

2008 Hummer H3

2008 ENGINE Engine Mechanical - 5.3L - H3

2008 ENGINE**Engine Mechanical - 5.3L - H3****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS**

| Application | Specification | |
|---|----------------------|----------------|
| | Metric | English |
| Accessory Drive Belt Idler Pulley Bolt | 50 N.m | 37 lb ft |
| Accessory Drive Belt Tensioner Bolts | 50 N.m | 37 lb ft |
| Automatic Transmission Flex Plate Bolts - First Pass | 20 N.m | 15 lb ft |
| Automatic Transmission Flex Plate Bolts - Second Pass | 50 N.m | 37 lb ft |
| Automatic Transmission Flex Plate Bolts - Final Pass | 100 N.m | 74 lb ft |
| Battery Cable Channel Bolt | 12 N.m | 106 lb in |
| Camshaft Position (CMP) Sensor Bolt | 12 N.m | 106 lb in |
| Camshaft Position (CMP) Sensor Wire Harness Bolt | 12 N.m | 106 lb ft |
| 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 | |
| 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 - Installation Pass - to Ensure the Balancer is Completely Installed | 330 N.m | 240 lb ft |
| Crankshaft Balancer Bolt - First Pass - Install a NEW Bolt After the Installation Pass and Tighten as Described in the First and Final Passes | 50 N.m | 37 lb ft |
| Crankshaft Balancer Bolt - Final Pass | 140 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 |
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| 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 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 | |
| Cylinder Head 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 Plugs | 60 N.m | 44 lb ft |
| Engine Harness Ground Strap Bolt/Stud | 16 N.m | 12 lb ft |
| Engine Harness-to-Generator Bracket Bolt | 9 N.m | 80 lb in |
| Engine Harness Retainer-to-Intake Manifold Nut | 5 N.m | 44 lb in |
| Engine Mount Bracket Through Bolt | 100 N.m | 74 lb ft |
| Engine Mount-to-Engine Block Bolts | 55 N.m | 41 lb ft |
| Evaporative (EVAP) Emission Pipe Bracket Nut | 20 N.m | 15 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 |
| Front Cover Bolts | 25 N.m | 18 lb ft |
| Fuel Injection Fuel Rail Bolts | 10 N.m | 89 lb in |
| Fuel Injection Fuel Rail Crossover Tube Bolts | 3.8 N.m | 34 lb in |
| Fuel Rail Stop Bracket Bolt | 50 N.m | 37 lb ft |
| Generator Bracket Bolts | 50 N.m | 37 lb ft |
| Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs | 12 N.m | 106 lb in |
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| 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 |
| Intake Manifold Sight Shield Retainer Bolts | 5 N.m | 44 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 | 25 N.m | 18 lb ft |
| Negative Battery Cable Stud | 25 N.m | 18 lb ft |
| Oil Filter | 30 N.m | 22 lb ft |
| Oil Filter Fitting | 55 N.m | 40 lb ft |
| Oil Level Indicator Switch | 20 N.m | 15 lb ft |
| Oil Level Indicator Tube Bolt | 25 N.m | 18 lb ft |
| Oil Pan Baffle Bolts | 9 N.m | 80 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 | 9 N.m | 80 lb in |
| Oil Pan Drain Plug | 25 N.m | 18 lb ft |
| Oil Pan M6 Bolts - Oil Pan-to-Rear 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 Relief Valve | 27 N.m | 20 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 Bolts | 12 N.m | 106 lb in |
| Oil Pump-to-Engine Block Bolts | 25 N.m | 18 lb ft |
| Power Steering Pump-to-Engine Block Bolts | 50 N.m | 37 lb ft |
| Spark Plugs | 15 N.m | 11 lb ft |
| Throttle Body Bolts | 10 N.m | 89 lb in |
| Throttle Body Nuts | 10 N.m | 89 lb in |
| Throttle Body Studs | 6 N.m | 53 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 |

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| 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

| Application | Specification | |
|--|---------------------|----------------|
| | Metric | English |
| General | | |
| • Engine Type | V8 | |
| • Displacement | 5.3L | 325 CID |
| • RPO | LH8 | |
| • VIN | L | |
| • Bore | 96.0-96.018 mm | 3.779-3.78 in |
| • Stroke | 92.0 mm | 3.622 in |
| • Compression Ratio | 9.95:1 | |
| • 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 | 96.0-96.018 mm | 3.779-3.78 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 |

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| <ul style="list-style-type: none"> • Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck | 0.22 mm | 0.008 in |
| <ul style="list-style-type: none"> • Valve Lifter Bore Diameter | 21.417-21.443 mm | 0.843-0.844 in |
| Camshaft | | |
| <ul style="list-style-type: none"> • Camshaft End Play | 0.025-0.305 mm | 0.001-0.012 in |
| <ul style="list-style-type: none"> • Camshaft Journal Diameter | 54.99-55.04 mm | 2.164-2.166 in |
| <ul style="list-style-type: none"> • Camshaft Journal Out-of-Round | 0.025 mm | 0.001 in |
| <ul style="list-style-type: none"> • Camshaft Lobe Lift - Intake | 7.20 mm | 0.283 in |
| <ul style="list-style-type: none"> • Camshaft Lobe Lift - Exhaust | 7.20 mm | 0.283 in |
| <ul style="list-style-type: none"> • Camshaft Runout - Measured at the Intermediate Journals | 0.05 mm | 0.002 in |
| Connecting Rod | | |
| <ul style="list-style-type: none"> • Connecting Rod Bearing Clearance - Production | 0.023-0.065 mm | 0.0009-0.0025 in |
| <ul style="list-style-type: none"> • Connecting Rod Bearing Clearance - Service | 0.023-0.076 mm | 0.0009-0.003 in |
| <ul style="list-style-type: none"> • Connecting Rod Bore Diameter - Bearing End | 56.505-56.525 mm | 2.224-2.225 in |
| <ul style="list-style-type: none"> • Connecting Rod Bore Out-of-Round - Bearing End - Production | 0.004-0.008 mm | 0.00015-0.0003 in |
| <ul style="list-style-type: none"> • Connecting Rod Bore Out-of-Round - Bearing End - Service | 0.004-0.008 mm | 0.00015-0.0003 in |
| <ul style="list-style-type: none"> • Connecting Rod Side Clearance | 0.11-0.51 mm | 0.00433-0.02 in |
| Crankshaft | | |
| <ul style="list-style-type: none"> • Connecting Rod Journal Diameter - Production | 53.318-53.338 mm | 2.0991-2.0999 in |
| <ul style="list-style-type: none"> • Connecting Rod Journal Diameter - Service | 53.308 mm | 2.0987 in |
| <ul style="list-style-type: none"> • Connecting Rod Journal Out-of-Round - Production | 0.005 mm | 0.0002 in |
| <ul style="list-style-type: none"> • Connecting Rod Journal Out-of-Round - Service | 0.01 mm | 0.0004 in |
| <ul style="list-style-type: none"> • Connecting Rod Journal Taper - Maximum for | 0.005 mm | 0.0002 in |

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| 1/2 of Journal Length - Production | | |
| • 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 (0.04 in) Below Tooth Diameter | 0.7 mm | 0.028 in |
| • 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 |

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| <ul style="list-style-type: none"> Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide | 17.32 mm | 0.682 in |
| Intake Manifold | | |
| <ul style="list-style-type: none"> 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 | | |
| <ul style="list-style-type: none"> Oil Capacity - with Filter | 5.68 liters | 6.0 quarts |
| <ul style="list-style-type: none"> Oil Capacity - without Filter | 5.20 liters | 5.5 quarts |
| <ul style="list-style-type: none"> 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 | | |
| <ul style="list-style-type: none"> Front Cover Alignment - at Oil Pan Surface | 0.0-0.5 mm | 0.0-0.02 in |
| <ul style="list-style-type: none"> Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface | 0.0-0.5 mm | 0.0-0.02 in |
| <ul style="list-style-type: none"> Oil Pan Alignment - to Rear of Engine Block at Transmission Housing Mounting Surface | 0.0-0.1 mm | 0.0-0.004 in |
| Piston Rings | | |
| <ul style="list-style-type: none"> Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production | 0.23-0.44 mm | 0.009-0.017 in |
| <ul style="list-style-type: none"> Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service | 0.23-0.5 mm | 0.009-0.0196 in |
| <ul style="list-style-type: none"> Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production | 0.44-0.7 mm | 0.017-0.027 in |
| <ul style="list-style-type: none"> Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service | 0.44-0.76 mm | 0.0173-0.03 in |
| <ul style="list-style-type: none"> Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production | 0.18-0.75 mm | 0.007-0.029 in |
| <ul style="list-style-type: none"> Piston Ring End Gap - Oil Control Ring - | 0.18-0.81 mm | 0.007-0.032 in |

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| Measured in Cylinder Bore - Service | | |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - First Compression Ring - Production | 0.04-0.085 mm | 0.00157-0.00335 in |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - First Compression Ring - Service | 0.04-0.085 mm | 0.00157-0.00335 in |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - Second Compression Ring - Production | 0.04-0.078 mm | 0.00157-0.0031 in |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - Second Compression Ring - Service | 0.04-0.078 mm | 0.00157-0.0031 in |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - Oil Control Ring - Production | 0.012-0.2 mm | 0.0005-0.0078 in |
| <ul style="list-style-type: none"> ● Piston Ring-to-Groove Clearance - Oil Control Ring - Service | 0.012-0.2 mm | 0.0005-0.0078 in |
| Pistons and Pins | | |
| <ul style="list-style-type: none"> ● Pin - Piston Pin Clearance-to-Piston Pin Bore - Production | 0.002-0.01 mm | 0.00008-0.0004 in |
| <ul style="list-style-type: none"> ● Pin - Piston Pin Clearance-to-Piston Pin Bore - Service | 0.002-0.015 mm | 0.00008-0.0006 in |
| <ul style="list-style-type: none"> ● Pin - Piston Pin Diameter | 23.952-23.955 mm | 0.9430-0.9431 in |
| <ul style="list-style-type: none"> ● Pin - Piston Pin Fit in Connecting Rod Bore - Production | 0.007-0.02 mm | 0.00027-0.00078 in |
| <ul style="list-style-type: none"> ● Pin - Piston Pin Fit in Connecting Rod Bore - Service | 0.007-0.022 mm | 0.00027-0.00086 in |
| <ul style="list-style-type: none"> ● Piston - Piston Diameter - Measured Over Skirt Coating | 96.002-96.036 mm | 3.7796-3.7809 in |
| <ul style="list-style-type: none"> ● Piston - Piston-to-Bore Clearance - Production | -0.036 to +0.016 mm | -0.0014 to +0.0006 in |
| <ul style="list-style-type: none"> ● Piston - Piston-to-Bore Clearance - Service Limit with Skirt Coating Worn Off | 0.071 mm | 0.0028 in |
| Valve System | | |
| <ul style="list-style-type: none"> ● Valves - Valve Face Angle | 45 degrees | |
| <ul style="list-style-type: none"> ● Valves - Valve Face Width | 1.25 mm | 0.05 in |
| | Net Lash - No Adjustment | |

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| • Valves - Valve Lash | | |
| • Valve Lift - Intake | 12.24 mm | 0.482 in |
| • Valve Lift - Exhaust | 12.24 mm | 0.482 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 | 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 |

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 Plug | Threadlock | 12345382 | 10953489 |
| Cylinder Head Plug | Threadlock | 12345382 | 10953489 |

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| Engine Block Coolant Drain Hole Plug Sealing Washer | Sealant | 12346004 | 10953480 |
| Engine Block Front Oil Gallery Plug | Threadlock | 12345382 | 10953489 |
| Engine Block Oil Gallery Plug Sealing Washers | Sealant | 12346004 | 10953480 |
| Engine Oil Pressure Sensor Threads | Sealant | 12346004 | 10953480 |
| Engine Oil Supplement | Fluorescent Dye | 12345795 | 10953470 |
| Exhaust Manifold Bolts | Threadlock | 12345493 | 10953488 |
| Flywheel/Flex Plate 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 Oil Gallery Plug Threads | Sealant | 12346004 | 10953480 |
| 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**

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

Engine Block - Front/Rear Views

| Hole | Thread Size | Insert | Drill | Counterbore Tool | Tap | Driver | Drill Depth - Maximum mm (in) | Tap Depth - Maximum mm (in) |
|----------|-------------|--------|-------|------------------|-----|--------|-------------------------------|-----------------------------|
| J 42385- | | | | | | | | |
| 1 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 22.5 (0.885) | 17.5 (0.688) |
| 2 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 27.5 (1.08) | 22.0 (0.866) |
| 3 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | Thru | Thru |
| 4 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | Thru | Thru |
| 5 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 25.0 (0.984) | 19.5 (0.767) |
| 6 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 32.5 (1.279) | 25.0 (0.984) |
| 7 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | Thru | Thru |

Bolt hole 6 is drilled and tapped for aluminum block applications only.

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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 | Thread Size | Insert | Drill | Counterbore Tool | Tap | Driver | Drill Depth - Maximum mm (in) | Tap Depth - Maximum mm (in) |
|----------|-------------|--------|-------|------------------|-----|--------|-------------------------------|-----------------------------|
| J 42385- | | | | | | | | |
| 1 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 22.5 (0.885) | 17.5 (0.688) |
| 2 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 28.5 (1.122) | 23.0 (0.905) |
| 3 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 21.5 (0.846) | 16.0 (0.629) |
| 4 | M10 x 1.25 | 215 | 211 | 212 | 213 | 214 | 29.0 (1.141) | 23.0 (0.905) |
| 5 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 27.0 (1.062) | 21.5 (0.846) |
| 6 | M16 x 1.5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 7 | M11 x 2.0 | 108 | 105 | N/A | 106 | 107 | 69.0 (2.72) | 60.0 (2.36) |

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| 8 | M28 x 1.25 | N/A |
| 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 | Thread Size | Insert | Drill | Counterbore Tool | Tap | Driver | Drill Depth - Maximum mm (in) | Tap Depth - Maximum mm (in) |
|----------|--------------|--------|-------|------------------|-----|--------|-------------------------------|-----------------------------|
| J 42385- | | | | | | | | |
| 1 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 22.5 (0.885) | 17.5 (0.688) |
| 2 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 42.5 (1.67) | 37.0 (1.45) |
| 3 | M10 x 2.0 | 104 | 101 | N/A | 102 | 103 | 31.0 (1.22) | 25.5 (1.0) |
| 4 | M10 x | 104 | 101 | N/A | 102 | 103 | 53.5 (2.10) | 44.0 (1.73) |

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| | | | | | | | | |
|---|--------------|-----|-----|-----|-----|-----|-----------------|-----------------|
| | 2.0 | | | | | | | |
| 5 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 26.5 (1.043) | 19.0 (0.748) |
| <ul style="list-style-type: none"> • 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 | Thread Size | Insert | Drill | Counterbore Tool | Tap | Driver | Drill Depth - Maximum mm (in) | Tap Depth - Maximum mm (in) |
|----------|--------------|--------|-------|------------------|-----|--------|-------------------------------|-----------------------------|
| J 42385- | | | | | | | | |
| 1 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 26.5 (1.04) | 19.0 (0.784) |
| 2 | M6 x 1.0 | 205 | 201 | 202 | 203 | 204 | 20.05 (0.789) | 16.05 (0.632) |
| 3 | M10 x | 215 | 211 | 212 | 213 | 214 | 28.0 (1.10) | 20.0 |

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| | | | | | | | | |
|---|-------------|-----|-----|-----|-----|-----|-----------------|-----------------|
| | 1.5 | | | | | | | (0.787) |
| 4 | M6 x 1.0 | 205 | 201 | 202 | 203 | 204 | 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 | Thread Size | Insert | Drill | Counterbore Tool | Tap | Driver | Drill Depth - Maximum mm (in) | Tap Depth - Maximum mm (in) |
|----------|--------------|--------|-------|------------------|-----|--------|-------------------------------|-----------------------------|
| J 42385- | | | | | | | | |
| 1 | M6 x 1.0 | 205 | 201 | 202 | 203 | 204 | Thru | Thru |
| 2 | M10 x 1.5 | 215 | 211 | 212 | 213 | 214 | 28.0 (1.10) | 20.0 (0.787) |

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| | | | | | | | | |
|---|---------------|-----|-----|-----|-----|-----|-----------------|-----------------|
| 3 | M8 x 1.25 | 210 | 206 | 207 | 208 | 209 | 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 |
| 5 | M12 x 1.5 | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

COMPONENT LOCATOR**DISASSEMBLED VIEWS**

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Fig. 6: Intake Manifold/Upper Engine
Courtesy of GENERAL MOTORS CORP.

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| Callout | Component Name |
|----------------|---|
| 100 | Engine Block |
| 307 | Engine Coolant Air Bleed Pipe |
| 308 | Engine Coolant Air Bleed Pipe O-Ring Seal |
| 308 | Engine Coolant Air Bleed Pipe O-Ring Seal |
| 309 | Bolt |
| 312 | Bolt |
| 313 | Engine Coolant Air Bleed Pipe Hole Cover |
| 500 | Intake Manifold |
| 506 | Valve Lifter Oil Manifold Bolt |
| 507 | Throttle Body Nut |
| 508 | Throttle Body |
| 509 | Throttle Body Seal |
| 510 | Sequential Multi-Port Fuel Injector Assembly with Fuel Rail |
| 511 | Fuel Injection Fuel Rail Bracket Bolt |
| 512 | Intake Manifold Bolt |
| 513 | Intake Manifold Seal |
| 514 | Intake Manifold Gasket |
| 537 | O-Ring Seal |
| 538 | Throttle Body Bolt |
| 555 | Engine Valley Cover |
| 556 | Gasket |
| 557 | Fuel Injection Fuel Rail Bracket |
| 706 | Engine Oil Pressure Sensor |
| 712 | Fuel Injection Fuel Rail Stop |
| 713 | Bolt |
| 714 | Manifold Absolute Pressure (MAP) Sensor |
| 715 | MAP Sensor O-Ring Seal |
| 729 | Evaporative (EVAP) Emission Canister Purge Tube |
| 730 | EVAP Emission Canister Purge Solenoid Valve |
| 731 | EVAP Emission Canister Port Cap |
| 734 | EVAP Emission Service Valve |
| 735 | EVAP Emission Canister Purge Tube |

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Fig. 7: Cylinder Head/Upper Engine
Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name |
|----------------|-------------------------------------|
| 100 | Engine Block |
| 209 | Valve Lifter |
| 210 | Valve Lifter Guide |
| 211 | Valve Lifter Guide Bolt |
| 212 | Valve Push Rod |
| 213 | Valve Rocker Arm |
| 214 | Valve Rocker Arm Pivot Support Bolt |
| 215 | Valve Rocker Arm Pivot Support |
| 216 | Cylinder Head Core Hole Plug |

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| | |
|-----|---|
| 217 | Cylinder Head Gasket |
| 218 | Cylinder Head |
| 220 | Cylinder Head Bolt - M10 |
| 221 | Cylinder Head Bolt - M8 |
| 222 | Valve Stem Oil Seal |
| 223 | Valve Spring |
| 224 | Valve Spring Cap |
| 225 | Valve Stem Key |
| 226 | Cylinder Head Core Hole Plug |
| 227 | Intake Valve |
| 228 | Exhaust Valve |
| 229 | Cylinder Head Plug |
| 230 | Cylinder Head Locating Pin |
| 422 | Oil Fill Tube O-Ring Seal |
| 423 | Oil Fill Tube |
| 424 | Oil Fill Cap |
| 450 | Oil Fill Cap O-Ring Seal |
| 504 | Valve Rocker Arm Cover Gasket |
| 504 | Valve Rocker Arm Cover Gasket |
| 505 | Valve Rocker Arm Cover |
| 505 | Valve Rocker Arm Cover |
| 516 | Valve Rocker Arm Cover Bolt |
| 600 | Exhaust Manifold |
| 601 | Exhaust Manifold Gasket |
| 602 | Exhaust Manifold Flange Bolt |
| 603 | Exhaust Manifold Heat Shield |
| 604 | Exhaust Manifold Heat Shield Bolt |
| 700 | Positive Crankcase Ventilation (PCV) Hose - Fresh Air |
| 716 | PCV Hose - Dirty Air |
| 719 | Ignition Coil Bracket |
| 720 | Ignition Coil Bracket Bolt |
| 721 | Ignition Coil Wire Harness Assembly |
| 722 | Ignition Coil |
| 723 | Ignition Coil Bolt |
| 724 | Spark Plug Wire |

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| | |
|-----|-----------------------------------|
| | Engine Coolant Temperature Sensor |
| 726 | Spark Plug |

Fig. 8: Front of Engine
Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name |
|----------------|---------------------------|
| 100 | Engine Block |
| 138 | Crankshaft Balancer |
| 139 | Crankshaft Balancer Bolt |
| 140 | Crankshaft Front Oil Seal |
| 200 | Camshaft |

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| | |
|-----|-------------------------------------|
| 201 | Camshaft Bearing |
| 202 | Camshaft Sprocket Locating Pin |
| 203 | Camshaft Retainer |
| 204 | Camshaft Retainer Bolt |
| 205 | Camshaft Sprocket |
| 206 | Camshaft Sprocket Bolt |
| 207 | Crankshaft Sprocket |
| 208 | Timing Chain |
| 231 | Timing Chain Tensioner Bolt |
| 232 | Timing Chain Tensioner |
| 300 | Water Pump |
| 301 | Water Pump Bolt |
| 302 | Water Pump Inlet Bolt |
| 303 | Water Pump Inlet |
| 305 | Engine Coolant Thermostat |
| 306 | Water Pump Gasket |
| 404 | Oil Pump Suction Pipe Nut |
| 405 | Oil Pump Suction Pipe Bolt |
| 406 | Oil Pump O-Ring Seal |
| 407 | Oil Pump Suction Pipe |
| 408 | Oil Pump Cover Bolt |
| 409 | Oil Pump Cover |
| 410 | Oil Pump Drive Gear |
| 411 | Oil Pump Bolt |
| 412 | Oil Pump Driven Gear |
| 413 | Oil Pump |
| 414 | Oil Pressure Relief Valve |
| 415 | Oil Pressure Relief Valve Spring |
| 416 | Oil Pressure Relief Valve Bore Plug |
| 417 | Oil Level Indicator O-Ring Seal |
| 418 | Oil Level Indicator |
| 419 | Oil Level Indicator Tube Bolt |
| 420 | Oil Level Indicator Tube |
| 421 | O-Ring |
| 501 | Engine Front Cover Bolt |

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| | |
|-----|---------------------------------------|
| | Engine Front Cover |
| 503 | Engine Front Cover Gasket |
| 703 | Camshaft Position (CMP) Sensor |
| 704 | CMP Sensor O-Ring Seal |
| 705 | CMP Sensor Bolt |
| 737 | CMP Sensor Wire Harness Assembly |
| 738 | CMP Sensor Wire Harness Assembly Bolt |

Fig. 9: Rear of Engine

Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name |
|----------------|---|
| 100 | Engine Block |
| 132 | Flex Plate - Automatic Transmission |
| 133 | Flywheel Bolt |
| 141 | Crankshaft Rear Oil Seal |
| 517 | Crankshaft Rear Oil Seal Housing Bolt |
| 518 | Crankshaft Rear Oil Seal Housing |
| 519 | Crankshaft Rear Oil Seal Housing Gasket |

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Fig. 10: Lower Engine Assembly
Courtesy of GENERAL MOTORS CORP.

| Callout | Component Name |
|----------------|------------------------|
| 100 | Engine Block |
| 102 | Connecting Rod Bolt |
| 103 | Connecting Rod Cap |
| 104 | Connecting Rod Bearing |

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| | |
|-----|-----------------------------------|
| 105 | Connecting Rod |
| 106 | Piston Pin |
| 107 | Piston |
| 108 | Piston Ring Set |
| 109 | Piston Pin Retainer |
| 120 | Crankshaft Thrust Bearing |
| 120 | Crankshaft Thrust Bearing |
| 121 | Crankshaft Bearing |
| 121 | Crankshaft Bearing |
| 122 | Crankshaft Balancer Key |
| 124 | Crankshaft |
| 126 | Crankshaft Bearing Cap |
| 127 | Crankshaft Bearing Cap Bolt - M8 |
| 128 | Crankshaft Bearing Cap Stud - M10 |
| 129 | Crankshaft Bearing Cap Bolt - M10 |
| 400 | Oil Pan |
| 401 | Oil Pan Closeout Cover |
| 402 | Oil Pan Closeout Cover Bolt |
| 403 | Crankshaft Oil Deflector Nut |
| 404 | Oil Pump Suction Pipe Nut |
| 405 | Oil Pump Suction Pipe Bolt |
| 406 | Oil Pump O-Ring Seal |
| 407 | Oil Pump Suction Pipe |
| 425 | Crankshaft Oil Deflector |
| 426 | Oil Pan Gasket |
| 427 | Oil Pan Baffle Bolt |
| 428 | Oil Pan Baffle |
| 430 | Oil Pan Drain Plug |
| 431 | Oil Pan Closeout Cover |
| 432 | Oil Pan Closeout Cover Bolt |
| 433 | Oil Pan Cover Gasket |
| 434 | Oil Pan Cover |
| 435 | Oil Pan Cover Bolt |
| 437 | Oil Filter |
| 438 | Oil Filter Fitting |

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| | |
|-----|-----------------------------------|
| | Oil Pan Bolt |
| 453 | Oil Pan Bolt |
| 727 | Engine Oil Level Indicator Switch |
| 728 | O-Ring |

Fig. 11: 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 |

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| | |
|-----|--------------------------------------|
| 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. 12: Exploded View Of Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

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| 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

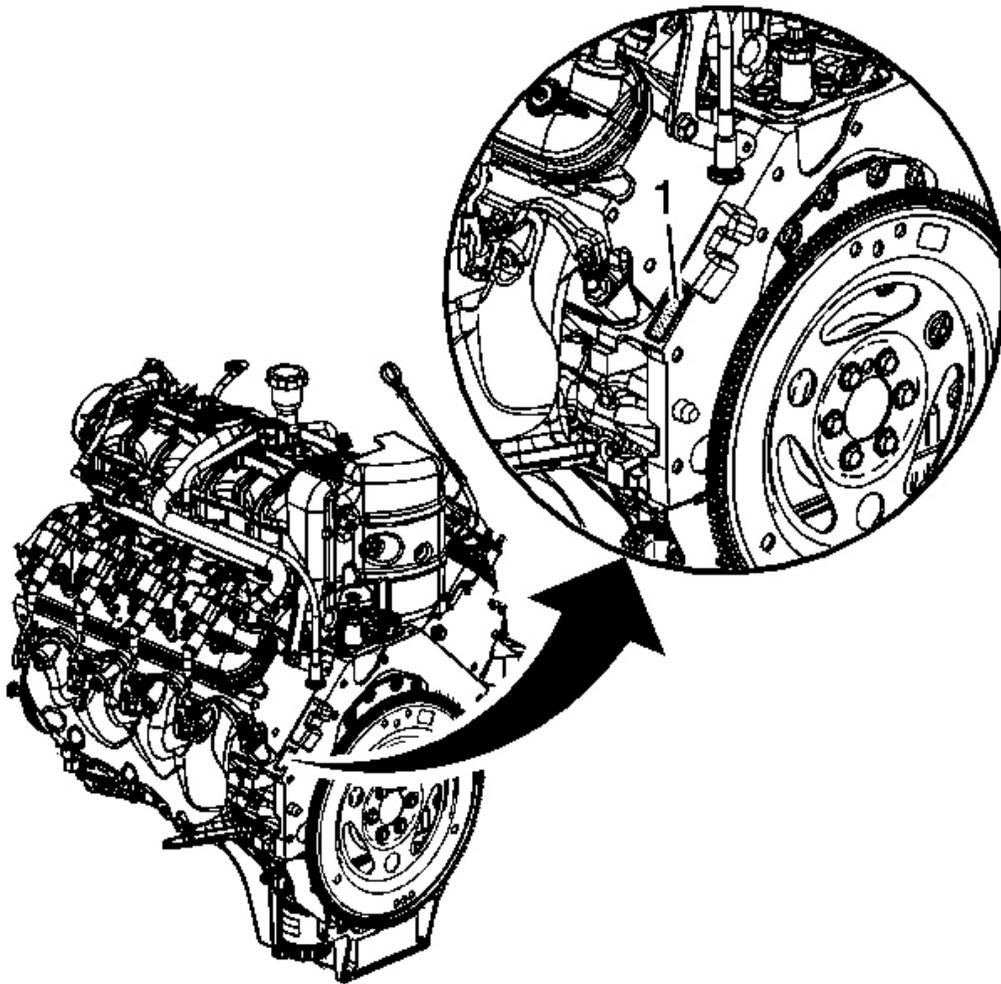


Fig. 13: Vehicle Identification Number
Courtesy of GENERAL MOTORS CORP.

The vehicle identification number (VIN) is located on the left side rear of the engine block (1) 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**, **Engine Component Description**, and **Lubrication 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**, **Engine Component Description**, and **Lubrication 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**
- **Engine Compression Test**
- **Cylinder Leakage Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Crankcase Ventilation System Inspection/Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

| | |
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| | |
|--|--|

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| 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 diagnostic trouble code (DTC). A misfire code may be present without an actual misfire condition. | Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> . |
| Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout May lead to a misfire DTC. A misfire code may be present without an actual misfire condition. | Inspect the components and repair or replace, as required. |
| Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition. | Repair or replace the flex plate and/or balancer, as required. Refer to <u>Automatic Transmission Flex Plate Replacement</u> , or <u>Crankshaft Balancer Replacement</u> . |
| Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters. | Repair or replace, as required. |
| Improperly installed or damaged vacuum hoses | Repair or replace, as required. |
| 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 | Replace the valve rocker arms, as required. |

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| | |
|---|--|
| <p>The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.</p> | |
| <p>Worn or bent pushrods</p> | <ul style="list-style-type: none"> ● 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. |
| <p>Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.</p> | <p>Repair or replace, as required.</p> |
| <p>Excessively worn or mis-aligned timing chain</p> | <p>Replace the timing chain and sprockets, as required.</p> |
| <p>Worn camshaft lobes</p> | <p>Replace the camshaft and valve lifters.</p> |
| <p>Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.</p> | <ol style="list-style-type: none"> 1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Repair or replace the oil pump, as required. |
| <p>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.</p> | <ol style="list-style-type: none"> 1. Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> . 2. Inspect the cylinder heads, engine block, and/or head gaskets. Refer to <u>Coolant in Combustion Chamber</u>. 3. Repair or replace, as required. |
| <p>Worn piston rings Oil consumption may or may not cause the engine to misfire.</p> | <ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . 2. Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. 3. Perform cylinder leak down and compression testing to identify the cause. Refer to <u>Cylinder Leakage Test</u>. 4. Repair or replace, as required. |
| <p>A damaged crankshaft reluctor wheel</p> | <p>Replace the sensor and/or crankshaft, as</p> |

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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 P0300 DTC may be set.
- Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336.

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 <u>Drive Belt Replacement - Accessory</u> . |
| Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an | Inspect the components and repair or replace, as required. |

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| | |
|---|---|
| actual misfire condition. | |
| Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition. | Repair or replace the flex plate and/or balancer, as required. Refer to <u>Automatic Transmission Flex Plate Replacement</u> , or <u>Crankshaft Balancer Replacement</u> . |
| Worn piston rings Oil consumption may or may not cause the engine to misfire. | <ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . 2. Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to <u>Cylinder Leakage Test</u>. 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 | <ul style="list-style-type: none"> ● 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 | Repair or replace, as required. |

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| | |
|---|--|
| the valve to not close properly. | |
| 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 <u>Oil Pressure Diagnosis and Testing</u> . |

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. | <ol style="list-style-type: none"> 1. Inspect for spark plugs saturated by coolant. Refer to <u>Spark Plug Inspection</u> . 2. Perform a cylinder leak down test. Refer to <u>Cylinder Leakage Test</u>. 3. Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to <u>Coolant in Combustion Chamber</u>. 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 | <ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . 2. Repair or replace, as required. |
| Worn piston rings Oil consumption may or may not cause the engine to misfire. | <ol style="list-style-type: none"> 1. Inspect the spark plugs for oil deposits. Refer to <u>Spark Plug Inspection</u> . 2. Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. 3. Perform cylinder leak down and compression testing to determine the |

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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 | <ol style="list-style-type: none">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 | <ol style="list-style-type: none">1. Inspect the crankshaft end play.2. Inspect the thrust bearing and crankshaft.3. Repair or replace, as required. |
| Damaged or faulty oil filter bypass valve The bypass valve is now internal to the oil filter. | <ol style="list-style-type: none">1. Inspect the oil filter bypass valve for proper operation.2. Repair or replace, as required. |

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

| Cause | Correction |
|--|--|
| Low oil pressure | <ol style="list-style-type: none">1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>.2. Repair or replace, as required. |
| Loose and/or worn valve rocker arm attachments | <ol style="list-style-type: none">1. Inspect the valve rocker arm, bolt, and pedestal.2. Repair or replace, as required. |
| Worn or damaged valve rocker arm | <ol style="list-style-type: none">1. Inspect the rocker arm for wear or missing needle bearings2. Replace the valve rocker arms, as required. |
| Bent or damaged push rod | Inspect the following components and replace, as required: |

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| | |
|--|--|
| | <ul style="list-style-type: none">• The valve rocker arm• The valve push rod• The valve lifter• The valve lifter guide• The piston <p>Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.</p> |
| Improper lubrication to the valve rocker arms | <p>Inspect the following components and repair or replace, as required:</p> <ul style="list-style-type: none">• The valve rocker arm• The valve push rod• The valve lifter• The oil filter bypass valve• The oil pump and pump screen• The engine block oil galleries |
| Broken valve spring | Replace the valve spring and spring shim. |
| Worn or dirty valve lifters | Replace the valve lifters, as required. |
| Stretched or broken timing chain and/or damaged sprocket teeth | Replace the timing chain and sprockets. |
| Worn engine camshaft lobes | <ol style="list-style-type: none">1. Inspect the engine camshaft lobes.2. Replace the camshaft and valve lifters, as required. |
| Worn valve guides or valve stems | <p>Inspect the following components and repair, as required:</p> <ul style="list-style-type: none">• The valves• The valve guides |
| Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open. | <p>Inspect the following components and repair, as required:</p> <ul style="list-style-type: none">• The valves• The valve guides |

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| Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil | Repair, as required. Refer to <u>Oil Pressure Diagnosis and Testing</u> . |
|---|--|

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

| Cause | Correction |
|--|---|
| Low oil pressure | <ol style="list-style-type: none">1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>.2. Repair or replace damaged components, as required. |
| Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components. | <ol style="list-style-type: none">1. Inspect the accessory drive system.2. Repair or replace, as required. |
| Loose or damaged crankshaft balancer | <ol style="list-style-type: none">1. Inspect the crankshaft balancer.2. Repair or replace, as required. |
| Detonation or spark knock | Verify the correct operation of the ignition controls system. Refer to <u>Symptoms - Engine Controls</u> . |
| Loose torque converter bolts | <ol style="list-style-type: none">1. Inspect the torque converter bolts and 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 | <ol style="list-style-type: none">1. Inspect the oil pump screen.2. Repair or replace, as required. |
| Excessive piston-to-cylinder bore clearance | <ol style="list-style-type: none">1. Inspect the piston and cylinder bore.2. Repair, as required. |
| Excessive piston pin-to-bore clearance | <ol style="list-style-type: none">1. Inspect the piston, 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: <ul style="list-style-type: none">• The connecting rod bearings |

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| | |
|--|--|
| | <ul style="list-style-type: none">• The connecting rods• The crankshaft• The crankshaft journals |
| Excessive crankshaft bearing clearance | Inspect the following components and repair, as required: <ul style="list-style-type: none">• The crankshaft bearings• The crankshaft journals |
| Incorrect piston, piston pin, and connecting rod installation Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore. | <ol style="list-style-type: none">1. Verify the pistons, piston pins and connecting rods are installed correctly. Refer to <u>Piston, Connecting Rod, and Bearing Installation</u>.2. Repair, as required. |

ENGINE NOISE UNDER LOAD

| Cause | Correction |
|---|--|
| Low oil pressure | <ol style="list-style-type: none">1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>.2. Repair or replace, as required. |
| Detonation or spark knock | Verify the correct operation of the ignition controls. Refer to <u>Symptoms - Engine Controls</u> . |
| Loose torque converter bolts | <ol style="list-style-type: none">1. Inspect the torque converter bolts and flex plate.2. Repair, as required. |
| Cracked flex plate - automatic transmission | <ol style="list-style-type: none">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: <ul style="list-style-type: none">• The connecting rod bearings• The connecting rods• The crankshaft |
| | |

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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 | <ol style="list-style-type: none">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 | <ol style="list-style-type: none">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 | <ol style="list-style-type: none">1. Inspect the timing chain and sprockets.2. Repair or replace the components, as required. |
| Seized timing chain or timing sprockets | <ol style="list-style-type: none">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 | <ol style="list-style-type: none">1. Inspect the camshaft and the camshaft bearings.2. Repair or replace the components, as |

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| | |
|---|---|
| | required. |
| Bent valve in the cylinder head | <ol style="list-style-type: none">1. Inspect the valves and the cylinder heads.2. Repair or replace the components, as required. |
| Seized oil pump | <ol style="list-style-type: none">1. Inspect the oil pump assembly.2. Repair or replace, as required. |
| Hydraulically locked cylinder <ul style="list-style-type: none">• Coolant/antifreeze in the cylinder• Oil in the cylinder• Fuel in the cylinder | <ol style="list-style-type: none">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 <u>Coolant in Combustion Chamber</u>.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 <ul style="list-style-type: none">• Broken valve• Broken piston rings• Piston material• Foreign material | <ol style="list-style-type: none">1. Inspect the cylinder for damaged components and/or foreign materials.2. Repair or replace the components, as required. |
| Seized crankshaft or connecting rod bearings | <ol style="list-style-type: none">1. Inspect crankshaft and connecting rod bearings.2. Repair or replace the components, as required. |
| Bent or broken connecting rod | <ol style="list-style-type: none">1. Inspect the connecting rods.2. Replace the piston and pin as an assembly, as required. |
| Broken crankshaft | <ol style="list-style-type: none">1. Inspect the crankshaft.2. Repair or replace the components, as |

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required.

COOLANT IN COMBUSTION CHAMBER

| Cause | Correction |
|--|---|
| <p>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.</p> <ol style="list-style-type: none">1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>.2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore.3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.4. Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>. | |
| Faulty cylinder head gasket | Replace the head gasket and components, as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> . |
| Warped cylinder head | Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> . |
| Cracked cylinder head | Replace the cylinder head and gasket. |
| Cracked cylinder liner or engine block | Replace the components, as required. |
| Cylinder head or engine block porosity | Replace the components, as required. |

COOLANT IN ENGINE OIL

| Cause | Correction |
|---|------------|
| <p>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</p> | |

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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 <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement - Left Side</u> or <u>Cylinder Head Replacement - Right Side</u> . |
| Warped cylinder head | Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> . |
| Cracked cylinder head | Replace the cylinder head and gasket. |
| Cracked cylinder liner or engine block | Replace the components, as required. |
| Cylinder head, block, or manifold porosity | Replace the components, as required. |

ENGINE COMPRESSION TEST

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). ($1\ 035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - 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 LEAKAGE TEST

Tools Required

J 35667-A Cylinder Head Leakdown Tester, or equivalent

IMPORTANT: 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 Procedure

CAUTION: Refer to Battery Disconnect Caution .

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** , or equivalent.

IMPORTANT: 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** 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

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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

Test Procedure

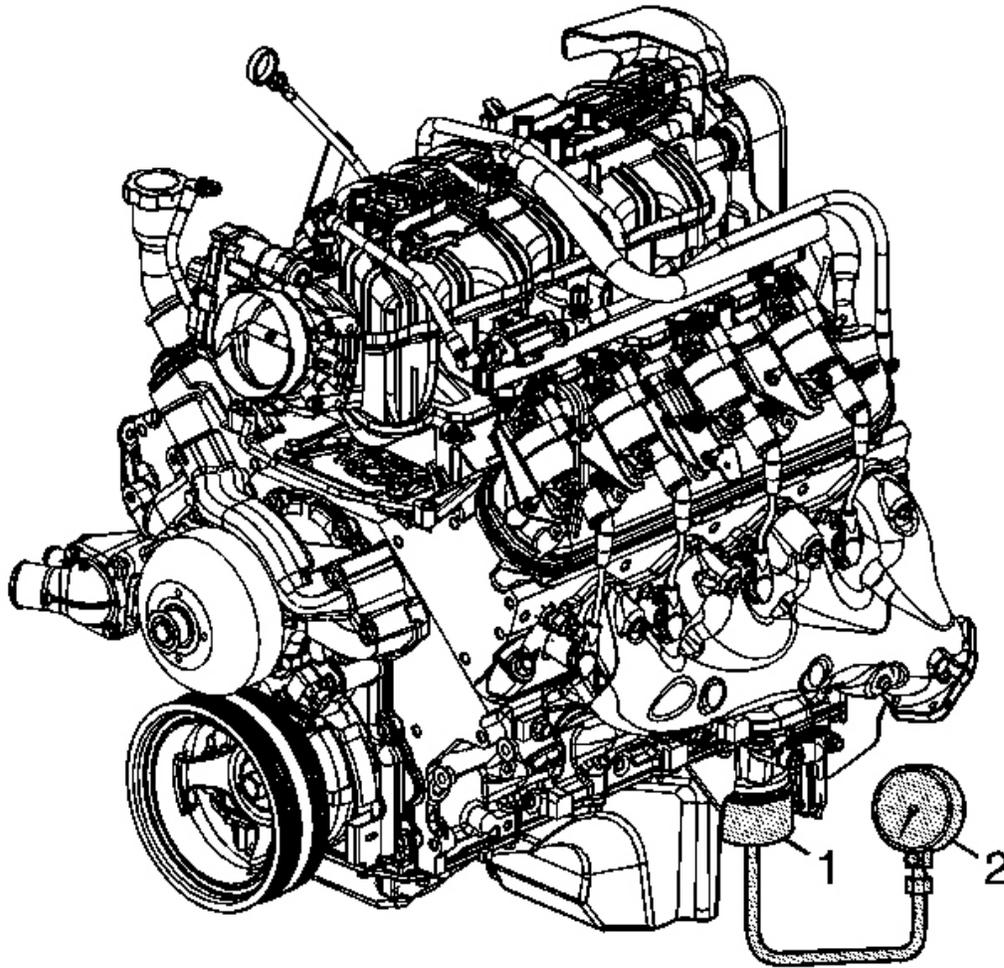


Fig. 14: View Of Special Tools Oil Pressure Gage & Adapter
Courtesy of GENERAL MOTORS CORP.

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**.

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** .

OIL LEAK DIAGNOSIS

| Step | Action | Yes | No |
|---|---|-----|----|
| <p>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.</p> | | | |
| | <p>1. Operate the vehicle until it reaches normal</p> | | |

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

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|---|---|----------------------|---------------------|
| 5 | <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p> | Go to Step 10 | Go to Step 6 |
| 6 | <ol style="list-style-type: none"> 1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, 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. <p>Can you identify the type of fluid and the approximate location of the leak?</p> | Go to Step 10 | Go to Step 7 |
| 7 | <ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p> | Go to Step 10 | Go to Step 8 |
| 8 | <p>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.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p> | Go to Step 10 | Go to Step 9 |
| | | | |

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|----|--|----------------------|-----------|
| 9 | <ol style="list-style-type: none"> 1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components <p>Can you identify the type of fluid and the approximate location of the leak?</p> | Go to Step 10 | System OK |
| 10 | <ol style="list-style-type: none"> 1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: <ul style="list-style-type: none"> • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. <p>Is there mechanical damage, or customer modifications to the engine?</p> | Go to Step 11 | System OK |
| 11 | <p>Repair or replace all damaged or modified components.</p> <p>Does the engine still leak oil?</p> | Go to Step 1 | System OK |

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CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

| Symptom | Correction |
|-----------------------------|---|
| External oil leak | Inspect for any of the following conditions: <ul style="list-style-type: none">• Restricted positive crankcase ventilation (PCV) orifice• Restricted or kinked PCV hose or engine vent hose• Damaged, incorrect, or incorrectly installed PCV hose• Excessive crankcase pressure |
| Rough Idle | Inspect for any of the following conditions: <ul style="list-style-type: none">• Restricted PCV orifice• Restricted or kinked PCV hose or engine vent hose• Leaking (damaged) PCV hose• Vacuum hoses worn or not properly installed |
| Stalling or slow idle speed | Inspect for any of the following conditions: <ul style="list-style-type: none">• Restricted PCV orifice• Restricted or kinked PCV hose or engine vent hose• Leaking (damaged) PCV hose |
| High idle speed | Inspect for a leaking (damaged) PCV hose |
| Sludge in the engine | Inspect for any of the following conditions: <ul style="list-style-type: none">• Restricted PCV orifice• Restricted or kinked PCV hose or engine vent hose |

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customer's concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.

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- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

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

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

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

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

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

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

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

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

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

16: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a

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straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

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

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

| Step | Action | Yes | No |
|--|---|---------------------|--|
| <p>NOTE: Refer to <u>Belt Dressing Notice</u> .</p> <p>DEFINITION: The following items are indications of chirping:</p> <ul style="list-style-type: none"> • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp. <p>DEFINITION: The following items are indications of drive belt squeal:</p> <ul style="list-style-type: none"> • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component. <p>DEFINITION: The following items are indications of drive belt whine:</p> <ul style="list-style-type: none"> • A high pitched continuous noise. • The noise may be caused by an accessory drive component failed bearing. | | | |
| 1 | Did you review the Drive Belt Symptom operation and perform the necessary inspections? | Go to Step 2 | Go to <u>Symptoms - Engine Mechanical</u> |
| 2 | Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise? | Go to Step 3 | Go to Diagnostic Aids |
| | 1. Remove the drive belt. | | |

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| | | | |
|-----------|---|---|----------------------|
| 3 | <p>If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed.</p> <ol style="list-style-type: none"> 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). <p>Does the chirping, squeal or whine noise still exist?</p> | Go to Symptoms - Engine Mechanical | Go to Step 4 |
| 4 | <ul style="list-style-type: none"> • If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. • If diagnosing a squeal or whine noise, proceed to step 13. <p>Do the belt grooves have pilling?</p> | Go to Step 5 | Go to Step 6 |
| 5 | <p>Clean the drive belt pulleys with a suitable wire brush.</p> <p>Did you complete the repair?</p> | Go to Step 20 | Go to Step 6 |
| 6 | <p>Inspect for misalignment of the pulleys.</p> <p>Are any of the pulleys misaligned?</p> | Go to Step 7 | Go to Step 8 |
| 7 | <p>Replace or repair any misaligned pulleys.</p> <p>Did you complete the repair?</p> | Go to Step 20 | Go to Step 8 |
| 8 | <p>Inspect for bent or cracked brackets.</p> <p>Did you find any bent or cracked brackets?</p> | Go to Step 9 | Go to Step 10 |
| 9 | <p>Replace any bent or cracked brackets.</p> <p>Did you complete the repair?</p> | Go to Step 20 | Go to Step 10 |
| 10 | <p>Inspect for improper, loose or missing fasteners.</p> <p>Did you find the condition?</p> | Go to Step 11 | Go to Step 12 |
| 11 | <p>NOTE: Refer to Fastener Notice .</p> <ol style="list-style-type: none"> 1. Tighten any loose fasteners. Refer to Fastener Tightening Specifications. 2. Replace any improper or missing | | |

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|-----------|---|----------------------|-----------------------|
| | fasteners. | | |
| | Did you complete the repair? | Go to Step 20 | Go to Step 12 |
| 12 | Inspect for a bent pulley. Did you find the condition? | Go to Step 18 | Go to Step 13 |
| 13 | Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition? | Go to Step 20 | Go to Step 14 |
| 14 | Test the drive belt tensioner for proper operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Did you find and correct the condition? | Go to Step 20 | Go to Step 15 |
| 15 | Inspect for the correct drive belt length. Did you find and correct the condition? | Go to Step 20 | Go to Step 16 |
| 16 | Inspect for misalignment of a pulley. Did you find and correct the condition? | Go to Step 20 | Go to Step 17 |
| 17 | Inspect for the correct pulley size. Did you find and correct the condition? | Go to Step 20 | Go to Diagnostic Aids |
| 18 | Replace the bent pulley. Did you complete the repair? | Go to Step 20 | Go to Step 19 |
| 19 | Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u> . Did you complete the repair? | Go to Step 20 | Go to Diagnostic Aids |
| 20 | Operate the system in order to verify the repair. Did you correct the condition? | System OK | Go to Step 3 |

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the air conditioning (A/C) system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the

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generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

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

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

Test Description

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

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

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

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

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

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

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

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

| Step | Action | Yes | No |
|---|--------|-----|----|
| NOTE: Refer to <u>Belt Dressing Notice</u> . | | | |

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DEFINITION: The following items are indications of drive belt rumbling:

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

DEFINITION: The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

| | | | |
|---|--|---|--|
| 1 | Did you review the Drive Belt Symptom operation and perform the necessary inspections? | Go to Step 2 | Go to <u>Symptoms - Engine Mechanical</u> |
| 2 | Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration? | Go to Step 3 | Go to Diagnostic Aids |
| 3 | <p>IMPORTANT: If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed.</p> <ol style="list-style-type: none"> 1. Remove the drive belt. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). <p>Does the rumbling or vibration still exist?</p> | Go to <u>Symptoms - Engine Mechanical or Vibration Analysis - Engine</u> | Go to Step 4 |
| 4 | Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions? | Go to Step 7 | Go to Step 5 |
| | Inspect for severe pilling of more than 1/3 of | | |

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| | | | |
|----|--|----------------------|-----------------------|
| 5 | the drive belt pulley grooves. Did you find severe pilling? | Go to Step 6 | Go to Step 7 |
| 6 | <ol style="list-style-type: none"> 1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u>. <p>Did you correct the condition?</p> | Go to Step 8 | Go to Step 7 |
| 7 | <p>Install a new drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u>.</p> <p>Did you complete the replacement?</p> | Go to Step 8 | Go to Step 9 |
| 8 | Operate the system in order to verify the repair. Did you correct the condition? | System OK | Go to Step 9 |
| 9 | Inspect for improper, loose or missing fasteners. Did you find any of these conditions? | Go to Step 10 | Go to Step 11 |
| 10 | <p>NOTE: Refer to <u>Fastener Notice</u> .</p> <ol style="list-style-type: none"> 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u>. 2. Replace improper or missing fasteners. <p>Did you complete the repair?</p> | Go to Step 13 | Go to Step 11 |
| 11 | <p>Inspect for a bent water pump shaft. Refer to <u>Water Pump Replacement (With LH8)</u> or <u>Water Pump Replacement (With LLR)</u> .</p> <p>Did you find and correct the condition?</p> | Go to Step 13 | Go to Step 12 |
| 12 | Inspect for bent or cracked brackets. Did you find and correct the condition? | Go to Step 13 | Go to Diagnostic Aids |
| 13 | Operate the system in order to verify the repair. Did you correct the condition? | System OK | Go to Step 3 |

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

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

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

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

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

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

Test Description

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

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

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

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

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

7: Inspection of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or

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washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

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

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

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

| Step | Action | Yes | No |
|--|---|----------------------|--|
| NOTE: Refer to <u>Belt Dressing Notice</u> . | | | |
| DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt. | | | |
| 1 | Did you review the Drive Belt Symptom operation and perform the necessary inspections? | Go to Step 2 | Go to <u>Symptoms - Engine Mechanical</u> |
| 2 | <ul style="list-style-type: none"> • If diagnosing excessive wear, proceed to step 13. • If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition? | Go to Step 3 | Go to Step 4 |
| 3 | Install a new drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u> . Does the drive belt continue to fall off? | Go to Step 4 | System OK |
| 4 | Inspect for misalignment of the pulleys. Did you find and repair the condition? | Go to Step 12 | Go to Step 5 |
| 5 | Inspect for a bent or dented pulley. Did you find and repair the condition? | Go to Step 12 | Go to Step 6 |

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| | | | |
|----|---|----------------------|-----------------------|
| 6 | Inspect for a bent or a cracked bracket. Did you find and repair the condition? | Go to Step 12 | Go to Step 7 |
| 7 | Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners? | Go to Step 8 | Go to Step 9 |
| 8 | <p>NOTE: Refer to <u>Fastener Notice</u> .</p> <p>1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u>. 2. Replace improper or missing fasteners.</p> <p>Does the drive belt continue to fall off?</p> | Go to Step 9 | System OK |
| 9 | Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Does the drive belt tensioner operate correctly? | Go to Step 11 | Go to Step 10 |
| 10 | Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Accessory</u> . Does the drive belt continue to fall off? | Go to Step 11 | System OK |
| 11 | Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition? | Go to Step 12 | Go to Diagnostic Aids |
| 12 | Operate the system in order to verify the repair. Did you correct the condition? | System OK | Go to Step 13 |
| 13 | Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u> . Did you find this condition? | Go to Step 16 | Go to Step 14 |
| 14 | Inspect for the proper drive belt. Did you find this condition? | Go to Step 16 | Go to Step 15 |
| 15 | Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition? | Go to Step 17 | Go to Diagnostic Aids |
| 16 | Replace the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> or <u>Air Conditioning Compressor Belt Replacement (LH8)</u> . | | |

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

DRIVE BELT TENSIONER DIAGNOSIS

| Step | Action | Yes | No |
|------|--|---------------------|---------------------|
| 1 | Remove the drive belt. Refer to <u>Drive Belt Replacement - Accessory</u> . Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned? | Go to Step 4 | Go to Step 2 |
| 2 | Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding? | Go to Step 3 | Go to Step 4 |
| 3 | <ol style="list-style-type: none"> 1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10% of the second torque reading? | System OK | Go to Step 4 |
| 4 | Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement - Accessory</u> . Is the repair complete? | System OK | - |

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT - ACCESSORY

Removal Procedure

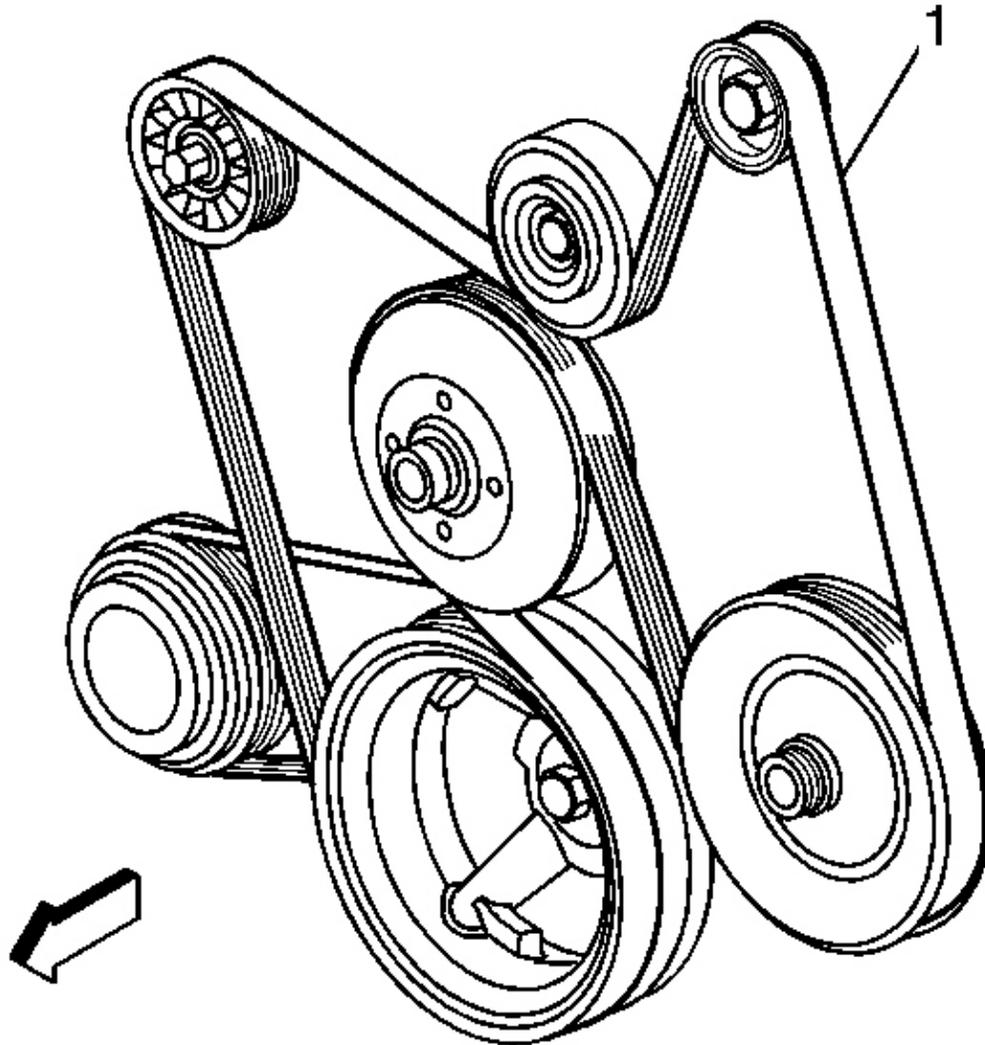


Fig. 15: Drive Belt Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Resonator Outlet Duct Replacement](#) .
3. Install a breaker bar with hex-head socket to the drive belt tensioner bolt.
4. Rotate the drive belt tensioner clockwise in order to relieve tension on the belt.

5. Remove the drive belt (1) from the pulleys and the drive belt tensioner.
6. Slowly release the tension on the drive belt tensioner.
7. Remove the breaker bar and socket and from the drive belt tensioner bolt.
8. Clean and inspect the belt surfaces of all the pulleys.

Installation Procedure

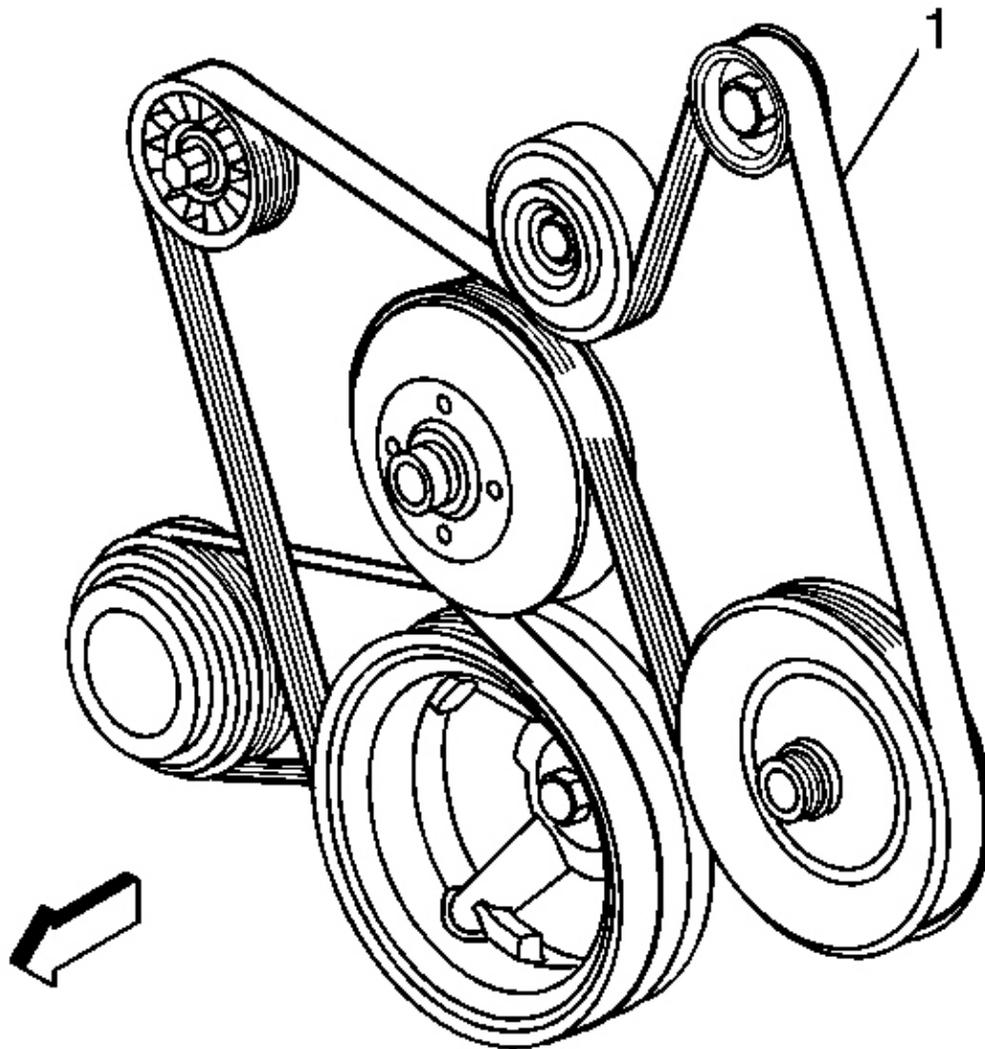


Fig. 16: Drive Belt Tensioner Bolt

Courtesy of GENERAL MOTORS CORP.

1. Route the drive belt (1) around all the pulleys except the idler pulley.
2. Install the breaker bar with hex-head socket to the belt tensioner bolt.
3. Rotate the belt tensioner clockwise in order to relieve the tension on the tensioner.
4. Install the drive belt under the idler pulley.
5. Slowly release the tension on the belt tensioner.
6. Remove the breaker bar and socket from the belt tensioner bolt.
7. Inspect the drive belt for proper installation and alignment.
8. Install the air cleaner outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
9. Start the vehicle and inspect the drive belt for proper operation.
10. Close the hood.

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT (LH8)

Removal Procedure

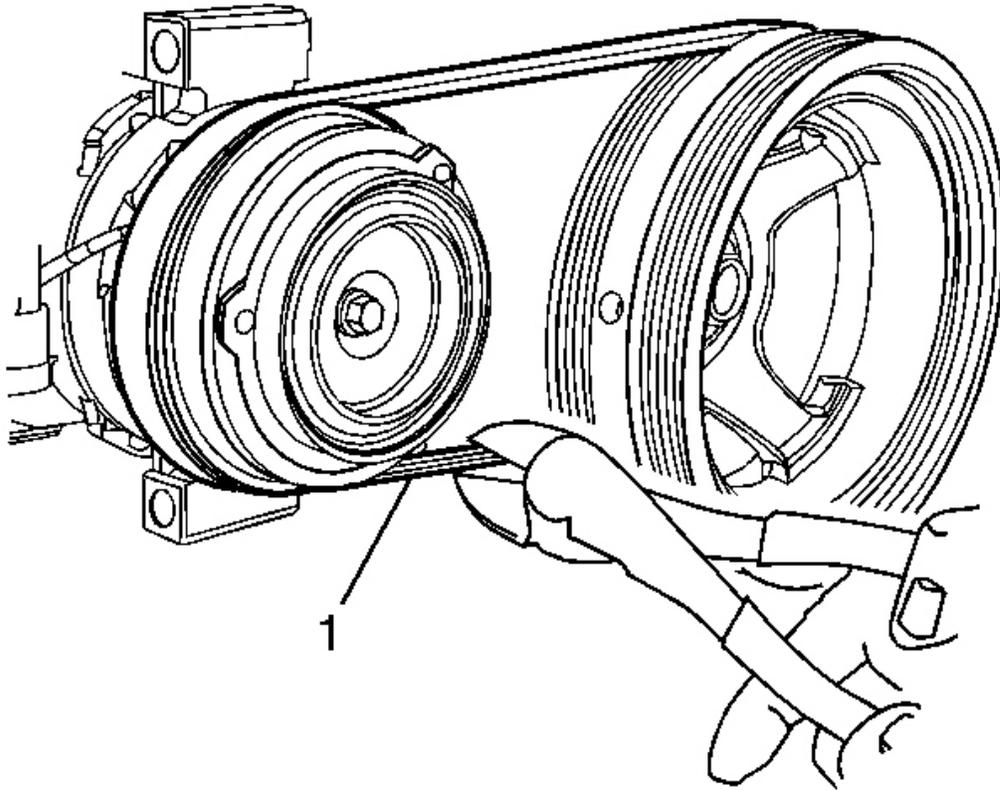


Fig. 17: Removing Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the skid plate. Refer to **Engine Shield Replacement** .
2. Cut the belt (1) from air conditioning (A/C) and crankshaft pulleys.

Installation Procedure

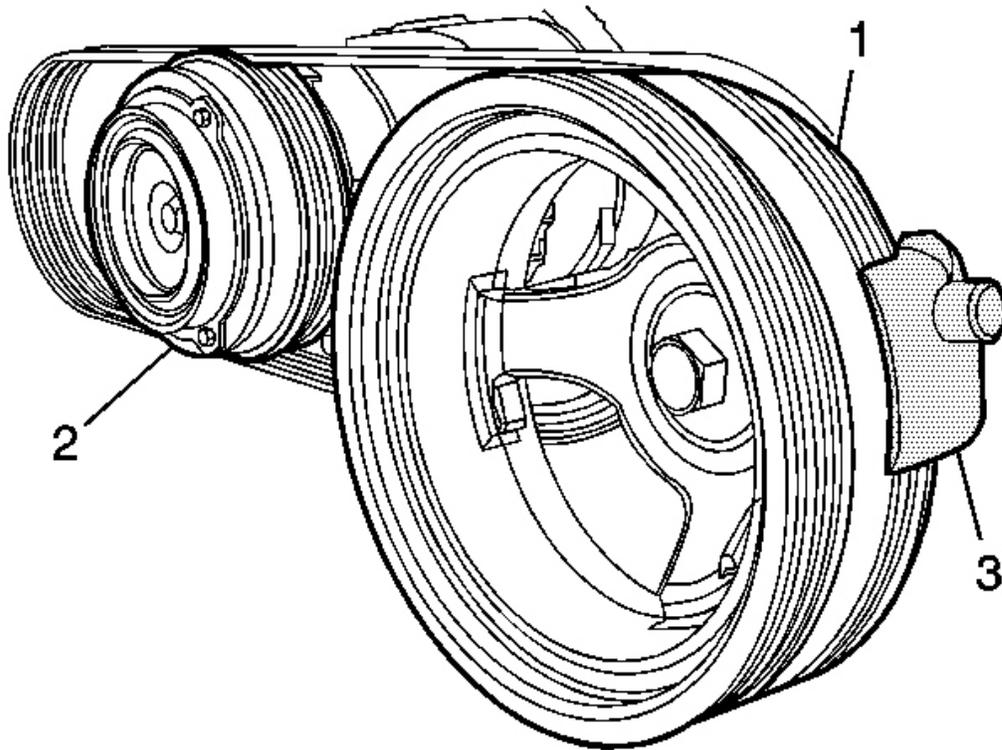


Fig. 18: Installing Belt
Courtesy of GENERAL MOTORS CORP.

1. Position the belt behind the rear face of the balancer (1) and off of the A/C pulley (2).
2. Install the belt installation tool (3) onto the balancer.

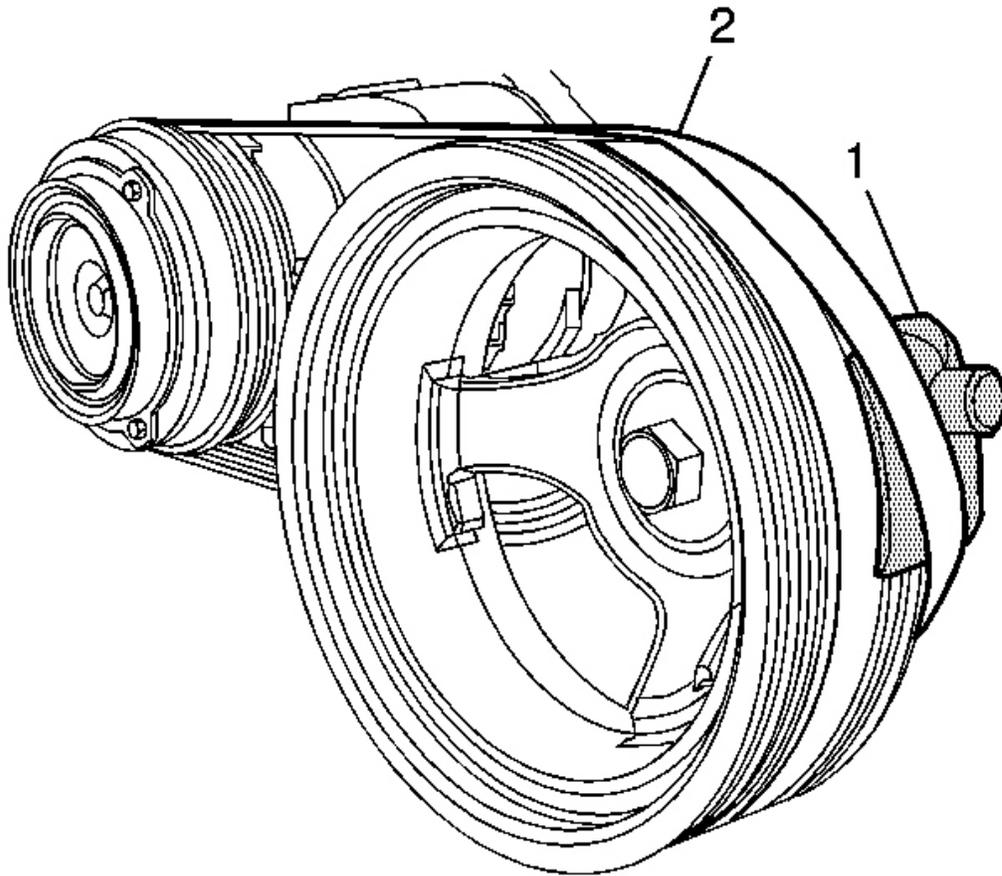


Fig. 19: Belt Installation Tool
Courtesy of GENERAL MOTORS CORP.

3. Slide the belt installation tool (1) upward, installing the belt (2) onto the belt installation tool.
4. Slide the belt installation tool downward, positioning the belt onto the A/C pulley, applying light tension to the belt.

Fig. 20: Locating Lower Portion Of Belt & Ribbed Area Facing Forward
Courtesy of GENERAL MOTORS CORP.

5. Position the lower portion of the belt (1) with the ribbed area facing forward.

Fig. 21: Rotating Crankshaft Pulley
Courtesy of GENERAL MOTORS CORP.

6. Slowly rotate the crankshaft pulley (1) in a clockwise direction while using finger pressure to pull the belt (2) forward. Ensure that the ribbed area of the belt remains facing forward and the belt aligns properly to the A/C pulley.

Fig. 22: Drive Belt Alignment
Courtesy of GENERAL MOTORS CORP.

7. Inspect the drive belt (1) for proper installation and alignment.

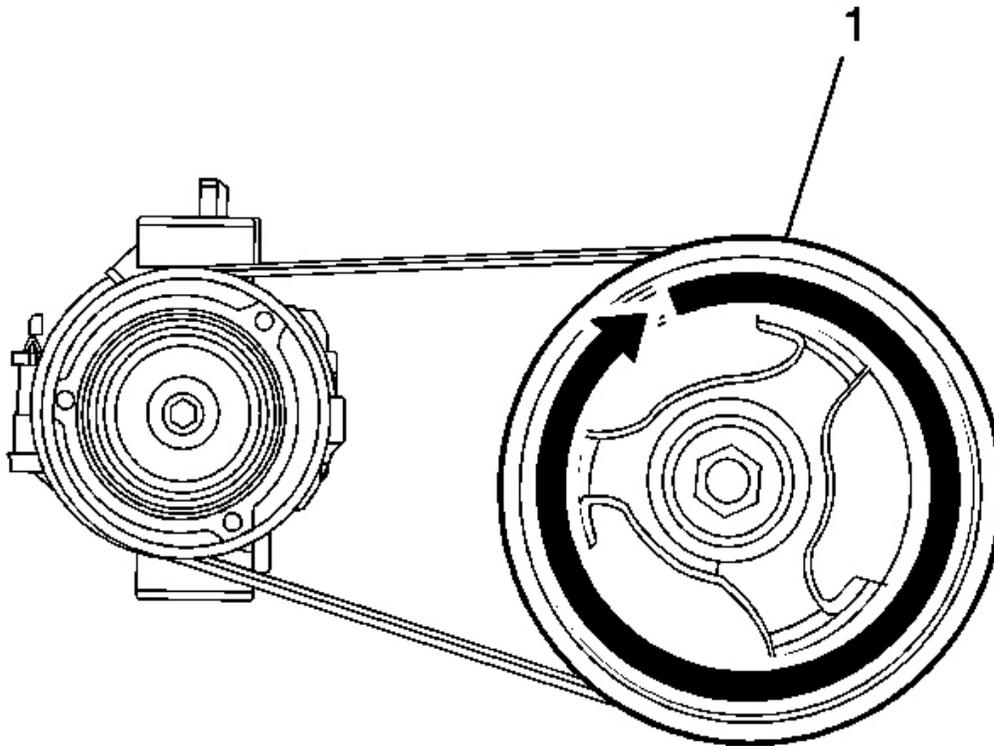


Fig. 23: Rotating Clockwise
Courtesy of GENERAL MOTORS CORP.

8. Rotate the balancer (1) and additional 360 degrees to ensure proper belt installation.
9. Install the skid plate. Refer to **Engine Shield Replacement** .

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

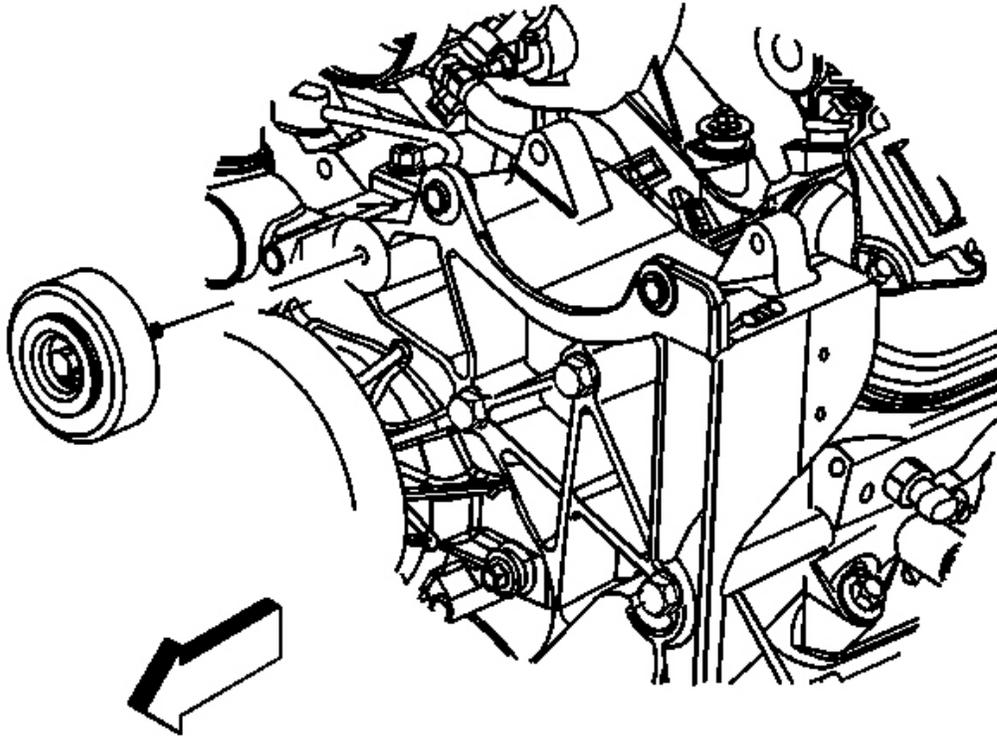


Fig. 24: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Loosen the drive belt idler pulley bolt and remove the idler pulley.

Installation Procedure

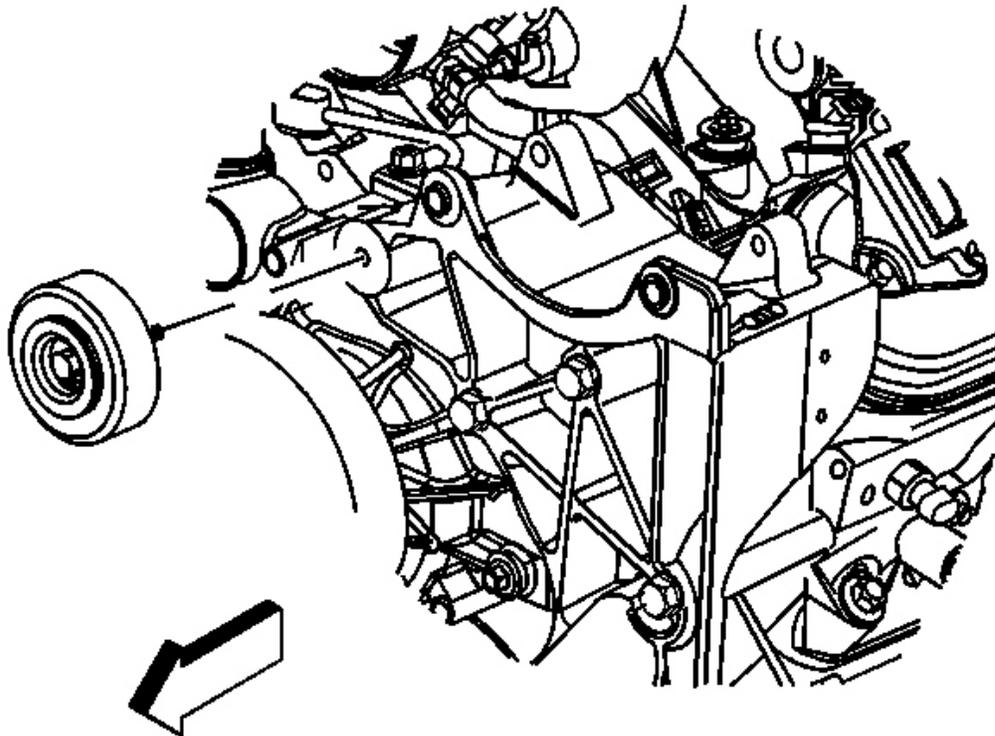


Fig. 25: View Of Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt idler pulley to the generator bracket and tighten the idler pulley bolt finger tight.

NOTE: Refer to Fastener Notice .

2. Tighten the drive belt idler pulley bolt.

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

3. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

Removal Procedure

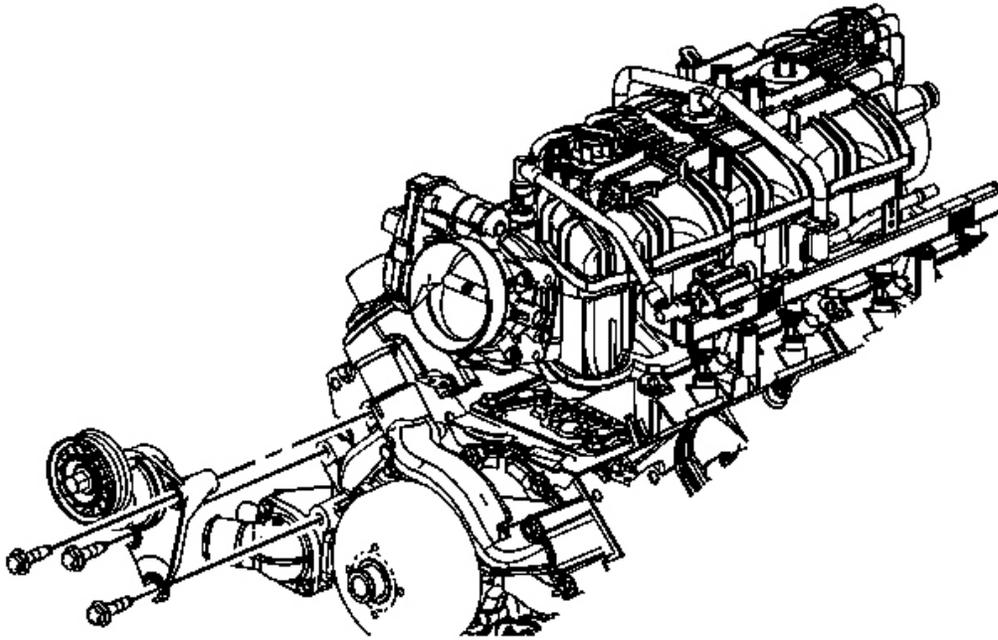


Fig. 26: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Remove the drive belt tensioner bolts.
3. Remove the drive belt tensioner.

Installation Procedure

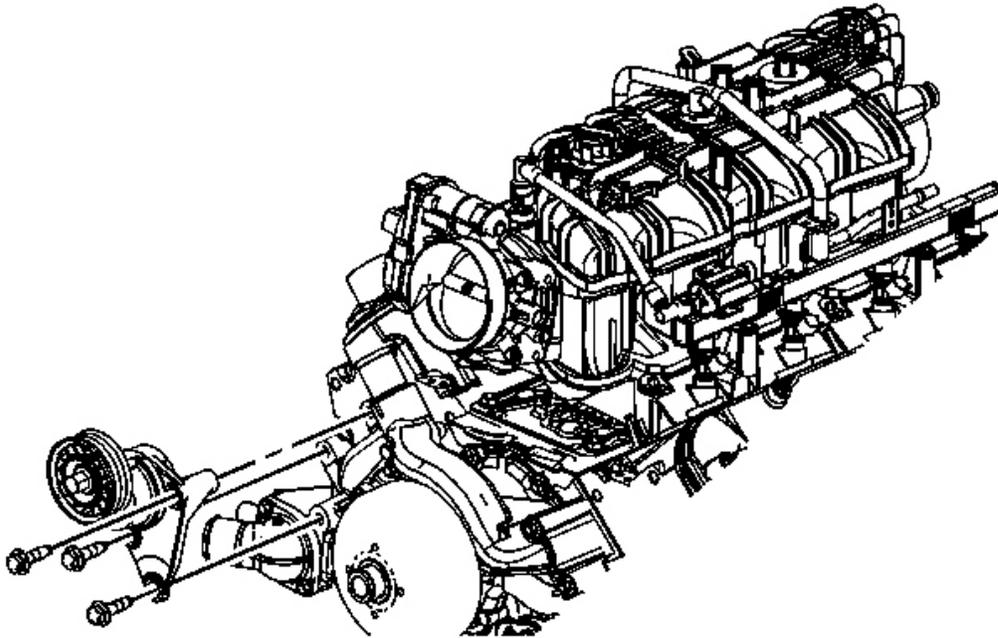


Fig. 27: View Of Drive Belt Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the drive belt tensioner to the water pump.

NOTE: Refer to Fastener Notice .

2. Install and tighten the drive belt tensioner bolts.

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

3. Install the accessory drive belt. Refer to Drive Belt Replacement - Accessory.

ENGINE MOUNT INSPECTION

NOTE: 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: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

Visual/Physical Inspection

1. Support the powertrain using the appropriate support method; refer to the powertrain mount replacement procedure. Raising the powertrain removes the weight from the engine mount and creates slight tension in the rubber.
2. Clean the mount and surrounding area to ensure good visibility of the mount condition.
3. Verify all attaching fasteners are present and at the correct torque. Refer to **Engine Mount Replacement - Left Side** and/or **Engine Mount Replacement - Right Side** for any torque sequencing and/or torque specifications.

IMPORTANT: Observe the engine mount while raising the engine. If the engine mount exhibits any of the following conditions the mount may require replacement. Refer to **Engine Mount Replacement - Left Side** and/or **Engine Mount Replacement - Right Side**.

4. Slightly raise the engine approximately 5-7 mm.
5. Inspect the mount for any of the following conditions:
 - Hard rubber surfaces - covered with extreme heat check cracks.
 - Rubber separation from the metal plate of the engine mount.
 - Rubber is split through the center of the engine mount.

IMPORTANT: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is from the engine mount , and not the engine or an external source.

- If equipped with a hydraulic mount, inspect for GLYCOL™ fluid leaking from the engine mount.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

NOTE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

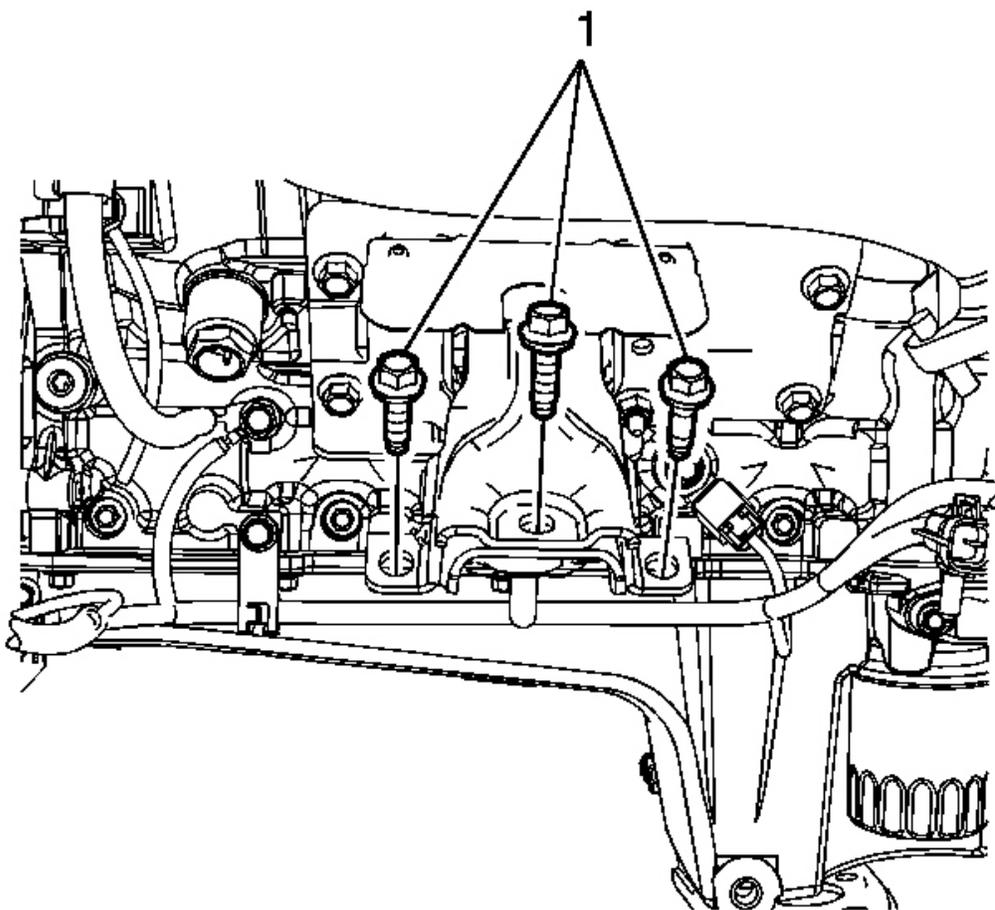


Fig. 28: Engine Mount Replacement - Left Side
Courtesy of GENERAL MOTORS CORP.

1. Remove the left front wheelhouse panel. Refer to Wheelhouse Panel Replacement (Front) or Wheelhouse Panel Replacement (Rear) .

2. Remove the engine protection shield. Refer to **Engine Shield Replacement** .
3. Remove the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement** .
4. Remove the wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
5. Remove the engine mount to frame bolts (1).

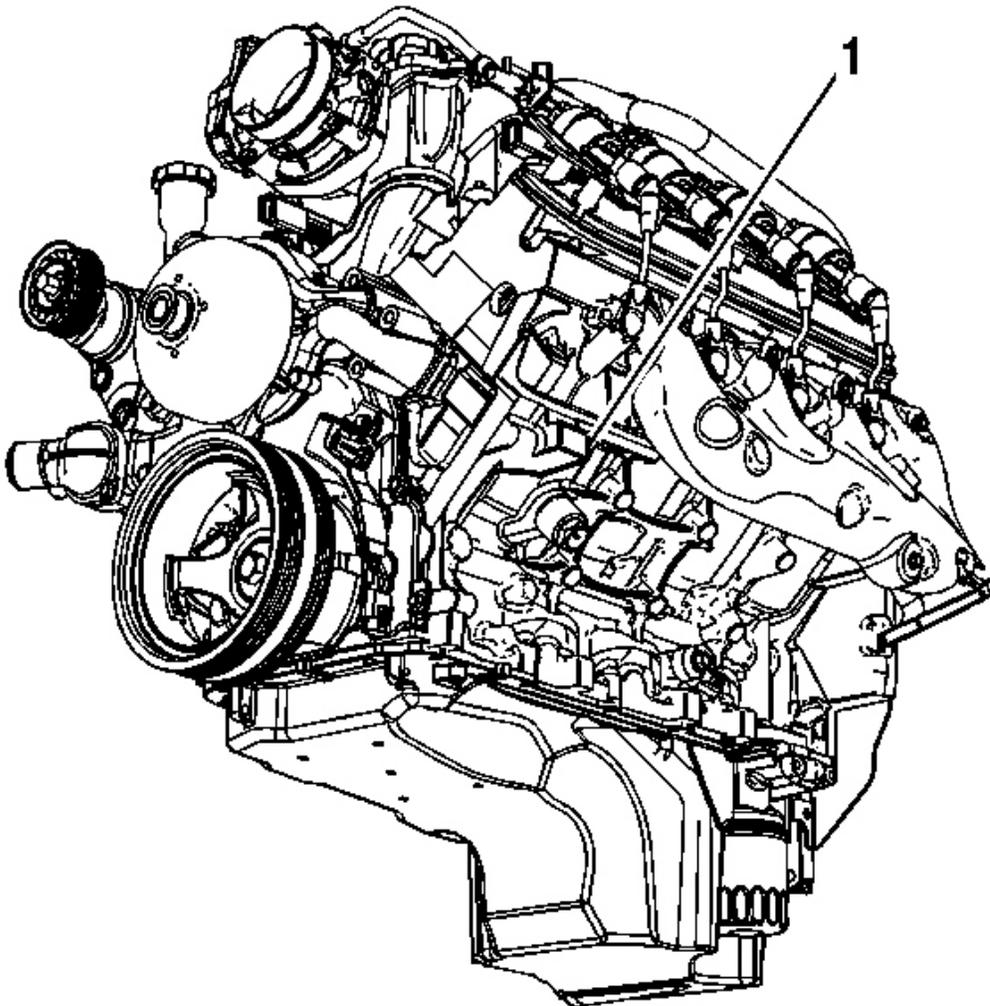


Fig. 29: Engine Mount & Frame Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT raise and/or support the engine by the crankshaft balancer, or oil pan.

6. Place an adjustable (screw type) jack to the tab (1) located on the engine block.

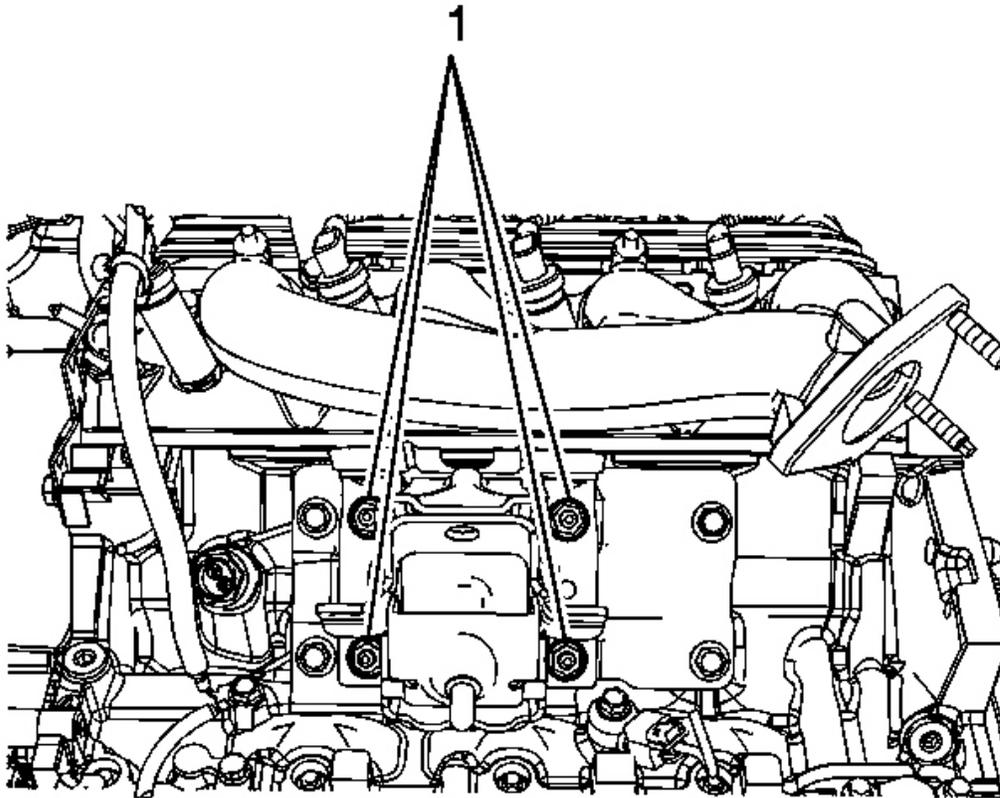


Fig. 30: Engine Mount & Engine Bolts
Courtesy of GENERAL MOTORS CORP.

7. Working through the wheelhouse opening, remove the engine mount to engine bolts (1).
8. Using the adjustable jack, raise the engine slightly until there is enough clearance to remove the engine mount.

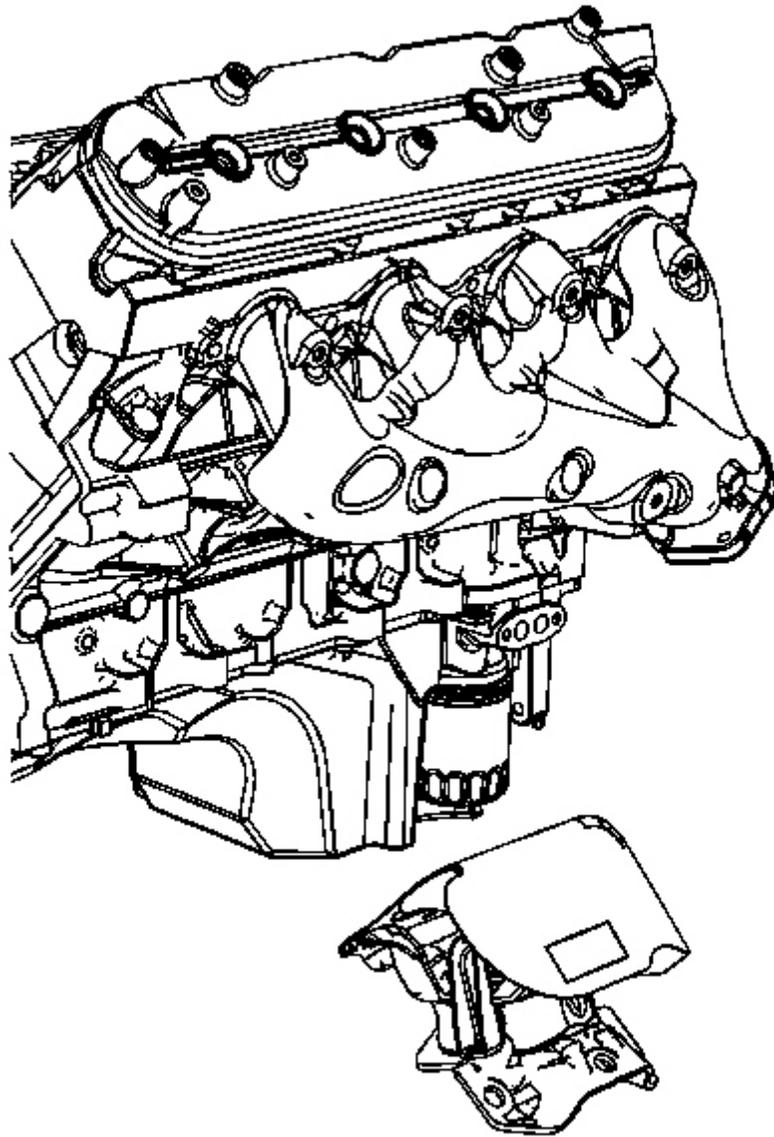


Fig. 31: Engine Mount
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine mount.

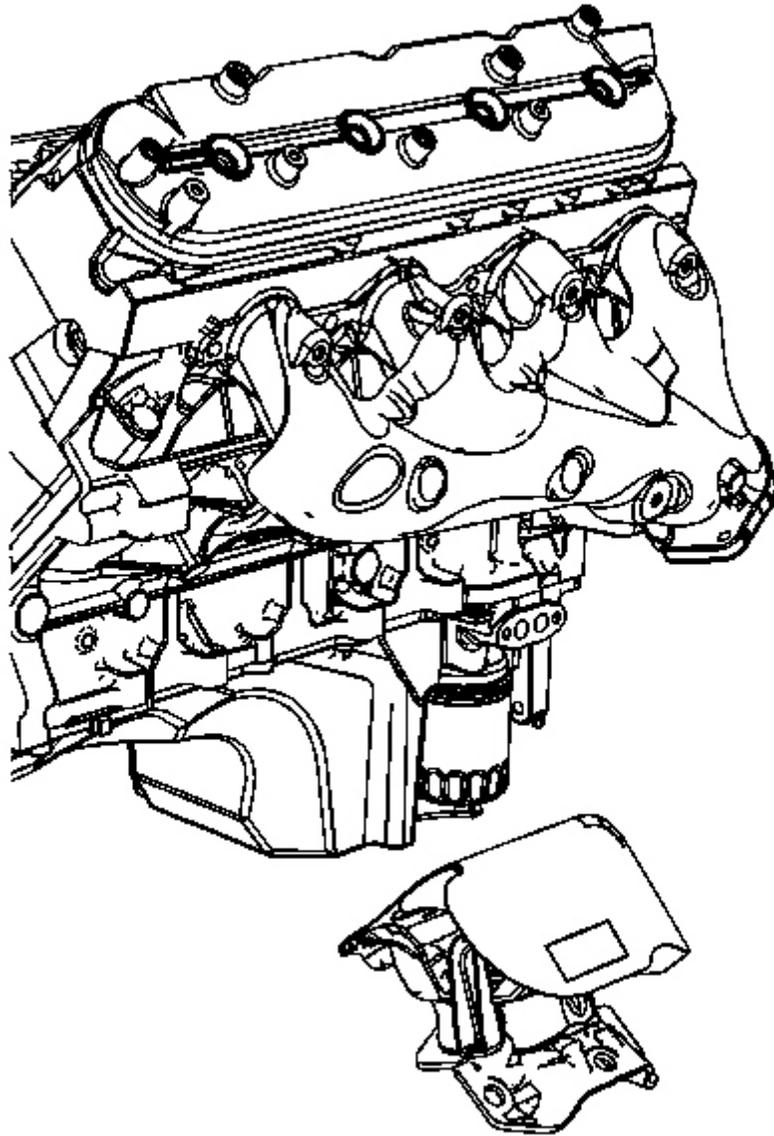


Fig. 32: Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount to the engine.

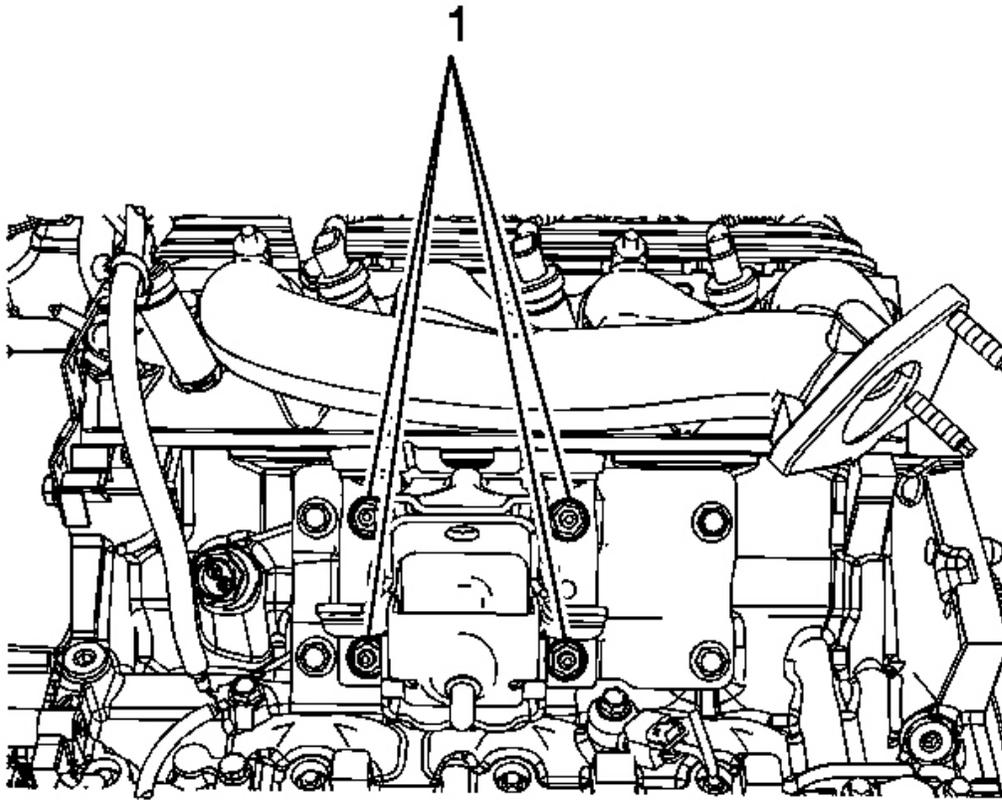


Fig. 33: Engine Mount & Engine Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Working through the wheelhouse opening, install the engine mount to engine nuts (1).

Tighten: Tighten the bolts to 55 N.m (41 lb ft).

3. Using the adjustable jack, lower the engine until the engine mount is sitting flush on the frame.
4. Remove the adjustable jack from the engine block.

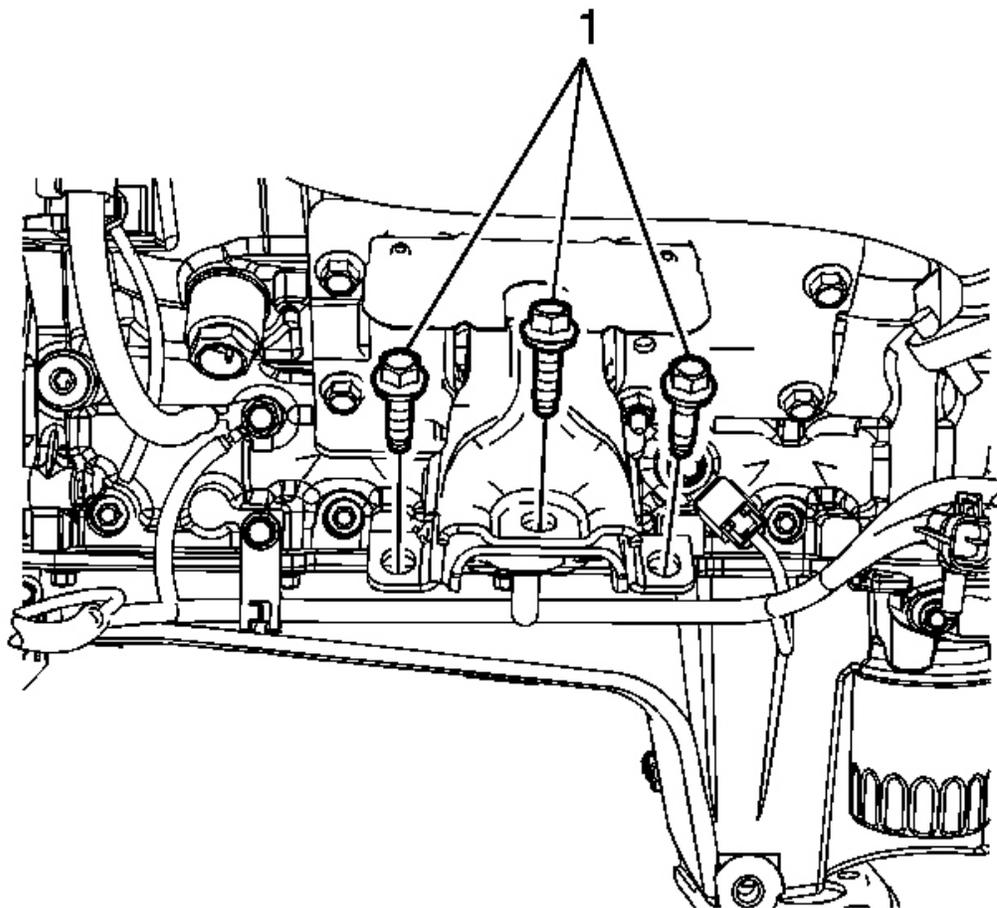


Fig. 34: Engine Mount Replacement - Left Side
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount to frame bolts (1).

Tighten: Tighten the bolts to 65 N.m (48 lb ft) starting with the middle bolt then either side bolt.

6. Install the wheelhouse liner. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
7. Install the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement** .
8. Install the engine protection shield. Refer to **Engine Shield Replacement** .

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9. Install the left front wheelhouse panel. Refer to **Wheelhouse Panel Replacement (Front)** or **Wheelhouse Panel Replacement (Rear)** .
10. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Removal Procedure

NOTE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

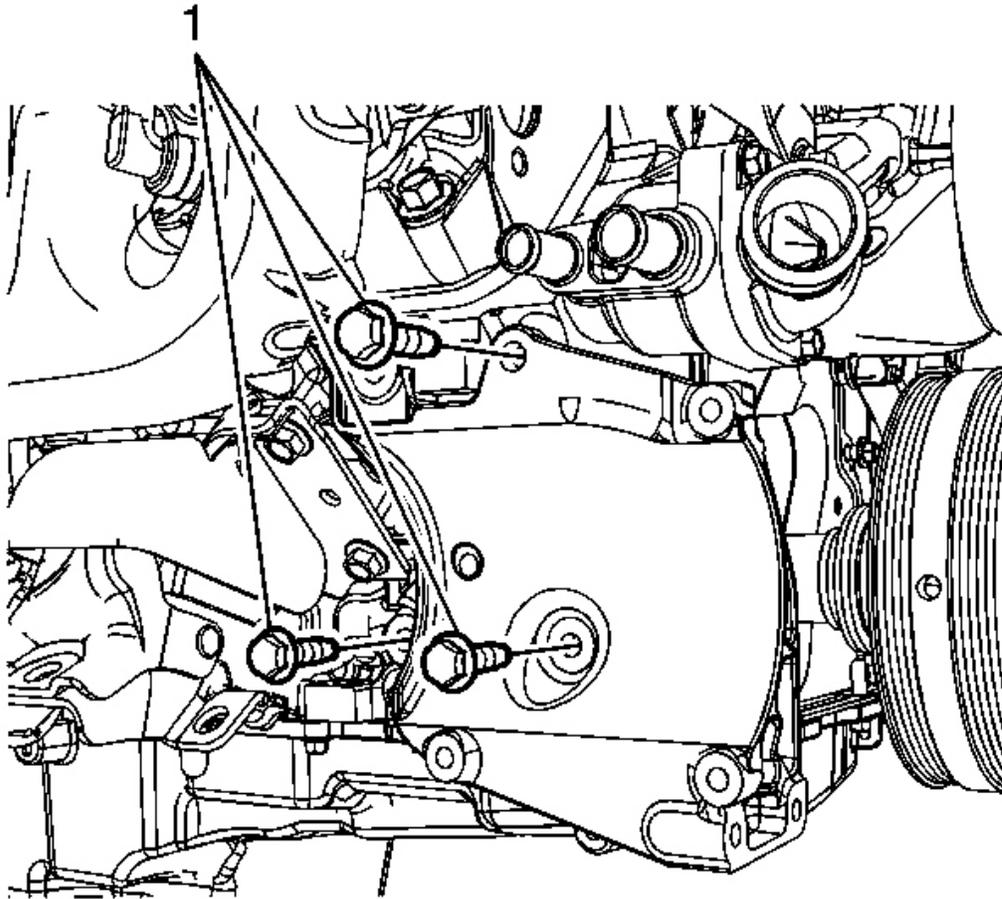


Fig. 35: Engine Mount Replacement - Right Side
Courtesy of GENERAL MOTORS CORP.

1. Remove the front tire and wheels. Refer to **Tire and Wheel Removal and Installation** .
2. Remove the engine protection shield. Refer to **Engine Shield Replacement** .
3. Remove the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement** .
4. Unbolt the air conditioning compressor and position aside. Refer to **Air Conditioning Compressor Replacement (LH8)** .
5. Remove the air conditioning bracket bolts (1).

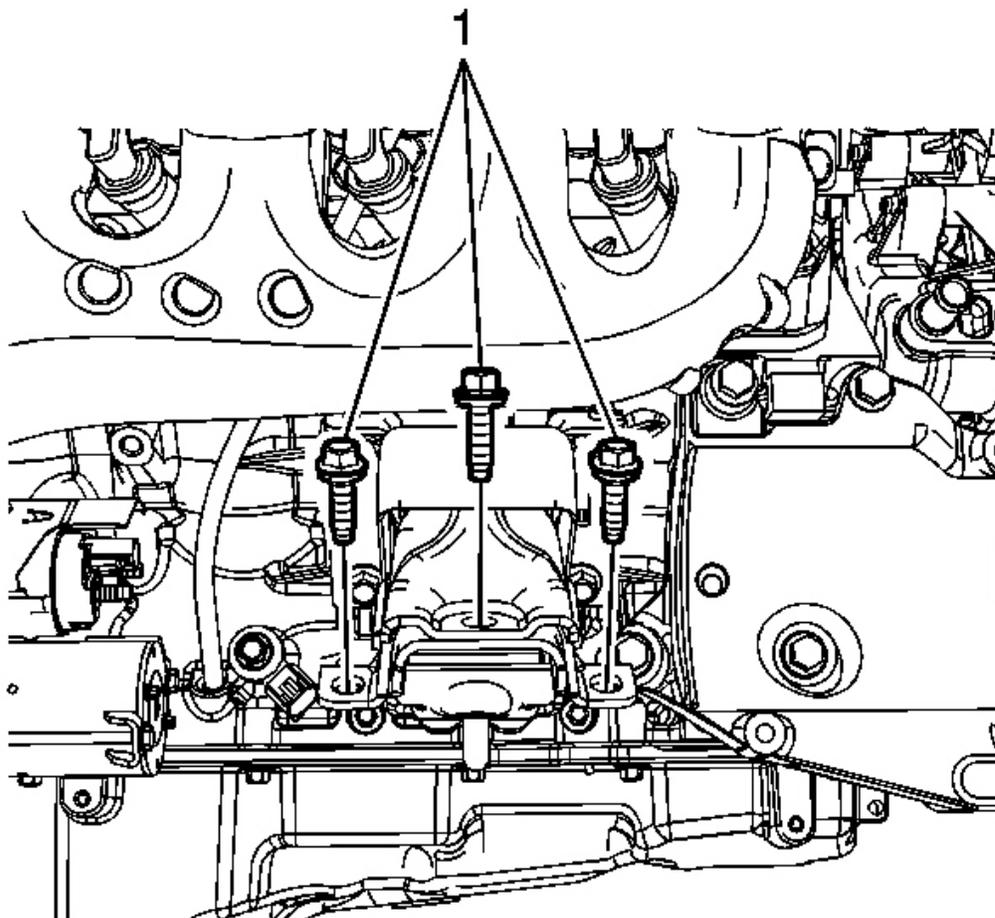


Fig. 36: Engine Mount & Frame Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine mount to frame bolts (1).

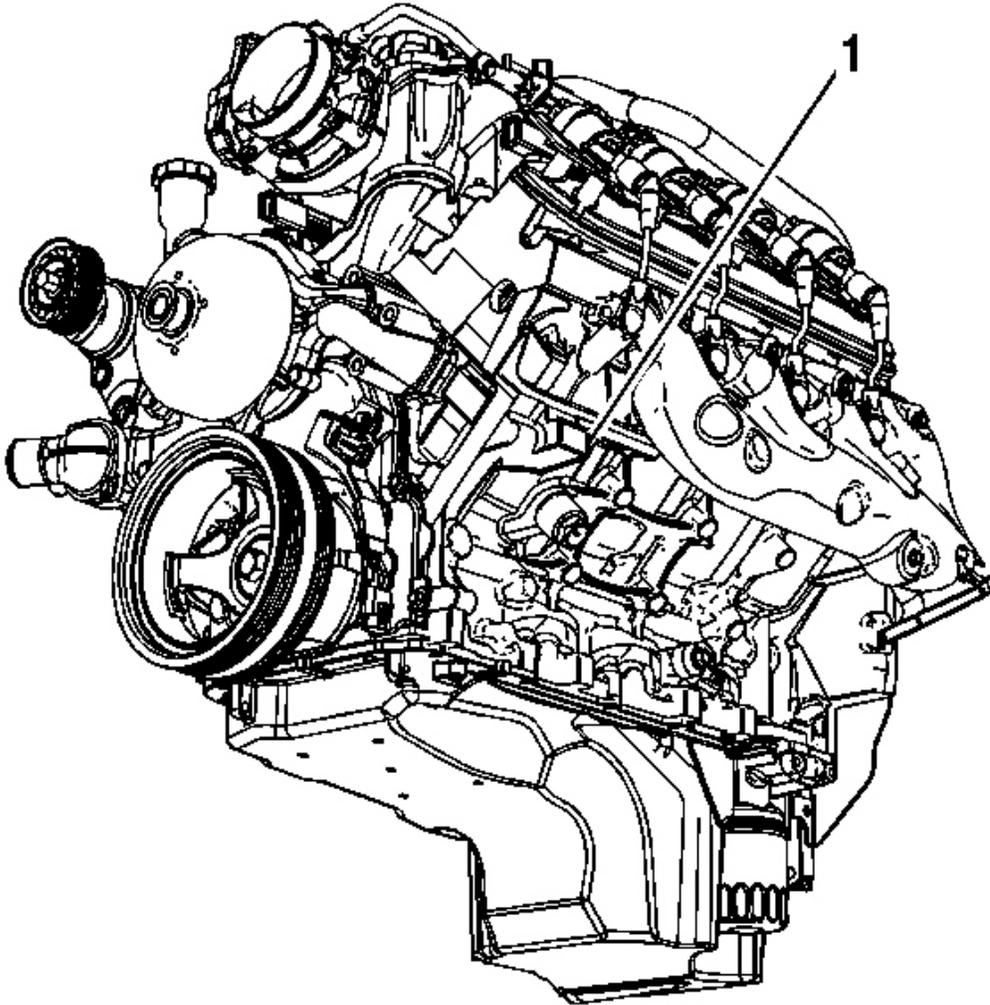


Fig. 37: Engine Mount & Frame Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT raise and/or support the engine by the crankshaft balancer, or oil pan.

7. Place an adjustable (screw type) jack to the tab (1) located on the engine block.

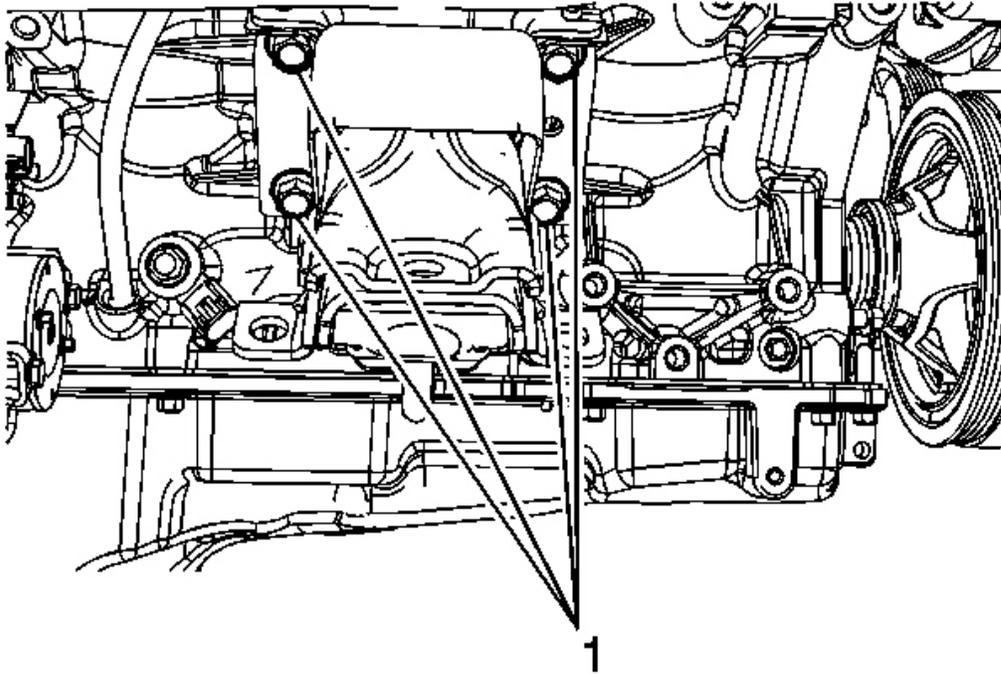


Fig. 38: Engine Mount & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine mount to engine bolts (1).
9. Using the adjustable jack, raise the engine slightly until there is enough clearance to remove the engine mount.

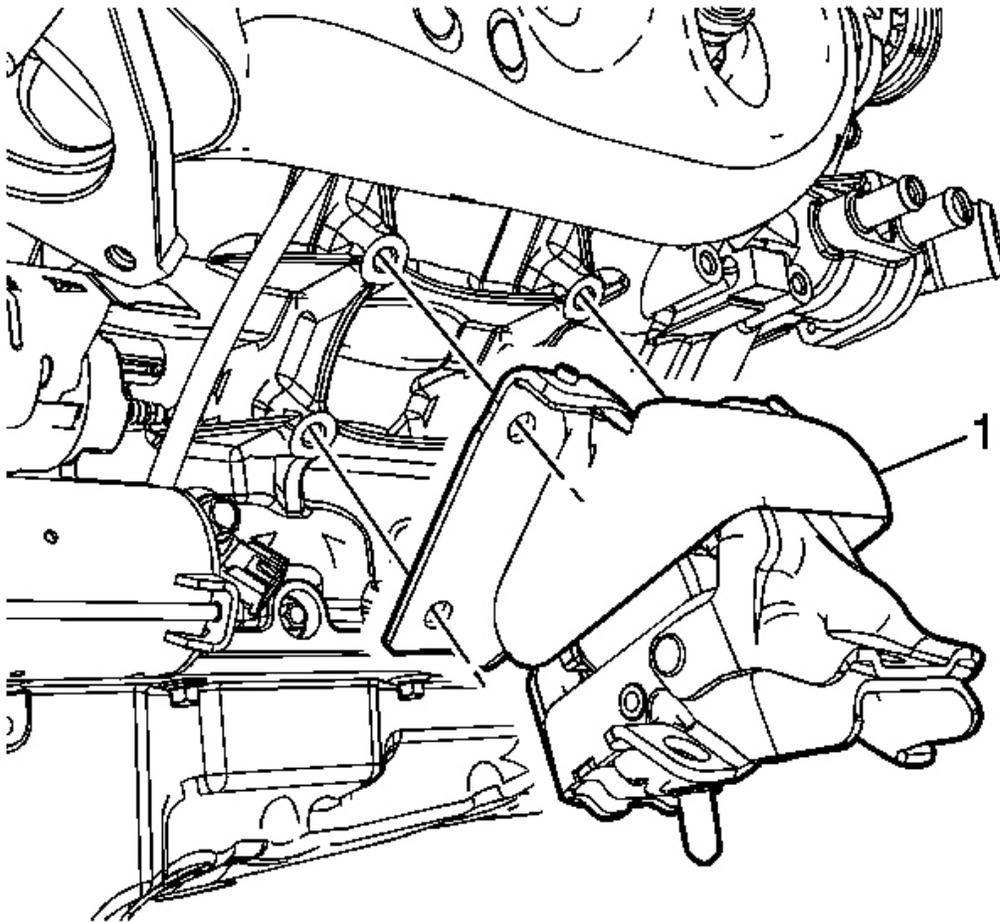


Fig. 39: Locating Engine Mount
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine mount (1).

Installation Procedure

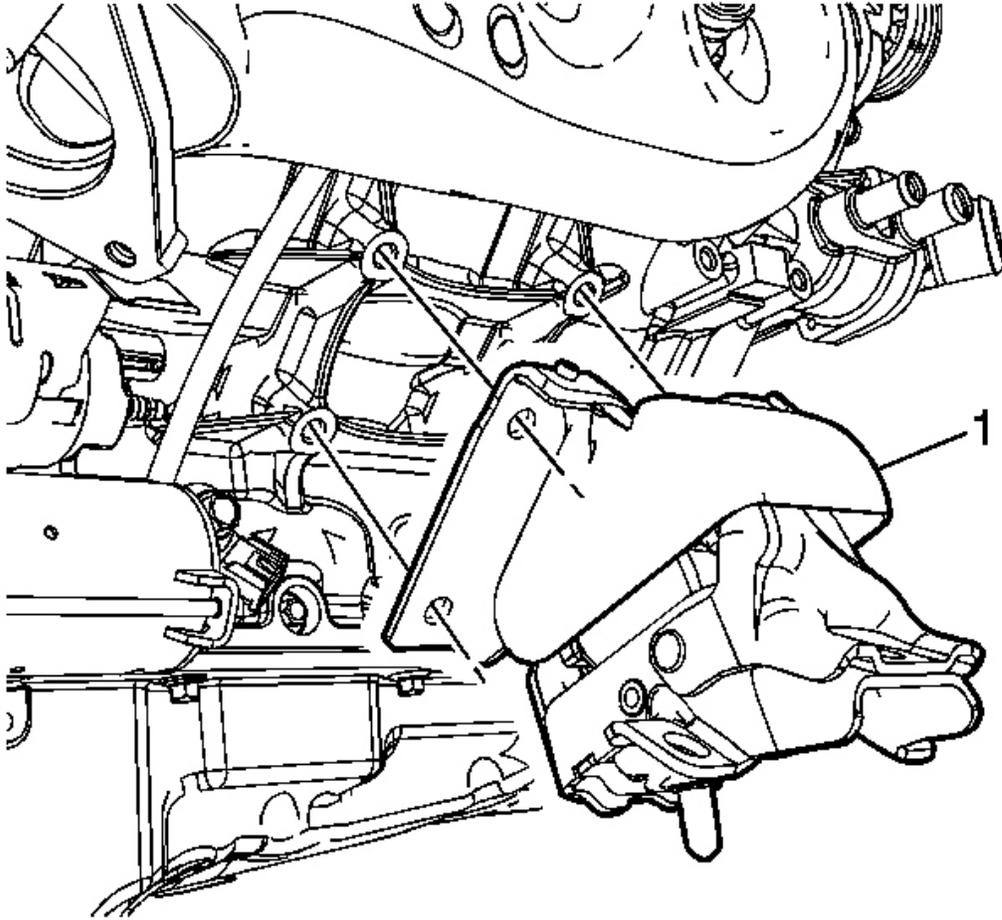


Fig. 40: Locating Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount (1) to the engine.

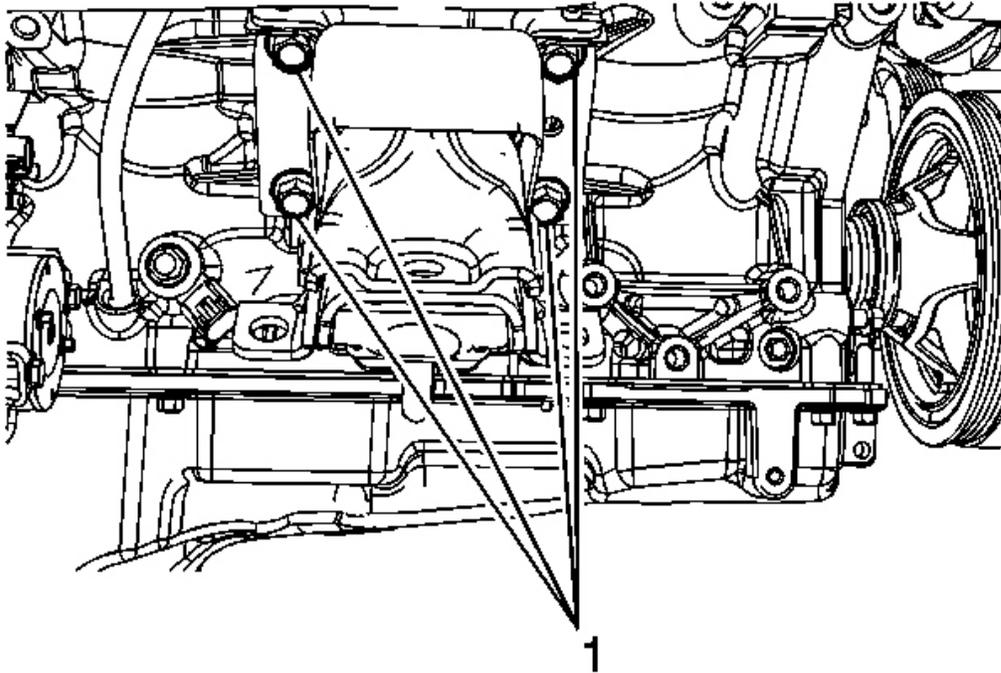


Fig. 41: Engine Mount & Engine Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the engine mount to engine nuts (1).

Tighten: Tighten the bolts to 55 N.m (41 lb ft).

3. Using the adjustable jack, lower the engine until the engine mount is sitting flush on the frame.
4. Remove the adjustable jack from the engine block.

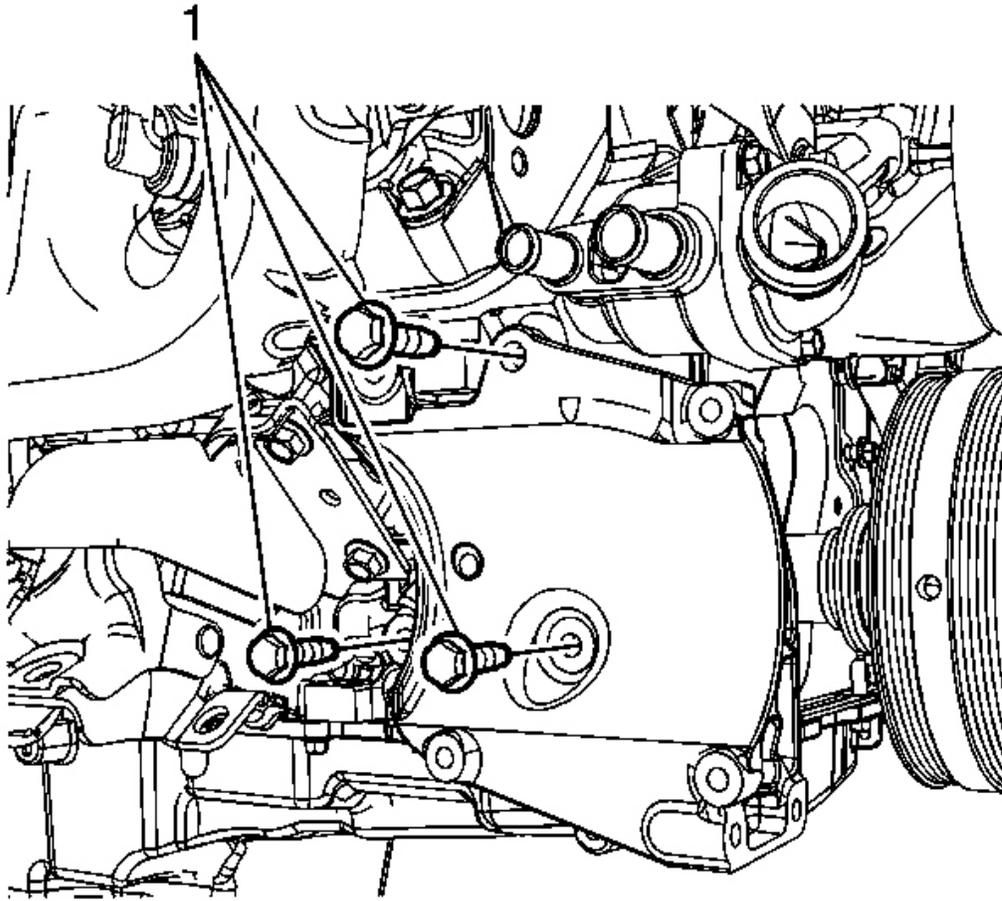


Fig. 42: Engine Mount Replacement - Right Side
Courtesy of GENERAL MOTORS CORP.

5. Install the air conditioning compressor bracket bolts (1).
6. Install the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (LH8)** .

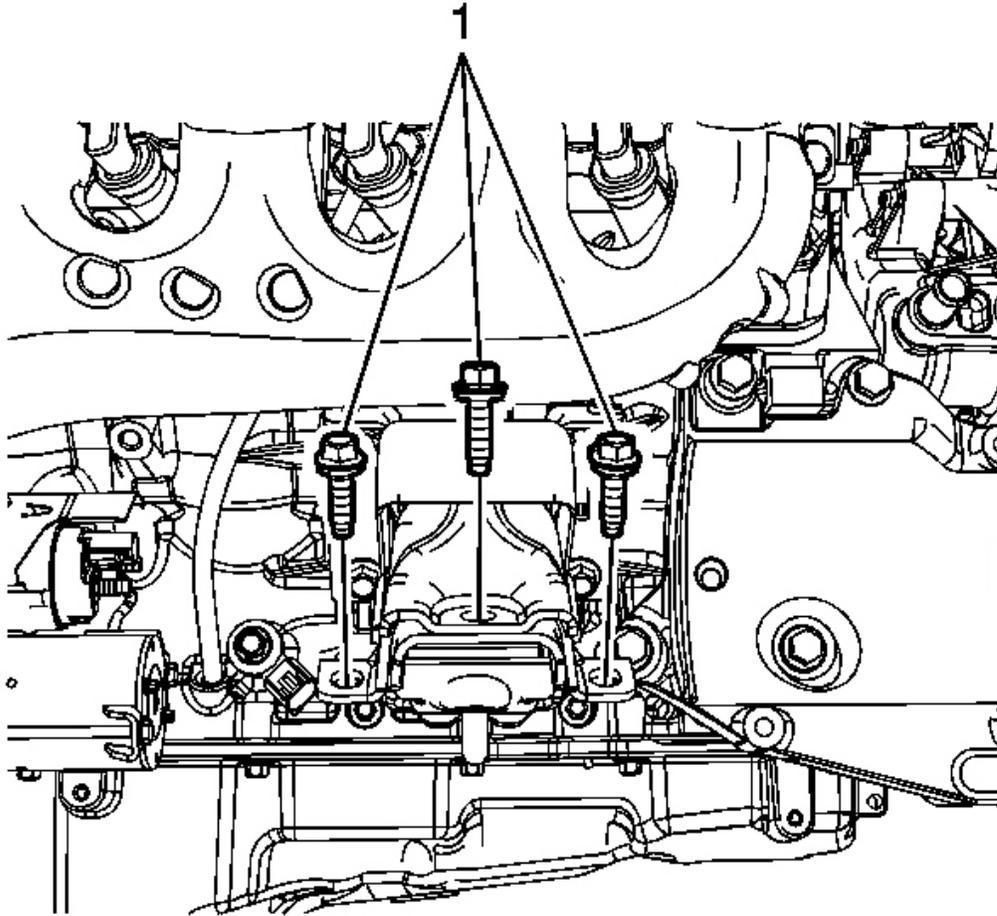


Fig. 43: Engine Mount & Frame Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the engine mount to frame bolts (1).

Tighten: Tighten the bolts to 65 N.m (48 lb ft) starting with the middle bolt then either side bolt.

8. Install the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement** .
9. Install the engine protection shield. Refer to **Engine Shield Replacement** .
10. Install the front tire and wheels. Refer to **Tire and Wheel Removal and Installation** .
11. Lower the vehicle.

UPPER INTAKE MANIFOLD SIGHT SHIELD REPLACEMENT

Removal Procedure

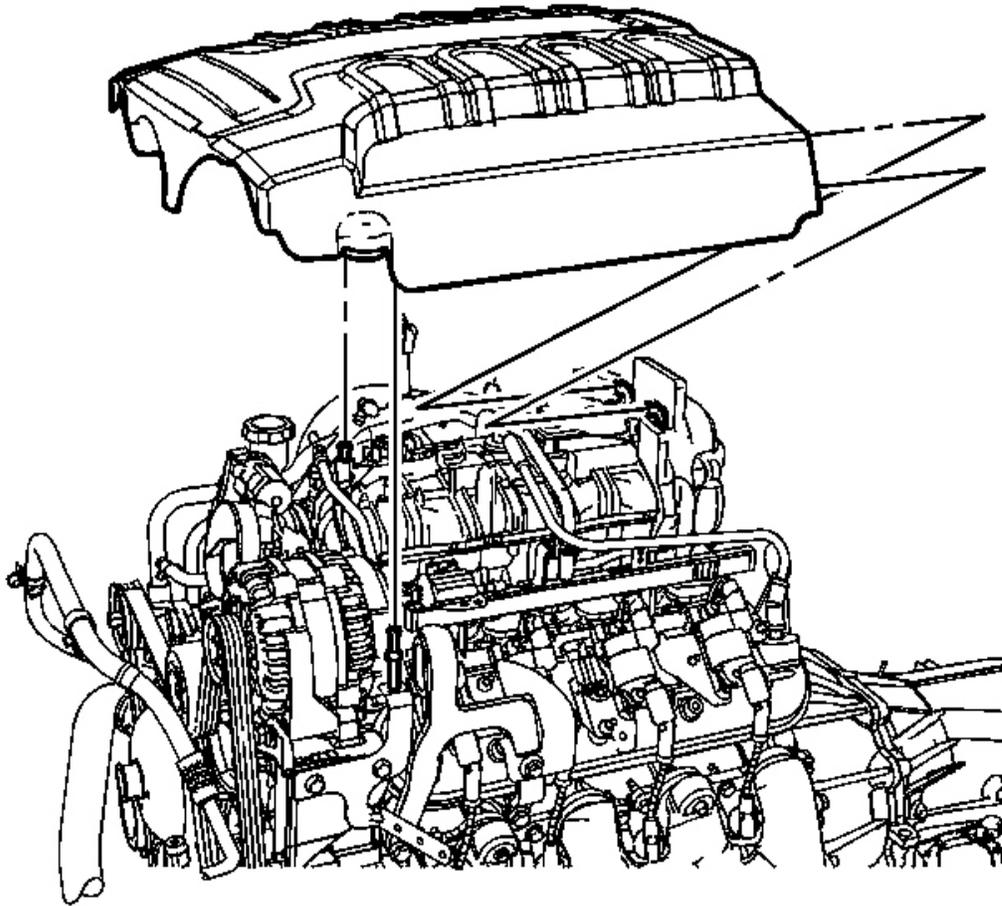


Fig. 44: Upper Intake Manifold Sight Shield Replacement
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill cap.
2. Grasp the front of the intake manifold sight shield and lift up disengaging the grommets from the studs.
3. Remove the intake manifold sight shield from the retainer slots.

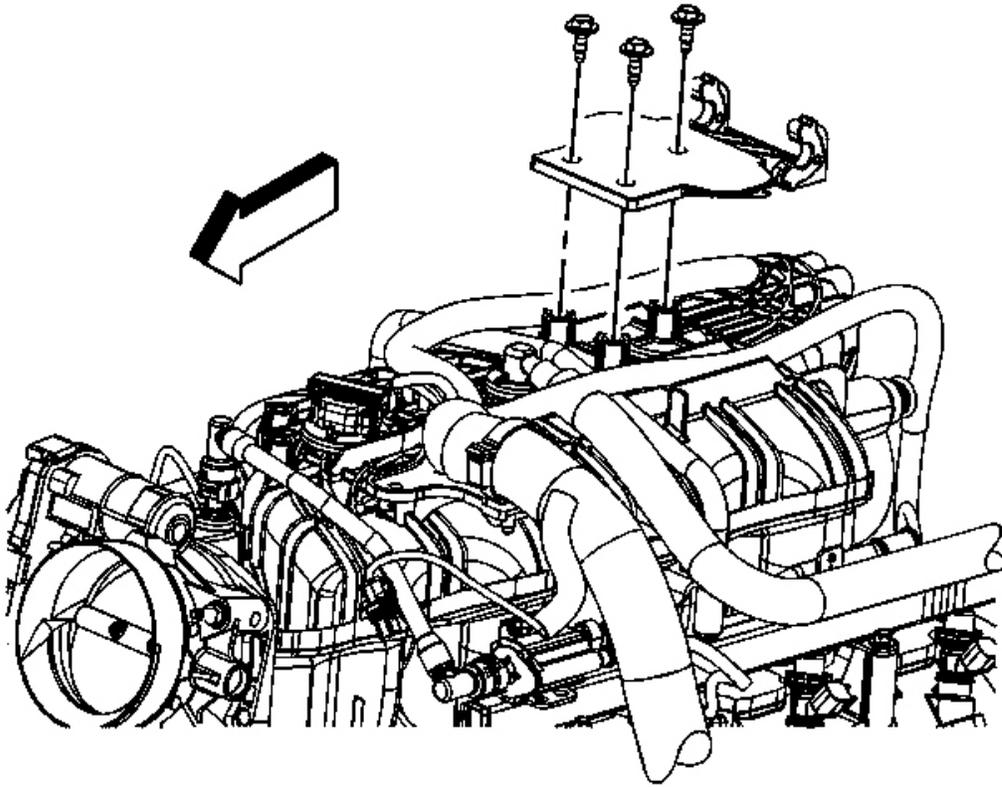


Fig. 45: Manifold Sight Shield Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold sight shield retainer bolts and retainer, if required.

Installation Procedure

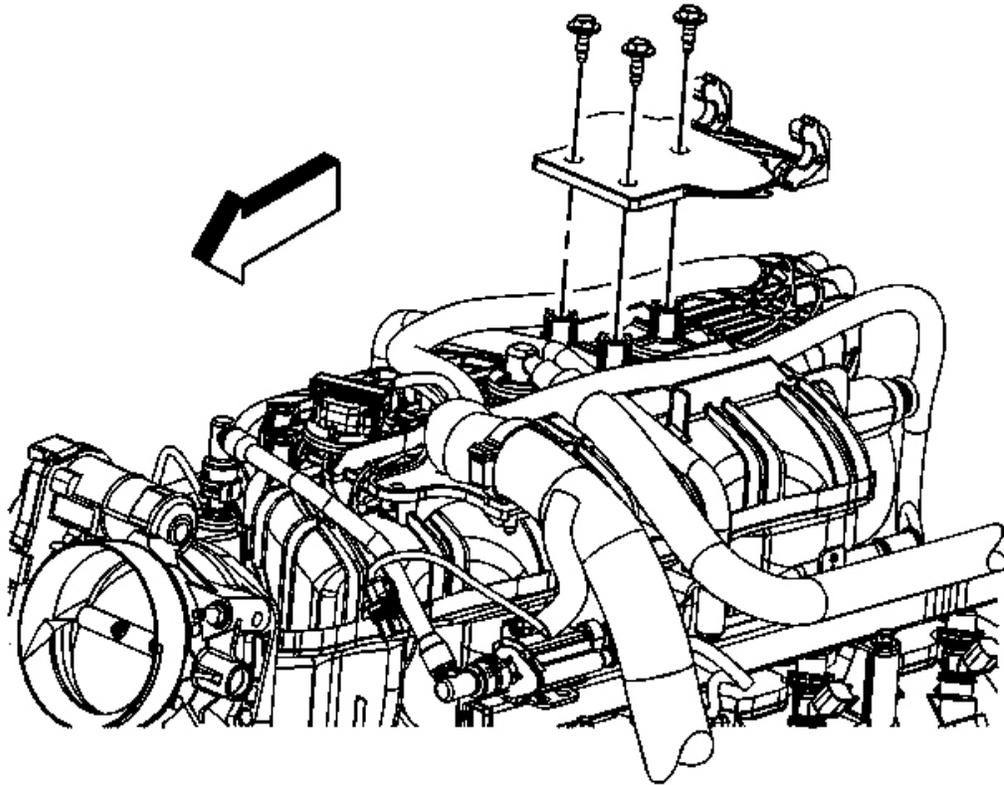


Fig. 46: Manifold Sight Shield Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Position the intake manifold sight shield on top of the intake manifold, aligning the holes, if required.
2. Install the intake manifold sight shield retainer bolts, if required.

Tighten: Tighten the bolts to 5 N.m (44 lb in).

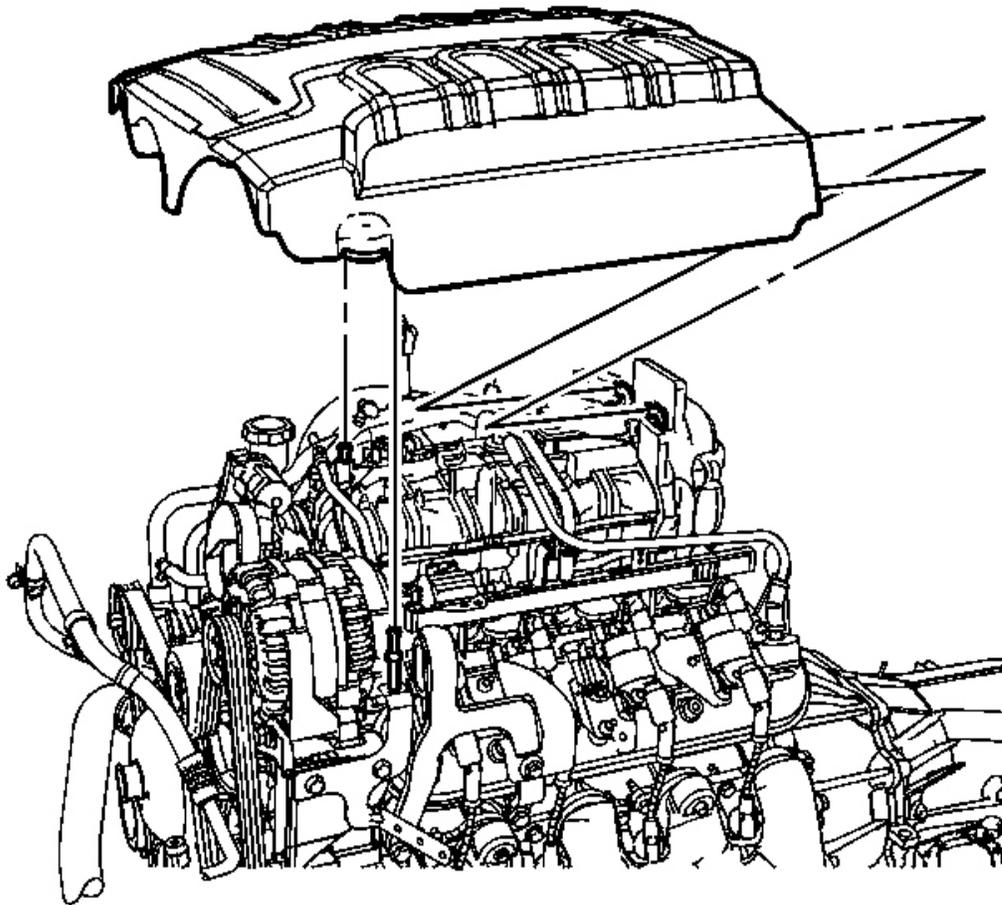


Fig. 47: Upper Intake Manifold Sight Shield Replacement
Courtesy of GENERAL MOTORS CORP.

3. Install the intake manifold sight shield tabs into the slots in the retainer.
4. Align the intake manifold sight shield grommets with the studs.
5. Gently push down on the intake manifold sight shield over the grommets, seating the intake manifold sight shield.
6. Install the oil fill cap.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

Removal Procedure

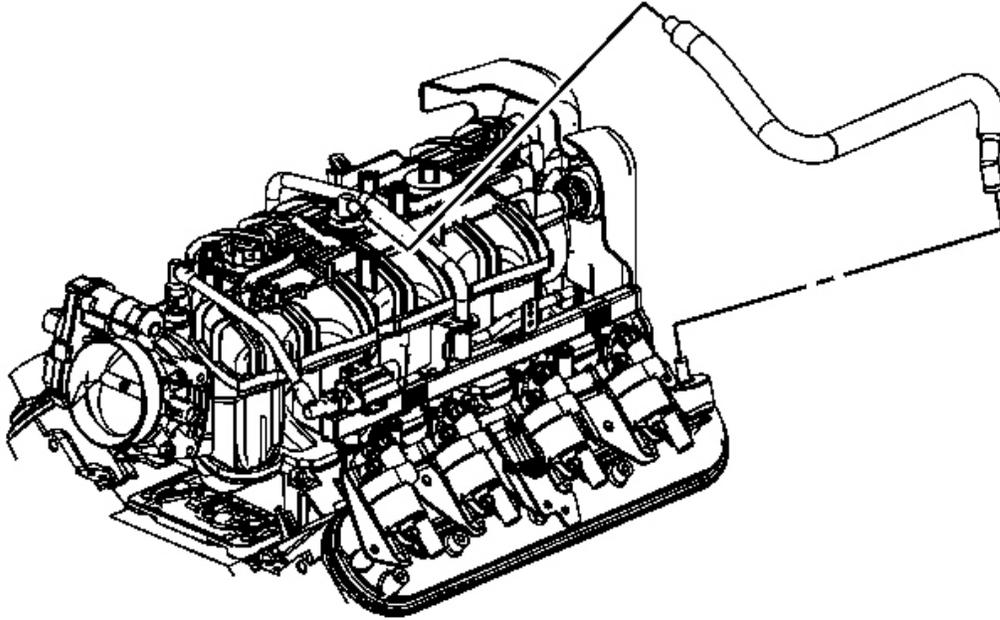


Fig. 48: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.
2. Remove the positive crankcase ventilation (PCV) hose from the intake manifold fitting and left valve rocker arm cover, if required.

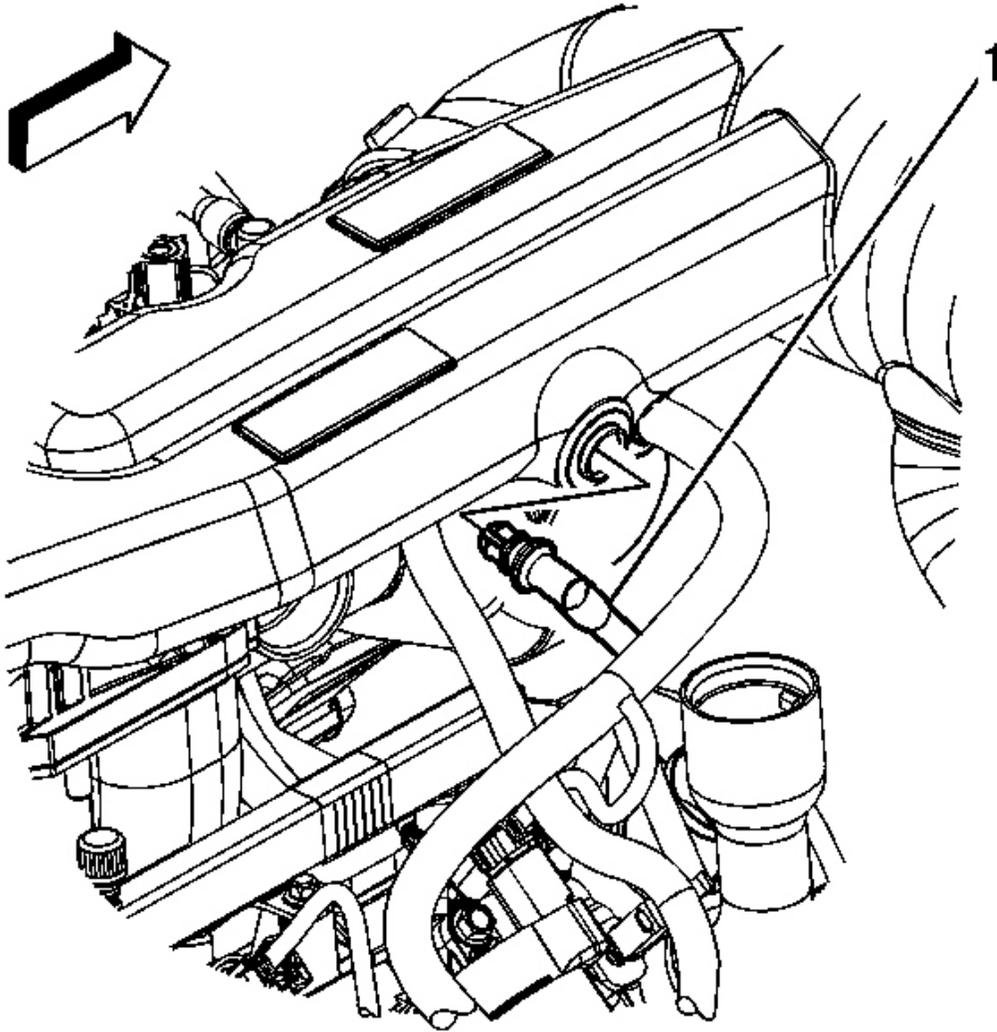


Fig. 49: PCV Tube

Courtesy of GENERAL MOTORS CORP.

3. Remove the PCV tube (1) from the air cleaner outlet duct, if required.

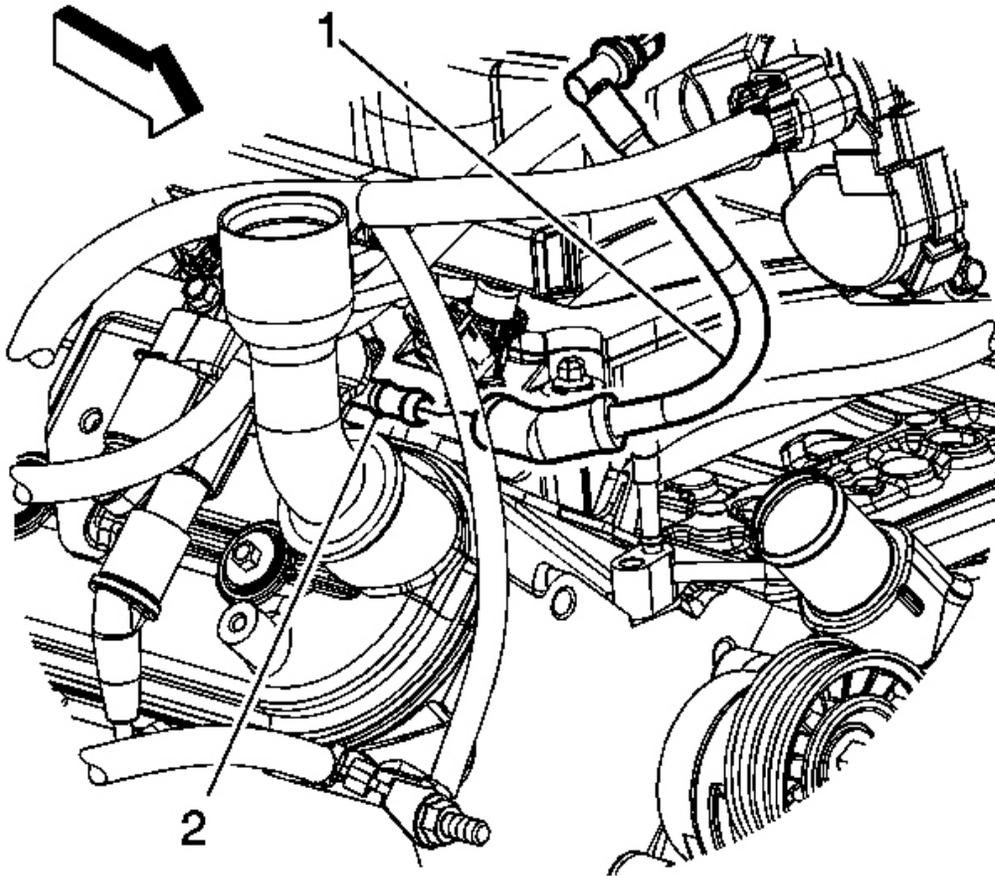


Fig. 50: PCV Hose/Tube

Courtesy of GENERAL MOTORS CORP.

4. Remove the PCV tube (1) from the right valve rocker arm cover fitting (2), if required.
5. Remove the appropriate PCV hose/tube from the vehicle.

Installation Procedure

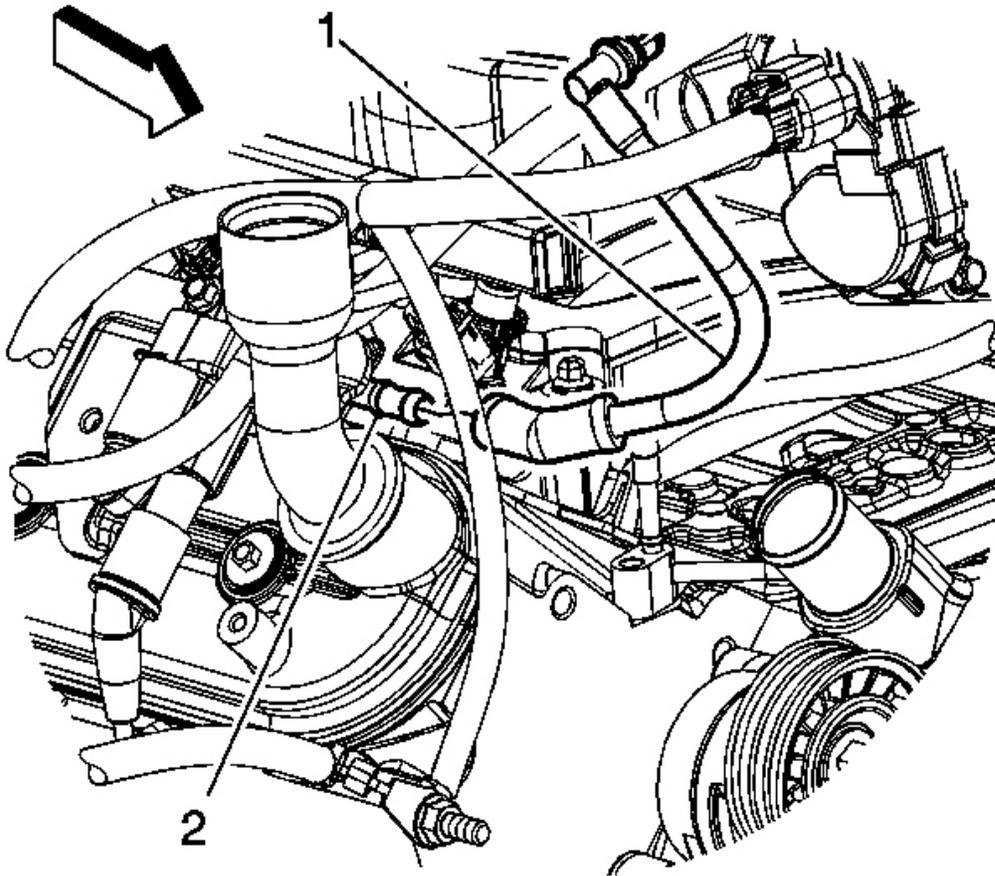


Fig. 51: PCV Hose/Tube

Courtesy of GENERAL MOTORS CORP.

1. Install the appropriate PCV hose/tube to the vehicle.
2. Install the PCV tube (1) to the right valve rocker arm cover fitting (2), if required.

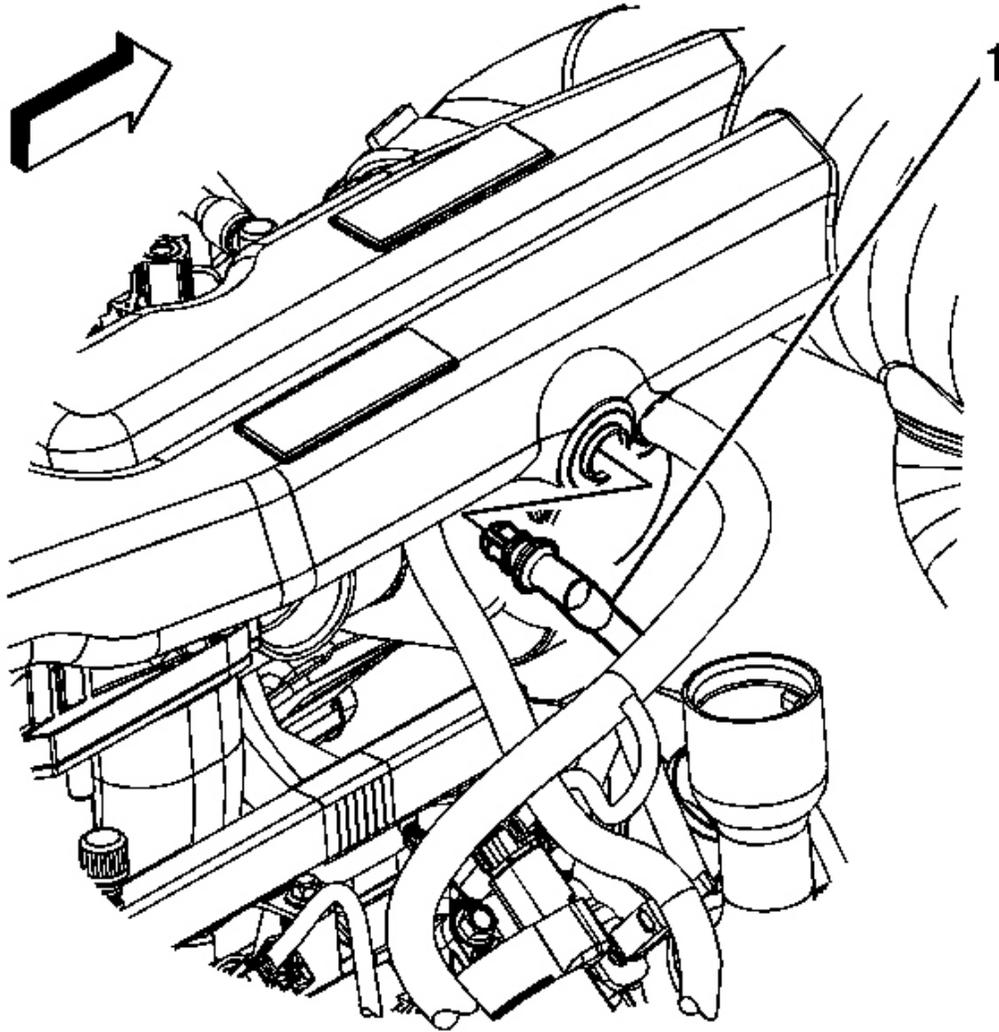


Fig. 52: PCV Tube

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Route the PCV tube between the engine harness and generator battery jumper cable.

3. Install the PCV tube (1) to the air cleaner outlet duct, if required.

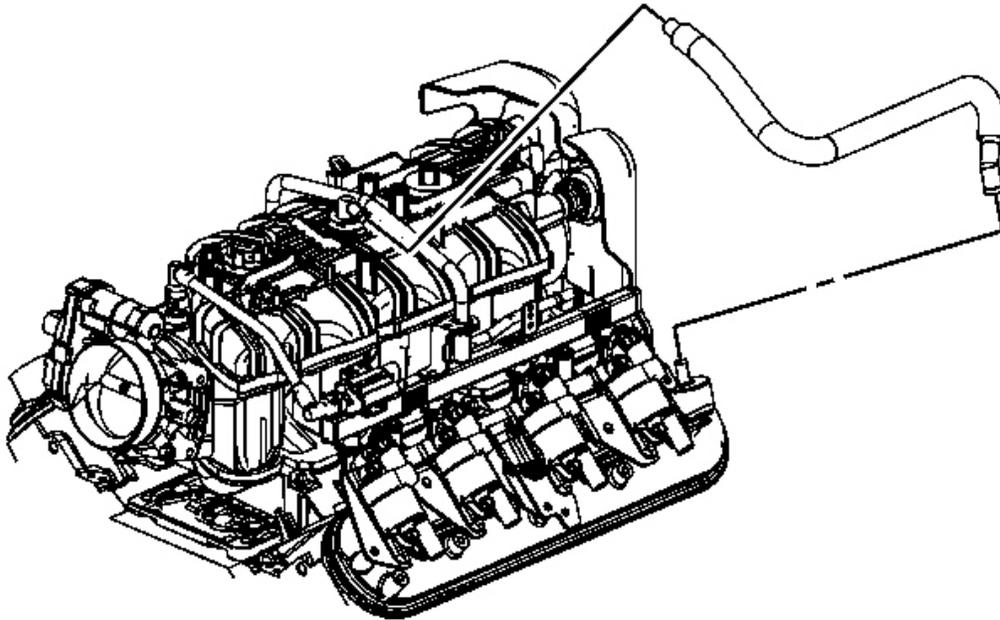


Fig. 53: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

4. Install the PCV hose to the intake manifold fitting and left valve rocker arm cover, if required.
5. Install the intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.

PCV HOSE/TUBE

Removal Procedure

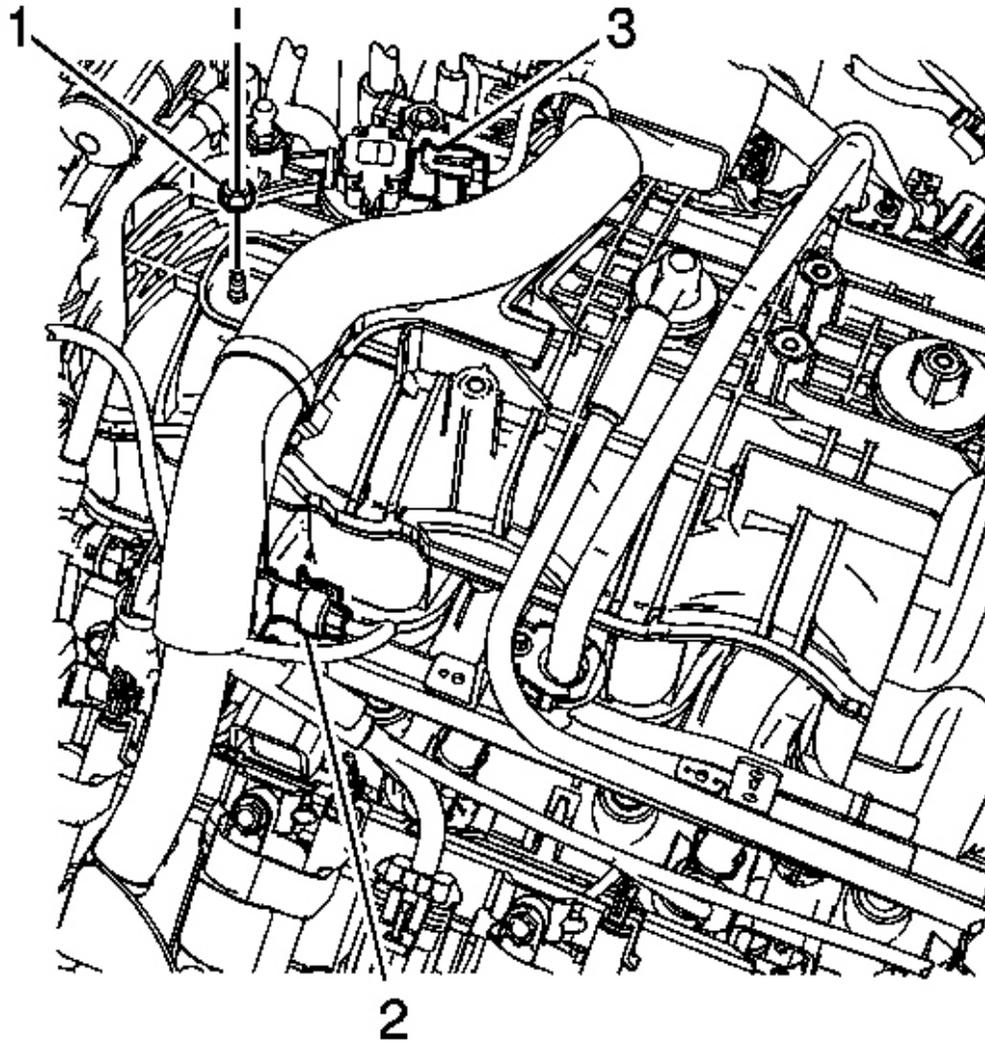


Fig. 54: PCV Hose/Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .
2. Remove the generator. Refer to **Generator Replacement (LH8)** .
3. Remove the engine harness retainer nut (1).
4. Remove the engine harness retainer from the stud and locator pin.

5. Disconnect the engine harness electrical connector (2) from the evaporative emission (EVAP) canister purge solenoid.
6. Disconnect the engine wiring harness electrical connector (3) from the manifold absolute pressure (MAP) sensor.

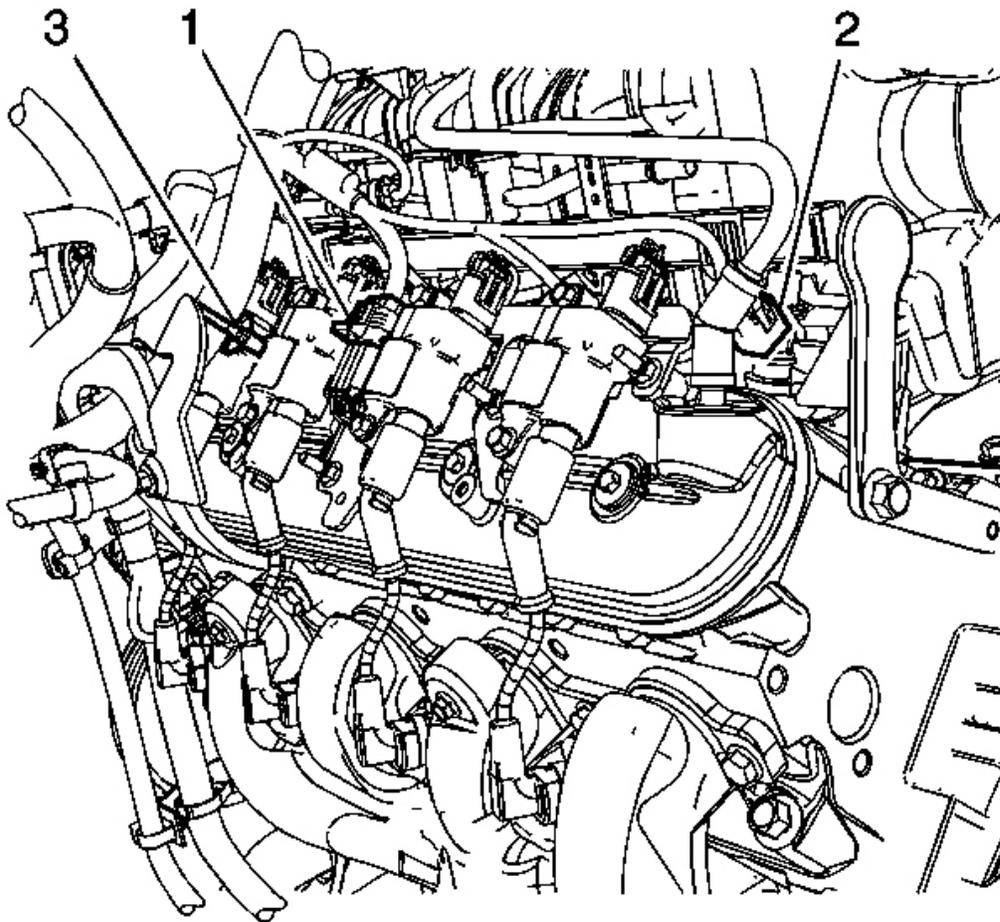


Fig. 55: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the engine harness electrical connector (1) from the ignition coil harness electrical connector.
8. Disconnect the engine harness electrical connectors (2) from the left side fuel injectors.
9. Remove the engine harness clip (3) from the ignition coil bracket stud.

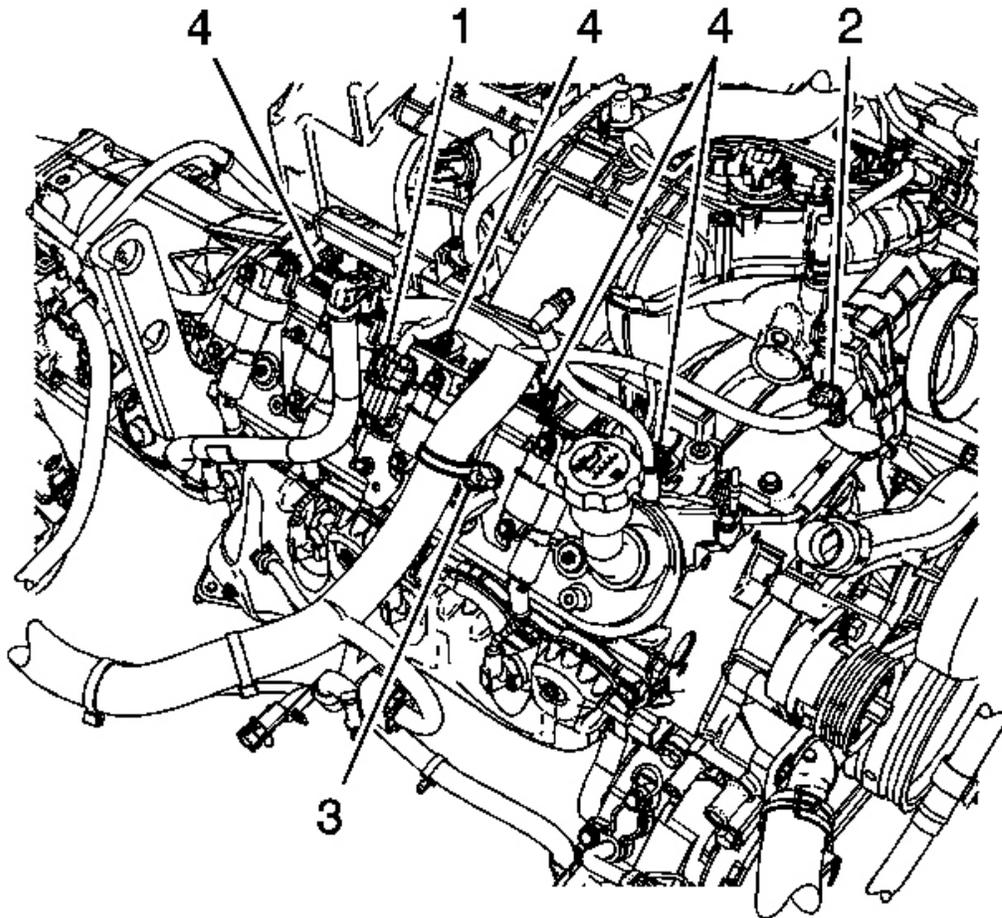


Fig. 56: Engine Harness Electrical Connector & Ignition Coil Harness Electrical Connector

Courtesy of GENERAL MOTORS CORP.

10. Disconnect the engine harness electrical connector (1) from the ignition coil harness electrical connector.
11. Disconnect the engine harness electrical connector (2) from the throttle actuator.
12. Remove the engine harness clip (3) from the ignition coil bracket stud.
13. Disconnect the engine harness electrical connectors (4) from the right side fuel injectors.

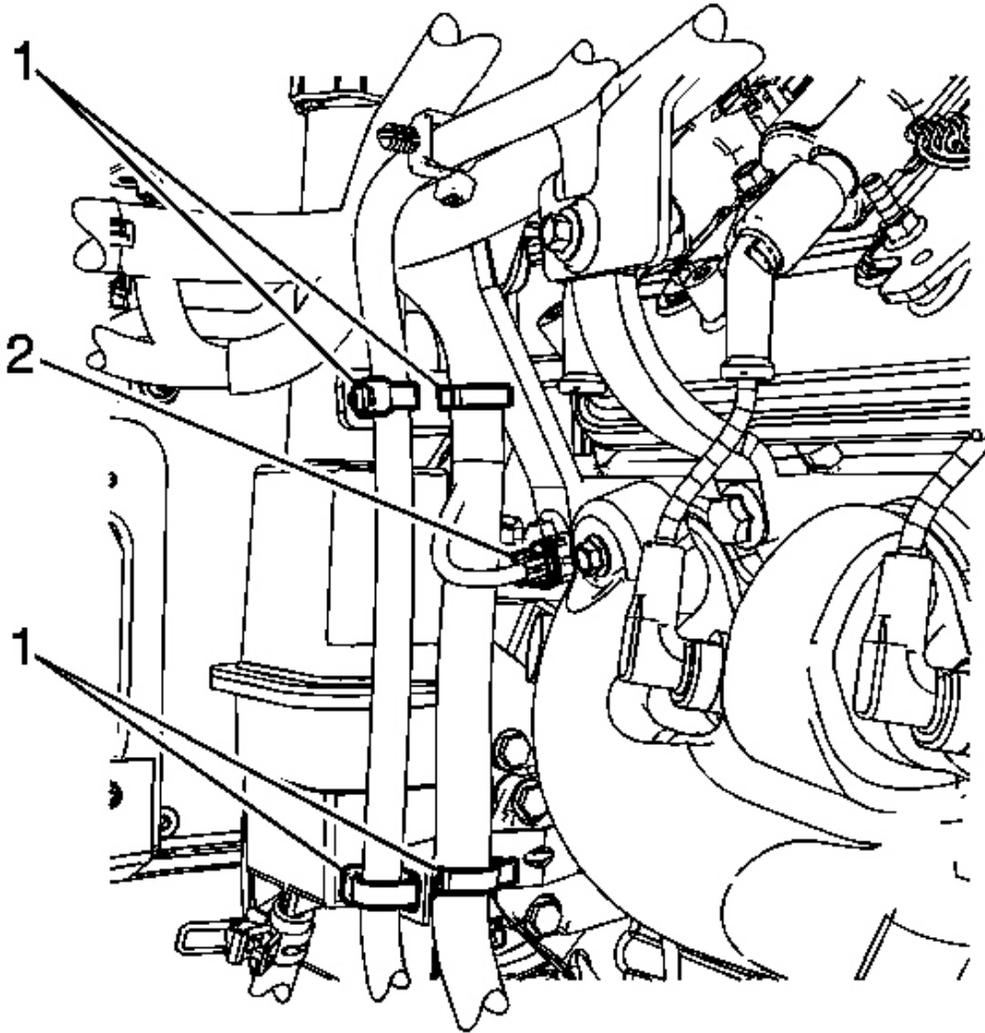


Fig. 57: Engine Harness Clips
Courtesy of GENERAL MOTORS CORP.

14. Remove the engine harness clips (1).
15. Disconnect the engine harness electrical connector (2) from the engine coolant temperature (ECT) sensor.
16. Gather the engine harness branches and tie the harness up out of the way to the front of the engine compartment.

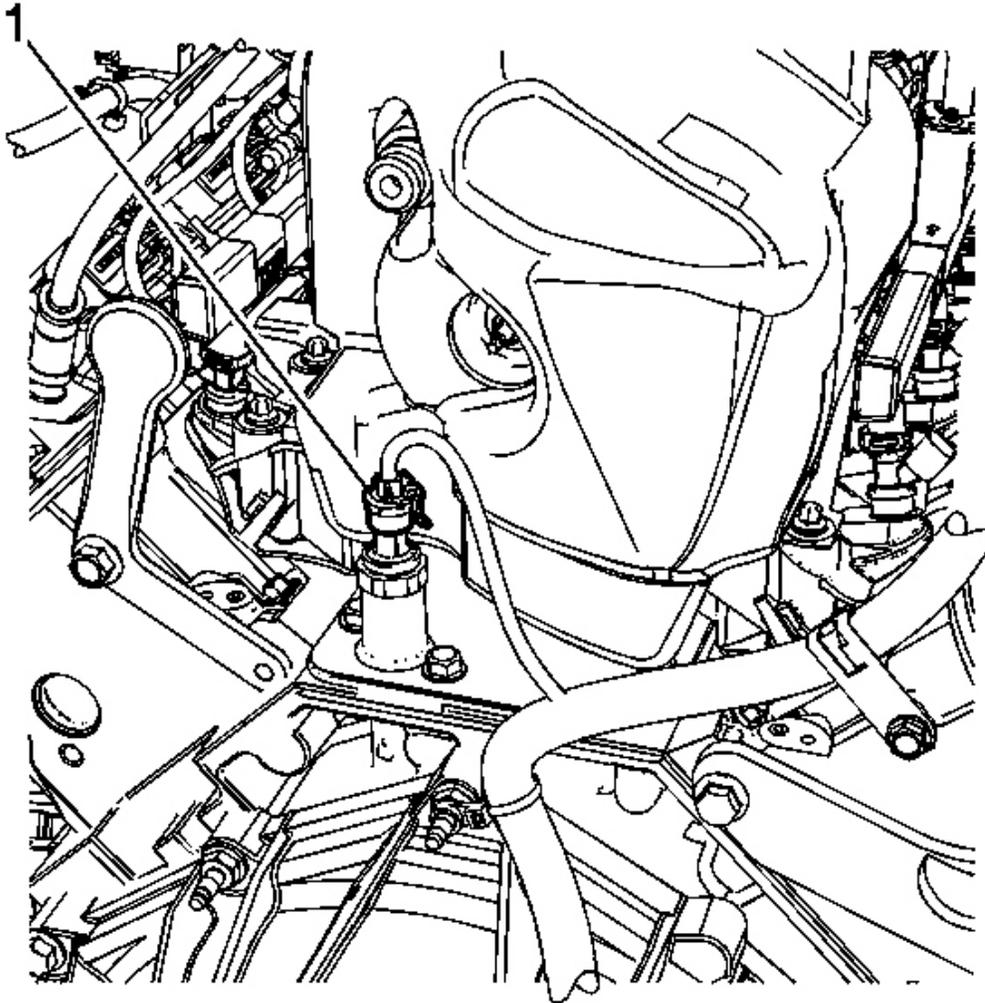


Fig. 58: Engine Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the engine oil pressure sensor electrical connector (1).

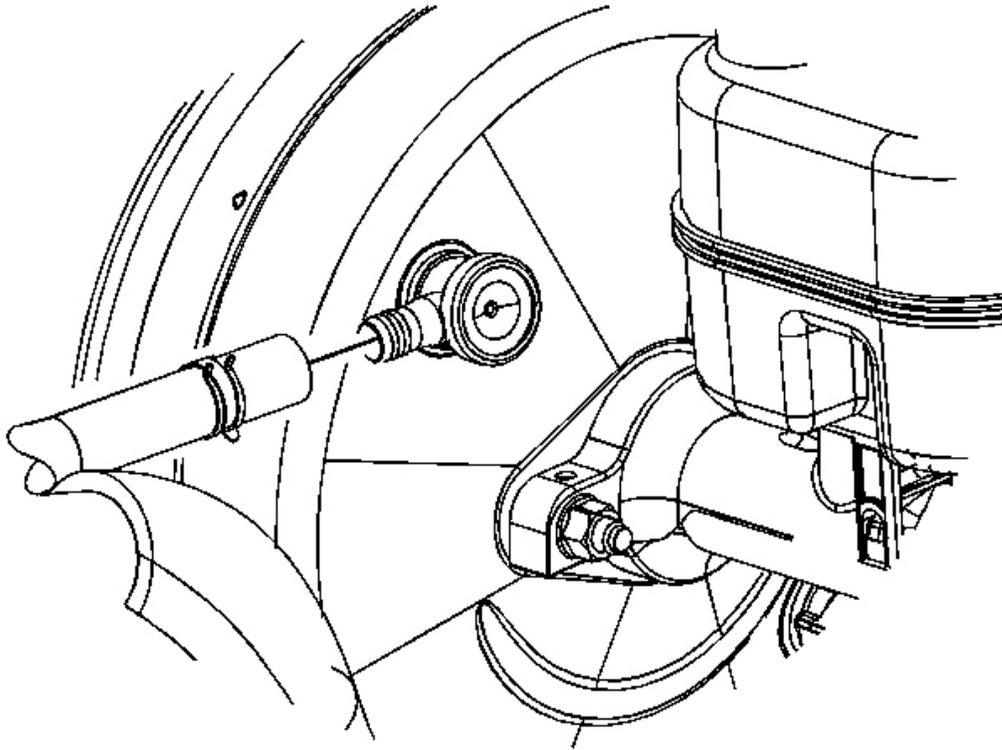


Fig. 59: Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

18. Reposition the brake booster vacuum hose clamp at the booster.
19. Remove the brake booster vacuum hose from the booster fitting.
20. Secure the brake booster vacuum hose to the intake manifold.

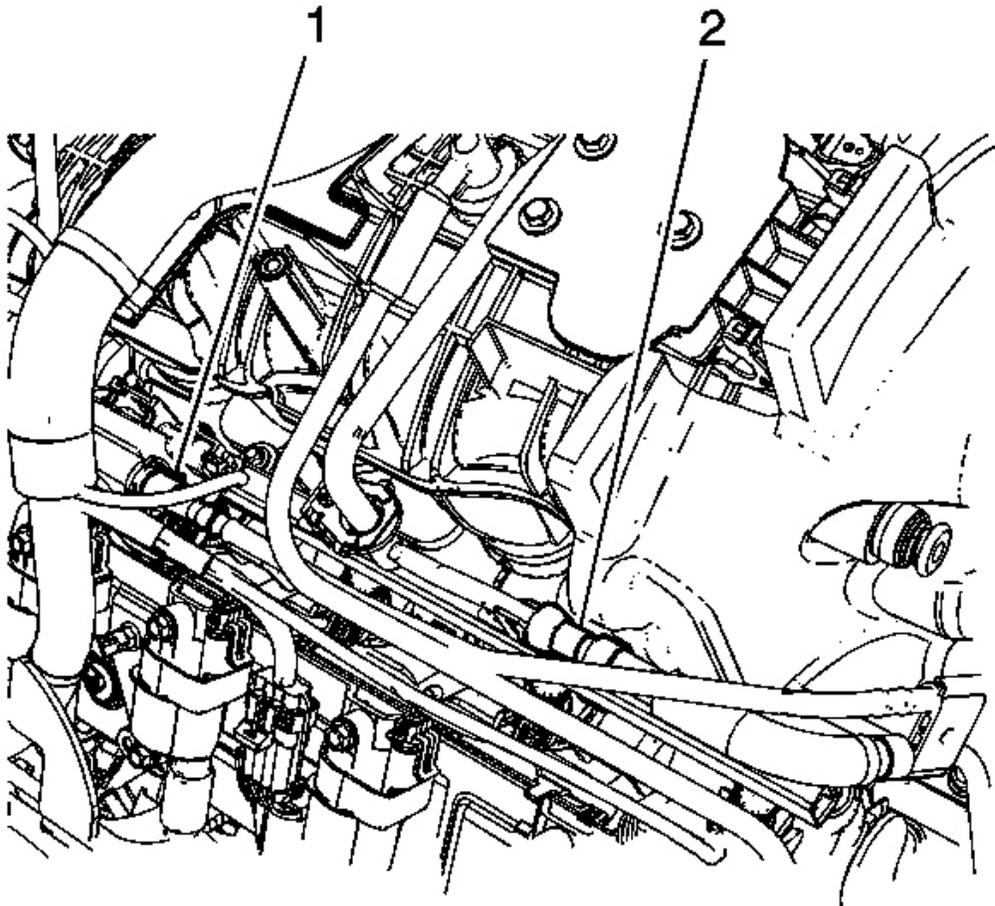


Fig. 60: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS CORP.

21. Disconnect the EVAP canister purge tube (1) quick connect fitting from the EVAP canister purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .
22. Disconnect the fuel feed line quick connect fitting (2) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .

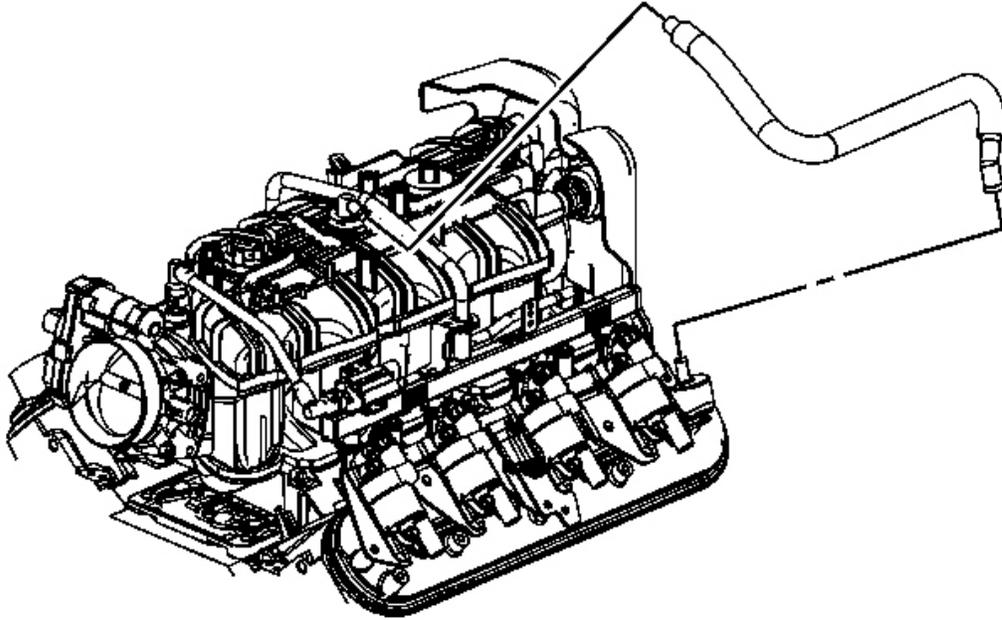


Fig. 61: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

23. Remove the positive crankcase ventilation (PCV) hose from the intake manifold fitting.
24. Position the hose out of the way.

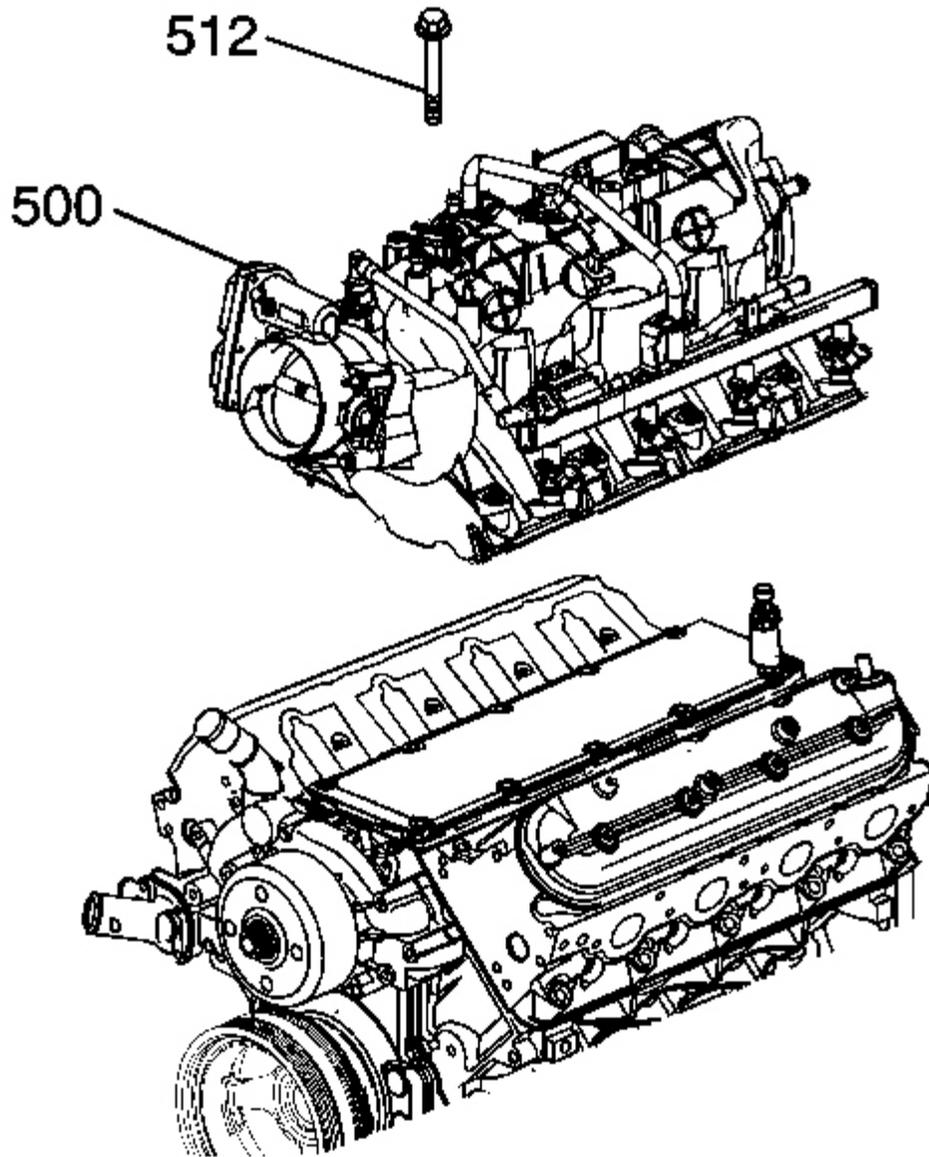


Fig. 62: Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

25. Loosen the intake manifold bolts (512).

IMPORTANT: The aid of an assistant may be helpful in holding the engine

harness up out of the way so the upper intake manifold cover does not get caught against the engine harness.

26. Remove the intake manifold (500).
27. Cover the cylinder head passages in order to prevent dirt or debris from entering the passages.

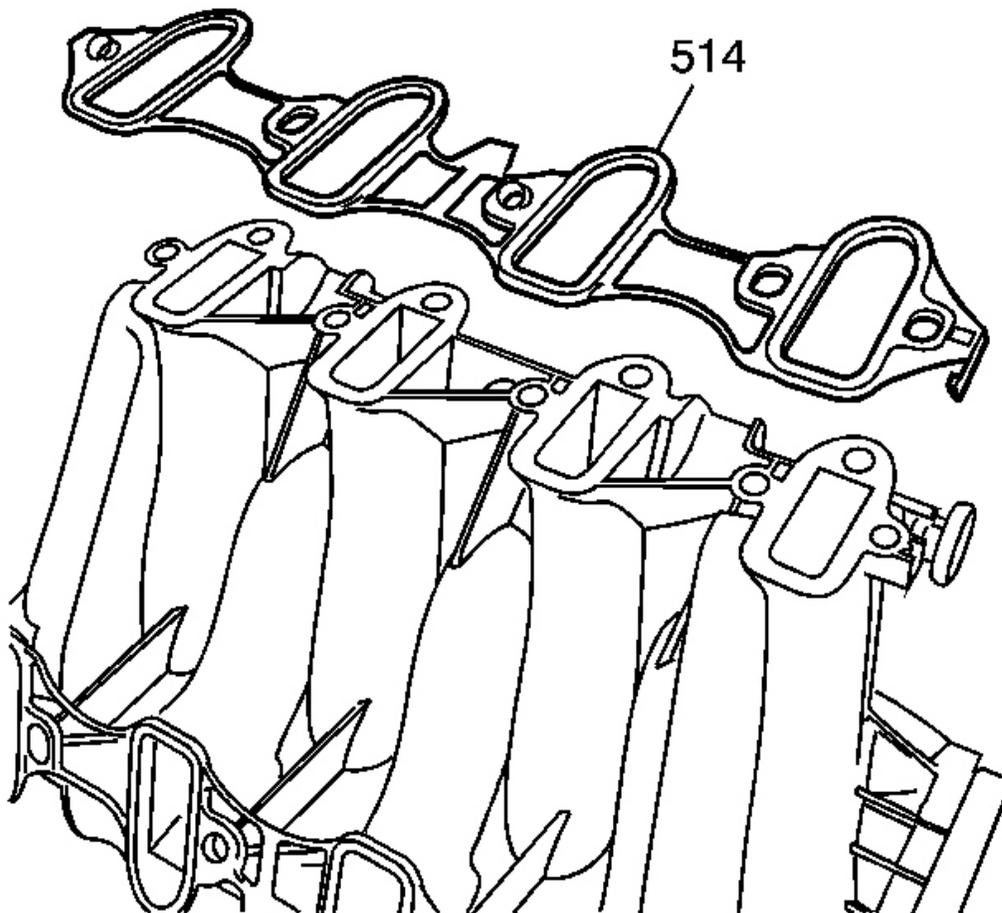


Fig. 63: View Of Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

28. Remove and discard the intake manifold gaskets (514).

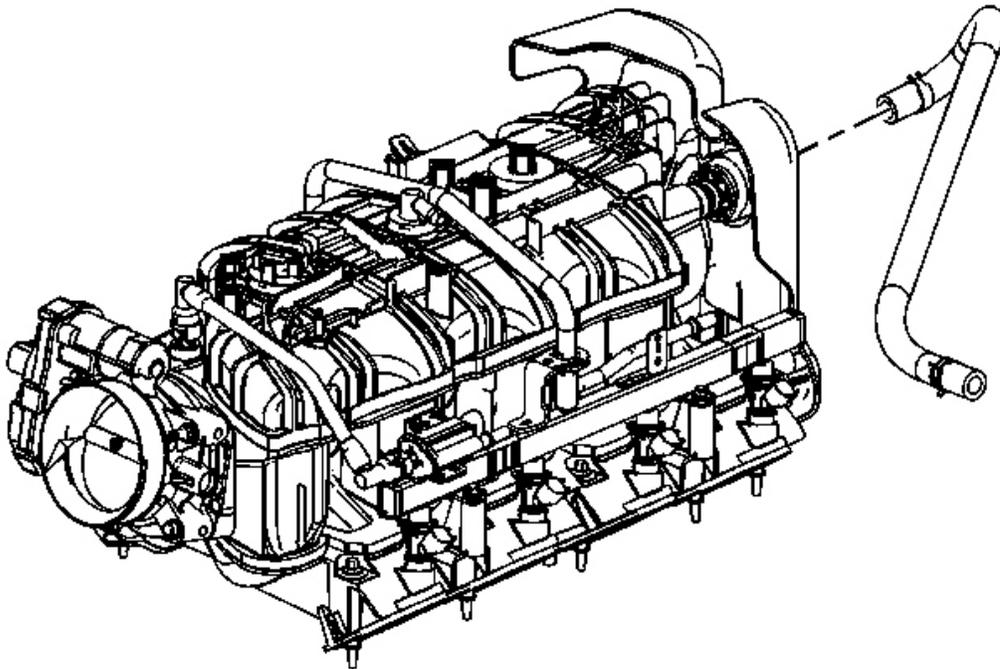


Fig. 64: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

29. If replacing the intake manifold, perform the following steps, otherwise proceed to step 21 of the installation procedure.
30. Place the intake manifold on a clean work surface.
31. Reposition the brake booster vacuum hose clamp at the intake manifold.
32. Remove the brake booster vacuum hose from the intake manifold nipple.

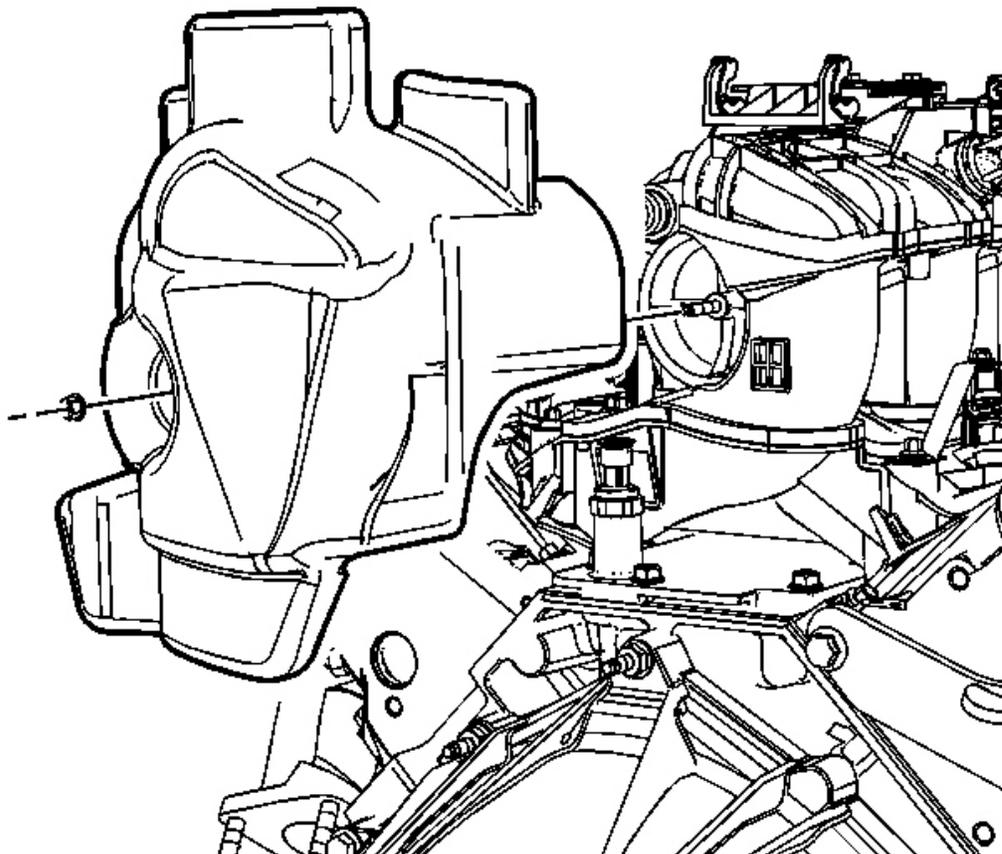


Fig. 65: Upper Intake Manifold Cover Nut
Courtesy of GENERAL MOTORS CORP.

33. Remove the upper intake manifold cover nut.
34. Remove the upper intake manifold cover.

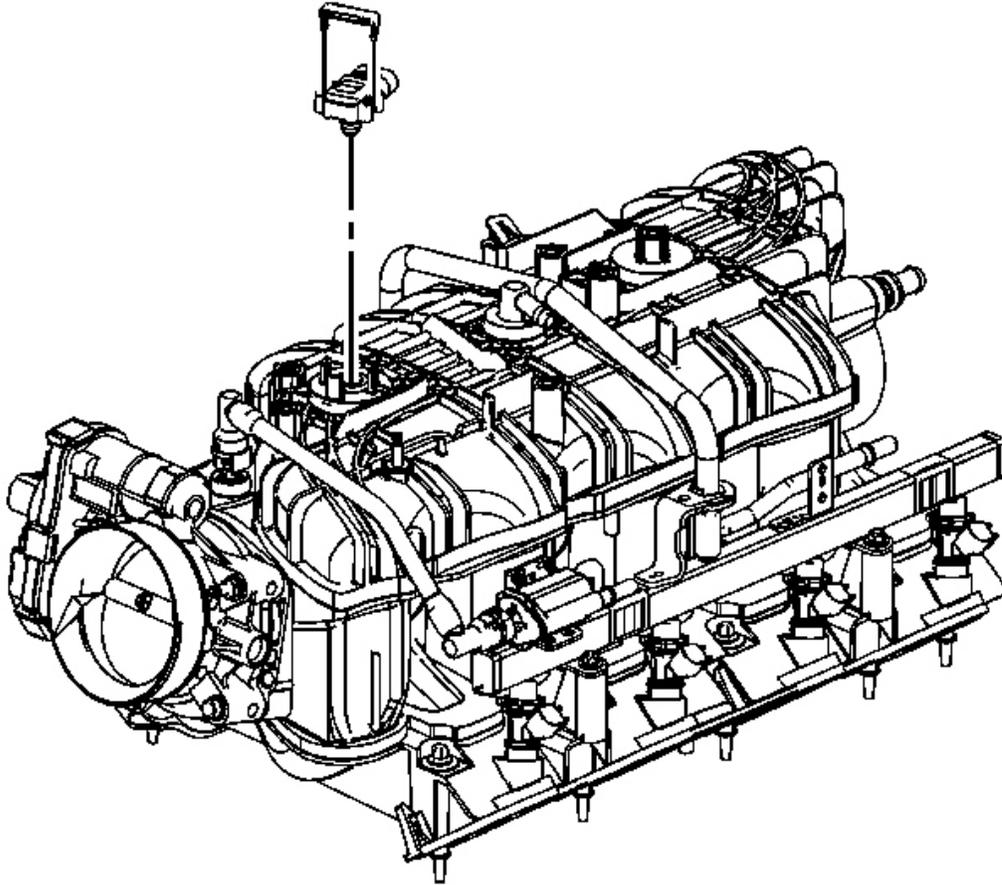


Fig. 66: Manifold Absolute Pressure (MAP) Sensor Retainer
Courtesy of GENERAL MOTORS CORP.

35. Remove the manifold absolute pressure (MAP) sensor retainer.
36. Remove the MAP sensor.

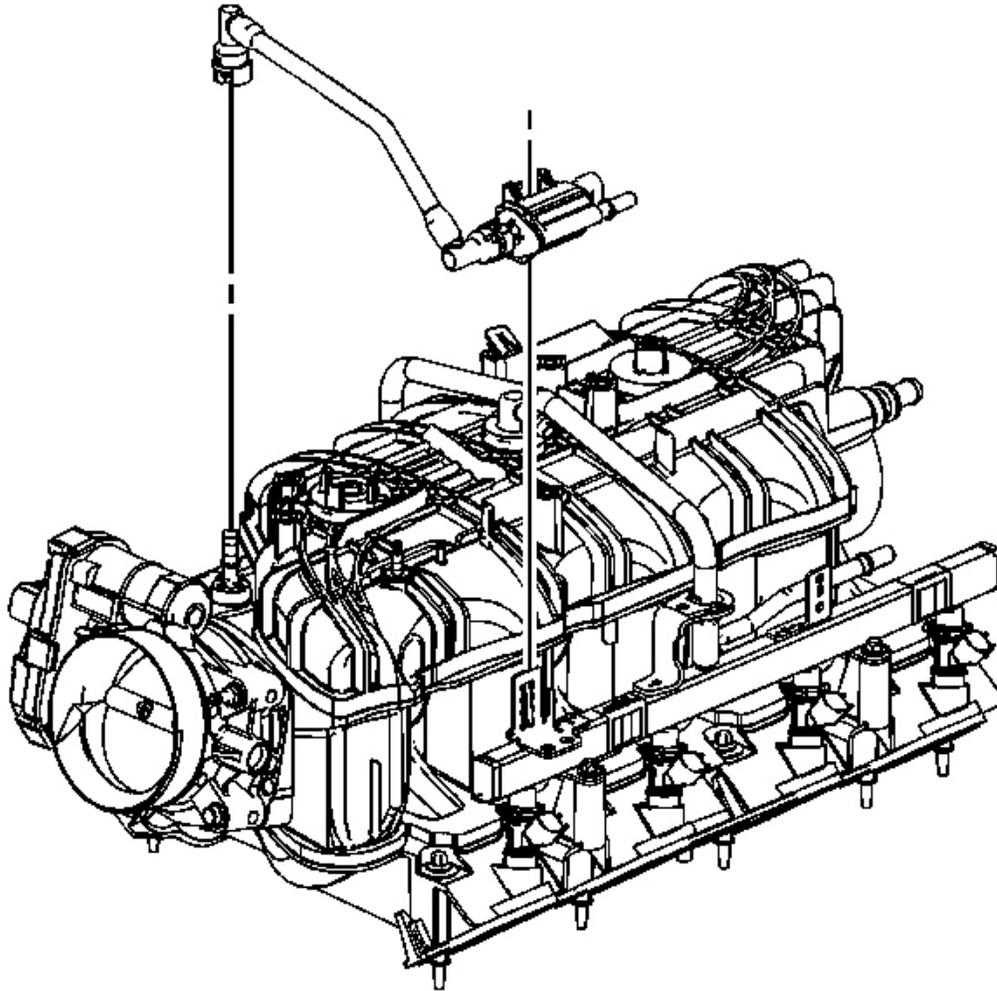


Fig. 67: View Of EVAP Tube & Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

37. Disconnect the EVAP tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .
38. Disengage the retainer securing the EVAP canister purge solenoid to the fuel rail.
39. Remove the EVAP tube and purge solenoid.

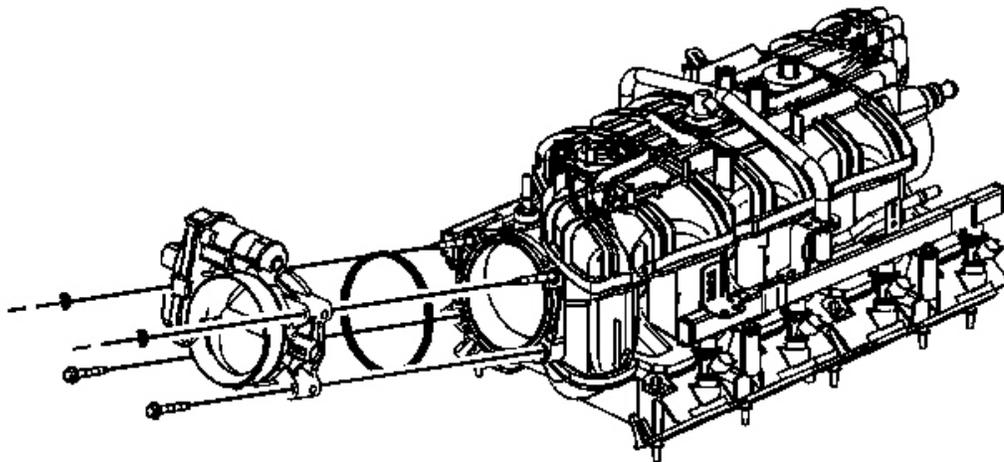


Fig. 68: Throttle Body Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

40. Remove the throttle body bolts/nuts.
41. Remove the throttle body.
42. Remove and discard the throttle body gasket.

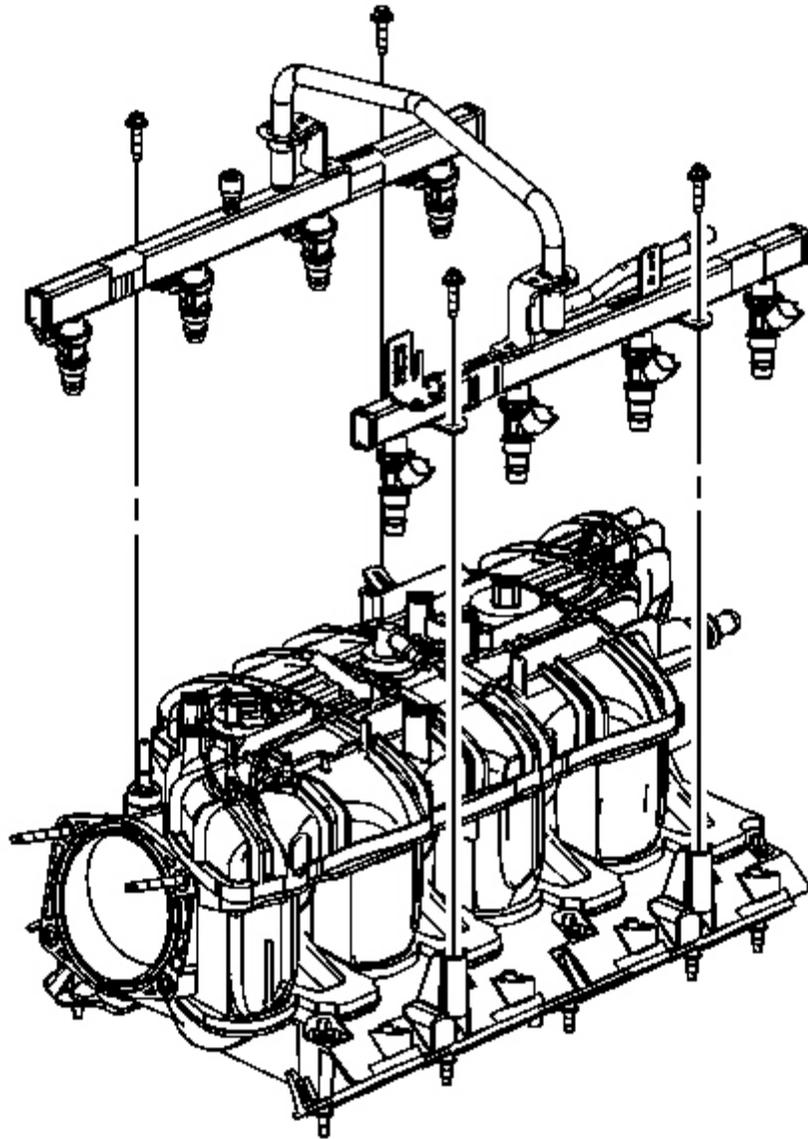


Fig. 69: Fuel Rail Bolts
Courtesy of GENERAL MOTORS CORP.

43. Remove the fuel rail bolts.

IMPORTANT: Lift evenly on both sides of the fuel rail until all injectors are

removed from their bores.

44. Remove the fuel rail.
45. Remove and discard the fuel injector lower O-ring seals.

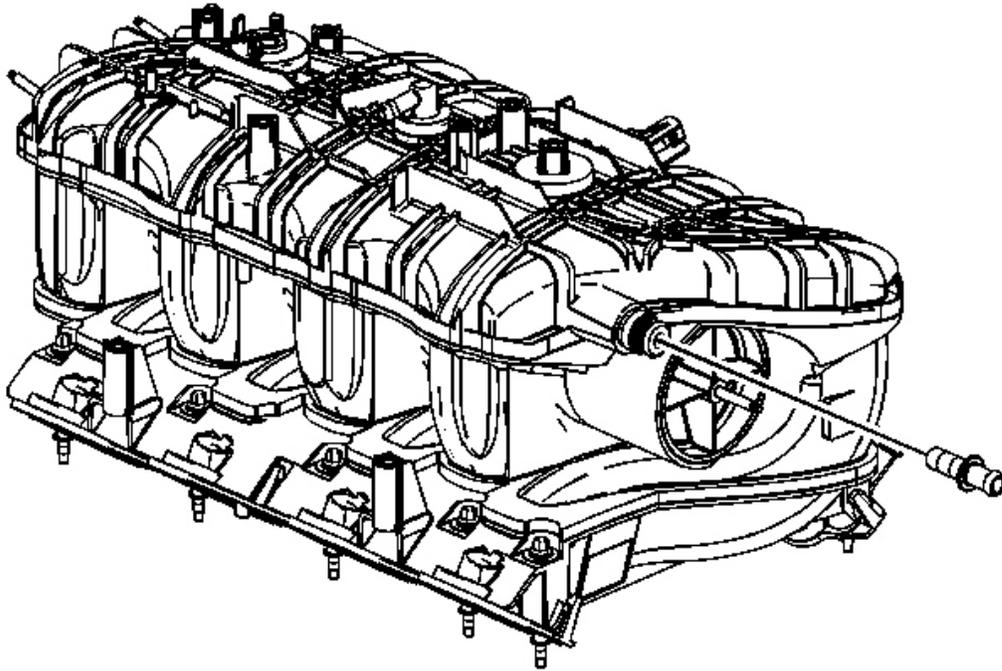


Fig. 70: Brake Booster Vacuum Hose Nipple
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Evenly push in the RED collar in order to remove the nipple.

46. Remove the brake booster vacuum hose nipple.

Installation Procedure

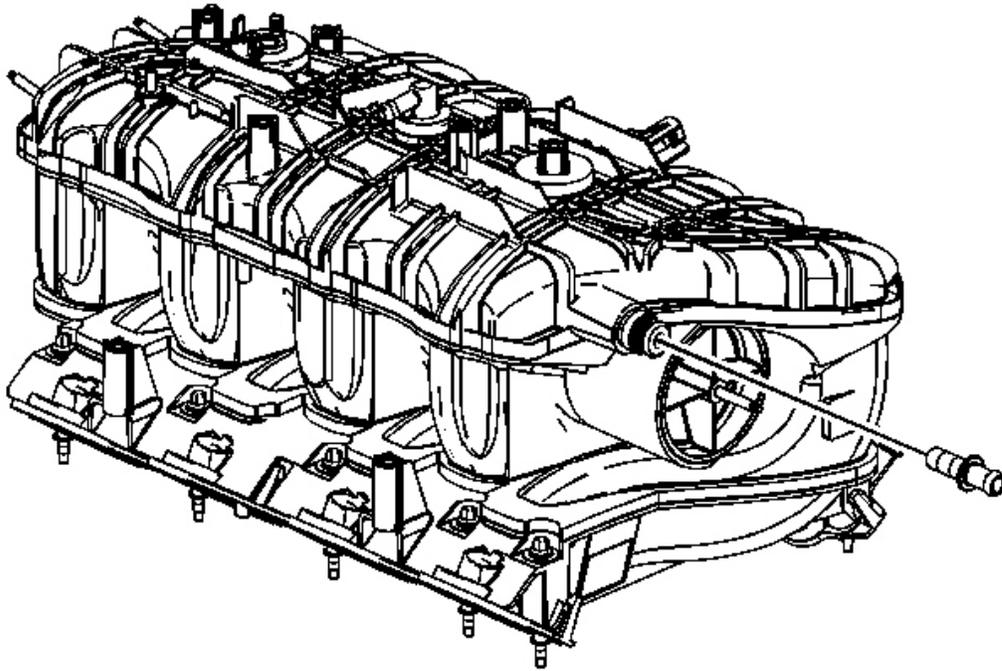


Fig. 71: Brake Booster Vacuum Hose Nipple
Courtesy of GENERAL MOTORS CORP.

1. If the intake manifold was replaced perform the following steps, otherwise proceed to step 21.

IMPORTANT: Evenly push in the RED collar in order to install the nipple.

2. Install the brake booster vacuum hose nipple to the NEW intake manifold.

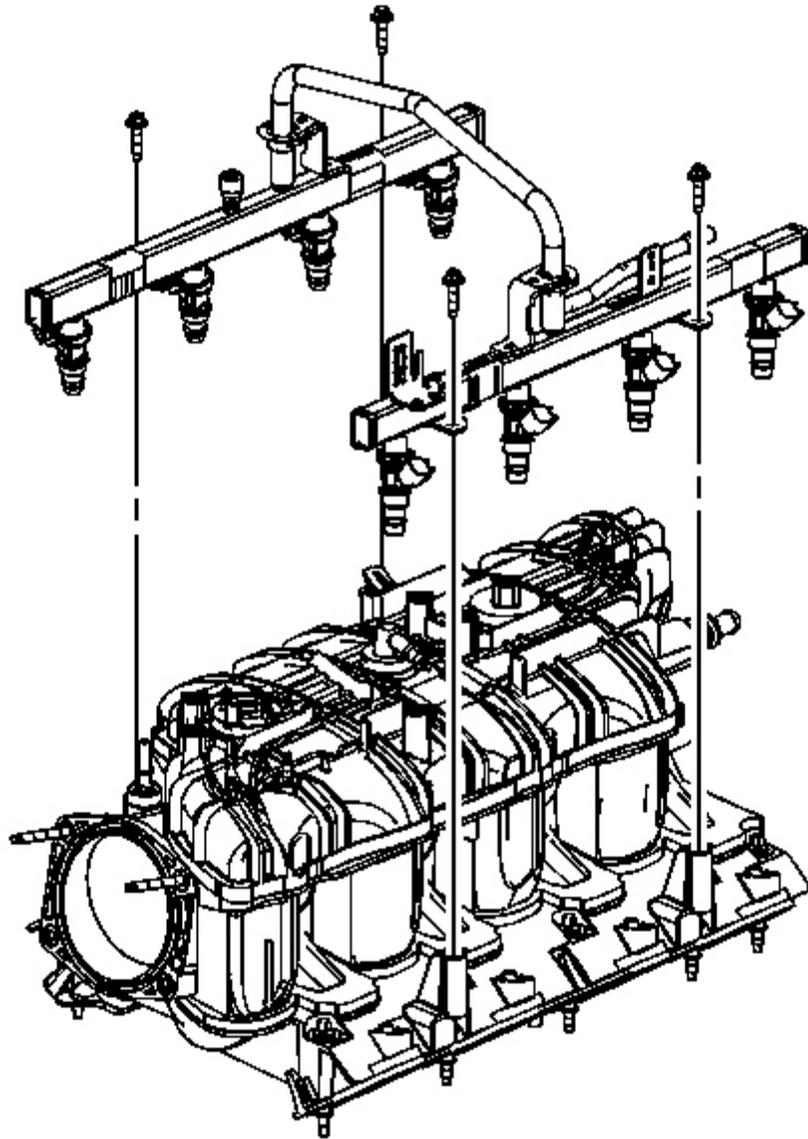


Fig. 72: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

3. Install NEW fuel injector lower O-ring seals onto the injectors.
4. Lubricate the NEW O-ring seals with clean engine oil.

IMPORTANT: Push down firmly on both sides of the rail until all the injectors have been seated into their bores.

5. Install the fuel rail.

NOTE: Refer to Fastener Notice .

6. Install the fuel rail bolts.

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

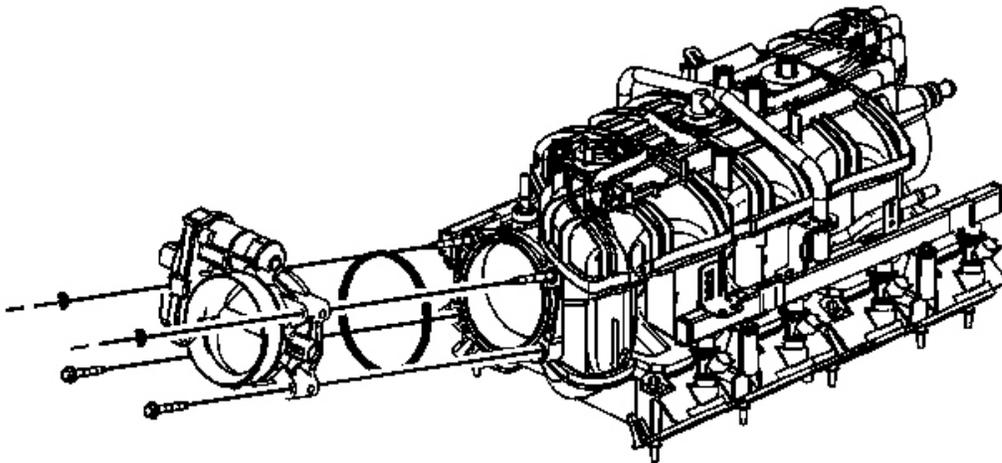


Fig. 73: Throttle Body Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

7. Install a NEW throttle body gasket to the intake manifold.

8. Install the throttle body.

9. Install the throttle body bolts/nuts.

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

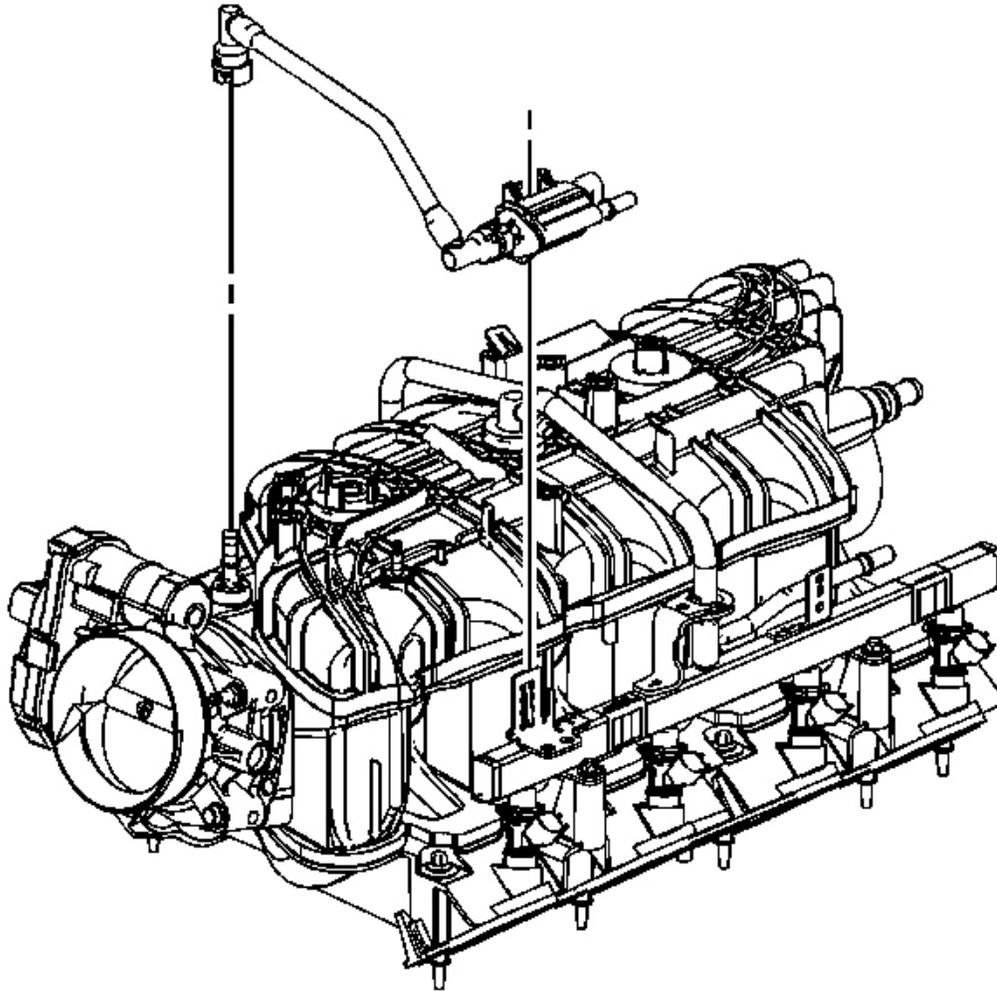


Fig. 74: View Of EVAP Tube & Purge Solenoid
Courtesy of GENERAL MOTORS CORP.

10. Install the EVAP tube and purge solenoid.
11. Install the EVAP canister purge solenoid to the fuel rail bracket and engage the retainer.
12. Connect the EVAP tube quick connect fitting at the intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .

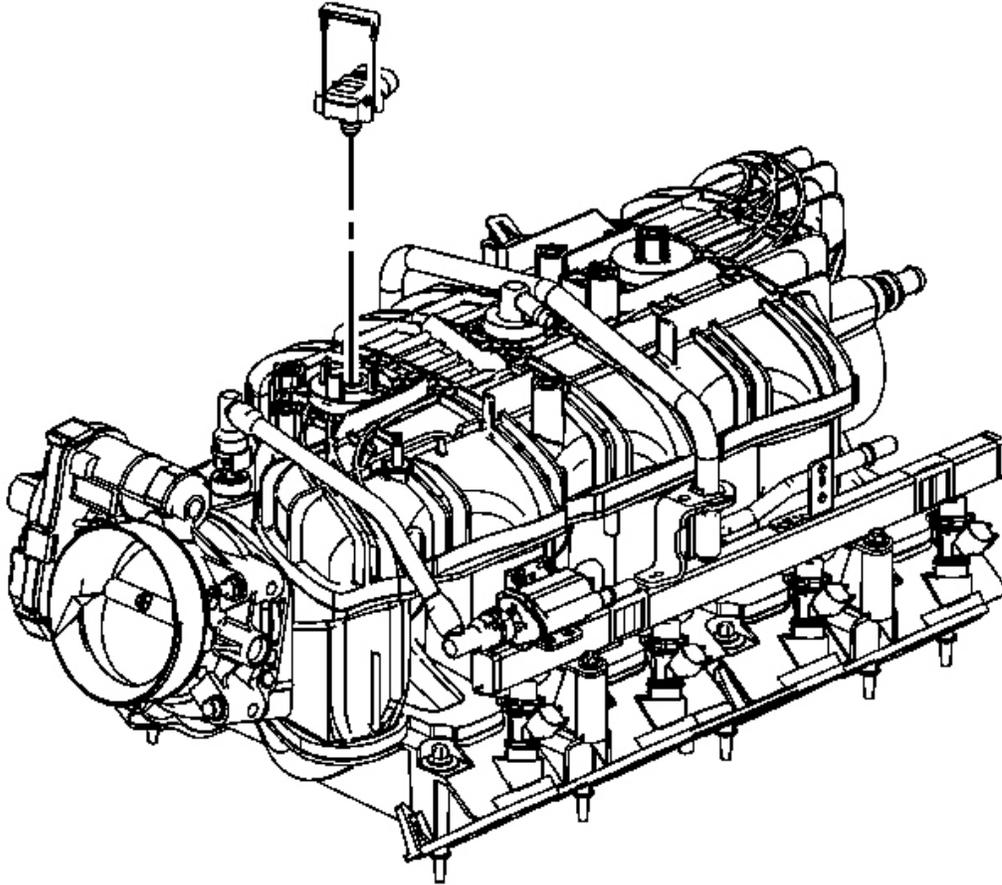


Fig. 75: Manifold Absolute Pressure (MAP) Sensor Retainer
Courtesy of GENERAL MOTORS CORP.

13. Lubricate the MAP sensor seal with clean engine oil.
14. Install the MAP sensor.
15. Install the MAP sensor retainer.

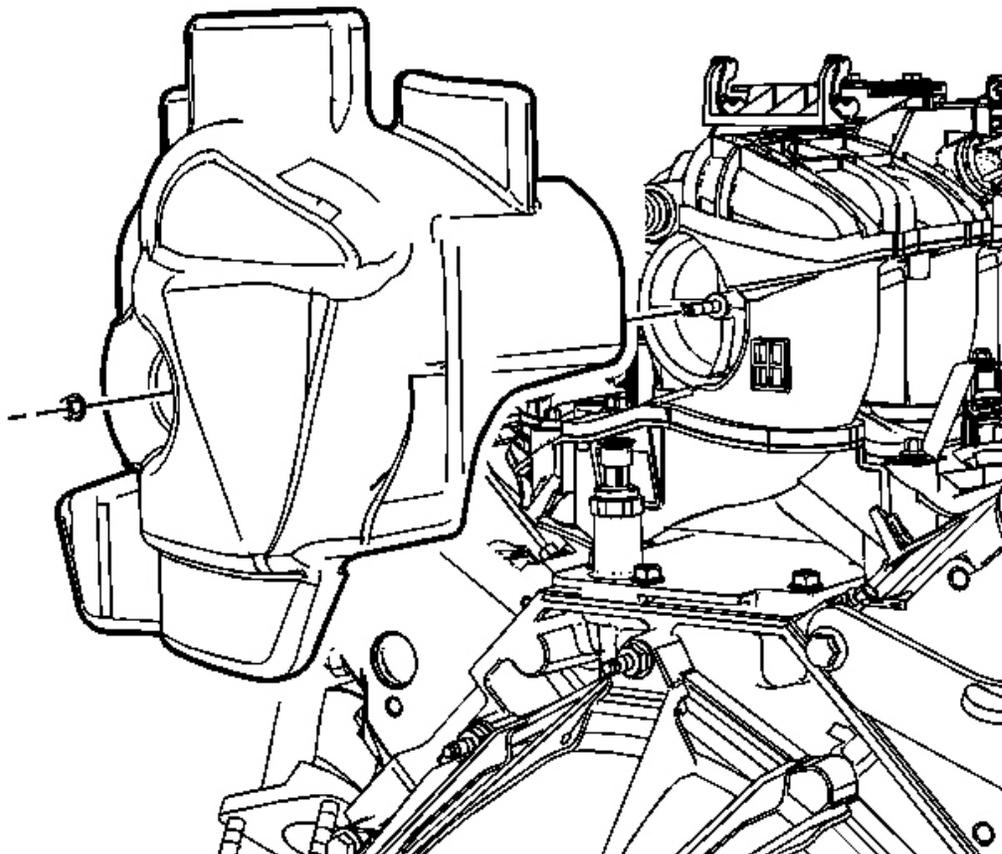


Fig. 76: Upper Intake Manifold Cover Nut
Courtesy of GENERAL MOTORS CORP.

16. Install the upper intake manifold cover.
17. Install the upper intake manifold cover nut until snug

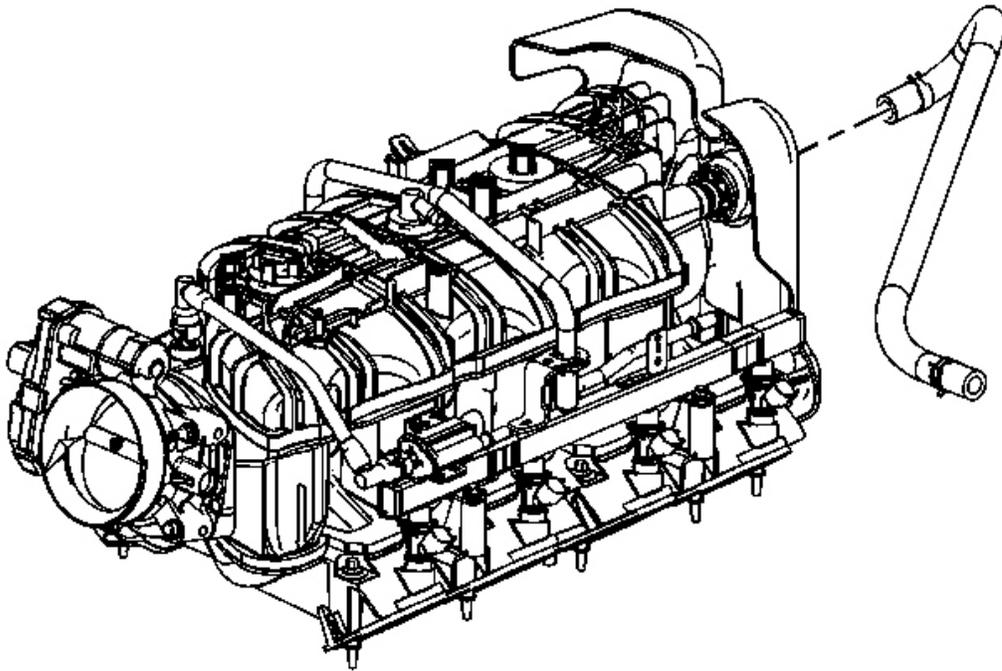


Fig. 77: Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

18. Install the brake booster vacuum hose to the intake manifold nipple.
19. Position the brake booster vacuum hose clamp at the intake manifold.
20. Secure the brake booster vacuum hose to the intake manifold.

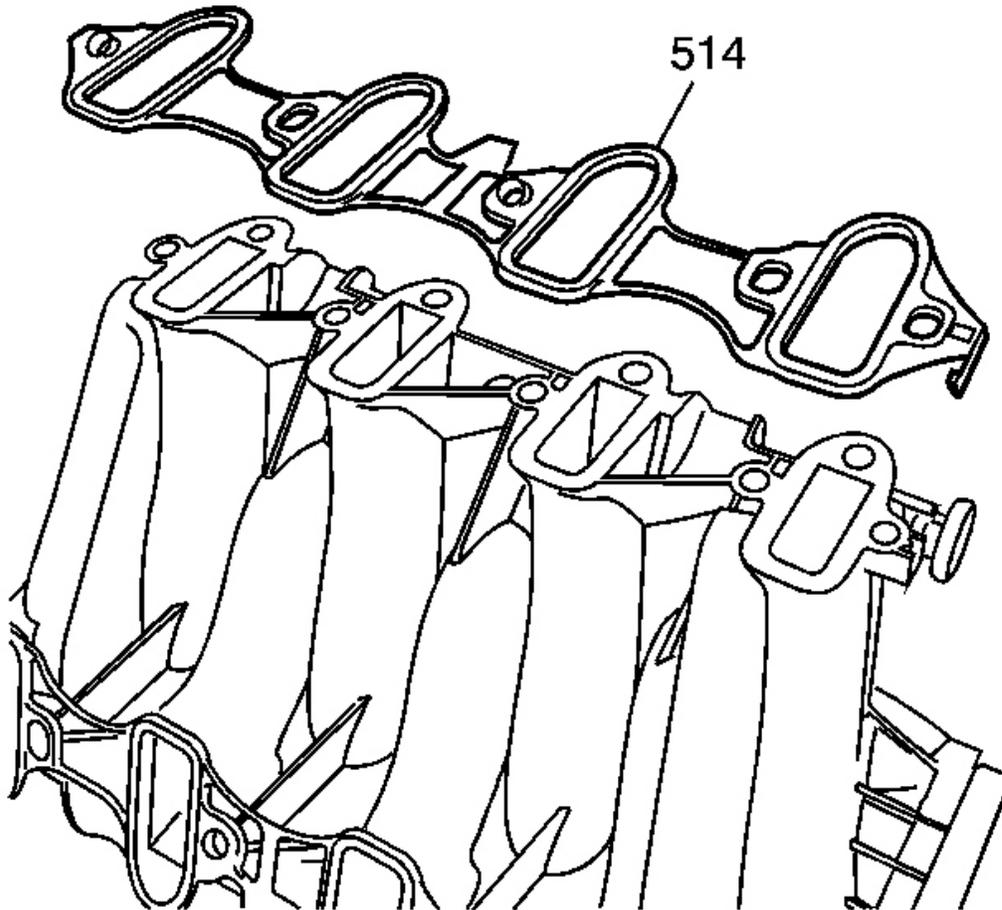


Fig. 78: View Of Intake Manifold-To-Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

21. Install NEW intake manifold gaskets (514) to the intake manifold.
22. Remove the covers from the cylinder head passages.

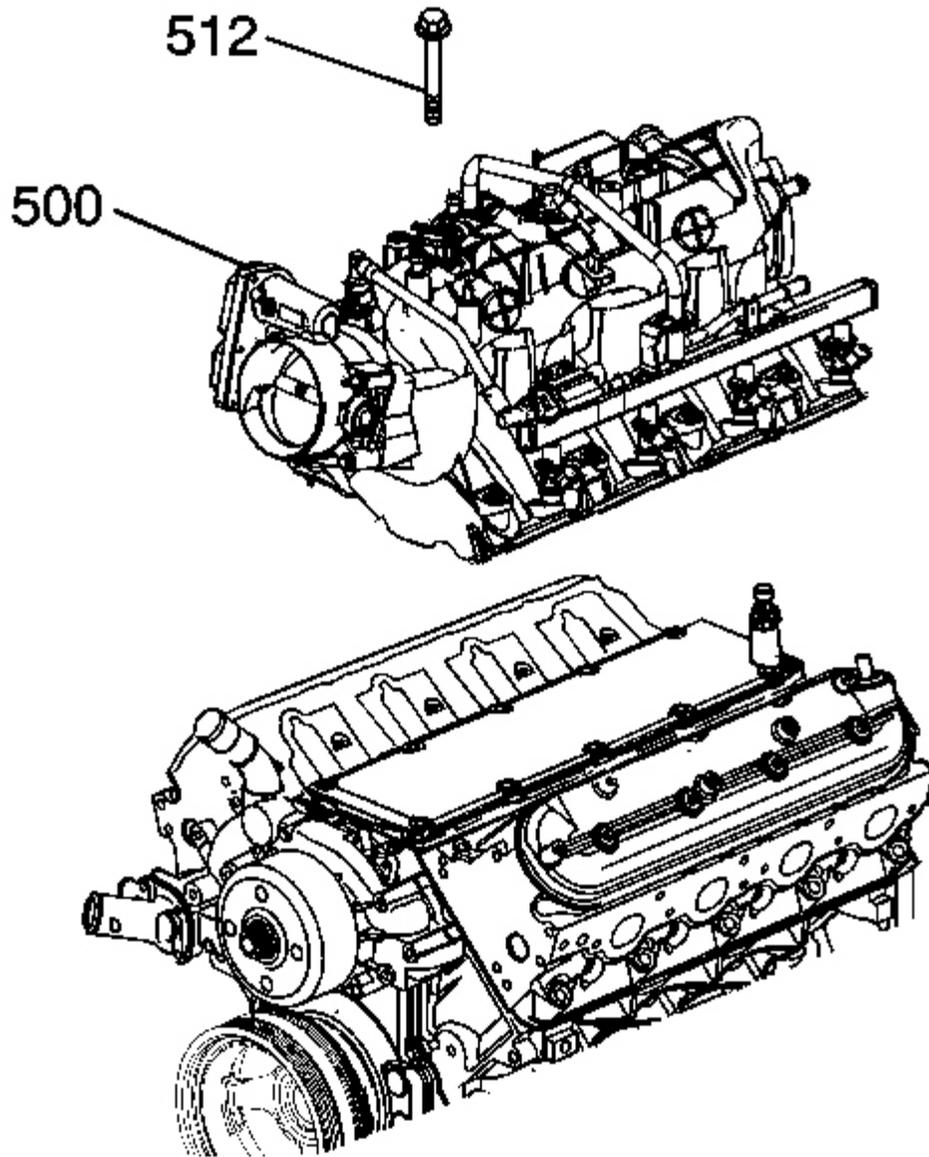


Fig. 79: Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

23. Install the intake manifold (500).

IMPORTANT: The aid of an assistant may be helpful in holding the engine

harness up out of the way so the upper intake manifold cover does not get caught against the engine harness.

24. Tighten the intake manifold bolts (512) until snug.

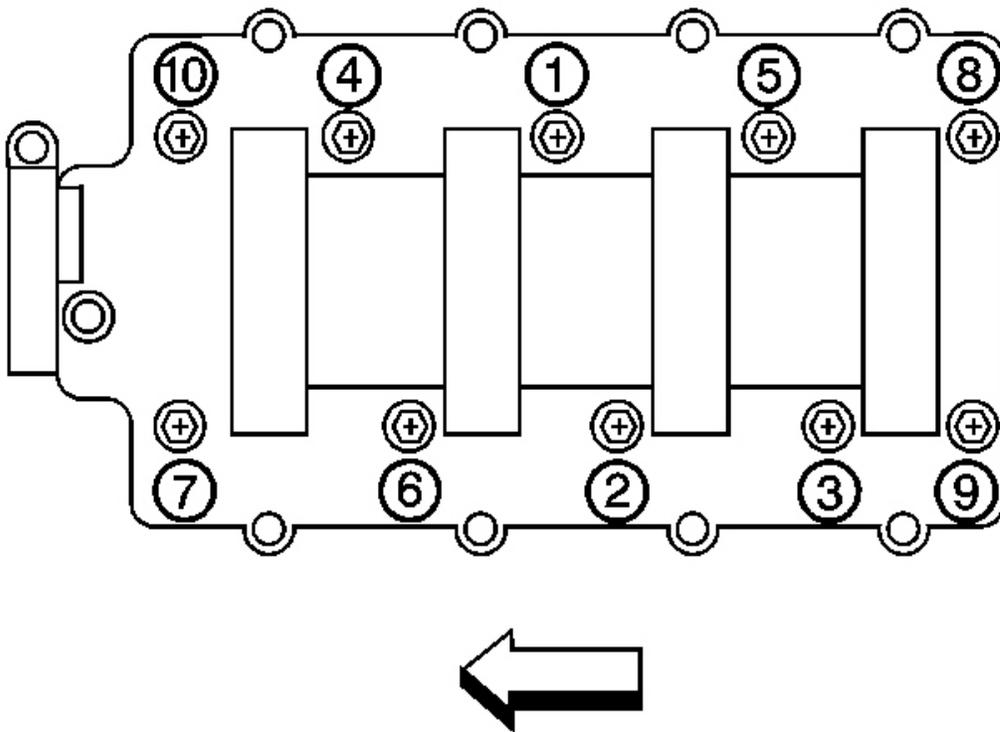


Fig. 80: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

25. Tighten the intake manifold bolts to specifications.

Tighten:

- Tighten the bolts a first pass in the sequence shown to 5 N.m (44 lb in).
- Tighten the bolts a final pass in the sequence shown to 10 N.m (89 lb in).

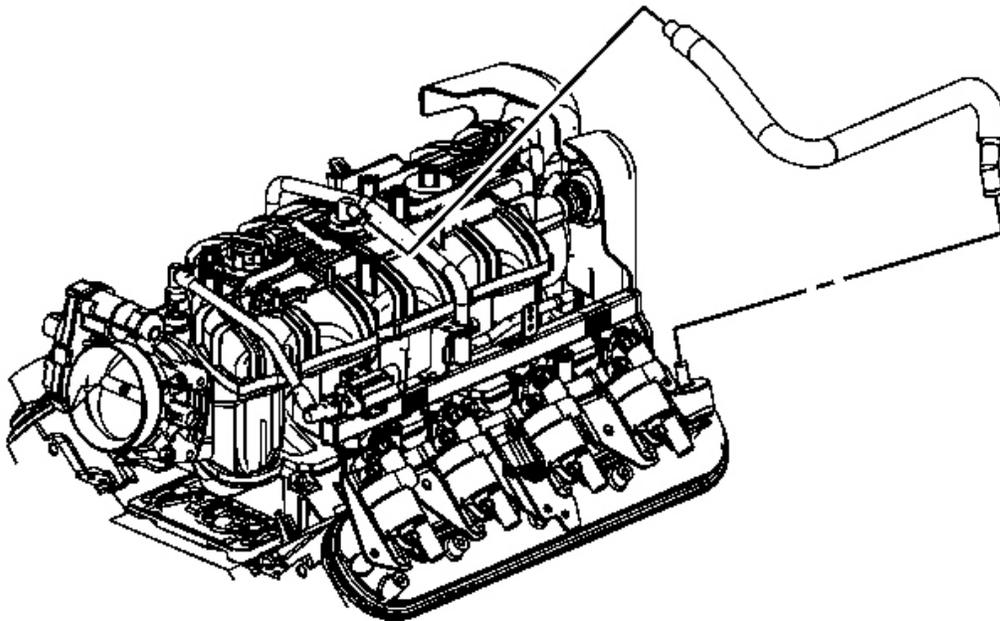


Fig. 81: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

26. Position and install the PCV hose to the intake manifold fitting.

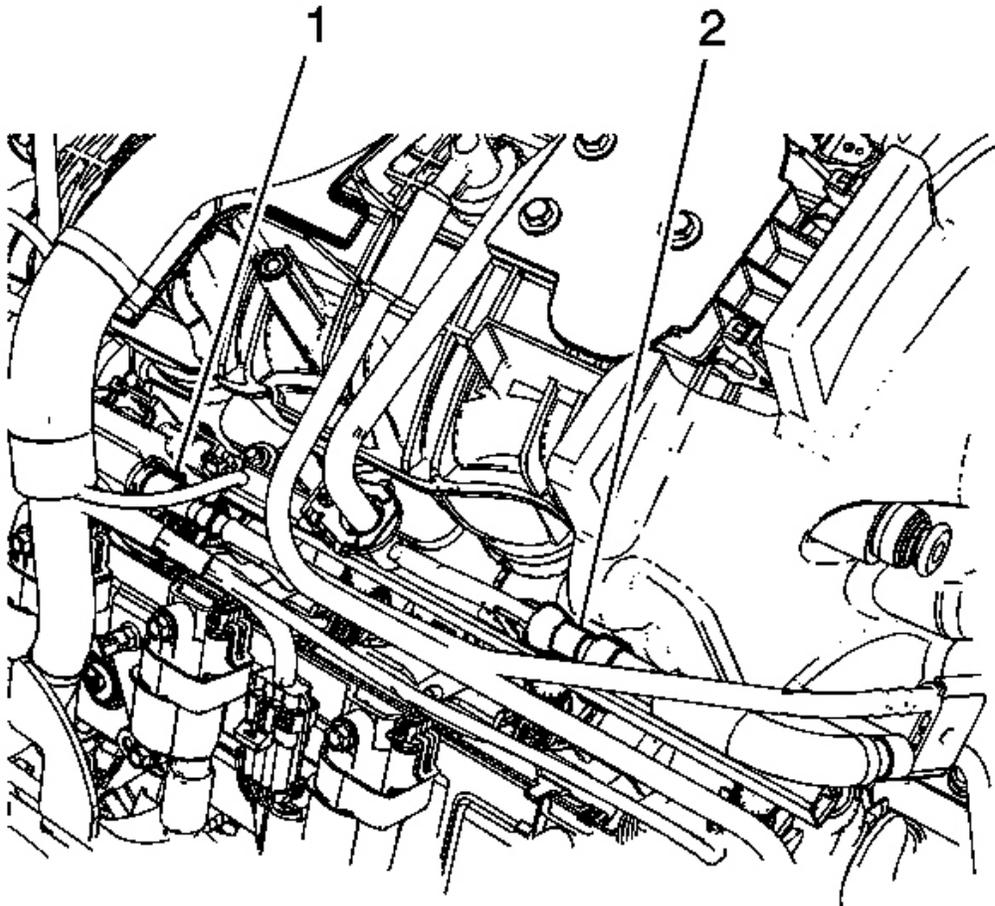


Fig. 82: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS CORP.

27. Connect the fuel feed line quick connect fitting (2) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service** .
28. Connect the EVAP canister purge tube (1) quick connect fitting to the EVAP canister purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service** .

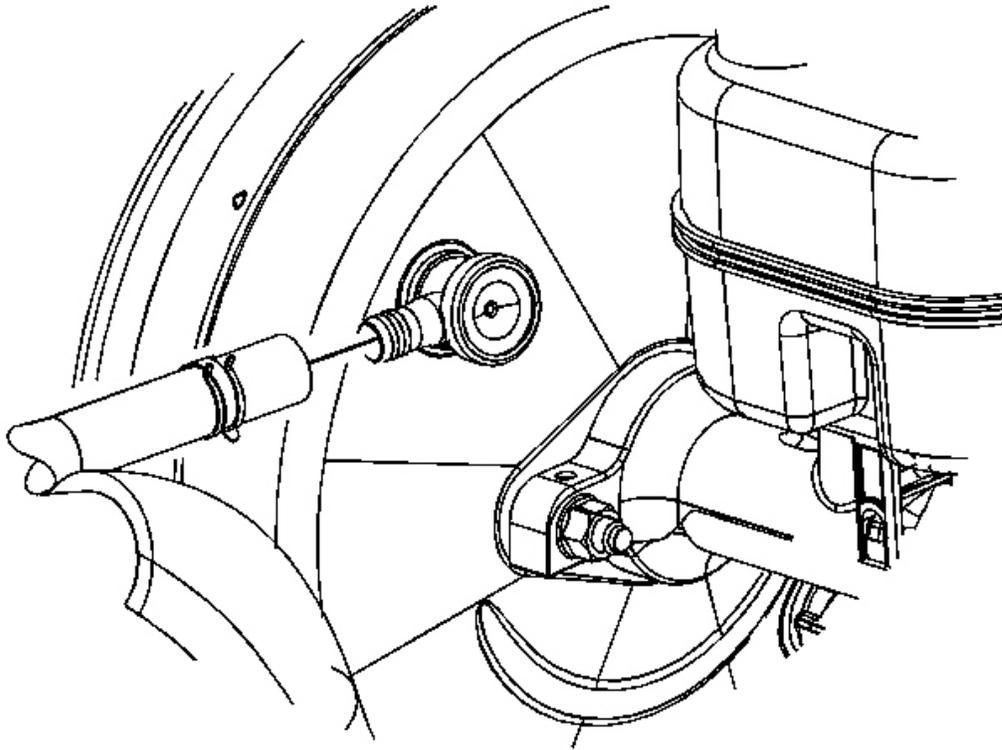


Fig. 83: Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

29. Unsecure the brake booster vacuum hose from the intake manifold.
30. Install the brake booster vacuum hose to the booster fitting.
31. Position the brake booster vacuum hose clamp at the booster.

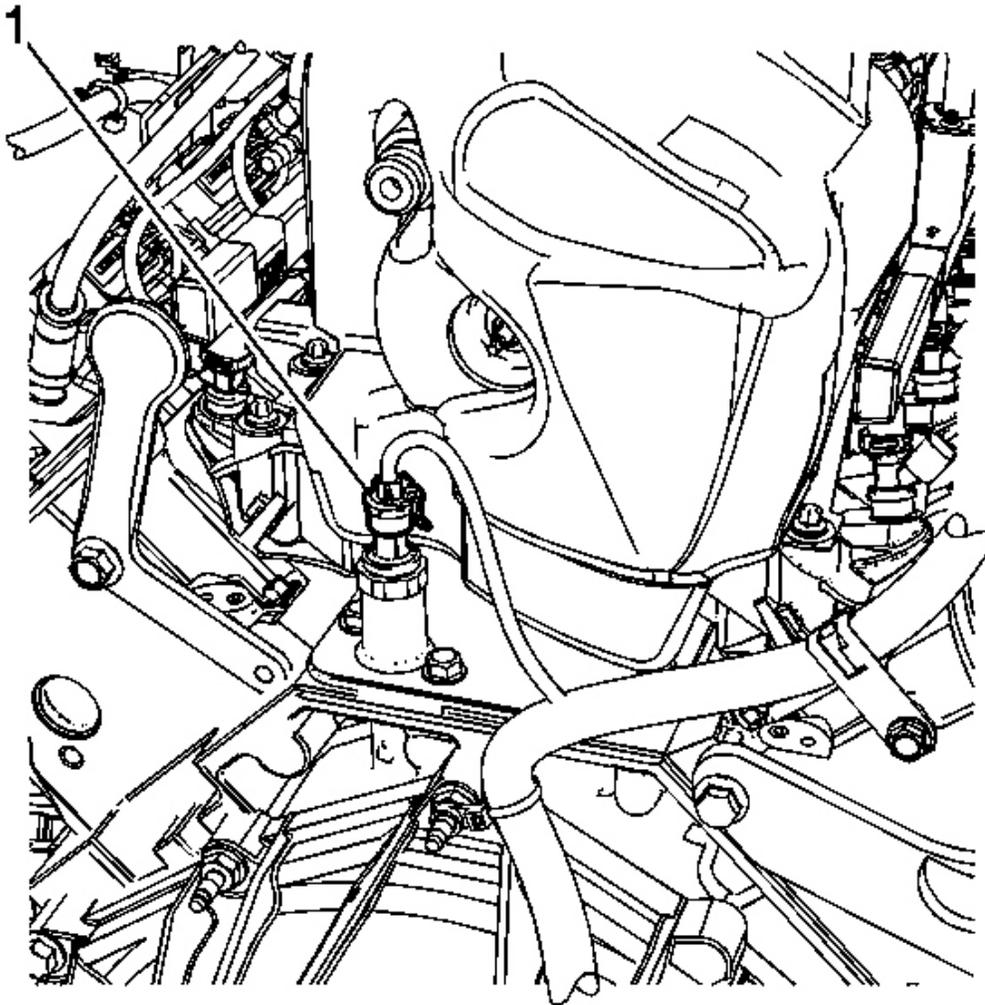


Fig. 84: Engine Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

32. Connect the engine oil pressure sensor electrical connector (1).

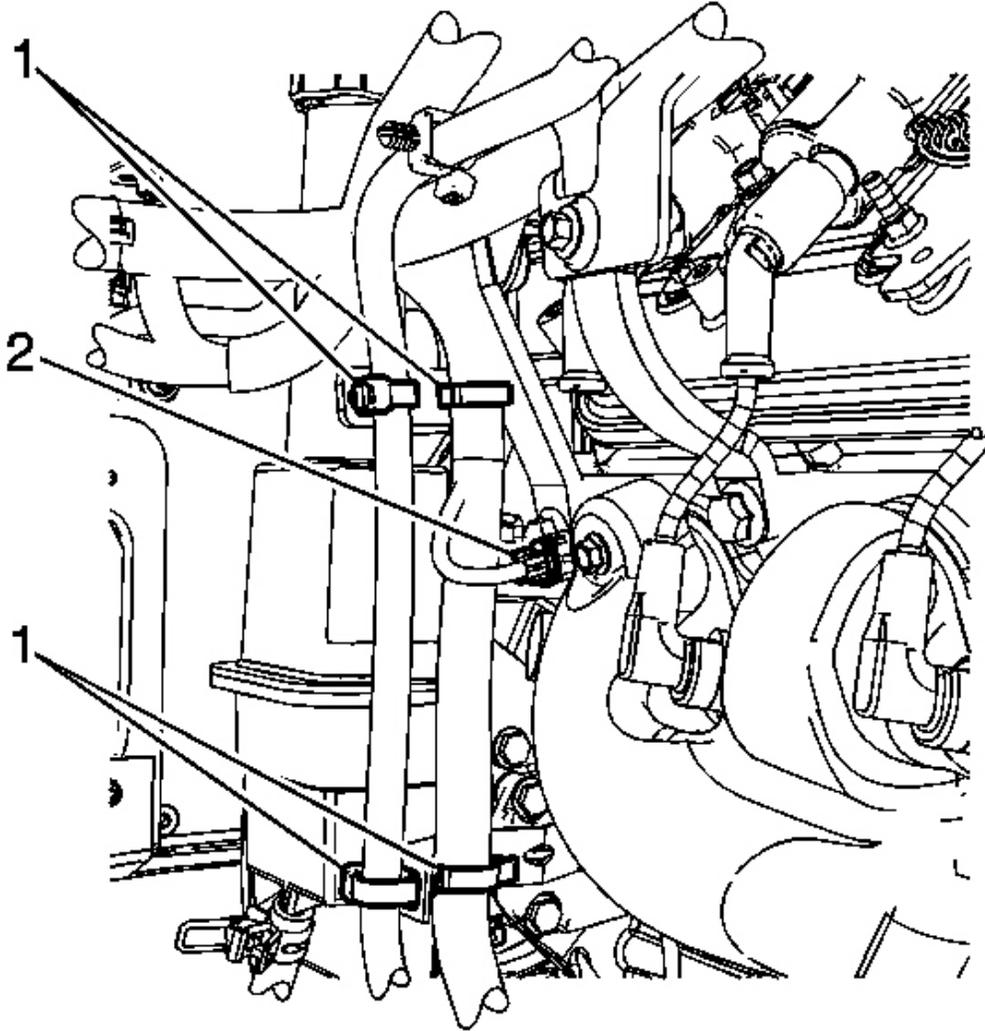


Fig. 85: Engine Harness Clips
Courtesy of GENERAL MOTORS CORP.

33. Untie the engine harness branches from the front of the engine compartment and position over the engine.
34. Connect the engine harness electrical connector (2) to the ECT sensor.
35. Position the engine harness clips (1) to the bracket.

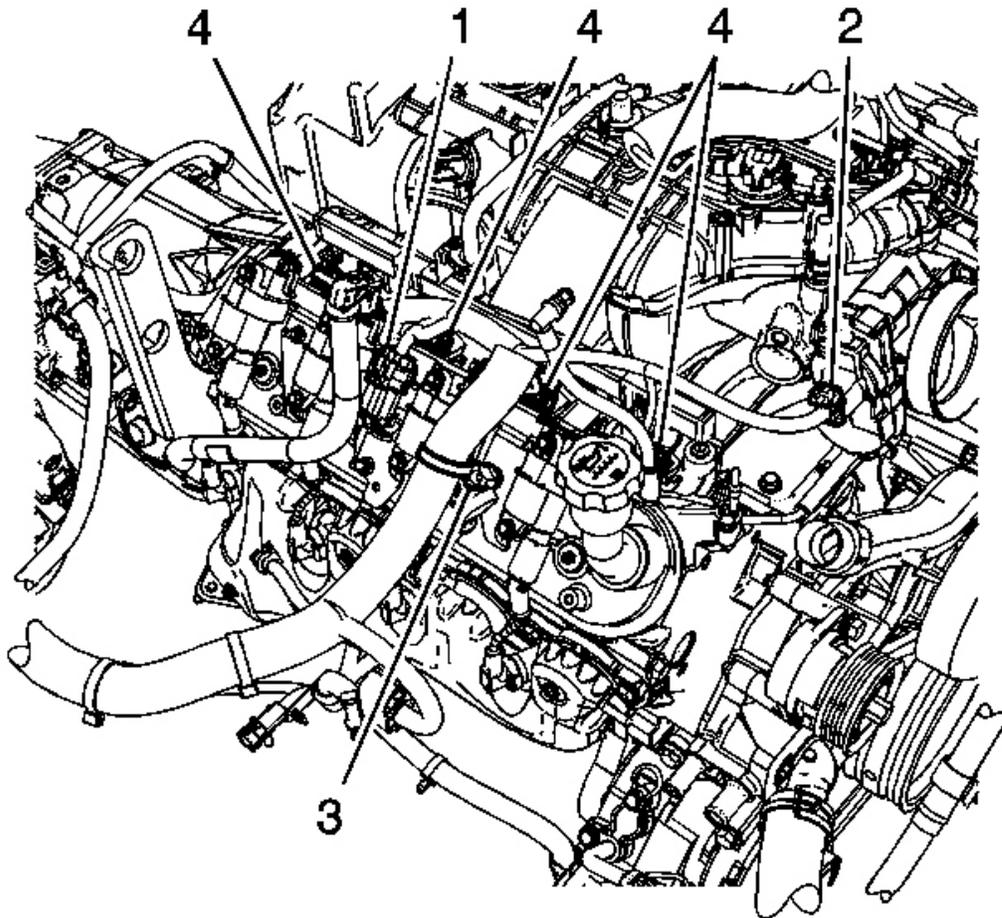


Fig. 86: Engine Harness Electrical Connector & Ignition Coil Harness Electrical Connector

Courtesy of GENERAL MOTORS CORP.

36. Connect the engine harness electrical connectors (4) to the right side fuel injectors.
37. Install the engine harness clip (3) to the ignition coil bracket stud.
38. Connect the engine harness electrical connector (2) to the throttle actuator.
39. Connect the engine harness electrical connector (1) to the ignition coil harness electrical connector.

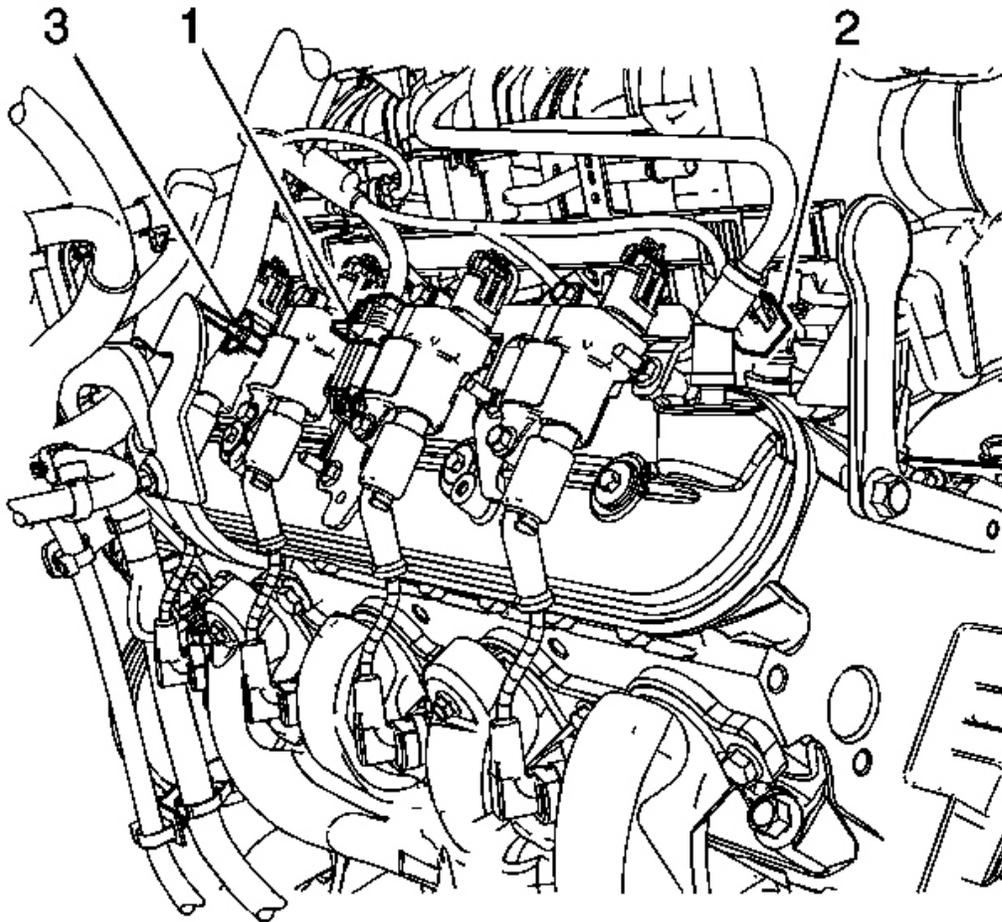


Fig. 87: Engine Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

40. Install the engine harness clip (3) to the ignition coil bracket stud.
41. Connect the engine harness electrical connectors (2) to the left side fuel injectors.
42. Connect the engine harness electrical connector (1) to the ignition coil harness electrical connector.
43. Install the CPA retainer (1).

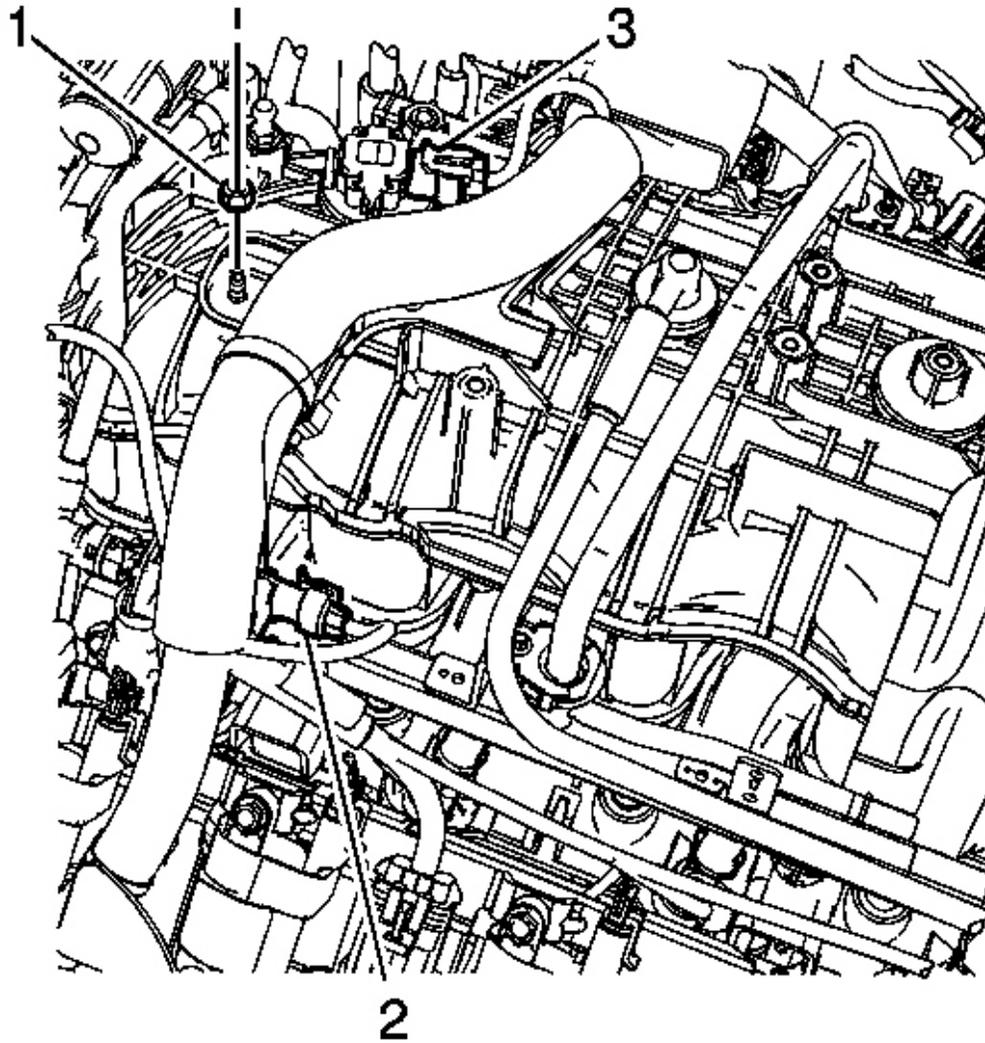


Fig. 88: PCV Hose/Tube
Courtesy of GENERAL MOTORS CORP.

44. Connect the engine wiring harness electrical connector (3) to the MAP sensor.
45. Connect the engine harness electrical connector (2) to the EVAP canister purge solenoid.
46. Install the engine harness retainer to the stud and locator pin.
47. Install the engine harness retainer nut (1).

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Tighten: Tighten the nut to 5 N.m (44 lb in).

48. Install the generator. Refer to **Generator Replacement (LH8)** .
49. Install the air cleaner outlet duct. Refer to **Air Cleaner Resonator Outlet Duct Replacement** .

ENGINE BLOCK VALLEY COVER REPLACEMENT

Removal Procedure

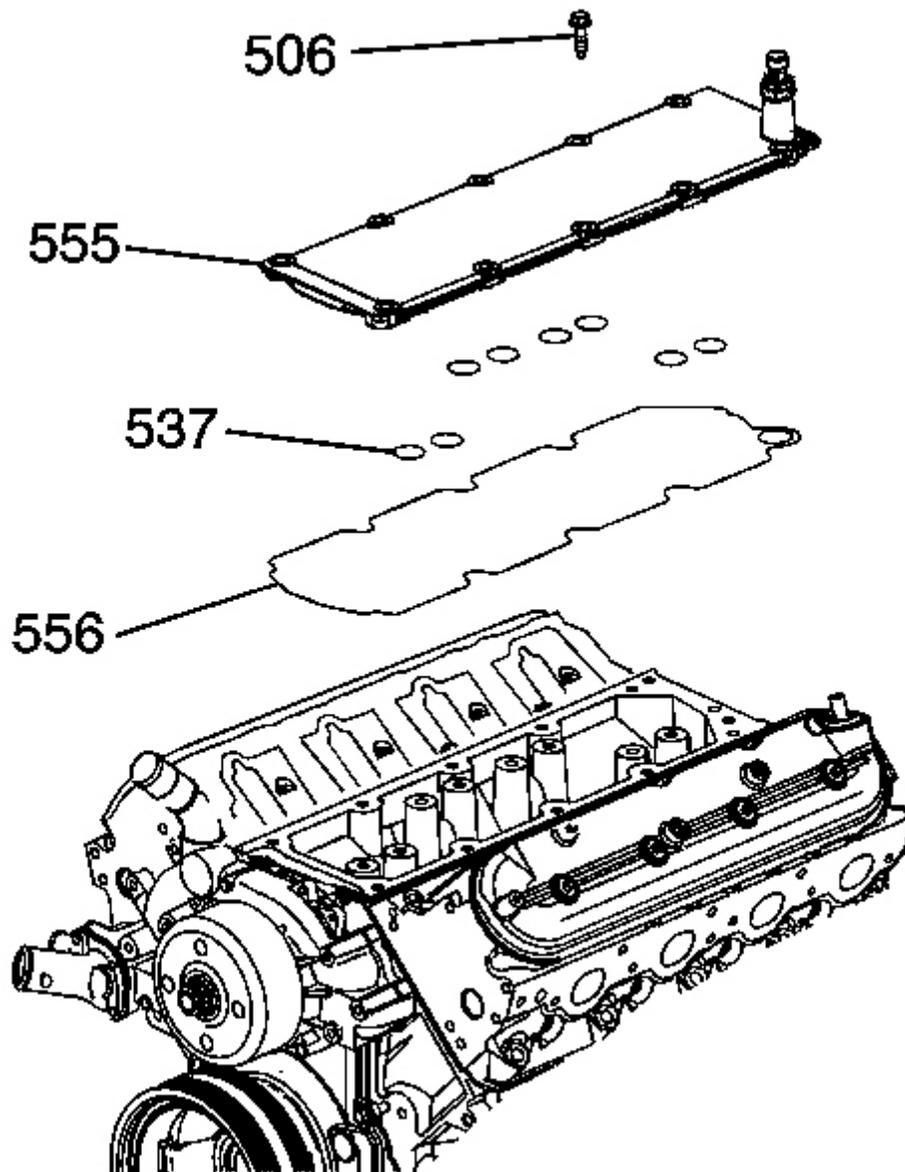


Fig. 89: View Of Engine Valley Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the engine valley cover bolts (506).

3. Remove the engine valley cover (555) and gasket (556).
4. Remove the O-ring seals (537) from the cover.

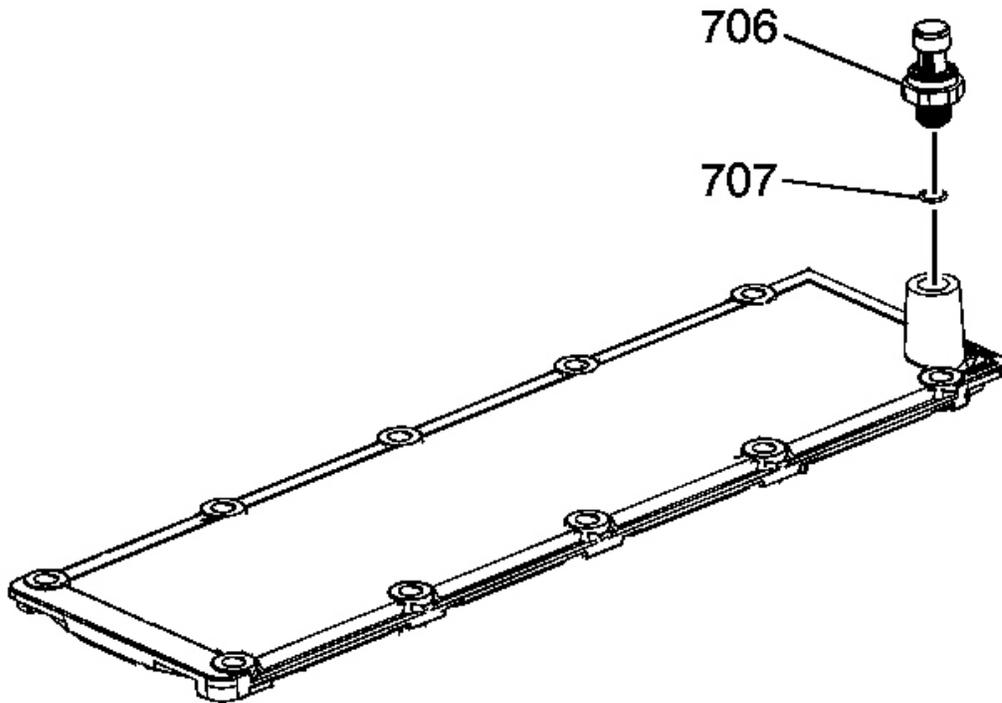


Fig. 90: View Of Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pressure sensor (706) and washer (707).

Installation Procedure

IMPORTANT: All gasket surfaces should be free of oil or other foreign material during assembly.

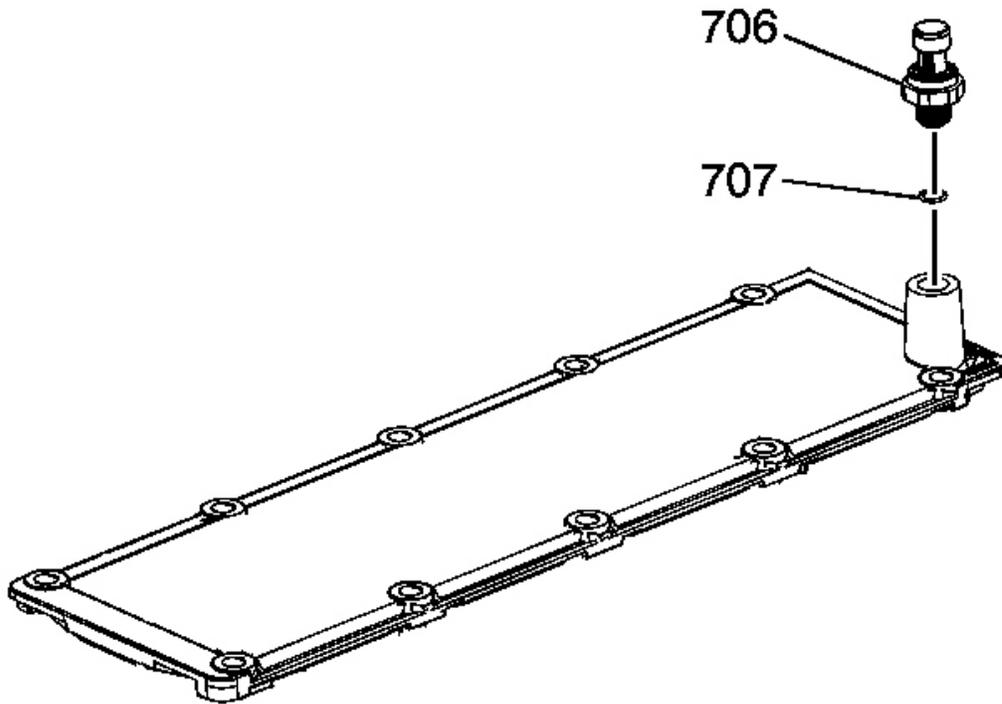


Fig. 91: View Of Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

1. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent, to the threads of the oil pressure sensor.

NOTE: Refer to Fastener Notice .

2. Install a NEW washer (707) and the oil pressure sensor (706).

Tighten: Tighten the sensor to 35 N.m (26 lb ft).

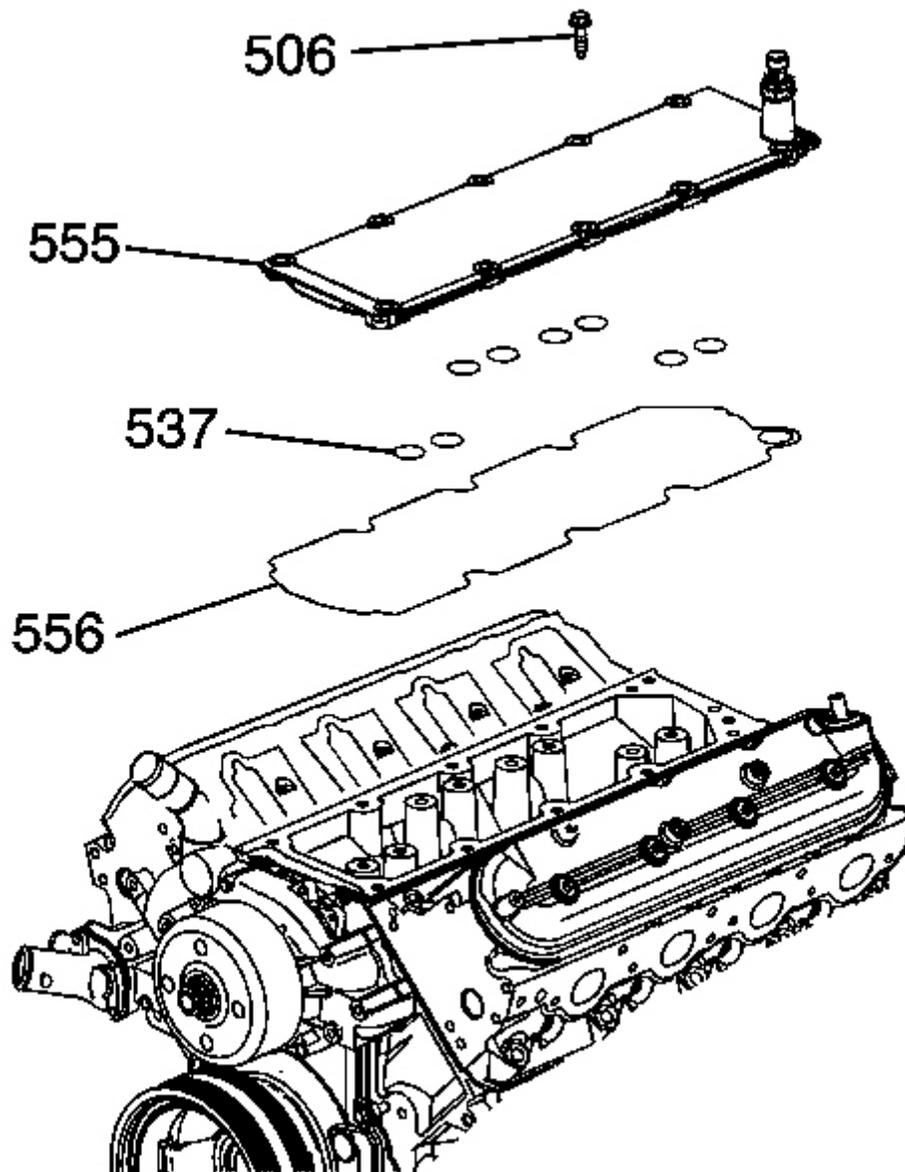


Fig. 92: View Of Engine Valley Cover
Courtesy of GENERAL MOTORS CORP.

3. Lubricate the O-ring seals with clean engine oil.
4. Install the O-ring seals (537) to the cover.

5. Set the engine valley cover (555) onto the engine.
6. Install the engine valley cover bolts (506).

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

7. Install the intake manifold. Refer to **Intake Manifold Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

Removal Procedure

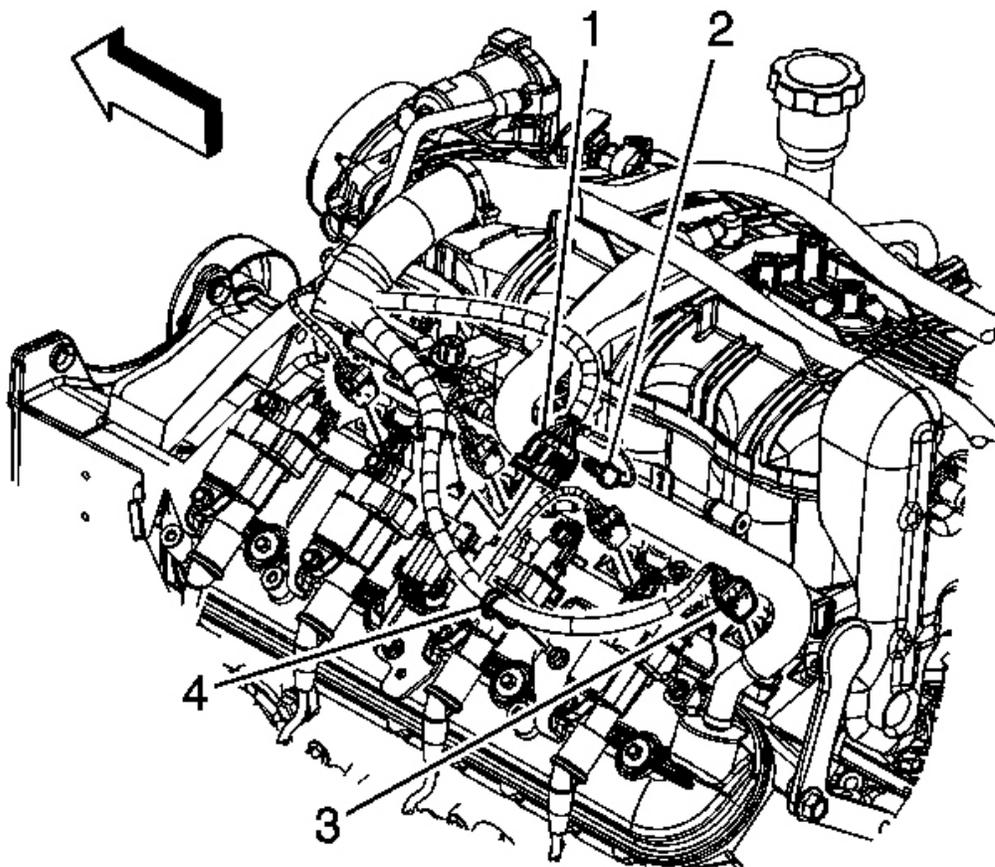


Fig. 93: Valve Rocker Arm Cover Replacement - Left Side
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Upper Intake Manifold Sight Shield Replacement**.
2. Remove the connector position assurance (CPA) retainer (2).
3. Disconnect the engine harness electrical connector (1) from the ignition coil wire harness.
4. Remove the engine harness clip (4) from the ignition coil bracket stud.
5. Reposition the engine harness, as necessary.

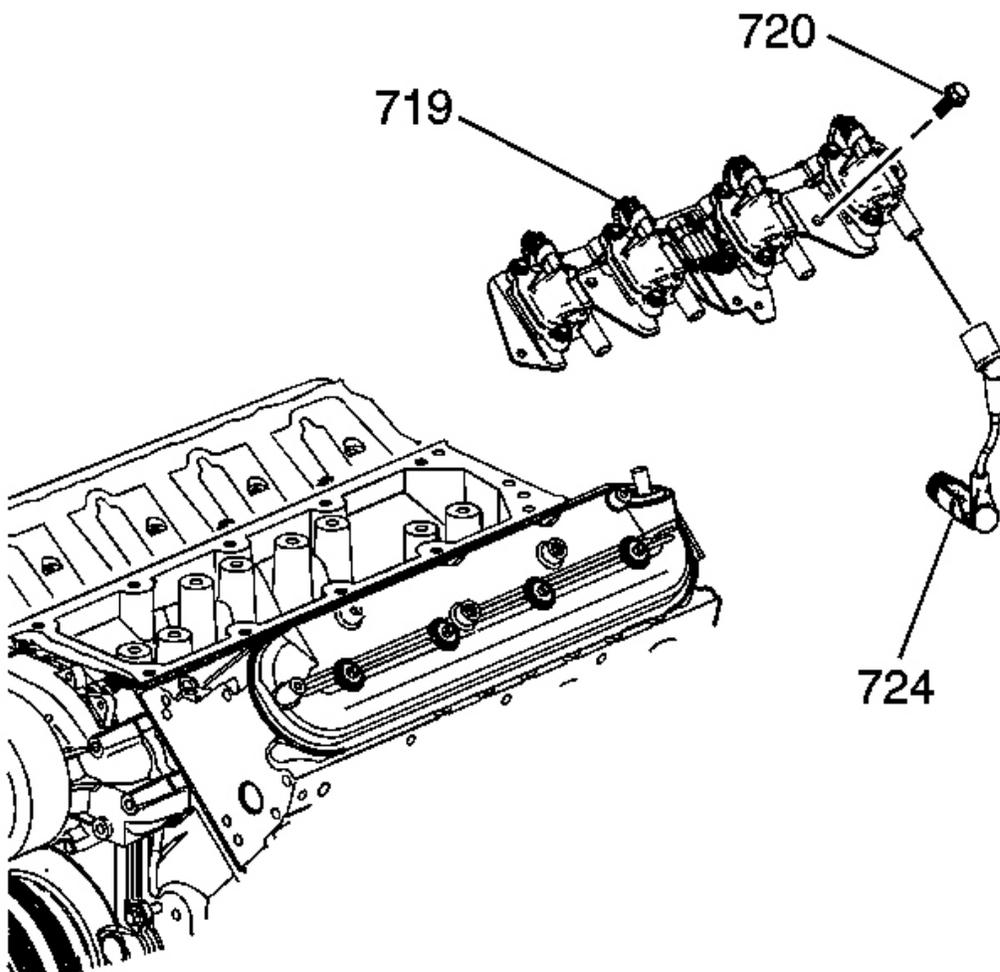


Fig. 94: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

6. Remove the spark plug wires (724) from the ignition coils.
 - Twist each plug wire 1/2 turn.
 - Pull only on the boot in order to remove the wire from the ignition coil.
7. Remove the ignition coil bracket studs (720).
8. Remove the ignition coil bracket (719).

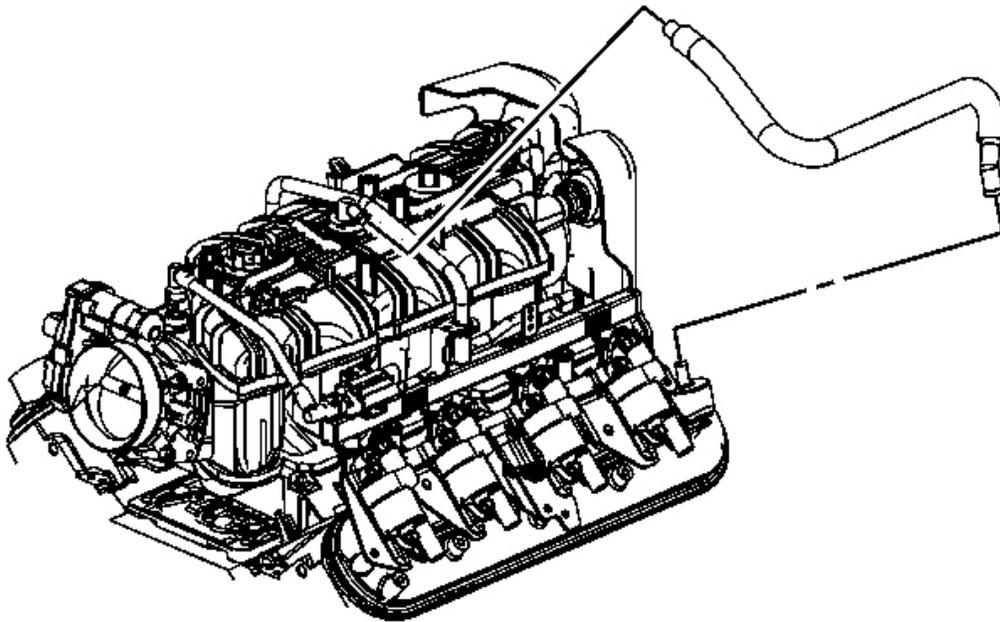


Fig. 95: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

9. Remove the positive crankcase ventilation (PCV) hose.

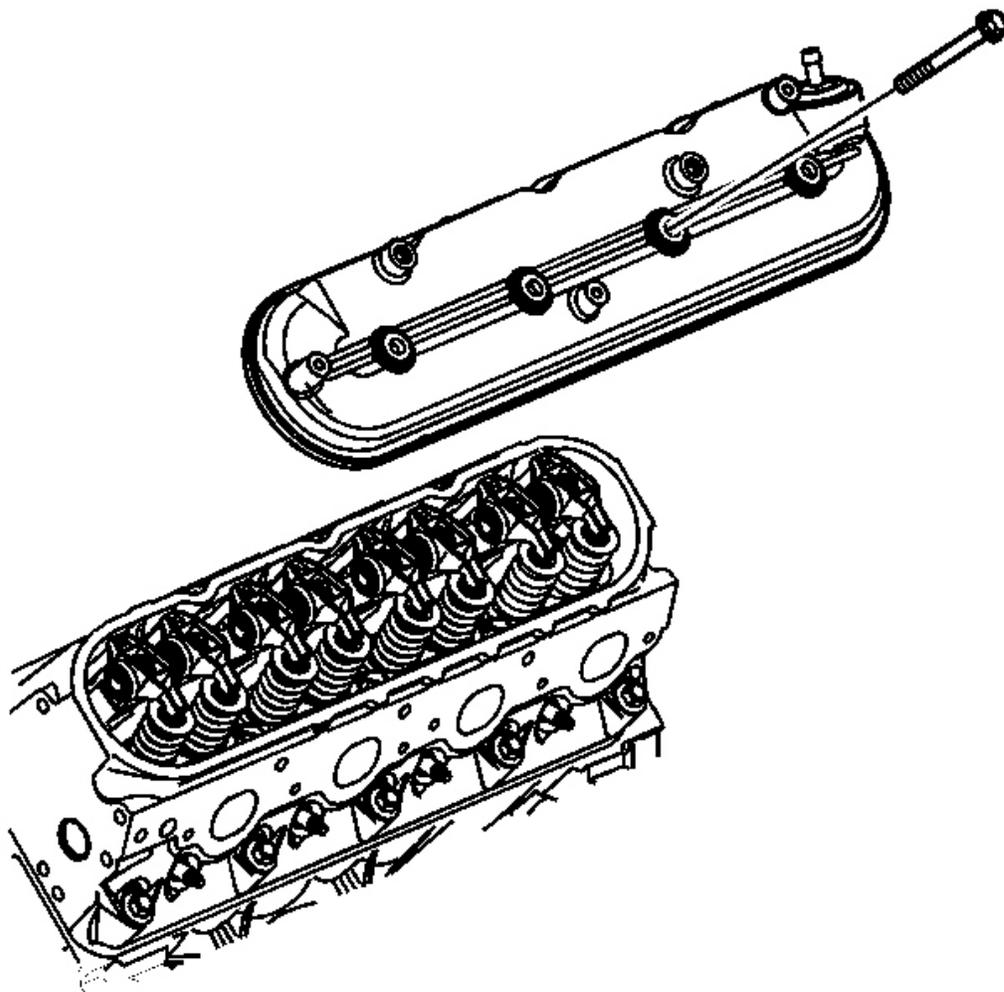


Fig. 96: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

10. Loosen the valve rocker arm cover bolts.
11. Remove the valve rocker arm cover.

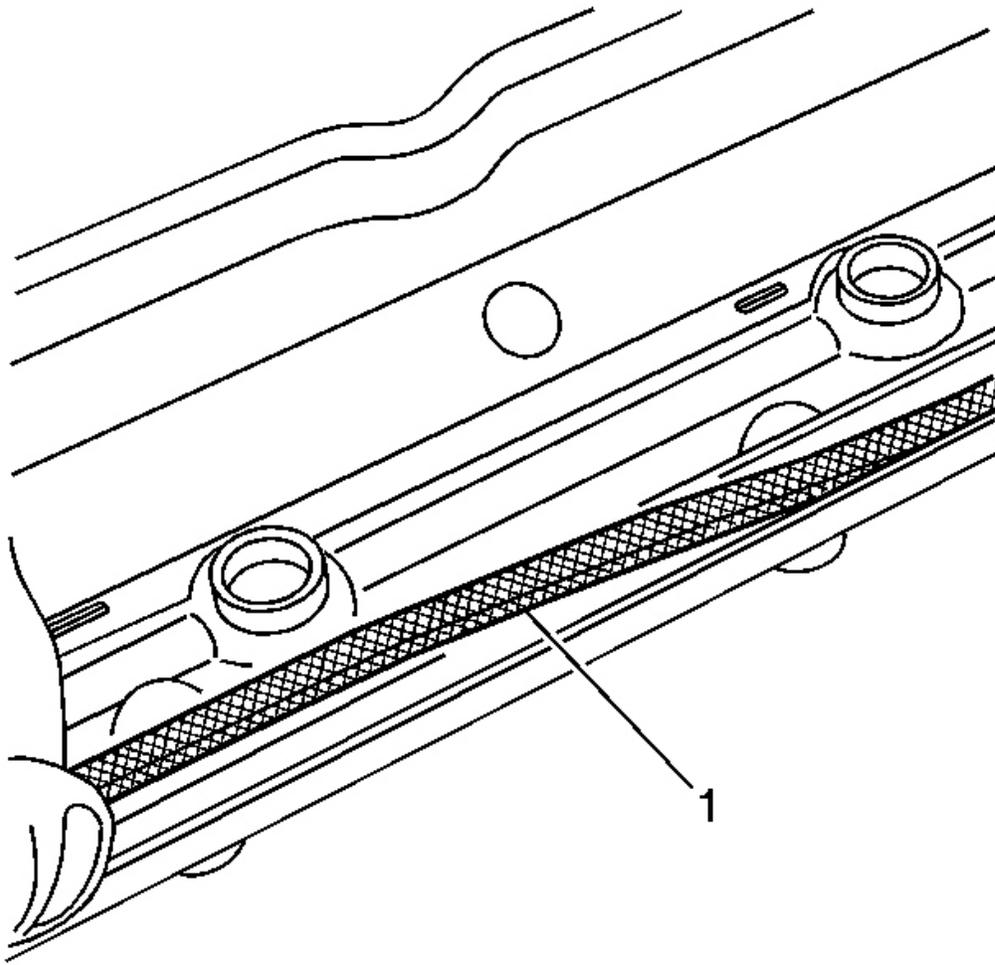


Fig. 97: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

12. Remove and discard the old gasket (1).

Installation Procedure

IMPORTANT:

- All gasket surfaces should be free of oil an/or other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- If the PCV valve grommet has been removed from the rocker

cover, install a **NEW** grommet during assembly.

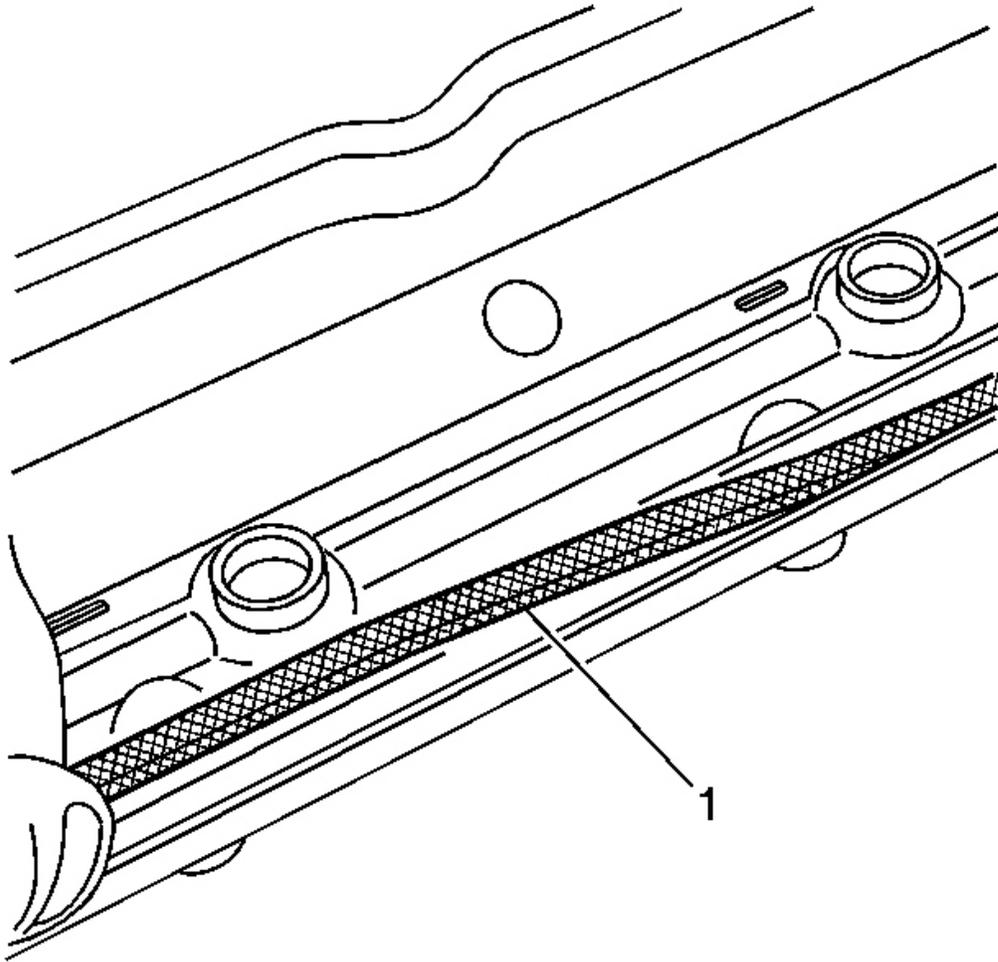


Fig. 98: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a **NEW** rocker cover gasket (1).

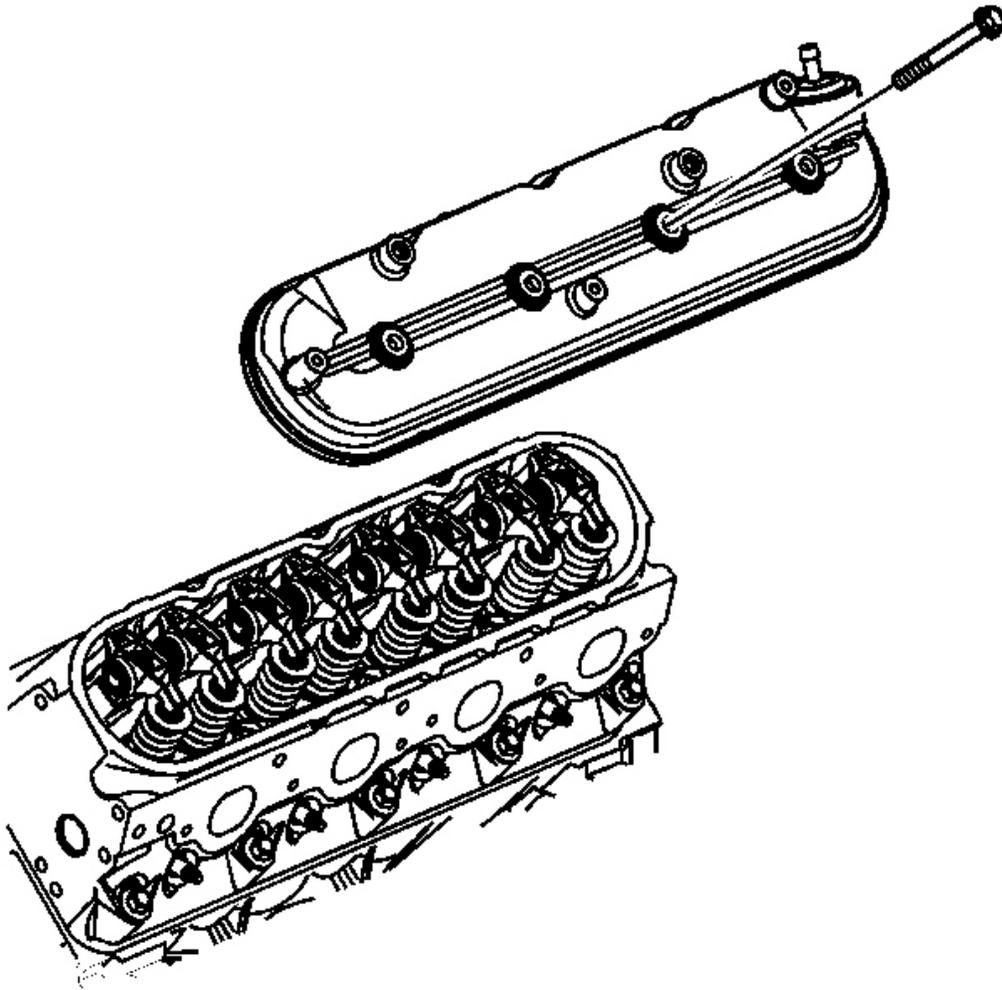


Fig. 99: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the valve rocker arm cover.

NOTE: Refer to Fastener Notice .

3. Tighten the rocker arm cover bolts.

Tighten: Tighten the bolts to 12 N.m (106 lb in).

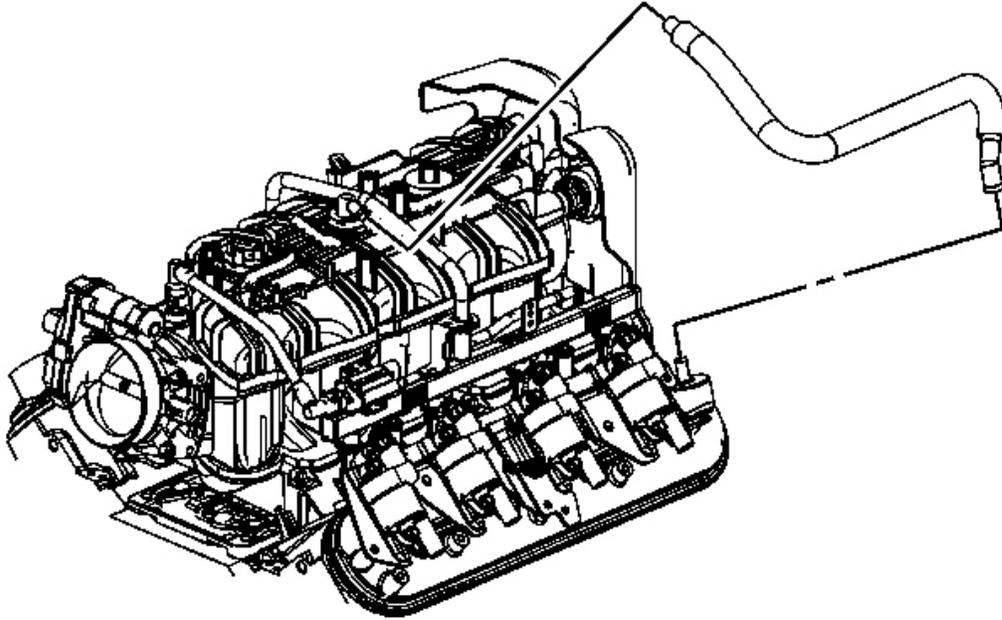


Fig. 100: Positive Crankcase Ventilation Hose/Pipe/Tube Replacement
Courtesy of GENERAL MOTORS CORP.

4. Install the PCV hose.

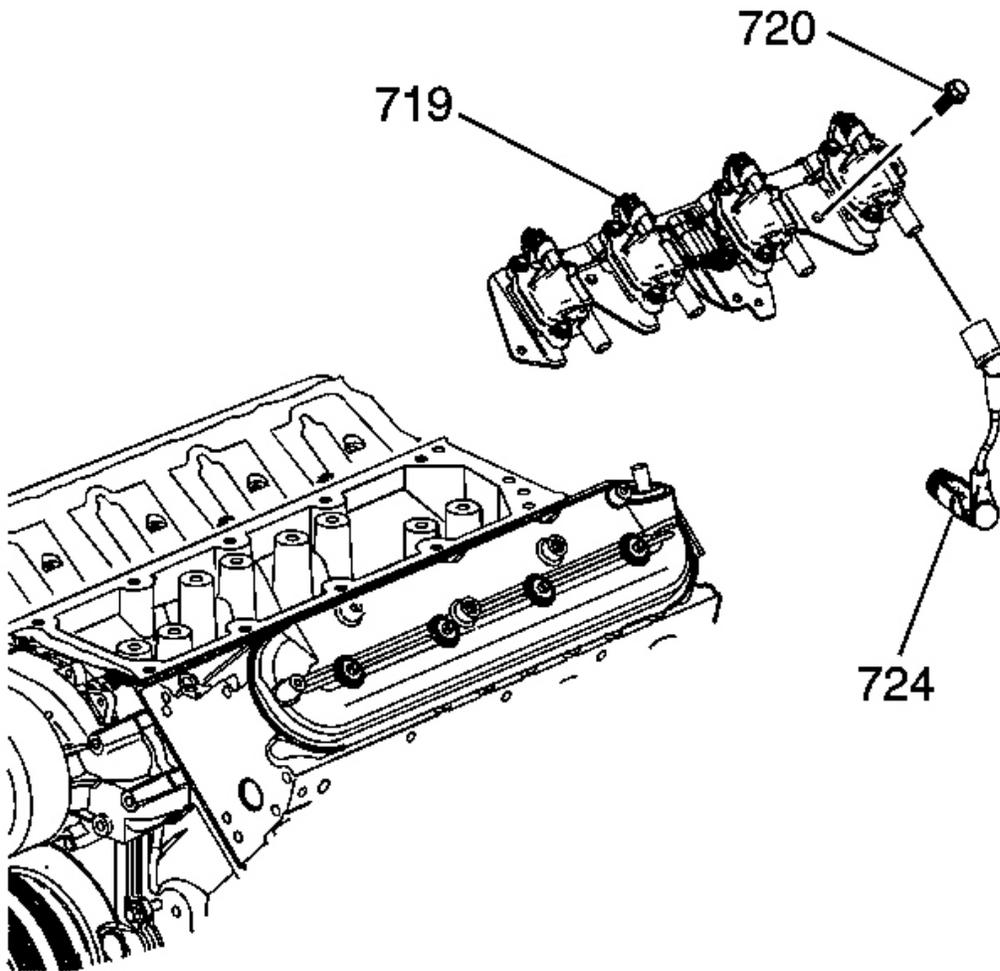


Fig. 101: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

5. Apply threadlock to the threads of the ignition coil bracket studs. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
6. Position the ignition coil bracket (719) onto the rocker cover.
7. Install the ignition coil bracket studs (720).

Tighten: Tighten the studs to 12 N.m (106 lb in).

8. Install the spark plug wires (724) to the ignition coils.

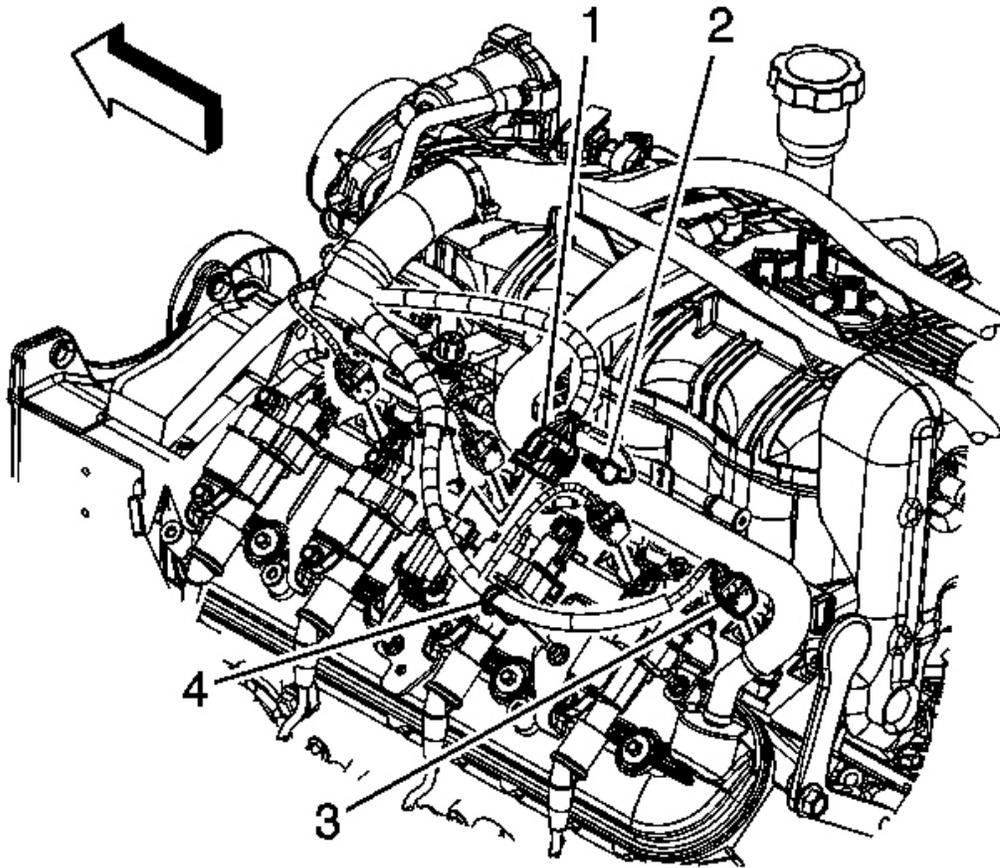


Fig. 102: Valve Rocker Arm Cover Replacement - Left Side
Courtesy of GENERAL MOTORS CORP.

9. Position the engine harness, as necessary.
10. Install the engine harness clip (4) to the ignition coil bracket stud.
11. Connect the engine harness electrical connector (1) to the ignition coil wire harness.
12. Install the CPA retainer (2).
13. Install the intake manifold cover. Refer to **Upper Intake Manifold Sight Shield Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

Removal Procedure

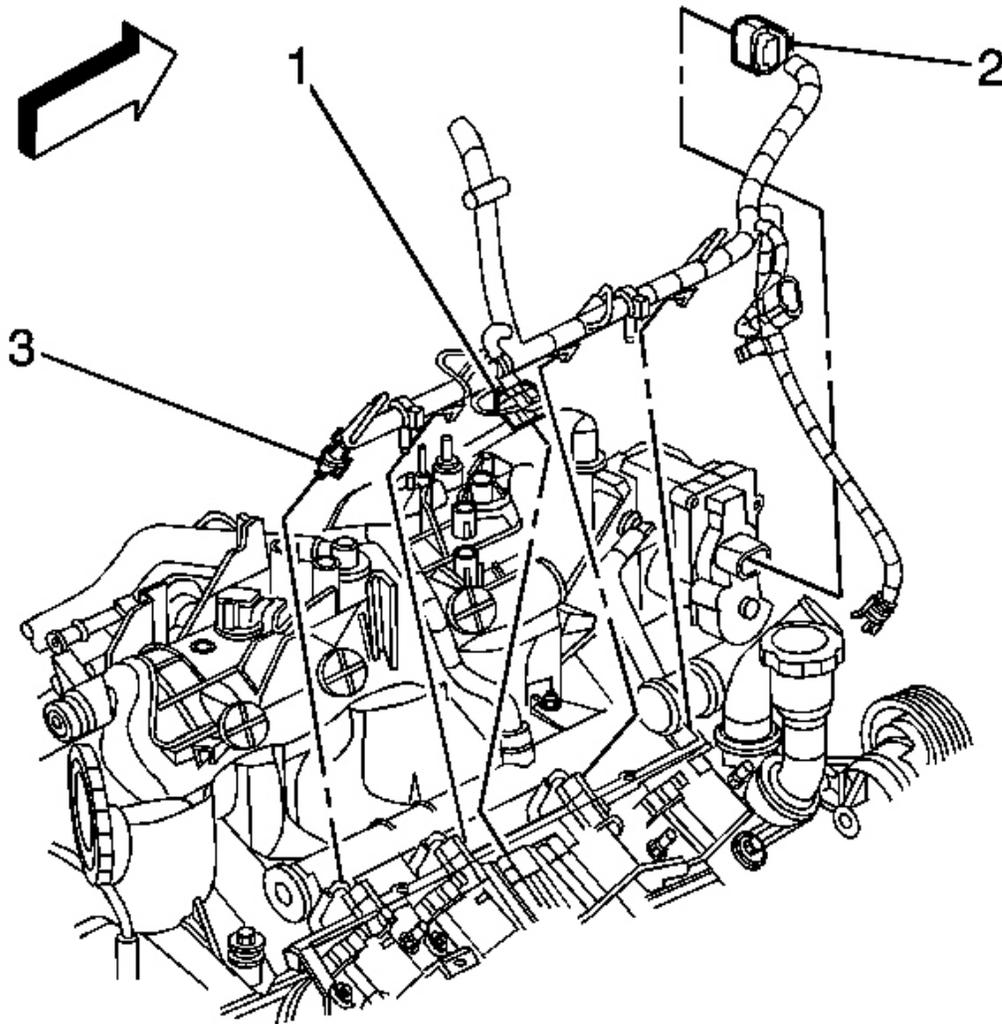


Fig. 103: Locating Electrical Components At Top Of Engine
Courtesy of GENERAL MOTORS CORP.

1. Remove the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.
2. Remove the connector position assurance (CPA) lock.
3. Disconnect the main electrical connector (1) to the ignition coil wire harness.
4. Remove the harness clips.
5. Reposition the engine harness, if necessary.

6. Remove the spark plug wires from the ignition coils.
 - Twist each plug wire 1/2 turn.
 - Pull only on the boot in order to remove the wire from the ignition coil.

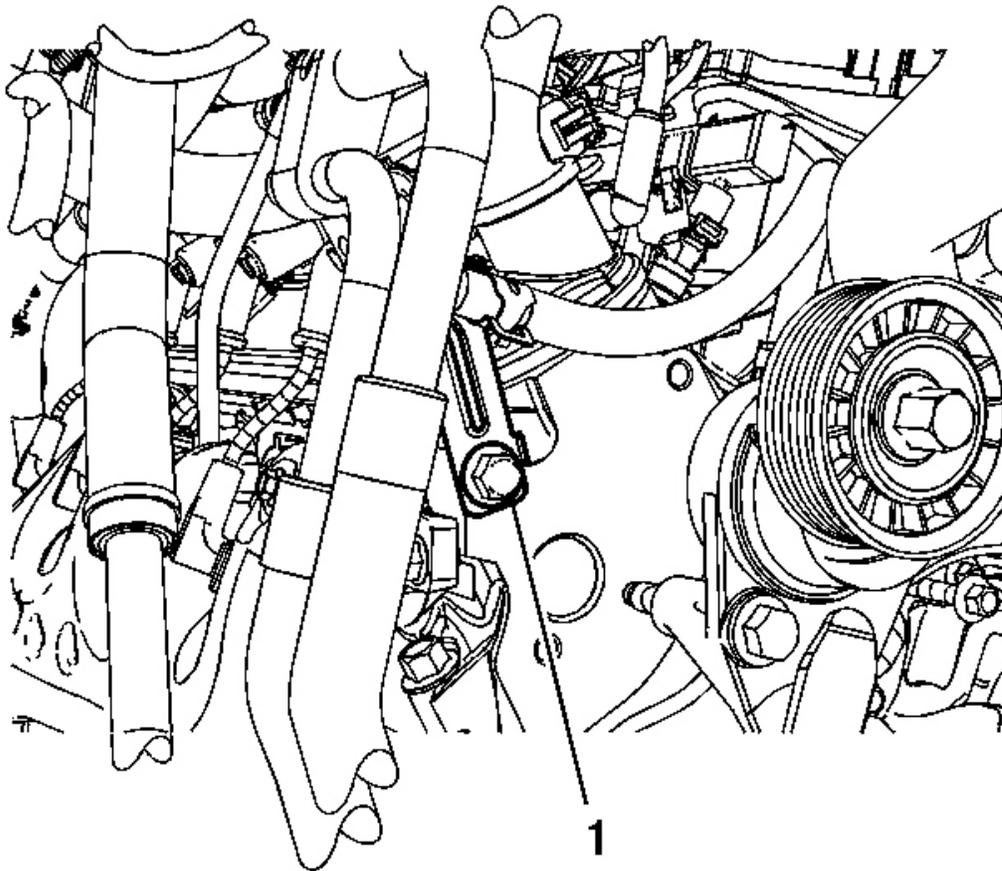


Fig. 104: Heater Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the heater hose bracket bolt (1) from the front of the right cylinder head.

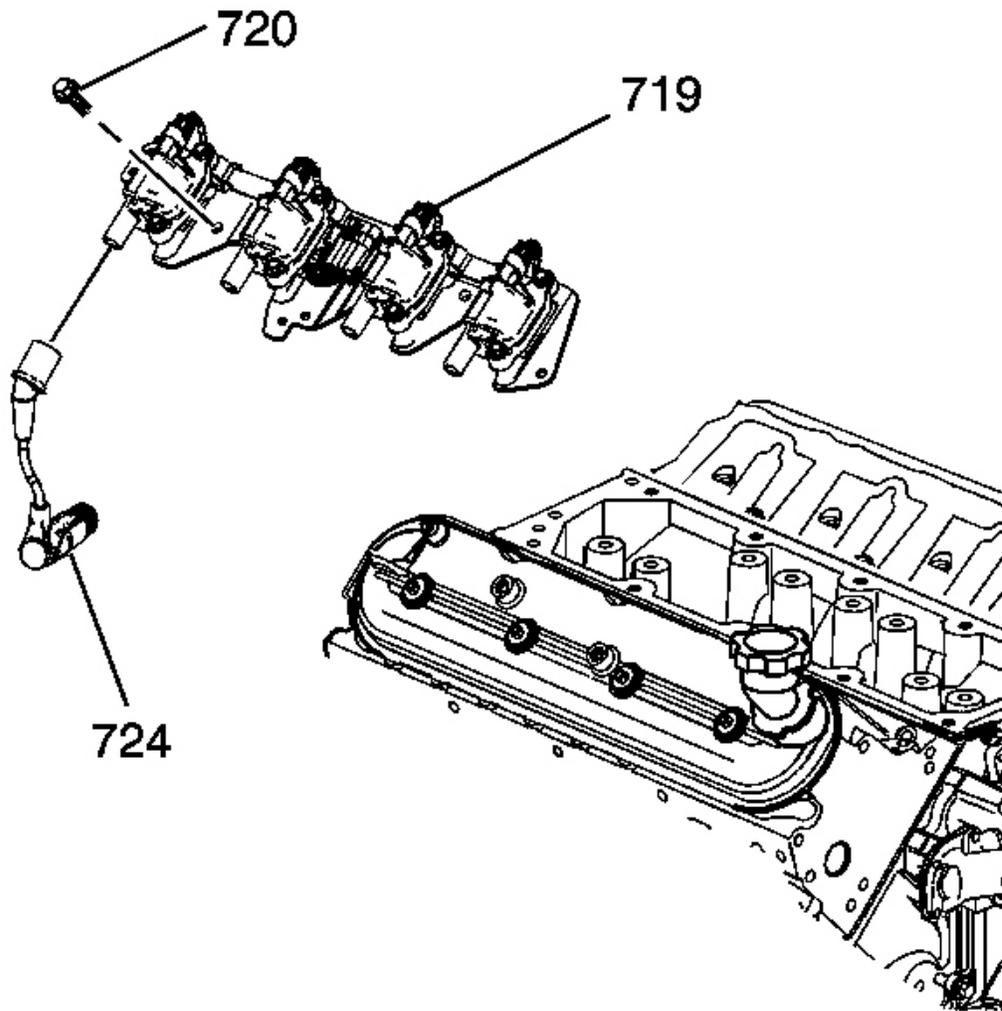


Fig. 105: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

8. If necessary, remove the ignition coil bracket studs from the rocker arm cover.
9. If necessary, remove the ignition coils and bracket from the rocker cover.

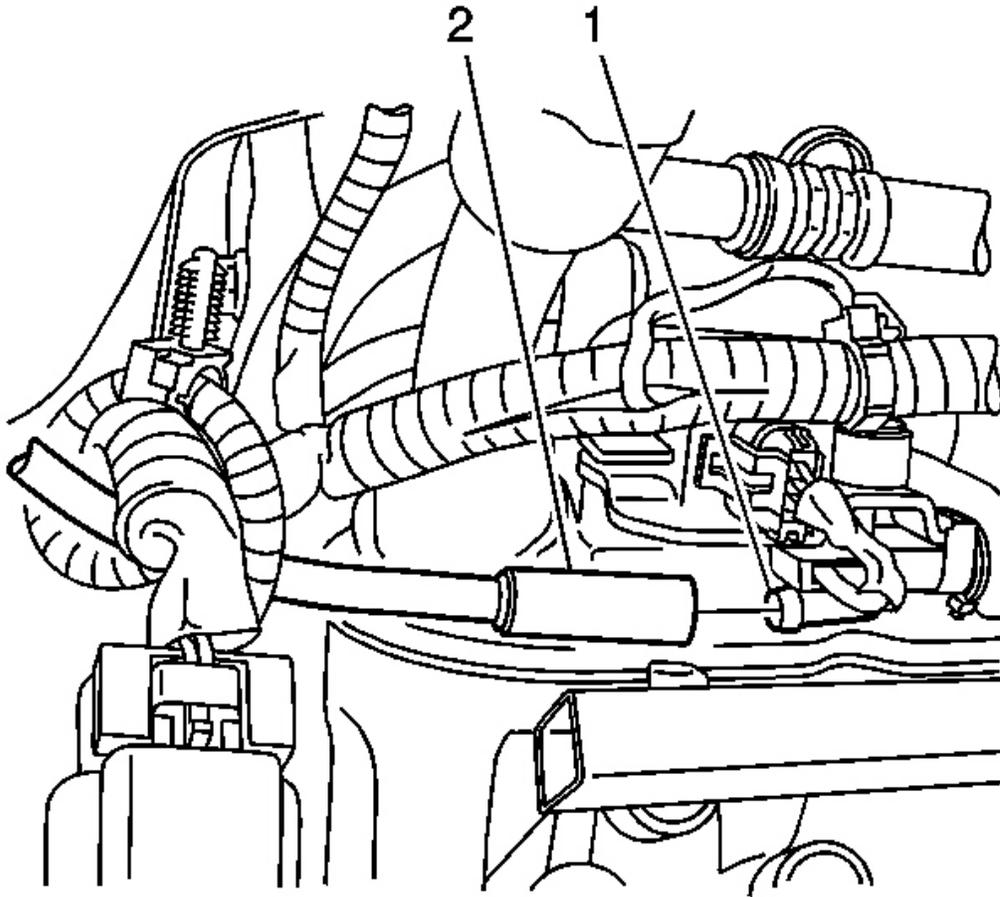


Fig. 106: Vent Hose

Courtesy of GENERAL MOTORS CORP.

10. Remove the vent hose (2) from the valve rocker arm cover (1).

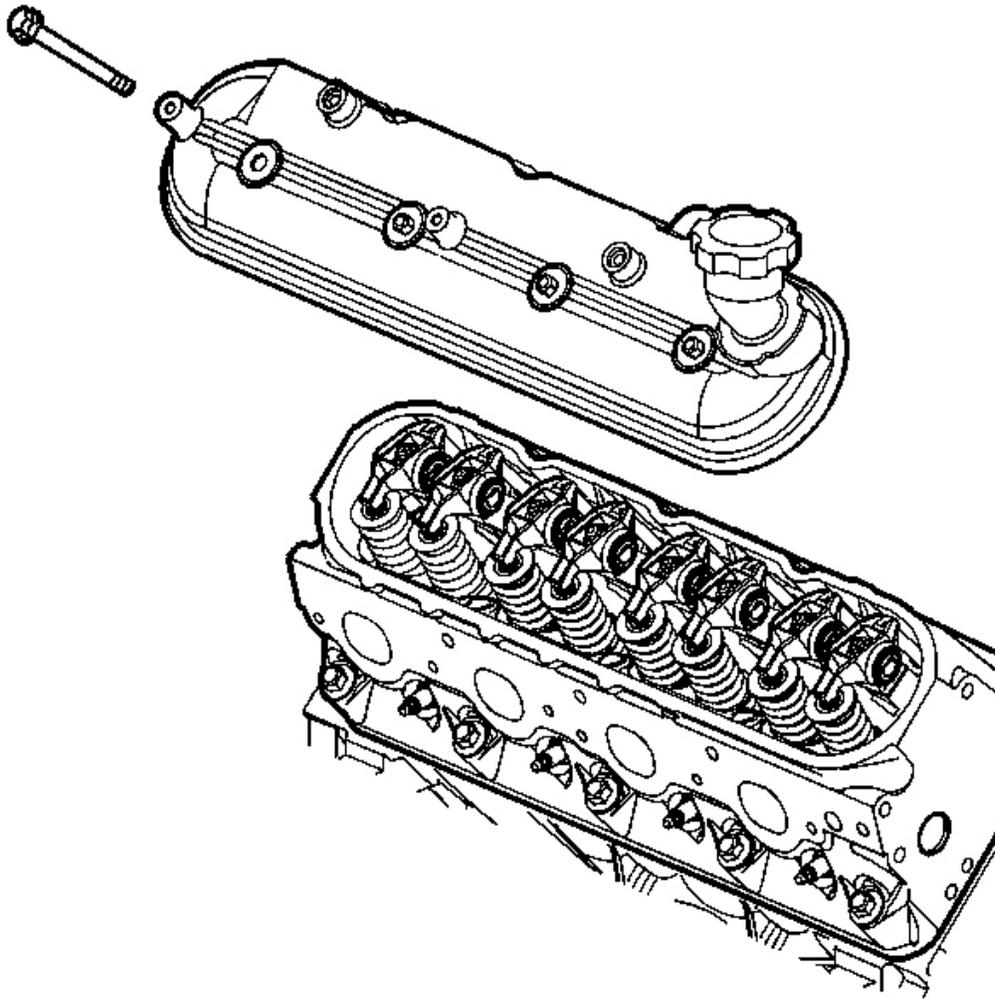


Fig. 107: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

11. Remove the valve rocker arm cover bolts.
12. Remove the valve rocker arm cover.

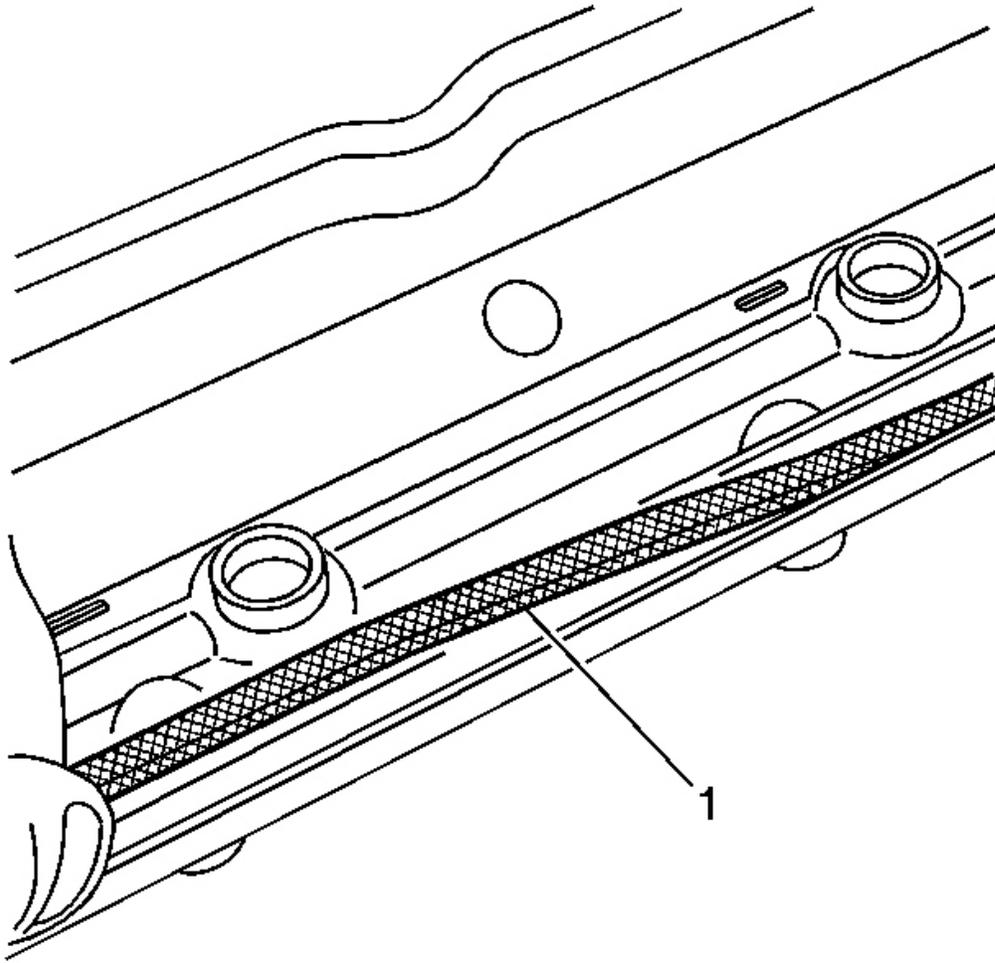


Fig. 108: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

13. Remove the gasket (1) from the rocker cover.
14. Discard the OLD gasket.

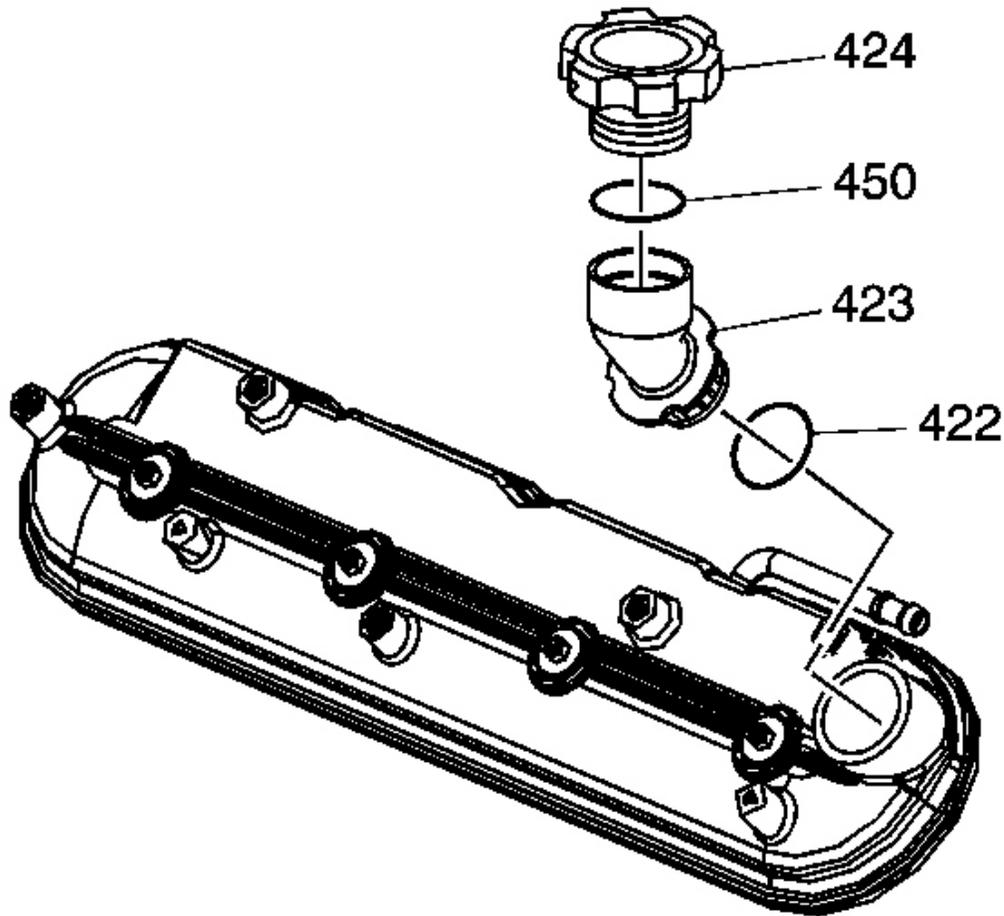


Fig. 109: Oil Fill Cap & Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

15. Remove the oil fill cap from the oil fill tube.
16. Remove the oil fill tube from the rocker cover, if required.
17. Discard the oil fill tube.

Installation Procedure

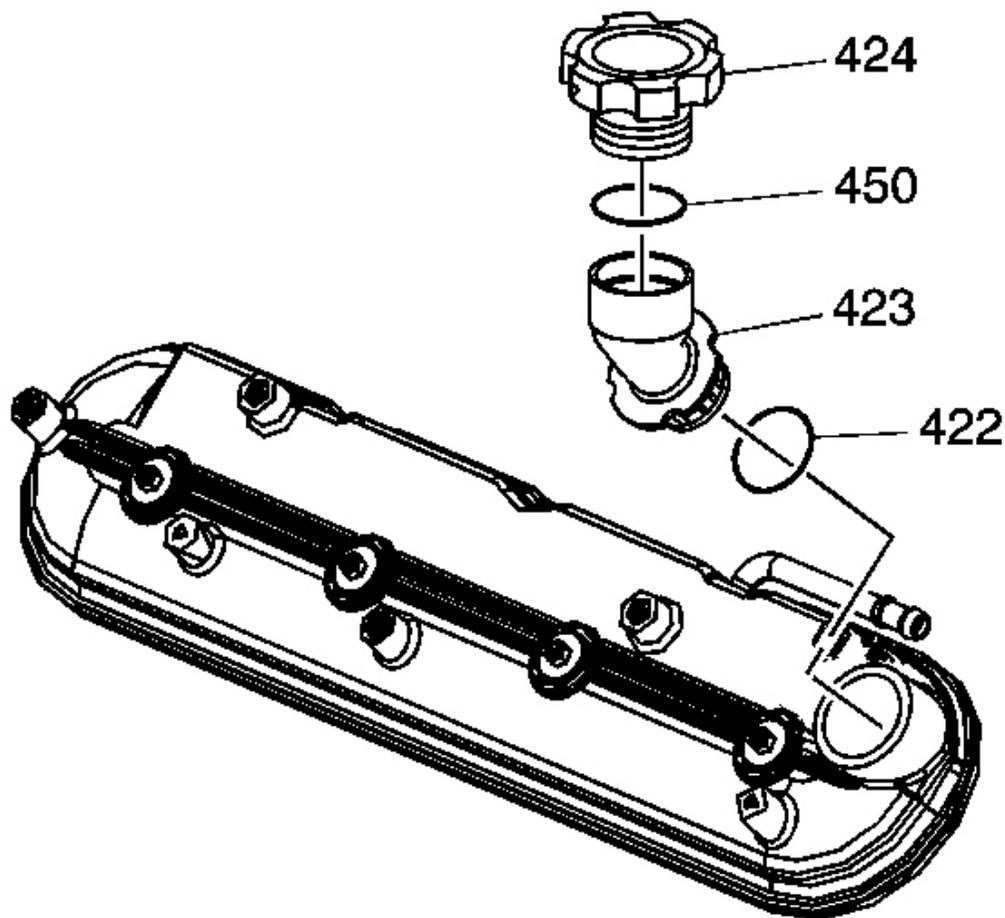


Fig. 110: Oil Fill Cap & Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- All gasket surfaces should be free of oil or 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 oil fill tube has been removed from the rocker arm cover, install a NEW fill tube during assembly.

1. Lubricate the O-ring seal of the NEW oil fill tube with clean engine oil.
2. Insert the NEW oil fill tube into the rocker arm cover.

Rotate the tube clockwise until locked in the proper position.

3. Install the oil fill cap into the tube.

Rotate the cap clockwise until locked in the proper position.

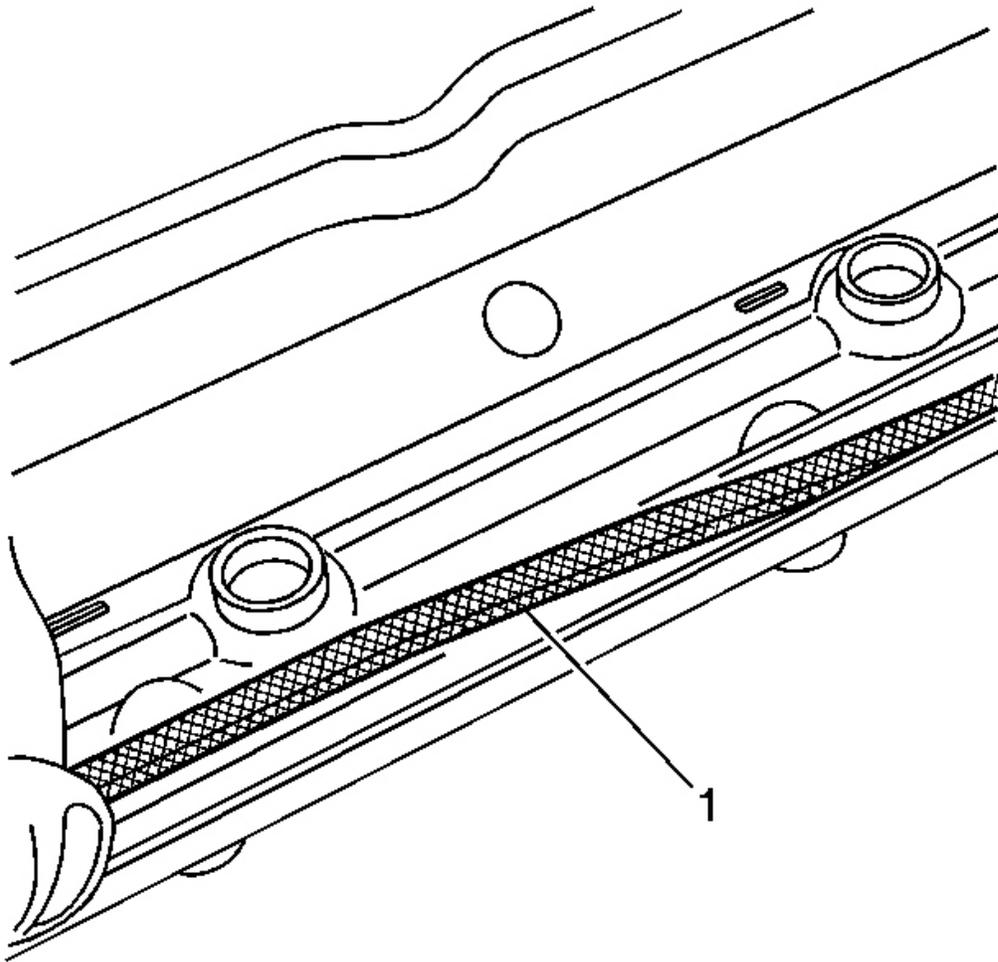


Fig. 111: Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

4. Install a NEW rocker cover gasket (1) into the valve rocker arm cover.

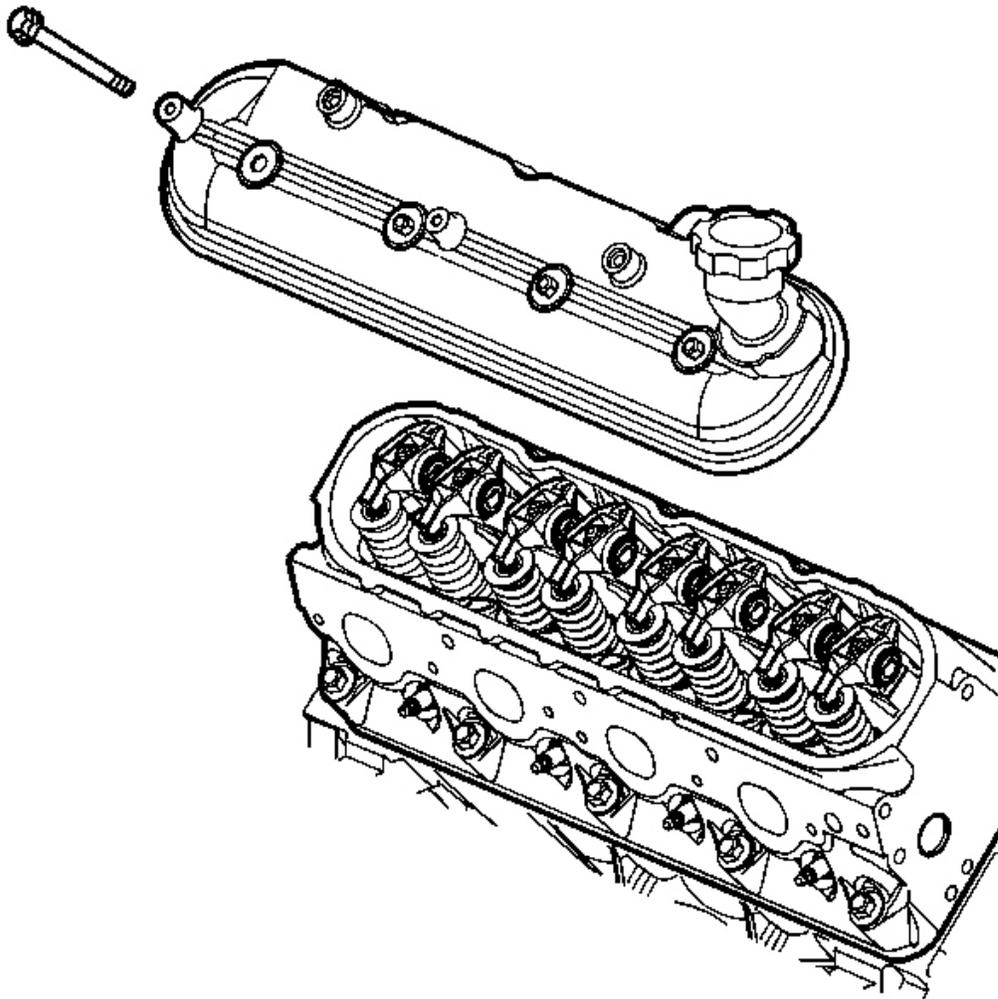


Fig. 112: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

5. Install the valve rocker arm cover onto the cylinder head.
6. Install new rocker arm cover grommets, if necessary.

NOTE: Refer to **Fastener Notice** .

7. Install the rocker arm cover bolts and grommets.

Tighten: Tighten the bolts to 12 N.m (106 lb in).

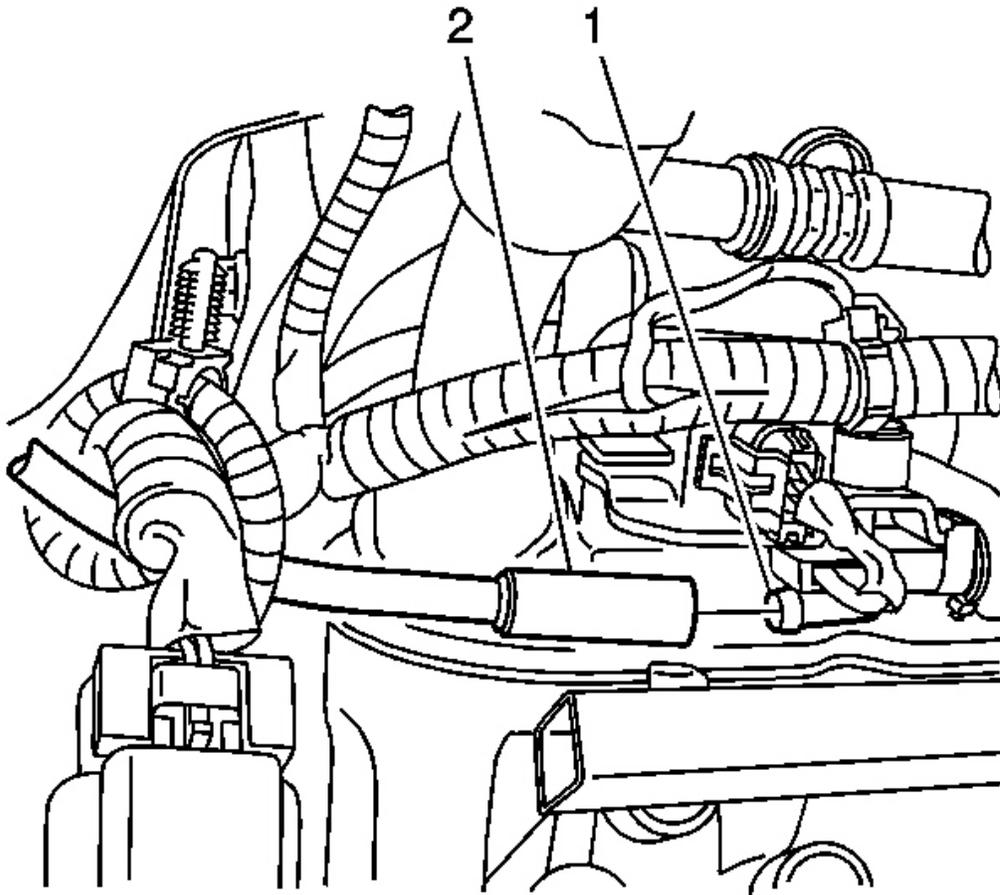


Fig. 113: Vent Hose

Courtesy of GENERAL MOTORS CORP.

8. Install the vent hose (2) to the valve rocker arm cover (1).

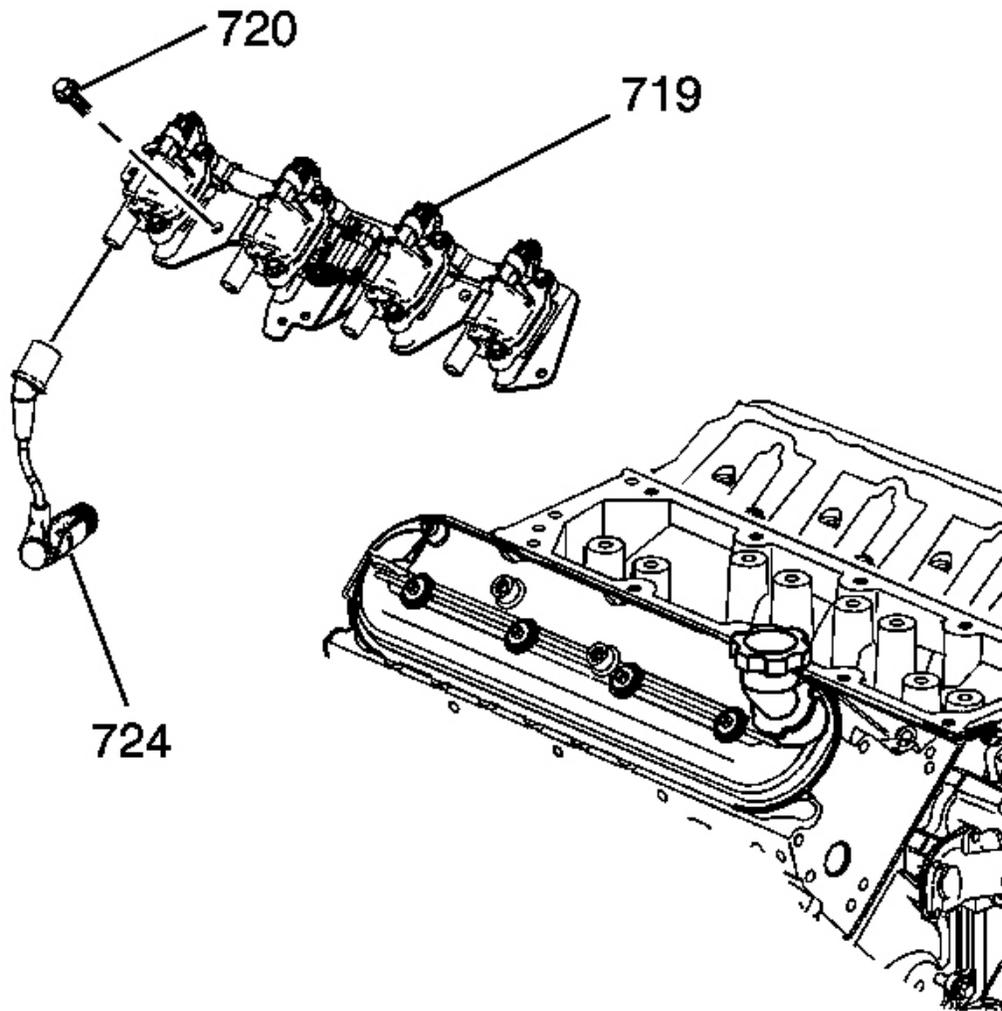


Fig. 114: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

9. Apply threadlock to the threads of the bracket bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
10. If necessary, install the ignition coils and bracket to the rocker arm cover.
11. If necessary, install the ignition coil bracket studs to the rocker cover.

Tighten: Tighten the studs to 12 N.m (106 lb in).

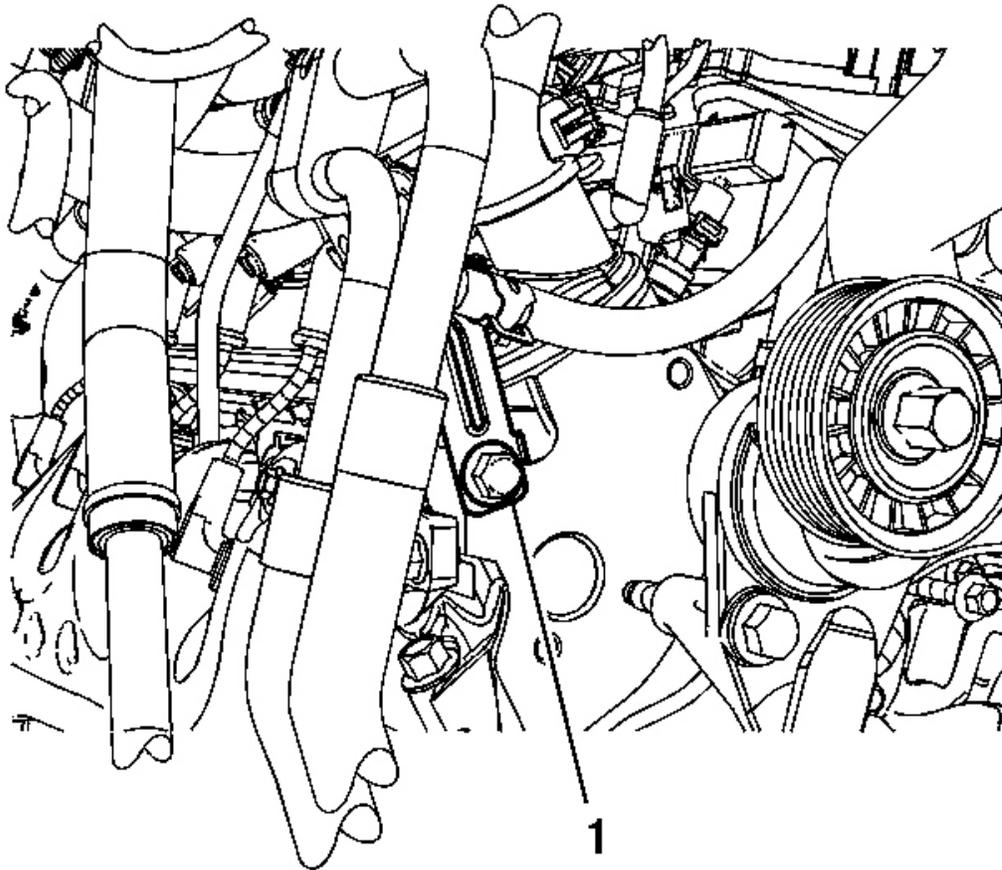


Fig. 115: Heater Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

12. Install the heater hose bracket bolt (1) to the front of the right cylinder head.

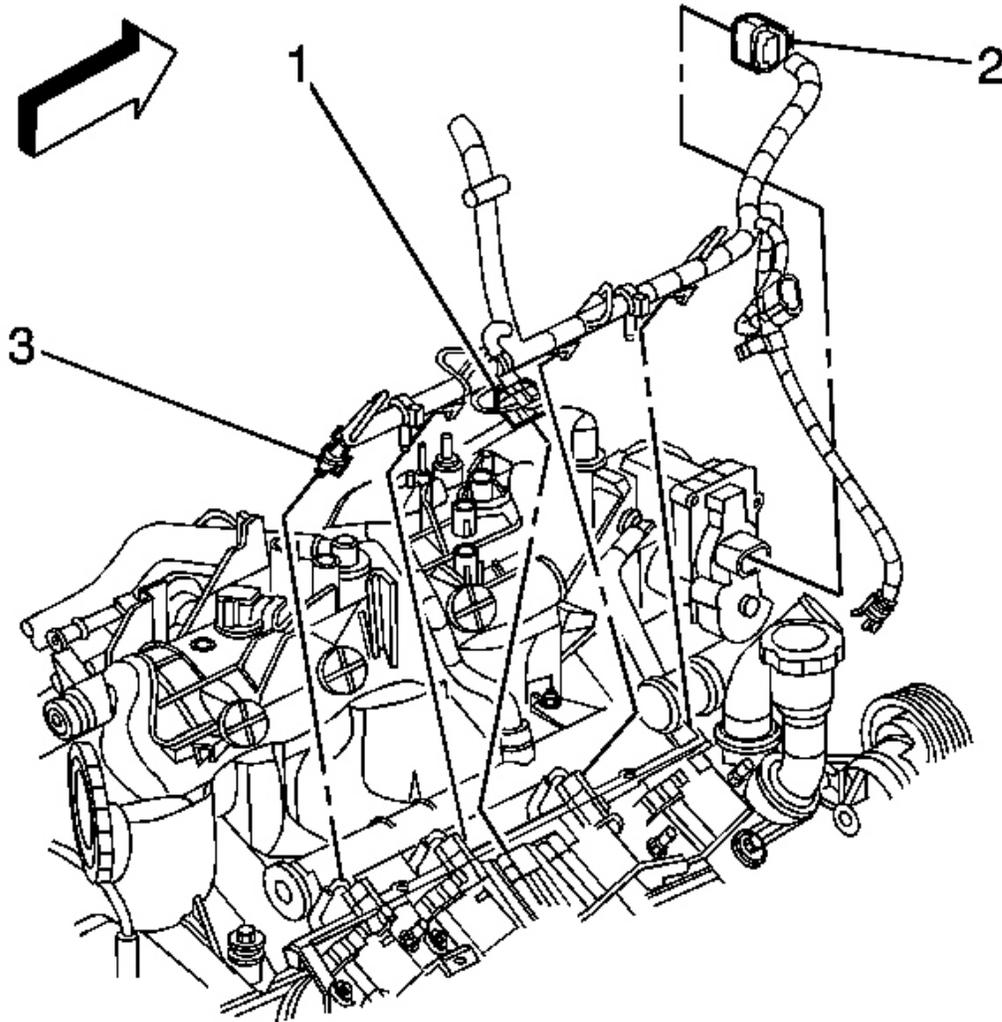


Fig. 116: Locating Electrical Components At Top Of Engine
Courtesy of GENERAL MOTORS CORP.

13. Install the spark plug wires to the ignition coils.
14. Position the engine harness, if necessary.
15. Install the harness clips.
16. Connect the main electrical connector (1) feeding the ignition coils.
17. Install the CPA lock.

18. Install the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement**.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

Removal Procedure

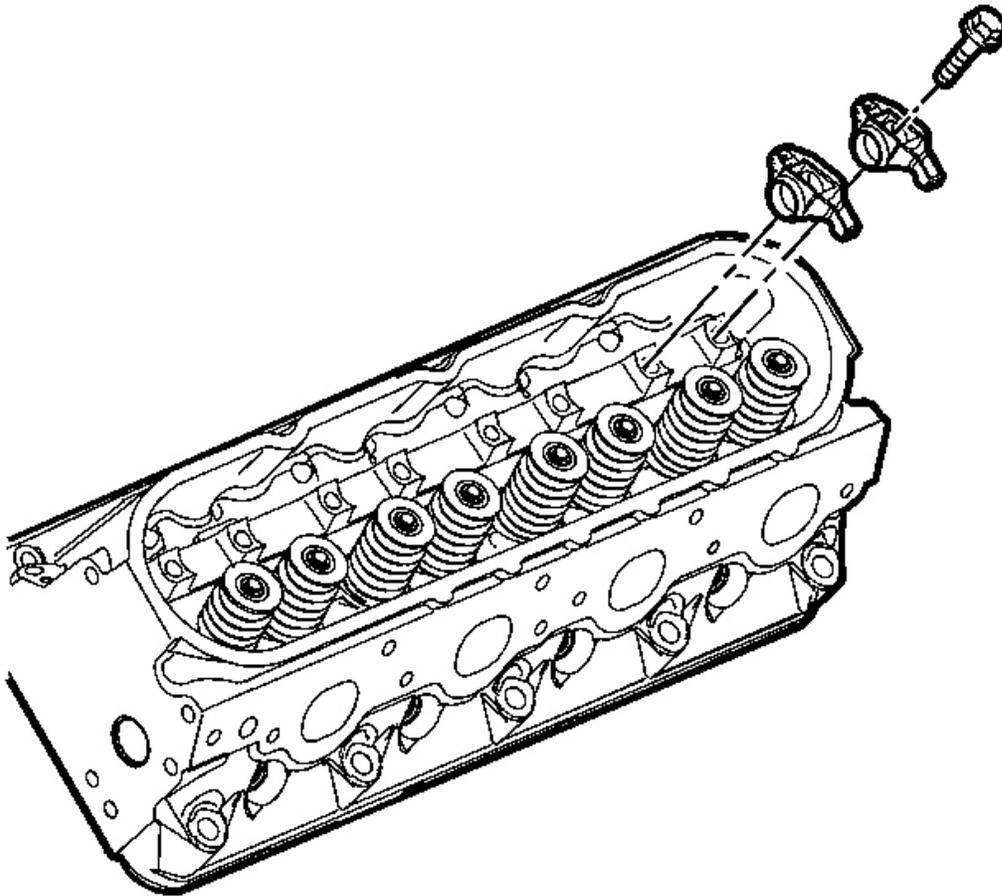


Fig. 117: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

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

IMPORTANT: The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3. Cylinders 1, 3, 5 and 7 are the left bank.

2. Remove the number one cylinder spark plug. Refer to [Spark Plug Replacement](#) .

IMPORTANT: Place the rocker arms, pushrods, and pivot support, in a rack so that they can be installed in the same location from which they were removed.

3. Remove the rocker arm bolts.
4. Remove the rocker arms.

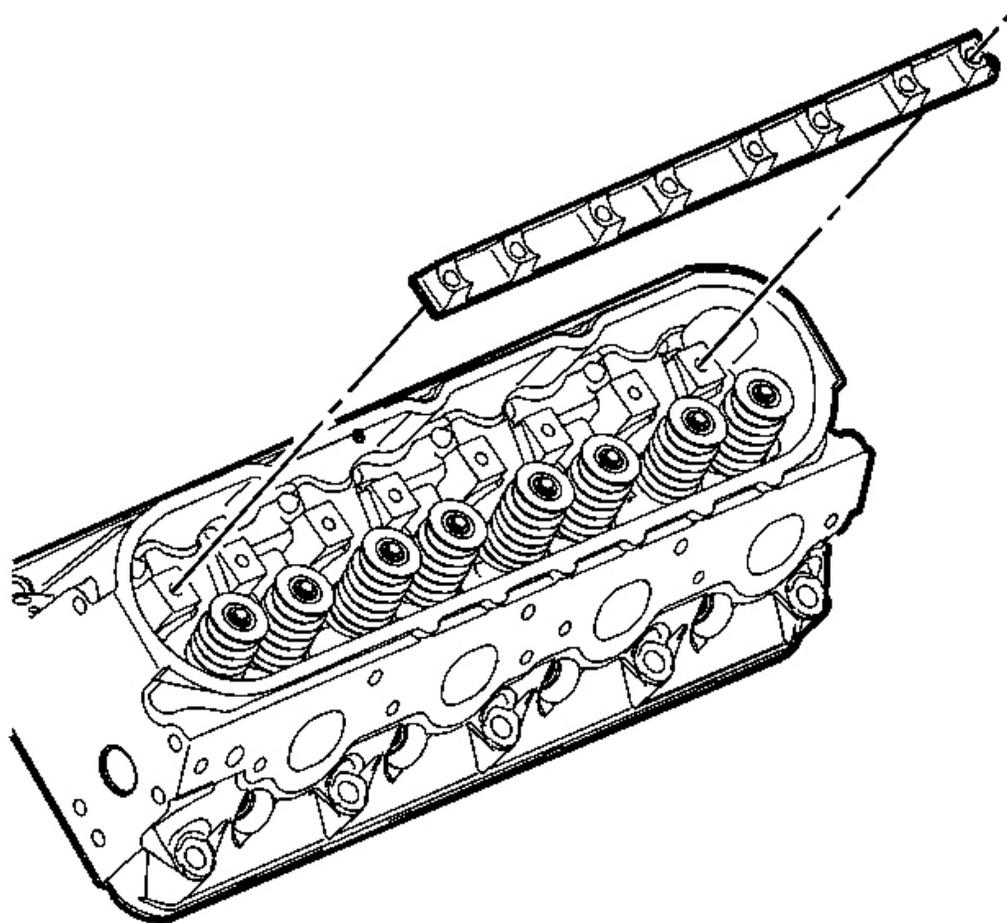


Fig. 118: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

5. Remove the rocker arm pivot support.

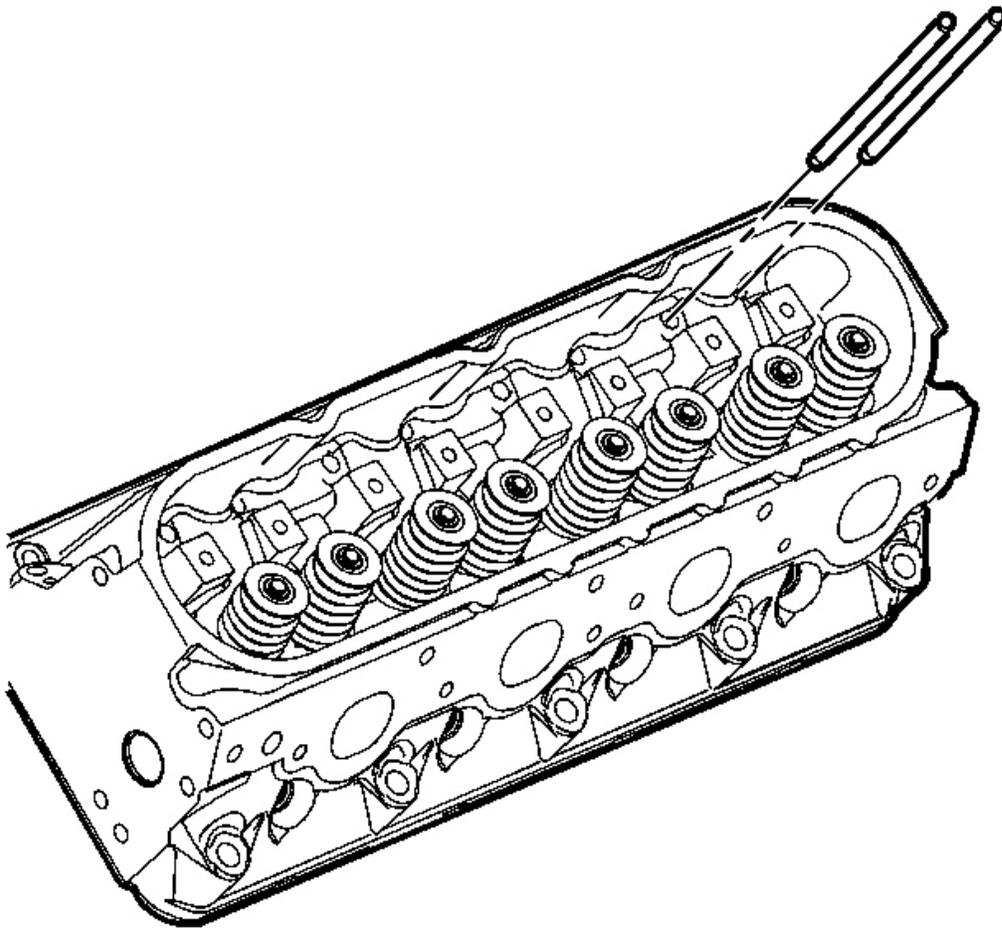


Fig. 119: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

6. Remove the pushrods.
7. Clean and inspect the rocker arms and pushrods, if required. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection**.

IMPORTANT: When reusing the valve train components, always install the components to the original location and position.

Valve lash is net build, no valve adjustment is required.

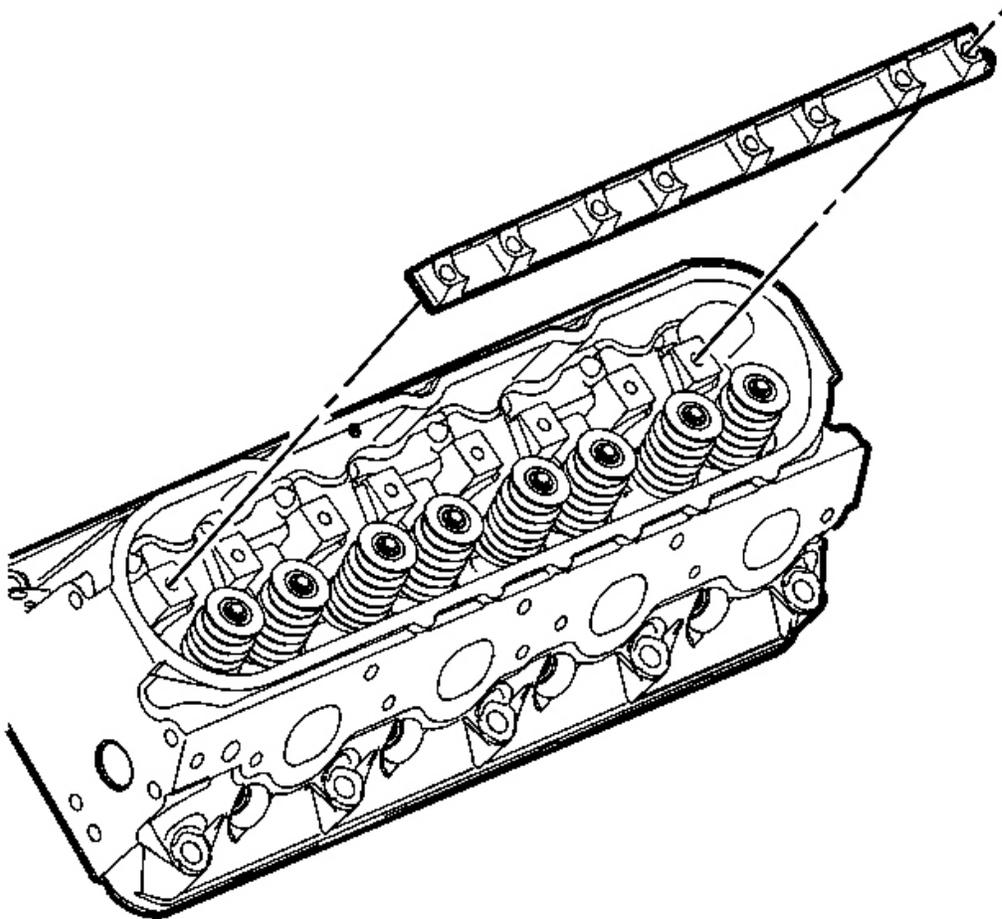


Fig. 120: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the rocker arm bolts with clean engine oil. Lubricate the flange or washer surface of the bolt that will contact the rocker arm.
3. Install the rocker arm pivot support.

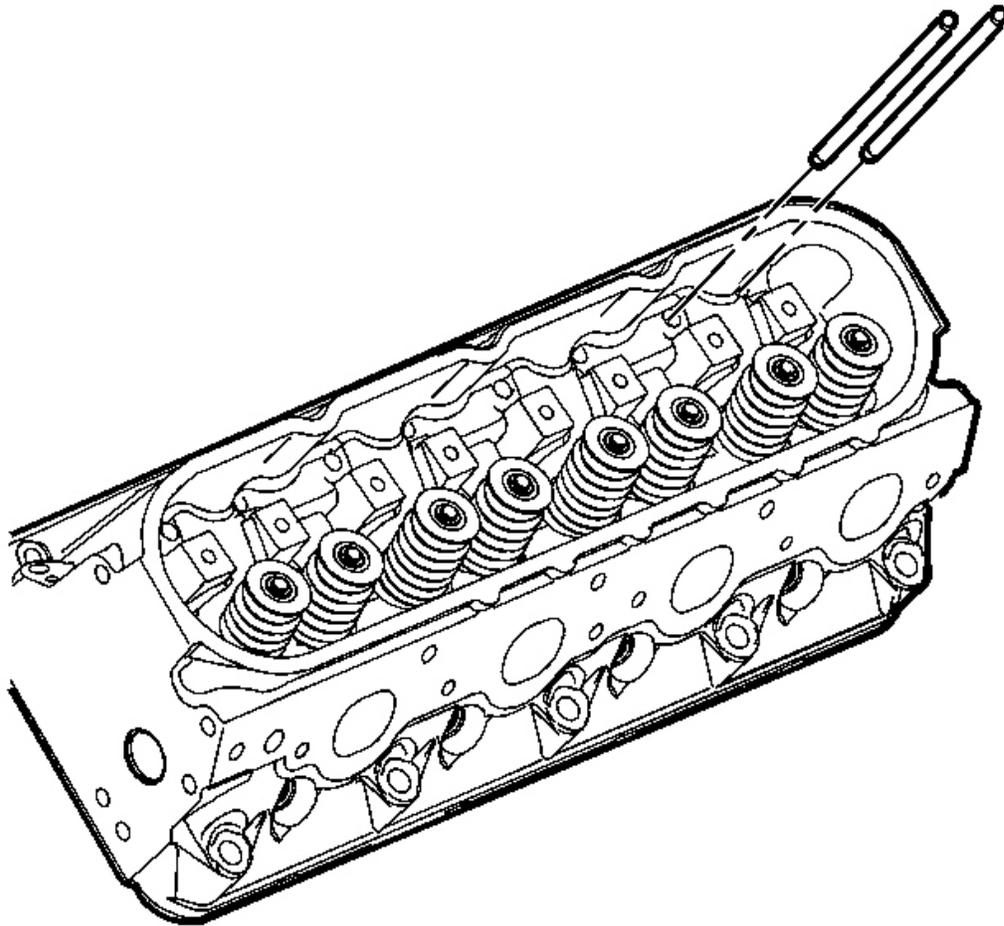


Fig. 121: View Of Pushrods

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

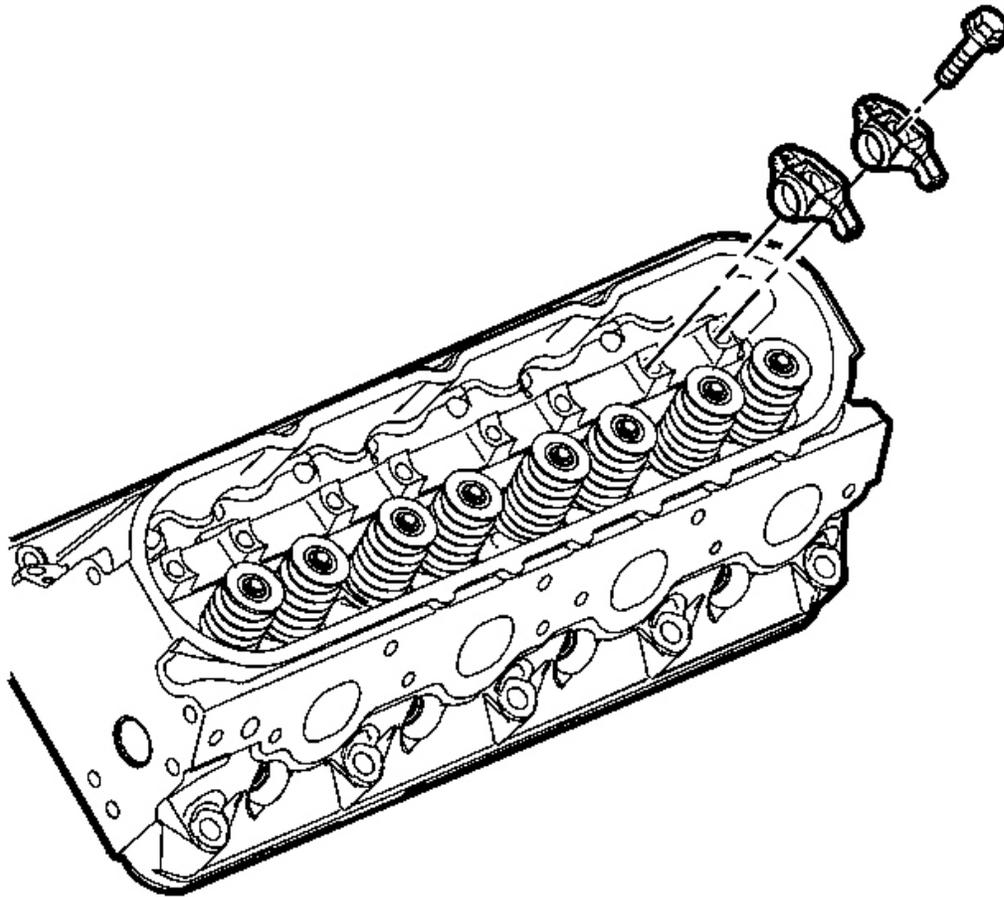


Fig. 122: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that 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.

IMPORTANT: The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3. Cylinders 1, 3, 5 and 7 are the left bank. Cylinders 2, 4, 6 and 8 are the right bank.

6. Rotate the crankshaft until the number one piston is at top dead center (TDC) of the compression stroke. In this position, the number one cylinder rocker arms will be off lobe lift.

NOTE: Refer to **Fastener Notice** .

7. With the engine in the number one firing position, tighten the following rocker arm bolts:

Tighten:

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

8. Rotate the crankshaft 360 degrees.
9. Tighten the following rocker arm bolts:

Tighten:

- Tighten cylinders 3, 4, 5 and 6 exhaust valve rocker arm bolts to 30 N.m (22 lb ft).
- Tighten cylinders 2, 6, 7 and 8 intake valve rocker arm bolts to 30 N.m (22 lb ft).

10. Install the number one cylinder spark plug. Refer to **Spark Plug Replacement** .
11. Install the rocker arm cover. 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. See **Special Tools**.

Removal Procedure

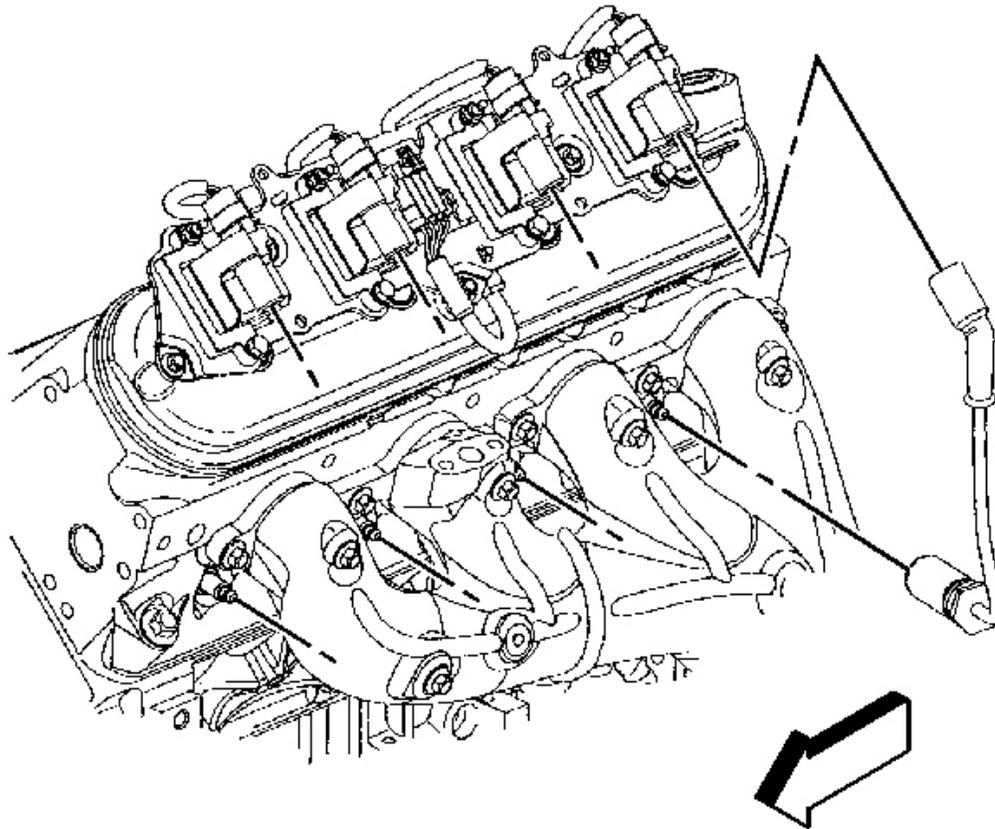


Fig. 123: View Of Spark Plug Wire & Boot
Courtesy of GENERAL MOTORS CORP.

1. Remove the rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement.**
2. Disconnect the spark plug wire at the spark plug.
 - Twist each plug wire boot 1/2 turn.
 - Pull only on the boot in order to remove the wire from the spark plug.

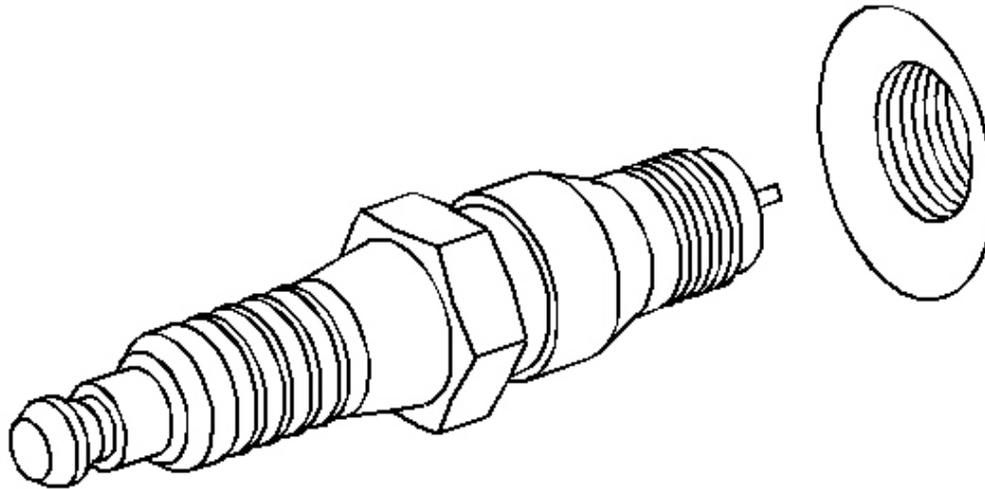


Fig. 124: View Of Spark Plug And Sparkplug Seat
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove the spark plugs from the cylinder head with the engine at room temperature.

3. Loosen the spark plug 1 or 2 turns.
4. Brush or air blast away any dirt or debris from around the spark plug.
5. Remove the spark plug.

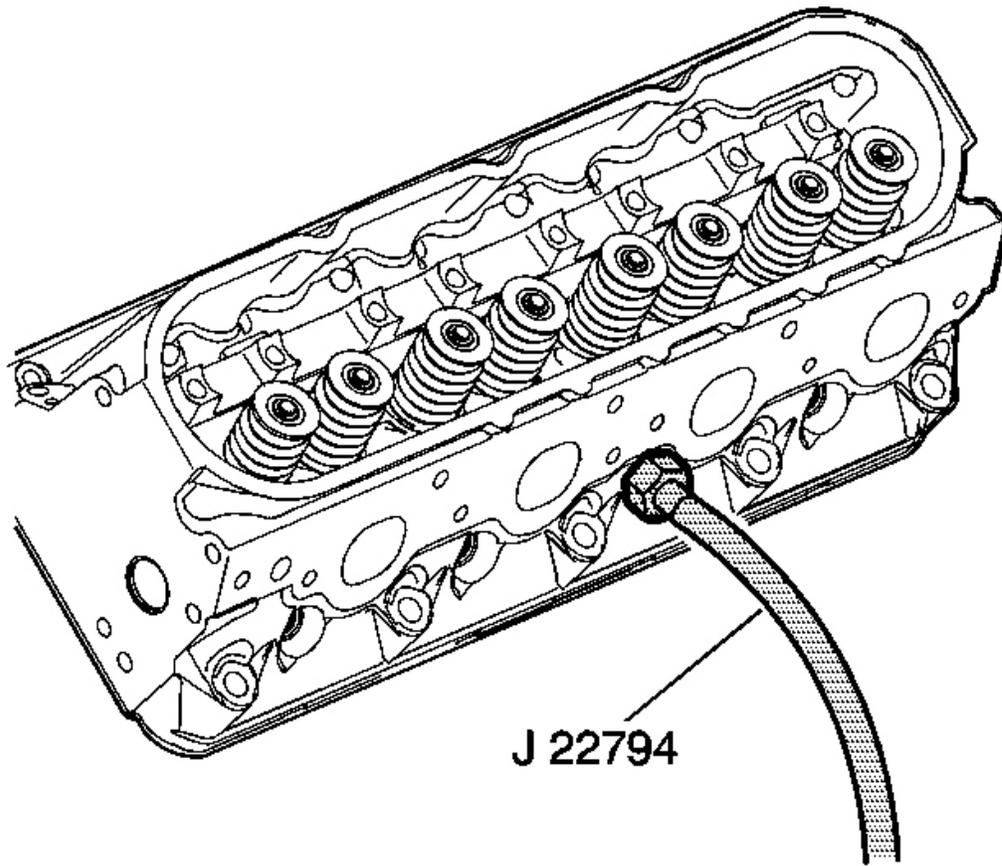


Fig. 125: Applying Compressed Air To J 22794
Courtesy of GENERAL MOTORS CORP.

6. Install the **J 22794** into the spark plug hole. See **Special Tools**.
7. Attach an air hose to the **J 22794** . See **Special Tools**.
8. Apply compressed air to the **J 22794** in order to hold the valves in place. See **Special Tools**.

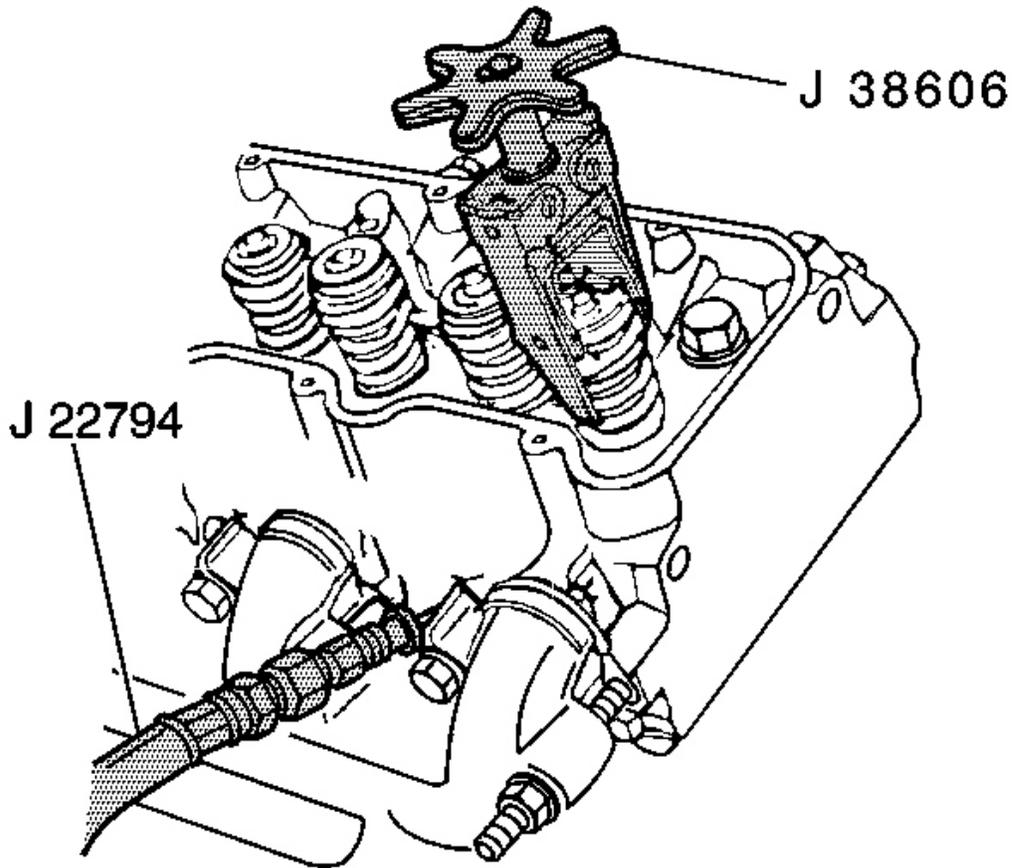


Fig. 126: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

9. Use the **J 38606** in order to compress the valve spring. See **Special Tools**.

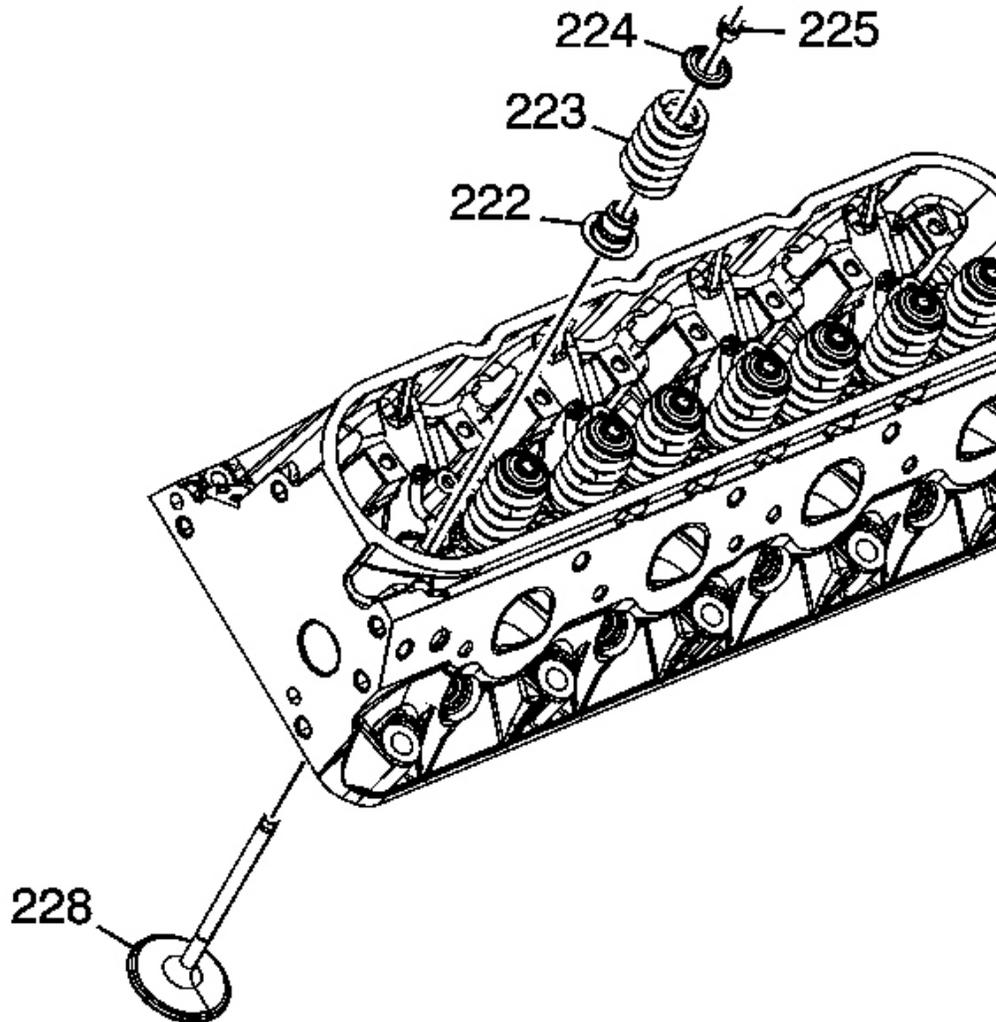


Fig. 127: Valve Stem Keys, Valve Spring Cap & Valve Spring
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve stem keys (225).
11. Carefully release the valve spring tension.
12. Remove the **J 38606** . See **Special Tools**.
13. Remove the valve spring cap (224).
14. Remove the valve spring (223).

15. Remove the valve stem oil seal (222).

16. Remove the valve (228).

Installation Procedure

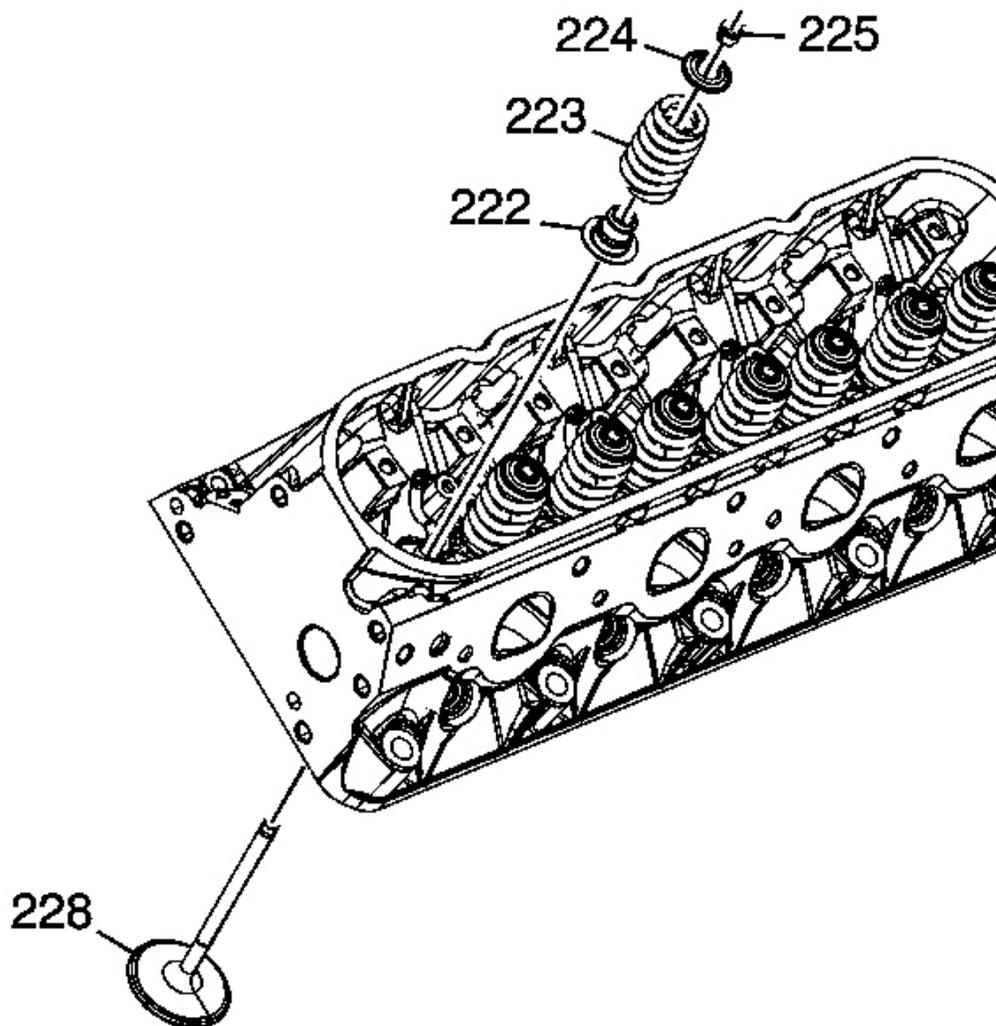


Fig. 128: Valve Stem Keys, Valve Spring Cap & Valve Spring
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring seat area.

2. Lubricate the valve guide and valve stem oil seal with clean engine oil.
3. Install the valves (228) into the proper port.
4. Install the valve stem oil seal (222).
5. Install the valve spring (223).
6. Install the valve spring cap (224).

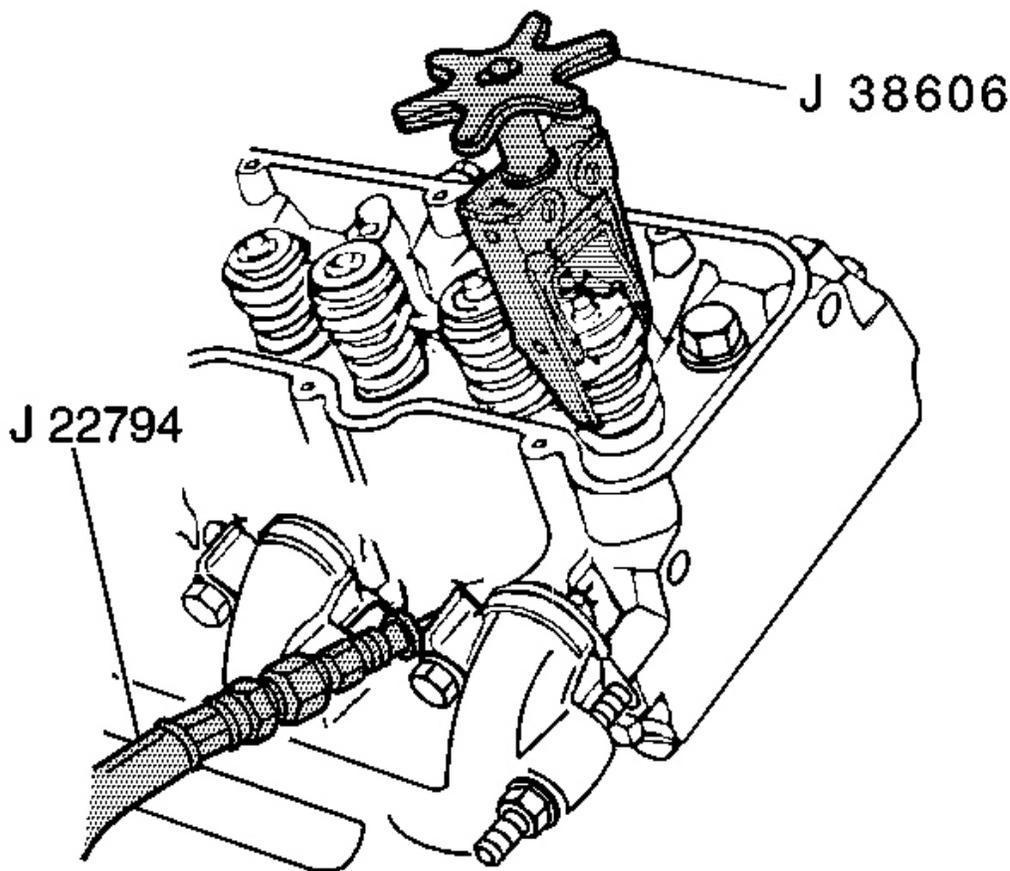


Fig. 129: Compressing Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

7. Compress the valve spring using the **J 38606** . See **Special Tools**.
8. Install the valve keys.
 - Use grease in order to hold the valve keys in place.

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- Make sure the keys seat properly in the groove of the valve stem.
- Carefully release the valve spring pressure, making sure the valve keys stay in place.
- Remove the **J 38606** . See **Special Tools**.
- Tap the end of the valve stem with a plastic faced hammer to seat the keys, if necessary.

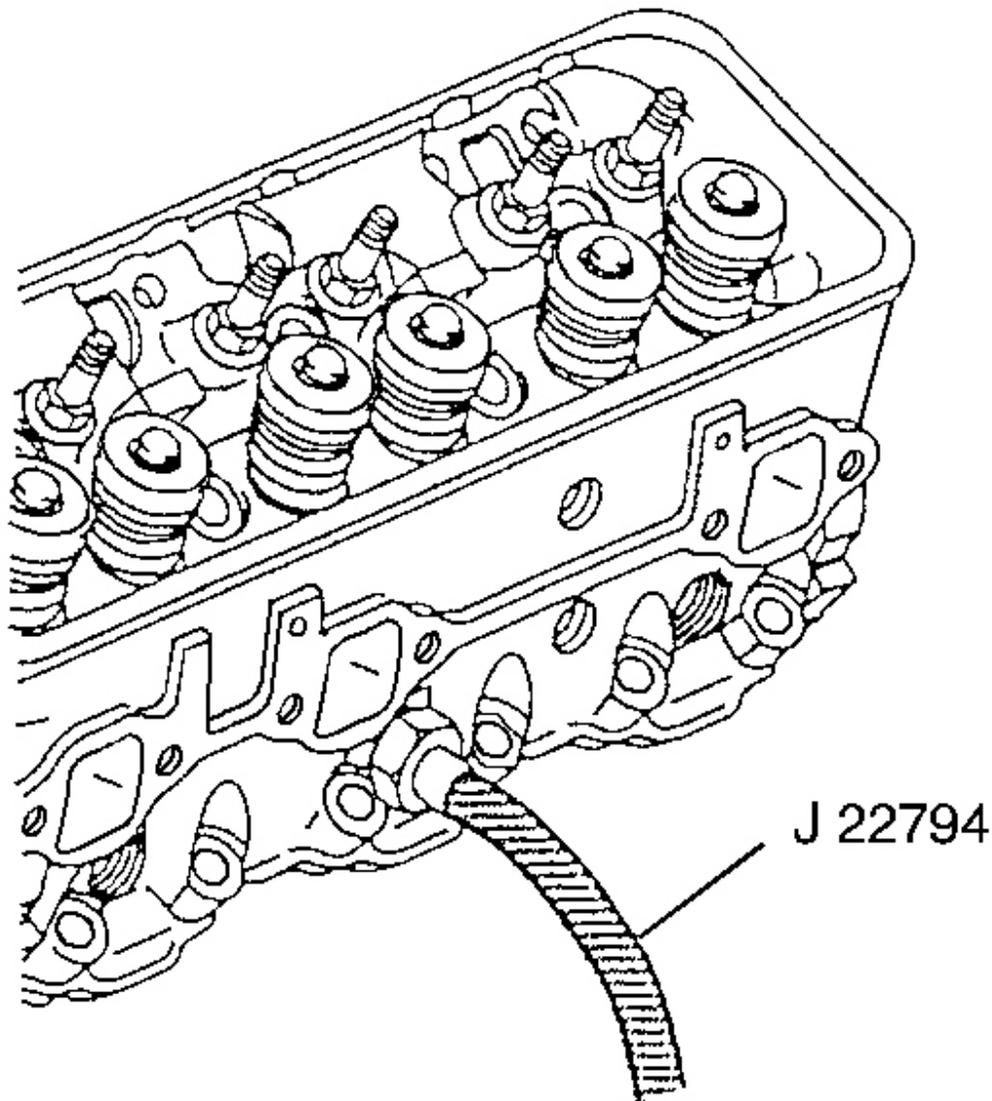
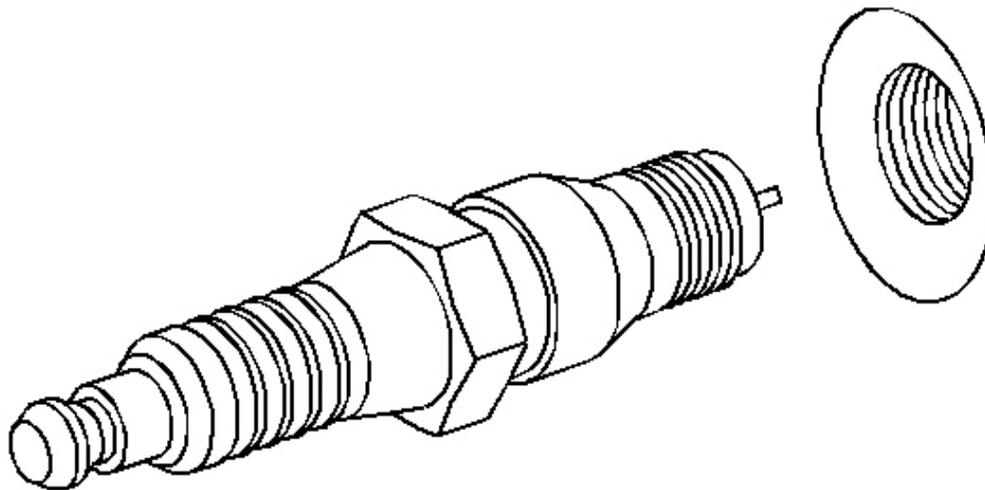


Fig. 130: View Of J 22794

Courtesy of GENERAL MOTORS CORP.

9. Remove the **J 22794** from the spark plug port. See **Special Tools**.

**Fig. 131: View Of Spark Plug And Sparkplug Seat**

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **Fastener Notice** .

10. Hand start the spark plug.

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

11. Install the spark plug wires at the ignition coil.
12. Install the spark plug wire to the spark plug.
13. Inspect the wires for proper installation:
 - Push sideways on each boot in order to check for proper installation.
 - Reinstall any loose boot.
14. Install the rocker arm. Refer to **Valve Rocker Arm and Push Rod Replacement**.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

Removal Procedure

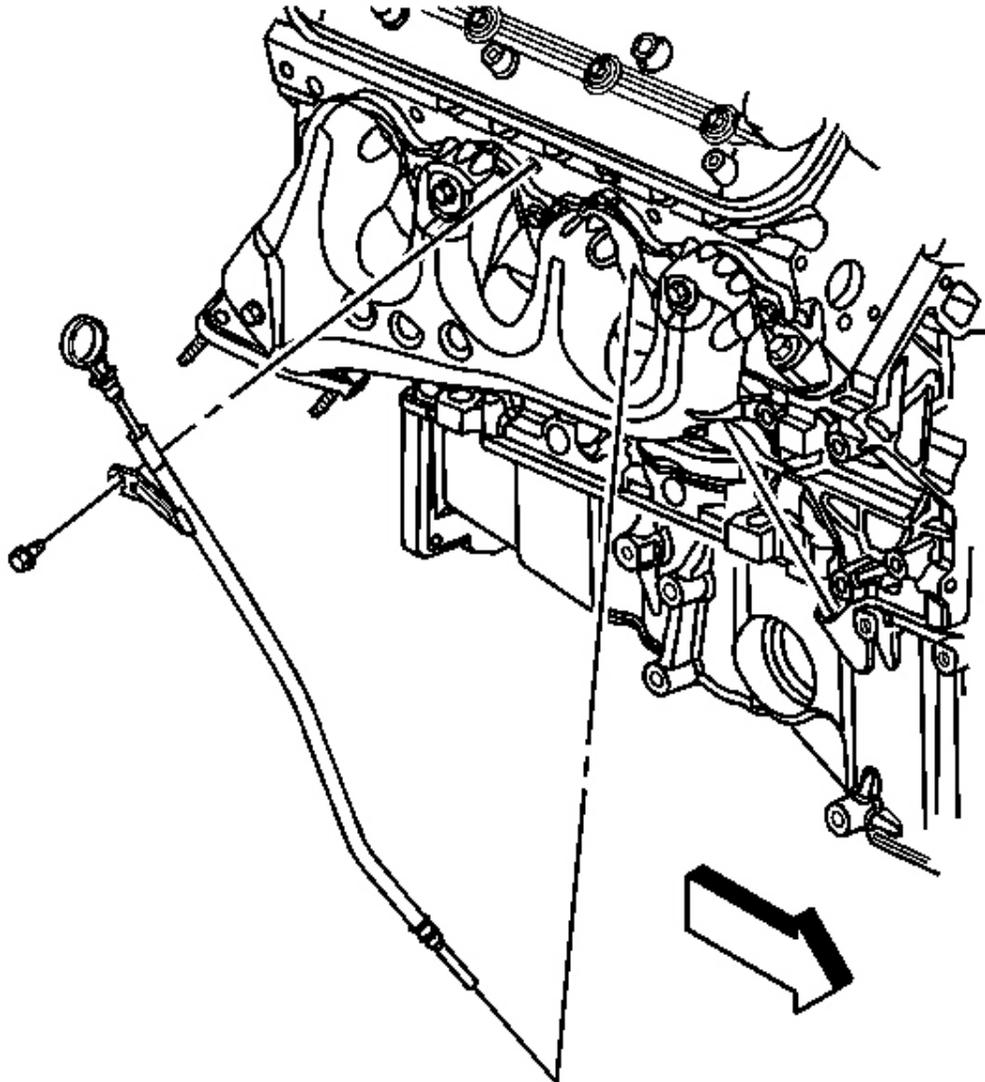


Fig. 132: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder number 2 spark plug and wire. Refer to **Spark Plug Replacement** .

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2. Remove the oil level indicator from the tube.
3. Remove the oil level indicator tube bolt.
4. Remove the oil level indicator tube from the engine block.

IMPORTANT: The O-ring seal may be reused if not cut or damaged.

5. Inspect the O-ring seal for cuts or damage.
6. Remove the O-ring seal from the tube, if required.

Installation Procedure

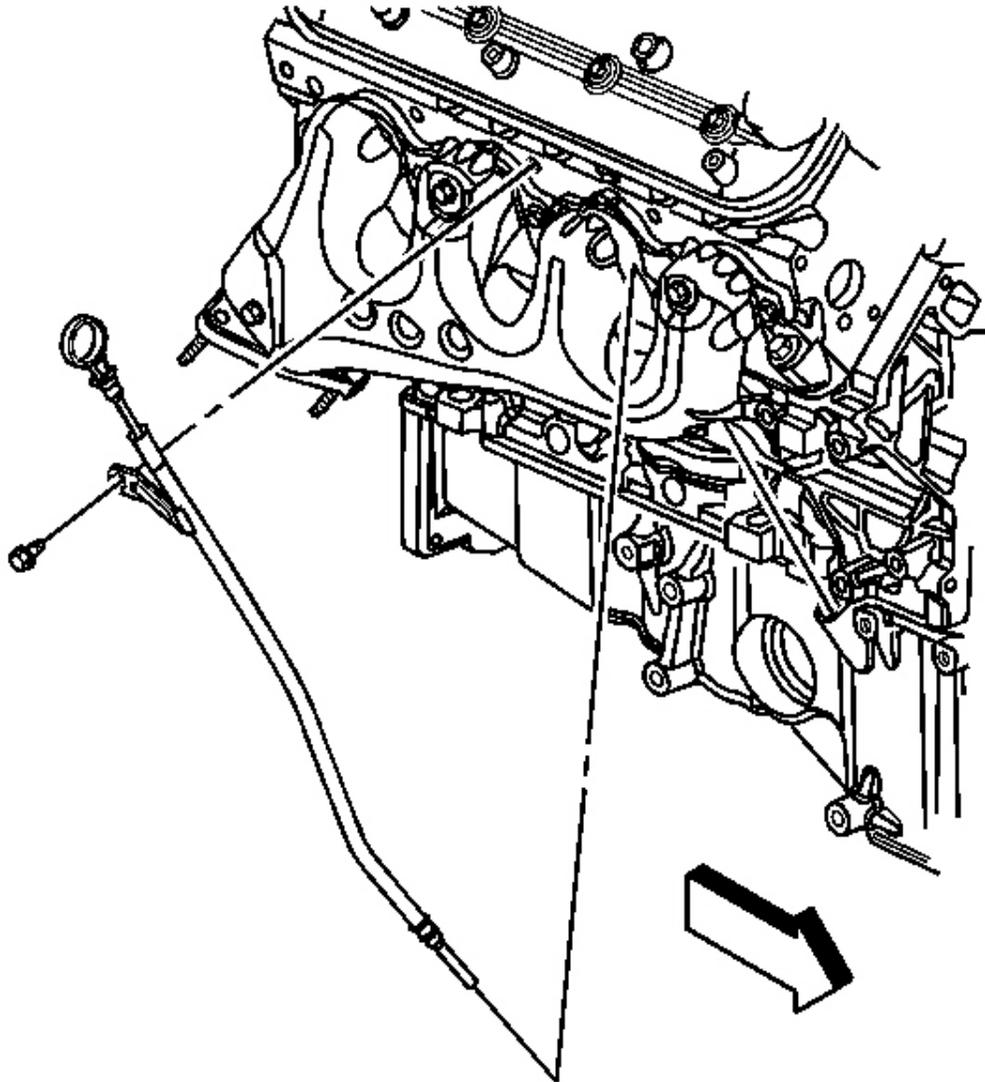


Fig. 133: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seal with clean engine oil.
2. Install the O-ring seal onto the oil level indicator tube.
3. Install the oil level indicator tube behind the exhaust manifold.
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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5. Install the oil level indicator tube into the block. Install the tube with the collar flush to the block.
6. Lower the vehicle.

NOTE: Refer to Fastener Notice .

7. Install the oil level indicator tube bolt.

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

8. Install the oil level indicator to the tube.
9. Install the cylinder number 2 spark plug and wire. Refer to Spark Plug Replacement .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Tools Required

- **J 45059** Angle Meter
- **J 42385-200** Common Thread Repair Kit. See Special Tools.

Removal Procedure

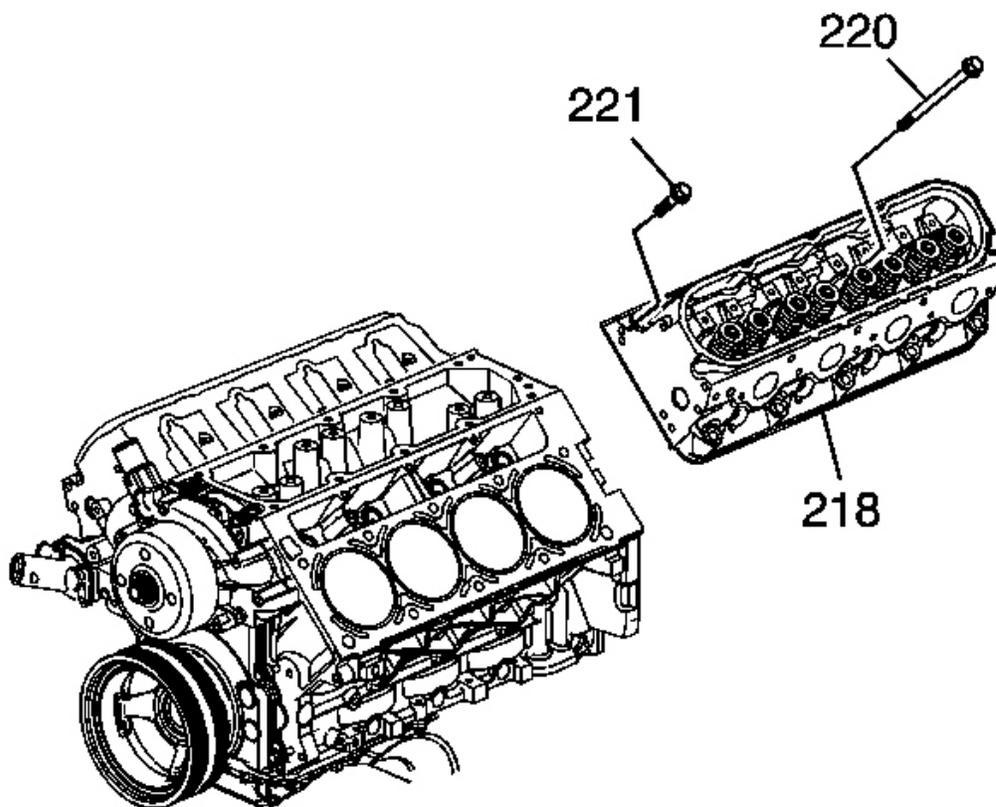


Fig. 134: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator bracket. Refer to **Generator Replacement (LH8)** .
2. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
3. Remove the coolant air bleed pipe. Refer to **Coolant Air Bleed Pipe Assembly Replacement (With LH8)** .
4. Remove the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LH8)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement** .

IMPORTANT: The cylinder head bolts are of a torque-to-yield design and are NOT to be reused.

6. Remove and discard the cylinder head bolts (220, 221).

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

7. Remove the cylinder head (218).

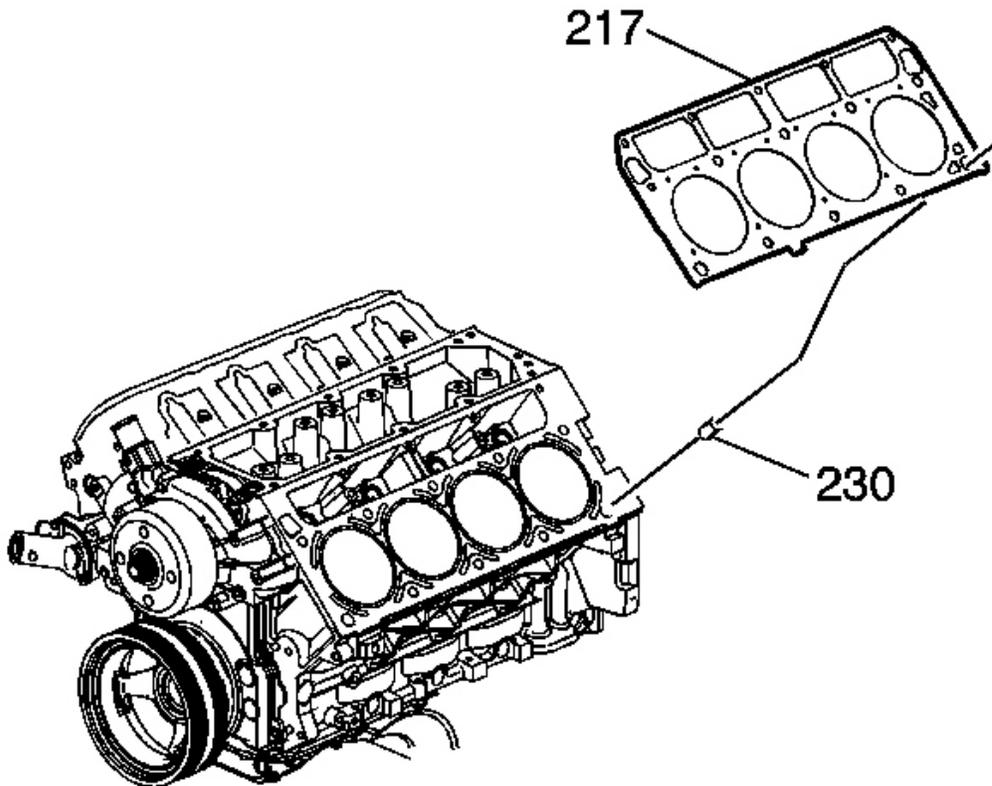


Fig. 135: Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the cylinder head gasket (217).
9. If required, clean and inspect the cylinder head. Refer to Cylinder Head Cleaning and Inspection.

CAUTION: Wear safety glasses in order to avoid eye damage.

NOTE: 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.

IMPORTANT:

- Do not reuse the cylinder head bolts. Install **NEW** cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket (unless specified).

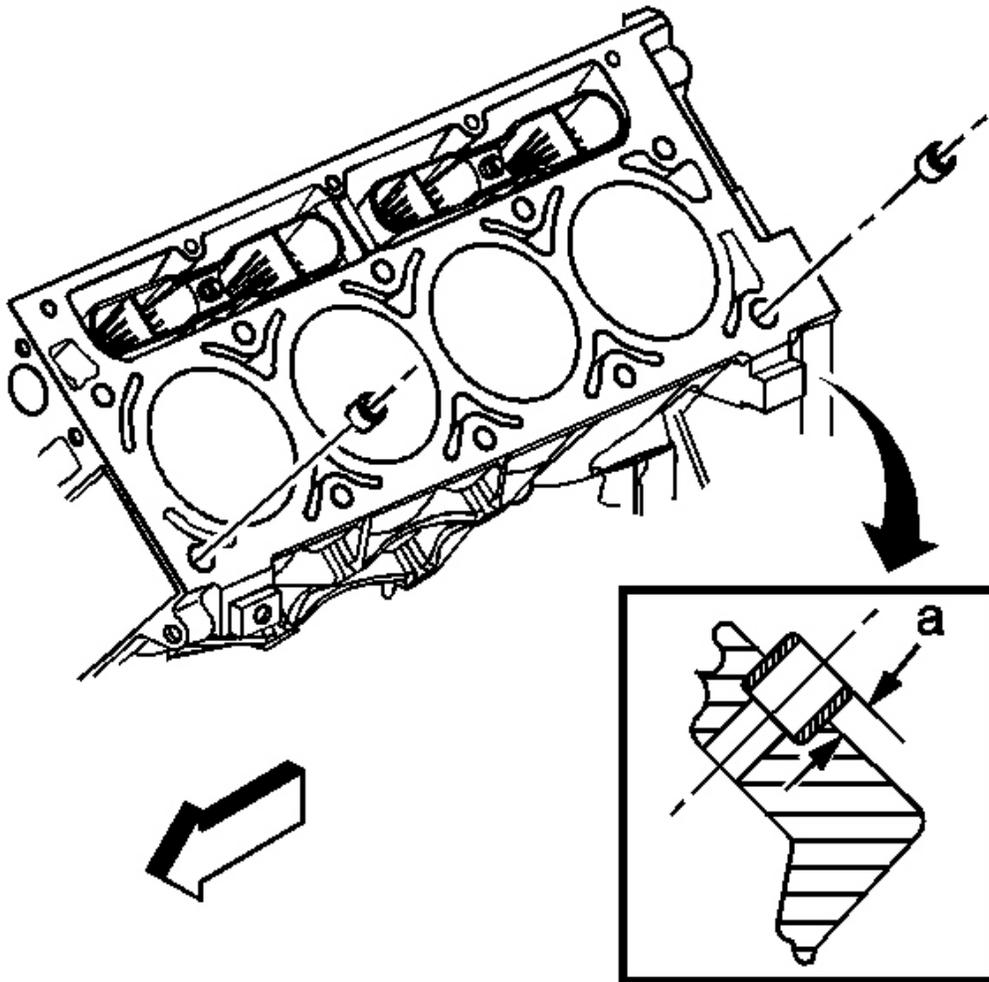


Fig. 136: Checking Cylinder Head Bolt Holes
Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes, if required. Thread repair tool J 42385-107, found in J 42385-200 may be used to clean the threads of old threadlocking material. See **Special Tools**.
2. Spray cleaner GM P/N 12346139, P/N 12377981 (Canadian P/N 10953463), or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation (a) 8.3 mm (0.327 in).

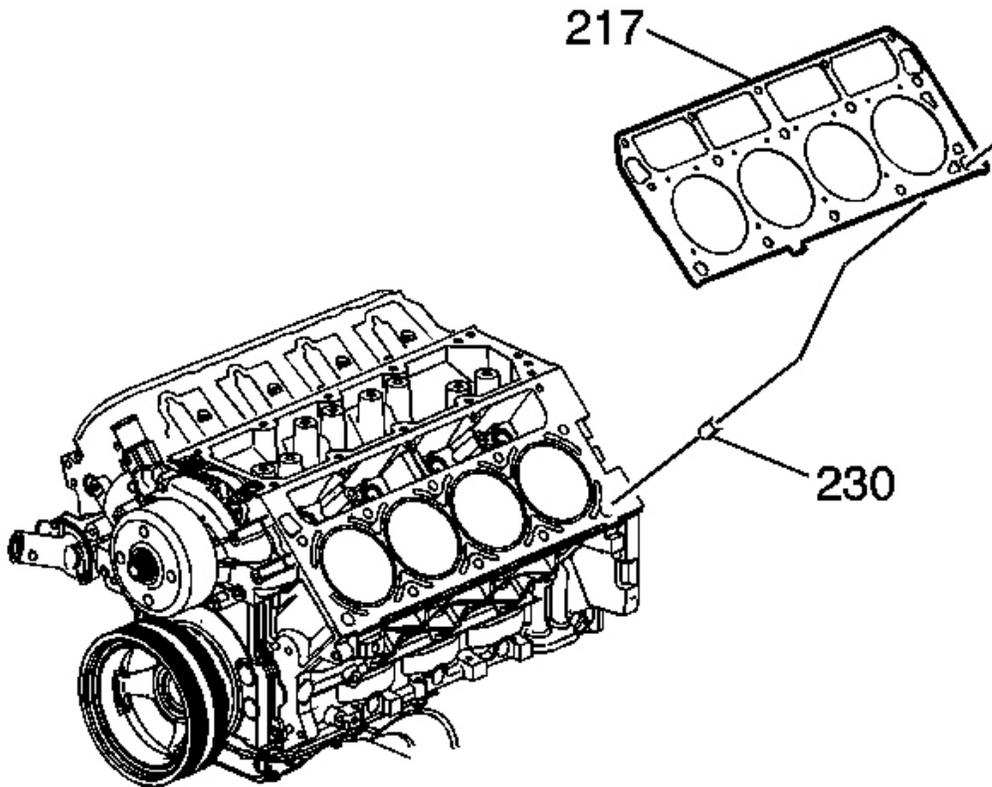


Fig. 137: Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When properly installed, with FRONT on the left side, the tab on the cylinder head gasket should be located left of center.

5. Install the NEW cylinder head gasket (217) onto the locating pins.

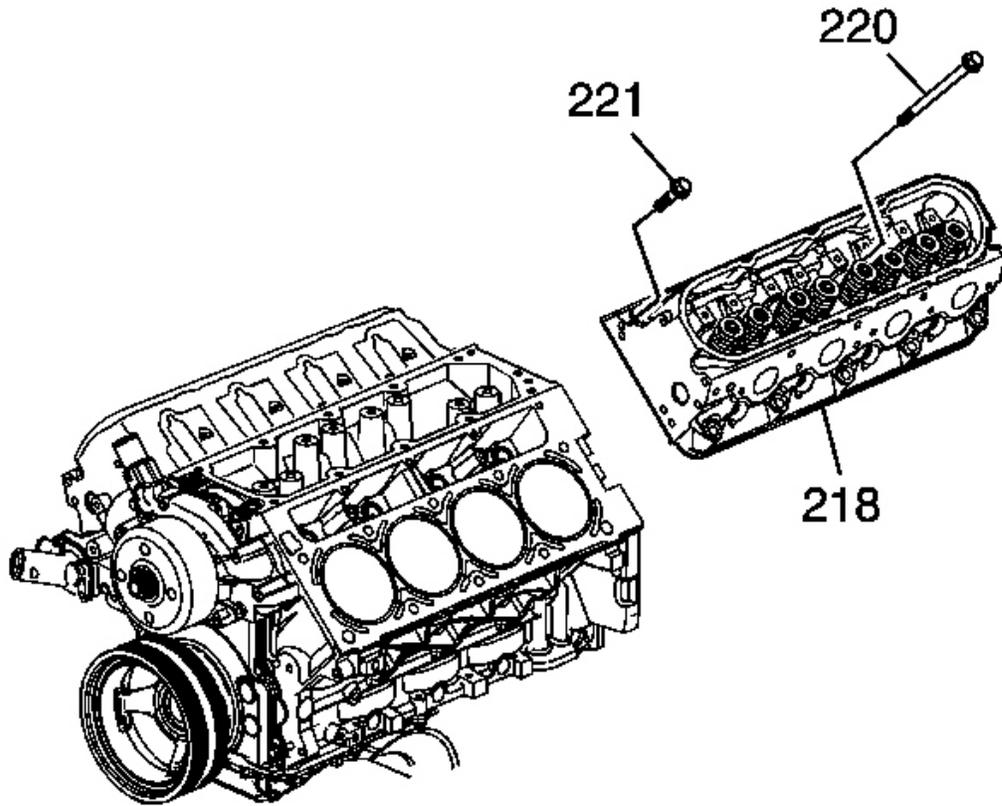


Fig. 138: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head (218) onto the locating pins.
7. Install the NEW cylinder head bolts (220, 221).

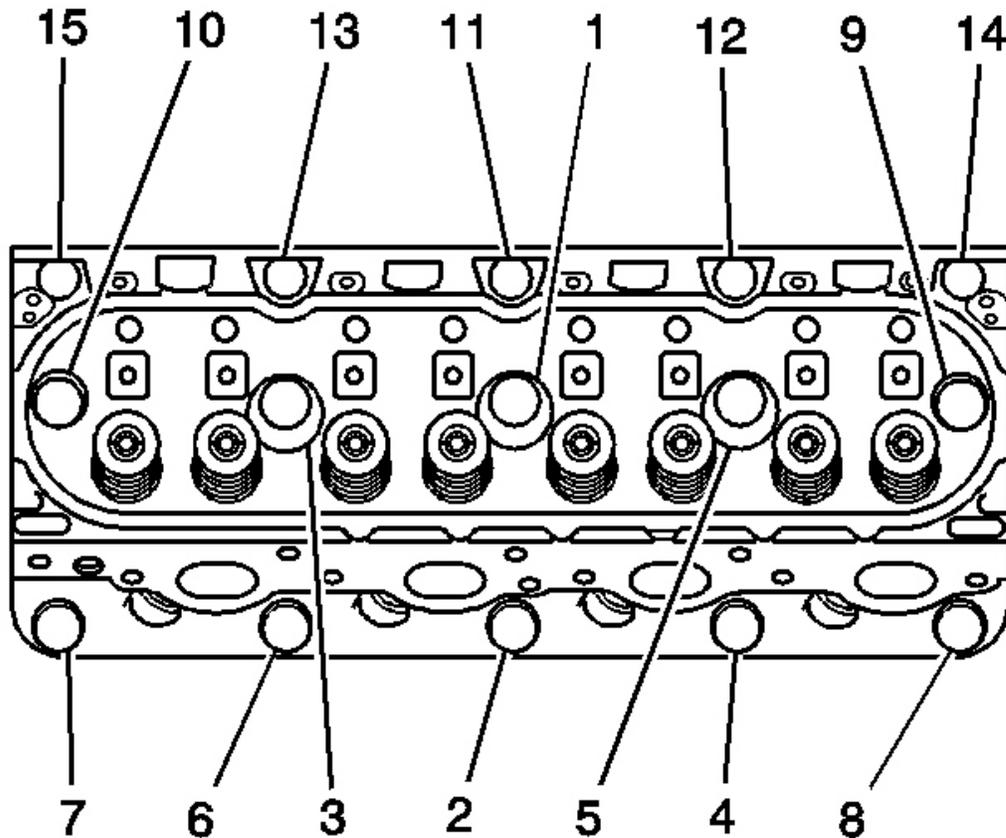


Fig. 139: Cylinder Head Bolts Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Tighten the cylinder head bolts.

Tighten:

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 **J 45059** .
3. Tighten the M11 cylinder head bolts (1-10) a final pass to 70 degrees using **J 45059** .

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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.
9. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
10. Install the left exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LH8)** .
11. Install the coolant air bleed pipe. Refer to **Coolant Air Bleed Pipe Assembly Replacement (With LH8)** .
12. Install the intake manifold. Refer to **Intake Manifold Replacement**.
13. Install the generator bracket. Refer to **Generator Replacement (LH8)** .

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Tools Required

- **J 45059** Angle Meter
- **J 42385-200** Common Thread Repair Kit. See **Special Tools**.

Removal Procedure

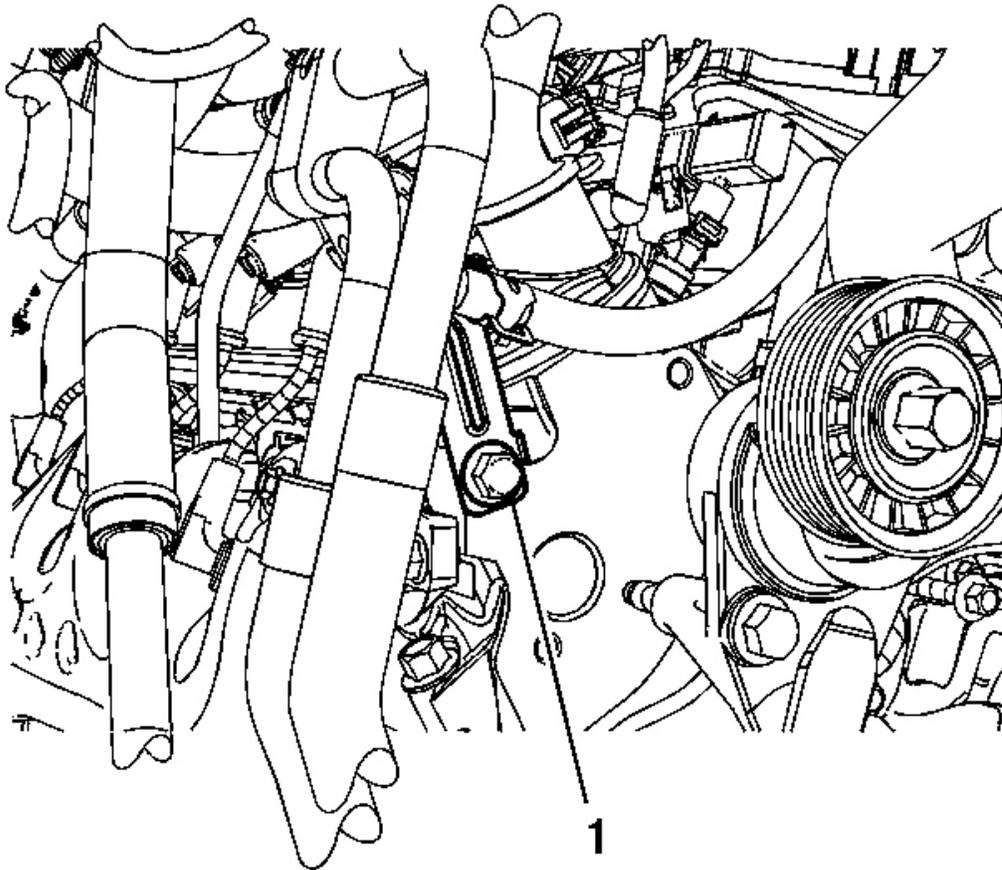


Fig. 140: Heater Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator. Refer to **Oil Level Indicator and Tube Replacement**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
3. Remove the coolant air bleed pipe. Refer to **Coolant Air Bleed Pipe Assembly Replacement (With LH8)** .
4. Remove the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LH8)** .
5. Remove the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Remove the heater hose bracket bolt (1) from the front of the right cylinder head.

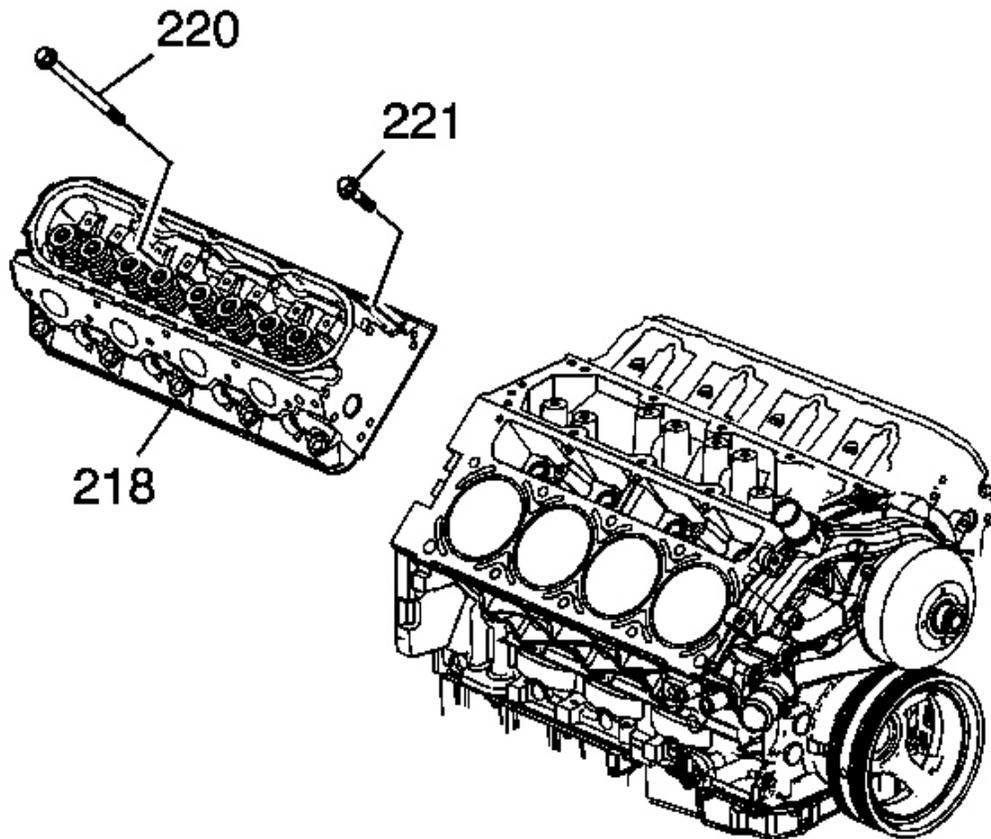


Fig. 141: Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The cylinder head bolts are of a torque-to-yield design and are **NOT** to be reused.

7. Remove and discard the cylinder head bolts (220, 221).

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

8. Remove the cylinder head (218).

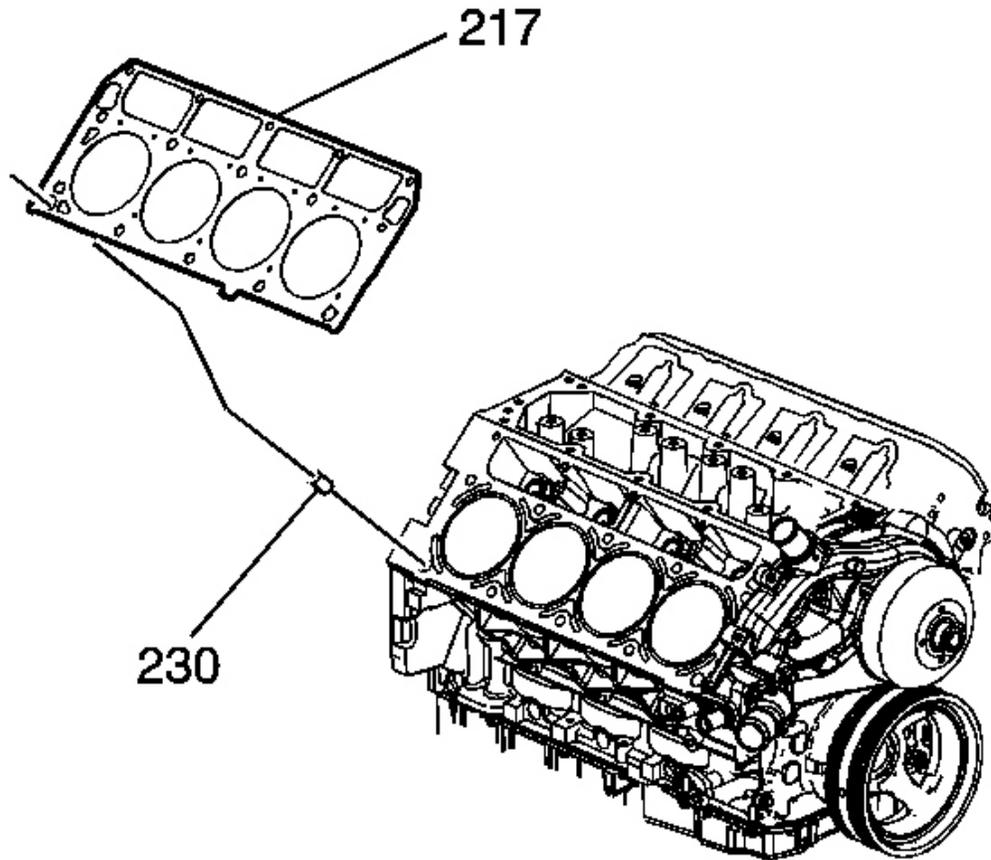


Fig. 142: Cylinder Head

Courtesy of GENERAL MOTORS CORP.

9. Remove and discard the cylinder head gasket (217).
10. If required, clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection**.

Installation Procedure

CAUTION: Wear safety glasses in order to avoid eye damage.

NOTE: 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.

IMPORTANT:

- Do not reuse the cylinder head bolts. Install **NEW** cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket (unless specified).

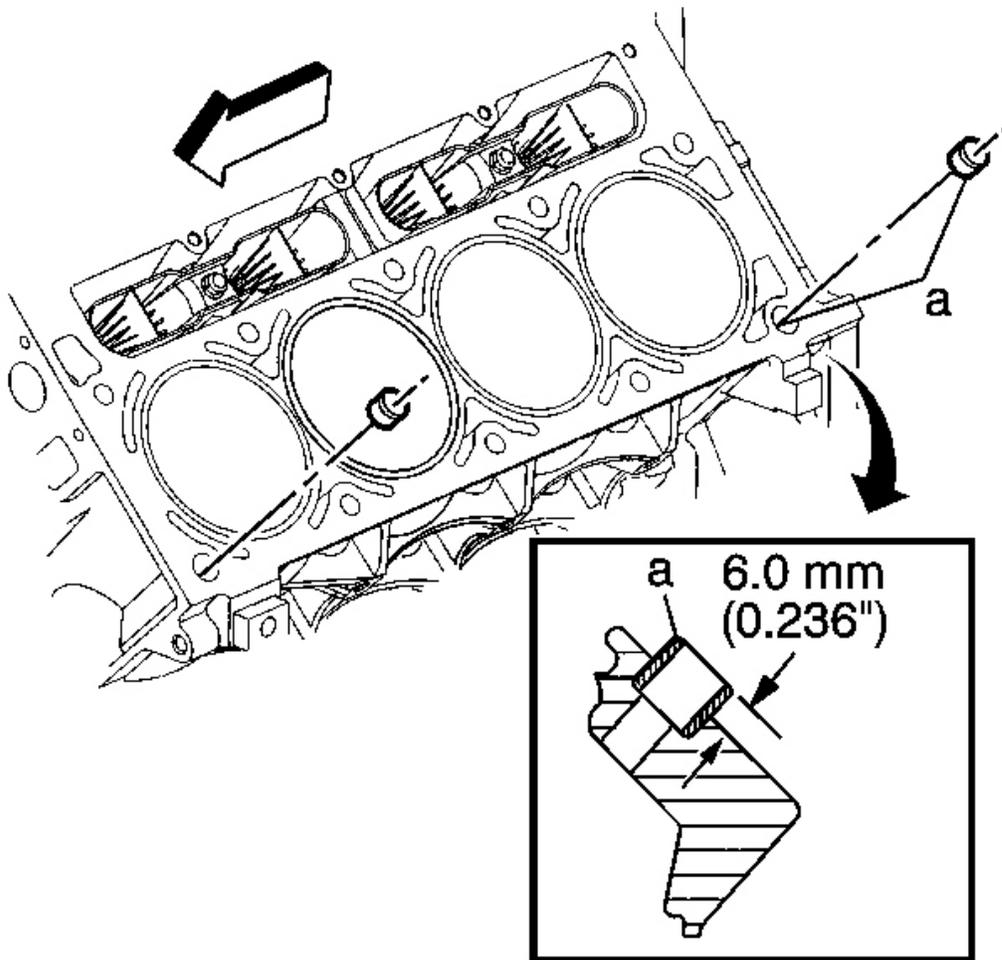


Fig. 143: Identifying Cylinder Head Locating Pins Installation Position

Courtesy of GENERAL MOTORS CORP.

1. Clean the engine block cylinder head bolt holes, if required. Thread repair tool J 42385-107, found in **J 42385-200** may be used to clean the threads of old threadlocking material. See **Special Tools**.
2. Spray cleaner GM P/N 12346139, P/N 12377981 (Canadian P/N 10953463), or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation (a) 8.3 mm (0.327 in).

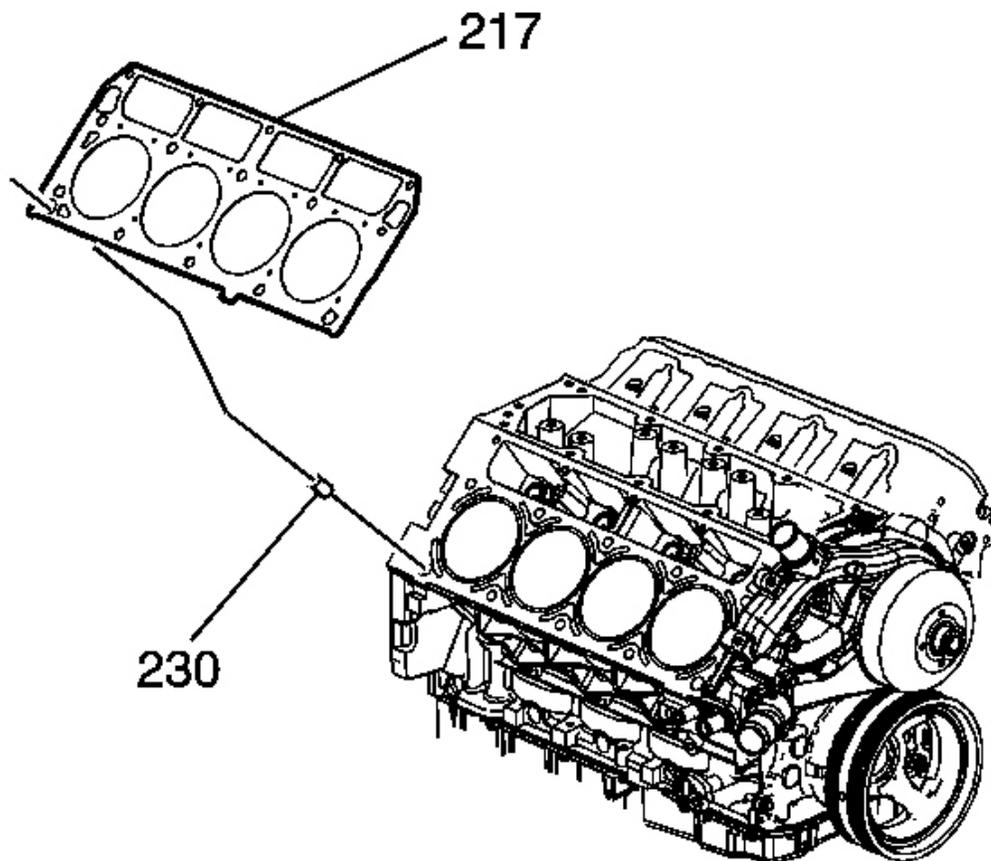


Fig. 144: Cylinder Head
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When properly installed, with FRONT on the right side, the tab on the cylinder head gasket should be located right of center.

5. Install the NEW cylinder head gasket (217) onto the locating pins.

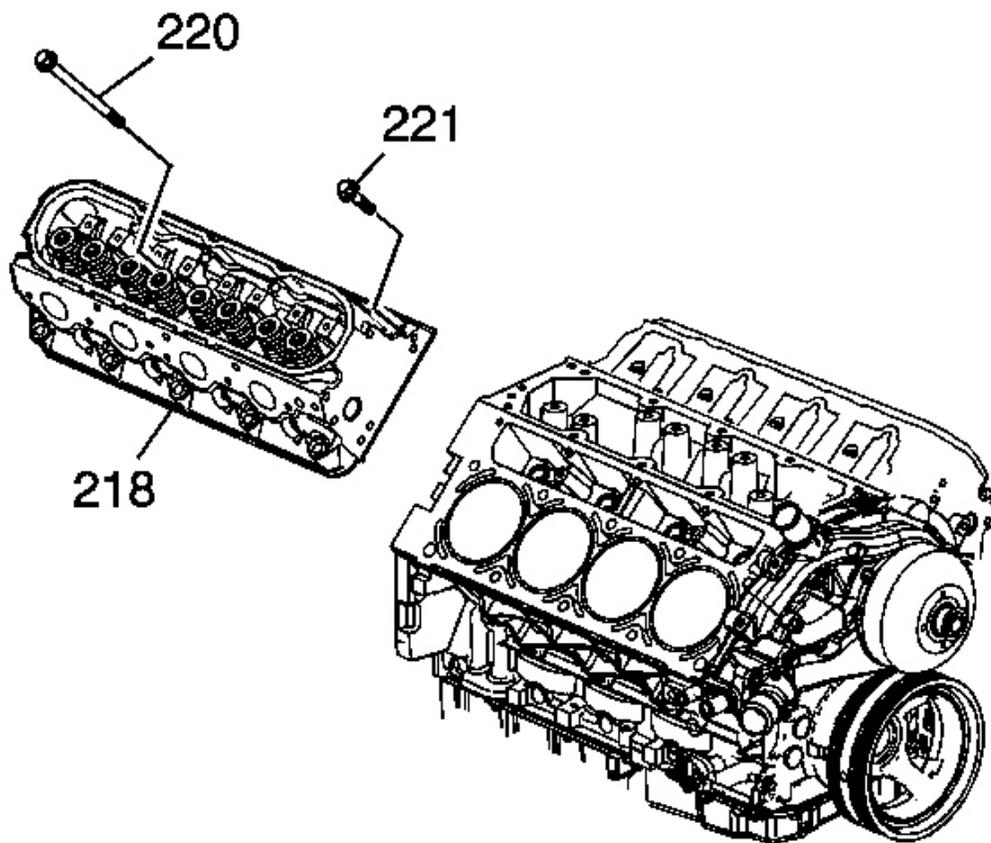


Fig. 145: Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the cylinder head (218) onto the locating pins.
7. Install the NEW cylinder head bolts (220, 221).

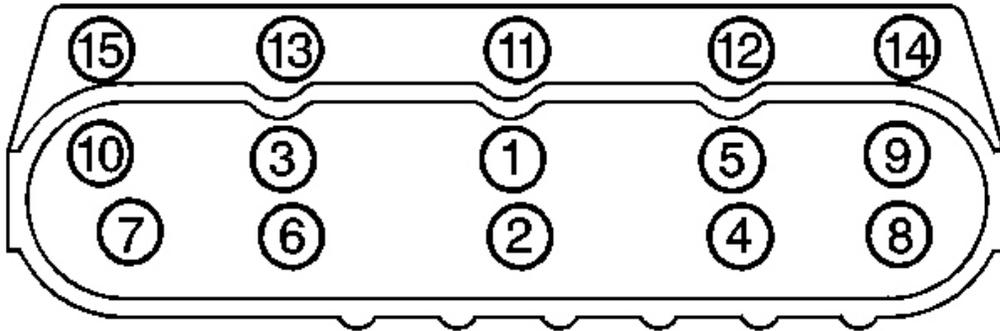


Fig. 146: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Tighten the cylinder head bolts.

Tighten:

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 **J 45059** .
3. Tighten the M11 cylinder head bolts (1-10) a final pass to 70 degrees in sequence using **J 45059** .
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.

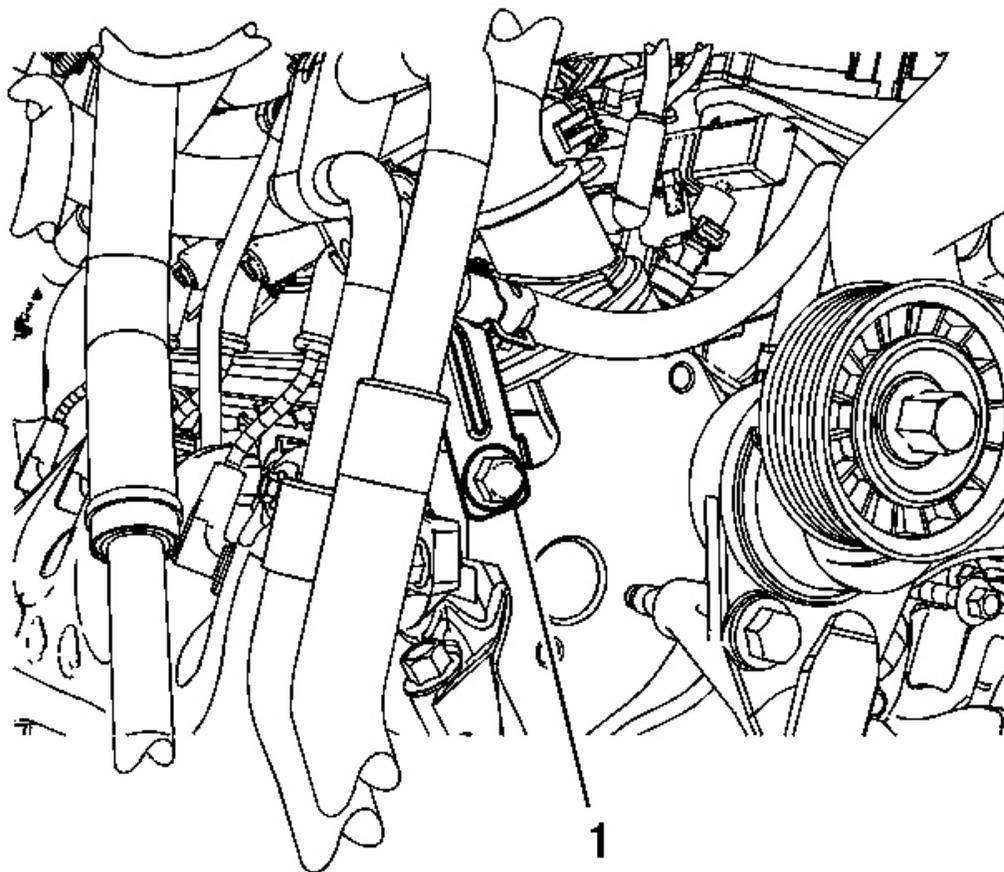


Fig. 147: Heater Hose Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

9. Install the heater hose bracket bolt (1) to the front of the right cylinder head.

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

10. Install the pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
11. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LH8)** .
12. Install the coolant air bleed pipe. Refer to **Coolant Air Bleed Pipe Assembly Replacement (With LH8)** .
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.

14. Install the oil level indicator. Refer to Oil Level Indicator and Tube Replacement.

VALVE LIFTER REPLACEMENT

Tools Required

J 3049-A Valve Lifter Remover

Removal Procedure

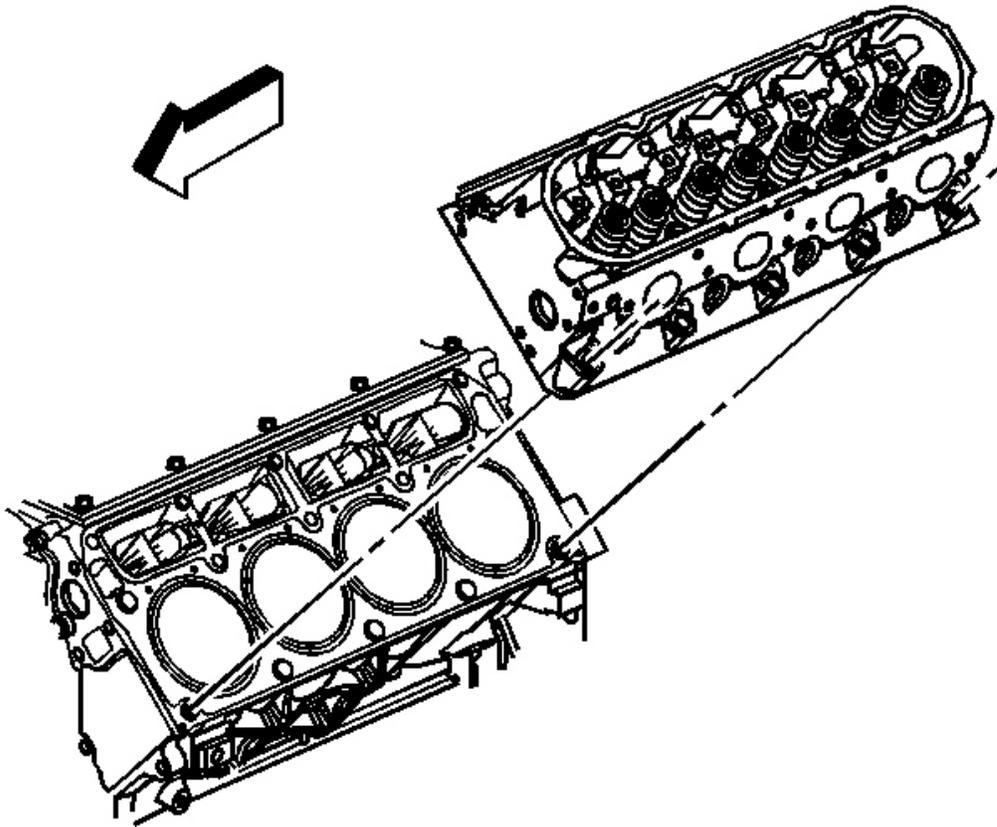


Fig. 148: View Of Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side or to Cylinder Head Replacement - Right Side.

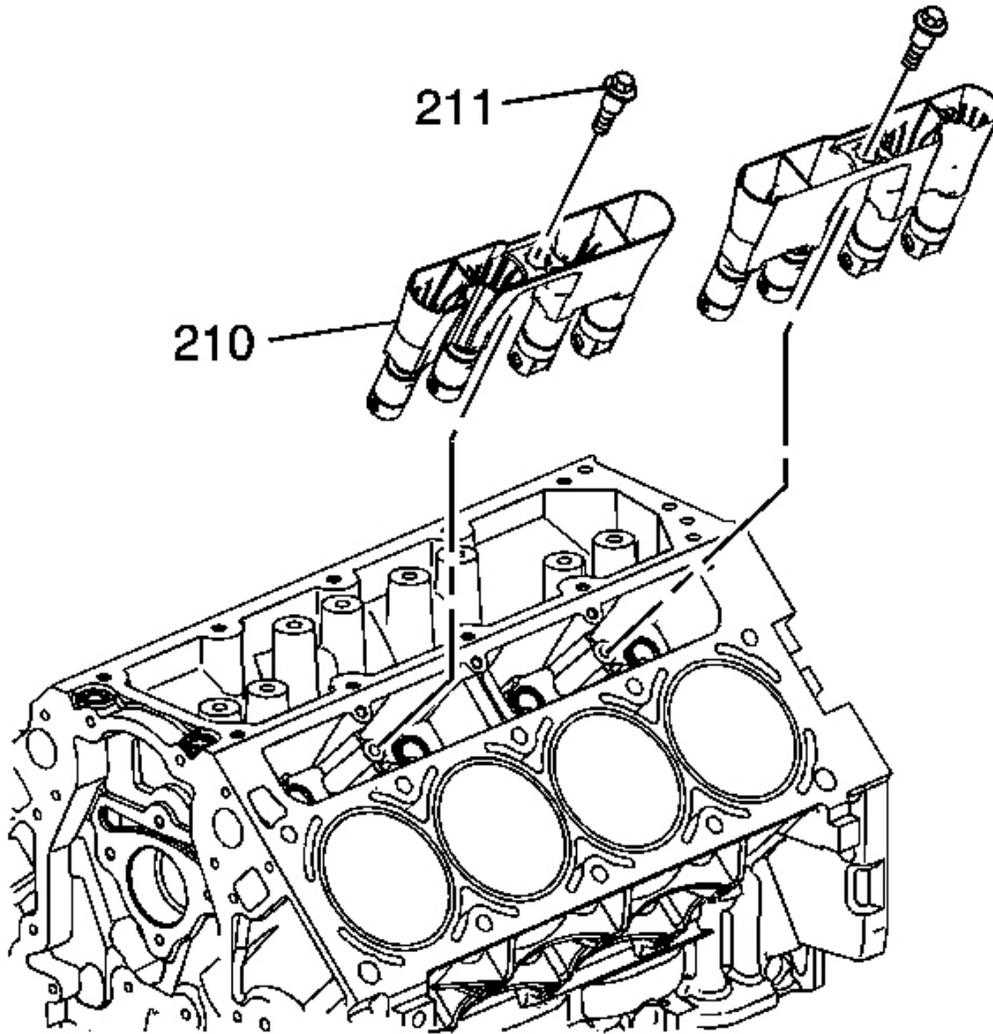


Fig. 149: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve lifter. Refer to **Valve Lifter Removal**.
3. Clean and inspect the valve lifters. Refer to **Valve Lifter and Guide Cleaning and Inspection**.

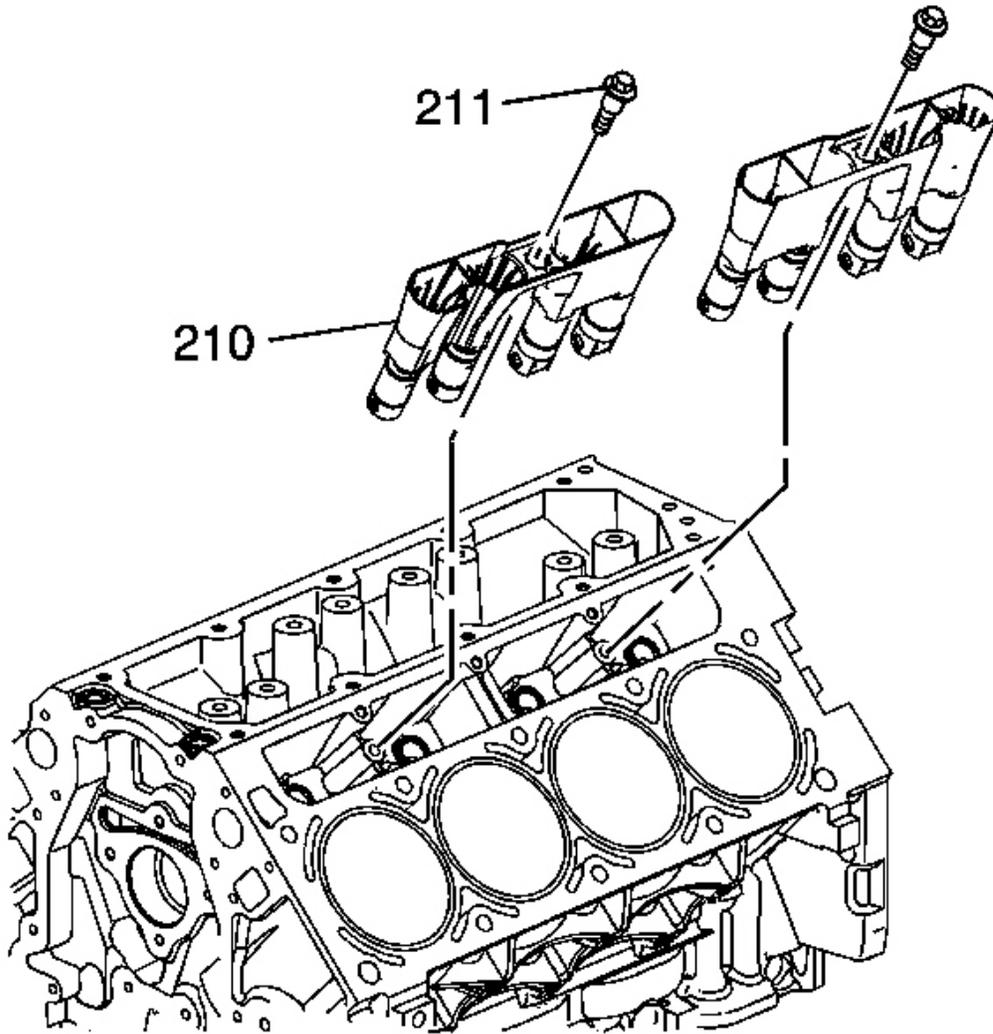


Fig. 150: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

1. Install the valve lifter. Refer to **Valve Lifter Installation**.

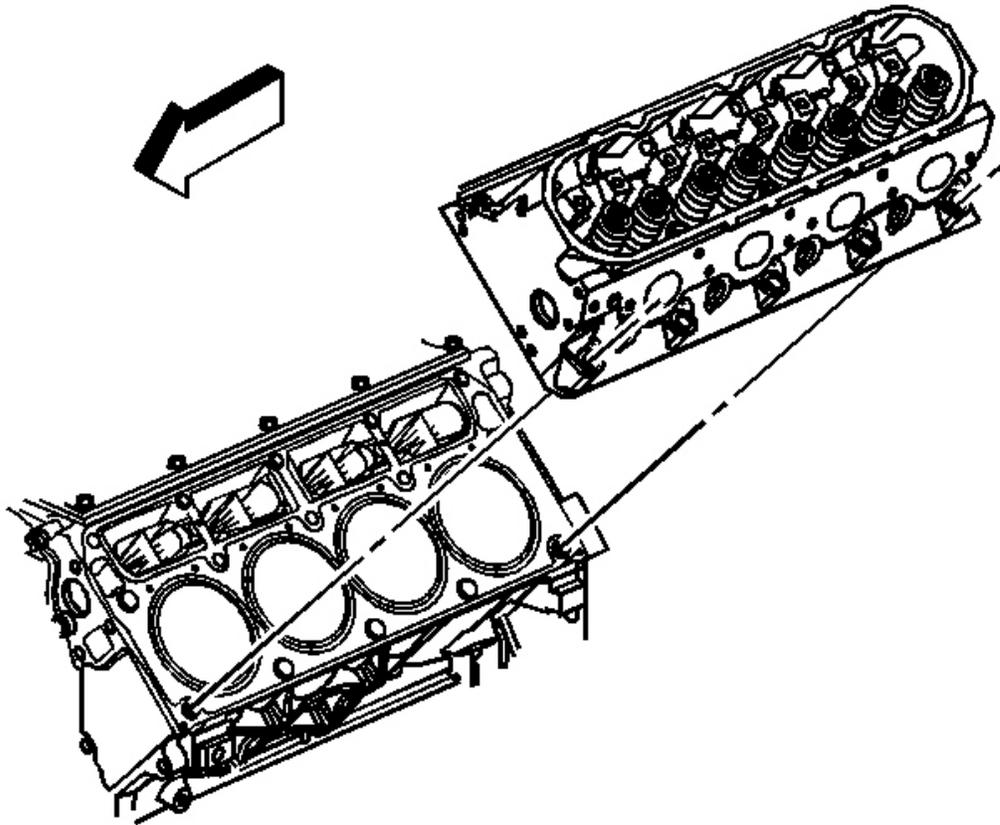


Fig. 151: View Of Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

2. Install the cylinder head and gasket. Refer to Cylinder Head Replacement - Left Side or to Cylinder Head Replacement - Right Side.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **J 41478** Crankshaft Front Oil Seal Installer. See Special Tools.
- **J 41665** Crankshaft Balancer and Sprocket Installer. See Special Tools.
- **J 41816-A** Crankshaft Balancer Remover. See Special Tools.
- **J 41816-2** Crankshaft End Protector

- **J 42386-A** Flywheel Holding Tool. See **Special Tools**.
- **J 45059** Angle Meter

Removal Procedure

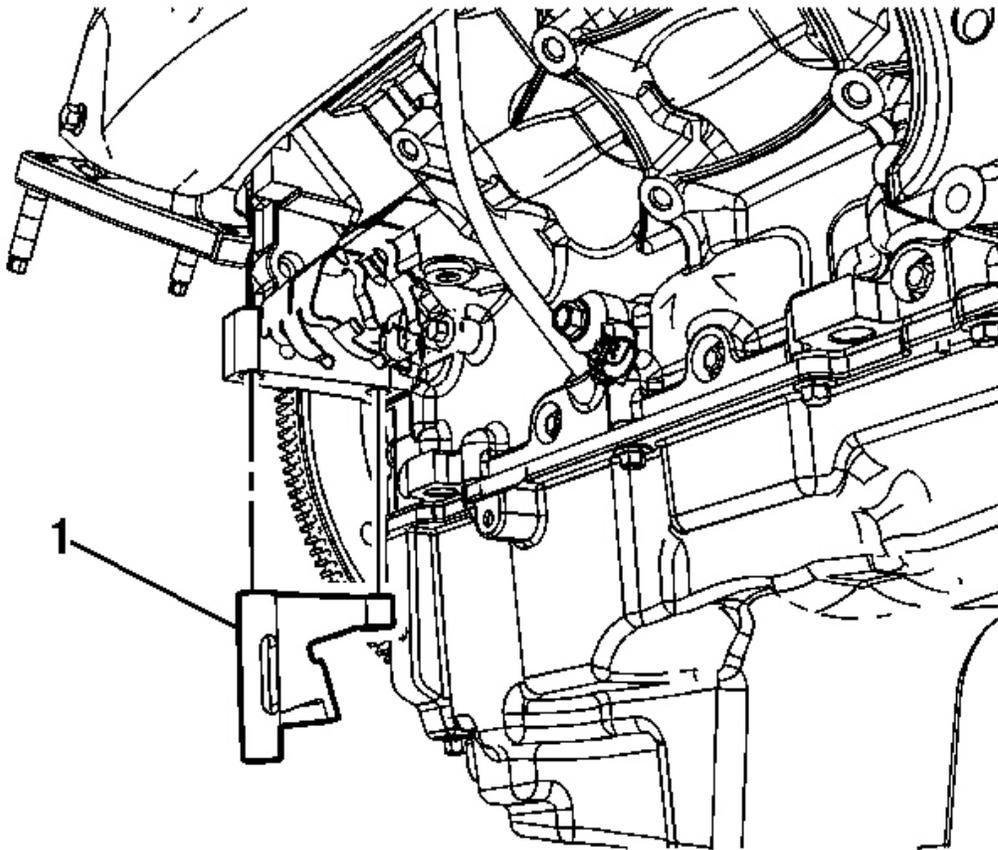


Fig. 152: Air Conditioning Drive Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement (LH8)**.
2. Remove the cooling fan and shroud. Refer to **Fan Shroud Replacement (LLR)**.
3. Remove the starter motor. Refer to **Starter Motor Replacement (LH8)**.

NOTE: Refer to Fastener Notice .

IMPORTANT: Ensure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See Special Tools.

4. Install the J 42386-A (1) and bolts. See Special Tools. Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

Tighten: Tighten the J 42386-A bolts to 50 N. See Special Tools.m (37 lb ft).

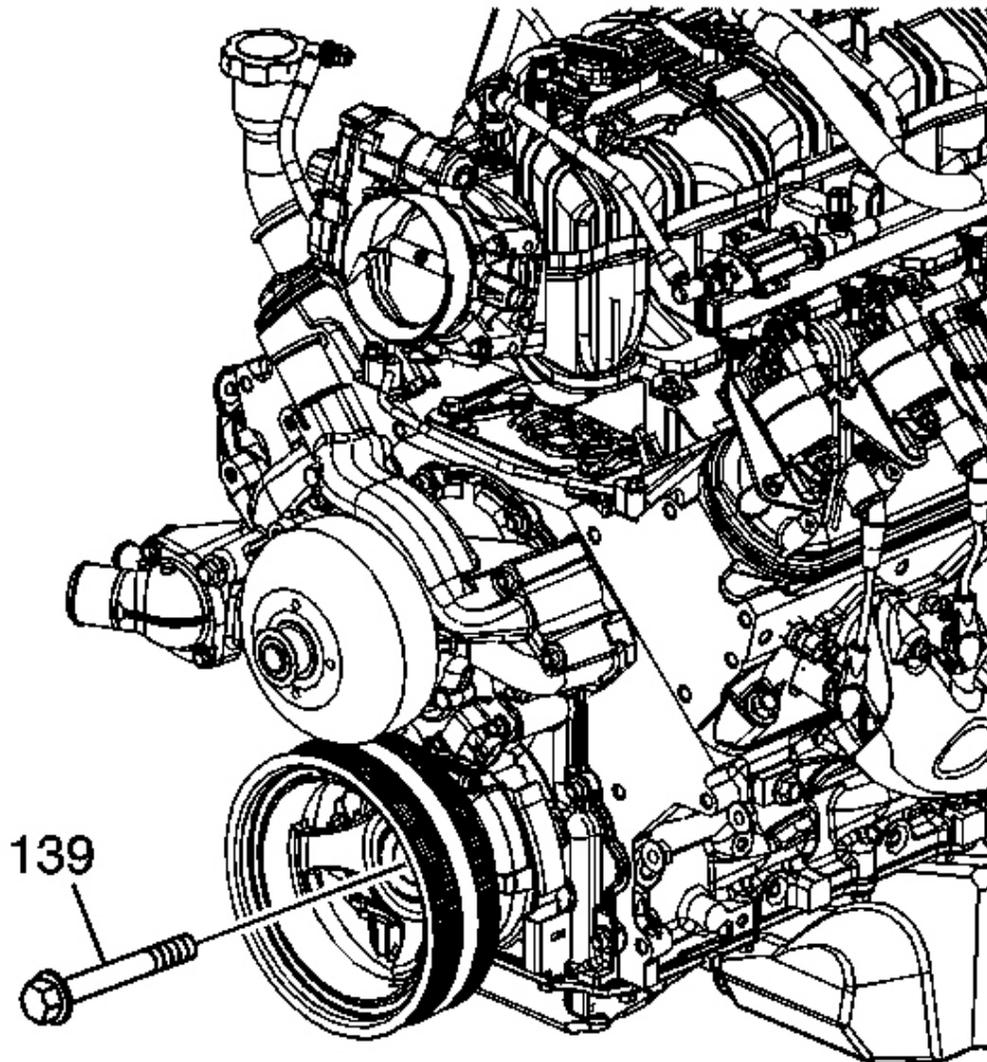


Fig. 153: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft balancer bolt (139). Do not discard the crankshaft balancer bolt at this time. The old balancer bolt will be used during the balancer installation procedure.

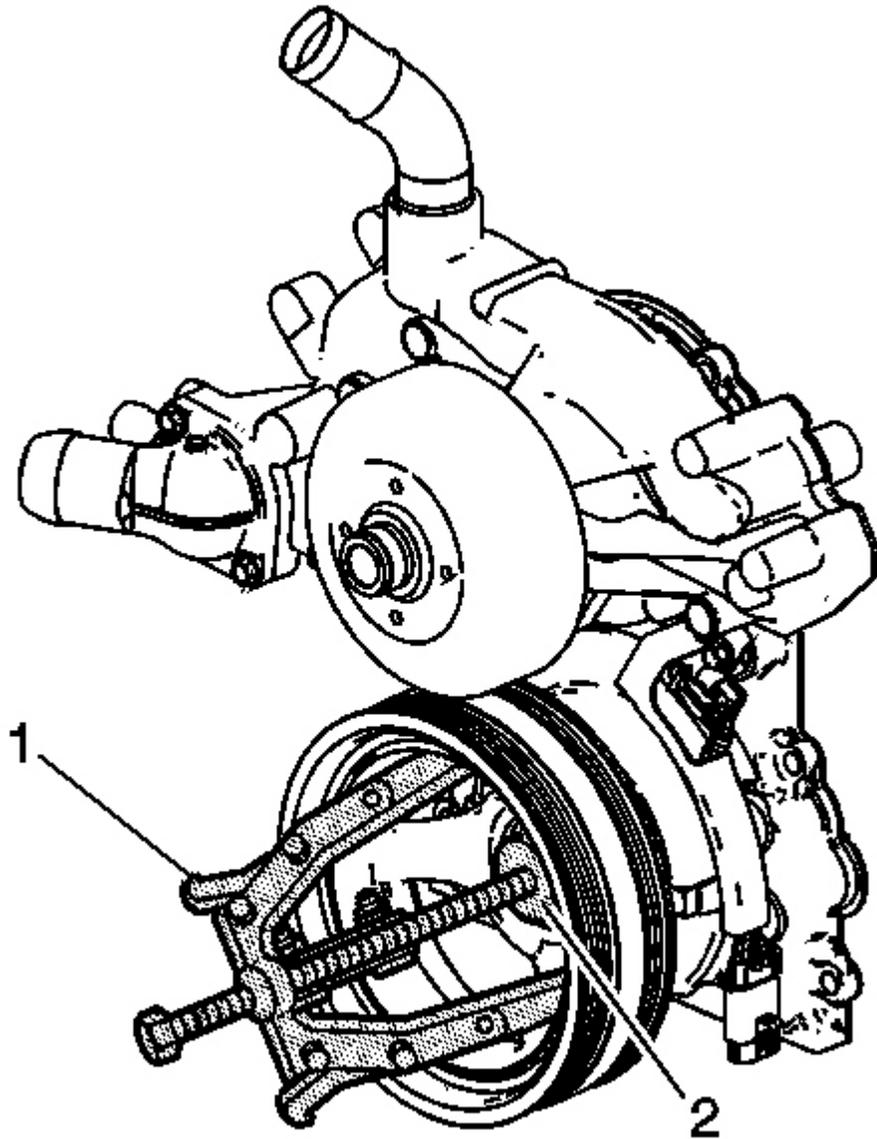


Fig. 154: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

6. Install the **J 41816** (1) and **J 41816-2** (2) to the crankshaft balancer.

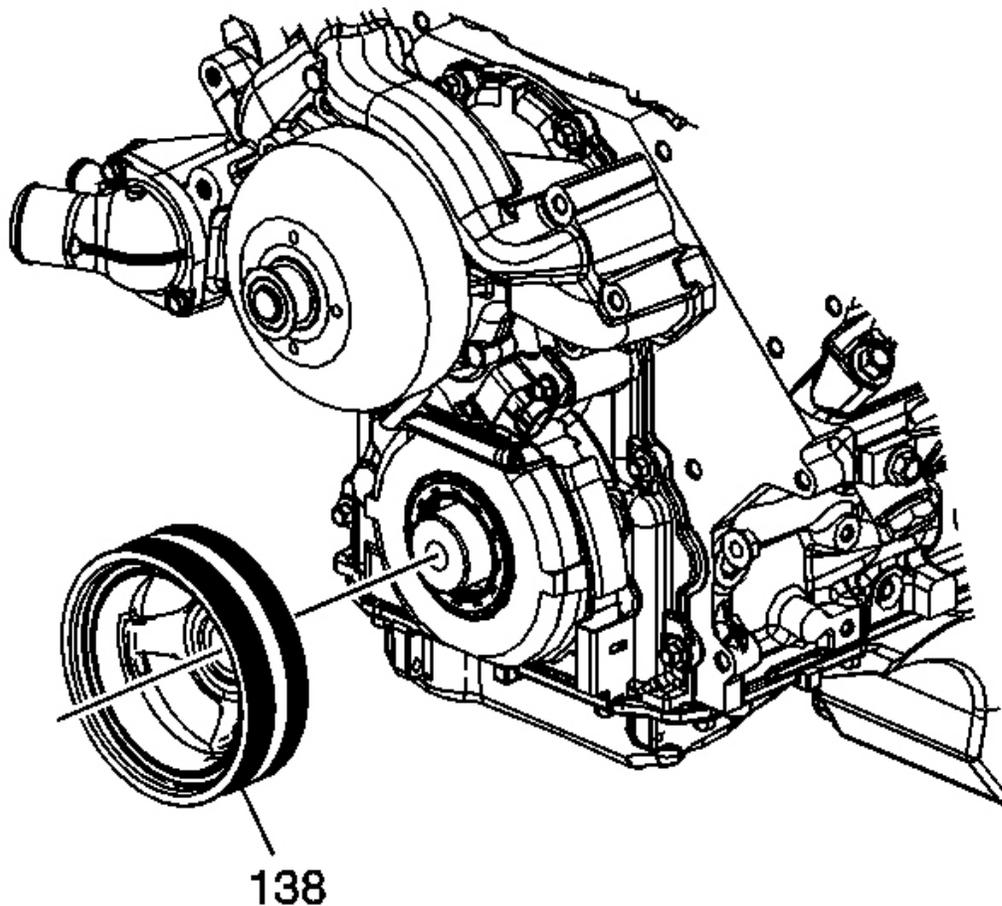


Fig. 155: Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The crankshaft balancer is balanced as an individual component. It is not necessary to mark the balancer prior to removal.

7. Use the **J 41816** and the **J 41816-2** to remove the crankshaft balancer (138).
8. Remove the **J 41816** and the **J 41816-2** from the crankshaft balancer.

IMPORTANT:

- The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third, and fourth passes tighten the **NEW** bolt to the proper torque.
- The used crankshaft balancer bolt will be used **ONLY** during the first pass of the balancer installation procedure. Install a **NEW** bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.

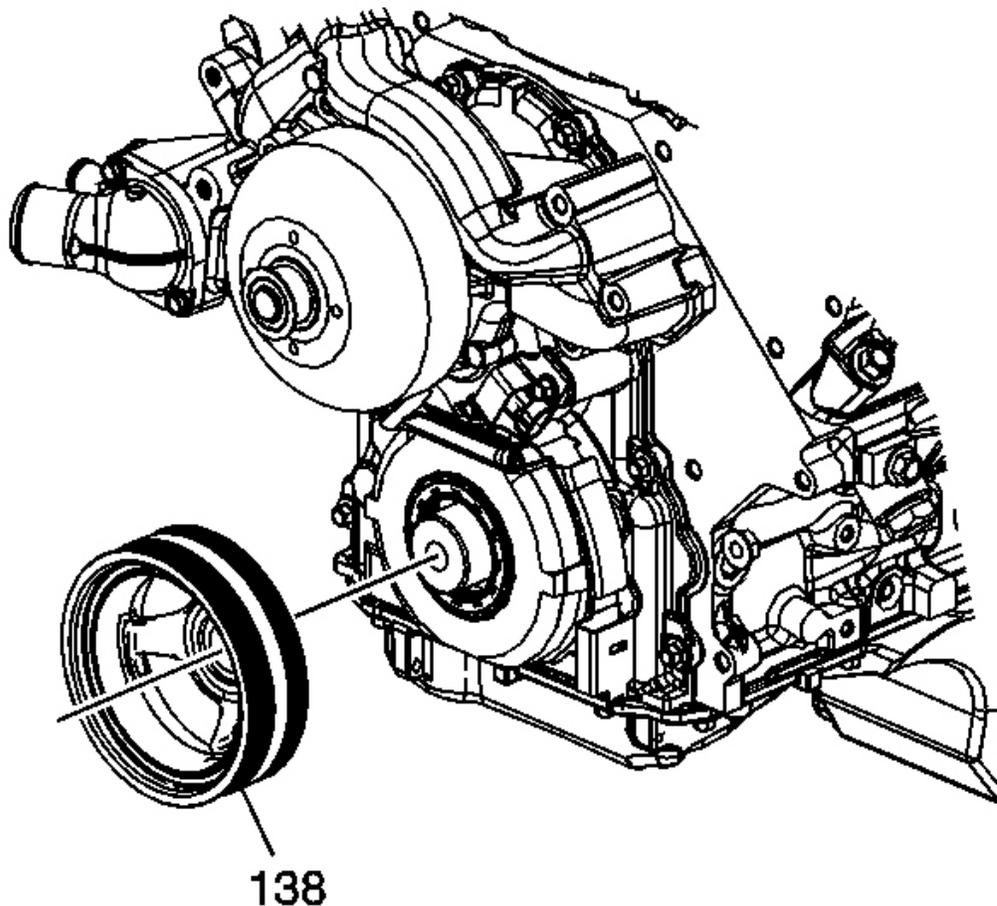


Fig. 156: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

1. Position the crankshaft balancer (138) onto the end of the crankshaft.

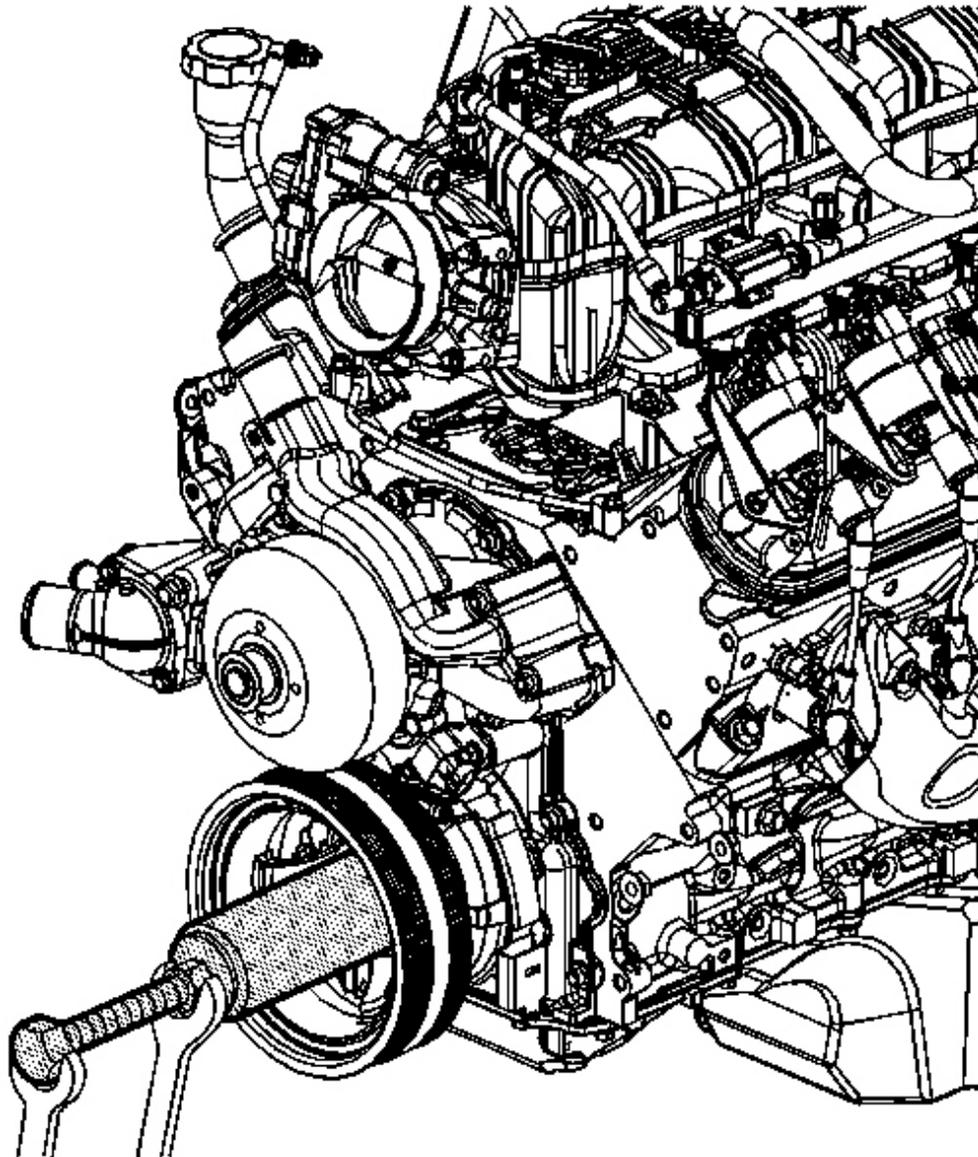


Fig. 157: View Of Balancer Installation Special Tools
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41665** and the threaded rod from the **J 41478** to crankshaft balancer and install the balancer. See **Special Tools**.
 1. Assemble the threaded rod, nut, washer and 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 **J 41665** and the threaded rod. See **Special Tools**.

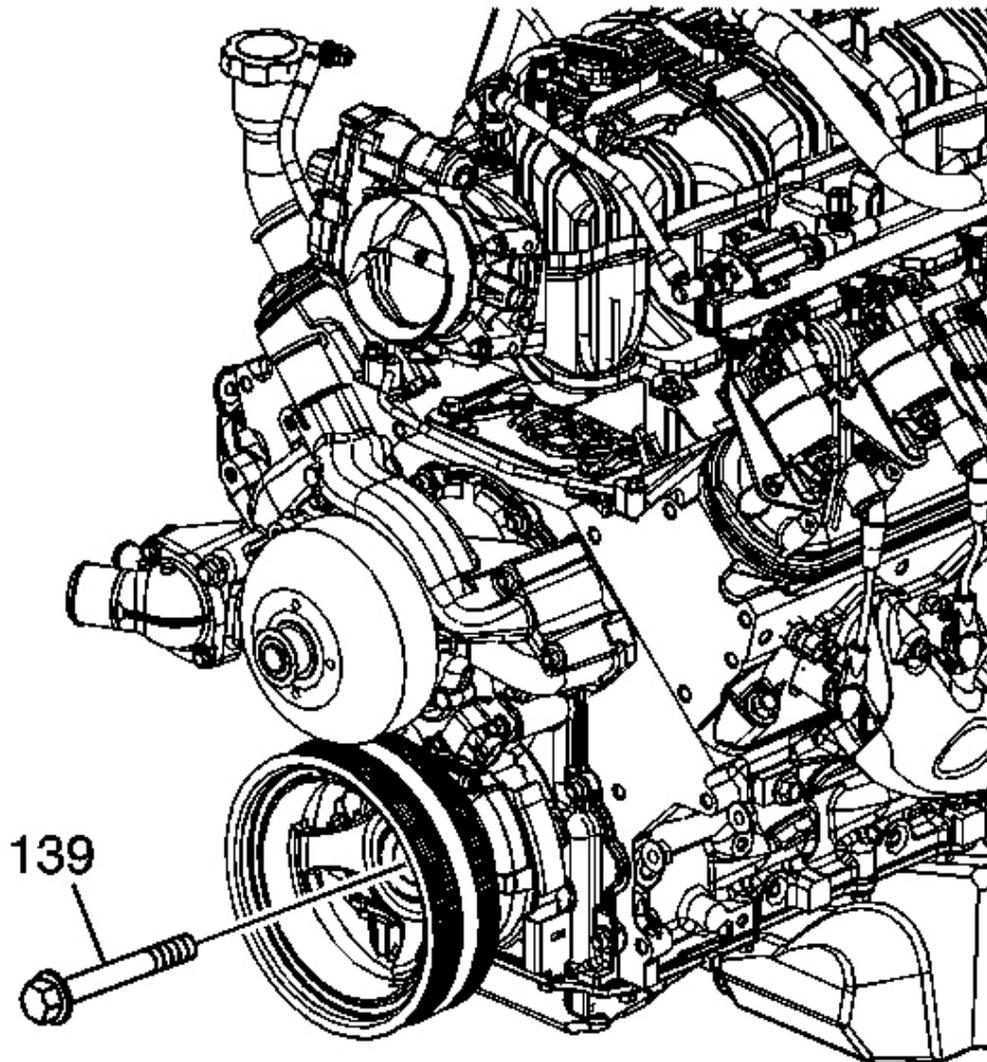


Fig. 158: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the USED crankshaft balancer bolt (139).

Tighten: Tighten the USED bolt to 330 N.m (240 lb ft).

4. Remove the USED crankshaft balancer bolt.

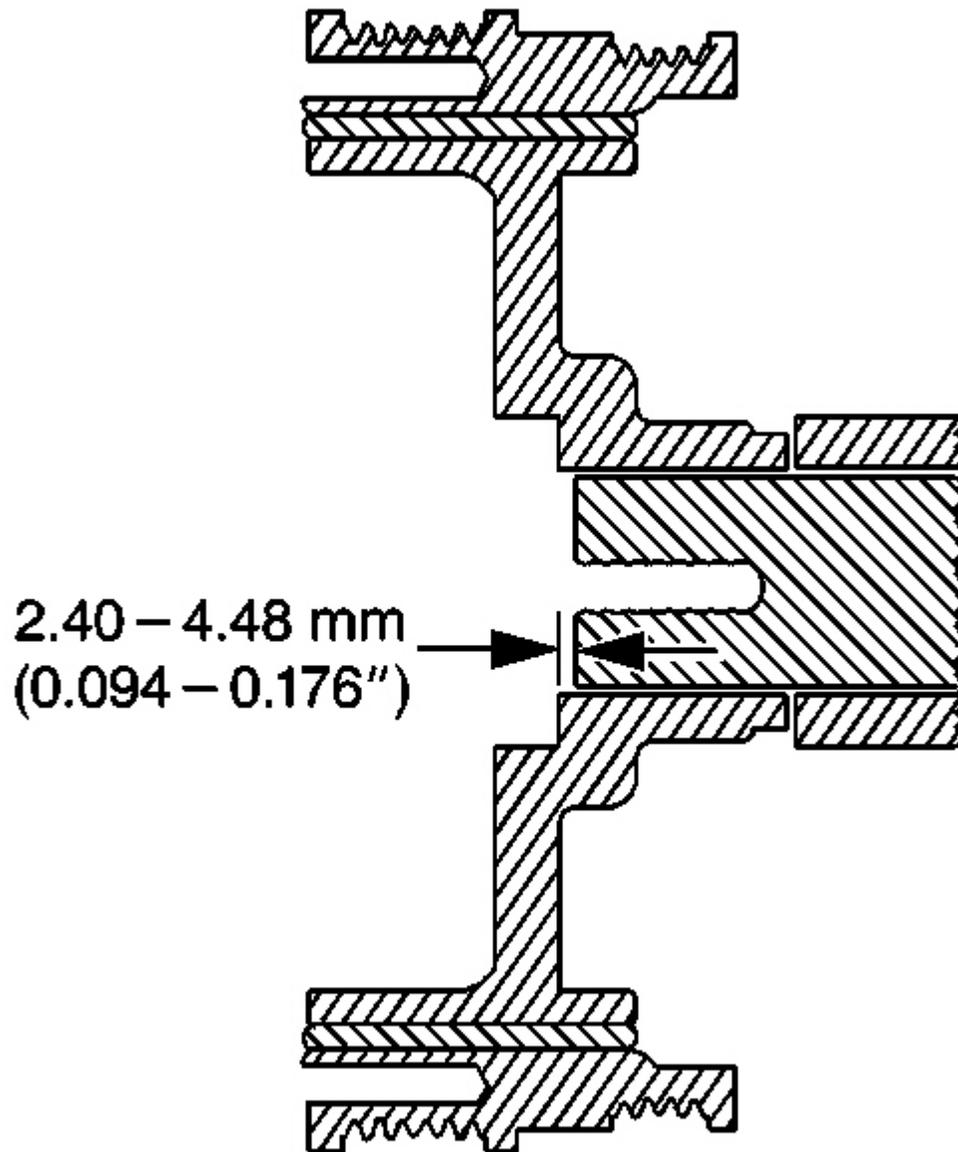


Fig. 159: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

5. Measure for a correctly installed balancer. If the balancer is not installed to the proper dimension, install the **J 41665** and repeat the installation procedure. See **Special Tools**.

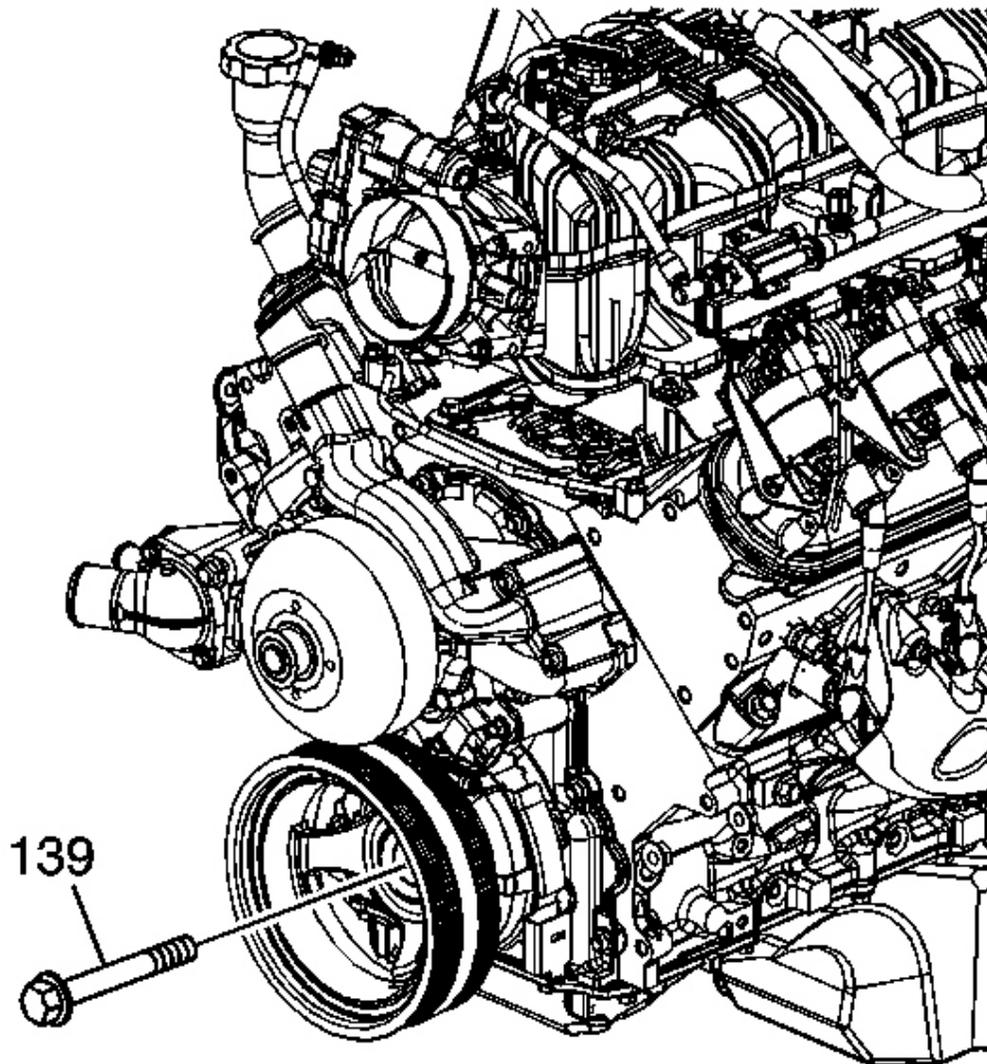


Fig. 160: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

6. Install the NEW crankshaft balancer bolt (139).

Tighten:

1. Tighten the bolt a first pass to 50 N.m (37 lb ft).
2. Tighten the bolt a final pass to 140 degrees using **J 45059** .

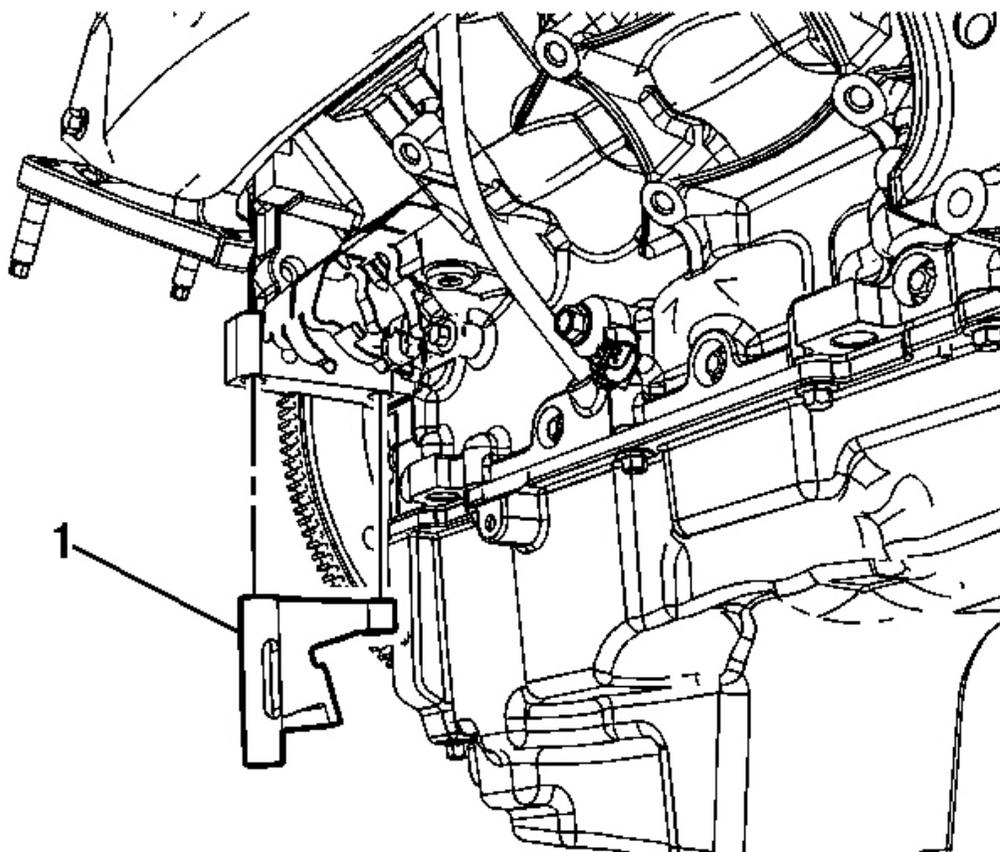


Fig. 161: Air Conditioning Drive Belt
Courtesy of GENERAL MOTORS CORP.

7. Remove the **J 42386-A** (1) and bolts. See **Special Tools**.
8. Install the starter motor. Refer to **Starter Motor Replacement (LH8)** .
9. Install the cooling fan and shroud. Refer to **Fan Shroud Replacement (LH8)** .
10. Install the A/C drive belt. Refer to **Air Conditioning Compressor Belt Replacement**

(LH8).

11. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

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

Removal Procedure

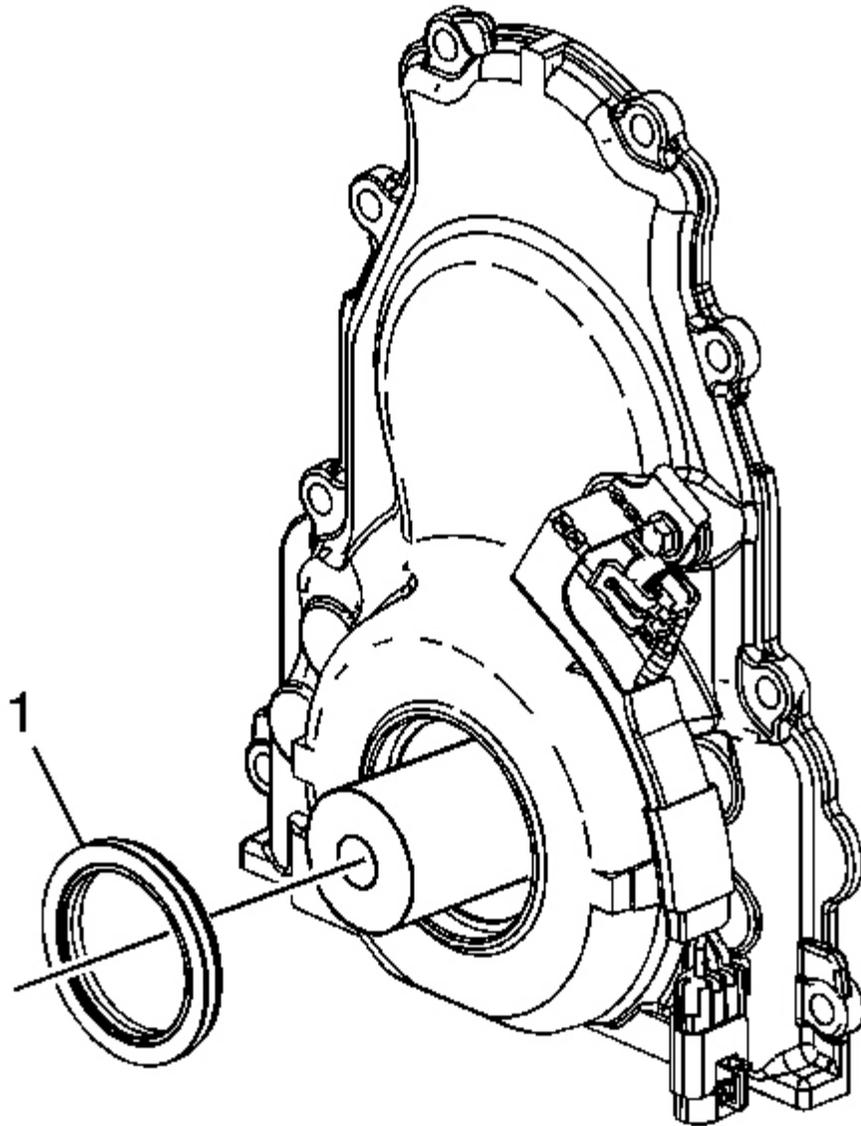


Fig. 162: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
2. Remove the crankshaft front oil seal (1) from the front cover.

- IMPORTANT:**
- Do not lubricate the oil seal sealing surface.
 - Do not reuse the crankshaft front oil seal.

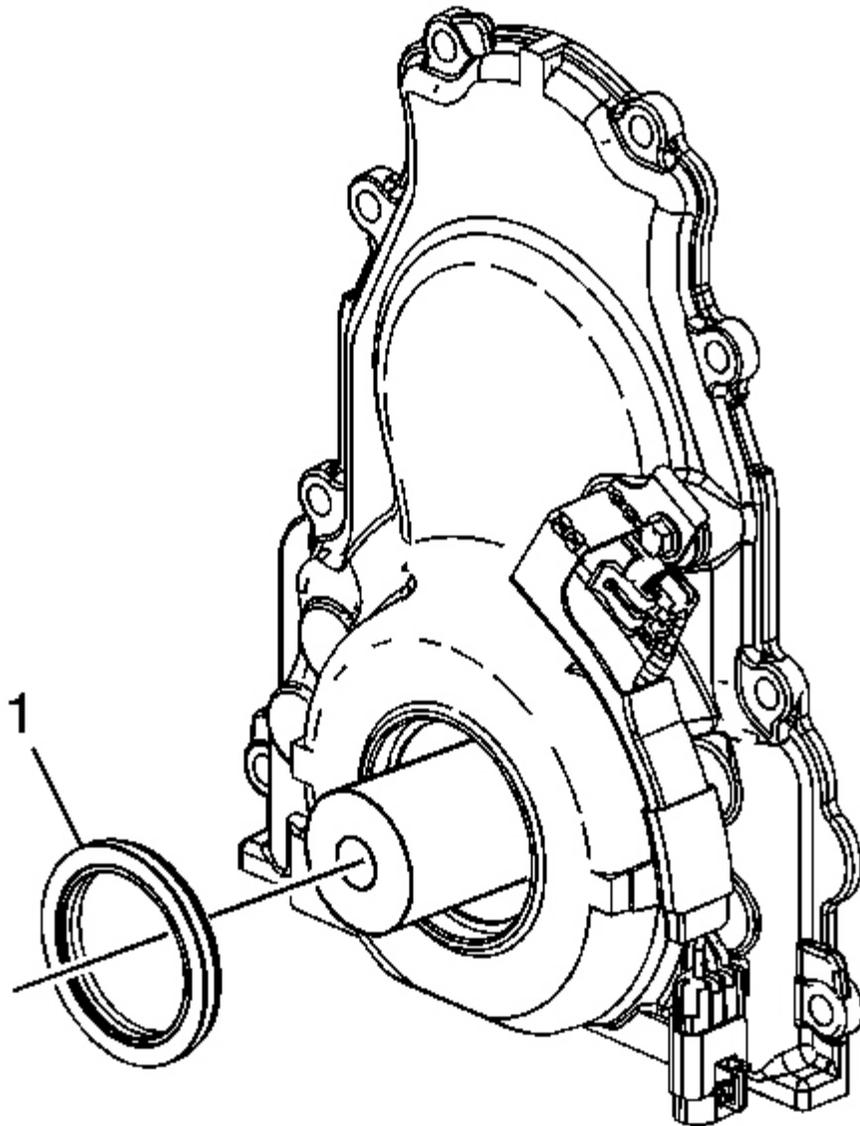


Fig. 163: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

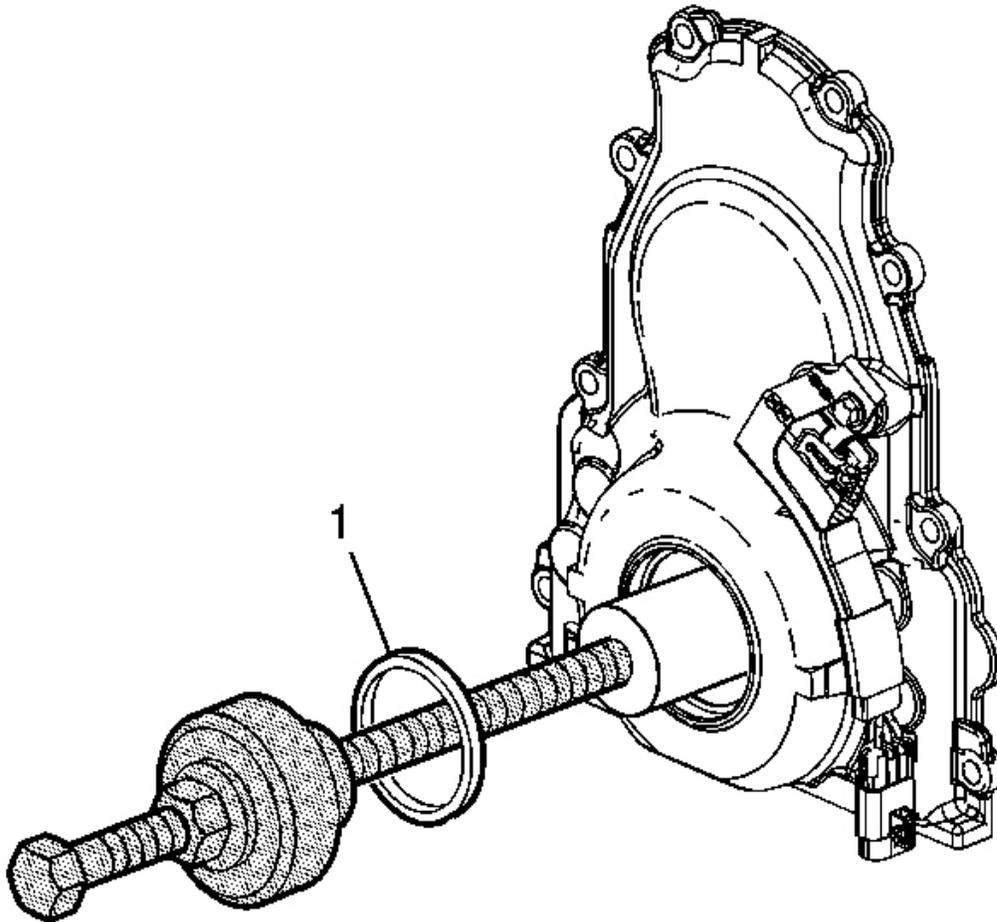


Fig. 164: View Of Crankshaft Front Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal (1) onto the **J 41478** guide. See **Special Tools**.
4. Install the **J 41478** threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft. See **Special Tools**.
5. Use the **J 41478** in order to install the oil seal into the cover bore. See **Special Tools**.
 1. Use a wrench and hold the hex on the installer bolt.

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2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
3. Remove the **J 41478** . See **Special Tools**.
4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.
6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

Special Tools

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

Removal Procedure

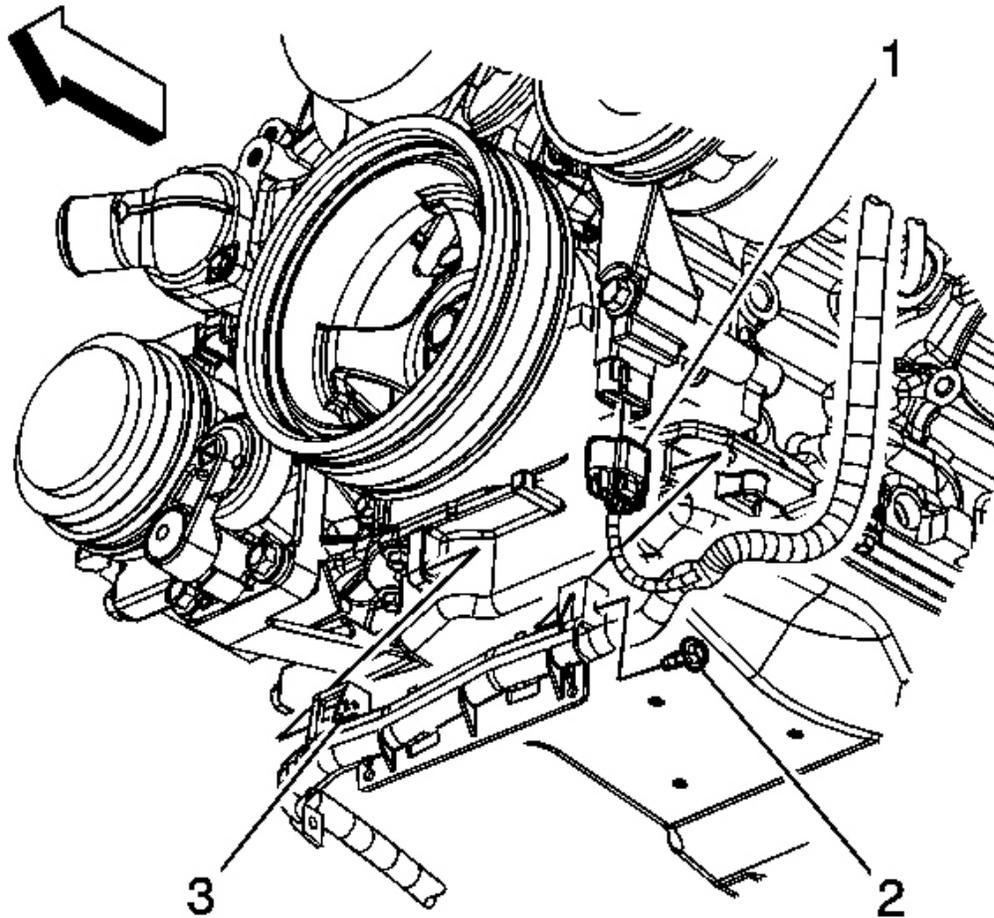


Fig. 165: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (With LH8)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Disconnect the engine harness electrical connector (1) from the camshaft position (CMP) sensor wire harness electrical connector.

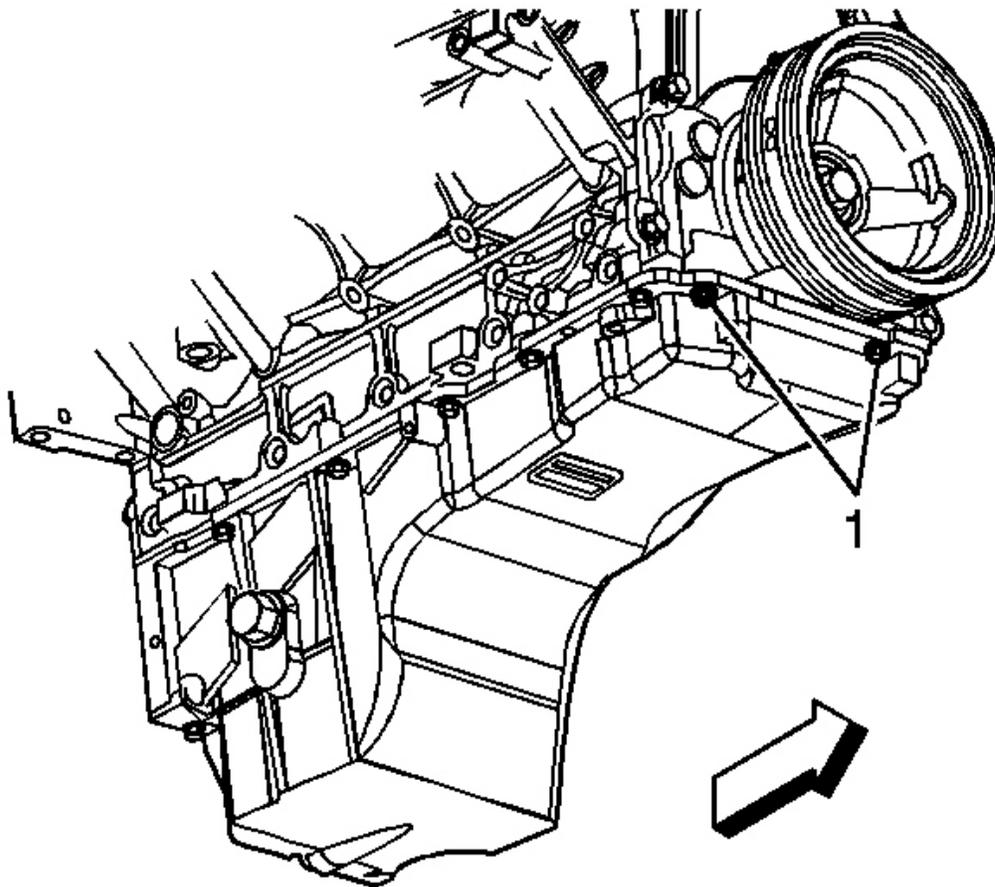


Fig. 166: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan-to-front cover bolts (1).

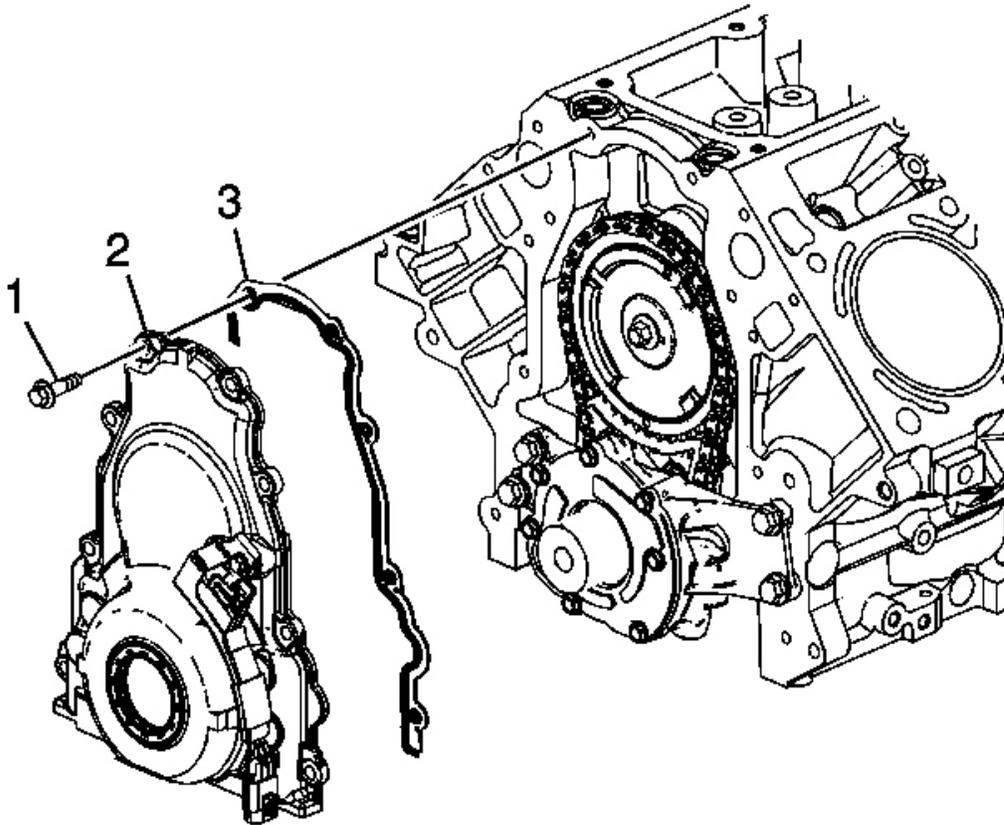


Fig. 167: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove the front cover bolts (1).
6. Remove the front cover (2) and gasket (3).
7. Discard the front cover gasket.
8. Remove the crankshaft front oil seal.

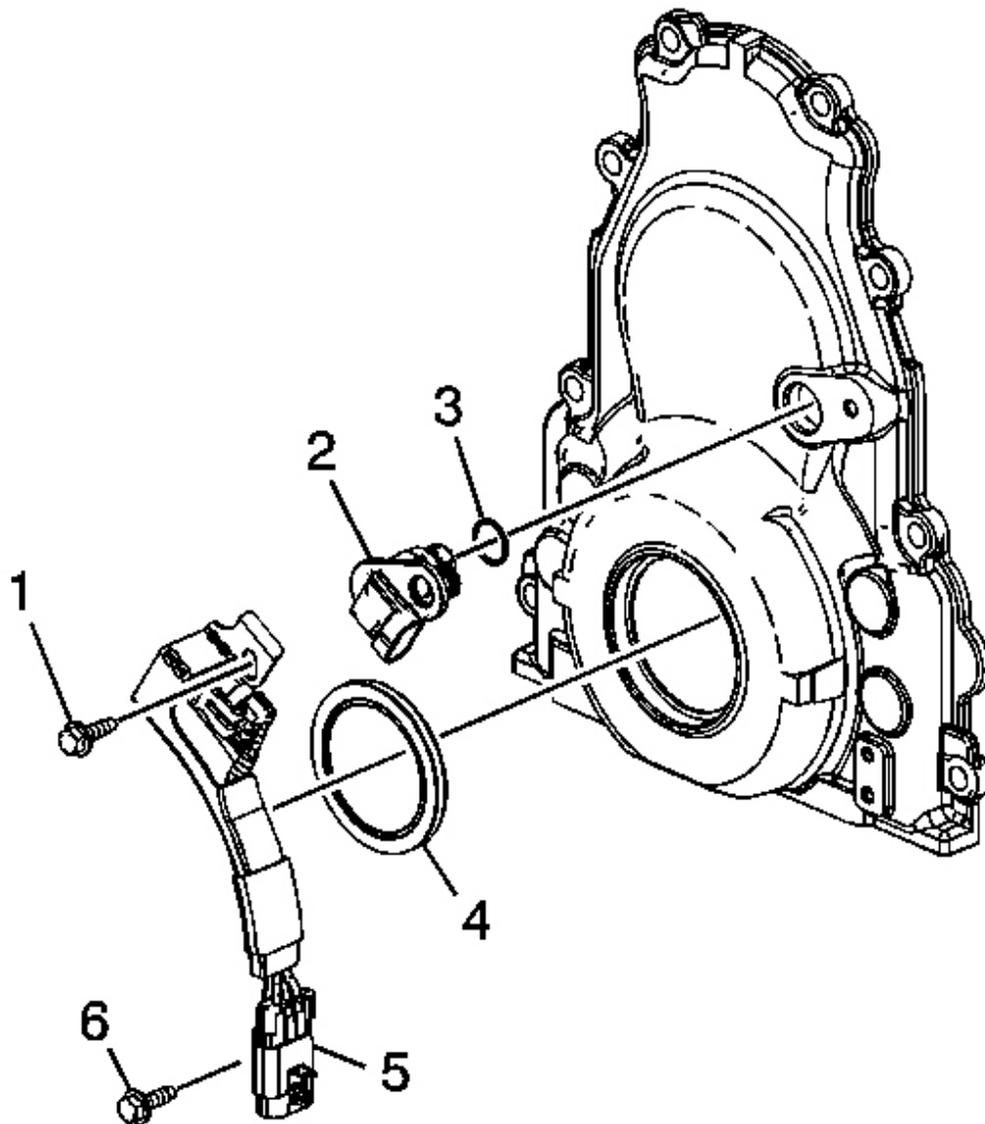


Fig. 168: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring

Courtesy of GENERAL MOTORS CORP.

9. If replacing the engine front cover perform the following steps, otherwise proceed to step 10 of the installation procedure.

10. Remove the CMP sensor wire harness bolts (1, 6).
11. Disconnect the CMP sensor wire harness from the CMP sensor.
12. Remove the CMP sensor wire harness (5).
13. Remove the CMP sensor (2).

Installation Procedure

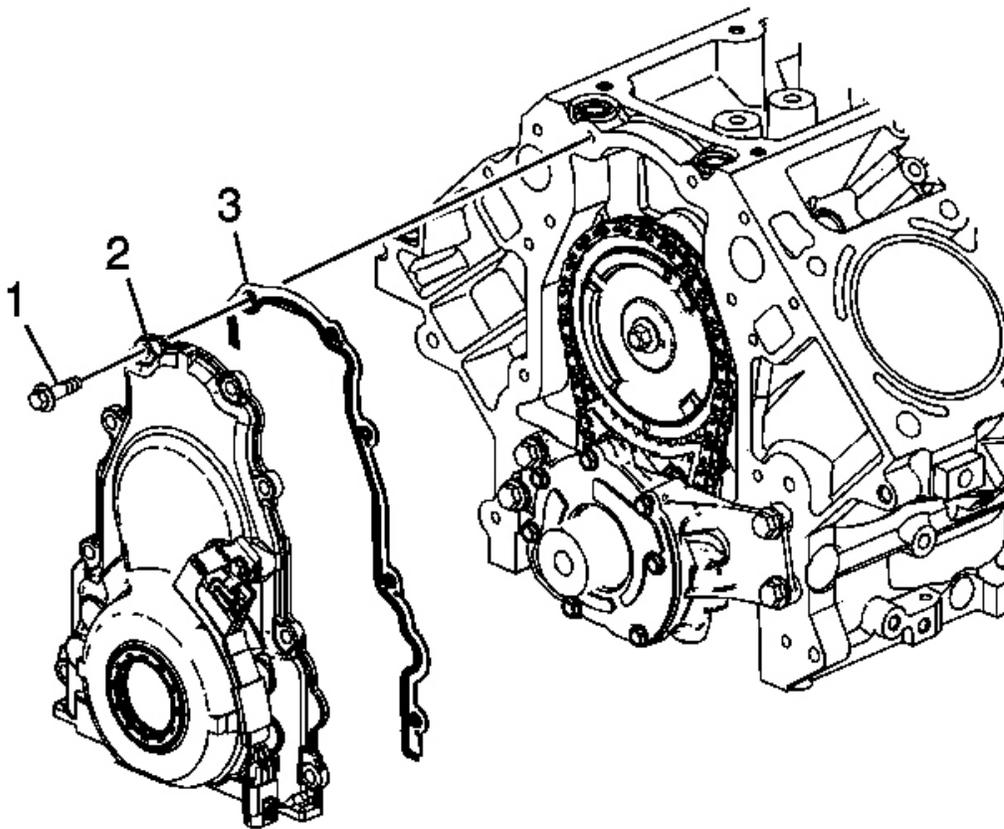


Fig. 169: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- 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.**

1. Install the front cover gasket (3), front cover (2), and bolts (1).
2. Tighten the cover bolts finger tight. Do not overtighten.

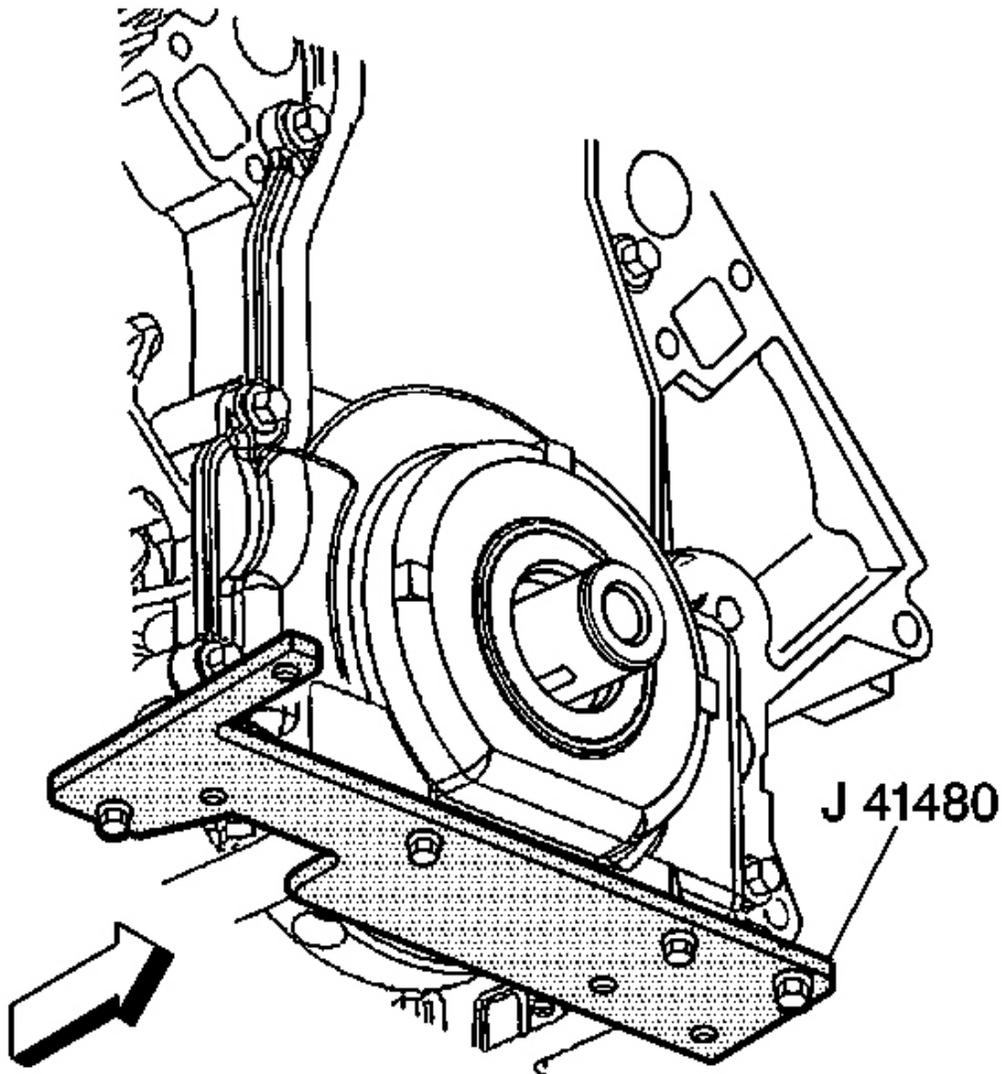


Fig. 170: View Of J 41480 Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

IMPORTANT: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

3. Install the **J 41480** . See Special Tools.

Tighten: Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

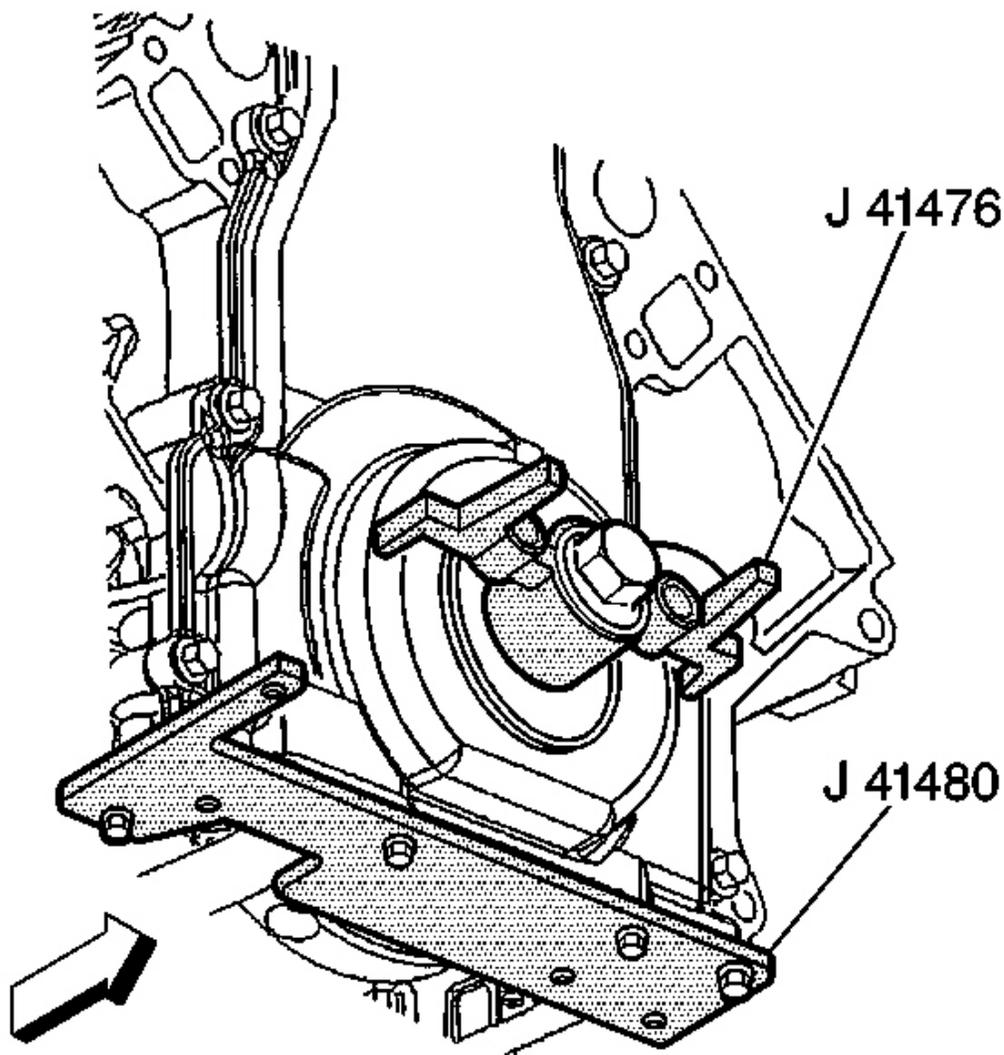


Fig. 171: View Of J 41476 & J 41480 Installed On Engine
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the tapered legs of the tool with the machined

alignment surfaces on the front cover.

4. Install the **J 41476** . See **Special Tools**.
5. Install the crankshaft balancer bolt.

Tighten:

1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
 2. Tighten the **J 41480** . See **Special Tools**.
 3. Tighten the engine front cover bolts to 25 N.m (18 lb ft).
6. Remove the tools.

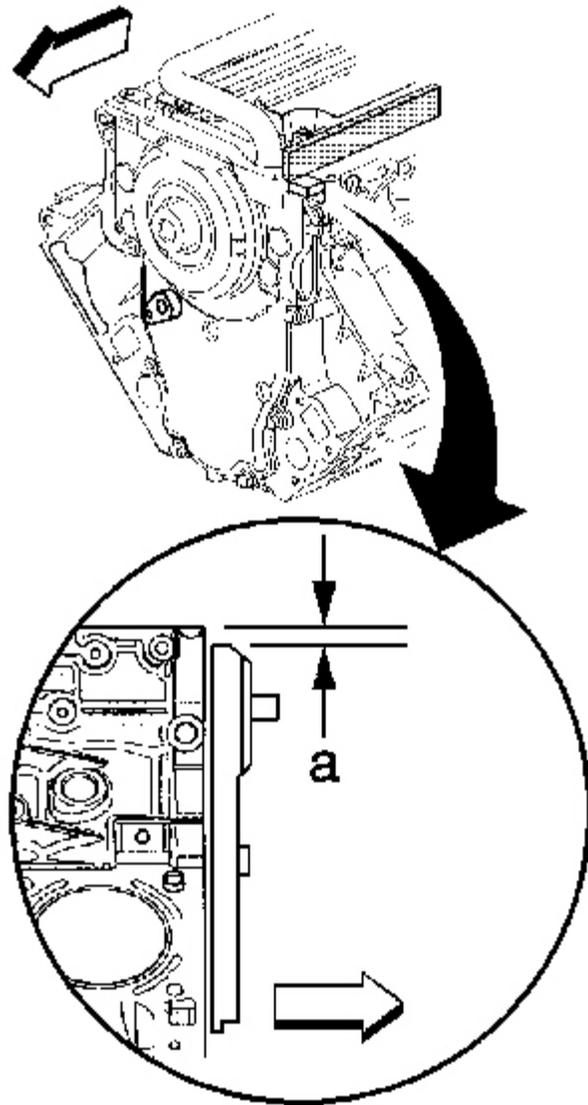


Fig. 172: Oil Pan Surface Flatness & Front Cover-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

7. 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.

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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.
8. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
9. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

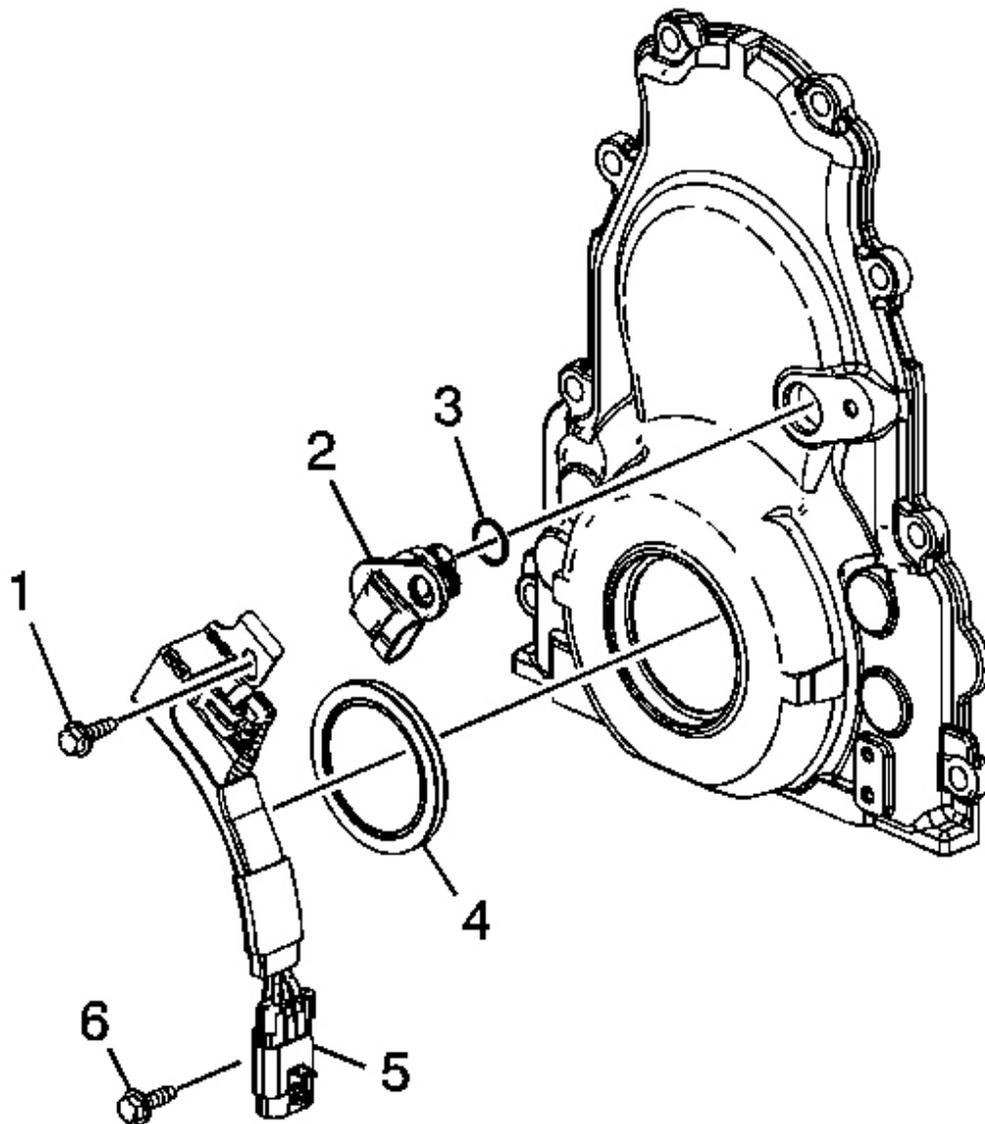


Fig. 173: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring

Courtesy of GENERAL MOTORS CORP.

10. 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.

11. Lubricate the O-ring seal with clean engine oil.
12. Install the O-ring seal onto the sensor (2).
13. Install the sensor to the cover.
14. Install the CMP sensor wire harness (5) and bolts (1, 6).

Tighten: Tighten the bolts to 12 N.m (106 lb in).

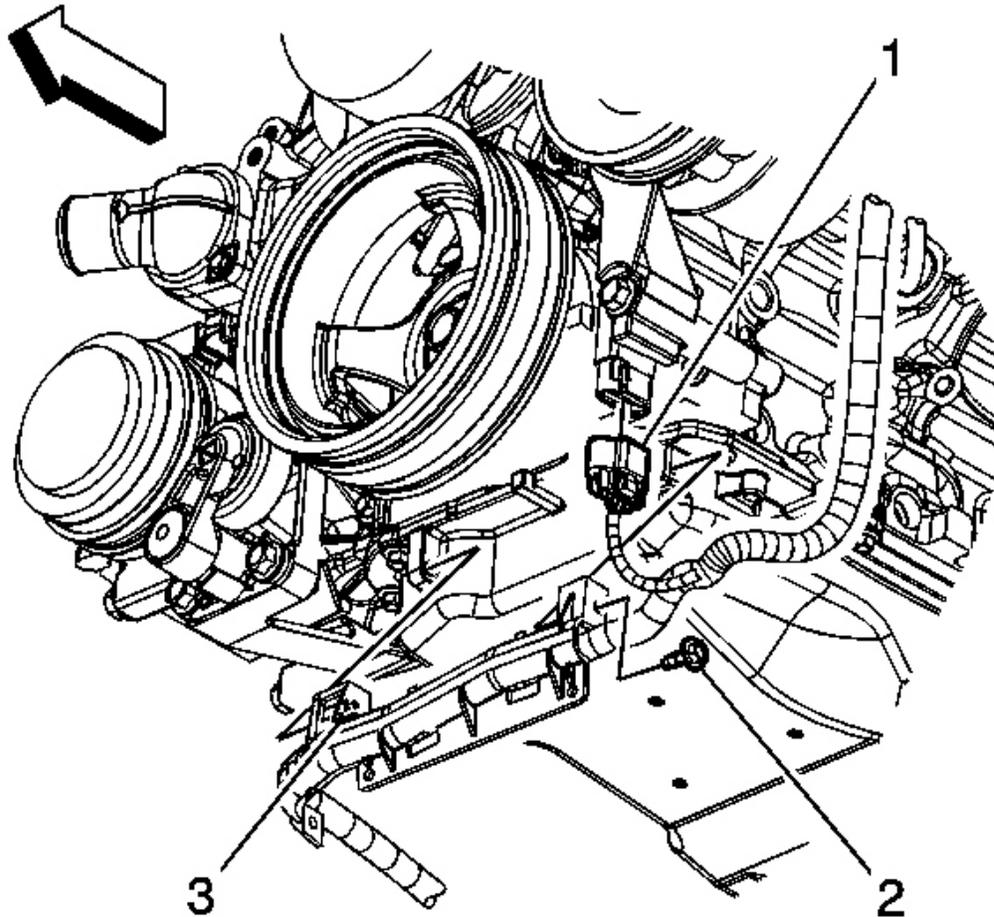


Fig. 174: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

15. Connect the engine harness electrical connector (1) to the CMP sensor wire harness

electrical connector.

16. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
17. Install the water pump. Refer to **Water Pump Replacement (With LH8)** .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Tools Required

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

Removal Procedure

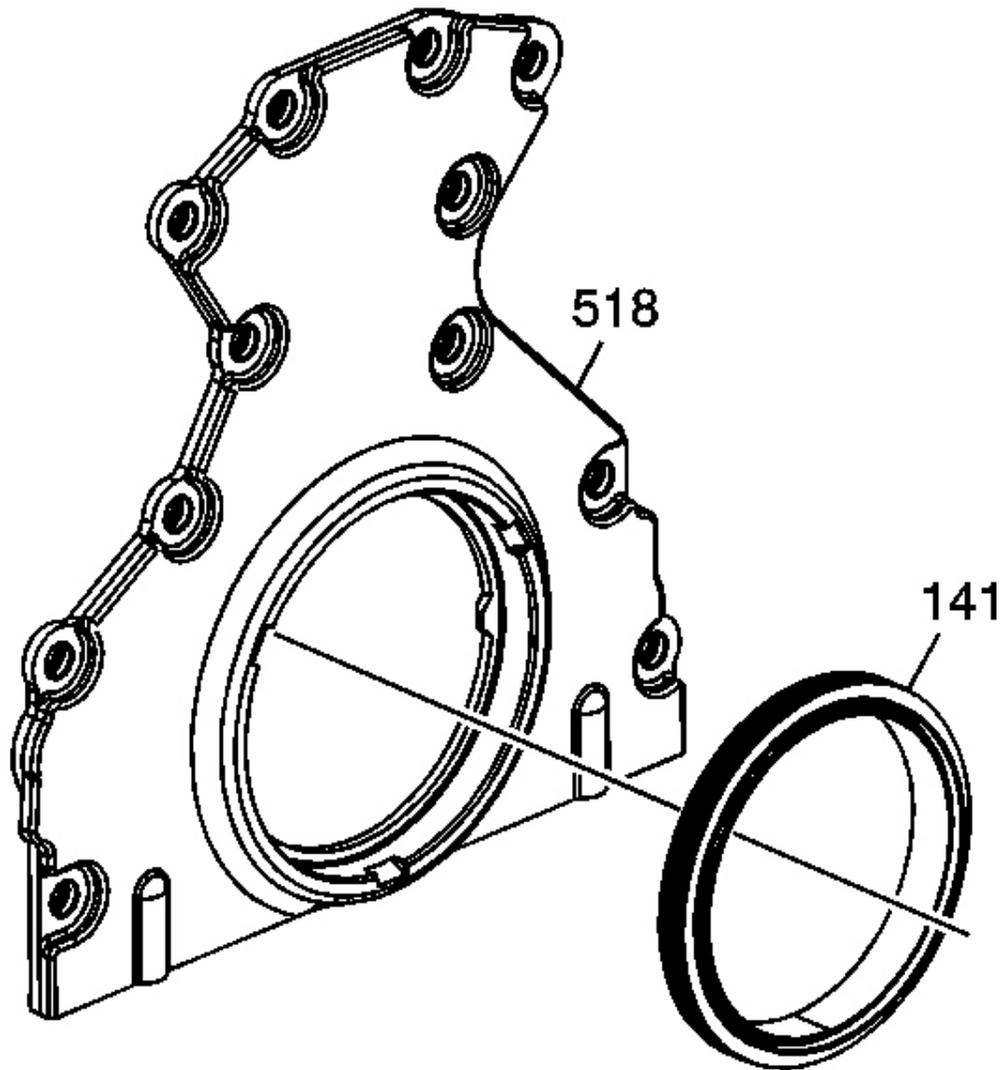


Fig. 175: Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission flexplate, refer to [Automatic Transmission Flex Plate Replacement](#).
2. Remove and discard the crankshaft rear oil seal (141).

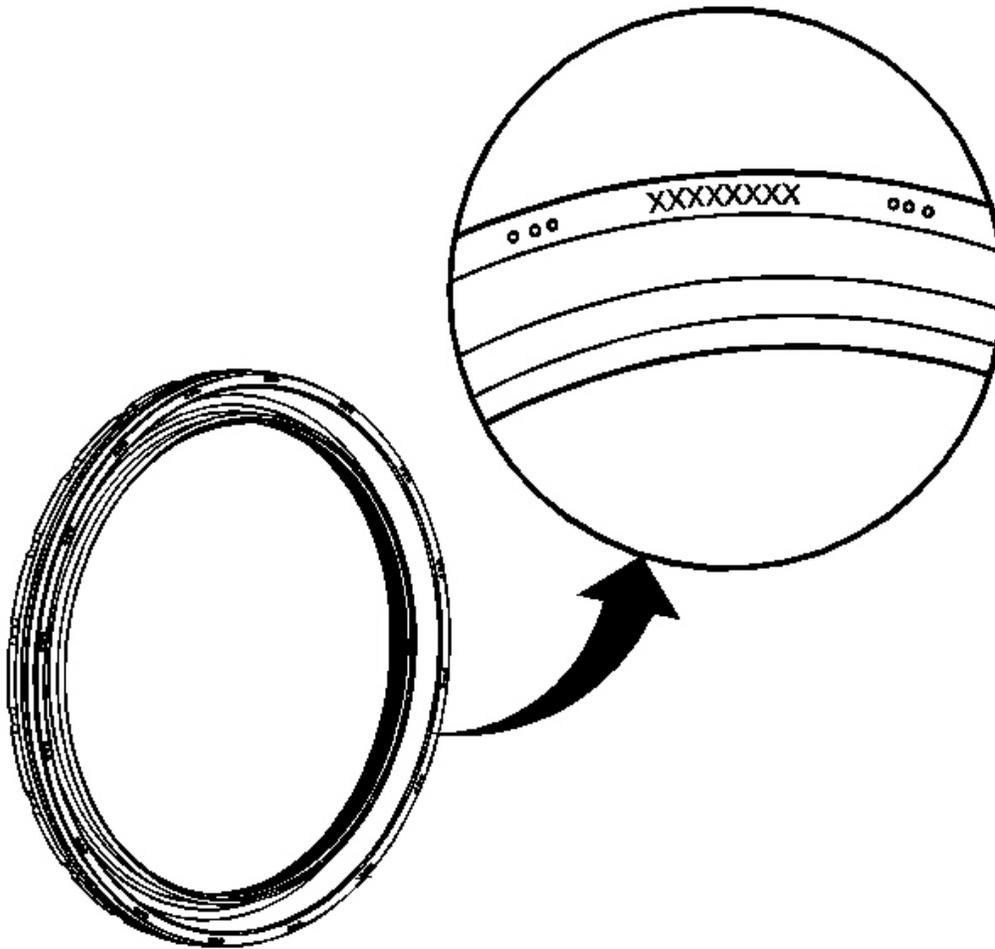


Fig. 176: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

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.

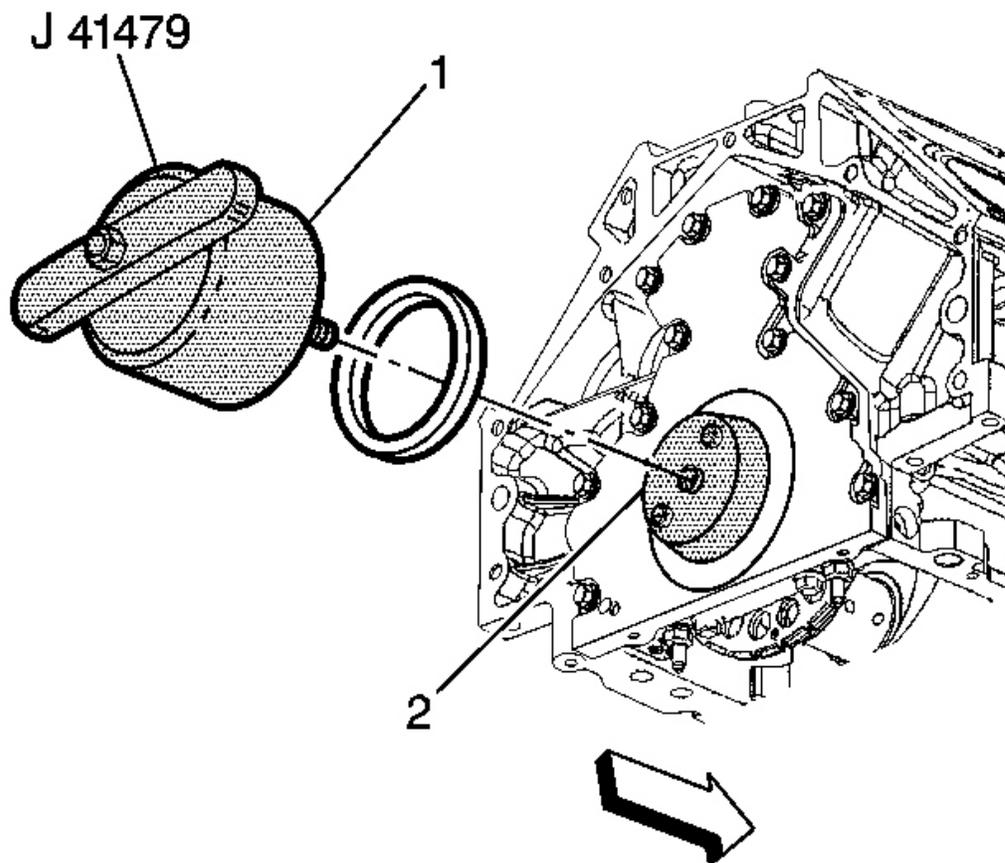


Fig. 177: View Of J 41479 Cone & Bolts
 Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41479** cone (2) and bolts onto the rear of the crankshaft. See **Special Tools**.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal. See **Special Tools**.
6. Align the oil seal into the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.

8. Remove the **J 41479** . See **Special Tools**.
9. Install the automatic transmission flexplate, refer to **Automatic Transmission Flex Plate Replacement**.

ENGINE REAR COVER REPLACEMENT

Tools Required

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

Removal Procedure

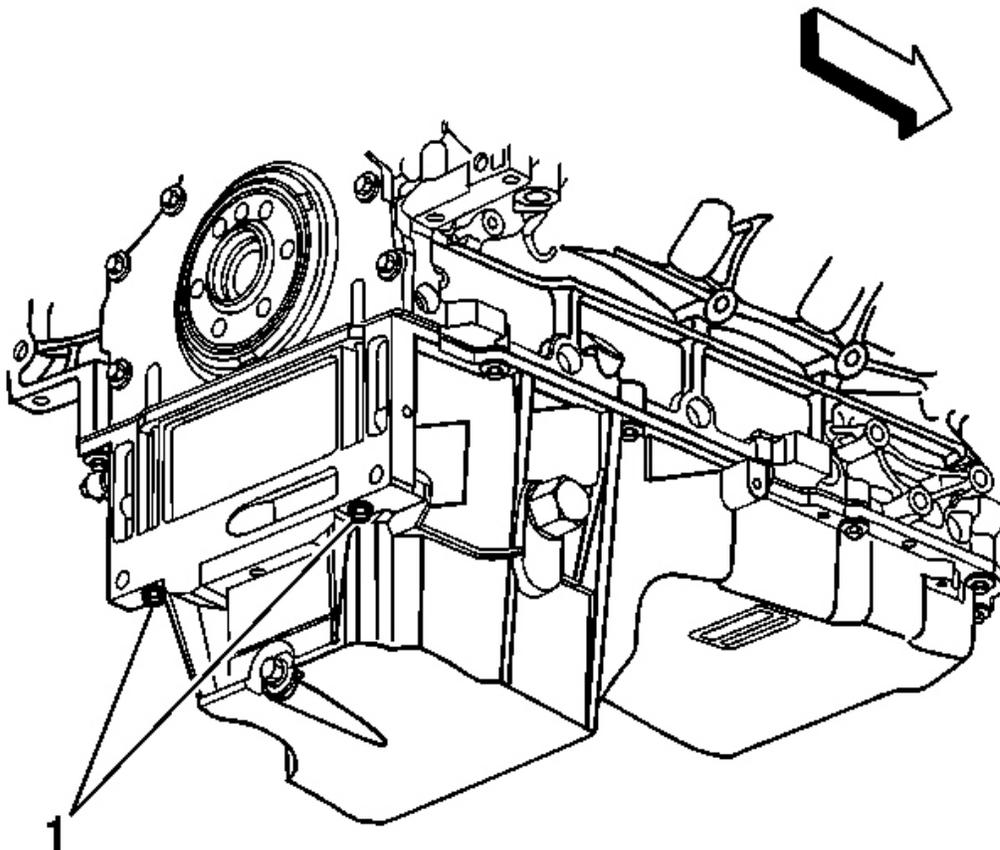


Fig. 178: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission flexplate, refer to [Automatic Transmission Flex Plate Replacement](#).
2. Remove the oil pan-to-rear oil seal housing bolts (1).

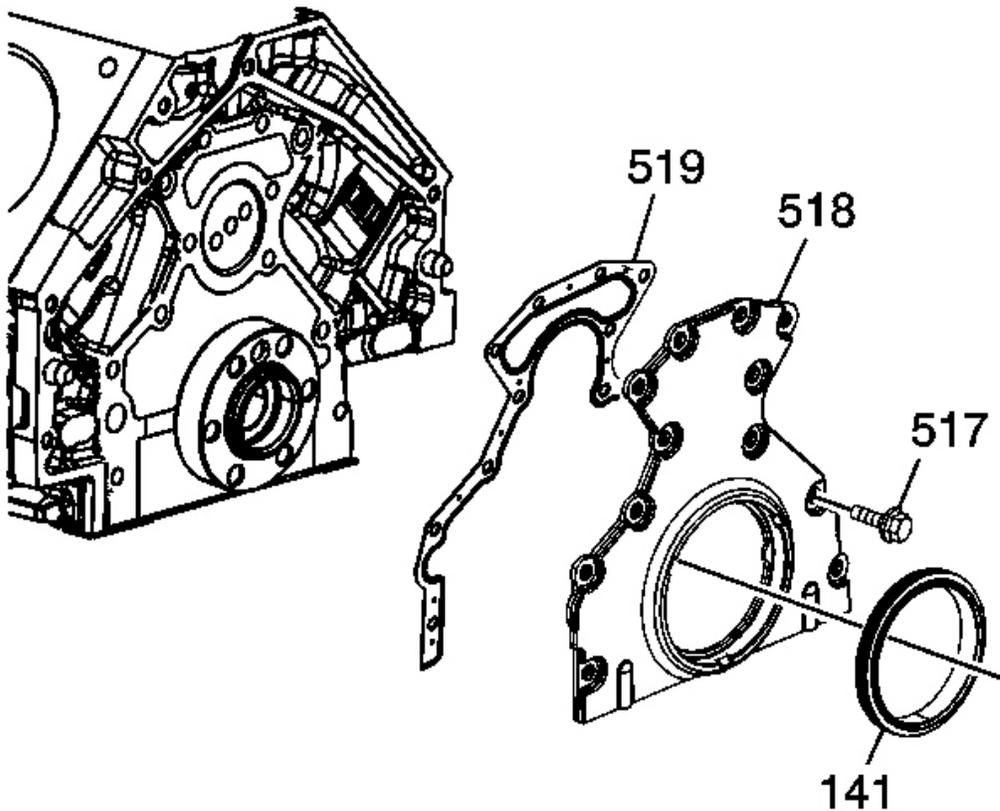


Fig. 179: View of Rear Housing, Gasket and Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the rear oil seal housing bolts (517).
4. Remove the rear oil seal housing (518) and gasket (519). Discard the gasket.
5. Remove and discard the rear oil seal (141).

Installation Procedure

IMPORTANT: • Do not reuse the crankshaft oil seal or rear cover gasket.

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- **Do not apply any type of sealant to the rear cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the crankshaft rear oil seal.**
- **The crankshaft rear oil seal will be installed after the rear cover has been installed and aligned. Install the rear cover without the crankshaft oil seal.**
 - **All gasket surfaces should be free of oil or other foreign material during assembly.**
 - **The crankshaft rear oil seal **MUST** be centered in relation to the crankshaft.**
 - **An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.**

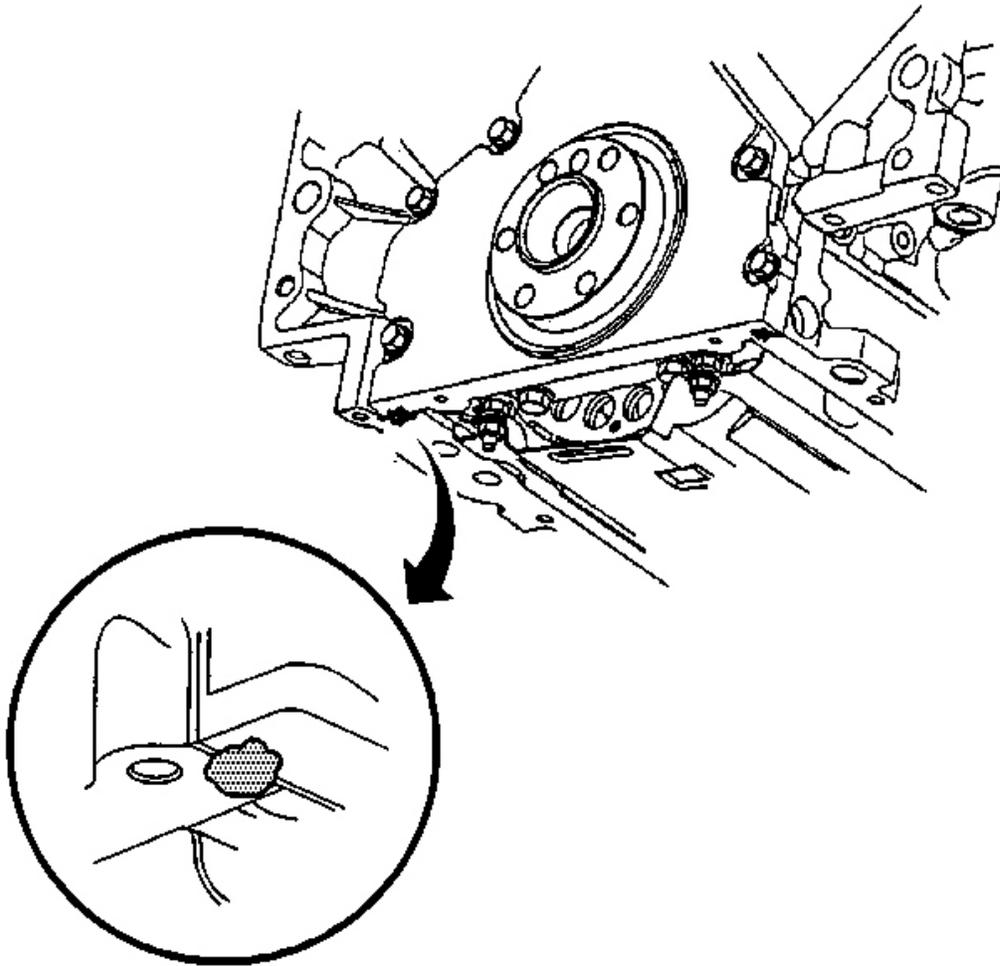


Fig. 180: View Of Sealant Applied To Rear Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.2 in) bead of sealant, 20 mm (0.8 in) long to the oil pan to engine block junction. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

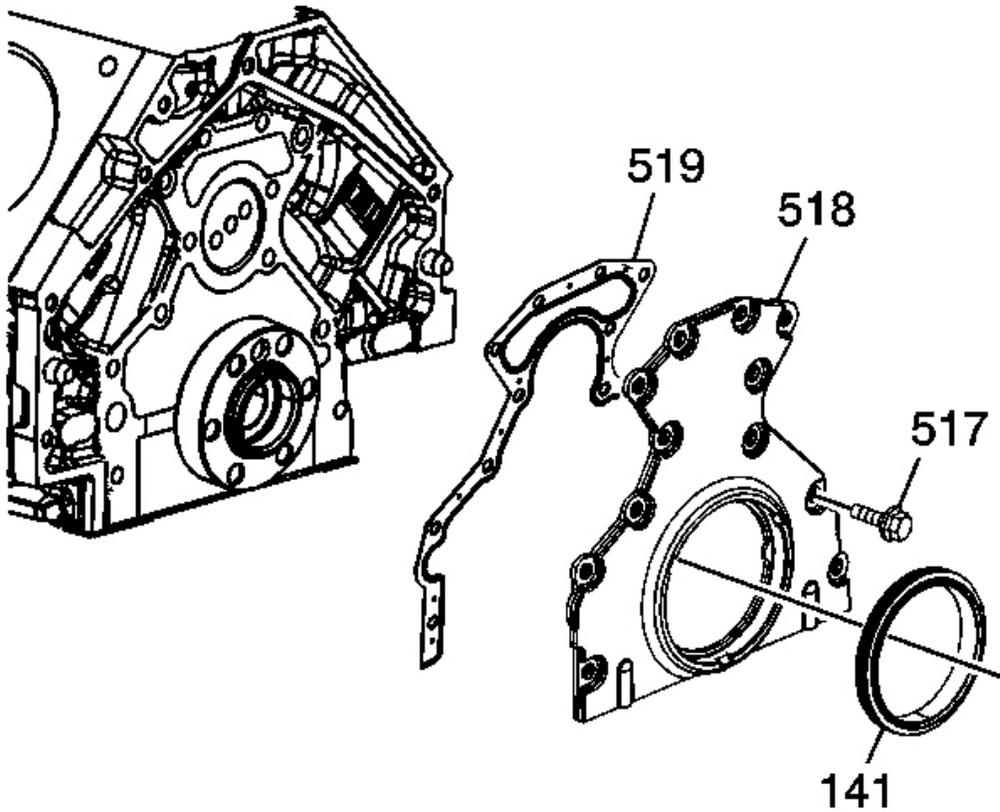


Fig. 181: View of Rear Housing, Gasket and Seal
Courtesy of GENERAL MOTORS CORP.

2. Position a NEW rear oil seal housing gasket (519) and the housing (518) to the engine.
3. Install the rear oil seal housing bolts until snug. Do not overtighten.

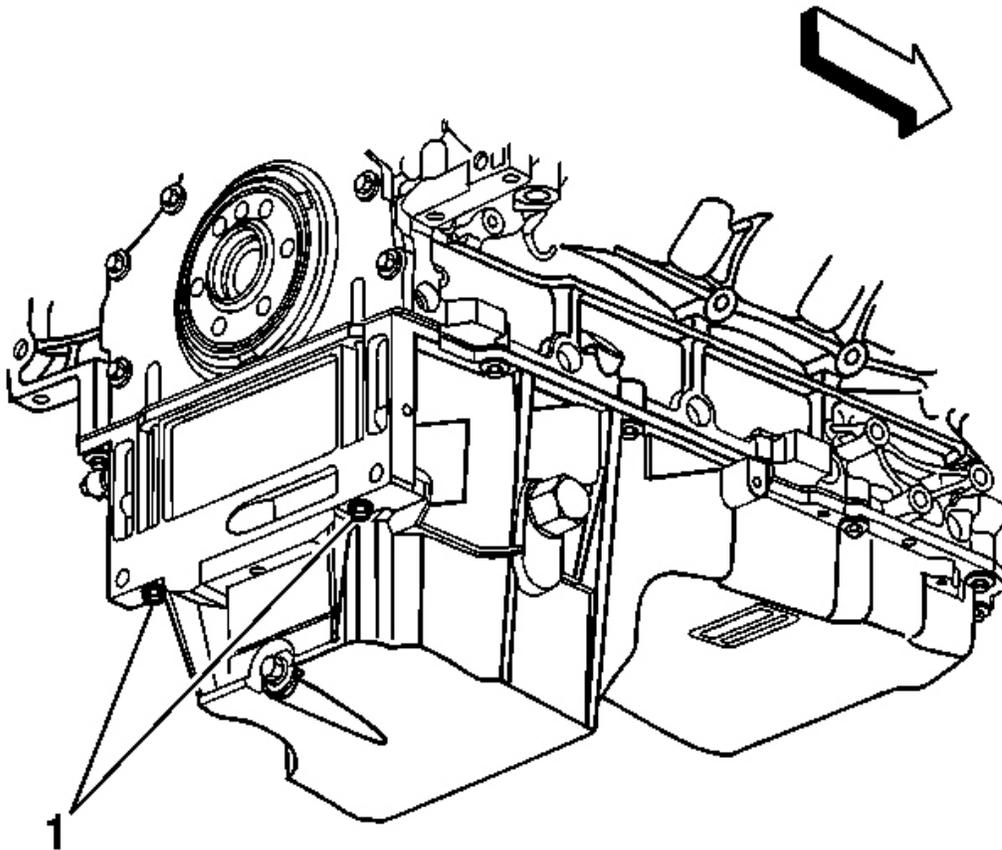


Fig. 182: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan-to-rear oil seal housing bolts (1) until snug. Do not overtighten.

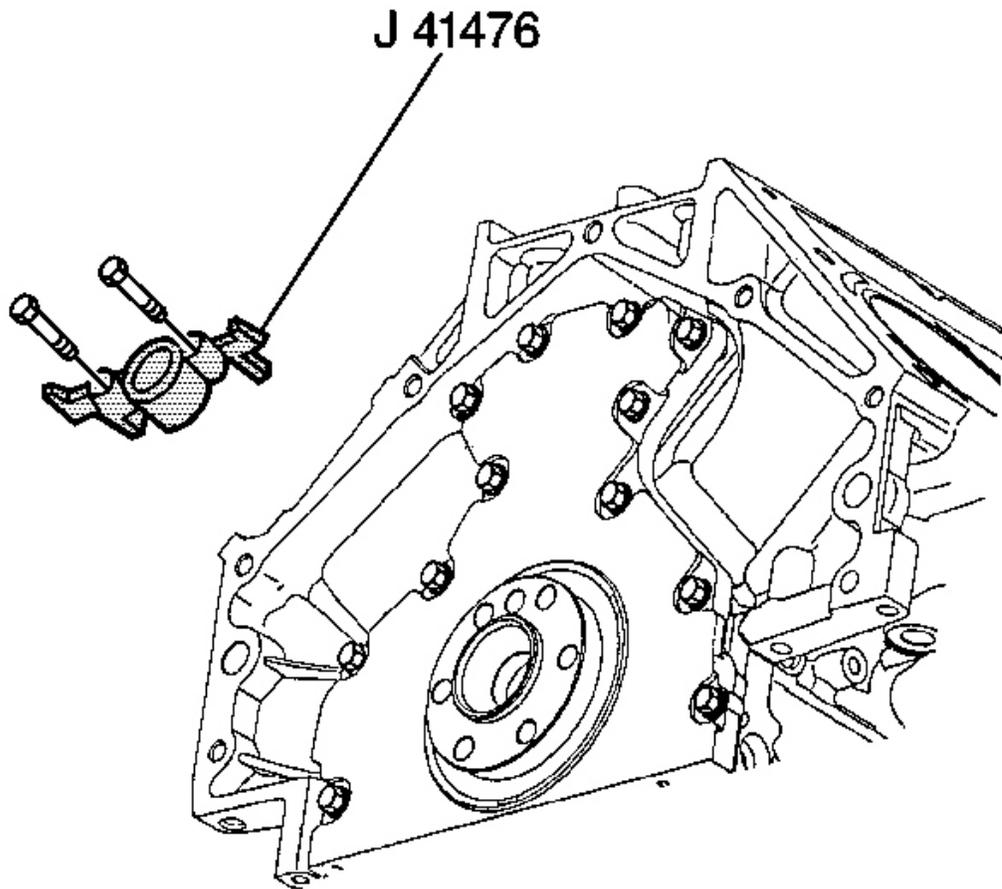


Fig. 183: View Of J 41476

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

5. Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.
6. Install the **J 41476** and bolts onto the rear of the crankshaft. See **Special Tools**.

NOTE: Refer to **Fastener Notice** .

7. Tighten the **J 41476** bolts until snug. See **Special Tools**. Do not overtighten.

Tighten:

1. Tighten the oil pan-to-rear oil seal housing bolts to 12 N.m (106 lb in).
2. Tighten the rear oil seal housing bolts to 30 N.m (22 lb ft).

8. Remove the **J 41476** . See **Special Tools**.
9. Install a NEW crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
10. Remove the automatic transmission flexplate, refer to **Automatic Transmission Flex Plate Replacement**.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

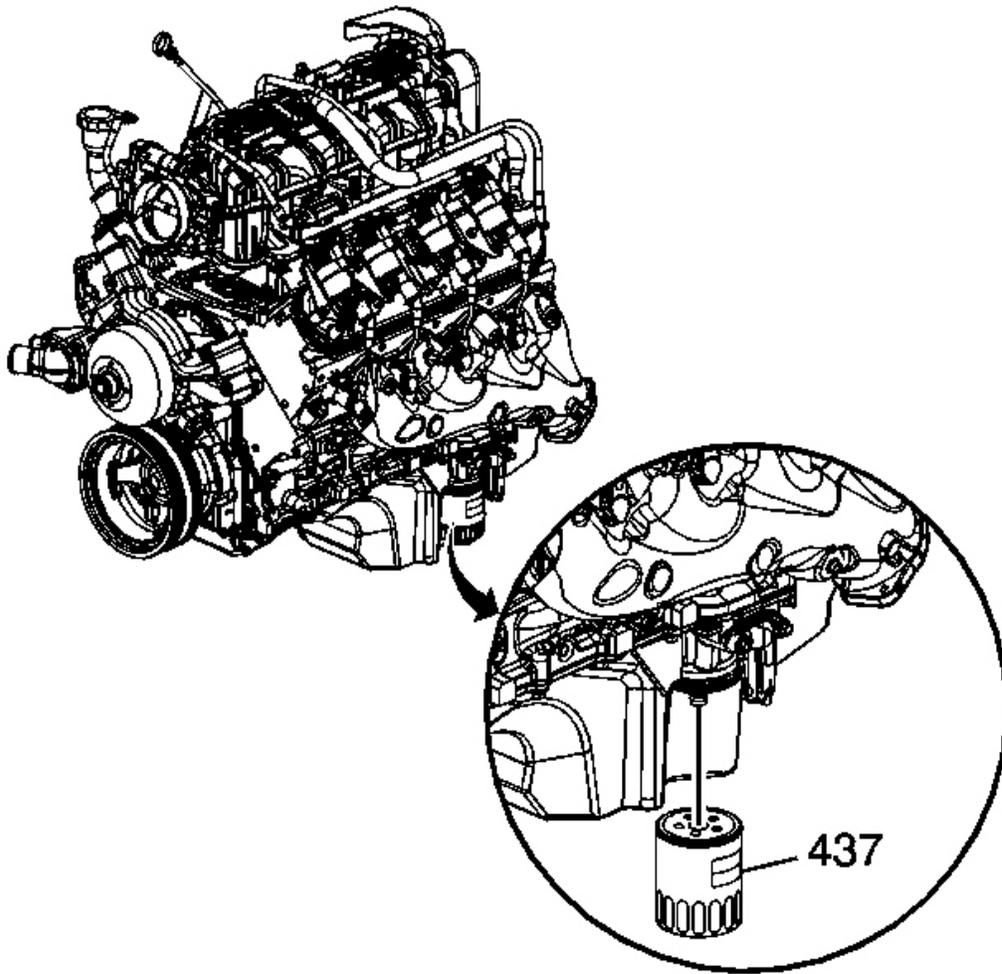


Fig. 184: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a suitable drain pan under the oil filter.
3. Remove the oil filter (437).

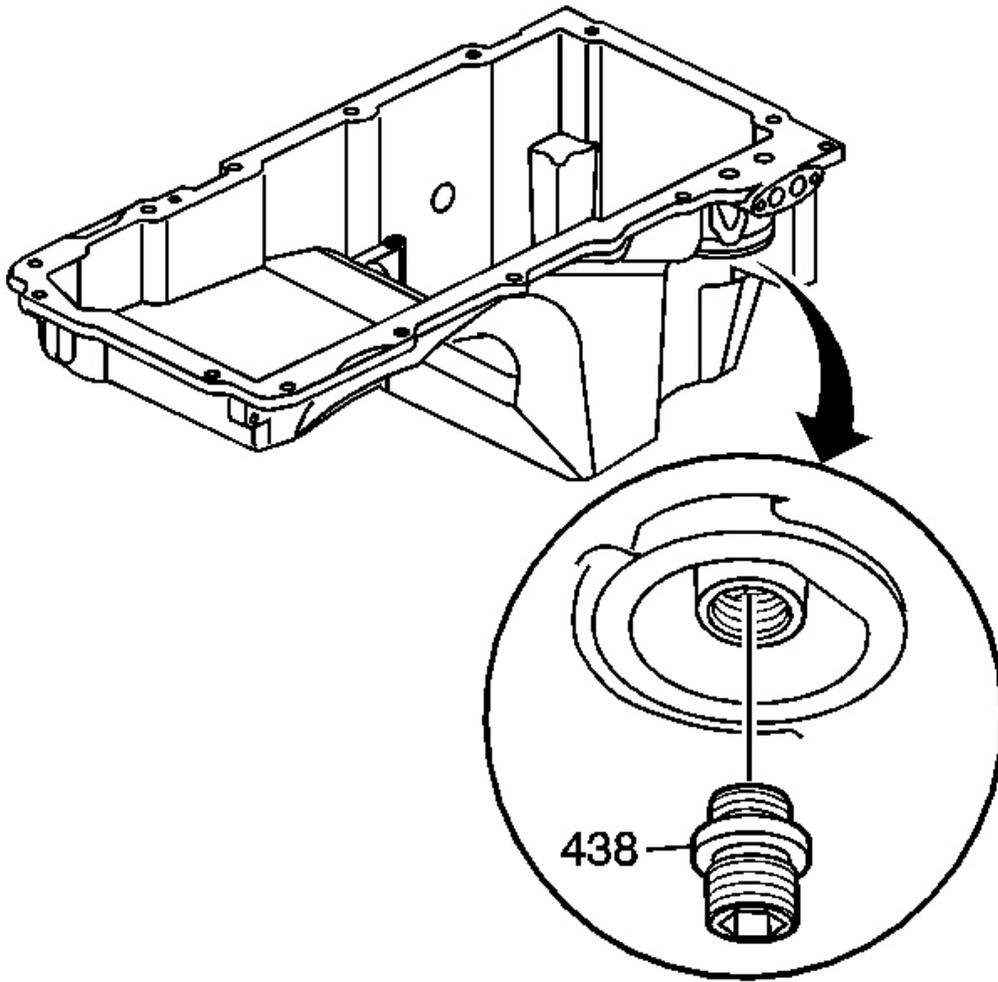


Fig. 185: Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filter adapter (438).

Installation Procedure

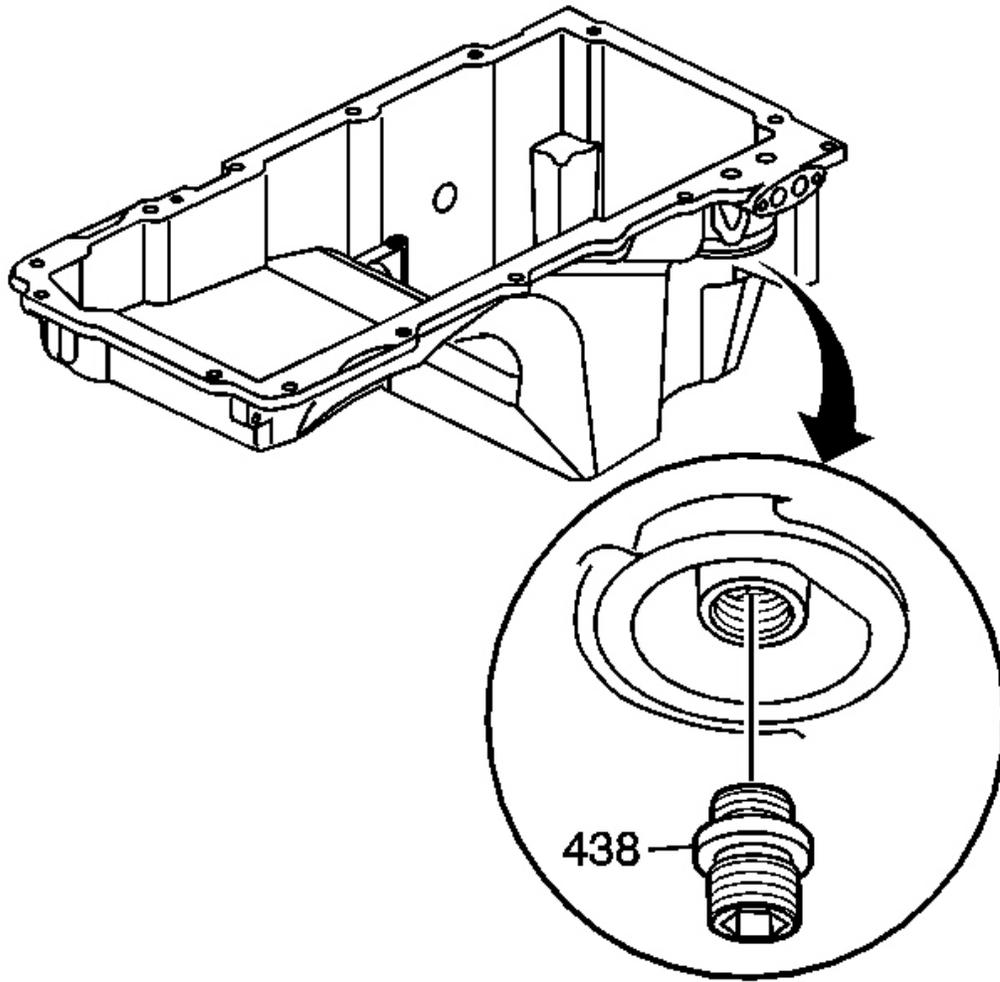


Fig. 186: Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the oil filter adapter (438).

Tighten: Tighten the adapter to 55 N.m (40 lb ft).

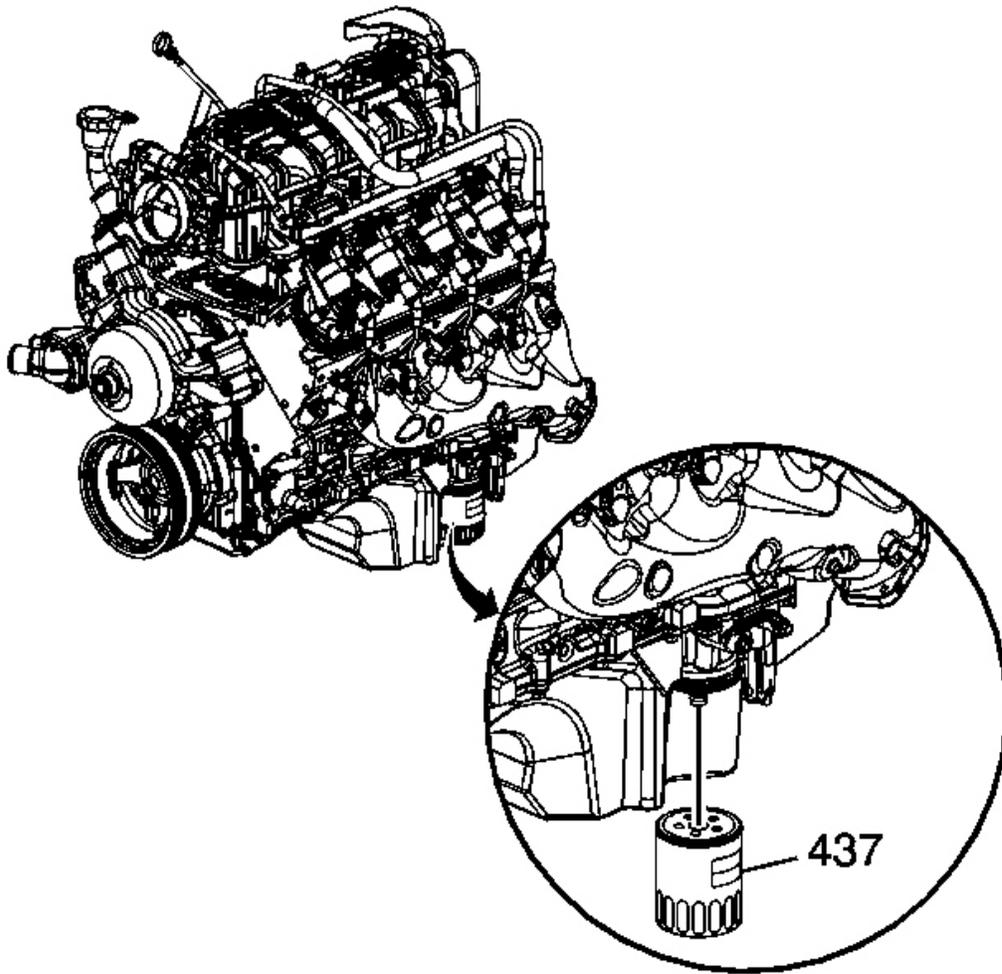


Fig. 187: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Lubricate the oil filter seal with clean engine oil.
3. Install the oil filter (437).

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

4. Lower the vehicle.
5. Refill the engine oil. Refer to Approximate Fluid Capacities and/or Fluid and Lubricant Recommendations .

6. Start the engine and inspect for leaks.

OIL PAN REPLACEMENT

Removal Procedure

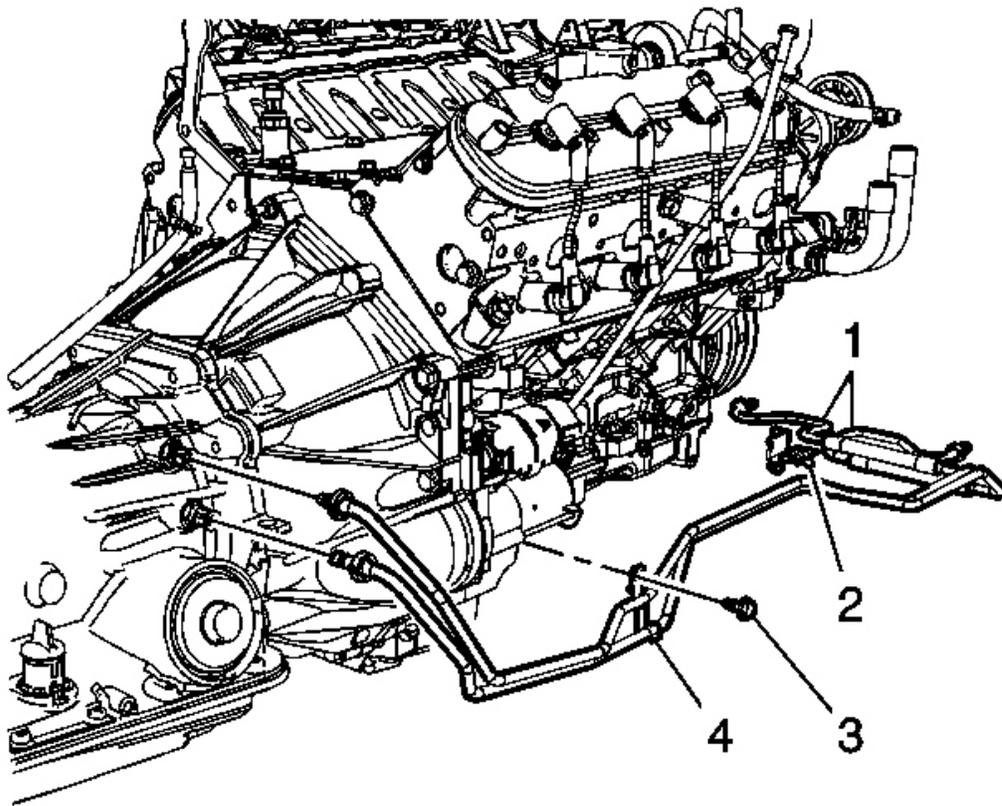


Fig. 188: Transmission Cooler Lines And Brackets
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the oil level indicator tube. Refer to **Oil Level Indicator and Tube Replacement** .
3. Remove the front differential and secure to the frame. Refer to **Differential Carrier Assembly Replacement** .

4. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.
5. Remove the transmission oil cooler lines (1) from the retainer (2).
6. Remove the transmission oil cooler line retaining bracket bolt (3) and bracket (4).
7. Remove the inner axle shaft. Refer to **Front Drive Axle Inner Shaft and Inner Shaft Housing Replacement** .
8. Remove the starter. Refer to **Starter Motor Replacement (LH8)** .
9. Remove the flywheel inspection cover from the left side of the transmission.

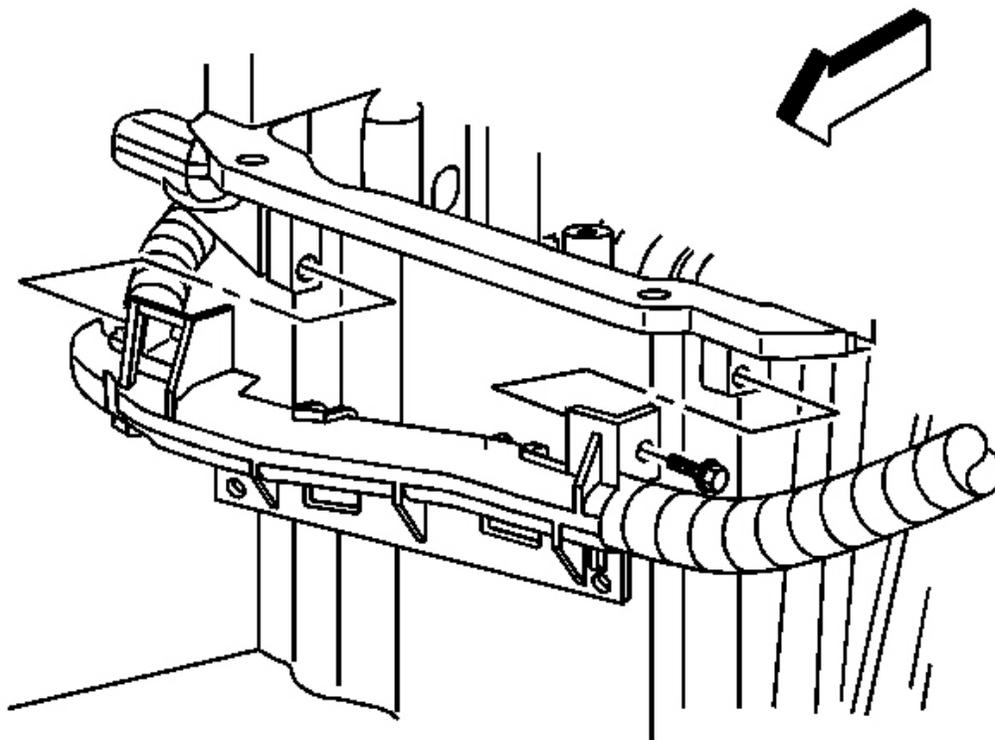


Fig. 189: View Of Battery Cable Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the battery cable channel bolt from the front of the oil pan.
11. Remove the battery cable channel from the oil pan.

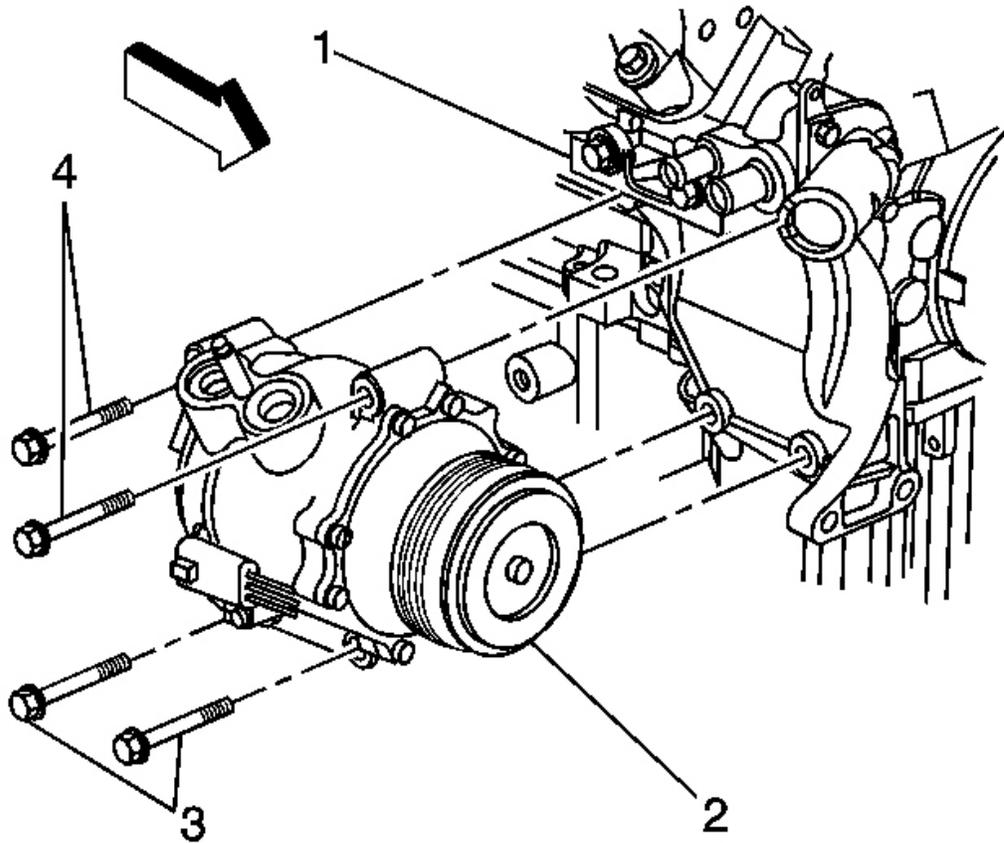


Fig. 190: View Of A/C Compressor Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

12. Loosen the 2 upper air conditioning (A/C) compressor bracket bolts (4).
13. Remove the 2 lower A/C compressor bracket bolts (3).

Position the A/C compressor aside and secure.

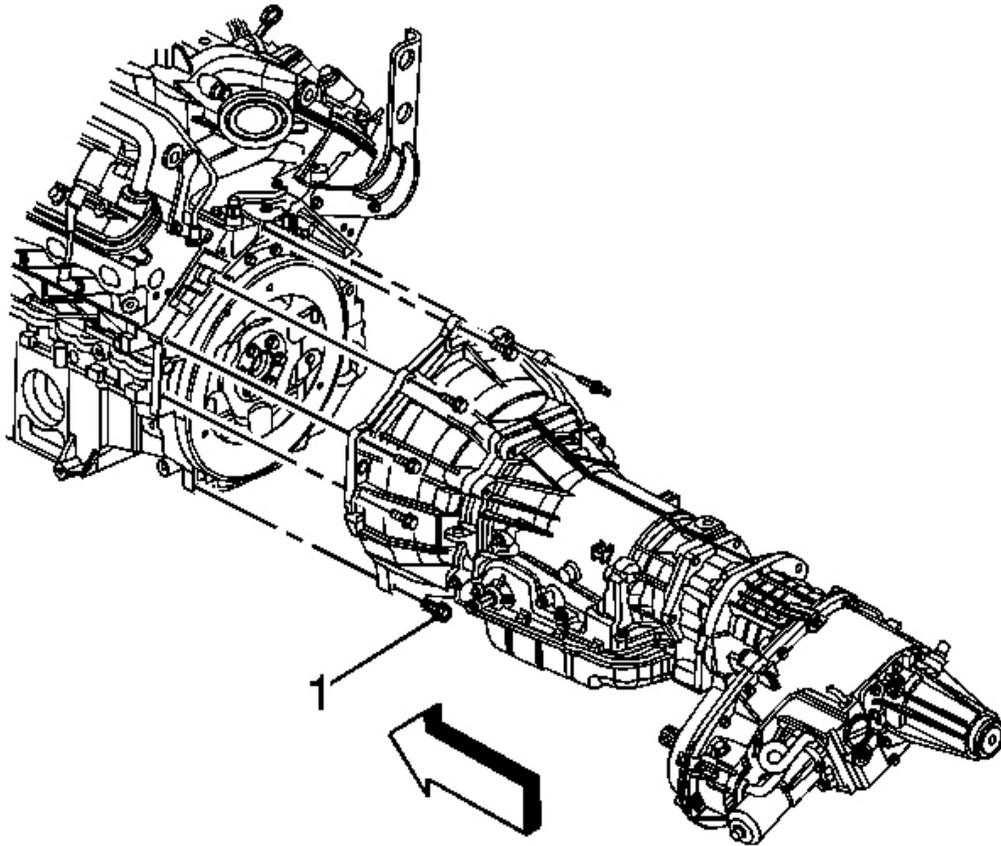


Fig. 191: View Of Lower Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the 2 lower bellhousing bolts (1).

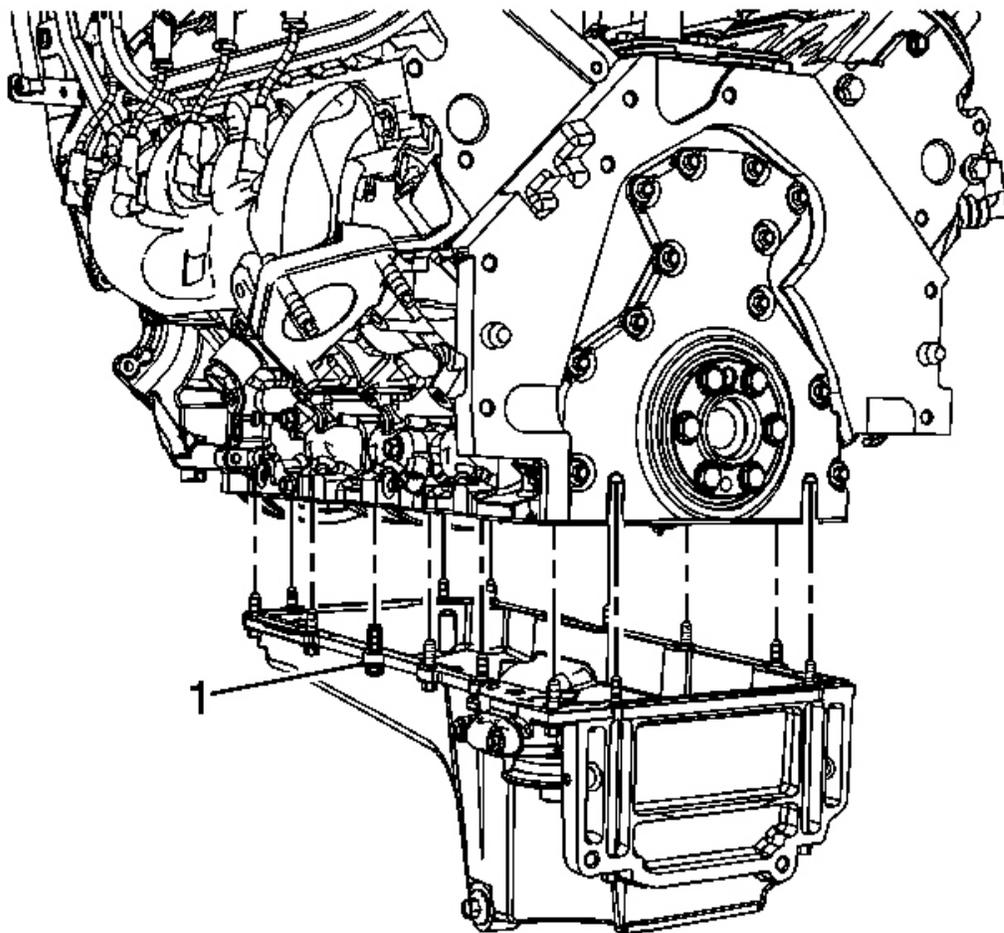


Fig. 192: Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the oil pan bolts (1).
16. Remove the oil pan by tilting the rear of the oil pan down to clear the transmission, pull the oil pan rearward past the front wire harness, then lower the oil pan clear of the vehicle.

- IMPORTANT:**
- The oil pan gasket is reusable. It is NOT necessary to remove the oil pan gasket unless damaged.
 - DO NOT allow foreign material to enter the oil passages of the oil pan, cap or cover the openings as required.

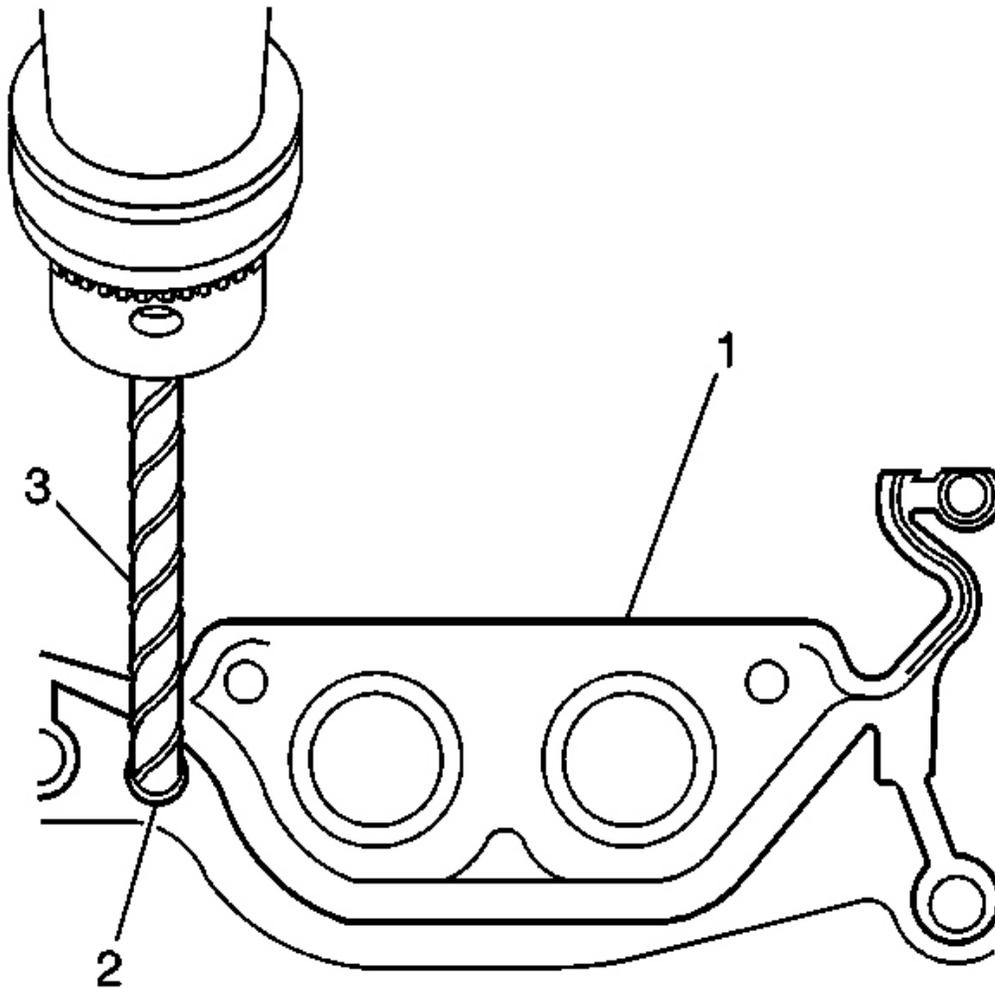


Fig. 193: Drilling Oil Pan Gasket Retaining Rivets
Courtesy of GENERAL MOTORS CORP.

17. Drill out the oil pan gasket retaining rivets (2), if required.
18. Remove the gasket (1) from the pan.
19. Discard the gasket and rivets.
20. Clean and inspect the oil pan. Refer to **Automatic Transmission Flex Plate Cleaning and Inspection**.

IMPORTANT:

- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission bellhousing. 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 must **NEVER** protrude beyond the engine block and transmission bellhousing plane.
- If replacing the oil pan gasket it is not necessary to rivet the **NEW** gasket to the oil pan.

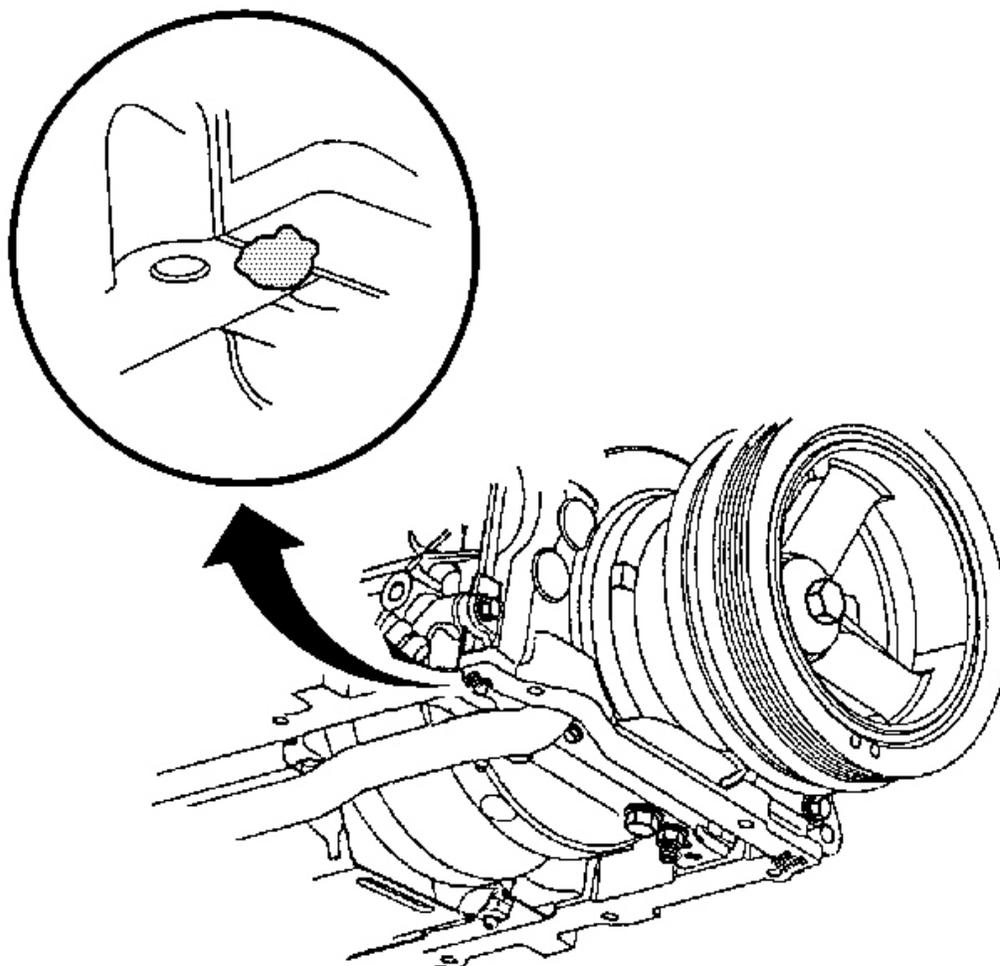


Fig. 194: View Of Sealant Applied To Front Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Apply the sealant directly onto the tabs of the front cover gasket that protrudes into the oil pan surface.

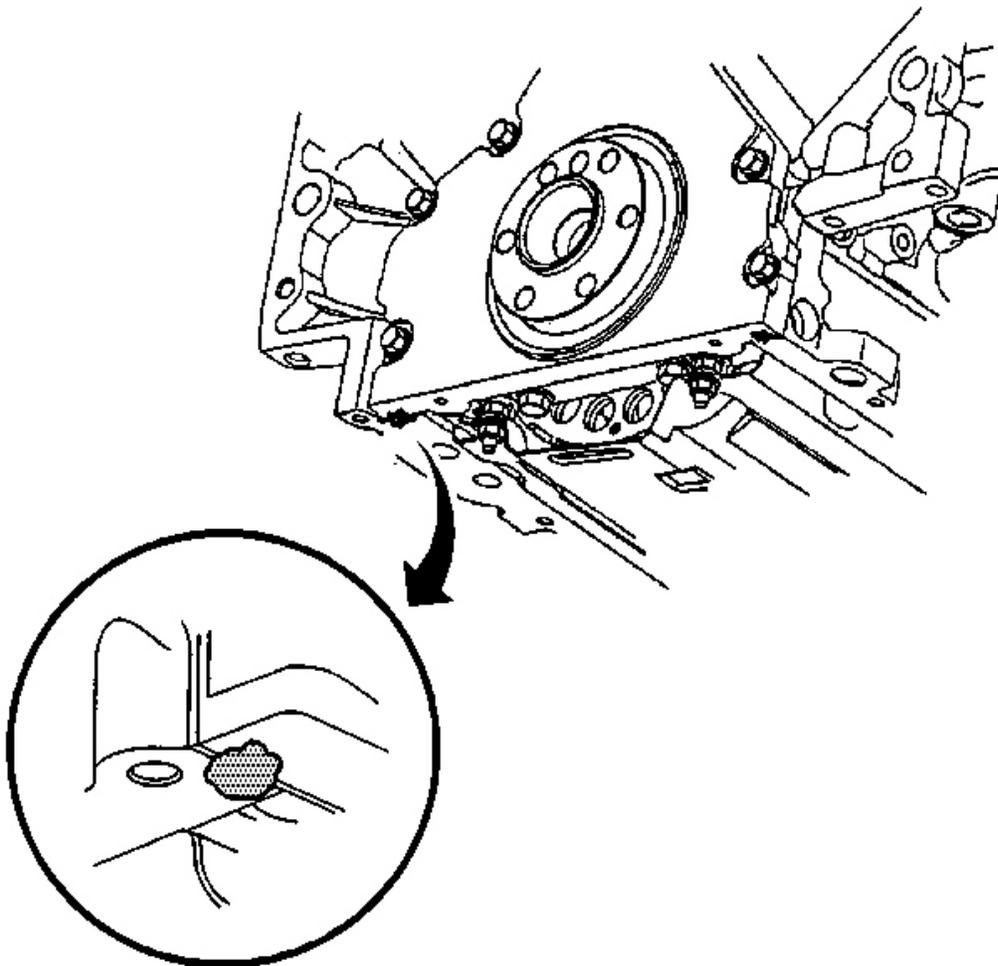


Fig. 195: View Of Sealant Applied To Rear Oil Pan-To-Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number. Apply the sealant

directly onto the tabs of the rear cover gasket that protrudes into the oil pan surface.

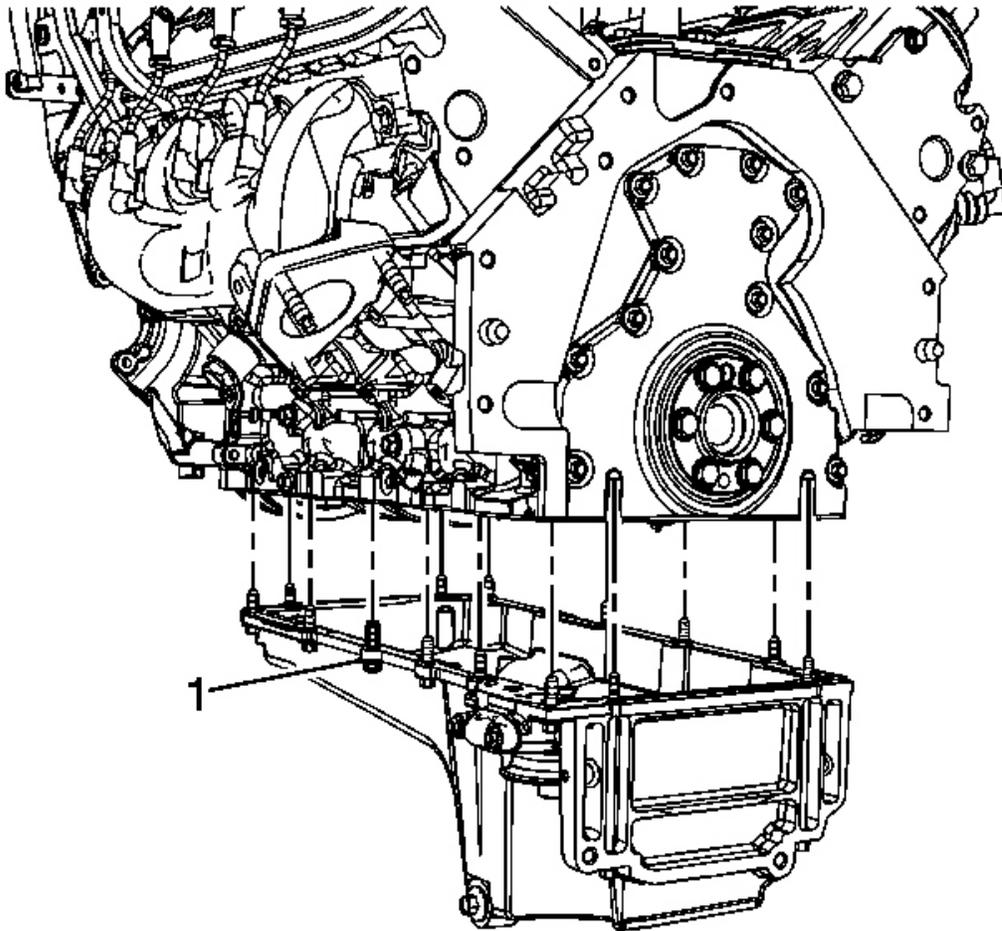


Fig. 196: Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

3. Pre-assemble the oil pan gasket and bolts (1) to the pan.
 - Install the gasket onto the pan.
 - Install the oil pan bolts to the pan and through the gasket.
4. Install the oil pan, oil pan gasket, and bolts to the engine block as an assembly.
5. Hand thread the oil pan bolts into the engine block until snug. Do not tighten at this time.

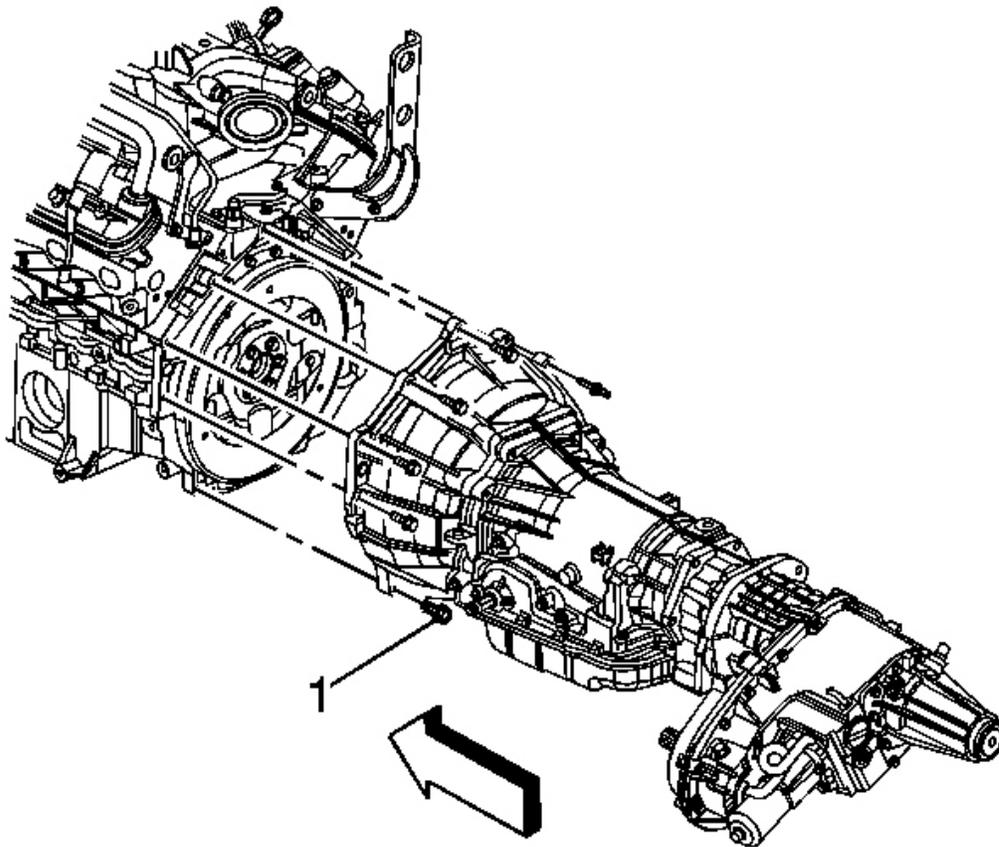


Fig. 197: View Of Lower Bellhousing Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

6. Install the 2 lower bellhousing bolts (1).

Tighten:

1. Tighten the lower bellhousing bolts to 50 N.m (37 lb ft).
2. Tighten the 2 rear oil pan to rear cover bolts to 12 N.m (106 lb in).
3. Tighten the remaining oil pan bolts to 25 N.m (18 lb ft).

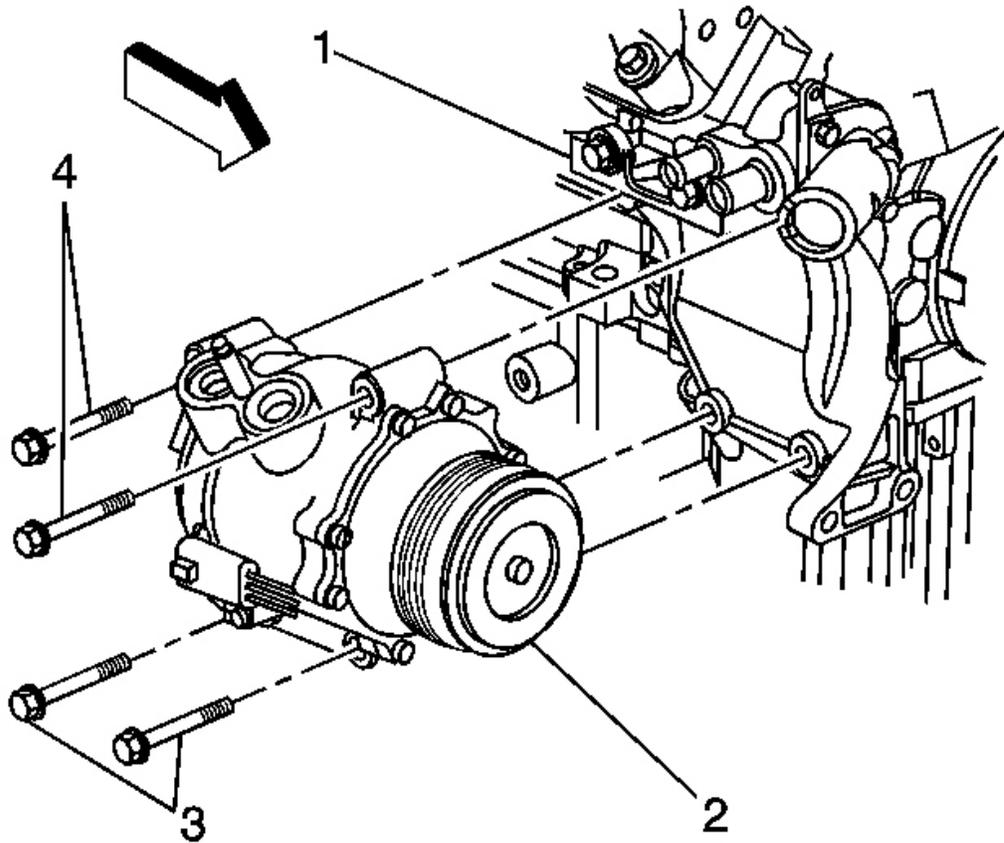


Fig. 198: View Of A/C Compressor Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the 2 lower A/C compressor bracket bolts (3).

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

8. Tighten the 2 upper A/C compressor bracket bolts (4).

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

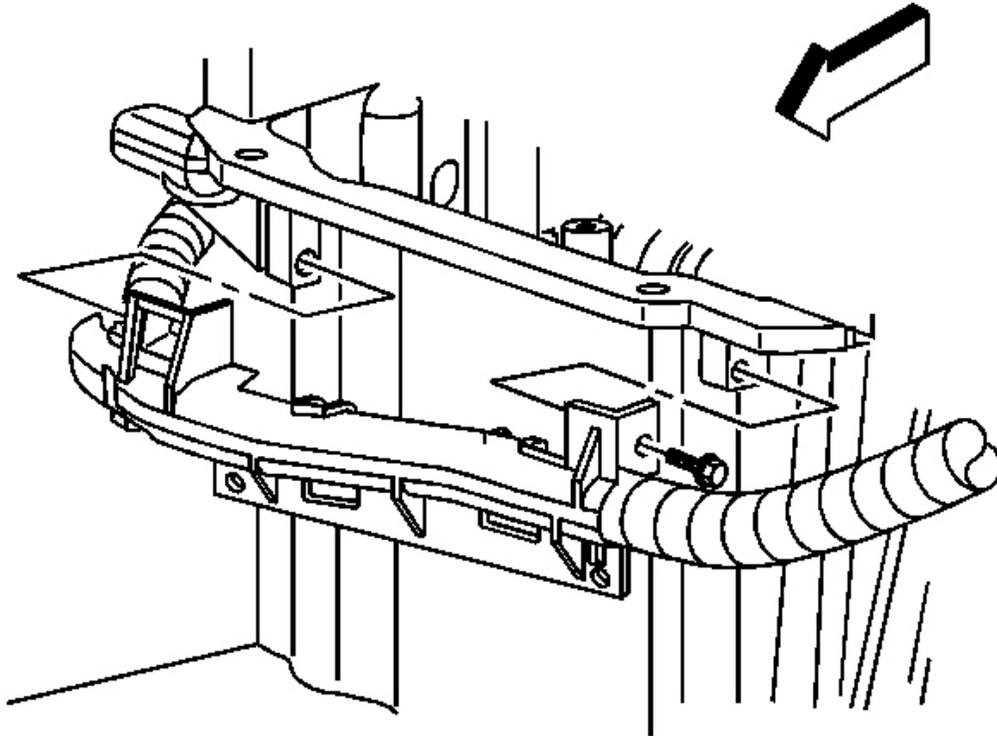


Fig. 199: View Of Battery Cable Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Install the battery cable channel to the oil pan.
10. Install the battery cable channel bolt to the oil pan.

Tighten: Tighten the bolt to 12 N.m (106 lb in).

11. Install the flywheel inspection cover to the left side of the transmission.

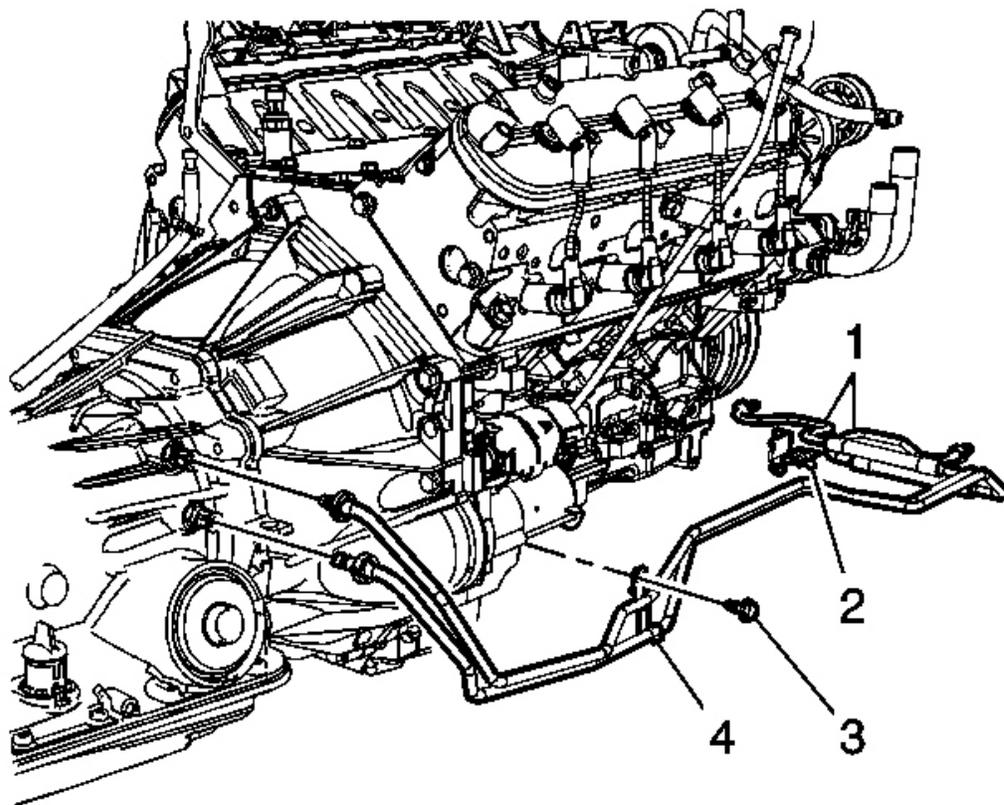


Fig. 200: Transmission Cooler Lines And Brackets
Courtesy of GENERAL MOTORS CORP.

12. Install the starter. Refer to **Starter Motor Replacement (LH8)** .
13. Install the inner axle shaft. Refer to **Front Drive Axle Inner Shaft and Inner Shaft Housing Replacement** .
14. Install the transmission oil cooler line retaining bracket (4) and bolt (3).

Tighten: Tighten the bolt to 9 N.m (80 lb in).

15. Install the transmission oil cooler lines (1) to the retainer (2).
16. Install the oil level indicator tube. Refer to **Oil Level Indicator and Tube Replacement**.
17. Fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
18. Install the front differential. Refer to **Differential Carrier Assembly Replacement** .

19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required

J 41712 Oil Pressure Switch Socket. See **Special Tools**.

Removal Procedure

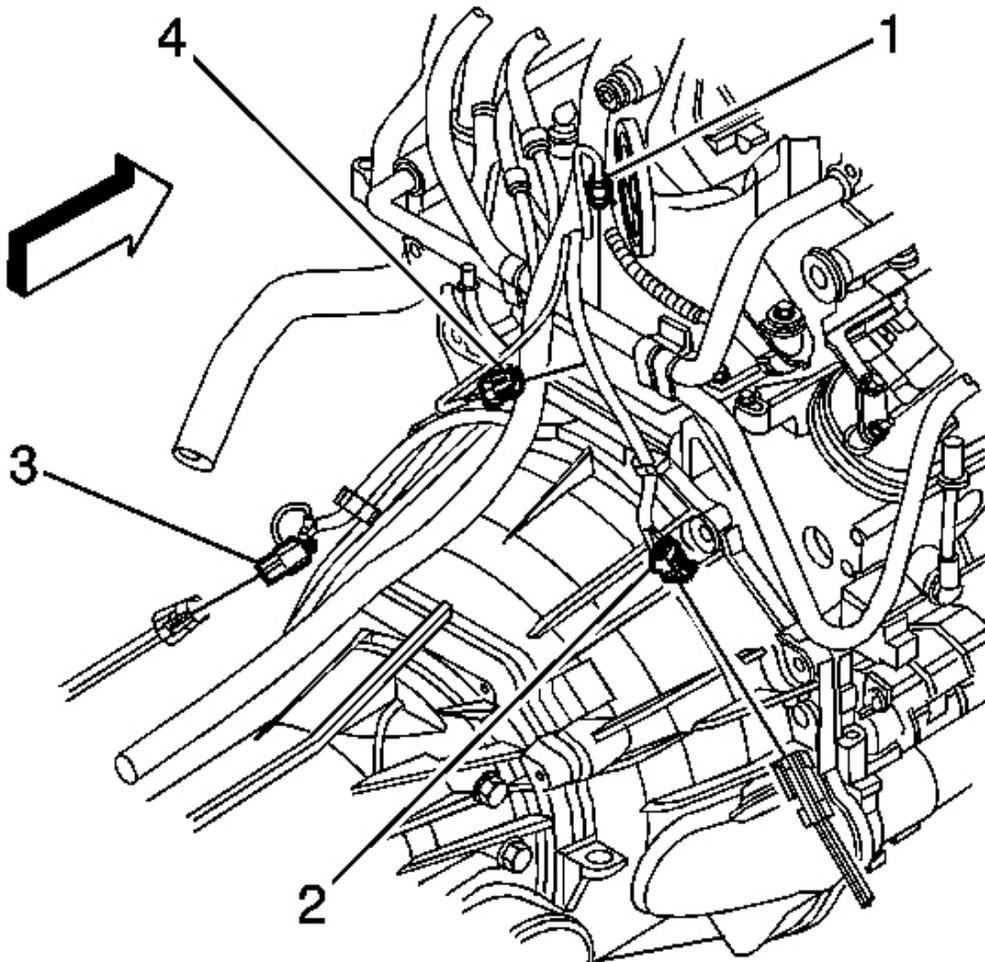


Fig. 201: Locating Components Connectors At Rear Of Engine

Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to Intake Manifold Replacement.
2. Disconnect the oil pressure sensor electrical connector (1).

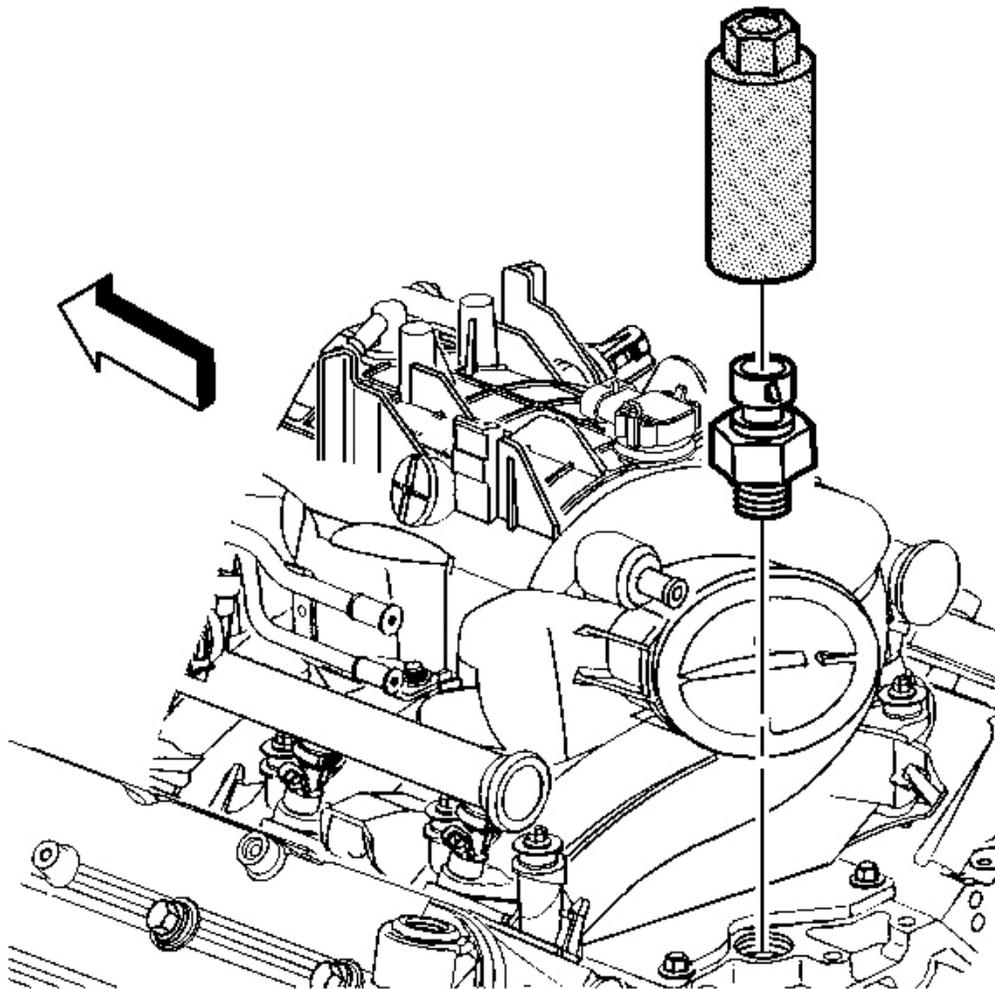


Fig. 202: View Of Oil Pressure Sensor & J 41712
Courtesy of GENERAL MOTORS CORP.

3. Using **J 41712** or equivalent, remove the oil pressure sensor. See Special Tools.

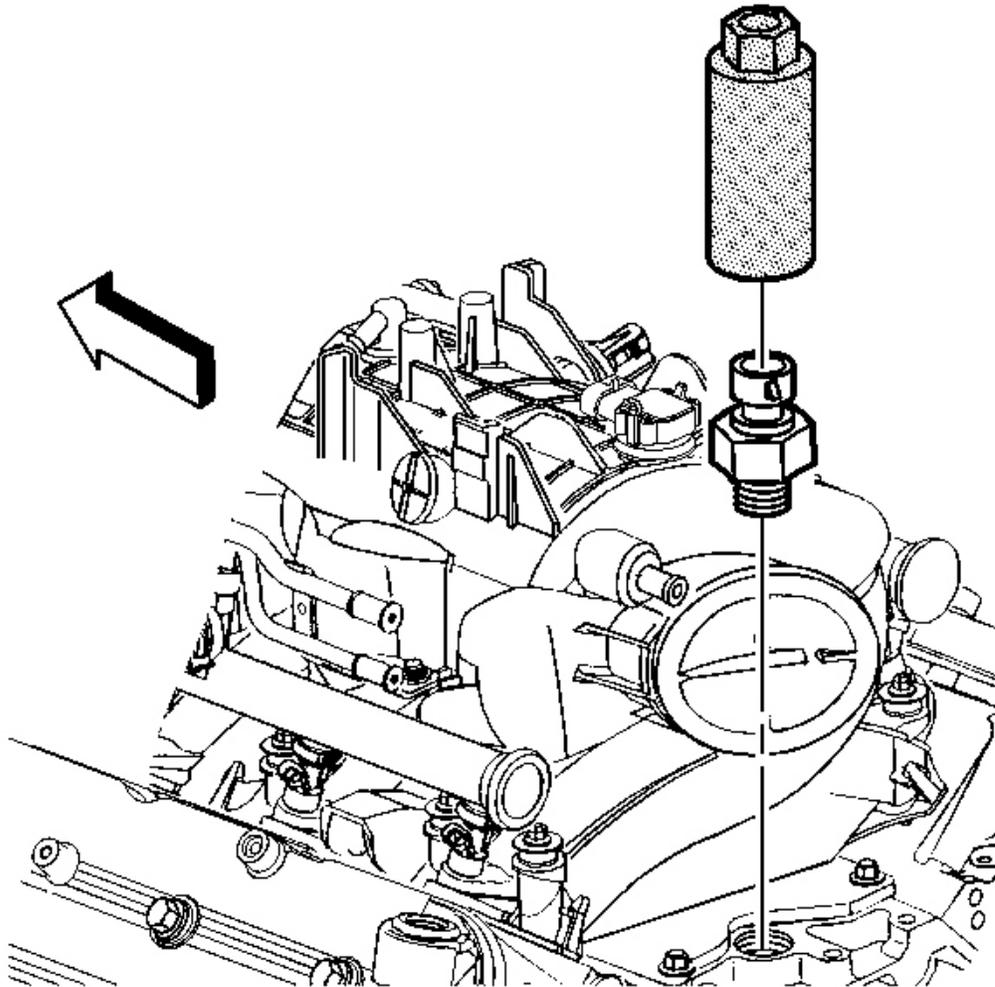


Fig. 203: View Of Oil Pressure Sensor & J 41712
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Apply sealant to the threads of the oil pressure sensor. Refer to Adhesives, Fluids, Lubricants, and Sealers for the correct part number.
2. Using **J 41712** or equivalent, install the oil pressure sensor. See Special Tools.

Tighten: Tighten the sensor to 35 N.m (26 lb ft).

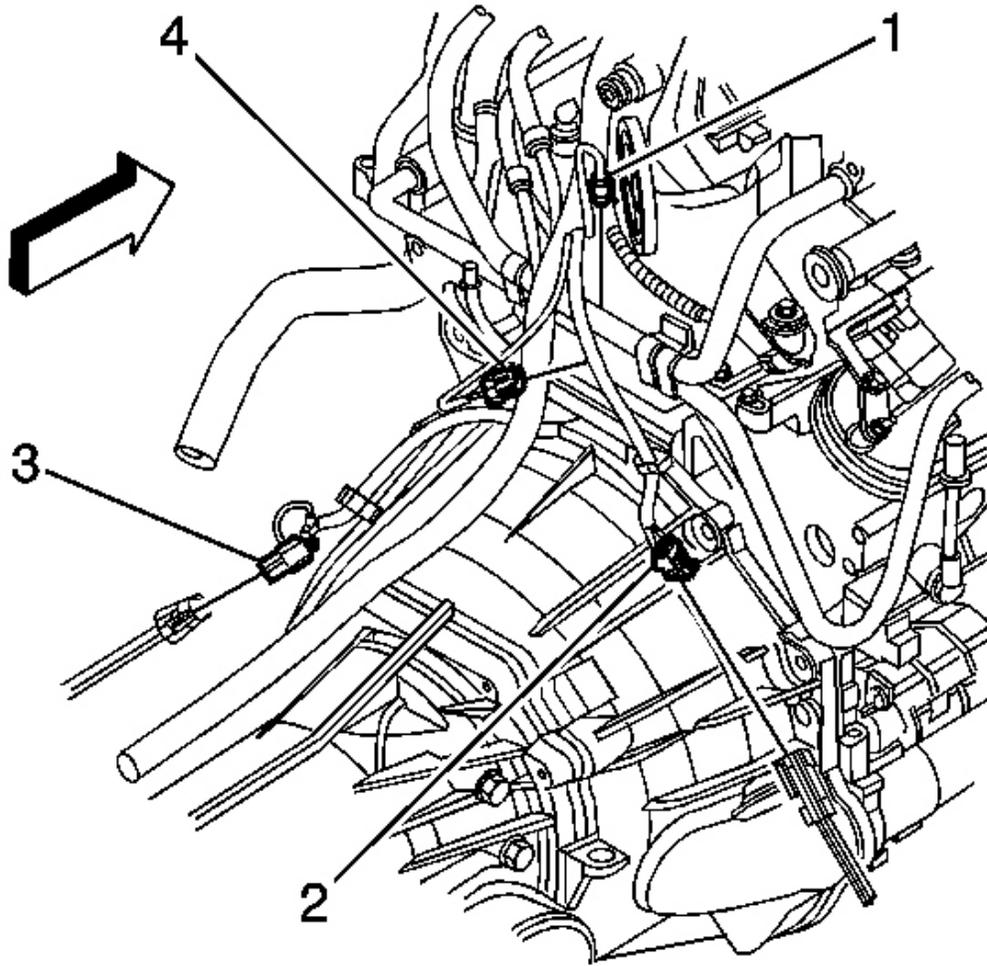


Fig. 204: Locating Components Connectors At Rear Of Engine
Courtesy of GENERAL MOTORS CORP.

3. Connect the oil pressure sensor electrical connector (1).
4. Install the intake manifold. Refer to **Intake Manifold Replacement**.

OIL PUMP, SCREEN, AND CRANKSHAFT OIL DEFLECTOR REPLACEMENT

Removal Procedure

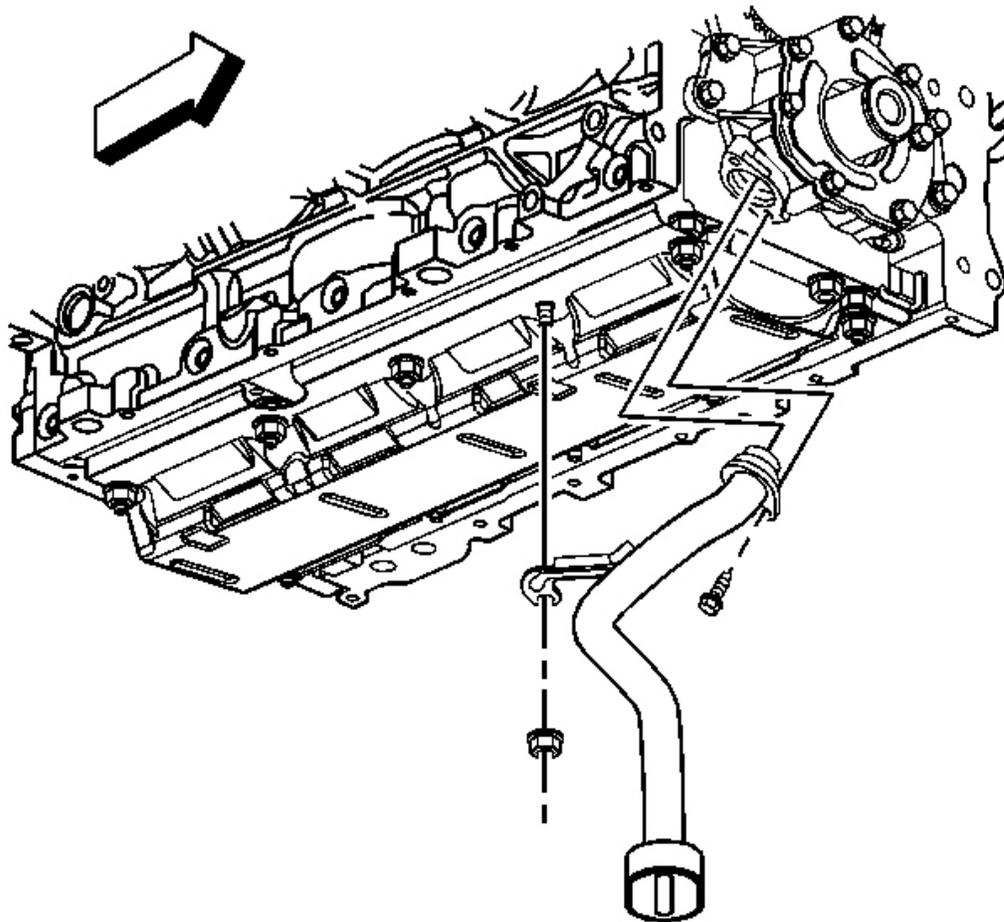


Fig. 205: View Of Oil Pump, Screen & Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the oil pump screen bolt and nuts.
4. Remove the oil pump screen with O-ring seal.
5. Remove the O-ring seal from the pump screen.
6. Discard the O-ring seal.

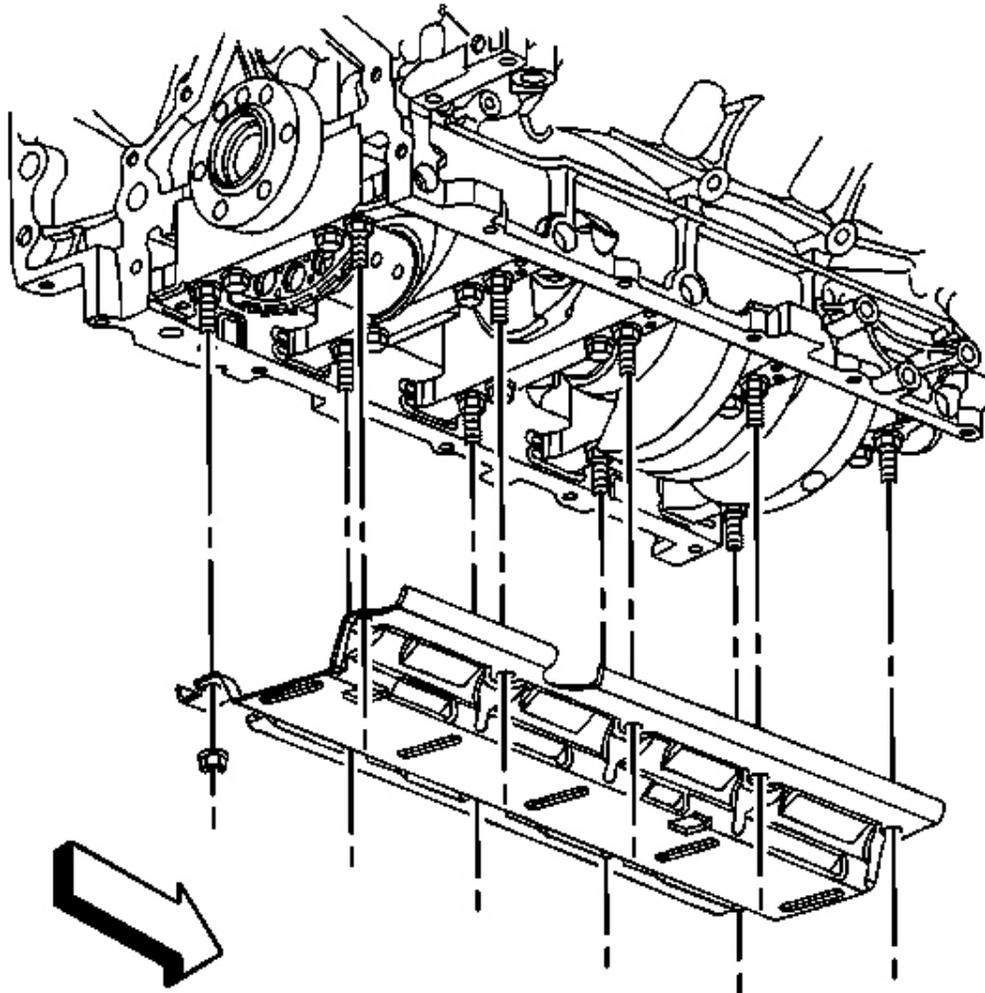


Fig. 206: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the remaining crankshaft oil deflector nuts.
8. Remove the crankshaft oil deflector.

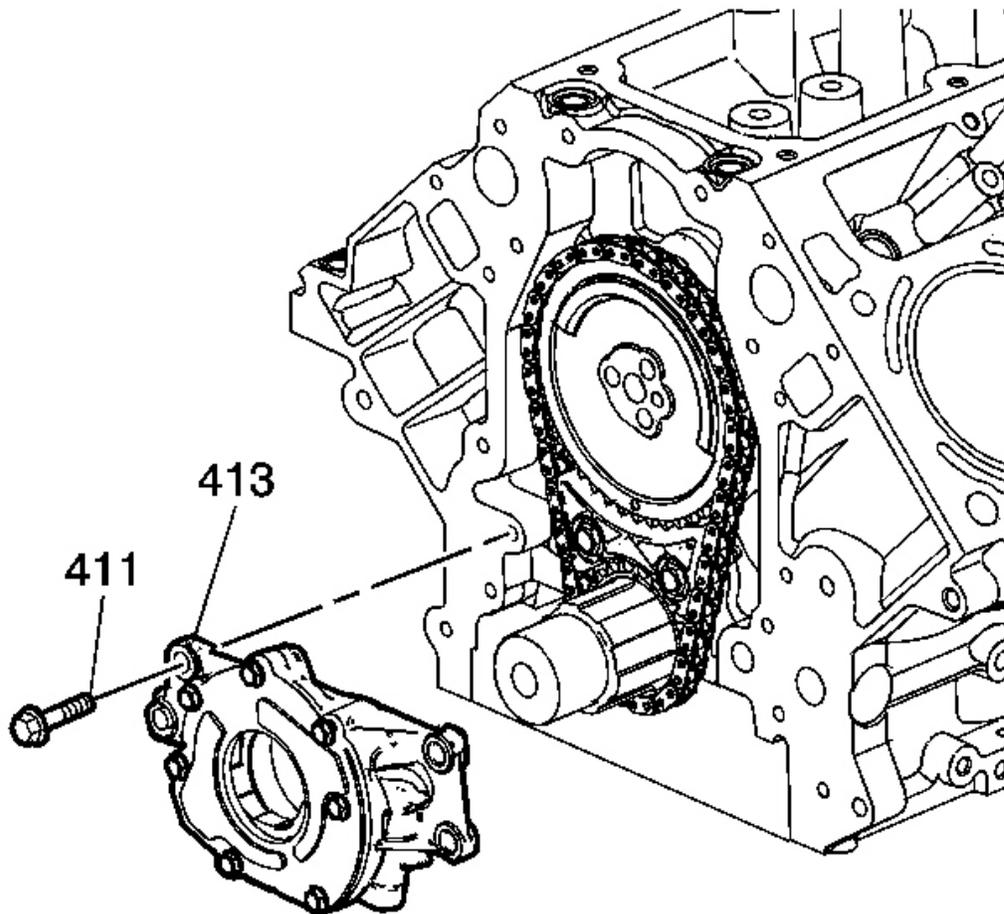


Fig. 207: Removing/Installing Oil Pump Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the oil pump bolts.

IMPORTANT: Do not allow dirt or debris to enter the oil pump assembly, cap end as necessary.

10. Remove the oil pump.

11. Clean and inspect the oil pump. Refer to Oil Pump Cleaning and Inspection.

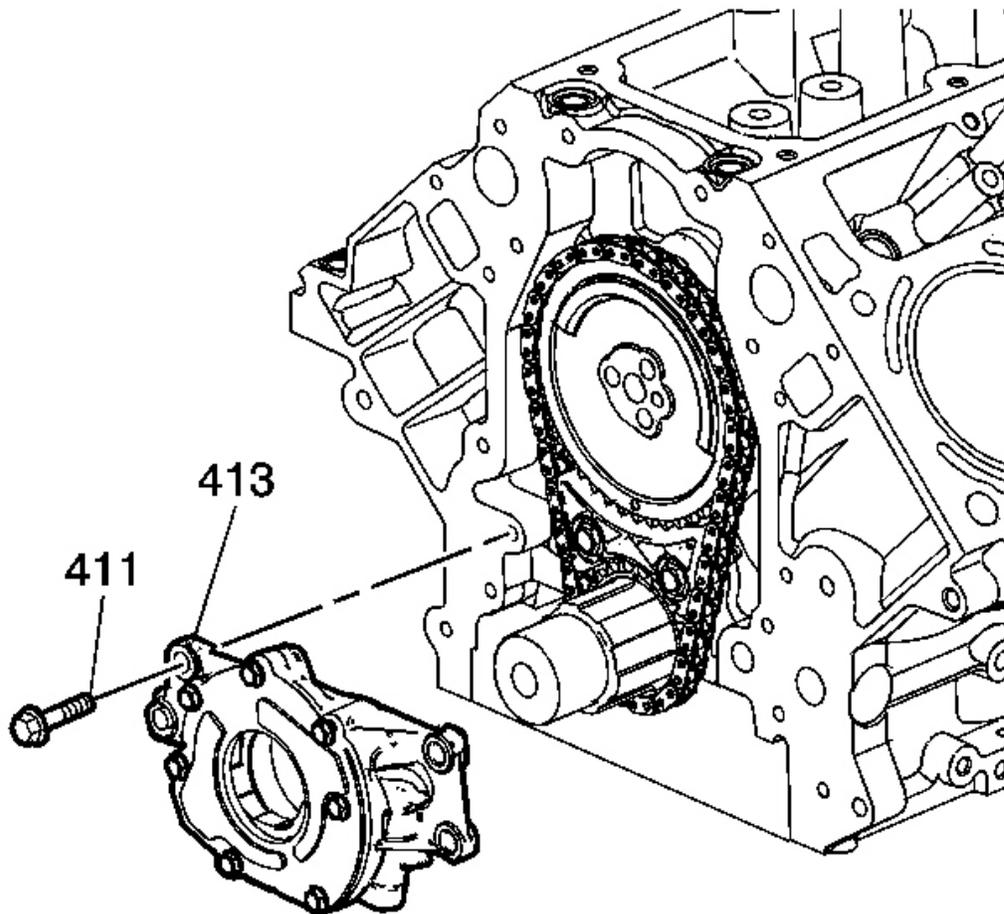


Fig. 208: Locating Oil Pump Bolts
Courtesy of GENERAL MOTORS CORP.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump.
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

NOTE: Refer to Fastener Notice .

3. Install the oil pump bolts.

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

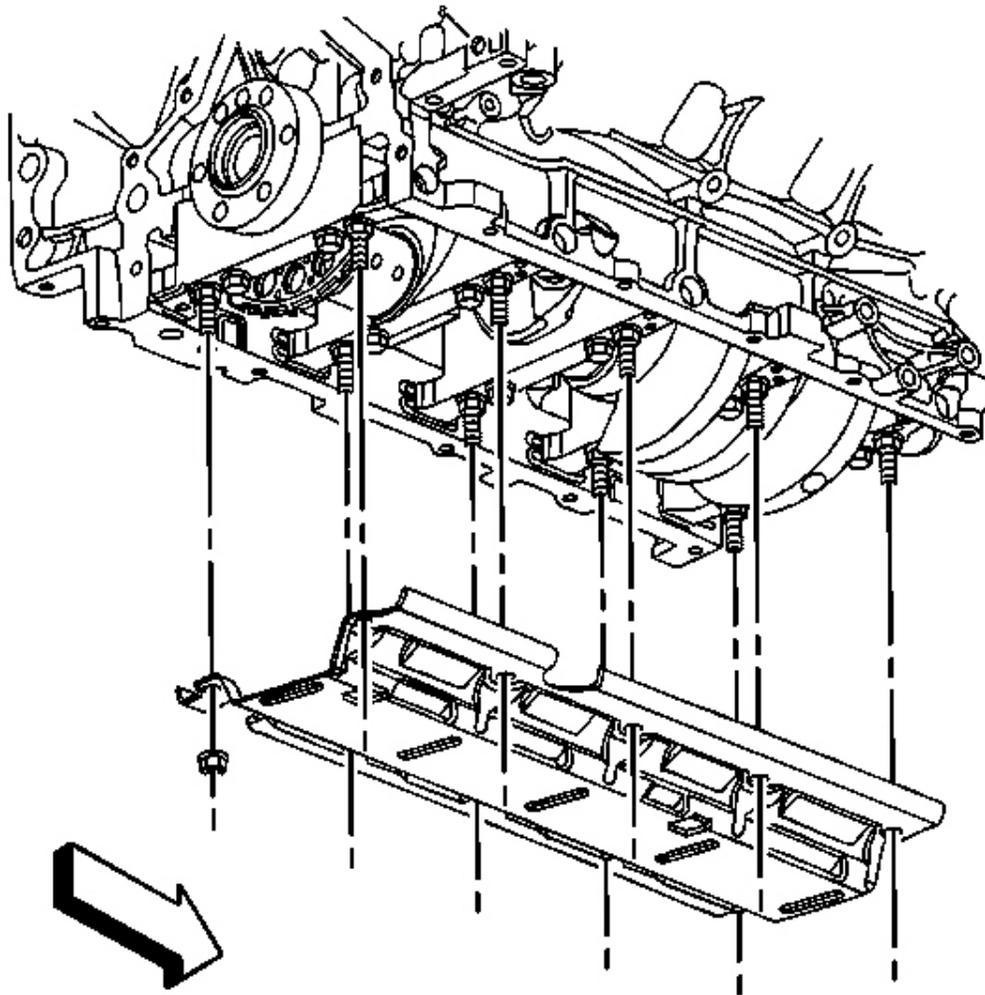


Fig. 209: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector and nuts until snug.

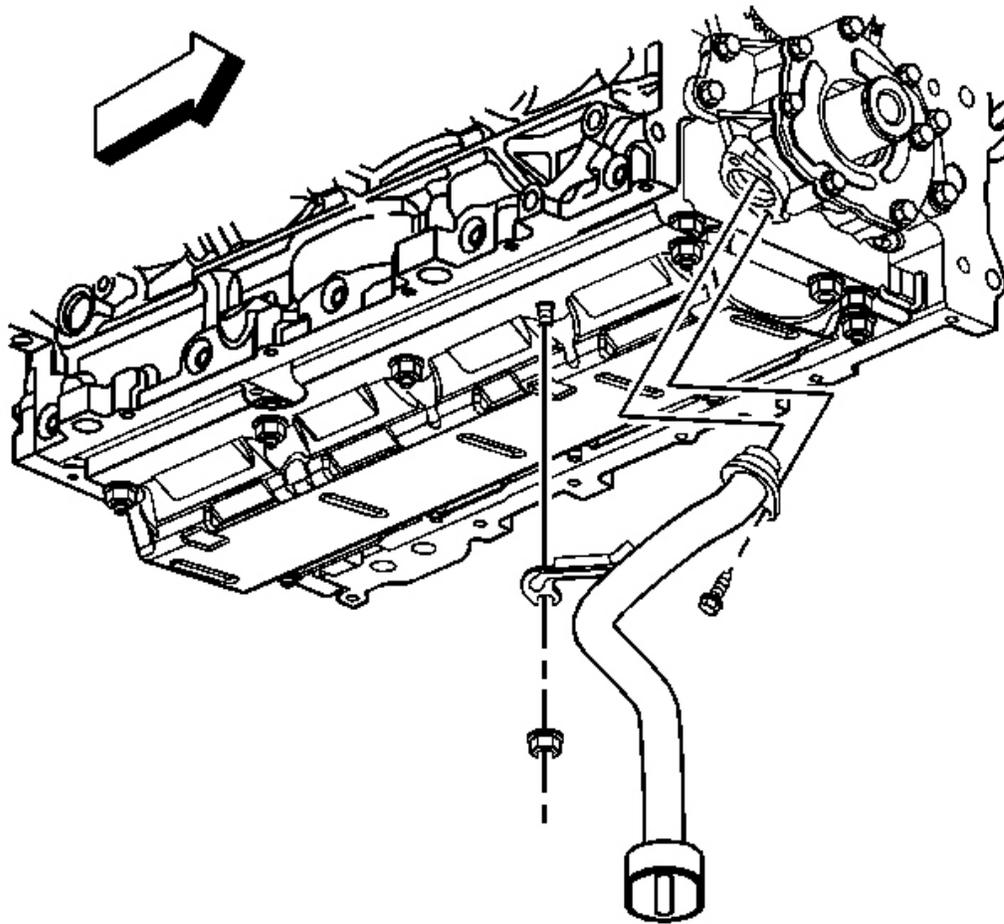


Fig. 210: View Of Oil Pump, Screen & Components
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

IMPORTANT: 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.

7. Align the oil pump screen mounting brackets with the correct crankshaft bearing cap studs.
8. Install the oil pump screen.

9. Install the oil pump screen bolt and nuts.

Tighten:

- Tighten the bolt to 12 N.m (106 lb in).
- Tighten the nuts to 25 N.m (18 lb ft).

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

11. Install the oil pan. Refer to **Oil Pan Replacement**.

TIMING CHAIN AND SPROCKET REPLACEMENT

Tools Required

- **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

Removal Procedure

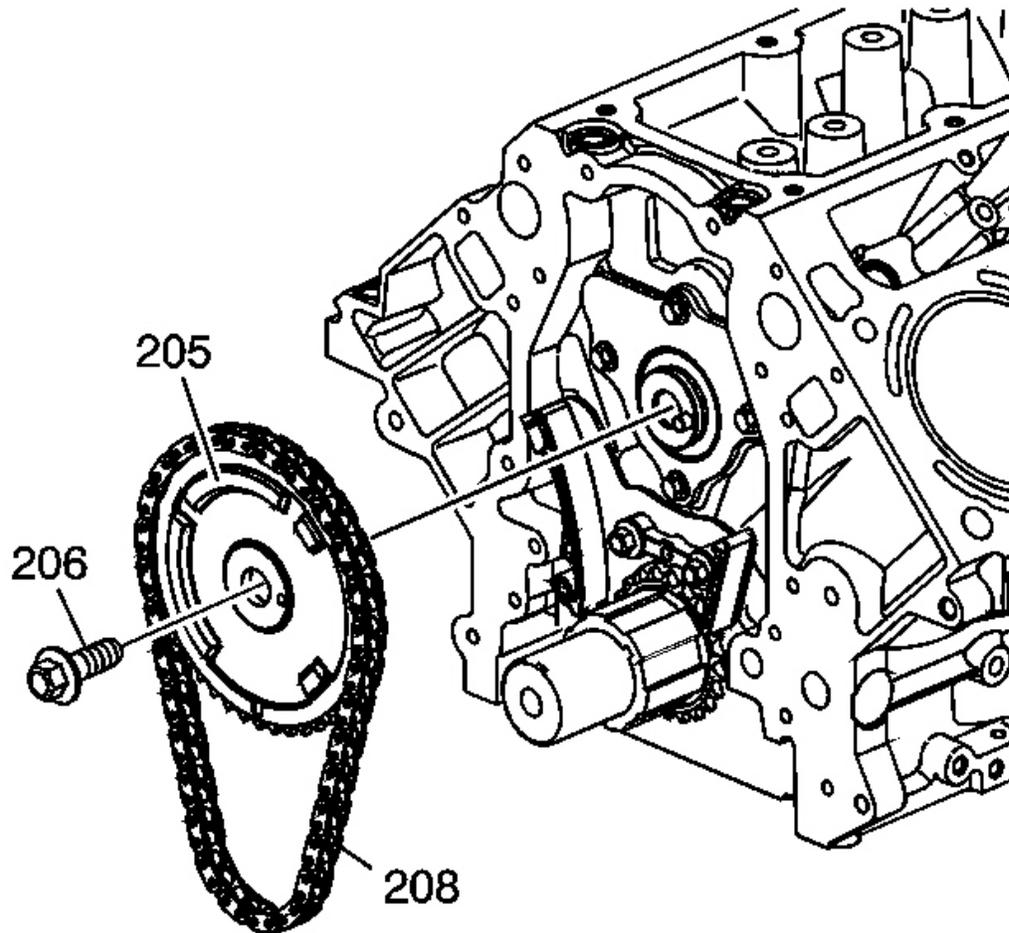


Fig. 211: View Of Camshaft Sprocket, Timing Chain & Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

NOTE: 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. Rotate the crankshaft until the timing marks on the crankshaft and the camshaft sprockets are aligned.

NOTE: 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.

3. Remove and discard the camshaft sprocket bolt (206).
4. Remove the camshaft sprocket (205) and timing chain (208).

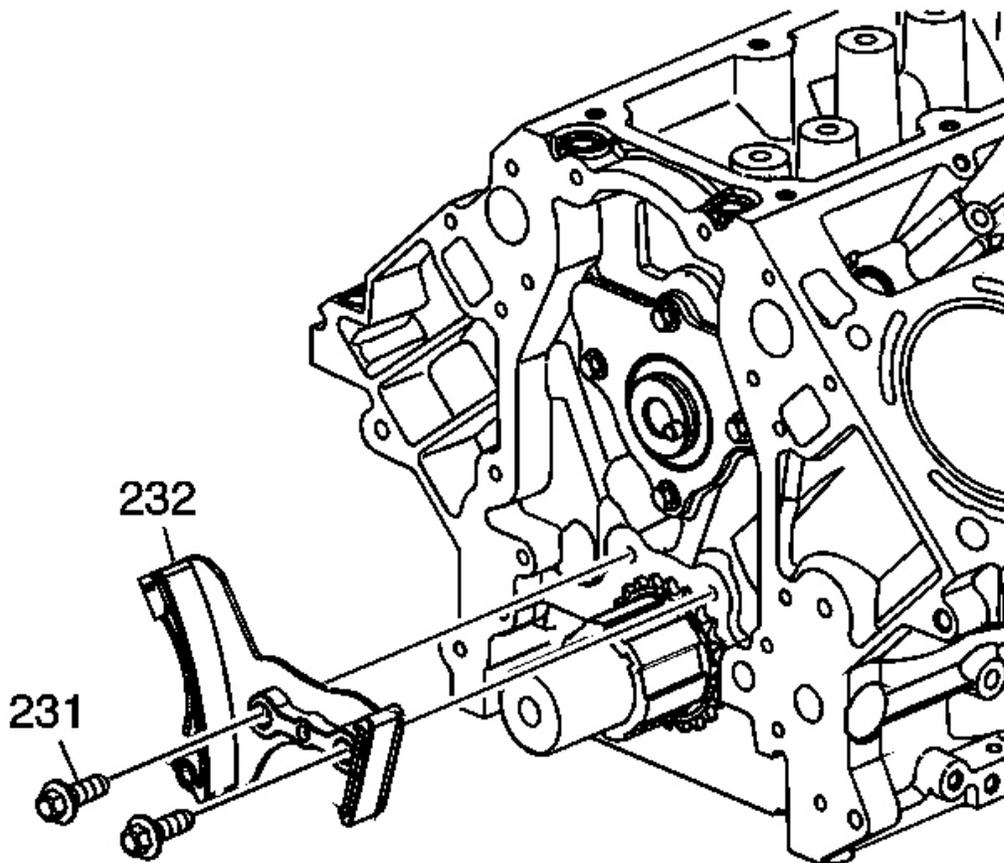


Fig. 212: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolts (231) and timing chain tensioner (232).

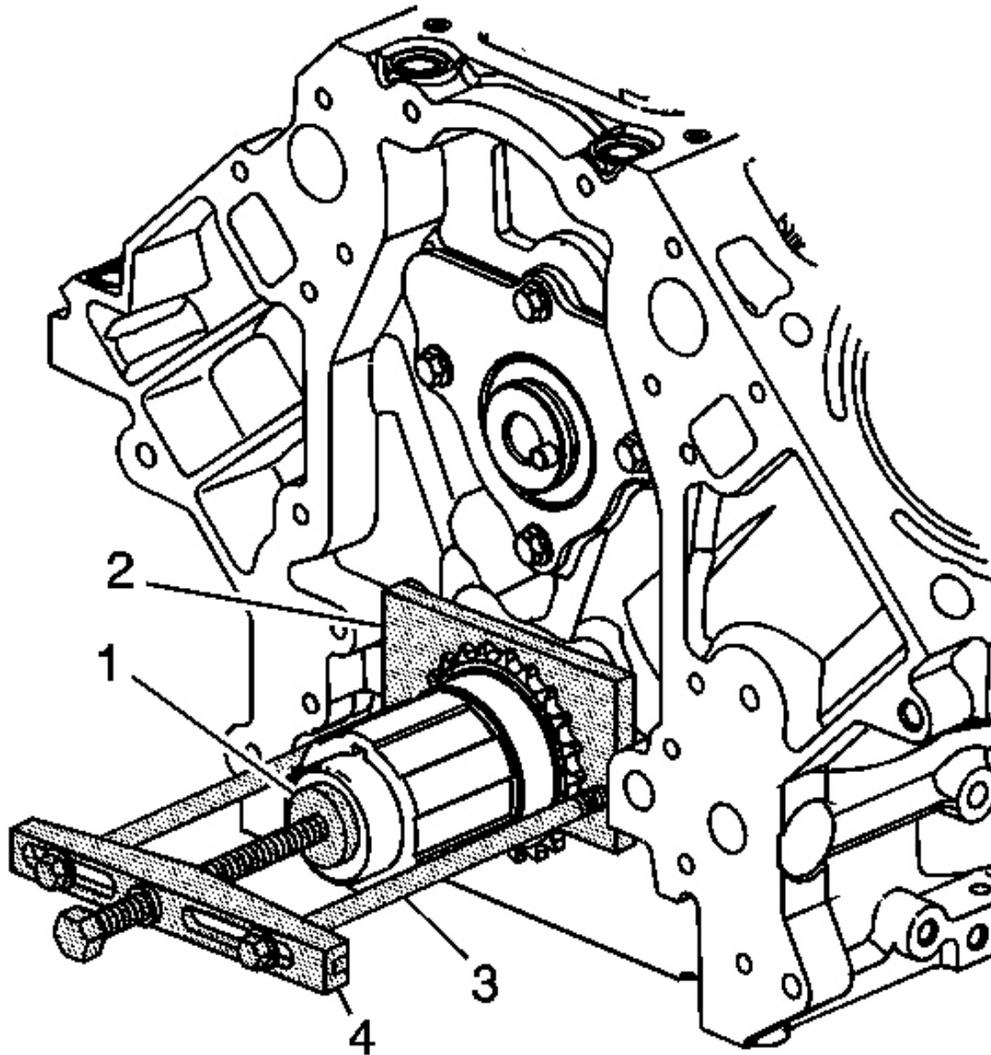


Fig. 213: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

6. Use the **J 41816-2** (1), the **J 41558** (2), bolts (3), and the **J 8433** (4) in order to remove the crankshaft sprocket. See **Special Tools**.

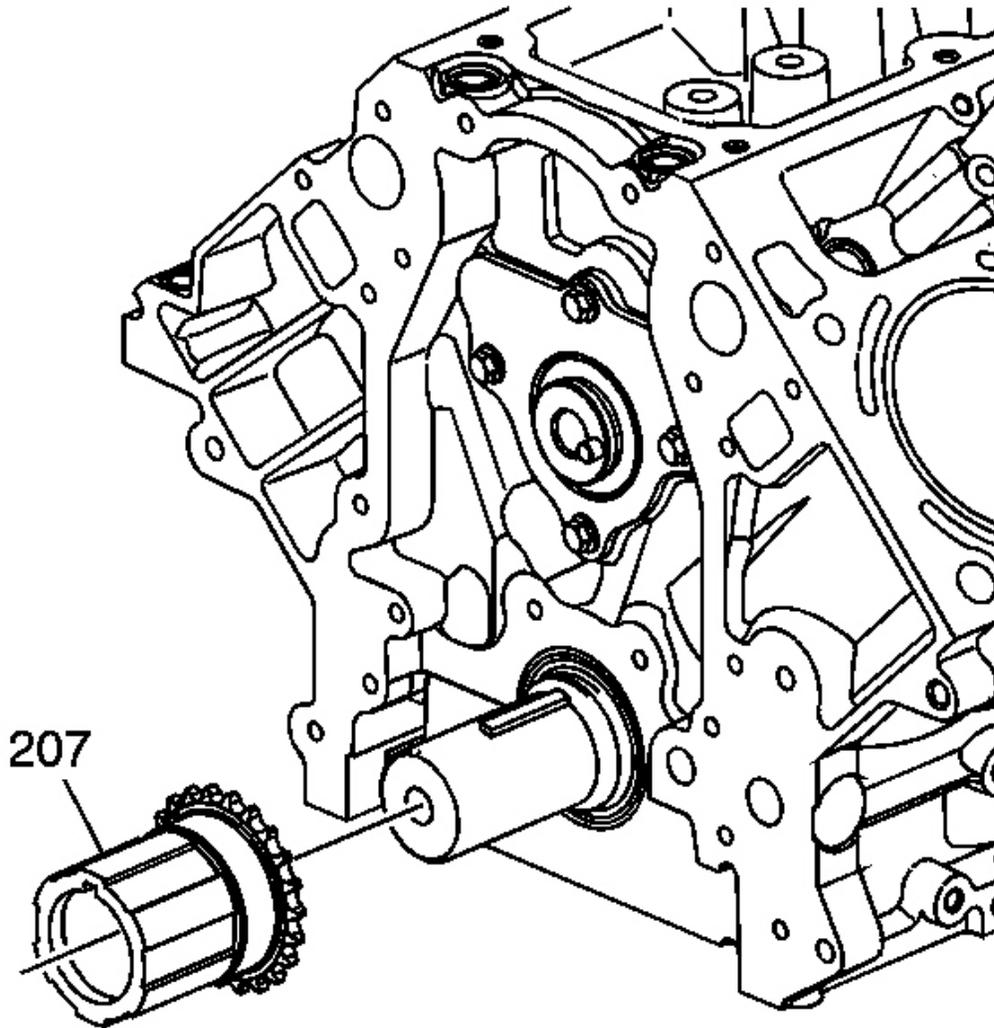


Fig. 214: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket (207).

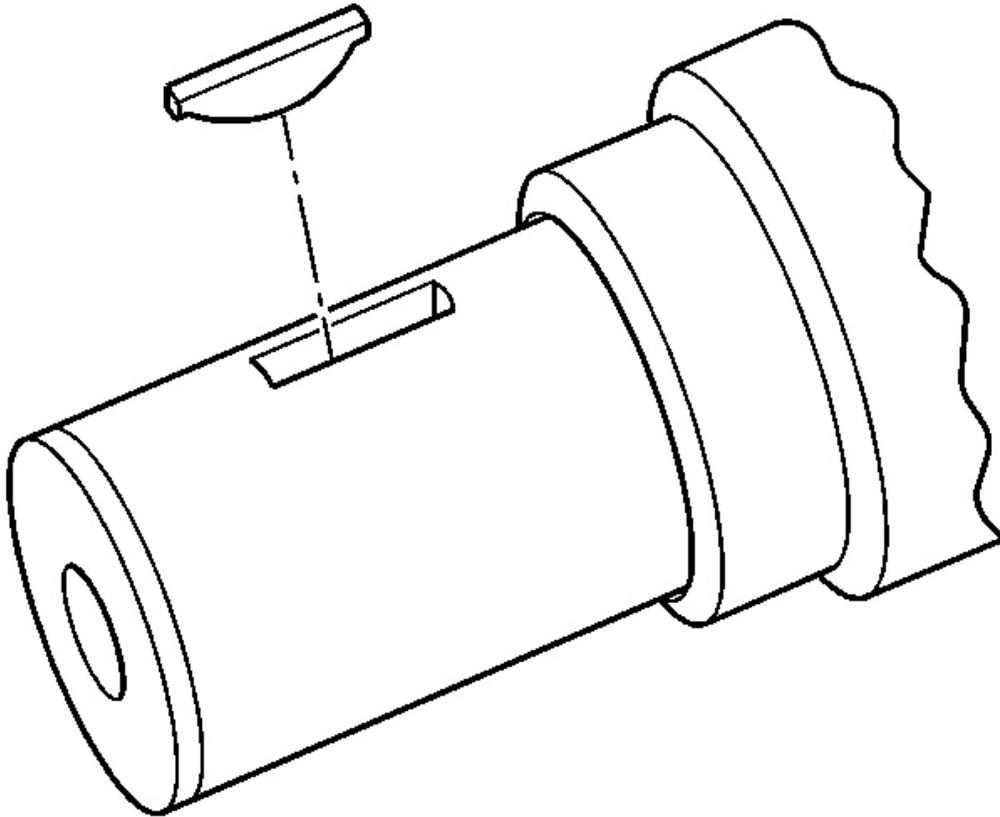


Fig. 215: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft sprocket key, as required.

Installation Procedure

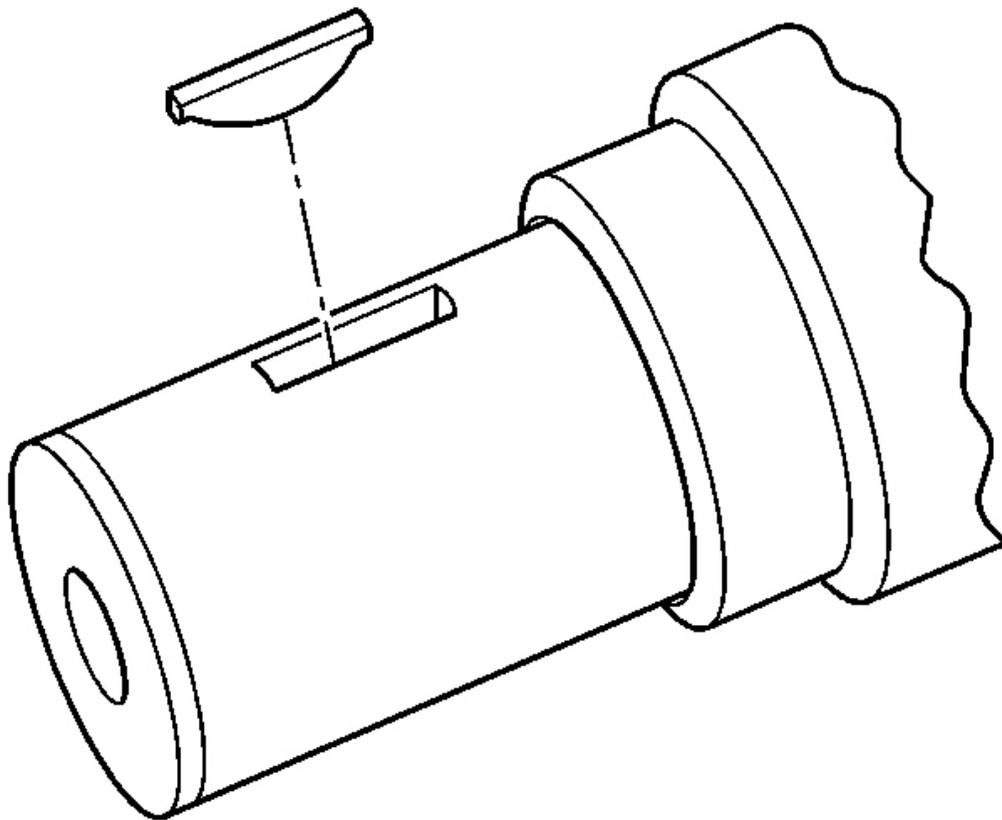


Fig. 216: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

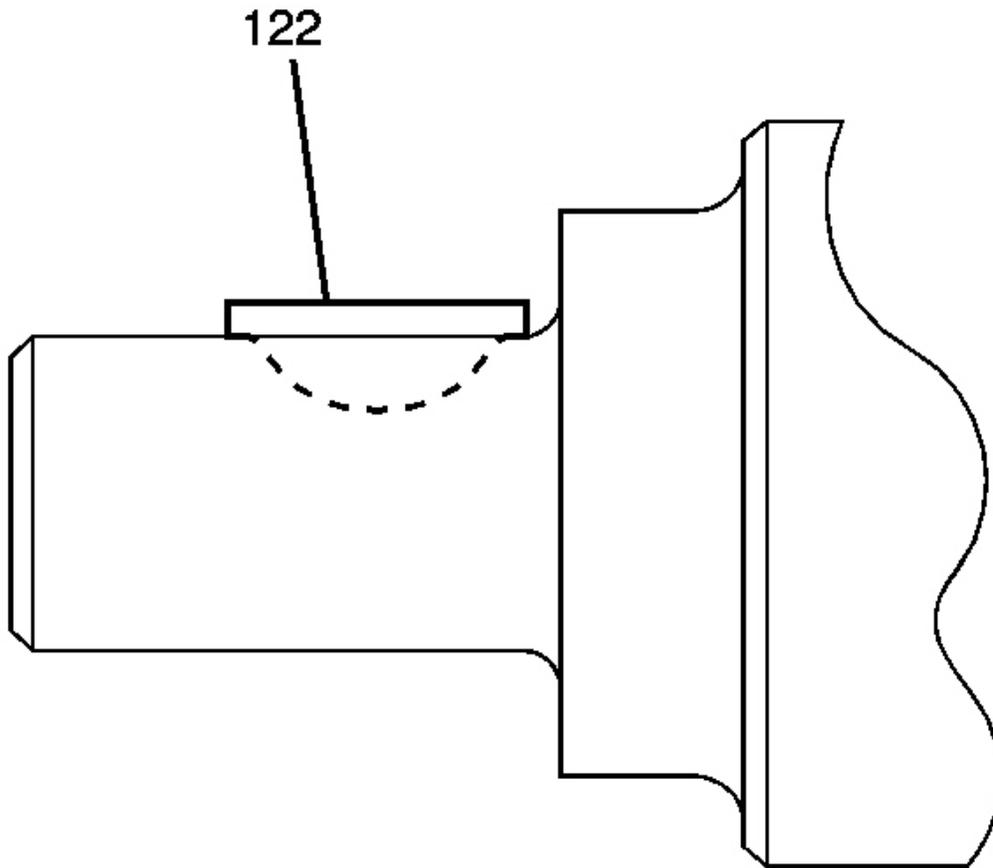


Fig. 217: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

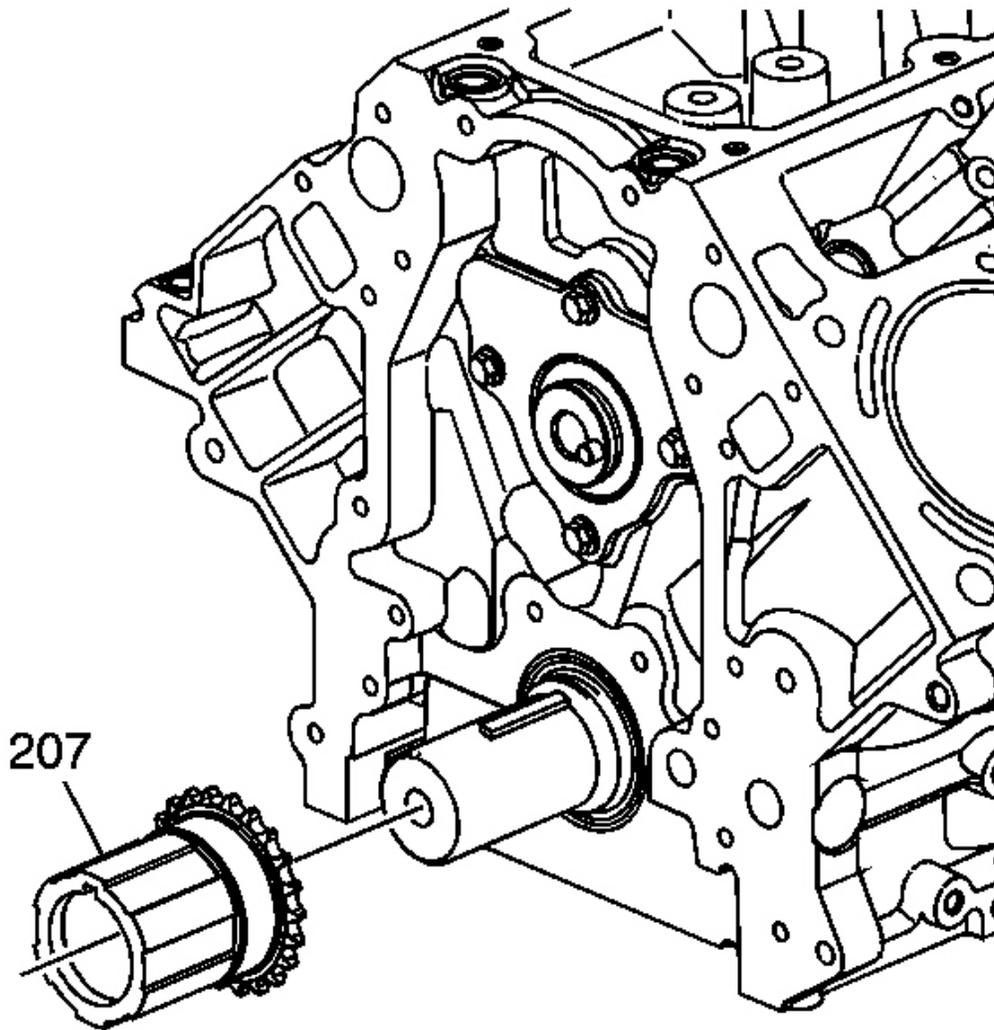


Fig. 218: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

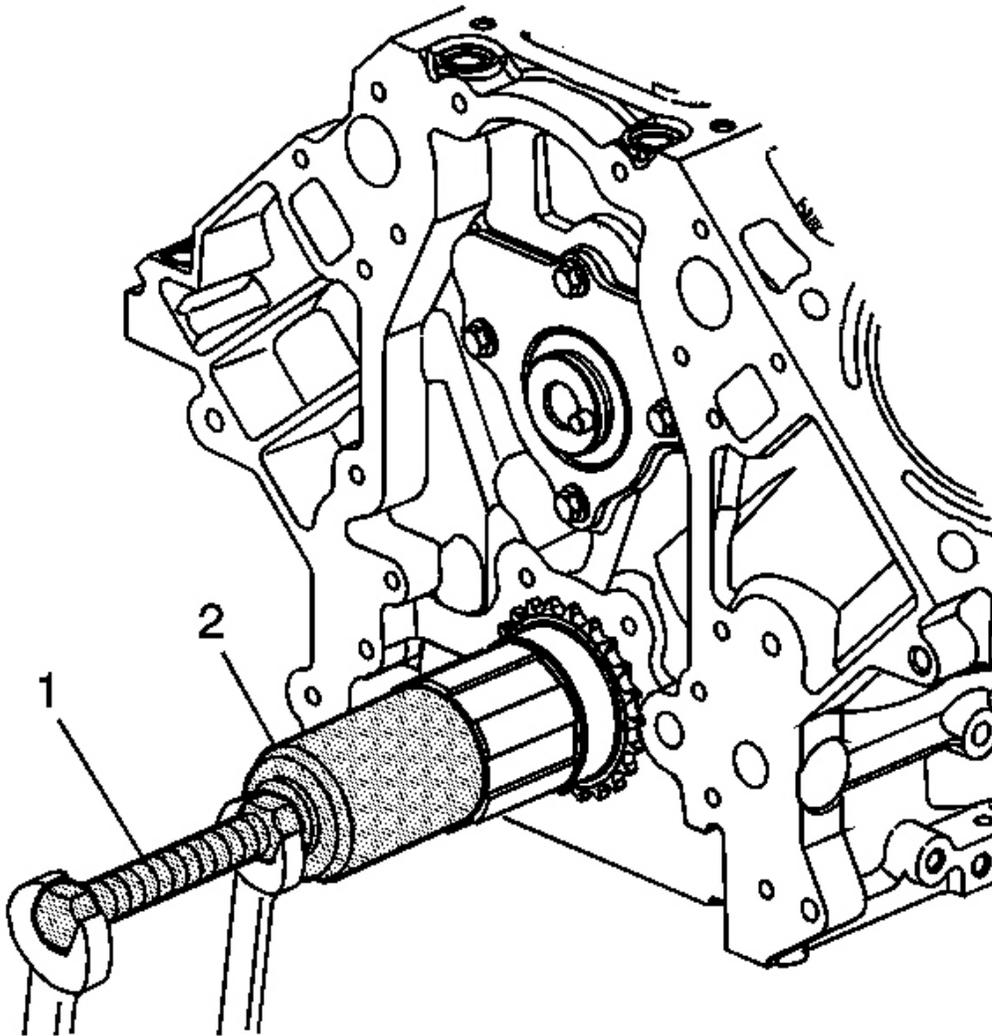


Fig. 219: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478** (1) and the **J 41665** (2) in order to install the crankshaft sprocket. See **Special Tools**.

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.

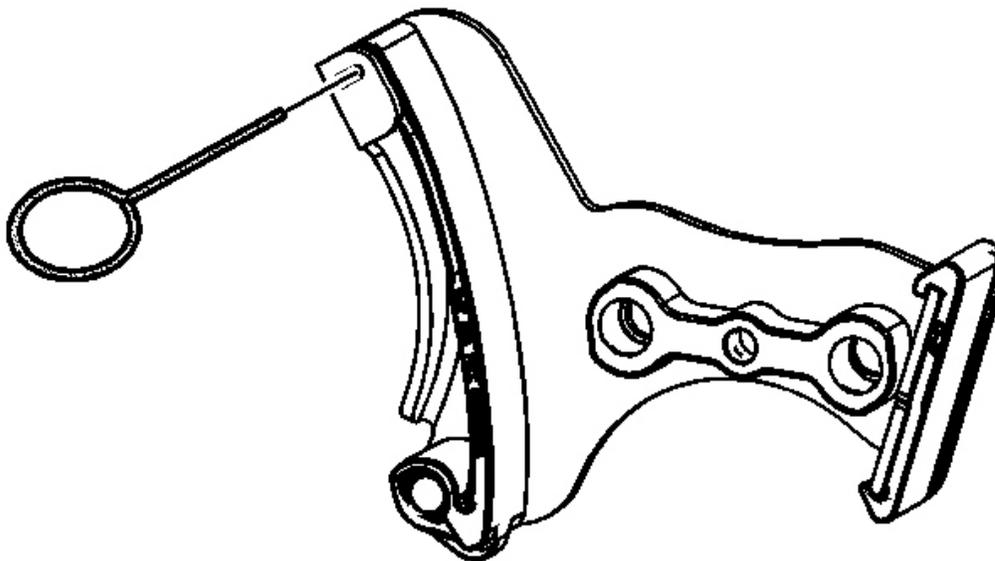


Fig. 220: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools**.

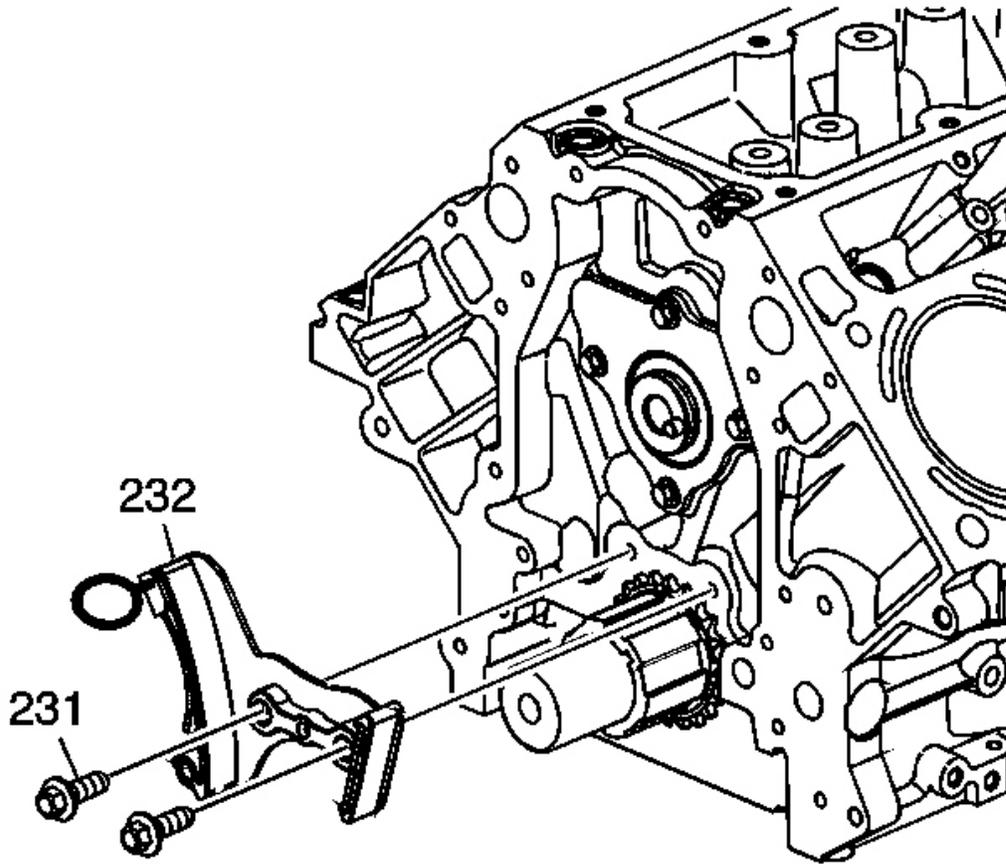


Fig. 221: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

7. Install the timing chain tensioner (232) and bolts (231).

Tighten: Tighten the timing chain tensioner bolts to 25 N.m (18 lb ft).

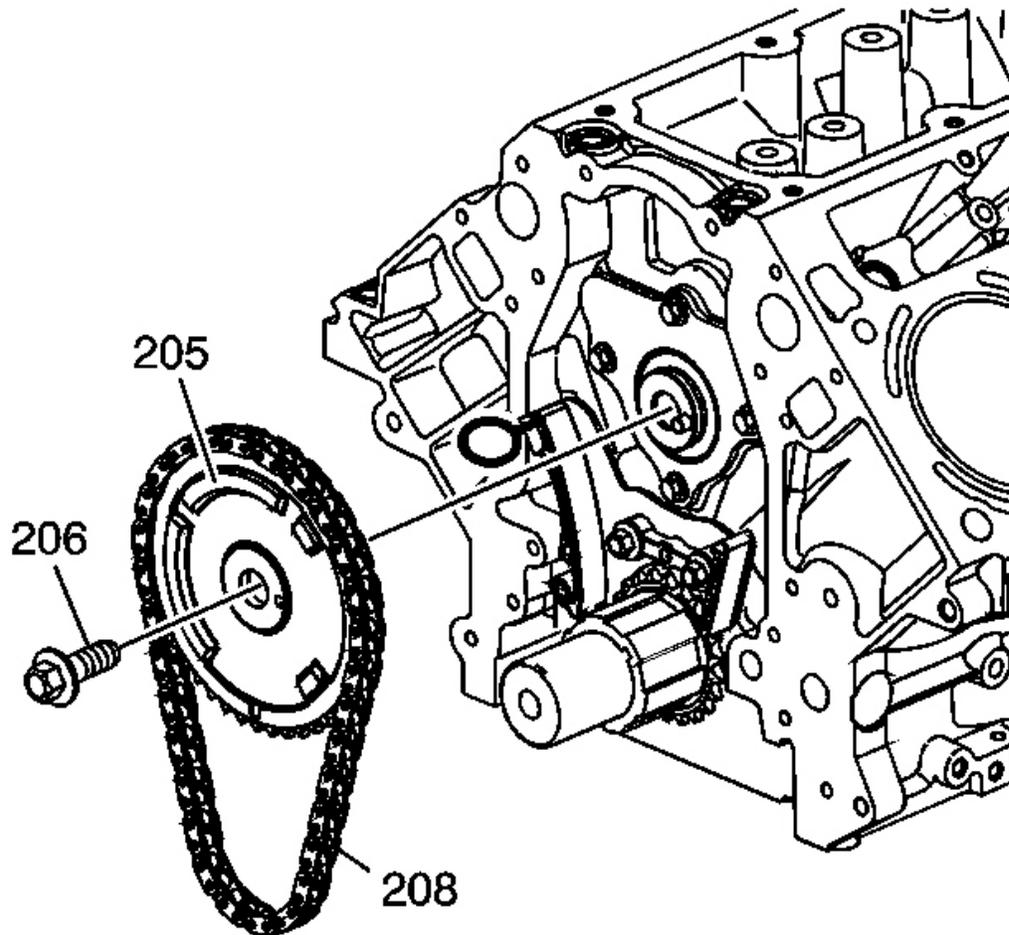


Fig. 222: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- 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).

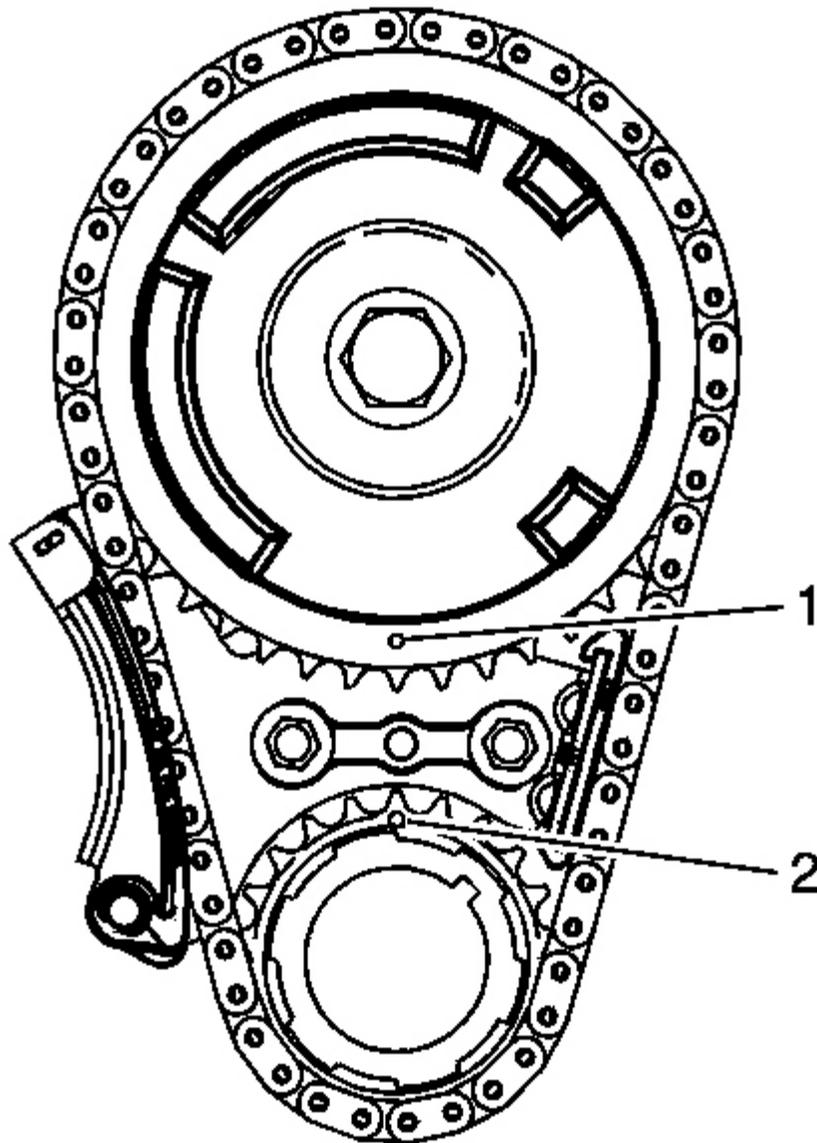


Fig. 223: Identifying Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

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.

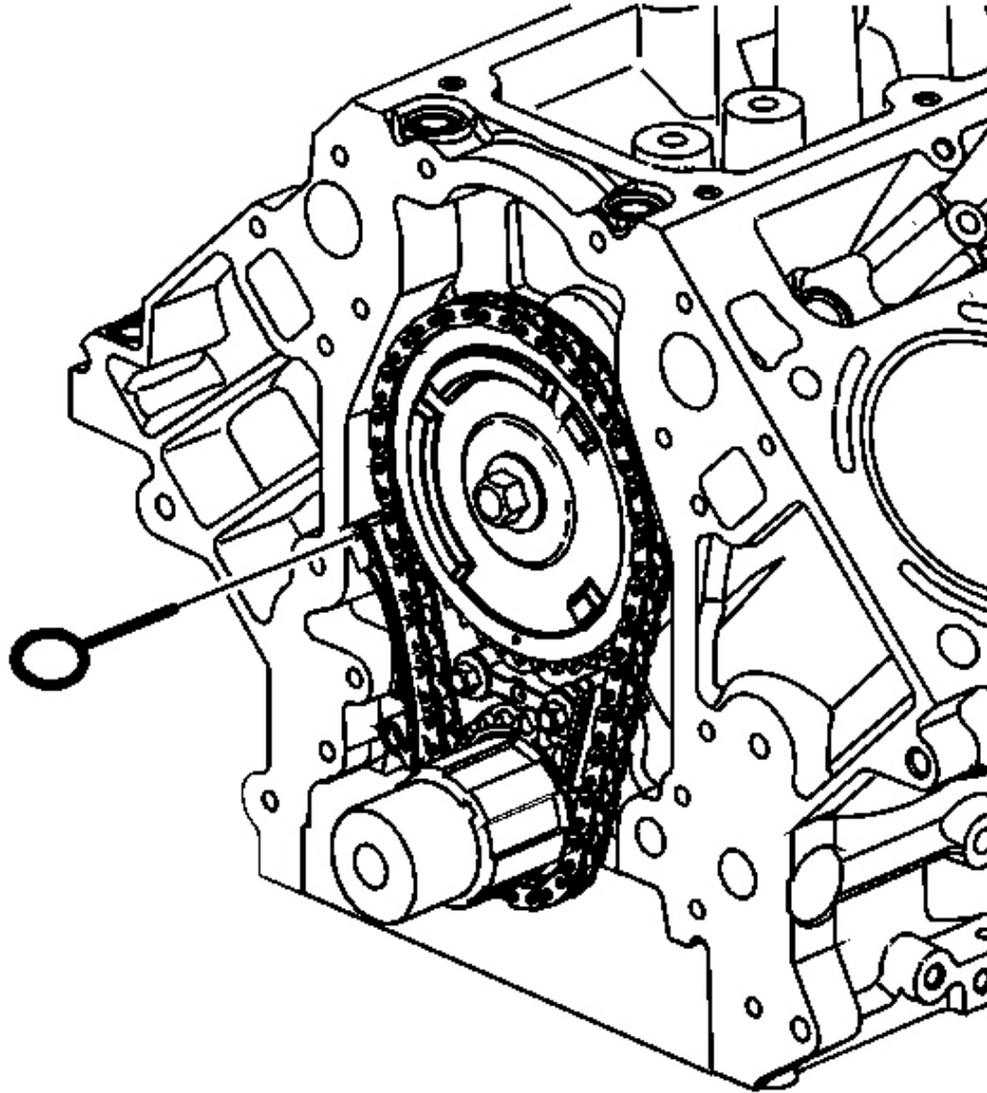


Fig. 224: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

10. Remove the EN 46330 . See Special Tools.

IMPORTANT: 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 Cleaning and Inspection.**

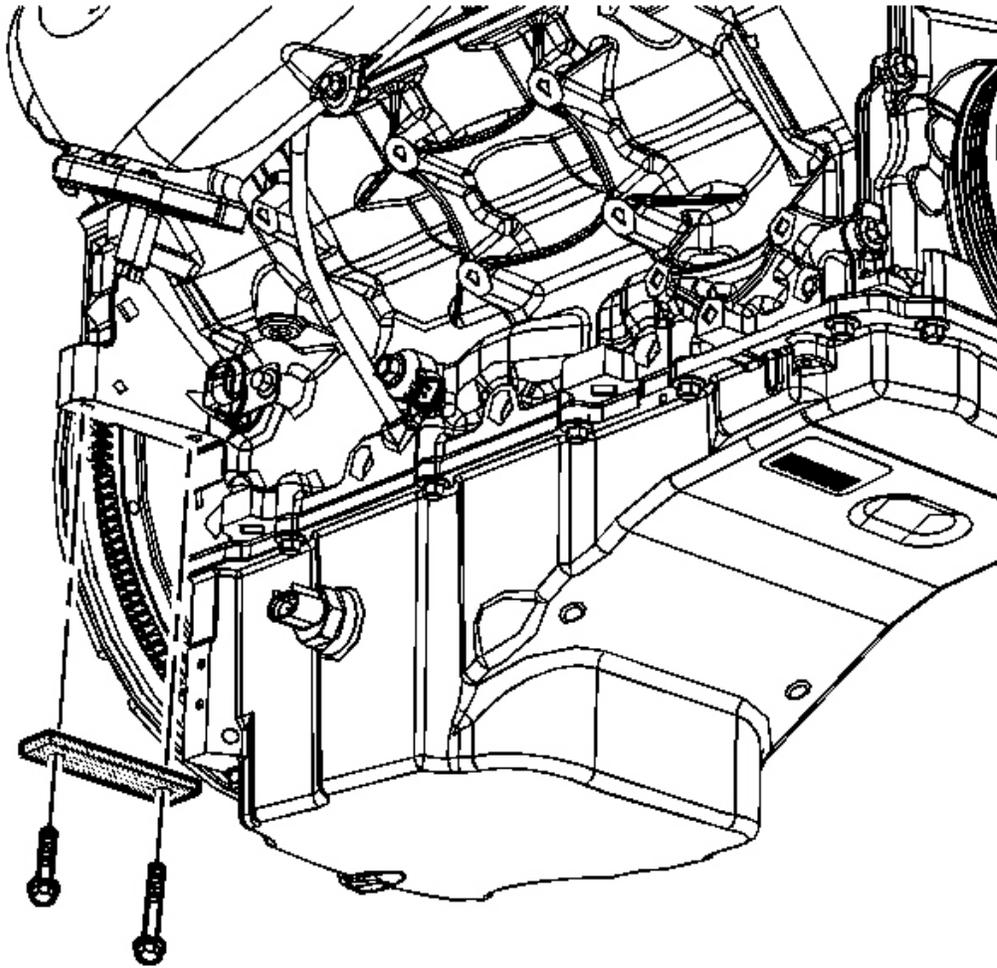


Fig. 225: Identifying J 42386-A Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 42386-A** and bolts. See **Special Tools.** Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation.

Tighten: Tighten the **J 42386-A** bolts to 50 N. See **Special Tools.m** (37 lb ft).

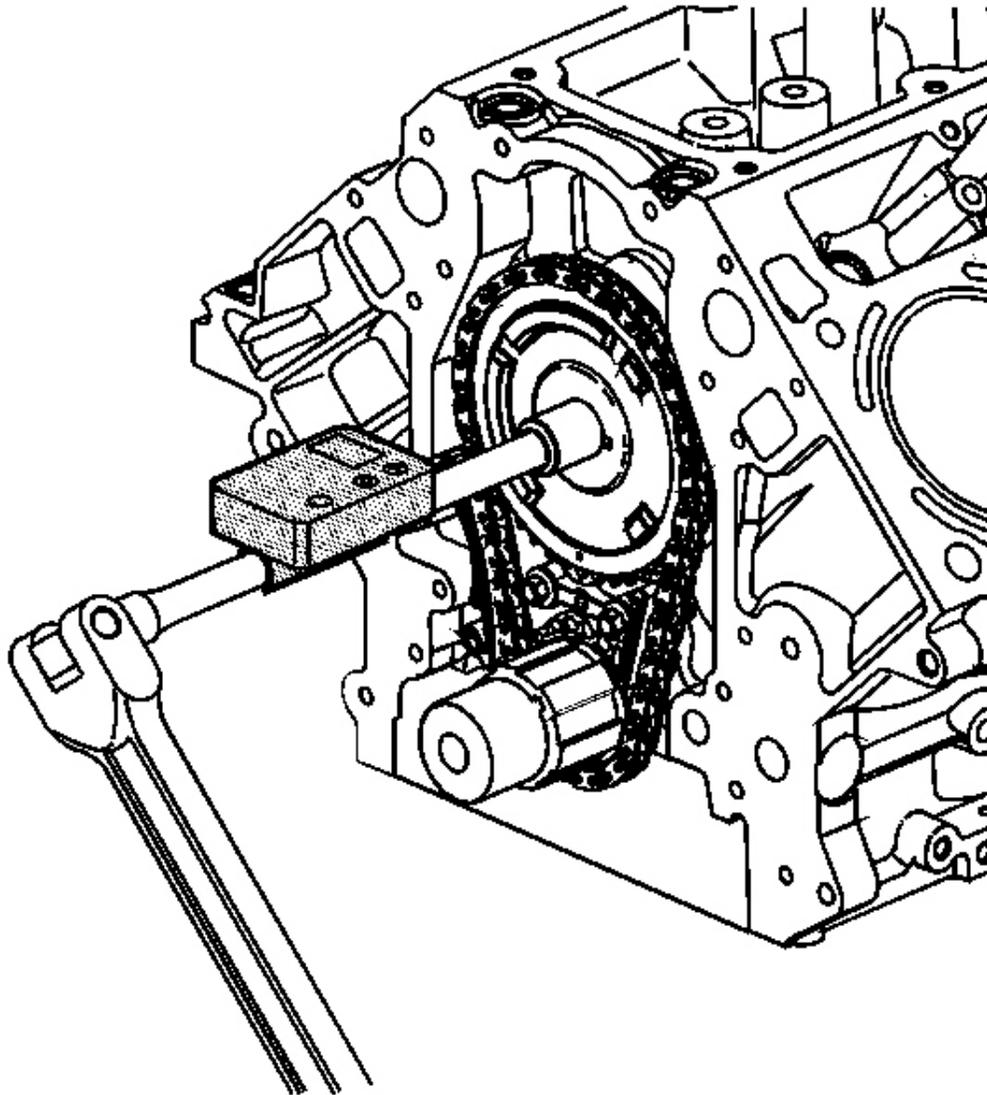


Fig. 226: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

13. Tighten the camshaft sprocket bolt.

Tighten:

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** .
14. Remove the **J 42386-A** and bolts. See **Special Tools**.
15. Remove the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal**.
16. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CAMSHAFT REPLACEMENT

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools**.
- **EN 46330** Angle Meter. See **Special Tools**.

Removal Procedure

1. Remove the condenser. Refer to **Condenser Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove all of the valve lifters. Refer to **Valve Lifter Replacement**.

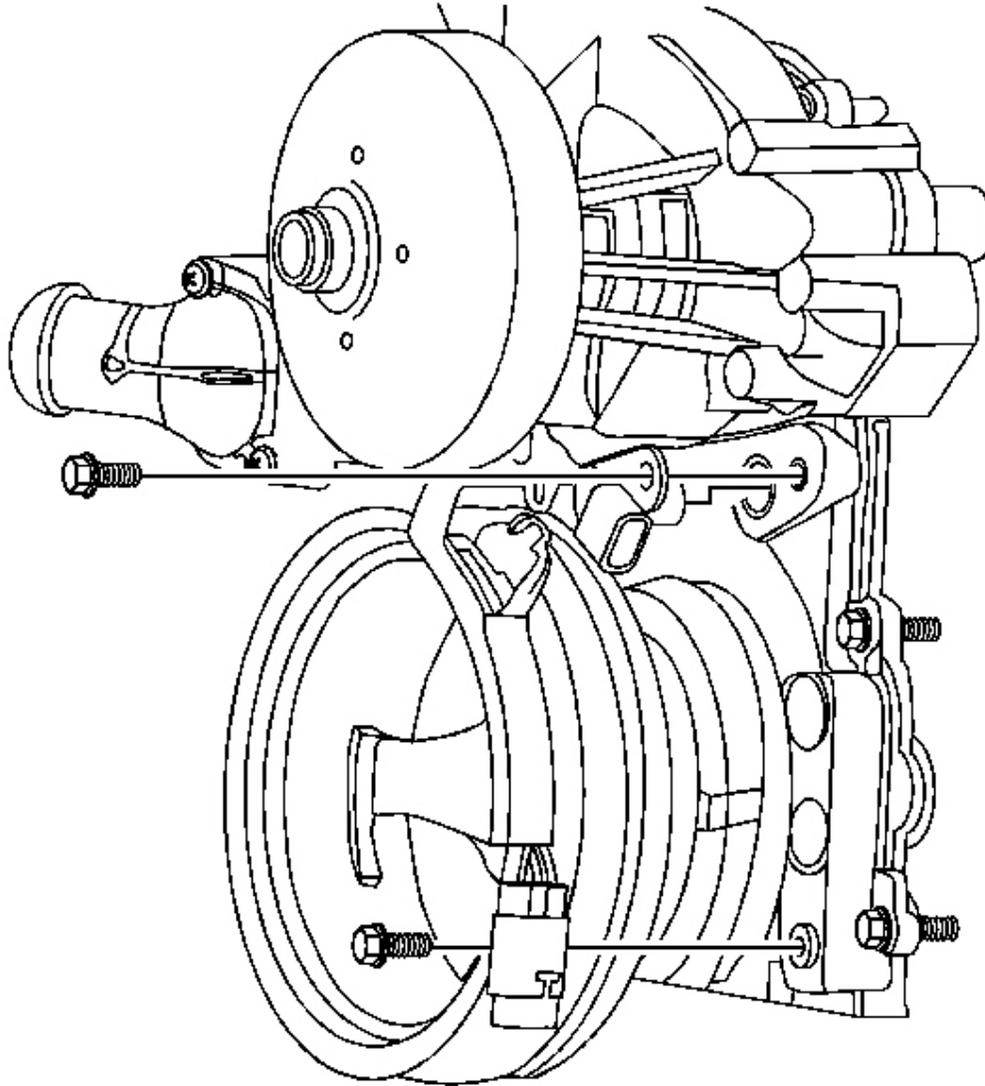


Fig. 227: View Of Camshaft Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft sensor bolt and sensor.

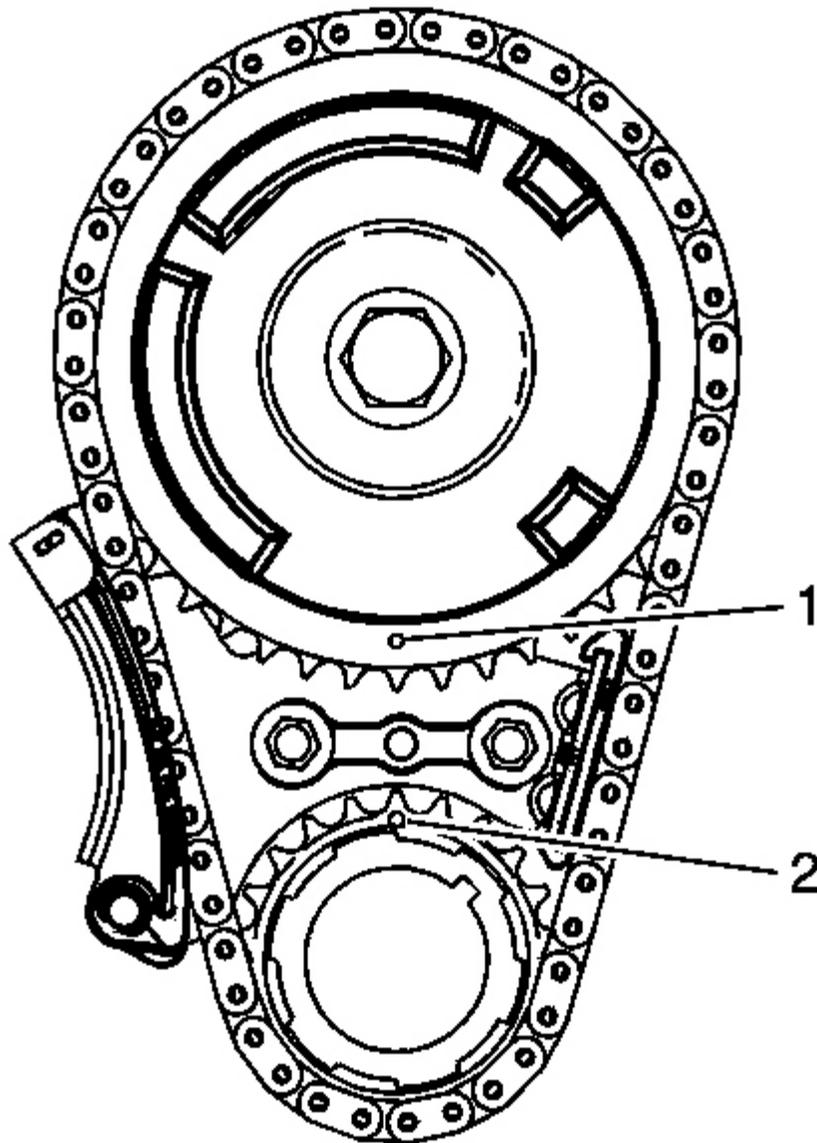


Fig. 228: Identifying Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

5. Rotate the crankshaft until the timing marks on the crankshaft and camshaft sprockets are aligned.

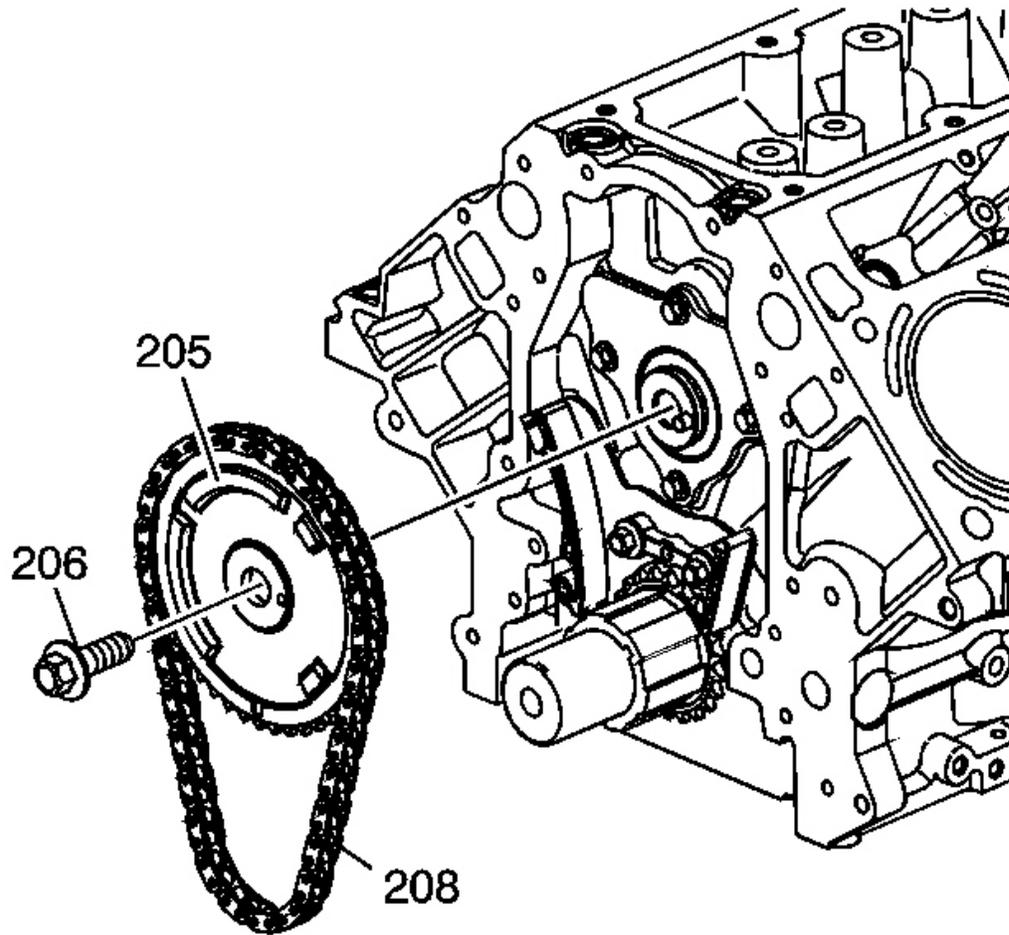


Fig. 229: Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft sprocket bolt (206).

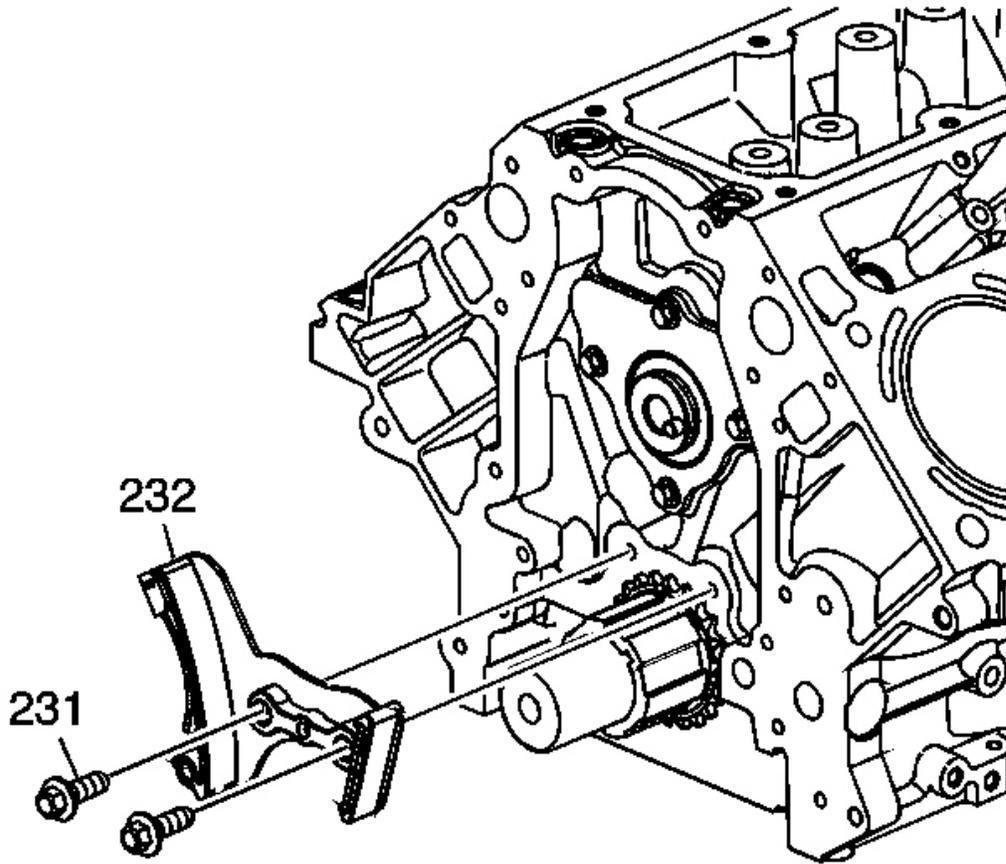


Fig. 230: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the bolts (231) and timing chain tensioner (232).
8. Remove the camshaft sprocket and reposition the timing chain.

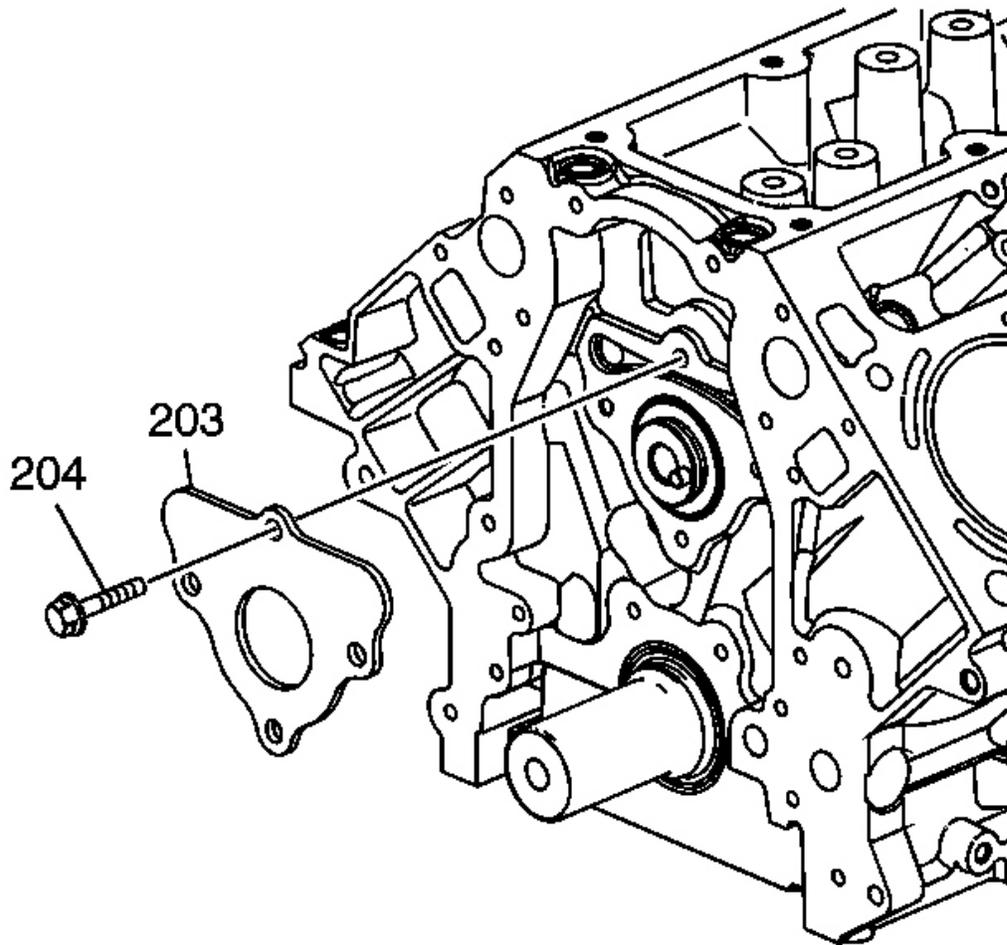


Fig. 231: Camshaft Sprocket Bolts & Retainer
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft retainer bolts (204) and retainer (203).

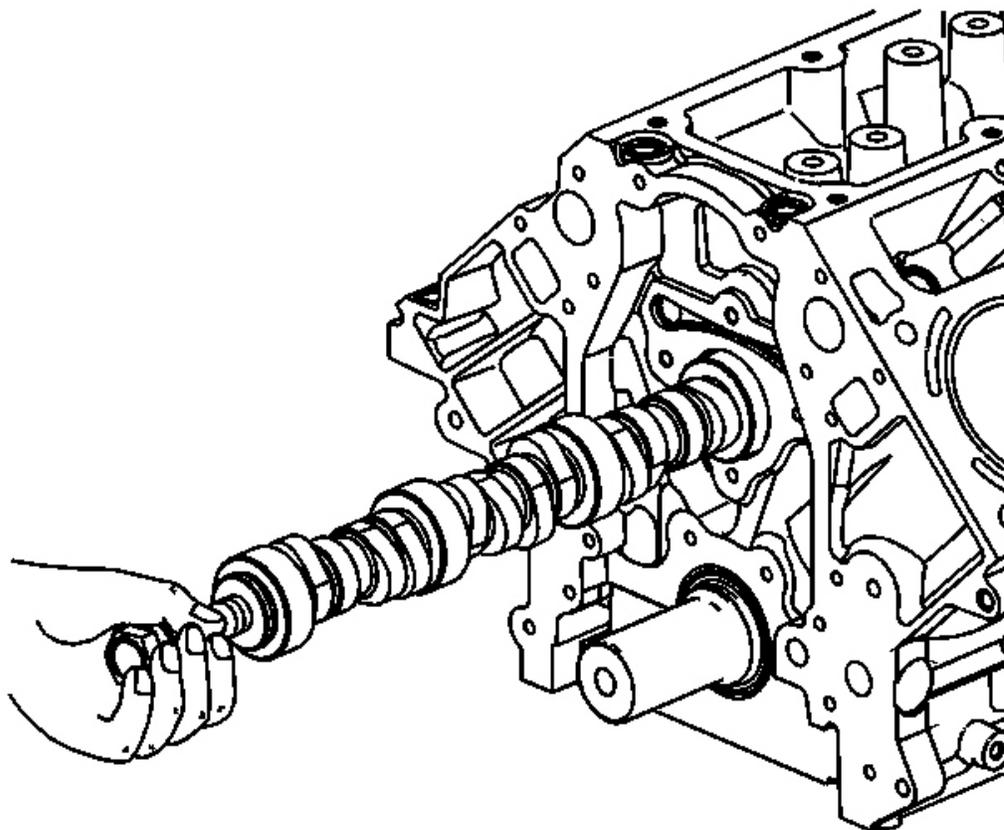


Fig. 232: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: 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.

10. Install a bolt into the camshaft.
11. Using the bolt as a handle, carefully rotate and pull the camshaft out of the engine block.
12. Clean and inspect the camshaft and bearings. Refer to **Camshaft and Bearings Cleaning and Inspection**.

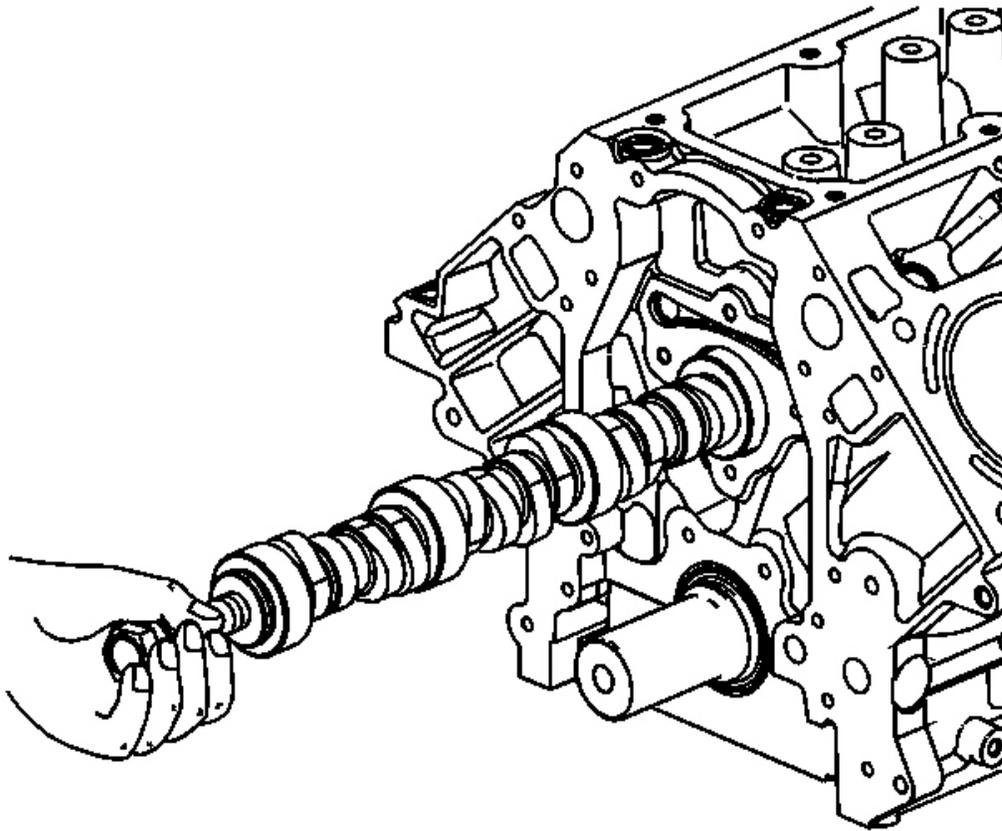


Fig. 233: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.

NOTE: 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.

2. Using the bolt as a handle, carefully install the camshaft into the engine block.
3. Remove the bolt from the front of the camshaft.

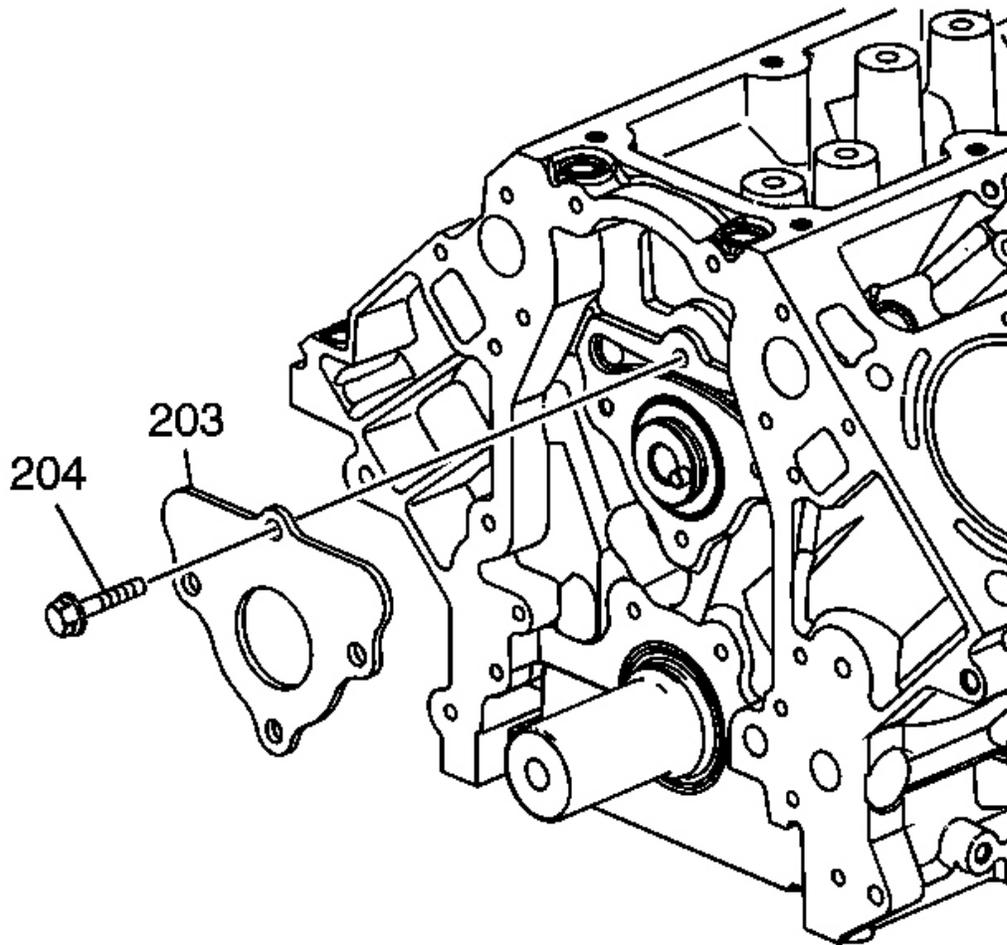


Fig. 234: Camshaft Sprocket Bolts & Retainer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install the retainer with the sealing gasket facing the engine block.

The gasket surface on the engine block should be clean and free of dirt and/or debris.

4. Install the camshaft retainer (203) and bolts (204).

NOTE: Refer to Fastener Notice .

5. Tighten the camshaft retainer bolts.

Tighten:

- Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft).
- Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft).

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools**.

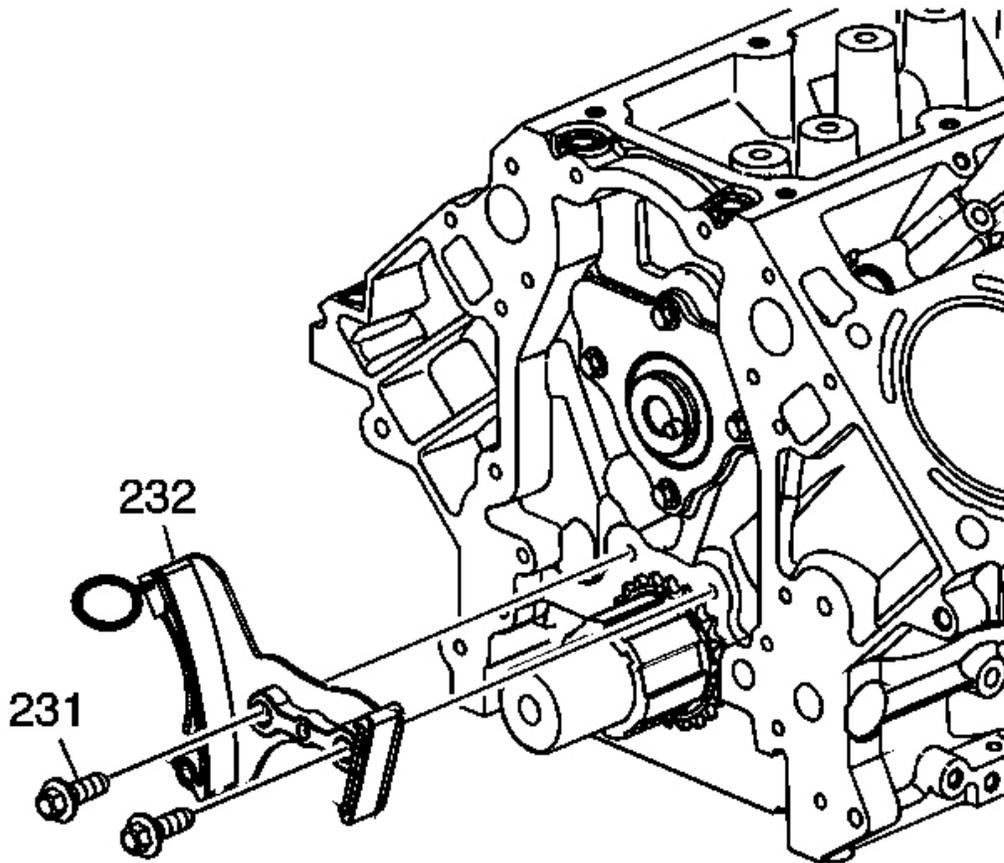


Fig. 235: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

7. Install the timing chain tensioner (232) and bolts (231).

Tighten: Tighten the timing chain tensioner bolts to 25 N.m (18 lb ft).

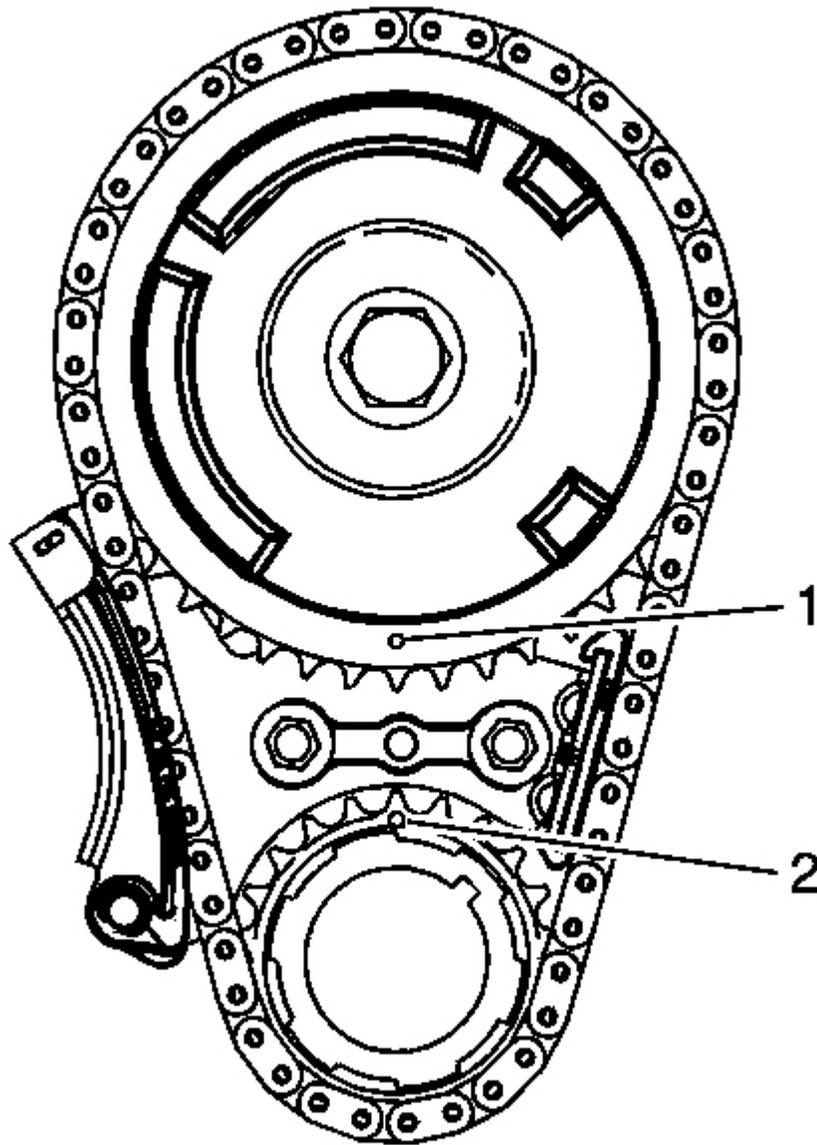


Fig. 236: Identifying Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: • Properly locate the camshaft sprocket locating pin with

the camshaft sprocket alignment hole.

- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly. Locate the camshaft sprocket alignment mark (1) in the 6 o'clock position and the crankshaft sprocket (2) should be located in the 12 o'clock position.

8. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks.

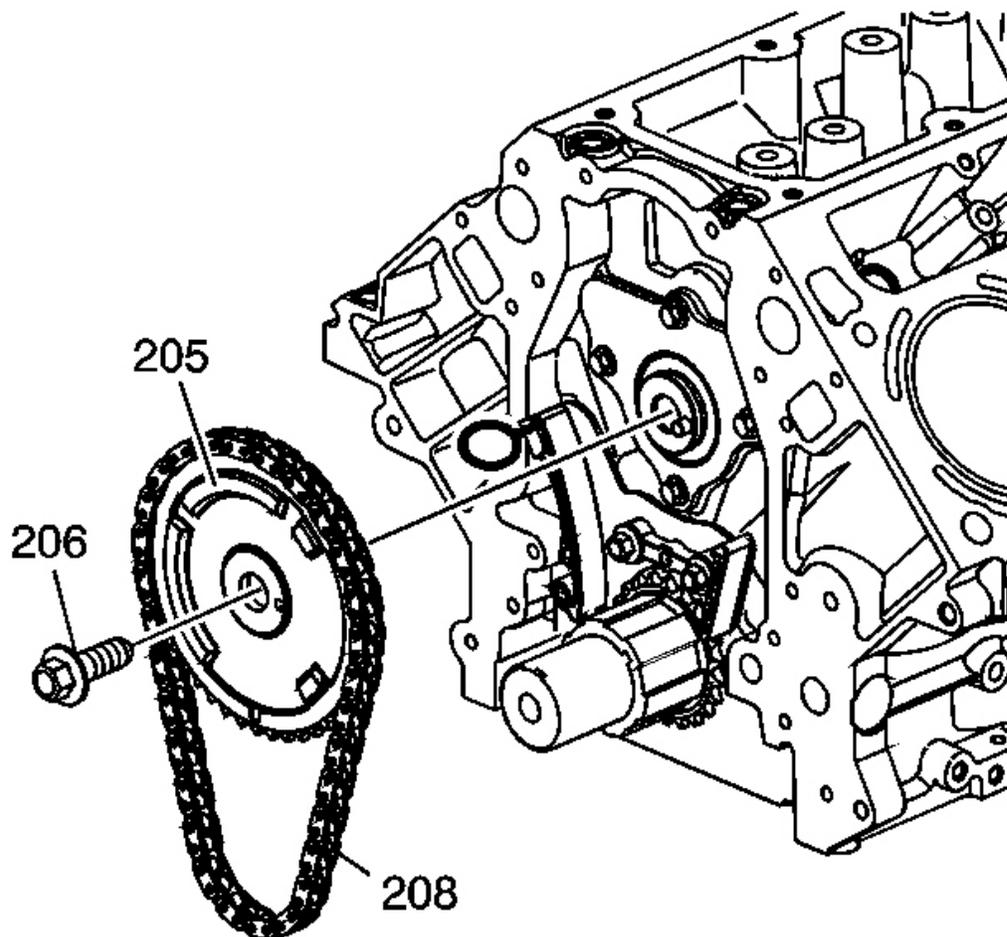


Fig. 237: Camshaft Sprocket Bolts & Timing Chain

Courtesy of GENERAL MOTORS CORP.

9. Install the camshaft sprocket (205) and the timing chain (208).
10. Install a NEW camshaft sprocket bolt (206).

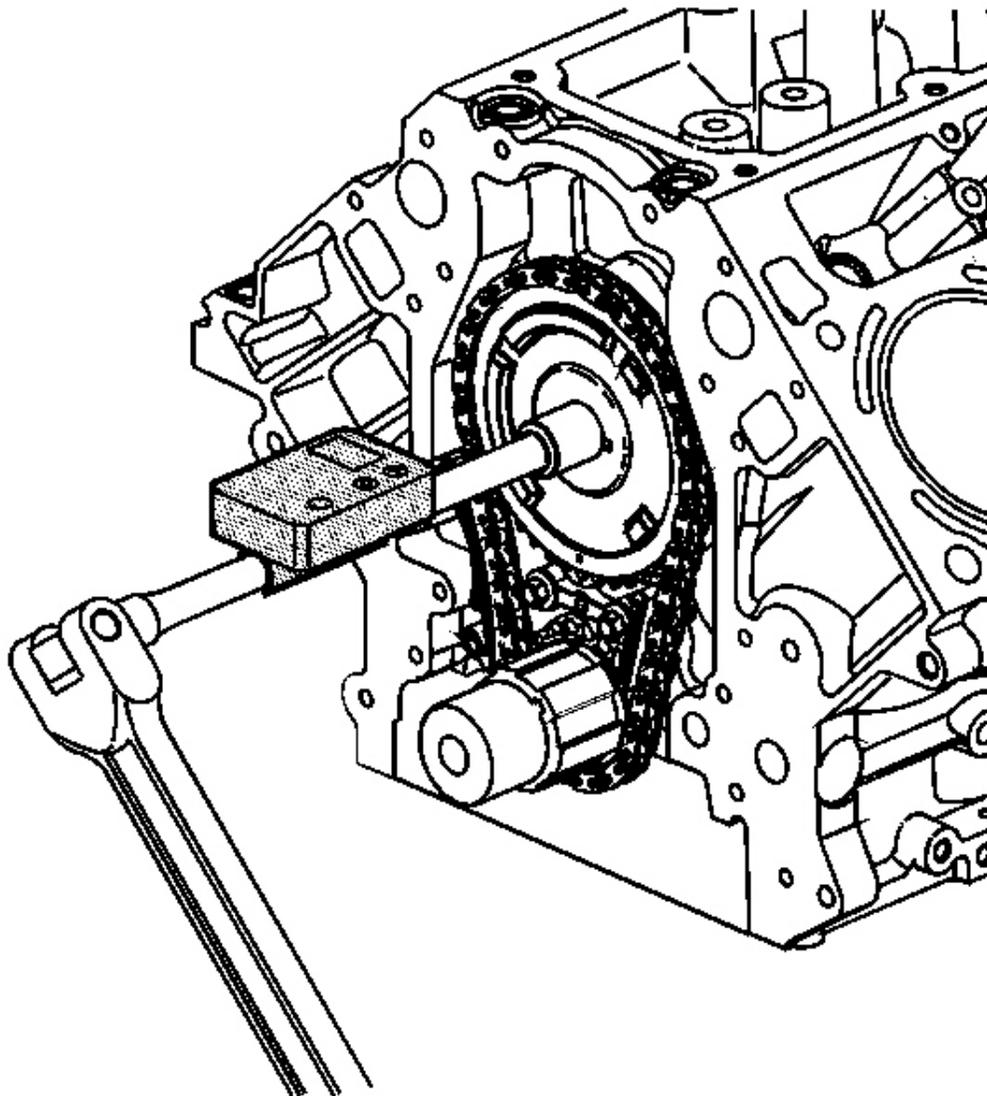


Fig. 238: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

11. Tighten the camshaft sprocket bolt.

Tighten:

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** .

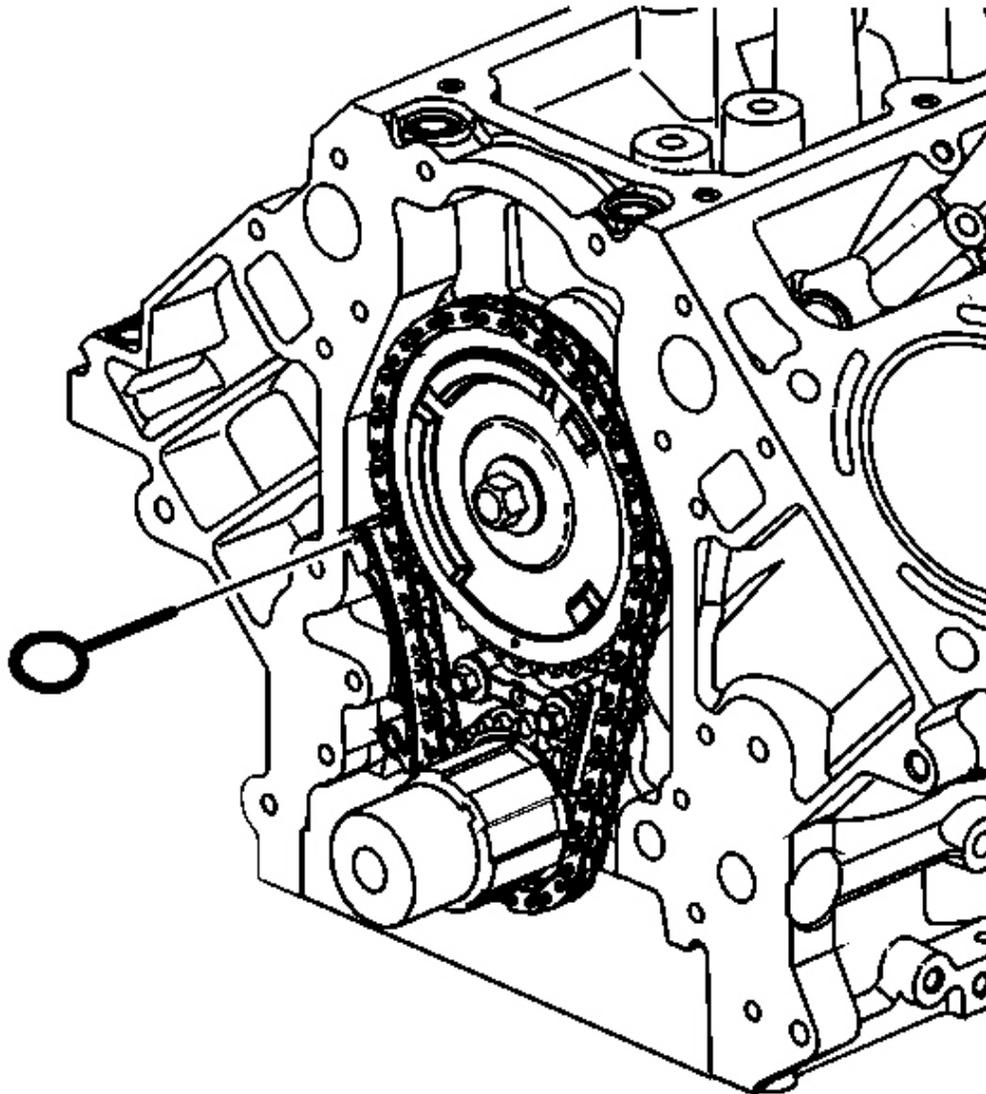


Fig. 239: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

12. Remove the EN 46330 . See Special Tools.

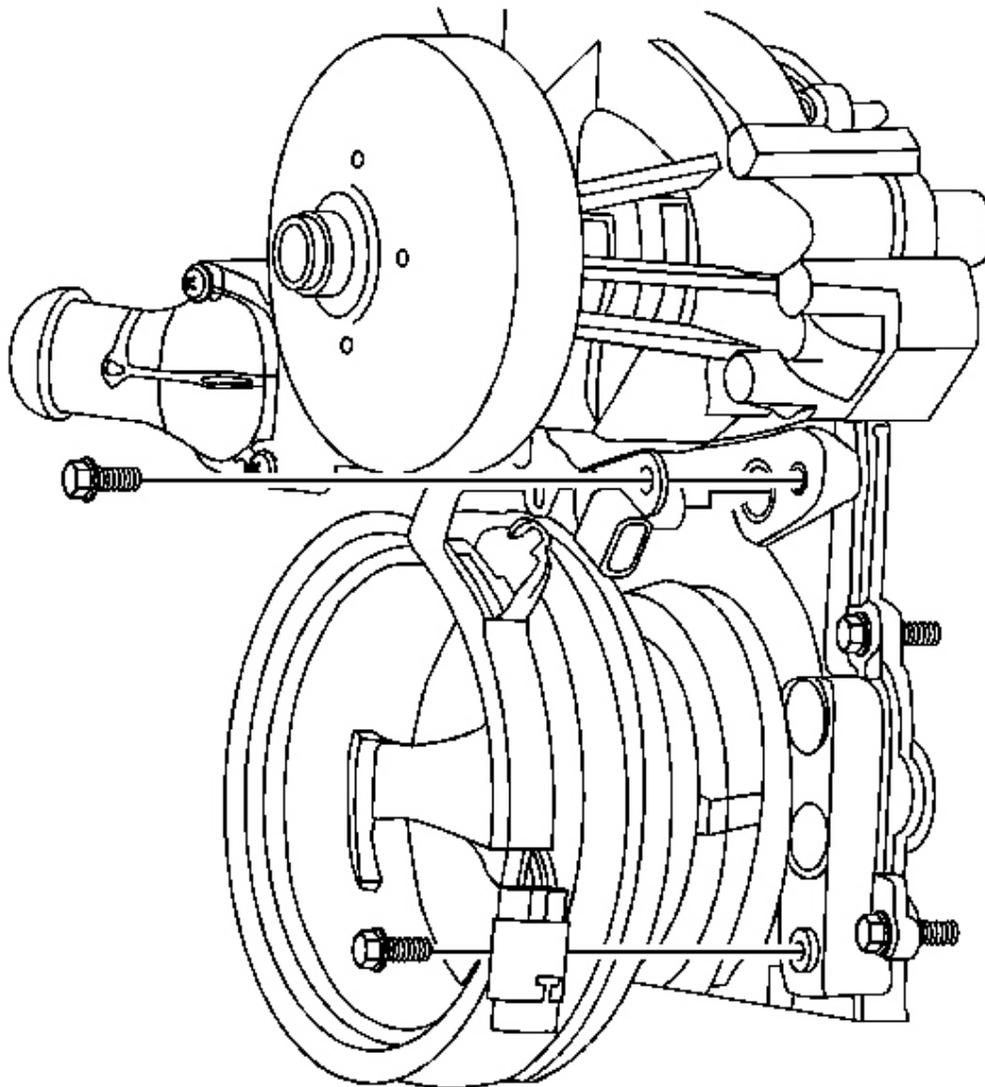


Fig. 240: View Of Camshaft Sensor Bolt & Sensor
Courtesy of GENERAL MOTORS CORP.

13. Inspect the camshaft sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be reused.
14. Lubricate the O-ring seal with clean engine oil.
15. Install the camshaft sensor and bolt.

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

16. Install the valve lifters. Refer to **Valve Lifter Replacement**.
17. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
18. Install the condenser. Refer to **Condenser Replacement**.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

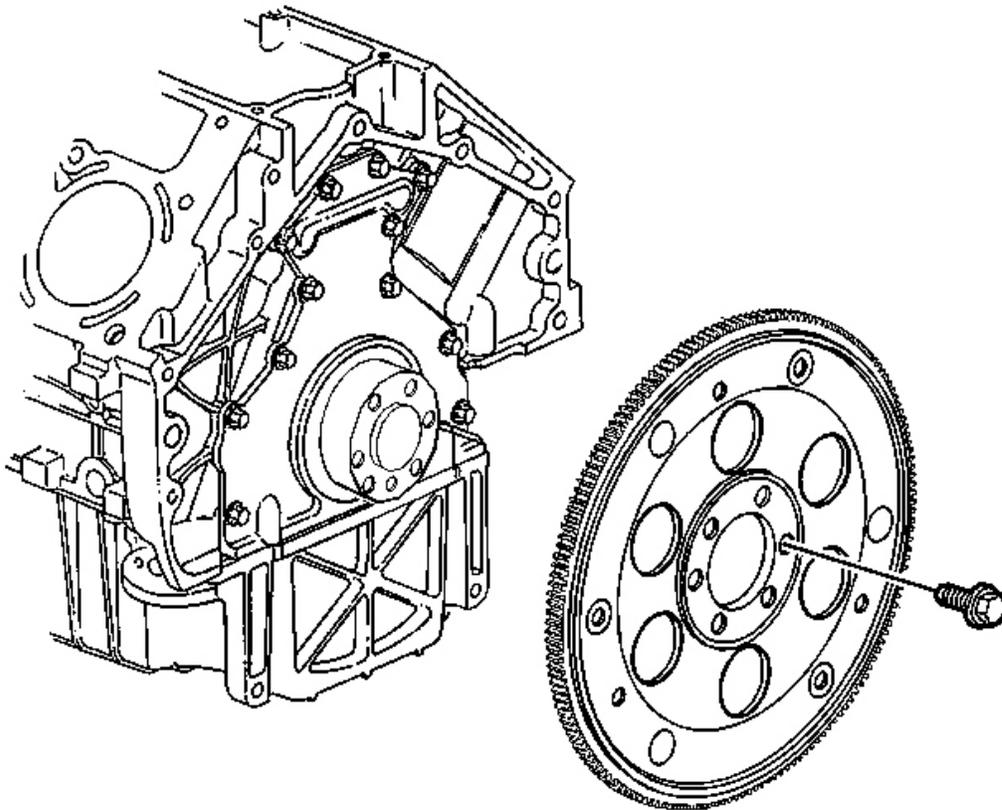


Fig. 241: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the position and direction of the engine flywheel before removal.

1. Remove the transmission. Refer to Transmission Replacement (3.7L) or Transmission Replacement (5.3L) .
2. Remove the engine flywheel bolts.
3. Remove the engine flywheel.
4. Clean and inspect the engine flywheel. Refer to Automatic Transmission Flex Plate Cleaning and Inspection.

Installation Procedure

IMPORTANT: The flywheel 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 flywheel bolts. This procedure requires a three stage tightening process.

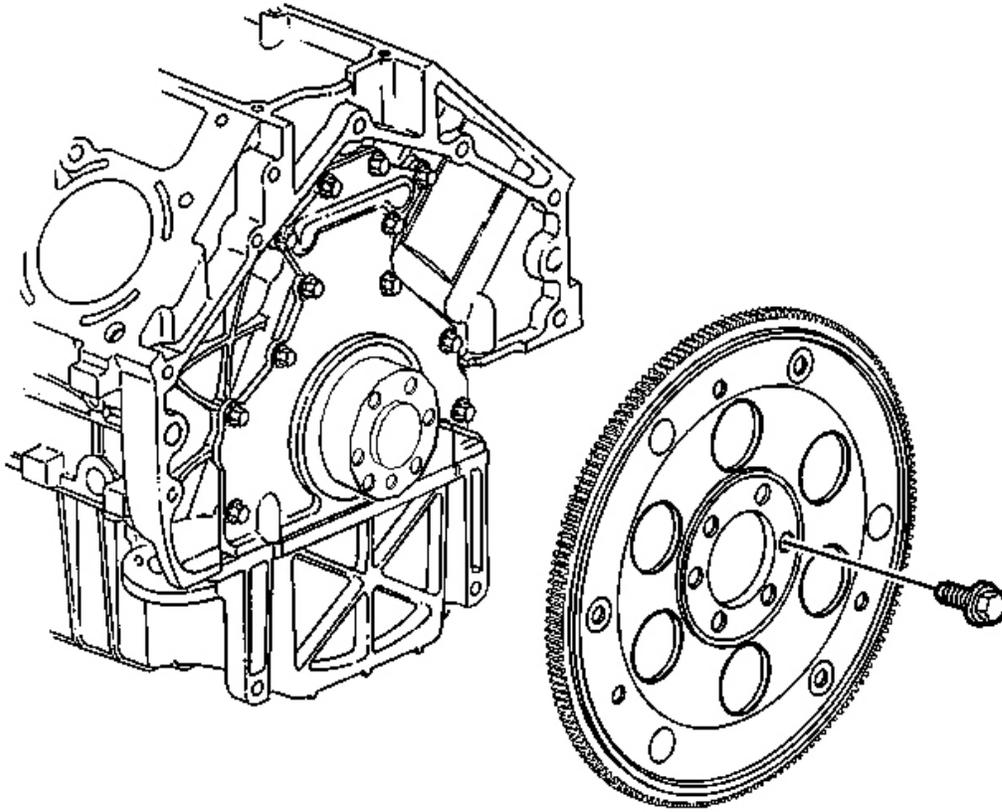


Fig. 242: View Of Engine Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the engine flywheel to the crankshaft.
2. Apply threadlock to the threads of the flywheel bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

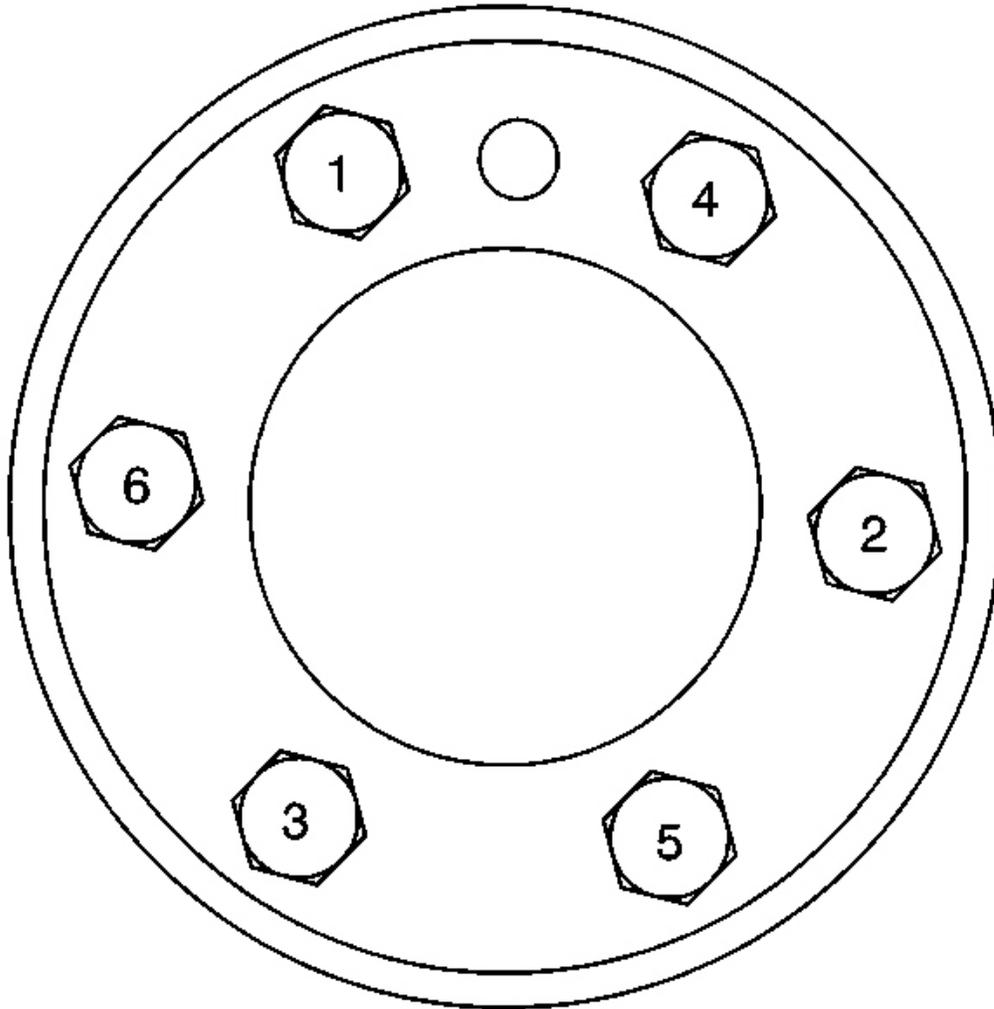


Fig. 243: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the engine flywheel bolts.

Tighten:

1. Tighten the bolts a first pass in sequence to 20 N.m (15 lb ft).

2. Tighten the bolts a second pass in sequence to 50 N.m (37 lb ft).
3. Tighten the bolts a final pass in sequence to 100 N.m (74 lb ft).
4. Install the transmission. Refer to **Transmission Replacement (3.7L)** or **Transmission Replacement (5.3L)** .

ENGINE REPLACEMENT

Special Tools

- **J 21366** Converter Holding Strap. See **Special Tools**.
- **J 38185** Hose Clamp Pliers
- **J 41798** Engine Lift Bracket. See **Special Tools**.

Removal Procedure

1. Remove the hood. Refer to **Hood Replacement** .
2. Place fender covers over both fenders.
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging (Non HP2)** .
5. Remove the radiator. Refer to **Radiator Replacement** .
6. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
7. Disconnect the oil pressure sensor and the oxygen sensors from the rear of the engine.

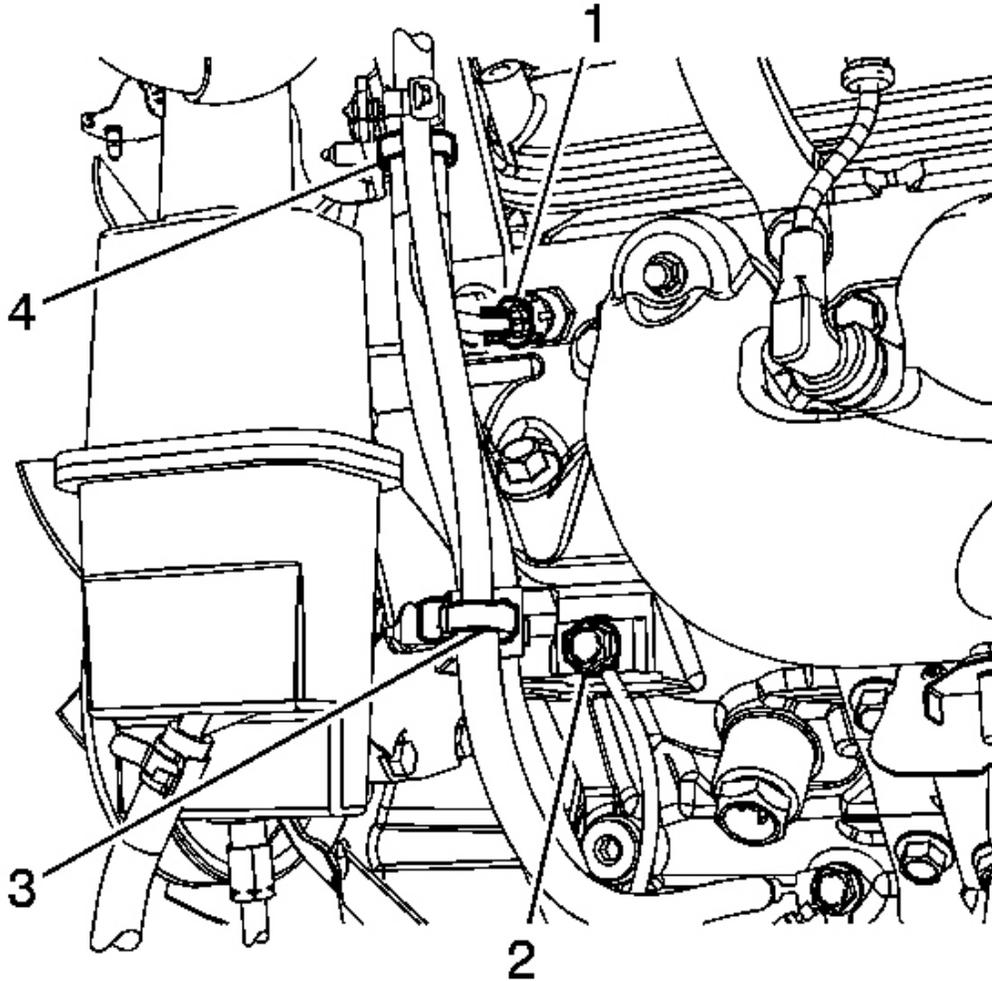


Fig. 244: Engine Coolant Temperature (ECT) Sensor
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the engine coolant temperature (ECT) sensor (1).
9. Remove the ground terminal bolt (2).
10. Remove the retaining clips (3, 4) from the brackets.
11. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
12. Remove the starter. Refer to **Starter Motor Replacement (LH8)** .

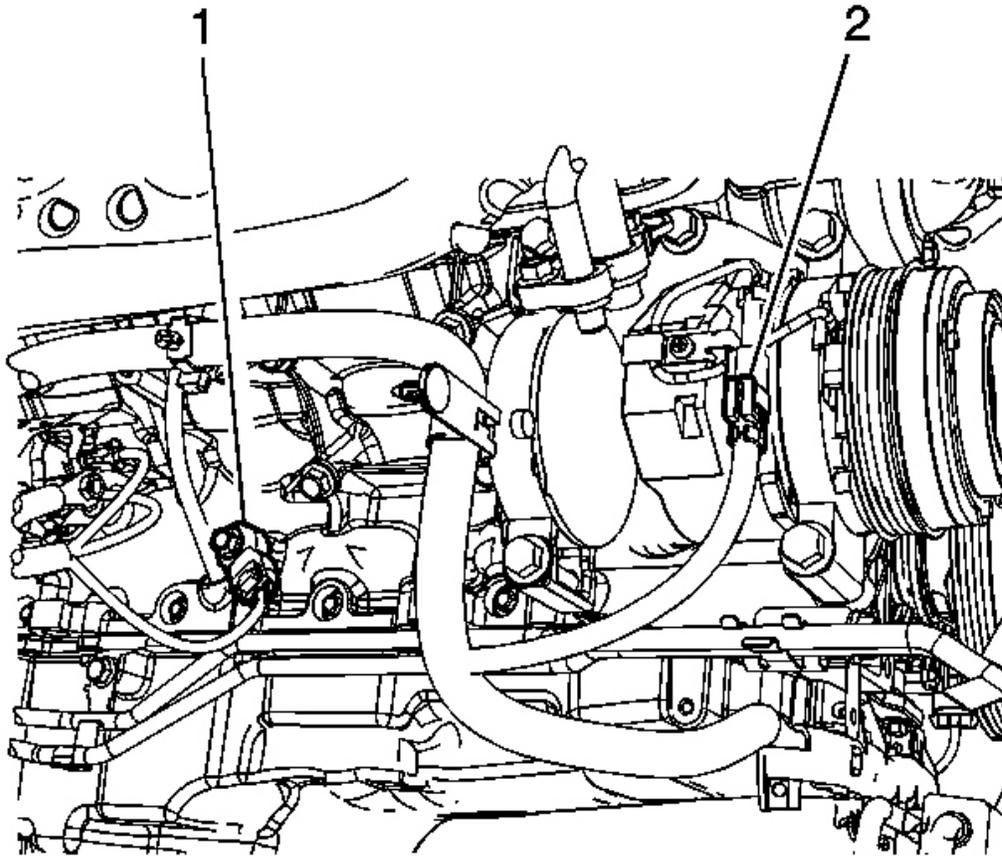


Fig. 245: Knock Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the following connectors:
- Left and right side knock sensor electrical connector (1).
 - A/C pressure switch electrical connector (2).
 - Block heater electrical connector.

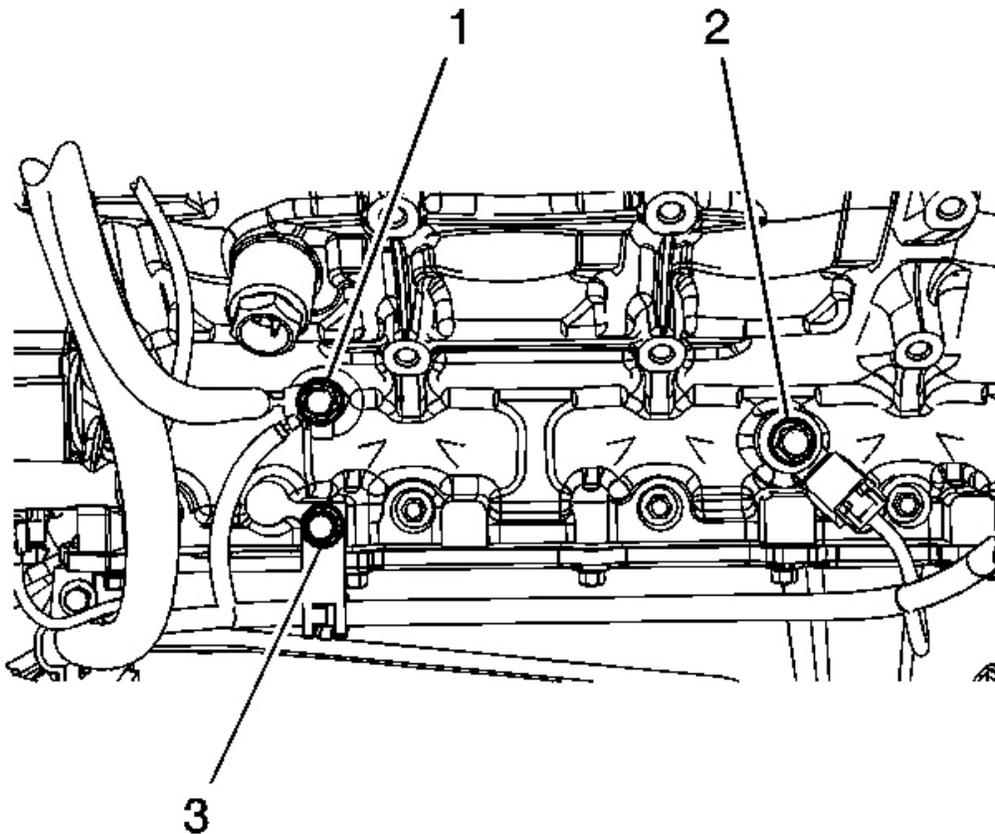


Fig. 246: Ground Terminal Bolt
Courtesy of GENERAL MOTORS CORP.

14. Remove the ground terminal bolt (1).
15. Remove the engine harness bracket bolt (3).

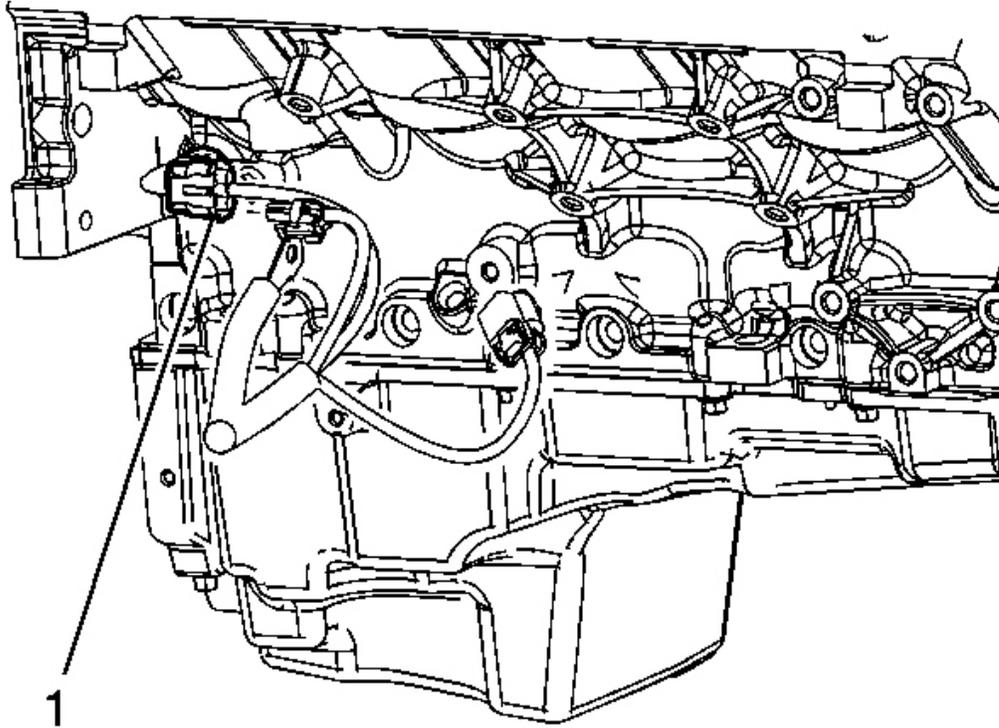


Fig. 247: Engine Wiring Harness Electrical Connector & Crankshaft Position (CKP) Sensor

Courtesy of GENERAL MOTORS CORP.

16. Disconnect the engine wiring harness electrical connector (1) from the crankshaft position (CKP) sensor.

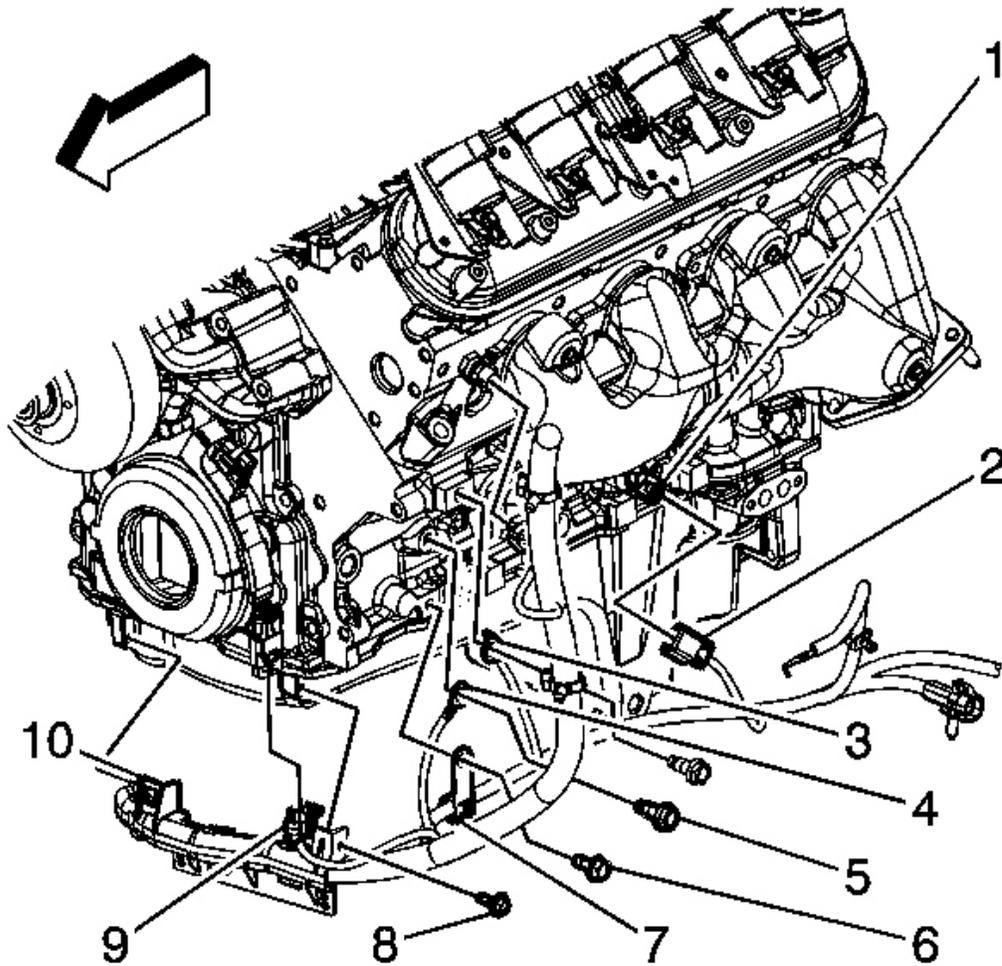


Fig. 248: Engine Wiring Harness Electrical Connector & Crankshaft Position (CKP) Sensor Wire Harness
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the engine wiring harness electrical connector (9) from the camshaft position (CMP) sensor wire harness.

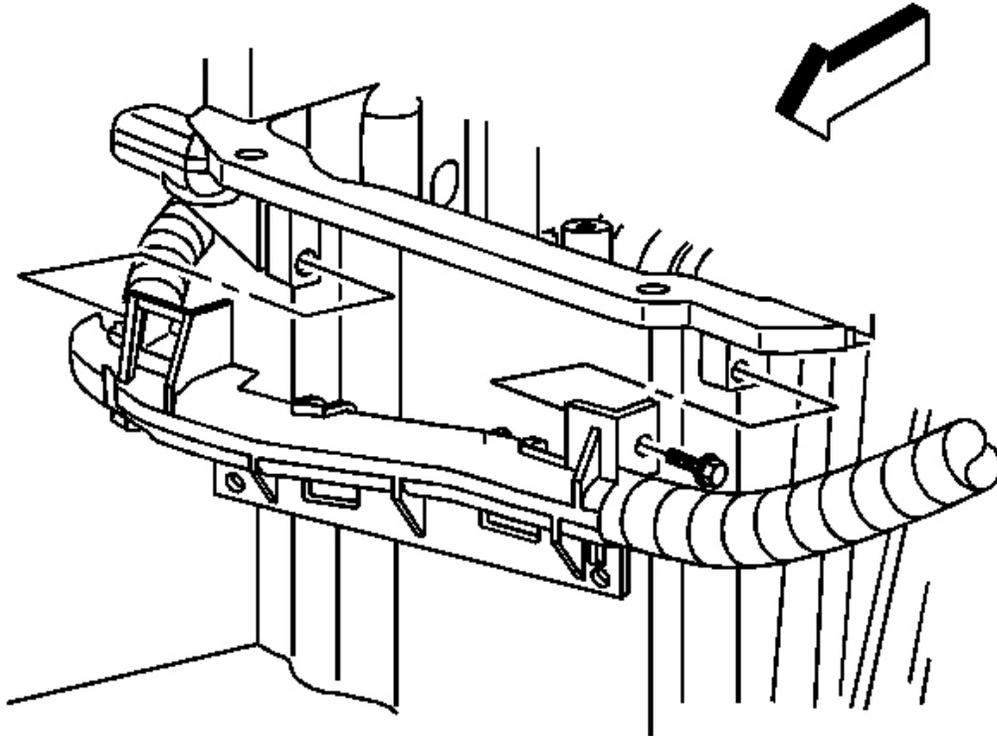


Fig. 249: View Of Battery Cable Channel & Bolt
Courtesy of GENERAL MOTORS CORP.

18. Remove the battery cable channel bolt.
19. Remove the battery cable channel from the oil pan.
20. Lower the vehicle.
21. Gather all branches of the engine wiring harness and reposition the harness off to the side.

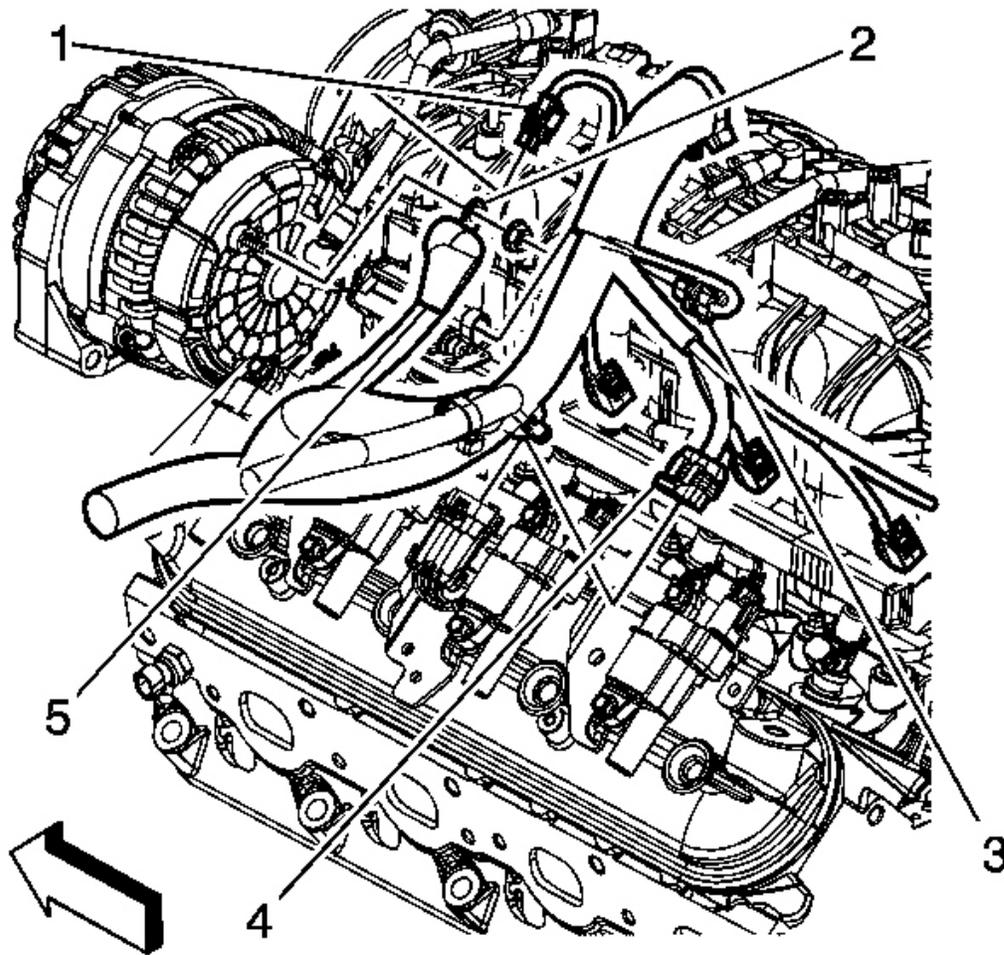


Fig. 250: Engine Wiring Harness/Positive Battery Cable Boot
Courtesy of GENERAL MOTORS CORP.

22. Disconnect the engine wiring harness electrical connector (1) from the generator.
23. Reposition the engine wiring harness/positive battery cable boot (5).
24. Remove the engine wiring harness/positive battery cable nut from the generator.
25. Remove the engine wiring harness/positive battery cable (2) from the generator.

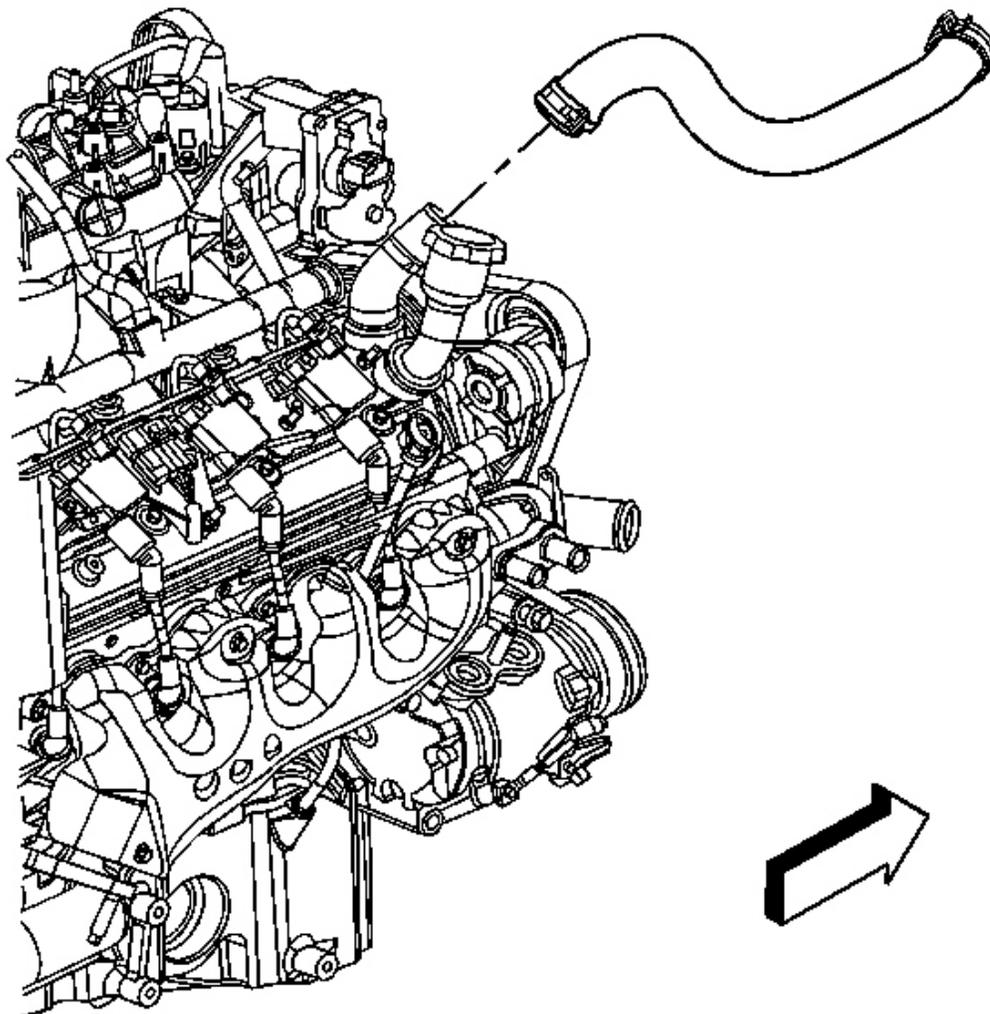


Fig. 251: View Of Inlet Hose
Courtesy of GENERAL MOTORS CORP.

26. Using **J 38185** , remove the inlet hose from the water outlet.

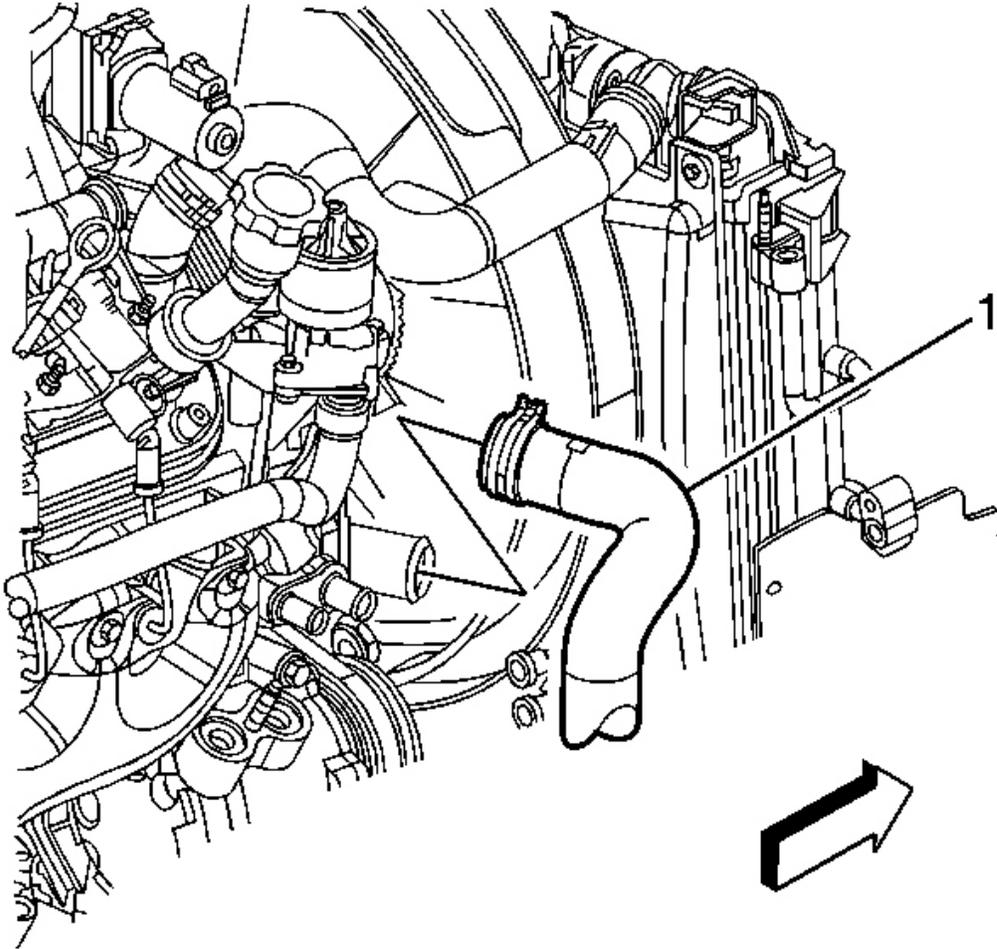


Fig. 252: Outlet Hose & Water Outlet
Courtesy of GENERAL MOTORS CORP.

27. Using **J 38185** , remove the outlet hose (1) from the water outlet.
28. Remove the heater inlet and outlet hoses. Refer to **Heater Inlet Hose Replacement (Right Hand Drive)** or **Heater Outlet Hose Replacement (Right Hand Drive)** .
29. Raise the vehicle.
30. Remove the catalytic converters. Refer to **Catalytic Converter Replacement - Left Side (LH8)** and **Catalytic Converter Replacement - Right Side (LH8)** .
31. Remove the 3 bracket bolts from both the right and the left side engine mounts. Refer to

Engine Mount Replacement - Left Side and Engine Mount Replacement - Right Side

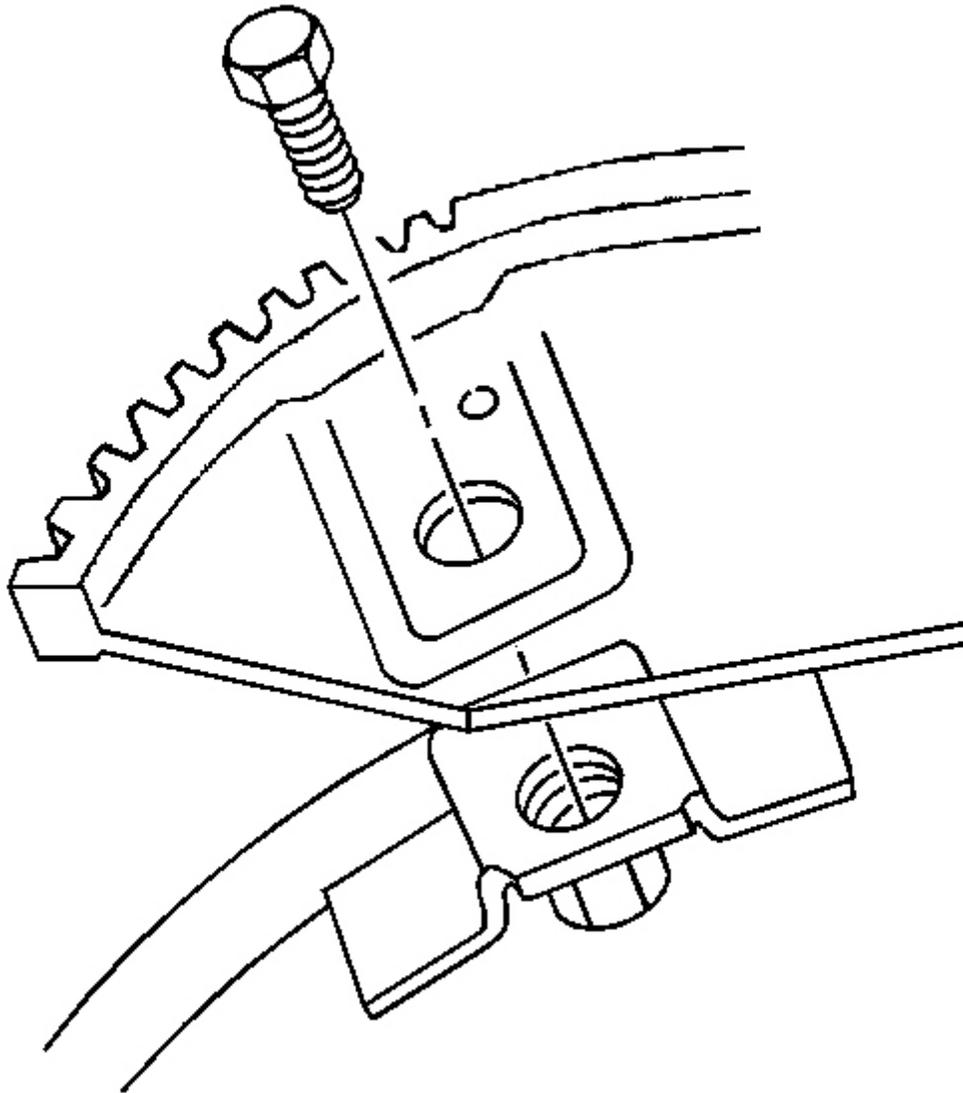


Fig. 253: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

32. Remove the torque converter bolts.

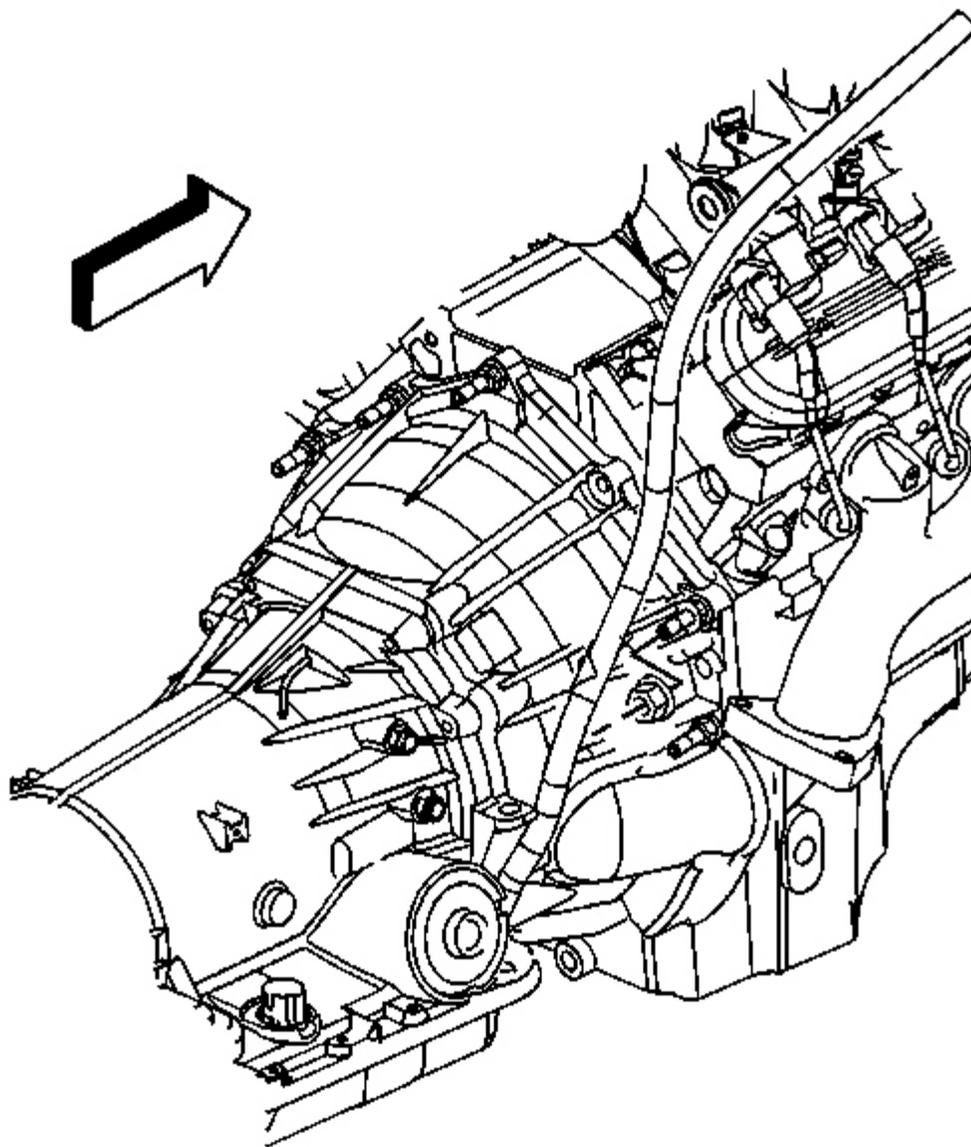


Fig. 254: View Of Oil Level Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

33. Remove the transmission oil level indicator tube nut.

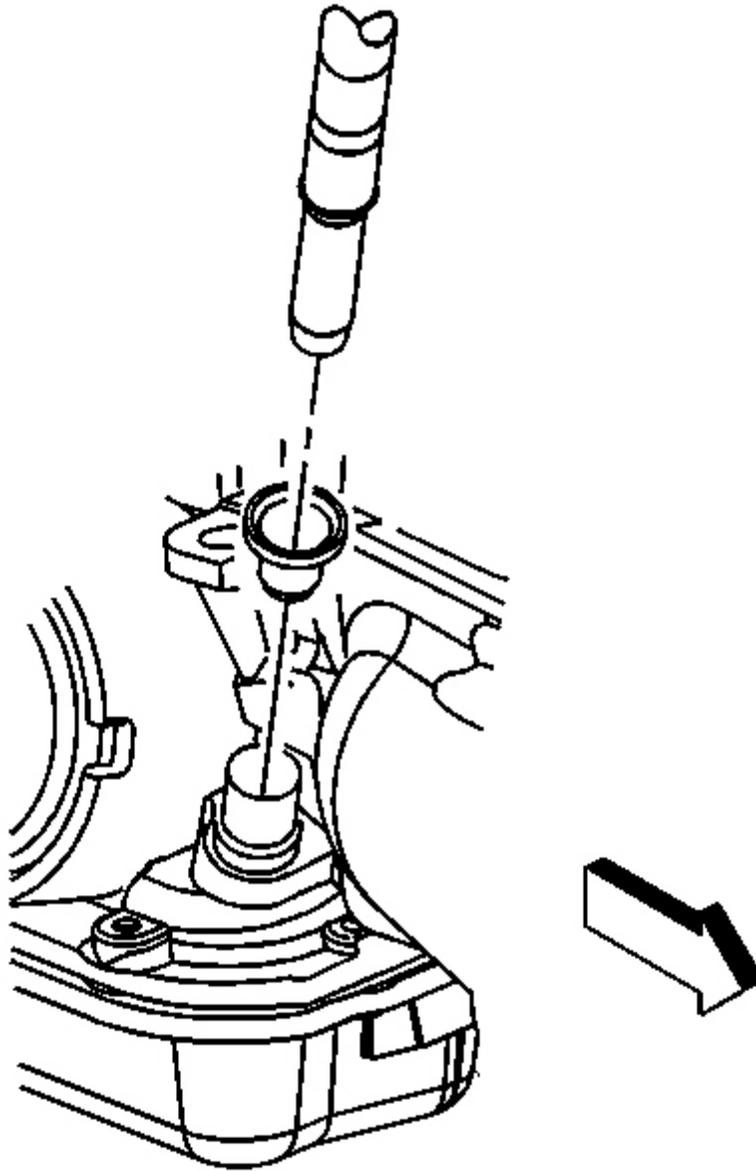


Fig. 255: View Of Oil Level Indicator Tube & Seal
Courtesy of GENERAL MOTORS CORP.

34. Remove the transmission oil level indicator tube.

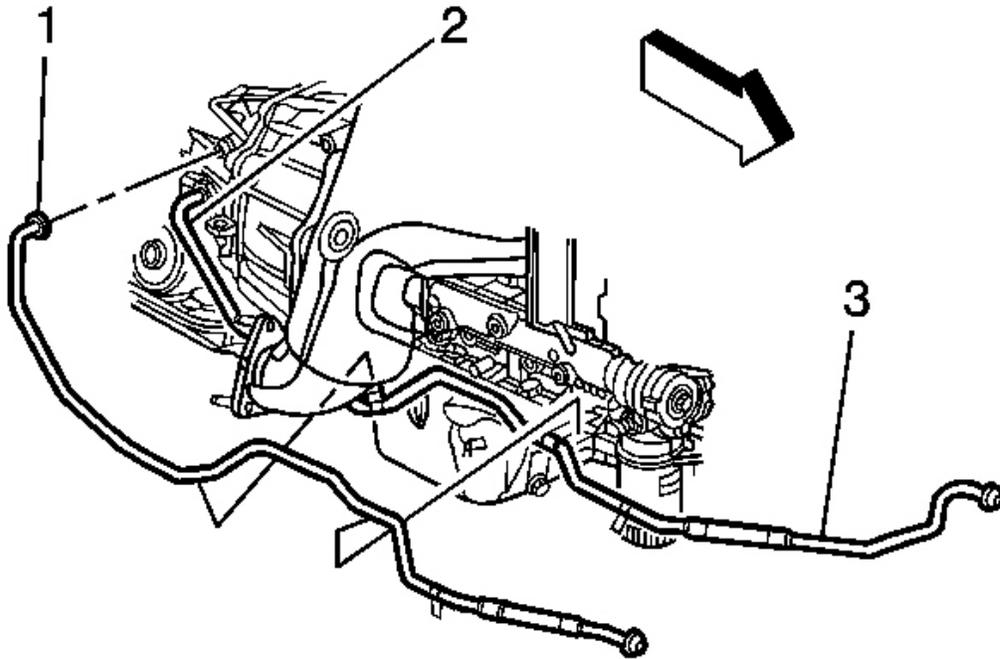


Fig. 256: View Of Transmission Fluid Cooler Lines
Courtesy of GENERAL MOTORS CORP.

35. Remove the transmission fluid cooler lines from the retainer located on the right side of the engine.

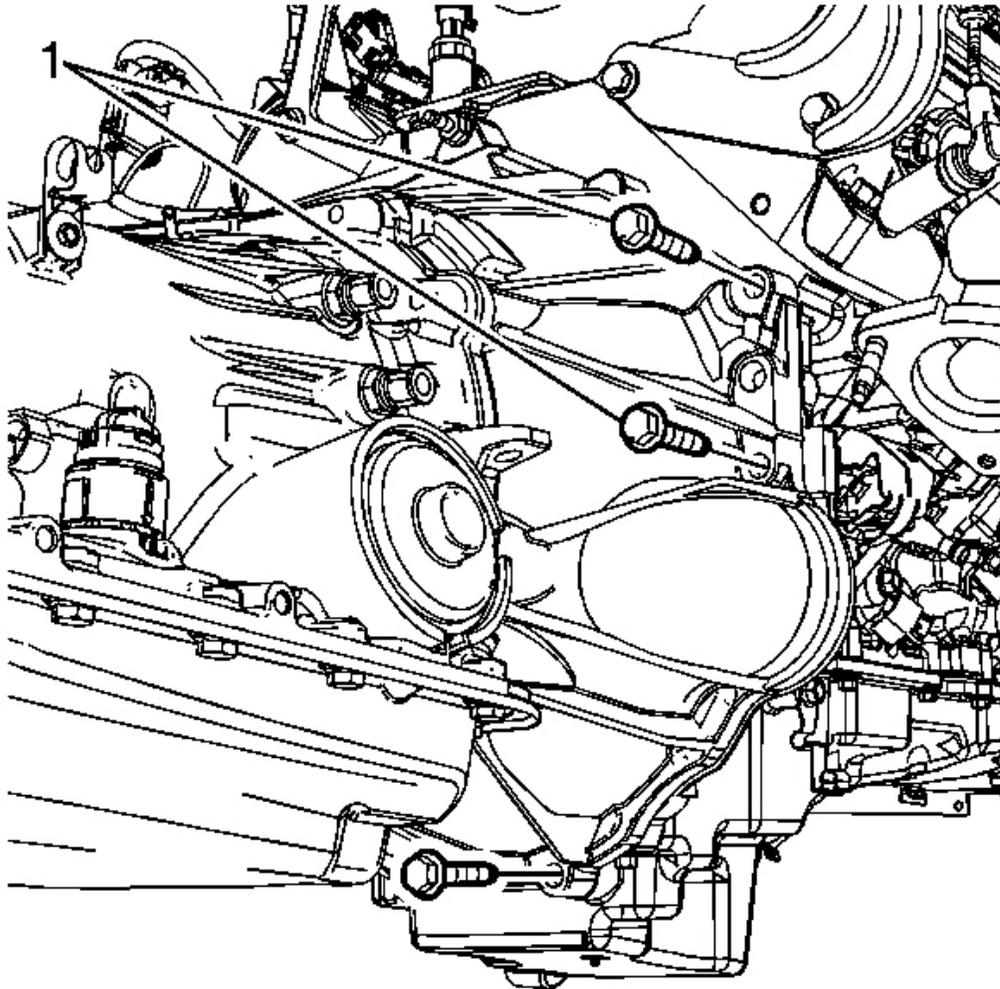


Fig. 257: Lower Transmission Bolt/Studs - Right & Left Side
Courtesy of GENERAL MOTORS CORP.

36. Remove the lower transmission bolts (1) on the right and left side.

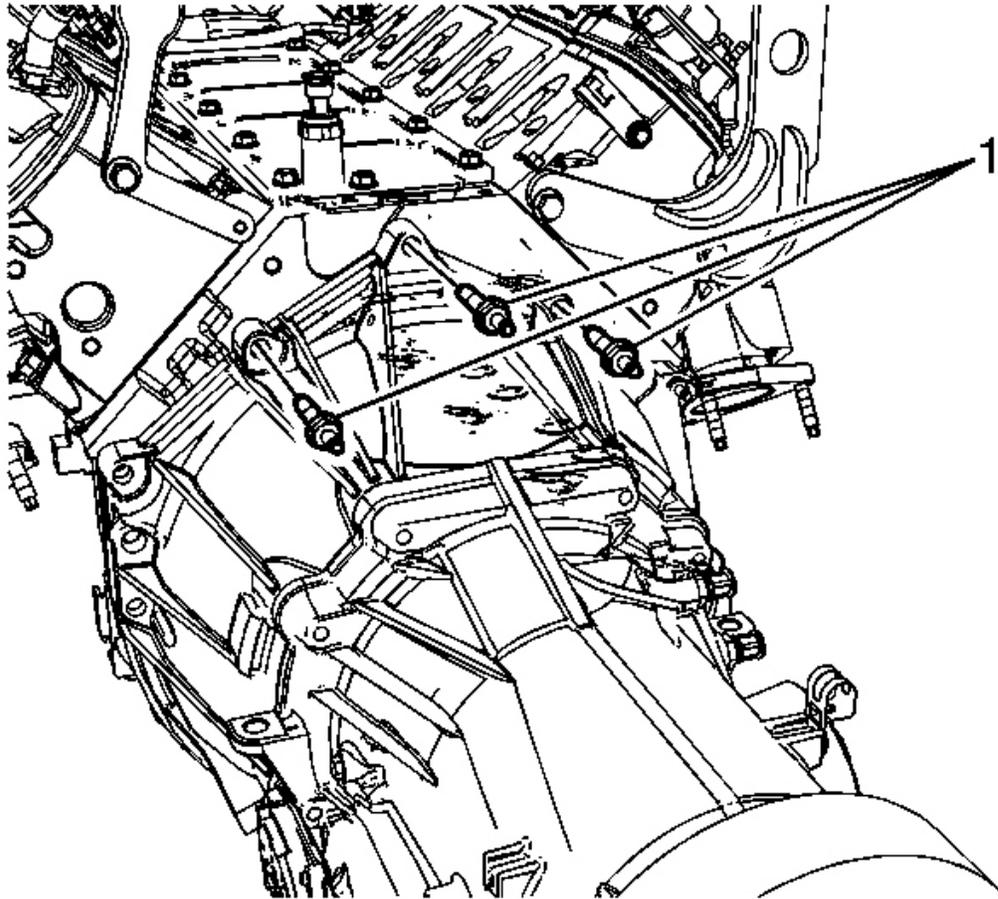


Fig. 258: Lower Transmission Bolt/Studs
Courtesy of GENERAL MOTORS CORP.

37. Remove the lower transmission bolt/studs.
38. Lower the vehicle.
39. Remove the 3 upper transmission bolts/studs (1).
40. Install an engine hoist to **J 41798** . See **Special Tools**.
41. Install a floor jack under the transmission for support.
42. Separate the engine from the transmission.
43. Remove the engine.
44. Install the engine to an engine stand.