

2002 ENGINE

Engine Mechanical - 4.3L - Sierra & Silverado

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Cable Bracket Nut	12 N.m	106 lb in
Accelerator Control Cable Bracket Nut	9 N.m	80 lb in
Balance Shaft Driven Gear Bolt		
• First Pass	20 N.m	15 lb ft
• Final Pass	35 degrees	
Balance Shaft Retainer Bolt	12 N.m	106 lb in
Battery Cable Bracket Bolt	12 N.m	106 lb in
Camshaft Retainer Bolt	12 N.m	106 lb in
Camshaft Sprocket Bolt	25 N.m	18 lb ft
Crankshaft Balancer Bolt	95 N.m	70 lb ft
Crankshaft Position (CKP) Sensor Bolt	8 N.m	71 lb in
Crankshaft Pulley Bolt	58 N.m	43 lb ft
Crankshaft Rear Oil Seal Housing Bolt/Nut	12 N.m	106 lb in
Crossbar Bolt	100 N.m	74 lb ft
Cylinder Head Bolt		
• First Pass	30 N.m	22 lb ft
• Final Pass - Long Bolt (1, 4, 5, 8, 9)	75 degrees	
• Final Pass - Medium Bolt (12, and 13)	65 degrees	
• Final Pass - Short Bolt (2, 3, 6, 7, 10, 11)	55 degrees	
Drive Belt Idler Pulley Bolt	50 N.m	37 lb ft
Drive Belt Tensioner Bolt	50 N.m	37 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Engine Front Cover Bolt	12 N.m	106 lb in
Engine Mount Bolt	50 N.m	37 lb ft
Engine Mount Bracket Bolt	75 N.m	55 lb ft
Engine Mount Side Bracket Bolt	50 N.m	37 lb ft
Engine Mount to Engine Mount Bracket Bolt	65 N.m	48 lb ft
Engine Oil Level Sensor	13 N.m	115 lb in
Engine Shield Bolt	20 N.m	15 lb ft
Engine Wiring Harness Bracket Nut	12 N.m	106 lb in

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Engine Wiring Harness Clip Bolt	9 N.m	80 lb in
Engine Wiring Harness Ground Nut	16 N.m	12 lb ft
Engine Wiring Harness Rear Bracket Nut	9 N.m	80 lb in
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Stud	10 N.m	89 lb in
Exhaust Gas Recirculation (EGR) Valve Inlet Pipe Bracket Bolt	25 N.m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Inlet Pipe Fitting to Exhaust Manifold	25 N.m	18 lb ft
Exhaust Gas Recirculation (EGR) Valve Inlet Pipe Fitting to Intake Manifold	30 N.m	22 lb ft
Flywheel Bolt	100 N.m	74 lb ft
Fuel Pump/Oil Pressure Sensor	30 N.m	22 lb ft
Fuel Pump/Oil Pressure Sensor Fitting	15 N.m	11 lb ft
• Centerline of Fitting to Centerline of Crankshaft	50 degrees	
Generator Bracket Stud	20 N.m	15 lb ft
Harness Ground Bolt	16 N.m	12 lb ft
Heater Outlet Hose Clip Bolt	25 N.m	18 lb ft
Hood Hinge Bolt	25 N.m	18 lb ft
Intake Manifold - Lower		
• First Pass	3 N.m	27 lb in
• Second Pass	12 N.m	106 lb in
• Final Pass	15 N.m	11 lb ft
Intake Manifold - Upper Stud	9 N.m	80 lb in
J 23523-F Bolt	25 N.m	18 lb ft
Junction Block Bracket Bolt	25 N.m	18 lb ft
Lift Bracket Bolts	15 N.m	11 N.m
Oil Filter	30 N.m	22 lb ft
Oil Filter Adapter	55 N.m	41 lb ft
Oil Level Indicator Tube Bolt	12 N.m	106 lb in
Oil Pan Bolt	25 N.m	18 lb ft
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan Skid Plate Bolt	20 N.m	15 lb ft
Oil Pump Bolt	90 N.m	66 lb ft
Positive Cable Generator Nut	18 N.m	13 lb ft
Power Steering (P/S) Pump Bracket Bolt/Nut	41 N.m	30 lb ft
Power Steering (P/S) Pump Bracket Stud	20 N.m	15 lb ft
Spark Plug - New Cylinder Head	30 N.m	22 lb ft
Spark Plug - Used Cylinder Head	15 N.m	11 lb ft
Spark Plug Wire Support Bolt	12 N.m	106 lb in
Throttle Body Stud	9 N.m	80 lb in

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Torque Converter Bolt	63 N.m	47 lb ft
Transmission Bolt	50 N.m	37 lb ft
Transmission Cover Bolt	12 N.m	106 lb in
Transmission Oil Cooler Line Bracket	9 N.m	80 lb in
Valve Lifter Pushrod Guide Bolt	16 N.m	12 lb ft
Valve Rocker Arm Bolt	30 N.m	22 lb ft
Valve Rocker Arm Cover Bolt	12 N.m	106 lb in

ENGINE MECHANICAL SPECIFICATIONS**Engine Mechanical Specifications**

Application	Specification	
	Metric	English
General Data		
• Engine Type	V6	
• RPO Code	L35/LU3	
• VIN Code	W/X	
• Displacement	4.3 L	262 CID
• Bore	101.60 mm	4.012 in
• Stroke	88.39 mm	3.480 in
• Compression Ratio	9.2:1	
• Firing Order	1-6-5-4-3-2	
• Spark Plug Gap	1.52 mm	0.060 in
• Oil Pressure - Minimum - at Normal Operating Temperature	42 kPa at 1,000 RPM 125 kPa at 2,000 RPM 166 kPa at 4,000 RPM	6 psig at 1,000 RPM 18 psig at 2,000 RPM 24 psig at 4,000 RPM
Balance Shaft		
• Rear Bearing Journal Clearance	0.050-0.088 mm	0.0020-0.0035 in
• Rear Bearing Journal Diameter	38.085-38.100 mm	1.4994-1.500 in
Camshaft		
• End Play	0.0254-0.2286 mm	0.0010-0.0090 in
• Journal Diameter	47.440-47.490 mm	1.8677-1.8696 in
• Journal Diameter Out-of-Round	0.025 mm - Maximum	0.0010 in - Maximum
• Lobe Lift - Exhaust	7.20-7.30 mm	0.283-0.287 in
• Lobe Lift - Intake	6.97-7.07 mm	0.274-0.278 in

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• Runout	0.065 mm	0.0026 in
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.038-0.078 mm	0.0015-0.0031 in
• Connecting Rod Bearing Clearance - Service	0.025-0.063 mm	0.0010-0.0025 in
• Connecting Rod Journal Diameter	57.116-57.148 mm	2.2487-2.2497 in
• Connecting Rod Journal Out-of-Round - Production	0.007 mm - Maximum	0.0002 in - Maximum
• Connecting Rod Journal Out-of-Round - Service	0.025 mm - Maximum	0.0010 in - Maximum
• Connecting Rod Journal Taper - Production	0.00508 mm - Maximum	0.00030 in - Maximum
• Connecting Rod Journal Taper - Service	0.025 mm - Maximum	0.0010 in - Maximum
• Connecting Rod Side Clearance	0.15-0.44 mm	0.006-0.017 in
Crankshaft		
• Crankshaft Bearing Clearance - Journal #1-Production	0.02-0.508 mm	0.0008-0.0020 in
• Crankshaft Bearing Clearance - Journal #2, #3, and #4-Production	0.028-0.058 mm	0.0011-0.0023 in
• Crankshaft Bearing Clearance - Journal #1-Service	0.0254-0.05 mm	0.0010-0.0020 in
• Crankshaft Bearing Clearance - Journal #2, #3, and #4-Service	0.025-0.063 mm	0.0010-0.0250 in
• Crankshaft End Play	0.050-0.20 mm	0.002-0.008 in
• Crankshaft Journal Diameter - Journal #1	62.199-62.217 mm	2.4488-2.4495 in
• Crankshaft Journal Diameter - Journal #2 and #3	62.191-62.215 mm	2.4485-2.4494 in
• Crankshaft Journal Diameter - Journal #4	62.179-62.203 mm	2.4480-2.4489 in
• Crankshaft Journal Out-of-Round - Production	0.005 mm - Maximum	0.0002 in - Maximum
• Crankshaft Journal Out-of-Round - Service	0.025 mm - Maximum	0.0010 in - Maximum
• Crankshaft Journal Taper - Production	0.007 mm - Maximum	0.0003 in - Maximum
• Crankshaft Runout	0.025 mm - Maximum	0.0010 in - Maximum
Cylinder Bore		
• Diameter	101.618-101.643 mm	4.0007-4.0017 in
• Out-of-Round - Production	0.0127 mm - Maximum	0.00050 in - Maximum
• Out-of-Round - Service	0.05 mm - Maximum	0.002 in - Maximum
• Taper - Production Relief Side	0.025 mm -	0.0010 in - Maximum

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	Maximum	
• Taper - Production Thrust Side	0.012 mm - Maximum	0.0005 in - Maximum
• Taper - Service	0.025 mm - Maximum	0.0010 in - Maximum
Cylinder Head		
• Surface Flatness	0.10 mm - Maximum	0.004 in - Maximum
Exhaust Manifold		
• Surface Flatness - Flange to Flange	0.25 mm - Maximum	0.010 in - Maximum
• Surface Flatness - Individual Flange	0.05 mm - Maximum	0.002 in - Maximum
Intake Manifold		
• Surface Flatness	0.10 mm - Maximum	0.004 in - Maximum
Oil Pan		
• Oil Pan Alignment at Rear of Engine Block	0.3 mm - Maximum	0.011 in - Maximum
Piston		
• Piston Bore Clearance - Production	0.018-0.061 mm	0.0007-0.0024 in
• Piston Bore Clearance - Service	0.075 mm - Maximum	0.0029 in - Maximum
Piston Pin		
• Clearance in Piston - Production	0.013-0.023 mm	0.0005-0.0009 in
• Clearance in Piston - Service	0.025 mm - Maximum	0.0010 in - Maximum
• Diameter	23.545-23.548 mm	0.9270-0.9271 in
• Fit in Connecting Rod	0.012-0.048 mm - Interference	0.0005-0.0019 in - Interference
Piston Rings - End Gap Measured in Cylinder Bore		
• Piston Compression Ring Gap - Production-Top Groove	0.25-0.40 mm	0.010-0.016 in
• Piston Compression Ring Gap - Production-2nd Groove	0.38-0.58 mm	0.015-0.023 in
• Piston Compression Ring Gap - Service-Top Groove	0.25-0.50 mm	0.010-0.020 in
• Piston Compression Ring Gap - Service-2nd Groove	0.38-0.80 mm	0.015-0.031 in
• Piston Compression Ring Groove Clearance - Production-Top Groove	0.030-0.070 mm	0.0012-0.0027 in
• Piston Compression Ring Groove Clearance - Production-2nd Groove	0.040-0.080 mm	0.0015-0.0031 in
• Piston Compression Ring Groove Clearance - Service	0.030-0.085 mm	0.0012-0.0033 in
• Piston Oil Ring Gap - Production	0.25-0.76 mm	0.010-0.029 in

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• Piston Oil Ring Gap - Service	0.005-0.090 mm	0.0002-0.0035 in
• Piston Oil Ring Groove Clearance - Production	0.046-0.196 mm	0.0018-0.0077 in
• Piston Oil Ring Groove Clearance - Service	0.046-0.200 mm	0.0018-0.0079 in
Valve System		
• Valve Face Angle	45 degrees	
• Valve Head Edge Margin	0.79 mm - Minimum	0.031 in - Minimum
• Valve Lash	Net Lash-No Adjustment	
• Valve Lift - Exhaust	10.879 mm	0.4280 in
• Valve Lift - Intake	10.527 mm	0.4140 in
• Valve Lifter	Hydraulic Roller Type	
• Valve Rocker Arm	Roller Pivot Type	
• Valve Rocker Arm Ratio	1.5:1	
• Valve Seat Angle	46 degrees	
• Valve Seat Runout	0.05 mm - Maximum	0.002 in - Maximum
• Valve Seat Width - Exhaust	1.651-2.489 mm	0.065-0.098 in
• Valve Seat Width - Intake	1.016-1.651 mm	0.040-0.065 in
• Valve Spring Free Length	51.3 mm	2.02 in
• Valve Spring Installed Height - Exhaust	42.92-43.43 mm	1.670-1.700 in
• Valve Spring Installed Height - Intake	42.92-43.43 mm	1.670-1.700 in
• Valve Spring Pressure - Closed	338-374 N at 43.2 mm	76-84 lb at 1.70 in
• Valve Spring Pressure - Open	832-903 N at 32.3 mm	187-203 lb at 1.27 in
• Valve Stem Clearance - Exhaust-Production	0.025-0.069 mm	0.0010-0.0027 in
• Valve Stem Clearance - Exhaust-Service	0.025-0.094 mm	0.0010-0.0037 in
• Valve Stem Clearance - Intake-Production	0.025-0.069 mm	0.0010-0.0027 in
• Valve Stem Clearance - Intake-Service	0.025-0.094 mm	0.0010-0.0037 in
• Valve Stem Oil Seal Installed Height - Measured from the Top of the Large Diameter Valve Guide Bevel to the Bottom of the Valve Stem Oil Seal	1-2 mm	0.03937-0.07874 in

SEALERS, ADHESIVES, AND LUBRICANTS

Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number
United States	Canada	

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Balance Shaft Driven Gear Bolt	Threadlock	12345382	10953489
Camshaft Retainer Bolt	Threadlock	12345382	1093489
Crankshaft Balancer Keyway	Adhesive	12346141	10953433
Cylinder Head Bolt	Sealant	12346004	10953480
Engine Block to Crankcase Rear Oil Seal Housing Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141	10953433
Engine Block to Engine Front Cover Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141	10953433
Engine Block at Intake Manifold Sealing Surfaces	Adhesive	12346141	10953433
Engine Coolant Temperature (ECT) Sensor	Sealant	12346004	10953480
Engine Oil Pressure Sensor	Sealant	12346004	10953480
Engine Oil Pressure Sensor Fitting	Sealant	12346004	10953480
Engine Oil Supplement	Lubricant	1052367	992869
EVAP Canister Purge Solenoid Valve Stud	Threadlock	12345382	10953489
Intake Manifold - Lower Bolt	Threadlock	12345382	10953489
Intake Manifold - Upper Stud	Threadlock	12345382	10953489
Oil Level Indicator Tube	Sealant	12346004	10953480
Throttle Body Stud	Threadlock	12345382	10953489
Valvetrain Component	Lubricant	12345501	992704

DIAGNOSTIC INFORMATION AND PROCEDURES**DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL**

Begin the system diagnosis by reviewing the **DISASSEMBLED VIEWS** , **ENGINE COMPONENT DESCRIPTION** , **LUBRICATION DESCRIPTION** , and **NEW PRODUCT INFORMATION** and the **Drive Belt System Description**. Reviewing the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and

where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform the **DIAGNOSTIC SYSTEM CHECK - ENGINE CONTROLS** .
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **DISASSEMBLED VIEWS** , **ENGINE COMPONENT DESCRIPTION** , **LUBRICATION DESCRIPTION** , and **NEW PRODUCT INFORMATION** and to **Drive Belt System Description**.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system problem. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

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

- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire without Internal Engine Noises

Cause	Correction
High oil pressure	<ul style="list-style-type: none"> • Verify oil pressure. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn, damaged, or improperly installed accessory drive belt - severe cracking, bumps or missing segments A misfire DTC may be present without an actual misfire condition.	<ul style="list-style-type: none"> • Inspect the accessory drive system components. • Repair or replace damaged components as required. Refer to <u>Drive Belt Replacement</u>.
Worn, damaged, or improperly installed accessory drive system components A misfire DTC may be present without an actual misfire condition.	<ul style="list-style-type: none"> • Inspect the accessory drive system components. • Repair or replace damaged components as required.
Damaged, loose or improperly installed crankshaft balancer A misfire DTC may be present without an actual misfire condition.	<ul style="list-style-type: none"> • Inspect the crankshaft balancer. • Repair or replace damaged components as required. Refer to <u>Crankshaft Balancer Replacement</u>.
Worn, damaged, or improperly installed crankshaft reluctor wheel A worn or damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the wear or damage. <ul style="list-style-type: none"> • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. 	<ul style="list-style-type: none"> • Inspect the crankshaft position sensor. • Inspect the crankshaft reluctor wheel. • Inspect the crankshaft. • Repair or replace damaged components as required.

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<ul style="list-style-type: none"> Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery. A DTC P0300 or P0336 may be set. 	
<p>Damaged, loose or improperly installed engine flywheel A misfire DTC may be present without an actual misfire condition.</p>	<ul style="list-style-type: none"> Inspect the flywheel. Repair or replace damaged components as required. Refer to <u>Engine Flywheel Replacement</u>.
<p>Damaged, improperly installed or restricted exhaust system, collapsed or dented pipes, plugged mufflers or malfunctioning catalytic converters A DTC may be present without an actual fault condition.</p>	<ul style="list-style-type: none"> Inspect the exhaust system components. Repair or replace damaged components as required.
<p>Worn, damaged or improperly installed vacuum hoses</p>	<ul style="list-style-type: none"> Inspect the vacuum system components. Repair or replace damaged components as required.
<p>Damaged or improperly installed MAP sensor, sealing grommet nicked, torn or missing</p>	<ul style="list-style-type: none"> Inspect the MAP sensor. Repair or replace damaged components as required.
<p>Damaged or improperly installed throttle body</p>	<ul style="list-style-type: none"> Inspect the throttle body. Repair or replace damaged components as required.
<p>Damaged or improperly installed intake manifold</p>	<ul style="list-style-type: none"> Inspect the intake manifold. Repair or replace damaged components as required.
<p>Damaged or improperly installed cylinder head Oil consumption may or may not cause the engine to misfire.</p>	<ul style="list-style-type: none"> Inspect the spark plugs. Refer to Verify engine compression. Refer to <u>Engine Compression Test</u>. Inspect the cylinder heads. Inspect the engine block. Repair or replace damaged components as required.
<p>Worn, damaged or loose valve rocker arm</p>	<ul style="list-style-type: none"> Inspect the valve rocker arms. Repair or replace damaged components as required.
<p>Worn, damaged or loose valve rotator</p>	<ul style="list-style-type: none"> Inspect the valve rotators. Repair or replace damaged components as required.
<p>Worn, damaged, loose or broken valve spring</p>	<ul style="list-style-type: none"> Inspect the valve springs.

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	<ul style="list-style-type: none">• Repair or replace damaged components as required.
Worn, damaged or stuck valve, carbon on the valve stem or valve seat	<ul style="list-style-type: none">• Inspect the valves.• Inspect the valve guides.• Repair or replace damaged components as required.
Worn or damaged valve guide	<ul style="list-style-type: none">• Inspect the valve guides.• Inspect the valves.• Repair or replace damaged components as required.
Worn, damaged, loose or bent valve push rod	<ul style="list-style-type: none">• Inspect the valve push rods.• Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	<ul style="list-style-type: none">• Inspect the valve lifters.• Inspect the camshaft.• Repair or replace damaged components as required.
Worn or damaged camshaft lobe	<ul style="list-style-type: none">• Inspect the camshaft.• Inspect the valve lifters.• Repair or replace damaged components as required.
Worn, damaged or loose timing chain and sprockets	<ul style="list-style-type: none">• Inspect the timing chain and sprockets.• Repair or replace damaged components as required.
Worn, damaged or improperly installed piston 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. Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none">• Inspect the spark plugs. Refer to• Verify engine compression. Refer to <u>Engine Compression Test</u>.• Inspect the cylinder bores.• Inspect the pistons.• Inspect the piston pins.• Inspect the connecting rods.• Repair or replace damaged components as required.

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

Cause	Correction
Worn, damaged, or improperly installed accessory	<ul style="list-style-type: none">• Inspect the accessory drive system

drive belt - severe cracking, bumps or missing segments A misfire DTC may be present without an actual misfire condition.	components. <ul style="list-style-type: none"> Repair or replace damaged components as required. Refer to <u>Drive Belt Replacement</u>.
Worn, damaged, or improperly installed accessory drive system components A misfire DTC may be present without an actual misfire condition.	<ul style="list-style-type: none"> Inspect the accessory drive system components. Repair or replace damaged components as required.
Worn, damaged, improperly installed or loose crankshaft balancer A misfire code may be present without an actual misfire condition.	<ul style="list-style-type: none"> Inspect the crankshaft balancer. Repair or replace damaged components as required. Refer to <u>Crankshaft Balancer Replacement</u>.
Worn, damaged, improperly installed or loose engine flywheel A misfire code may be present without an actual misfire condition.	<ul style="list-style-type: none"> Inspect the engine flywheel. Repair or replace damaged components as required. Refer to <u>Engine Flywheel Replacement</u>.
Worn, damaged or improperly installed piston 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. Oil consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> Inspect the spark plugs. Refer to Verify engine compression. Refer to <u>Engine Compression Test</u>. Inspect the cylinder bores. Inspect the pistons. Inspect the piston pins. Inspect the connecting rods. Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft thrust bearing A misfire code may be present without an actual misfire condition.	<ul style="list-style-type: none"> Inspect the crankshaft. Inspect the crankshaft thrust bearing. Repair or replace damaged components as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn, damaged or loose rocker arm	<ul style="list-style-type: none"> Inspect the valve rocker arms. Repair or replace damaged components as required.
Worn, damaged, loose or bent valve push rod	<ul style="list-style-type: none"> Inspect the valve push rods. Repair or replace damaged components as required.
Worn, damaged or stuck valve, carbon on the valve	

stem or valve seat	<ul style="list-style-type: none"> • Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	<ul style="list-style-type: none"> • Inspect the valve lifters. • Inspect the camshaft. • Repair or replace damaged components as required.
Worn or damaged camshaft lobe	<ul style="list-style-type: none"> • Inspect the camshaft. • Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or loose timing chain and sprockets	<ul style="list-style-type: none"> • Inspect the timing chain and sprockets. • Repair or replace damaged components as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Damaged or improperly installed cylinder head Coolant consumption may or may not cause the engine to misfire.	<ul style="list-style-type: none"> • Inspect the spark plugs. Refer to • Verify engine compression. Refer to <u>Engine Compression Test</u>. • Inspect the cylinder heads. • Inspect the engine block. • Repair or replace damaged components as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn or damaged valve	<ul style="list-style-type: none"> • Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn, damaged or improperly installed piston rings Piston rings must be installed with the mark, or dimple, on the top of the piston ring, facing up.	<ul style="list-style-type: none"> • Inspect the spark plugs. Refer to • Verify engine compression. Refer to <u>Engine Compression Test</u>. • Inspect the cylinder bores.

- Inspect the pistons.
- Inspect the piston pins.
- Inspect the connecting rods.
- Repair or replace damaged components as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect engine oil, viscosity	Install the correct engine oil and oil filter. Refer to <u>Engine Oil and Oil Filter Replacement</u> .
Incorrect oil filter, without anti-drainback feature	Install the correct engine oil and oil filter. Refer to <u>Engine Oil and Oil Filter Replacement</u> .
Worn, damaged or improperly installed oil filter by-pass valve	<ul style="list-style-type: none"> • Inspect the oil filter by-pass valve. • Repair or replace damaged components as required.
High valve lifter leak down rate	<ul style="list-style-type: none"> • Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft thrust bearing	<ul style="list-style-type: none"> • Inspect the crankshaft. • Inspect the crankshaft thrust bearing. • Repair or replace damaged components as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Verify oil pressure. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Improper lubrication of the valve train components	<ul style="list-style-type: none"> • Verify oil pressure. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Inspect the valve rocker arms. • Inspect the valve push rods. • Inspect the valve lifters. • Inspect the oil filter bypass valve. • Inspect the oil pump and pump screen.

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	<ul style="list-style-type: none">• Inspect the engine block oil galleries.• Repair or replace damaged components as required.
Worn, damaged or improperly installed valve rocker arm	<ul style="list-style-type: none">• Inspect the valve rocker arms.• Repair or replace damaged components as required.
Worn or damaged valve rotator	<ul style="list-style-type: none">• Inspect the valve rotators.• Repair or replace damaged components as required.
Broken valve spring	<ul style="list-style-type: none">• Inspect the valve springs.• Repair or replace damaged components as required.
Worn, damaged or stuck valves, carbon on the valve stem or valve seat	<ul style="list-style-type: none">• Inspect the valves.• Inspect the valve guides.• Repair or replace damaged components as required.
Worn or damaged valve guide	<ul style="list-style-type: none">• Inspect the valve guides.• Inspect the valves.• Repair or replace damaged components as required.
Worn, damaged or bent valve push rod	<ul style="list-style-type: none">• Inspect the valve rocker arms.• Inspect the valve push rods.• Inspect the valve lifters.• Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	<ul style="list-style-type: none">• Inspect the valve lifters.• Repair or replace damaged components as required.
Worn or damaged camshaft lobes	<ul style="list-style-type: none">• Inspect the engine camshaft lobes.• Repair or replace damaged components as required.
Worn, damaged, improperly installed or loose timing chain and sprockets	<ul style="list-style-type: none">• Inspect the timing chain and sprockets.• Repair or replace damaged components as required.
Worn, damaged or improperly installed timing chain tensioner, if equipped	<ul style="list-style-type: none">• Inspect the timing chain tensioner.• Repair or replace damaged components as required.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Verify oil pressure. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Detonation or spark knock	<ul style="list-style-type: none"> • Verify the operation of the ignition controls system. Refer to <u>DIAGNOSTIC SYSTEM CHECK - ENGINE CONTROLS</u>. • Repair or replace damaged components as required.
Worn, damaged or improperly installed accessory drive belt - severe cracking, bumps or missing segments in the accessory drive belt	<ul style="list-style-type: none"> • Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged or improperly installed accessory drive system components	<ul style="list-style-type: none"> • Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft balancer	<ul style="list-style-type: none"> • Inspect the crankshaft balancer. • Inspect the crankshaft. • Repair or replace damaged components as required.
Worn, damaged or improperly installed engine flywheel	<ul style="list-style-type: none"> • Inspect the engine flywheel. • Inspect the engine flywheel bolts. • Inspect the torque converter. • Inspect the torque converter bolts. • Inspect the crankshaft. • Repair or replace damaged components as required.
Worn, damaged or improperly installed torque converter	<ul style="list-style-type: none"> • Inspect the torque converter. • Inspect the torque converter bolts. • Inspect the engine flywheel. • Repair or replace damaged components as required.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged may loosen, improperly position or restrict oil flow at the oil pump screen, preventing proper oil flow to the oil pump.	<ul style="list-style-type: none"> • Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace damaged components as required.

Worn, damaged, improperly installed or restricted oil pump screen An oil pan that has been damaged may loosen, improperly position or restrict oil flow at the oil pump screen, preventing proper oil flow to the oil pump.	<ul style="list-style-type: none"> • Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace damaged components as required.
Worn, damaged or improperly installed piston 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.	<ul style="list-style-type: none"> • Inspect the spark plugs. Refer to • Verify engine compression. Refer to <u>Engine Compression Test</u>. • Inspect the cylinder bores. • Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.
Worn, damaged or improperly installed connecting rod bearing	<ul style="list-style-type: none"> • Inspect the connecting rods. • Inspect the connecting rod bearings. • Inspect the crankshaft connecting rod journals. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft bearing	<ul style="list-style-type: none"> • Inspect the crankshaft bearings. • Inspect the crankshaft journals. • Repair or replace damaged components as required.

ENGINE NOISE UNDER LOAD

Engine Noise Under Load

Cause	Correction
Low oil pressure	<ul style="list-style-type: none"> • Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Detonation or spark knock	<ul style="list-style-type: none"> • Verify the correct operation of the ignition controls. Refer to <u>DIAGNOSTIC SYSTEM CHECK - ENGINE CONTROLS</u>. • Repair or replace damaged components as required.
Worn, damaged or improperly installed engine flywheel	<ul style="list-style-type: none"> • Inspect the engine flywheel. • Inspect the engine flywheel bolts. • Inspect the torque converter.

	<ul style="list-style-type: none"> • Inspect the torque converter bolts. • Inspect the crankshaft. • Repair or replace damaged components as required.
Worn, damaged or improperly installed torque converter	<ul style="list-style-type: none"> • Inspect the torque converter. • Inspect the torque converter bolts. • Inspect the engine flywheel. • Repair or replace damaged components as required.
Worn, damaged or improperly installed pistons 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.	<ul style="list-style-type: none"> • Inspect the cylinder bores. • Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.
Worn, damaged or improperly installed connecting rod bearing	<ul style="list-style-type: none"> • Inspect the connecting rods. • Inspect the connecting rod bearings. • Inspect the crankshaft connecting rod journals. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft bearing	<ul style="list-style-type: none"> • Inspect the crankshaft bearings. • Inspect the crankshaft journals. • Repair or replace damaged components as required.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	<ol style="list-style-type: none"> 1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder <ul style="list-style-type: none"> • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder 	<ol style="list-style-type: none"> 1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector.
Seized automatic transmission torque converter	<ol style="list-style-type: none"> 1. Remove the torque converter bolts.

	2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	<ol style="list-style-type: none"> 1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location. <p>Refer to Unit Repair Manual - Manual Transmission.</p>
Broken timing chain and/or gears	<ul style="list-style-type: none"> • Inspect timing chain and gears. • Repair as required.
Seized balance shaft	<ul style="list-style-type: none"> • Inspect balance shaft. • Repair as required.
Material in cylinder <ul style="list-style-type: none"> • Broken valve • Piston material • Foreign material 	<ul style="list-style-type: none"> • Inspect cylinder for damaged components and/or foreign materials. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	<ul style="list-style-type: none"> • Inspect crankshaft and connecting rod bearings. • Repair as required.
Bent or broken connecting rod	<ul style="list-style-type: none"> • Inspect connecting rods. • Repair as required.
Broken crankshaft	<ul style="list-style-type: none"> • Inspect crankshaft. • Repair as required.

COOLANT IN COMBUSTION CHAMBER

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</u> 	

Compression Test.

Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>CYLINDER HEAD CLEANING & INSPECTION</u> and <u>Cylinder Head Replacement - Left</u> or <u>Cylinder Head Replacement - Right</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 & 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**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 component damage. Contaminated engine oil and oil filter should be changed.</p> <ol style="list-style-type: none"> 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 <u>Lower Engine Noise, Regardless of Engine Speed</u>. 2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>. 	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>CYLINDER HEAD CLEANING & INSPECTION</u> and <u>Cylinder Head Replacement - Left</u> or <u>Cylinder Head Replacement - Right</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 & 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.

CYLINDER LEAKAGE TEST

Tools Required

J 35667-A Cylinder Head Leakdown Tester

Cylinder Leakage Test Procedure

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

CAUTION: Refer to BATTERY DISCONNECT CAUTION .

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs.
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke, with both valves closed.
4. Install the J 35667-A .

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

5. Apply shop air pressure to the J 35667-A and adjust according to the manufacturer instructions.

IMPORTANT: Perform the leakage test on all cylinders and record the values before doing any repairs.

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:
 1. Air leakage from the intake or exhaust system may indicate a worn or burnt valve or a broken valve spring.
 1. Remove the valve rocker arm cover of the suspect cylinder head. Refer to Valve Rocker Arm Cover Replacement - Left or Valve Rocker Arm Cover Replacement - Right.
 2. Ensure that both valves are closed.
 3. Inspect the cylinder head for a broken valve spring.
 4. Remove and inspect the suspect cylinder head. Refer to Cylinder Head Replacement - Left or Cylinder Head Replacement - Right.
 2. Air leakage from the crankcase, oil level indicator, or oil fill tube may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
 1. Remove the piston from the suspect cylinder. Refer to PISTON, CONNECTING ROD & BEARING REMOVAL or PISTON, CONNECTING ROD & BEARING INSTALLATION .

2. Inspect the piston and connecting rod assembly. Refer to **PISTON, CONNECTING ROD & BEARINGS -- CLEANING**.
3. Inspect the engine block. Refer to **ENGINE BLOCK CLEANING & INSPECTION**.
4. Inspect the cylinder head. Refer to **CYLINDER HEAD CLEANING & INSPECTION**.
3. Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
 1. Remove both cylinder heads. Refer to **Cylinder Head Replacement - Left** or **Cylinder Head Replacement - Right**.
 2. Inspect both cylinder heads. Refer to **CYLINDER HEAD CLEANING & INSPECTION**.
 3. Inspect the engine block. Refer to **ENGINE BLOCK CLEANING & INSPECTION**.
7. Remove the J 35667-A.
8. Install the spark plugs.

CAUTION: Refer to **BATTERY DISCONNECT CAUTION**.

9. Connect the battery ground negative cable.

ENGINE COMPRESSION TEST

1. Ensure that the vehicle batteries are in good condition, and fully charged.
2. Operate the vehicle until the engine is at normal operating temperature.
3. Disconnect the positive ignition coil wire plug from the ignition coil.
4. Disconnect the fuel injector electrical connector.
5. Remove all of the spark plugs.

NOTE: Do not insert objects into the throttle plate opening. Damage to the throttle body can result, requiring replacement of the throttle body assembly.

6. Block the throttle linkage wide open.
7. Install the engine cylinder compression gage to the cylinder being tested.
8. Using the vehicle starter motor, rotate, or crank the engine for 4 compression strokes, or puffs, for the cylinder being tested. If the engine rotates for more than 4 compression strokes, test the cylinder again.
9. Record the compression reading.
10. Remove the engine cylinder compression gage from the cylinder being tested.
11. Repeat steps 8-11 for each additional cylinder. All cylinders must be tested to obtain valid test results.
12. If any cylinders have low compression, inject approximately 15 ml (1 oz) of engine oil into the cylinder through the spark plug hole.
13. Repeat steps 8-11 for all low compression cylinders.
14. The minimum compression in any one 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 one

cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). Multiply the highest cylinder pressure by 70 percent, $1035 \text{ kPa} \times 70 \text{ percent} = 725 \text{ kPa}$ (150 psi $\times 70 \text{ percent} = 105 \text{ psi}$), in order to determine the lowest allowable pressure in any other cylinder.

- Normal

The compression builds up quickly and evenly to the specified compression.

- Piston rings leaking

Compression is low on the first compression stroke. The compression builds up on the following strokes, but does not reach normal. Compression improves considerably when you add oil.

- Valves leaking

Compression is low on the first compression stroke. The compression does not build up on the following strokes, and does not reach normal. Compression does not improve much, if at all, when you add oil.

- Head gasket leaking

Compression is low on the first stroke. The compression does not build up on the following strokes, and does not reach normal. Compression does not improve much, if at all, when you add oil. Adjacent cylinders have the same, or similar, low compression readings.

15. If one or more cylinders fails to meet the minimum specified compression, repair or replace all damaged or worn components and test the engine again.

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 1 liter (1 quart) of engine oil within 3 200 kilometers (2,000 miles). However, during initial engine break-in periods 4 828-6 437 kilometers (3,000-4,000 miles), oil consumption may exceed 1 liter (1 quart) or more. The causes of excessive oil consumption include the following conditions:

- External oil leaks

Tighten the bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

With the vehicle on a level surface, allow adequate drain down time and check for the correct oil level.

- Improper oil viscosity

Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage

- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, damaged, or the seal omitted

Ream the valve guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

Allow adequate time for the piston rings to seat. Replace broken or worn piston rings as necessary.

- Piston improperly installed or miss-fitted

OIL PRESSURE DIAGNOSIS AND TESTING

1. With the vehicle on a level surface, allow adequate drain down time, 2-3 minutes, and measure for a low engine oil level.

Add the recommended grade engine oil, and fill the crankcase until the oil level measures FULL on the oil level indicator.

2. Operate the engine and verify low or no oil pressure on the vehicle oil pressure gage or the oil indicator light.

Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:

- Engine oil diluted by moisture or unburned fuel mixtures
- Improper engine oil viscosity for the expected temperature
- Incorrect or faulty oil pressure gage sensor
- Incorrect or faulty oil pressure gage
- Plugged oil filter
- Malfunctioning oil filter bypass valve

4. Remove the oil pressure gage sensor or another engine block oil gallery plug.

5. Install an oil pressure gage.

6. Start the engine and then allow the engine to reach normal operation temperature.

7. Measure the engine oil pressure at the following RPM:

Specification:

1. 42 kPa (6 psig) minimum, at 1,000 RPM
2. 125 kPa (18 psig) minimum, at 2,000 RPM
3. 166 kPa (24 psig) minimum, at 4,000 RPM

8. If the engine oil pressure is below minimum specifications, inspect the engine for one or more of the following:

- Oil pump worn or dirty
- Malfunctioning oil pump pressure relief valve
- Oil pump screen loose, plugged, or damaged
- Excessive bearing clearance
- Cracked, porous or restricted oil galleries
- Engine block oil gallery plugs missing or incorrectly installed
- Broken valve lifters

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Step	Action	Yes	No
IMPORTANT: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
1	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers - miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large		

	<p>sheet of paper or other clean surface.</p> <p>4. Wait 15 minutes.</p> <p>5. Identify the type of fluid, and the approximate location of the leak.</p> <p>Can you identify the type of fluid and the approximate location of the leak?</p>	Go to Step 10	Go to Step 5
5	<p>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</p> <p>2. Check for leaks at the following locations:</p> <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	<p>1. Completely clean the entire engine and surrounding components.</p> <p>2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area.</p> <p>3. Operate the vehicle for several kilometers (miles) at normal operating temperature and at varying speeds.</p> <p>4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface.</p> <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	<p>1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.</p> <p>2. Check for leaks at the following locations:</p> <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 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</p>		

	location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: <ul style="list-style-type: none"> • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: <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. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

DRIVE BELT CHIRPING DIAGNOSIS

Diagnostic Aids

The chirping noise may be intermittent due to moisture on the drive belt or the accessory drive pulley(s). In order to duplicate the customer's concern, It may be necessary to spray a small amount of water onto the drive belt. If spraying water onto the drive belt duplicates the symptom, cleaning the accessory belt pulley(s) may be the most probable solution.

A loose or improper installation of a body or suspension component, or other item(s) on the vehicle may also cause the chirping noise.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

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

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

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

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

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

12: Inspect the accessory drive pulley(s) should include inspecting for bends, dents or other damage to the pulley(s) that would prevent the drive belt from seating properly in the pulley grooves, or on the smooth surface of the pulley when the back side of the drive belt is used to drive the pulley.

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

Drive Belt Chirping Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>BELT DRESSING NOTICE</u> .			
DEFINITION: The following items are indications of chirping: <ul style="list-style-type: none"> • A high pitched noise that is heard once per revolution of the drive belt or a accessory drive pulley. • Chirping may occur on cold damp start-up conditions and will subside once the vehicle reaches normal operating temperature. 			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to Step 3	Go to Diagnostic Aids
	1. Remove the drive belt. Refer to <u>Drive Belt</u>		

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3	<p><u>Replacement.</u></p> <p>2. Operate the engine for no longer than 30 to 40 seconds.</p> <p>Does the chirping noise still exist?</p>	<p>Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u></p>	<p>Go to Step 4</p>
4	<p>Inspect for severe drive belt pilling exceeding 1/3 of the drive belt groove depth.</p> <p>Does the drive belt grooves have pilling?</p>	<p>Go to Step 5</p>	<p>Go to Step 6</p>
5	<p>Clean the accessory drive belt pulley(s) with a suitable wire brush.</p> <p>Were the accessory drive belt pulley(s) cleaned?</p>	<p>Go to Step 15</p>	<p>-</p>
6	<p>Inspect for a misaligned accessory drive pulley(s).</p> <p>Is there a misaligned pulley(s)?</p>	<p>Go to Step 7</p>	<p>Go to Step 8</p>
7	<p>Replace and/or repair the misaligned accessory drive pulley(s).</p> <p>Were the misaligned accessory drive pulley(s) replaced and/or repaired?</p>	<p>Go to Step 15</p>	<p>-</p>
8	<p>Inspect for a bent or cracked accessory drive bracket (s).</p> <p>Is there a bent and/or cracked accessory drive bracket (s)?</p>	<p>Go to Step 9</p>	<p>Go to Step 10</p>
9	<p>Replace the bent and/or cracked accessory drive bracket(s).</p> <p>Was the bent and/or cracked accessory drive bracket(s) replaced?</p>	<p>Go to Step 15</p>	<p>-</p>
10	<p>Inspect for incorrect, loose and/or missing fasteners.</p> <p>Were there any incorrect, loose, and/or missing fasteners found?</p>	<p>Go to Step 11</p>	<p>Go to Step 12</p>
11	<p>1. Replace any incorrect and/or missing fasteners.</p> <p>2. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications.</u></p> <p>Were the fasteners replaced and/or tightened?</p>	<p>Go to Step 15</p>	<p>-</p>
12	<p>Inspect for a bent accessory drive pulley(s).</p> <p>Was a bent accessory drive pulley(s) found?</p>	<p>Go to Step 13</p>	<p>Go to Step 14</p>
13	<p>Replace the bent accessory drive pulley(s).</p> <p>Was the bent accessory drive pulley(s) replaced?</p>	<p>Go to Step 15</p>	<p>-</p>
14	<p>Replace the drive belt. Refer to <u>Drive Belt Replacement.</u></p> <p>Was the drive belt replaced?</p>	<p>Go to Step 15</p>	<p>-</p>
15	<p>1. Clear any codes.</p> <p>2. Run the engine in order to verify the repair.</p> <p>Does the chirping noise still exist?</p>	<p>-</p>	<p>System OK</p>

DRIVE BELT SQUEAL DIAGNOSIS

Diagnostic Aids

A loose or improper installation of a body or suspension component, or other item(s) on the vehicle may cause the squeal noise.

If the squeal is intermittent, verify that it is not the accessory drive component(s) by varying their load(s), making sure they are operating to their maximum capacity. An overcharged air conditioning (A/C) system, a power steering system restriction or the incorrect fluid, or a failing generator are suggested items to inspect.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

- 2:** The squeal may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table
- 3:** The squeal may be an internal engine noise. Remove the drive belt and operate the engine for a few seconds, this will verify if the squealing noise is related to the drive belt or an accessory drive component. With the drive belt removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.
- 4:** This test is to verify that an accessory drive component(s) does not have a seized bearing. With the belt removed test the bearings in the accessory drive component(s) for smooth operation. Also test the accessory drive components with the engine operating by varying the load on the accessory drive component(s) to verify that the component(s) is operating properly.
- 5:** This test is to verify that the drive belt tensioner is operating 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 squealing noise.
- 6:** This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from operating properly. Also if the incorrect length drive belt was installed, it may not be routed correctly and may be turning an accessory drive component in the incorrect direction.
- 7:** Misalignment of the accessory drive pulley(s) may be caused from improper mounting or incorrect installation of a accessory drive component, or the pulley may be bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found, refer to that accessory drive component for the proper removal and installation procedure for that pulley.
- 8:** Inspect the accessory drive pulley(s) to verify that they are the correct diameter or width. Using a known good vehicle, compare the accessory drive pulleys.

Drive Belt Squeal Diagnosis

Step	Action	Yes	No
NOTE: Refer to BELT DRESSING NOTICE .			
DEFINITION: The following items are indications of drive belt squeal:			

- A loud screeching noise that is caused by a slipping drive belt (this is unusual for a drive belt with multiple ribs)
- The squeal occurs when a heavy load is applied to the drive belt, such as an A/C compressor engagement, snapping the throttle, slipping on a seized pulley, or a faulty accessory drive component.

1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a squealing noise. Does the engine make the squeal noise?	Go to Step 3	Go to Diagnostic Aids
3	<ol style="list-style-type: none"> 1. Remove the drive belt. Refer to Drive Belt Replacement. 2. Operate the engine for no longer than 30 to 40 seconds. Does the squealing noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds	Go to Step 4
4	Inspect for a seized accessory drive component bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to Step 9	Go to Step 5
5	Inspect the drive belt tensioner for proper operation. Refer to Drive Belt Tensioner Diagnosis . Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Check for the correct length drive belt. Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for a misaligned pulley. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for an incorrect size pulley. Did you find and correct the condition?	Go to Step 9	-
9	<ol style="list-style-type: none"> 1. Install the drive belt. Refer to Drive Belt Replacement. 2. Clear any codes. 3. Run the engine in order to verify the repair. Does the squealing noise still exist?	-	System OK

DRIVE BELT WHINE DIAGNOSIS

Diagnostic Aids

The drive belt will not cause the whine.

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

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

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

4: This inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt may have to be installed and the accessory drive component(s) operated separately by varying their loads. Refer to the suspected accessory drive component for the proper removal and replacement procedure.

Drive Belt Whine Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>BELT DRESSING NOTICE</u> . DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a whining noise. Does the engine make the whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. <u>Drive Belt Replacement.</u> 2. Operate the engine for no longer than 30 to 40 seconds. Does the whining noise still exist?	Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u>	Go to Step 4
4	1. Inspect for a failed accessory drive component bearing. 2. Install the drive belt. <u>Drive Belt Replacement.</u> Did you find and correct the condition?	Go to Step 5	-
5	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the whining still exist?	-	System OK

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

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

3: This test is to verify that the drive belt is causing the rumbling. Rumbling may be confused with an internal engine noise due to the similarity in the description. Operate the engine for a few seconds, this will verify if the rumbling noise is related to the drive belt or not. With the drive belt removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

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

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

Drive Belt Rumbling Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>BELT DRESSING NOTICE</u> .			
DEFINITION: <ul style="list-style-type: none"> • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley(s). • Rumbling may be caused from: <ul style="list-style-type: none"> ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt 			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary		Go to <u>Symptoms -</u>

	inspections?	Go to Step 2	Engine Mechanical
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt(s). Refer to <u>Drive Belt Replacement</u> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to <u>Engine Noise on Start-Up, but Only Lasting a Few Seconds</u>	Go to Step 4
4	Inspect the drive belt for damage, separation, or sections of missing ribs. Were any of these conditions found?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt groove depth. Do the drive belt grooves have pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Install the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 8	-
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 8	-
8	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the rumbling noise still exist?	-	System OK

DRIVE BELT VIBRATION DIAGNOSIS

Diagnostic Aids

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

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

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

3: This test is to verify that the drive belt or accessory drive components may be causing the vibration.

Remove the drive belt and operate the engine for a few seconds, this will verify if the vibration is related to the drive belt or not. With the drive belt removed the water pump will not operate and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operated with the drive belt removed.

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

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

8: This step should only be performed if the fan is driven by the drive belt. Inspect the engine cooling fan for bent, twisted, loose, or cracked blades. Inspect the fan clutch for smooth operation. Inspect for a bent fan shaft or bent mounting flange.

9: Inspect the water pump drive 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.

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

Drive Belt Vibration Diagnosis

Step	Action	Yes	No
NOTE: Refer to <u>BELT DRESSING NOTICE</u> .			
DEFINITION: The following items are indications of drive belt vibration: <ul style="list-style-type: none"> • The vibration is engine-speed related. • The vibration may be sensitive to accessory load. 			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <u>Drive Belt Replacement</u> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Go to <u>DIAGNOSTIC STARTING POINT - VIBRATION DIAGNOSIS AND CORRECTIONS</u> .	Go to Step 4
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Were any of these conditions found?	Go to Step 5	Go to Step 6
5	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 11	-
6	Inspect for incorrect, loose and/or missing fasteners.		

	Were any of these conditions found?	Go to Step 7	Go to Step 8
7	Replace any incorrect and/or missing fastener. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . Were the fasteners replaced and/or tightened?	Go to Step 11	-
8	Inspect for damaged fan blades or a bent fan clutch shaft. Did you find and correct the condition?	Go to Step 11	Go to Step 9
9	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to Step 11	Go to Step 10
10	Inspect for bent or cracked accessory drive bracket(s). Did you find and correct the condition?	Go to Step 11	-
11	1. Clear any codes. 2. Run the engine in order to verify the repair. Does the vibration still exist?	-	System OK

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

If the drive belt repeatedly falls off the accessory drive belt pulley(s), this may be caused by a pulley misalignment.

An extra load that is quickly applied or released by an accessory drive component may also cause the drive belt to fall off. Verify that the accessory drive component(s) are operating properly.

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

Test Description

The number(s) below refer to the step(s) on the diagnostic table.

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

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

5: Inspection of the accessory drive pulley(s) should include inspecting for bends, dents or other damage to the pulleys that would prevent the drive belt from seating properly in the pulley grooves or on the smooth surface of a pulley when the back side of the drive belt is used to drive the pulley.

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

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

Drive Belt Falls Off Diagnosis

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.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect for a damaged drive belt. Was a damaged drive belt found?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misaligned accessory drive pulley. Did you find and correct the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented accessory drive pulley. Did you find and correct the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked accessory drive bracket (s). Did you find and correct the condition?	Go to Step 12	Go to Step 7
7	Inspect for incorrect, loose and/or missing fasteners. Were there any incorrect, loose and/or missing fasteners?	Go to Step 8	Go to Step 9
8	1. Replace any incorrect and/or missing fasteners. 2. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for correct operation. 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</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for a failed drive belt idler and/or tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	-

12	Run the engine in order to verify the repair. Does the drive belt still fall off?	-	System OK
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DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

Minor misalignment of the accessory drive belt pulley(s) will not cause excessive wear, but will probably cause the drive belt to make a noise or fall off.

Excessive misalignment of the accessory drive pulley(s) will cause excessive wear and may also make the drive belt fall off.

Test Description

The number(s) below refer to the step(s) in the diagnostic table.

2: This inspection is to verify that the drive belt is correctly installed on all of the accessory drive pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley(s).

3: 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 the pulleys.

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

Drive Belt Excessive Wear Diagnosis

Step	Action	Yes	No
NOTE: Refer to BELT DRESSING NOTICE .			
DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Symptoms - Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Inspect the drive belt(s) for proper installation. Is the drive belt installed properly?	Go to Step 5	Go to Step 3
3	Inspect for the correct drive belt. Is the correct drive belt installed?	Go to Step 5	Go to Step 4
4	Inspect the drive belt for signs of rubbing against a bracket, hose, or wiring harness. Was the drive belt rubbing against anything?	Go to Step 5	Go to Diagnostic Aids

5	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 6	-
6	Run the engine in order to verify the repair. Is there still excessive drive belt wear?	-	System OK

DRIVE BELT TENSIONER DIAGNOSIS

Inspection Procedure

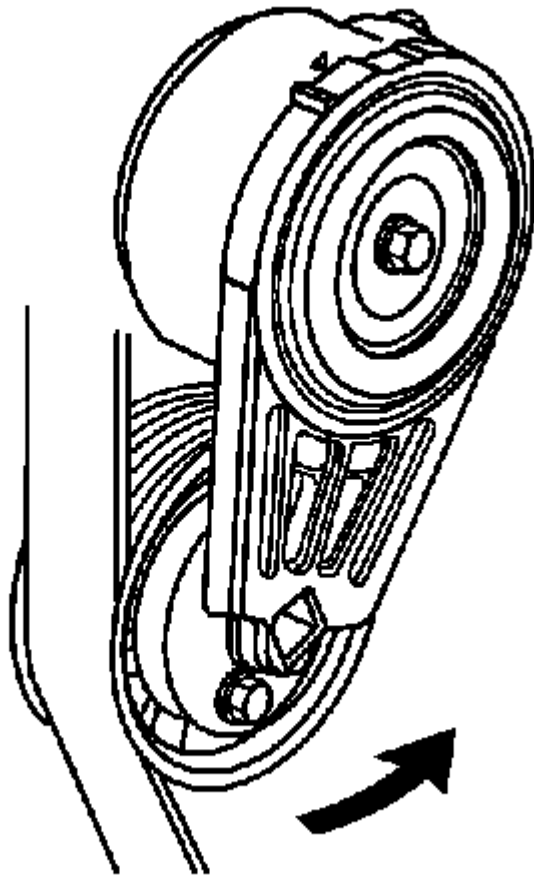


Fig. 1: Releasing Drive Belt Tension

Courtesy of GENERAL MOTORS CORP.

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

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

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Move the drive belt tensioner through it's full travel.
 - The movement should feel smooth
 - There should be no binding
 - The tensioner should return freely
3. If any binding is observed, replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
4. Install the drive belt. Refer to **Drive Belt Replacement**.

REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT

Removal Procedure

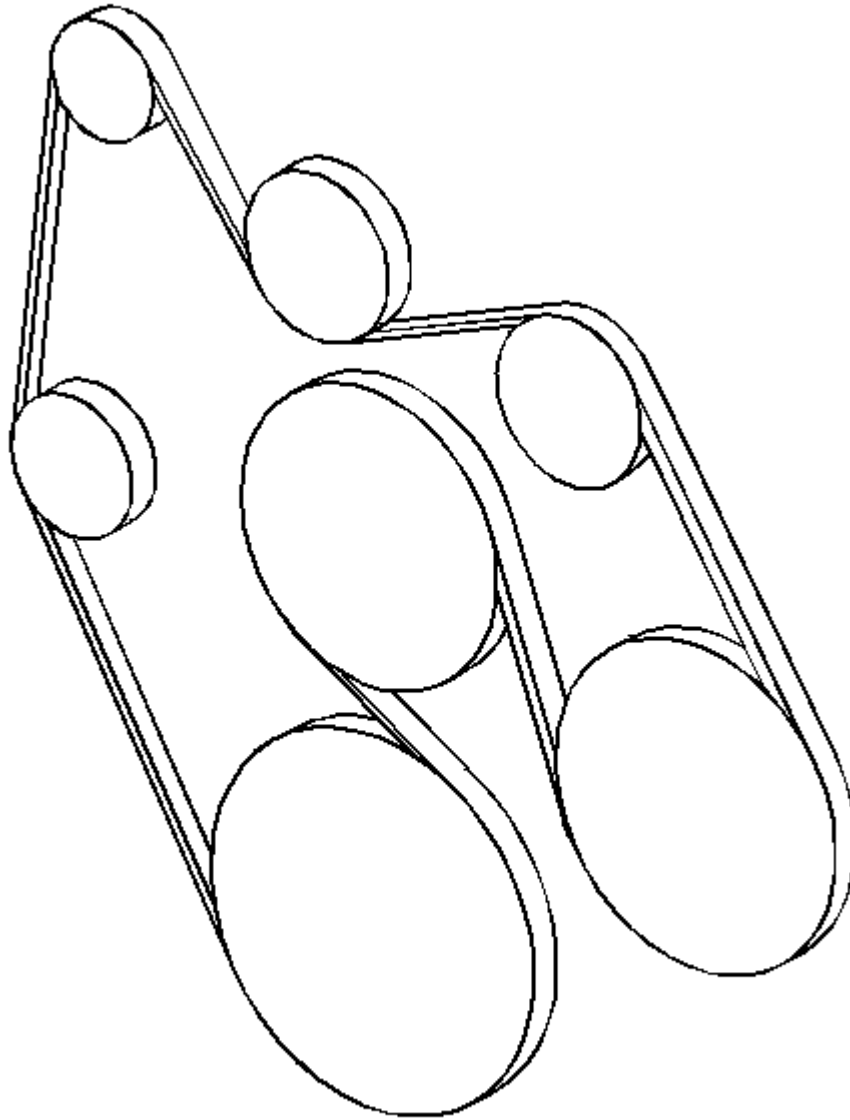


Fig. 2: View Of Drive Belt Routing (W/Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Install a 3/8 inch drive breaker bar to the drive belt tensioner arm.
2. Rotate the drive belt tensioner counterclockwise in order to relieve tension on the belt.
3. If equipped without air conditioning (A/C), remove the belt from the pulleys and the drive belt tensioner.

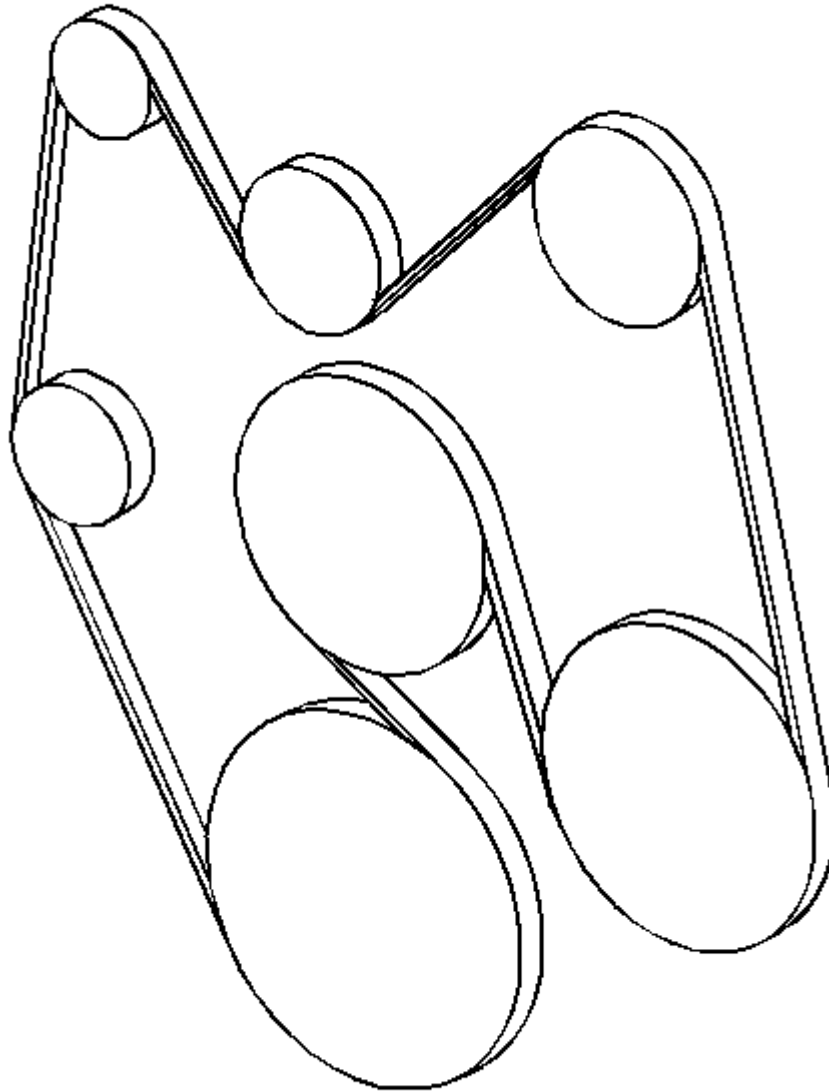


Fig. 3: View Of Drive Belt Routing (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

4. If equipped with A/C, remove the belt from the pulleys and the drive belt tensioner.
5. Slowly release the tension on the drive belt tensioner.
6. Remove the breaker bar from the drive belt tensioner.
7. Clean and inspect the belt surfaces of all the pulleys.

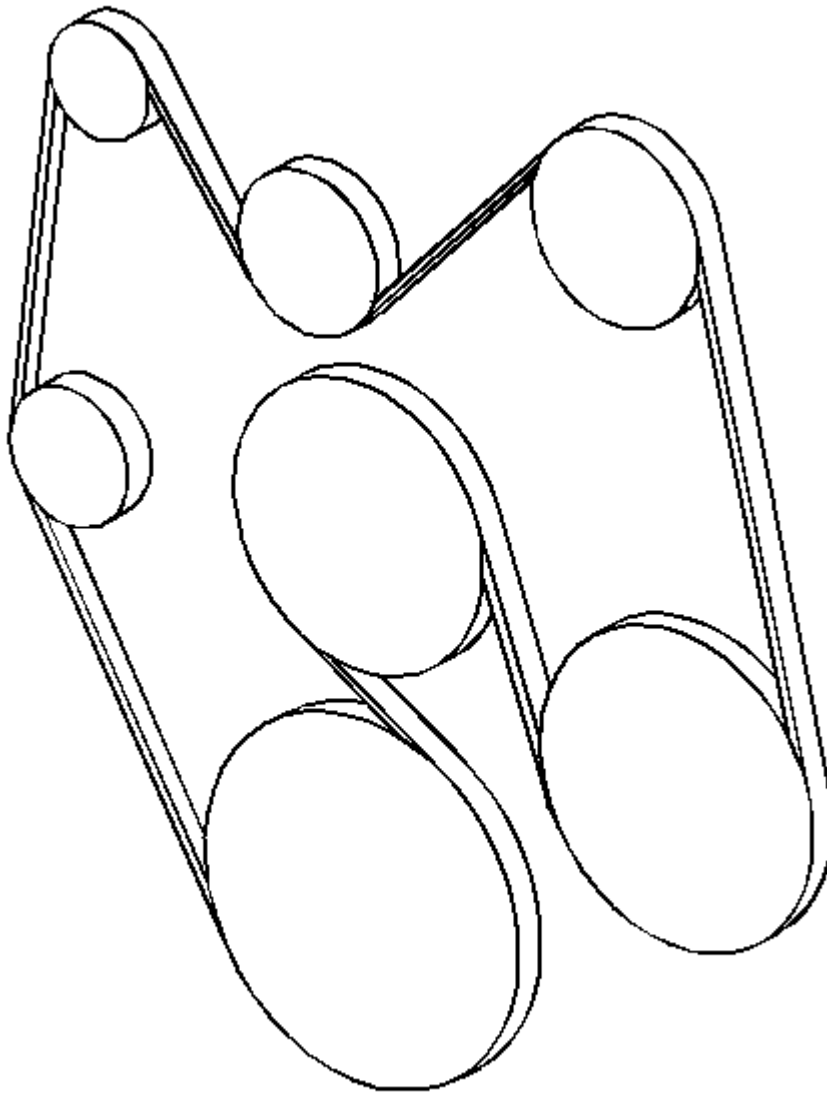
Installation Procedure

Fig. 4: View Of Drive Belt Routing (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Route the belt around all the pulleys except the flat idler pulley.
2. Install a 3/8 inch drive breaker bar to the drive belt tensioner arm.
3. Rotate the belt tensioner counterclockwise in order to relieve the tension on the tensioner.

4. If equipped with A/C, install the belt under the flat idler pulley.

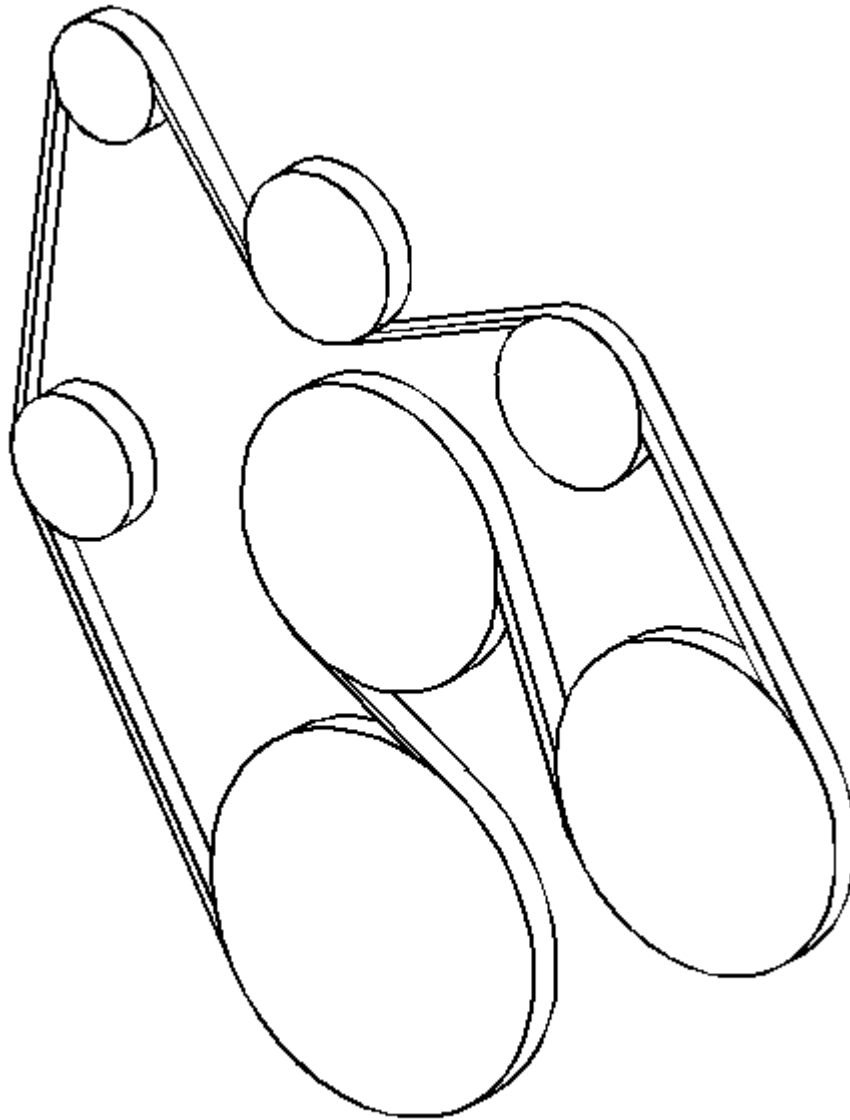


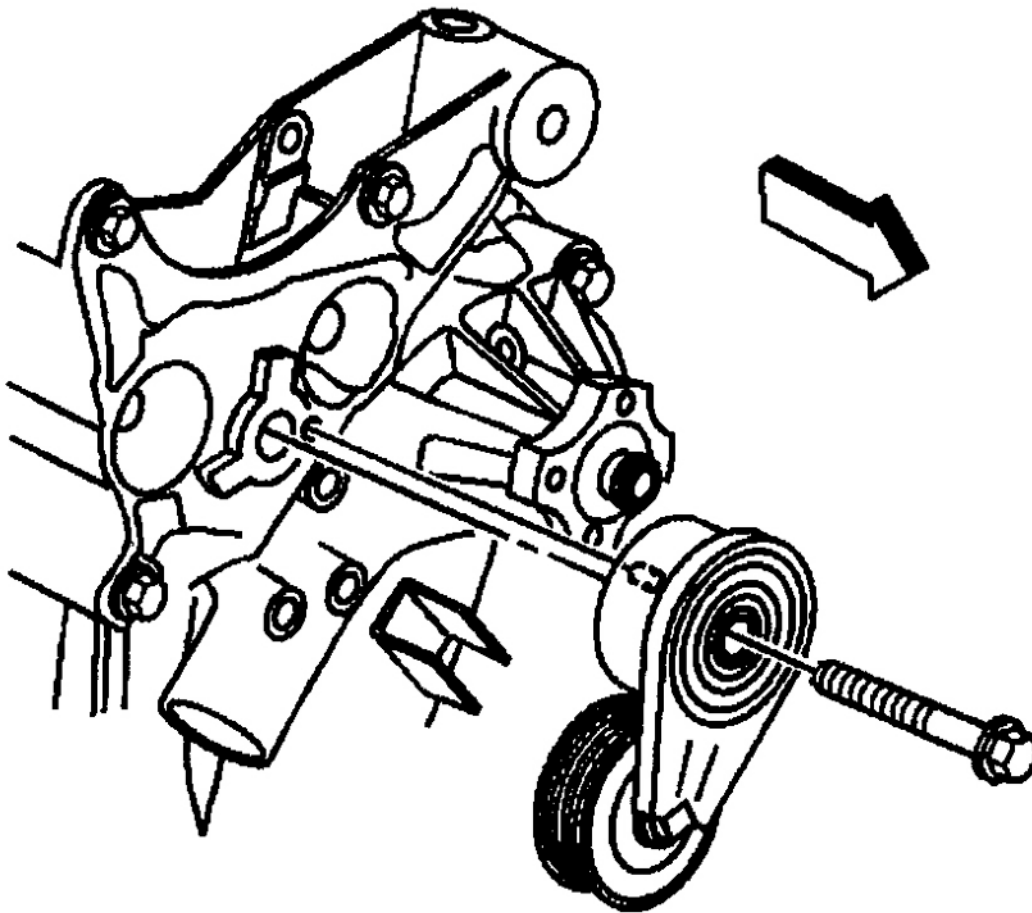
Fig. 5: View Of Drive Belt Routing (W/Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

5. If equipped without A/C, remove the belt from the pulleys and the drive belt tensioner.
6. Slowly release the tension on the belt tensioner.

7. Remove the breaker bar from the drive belt tensioner.
8. Inspect the drive belt for proper installation and alignment.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

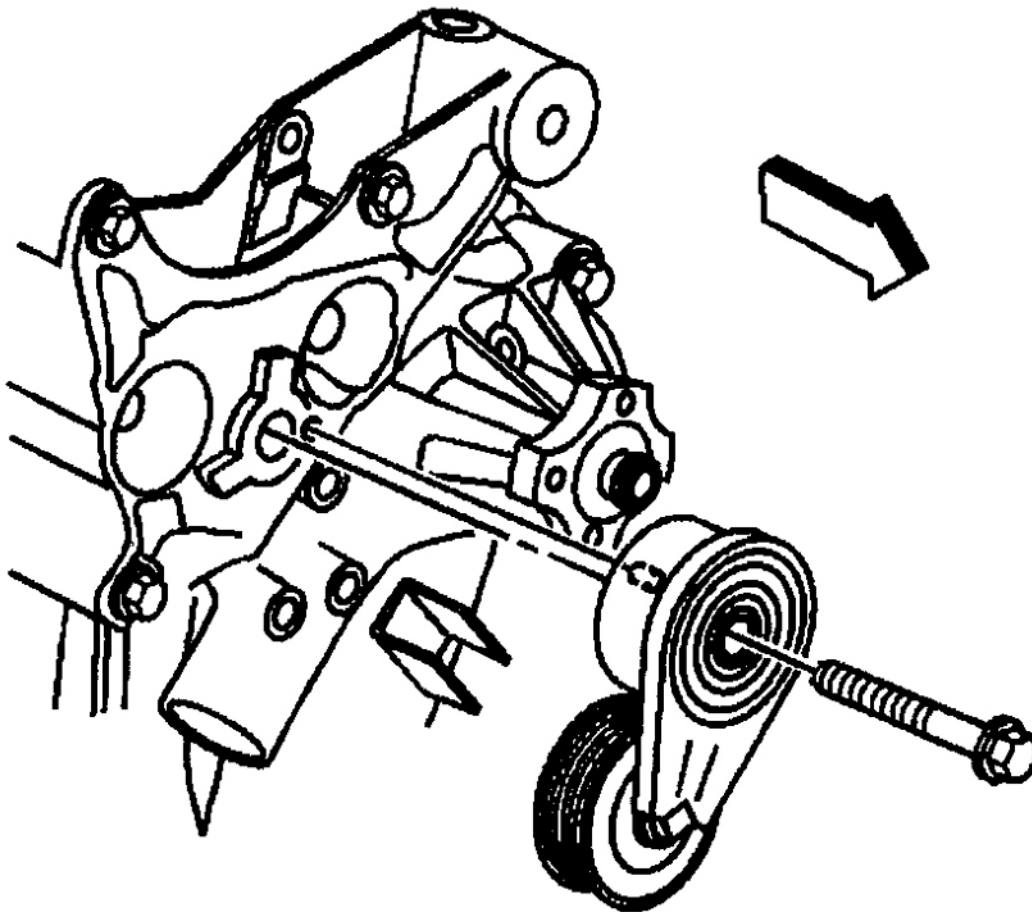


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Fig. 6: View Of Drive Belt Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to Drive Belt Replacement.
2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure



G01654393

Fig. 7: View Of Drive Belt Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to in **FASTENER NOTICE** .

1. Install the drive belt tensioner. Position the locating pin on the tensioner into the hole in the generator bracket.
2. Install the drive belt tensioner bolt.

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

3. Install the drive belt. Refer to **Drive Belt Replacement**.

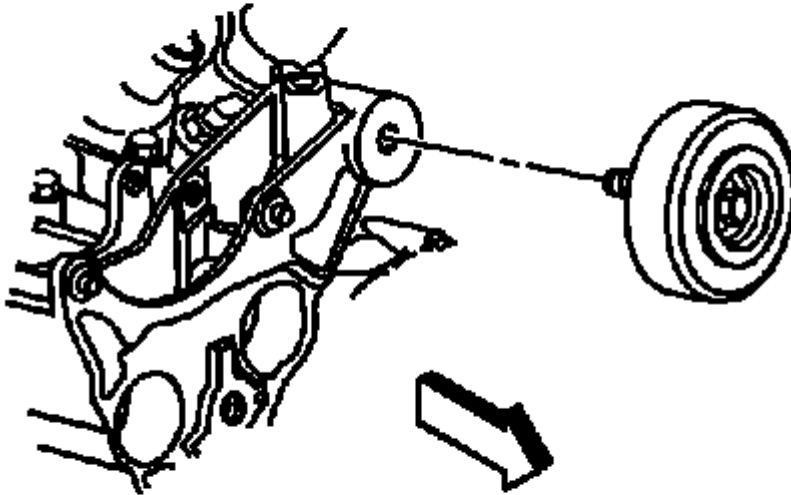
DRIVE BELT IDLER PULLEY REPLACEMENT - RIGHT**Removal Procedure**

Fig. 8: View Of Right Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Loosen the drive belt idler pulley bolt.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the drive belt idler pulley.

Installation Procedure

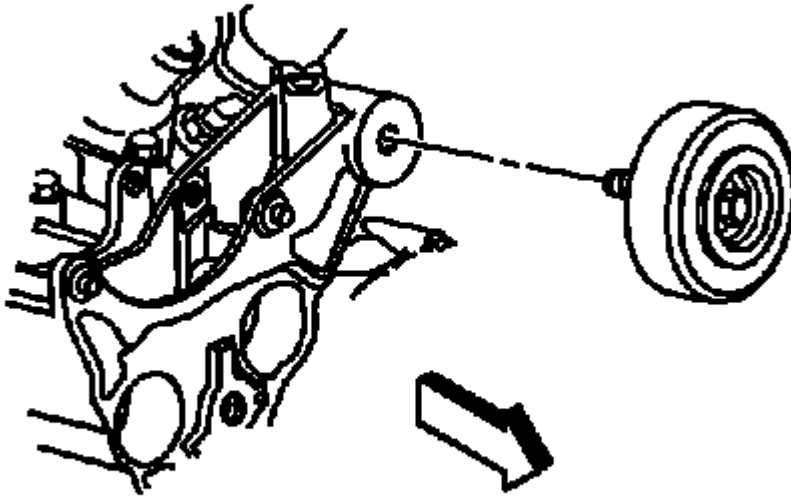


Fig. 9: View Of Right Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.
2. Install the drive belt idler pulley bolt until snug.
3. Install the drive belt. Refer to **Drive Belt Replacement**.

NOTE: Refer to **FASTENER NOTICE** .

4. Tighten the drive belt idler pulley bolt.

Tighten: Tighten the drive belt idler pulley bolt to 50 N.m (37 lb ft).

DRIVE BELT IDLER PULLEY REPLACEMENT - WITHOUT AIR CONDITIONING

Removal Procedure

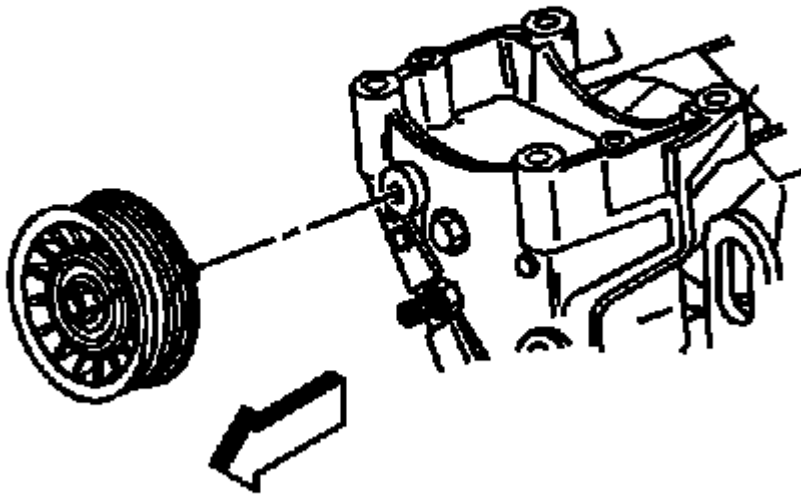


Fig. 10: View Of Drive Belt Idler Pulley (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Loosen the drive belt idler pulley bolt.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the drive belt idler pulley.

Installation Procedure

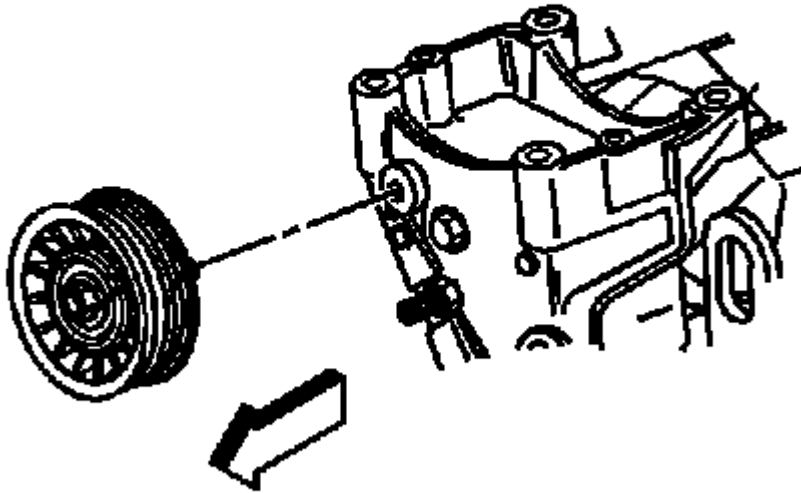


Fig. 11: View Of Drive Belt Idler Pulley (W/O Air Conditioning)
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt idler pulley.
2. Install the drive belt idler pulley bolt until snug.
3. Install the drive belt. Refer to **Drive Belt Replacement**.

NOTE: Refer to **FASTENER NOTICE** .

4. Tighten the drive belt idler pulley bolt.

Tighten: Tighten the drive belt idler pulley bolt to 50 N.m (37 lb ft).

ENGINE MOUNT INSPECTION

NOTE: Refer to Engine Mounting Notice in Cautions and Notices.

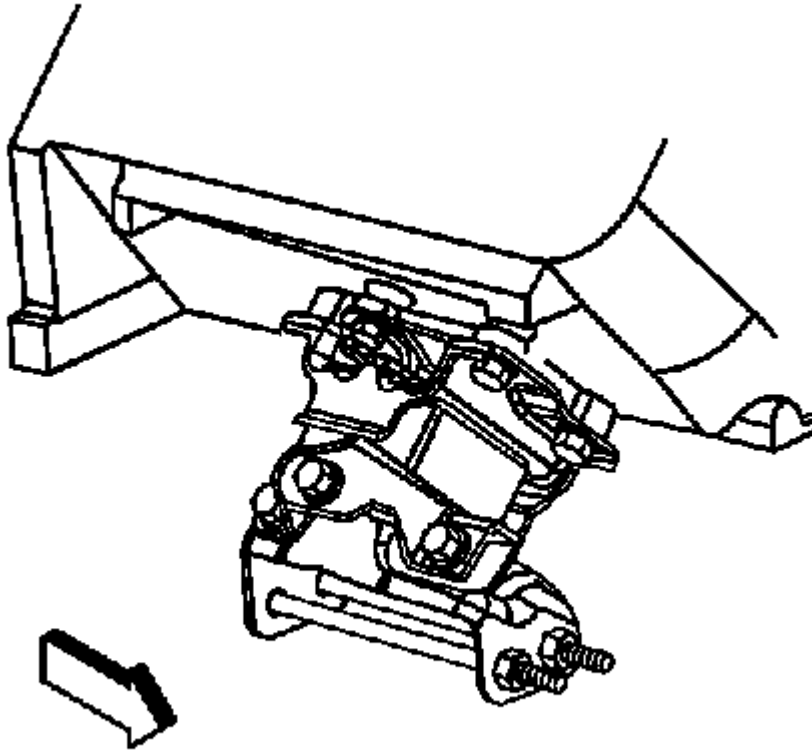


Fig. 12: Inspecting Engine Mount
Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
2. Inspect for loose or missing bolts at the following locations:
 - Engine mount bracket to engine
 - Engine mount frame bracket to frame
 - Engine mount to engine mount bracket
 - Engine mount to engine mount frame bracket
3. Replace missing or loose bolts.

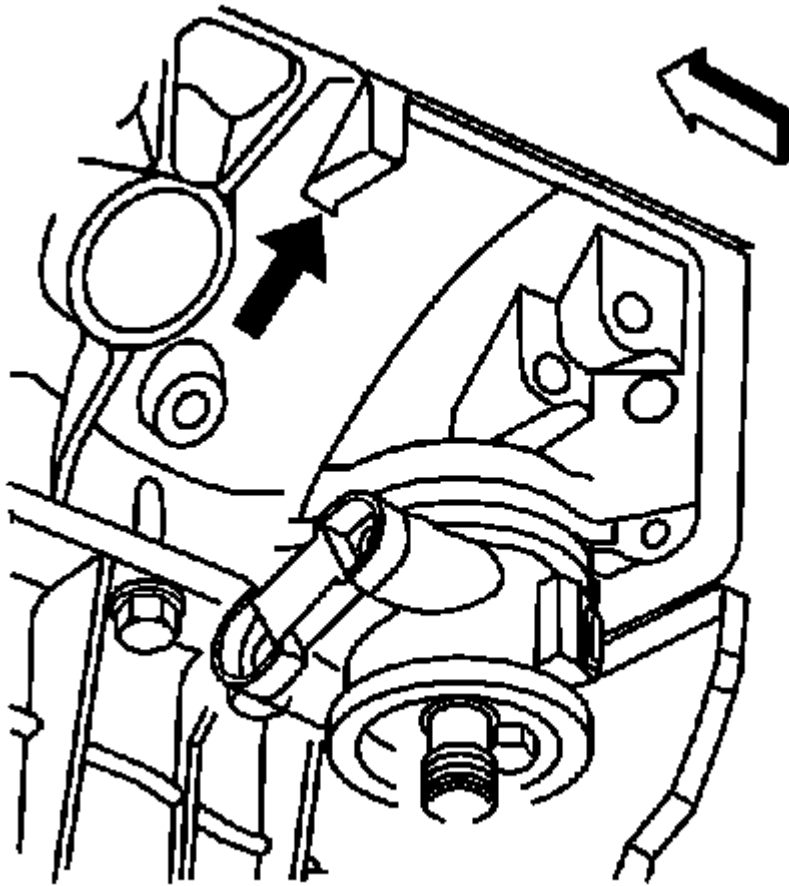


Fig. 13: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Engine Lifting Notice in Cautions and Notices.

4. In order to access the square tab on the right side of the engine remove the starter. Refer to **STARTER** .
5. Using a jack on the square tab at the rear of the engine block (left side shown) raise the engine in order to complete the following tasks:
 - Remove weight from the engine mount.
 - Place a slight tension on the rubber cushion.
 - Observe the engine mount while raising the engine.
6. Replace the engine mount if the following conditions exist:
 - Heat check cracks cover the hard rubber surface.
 - The rubber cushion is separated from the metal plate of the engine mount.
 - There is a split through the rubber cushion.
7. Install the starter, if removed. Refer to **STARTER** .

ENGINE MOUNT REPLACEMENT - LEFT

NOTE: Refer to ENGINE MOUNTING NOTICE in Cautions and Notices.

Removal Procedure

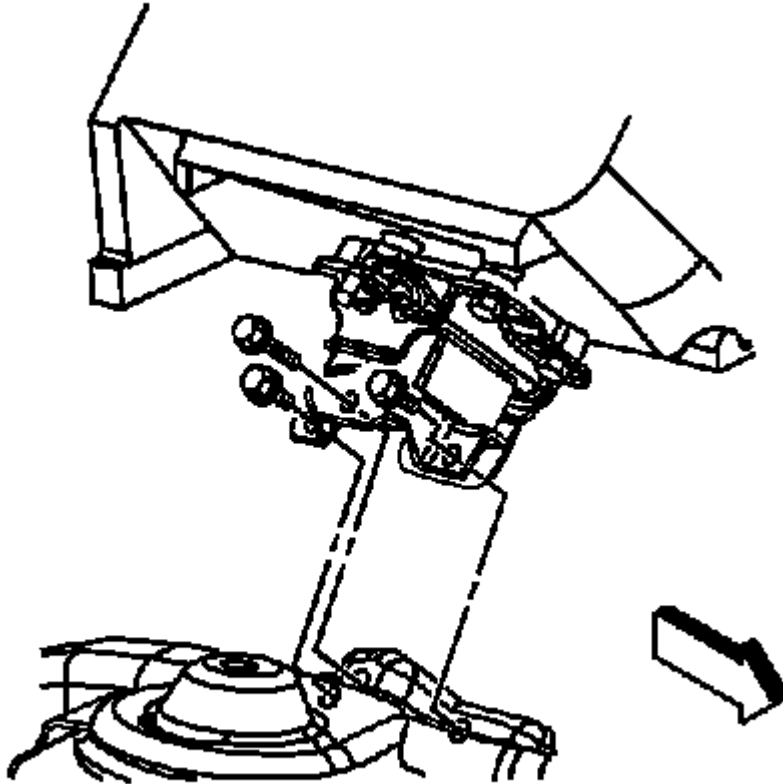


Fig. 14: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. From under the hood, remove the engine mount to engine mount bracket bolts (right side shown, left side similar).

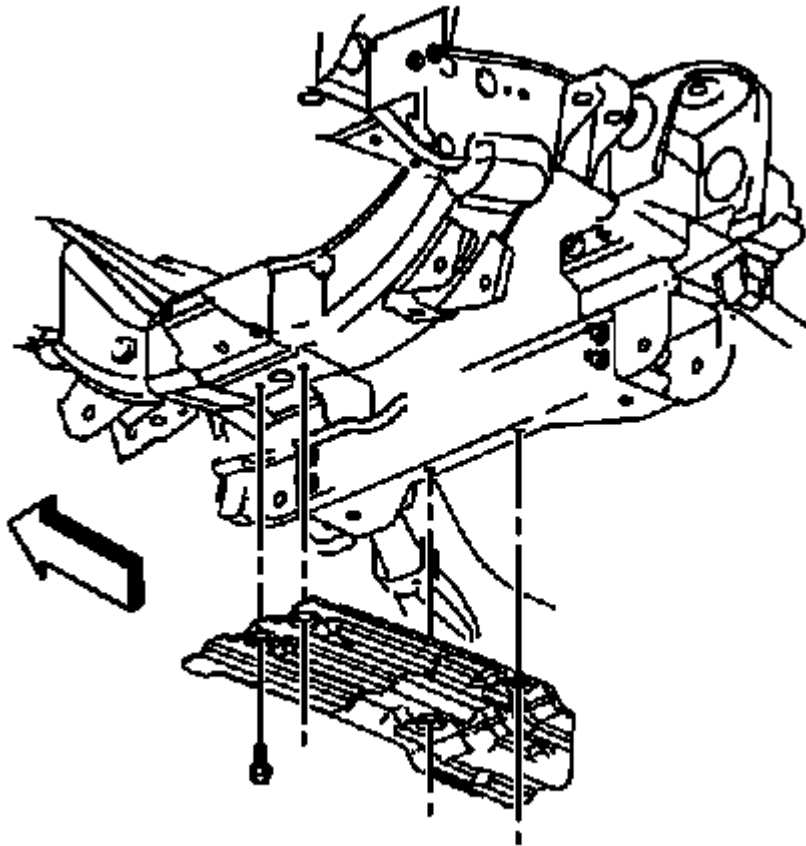


Fig. 15: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

2. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
3. Remove the oil pan skid plate bolts and plate.

NOTE: Refer to Engine Lifting Notice in Cautions and Notices.

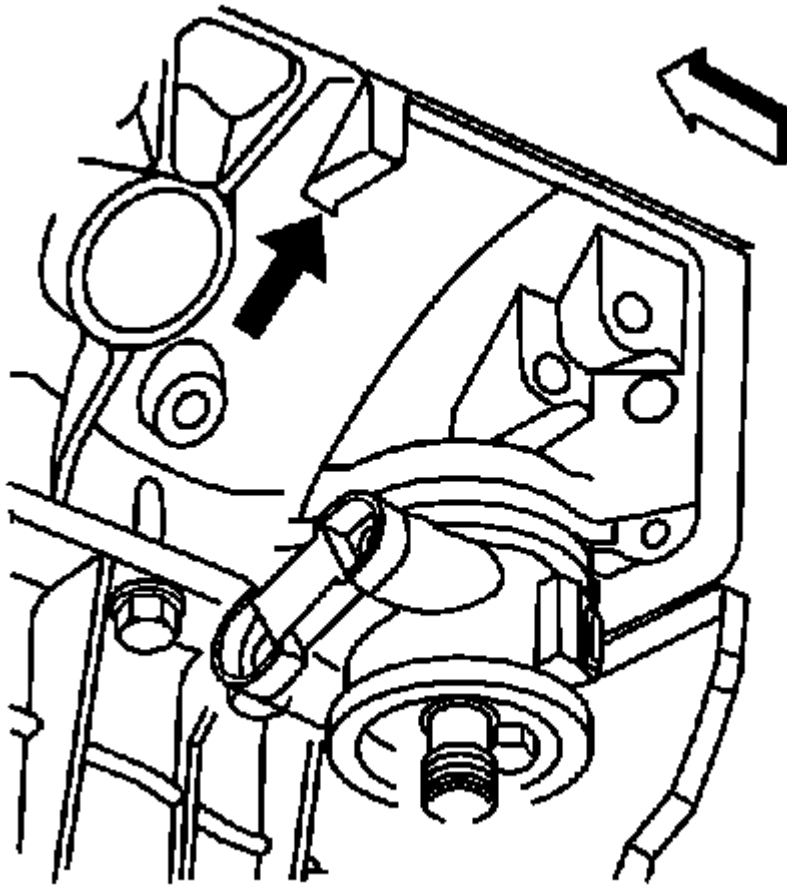


Fig. 16: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Using an adjustable jack on the square tab at the rear of the engine block, raise the engine.

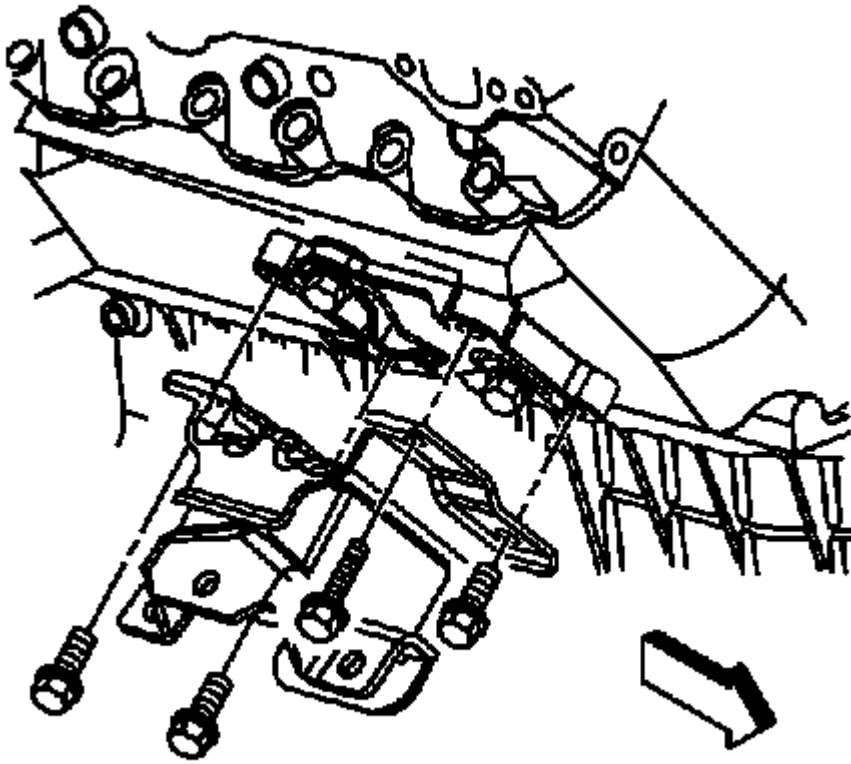


Fig. 17: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount bolts (right side shown, left side similar).
6. Remove the engine mount.

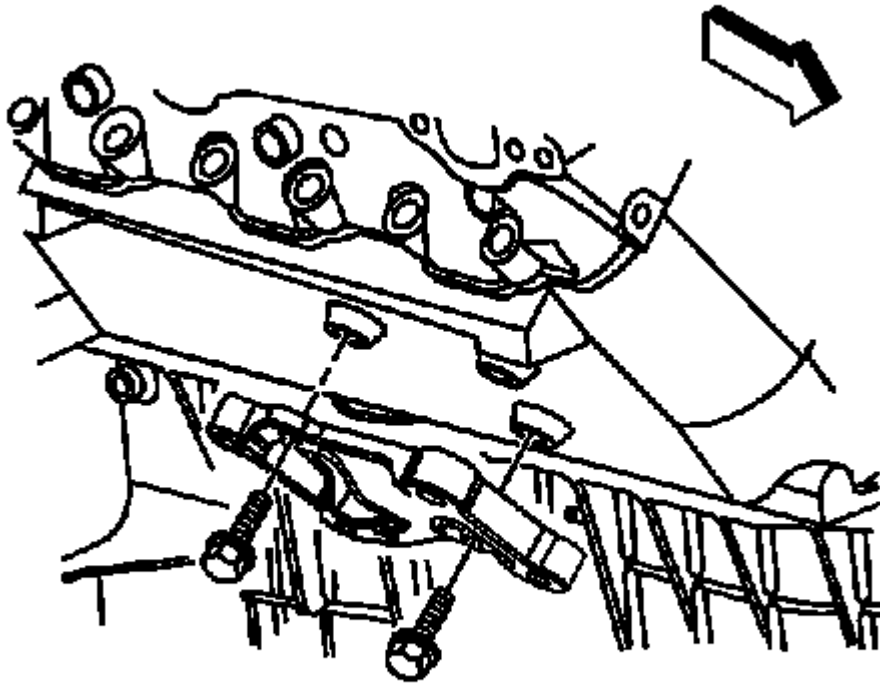


Fig. 18: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. If equipped and necessary, remove the engine mount side bracket bolts and bracket (right side shown, left side similar).

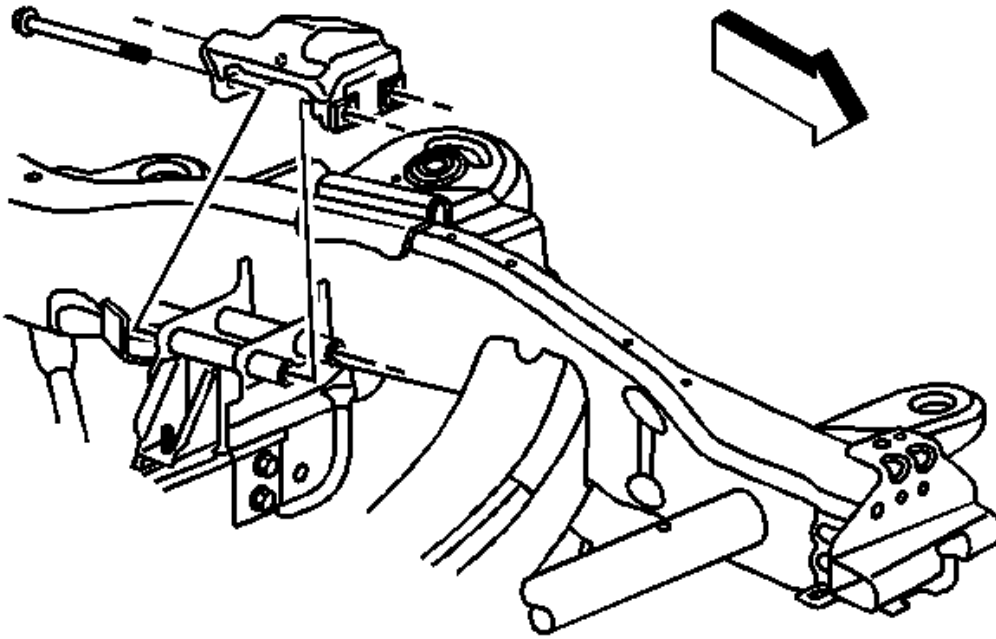


Fig. 19: View Of Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine mount bracket bolts.
9. Remove the engine mount bracket.

Installation Procedure

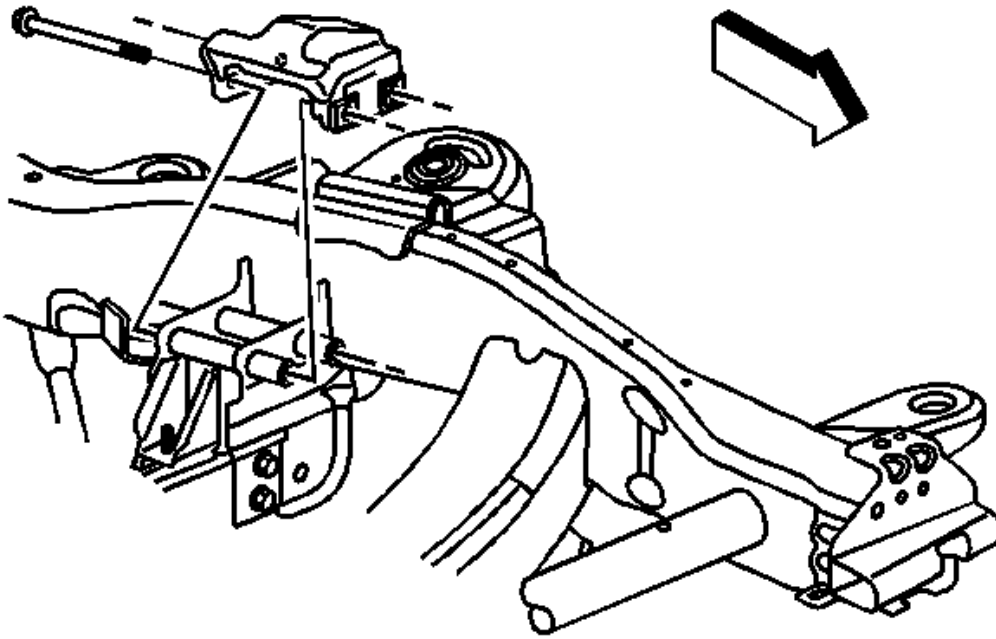


Fig. 20: View Of Left Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket.
2. Perform the following procedure prior to installing the engine mount bracket bolts.
 - Remove all traces of the original adhesive patch.
 - Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to **FASTENER NOTICE** .

3. Install the engine mount bracket bolts.

Tighten: Tighten the engine mount bracket bolts to 75 N.m (55 lb ft).

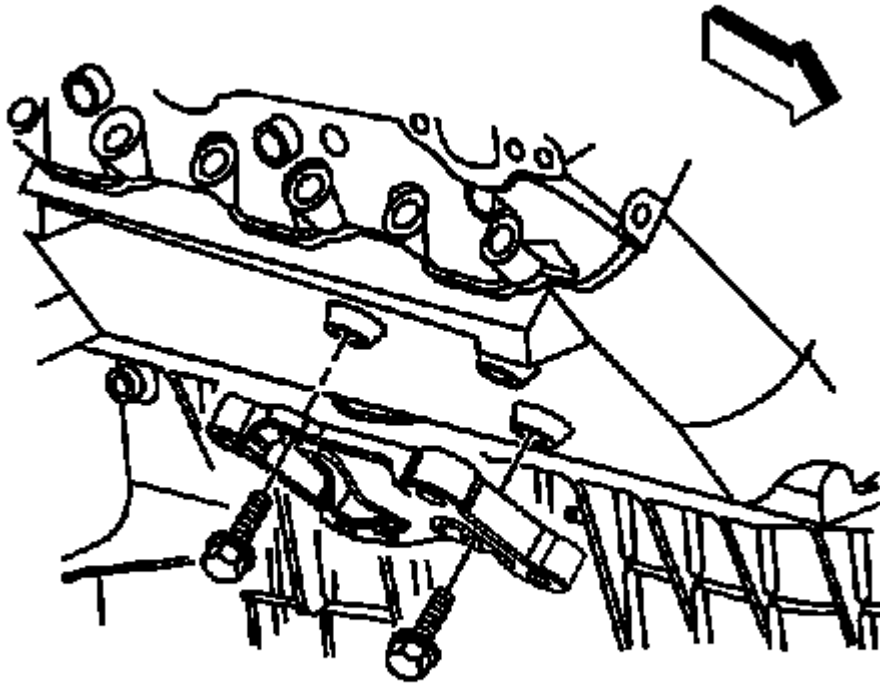


Fig. 21: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Position the engine mount side bracket to the engine, if removed and equipped (right side shown, left side similar).
5. Install the engine mount side bracket bolts.

Tighten: Tighten the engine mount side bracket bolts to 50 N.m (37 lb ft).

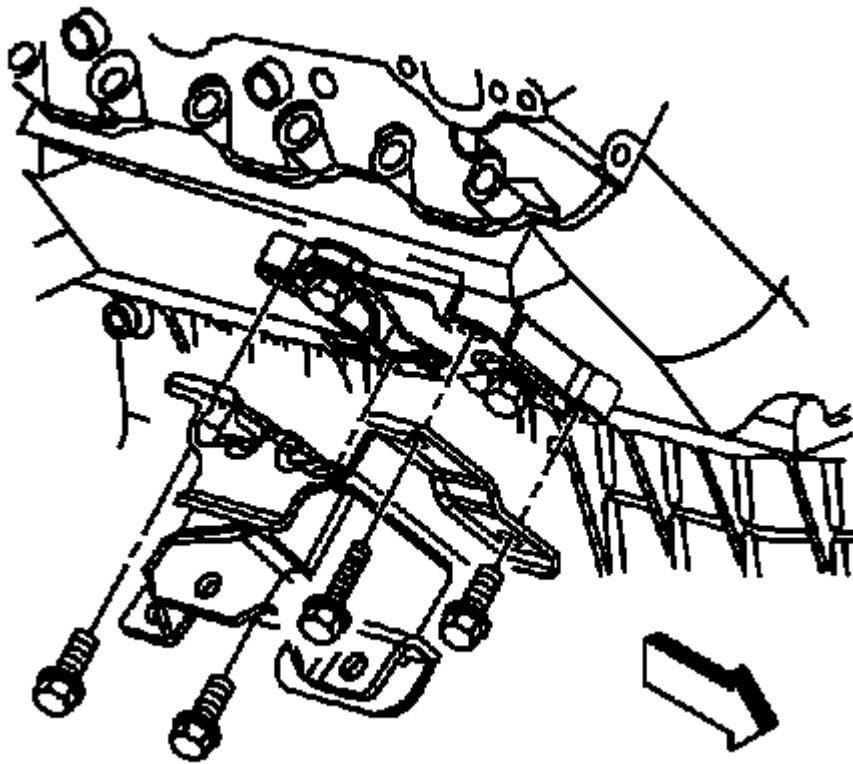


Fig. 22: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount (right side shown, left side similar).
7. Install the engine mount bolts.

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

8. Lower the engine.

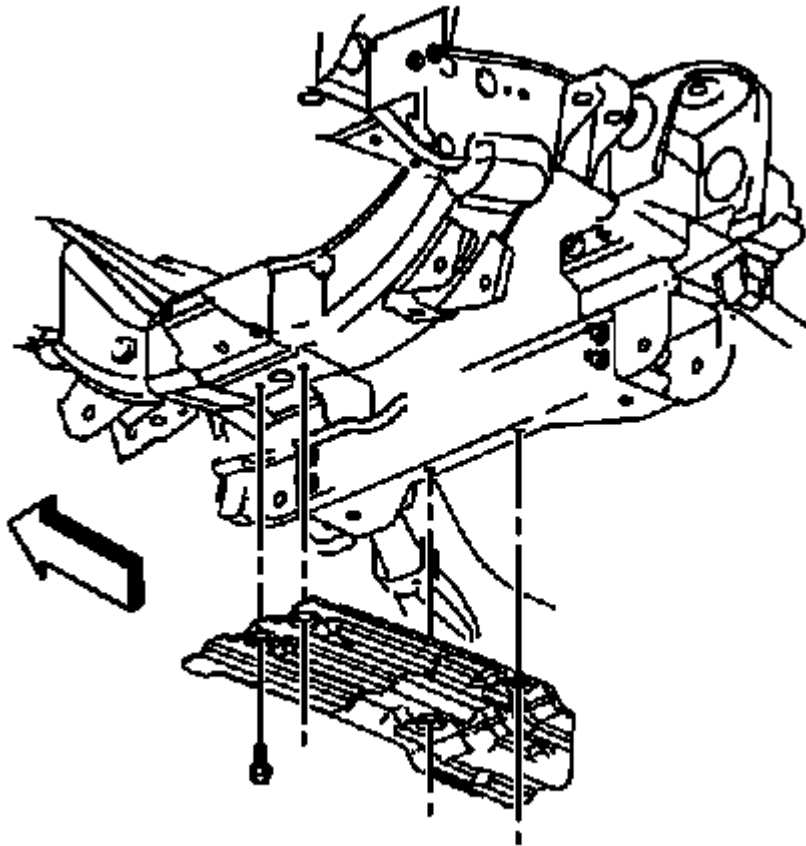


Fig. 23: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

9. Install the oil pan skid plate and bolts.

Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

10. Lower the vehicle.

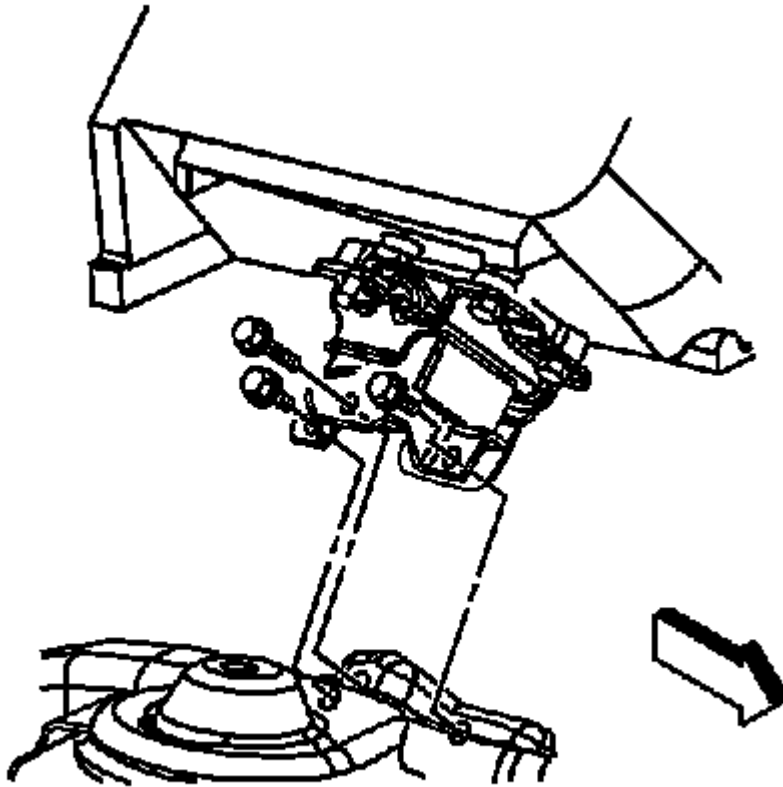


Fig. 24: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the engine mount to engine mount bracket bolts (right side shown, left side similar).

Tighten: Tighten the engine mount to engine mount bracket bolts to 65 N.m (48 lb ft).

ENGINE MOUNT REPLACEMENT - RIGHT

Removal Procedure

NOTE: Refer to ENGINE MOUNTING NOTICE in Cautions and Notices.

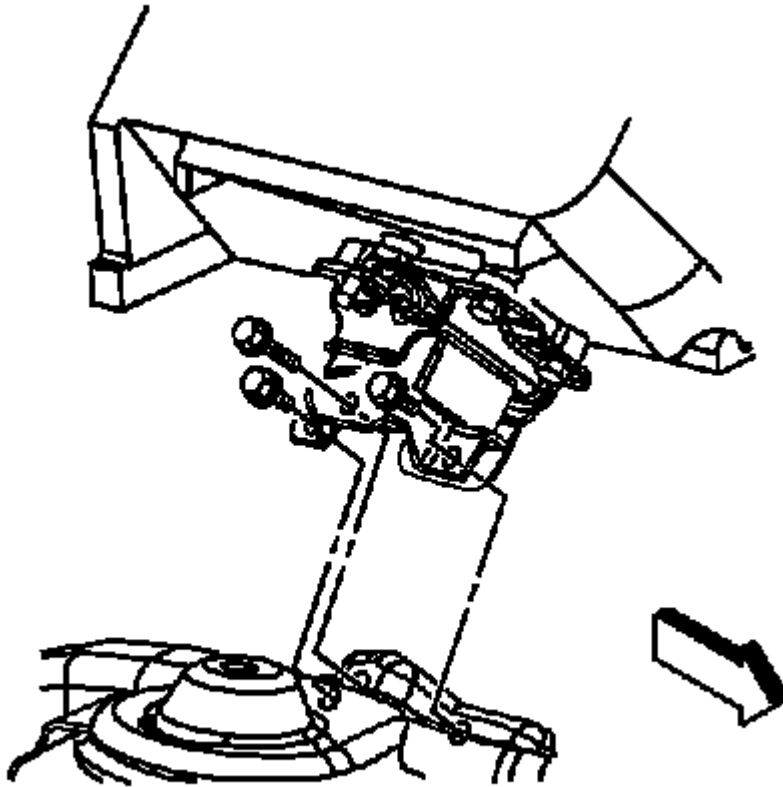


Fig. 25: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. From under the hood, remove the engine mount to engine mount bracket bolts (left side shown, right side similar).

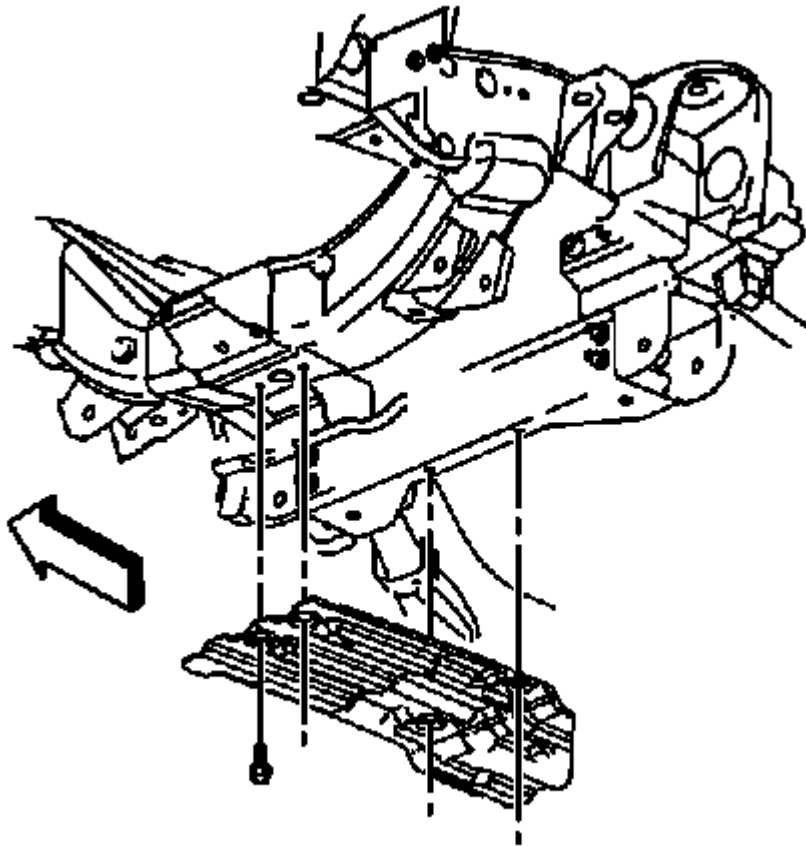


Fig. 26: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

2. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
3. Remove the oil pan skid plate bolts and plate.

NOTE: Refer to Engine Lifting Notice in Cautions and Notices.

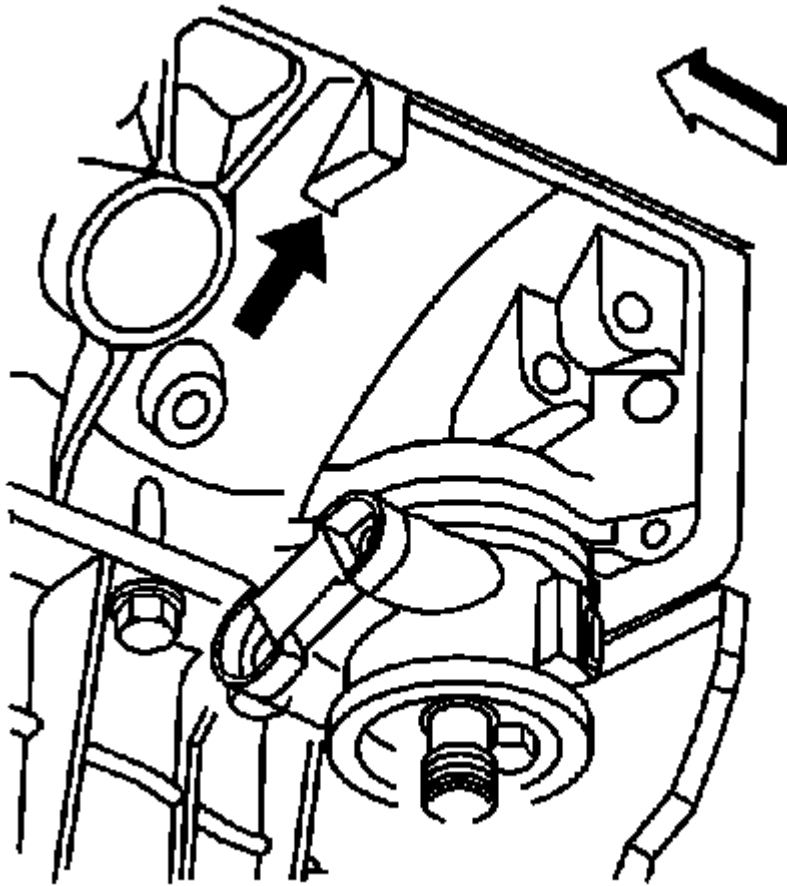


Fig. 27: View Of Square Tab At Rear Of Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Using an adjustable jack on the square tab (left side shown) at the rear of the engine block, raise the engine. In order to access the square tab, remove the starter (left side shown, right side similar). Refer to **STARTER**.

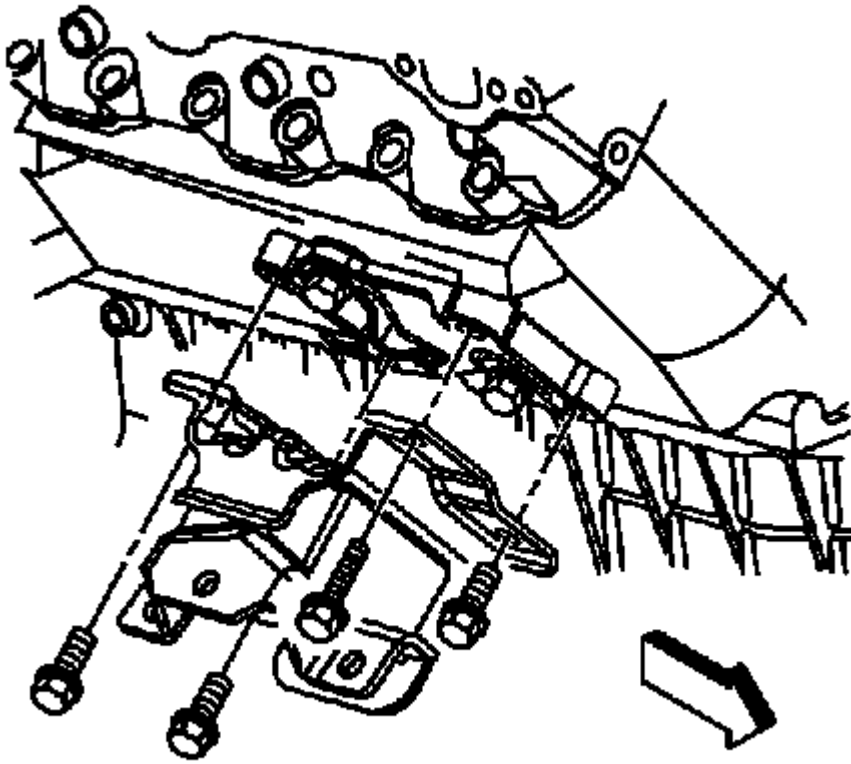


Fig. 28: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine mount bolts.
6. Remove the engine mount.

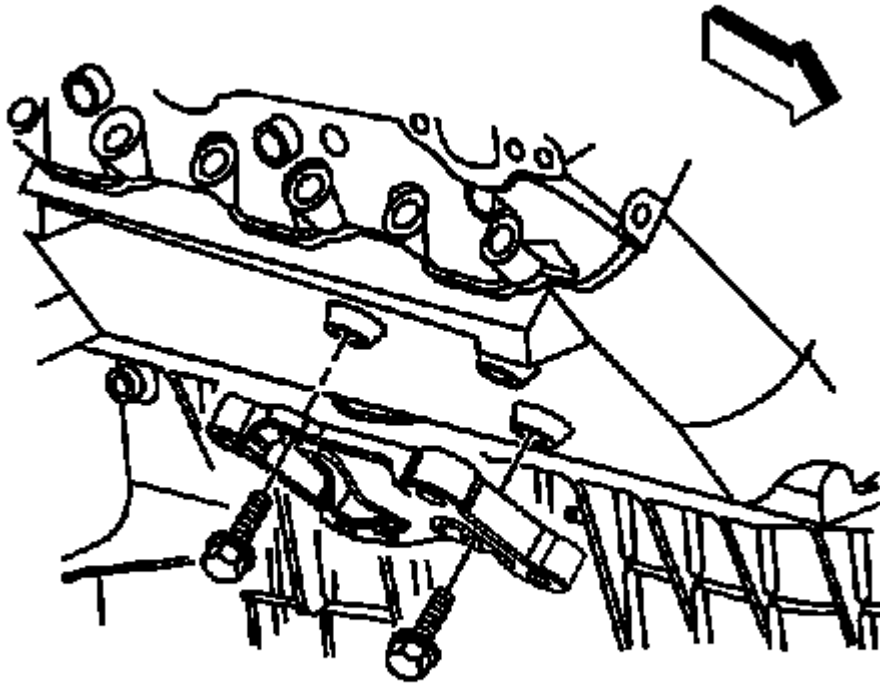


Fig. 29: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. If necessary, remove the engine mount side bracket bolts and bracket.

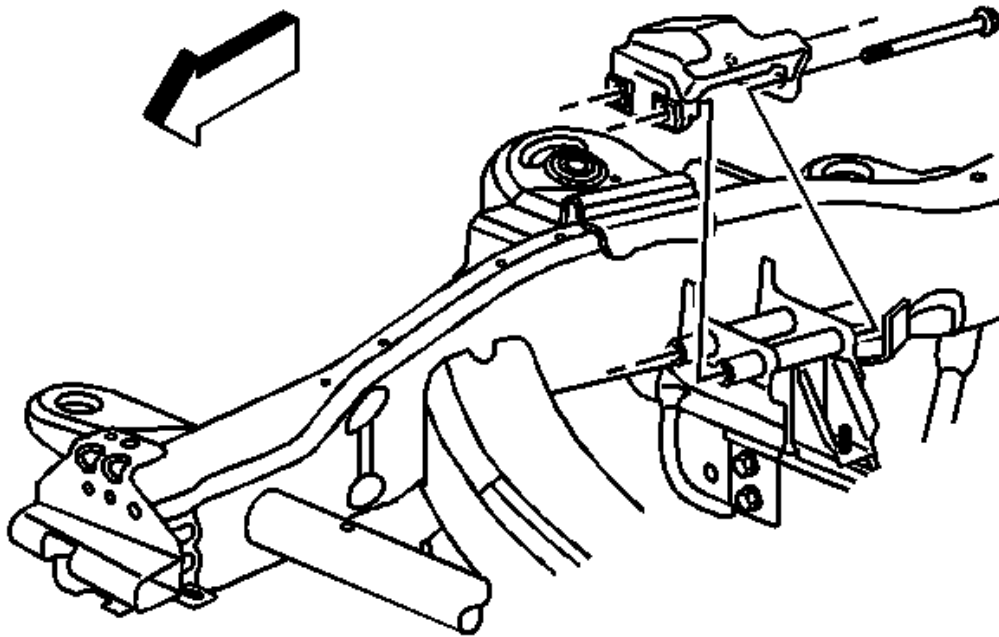


Fig. 30: View Of Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine mount bracket bolts.
9. Remove the engine mount bracket.

Installation Procedure

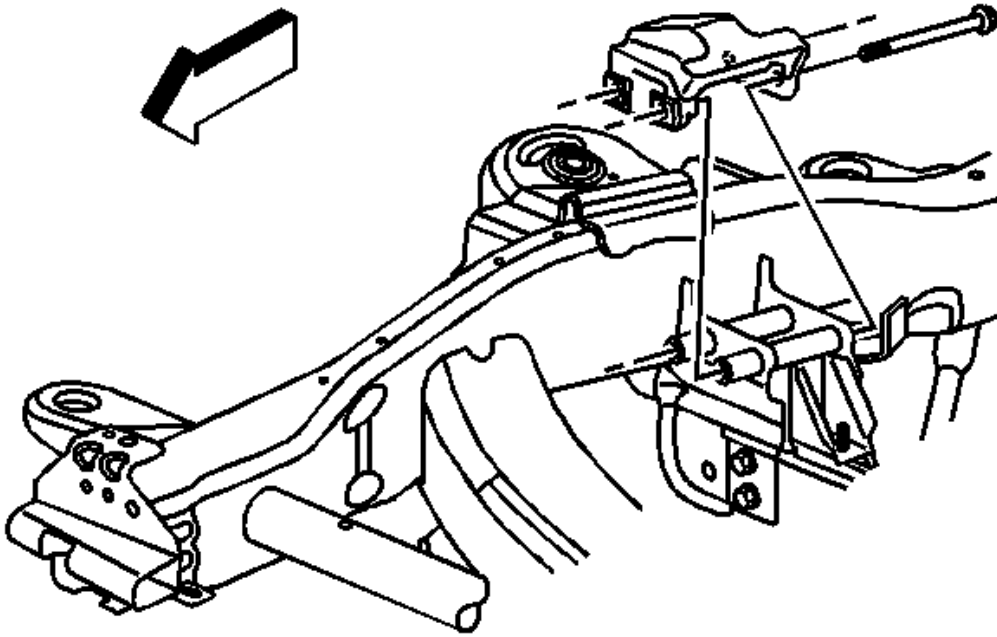


Fig. 31: View Of Right Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine mount bracket.
2. Perform the following procedure prior to installing the engine mount bracket bolts.
 - Remove all traces of the original adhesive patch.
 - Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to **FASTENER NOTICE** .

3. Install the engine mount bracket bolts.

Tighten: Tighten the engine mount bracket bolts to 75 N.m (55 lb ft).

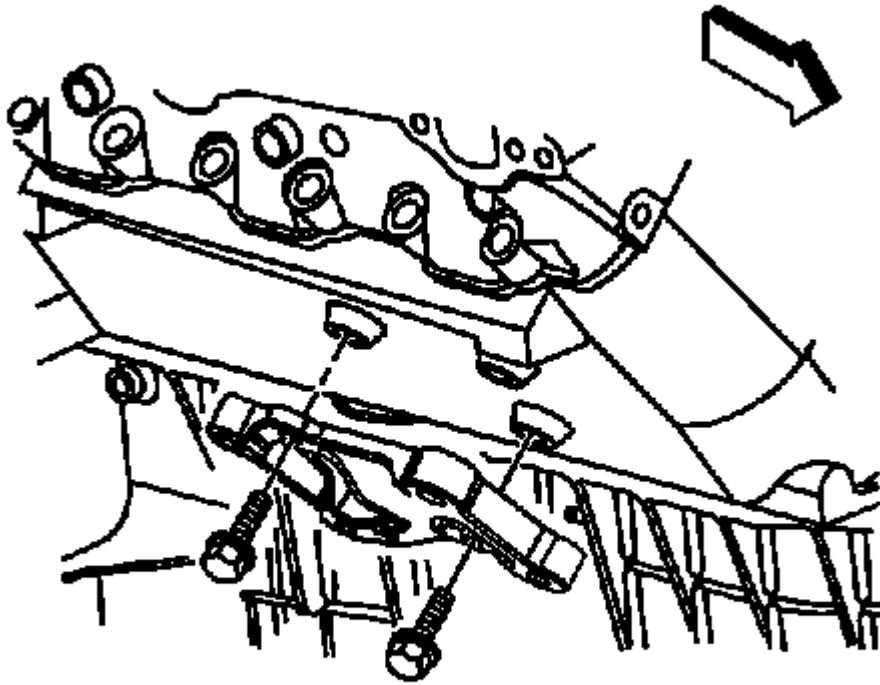


Fig. 32: View Of Right Side (Left Side Similar) Engine Mount Side Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Position the engine mount side bracket to the engine, if removed.
5. Install the engine mount side bracket bolts.

Tighten: Tighten the engine mount side bracket bolts to 50 N.m (37 lb ft).

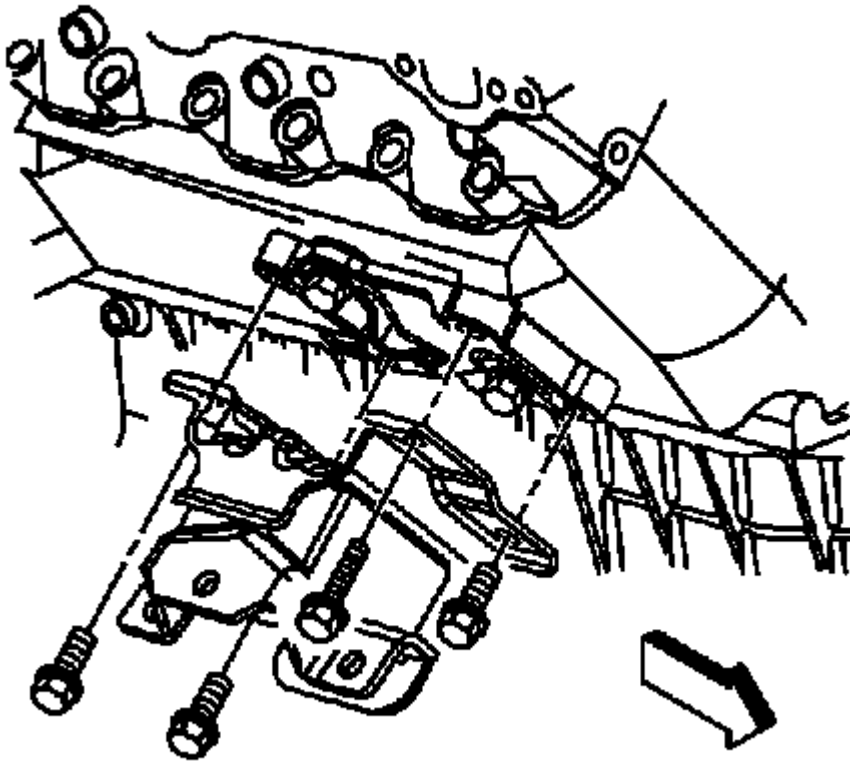


Fig. 33: View Of Right Side (Left Side Similar) Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount.
7. Install the engine mount bolts.

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

8. Lower the engine.
9. Install the starter. Refer to **STARTER** .

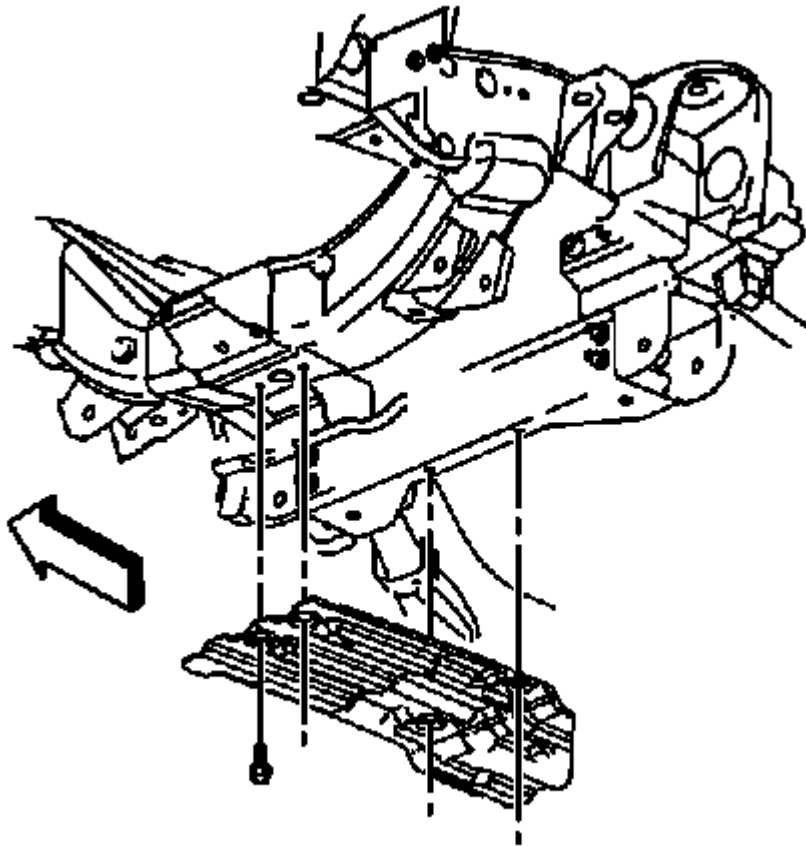


Fig. 34: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

10. Install the oil pan skid plate and bolts.

Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

11. Lower the vehicle.

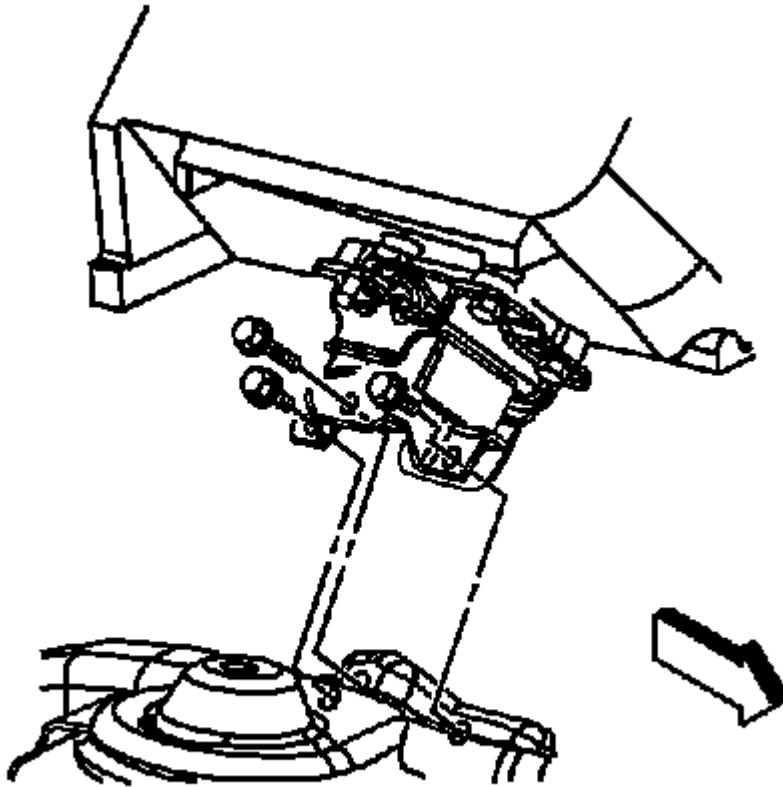


Fig. 35: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the engine mount to engine mount bracket bolts.

Tighten: Tighten the engine mount to engine mount bracket bolts to 65 N.m (48 lb ft).

INTAKE MANIFOLD REPLACEMENT - UPPER

Removal Procedure

1. Remove the fuel pipes/hoses.
2. Disconnect the cruise control cable from the throttle lever, if equipped.

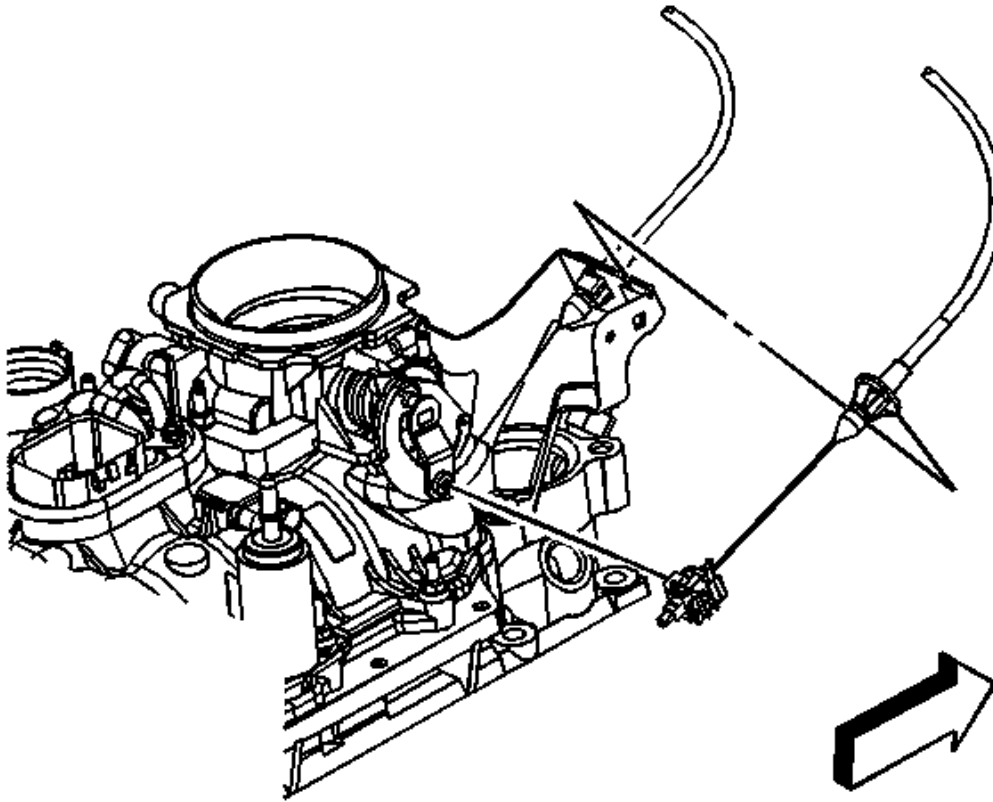


Fig. 36: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

3. Remove the cruise control cable from the accelerator control cable bracket, if equipped.

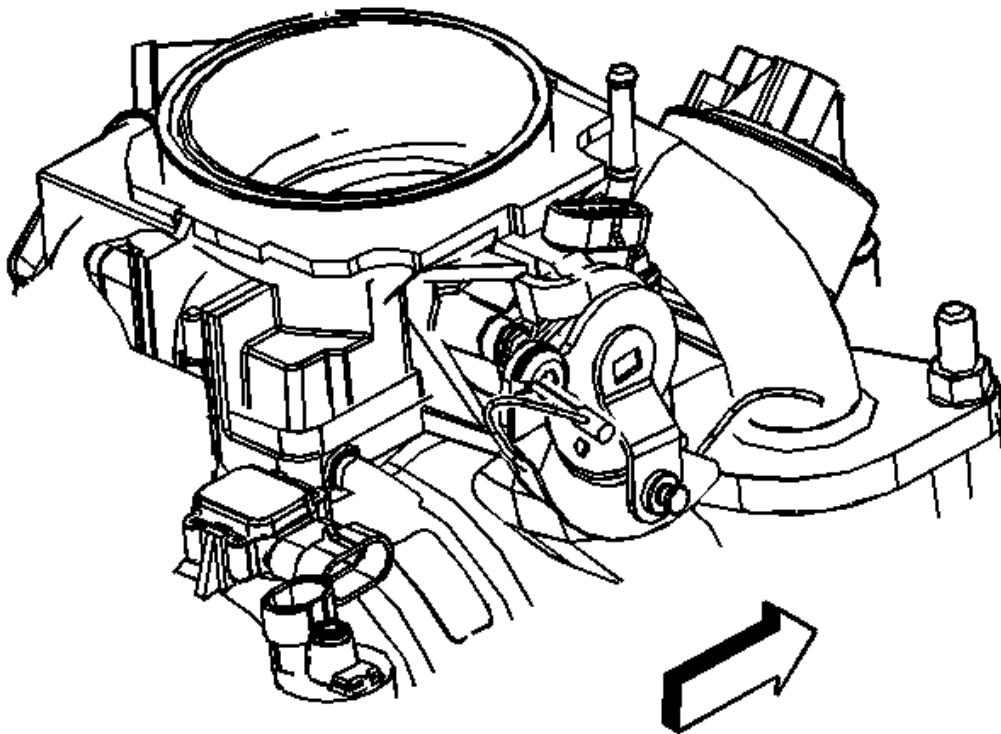


Fig. 37: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

4. Remove the accelerator cable from the throttle body lever.

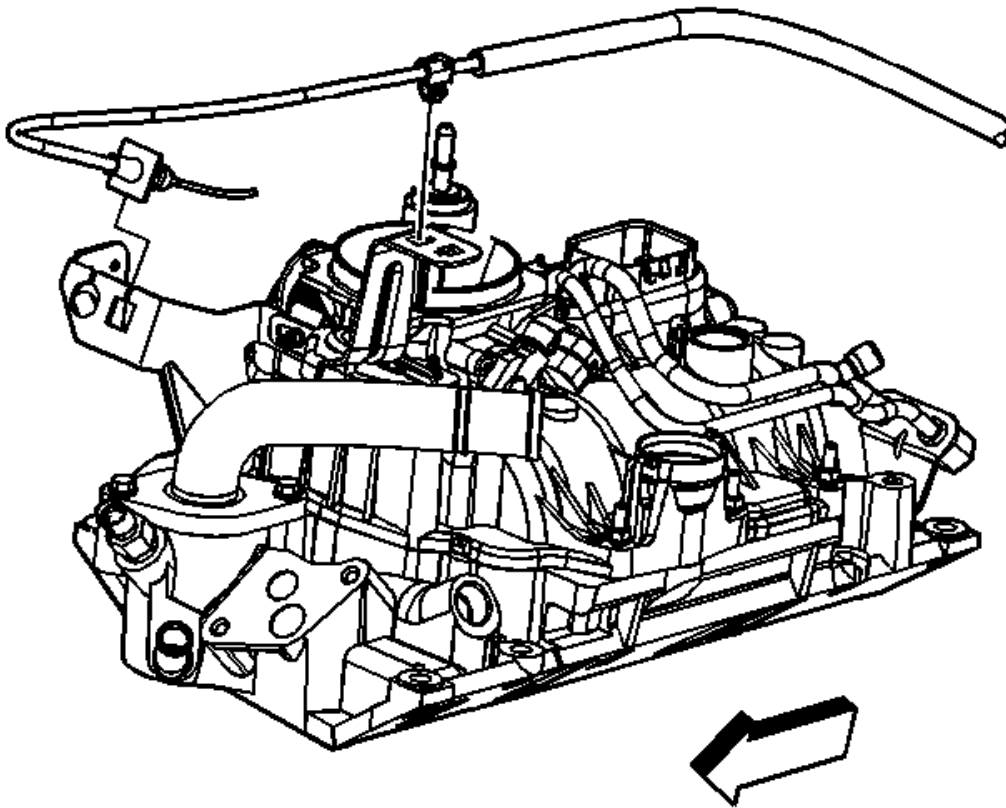


Fig. 38: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

5. Remove the accelerator cable from the accelerator control cable bracket.

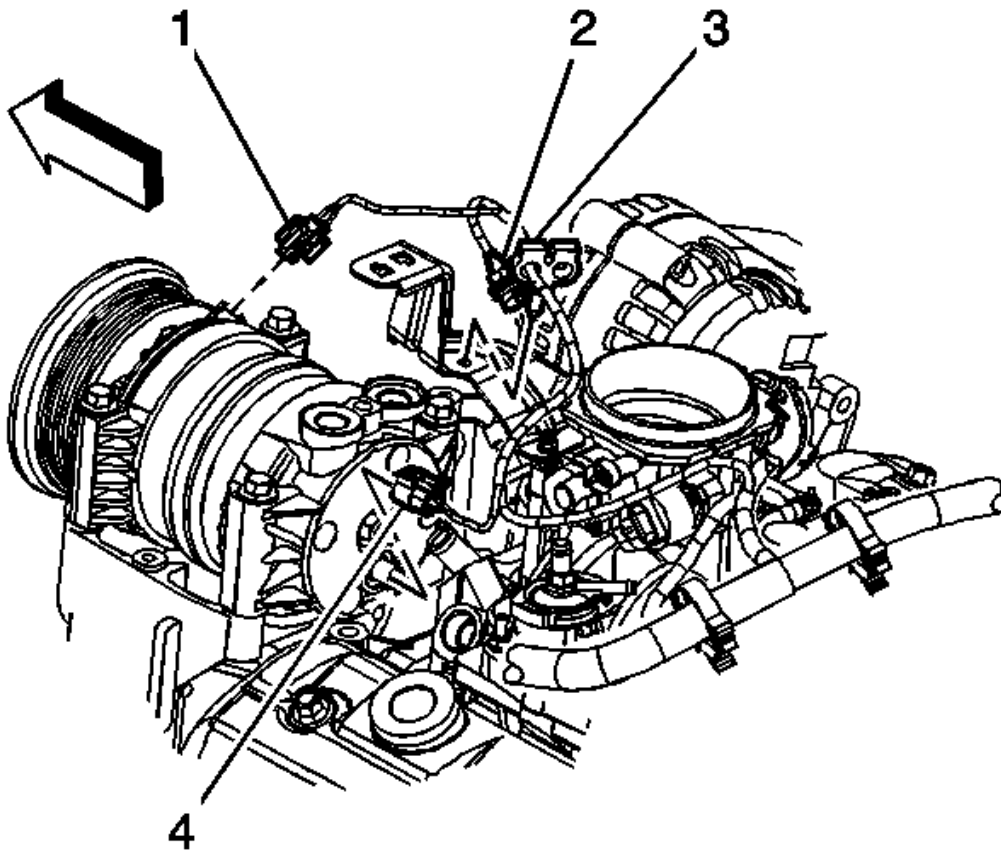


Fig. 39: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the following electrical connectors:
 - The air conditioning (A/C) compressor clutch (1), if equipped
 - The exhaust gas recirculation (EGR) valve (2)
 - The A/C pressure switch (4), if equipped
7. Remove the engine wiring harness clip (3) from the accelerator control cable bracket.

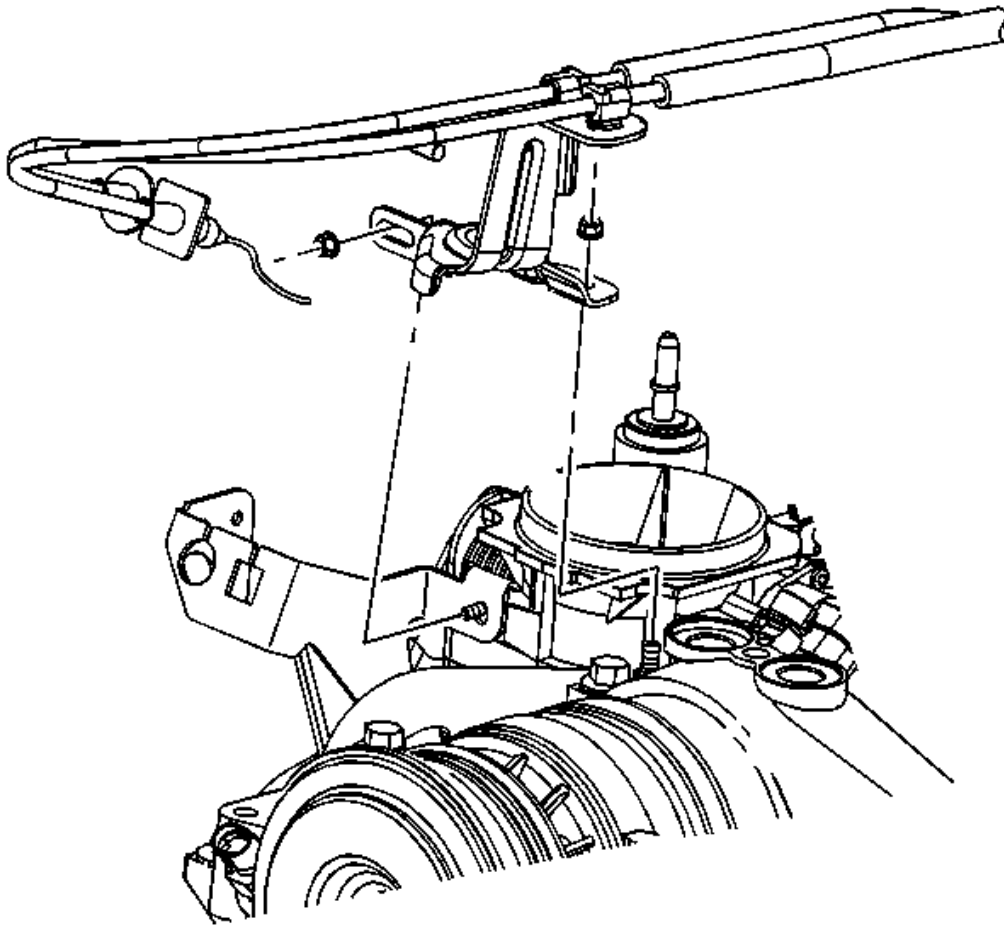


Fig. 40: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

8. Remove the accelerator control cable bracket nuts.
9. Remove the accelerator control cable bracket with the cables attached, from the throttle body.
10. Reposition and secure the bracket and cables out of the way.

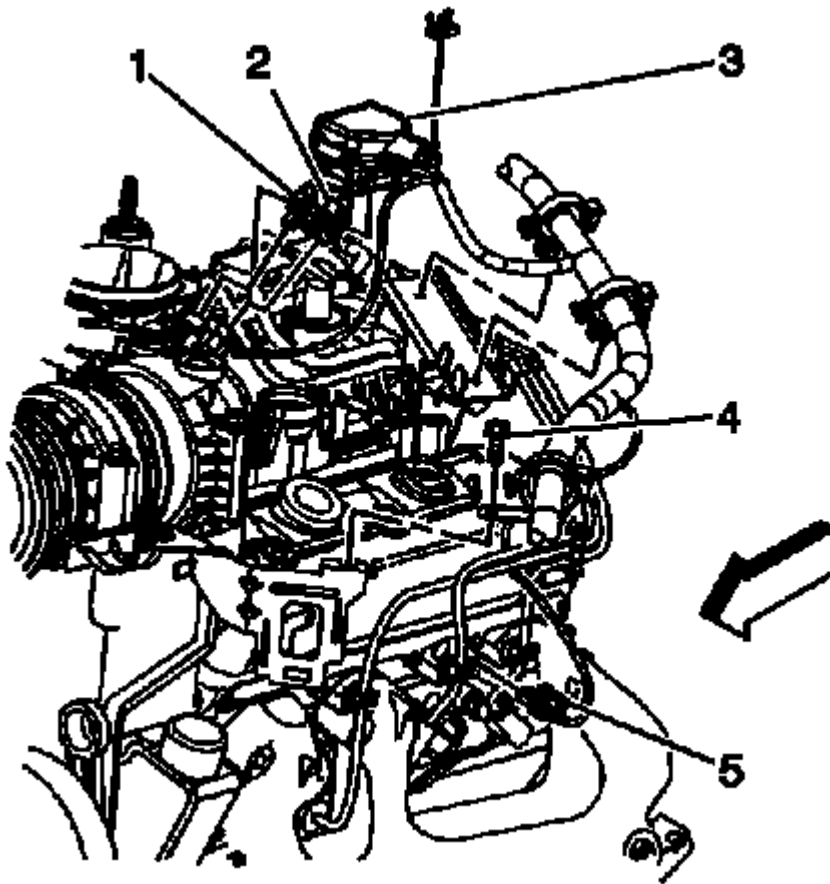


Fig. 41: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

11. Disconnect the following electrical connectors:
 - The throttle position (TP) sensor (1)
 - The idle air control (IAC) motor (2)
 - The control port injector module (3)
12. Remove the engine wiring harness clip bolt (4).

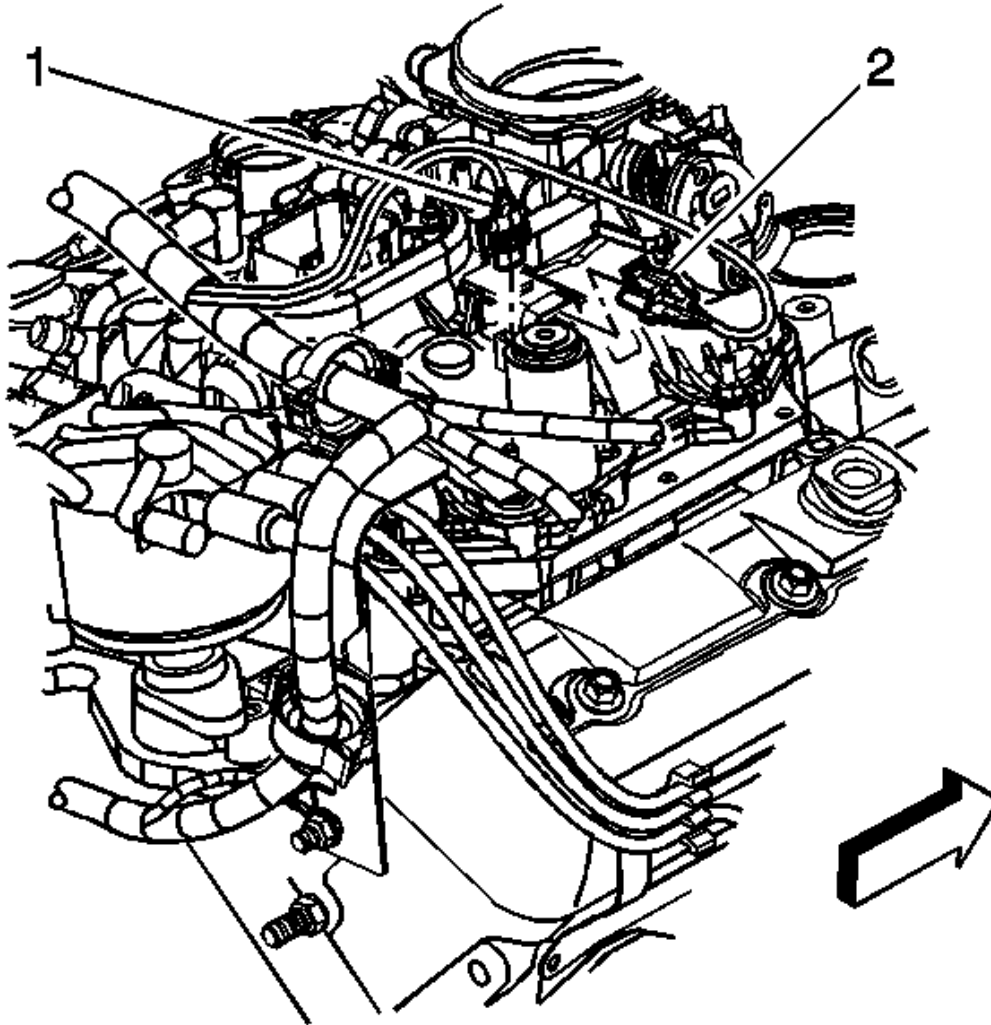
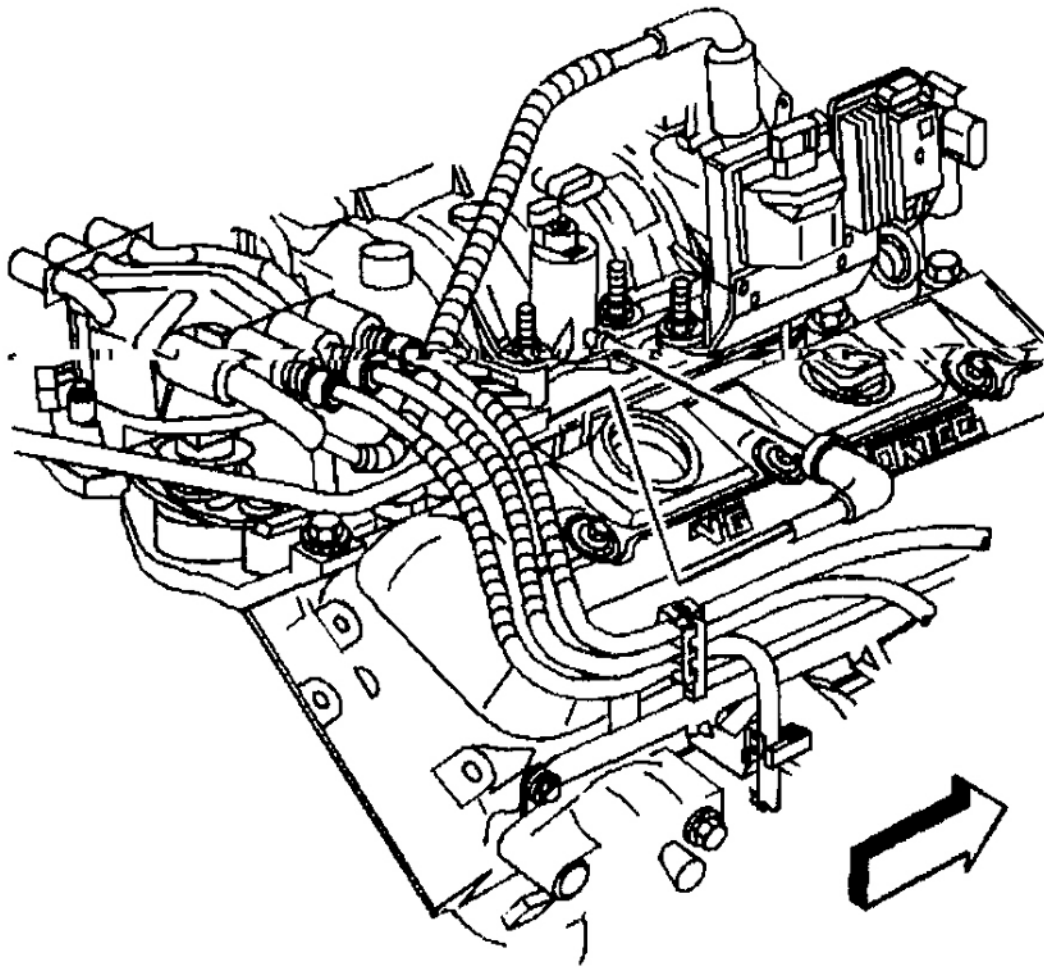


Fig. 42: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

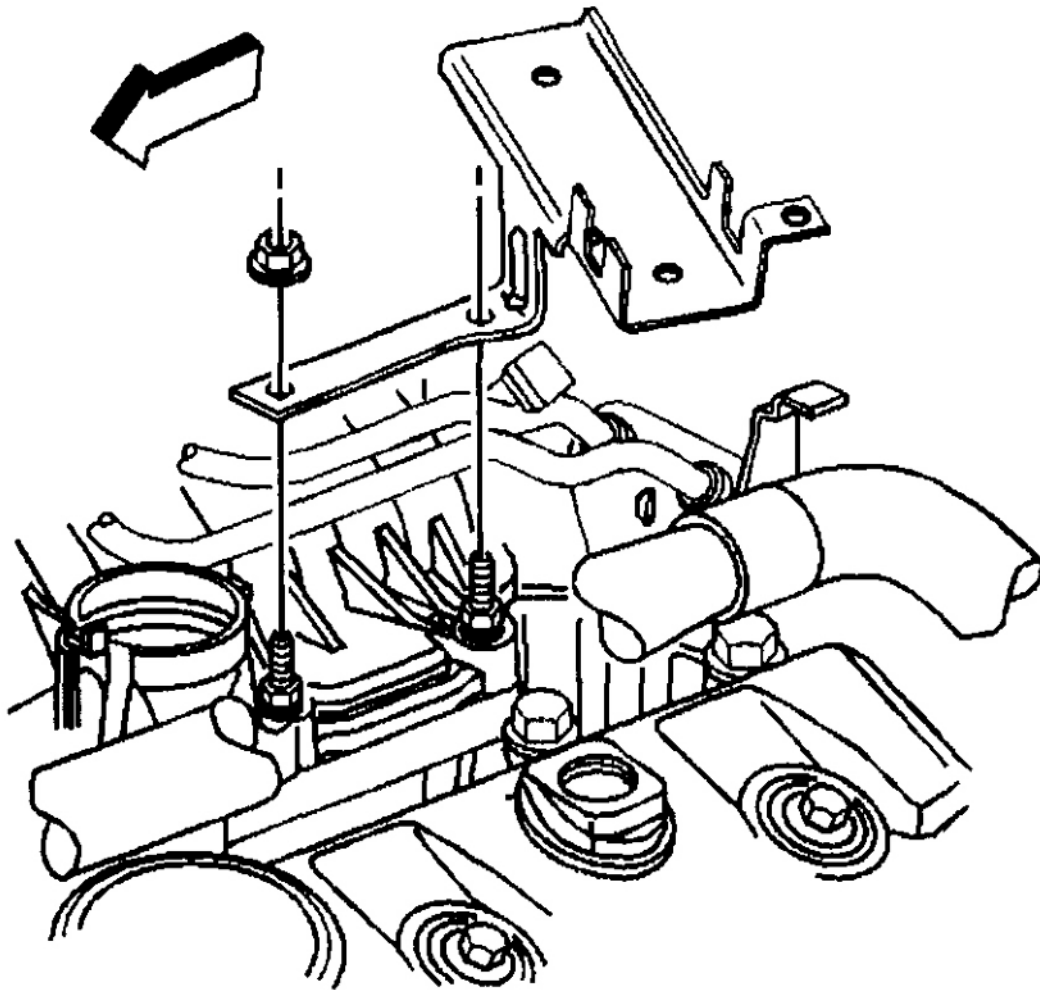
13. Disconnect the following electrical connectors:
- The evaporative emission (EVAP) canister purge solenoid valve (1)
 - The manifold absolute pressure (MAP) sensor (2)



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Fig. 43: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the EVAP canister harness from the purge solenoid valve.



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Fig. 44: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

15. Remove the engine wiring harness bracket nuts.
16. Remove the engine wiring harness bracket from the studs.

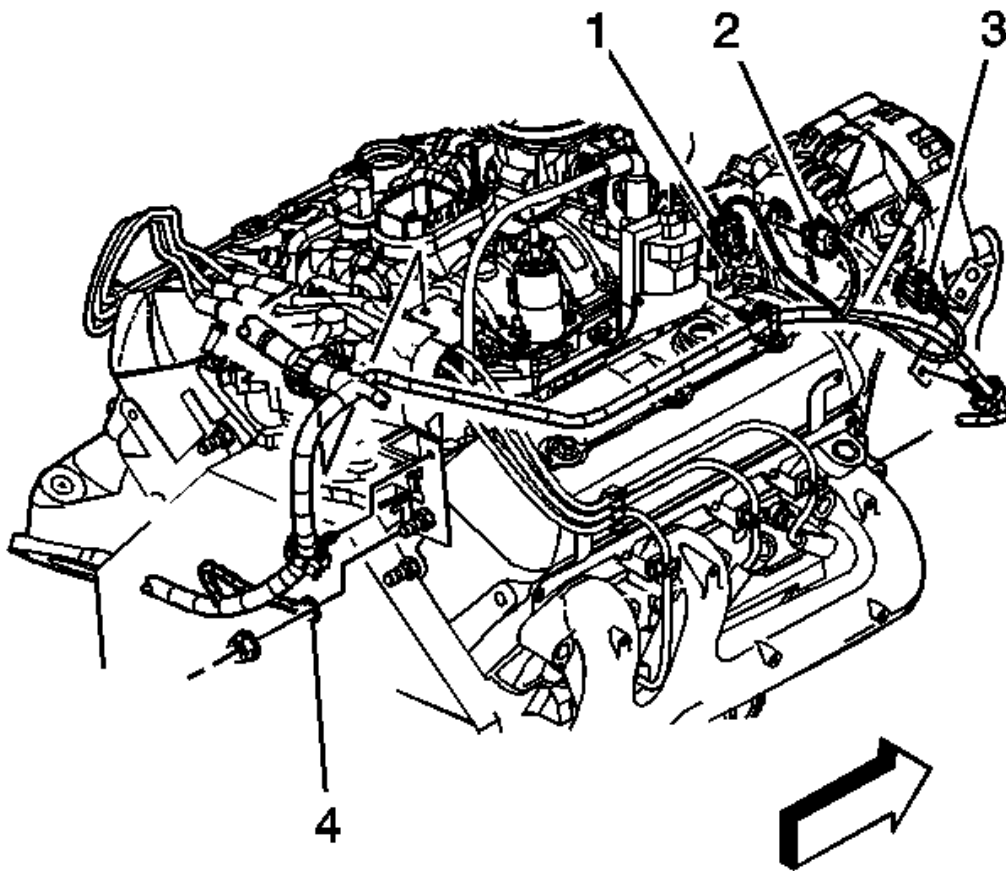


Fig. 45: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

17. Remove the engine wiring harness ground nut and ground wire (4) from the rear of the right cylinder head.

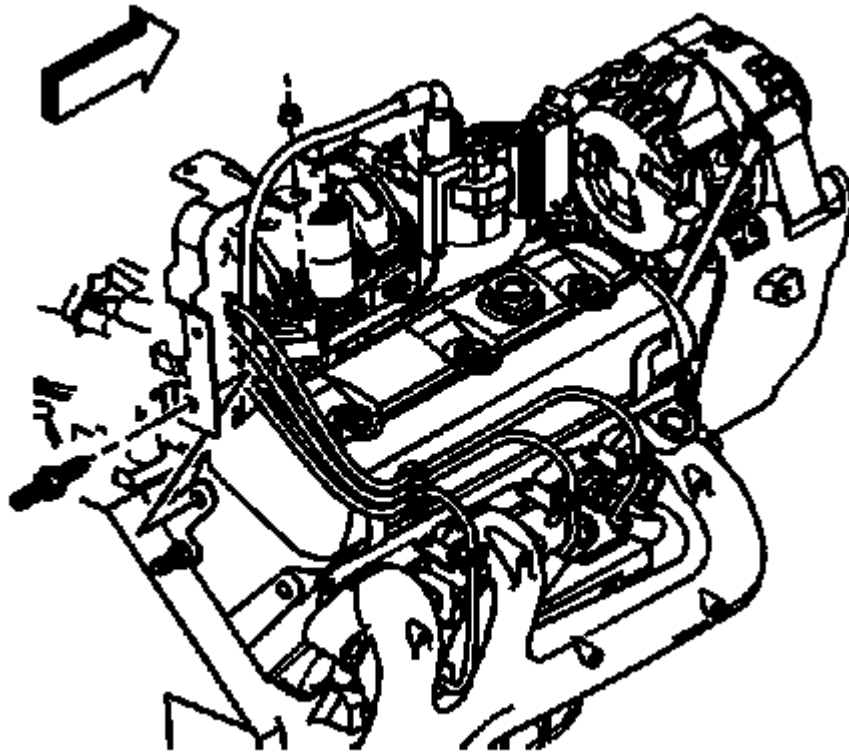
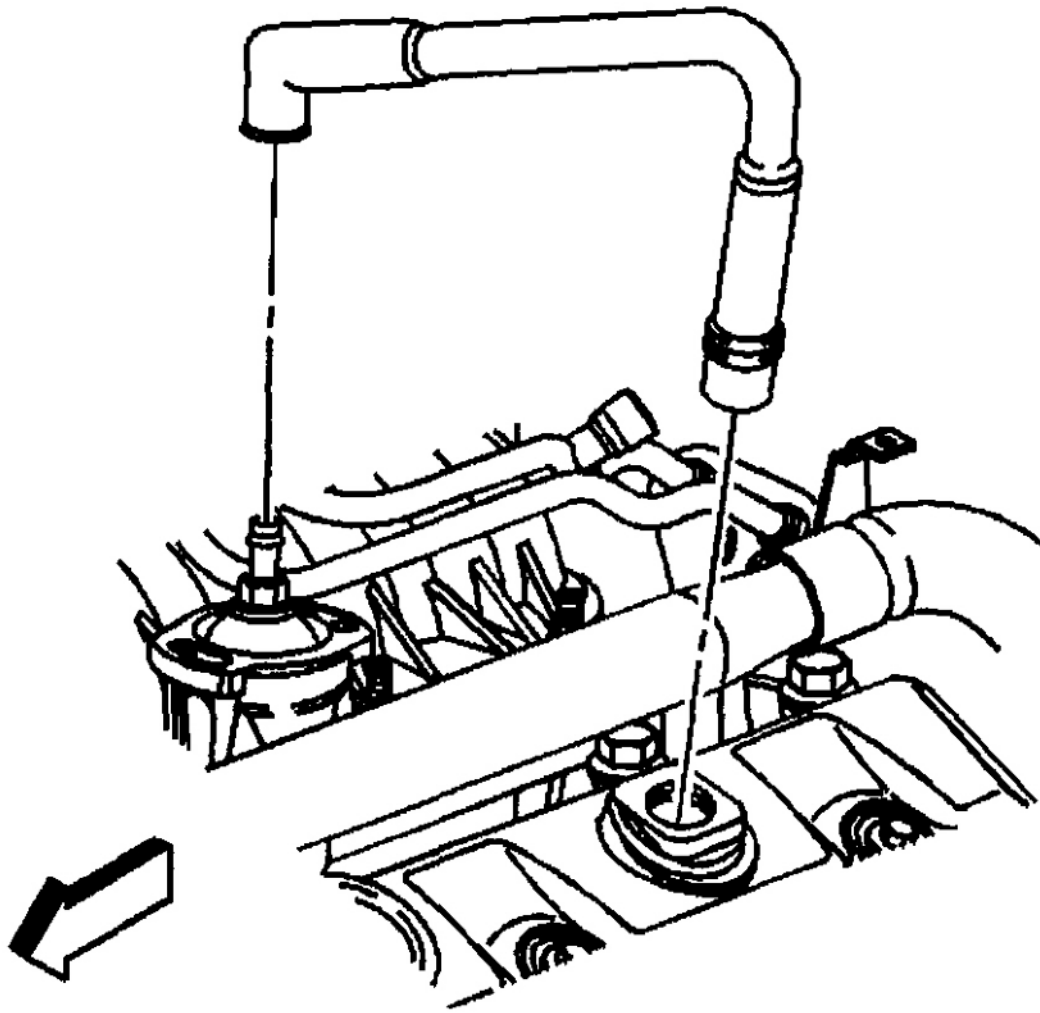


Fig. 46: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

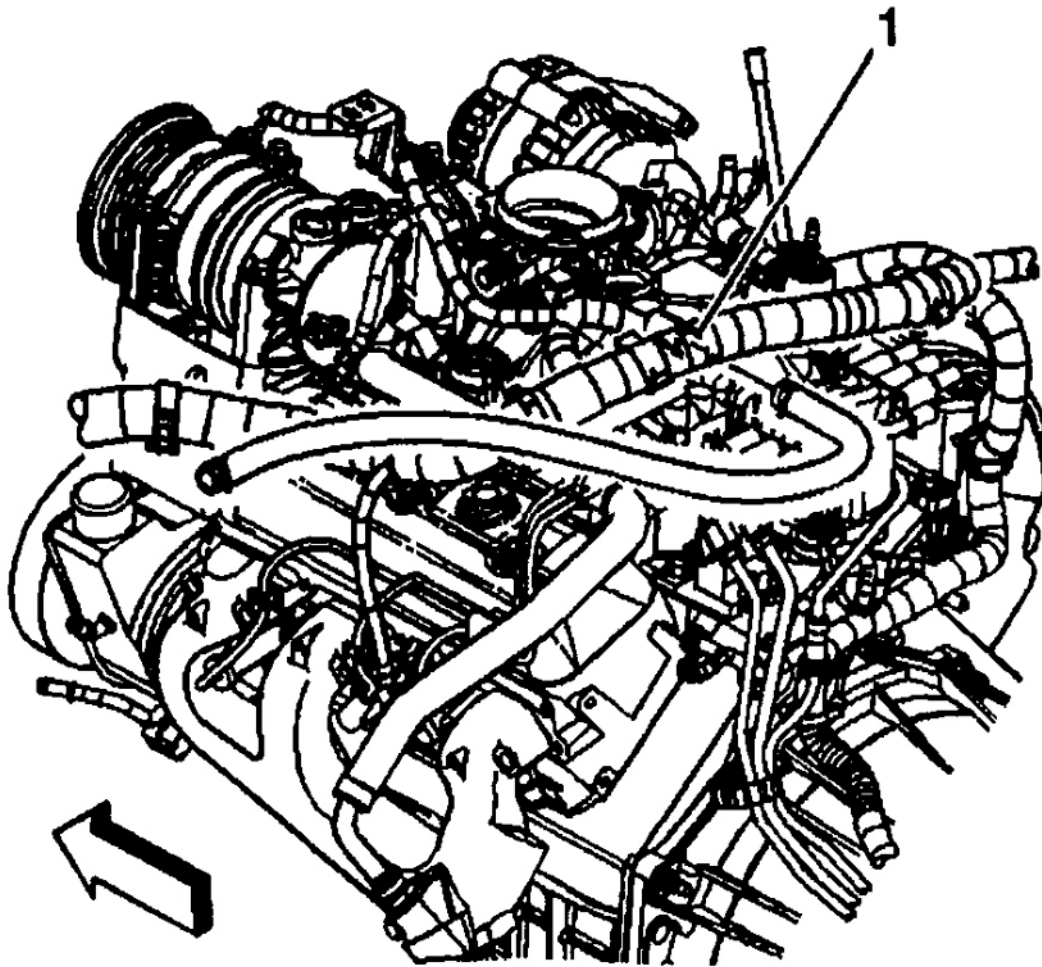
18. Remove the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.
19. Remove the stud holding the engine wiring harness bracket.
20. Reposition the engine wiring harness with the bracket aside.



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Fig. 47: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

21. Remove the PCV valve hose from the PCV valve cover and the rocker arm cover.



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Fig. 48: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

22. Disconnect the power brake booster vacuum hose from the vacuum fitting (1).

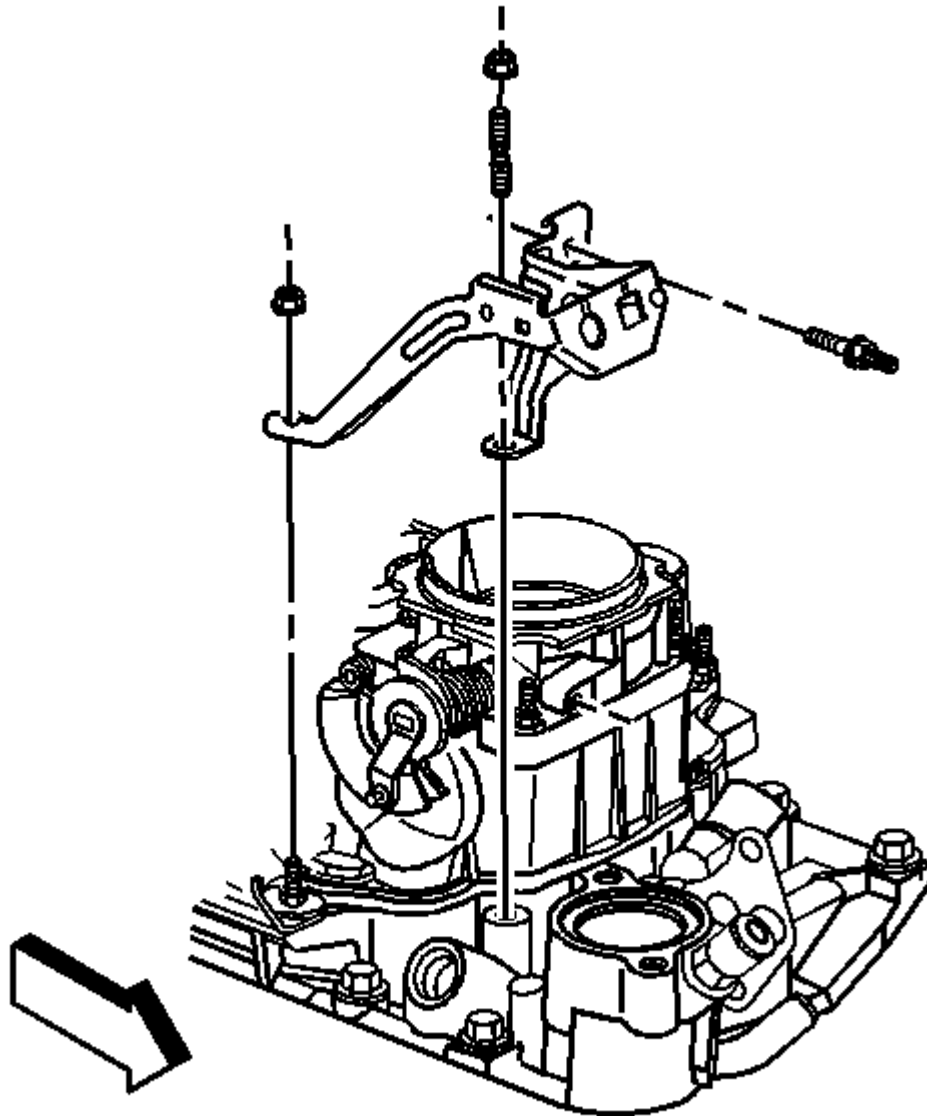


Fig. 49: View Of Accelerator Cable Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

23. Remove the accelerator cable bracket nuts.
24. Remove the accelerator cable bracket.

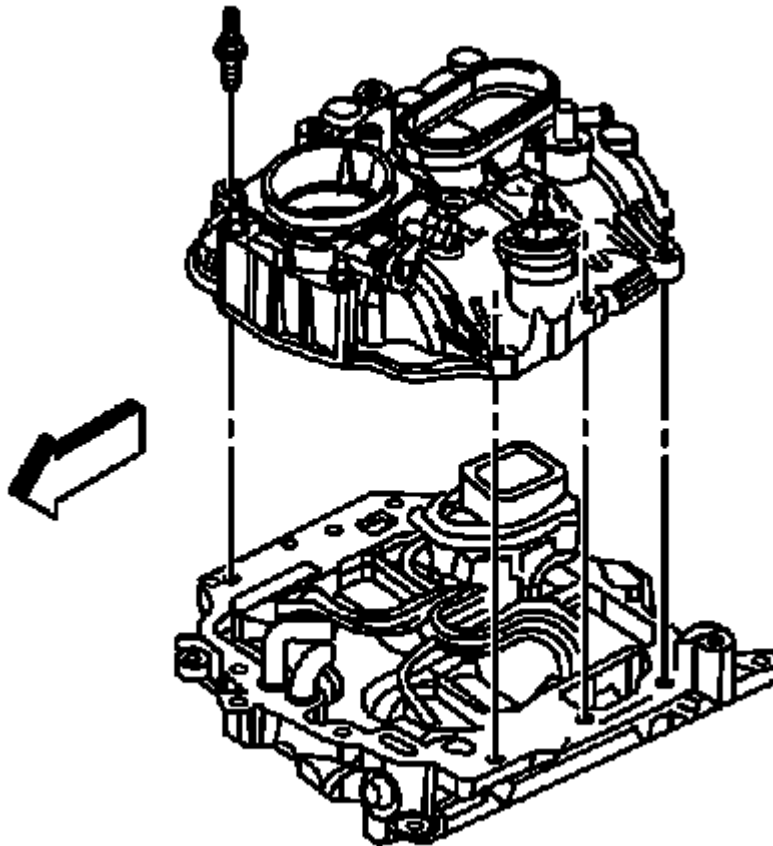


Fig. 50: View Of Intake Manifold Upper Studs
Courtesy of GENERAL MOTORS CORP.

25. Remove the intake manifold - upper studs.
26. Remove the front two throttle body studs.
27. Remove the intake manifold - upper.

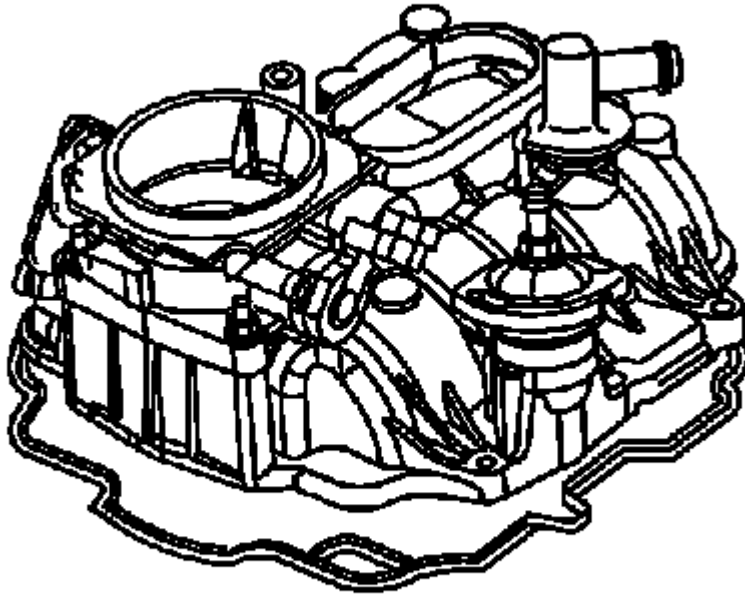


Fig. 51: View Of Intake Manifold Upper Gasket
Courtesy of GENERAL MOTORS CORP.

28. Remove and discard the intake manifold - upper gasket.

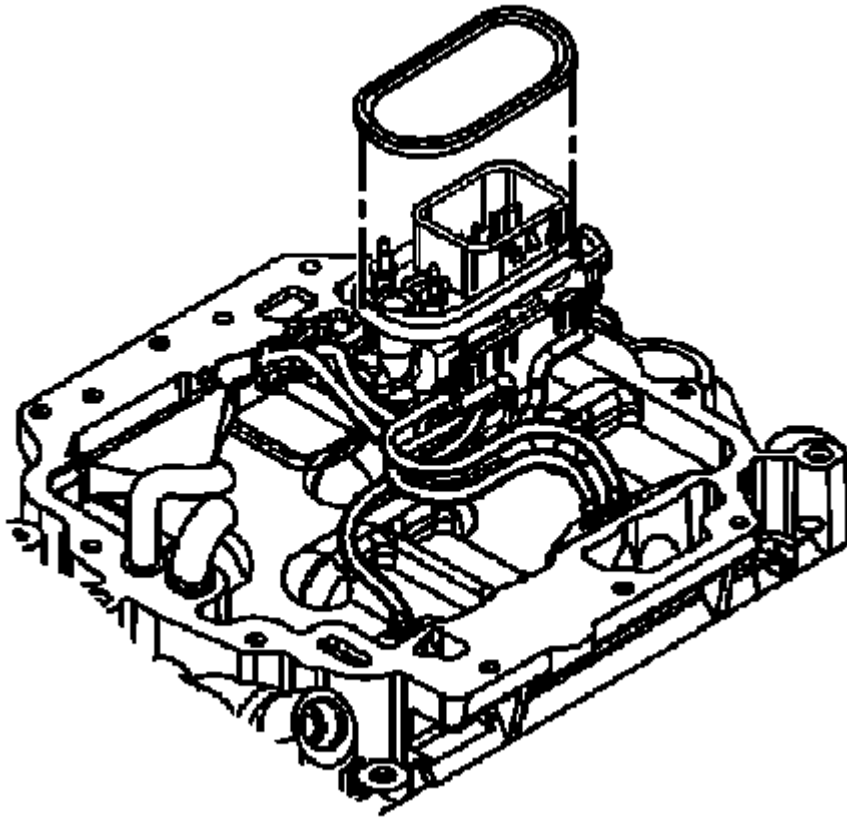


Fig. 52: View Of Fuel Meter Body O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

29. Remove and discard the O-ring seal from the fuel meter body.

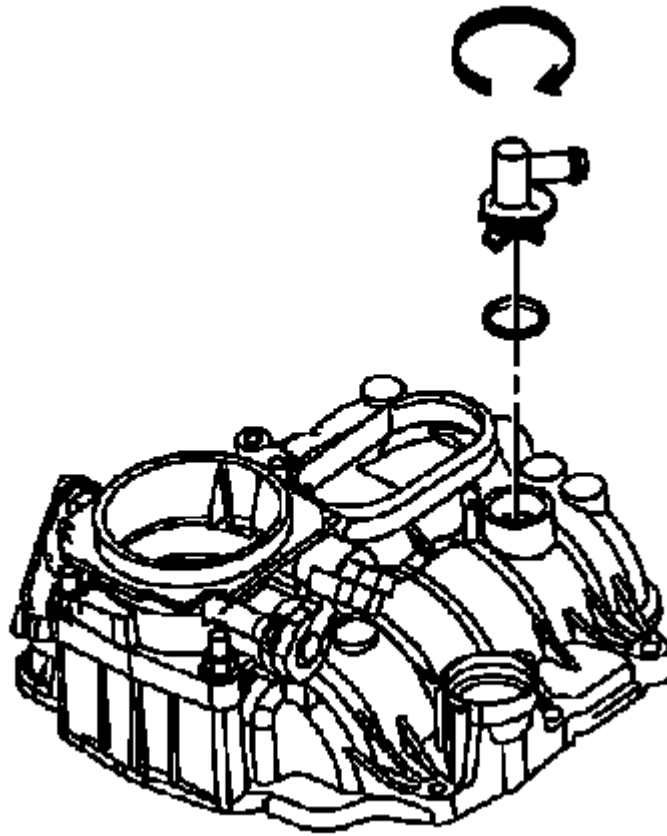
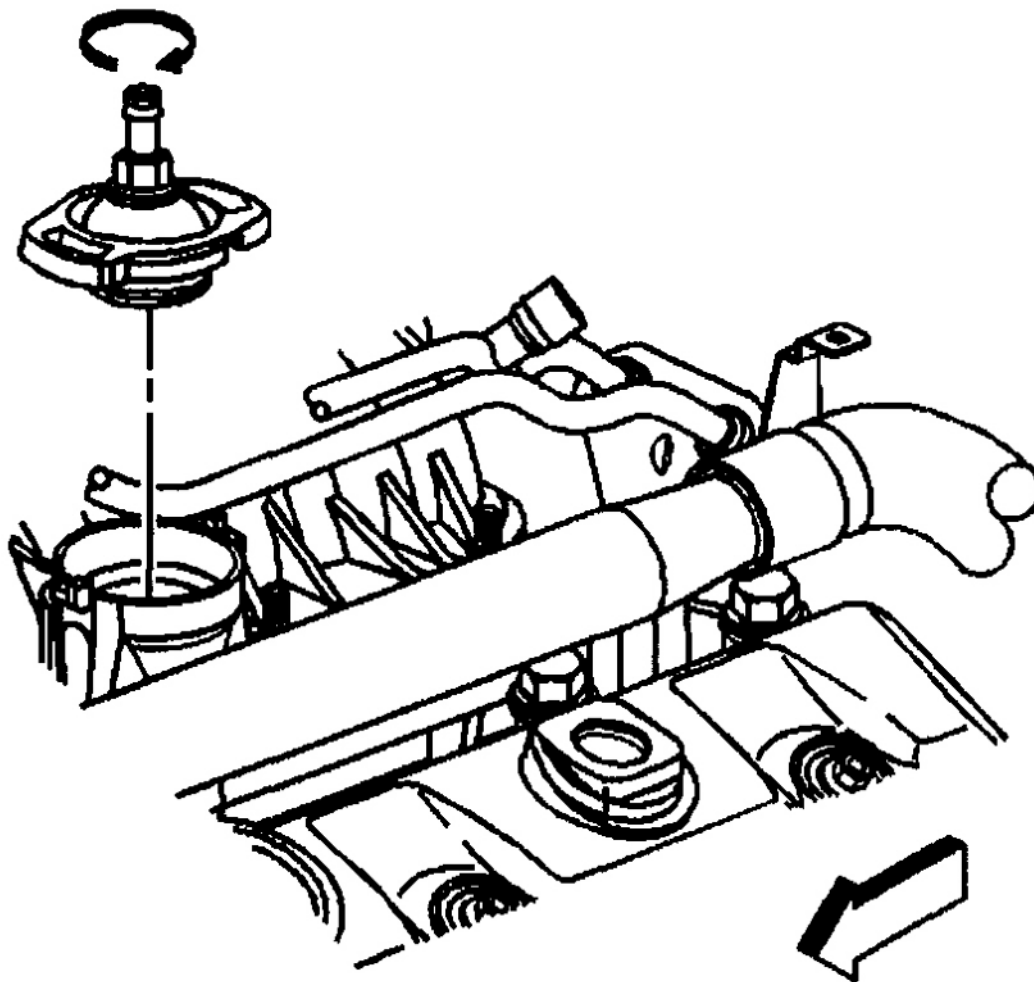


Fig. 53: View Of Power Brake Booster Vacuum O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

30. If required, remove the power brake booster vacuum fitting.
31. Remove and discard the O-ring seal.



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Fig. 54: View Of PCV Valve Cover & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

32. If required, remove the PCV valve cover.
33. Remove and discard the O-ring seal.

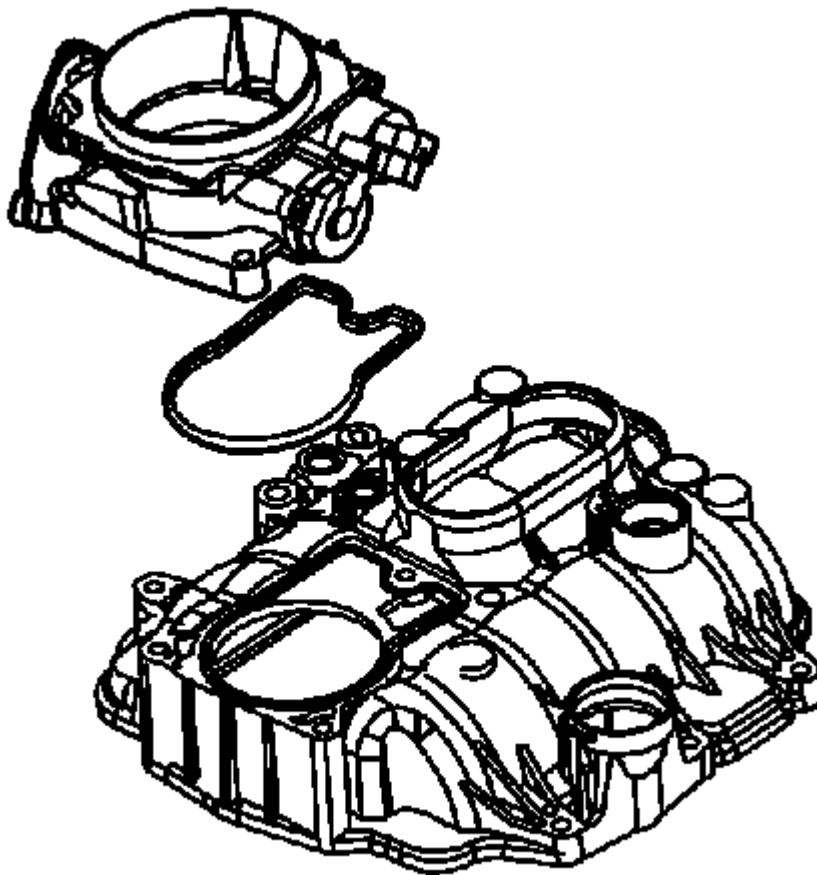


Fig. 55: View Of Throttle Body & Gasket
Courtesy of GENERAL MOTORS CORP.

34. If required, remove the rear throttle body stud.
35. Remove the throttle body.
36. Remove and discard the throttle body gasket.

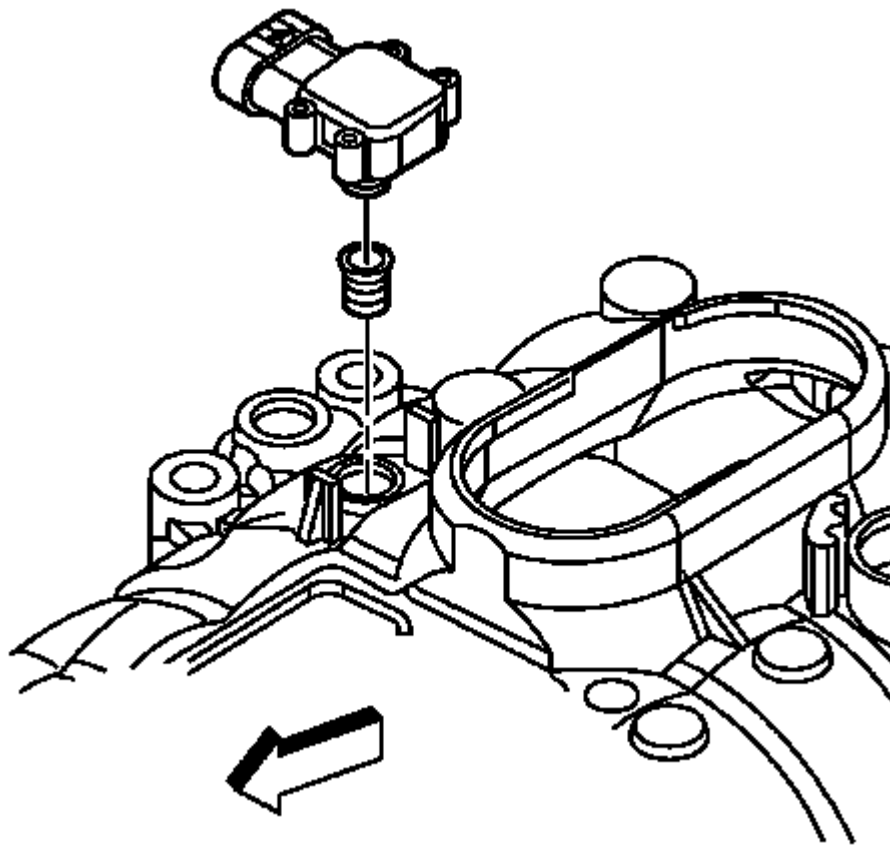


Fig. 56: Installing MAP Sensor
Courtesy of GENERAL MOTORS CORP.

37. If required, remove the MAP sensor.
38. Remove and discard the MAP sensor seal.

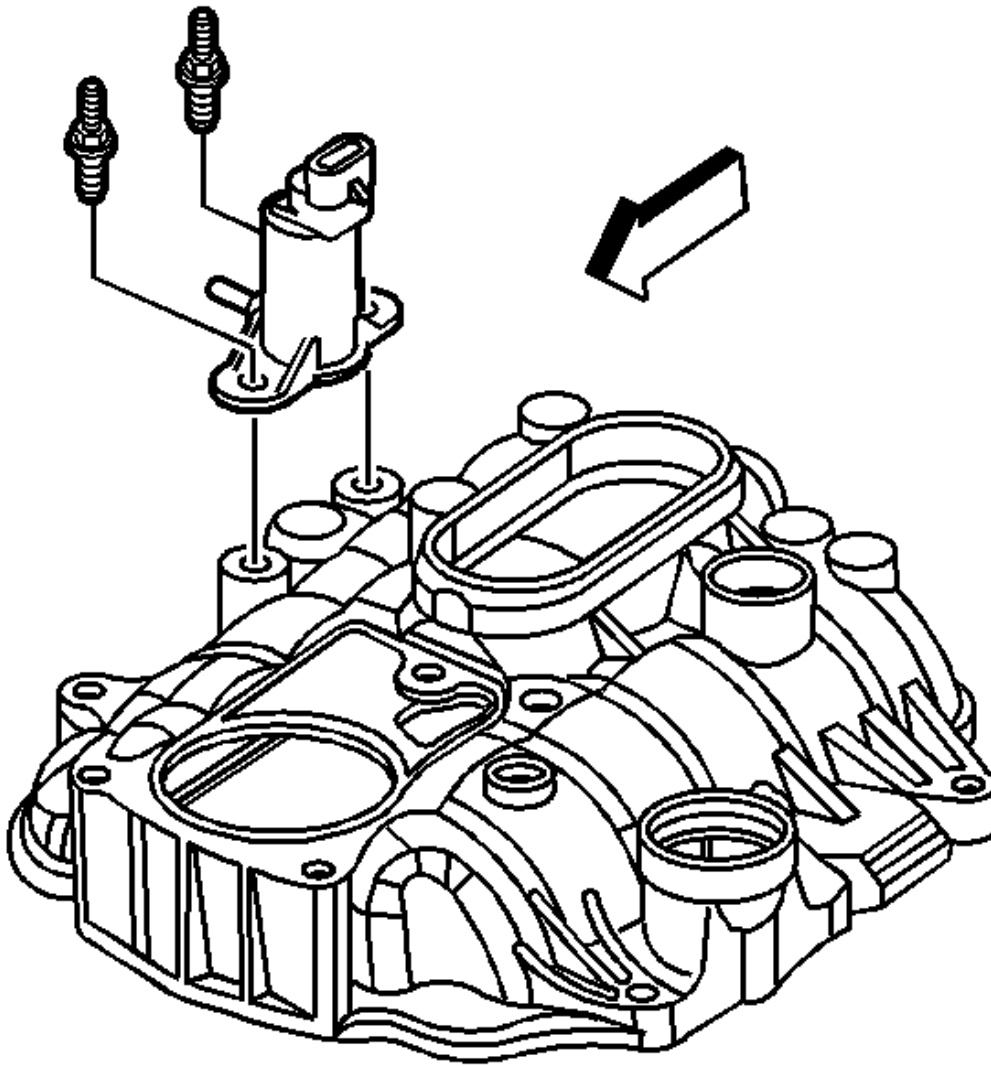


Fig. 57: View Of EVAP Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

39. If required, remove the EVAP canister purge solenoid valve studs.
40. Remove the purge solenoid valve.
41. Clean and inspect the intake manifold - upper, if necessary. Refer to **INTAKE MANIFOLD CLEANING & INSPECTION** .

Installation Procedure

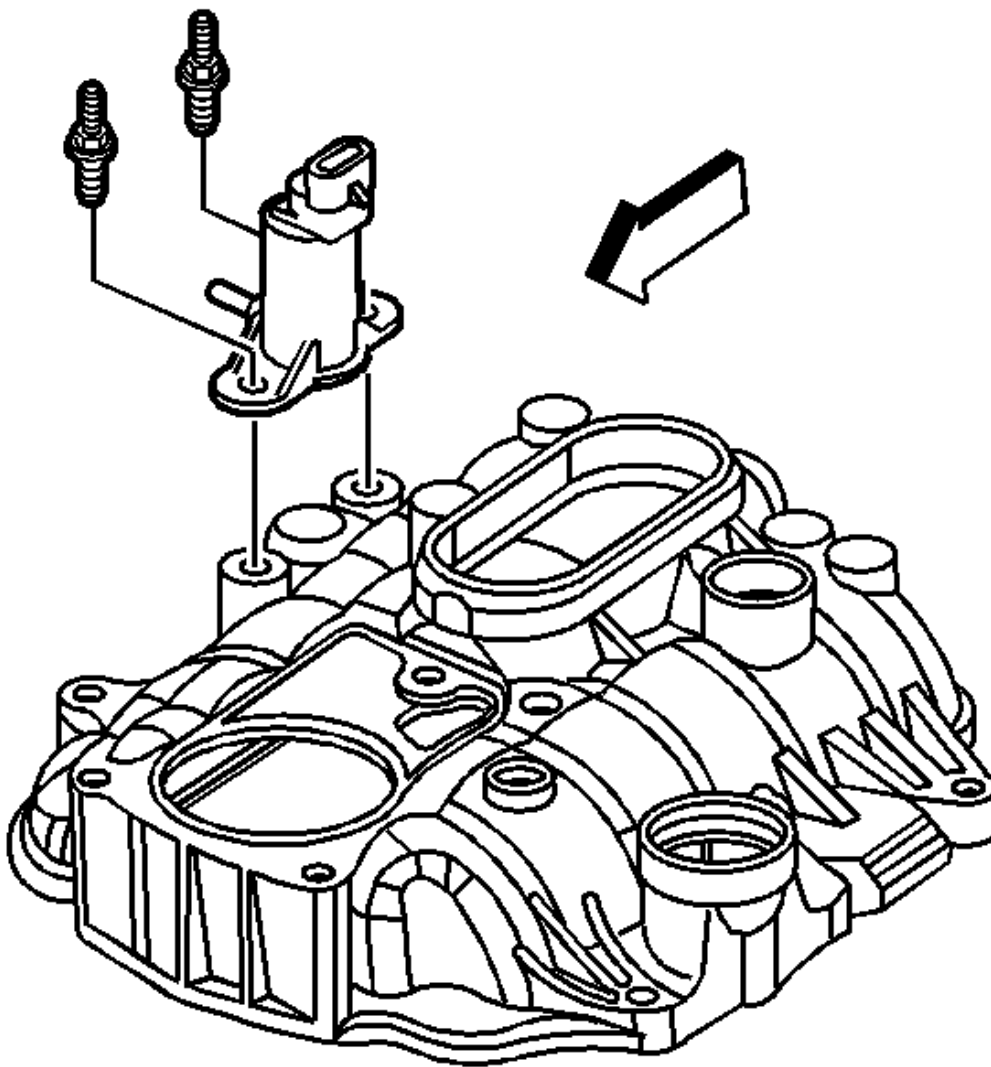


Fig. 58: View Of EVAP Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER NOTICE** .

1. If required, install the purge solenoid valve.
2. Install the EVAP canister purge solenoid valve studs. If reusing the old studs, apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads.

Tighten: Tighten the EVAP canister purge solenoid valve studs to 10 N.m (89 lb in).

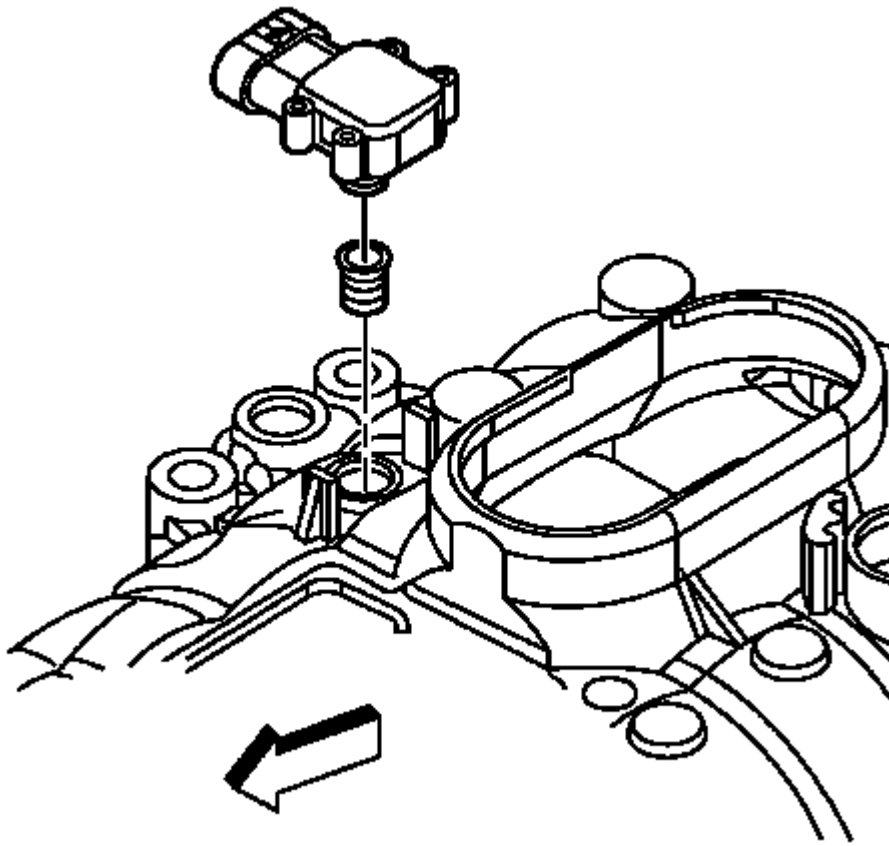


Fig. 59: Installing MAP Sensor
Courtesy of GENERAL MOTORS CORP.

3. If required, install a NEW MAP sensor seal. Apply a small drop of clean engine oil to the seal.
4. Install the MAP sensor.

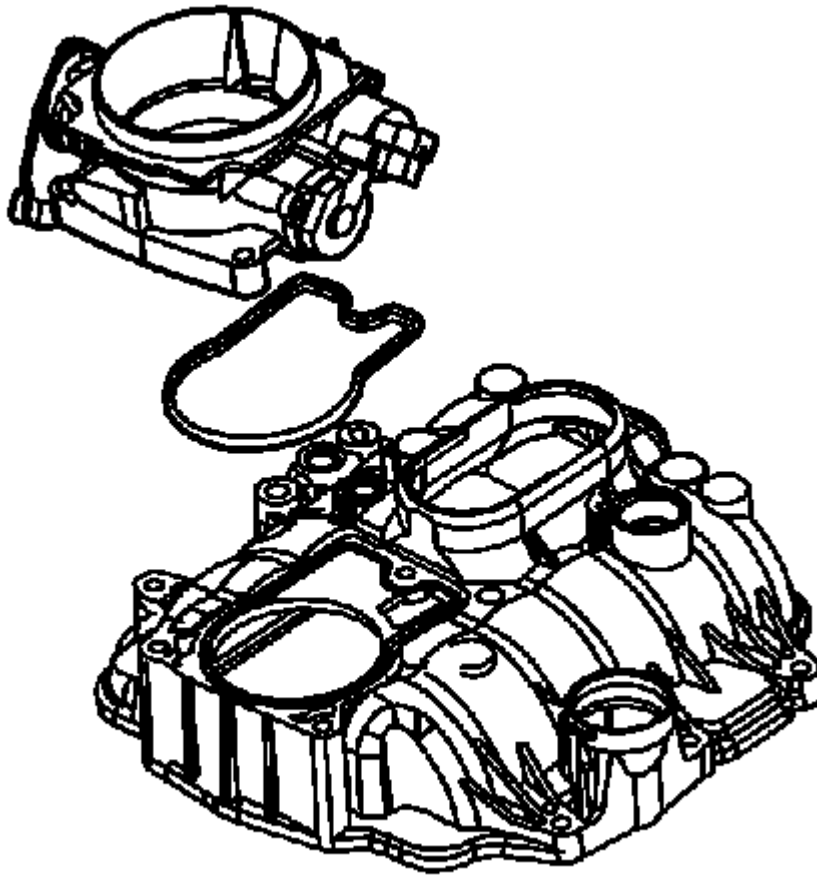
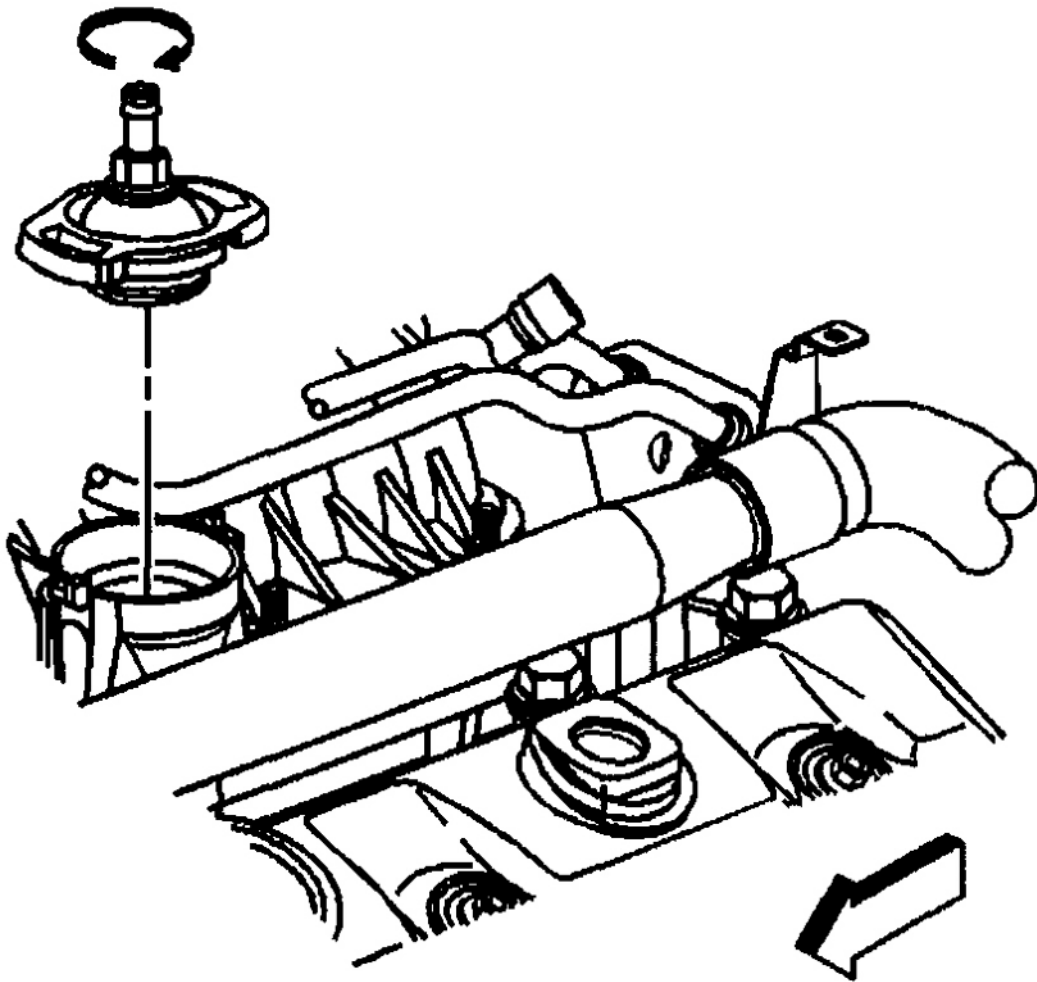


Fig. 60: View Of Throttle Body & Gasket
Courtesy of GENERAL MOTORS CORP.

5. If required, install a NEW throttle body gasket.
6. Install the throttle body.
7. Install the rear throttle body stud. If reusing the old studs, apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads.

Tighten: Tighten the throttle body stud to 9 N.m (80 lb in).



G01654441

Fig. 61: View Of PCV Valve Cover & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

8. If required, install a NEW O-ring seal to the PCV cover. Apply clean engine oil to the seal.
9. Install the PCV valve cover.

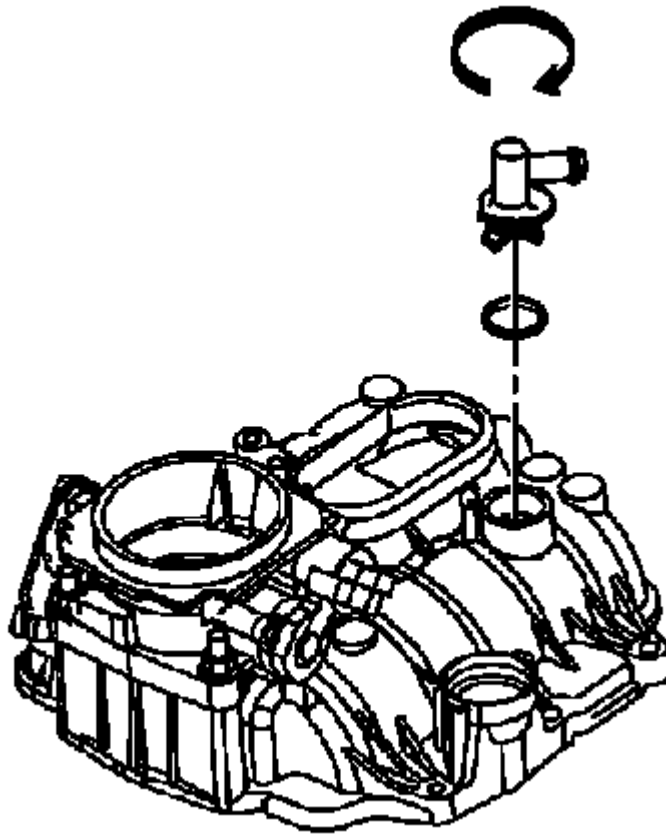


Fig. 62: View Of Power Brake Booster Vacuum O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

10. If required, install a NEW O-ring seal. Apply clean engine oil to the seal.
11. Install the power brake booster vacuum fitting.

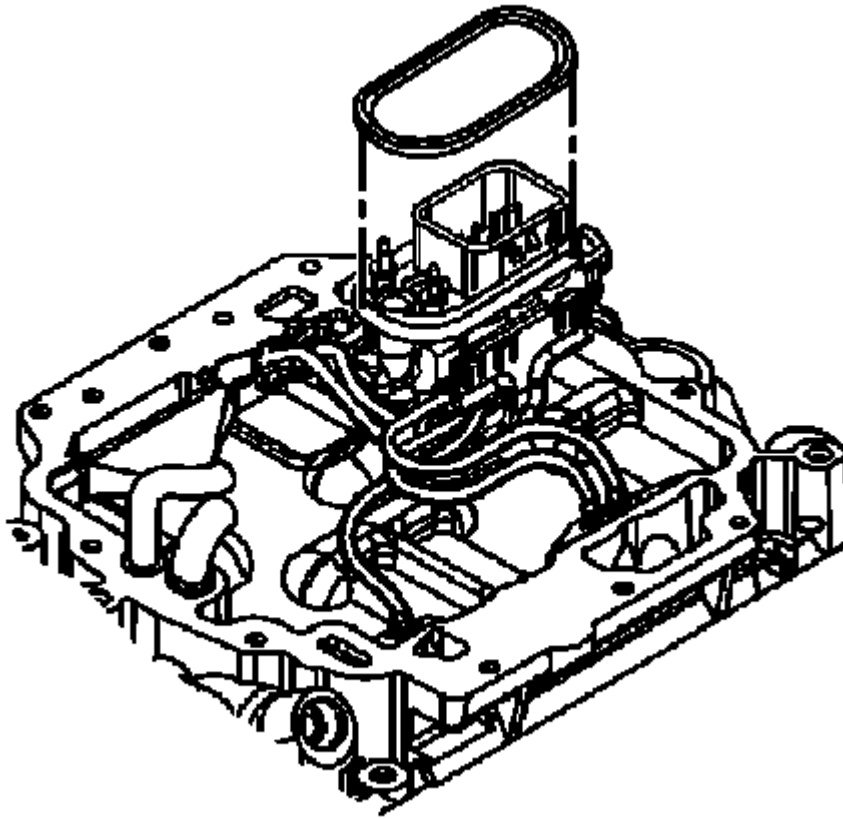


Fig. 63: View Of Fuel Meter Body O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW O-ring seal to the fuel meter body.

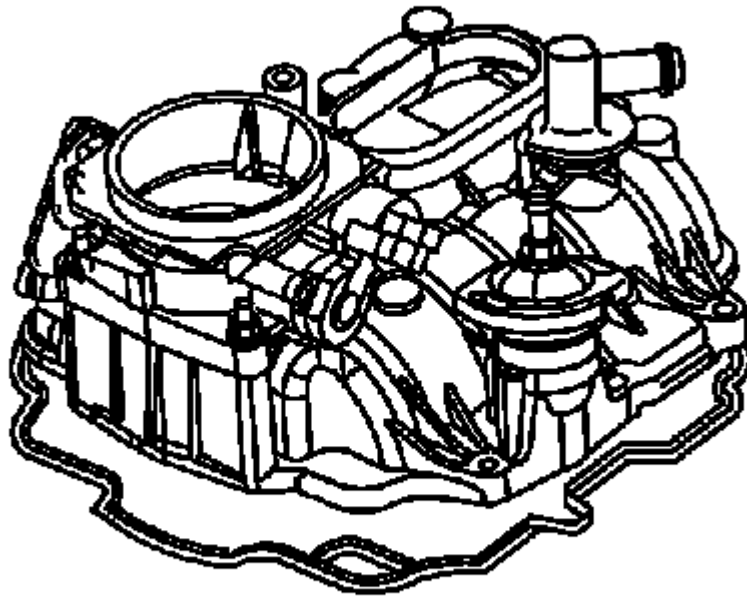


Fig. 64: View Of Intake Manifold Upper Gasket
Courtesy of GENERAL MOTORS CORP.

13. Install a NEW upper intake manifold gasket.

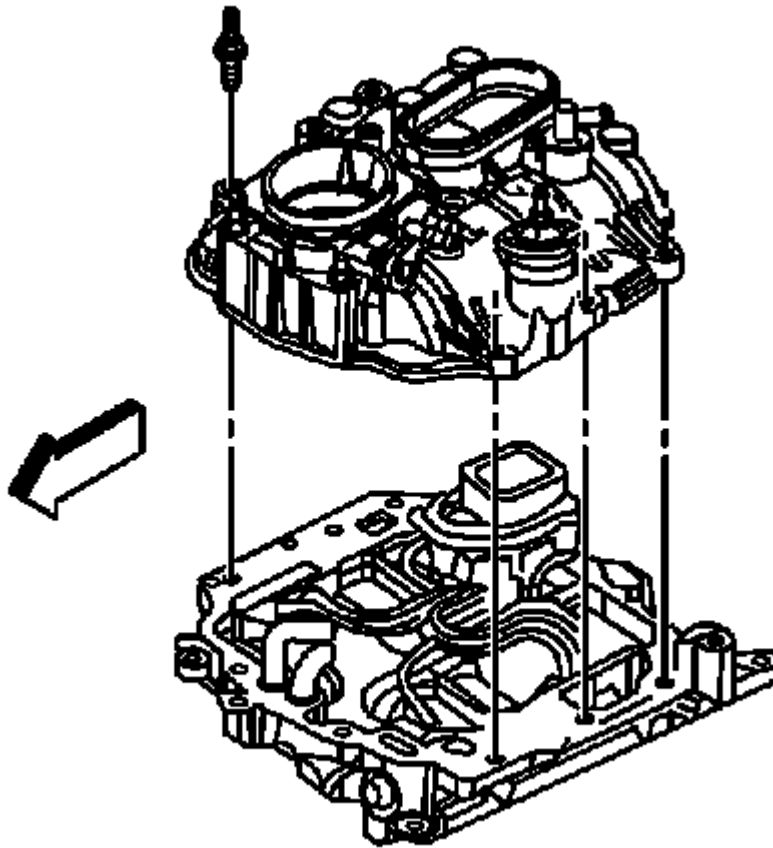


Fig. 65: View Of Intake Manifold Upper Studs
Courtesy of GENERAL MOTORS CORP.

14. Install the intake manifold - upper.
15. If reusing the old throttle body/intake manifold studs, apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads.
16. Install the front two throttle body studs.
17. Install the intake manifold - upper studs.

Tighten: Tighten the intake manifold - upper studs to 9 N.m (80 lb in).

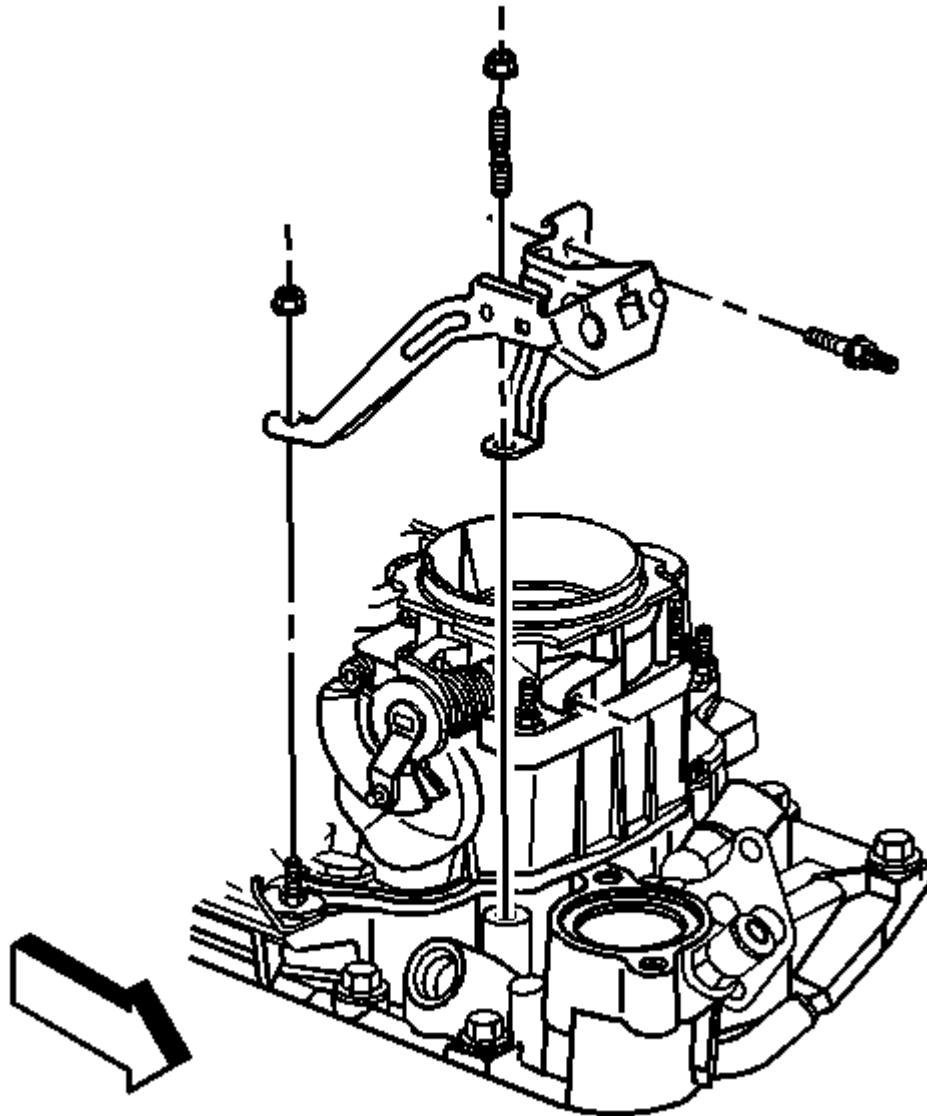
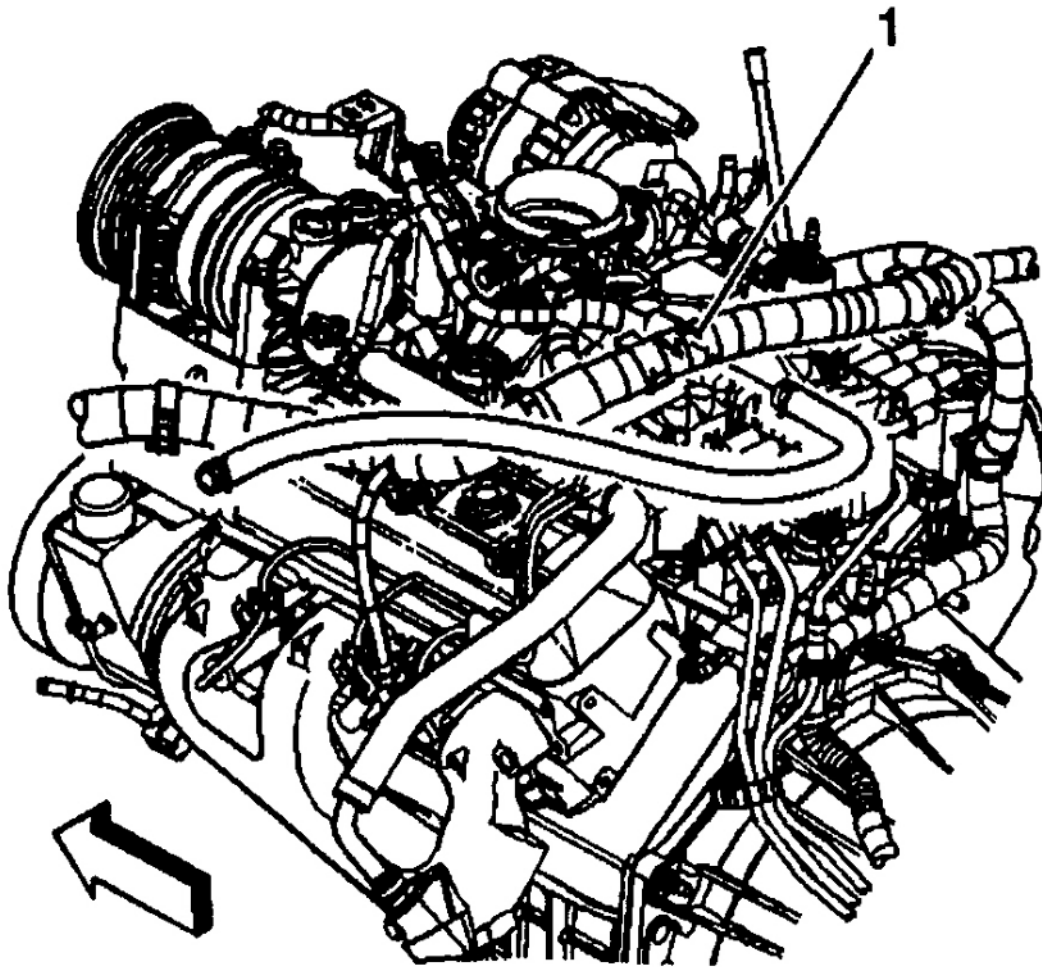


Fig. 66: View Of Accelerator Cable Bracket Nuts
Courtesy of GENERAL MOTORS CORP.

18. Install the accelerator cable bracket.
19. Install the accelerator cable bracket nuts.

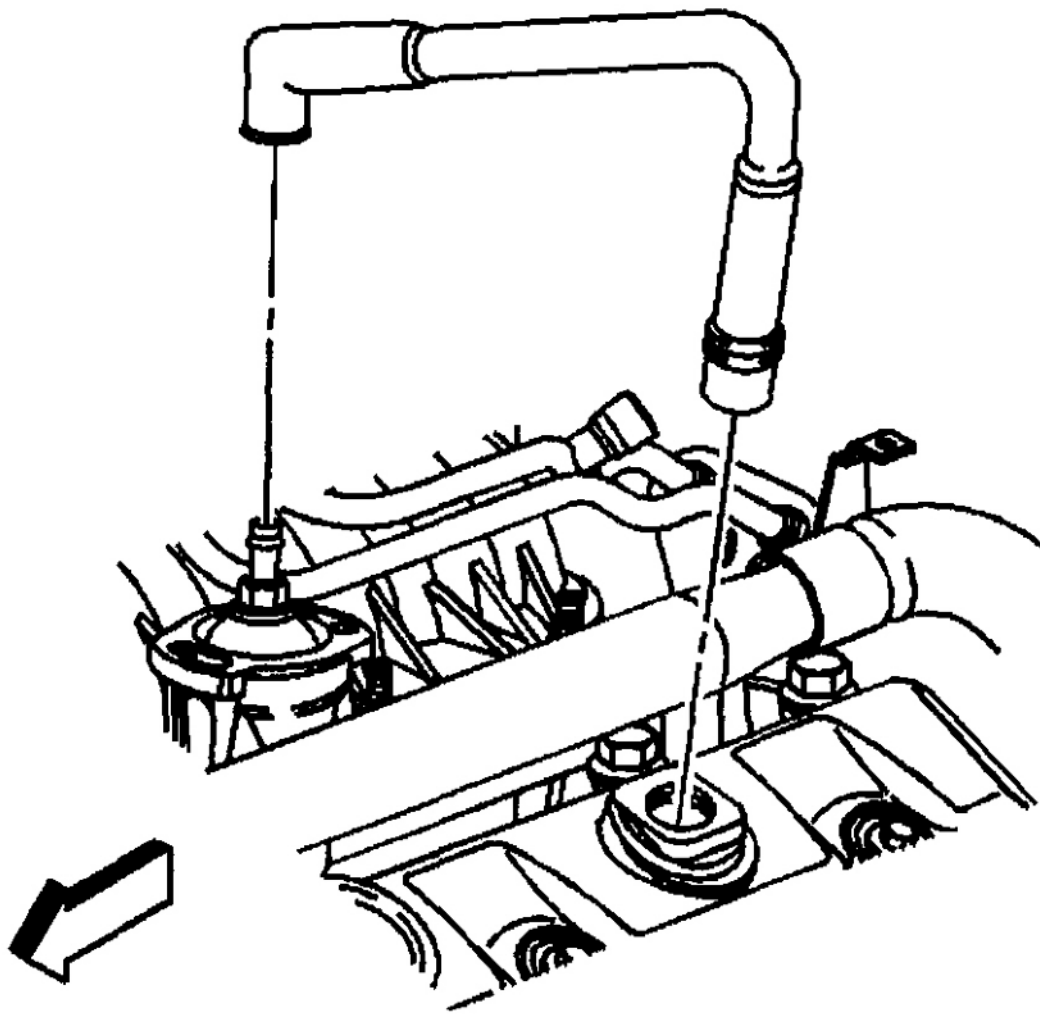
Tighten: Tighten the accelerator cable bracket nuts to 12 N.m (106 lb in).



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Fig. 67: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

20. Connect the power brake booster vacuum hose to the vacuum fitting (1).



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Fig. 68: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

21. Install the PCV valve hose to the PCV valve cover and the rocker arm cover.

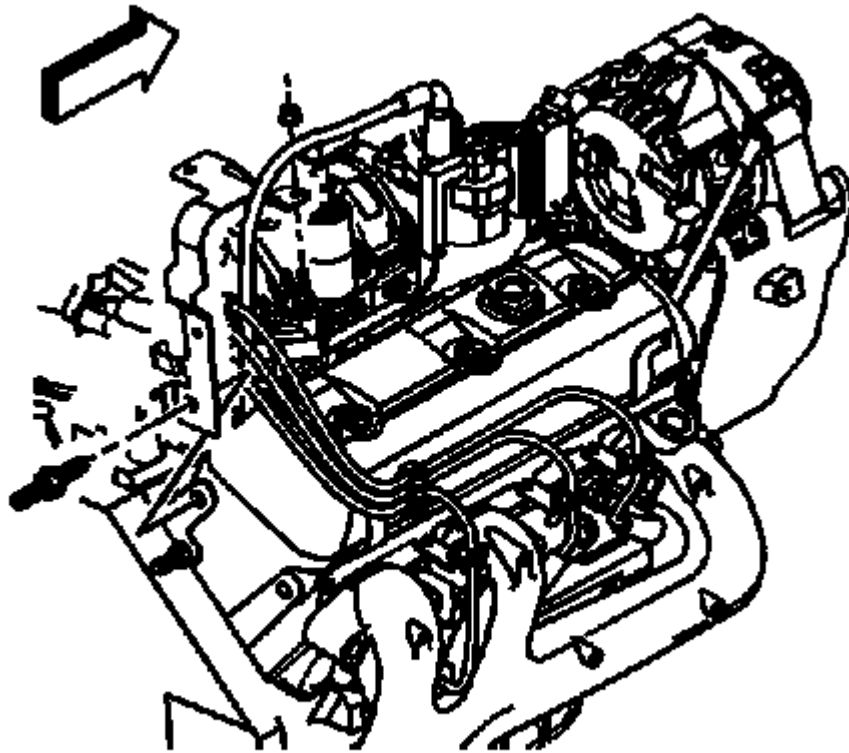


Fig. 69: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

22. Position the engine wiring harness and bracket.
23. Install the engine wiring harness bracket stud.

Tighten: Tighten the engine wiring harness rear bracket stud to 25 N.m (18 lb ft).

24. Install the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.

Tighten: Tighten the engine wiring harness rear bracket nut to 9 N.m (80 lb in).

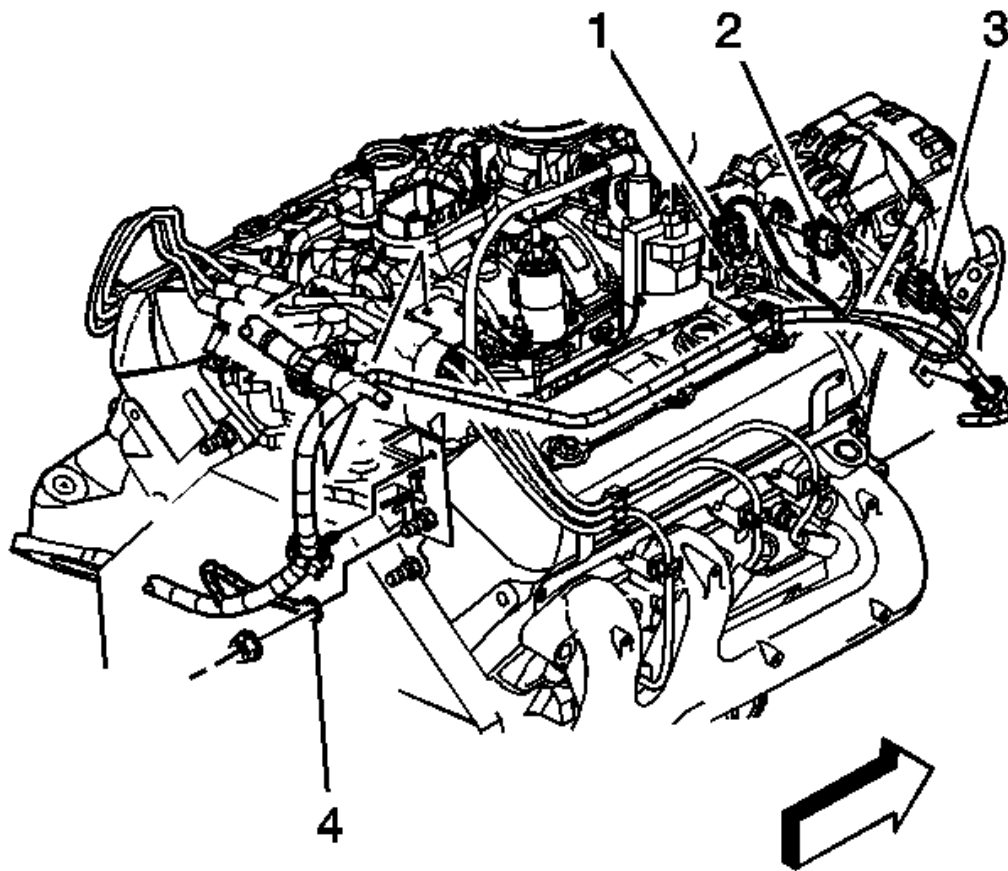
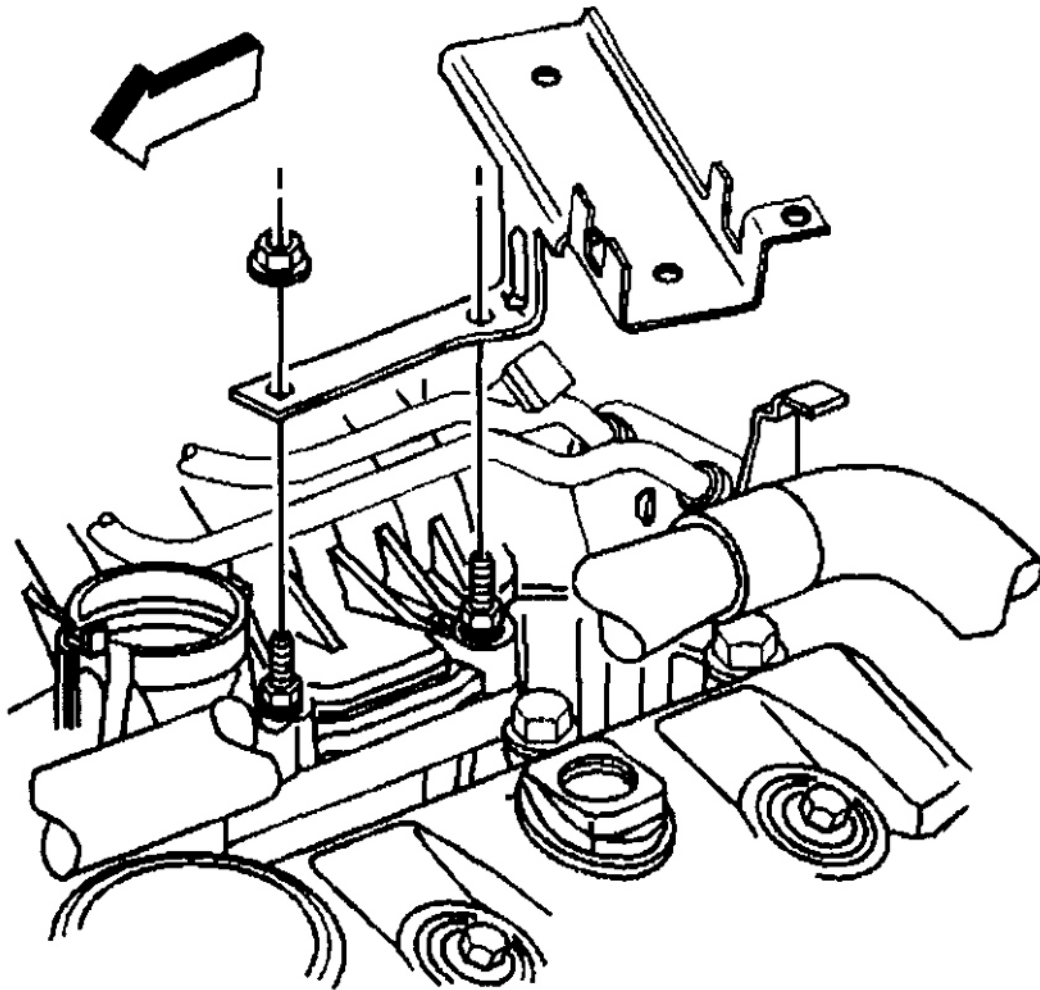


Fig. 70: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

25. Install the engine wiring harness ground nut and ground wire (4) to the rear of the right cylinder head.

Tighten: Tighten the engine wiring harness ground nut to 16 N.m (12 lb ft).

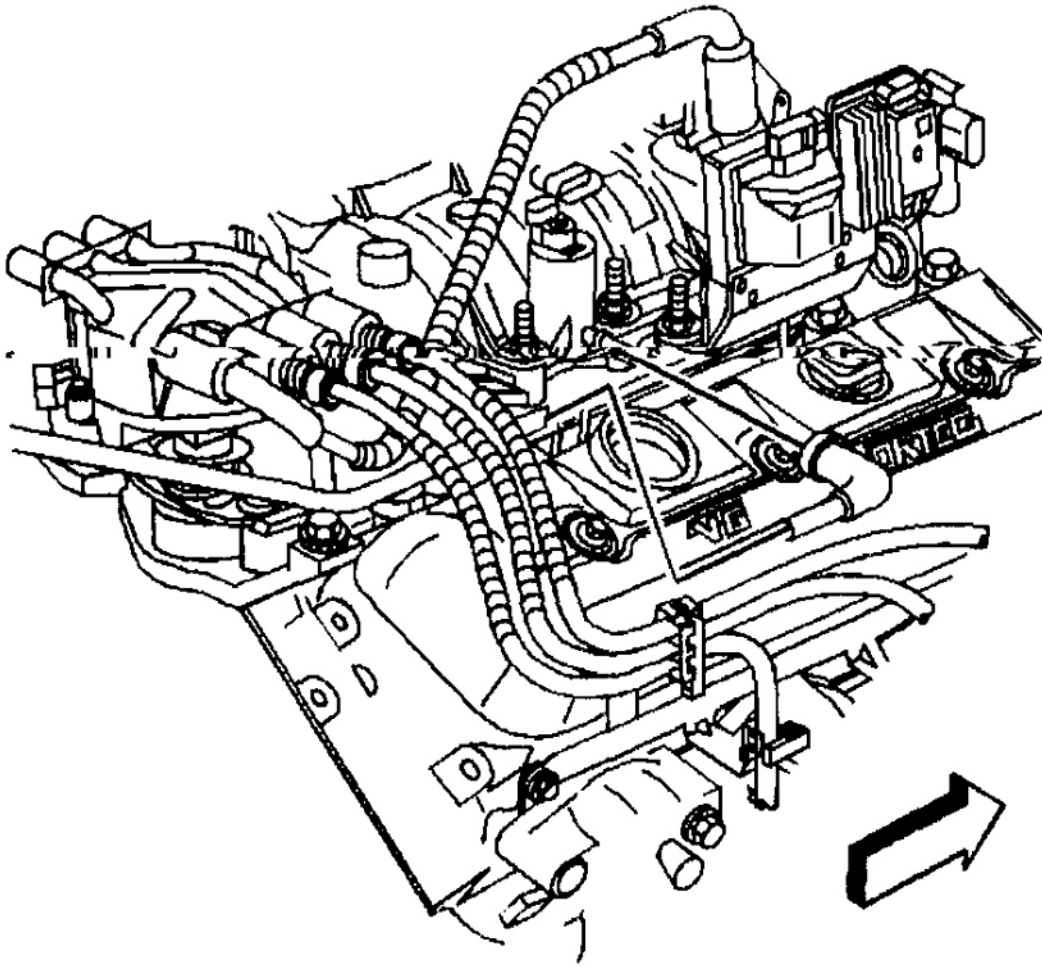


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Fig. 71: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

26. Install the engine wiring harness bracket to the studs.
27. Install the engine wiring harness bracket nuts.

Tighten: Tighten the engine wiring harness bracket nuts to 12 N.m (106 lb in).



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Fig. 72: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

28. Connect the EVAP canister harness to the purge solenoid valve.

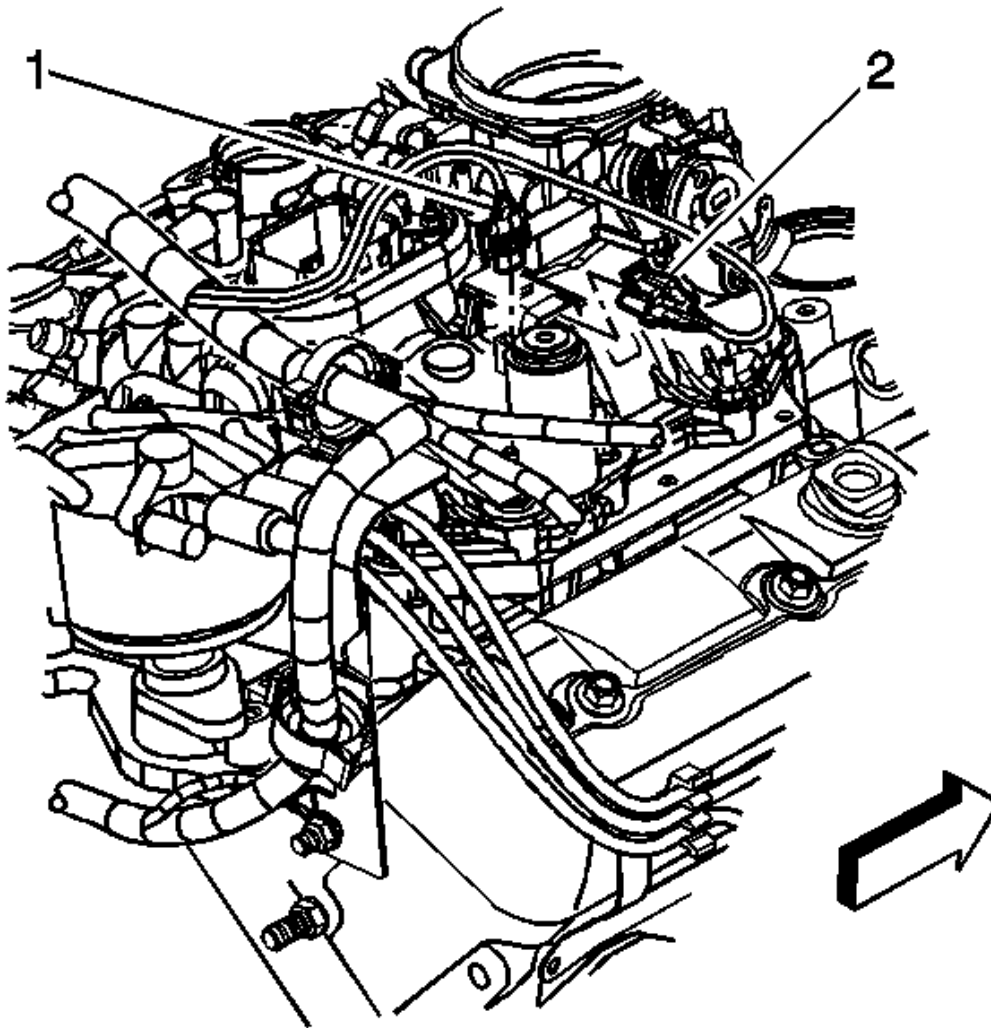


Fig. 73: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

29. Connect the following electrical connectors:
- The EVAP canister purge solenoid valve (1)
 - The MAP sensor (2)

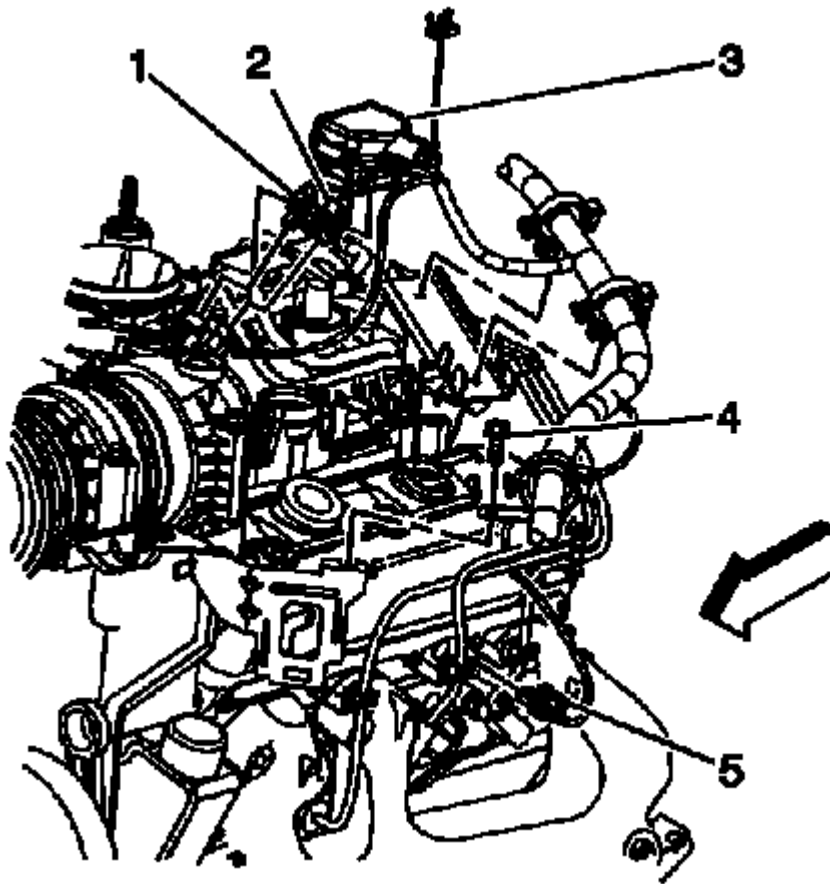


Fig. 74: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

30. Connect the following electrical connectors:
 - The TP sensor (1)
 - The IAC motor (2)
 - The control port injector module (3)
31. Install the engine wiring harness clip bolt (4).

Tighten: Tighten the engine wiring harness clip bolt to 9 N.m (80 lb in).

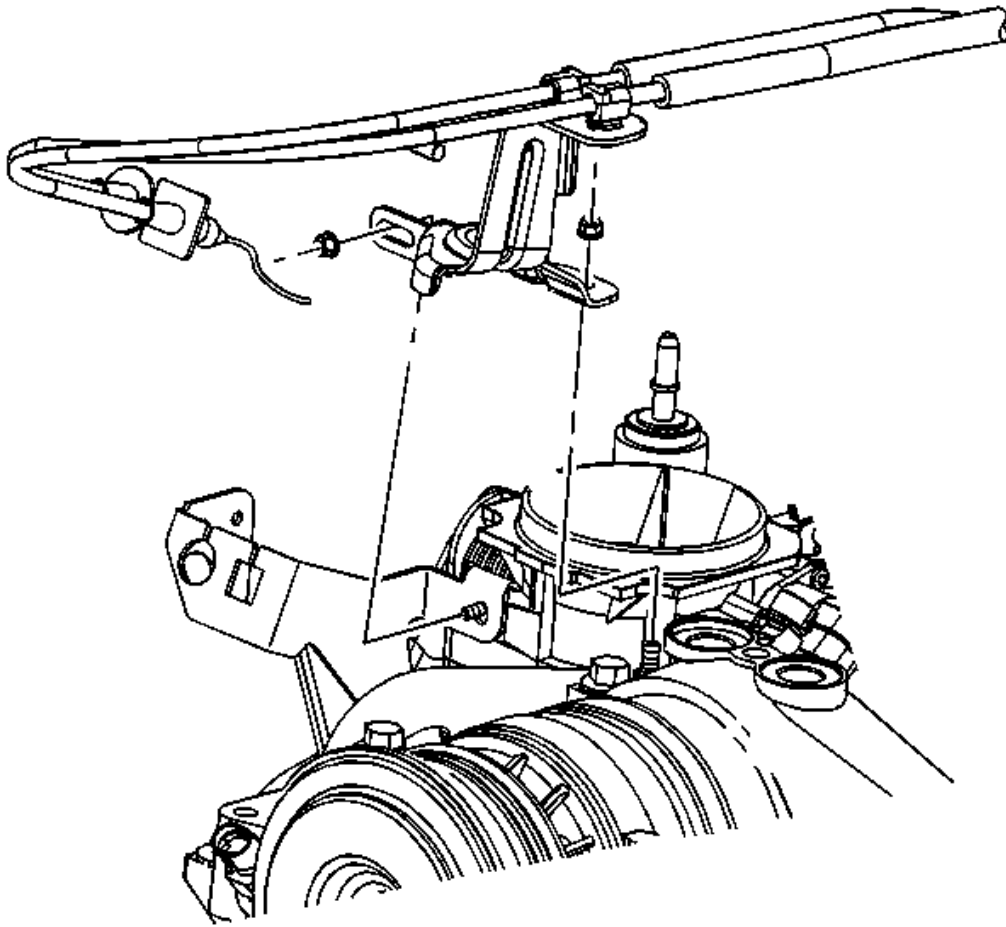


Fig. 75: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

32. Position the bracket and cables.
33. Install the accelerator control cable bracket with the cables attached, to the throttle body.
34. Install the accelerator control cable bracket nuts.

Tighten: Tighten the accelerator control cable bracket nuts to 9 N.m (80 lb in).

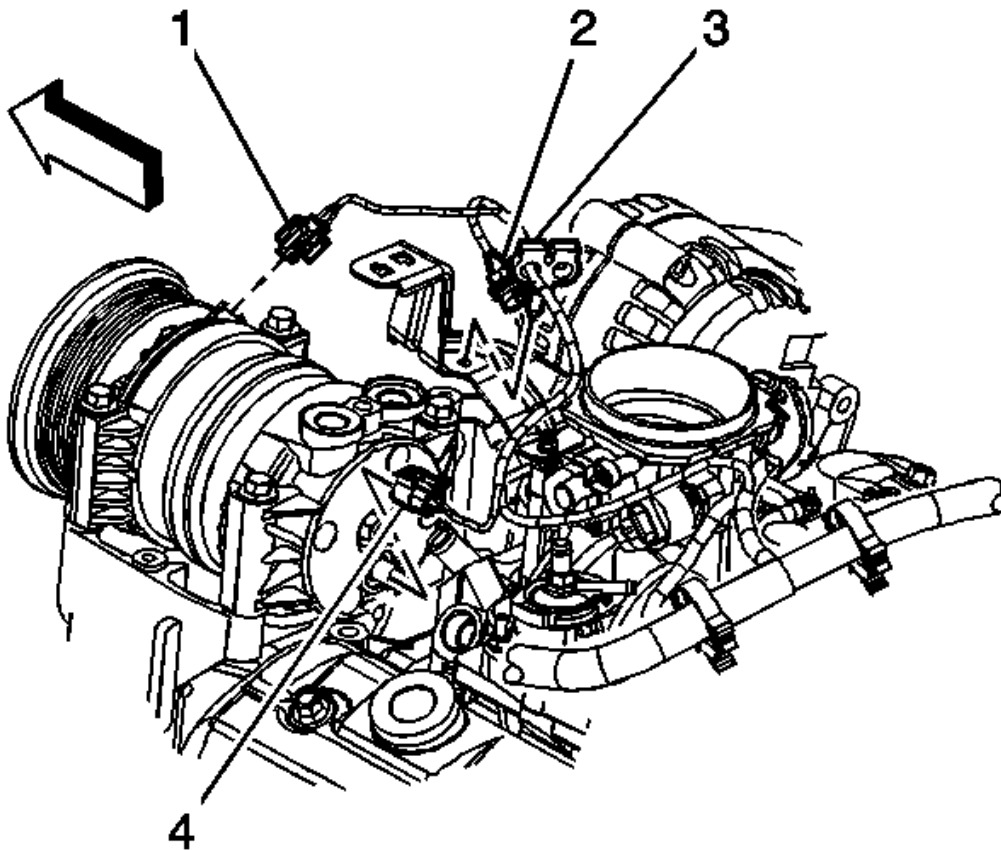


Fig. 76: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

35. Connect the following electrical connectors:
- The A/C compressor clutch (1), if equipped
 - The EGR valve (2)
 - The A/C pressure switch (4), if equipped
36. Install the engine wiring harness clip (3) to the accelerator control cable bracket.

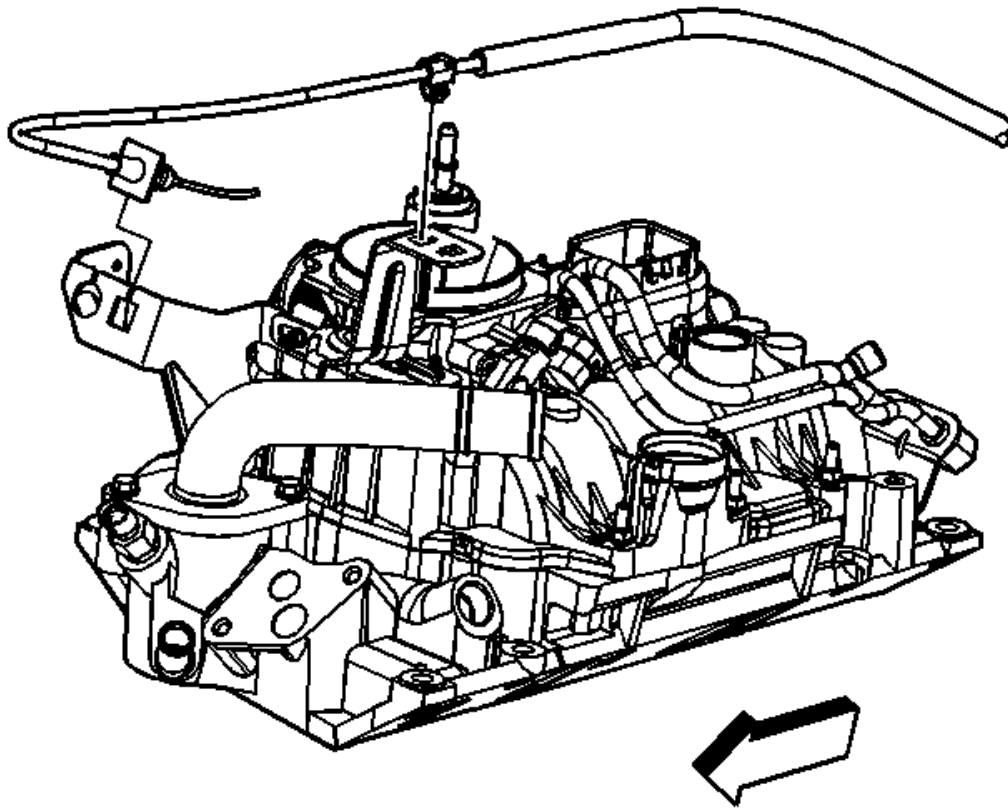


Fig. 77: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

37. Install the accelerator cable to the accelerator control cable bracket.

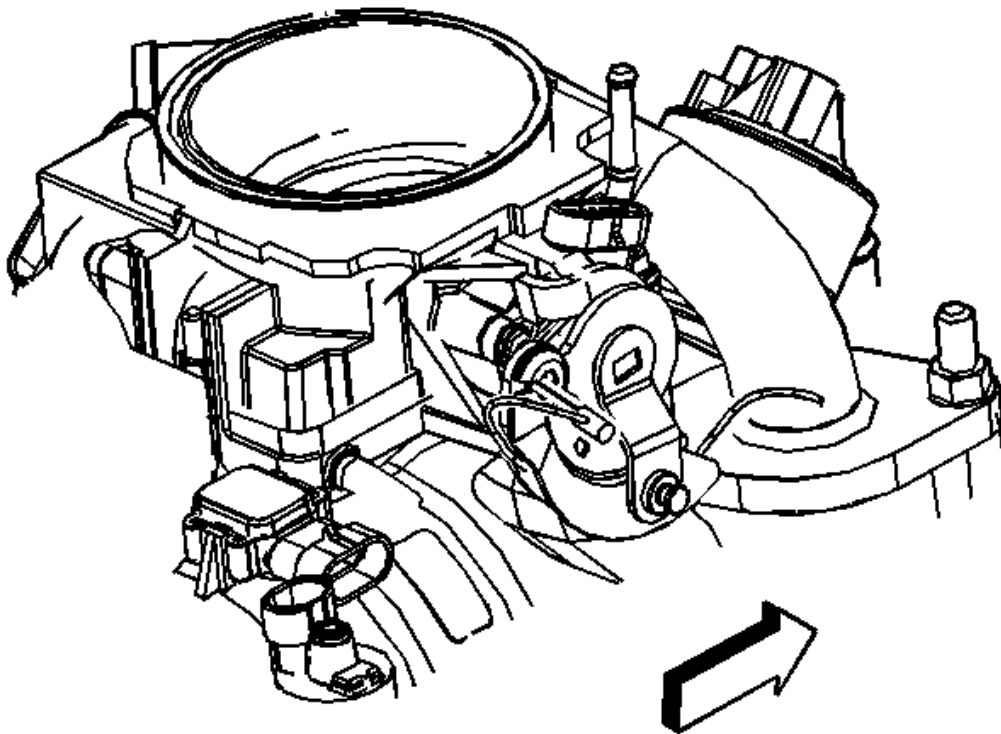


Fig. 78: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

38. Install the accelerator cable to the throttle body lever.

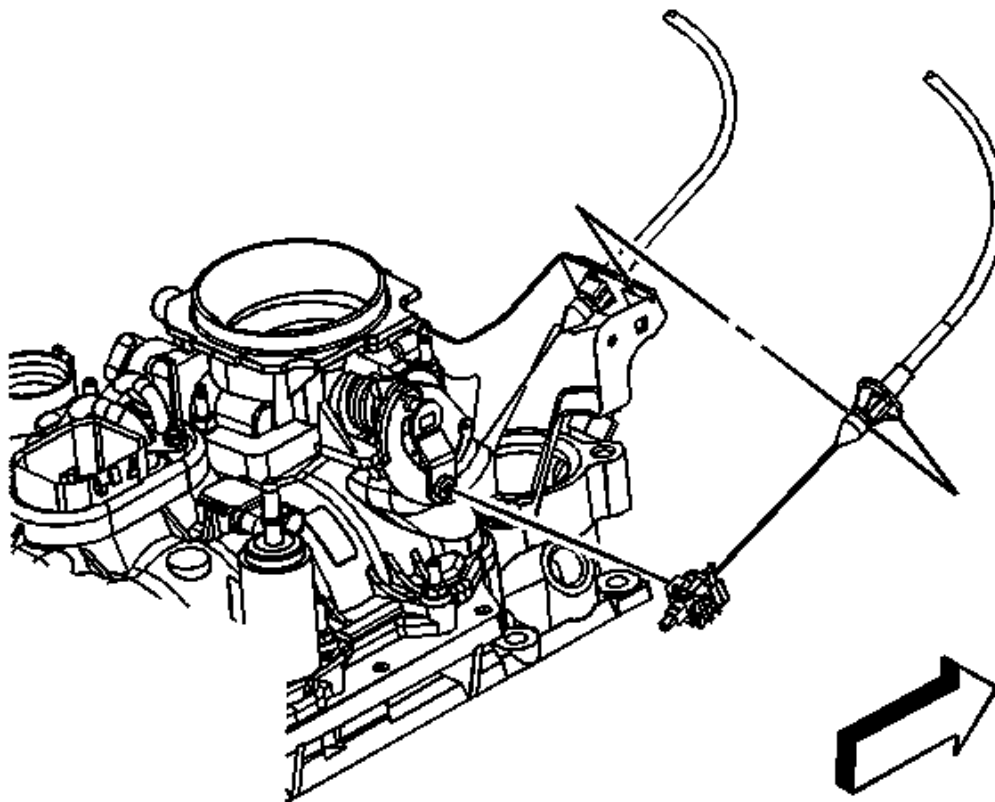


Fig. 79: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

39. Install the cruise control cable to the accelerator control cable bracket, if equipped.
40. Connect the cruise control cable to the throttle lever, if equipped.
41. Install the fuel pipes/hoses.

INTAKE MANIFOLD REPLACEMENT - LOWER

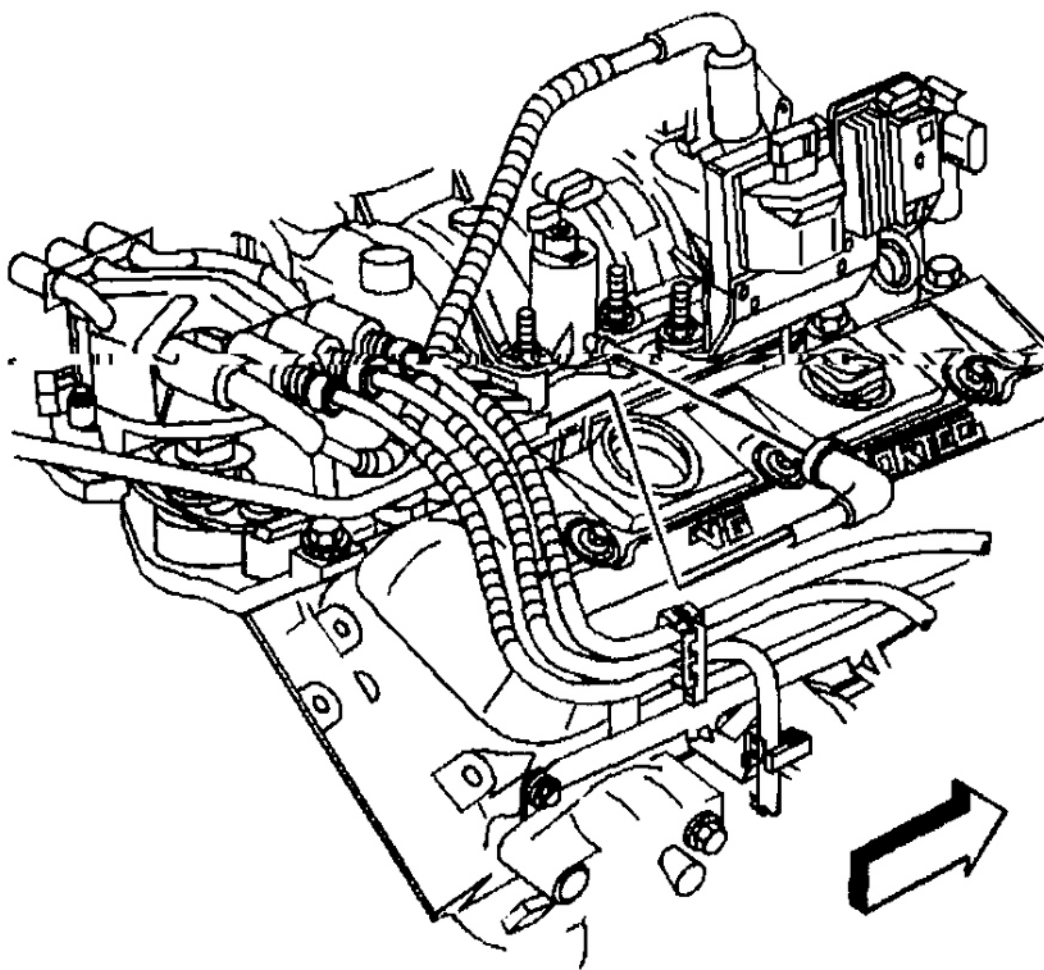
IMPORTANT:

- The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.
- It is not necessary to remove the upper intake manifold in order to remove the lower intake manifold.
- Do not allow dirt or debris to enter the fuel system. Ensure that the ends of the fuel system are properly sealed.

- Do not disassemble the Central Sequential Fuel Injection (SFI) unit, unless service is required.

Removal Procedure

1. Drain the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM** .
2. Remove the fuel pipes/hoses.
3. Remove the distributor. Refer to **DISTRIBUTOR** .
4. Disconnect the evaporative emission (EVAP) canister harness from the purge solenoid valve.



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Fig. 80: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

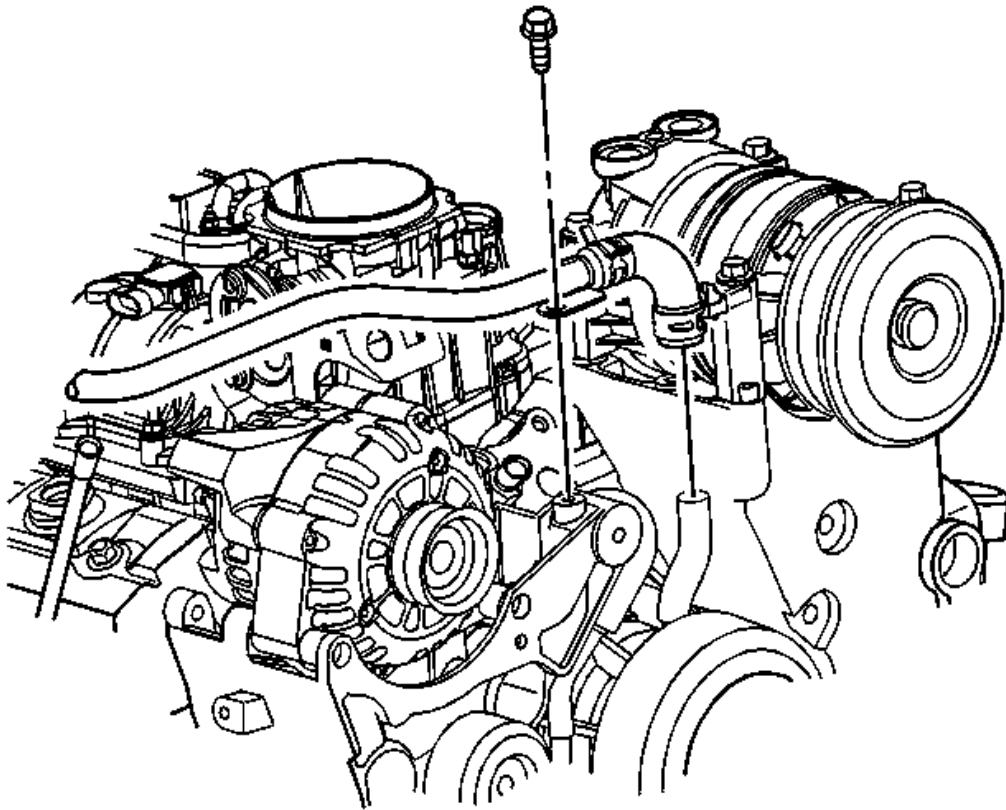


Fig. 81: View Of Heater Outlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

5. Reposition the heater outlet hose clamp.
6. Remove the heater outlet hose from the intake manifold.

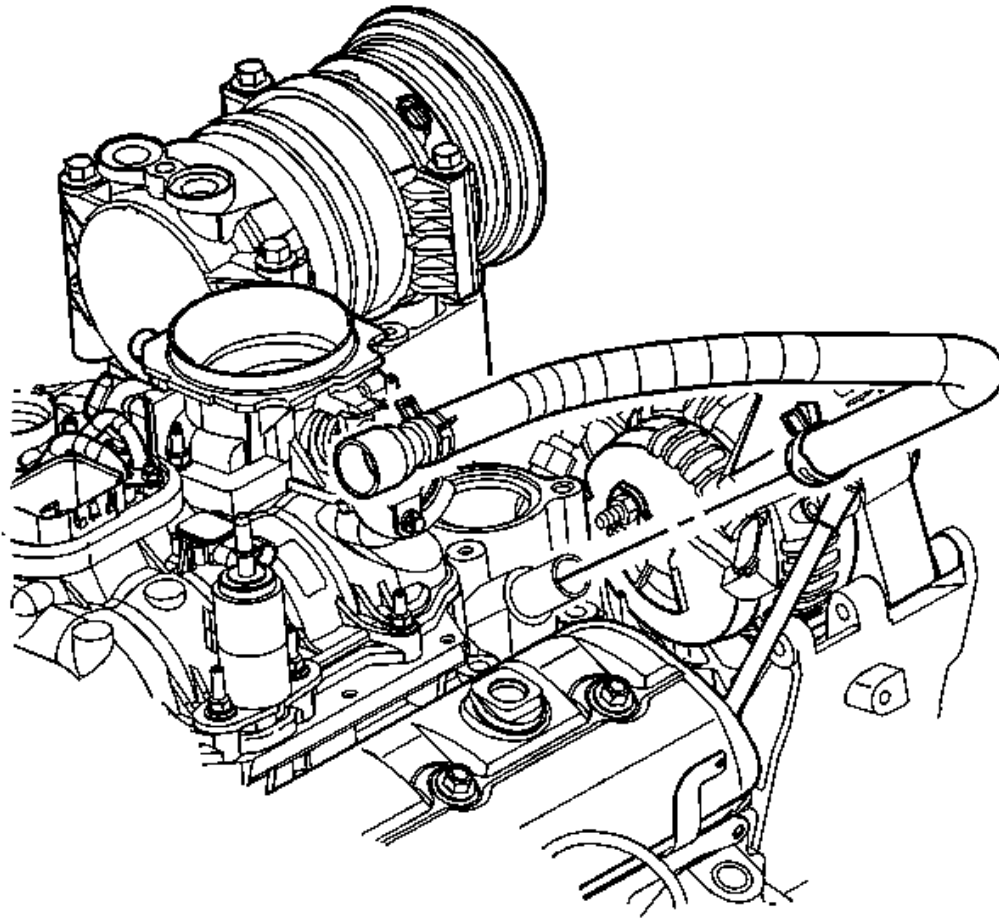


Fig. 82: View Of Heater Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

7. Reposition the heater inlet hose clamp.
8. Remove the heater outlet hose clip bolt.
9. Remove the heater inlet hose from the water pump.
10. Reposition the heater inlet and outlet hoses.

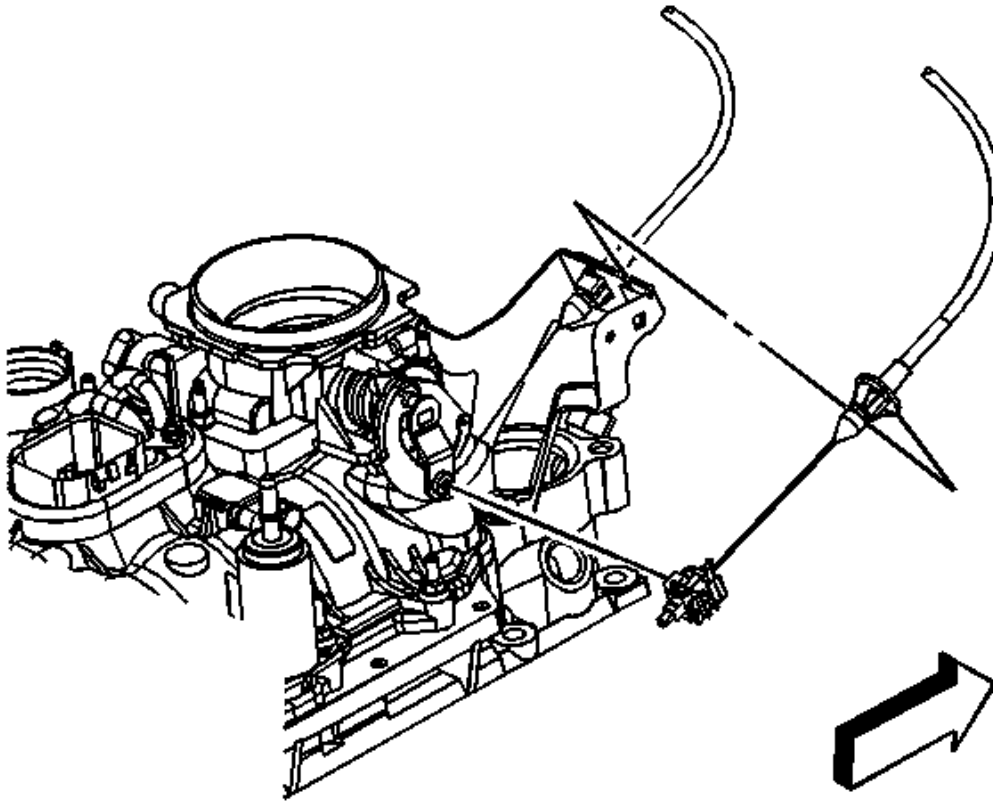


Fig. 83: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the cruise control cable from the throttle body lever, if equipped.
12. Remove the cruise control cable from the accelerator control cable bracket, if equipped.

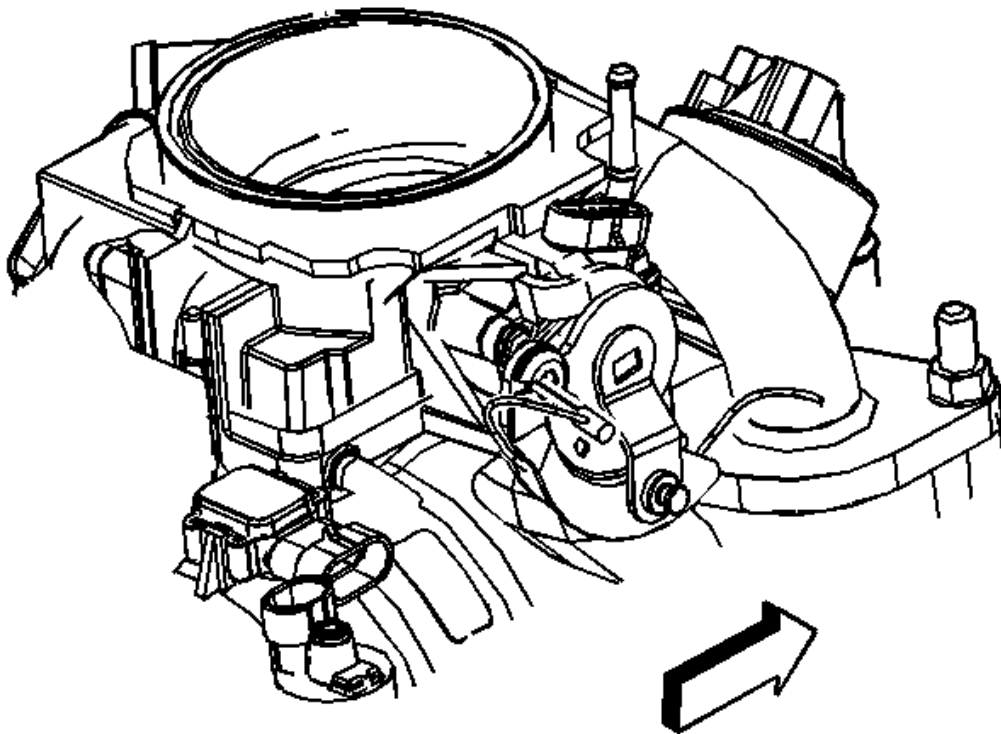


Fig. 84: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

13. Remove the accelerator cable from the throttle body lever.

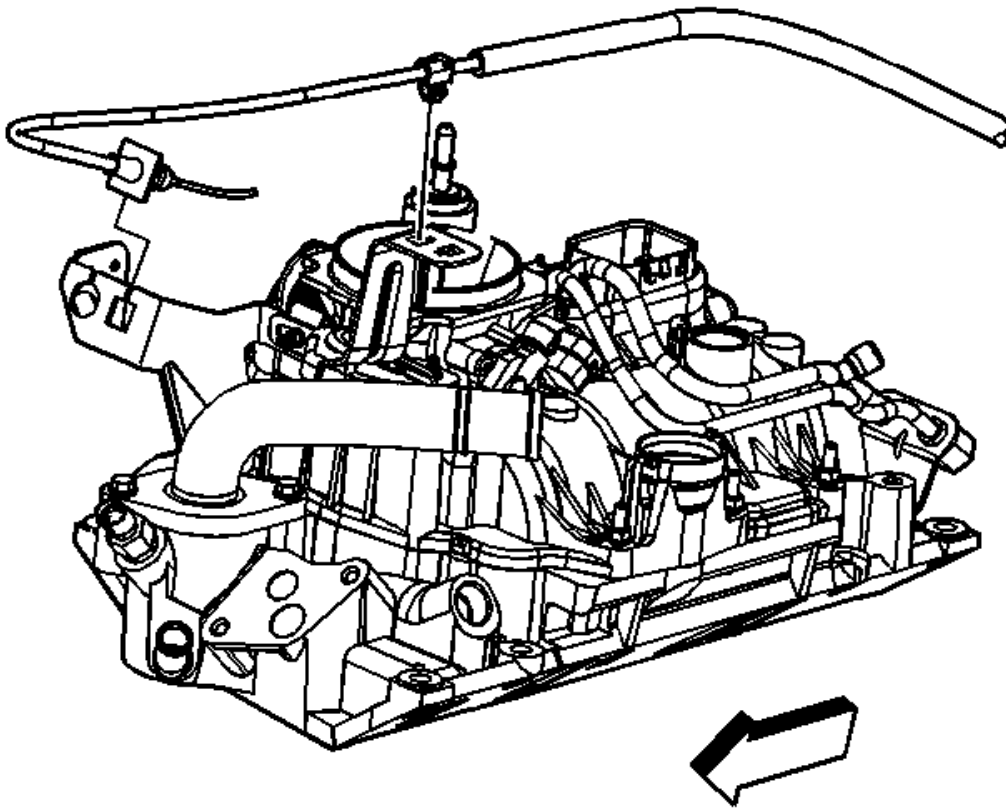


Fig. 85: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

14. Remove the accelerator cable from the accelerator control cable bracket.

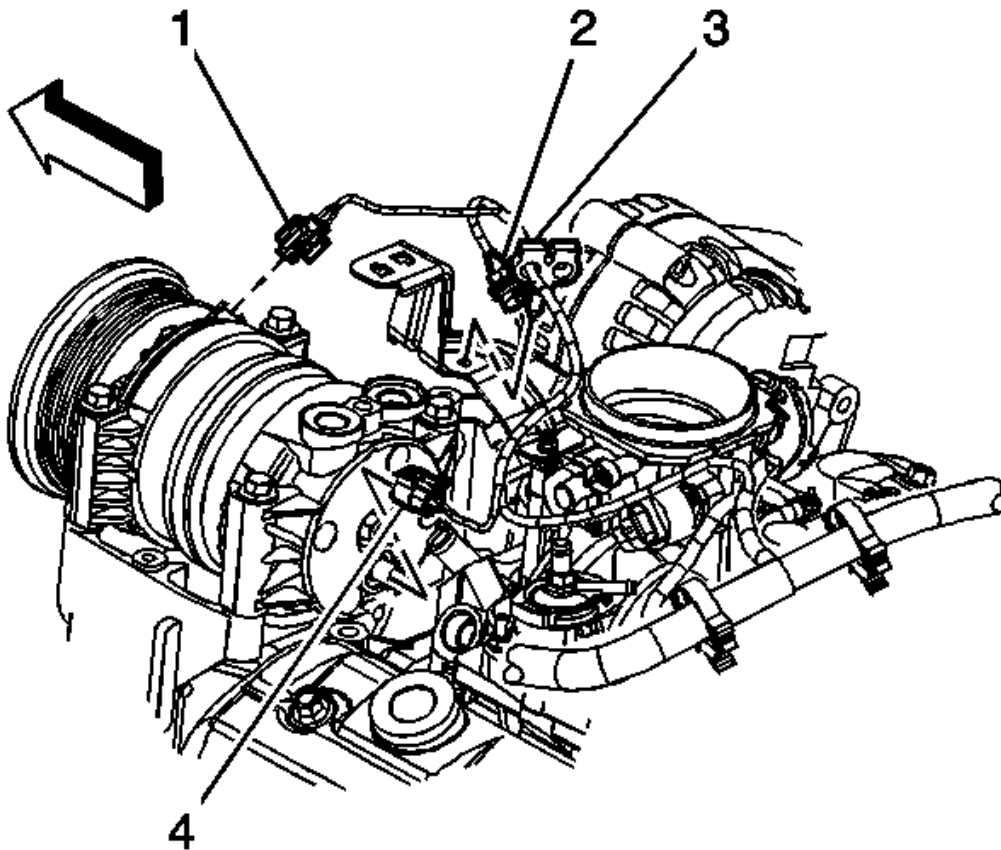


Fig. 86: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the following electrical connectors:
 - The air conditioning (A/C) compressor clutch (1), if equipped
 - The exhaust gas recirculation (EGR) valve (2)
 - The A/C pressure switch (4), if equipped
16. Remove the engine wiring harness clip (3) from the accelerator control cable bracket.

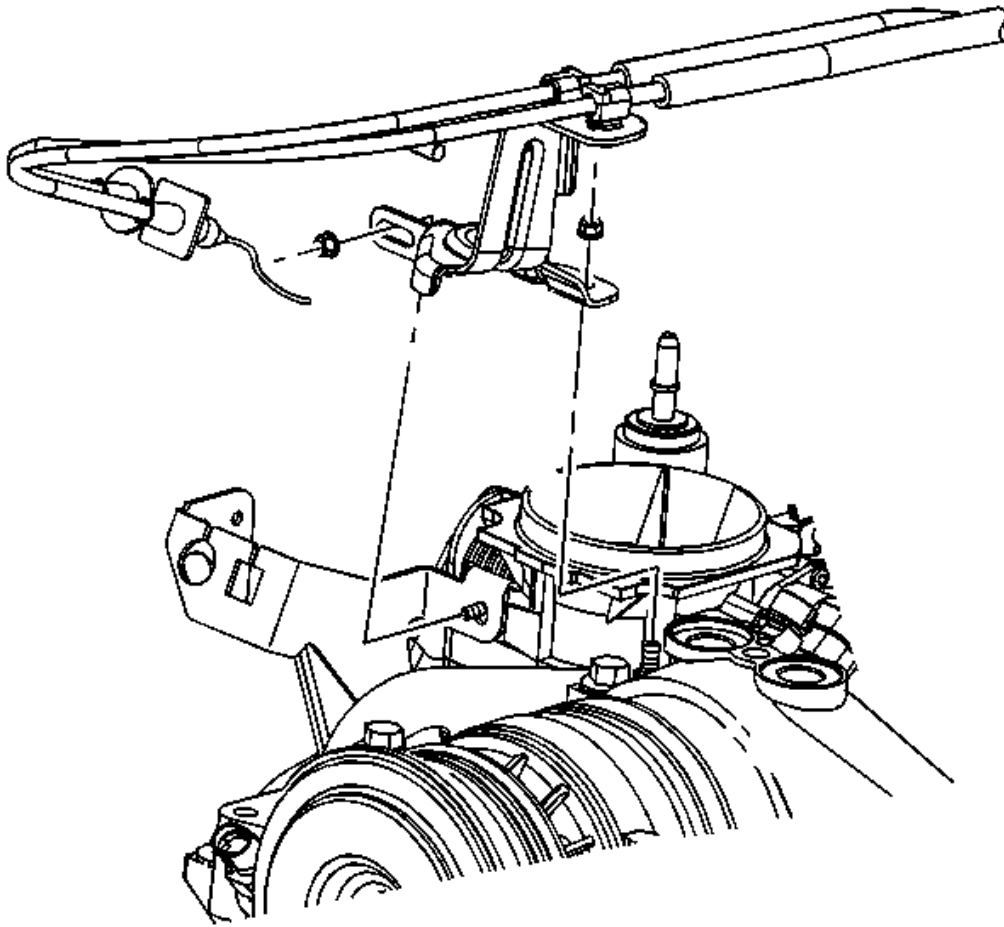


Fig. 87: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

17. Remove the accelerator control cable bracket nuts.
18. Remove the accelerator control cable bracket with the cables attached, from the throttle body.
19. Reposition and secure the bracket and cables out of the way.

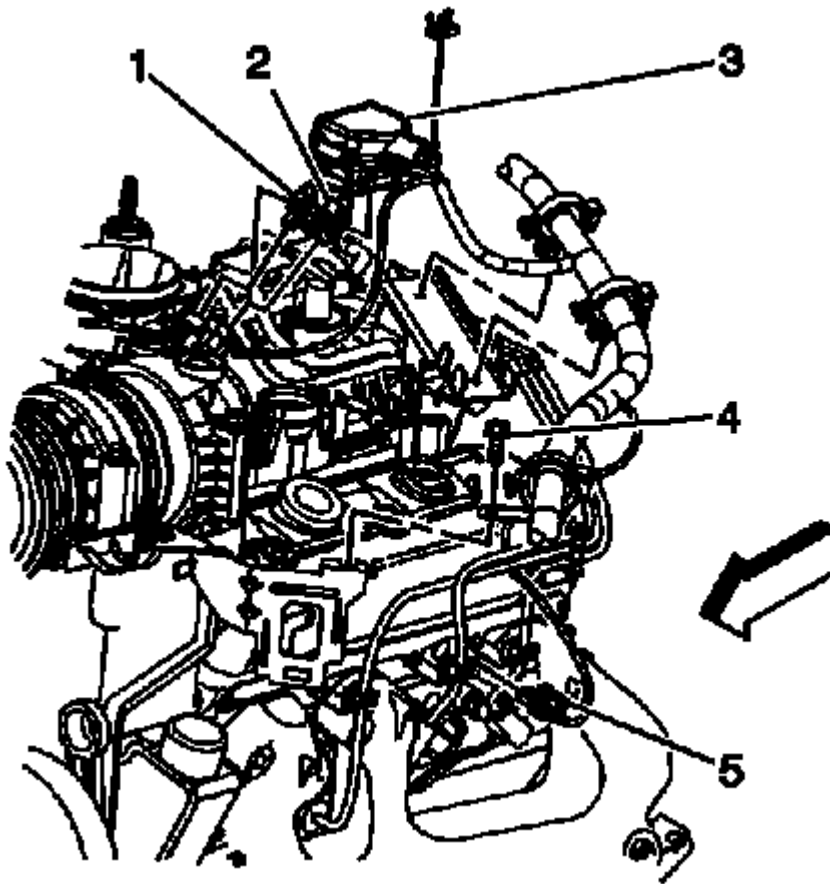


Fig. 88: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

20. Disconnect the following electrical connectors:
 - The throttle position (TP) sensor (1)
 - The idle air control (IAC) motor (2)
 - The control port injector module (3)
21. Remove the engine wiring harness clip bolt (4).

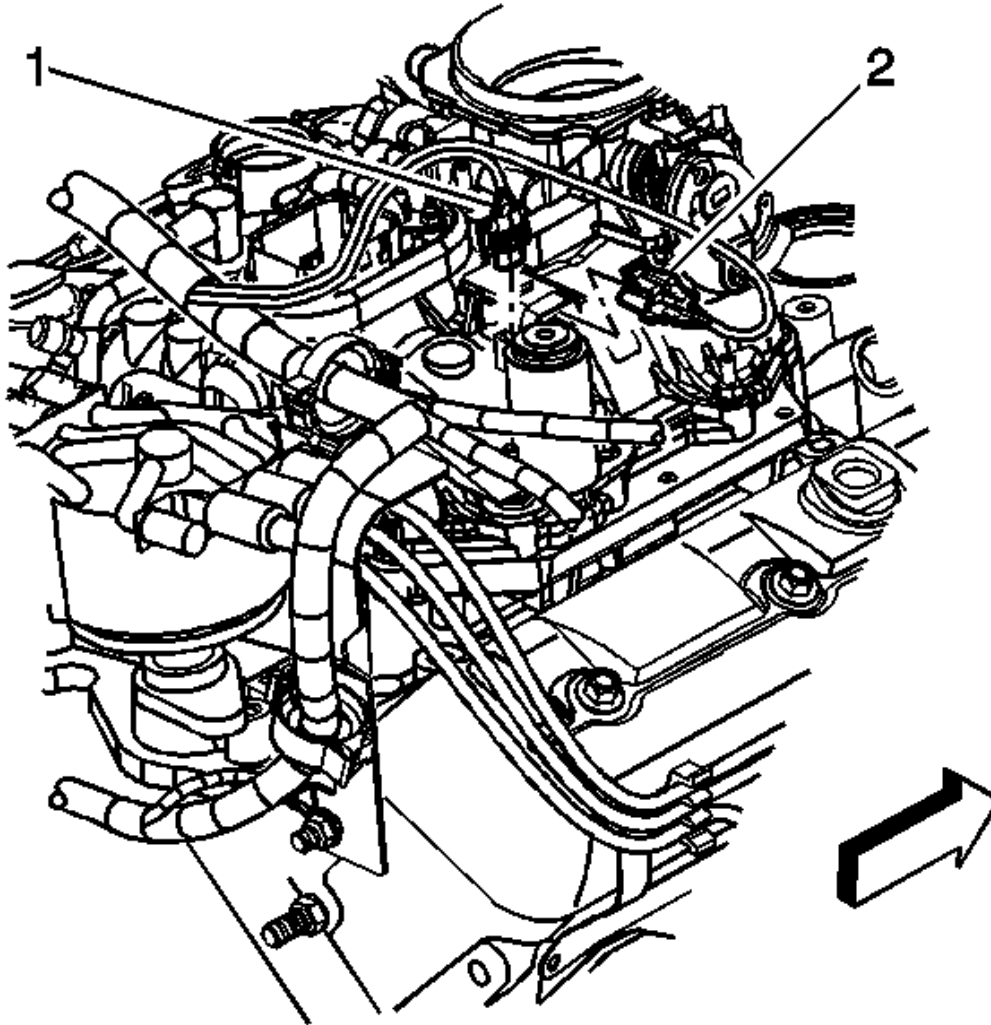
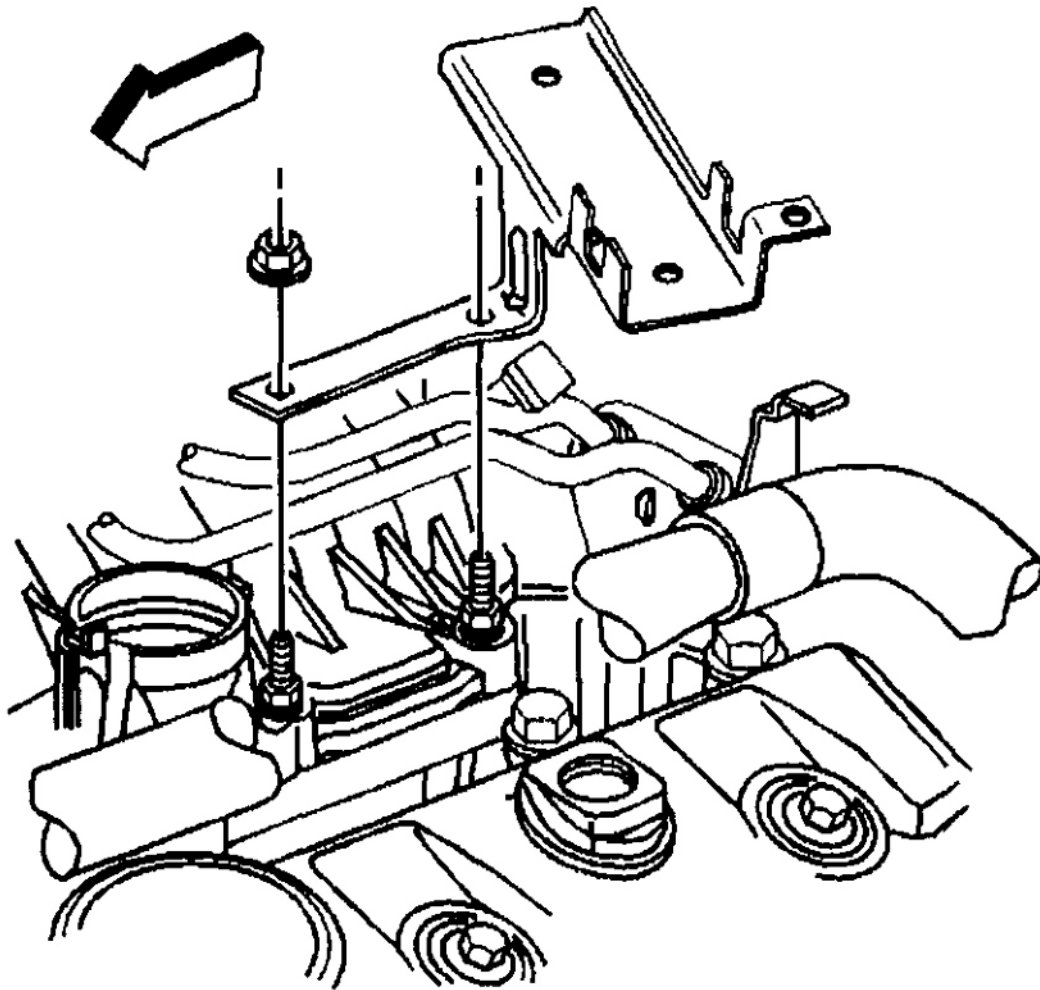


Fig. 89: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

22. Disconnect the following electrical connectors:
- The evaporative emission (EVAP) canister purge solenoid valve (1)
 - The manifold absolute pressure (MAP) sensor (2)



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Fig. 90: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

23. Remove the engine wiring harness bracket nuts.
24. Remove the engine wiring harness bracket from the studs.

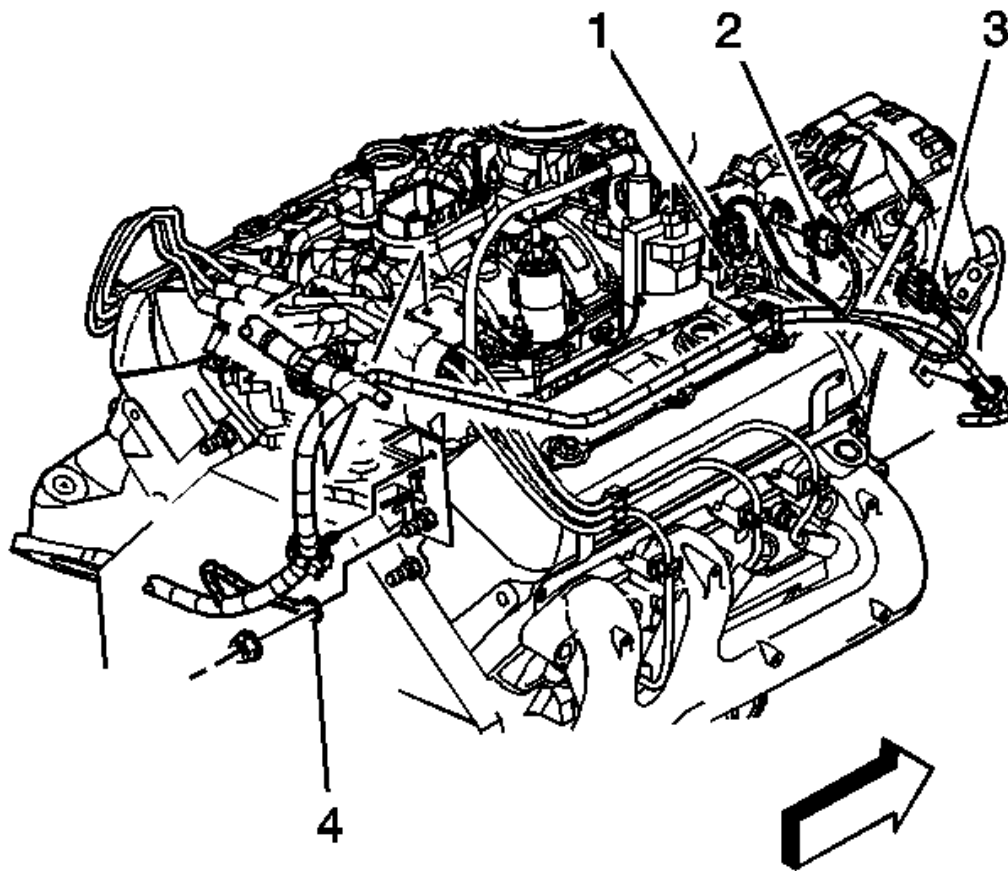


Fig. 91: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

25. Remove the engine wiring harness ground nut and ground wire (4) from the rear of the right cylinder head.

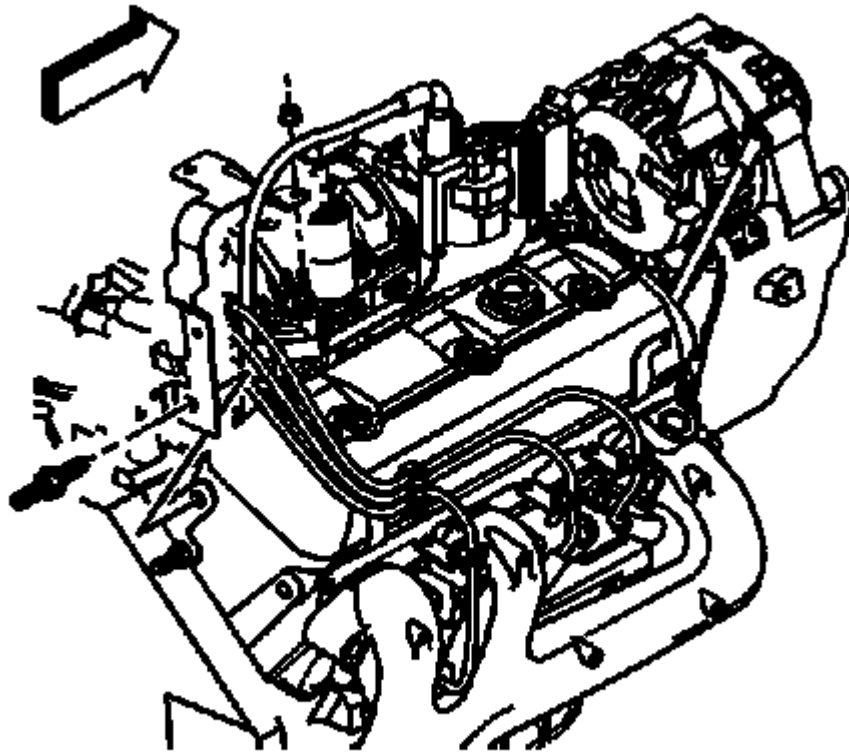
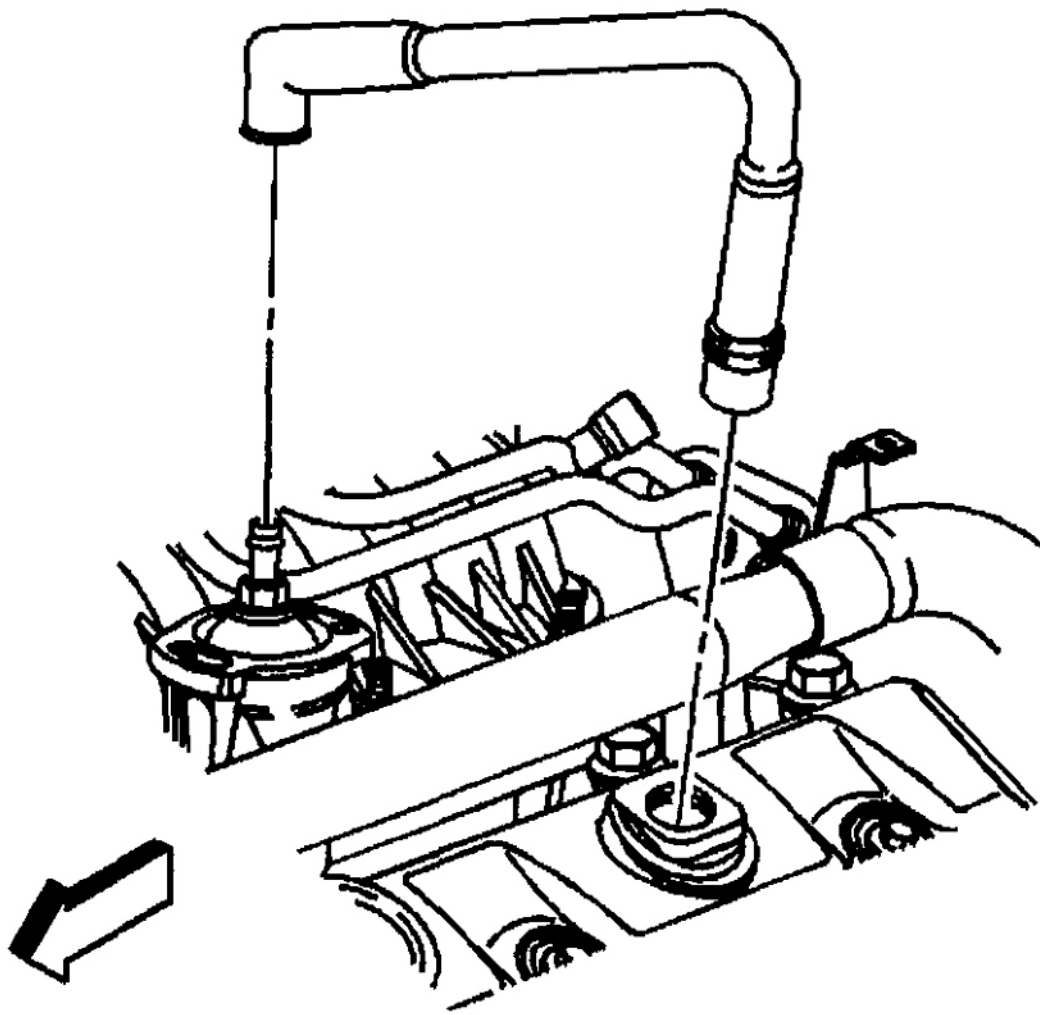


Fig. 92: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

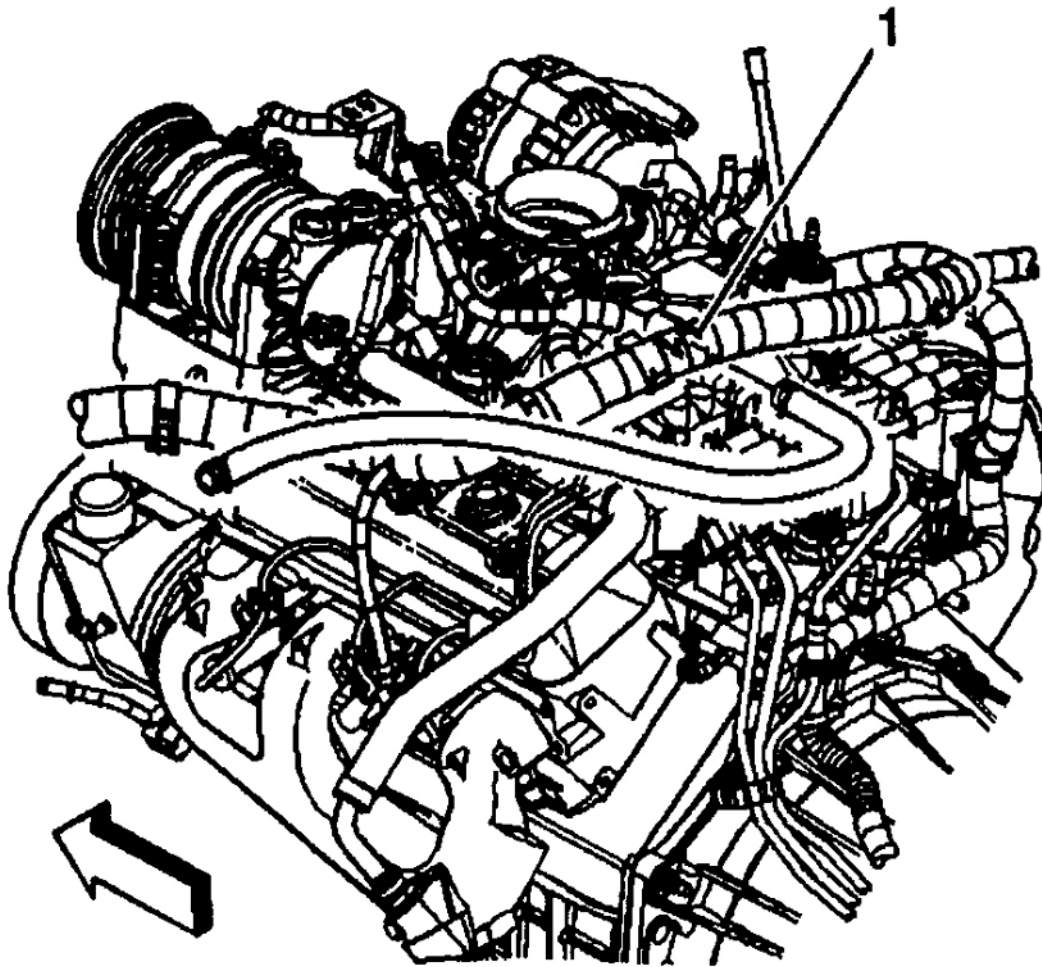
26. Remove the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.
27. Remove the stud holding the engine wiring harness bracket.
28. Reposition the engine wiring harness with the bracket aside.



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Fig. 93: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

29. Remove the PCV valve hose from the PCV valve cover and the rocker arm cover.



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Fig. 94: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

30. Disconnect the power brake booster vacuum hose from the vacuum fitting (1).

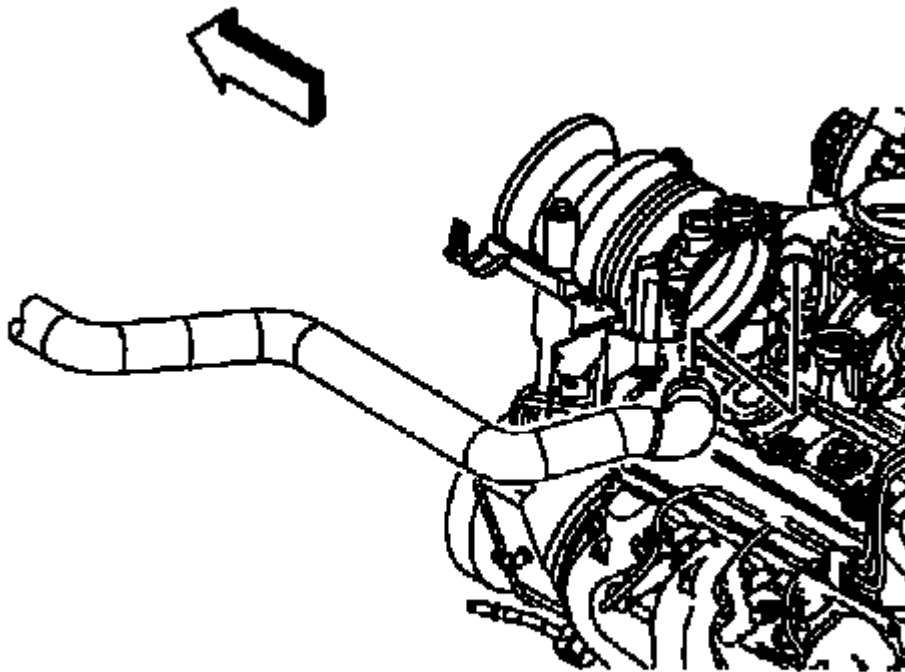


Fig. 95: View Of Radiator Inlet Hose, Clamps & Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

31. Reposition the radiator inlet hose clamps.
32. Remove the radiator inlet hose from the thermostat housing.

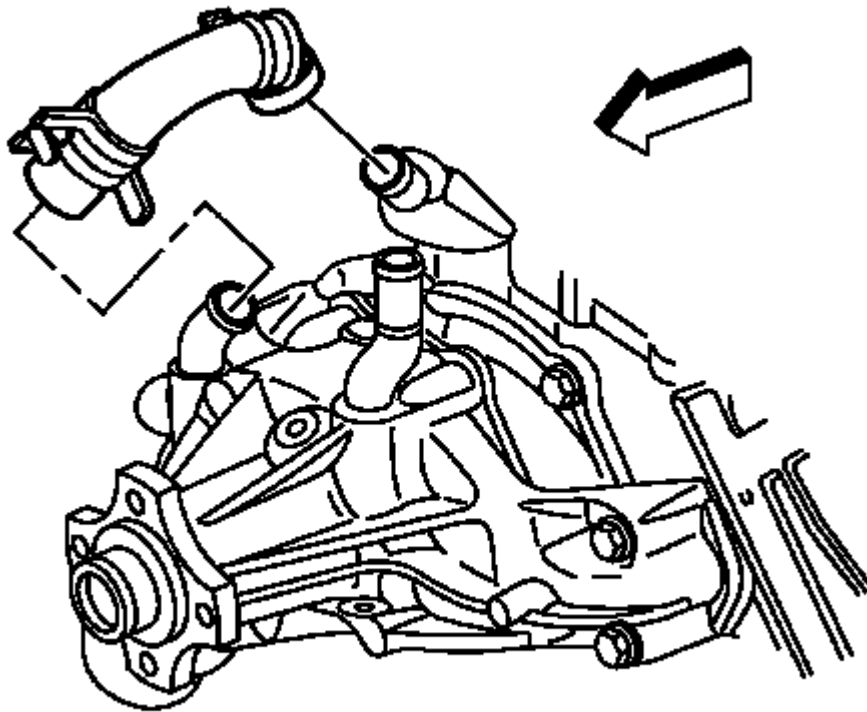
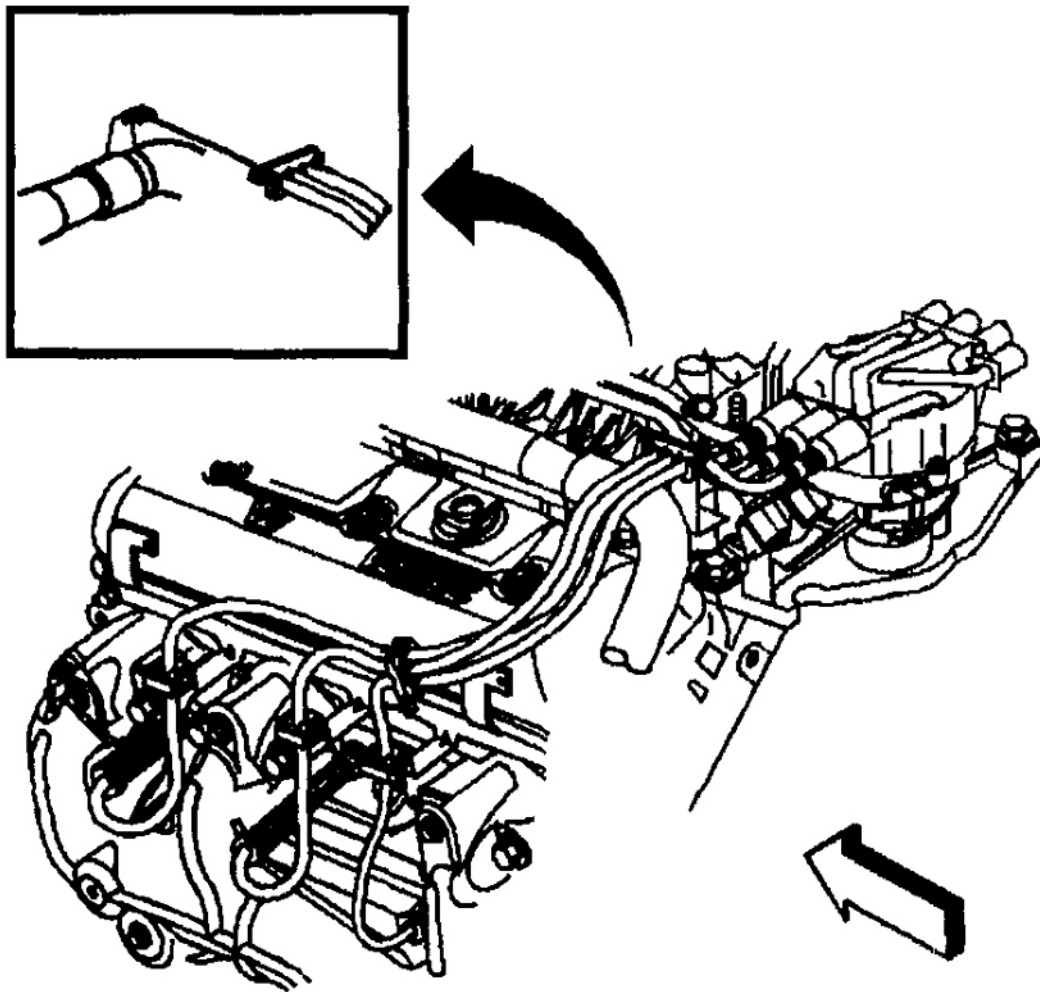


Fig. 96: View Of Water Pump Inlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

33. Reposition the water pump inlet hose clamps.
34. Remove the water pump inlet hose.



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Fig. 97: View Of Spark Plug Wire Harness Retainer
Courtesy of GENERAL MOTORS CORP.

35. Remove the spark plug wire harness retainer from the EGR valve inlet pipe.

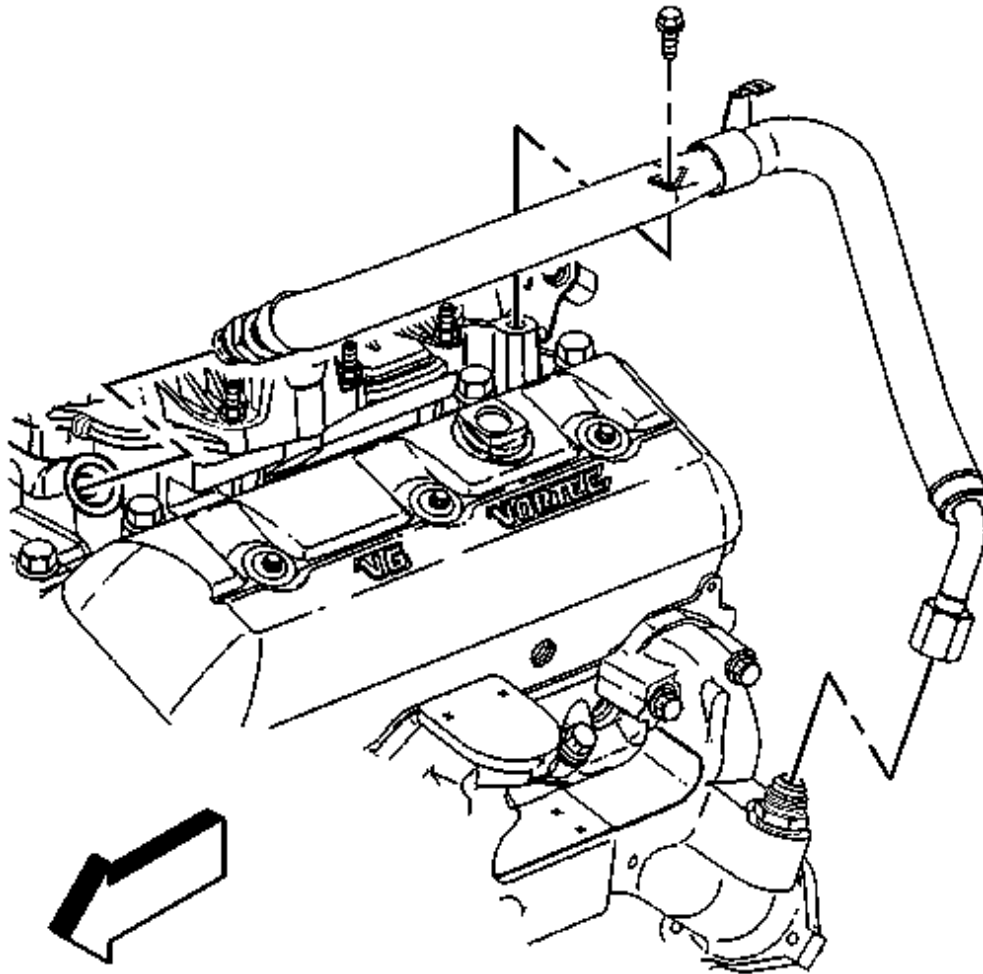


Fig. 98: View Of EGR Valve Inlet Pip & Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

36. Remove the EGR valve inlet pipe bracket bolt.
37. Remove the EGR valve inlet pipe.

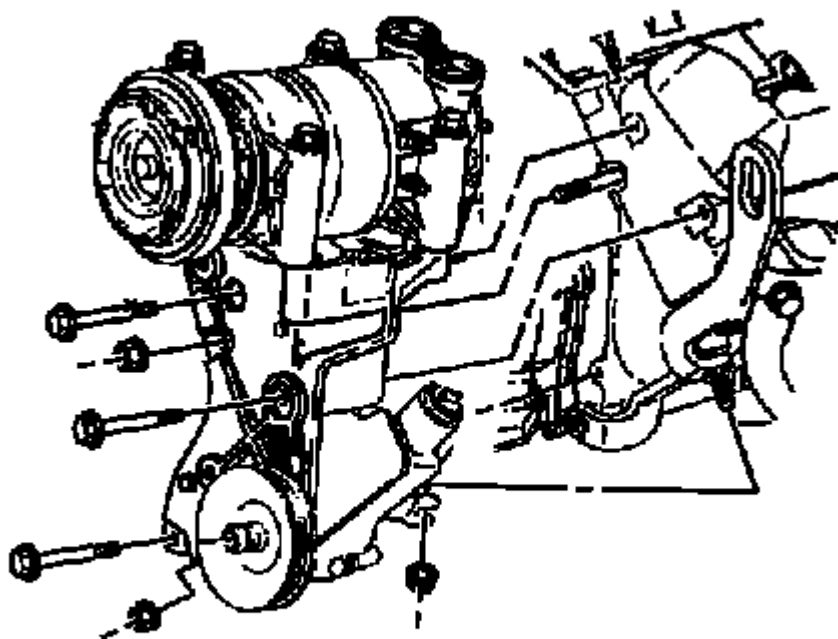


Fig. 99: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

38. In order to remove the front intake manifold bolt, perform the following:
1. Remove the drive belt. Refer to **Drive Belt Replacement**.
 2. Loosen the power steering (P/S) pump rear bracket nut.
 3. Remove the P/S pump rear bracket front nut.
 4. Remove the bolts and the nut for the P/S pump bracket.
 5. Leave the A/C compressor, if equipped, and the P/S pump on the bracket.
 6. Slide the P/S pump bracket forward to access the front intake manifold bolt.

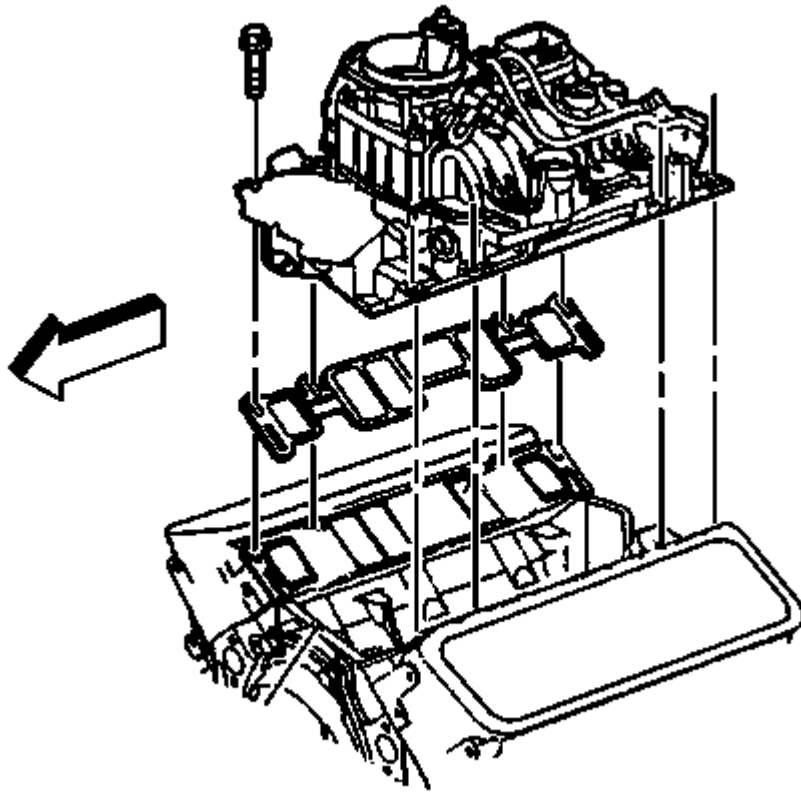


Fig. 100: View Of Intake Manifold Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

39. Remove the intake manifold - lower bolts.
40. Remove the intake manifold.
41. Remove and discard the intake manifold gaskets.
42. Clean and inspect the intake manifold - lower, if necessary. Refer to **INTAKE MANIFOLD CLEANING & INSPECTION** .

Installation Procedure

NOTE: Apply the proper amount of the sealant when assembling this component. Excessive use of the sealant can prohibit the component from sealing properly. A component that is not sealed properly can leak leading to extensive engine damage.

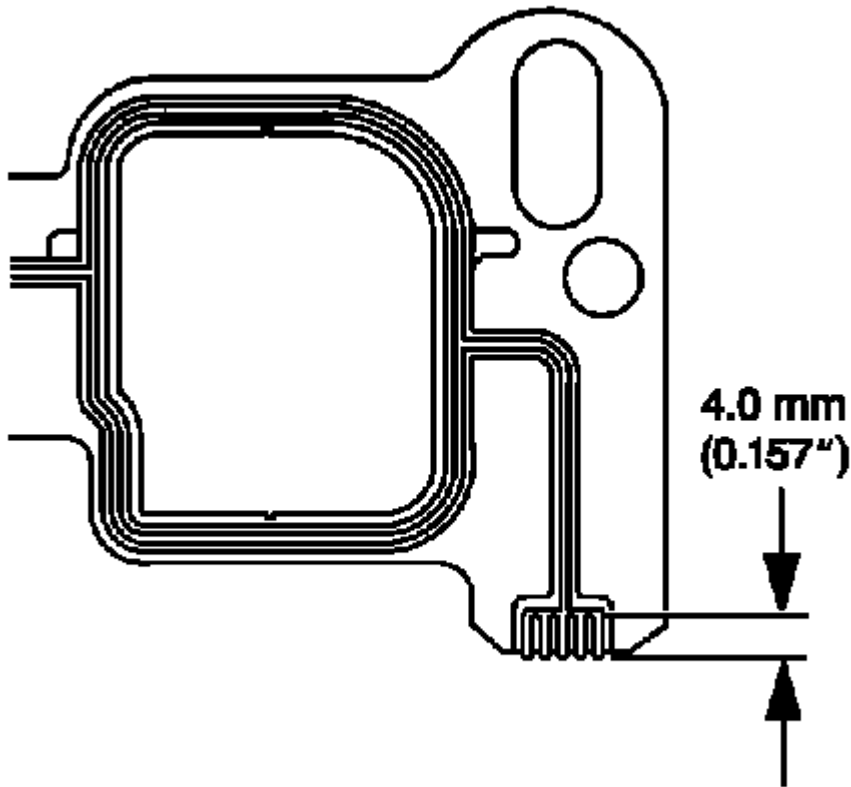


Fig. 101: Applying Adhesive To Cylinder Head Side Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The intake manifold gasket must be installed while the adhesive is still wet to the touch.

1. Apply a 4.0 mm (0.157 in) patch of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent to the cylinder head side of the intake manifold gasket at each end.
2. Install the intake manifold gasket onto the cylinder head. Use the gasket locating pins in order to properly seat the gasket.

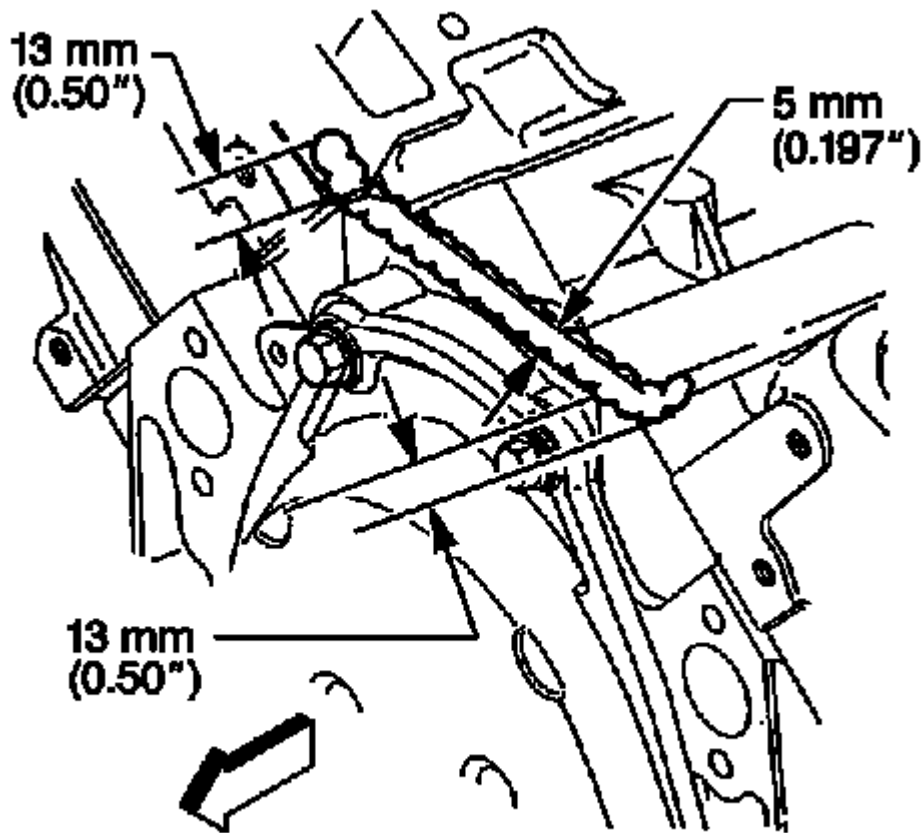


Fig. 102: Applying Adhesive To Front Top Of Engine Block
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The intake manifold must be installed and the fasteners tightened while the adhesive is still wet to the touch.

3. Apply a 5 mm (0.197 in) bead of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent to the front top of the engine block.
4. Extend the adhesive bead 13 mm (0.50 in) onto each intake manifold gasket.

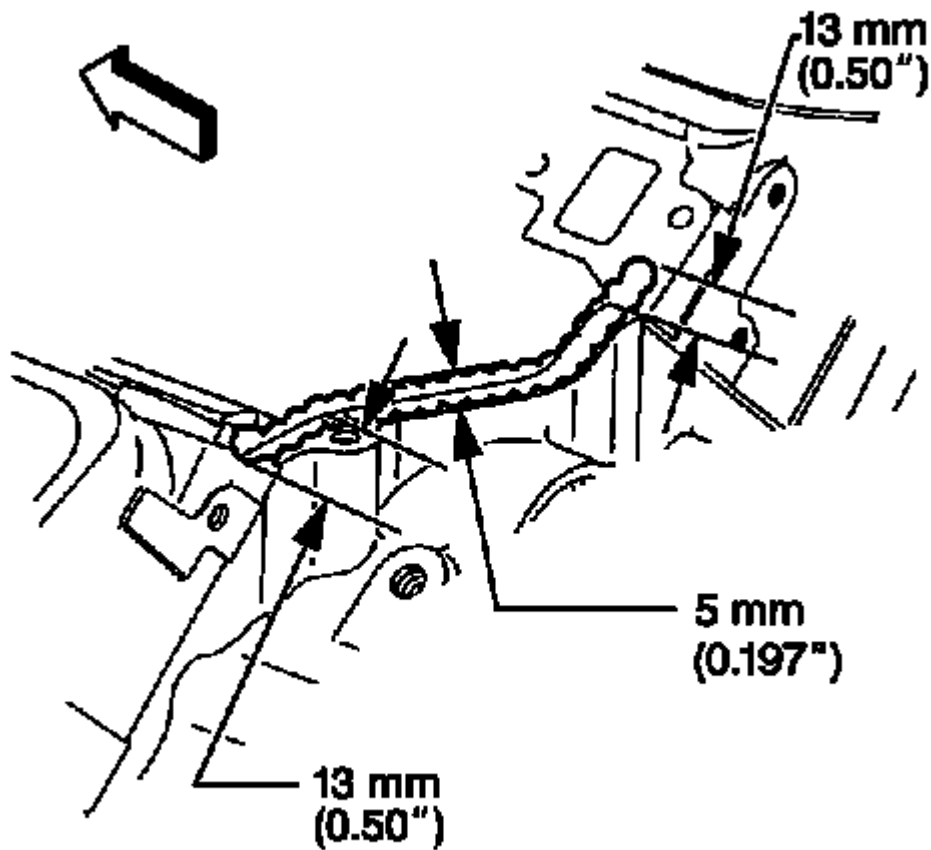


Fig. 103: Applying Adhesive To Rear Top Of Engine Block
Courtesy of GENERAL MOTORS CORP.

5. Apply a 5 mm (0.197 in) bead of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent to the rear top of the engine block.
6. Extend the adhesive bead 13 mm (0.50 in) onto each intake manifold gasket.

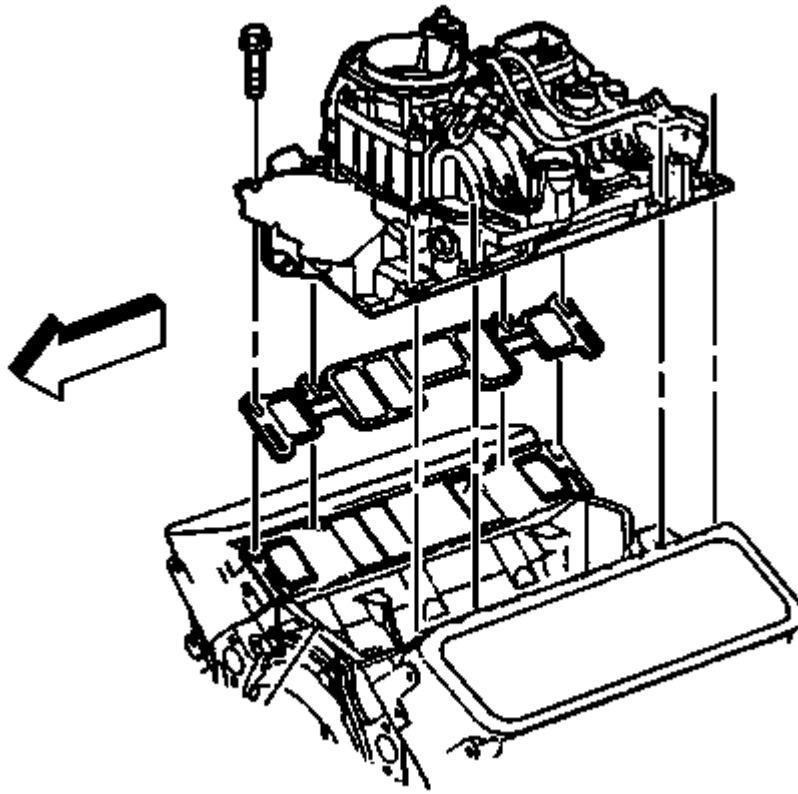


Fig. 104: View Of Intake Manifold Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the intake manifold.
8. If reusing the old fasteners, apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the intake manifold - lower bolts.
9. Install the intake manifold - lower bolts.

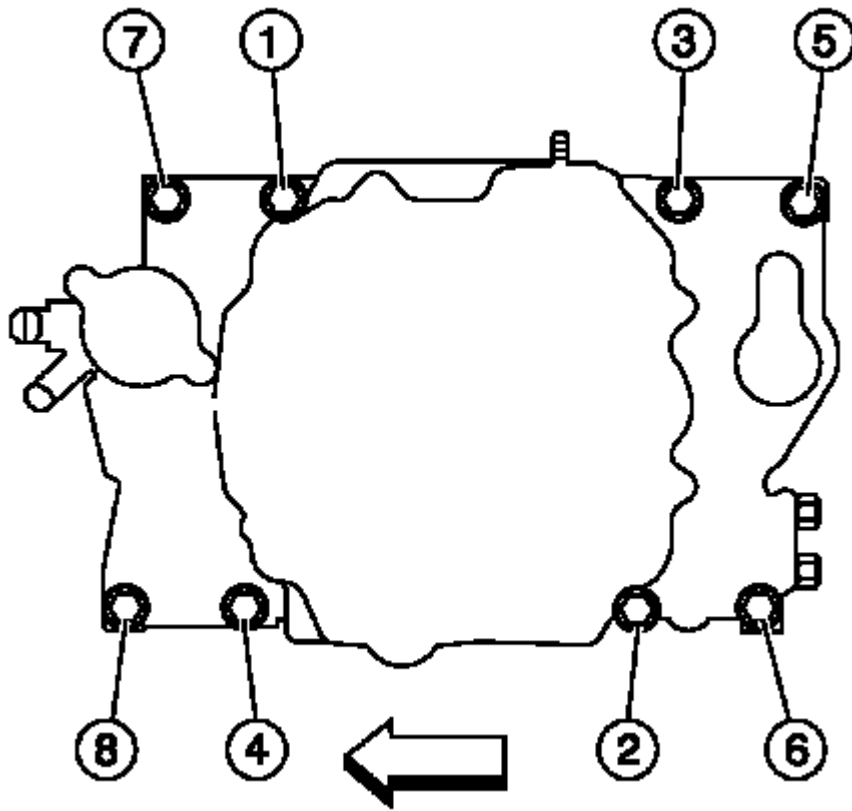


Fig. 105: View Of Tightening Sequence For Intake Manifold Lower Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Proper lower intake manifold fastener tightening sequence and torque is critical. Always follow the tightening sequence, and torque the intake manifold bolts using the 3 step method. Failing to do so may distort the crankshaft bearing bore alignment and cause damage to the crankshaft bearings.

NOTE: Refer to FASTENER NOTICE .

10. Tighten the intake manifold - lower bolts in sequence shown.

Tighten:

1. Tighten the intake manifold - lower bolts a first pass to 3 N.m (27 lb in).
2. Tighten the intake manifold - lower bolts a second pass to 12 N.m (106 lb in).
3. Tighten the intake manifold - lower bolts a final pass to 15 N.m (11 lb ft).

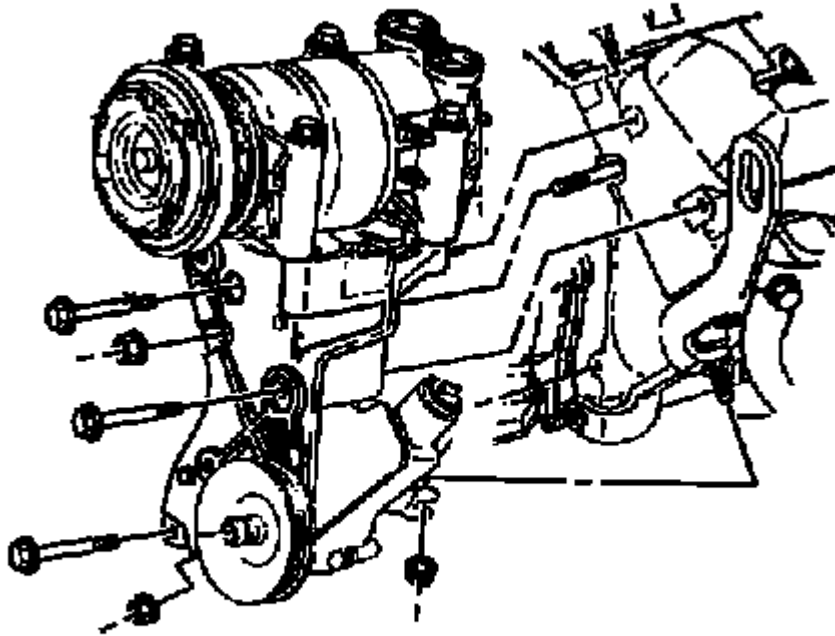


Fig. 106: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

11. Slide the P/S pump bracket rearward.
12. Install the bolts and the nut for the P/S pump bracket.
13. Install the P/S pump rear bracket front nut.
14. Tighten the P/S pump rear bracket nut.

Tighten: Tighten the P/S pump bracket bolts and nuts to 41 N.m (30 lb ft).

15. Install the drive belt. Refer to **Drive Belt Replacement**.

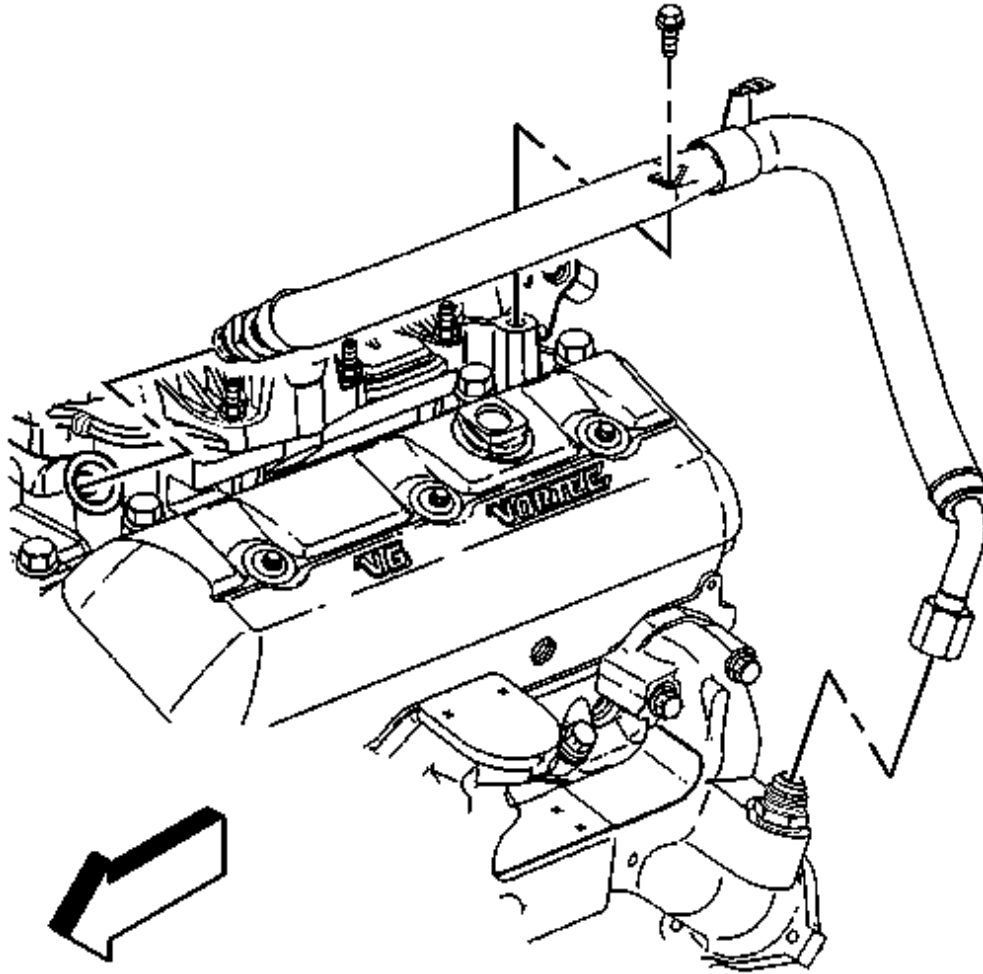
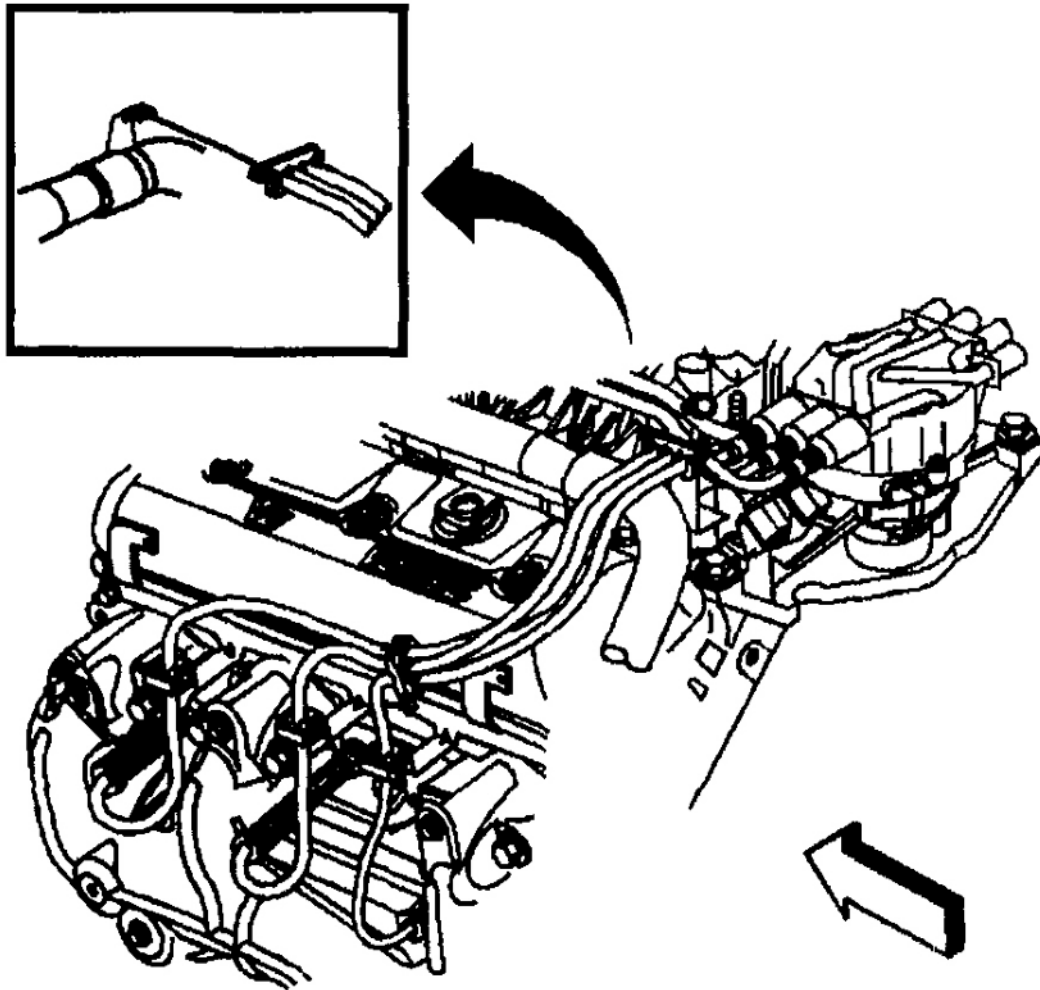


Fig. 107: View Of EGR Valve Inlet Pip & Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

16. Install the EGR valve inlet pipe until snug.
17. Install the EGR valve inlet pipe bracket bolt.

Tighten:

- Tighten the EGR valve inlet pipe fitting to the exhaust manifold to 25 N.m (18 lb ft).
- Tighten the EGR valve inlet pipe fitting to the intake manifold to 30 N.m (22 lb ft).
- Tighten the EGR valve inlet pipe bracket bolt to 25 N.m (18 lb ft).



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Fig. 108: View Of Spark Plug Wire Harness Retainer
Courtesy of GENERAL MOTORS CORP.

18. Install the spark plug wire harness retainer to the EGR valve inlet pipe.

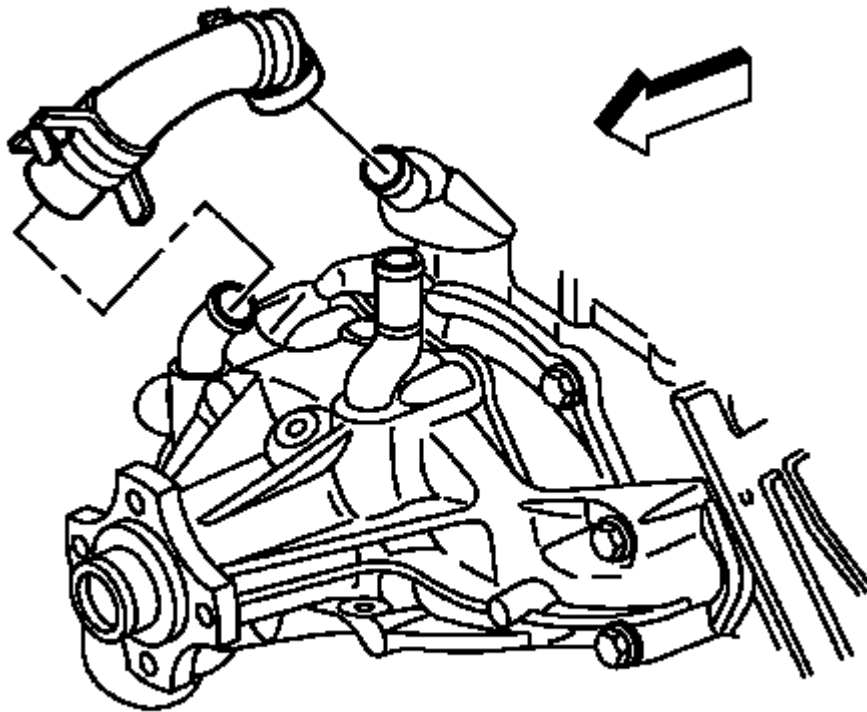


Fig. 109: View Of Water Pump Inlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

19. Install the water pump inlet hose.
20. Position the water pump inlet hose clamps.

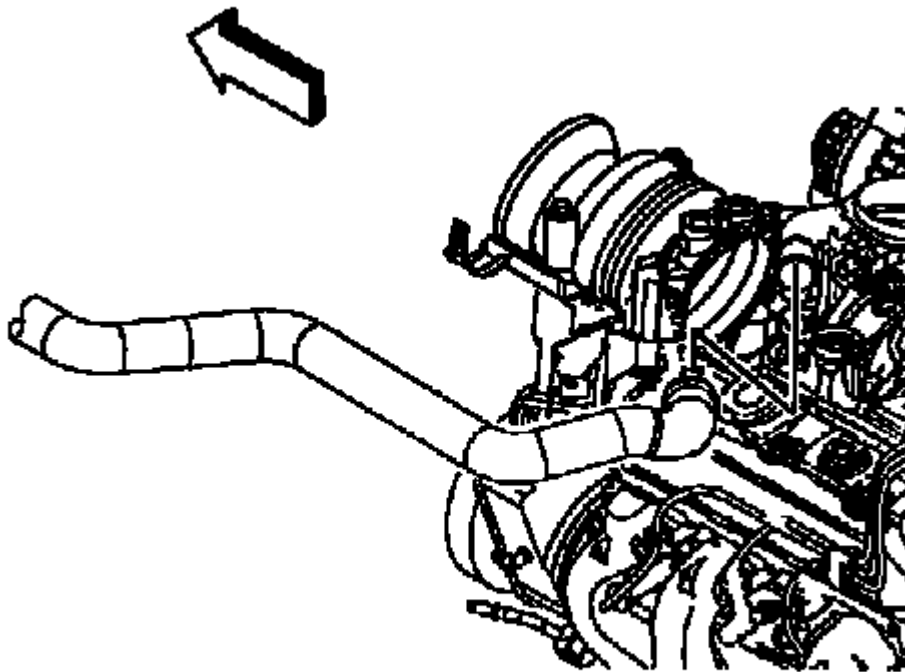
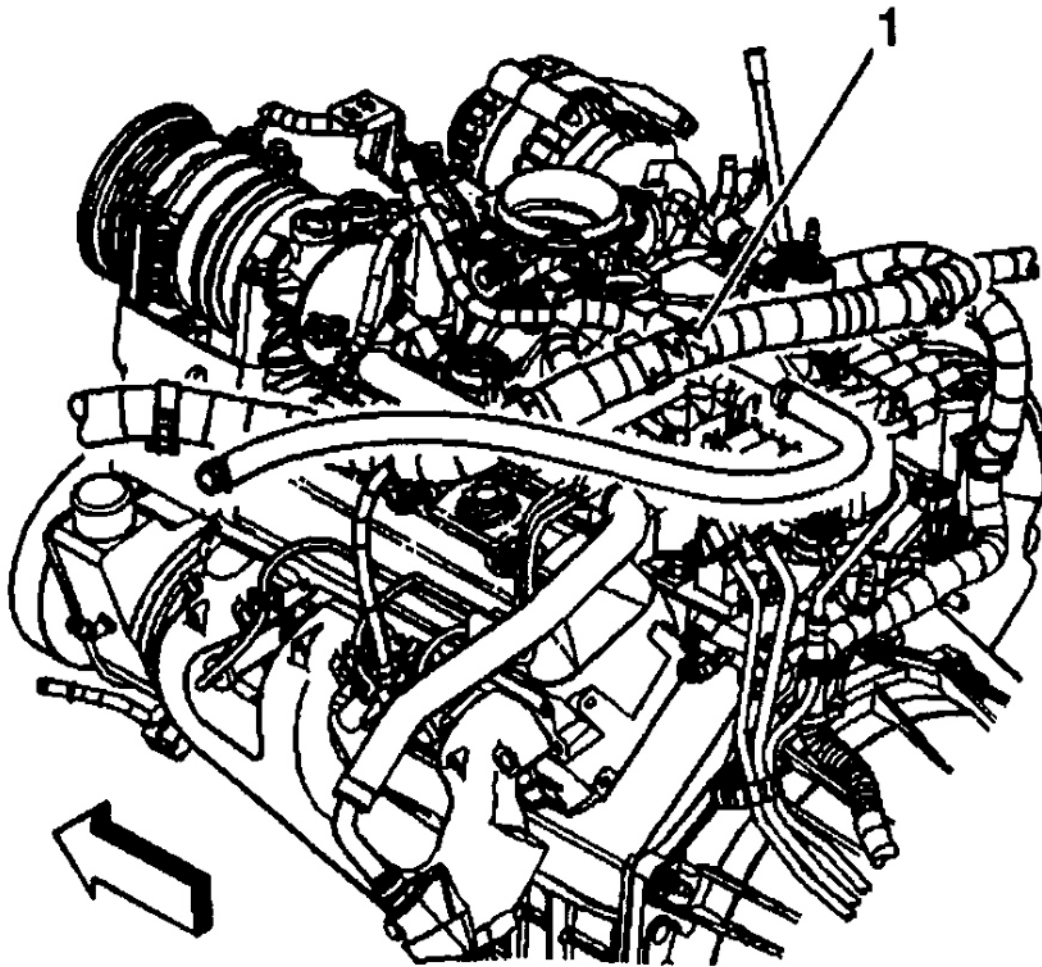


Fig. 110: View Of Radiator Inlet Hose, Clamps & Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

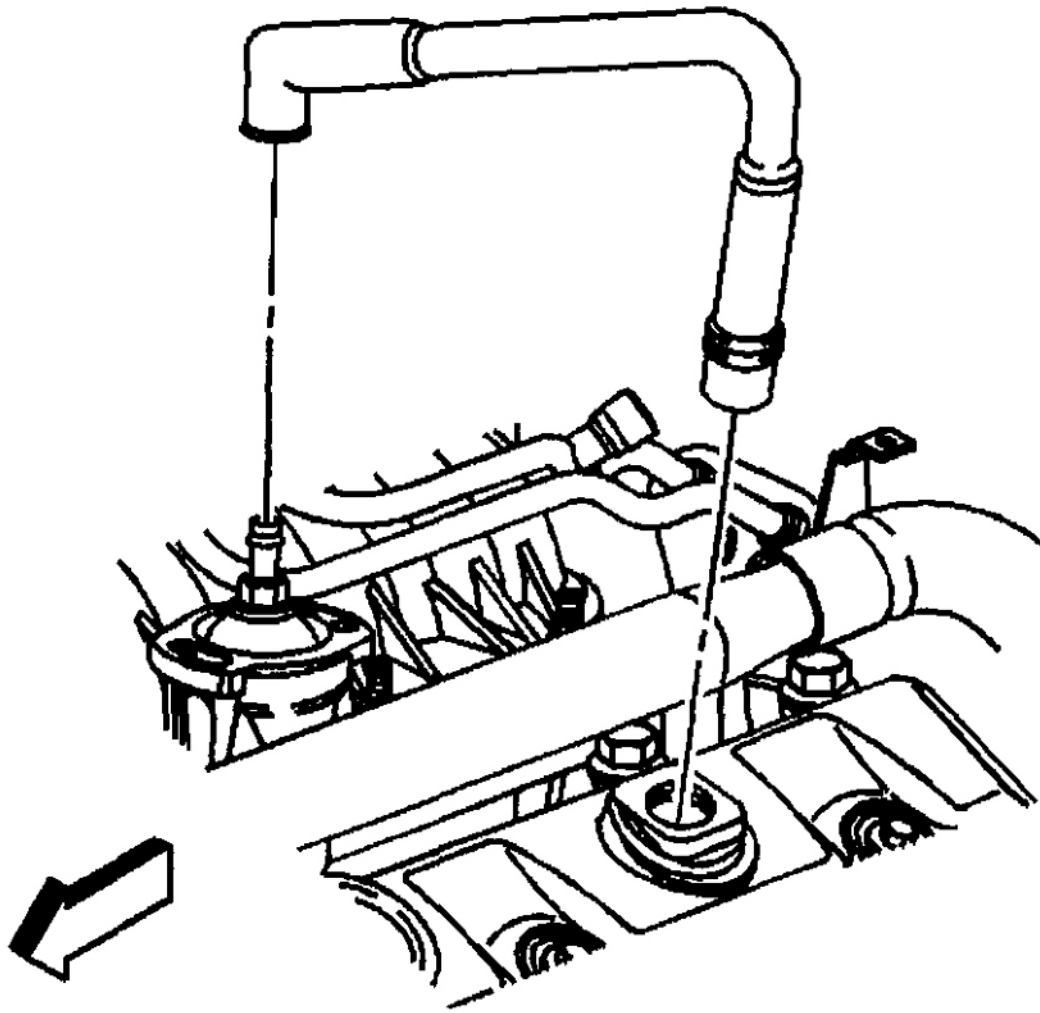
21. Install the radiator inlet hose to the thermostat housing.
22. Position the radiator inlet hose clamps.



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Fig. 111: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

23. Connect the power brake booster vacuum hose to the vacuum fitting (1).



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Fig. 112: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

24. Install the PCV valve hose to the PCV valve cover and the rocker arm cover.

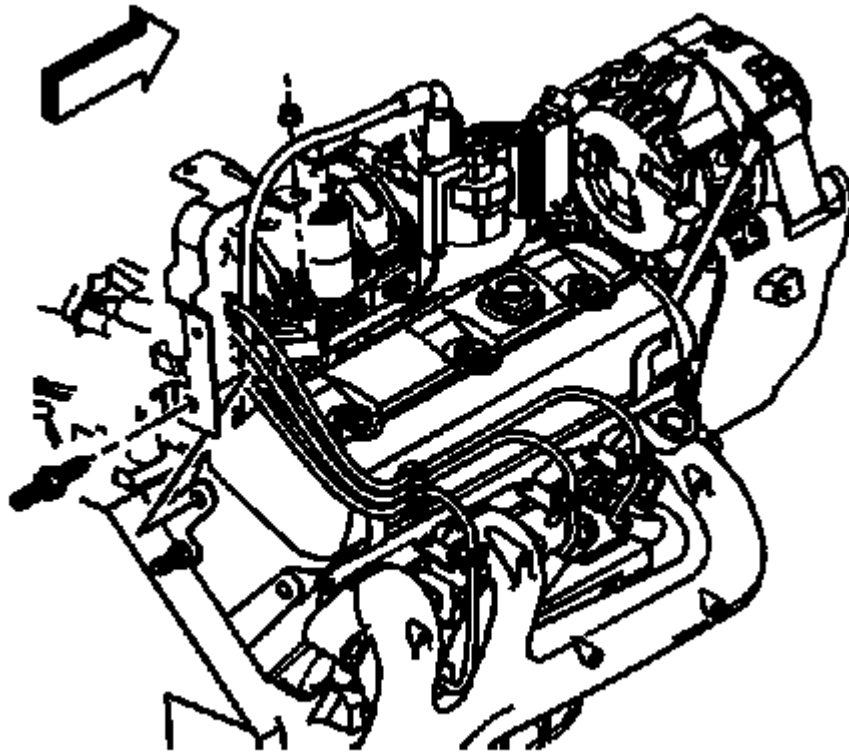


Fig. 113: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

25. Position the engine wiring harness and bracket.
26. Install the engine wiring harness bracket stud.

Tighten: Tighten the engine wiring harness rear bracket stud to 25 N.m (18 lb ft).

27. Install the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.

Tighten: Tighten the engine wiring harness rear bracket nut to 9 N.m (80 lb in).

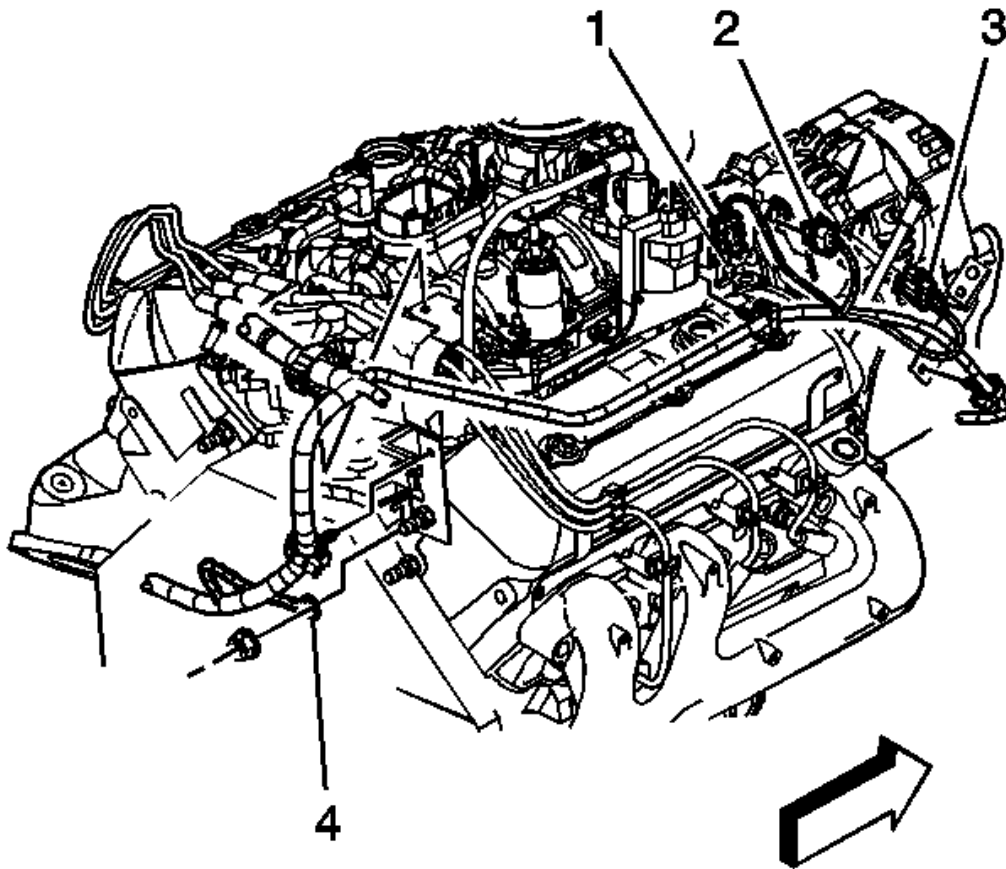
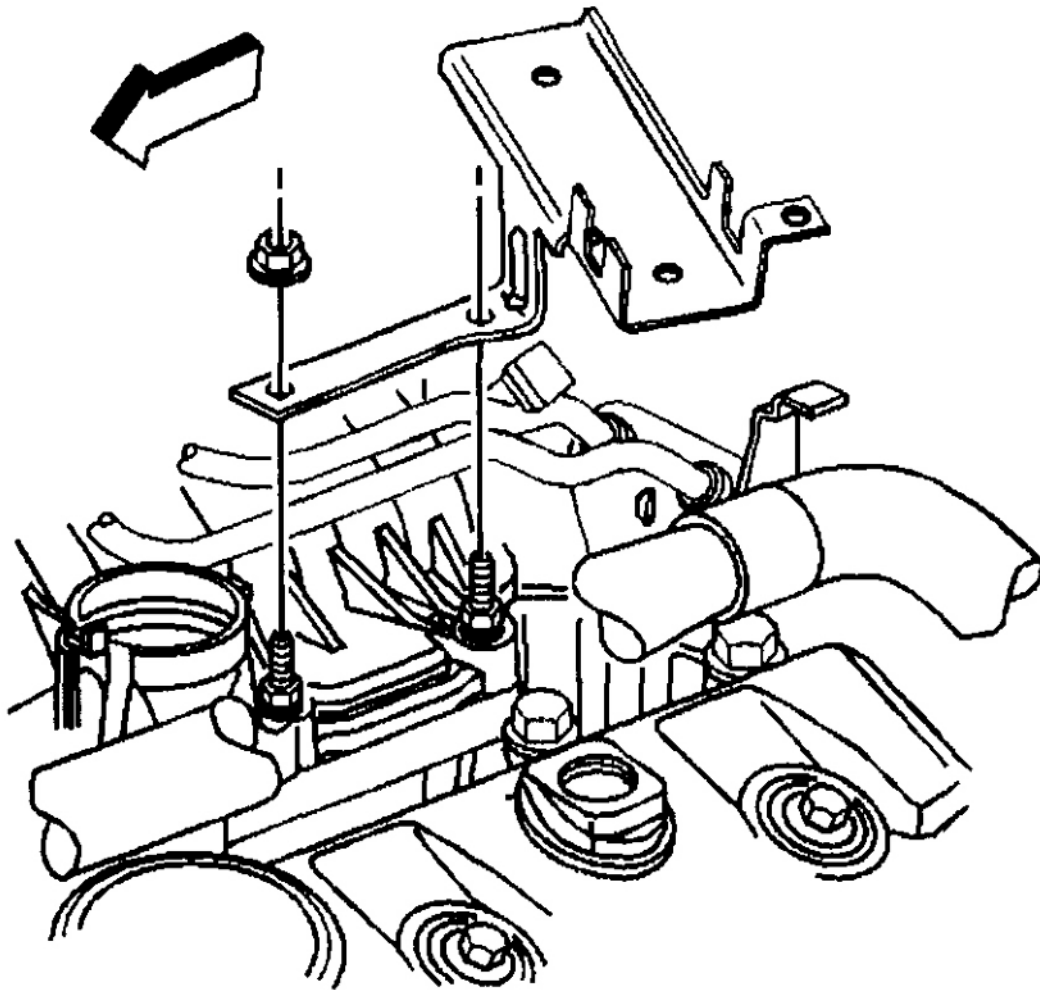


Fig. 114: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

28. Install the engine wiring harness ground nut and ground wire (4) to the rear of the right cylinder head.

Tighten: Tighten the engine wiring harness ground nut to 16 N.m (12 lb ft).

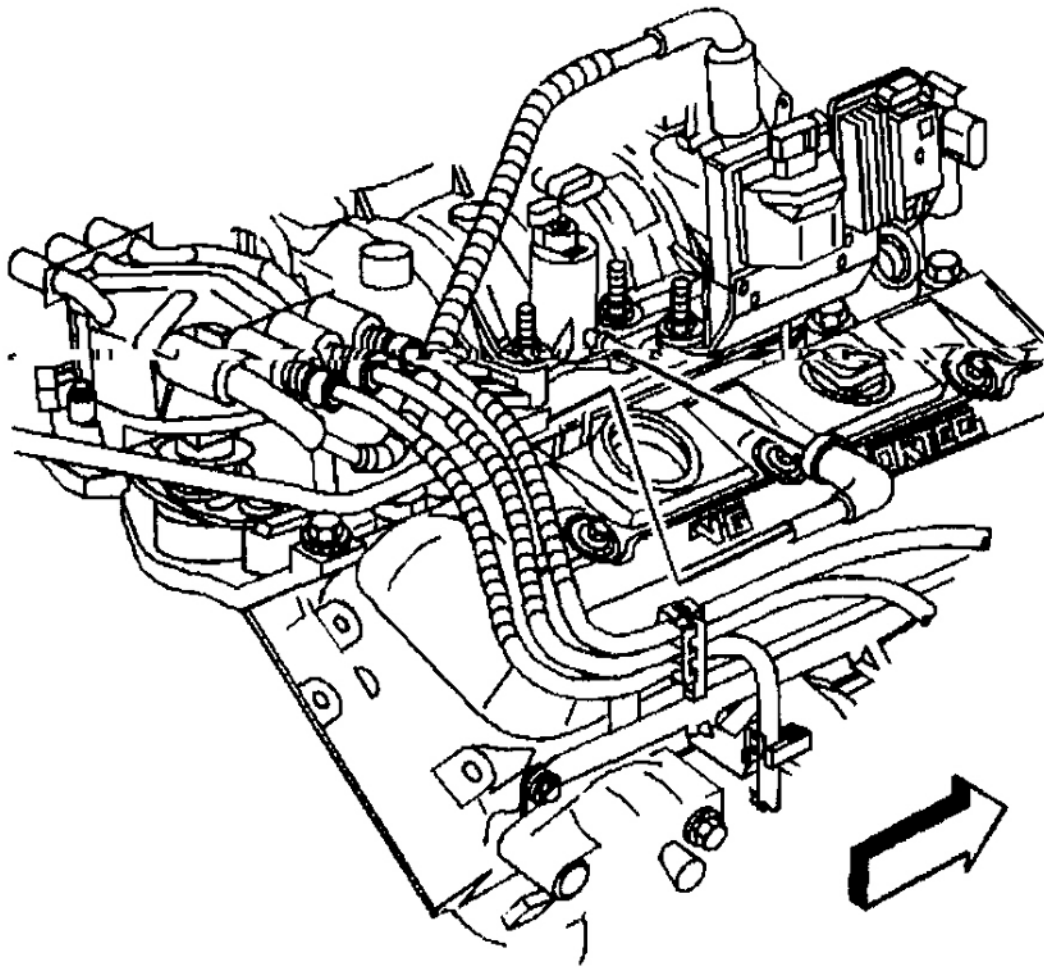


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Fig. 115: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

29. Install the engine wiring harness bracket to the studs.
30. Install the engine wiring harness bracket nuts.

Tighten: Tighten the engine wiring harness bracket nuts to 12 N.m (106 lb in).



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Fig. 116: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

31. Connect the EVAP canister harness to the purge solenoid valve.

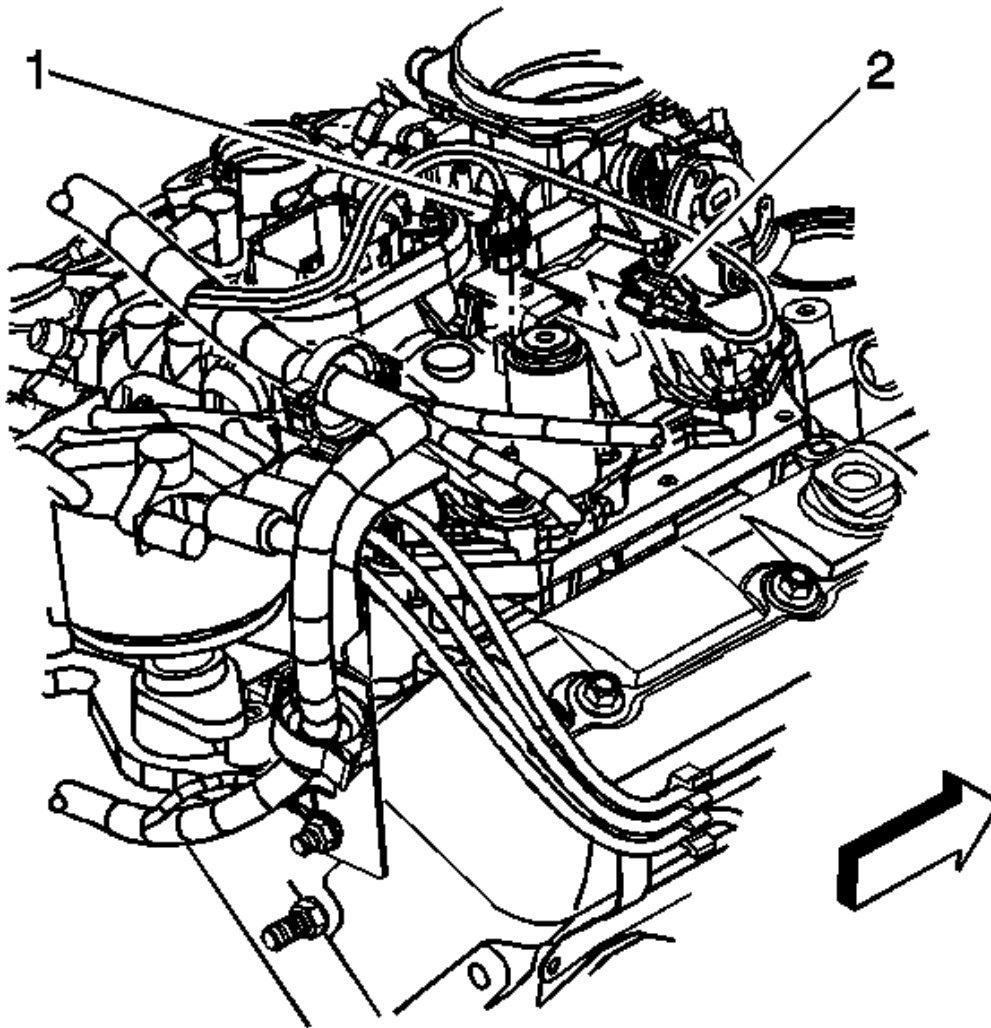


Fig. 117: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

32. Connect the following electrical connectors:
- The EVAP canister purge solenoid valve (1)
 - The MAP sensor (2)

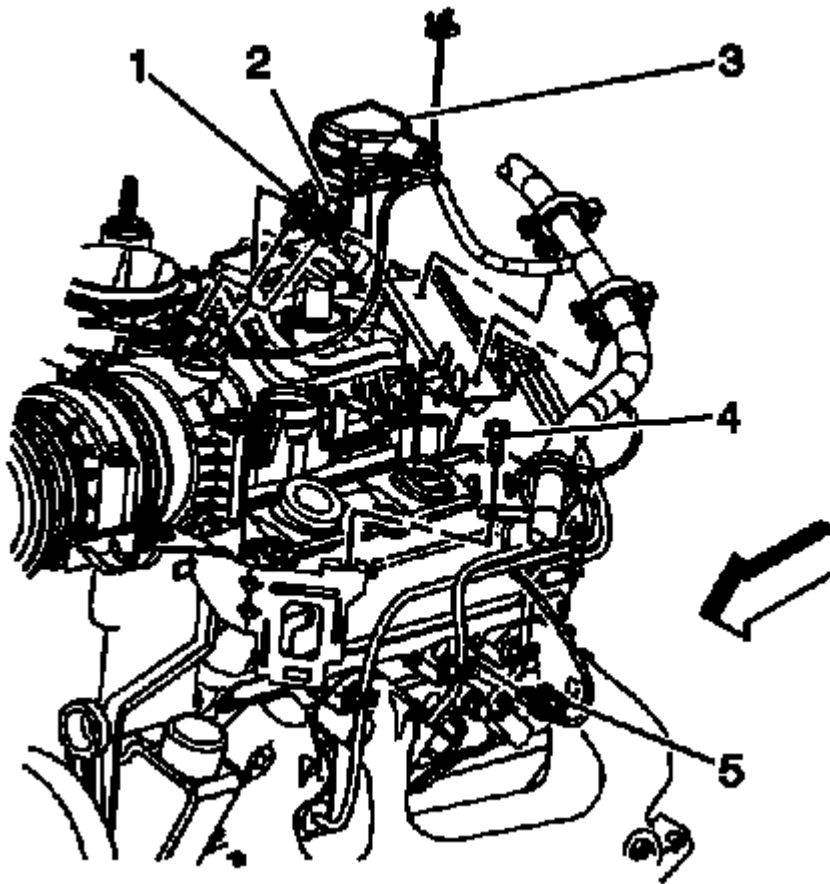


Fig. 118: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

33. Connect the following electrical connectors:
 - The TP sensor (1)
 - The IAC motor (2)
 - The control port injector module (3)
34. Install the engine wiring harness clip bolt (4).

Tighten: Tighten the engine wiring harness clip bolt to 9 N.m (80 lb in).

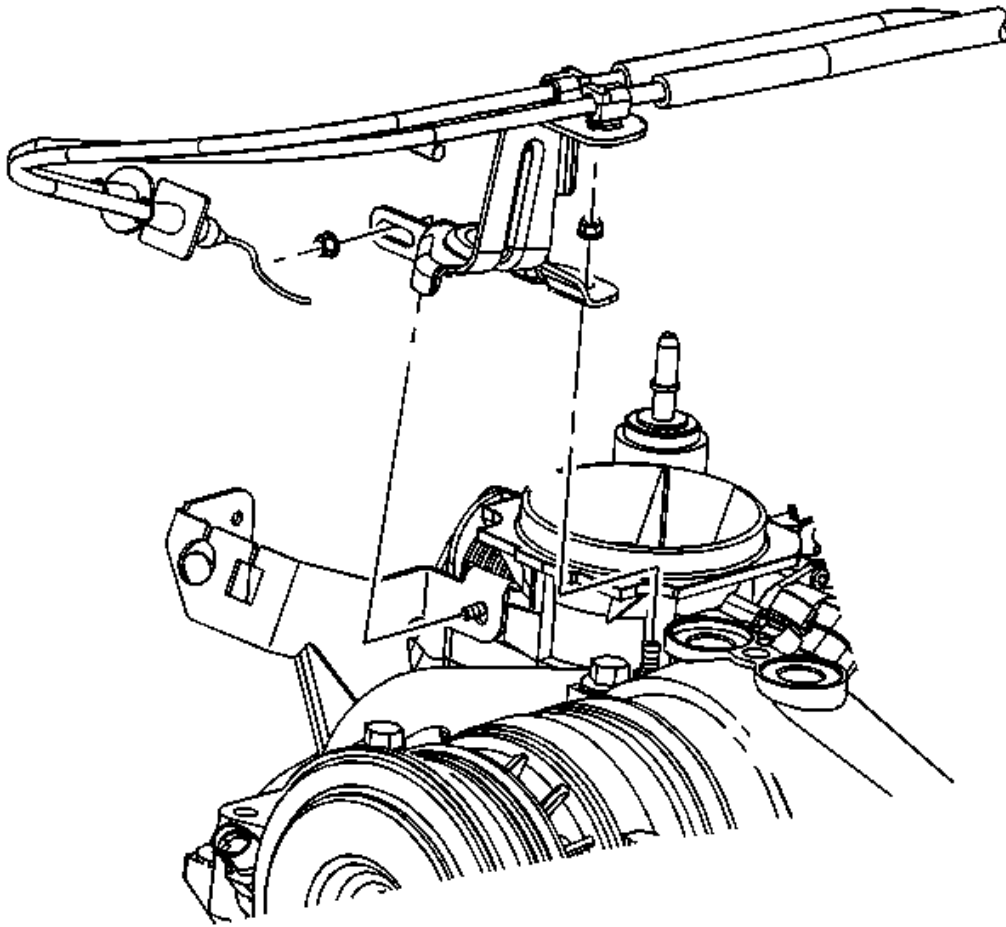


Fig. 119: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

35. Position the bracket and cables.
36. Install the accelerator control cable bracket with the cables attached, to the throttle body.
37. Install the accelerator control cable bracket nuts.

Tighten: Tighten the accelerator control cable bracket nuts to 9 N.m (80 lb in).

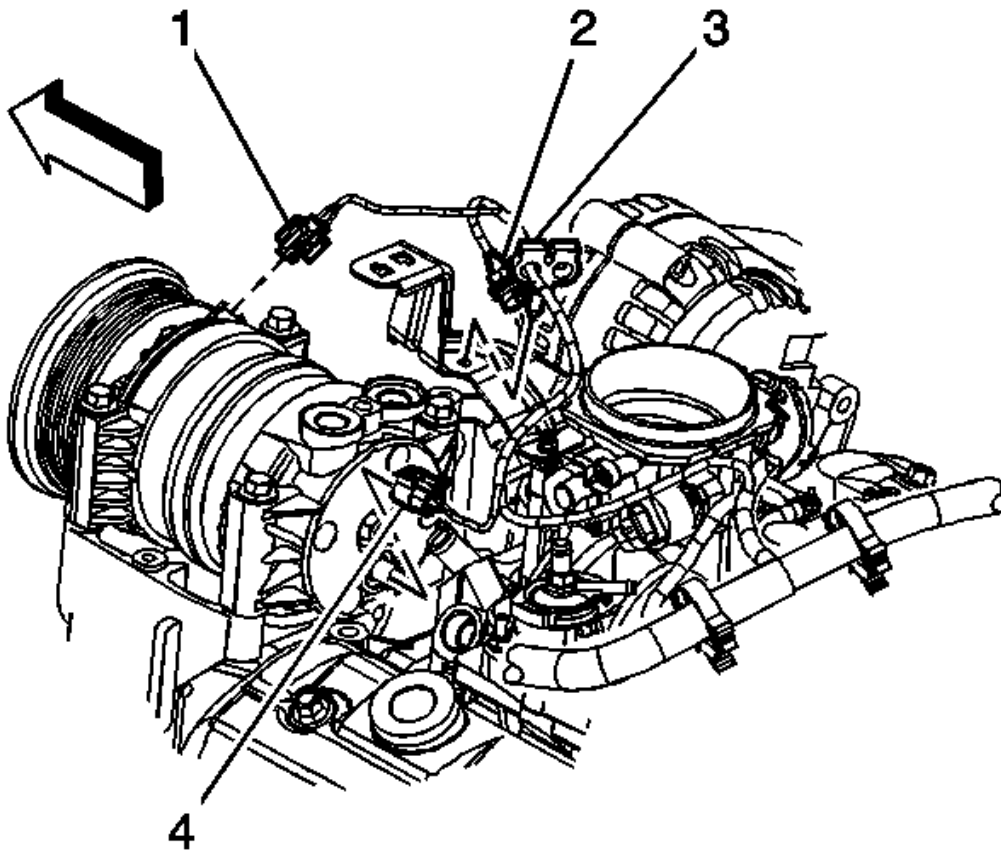


Fig. 120: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

38. Connect the following electrical connectors:
- The A/C compressor clutch (1), if equipped
 - The EGR valve (2)
 - The A/C pressure switch (4), if equipped
39. Install the engine wiring harness clip (3) to the accelerator control cable bracket.

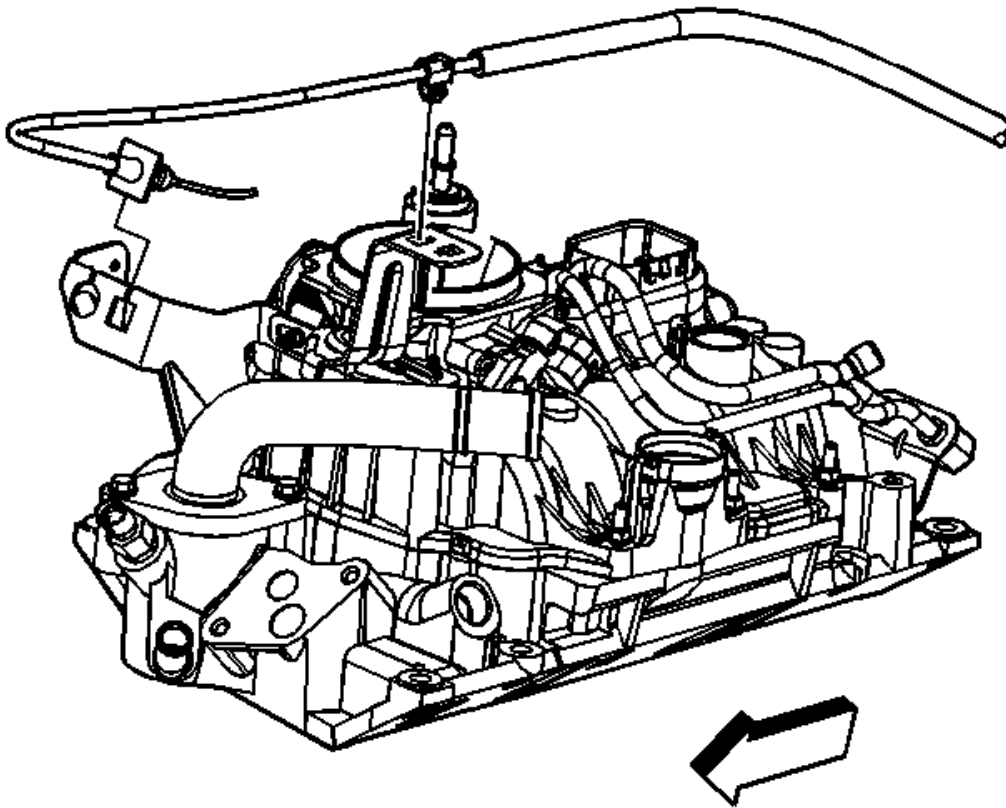


Fig. 121: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

40. Install the accelerator cable to the accelerator control cable bracket.

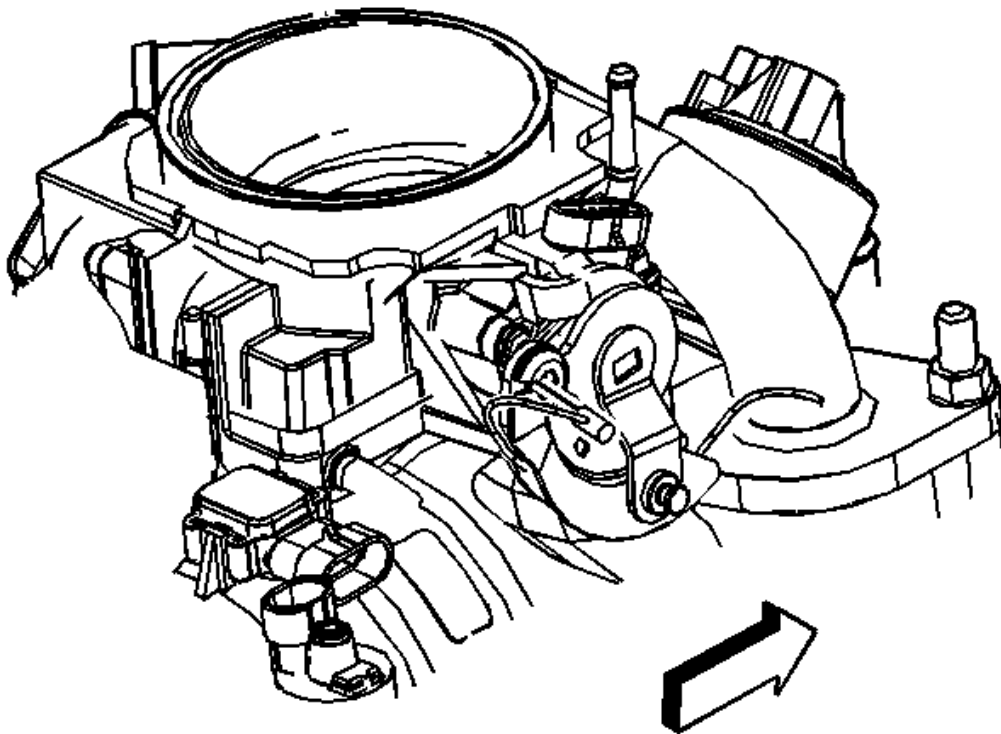


Fig. 122: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

41. Install the accelerator cable to the throttle body lever.

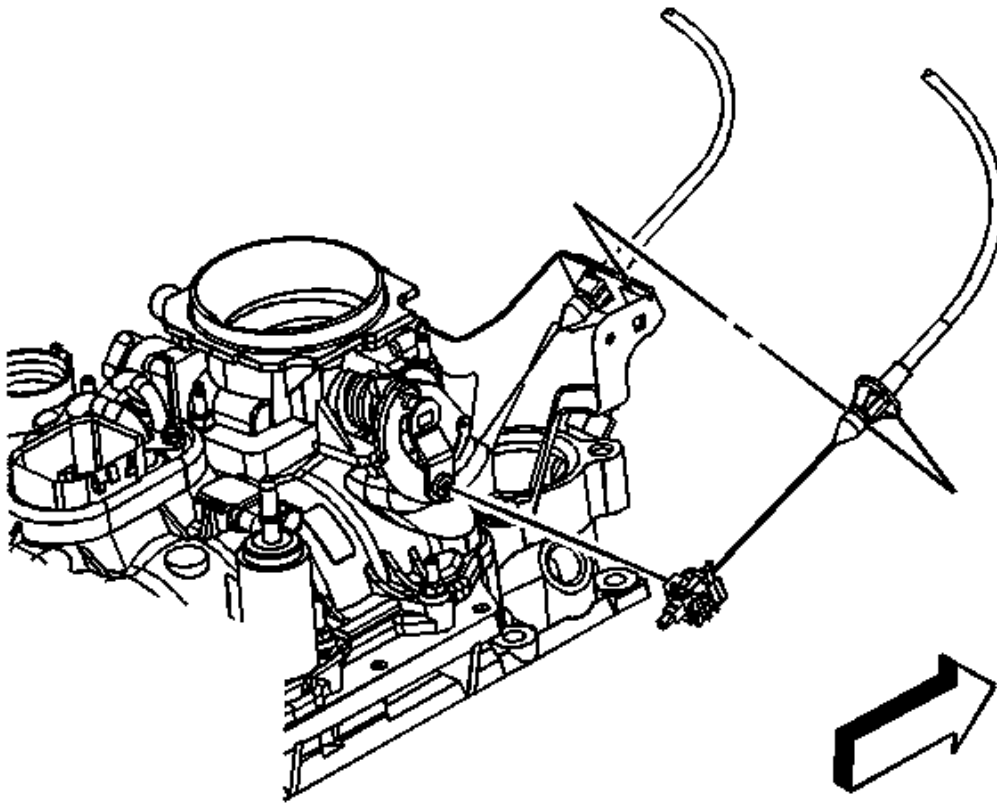


Fig. 123: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

42. Install the cruise control cable to the accelerator control cable bracket, if equipped.
43. Connect the cruise control cable to the throttle lever, if equipped.

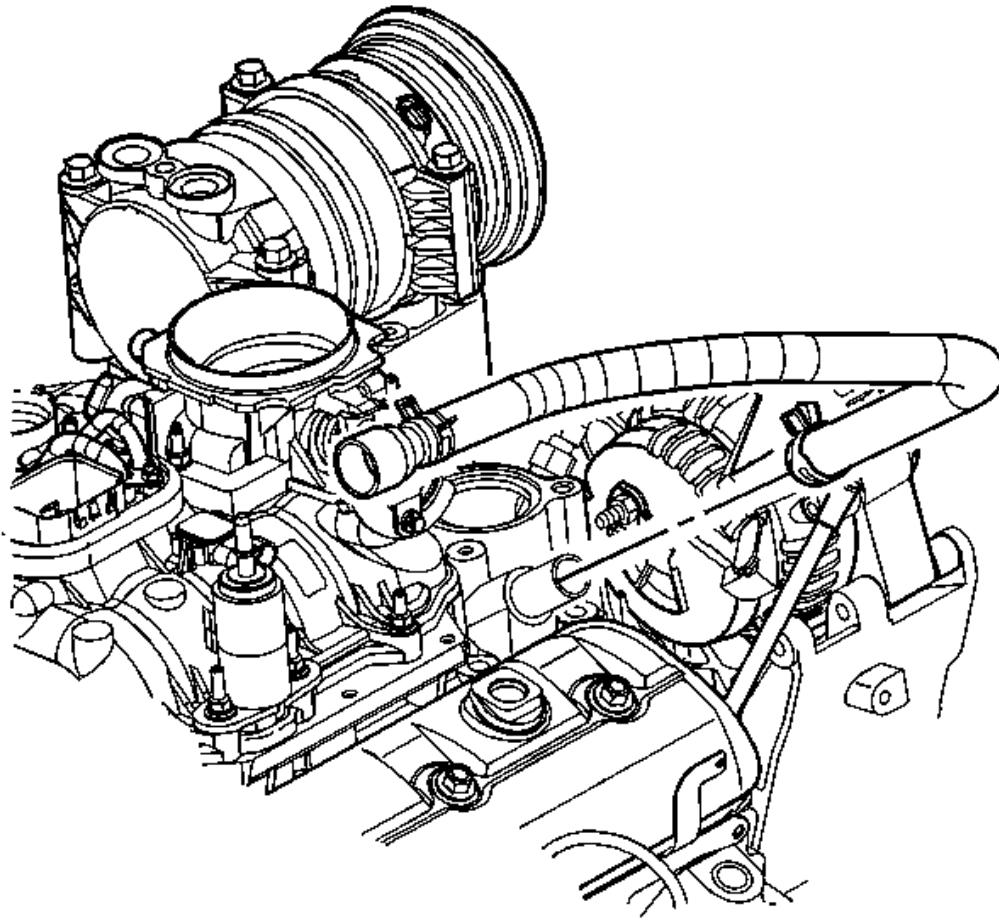


Fig. 124: View Of Heater Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

44. Position the heater inlet and outlet hoses.
45. Install the heater inlet hose to the water pump.
46. Install the heater outlet hose clip bolt.

Tighten: Tighten the heater outlet hose clip bolt to 25 N.m (18 lb ft).

47. Position the heater inlet hose clamp.

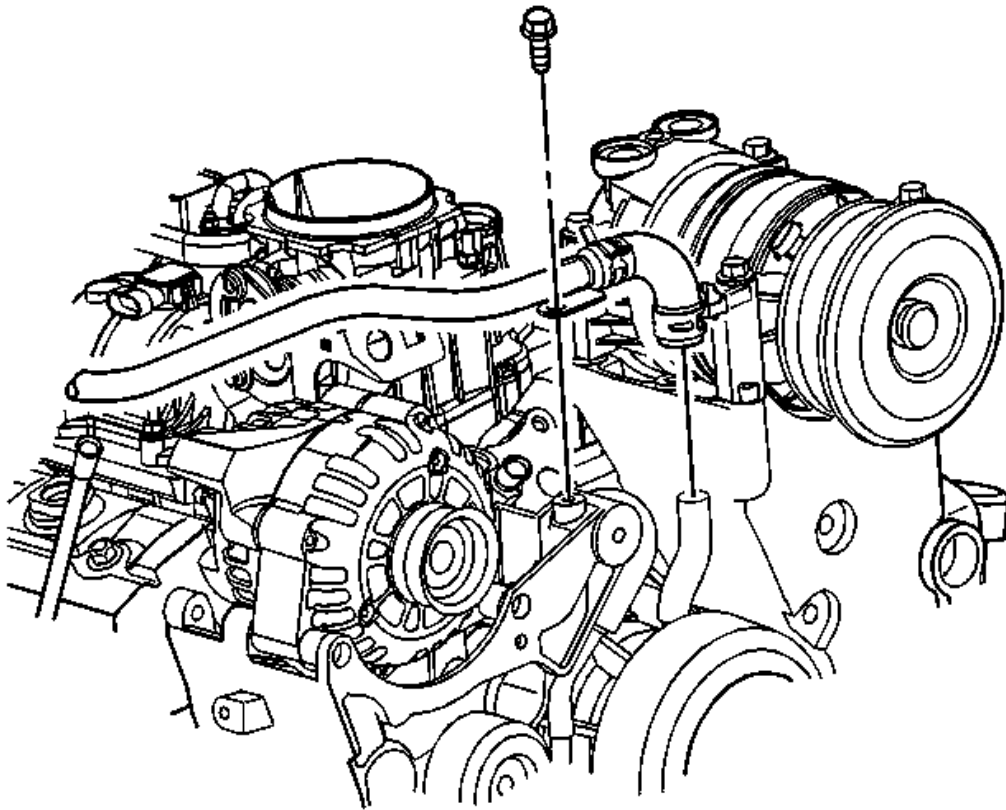
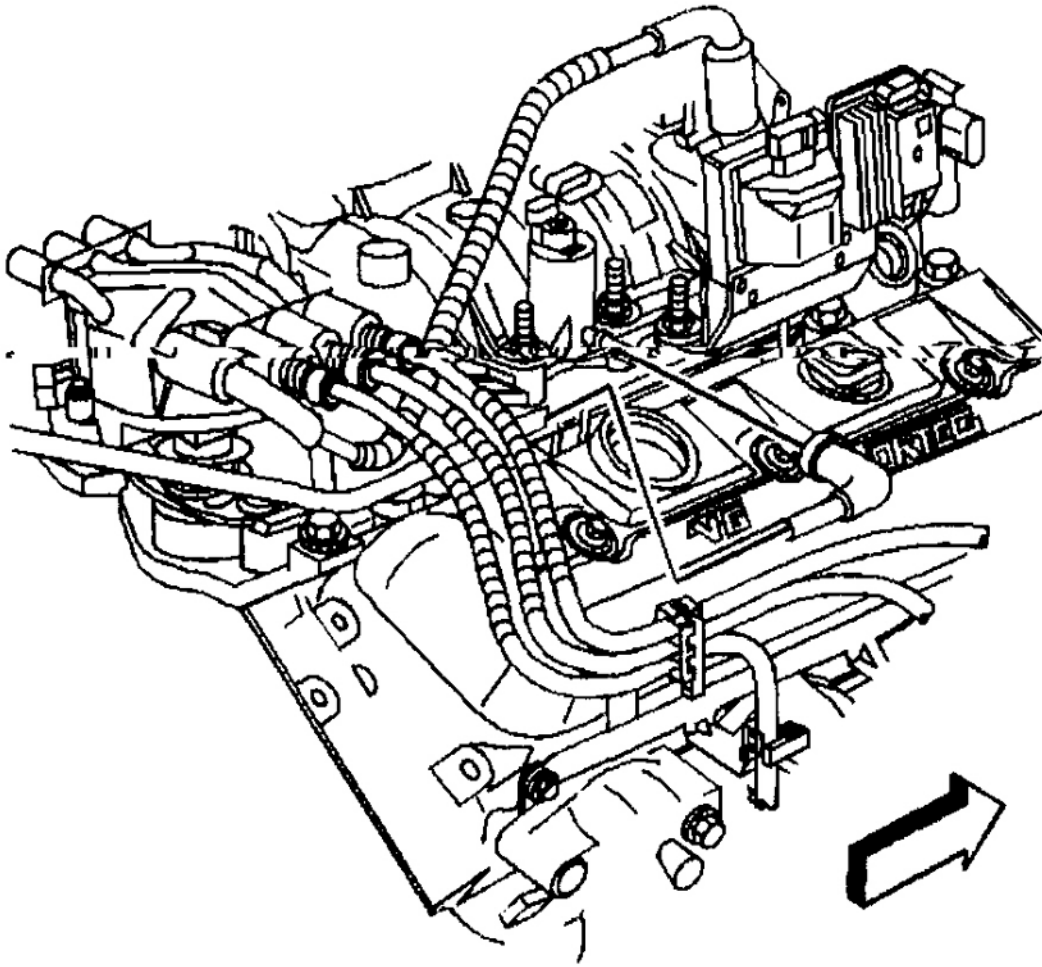


Fig. 125: View Of Heater Outlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

48. Install the heater outlet hose to the intake manifold.
49. Position the heater outlet hose clamp.



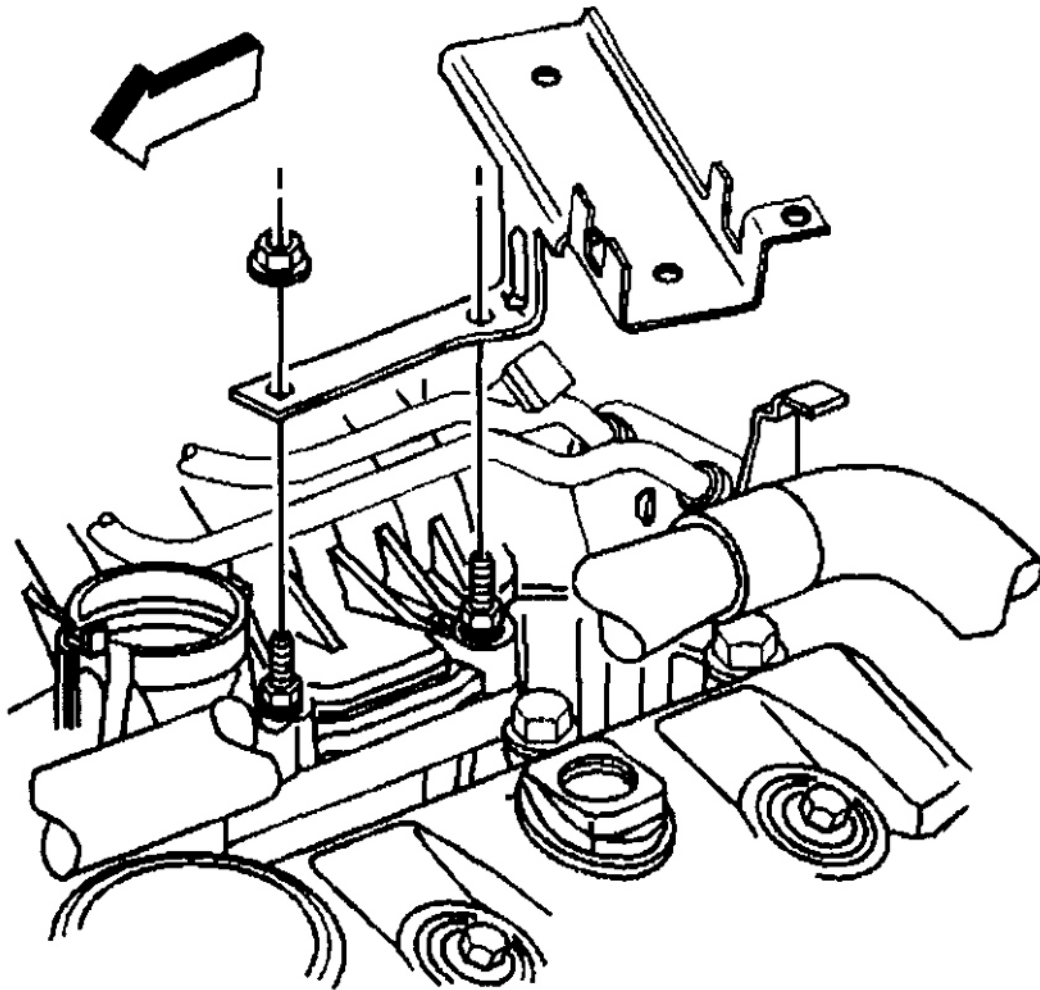
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Fig. 126: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

50. Connect the EVAP canister harness to the purge solenoid valve.
51. Install the fuel pipes/hoses.
52. Install the distributor. Refer to **DISTRIBUTOR**.
53. Fill the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM**.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT

Removal Procedure



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Fig. 127: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine wiring harness bracket nuts.
2. Remove the engine wiring harness bracket.

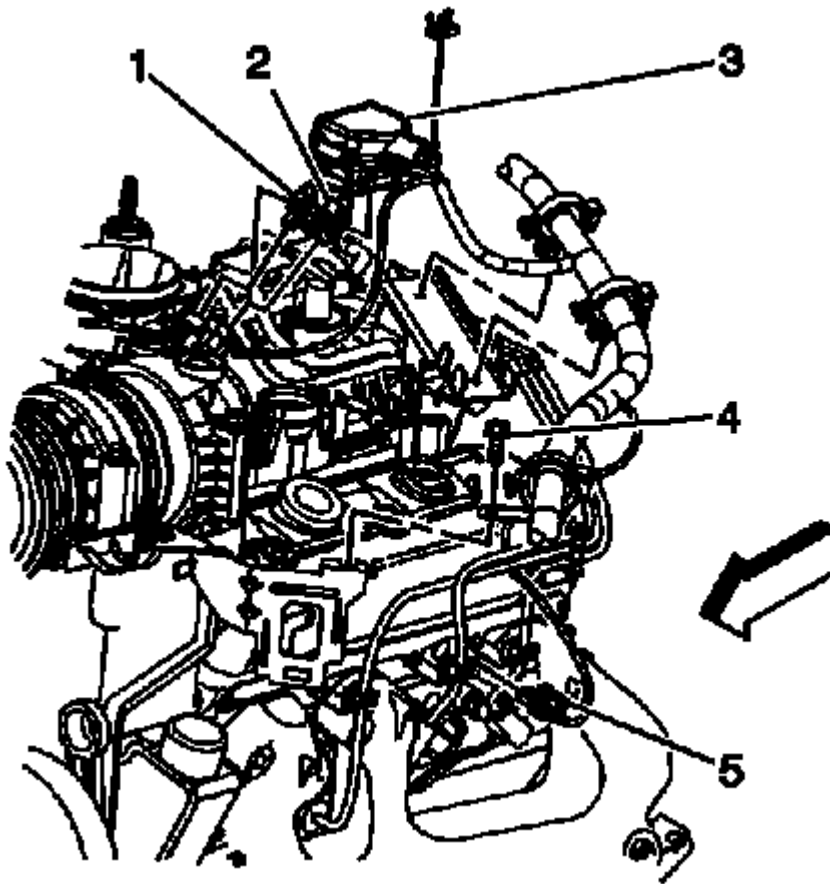


Fig. 128: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine wiring harness clip bolt (4).

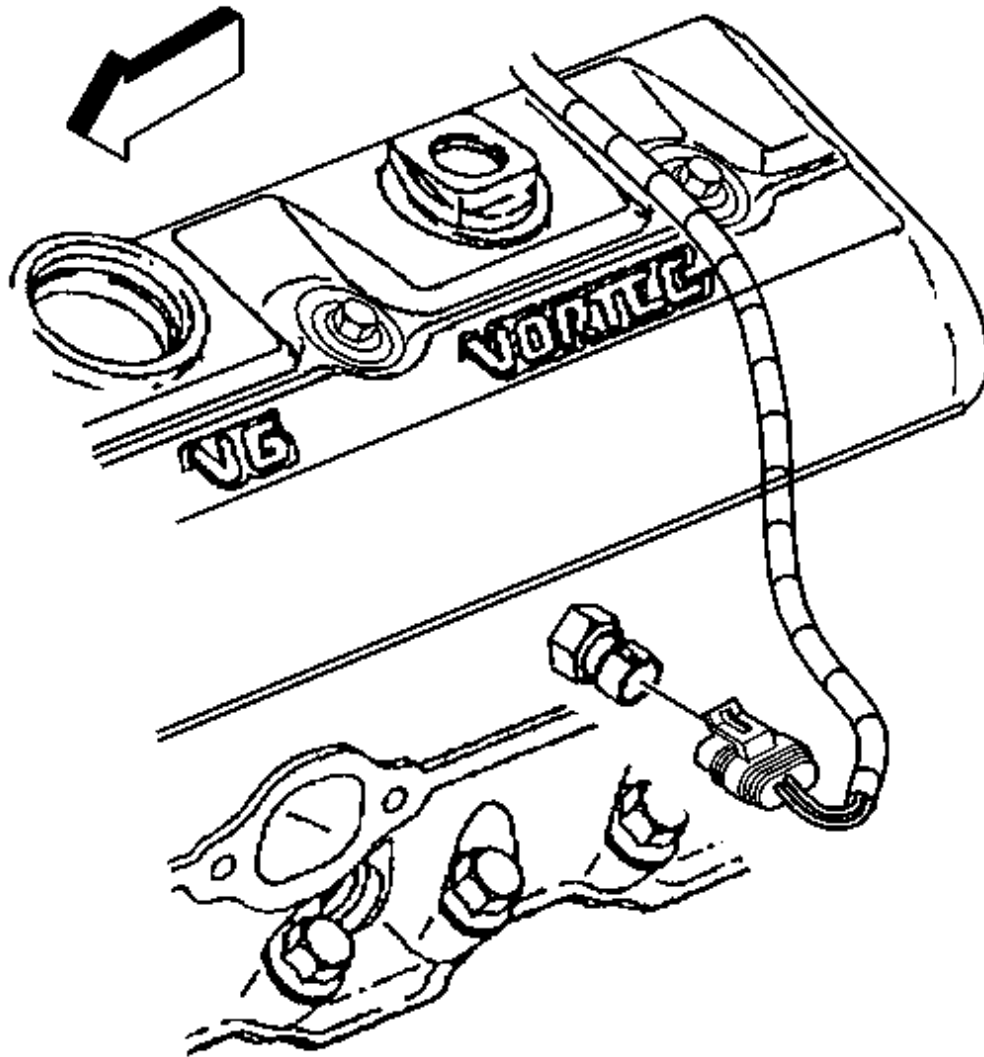
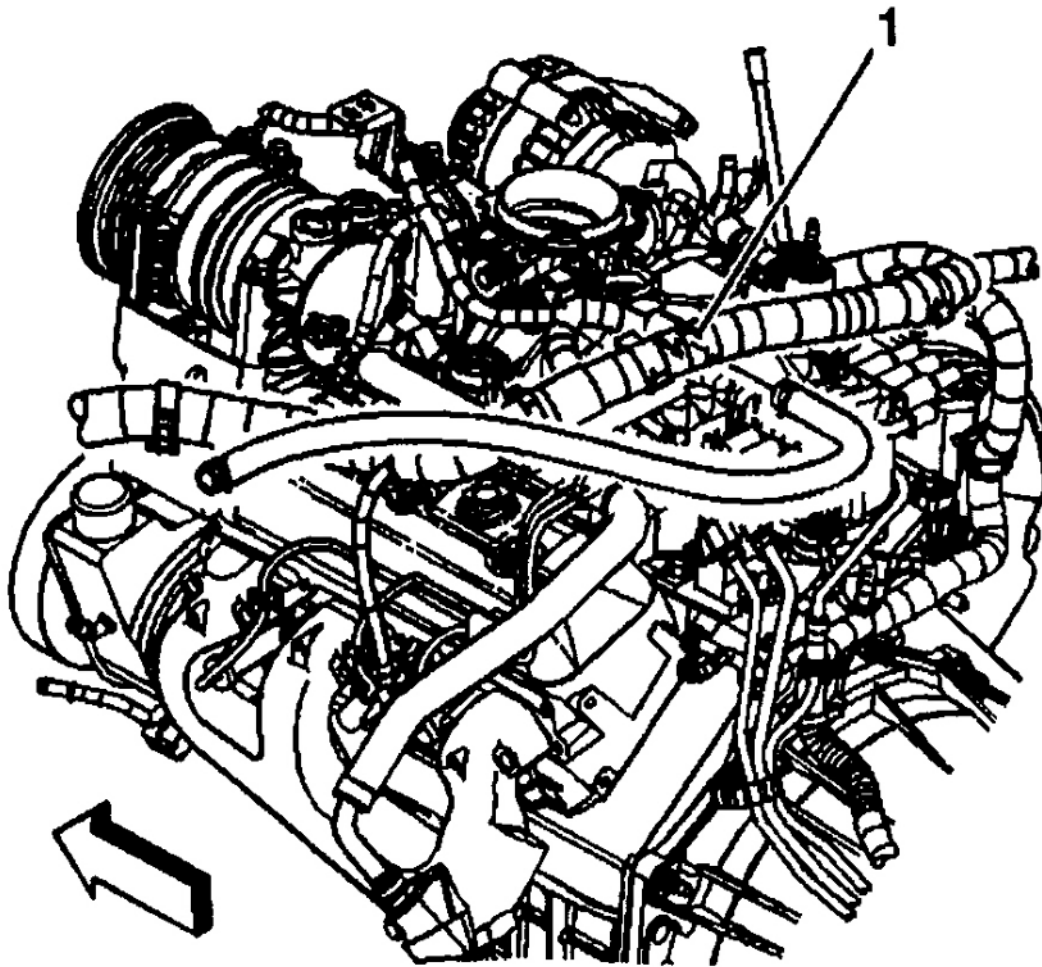


Fig. 129: View Of ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

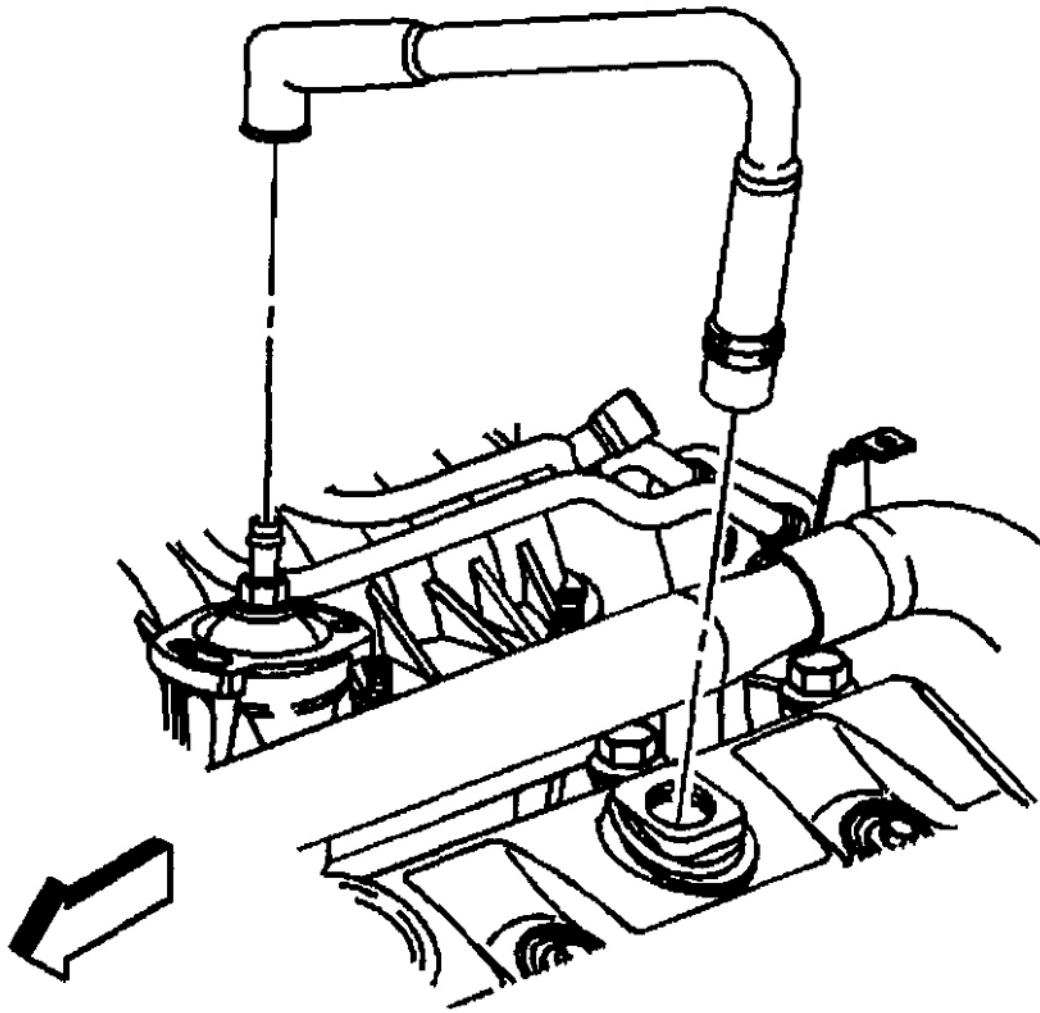
4. Disconnect the engine coolant temperature (ECT) sensor electrical connector.
5. Reposition the engine wiring harness and bracket.



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Fig. 130: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the power brake booster vacuum hose from the vacuum fitting (1).



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Fig. 131: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

7. Remove the positive crankcase ventilation (PCV) valve hose from the PCV valve cover and rocker arm cover.

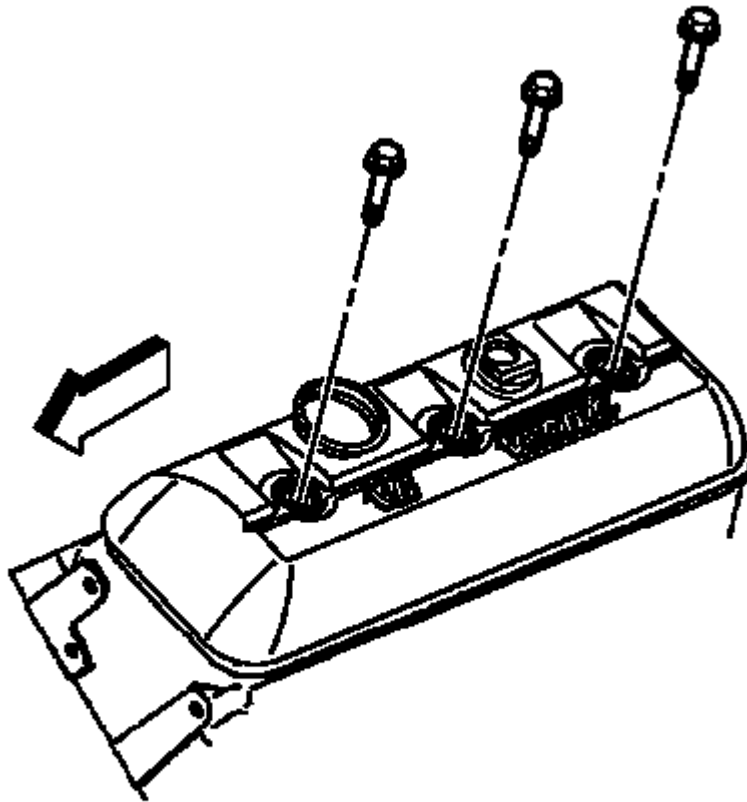


Fig. 132: View Of Valve Rocker Arm Cover Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

8. Remove the valve rocker arm cover bolts.
9. Remove and discard the valve rocker arm cover bolt grommets.

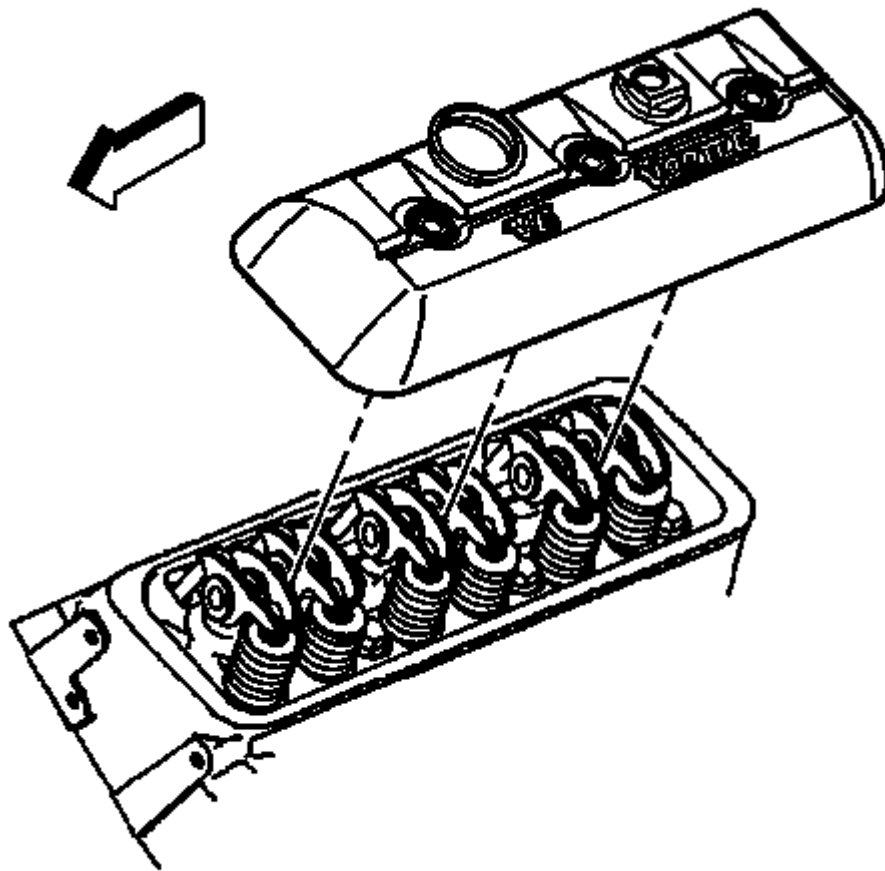


Fig. 133: View Of Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve rocker arm cover.

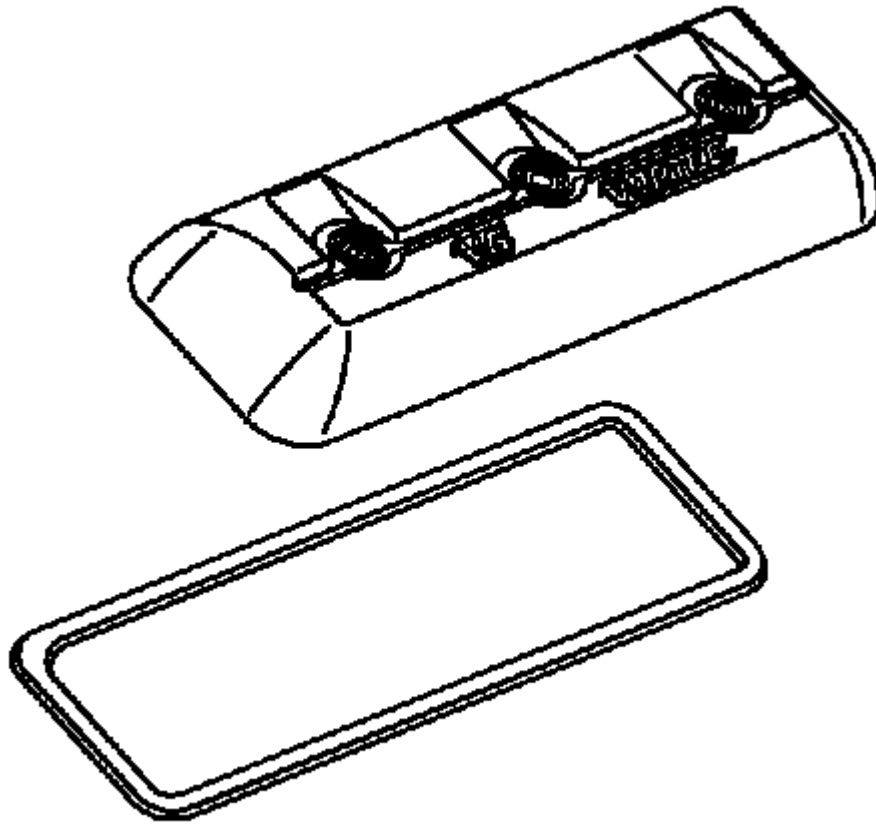


Fig. 134: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

11. Remove and discard the valve rocker arm cover gasket.
12. Clean and inspect the valve rocker arm cover, if necessary. Refer to **VALVE ROCKER ARM COVER CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT: Do not reuse the valve cover gasket or the valve rocker arm cover bolt grommets.

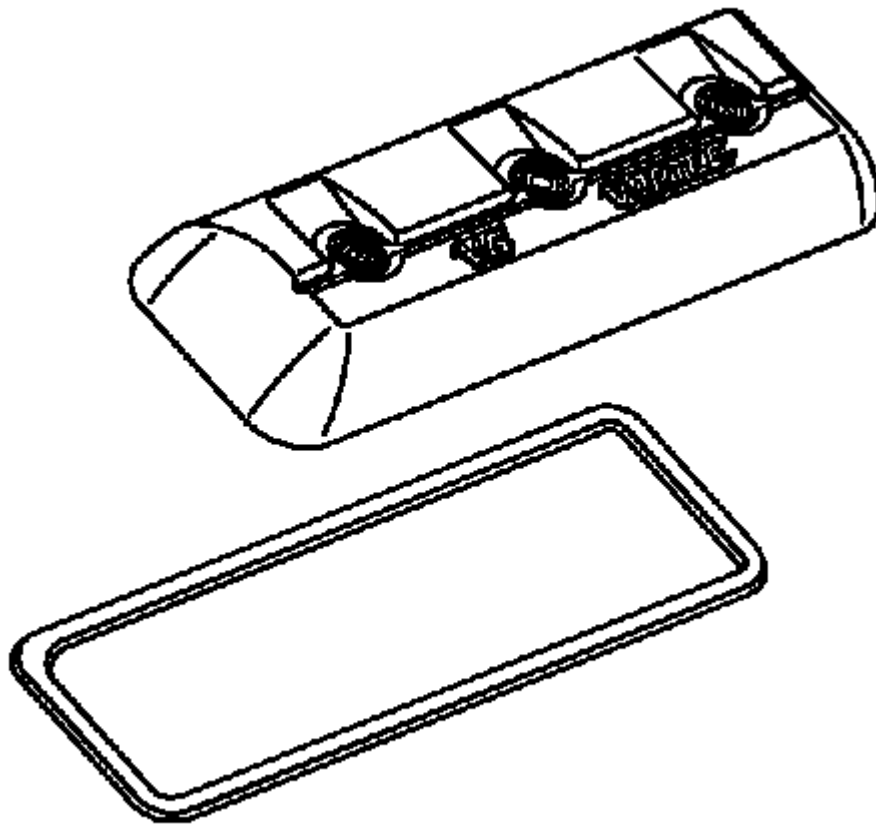


Fig. 135: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve rocker arm cover gasket to the valve rocker arm cover.
2. Install NEW valve rocker arm cover bolt grommets to the valve rocker arm cover.

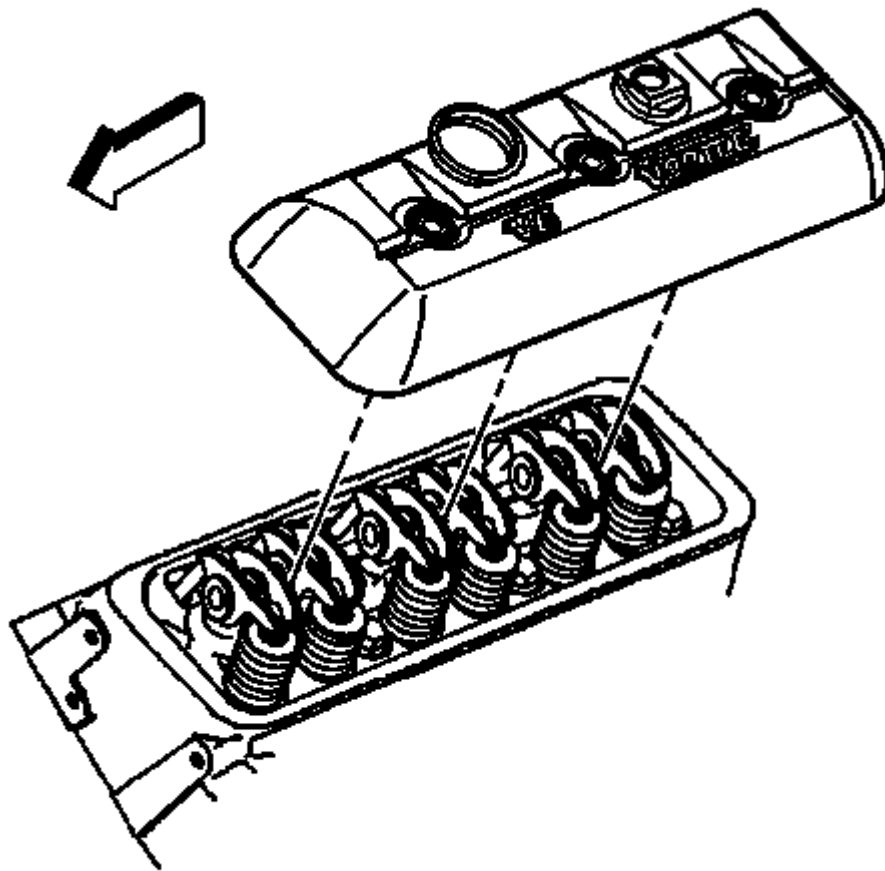


Fig. 136: View Of Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm cover.

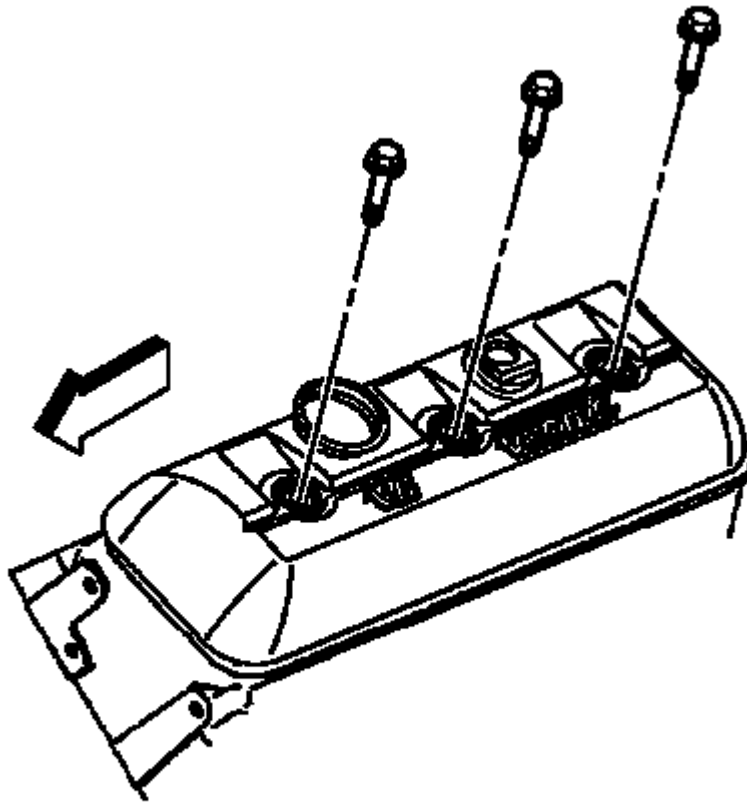
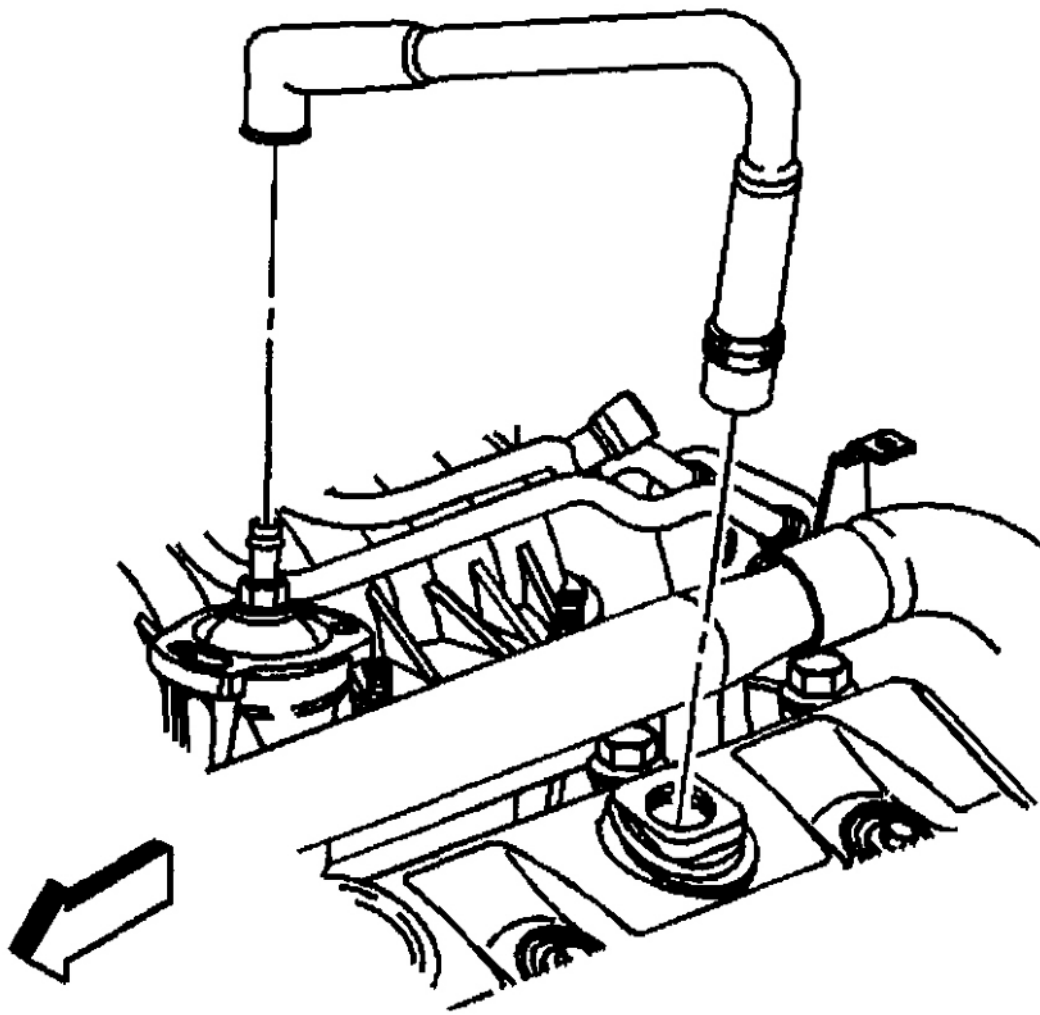


Fig. 137: View Of Valve Rocker Arm Cover Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

4. Install the valve rocker arm cover bolts.

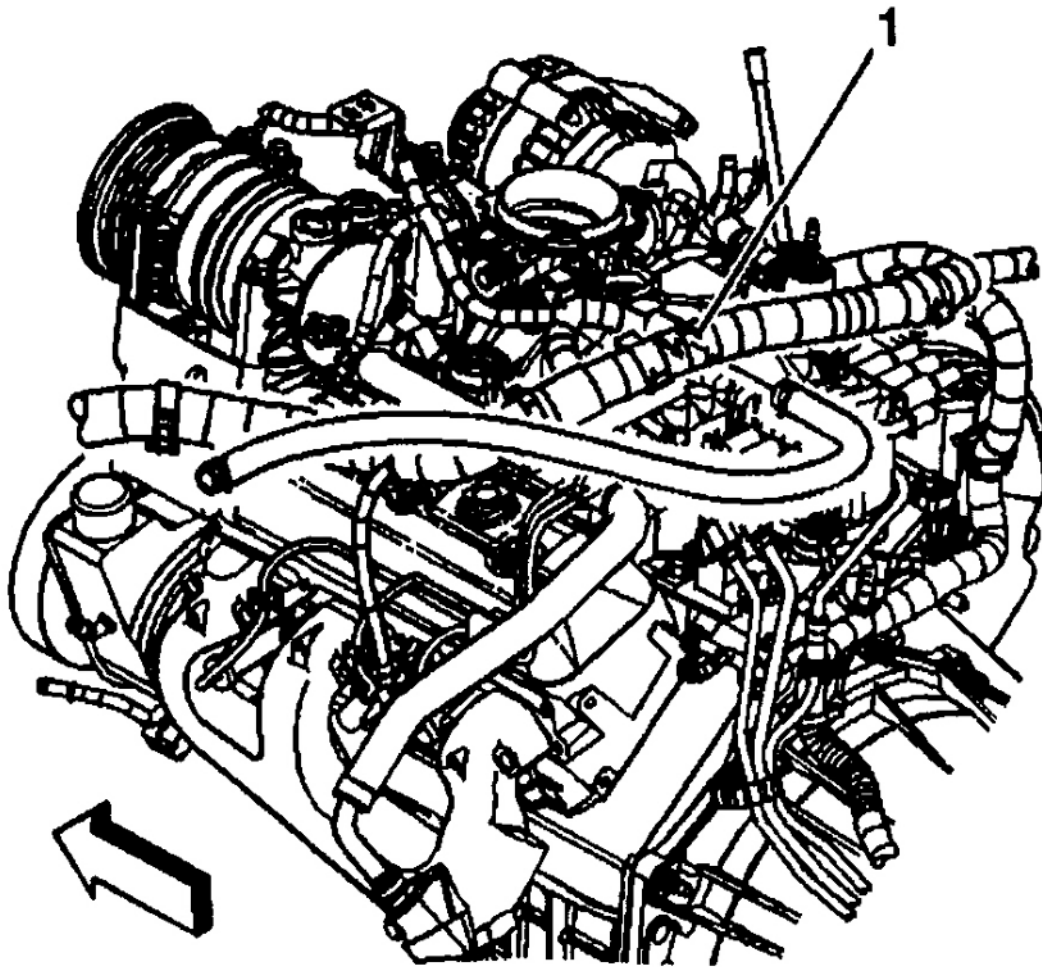
Tighten: Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).



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Fig. 138: View Of PCV Valve Hose
Courtesy of GENERAL MOTORS CORP.

5. Install the PCV valve hose to the PCV valve cover and rocker arm cover.



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Fig. 139: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

6. Connect the power brake booster vacuum hose to the vacuum fitting (1).

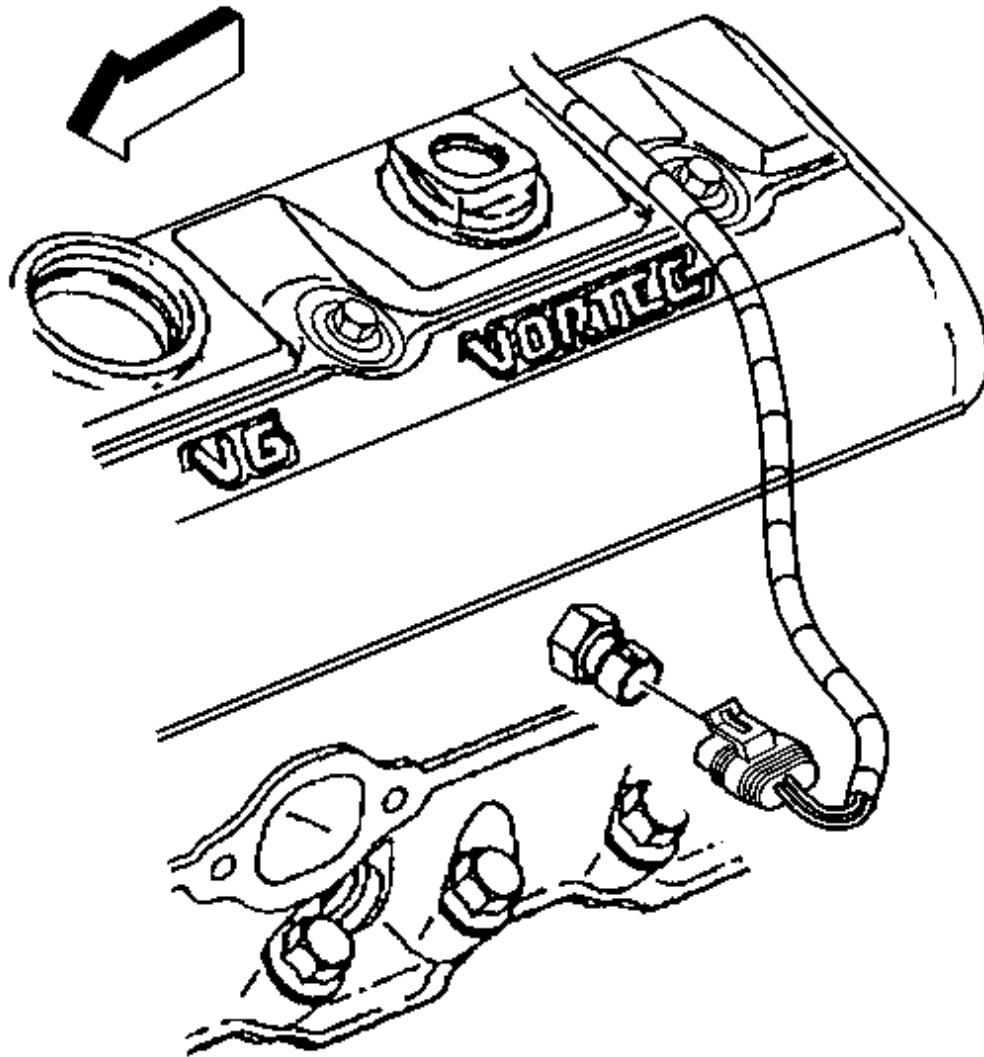


Fig. 140: View Of ECT Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Position the engine wiring harness and bracket.
8. Connect the ECT sensor electrical connector.

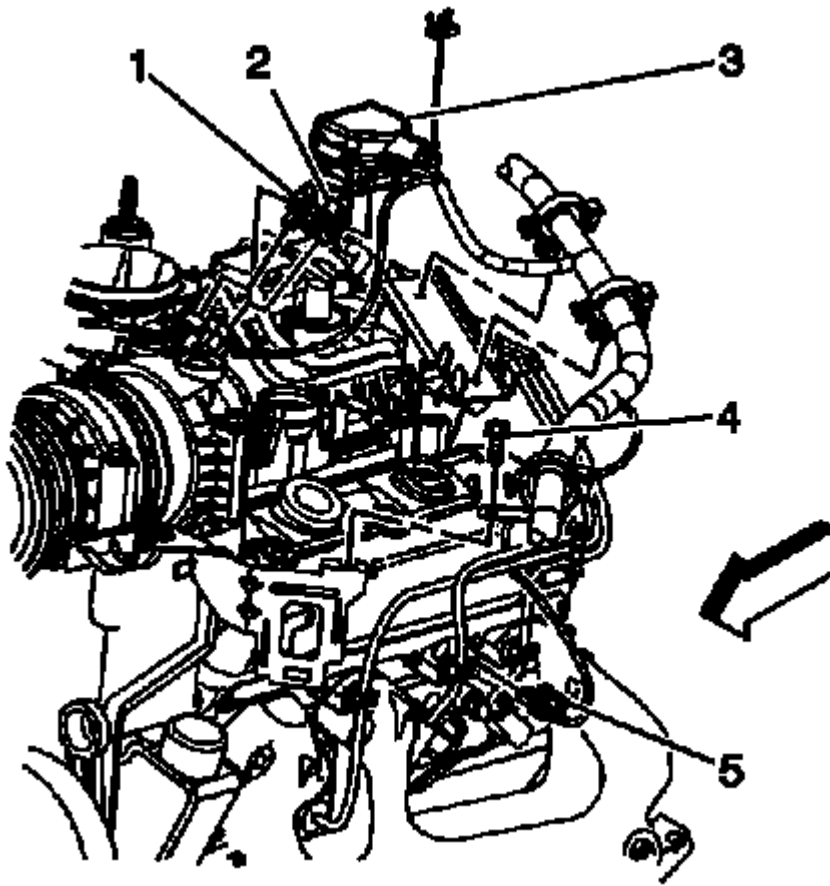
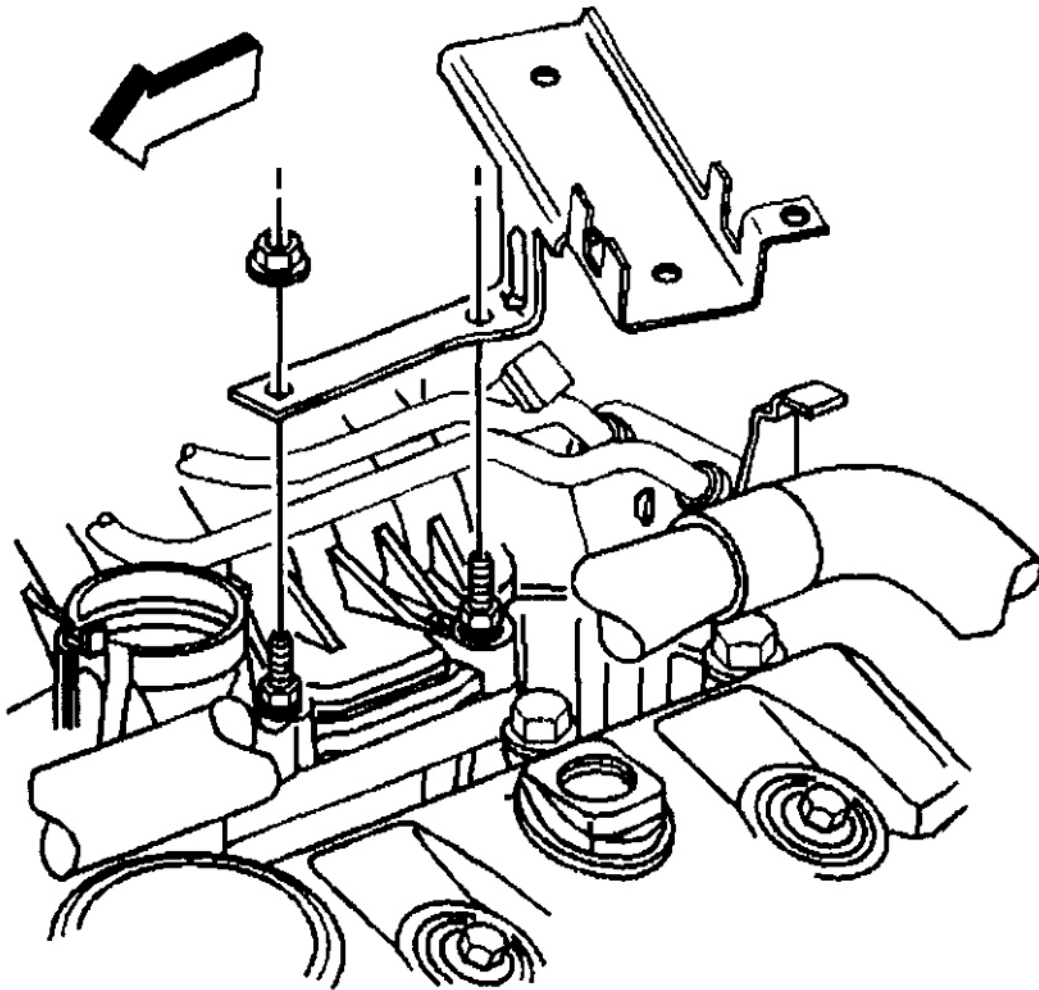


Fig. 141: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt
Courtesy of GENERAL MOTORS CORP.

9. Install the engine wiring harness clip bolt (4).

Tighten: Tighten the engine wiring harness clip bolt to 9 N.m (80 lb in).



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Fig. 142: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

10. Install the engine wiring harness bracket.
11. Install the engine wiring harness bracket nuts.

Tighten: Tighten the engine wiring harness bracket nuts to 12 N.m (106 lb in).

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT

Removal Procedure

1. Loosen the air cleaner outlet duct clamp at the mass airflow/intake air temperature (MAF/IAT) sensor.

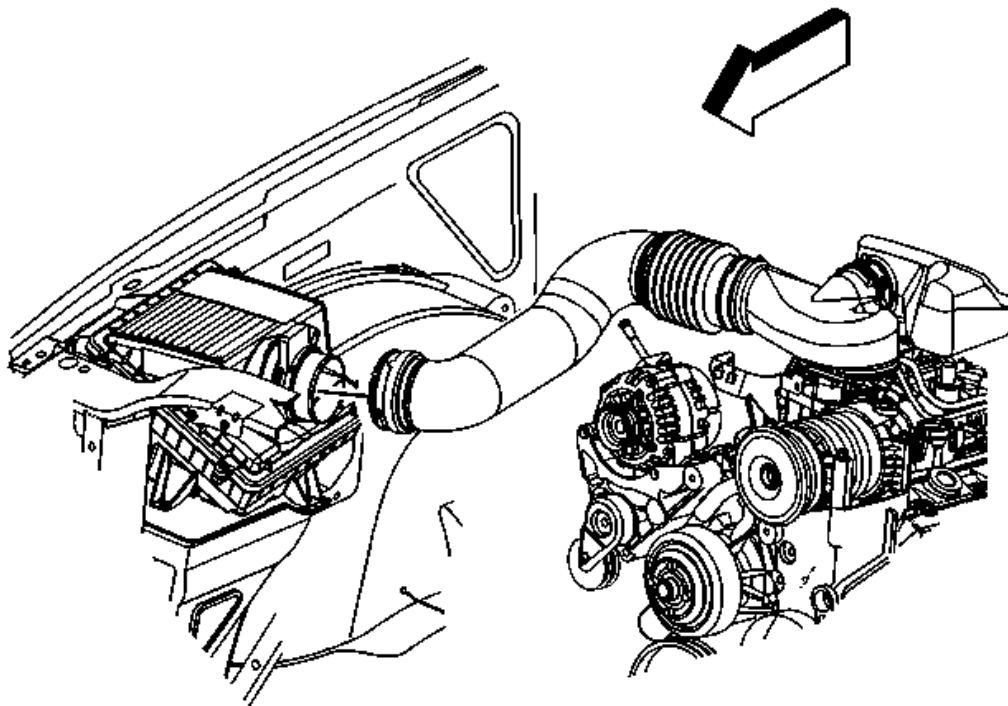


Fig. 143: View Of Air Cleaner Outlet Duct Clamp
Courtesy of GENERAL MOTORS CORP.

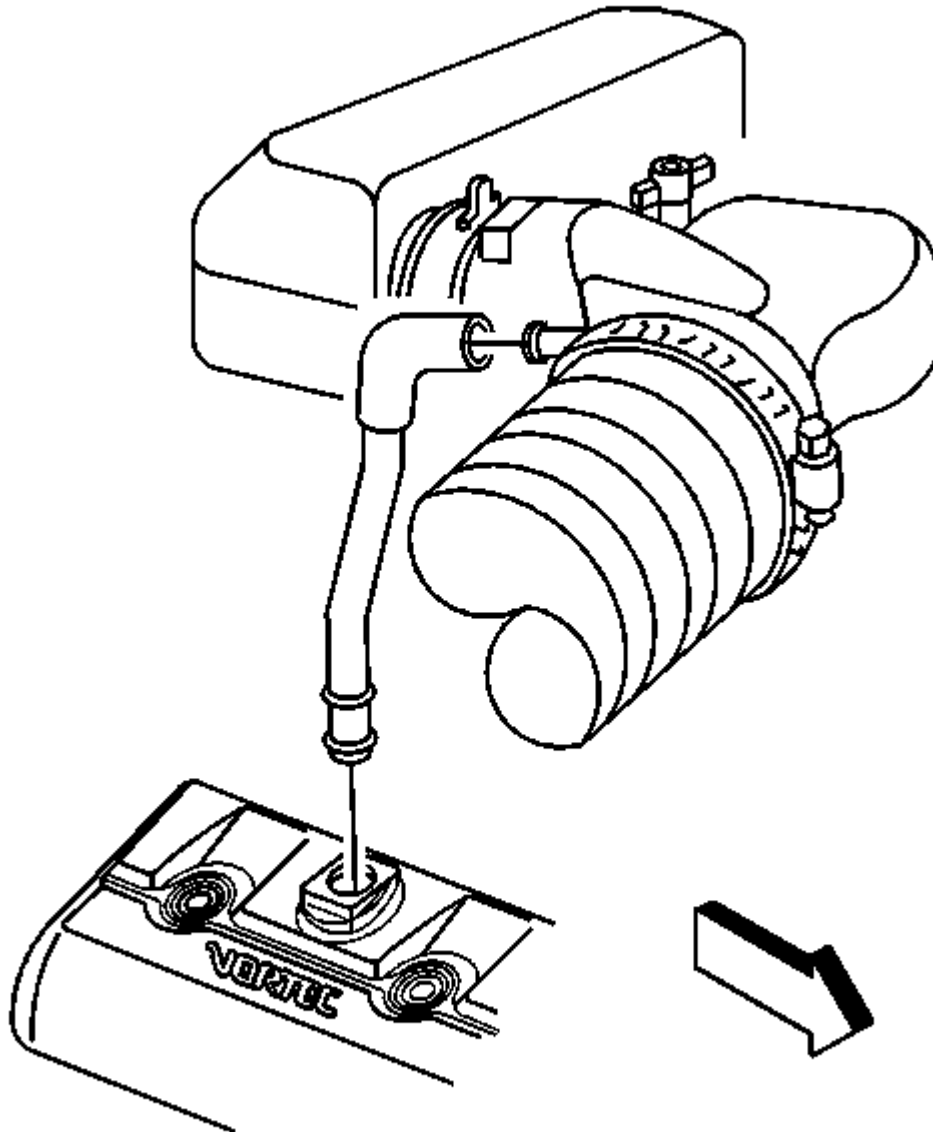


Fig. 144: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

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

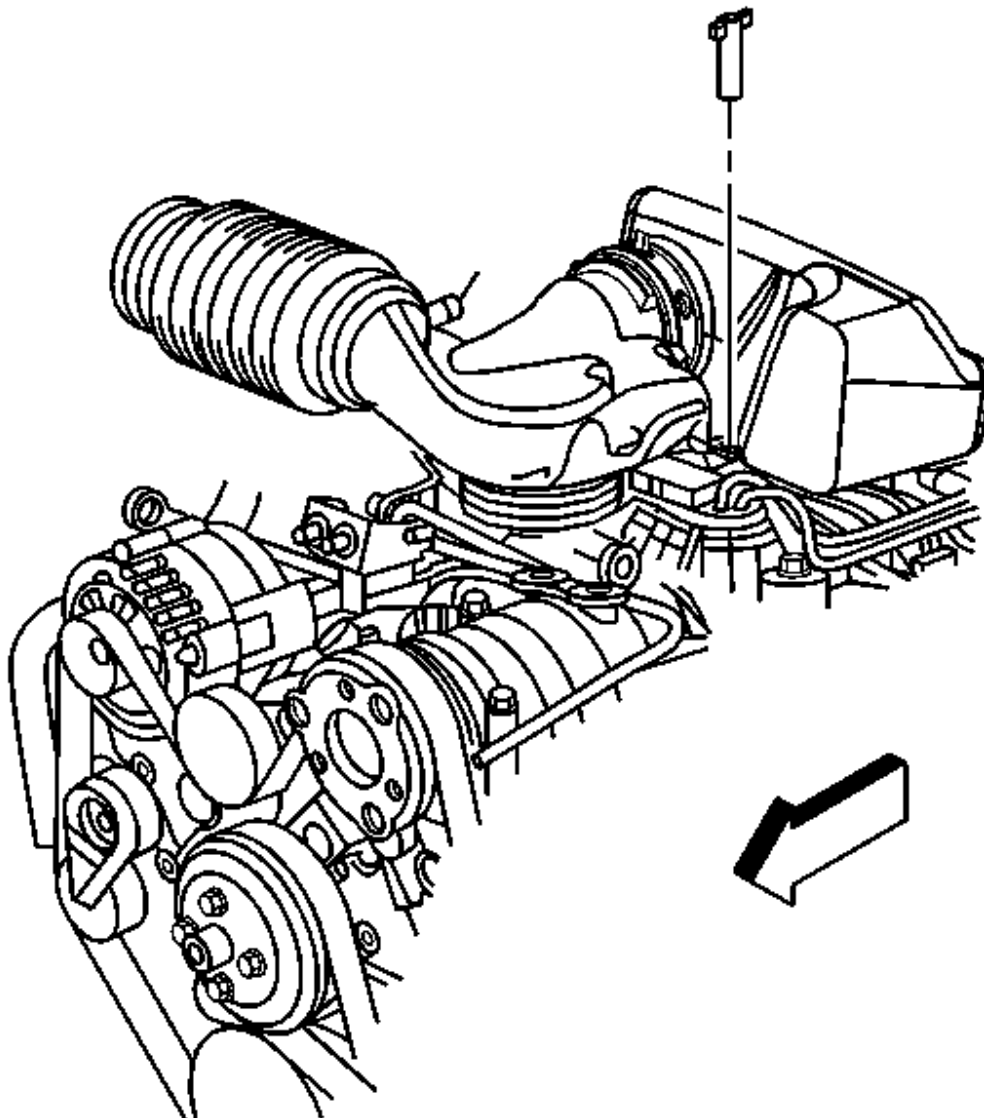


Fig. 145: View Of Air Cleaner Adapter Nut
Courtesy of GENERAL MOTORS CORP.

3. Remove the air cleaner adapter nut.

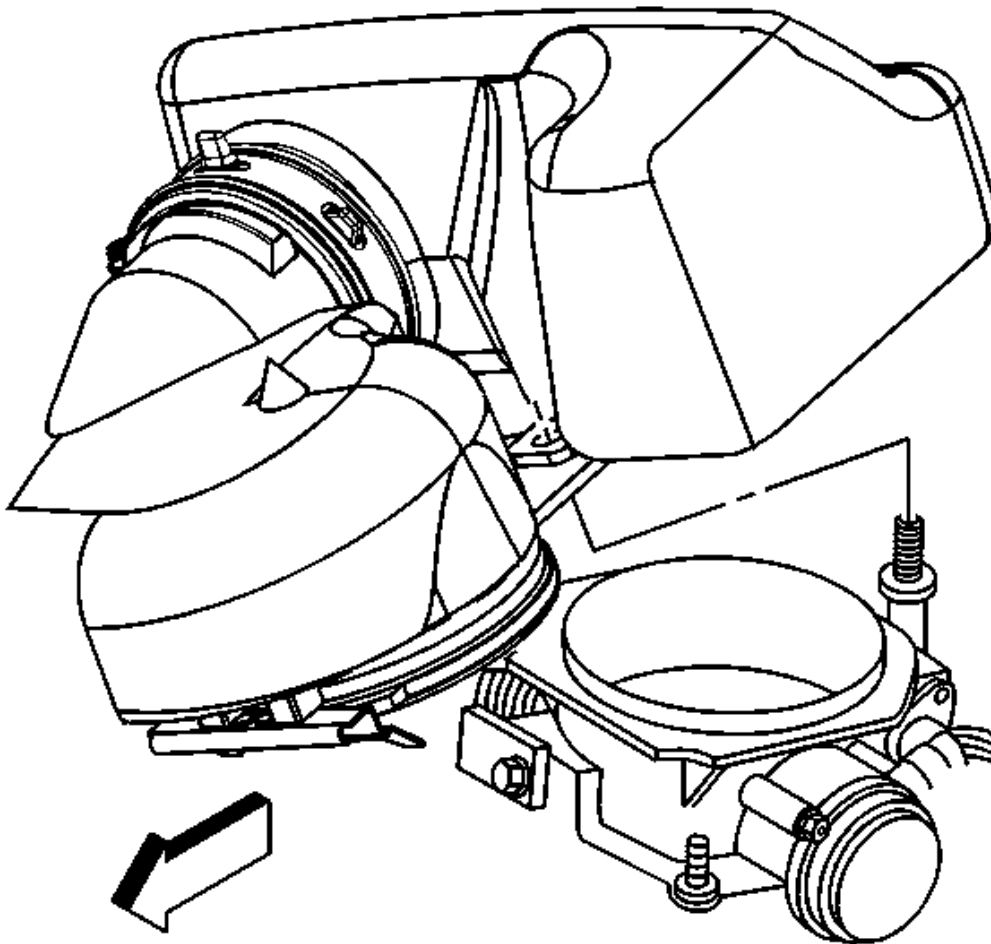


Fig. 146: View Of Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

4. In order to remove the air cleaner outlet duct, pivot the duct upward until the hinge clip releases from the lip on the throttle body.

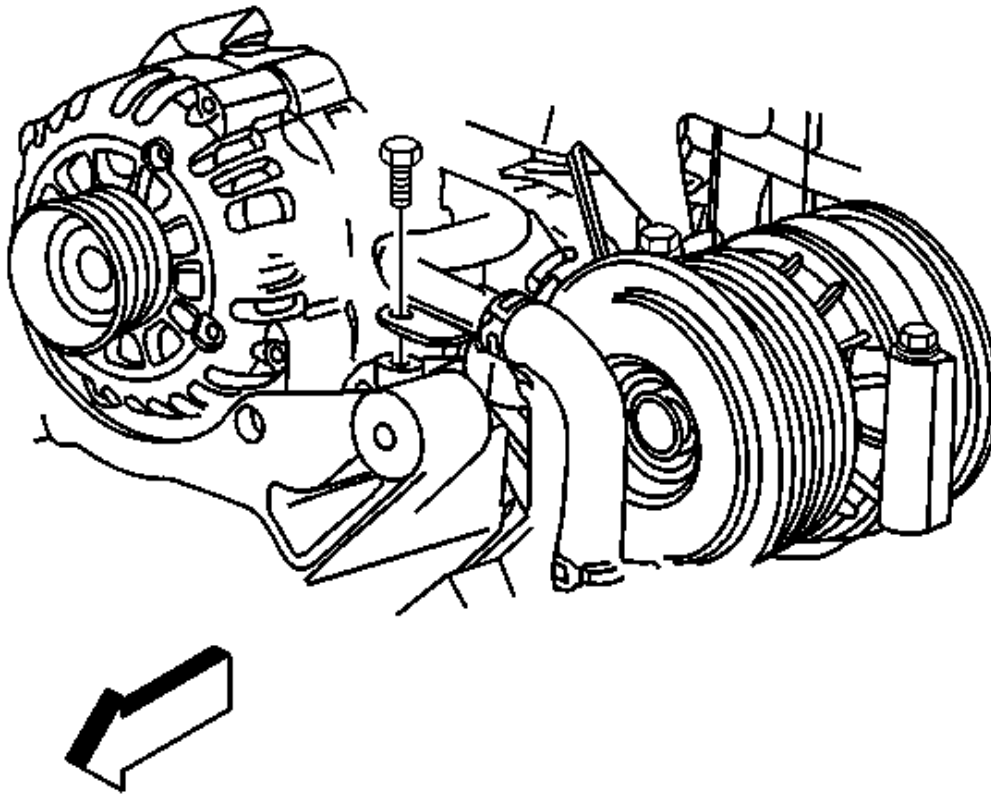


Fig. 147: View Of Heater Outlet Hose Clip Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the heater outlet hose clip bolt.
6. Move and secure the heater hoses out of the way.

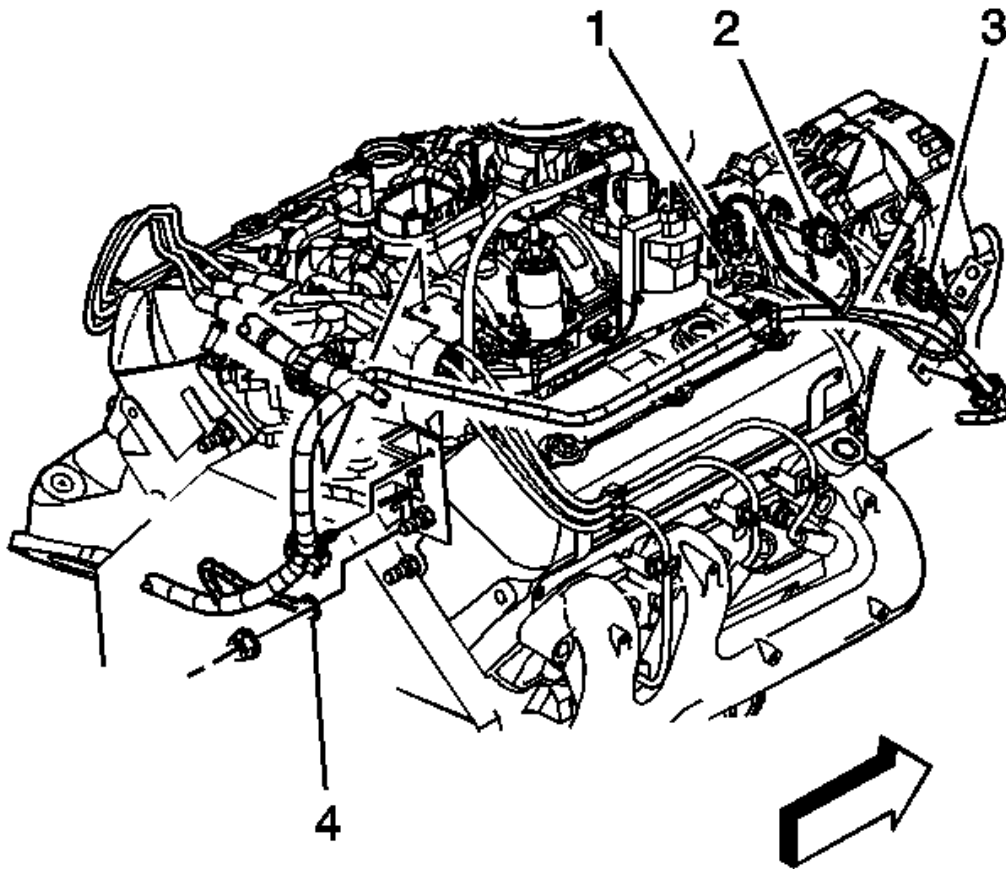


Fig. 148: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the following electrical connectors:
 - The ignition coil (1)
 - The ignition coil drive (2)
 - The generator (3)
8. Disconnect the engine wiring harness clips.
9. Reposition the engine wiring harness.

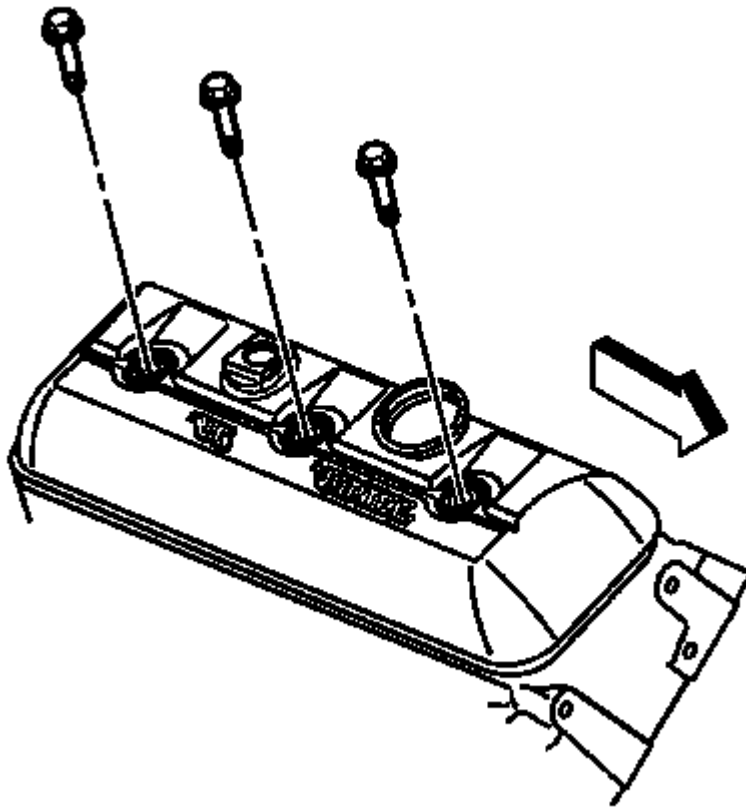


Fig. 149: View Of Valve Rocker Arm Cover Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve rocker arm cover bolts.
11. Remove and discard the valve rocker arm cover bolt grommets.

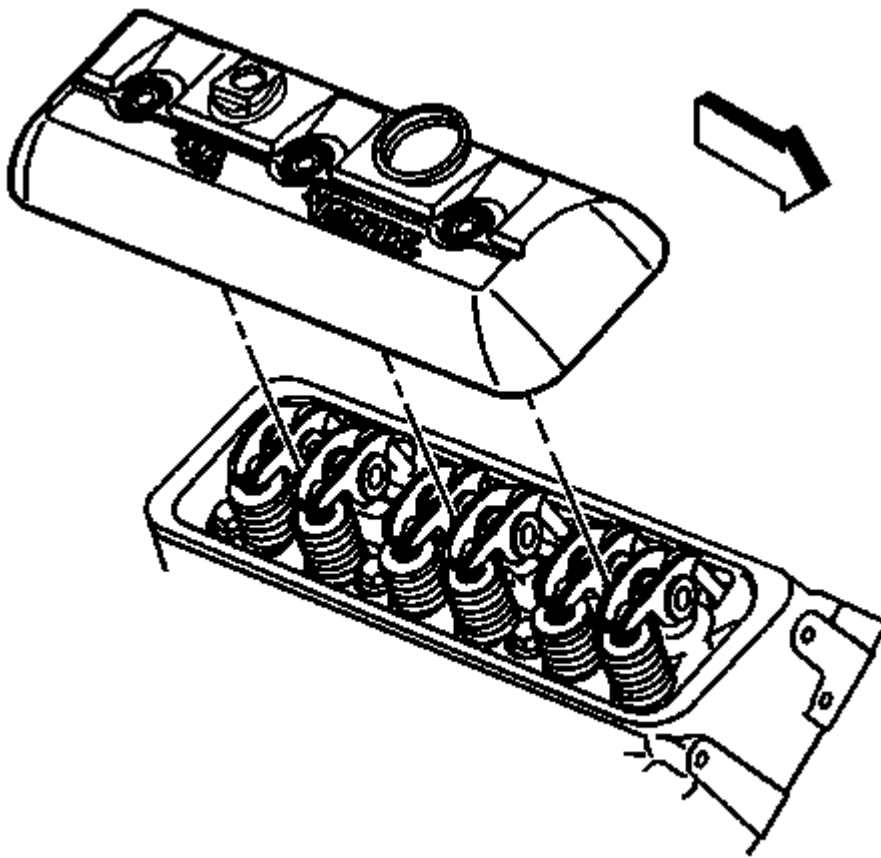


Fig. 150: Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve rocker arm cover.

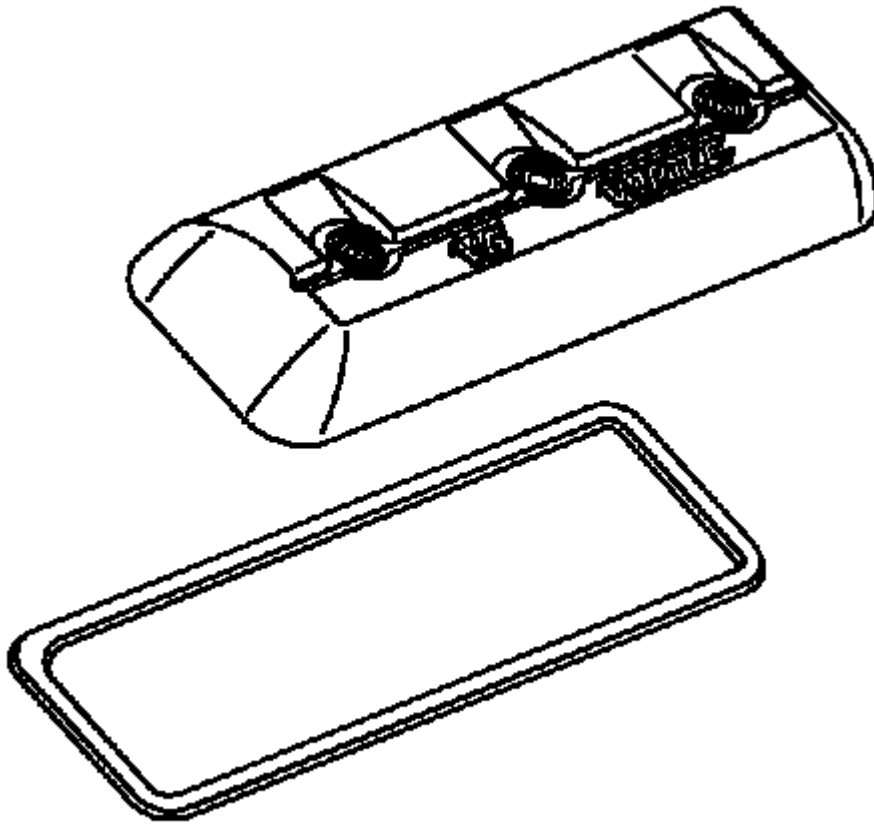


Fig. 151: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

13. Remove and discard the valve rocker arm cover gasket.
14. Clean and inspect the valve rocker arm cover, if necessary. Refer to **VALVE ROCKER ARM COVER CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT: Do not reuse the valve cover gasket or the valve rocker arm cover bolt grommets.

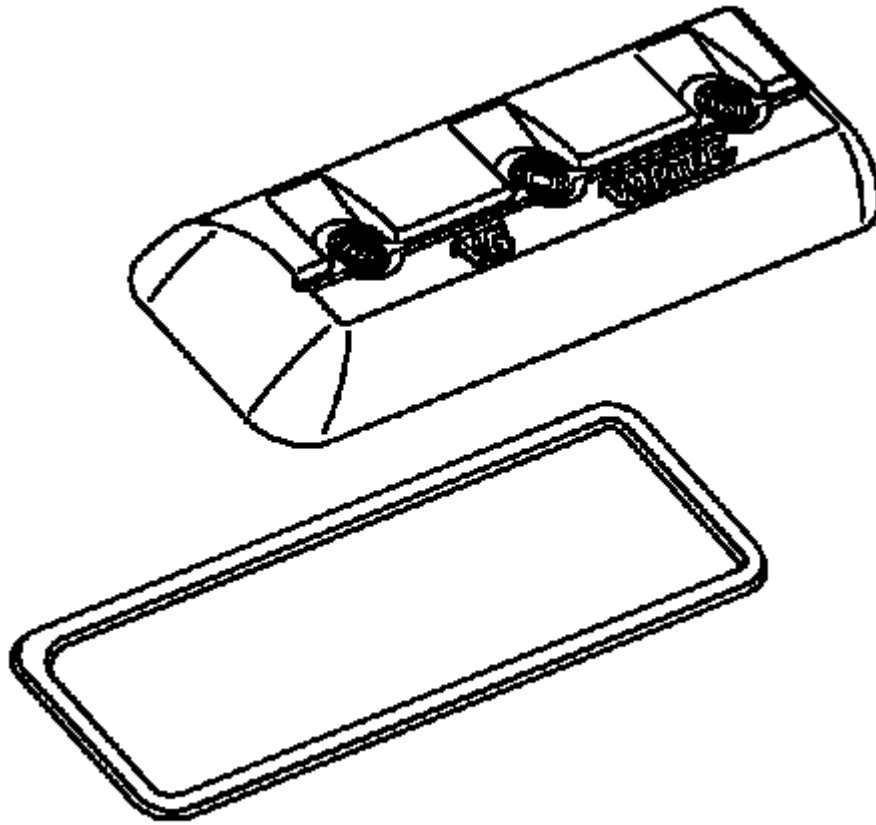


Fig. 152: View Of Rocker Arm Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve rocker arm cover gasket.
2. Install NEW valve rocker arm cover bolt grommets.

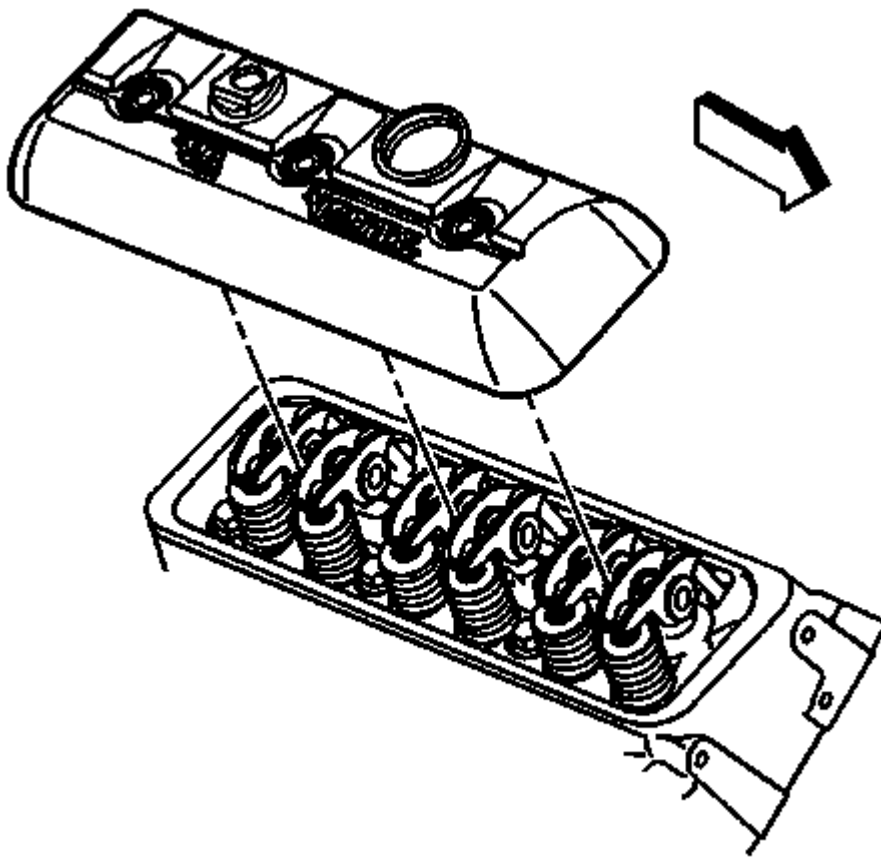


Fig. 153: Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm cover.

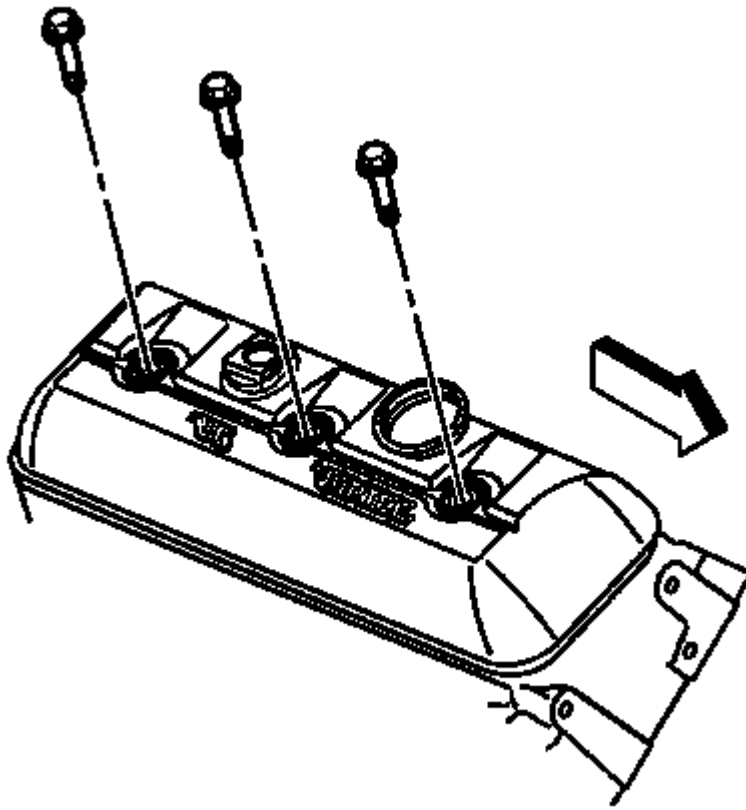


Fig. 154: View Of Valve Rocker Arm Cover Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

4. Install the valve rocker arm cover bolts.

Tighten: Tighten the valve rocker arm cover bolts to 12 N.m (106 lb in).

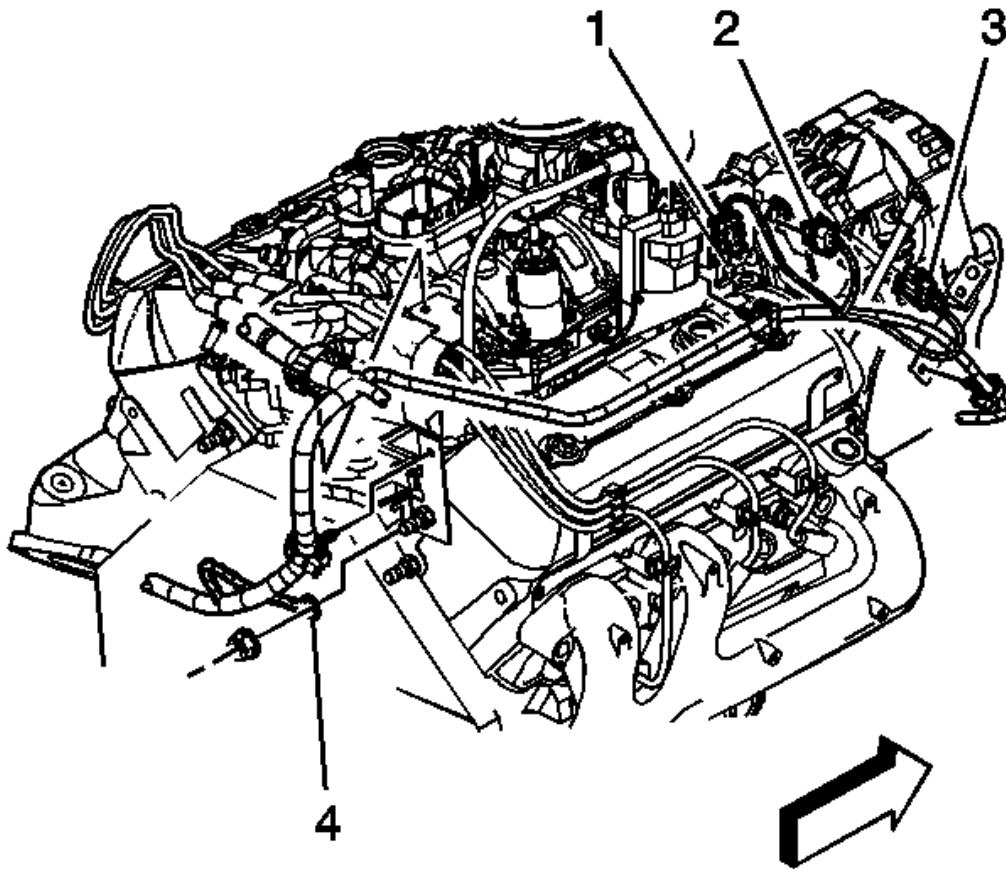


Fig. 155: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Position the engine wiring harness.
6. Connect the engine wiring harness clips.
7. Connect the following electrical connectors:
 - The ignition coil (1)
 - The ignition coil drive (2)
 - The generator (3)

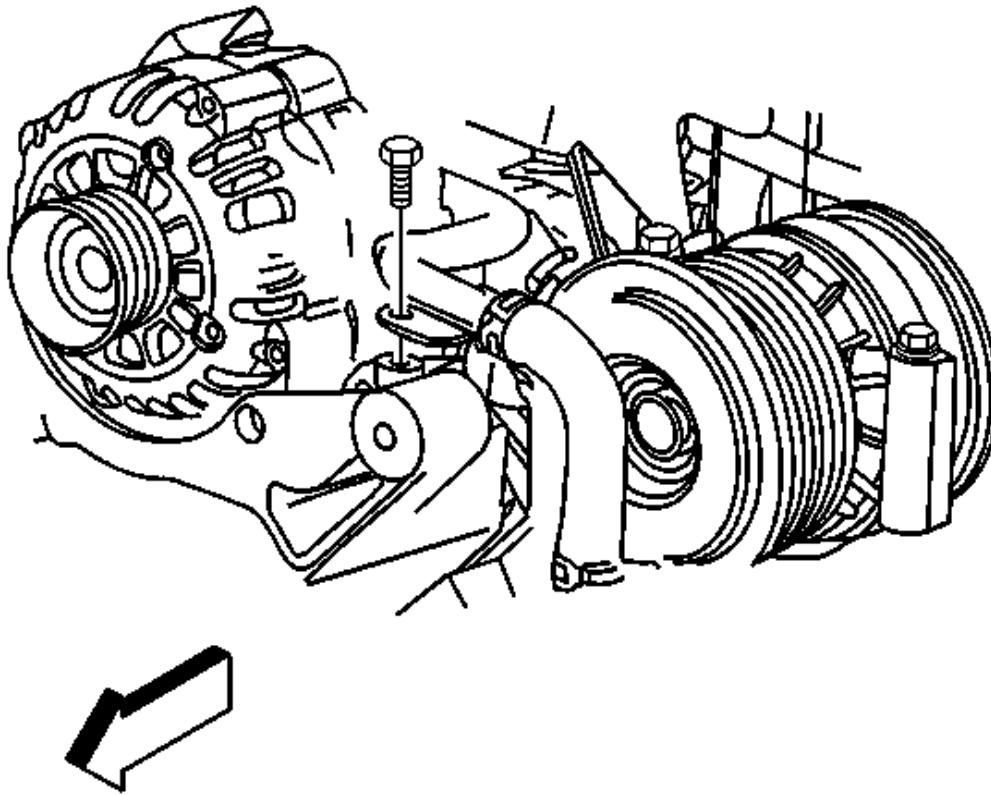


Fig. 156: View Of Heater Outlet Hose Clip Bolt
Courtesy of GENERAL MOTORS CORP.

8. Position the heater hoses.
9. Install the heater outlet hose clip bolt.

Tighten: Tighten the heater outlet hose clip bolt to 25 N.m (18 lb ft).

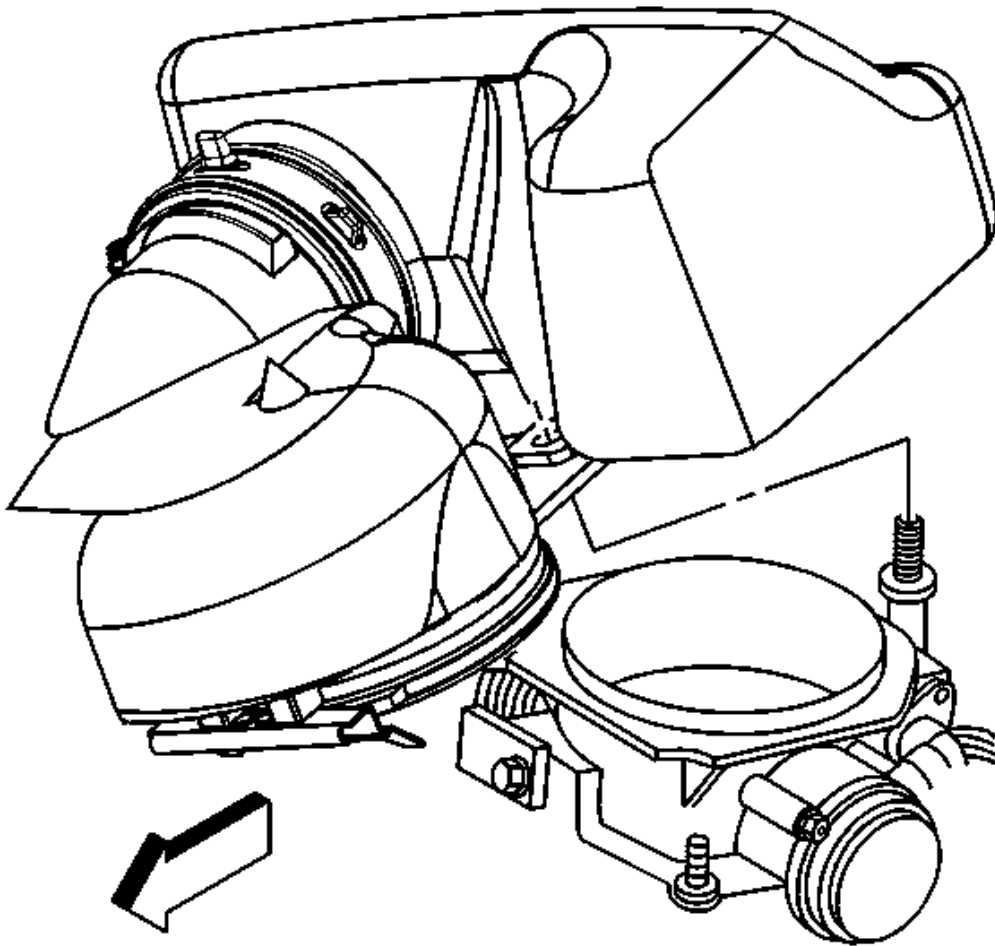


Fig. 157: View Of Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

10. Align the hinge clip with the lip on the throttle body.

In order to install the air cleaner outlet duct, pivot the air cleaner outlet duct downward until the mounting stud is through the hole.

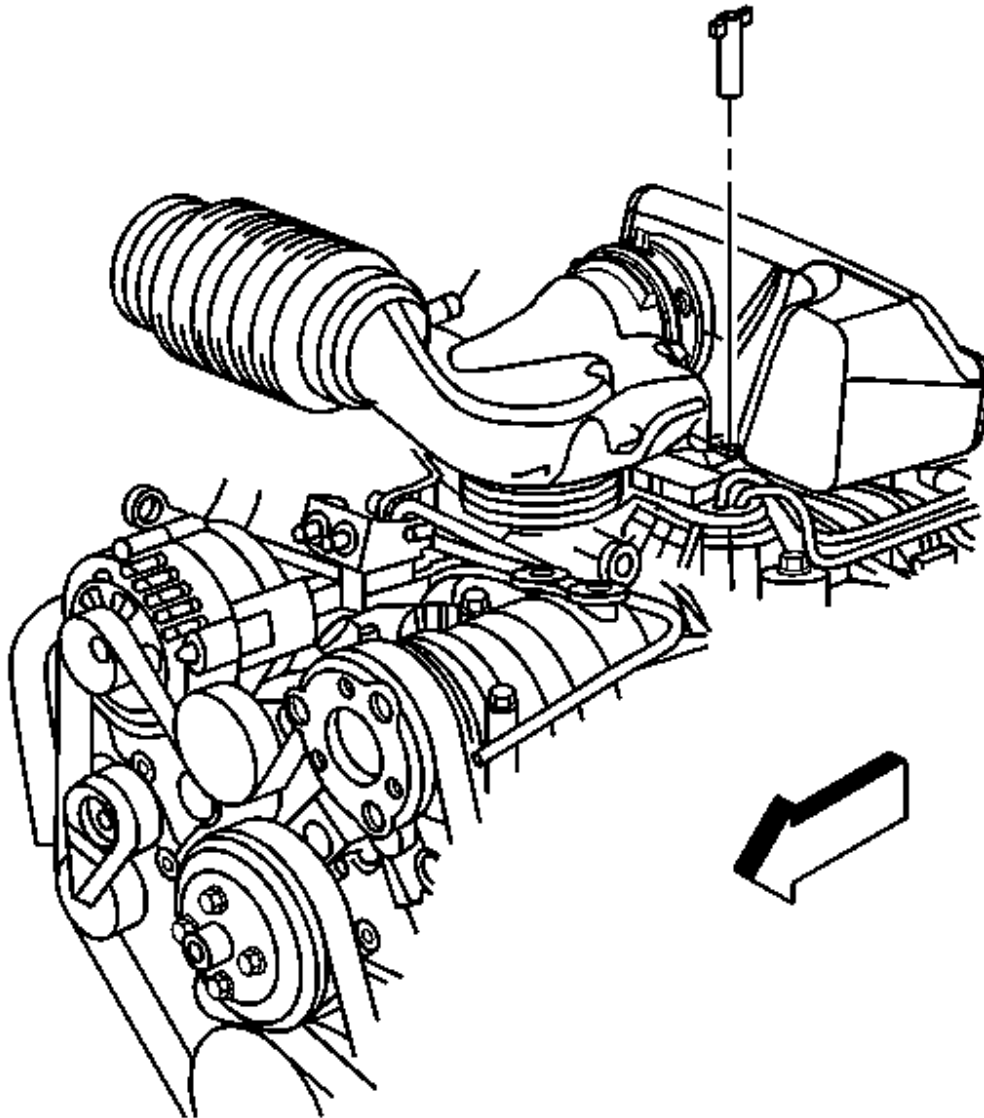


Fig. 158: View Of Air Cleaner Adapter Nut
Courtesy of GENERAL MOTORS CORP.

11. Install the air cleaner adapter nut.

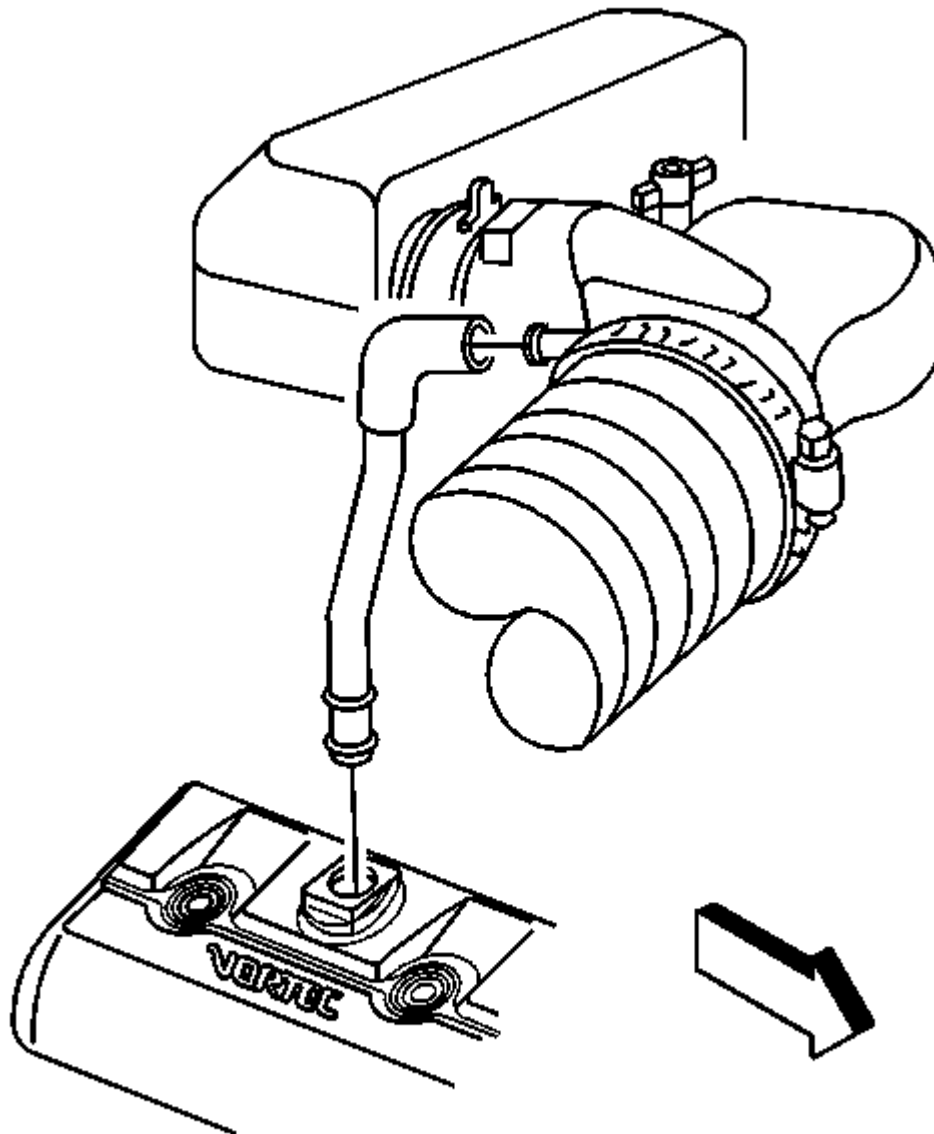


Fig. 159: View Of Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

12. Install the positive crankcase ventilation (PCV) hose.

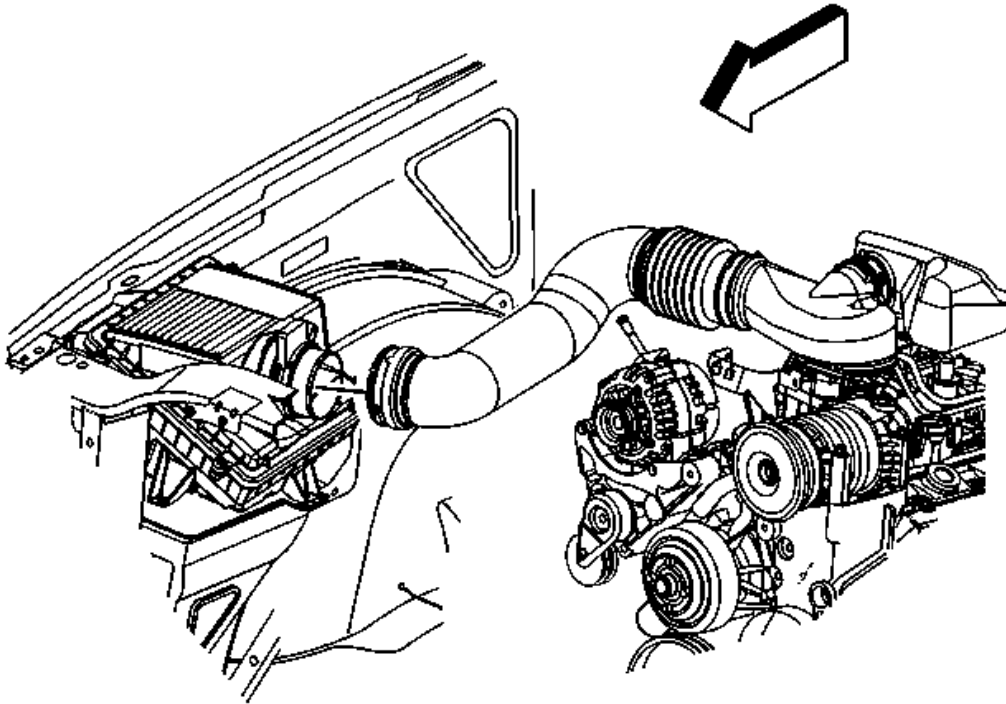


Fig. 160: View Of Air Cleaner Outlet Duct Clamp
Courtesy of GENERAL MOTORS CORP.

13. Tighten the air cleaner outlet duct clamp at the MAF/IAT sensor.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

IMPORTANT: Mark, sort, and organize all the components for assembly.

Removal Procedure

1. Remove the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left or Valve Rocker Arm Cover Replacement - Right.
2. Remove the valve rocker arms.

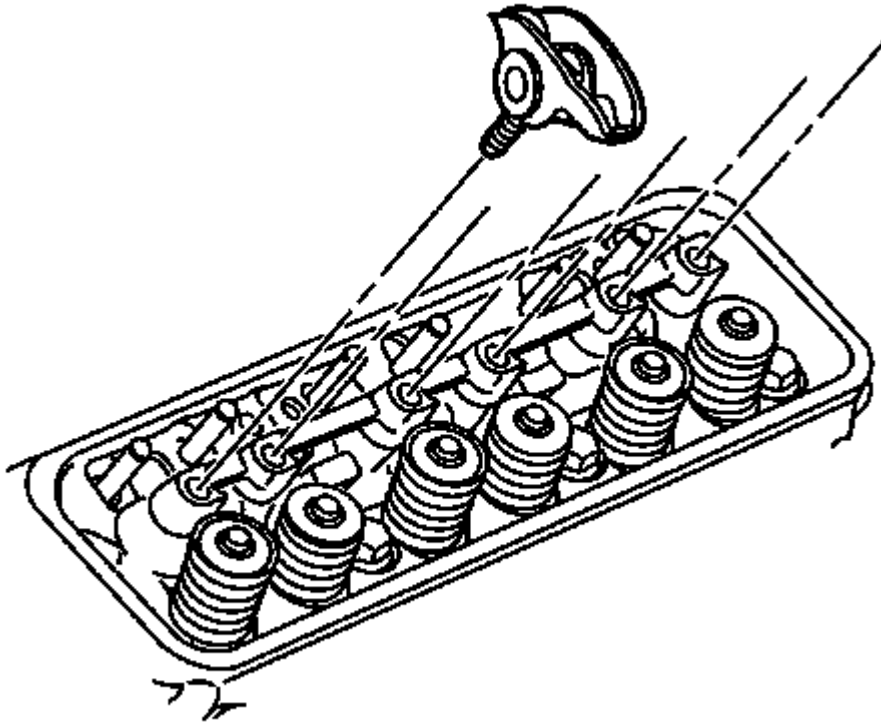


Fig. 161: View Of Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

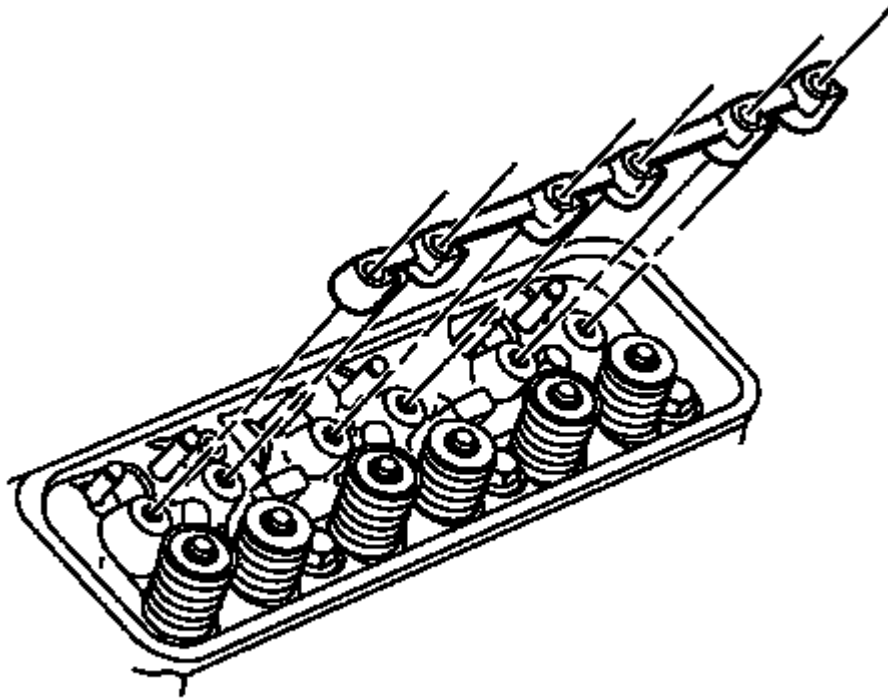


Fig. 162: View Of Valve Rocker Arm Supports
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve rocker arm supports.

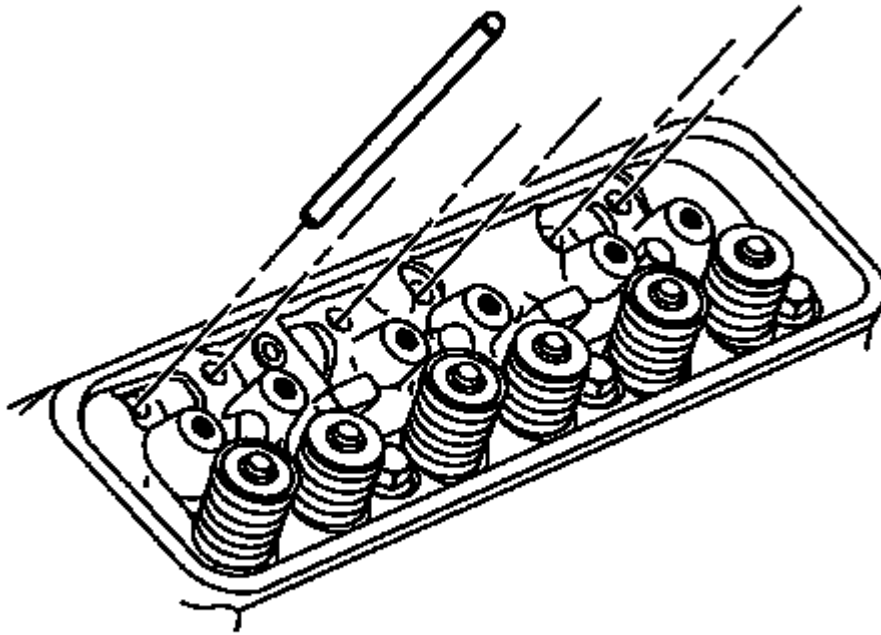


Fig. 163: View Of Valve Pushrods
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve pushrods.
5. Clean and inspect the valve rocker arms and/or pushrods, if necessary. Refer to **VALVE ROCKER ARM & PUSH RODS -- CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT: Be sure to keep parts in order. Parts must be reinstalled into the original location and position.

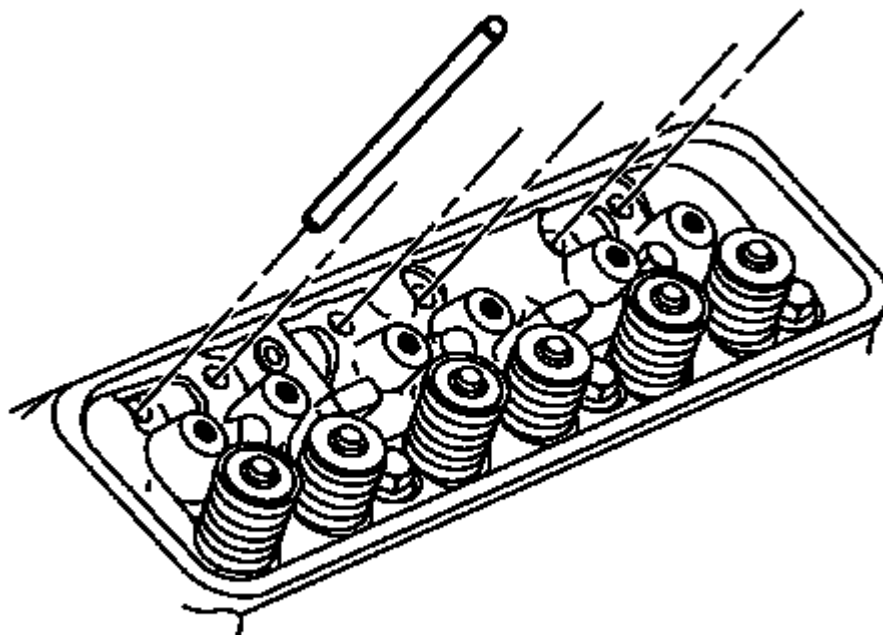


Fig. 164: View Of Valve Pushrods
Courtesy of GENERAL MOTORS CORP.

1. Install the valve pushrods.

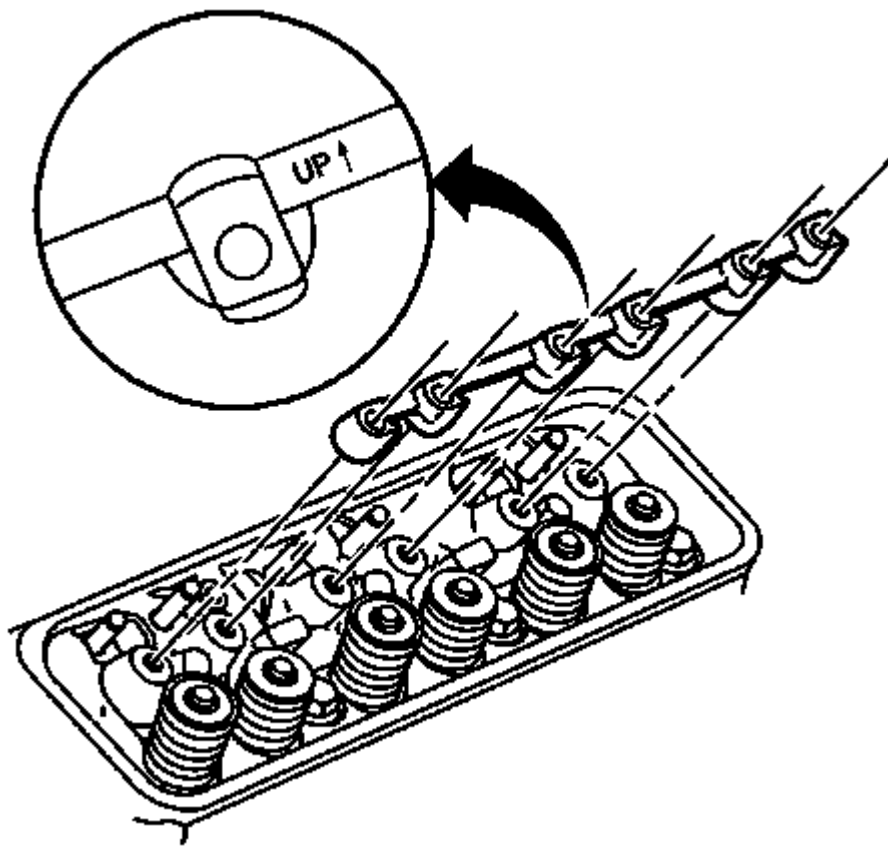


Fig. 165: Locating Valve Rocker Arm Supports
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Be sure that the arrow on the valve rocker arm support is in the up position.

2. Install the valve rocker arm supports.

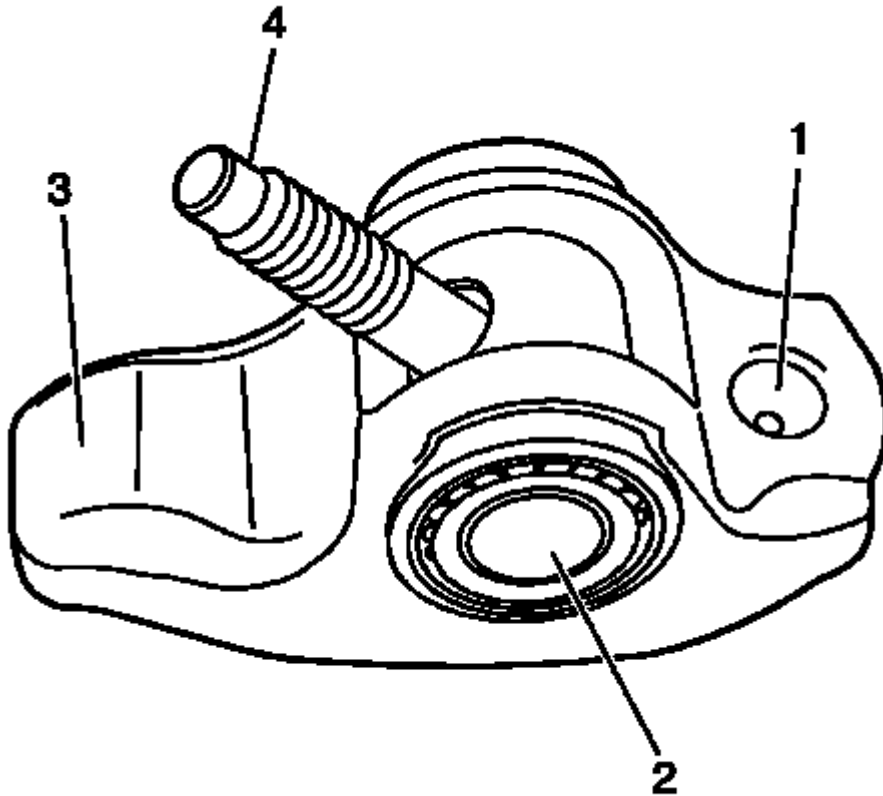


Fig. 166: View Of Valve Pushrod Socket, Roller Pivot & Valve Stem Tip
Courtesy of GENERAL MOTORS CORP.

3. Apply lubricant GM U.S. P/N 12345501, Canada P/N 992704, or equivalent to the following valve rocker arm contact surfaces:
 - Valve pushrod socket (1)
 - Roller pivot (2)
 - Valve stem tip (3)

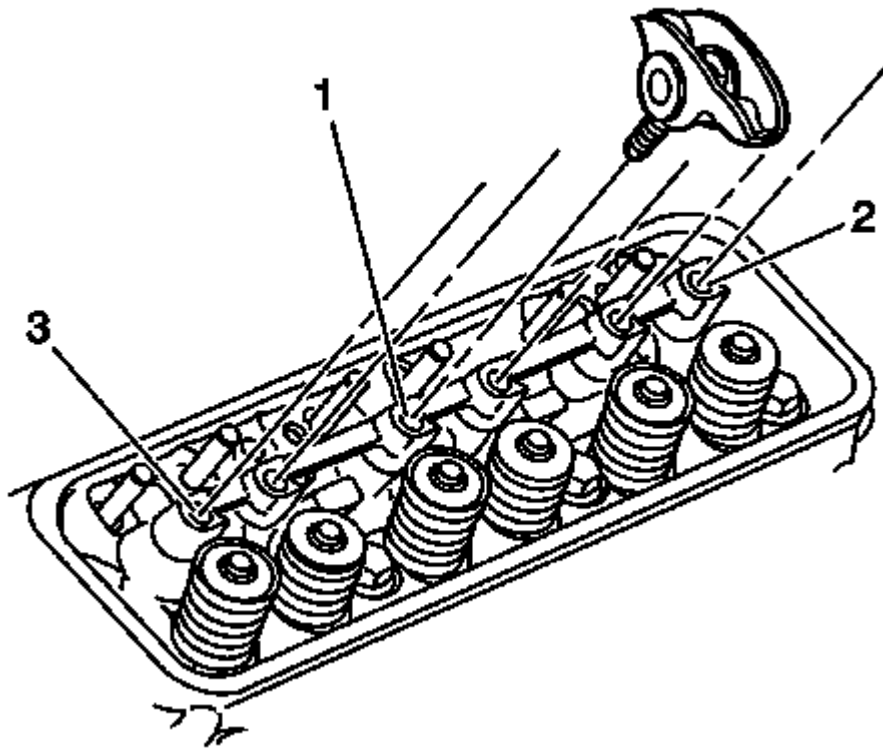


Fig. 167: View Of Valve Rocker Arm Bolt Locations
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

4. Install the valve rocker arms as follows:
 1. Finger start the bolt at location (1)
 2. Finger start the bolt at location (2)
 3. Finger start the bolt at location (3)
 4. Finger start the remaining valve rocker arm bolts

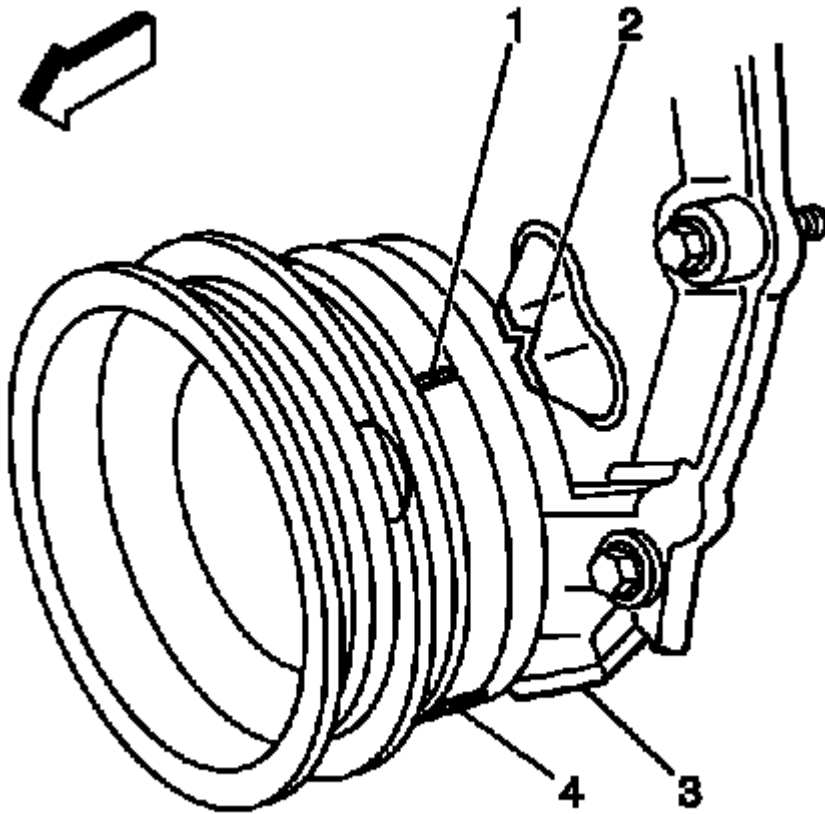


Fig. 168: View Of Crankshaft Balancer Alignment Mark & Engine Front Cover Alignment Tab
Courtesy of GENERAL MOTORS CORP.

5. Rotate the crankshaft balancer to position the crankshaft balancer alignment mark (1) 57-63 degrees clockwise or counterclockwise from the engine front cover alignment tab (2).

IMPORTANT: Once the valve rocker arms are installed and properly torqued, no additional valve lash adjustment is required.

6. Tighten the valve rocker arm bolts.

Tighten: Tighten valve rocker arm bolts to 30 N.m (22 lb ft).

7. Install the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement - Left or Valve Rocker Arm Cover Replacement - Right.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Tools Required

- **J 22794** Spark Plug Port Adapter
- **J 38606** Valve Spring Compressor
- **J 5892-D** Valve Spring Compressor
- **J 42073** Valve Stem Oil Seal Installer

Removal Procedure

1. Remove the required valve rocker arms. Refer to Valve Rocker Arm and Push Rod Replacement.
2. Remove the required spark plugs.
3. Install the **J 22794** into the spark plug hole.

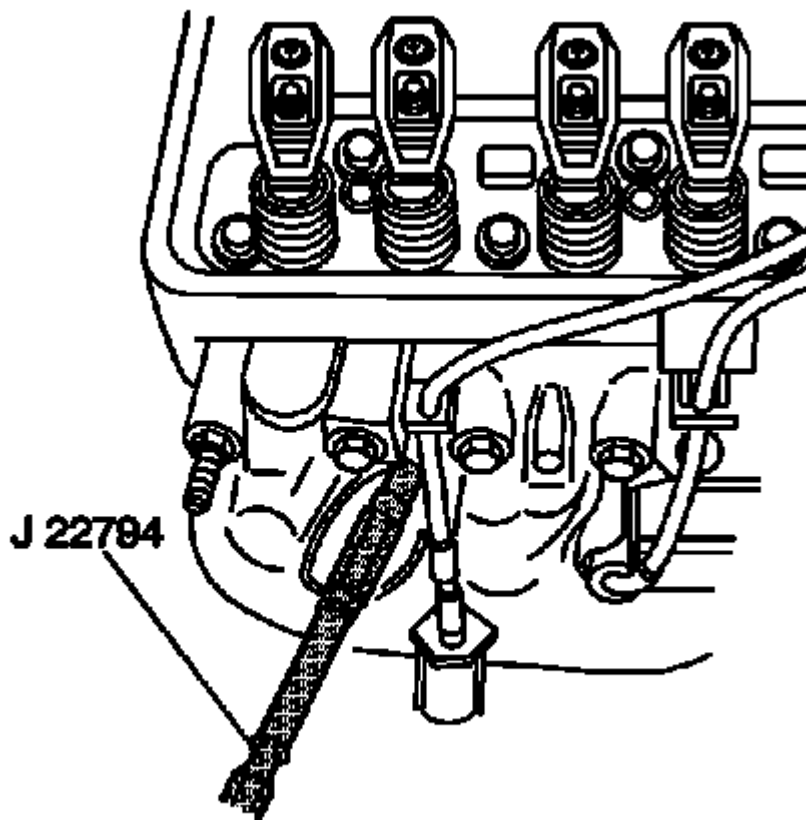


Fig. 169: View Of J 22794 Installed Into Spark Plug Hole
Courtesy of GENERAL MOTORS CORP.

4. Connect a shop air supply hose and apply compressed air in order to hold the valves in place.

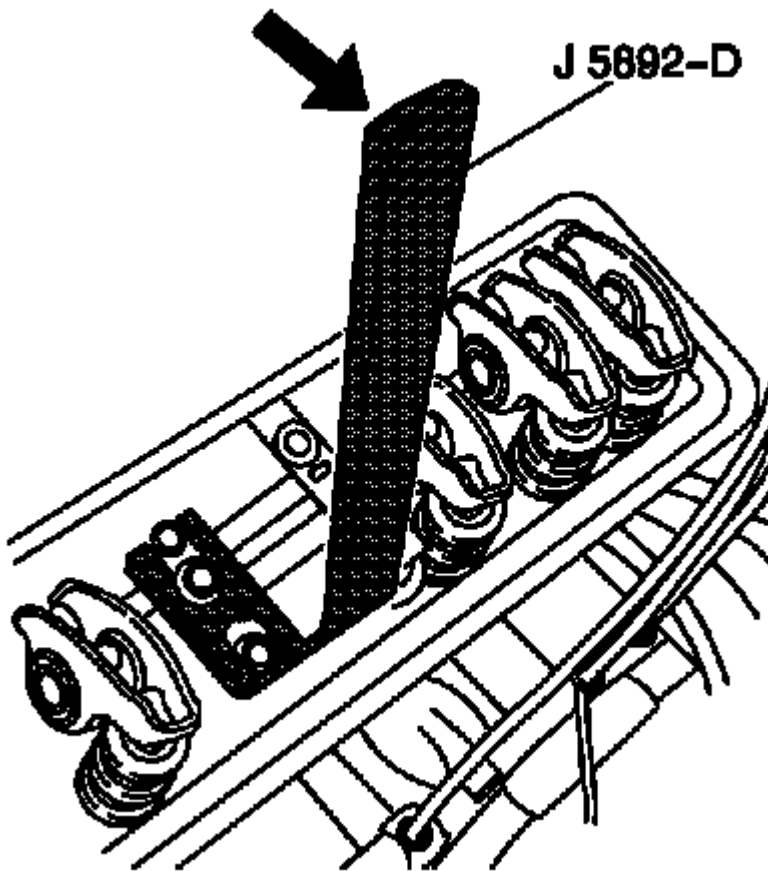


Fig. 170: View Of J 5892-D, Valve Rocker Arm Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

5. Remove a bolt from a valve rocker arm.
6. Install a flat washer on the bolt.
7. Install the bolt in the valve rocker arm bolt hole for the valve spring requiring removal.

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

8. Use the **J 5892-D** in order to compress the valve spring.
 1. Hook the slotted end of **J 5892-D** under the washer on the valve rocker arm bolt.
 2. Apply steady pressure on the valve spring cap until the valve keys are accessible.

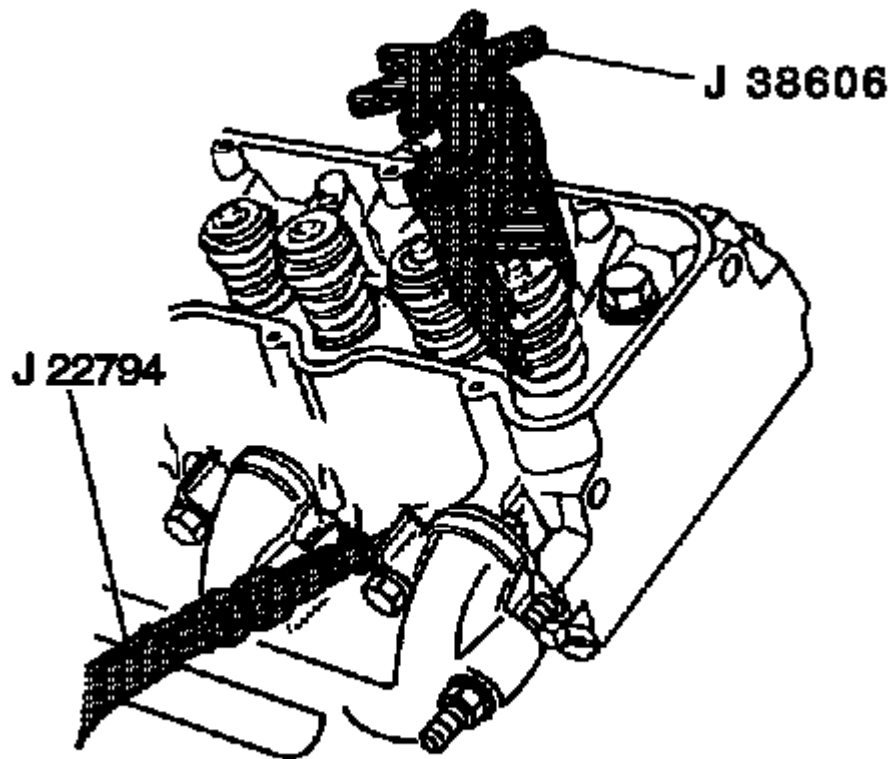


Fig. 171: Compress The Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

NOTE: Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratch.

9. Use J 38606 when J 5892-D will not fit.

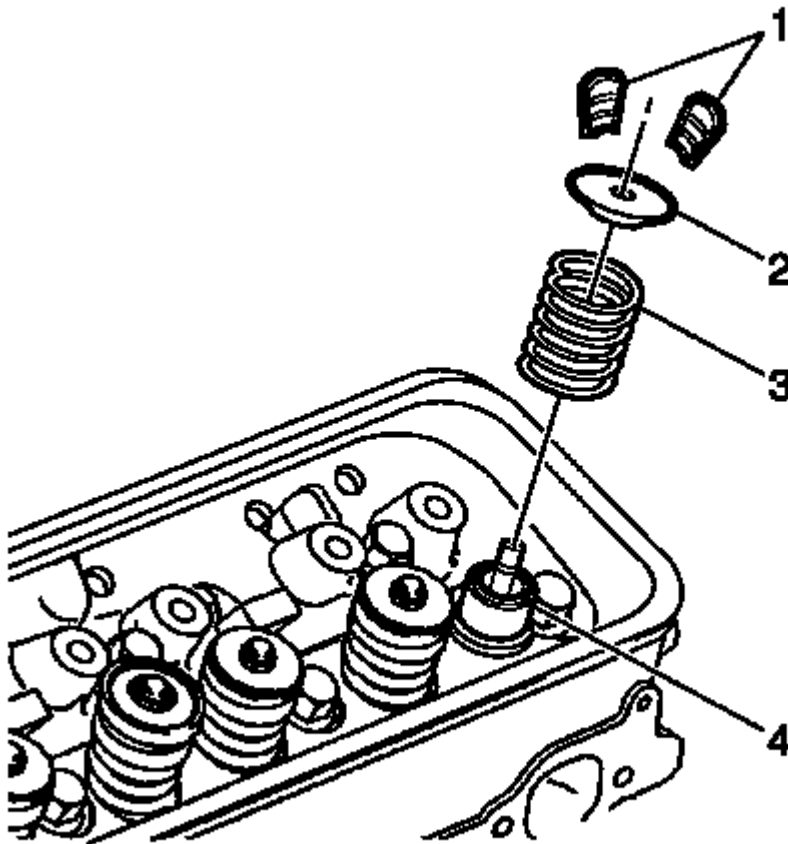


Fig. 172: Identifying Valve Components
Courtesy of GENERAL MOTORS CORP.

10. Remove the valve keys (1).
11. Carefully release the valve spring tension.
12. Remove the **J 5892-D** or the **J 38606**.
13. Remove the valve spring cap (2) and valve spring (3).
14. Remove the valve stem oil seal (4).

Installation Procedure

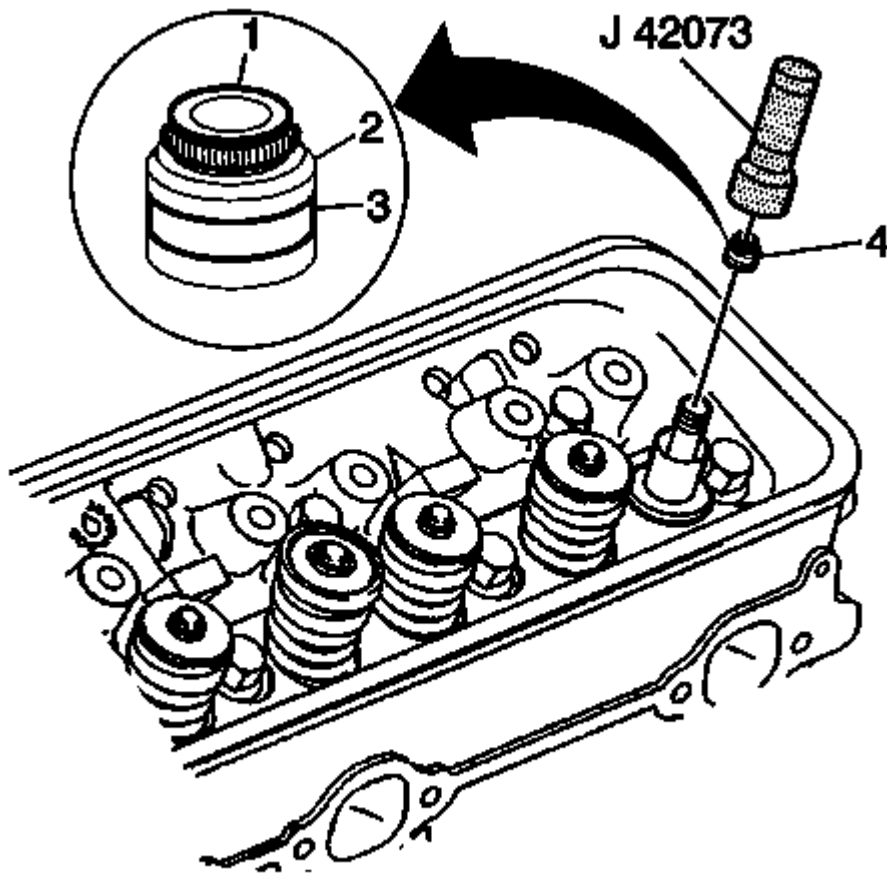


Fig. 173: View Of Exhaust Valve Stem Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The exhaust valve oil stem seal has the letters EX (1) molded into the top of the seal. The exhaust valve oil stem seal material is brown in color (2) with a white stripe (3) painted onto the outside diameter of the seal, or the material may be red in color (2) with no paint stripe. The intake valve oil seal is black in color.

1. Assemble the valve into the proper valve guide.
2. Select the proper valve stem oil seal for the specific valve guide.
3. Lubricate the valve stem oil seal and the outside diameter of the valve guide with clean engine oil.
4. Assemble the valve stem oil seal onto the valve stem.

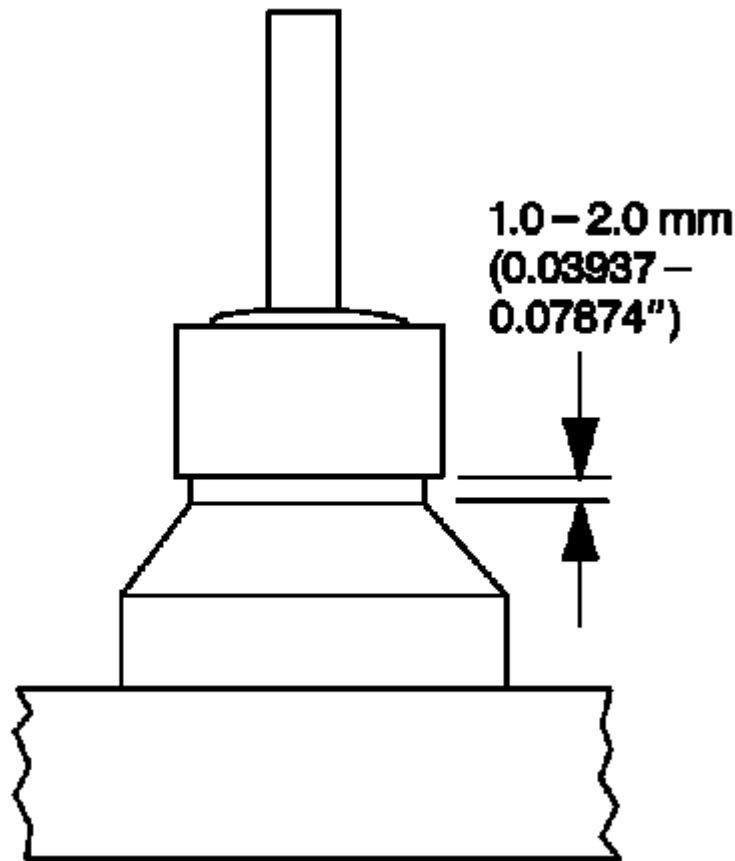


Fig. 174: Positioning Valve Stem Oil Seal Into Valve Guide
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 42073** , install the valve stem oil seal onto the valve guide.
 1. Tap the valve stem oil seal onto the valve guide until the **J 42073** bottoms against the valve spring seat.
 2. Inspect the valve stem oil seal. The valve stem oil seal should not be bottomed against the valve guide.

There should be a 1-2 mm (0.03937-0.07874 in) gap between the bottom edge of the valve stem oil seal and the valve guide.

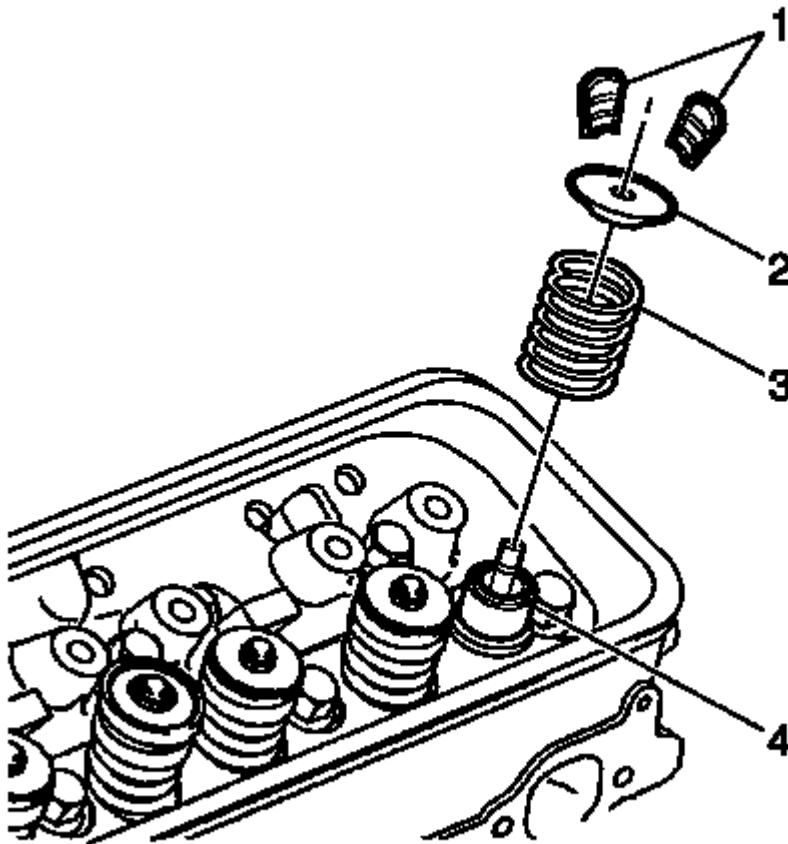


Fig. 175: Identifying Valve Components
Courtesy of GENERAL MOTORS CORP.

6. Install the valve spring (3).
7. Install the valve spring cap (2) onto the valve spring (3), over the valve stem.

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

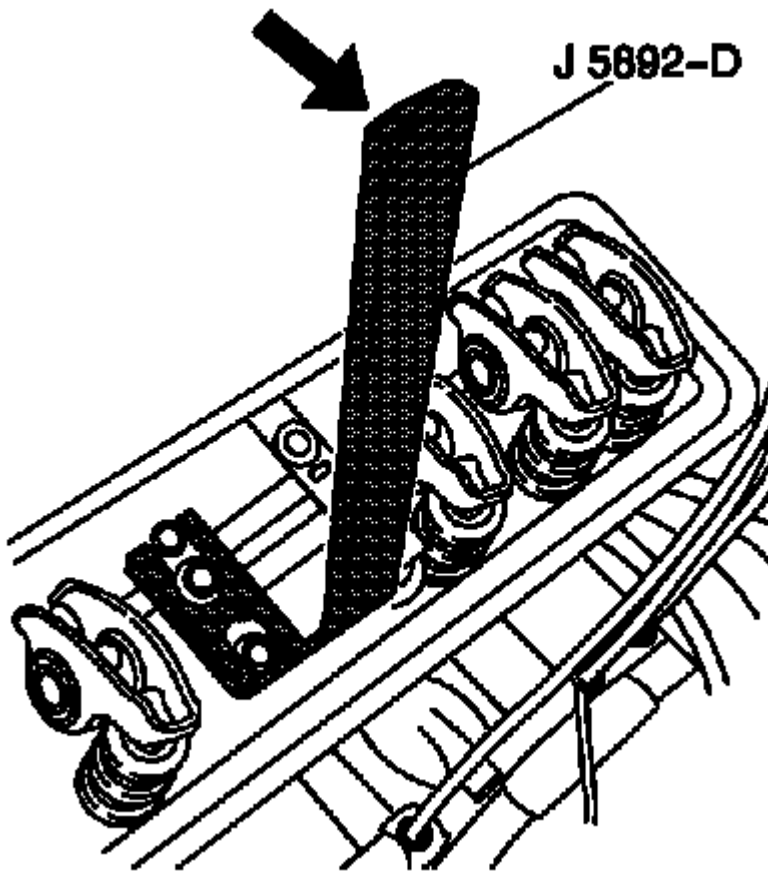


Fig. 176: View Of J 5892-D, Valve Rocker Arm Bolt & Washer
Courtesy of GENERAL MOTORS CORP.

8. Use the **J 5892-D** in order to compress the valve spring.

Hook the slotted end of **J 5892-D** under the washer on the valve rocker arm bolt.

9. Apply steady pressure on the valve spring cap until the valve keys are accessible.

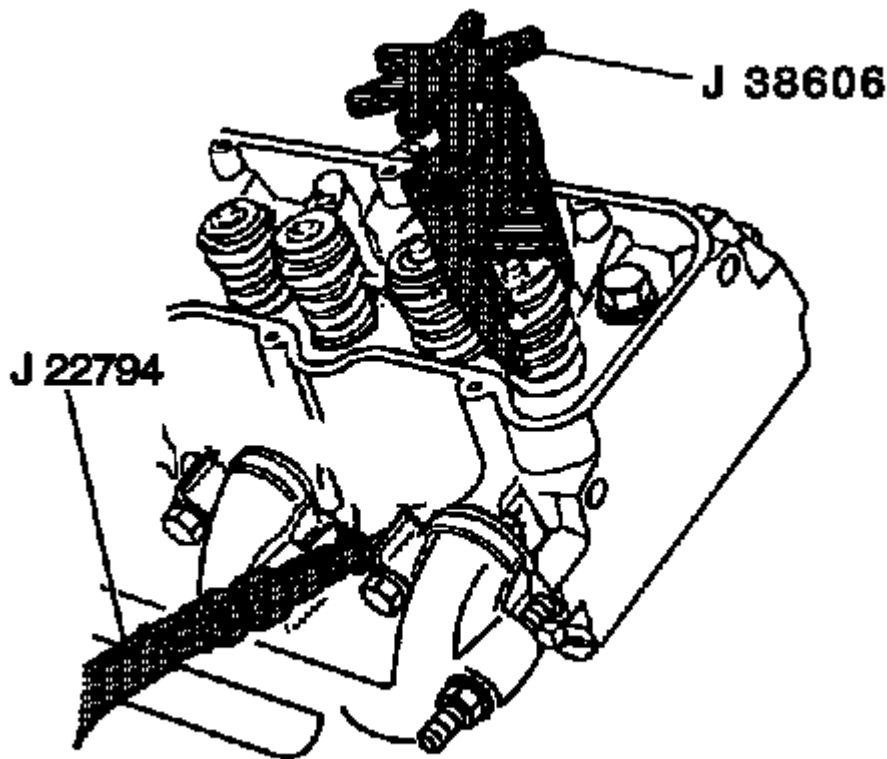


Fig. 177: Compress The Valve Spring (Cylinder Head Installed) Using Special Tools
Courtesy of GENERAL MOTORS CORP.

NOTE: Completely engage the J 38606 jaws on the valve spring. The J 38606 may slip off and scratch the valve spring. Replace the valve spring if the valve spring becomes scratch.

10. Use the J 38606 if the clearance does not permit use of the J 5892-D .
11. Install the valve stem O-ring seal.
12. Install the valve stem keys.

Use grease in order to hold the valve stem keys in place.

13. Carefully release the valve spring pressure, making sure the valve stem keys stay in place.

NOTE: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

14. Remove the J 5892-D or the J 38606 .

1. Look to ensure that the valve stem keys seat properly in the upper groove of the valve stem.
2. Tap the end of the valve stem with a plastic faced hammer in order to seat the valve stem keys, if necessary.

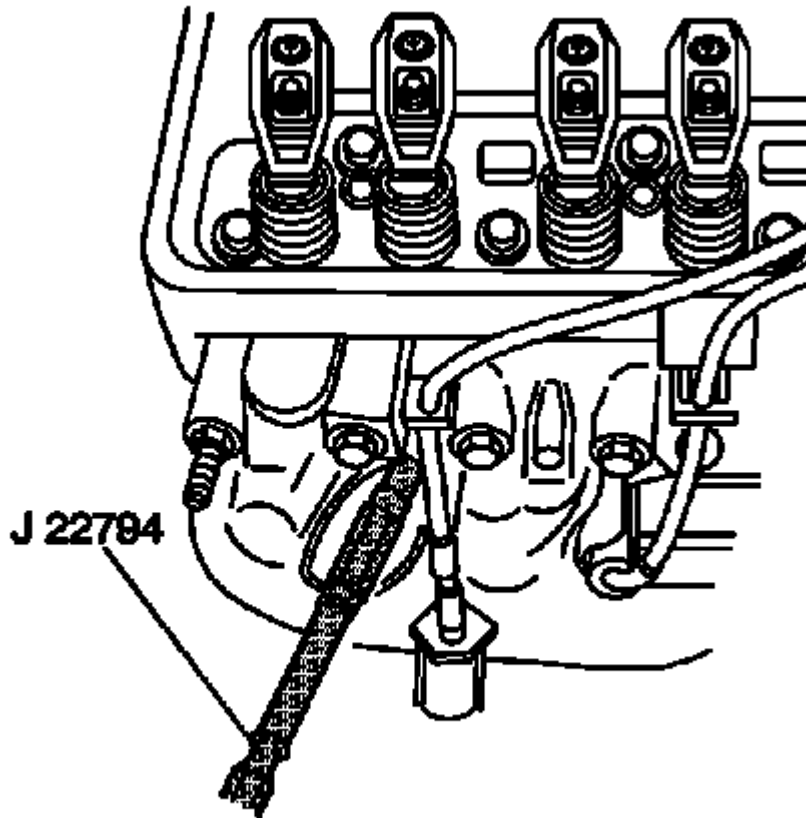


Fig. 178: View Of J 22794 Installed Into Spark Plug Hole
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 22794** .
16. Install the spark plugs.
17. Install the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.

VALVE LIFTER REPLACEMENT

Tools Required

J 3049-A Valve Lifter Remover

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement - Lower**.
2. Remove the valve pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.

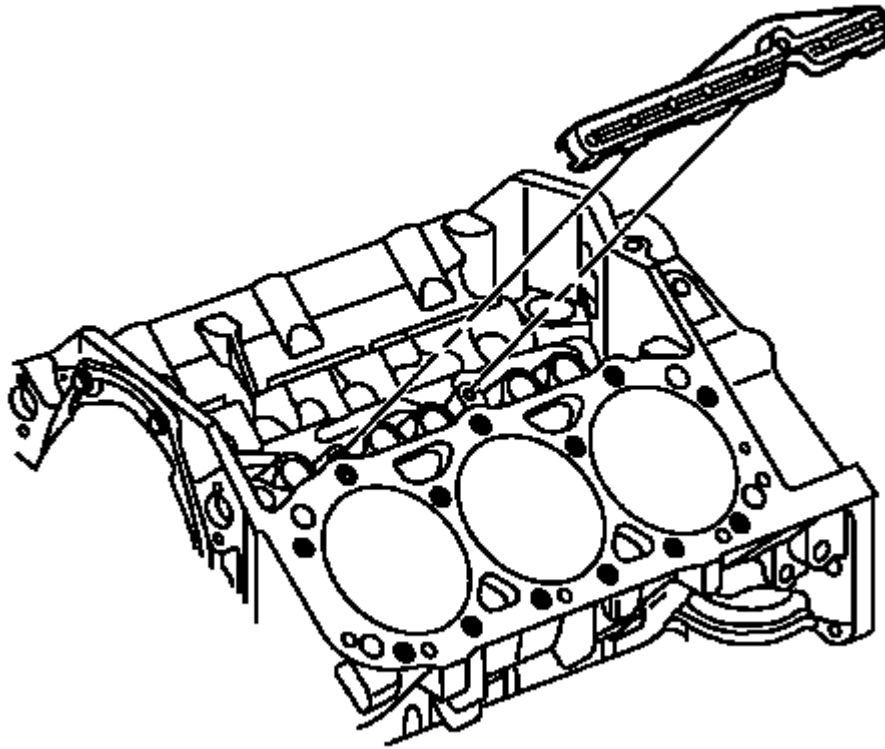


Fig. 179: View Of Valve Lifter Pushrod Guides
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Place the components in a rack so that the components can be installed to their original location.

3. Remove the bolts and valve lifter pushrod guide.

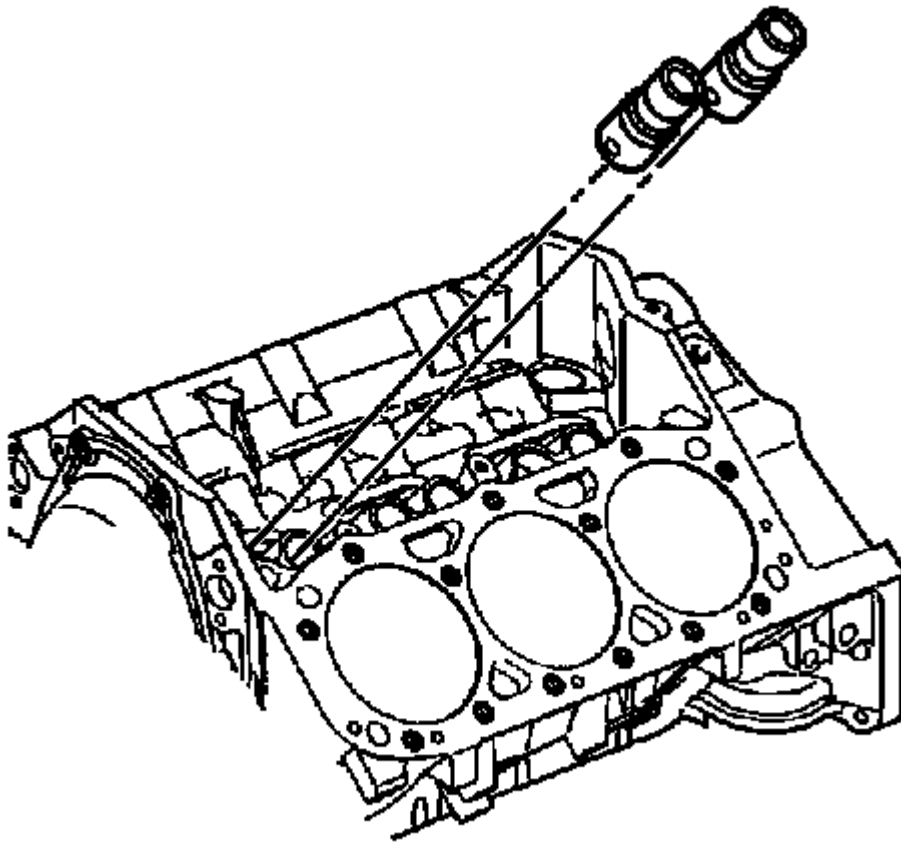


Fig. 180: View Of Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Place the valve lifters in the rack in the upright position in order to maintain the oil inside the valve lifters.

4. Remove the valve lifters.

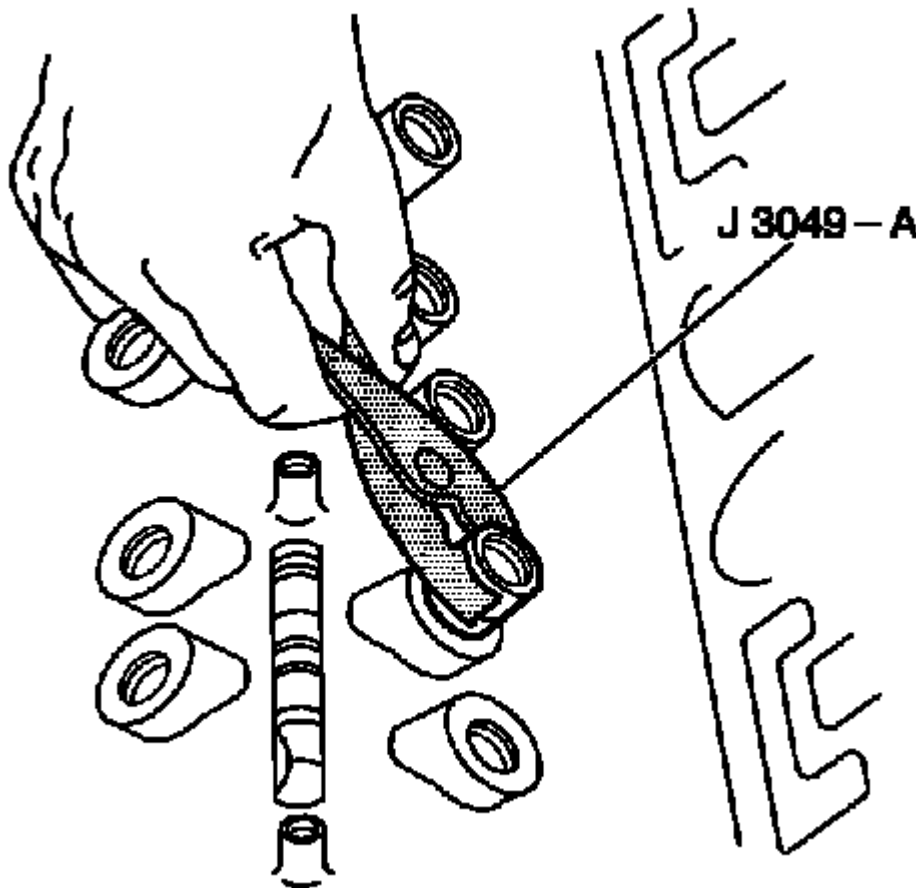


Fig. 181: Using J 3049-A To Remove The Stuck Valve Lifters
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Some valve lifters may be stuck in the valve lifter bores because of gum or varnish deposits and may require the use of J 3049-A for removal.

5. Use the **J 3049-A** in order to remove the stuck valve lifters.
6. Use a cleaning solvent and a shop towel to clean any varnish from the valve lifter bores.
7. Inspect the valve lifter bores for excessive wear or scoring. Replace the engine block if there is excessive wear or deep scoring.
8. Inspect the camshaft for wear or damage. If the wear is questionable remove the camshaft and inspect. Refer to **CAMSHAFT & BEARINGS -- CLEANING & INSPECTION** .
9. Clean and inspect the valve lifters, if necessary. Refer to **VALVE LIFTERS & GUIDES -- CLEANING & INSPECTION** .

Installation Procedure

IMPORTANT: It is normal for **NEW** lifters to make a slight ticking noise when the engine is first started. Increasing the engine RPMs slightly to raise oil pressure should

stop the noise.

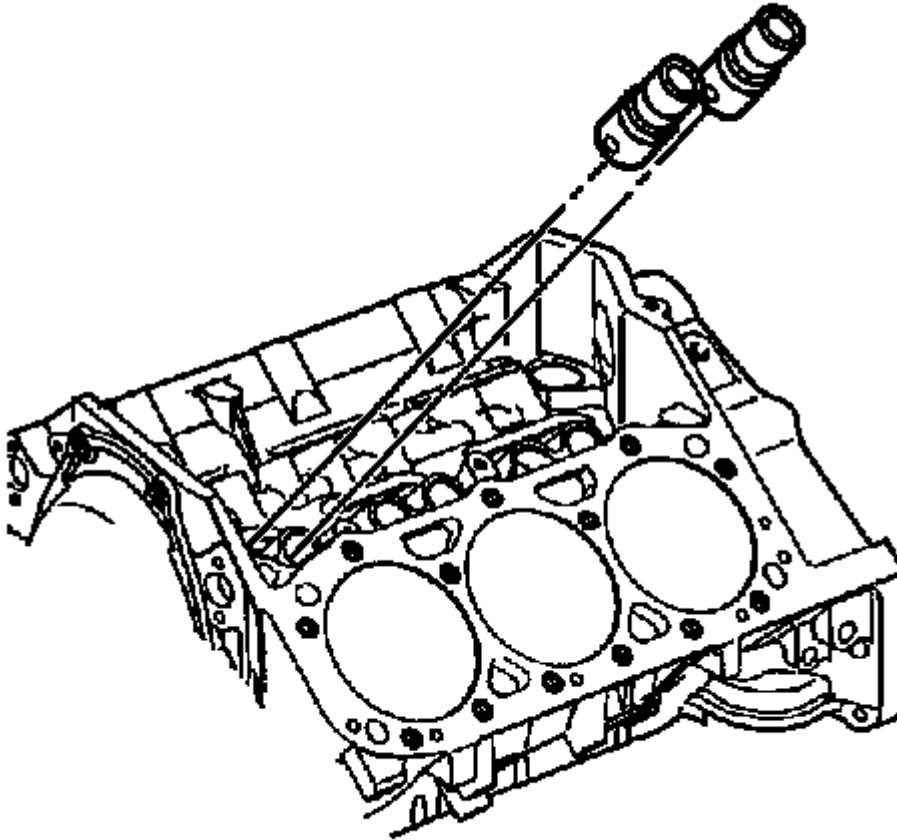


Fig. 182: View Of Valve Lifters

Courtesy of GENERAL MOTORS CORP.

1. Apply lubricant GM U.S. P/N 12345501, Canada P/N 992704, or equivalent to the valve lifter rollers.

IMPORTANT: If reusing the valve lifters, install the valve lifters in the original positions.

2. Install the valve lifters.

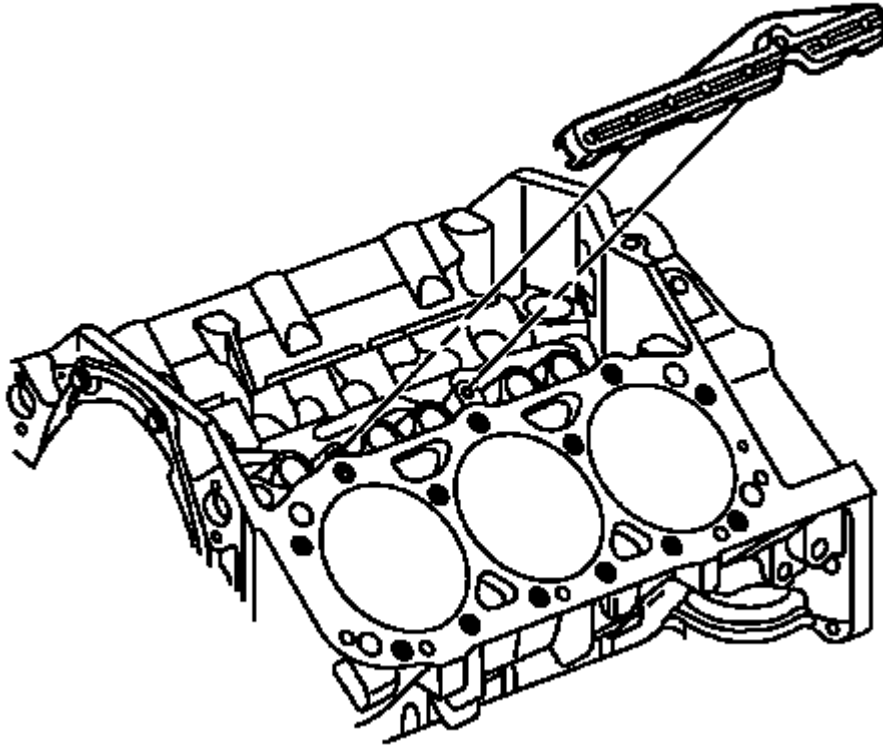


Fig. 183: View Of Valve Lifter Pushrod Guides
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the valve lifter pushrod guides.

Tighten: Tighten the valve lifter pushrod guide bolts to 16 N.m (12 lb ft).

4. Install the valve pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
5. Install the intake manifold. Refer to Intake Manifold Replacement - Lower.

CYLINDER HEAD REPLACEMENT - LEFT

Tools Required

J 36660-A Torque Angle Meter

Removal Procedure

1. Drain the cooling system. Refer to DRAINING & FILLING COOLING SYSTEM .
2. Remove the drive belt. Refer to Drive Belt Replacement.

3. Remove the lower intake manifold. Refer to Intake Manifold Replacement - Lower.
4. Remove the left exhaust manifold. Refer to EXHAUST MANIFOLD REPLACEMENT -- LEFT (4.3L ENGINE) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (4.8L, 5.3L, AND 6.0L ENGINES) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (6.6L ENGINE) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (8.1L ENGINE) .
5. Remove the left side pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
6. Remove the junction block bracket bolt.

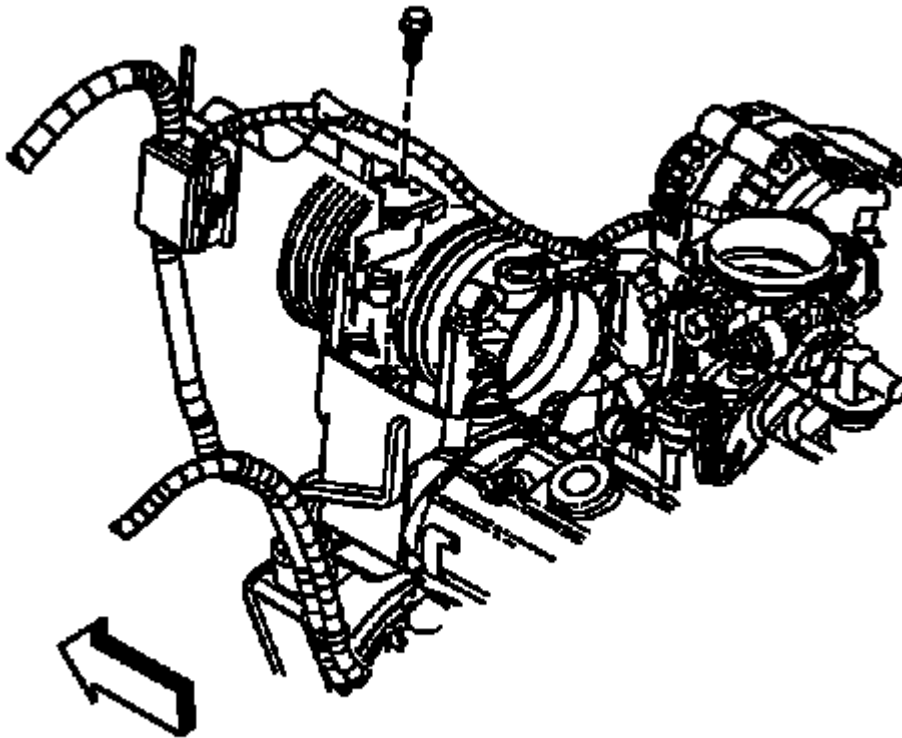


Fig. 184: View Of Junction Block Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

7. Position the bracket and wiring harness aside.

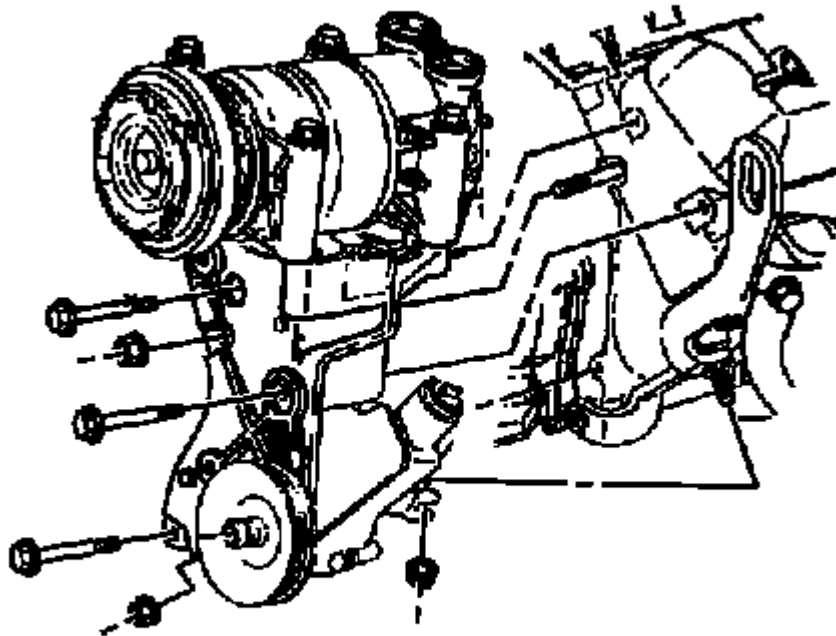


Fig. 185: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

8. Position the power steering (P/S) pump bracket off of the stud and set aside.

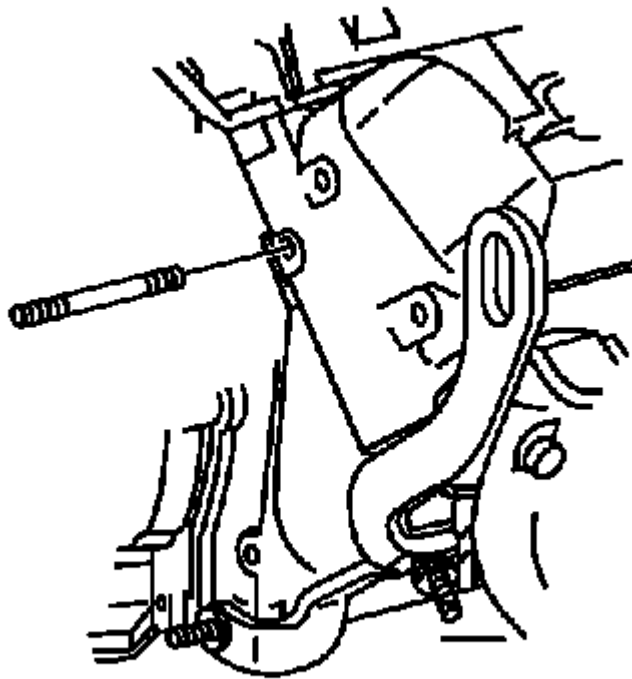
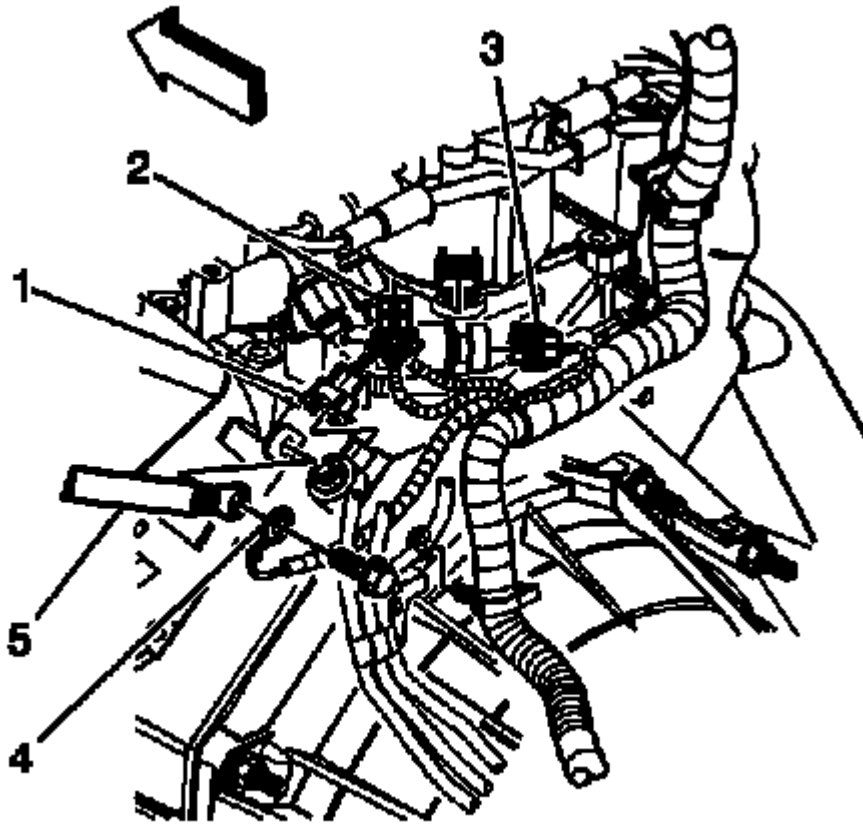


Fig. 186: View Of Power Steering Pump Bracket Stud
Courtesy of GENERAL MOTORS CORP.

9. Remove the P/S pump bracket stud.



10. Remove the harness ground bolt.
11. Position the harness ground (4) and ground strap (5).

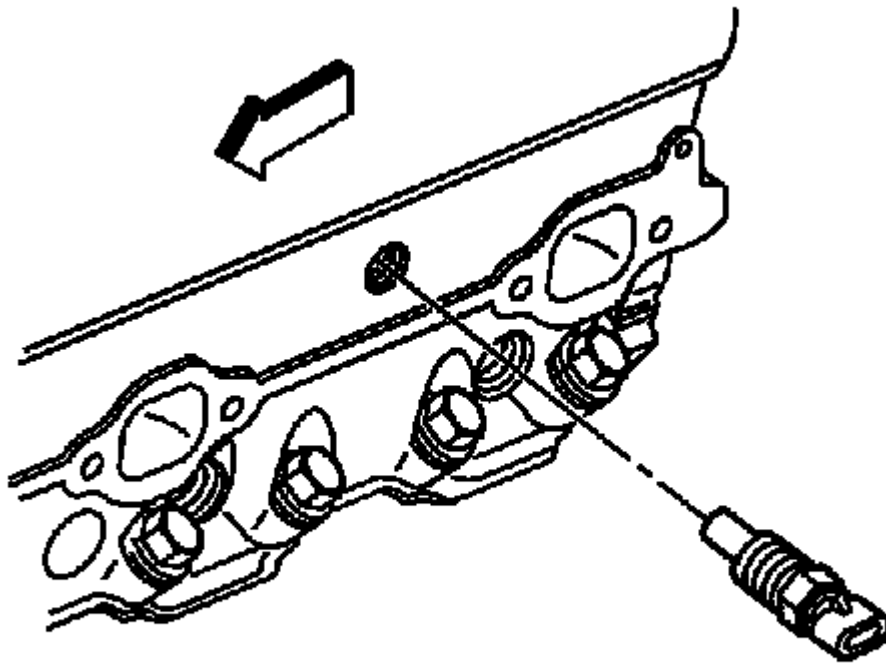


Fig. 188: View Of Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

12. Remove the engine coolant temperature (ECT) sensor.

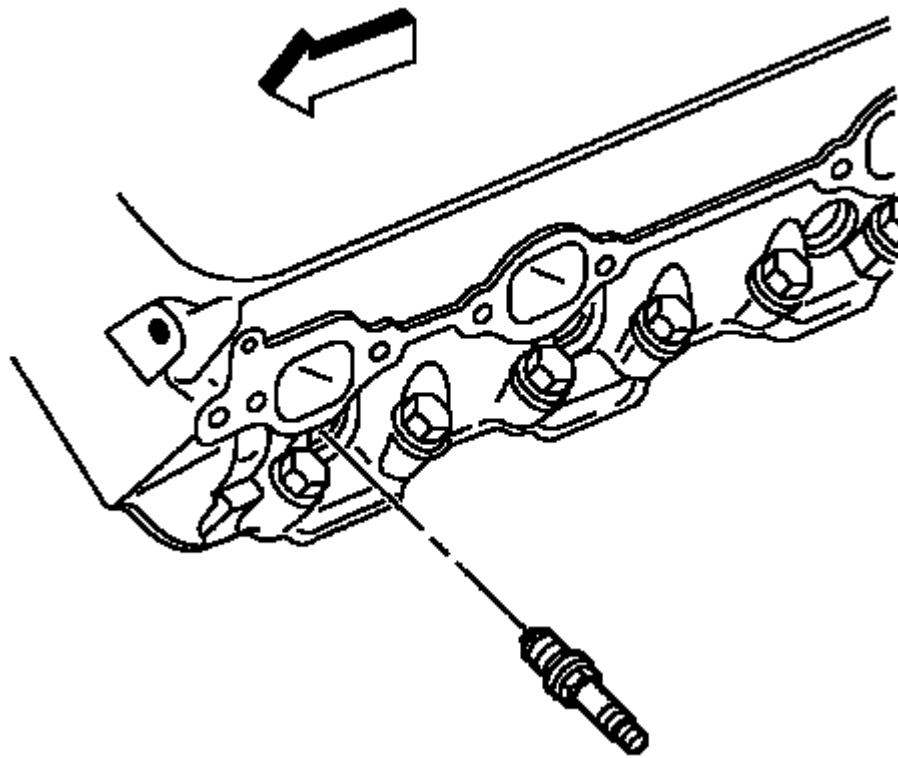


Fig. 189: View Of Spark Plugs (Left)
Courtesy of GENERAL MOTORS CORP.

13. Remove the spark plugs.

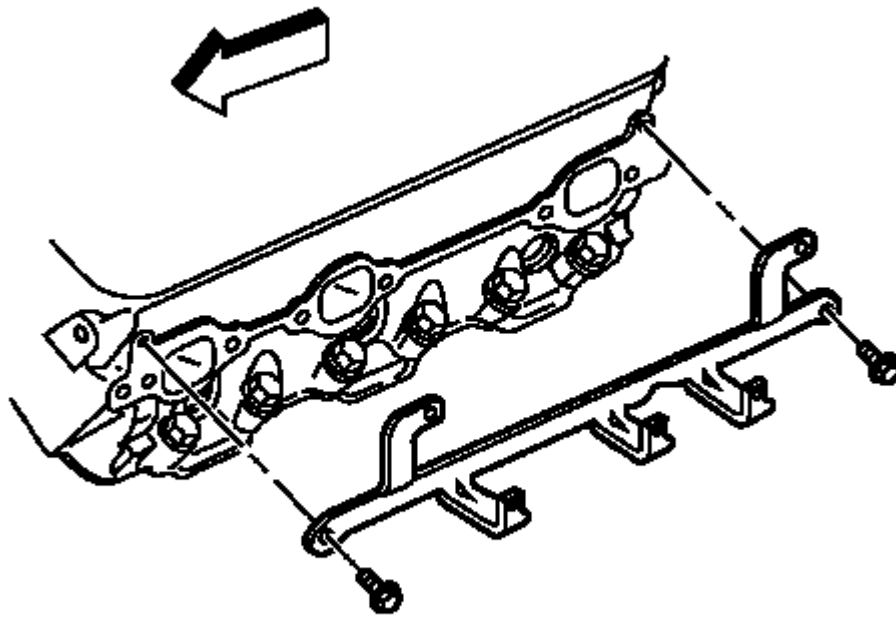


Fig. 190: Locating Spark Plug Wire Support
Courtesy of GENERAL MOTORS CORP.

14. Remove the spark plug wire support bolts and support.

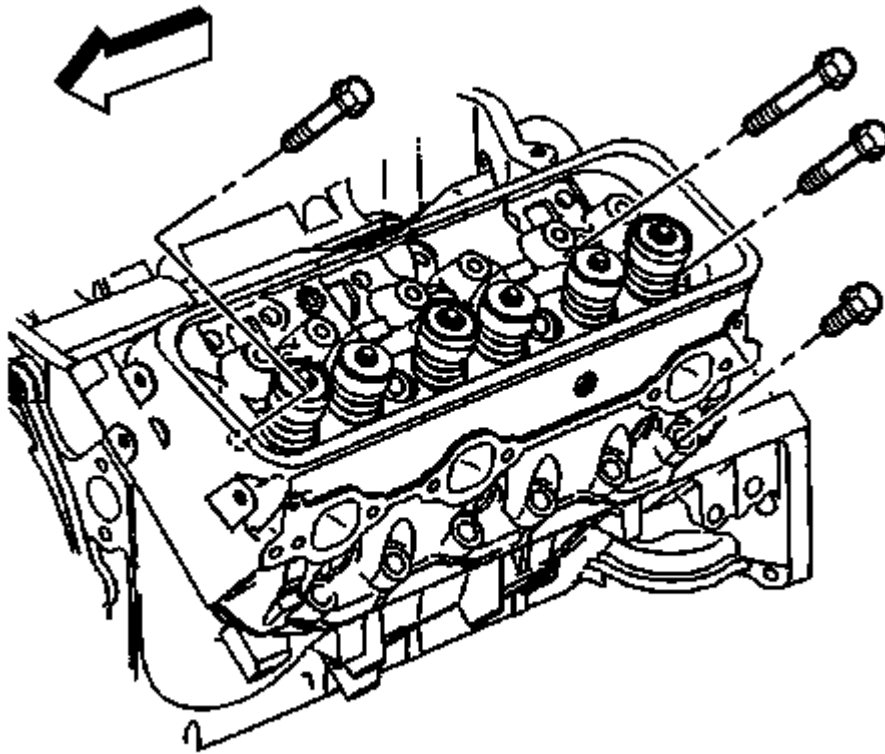


Fig. 191: Locating Cylinder Head Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

15. Remove the cylinder head bolts.

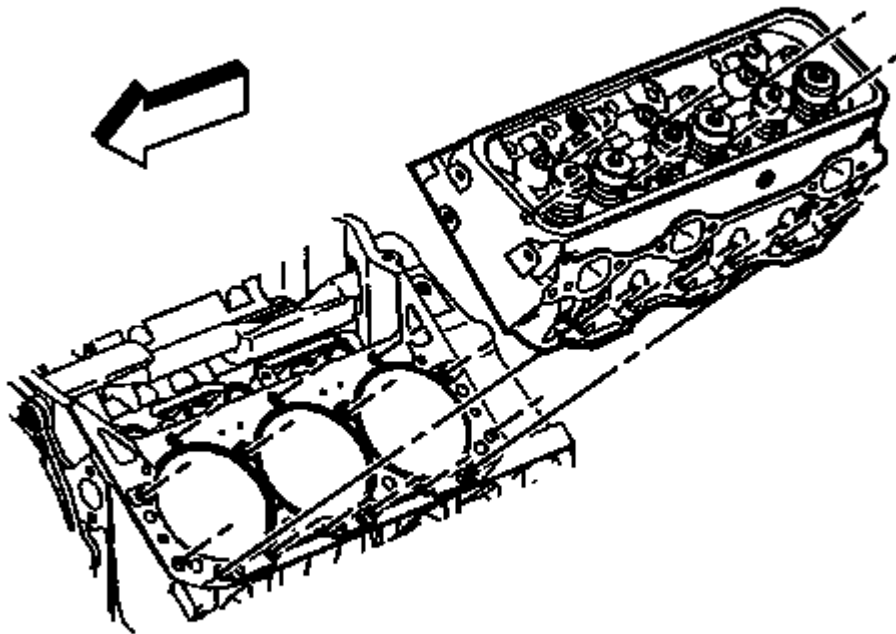


Fig. 192: Removing/Installing Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

16. Remove the cylinder head.

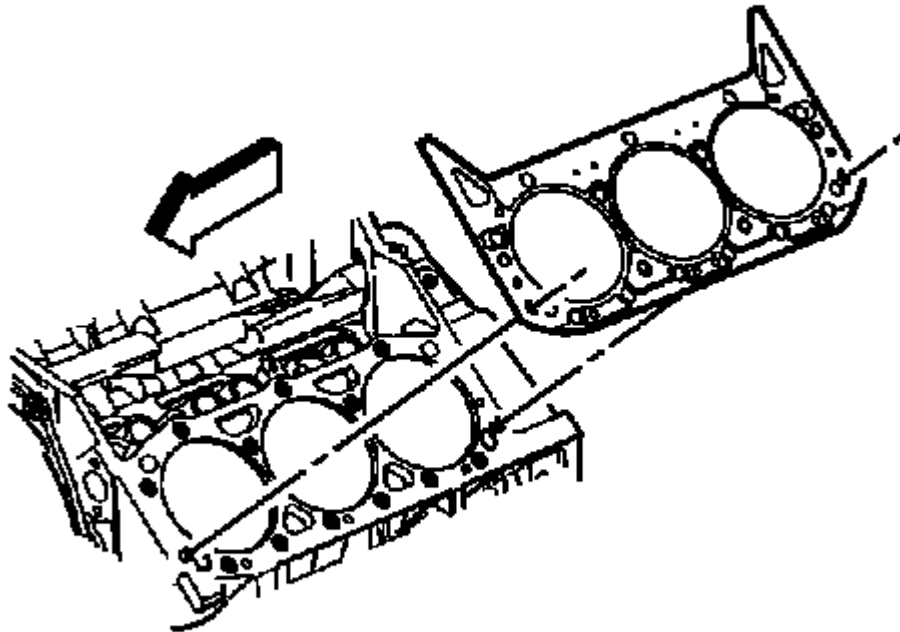


Fig. 193: View Of Cylinder Head Gasket And Alignment Pins - Left
Courtesy of GENERAL MOTORS CORP.

17. Remove and discard the cylinder head gasket.

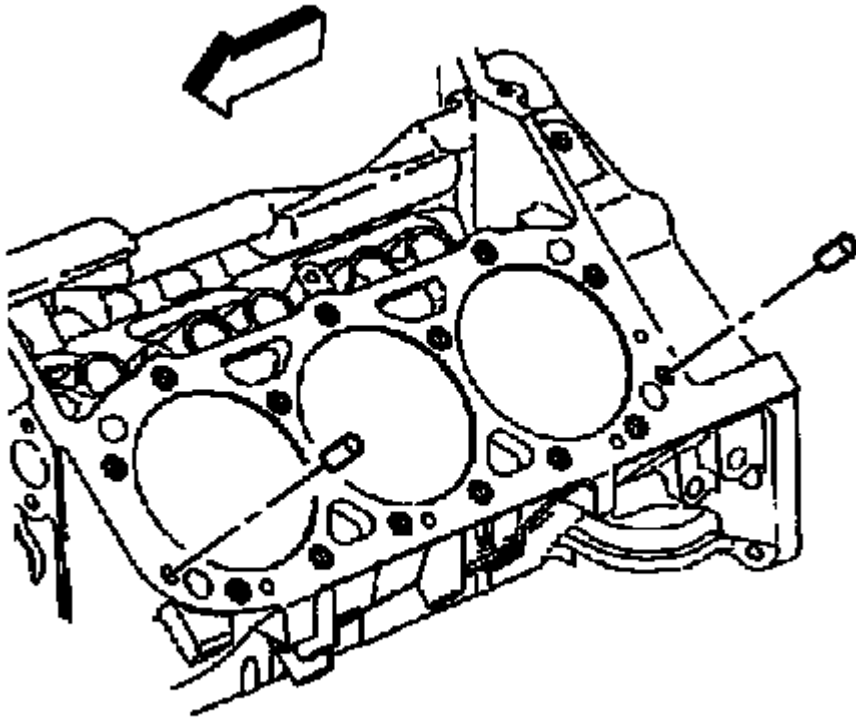


Fig. 194: View Of Cylinder Head Locator Pins
Courtesy of GENERAL MOTORS CORP.

18. Remove the cylinder head locator pins, if necessary.
19. Clean and inspect the cylinder head, if necessary. Refer to **CYLINDER HEAD CLEANING & INSPECTION**.
20. Disassemble the cylinder head, if necessary. Refer to **CYLINDER HEAD DISASSEMBLE**.

Installation Procedure

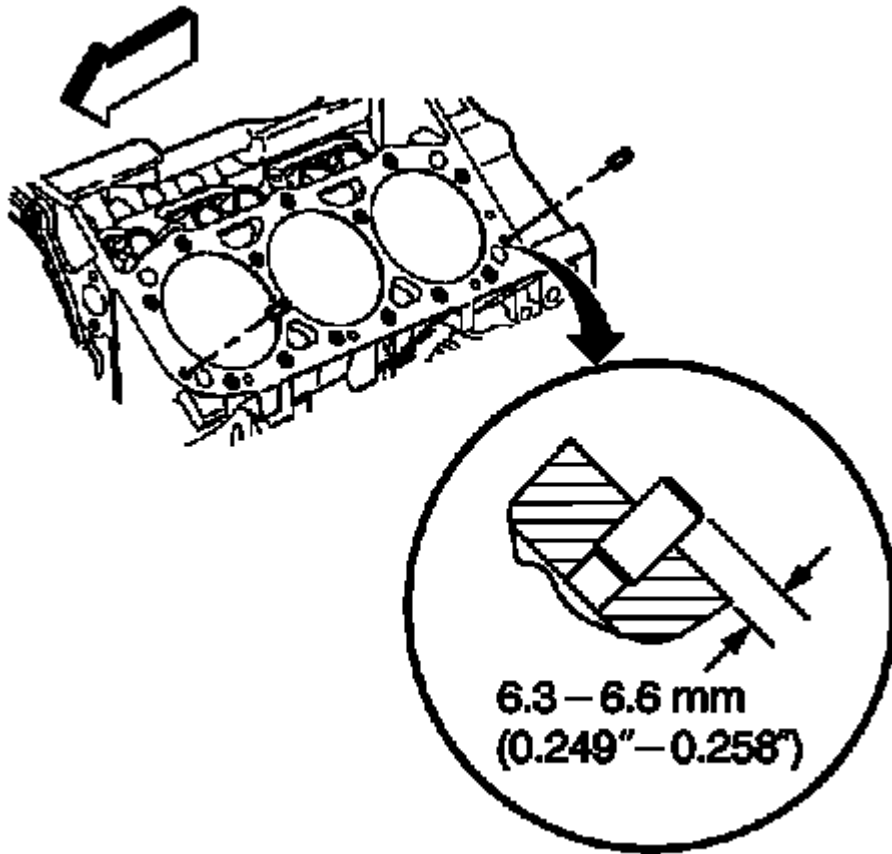


Fig. 195: Installing Cylinder Head
Courtesy of GENERAL MOTORS CORP.

1. Assemble the cylinder head, if necessary. Refer to CYLINDER HEAD ASSEMBLE .
2. Install the cylinder head locator pins, if necessary.

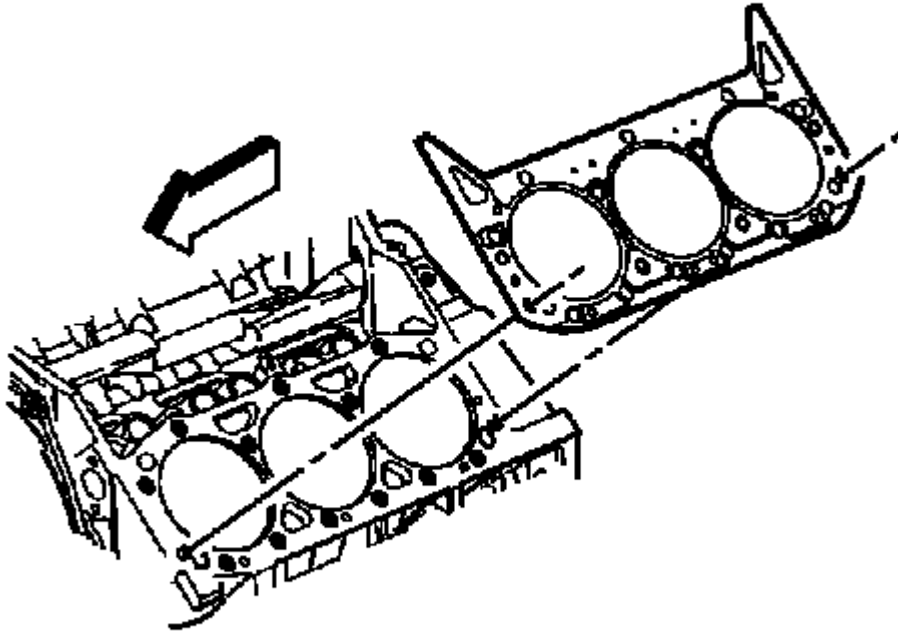


Fig. 196: View Of Cylinder Head Gasket And Alignment Pins - Left
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use any type of sealer on the cylinder head gasket.

3. Install a NEW cylinder head gasket.

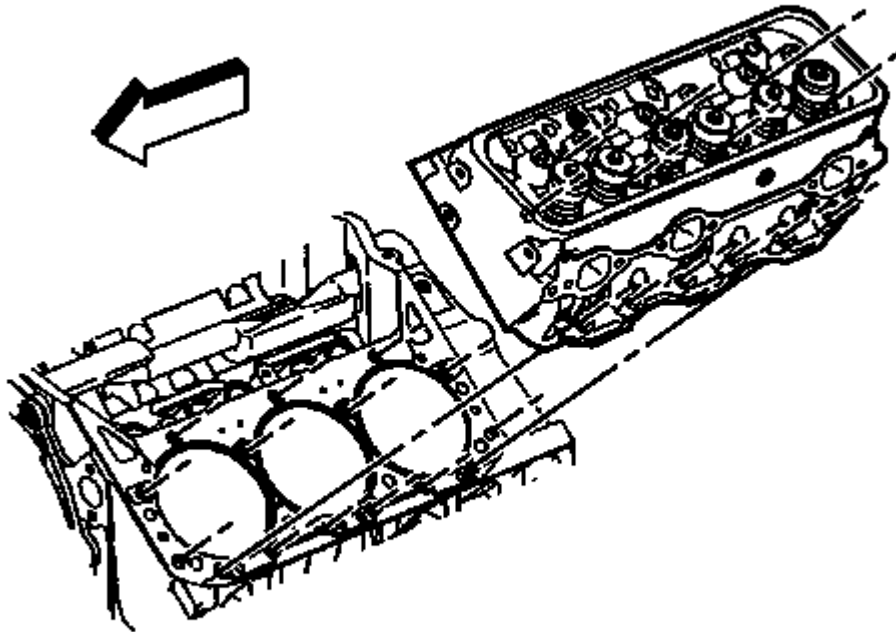


Fig. 197: Removing/Installing Cylinder Head (Left)
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder head.

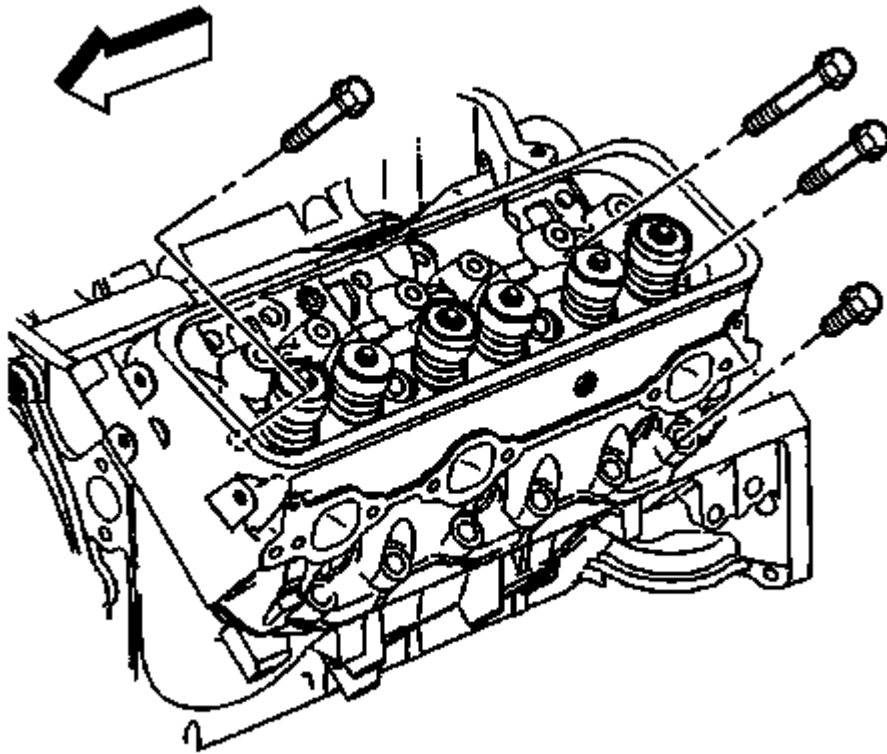


Fig. 198: Locating Cylinder Head Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER NOTICE** .

5. Apply sealant GM U.S. P/N 12346004, Canada P/N 109534480, or equivalent to the threads of the cylinder head bolts.
6. Install the cylinder head bolts finger tight.

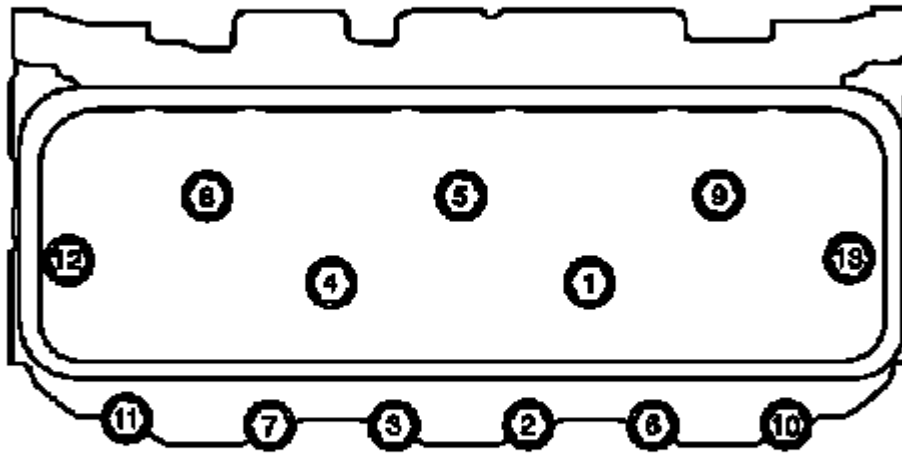


Fig. 199: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

7. Tighten the cylinder head bolts using the sequence shown.

Tighten:

1. Tighten the cylinder head bolts a first pass to 30 N.m (22 lb ft).
2. Tighten the long cylinder head bolts (1, 4, 5, 8, 9) a final pass to 75 degrees using **J 36660-A**.
3. Tighten the medium cylinder head bolts (12, 13) a final pass to 65 degrees using **J 36660-A**.
4. Tighten the short cylinder head bolts (2, 3, 6, 7, 10, 11) a final pass to 55 degrees using **J 36660-A**.

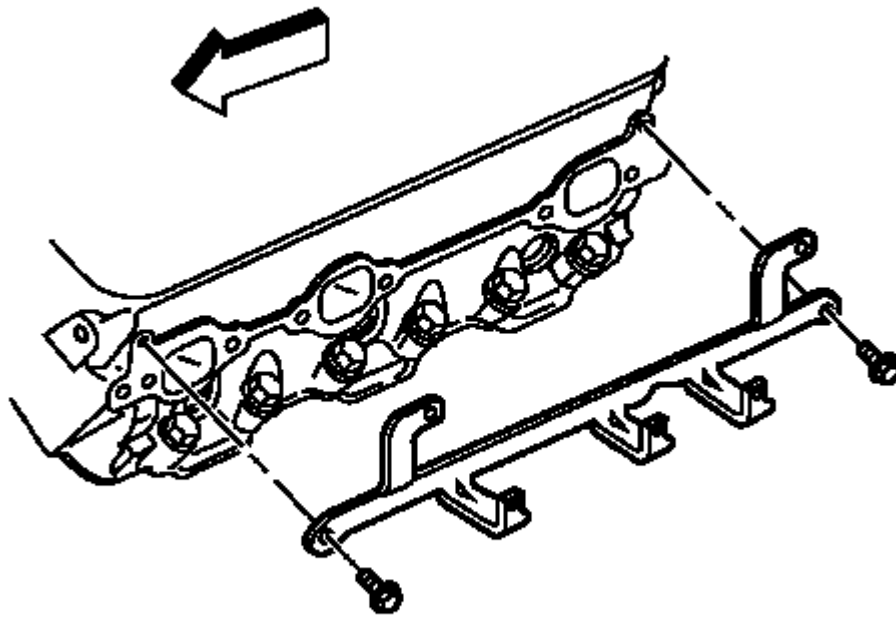


Fig. 200: Locating Spark Plug Wire Support
Courtesy of GENERAL MOTORS CORP.

8. Install the spark plug wire support and bolts.

Tighten: Tighten the spark plug wire support bolts to 12 N.m (106 lb in).

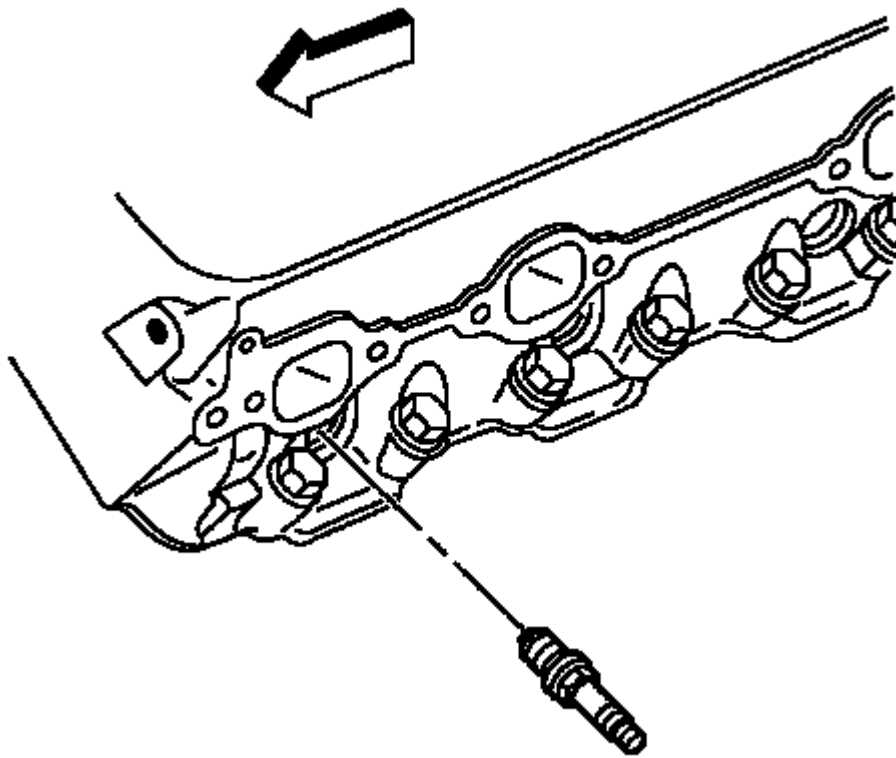


Fig. 201: View Of Spark Plugs (Left)
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plugs.
10. If installing NEW spark plugs measure for the correct gap. Adjust the spark plug gap if necessary.

Specification: Spark plug gap to 1.52 mm (0.060 in).

Tighten:

- Tighten the spark plugs for a USED cylinder head to 15 N.m (11 lb ft).
- Tighten the spark plugs on the initial installation of a NEW cylinder head to 30 N.m (22 lb ft).

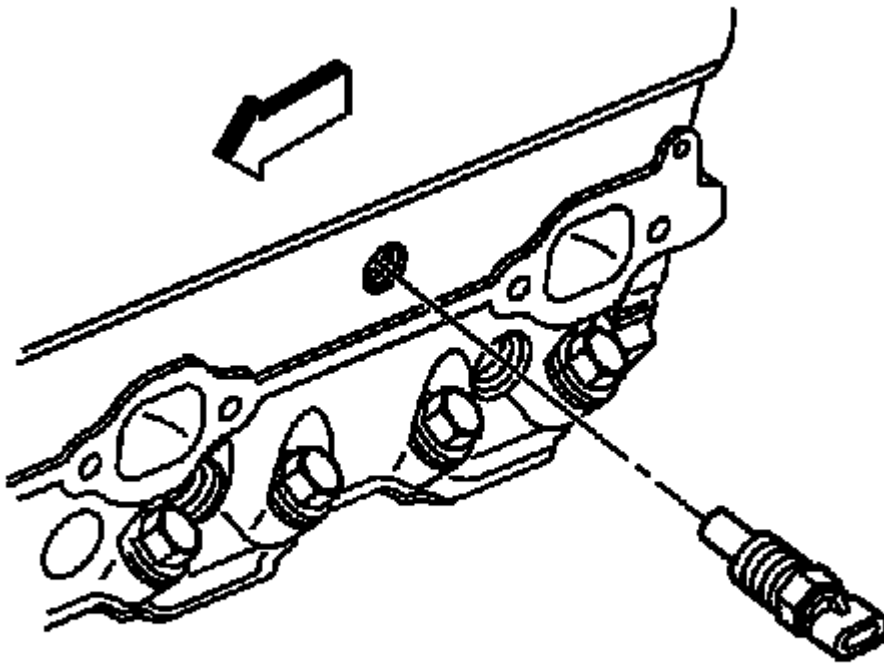


Fig. 202: View Of Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

11. Install the ECT sensor. If reusing the old sensor, apply sealant GM U.S. P/N 12346004, Canada P/N 109534480, or equivalent to the threads.

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

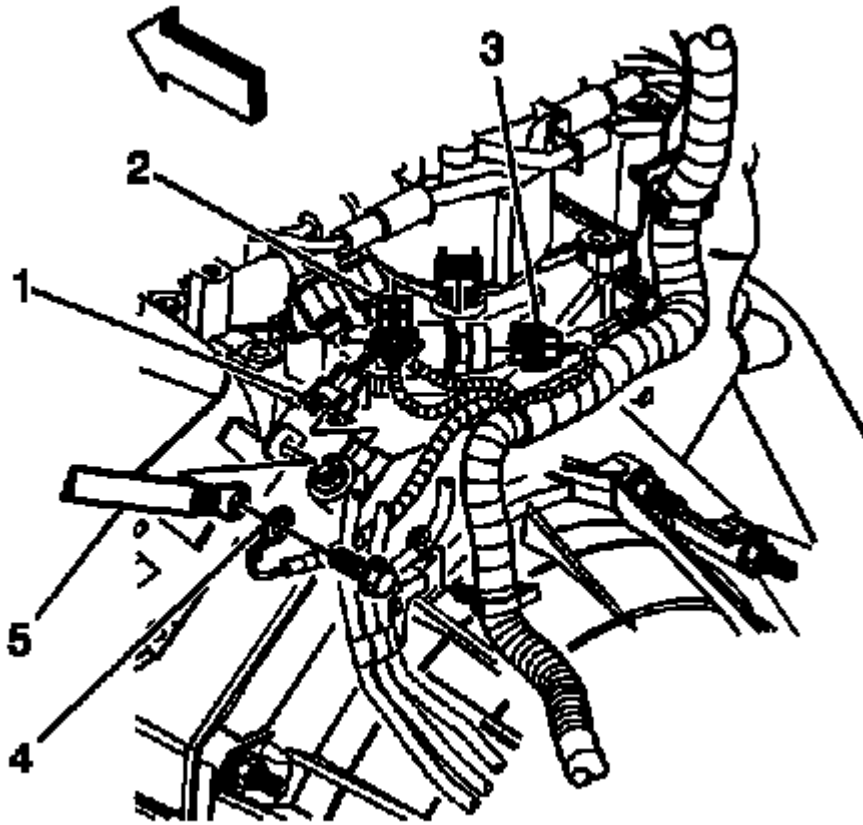


Fig. 203: View Of Ground Strap And CMP & Fuel Pump/Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

12. Position the ground strap (5) and harness ground (4).
13. Install the harness ground bolt.

Tighten: Tighten the harness ground bolt to 16 N.m (12 lb ft).

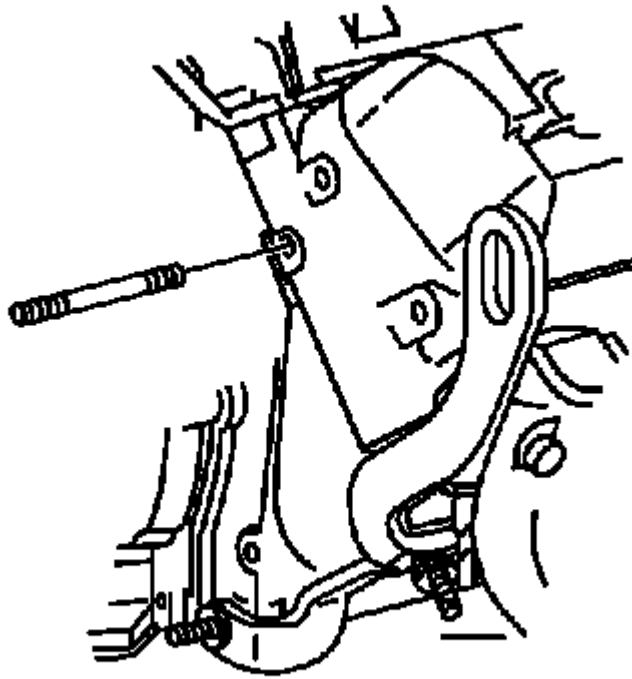


Fig. 204: View Of Power Steering Pump Bracket Stud
Courtesy of GENERAL MOTORS CORP.

14. Install the P/S pump bracket stud.

Tighten: Tighten the P/S pump bracket stud to 20 N.m (15 lb ft).

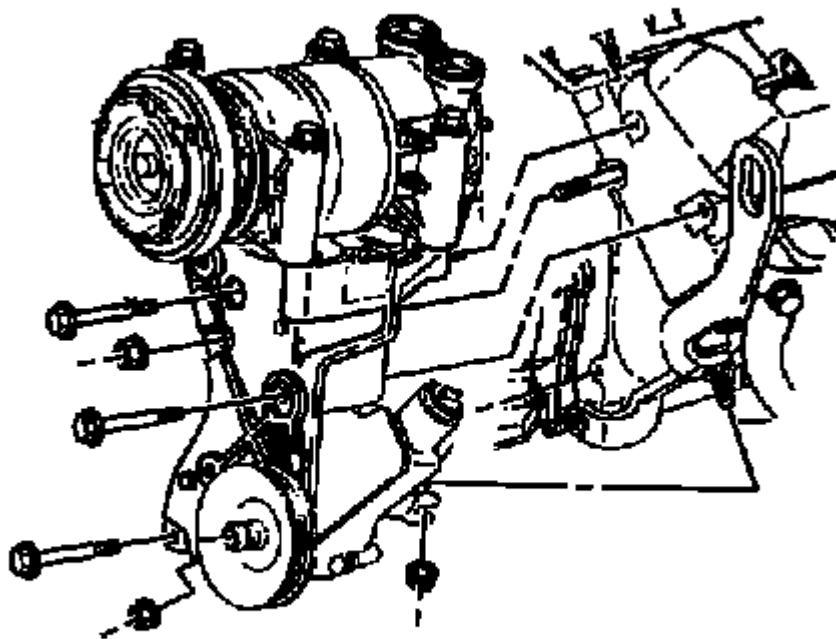


Fig. 205: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

15. Position the P/S pump bracket onto the stud.

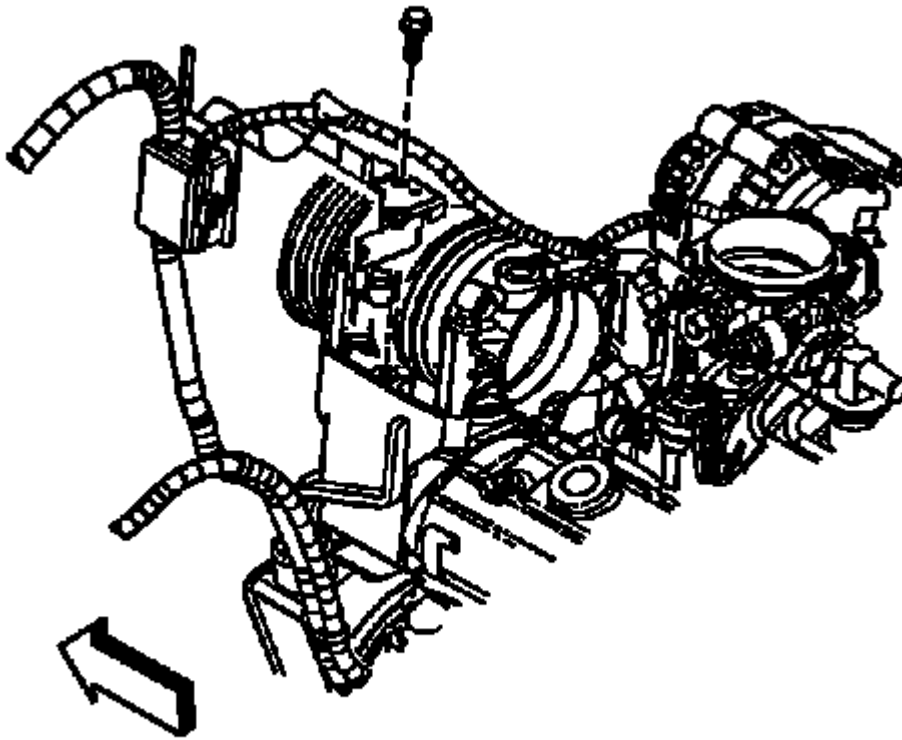


Fig. 206: View Of Junction Block Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

16. Position the bracket and wiring harness.
17. Install the junction block bracket bolt.

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

18. Install the left side pushrods. Refer to Valve Rocker Arm and Push Rod Replacement.
19. Install the left exhaust manifold. Refer to EXHAUST MANIFOLD REPLACEMENT -- LEFT (4.3L ENGINE) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (4.8L, 5.3L, AND 6.0L ENGINES) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (6.6L ENGINE) or EXHAUST MANIFOLD REPLACEMENT -- LEFT (8.1L ENGINE).
20. Install the lower intake manifold. Refer to Intake Manifold Replacement - Lower.
21. Install the drive belt. Refer to Drive Belt Replacement.
22. Fill the cooling system. Refer to DRAINING & FILLING COOLING SYSTEM

CYLINDER HEAD REPLACEMENT - RIGHT

Tools Required

J 36660-A Torque Angle Meter**Removal Procedure**

1. Drain the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM** .
2. Remove the generator bracket. Refer to
3. Remove the intake manifold. Refer to **Intake Manifold Replacement - Lower**.
4. Remove the right exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.3L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L, & 6.0L ENGINES)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (6.6L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (8.1L ENGINE)** .
5. Remove the right pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
6. Remove the generator bracket stud from the cylinder head.

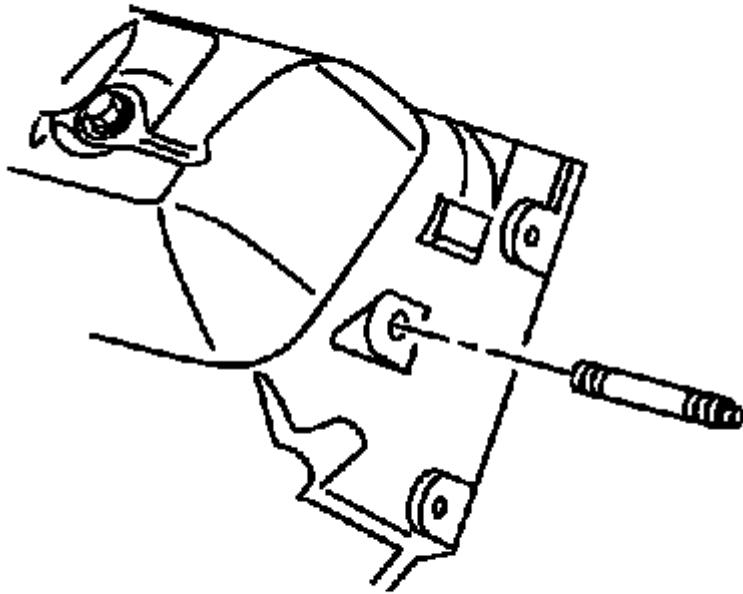


Fig. 207: View Of Generator Bracket Stud
Courtesy of GENERAL MOTORS CORP.

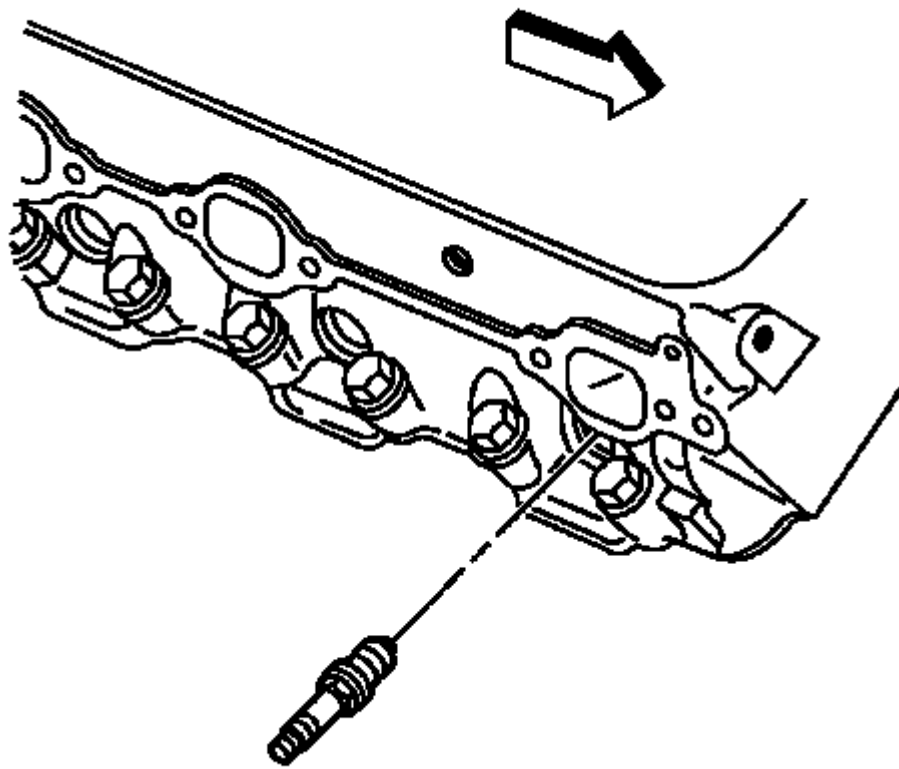


Fig. 208: Locating Spark Plugs
Courtesy of GENERAL MOTORS CORP.

7. Remove the spark plugs.

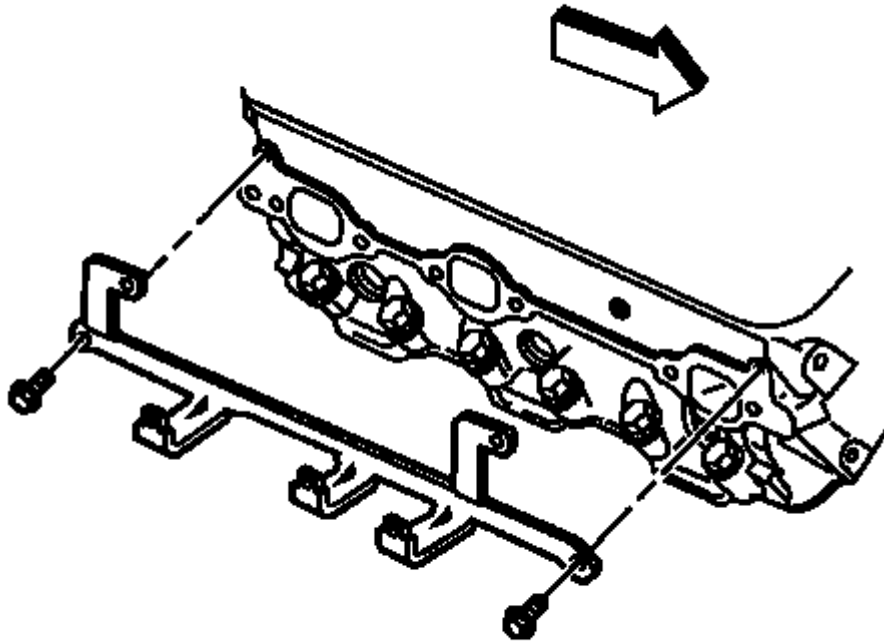


Fig. 209: View Of Spark Plug Wire Support Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

8. Remove the spark plug wire support bolts and support.

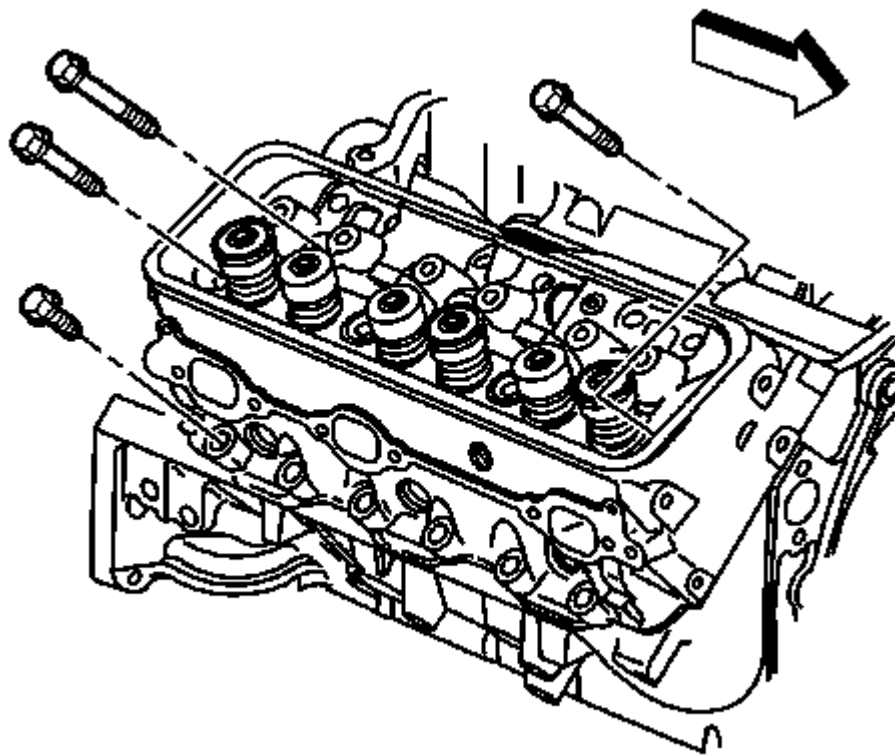


Fig. 210: Locating Cylinder Head Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

9. Remove the cylinder head bolts.

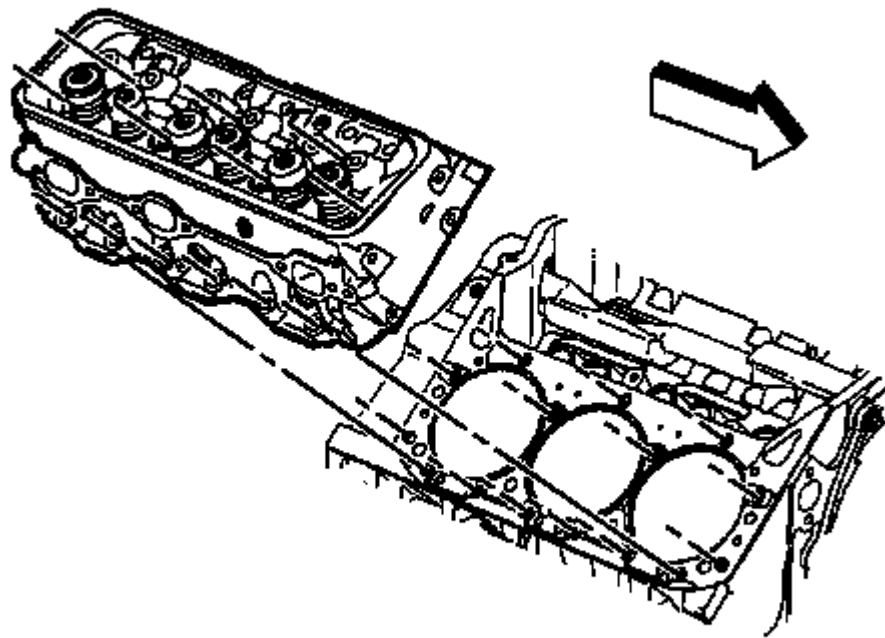


Fig. 211: Removing/Installing Cylinder Head (Right)
Courtesy of GENERAL MOTORS CORP.

10. Remove the cylinder head.

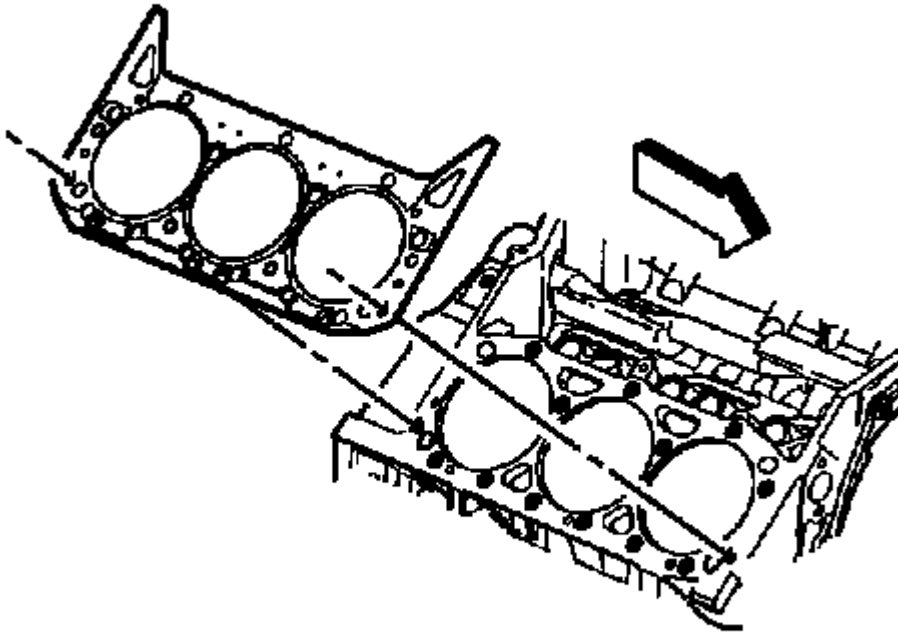


Fig. 212: View Of Cylinder Head Gasket And Alignment Pins - Right
Courtesy of GENERAL MOTORS CORP.

11. Remove and discard the cylinder head gasket.

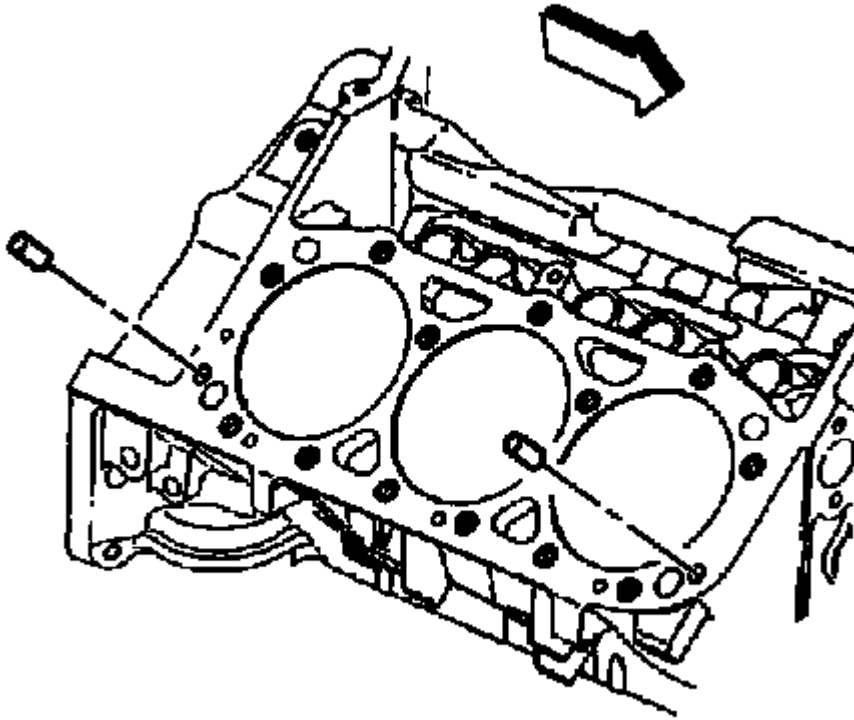


Fig. 213: View Of Cylinder Head Locator Pins - Right
Courtesy of GENERAL MOTORS CORP.

12. Remove the cylinder head locator pins, if necessary.
13. Clean and inspect the cylinder head, if necessary. Refer to **CYLINDER HEAD CLEANING & INSPECTION** .
14. Disassemble the cylinder head, if necessary. Refer to **CYLINDER HEAD DISASSEMBLE** .

Installation Procedure

1. Assemble the cylinder head, if necessary. Refer to **CYLINDER HEAD ASSEMBLE** .
2. Install the cylinder head locator pins, if necessary.

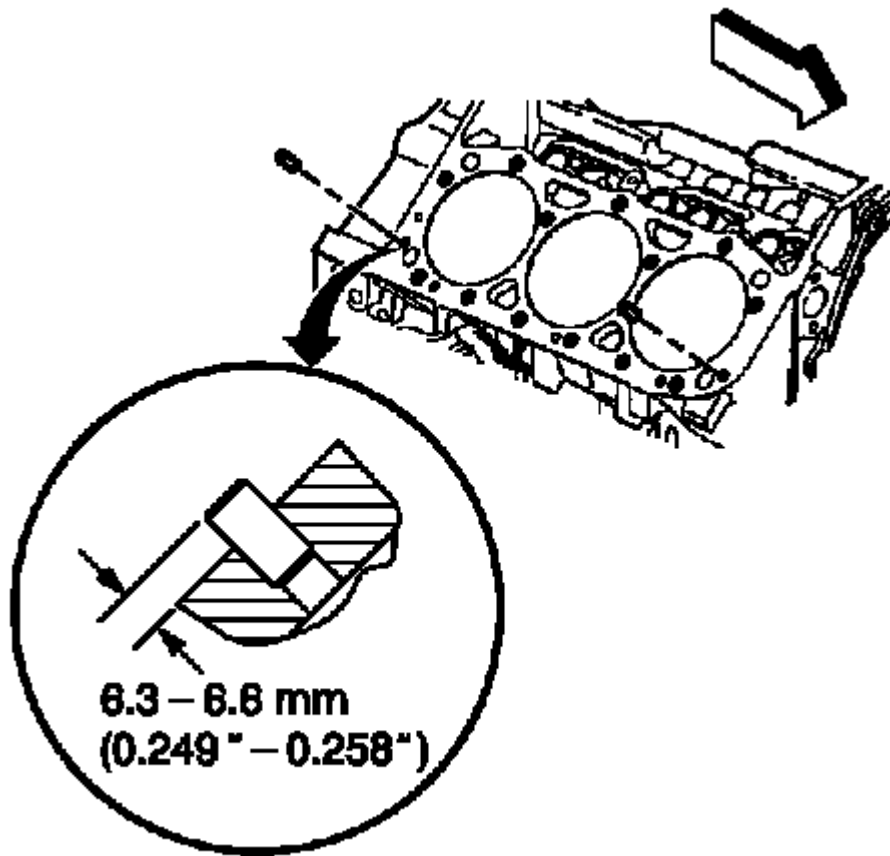


Fig. 214: Installing Cylinder Head Locator Pins - Right
Courtesy of GENERAL MOTORS CORP.

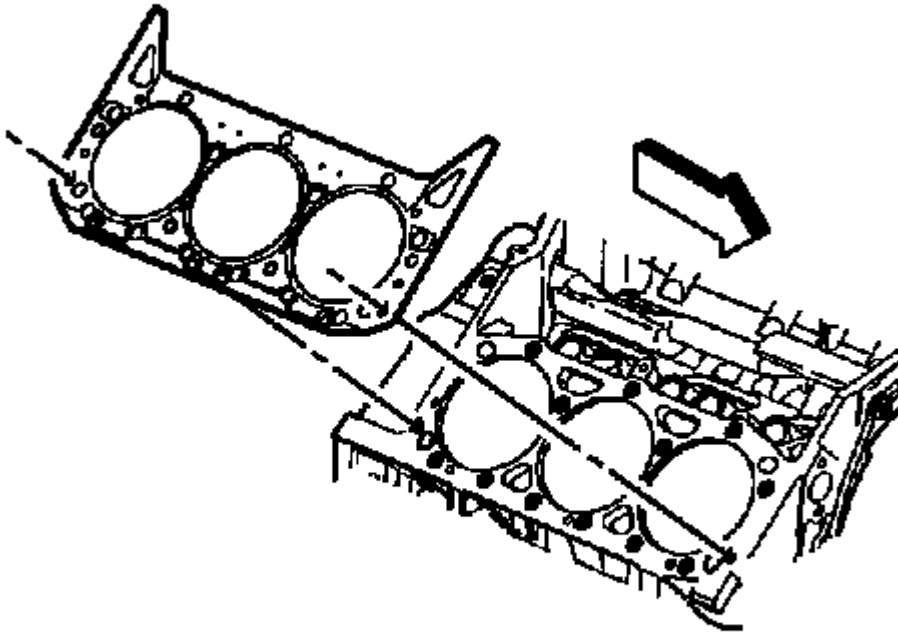


Fig. 215: View Of Cylinder Head Gasket And Alignment Pins - Right
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use any type of sealer on the cylinder head gasket.

3. Install a NEW cylinder head gasket.

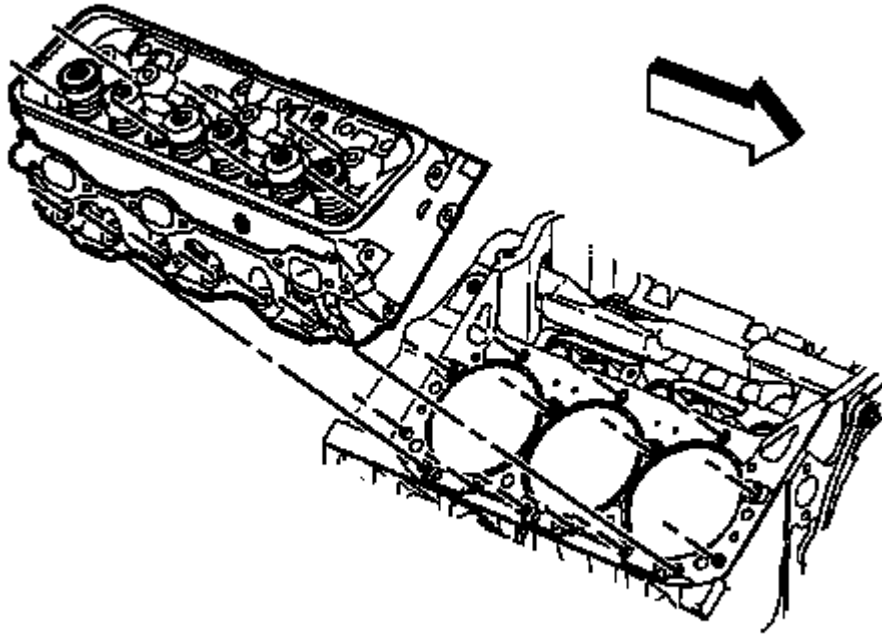


Fig. 216: Removing/Installing Cylinder Head (Right)
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder head.

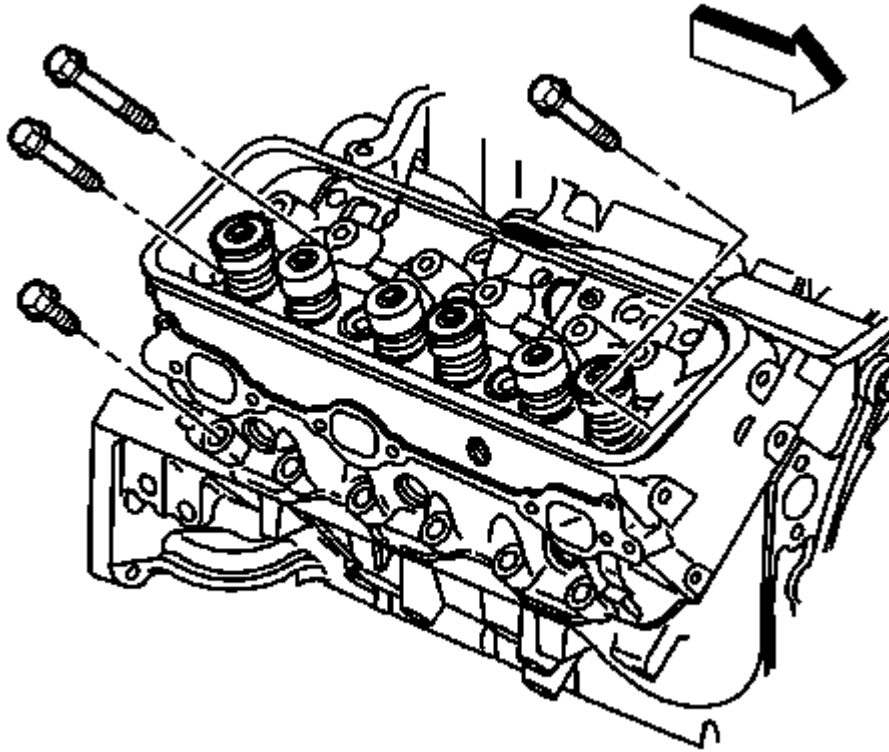


Fig. 217: Locating Cylinder Head Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER NOTICE** .

5. Apply sealant GM U.S. P/N 12346004, Canada P/N 109534480, or equivalent to the threads of the cylinder head bolts.
6. Install the cylinder head bolts finger tight.

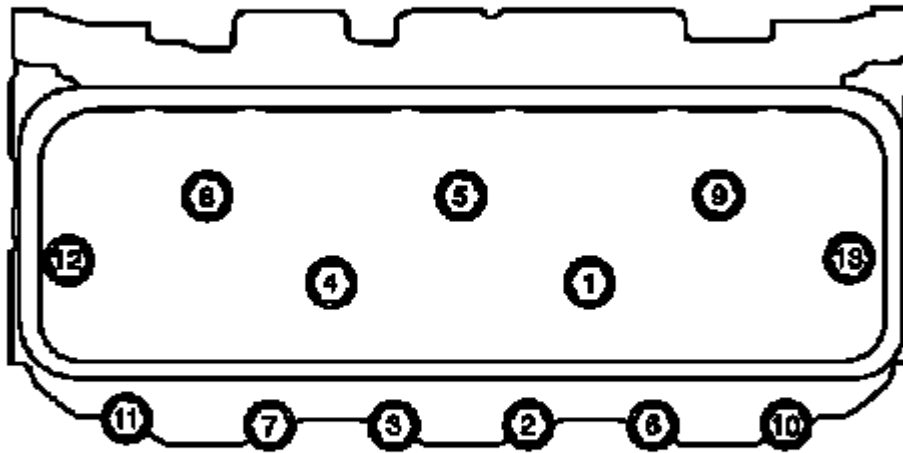


Fig. 218: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

7. Tighten the cylinder head bolts using the sequence shown.

Tighten:

- Tighten the cylinder head bolts a first pass to 30 N.m (22 lb ft).
- Tighten the long cylinder head bolts (1, 4, 5, 8, 9) a final pass to 75 degrees using **J 36660-A** .
- Tighten the medium cylinder head bolts (12, 13) a final pass to 65 degrees using **J 36660-A** .
- Tighten the short cylinder head bolts (2, 3, 6, 7, 10, 11) a final pass to 55 degrees using **J 36660-A** .

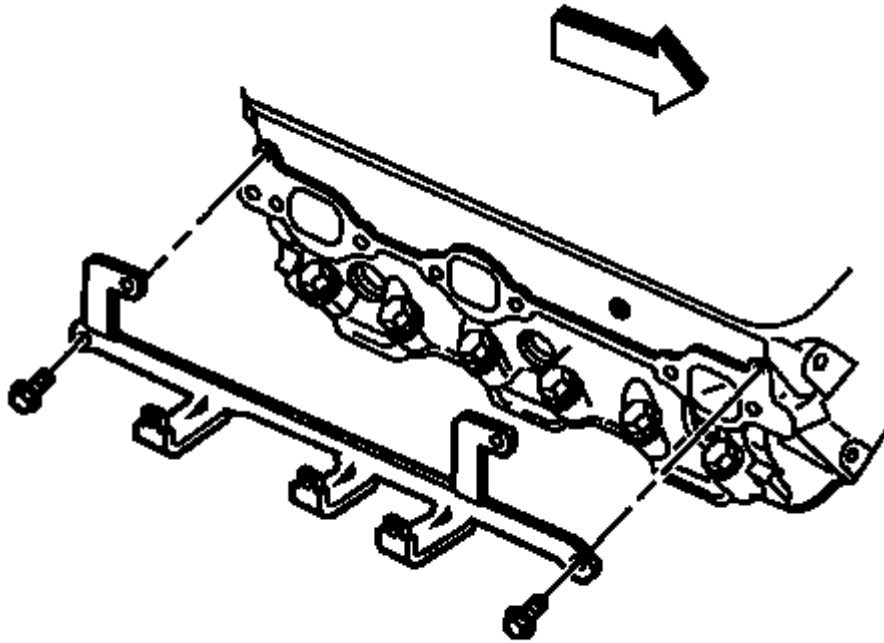


Fig. 219: View Of Spark Plug Wire Support Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

8. Install the spark plug wire support and bolts.

Tighten: Tighten spark plug wire support bolts to 12 N.m (106 lb in).

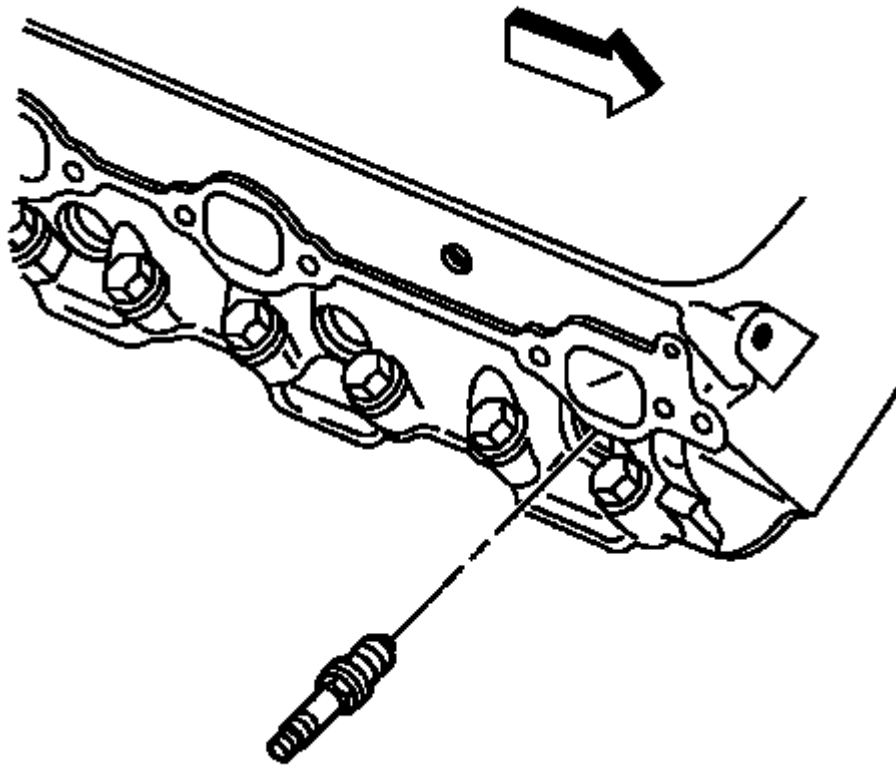


Fig. 220: Locating Spark Plugs
Courtesy of GENERAL MOTORS CORP.

9. Install the spark plugs.
10. If installing NEW spark plugs measure for the correct gap. Adjust the spark plug gap if necessary.

Specification: Spark plug gap to 1.52 mm (0.060 in).

Tighten:

- Tighten the spark plugs for a USED cylinder head to 15 N.m (11 lb ft).
- Tighten the spark plugs on the initial installation of a NEW cylinder head to 30 N.m (22 lb ft).

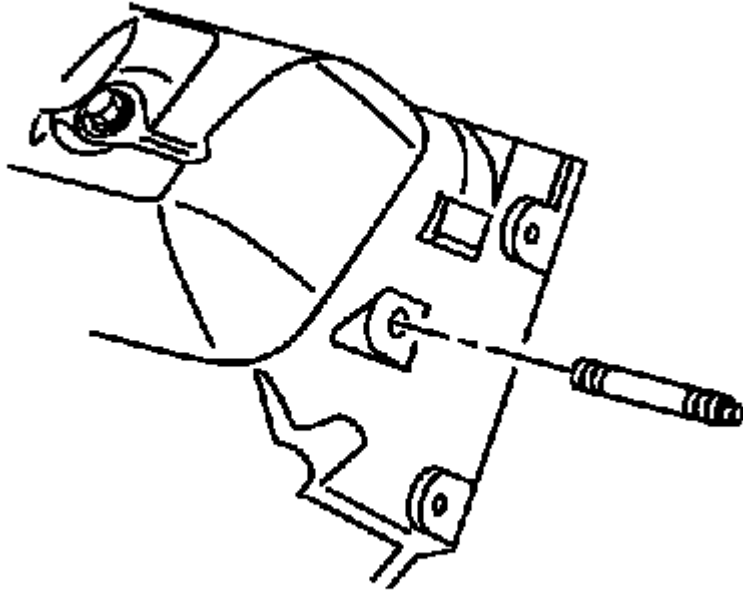


Fig. 221: View Of Generator Bracket Stud
Courtesy of GENERAL MOTORS CORP.

11. Install the generator bracket stud.

Tighten: Tighten the generator bracket stud to 20 N.m (15 lb ft).

12. Install the right pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
13. Install the exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.3L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L, & 6.0L ENGINES)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (6.6L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (8.1L ENGINE)** .
14. Install the intake manifold. Refer to **Intake Manifold Replacement - Lower**.
15. Install the generator bracket. Refer to
16. Fill the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM** .

CRANKSHAFT BALANCER REPLACEMENT

Tools Required

J 23523-F Crankshaft Balancer Remover and Installer

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the cooling fan. Refer to **FAN REPLACEMENT**.

NOTE: To prevent damage to the end of the crankshaft when using a crankshaft balancer removal tool install a bolt in the crankshaft. Use a shorter bolt with the same threads as the crankshaft balancer bolt. This bolt will allow a place for the tool to push against. The shorter bolt is to keep from going past the threads in the crankshaft and damaging the crankshaft threads.

3. Remove the crankshaft balancer bolt and washer.

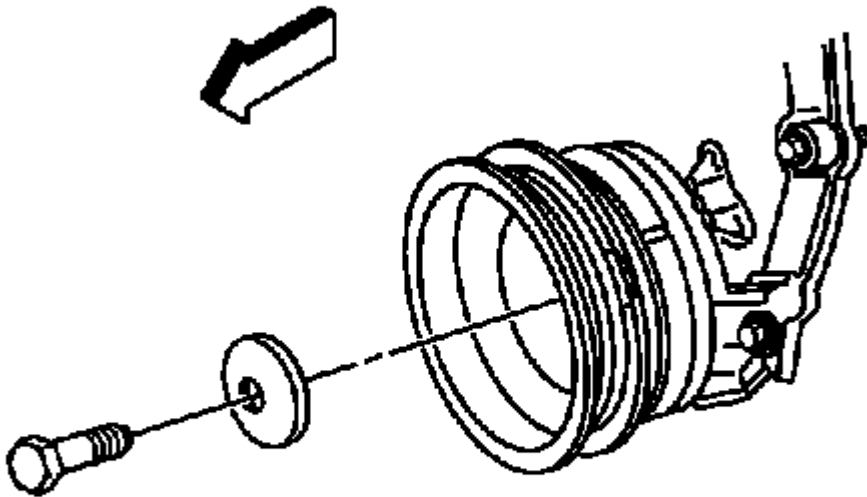


Fig. 222: View Of Crankshaft Balancer Washer & Bolt
Courtesy of GENERAL MOTORS CORP.

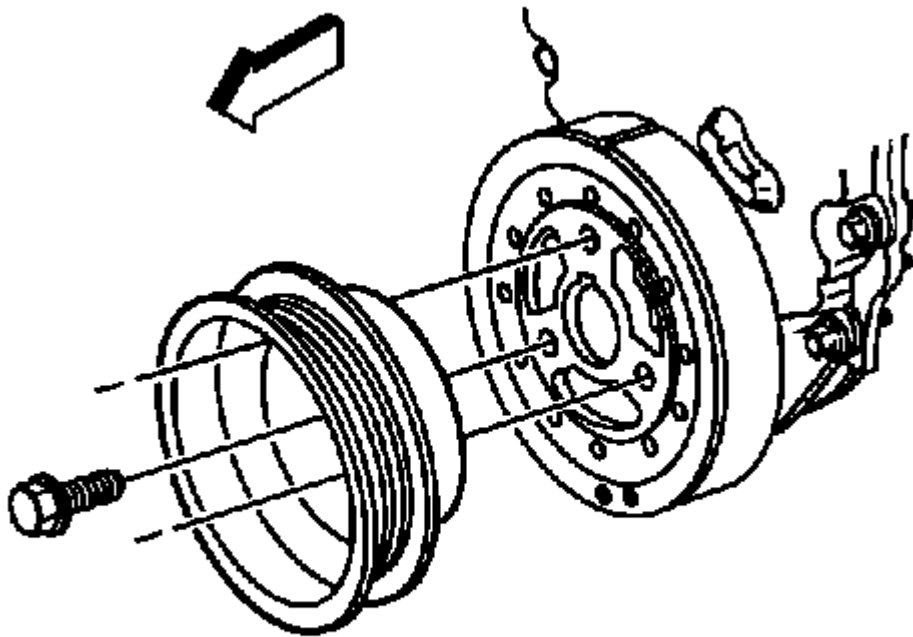


Fig. 223: View Of Crankshaft Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft pulley bolts and pulley.

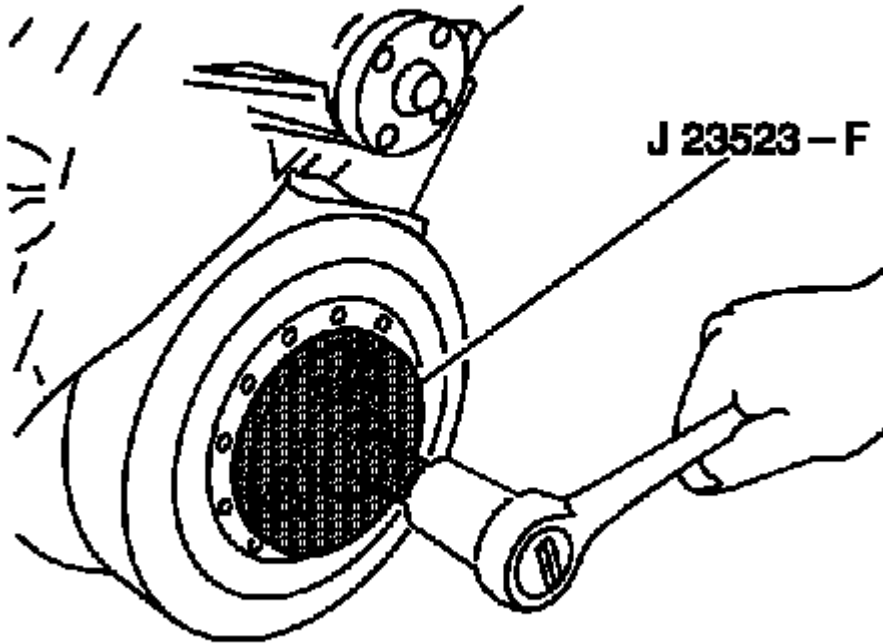


Fig. 224: View Of J 23523-F Removing The Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

5. Using **J 23523-F** , remove the crankshaft balancer.
 1. Install the **J 23523-F** plate and bolts onto the crankshaft balancer.

Tighten: Tighten the **J 23523-F** bolts to 25 N.m (18 lb ft).
 2. Install the **J 23523-F** forcing screw into the plate.
 3. Rotate the **J 23523-F** forcing screw clockwise in order to remove the crankshaft balancer.
6. Remove the **J 23523-F** from the crankshaft balancer.

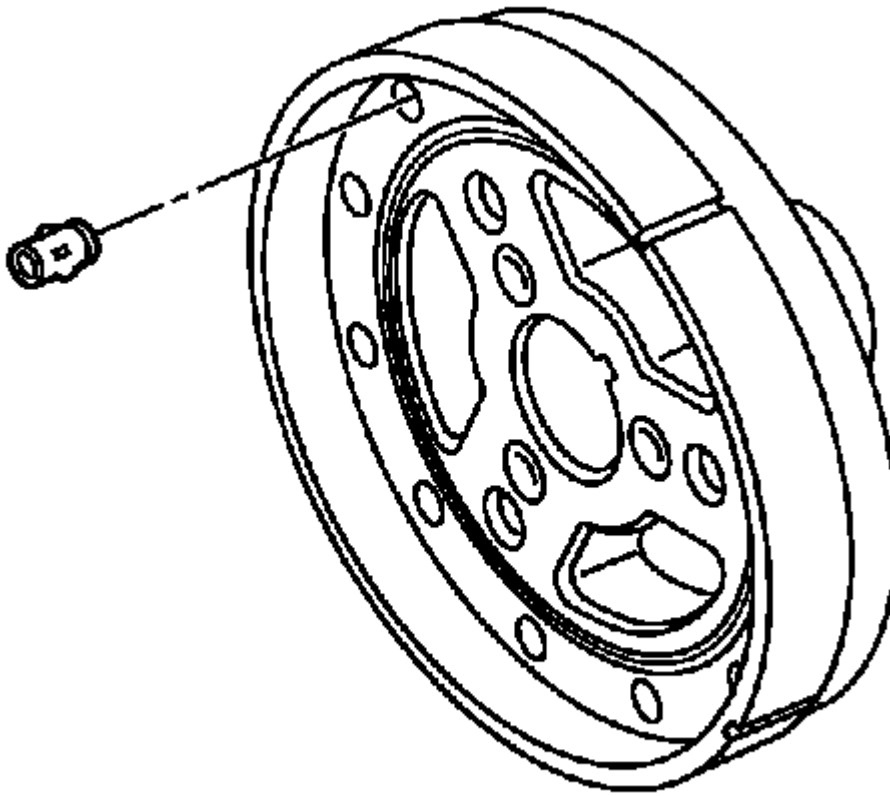


Fig. 225: View Of Crankshaft Balancer Weights
Courtesy of GENERAL MOTORS CORP.

7. Note the position and length of any crankshaft balancer weights, if necessary.
8. Clean and inspect the crankshaft balancer, if necessary. Refer to **CRANKSHAFT BALANCER CLEANING & INSPECTION** .

Installation Procedure

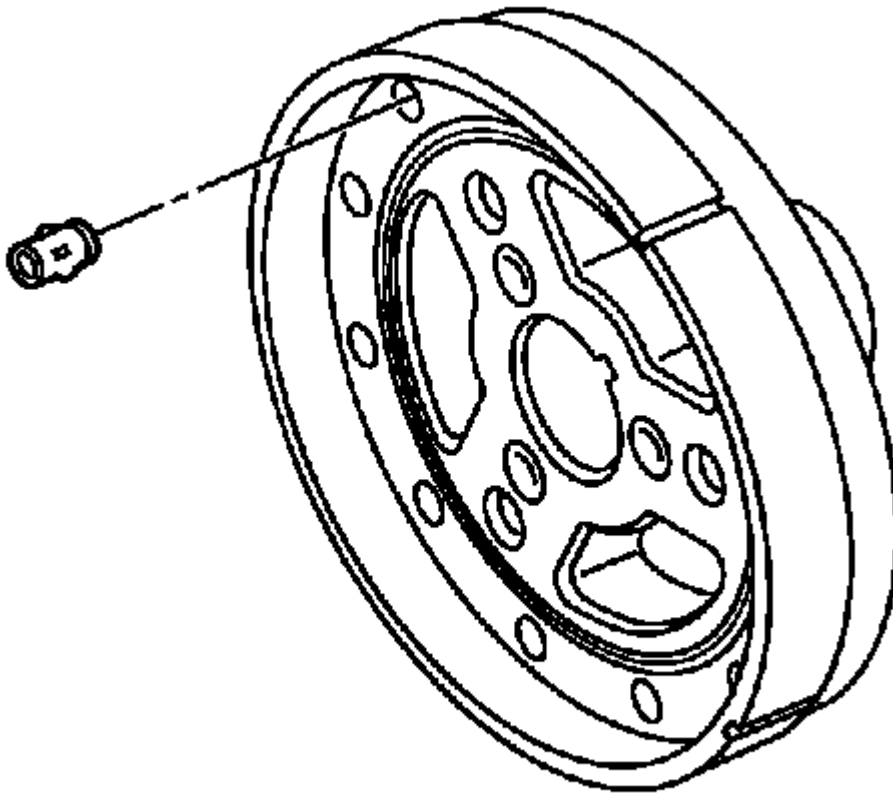


Fig. 226: View Of Crankshaft Balancer Weights
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The length and location of the weight(s) must be the same as the original.

1. Apply a small amount of grease to the crankshaft front cover seal sealing surface if reusing the seal.
2. Ensure that the crankshaft balancer weight(s) is installed in the proper location, if necessary.

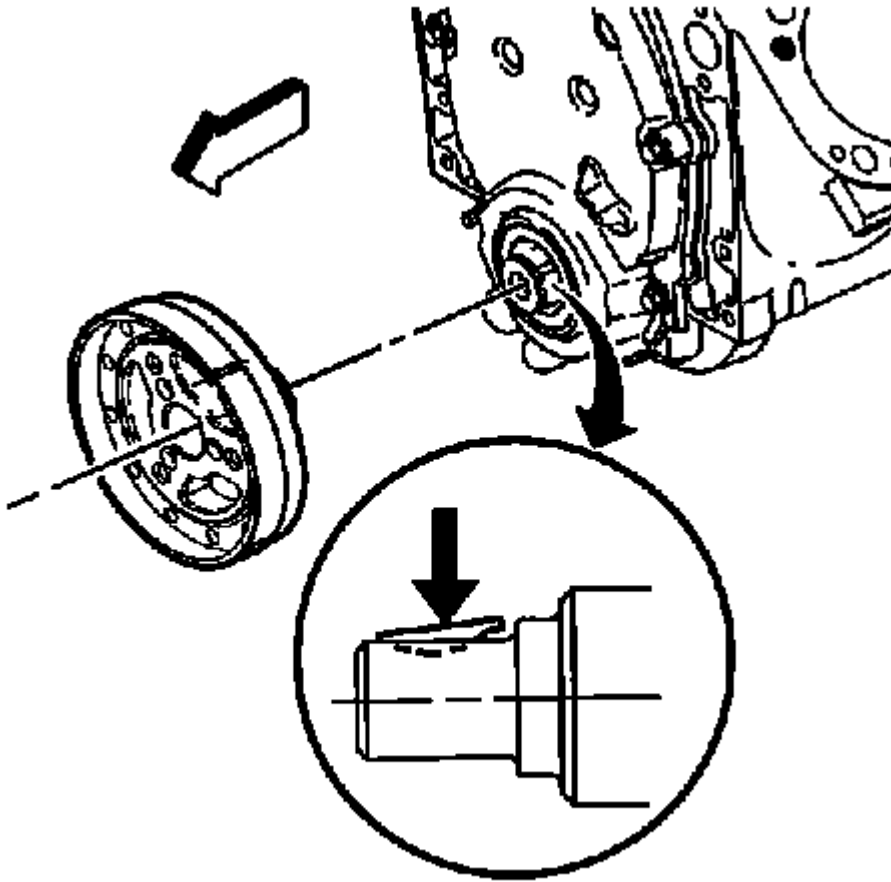


Fig. 227: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the crankshaft balancer.

3. Apply a small amount of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent into the crankshaft balancer keyway in order to seal the crankshaft balancer keyway and crankshaft joint.
4. Align the keyway of the crankshaft balancer with the crankshaft balancer key.
5. Install the crankshaft balancer onto the end of the crankshaft.

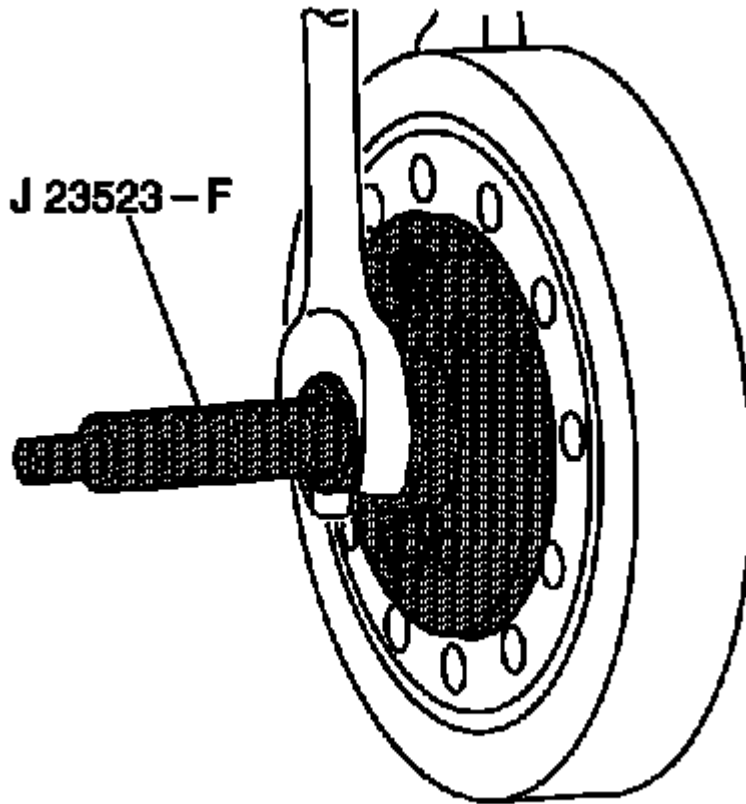


Fig. 228: Using J 23523-F To Press Crankshaft Balancer Onto Crankshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

6. Using **J 23523-F** , press the crankshaft balancer onto the crankshaft.
 1. Install the **J 23523-F** plate and bolts onto the front of the crankshaft balancer.

Tighten: Tighten the **J 23523-F** bolts to 25 N.m (18 lb ft).
 2. Install the **J 23523-F** forcing screw into the end for the crankshaft.
 3. Install the **J 23523-F** bearing, the washer, and the nut onto the forcing screw.
 4. Rotate the **J 23523-F** nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.
7. Remove the **J 23523-F** .

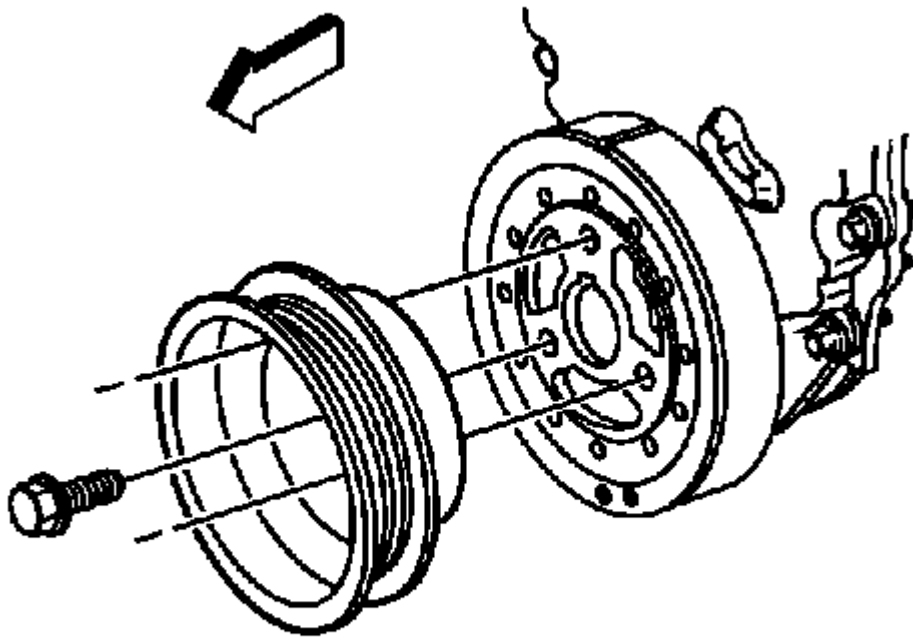


Fig. 229: View Of Crankshaft Pulley & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the crankshaft pulley and bolts.

Tighten: Tighten the crankshaft pulley bolts to 58 N.m (43 lb ft).

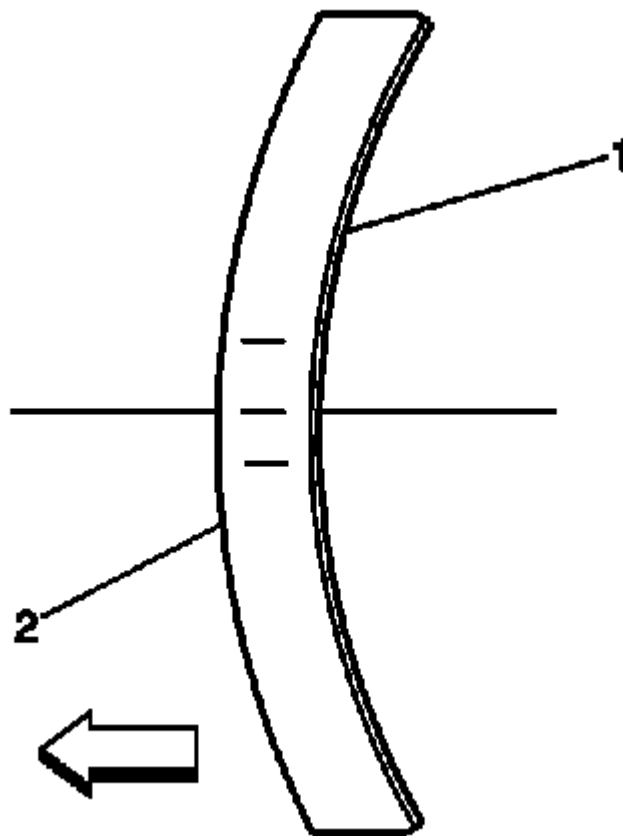


Fig. 230: View Of Crown Of Crankshaft Balancer Washer
Courtesy of GENERAL MOTORS CORP.

9. Ensure that the crown of the crankshaft balancer washer (2) is faced away from the engine.

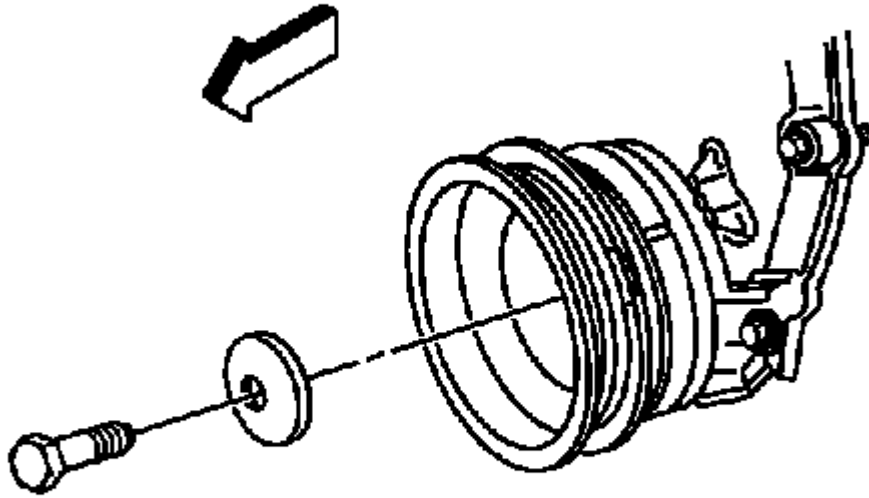


Fig. 231: View Of Crankshaft Balancer Washer & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the crankshaft balancer washer and bolt.

Tighten: Tighten the crankshaft balancer bolt to 95 N.m (70 lb ft).

11. Install the cooling fan. Refer to **FAN REPLACEMENT**.
12. Install the drive belt. Refer to **Drive Belt Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

J 35468 Cover Aligner and Seal Installer

Removal Procedure

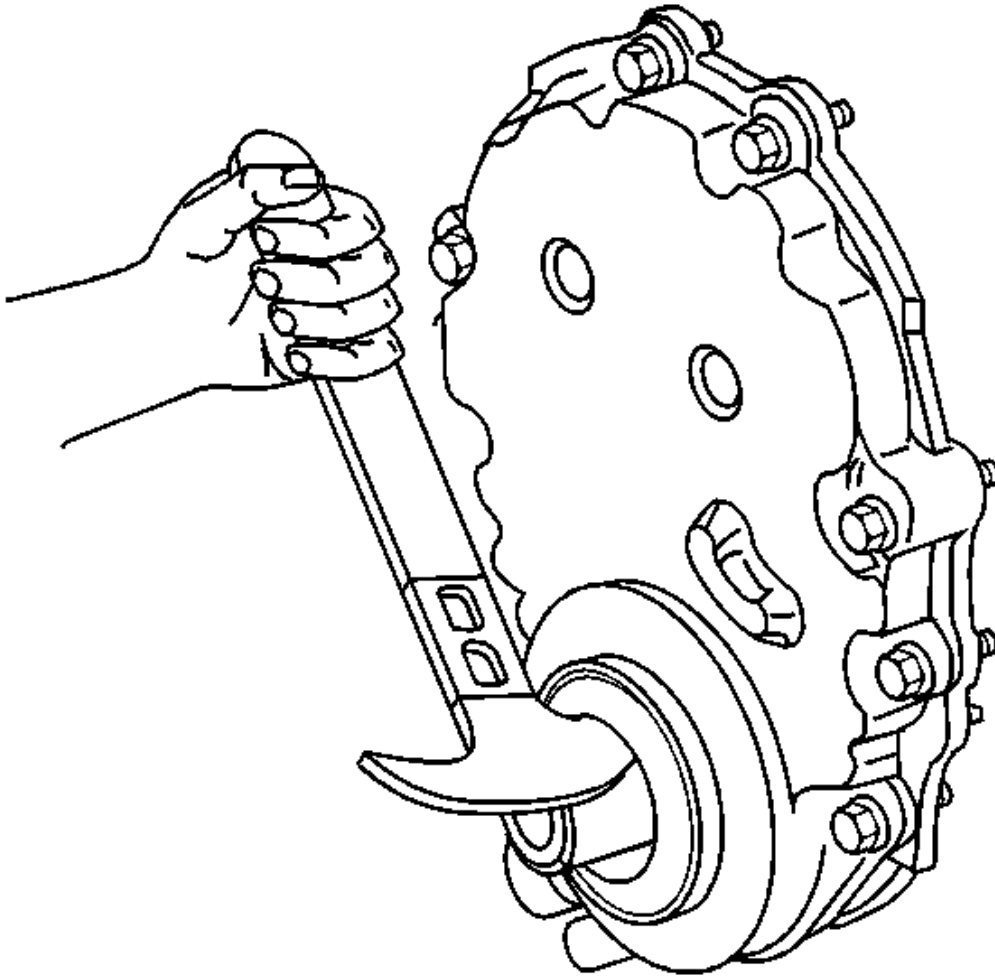


Fig. 232: View Of Front Crankshaft Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Use a suitable seal puller, remove the crankshaft front oil seal.
3. Inspect the engine front cover seal bore area for damage.

Installation Procedure

1. Lubricate the exterior of the NEW seal with clean engine oil.
2. Using **J 35468** and a hammer, install the crankshaft front oil seal.

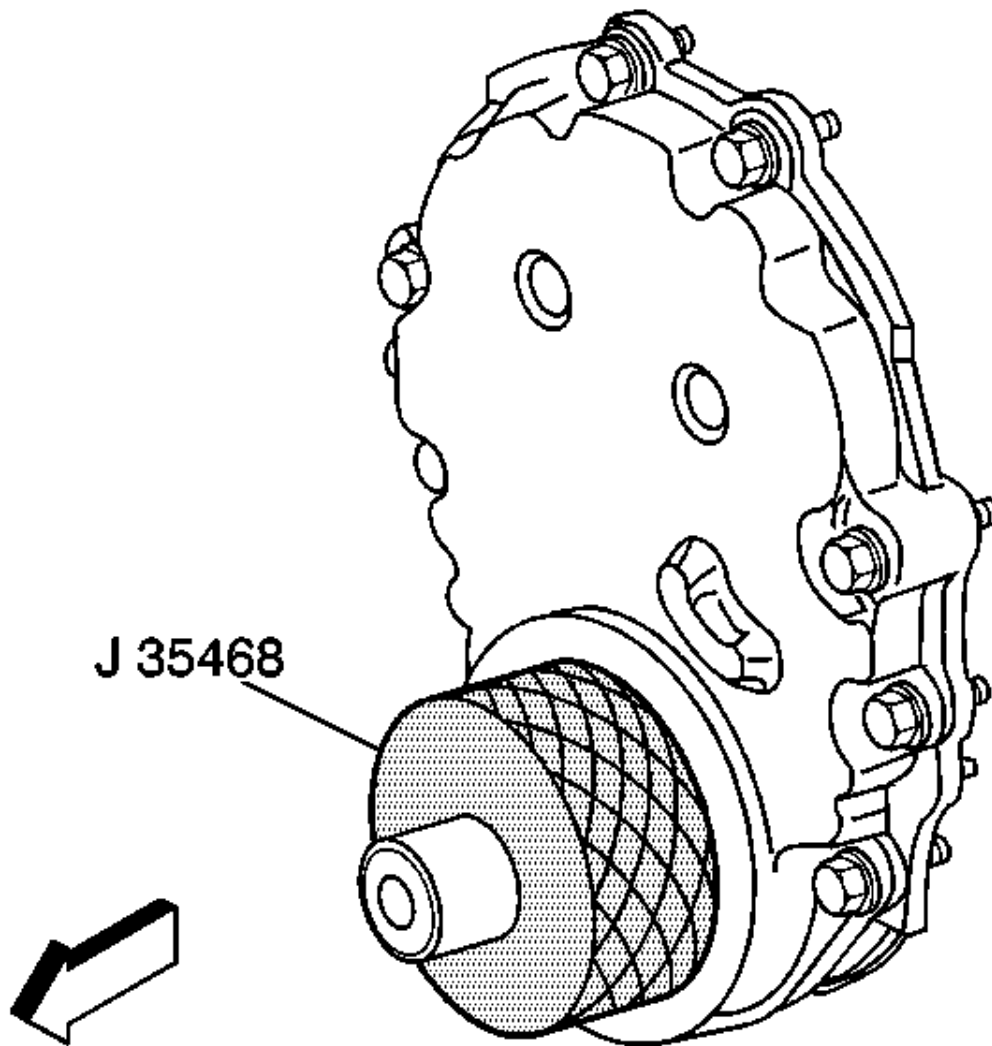


Fig. 233: View Of J 35468 Installing The Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Ensure the crankshaft front oil seal is flush and square to the engine front cover.
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

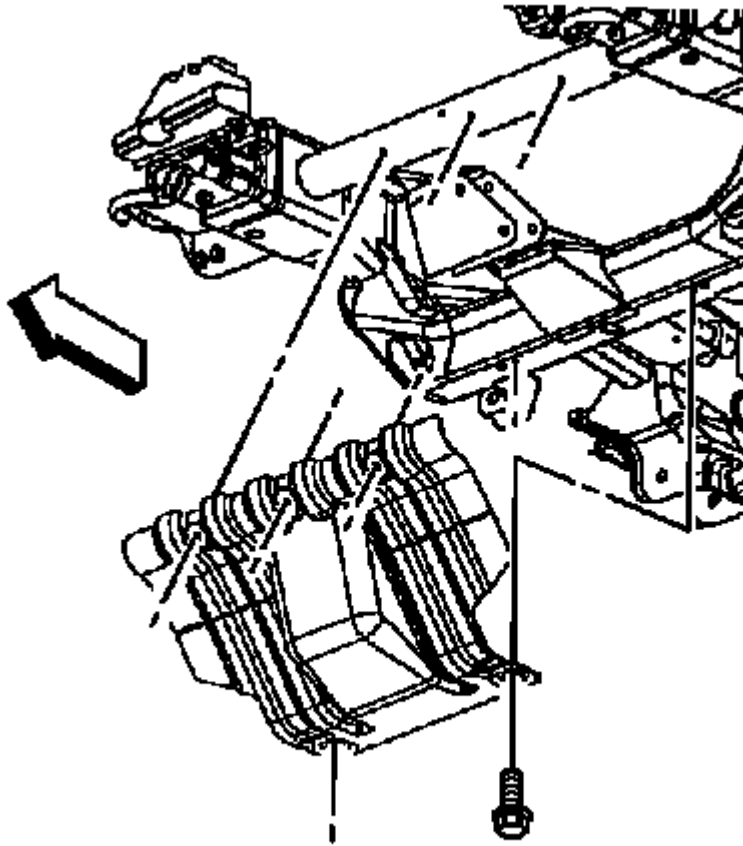


Fig. 234: View Of Engine Protection Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **WATER PUMP REPLACEMENT (4.3L ENGINE)** or **WATER PUMP REPLACEMENT (4.8L, 5.3L & 6.0L ENG or WATER PUMP REPLACEMENT (6.6L ENGINE)** or **WATER PUMP REPLACEMENT (8.1L ENGINE)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the oil pan. Refer to **Oil Pan Replacement**.
4. Remove the engine shield bolts and shield.

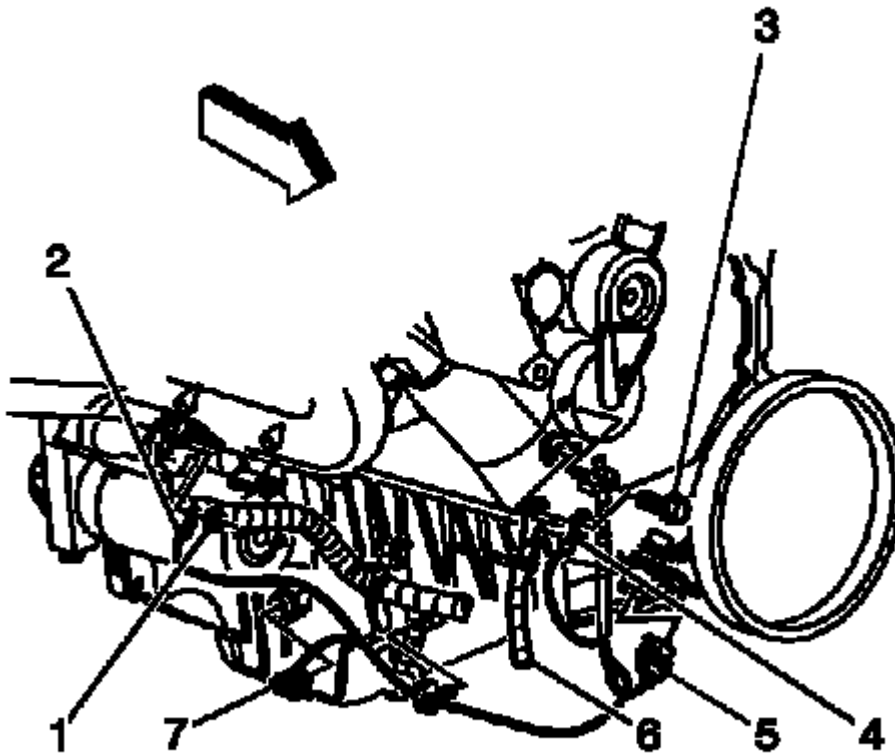


Fig. 235: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

5. Disconnect the crankshaft position (CKP) sensor electrical connector (5).

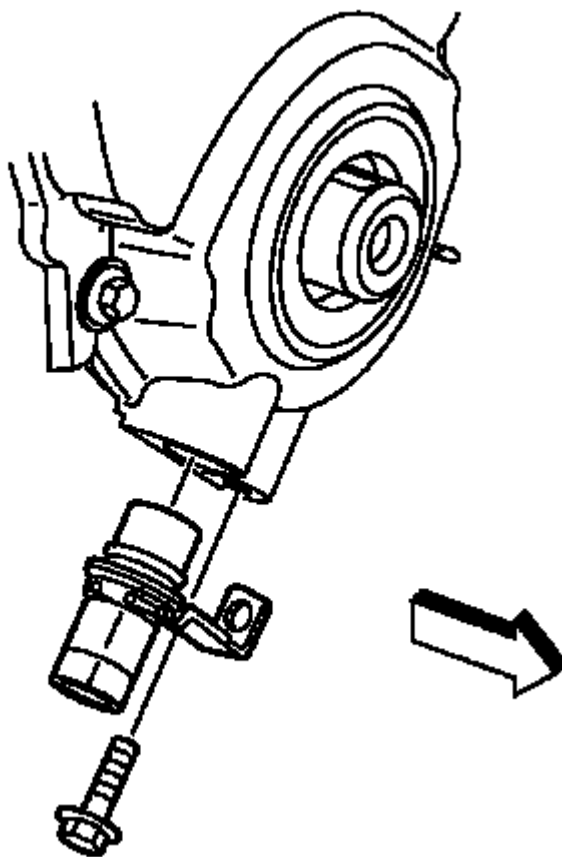


Fig. 236: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the CKP sensor bolt and sensor.

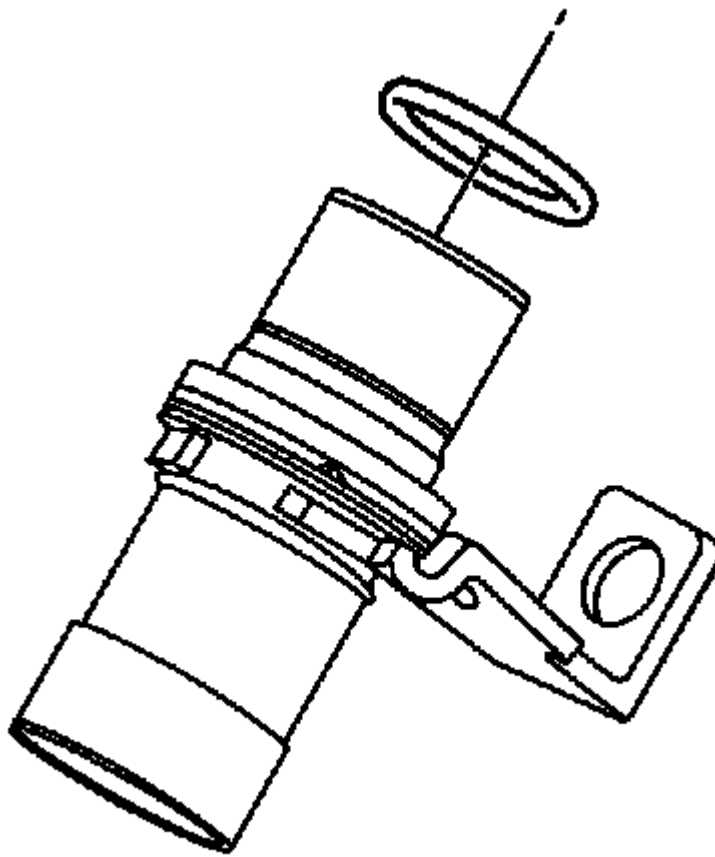


Fig. 237: View Of Crankshaft Position Sensor Seal O-Ring
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard the CKP sensor O-ring seal.

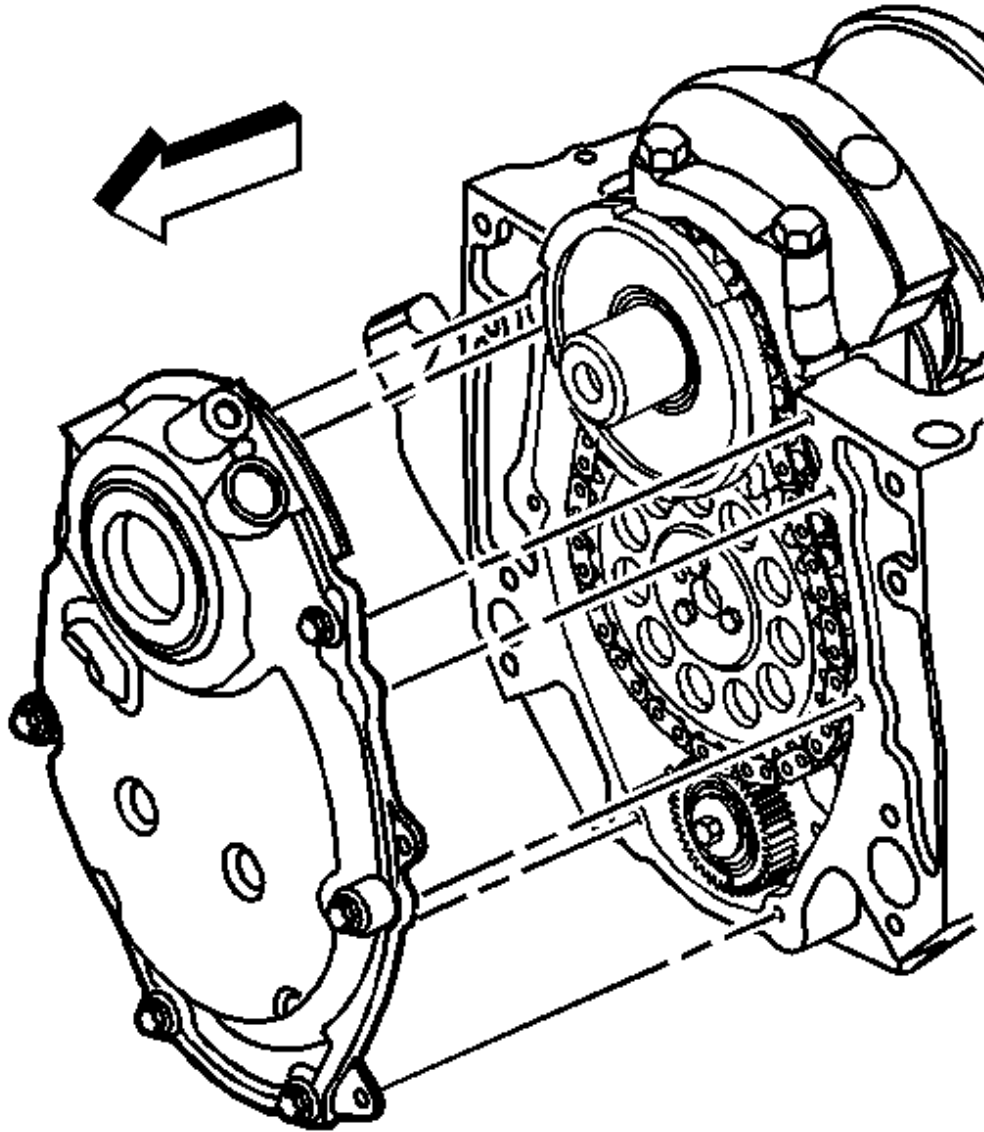


Fig. 238: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine front cover bolts.

IMPORTANT: After the composite engine front cover is removed do not reinstall the engine front cover. Always install a NEW engine front cover.

9. Remove and discard the engine front cover.
10. Clean all sealing surfaces.

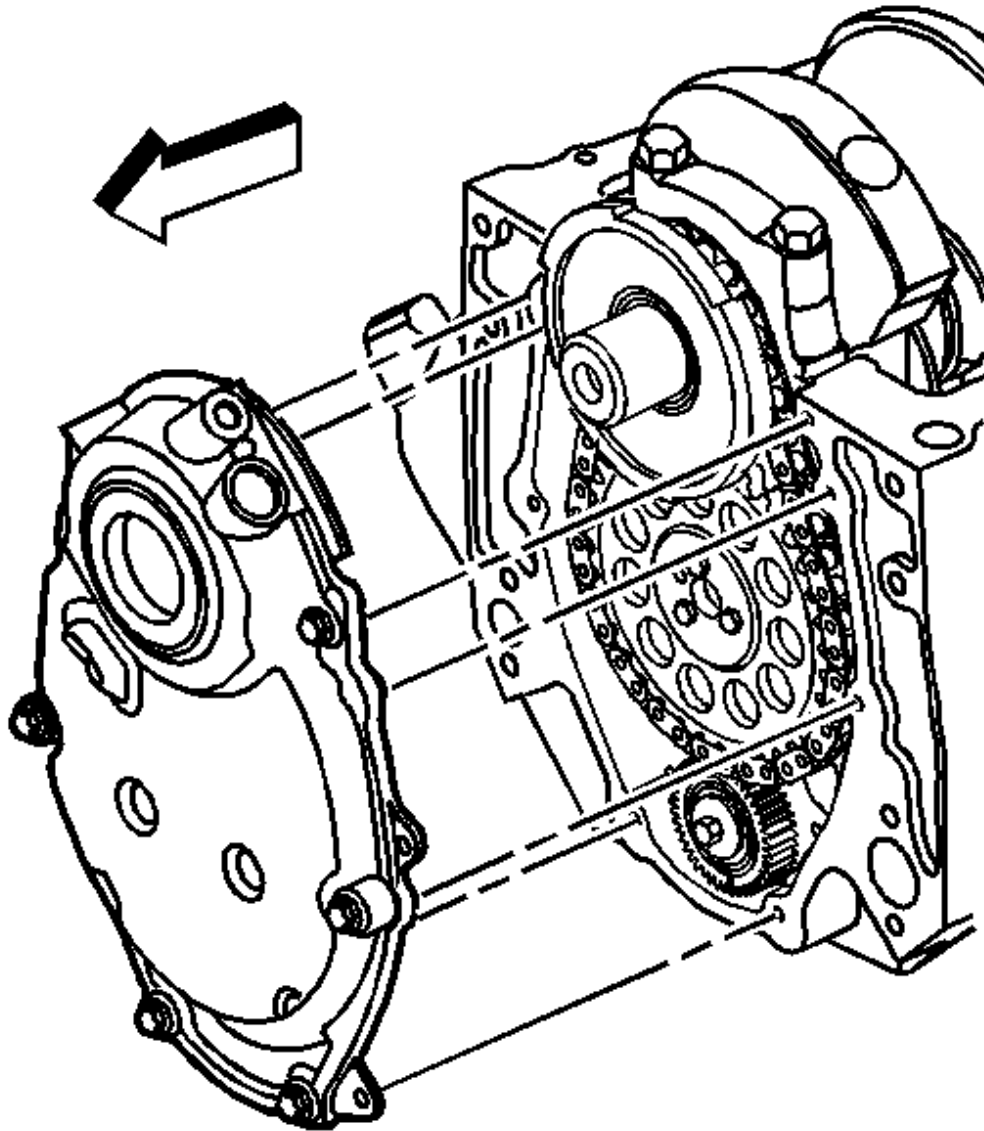
Installation Procedure

Fig. 239: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

1. Install a NEW engine front cover.
2. Install the engine front cover bolts.

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

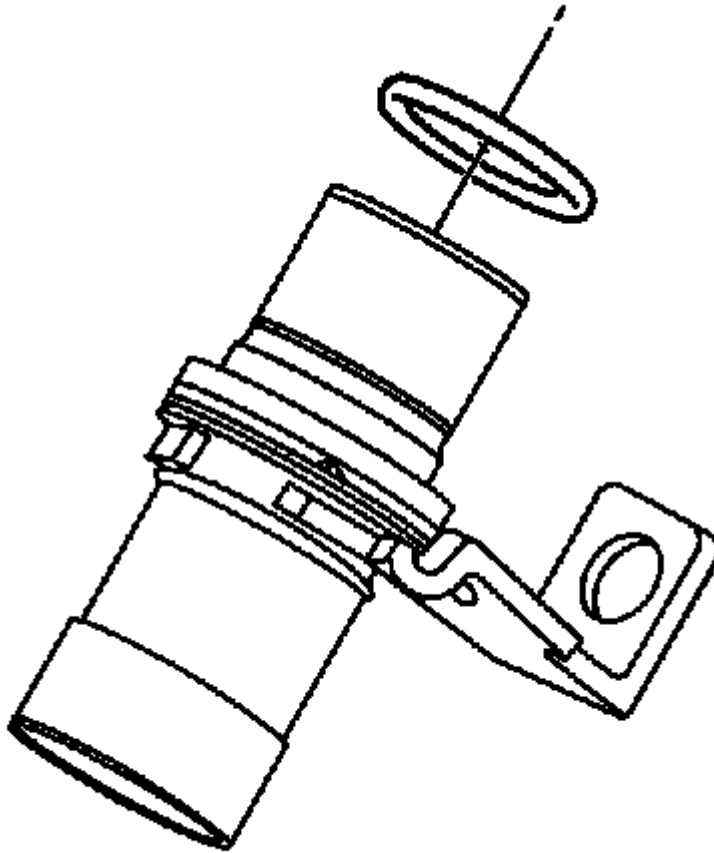


Fig. 240: View Of Crankshaft Position Sensor Seal O-Ring
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the original CKP sensor O-ring seal.

3. Lubricate a NEW CKP sensor O-ring seal with clean engine oil.
4. Install the NEW O-ring seal onto the CKP sensor.

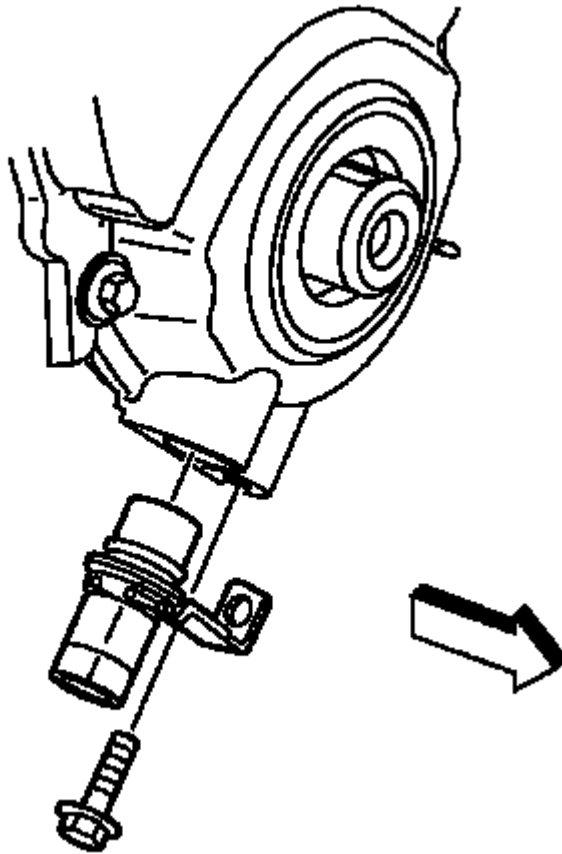


Fig. 241: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When installing the CKP sensor, make sure the sensor is fully seated before tightening the bolt. A poorly seated sensor may perform erratically and may set false DTCs.

5. Install the CKP sensor and bolt.

Tighten: Tighten the CKP sensor bolt to 8 N.m (71 lb in).

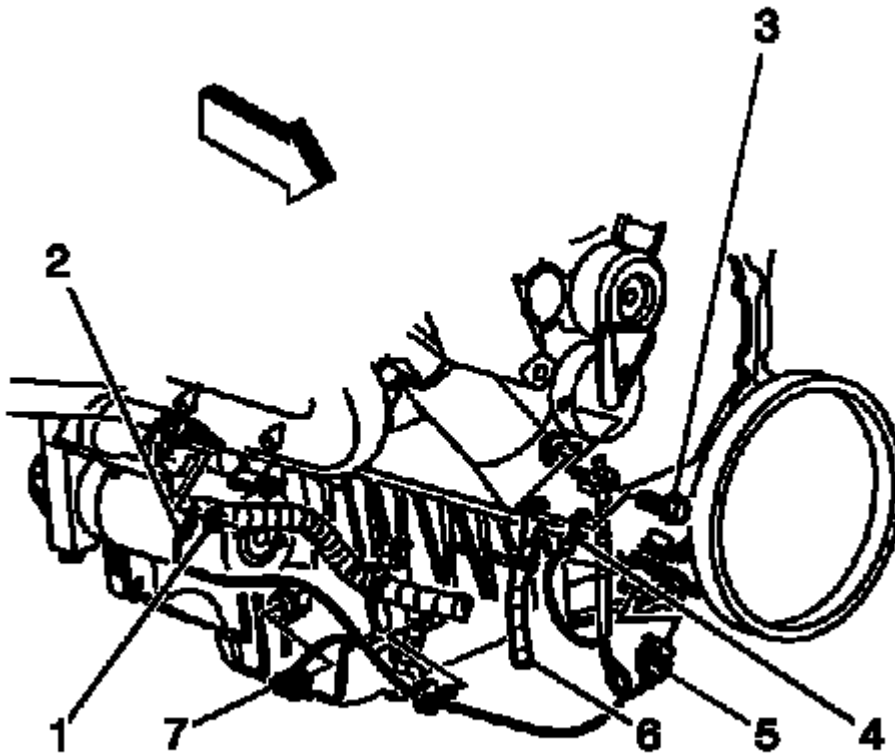


Fig. 242: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

6. Connect the CKP sensor electrical connector (5).

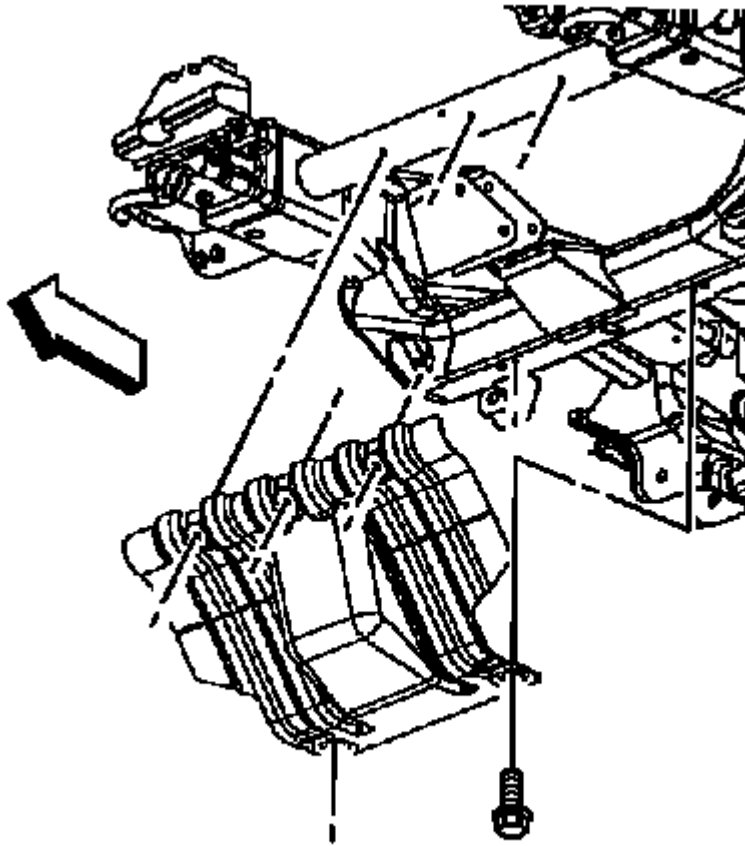


Fig. 243: View Of Engine Protection Shield
 Courtesy of GENERAL MOTORS CORP.

7. Install the engine shield and bolts.

Tighten: Tighten the engine shield bolts to 20 N.m (15 lb ft).

8. Install the oil pan. Refer to **Oil Pan Replacement**.
9. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
10. Install the water pump. Refer to **WATER PUMP REPLACEMENT (4.3L ENGINE)** or **WATER PUMP REPLACEMENT (4.8L, 5.3L & 6.0L ENG** or **WATER PUMP REPLACEMENT (6.6L ENGINE)** or **WATER PUMP REPLACEMENT (8.1L ENGINE)** .

CRANKSHAFT POSITION (CKP) RELUCTOR RING REPLACEMENT

Tools Required

J 5590 Rear Pinion Bearing Race Installer

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the crankshaft position (CKP) sensor reluctor ring.

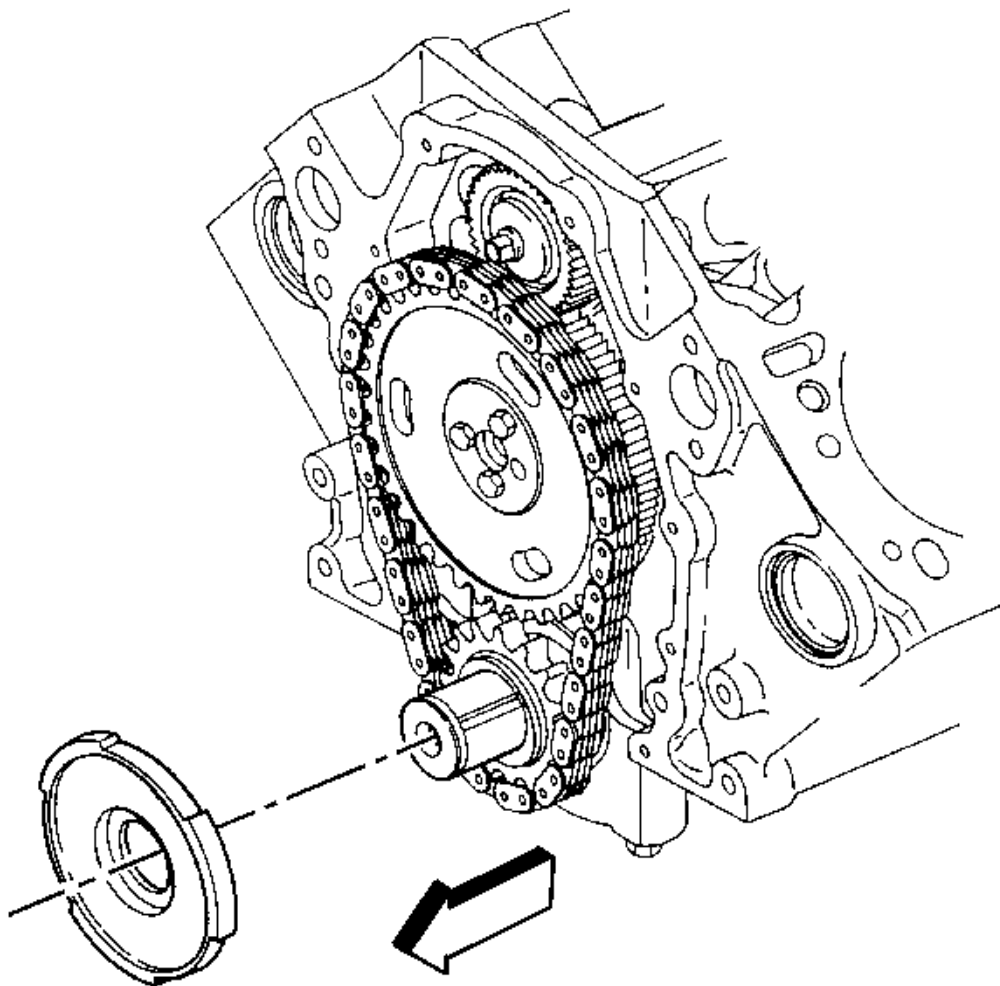


Fig. 244: View Of Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

NOTE: Failure to properly align the crankshaft position sensor reluctor ring may result in component damage and effect OBD II system performance.

IMPORTANT: The reluctor ring is shaped like a dish. The dish must face the engine

front cover. Failure to do so will damage the front cover and the reluctor ring.

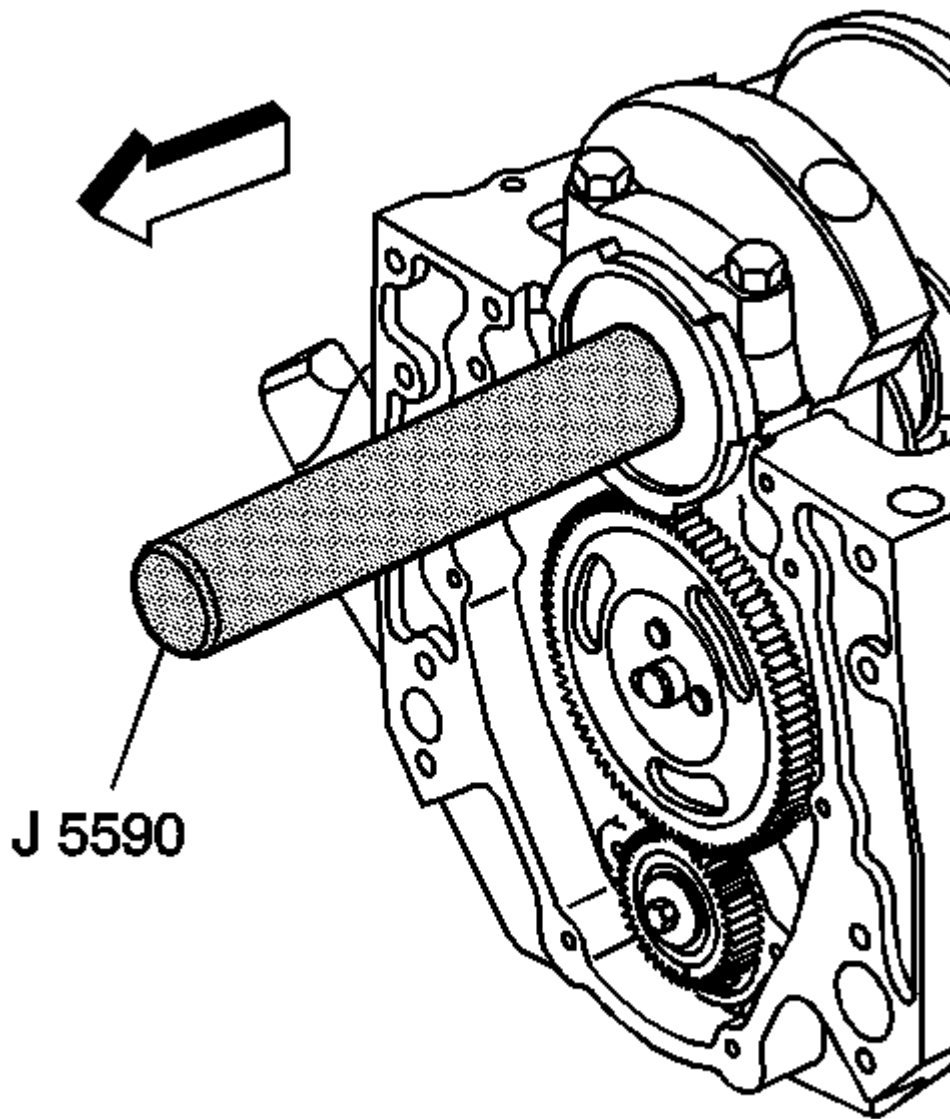


Fig. 245: Installing CKP Sensor Reluctor Ring Onto The Crankshaft Using J 5590
Courtesy of GENERAL MOTORS CORP.

1. Install the CKP sensor reluctor ring.
 1. Align the keyway on the CKP sensor reluctor ring with the key in the crankshaft.

2. Using **J 5590** , push the CKP sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN AND SPROCKETS REPLACEMENT

Tools Required

- **J 5825-A** Crankshaft Gear Remover
- **J 5590** Rear Pinion Bearing Race Installer

Removal Procedure

NOTE: In order to rotate the engine install a bolt with the same threads as the crankshaft, but do not use the crankshaft balancer bolt or a bolt longer than 1 inch, in the crankshaft. Failing to do so will cause damage to the bolt threads and the crankshaft threaded hole when removing the bolt.

1. Remove the crankshaft position (CKP) sensor reluctor ring. Refer to **Crankshaft Position (CKP) Reluctor Ring Replacement**.
2. Install a 7/16-20 x 1 inch bolt into the end of the crankshaft.

NOTE: Align the timing marks before removing the timing chain. If it is necessary to turn either the camshaft or the crankshaft with the timing chain removed, loosen or remove the valve rocker arms. Turning either the crankshaft or camshaft with the timing chain removed may cause the pistons to contact the valves, resulting in damage.

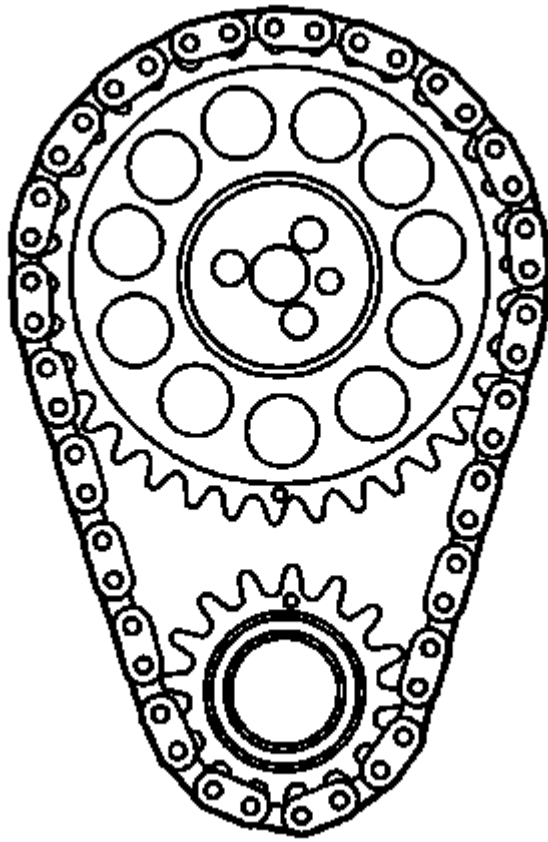


Fig. 246: View Of Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft until:
 1. The timing marks on both sprockets line up.
 2. The number four cylinder is at top dead center (TDC) of the compression stroke.

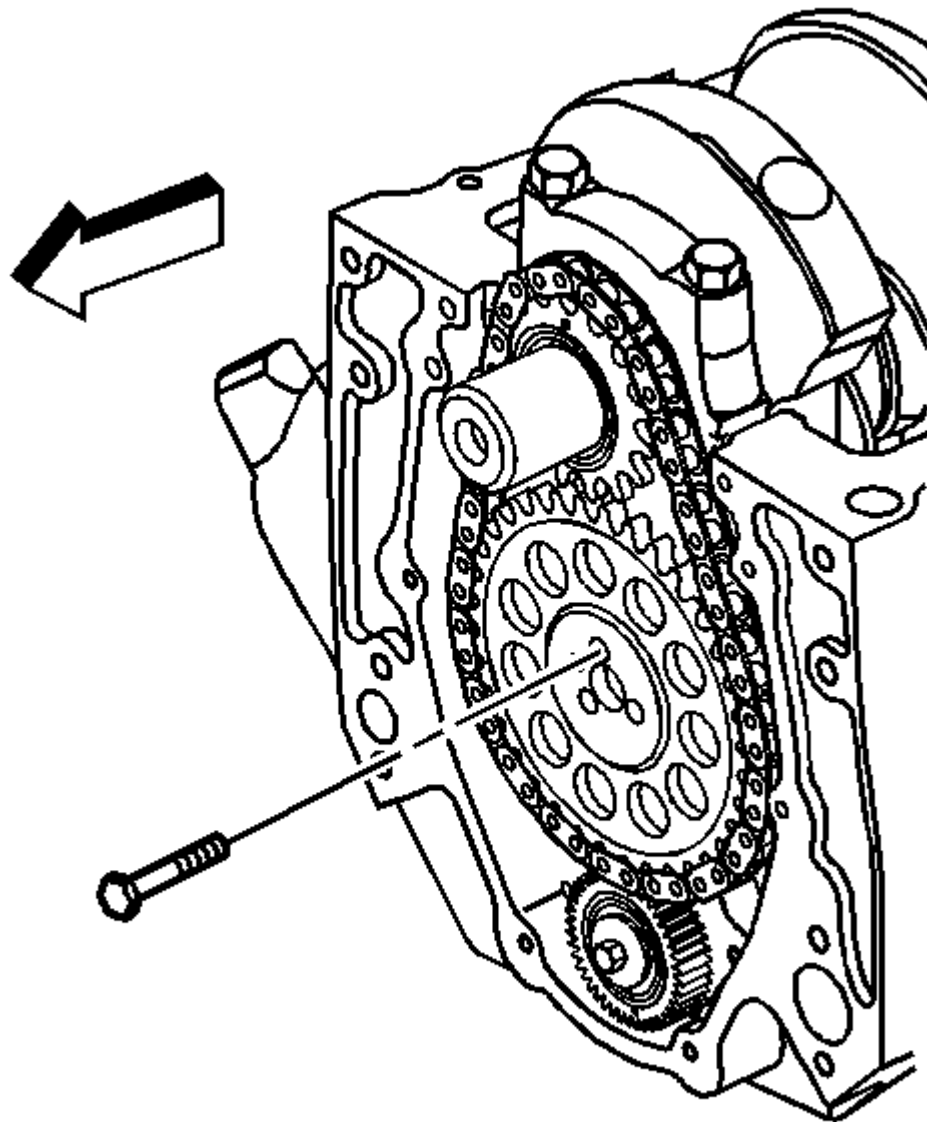


Fig. 247: View Of Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft sprocket bolts.

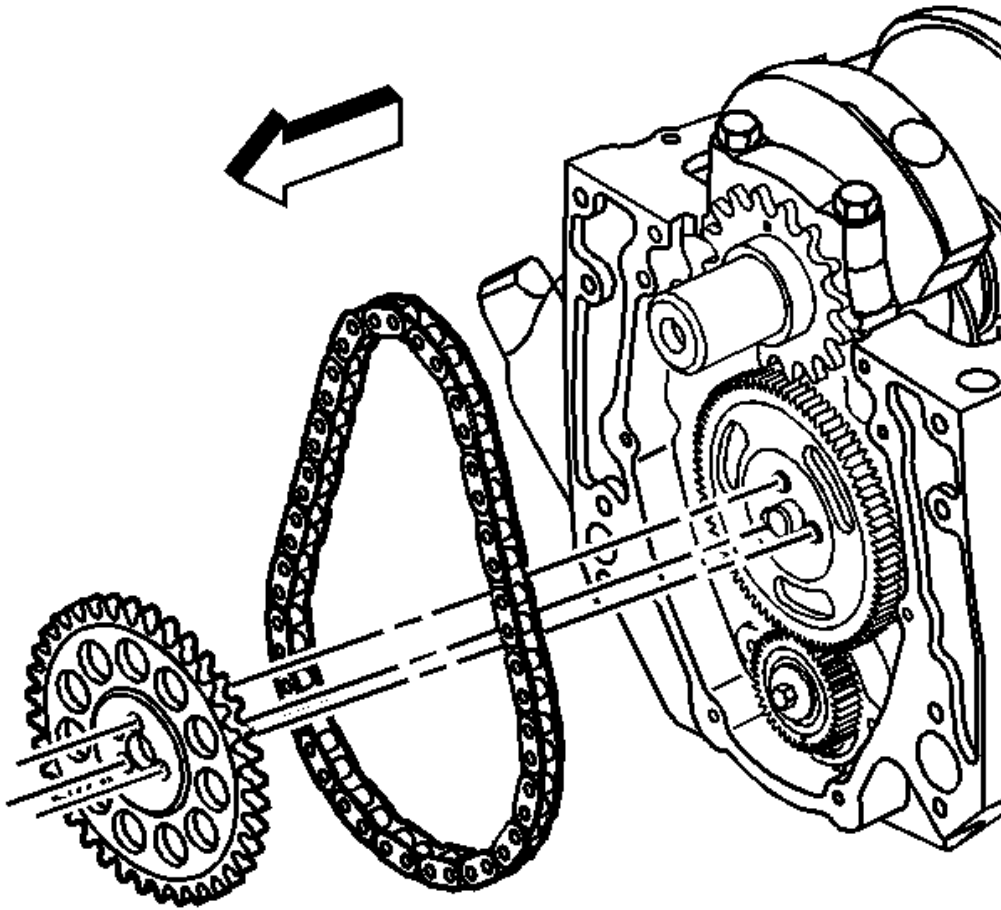


Fig. 248: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket and the camshaft timing chain.

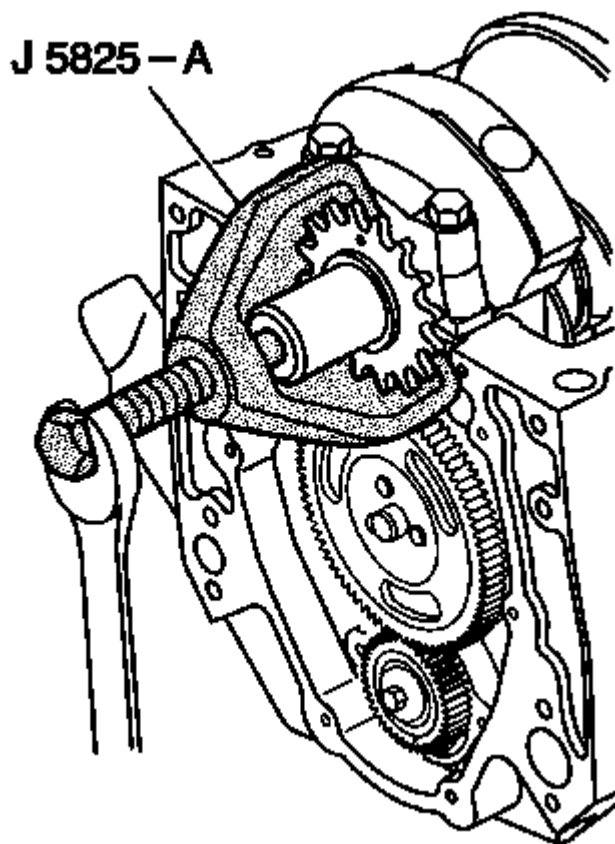


Fig. 249: View Of J 5825-A Removing Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

6. Using **J 5825-A** and an open end wrench, remove the crankshaft sprocket.

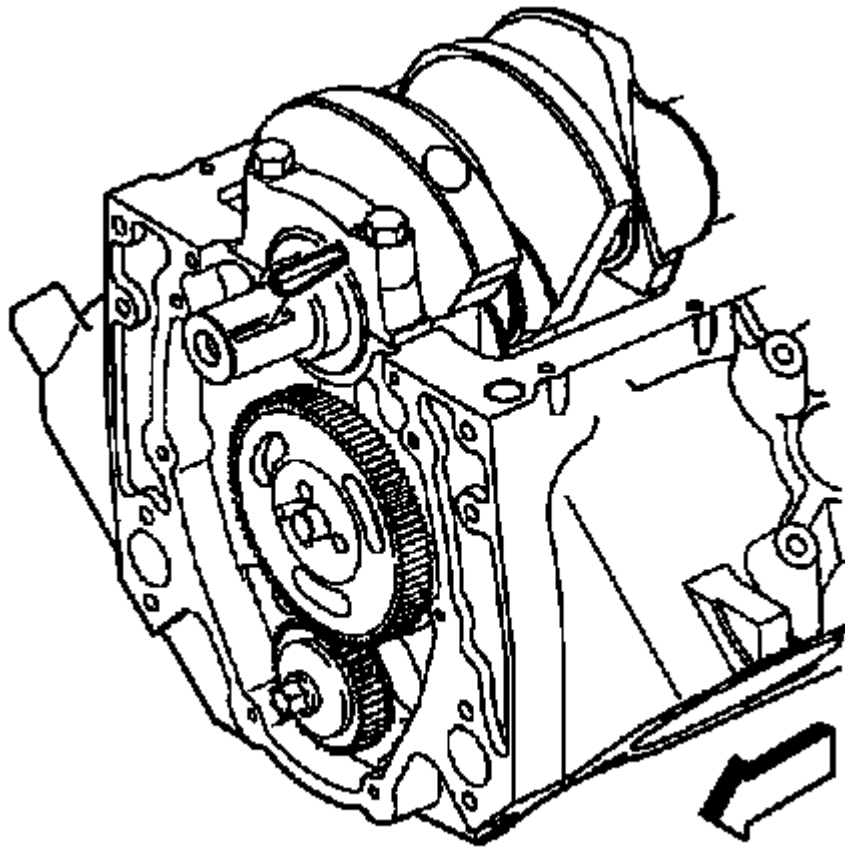


Fig. 250: View Of Crankshaft Balancer Key
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft balancer key.
8. Clean and inspect the timing chain and sprockets, if necessary. Refer to **TIMING CHAIN & SPROCKETS -- CLEANING & INSPECTION**.

Installation Procedure

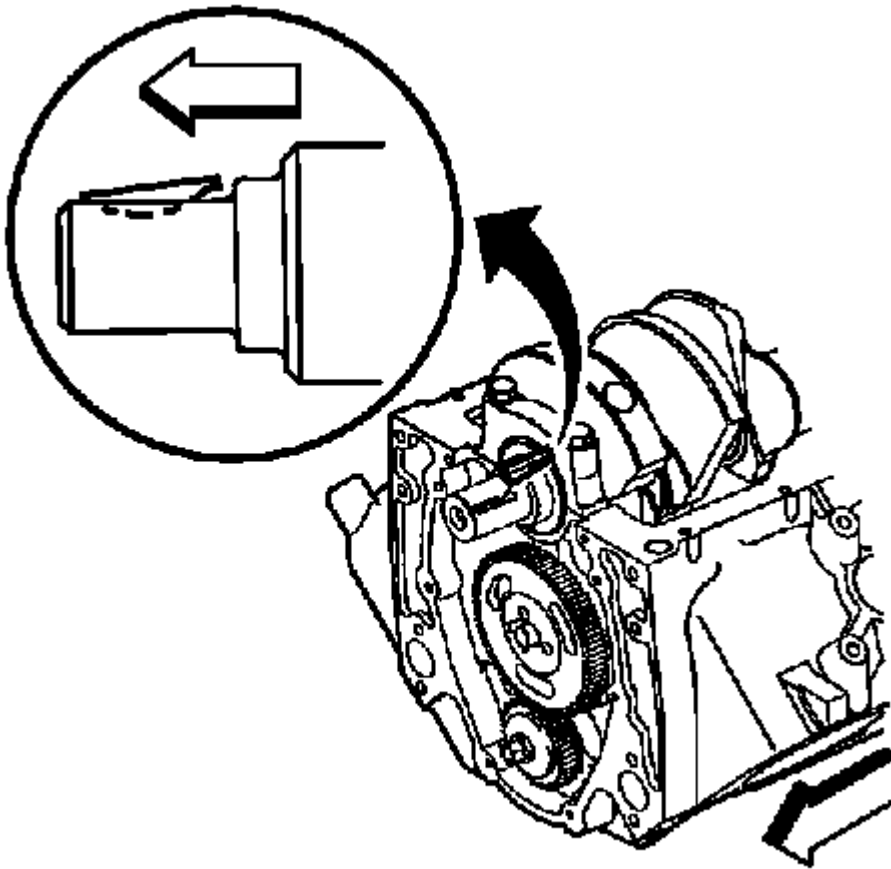


Fig. 251: Installing Crankshaft Balancer Key
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway.

The crankshaft balancer key should be parallel to the crankshaft or with a slight incline.

2. Align the keyway of the crankshaft sprocket with the crankshaft balancer key.
3. Using **J 5590** , install the crankshaft sprocket.

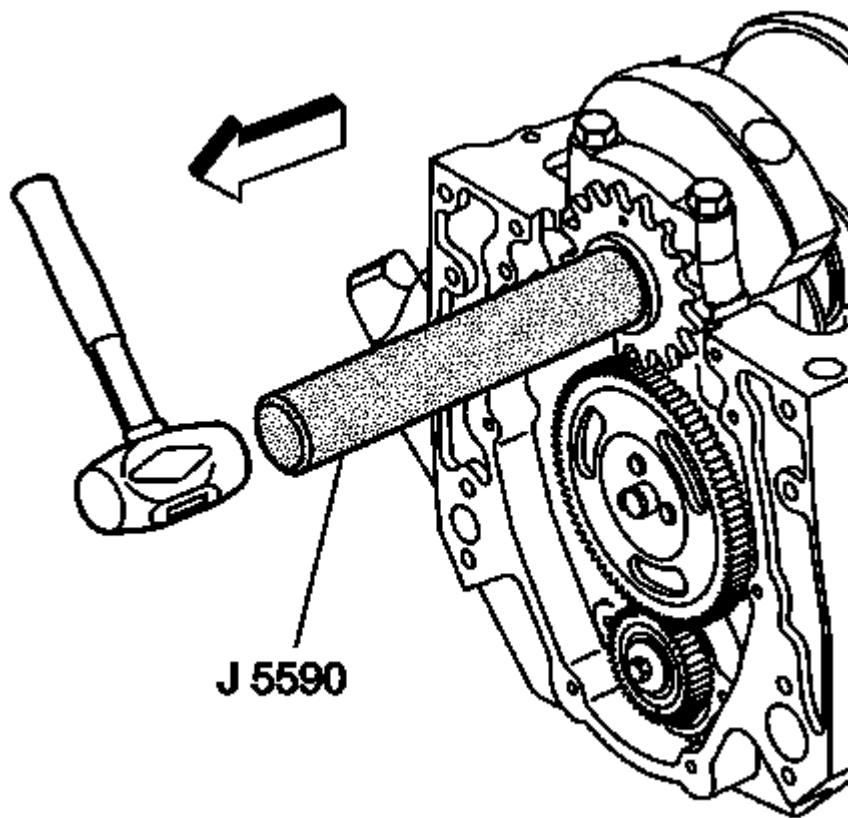


Fig. 252: Installing The Crankshaft Sprocket Using J 5590
Courtesy of GENERAL MOTORS CORP.

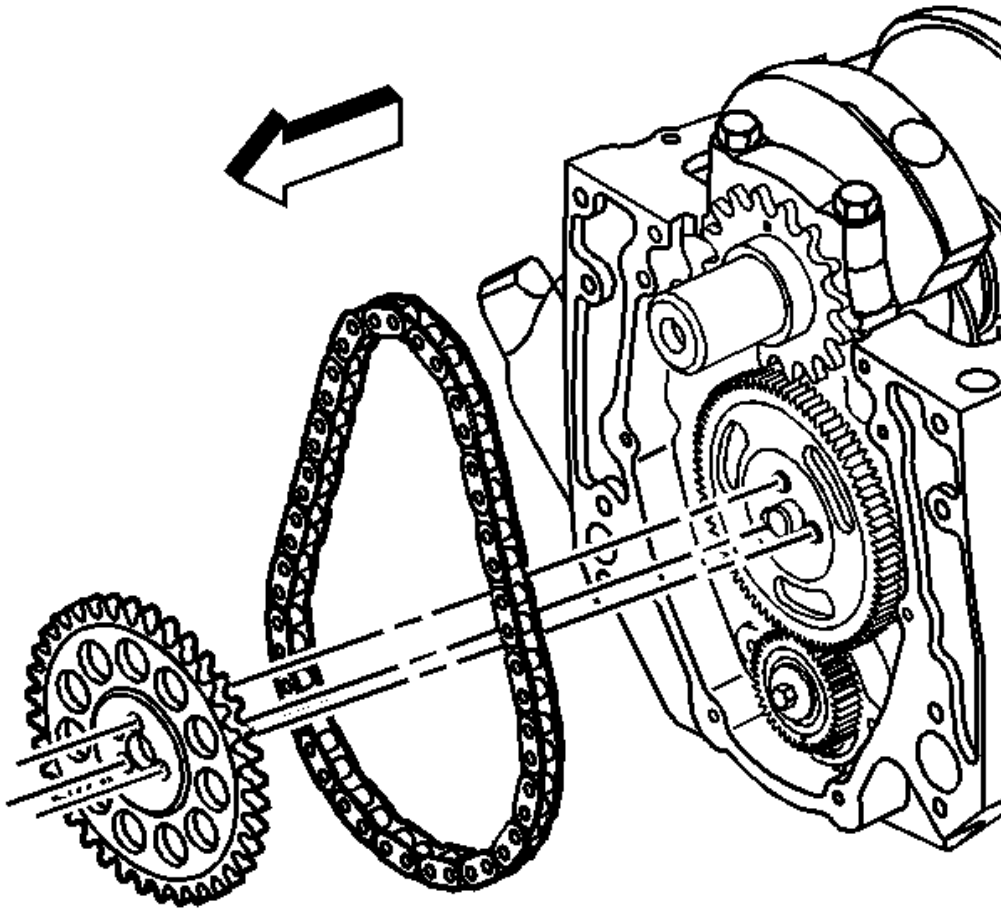


Fig. 253: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install the camshaft sprocket with the alignment mark at the 6 o'clock position.

4. Install the camshaft sprocket and the camshaft timing chain.

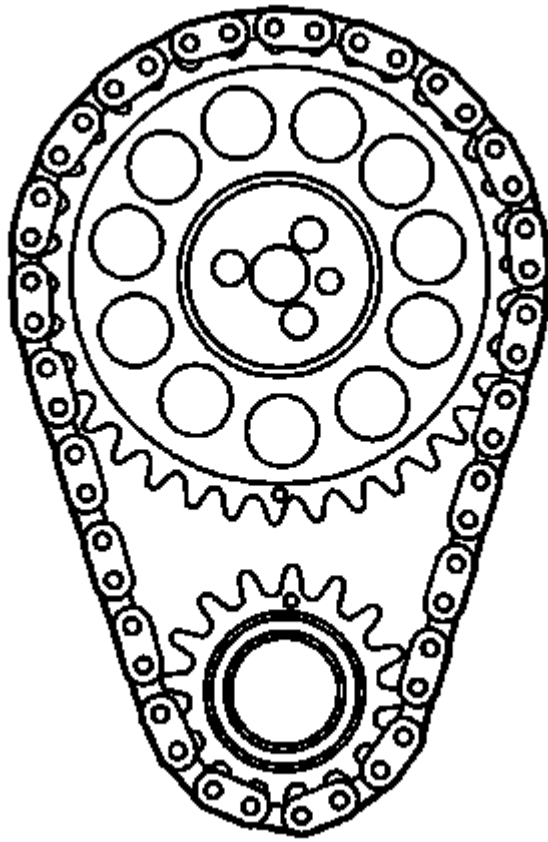


Fig. 254: View Of Camshaft & Crankshaft Sprocket Timing Marks
Courtesy of GENERAL MOTORS CORP.

5. Ensure that the crankshaft sprocket is aligned at the 12 o'clock position and camshaft sprocket is aligned at the 6 o'clock position.

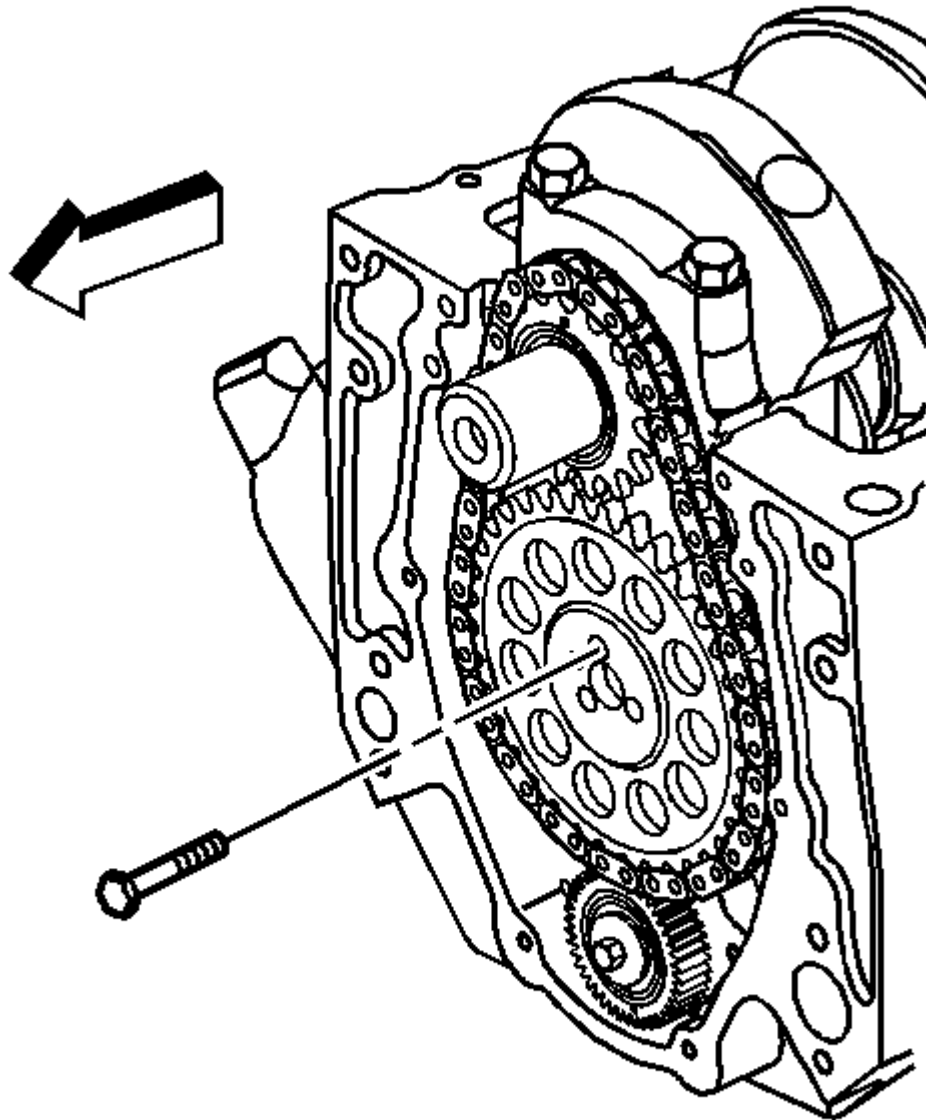


Fig. 255: View Of Camshaft Sprocket Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

IMPORTANT: Do not use a hammer to install the camshaft sprocket onto the camshaft.
To do so may dislodge the expansion cup plug.

6. Install camshaft sprocket bolts.

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

7. Remove the bolt that was installed in the end of the crankshaft.
8. Install the CKP sensor reluctor ring. Refer to **Crankshaft Position (CKP) Reluctor Ring Replacement**.

BALANCE SHAFT REPLACEMENT

Tools Required

- **J 8092** Universal Driver Handle
- **J 36660-A** Torque Angle Meter
- **J 36996** Balance Shaft Installer

Removal Procedure

1. Remove the radiator. Refer to **RADIATOR REPLACEMENT** .
2. Remove the air conditioning (A/C) condenser. Refer to **CONDENSER REPLACEMENT** .
3. Remove the valve lifter pushrod guide. Refer to **Valve Lifter Replacement**.
4. Remove the timing chain and camshaft sprocket. Refer to **Timing Chain and Sprockets Replacement**.
5. Remove the balance shaft drive gear.

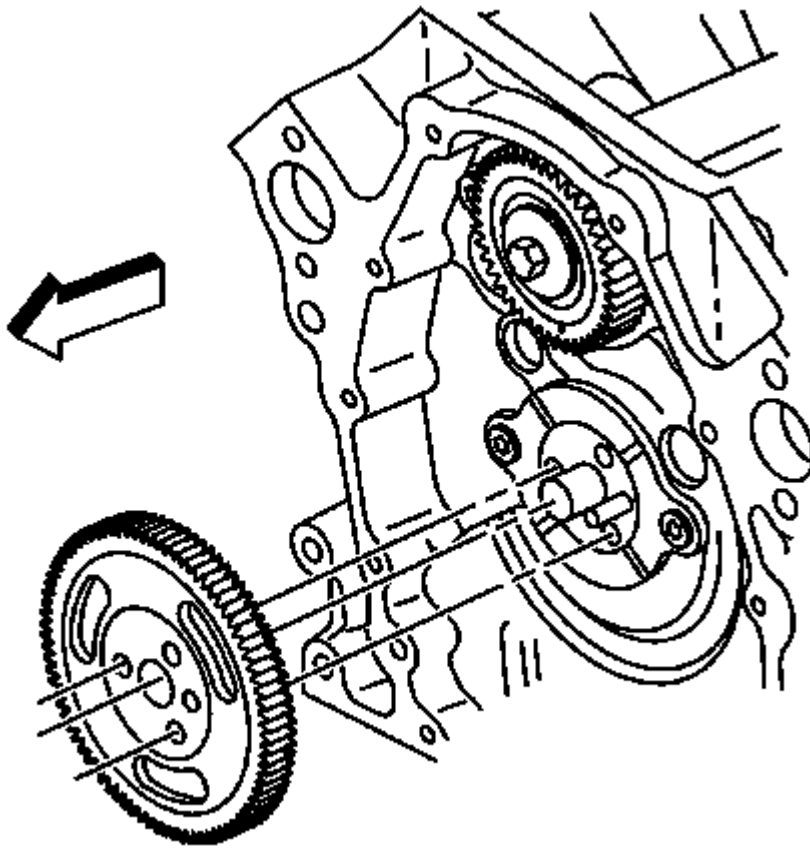


Fig. 256: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

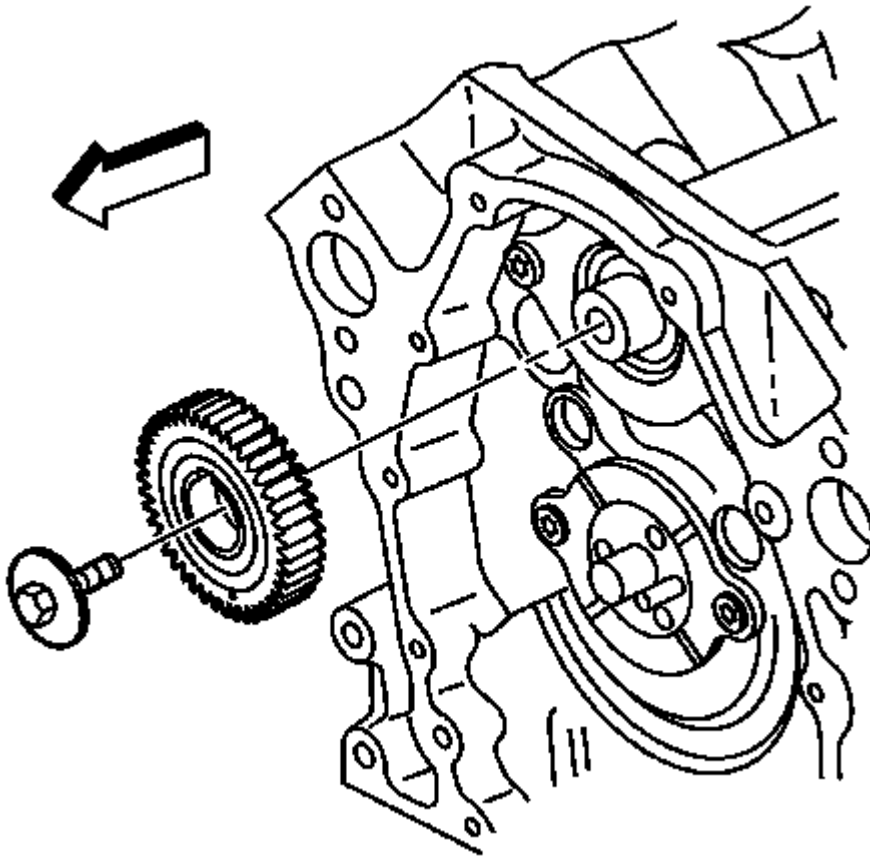


Fig. 257: Locating Balance Shaft Driven Gear
Courtesy of GENERAL MOTORS CORP.

6. Remove the balance shaft driven gear bolt.
 1. Use a wrench in order to secure the balance shaft.

Place the wrench onto the balance shaft near to the balance shaft front bearing.

2. Remove the balance shaft bolt.
 3. Remove the wrench from the balance shaft.
7. Remove the balance shaft driven gear.

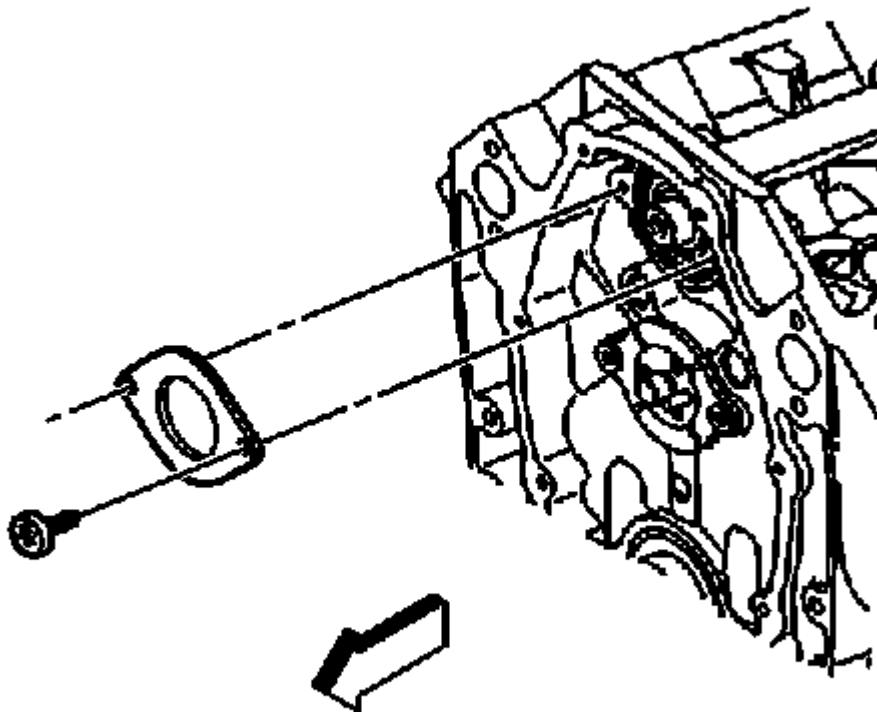


Fig. 258: View of Balance Shaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the balance shaft retainer bolts and retainer.

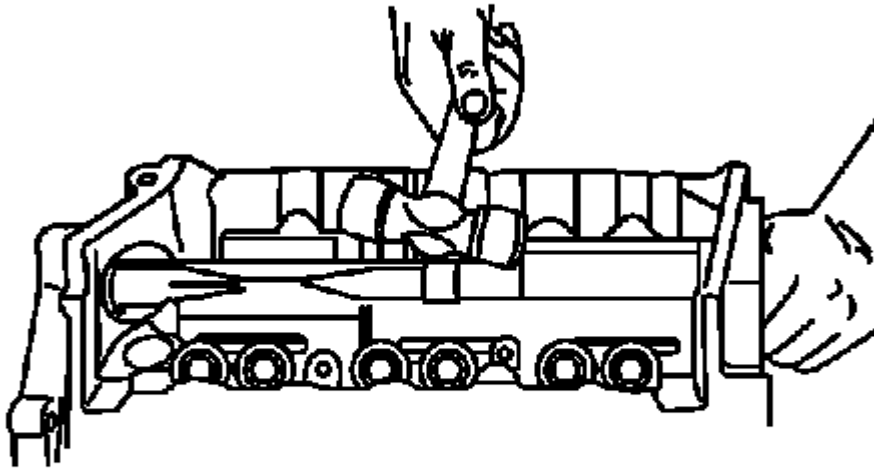


Fig. 259: Removing Balance Shaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The balance shaft and the balance shaft front bearing are serviced only as a package. Do not remove the balance shaft front bearing from the balance shaft.

9. Use a soft-faced hammer in order to remove the balance shaft from the engine block.
10. Clean and inspect the balance shaft, if necessary. Refer to **BALANCE SHAFT CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT: The balance shaft drive and balance shaft driven gears are serviced as a set. The set includes the balance shaft driven gear bolt.

1. Apply clean engine oil to the balance shaft front bearing.
2. Using **J 36996** and **J 8092**, install the balance shaft.

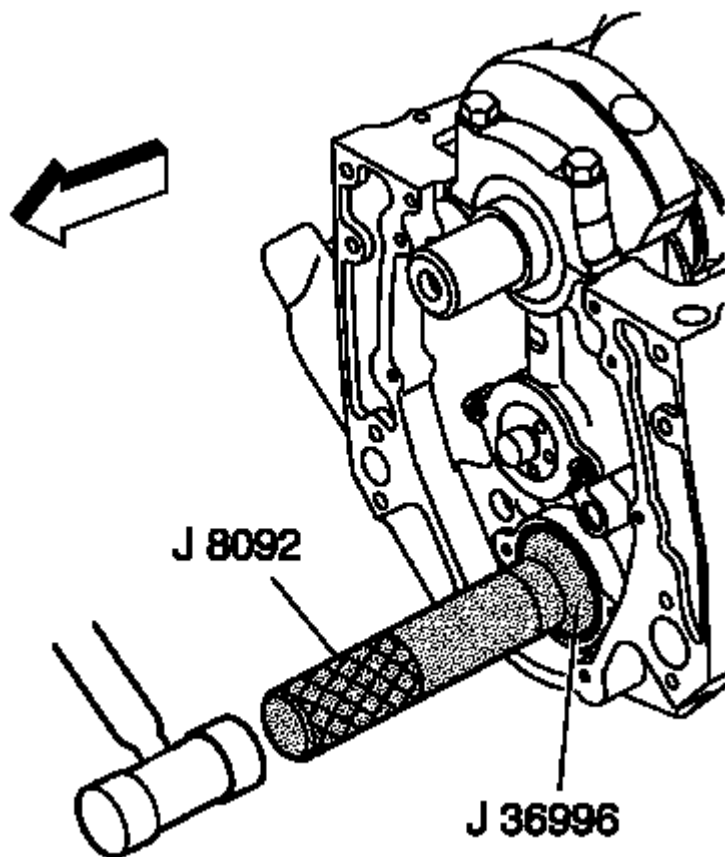


Fig. 260: View Of J 8092 & J 36996 Installing The Balance Shaft
Courtesy of GENERAL MOTORS CORP.

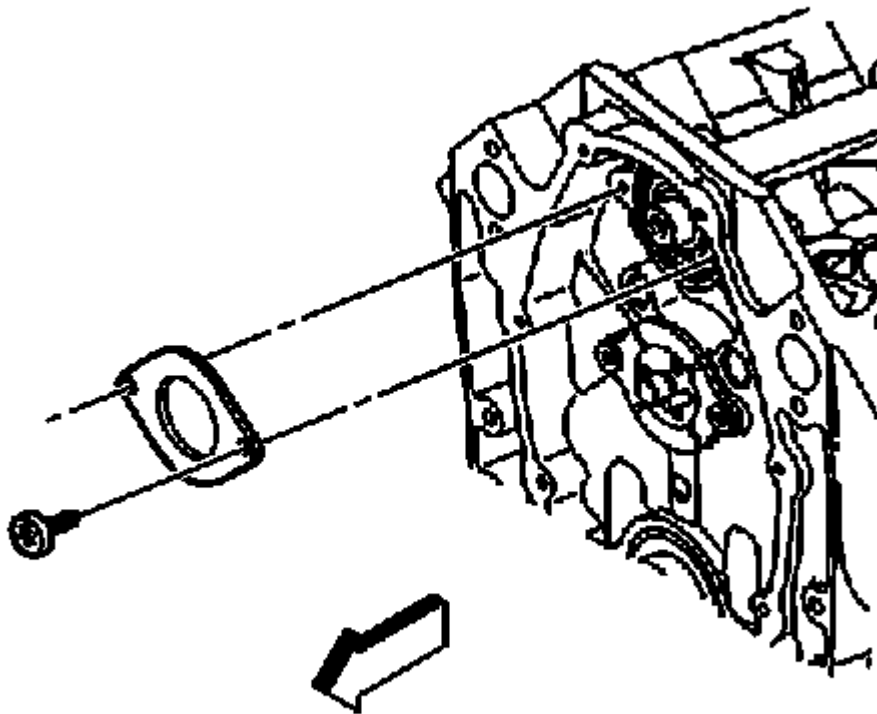


Fig. 261: View of Balance Shaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the balance shaft retainer and bolts.

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

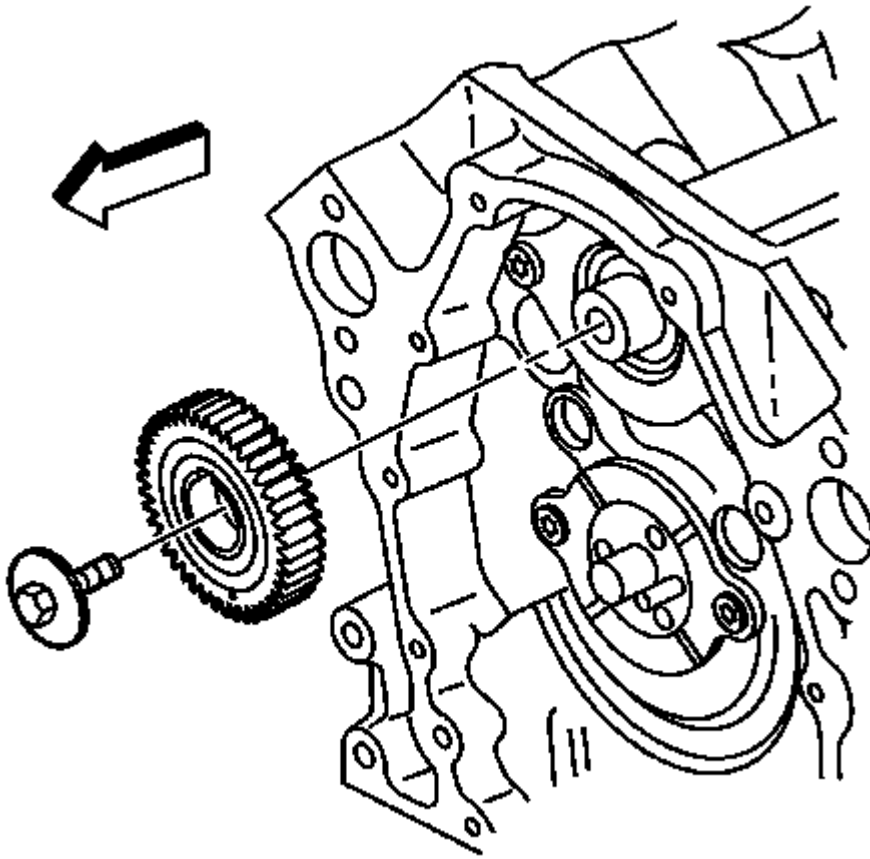


Fig. 262: Locating Balance Shaft Driven Gear
Courtesy of GENERAL MOTORS CORP.

4. Install the balance shaft driven gear.
5. If reusing the fastener, apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the balance shaft driven gear bolt.
6. Install the balance shaft driven gear bolt.
 1. Use a wrench to secure the balance shaft.

Place the wrench onto the balance shaft near to the balance shaft front bearing.

2. Install the balance shaft driven gear bolt.

Tighten:

1. Tighten the balance shaft driven gear bolt a first pass to 20 N.m (15 lb ft).
 2. Tighten the balance shaft driven gear bolt a final pass using **J 36660-A** an additional 35 degrees.
7. Remove the wrench from the balance shaft.
8. Rotate the balance shaft by hand in order to ensure that there is clearance between the balance shaft and the valve lifter pushrod guide. If the balance shaft does not rotate freely, check to ensure that the retaining

ring on the balance shaft front bearing is seated on the case.

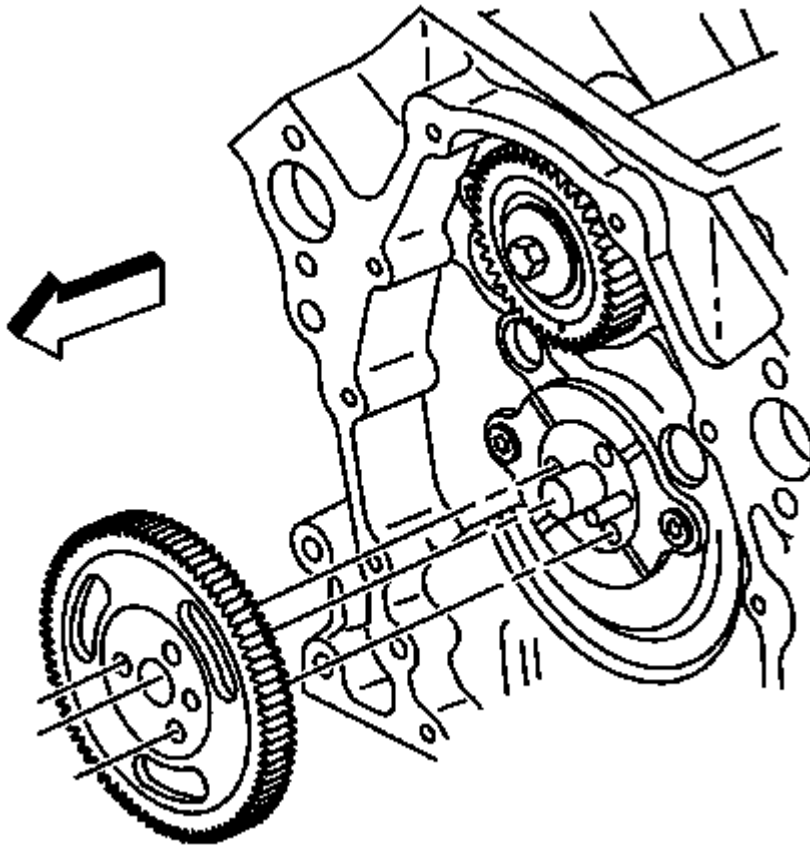


Fig. 263: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

9. Install the balance shaft drive gear. DO NOT install the camshaft sprocket bolts at this time.

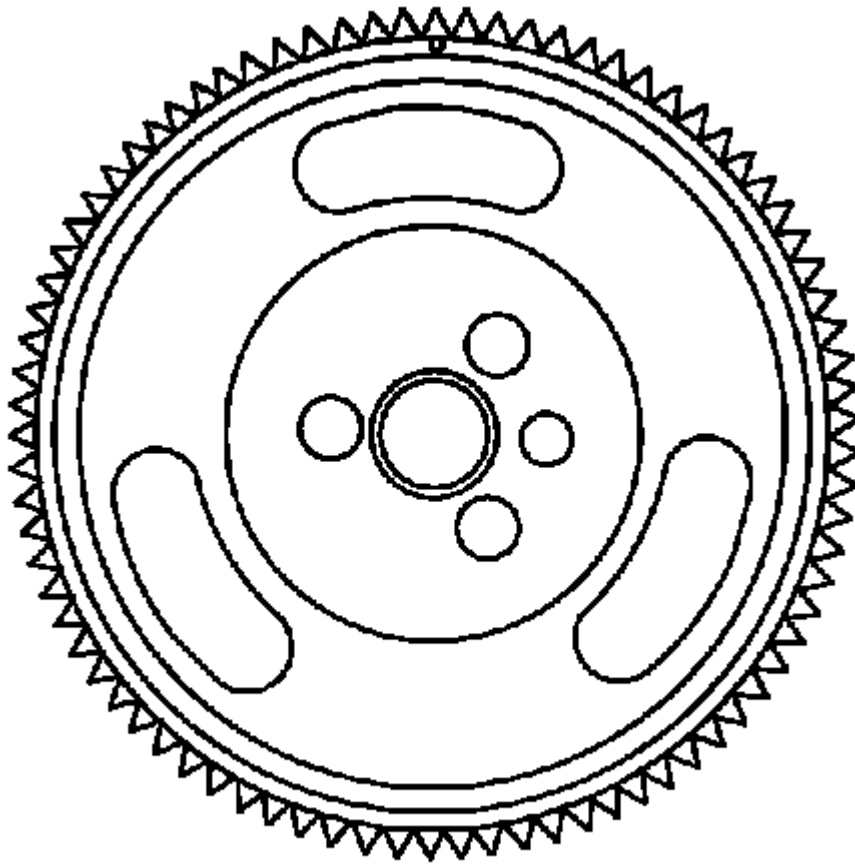


Fig. 264: Locating Balance Shaft Drive Gear Timing Mark In The 12 O'clock Position
Courtesy of GENERAL MOTORS CORP.

10. Rotate the camshaft so that the timing mark on the balance shaft drive gear is in the 12 o'clock position.

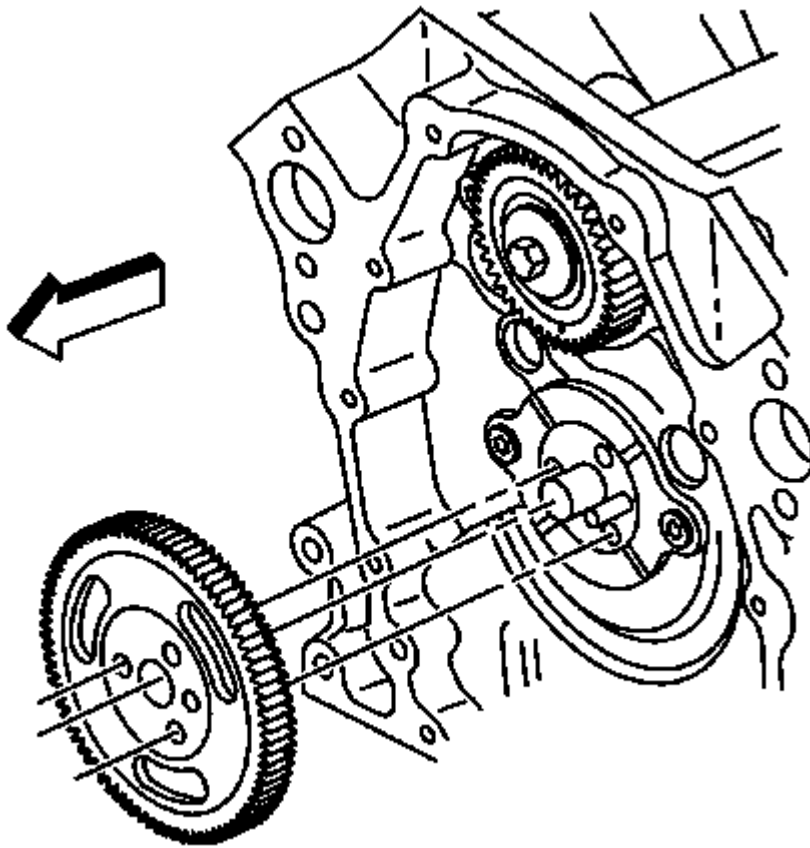


Fig. 265: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

11. Remove the balance shaft drive gear.

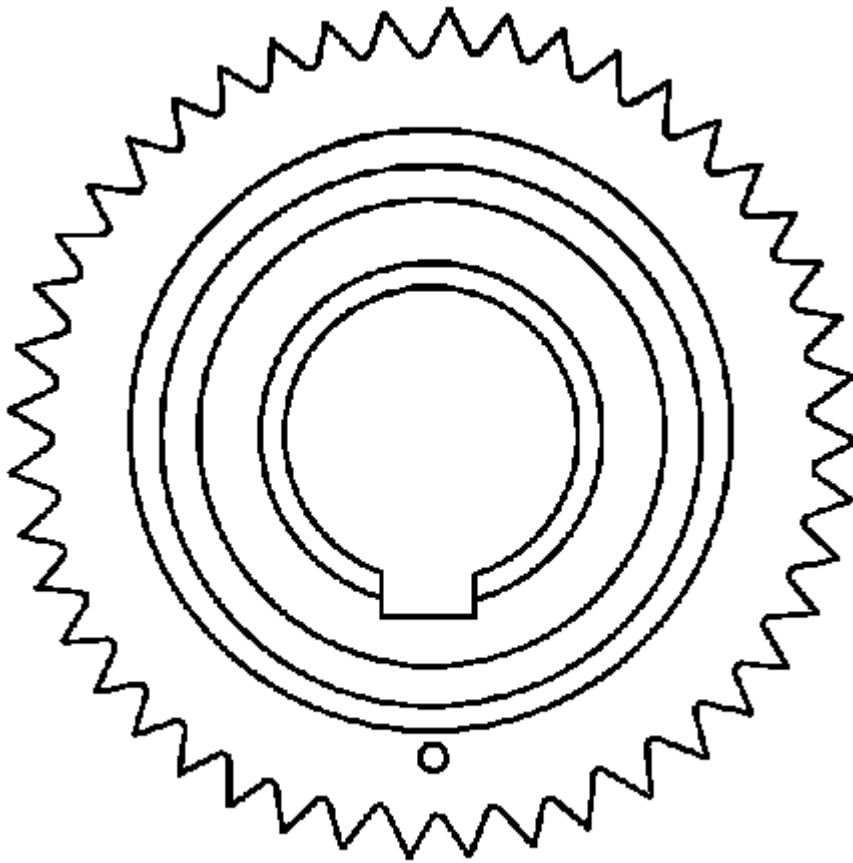


Fig. 266: View Of Balance Shaft Driven Gear Timing Mark
Courtesy of GENERAL MOTORS CORP.

12. Rotate the balance shaft so that the timing mark on the balance shaft driven gear is in the 6 o'clock position.

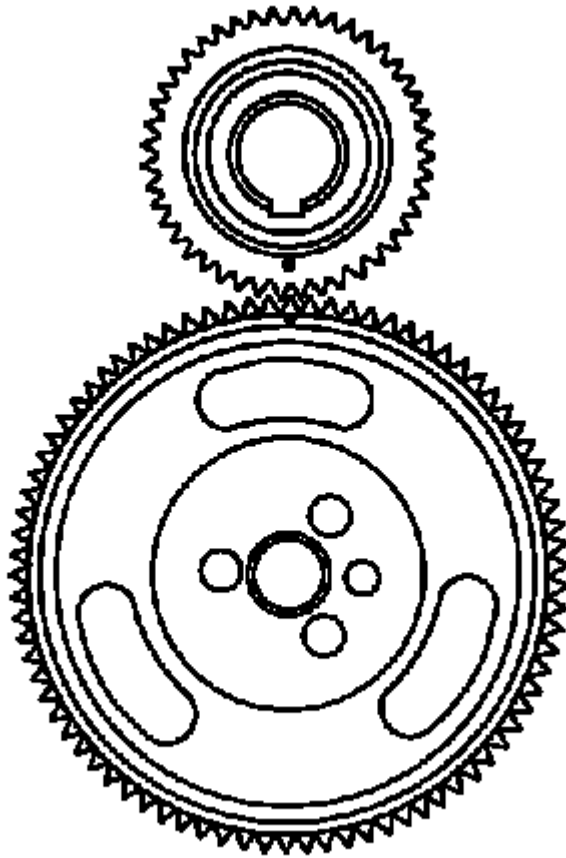


Fig. 267: Aligning Balance Shaft Drive Gear & Balance Shaft Driven Gear
Courtesy of GENERAL MOTORS CORP.

13. Position the balance shaft drive gear onto the engine camshaft.
14. Look to ensure that the balance shaft drive gear and the balance shaft driven gear timing marks are aligned.
15. Install the timing chain and the camshaft sprocket. Refer to **Timing Chain and Sprockets Replacement**.
16. Install the valve lifter pushrod guide. Refer to **Valve Lifter Replacement**.
17. Install the A/C condenser. Refer to **CONDENSER REPLACEMENT**.
18. Install the radiator. Refer to **RADIATOR REPLACEMENT**.

BALANCE SHAFT BEARING AND/OR BUSHING REPLACEMENT

Tools Required

- J 26941 Bushing and Bearing Remover
- J 38834 Balance Shaft Service Kit

Removal Procedure

IMPORTANT: The balance shaft and the front bearing are serviced only as a package. Do not remove the bearing from the balance shaft.

1. Remove the balance shaft. Refer to **Balance Shaft Replacement**.
2. Using J 26941 and the J 38834 , remove the balance shaft rear bearing.

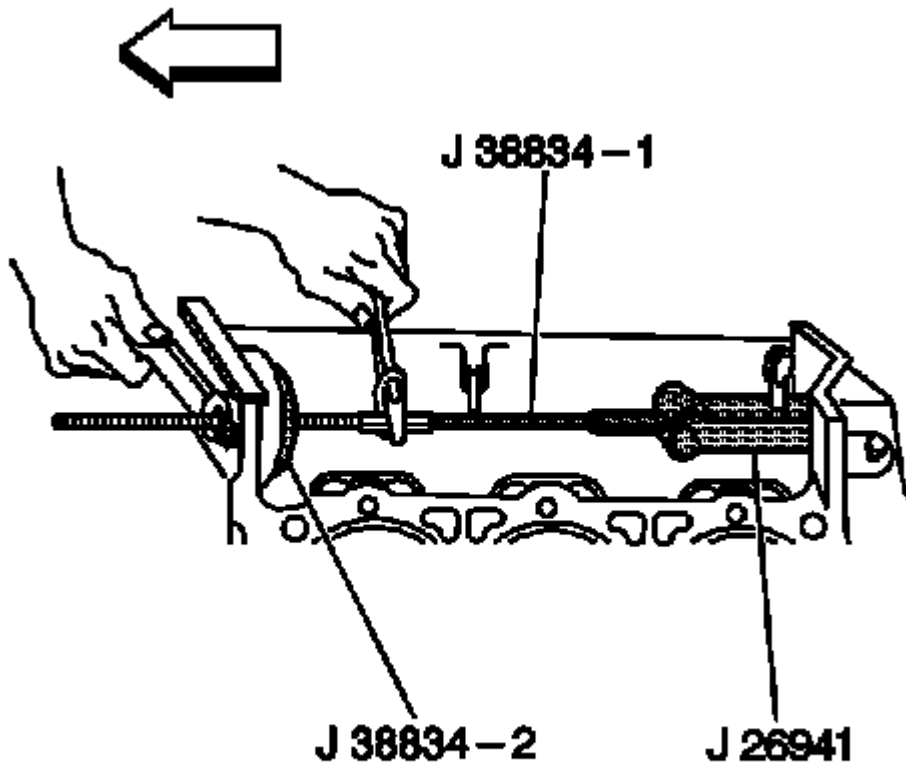


Fig. 268: Removing The Balance Shaft Rear Bearing Using J 38834, J 38834-1 & J 26941
Courtesy of GENERAL MOTORS CORP.

1. Install the J 26941 legs behind the balance shaft rear bearing and secure.
2. Install the J 38834-1 with the short threaded end through the balance shaft bore in the front of the engine block.
3. Install J 38834-1 into the J 26941 .
4. Slide the J 38834-2 onto the J 38834-1 and into the balance shaft bore of the engine block.
5. Install the **J 38834** bearing, washer, and nut onto the J 38834-1.
6. Using a wrench, secure the J 38834-1, and then rotate the **J 38834** nut clockwise until the balance shaft rear bearing is removed from the engine block.
7. Remove the J 26941 from the balance shaft rear bearing.

3. Discard the balance shaft rear bearing.

Installation Procedure

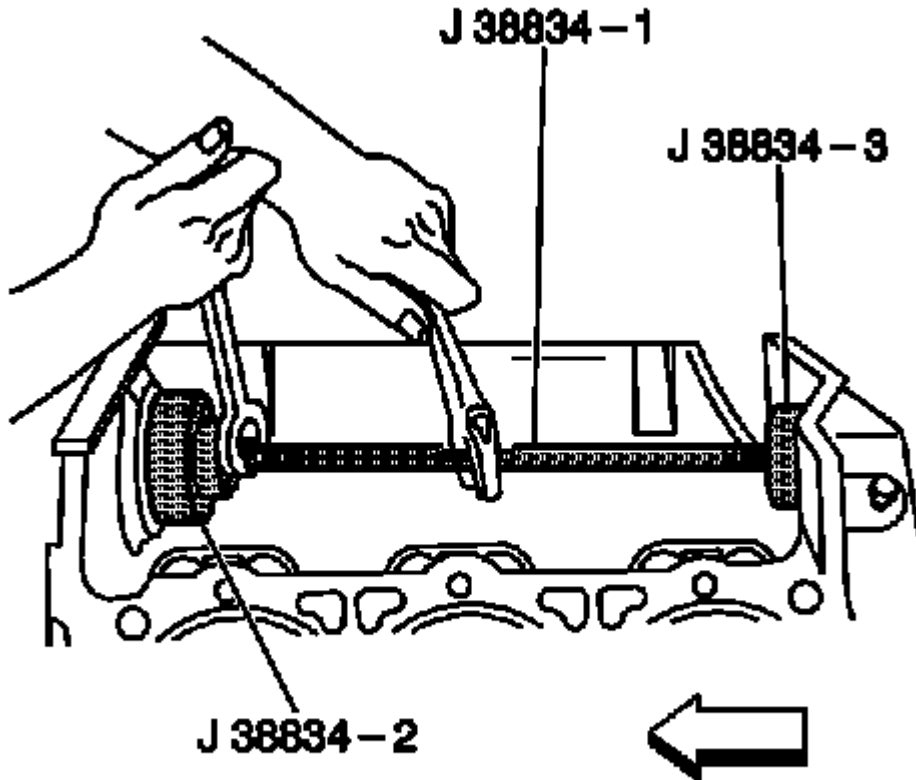


Fig. 269: Installing Balance Shaft Rear Bearing Using J 38834, J 38834-1 & J 38834-2
Courtesy of GENERAL MOTORS CORP.

1. Using **J 38834** , install the balance shaft rear bearing.
 1. Install the J 38834-3 onto the short threaded end of the J 38834-1.
 2. Install the **J 38834** nut, the washer, and the bearing on the long threaded end of the J 38834-1.
 3. Install the J 38834-2 onto the J 38834-1 so that the smaller diameter of the J 38834-2 will be facing the front of the engine block.
 4. Install the J 38834-2 on the inside of the balance shaft front bearing bore.
 5. Lubricate the NEW balance shaft rear bearing with clean engine oil.
 6. Install the balance shaft rear bearing onto the J 38834-2.
 7. Align the balance shaft rear bearing for installation.
 8. Using a wrench, secure the J 38834-1 into place.
 9. Rotate the **J 38834** nut until the balance shaft rear bearing is properly and completely pushed into

the balance shaft rear bearing bore.

2. Remove the **J 38834**.
3. Install the balance shaft. Refer to **Balance Shaft Replacement**.

CAMSHAFT REPLACEMENT

Removal Procedure

1. Remove the radiator. Refer to **RADIATOR REPLACEMENT**.
2. Remove the air conditioning (A/C) condenser. Refer to **CONDENSER REPLACEMENT**.
3. Remove the lifters. Refer to **Valve Lifter Replacement**.
4. Remove the timing chain and the camshaft sprocket. Refer to **Timing Chain and Sprockets Replacement**.
5. Remove the balance shaft drive gear.

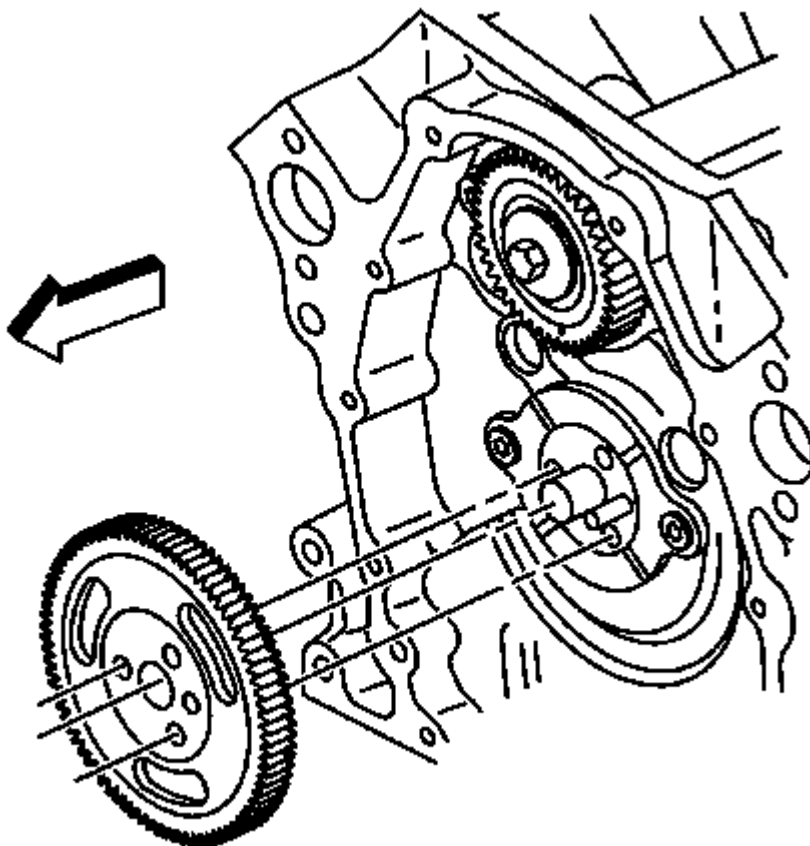


Fig. 270: View Of Balance Shaft Drive Gear
Courtesy of GENERAL MOTORS CORP.

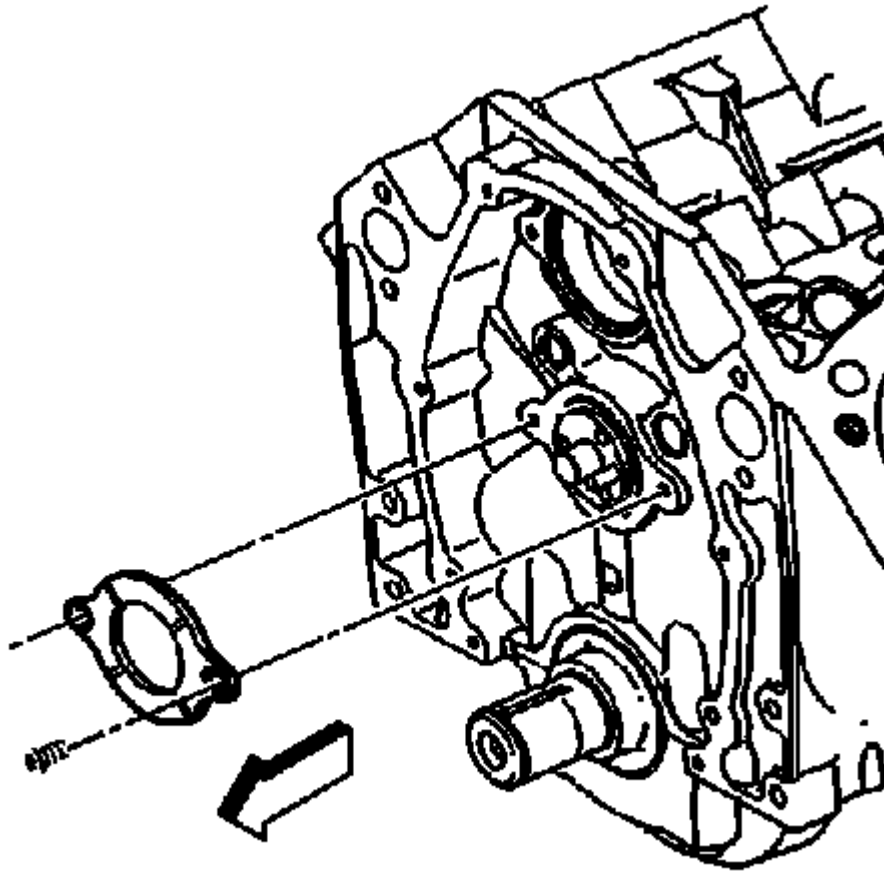


Fig. 271: View Of Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft retainer bolts and retainer.

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.

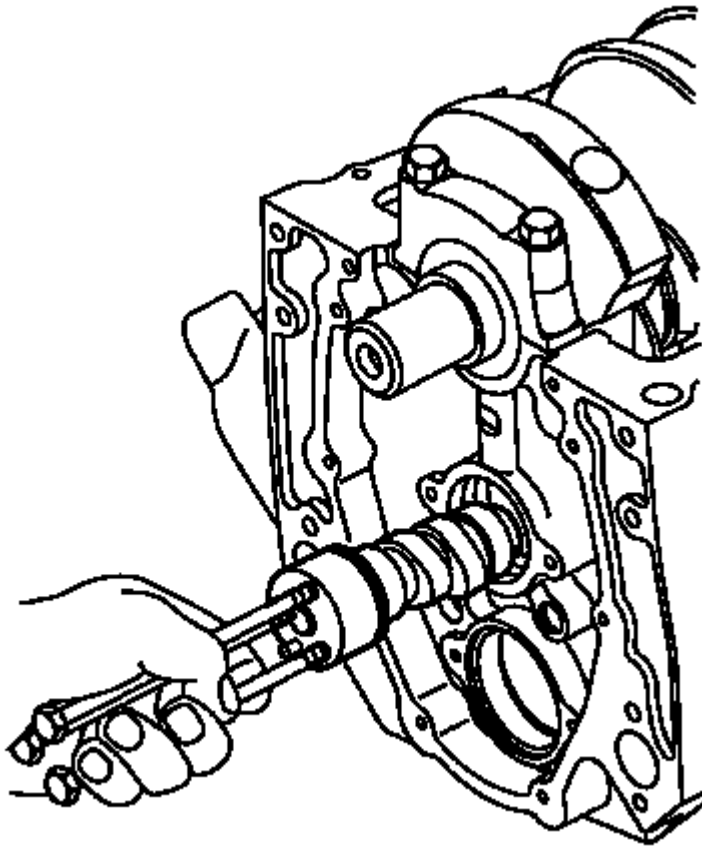


Fig. 272: View Of 5/16-18 X 4.0 Inch Bolts Installed Into Front Of Camshaft
Courtesy of GENERAL MOTORS CORP.

7. Remove the engine camshaft.
 1. Install the three 5/16-18 x 4.0 inch bolts into the engine camshaft front bolt holes.
 2. Using the bolts as a handle, carefully rotate and pull the engine camshaft out of the camshaft bearings.
 3. Remove the bolts from the front of the engine camshaft.
 4. Clean and inspect the camshaft and/or bearings, if necessary. Refer to **CAMSHAFT & BEARINGS -- CLEANING & INSPECTION**.

Installation Procedure

IMPORTANT: Whenever a new camshaft is installed, perform the following:

- **Change the engine oil and filter.**
- **Add engine oil supplement GM U.S. P/N 1052367, Canada P/N 992869, or equivalent to the engine oil.**

1. Apply lubricant GM U.S. P/N 12345501, Canada P/N 992704, or equivalent, or engine oil supplement GM U.S. P/N 1052367, Canada P/N 992869, or equivalent to the following components:

- The engine camshaft lobes
 - The camshaft bearing journals
 - The camshaft bearings
2. Install three 5/16-18 x 4.0 inch bolts into the engine camshaft front bolt holes.

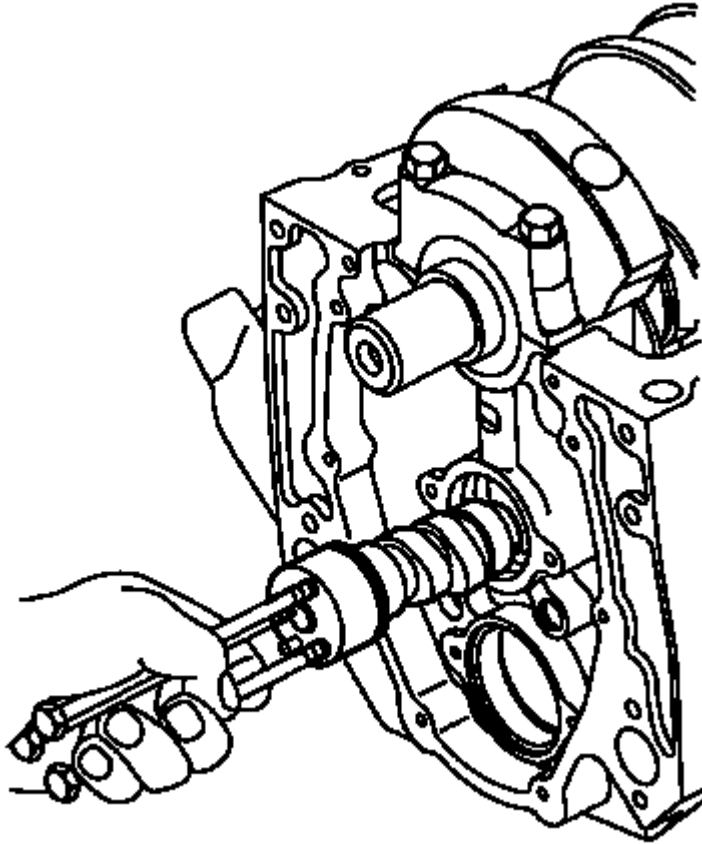


Fig. 273: View Of 5/16-18 X 4.0 Inch Bolts Installed Into Front Of Camshaft
Courtesy of GENERAL MOTORS CORP.

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.

3. Using the bolts as a handle, install the engine camshaft.
4. Remove the 3 bolts from the front of the engine camshaft.

NOTE: Refer to **FASTENER NOTICE** .

5. If reusing the fasteners, apply threadlock GM P/N 12345382 or equivalent to the threads of the camshaft retainer bolts.
6. Install the camshaft retainer and bolts.

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

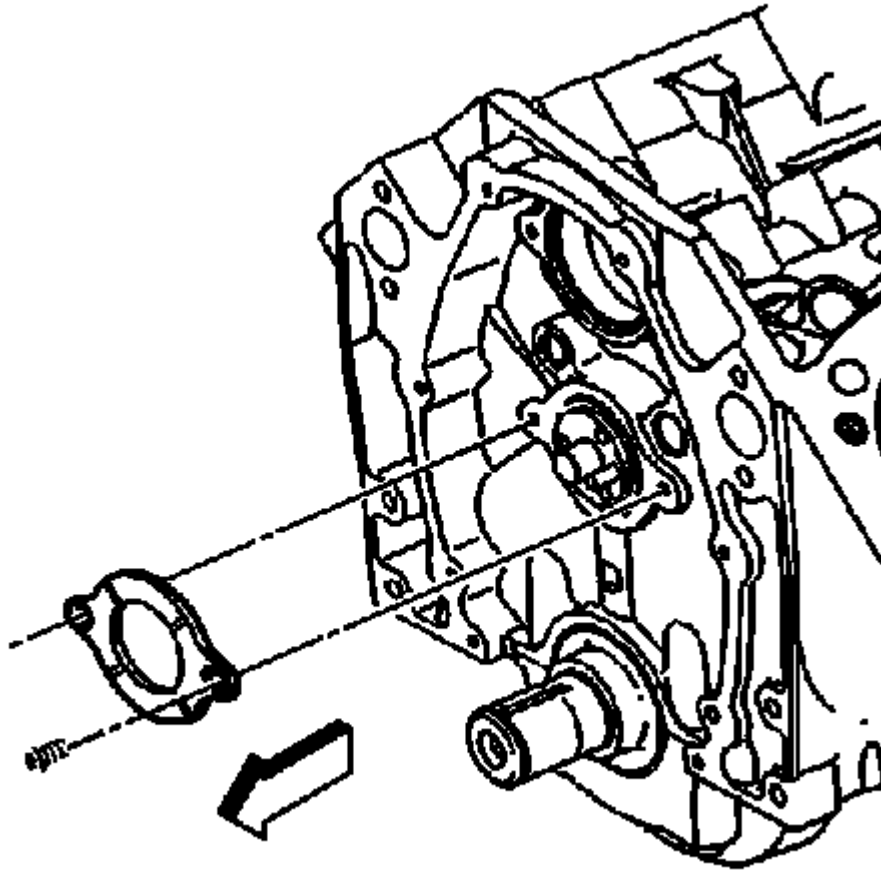


Fig. 274: View Of Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the balance shaft drive gear. Refer to BALANCE SHAFT INSTALLATION , for alignment of the balance shaft drive gear and the driven gear.
8. Install the timing chain and camshaft sprocket. Refer to Timing Chain and Sprockets Replacement.
9. Install the lifters. Refer to Valve Lifter Replacement.
10. Install the A/C condenser. Refer to CONDENSER REPLACEMENT .
11. Install the radiator. Refer to RADIATOR REPLACEMENT .

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to LIFTING AND JACKING THE VEHICLE .
2. Remove the oil pan drain plug and drain the oil into a suitable container.

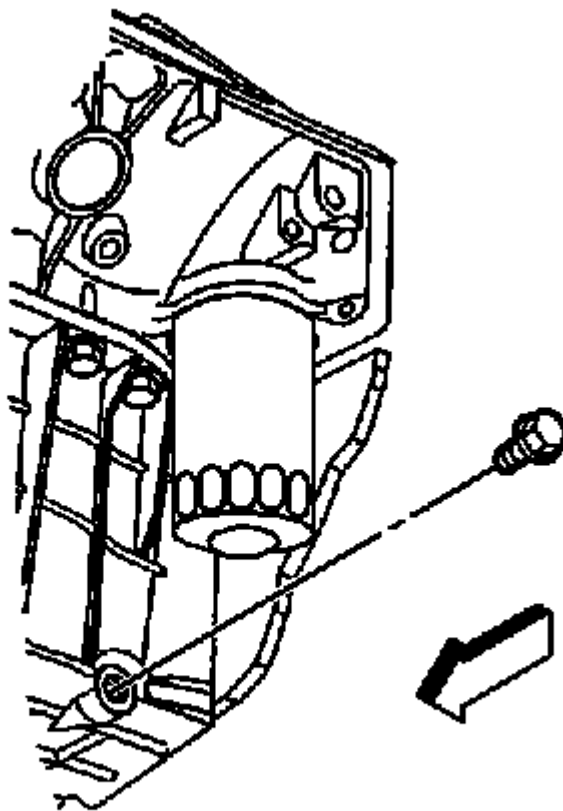


Fig. 275: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

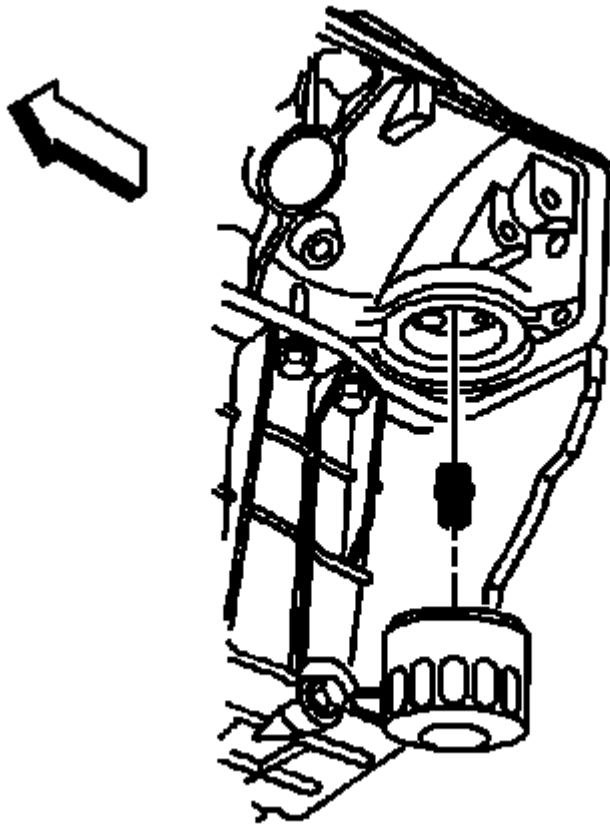


Fig. 276: View Of Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter.
4. Remove the oil filter adapter.

Installation Procedure

NOTE: Refer to FASTENER NOTICE .

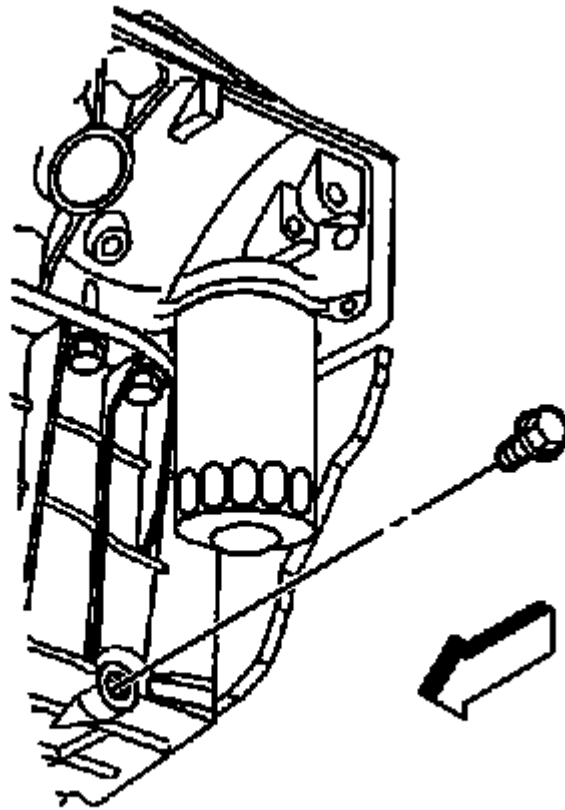


Fig. 277: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pan drain plug into the drain pan.

Tighten: Tighten the oil pan drain plug to 25 N.m (18 lb ft).

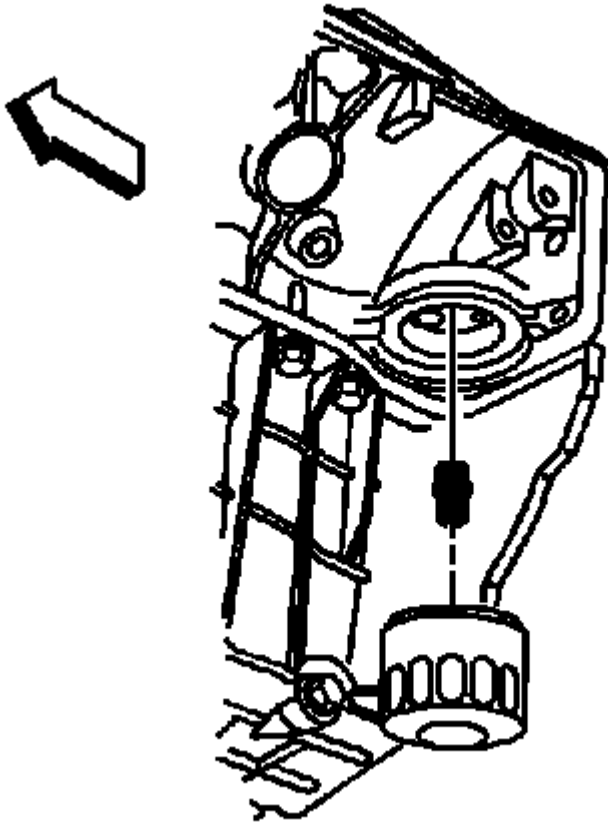


Fig. 278: View Of Oil Filter & Adapter
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter adapter.

Tighten: Tighten the oil filter adapter to 55 N.m (41 lb ft).

3. Install the oil filter

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

4. Lower the vehicle.
5. Fill the engine with the proper quantity and quality of engine oil.

OIL FILTER BYPASS VALVE REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
2. Position a suitable container under the vehicle to catch the oil.
3. Remove the oil filter.

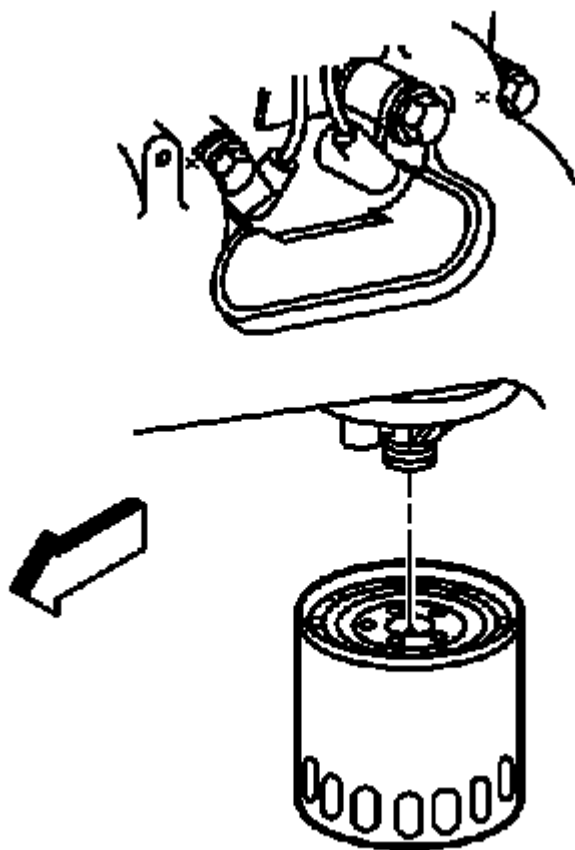


Fig. 279: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

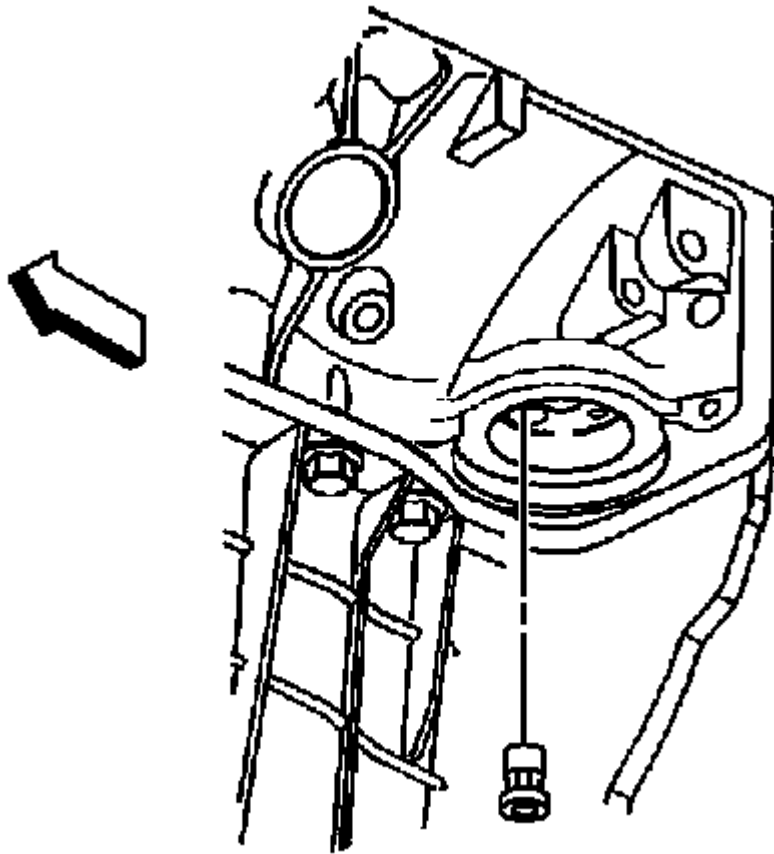


Fig. 280: View Of Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

4. Using a suitable prying tool, remove the oil filter bypass valve.
5. Clean and inspect the valve bore for damage.

Installation Procedure

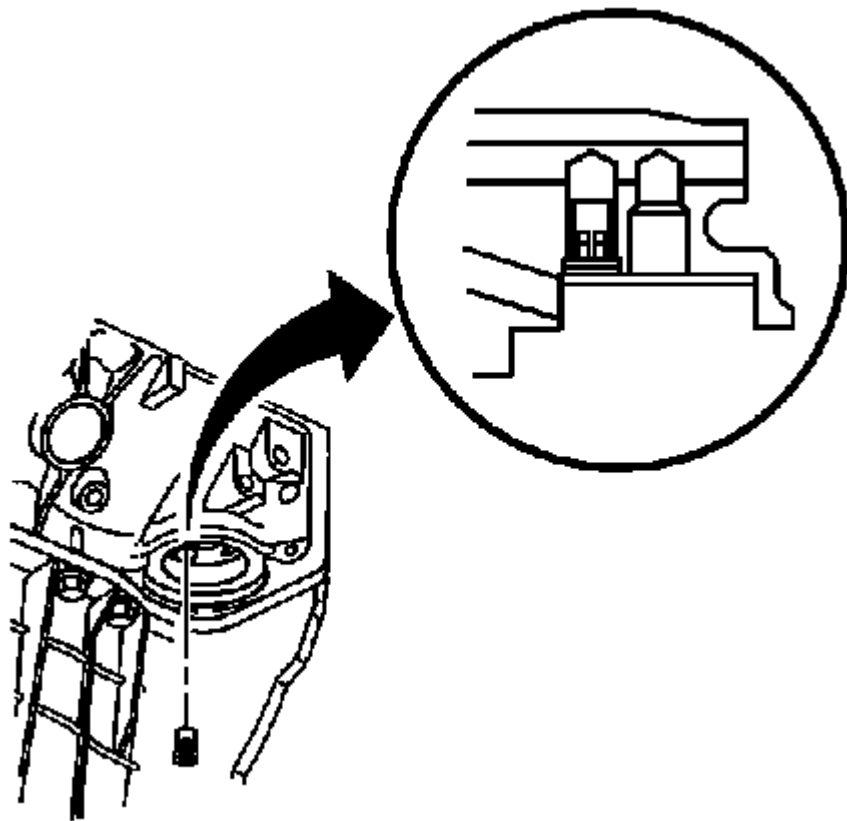


Fig. 281: Installing New Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil filter bypass valve using the following procedure:
 1. Use a brass drift that is the same diameter as the outside diameter of the oil filter bypass valve.
 2. Install the oil filter bypass valve into the oil gallery bore until slightly below flush with the surface of the engine block.
 3. Using a pointed punch, stake the engine block area around the oil filter bypass valve.

Stake in 3 locations 120 degrees apart.

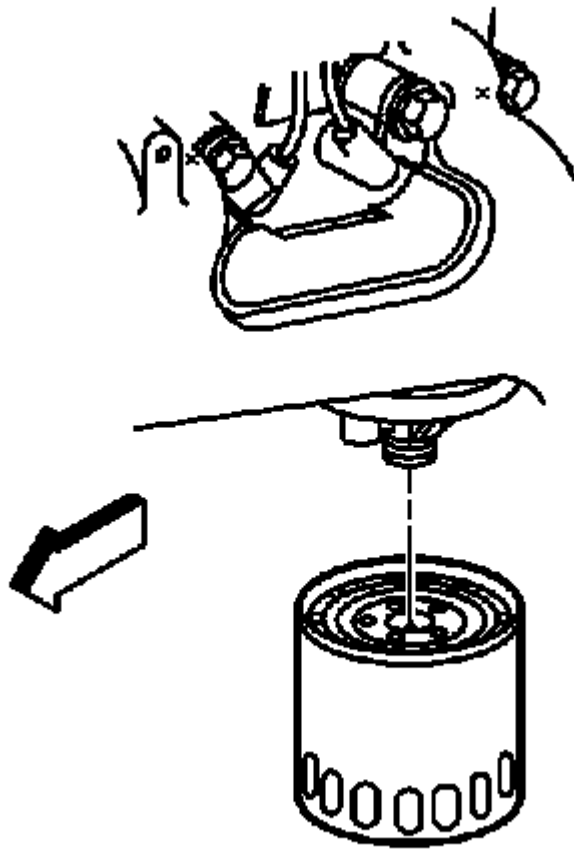


Fig. 282: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
3. Lower the vehicle.

OIL PAN REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
2. If equipped, remove the oil pan skid plate bolts and plate.

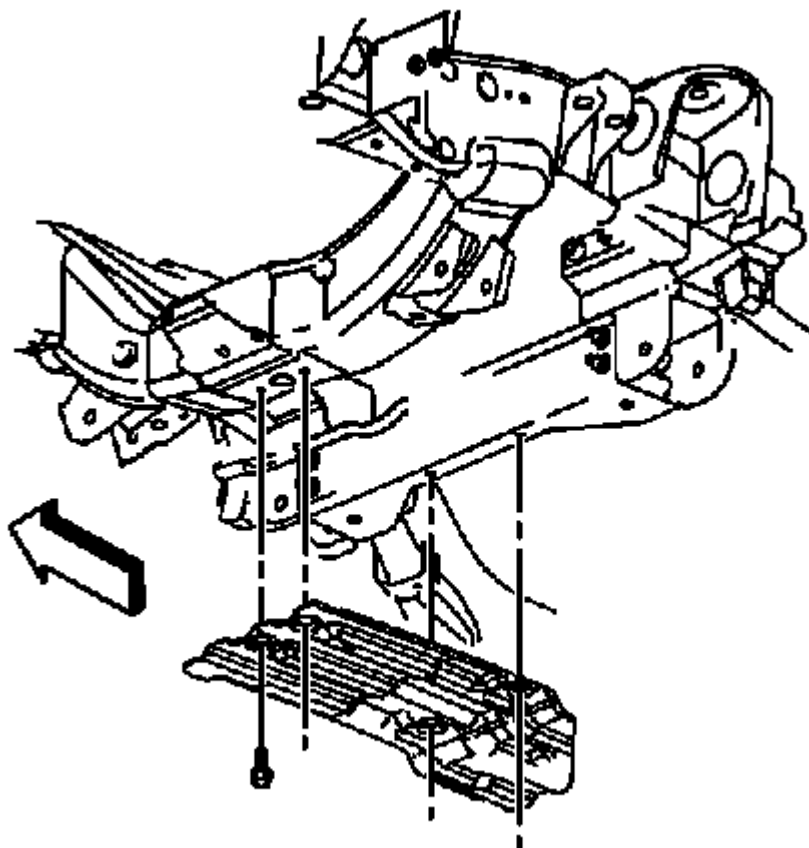


Fig. 283: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

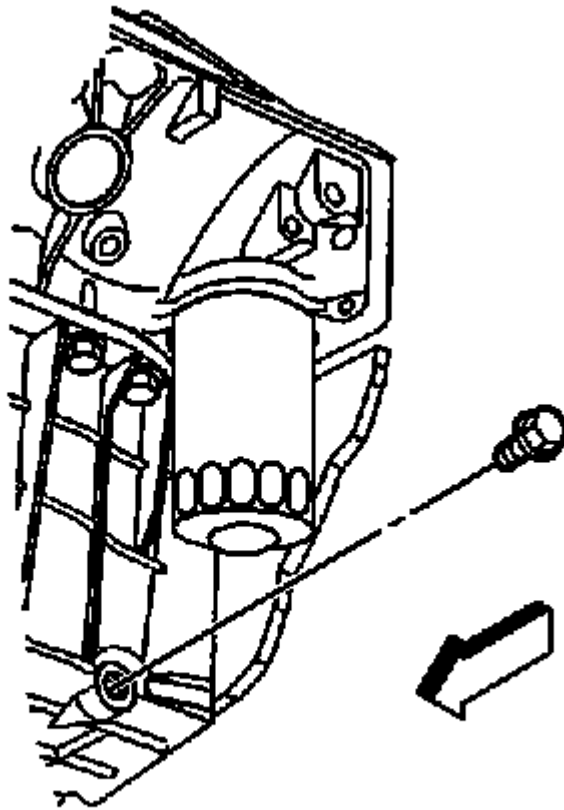


Fig. 284: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan drain plug and drain the oil into a suitable container.

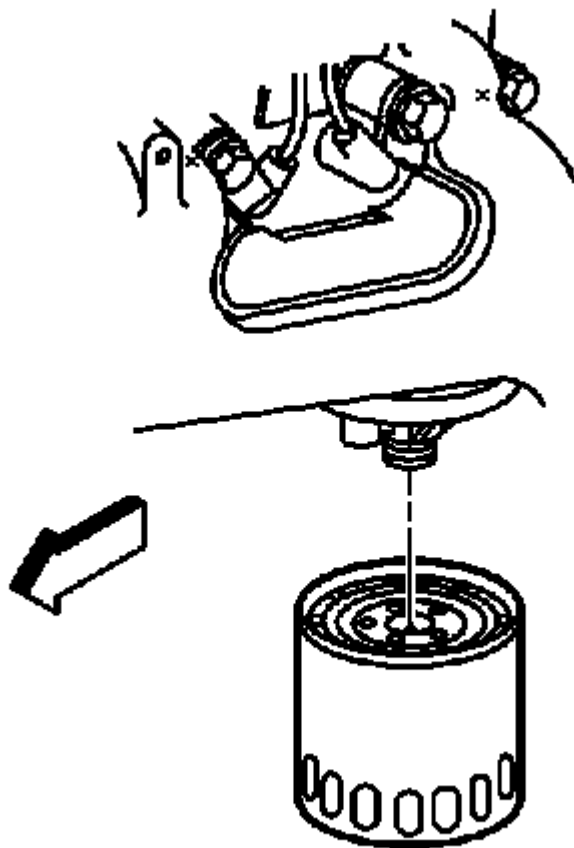


Fig. 285: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filter.

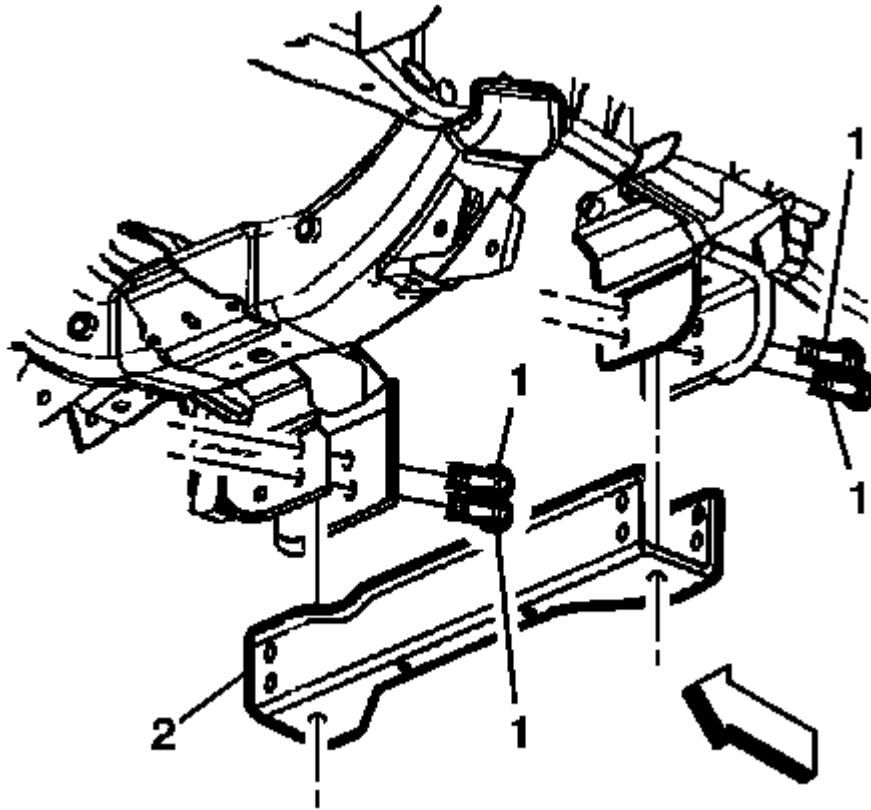


Fig. 286: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

5. If equipped with 2 wheel drive (2WD), remove the crossbar bolts and bar.

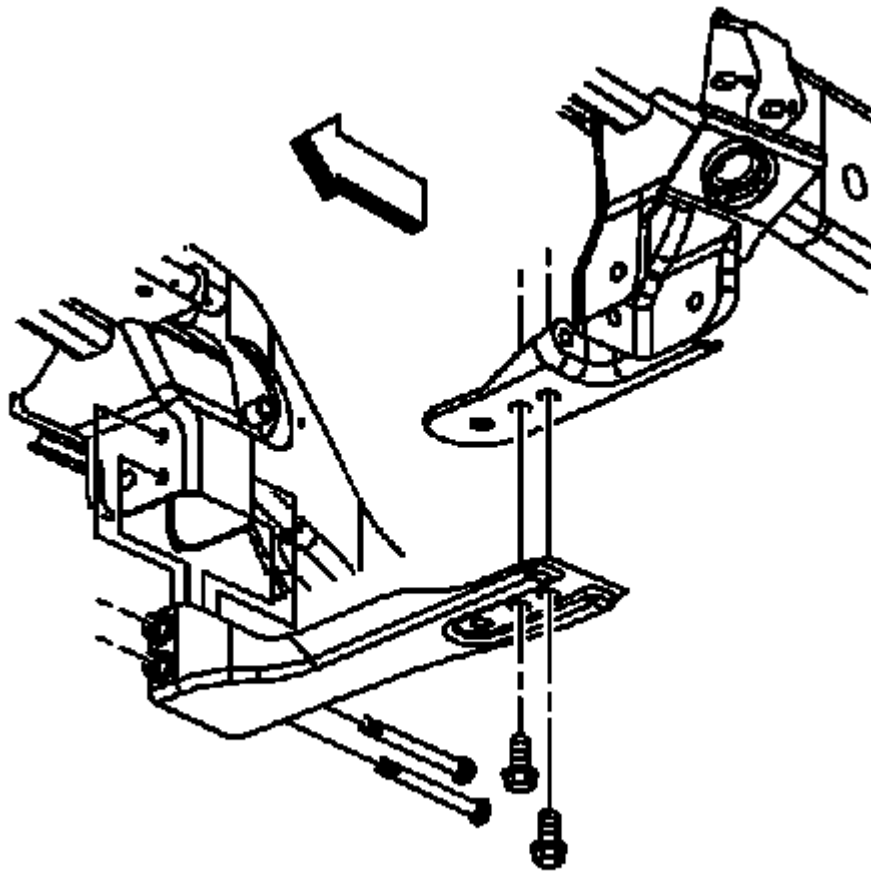


Fig. 287: View Of Crossmember Bolts & Bar (4WD Only)
Courtesy of GENERAL MOTORS CORP.

6. If equipped with 4 wheel drive (4WD), remove the crossbar bolts and bar.
7. If equipped with 4WD, remove the front differential carrier. Refer to **REAR DRIVE AXLE** .

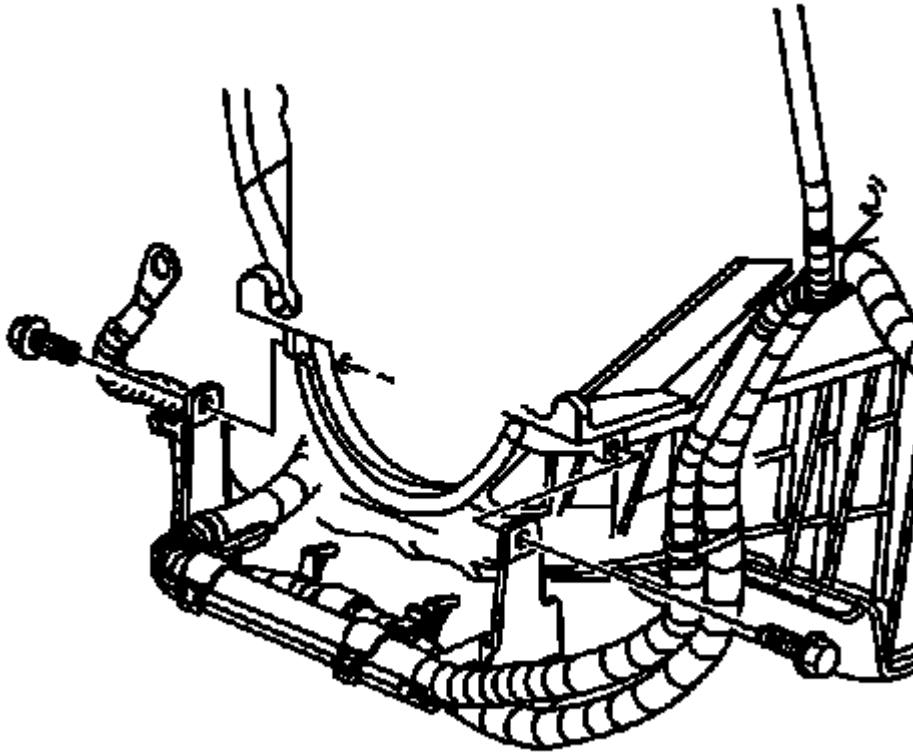
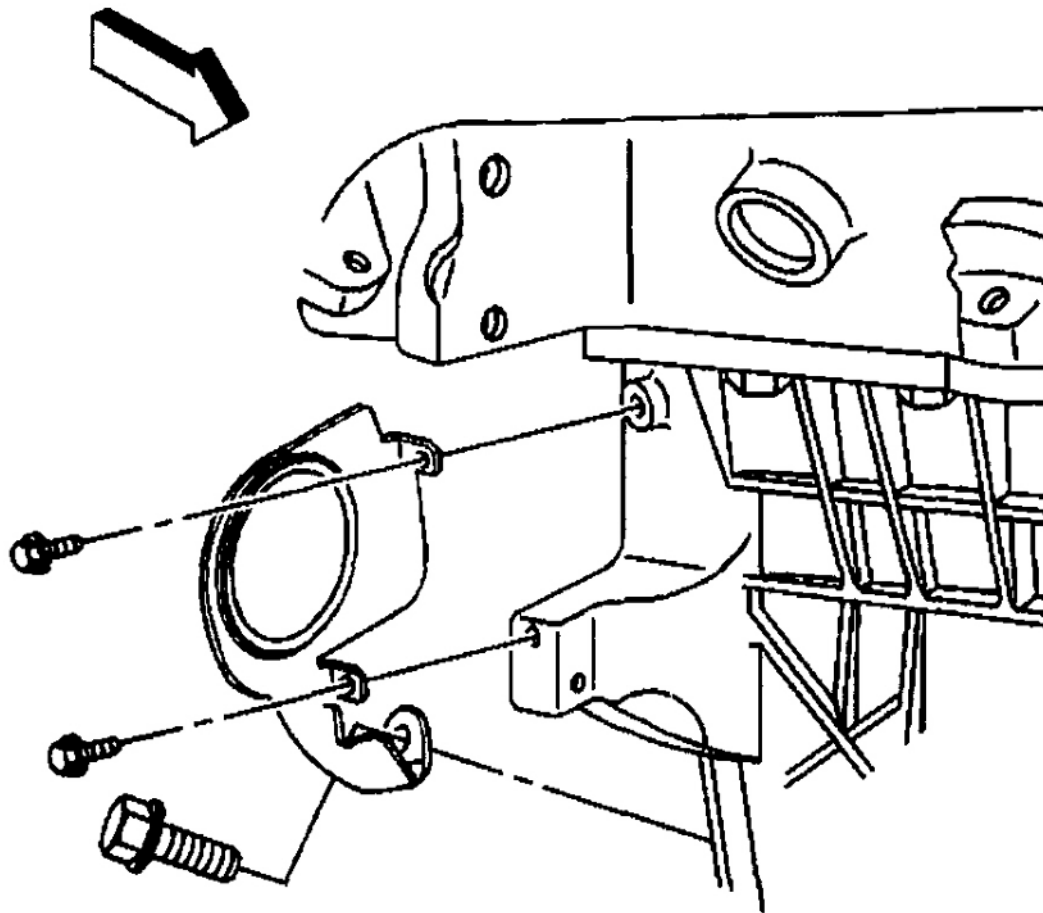


Fig. 288: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

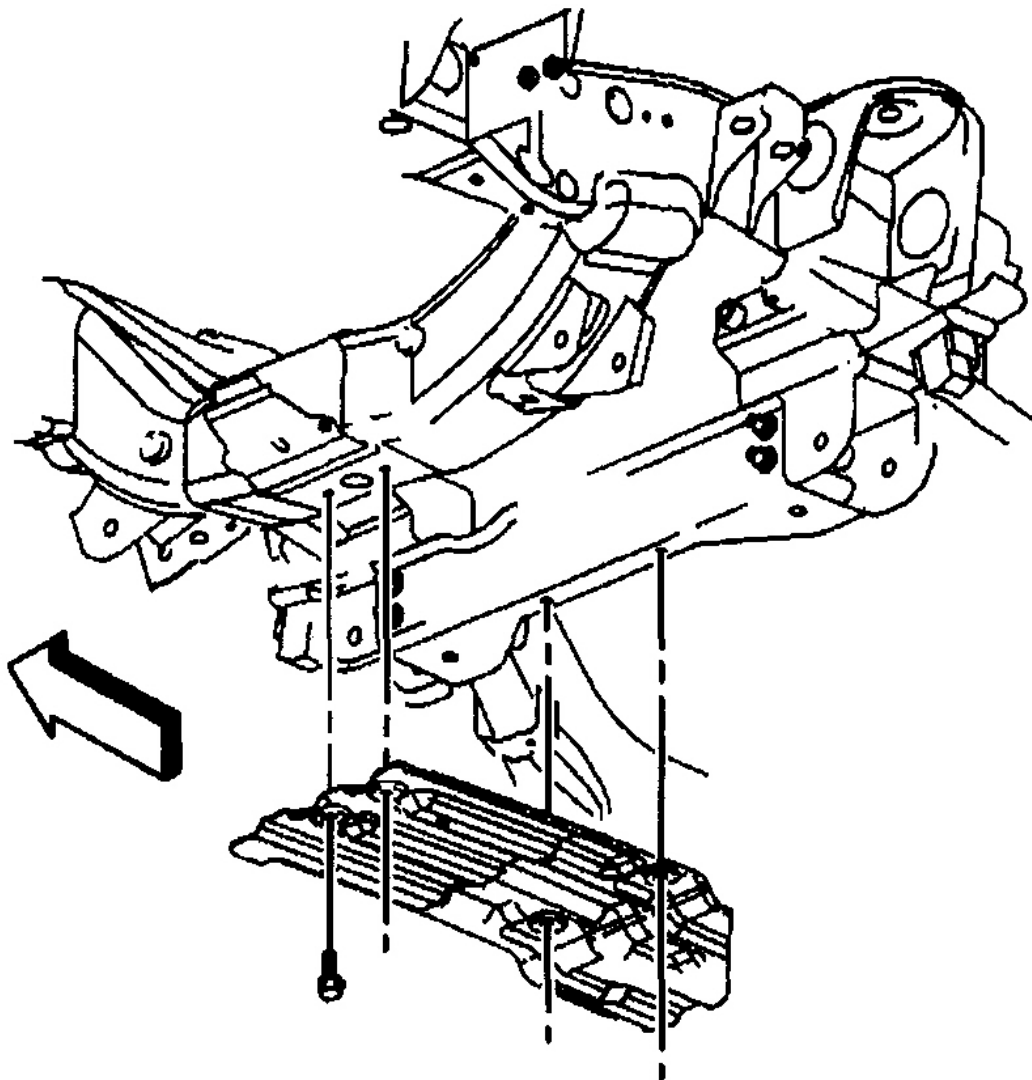
8. Remove the battery cable bracket bolts.
9. Remove the starter. Refer to **STARTER**.



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Fig. 289: View Of Transmission Cover Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the transmission cover.



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Fig. 290: View Of Transmission Oil Cooler Liner Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the transmission oil cooler liner bracket bolt, if equipped.

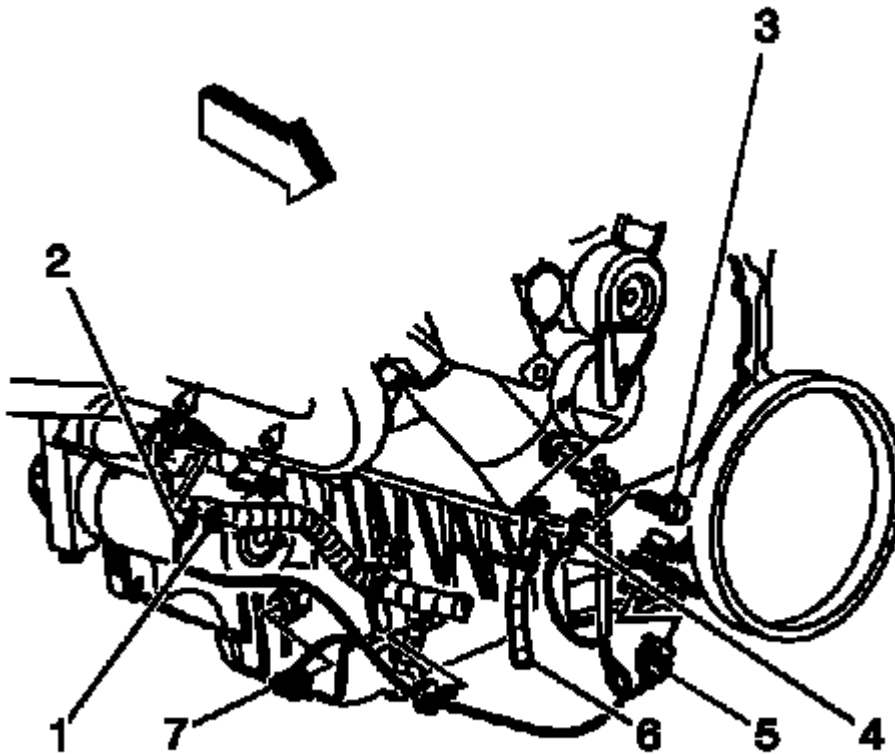


Fig. 291: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

12. Disconnect the low oil level sensor electrical connector (7).

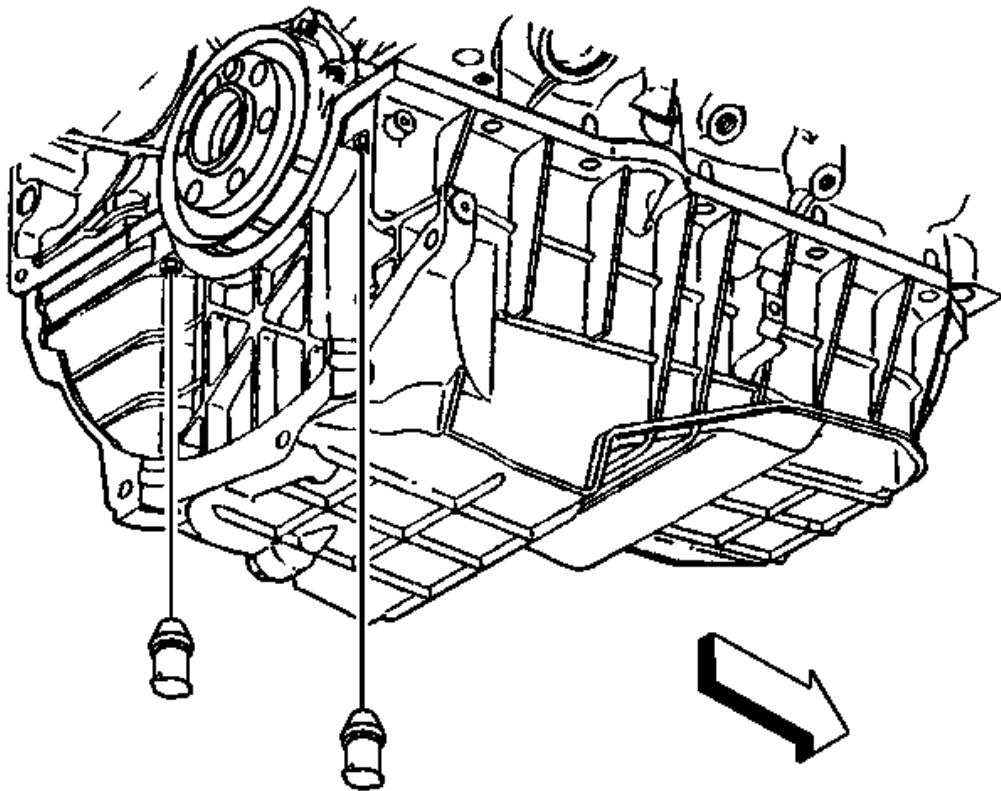
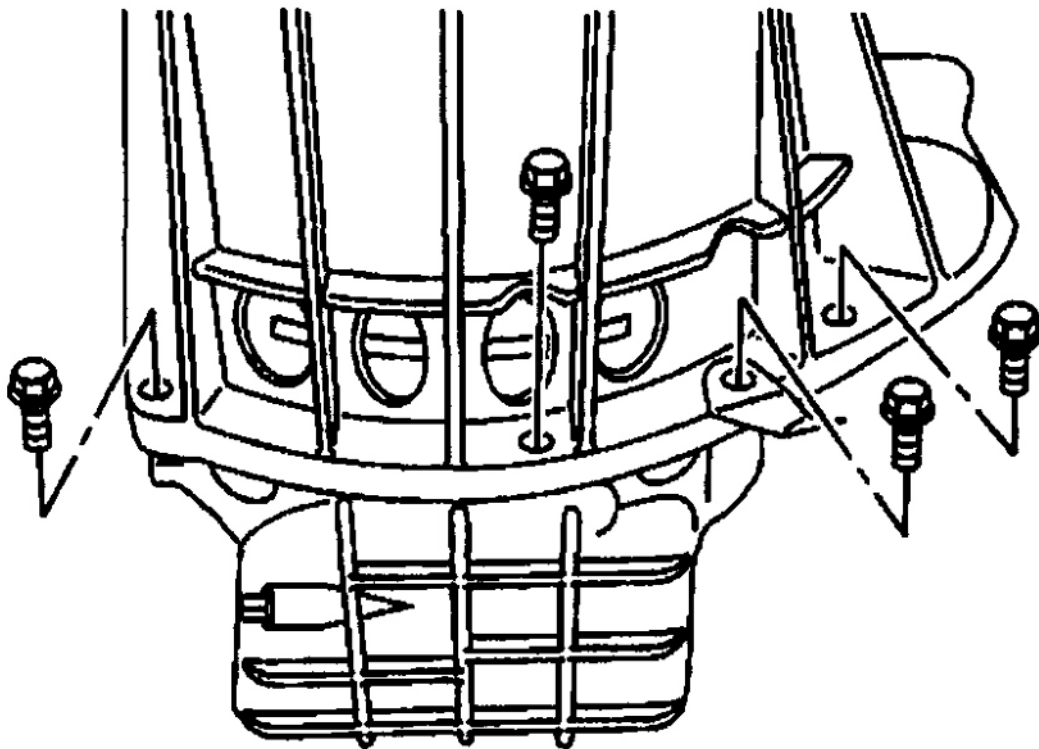


Fig. 292: View Of Access Plugs For Oil Pan Rear Nuts
Courtesy of GENERAL MOTORS CORP.

13. Remove the access plugs for the oil pan rear nuts.



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Fig. 293: View Of Transmissions Bolts (M/T Shown)
Courtesy of GENERAL MOTORS CORP.

14. Remove the transmission bolts (manual transmission shown).

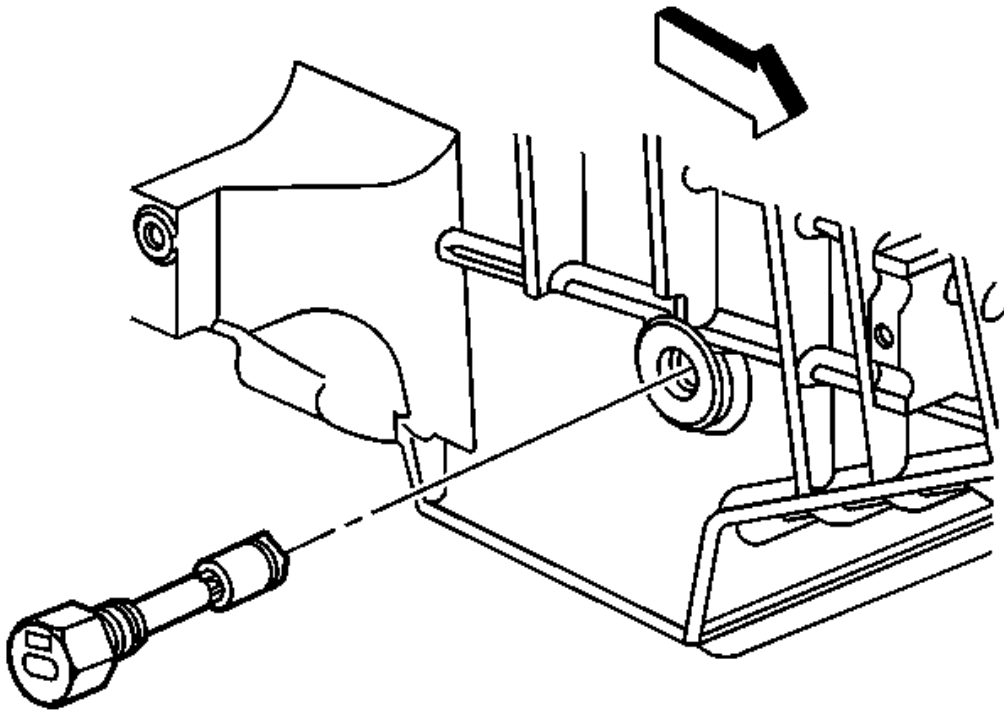


Fig. 294: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The low oil level sensor is not reusable.

15. Remove and discard the engine oil level sensor.

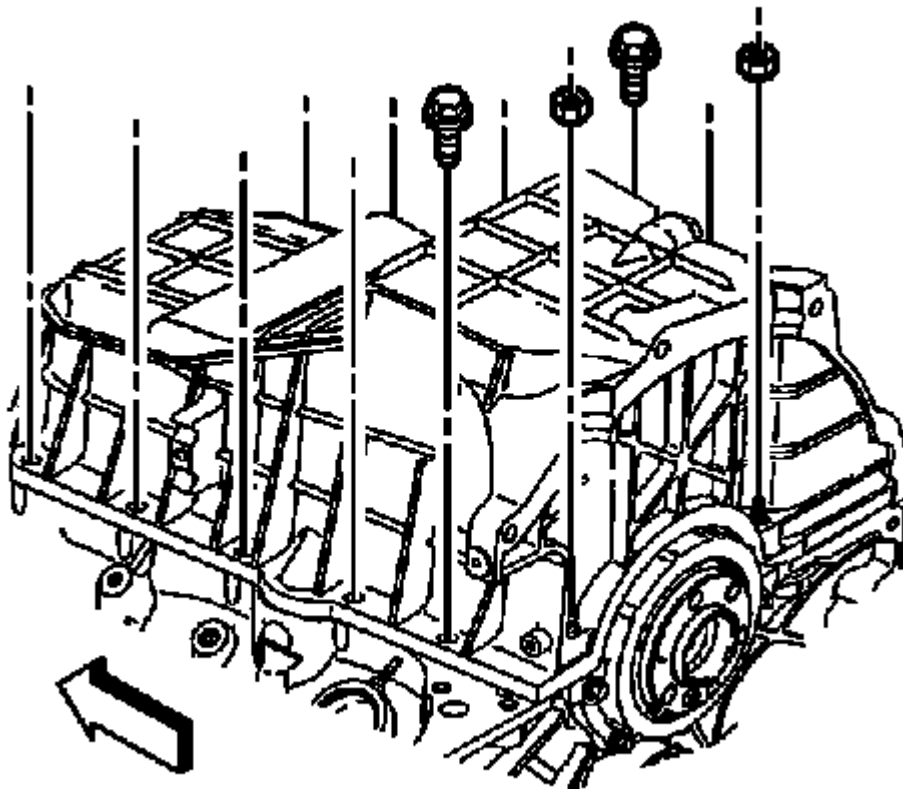


Fig. 295: View Of Oil Pan Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

16. Remove the oil pan bolts and nuts.

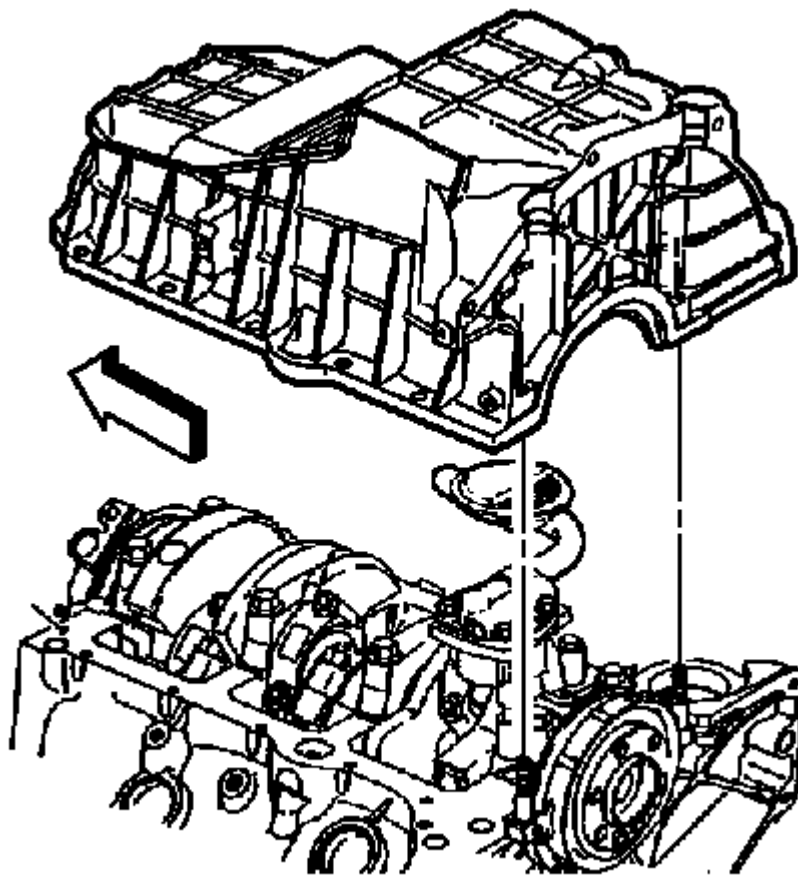


Fig. 296: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

17. Remove the oil pan.

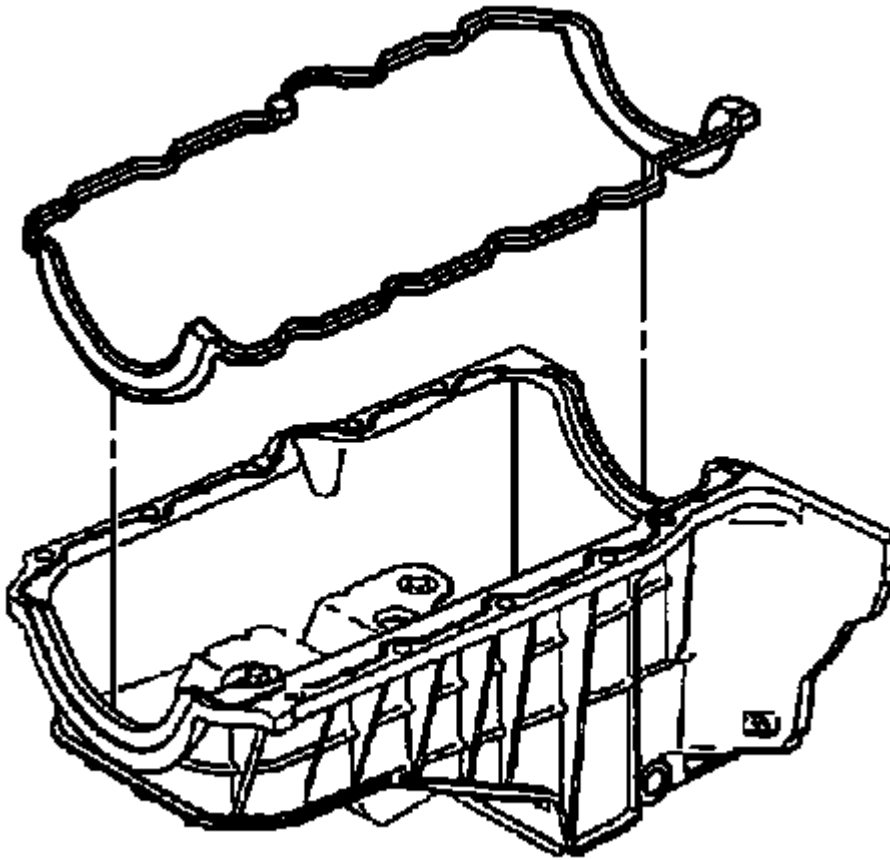


Fig. 297: View Of Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

18. Remove and discard the oil pan gasket.
19. Clean and inspect the oil pan, if necessary. Refer to OIL PAN CLEANING & INSPECTION .

Installation Procedure

NOTE: Any time the transmission and the engine oil pan are off of the engine at the same time, install the transmission before the oil pan. This is to allow for the proper oil pan alignment. Failure to achieve the correct oil pan alignment can result in transmission failure.

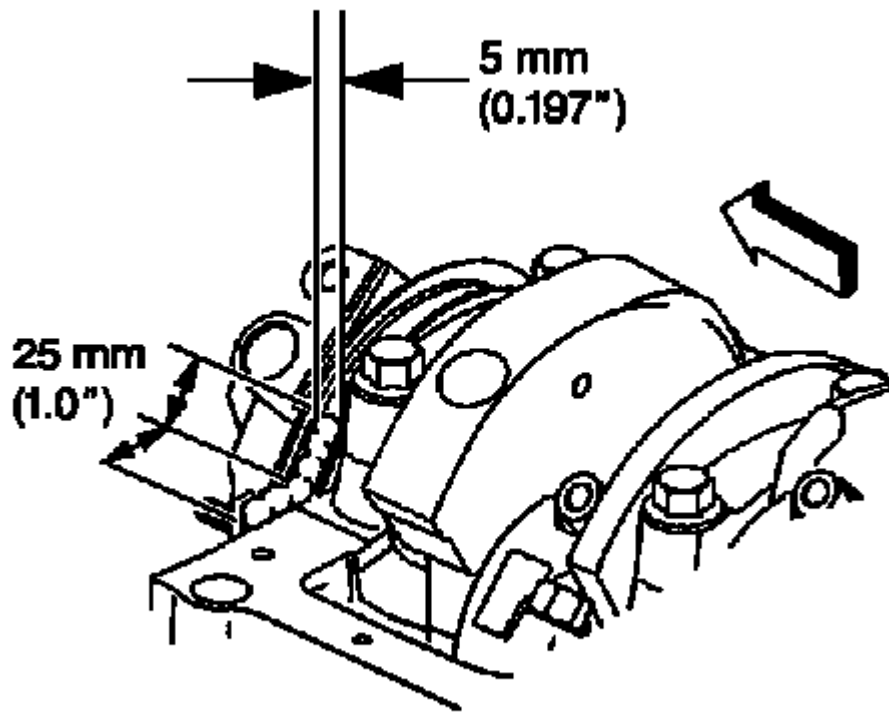


Fig. 298: Applying Adhesive To Right & Left Sides Of Front Cover To Engine Block Junction
Courtesy of GENERAL MOTORS CORP.

1. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent to both the right and left sides of the front cover to engine block junction at the oil pan sealing surfaces.

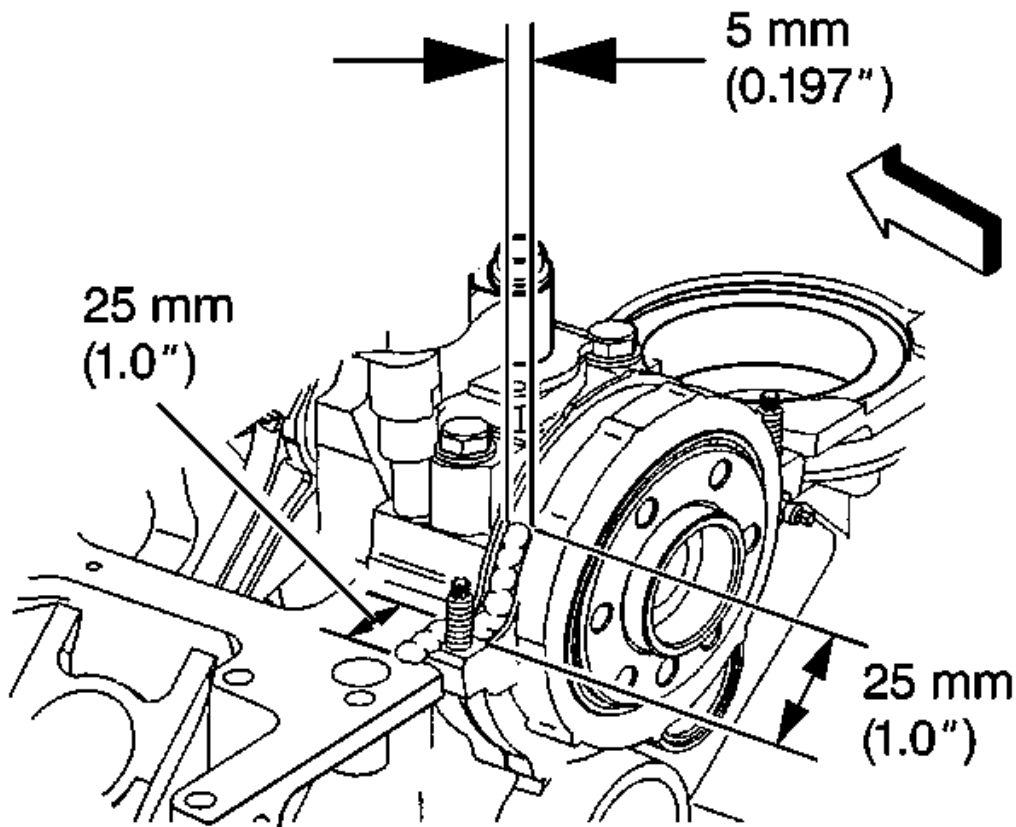


Fig. 299: Applying Adhesive To Right & Left Sides Of Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

2. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM U.S. P/N 12346141, Canada P/N 10953433, or equivalent to both the right and left sides of the rear oil seal housing to engine block junction at the oil pan sealing surfaces.

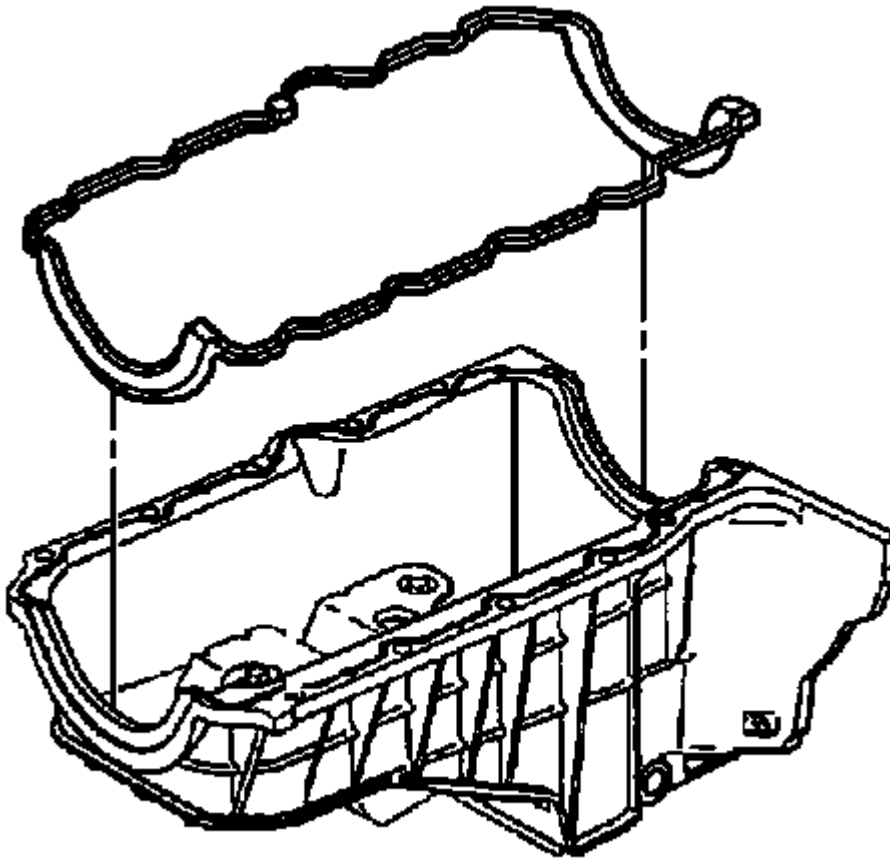


Fig. 300: View Of Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Always install a **NEW** oil pan gasket.
The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

3. Install the **NEW** oil pan gasket into the groove in the oil pan.

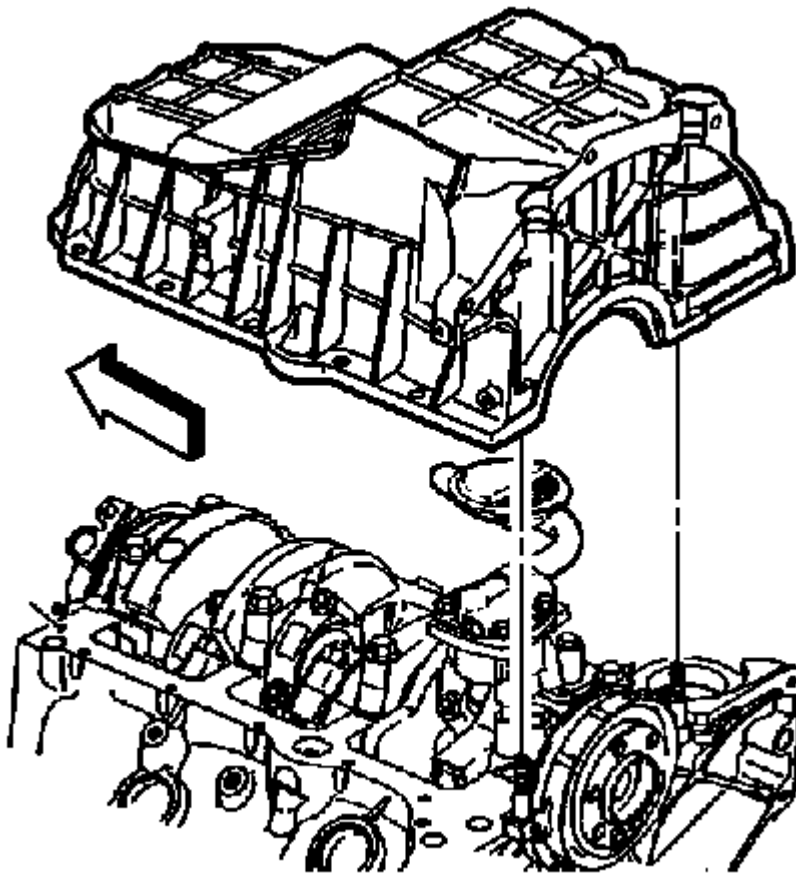


Fig. 301: View Of Oil Pan

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The oil pan alignment must always be flush or forward no more than 0.3 mm (0.011 in) from the rear face of the engine block.

4. Install the oil pan onto the engine block.

Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.

5. Slide the oil pan back against a suitable straight edge.

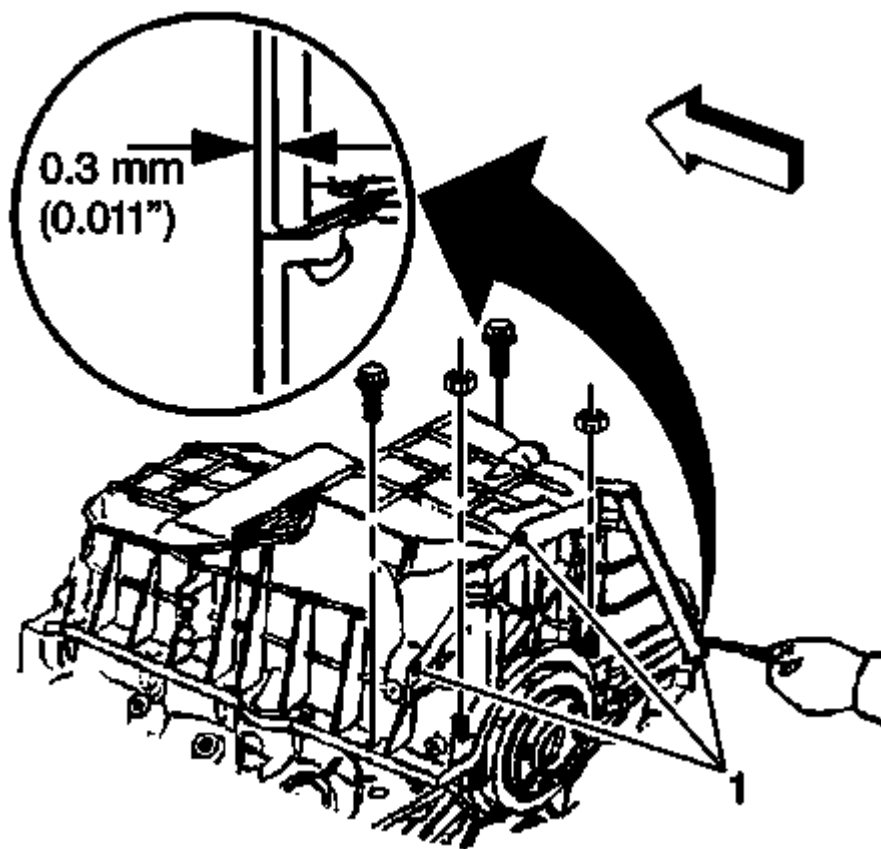


Fig. 302: View Of Oil Pan-To-Transmission Housing Measurement Points
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan bolts and nuts until snug.
7. Measure the pan-to-transmission housing clearance using a feeler gage and a straight edge.

Use a feeler gage to check the clearance between the oil pan-to-transmission housing measurement points. If the clearance exceeds 0.3 mm (0.011 in) at any of the 3 oil pan-to-transmission housing measurement points (1), then repeat the step until the oil pan-to-transmission housing clearance is within the specification. The oil pan must always be forward of the rear face of the engine block.

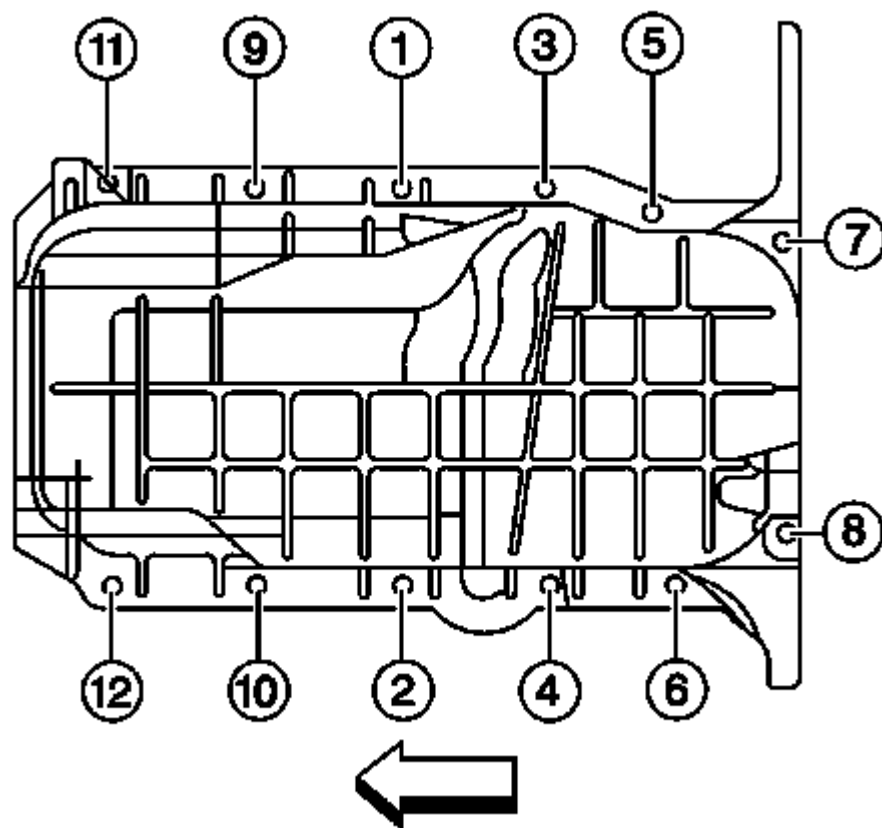


Fig. 303: View Of Tightening Sequence For Oil Pan Nuts & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

8. Tighten the oil pan bolts and nuts in the sequence shown.

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

9. Measure the clearance between the 3 oil pan-to-transmission housing measurement points in order to ensure proper alignment.

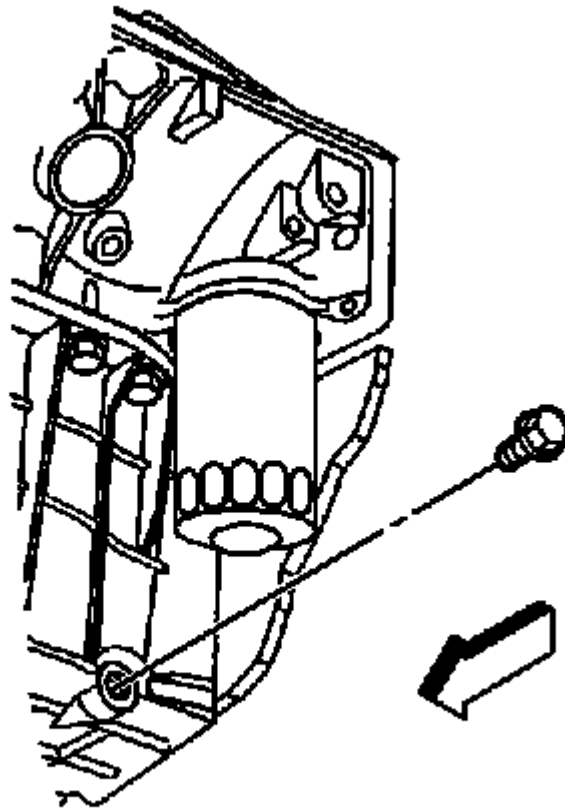


Fig. 304: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

10. Install a NEW oil pan drain plug O-ring seal onto the oil pan drain plug.
11. Install the oil pan drain plug into the oil pan.

Tighten: Tighten the oil pan drain plug to 25 N.m (18 lb ft).

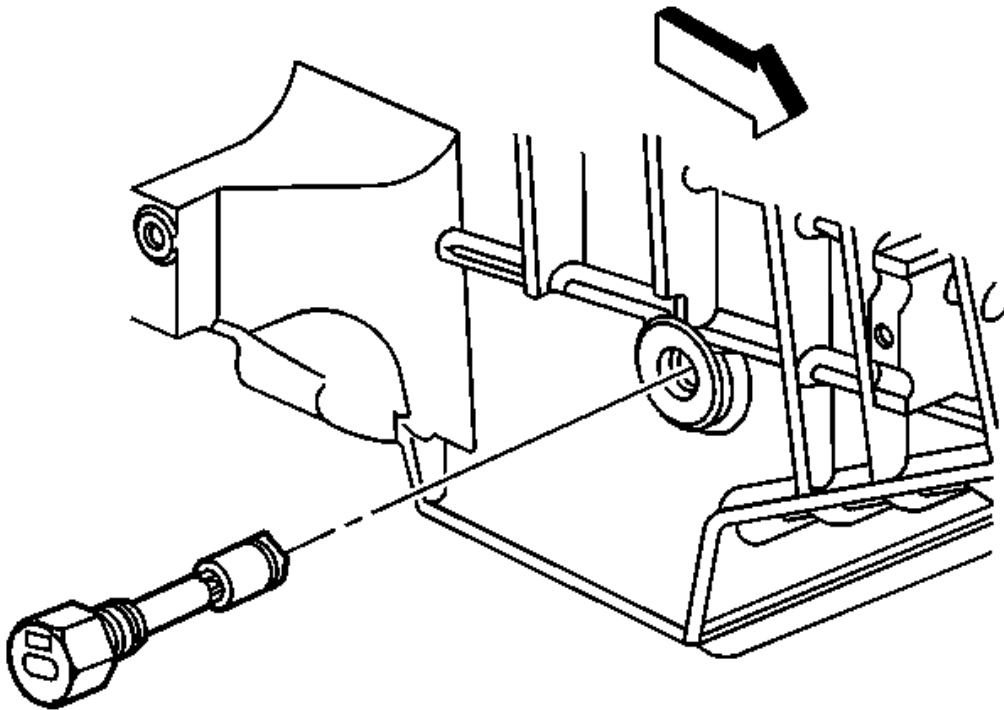
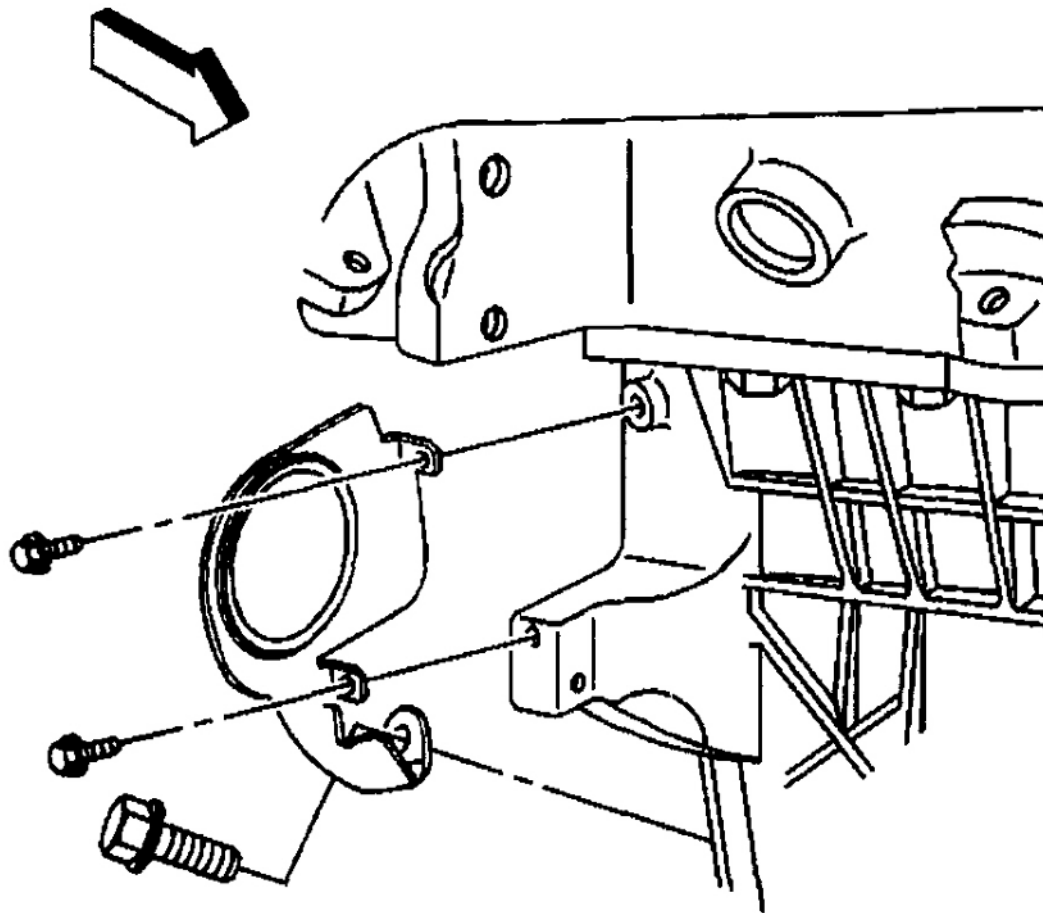


Fig. 305: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The low oil level sensor is not reusable. Use a NEW low oil sensor.

12. Install a NEW engine oil level sensor.

Tighten: Tighten the engine oil level sensor to 13 N.m (115 lb in).

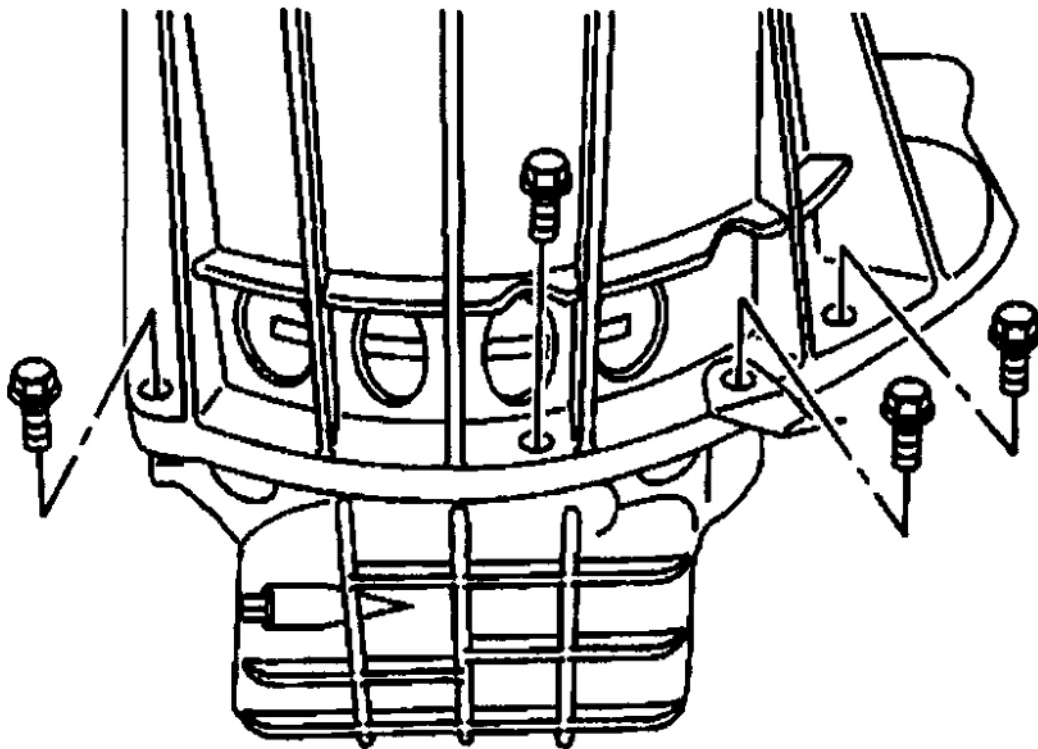


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Fig. 306: View Of Transmission Cover Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the transmission cover.

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



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Fig. 307: View Of Transmissions Bolts (M/T Shown)
Courtesy of GENERAL MOTORS CORP.

14. Install the transmission bolts (manual transmission shown).

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

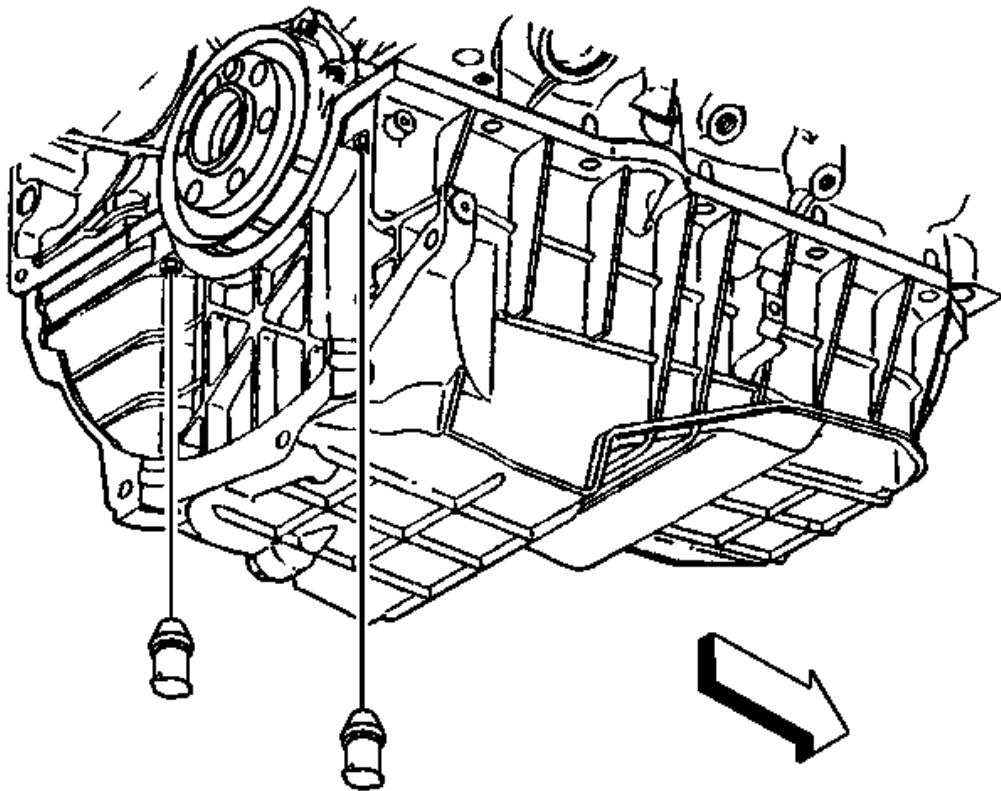
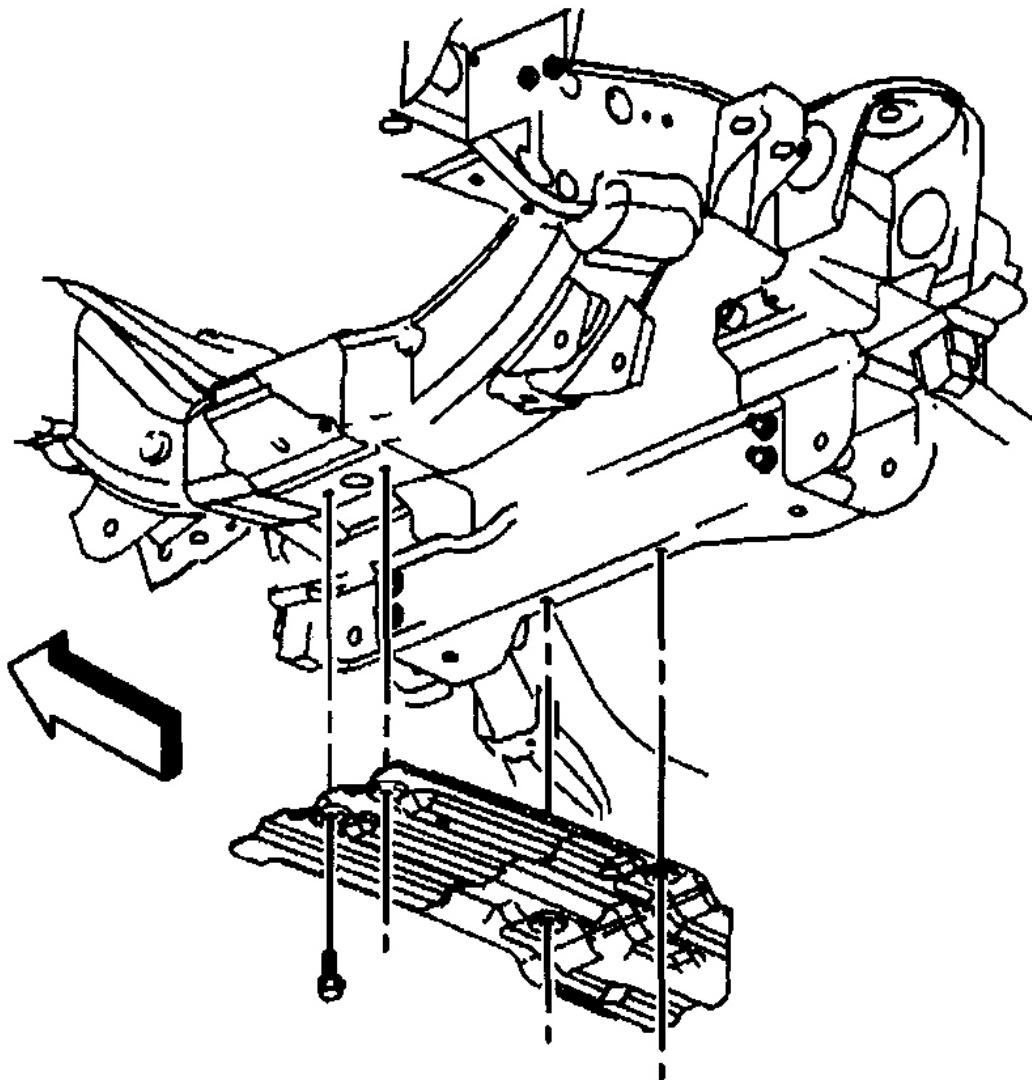


Fig. 308: View Of Access Plugs For Oil Pan Rear Nuts
Courtesy of GENERAL MOTORS CORP.

15. Install the access plugs for the oil pan rear nuts,



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Fig. 309: View Of Transmission Oil Cooler Liner Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

16. Install the transmission oil cooler line bracket bolt, if equipped.

Tighten: Tighten the transmission oil cooler line bracket bolt to 9 N.m (80 lb in).

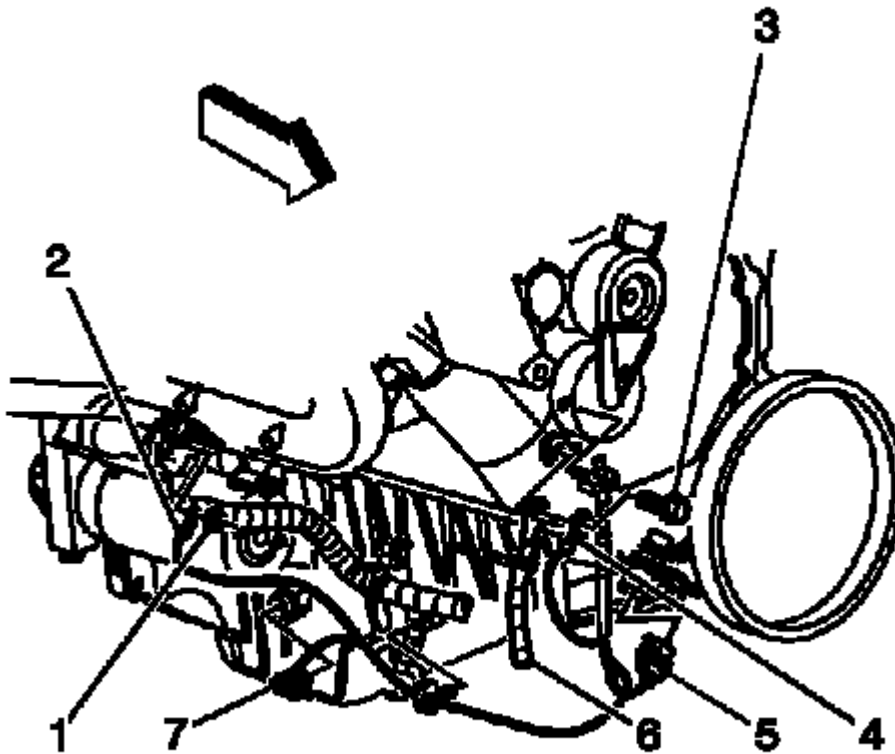


Fig. 310: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

17. Install the starter. Refer to **STARTER** .
18. Connect the low oil level sensor electrical connector (7).

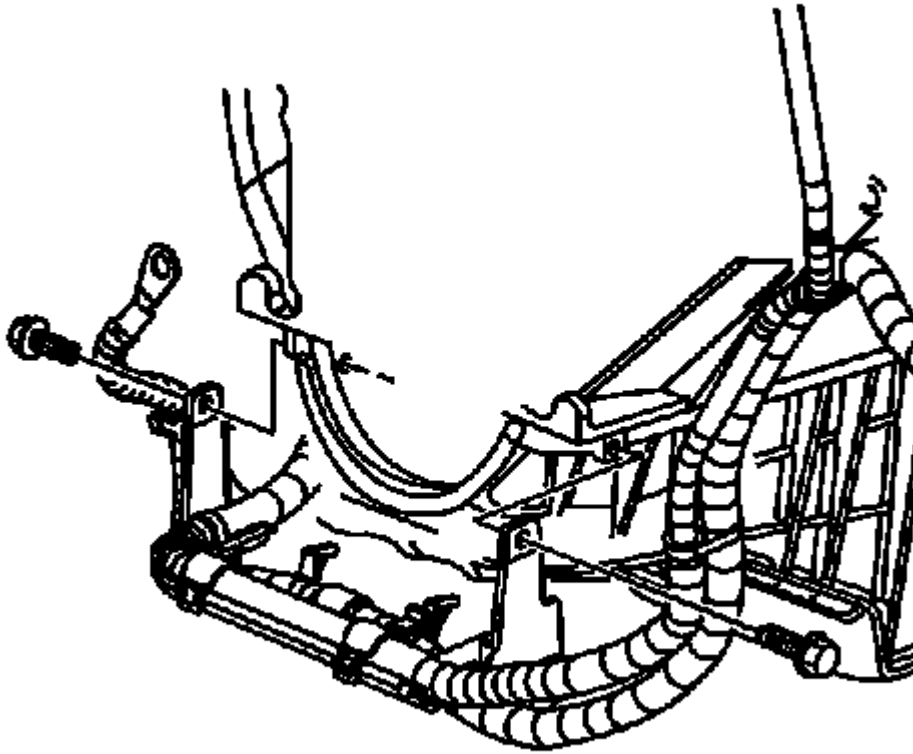


Fig. 311: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the battery cable bracket bolts.

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

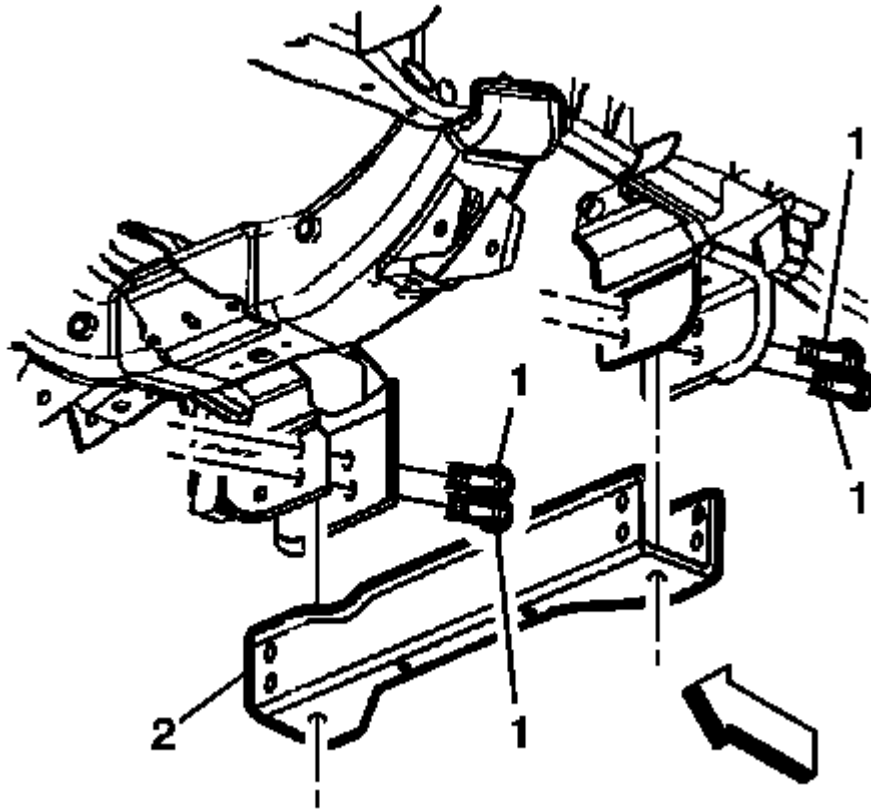


Fig. 312: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

20. If equipped with 2WD, install the crossbar and bolts.

Tighten: Tighten the crossbar bolts to 100 N.m (74 lb ft).

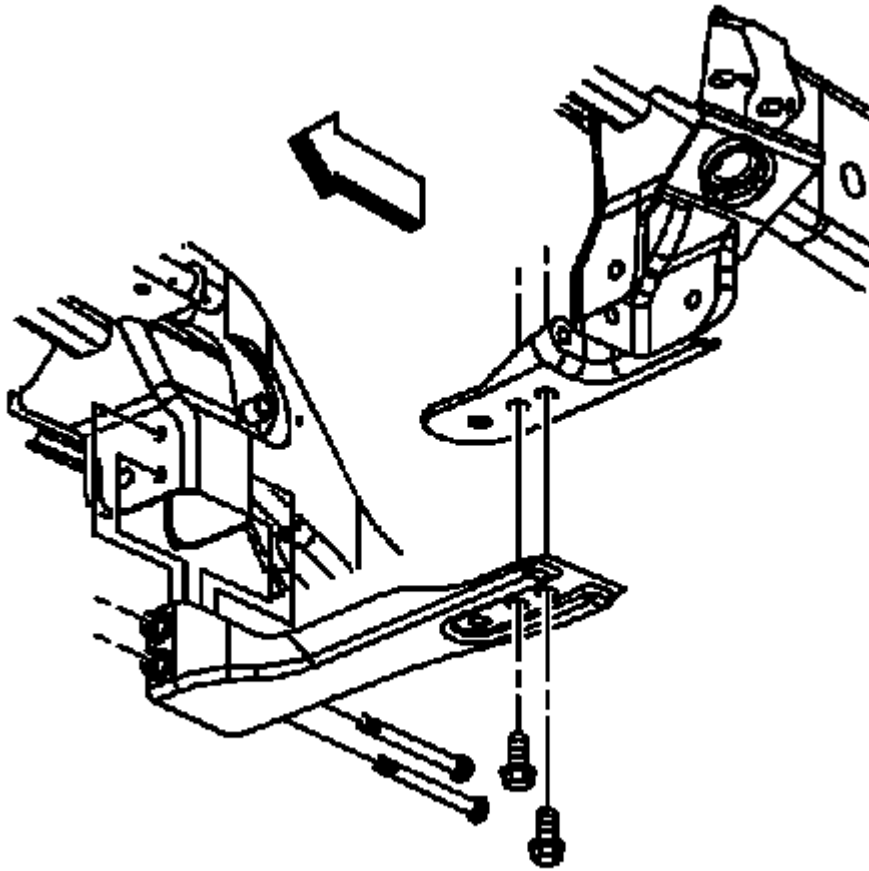


Fig. 313: View Of Crossmember Bolts & Bar (4WD Only)
Courtesy of GENERAL MOTORS CORP.

21. If equipped with 4WD, install the front differential carrier, if equipped. Refer to **REAR DRIVE AXLE** .
22. If equipped with 4WD, install the crossbar and bolts.

Tighten: Tighten the crossbar bolts to 100 N.m (74 lb ft).

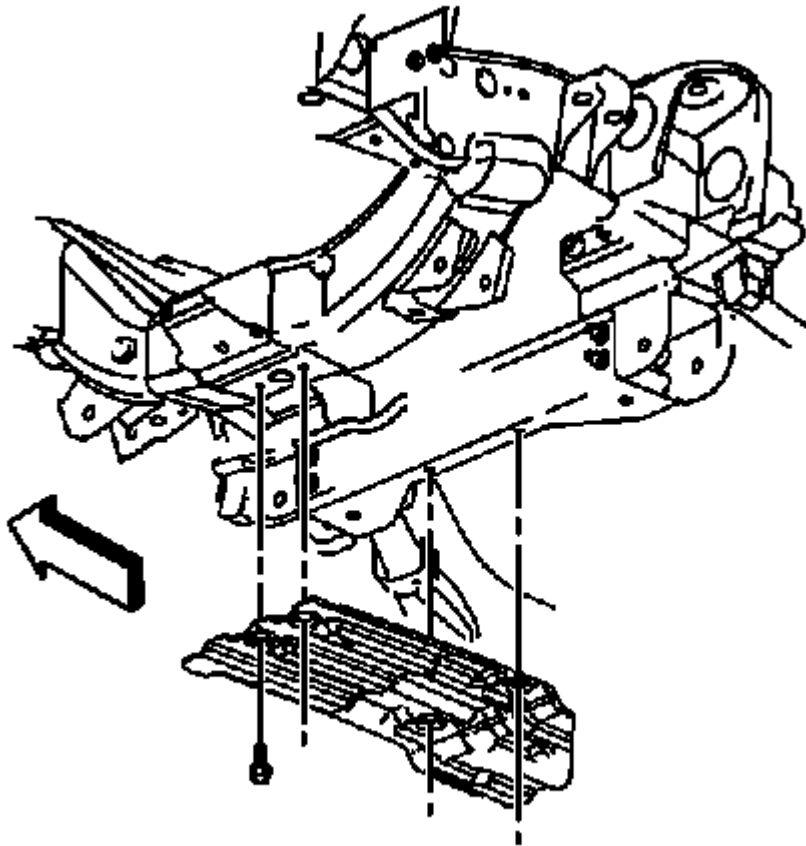


Fig. 314: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

23. If equipped, install the oil pan skid plate and bolts.

Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

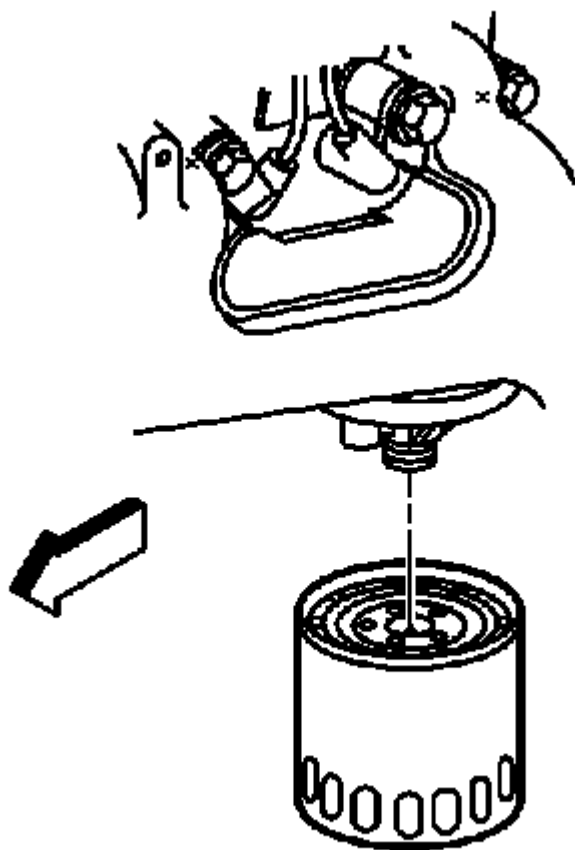


Fig. 315: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

24. Lubricate the oil filter gasket with clean engine oil.
25. Install the oil filter to the engine.

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

26. Lower the vehicle.
27. Fill the engine with the proper capacity and quality of engine oil.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required

J 41712 Oil Pressure Switch Socket

Removal Procedure

IMPORTANT: Clean the area around the oil pressure sensor. Do not allow debris to enter the

engine.

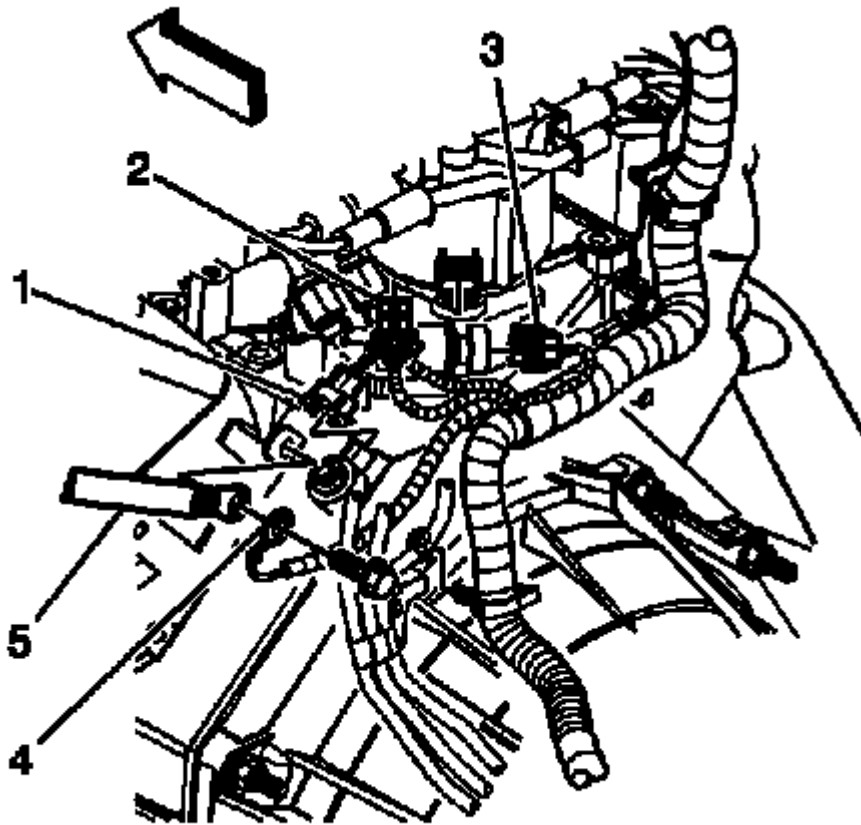


Fig. 316: View Of Ground Strap And CMP & Fuel Pump/Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the fuel pump/oil pressure sensor electrical connector (3).

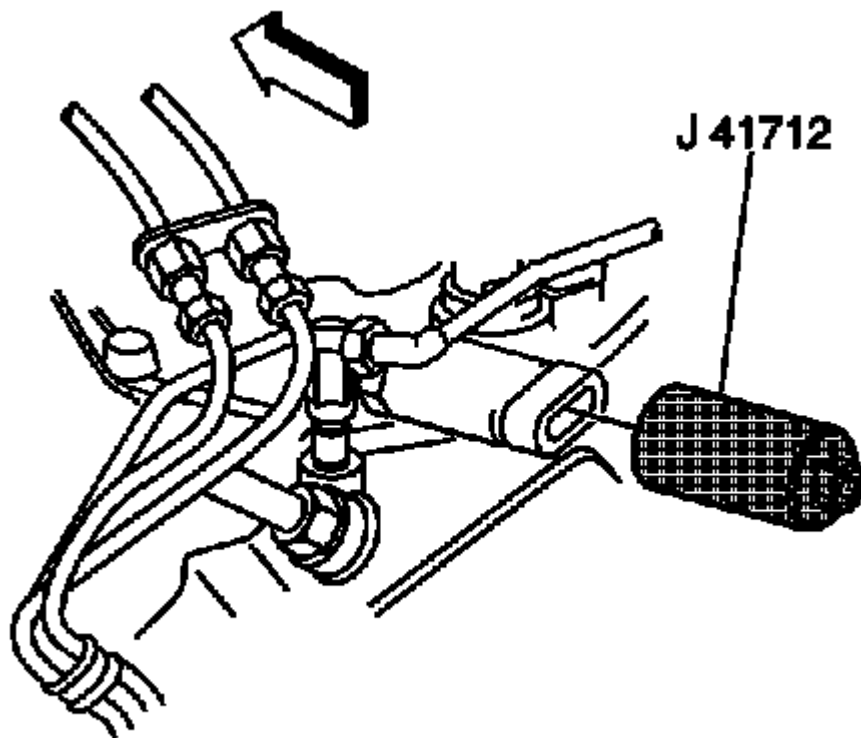


Fig. 317: View Of J 41712 Removing The Fuel Pump/Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

2. Using **J 41712** , remove the fuel pump/oil pressure sensor.

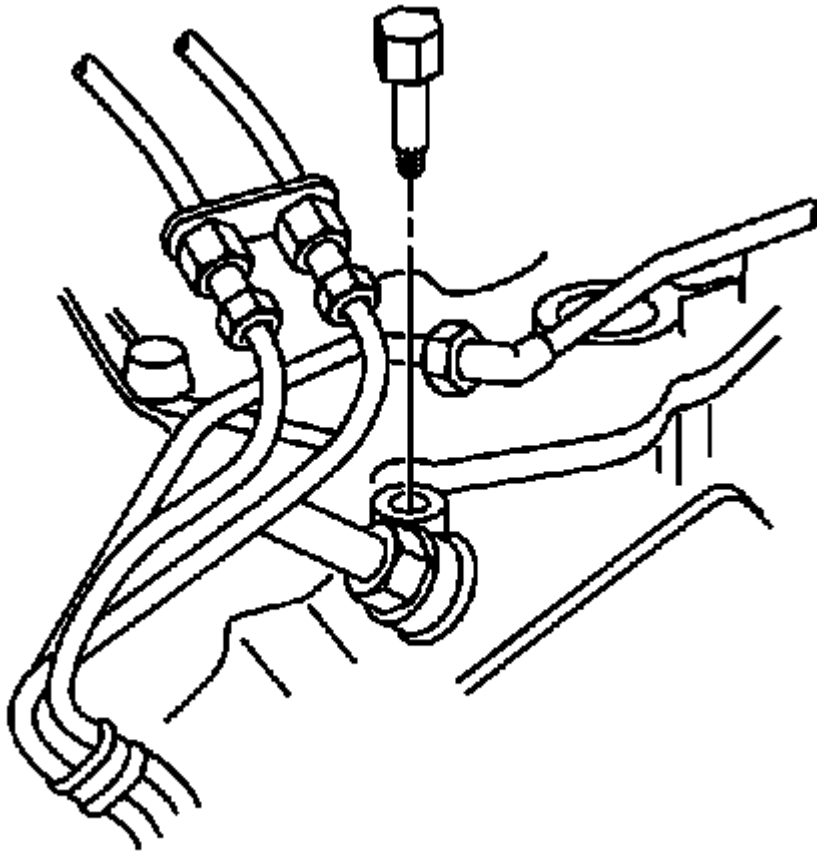


Fig. 318: View Of Fuel Pump/Oil Pressure Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Note the alignment of the engine oil pressure sensor fitting prior to removal.

3. Remove the fuel pump/oil pressure sensor fitting, if necessary.

Installation Procedure

1. Apply sealant GM U.S. P/N 12346004, Canada P/N 10953480, or equivalent to the threads of the sensor fitting, if installing the old fitting.
2. Install the fuel pump/oil pressure sensor fitting until snug, if necessary.

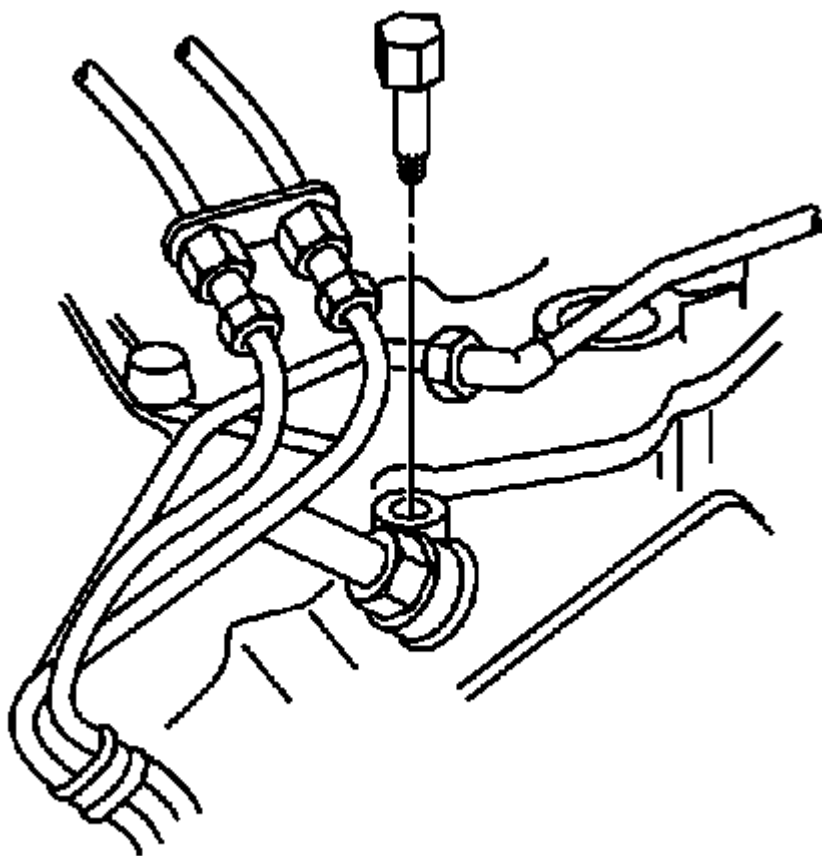


Fig. 319: View Of Fuel Pump/Oil Pressure Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

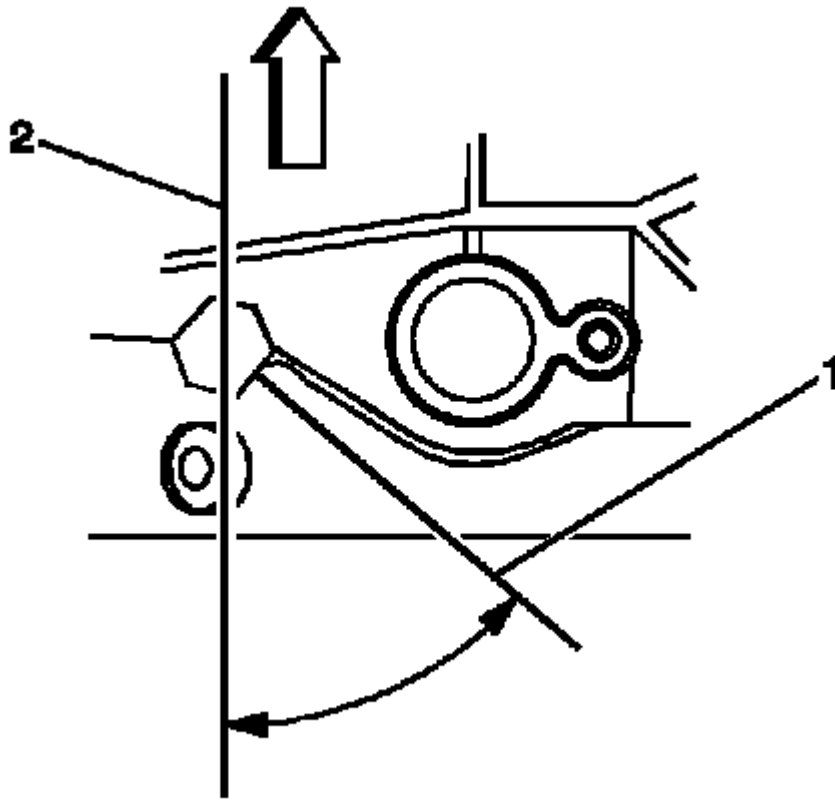


Fig. 320: View Of Centerlines Of Fitting & Crankshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER NOTICE** .

3. Tighten the fuel pump/oil pressure sensor fitting.

Tighten:

1. Tighten the fuel pump/oil pressure sensor fitting to 15 N.m (11 lb ft).
2. Increase torque until the centerline of the fitting (1) is 50 degrees from the centerline of the crankshaft (2).

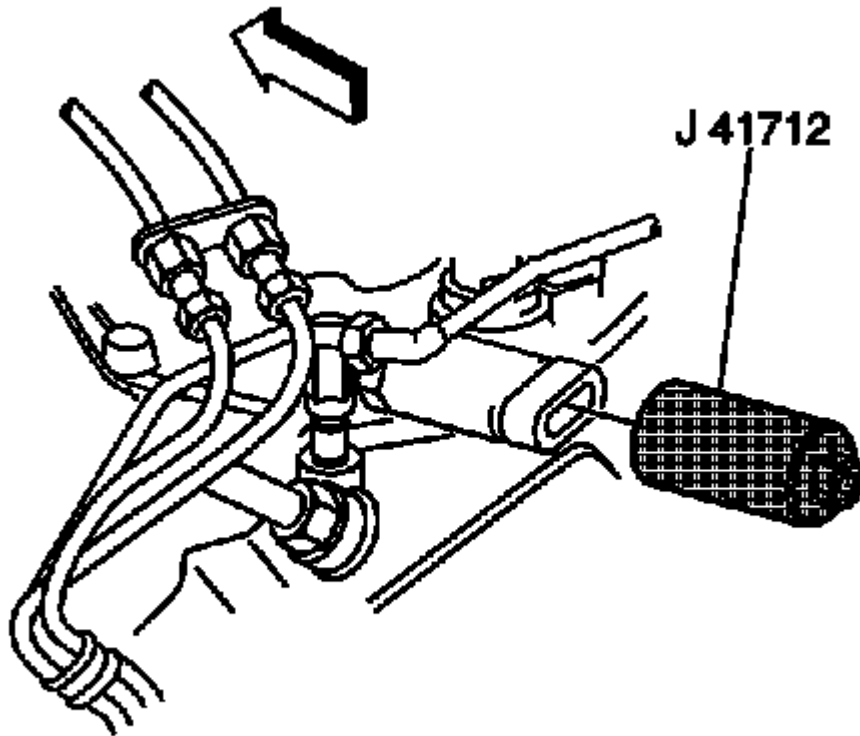


Fig. 321: View Of J 41712 Installing The Fuel Pump/Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

4. Apply sealant GM U.S. P/N 12346004, Canada P/N 10953480, or equivalent to the threads of the fuel pump/oil pressure sensor, if installing the old sensor.
5. Using **J 41712** , install the fuel pump/oil pressure sensor.

Tighten: Tighten the fuel pump oil pressure sensor to 30 N.m (22 lb ft).

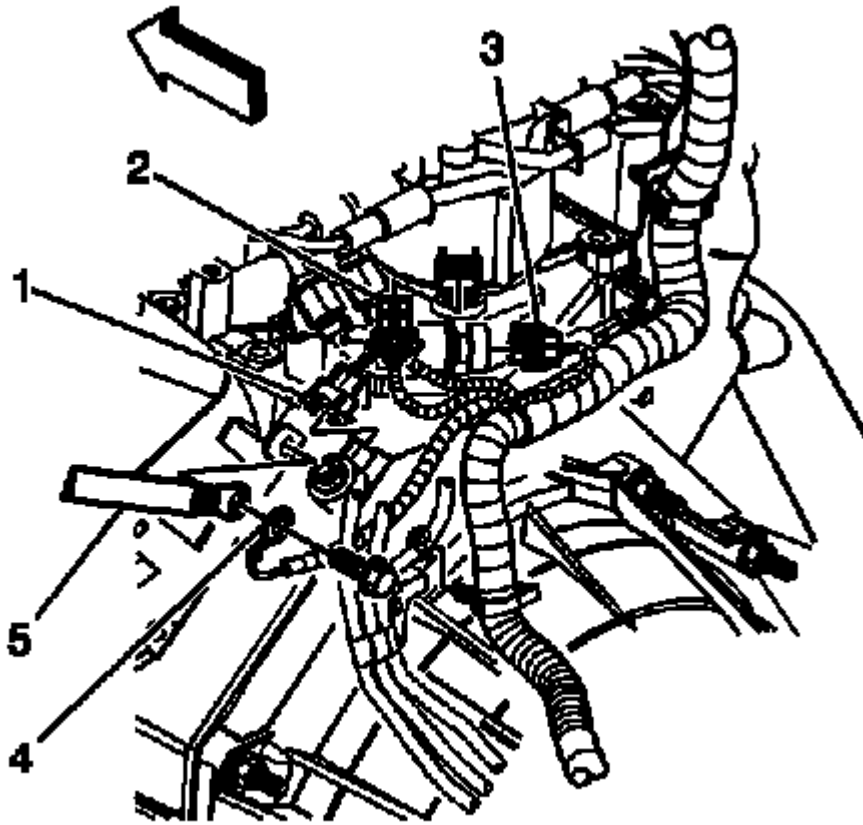


Fig. 322: View Of Ground Strap And CMP & Fuel Pump/Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

6. Connect the fuel pump/oil pressure sensor electrical connector (3).
7. Check and adjust the engine oil level, if necessary.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
2. Remove the oil pan drain plug and drain the oil into a suitable container.

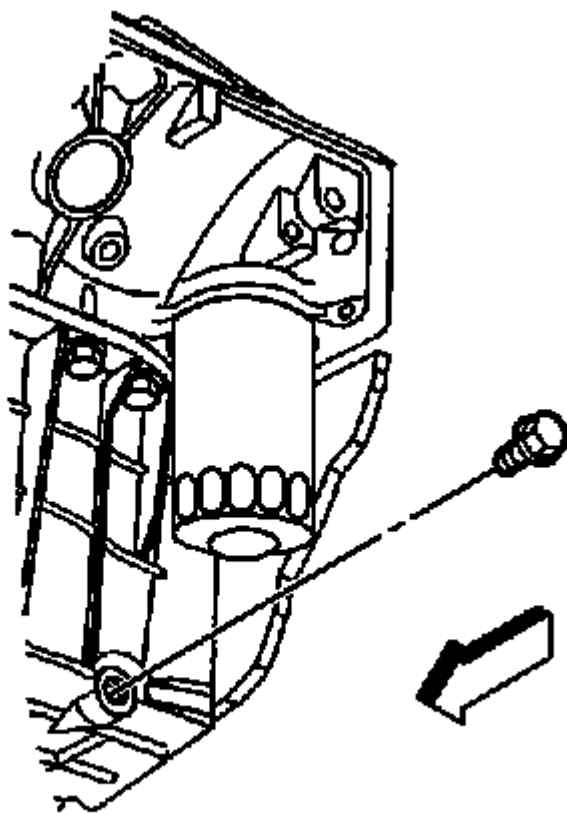


Fig. 323: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

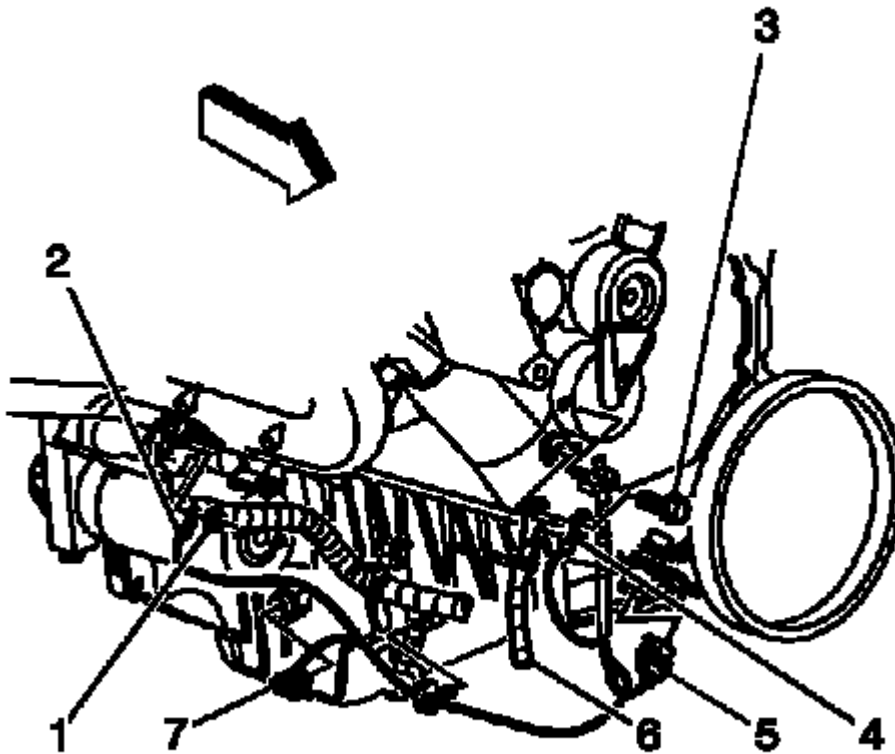


Fig. 324: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

3. Disconnect the oil level sensor electrical connector (7).

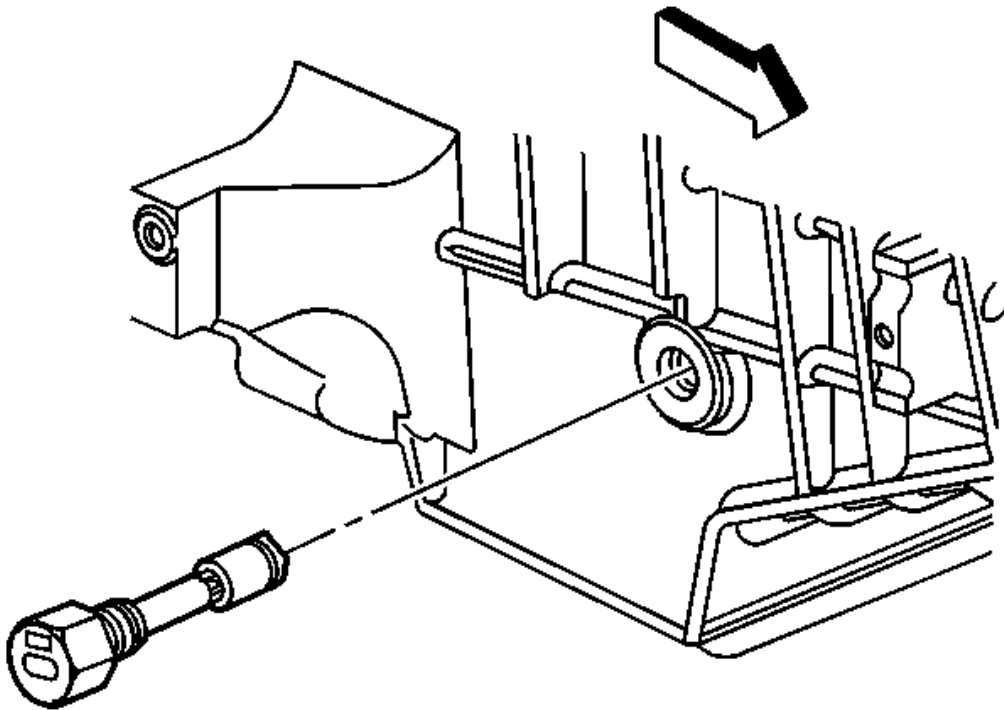


Fig. 325: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor.

Installation Procedure

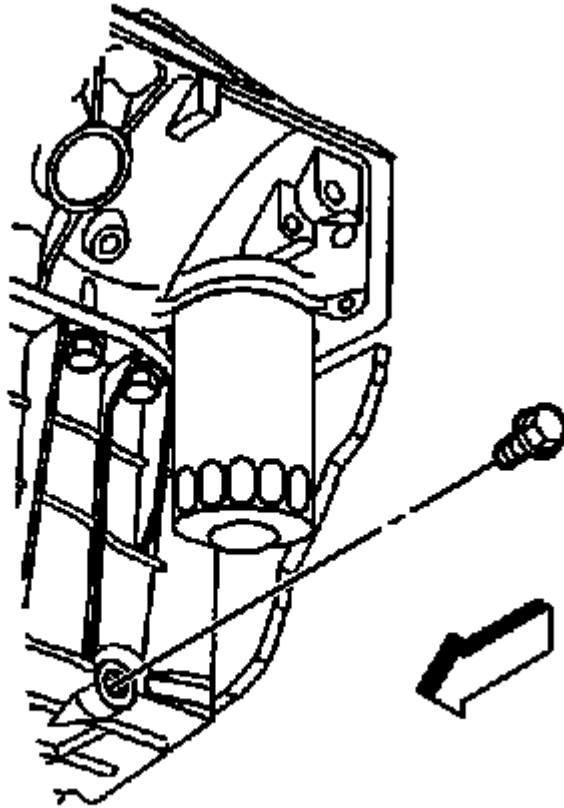


Fig. 326: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

1. Install the oil pan drain plug into the oil pan.

Tighten: Tighten the oil pan drain plug to 25 N.m (18 lb ft).

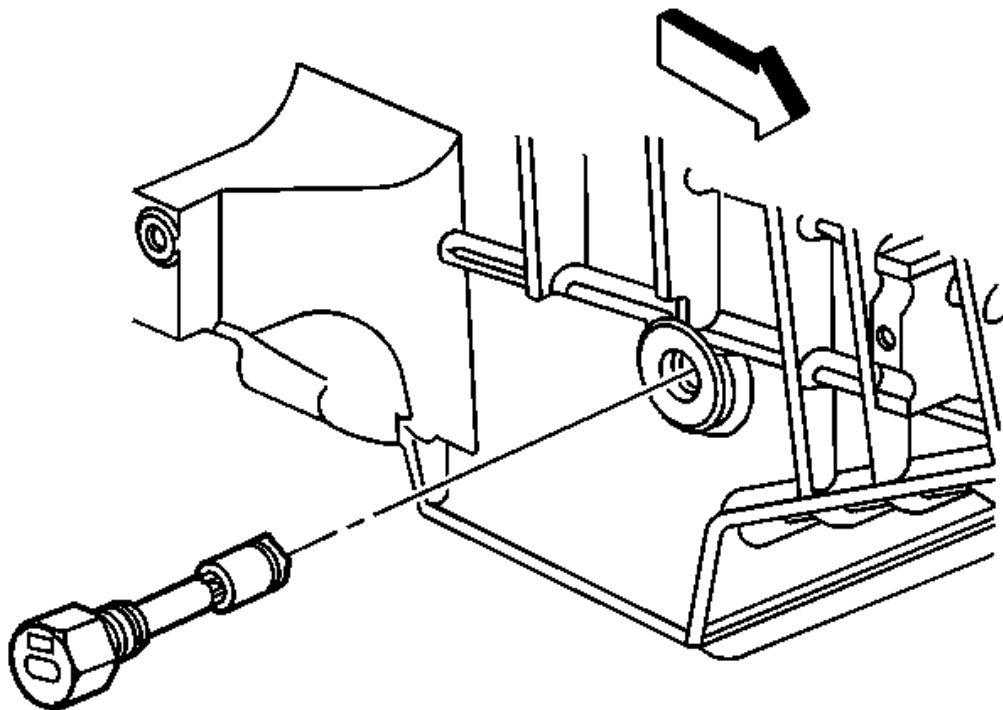


Fig. 327: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

2. Install the oil level sensor.

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

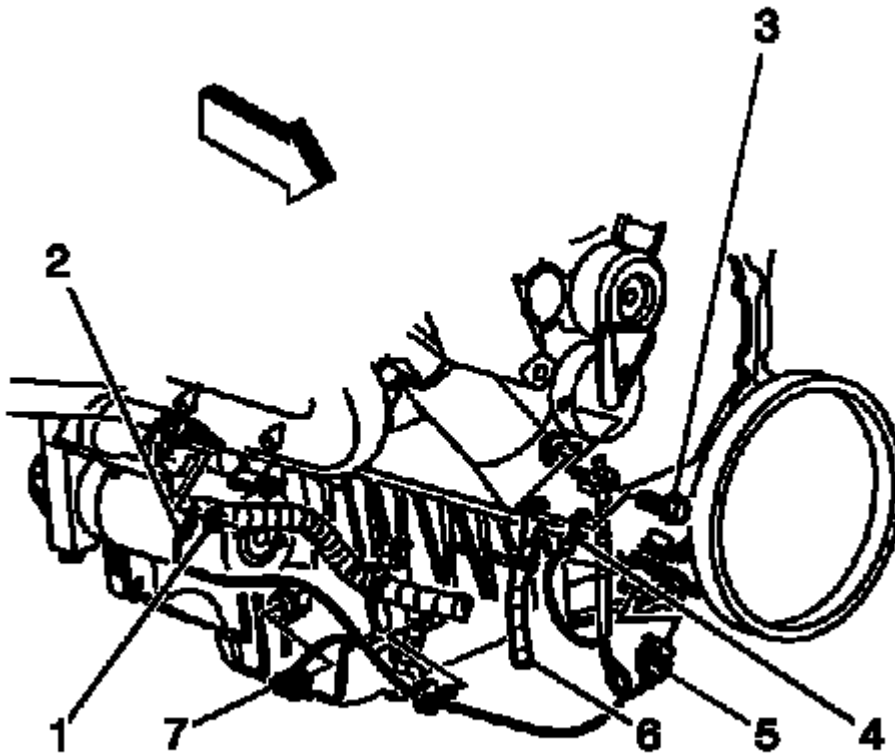


Fig. 328: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

3. Connect the oil level sensor electrical connector (7).
4. Lower the vehicle.
5. Fill the engine with the proper quantity and grade of oil.

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

Removal Procedure

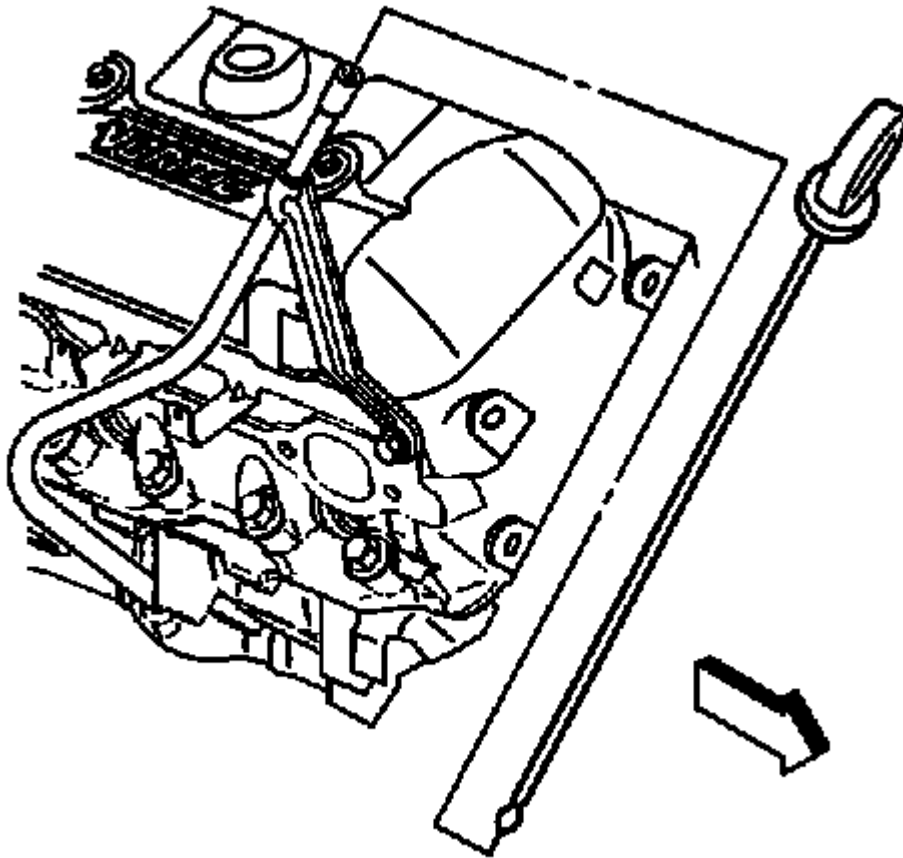


Fig. 329: Locating Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the right exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.3L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L, & 6.0L ENGINES)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (6.6L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (8.1L ENGINE)** .

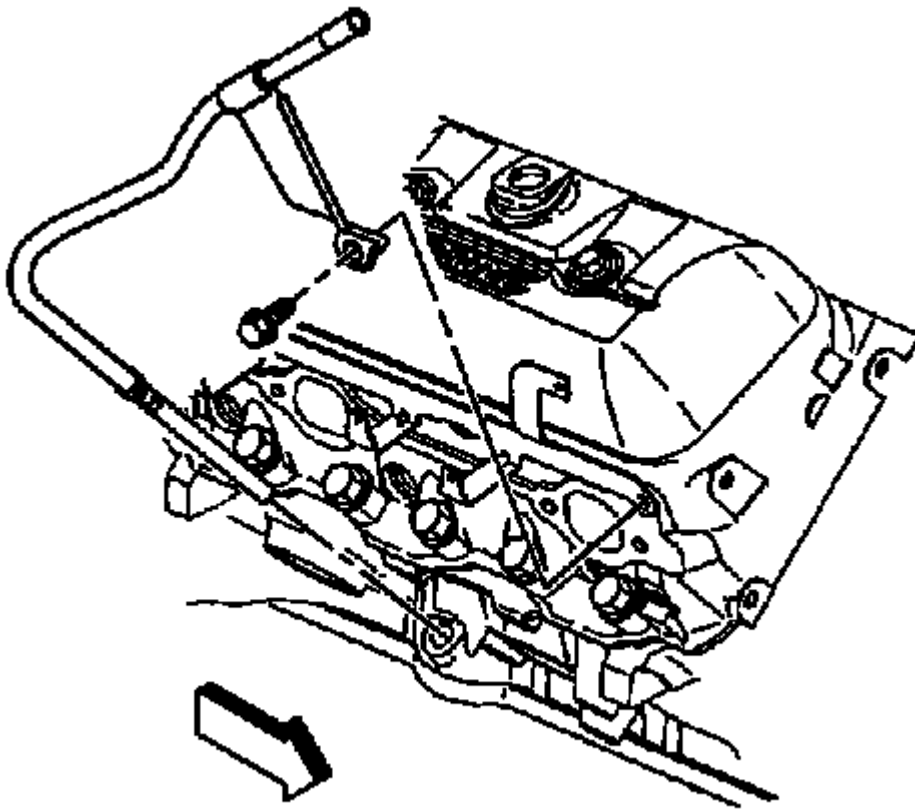


Fig. 330: View Of Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil level indicator tube bolt.
4. Remove the oil level indicator tube from the engine using a twisting motion.
5. Clean the old sealer from the oil level indicator tube and the engine block.

Installation Procedure

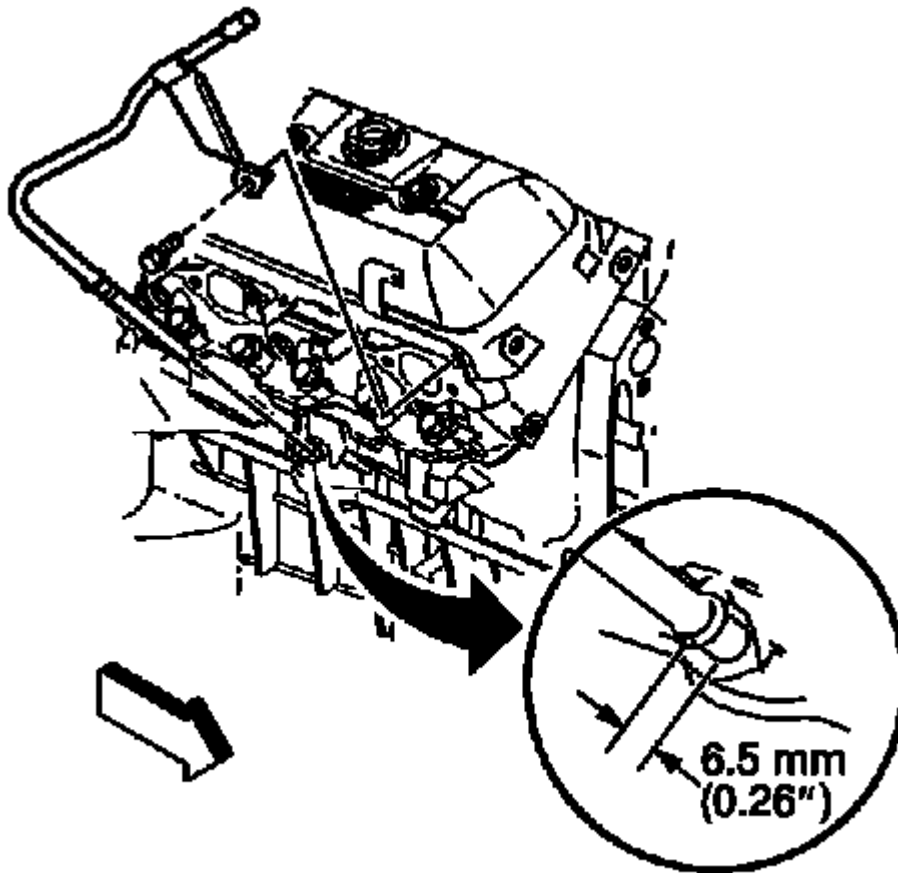


Fig. 331: Applying Sealant Around Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Apply sealant GM U.S. P/N 12346004, Canada P/N 10953480, or equivalent around the oil level indicator tube 13 mm (0.5 in) below the tube bead.
2. Install the oil level indicator tube into the engine block. Rotate the oil level indicator tube into position.

NOTE: Refer to **FASTENER NOTICE** .

3. Install the oil level indicator tube bolt.

Tighten: Tighten the oil level indicator tube bolt to 12 N.m (106 lb in).

4. Install the right exhaust manifold. Refer to **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.3L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (4.8L, 5.3L, & 6.0L ENGINES)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (6.6L ENGINE)** or **EXHAUST MANIFOLD REPLACEMENT -- RIGHT (8.1L ENGINE)** .

Install the oil level indicator.

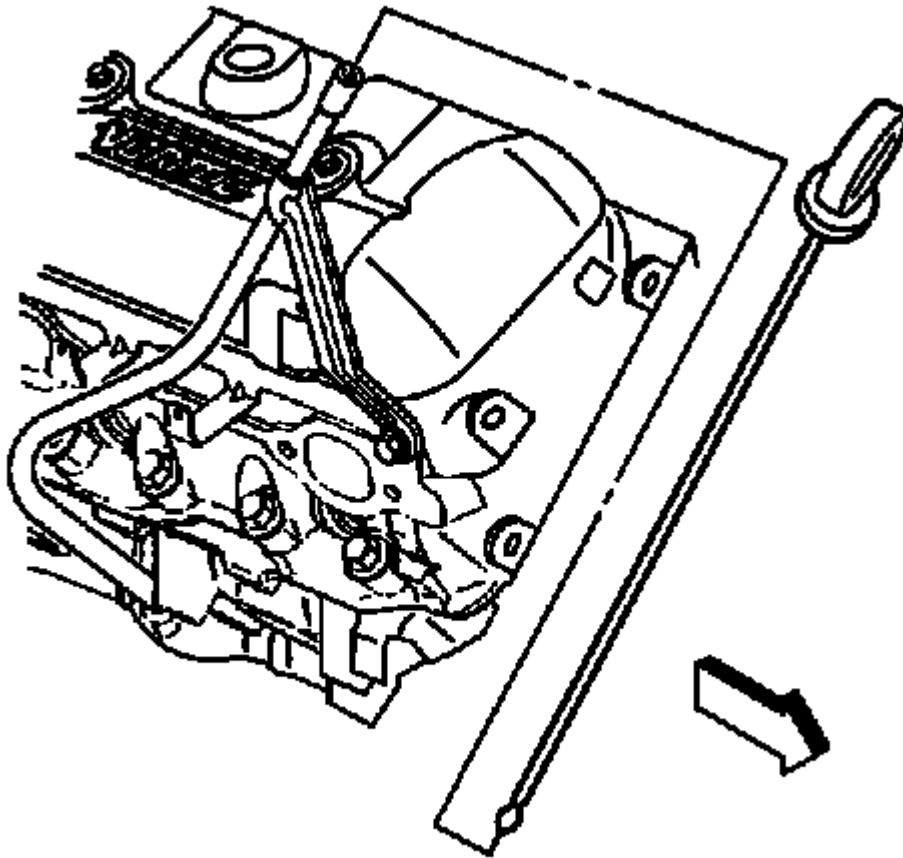


Fig. 332: Locating Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

OIL PUMP REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the oil pump bolt.

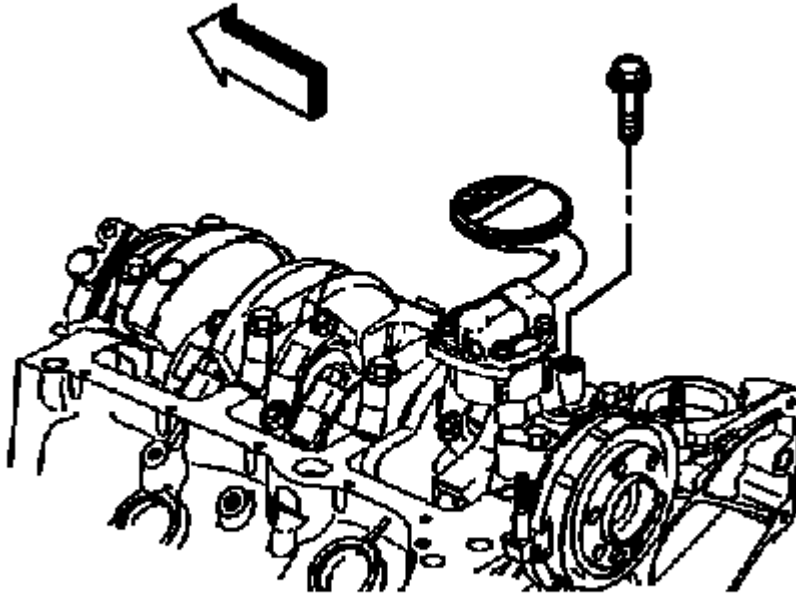


Fig. 333: View Of Oil Pump Bolt
Courtesy of GENERAL MOTORS CORP.

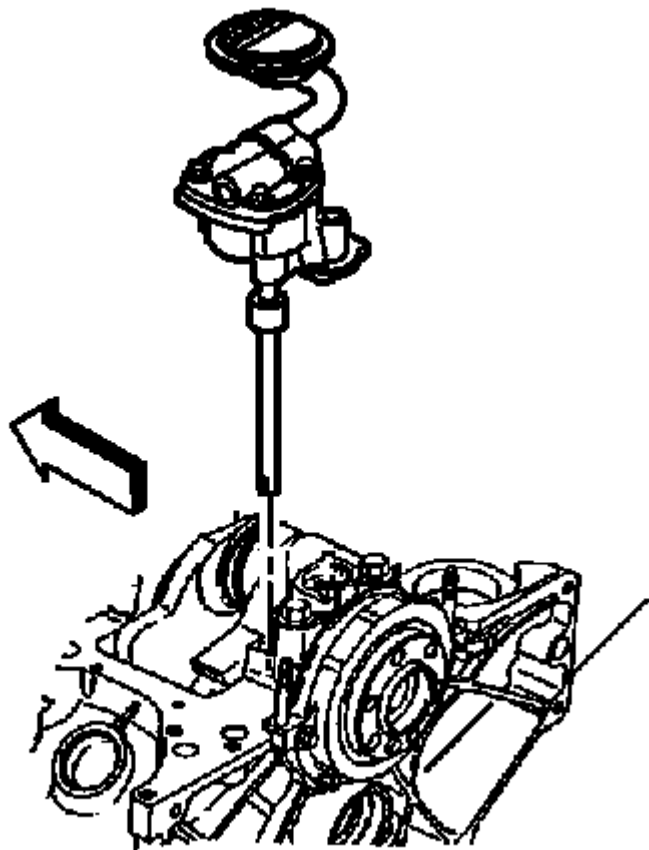


Fig. 334: View Of Oil Pump

Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pump.

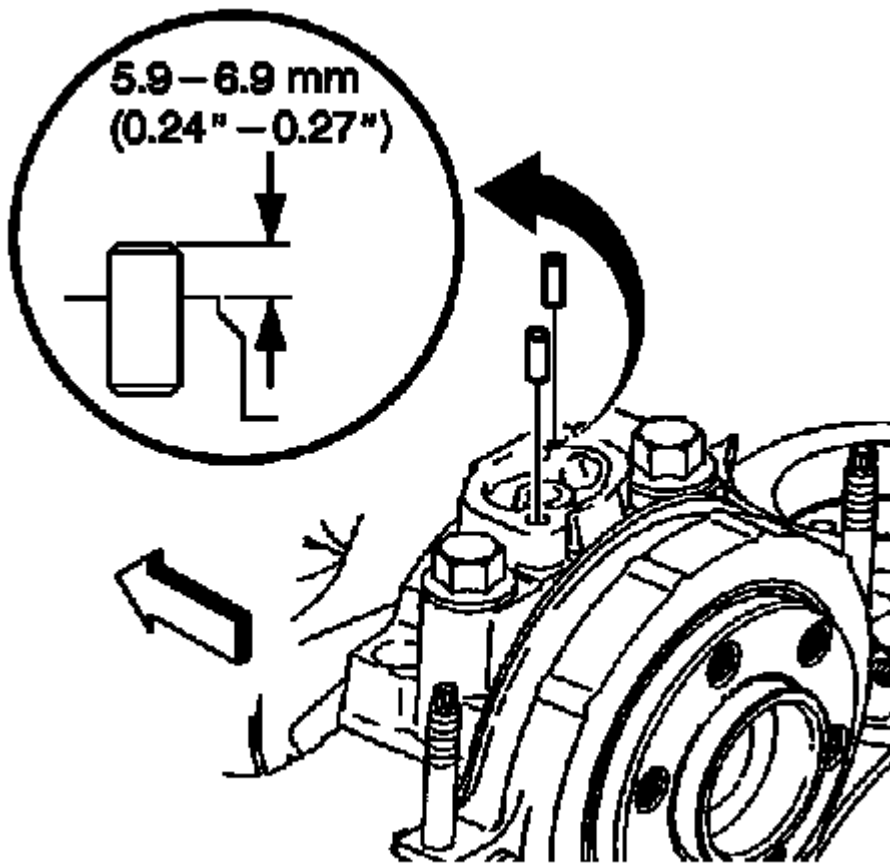


Fig. 335: Oil Pump Locator Pins Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

4. Inspect the oil pump locator pins for damage, and replace if required.
5. Clean and inspect the oil pump, if necessary. Refer to **OIL PUMP CLEANING & INSPECTION**.

Installation Procedure

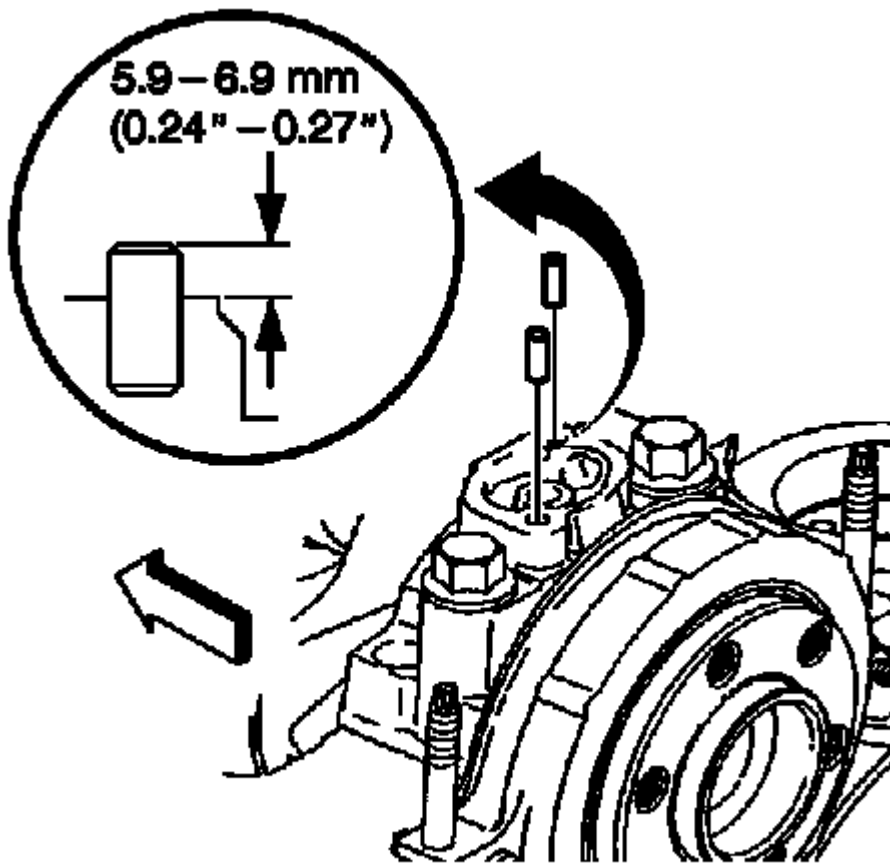


Fig. 336: Oil Pump Locator Pins Proper Installation Position
Courtesy of GENERAL MOTORS CORP.

1. Inspect for properly installed oil pump locator pins.

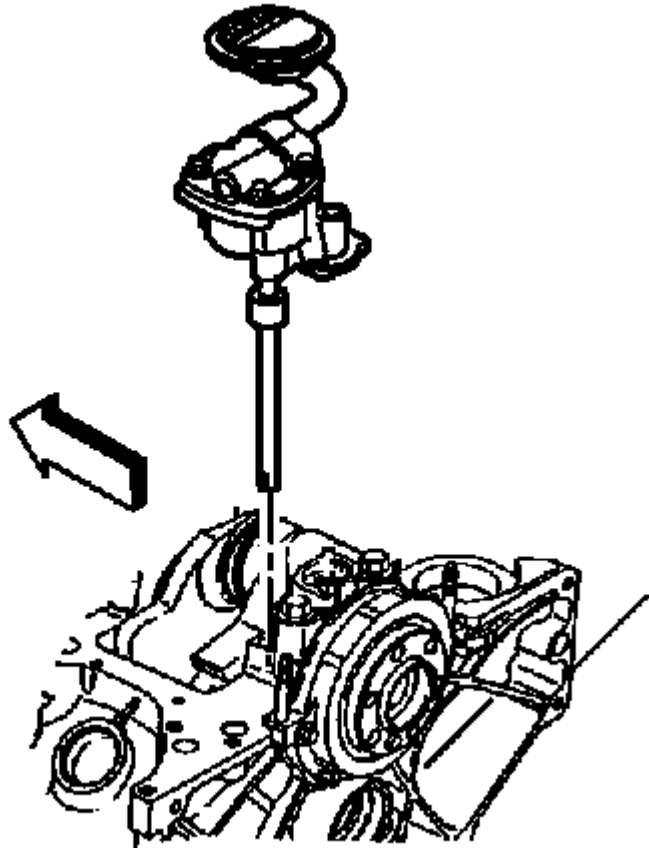


Fig. 337: View Of Oil Pump

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not reuse the oil pump driveshaft retainer. During assembly, install a **NEW** oil pump driveshaft retainer.

2. Install the oil pump. Position the oil pump onto the locator pins.

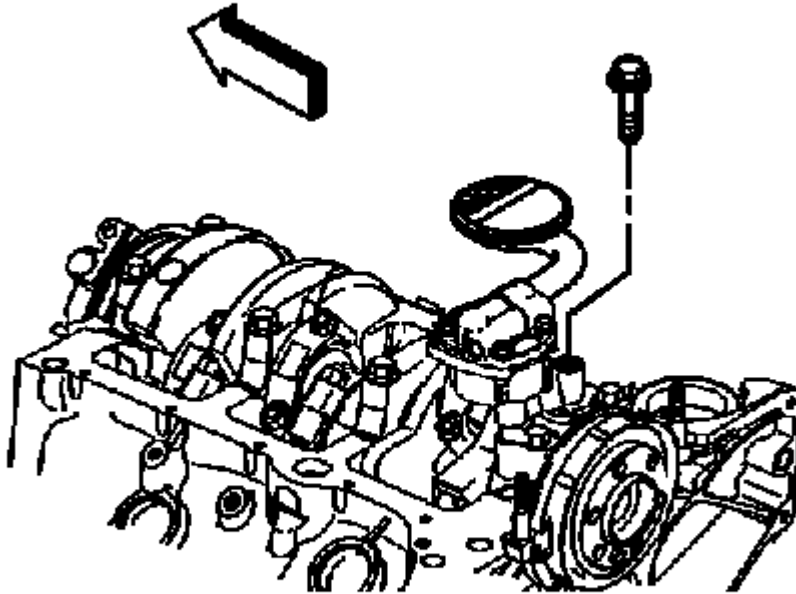


Fig. 338: View Of Oil Pump Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the oil pump bolt.

Tighten: Tighten the oil pump bolt to 90 N.m (66 lb ft).

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

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Tools Required

J 35621-B Rear Main Seal Installer

Removal Procedure

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

2. Remove the crankshaft rear oil seal from the crankshaft rear oil seal housing.

Insert a suitable tool into the access notches and then carefully pry the crankshaft rear oil seal from the crankshaft rear oil seal housing.

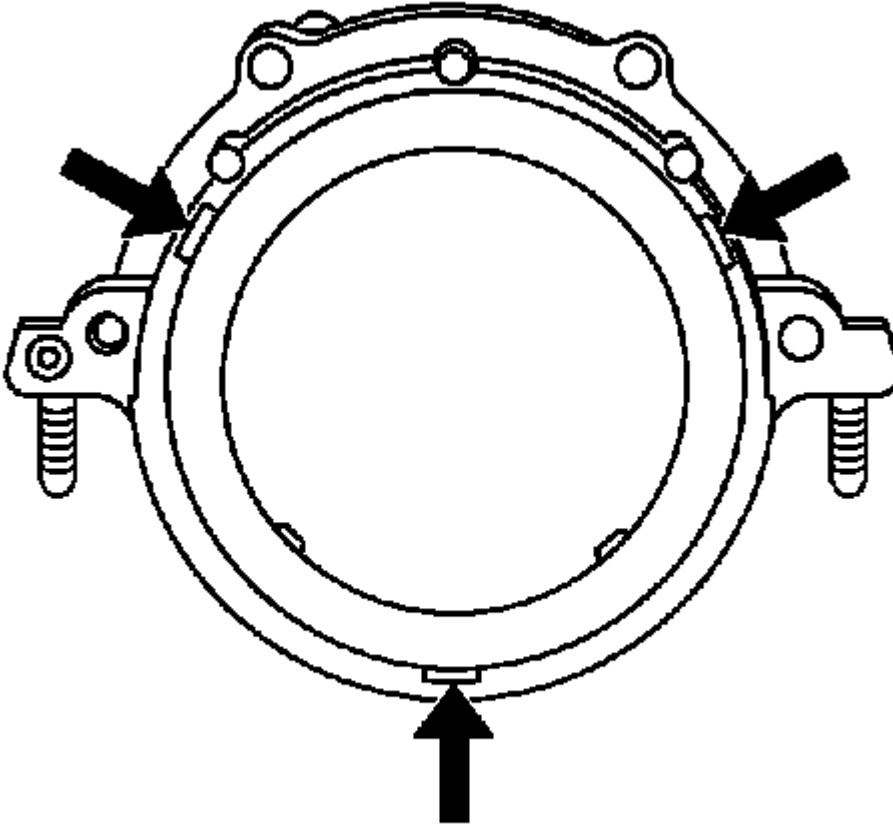


Fig. 339: View Of Crankshaft Rear Oil Seal Notches
Courtesy of GENERAL MOTORS CORP.

3. Discard the crankshaft rear oil seal.
4. Clean off any dirt or rust in the area.

Installation Procedure

1. Apply a small amount (2 to 3 drops) of clean engine oil to the bore of the crankshaft rear oil seal housing.
2. Apply a small amount (2 to 3 drops) of clean engine oil to the outside diameter of the engine flywheel pilot flange.
3. Apply a small amount (1 drop) of clean engine oil to the outside diameter of the flywheel locator pin.
4. Apply a small amount (2 to 3 drops) of clean engine oil to the crankshaft seal surface.
5. Inspect the **J 35621-B** flange for imperfections that may damage the crankshaft rear oil seal.

Minor imperfections may be removed with a fine grade emery cloth.

IMPORTANT: DO NOT allow oil or any other lubricants to contact the seal lip surface of the crankshaft rear oil seal.

6. Remove the sleeve from the crankshaft rear oil seal.
7. Apply a small amount (2 to 3 drops) of clean engine oil to the outside diameter of the crankshaft rear oil seal.
8. Install the crankshaft rear oil seal onto the **J 35621-B**.

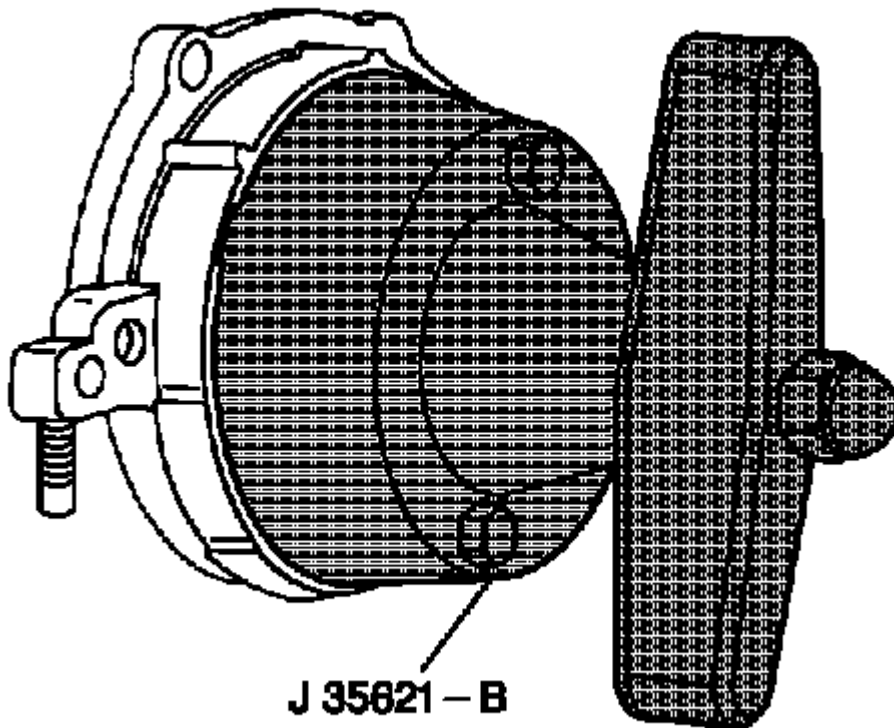


Fig. 340: Installing The Crankshaft Rear Oil Seal Using J 35621-B
Courtesy of GENERAL MOTORS CORP.

9. Install the **J 35621-B** onto the rear of the crankshaft and hand tighten the tool bolts until snug.

NOTE: Proper alignment of the crankshaft rear oil seal is critical. Install the crankshaft rear oil seal near to flush and square to the crankshaft rear oil seal housing. Failing to do so may cause the crankshaft rear oil seal or the crankshaft rear oil seal installation tool to fail.

10. Install the crankshaft rear oil seal onto the crankshaft and into the crankshaft rear oil seal housing.
 1. Turn the **J 35621-B** wing nut clockwise until the crankshaft rear oil seal is installed near to flush and square to the crankshaft rear oil seal housing.

Increased resistance will be felt when the crankshaft rear oil seal has reached the bottom of the crankshaft rear oil seal housing bore.
 2. Turn the **J 35621-B** wing nut counterclockwise to release the **J 35621-B** from the crankshaft rear oil seal.
11. Remove the **J 35621-B** from the crankshaft.
12. Wipe off any excess engine oil with a clean rag.
13. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

IMPORTANT: Do not remove the crankshaft rear oil seal housing if only replacing the crankshaft rear oil seal.

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
3. Remove the crankshaft rear oil seal housing bolts and nut.
4. Remove the crankshaft rear oil seal housing.

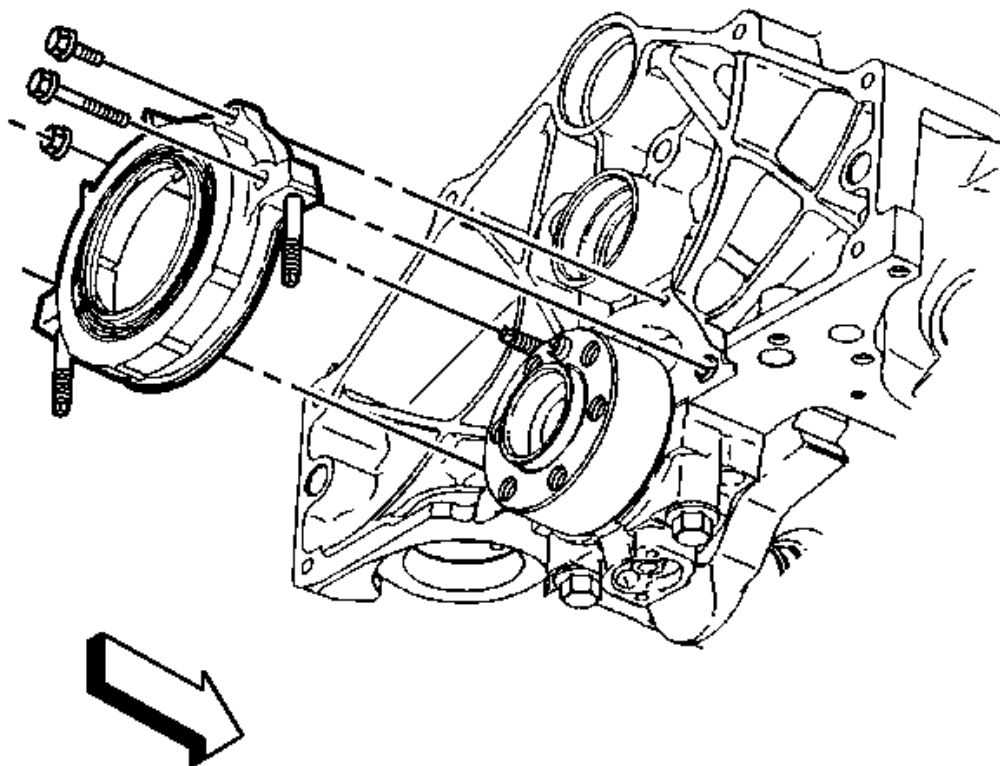


Fig. 341: View Of Crankshaft Rear Oil Seal Housing Nuts & Bolts
Courtesy of GENERAL MOTORS CORP.

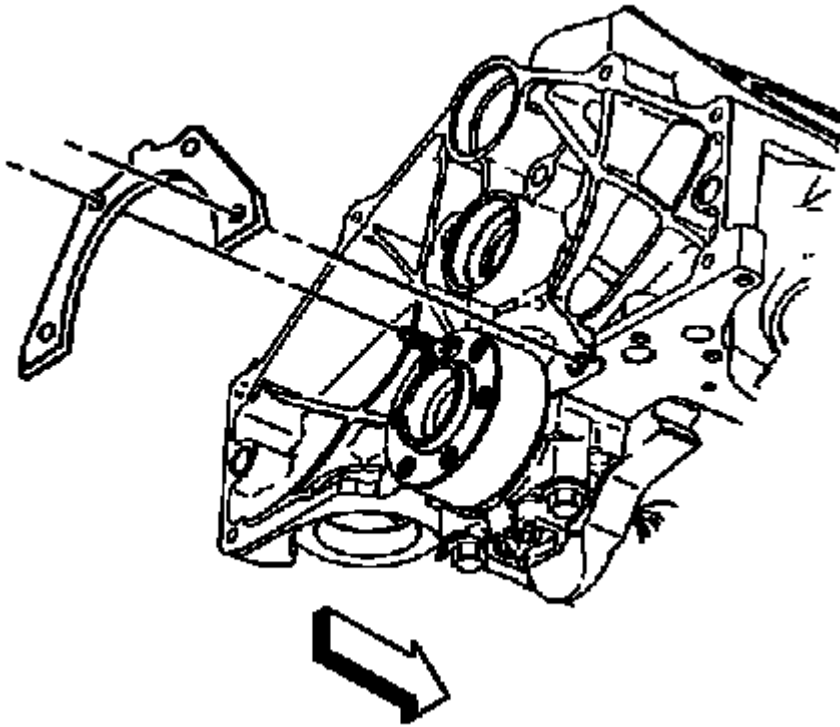


Fig. 342: View Of Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the crankshaft rear oil seal housing gasket.
6. Clean all the sealing surfaces.
7. Inspect and replace the crankshaft rear oil seal housing for warping, cracks, wear, or damage.

Installation Procedure

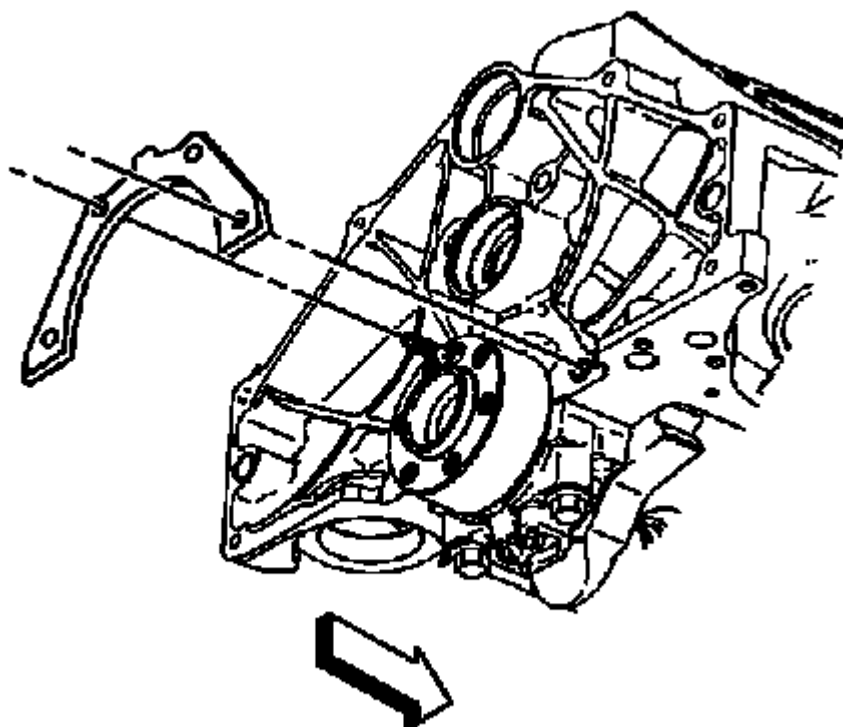


Fig. 343: View Of Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When installing a NEW crankshaft rear oil seal housing the crankshaft rear oil seal will come with the housing. If reusing the housing and then installing a NEW seal follow the instructions for installing the housing and than refer to Crankshaft Rear Oil Seal Replacement to install the seal.

1. Install a NEW crankshaft rear oil seal housing gasket.

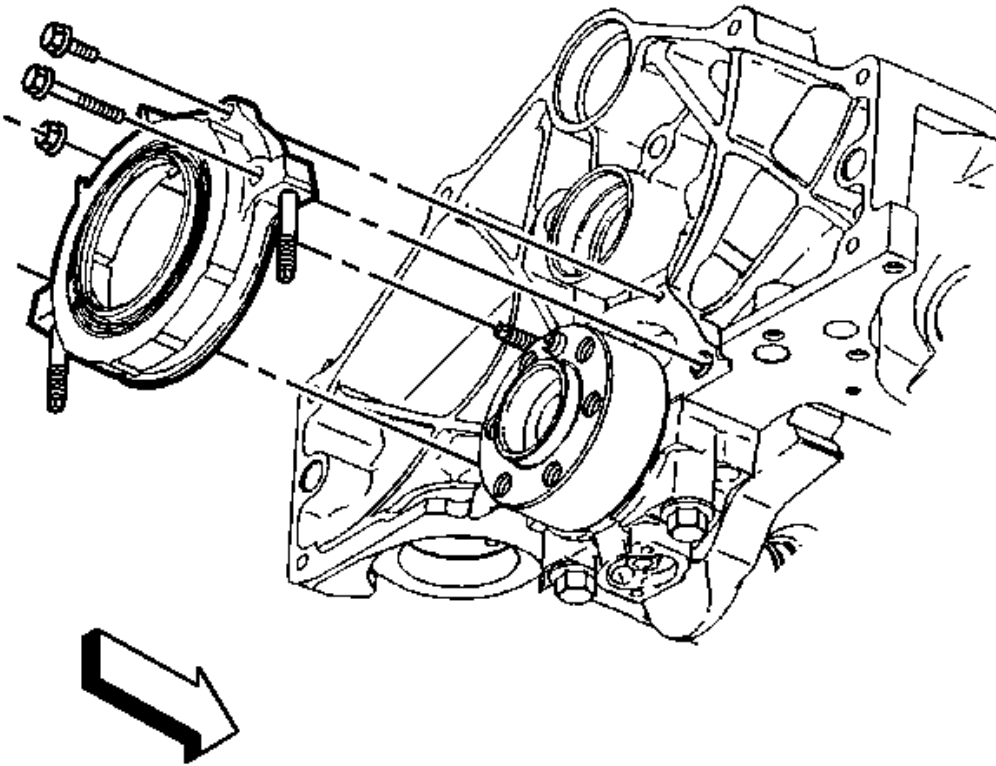


Fig. 344: View Of Crankshaft Rear Oil Seal Housing Nuts & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW crankshaft rear oil seal housing with the oil seal to the engine block using the following procedure.

IMPORTANT: Do not oil or grease the seal lip or the crankshaft seal area.

1. Leave the sleeve in the crankshaft rear oil seal and use the sleeve as a guide to ease the seal lip over the end of the crankshaft.
2. Push the crankshaft rear oil seal housing fully onto the crankshaft until the crankshaft rear oil seal housing is against the crankshaft rear oil seal gasket and the engine.
3. Remove the sleeve.

NOTE: Refer to **FASTENER NOTICE** .

3. Install the crankshaft rear oil seal housing bolts and nut.

Tighten: Tighten the crankshaft rear oil seal housing bolts and nut to 12 N.m (106 lb in).

4. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.
5. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

1. Remove the automatic transmission, if equipped. Refer to **TRANSMISSION**.
2. Remove the clutch, if equipped. Refer to **CLUTCH ASSEMBLY & PILOT BEARING**.
3. Remove the flywheel bolts.
4. Remove the flywheel (1 or 2).

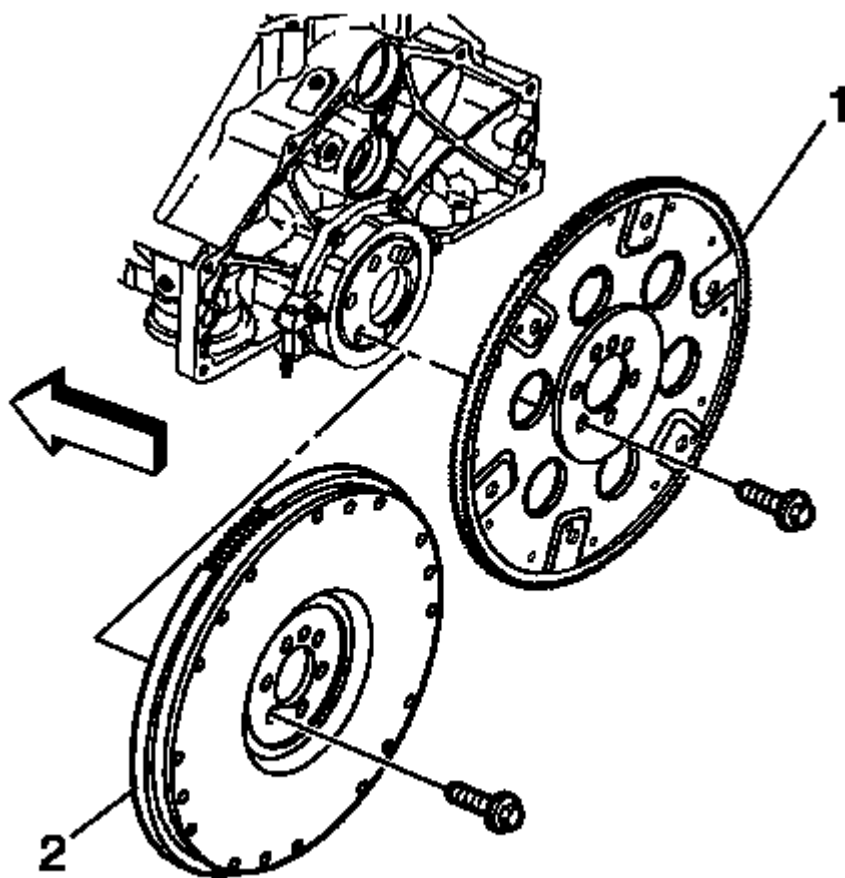


Fig. 345: View Of Flywheels

Courtesy of GENERAL MOTORS CORP.

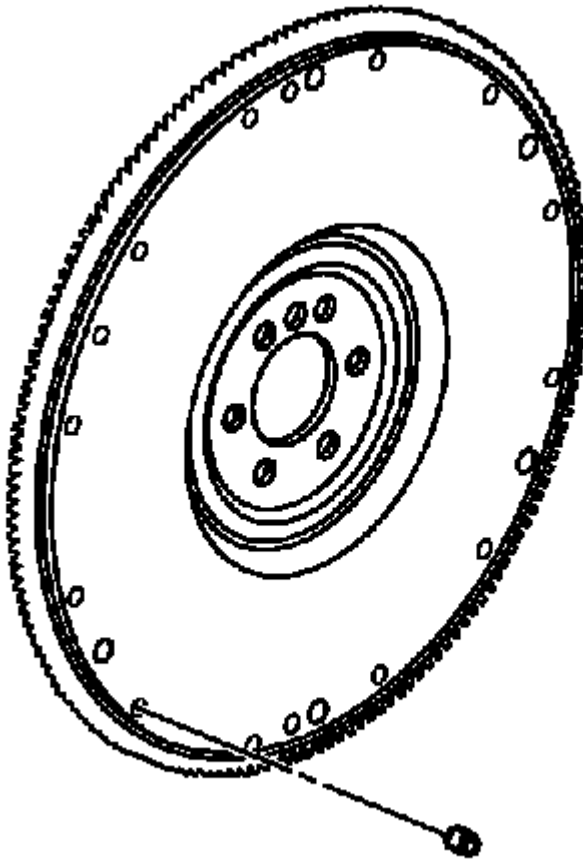


Fig. 346: Locating Flywheel Weights (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If equipped with a manual transmission, **NEW** flywheel weights must be installed into the **NEW** flywheel in the same location as the old weights in the old flywheel.

5. Note the position of any flywheel weights for assembly (if applicable).
6. Clean and inspect the flywheel, if necessary. Refer to **ENGINE FLYWHEEL CLEANING & INSPECTION** .

Installation Procedure

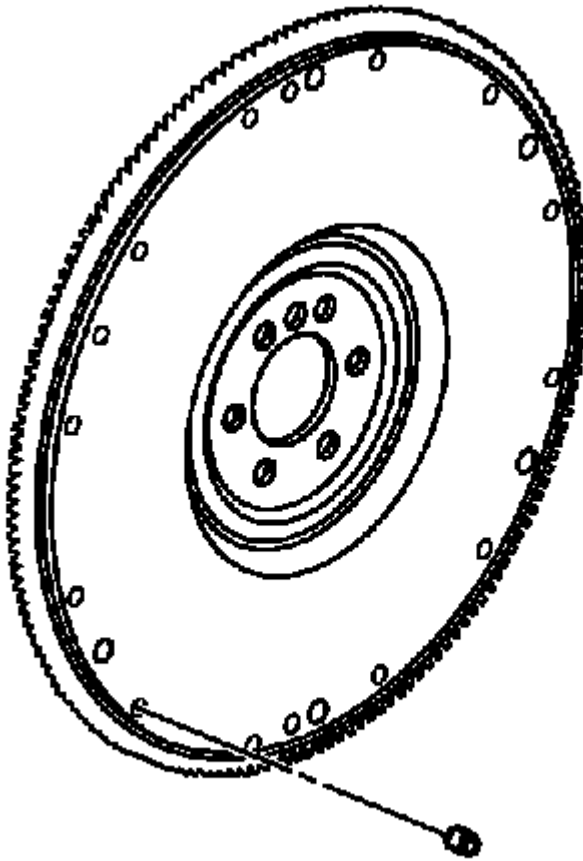


Fig. 347: Locating Flywheel Weights (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If replacing the flywheel on a manual transmission, note the position and length of the original flywheel weights (if applicable). Flywheel weights of the same length must be installed into the NEW flywheel in the same location as the old weights were in the old flywheel.

1. Note the position of the flywheel weights and install the NEW flywheel weights as required.

A properly installed flywheel weight will be flush or slightly below flush with the face of the flywheel.

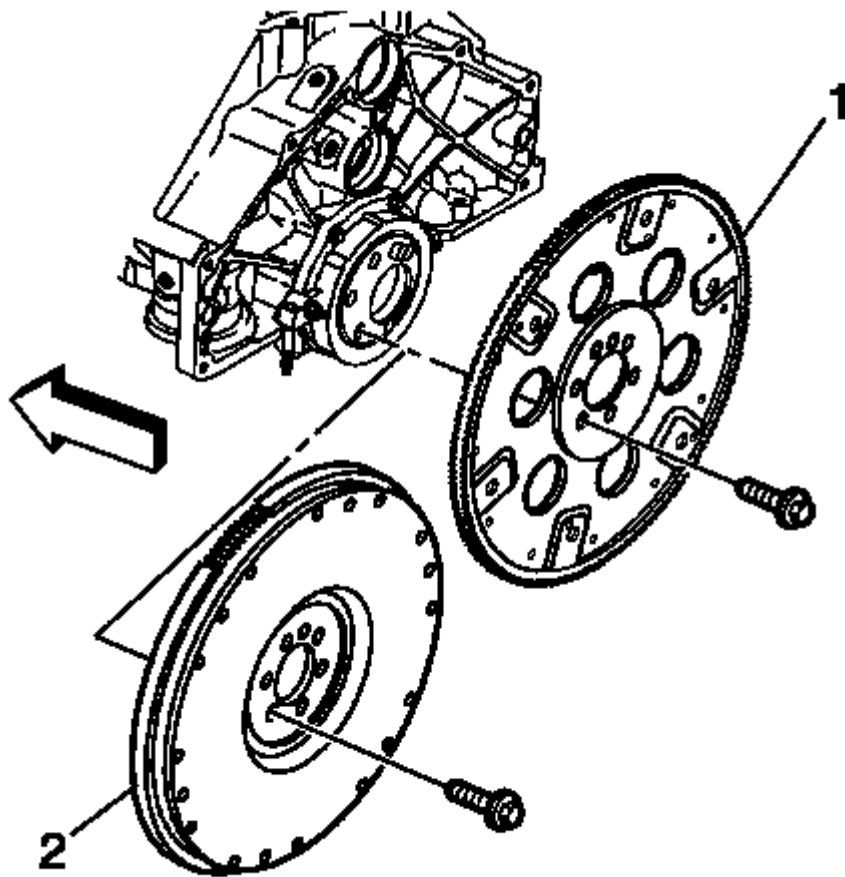


Fig. 348: View Of Flywheels

Courtesy of GENERAL MOTORS CORP.

2. Install the flywheel (1 or 2) to the crankshaft.

Align the flywheel locator hole to the flywheel locator pin.

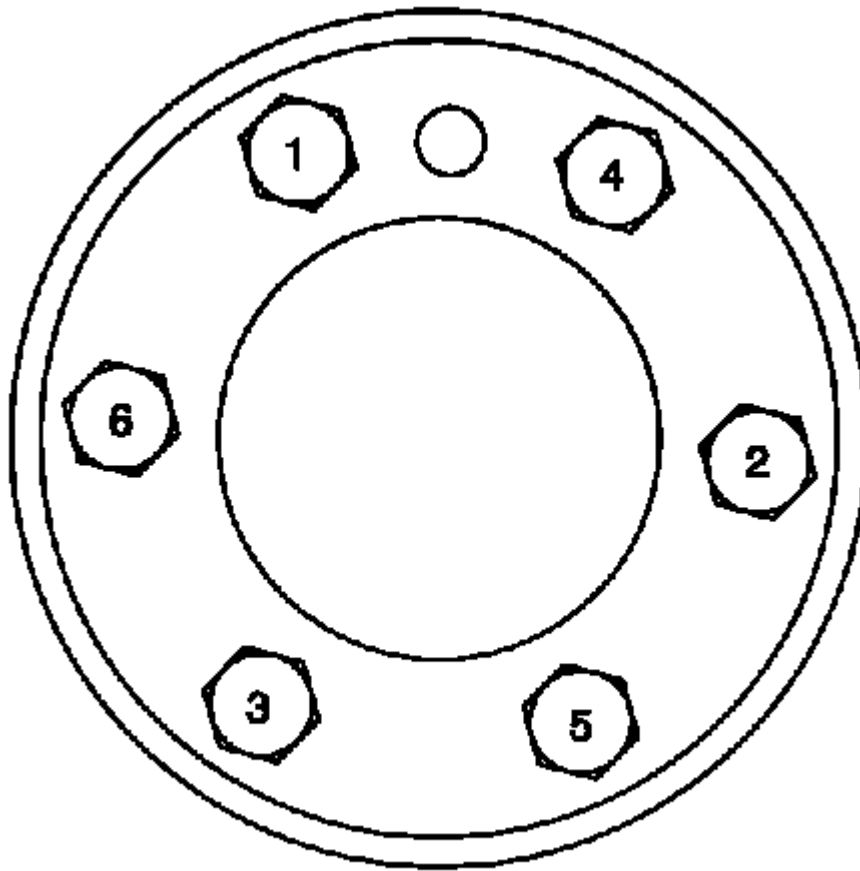


Fig. 349: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the flywheel bolts.

Tighten: Tighten the flywheel bolts in the sequence shown to 100 N.m (74 lb ft).

4. Install the clutch, if equipped. Refer to CLUTCH ASSEMBLY & PILOT BEARING .
5. Install the transmission, if equipped. Refer to TRANSMISSION .

ENGINE REPLACEMENT

Tools Required

J 41427 Engine Lift Brackets

Removal Procedure

1. Disconnect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)** or **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (AUXILIARY BATTERY)** .
2. Drain the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM** .
3. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
4. If equipped, remove the oil pan skid plate bolts and plate.

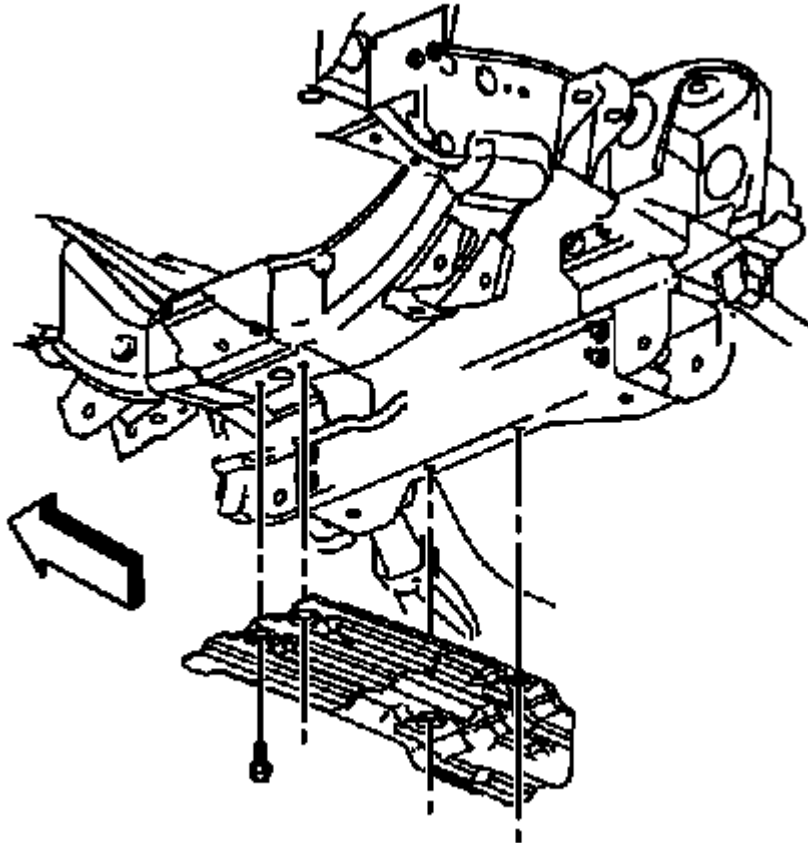
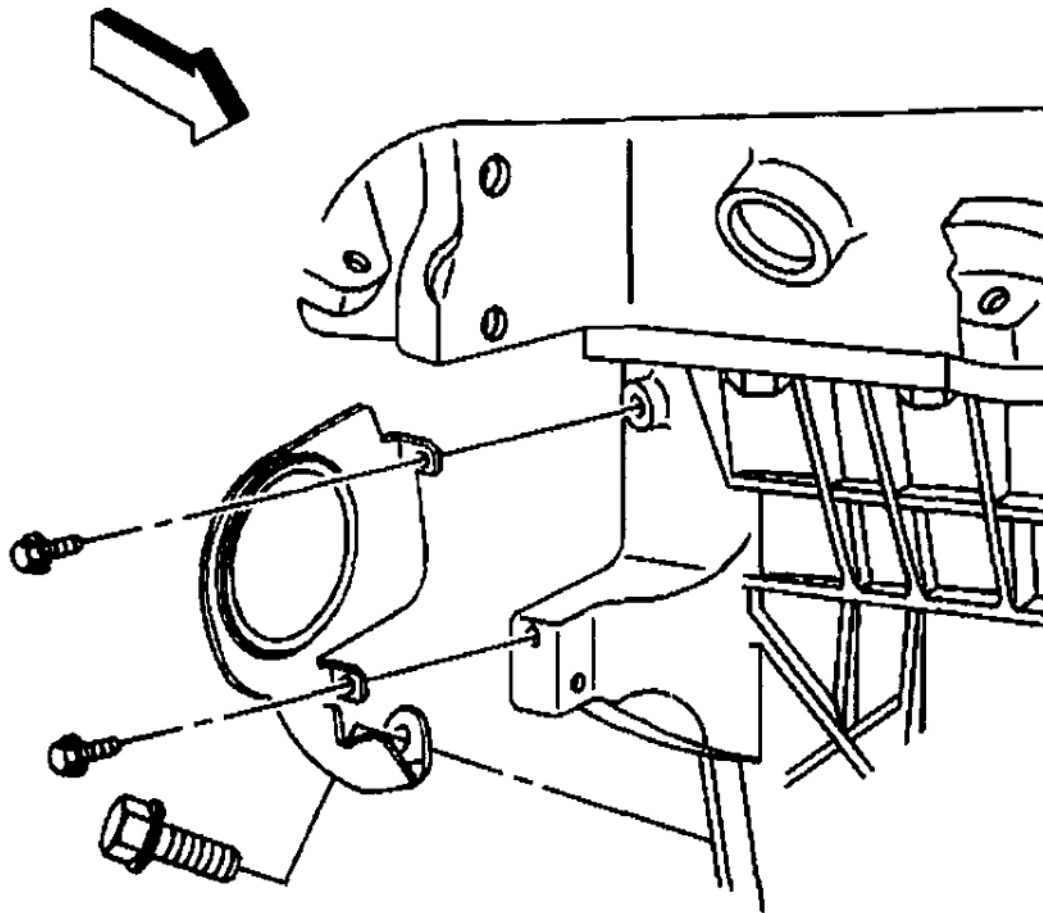


Fig. 350: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

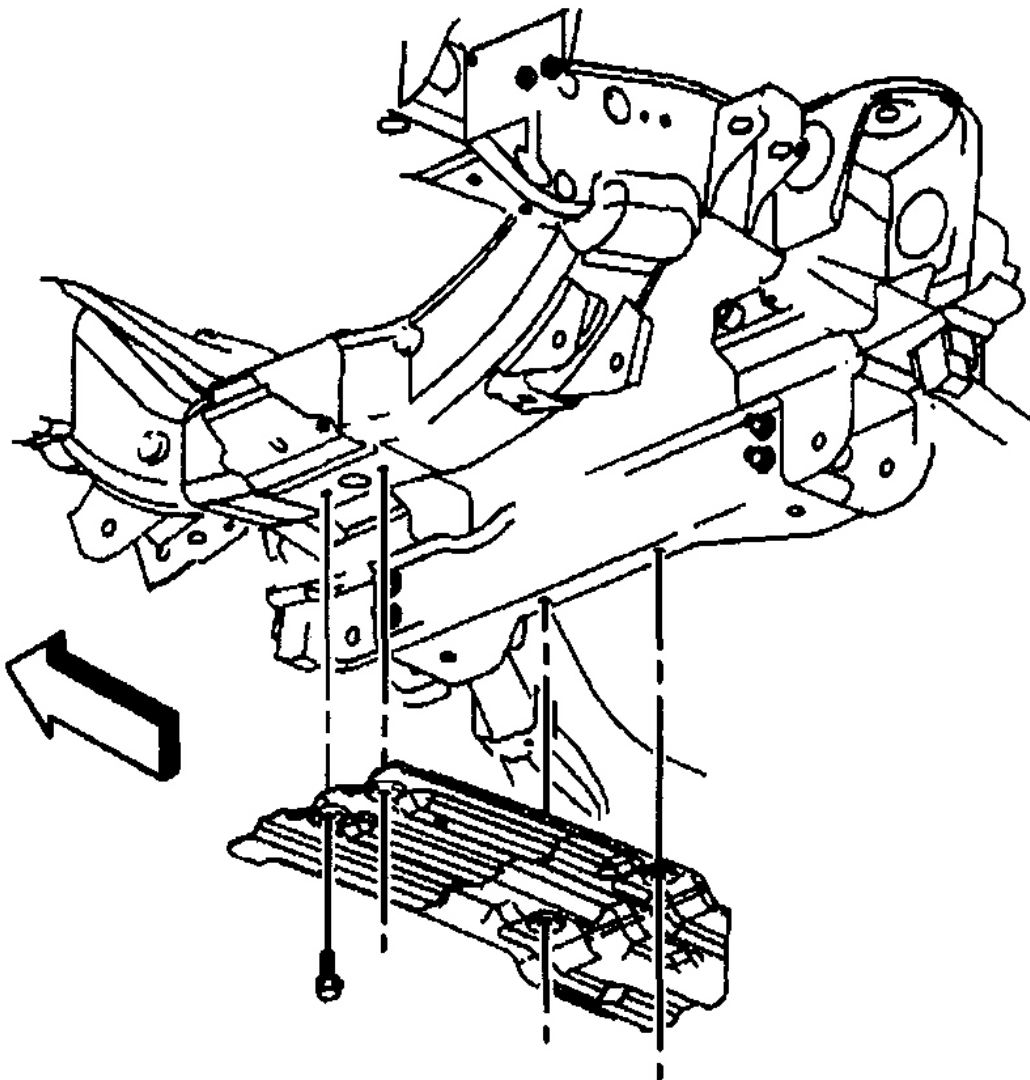
5. Remove the engine shield, if equipped. Refer to
6. Remove the starter. Refer to **STARTER** .



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Fig. 351: View Of Transmission Cover Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the transmission cover.



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Fig. 352: View Of Transmission Oil Cooler Liner Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the transmission oil cooler line bracket bolt, if equipped.
9. Remove the catalytic converter. Refer to **CATALYTIC CONVERTER REPLACEMENT (4.3L, 4.8L & 4.8L, and 5.3L Engines)** or **CATALYTIC CONVERTER REPLACEMENT (6.0L & 8.1L Engines)** .

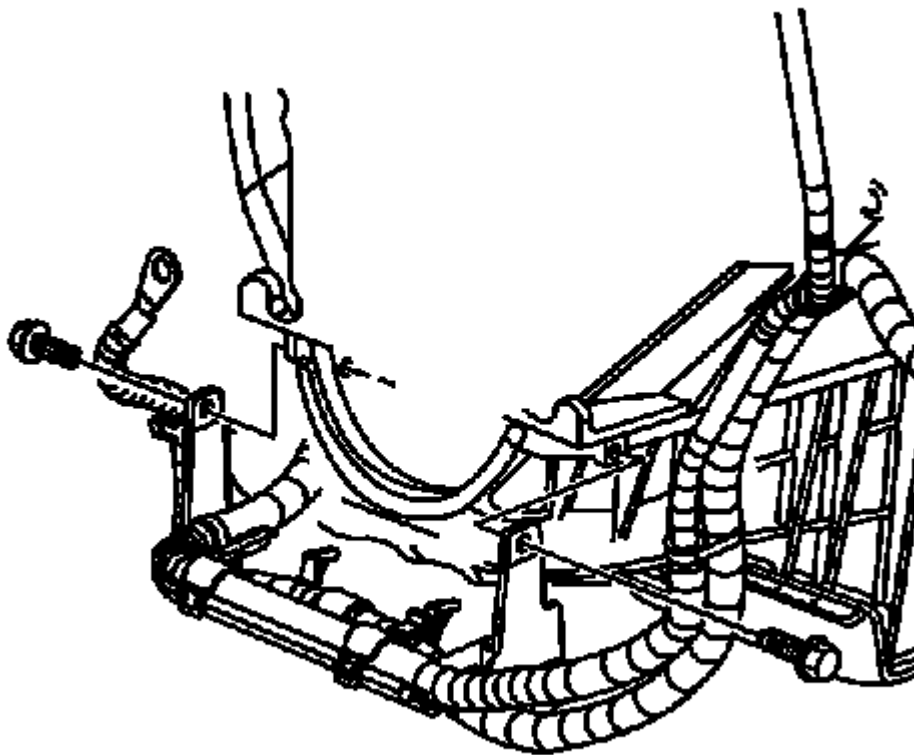


Fig. 353: View Of Battery Cable Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the battery cable bracket bolts.

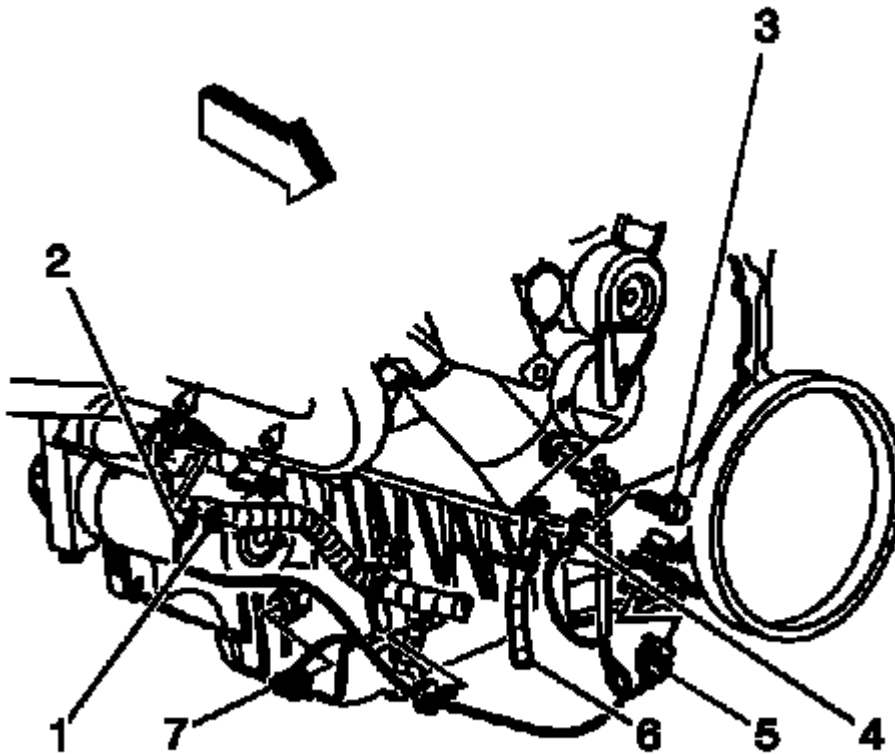


Fig. 354: View Of Oil Level Sensor Electrical Connector, CKP Electrical Connector & Battery Ground Bolt

Courtesy of GENERAL MOTORS CORP.

11. Disconnect the low oil level sensor electrical connector (7).
12. Disconnect the crankshaft position (CKP) sensor electrical connector (5) and remove the harness from the retainer clip.
13. Remove the ground bolt (3) holding the battery negative cable and a ground cable to the engine.

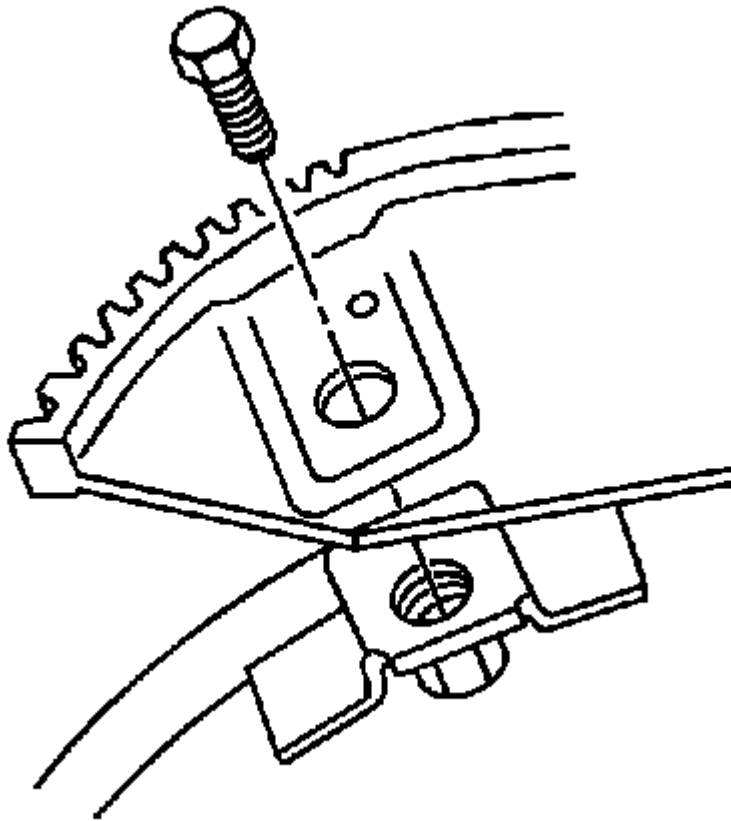


Fig. 355: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the torque converter bolts, if equipped, through the starter opening.
15. Remove the transmission bolts.
16. Lower the vehicle.

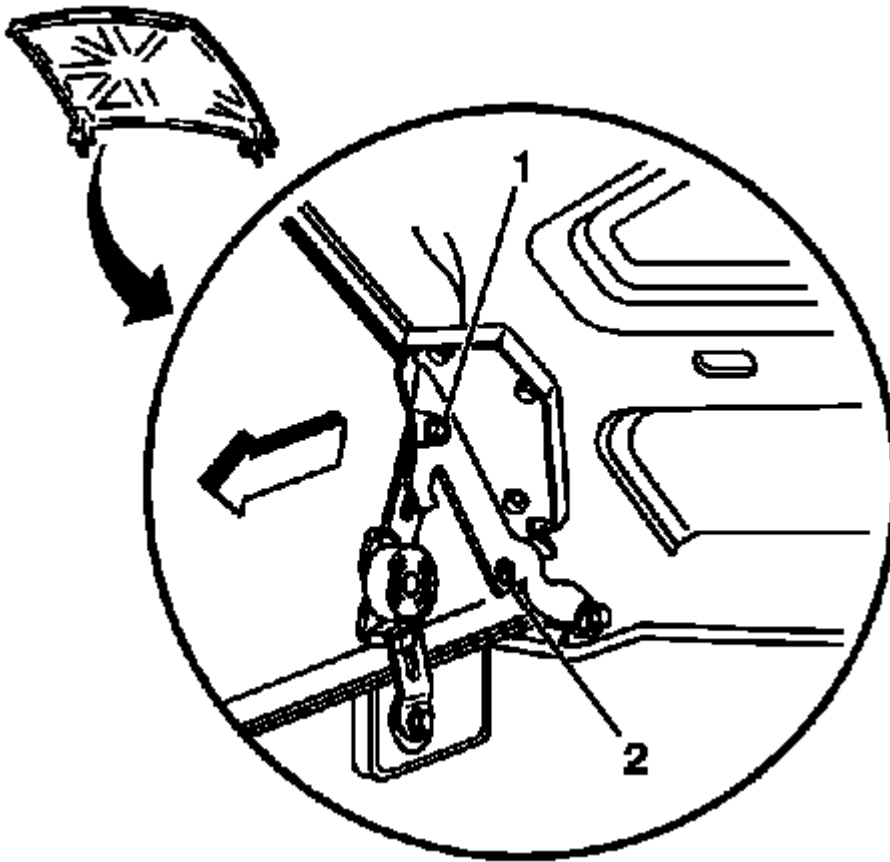


Fig. 356: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

17. Raise the hood to the service position, perform the following:
 1. Remove the hood hinge bolts (1).
 2. Raise the hood until vertical.
 3. Install the hood hinge bolts until snug in the service position (2).
18. Remove the fuel pipes/hoses.
19. Remove the lower fan shroud. Refer to **FAN SHROUD REPLACEMENT - LOWER** .
20. Remove the drive belt. Refer to **Drive Belt Replacement**.

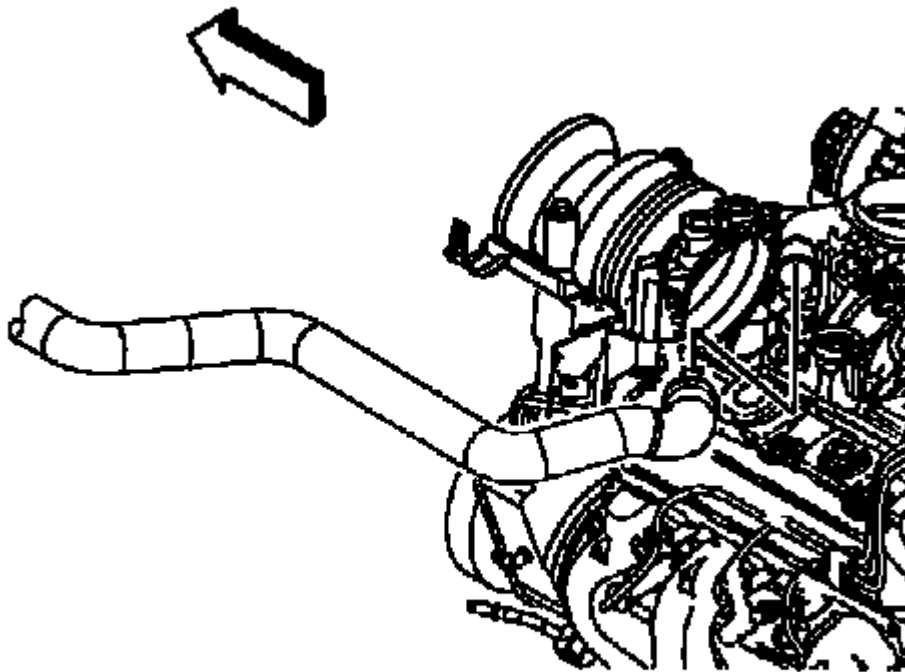


Fig. 357: View Of Radiator Inlet Hose, Clamps & Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

21. Reposition the radiator inlet hose clamp.
22. Remove the radiator inlet hose from the thermostat housing.

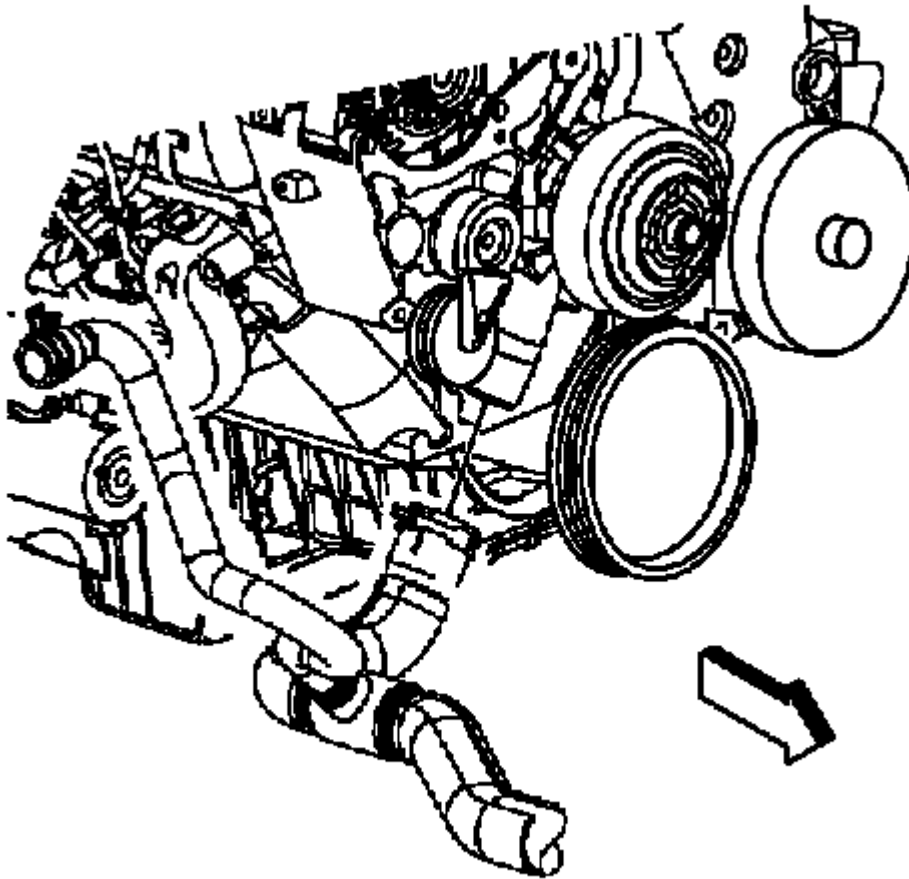


Fig. 358: Installing Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

23. Reposition the radiator outlet hose clamps.
24. Remove the radiator outlet hose from the surge tank.
25. Remove the radiator outlet hose from the water pump.

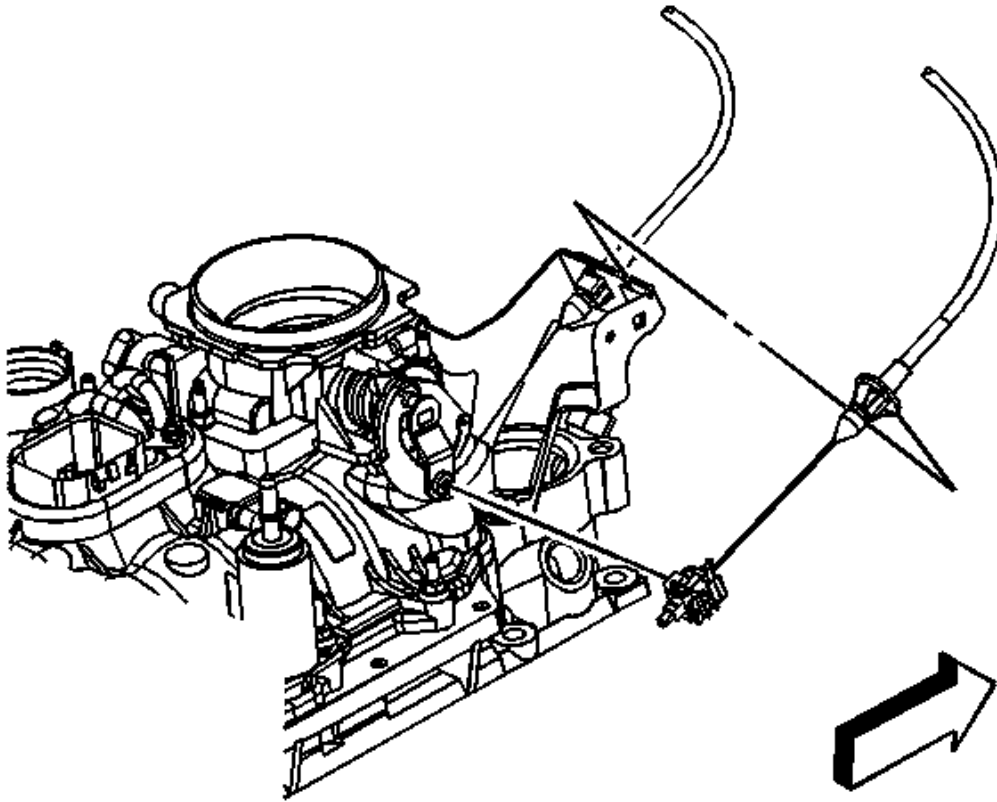


Fig. 359: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

26. Disconnect the cruise control cable from the throttle lever, if equipped.
27. Remove the cruise control cable from the accelerator control cable bracket, if equipped.

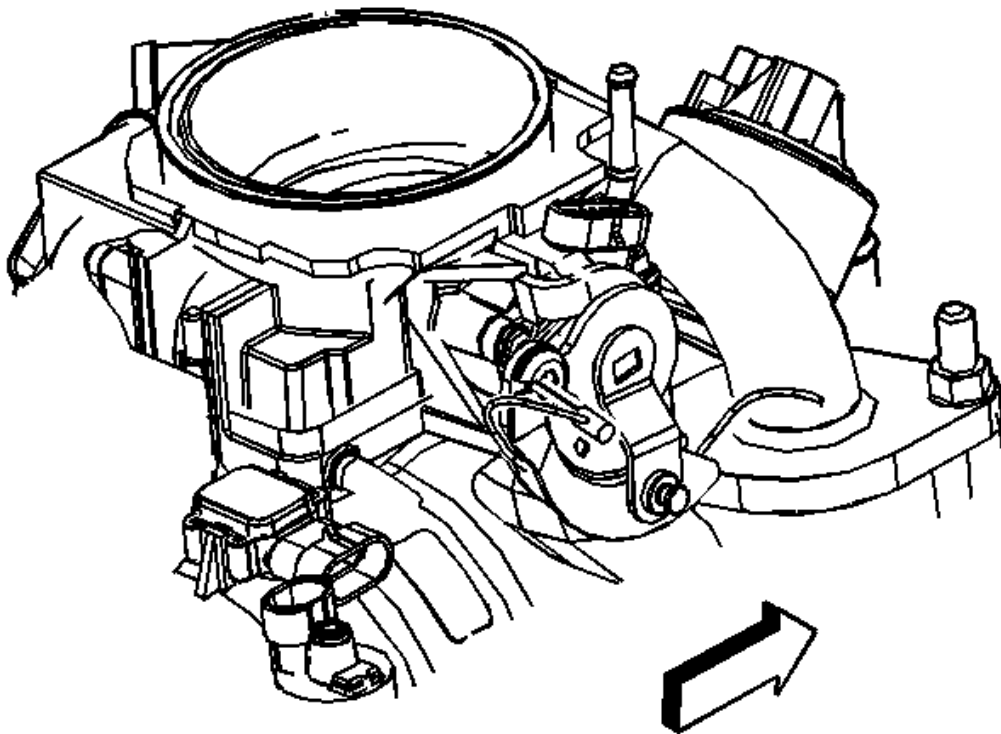


Fig. 360: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

28. Remove the accelerator cable from the throttle body lever.

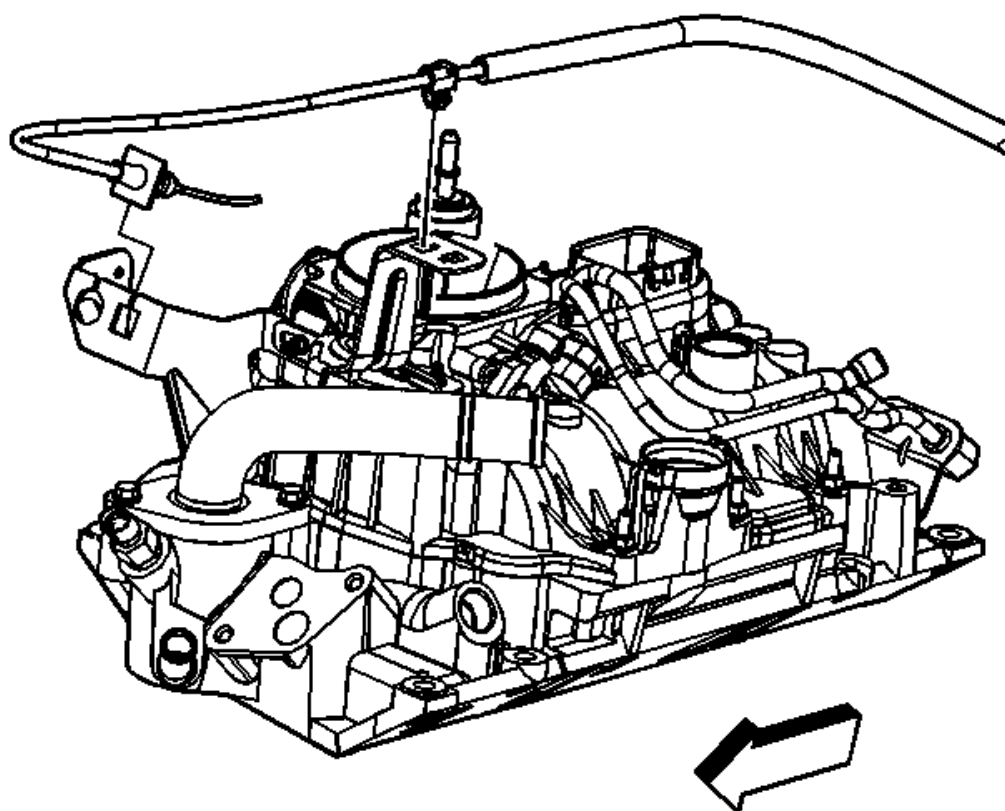


Fig. 361: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a **NEW** cable whenever you remove the engine from the vehicle.
In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

29. Remove the accelerator cable from the accelerator control cable bracket.

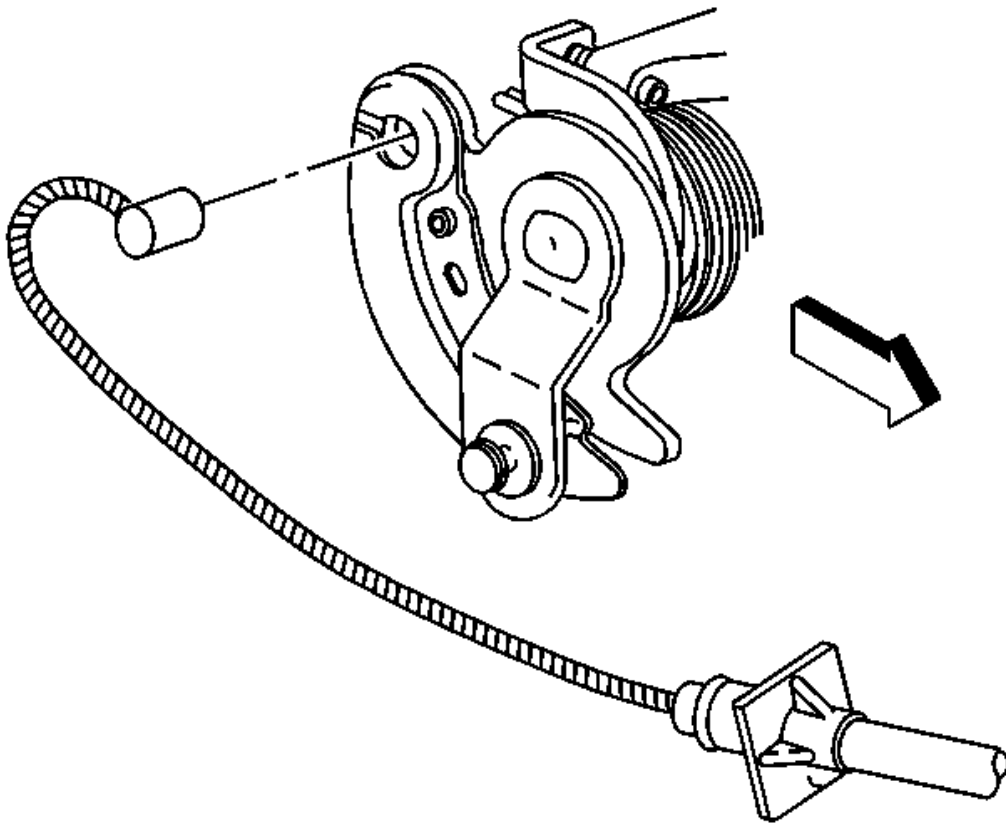


Fig. 362: Identifying Accelerator Cable/Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

30. Remove the accelerator cable from the throttle body lever.

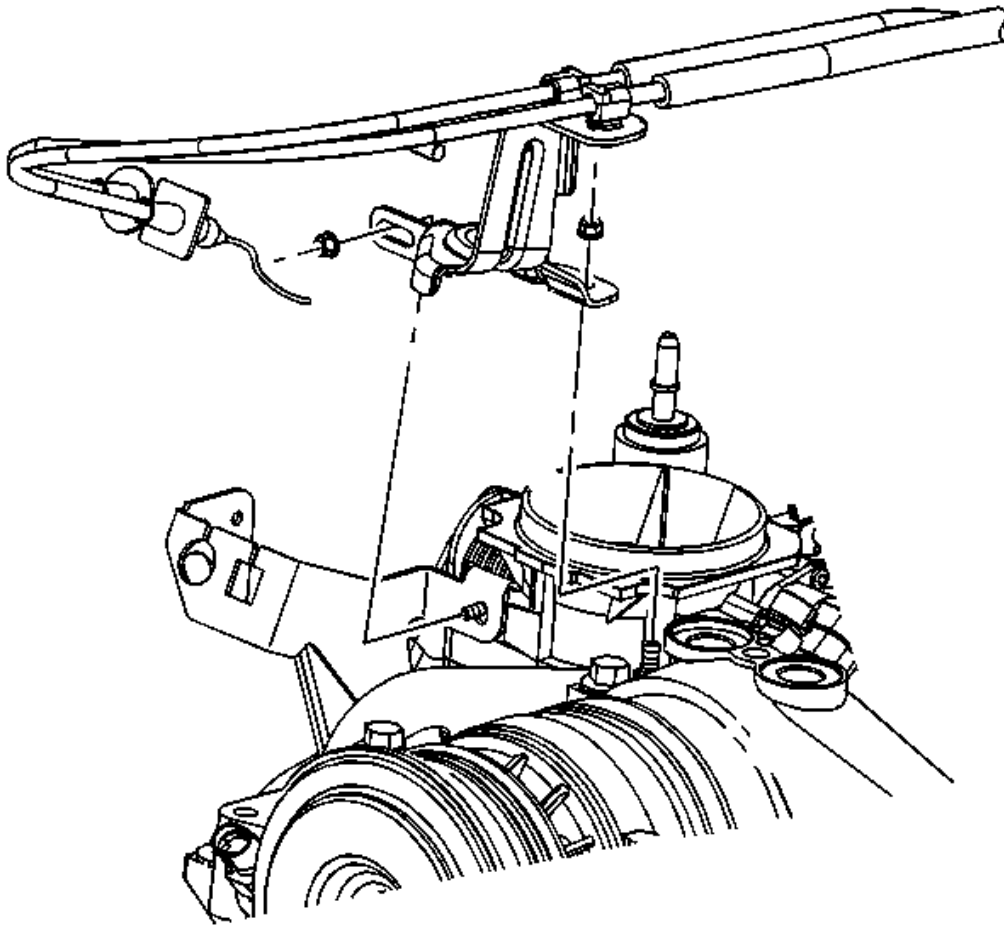


Fig. 363: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

31. Remove the accelerator control cable bracket nuts
32. Remove the accelerator control cable bracket with the cables attached, from the throttle body.
33. Reposition and secure the bracket and cables out of the way.
34. Remove the air conditioning (A/C) compressor hose, if equipped. Refer to **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (L35 W/HARRISON)** or **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (L18 W/HARRISON)** or **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (LB7 W/HARRISON)** .

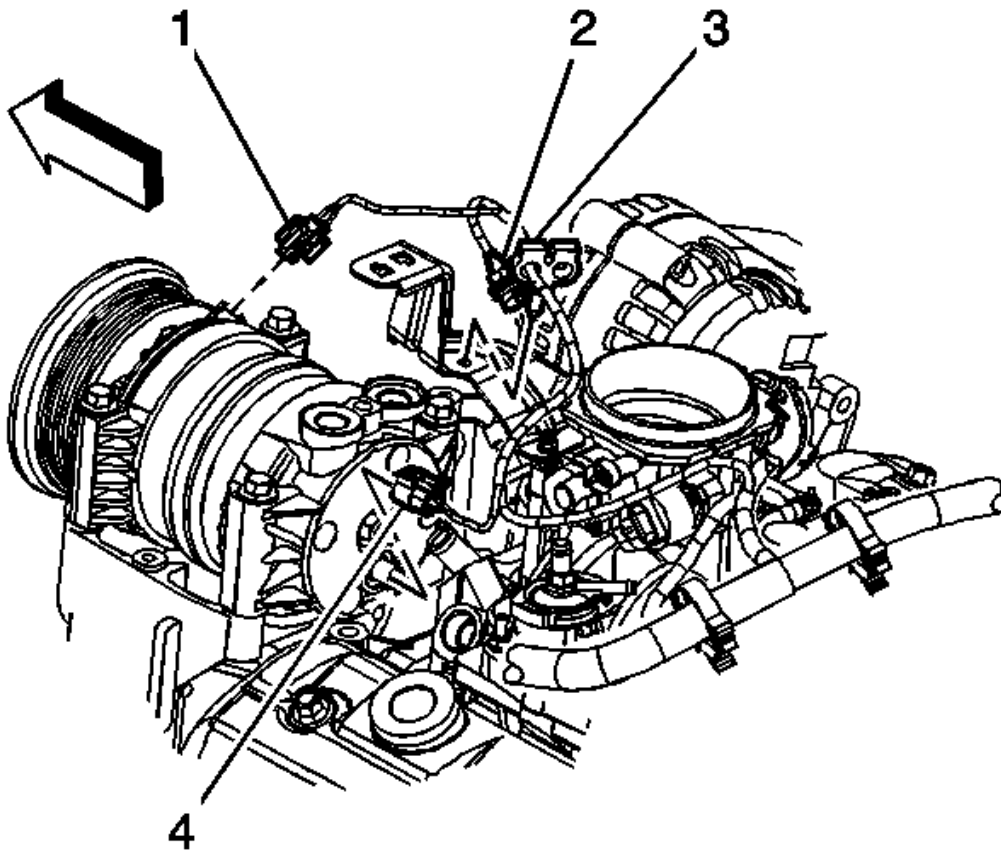


Fig. 364: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

35. Disconnect the following electrical connectors:
- The A/C pressure switch (4), if equipped
 - The A/C compressor clutch (1), if equipped
 - The exhaust gas recirculation (EGR) valve (2)
36. Remove the positive cable nut and cable from the generator.

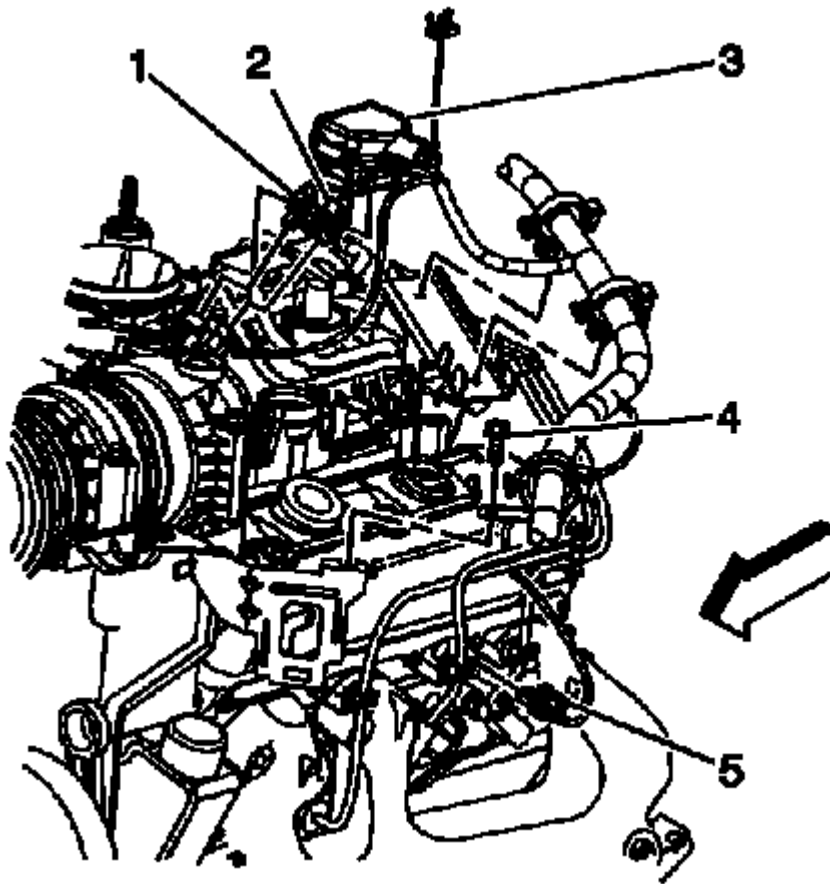


Fig. 365: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

37. Disconnect the following electrical connectors:
 - The throttle position (TP) sensor (1)
 - The idle air control (IAC) motor (2)
 - The control port injector module (3)
 - The engine coolant temperature (ECT) sensor (5)
38. Remove the engine wiring harness clip bolt (4).

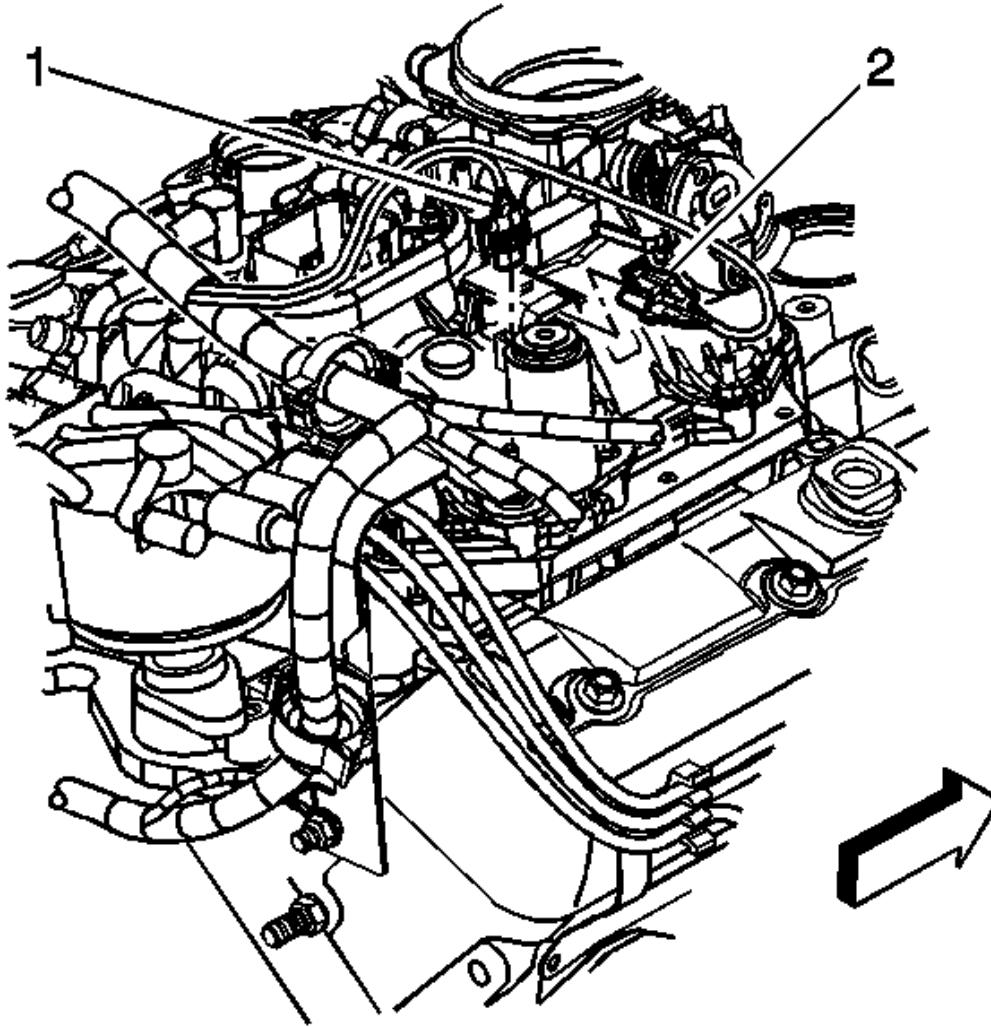


Fig. 366: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

39. Disconnect the following electrical connectors:
- The evaporative emission (EVAP) canister purge solenoid valve (1)
 - The manifold absolute pressure (MAP) sensor (2)

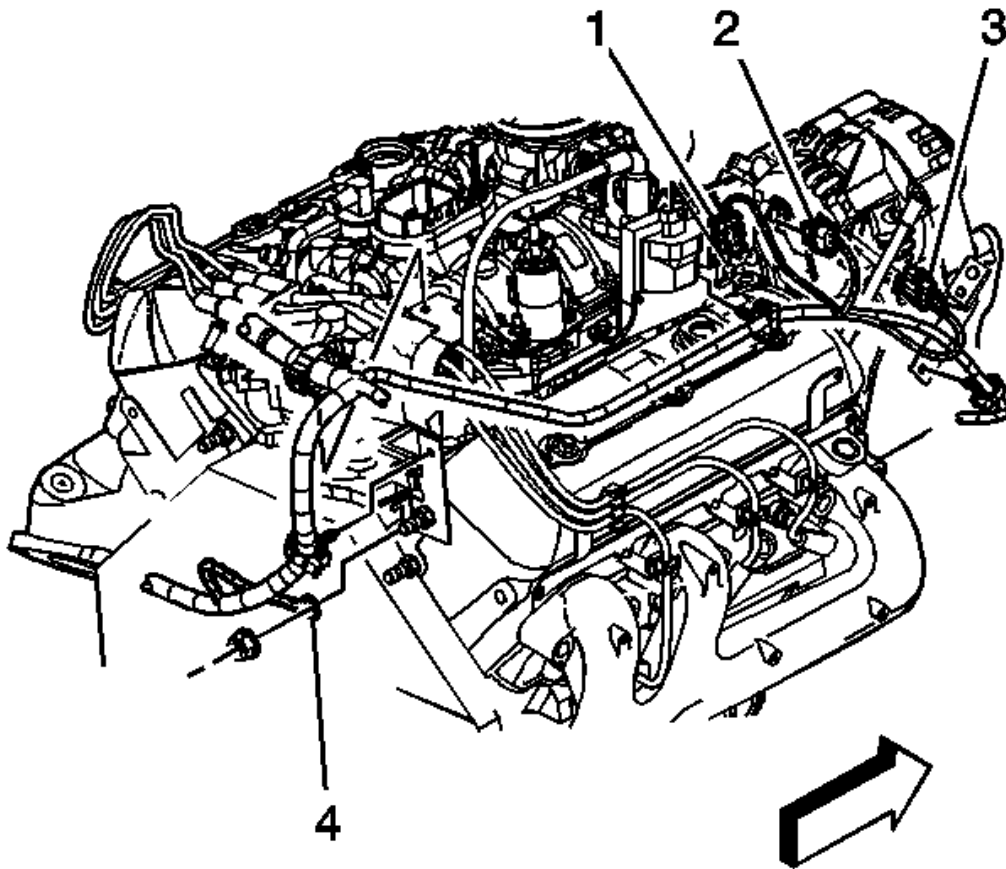


Fig. 367: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

40. Disconnect the following electrical connectors:
 - The ignition coil (1)
 - The ignition coil driver (2)
 - The generator (3)
41. Remove the engine wiring harness ground nut and ground wire (4) from the rear of the right cylinder head.

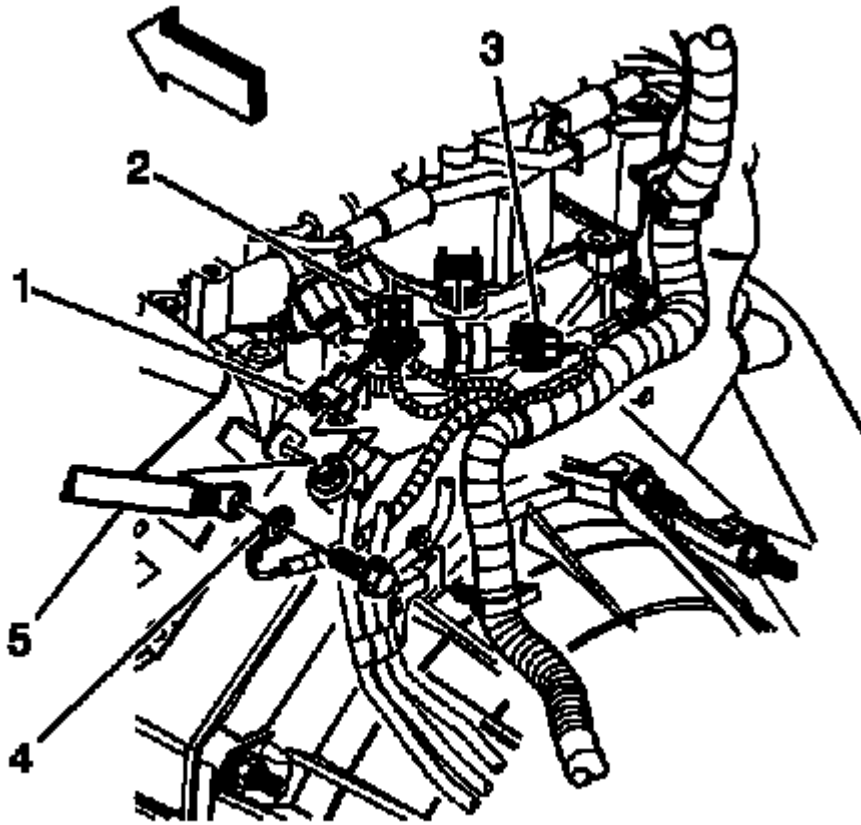


Fig. 368: View Of Ground Strap And CMP & Fuel Pump/Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

42. Disconnect the following electrical connectors:
 - The knock sensor (KS) (1)
 - The camshaft position (CMP) sensor (2)
 - The fuel pump/oil pressure sensor (3)
 - The distributor (2)
43. Remove the harness ground bolt.
44. Reposition the harness ground (4) and ground strap (5).

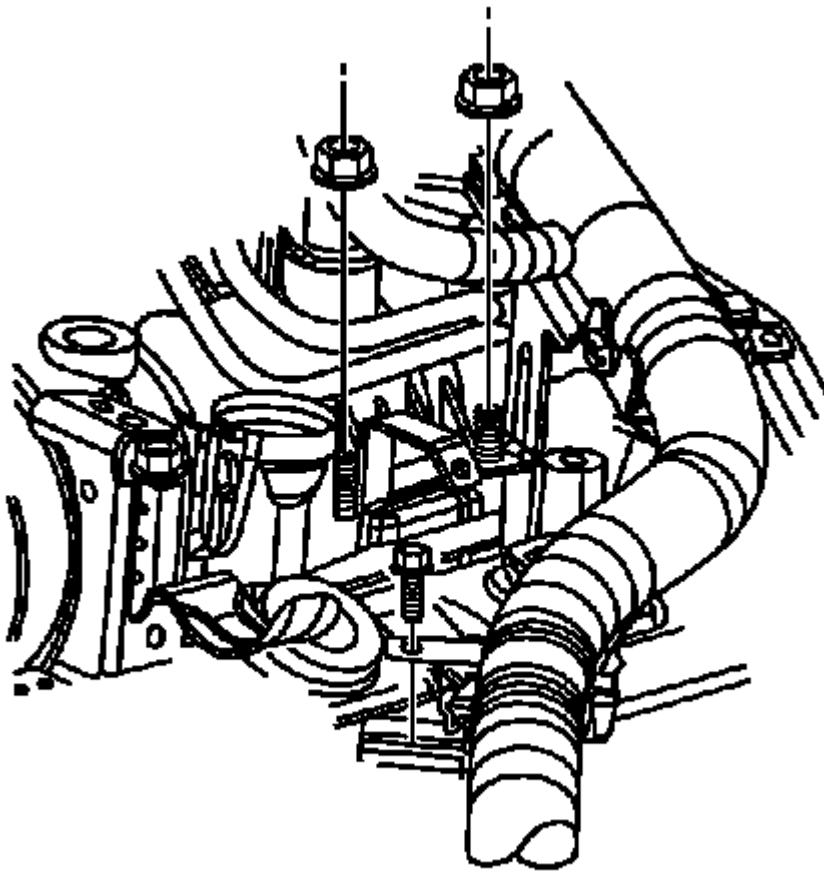


Fig. 369: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

45. Remove the engine wiring harness bracket nuts.
46. Remove the engine wiring harness bracket from the studs.

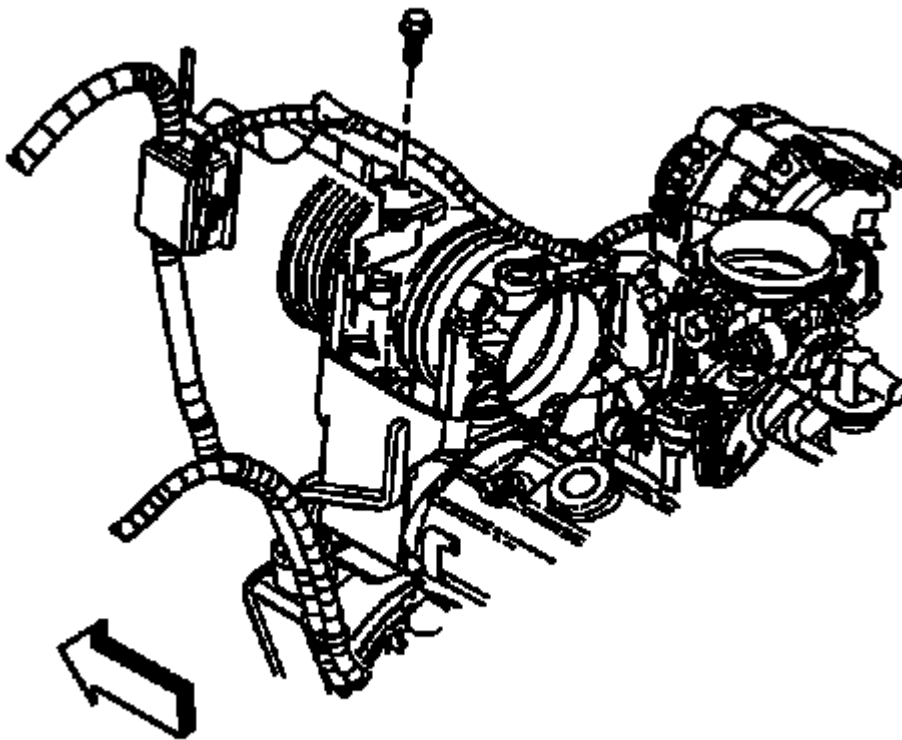


Fig. 370: View Of Junction Block Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

47. Remove the junction block bracket bolt.
48. Reposition the bracket and wiring harness aside.

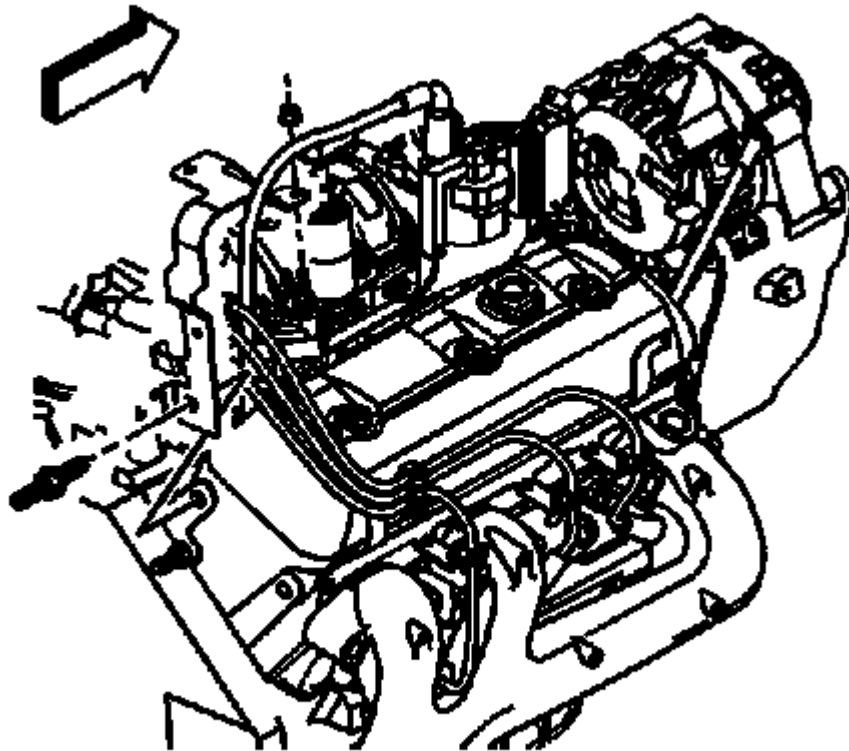
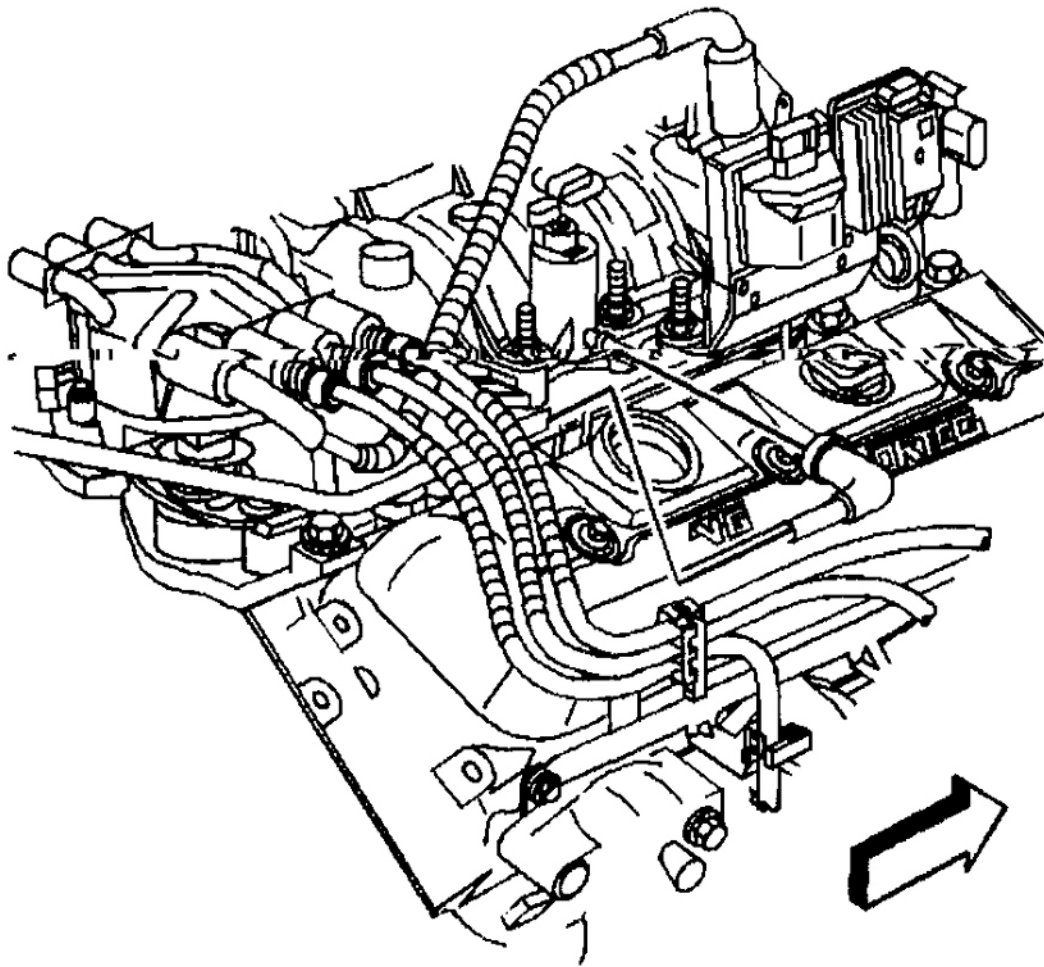


Fig. 371: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

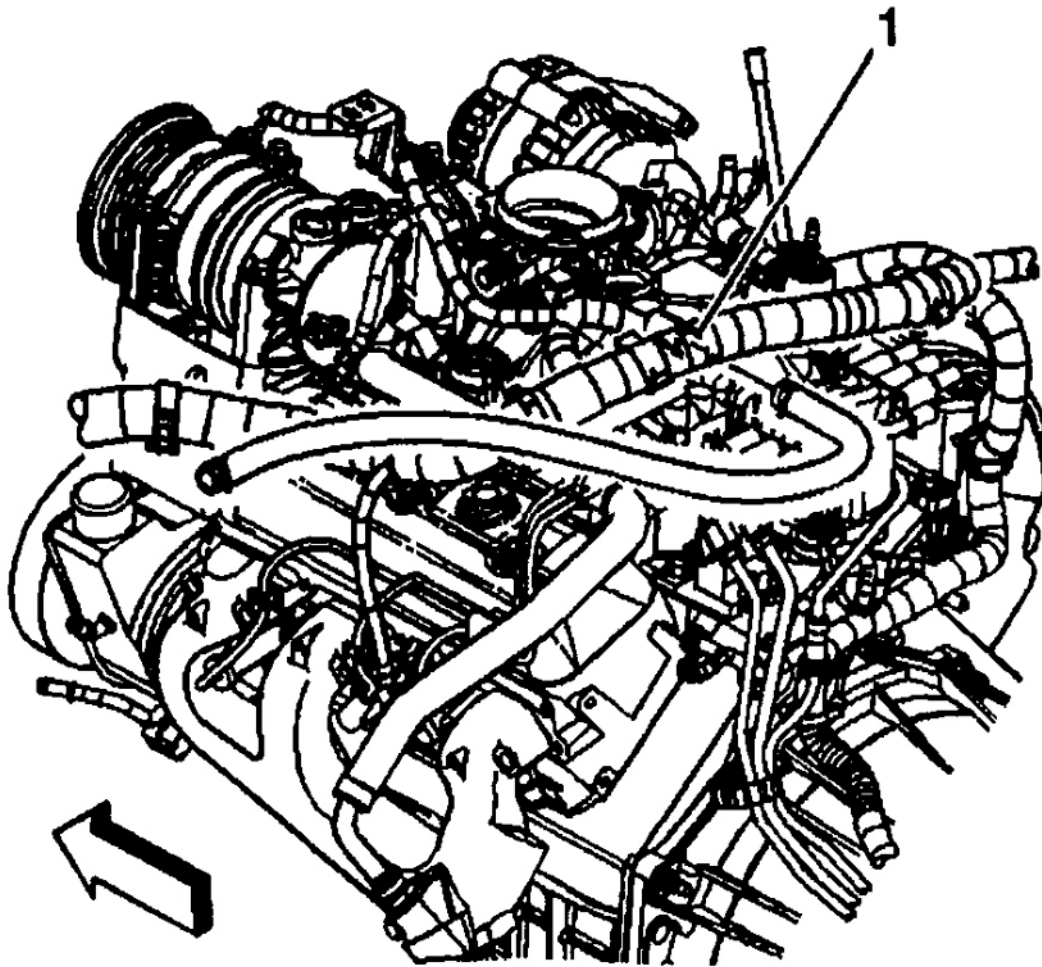
49. Remove the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.
50. Remove the stud holding the engine wiring harness bracket.
51. Reposition the engine wiring harness with the bracket aside.
52. Remove the heater hoses. Refer to one of the following.
 - **HEATER HOSE REPLACEMENT -- INLET (L18)**
 - **HEATER HOSE REPLACEMENT -- INLET (LB7)**
 - **HEATER HOSE REPLACEMENT -- INLET (L35)**
 - **HEATER HOSE REPLACEMENT -- INLET (LR4, LM7 & LQ4)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (L18)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (LB7)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (L35)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (LR4, LM7, & LQ4)**
53. Remove the distributor cap. Refer to **DISTRIBUTOR** .



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Fig. 372: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

54. Disconnect the EVAP canister harness from the purge solenoid valve.



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Fig. 373: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

55. Disconnect the power brake booster vacuum hose from the vacuum fitting (1).

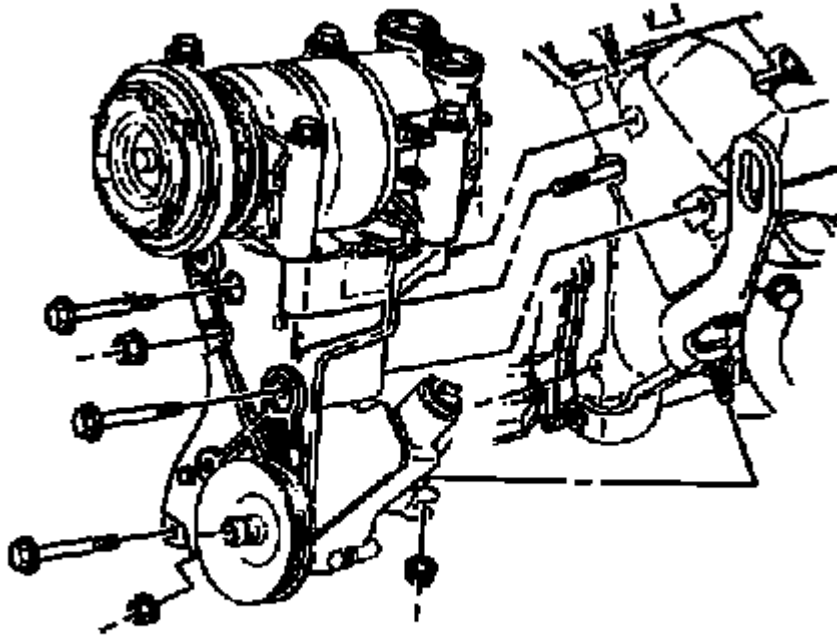
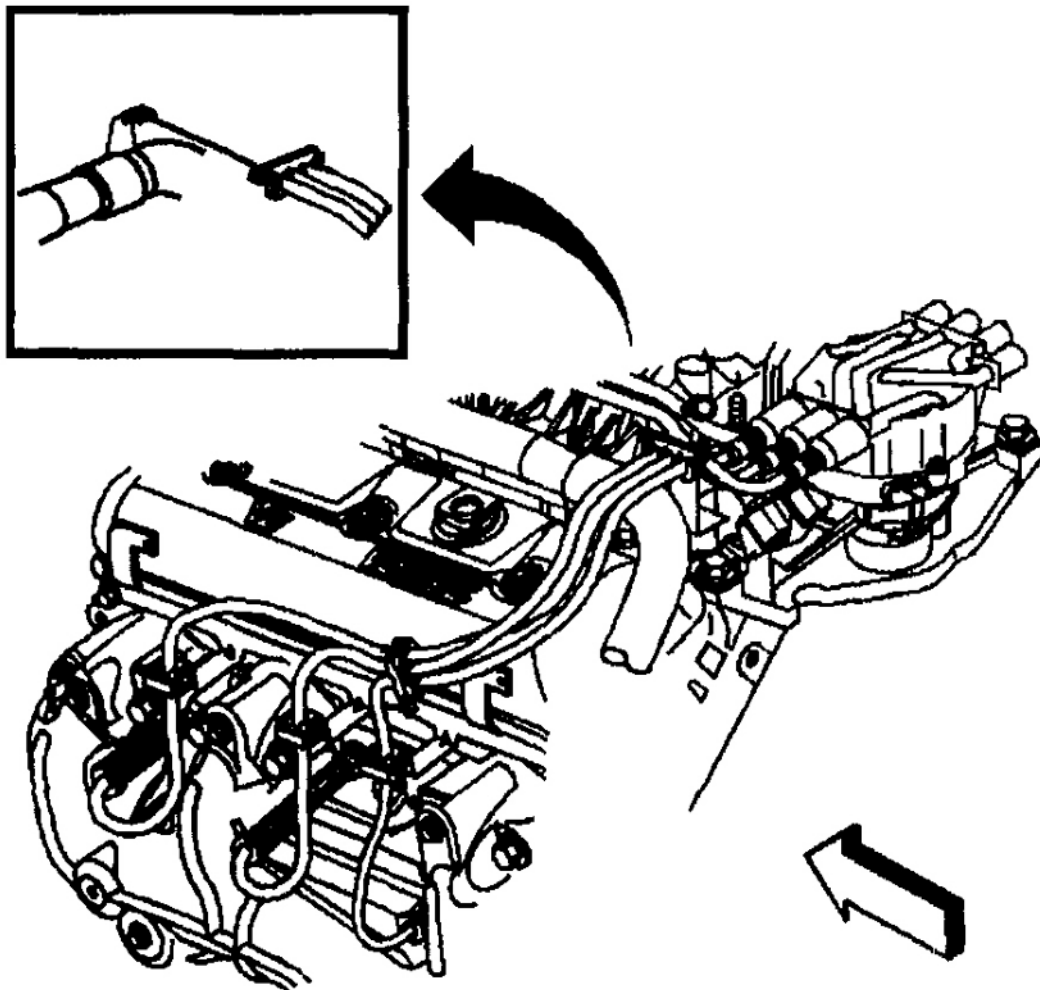


Fig. 374: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

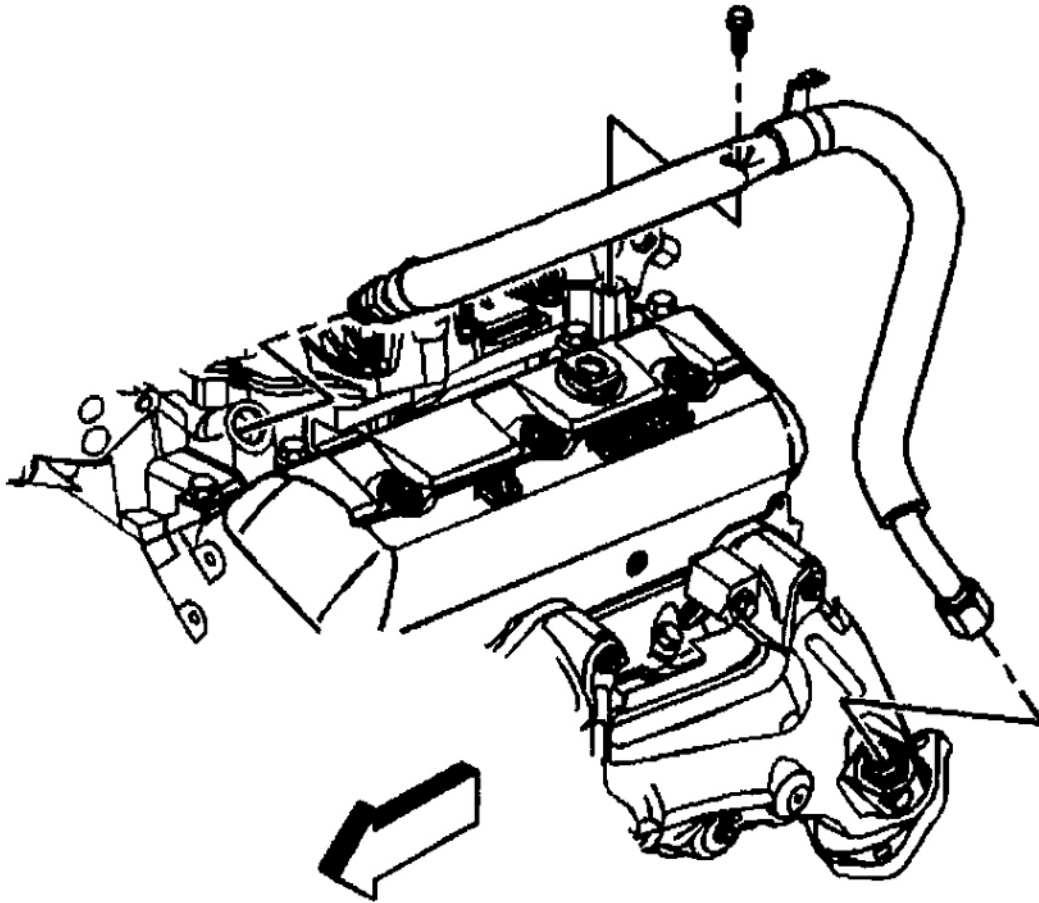
56. Loosen the power steering (P/S) pump rear bracket nut.
57. Remove the P/S pump rear bracket front nut.
58. Remove the bolts and the nut for the P/S pump bracket.
59. Leave the A/C compressor, if equipped and the P/S pump on the bracket.
60. Slide the P/S pump bracket off the stud and set aside.
61. Remove the thermostat and water outlet. Refer to **THERMOSTAT REPLACEMENT (4.3L ENGINE)** or **THERMOSTAT REPLACEMENT (6.6L ENGINE)** or **THERMOSTAT REPLACEMENT (8.1L ENGINE)** .



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Fig. 375: View Of Spark Plug Wire Harness Retainer
Courtesy of GENERAL MOTORS CORP.

62. Remove the spark plug wire harness retainer from the EGR valve inlet pipe.



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Fig. 376: View Of EGR Valve Inlet Pipe & Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

63. Remove the EGR valve inlet pipe bracket bolt.
64. Remove the EGR valve inlet pipe.
65. Remove the left front and right rear intake manifold - lower bolts.
66. Install J 41427 to the left front and right rear intake manifold bolts, using the following procedure:
 1. Install the J 41427 marked RIGHT REAR.

NOTE: Refer to **FASTENER NOTICE** .

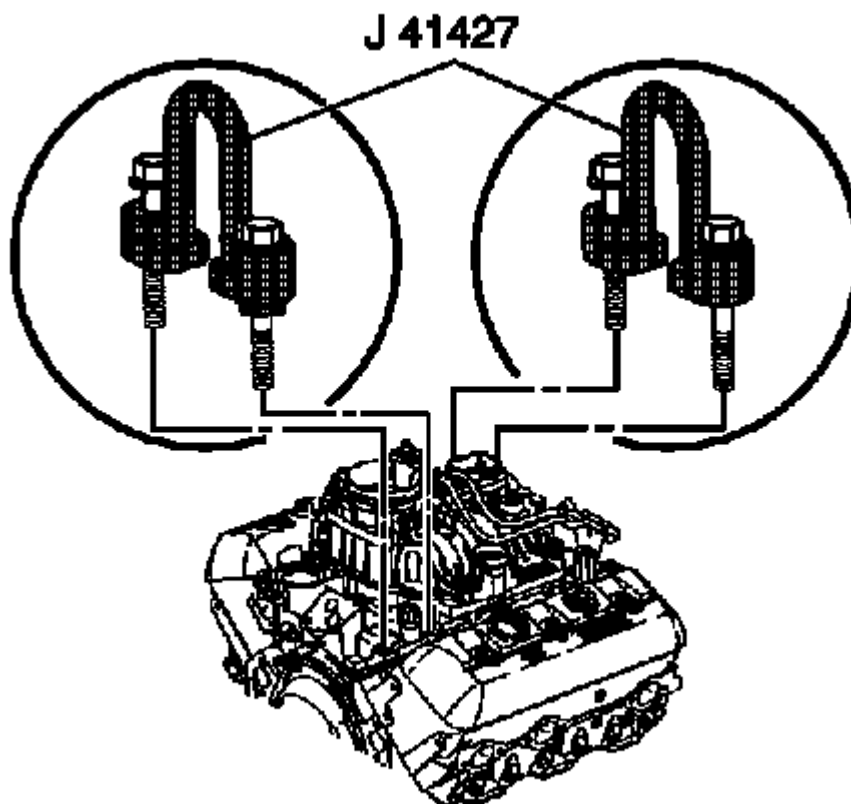


Fig. 377: View Of J 41427 & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

2. Install the lift bracket retaining bolts.

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

3. Install the J 41427 marked LEFT FRONT with the arrow pointing to the front of the engine.
4. Install the lift bracket retaining bolts.

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

67. Attach a suitable lifting device to the engine lift brackets.

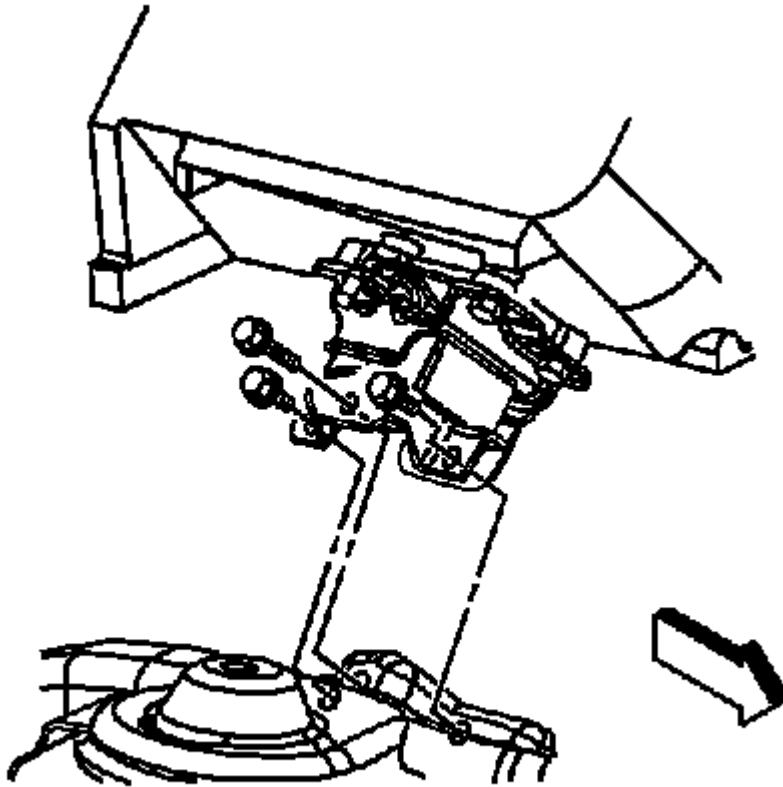


Fig. 378: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

68. Remove the engine mount to engine mount bracket bolts.
69. Support the transmission with a suitable floor jack.
70. Remove the engine.

Installation Procedure

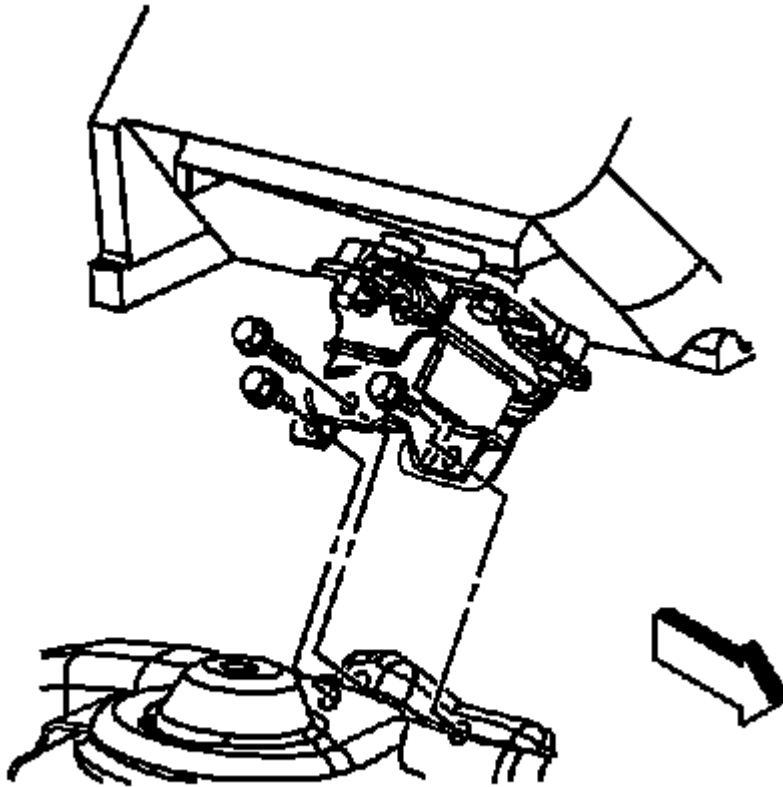


Fig. 379: View Of Right Side (Left Side Similar) Engine Mount To Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

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

Tighten: Tighten the engine mount to engine mount bracket bolts to 65 N.m (48 lb ft).

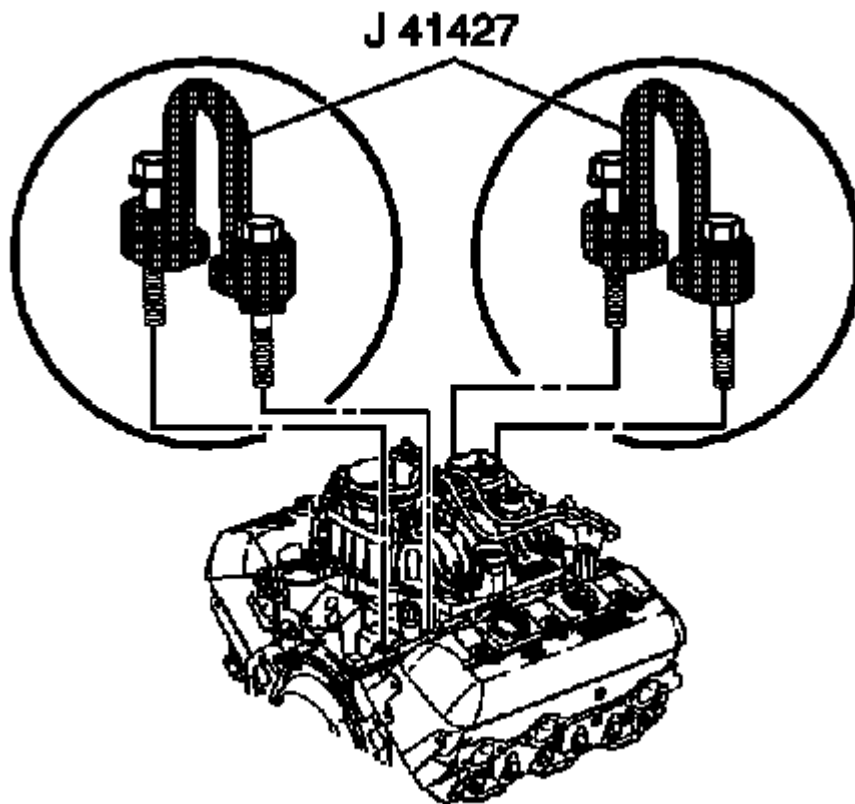
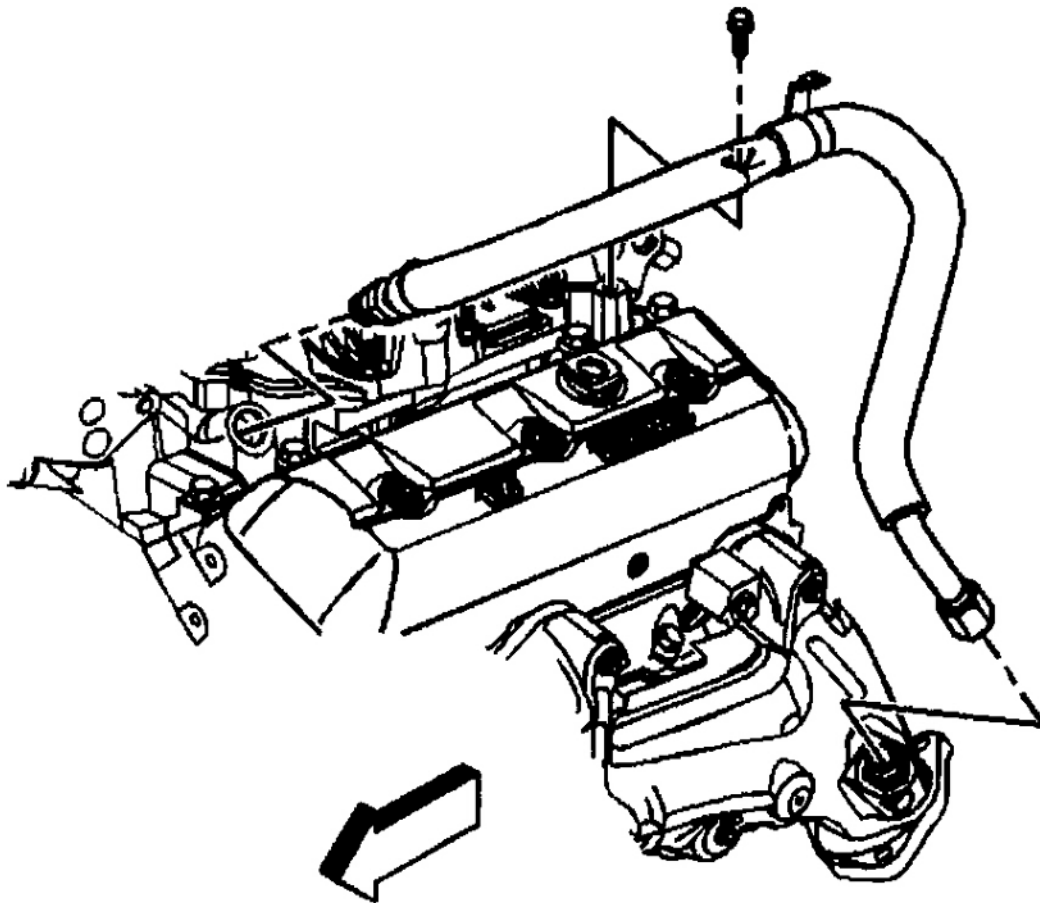


Fig. 380: View Of J 41427 & Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

3. Remove the J 41427 and the lifting device.
4. Apply threadlock GM U.S. P/N 12345382, Canada P/N 10953489, or equivalent to the threads of the intake manifold - lower bolts.
5. Install the intake manifold bolts.

Tighten:

1. Tighten the intake manifold - lower bolts a first pass to 3 N.m (27 lb in).
 2. Tighten the intake manifold - lower bolts a second pass to 12 N.m (106 lb in).
 3. Tighten the intake manifold - lower bolts a final pass to 15 N.m (11 lb ft).
6. Install one transmission bolt until snug.
 7. Remove the support jack from under the transmission.



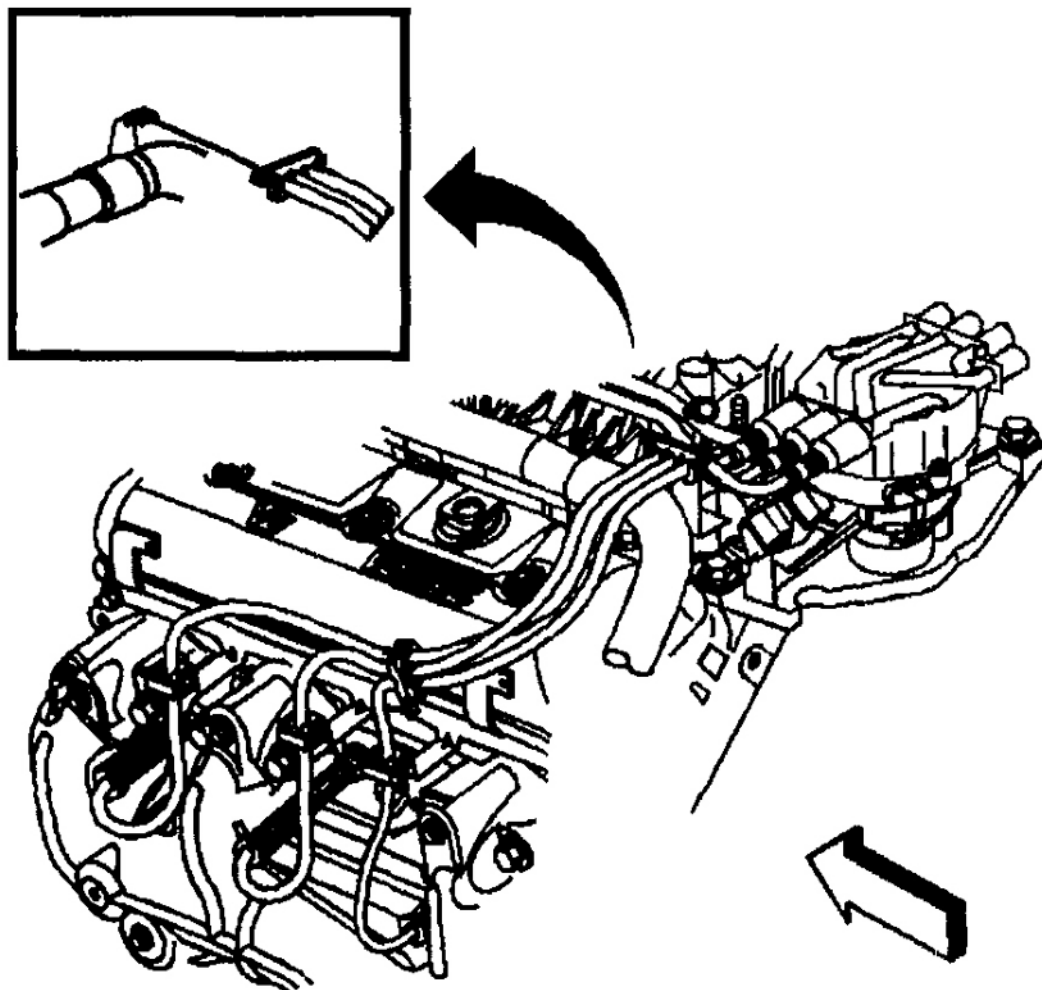
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Fig. 381: View Of EGR Valve Inlet Pipe & Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the EGR valve inlet pipe.
9. Install the EGR valve inlet pipe bracket bolt.

Tighten:

- Tighten the EGR valve inlet pipe fitting to the exhaust manifold to 25 N.m (18 lb ft).
- Tighten the EGR valve inlet pipe fitting to the intake manifold to 30 N.m (22 lb ft).
- Tighten the EGR valve inlet pipe bracket bolt to 25 N.m (18 lb ft).



G01654484

Fig. 382: View Of Spark Plug Wire Harness Retainer
Courtesy of GENERAL MOTORS CORP.

10. Install the spark plug wire harness retainer to the EGR valve inlet pipe.
11. Install the thermostat and water outlet. Refer to **THERMOSTAT REPLACEMENT (4.3L ENGINE)** or **THERMOSTAT REPLACEMENT (6.6L ENGINE)** or **THERMOSTAT REPLACEMENT (8.1L ENGINE)** .

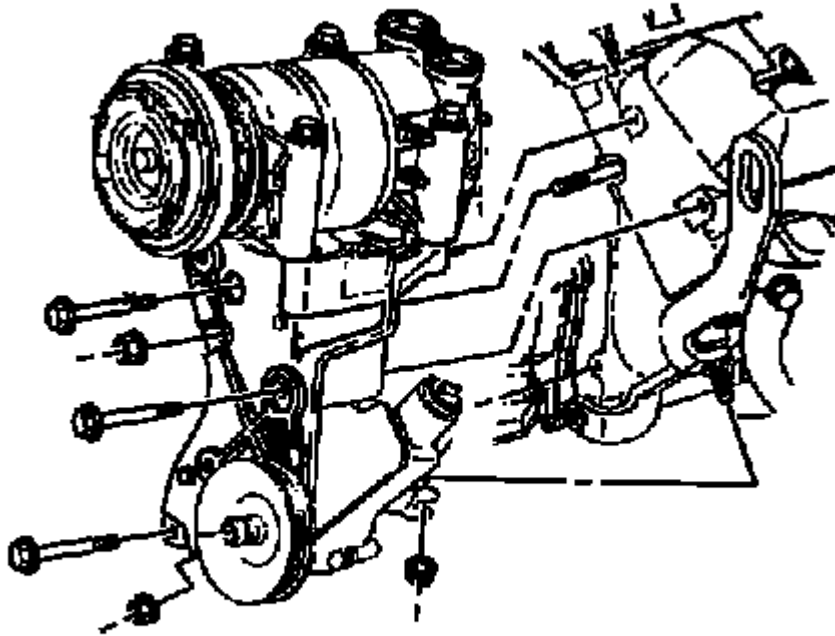
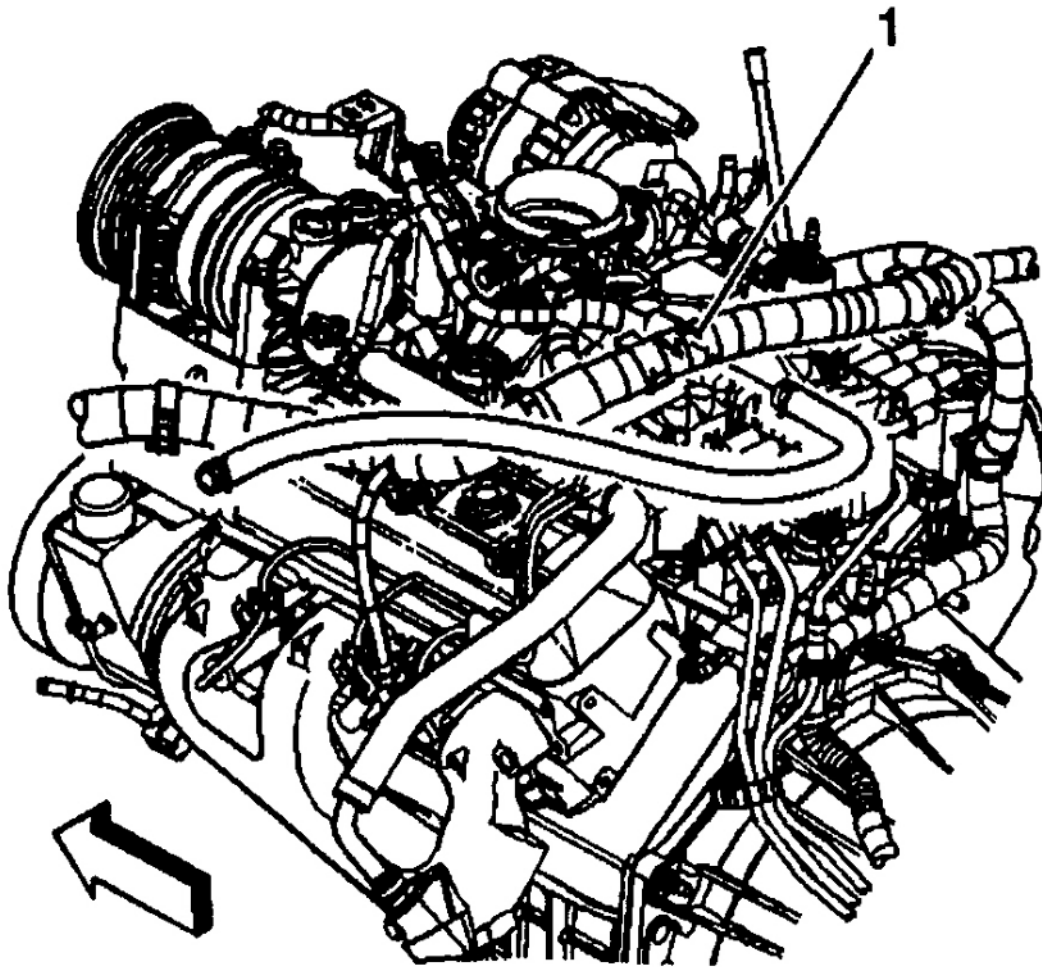


Fig. 383: View Of Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

12. Slide the P/S pump bracket onto the stud.
13. Install the bolts and the nut for the P/S pump bracket.
14. Install the P/S pump rear bracket front nut.
15. Tighten the P/S pump rear bracket nut.

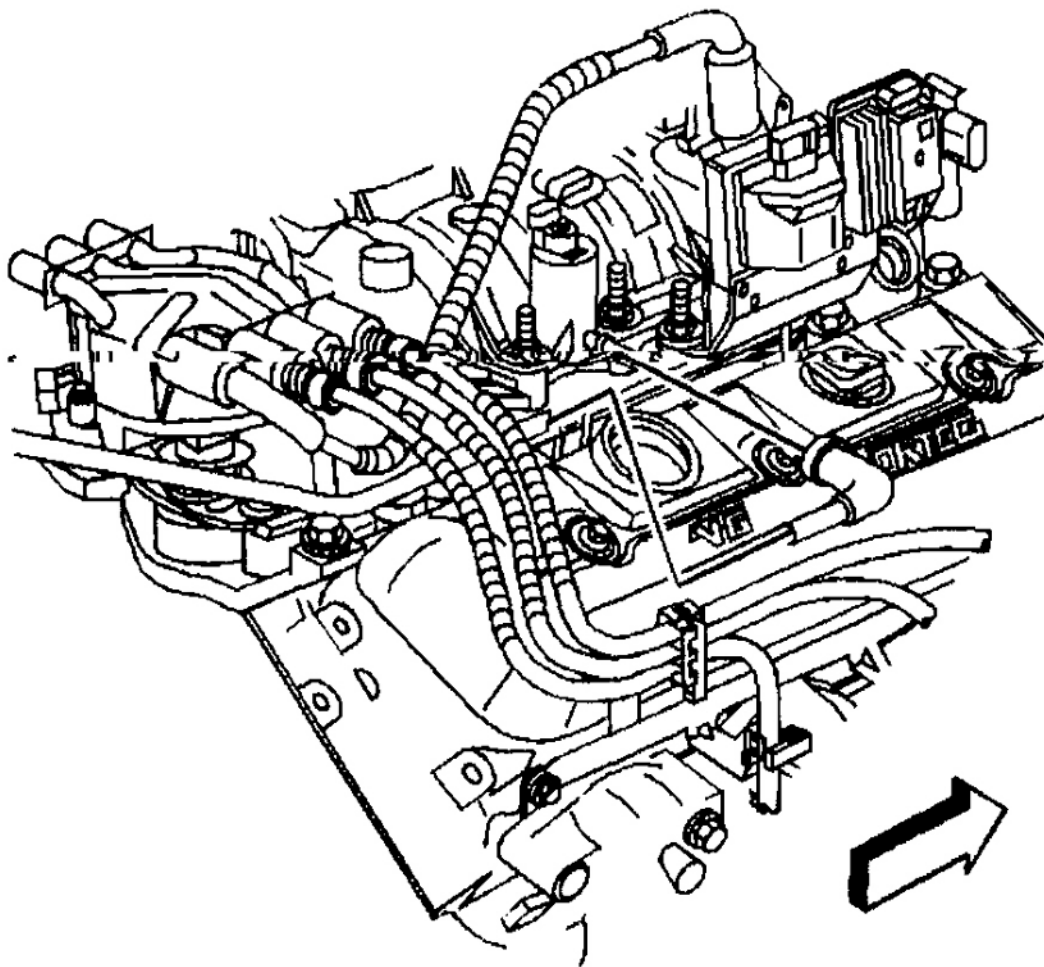
Tighten: Tighten the P/S pump bracket bolts and nuts to 41 N.m (30 lb ft).



G01654435

Fig. 384: View Of Power Brake Booster Vacuum Hose & Vacuum Fitting
Courtesy of GENERAL MOTORS CORP.

16. Connect the power brake booster vacuum hose to the vacuum fitting (1).



G01654430

Fig. 385: View Of EVAP Canister Harness & Purge Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

17. Connect the EVAP canister harness to the purge solenoid valve.
18. Install the distributor cap. Refer to **DISTRIBUTOR** .
19. Install the heater hoses. Refer to one of the following.
 - **HEATER HOSE REPLACEMENT -- INLET (L18)**
 - **HEATER HOSE REPLACEMENT -- INLET (LB7)**
 - **HEATER HOSE REPLACEMENT -- INLET (L35)**
 - **HEATER HOSE REPLACEMENT -- INLET (LR4, LM7 & LQ4)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (L18)**
 - **HEATER HOSE REPLACEMENT -- OUTLET (LB7)**

- HEATER HOSE REPLACEMENT -- OUTLET (L35)
- HEATER HOSE REPLACEMENT -- OUTLET (LR4, LM7, & LQ4)

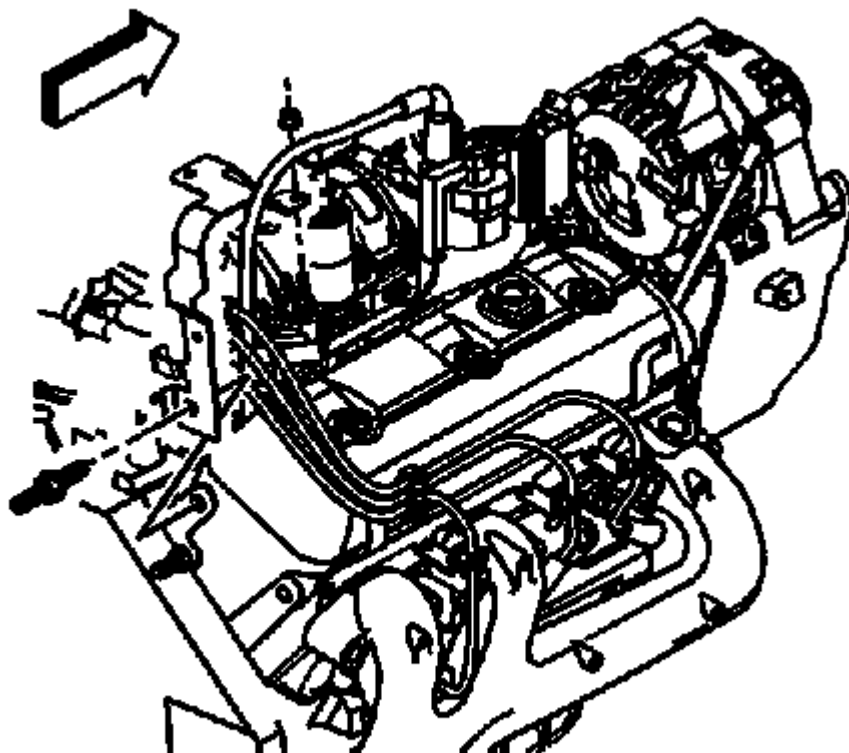


Fig. 386: View Of Engine Wiring Harness Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

20. Position the engine wiring harness.
21. Install the stud holding the engine wiring harness bracket.
22. Install the engine wiring harness rear bracket nut at the EVAP canister purge solenoid valve.

Tighten: Tighten the engine wiring harness rear bracket nut to 9 N.m (80 lb in).

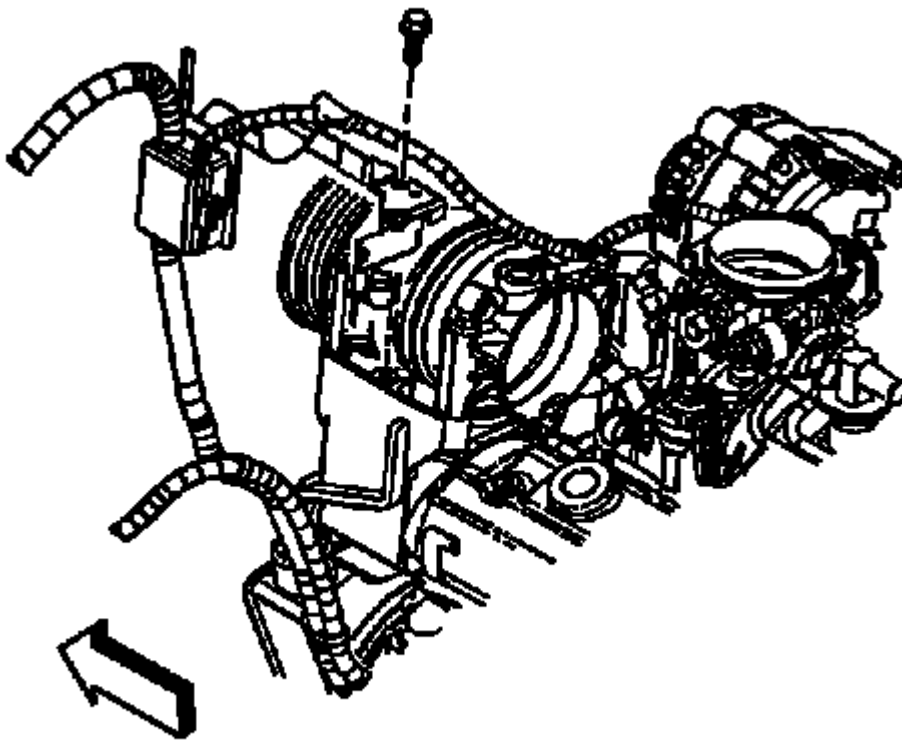


Fig. 387: View Of Junction Block Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

23. Position the bracket and wiring harness.
24. Install the junction block bracket bolt.

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

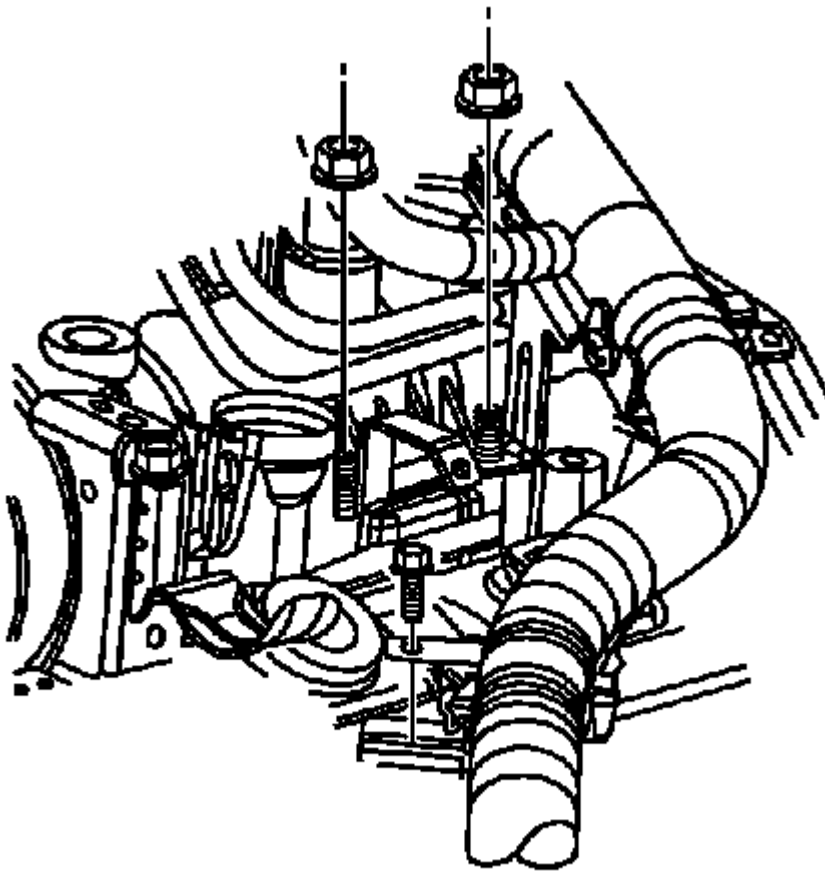


Fig. 388: View Of Engine Wiring Harness Bracket & Nuts
Courtesy of GENERAL MOTORS CORP.

25. Install the engine wiring harness bracket to the studs.
26. Install the engine wiring harness bracket nuts.

Tighten: Tighten the engine wiring harness bracket nuts to 12 N.m (106 lb in).

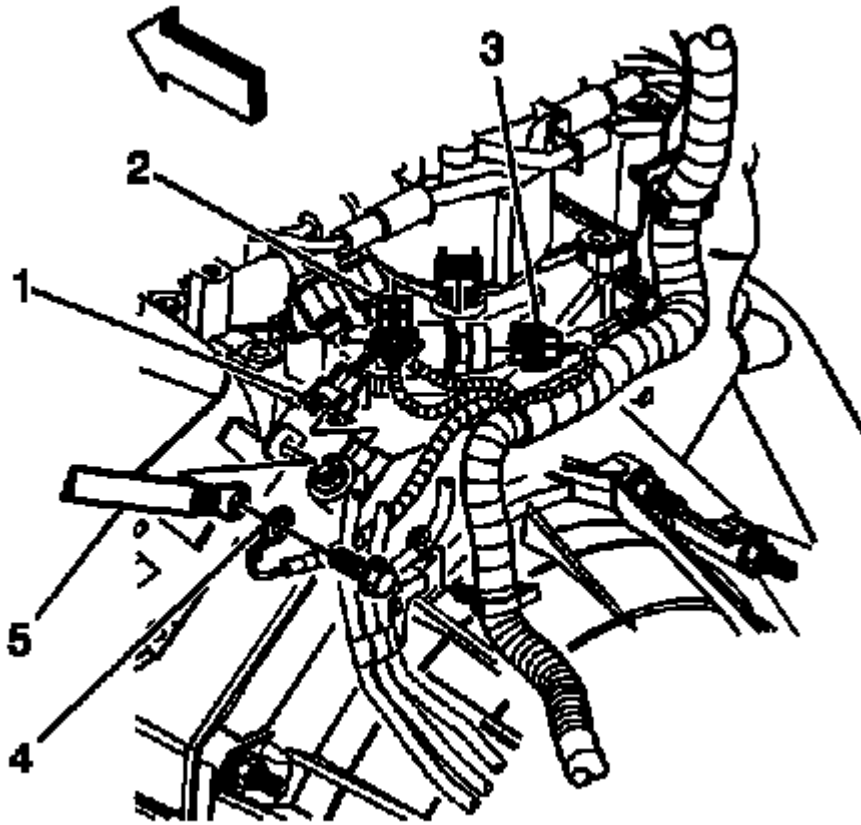


Fig. 389: View Of Ground Strap And CMP & Fuel Pump/Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

27. Position the harness ground (4) and ground strap (5).
28. Install the harness ground bolt.

Tighten: Tighten the harness ground bolt to 16 N.m (12 lb ft).

29. Connect the following electrical connectors:
 - The KS (1)
 - The CMP sensor (2)
 - The fuel pump/oil pressure sensor (3)
 - The distributor (2)

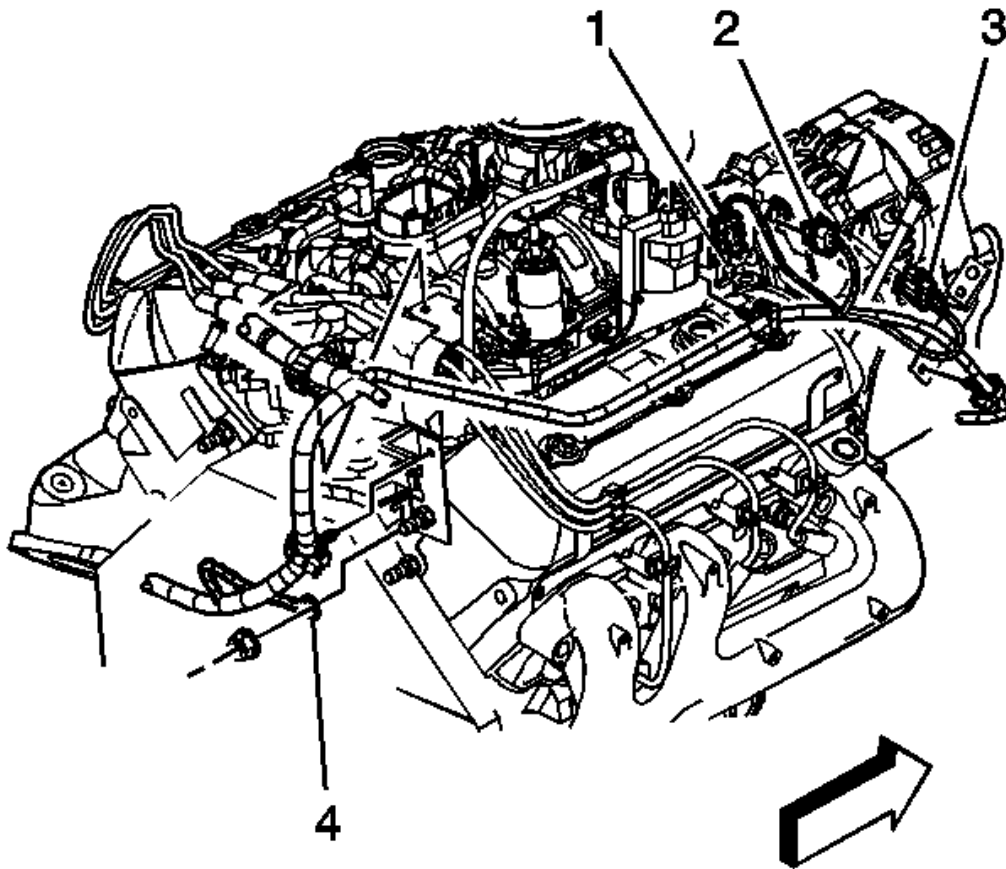


Fig. 390: Ignition Coil, Ignition Coil Driver, Ground Nut/Cable & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

30. Install the engine wiring harness ground nut and ground wire (4) to the rear of the right cylinder head.

Tighten: Tighten the engine wiring harness ground nut to 16 N.m (12 lb ft).

31. Connect the following electrical connectors:

- The ignition coil (1)
- The ignition coil driver (2)
- The generator (3)

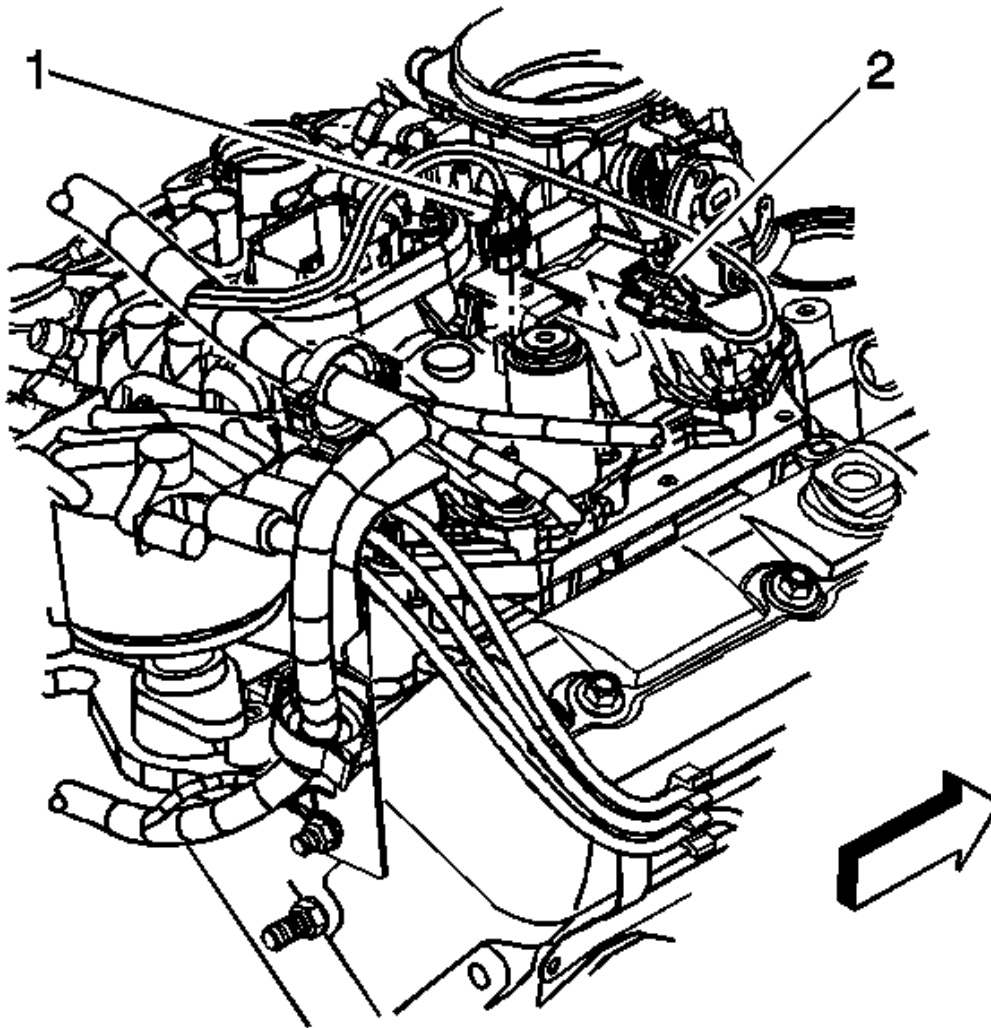


Fig. 391: View Of EVAP Canister Purge Solenoid Valve & MAP Sensor
Courtesy of GENERAL MOTORS CORP.

32. Connect the following electrical connectors:
- The EVAP canister purge solenoid valve (1)
 - The MAP sensor (2)

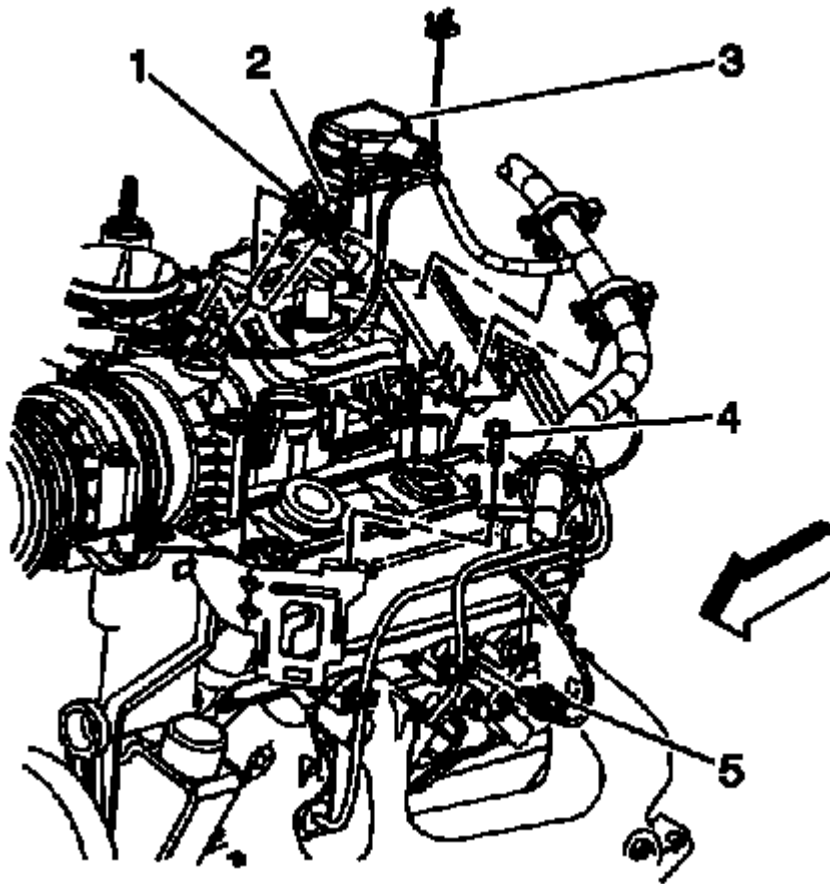


Fig. 392: View Of TP Sensor, IAC Motor, ECT Sensor, Control Port Injector Module & Engine Harness Clip Bolt

Courtesy of GENERAL MOTORS CORP.

33. Install the engine wiring harness clip bolt (4).

Tighten: Tighten the engine wiring harness clip bolt to 9 N.m (80 lb in).

34. Connect the following electrical connectors:

- The TP sensor (1)
- The IAC motor (2)
- The control port injector module (3)
- The ECT sensor (5)

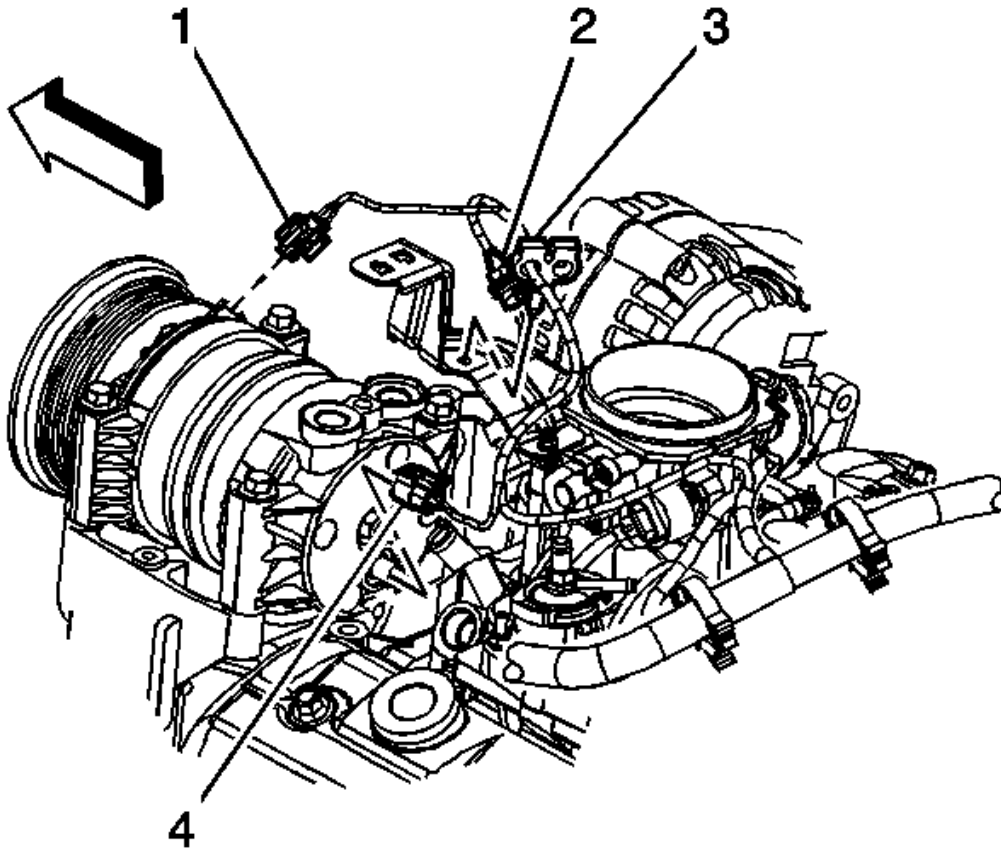


Fig. 393: View Of A/C Compressor Clutch, A/C Pressure Switch & EGR Valve
Courtesy of GENERAL MOTORS CORP.

35. Install the positive cable and nut to the generator.

Tighten: Tighten the positive cable generator nut to 18 N.m (13 lb ft).

36. Connect the following electrical connectors:

- The A/C pressure switch (4), if equipped
- The A/C compressor clutch (1), if equipped
- The EGR valve (2)

37. Install the A/C compressor hose, if equipped. Refer to **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (L35 W/HARRISON)** or **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (L18 W/HARRISON)** or **COMPRESSOR HOSE ASSEMBLY REPLACEMENT (LB7 W/HARRISON)**.

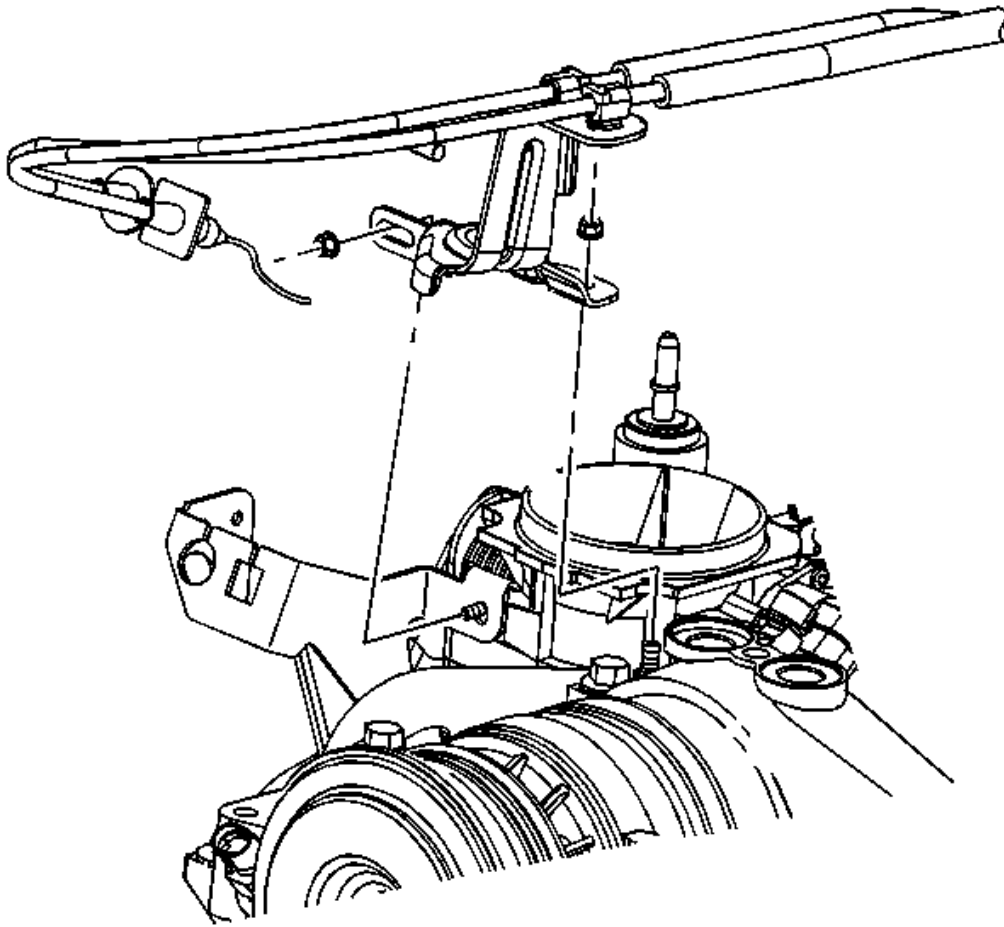


Fig. 394: View Of Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

38. Position the bracket and cables.
39. Install the accelerator control cable bracket with the cables attached, to the throttle body.
40. Install the accelerator control cable bracket nuts.

Tighten: Tighten the accelerator control cable bracket nuts to 9 N.m (80 lb in).

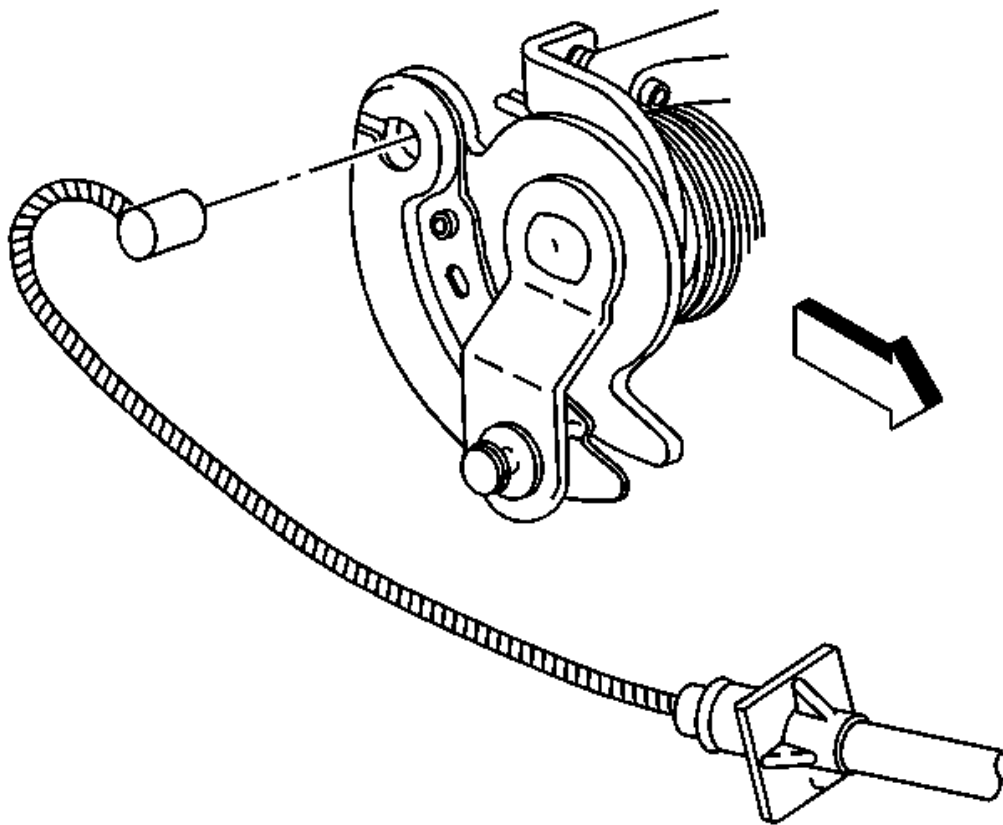


Fig. 395: Identifying Accelerator Cable/Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

41. Install the accelerator cable to the throttle body lever.

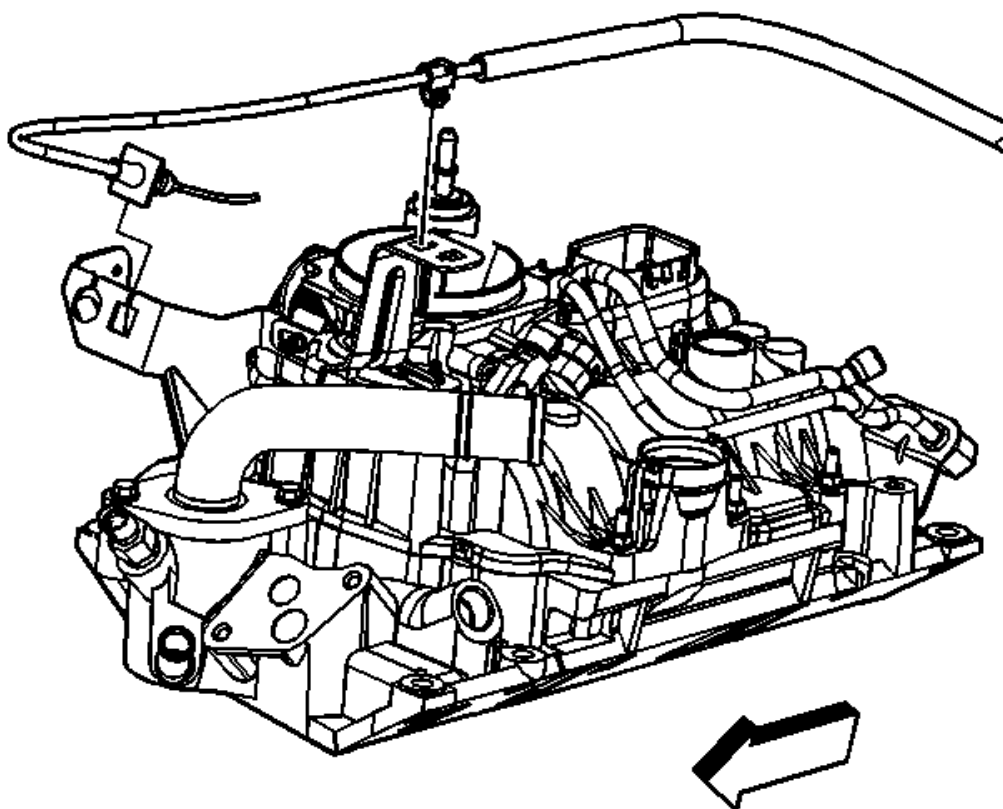


Fig. 396: View Of Accelerator Cable To Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a **NEW** cable whenever you remove the engine from the vehicle.
In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

42. Install the accelerator cable to the accelerator control cable bracket.

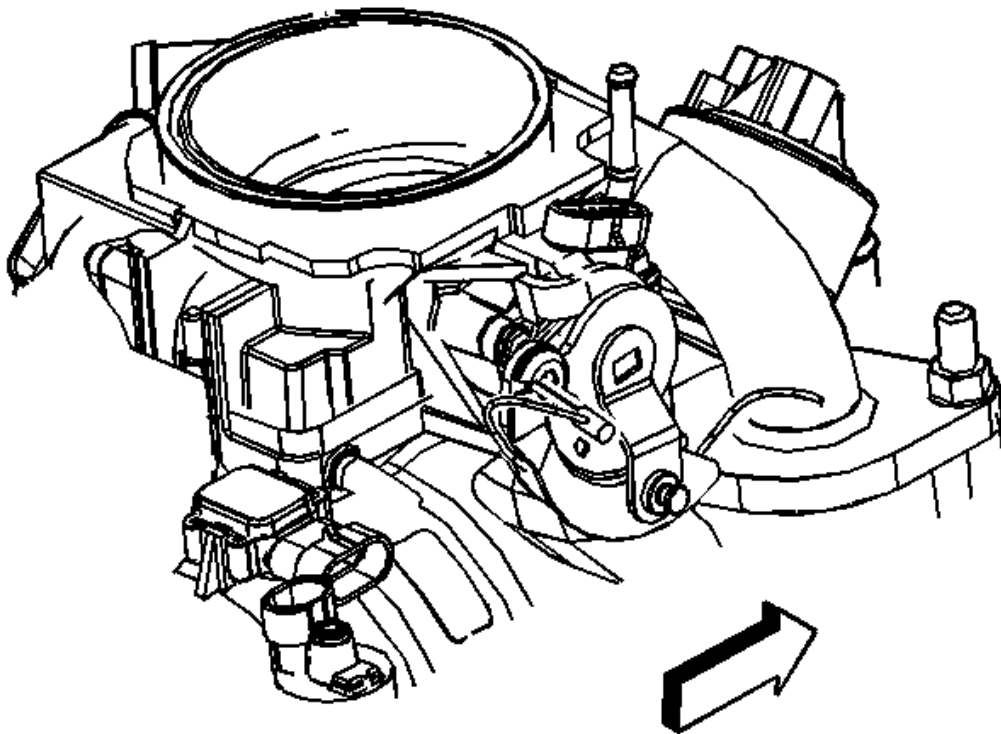


Fig. 397: View Of Accelerator Cable & Throttle Body Lever
Courtesy of GENERAL MOTORS CORP.

43. Install the accelerator cable to the throttle body lever.

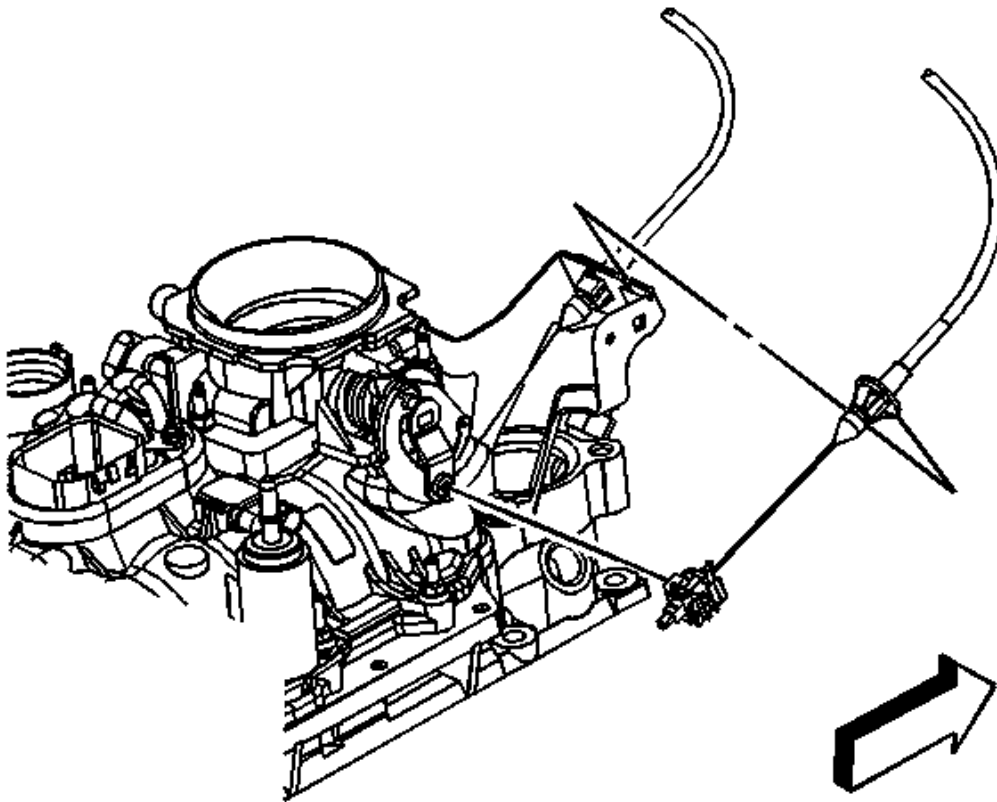


Fig. 398: View Of Cruise Control Cable & Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

44. Install the cruise control cable to the accelerator control cable bracket, if equipped.
45. Connect the cruise control cable to the throttle lever, if equipped.

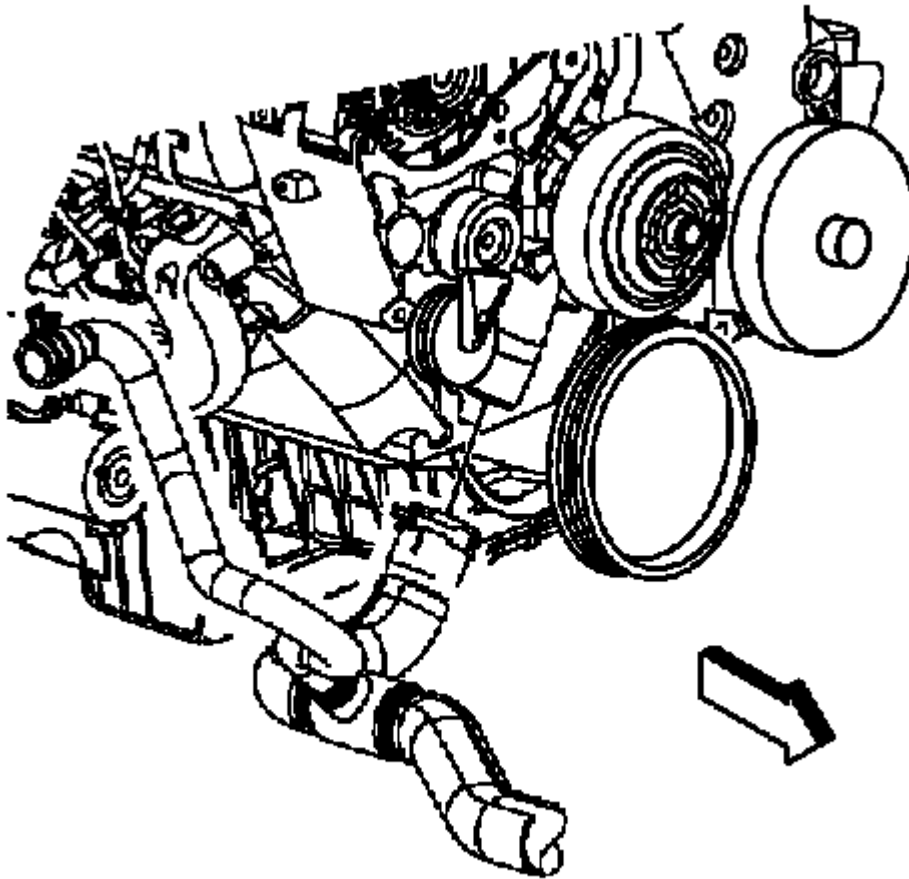


Fig. 399: Installing Radiator Outlet Hose
Courtesy of GENERAL MOTORS CORP.

46. Install the radiator outlet hose to the water pump.
47. Install the radiator outlet hose to the surge tank.
48. Position the radiator outlet hose clamps.

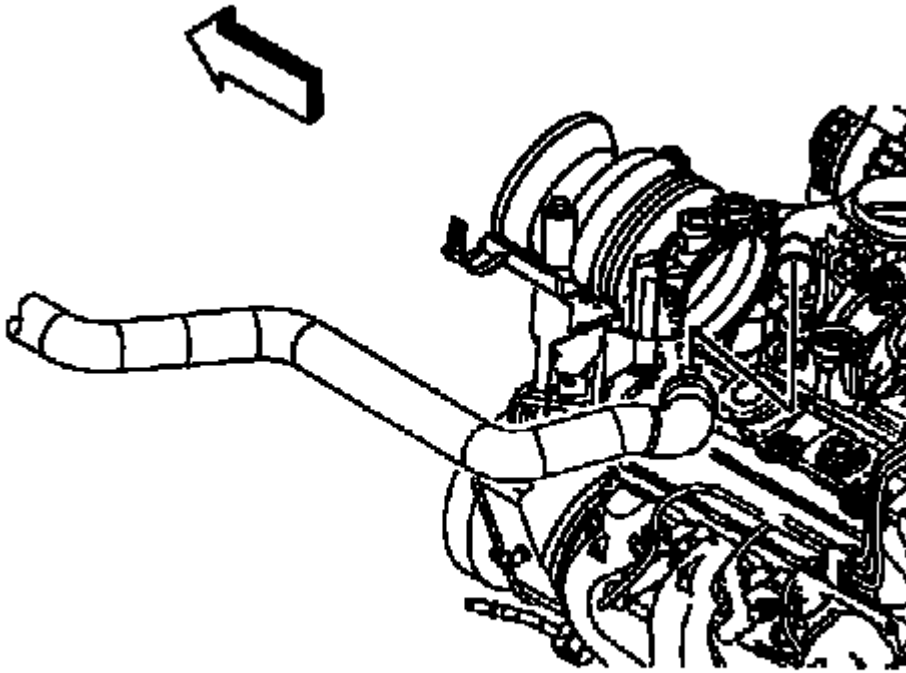


Fig. 400: View Of Radiator Inlet Hose, Clamps & Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

49. Install the radiator inlet hose to the thermostat housing.
50. Position the radiator inlet hose clamp.
51. Install the drive belt. Refer to **Drive Belt Replacement**.
52. Install the lower fan shroud. Refer to **FAN SHROUD REPLACEMENT - LOWER**.
53. Install the fuel pipes/hoses.

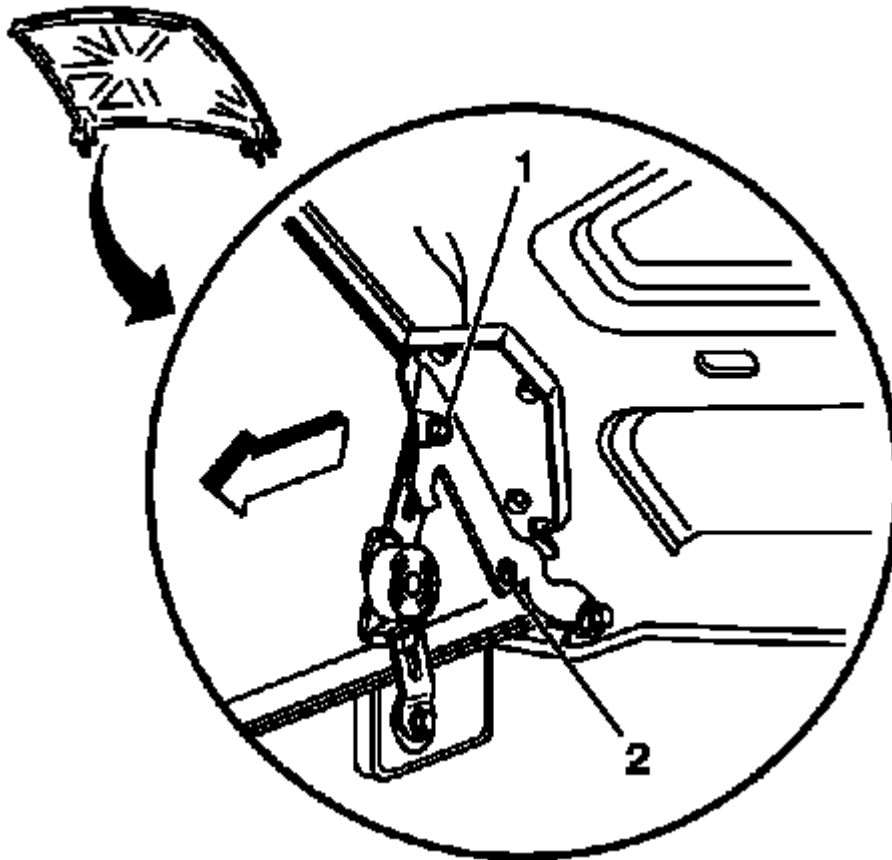


Fig. 401: Identifying Hood Hinge Normal And Service Position Bolt Holes
Courtesy of GENERAL MOTORS CORP.

54. Remove the hood hinge bolts from the service position (2).
55. Lower the hood to the normal position.
56. Install the hood hinge bolts.

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

57. Raise the vehicle.

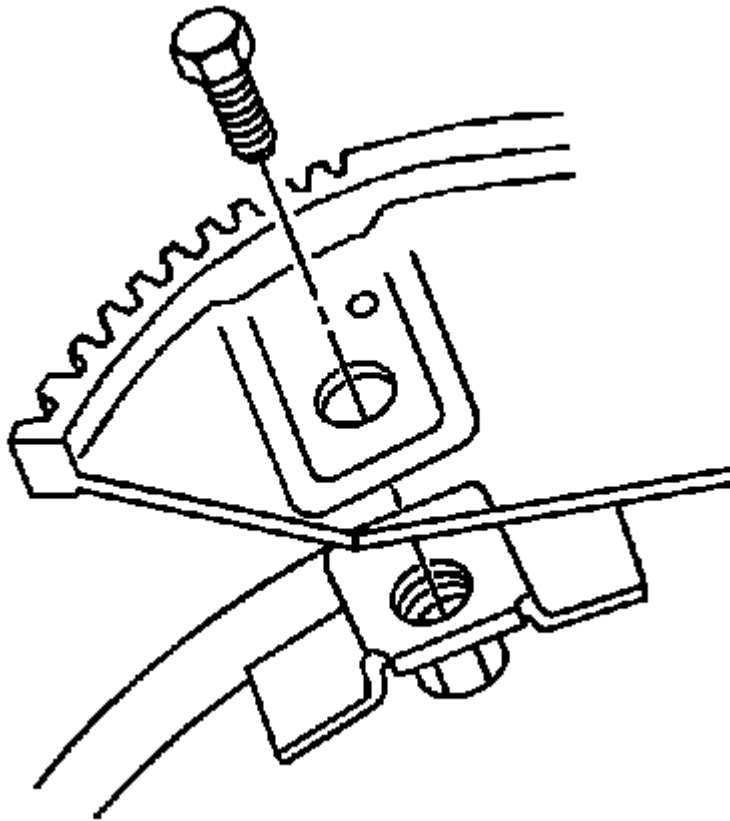


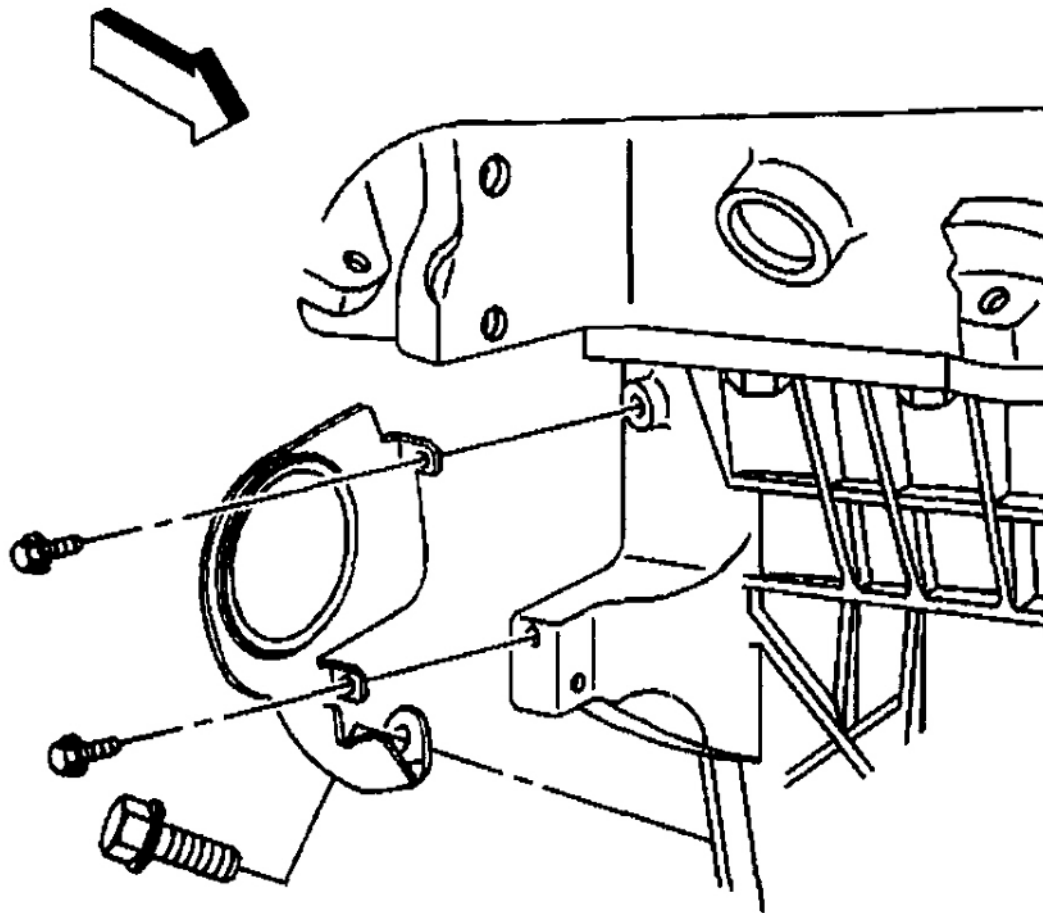
Fig. 402: Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

58. Install the transmission bolts.

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

59. Install the torque converter bolts, if equipped, through the starter opening.

Tighten: Tighten the torque converter bolts to 63 N.m (47 lb ft).



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Fig. 403: View Of Transmission Cover Bolts
Courtesy of GENERAL MOTORS CORP.

60. Install the transmission cover.
61. Install the starter. Refer to **STARTER** .
62. Install the engine shield, if equipped. Refer to

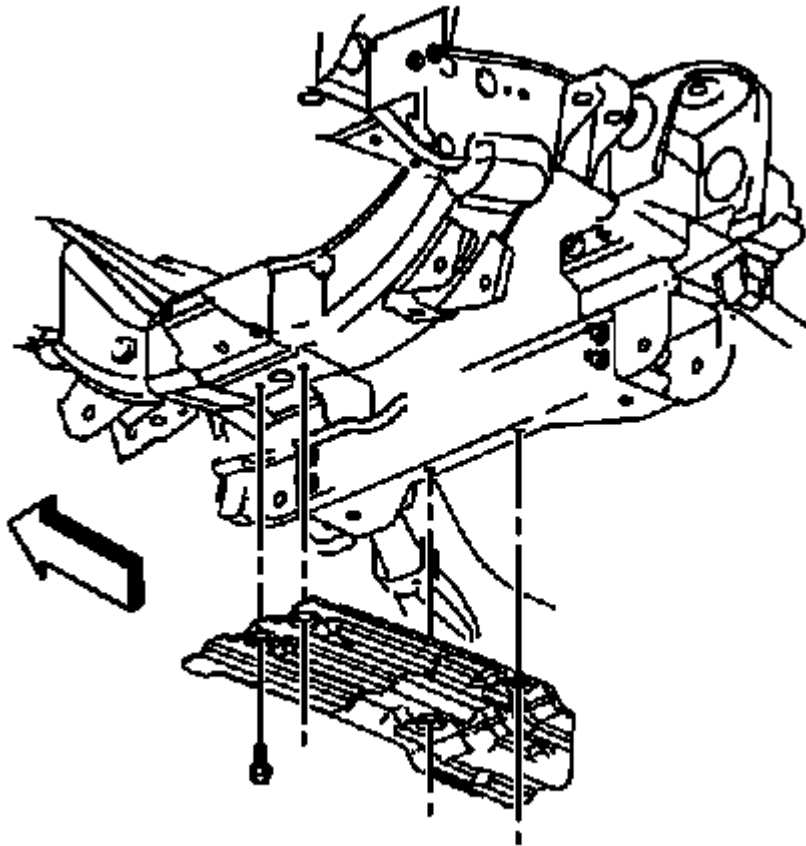


Fig. 404: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

63. If equipped, install the oil pan skid plate and bolts.
64. Lower the vehicle.
65. Connect the negative battery cable. Refer to **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (SINGLE BATTERY)** or **BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE (AUXILIARY BATTERY)** .
66. Fill the engine with the proper quantity and grade of oil.
67. Add engine oil supplement GM U.S. P/N 1052367, Canada P/N 992869, or equivalent to the engine oil.
68. Fill the cooling system. Refer to **DRAINING & FILLING COOLING SYSTEM** .
69. Bleed the hydraulic clutch, if equipped. Refer to **BLEEDING** .
70. Recharge the A/C system. Refer to **REFRIGERANT RECOVERY & RECHARGING** .

IMPORTANT: After an overhaul, the engine should be tested. Use the following procedure after the engine is installed in the vehicle.

71. Disable the ignition system.

72. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
73. Start the engine and listen for unusual noises.
74. Check the oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
75. If necessary, install an oil pressure gauge and measure the oil pressure.
76. Run the engine speed at about 1000 RPM until the engine has reached normal operating temperature.
77. Listen for sticking valve lifters, or other unusual noises.
78. Inspect for fuel, oil, and/or coolant leaks while the engine is running.
79. Verify that the distributor is properly positioned.
80. Perform a final inspection for the proper oil and coolant levels.
81. Close the hood.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **LIFTING AND JACKING THE VEHICLE** .
2. Remove the oil pan drain plug and drain the engine oil in a suitable container.

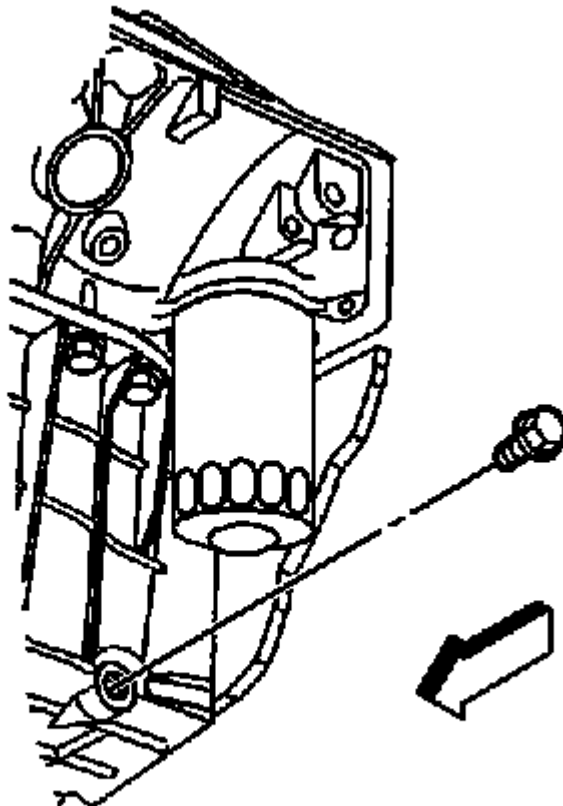


Fig. 405: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

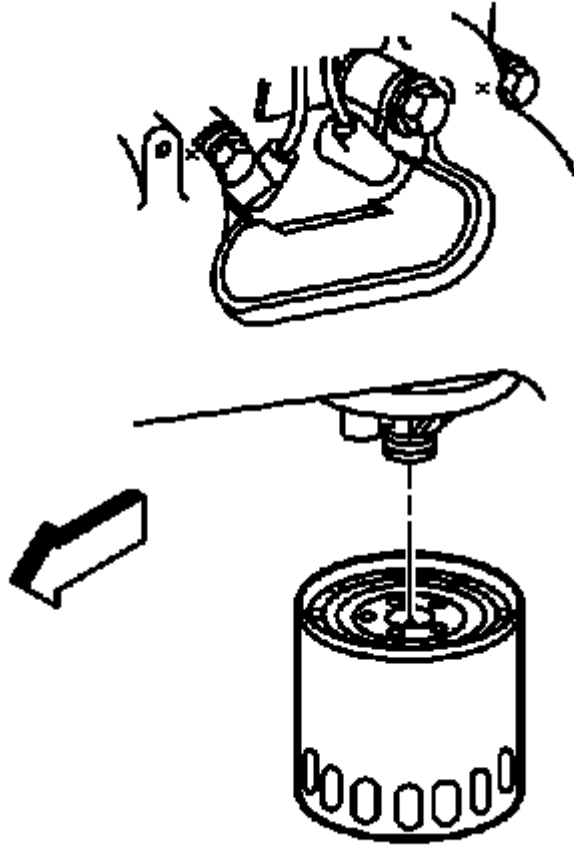


Fig. 406: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil filter from the engine.
4. Inspect to ensure the engine oil filter gasket is removed.

Installation Procedure

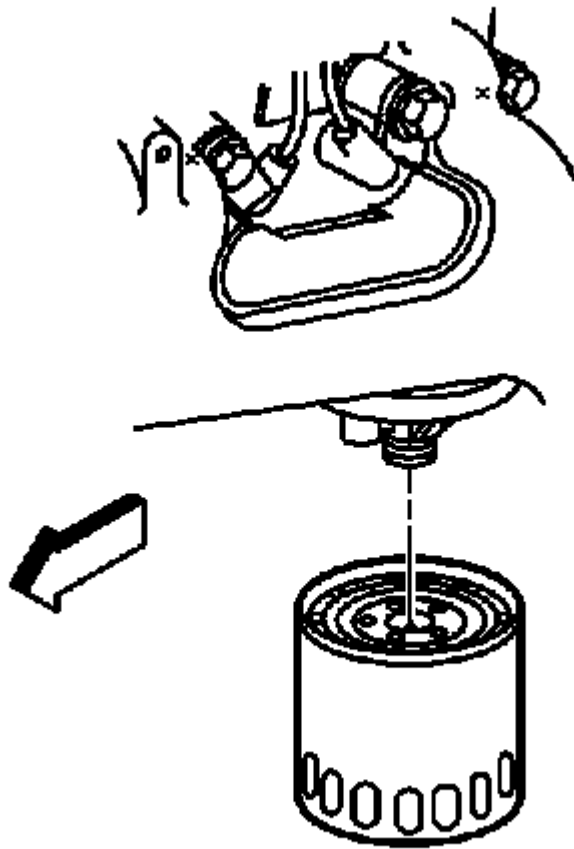


Fig. 407: View Of Oil Filter

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

1. Lubricate the oil filter gasket with clean engine oil.
2. Install the oil filter to the engine.

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

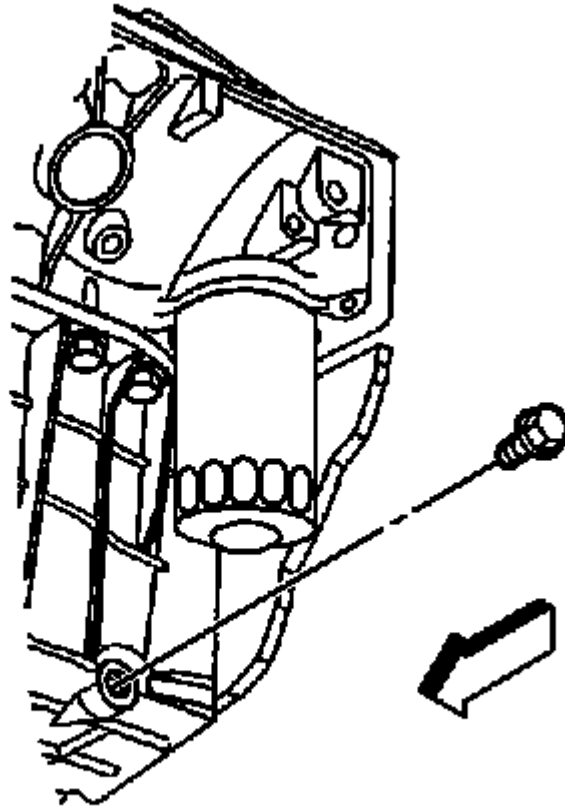


Fig. 408: Identifying Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Install the oil pan drain plug to the oil pan.

Tighten: Tighten the oil pan drain plug to 25 N.m (18 lb ft).

4. Lower the vehicle.
5. Fill the engine with the proper capacity and quality of engine oil.
6. Operate the engine, check for leaks, and oil pressure.

DESCRIPTION AND OPERATION

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner

- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

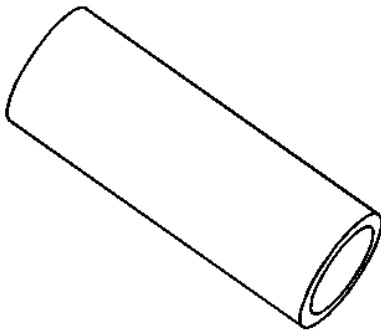
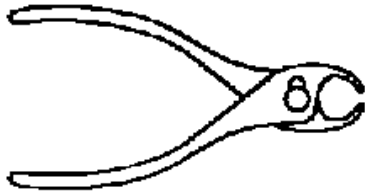
The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

SPECIAL TOOLS AND EQUIPMENT

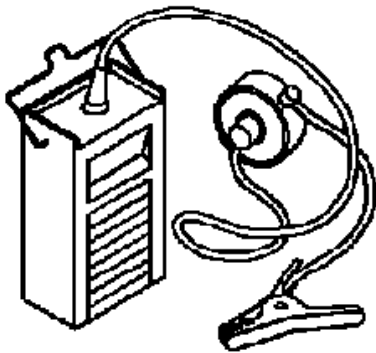
SPECIAL TOOLS

Special Tools

Illustration	Tool Number/ Description
	J 3049-A Valve Lifter Remover



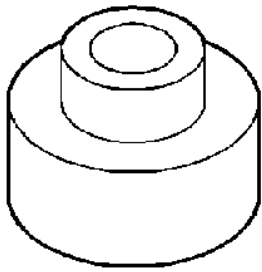
J 5590
Rear Pinion Bearing Race Installer



J 5825-A
Crankshaft Gear Remover



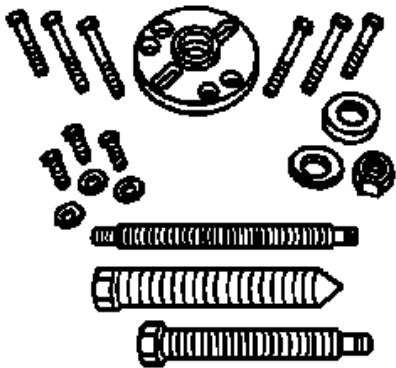
J 5892-D
Valve Spring Compressor



J 8092
Universal Driver Handle

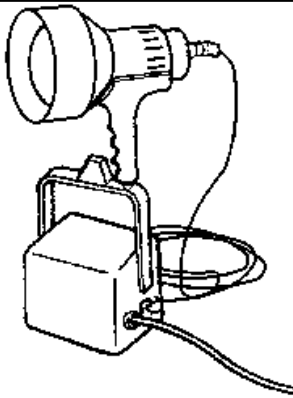
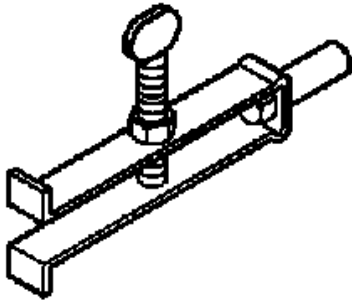


J 22794
Spark Plug Port Adapter

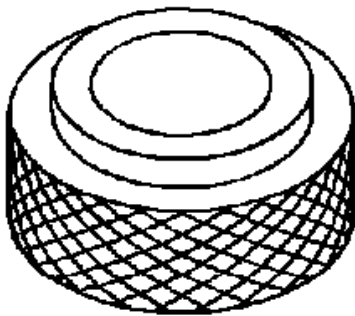


J 23523-F
Crankshaft Balancer Remover and Installer

J 26941
Bushing and Bearing Remover

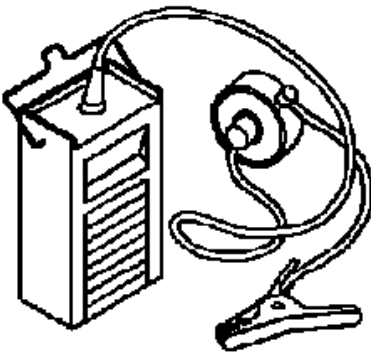
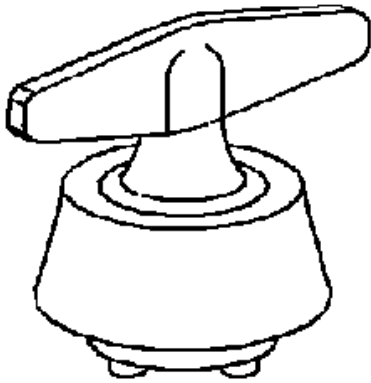


J 28428-E
High Intensity Black Light

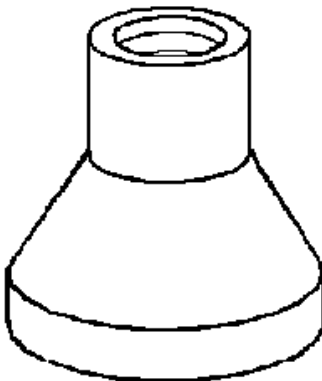


J 35468
Cover Aligner/Seal Installer

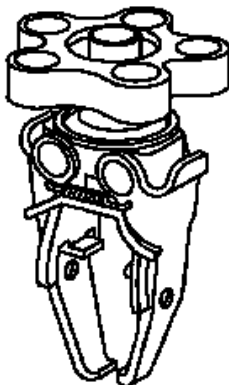
J 35621-B
Rear Main Seal Installer



J 36660-A
Torque Angle Meter



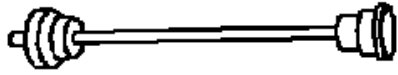
J 36996
Balance Shaft Installer



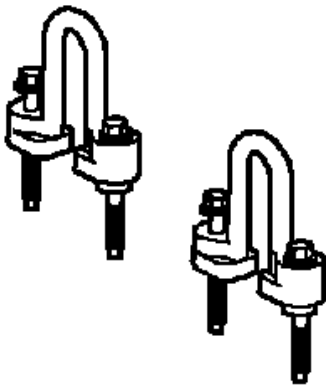
J 38606
Valve Spring Compressor

2002 GMC Sierra 3500

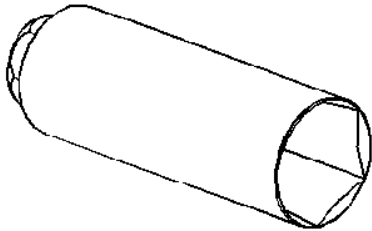
2002 ENGINE Engine Mechanical - 4.3L - Sierra & Silverado



J 38834
Balance Shaft Service Kit

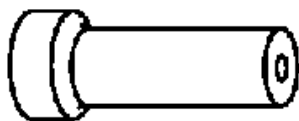


J 41427
Engine Lift Bracket



J 41712
Oil Pressure Switch Socket

J 42073
Valve Stem Oil Seal Installer



TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS (4.3L)

Application	Ft. Lbs (N.m)
Balance Shaft Driven Gear Bolt	
First Tightening Pass	15 (20)
Final Tightening Pass	35 Degrees
Camshaft Sprocket Bolt	18 (25)
Crankshaft Balancer Bolt	70 (95)
Crankshaft Pulley Bolt	43 (58)
Crossbar Bolt	74 (100)
Cylinder Head Bolt	
First Tightening Pass ⁽¹⁾	22 (30)
Final Tightening Pass (Long Bolt)	75 Degrees
Final Tightening Pass (Medium Bolt)	65 Degrees
Final Tightening Pass (Short Bolt)	55 Degrees
Drive Belt Idler Pulley Bolt	37 (50)
Drive Belt Tensioner Bolt	37 (50)
Engine Coolant Temperature Sensor	15 (20)
Engine Mount Bolt	37 (50)
Engine Mount Bracket Bolt	55 (75)
Engine Mount Side Bracket Bolt	37 (50)
Engine Mount-To-Engine Mount Bracket Bolt	48 (65)
Engine Shield Bolt	15 (20)
Engine Wiring Harness Ground Nut	12 (16)
Exhaust Gas Recirculation Valve Inlet Pipe Bracket Bolt	18 (25)
Exhaust Gas Recirculation Valve Inlet Pipe-To-Exhaust Manifold Fitting	18 (25)
Exhaust Gas Recirculation Valve Inlet Pipe-To-Intake Manifold Fitting	22 (30)
Flywheel Bolt ⁽²⁾	74 (100)

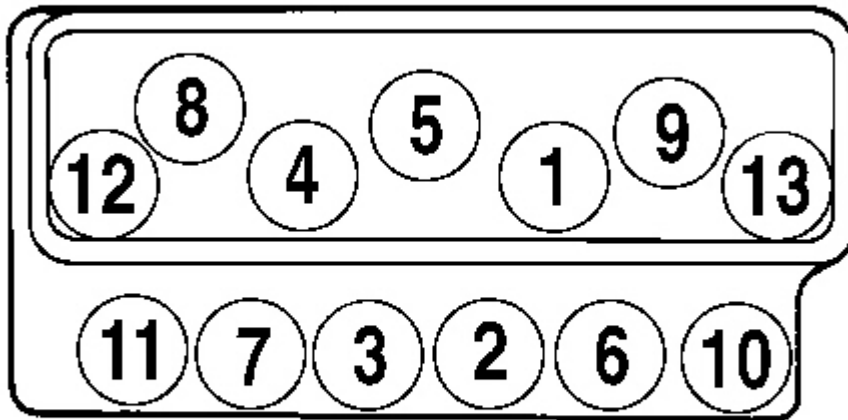
2002 GMC Sierra 3500

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Fuel Pump/Oil Pressure Sensor	22 (30)
Fuel Pump/Oil Pressure Sensor Fitting	11 (15)
Centerline Of Fitting-To-Centerline Of Crankshaft	50 Degrees
Generator Bracket Stud	15 (20)
Harness Ground Bolt	12 (16)
Heater Outlet Hose Clip Bolt	18 (25)
Hood Hinge Bolt	18 (25)
J-23523-F Bolt	18 (25)
Junction Block Bracket Bolt	18 (25)
Lift Bracket Bolts	11 (15)
Oil Filter	22 (30)
Oil Filter Adapter	41 (55)
Oil Pan Bolt ⁽³⁾	18 (25)
Oil Pan Drain Plug	18 (25)
Oil Pan Skid Plate Bolt	15 (20)
Oil Pump Bolt	66 (90)
Positive Cable Generator Nut	13 (18)
Power Steering Pump Bracket Bolt/Nut	30 (41)
Power Steering Pump Bracket Stud	15 (20)
Spark Plug (New Cylinder Head)	22 (30)
Spark Plug (Used Cylinder Head)	11 (15)
Torque Converter Bolt	47 (63)
Transmission Bolt	37 (50)
Valve Lifter Pushrod Guide Bolt	12 (16)
Valve Rocker Arm Bolt	22 (30)
INCH Lbs. (N.m)	
Accelerator Cable Bracket Nut	106 (12)
Accelerator Control Cable Bracket Nut	80 (9)
Balance Shaft Retainer Bolt	106 (12)
Battery Cable Bracket Bolt	106 (12)
Camshaft Retainer Bolt	106 (12)
Crankshaft Position Sensor Bolt	71 (8)
Crankshaft Rear Oil Seal Housing Bolt/Nut	106 (12)
Engine Front Cover Bolt	106 (12)
Engine Oil Level Sensor	115 (13)
Engine Wiring Harness Bracket Nut	106 (12)
Engine Wiring Harness Clip Bolt	80 (9)
Engine Wiring Harness Rear Bracket Nut	80 (9)
Evaporative Emission Canister Purge Solenoid Valve Stud	89 (10)
Intake Manifold (Lower) ⁽⁴⁾	
First Tightening Pass	27 (3)

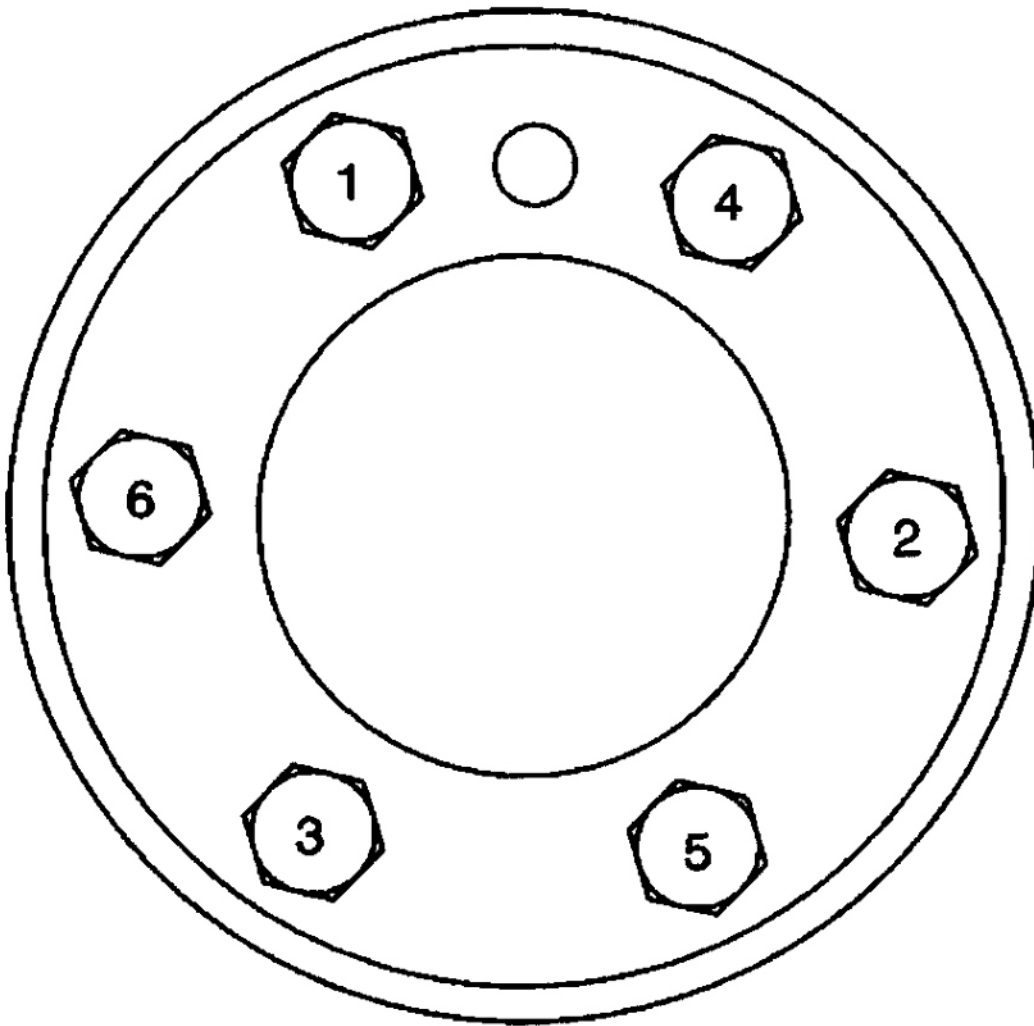
Second Tightening Pass	106 (12)
Final Tightening Pass	134 (15)
Intake Manifold (Upper Stud)	80 (9)
Oil Level Indicator Tube Bolt	106 (12)
Spark Plug Wire Support Bolt	106 (12)
Throttle Body Stud	80 (9)
Transmission Cover Bolt	106 (12)
Transmission Oil Cooler Line Bracket	80 (9)
Valve Rocker Arm Cover Bolt	106 (12)

- (1) Tighten bolts/nuts following the sequence shown. See **Fig. 409**.
- (2) Tighten bolts/nuts following the sequence shown. See **Fig. 410**.
- (3) Tighten bolts/nuts following the sequence shown. See **Fig. 411**.
- (4) Tighten bolts/nuts following the sequence shown. See **Fig. 412**.



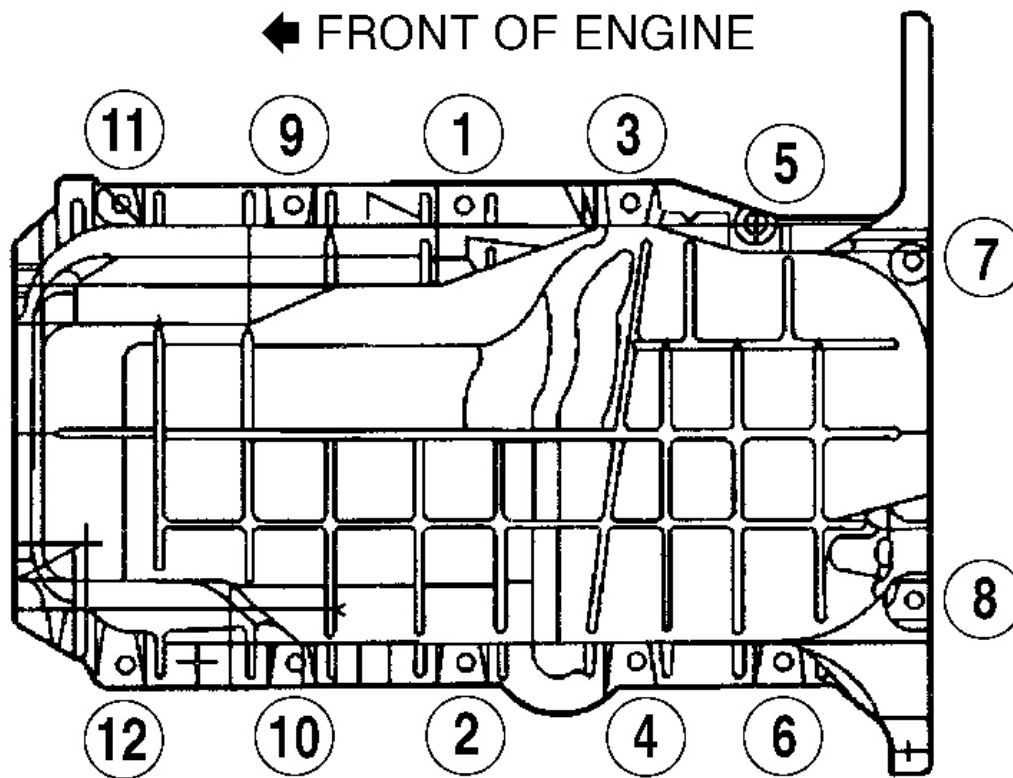
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Fig. 409: Identifying Cylinder Head Bolt Tightening Sequence (4.3L)
 Courtesy of GENERAL MOTORS CORP.



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Fig. 410: Identifying Flywheel Bolt Tightening Sequence (4.3L)
Courtesy of GENERAL MOTORS CORP.



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Fig. 411: Identifying Oil Pan Bolts Tightening Sequence (4.3L)
Courtesy of GENERAL MOTORS CORP.

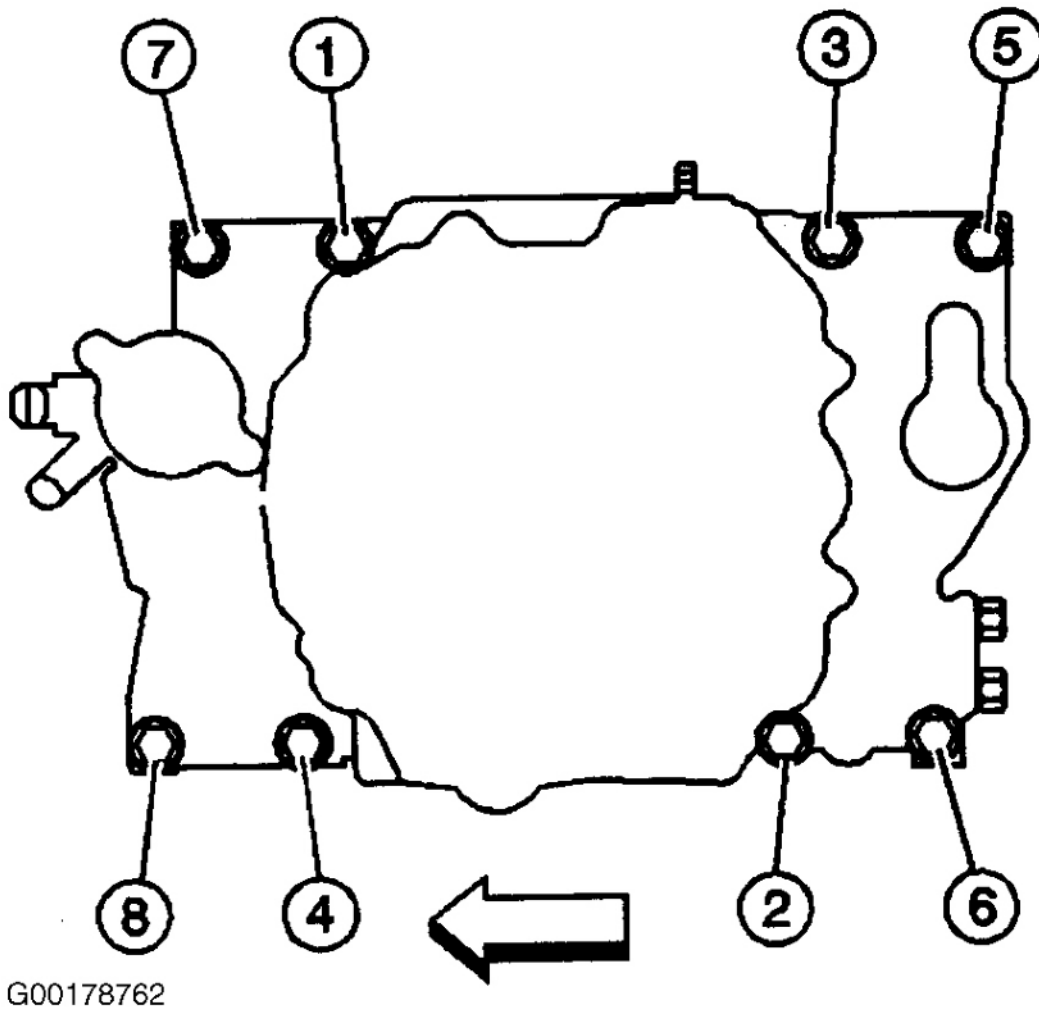


Fig. 412: Identifying Lower Intake Manifold Bolt Tightening Sequence (4.3L)
Courtesy of GENERAL MOTORS CORP.