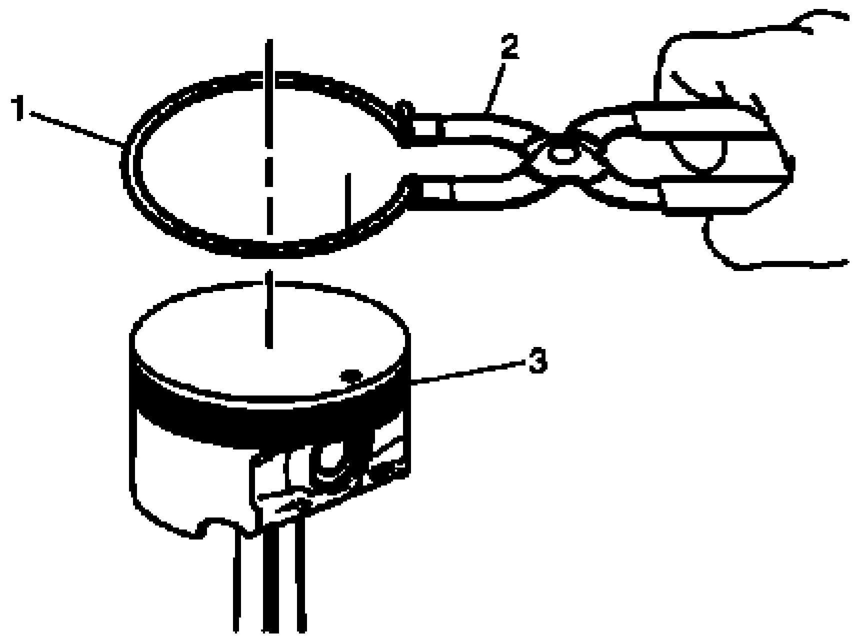


Fig. 137: View Of Ring Expander, Second Piston Ring & Piston
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.

IMPORTANT: Install the top piston ring (2) onto the piston (3) using the ring expander (1).

4. Install the top piston ring (2) onto the piston (3).

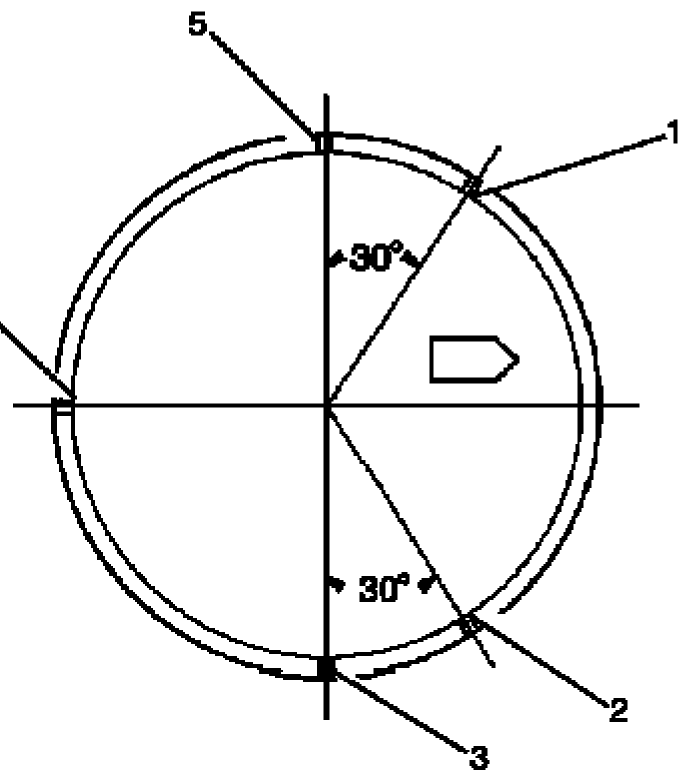


Fig. 138: View Of Second Ring, Oil Control Ring Expander, Top Ring, Lower & Upper Oil Control Ring
Courtesy of GENERAL MOTORS CORP.

5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.
    1. Lower oil control ring - position (1).
    2. Upper oil control ring - position (2).
    3. Top Ring - position (3).
    4. Oil control ring expander - position (4).
    5. Second ring - position (5).

Connecting Rod Bearing Installation Procedure

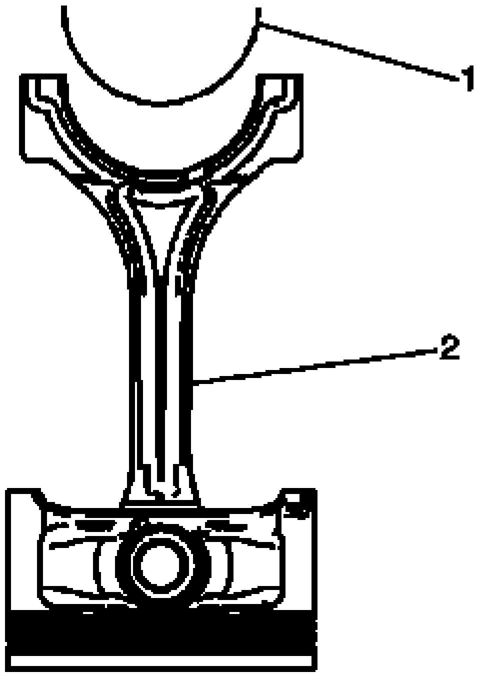


Fig. 139: Locating Second Ring, Oil Control Ring Expander, Top Ring, Lower & Upper Oil Control Ring
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the connecting rod bearings (1) have been used in a running engine, you must replace them with NEW connecting rod bearings (1) for reassembly.

1. Clean the connecting rod (2) and the connecting rod cap bearing bore with a lint-free cloth.
2. Clean all the oil from behind the connecting rod bearing (1) halves.
3. Install new upper connecting rod bearings (1) into position. Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The connecting rod bearings (1) must fit flush in the connecting rod (2).

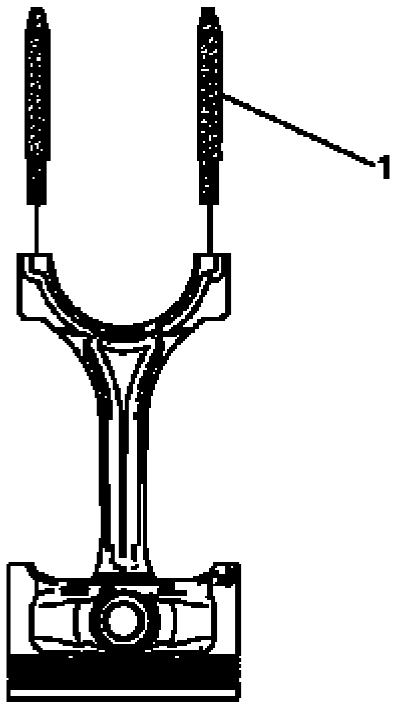


Fig. 140: View Of EN 46121
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46121** (1) into the connecting rod bolt holes.

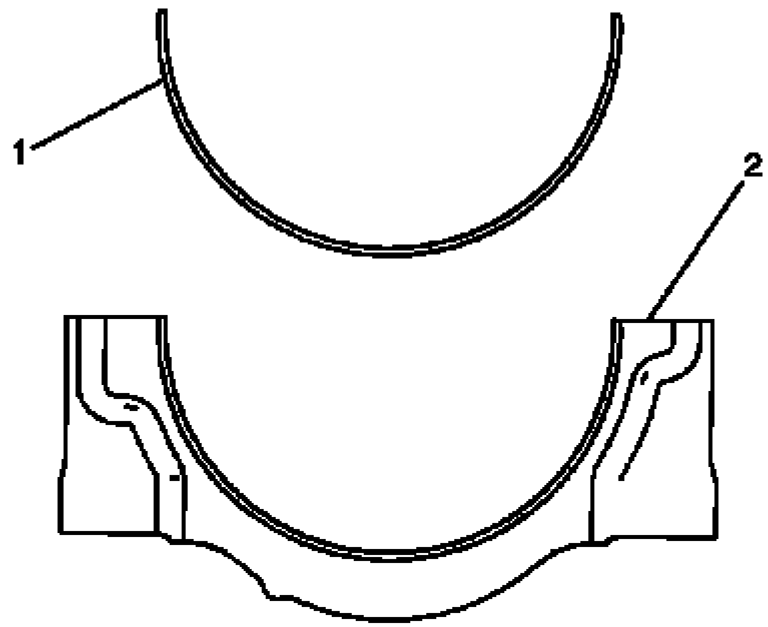


Fig. 141: Identifying Lower Connecting Rod Bearings & Connecting Rod Cap
Courtesy of GENERAL MOTORS CORP.

5. Install new lower connecting rod bearings (1) into position in the connecting rod cap (2). Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap (2).

CAMSHAFT BEARING REMOVAL

Tools Required

J 33049 Camshaft Bearing Service Set. See **Special Tools** .

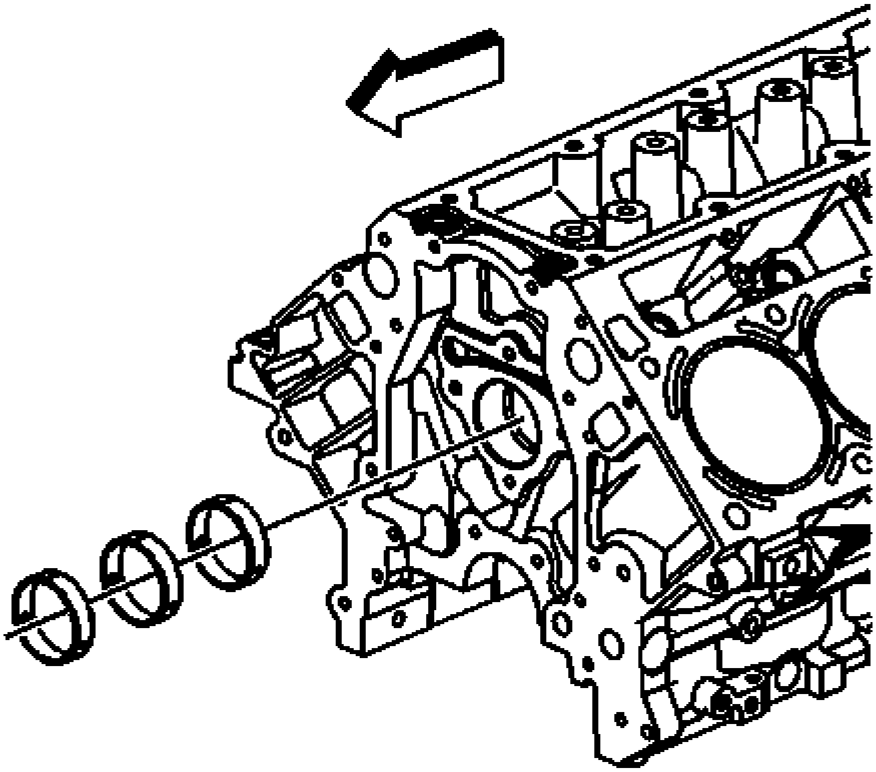


Fig. 142: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to **Camshaft and Bearings Cleaning and Inspection**.
2. Repair or replace the components, as required.

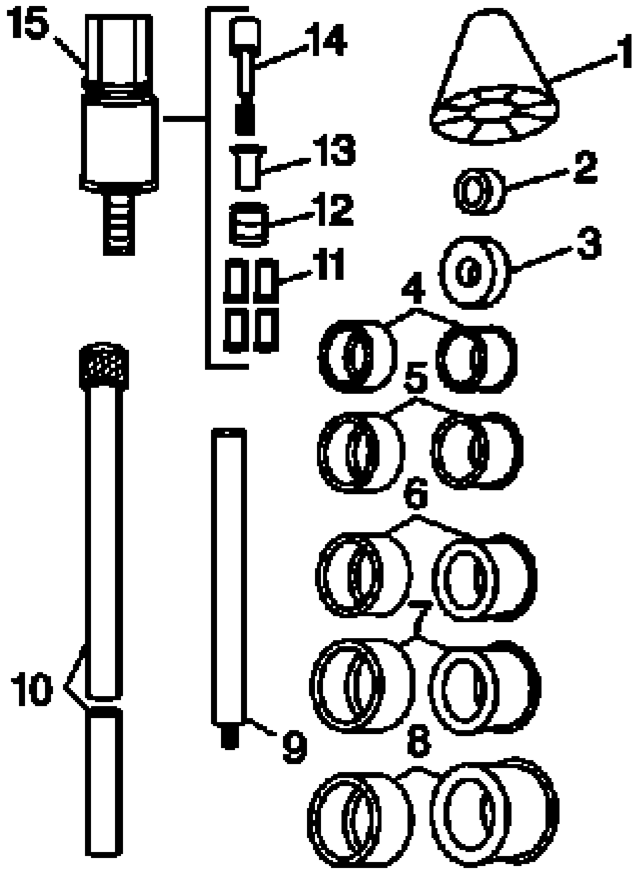


Fig. 143: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

3. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** . See **Special Tools** .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.

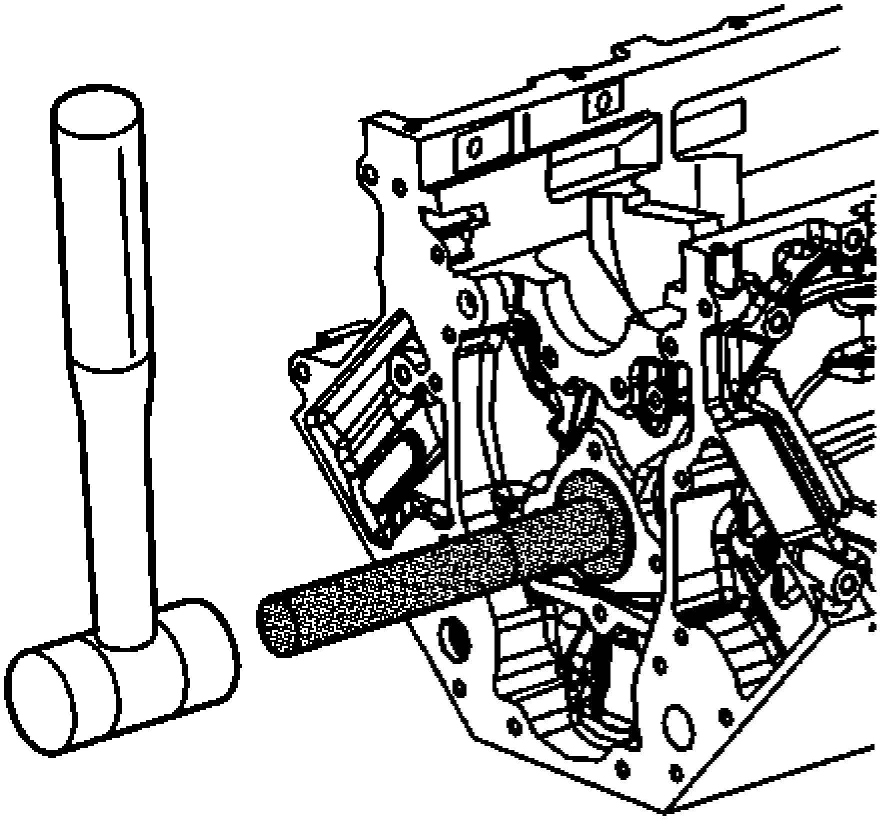


Fig. 144: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Drive the bearing from the block bore.

IMPORTANT: In order to remove the front camshaft bearing, operate the tool from the rear of the block, using the guide cone in the rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander, and Expander Driver Information

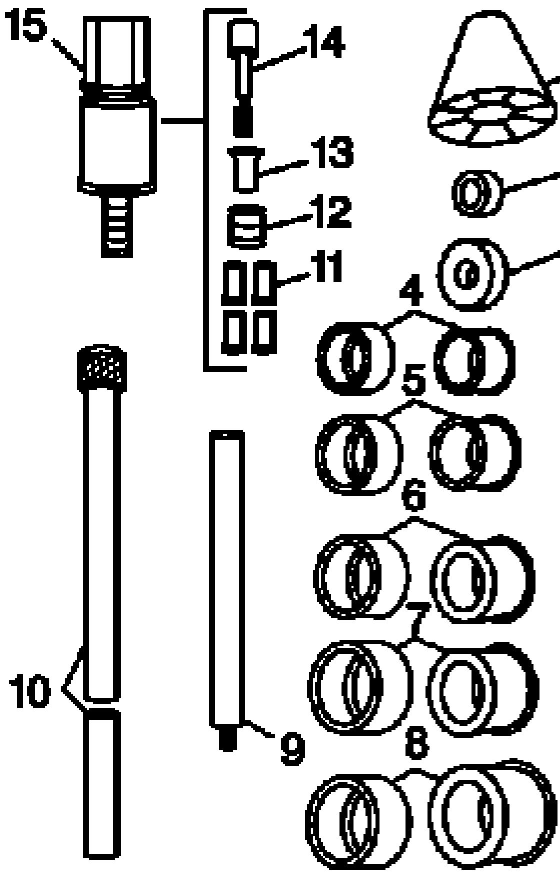


Fig. 145: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).
- Expander bearing driver number 1 inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number 2 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with number 1 expanding driver and the small washer.
- Expander bearing driver number 3 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with number 2 expanding driver and the large washer.
- Expander bearing driver number 4 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with number 3 expanding driver and the large washer.
- Expander bearing driver number 5 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with number 4 expanding driver and the large washer.
- Expander bearing driver number 6 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with number 5 expanding driver and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

   **IMPORTANT: To install or remove the expanding driver, always push on or pull from the ends.
   Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.**

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

   For removal of the inner bearings, it may be necessary to install the driver bar extension.

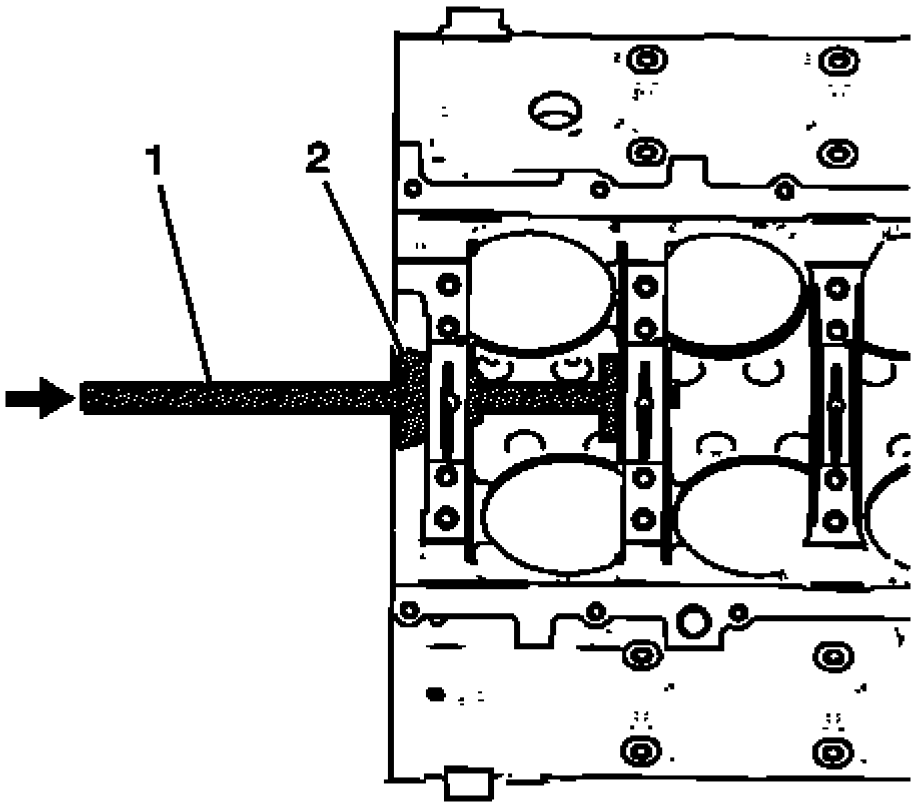


Fig. 146: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Insert the tool into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.

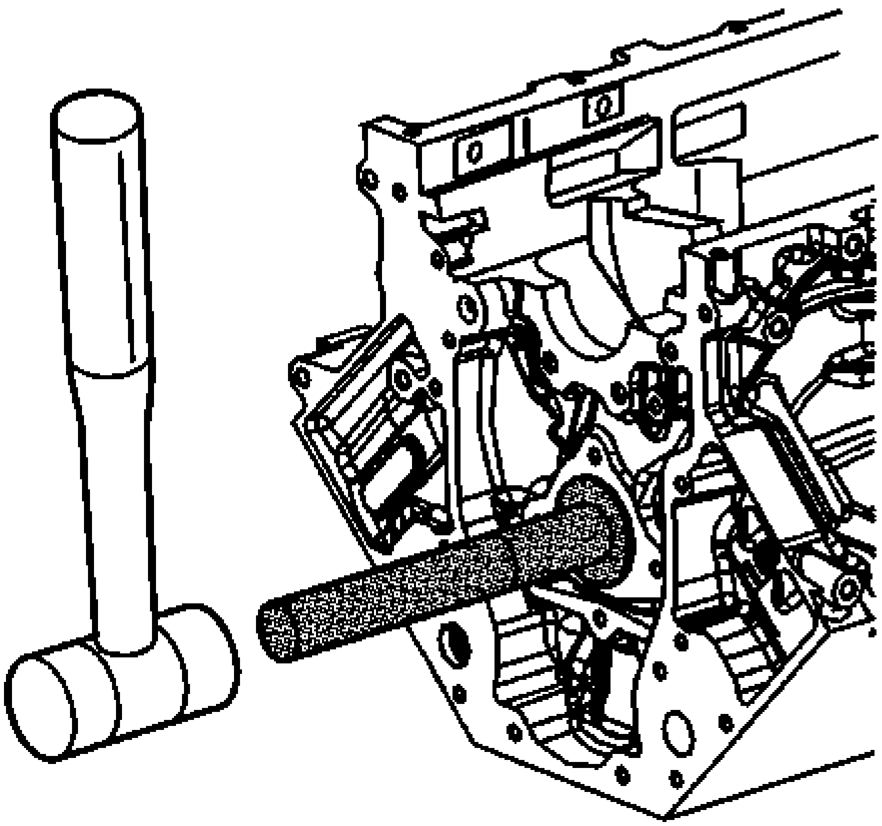


Fig. 147: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

11. For the 2 end bearings, front and rear, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

Special Tools

- **J 7872:** Magnetic Base Dial Indicator Set
- **J 8520:** Camshaft Lobe Lift Indicator

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

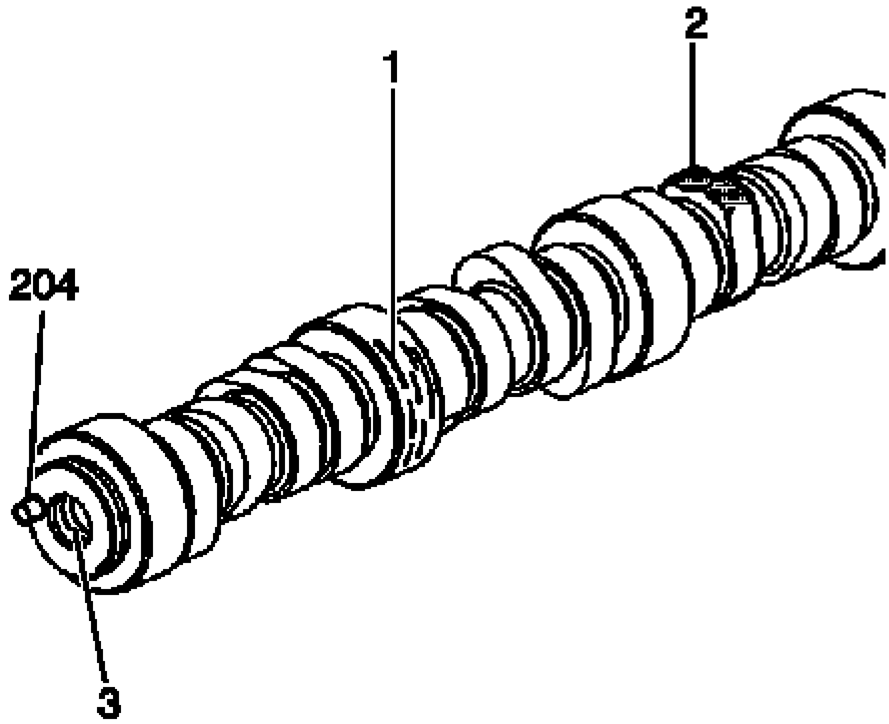


Fig. 148: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (204) for damage.

7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

   If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

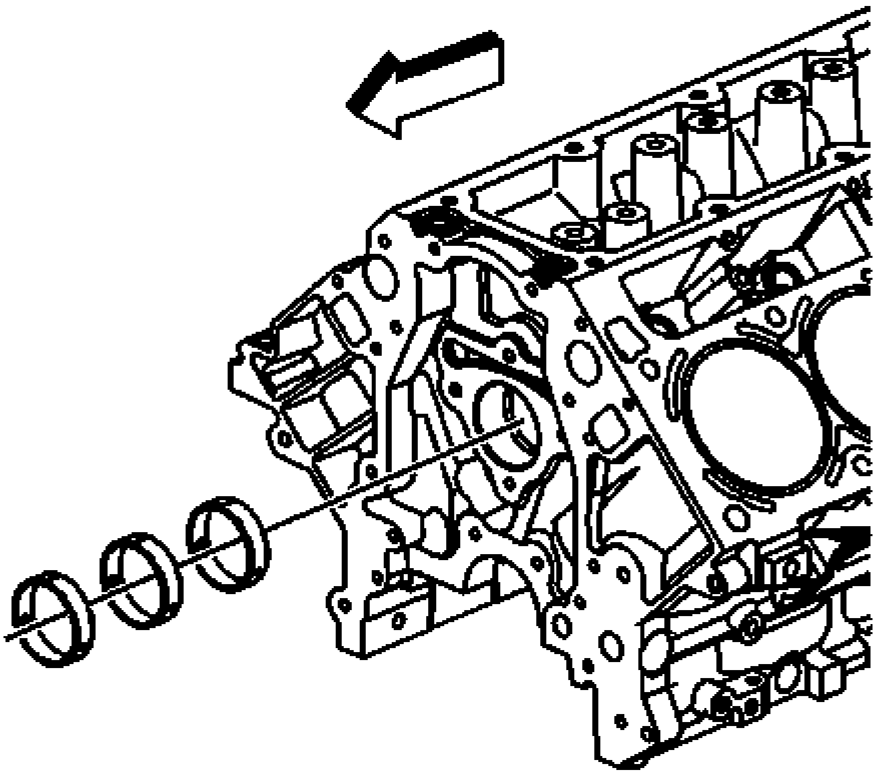


Fig. 149: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

8. Inspect the camshaft bearings for the following:
   - Excessive wear or scoring. The presence of the copper color bearing material should be considered normal and not a guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to **Engine Mechanical Specifications (6.2L LS3) Engine Mechanical Specifications (6.0L L76)** .
   - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
   - Oil lubrication hole plugged by debris.

     Bearings with excessive wear or scoring must be replaced.

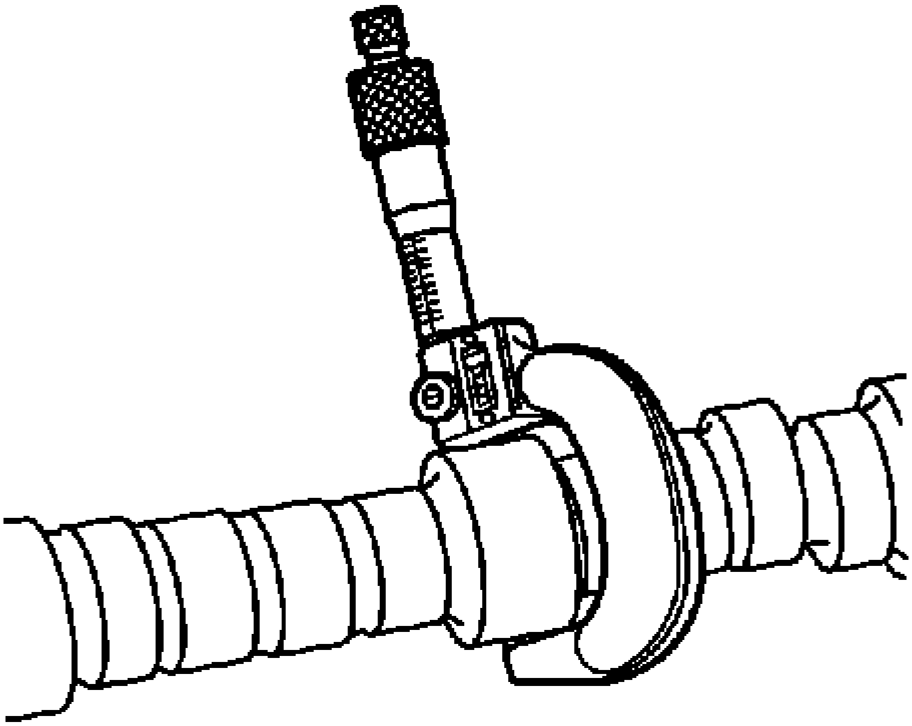


Fig. 150: Measure Camshaft Journals With Micrometer
Courtesy of GENERAL MOTORS CORP.

9. Using a micrometer, measure the camshaft journals for wear and out-of-round.
    - If the camshaft bearing journals are greater than 0.025 mm (0.001 in) out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is less than 54.99 mm (2.164 in) , replace the camshaft.

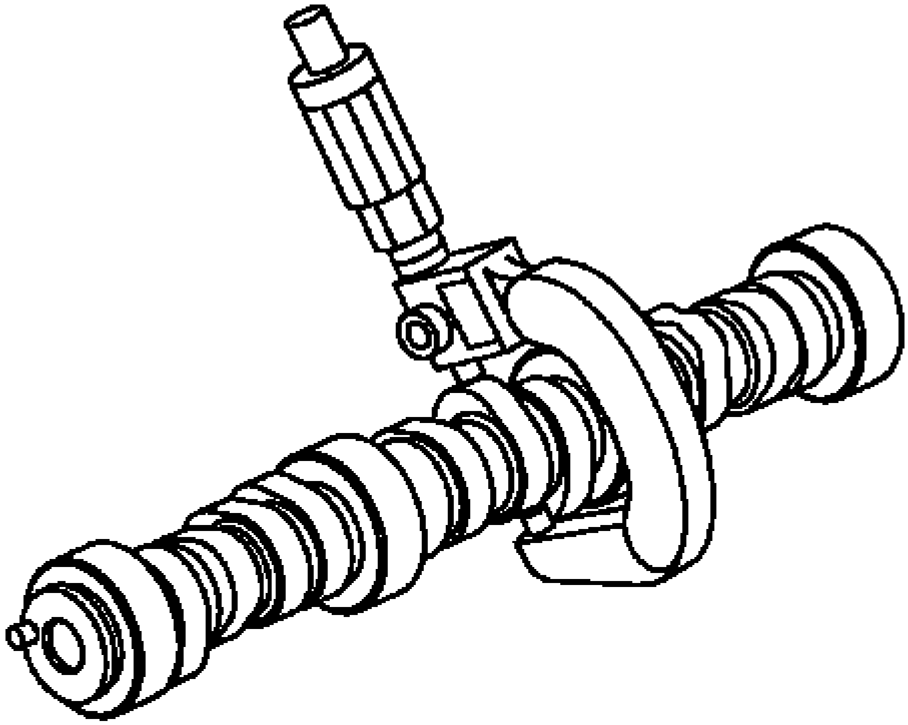


Fig. 151: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

10. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

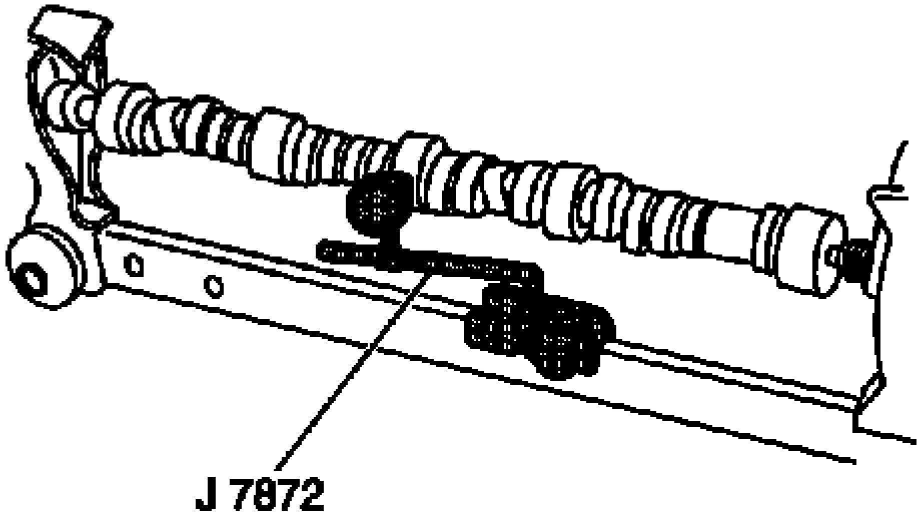


Fig. 152: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

11. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872:** dial indicator set , measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout exceeds 0.05 mm (0.002 in) , the camshaft is bent and should be replaced.

Measuring Camshaft Lobe Lift

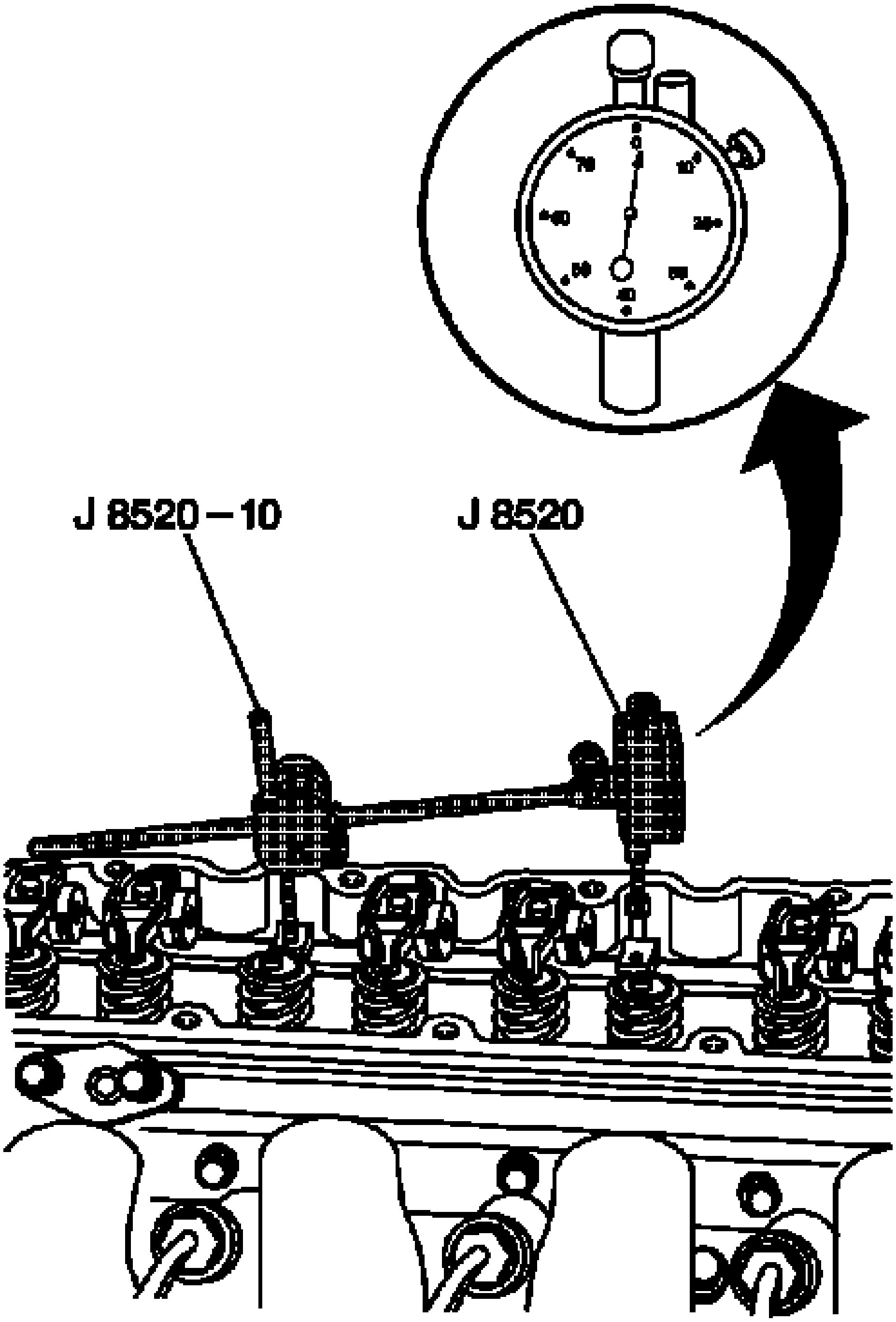


Fig. 153: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.**

1. Using the **J 8520:** camshaft lobe lift indicator, measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520:** camshaft lobe lift indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

CAMSHAFT BEARING INSTALLATION

Tools Required

J 33049 Camshaft Bearing Service Set. See **Special Tools** .

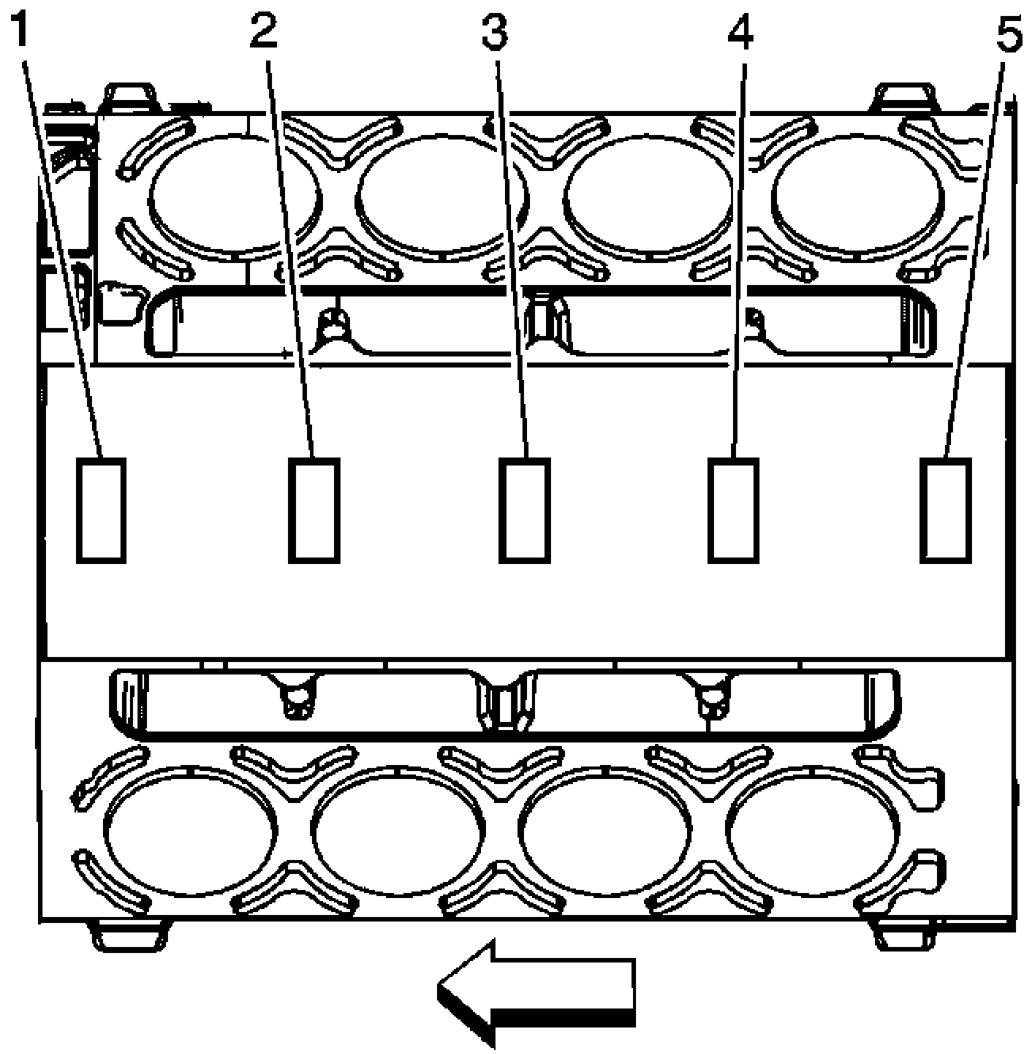


Fig. 154: Identifying Engine Block Camshaft Bearing Bores
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

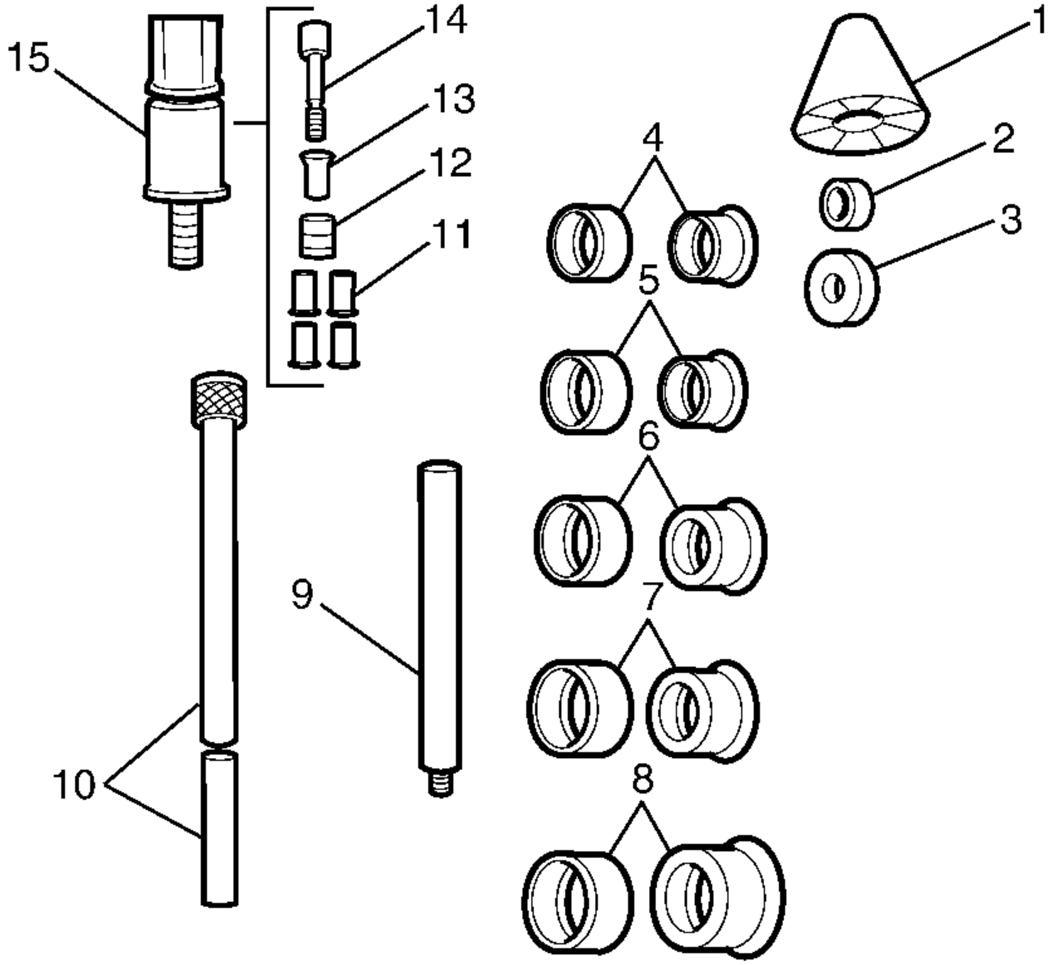


Fig. 155: View Of Expander Assembly, Shaft, Cone, Sleeve, Jaws, Bearing Drivers, Driver Bars, Washers & Guide Cone
Courtesy of GENERAL MOTORS CORP.

2. Select the expanding driver (4 - 8) and washer (2 or 3) from the **J 33049** . See **Special Tools** .
3. Assemble the tool.

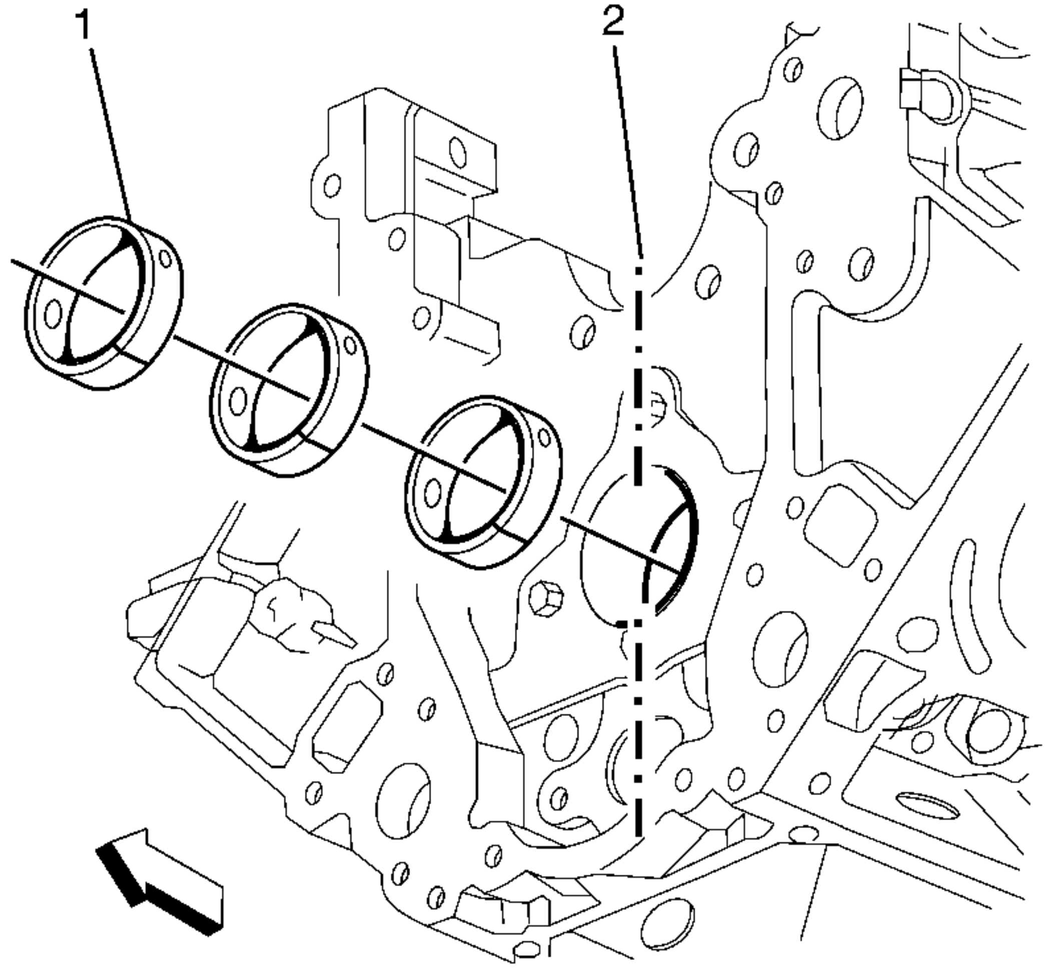


Fig. 156: Identifying Camshaft Bearing & Cylinder Block Centerline
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **The joint in the new camshaft bearing (1) must be aligned with the top of the cylinder block centreline (2). To assist with alignment of the bearing, use a felt tip pen to mark the back of the bearing 180° from the join, as this will be visible when installing the bearing.**
- **Make sure the bearing is installed correctly allowing maximum exposure to the oil feed hole.**

4. Align the new camshaft bearing (1) with the top of the cylinder block centreline (2).

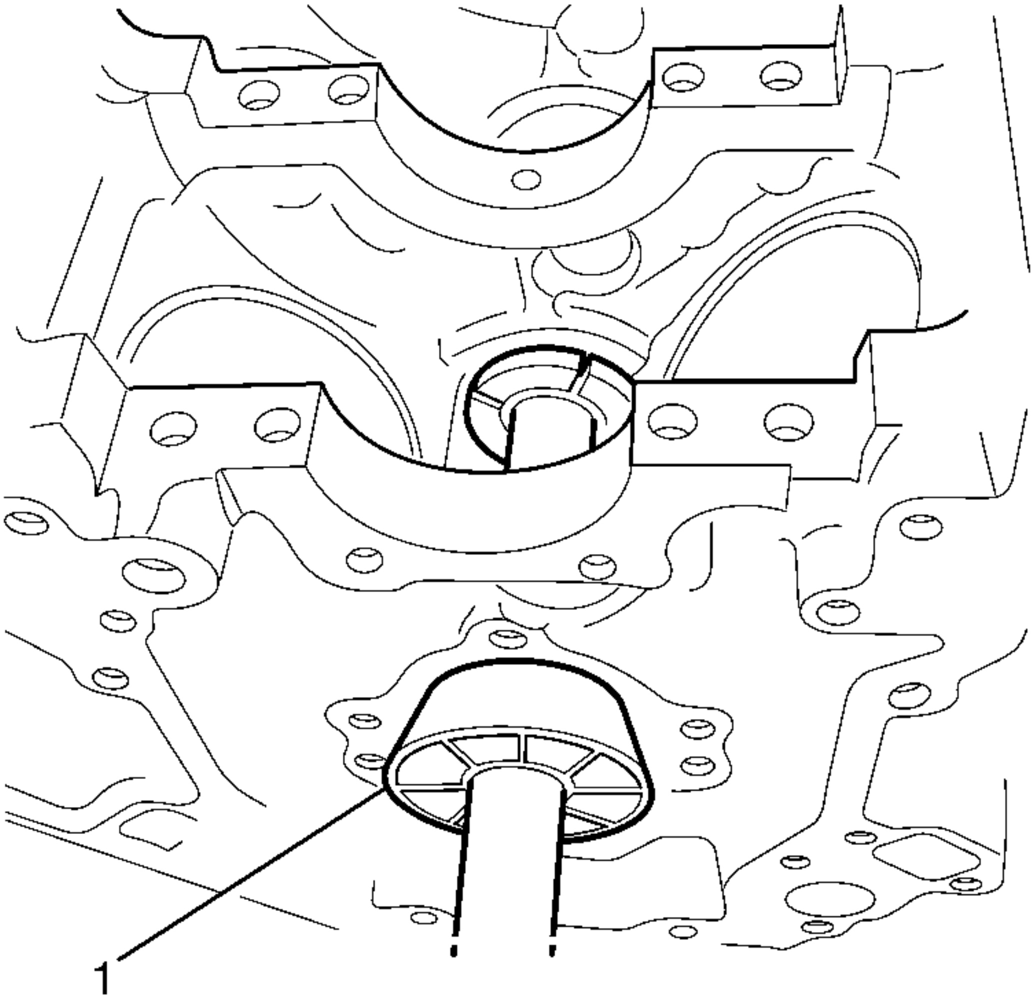


Fig. 157: Identifying Camshaft Bearing & J 33049
Courtesy of GENERAL MOTORS CORP.

5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly nut until firm.
7. Push the guide cone into the front camshaft bearing in order to align the tool.

IMPORTANT: After installing the bearings, use a thin piece of wire to ensure the oil feed passage has not been obstructed.

8. Drive the bearing into the block bore.

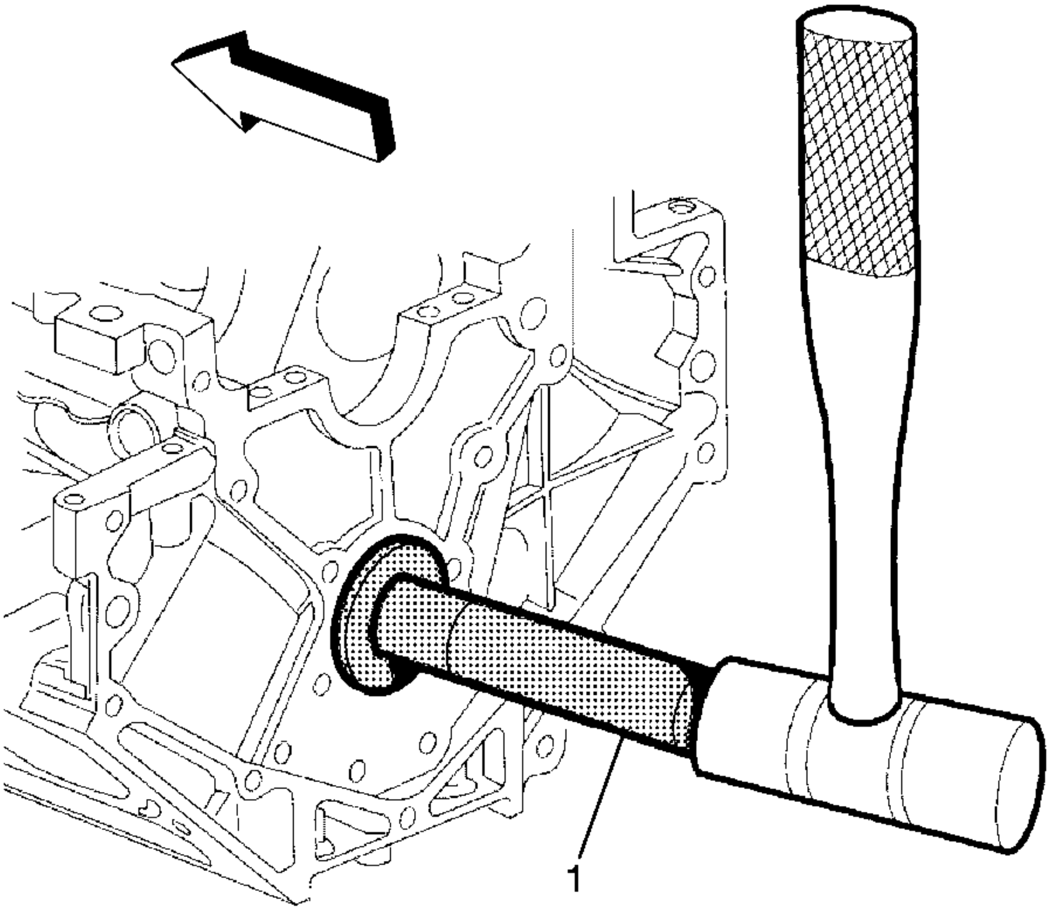


Fig. 158: Locating J 33049
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: After installing the bearings, use a thin piece of wire to ensure the oil feed passage has not been obstructed.

9. Install the front and rear bearings to the block.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

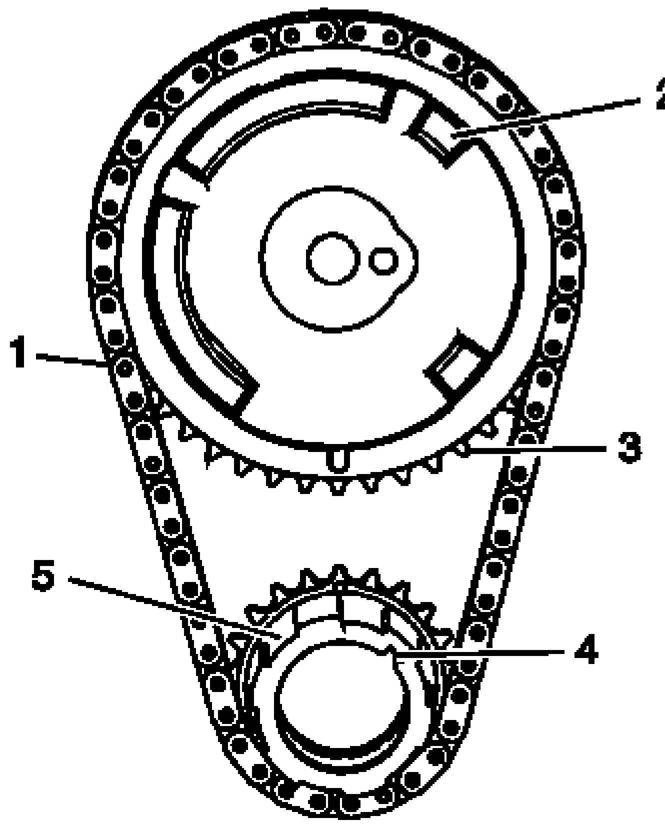


Fig. 159: Identifying Timing Chain and Sprockets Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components with cleaning solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the components with compressed air.
3. Inspect the timing chain (1) for binding or wear.
4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.
5. Inspect for worn, damaged, or chipped teeth (3).
6. Inspect for a damaged keyway (4).
7. Inspect for worn oil pump drive splines (5).

VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

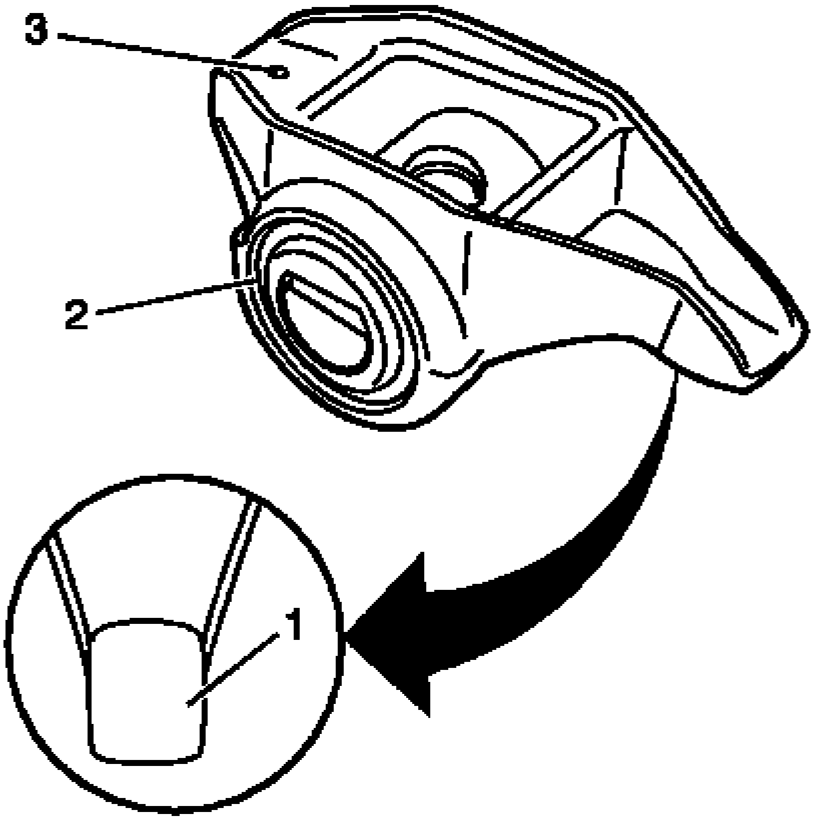


Fig. 160: Identifying Valve Rocker Arm Components
Courtesy of GENERAL MOTORS CORP.

NOTE: **Parts that are to be used again must be marked, sorted or organized for assembly.**

1. Mark, sort, or organize the components for assembly. Refer to **Separating Parts** .
2. Clean the components with cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.

8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

VALVE LIFTER AND GUIDE CLEANING AND INSPECTION

Non Active Fuel Management Valve Lifters

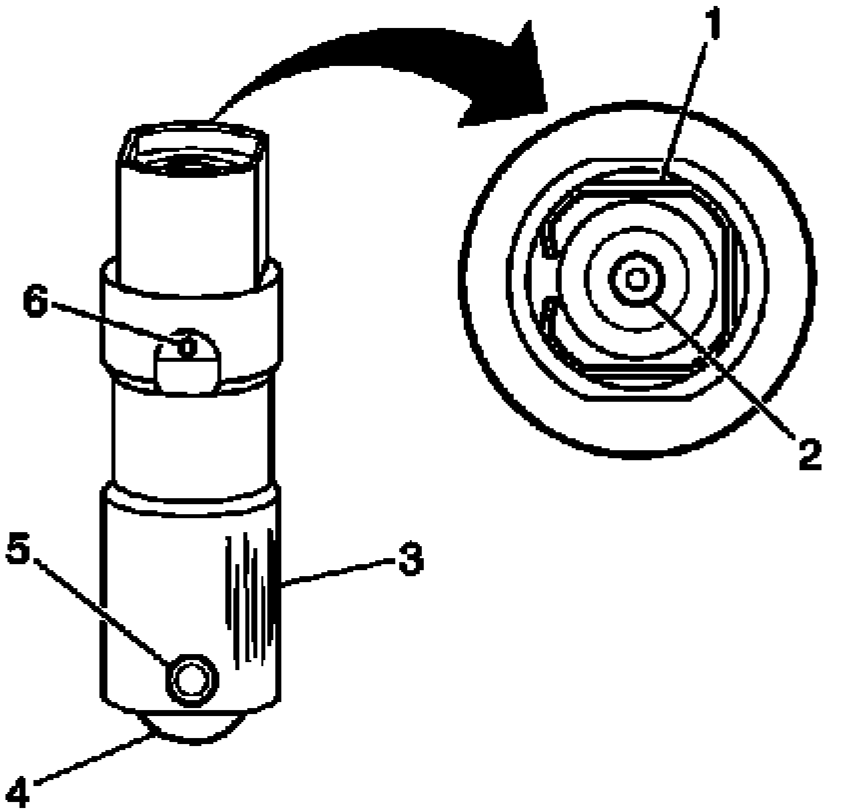


Fig. 161: Identifying Valve Lifter Inspection Areas
Courtesy of GENERAL MOTORS CORP.

NOTE: **Components that are to be used again must be marked, sorted or organized for assembly.**

1. Clean the components in cleaning solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the components with compressed air.

3. Inspect the valve lifters for the following conditions:
   - Bent or broken clip (1)
   - Worn pushrod socket (2)
   - Scuffed or worn sides (3)

     If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

   - Flat spots on the roller (4)
   - Loose or damaged pin (5)
   - Plugged oil hole (6)
   - Worn or damaged roller bearing

     The roller should rotate freely with no binding or roughness.

Active Fuel Management Valve Lifters

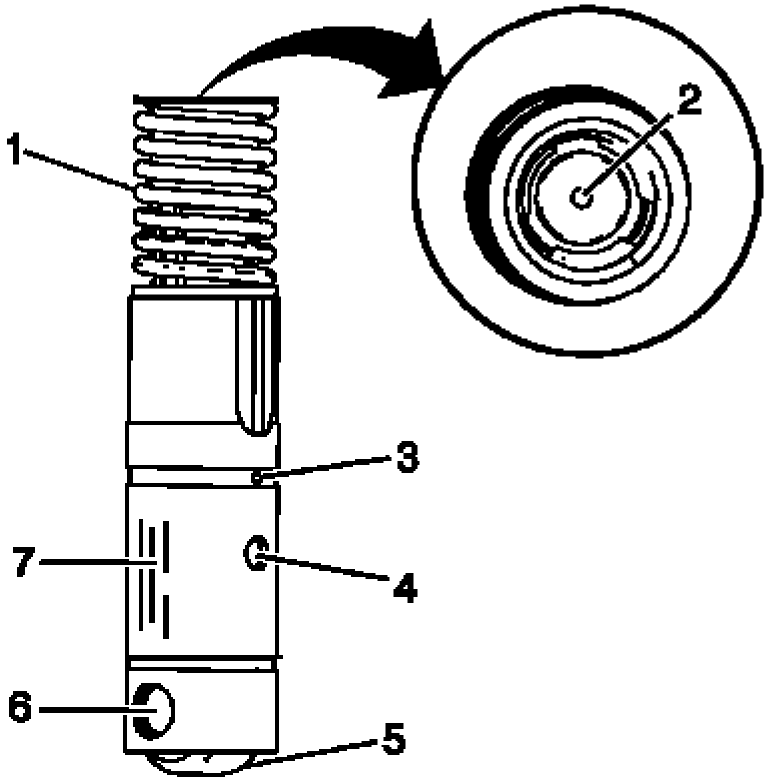


Fig. 162: Displacement On Demand Valve Lifters Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Components that are to be used again must be marked, sorted or

organized for assembly.

1. Clean the components in cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
   - Broken or collapsed spring (1)
   - Worn pushrod socket (2)
   - Plugged lubrication hole (3)
   - Plugged lifter oil-switching hole (4)
   - Flat spots on the roller (5)
   - Worn or damaged roller bearing (6)

     The roller should rotate freely with no binding or roughness.

   - Scuffed or worn sides (7)

Valve Guides

Inspect the valve lifter guides for the following conditions:

- Cracks or damage
- Excessive wear in the lifter mounting bores

CYLINDER HEAD DISASSEMBLE

Special Tools

J 8062: Valve Spring Compressor - Head Off

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

1. Remove the spark plugs from the cylinder heads. Refer to **Spark Plug Replacement** .

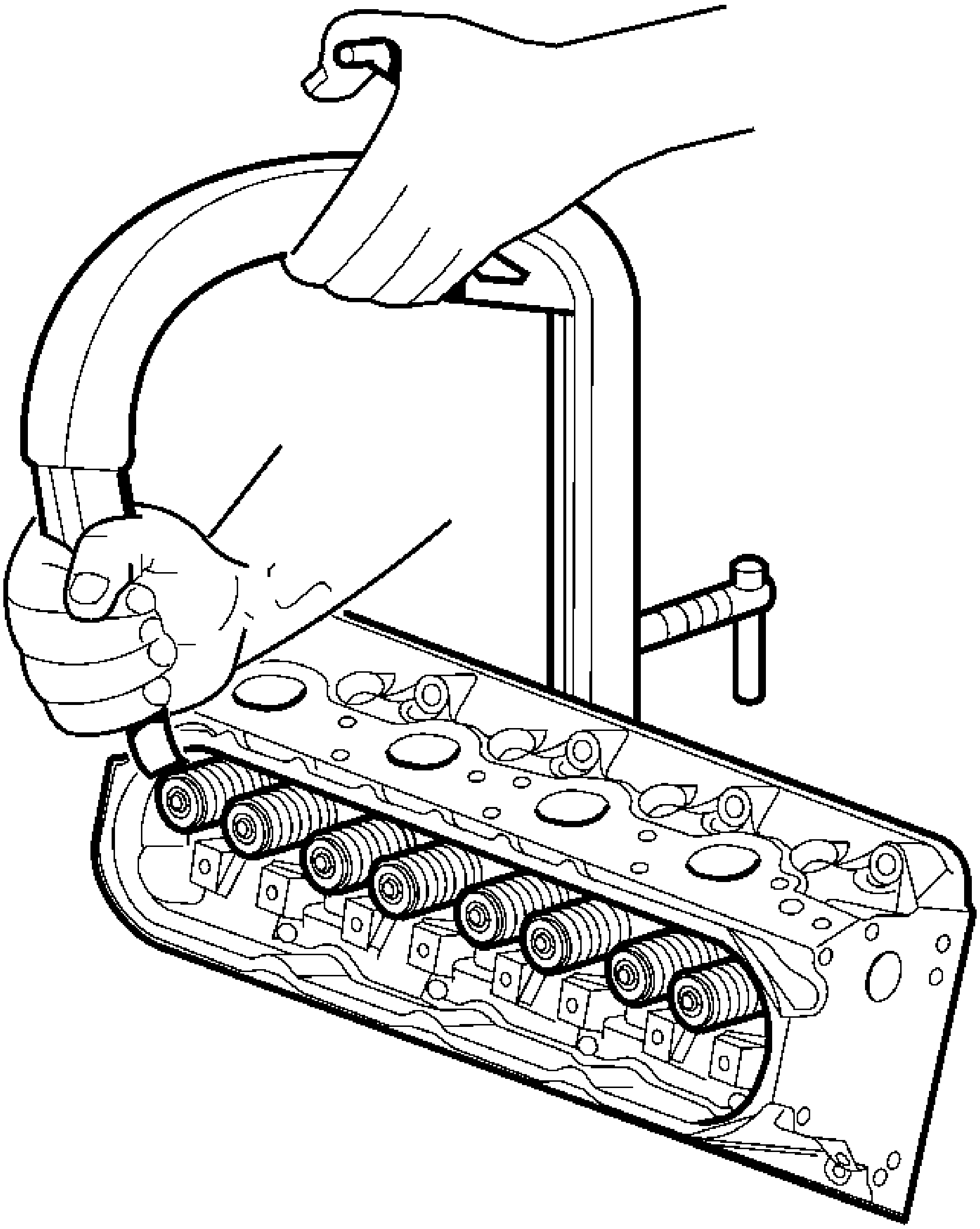


Fig. 163: View Of Commercially Available Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

NOTE:	• **With the components at room temperature, remove the spark plugs from the cylinder head.**

- **Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.**

2. Use a commercially available valve spring compressor in order to compress the valve spring.

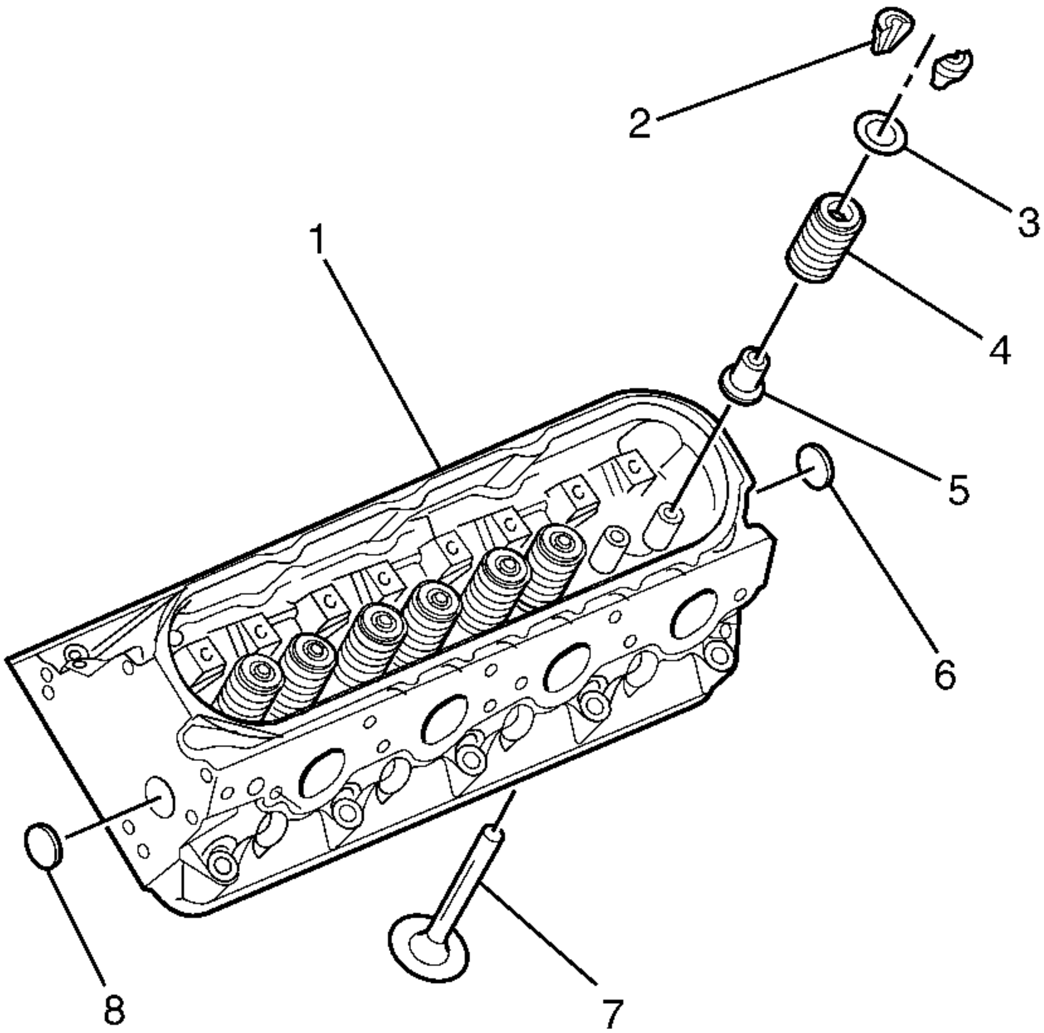


Fig. 164: View Of Cylinder Head, Valve Stem Keys, Spring, Cap, Oil Seal & Coolant Core Plugs
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve stem keys (2).
4. Release the spring compressor and remove from the cylinder head (1).
5. Remove the valve spring cap (3).
6. Remove the valve spring (4).

7. Remove the valve (7).
8. Remove the valve stem oil seal (5). Refer to **Separating Parts** .
9. Repeat steps 2-8 for each valve as required.
10. Remove the cylinder head core hole plugs (6), as required.

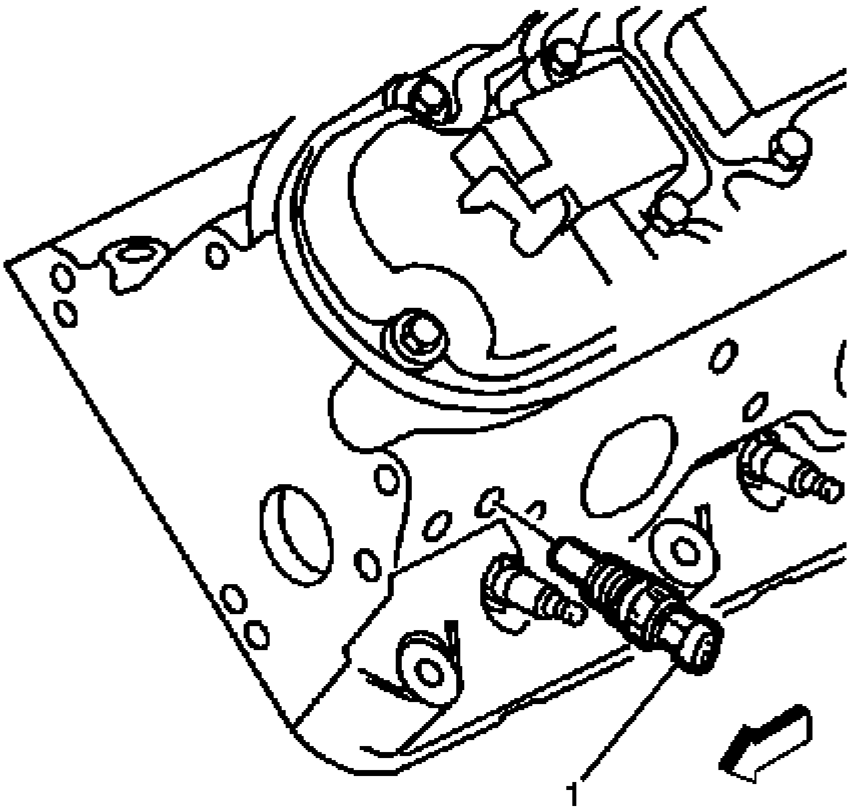


Fig. 165: Identifying ECT Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

11. Remove the ECT sensor (1) from the cylinder head.

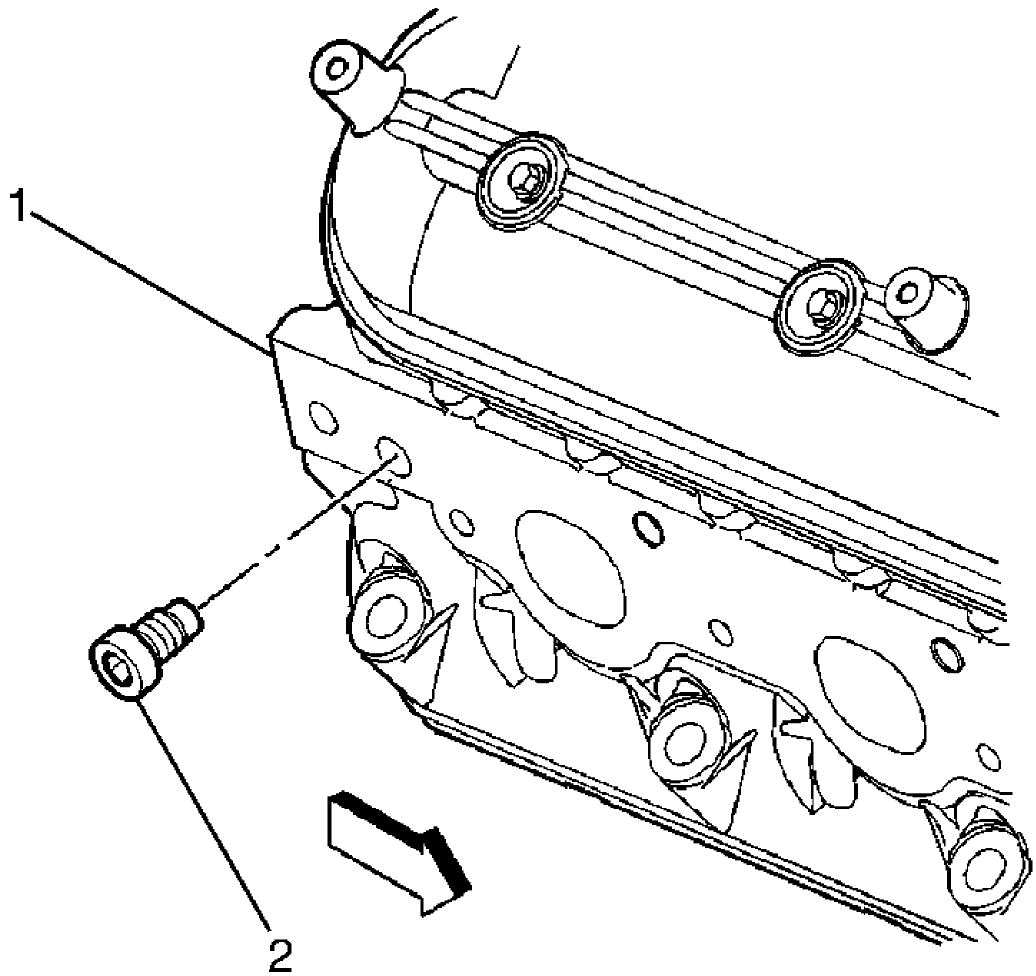


Fig. 166: Identifying Coolant Plug & Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

12. Remove the coolant plug (2) from the right cylinder head (1).

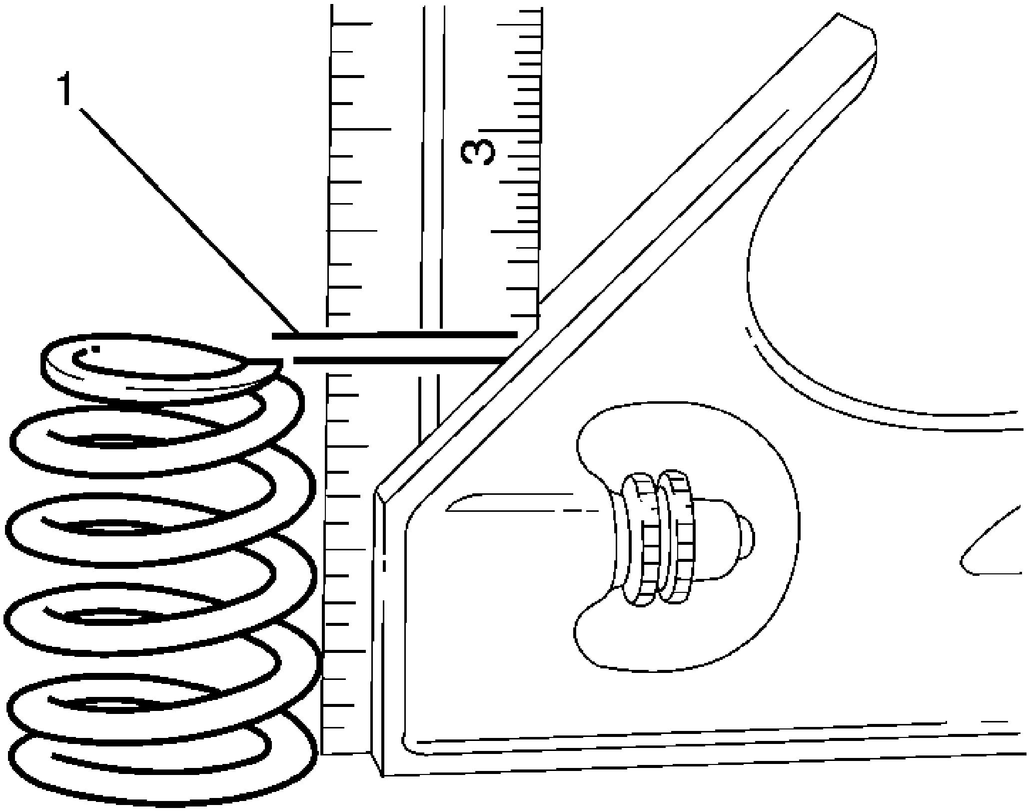


Fig. 167: Identifying Valve Spring Variance
Courtesy of GENERAL MOTORS CORP.

13. Check all valve springs for distortion. There should be no more than 1.6 mm variance (1) of the spring end while the spring is being rotated on a flat surface.

    Replace springs that exceed this specification.

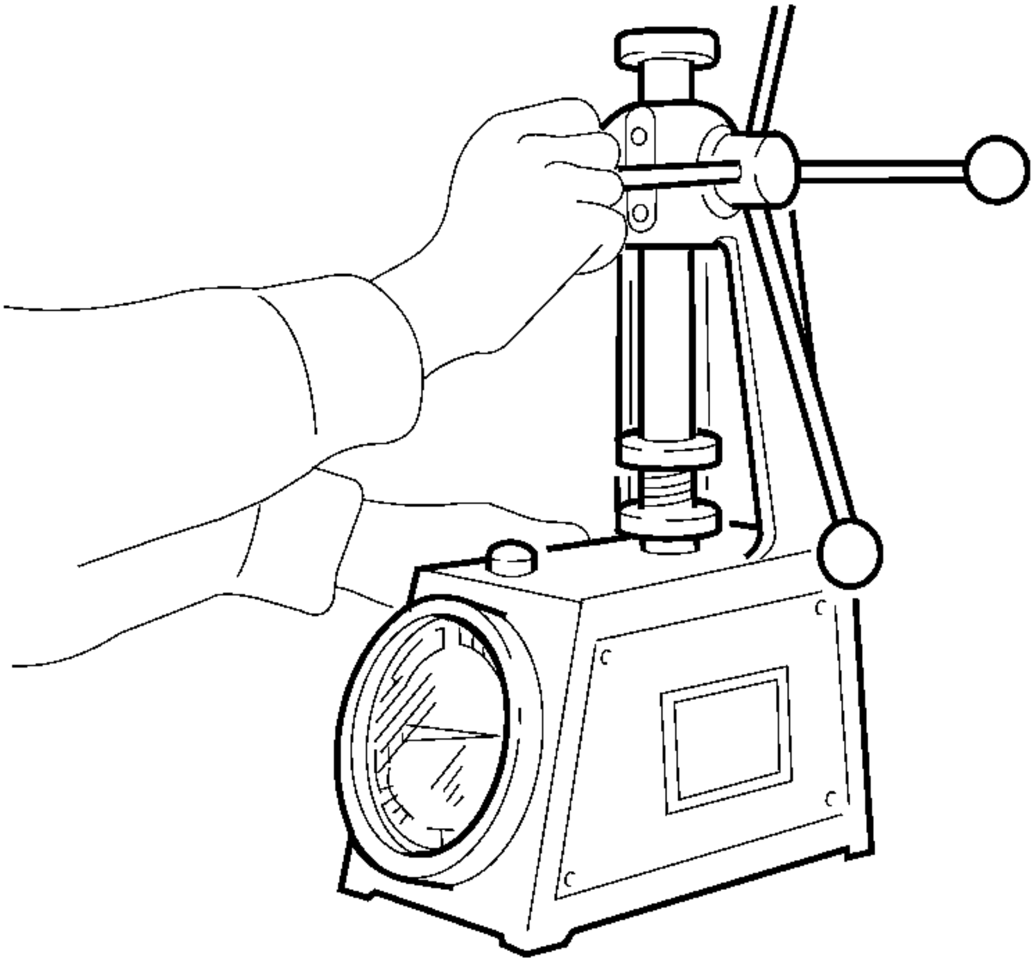


Fig. 168: Identifying Commercially Available Valve Spring Tester
Courtesy of GENERAL MOTORS CORP.

14. Use a commercially available valve spring tester and measure each valve spring for free height and tension. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **J 8089:** Carbon Removal Brush
- **J 9666:** Valve Spring Tester

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

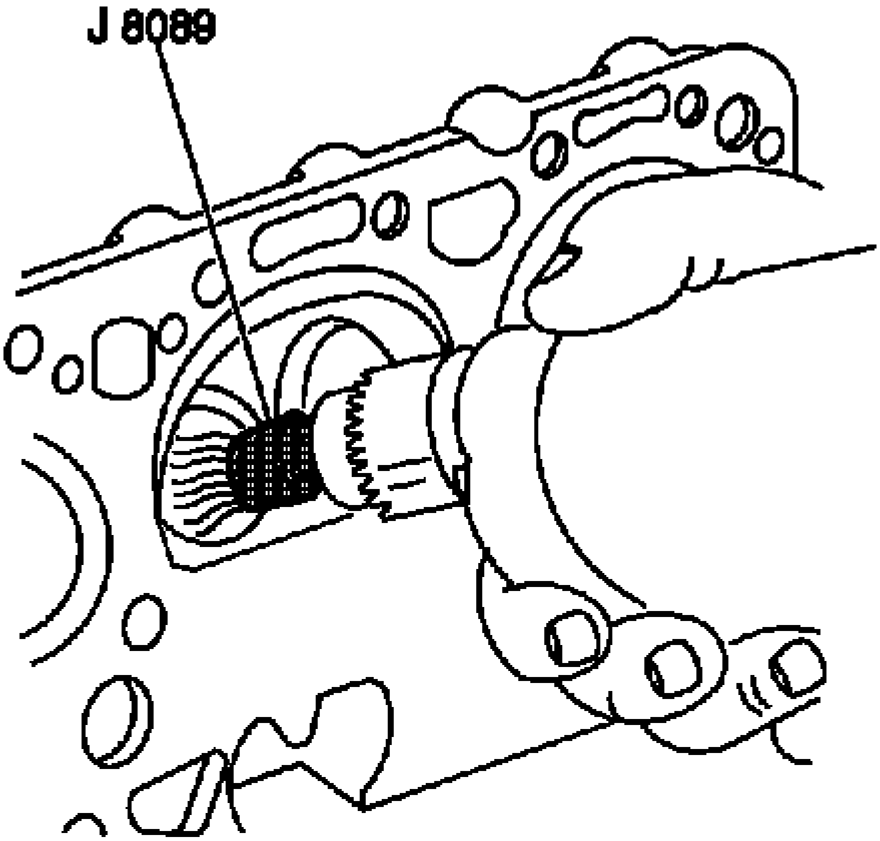


Fig. 169: Cleaning Carbon Using J 8089
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:
- **When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).**
- **Be careful not to scuff the chamber.**

1. Clean the following components:
   - Use the **J 8089:** brush in order to remove the carbon from the combustion chambers.
   - Gasket surfaces

     Refer to **Replacing Engine Gaskets** .

   - Valve stems and heads on a buffing wheel
   - Bolt hole threads

Remove all dirt, debris, or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:
    1. Cracks in the exhaust ports and combustion chambers
    2. External cracks in the water chambers
    3. Gasket surfaces for excessive scratches or gouging

        Refer to **Replacing Engine Gaskets** .

    4. Bolt hole threads for debris or damaged threads

        Refer to **Thread Repair** or **Thread Repair Specifications** .

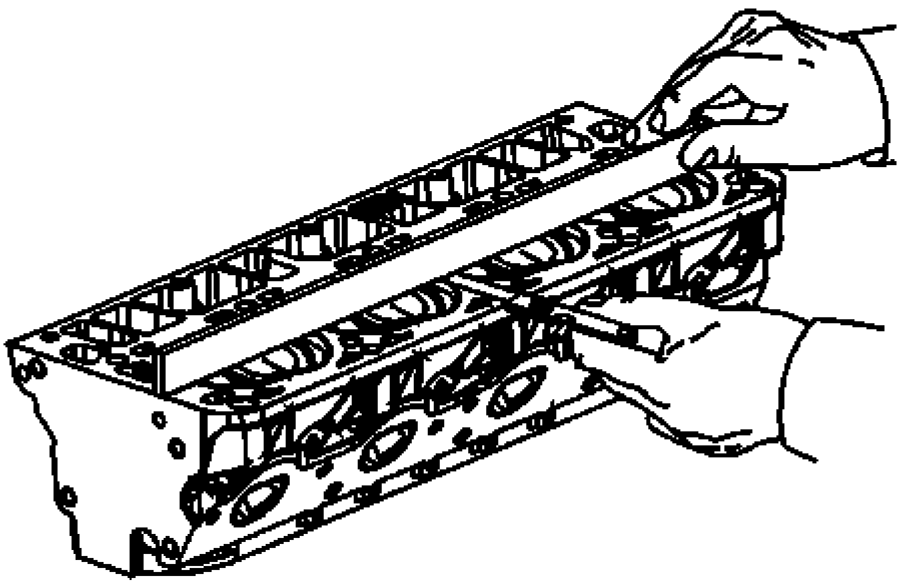


Fig. 170: Inspecting Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

3. Inspect the cylinder head for warpage. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

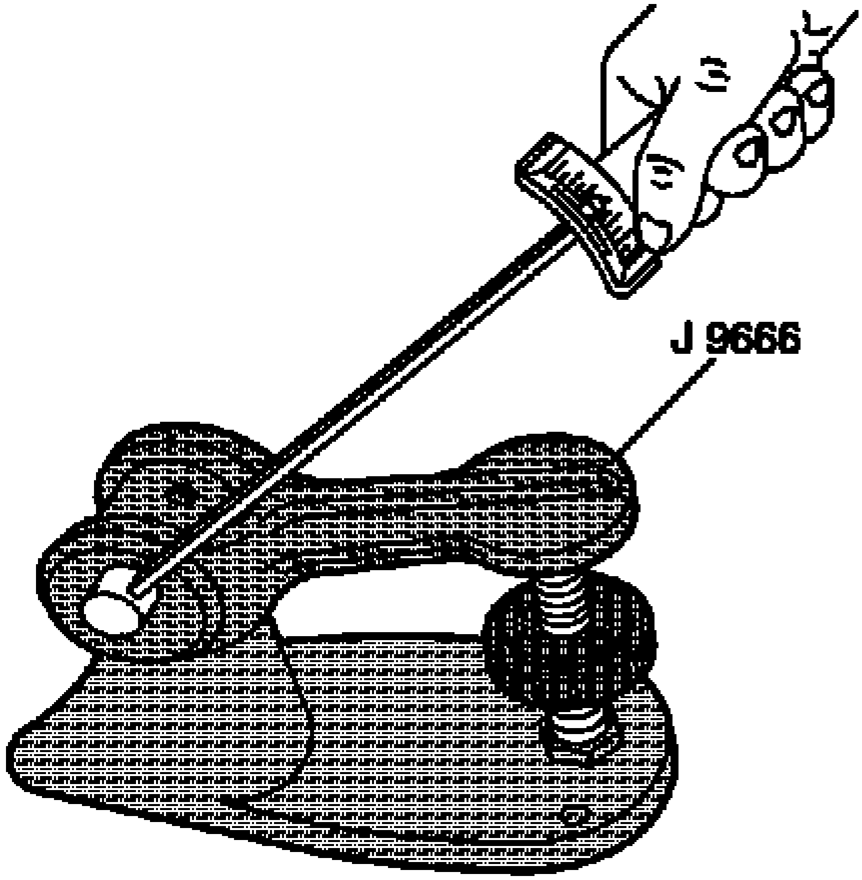


Fig. 171: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 9666:** tester in order to measure the valve spring tension. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

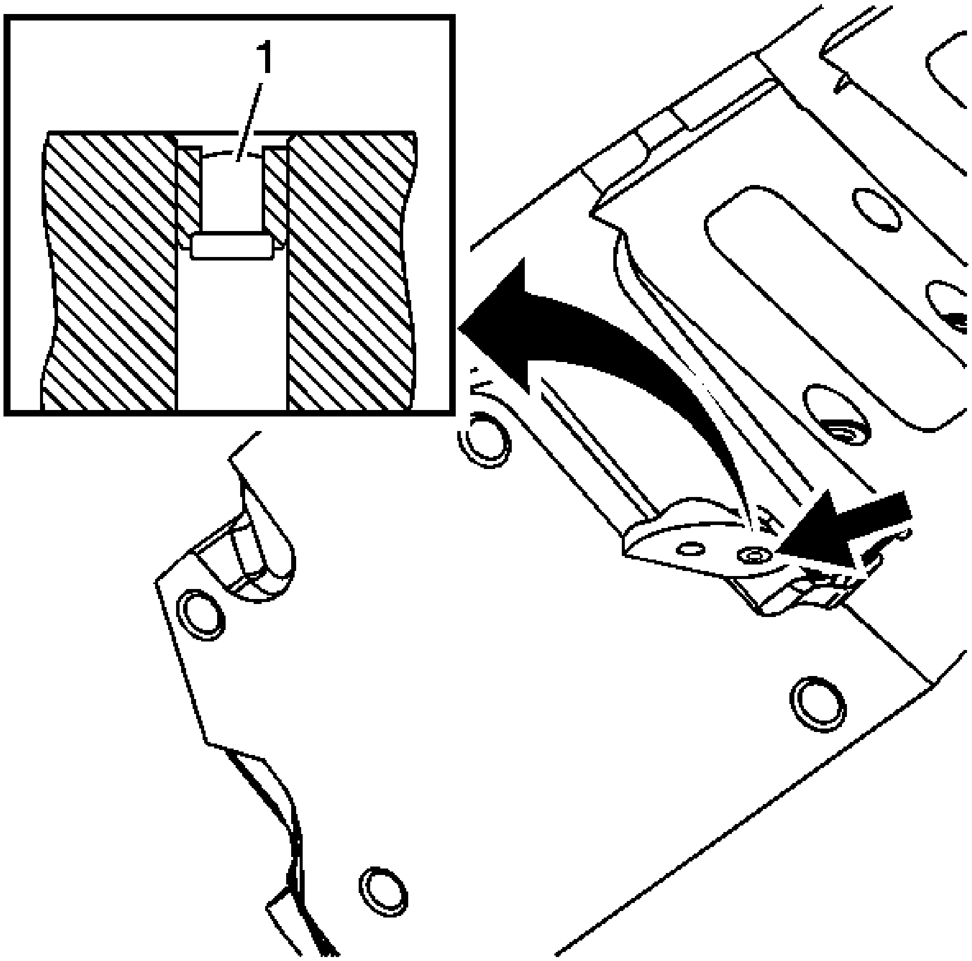


Fig. 172: Rivet-Type Plug
Courtesy of GENERAL MOTORS CORP.

5. Inspect for a leaking plug (1). Second design applications use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to **Cylinder Head Disassemble**.

VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING

Valve Guide Reaming

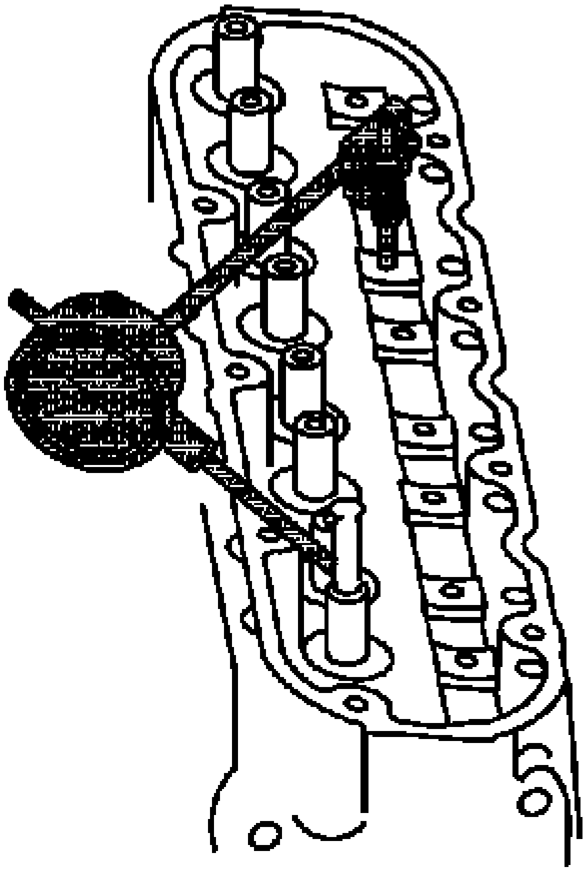


Fig. 173: Measuring Valve Stem-To-Guide Clearance
Courtesy of GENERAL MOTORS CORP.

CAUTION: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

CAUTION: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using a dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

   Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gage to measure the guide bore.

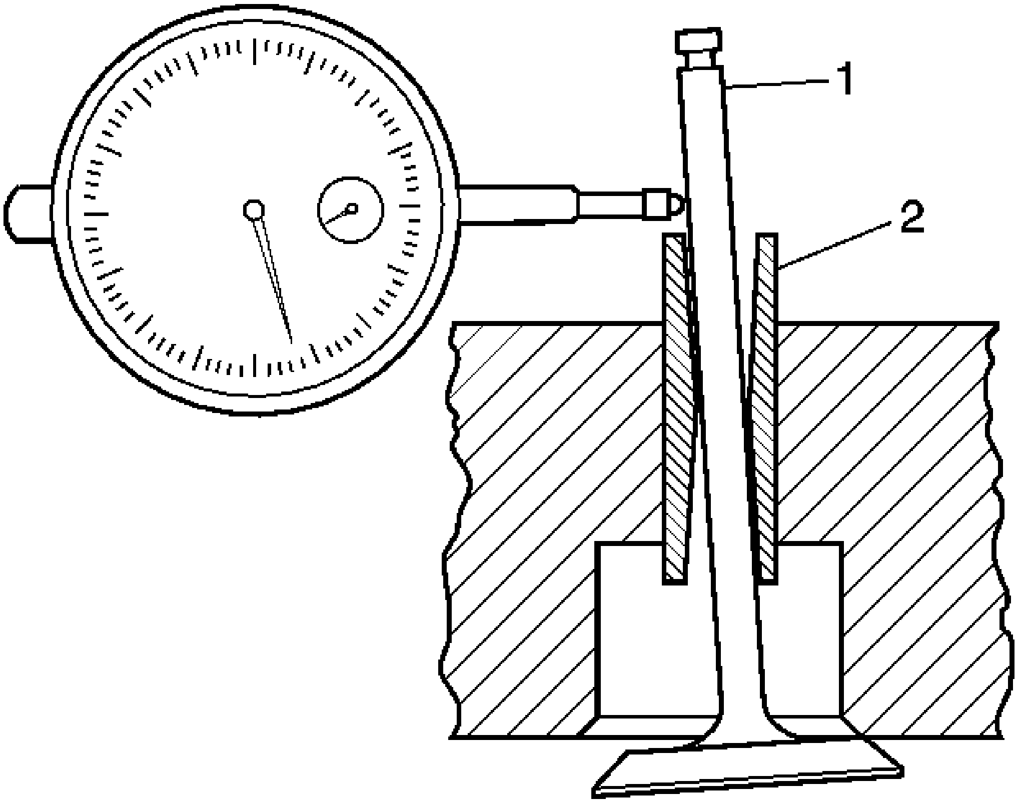


Fig. 174: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS CORP.

2. A valve stem (1) and guide (2), with excessive clearance, must be replaced or the cylinder head replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

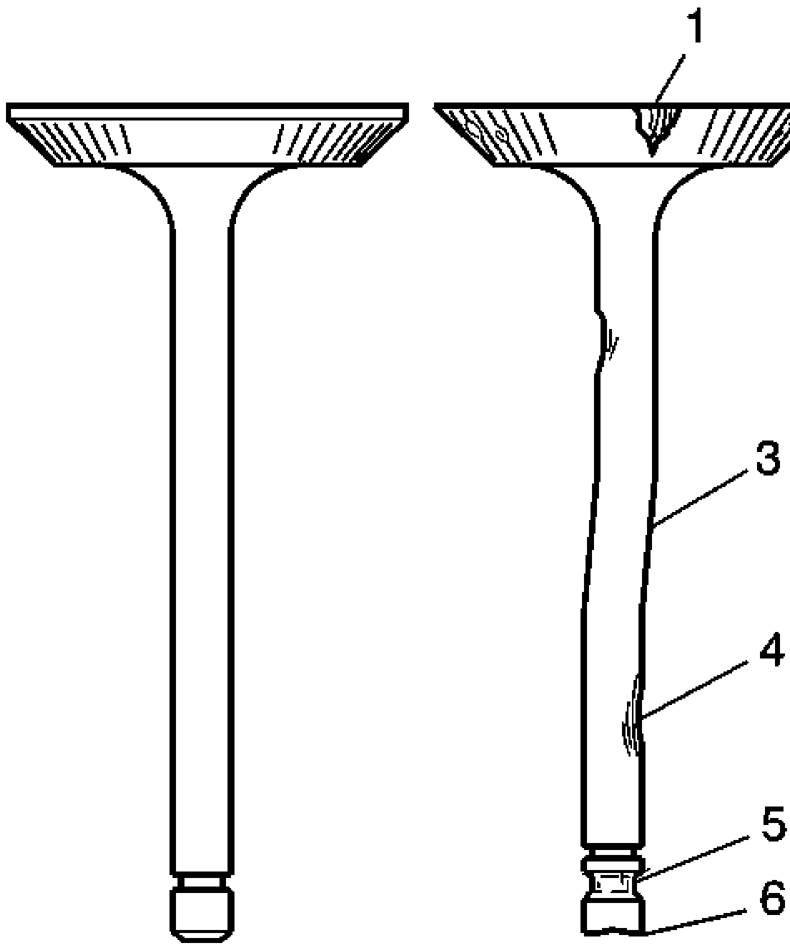


Fig. 175: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve stems for excessive scoring, wear, or warpage.
   - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
   - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced.

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

Valve and Seat Grinding

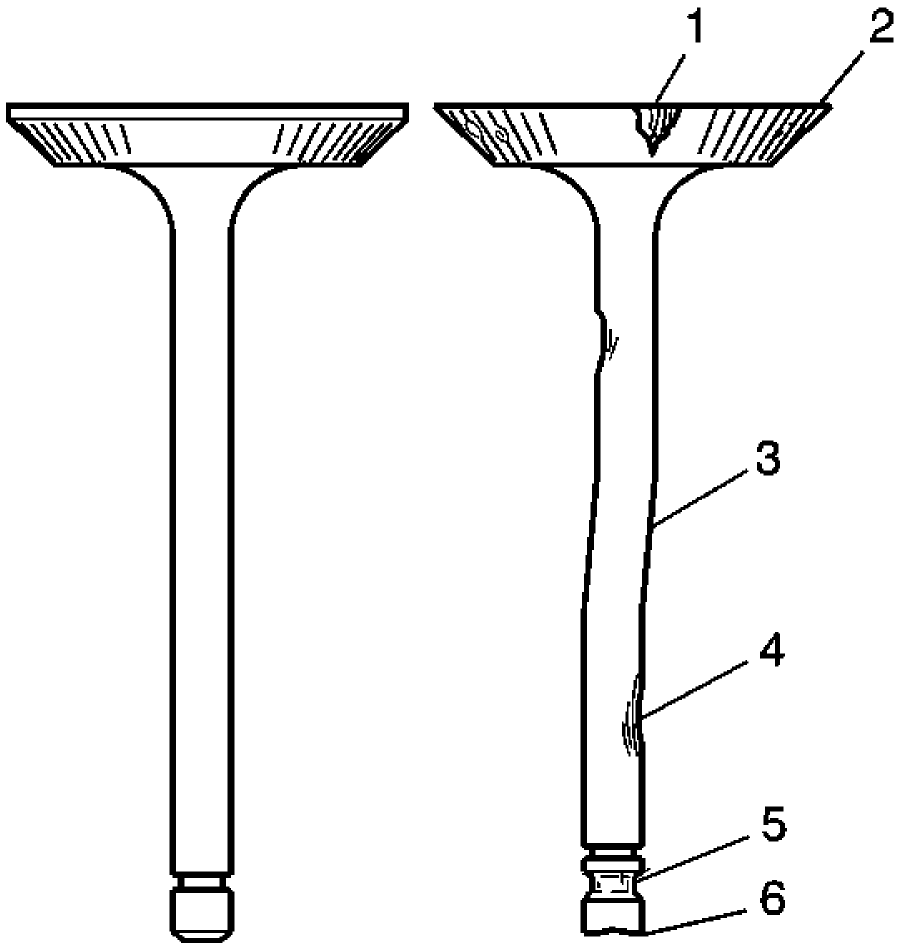


Fig. 176: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.**
- **Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.**
- **The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.**
- **Valves that are pitted must be refaced to the proper angle. Valve**

stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1.25 mm (0.05 in) after grinding, replace the valve.

- **Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.**
- **DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.**

1. Inspect the valve for the following conditions:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)
   - A worn or scored stem (4)
   - A worn key groove (5)
   - A worn stem tip (6)

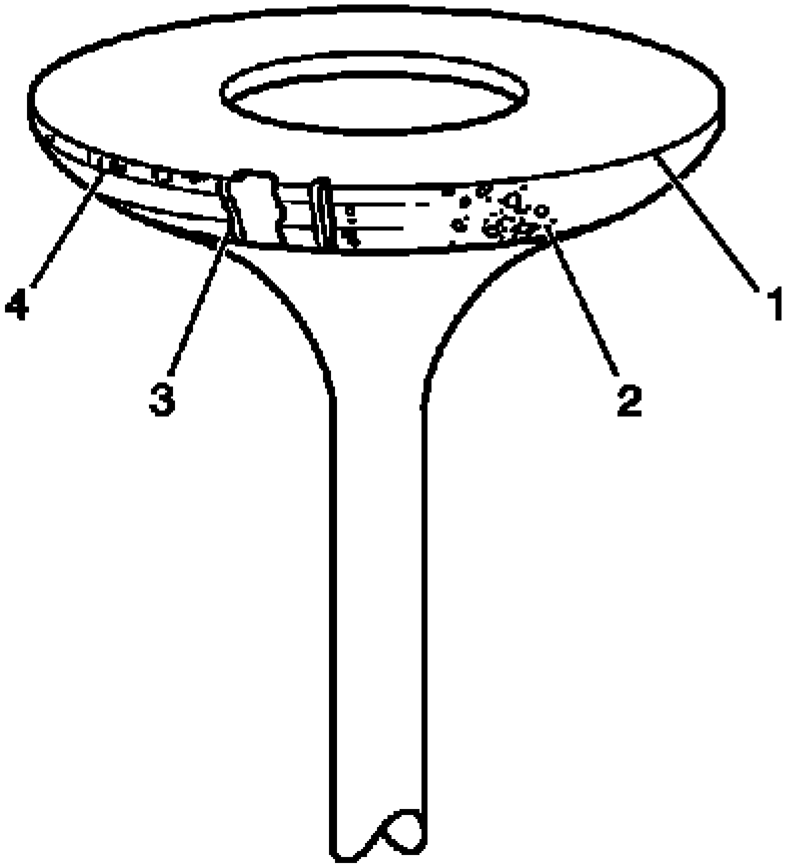


Fig. 177: Inspecting Valve Face For Burning, Pitting & Cracking
Courtesy of GENERAL MOTORS CORP.

2. Inspect the valve face for the following conditions:
   - Worn or no margin (1 or 4)
   - Pitted surfaces (2)
   - Burnt or eroded areas (3)

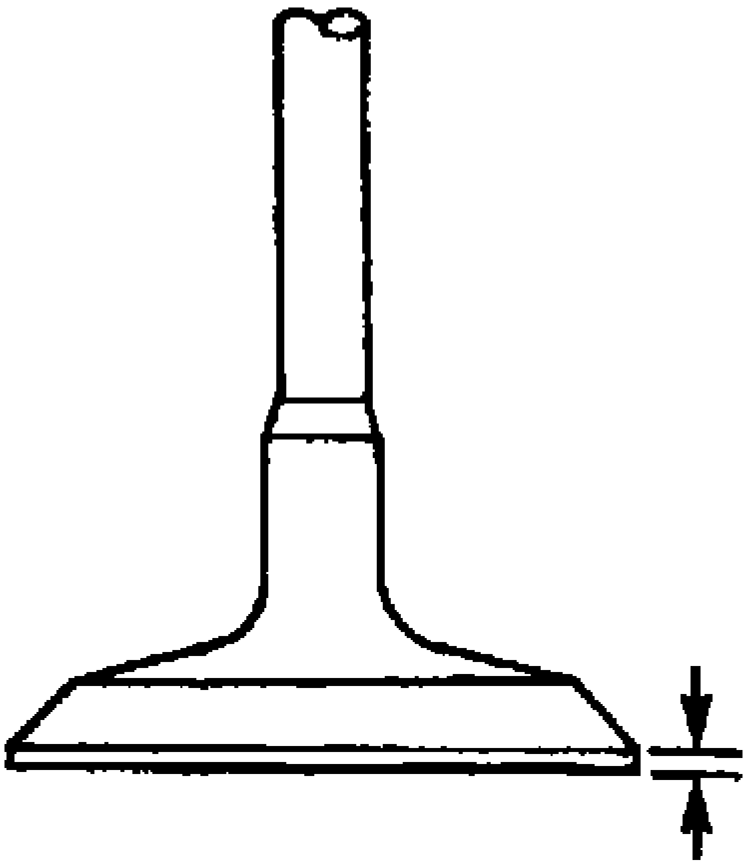


Fig. 178: Inspecting Valve Margin
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.

4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring in order to obtain the proper spring installed height. Refer to **Cylinder Head Disassemble**.
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

10. Inspect the valve seats.
    - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
    - If the valve seat has been ground, it may be necessary to shim the valve spring in order to attain the proper spring installed height. Refer to **Cylinder Head Disassemble**.

CYLINDER HEAD ASSEMBLE

Special Tools

J 8062: Valve Spring Compressor - Head Off

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

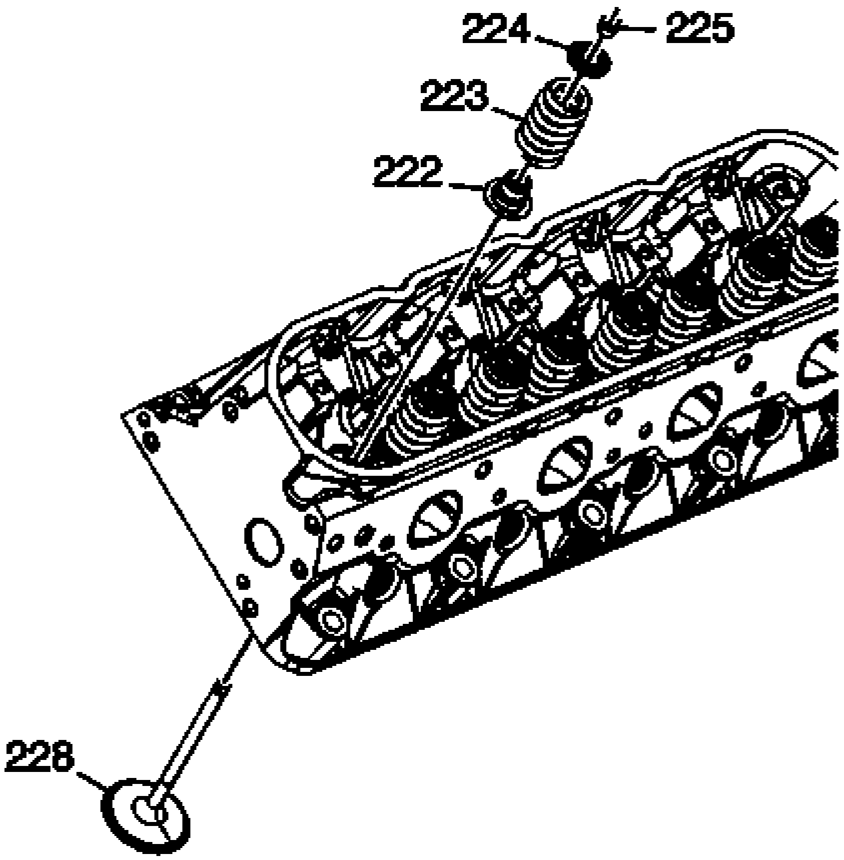


Fig. 179: Valve Stem Keys, Valve Spring Cap & Valve Spring
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring seat area.

NOTE: When using the valves and related components again, install the parts to

their original location.

2. Install the valves (228) into the proper port. Refer to **Separating Parts** .
3. Install the valve stem oil seal (222).
4. Install the valve spring (223).
5. Install the valve spring cap (224).

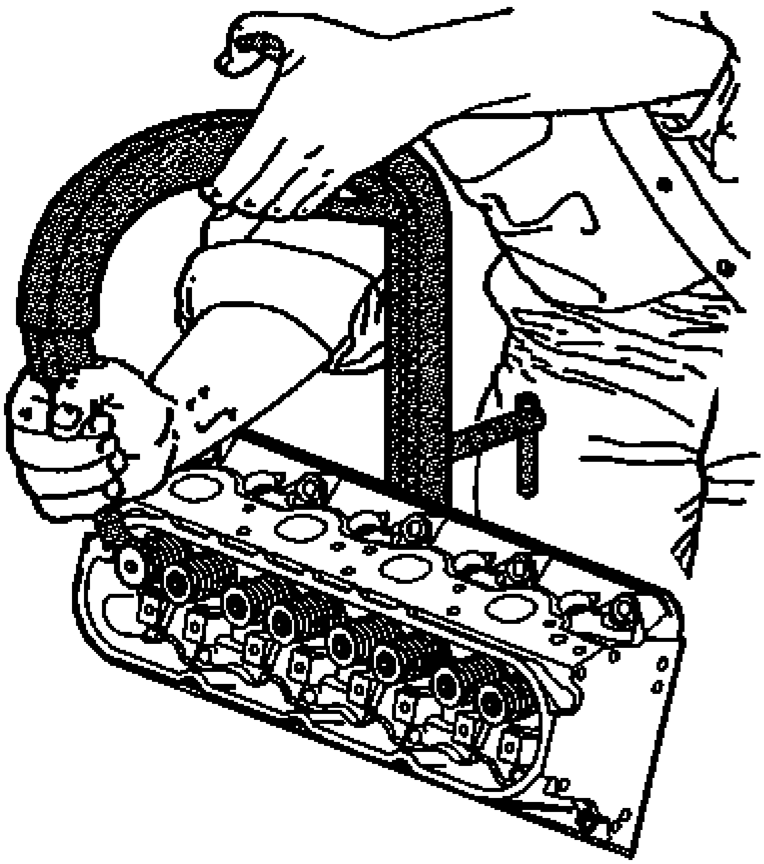


Fig. 180: Compressing Valve Spring Using
Courtesy of GENERAL MOTORS CORP.

6. Using the **J 8062:** valve spring compressor, compress the valve spring.
7. Install the valve stem keys.
    1. Use grease in order to hold the keys in place and remove the **J 8062:** valve spring compressor .
    2. Ensure the keys seat properly in the groove of the valve stem.
    3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.
8. Install the remaining valves, springs, and other components.

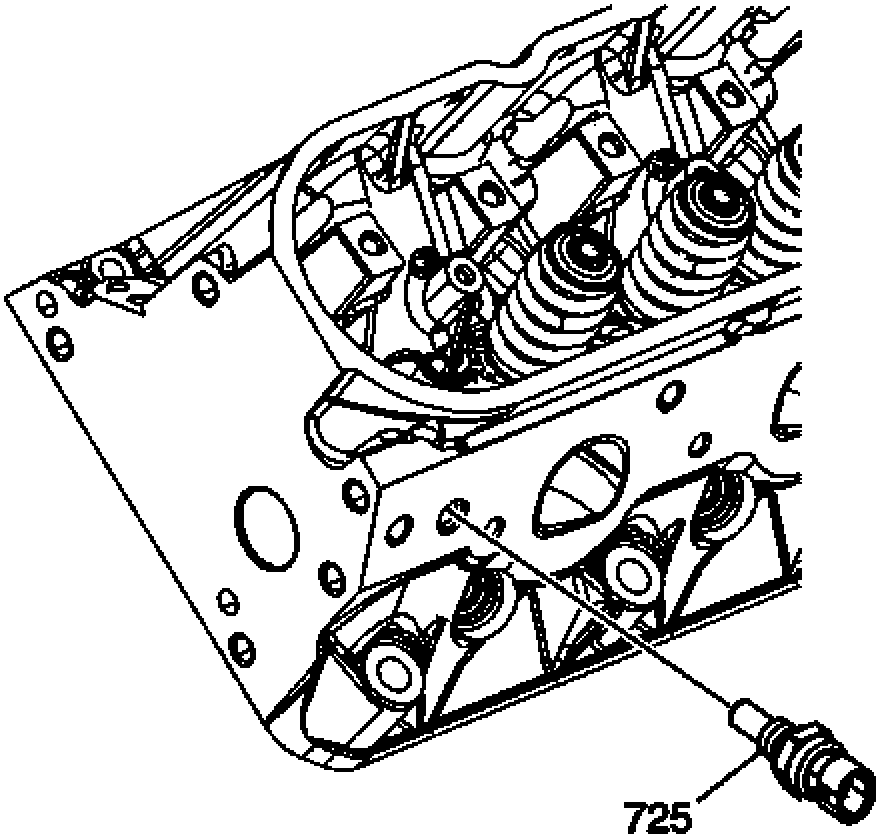


Fig. 181: Locating Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

9. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

CAUTION: Refer to Fastener Caution .

10. Install the coolant temperature sensor into the left cylinder head and tighten to 20 N.m (15 lb ft).

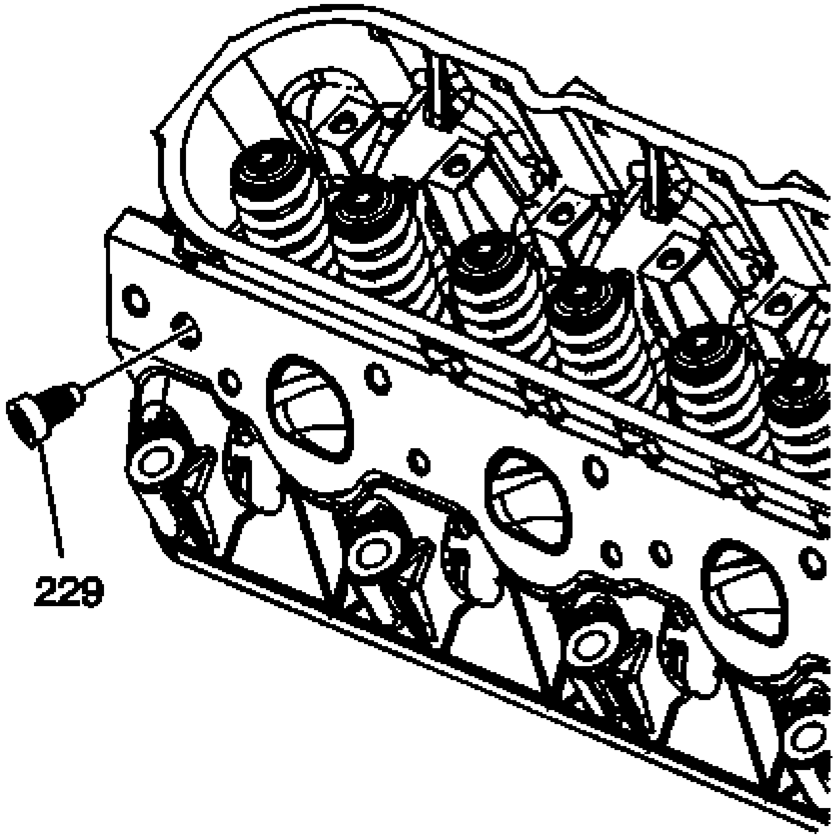


Fig. 182: Locating Coolant Plug
Courtesy of GENERAL MOTORS CORP.

11. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).
12. Install the cylinder head plug to the right cylinder head and tighten to 20 N.m (15 lb ft).

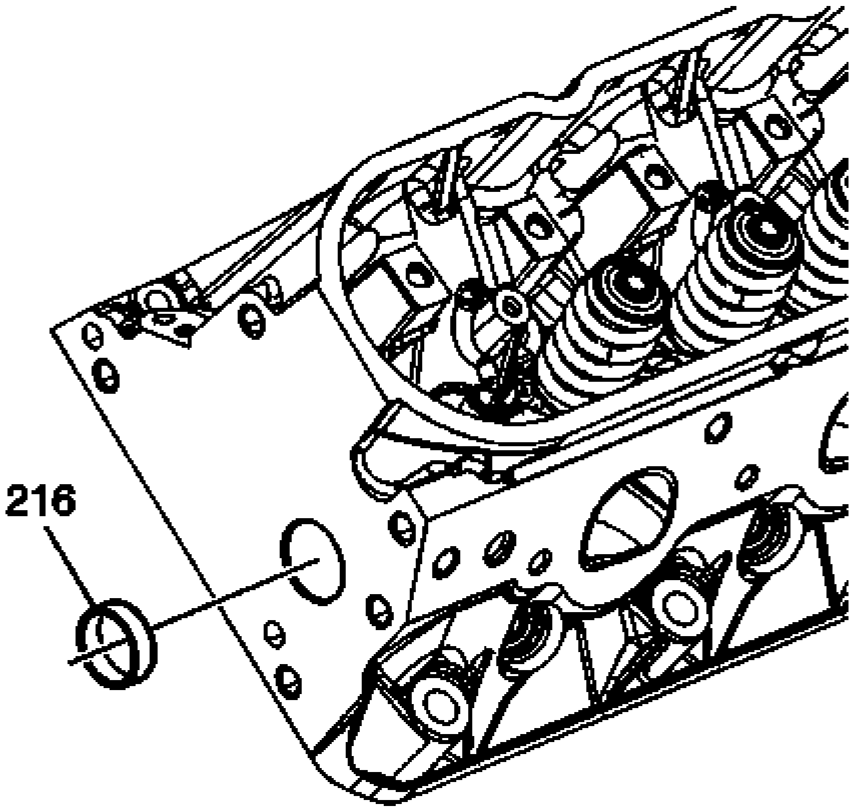


Fig. 183: Locating Cylinder Head Core Hole Plug
Courtesy of GENERAL MOTORS CORP.

13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the sides of the cylinder head plugs (216).
14. Install the cylinder head plugs into the cylinder head.

    A properly installed plug should be installed 2.5 mm (0.1 in) below the end face of the head.

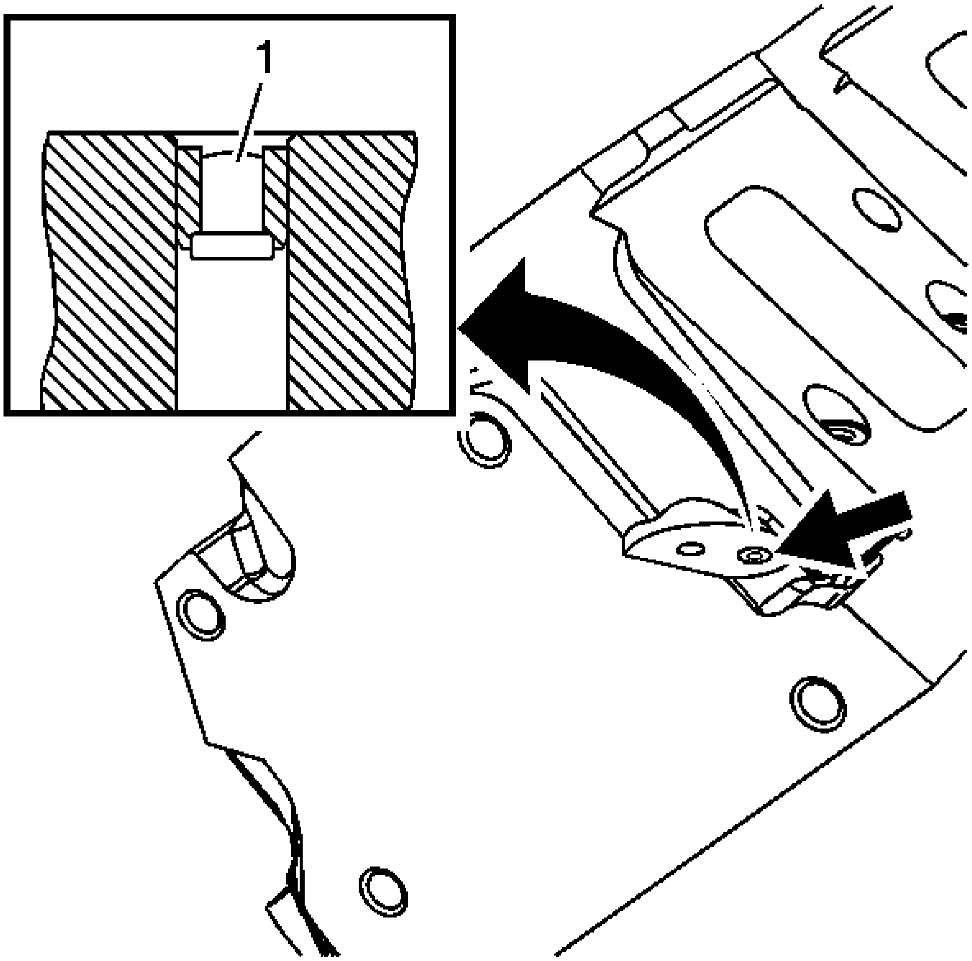


Fig. 184: Rivet-Type Plug
Courtesy of GENERAL MOTORS CORP.

15. Second design applications use a rivet-type plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to **Cylinder Head Disassemble**.

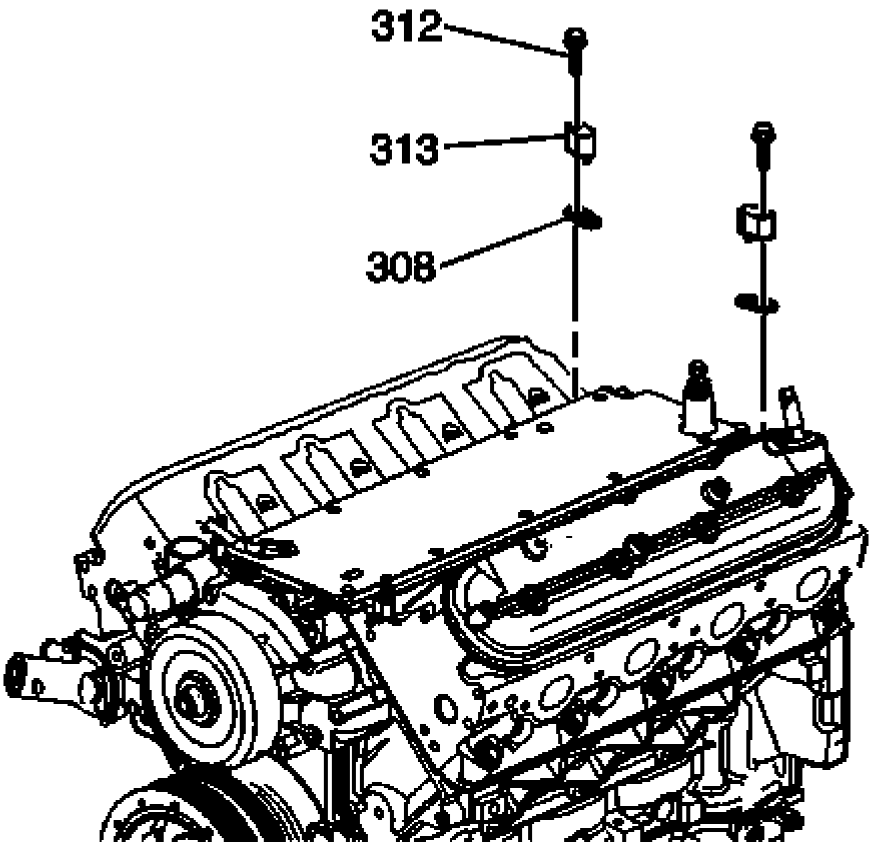


Fig. 185: Engine Coolant Air Bleed Cover, Bolts & Seals
Courtesy of GENERAL MOTORS CORP.

16. If plug removal is required, install a first design coolant air bleed cover and bolt to complete the repair.

OIL PUMP DISASSEMBLE

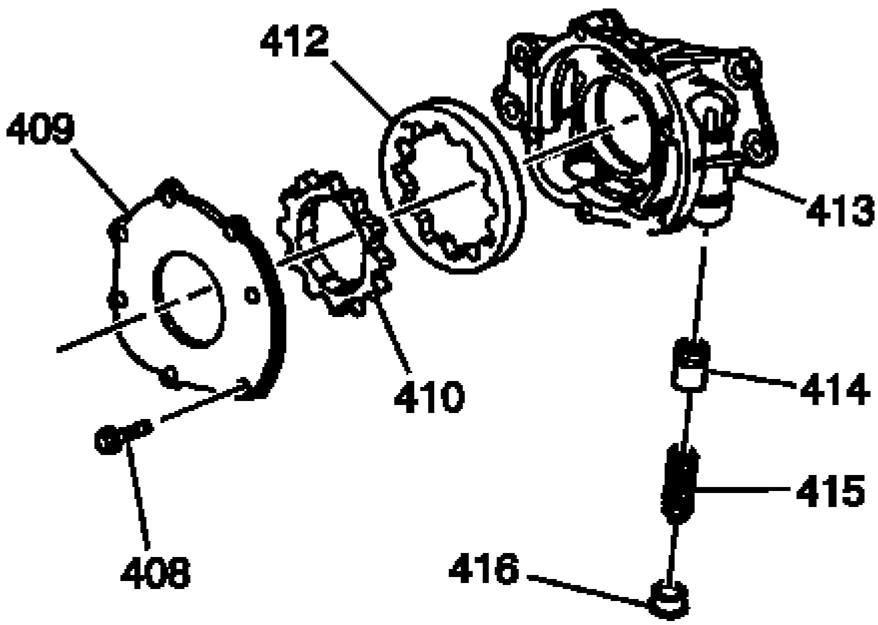


Fig. 186: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

IMPORTANT: Mark or identify the gears for assembly. Refer to Separating Parts .

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to **Oil Pump Cleaning and Inspection**.

OIL PUMP CLEANING AND INSPECTION

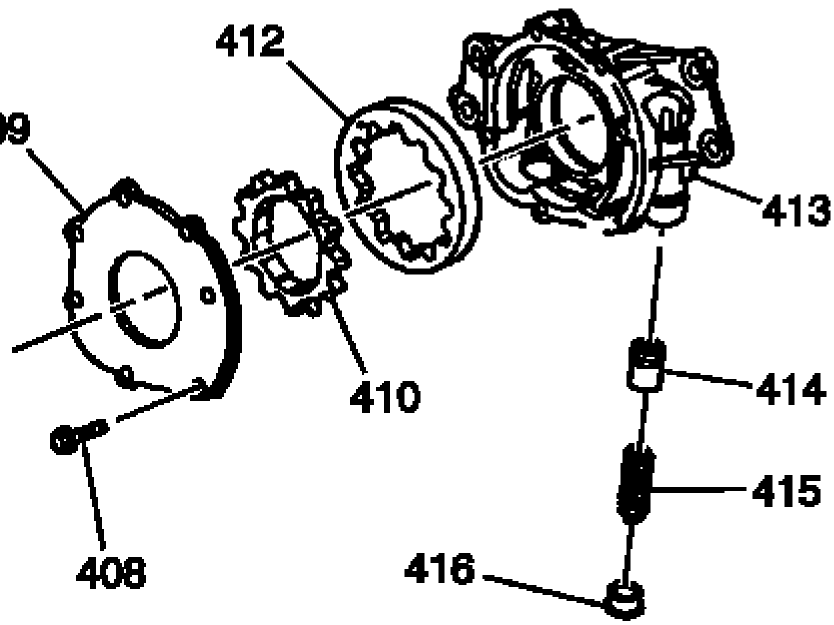


Fig. 187: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.**
- **The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.**

1. Clean the parts in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.

5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

   Minor burrs or imperfections on the gears may be removed with a fine oil stone.

9. Inspect the drive gear splines for excessive wear.
10. Inspect the pressure relief valve (414) and bore for scoring or wear.

    The valve must move freely in the bore, with no restrictions.

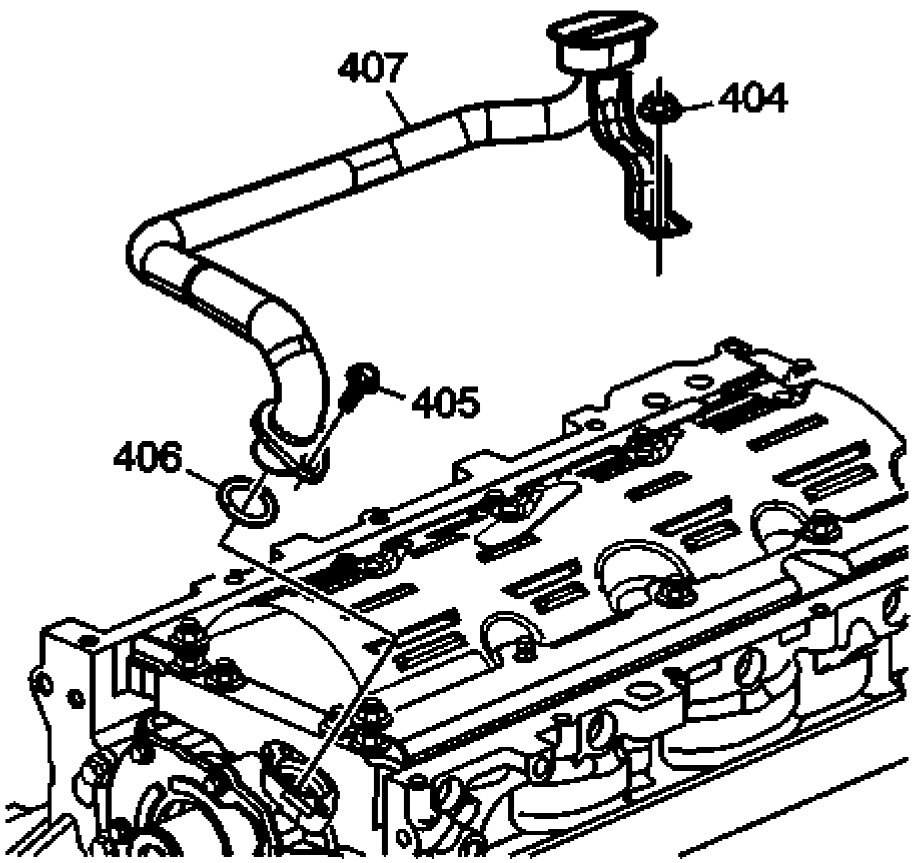


Fig. 188: Oil Pump Screen Bolt, Nut & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

11. Inspect the oil pump screen (407) for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

OIL PUMP ASSEMBLE

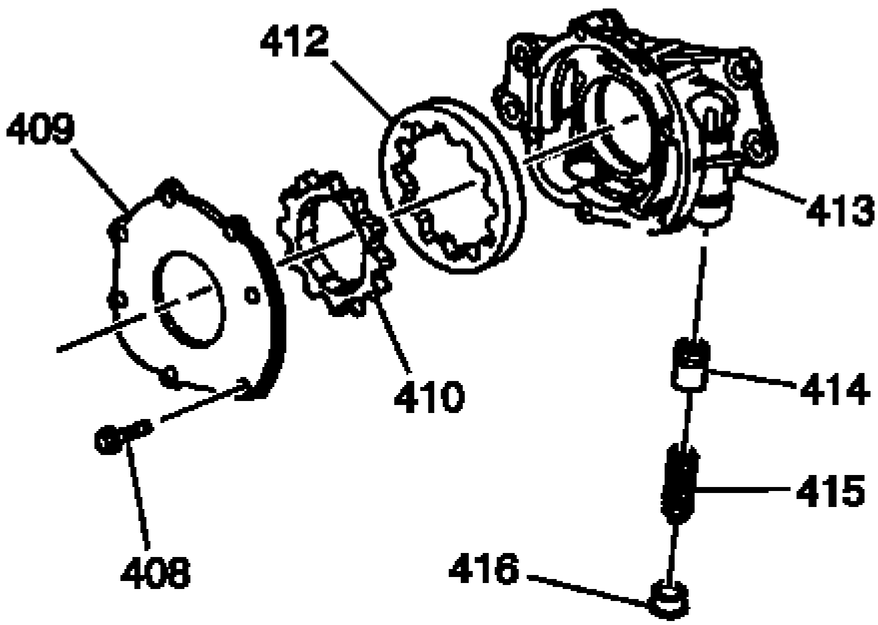


Fig. 189: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

NOTE: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).

   Install the driven gear with the orientation mark facing the pump cover.

2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).

   CAUTION: Refer to Fastener Caution .

4. Install the oil pump cover bolts (408) and tighten to 12 N.m (106 lb in).
5. Install the relief valve (414).
6. Install the relief valve spring (415).
7. Install the relief valve plug (416) and tighten to 12 N.m (106 lb in).

8. Inspect the oil pump for smooth operation by rotating the drive gear.

ENGINE FRONT COVER CLEANING AND INSPECTION

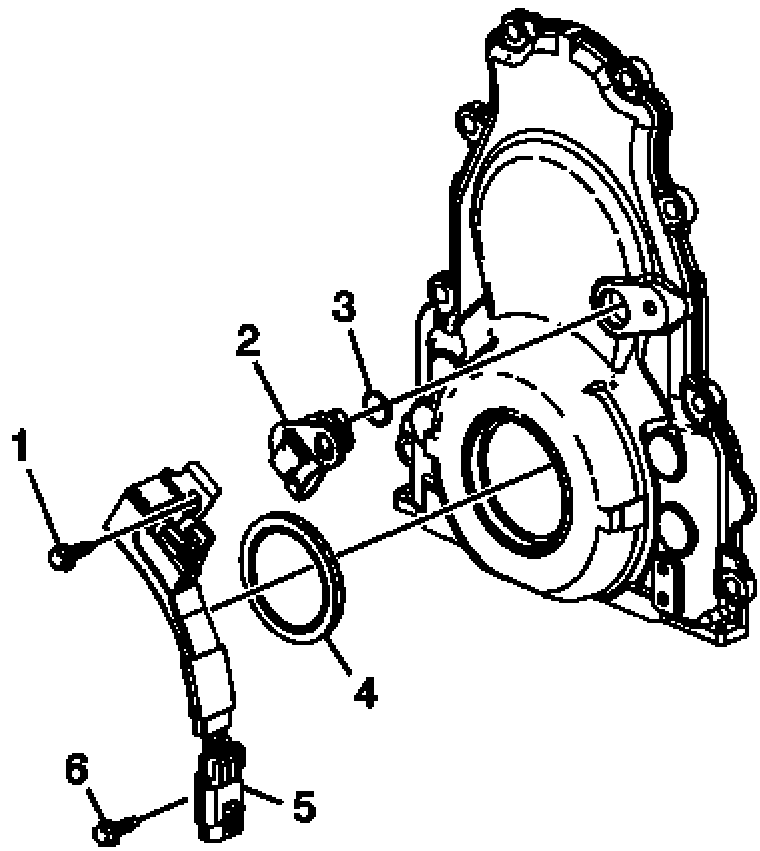


Fig. 190: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Remove the crankshaft oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the cover with compressed air.

4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

CRANKSHAFT REAR OIL SEAL HOUSING CLEANING AND INSPECTION

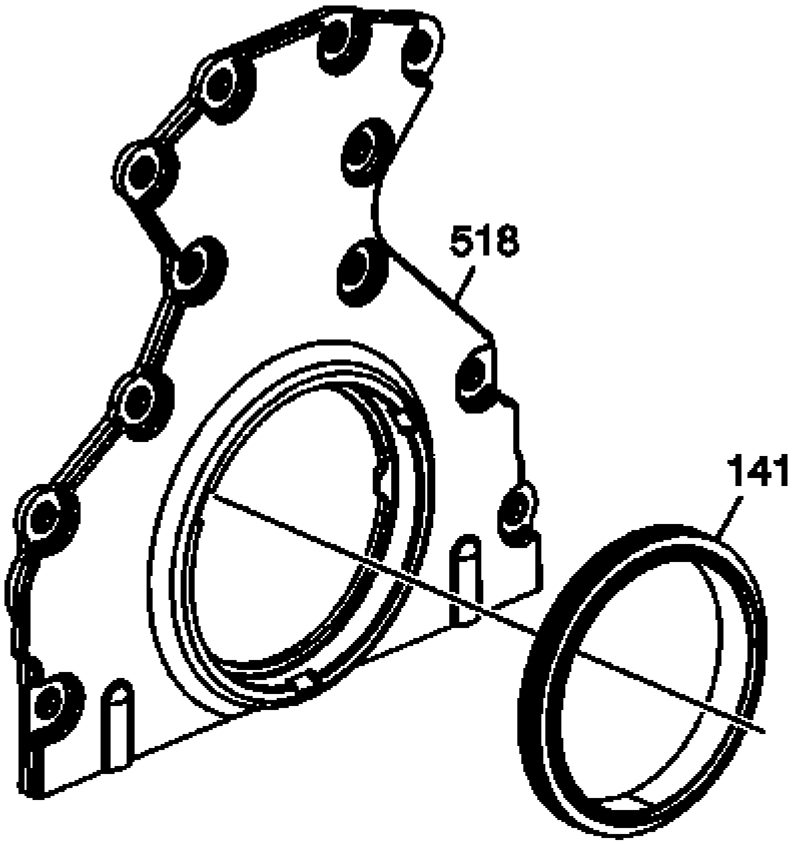


Fig. 191: Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Remove the crankshaft oil seal (141) from the rear housing.
2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

ENGINE BLOCK VALLEY COVER CLEANING AND INSPECTION

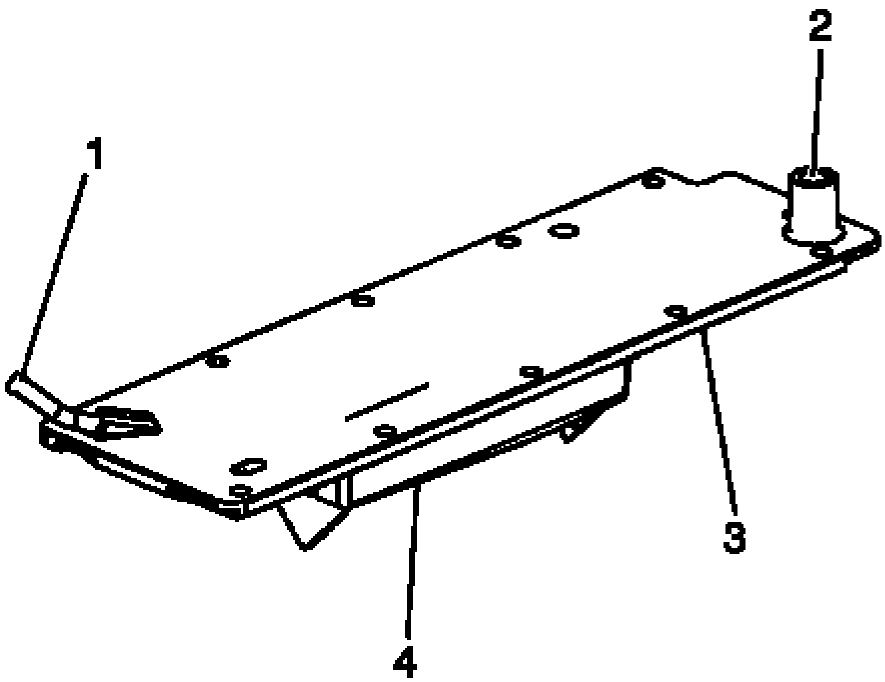


Fig. 192: PCV Passages, Damaged Threads & Damaged Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

1. Clean the valley cover in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry with compressed air.
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).
4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

VALVE LIFTER OIL MANIFOLD CLEANING AND INSPECTION

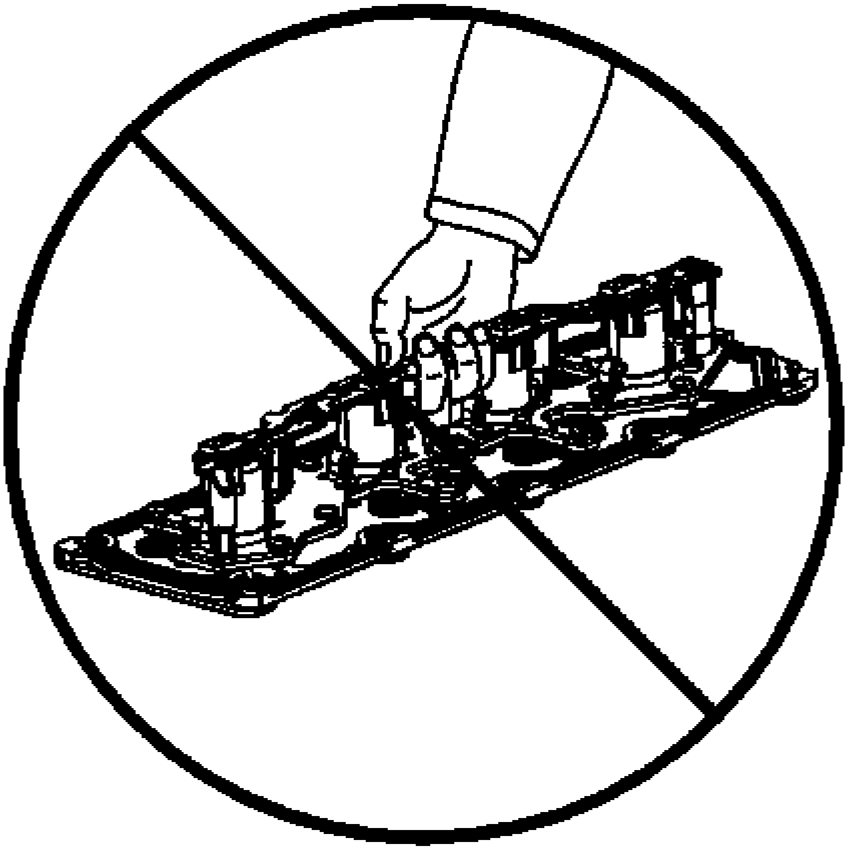


Fig. 193: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.**
- **Do not disassemble the electrical components from the manifold.**
- **Do not submerge the electrical components in cleaning solvent.**
- **Do not use the manifold exterior gasket again. Remove the exterior gasket and install a NEW service gasket during assembly.**

1. Do not lift the manifold assembly by the electrical lead frame.

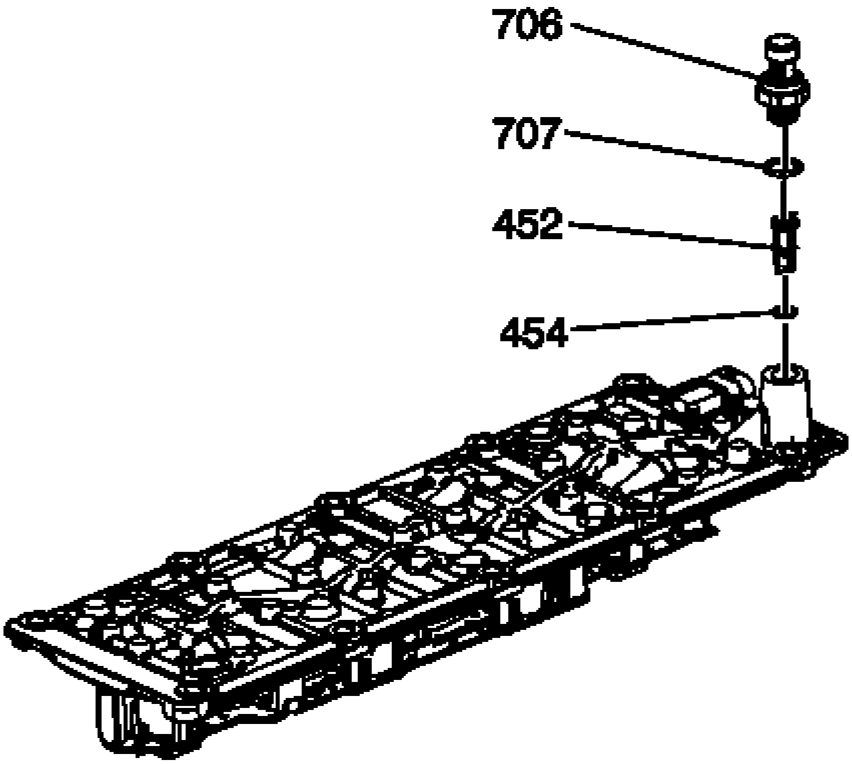


Fig. 194: View Of Oil Pressure Sensor, Washer And Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pressure sensor (706) and washer (707).
3. Remove the oil screen (452) with O-ring (454).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

4. Clean the manifold with compressed air.

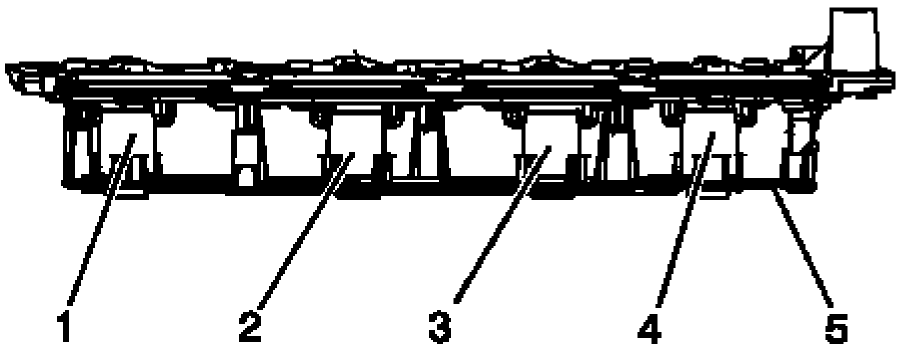


Fig. 195: Electrical Solenoids
Courtesy of GENERAL MOTORS CORP.

5. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
6. Inspect for damage to the electrical lead frame (5).
7. Inspect for a damaged electrical connector, for bent or corroded pins.

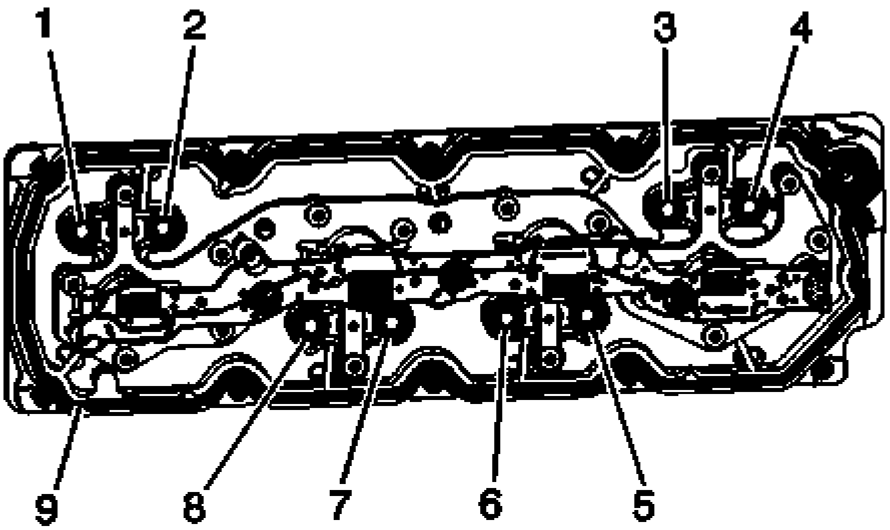


Fig. 196: Sealing Gaskets
Courtesy of GENERAL MOTORS CORP.

8. Inspect for damaged interior sealing gaskets (1-8). If the interior sealing gaskets are damaged, the manifold must be replaced as an assembly.
9. Inspect for a damaged exterior sealing gasket (9) or scored gasket surfaces.
10. Inspect for debris or restrictions within the oil passages of the manifold. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

2009 ENGINEEngine

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REPAIR INSTRUCTIONS - OFF VEHICLE

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

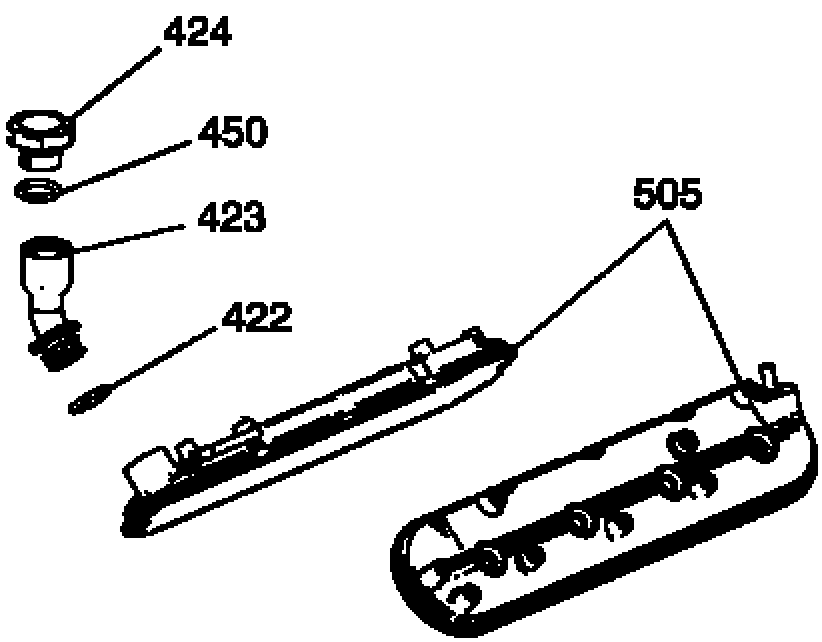


Fig. 1: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.**
- **Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.**
- **Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.**

1. Inspect the oil fill tube (423) for a loose fit or damage.

2. Inspect the covers (505) for the following conditions:
   - Scoring or damage to the gasket surfaces
   - Ventilation system passages for restrictions
   - Threaded bolt holes for damage or debris

OIL PAN CLEANING AND INSPECTION

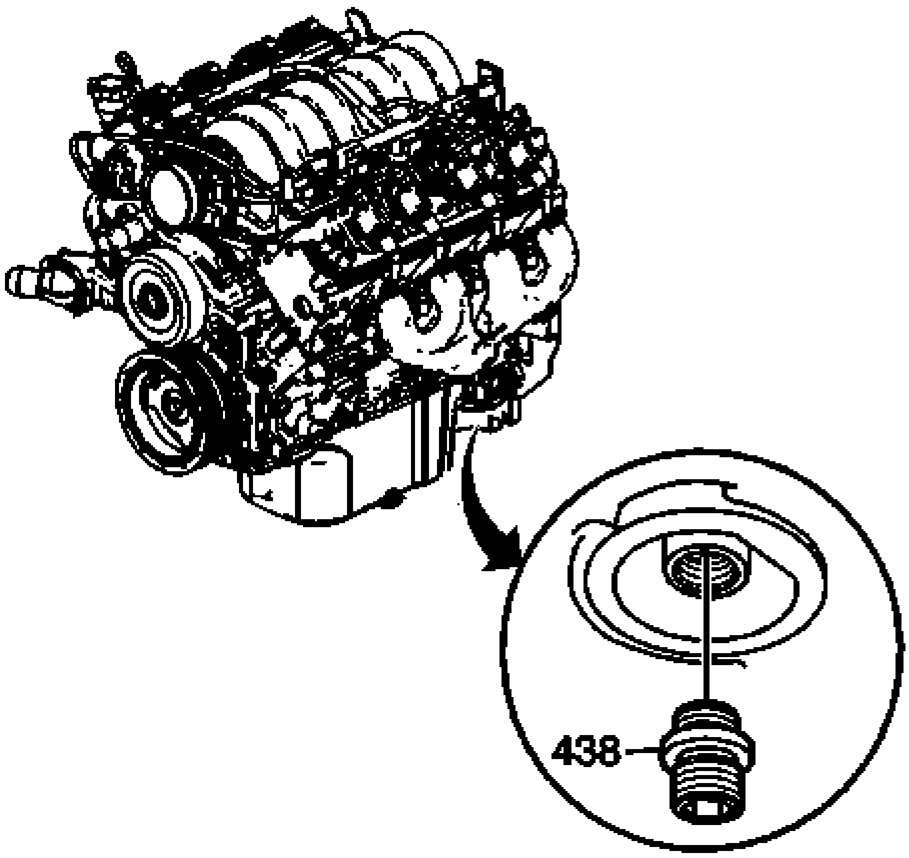


Fig. 2: Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter fitting (438) as required. Refer to **Oil Filter, Adapter, and Pan Cover Removal** .

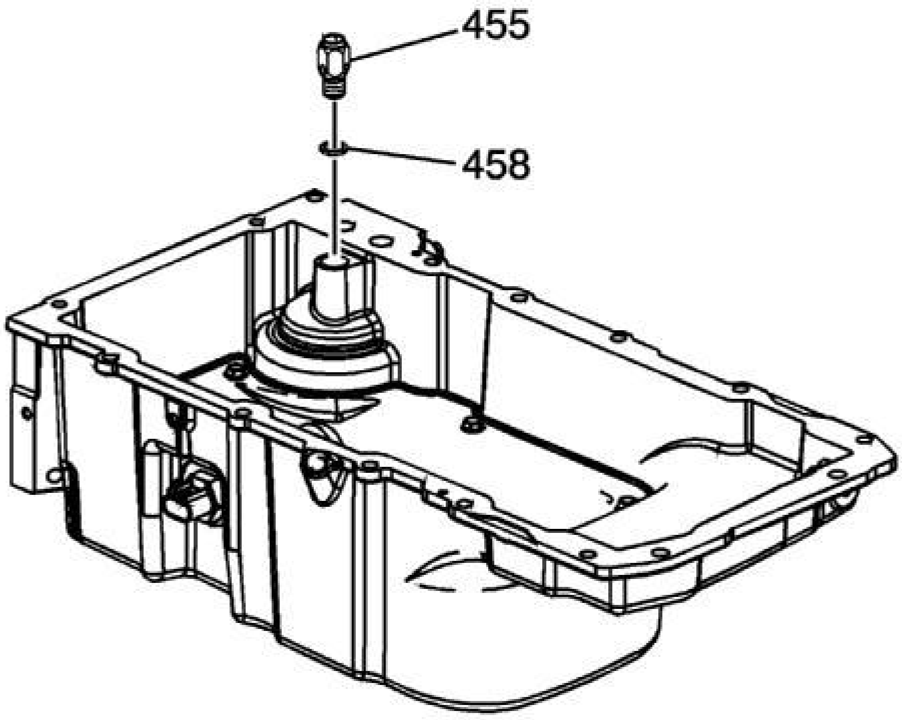


Fig. 3: Oil Pressure Relief Valve & Washer
Courtesy of GENERAL MOTORS CORP.

2. Remove the active fuel management oil pressure relief valve (455) and washer (458).

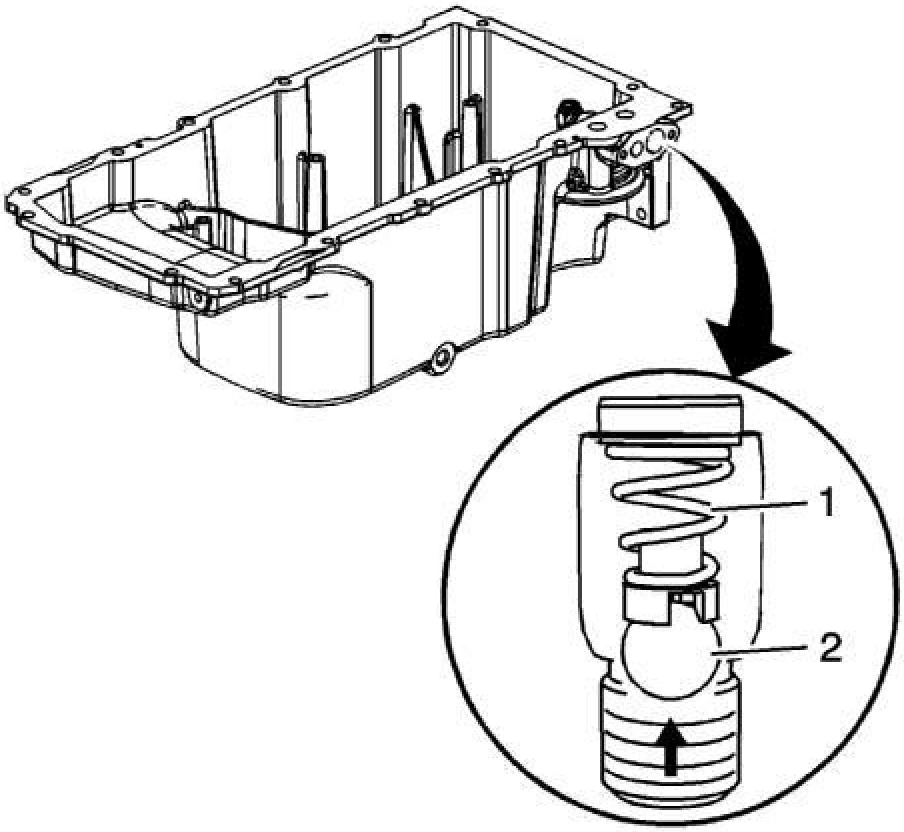


Fig. 4: Ball & Spring
Courtesy of GENERAL MOTORS CORP.

3. Inspect the active fuel management oil pressure relief valve for proper operation. Lightly depress the ball (2). The valve spring (1) should seat the ball to the proper closed position.

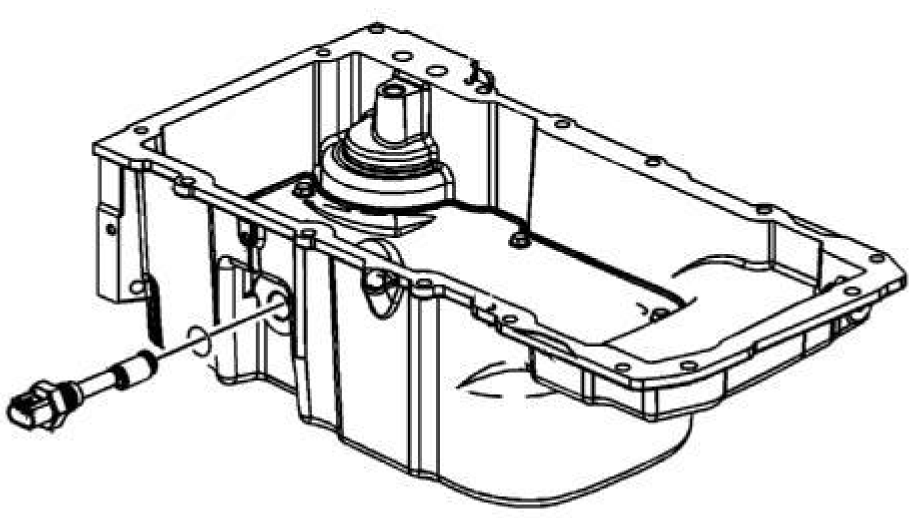


Fig. 5: Oil Level Sensor And O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor and O-ring.

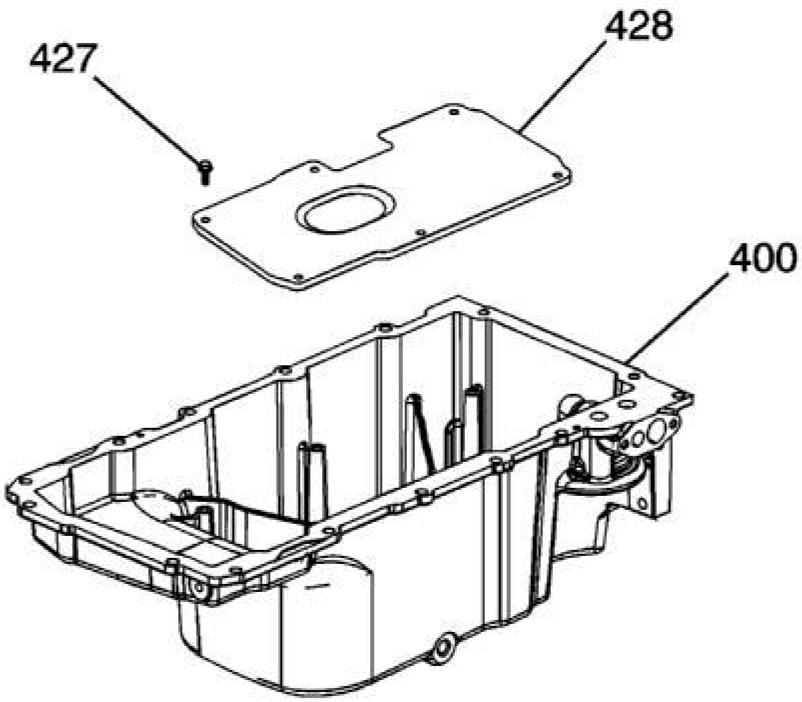


Fig. 6: Bolts And Baffle
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolts (427) and baffle (428).
6. Clean the oil pan in solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

7. Dry the oil pan with compressed air.

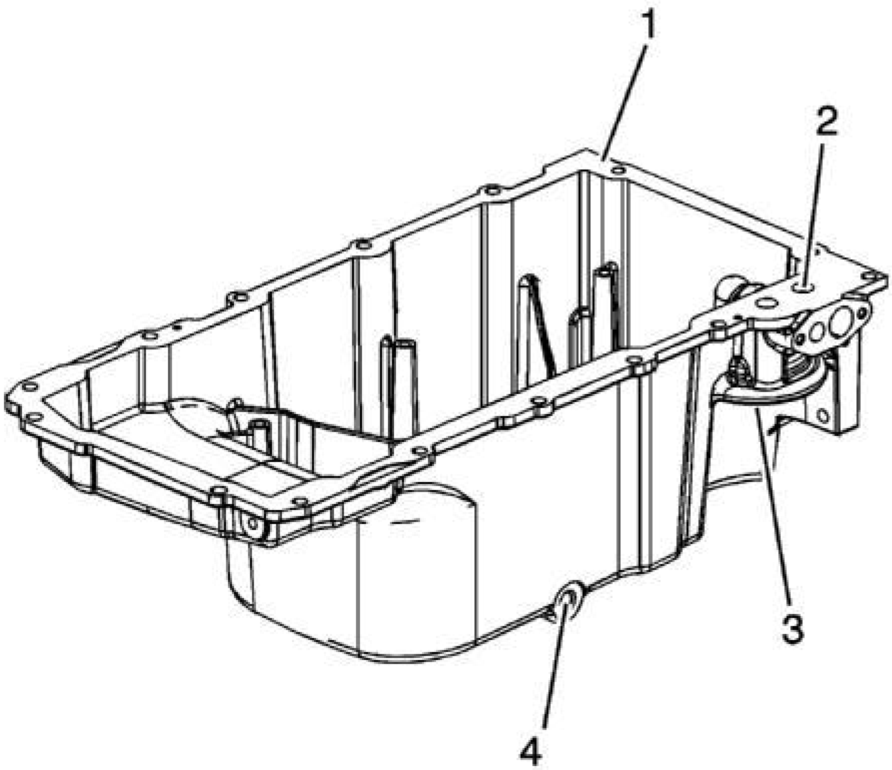


Fig. 7: Identifying Oil Pan Inspection Areas
Courtesy of GENERAL MOTORS CORP.

8. Inspect the oil pan for the following conditions:
   - Damaged gasket surfaces (1)
   - Restrictions within the oil passages (2) of the pan
   - Damaged oil filter seal surface (3)
   - Threaded bolt holes (4) for damage

INTAKE MANIFOLD CLEANING AND INSPECTION

Cleaning Procedure

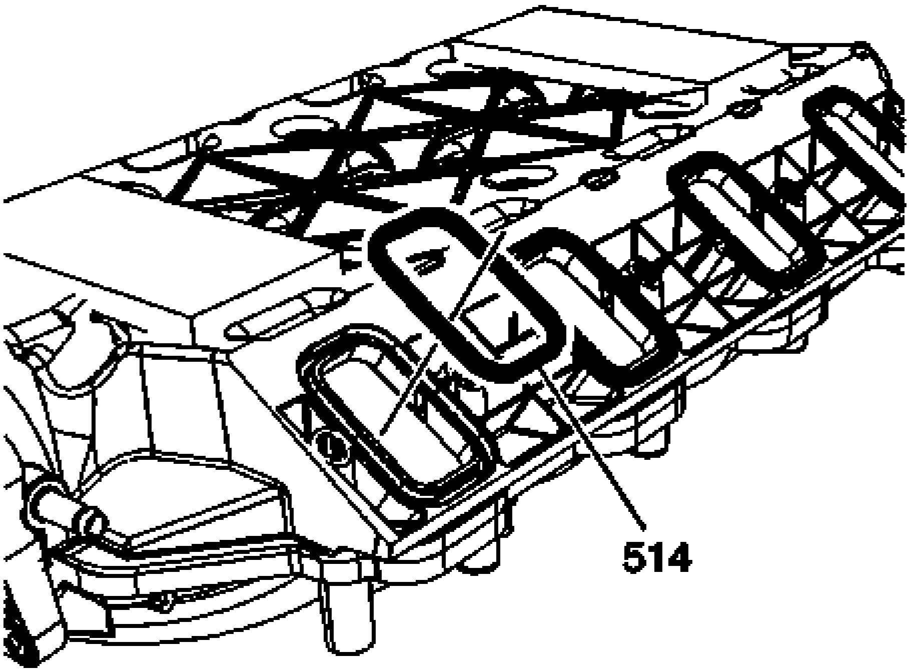


Fig. 8: Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove and discard the intake manifold-to-cylinder head gaskets (514).
2. Remove the manifold absolute pressure (MAP) sensor. Refer to **Intake Manifold Removal** .
3. Remove the evaporative emission (EVAP) canister purge solenoid valve, EVAP tubes, and fuel rail with injectors. Refer to **Fuel Rail and Injectors Removal** .
4. Remove the throttle body and gasket. Refer to **Throttle Body Removal** .
5. Clean the intake manifold in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

6. Dry the intake manifold with compressed air.

Inspection Procedure

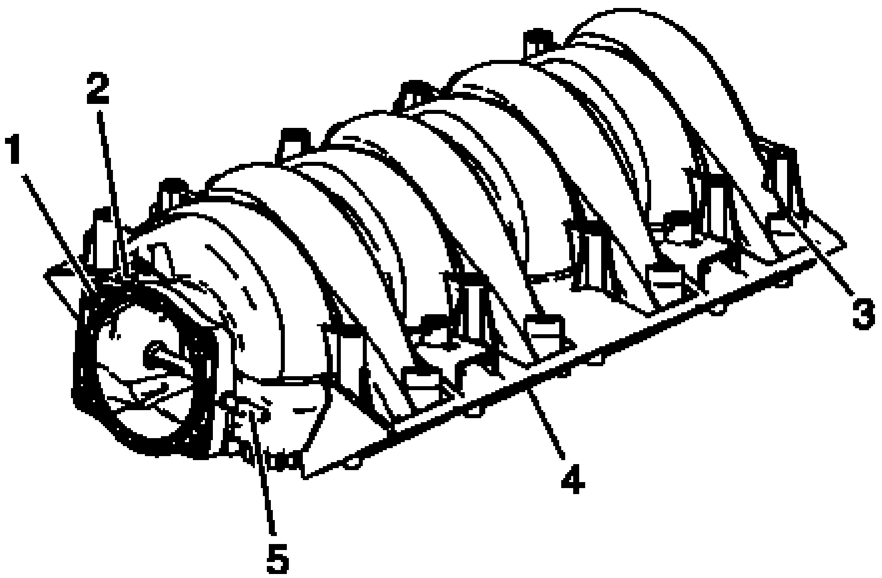


Fig. 9: Identifying Manifold Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Inspect the manifold for the following conditions:
   - Loose threaded inserts (1)
   - Damaged MAP sensor bore (2)
   - Damaged fuel injector bore (3)
   - Damaged gasket or sealing surfaces (4)
   - Damaged or broken vacuum fittings (5)
   - Debris or restrictions within the passages of the manifold
   - Inspect the composite intake manifold assembly for cracks or other damage.
2. Inspect the intake manifold cylinder head deck for warpage.
   1. Locate a straight edge across the intake manifold cylinder head deck surface.

      Position the straight edge across a minimum of two runner port openings.

   2. Insert a feeler gage between the intake manifold and the straight edge.

      An intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

EXHAUST MANIFOLD CLEANING AND INSPECTION

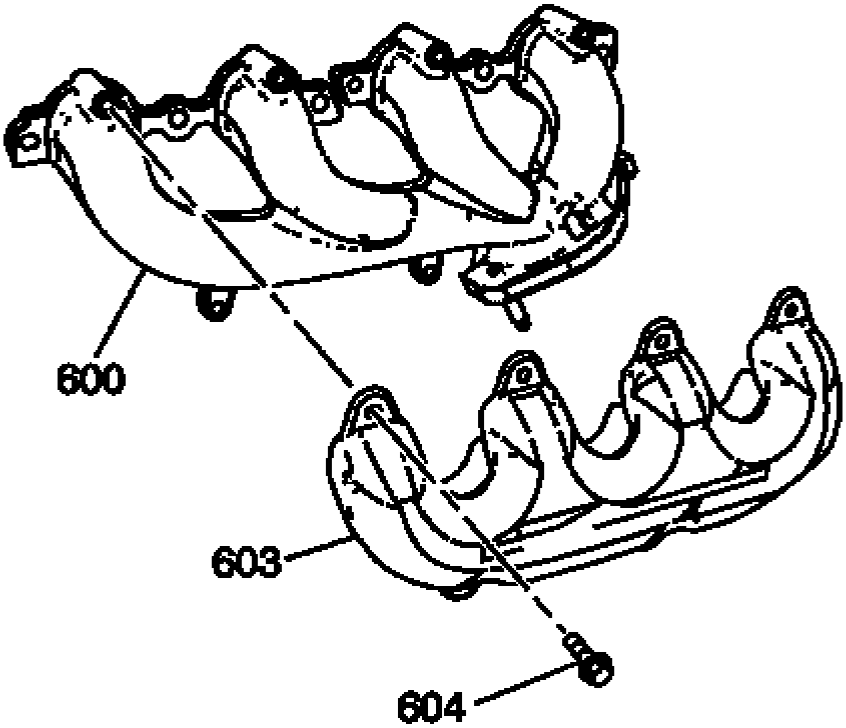


Fig. 10: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect on-board diagnostics (OBD) II system performance.**

1. Clean the exhaust manifold (600) and heat shield (603) in solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (603), or missing bolts (604).
5. Inspect the exhaust pipe studs for damaged threads.

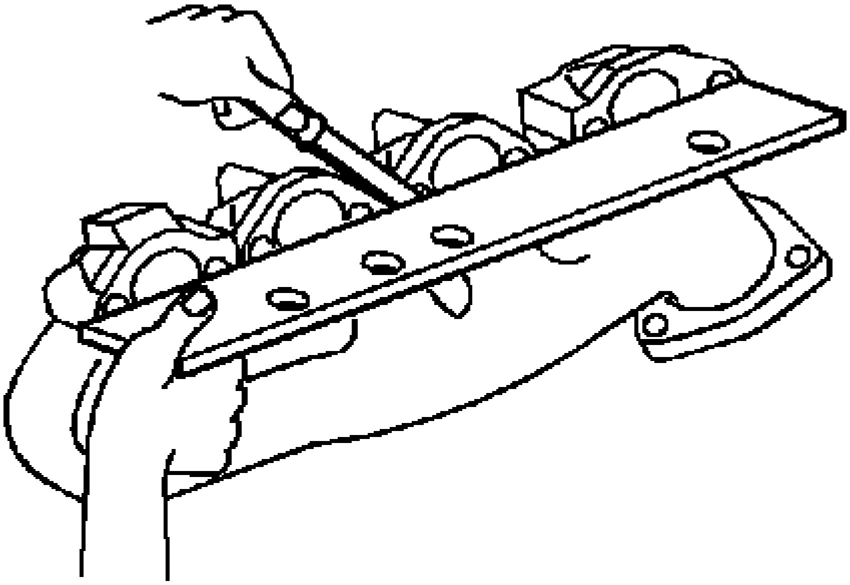


Fig. 11: Measuring Exhaust Manifold To Cylinder Head Surface For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Use a straight edge and a feeler gage and measure the exhaust manifold cylinder head deck for warpage.

   An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER CLEANING AND INSPECTION

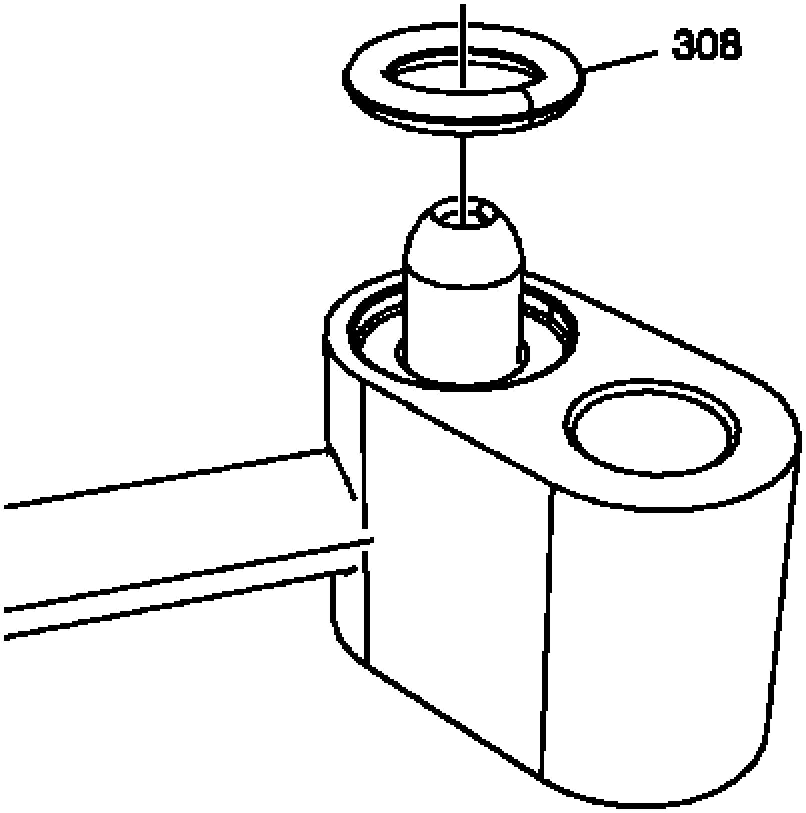


Fig. 12: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipe, install NEW seals.**

1. Remove the seals (308) from the pipe.

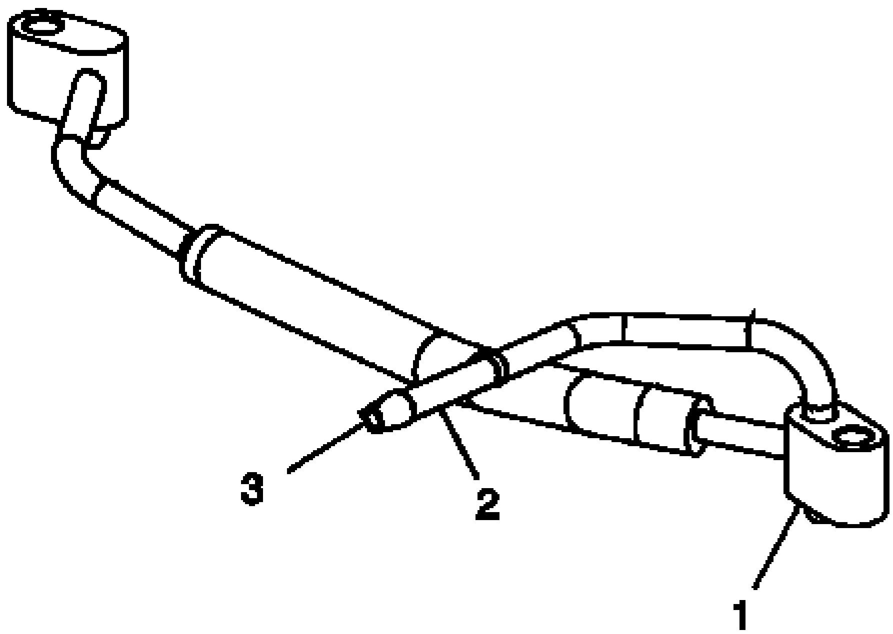


Fig. 13: Coolant Air Bleed Pipe
Courtesy of GENERAL MOTORS CORP.

2. Clean the pipe in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the pipe with compressed air.
4. Inspect the pipe for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

WATER PUMP CLEANING AND INSPECTION

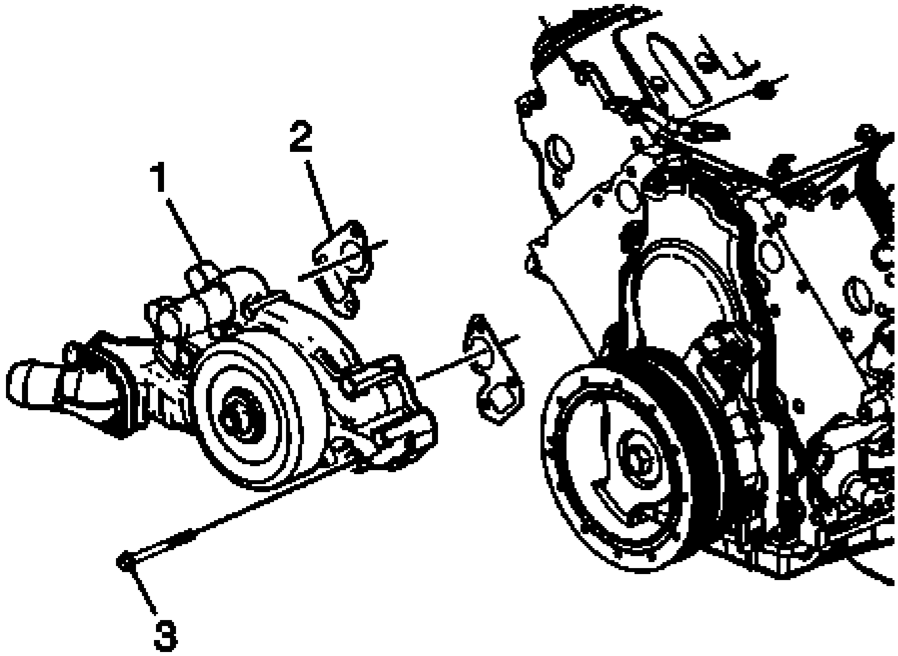


Fig. 14: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove the old gasket from the water pump sealing surfaces. Refer to **Replacing Engine Gaskets** .
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water inlet housing or rear cover gasket
   - Leakage at the water pump vent hole

     A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.

   - Wear or damage in the belt tracking area of the pulley

THREAD REPAIR

Special Tools

- **J 42385-100:** Head/Main Bolt Thread Repair Kit
- **J 42385-200:** Common Thread Repair Kit
- **J 42385-300:** Fixtures and Hardware Kit

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

General Thread Repair

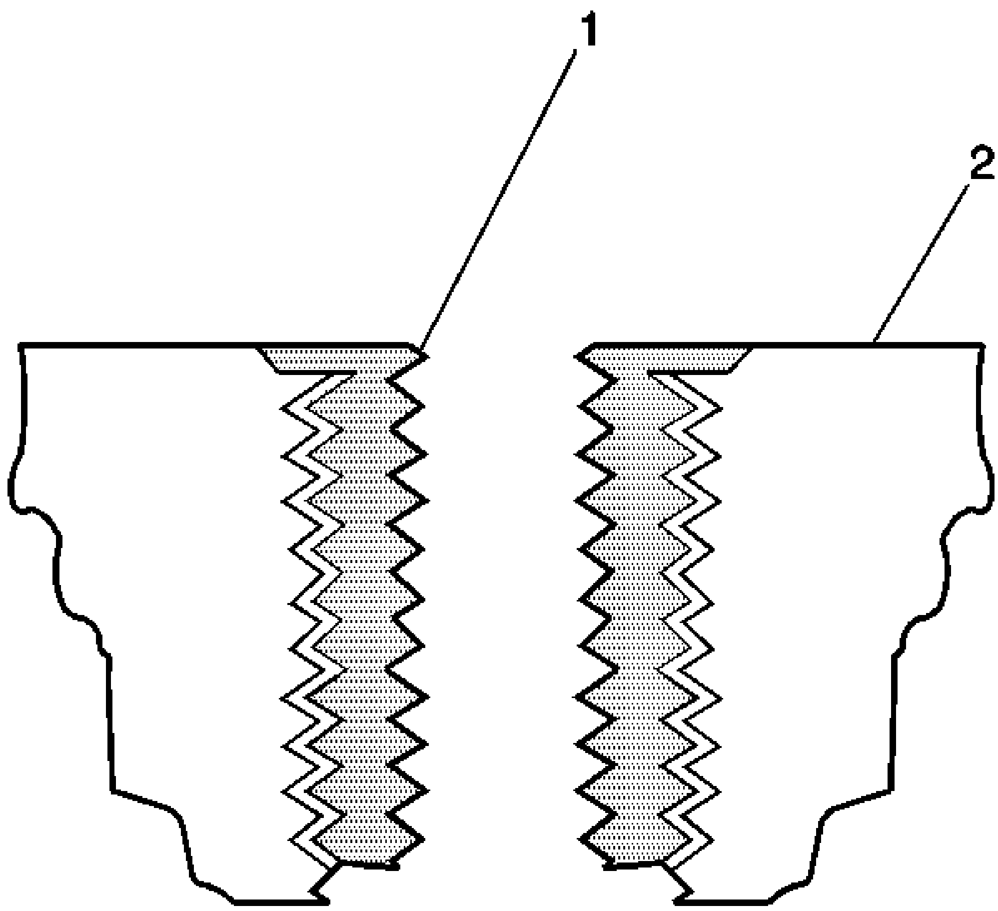


Fig. 15: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.

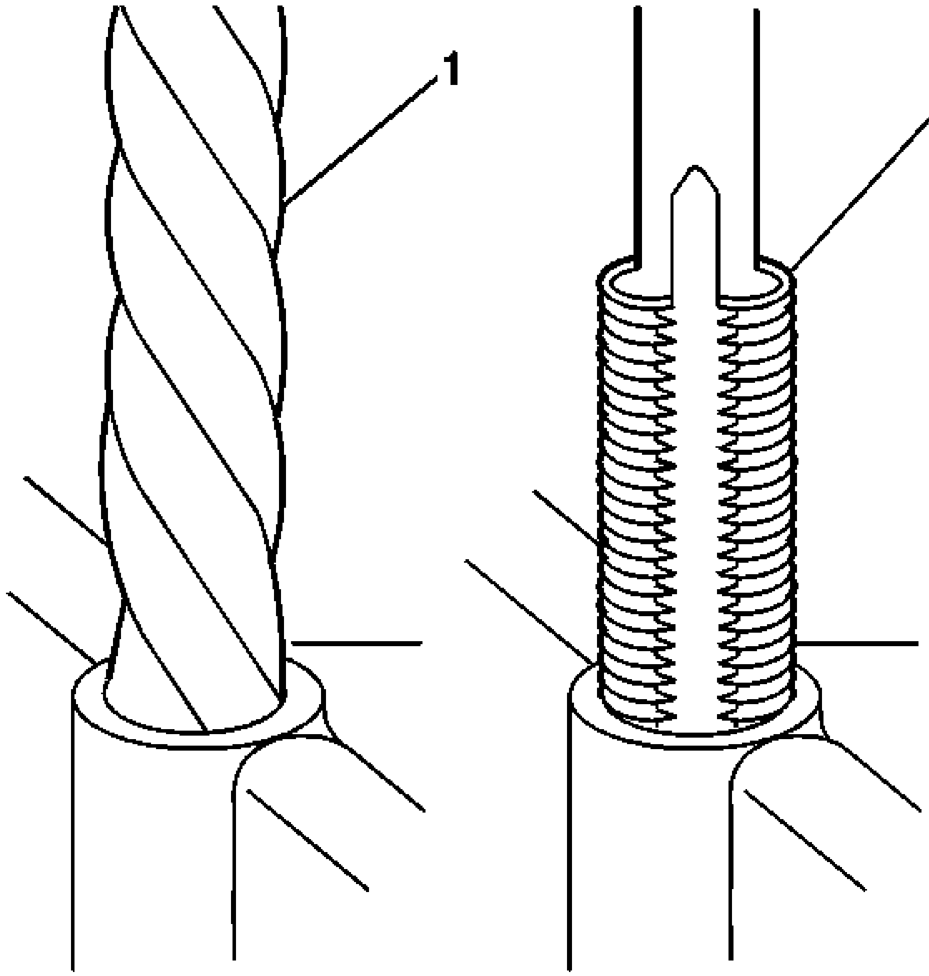


Fig. 16: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

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

NOTE:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

1. Drill out the threads of the damaged hole (1).
   - M6 inserts require a minimum drill depth of 15 mm (0.59 in).

- M8 inserts require a minimum drill depth of 20 mm (0.79 in).
- M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

2. Using compressed air, clean out any chips.

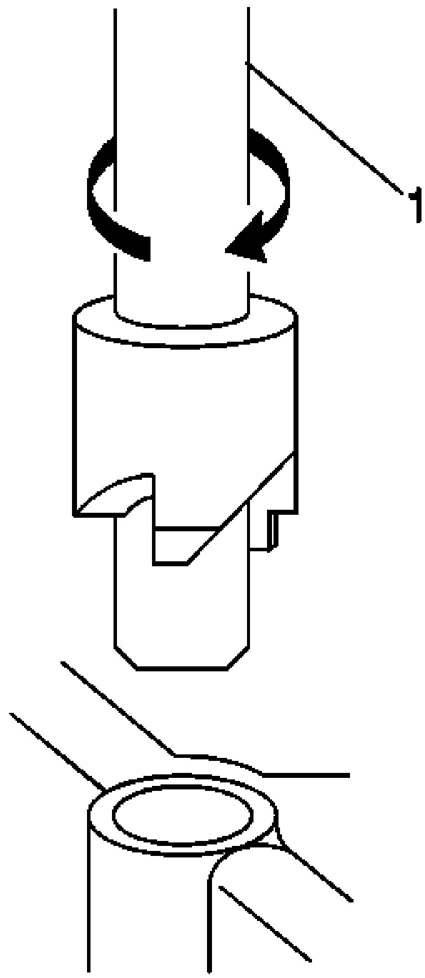


Fig. 17: View Of Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

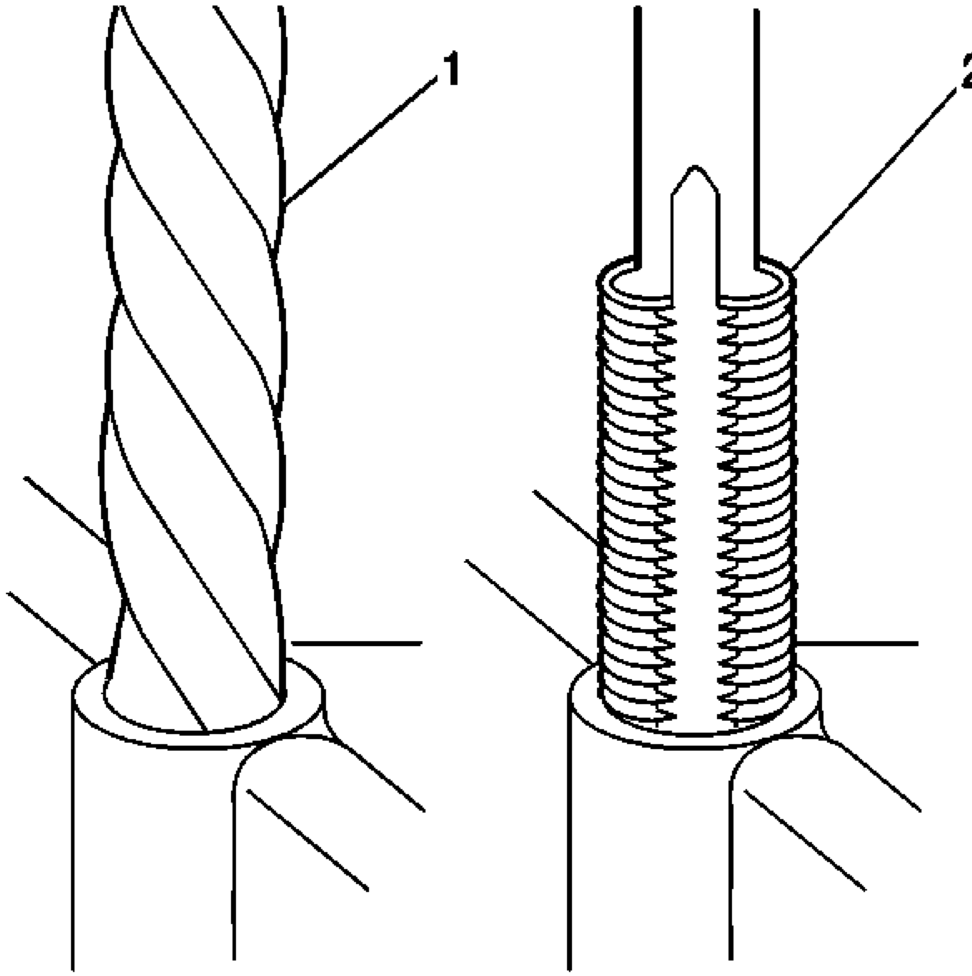


Fig. 18: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

5. Using a tap wrench (2), tap the threads of the drilled hole.
    - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
    - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
    - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

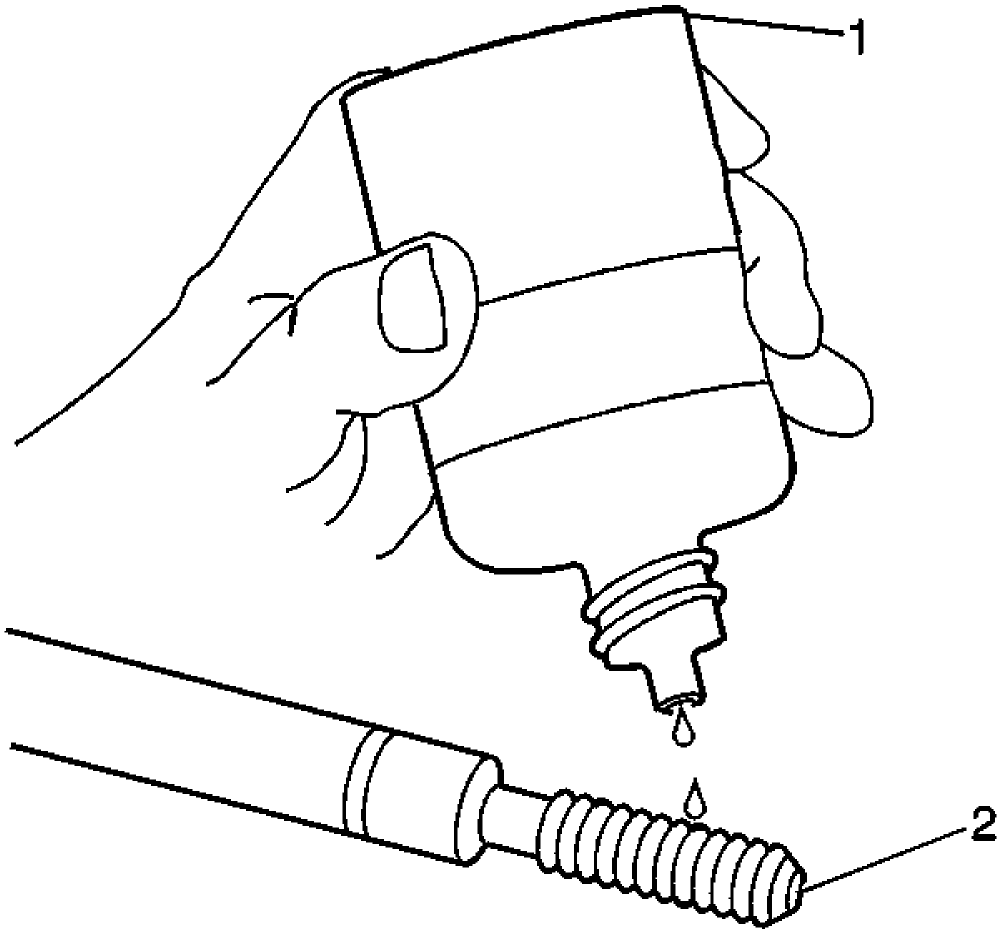


Fig. 19: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

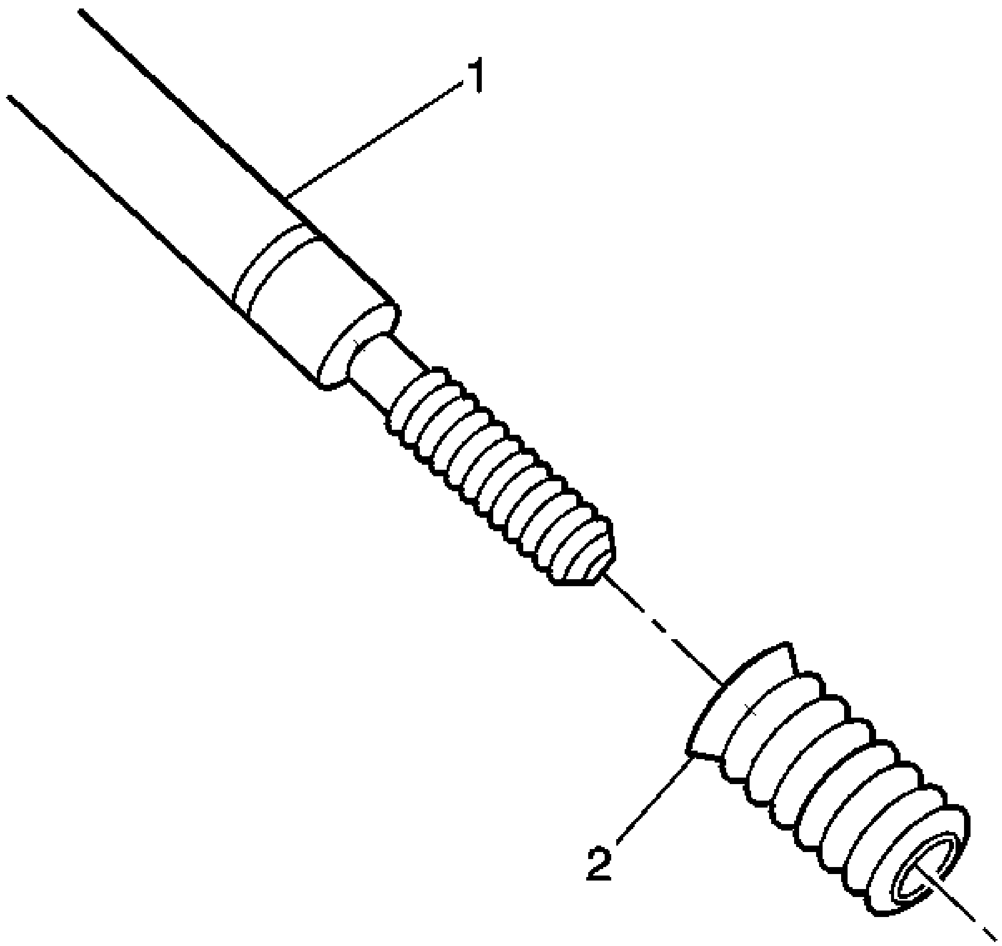


Fig. 20: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

10. Install the insert (2) onto the driver tool (1).

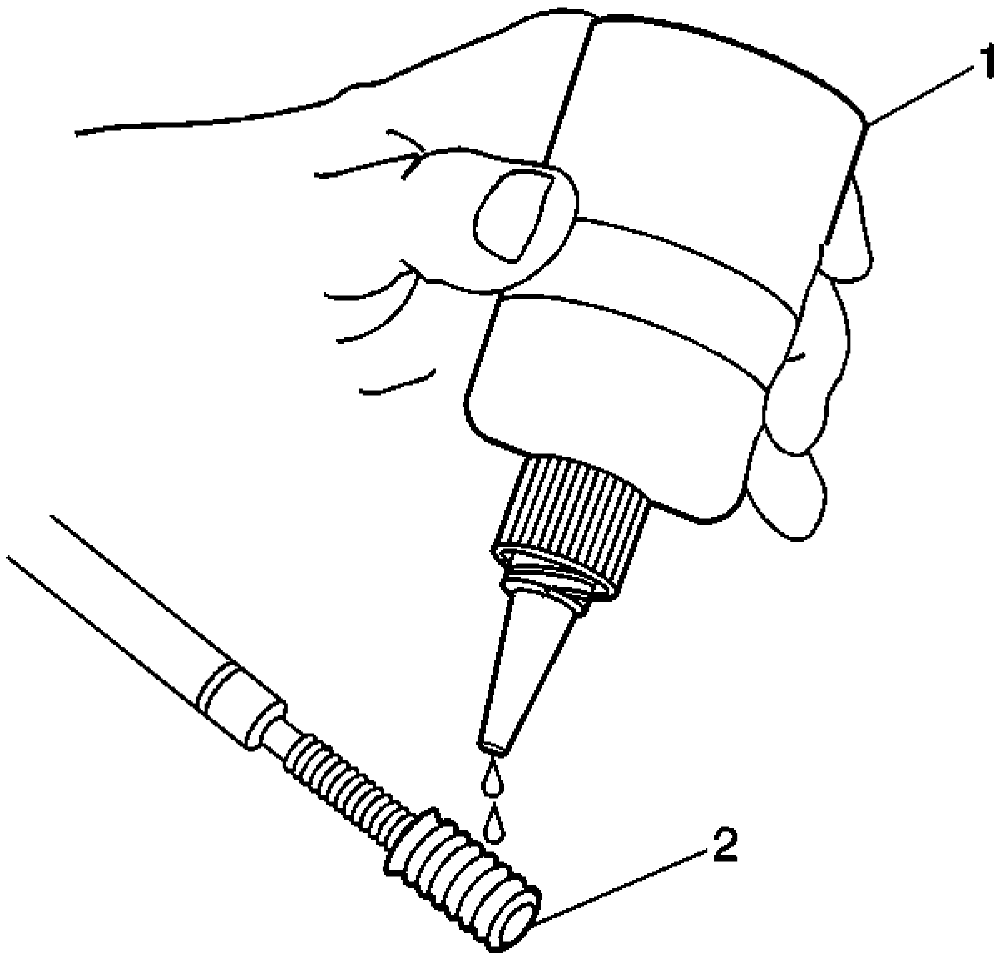


Fig. 21: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

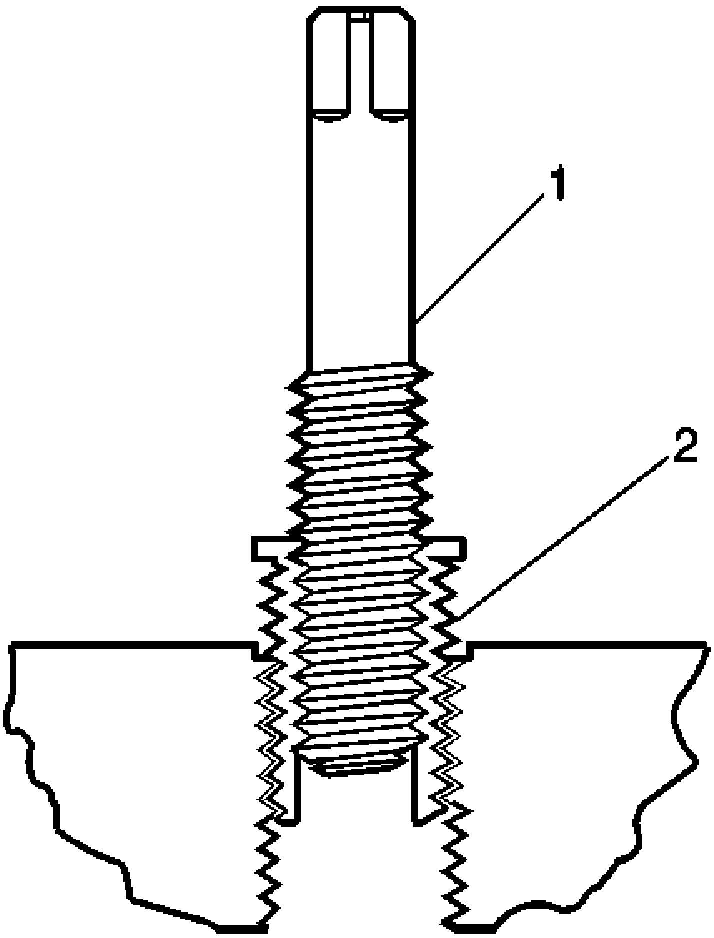


Fig. 22: Installing Insert Into Tapped Bolt Hole
Courtesy of GENERAL MOTORS CORP.

12. Install the insert (2) into the hole.

    Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

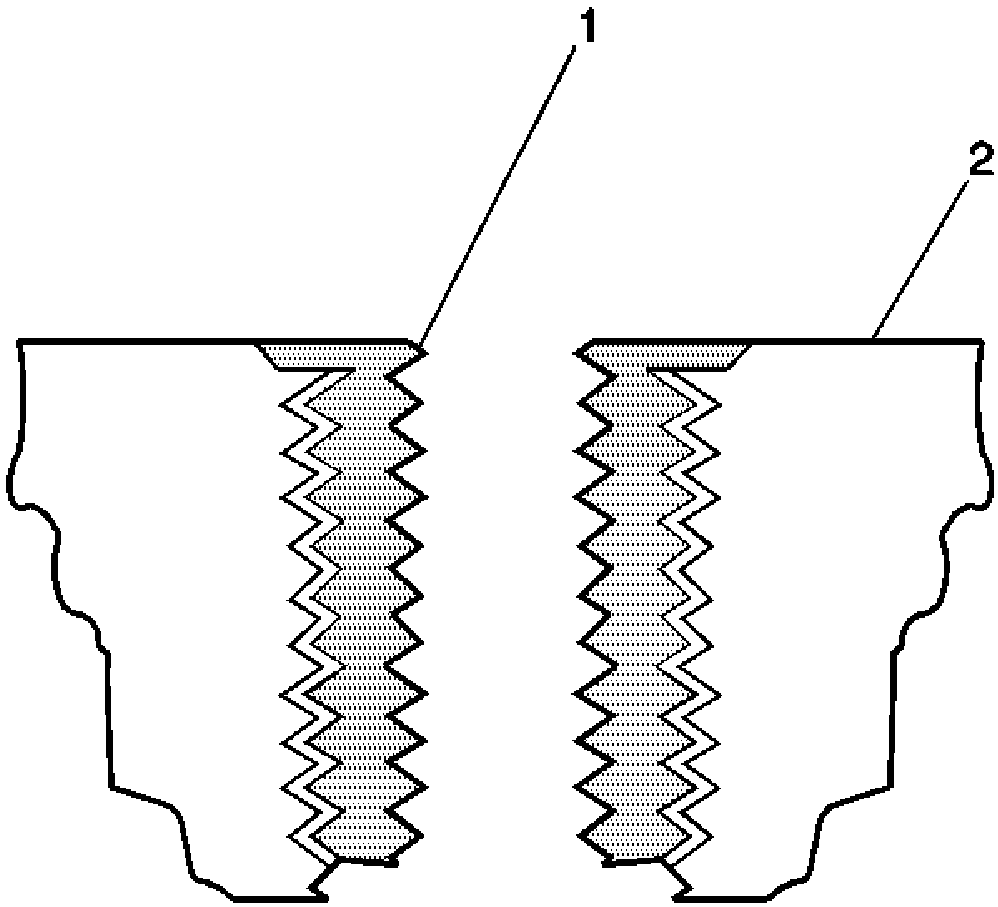


Fig. 23: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

13. Inspect the insert for proper installation into the hole.

    A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

Cylinder Head Bolt Hole Thread Repair

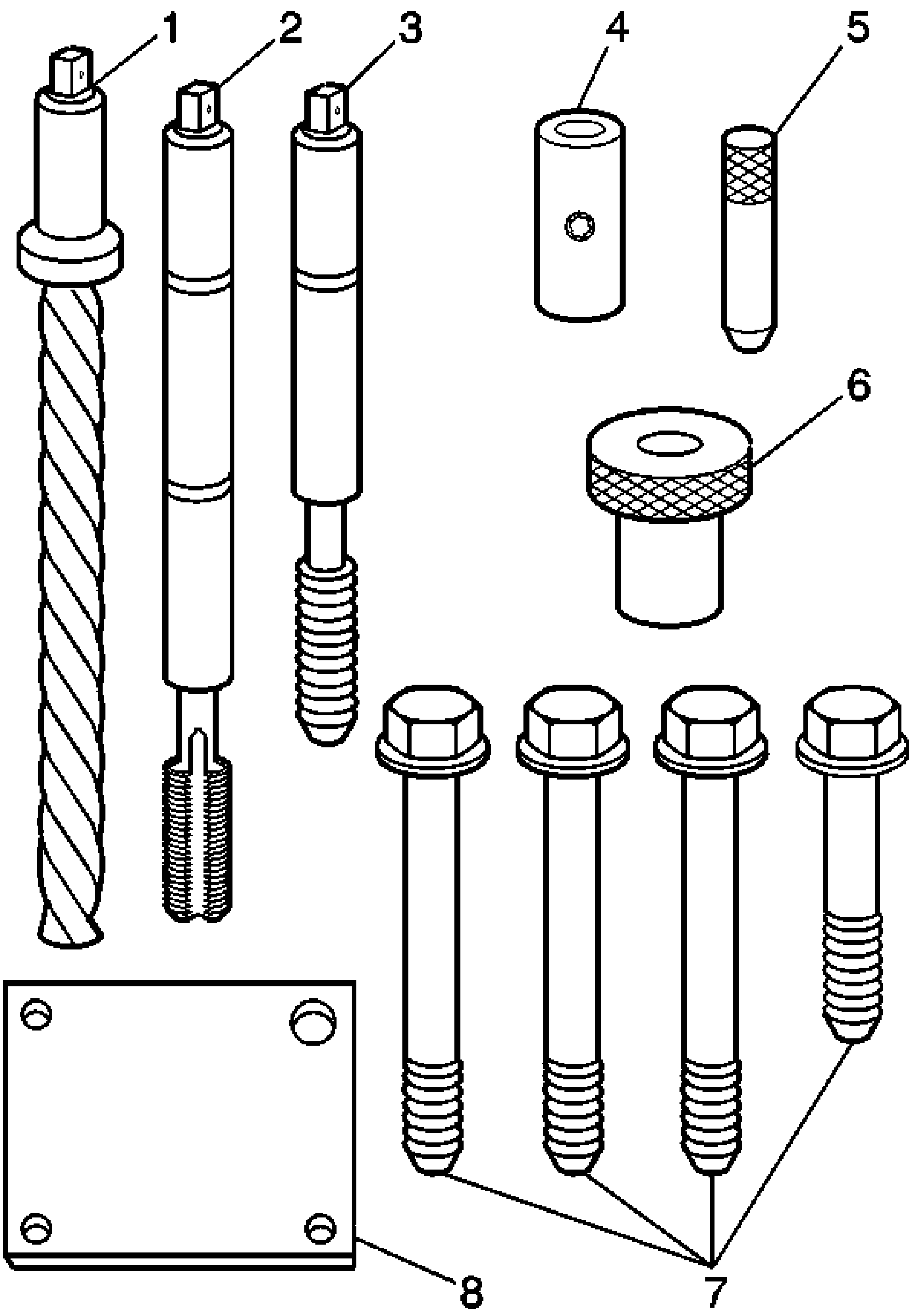


Fig. 24: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The cylinder head bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)
   - The sleeve (4)
   - The alignment pin (5)
   - The bushing (6)
   - The bolts (7)
   - The fixture plate (8)

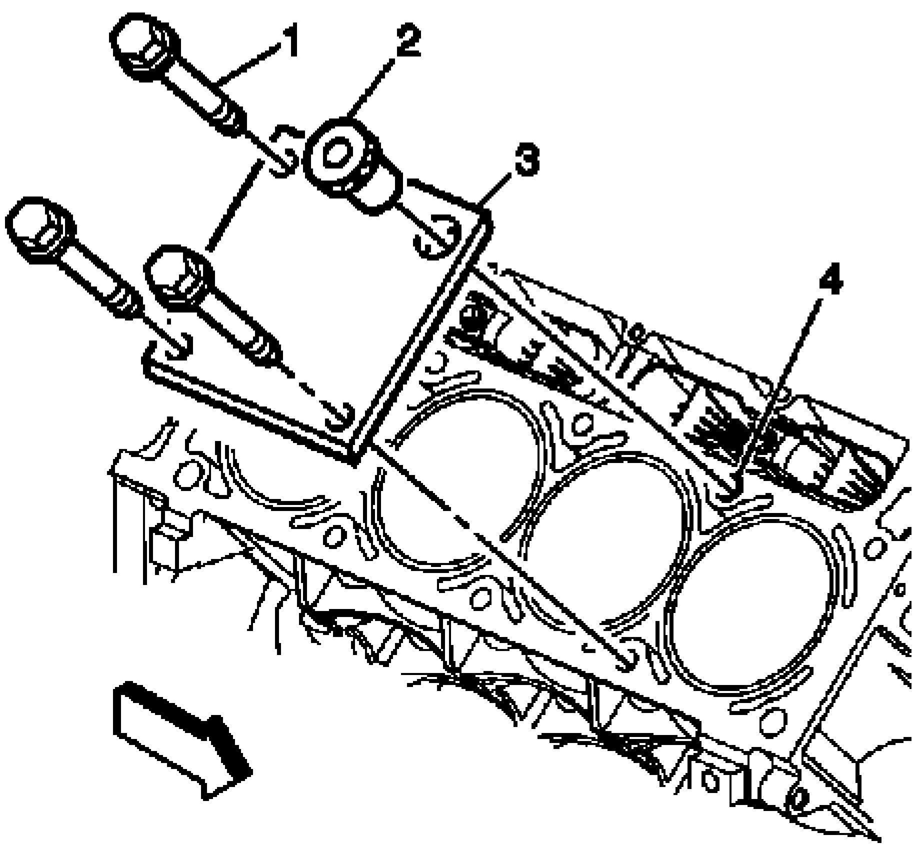


Fig. 25: View Of Fixture Plate, Bolts, Bushing & Cylinder Hole
Courtesy of GENERAL MOTORS CORP.

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

NOTE:
- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N**

992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.

- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

   Position the fixture plate and bushing over the hole that is to be repaired (4).

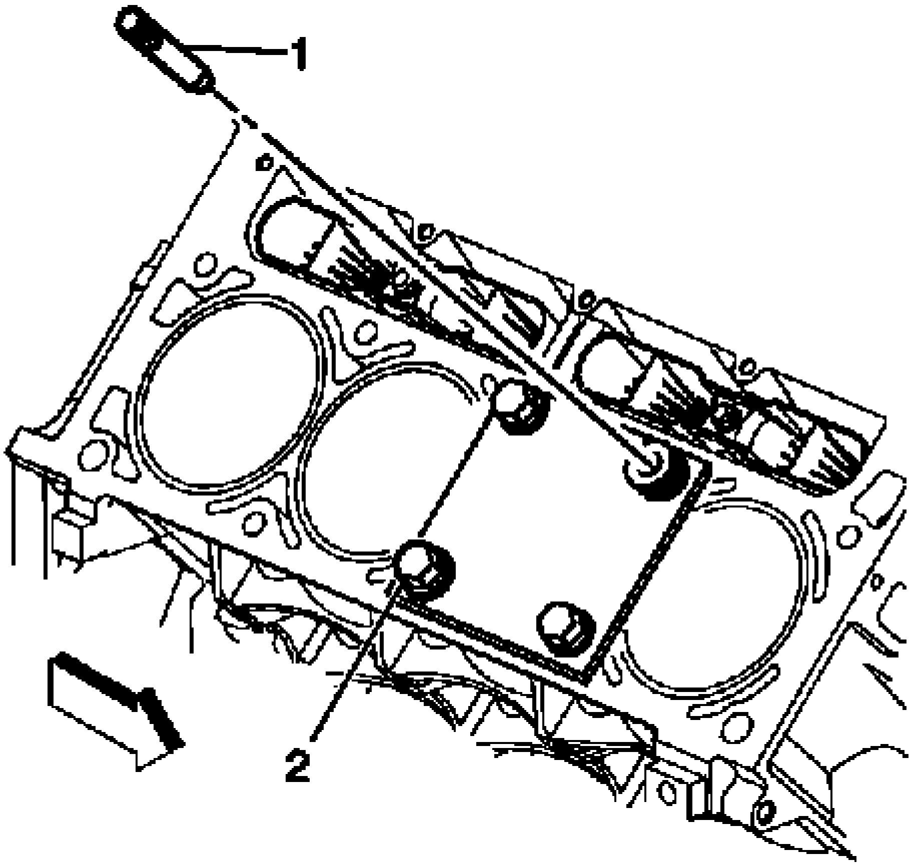


Fig. 26: View Of Alignment Pin & Fixture Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

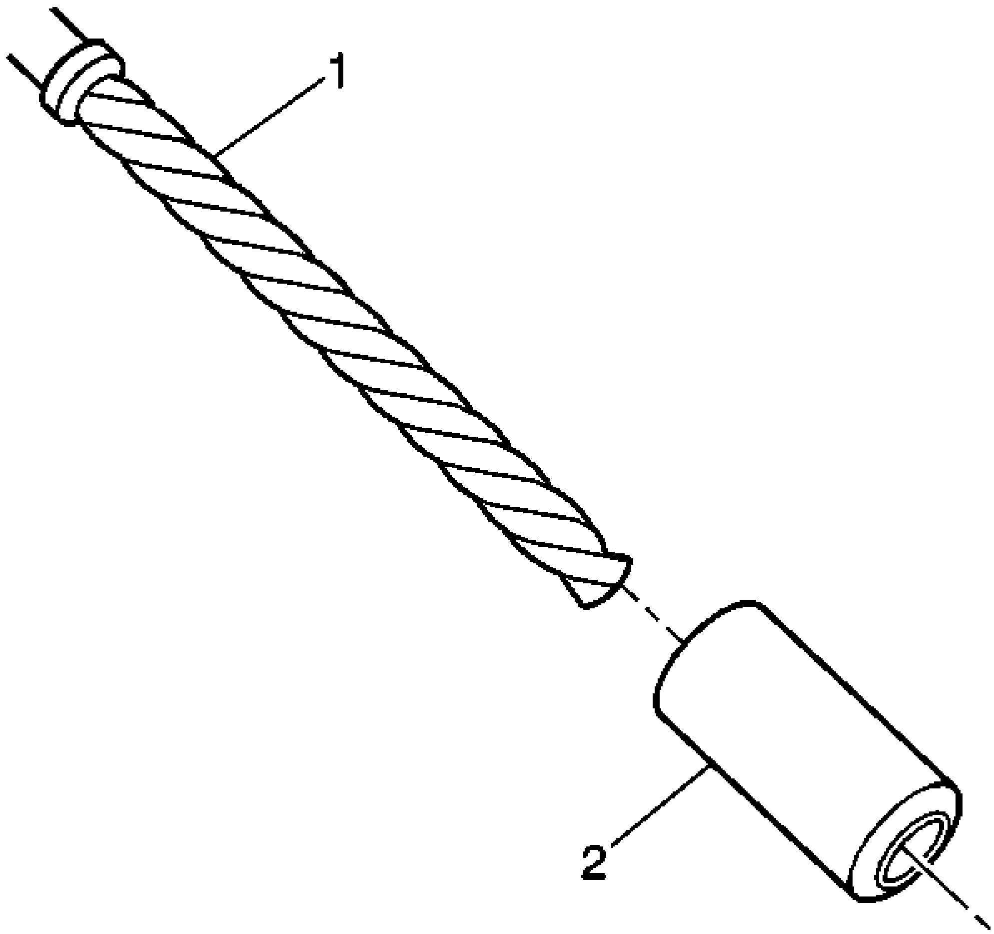


Fig. 27: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

6. Install the sleeve (2) onto the drill (1).

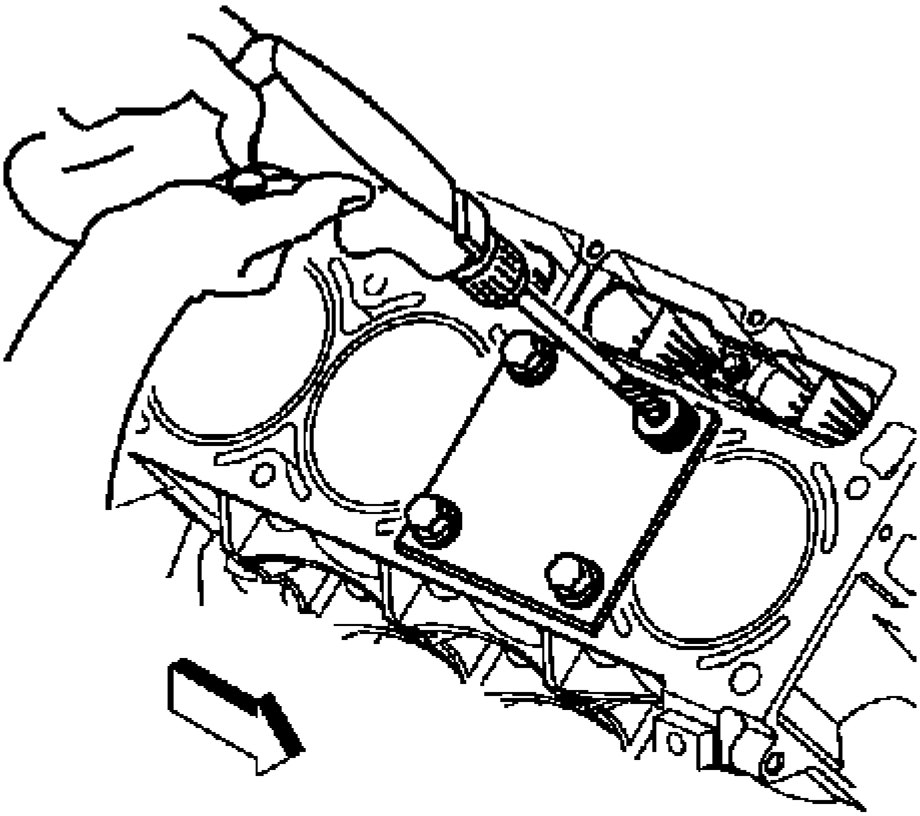


Fig. 28: Drilling Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

NOTE: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

   Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.

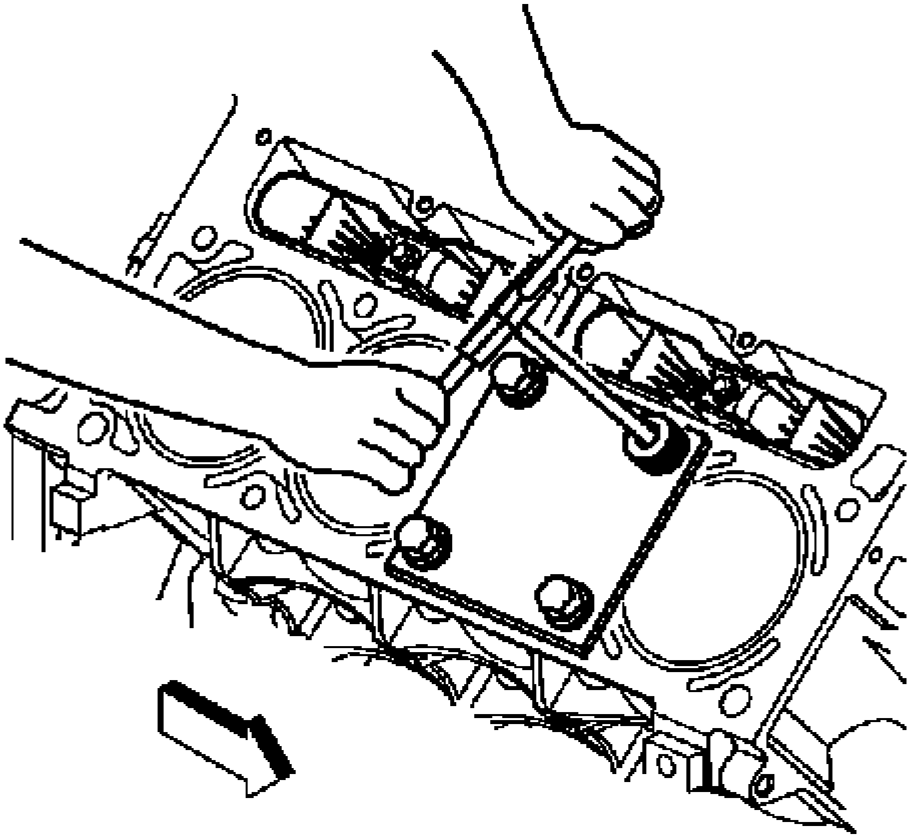


Fig. 29: Tapping Threads Of Drilled Hole Using Tapping Wrench
Courtesy of GENERAL MOTORS CORP.

9. Using a tap wrench, tap the threads of the drilled hole.

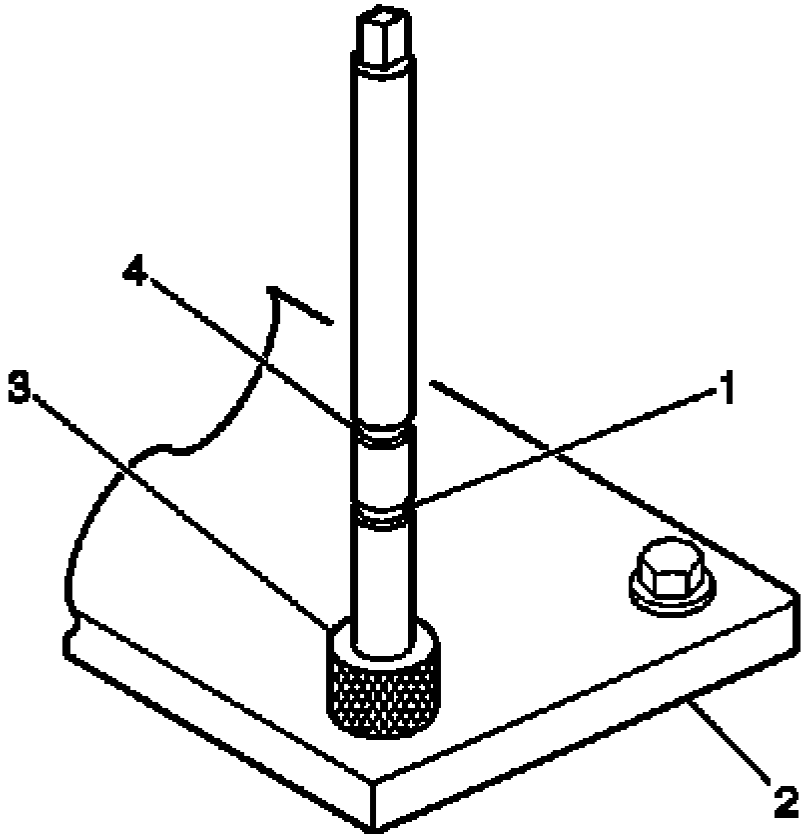


Fig. 30: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

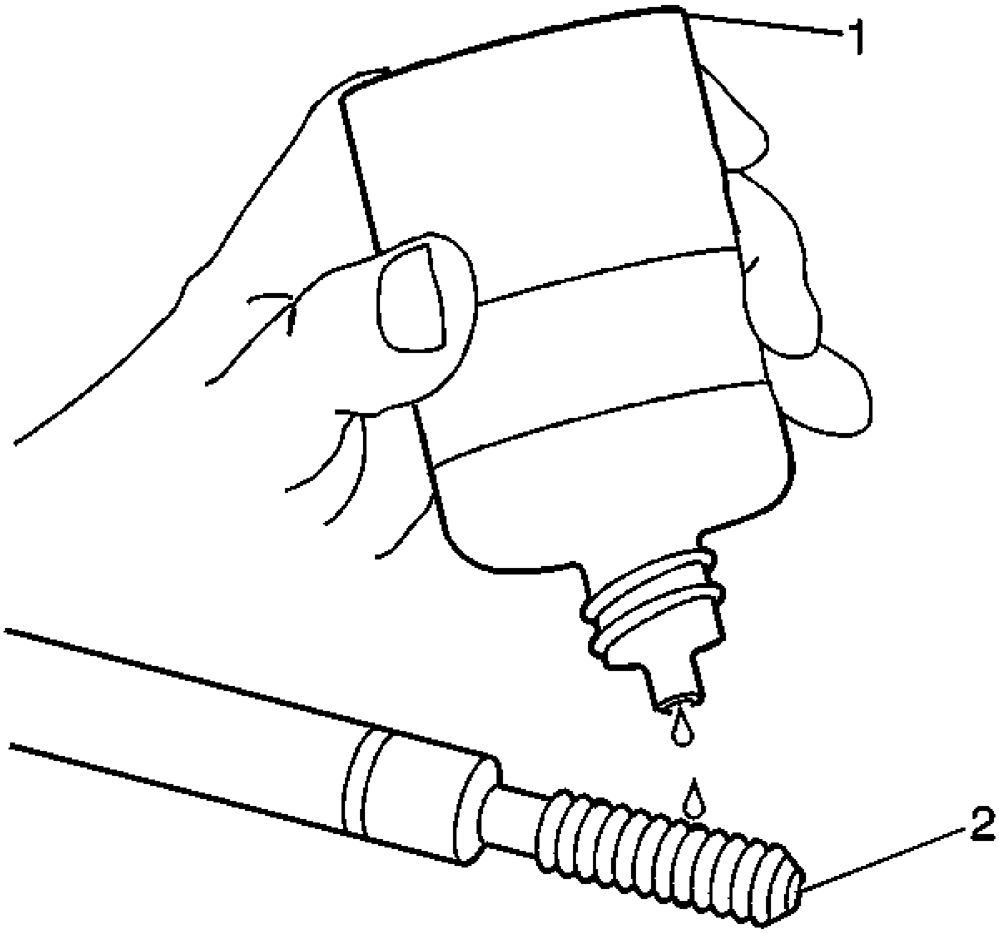


Fig. 31: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

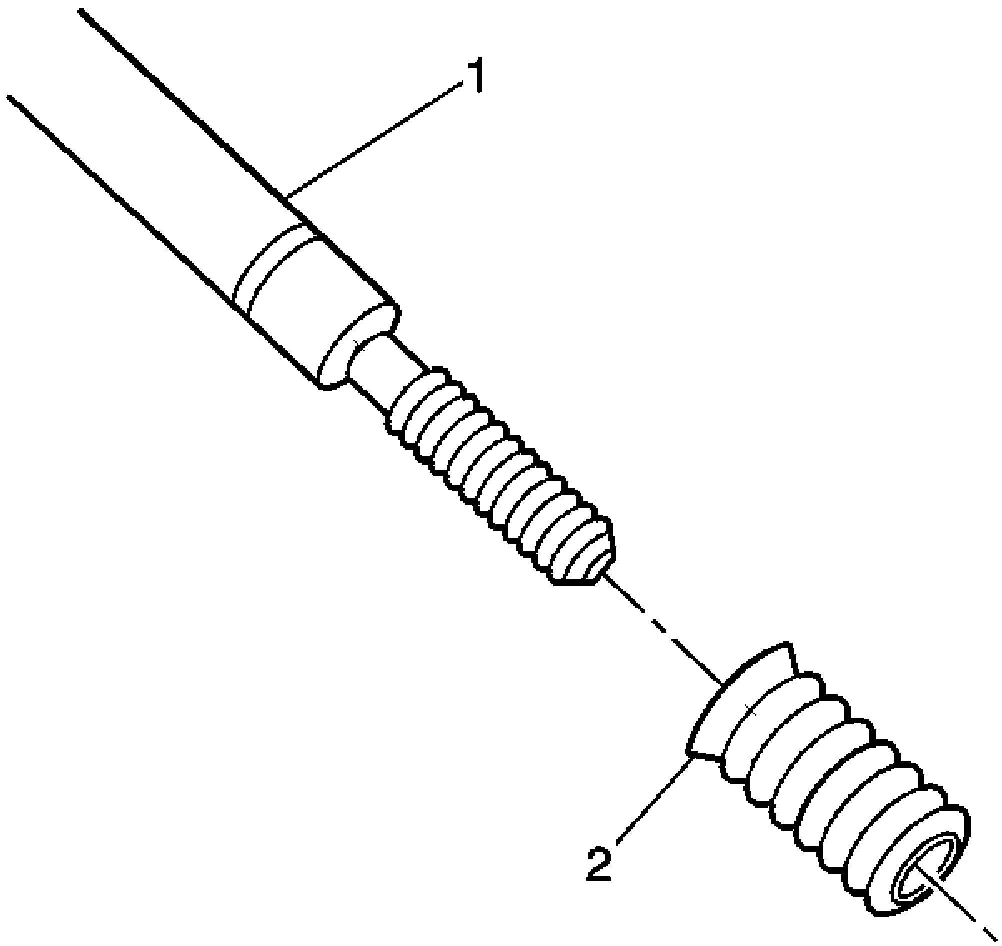


Fig. 32: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

16. Install the insert (2) onto the driver tool (1).

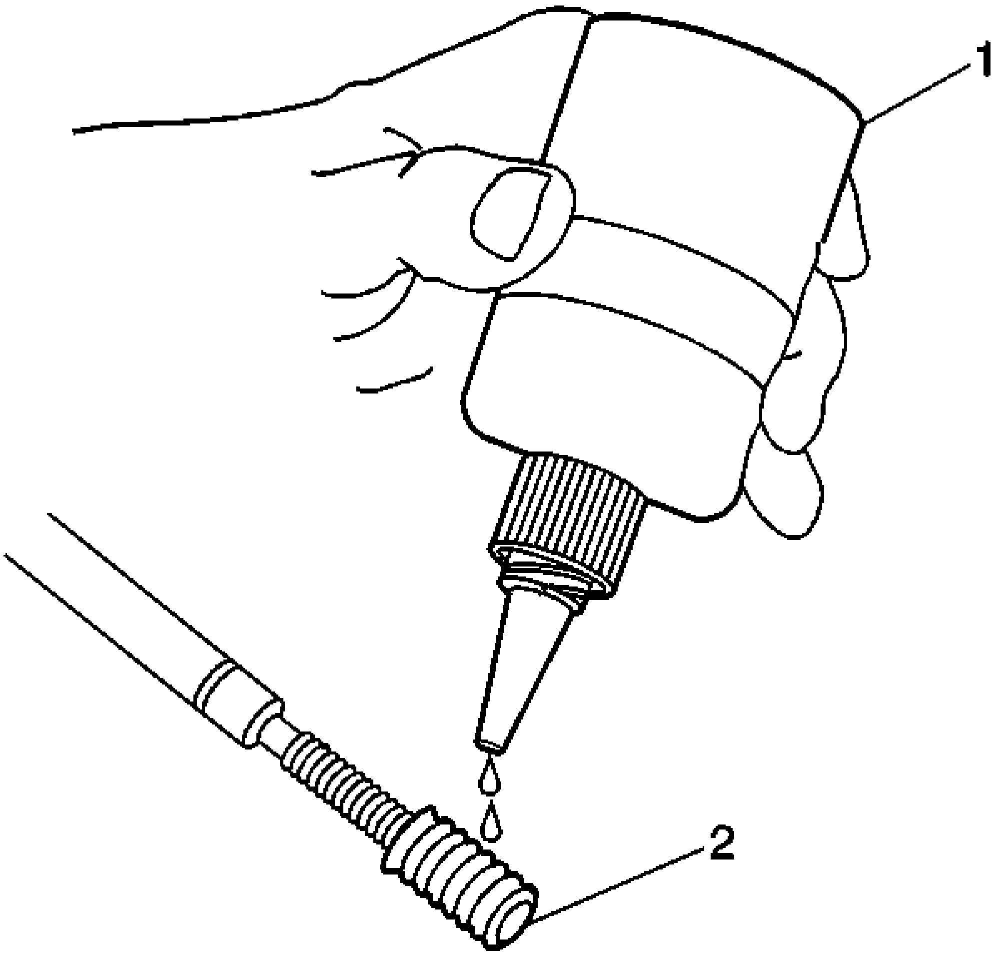


Fig. 33: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

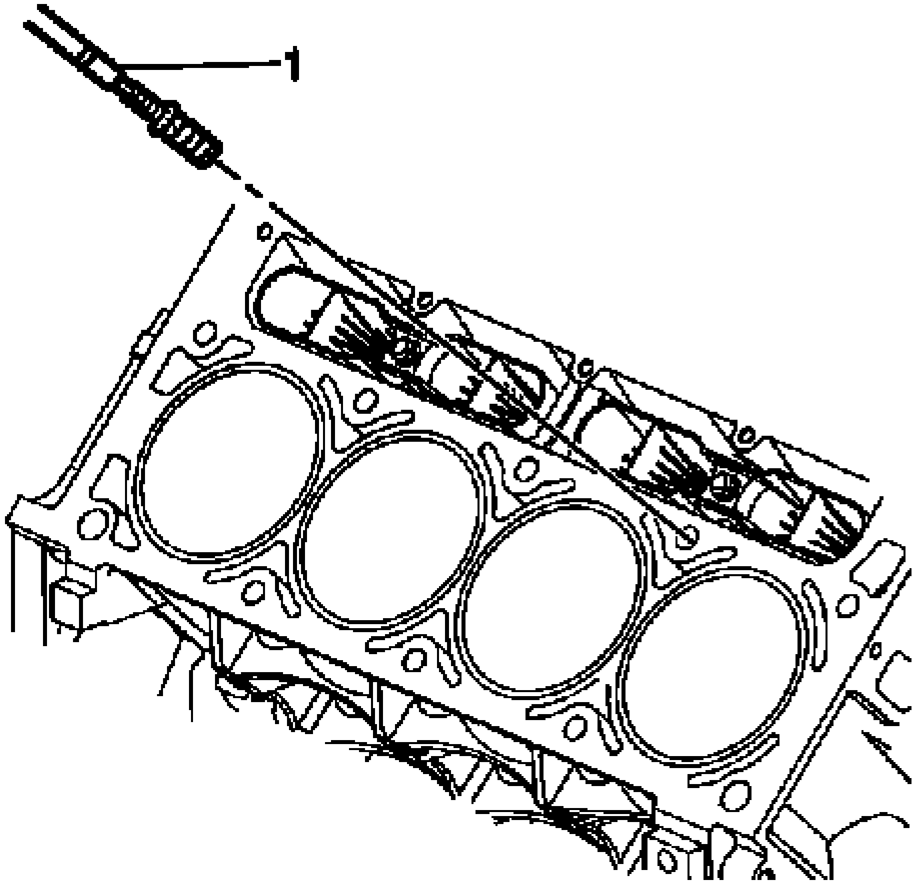


Fig. 34: Installing Insert & Driver Into Cylinder Bolt Hole
Courtesy of GENERAL MOTORS CORP.

18. Install the insert and driver (1) into the hole.

    Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Main Cap Bolt Hole Thread Repair

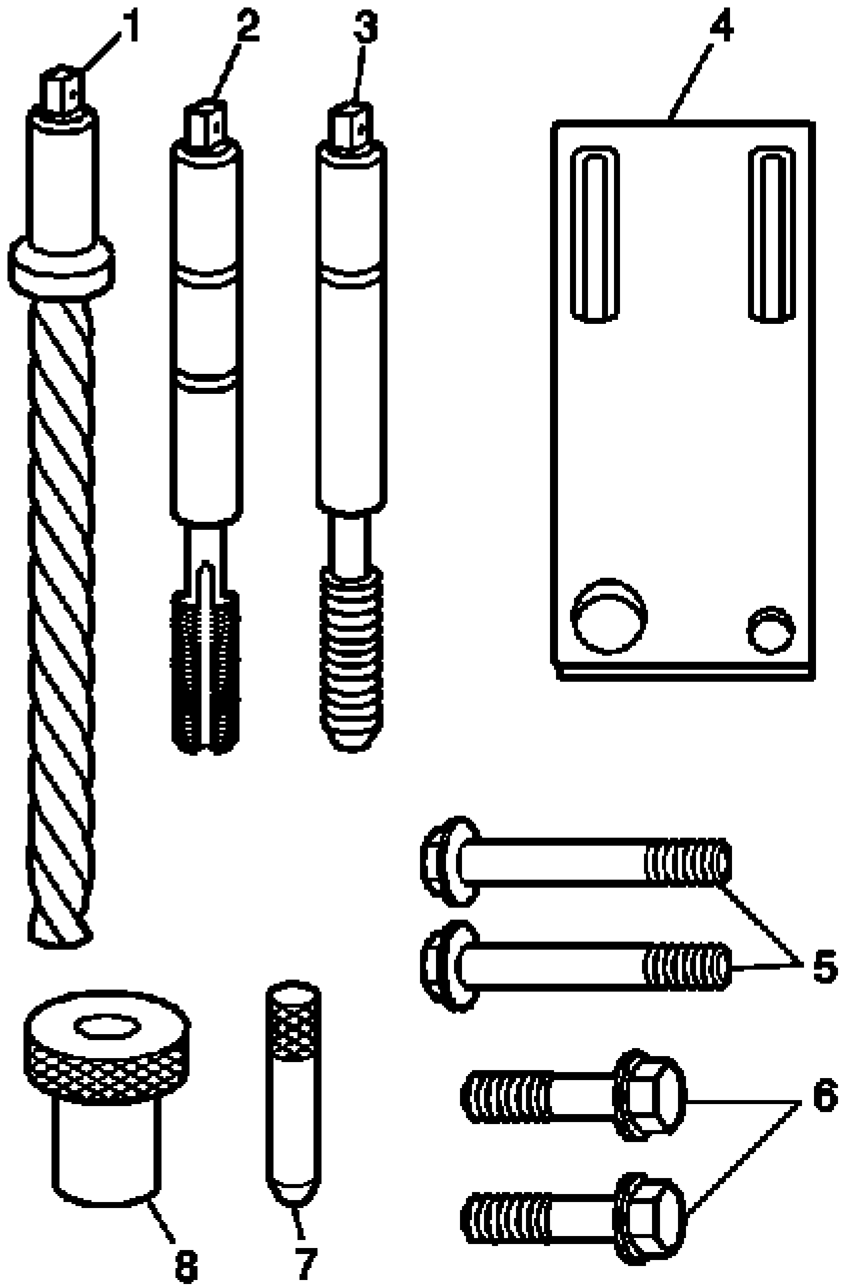


Fig. 35: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The main cap bolt hole thread repair kit consists of the following items:
   - The drill (1)
   - The tap (2)
   - The installer (3)

- The fixture plate (4)
- The long bolts (5)
- The short bolts (6)
- The alignment pin (7)
- The bushing (8)

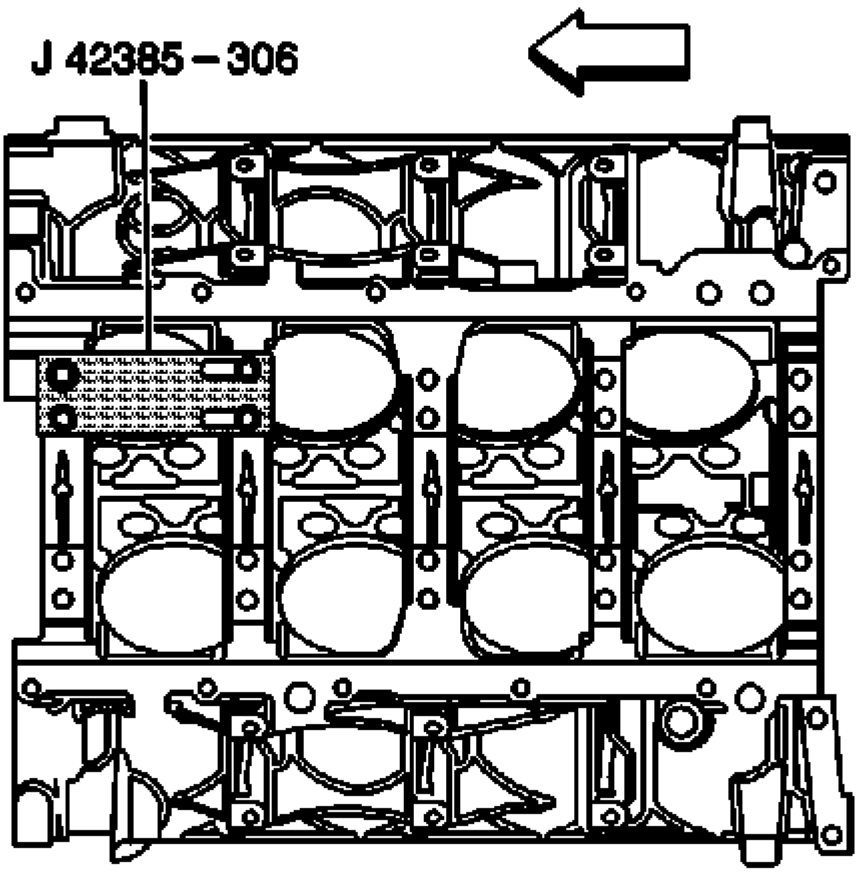


Fig. 36: View Of Fixture Plate, Bolt & Bushing
Courtesy of GENERAL MOTORS CORP.

2. Install the fixture plate, bolt, and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

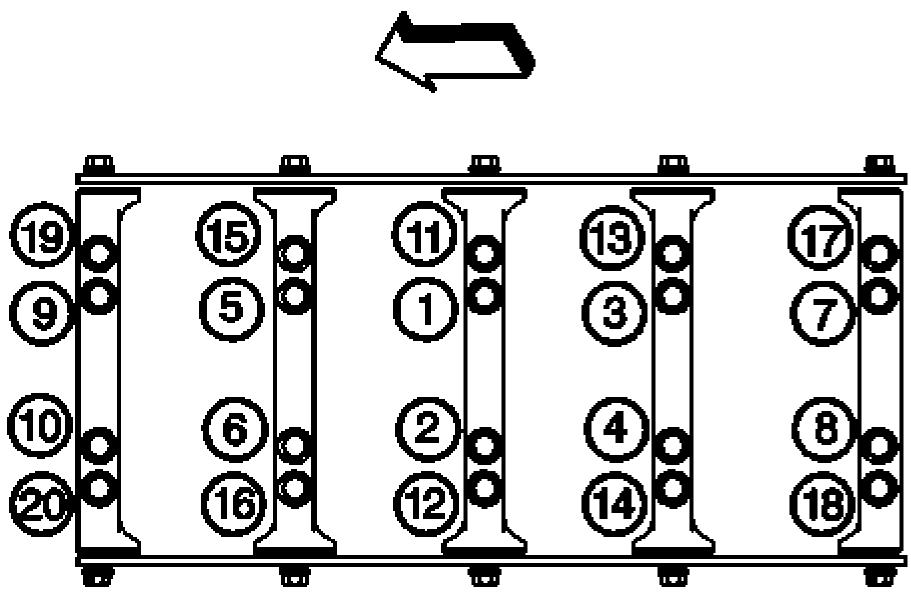


Fig. 37: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Drill out the damaged hole.

   The outer bolt hole locations 11-20 have the shallower counterbores. Use **J 42385-316:** sleeve with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.

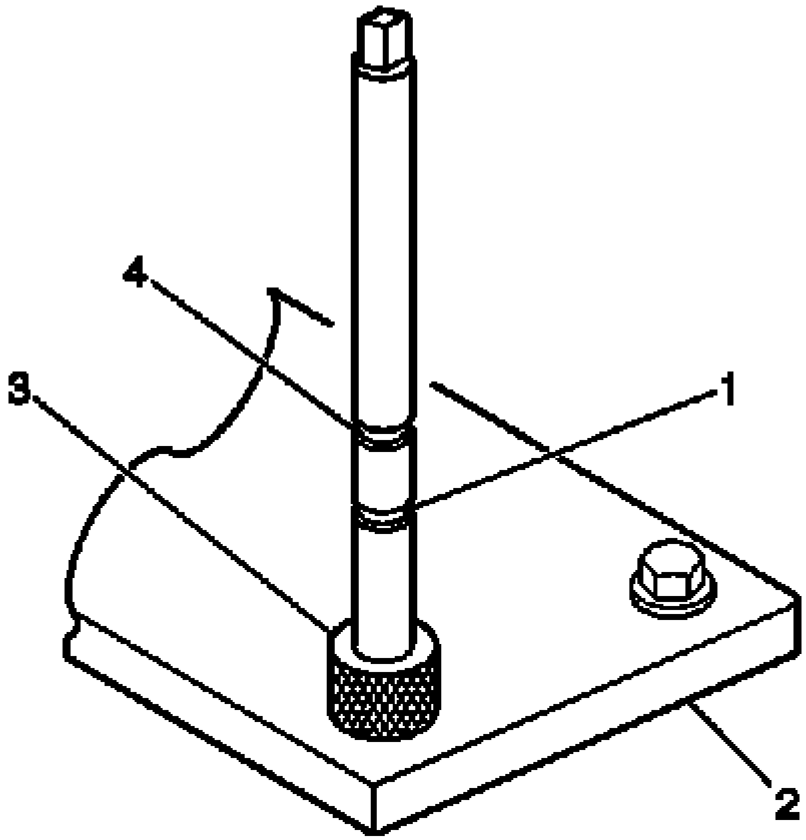


Fig. 38: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

   For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

   For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

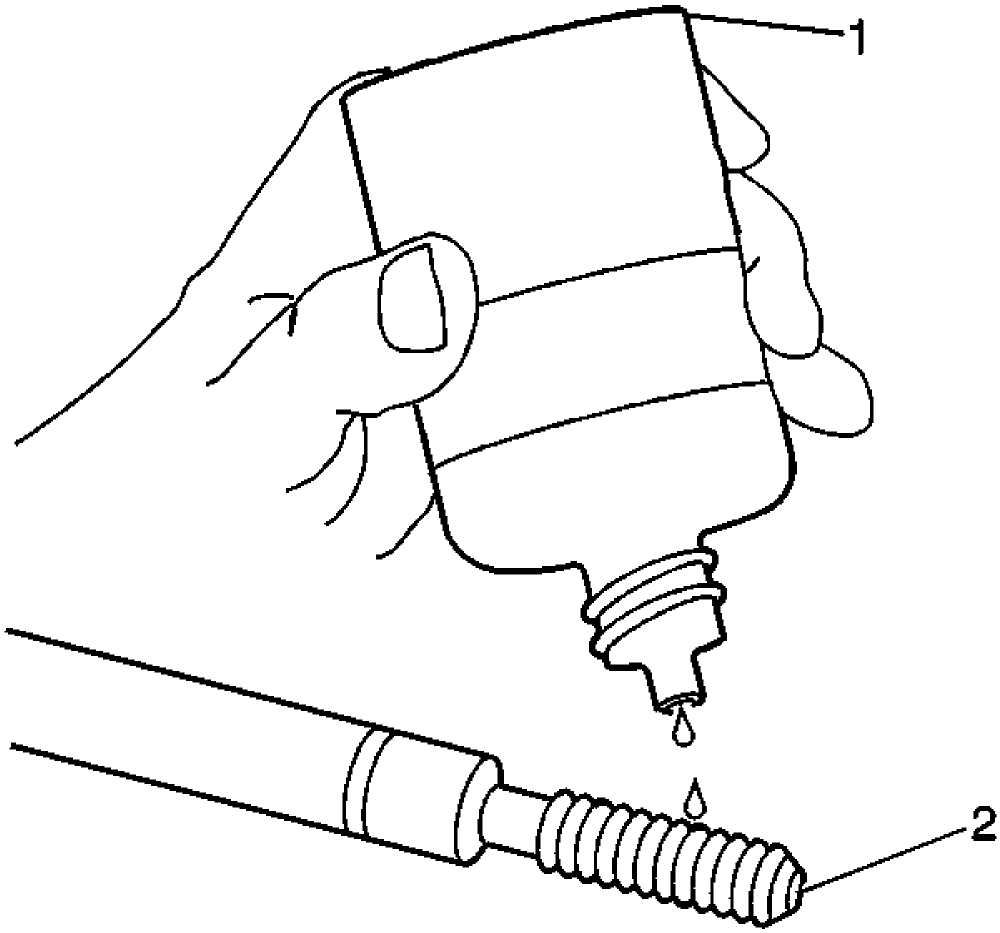


Fig. 39: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

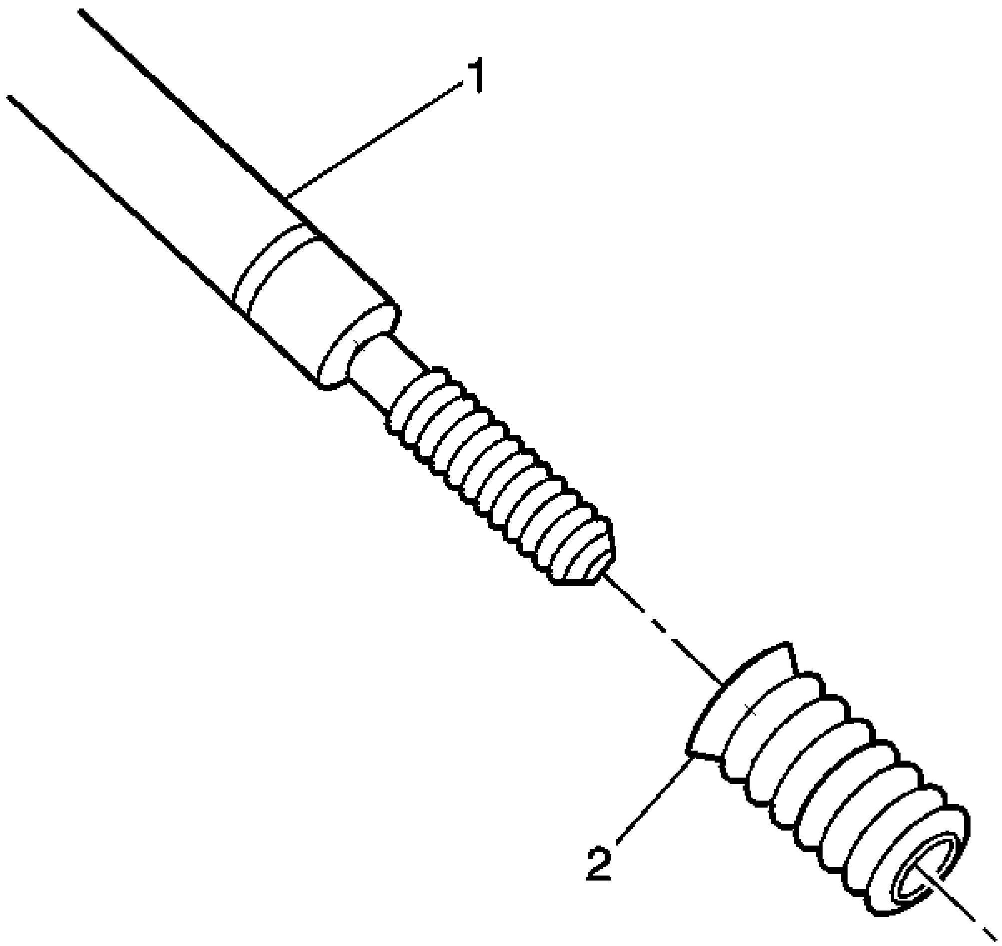


Fig. 40: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) onto the driver tool (1).

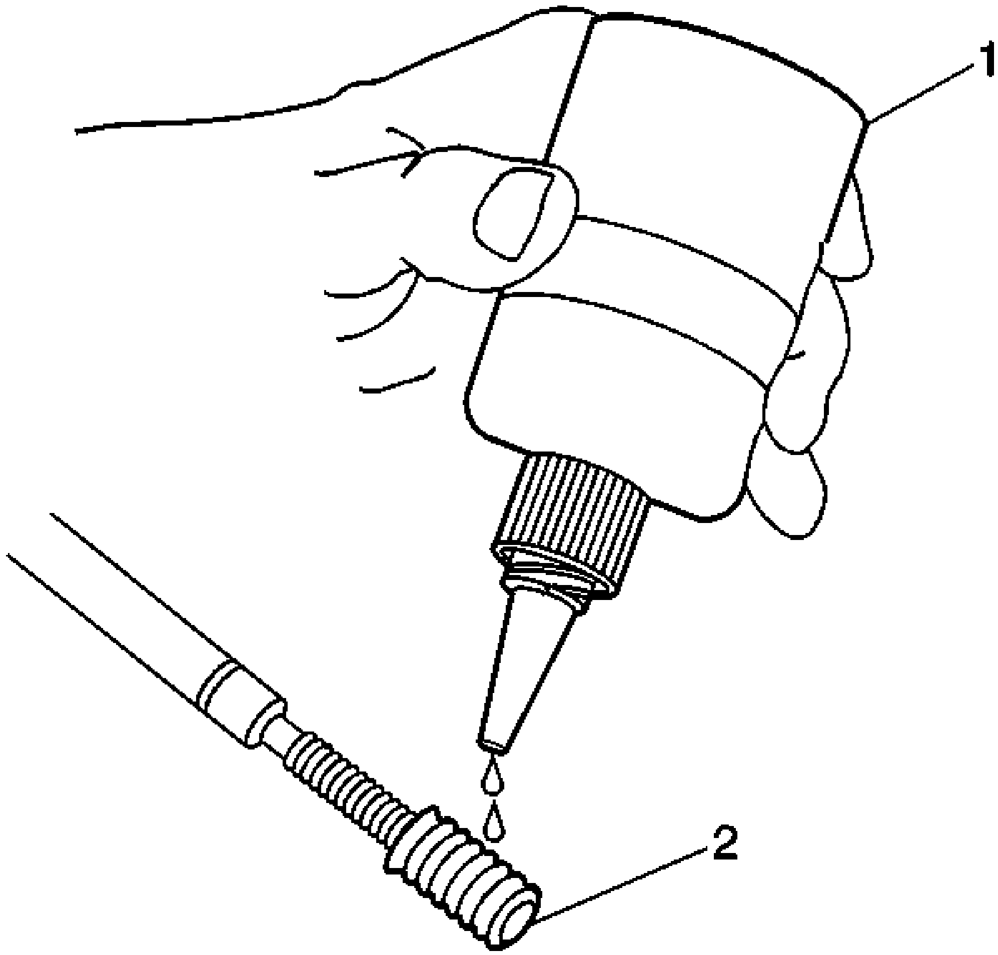


Fig. 41: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

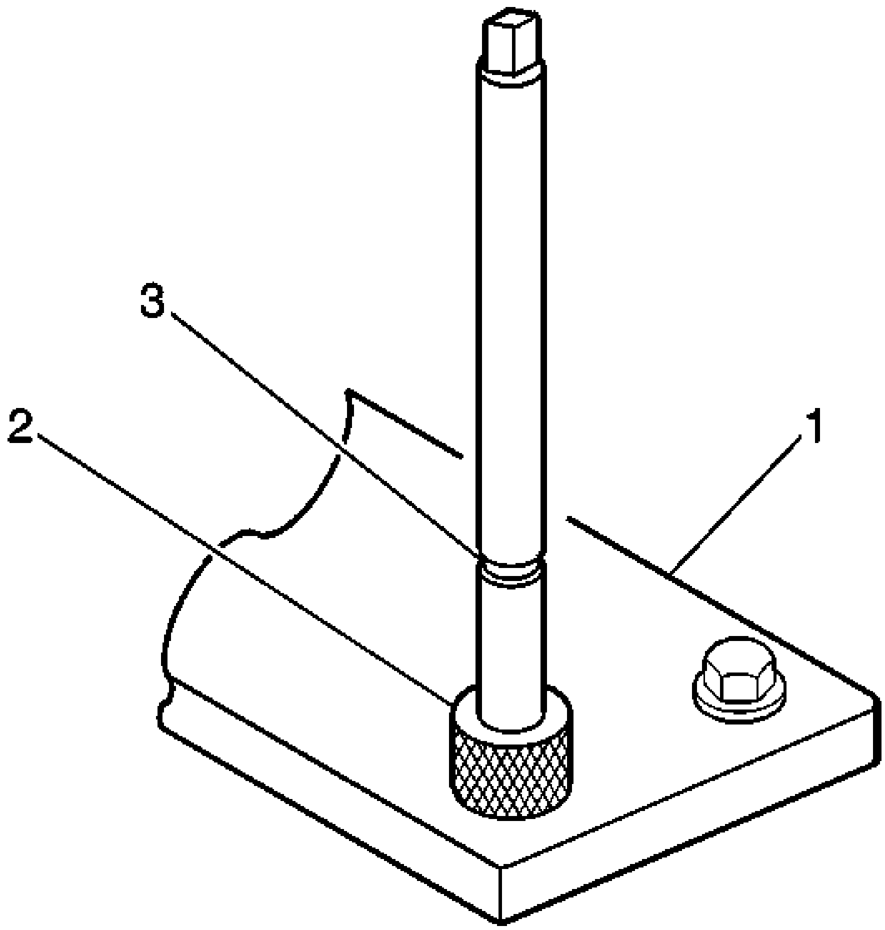


Fig. 42: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

NOTE: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

    Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

SERVICE PRIOR TO ASSEMBLY

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all components. Refer to **Cleanliness**

and Care .

- Use the correct tools to measure components when inspecting for above acceptable wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to **Separating Parts** .
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

ENGINE BLOCK PLUG INSTALLATION

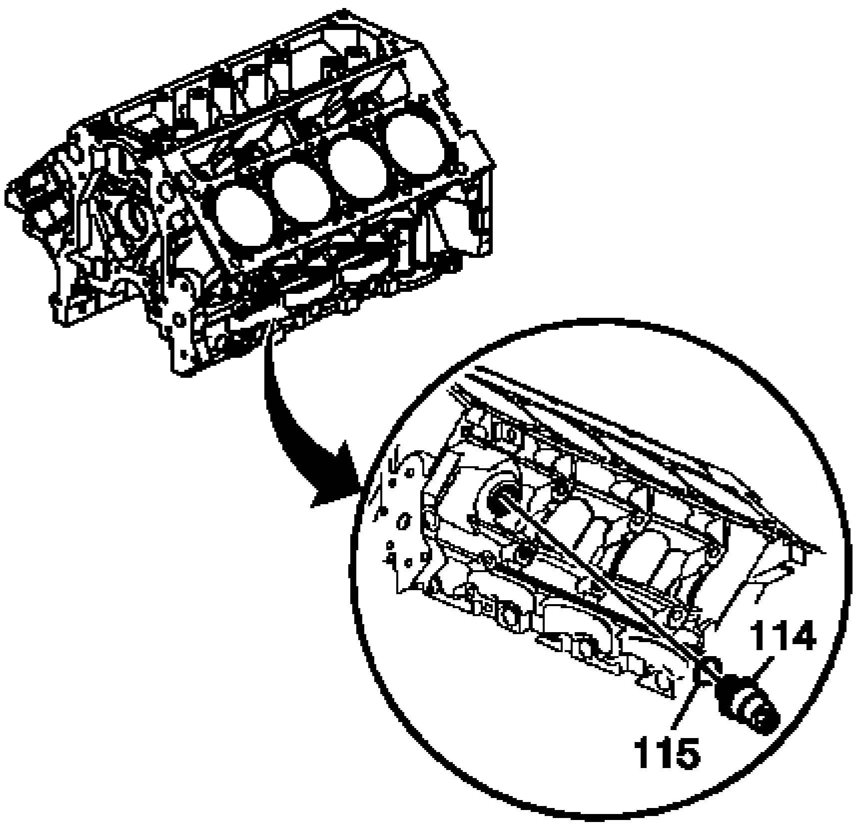


Fig. 43: Identifying Engine Block Coolant Heater
Courtesy of GENERAL MOTORS CORP.

NOTE: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block coolant heater sealing washer (115), if applicable. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

2. Install the engine block coolant heater (114) to the engine block.

   Tighten: Tighten the engine block coolant heater to 50 N.m (37 lb ft).

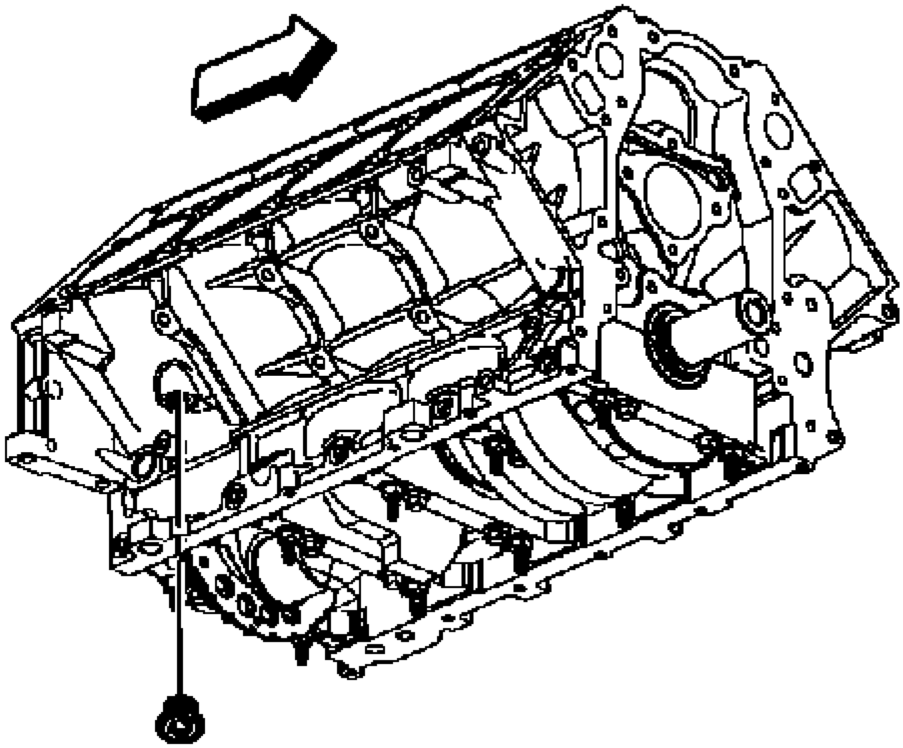


Fig. 44: Identifying Plug Location On Underside Of Block
Courtesy of GENERAL MOTORS CORP.

3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug.

   Tighten: Tighten the engine block right rear coolant drain hole plug to 60 N.m (44 lb ft).

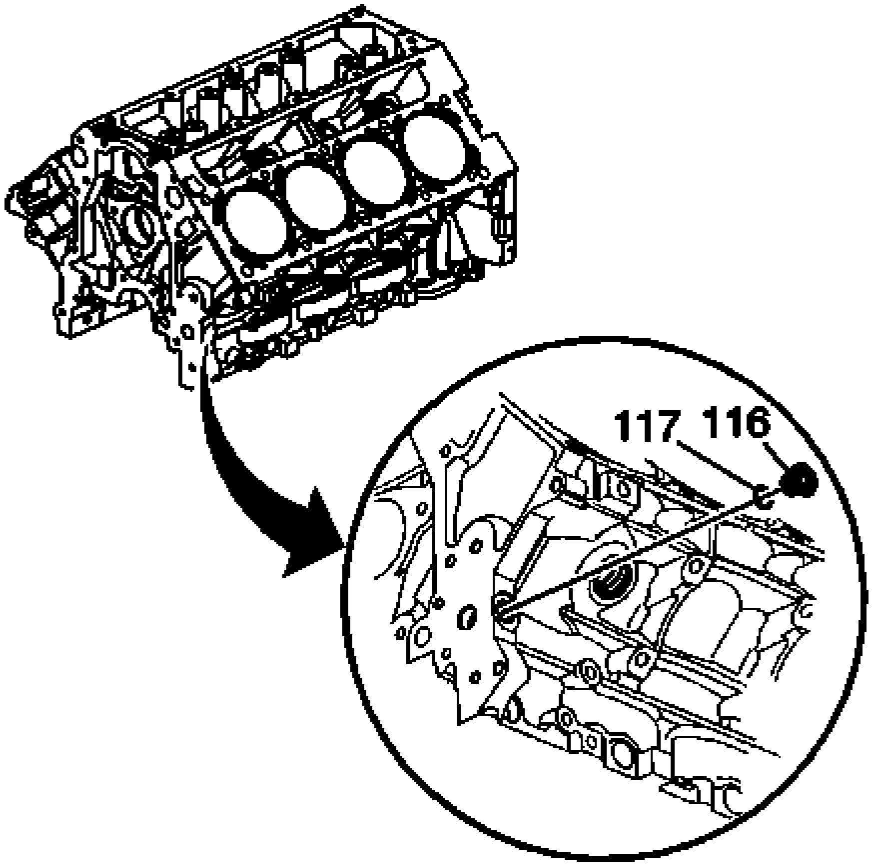


Fig. 45: Locating Engine Block Left Front Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116).

   Tighten: Tighten the engine block left front oil gallery plug to 60 N.m (44 lb ft).

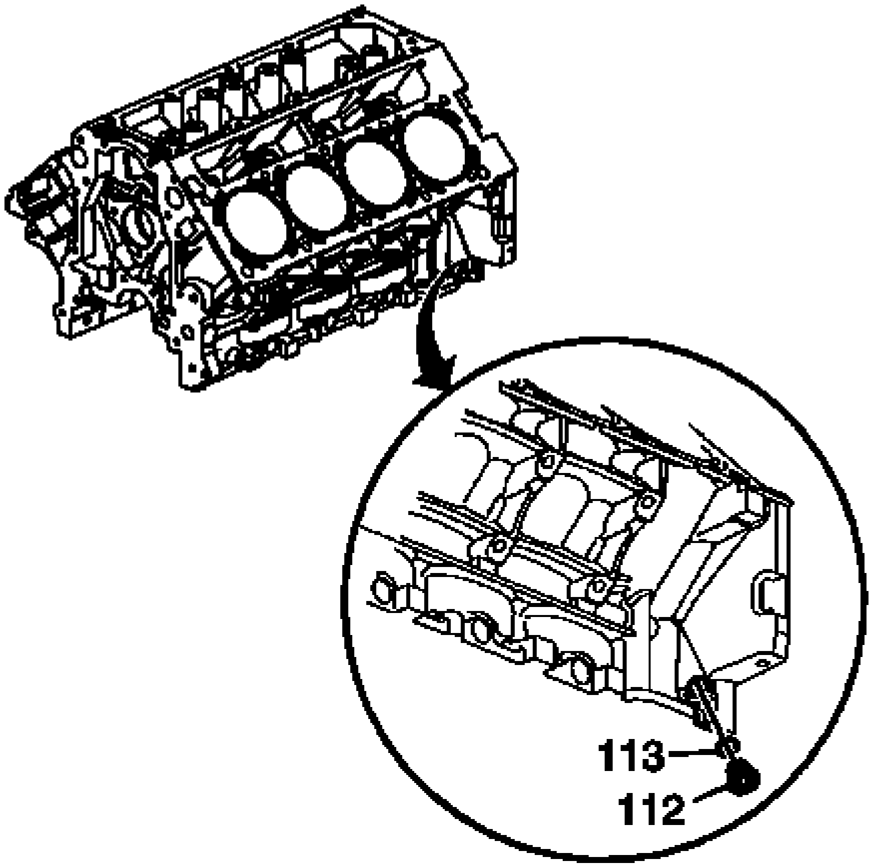


Fig. 46: Locating Engine Block Left Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112).

   Tighten: Tighten the engine block left rear oil gallery plug to 60 N.m (44 lb ft).

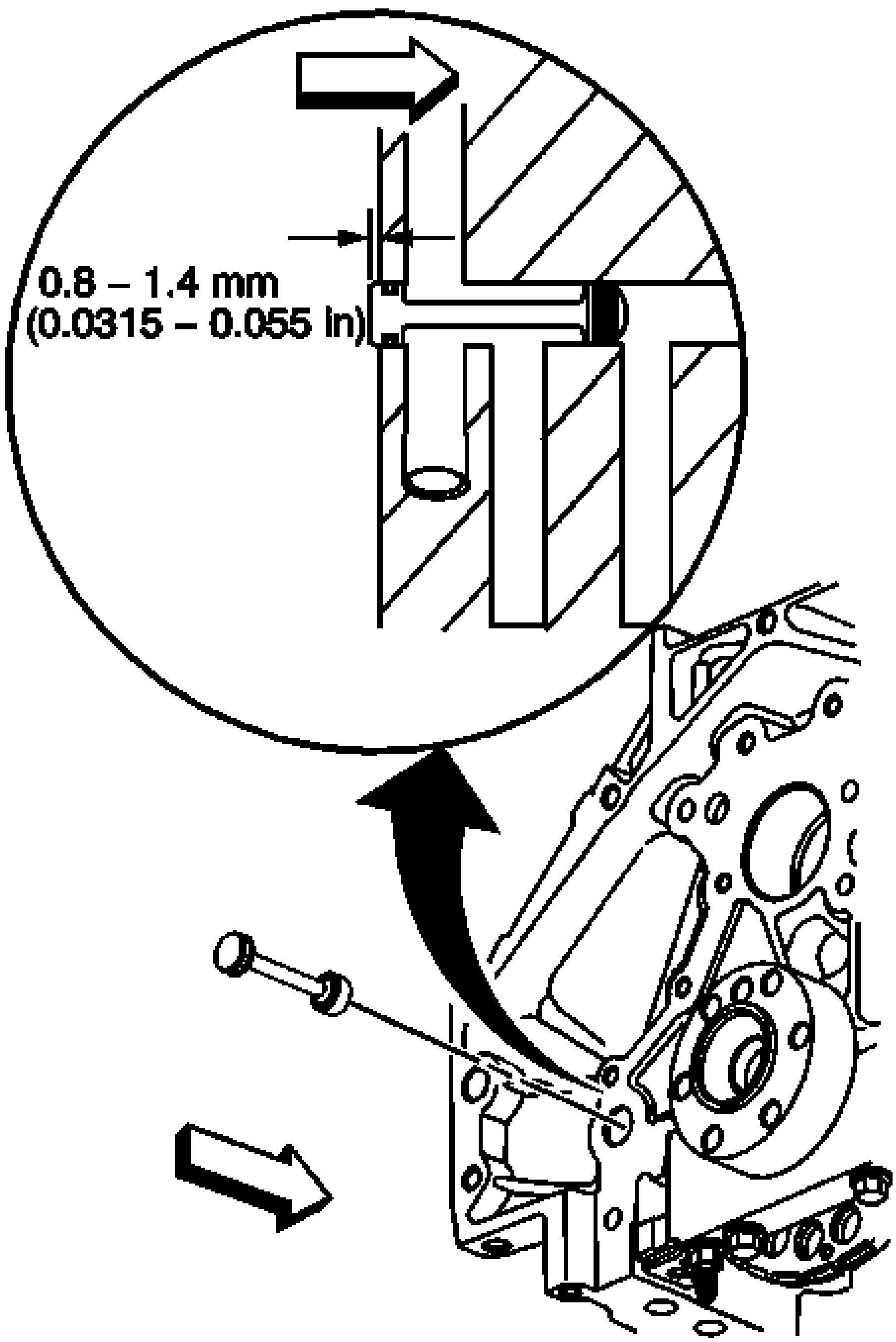


Fig. 47: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8-1.4 mm (0.0315-0.055 in) beyond the rear face of the block.

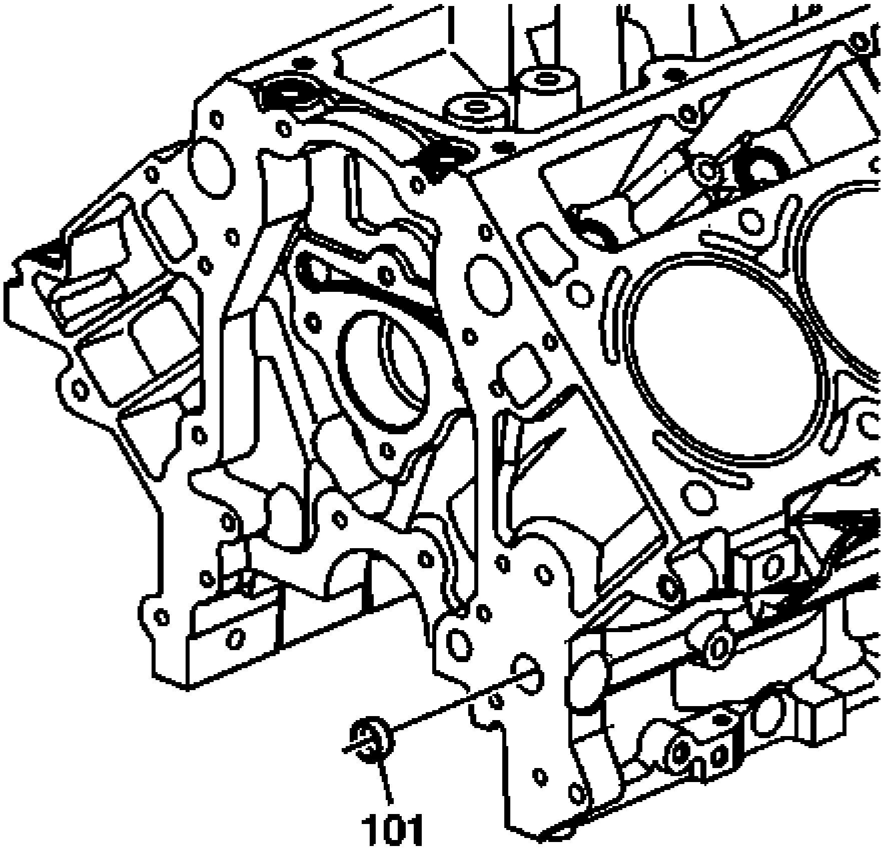


Fig. 48: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).

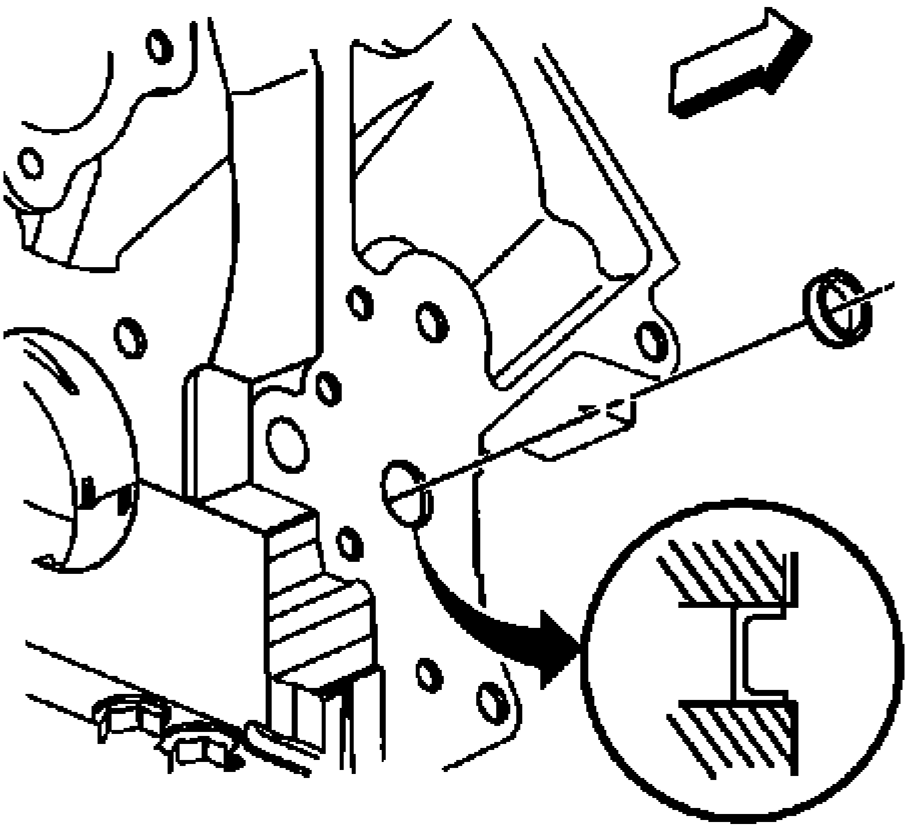


Fig. 49: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2-2.8 mm (0.0086-0.011 in) below flush.

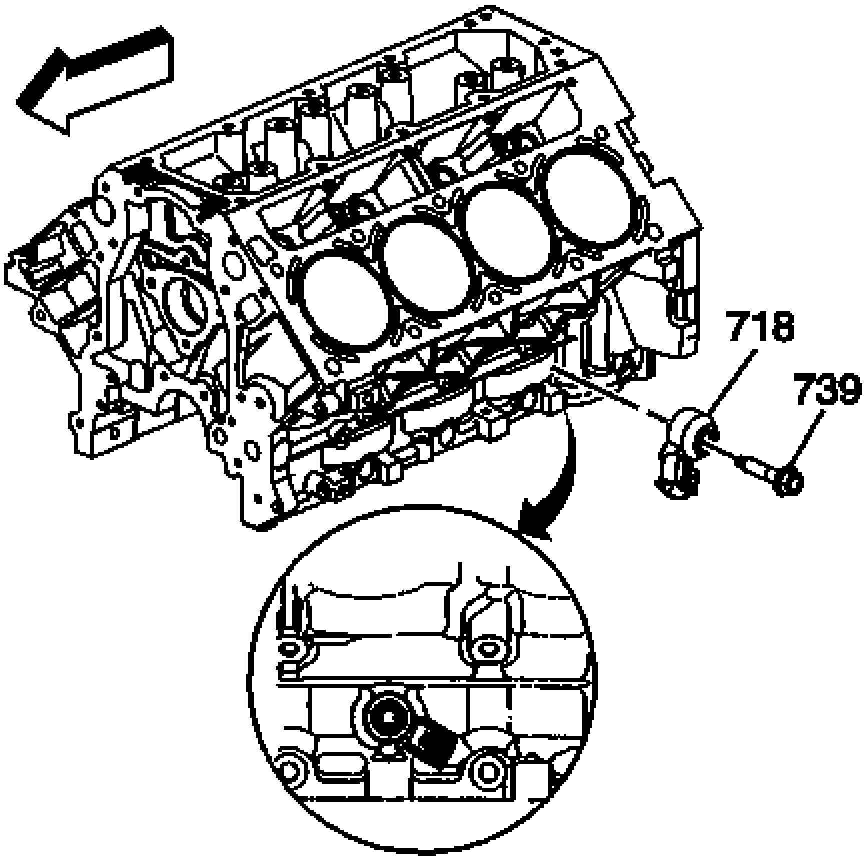


Fig. 50: Left Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

15. Install the left side knock sensor (718) and bolt (739).

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

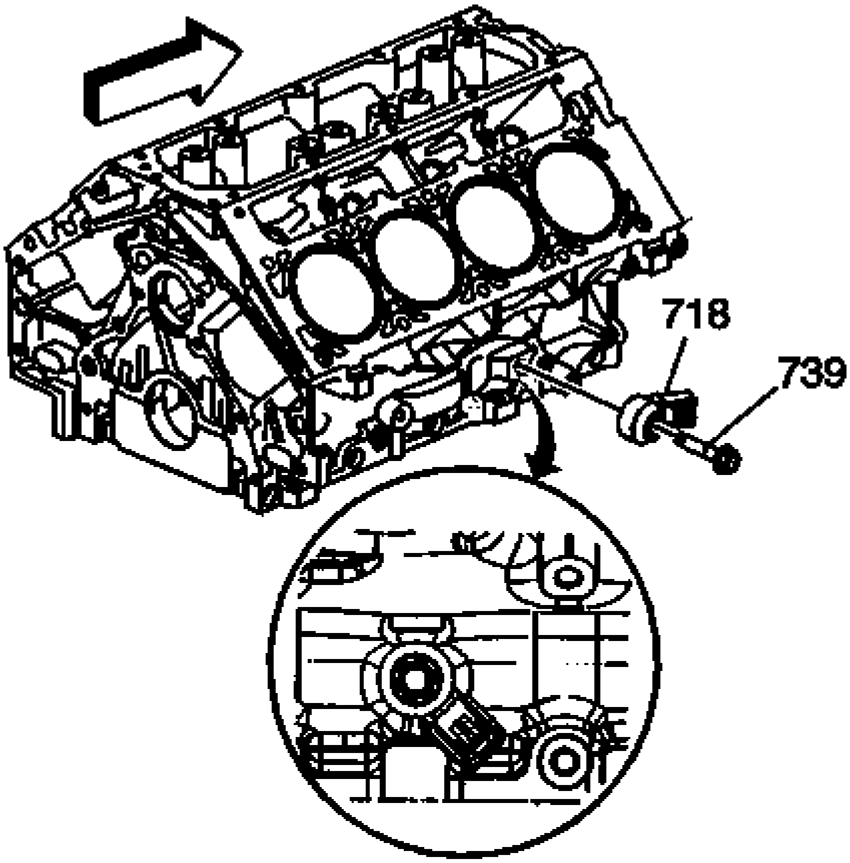


Fig. 51: Right Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

16. Install the right side knock sensor (718) and bolt (739).

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

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

J 45059: Angle Meter

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

Installation

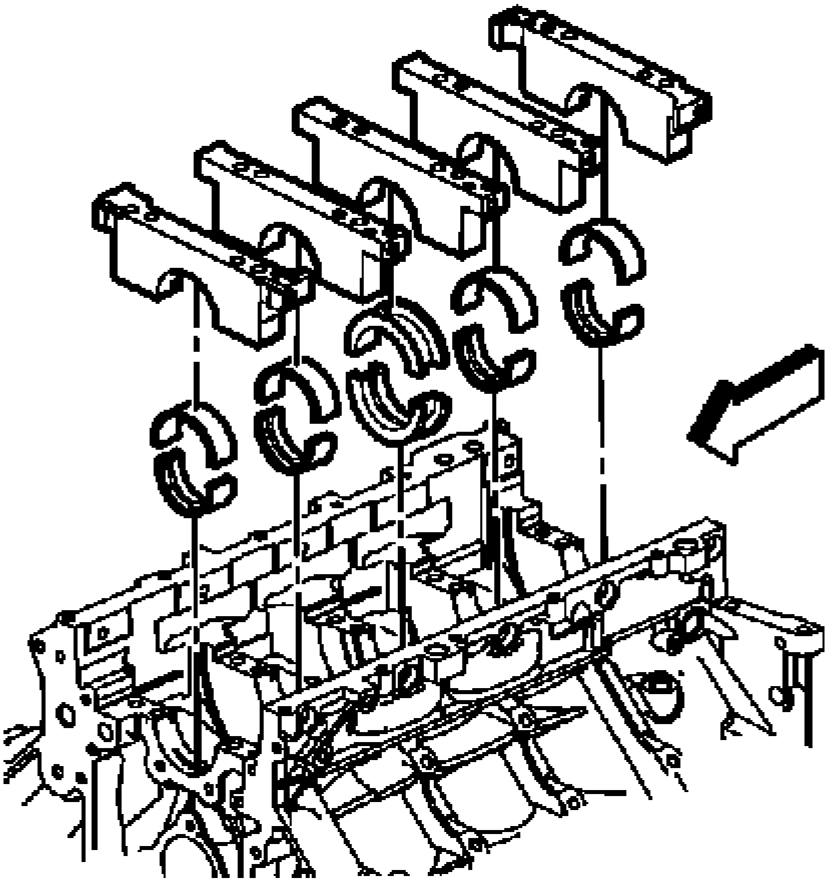


Fig. 52: View Of Crankshaft Bearings & Bearing Caps
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.**
- **Crankshaft bearing caps must be installed to the proper location and direction.**
- **When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.**
- **Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.**
- **In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.**

  The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

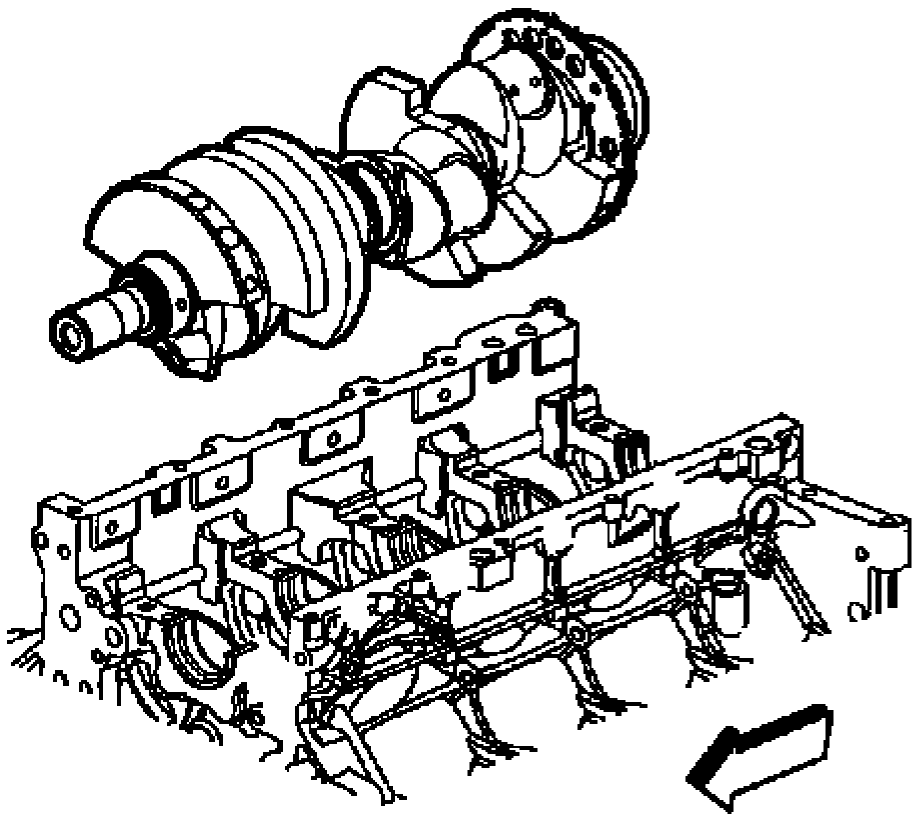


Fig. 53: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.

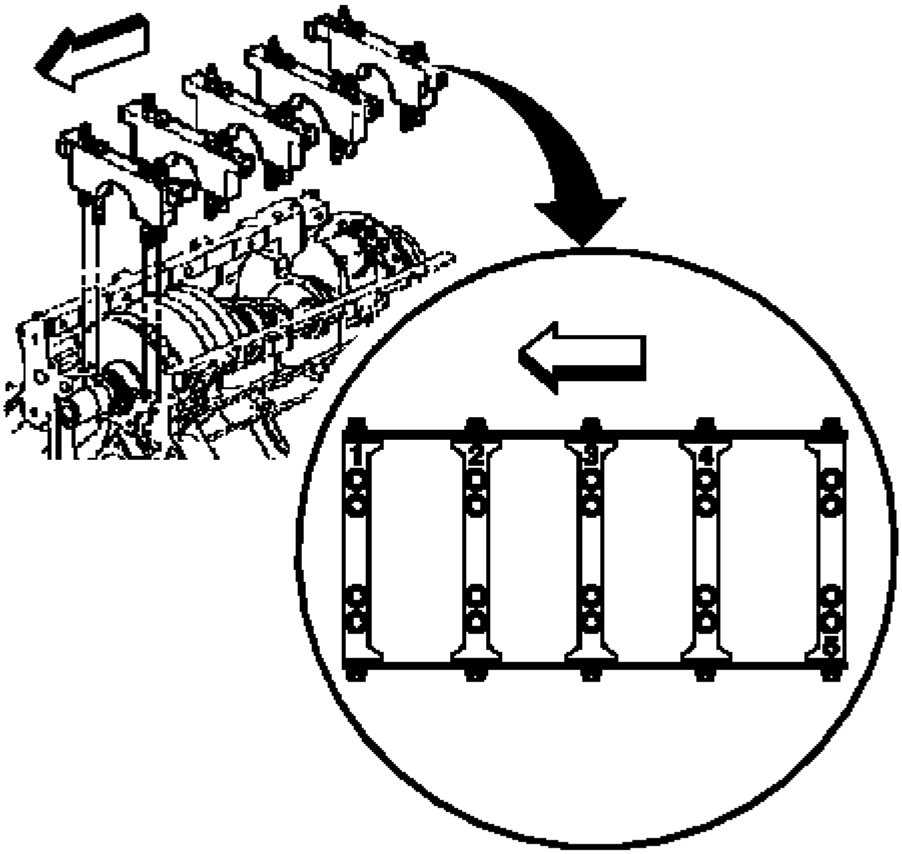


Fig. 54: View of Proper Bearing Cap Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: The bearing caps must be installed in the proper location and direction.

4. Install the crankshaft bearing caps, with bearings, into the engine block.

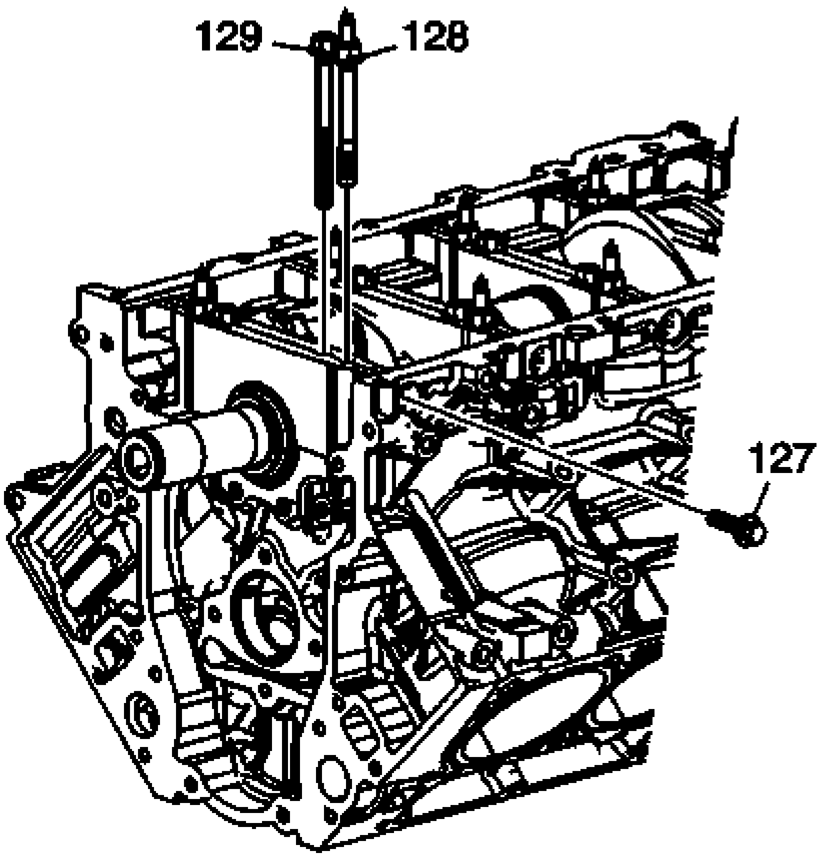


Fig. 55: Identifying Bearing Cap Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

5. Install the M10 bolts (129) and studs (128).
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW M8 bearing cap side bolts (127).

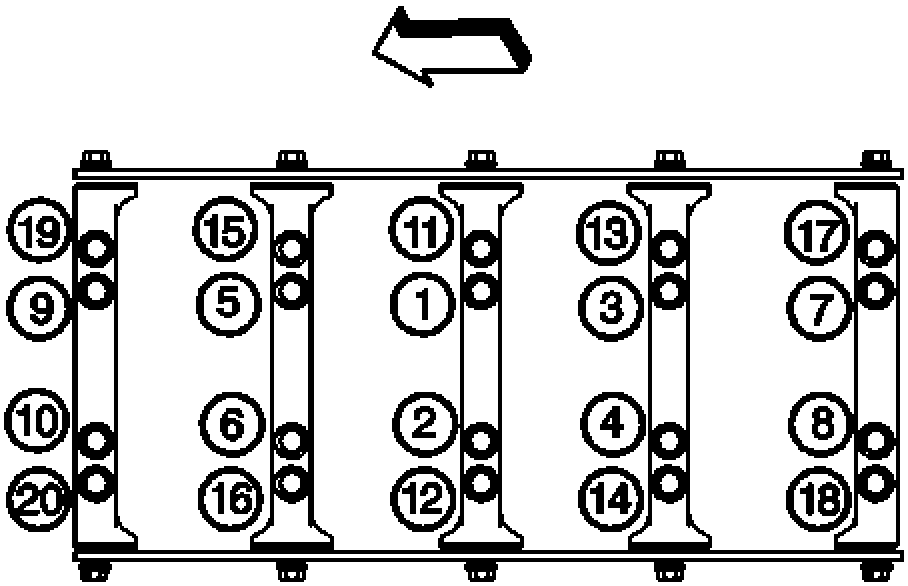


Fig. 56: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the bearing cap M10 bolts (1-10). Tighten the M10 bearing cap bolts (1-10) a first pass in sequence to 20 N.m (15 lb ft).

NOTE: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.
    1. Tighten the M10 bolts (1-10) a final pass in sequence 80 degrees using the **J 45059:** angle meter .
    2. Tighten the M10 studs (11-20) a first pass in sequence to 20 N.m (15 lb ft) .
    3. Tighten the M10 studs (11-20) a final pass in sequence 51 degrees using the **J 45059:** angle meter .
    4. Tighten the bearing cap side M8 bolts to 25 N.m (18 lb ft) .

       Tighten the bolt on 1 side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.

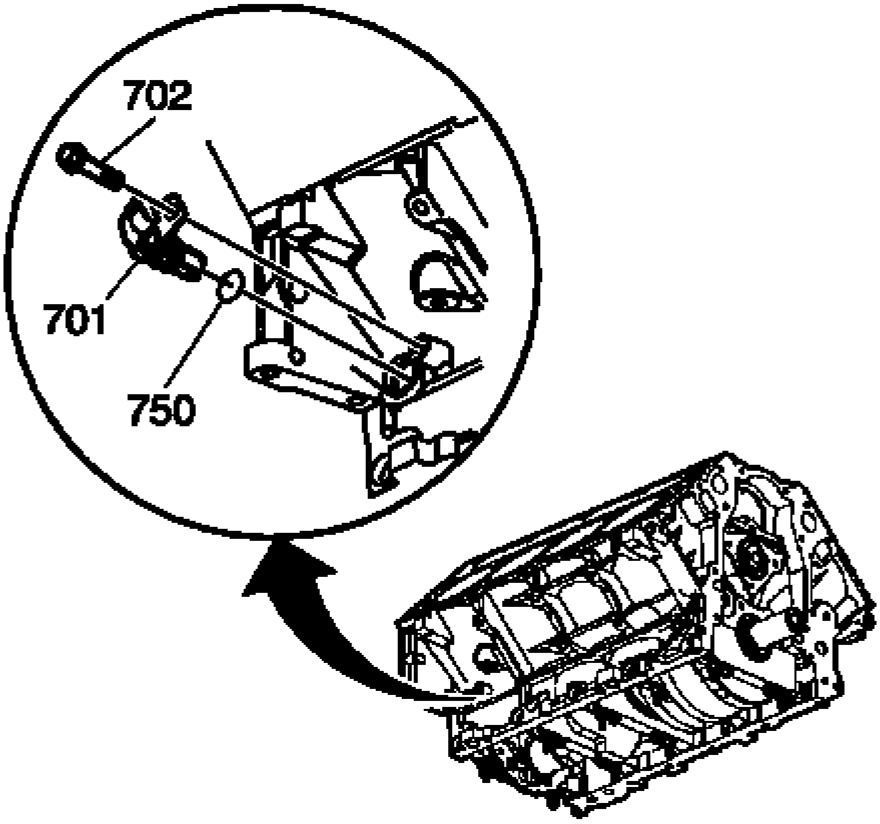


Fig. 57: CKP Sensor, Bolt & O-Ring
Courtesy of GENERAL MOTORS CORP.

10. Install the CKP sensor.
    1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.
    2. Coat the O-ring seal with clean engine oil.
    3. Install the O-ring onto the sensor.
    4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
    5. Install the sensor bolt (702). Tighten the CKP sensor bolt to 25 N.m (18 lb ft) .

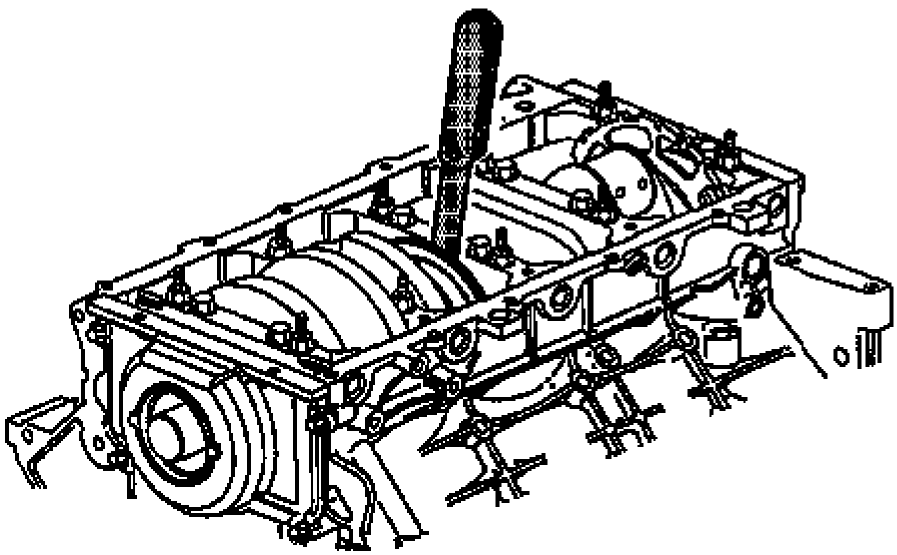


Fig. 58: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

11. Measure the crankshaft end play.
    1. Thrust the crankshaft forward or rearward.
    2. Insert a feeler gage between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

       The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in) .

    3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **J 8037:** Piston Ring Compressor
- **J 8087:** Cylinder Bore Gage
- **J 41556:** Connecting Rod Guide

- **J 45059:** Angle Meter

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

Piston Selection

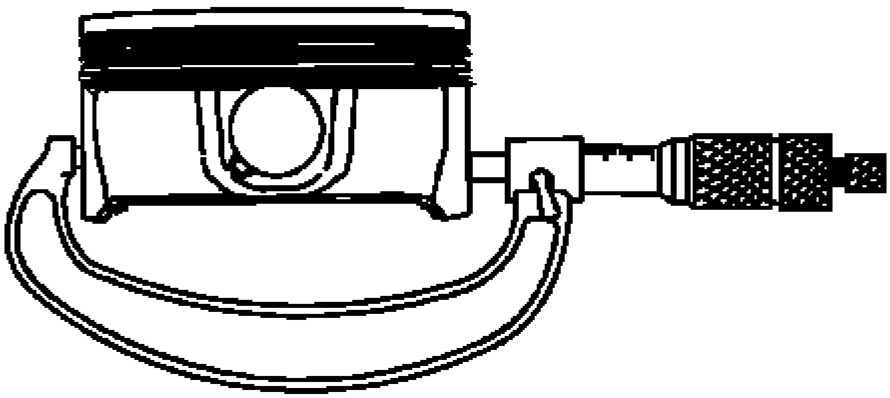


Fig. 59: Measuring Piston Outside Diameter
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.**

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .
2. Record the piston OD.

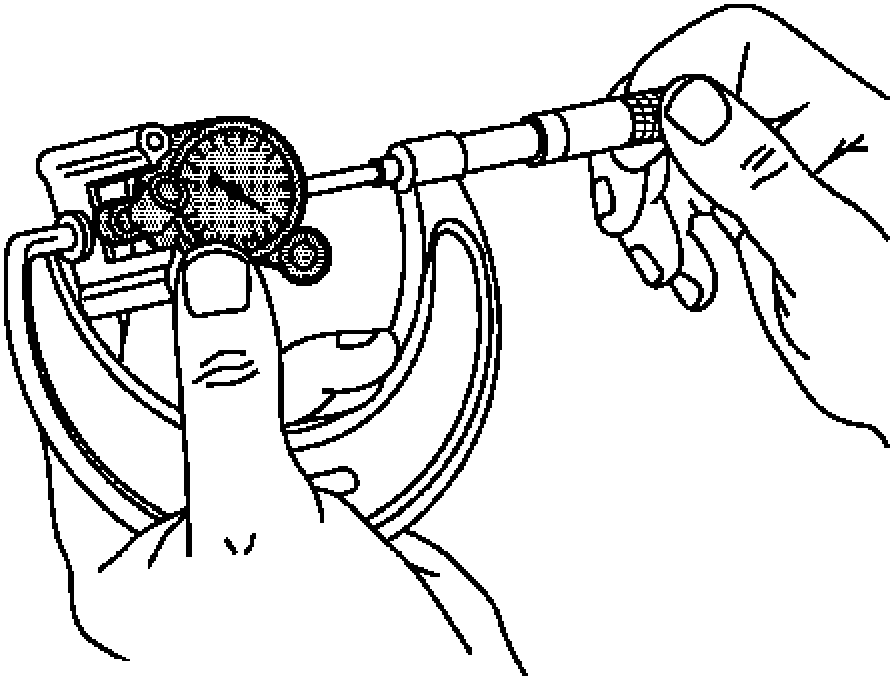


Fig. 60: Measuring Bore Gauge With Micrometer
Courtesy of GENERAL MOTORS CORP.

3. Adjust the micrometer to the recorded piston OD.
4. Insert the **J 8087:** gage into the micrometer and zero the gage dial.

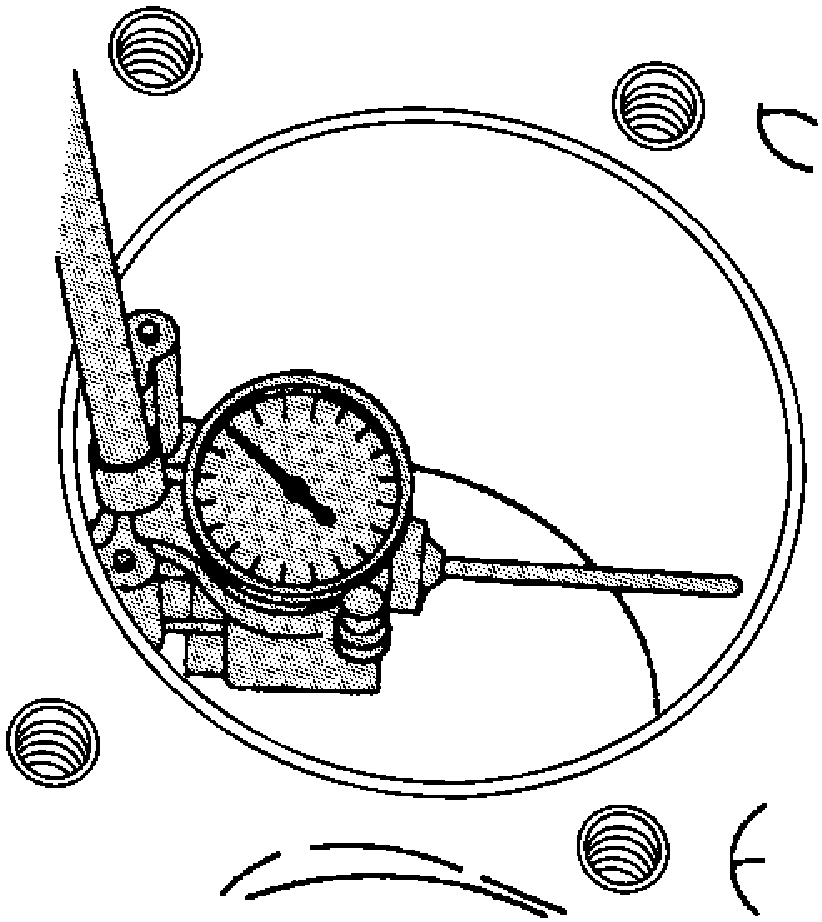


Fig. 61: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 8087:** gage, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

Piston, Pin, and Connecting Rod Installation

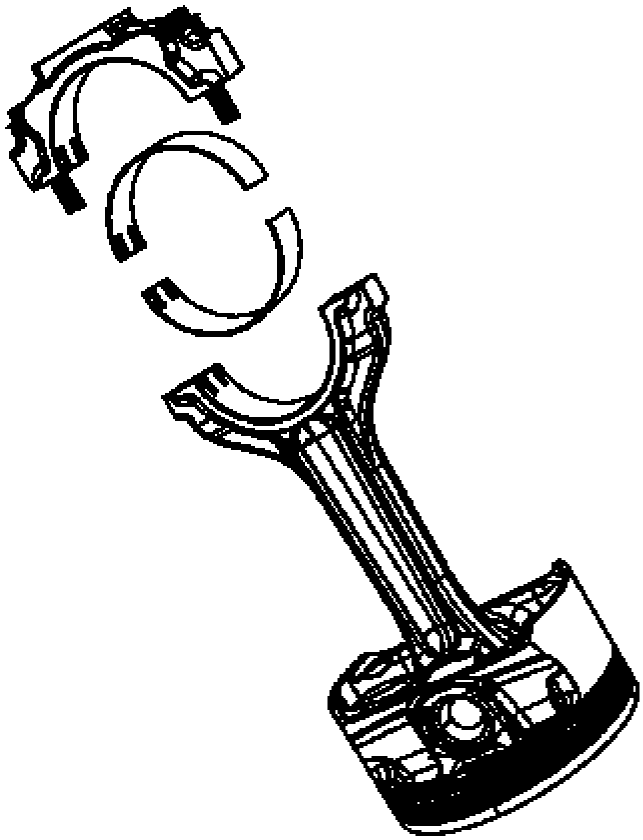


Fig. 62: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the following components with clean engine oil:
   - Piston
   - Piston rings
   - Cylinder bore
   - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.

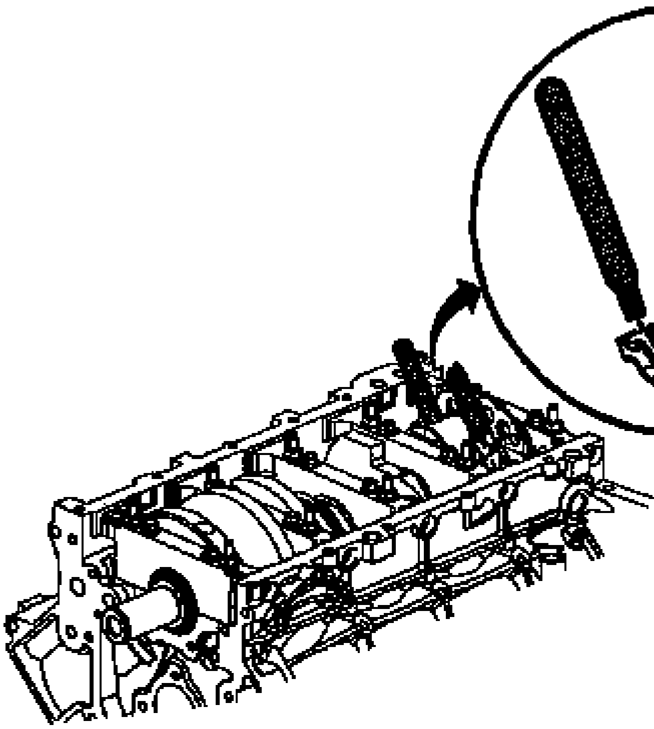


Fig. 63: View Of J 41556 & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Install the **J 41556:** guide to the connecting rod.

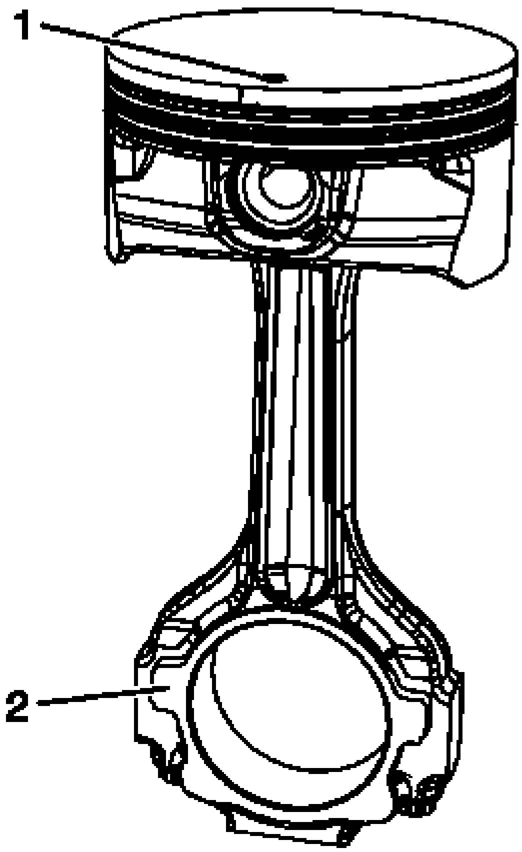


Fig. 64: View of Mark On Top Of Piston & Connecting Rod Tab
Courtesy of GENERAL MOTORS CORP.

6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.

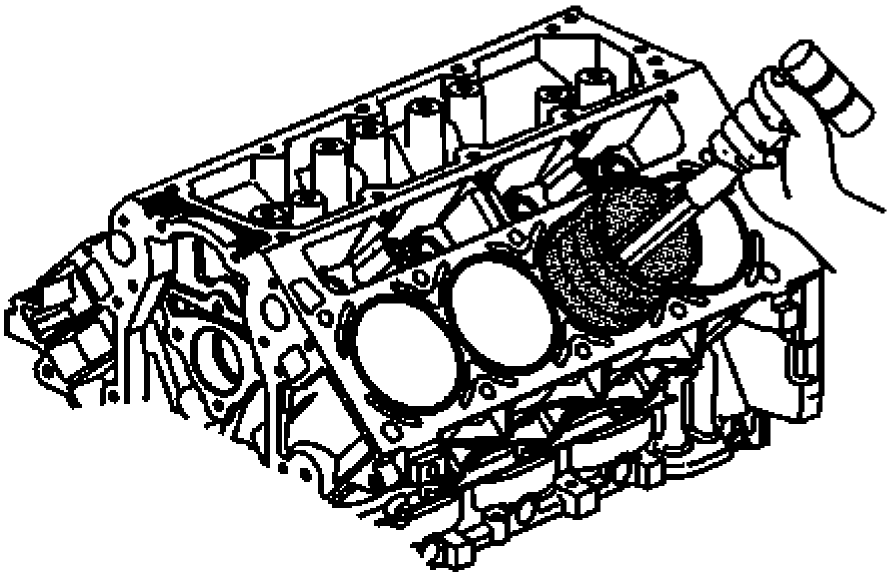


Fig. 65: Installing Piston
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 8037:** compressor onto the piston and compress the piston rings.

NOTE: The piston alignment mark MUST face the front of the engine block.

8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the **J 41556:** guide to guide the connecting rod onto the crankshaft journal.
10. Remove the **J 41556:** guide from the connecting rod.

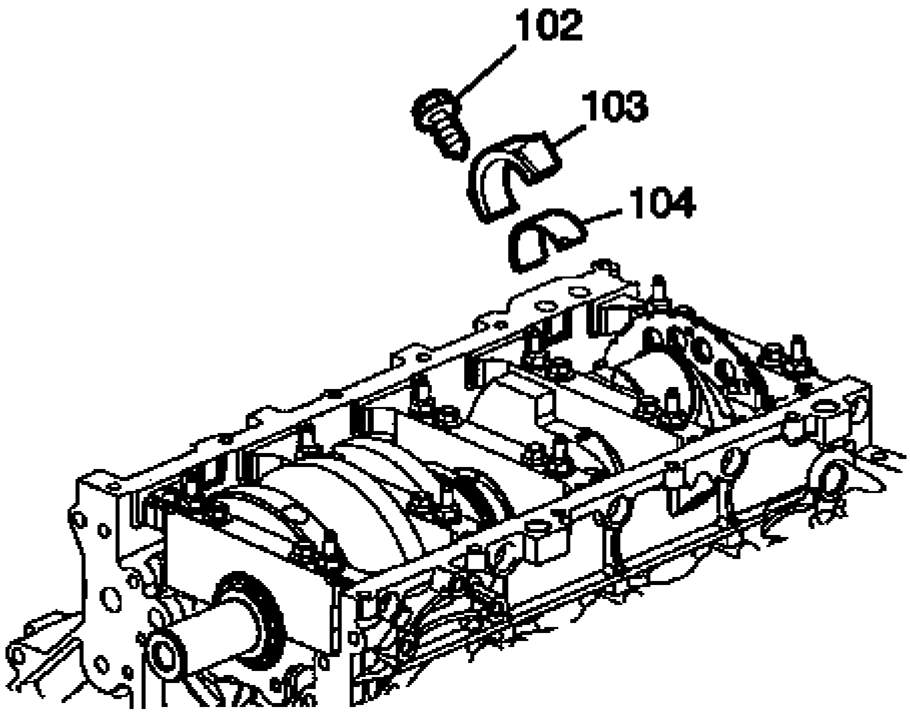


Fig. 66: Connecting Rod Bolt, Cap & Bearing
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: The connecting rod and cap must be assembled with the mating surfaces properly aligned.

11. Install the bearing cap (103), bearing (104), and bolts (102).
    1. Tighten the bolts a first pass to 20 N.m (15 lb ft).
    2. Tighten the bolts a final pass to 85 degrees using the **J 45059:** meter.

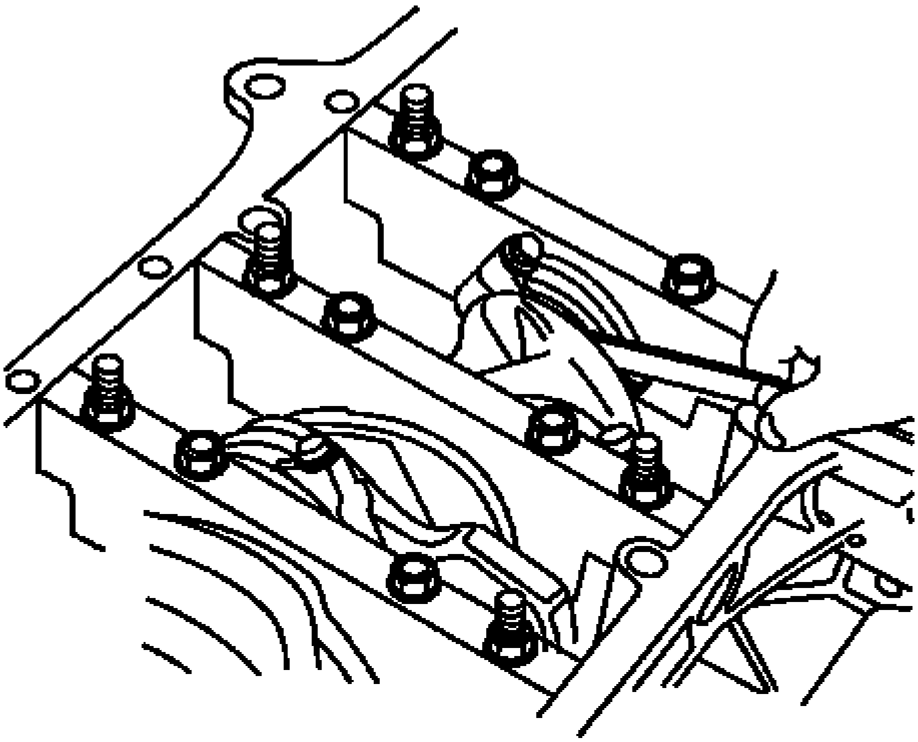


Fig. 67: Measuring Connecting Rod Side Clearance
Courtesy of GENERAL MOTORS CORP.

12. Measure the connecting rods for the proper side clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.0L L76)** .

CAMSHAFT INSTALLATION

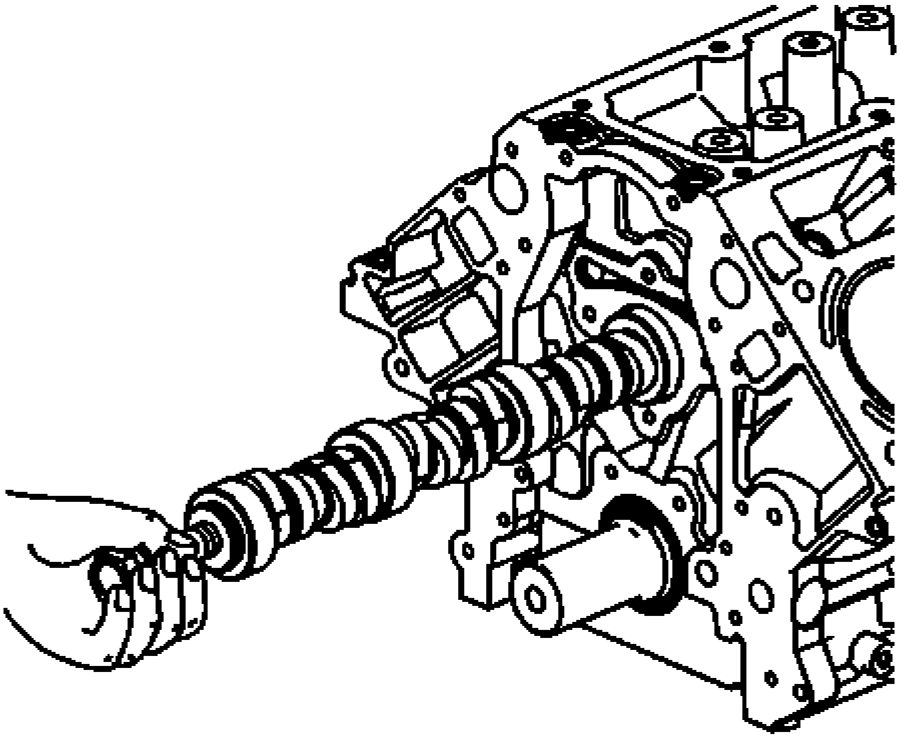


Fig. 68: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **If camshaft replacement is required, the valve lifters must also be replaced.**

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

CAUTION: **All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.**

3. Using the bolt as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt from the front of the camshaft.

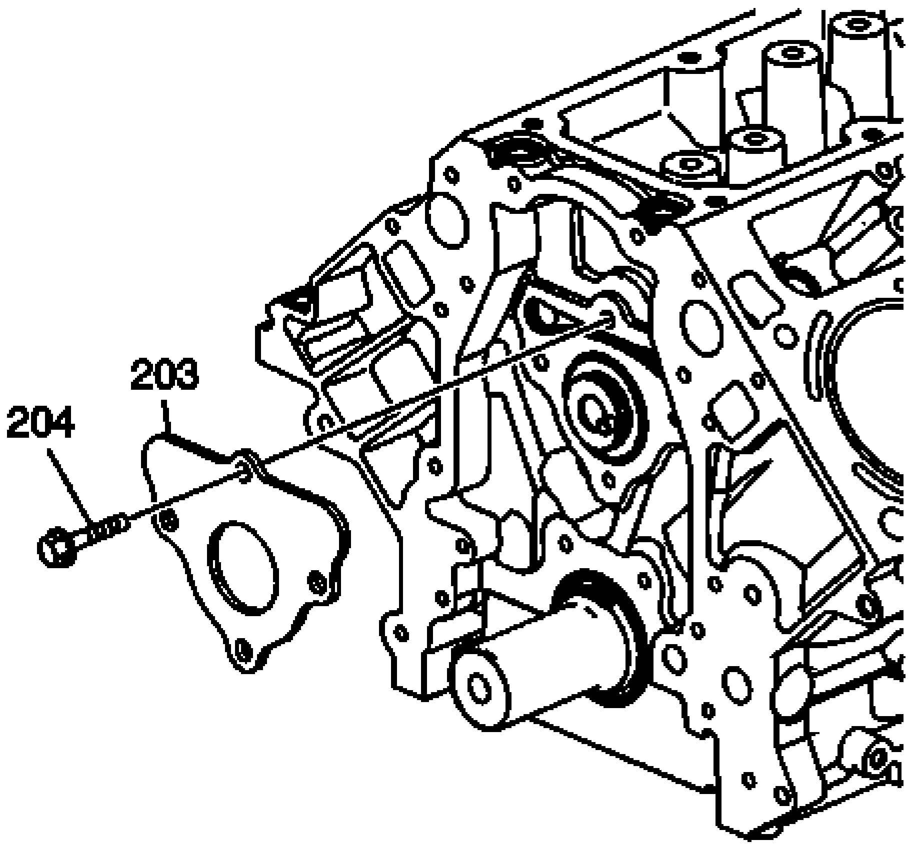


Fig. 69: View Of Camshaft Retainer & Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.

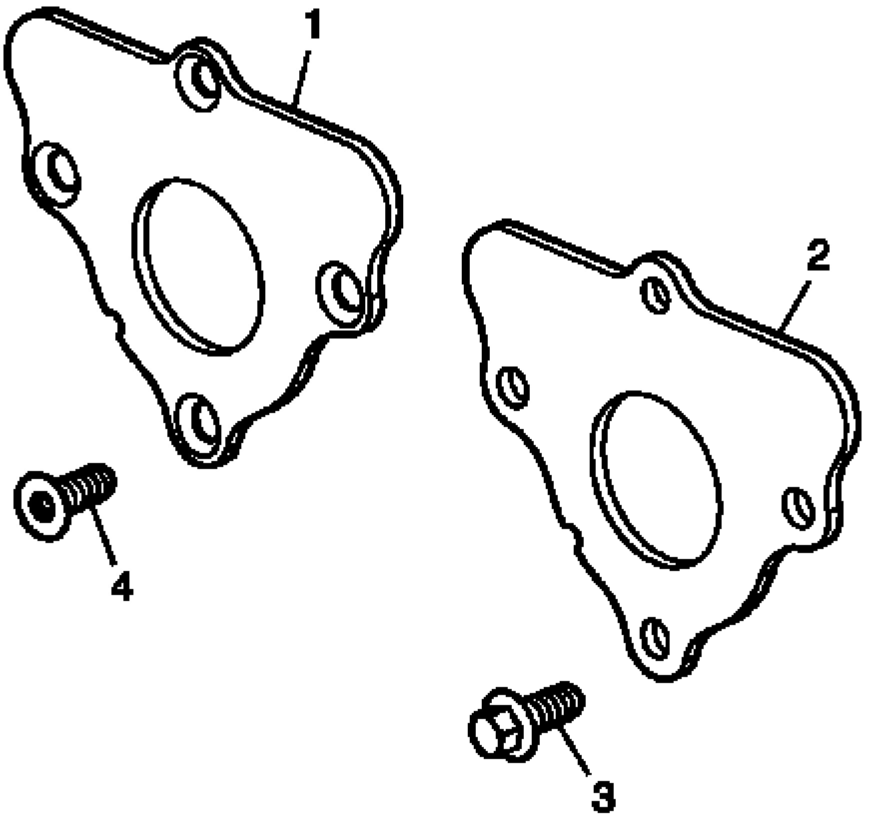


Fig. 70: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the camshaft retainer bolts.
    1. Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft) .
    2. Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft) .

TIMING CHAIN AND SPROCKET INSTALLATION

Special Tools

- **EN 46330:** Timing Belt Tensioner Retaining Pin
- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool
- **J 45059:** Angle Meter

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

INSTALLATION

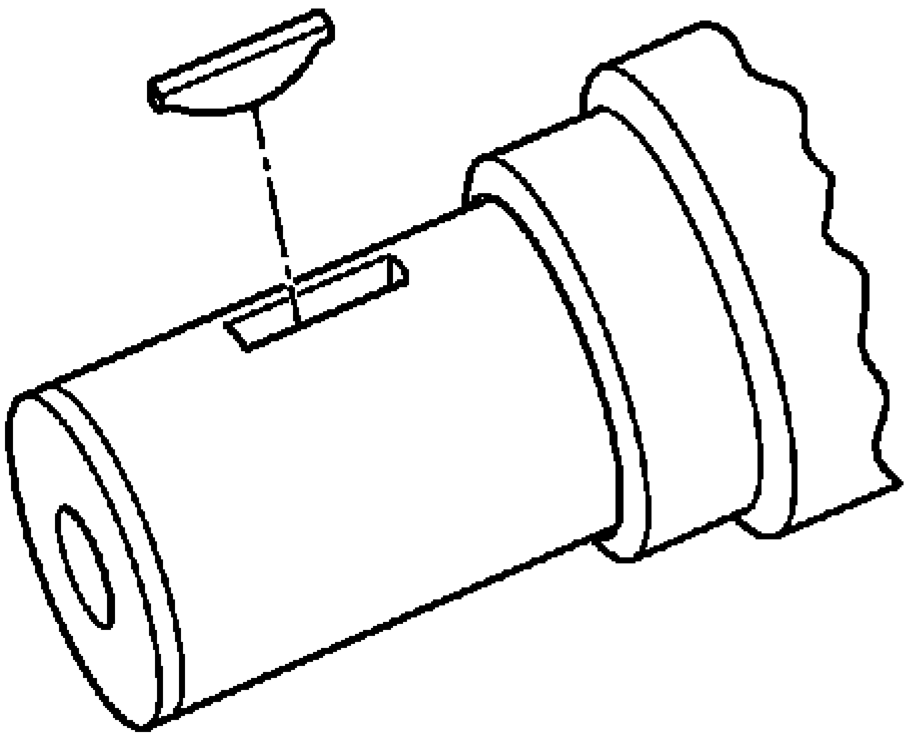


Fig. 71: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

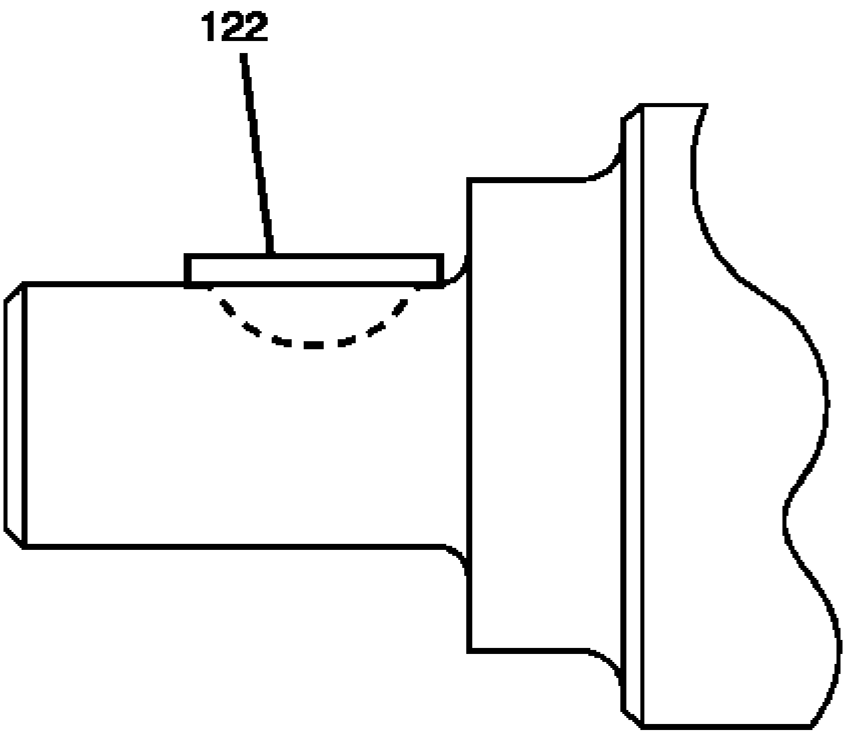


Fig. 72: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

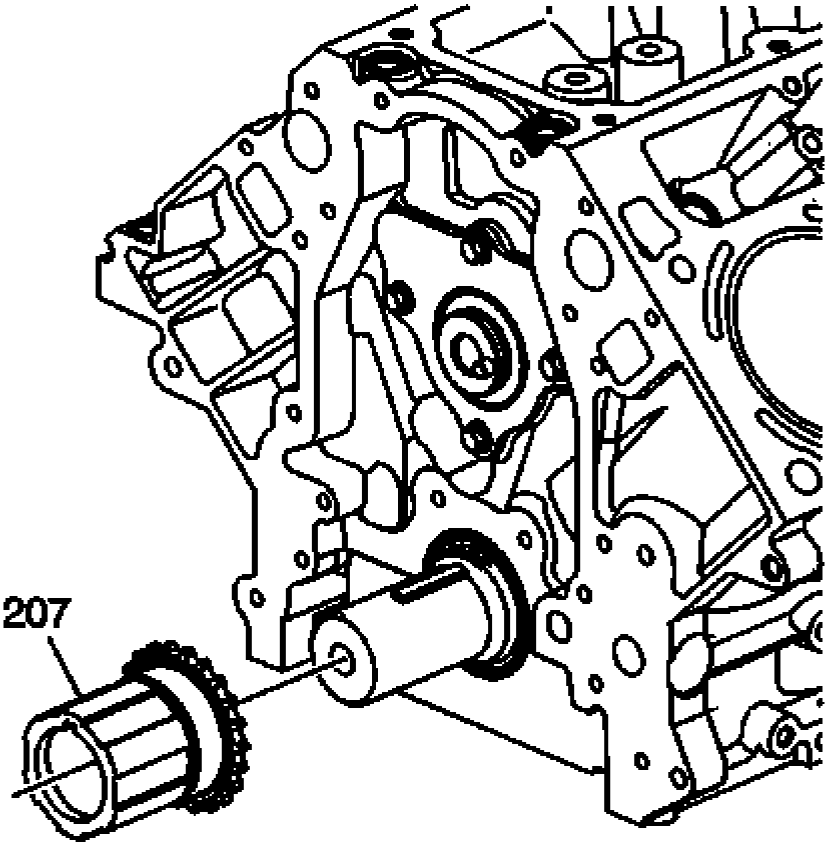


Fig. 73: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

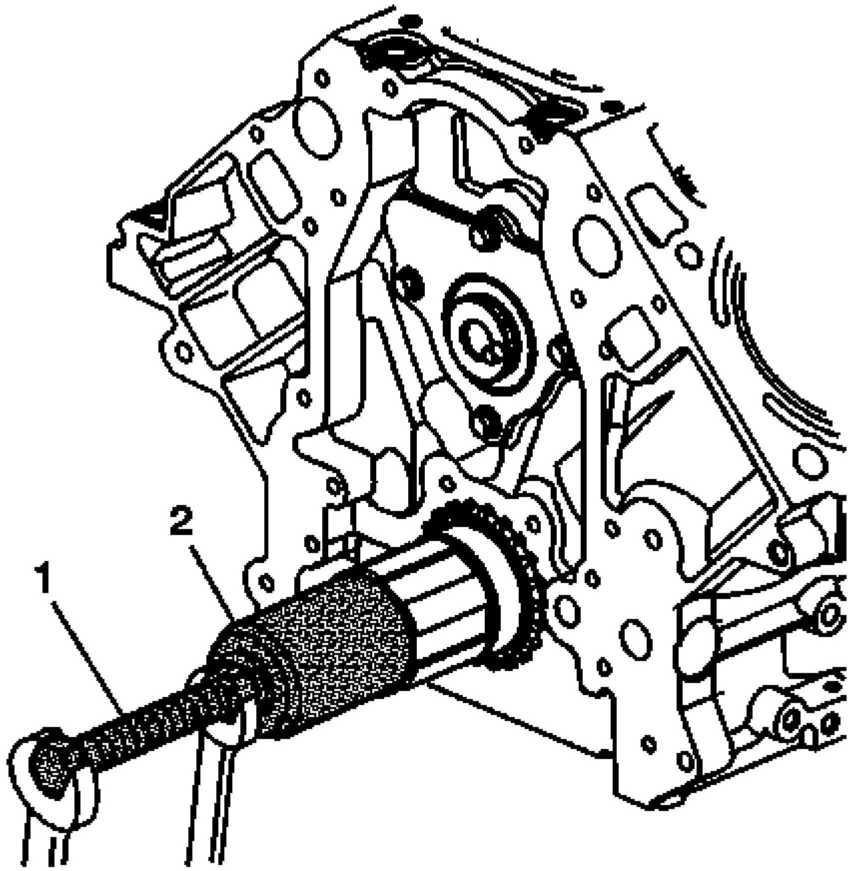


Fig. 74: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478:** seal installer (1) and the **J 41665:** balancer and sprocket installer (2) in order to install the crankshaft sprocket.

   Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

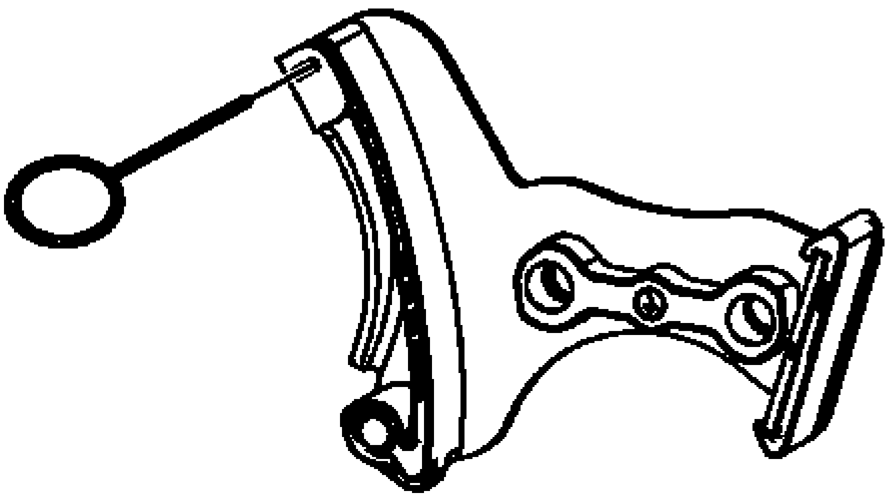


Fig. 75: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330:** retaining pin.

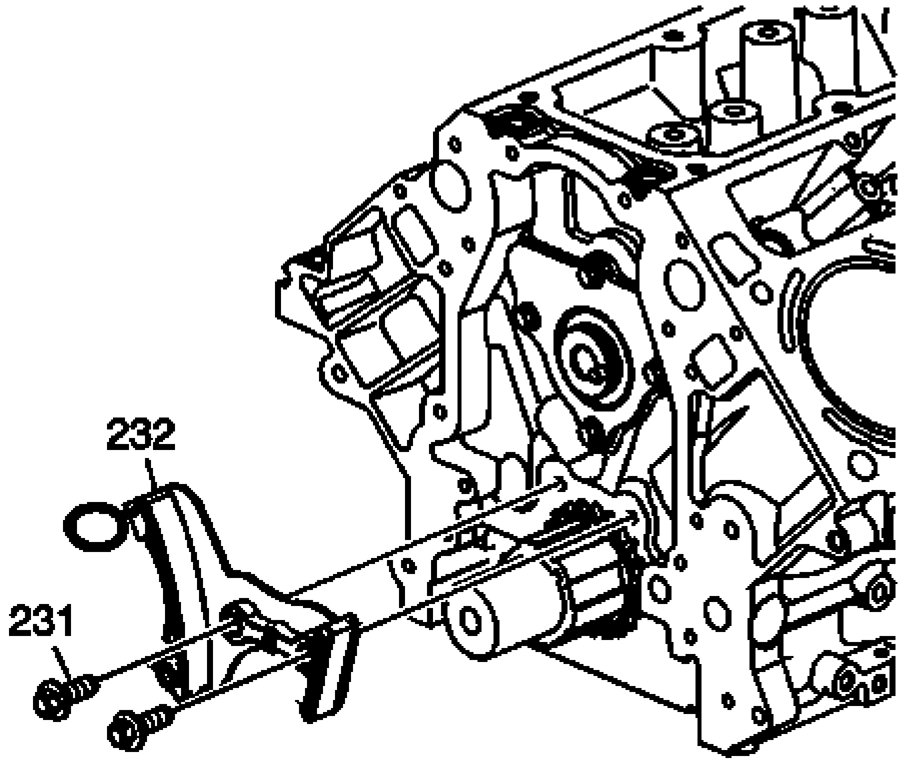


Fig. 76: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Install the timing chain tensioner (232) and bolts (231). Tighten the timing chain tensioner bolts to 25 N.m (18 lb ft).

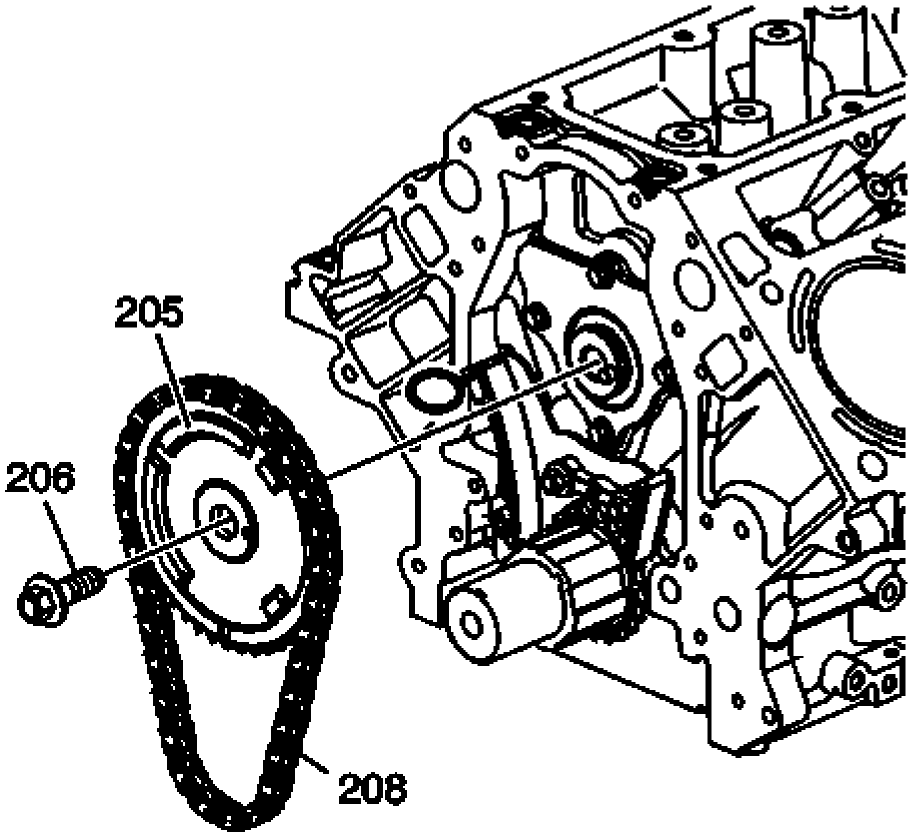


Fig. 77: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**

8. Install the camshaft sprocket (205), timing chain (208), and bolt (206).

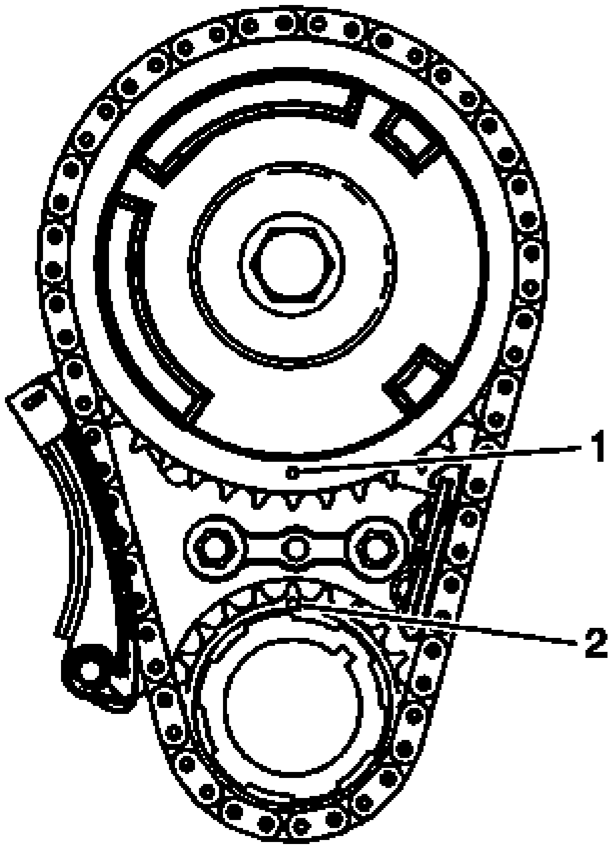


Fig. 78: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

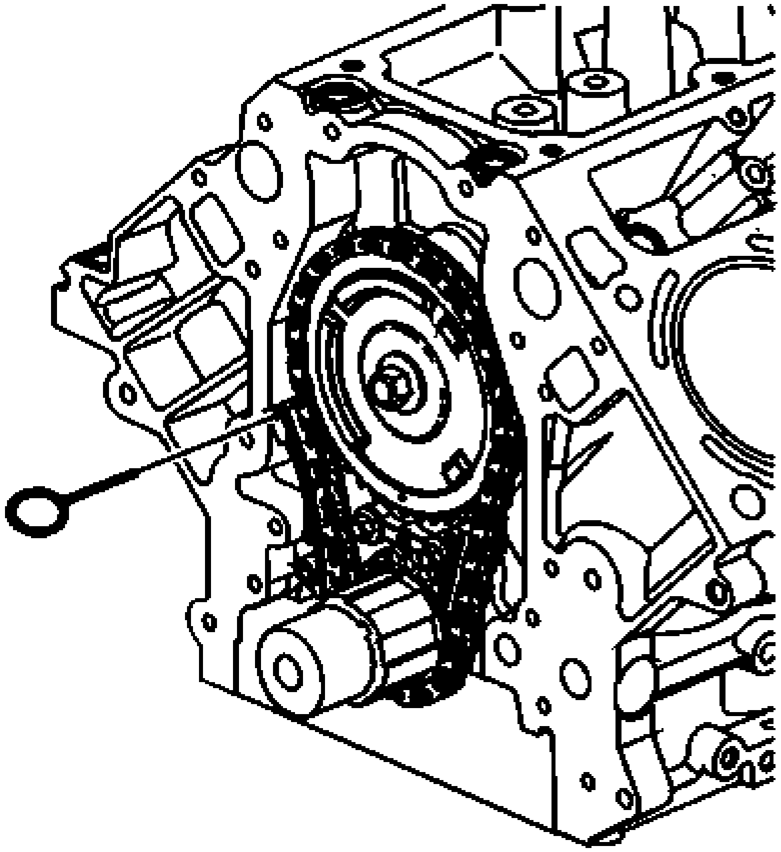


Fig. 79: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46330:** retaining pin.

NOTE: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Installation**.

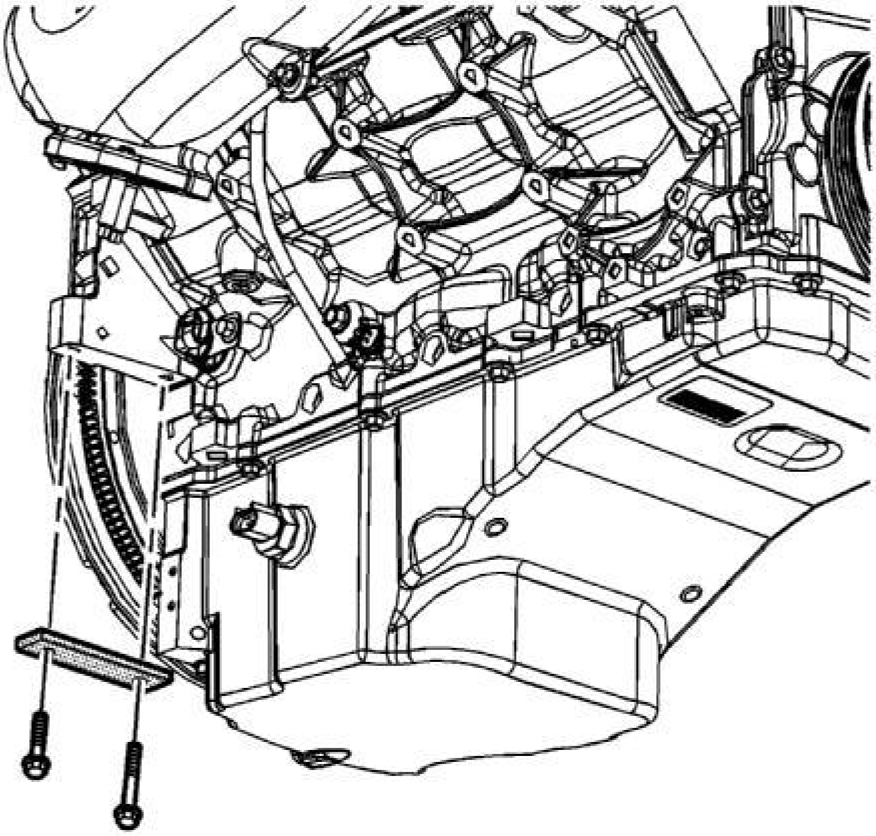


Fig. 80: Identifying J 42386-A Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 42386-A:** holding tool and bolts. Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

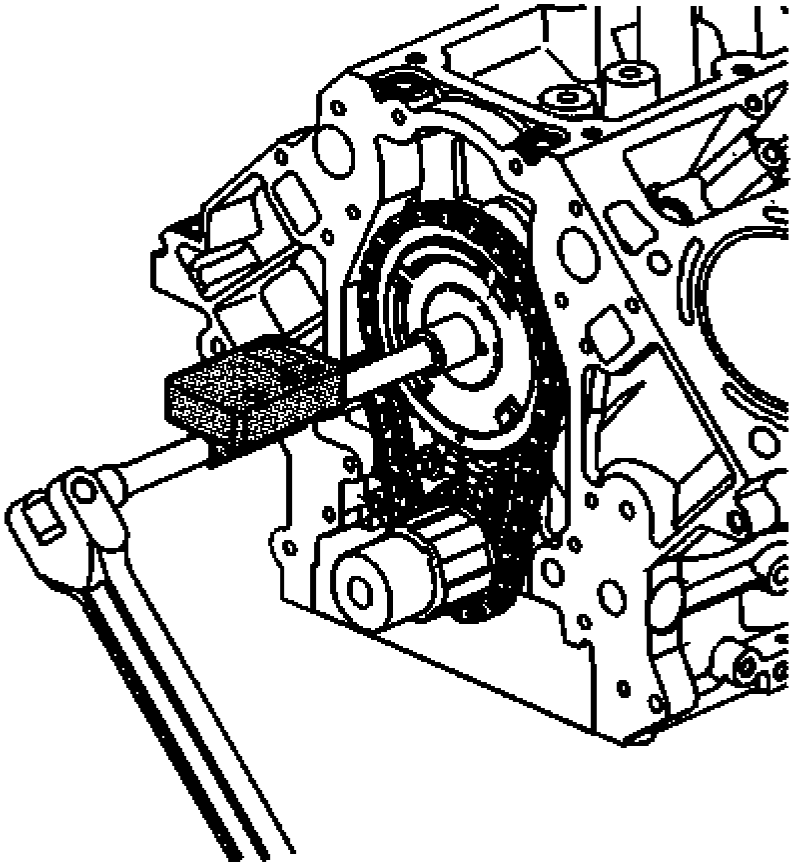


Fig. 81: Identifying Camshaft Sprocket Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

13. Tighten the camshaft sprocket bolt.
    1. Tighten the camshaft sprocket bolt a first pass to 75 N.m (55 lb ft) .
    2. Tighten the camshaft sprocket bolt a final pass an additional 50 degrees using the **J 45059:** meter .
14. Remove the **J 42386-A:** holding tool and bolts.
15. Remove the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal** .

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR INSTALLATION

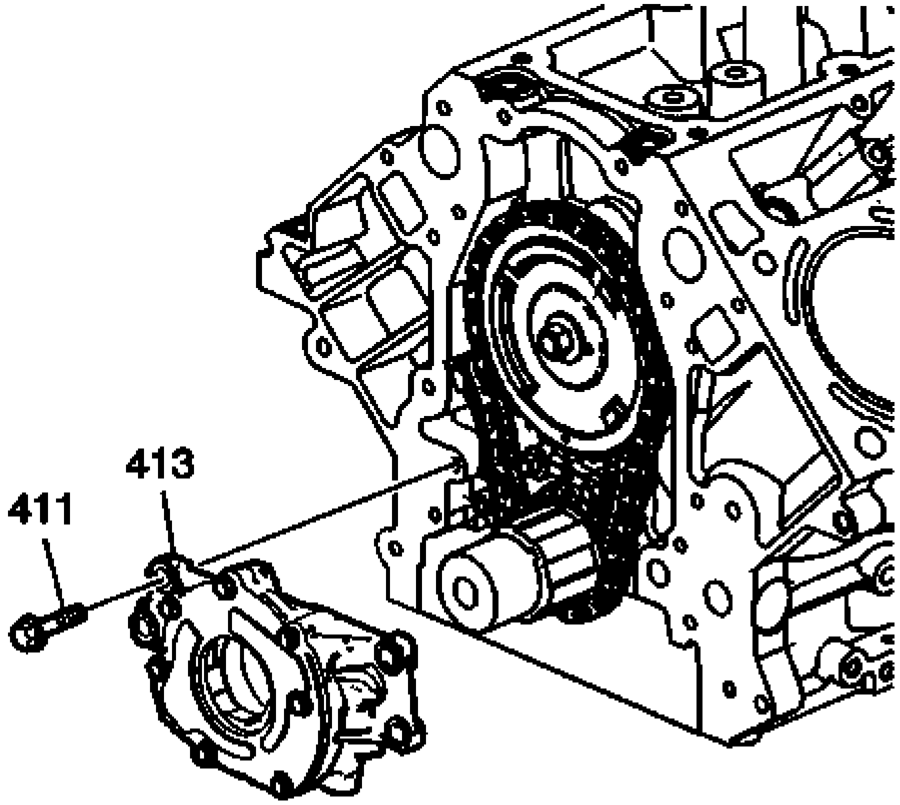


Fig. 82: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.**

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

CAUTION: **Refer to Fastener Caution .**

3. Install the oil pump bolts (411) and tighten to 25 N.m (18 lb ft).

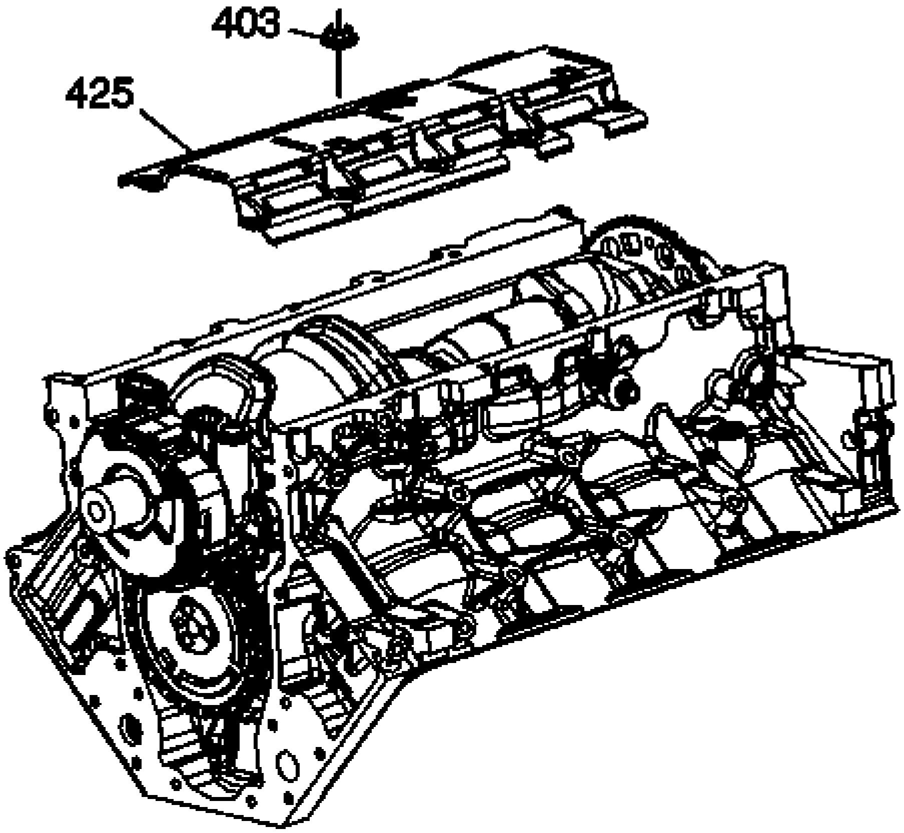


Fig. 83: Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector.

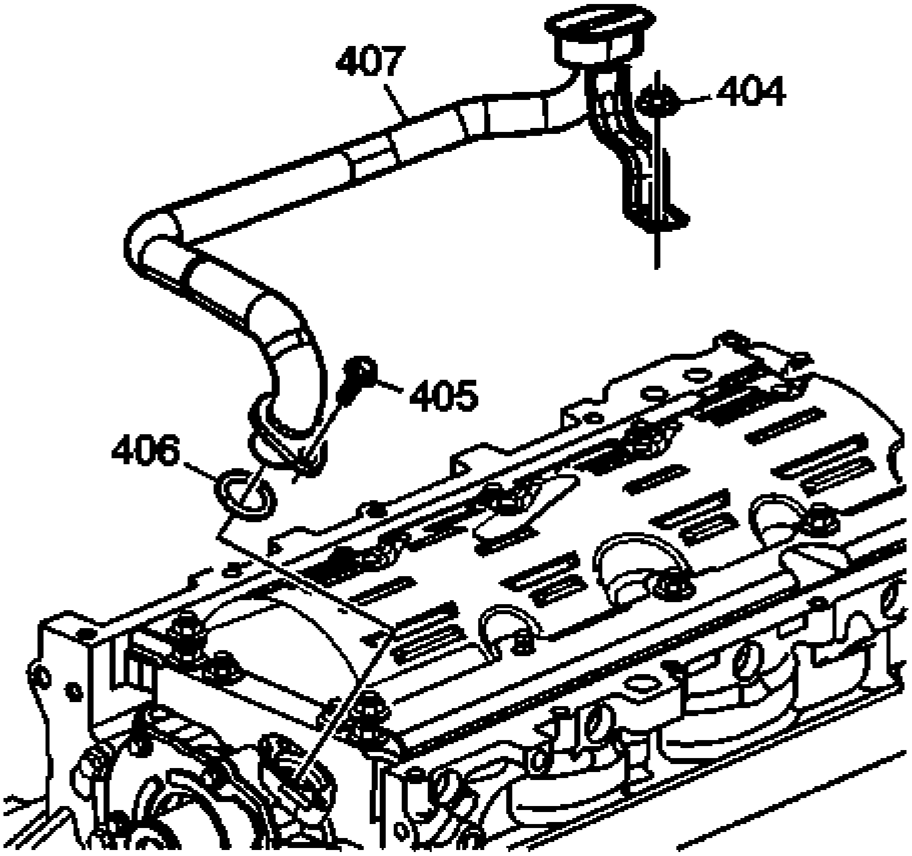


Fig. 84: Oil Pump Screen Bolt, Nut & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

NOTE:

- **Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.**
- **Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.**

7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the deflector nut (404).
    1. Tighten the oil pump screen bolt to 12 N.m (106 lb in) .
    2. Tighten the crankshaft oil deflector nut to 25 N.m (18 lb ft) .

CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION (WITHOUT SEAL IN HOUSING)

Special Tools

- **J 41476:** Front and Rear Cover Alignment Tool
- **J 41480:** Front and Rear Cover Alignment

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

INSTALLATION

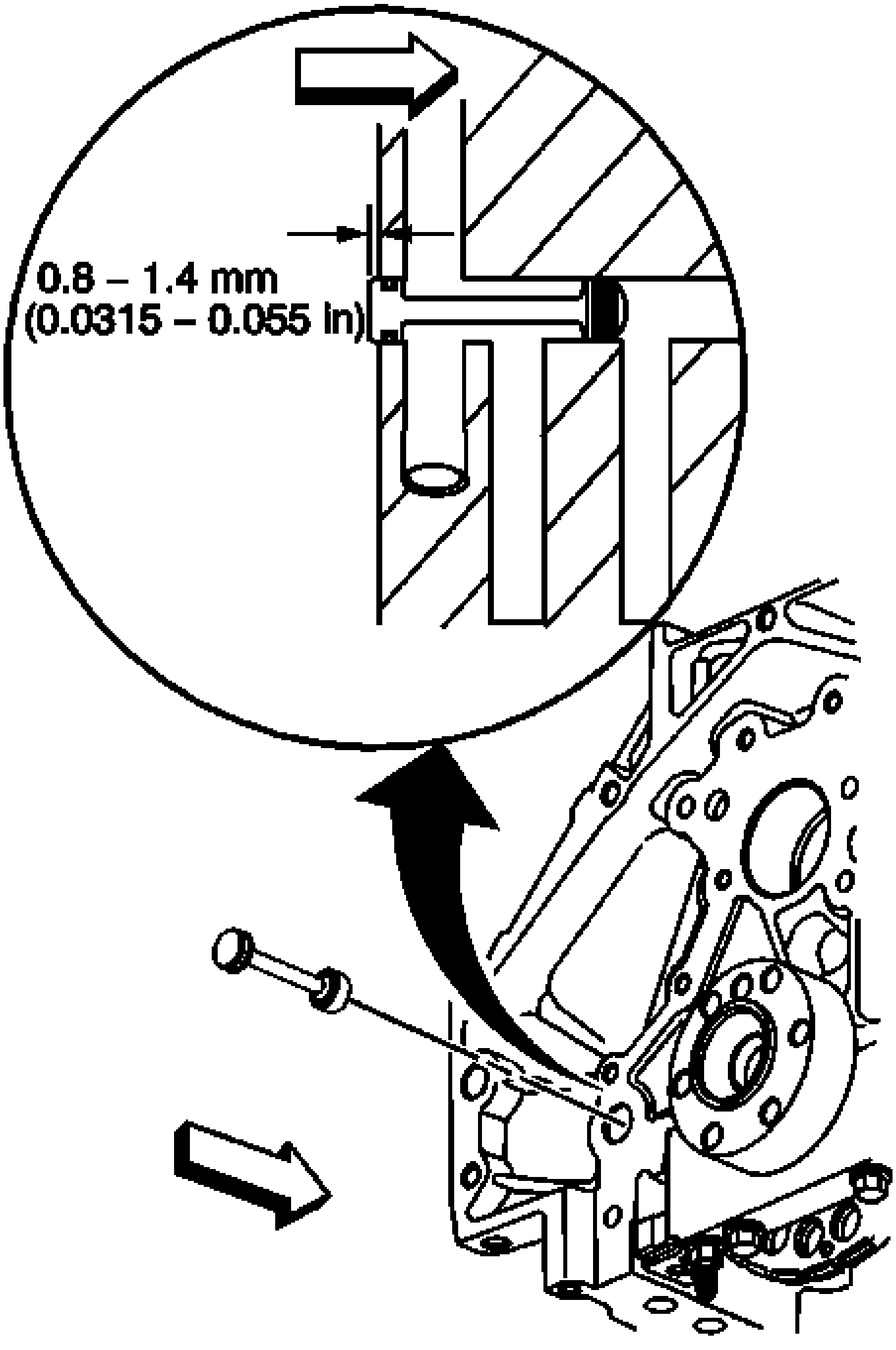


Fig. 85: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the crankshaft rear oil seal or the engine rear housing gasket again.**
- **Do not apply any type of sealant to the rear housing gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine rear housing at the oil pan surface and to center the crankshaft rear oil seal.**
- **The crankshaft rear oil seal will be installed after the rear housing has been installed and aligned. Install the rear housing without the crankshaft oil seal.**
    - **The crankshaft rear oil seal MUST be centered in relation to the crankshaft.**
    - **The oil pan sealing surface at the rear housing, and the engine block, MUST be aligned within specifications.**
    - **An improperly aligned rear housing may cause premature rear oil seal wear and/or engine assembly oil leaks.**

1. Inspect the rear oil gallery plug for proper installation.

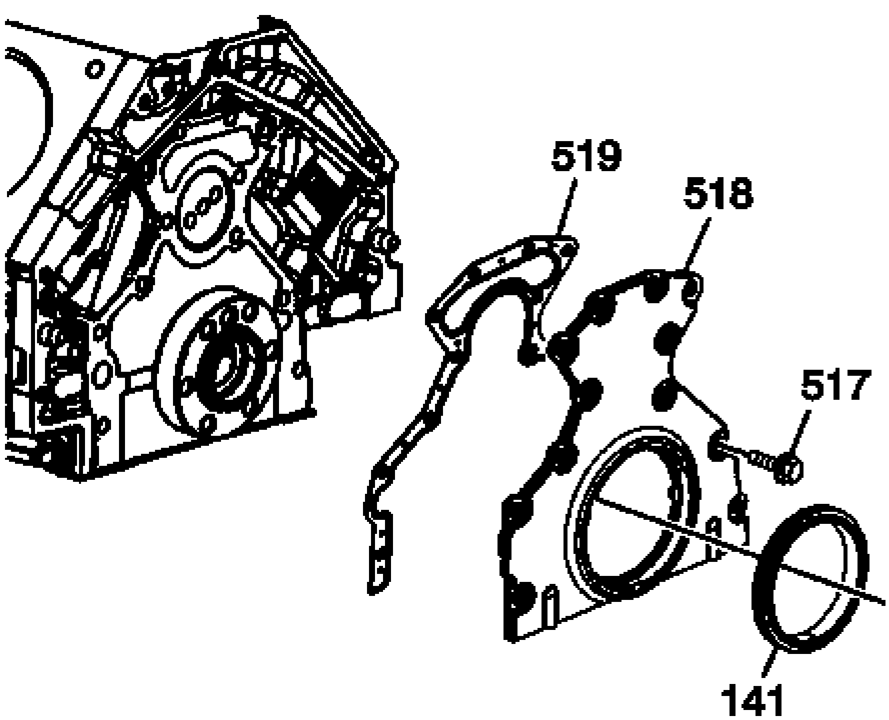


Fig. 86: View of Rear Housing, Gasket and Seal

Courtesy of GENERAL MOTORS CORP.

2. Install the rear housing gasket (519), rear housing (518), and bolts (517).
3. Tighten the bolts finger tight. Do not overtighten.

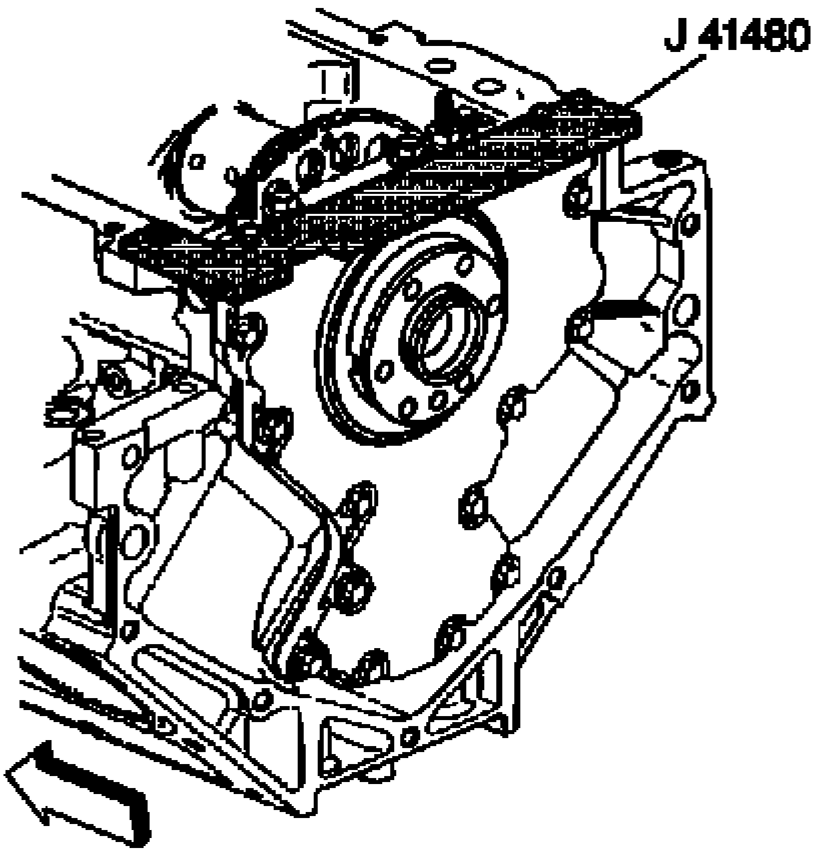


Fig. 87: View Of J 41480 Installed To Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Start the J 41480: alignment tool tool-to-rear housing bolts. Do not tighten the bolts at this time.

4. Install the **J 41480:** alignment tool and bolts. Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

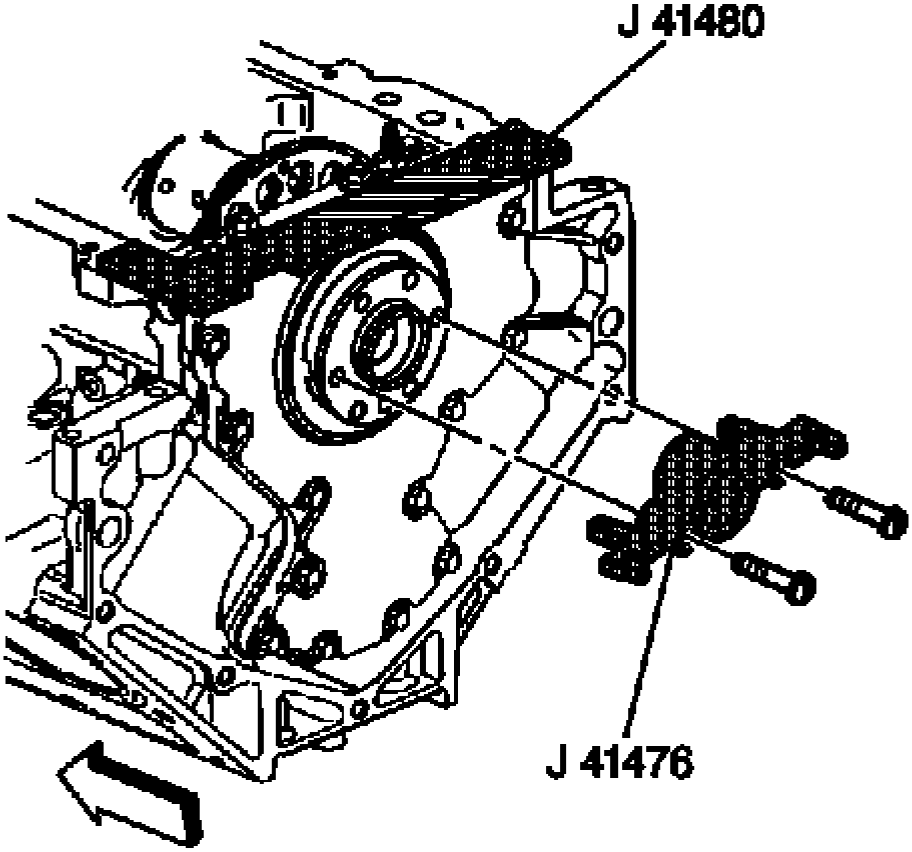


Fig. 88: View Of J 41480 & J 41476
Courtesy of GENERAL MOTORS CORP.

NOTE:	**To properly align the rear housing, the J 41476: alignment tool must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan surface.**

5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.

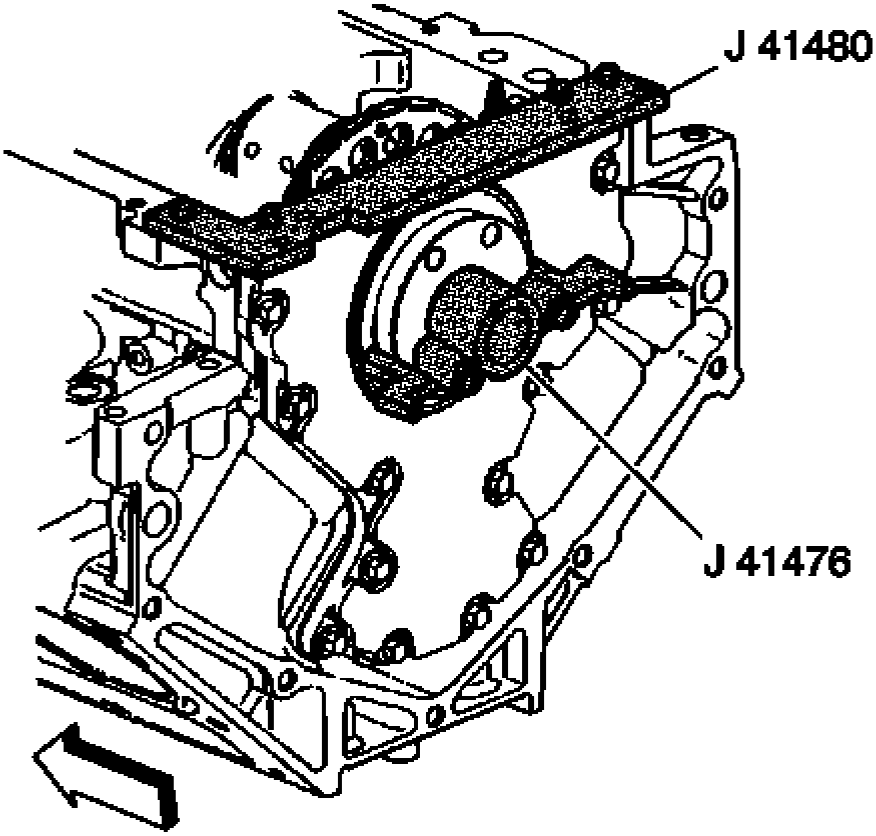


Fig. 89: View Of J 41480 & J 41476 Installed
Courtesy of GENERAL MOTORS CORP.

NOTE: The tapered legs of the alignment tool must enter the rear housing oil seal bore.

6. Install the **J 41476:** alignment tool and bolts onto the rear of the crankshaft.
    1. Tighten the tool mounting bolts until snug. Do not overtighten.
    2. Tighten the **J 41480:** alignment tool tool-to-rear housing bolts evenly to 12 N.m (106 lb in) .
    3. Tighten the rear housing bolts to 30 N.m (22 lb ft) .
7. Remove the tools.

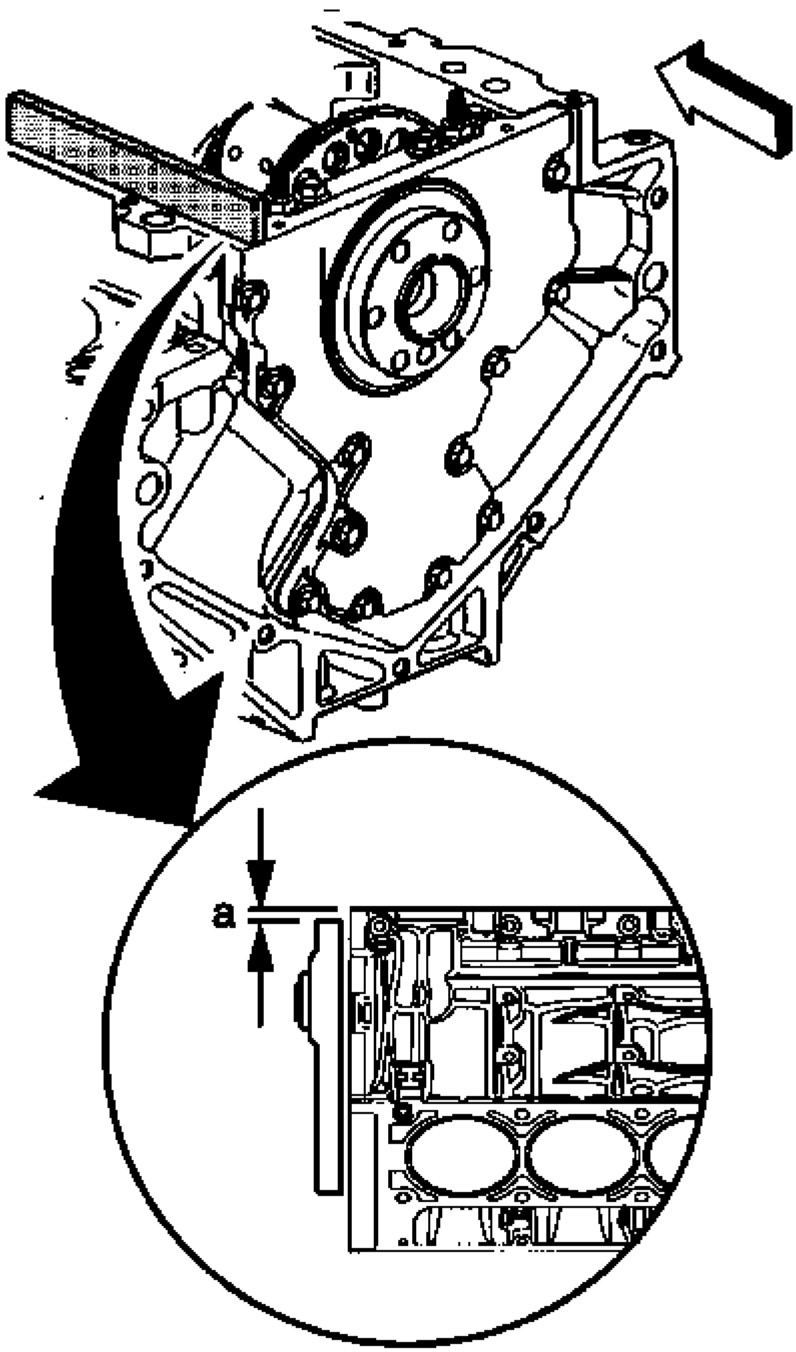


Fig. 90: Checking Rear Cover-To-Engine Block Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

8. Measure the rear housing-to-engine block oil pan surface for flatness.
   1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) below flush.

9. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
10. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION (WITH SEAL IN HOUSING)

Special Tools

- **J 41479-2A:** Crankshaft Rear Oil Seal Installation Guide
- **J 41480:** Front and Rear Cover Alignment

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

Installation

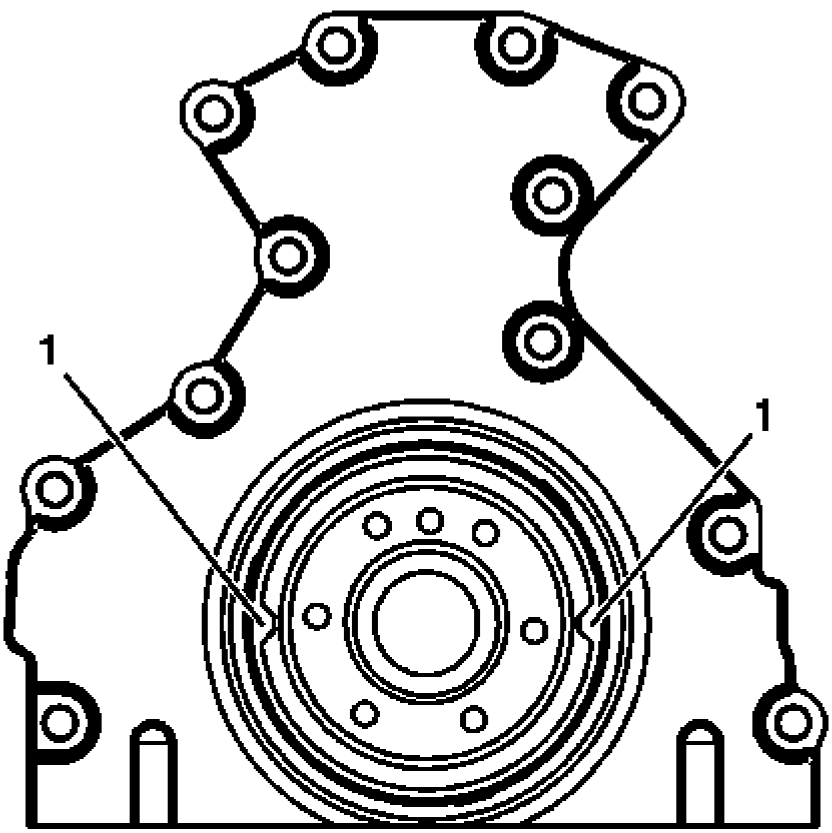


Fig. 91: View Of Rear Housing Alignment Tabs

Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the crankshaft rear oil seal or the engine rear housing gasket again.**
- **Do not apply any type of sealant to the rear housing gasket, unless specified.**
- **The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.**
- **First design rear housings do not have alignment tabs for alignment of the housing horizontally. J 41476: alignment tool is required to properly align first design rear housings. The rear oil seal must be removed from the housing for proper use of the tool.**
- **Second design rear housings have alignment tabs for alignment of the housing horizontally. J 41476: alignment tool is not required for proper alignment of second design rear housings. The housing may be installed and aligned with the seal already installed into the housing.**

1. Inspect the rear housing to identify for alignment tabs (1).

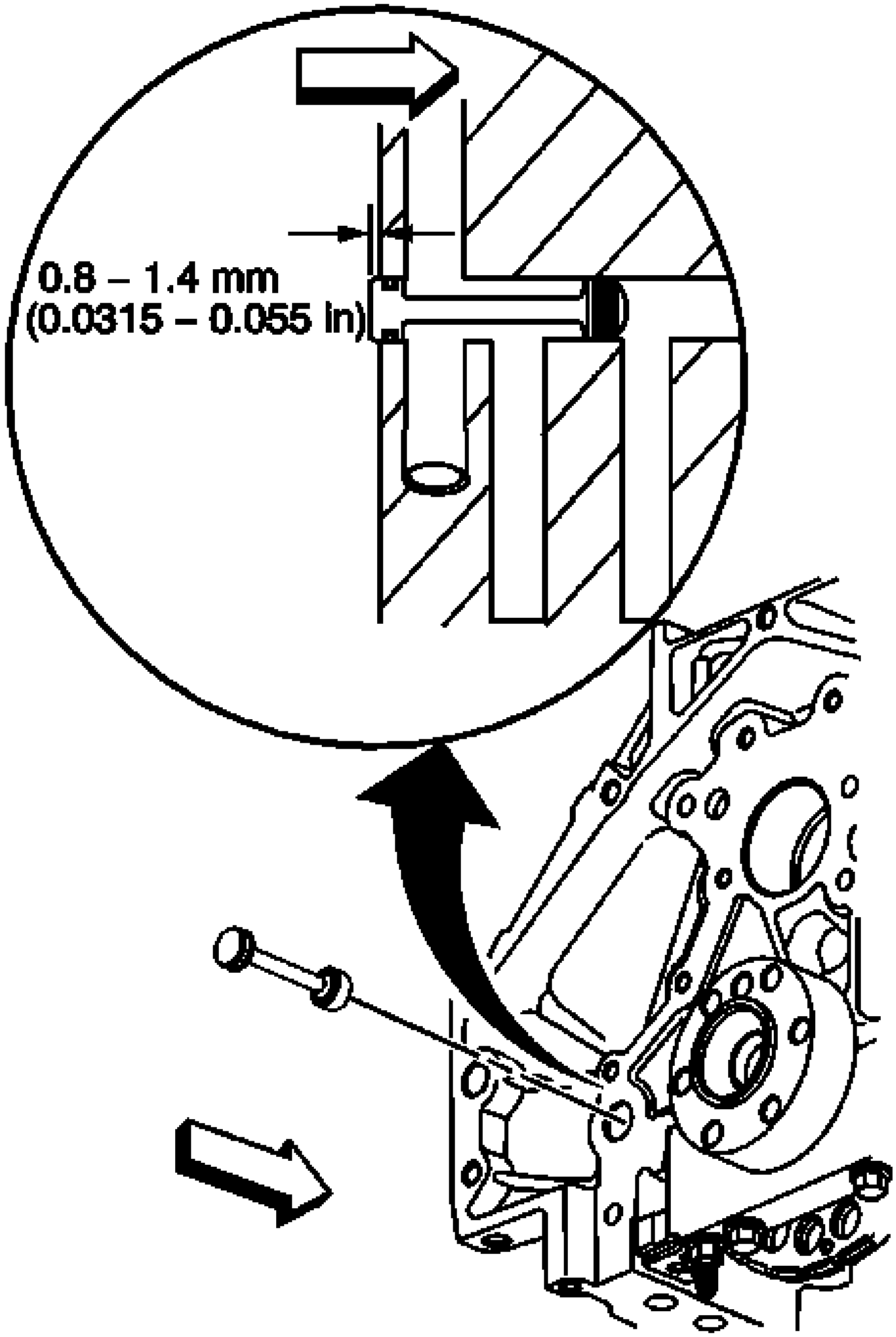


Fig. 92: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

2. Inspect the rear oil gallery plug for proper installation.

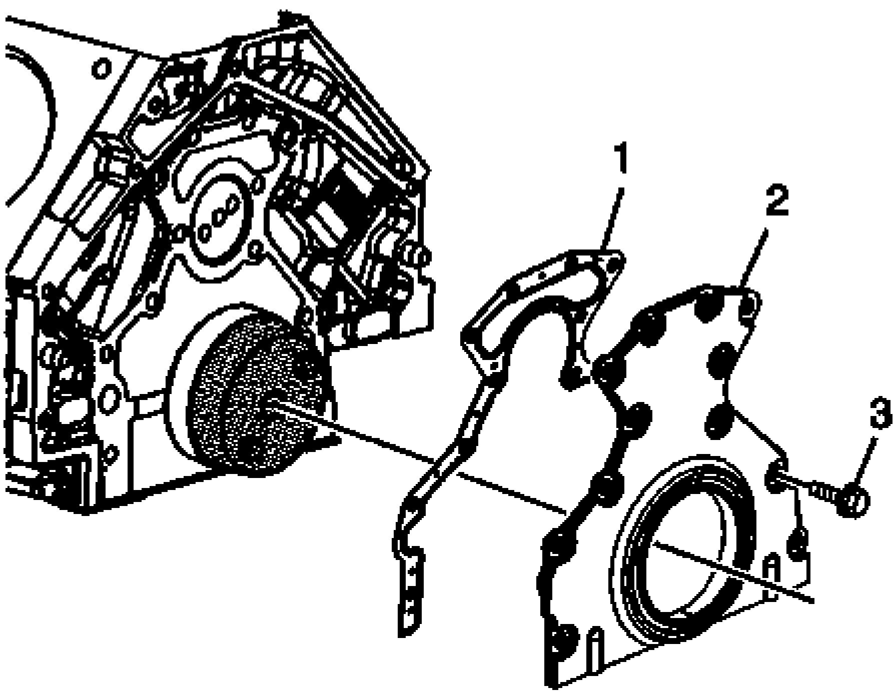


Fig. 93: View Of Rear Housing Gasket, Rear Housing With Seal And Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 41479-2A:** seal installation guide cone and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).
6. Tighten the bolts finger tight. Do not overtighten.
7. Remove the **J 41479-2A:** seal installation guide and bolts.

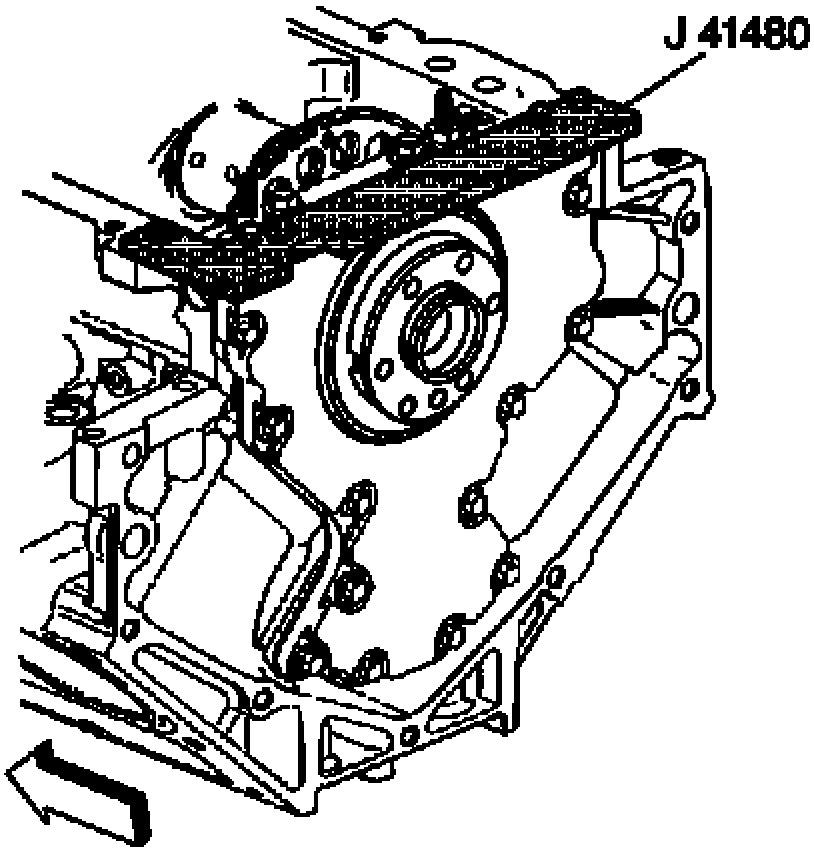


Fig. 94: View Of J 41480 Installed To Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Install the **J 41480:** alignment tool and bolts.
    1. Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft) .
    2. Tighten the **J 41480:** alignment tool tool-to-rear housing bolts evenly to 12 N.m (106 lb in) .
    3. Tighten the rear housing-to-engine block bolts to 25 N.m (18 lb ft) .
9. Remove the **J 41480:** alignment tool and bolts.

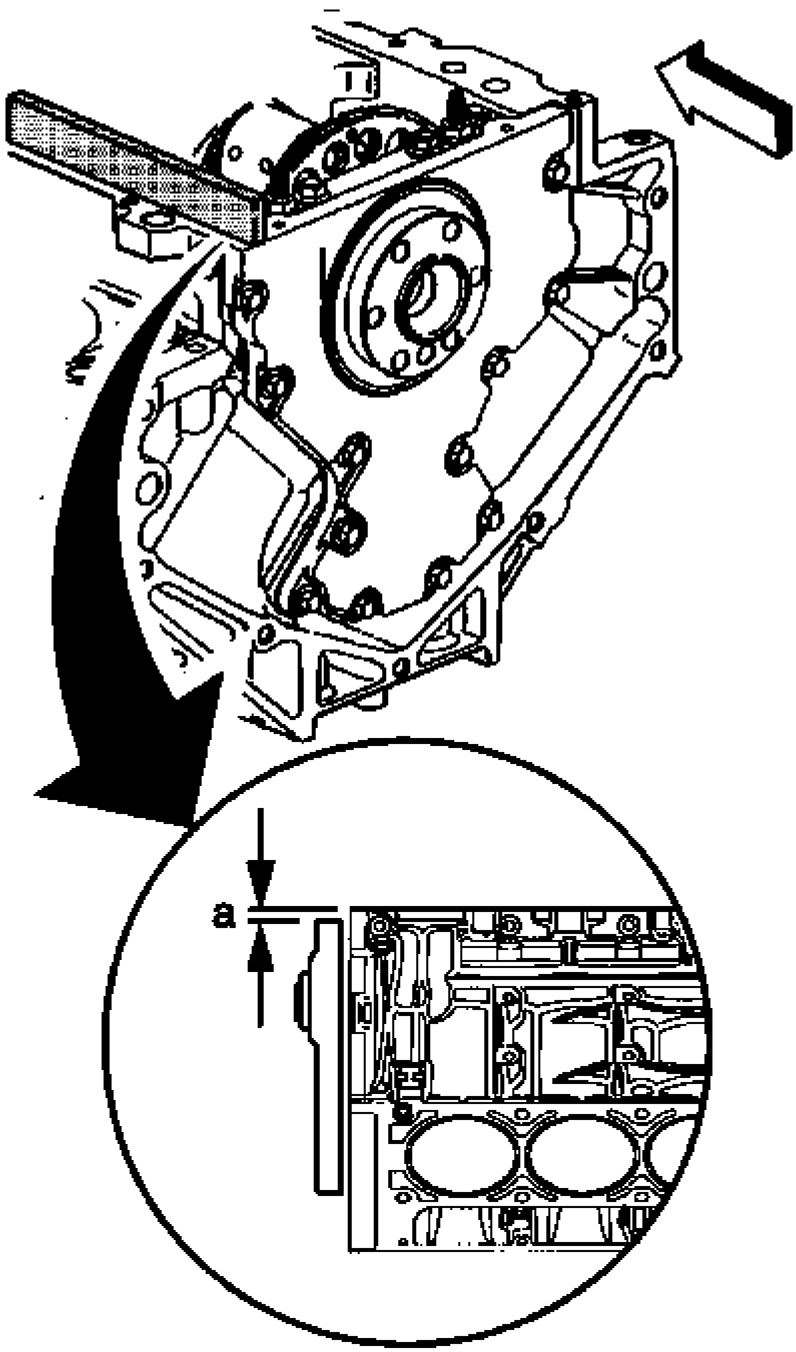


Fig. 95: Checking Rear Cover-To-Engine Block Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

10. Measure the rear housing-to-engine block oil pan surface for flatness.
    1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

2. Insert a feeler gage between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) below flush.

11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

CRANKSHAFT REAR OIL SEAL INSTALLATION

Special Tools

- **J 41479** Crankshaft Rear Oil Seal Installer. See **Special Tools** .
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide

Installation

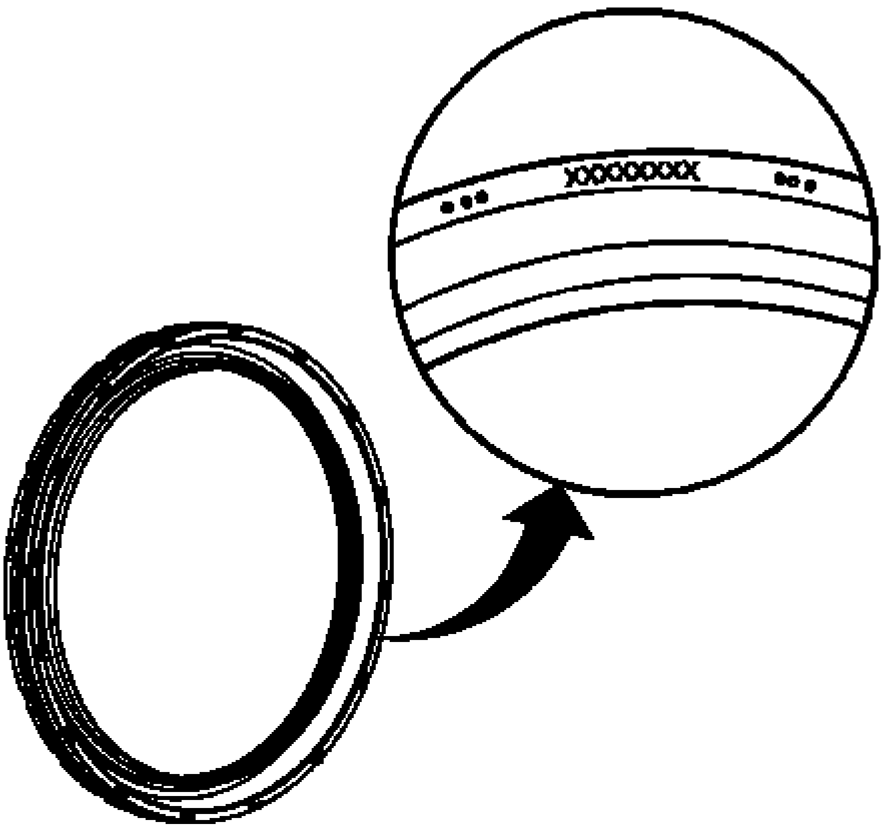


Fig. 96: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

IMPORTANT:

- **Do not lubricate the oil seal (1) inside diameter (ID) of the crankshaft surface.**
- **Do not reuse the crankshaft rear oil seal (1).**

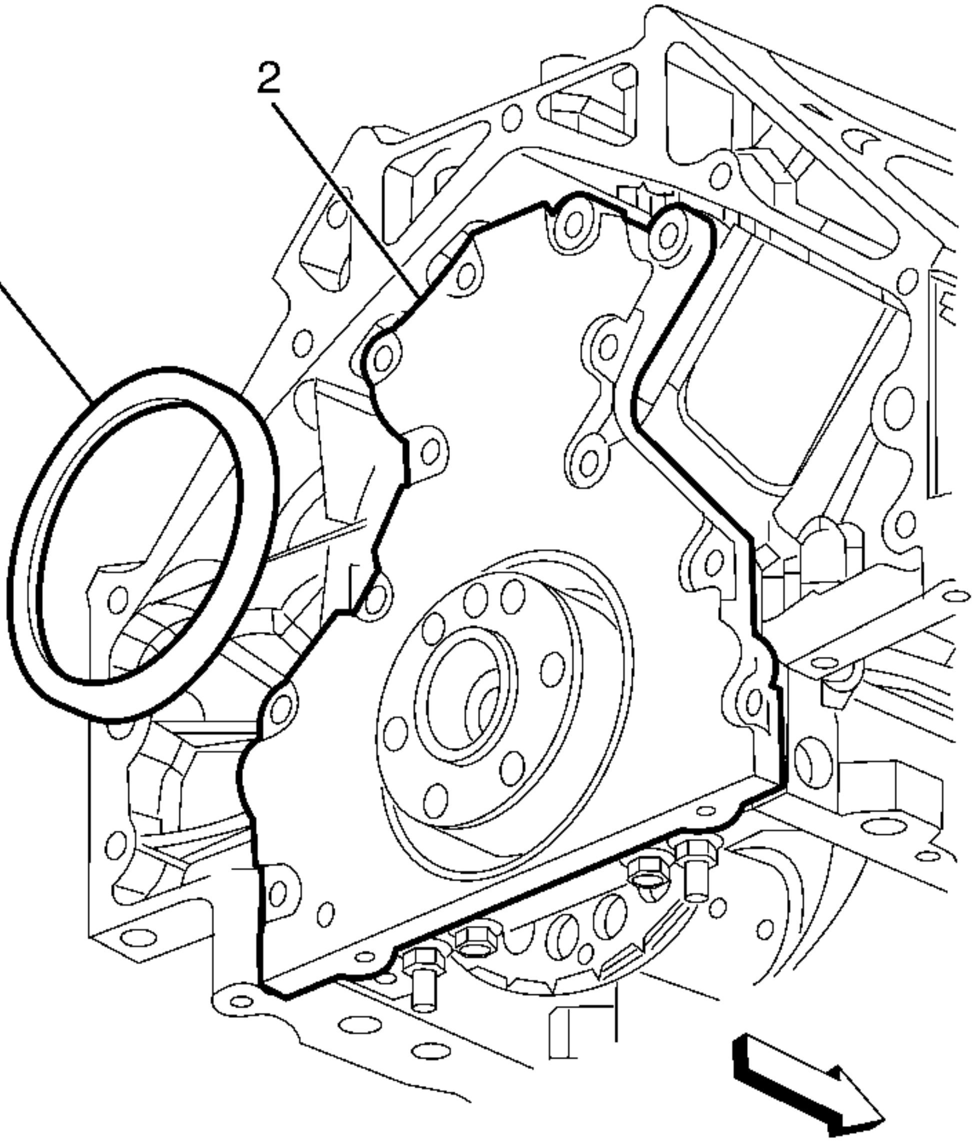


Fig. 97: Identifying Crankshaft Rear Cover & Oil Seal
Courtesy of GENERAL MOTORS CORP.

2. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.

   DO NOT allow oil or other lubricants to contact the seal surface.

3. Lubricate the rear cover (2) oil seal bore with clean engine oil.

   DO NOT allow oil or other lubricants to contact the crankshaft surface.

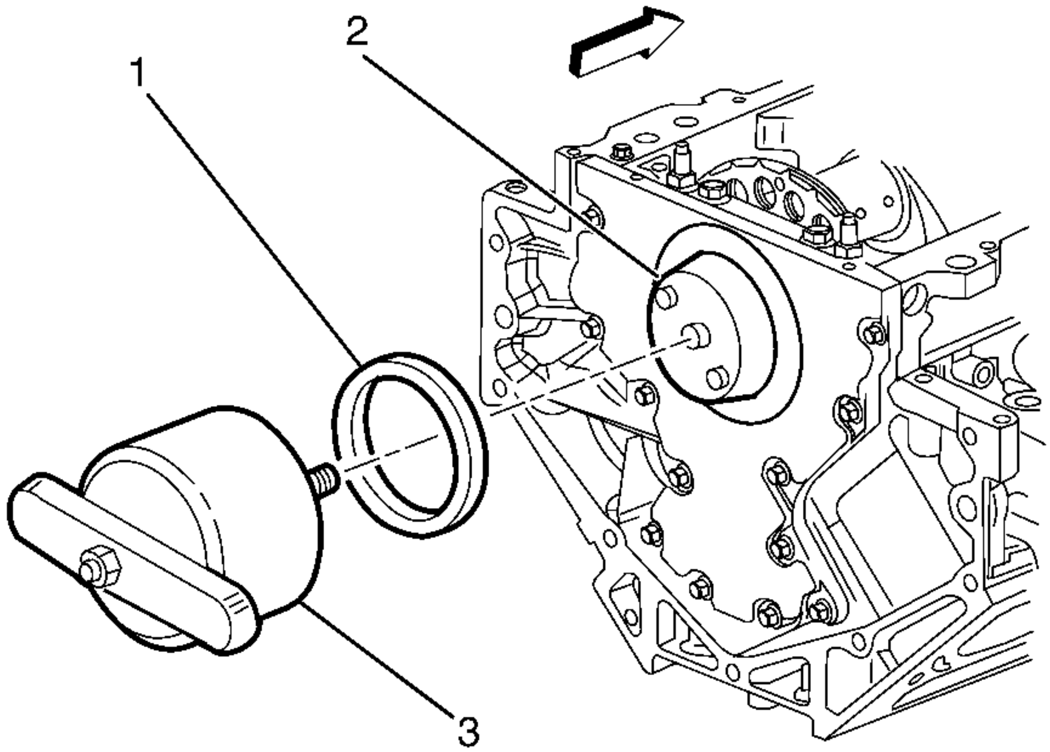


Fig. 98: Locating J 41479 Cone, Rear Oil Seal & Rear Cover Bore
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 41479-2A** (2) cone and bolts onto the rear of the crankshaft.

IMPORTANT: Do not over tighten the bolts.

5. Tighten the bolts.
6. Install the rear oil seal (1) onto the **J 41479** (3) and push the seal to the rear cover bore (2). See **Special Tools** .
7. Thread the **J 41479** (3) threaded rod into the tapered cone until the **J 41479** (3) contacts the rear oil seal (1). See **Special Tools** .
8. Align the rear oil seal (1) onto the **J 41479** (3). See **Special Tools** .
9. Rotate the handle of the **J 41479** (3) clockwise until the rear oil seal (1) enters and bottoms into the rear cover bore (2). See **Special Tools** .
10. Remove the **J 41479** (3) and **J 41479-2A** . See **Special Tools** .

ENGINE FRONT COVER INSTALLATION

Special Tools

- **EN-48853:** Front Cover Alignment Tool
- **J 41480:** Front and Rear Cover Alignment

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

Installation

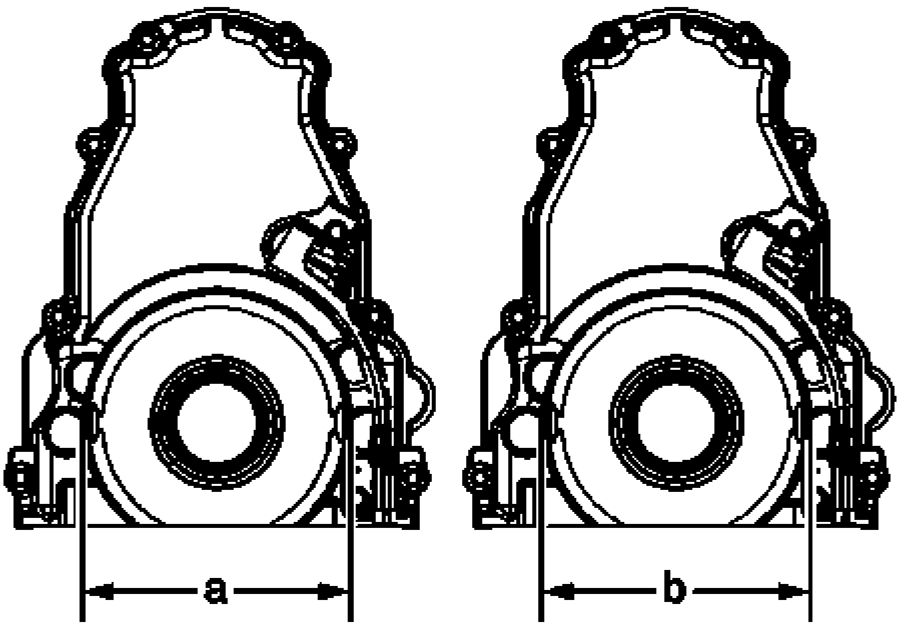


Fig. 99: Identifying Alignment Tab Distance
Courtesy of GENERAL MOTORS CORP.

1. Measure the alignment tab distance on the front cover.

   For 2009 model year, the engine front cover may have either a 141 mm (5.55 in) dimension (a) or 159 mm (6.26 in) dimension (b) alignment tab distance. The **EN-48853:** front cover alignment tool is designed to properly align both design front covers. For the 141 mm (5.55 in) cover, the **EN 48853-2:** adapters must be used.

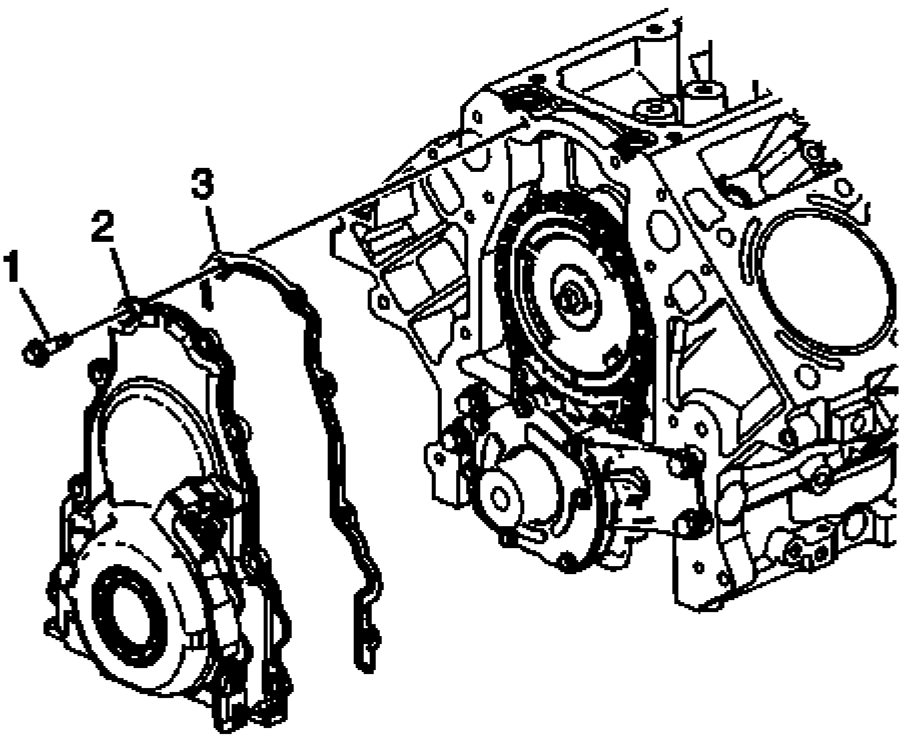


Fig. 100: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Do not use the crankshaft oil seal or the engine front cover gasket again.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.**
    - **All gasket surfaces should be free of oil or other foreign material during assembly.**

      The crankshaft front oil seal MUST be centered in relation to the crankshaft.
    - **The oil pan sealing surface at the front cover and engine block**

MUST be aligned within specifications.
- **An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.**

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

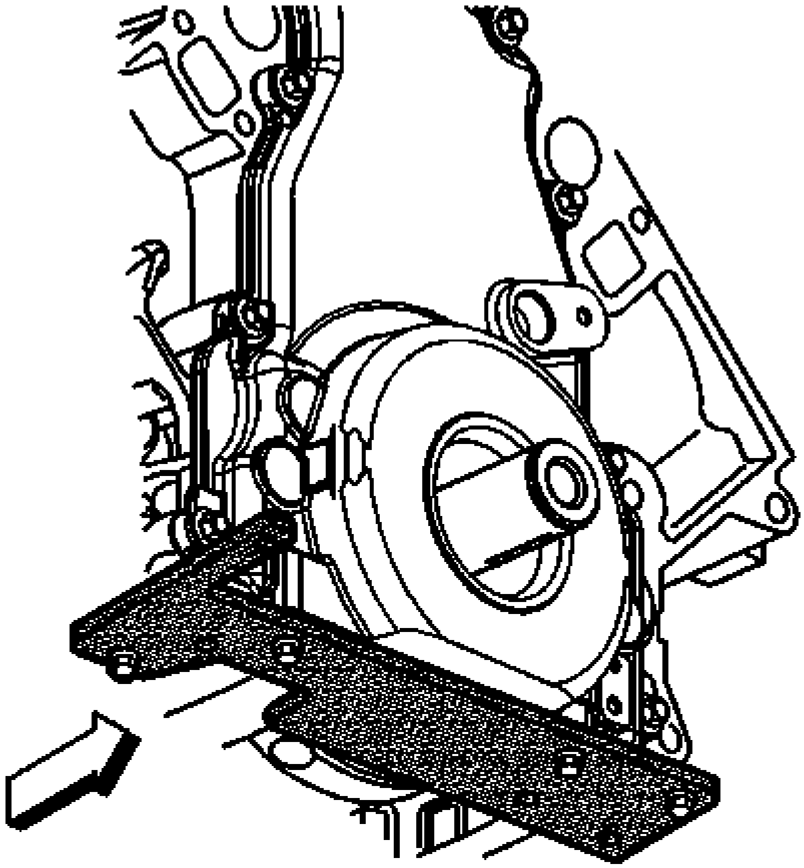


Fig. 101: Front Cover Alignment Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the **J 41480:** alignment tool. Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

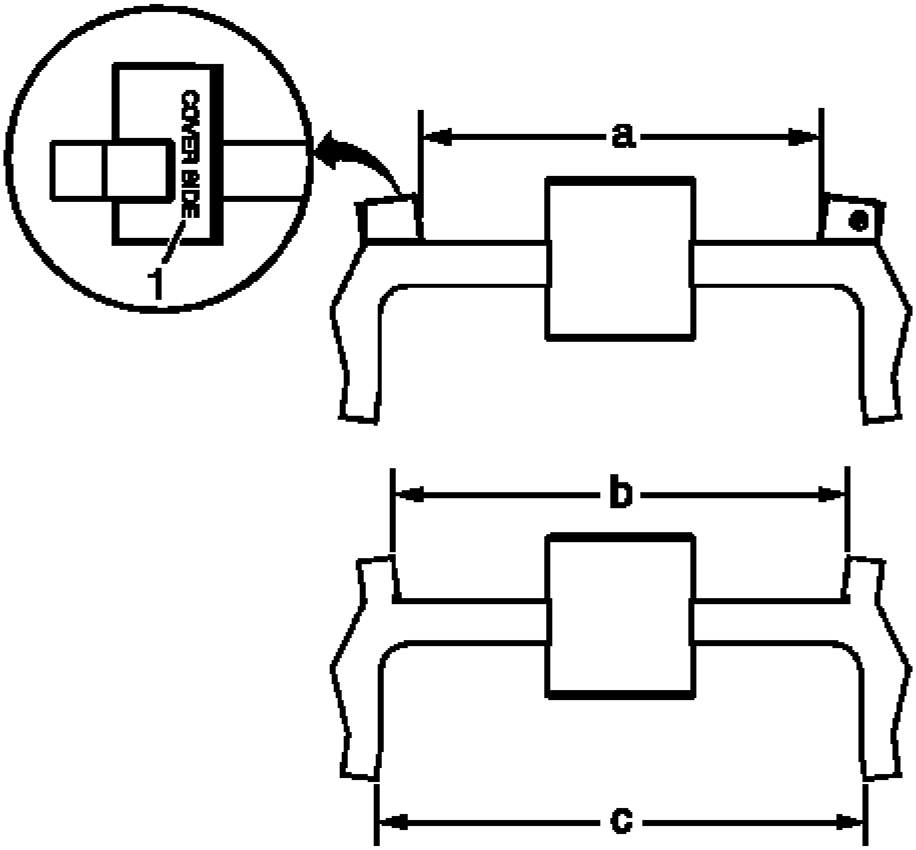


Fig. 102: Identifying Measurement Points
Courtesy of GENERAL MOTORS CORP.

5. Install the **EN 48853-2:** adapters as required for usage on the 141 mm (5.55 in) dimension (a) front cover. Position the adapters against the legs of the **EN-48853:** alignment tool with the words "cover side" (1) facing away from the tool.

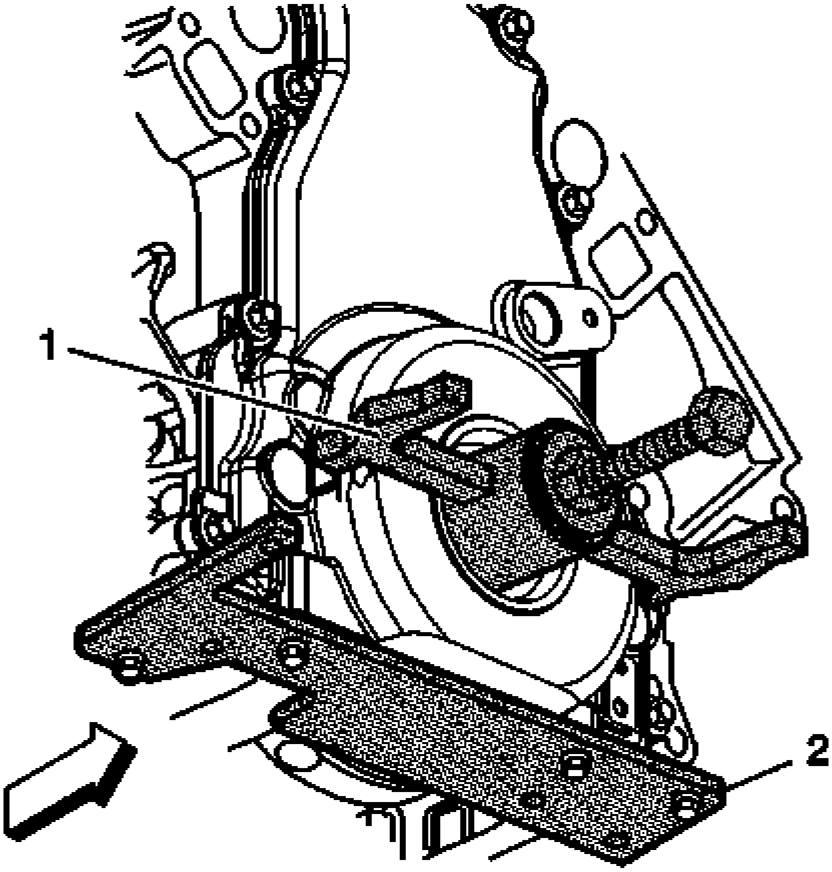
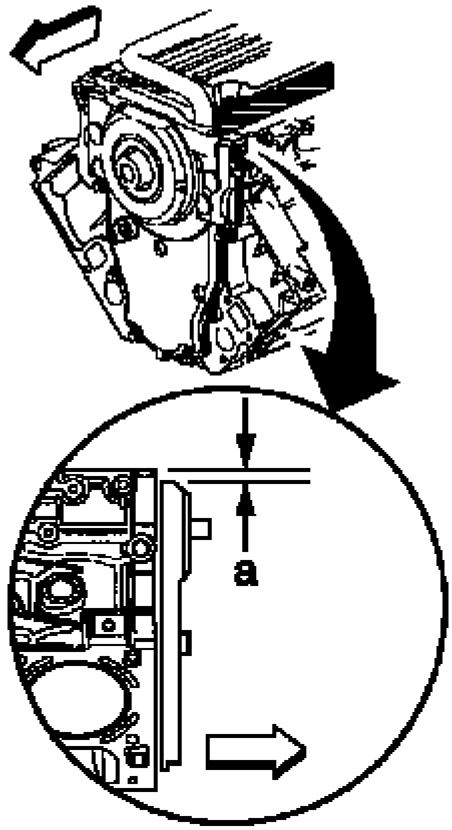


Fig. 103: Alignment Tools Installed
Courtesy of GENERAL MOTORS CORP.

NOTE: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the **EN-48853:** alignment tool (1).
7. Install the crankshaft balancer bolt.
    1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
    2. Tighten the **J 41480:** alignment tool (2).
    3. Tighten the engine front cover bolts to 25 N.m (18 lb ft) .
8. Remove the tools.



<u>Fig. 104: Measuring Oil Pan Surface Flatness & Front Cover-To-Engine Block</u>
Courtesy of GENERAL MOTORS CORP.

9. Measure the oil pan surface flatness, front cover-to-engine block.
    1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

       Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    2. Insert a feeler gage between the front cover and the straight edge tool. The cover must be flush with the oil pan surface, or no greater than 0.5 mm (0.02 in) (a) below flush.
10. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
11. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

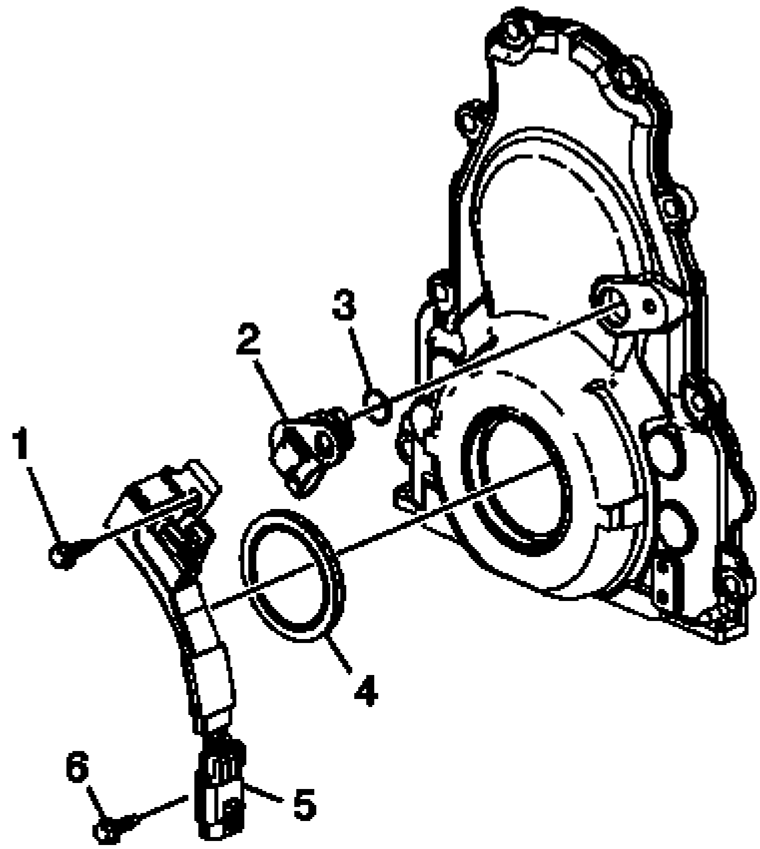


Fig. 105: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

12. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
13. Lubricate the O-ring seal with clean engine oil.
14. Install the O-ring seal onto the sensor (2).
15. Install the sensor to the cover.
16. Install the CMP sensor wire harness (5) and bolts (1, 6). Tighten the bolts to 12 N.m (106 lb in).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Tools Required

J 41478 Crankshaft Front Oil Seal Installer. See **Special Tools** .

Installation

IMPORTANT:
- **Do not lubricate the oil seal sealing surface.**
- **Do not reuse the crankshaft oil seal.**

- **Lubricate the outer edge of the oil seal with clean engine oil.**
- **Lubricate the front engine cover oil seal bore with clean engine oil.**

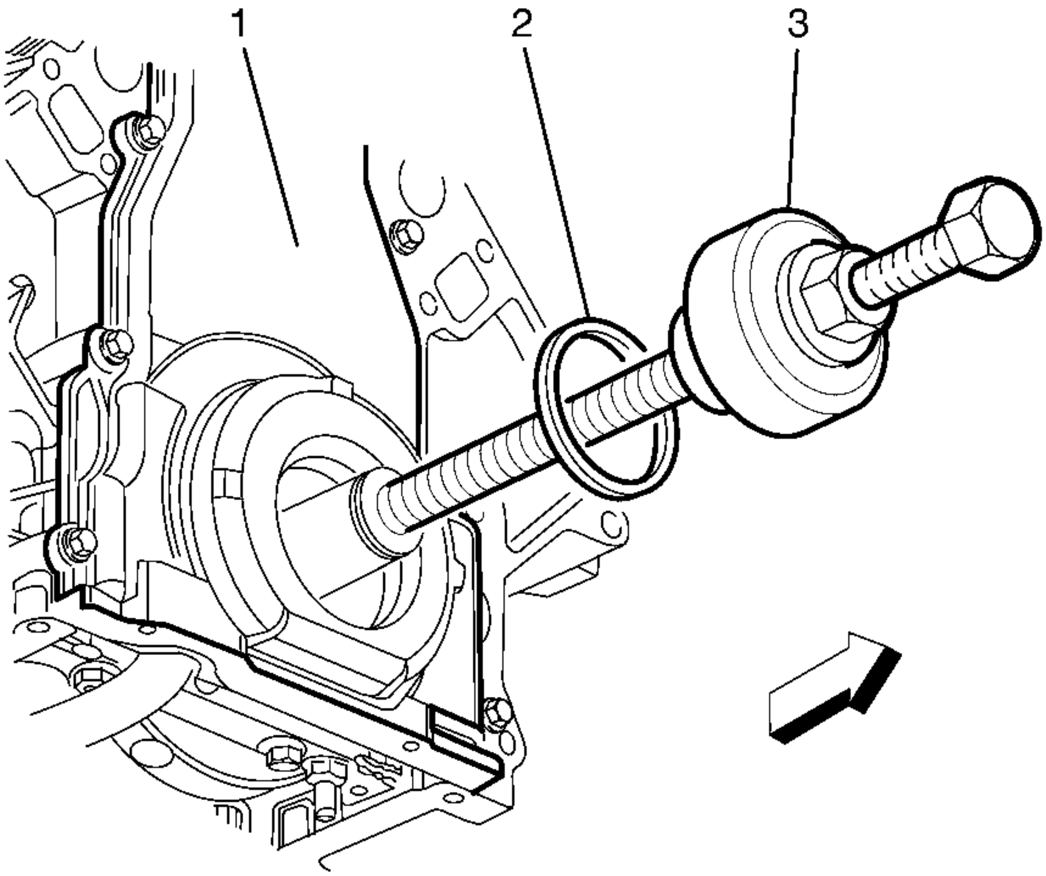


Fig. 106: Locating J 41478 Guide, Oil Seal & Front Engine Cover Bore
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft front oil seal onto the **J 41478** (3) guide. See **Special Tools** .
2. Install the **J 41478** (3) threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft. See **Special Tools** .
3. Use the **J 41478** (3) in order to install the oil seal (2) into the front engine cover (1) bore. See **Special Tools** .
    1. Use a wrench and hold the hex on the installer tool.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the front engine cover (1) bore.
    3. Remove the tool.
    4. Inspect the oil seal for correct installation. The oil seal should be installed evenly and completely

into the front cover bore.

OIL PAN INSTALLATION

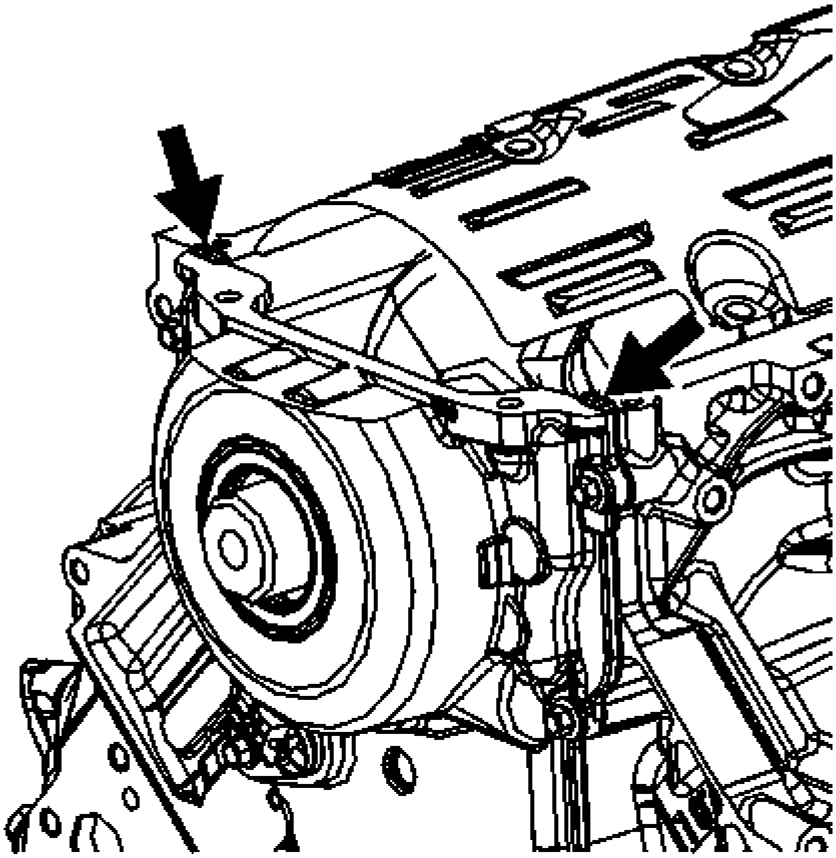


Fig. 107: Sealant Application Areas
Courtesy of GENERAL MOTORS CORP.

NOTE:	- **The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.** - **Do not use the oil pan gasket again.** - **It is not necessary to rivet the NEW gasket to the oil pan.**

1. Install the baffle, as required. Refer to **Oil Pan Cleaning and Inspection**.
2. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket

that protrude into the oil pan surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

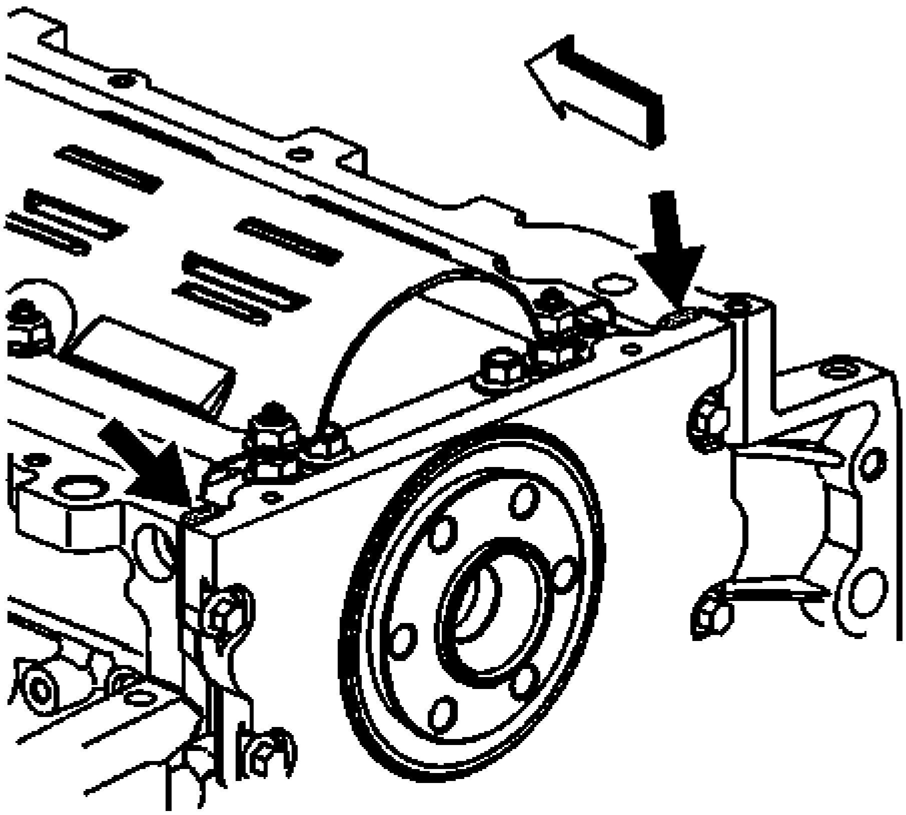


Fig. 108: View Of Sealant On Engine Rear Cover Gasket Tabs
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface.

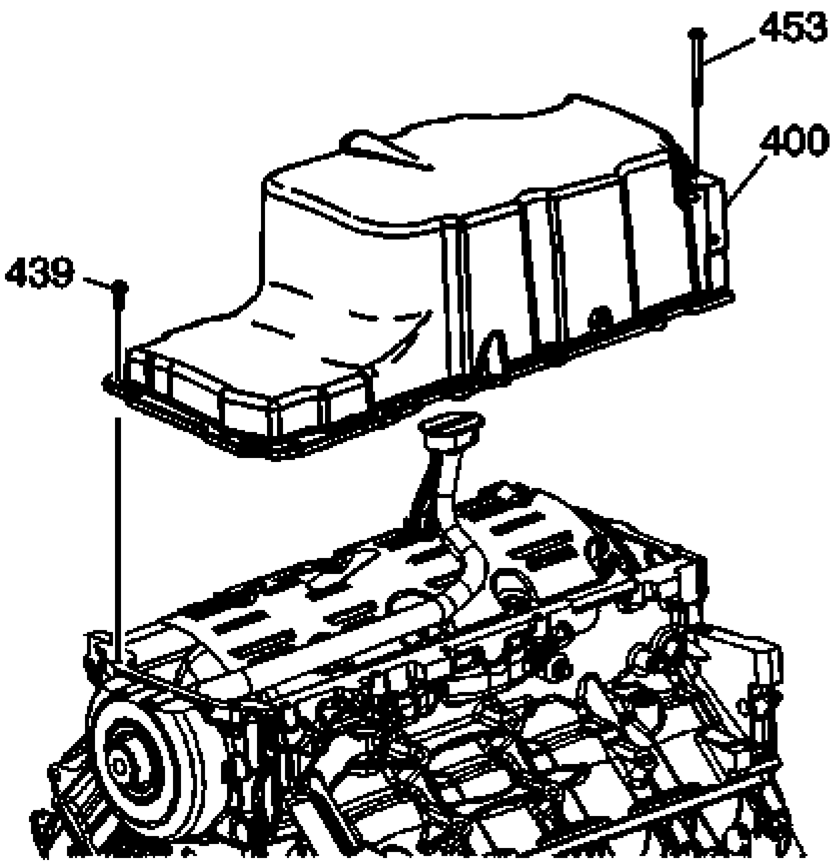


Fig. 109: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE:	**Ensure the oil gallery passages in the oil pan and engine block properly align with the oil pan gasket.**

4. Pre-assemble the oil pan gasket to the pan.
    1. Install the gasket onto the oil pan.
    2. Install the oil pan bolts to the pan and through the gasket.
5. Install the oil pan (400), gasket, and bolts (439 and 453) to the engine block.
6. Tighten the bolts finger tight. Do not overtighten.

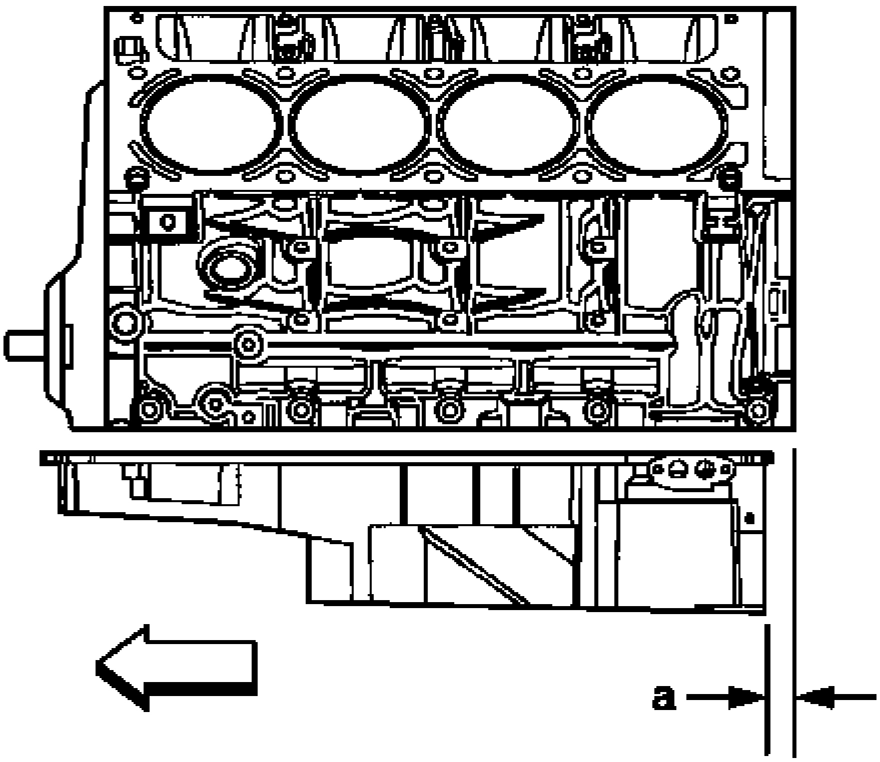


Fig. 110: Measuring Oil Pan-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

CAUTION: Refer to Fastener Caution .

8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.
    1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to 25 N.m (18 lb ft) .
    2. Tighten the oil pan-to-rear housing bolts to 12 N.m (106 lb in) .
9. Measure the oil pan-to-engine block alignment (a).
    1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

NOTE: The rear of the oil pan must NEVER protrude beyond the engine

block and transmission housing mounting surfaces.

2. Insert a feeler gage between the straight edge and the oil pan transmission housing mounting surface, and inspect to ensure there is no greater than a 0.1 mm (0.004 in) gap (a) between the pan and straight edge.
3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

OIL FILTER, ADAPTER, AND PAN COVER INSTALLATION

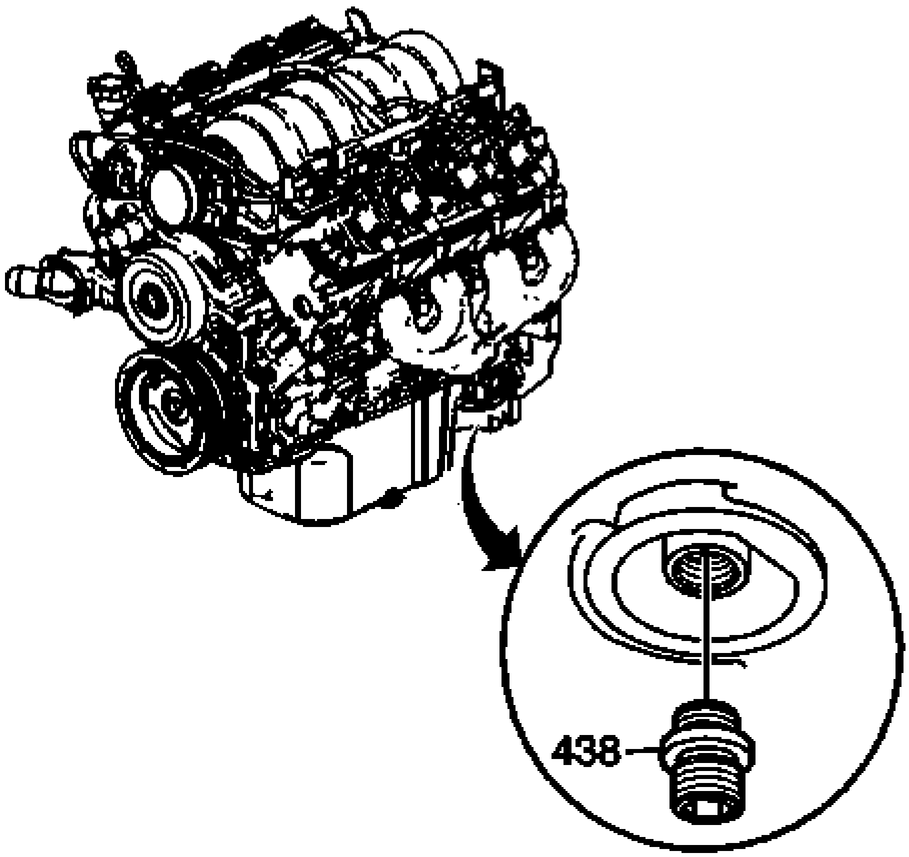


Fig. 111: Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil filter fitting (438) and tighten to 55 N.m (40 lb ft).

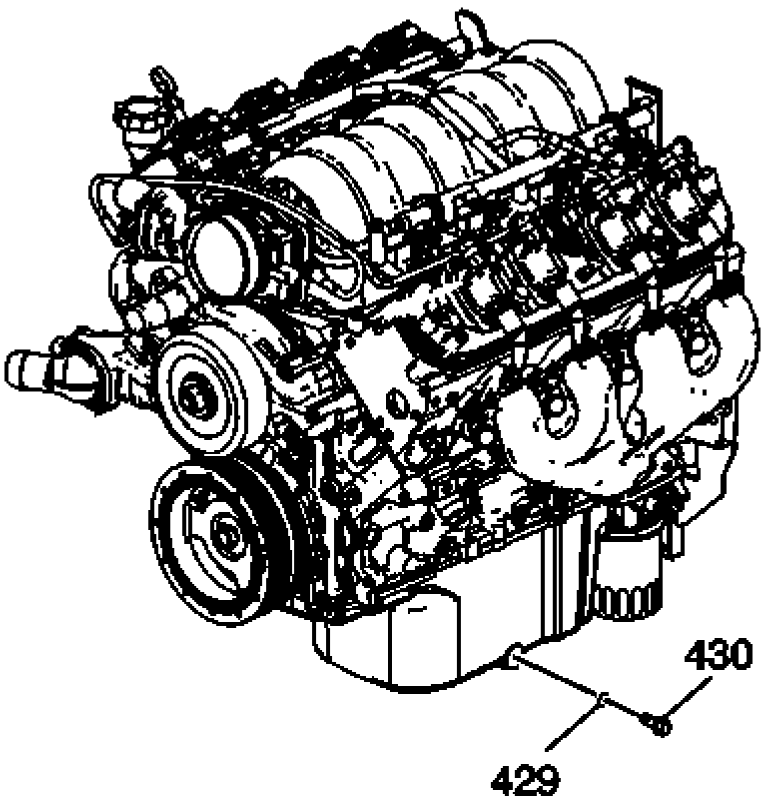


Fig. 112: Oil Pan Drain Plug & O Ring
Courtesy of GENERAL MOTORS CORP.

2. Install the oil pan drain plug (430) and O-ring (429) and tighten to 25 N.m (18 lb ft).

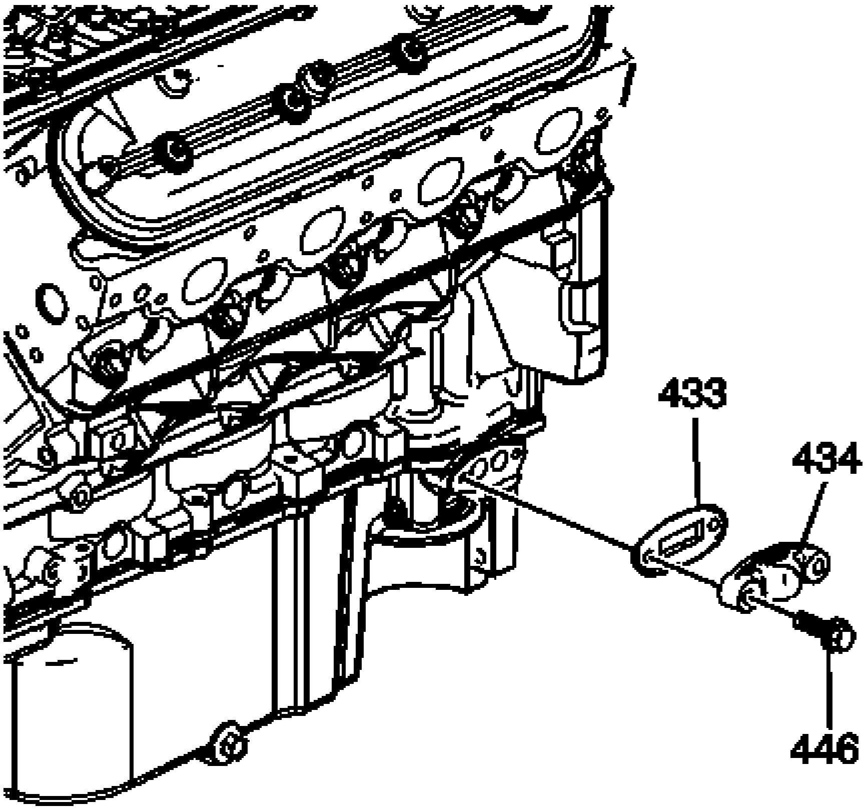


Fig. 113: Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the gasket (433), cover (434), and bolts (446) and tighten to 12 N.m (106 lb ft).

VALVE LIFTER INSTALLATION

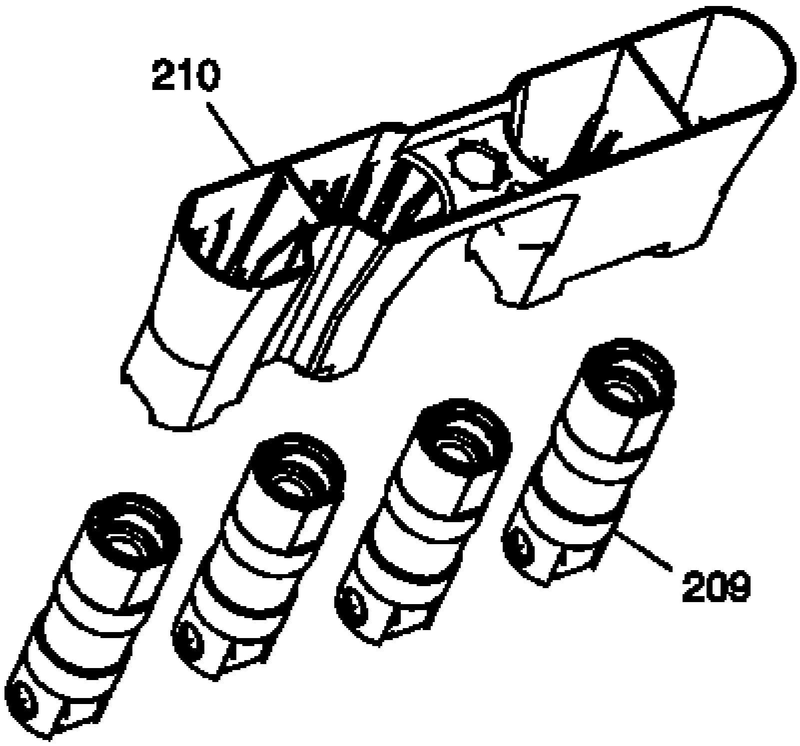


Fig. 114: Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the non-Active Fuel Management (AFM) valve lifters again, install the lifters to their original locations.**
- **If camshaft replacement is required, the valve lifters must also be replaced.**

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

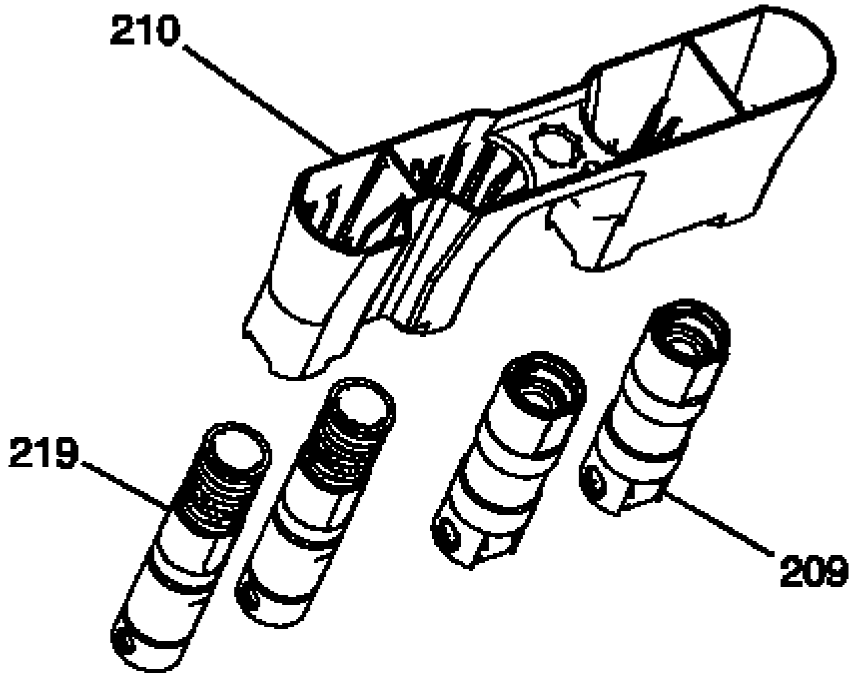


Fig. 115: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the AFM valve lifters again, install the lifters to their original locations.**
- **If camshaft replacement is required, the valve lifters must also be replaced.**
- **Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.**
- **With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.**

3. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

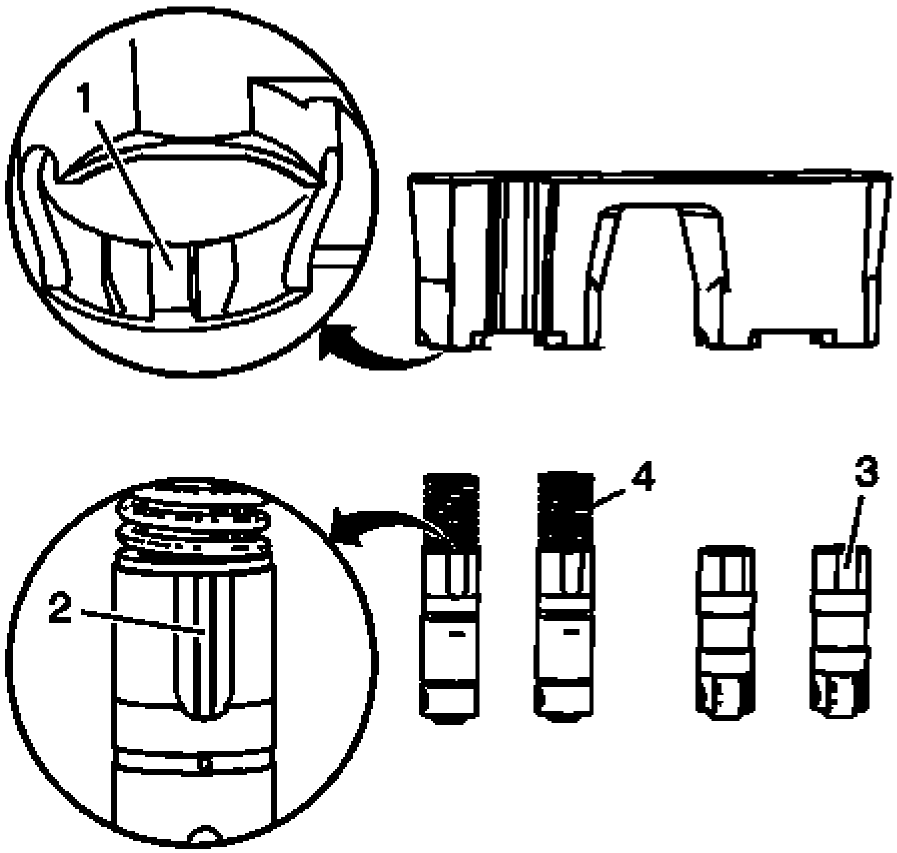


Fig. 116: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS CORP.

4. Insert the valve lifters into the lifter guides.
    - Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
    - The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

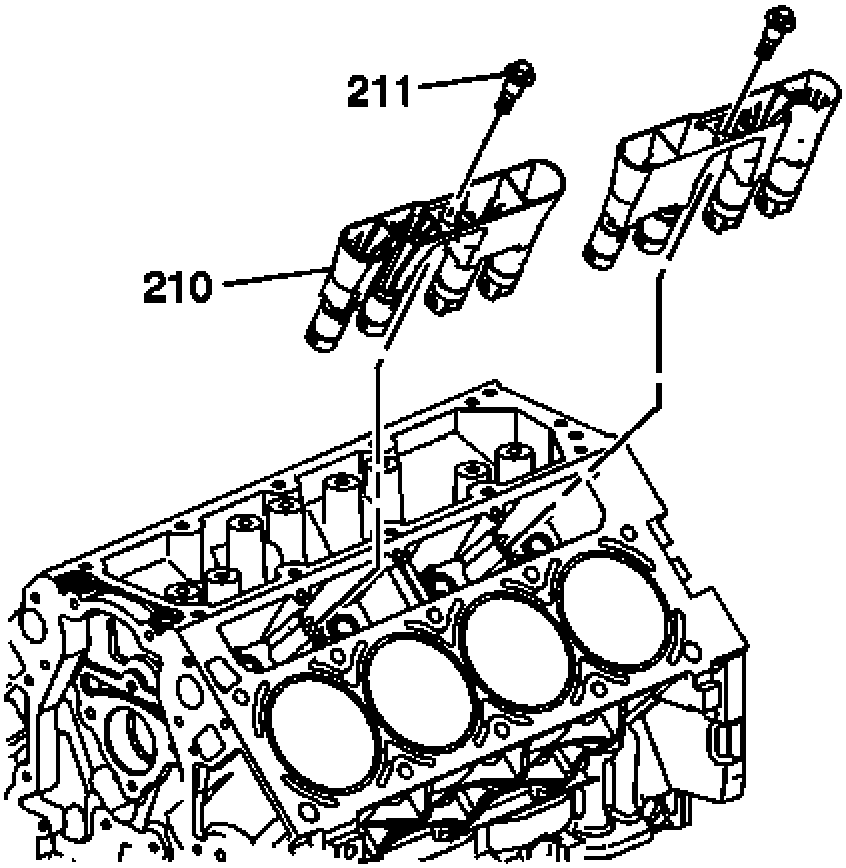


Fig. 117: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

5. Install the valve lifters and guide assembly (210) to the engine block.

CAUTION: Refer to Fastener Caution .

6. Install the valve lifter guide bolts (211) and tighten to 12 N.m (106 lb in).

CYLINDER HEAD INSTALLATION - LEFT SIDE

Special Tools

- **J 42385-100:** Head/Main Bolt Thread Repair Kit
- **J 45059:** Angle Meter

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

Installation

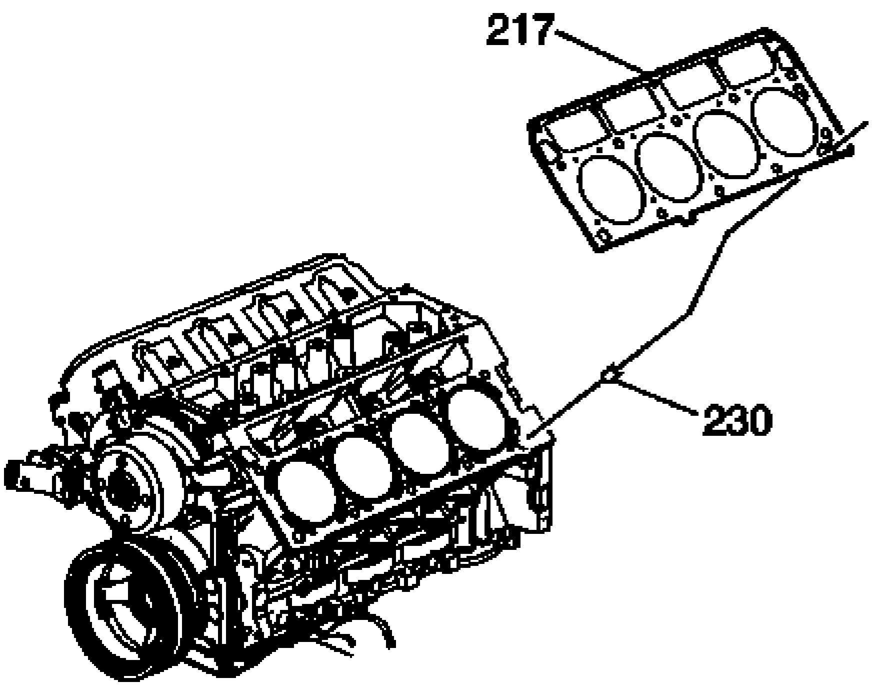


Fig. 118: View Of Cylinder Head Gasket & Locating Pins
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

CAUTION: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**

1. Clean the engine block cylinder head bolt holes, if required.

   J 42385-107: thread repair tool may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

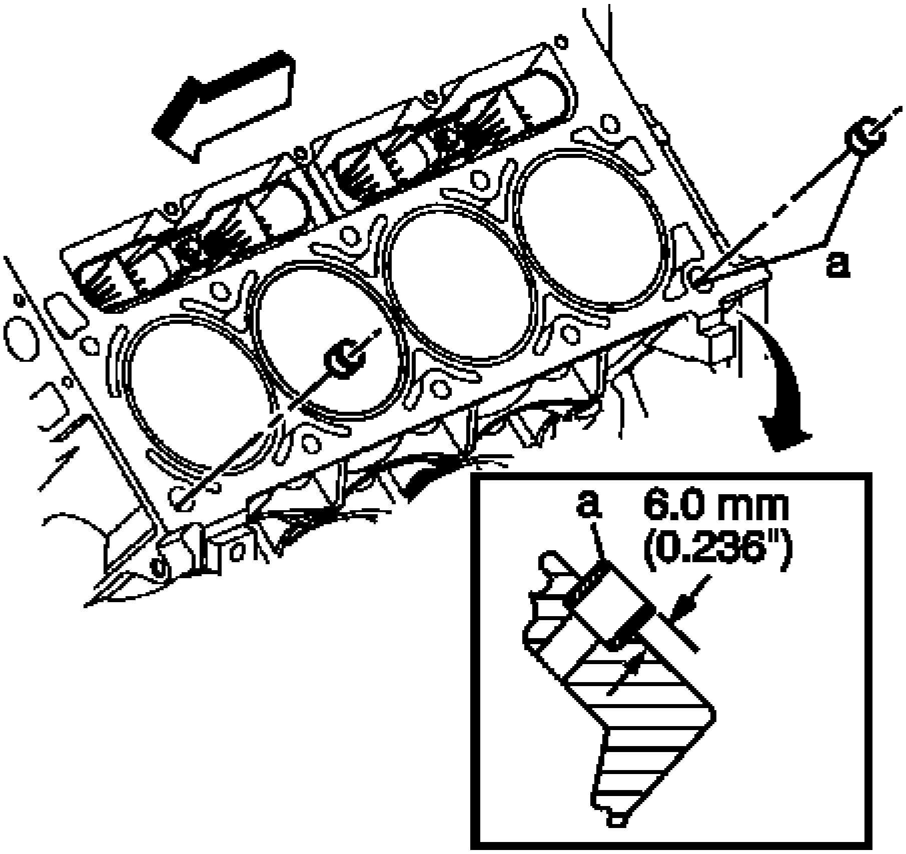


Fig. 119: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

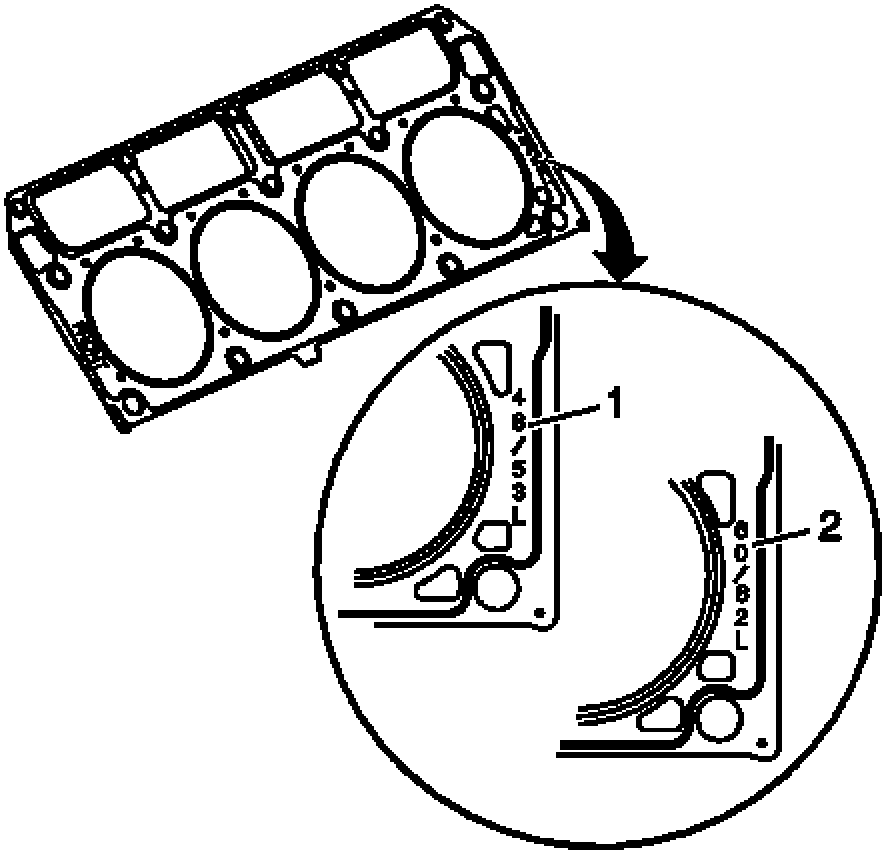


Fig. 120: View Of Displacement Markings On Gasket
Courtesy of GENERAL MOTORS CORP.

6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.

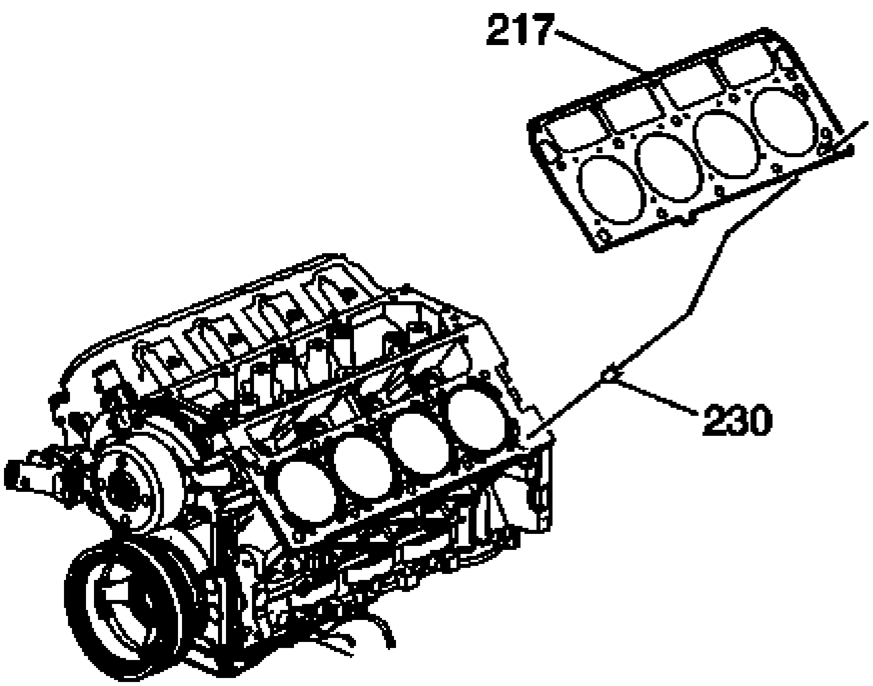


Fig. 121: View Of Cylinder Head Gasket & Locating Pins
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW cylinder head gasket (217) onto the locating pins.

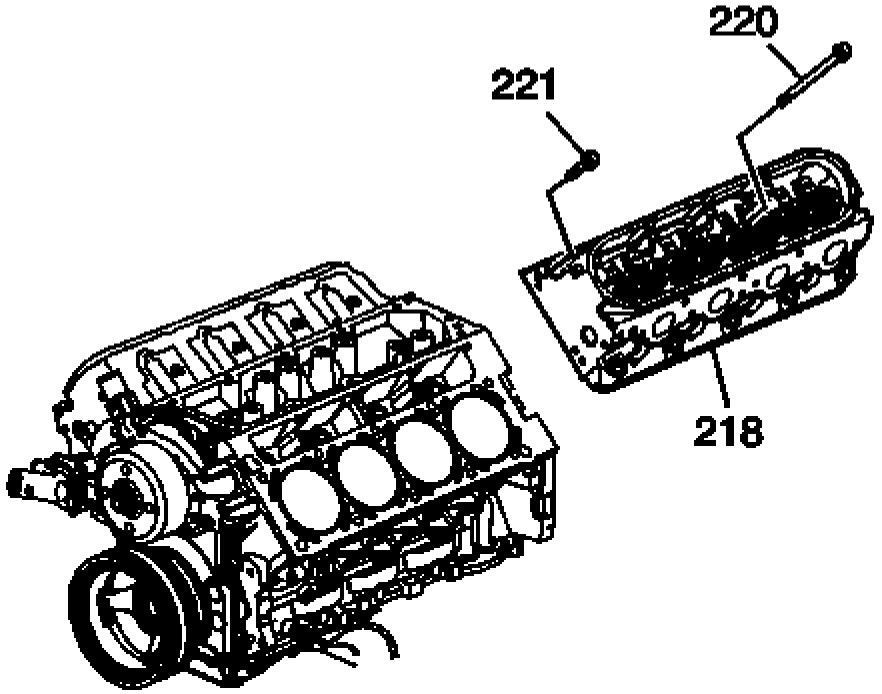


Fig. 122: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

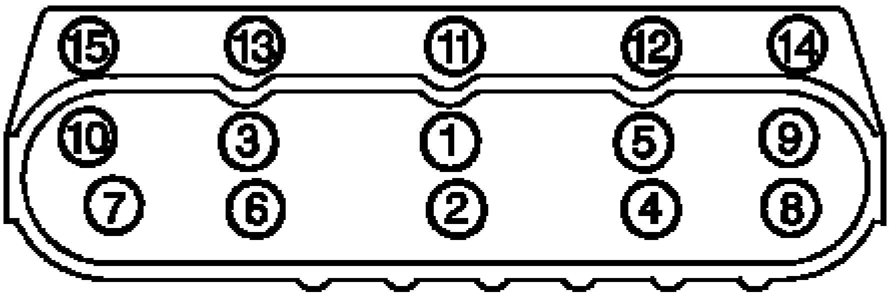


Fig. 123: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059:** meter .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059:** meter .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

CYLINDER HEAD INSTALLATION - RIGHT SIDE

Special Tools

- **J 42385-100:** Head/Main Bolt Thread Repair Kit
- **J 45059:** Angle Meter

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

Installation

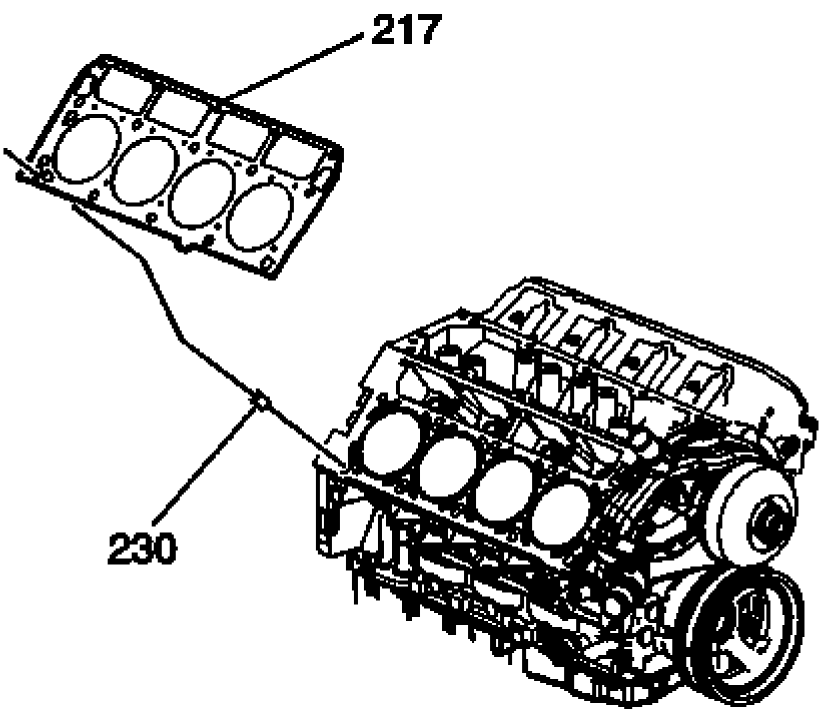


Fig. 124: View Of Cylinder Head Gasket & Locating Pins
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: **Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.**

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**

1. Clean the engine block cylinder head bolt holes, if required.

   J 42385-107: thread repair tool may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

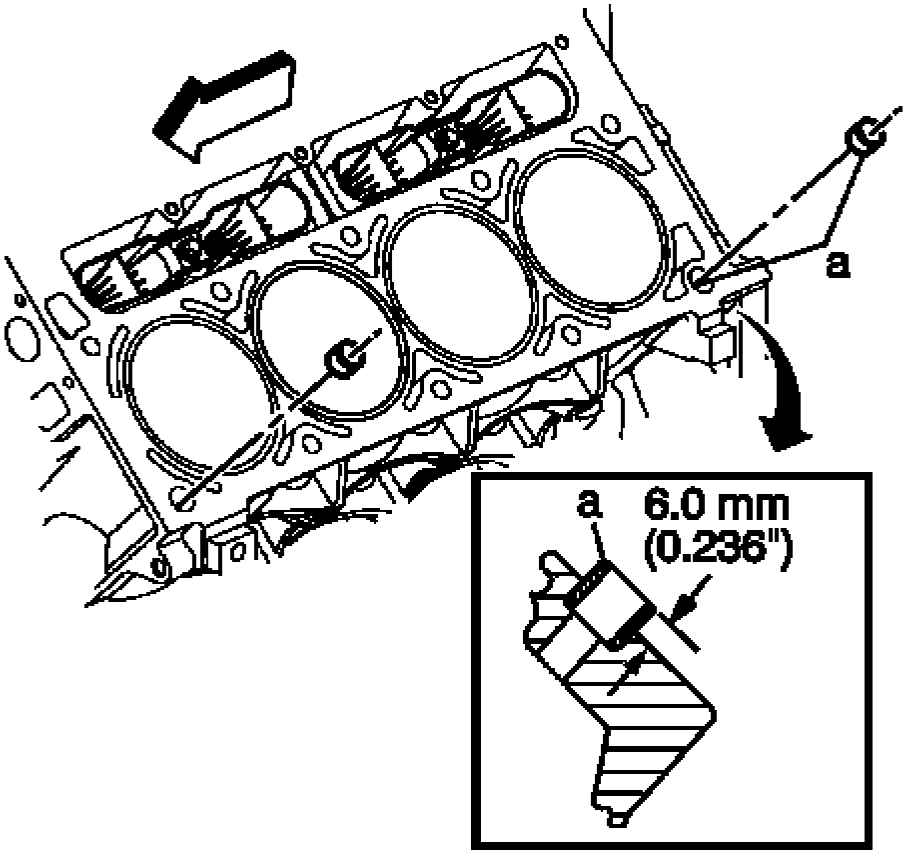


Fig. 125: Identifying Cylinder Head Locating Pins Installation Position
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

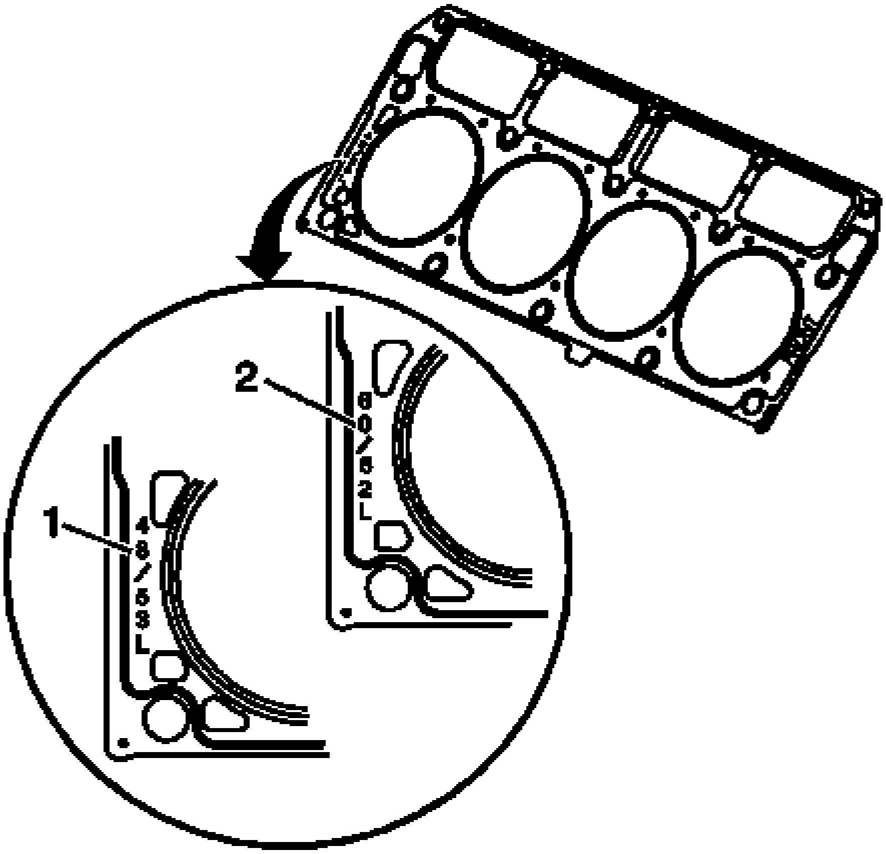


Fig. 126: View Of Displacement Markings On Gasket
Courtesy of GENERAL MOTORS CORP.

6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.

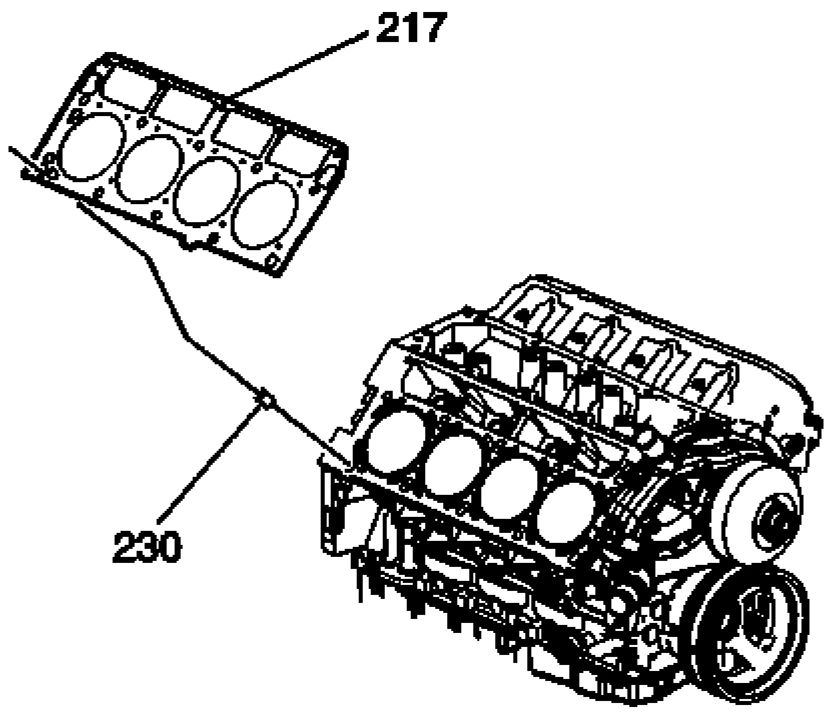


Fig. 127: View Of Cylinder Head Gasket & Locating Pins
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW cylinder head gasket (217) onto the locating pins.

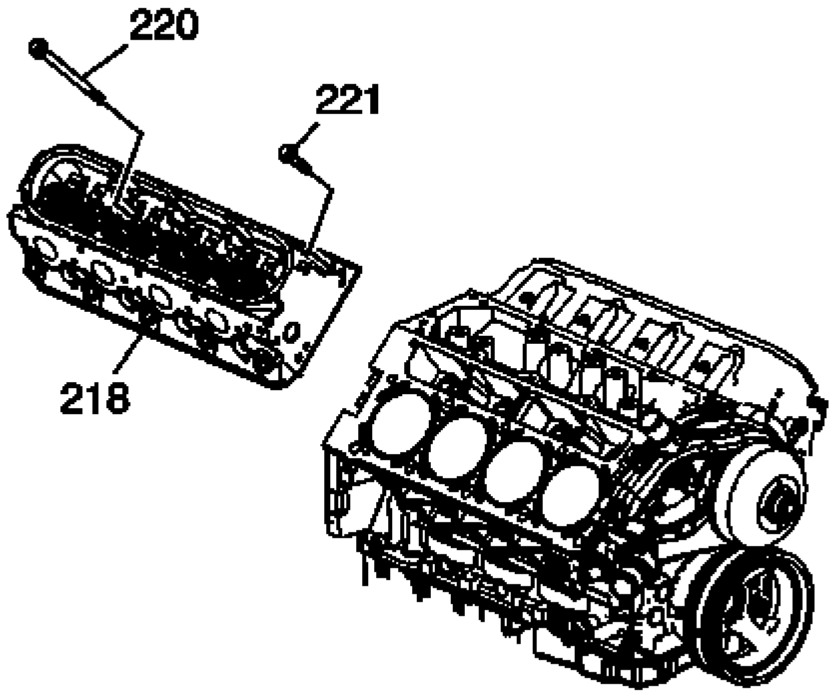


Fig. 128: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

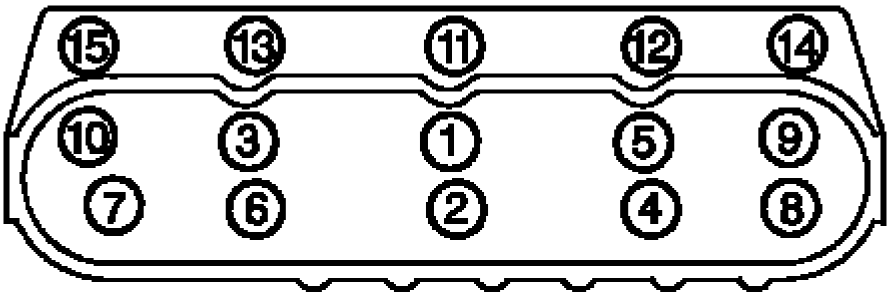


Fig. 129: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059:** meter .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059:** meter .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

VALVE ROCKER ARM AND PUSH ROD INSTALLATION

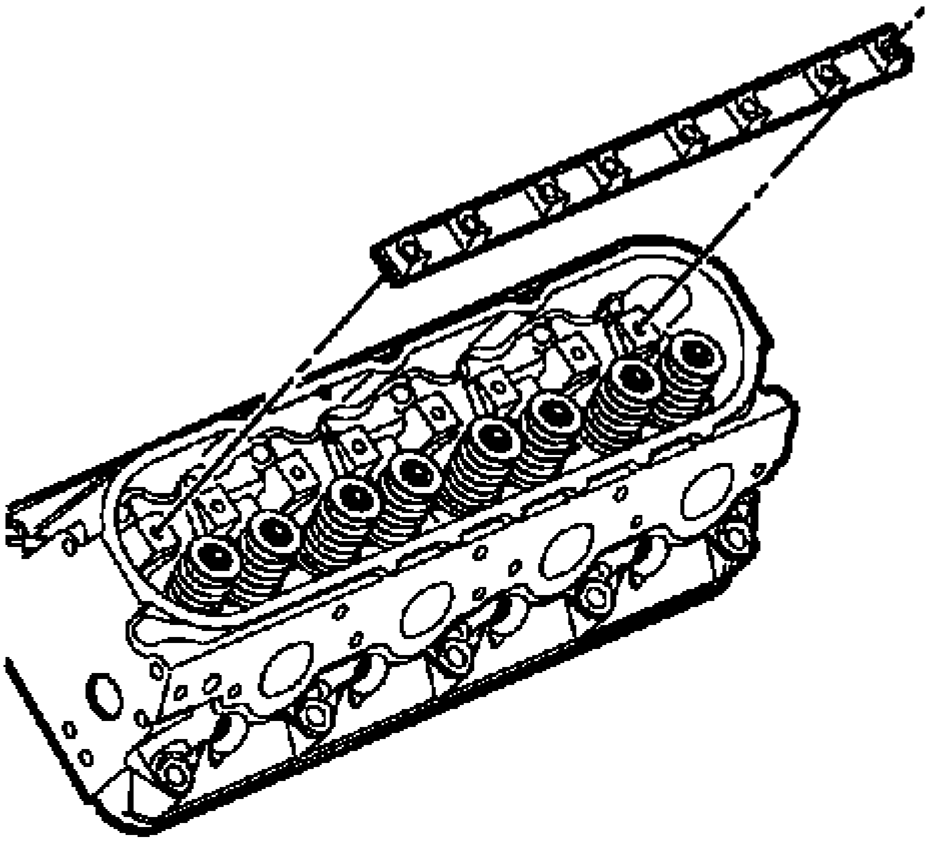


Fig. 130: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build. No valve adjustment is required.**

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.

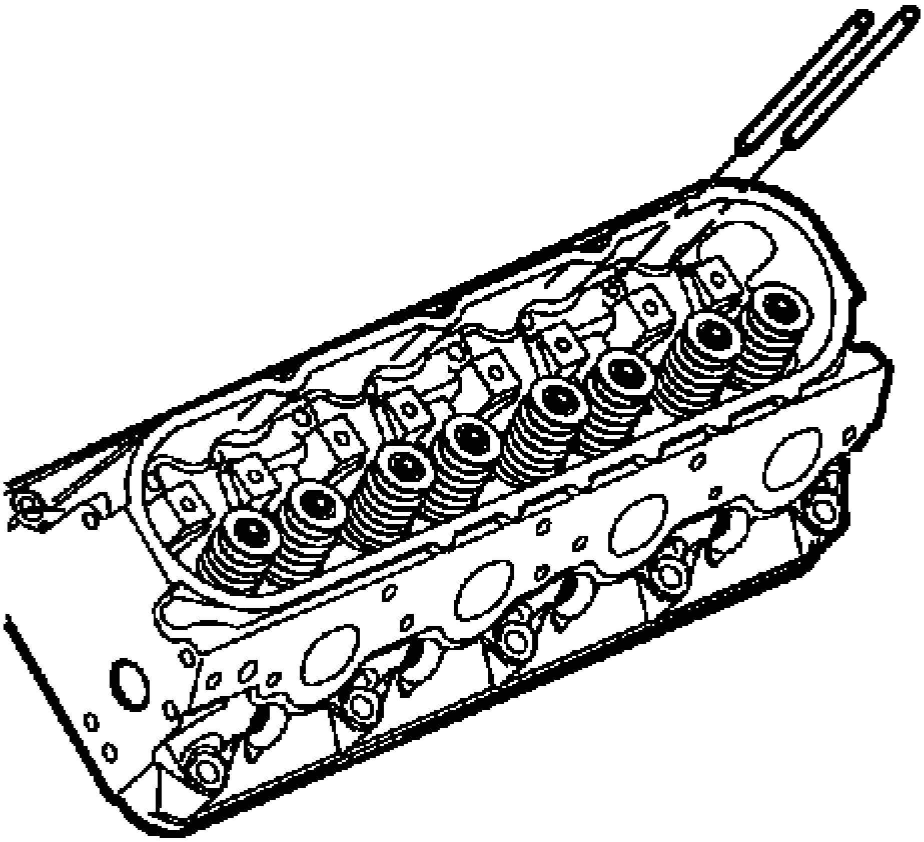


Fig. 131: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

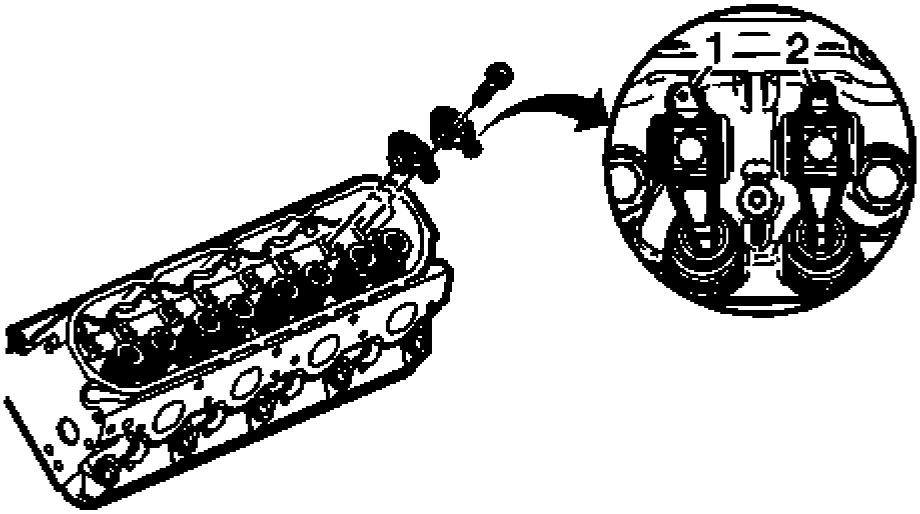


Fig. 132: View Of Offset Intake Rocker Arm & Intake Rocker Arm
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

5. Install the rocker arms and bolts.

   The intake rocker arms (1) have an offset design.

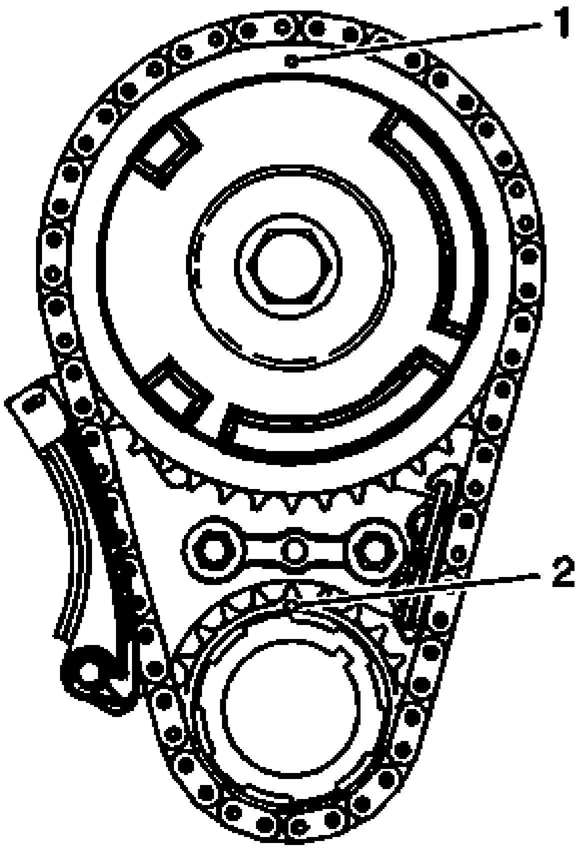


Fig. 133: View Of Camshaft & Crankshaft Sprocket Alignment Marks In 12 O'clock Position
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5 and 7 are left bank.

   Cylinders 2, 4, 6, and 8 are right bank.

   CAUTION: Refer to Fastener Caution .

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
   1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft) .

   2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft) .
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
   1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft) .
   2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft) .

VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

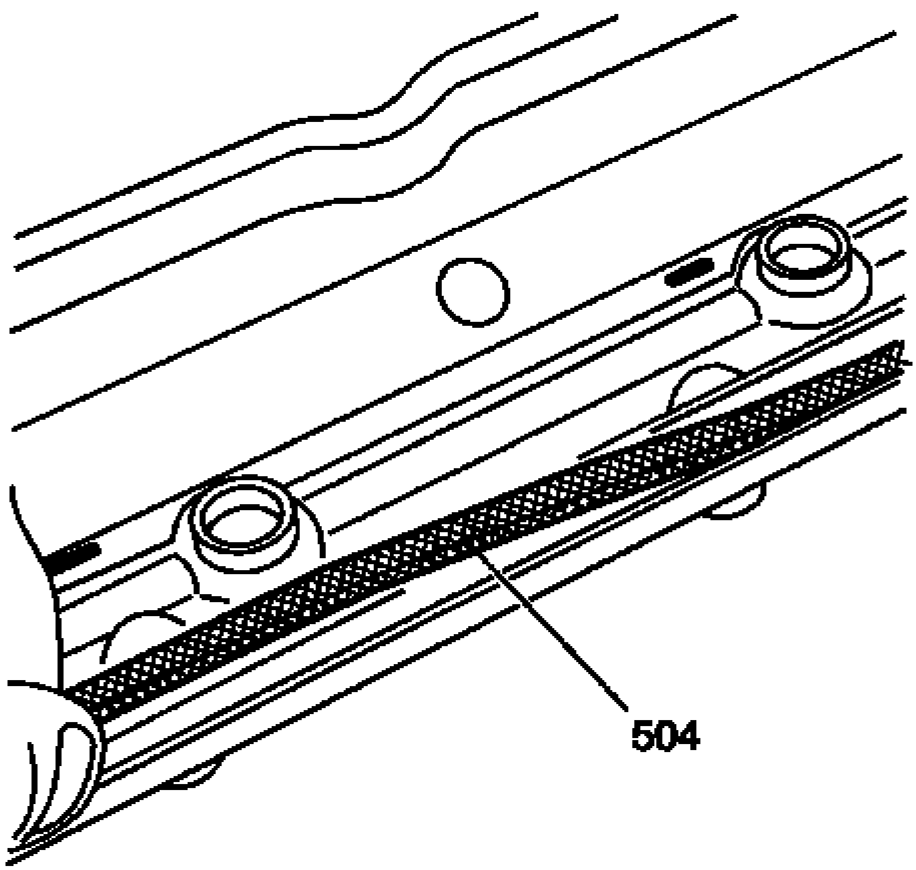


Fig. 134: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:
- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **DO NOT use the valve rocker arm cover gasket again.**

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.

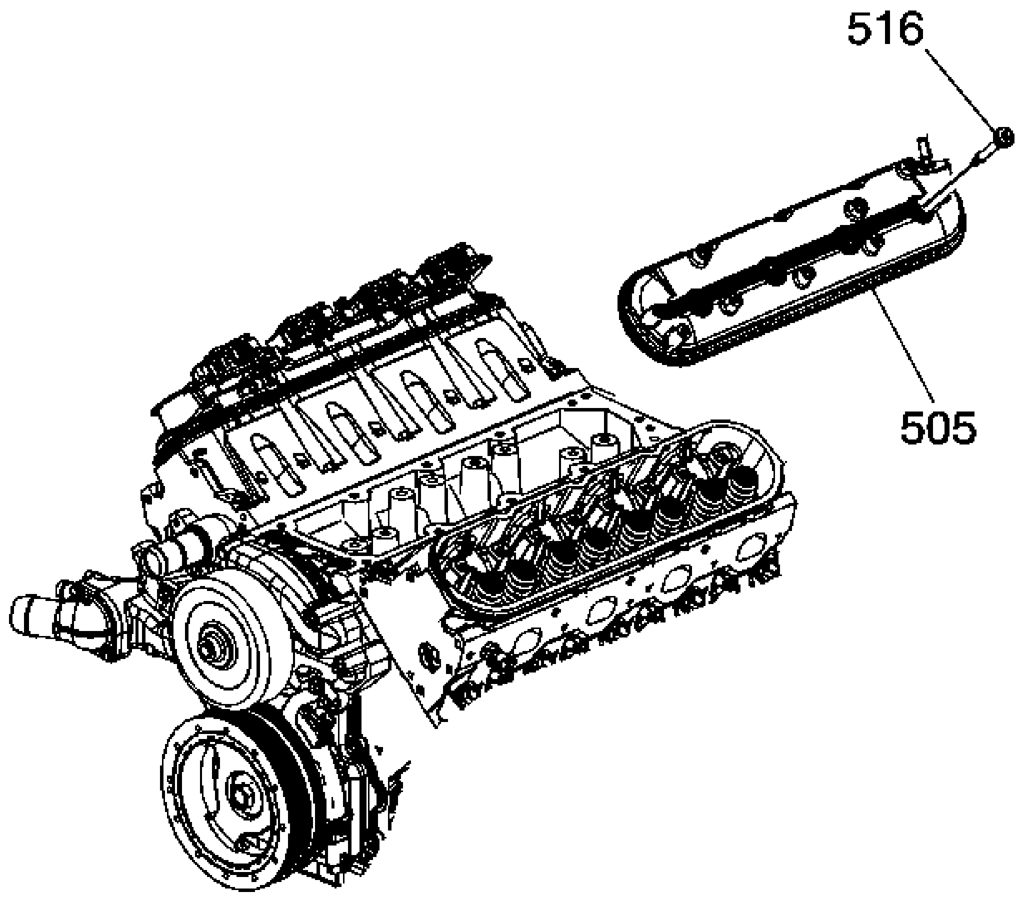


Fig. 135: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm cover (505) onto the cylinder head.

CAUTION: Refer to Fastener Caution .

4. Install the cover bolts (516) with grommets and tighten to 12 N.m (106 lb in).

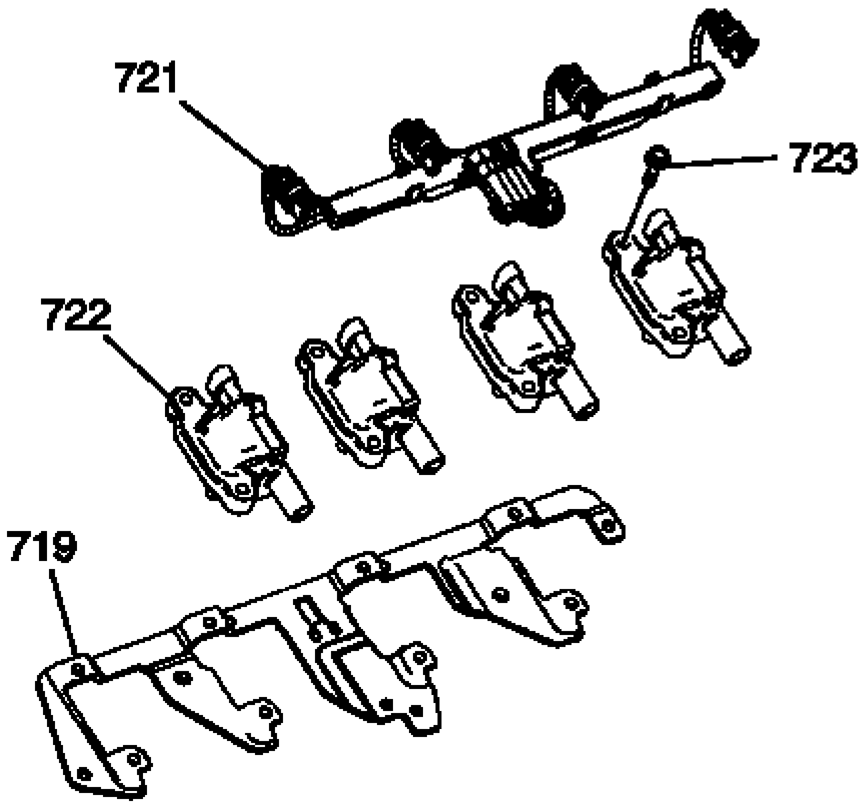


Fig. 136: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
6. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719) and tighten to 10 N.m (89 lb in).

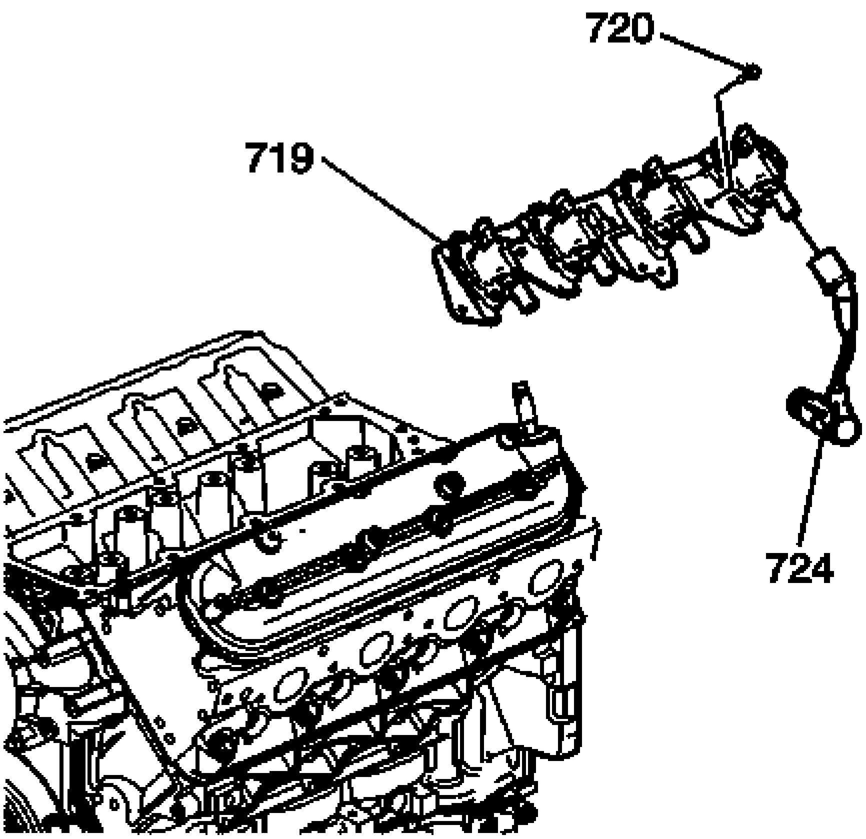


Fig. 137: Left Spark Plug Wires, Ignition Coil Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).
8. Install the ignition coil and bracket assembly (719) and studs (720) and tighten to 12 N.m (106 lb in).

VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE

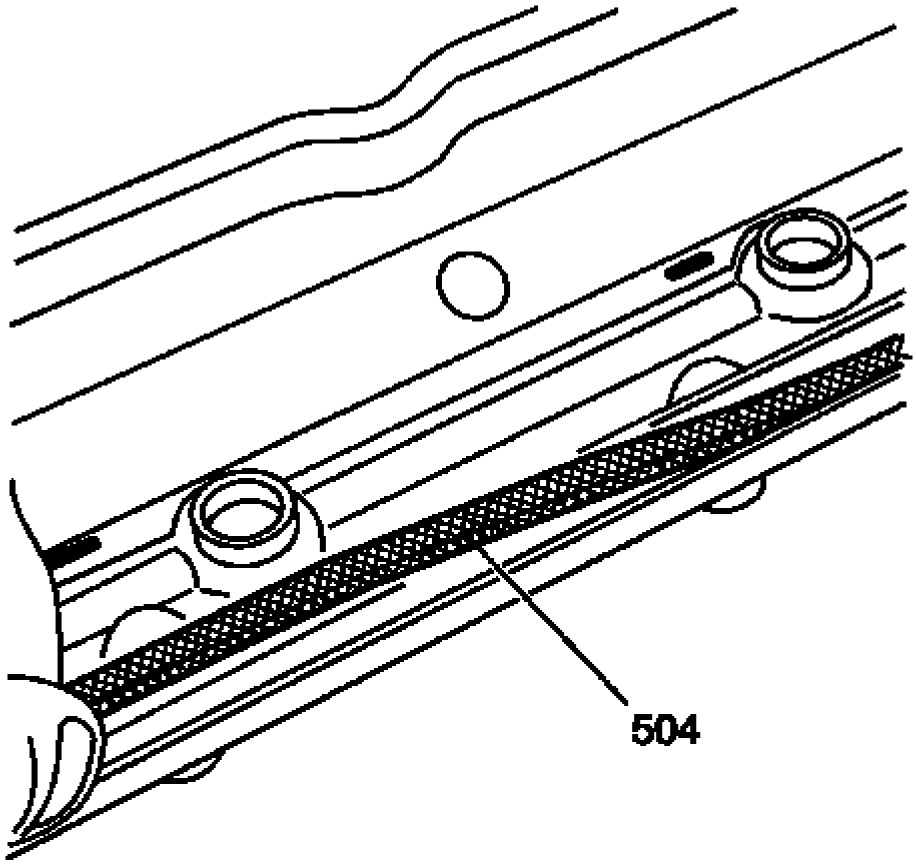


Fig. 138: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **DO NOT use the valve rocker arm cover gasket again.**

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.

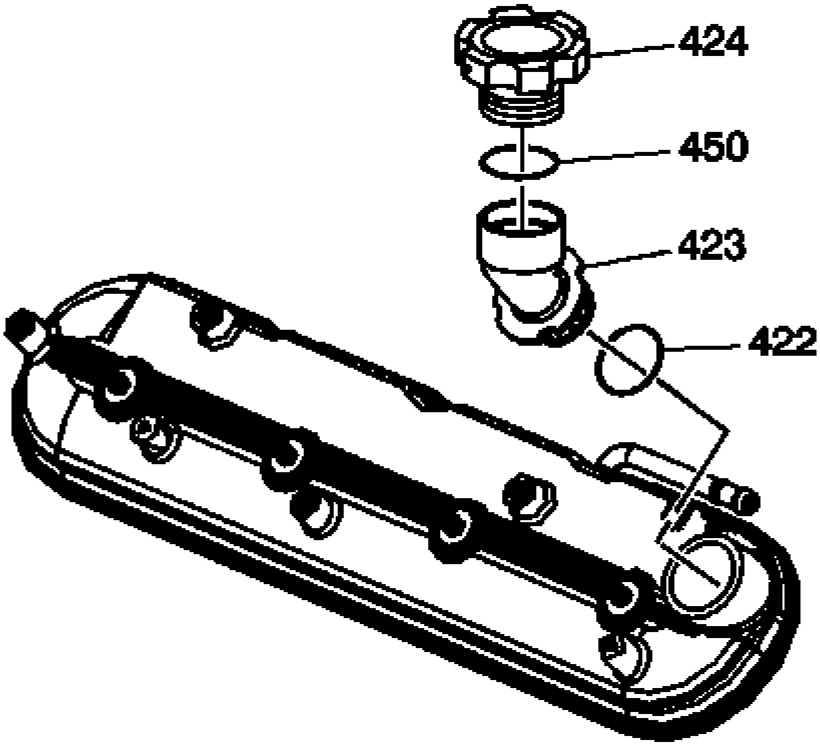


Fig. 139: Oil Fill Cap & Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW oil fill tube (423) and seal (422) to the valve rocker arm cover.

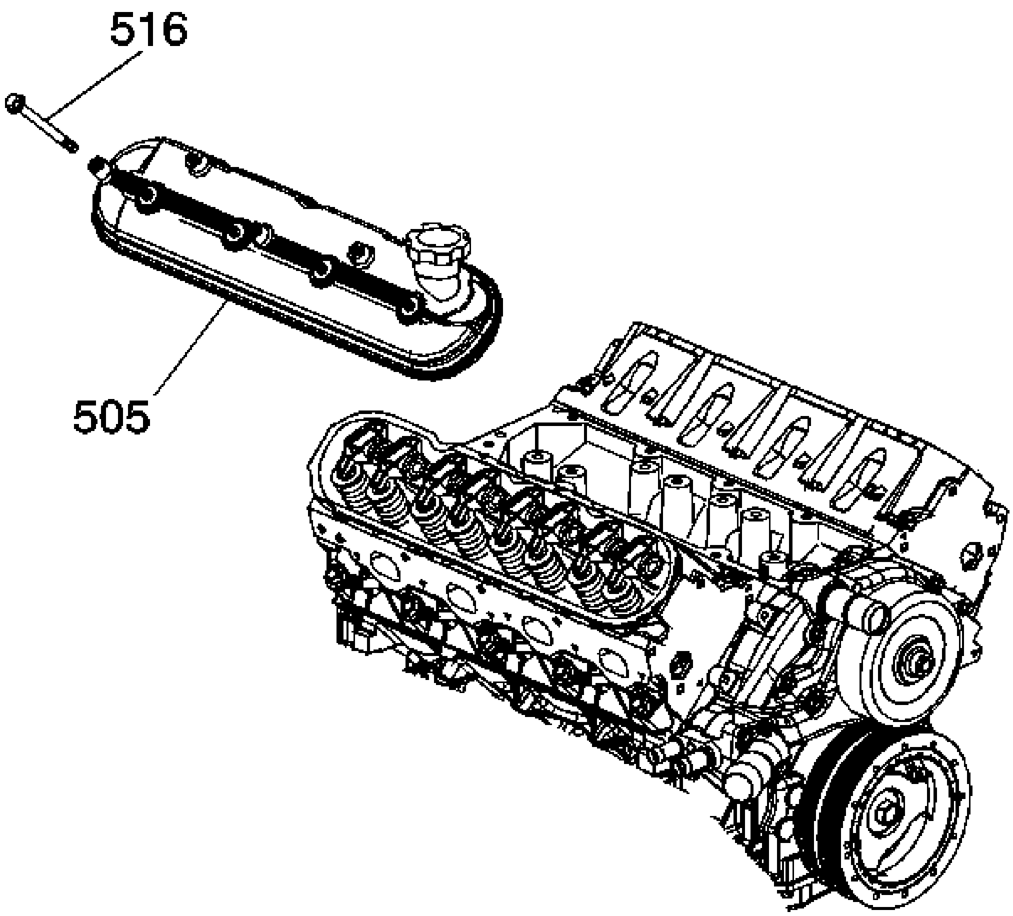


Fig. 140: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

4. Install the valve rocker arm cover (505) onto the cylinder head.

CAUTION: Refer to Fastener Caution .

5. Install the cover bolts (516) with grommets and tighten to 12 N.m (106 lb in).

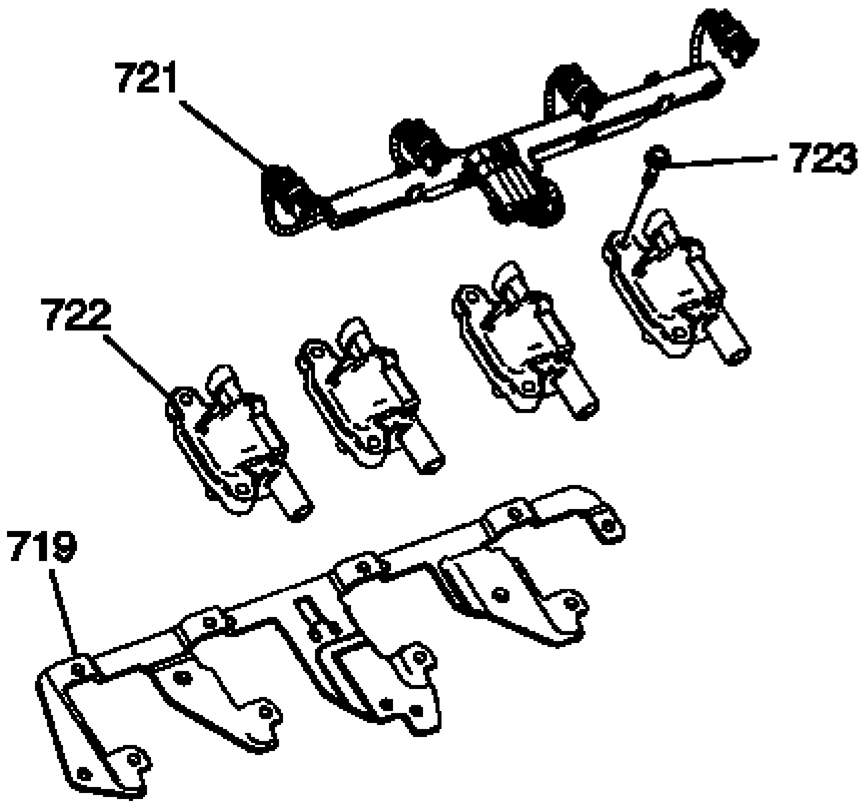


Fig. 141: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
7. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to 10 N.m (89 lb in).

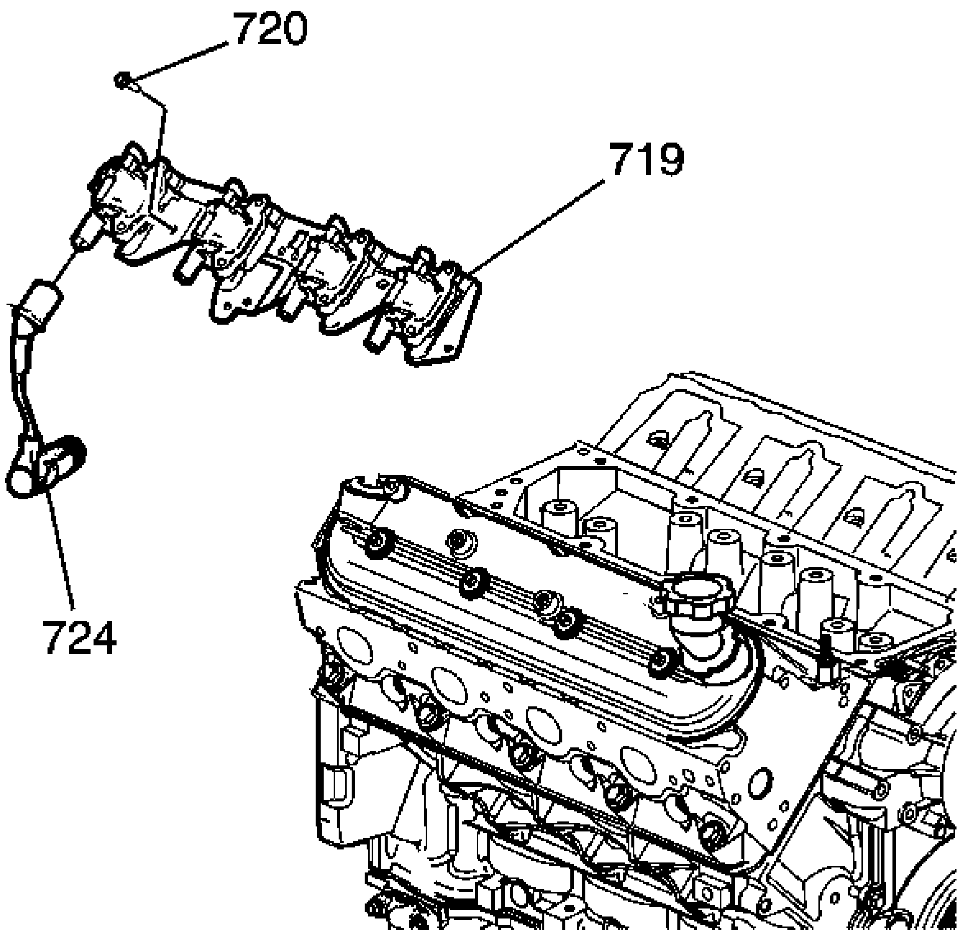


Fig. 142: Spark Plug Wires, Ignition Coil Bracket Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).
9. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to 12 N.m (106 lb in).

ENGINE BLOCK VALLEY COVER INSTALLATION

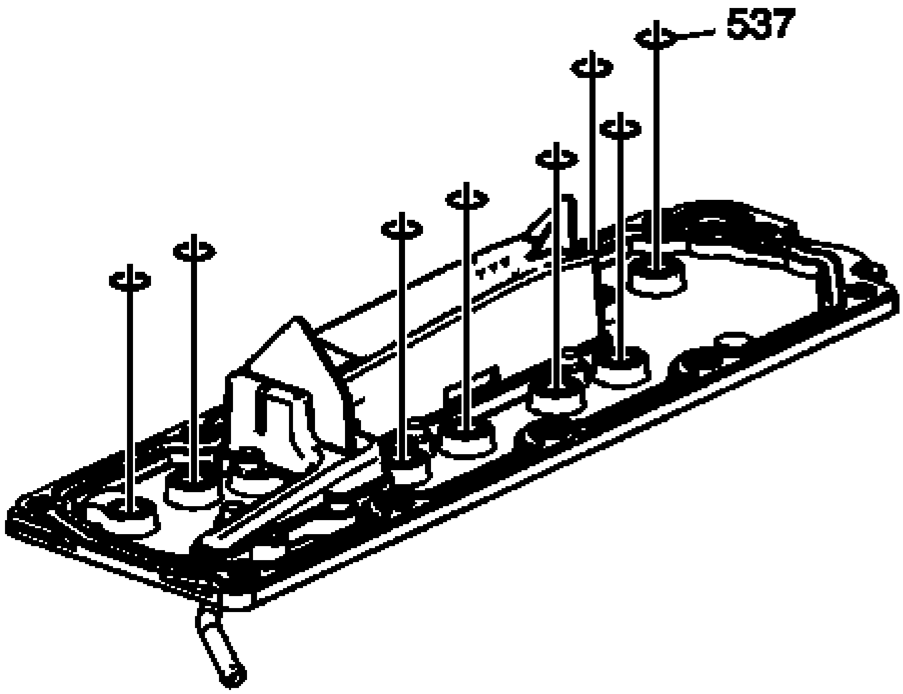


Fig. 143: Valley Cover Seals & Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Lubricate the O-ring seals (537) with clean engine oil.
2. Install the O-ring seals (537) to the cover.

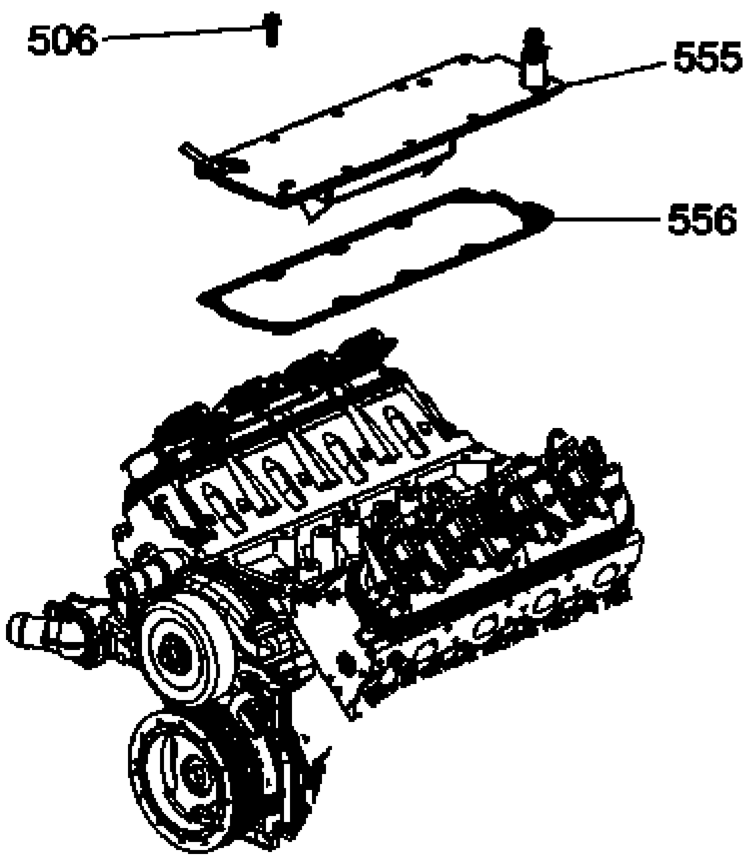


Fig. 144: View Of Cover, Gasket, And Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the cover (555), gasket (556), and bolts (506). Tighten the cover bolts to 25 N.m (18 lb ft).

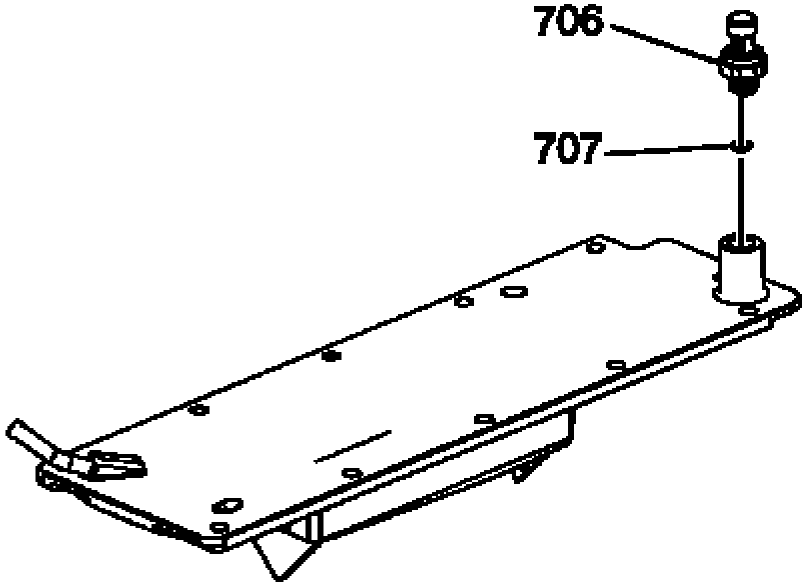


Fig. 145: Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707). Tighten the sensor to 35 N.m (26 lb ft).

VALVE LIFTER OIL FILTER INSTALLATION

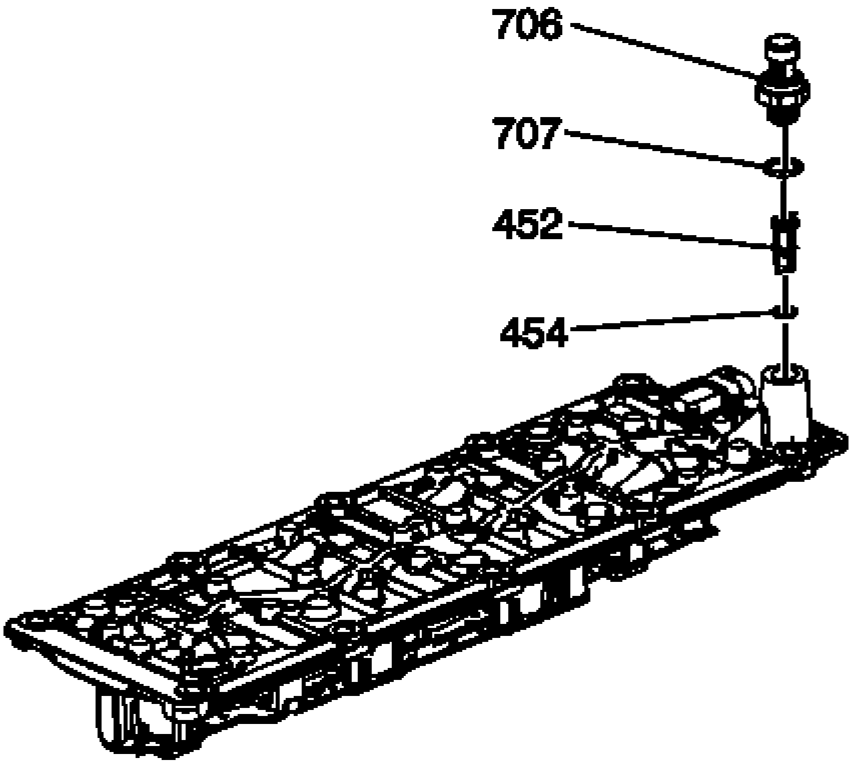


Fig. 146: View Of Oil Pressure Sensor, Washer And Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Install a NEW oil filter (452) and O-ring (454) assembly.
2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor.

CAUTION: Refer to Fastener Caution .

3. Install the oil pressure sensor (706) and washer (707). Tighten the oil pressure sensor to 35 N.m (26 lb ft).

VALVE LIFTER OIL MANIFOLD INSTALLATION

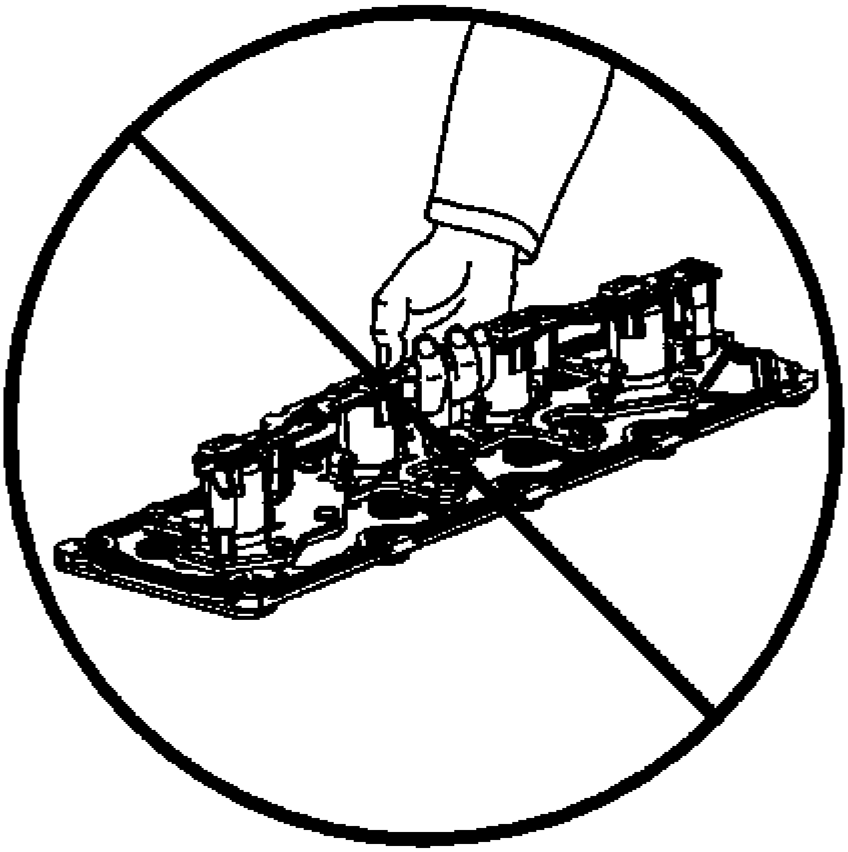


Fig. 147: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

1. Do not lift the manifold assembly by the electrical lead frame.

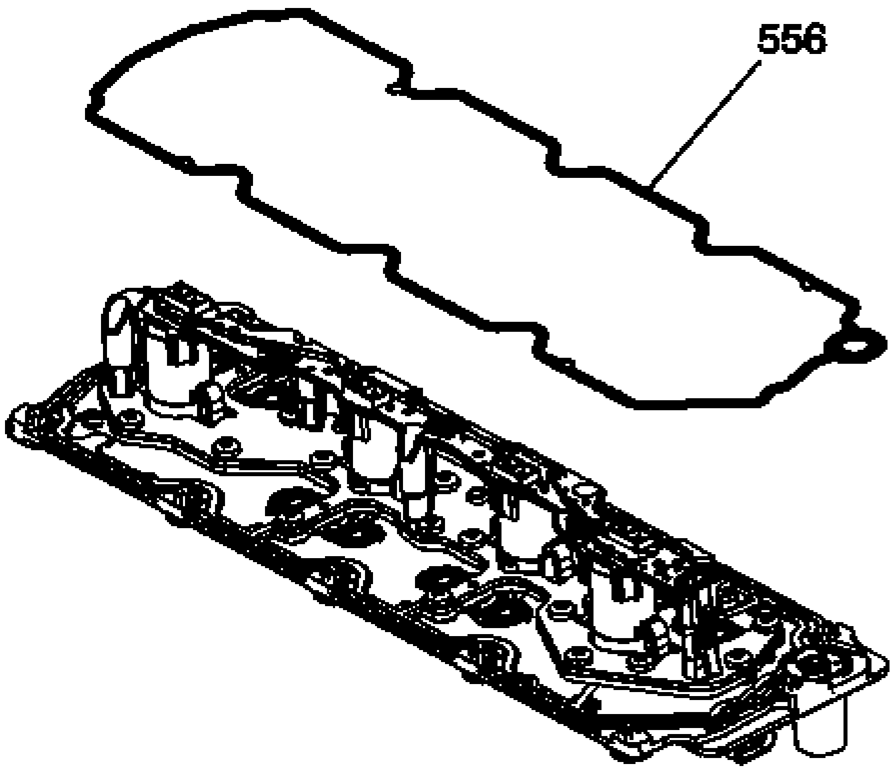


Fig. 148: View Of Outer Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:	• All gasket surfaces should be free of oil or other foreign material during assembly. • Do not allow dirt or debris to enter the manifold. Plug as required.

2. Install the service gasket (556) onto the manifold.

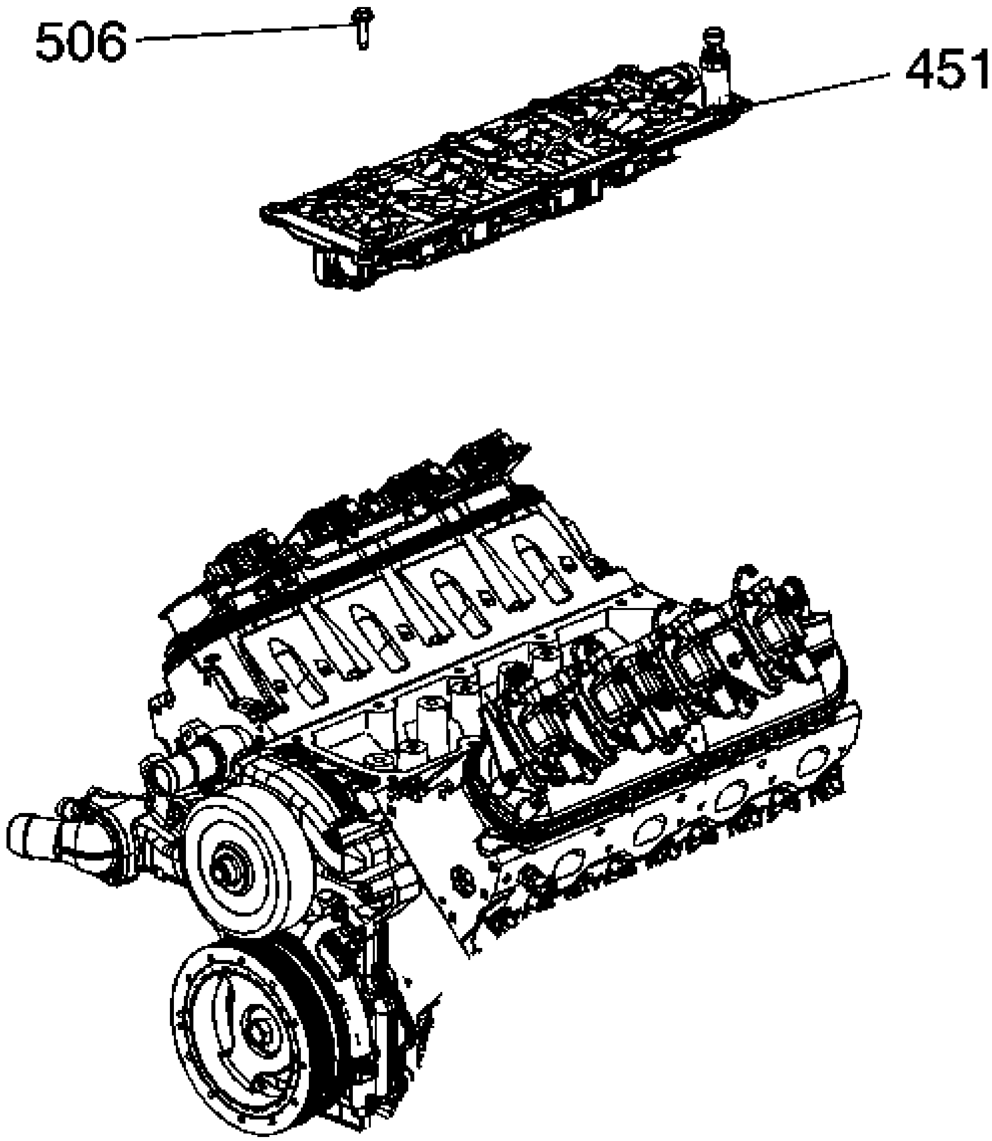


Fig. 149: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

3. Install the manifold (451) with gasket.

CAUTION: Refer to Fastener Caution .

4. Install the manifold bolts (506) and tighten to 25 N.m (18 lb ft).

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER INSTALLATION

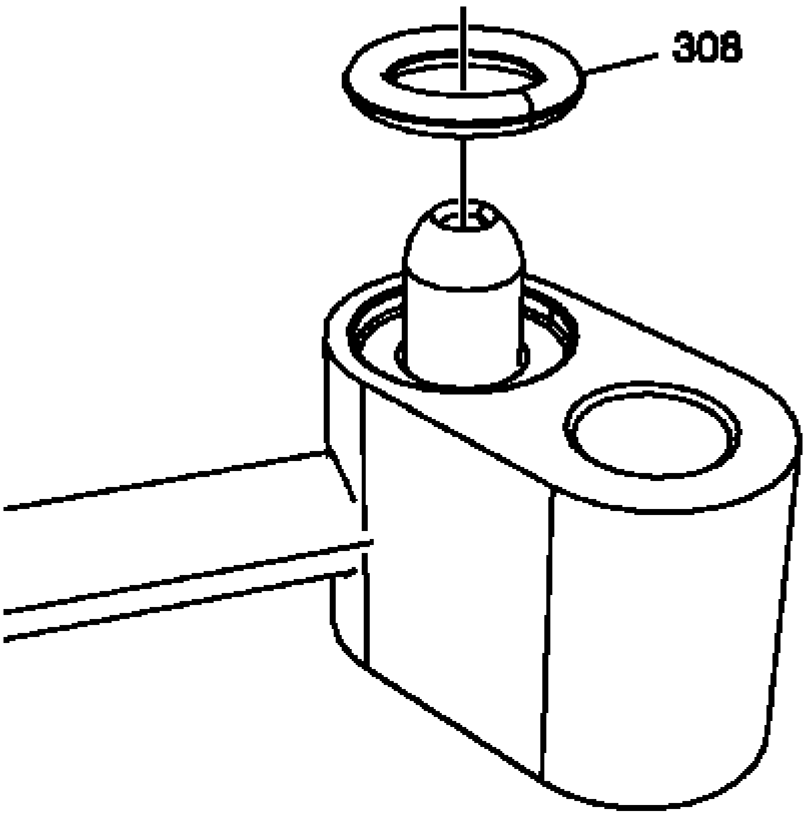


Fig. 150: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Position the O-ring seal (308) onto the nipple portion of the pipe.

1. Install the seals onto the engine coolant air bleed pipe and covers.

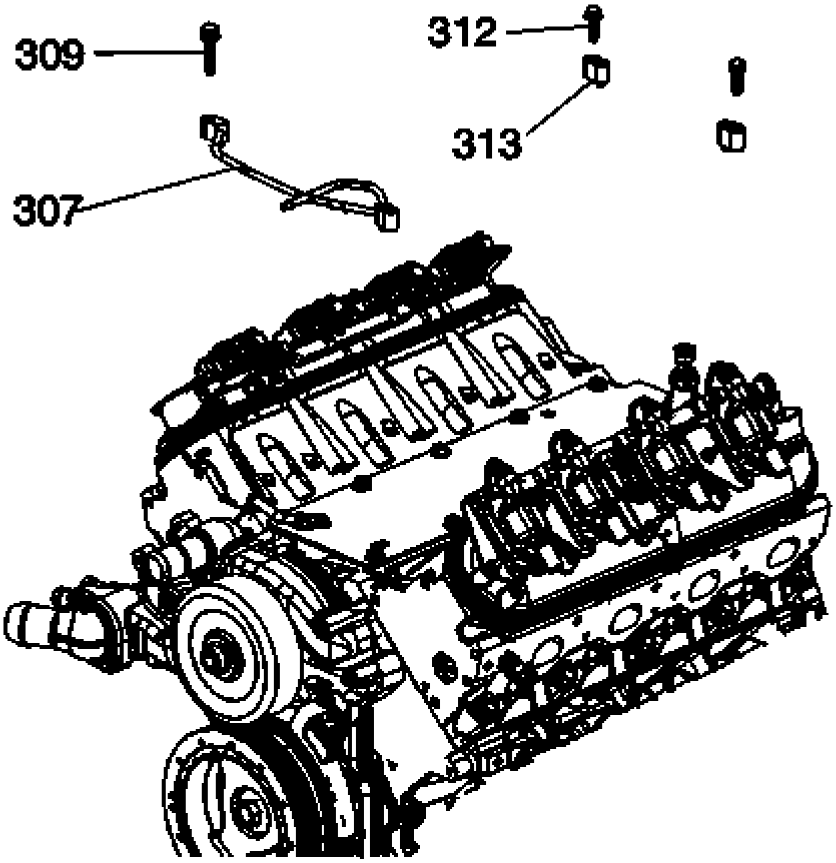


Fig. 151: Coolant Air Bleed Pipe, Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the pipe (307) and seals (308).

CAUTION: Refer to Fastener Caution .

3. Install the bolts (309) and tighten to 12 N.m (106 lb in).

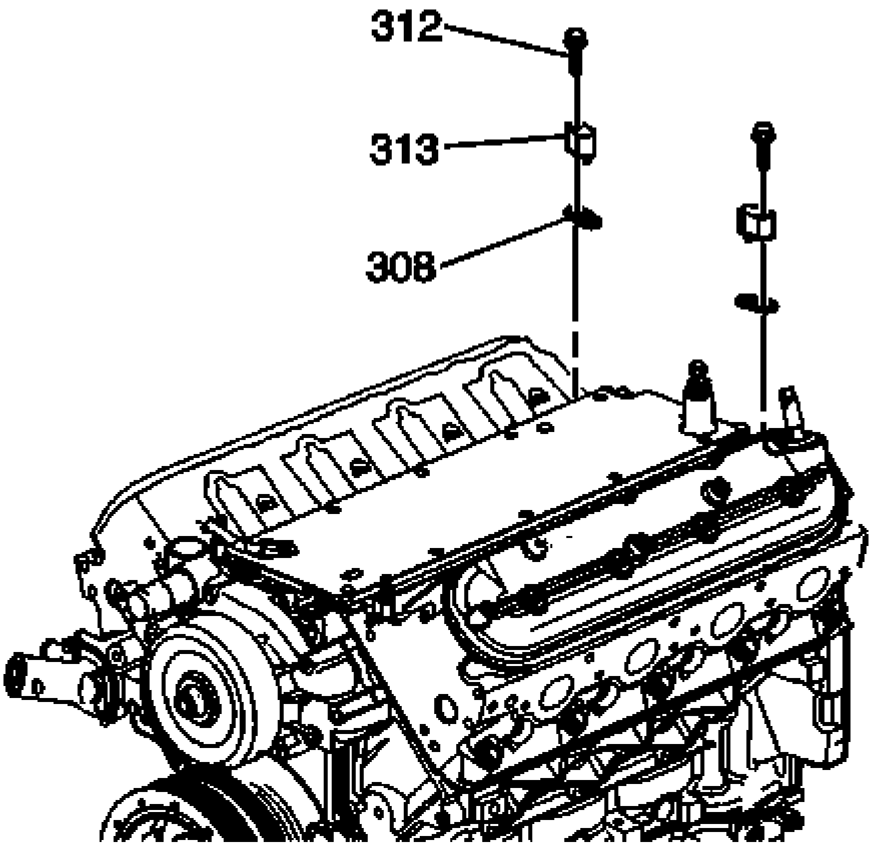


Fig. 152: Engine Coolant Air Bleed Cover, Bolts & Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug prior to cover installation.

4. Install the covers (313) and seals (308).
5. Install the bolts (312) and tighten to 12 N.m (106 lb in).

INTAKE MANIFOLD INSTALLATION

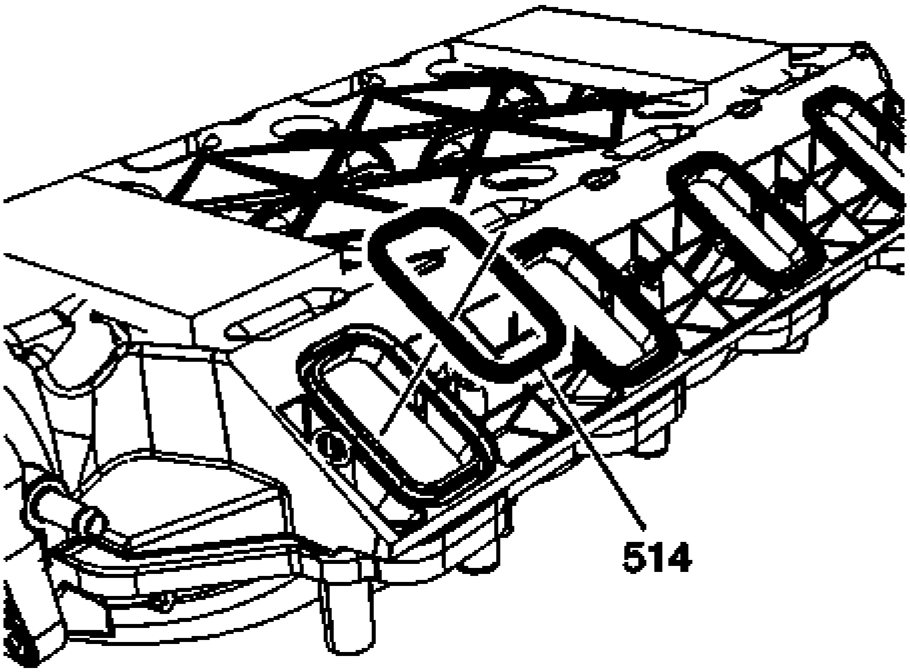


Fig. 153: Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.**
- **DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.**

1. Install NEW intake manifold-to-cylinder head gaskets (514).

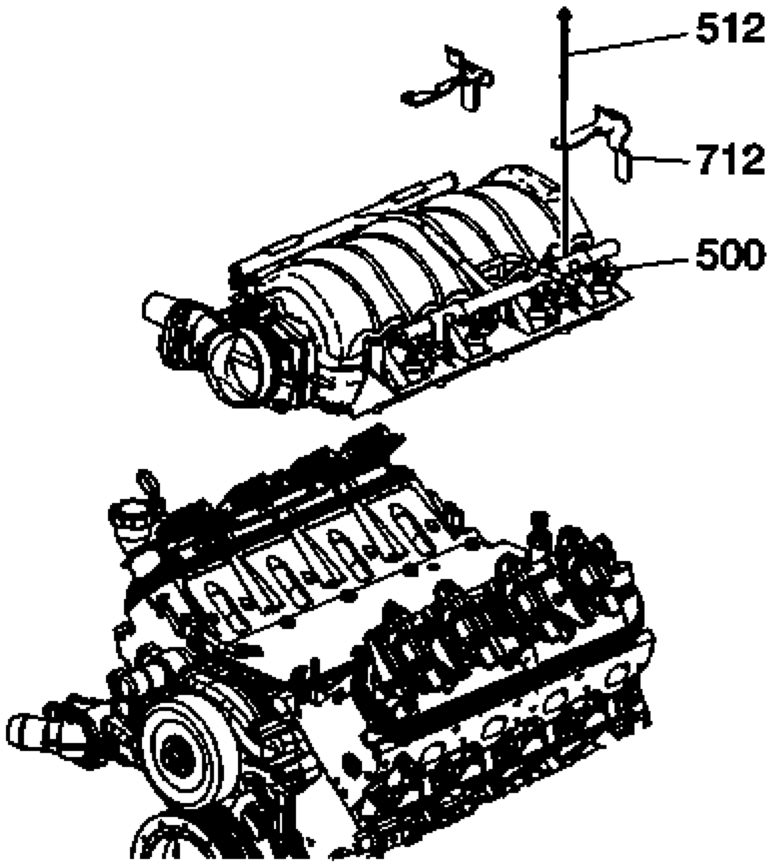


Fig. 154: Intake Manifold
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold (500).
3. Apply a 5 mm (0.20 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489) to the threads of the intake manifold bolts (512). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the intake manifold bolts (512) and fuel rail stop brackets (712).

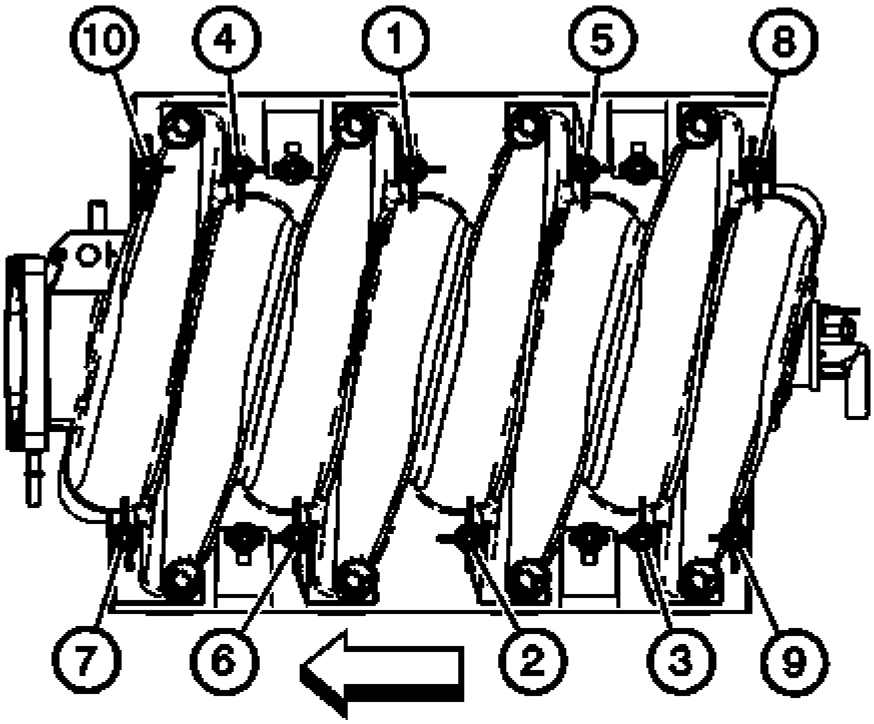


Fig. 155: View Of Intake Manifold Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Tighten the intake manifold bolts.
    1. Tighten the intake manifold bolts (1-10) a first pass in sequence to 5 N.m (44 lb in) .
    2. Tighten the intake manifold bolts (1-10) a final pass in sequence to 10 N.m (89 lb in) .

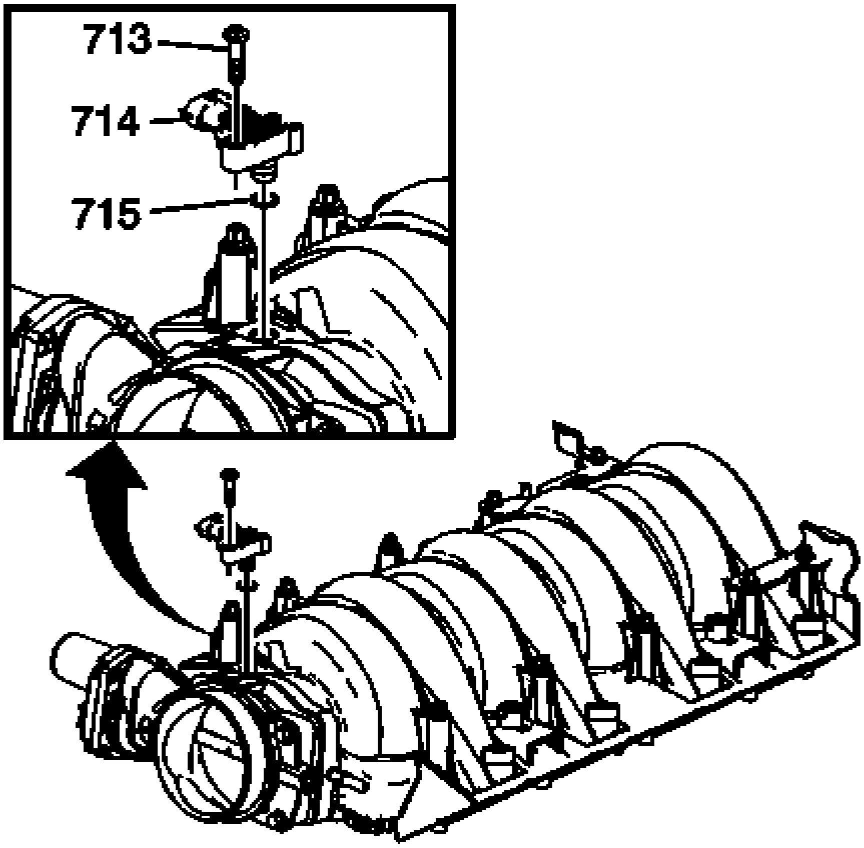


Fig. 156: Identifying Sensor Grommet, MAP Sensor And Bolt
Courtesy of GENERAL MOTORS CORP.

6. Lubricate the manifold absolute pressure (MAP) sensor grommet (715) with clean engine oil.
7. Install the MAP sensor (714) and grommet (715).
8. Install the MAP sensor bolt (713).

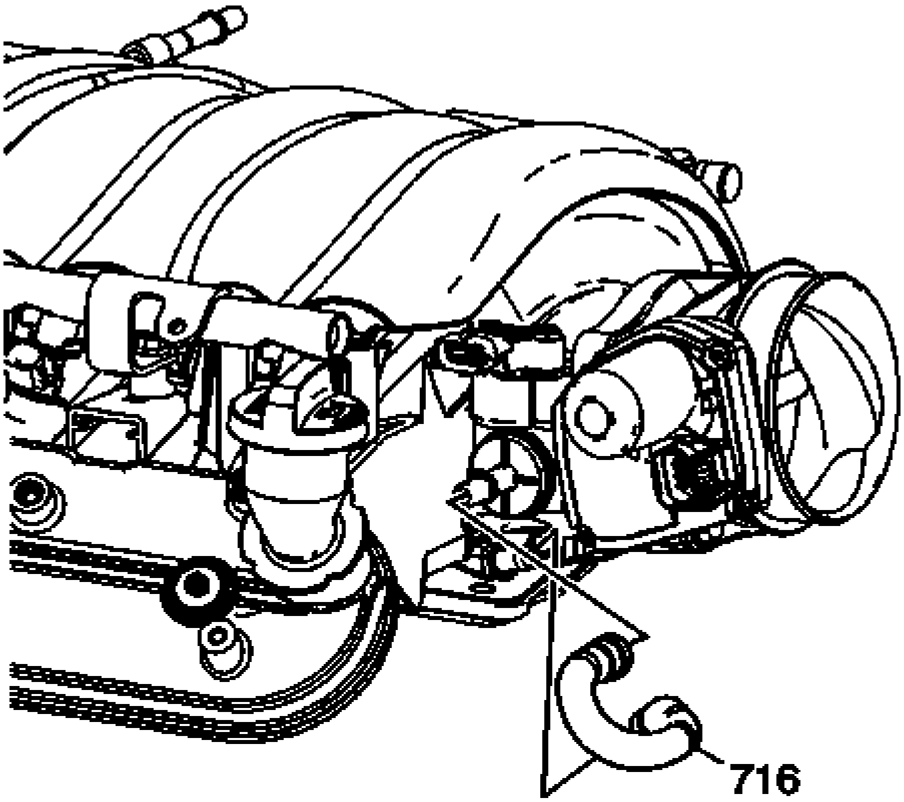


Fig. 157: Removing/Installing Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

9. Install the positive crankcase ventilation (PCV) - dirty air hose (716).
10. Install the PCV - fresh air hose.

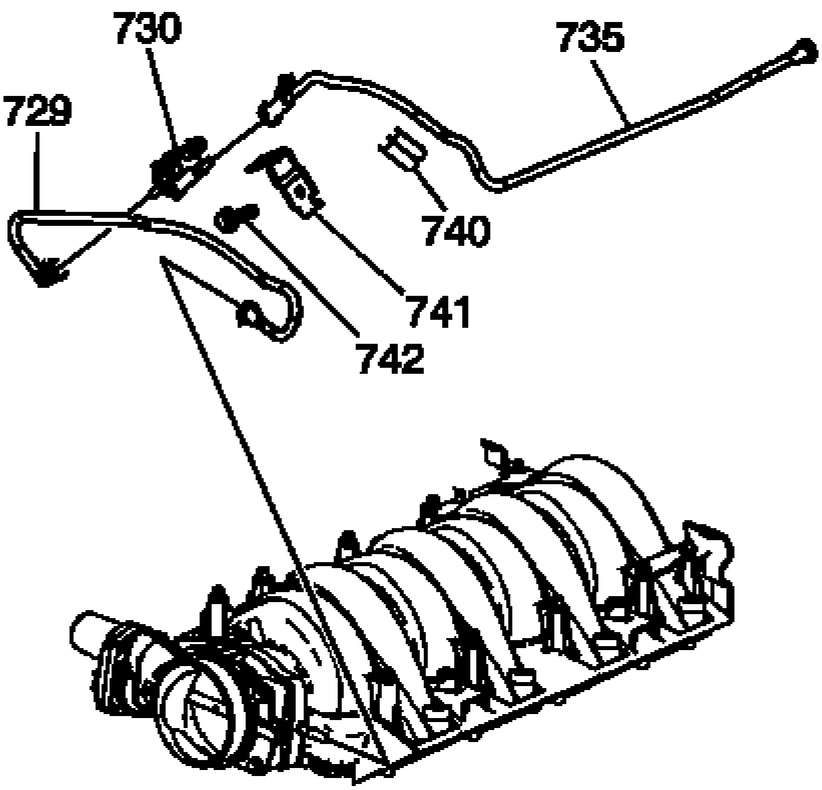


Fig. 158: EVAP Canister Purge Solenoid Valve, Bracket And Tubes
Courtesy of GENERAL MOTORS CORP.

11. Install the evaporative emission (EVAP) canister purge solenoid valve (730), bracket (741), and bolt (742). Tighten the bolt to 50 N.m (37 lb ft).
12. Install the EVAP tubes (729 and 735).
13. Install the fuel rail. Refer to **Fuel Rail and Injectors Installation**.

FUEL RAIL AND INJECTORS INSTALLATION

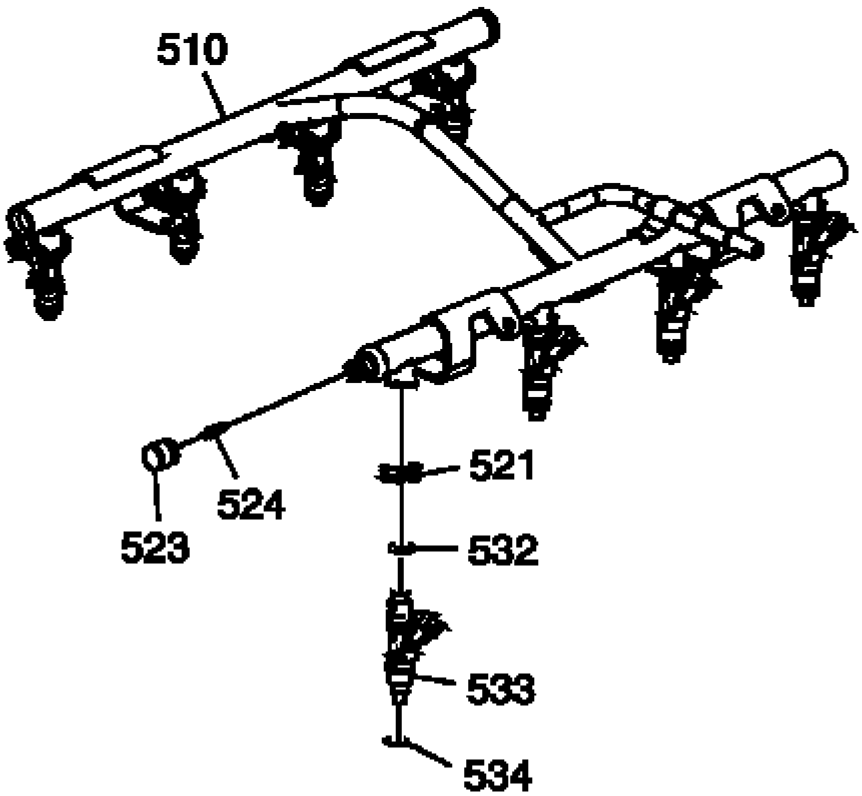


Fig. 159: Fuel Injectors & Retainers
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Rail Stop Bracket Installation Warning .

NOTE: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals (532 and 534) with clean engine oil.
2. Install the O-ring seals to the fuel injectors.
3. Install the fuel injectors (533) and retainers (521).

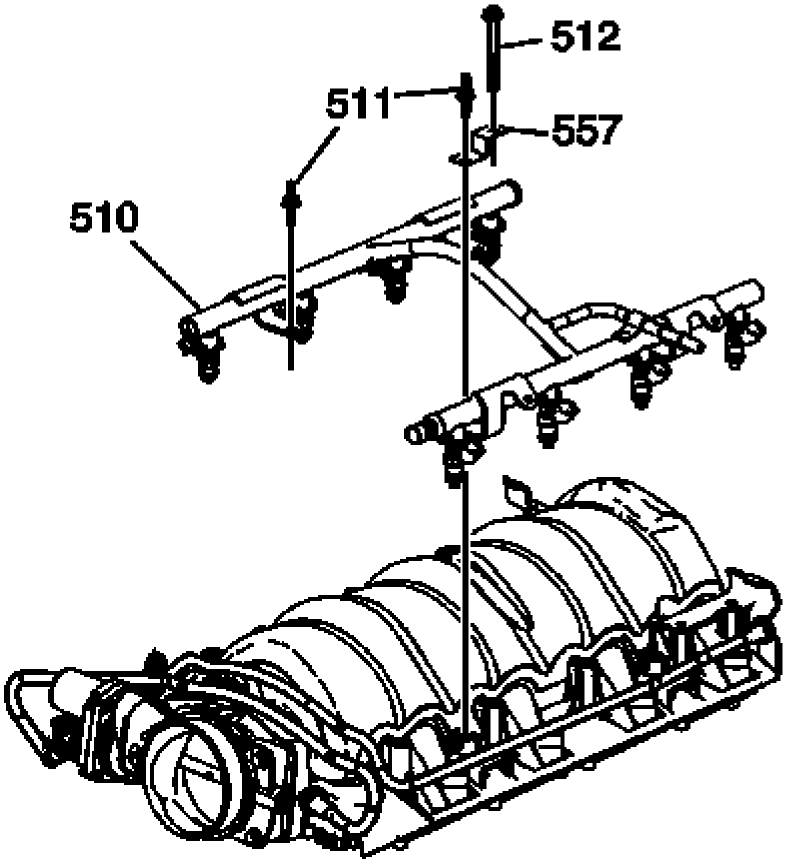


Fig. 160: Fuel Rail Assembly
Courtesy of GENERAL MOTORS CORP.

4. Install the fuel rail assembly (510) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
5. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the fuel rail bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

6. Install the fuel rail bolts (511 and 512) and fuel rail ground strap (557). Tighten the fuel rail bolts to 10 N.m (89 lb in).

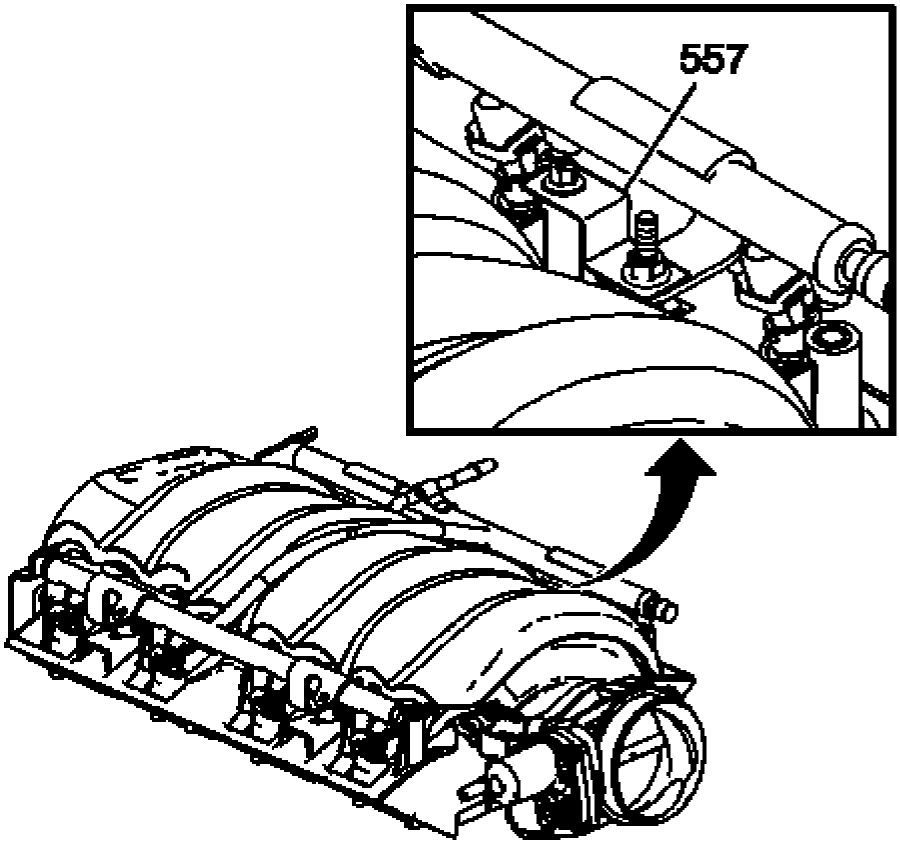


Fig. 161: Fuel Rail Ground Strap
Courtesy of GENERAL MOTORS CORP.

7. Inspect the fuel rail ground strap (557) for proper installation.

THROTTLE BODY INSTALLATION

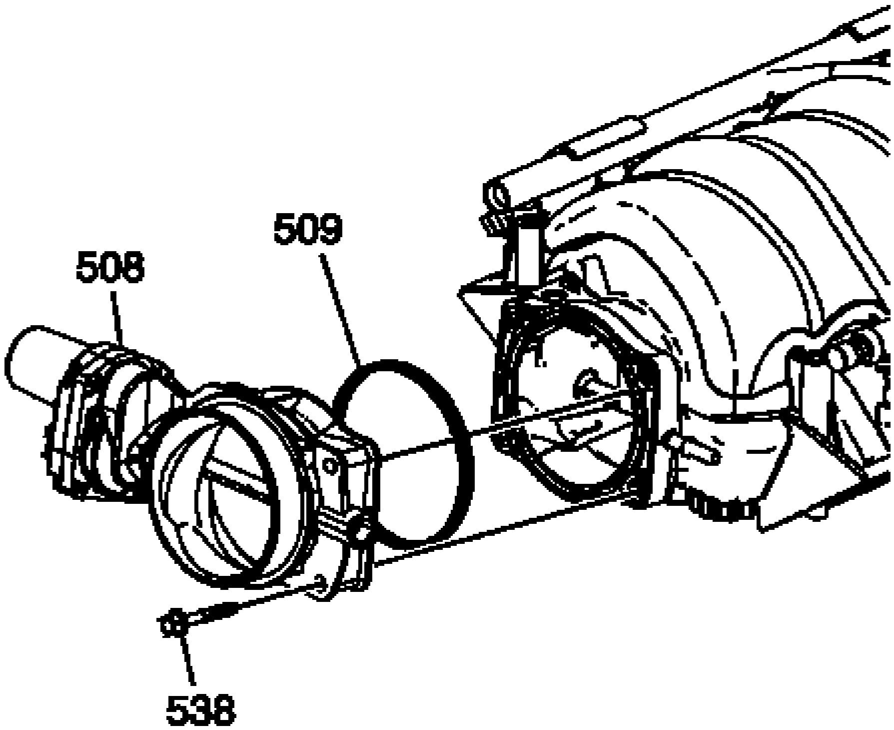


Fig. 162: Throttle Body & Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install the throttle body gasket (509) to the intake manifold. Align the locating tab of the gasket with the notch in the manifold.

CAUTION: Refer to Fastener Caution .

2. Install the throttle body (508) and bolts (538). Tighten the throttle body bolts to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

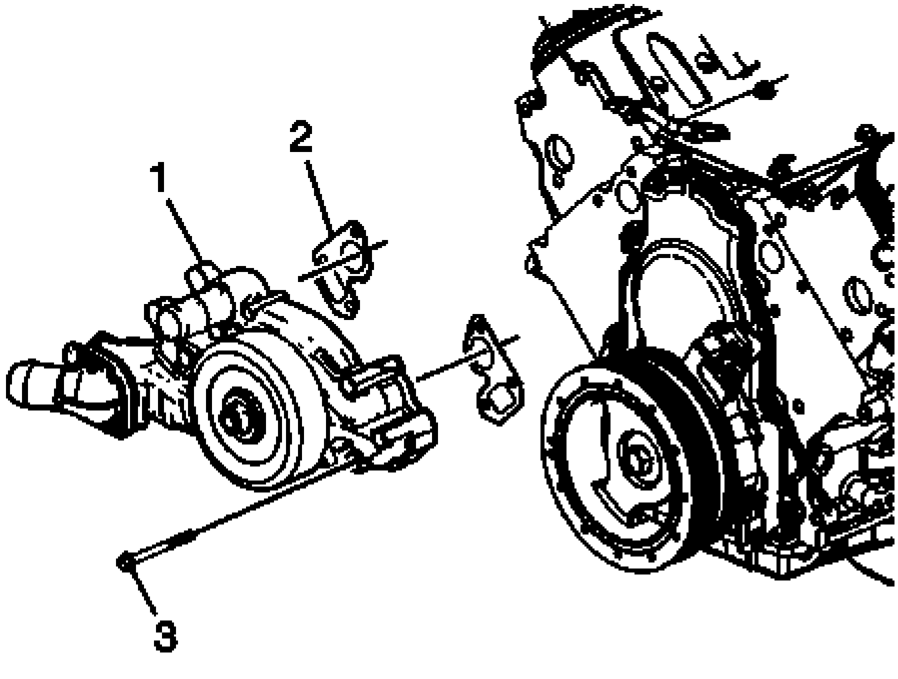


Fig. 163: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

CAUTION: DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

NOTE: All gasket surfaces are to be free of oil or other foreign material during assembly.

1. Install the water pump (1) and NEW gaskets (2).

CAUTION: Refer to Fastener Caution .

2. Install the water pump bolts (3).
    1. Tighten the water pump bolts a first pass to 15 N.m (11 lb ft) .

2. Tighten the water pump bolts a final pass to 30 N.m (22 lb ft) .

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

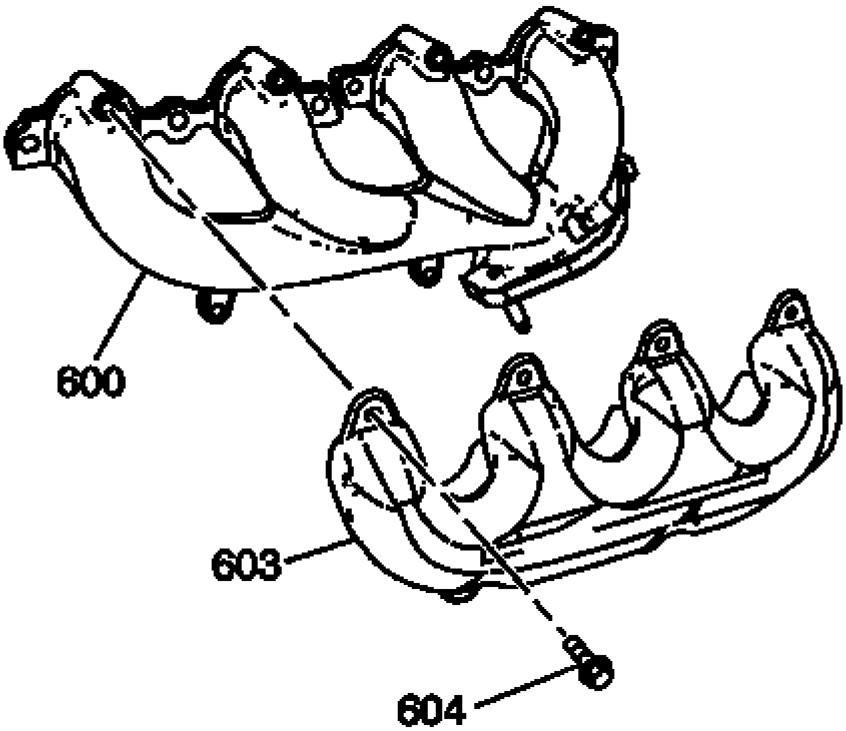


Fig. 164: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.**
- **The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.**
- **Do not apply sealant to the first 3 threads of the bolt.**

1. Install the heat shield (603) and bolts (604) and tighten to 9 N.m (80 lb in).
2. Install the exhaust pipe studs and tighten to 20 N.m (15 lb ft).

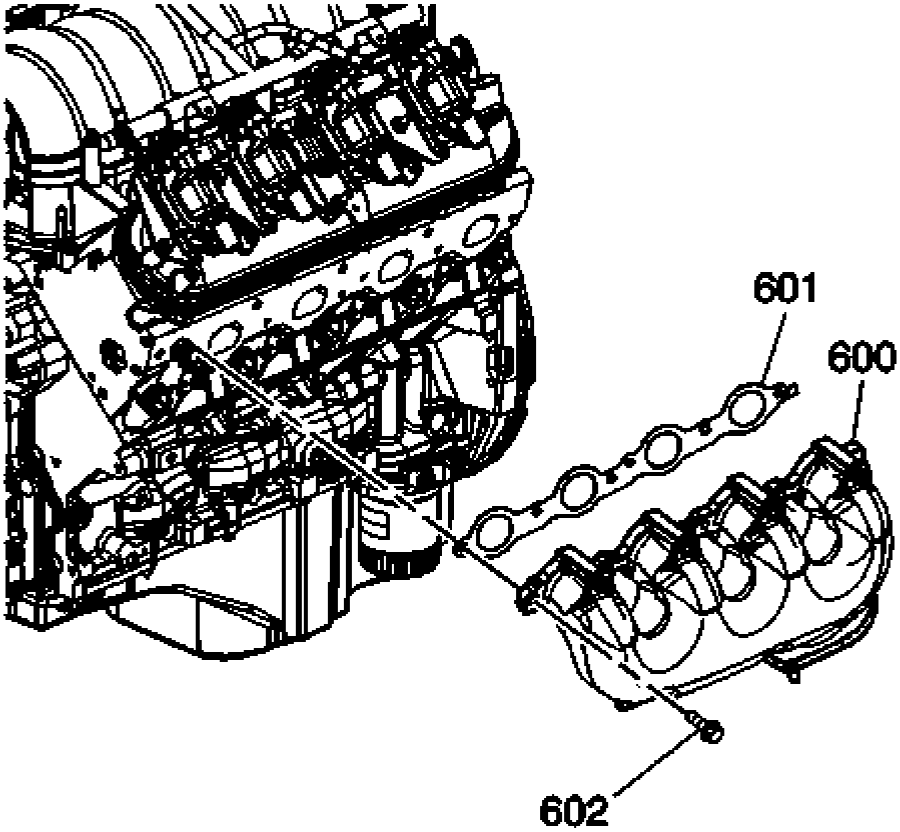


Fig. 165: Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
    1. Tighten the exhaust manifold bolts a first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
    2. Tighten the exhaust manifold bolts a final pass to 20 N.m (15 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

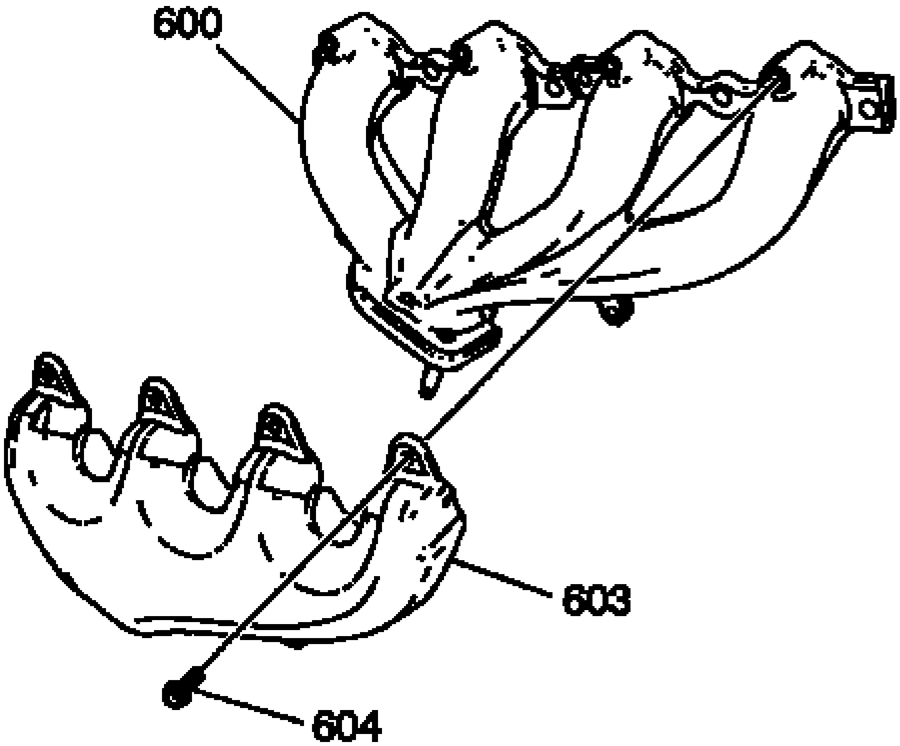


Fig. 166: View Of Heat Shield & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.**
- **The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.**
- **Do not apply sealant to the first 3 threads of the bolt.**

1. Install the heat shield (603) and bolts (604) and tighten to 9 N.m (80 lb in).
2. Install the exhaust pipe studs and tighten to 20 N.m (15 lb ft).

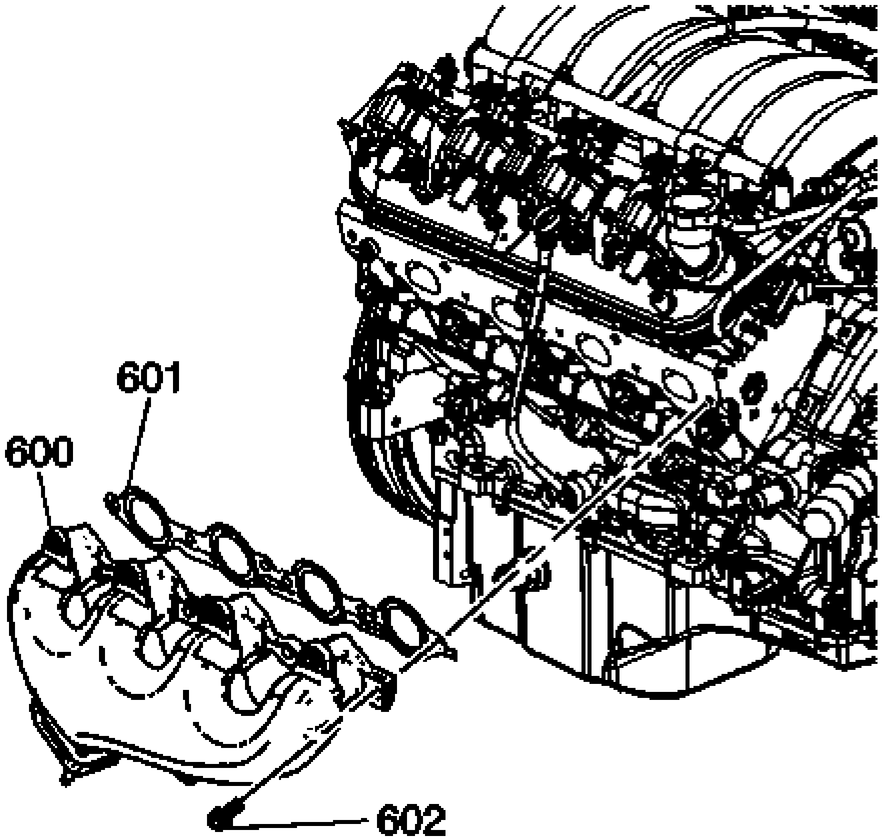


Fig. 167: Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
    1. Tighten the exhaust manifold bolts a first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
    2. Tighten the exhaust manifold bolts a final pass to 20 N.m (15 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the right cylinder head.

OIL LEVEL INDICATOR AND TUBE INSTALLATION

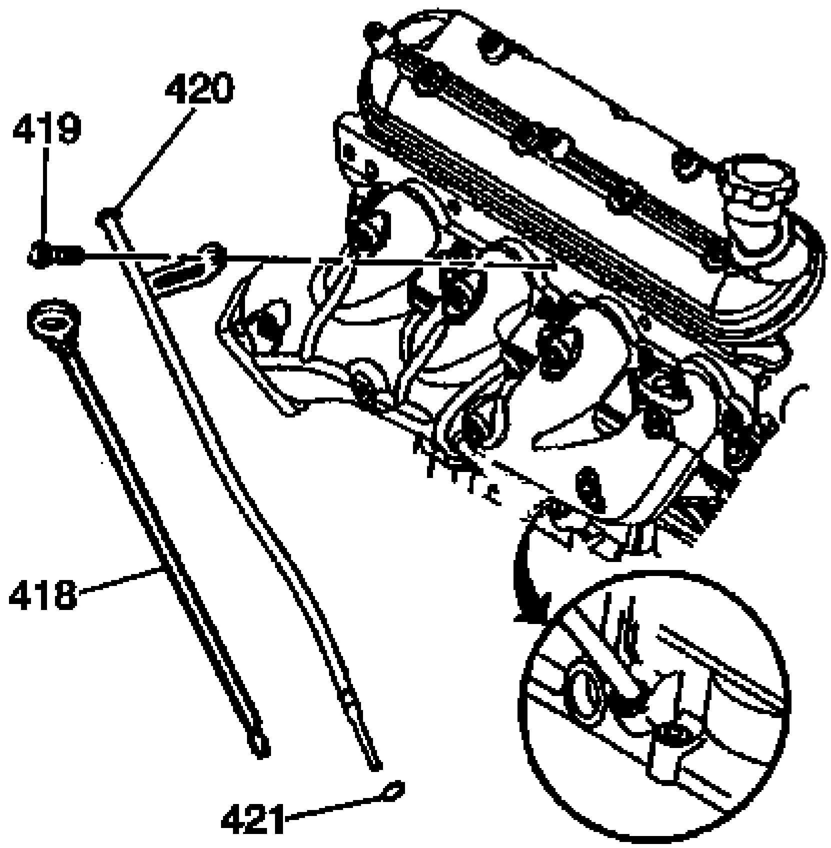


Fig. 168: Oil Level Indicator and Tube
Courtesy of GENERAL MOTORS CORP.

1. Inspect the O-ring seal (421) for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal with clean engine oil.
3. Install the O-ring seal onto the oil level indicator tube (420).
4. Install the oil level indicator tube into the engine block and rotate into proper position.

CAUTION: Refer to Fastener Caution .

5. Install the tube bolt (419) and tighten to 25 N.m (18 lb ft).
6. Install the oil level indicator (418) into the tube.

CLUTCH PILOT BEARING INSTALLATION

Tools Required

J 38836 Bushing Installer and Clutch Arbor

Installation

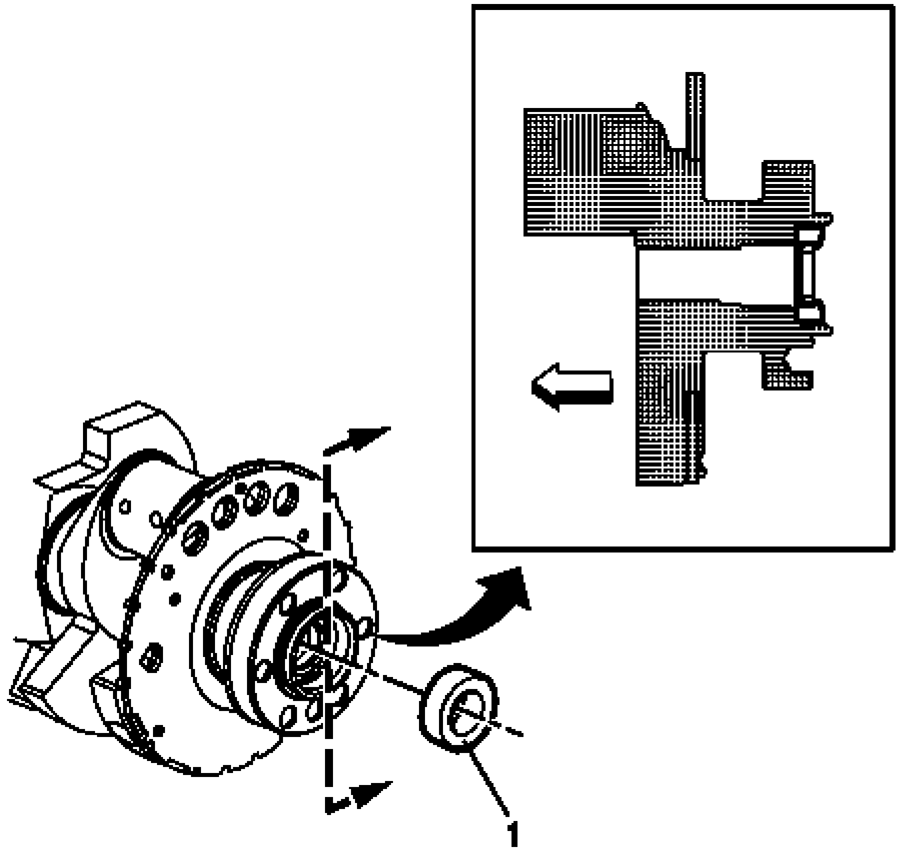


Fig. 169: Identifying Crankshaft Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the crankshaft rear oil gallery plug (1) is not a loose fit, damaged or leaking.

IMPORTANT: The correct depth (a) for the oil gallery plug is 31.2 to 31.6 mm.

1. Apply sealant LOCTITE R 242 and install it to the correct depth, If replacing the oil gallery plug (1).

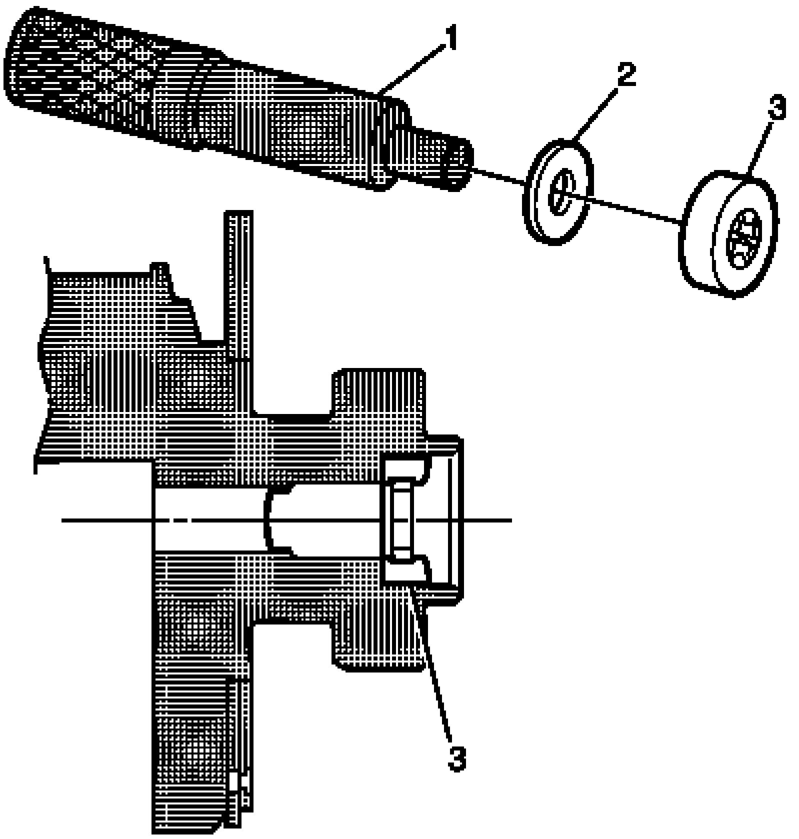


Fig. 170: Locating J 38836, 5/8 Inch Flat Washer & Clutch Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use a 5/8 inch flat washer (2) against the tool to support the bearing races.

IMPORTANT: When installed correctly the bearing should be flush with the crankshaft counter-bore.

2. Install the clutch pilot bearing (3) to the rear of the crankshaft, using **J 38836** (1).

ENGINE FLYWHEEL INSTALLATION

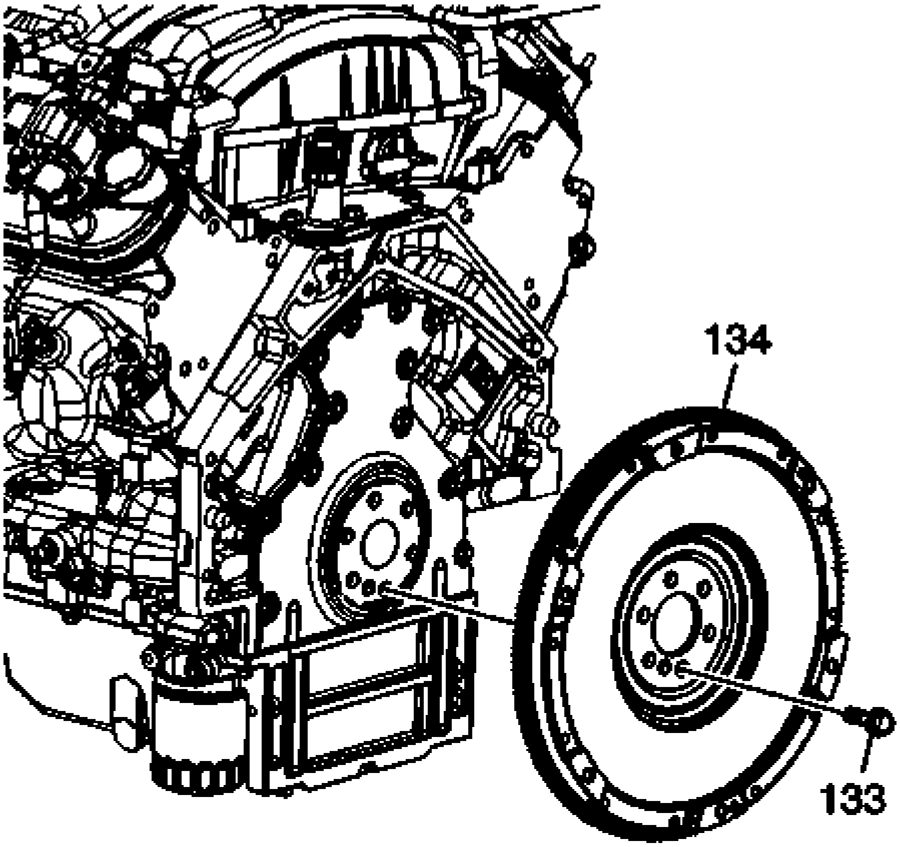


Fig. 171: Flywheel
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel (134) to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flywheel bolts (133).

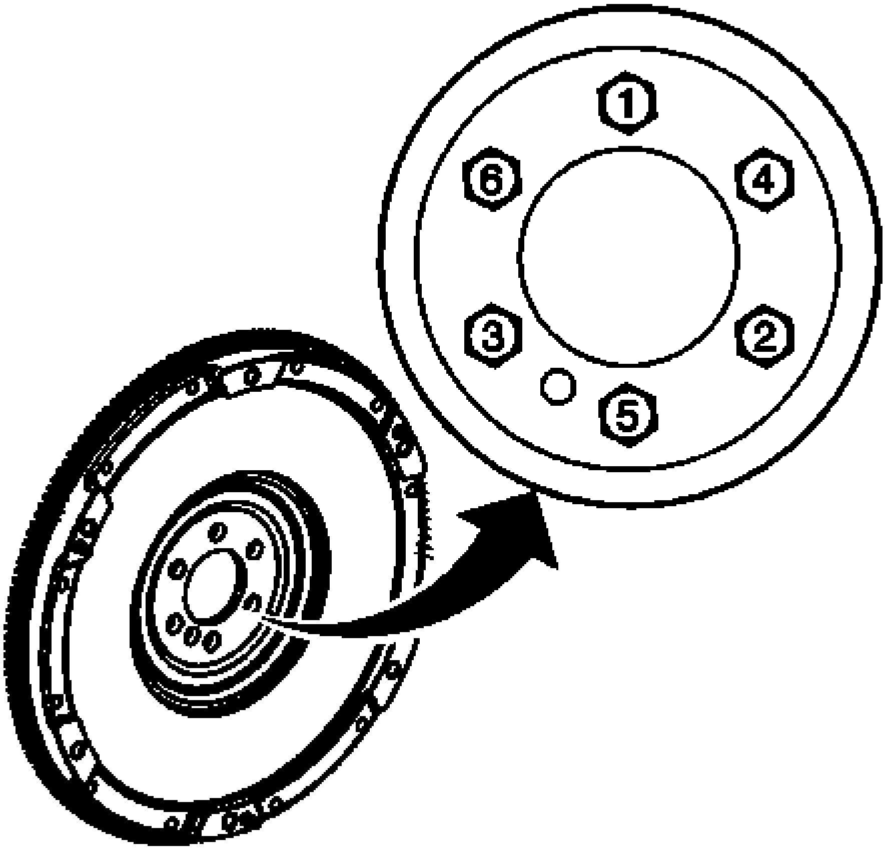


Fig. 172: Engine Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the bolts.
    1. Tighten the bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft) .
    2. Tighten the bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft) .
    3. Tighten the bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft) .

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

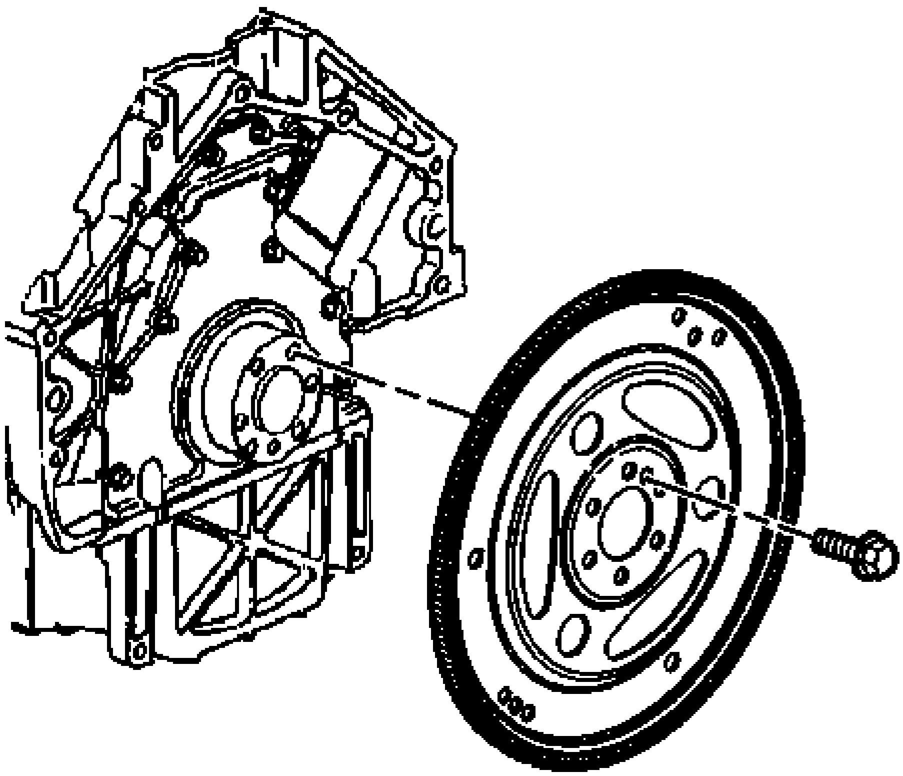


Fig. 173: View Of Engine Flex Plate
Courtesy of GENERAL MOTORS CORP.

NOTE: **The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.**

1. Install the flex plate to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flex plate bolts.

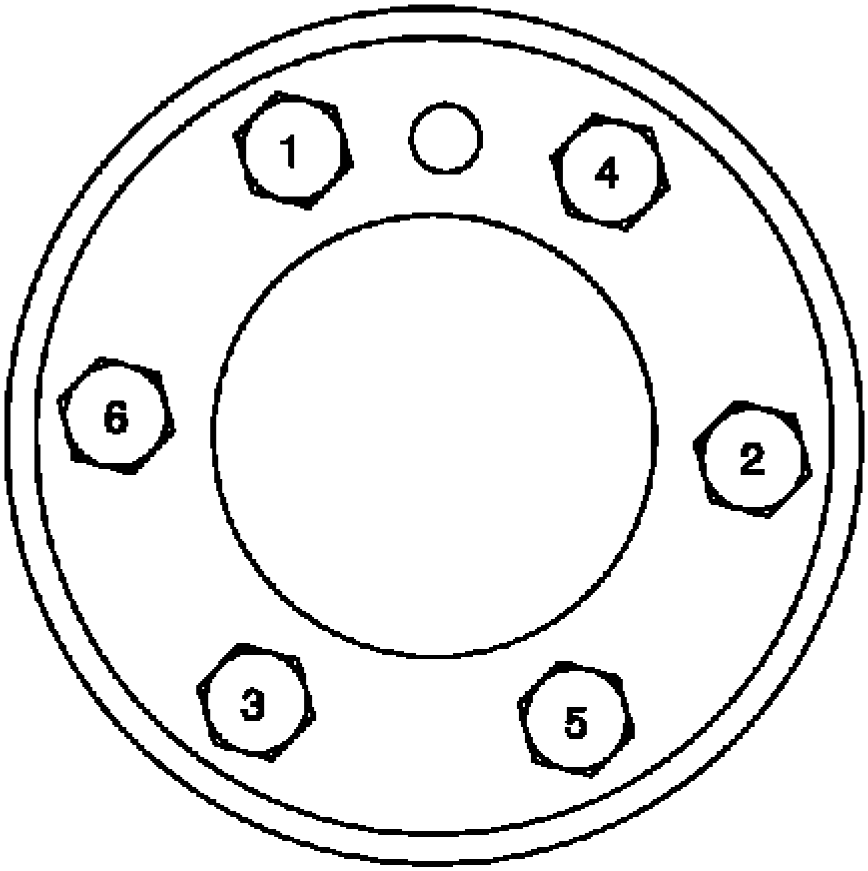


Fig. 174: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the engine flex plate bolts.
    1. Tighten the engine flex plate bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft) .
    2. Tighten the engine flex plate bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft) .
    3. Tighten the engine flex plate bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft) .

CRANKSHAFT BALANCER INSTALLATION (L76)

Special Tools

- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool

- **J 45059:** Angle Meter

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

Installation

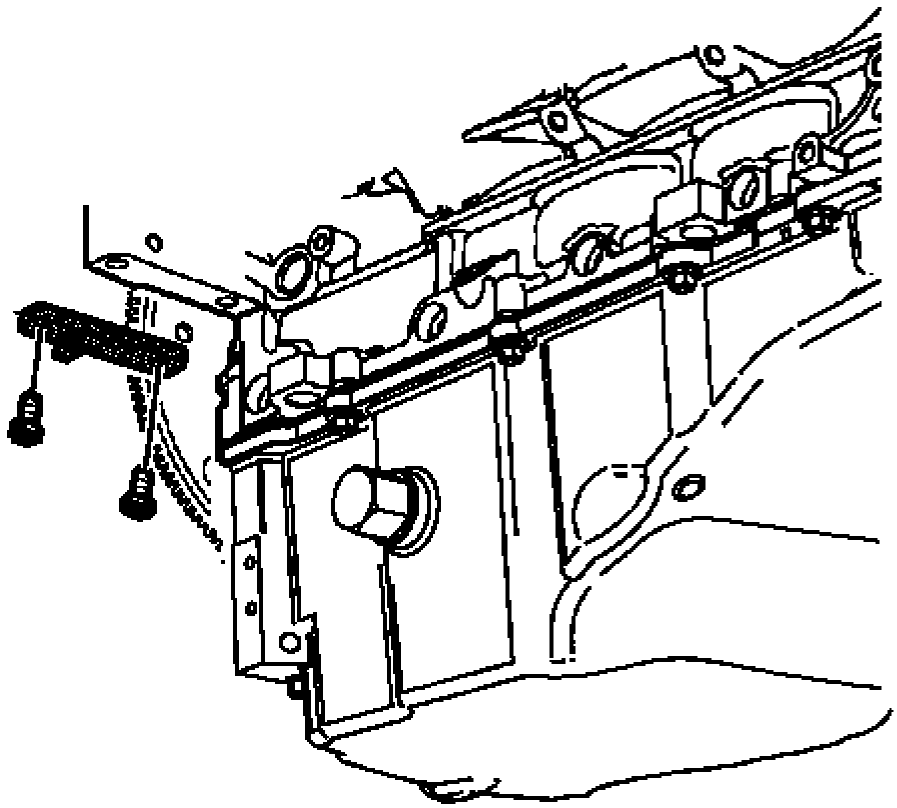


Fig. 175: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the **J 42386-A:** holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

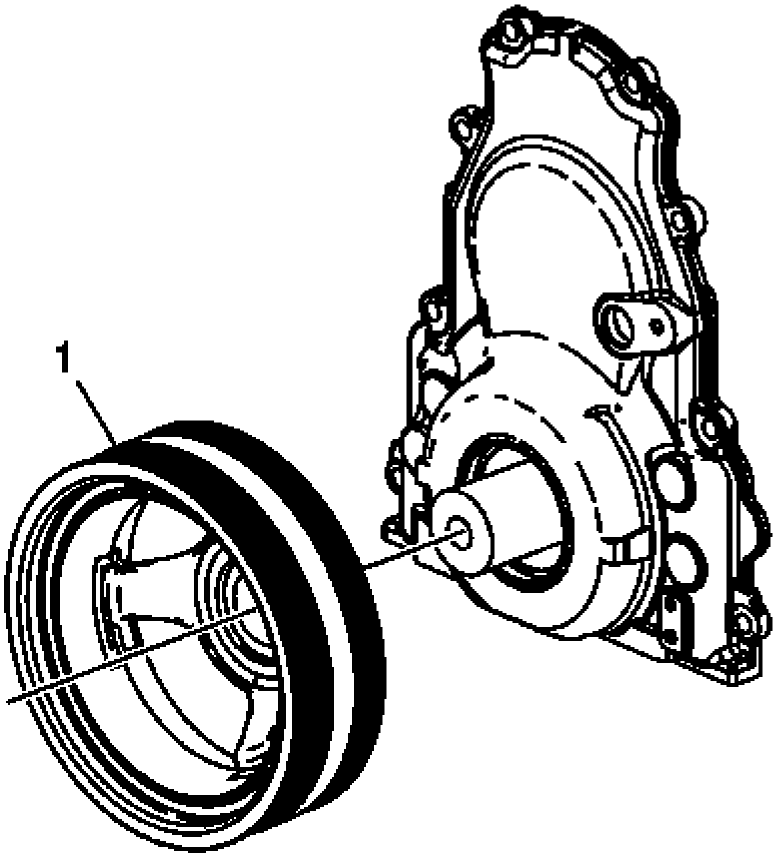


Fig. 176: Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE:	**The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.**

2. Position the balancer (1) onto the end of the crankshaft.

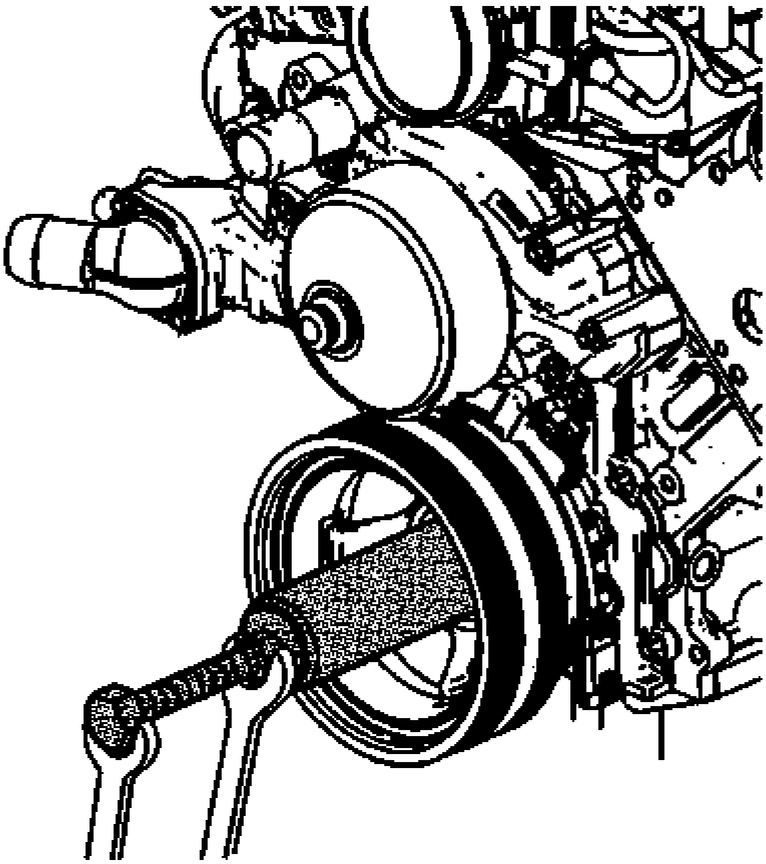


Fig. 177: Installing Balancer
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 41665:** installer and the **J 41478:** seal installer in order to install the balancer.
    1. Assemble the **J 41478:** seal installer threaded rod, nut, washer and the **J 41665:** installer .

       Insert the smaller end of the installer into the front of the balancer.

    2. Use a wrench and hold the hex end of the threaded rod.
    3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
    4. Remove and reverse the installation tool.

       Position the larger end of the installer against the front of the balancer.

    5. Use a wrench and hold the hex end of the threaded rod.
    6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
    7. Remove the balancer installation tools.

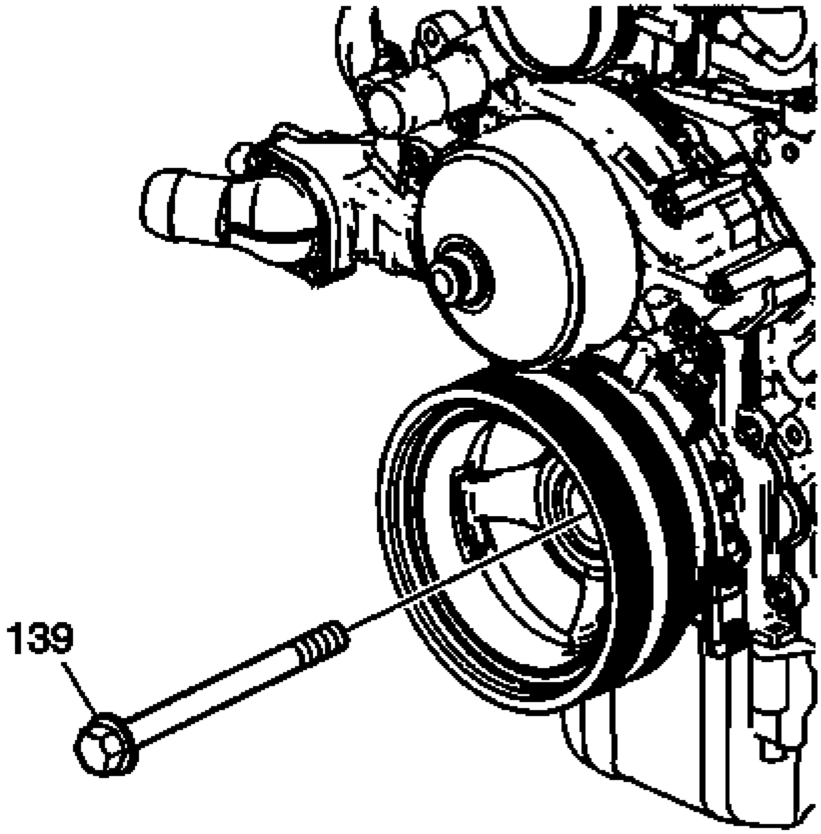


Fig. 178: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

4. Install the used crankshaft balancer bolt (139) and tighten to 330 N.m (240 lb ft).
5. Remove the used crankshaft balancer bolt.

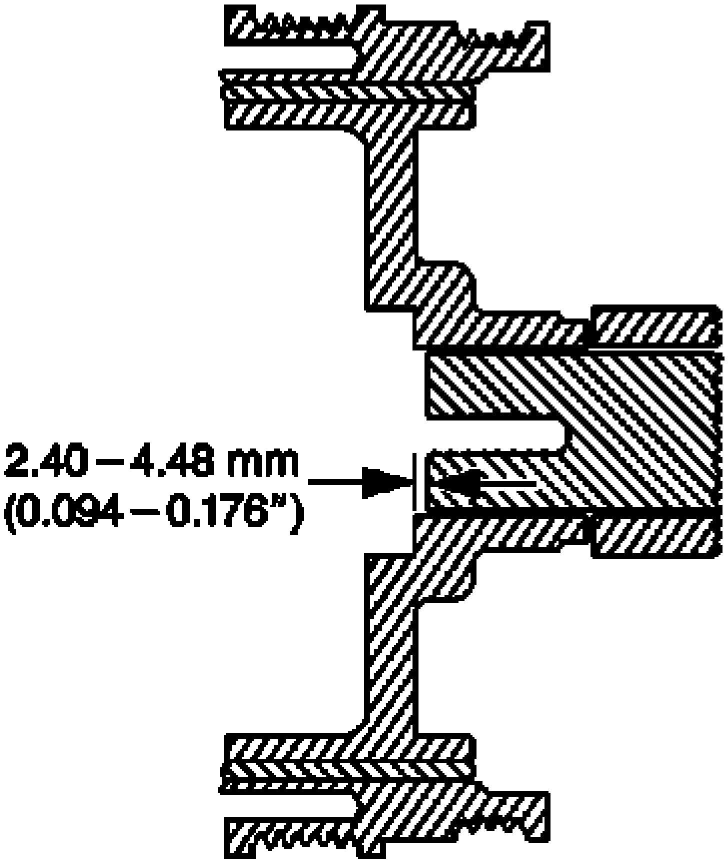


Fig. 179: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

NOTE: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

6. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the **J 41665:** installer and repeat the installation procedure.

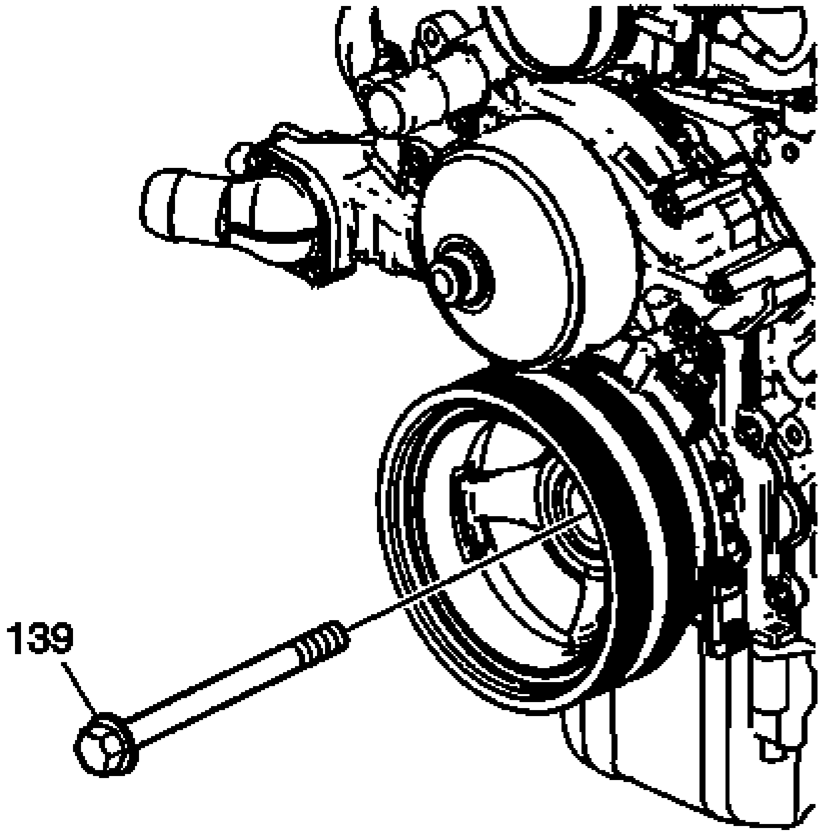


Fig. 180: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW crankshaft balancer bolt.
    1. Tighten the crankshaft balancer bolt a first pass to 150 N.m (110 lb ft) .
    2. Loosen the crankshaft balancer bolt a second pass 360 degrees .
    3. Tighten the crankshaft balancer bolt a third pass to 50 N.m (37 lb ft) .
    4. Tighten the crankshaft balancer bolt a final pass to 230 degrees using the **J 45059:** meter .
8. Remove the **J 42386-A:** holding tool.

CRANKSHAFT BALANCER INSTALLATION (6.2L LS3)

Special Tools

- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool
- **J 45059:** Angle Meter

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

Installation

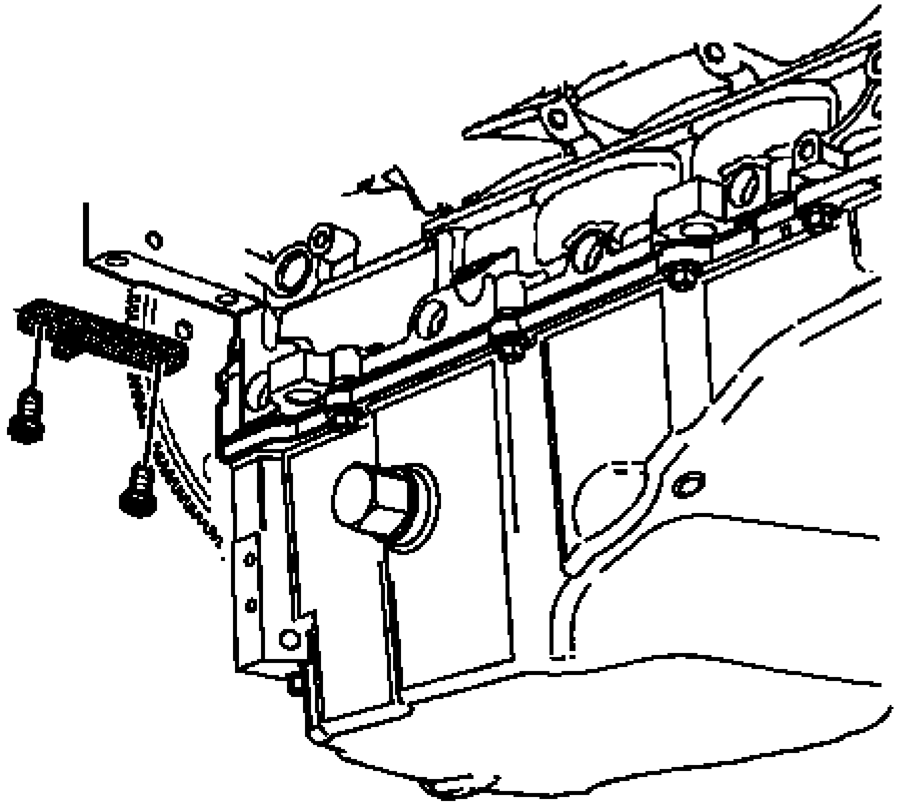


Fig. 181: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the **J 42386-A:** holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

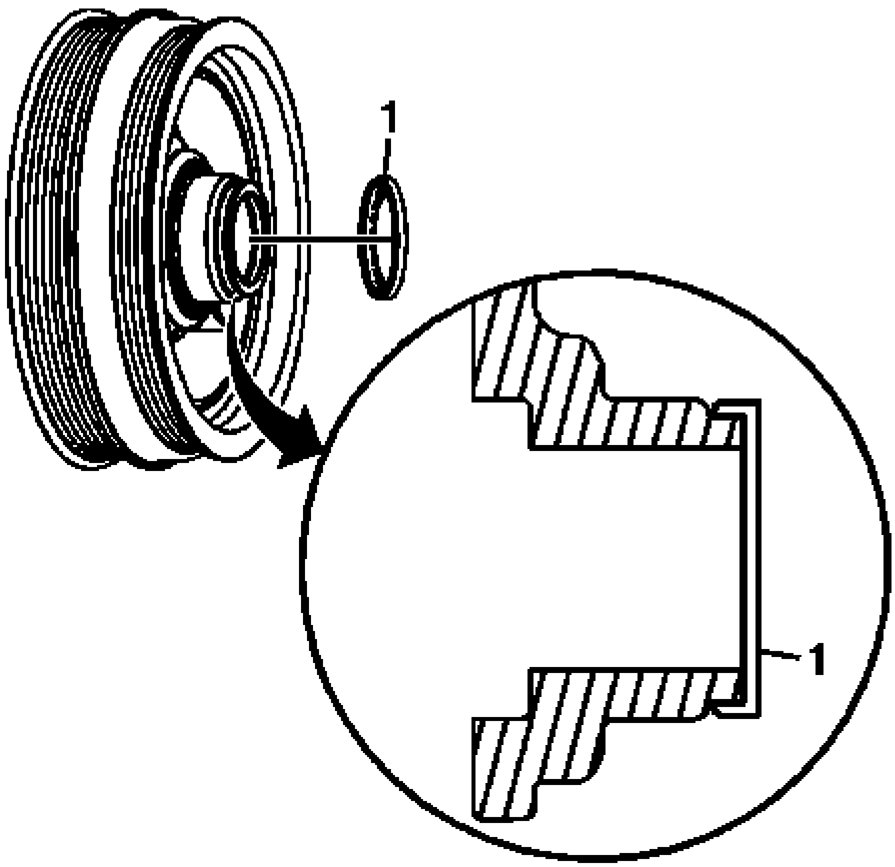


Fig. 182: POA Friction Washer
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft balancer washer (1) onto the crankshaft balancer.

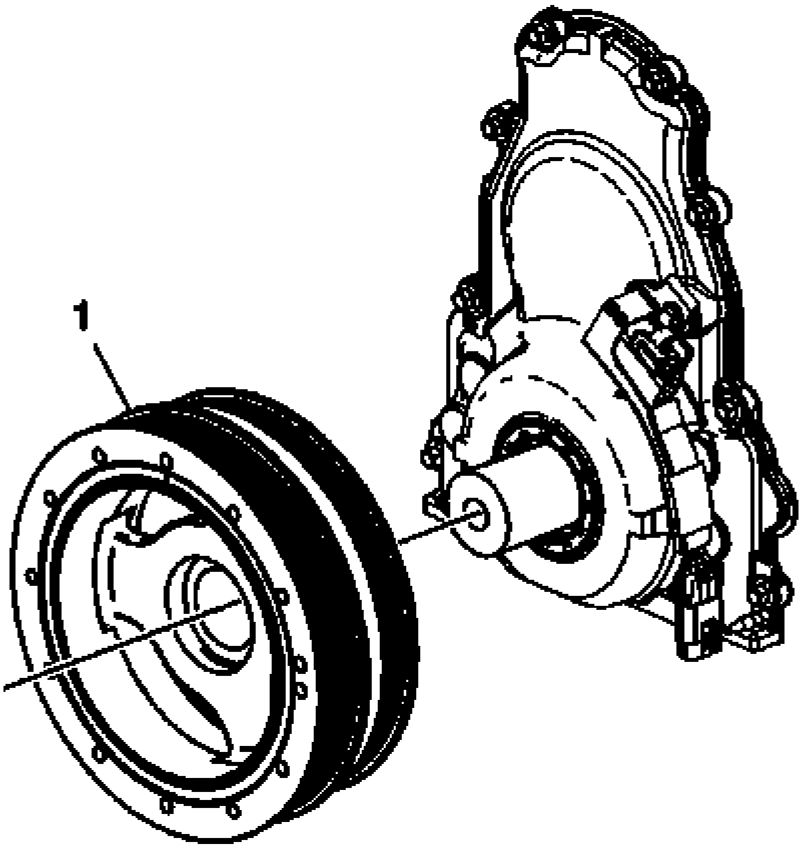


Fig. 183: Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

3. Position the balancer (1) onto the end of the crankshaft.

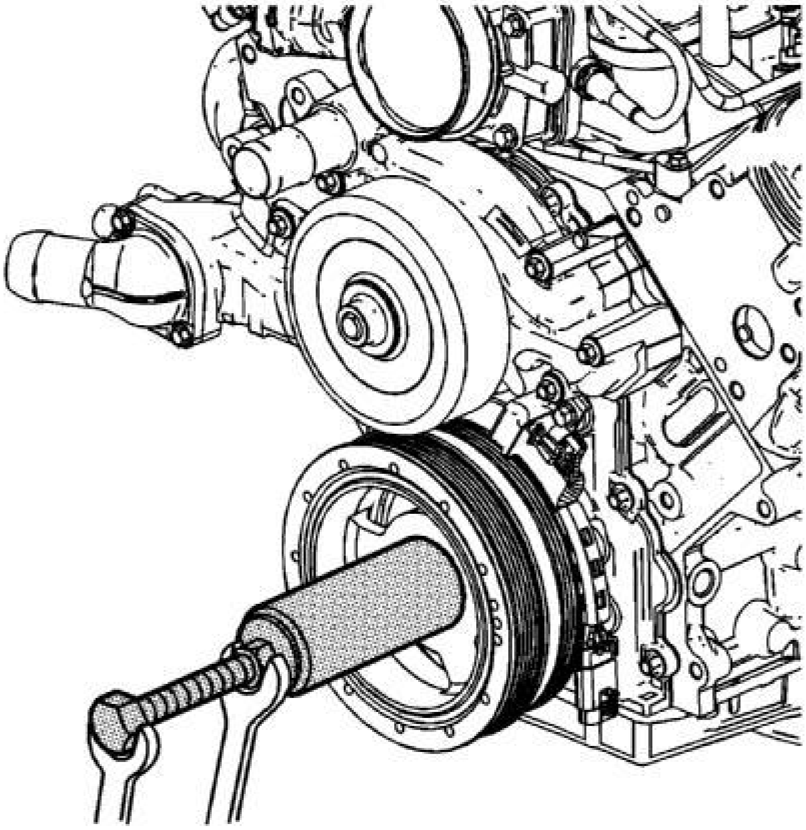


Fig. 184: J 41665 and J 41478
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41665:** installer and the **J 41478:** seal installer in order to install the balancer.
    1. Assemble the **J 41478:** seal installer threaded rod, nut, washer, and the **J 41665:** installer .

       Insert the smaller end of the installer into the front of the balancer.
    2. Use a wrench and hold the hex end of the threaded rod.
    3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
    4. Remove the tool and reverse the installation tool.

       Position the larger end of the installer against the front of the balancer.
    5. Use a wrench and hold the hex end of the threaded rod.
    6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
    7. Remove the balancer installation tools.

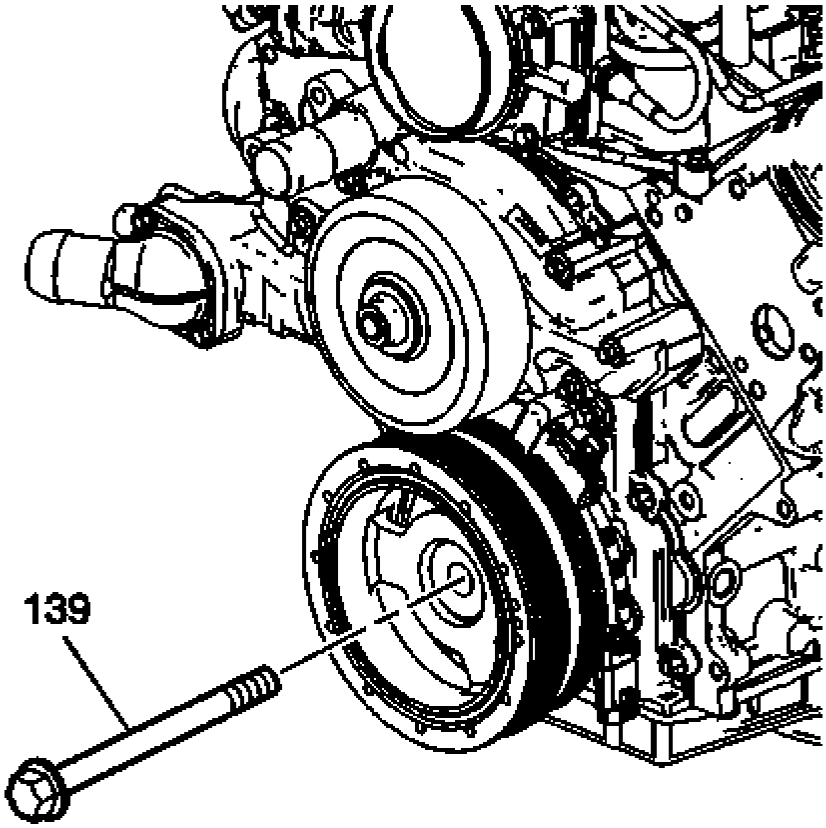


Fig. 185: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the NEW crankshaft balancer bolt (139).
    1. Tighten the crankshaft balancer bolt a first pass to 150 N.m (110 lb ft) .
    2. Loosen the crankshaft balancer bolt a second pass 360 degrees .
    3. Tighten the crankshaft balancer bolt a third pass to 50 N.m (37 lb ft) .
    4. Tighten the crankshaft balancer bolt a final pass to 230 degrees using the **J 45059:** meter .
6. Remove the **J 42386-A:** holding tool.

ENGINE PRELUBING

Special Tools

J 45299: Engine Preluber

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

Prelube

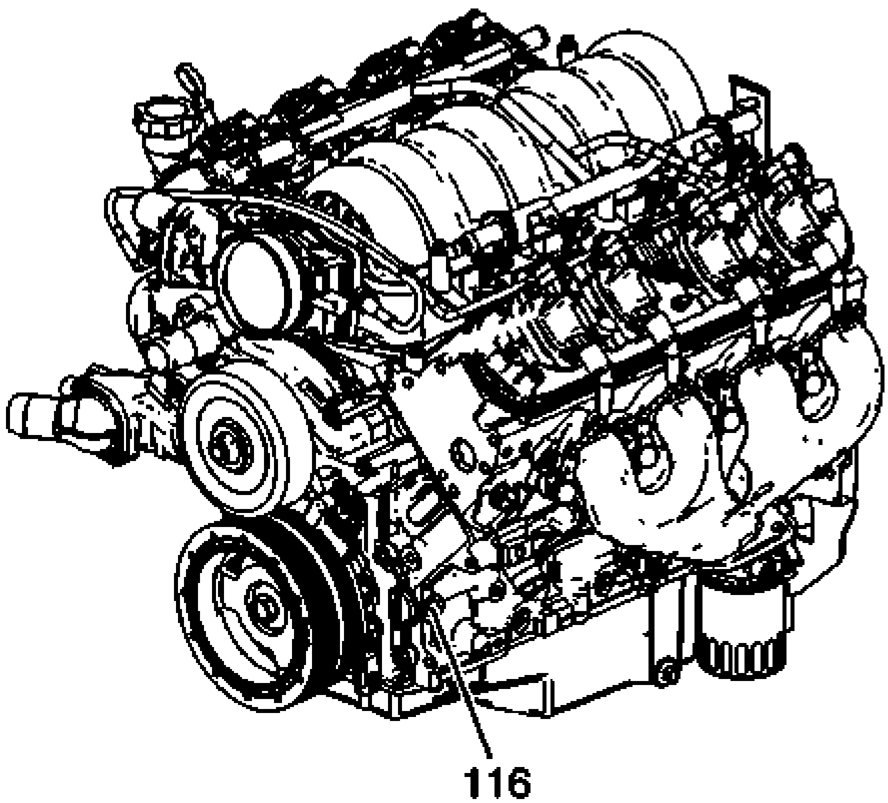


Fig. 186: Locating The Engine Block Left Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: A constant and 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, and fill with clean engine oil.

CAUTION: Refer to Fastener Caution .

2. Install the oil filter and tighten to 30 N.m (22 lb ft).
3. Locate the engine block left front oil gallery plug (116).
4. Install the M16 x 1.5 adapter P/N 509375.

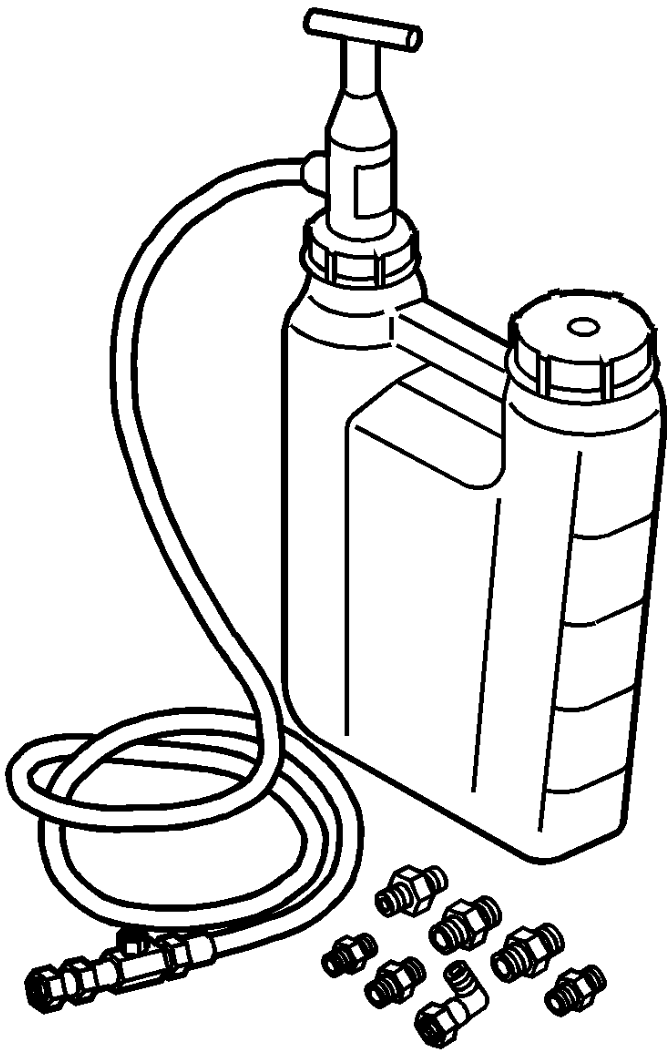


Fig. 187: Identifying Engine Preluber J 45299
Courtesy of GENERAL MOTORS CORP.

5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on the **J 45299:** preluber in order to flow a minimum of 1.0-1.9 liters (1-2 quarts) engine oil. 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 gallery plug to the engine and tighten to 60 N.m (44 lb ft).
9. Top-off the engine oil to the proper level.

