2000-01 ENGINES

Engine Mechanical - 4.3L - Astro & Safari

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs (N.m)
Air Conditioning Compressor Side Brace Bolt	18 (25)
Air Conditioning Pipe Bracket-To-Rear Of Left Cylinder Head Nut	26 (35)
Balance Shaft Driven Gear Bolt	
First Tightening Pass	15 (20)
Final Tightening Pass	35 Degrees
Belt Idler Pulley Bolt	37 (50)
Body Bolt (1)	
First Tightening Pass (All Bolts)	26 (35)
Final Tightening Pass (Center Bolts)	114 (155)
Final Tightening Pass (Front and Rear Bolts)	66 (90)
Camshaft Sprocket Bolt	18 (25)
Connecting Rod Nut	
First Tightening Pass	20 (27)
Final Tightening Pass	70 Degrees
Cooling Fan Blade-To-Fan Clutch Bolts	24 (33)
Cooling Fan Clutch-To-Water Pump Bolts	41 (56)
Crankshaft Balancer Bolt	70 (95)
Crankshaft Bearing Cap Bolt (Preferred Method)	
First Tightening Pass	15 (20)
Final Tightening Pass	73 Degrees
Crankshaft Bearing Cap Bolt (Optional Strategy)	77 (105)
Crankshaft Pulley Bolt	43 (58)
Cylinder Head Bolt (Optional On-Vehicle Strategy)	
First Tightening Pass	26 (35)
Second Tightening Pass	44 (60)
Final Tightening Pass	66 (90)
Cylinder Head Bolt (Preferred Method)	
First Tightening Pass (All Bolts)	22 (30)
Final Tightening Pass (Long Bolts)	75 Degrees
Final Tightening Pass (Medium Bolts)	65 Degrees
Final Tightening Pass (Short Bolts)	55 Degrees

Cylinder Head Core Hole Plug	15 (20)
Distributor Clamp Bolt	18 (25)
Drive Belt Tensioner Bolt	37 (50)
EGR Valve Bolt	
First Tightening Pass	62 INCH (7)
Final Tightening Pass	22 (30)
EGR Valve Inlet Pipe Clamp Bolt	18 (25)
EGR Valve Inlet Pipe Nut Exhaust Manifold	
Exhaust Manifold	22 (30)
Intake Manifold	18 (25)
Engine Block Coolant Drain Hole Plug	15 (20)
Engine Block Left Rear Oil Gallery Plug	22 (30)
Engine Block Left Side Oil Gallery Plug	15 (20)
Engine Block Oil Gallery Plug	15 (20)
Engine Block Right Rear Oil Gallery Plug	15 (20)
Engine Coolant Temperature Sensor	15 (20)
Engine Flywheel Bolt	74 (100)
Engine Lift Bracket Bolt (Special Tool J 41427)	11 (15)
Engine Lift Front Bracket Stud	26 (35)
Engine Mount-To-Frame Bolt (AWD)	44 (59)
Engine Mount Bracket-To-Engine Bolt	47 (64)
Engine Mount Bracket-To-Frame Bolt (RWD)	35 (47)
Engine Mount Bracket-To-Frame Nut (RWD)	31 (42)
Engine Mount Frame Bracket Through-bolt	50 (68)
Engine Mount-To-Frame Nut (RWD)	31 (42)
Engine Oil Cooler Lines-To-Oil Filter Adapter Assembly Bolt	26 (35)
Engine Oil Pressure Gage Sensor	22 (30)
Engine Oil Pressure Gage Sensor Fitting (Plus Required Angle)	11 (15)
Engine Wiring Harness Bracket-To-Generator and Drive Belt Tensioner Bracket Bolt	18 (25)
Engine Wiring Harness Retainer-To-Rear Of Right Cylinder Head Bolt	27 (36)
Exhaust Manifold Bolt/Stud	
First Tightening Pass	11 (15)
Final Tightening Pass	22 (30)
Fan & Water Pump Pulley Bolt	18 (25)
Fuel Pipe Bracket-To-Rear Of Cylinder Head Stud	24 (33)
Fuel Supply Pipe Nut (Fuel Tank Side)	22 (30)
Generator & Drive Belt Tensioner Bracket-To-Engine Bolt	30 (41)
Generator & Drive Belt Tensioner Bracket Stud Nut	30 (41)
Generator & Drive Belt Tensioner Bracket-To-Engine Stud	15 (20)

Ground Wire-To-Rear of Cylinder Head Bolt	26 (35)
Ground Wire-To-Water Outlet Stud Nut	14 (19)
Knock Sensor	15 (20)
Negative Battery Cable Stud	30 (40)
Oil Fill Tube Bolt	18 (25)
Oil Filter Adapter Bolt	15 (21)
Oil Filter Fitting	41 (56)
Oil Pan Bolt & Nut	18 (25)
Oil Pan Drain Plug	18 (25)
Oil Pump-To-Rear Crankshaft Bearing Cap Bolt	66 (90)
Park Brake Bracket-To-Frame Bolt	18 (24)
Power Steering Pump Bolt	37 (50)
Power Steering Pump Bracket-To-Engine Bolt	30 (41)
Power Steering Pump Bracket Stud Nut	30 (41)
Power Steering Pump Bracket-To-Engine Stud	15 (20)
Power Steering Pump Rear Bracket-To-Engine Nut	30 (41)
Power Steering Pump Rear Bracket-To-Power Steering Pump Nut	37 (50)
Spark Plug	
Initial Installation (NEW Cylinder Head)	22 (30)
All Subsequent Installations	11 (15)
Transmission-To-Oil Pan Bolt	35 (47)
Upper Fan Shroud Bolts	11 (15)
Upper Radiator Hose Support Bracket-To-Exhaust Manifold Stud Nut	27 (36)
Valve Lifter Pushrod Guide Bolt	12 (16)
Valve Rocker Arm Bolt	22 (30)
Water Outlet Stud	18 (25)
Water Pump Bolt	33 (45)
	INCH Lbs. (N.m)
Accelerator Control Cable Bracket Nut	106 (12)
Accelerator Control Cable Bracket-To-Intake Manifold Stud	53 (6)
Accelerator Control Cable Bracket-To-Throttle Body Stud	106 (12)
Air Cleaner Adapter Stud	71 (8)
Air Conditioning Hose Bracket-To-Intake Manifold Nut	44 (5)
Balance Shaft Retainer Bolt	106 (12)
Camshaft Retainer Bolt	106 (12)
Crankshaft Position Sensor Bolt	71 (8)
Crankshaft Rear Oil Seal Housing Bolt & Nut	106 (12)
Crankshaft Rear Oil Seal Housing Retainer Stud	53 (6)
Distributor Cap Bolt	21 (2.4)

Engine Coolant Heater Bolt/Screw	18 (2)
Engine Front Cover Bolt	106 (12)
Engine Wiring Harness Bracket-To-Evaporative Emission Canister Purge Solenoid Valve Nut	71 (8)
Engine Wiring Harness Bracket-To-Intake Manifold Nut	106 (12)
Evaporative Emission Canister Purge Solenoid Valve-To-Intake Manifold Nut	89 (10)
Fuel Meter Body Bracket Bolt	89 (10)
Fuel Pipe Bracket Bolt	53 (6)
Fuel Pipe Retainer Nut	27 (3)
Ignition Coil Stud	106 (12)
Lower Intake Manifold Bolt	
First Tightening Pass	27 (3)
Second Tightening Pass	106 (12)
Final Tightening Pass	133 (15)
Oil Cooler Pipe Bracket-To-Oil Pan Bolt	89 (10)
Oil Level Indicator Tube Bolt	106 (12)
Oil Level Indicator Tube-To-Transmission Fluid Fill Tube Bolt	106 (12)
Oil Pan Baffle Bolt	106 (12)
Oil Pump Cover Bolt	106 (12)
Spark Plug Wire Support Bolt	106 (12)
Starter Motor Wiring Harness/Transmission Cooler Pipe Bracket-To-Oil Pan Bolt	89 (10)
Throttle Body Stud	80 (9)
Transmission Cover Bolt	106 (12)
Transmission Fluid Fill Tube-To-Accelerator Control Cable Bracket Bolt	53 (6)
Upper Intake Manifold Stud	
First Tightening Pass	44 (5)
Final Tightening Pass	80 (9)
(1) Tighten bolts following sequence shown, see **Fig. 1**.	

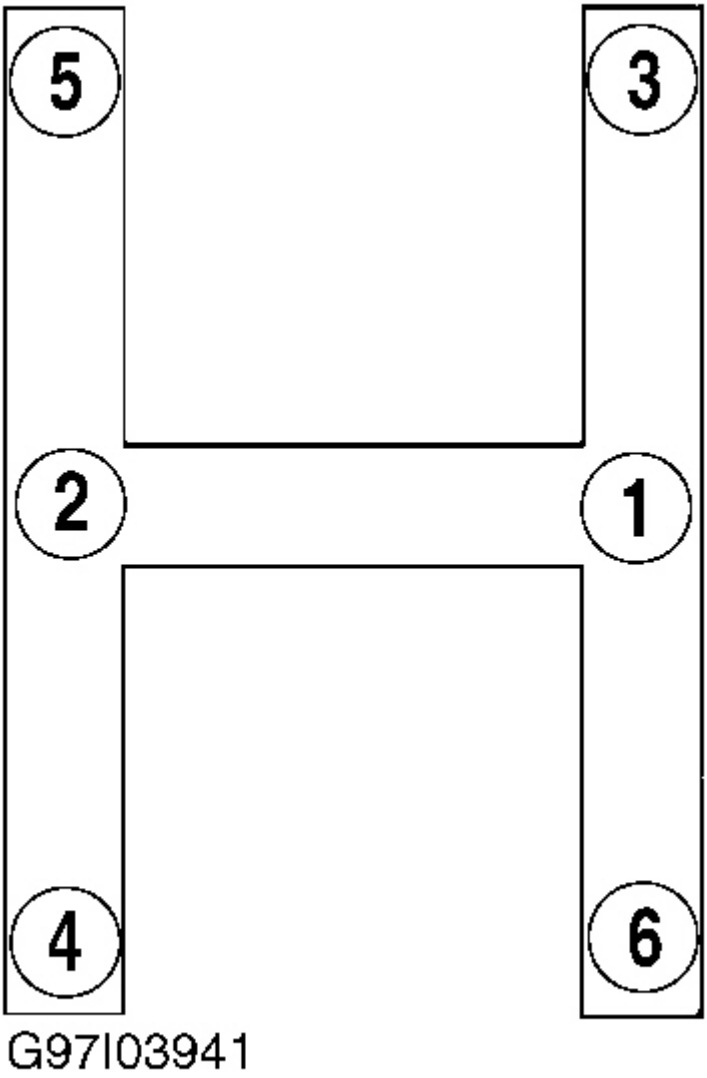

Fig. 1: Tightening Frame Mounting Bolts In Sequence (Astro & Safari 4.3L)
Courtesy of GENERAL MOTORS CORP.

ENGINE MECHANICAL SPECIFICATIONS

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		

Engine Type	V6	
Regular Production Option (RPO) Code L35 VIN Code W		
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	

SEALERS, ADHESIVES & LUBRICANTS

Application	Type of Material	GM Part Number
Balancer Shaft Driven Gear Bolt	Threadlock	12345382
Camshaft Retainer Bolt	Threadlock	12345382
Crankshaft Balancer Keyway	Adhesive	12346141
Cylinder Head Bolt	Sealant	12346004
Engine Block to the Crankshaft Rear Oil Seal Housing Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141
Engine Block to the Engine Front Cover Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141
Engine Block at the Lower Intake Manifold Sealing Surfaces	Adhesive	12346141
Engine Block Coolant Drain Hole Plug	Sealant	12346004
Engine Block Core Hole Plug	Threadlock	12345382
Engine Block Oil Gallery Plug	Sealant	12346004
Engine Coolant Temperature (ECT) Sensor	Sealant	12346004
Engine Coolant Temperature (ECT) Gage Sensor	Sealant	12346004
Engine Oil	SAE 5W-30 Oil	12345610
Engine Oil Pressure Sensor	Sealant	12346004
Engine Oil Pressure Sensor Fitting	Sealant	12346004
Engine Oil Supplement	Lubricant	1052367
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Stud	Threadlock	12345382
Exhaust Manifold Bolt/Stud	Threadlock	12345493
Expansion Cup Plug (Balance Shaft Rear Bearing Hole)	Sealant	12346004
Expansion Cup Plug (Camshaft Rear Bearing Hole)	Sealant	12346004
Fuel Meter Body Bracket Bolt	Threadlock	12345382
Fuel Pipe Bolt	Threadlock	12345382
Lower Intake Manifold Bolt	Threadlock	12345382
Oil Level Indicator Tube	Sealant	12346004
Oil Pump Screen Tube	Sealant	12346004
Throttle Body Stud	Threadlock	12345382
Upper Intake Manifold Stud	Threadlock	12345382
Valve Train Component Prelube	Lubricant	12345501
Water Pump Bolt	Sealant	12346004

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Fig. 2: Sealers, Adhesives & Lubricants
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION & PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the DISASSEMBLED VIEWS or ENGINE COMPONENT DESCRIPTION, LUBRICATION DESCRIPTION, 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 before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer 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.
- 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 & Testing**
- **Oil Leak Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
High oil pressure	• Verify oil pressure. • 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.	• Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged, or improperly installed accessory drive system components A misfire DTC may be present without an actual misfire condition.	• 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.	• Inspect the crankshaft balancer. • Repair or replace damaged components as required.
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. • 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. • 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.	• Inspect the crankshaft position sensor. • Inspect the crankshaft reluctor wheel. • Inspect the crankshaft. • Repair or replace damaged components as required.
Damaged, loose or improperly installed engine flywheel A misfire DTC may be present without an actual misfire condition.	• Inspect the flywheel. • Repair or replace damaged components as required.
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.	• Inspect the exhaust system components. • Repair or replace damaged components as required.
Worn, damaged or improperly installed vacuum hoses	• Inspect the vacuum system components. • Repair or replace damaged components as required.
Damaged or improperly installed MAP sensor, sealing grommet nicked, torn or missing	• Inspect the MAP sensor. • Repair or replace damaged components as required.
Damaged or improperly installed throttle body	• Inspect the throttle body. • Repair or replace damaged components as required.
Damaged or improperly installed intake manifold	• Inspect the intake manifold. • Repair or replace damaged components as required.
Damaged or improperly installed cylinder head Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs. • Verify engine compression. • Inspect the cylinder heads. • Inspect the engine block. • Repair or replace damaged components as required.
Worn, damaged or loose valve rocker arm	• Inspect the valve rocker arms. • Repair or replace damaged components as required.

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Fig. 3: Base Engine Misfire Without Internal Engine Noises (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
Worn, damaged or loose valve rotator	• Inspect the valve rotators. • Repair or replace damaged components as required.
Worn, damaged, loose or broken valve spring	• Inspect the valve springs. • Repair or replace damaged components as required.
Worn, damaged or stuck valve, carbon on the valve stem or valve seat	• Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn or damaged valve guide	• Inspect the valve guides. • Inspect the valves. • Repair or replace damaged components as required.
Worn, damaged, loose or bent valve push rod	• Inspect the valve push rods. • Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	• Inspect the valve lifters. • Inspect the camshaft. • Repair or replace damaged components as required.
Worn or damaged camshaft lobe	• Inspect the camshaft. • Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or loose timing chain and sprockets	• 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.	• Inspect the spark plugs. • Verify engine compression. • Inspect the cylinder bores. • Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.

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Fig. 4: Base Engine Misfire Without Internal Engine Noises (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
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.	• Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged, or improperly installed accessory drive system components A misfire DTC may be present without an actual misfire condition.	• 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.	• Inspect the crankshaft balancer. • Repair or replace damaged components as required.
Worn, damaged, improperly installed or loose engine flywheel A misfire code may be present without an actual misfire condition.	• Inspect the engine flywheel. • Repair or replace damaged components as required.

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Fig. 5: Base Engine Misfire With Abnormal Internal Lower Engine Noises (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
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.	• Inspect the spark plugs. • Verify engine compression. • 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.	• Inspect the crankshaft. • Inspect the crankshaft thrust bearing. • Repair or replace damaged components as required.

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Fig. 6: Base Engine Misfire With Abnormal Internal Lower Engine Noises (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn, damaged or loose rocker arm	• Inspect the valve rocker arms. • Repair or replace damaged components as required.
Worn, damaged, loose or bent valve push rod	• 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	• Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn, damaged or dirty valve lifter	• Inspect the valve lifters. • Inspect the camshaft. • Repair or replace damaged components as required.
Worn or damaged camshaft lobe	• Inspect the camshaft. • Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or loose timing chain and sprockets	• Inspect the timing chain and sprockets. • Repair or replace damaged components as required.

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Fig. 7: Base Engine Misfire With Abnormal Valve Train Noise
Courtesy of GENERAL MOTORS CORP.

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.	• Inspect the spark plugs. • Verify engine compression. • Inspect the cylinder heads. • Inspect the engine block. • Repair or replace damaged components as required.

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Fig. 8: Base Engine Misfire With Coolant Consumption
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn or damaged valve	• 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.	• Inspect the spark plugs • Verify engine compression. • Inspect the cylinder bores. • Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.

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Fig. 9: Base Engine Misfire With Excessive Oil Consumption
Courtesy of GENERAL MOTORS CORP.

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

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A light rattle/tapping noise may indicate a valve train, upper engine concern, or a low rumble/knocking may indicate a crankshaft or piston, lower engine concern.	
Incorrect engine oil, viscosity	Install the correct engine oil and oil filter.
Incorrect oil filter, without anti-drainback feature	Install the correct engine oil and oil filter.
Worn, damaged or improperly installed oil filter by-pass valve	• Inspect the oil filter by-pass valve. • Repair or replace damaged components as required.
High valve lifter leak down rate	• Inspect the valve lifters. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft thrust bearing	• Inspect the crankshaft. • Inspect the crankshaft thrust bearing. • Repair or replace damaged components as required.

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Fig. 10: Engine Noise On Start-Up, But Only Lasting A Few Seconds
Courtesy of GENERAL MOTORS CORP.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A light rattle/tapping noise may indicate a valve train, upper engine concern.	
Low oil pressure	• Verify oil pressure. • Repair or replace damaged components as required.
Improper lubrication of the valve train components	• Verify oil pressure. • 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. • Inspect the engine block oil galleries. • Repair or replace damaged components as required.
Worn, damaged or improperly installed valve rocker arm	• Inspect the valve rocker arms. • Repair or replace damaged components as required.
Worn or damaged valve rotator	• Inspect the valve rotators. • Repair or replace damaged components as required.

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Fig. 11: Upper Engine Noise, Regardless Of Engine Speed (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
Broken valve spring	• Inspect the valve springs. • Repair or replace damaged components as required.
Worn, damaged or stuck valves, carbon on the valve stem or valve seat	• Inspect the valves. • Inspect the valve guides. • Repair or replace damaged components as required.
Worn or damaged valve guide	• Inspect the valve guides. • Inspect the valves. • Repair or replace damaged components as required.
Worn, damaged or bent valve push rod	• 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	• Inspect the valve lifters. • Repair or replace damaged components as required.
Worn or damaged camshaft lobes	• Inspect the engine camshaft lobes. • Repair or replace damaged components as required.
Worn, damaged, improperly installed or loose timing chain and sprockets	• Inspect the timing chain and sprockets. • Repair or replace damaged components as required.
Worn, damaged or improperly installed timing chain tensioner, if equipped	• Inspect the timing chain tensioner. • Repair or replace damaged components as required.

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Fig. 12: Upper Engine Noise, Regardless Of Engine Speed (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A low rumble/knocking may indicate a crankshaft or piston, lower engine concern.	
Low oil pressure	• Verify oil pressure. • Repair or replace damaged components as required.
Detonation or spark knock	• Verify the operation of the ignition controls system. • 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	• Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged or improperly installed accessory drive system components	• Inspect the accessory drive system components. • Repair or replace damaged components as required.
Worn, damaged or improperly installed crankshaft balancer	• Inspect the crankshaft balancer. • Inspect the crankshaft. • Repair or replace damaged components as required.
Worn, damaged or improperly installed engine flywheel	• 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	• Inspect the torque converter. • Inspect the torque converter bolts. • Inspect the engine flywheel. • Repair or replace damaged components as required.

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Fig. 13: Lower Engine Noise, Regardless of Engine Speed (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
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.	• 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.	• 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.	• Inspect the spark plugs. • Verify engine compression. • 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	• 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	• Inspect the crankshaft bearings. • Inspect the crankshaft journals. • Repair or replace damaged components as required.

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Fig. 14: Lower Engine Noise, Regardless of Engine Speed (2 Of 2)

Courtesy of GENERAL MOTORS CORP.

ENGINE NOISE UNDER LOAD

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A low rumble/knocking may indicate a crankshaft or piston, lower engine concern.	
Low oil pressure	• Perform an oil pressure test. • Repair or replace as required.
Detonation or spark knock	• Verify the correct operation of the ignition controls. • Repair or replace damaged components as required.
Worn, damaged or improperly installed engine flywheel	• 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	• 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.	• Inspect the cylinder bores. • Inspect the pistons. • Inspect the piston pins. • Inspect the connecting rods. • Repair or replace damaged components as required.

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Fig. 15: Engine Noise Under Load (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
Worn, damaged or improperly installed connecting rod bearing	• 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	• Inspect the crankshaft bearings. • Inspect the crankshaft journals. • Repair or replace damaged components as required.

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Fig. 16: Engine Noise Under Load (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	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	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location. 3. Inspect the Manual Transmission.
Broken timing chain and/or gears	• Inspect timing chain and gears. • Repair as required.
Seized balance shaft	• Inspect balance shaft. • Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material	• Inspect cylinder for damaged components and/or foreign materials. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Repair as required.
Bent or broken connecting rod	• Inspect connecting rods. • Repair as required.
Broken crankshaft	• Inspect crankshaft. • Repair as required.

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Fig. 17: Engine Will Not Crank - Crankshaft Will Not Rotate
Courtesy of GENERAL MOTORS CORP.

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 through 10 for each additional cylinder. All cylinders must be tested to obtain valid test results.
12. Check the compression readings. Refer to **Engine Mechanical Specifications**.
    - **Normal:** The compression builds up quickly and evenly to the specified compression.
    - **Leaking:** The compression is low on the first compression stroke. The compression builds up with the following strokes, but does not reach the specified compression.
13. If any cylinders have low compression, inject approximately 15 ml (1 oz.) of engine oil into the cylinder through the spark plug hole.
14. Repeat steps 8 through 10 for all low compression cylinders.
15. Check the compression readings. Refer to **Engine Mechanical Specifications**.
    - **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.

16. 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 & 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:

   1,000 RPM: 42 kPa (6 psig) Minimum
   2,000 RPM: 125 kPa (18 psig) Minimum
   4,000 RPM: 166 kPa (24 psig) Minimum
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

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: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 4*
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers – miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 5*
5	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: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 6*
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. 3. Operate the vehicle for several kilometers (miles) at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 7*
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 8*

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Fig. 18: Oil Leak Diagnosis (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Step	Action	Yes	No
8	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. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 9*
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to *Step 11*	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to *Step 1*	System OK

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Fig. 19: Oil Leak Diagnosis (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Results Of Incorrect Operation

1. A plugged valve or hose may cause the following conditions:
   - Rough idle
   - Stalling or slow idle speed
   - Oil leaks
   - Oil in air cleaner
   - Sludge in engine
2. A leaking crankcase ventilation valve or hose may cause the following conditions:
   - Rough idle
   - Stalling
   - High idle speed

Functional Check

1. With these systems, any blow-by in excess of the system capacity, from a badly worn engine, sustained heavy load, etc., is exhausted into the air cleaner and is drawn into the engine.
2. Proper operation of the crankcase ventilation system depends upon a sealed engine. If oil slugging or dilution is noted and the crankcase ventilation system is functioning properly, check the engine for a possible cause. Correct any problems.
3. If an engine is idling rough, check for a clogged crankcase ventilation valve, a dirty vent filter, air cleaner element, or plugged hose. Replace as required. Use the following procedure:
    a. Remove the crankcase ventilation valve from the rocker arm cover.
    b. Operate the engine at idle.
    c. Place your thumb over the end of the valve in order to check for a vacuum. If there is no vacuum at the valve, check for the following items:
        - Plugged hoses
        - The manifold port
        - The crankcase ventilation valve
    d. Turn OFF the engine. Remove the crankcase ventilation valve. Shake the valve. Listen for the rattle of the check needle inside of the valve. If valve does not rattle, replace the valve.

DRIVE BELT CHIRPING DIAGNOSIS

Diagnostic Aids

1. The symptom may be intermittent due to moisture on the drive belt(s) or the pulleys. It may be necessary to spray a small amount of water on the drive belt(s) in order to duplicate the customers concern. If spraying water on the drive belt(s) duplicates the symptom, cleaning the belt pulleys may be the probable solution.
2. A loose or incorrect installation of a body component, a suspension component, or other items of the vehicle may cause the chirping noise.

Test Description

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

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

3. The noise may be an internal engine noise. Removing the drive belt and operating the engine verifies the noise is related to the drive belt. When removing the drive belt(s) the water pump may not be operating and cause the engine to overheat. Also DTCs may set if the engine is operating with the drive belt removed.

4. Inspect all drive belt pulleys for pilling. Pilling is i the small bails or strings in the drive belt grooves. Pilling occurs from the accumulation of rubber dust.

6. Misalignment of the pulleys may be caused from incorrect mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for an incorrectly aligned pulley. Use 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

correct installation procedure.

10. Inspection of the fasteners eliminates the installment of incorrect: bolts, nuts, spacers, or washers.

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

14. Replacing the drive belt when it is not damaged, or if there is no excessive pilling will be a temporary repair.

Step	Action	Yes	No
Notice: DO NOT use belt dressing on drive belt. DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. Chirping may occur on cold damp start up conditions and will subside once the vehicle reaches normal operating temperature. • It usually occurs on cold damp mornings.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt. 2. Operate the engine for no longer than 30 to 40 seconds. Does the chirping noise still exist?	Go to *Symptoms - Engine Mechanical*	Go to *Step 4*
4	Inspect for severe pilling exceeding 1/3 of the belt groove depth. Does the belt grooves have pilling?	Go to *Step 5*	Go to *Step 6*
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to*Step 15*	Go to*Step 6*
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to *Step 7*	Go to *Step 8*
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to *Step 15*	Go to *Step 8*
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to *Step 9*	Go to *Step 10*
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to *Step 15*	Go to *Step 10*
10	Inspect for incorrect, loose or missing fasteners. Did you find the condition?	Go to *Step 11*	Go to *Step 12*
11	1. Tighten any loose fasteners. 2. Replace any incorrect or missing fasteners. Did you complete the repair?	Go to *Step 15*	Go to *Step 12*
12	Inspect for a bent pulley. Did you find the condition?	Go to *Step 13*	Go to *Step 14*
13	Replace the bent pulley. Did you complete the repair?	Go to *Step 15*	Go to *Step 14*
14	Replace the drive belt. Did you complete the repair?	Go to *Step 15*	Go to Diagnostic Aids
15	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 3*

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Fig. 20: Drive Belt Chirping Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT SQUEAL DIAGNOSIS

Diagnostic Aids

1. A loose or incorrect installation of a body component, a suspension component, or other items of the vehicle may cause the squeal noise.
2. If the noise is intermittent verify the accessory drive components by varying their loads. Ensure the accessory components are operated to their maximum capacity. An overcharged A/C system or power steering system with: a pinched hose, an incorrect fluid, or a failed generator are suggested items to inspect.

Test Description

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

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

3. The noise may be an internal engine noise. Removing the drive belt and operating the engine verifies the noise is related to the drive belt or an accessory drive component. If the drive belt is removed, the water pump may not operate. Without the water pump the engine may overheat. DTCs may set when the engine is operating with the drive belt removed.

4. This test verifies that an accessory drive component does not have a seized bearing. Remove the belt and test the bearings for smooth turning in the accessory drive components. Test the accessory drive components with the engine operating, vary the load on the components to verify that the components operate correctly.

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

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

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

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

Step	Action	Yes	No
Notice: ***DO NOT use belt dressing on drive belt.*** DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt (this is unusual for a drive belt with multiple ribs) • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a squeal noise. Does the engine make the squeal noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the noise still exist?	Go to *Symptoms - Engine Mechanical*	Go to *Step 4*
4	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 5*
5	Test the drive belt tensioner for correct operation. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 6*
6	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 7*
7	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 8*
8	Inspect for the correct pulley size. Did you find and correct the condition?	Go to *Step 9*	Go to Diagnostic Aids
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 3*

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Fig. 21: Drive Belt Squeal Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT WHINE DIAGNOSIS

Diagnostic Aids

The drive belt(s) will not cause the whine noise. If the whine noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. Such items but not limited to may be an A/C system overcharged, the power steering system restricted or the wrong fluid, or the generator failing.

Test Description

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

3. This test is to verify that the noise is being caused by the drive belt(s) or the accessory drive components. When removing the drive belt the water pump may not be operating and the engine may overheat. DTCs may set if the engine is operating with the drive belt removed.

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

Step	Action	Yes	No
Notice: DO NOT use belt dressing on drive belt. DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a whine noise. Does the engine make the whine noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the whine noise still exist?	Go to *Symptoms - Engine Mechanical*	Go to *Step 4*
4	Inspect for a failed accessory drive component bearing. Did you find and repair the condition?	Go to *Step 5*	Go to Diagnostic Aids
5	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

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Fig. 22: Drive Belt Whine Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

1. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise.
2. The drive belt(s) may have a condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.
3. If replacing the drive belt(s), completing the diagnostic table, and the noise is only heard when the drive belt(s) is installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

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

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

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

4. Inspecting the drive belt(s) is to ensure that it is not causing a the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

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

Step	Action	Yes	No
Notice: *DO NOT use belt dressing on drive belt.* DEFINITION: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: – Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove – The separation of the drive belt – A damaged drive belt			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to *Symptoms - Engine Mechanical*	Go to *Step 4*
4	Inspect the drive belt(s) for damage, separation, or sections of missing ribs. Did you find any of these conditions?	Go to *Step 7*	Go to *Step 5*
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to *Step 6*	Go to *Step 7*
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belt. Did you complete the repair?	Go to *Step 8*	Go to *Step 7*
7	Install a new drive belt. Did you complete the replacement?	Go to *Step 8*	---
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Diagnostic Aids

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Fig. 23: Drive Belt Rumbling Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Such as but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

Test Description

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

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

3. This test is to verify that the drive belt(s) or accessory drive components may be causing the vibration. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.

4. The drive belt(s) may cause a vibration. While the drive belt(s) is removed this is the best time to

inspect the condition of the belt.

6. Inspecting of the fasteners can eliminate the possibility that a wrong 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 smoothness, ease of turning. Inspect for a bent fan shaft or bent mounting flange.

9. This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smoothness 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 extra strain on that accessory component causing it to vibrate.

Step	Action	Yes	No
	Notice: *DO NOT use belt dressing on drive belt.* DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.		
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt. 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Go to *Symptoms - Vibration Diagnosis and Correction* in Vibration and Diagnosis	Go to *Step 4*
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Did you find any of these conditions?	Go to *Step 5*	Go to *Step 6*
5	Install a new drive belt. Did you complete the replacement?	Go to *Step 11*	—
6	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to *Step 7*	Go to *Step 8*
7	1. Tighten any loose fasteners. 2. Replace improper or missing fasteners. Did you complete the repair?	Go to *Step 11*	—
8	Inspect for damaged fan blades or bent fan clutch shaft, if the fan is belt driven. Did you find and correct the condition?	Go to *Step 11*	Go to *Step 9*
9	Inspect for a bent water pump shaft, if the water pump is belt driven. Did you find and correct the condition?	Go to *Step 11*	Go to *Step 10*
10	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to *Step 11*	Go to Diagnostic Aids
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 3*

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Fig. 24: Drive Belt Vibration Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

1. If the drive belt(s) repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.
2. An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate correctly.
3. If the drive belt(s) is the incorrect length, the drive belt tensioner may not keep the correct tension on the drive belt.

Test Description

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

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

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

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

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

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

Step	Action	Yes	No
Notice: DO NOT use belt dressing on drive belt. DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Inspect for a damaged drive belt. Did you find the condition?	Go to *Step 3*	Go to *Step 4*
3	Install a new drive belt. Does the drive belt continue to fall off?	Go to *Step 4*	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 5*
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 6*
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 7*
7	Inspect for incorrect, loose or missing fasteners. Did you find loose or missing fasteners?	Go to *Step 8*	Go to *Step 9*
8	1. Tighten any loose fasteners. 2. Replace incorrect or missing fasteners. Does the drive belt continue to fall off?	Go to *Step 9*	System OK
9	Test the drive belt tensioner for operating correctly. Does the drive belt tensioner operate correctly?	Go to *Step 11*	Go to *Step 10*
10	Replace the drive belt tensioner. Does the drive belt continue to fall off?	Go to *Step 11*	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to *Step 12*	Go to Diagnostic Aids
12	*Operate the system in order to verify the repair.* Did you correct the condition?	System OK	Go to *Step 2*

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Fig. 25: Drive Belt Falls Off Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

1. Excessive wear on a drive belt(s) is usually caused by an incorrect installation or the wrong drive belt for the application.
2. Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt(s) to make a noise or to fall off.
3. Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt(s) fall off.

Test Description

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

2. The inspection is to verify the drive belt(s) is correctly installed on all of the drive belt pulleys. Wear

on the drive belt(s) may be caused by mis-positioning the drive belt(s) by one groove on a pulley.

3. The installation of a drive belt that is two wide or two narrow will cause wear on the drive belt.

The drive belt ribs should match all of the grooves on all of the pulleys.

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

Step	Action	Yes	No
Notice: DO NOT use belt dressing on drive belt. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical*
2	Inspect the drive belt(s) for the proper installation. Did you find this condition?	Go to *Step 5*	Go to *Step 3*
3	Inspect for the proper drive belt. Did you find this condition?	Go to *Step 5*	Go to *Step 4*
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to *Step 6*	Go to Diagnostic Aids
5	Replace the drive belt. Did you complete the replacement?	Go to *Step 6*	—
6	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

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Fig. 26: Drive Belt Excessive Wear Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT TENSIONER DIAGNOSIS

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

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

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Position a 3/8 inch drive wrench on the drive belt tensioner arm and rotate the arm counterclockwise.
3. 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.
4. If any binding is observed, replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

5. Install drive belt. Refer to **Drive Belt Replacement**.

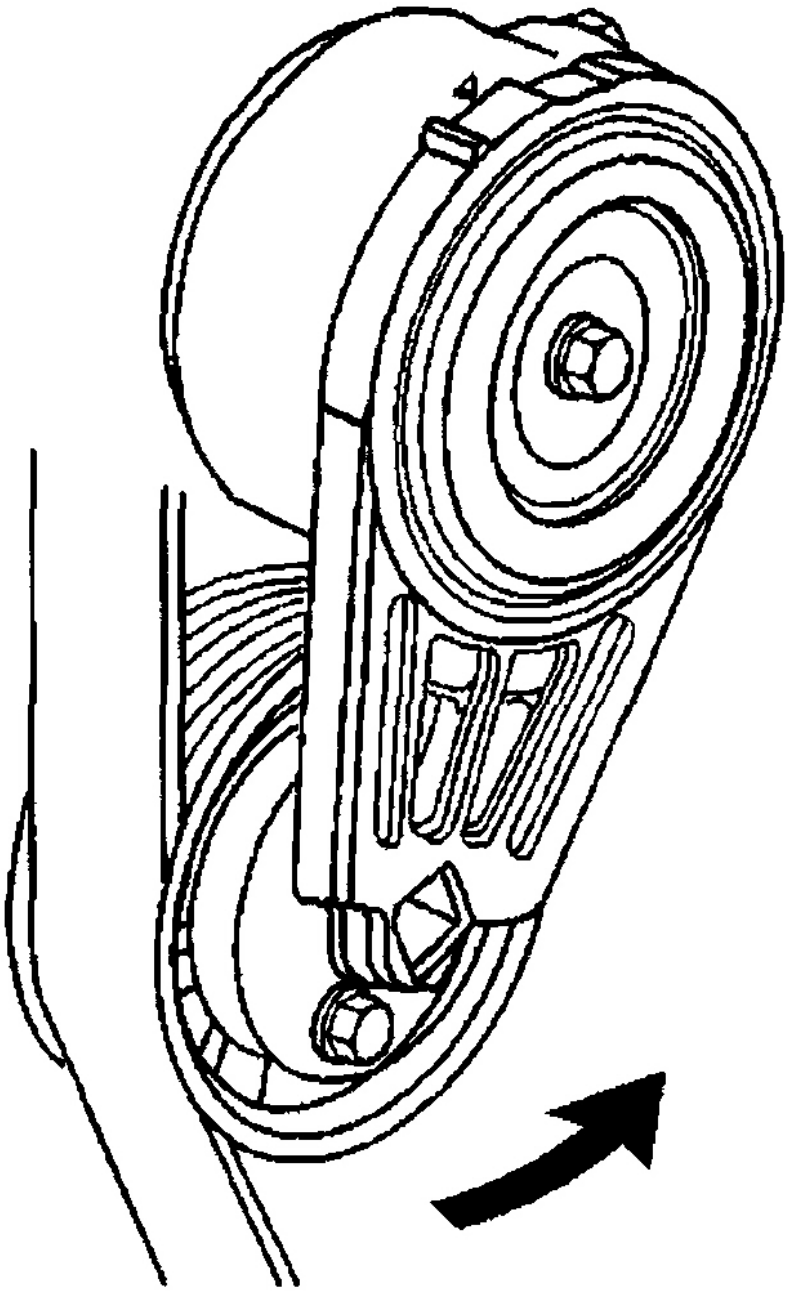

Fig. 27: Testing Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT

Removal Procedure

1. Remove the air cleaner assembly.
2. Remove the air cleaner outlet duct from the throttle body.
3. Install a 3/8 inch drive wrench on the drive belt tensioner arm and rotate the arm counterclockwise.
4. Remove the drive belt.
5. Slowly release the tension on the drive belt tensioner arm.

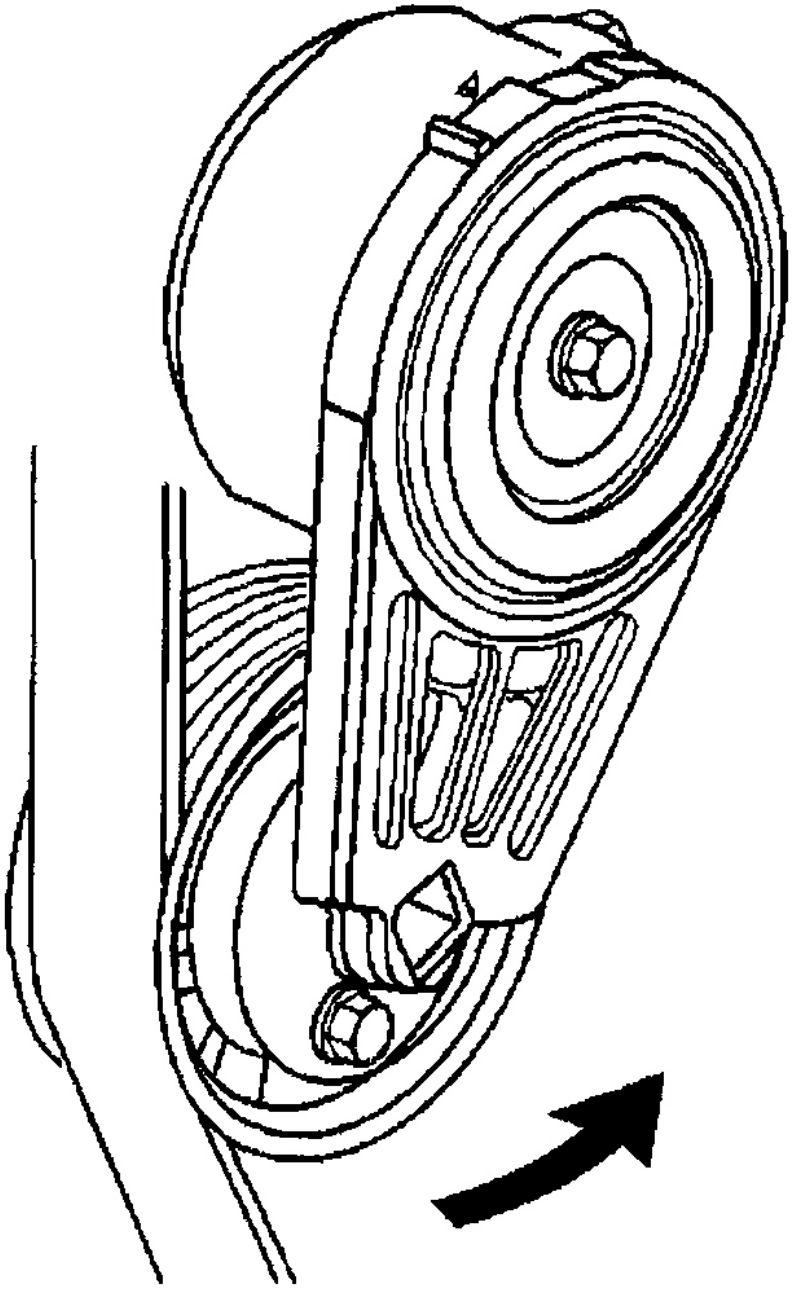

Fig. 28: Rotating Drive Belt Tensioner Arm
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Route the belt over all the pulleys except the tensioner arm.
2. Observe drive belt routing for vehicles without air conditioning.
3. Observe drive belt routing for vehicles with air conditioning.

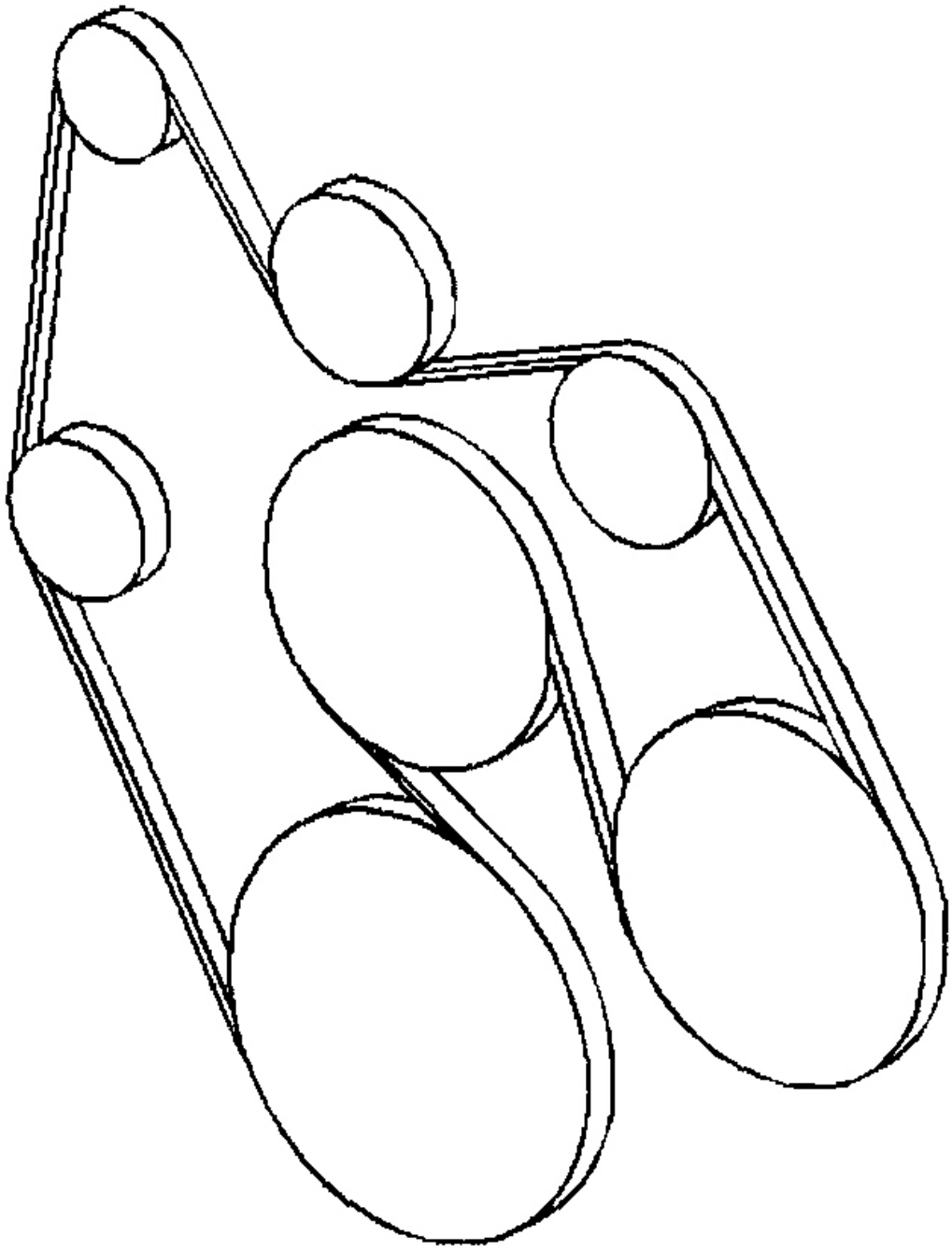

Fig. 29: Drive Belt Routing For Vehicles Without Air Conditioning
Courtesy of GENERAL MOTORS CORP.

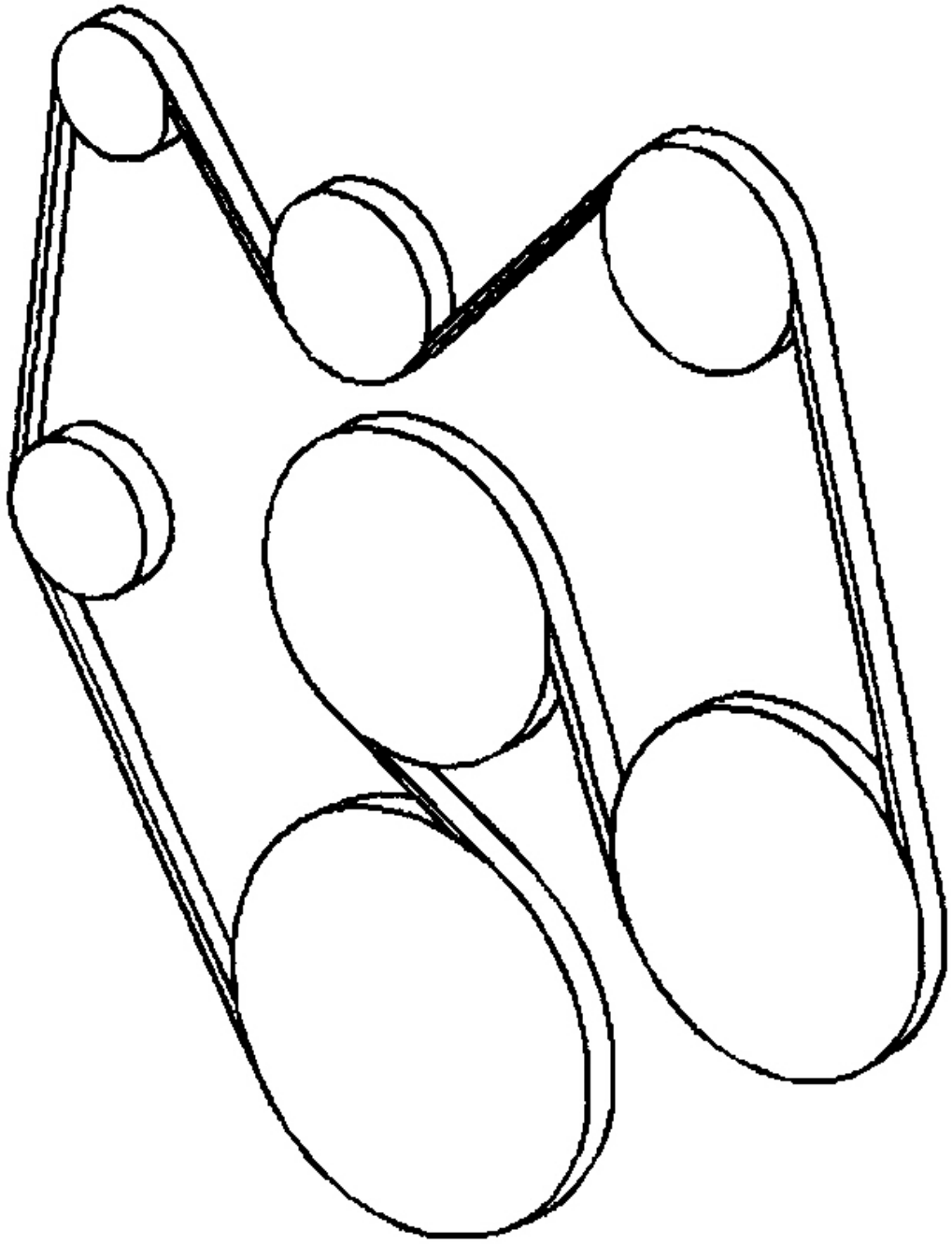

Fig. 30: Drive Belt Routing For Vehicles With Air Conditioning
Courtesy of GENERAL MOTORS CORP.

4. Install a 3/8 inch drive wrench on the drive belt tensioner arm and rotate the arm counterclockwise.
5. Install the drive belt over the drive belt tensioner pulley.
6. Slowly release the tension on the tensioner arm.

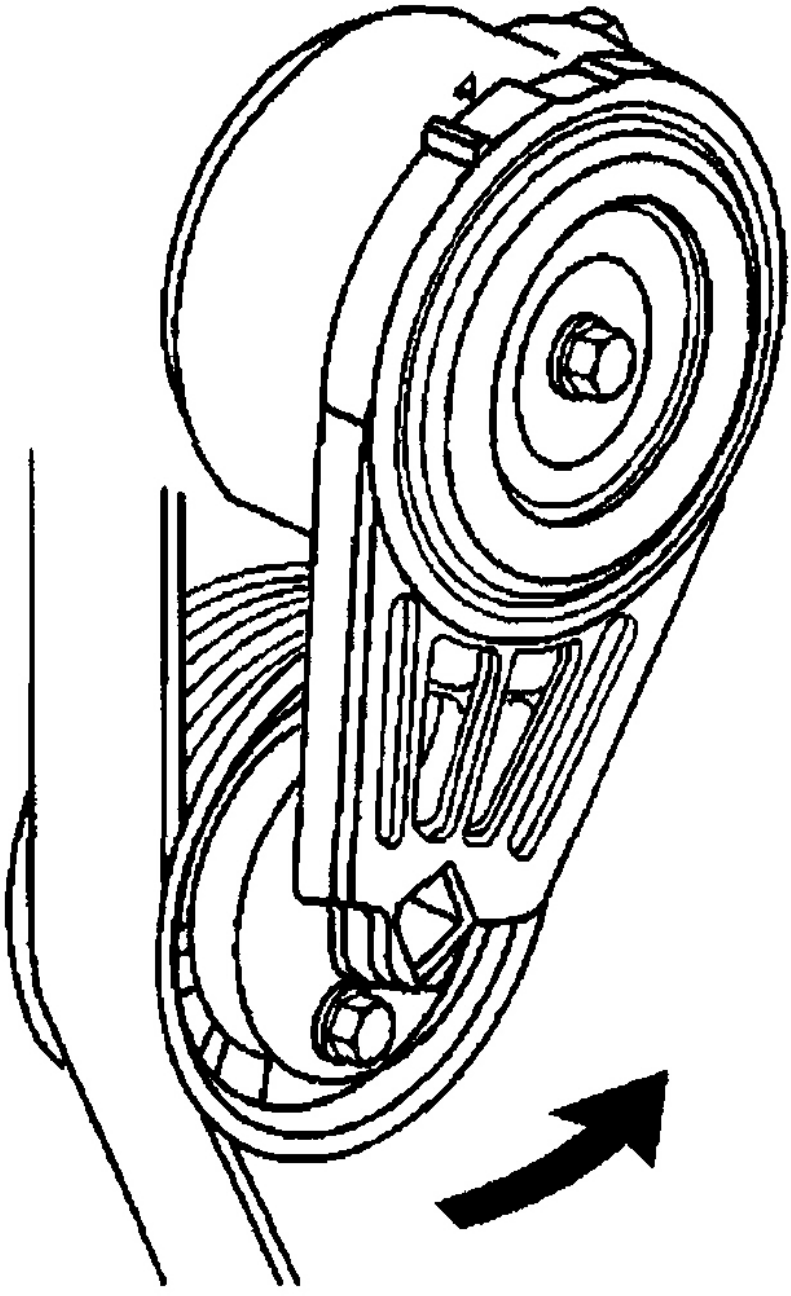

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Fig. 31: Releasing Tension On Drive Belt Tensioner Arm
Courtesy of GENERAL MOTORS CORP.

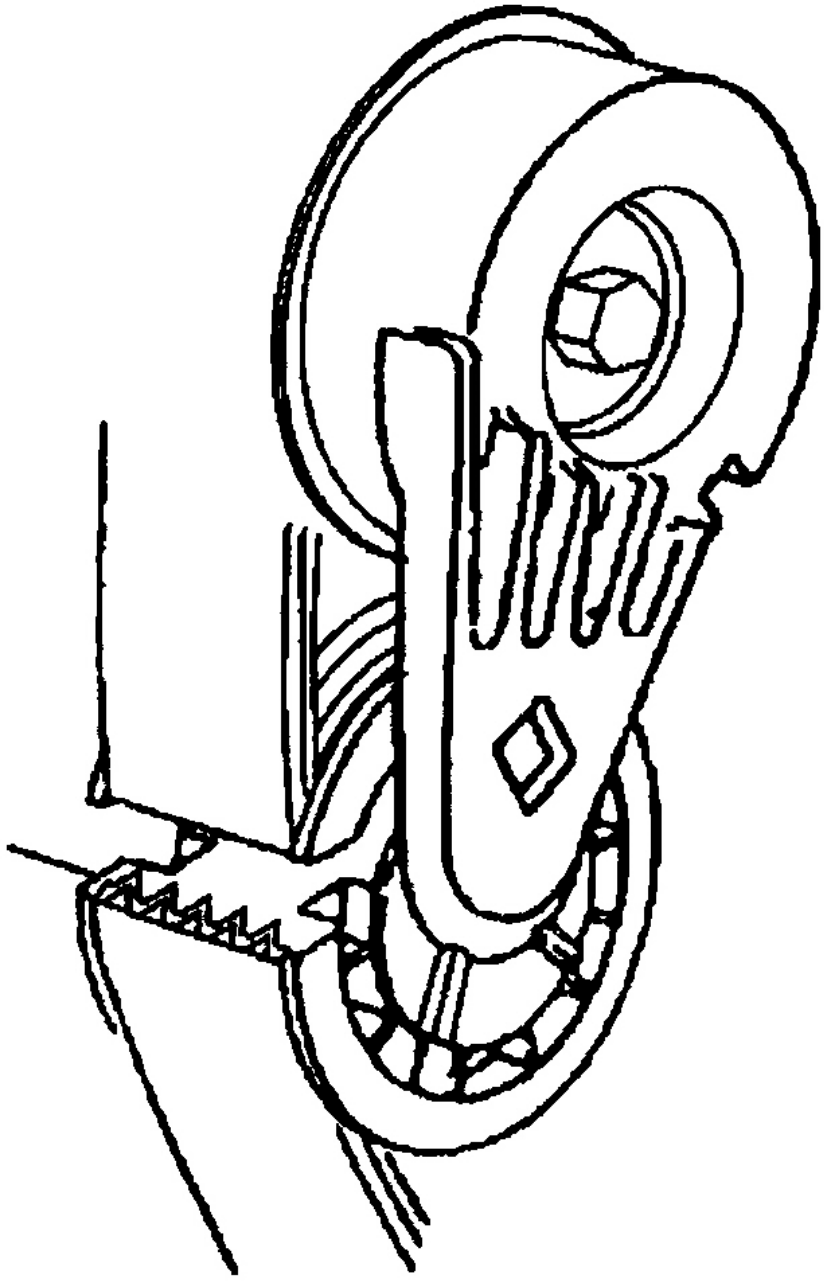

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Fig. 32: Inspecting Drive Belt Routing On Pulleys
Courtesy of GENERAL MOTORS CORP.

7. Inspect for the drive belt being properly installed on the pulleys.
8. Avoid mis-positioning the drive belt by one or more grooves.

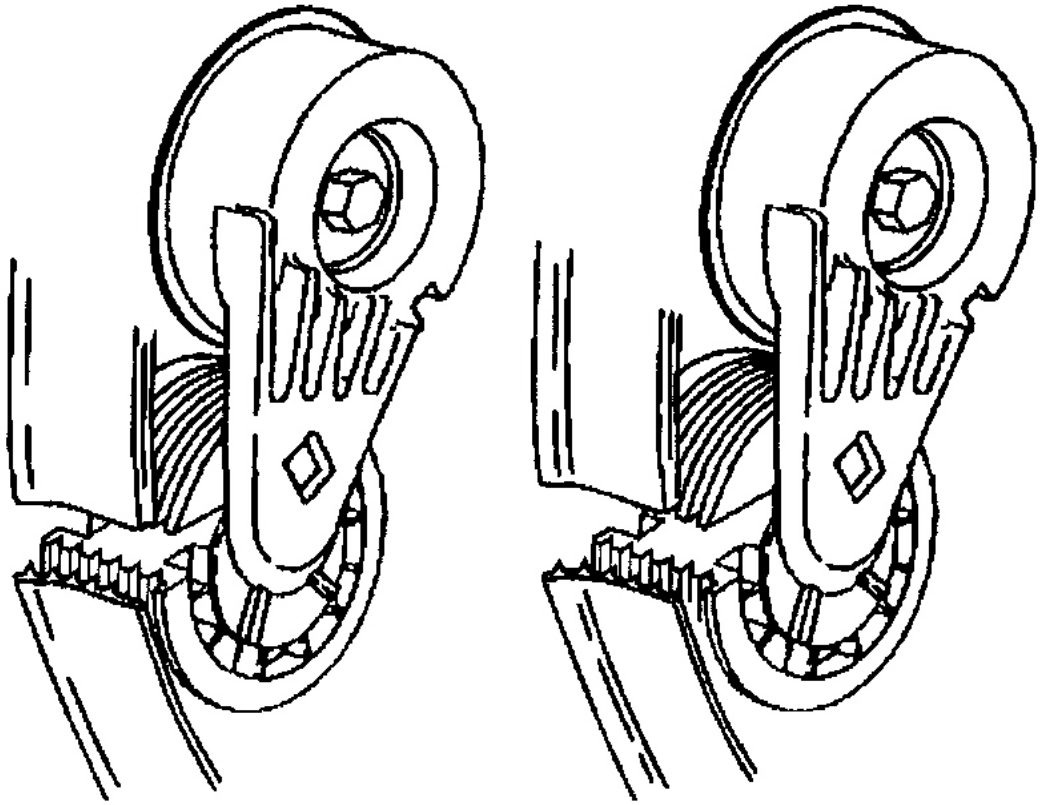

Fig. 33: Checking For Drive Belt Mis-Positioning
Courtesy of GENERAL MOTORS CORP.

9. Confirm for the proper drive belt size and the correct drive belt routing by observing the location of the fix pointer and the index marks on the drive belt tensioner. With a new drive belt installed, the fix pointer should align within the indentation on the drive belt tensioner.

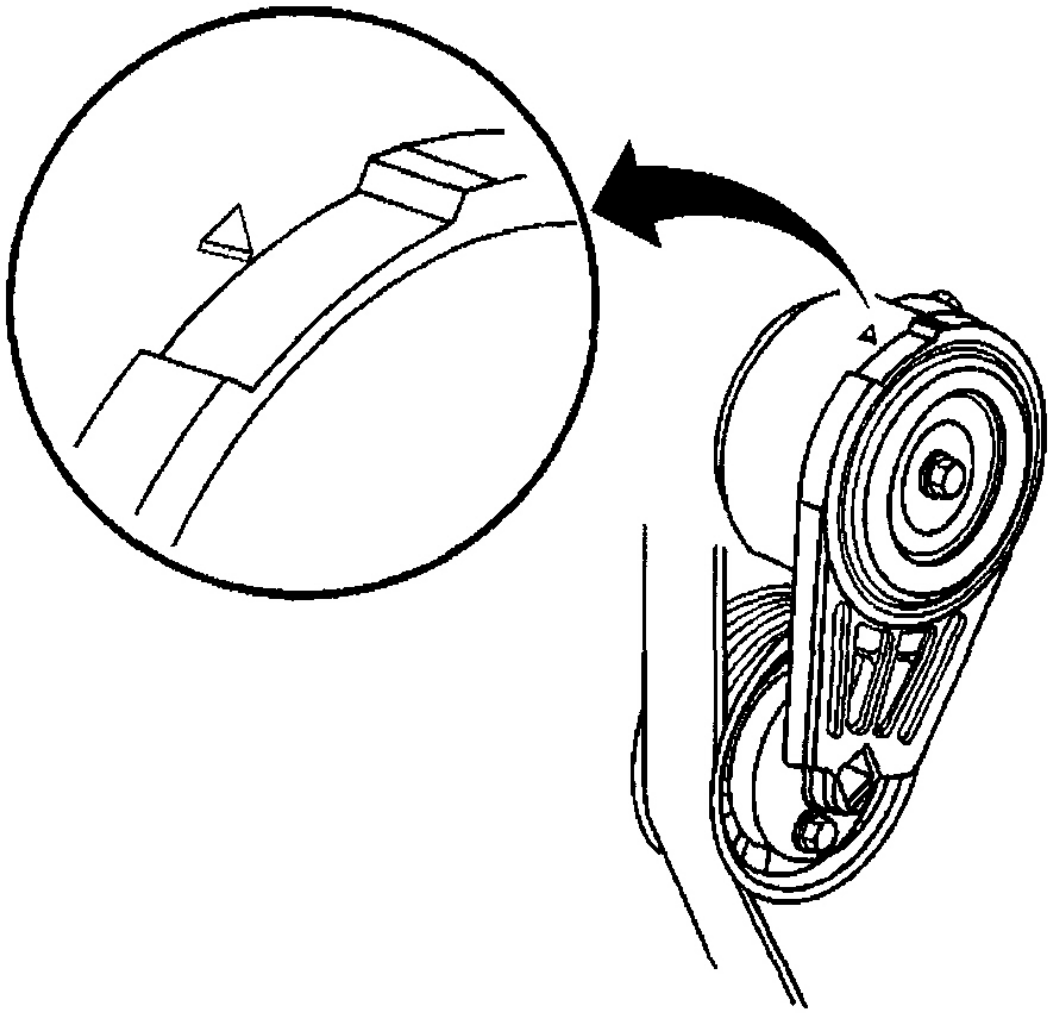

Fig. 34: NEW Drive Belt Fix Pointer Aligns Within Drive Belt Tensioner Indentation
Courtesy of GENERAL MOTORS CORP.

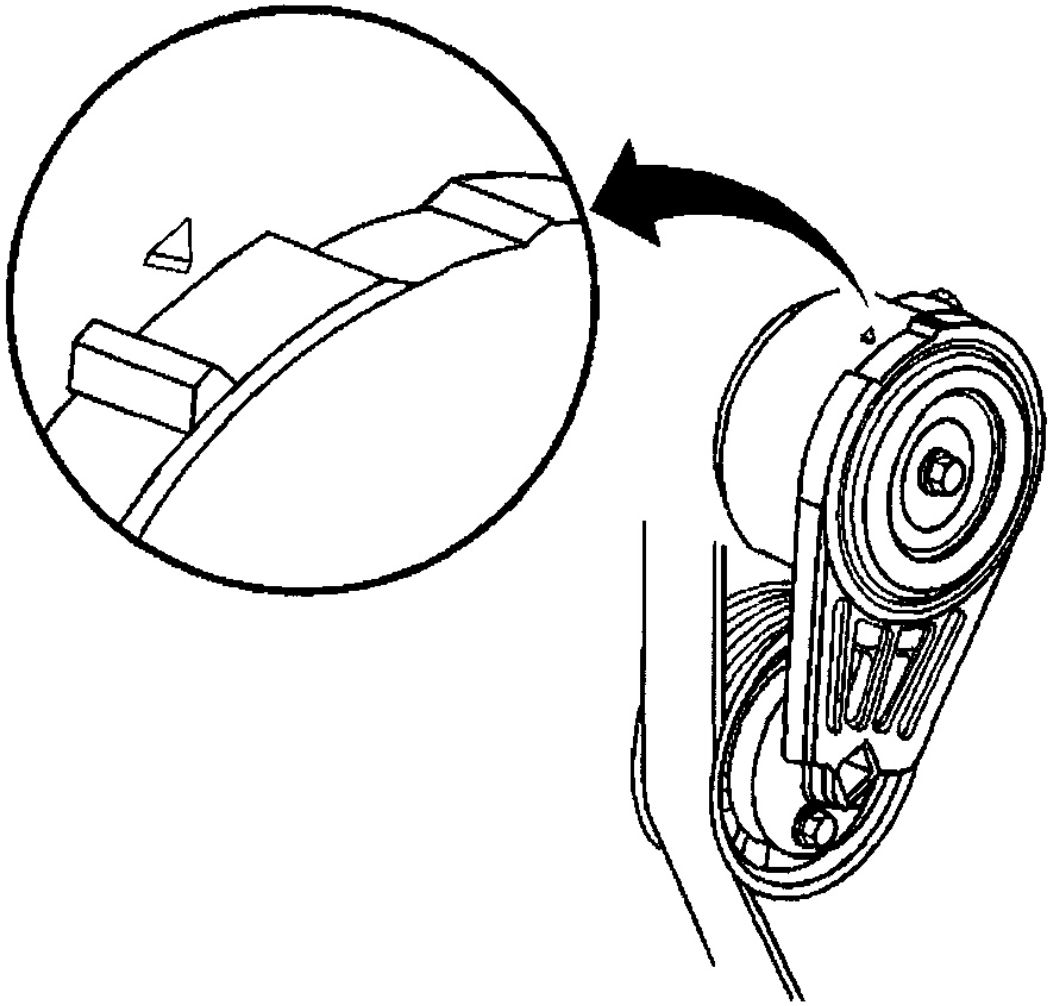

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Fig. 35: USED Drive Belt Fix Pointer Does NOT Align Within Drive Belt Tensioner Indentation
Courtesy of GENERAL MOTORS CORP.

10. With a used drive belt installed, the fix pointer should not align past the index mark.
11. Install the air cleaner outlet duct.
12. Install the air cleaner assembly.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.

2. Remove the bolt.
3. Remove the drive belt tensioner.

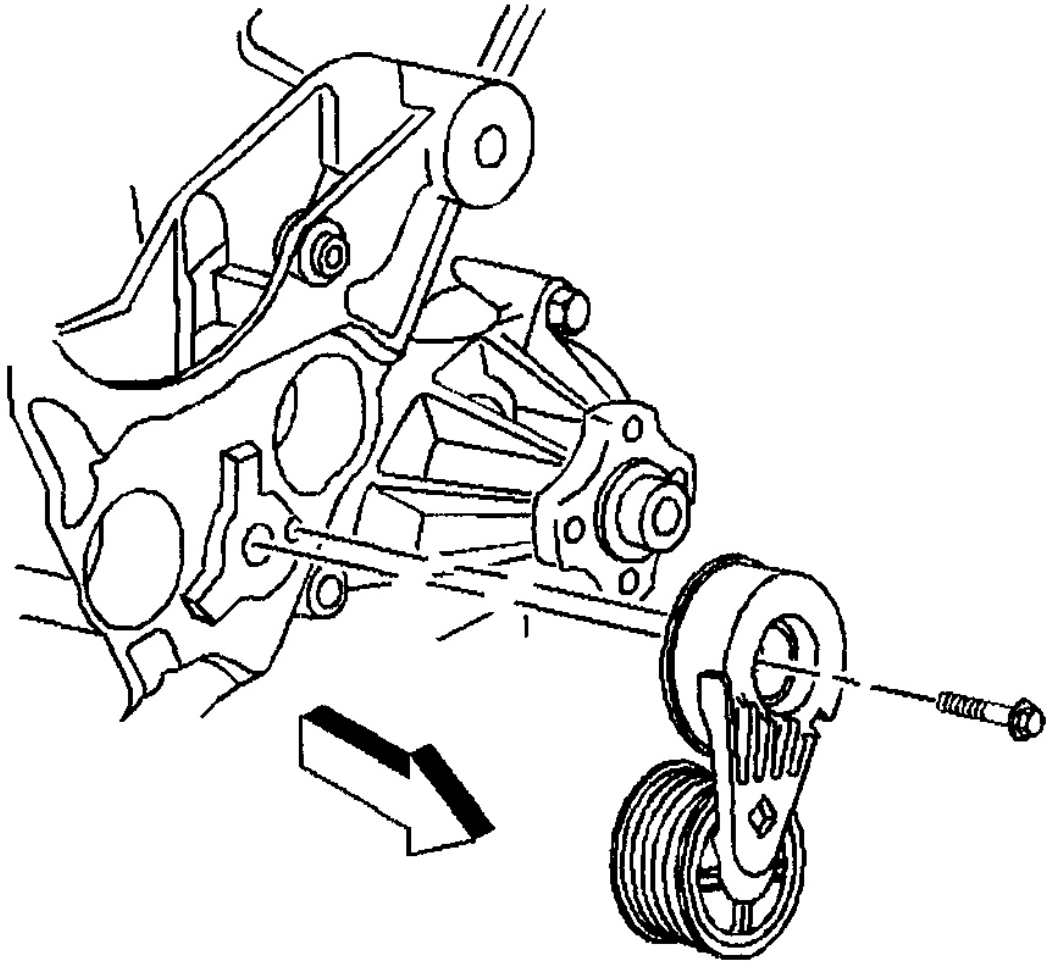

Fig. 36: Removing Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the drive belt tensioner assembly.
2. Install the attaching bolt. **Tighten:** Tighten the tensioner assembly bolt to 50 N.m (37 lb ft).
3. Install the drive belt. Refer to **Drive Belt Replacement**.

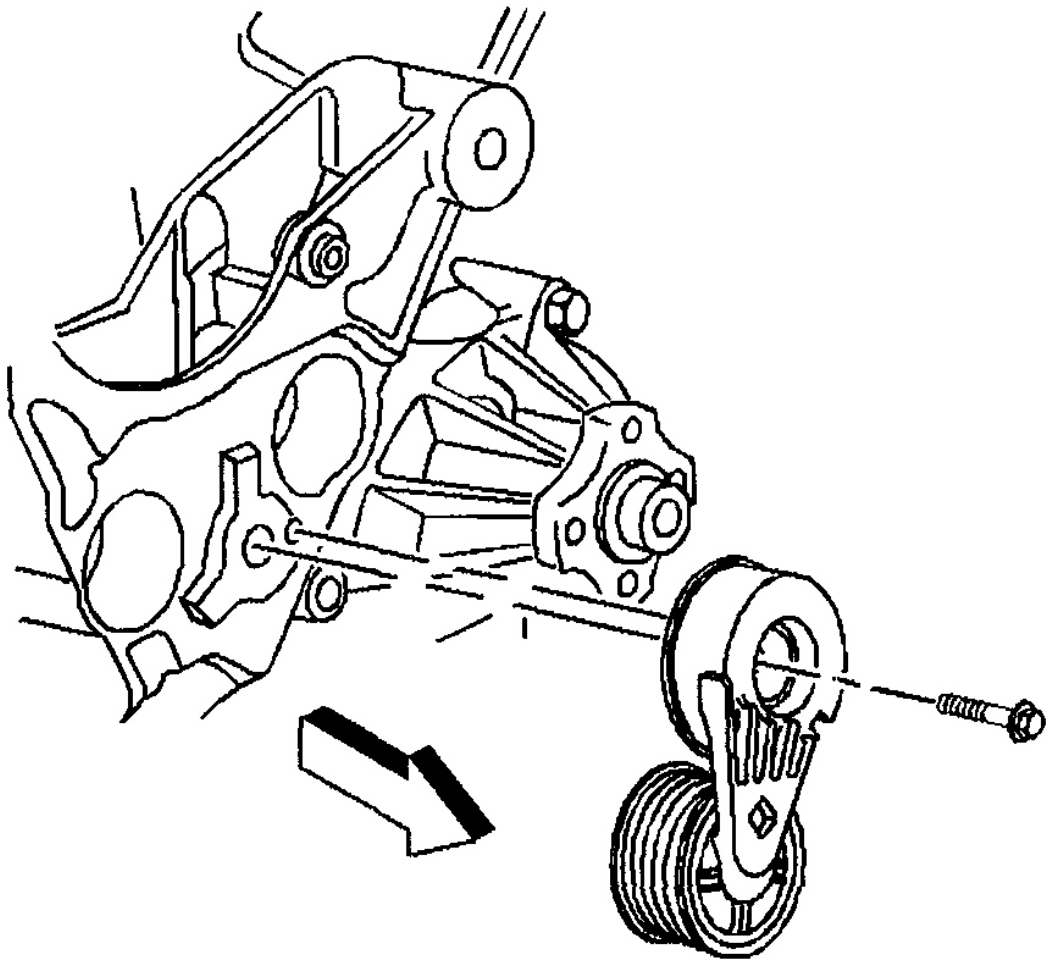

Fig. 37: Installing Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT IDLER PULLEY REPLACEMENT - RIGHT

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley from the generator mounting bracket.

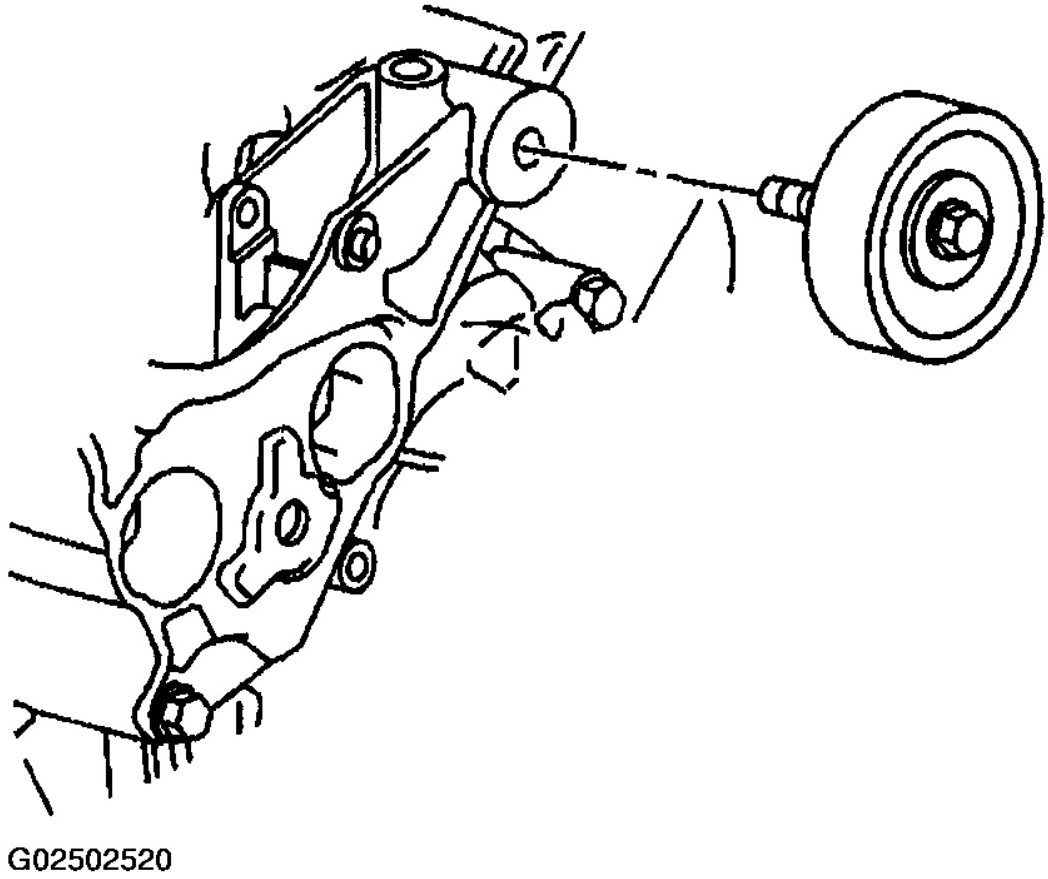

Fig. 38: Removing Drive Belt Idler Pulley - Right
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the drive belt idler pulley and bolt to the generator mounting bracket. **Tighten:** Tighten the bolt to 50 N.m (37 lb ft).
2. Install the drive belt. Refer to **Drive Belt Replacement**.

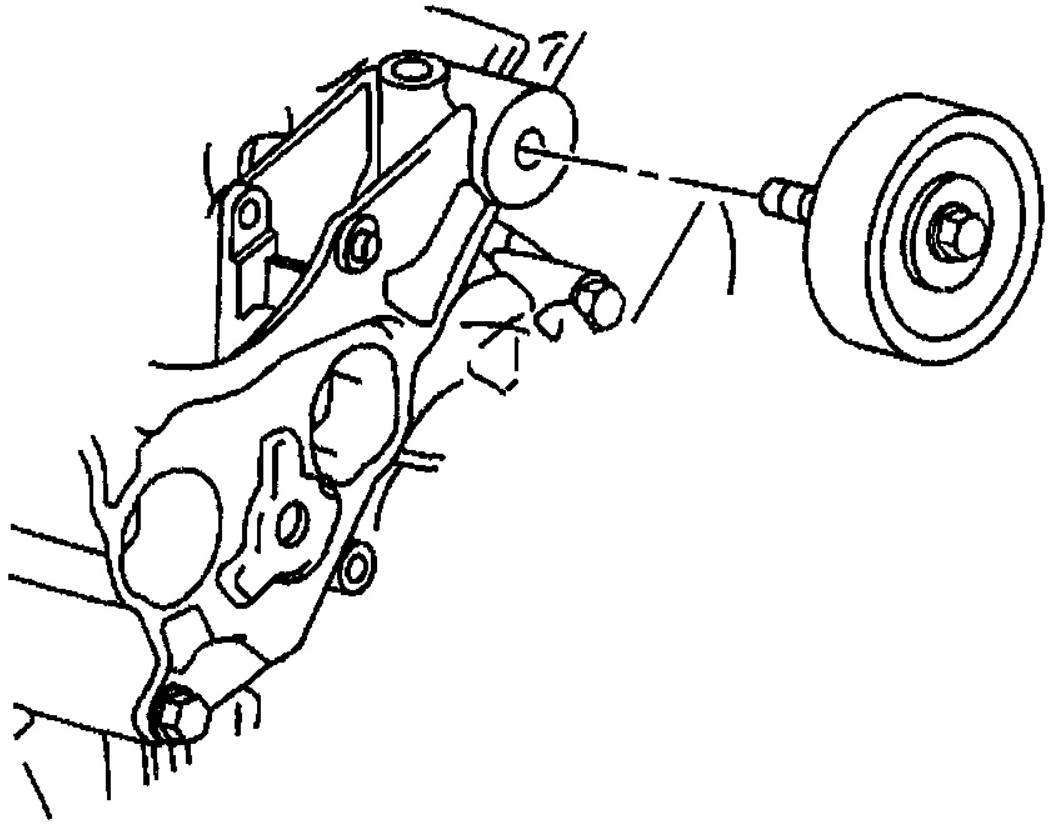

Fig. 39: Installing Drive Belt Idler Pulley - Right
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT IDLER PULLEY REPLACEMENT - WITHOUT AIR CONDITIONING

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley from the power steering pump mounting bracket.

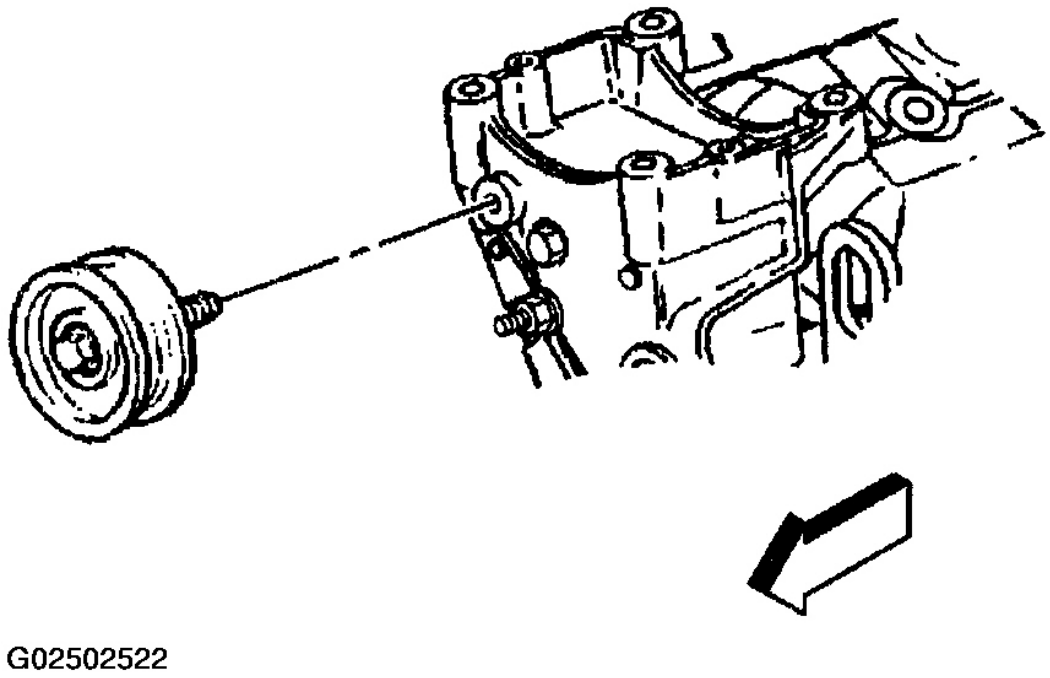

Fig. 40: Removing Drive Belt Idler Pulley - Without Air Conditioning
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the drive belt idler pulley and bolt to the power steering pump mounting bracket. **Tighten:** Tighten the bolt to 50 N.m (37 lb ft).
2. Install the drive belt. Refer to **Drive Belt Replacement**.

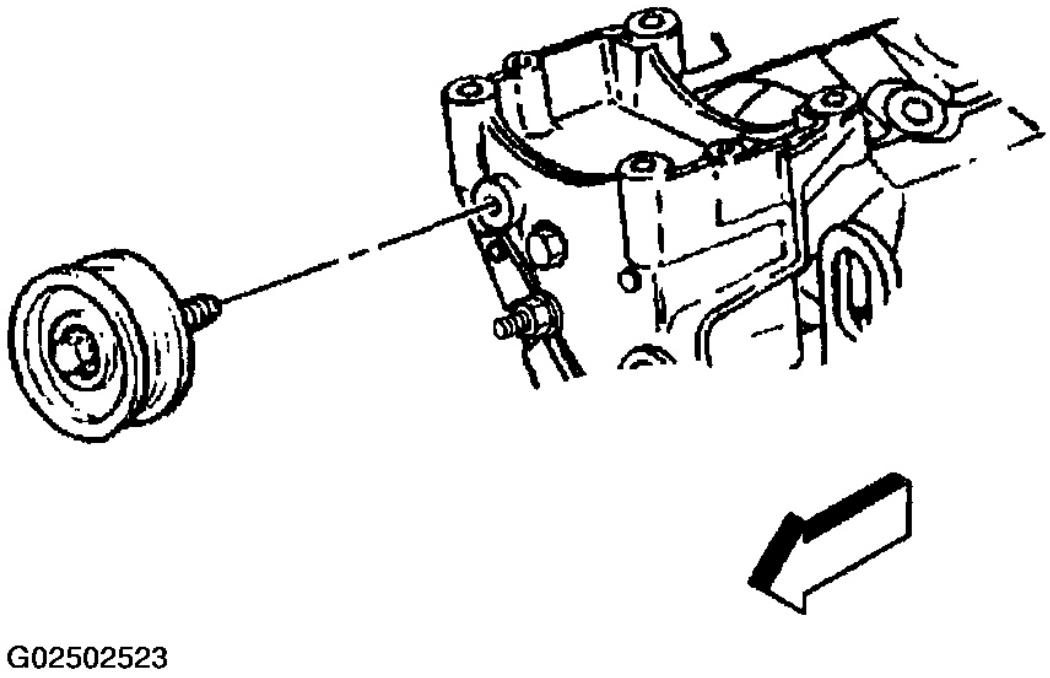

Fig. 41: Installing Drive Belt Idler Pulley - Without Air Conditioning
Courtesy of GENERAL MOTORS CORP.

ENGINE MOUNT INSPECTION

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

1. Raise the vehicle.
2. Inspect for loose or missing bolts at the following locations:
   - The engine mount bracket to the engine
   - The engine mount to the engine bracket through-bolts
   - The engine mount to frame bracket bolts
3. Replace loose or missing bolts.

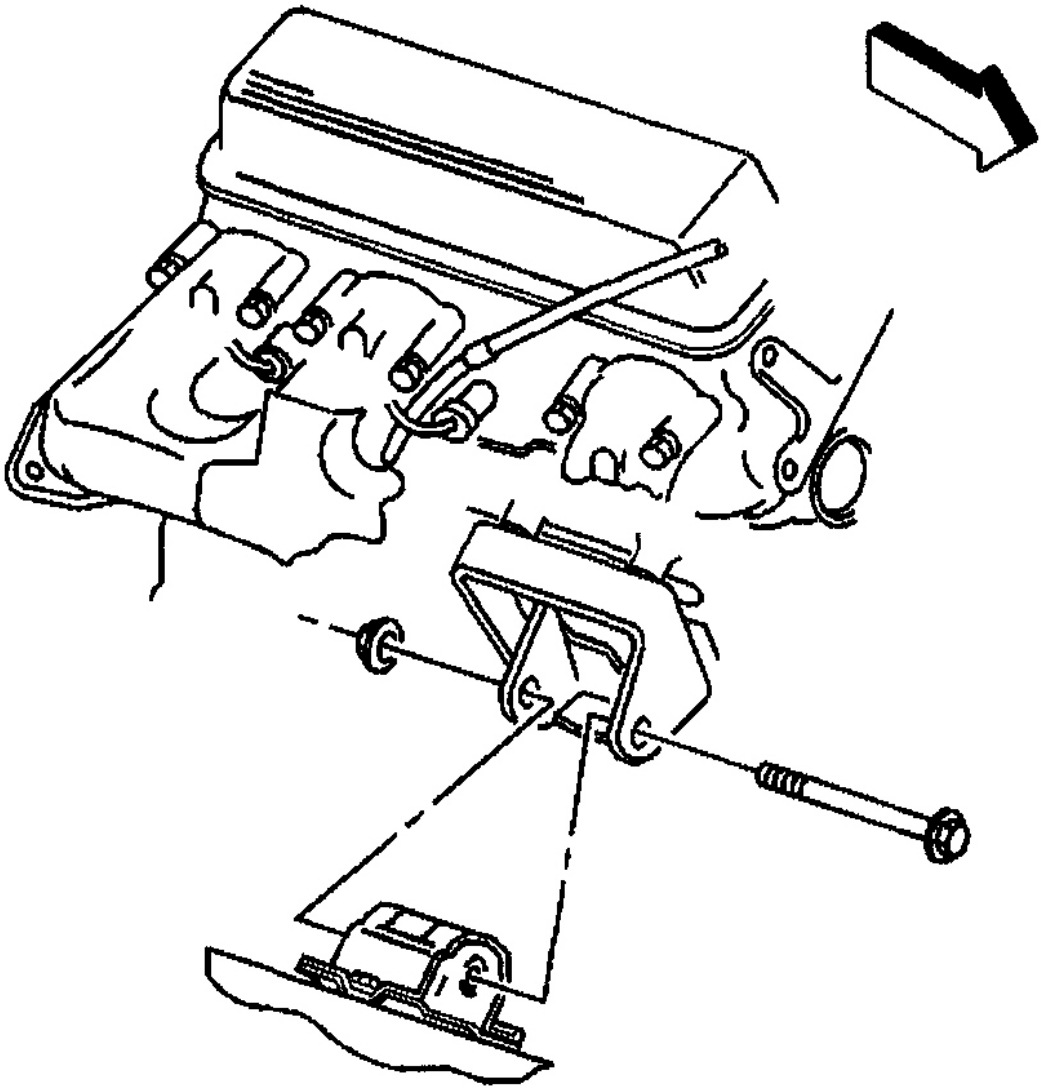

Fig. 42: Checking Engine Mounts
Courtesy of GENERAL MOTORS CORP.

4. In order to access the square tab on the left side of the engine, remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
5. In order to access the square tab on the right side of the engine, remove the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .

NOTE: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the

engine in an unapproved manner may cause component damage.

6. 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.

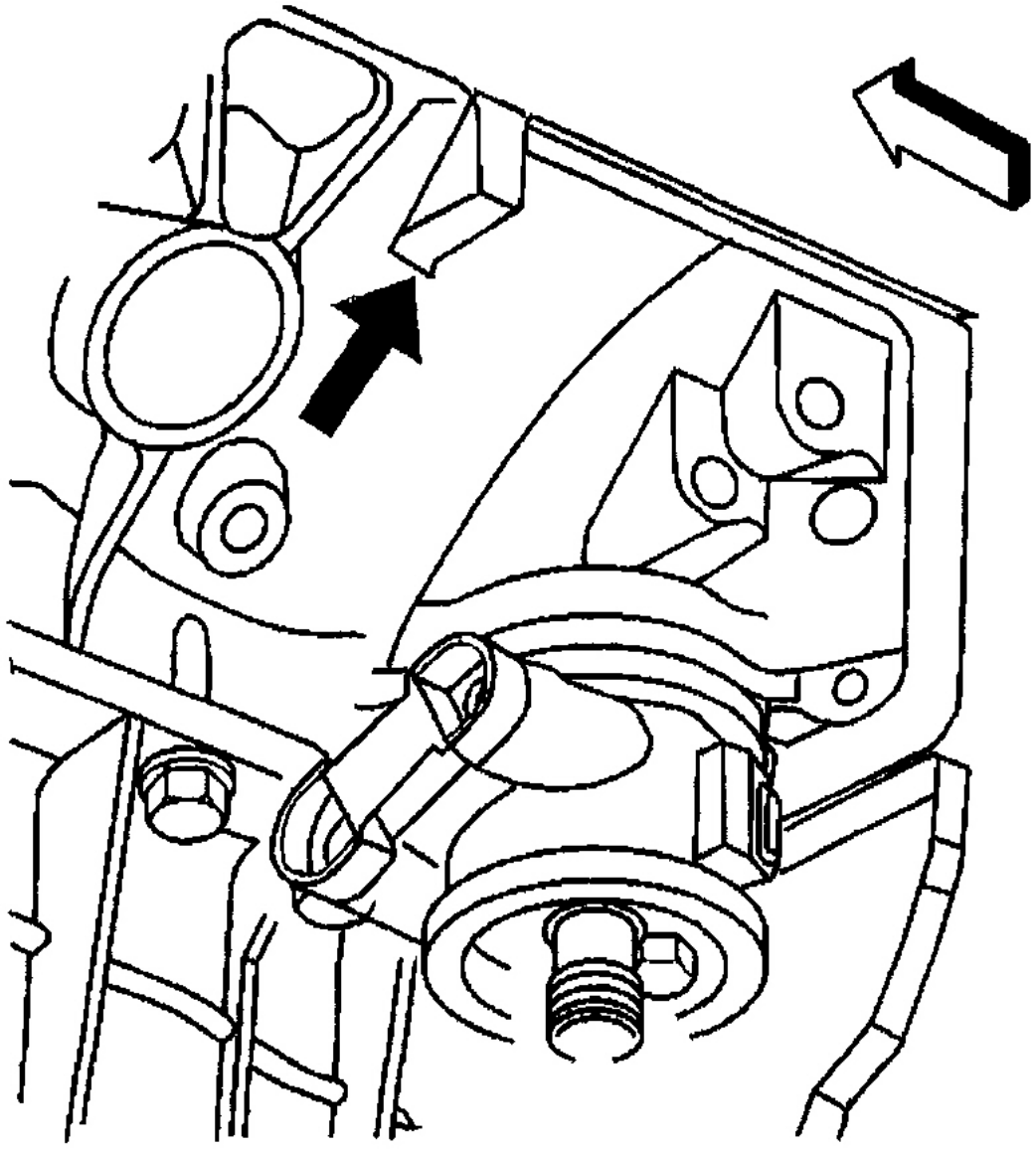

Fig. 43: Locating Square Tab At Left Rear Side Of Engine Block
Courtesy of GENERAL MOTORS CORP.

7. 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.

8. Replace the starter, if removed. Refer to **STARTERS 2000** or **STARTERS 2001** .
9. Replace the oil filter adapter, if removed. Refer to **Oil Filter Adapter Replacement**.
10. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - LEFT

Removal Procedure

1. Disconnect the battery negative cable.
2. Raise the vehicle.
3. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
4. Remove the engine mount through-bolt and nut for the side being replaced.

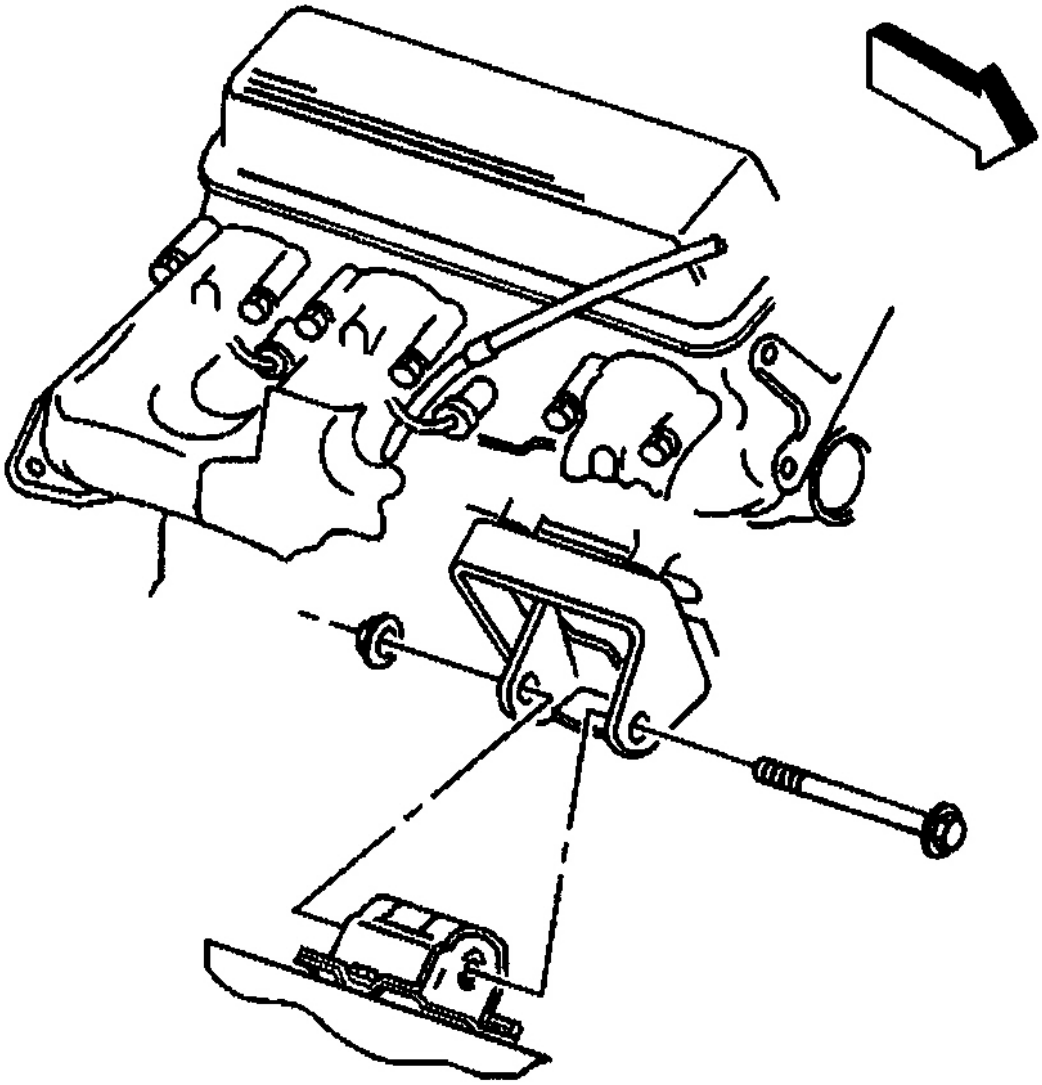

Fig. 44: Removing Engine Mount Through-Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

5. Using a jack on the square tab (left side shown) at the rear of the engine block, raise the engine only enough to remove the engine mount.

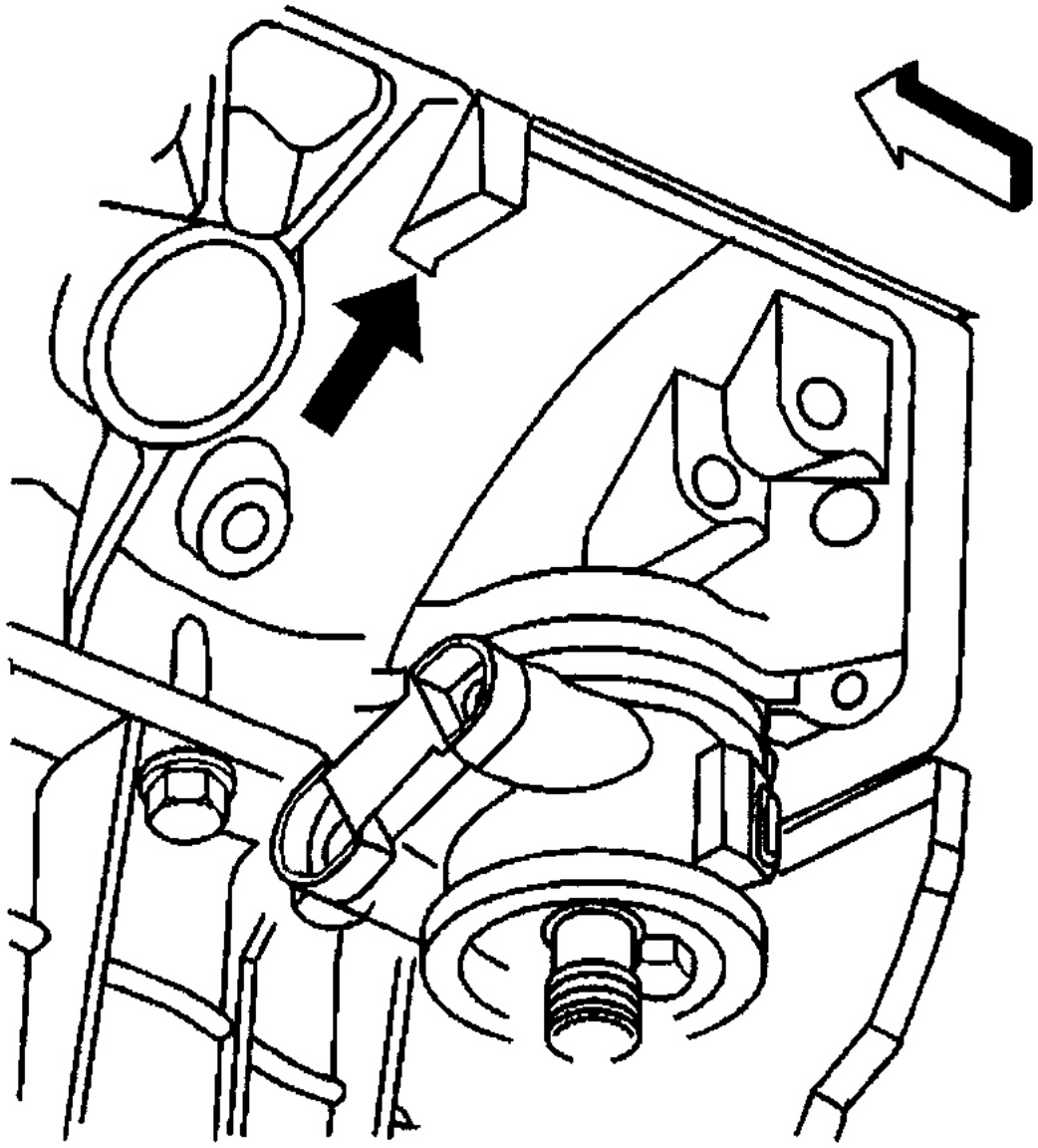

Fig. 45: Locating Square Tab At Left Rear Side Of Engine Block
Courtesy of GENERAL MOTORS CORP.

6. Remove the bolts for the engine mount bracket to the engine. Access the upper two bolts for the right engine mount bracket through the fender wheelhouse.
7. Remove the engine mount bracket.

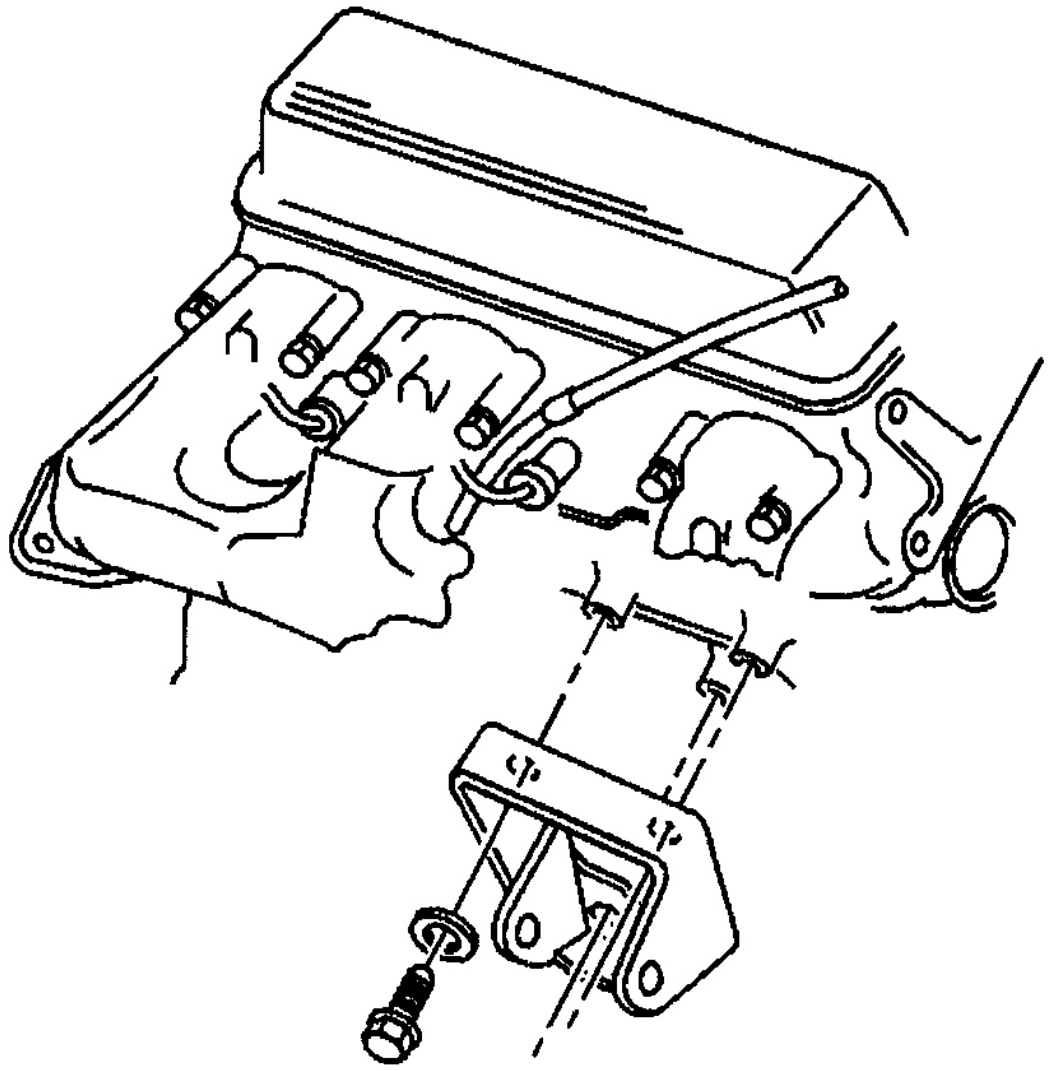

Fig. 46: Removing Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

8. For AWD vehicle remove the bolts for the engine mount to the frame (left side shown).
9. Remove the engine mount.

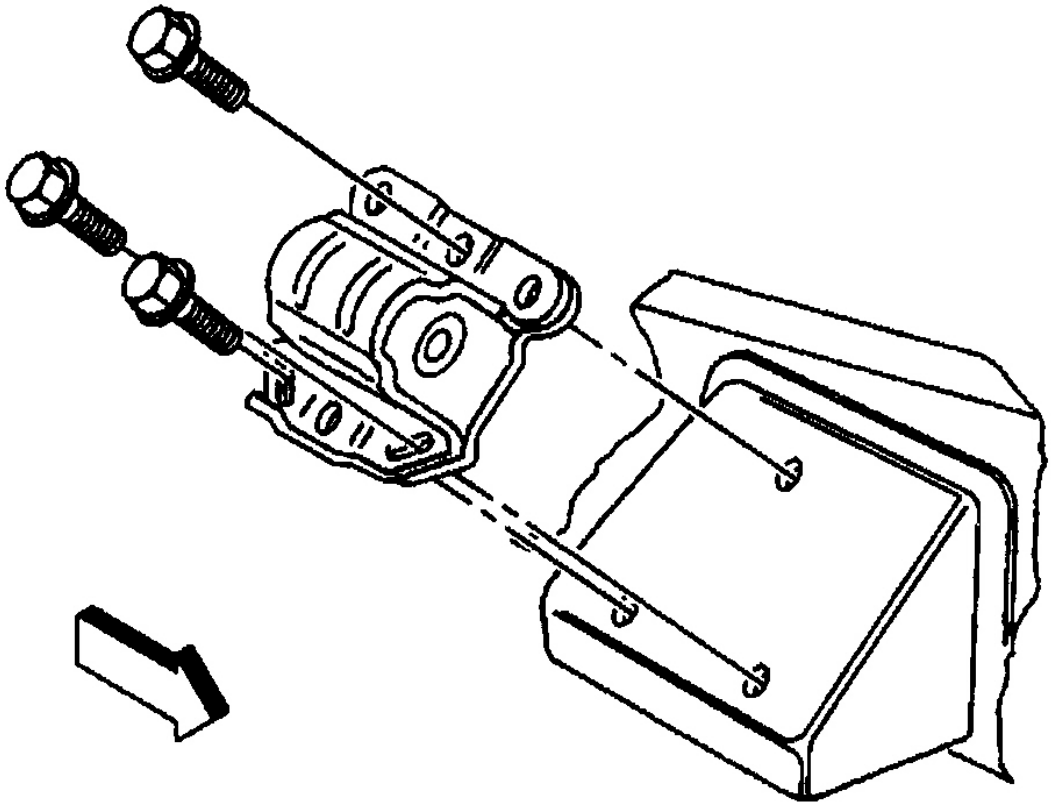

Fig. 47: Removing Engine Mount (AWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

10. For a RWD vehicle left side, remove the bolts and the nuts for the engine mount to the frame bracket (left side shown).
11. If necessary, remove the left side engine mount frame bracket from the frame.

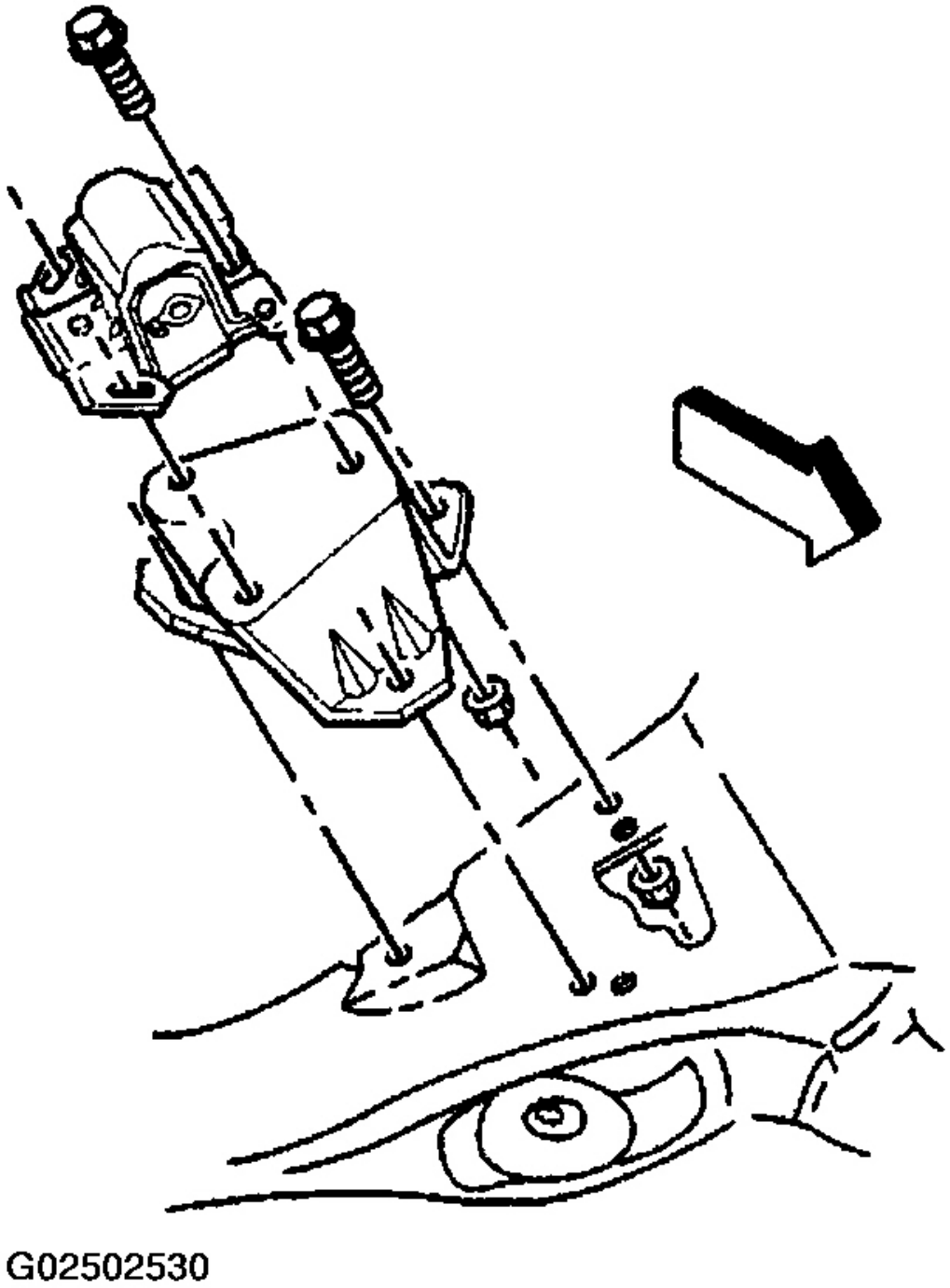

Fig. 48: Removing Engine Mount Frame Bracket (RWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. For AWD vehicle install the engine mount to the frame (left side shown).
2. Install the AWD vehicle engine mount to the frame bolts. **Tighten:** Tighten the AWD vehicle engine mount to frame bolts to 59 N.m (44 lb ft).

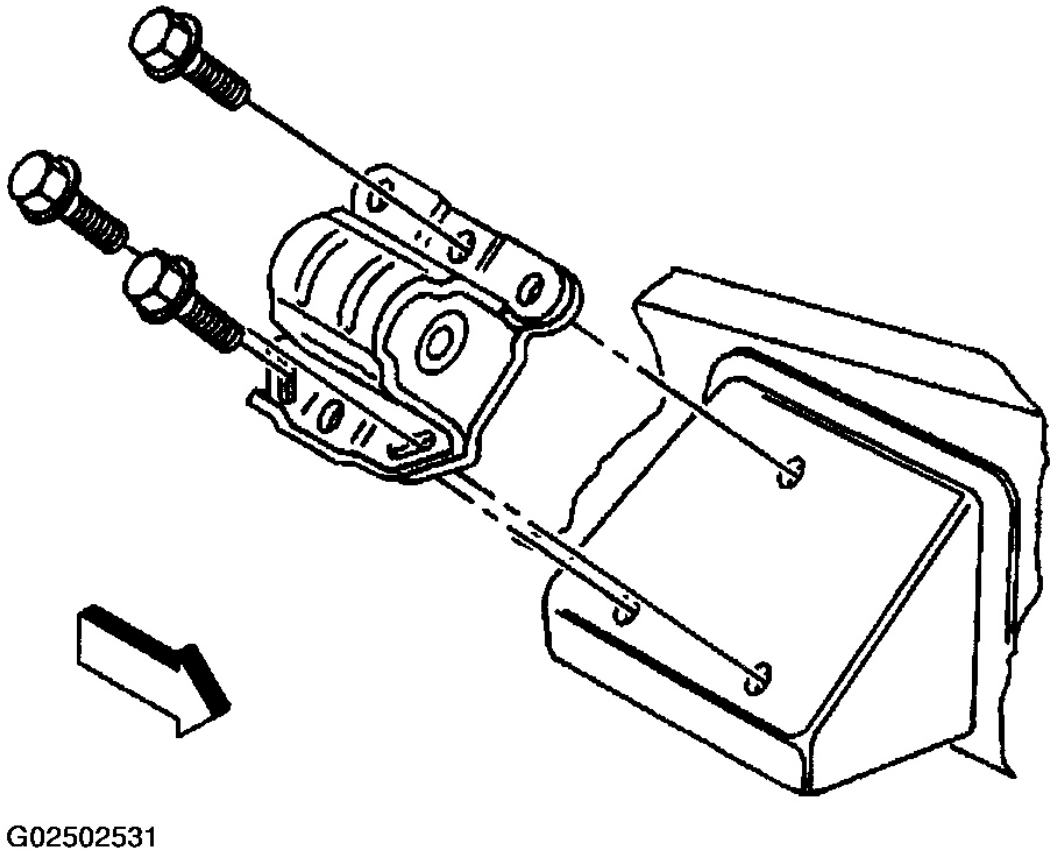

Fig. 49: Installing Engine Mount (AWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

3. If removed, install the RWD vehicle left side bolts, nuts and engine mount frame bracket to the frame.
   Tighten:
   - Tighten the engine mount frame bracket bolts to 47 N.m (35 lb ft).
   - Tighten the engine mount frame bracket nuts to 42 N.m (31 lb ft).
4. Install the RWD vehicle left side engine mount, the bolts, and the nuts to the frame bracket.
   Tighten:
   - Tighten the engine mount to frame bolts to 47 N.m (35 lb ft).
   - Tighten the engine mount to frame nuts to 42 N.m (31 lb ft).

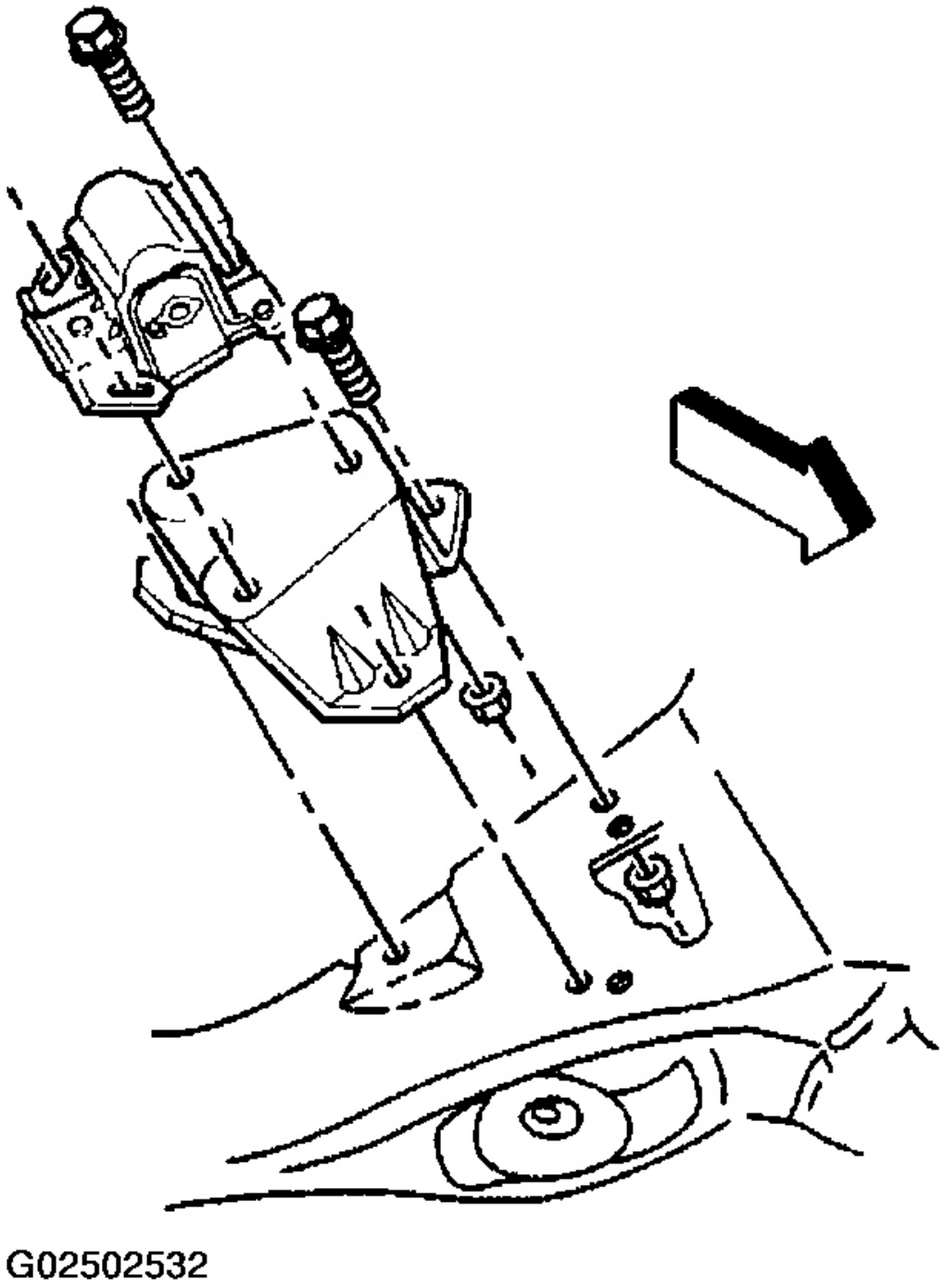

Fig. 50: Installing Engine Mount Frame Bracket (RWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

5. Install the engine mount bracket to the engine.
6. Install the engine mount bracket bolts. **Tighten:** Tighten the engine mount bracket bolts to 64 N.m (47 lb ft).

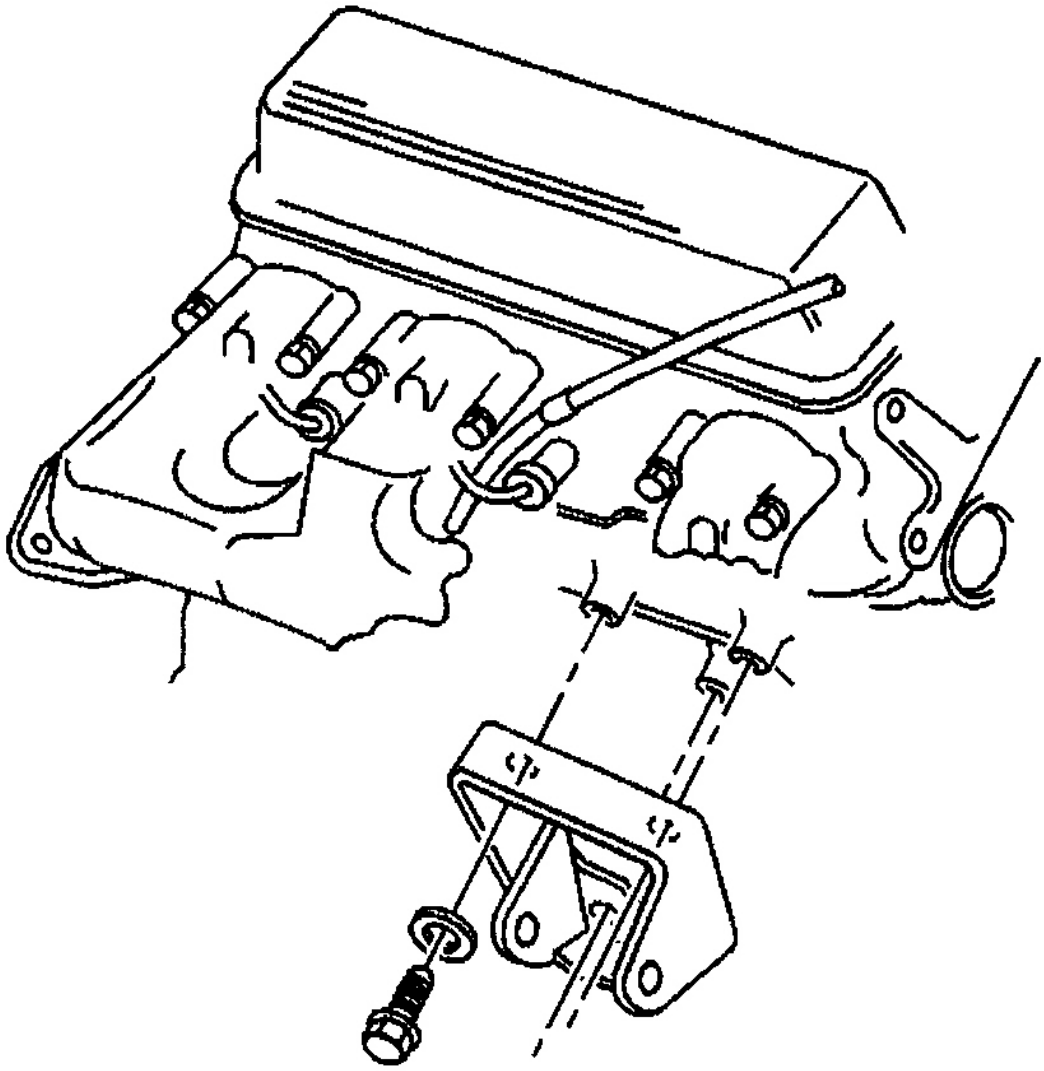

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Fig. 51: Installing Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

7. Lower the engine.
8. Install the engine mount through-bolt and the nut. **Tighten:** Tighten the engine mount through-bolt nuts to 68 N.m (50 lb ft).

9. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
10. Lower the vehicle.
11. Connect the battery negative cable.

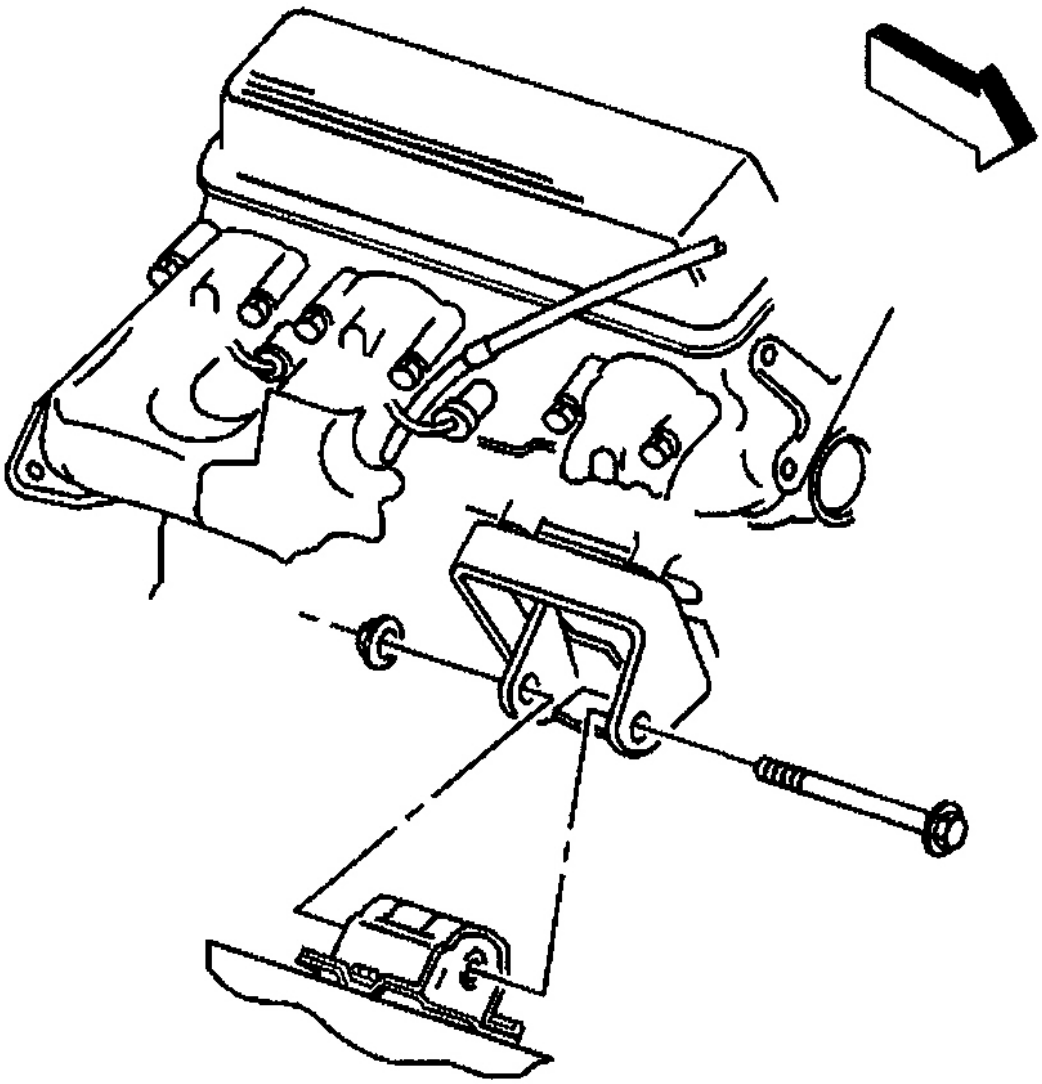

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Fig. 52: Installing Engine Mount Through-Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

ENGINE MOUNT REPLACEMENT - RIGHT

Removal Procedure

1. Disconnect the battery negative cable.
2. Raise the vehicle.
3. Remove the right front tire.
4. Remove the right fender wheelhouse extension.
5. Remove the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .
6. Remove the engine mount through-bolt and nut.

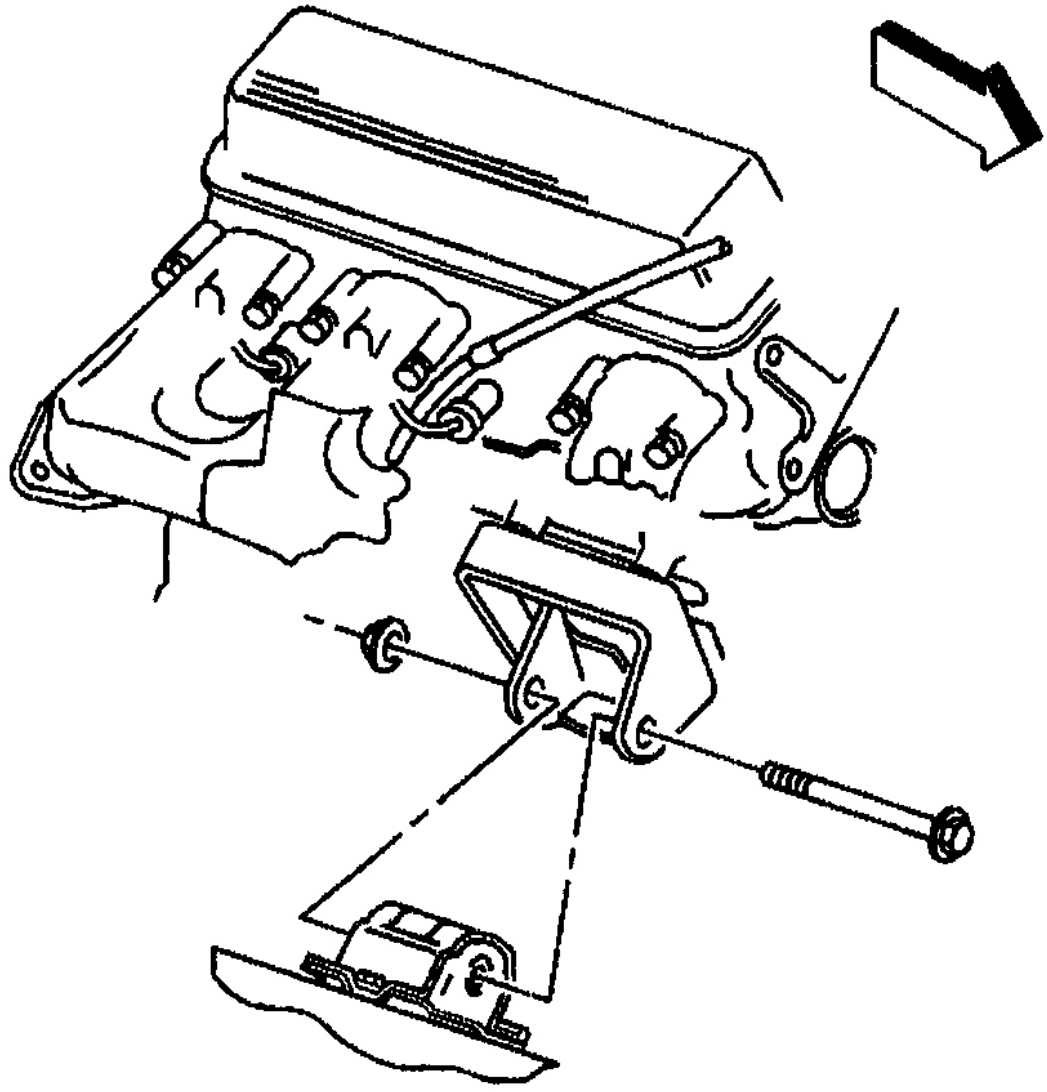

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Fig. 53: Removing Engine Mount Through-Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

7. Using a jack on the square tab (left side shown) at the rear of the engine block, raise the engine only enough to remove the engine mount.

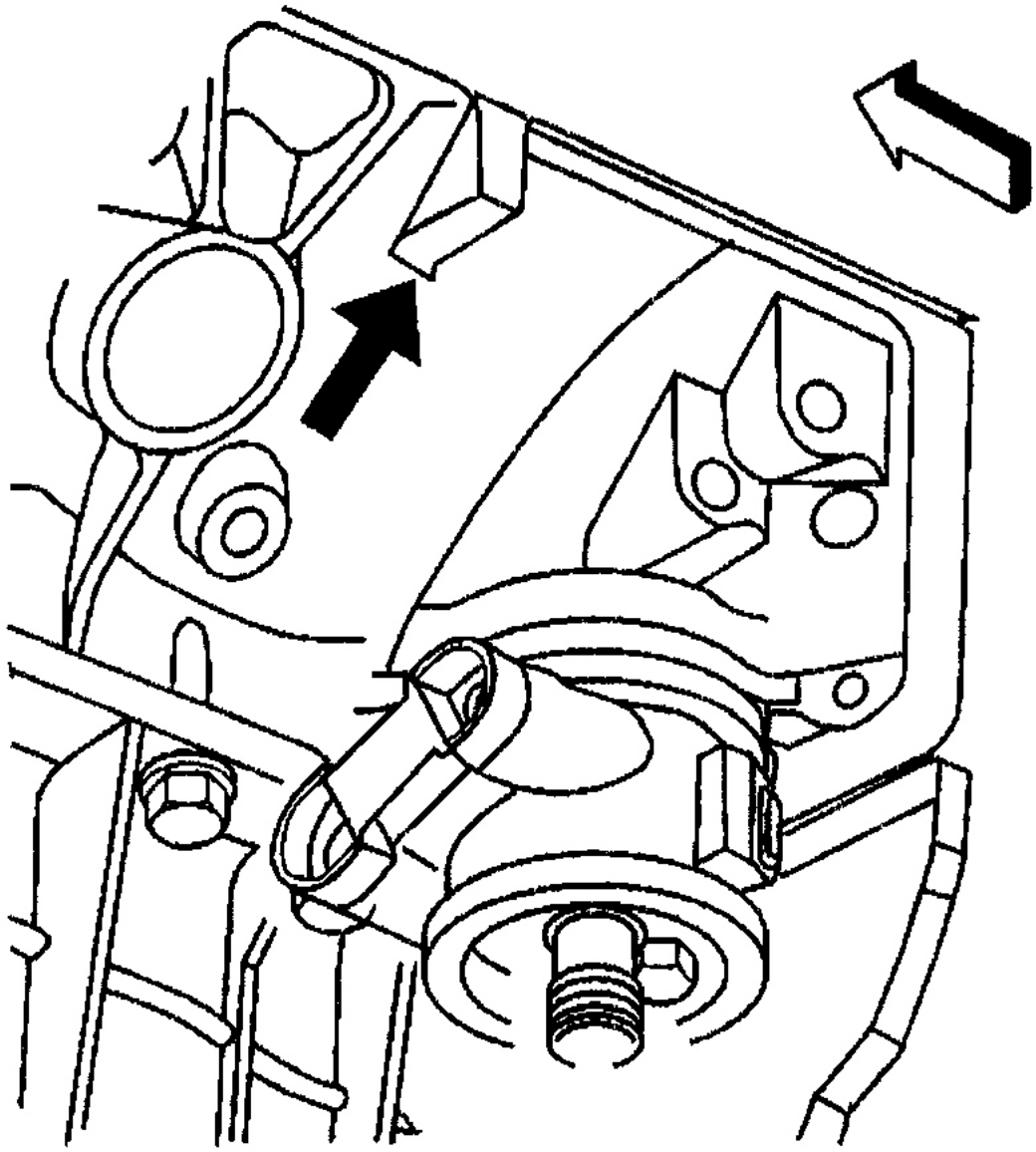

Fig. 54: Locating Square Tab At Left Rear Side Of Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolts for the engine mount bracket to the engine. Access the upper two bolts for the right engine mount bracket through the fender wheelhouse.

9. Remove the engine mount bracket.

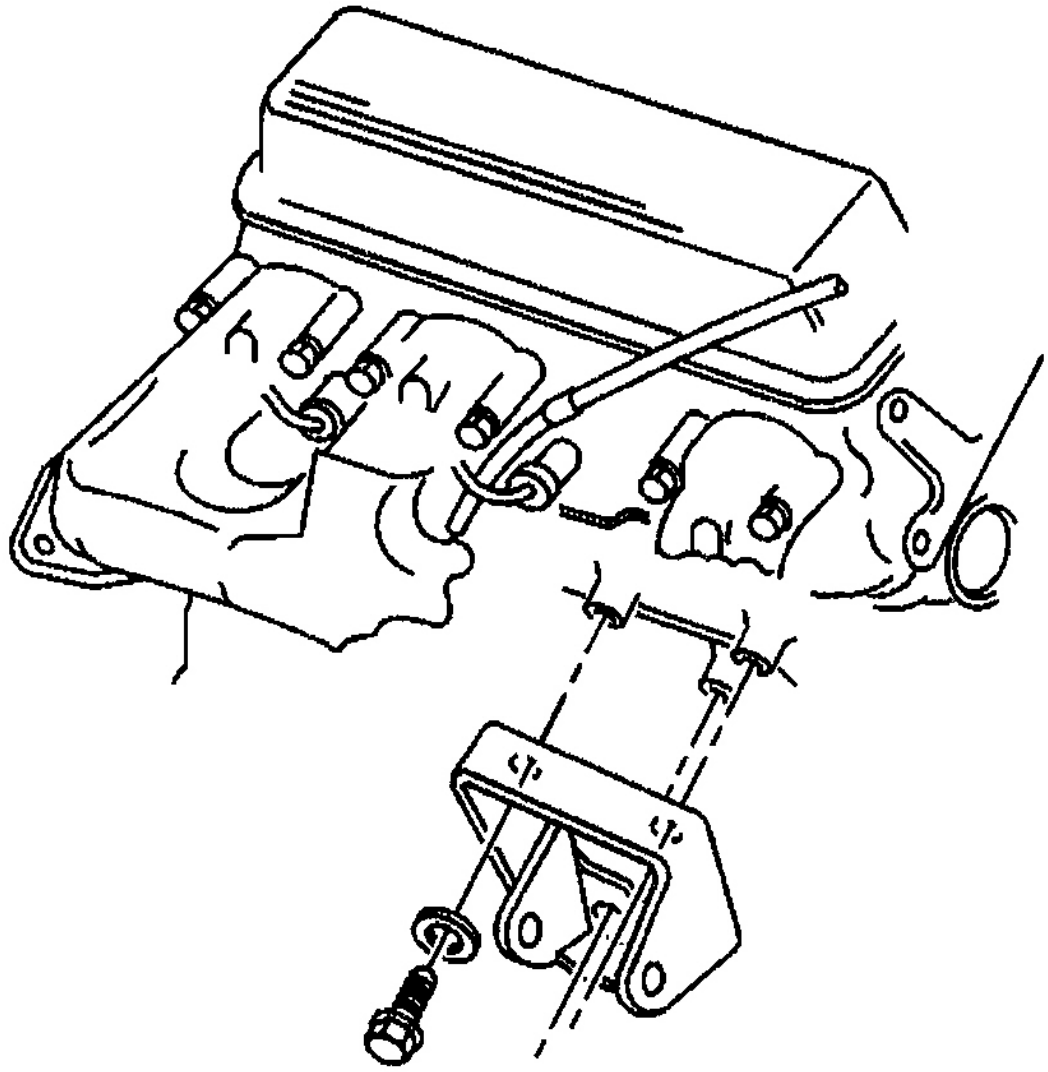

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Fig. 55: Removing Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

10. For AWD vehicle, remove the bolts for the engine mount to the frame (left side shown).
11. Remove the engine mount.

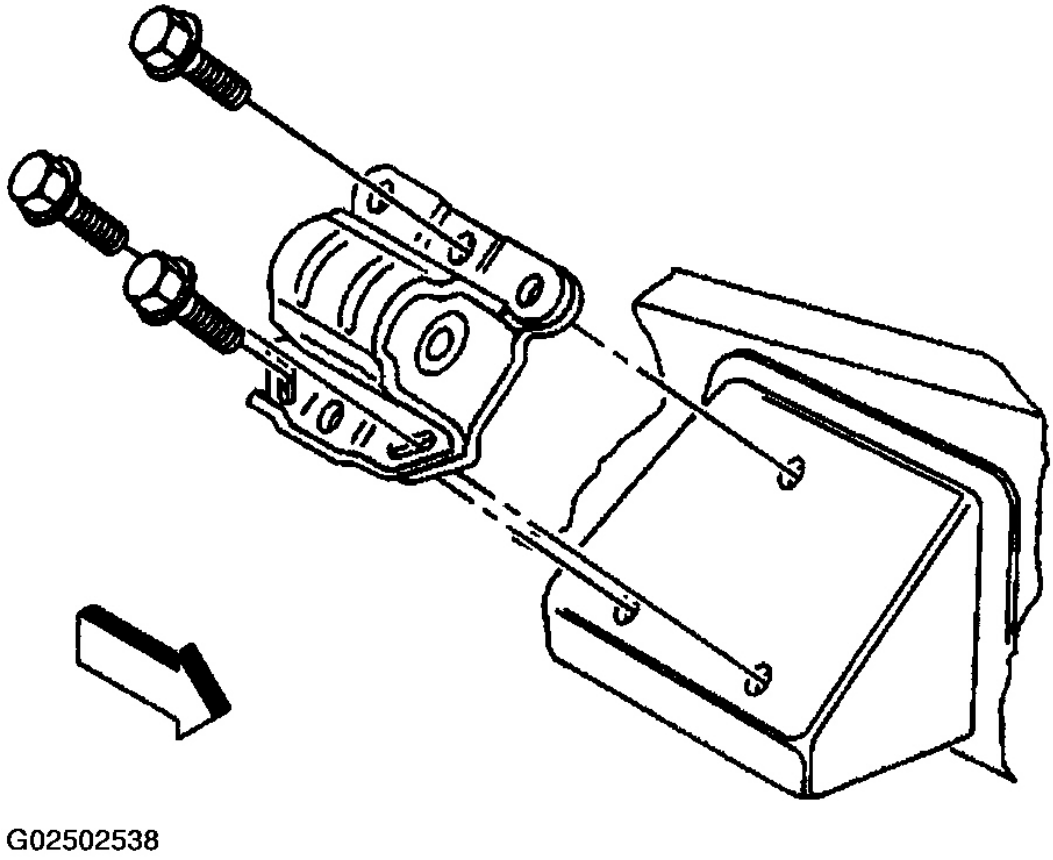

Fig. 56: Removing Engine Mount (AWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

12. For a RWD vehicle, right side remove the bolts and the nuts for the engine mount to the frame.

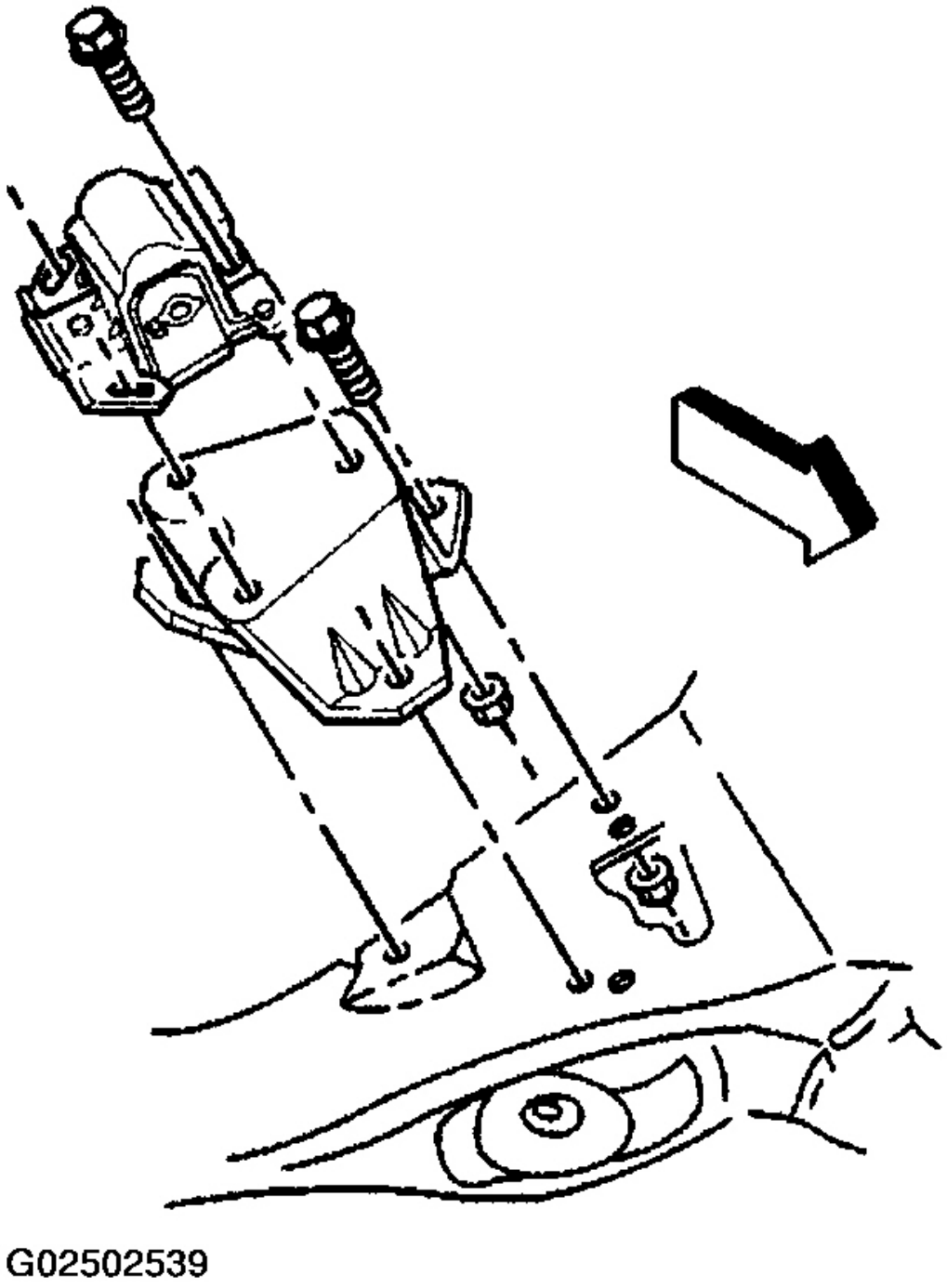

Fig. 57: Removing Engine Mount Frame Bracket (RWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the AWD vehicle engine mount to the frame bolts. **Tighten:** Tighten the AWD vehicle engine mount to frame bolts to 59 N.m (44 lb ft).

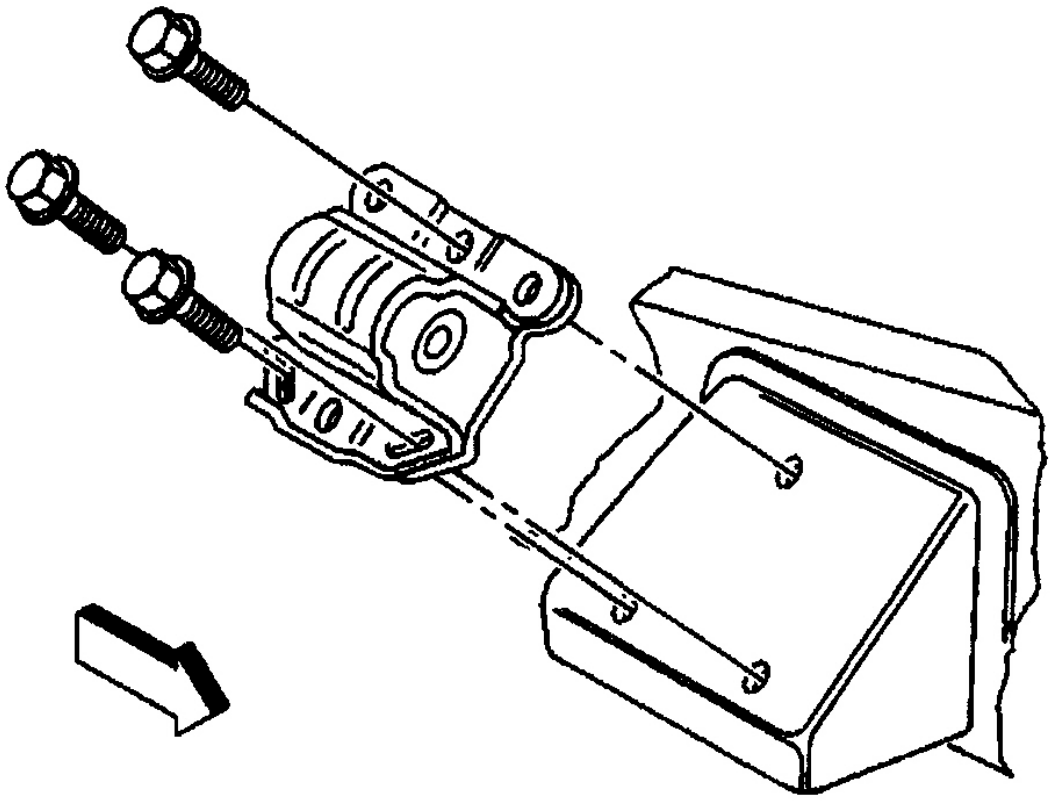

Fig. 58: Installing Engine Mount (AWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

2. Install the RWD vehicle right side engine mount, the bolts, and the nuts to the frame.
   Tighten:
   - Tighten the engine mount to frame bolts to 47 N.m (35 lb ft).
   - Tighten the engine mount to frame nuts to 42 N.m (31 lb ft).

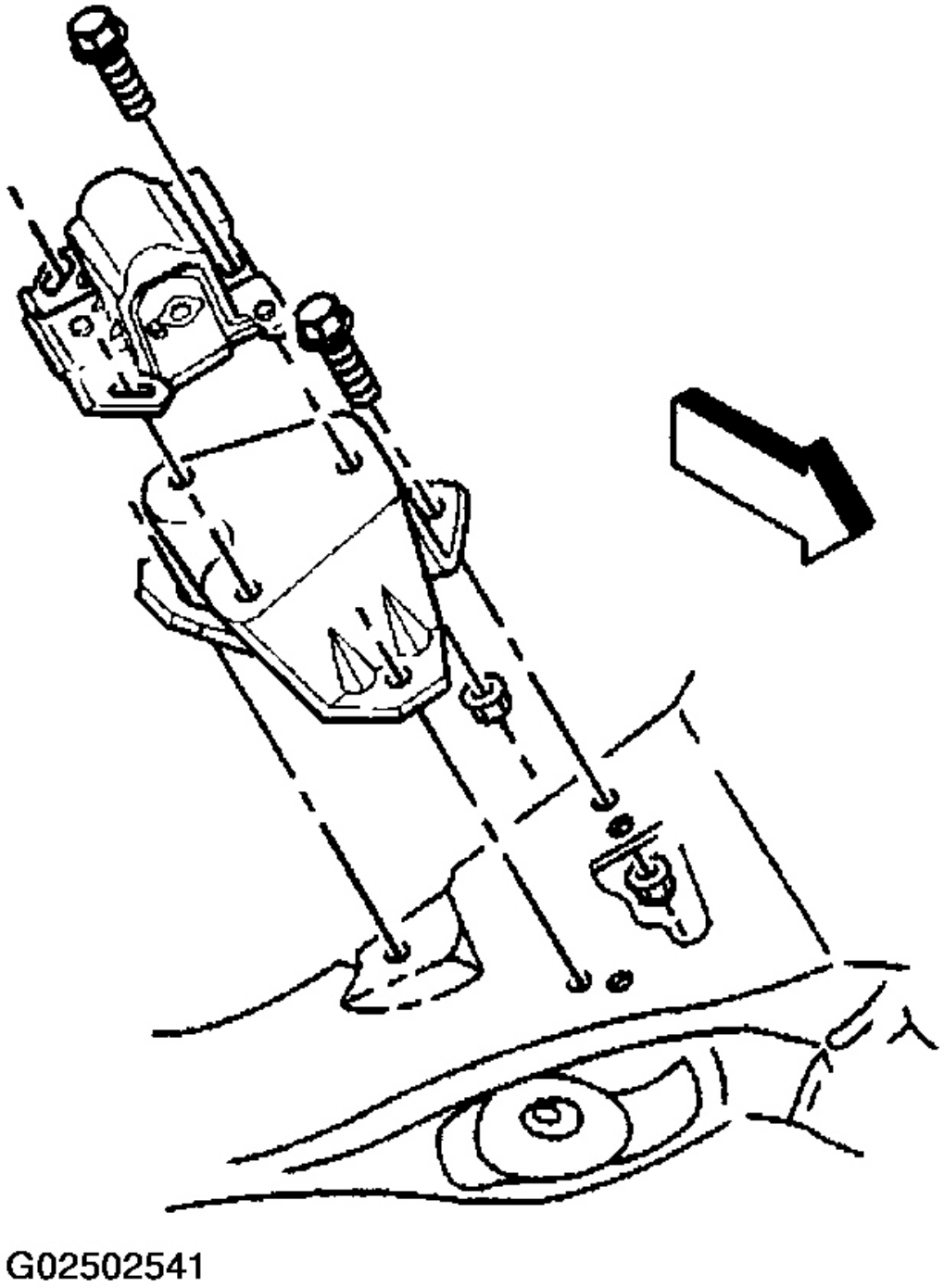

Fig. 59: Installing Engine Mount Frame Bracket (RWD Vehicle - Left Side Shown)
Courtesy of GENERAL MOTORS CORP.

3. Install the engine mount bracket to the engine.
4. Install the engine mount bracket bolts. **Tighten:** Tighten the engine mount bracket bolts to 64 N.m (47 lb ft).

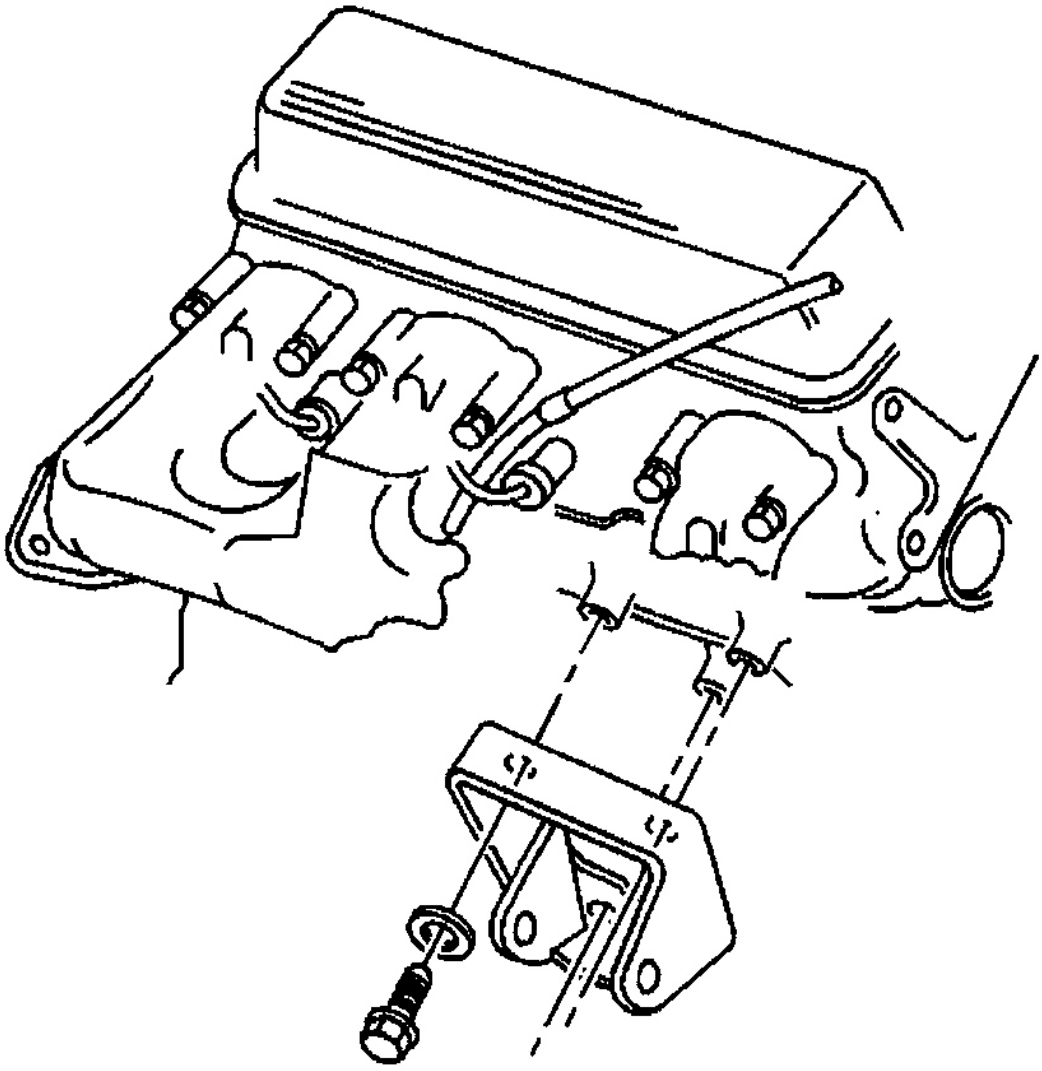

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Fig. 60: Installing Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

5. Lower the engine.
6. Install the engine mount through-bolt and the nut. **Tighten:** Tighten the engine mount through-bolt nuts to 68 N.m (50 lb ft).

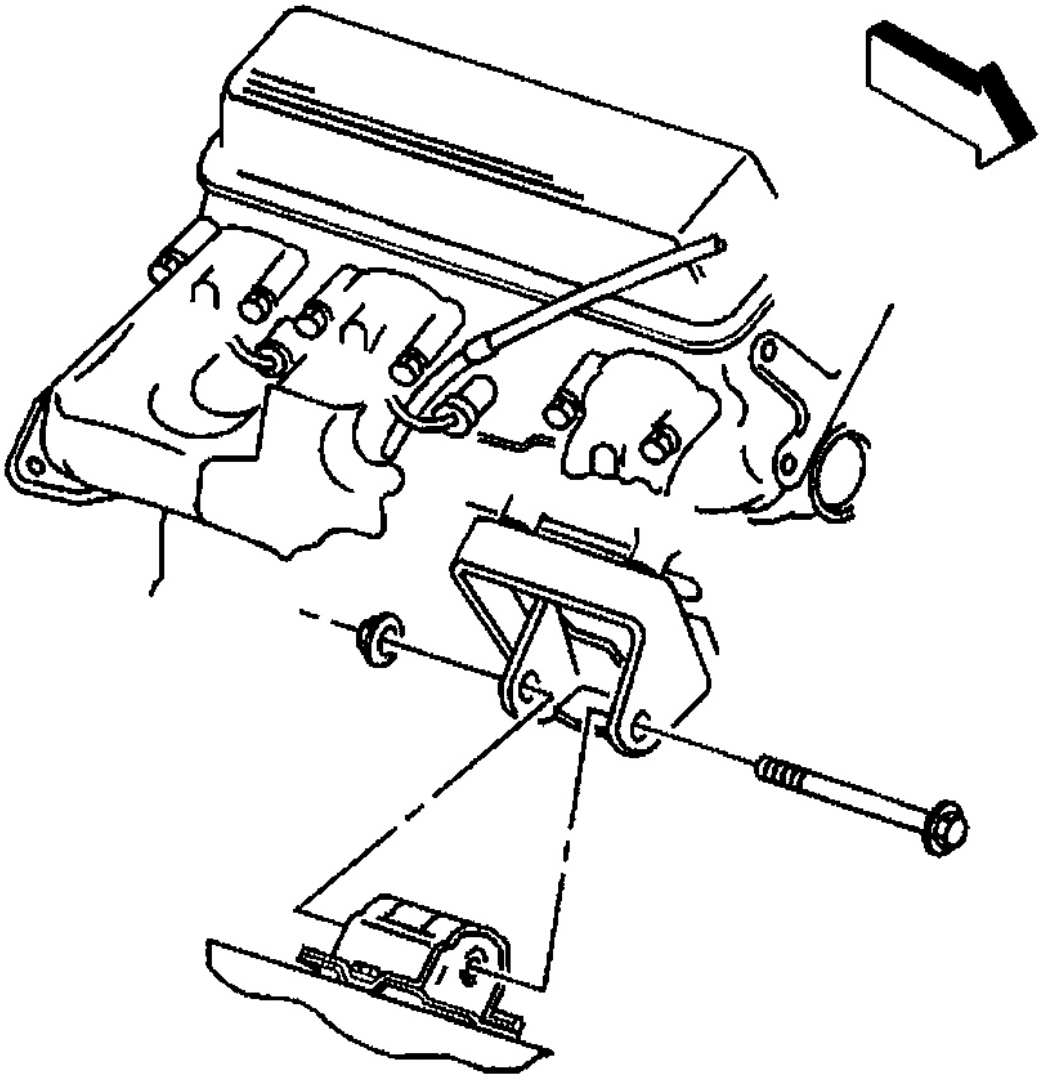

Fig. 61: Installing Engine Mount Through-Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .
8. Install the right fender wheelhouse extension.
9. Install the right front tire.
10. Lower the vehicle.
11. Connect the battery negative cable.

INTAKE MANIFOLD REPLACEMENT - UPPER

IMPORTANT: You do not have to remove the upper intake manifold in order to remove the lower intake manifold.

Removal Procedure

1. Remove the engine cover.
2. Remove the air cleaner outlet duct from the throttle body.
3. Disconnect the accelerator control cable from the throttle shaft and the accelerator control cable bracket.
4. Disconnect the cruise control cable, if equipped from the throttle shaft and the accelerator control cable bracket.
5. Remove the PCV valve hose assembly from the intake manifold and the valve rocker arm cover.

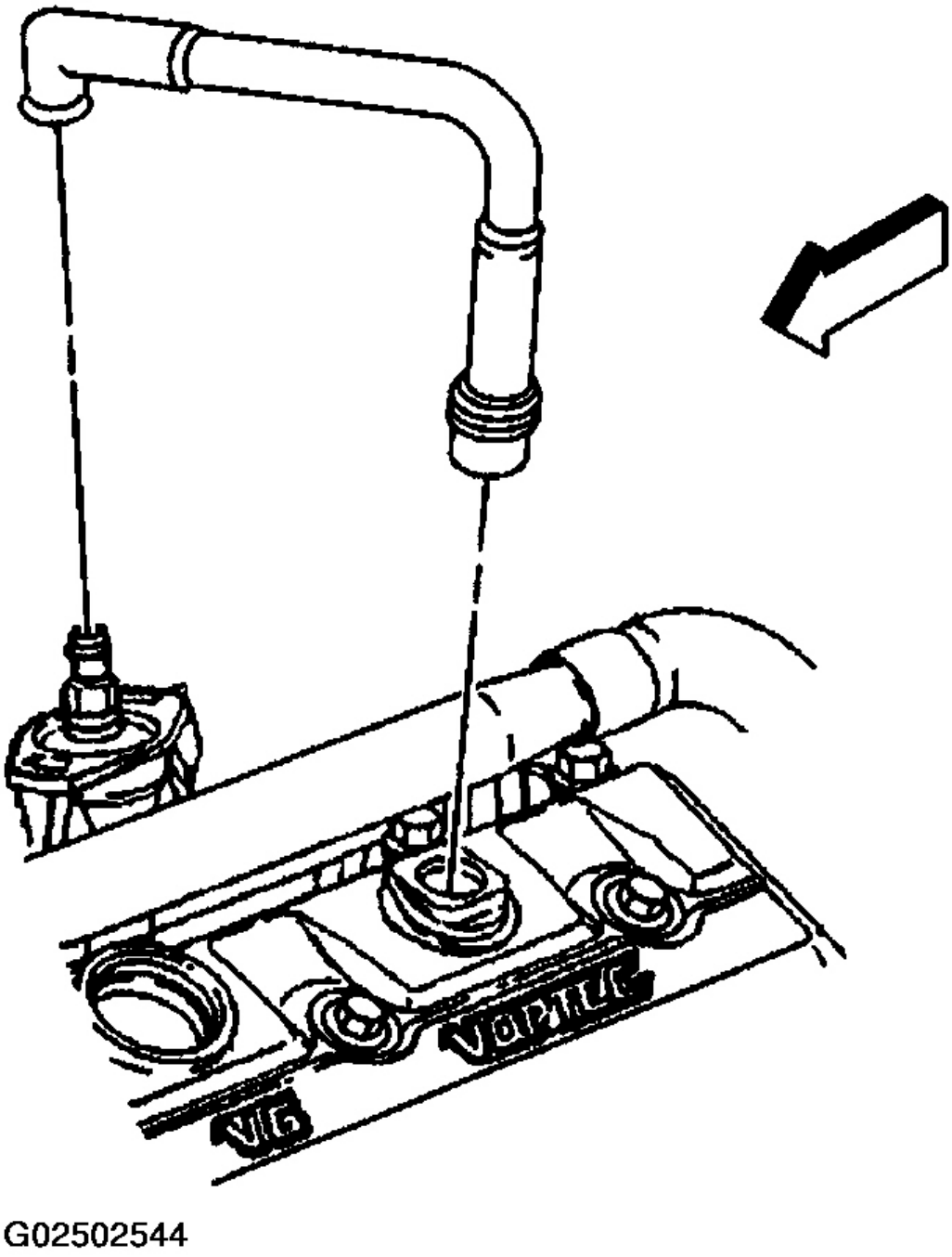

Fig. 62: Removing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

6. Remove the nut holding the A/C hose bracket, if equipped to the intake manifold stud.

7. Remove the A/C hose bracket from the stud.
8. Remove the nut holding the engine wiring harness bracket to the intake manifold stud.
9. Remove the engine wiring harness bracket from the stud.

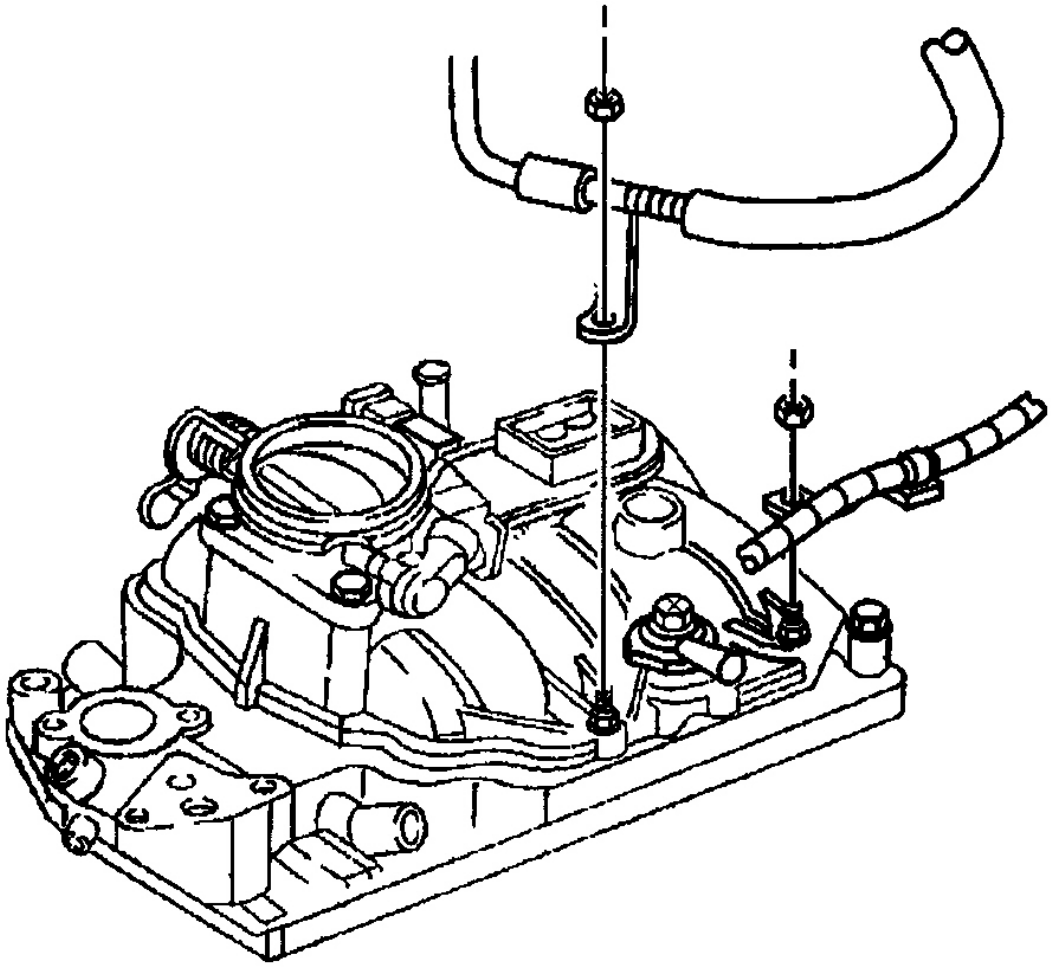

Fig. 63: Removing A/C Hose Bracket & Engine Wiring Harness Bracket At Intake Manifold
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the following electrical connectors:
    - The A/C compressor clutch, if equipped (1)
    - The A/C high pressure cutoff switch, if equipped (5)
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)

- The fuel meter body assembly connector (4)

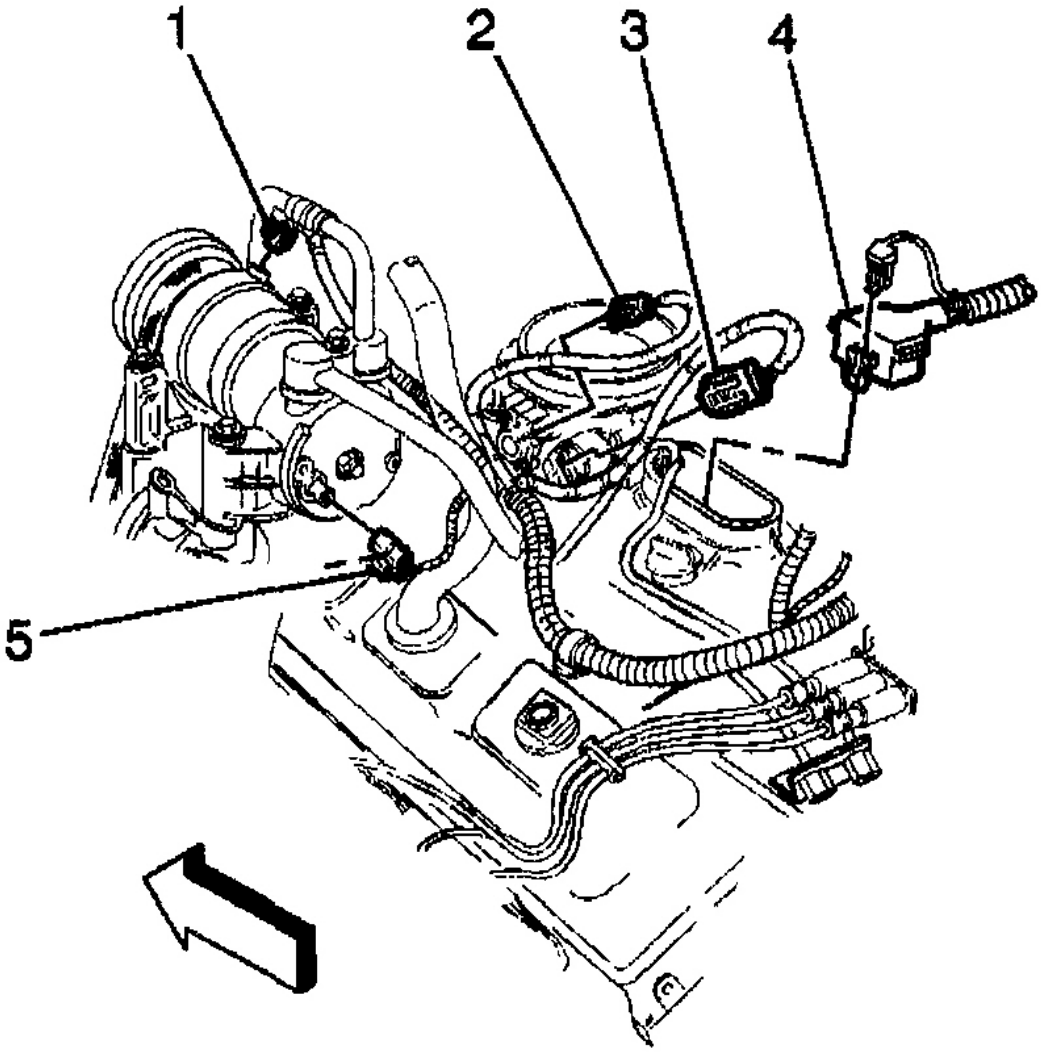

Fig. 64: Disconnecting A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position Sensor, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

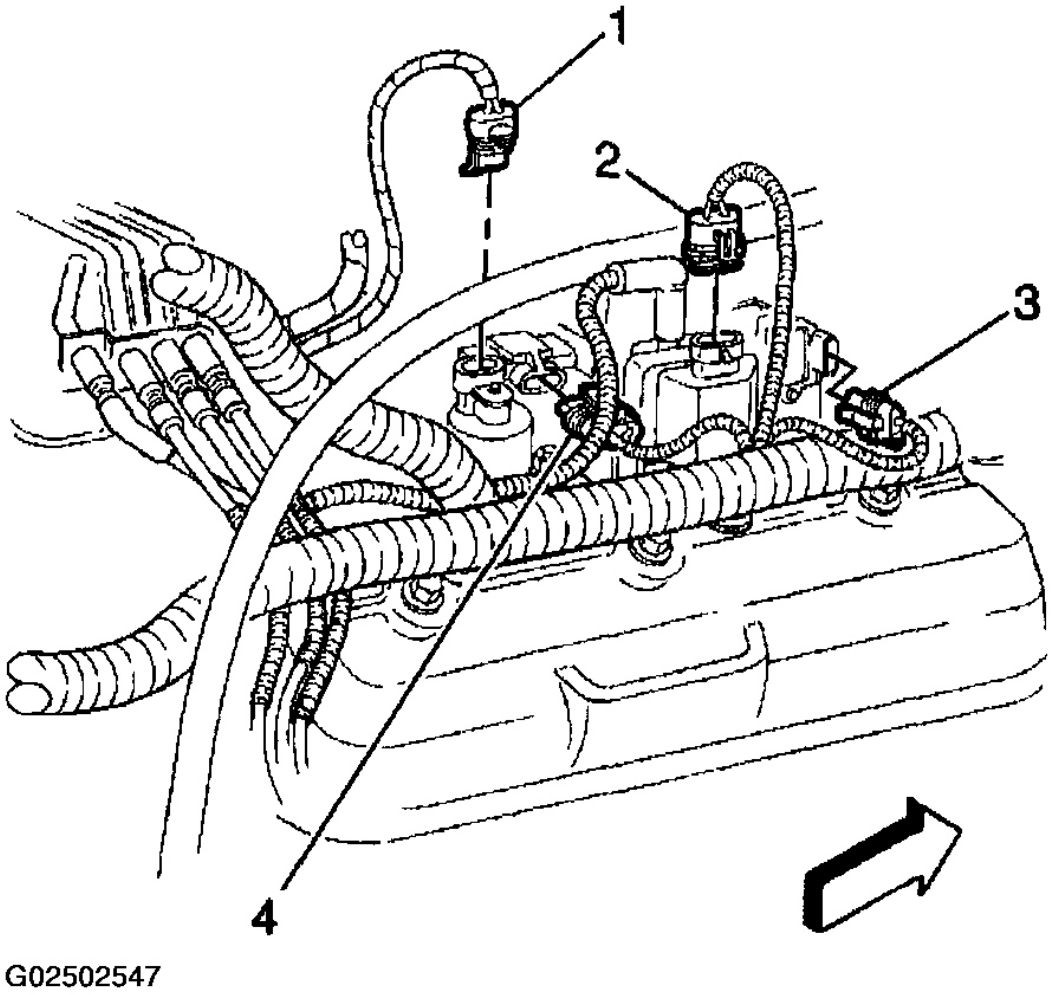

Fig. 65: Disconnecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)
12. Remove the engine wiring harness bracket from the stud at the EVAP canister purge solenoid valve.

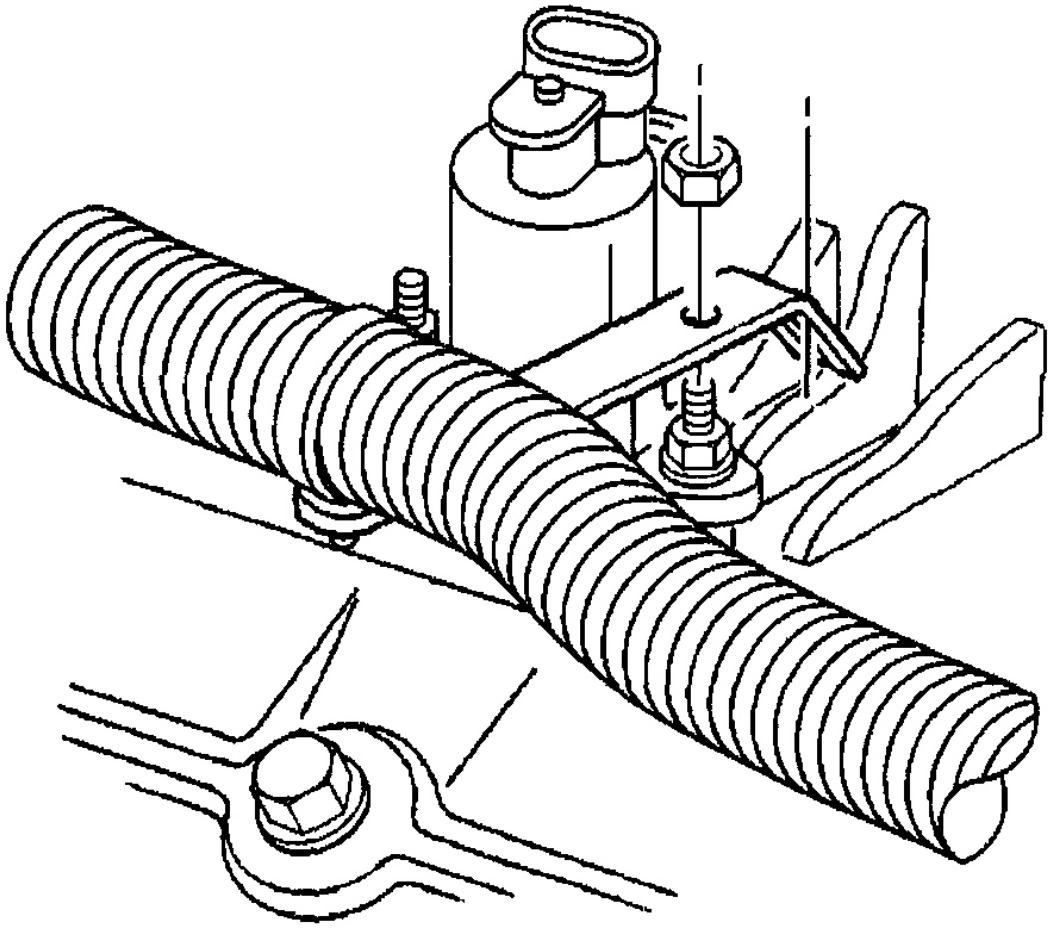

Fig. 66: Removing Engine Harness Bracket From EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

13. Move and secure the engine wiring harness out of the way.
14. Remove the EVAP canister purge valve.
15. Disconnect the vacuum hose from the intake manifold.

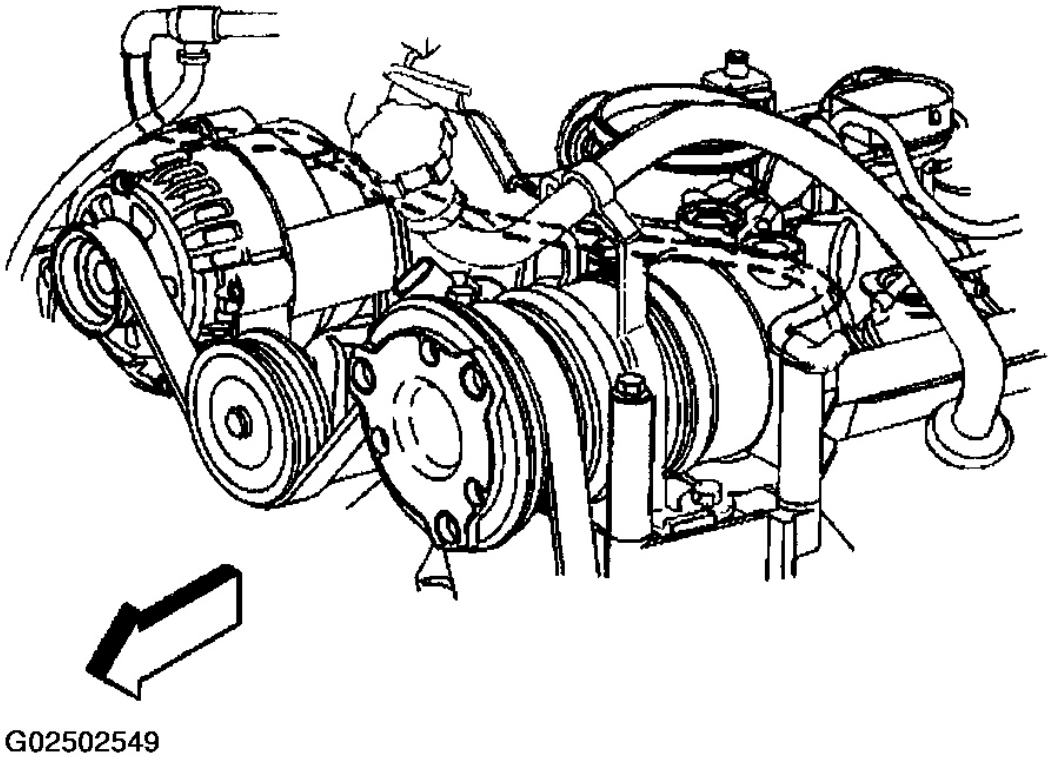

Fig. 67: Disconnecting Vacuum Hose From Intake Manifold
Courtesy of GENERAL MOTORS CORP.

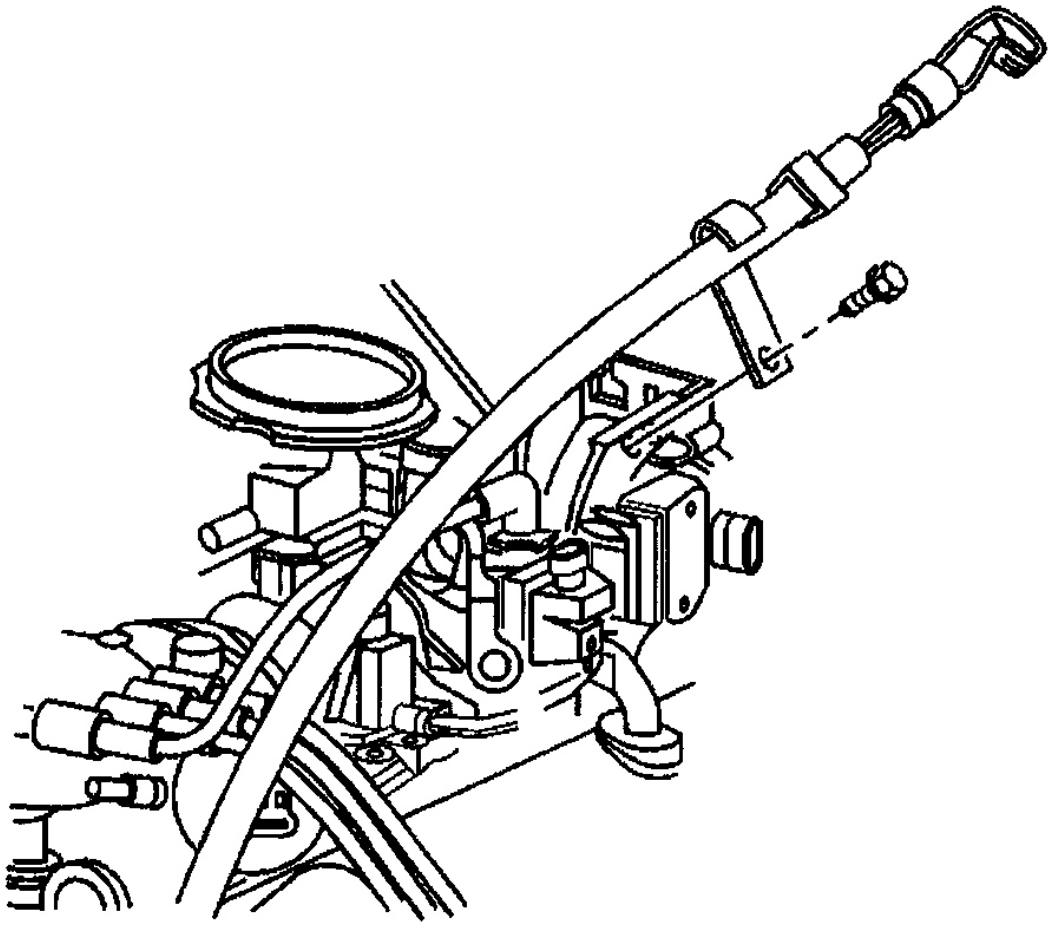

Fig. 68: Removing Transmission Fluid Filler Tube Bolt At Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

16. Remove the bolt holding the transmission fluid filler tube to the accelerator control cable bracket.
17. Remove the accelerator control cable bracket from the throttle body and the intake manifold.
18. Remove the fuel lines from the fuel meter body assembly.

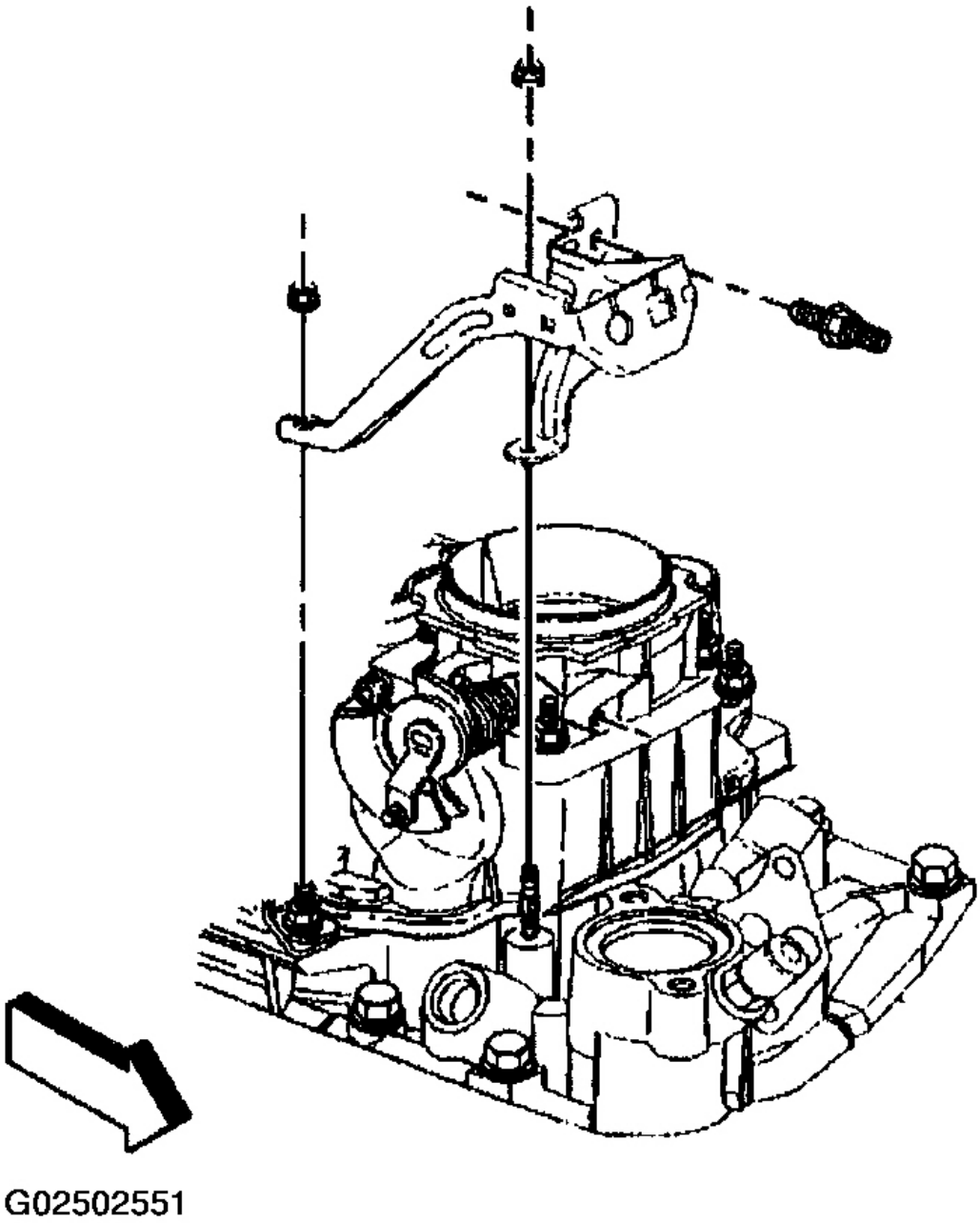

Fig. 69: Removing Accelerator Control Cable Bracket From Throttle Body & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

19. Remove the studs for the upper intake manifold.
20. Remove the upper intake manifold.

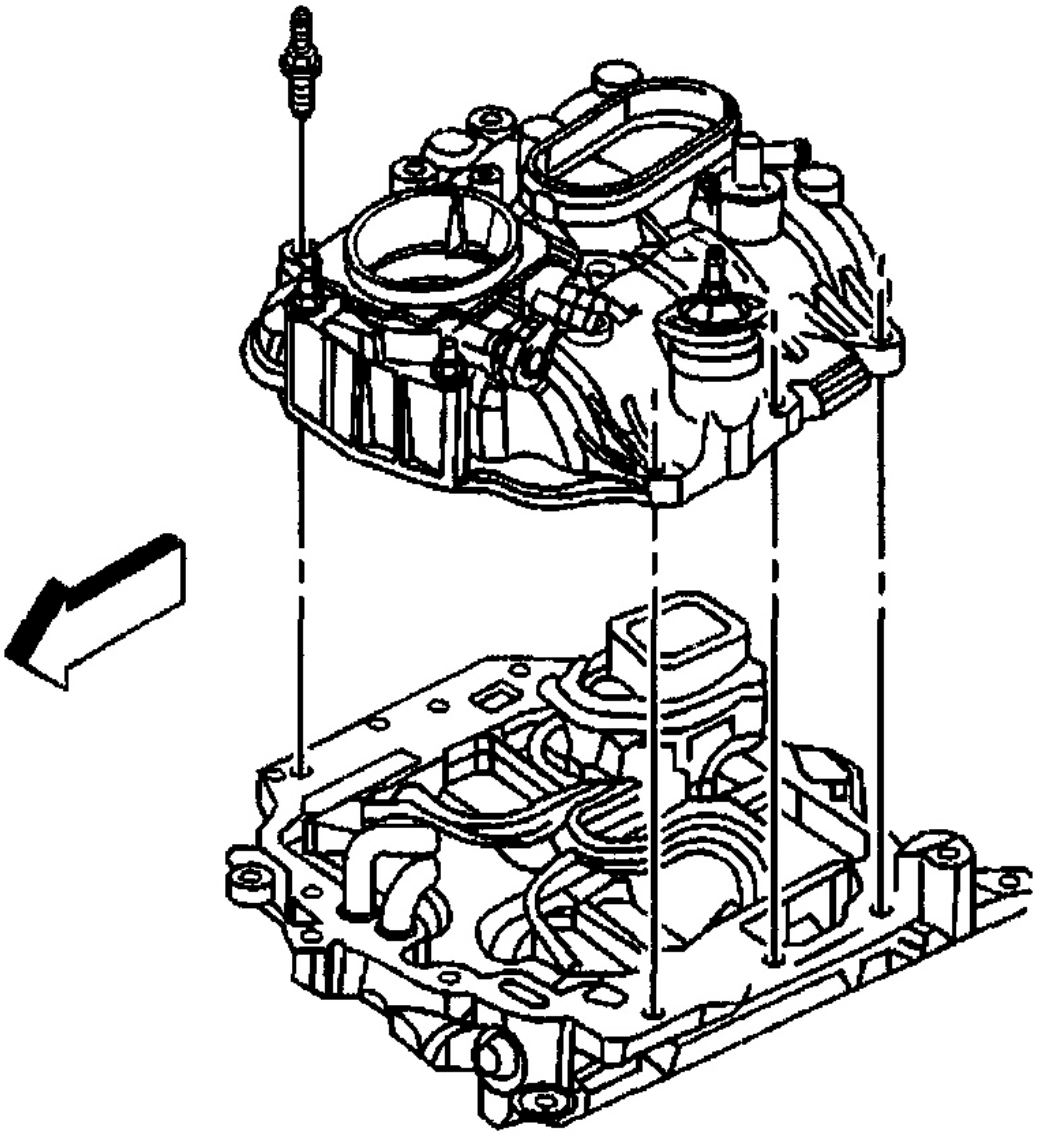

Fig. 70: Removing Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

21. Remove the upper intake manifold gasket from the groove.
22. Discard the gasket.

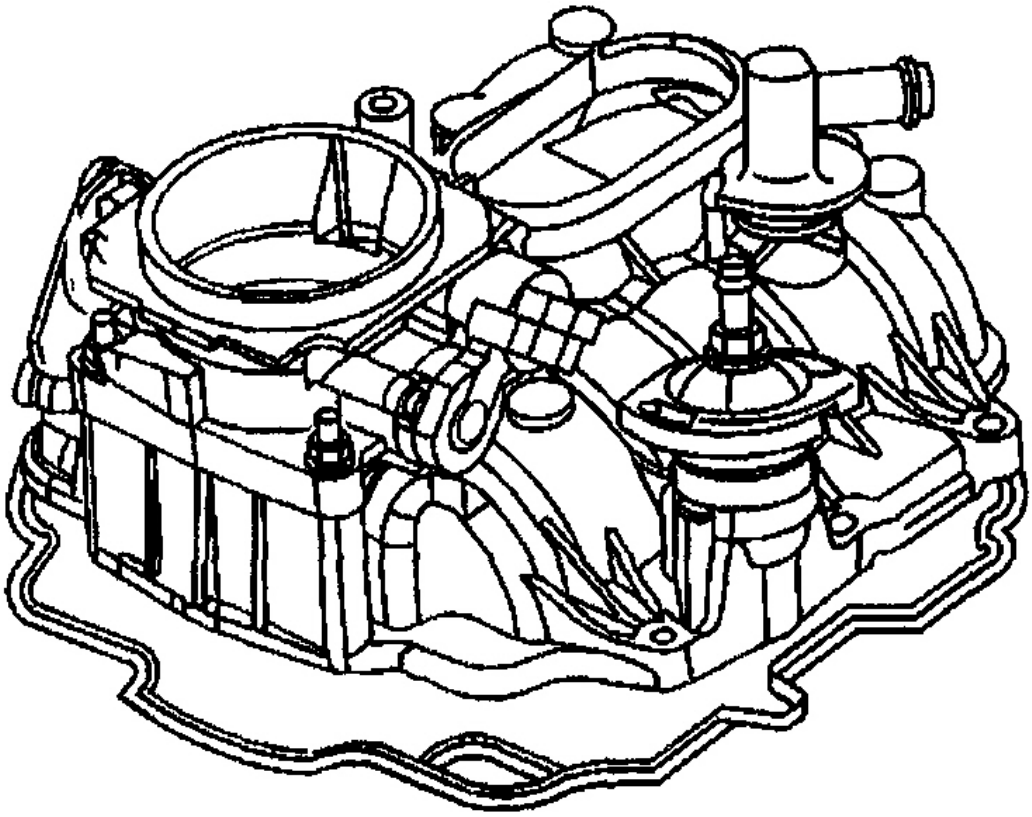

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Fig. 71: Removing Upper Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

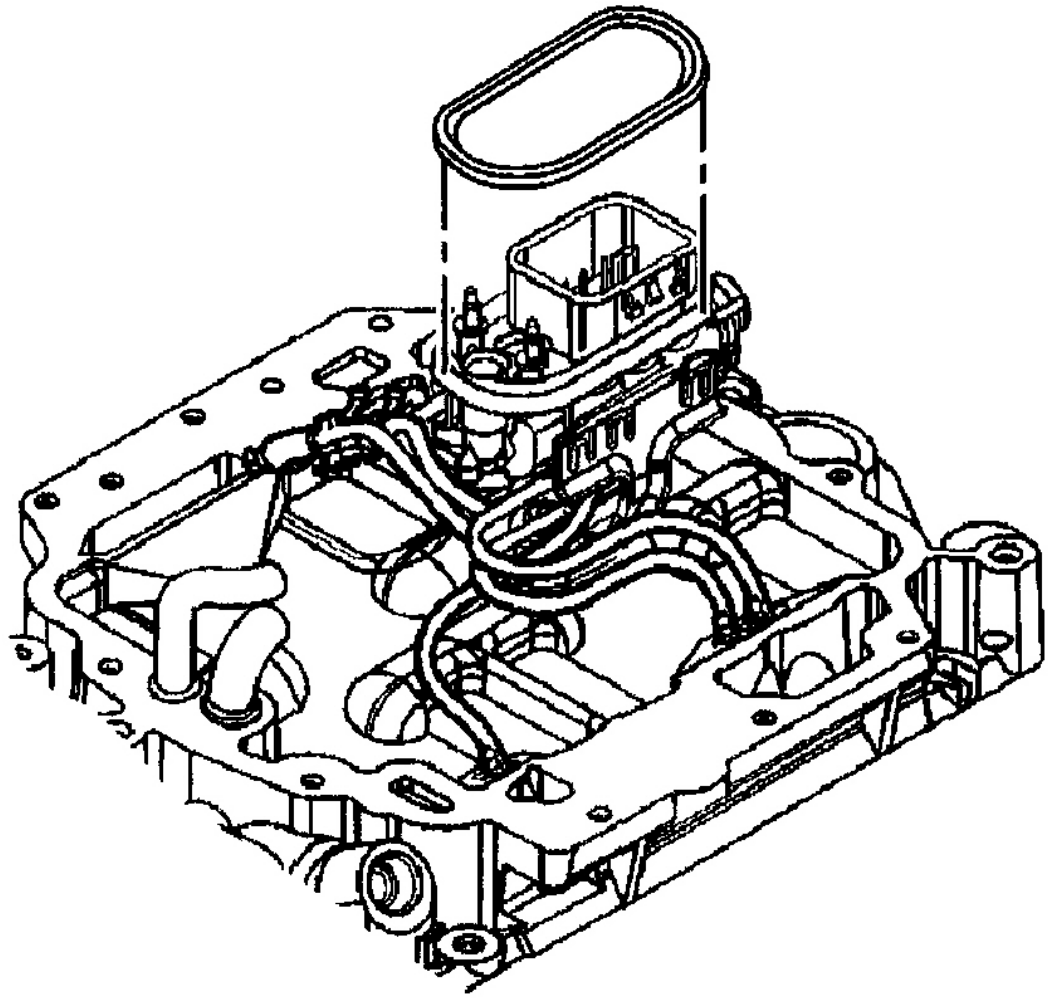

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Fig. 72: Removing Fuel Meter Body Assembly Seal
Courtesy of GENERAL MOTORS CORP.

23. Remove the seal from the fuel meter body assembly.
24. Discard the seal.

IMPORTANT: Do not immerse the assembled upper intake manifold in cleaning solvent.

25. Clean all sealing surfaces and the inside of the upper intake manifold with a shop towel and cleaning solvent.
26. Inspect the upper intake manifold for the following:
    - Cracks or other damage to the exterior

- Cracking or damage to the gasket grooves
- Loose or damaged bolt hole thread inserts

27. If replacing the upper intake manifold, turn and remove the PCV valve cover from the upper intake manifold.

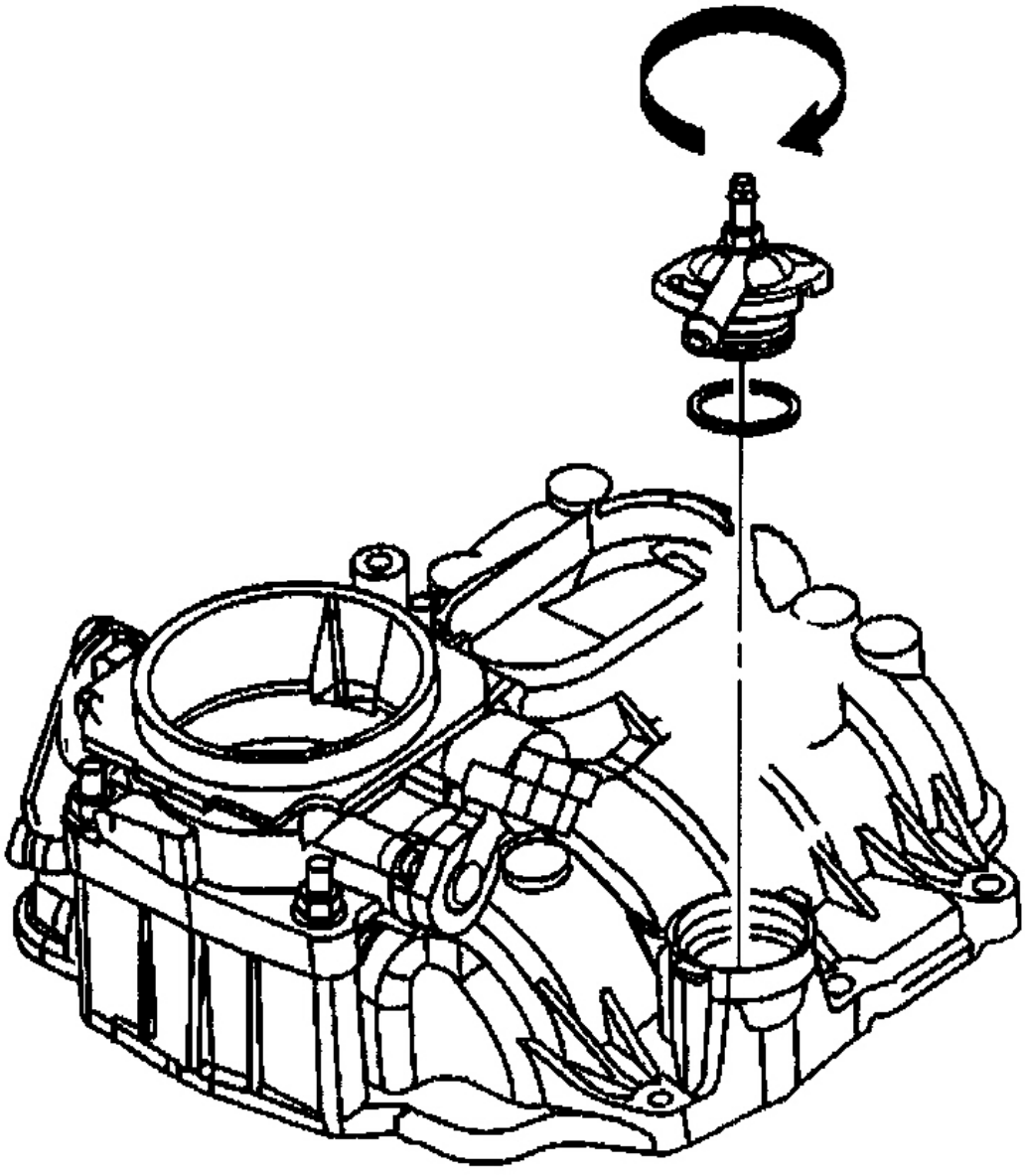

Fig. 73: Removing PCV Valve Cover

Courtesy of GENERAL MOTORS CORP.

28. Remove and discard the seal.
29. Remove the throttle body if replacing the upper intake manifold.
30. Remove the MAP sensor if replacing the upper intake manifold.

Installation Procedure

1. Install the throttle body, if removed.
2. Install the MAP sensor, if removed.
3. Install the PCV valve cover, if removed, using the following procedure:
    a. Install a NEW seal (O-ring) on the PCV valve cover.
    b. Lubricate the seal with clean engine oil.
    c. Install the PCV valve cover in the upper intake manifold.
    d. Turn and lock the PCV valve cover in position.

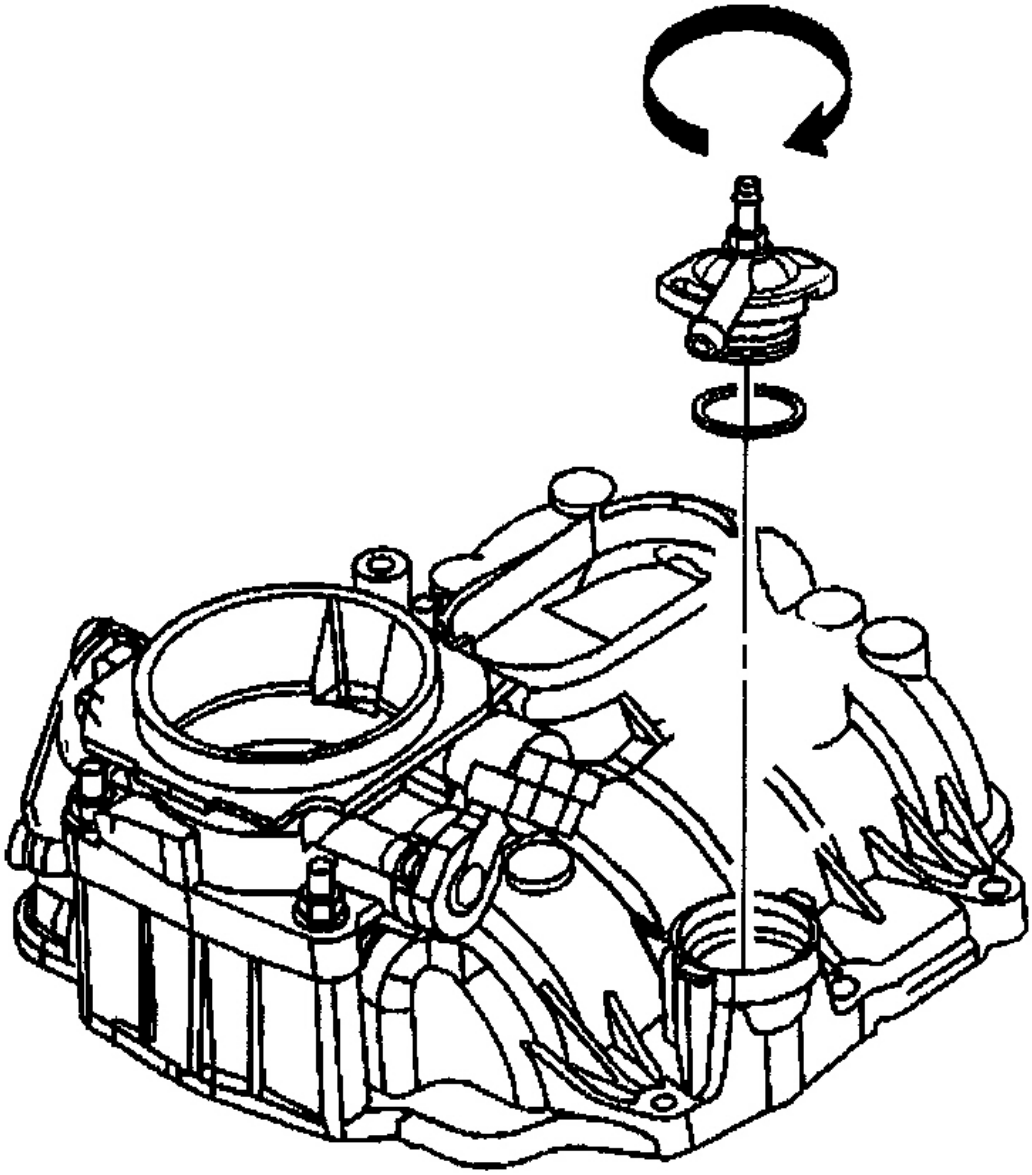

Fig. 74: Installing PCV Valve Cover
Courtesy of GENERAL MOTORS CORP.

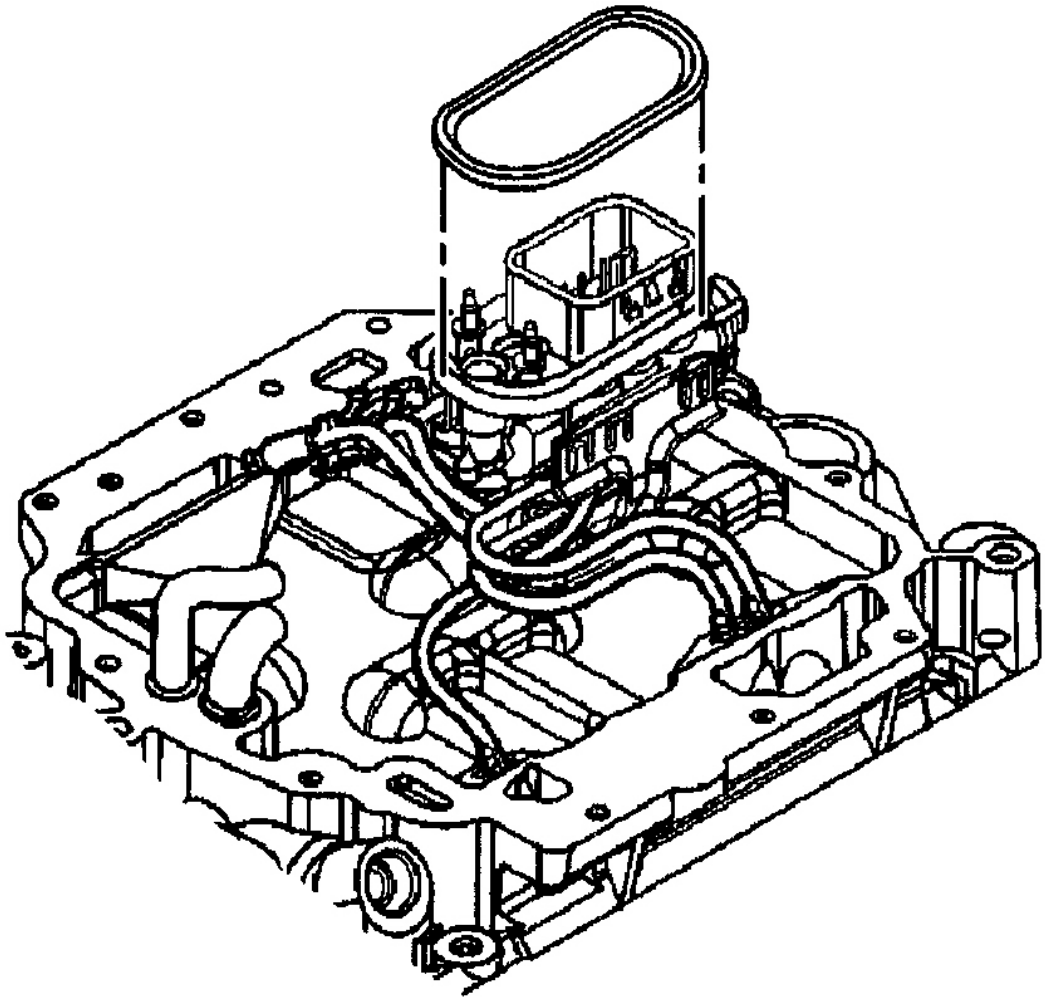

Fig. 75: Installing NEW Fuel Meter Body Assembly Seal
Courtesy of GENERAL MOTORS CORP.

4. Install a NEW seal on the fuel meter body assembly.
5. Lubricate the seal with clean engine oil.
6. Install a NEW upper intake manifold to lower intake manifold gasket in the groove of the upper intake manifold.

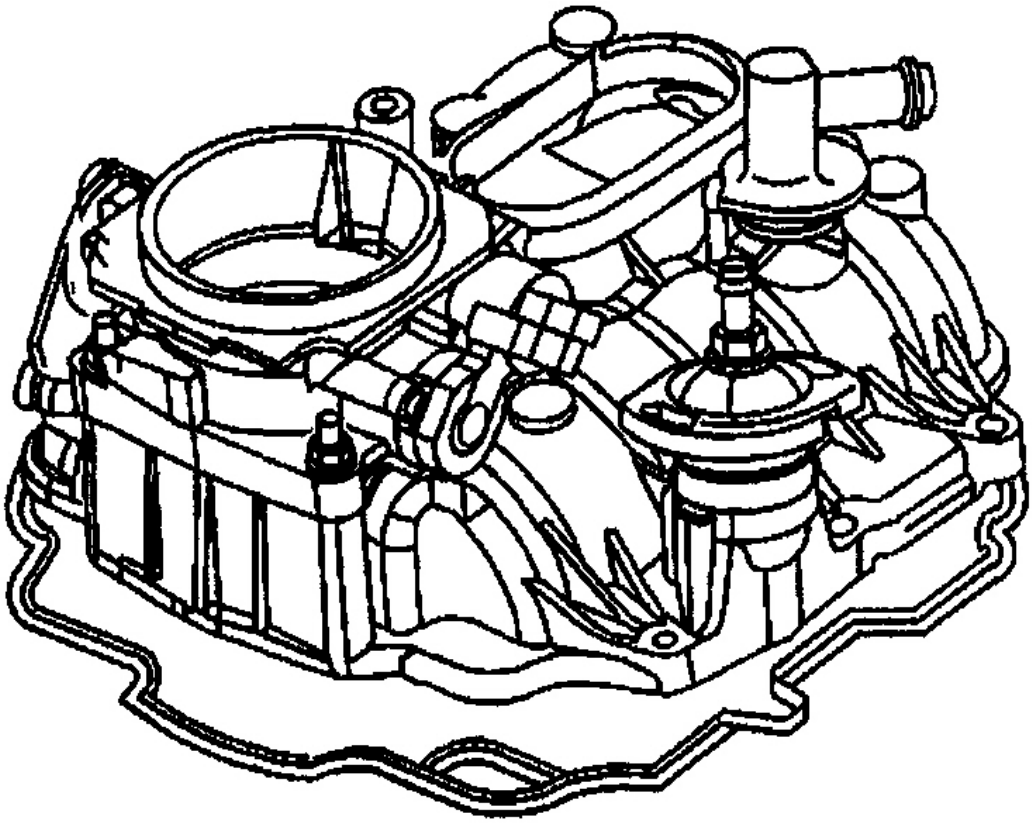

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Fig. 76: Installing NEW Upper Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

7. Install the upper intake manifold onto the lower intake manifold.
8. If reusing the fasteners, apply threadlock GM P/N 12345382 or equivalent to the threads of the upper intake manifold attaching bolts.
9. Install the upper intake manifold attaching studs.

   Tighten:

   - Tighten the upper intake manifold attaching studs on the first pass to 5 N.m (44 lb in).
   - Tighten the upper intake manifold attaching studs on the final pass to 9 N.m (80 lb in).

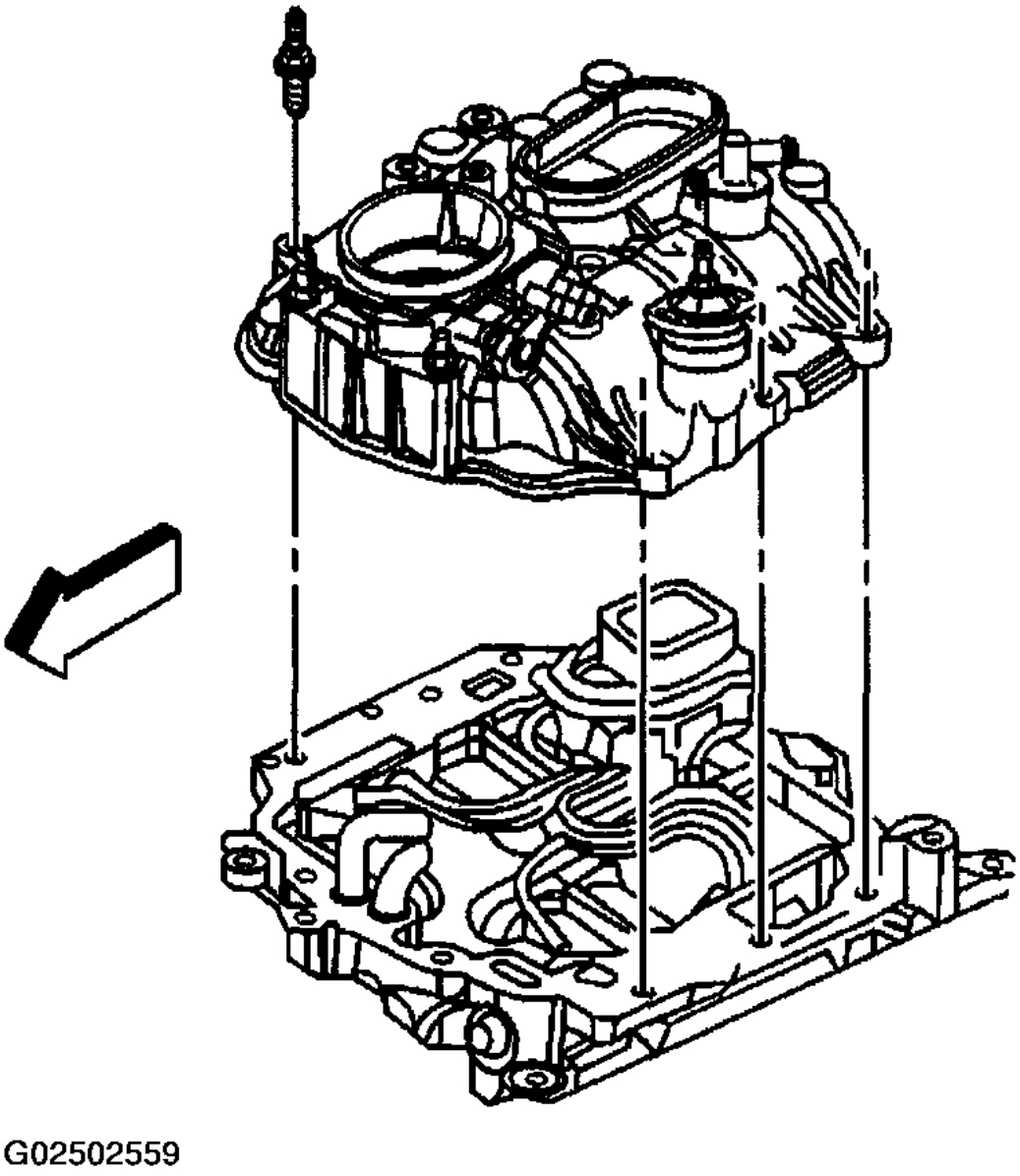

Fig. 77: Installing Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

10. Install the fuel lines to the fuel meter body assembly.
11. Install the EVAP canister purge valve.
12. Install the accelerator control cable bracket, studs, and nuts to the intake manifold and the throttle body. **Tighten:** Tighten the accelerator control cable bracket nuts and studs to 12 N.m (106 lb in).

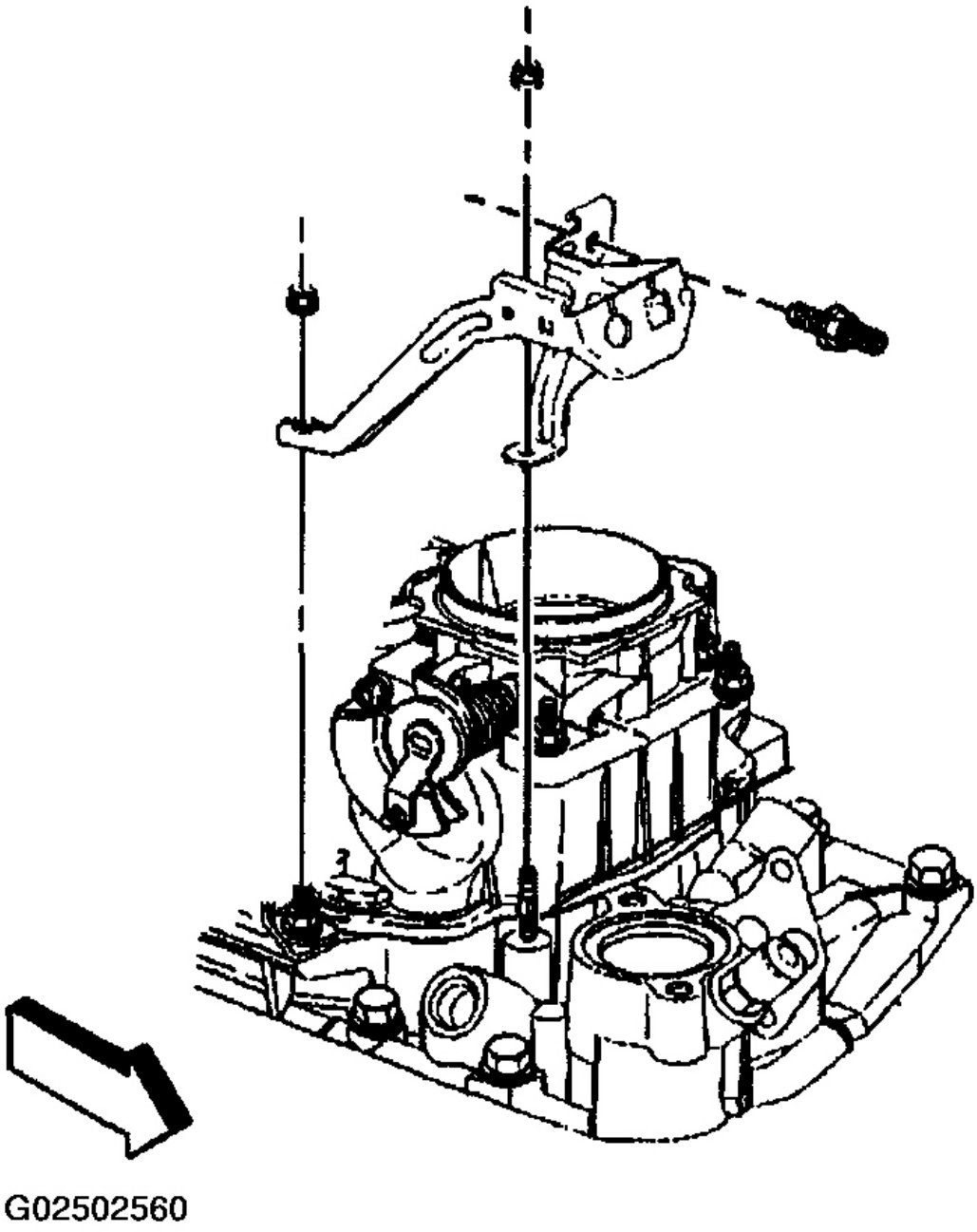

Fig. 78: Installing Accelerator Control Cable Bracket To Throttle Body & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

13. Connect the vacuum hose to the intake manifold.

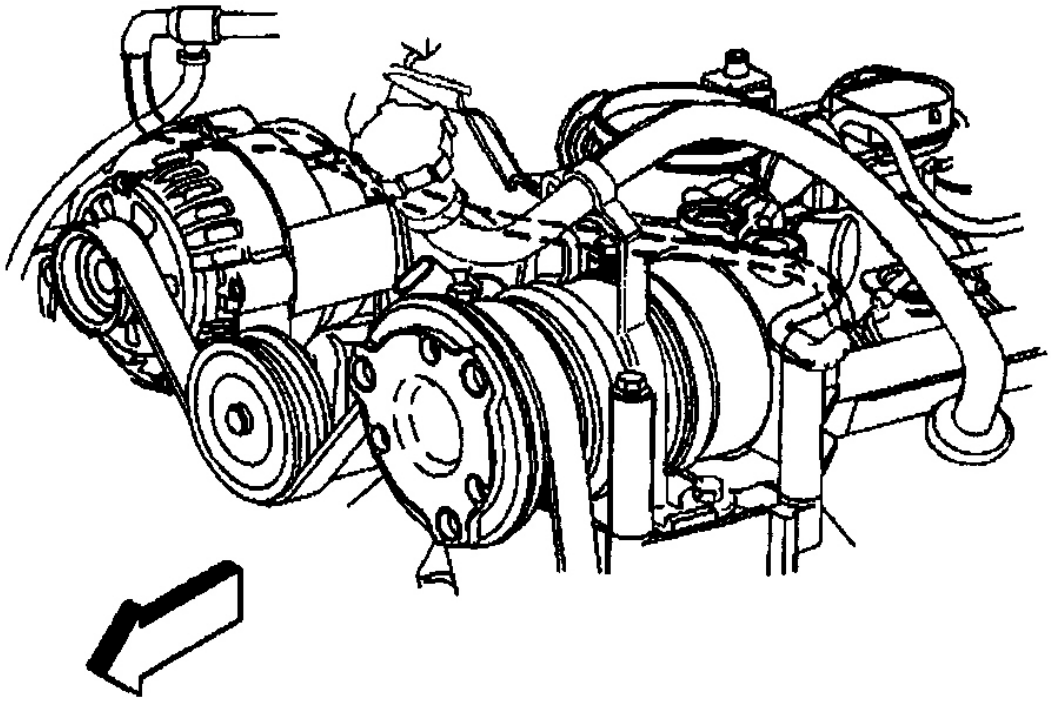

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Fig. 79: Connecting Vacuum Hose To Intake Manifold
Courtesy of GENERAL MOTORS CORP.

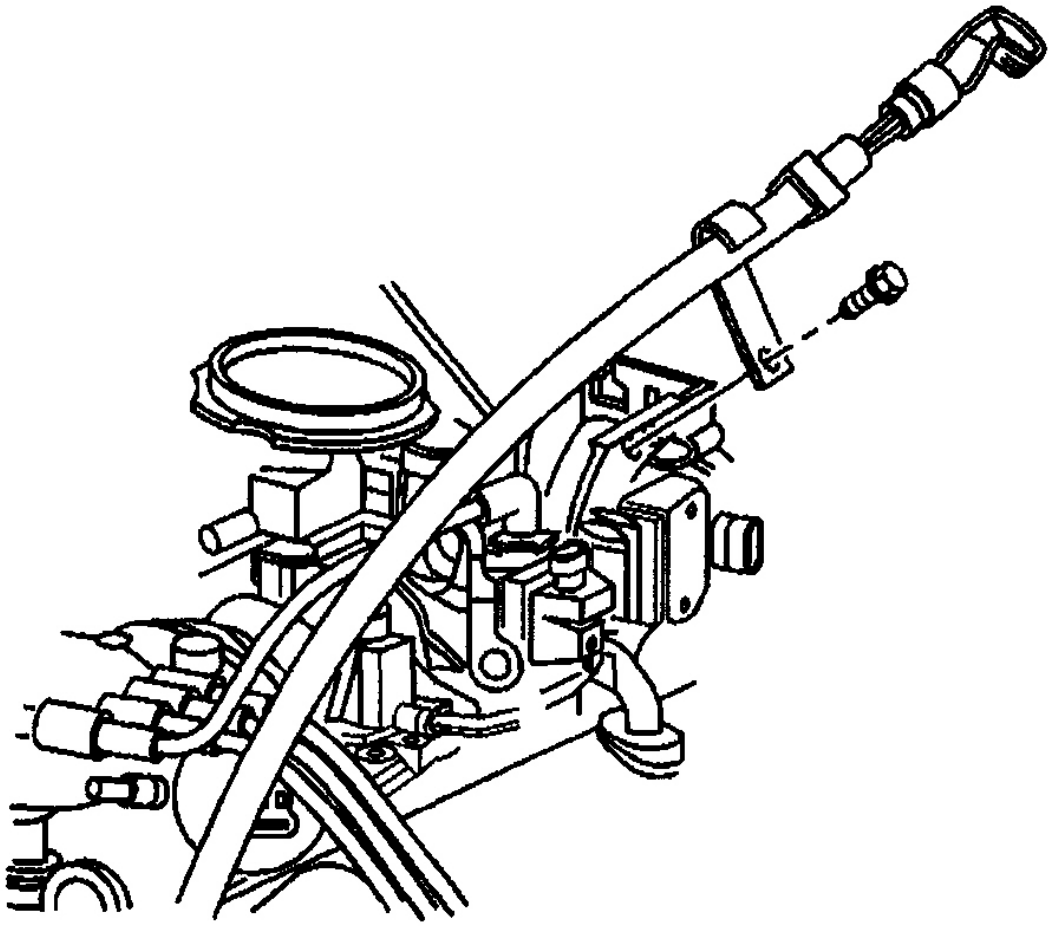

Fig. 80: Installing Transmission Fluid Filler Tube Bolt At Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

14. Install the transmission fluid fill tube and bolt to the accelerator control cable bracket. **Tighten:** Tighten the transmission fluid fill tube bolt 6 N.m (53 lb in).
15. Position the engine wiring harness.
16. Connect the following electrical connectors:
    - The A/C compressor clutch, if equipped (1)
    - The A/C high pressure cutoff switch, if equipped (5)
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)
    - The fuel meter body assembly connector (4)

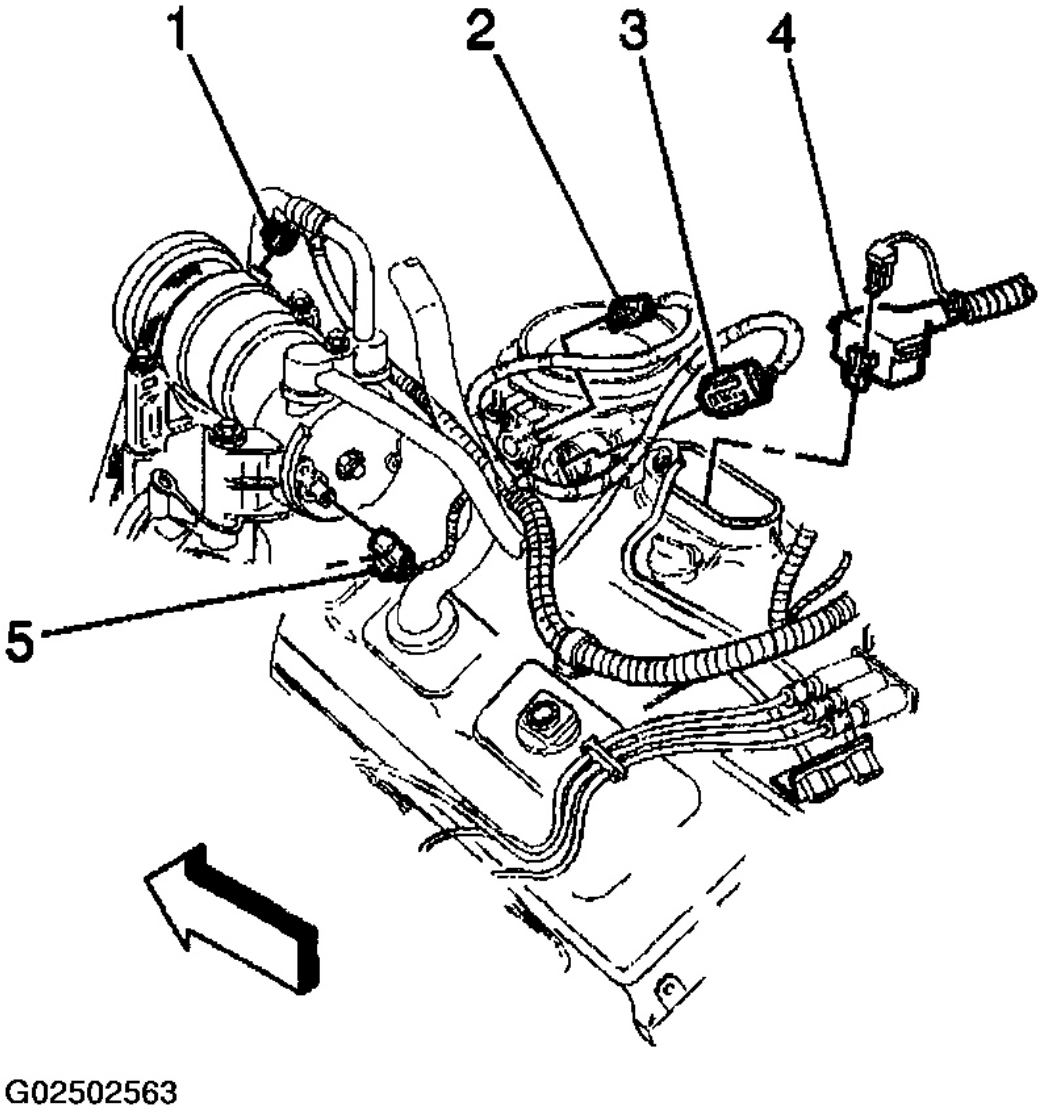

Fig. 81: Connecting A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position Sensor, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

17. Connect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)

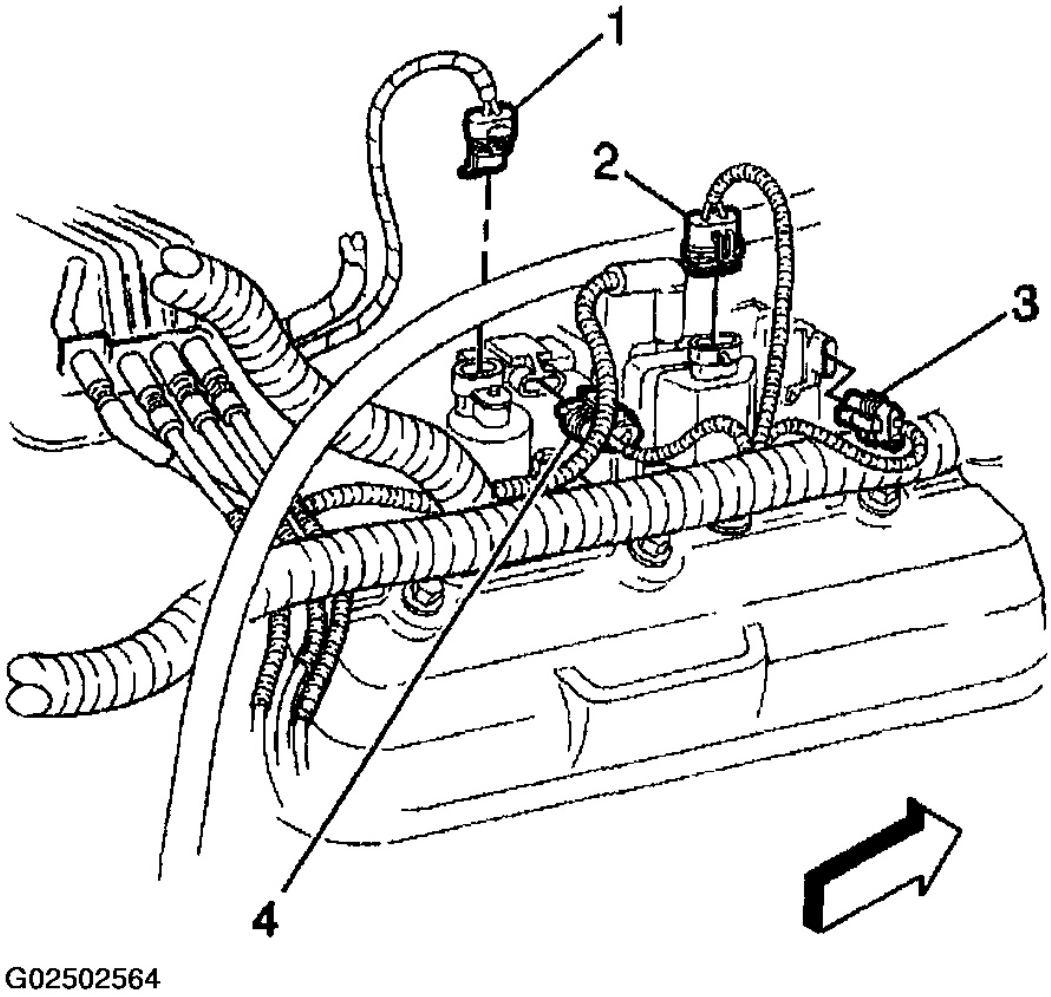

Fig. 82: Connecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

18. Install the engine wiring harness bracket and nut to the intake manifold stud. **Tighten:** Tighten the engine wiring harness bracket nut to 12 N.m (106 lb in).
19. Install the A/C hose bracket and nut, if equipped to the intake manifold stud. **Tighten:** Tighten the A/C hose bracket nut to 5 N.m (44 lb in).

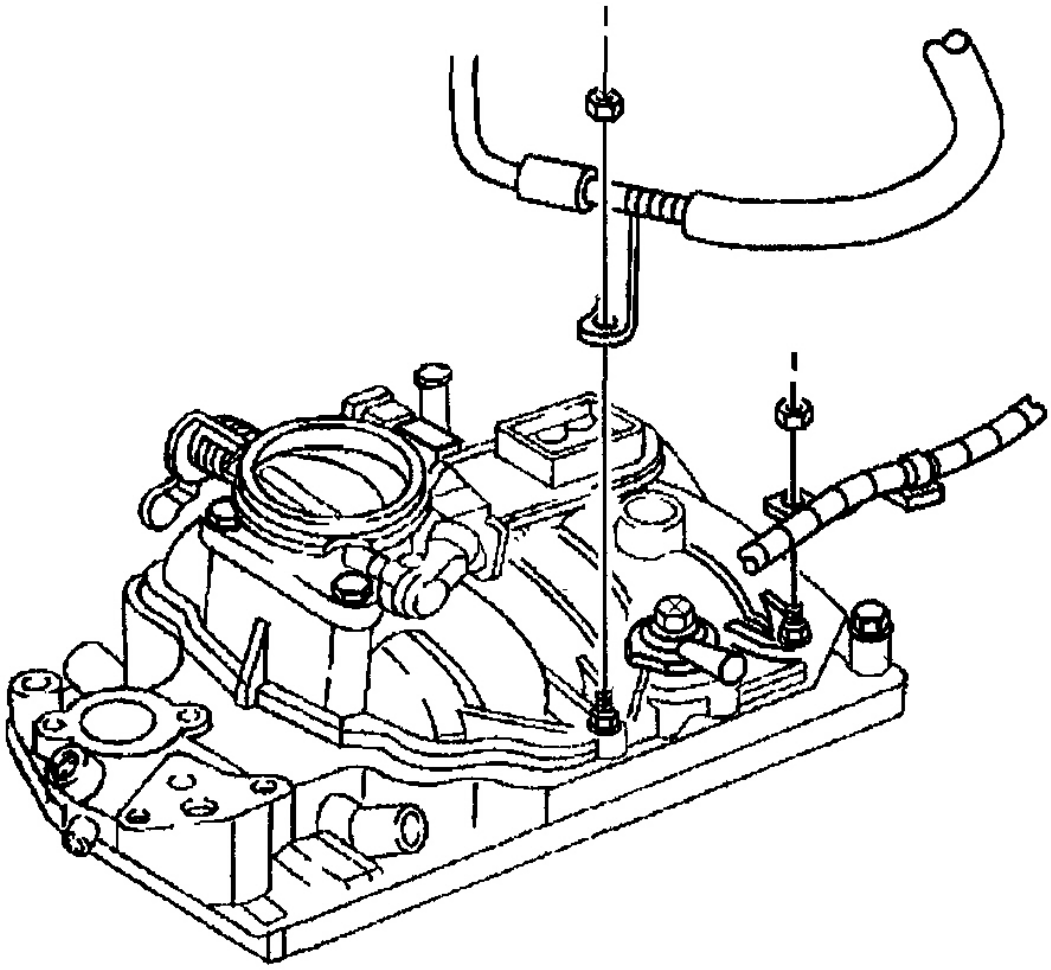

Fig. 83: Installing A/C Hose Bracket & Engine Wiring Harness Bracket At Intake Manifold
Courtesy of GENERAL MOTORS CORP.

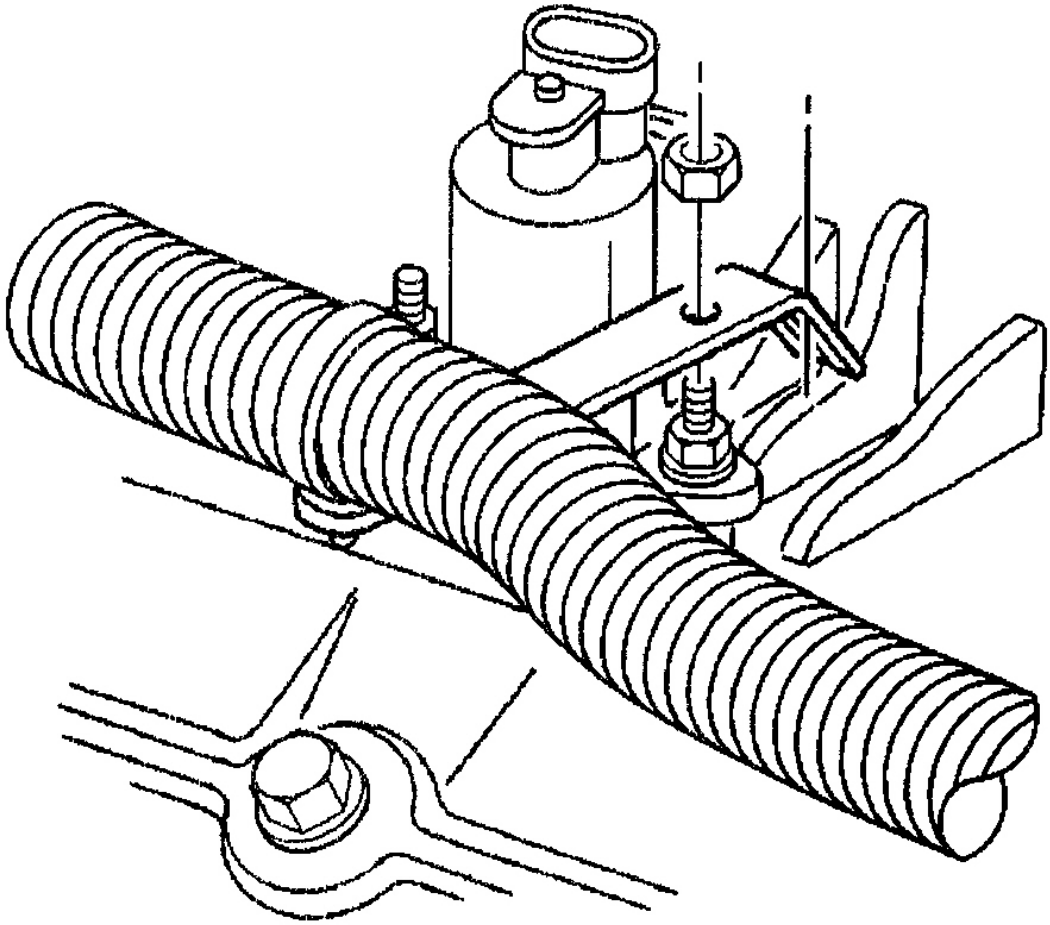

Fig. 84: Installing Engine Harness Bracket To EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

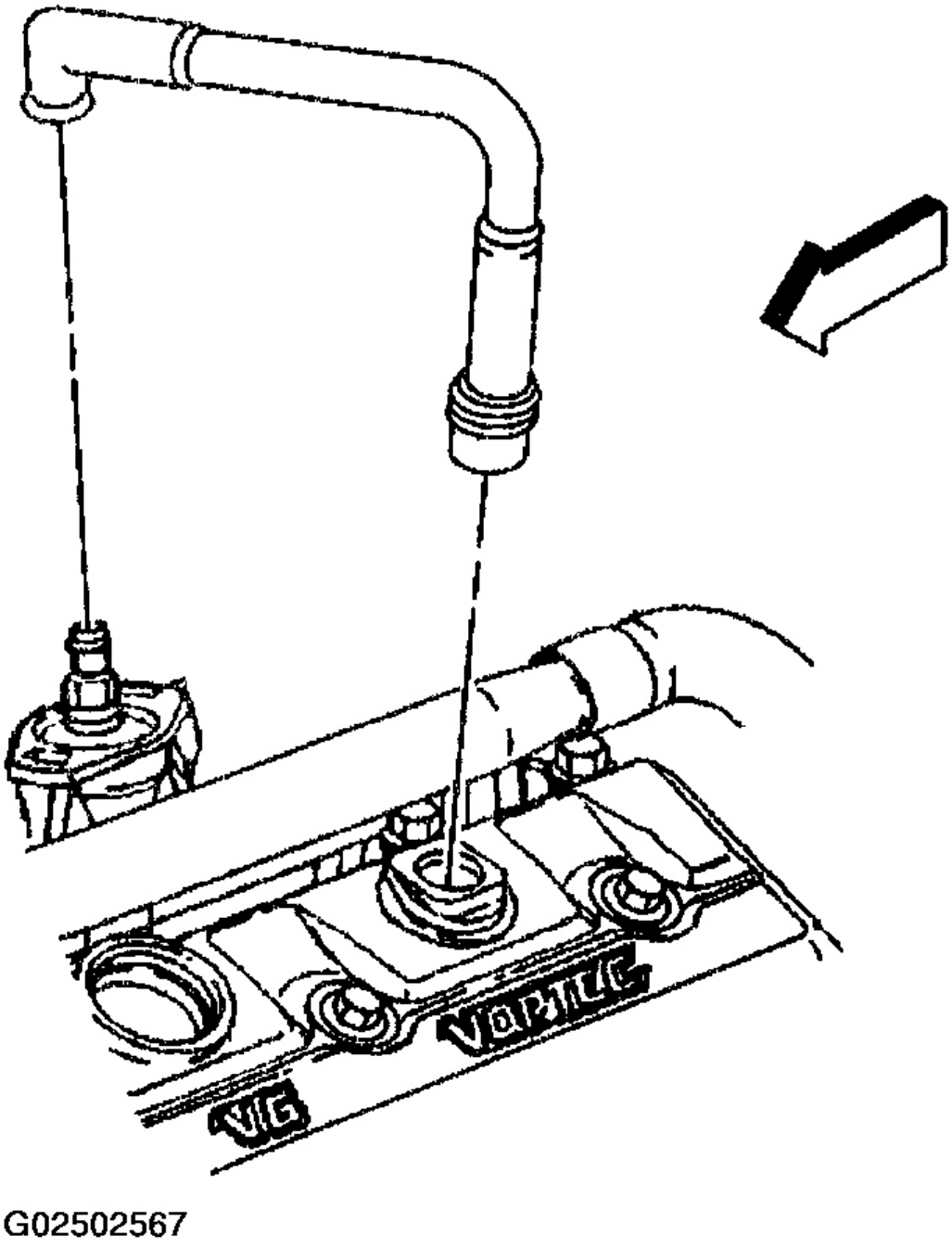

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Fig. 85: Installing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

20. Install the engine wiring harness bracket and the nut onto the stud at the EVAP canister purge solenoid

valve. **Tighten:** Tighten the engine wiring harness bracket nut to 8 N.m (71 lb in).

21. Connect the PCV valve hose assembly to the intake manifold and the valve rocker arm cover.
22. Install the cruise control cable, if equipped to the throttle shaft and the accelerator control cable bracket.
23. Install the accelerator control cable to the throttle shaft and the accelerator control cable bracket.
24. Install the air cleaner outlet duct to the throttle body assembly.
25. Install the engine cover.

INTAKE MANIFOLD REPLACEMENT - LOWER

Removal Procedure

1. Disconnect the battery negative cable.
2. Remove the engine cover.
3. Drain the cooling system.
4. Remove the air cleaner assembly.
5. Remove the air cleaner outlet duct from the throttle body assembly.
6. Disconnect the accelerator control cable from the throttle shaft and the accelerator control cable bracket.
7. Perform this step if the vehicle is equipped with a cruise control. Disconnect the cruise control cable from the throttle shaft, and from the accelerator control cable bracket.

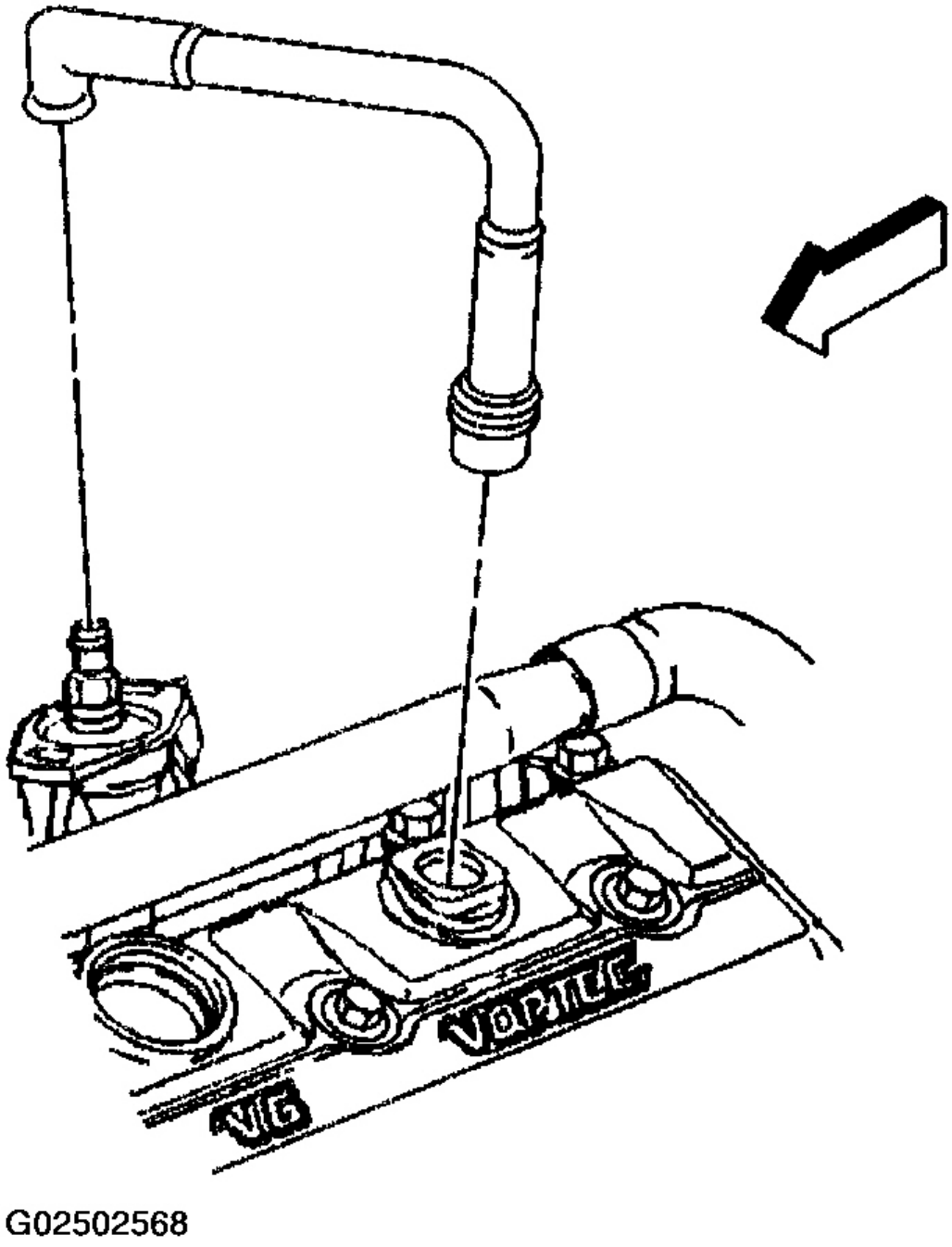

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Fig. 86: Removing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

8. Disconnect PCV valve hose assembly from the intake manifold and the valve rocker arm cover.

9. Remove the nut holding the A/C hose bracket to the intake manifold stud, if equipped.
10. Remove the nut holding the engine wiring harness bracket to the intake manifold stud.

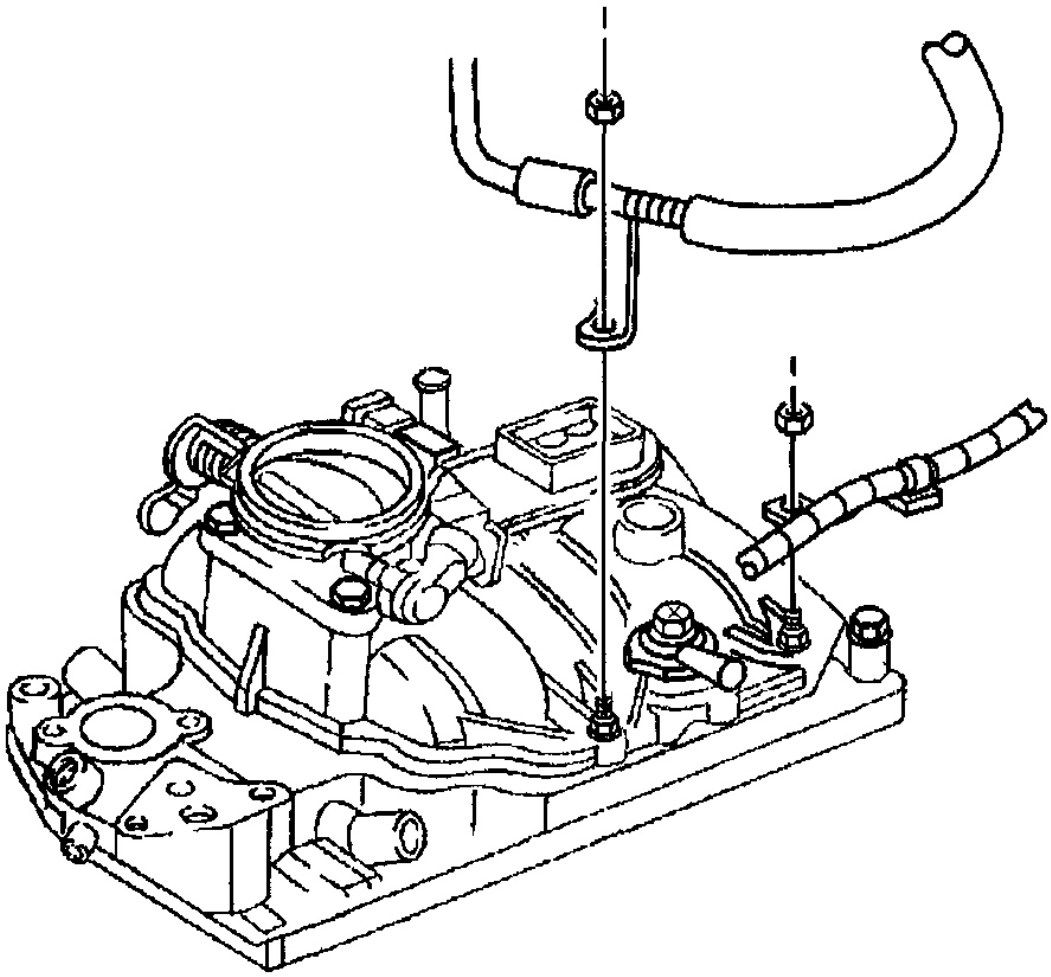

Fig. 87: Removing A/C Hose Bracket & Engine Wiring Harness Bracket At Intake Manifold
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the following electrical connectors:
    - The A/C compressor clutch, if equipped (1)
    - The A/C high pressure cutoff switch, if equipped (5)
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)
    - The fuel meter body assembly connector (4)

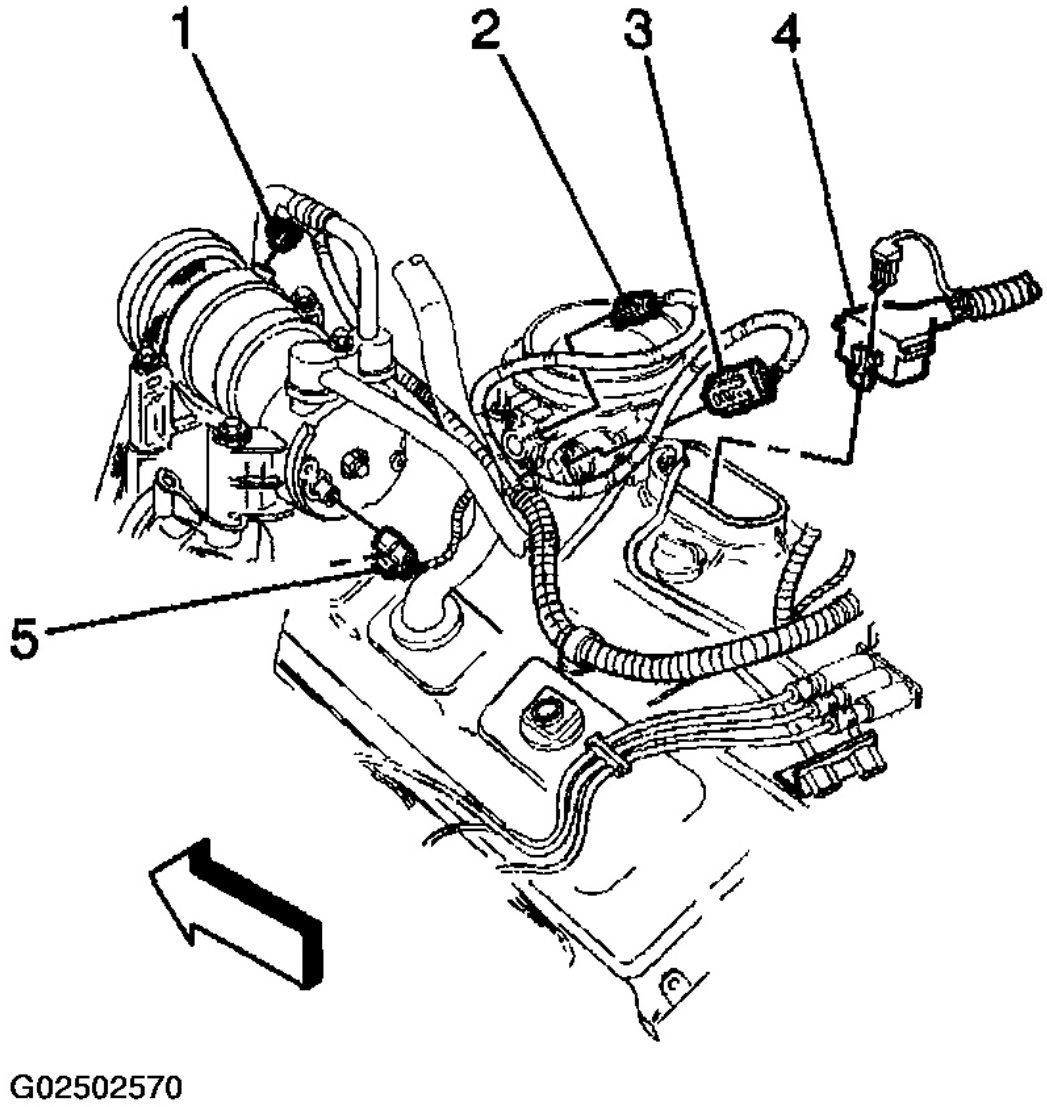

Fig. 88: Disconnecting A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position Sensor, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

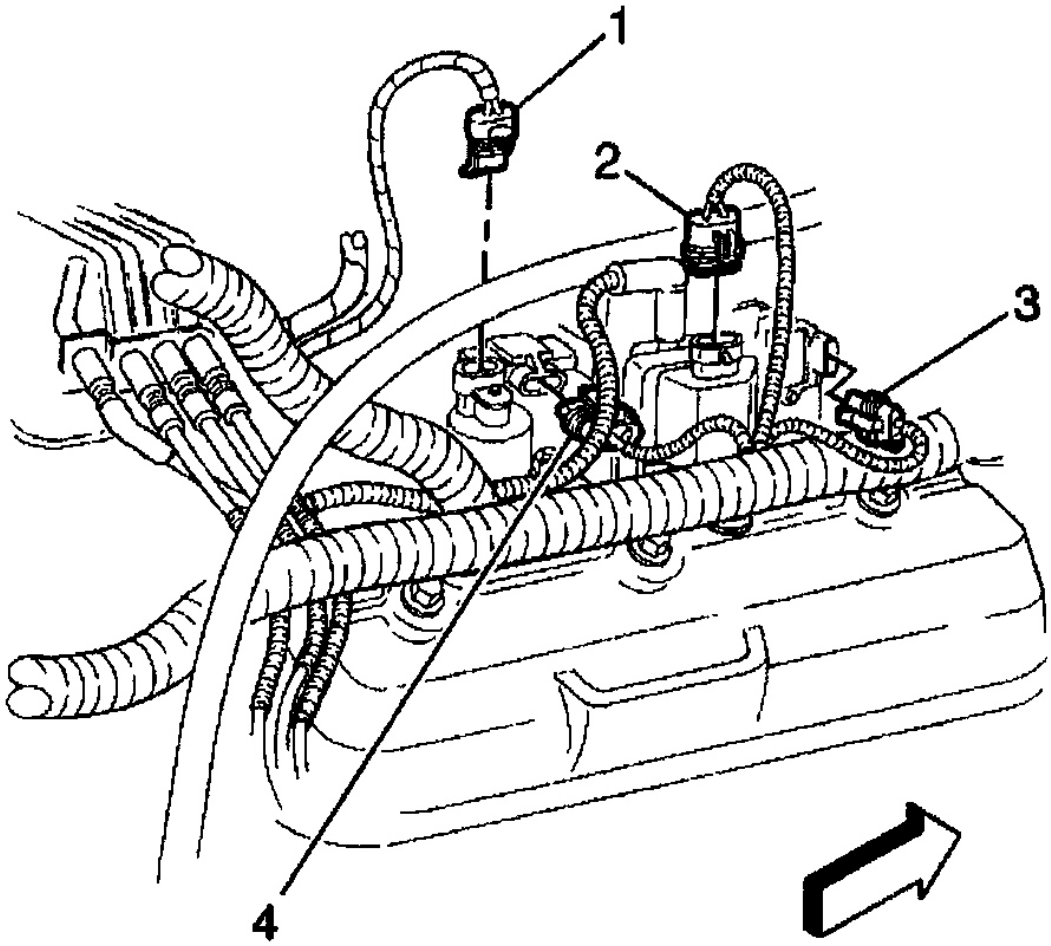

Fig. 89: Disconnecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)
13. Remove the ground wire (2) from the stud at the water outlet.
14. Remove the nut, and remove the engine wiring harness bracket from the stud, at the EVAP canister purge solenoid valve.
15. Move and secure the engine wire harness out of the way.

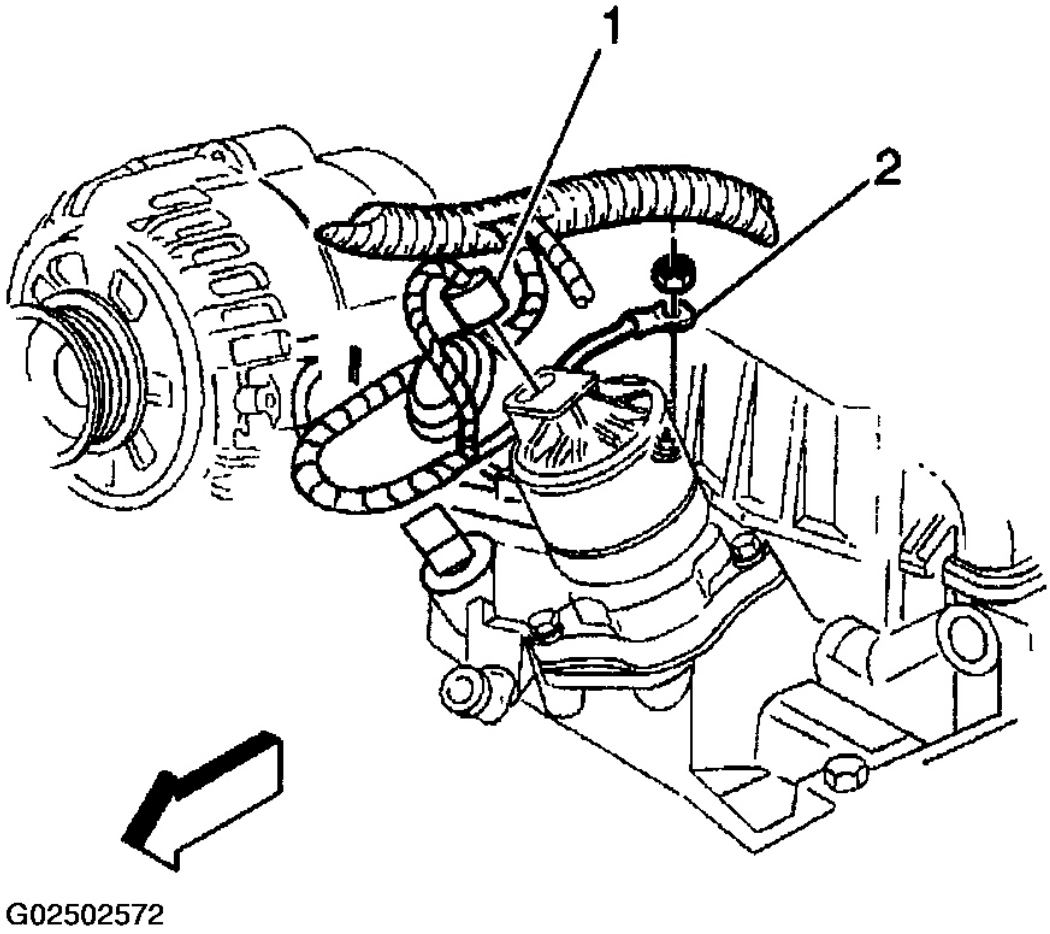

Fig. 90: Locating Ground Wire At Water Outlet
Courtesy of GENERAL MOTORS CORP.

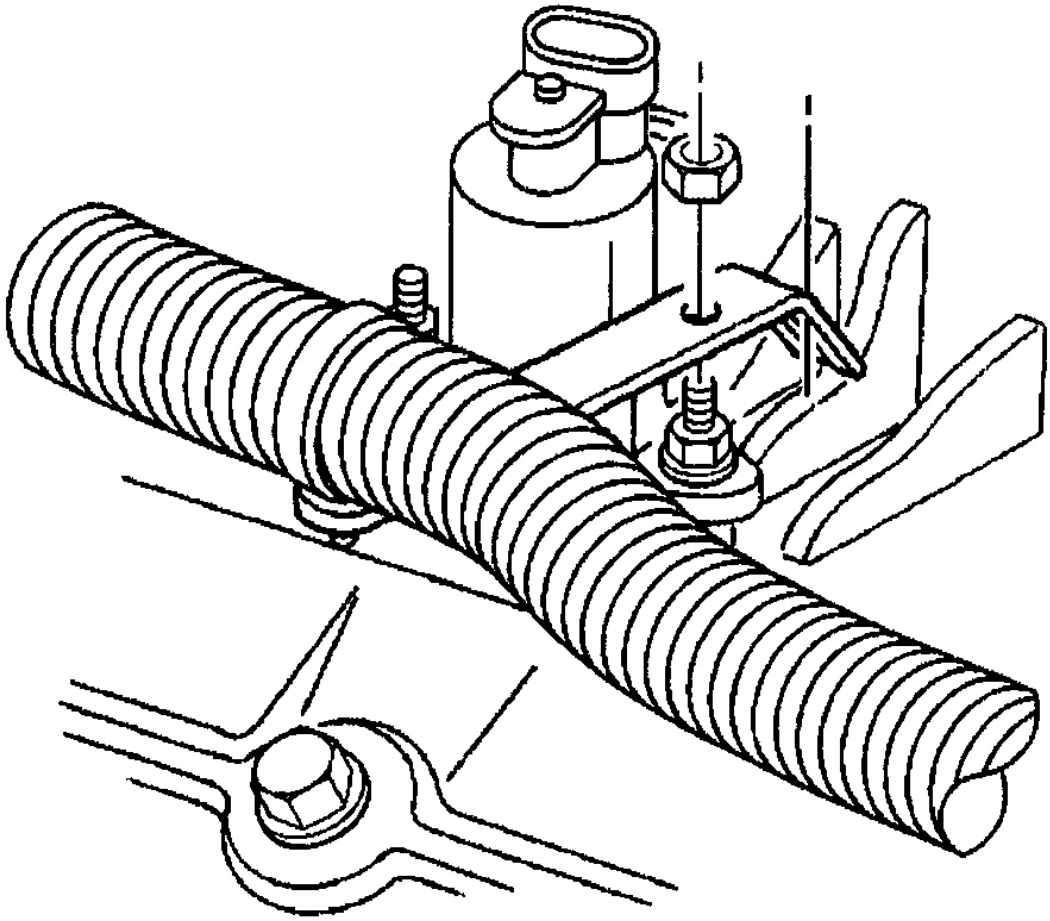

Fig. 91: Removing Engine Harness Bracket From EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

16. Remove the EVAP canister purge valve.
17. Remove the radiator inlet hose at the water outlet.
18. Remove the heater hose from the intake manifold.
19. Remove the water pump inlet hose from the intake manifold.

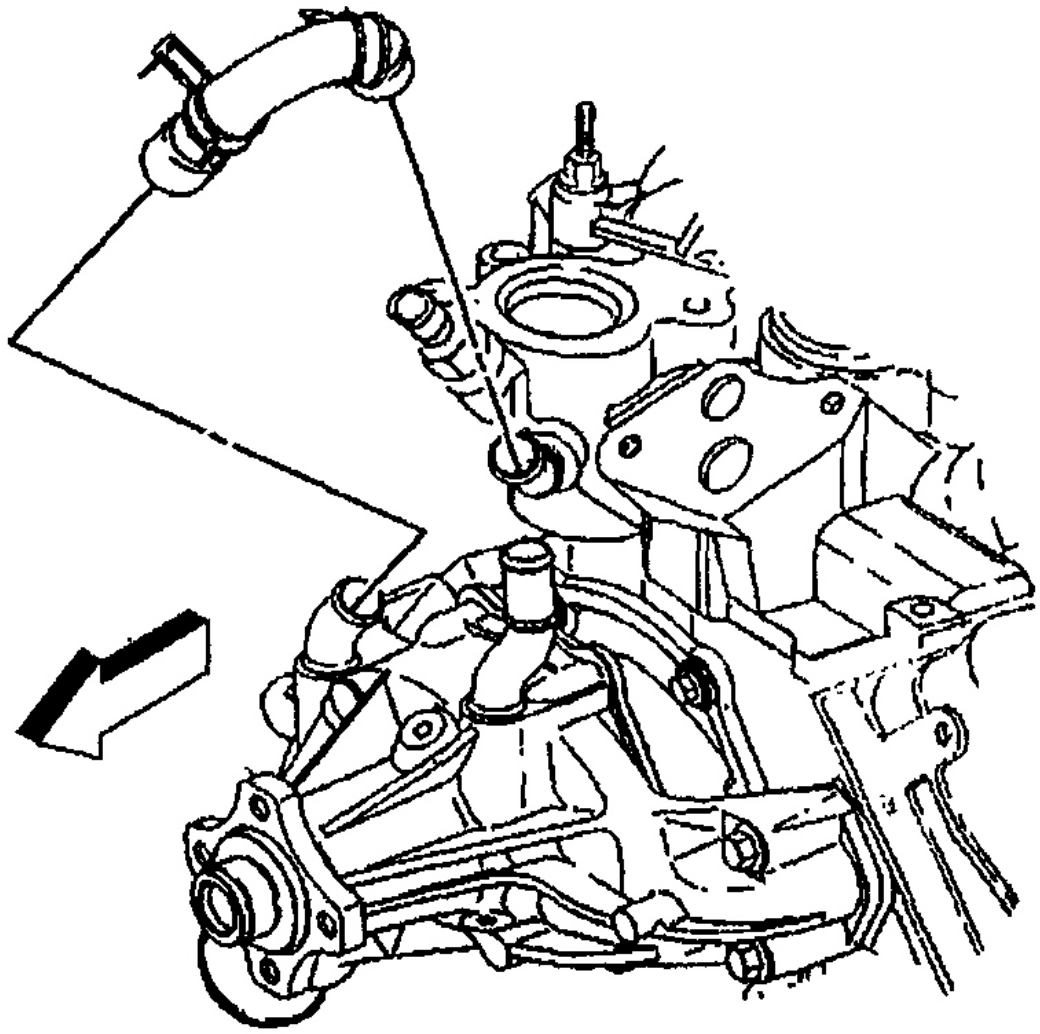

Fig. 92: Removing Coolant By-Pass Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

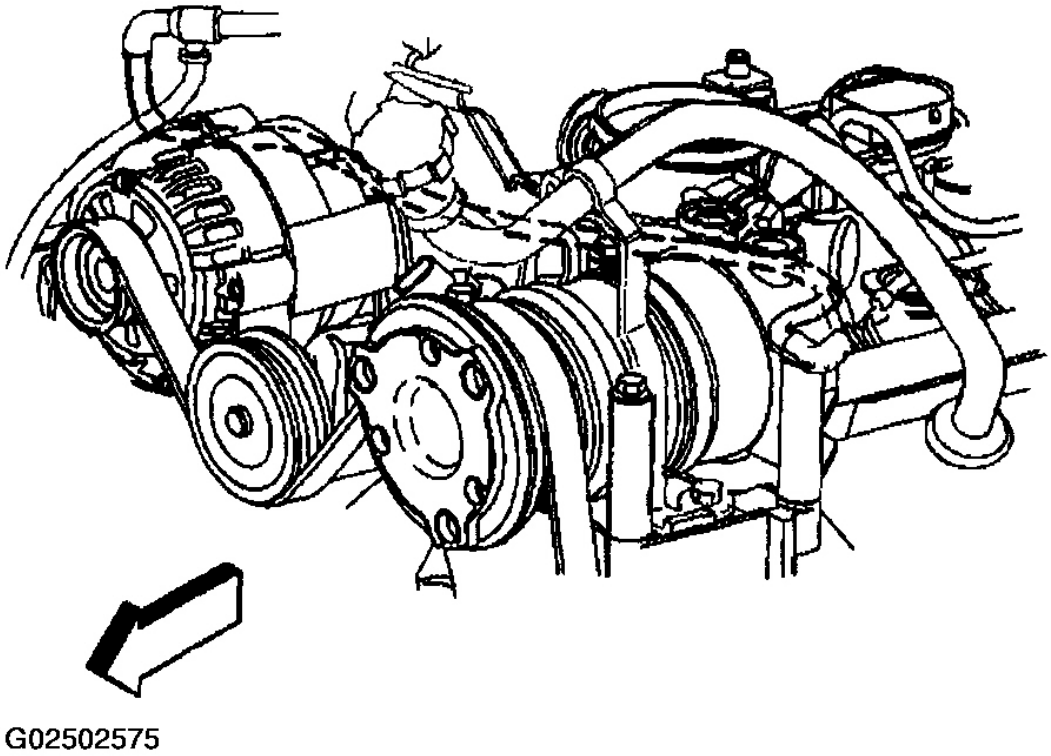

Fig. 93: Disconnecting Vacuum Hose From Intake Manifold
Courtesy of GENERAL MOTORS CORP.

20. Disconnect the vacuum hose from the intake manifold.
21. Remove the bolt holding the transmission fluid filler tube to the accelerator control cable bracket.
22. Remove the accelerator control cable bracket from the throttle body and the intake manifold.

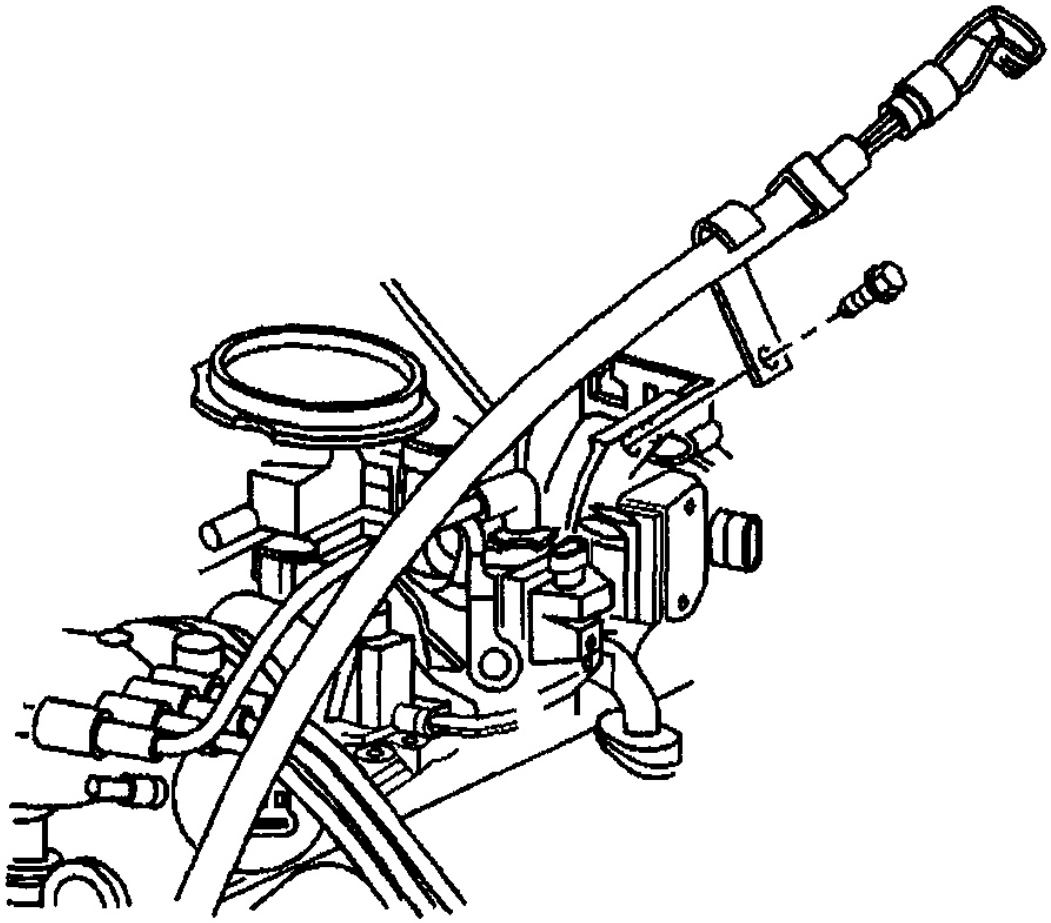

Fig. 94: Removing Transmission Fluid Filler Tube Bolt At Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

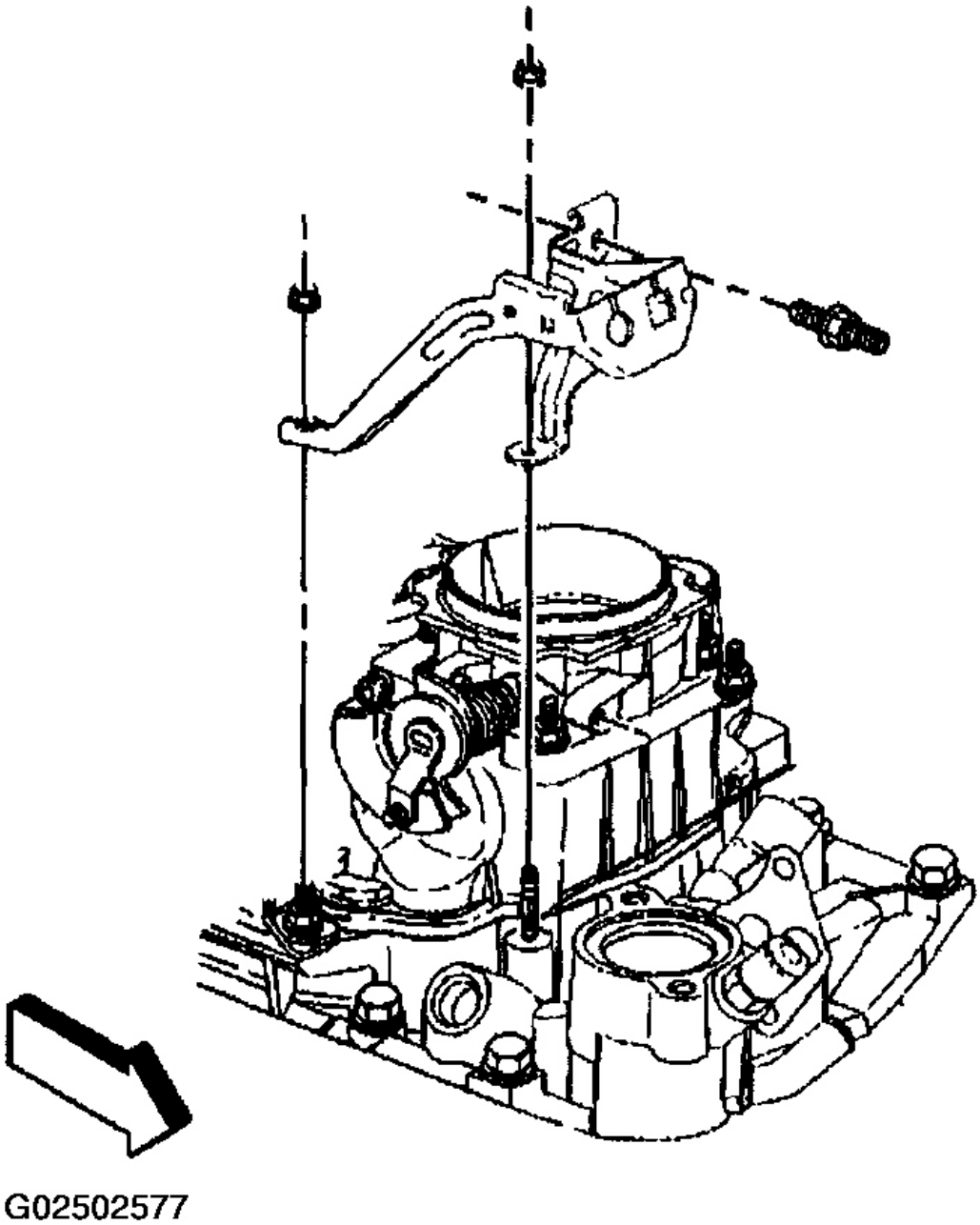

Fig. 95: Removing Accelerator Control Cable Bracket From Throttle Body & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

23. Remove the distributor.
24. Disconnect the fuel supply, and disconnect the return pipes, at the rear of the intake manifold.

25. Remove the ignition control module (ICM).
26. In order to remove the front intake manifold bolt, perform the following steps:
    a. Remove the drive belt. Refer to **Drive Belt Replacement**.
    b. Remove the A/C compressor side brace.
    c. Loosen the nut for the power steering pump rear bracket.
    d. Remove the oil filler tube bracket bolt and the oil filler tube.
    e. Remove the bolts and the nut for the power steering pump mounting bracket.
    f. Leave the A/C compressor, if equipped, and the power steering pump on the bracket.
    g. Slide the power steering pump bracket forward to access the bolt at the front of the intake manifold.

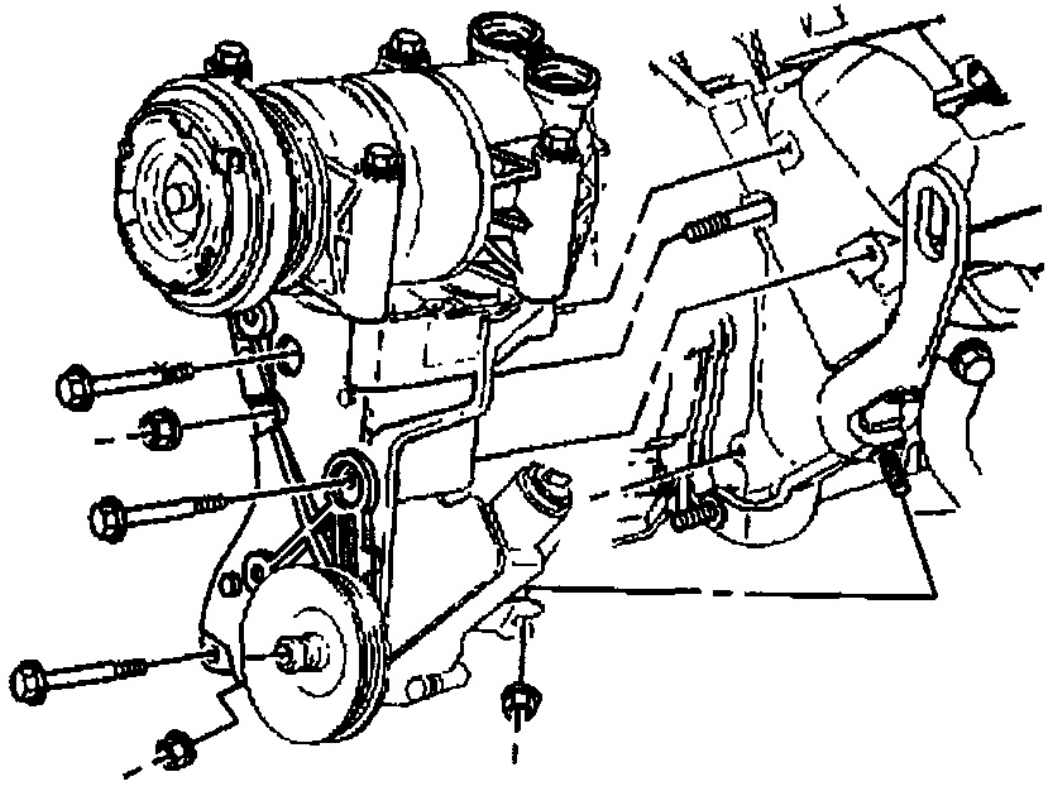

Fig. 96: Sliding Power Steering Pump Bracket Forward To Access Front Intake Manifold Bolt
Courtesy of GENERAL MOTORS CORP.

27. Remove the lower intake manifold.
28. Clean all sealing surfaces and the intake manifold.

Installation Procedure

1. Install the lower intake manifold. See **INTAKE MANIFOLD INSTALLATION** in Engine Mechanical - 4.3L Unit Repair (Overhaul) article.
2. Reposition the power steering pump mounting bracket.
3. Install the power steering pump mounting bracket three bolts and the nut. **Tighten:** Tighten the power steering pump mounting bracket bolts and the nut and the power steering pump rear bracket nut to 41 N.m (30 lb ft).

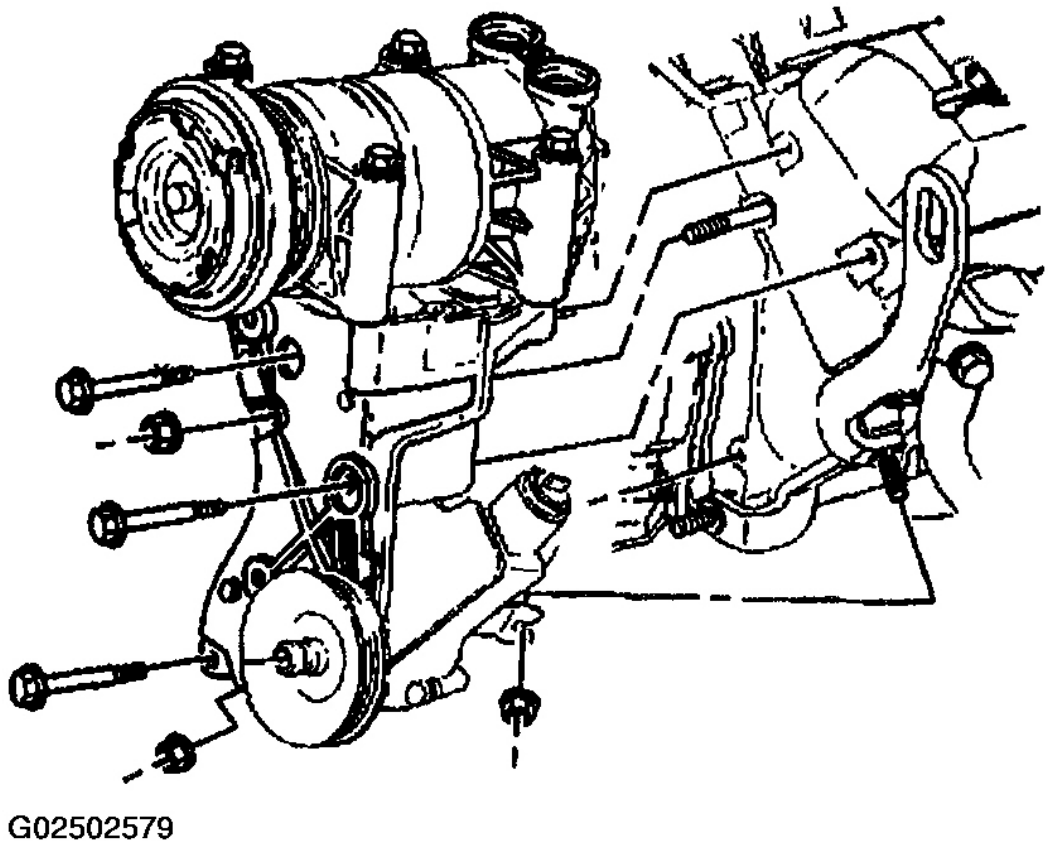

Fig. 97: Installing Power Steering Pump Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

4. Install A/C compressor side brace and bolts.
   Tighten:
   - Tighten the A/C compressor side brace bolt to 50 N.m (37 lb ft).
   - Tighten the side brace bolt to the generator bracket to 25 N.m (18 lb ft).
5. Install the oil filler tube and bolt. **Tighten:** Tighten the oil filler tube bolt to 25 N.m (18 lb ft).

6. Install the drive belt. Refer to **Drive Belt Replacement**.
7. Install the EVAP canister purge valve.

IMPORTANT: In order to install the distributor for the correct engine timing, position the engine to number one cylinder top dead center.

8. Install the fuel supply and return pipes to the rear of the intake manifold.
9. Remove the spark plug for number one cylinder.
10. Rotate the crankshaft until number one cylinder is in the compression stroke.
11. Align the 2 reference marks on the crankshaft balancer (1, 4) with the 2 alignment marks (2, 3) on the front cover.

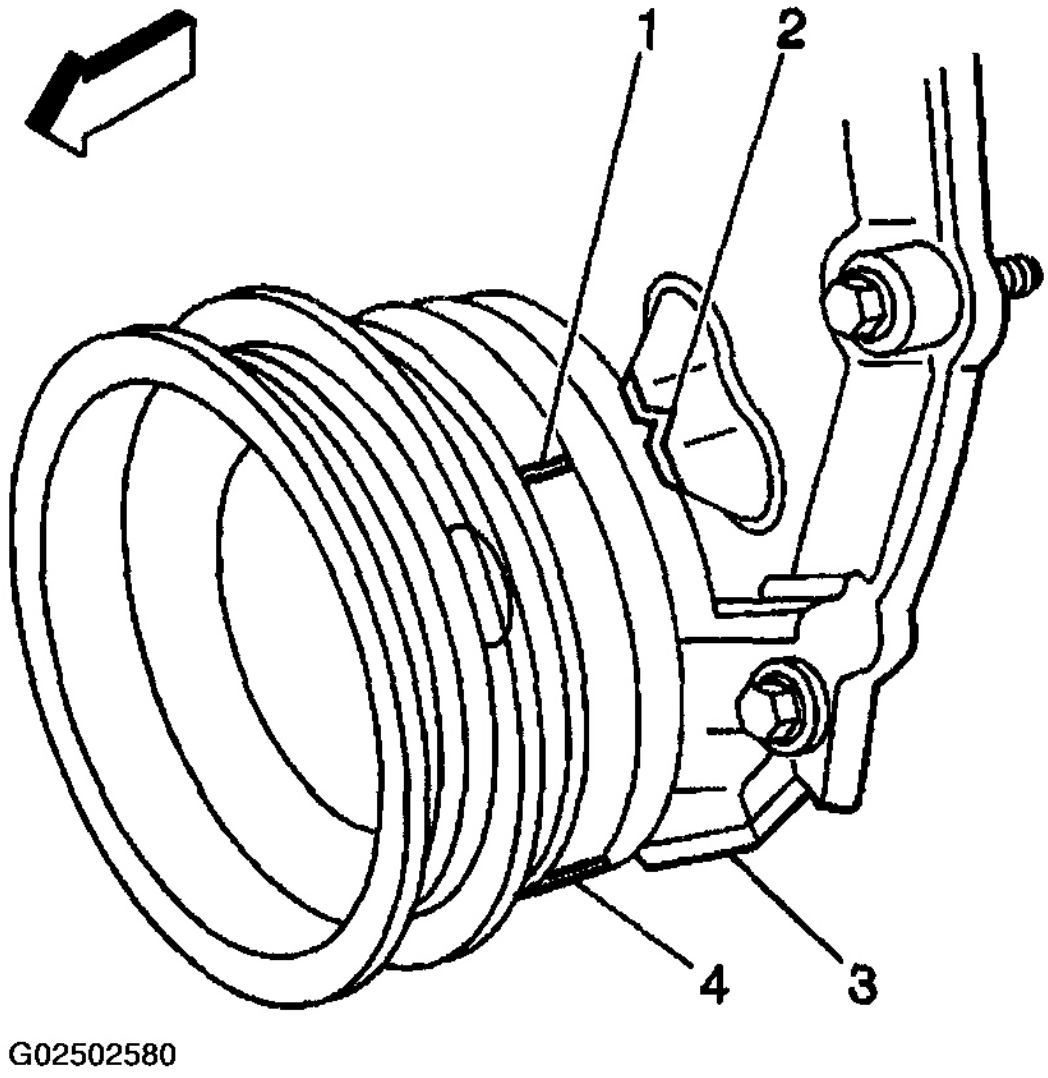

Fig. 98: Identifying Crankshaft Balancer & Front Cover Timing Marks
Courtesy of GENERAL MOTORS CORP.

12. Install the spark plug.
13. Install the distributor.
14. Install the ICM.
15. Install the accelerator control cable bracket, studs, and nuts to the intake manifold and the throttle body. **Tighten:** Tighten the accelerator control cable bracket nuts and studs to 12 N.m (106 lb in).

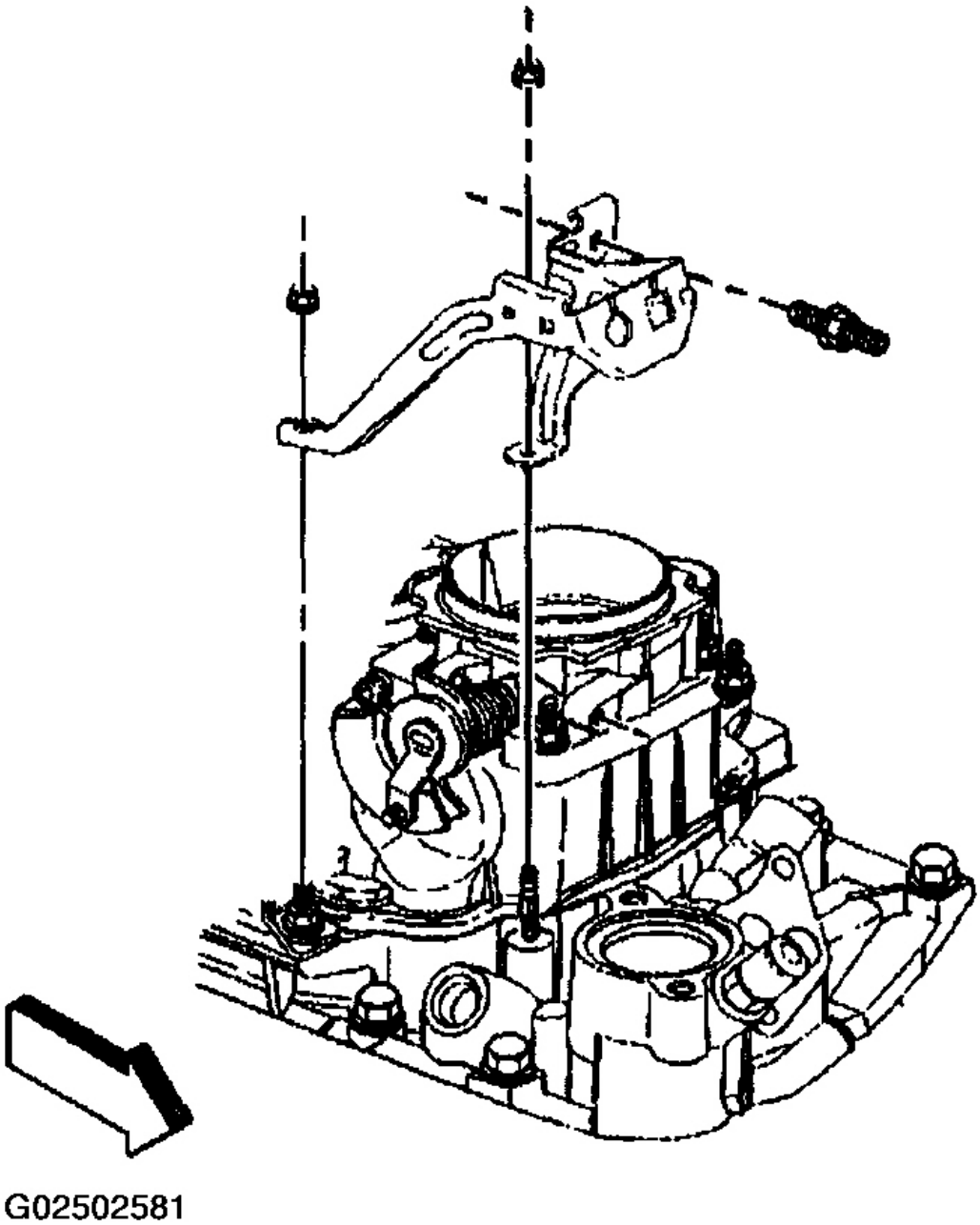

Fig. 99: Installing Accelerator Control Cable Bracket To Throttle Body & Intake Manifold
Courtesy of GENERAL MOTORS CORP.

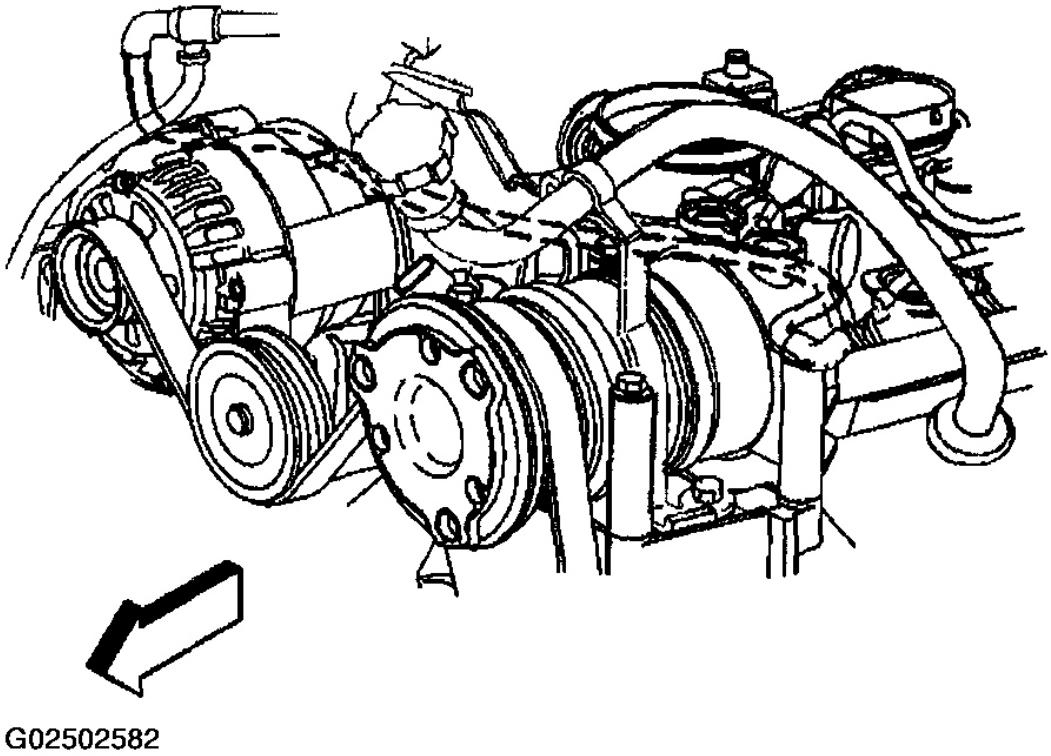

Fig. 100: Connecting Vacuum Hose To Intake Manifold
Courtesy of GENERAL MOTORS CORP.

16. Install the vacuum hose to the intake manifold.
17. Install the transmission fluid fill tube and bolt to the accelerator control cable bracket. **Tighten:** Tighten the transmission fluid fill tube bolt 6 N.m (53 lb in).
18. Install the water pump inlet hose to the intake manifold.

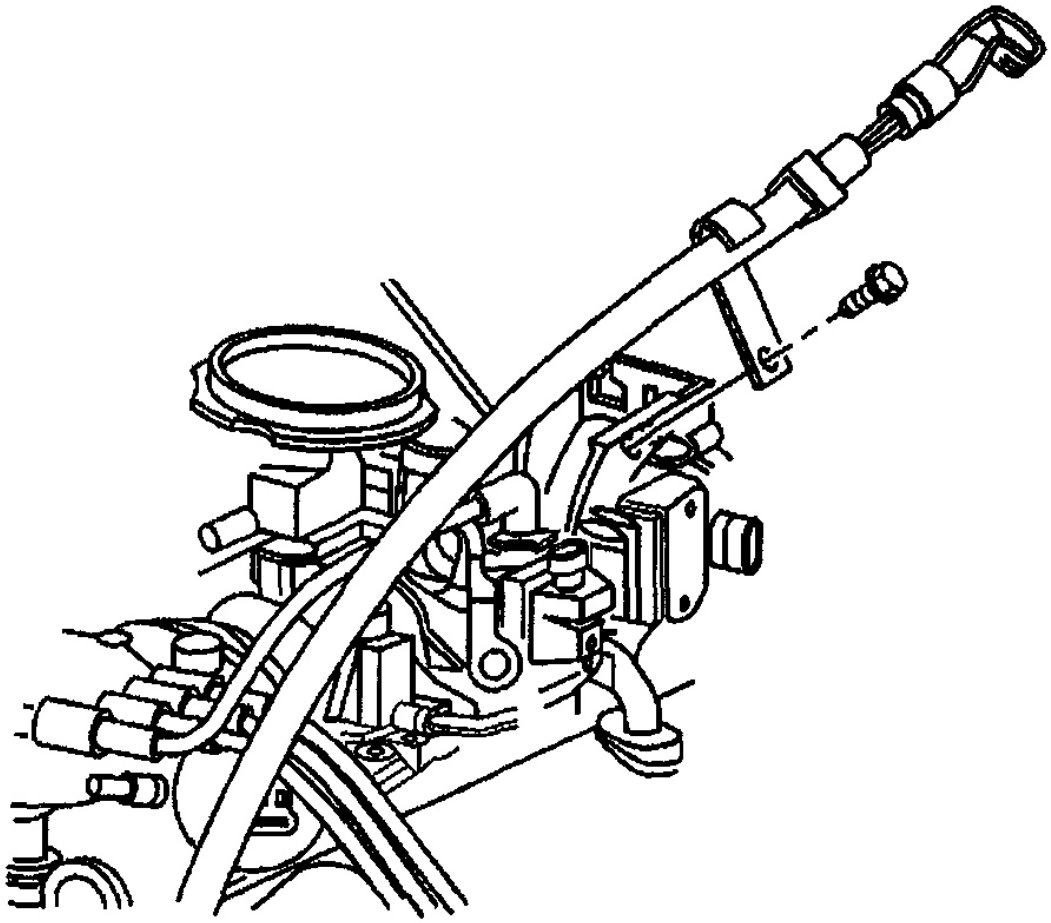

Fig. 101: Installing Transmission Fluid Filler Tube Bolt At Accelerator Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

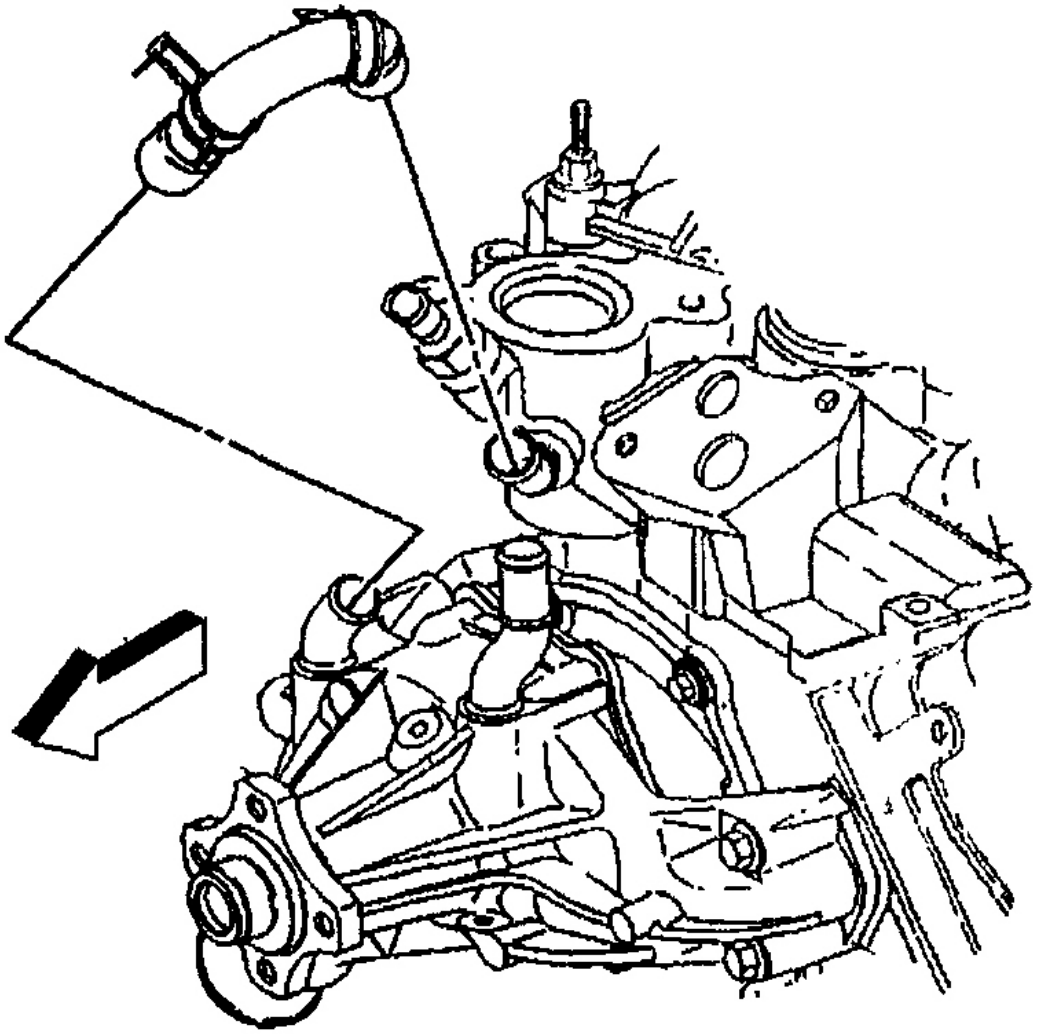

Fig. 102: Installing Coolant By-Pass Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

19. Install the heater hoses.
20. Install the radiator inlet hose to the water outlet.
21. Position the engine wiring harness.

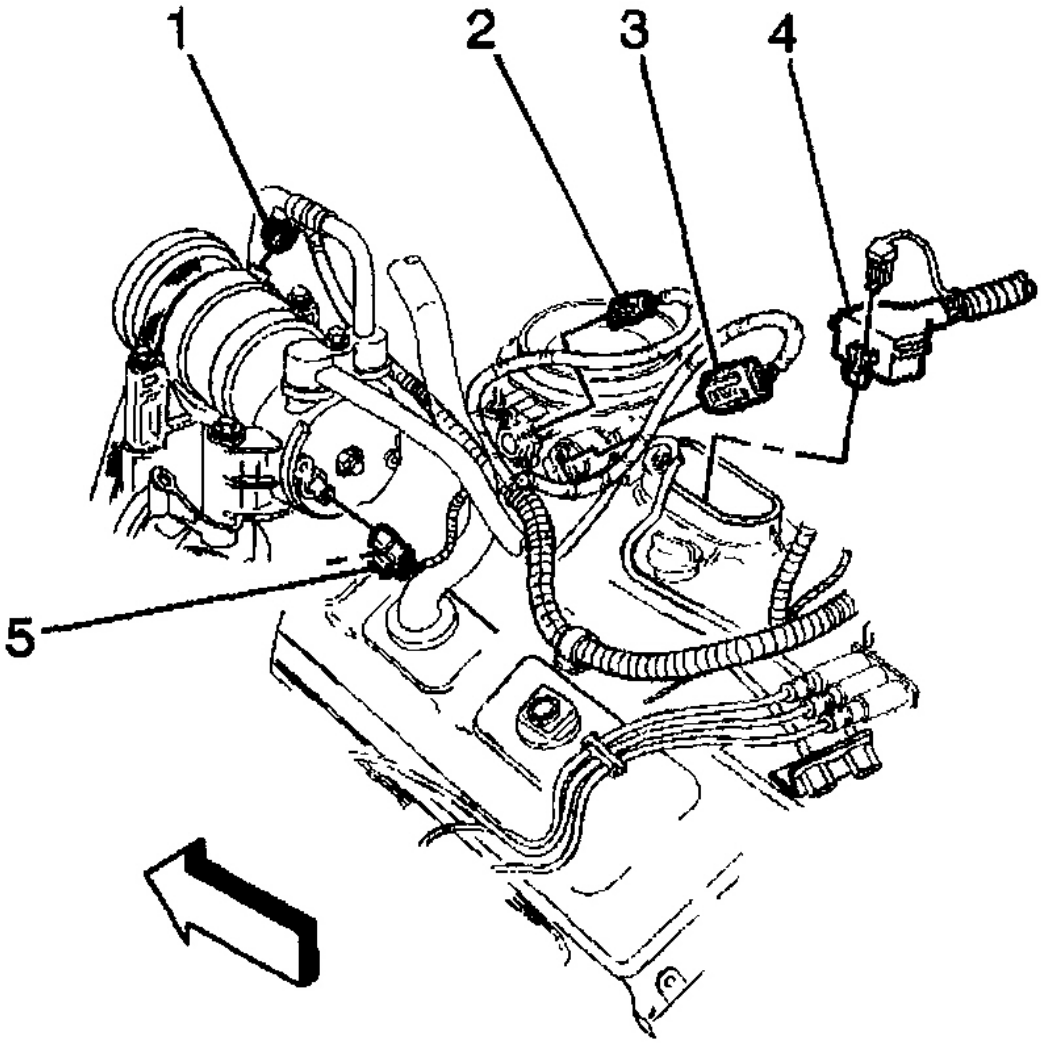

Fig. 103: Connecting A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position Sensor, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

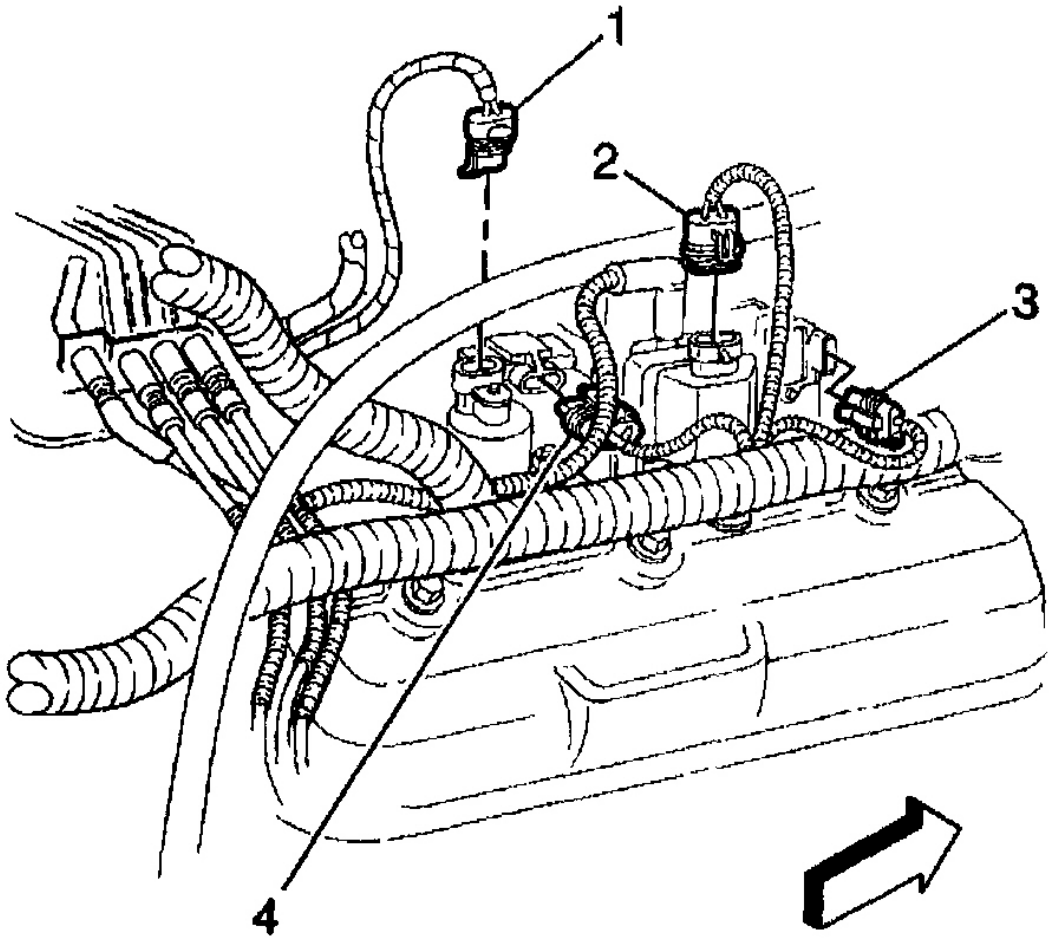

Fig. 104: Connecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

22. Connect the following electrical connectors:
    - The A/C compressor clutch, if equipped (1)
    - The A/C high pressure cutoff switch, if equipped (5)
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)
    - The fuel meter body assembly connector (4)
23. Connect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)

24. Install the ground wire (2) and the nut to the water outlet stud. **Tighten:** Tighten the ground wire nut to 19 N.m (14 lb ft).

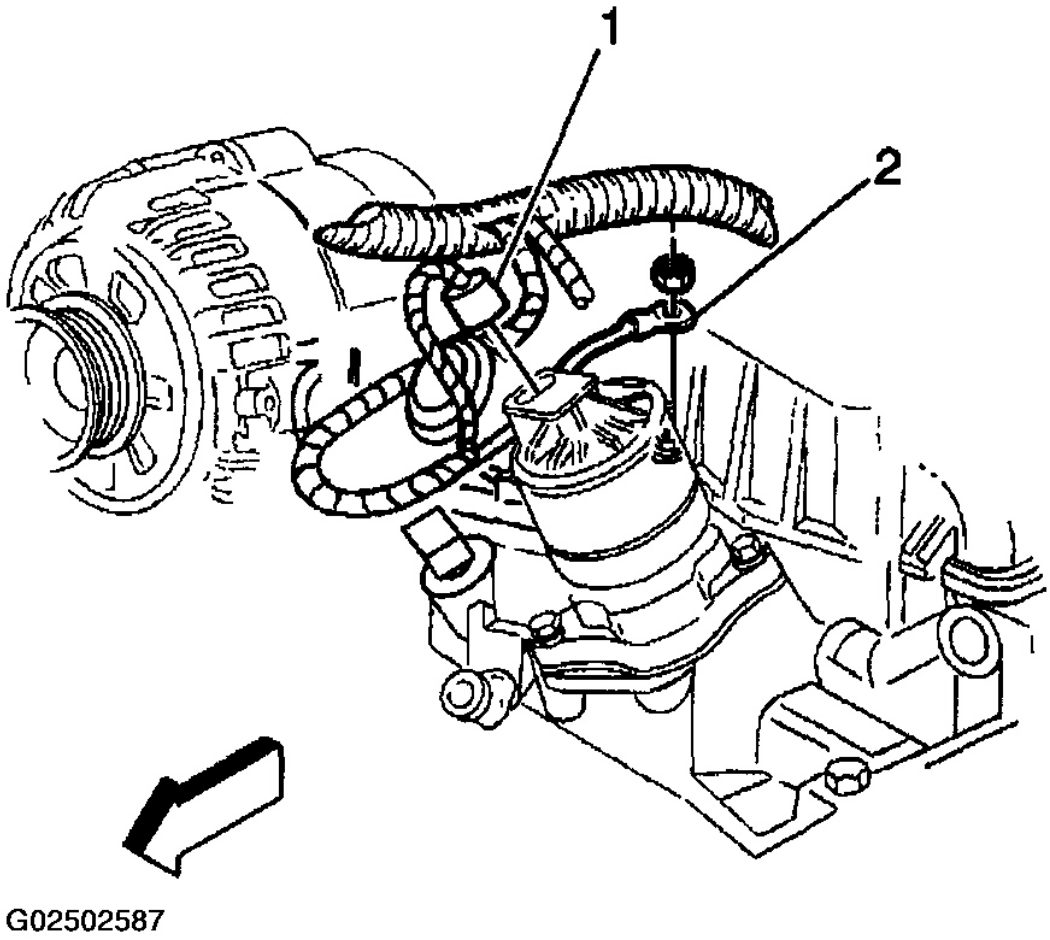

Fig. 105: Locating Ground Wire At Water Outlet
Courtesy of GENERAL MOTORS CORP.

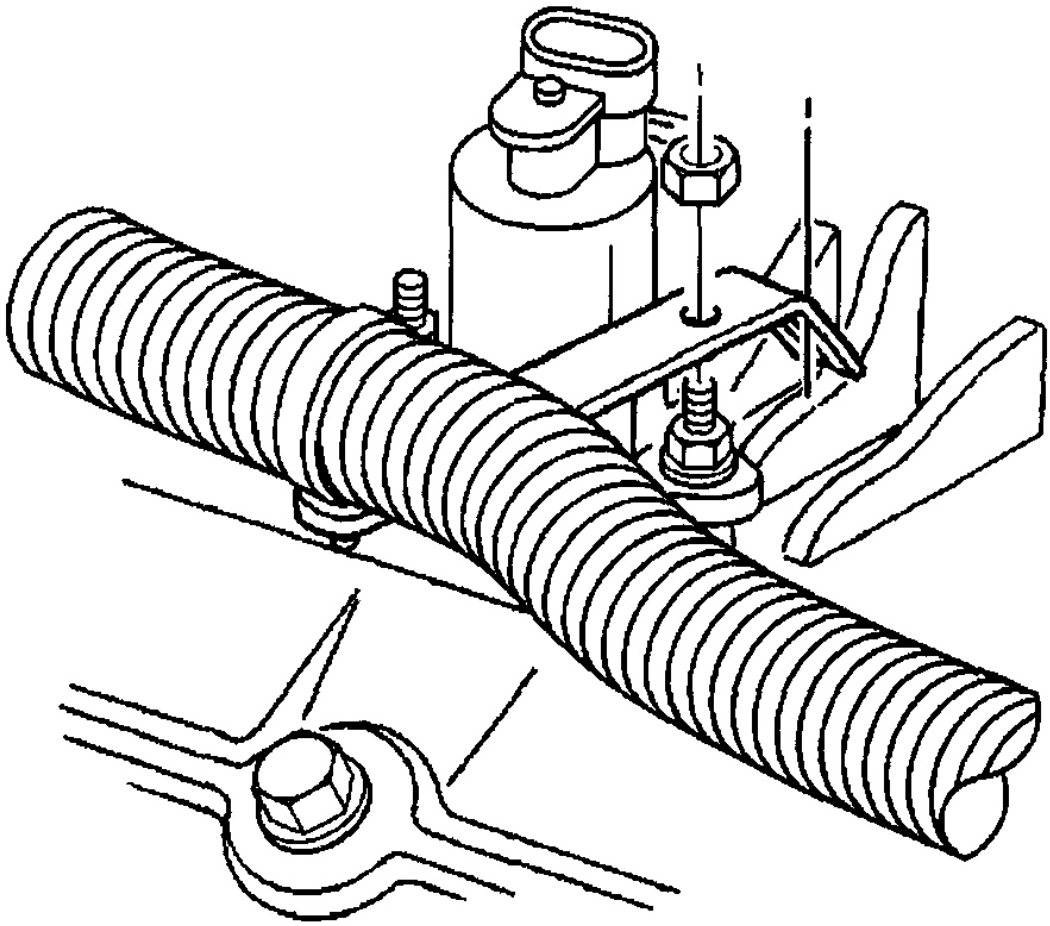

Fig. 106: Installing Engine Harness Bracket To EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

25. Install the nut and the engine wiring harness bracket to the stud for the EVAP canister purge valve. **Tighten:** Tighten the engine wiring harness bracket nut to 8 N.m (71 lb in).
26. Install the nut and the engine wiring harness bracket to the intake manifold stud. **Tighten:** Tighten the engine wiring harness bracket nut to 12 N.m (106 lb in).
27. Install the nut and the A/C hose bracket to the intake manifold stud, if equipped. **Tighten:** Tighten the A/C hose bracket nut to 5 N.m (44 lb in).

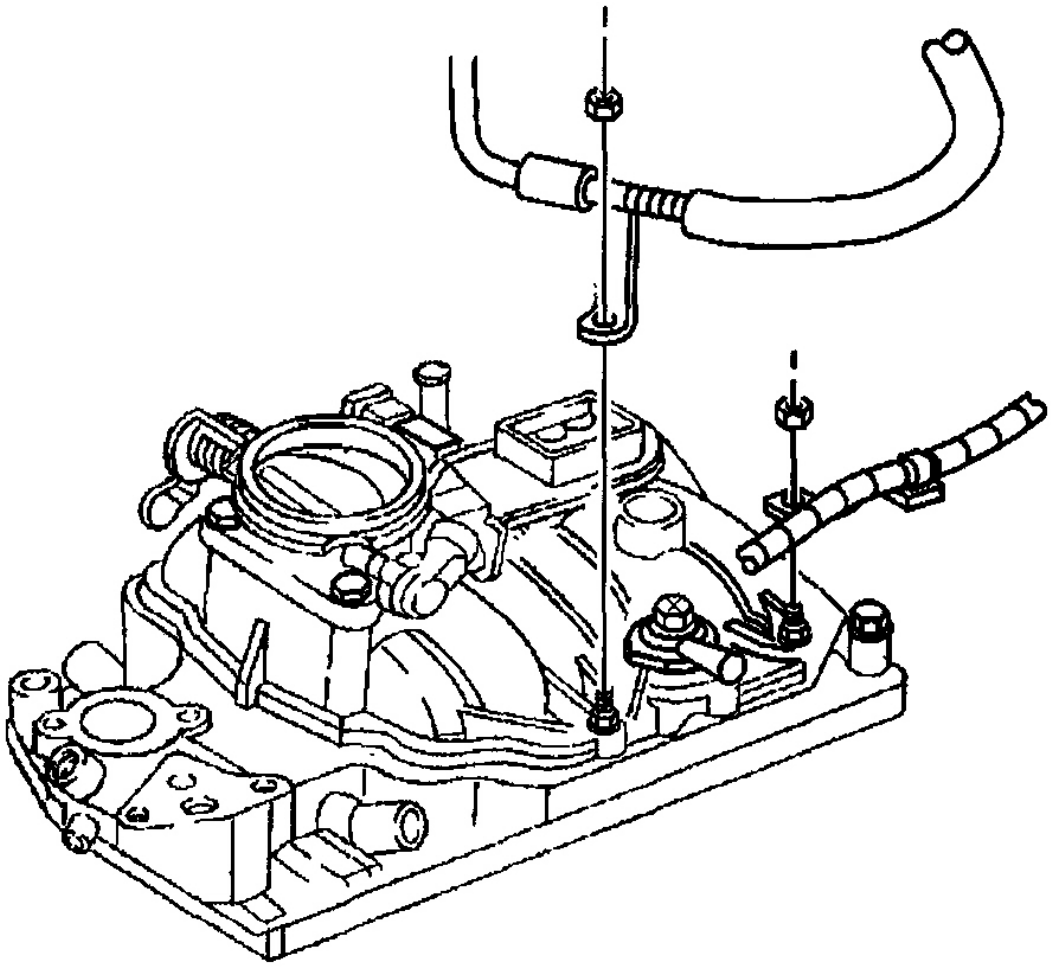

Fig. 107: Installing A/C Hose Bracket & Engine Wiring Harness Bracket At Intake Manifold
Courtesy of GENERAL MOTORS CORP.

28. Install the PCV valve hose assembly to the intake manifold and the valve rocker arm cover.
29. Install the cruise control cable, if equipped to the throttle shaft and the accelerator control cable bracket.
30. Install the accelerator control cable to the throttle shaft and the accelerator control cable bracket.
31. Refill the cooling system.
32. Install air cleaner outlet duct to the throttle body.
33. Install the air cleaner assembly.
34. Connect the battery negative cable.
35. Install the engine cover.

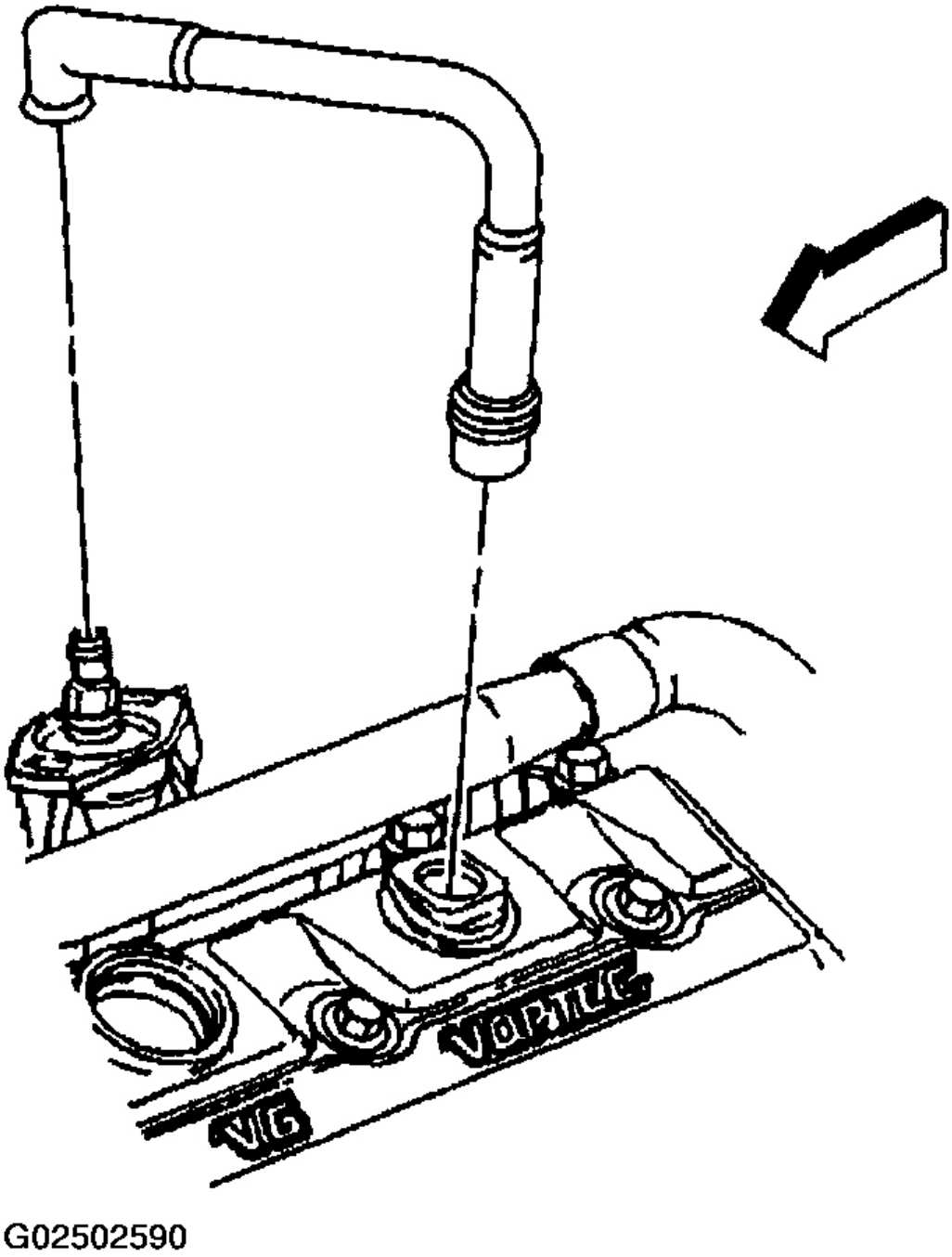

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Fig. 108: Installing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM COVER REPLACEMENT - LEFT

Removal Procedure

1. Remove the engine cover.
2. Remove the oil filler tube and bolt.

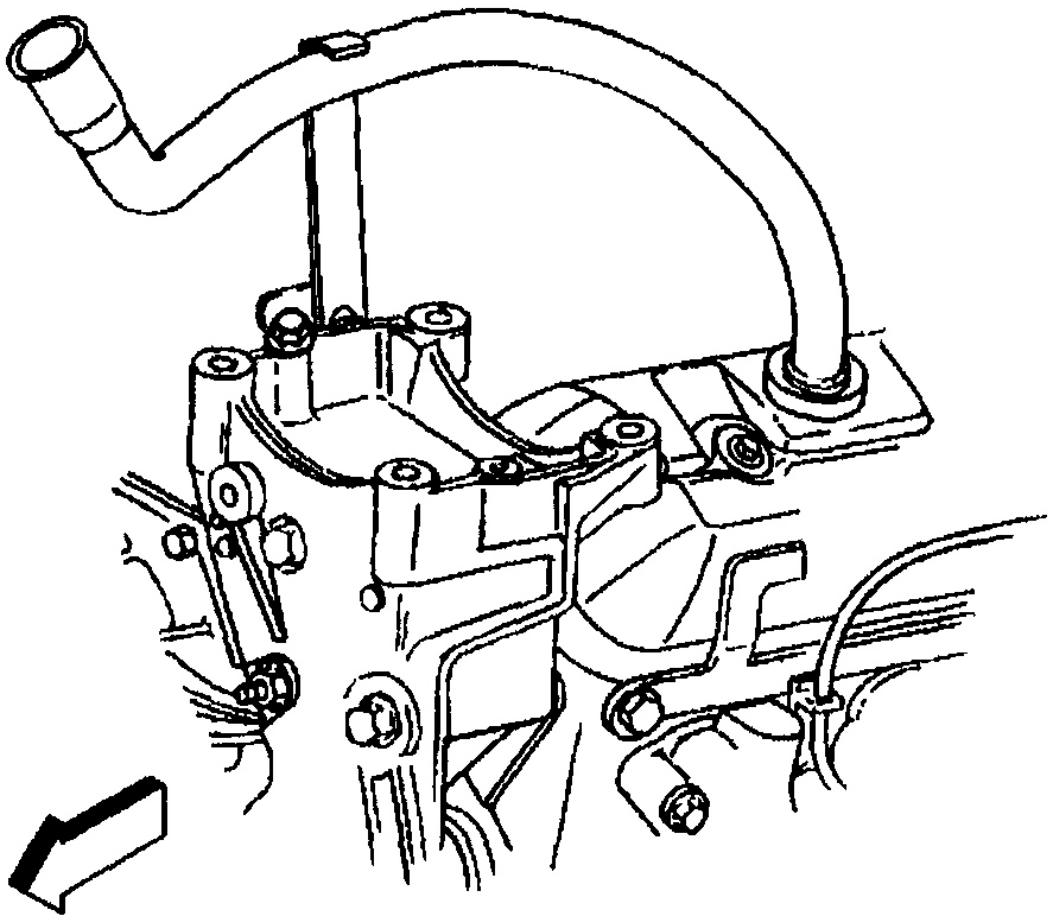

Fig. 109: Removing Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

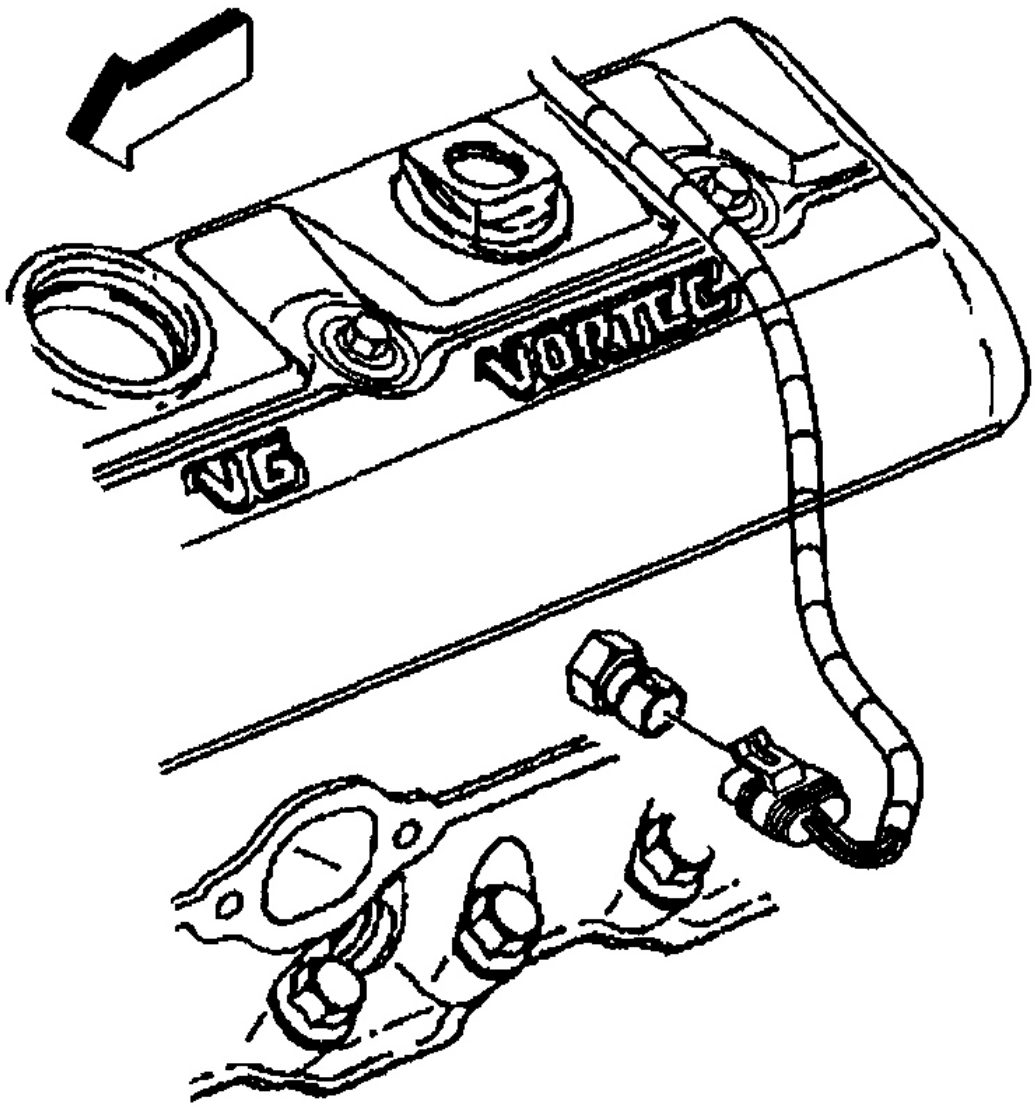

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Fig. 110: Disconnecting Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

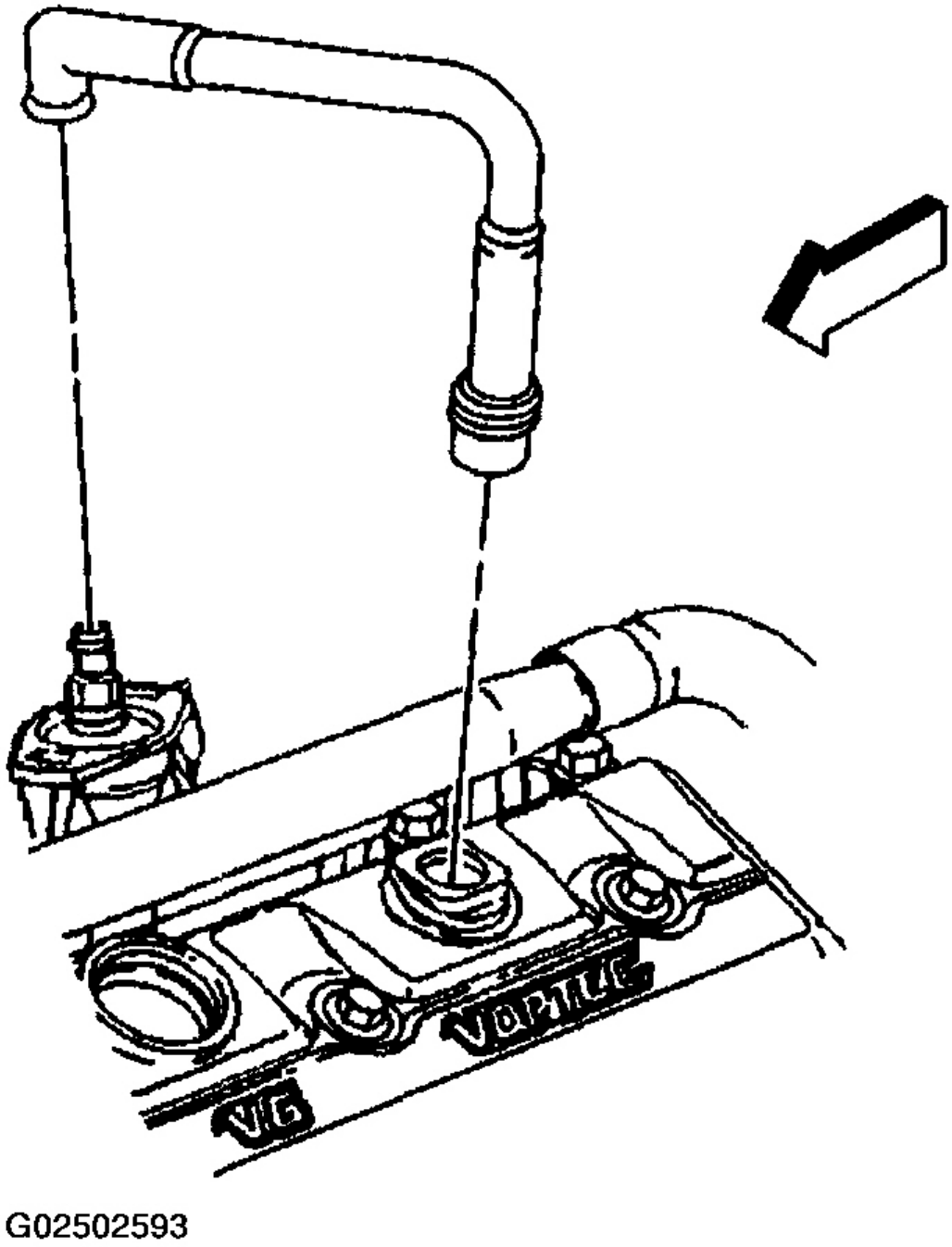

Fig. 111: Removing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

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

4. Remove the PCV valve hose assembly from the intake manifold and the valve rocker arm cover.
5. Remove the rear spark plug wire retainer from the support.
6. Remove the valve rocker arm cover.
7. Clean all sealing surfaces and the valve rocker arm cover.

Installation Procedure

1. Install the valve rocker arm cover and bolts.
2. Install the PCV valve hose assembly to the intake manifold and in the valve rocker arm cover.

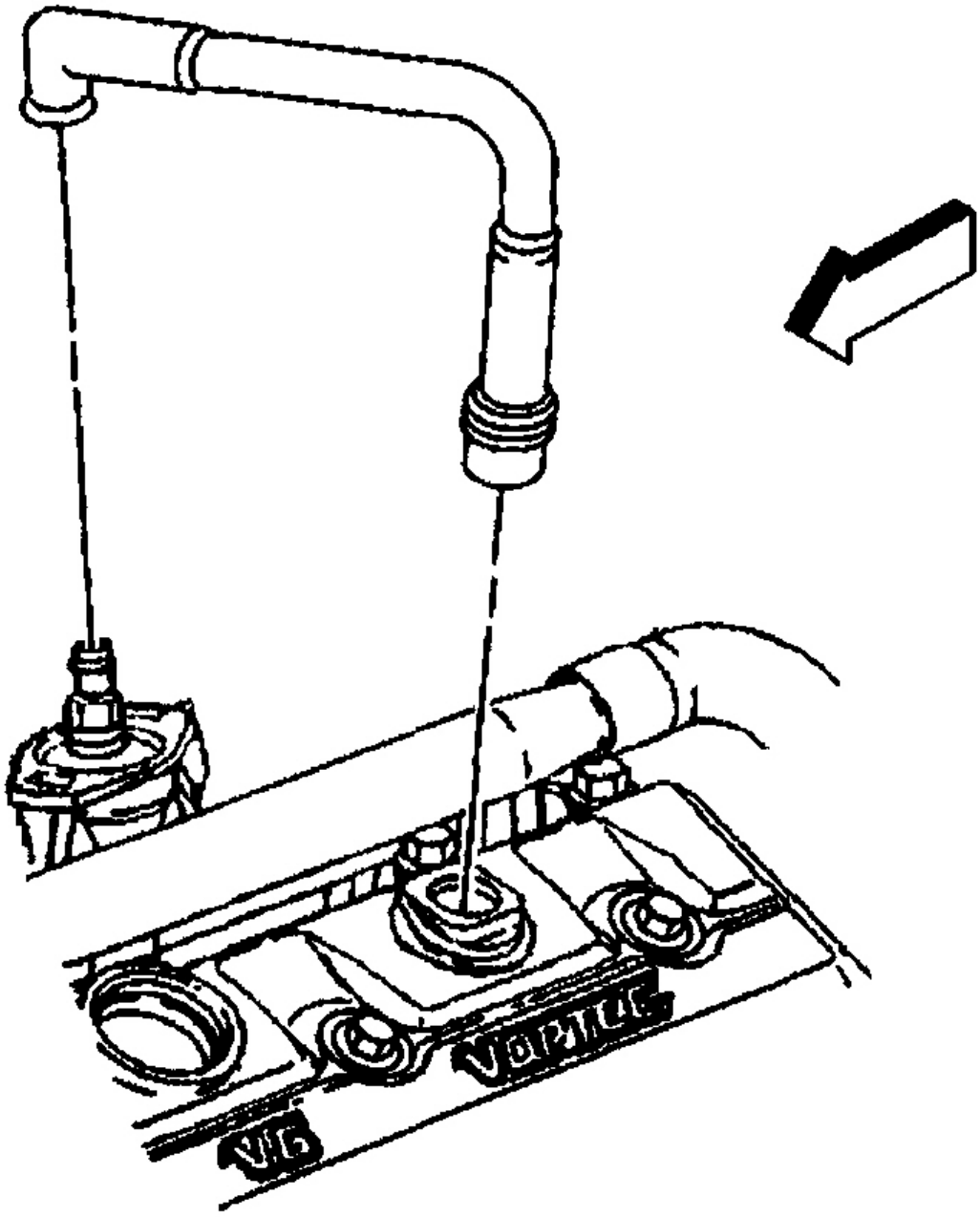

Fig. 112: Installing PCV Valve Hose Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the rear spark plug wire retainer to the support.

4. Install the oil filler tube and bolt. **Tighten:** Tighten the bolt to 25 N.m (18 lb ft).
5. Connect the ECT sensor electrical connector.
6. Install the engine cover.

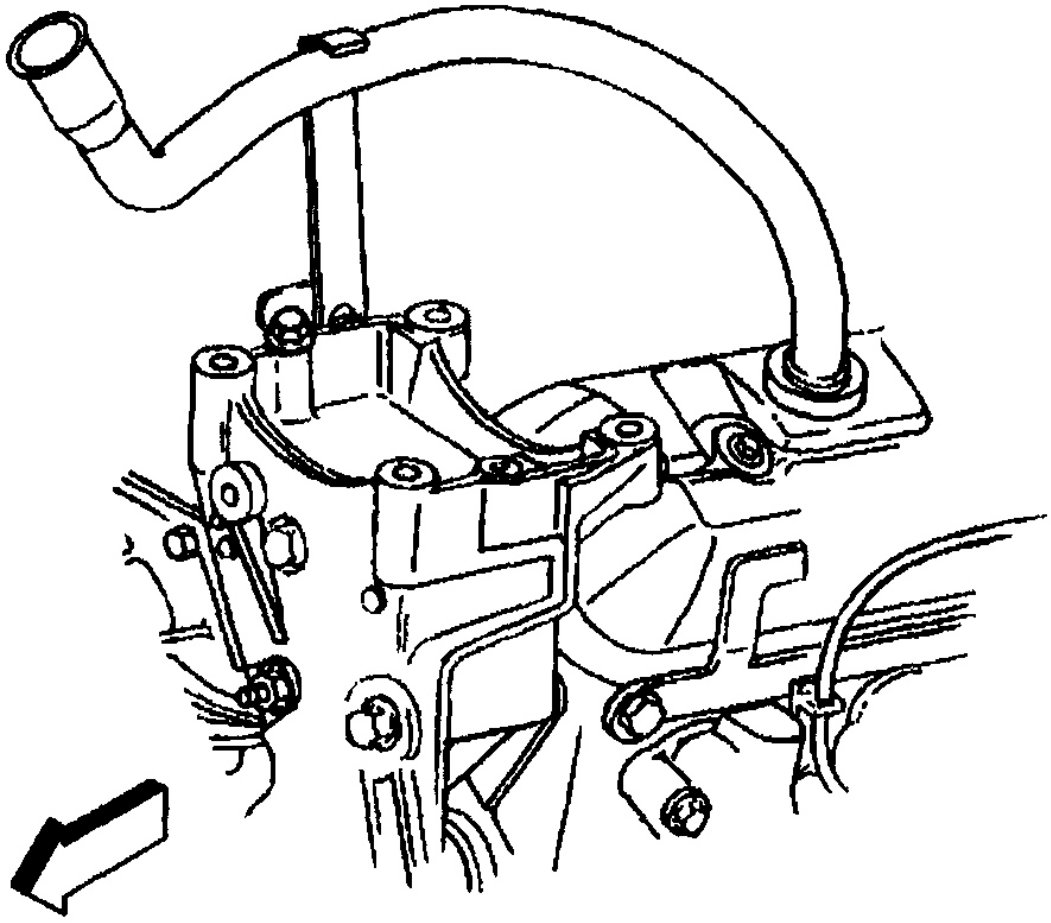

Fig. 113: Installing Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

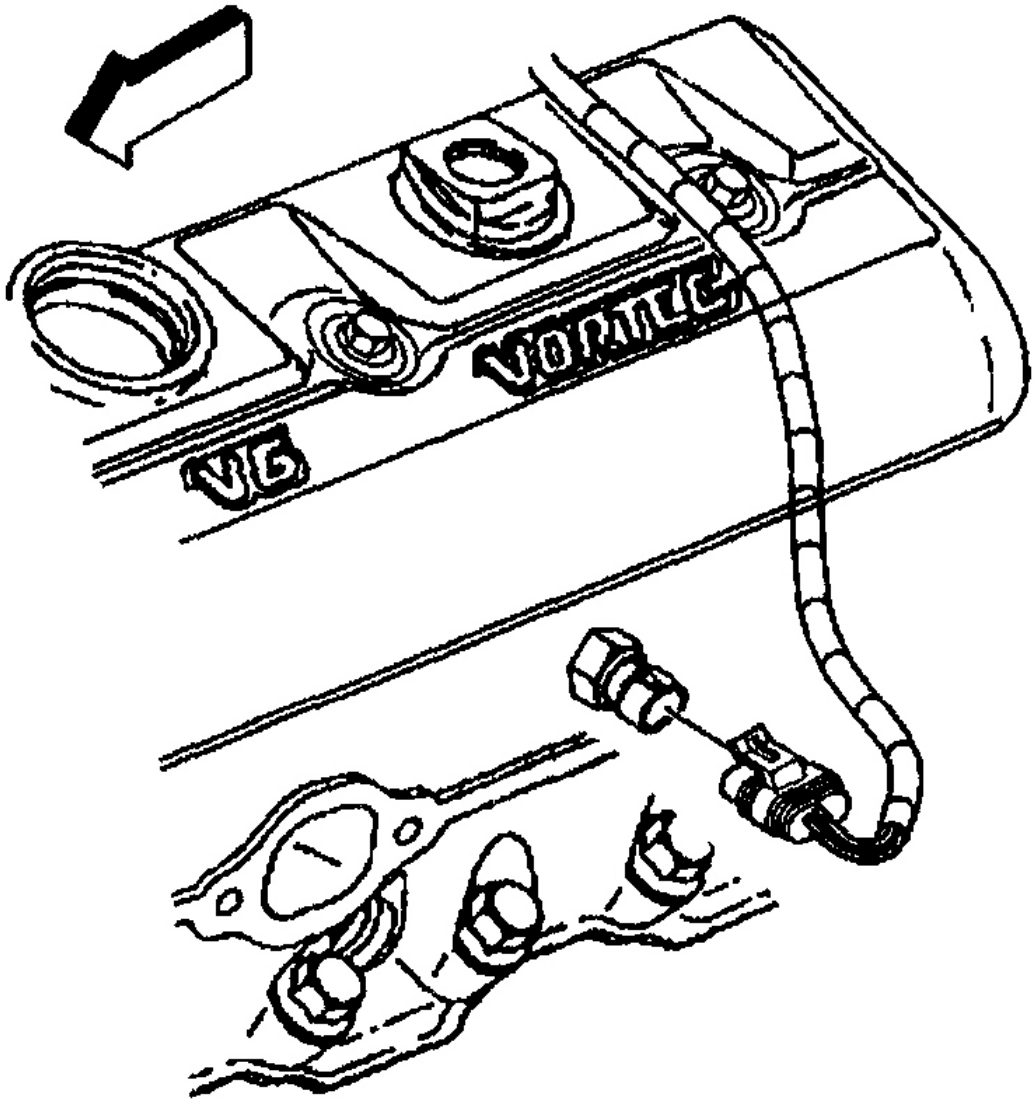

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Fig. 114: Connecting Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT

Removal Procedure

1. Remove the engine cover.
2. Disconnect the spark plug wires for the right side of the engine from the distributor cap.

3. Remove the PCV tube from the valve rocker arm cover and the air cleaner outlet duct.

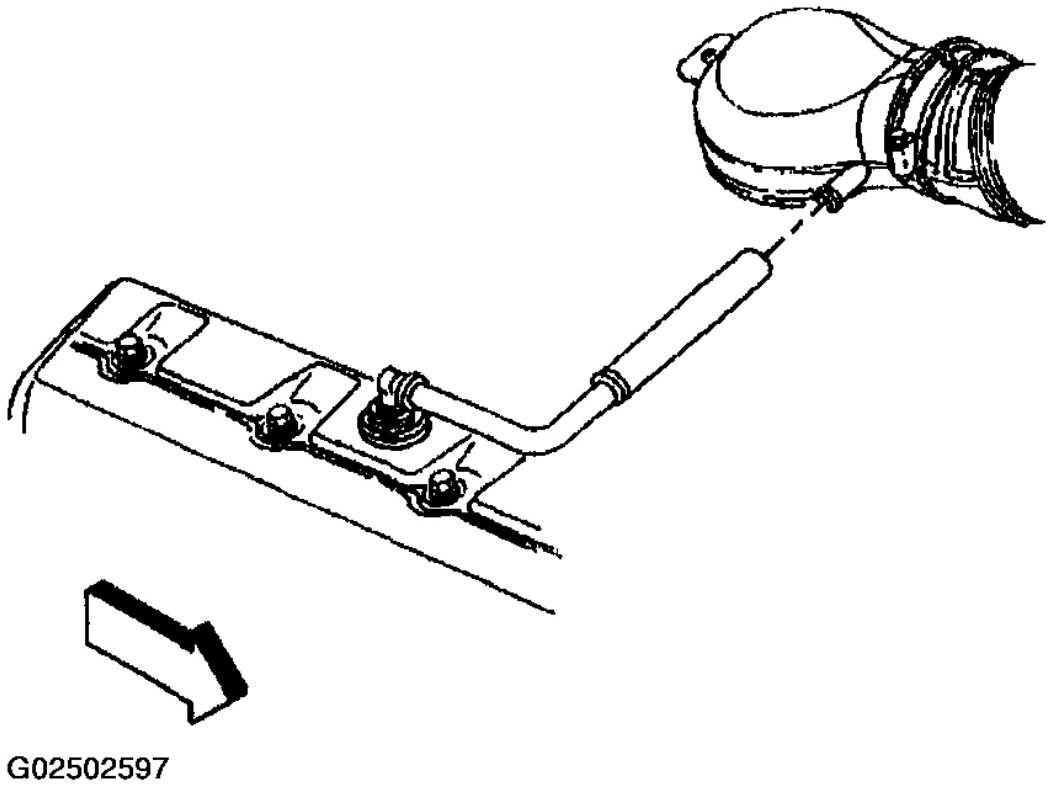

Fig. 115: Locating PCV Tube At Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

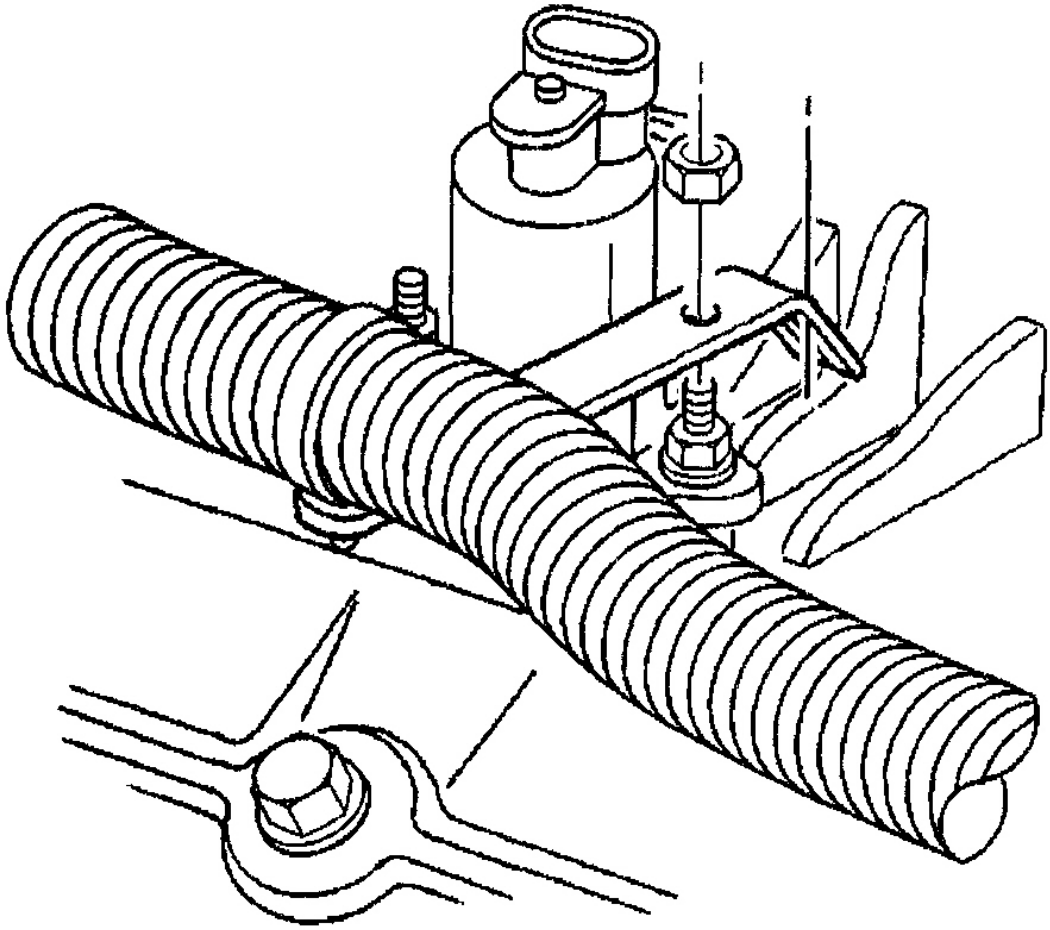

Fig. 116: Removing Engine Harness Bracket From EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine wiring harness bracket from the EVAP canister purge solenoid valve stud.
5. Move the engine wiring harness aside.
6. Remove the right valve rocker arm cover.
7. Clean all sealing surfaces and the valve rocker arm cover.

Installation Procedure

1. Install the right valve rocker arm cover and bolts.
2. Install the engine wiring harness bracket and nut to EVAP canister purge solenoid valve stud. **Tighten:** Tighten the engine wiring harness bracket nut to 8 N.m (71 lb in).

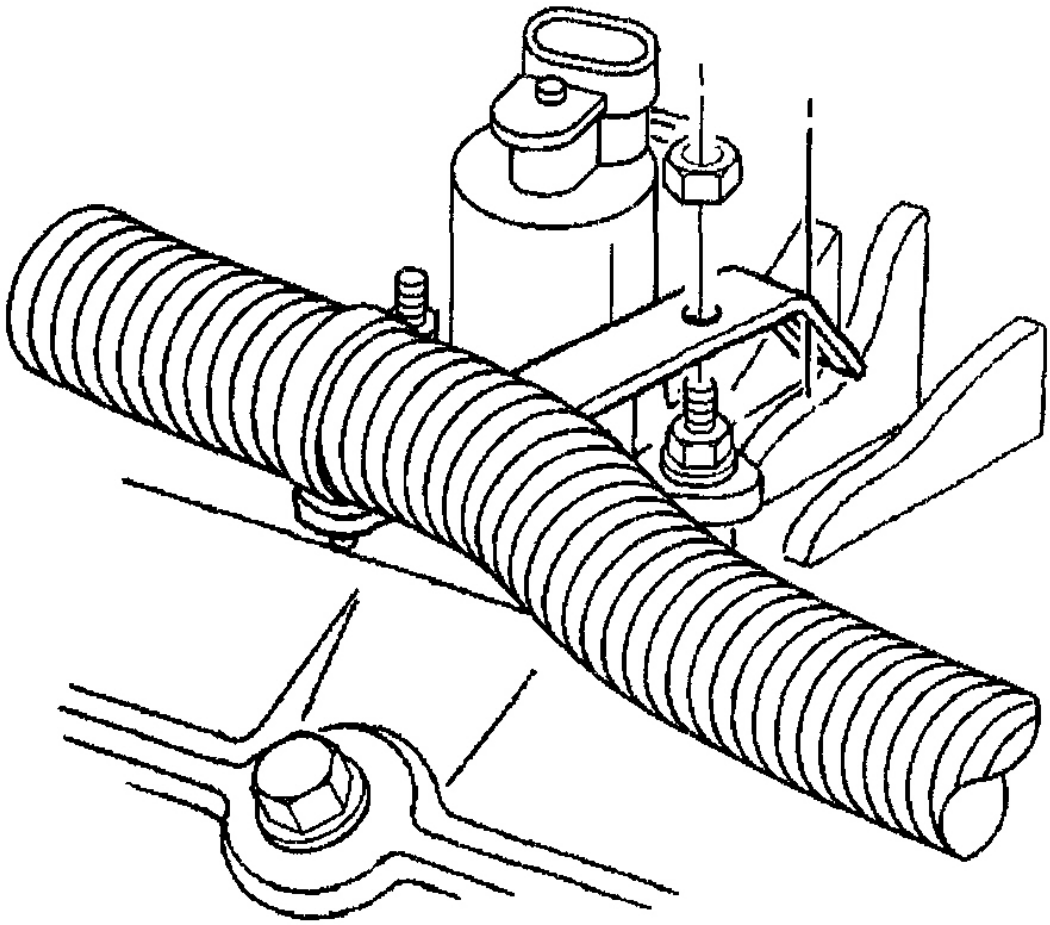

Fig. 117: Installing Engine Harness Bracket To EVAP Canister Purge Solenoid Valve Stud
Courtesy of GENERAL MOTORS CORP.

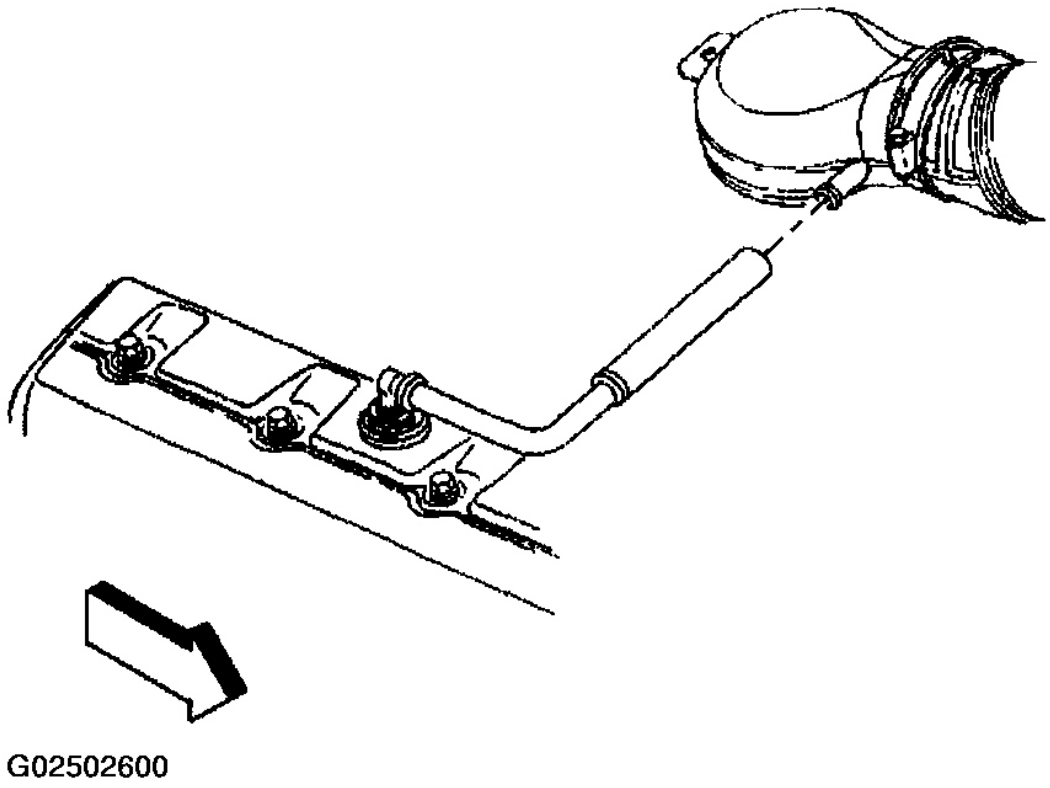

Fig. 118: Locating PCV Tube At Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS CORP.

3. Install the PCV hose in the valve rocker arm cover and the air cleaner outlet duct.
4. Connect the spark plug wires to the distributor cap.
5. Install the engine cover.

VALVE ROCKER ARM & PUSH ROD REPLACEMENT

Removal Procedure

1. Remove the valve rocker arm cover.
   - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - RIGHT**.
   - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - LEFT**.
2. Remove the valve rocker arm and the valve pushrod.
3. Clean and inspect the valve rocker arm and the valve pushrod.

Installation Procedure

1. Install the valve rocker arm and the valve pushrod.
2. Install the valve rocker arm cover.
    - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - LEFT**.
    - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - RIGHT**.

VALVE STEM OIL SEAL & VALVE SPRING REPLACEMENT

Tools Required:

- **J 22794:** Spark Plug Port Adapter
- **J 38606:** Valve Spring Compressor
- **J 5892-D:** Valve Spring Compressor

Removal Procedure

1. Remove the valve rocker arm cover.
    - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - LEFT**.
    - Refer to **VALVE ROCKER ARM COVER REPLACEMENT - RIGHT**.
2. Remove the required valve rocker arms. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
3. Remove the required spark plugs.
4. Install the J 22794 into the spark plug hole.

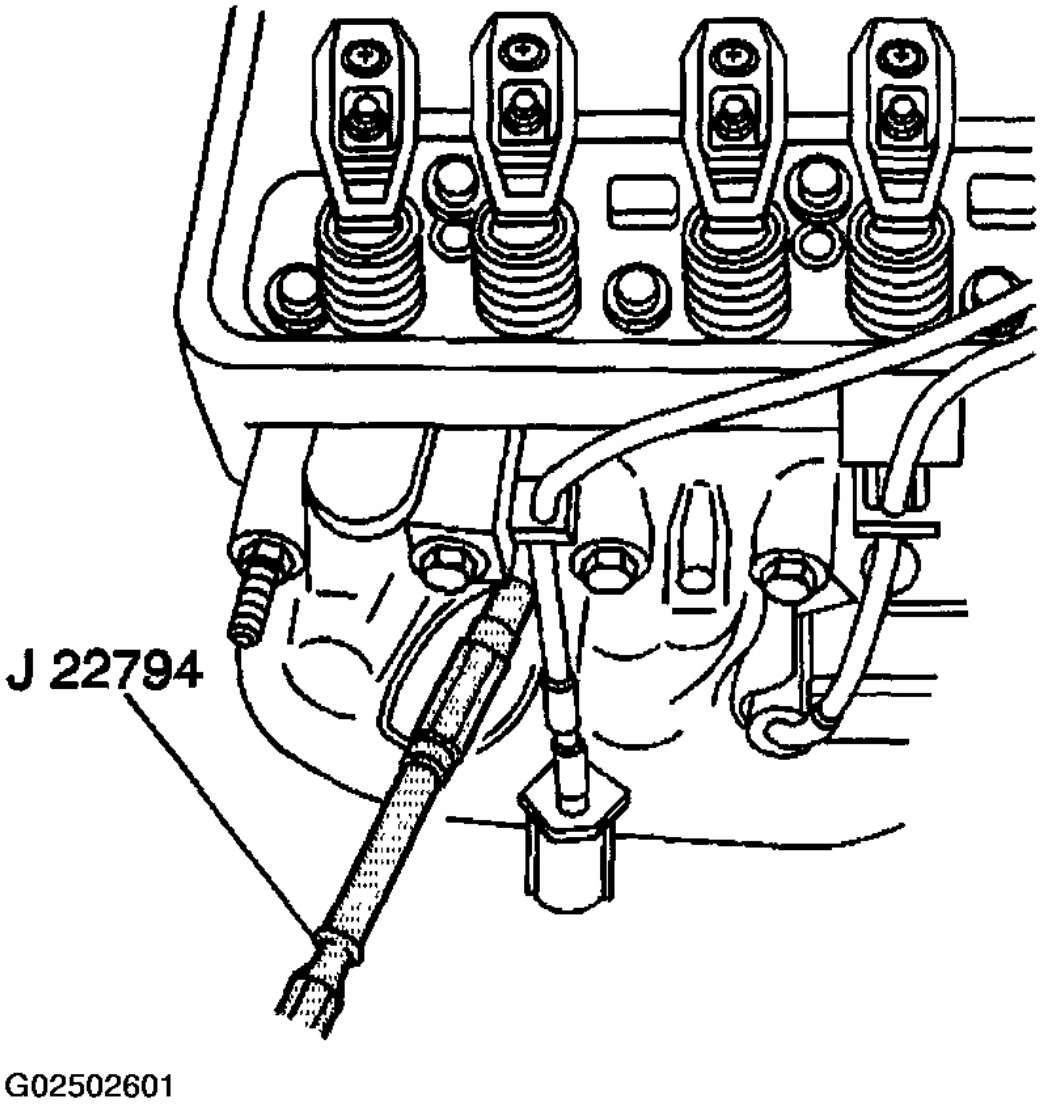

Fig. 119: Installing Spark Plug Port Adapter (J 22794)
Courtesy of GENERAL MOTORS CORP.

5. Connect a shop air supply hose and apply compressed air in order to hold the valves in place.
6. Remove a bolt from a valve rocker arm.
7. Install a flat washer on the bolt.
8. 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.

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

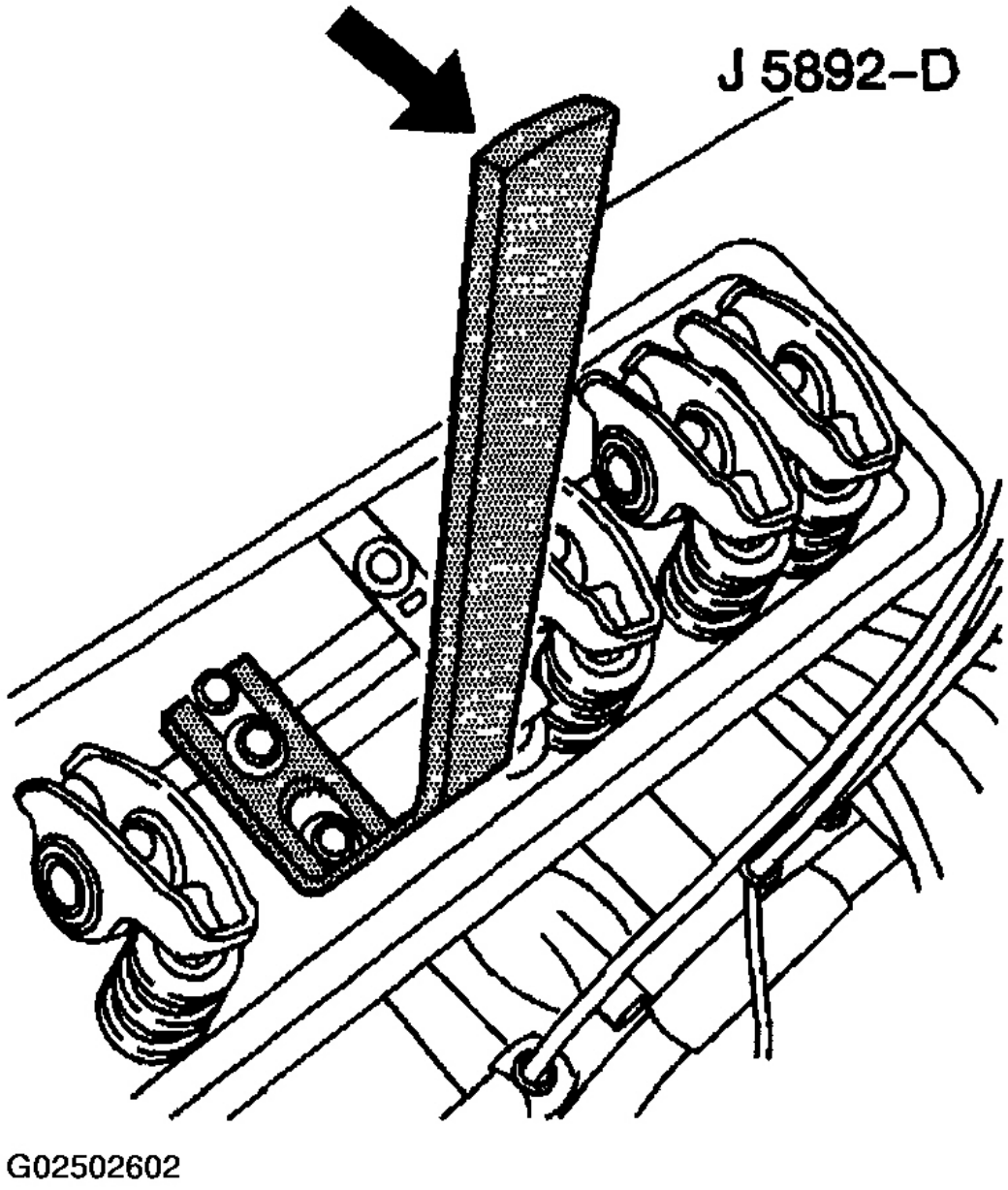

Fig. 120: Installing Valve Spring Compressor (J 5892-D)
Courtesy of GENERAL MOTORS CORP.

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 J 38606 when J 5892-D will not fit.

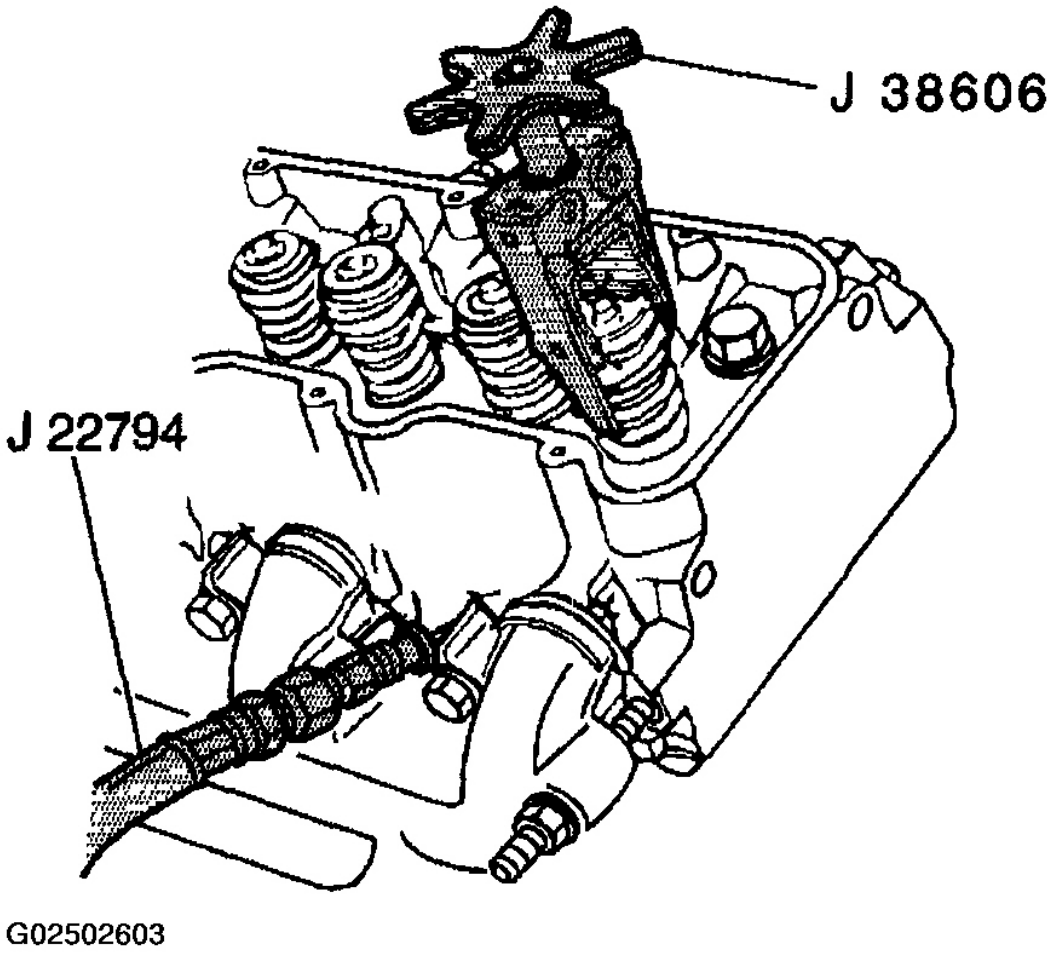

Fig. 121: Installing Valve Spring Compressor (J 38606)
Courtesy of GENERAL MOTORS CORP.

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

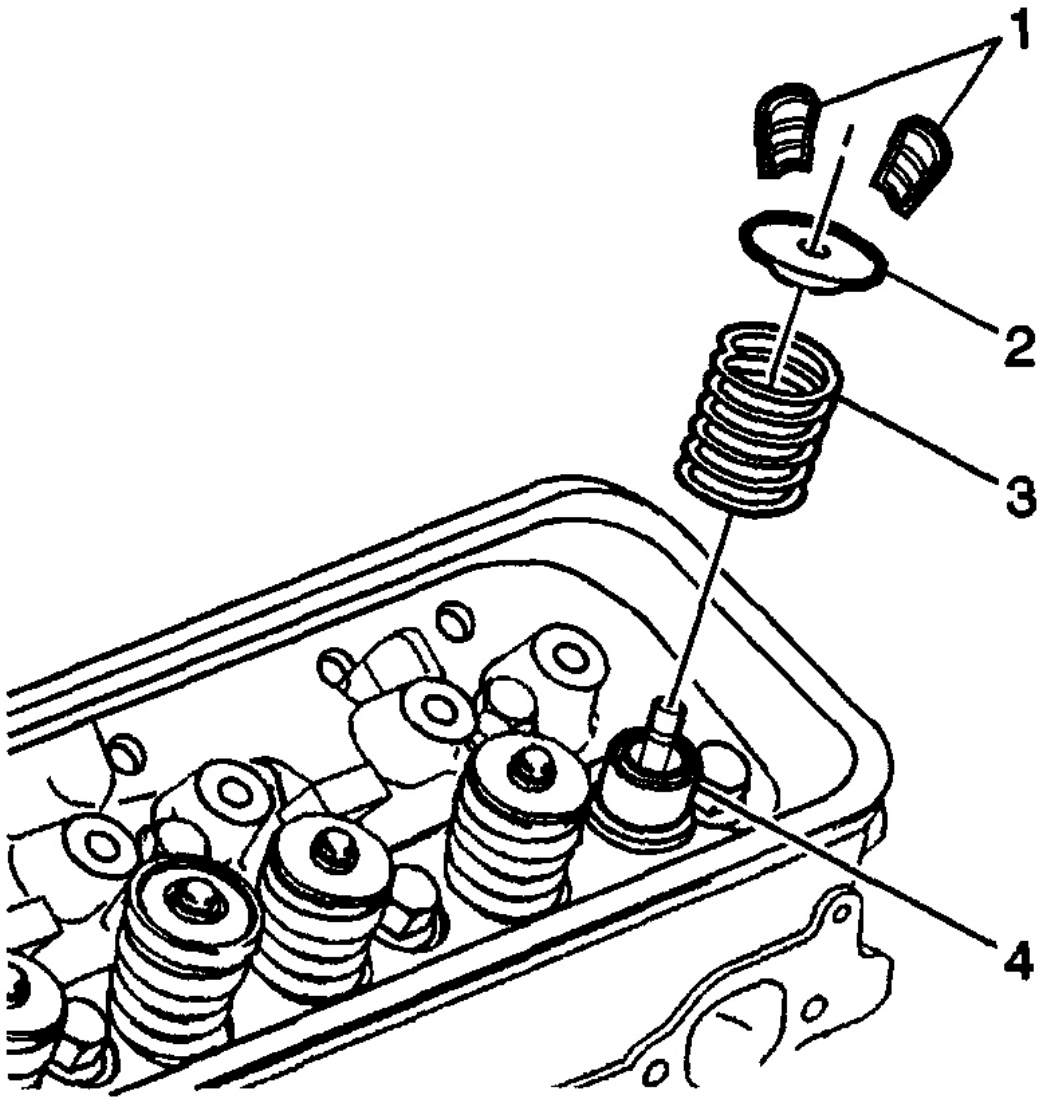

Fig. 122: Removing Valve Spring & Components
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the valve seals (4).
2. Install the valve spring (3).
3. Install the valve spring cap (2) on the valve stem.

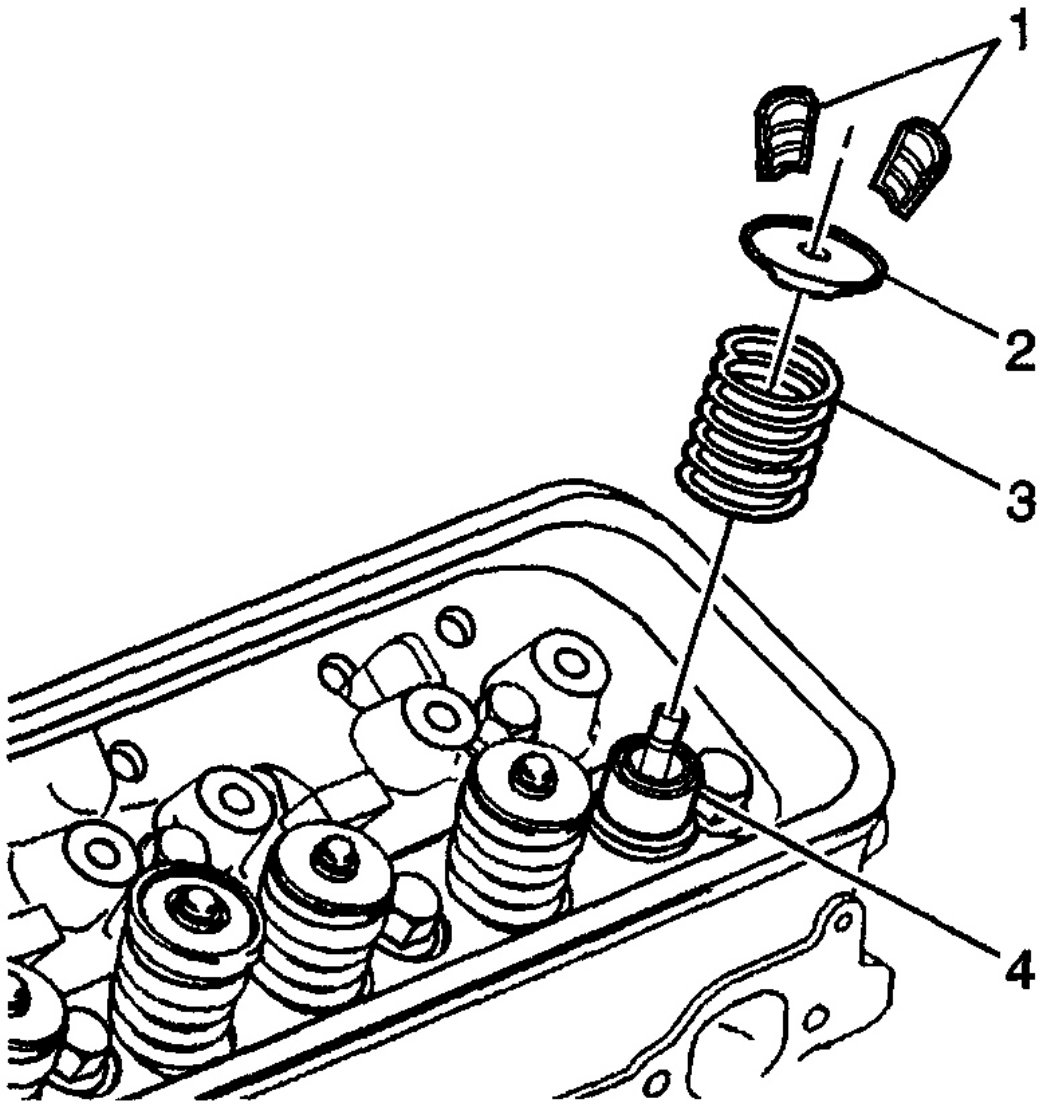

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Fig. 123: Installing Valve Spring & Components
Courtesy of GENERAL MOTORS CORP.

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.

4. To press the valve spring (3) use the J 5892-D.

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.**

5. Use the J 38606 if the clearance does not permit use of the J 5892-D.

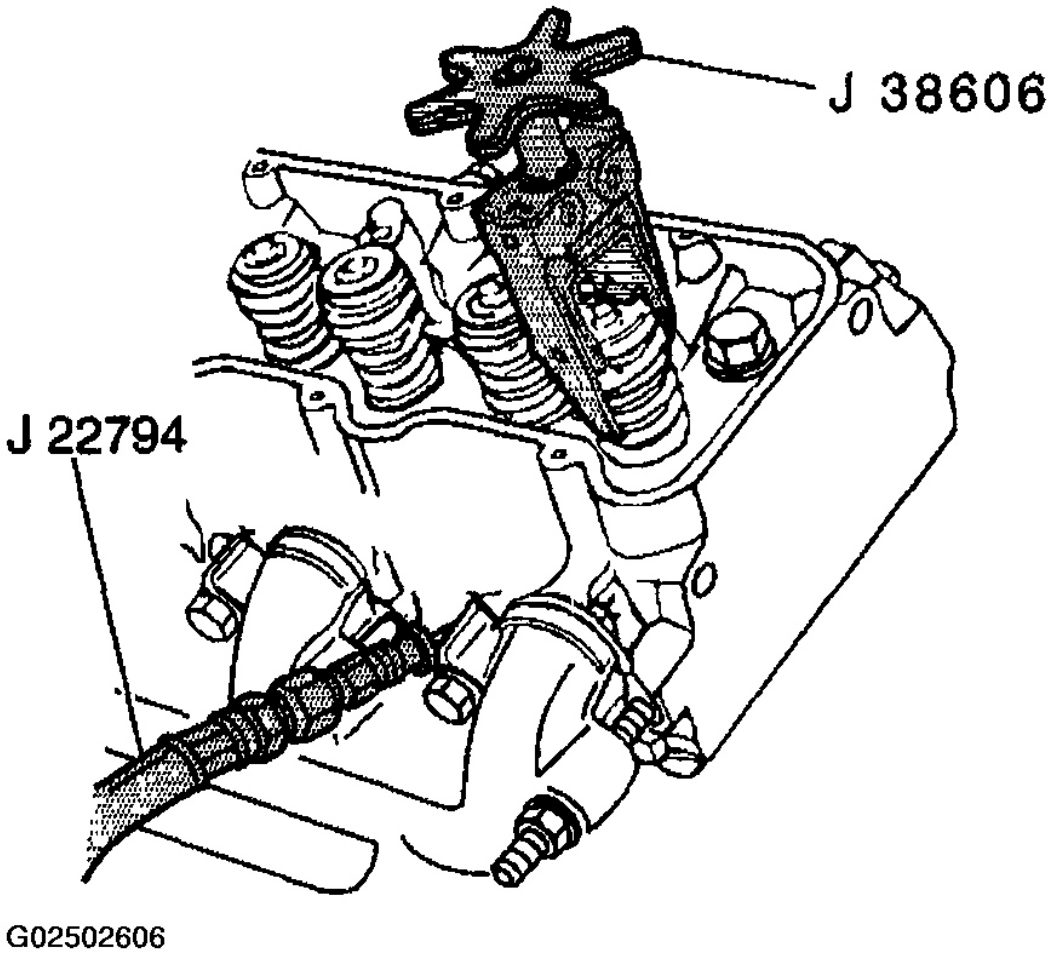

Fig. 124: Installing Valve Spring Compressor (J 38606)
Courtesy of GENERAL MOTORS CORP.

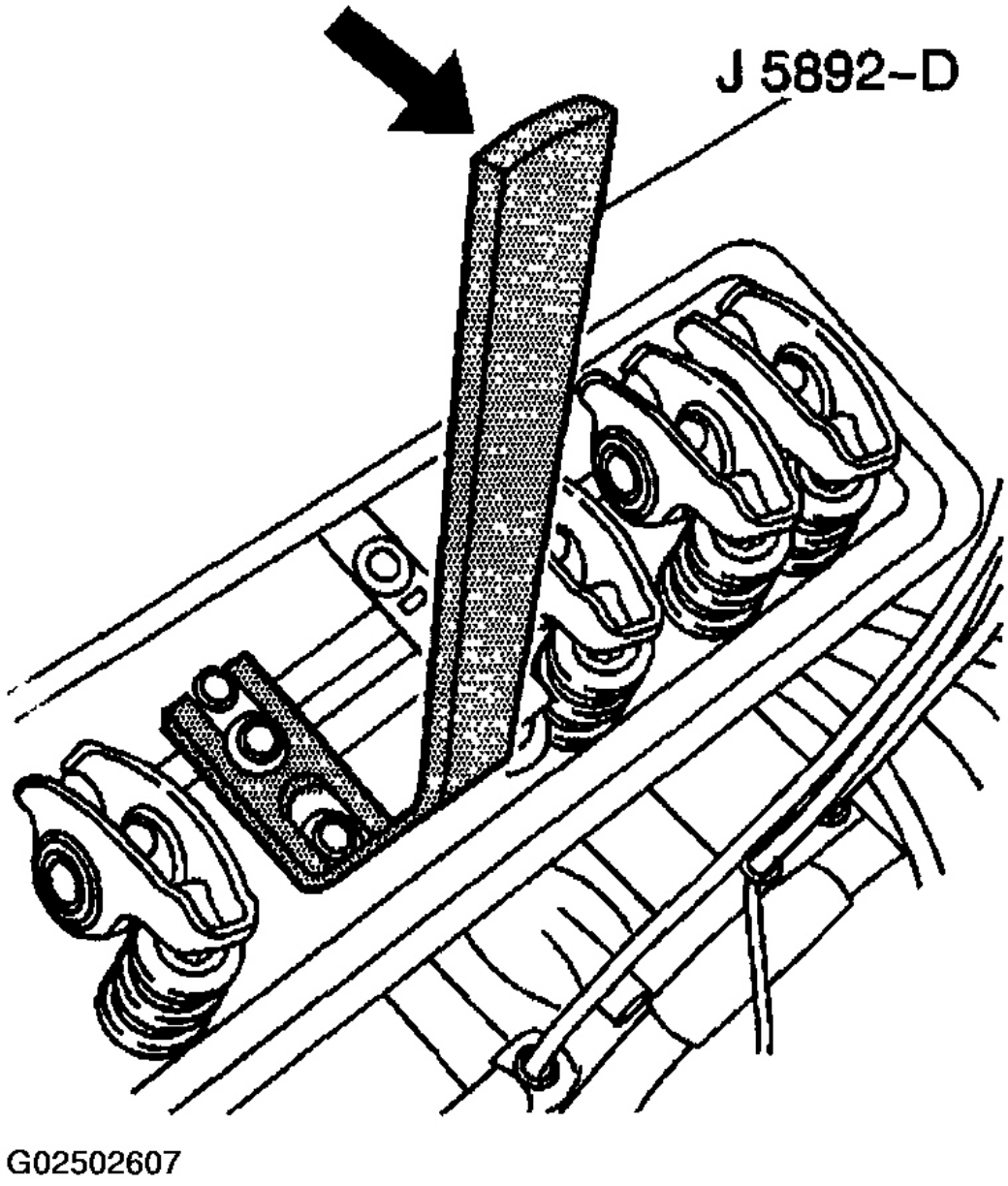

Fig. 125: Installing Valve Spring Compressor (J 5892-D)
Courtesy of GENERAL MOTORS CORP.

6. Install the valve stem keys. Use grease in order to hold the valve stem keys in place.
7. 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.

8. Remove the J 5892-D or the J 38606.
   a. Look to ensure that the valve stem keys seat properly in the upper groove of the valve stem.
   b. Tap the end of the valve stem with a plastic faced hammer in to seat the valve stem keys, if necessary.
9. Remove the J 22794.
10. Install the spark plugs.
11. Install the valve rocker arms to the cylinder head.
12. Install the valve rocker arm cover. Refer to **VALVE ROCKER ARM COVER REPLACEMENT - LEFT** or **VALVE ROCKER ARM COVER REPLACEMENT - RIGHT**.

VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the lower intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.
2. Remove the valve rocker arms and the valve push rods. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
3. Remove the valve lifters.
4. Use a cleaning solvent and a shop towel to clean any varnish from the valve lifter bores.
5. Inspect the valve lifter bores for excessive wear or scoring. Replace the engine block if there is excessive wear or deep scoring.
6. Inspect the camshaft for wear or damage. If the wear is questionable remove the camshaft and inspect.
7. Clean and inspect the valve lifters and the valve pushrod guide.

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.

1. Install the valve lifters.
2. Install the valve rocker arms and push rods. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
3. Install lower intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.

CYLINDER HEAD REPLACEMENT - LEFT

Removal Procedure

1. Disconnect the battery negative cable.
2. Remove the engine cover.

3. Remove the engine cooling fan.
4. Remove the air conditioning compressor, if equipped.
5. Remove the nut holding the power steering pump rear bracket to the engine.

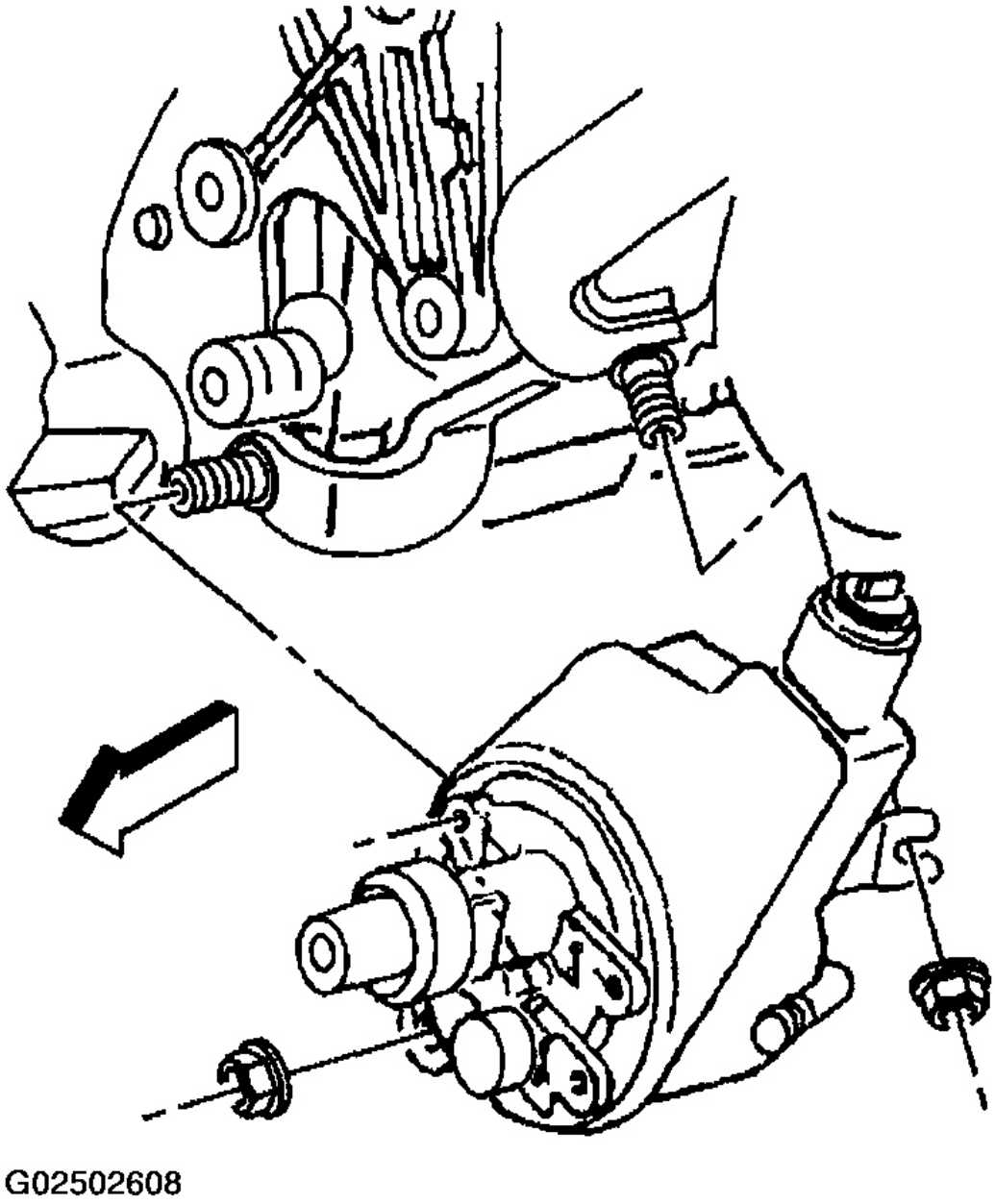

Fig. 126: Removing Power Steering Pump Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The power steering pump can remain on the power steering pump mounting bracket. The pump hoses can remain attached to the pump.

6. Remove the power steering pump mounting bracket and set aside.
7. Remove the power steering pump mounting bracket stud from the cylinder head.

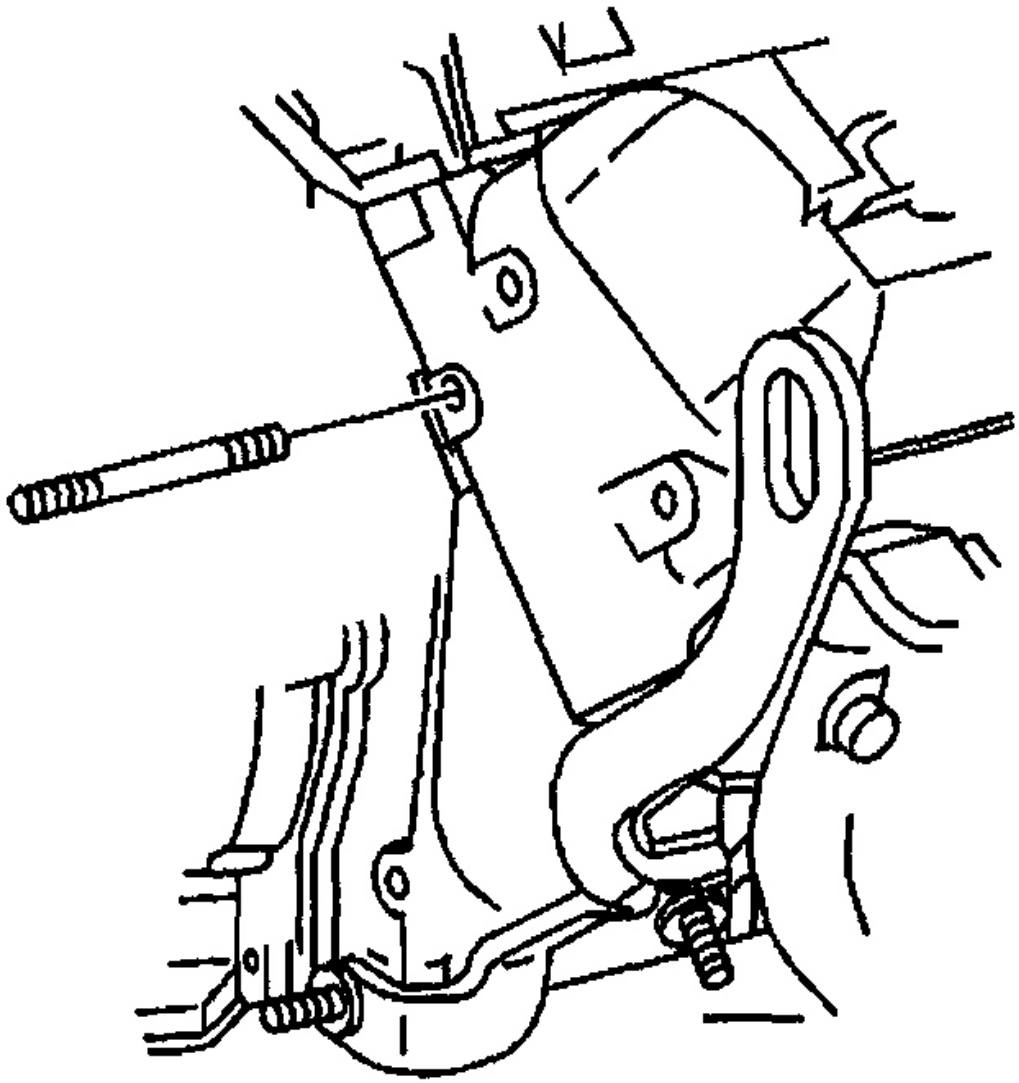

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Fig. 127: Removing Power Steering Pump Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

8. Remove the intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.
9. Remove the exhaust manifold.
10. Remove the ground wires at the rear of the left cylinder head.
11. Remove the A/C pipe bracket nut, if equipped.
12. Remove the fuel pipe bracket bolt at the rear of the cylinder head.

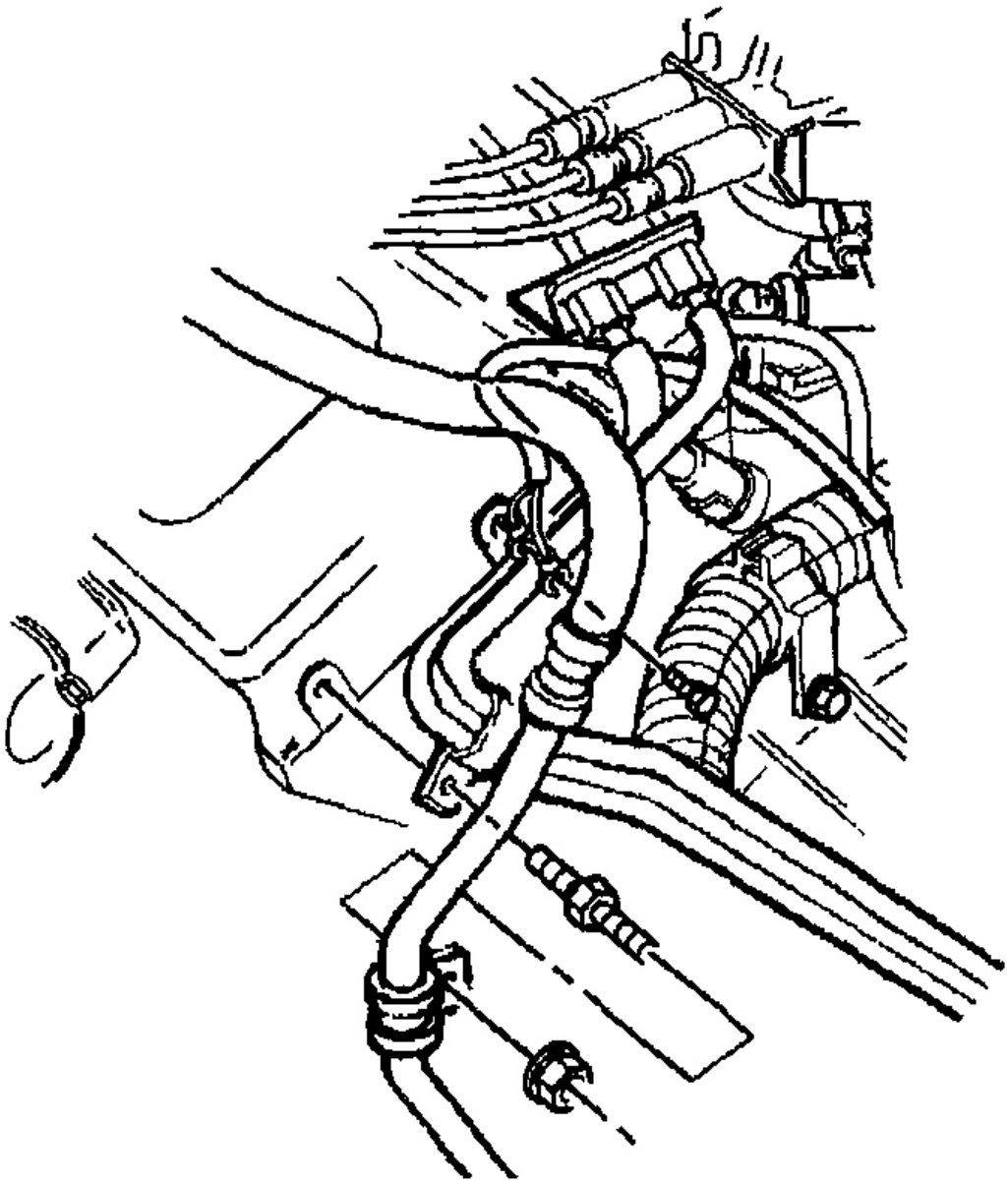

Fig. 128: Locating Ground Wires & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

13. Remove the valve push rods. Refer to **VALVE ROCKER ARM & Push Rod Replacement**.
14. Remove the cylinder head and the gasket.

15. Clean the engine block and the cylinder head sealing surfaces.

NOTE: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

16. Clean the cylinder head bolts and the engine block bolt holes.

Installation Procedure

1. Install the cylinder head.
2. Install the valve push rods. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
3. Install the ground wires and bolt at the rear of the left cylinder head. **Tighten:** Tighten the ground wire bolt to 35 N.m (26 lb ft).
4. Install the fuel pipe bracket and stud at the rear of the cylinder head. **Tighten:** Tighten the fuel pipe bracket stud to 33 N.m (24 lb ft).

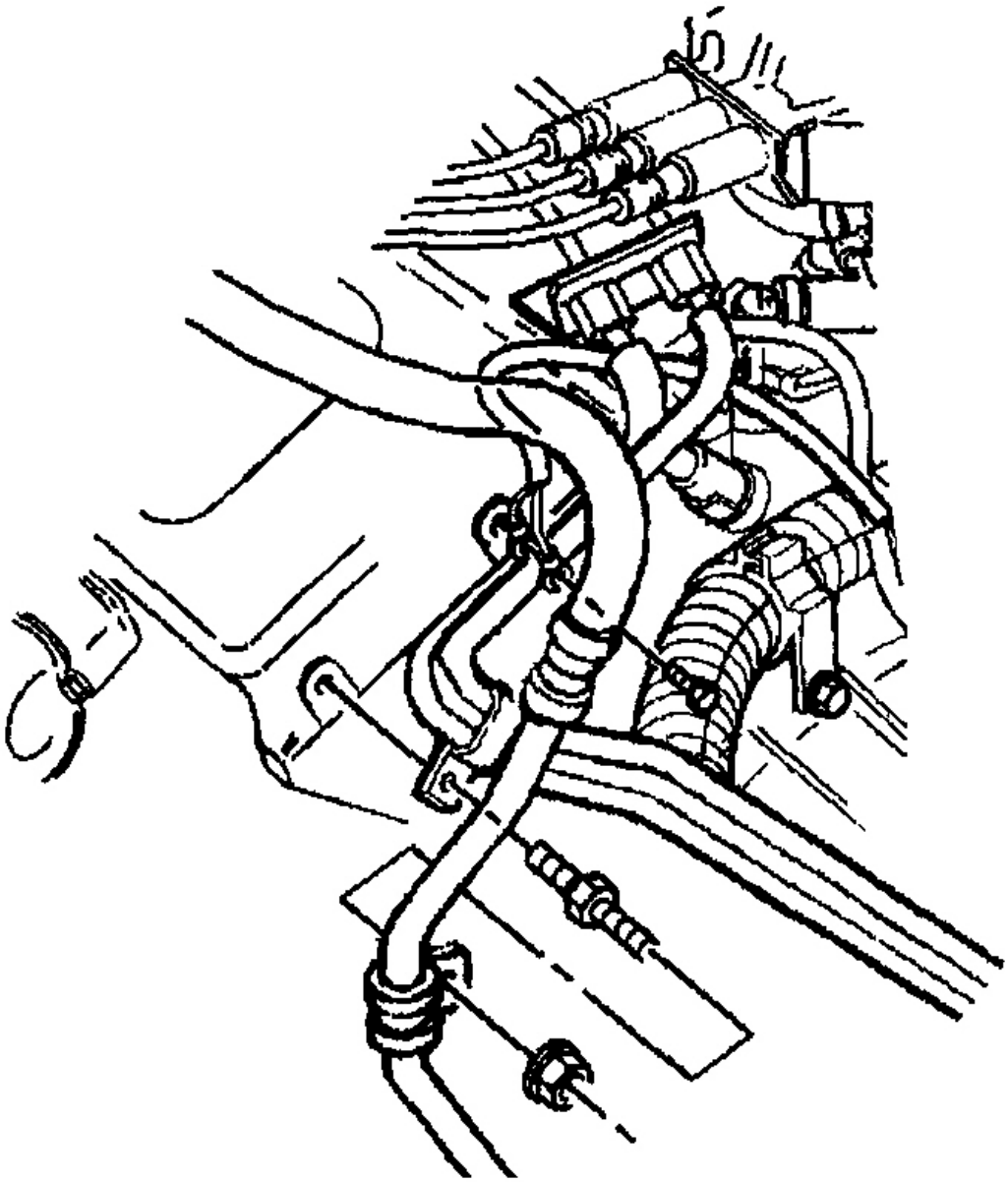

Fig. 129: Locating Ground Wires & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

5. Install the A/C pipe bracket and nut, if equipped. **Tighten:** Tighten the A/C pipe bracket nut to 35 N.m (26 lb ft).
6. Install the exhaust manifold.

7. Install the intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.
8. Install the stud for the power steering pump mounting bracket to the cylinder head. **Tighten:** Tighten the power steering pump mounting bracket stud to 20 N.m (15 lb ft).
9. Install the power steering pump mounting bracket.

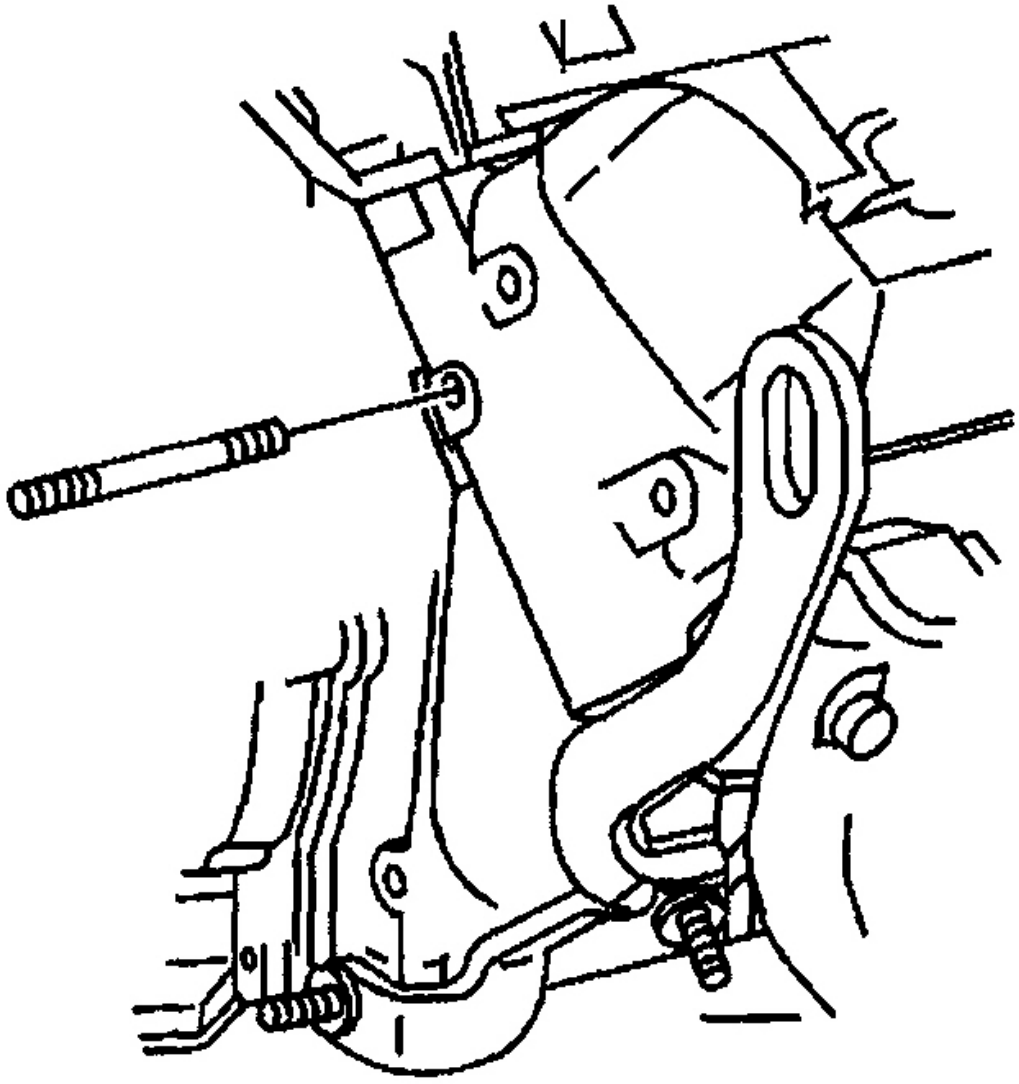

Fig. 130: Installing Power Steering Pump Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

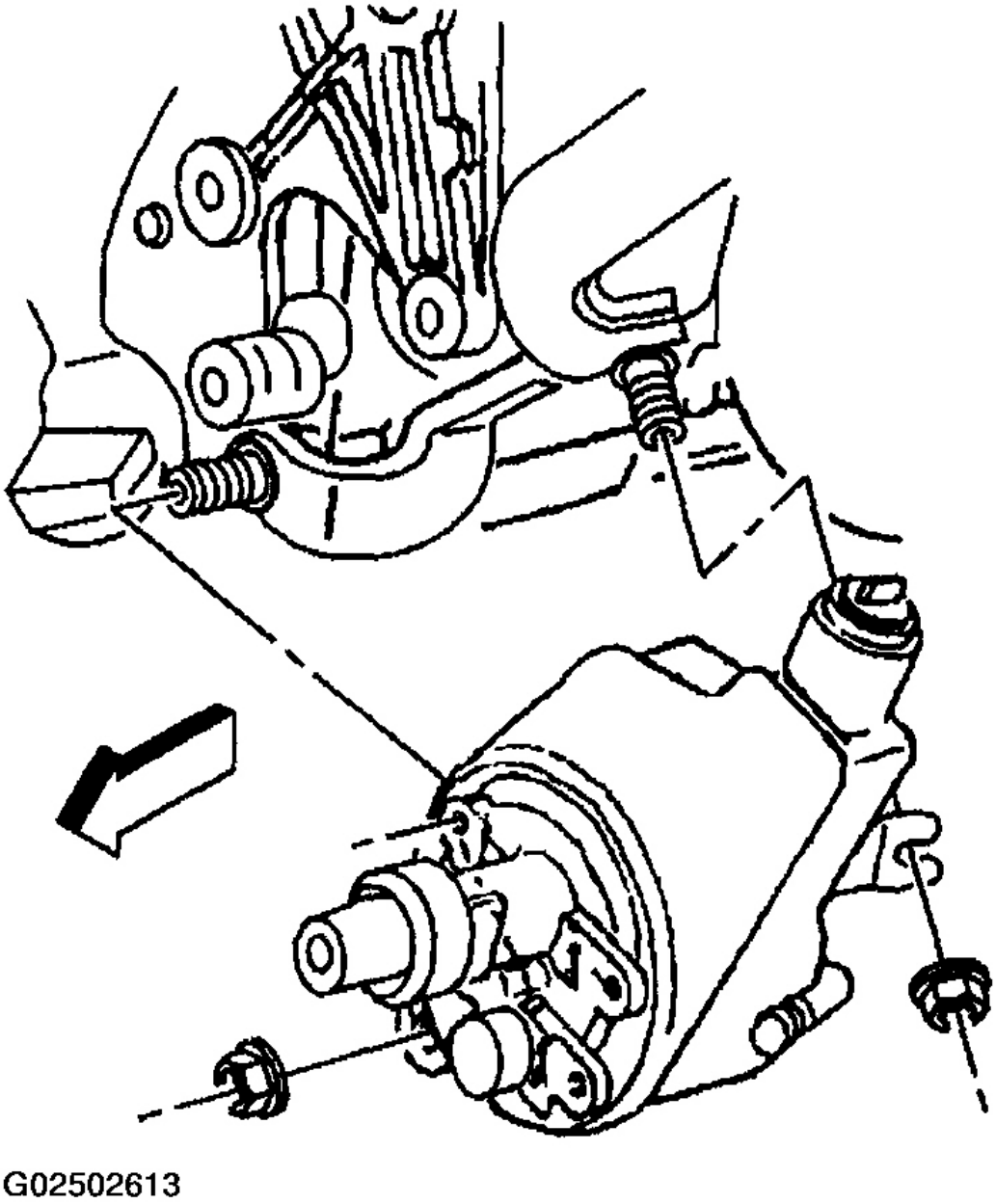

Fig. 131: Installing Power Steering Pump Rear Bracket Nut
Courtesy of GENERAL MOTORS CORP.

10. Install the nut holding the power steering pump rear bracket to the engine. **Tighten:** Tighten the power steering pump rear bracket nut to 41 N.m (30 lb ft).
11. Install the air conditioning compressor.
12. Install the engine cooling fan.

13. Connect the battery negative cable.
14. Install the engine cover.

CYLINDER HEAD REPLACEMENT - RIGHT

Removal Procedure

1. Disconnect the battery negative cable.
2. Remove the engine cover.
3. Remove the engine cooling fan.
4. Remove the intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.
5. Remove the spark plug wire harness support.

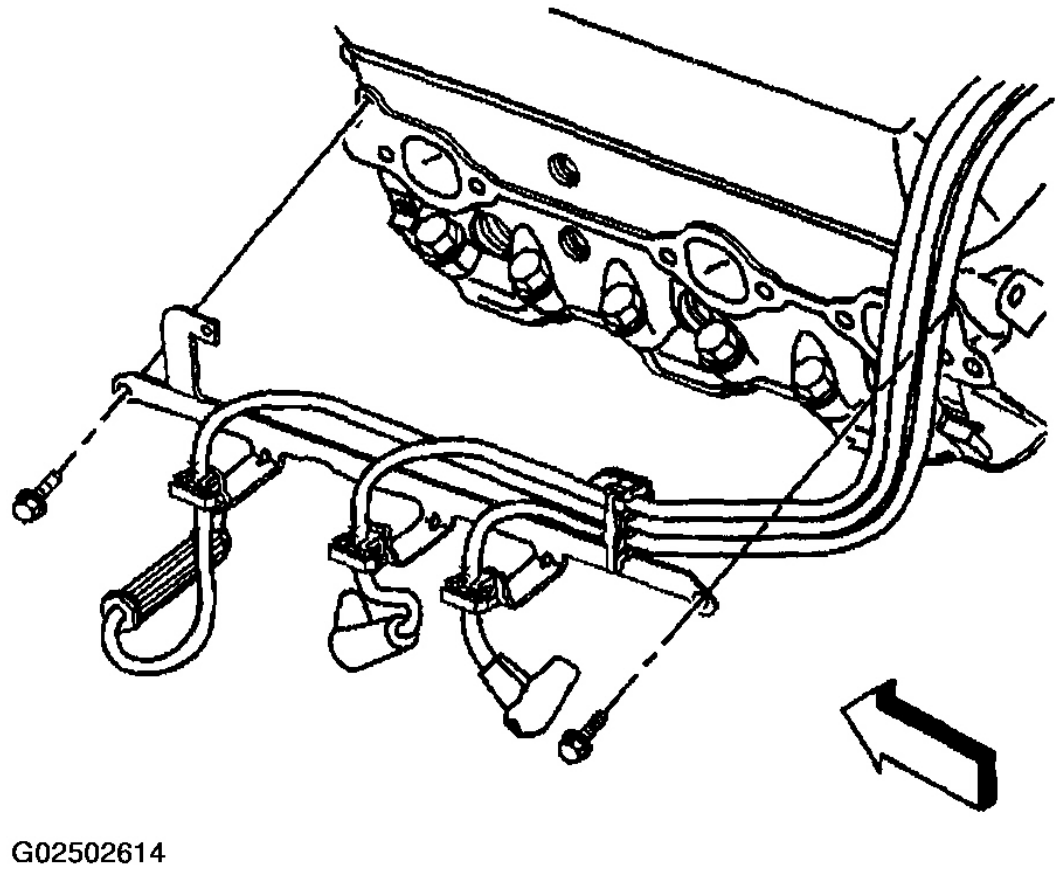

Fig. 132: Removing Spark Plug Wire Harness Support
Courtesy of GENERAL MOTORS CORP.

6. Remove the exhaust manifold.

7. Remove the generator mounting bracket.
8. Remove the generator mounting bracket stud from the cylinder head.

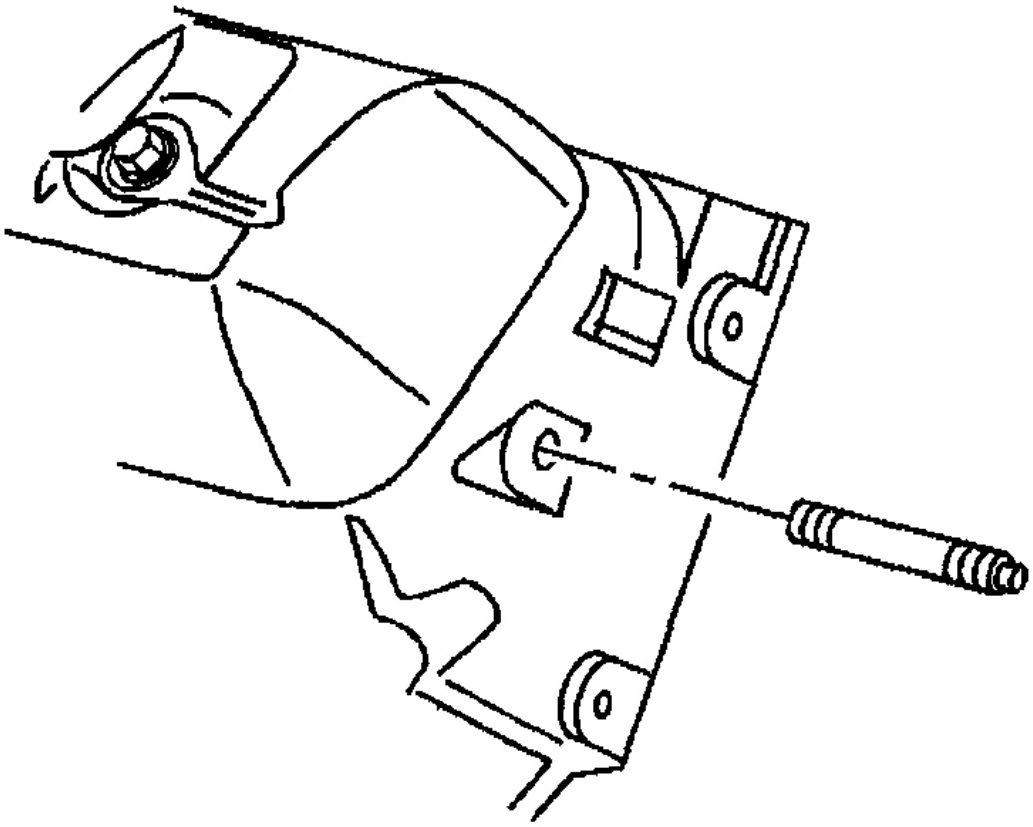

Fig. 133: Removing Generator Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine wiring harness bolt from the rear of the right cylinder head.
10. Remove the valve push rods. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
11. Remove the cylinder head and the gasket.
12. Clean the engine block and the cylinder head sealing surfaces.

NOTE: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

13. Clean the cylinder head bolts and the engine block bolt holes.

Installation Procedure

1. Install the cylinder head.
2. Install the valve push rods. Refer to **VALVE ROCKER ARM & PUSH ROD REPLACEMENT**.
3. Install the exhaust manifold.

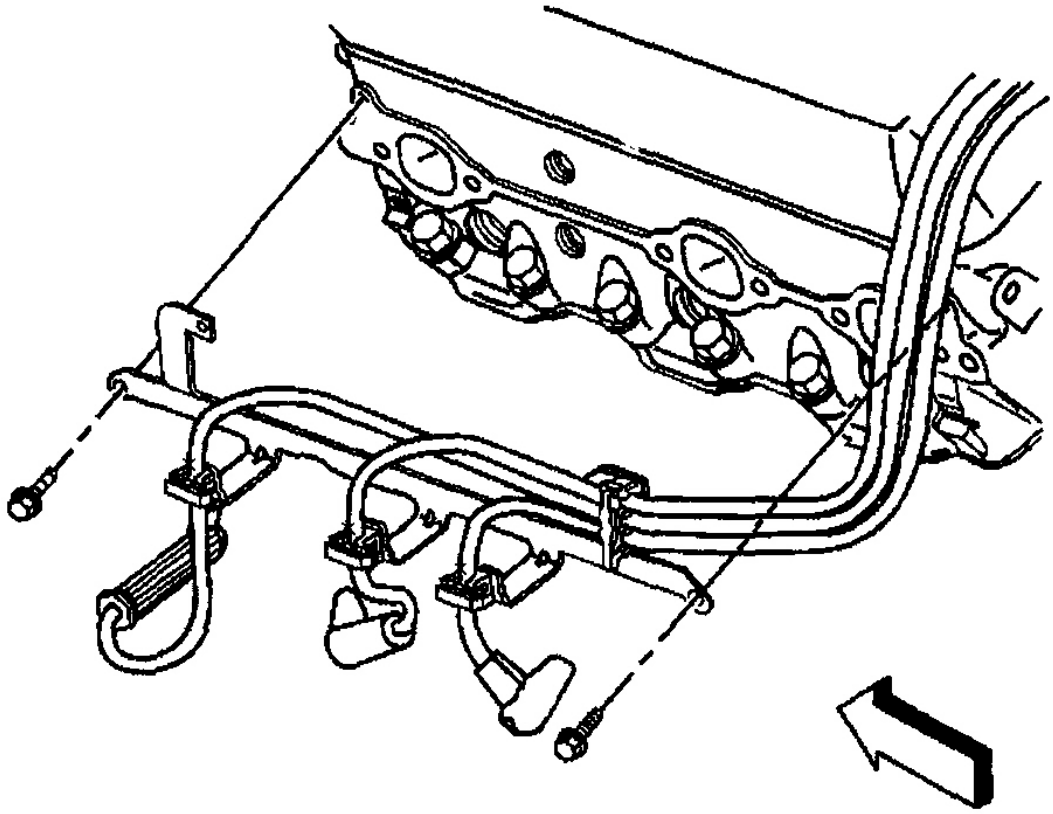

Fig. 134: Installing Spark Plug Wire Harness Support
Courtesy of GENERAL MOTORS CORP.

4. Install the spark plug wire harness and support. **Tighten:** Tighten the spark plug wire support bolts to 12 N.m (106 lb in).
5. Install the intake manifold. Refer to **INTAKE MANIFOLD REPLACEMENT - LOWER**.
6. Install the stud for the generator mounting bracket. **Tighten:** Tighten the generator mounting bracket stud to 20 N.m (15 lb ft).

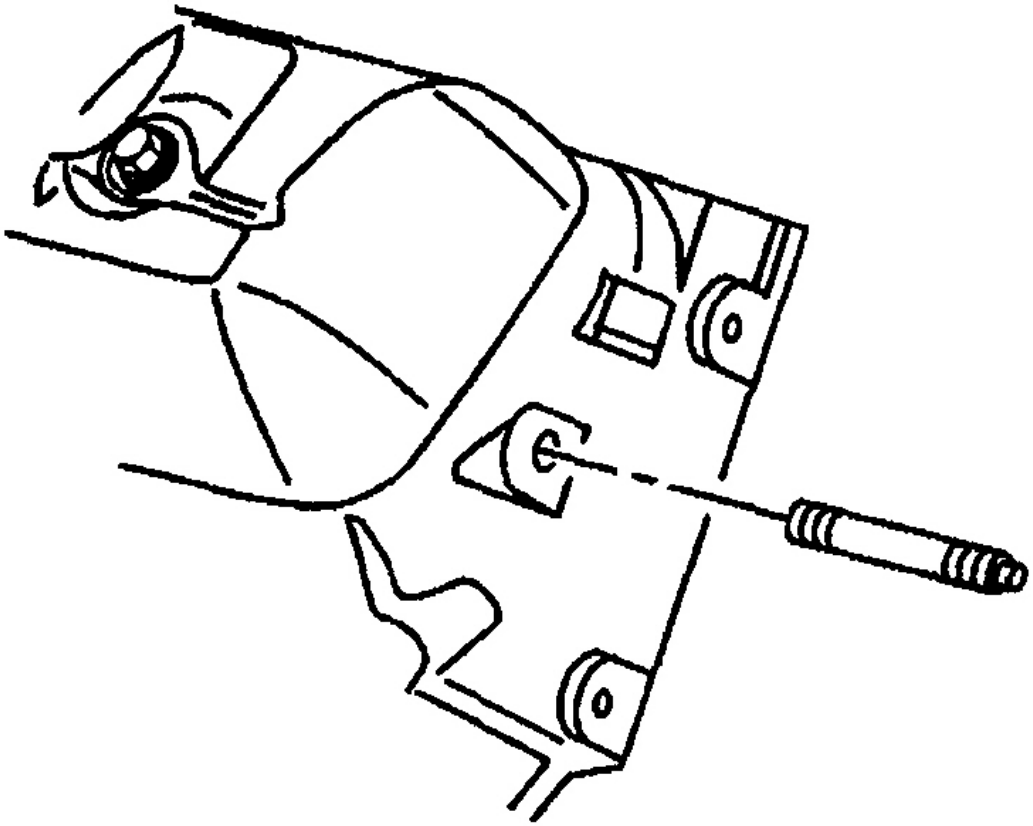

Fig. 135: Installing Generator Mounting Bracket Stud
Courtesy of GENERAL MOTORS CORP.

7. Install the generator mounting bracket.
8. Install the bolt holding the engine wiring harness to the rear of the right cylinder head. **Tighten:** Tighten the engine wiring harness bolt to 36 N.m (27 lb ft).
9. Install the engine cooling fan.
10. Connect the battery negative cable.
11. Install the engine cover.

CRANKSHAFT BALANCER REPLACEMENT

Removal Procedure

1. Remove the fan shroud assembly.
2. Remove the drive belt. Refer to **Drive Belt Replacement**.

3. Remove the crankshaft balancer.
4. Clean and inspect all parts.

Installation Procedure

1. Apply a small amount of grease to the crankshaft front cover oil seal sealing surface if reusing the seal.
2. Install the crankshaft balancer.
3. Install the drive belt. Refer to **Drive Belt Replacement**.
4. Install the fan shroud assembly.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required: J 35468 Crankshaft Aligner/Seal Installer.

Removal Procedure

1. Remove the crankshaft balancer.
2. Use a suitable prying tool to remove the crankshaft front oil seal.
3. Inspect the engine front cover seal bore for damage.
4. Inspect the crankshaft balancer seal area.

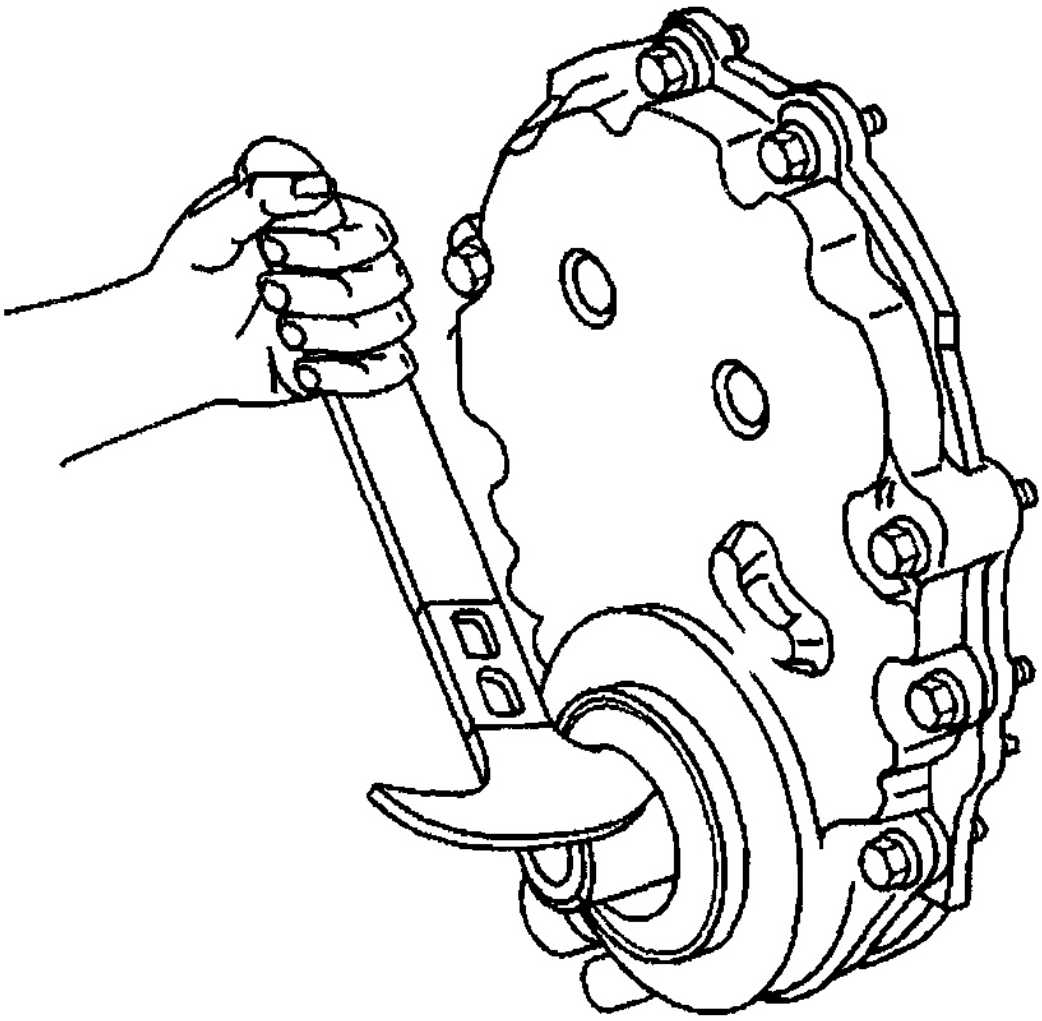

Fig. 136: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Lubricate the exterior of the crankshaft front oil seal with clean engine oil.
2. Use the J 35468 with a hammer in order to install the crankshaft front oil seal.
3. Inspect to ensure the crankshaft front oil seal is flush and square to the engine front cover.
4. Install the crankshaft balancer.

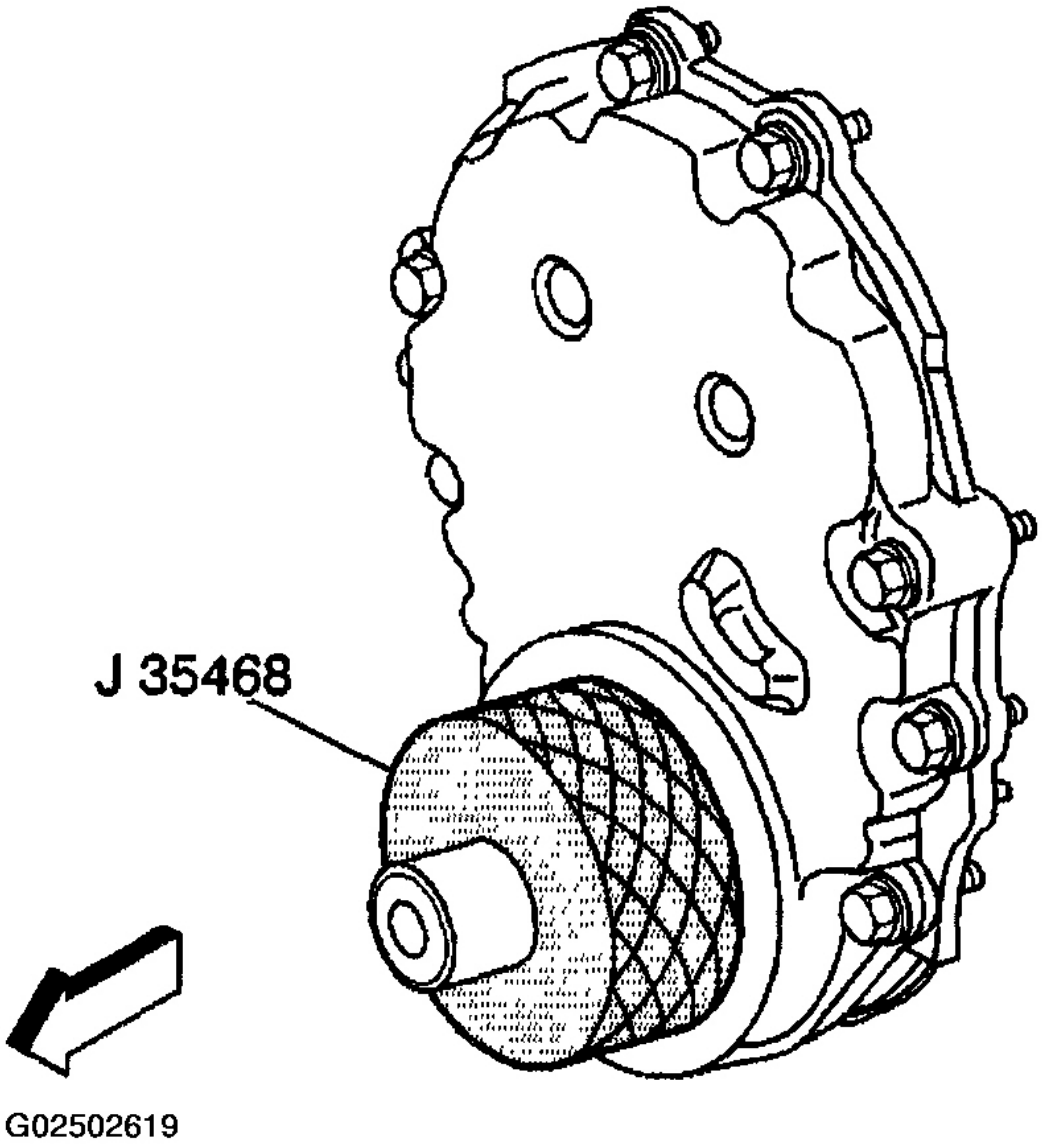

Fig. 137: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

1. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
3. Remove the water pump.

4. Remove the crankshaft position (CKP) sensor.

NOTE: Do not reuse the engine front cover. Oil leaks may result.

5. Remove the engine front cover.
6. Discard the engine front cover.
7. Clean all sealing surfaces.

Installation Procedure

NOTE: Do not reuse the engine front cover. Oil leaks may result.

1. Install the engine front cover
2. Install the engine oil pan. Refer to **Oil Pan Replacement**.

IMPORTANT: Do not reuse the original seal (O-ring) when installing the crankshaft position sensor to the engine front cover. Erratic engine operation may result.

3. Install the CKP sensor.
4. Install the water pump.
5. Install the crankshaft balancer.

CRANKSHAFT POSITION (CKP) RELUCTOR RING REPLACEMENT

Removal Procedure

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

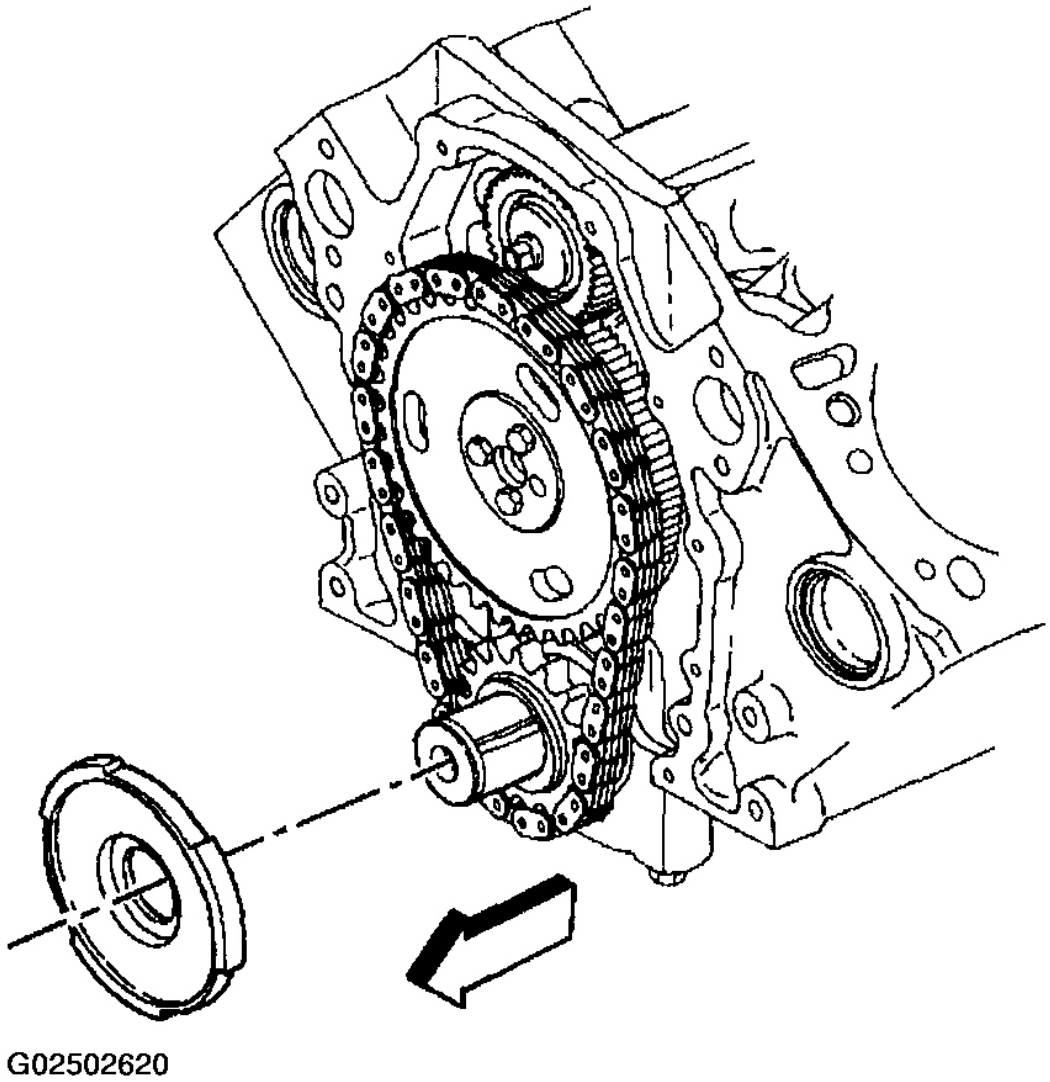

Fig. 138: Removing Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS CORP.

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 towards the engine front cover.

1. Install the crankshaft position sensor reluctor ring.

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

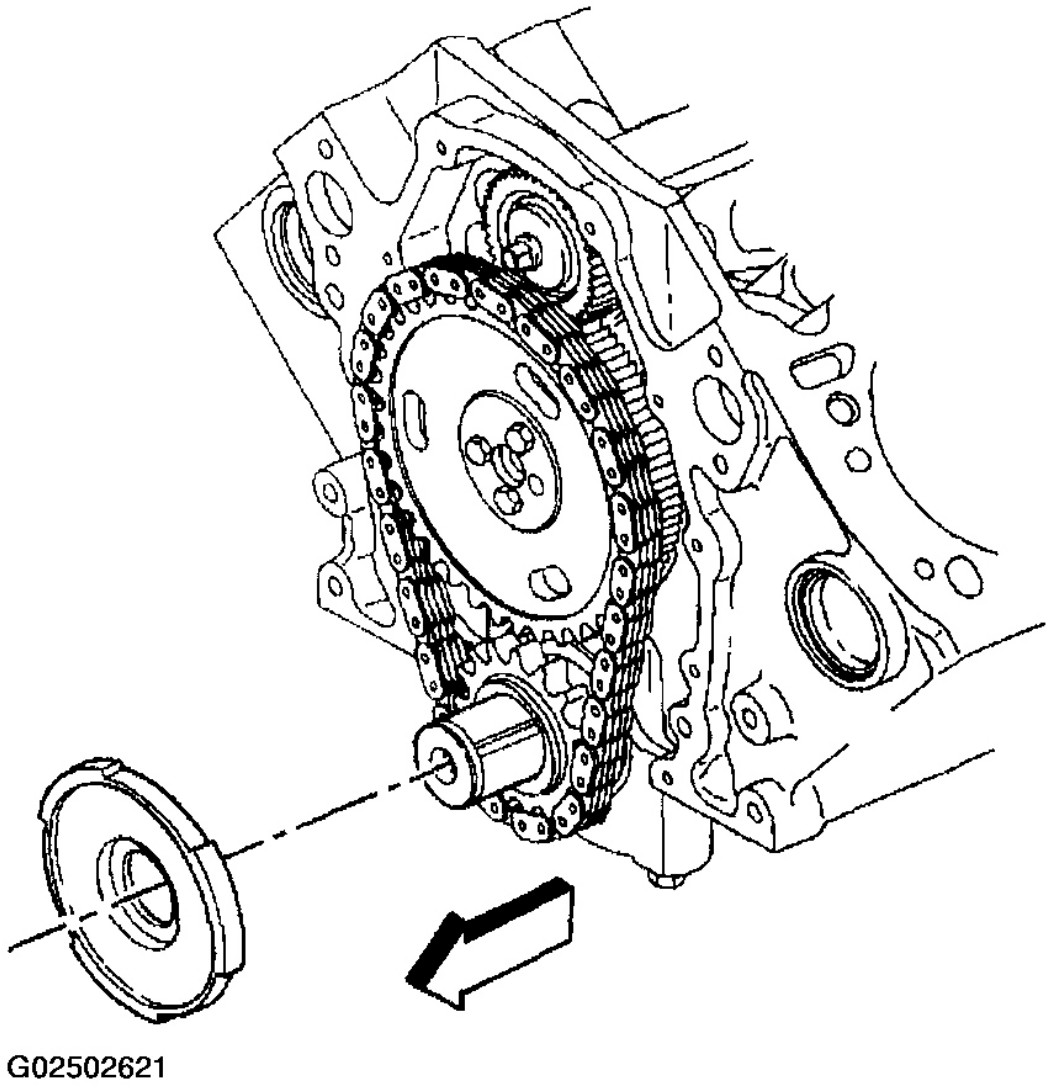

Fig. 139: Installing Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS CORP.

TIMING CHAIN & SPROCKETS REPLACEMENT

Removal Procedure

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

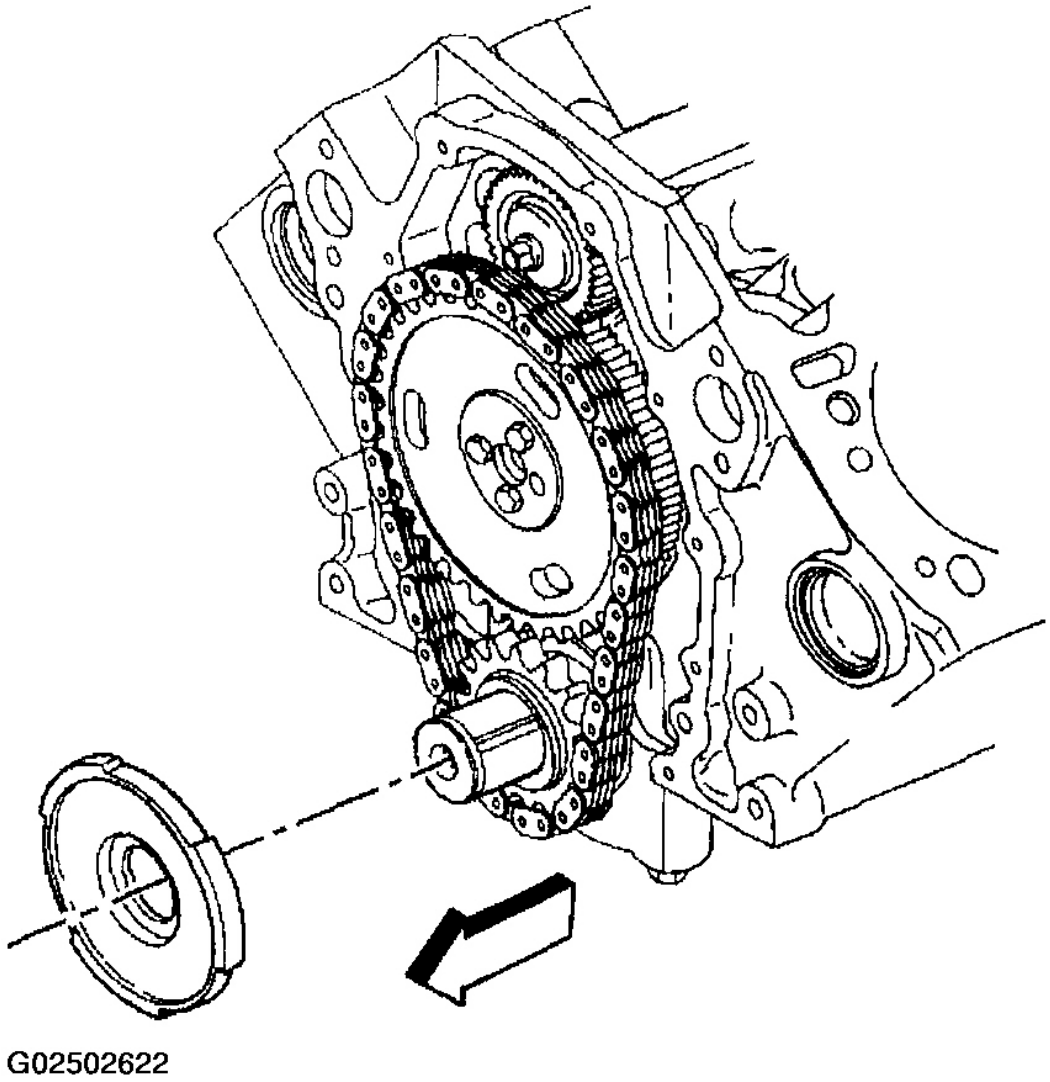

Fig. 140: Removing Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS CORP.

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.

3. 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.

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

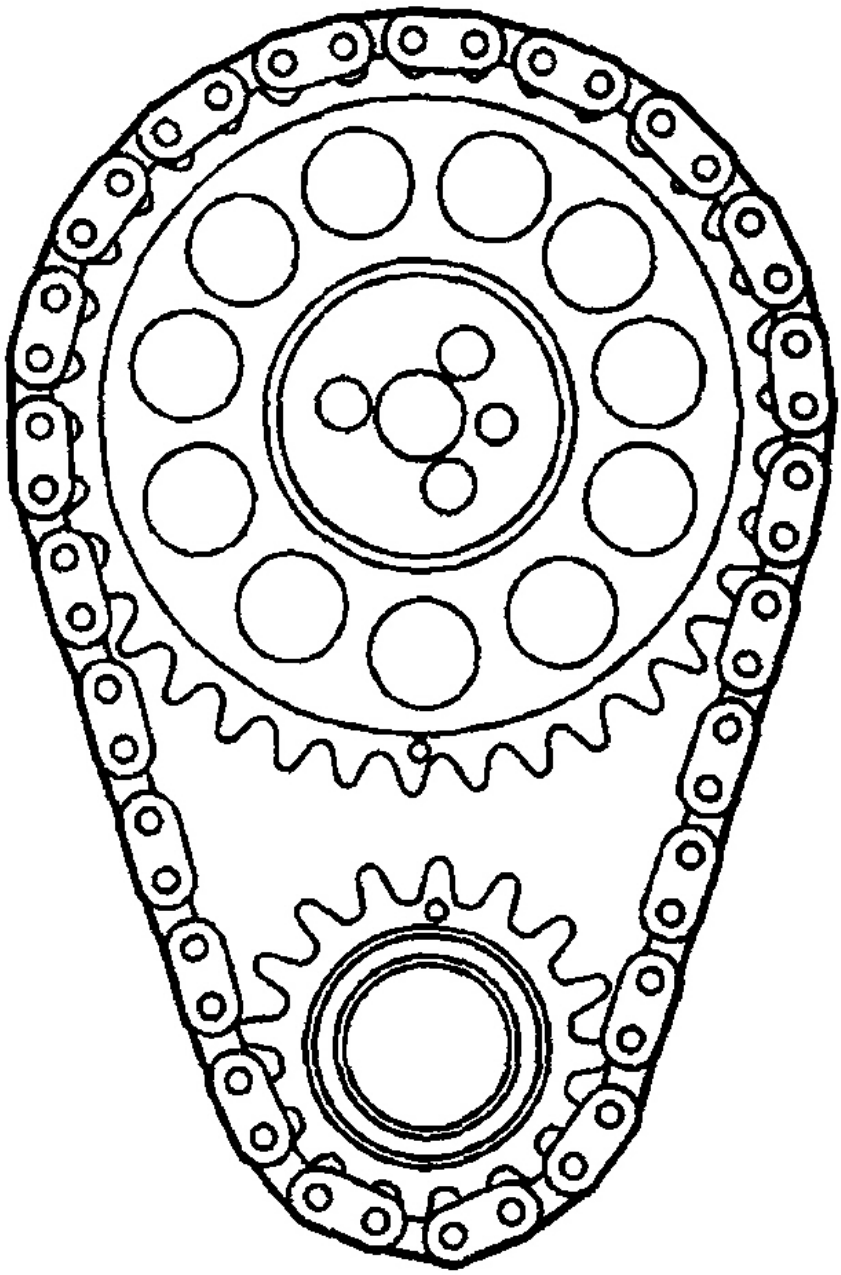

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Fig. 141: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

5. Remove the timing chain and sprockets
6. Clean and inspect the timing chain and sprockets.

Installation Procedure

1. Install the timing chain and the sprockets.
2. Remove the bolt from the crankshaft.

NOTE: Do not reuse the engine front cover. Oil leaks may result.

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

BALANCE SHAFT REPLACEMENT

Removal Procedure

1. Remove the radiator.
2. Remove the A/C condenser, if equipped.
3. Remove the valve lifter pushrod guide. Refer to **Valve Lifter Replacement**.
4. Remove the camshaft timing chain and sprockets. Refer to **TIMING CHAIN & Sprockets Replacement**.

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

5. Remove the balance shaft.
6. Clean and inspect the balance shaft.

Installation Procedure

1. Install the balance shaft.
2. Install the camshaft timing chain and the camshaft sprocket.
3. Install the crankshaft position reluctor ring and the engine front cover. Refer to **Crankshaft Position (CKP) Reluctor Ring Replacement**.
4. Install the valve lifter pushrod guide. Refer to **Valve Lifter Replacement**.
5. Install the A/C condenser, if equipped.
6. Install the radiator.

BALANCE SHAFT BEARING AND/OR BUSHING REPLACEMENT

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. Remove the balance shaft rear bearing.

Installation Procedure

1. Install the balance shaft rear bearing.
2. Install the balance shaft. Refer to **Balance Shaft Replacement**.

CAMSHAFT REPLACEMENT

Removal Procedure

1. Remove the engine cover.
2. Remove the air cleaner assembly.
3. Remove the radiator.
4. Remove the A/C condenser.
5. Remove the radiator grille.
6. Remove the valve lifters. Refer to **Valve Lifter Replacement**.
7. Remove the timing chain and the camshaft sprocket. Refer to **TIMING CHAIN & SPROCKETS REPLACEMENT**.
8. Remove the balance shaft drive gear.
9. Remove the camshaft.
10. Clean and inspect the camshaft and the bearings.

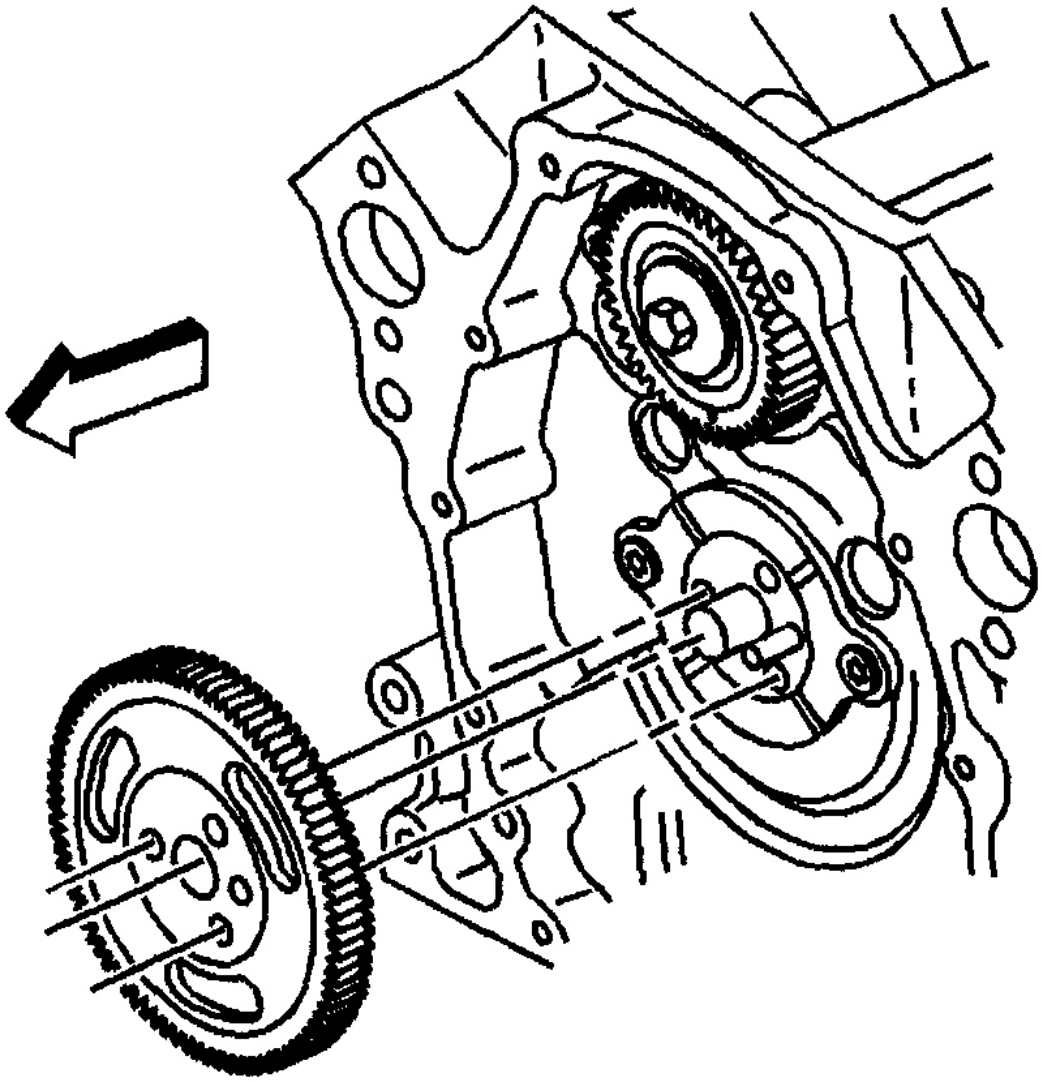

Fig. 142: Removing Camshaft
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

IMPORTANT: Whenever a new camshaft is installed, do the following procedures:

- **Change the engine oil.**
- **Change the engine oil filter.**
- **Add GM Engine Oil Supplement GM P/N 1052367 or the equivalent to the**

engine oil.

1. Install the camshaft into the engine block.
2. Install the balance shaft drive gear.
3. Install the timing chain and camshaft sprocket. Refer to **TIMING CHAIN & SPROCKETS REPLACEMENT**.
4. Install the valve lifters. Refer to **Valve Lifter Replacement**.
5. Install the A/C condenser.
6. Install the radiator grille.
7. Install the radiator.
8. Fill the engine cooling system.
9. Recharge the air conditioning system.
10. Install the air cleaner assembly.
11. Install the engine cover.

OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

1. Raise the vehicle.
2. Position a suitable container to catch the engine oil.
3. Remove the oil filter.
4. Disconnect the engine oil cooler pipes from the oil filter adapter.
5. Remove the oil filter adapter.

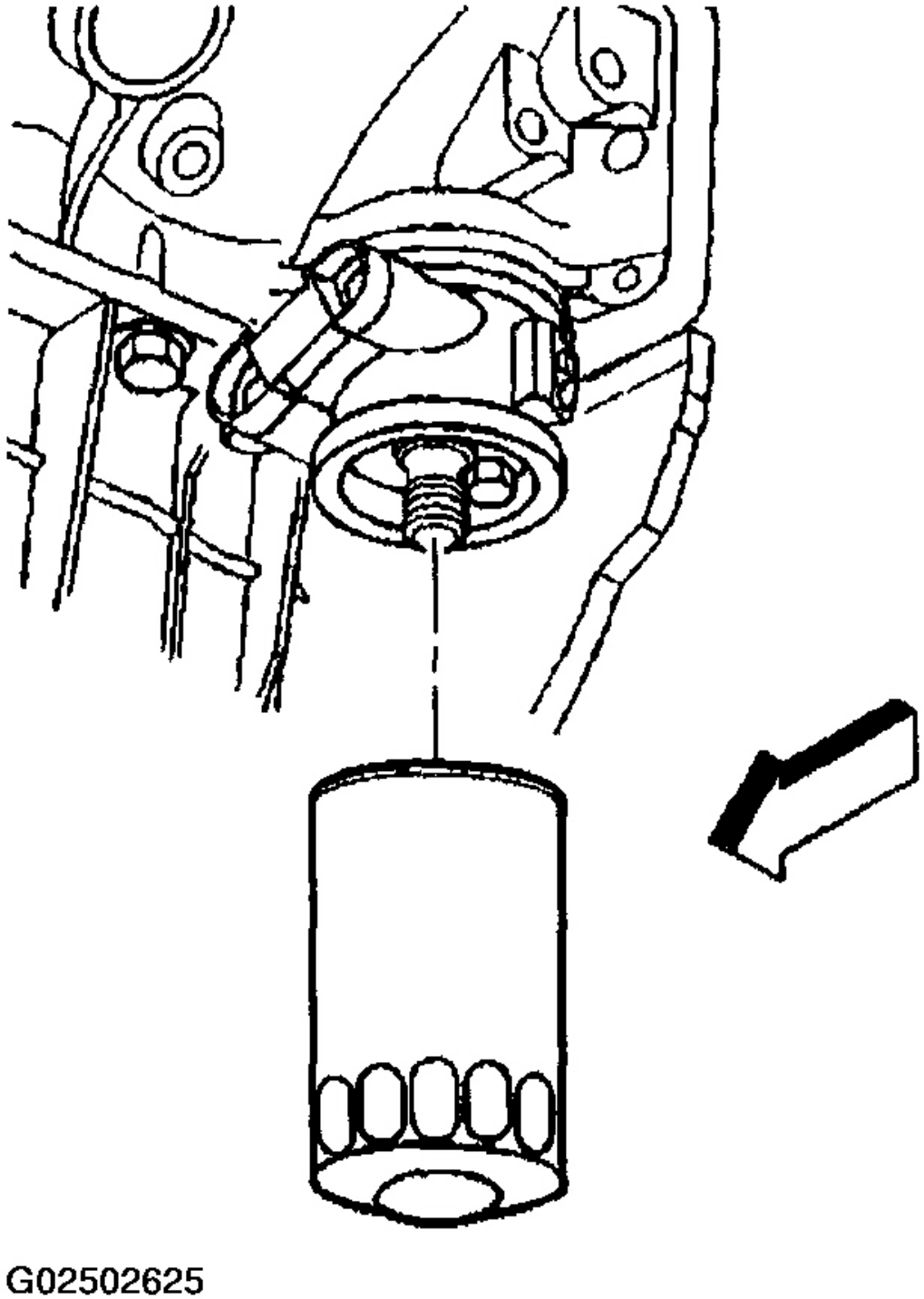

Fig. 143: Removing Oil Filter

Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the oil filter adapter with a NEW gasket.
2. Install the engine oil cooler pipes to the oil filter adapter.
3. Install the oil filter. Refer to **ENGINE OIL & OIL FILTER REPLACEMENT**.
4. Lower the vehicle.
5. Operate the vehicle and check for leaks.

OIL FILTER BYPASS VALVE REPLACEMENT

Removal Procedure

1. Raise the vehicle.
2. Position a suitable container to catch the engine oil.
3. Remove the oil filter.
4. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
5. Using a suitable prying tool remove the oil filter bypass valve.
6. Clean and inspect valve bore for damage.

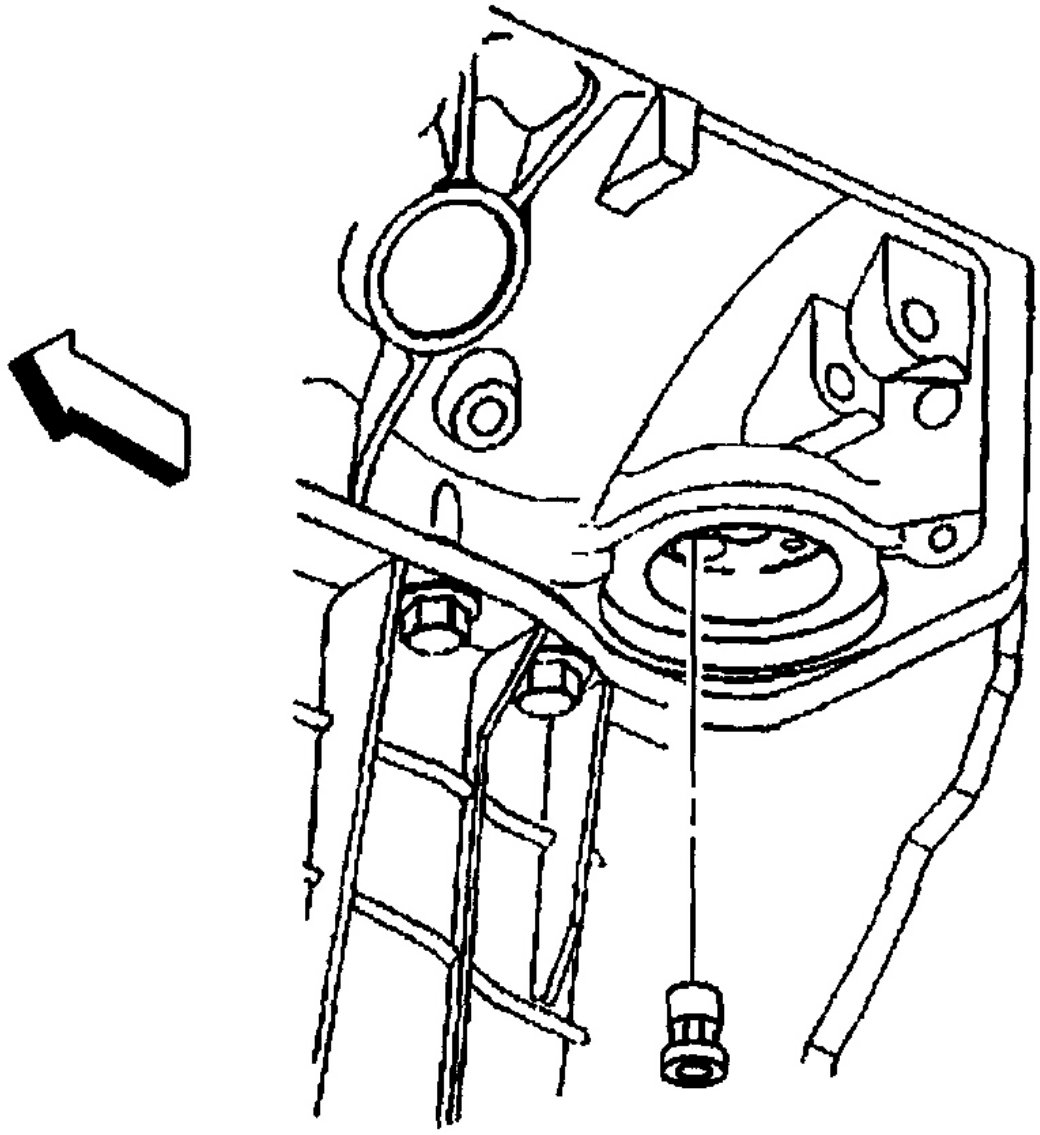

Fig. 144: Removing Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install a NEW oil filter bypass valve using the following procedure:
   a. Use a brass drift that is the same diameter as the outside diameter of the oil filter bypass valve.
   b. Install the oil filter bypass valve into the oil gallery bore until slightly below flush with the surface

of the engine block.

c. Using a pointed punch, stake the engine block area around the oil filter bypass valve. Stake in 3 locations 120 degrees apart.

2. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
3. Install the oil filter. Refer to **ENGINE OIL & OIL FILTER REPLACEMENT**.
4. Lower the vehicle.

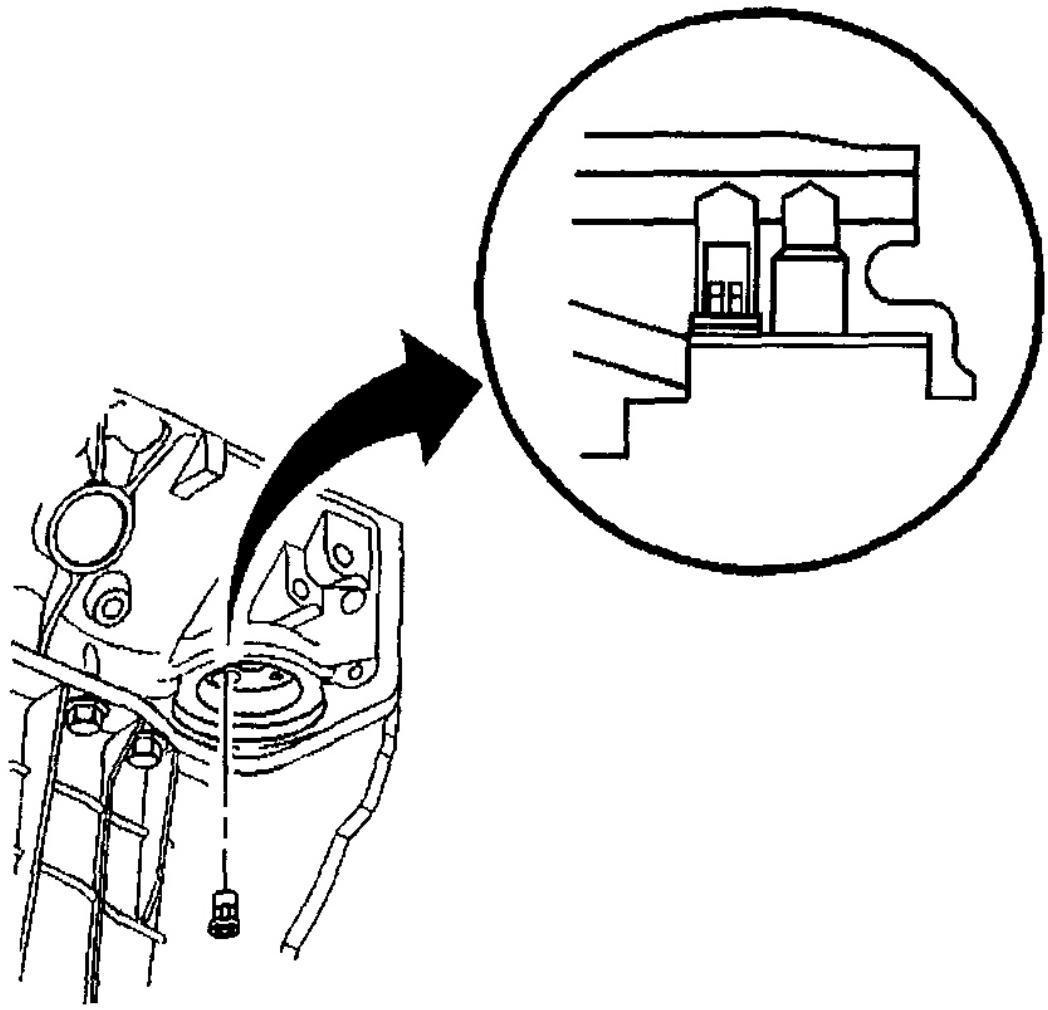

Fig. 145: Installing Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

OIL PAN REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable.
2. Remove the oil level indicator.
3. Raise the vehicle.
4. Remove the oil pan drain plug and drain the engine oil into a suitable container.
5. Remove the oil filter.
6. Remove the bolt holding the oil cooler pipes bracket to the oil pan.

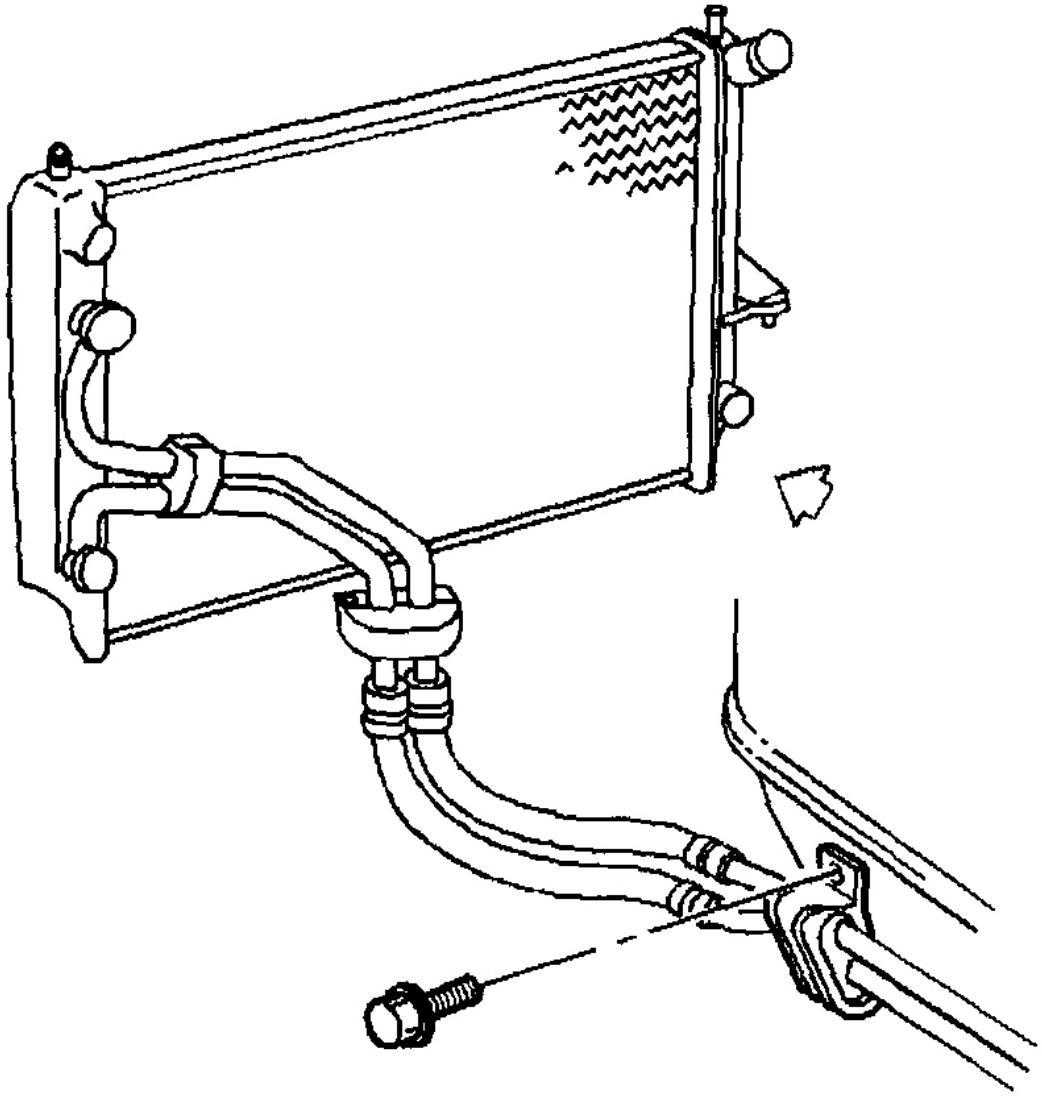

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Fig. 146: Removing Oil Cooler Pipes Bracket-To-Oil Pan Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
8. Remove the bolt holding the bracket for the starter wiring harness and the transmission cooler pipes.
9. Remove the crankcase position (CKP) sensor wiring harness from the retainer.
10. Remove the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .

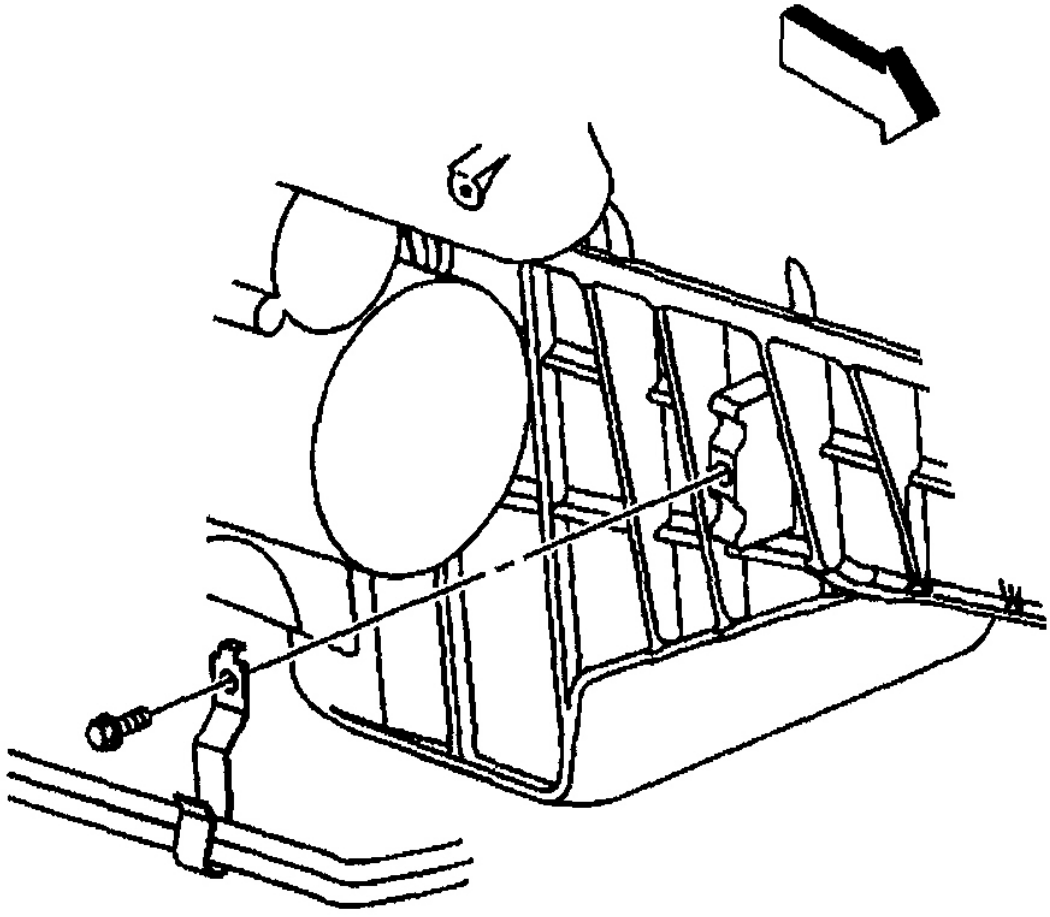

Fig. 147: Locating Bolt Holding Bracket For Starter Wiring Harness & Transmission Cooler Pipes
Courtesy of GENERAL MOTORS CORP.

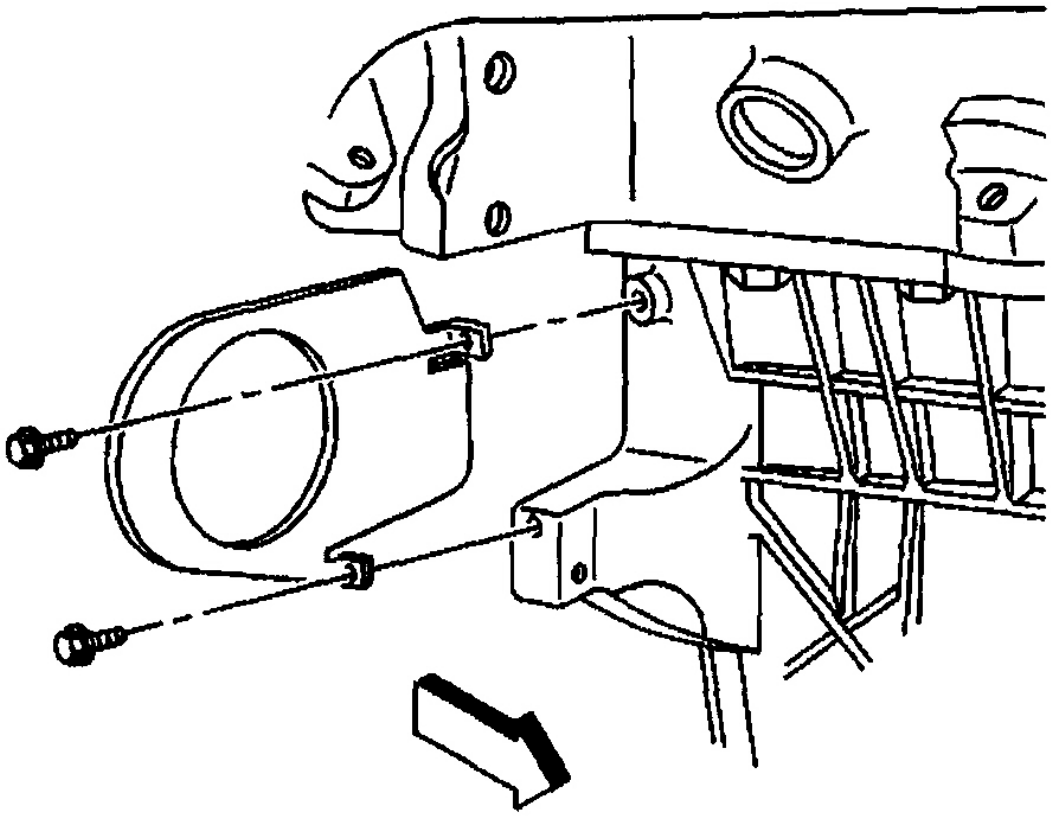

Fig. 148: Removing Transmission Cover
Courtesy of GENERAL MOTORS CORP.

11. Remove the transmission cover.
12. Remove the inner axle shaft housing support bracket to the frame nuts and the washers (AWD only).

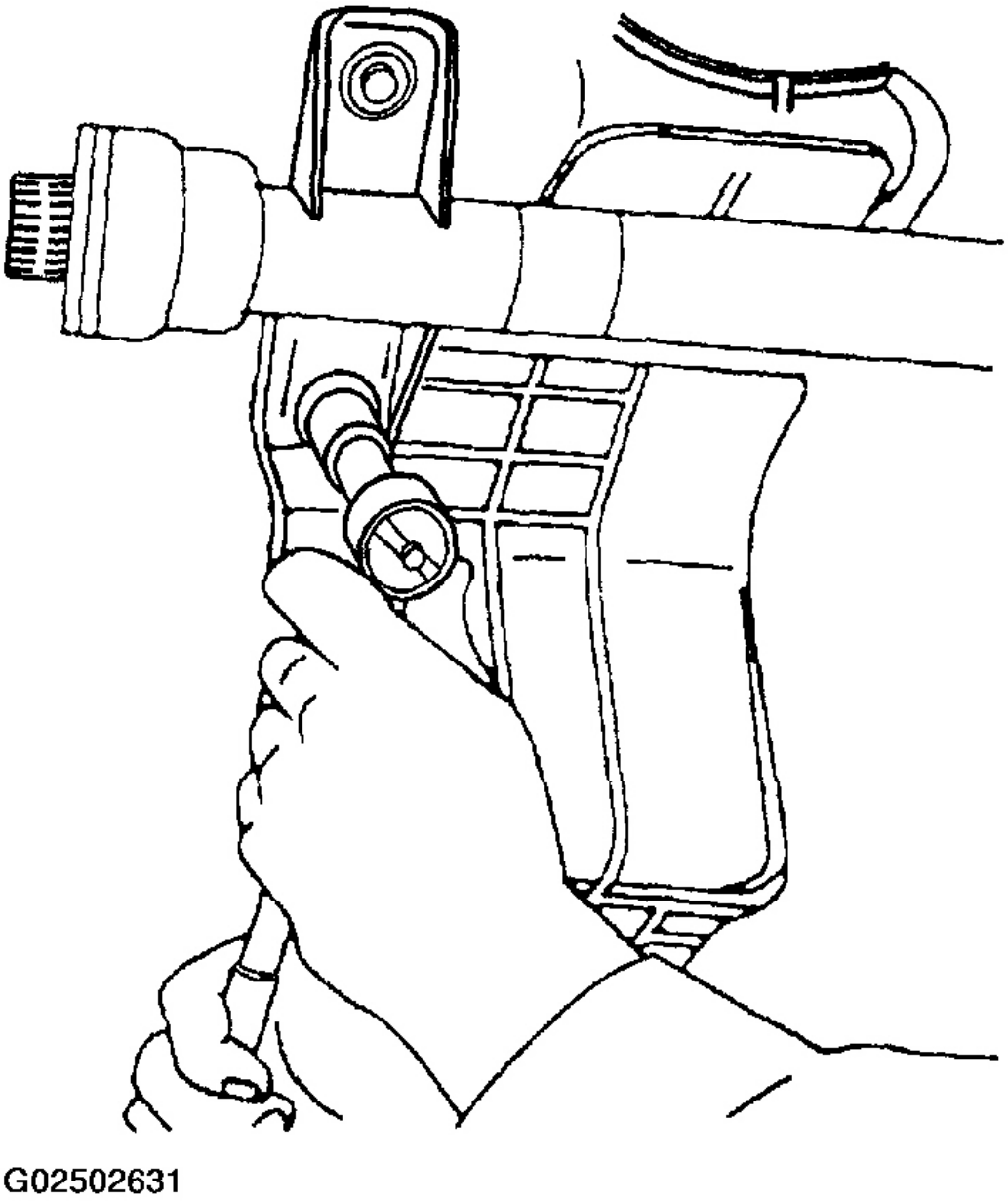

Fig. 149: Removing Inner Axle Shaft Housing Support Bracket-To-Frame Nuts & Washers (AWD Only)
Courtesy of GENERAL MOTORS CORP.

13. Remove the front differential carrier upper and lower mounting nuts and bolts (AWD only).
14. Lower the front differential carrier assembly only enough for removal of the oil pan.

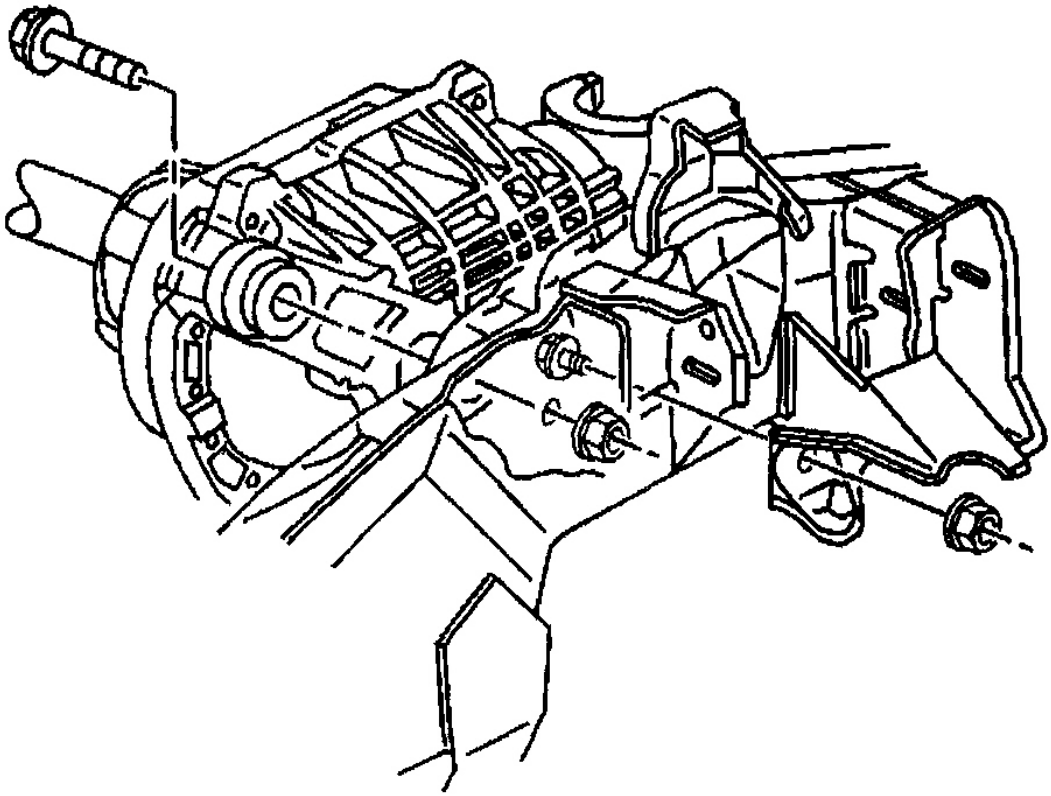

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Fig. 150: Removing Front Differential Carrier Upper & Lower Mounting Nuts & Bolts (AWD only)
Courtesy of GENERAL MOTORS CORP.

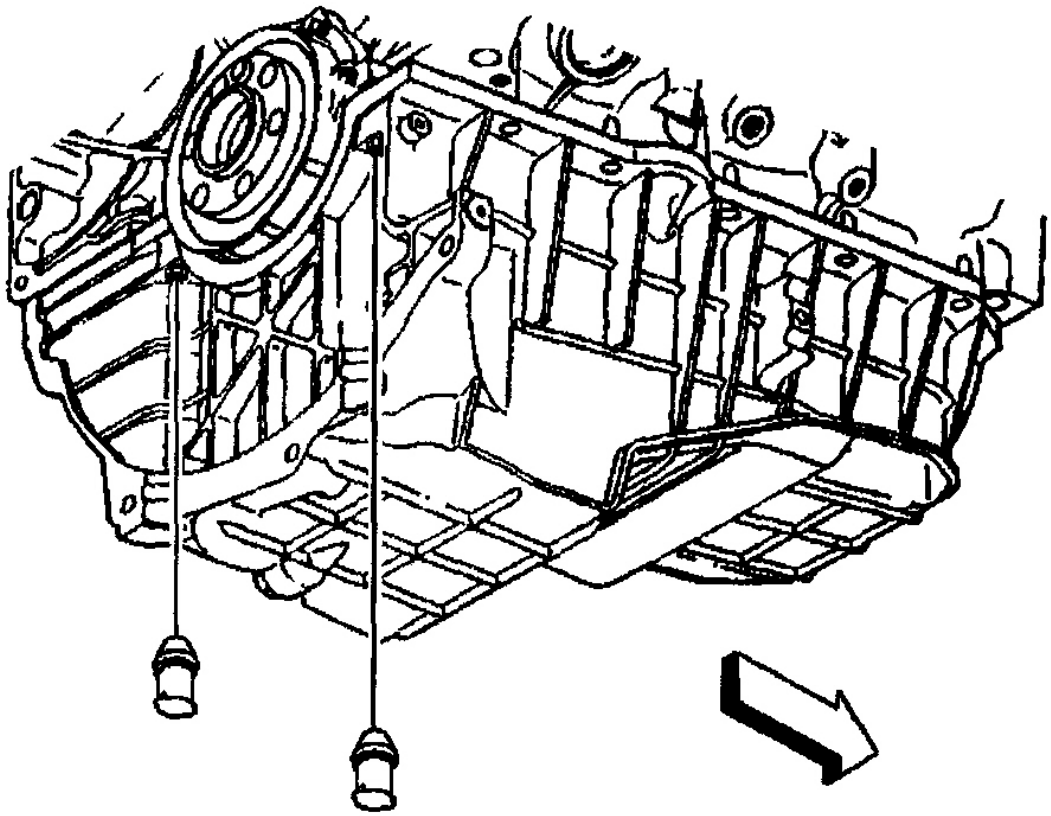

Fig. 151: Removing Access Plugs For Rear Oil Pan Nuts
Courtesy of GENERAL MOTORS CORP.

15. Remove the access plugs for the oil pan rear nuts.
16. Remove the transmission to oil pan bolts.

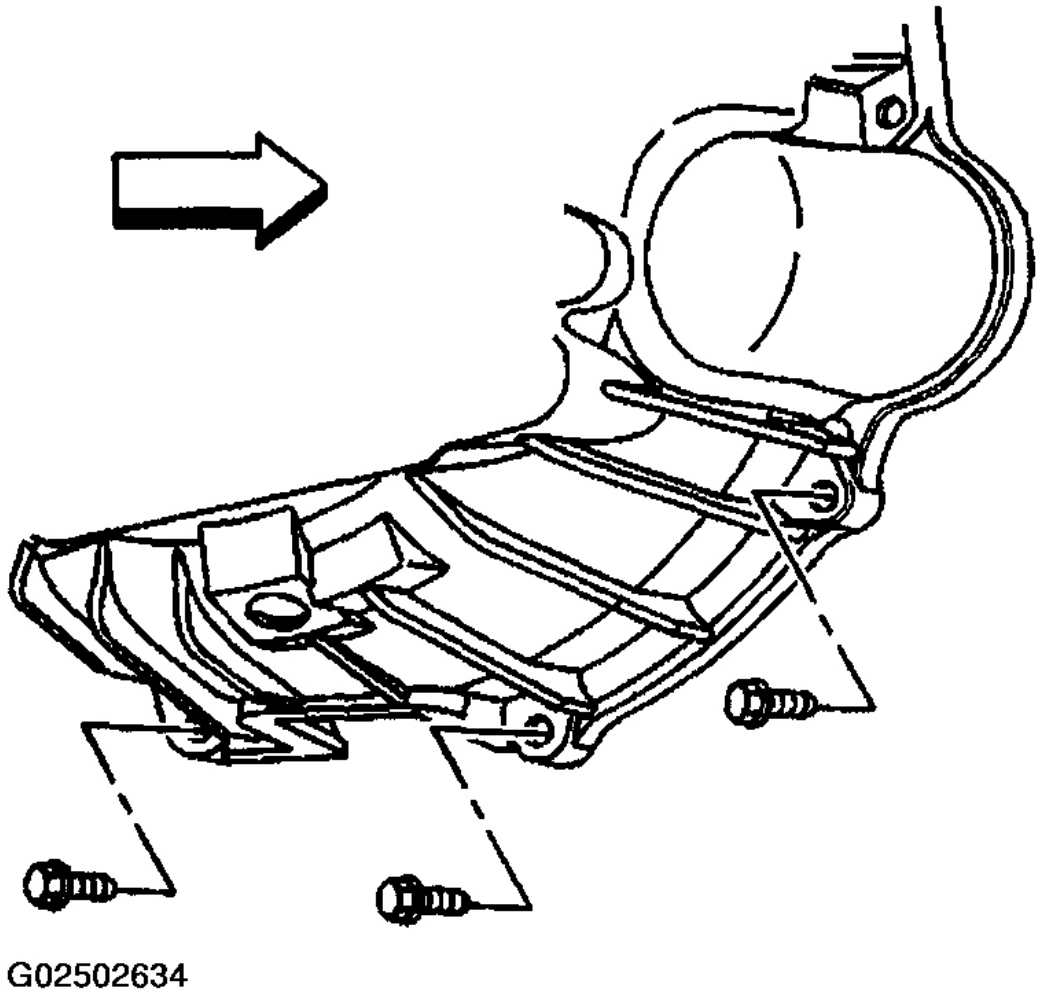

Fig. 152: Removing Transmission-To-Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the oil pan from the engine.
18. Clean all sealing surfaces on the engine and the oil pan.

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.

1. Install the oil pan to the engine.

2. Install the transmission to oil pan bolts and nuts. **Tighten:** Tighten the bolts to 47 N.m (34 lb ft).

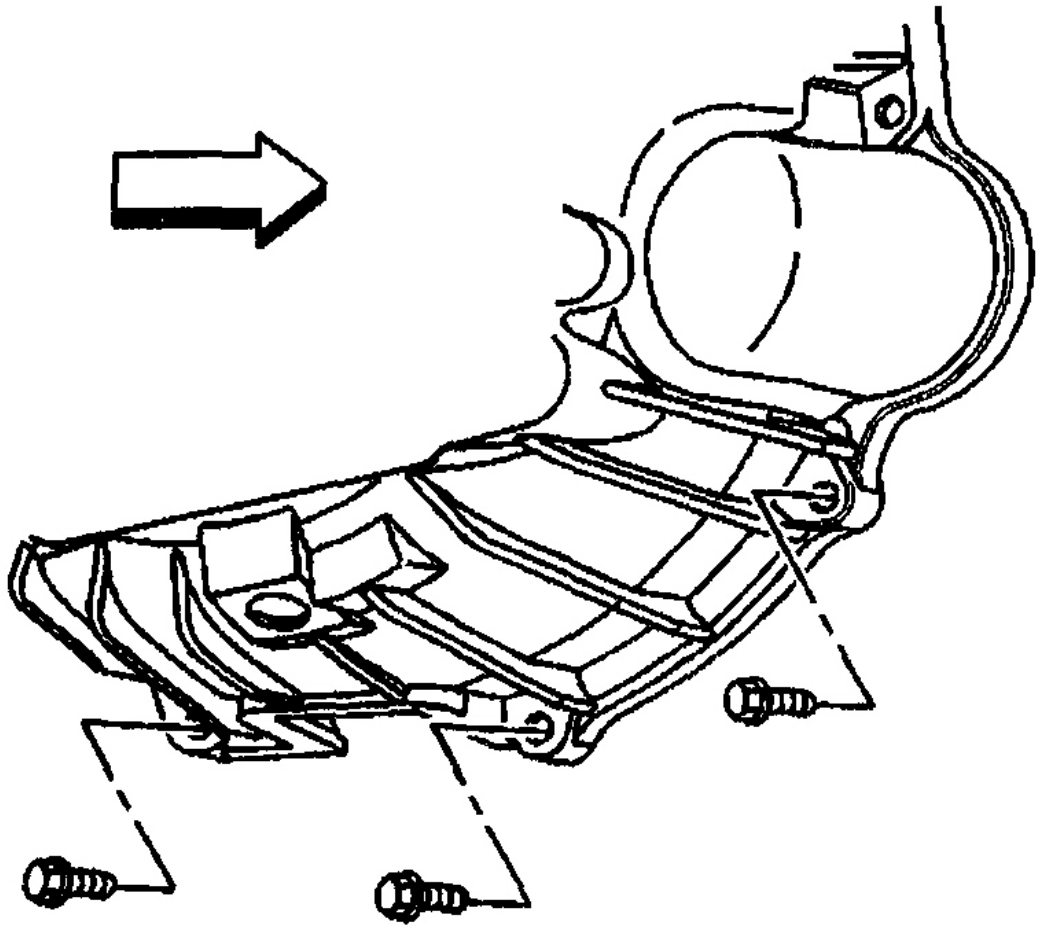

Fig. 153: Installing Transmission-To-Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

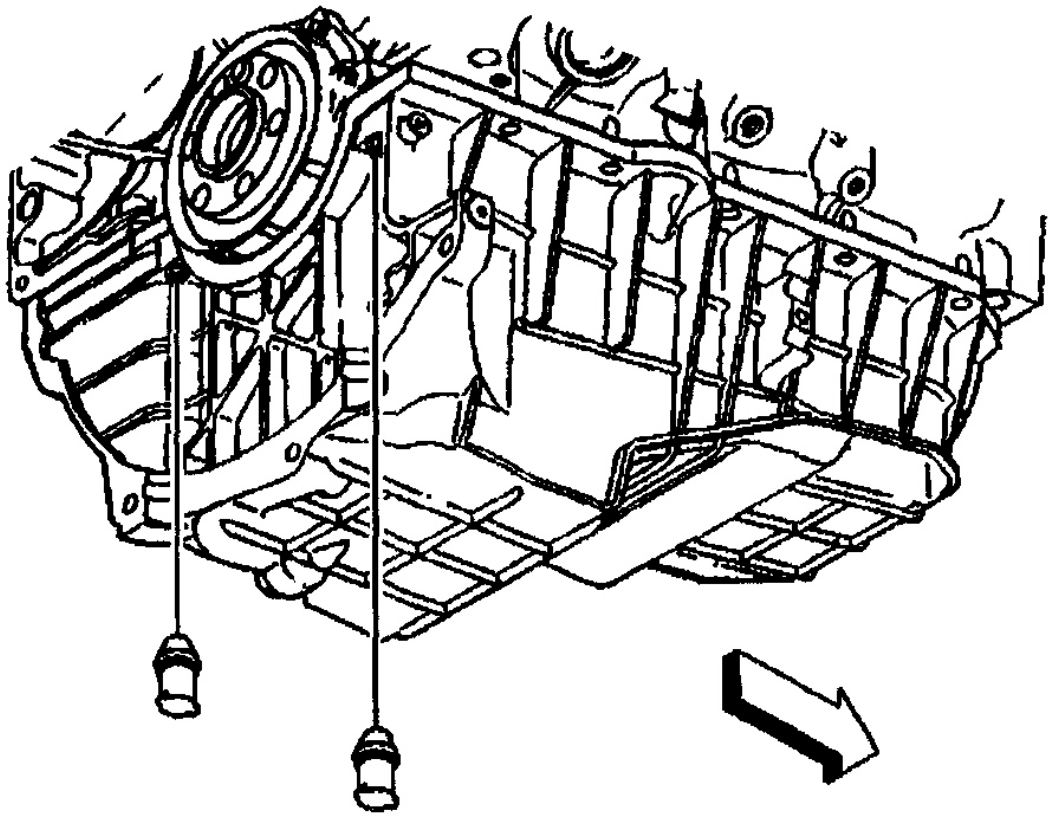

Fig. 154: Installing Access Plugs For Rear Oil Pan Nuts
Courtesy of GENERAL MOTORS CORP.

3. Install the access plugs for the oil pan rear nuts.
4. Position the front differential carrier assembly.
5. Install the carrier upper and lower mounting bolts and nuts (AWD only).
6. Install the inner axle shaft housing support bracket to frame washers and nuts (AWD only).
7. Install the transmission cover. **Tighten:** Tighten the bolts to 12 N.m (106 lb in).
8. Install the starter motor. Refer to **STARTERS 2000** or **STARTERS 2001** .

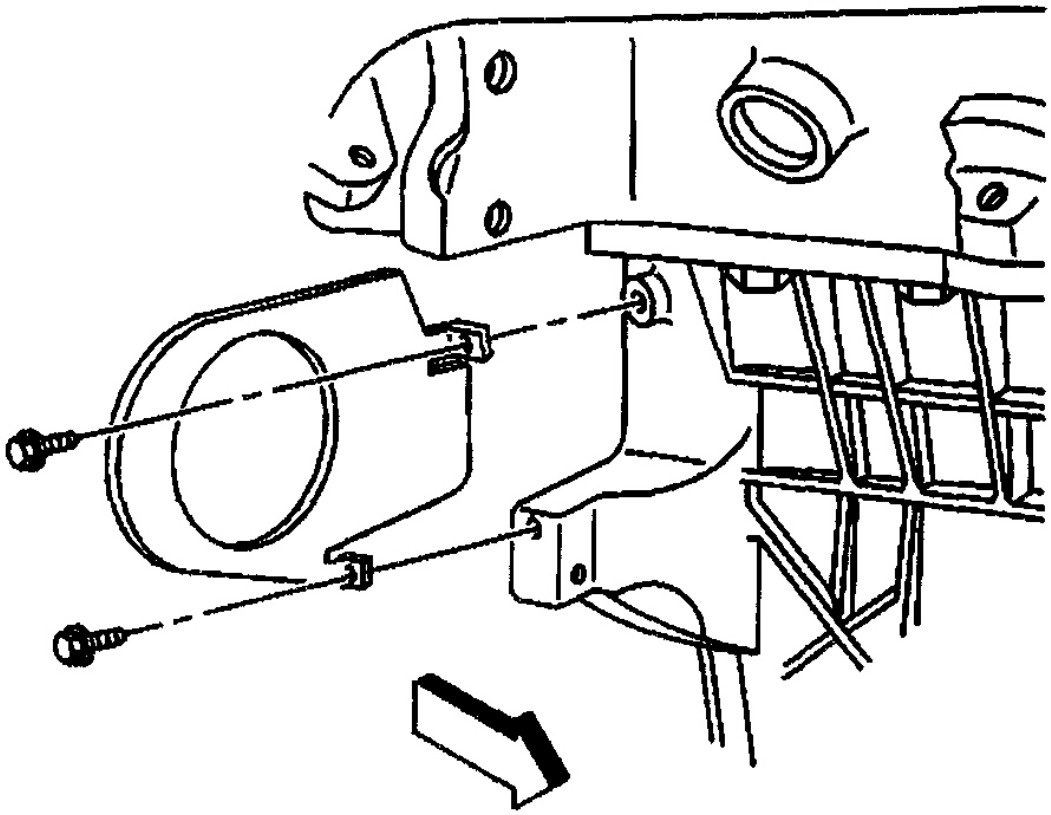

Fig. 155: Installing Transmission Cover
Courtesy of GENERAL MOTORS CORP.

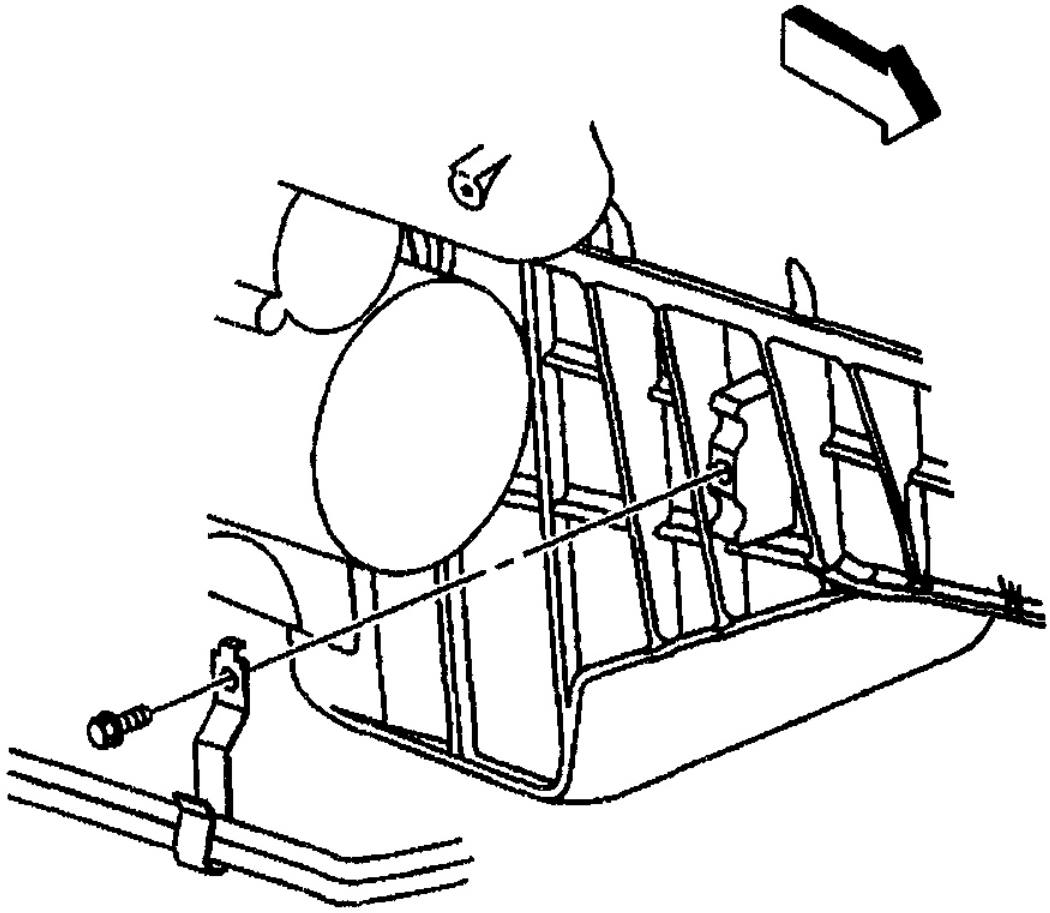

Fig. 156: Locating Bolt Holding Bracket For Starter Wiring Harness & Transmission Cooler Pipes
Courtesy of GENERAL MOTORS CORP.

9. Install the bolt holding the bracket for the starter wiring harness and the transmission cooler pipes. **Tighten:** Tighten the bolts to 10 N.m (89 lb in).
10. Install the CKP sensor wiring harness in the retainer.
11. Install the oil filter adapter. Refer to **Oil Filter Adapter Replacement**.
12. Install the oil cooler pipes bracket bolt. **Tighten:** Tighten the bolts to 10 N.m (89 lb in).

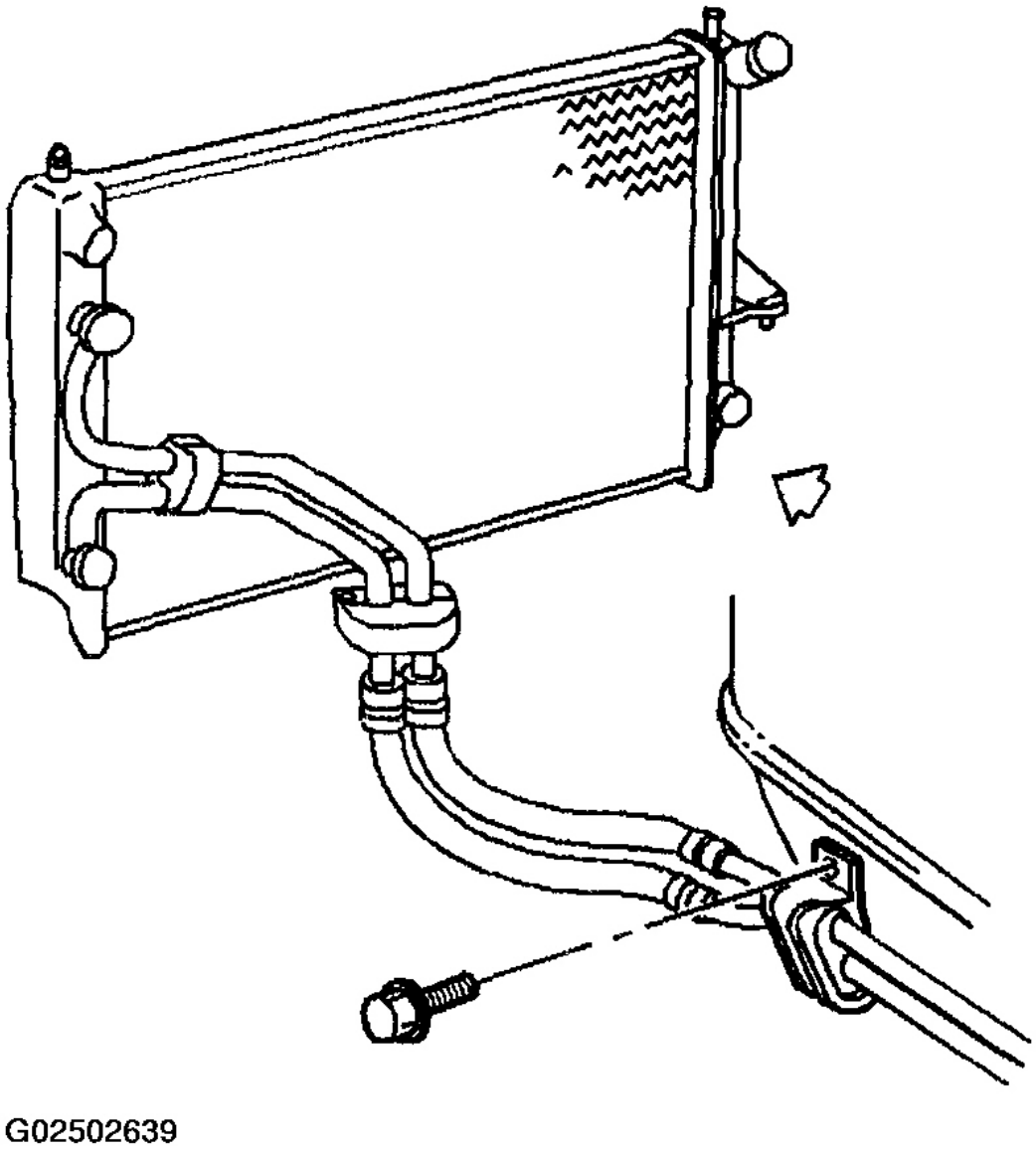

Fig. 157: Installing Oil Cooler Pipes Bracket-To-Oil Pan Bolt
Courtesy of GENERAL MOTORS CORP.

13. Install the oil filter. Refer to **ENGINE OIL & OIL FILTER REPLACEMENT**.
14. Install the oil pan drain plug. **Tighten:** Tighten the oil pan drain plug to 25 N.m (18 lb ft).
15. Lower the vehicle.
16. Fill the crankcase with engine oil. Refer to **ENGINE OIL & OIL FILTER REPLACEMENT**.
17. Connect the battery negative cable.

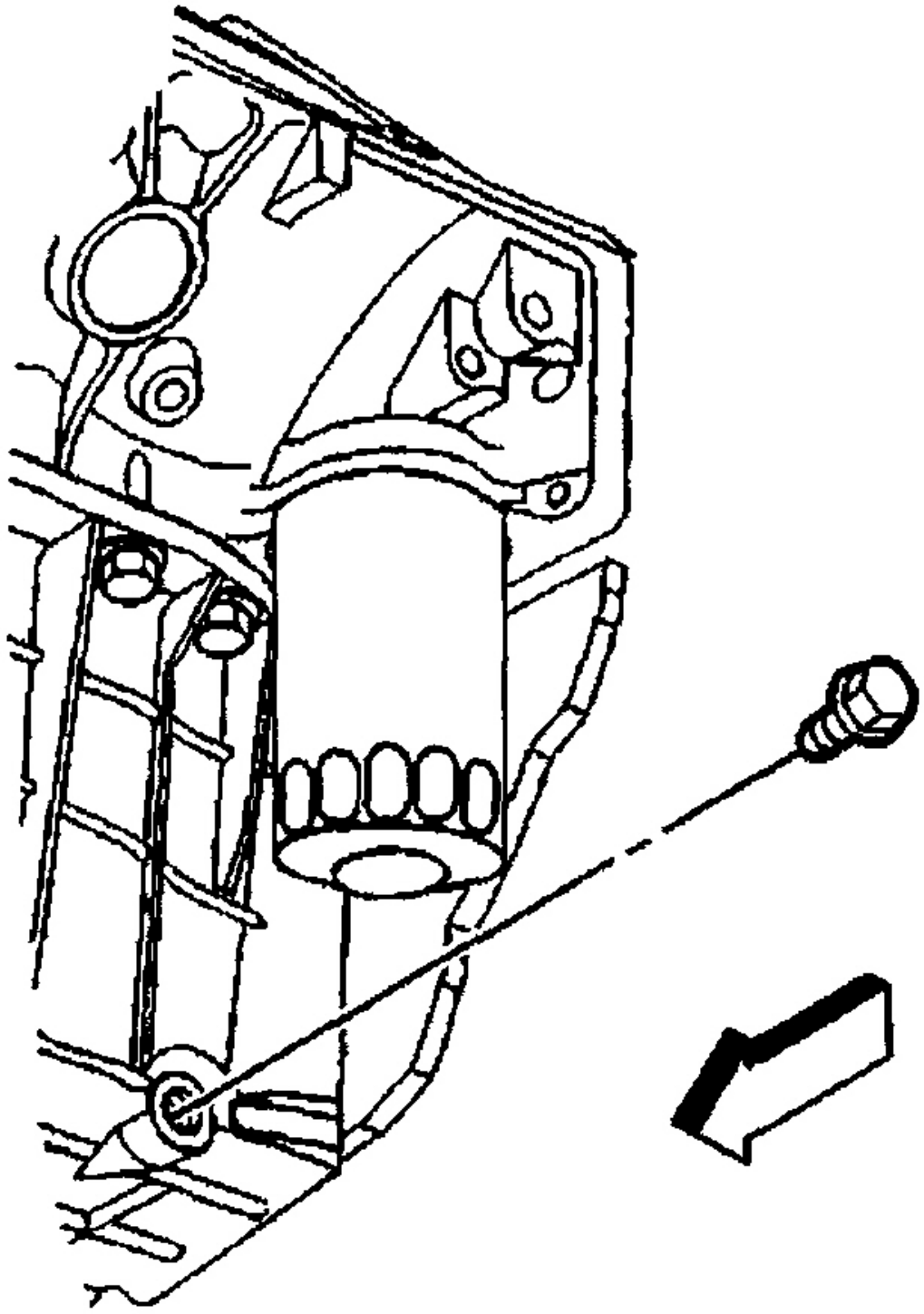

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Fig. 158: Installing Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required: J 41712 Oil Pressure Switch Socket.

Removal Procedure

1. Remove the engine cover.
2. Disconnect the engine oil pressure sensor gage electrical connector.
3. Hold the engine oil pressure gage sensor fitting with a wrench.
4. Remove the engine oil pressure gage sensor using J 41712.

IMPORTANT: Note the alignment of the engine oil pressure gage sensor fitting prior to removal.

5. Removing engine oil pressure gage sensor fitting, if necessary.

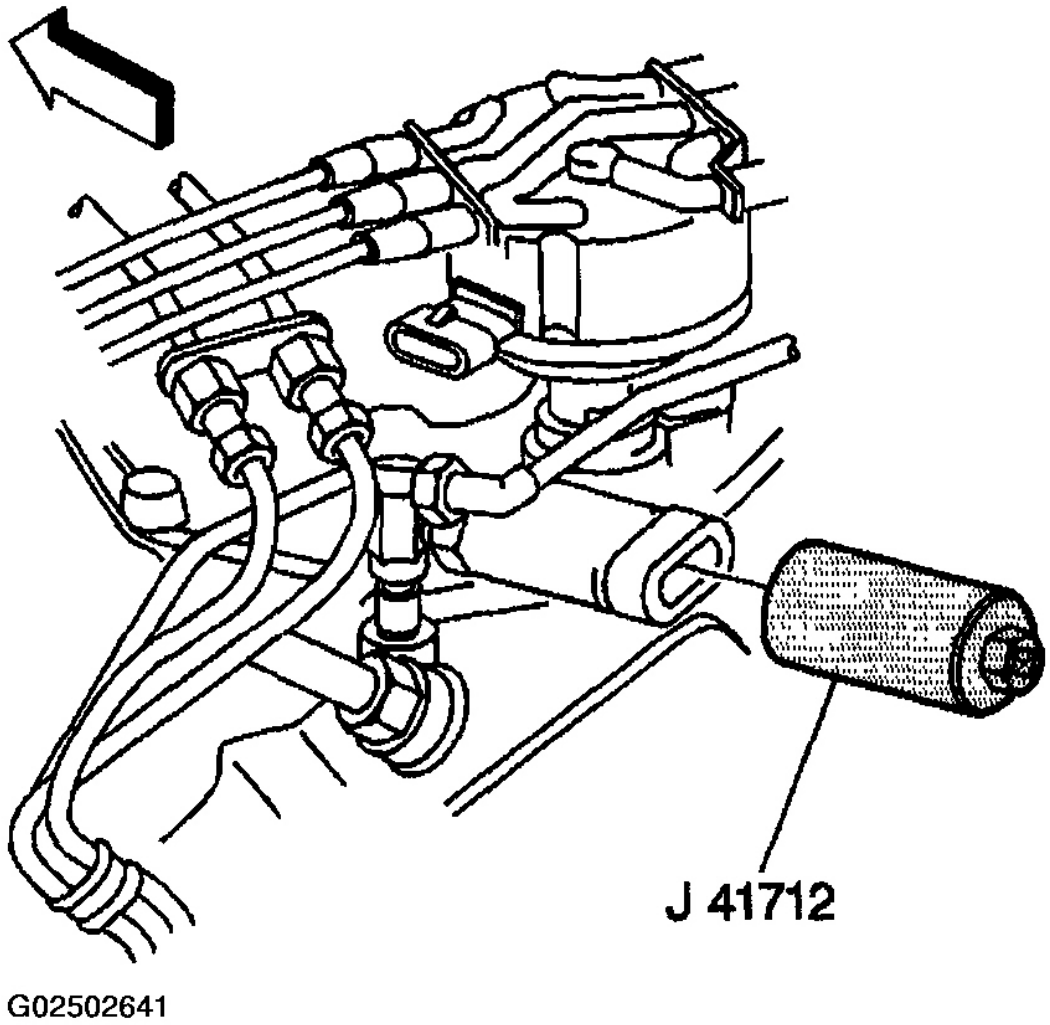

Fig. 159: Removing Engine Oil Pressure Gage Sensor
Courtesy of GENERAL MOTORS CORP.

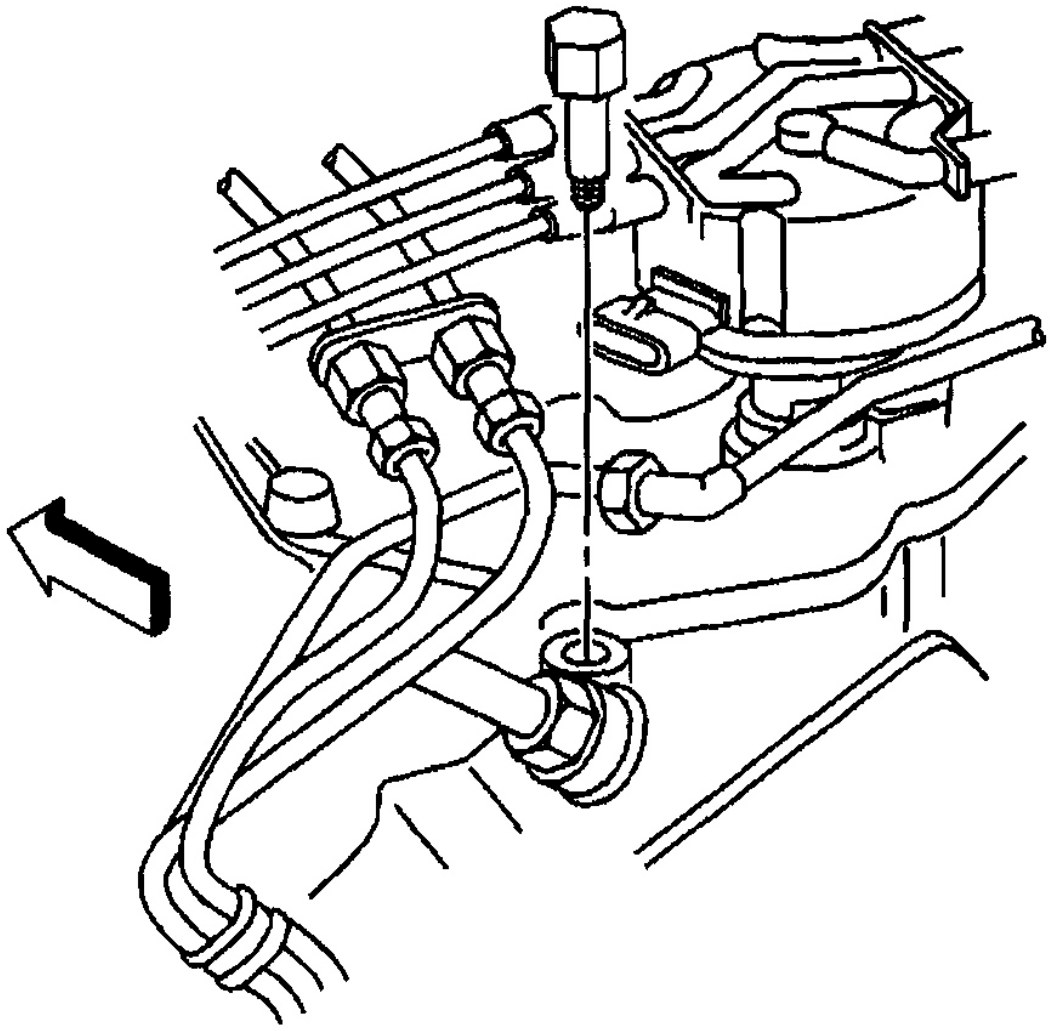

Fig. 160: Removing Engine Oil Pressure Gage Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine oil pressure gage sensor fitting, if removed.

   Tighten:

   a. Tighten the engine oil pressure gage sensor fitting to 15 N.m (11 lb ft).

IMPORTANT: Do not loosen the sensor fitting. Do not tighten the sensor fitting more than one turn to align.

b. Tighten the sensor fitting until properly aligned.

2. Install the engine oil pressure gage sensor.
3. Hold the engine oil pressure gage sensor fitting with a wrench to prevent from turning. **Tighten:** Using J 41712, tighten the engine oil pressure gage sensor to 30 N.m (22 lb ft).
4. Install the engine oil pressure gage sensor electrical connector.
5. Install the engine cover.

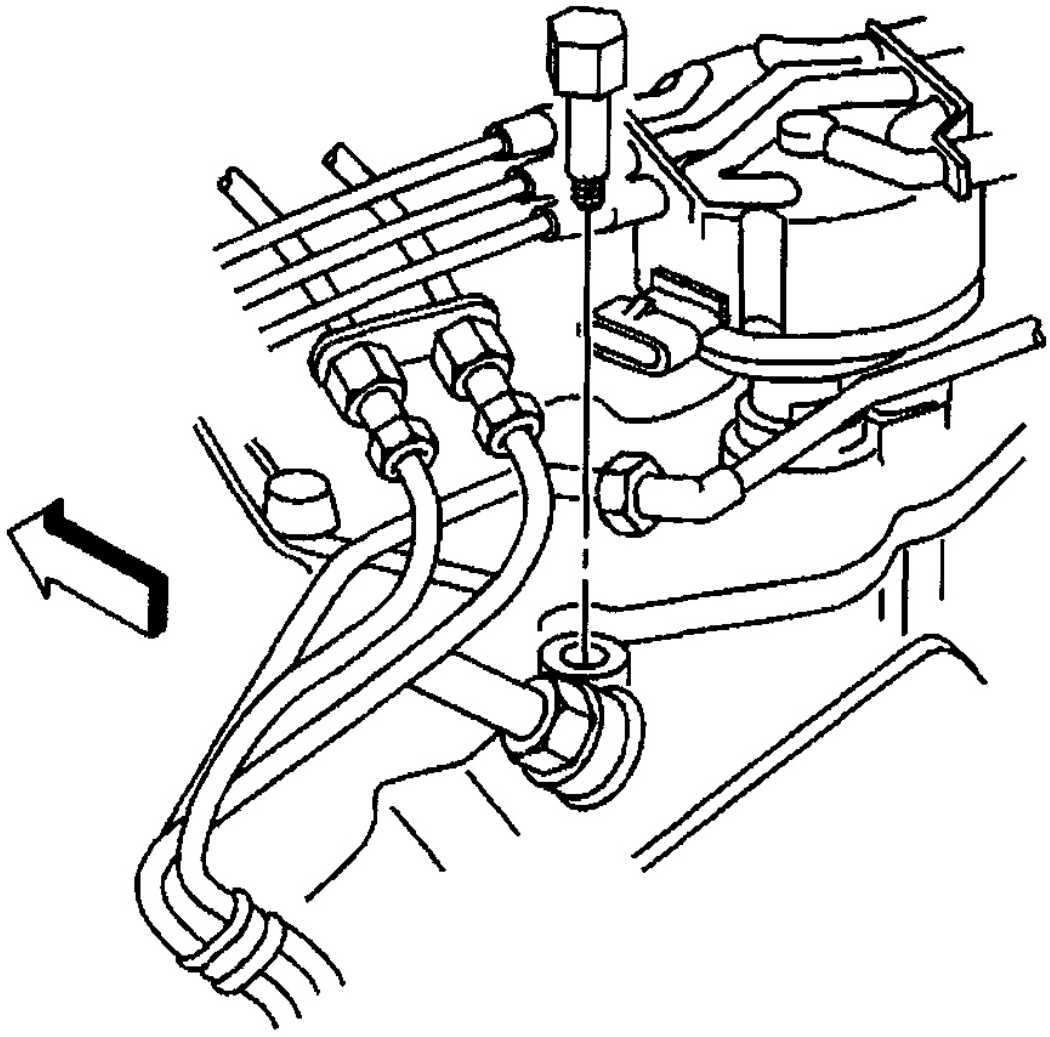

Fig. 161: Installing Engine Oil Pressure Gage Sensor Fitting
Courtesy of GENERAL MOTORS CORP.

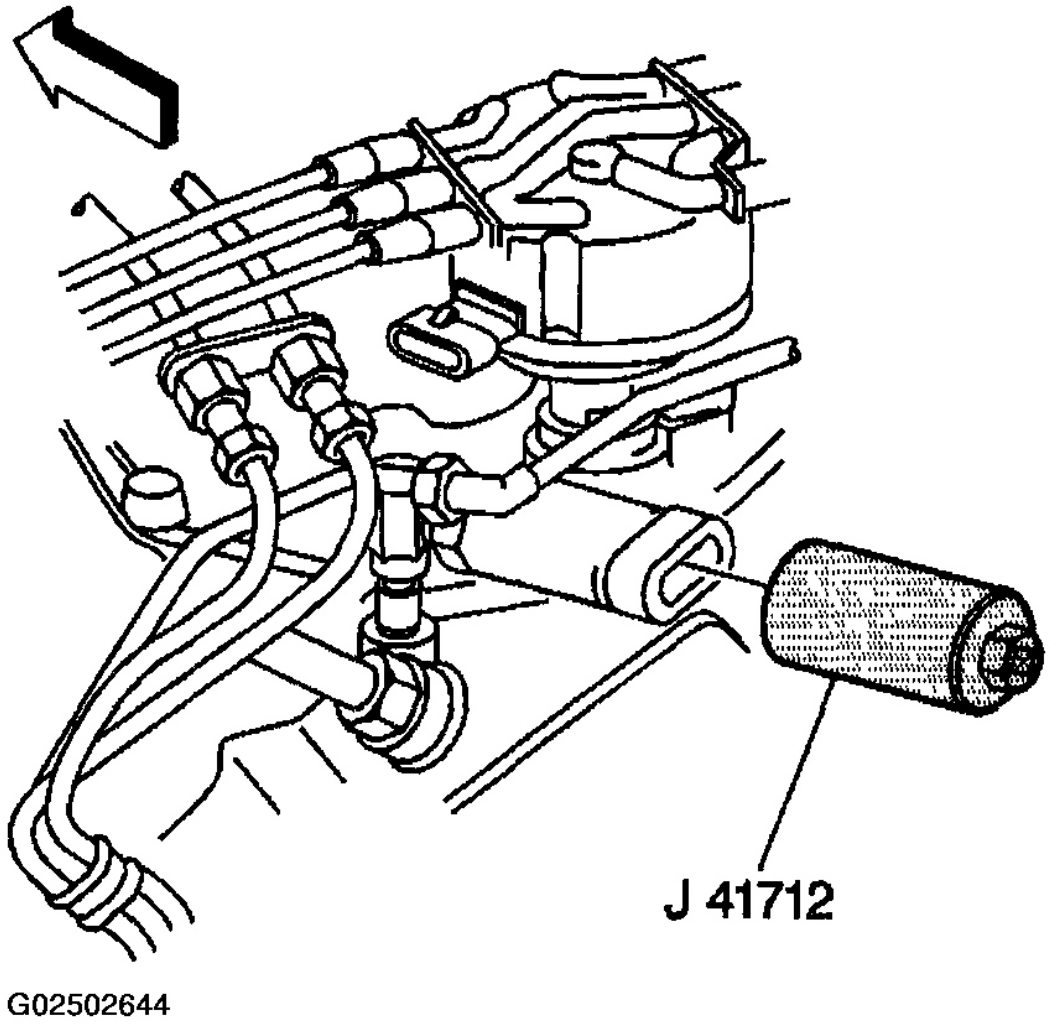

Fig. 162: Installing Engine Oil Pressure Gage Sensor
Courtesy of GENERAL MOTORS CORP.

OIL LEVEL INDICATOR & TUBE REPLACEMENT

Removal Procedure

1. Remove the engine cover.
2. Remove the oil level indicator.
3. Remove the bolt holding the oil level indicator tube to the transmission fluid fill tube.

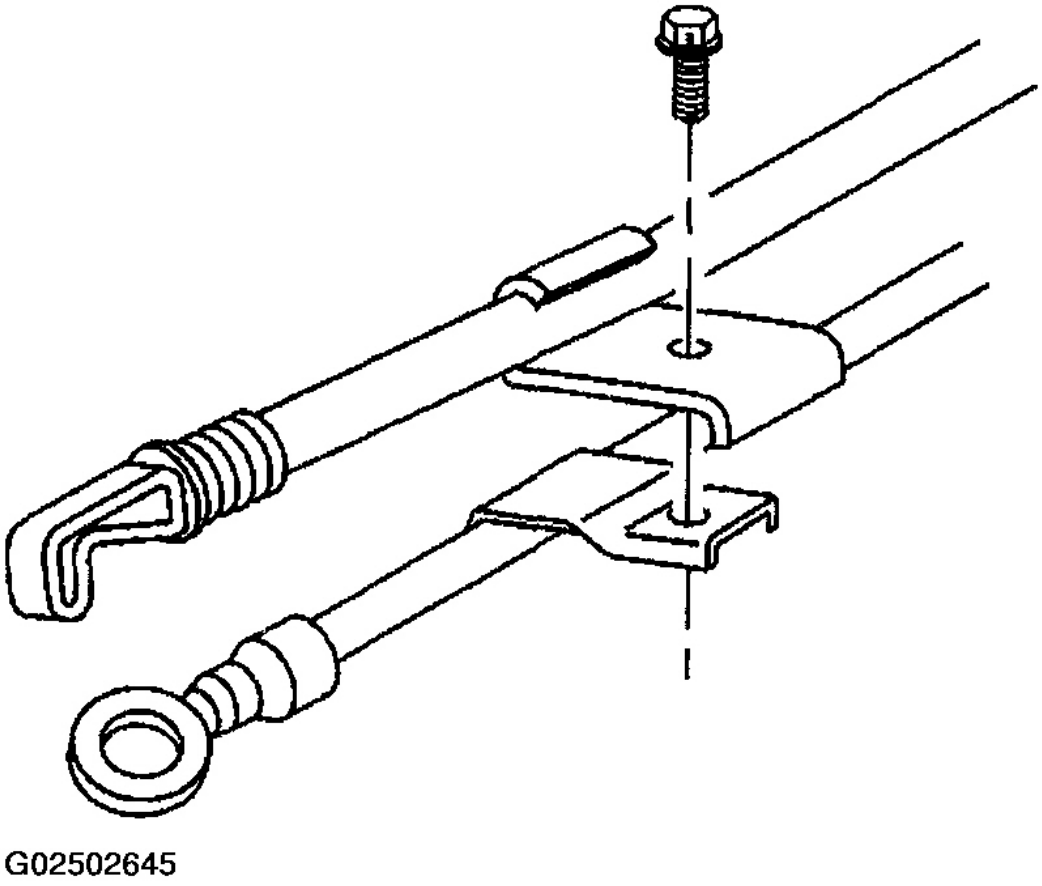

Fig. 163: Removing Oil Level Indicator Tube-To-Transmission Fluid Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

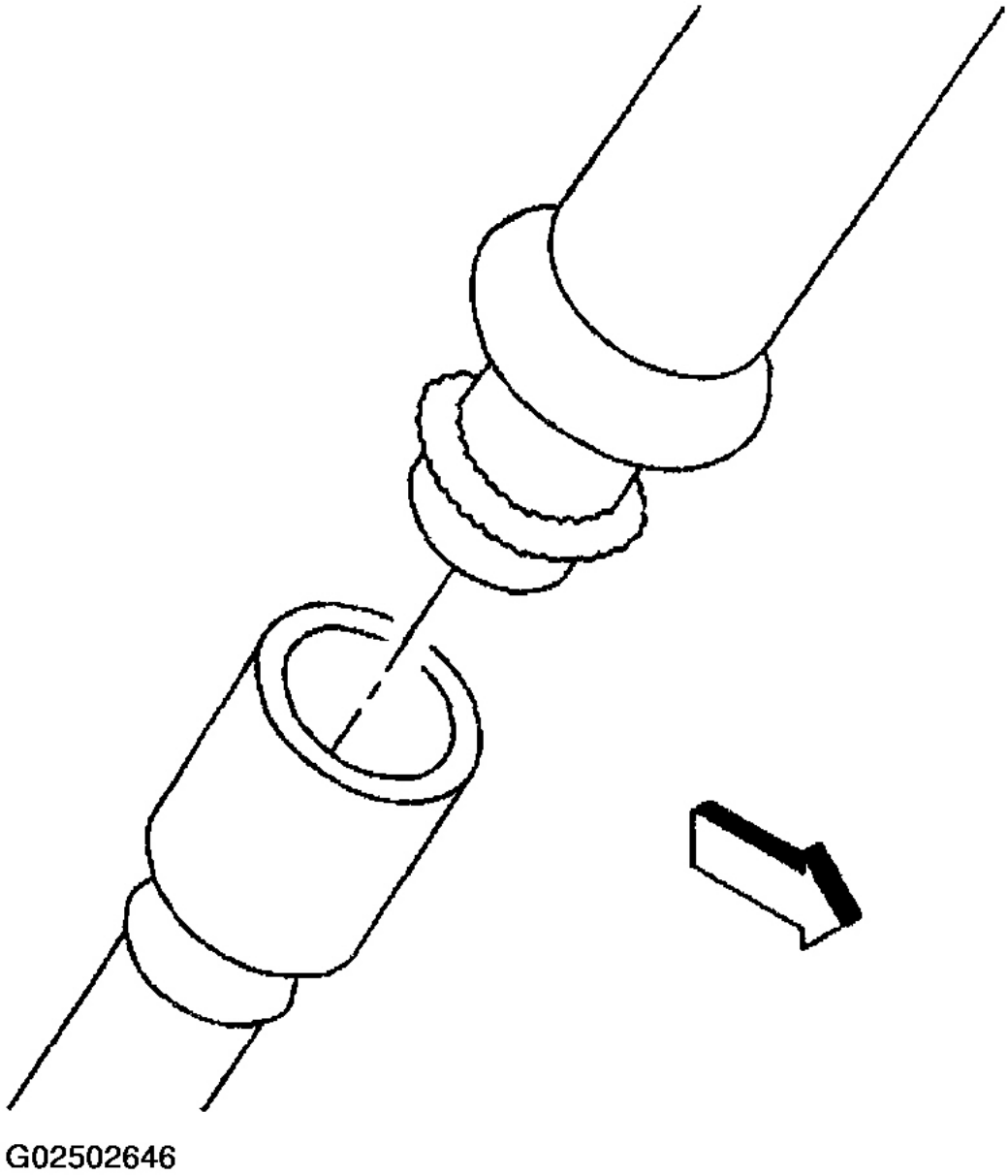

Fig. 164: Separating Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

4. Remove the upper half of the oil level indicator tube from the lower half.
5. Clean the old sealer from the tubes.
6. Remove the oil level indicator tube bolt.
7. Remove the oil level indicator tube from the engine using a twisting motion.

8. Clean the old sealer from the oil level indicator tube and the engine block.

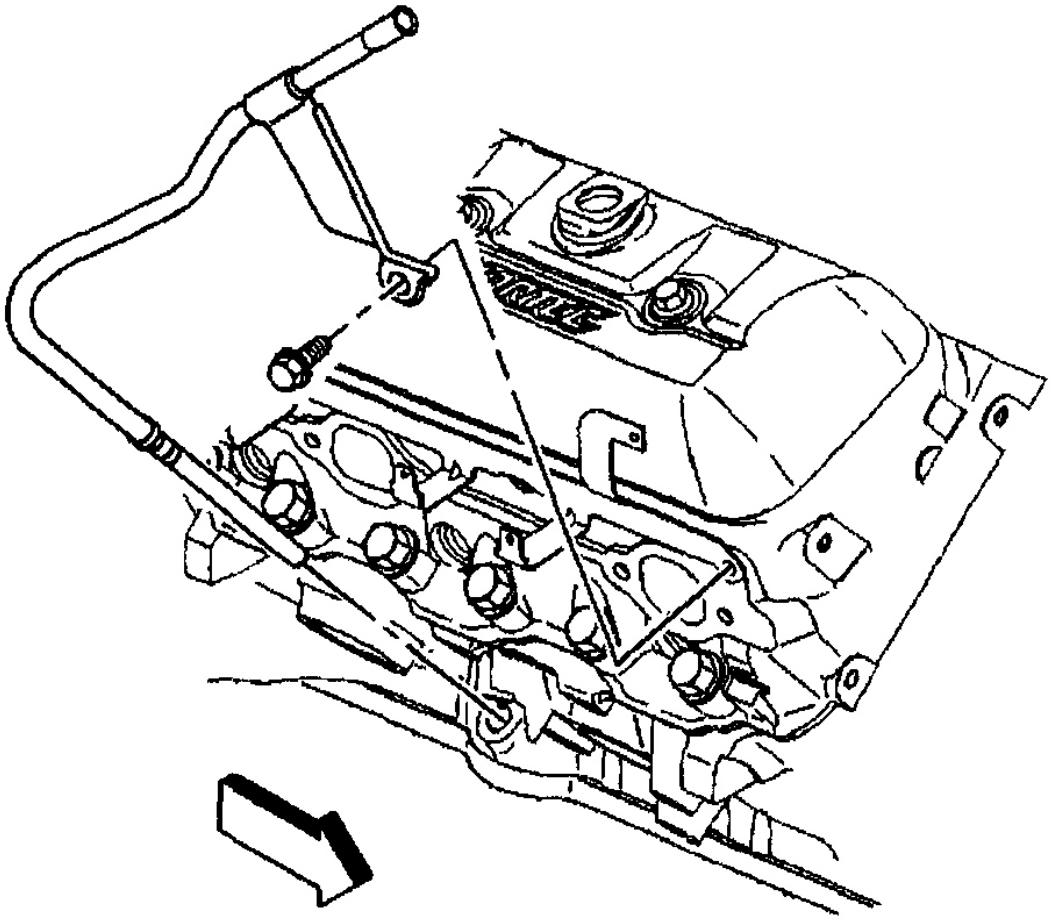

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Fig. 165: Removing Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the lower half of the oil level indicator tube to the engine.
2. Apply sealer, GM P/N 12346004 or equivalent, on the upper oil level indicator tube to the area where the tube fits into the lower half.
3. Install the oil level indicator tube upper half to the lower half.

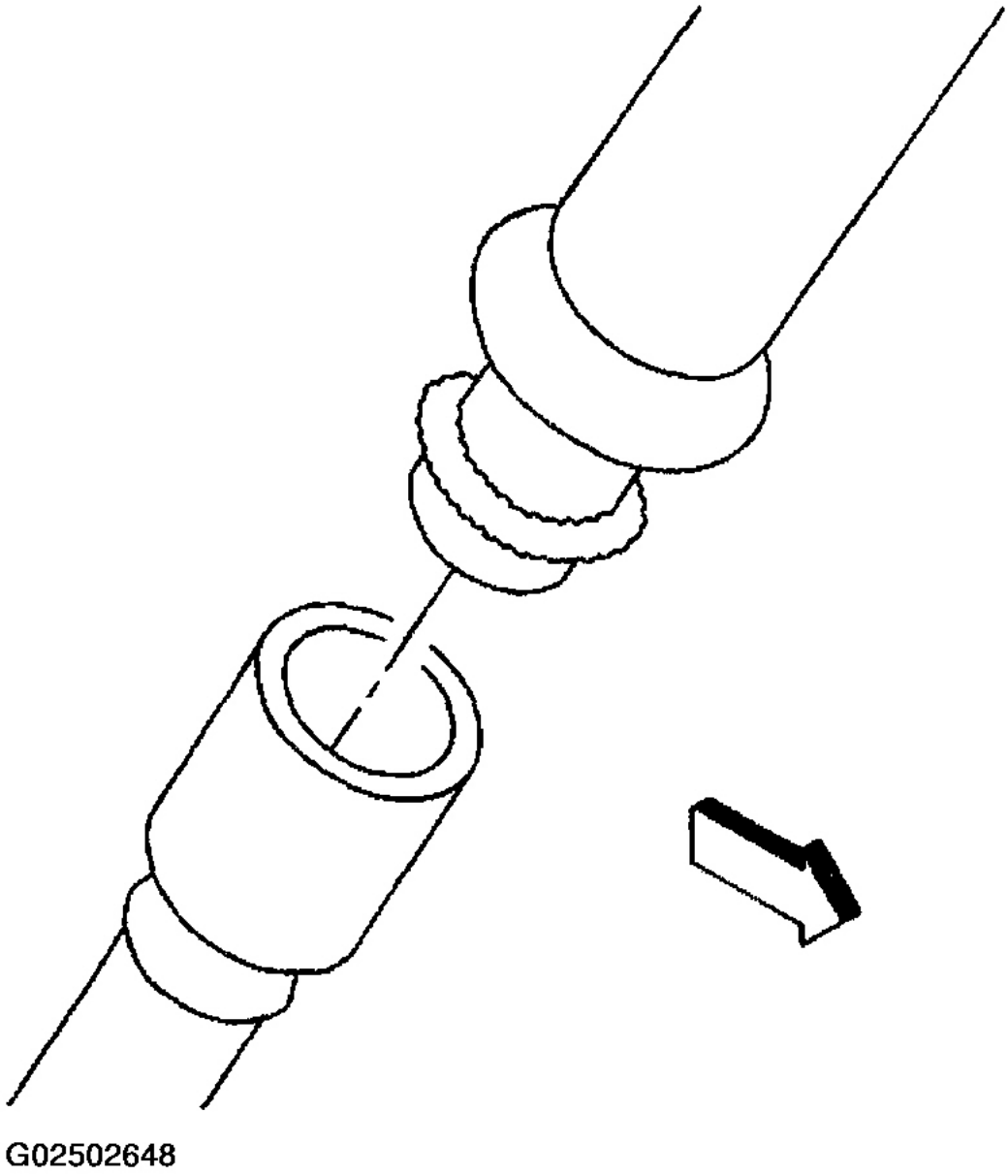

Fig. 166: Inserting Oil Level Indicator Tube Halves Together
Courtesy of GENERAL MOTORS CORP.

4. Secure the engine oil level indicator tube to the transmission fluid fill tube with the bolt. **Tighten:** Tighten the bolt to 12 N.m (106 lb in).
5. Install the oil level indicator.
6. Install the engine cover.

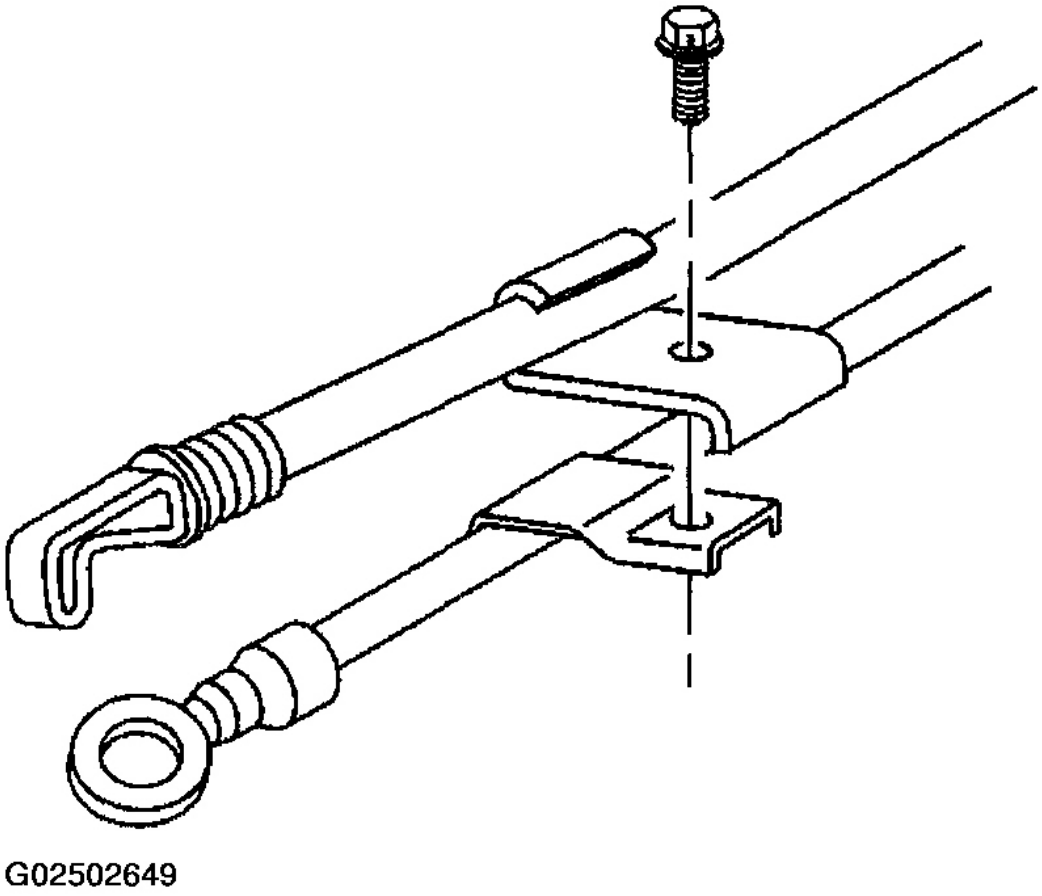

Fig. 167: Installing Oil Level Indicator Tube-To-Transmission Fluid Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

OIL PUMP REPLACEMENT

Removal Procedure

1. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
2. Remove the oil pump.
3. Clean and inspect all parts.

Installation Procedure

IMPORTANT: Use a NEW oil pump driveshaft retainer.

1. Install the oil pump.

2. 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 transmission assembly.
2. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
3. 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.
4. Discard the crankshaft rear oil seal.
5. Clean off any dirt or rust in the area.

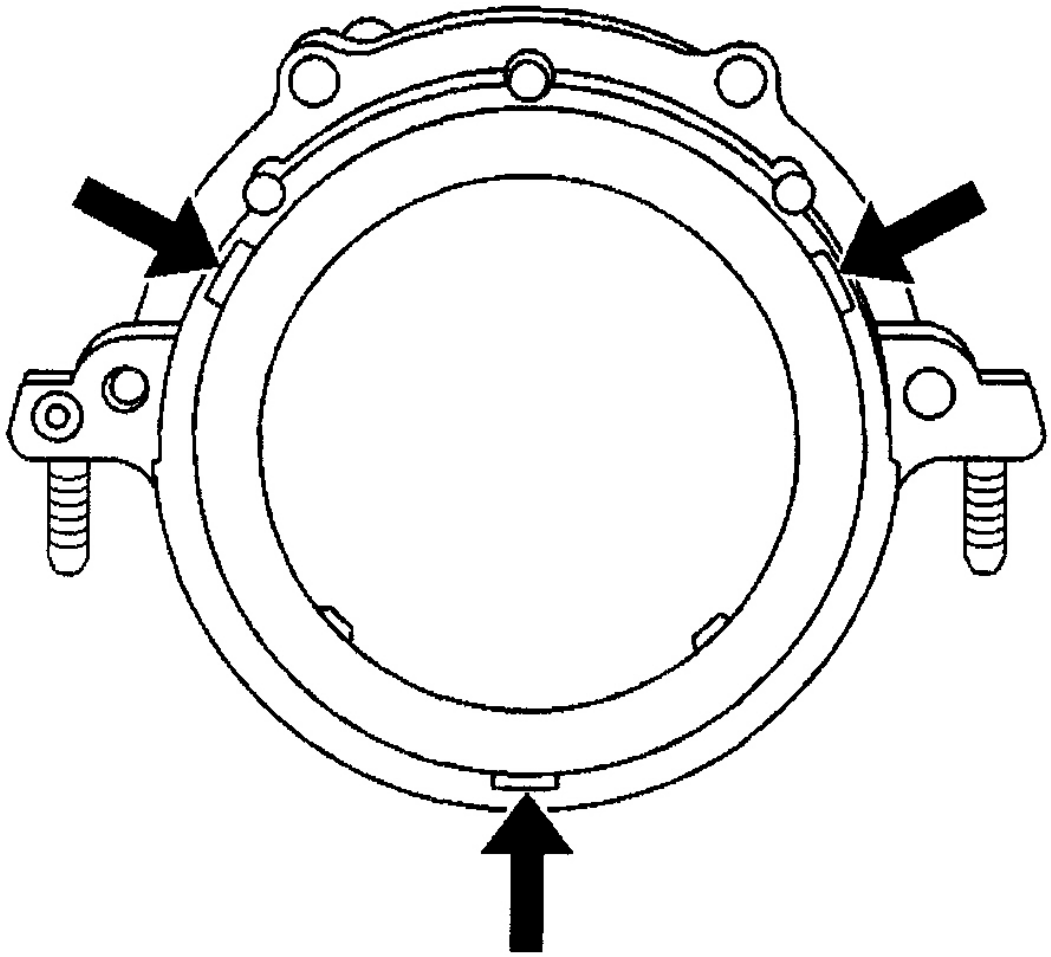

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Fig. 168: Locating Crankshaft Rear Oil Seal Access Notches
Courtesy of GENERAL MOTORS CORP.

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.

IMPORTANT: DO NOT allow oil or any other lubricants to contact the seal lip surface of the crankshaft rear oil seal.

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.
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.

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.

9. Install the J 35621-B onto the rear of the crankshaft and hand tighten the tool bolts until snug.

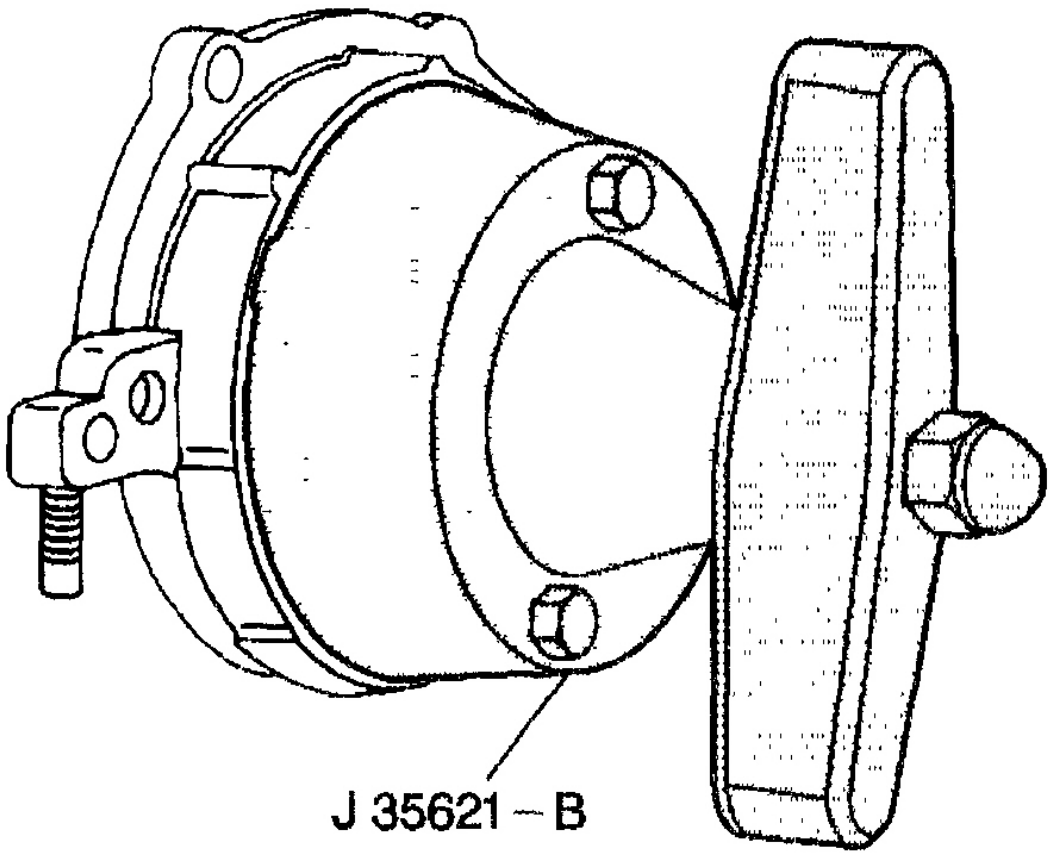

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Fig. 169: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

10. Install the crankshaft rear oil seal onto the crankshaft and into the crankshaft rear oil seal housing.
    a. 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.

    b. 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**.
14. Install transmission assembly.

CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

Removal Procedure

IMPORTANT: Do not remove the crankshaft rear oil seal housing if only replacing the crankshaft rear oil seal.

1. Remove the oil pan. Refer to **Oil Pan Replacement**.
2. Remove the transmission assembly.
3. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
4. Remove the bolts and the nut holding the crankshaft rear oil seal housing to the engine.
5. Remove the crankshaft rear oil seal housing.

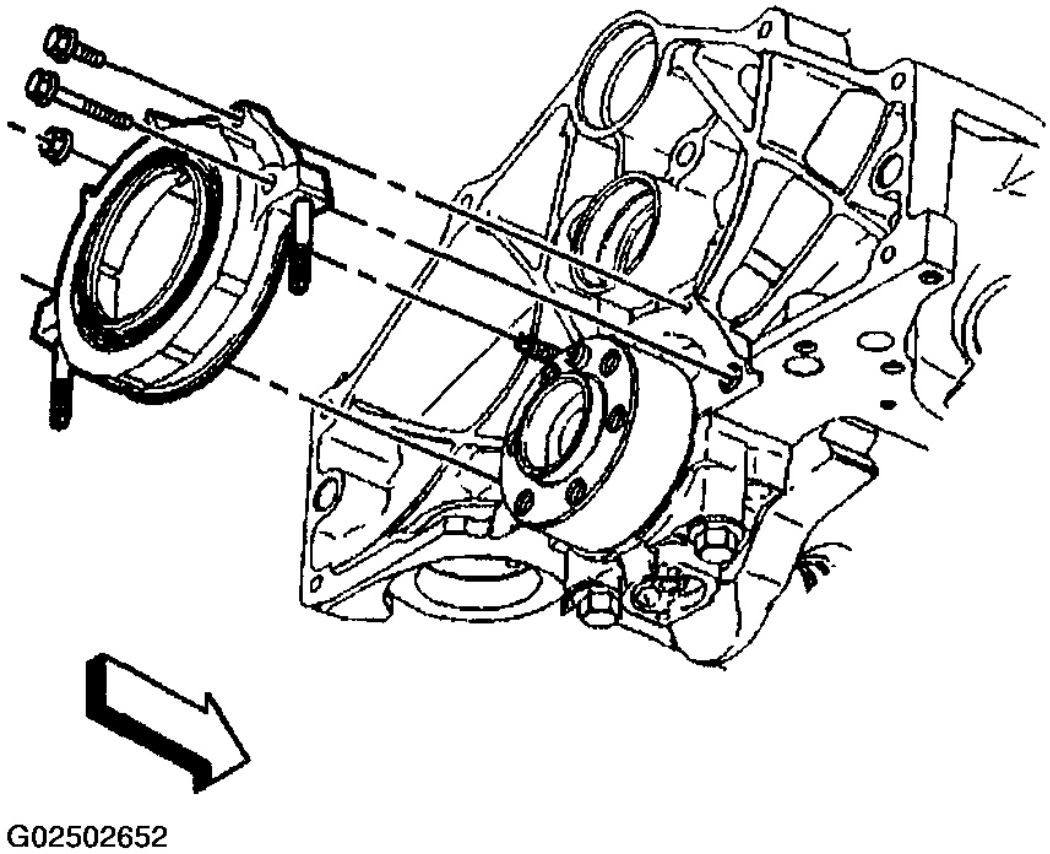

Fig. 170: Removing Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

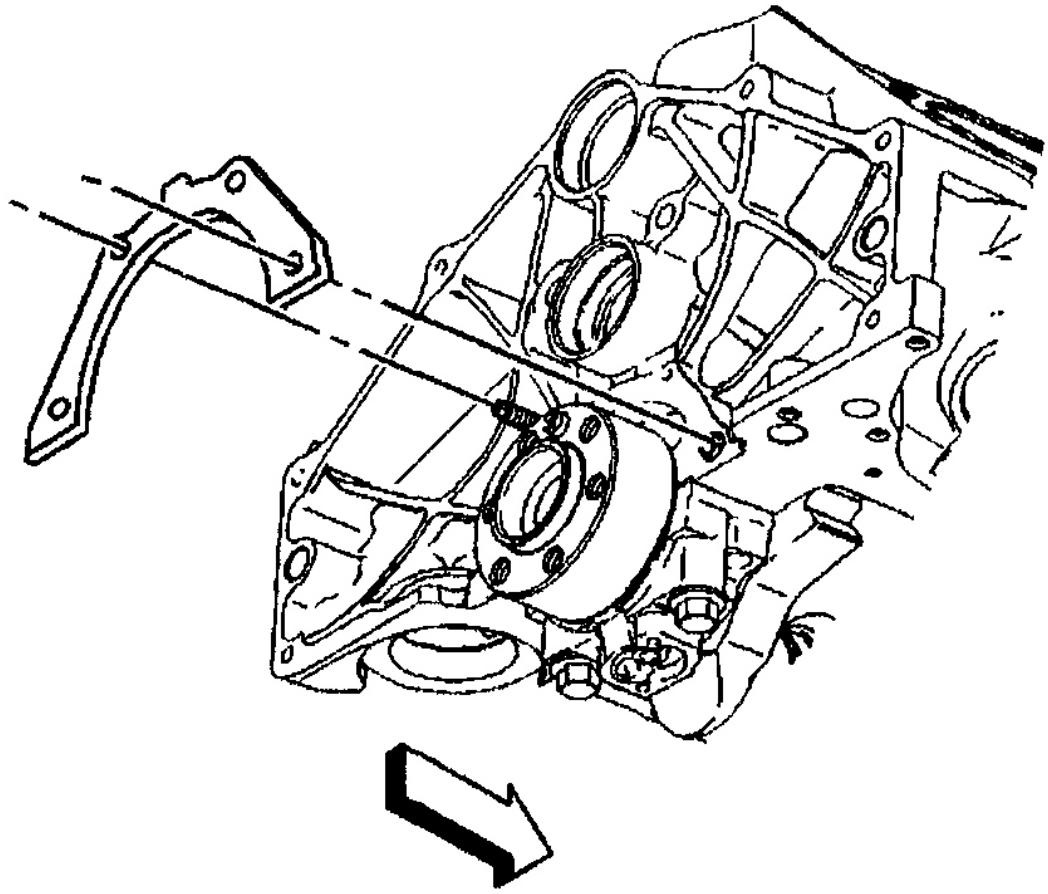

Fig. 171: Removing Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the crankshaft rear oil seal housing gasket.
7. Clean all the sealing surfaces.
8. Inspect and replace the crankshaft rear oil seal housing for warping, cracks, wear, or damage.

Installation Procedure

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 then refer to Crankshaft Rear Oil Seal Replacement to install the seal.

1. Install a NEW crankshaft rear oil seal housing gasket.

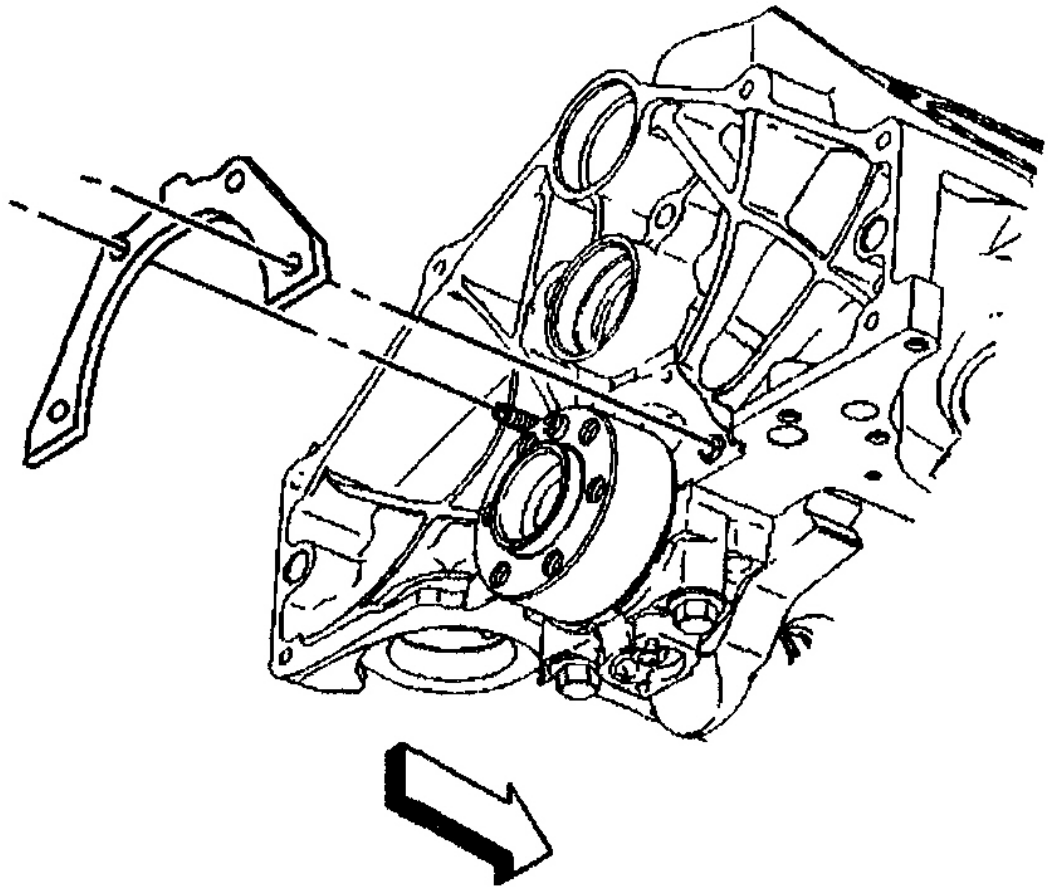

Fig. 172: Installing NEW Crankshaft Rear Oil Seal Housing Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not oil or grease the seal lip or the crankshaft seal area.

2. Install the NEW crankshaft rear oil seal housing with the oil seal to the engine block using the following procedure.
    a. 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.
    b. 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.
    c. Remove the sleeve.
3. Install the bolts and the nut to the crankshaft rear oil seal housing. **Tighten:** Tighten the crankshaft rear oil seal housing bolts and nut to 12 N.m (106 lb in).

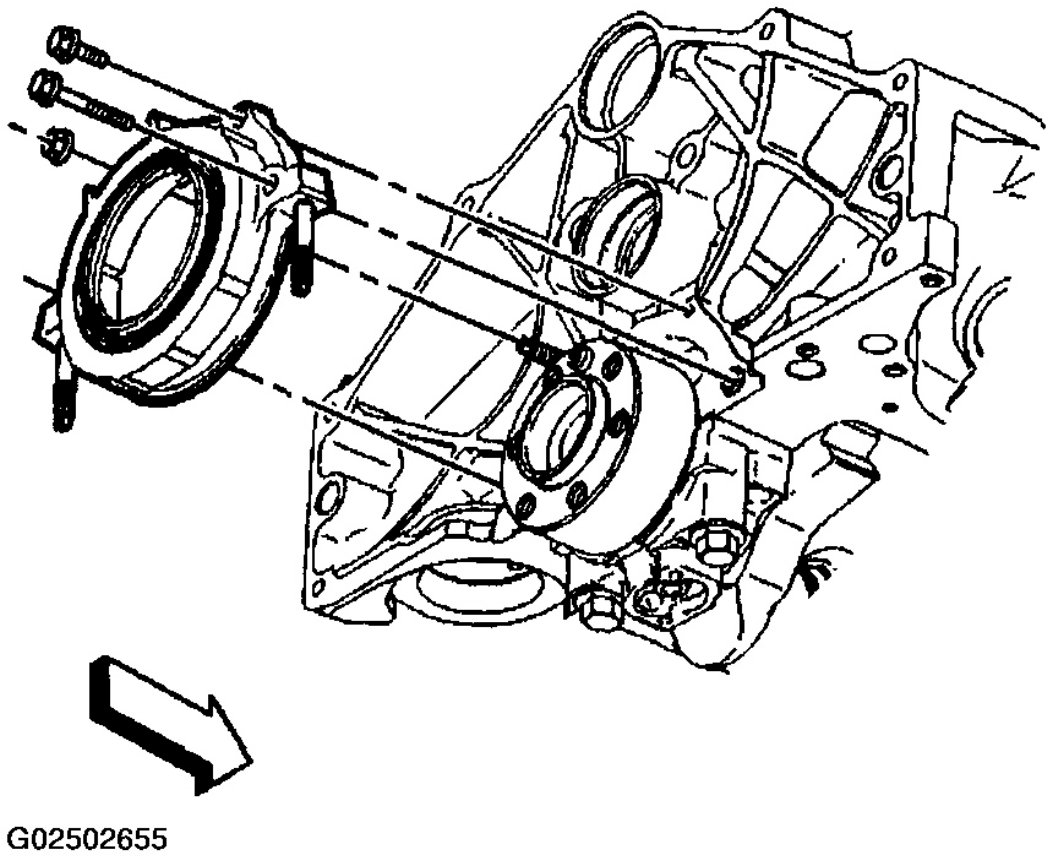

Fig. 173: Installing Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

4. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

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.**

5. Install the transmission assembly.
6. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

1. Remove the transmission assembly.

2. Remove the bolts and the engine flywheel.
3. Clean and inspect all parts.

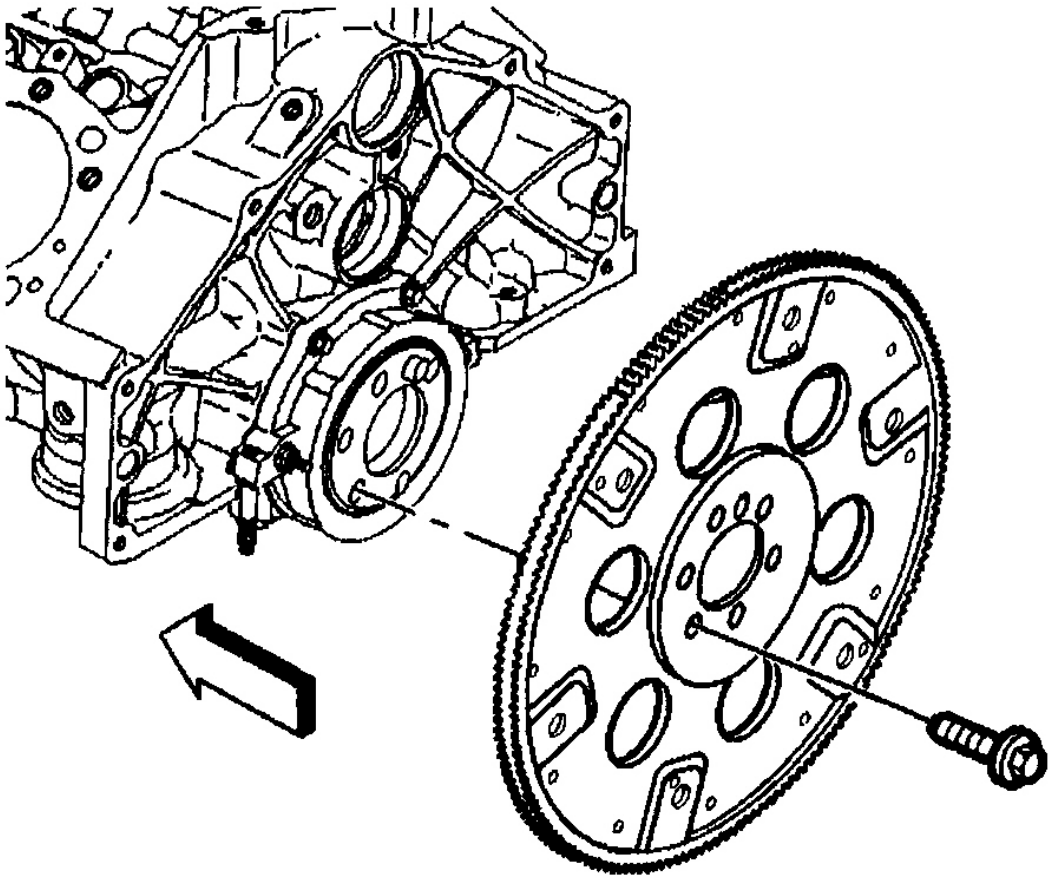

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Fig. 174: Removing Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine flywheel to the crankshaft.
2. Align the locator hole to the pin.

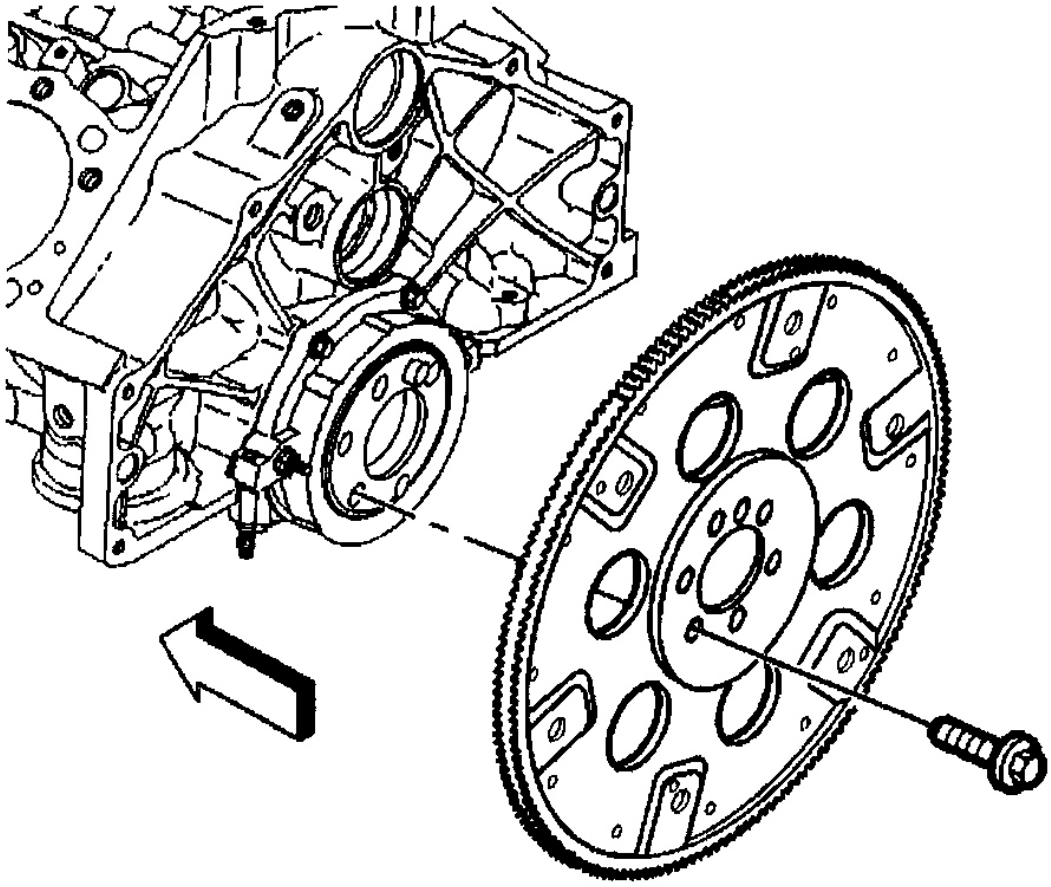

Fig. 175: Aligning Locator Hole To Pin
Courtesy of GENERAL MOTORS CORP.

3. Install the engine flywheel bolts. **Tighten:** Tighten the engine flywheel bolts in sequence to 100 N.m (74 lb ft).
4. Install the transmission assembly.

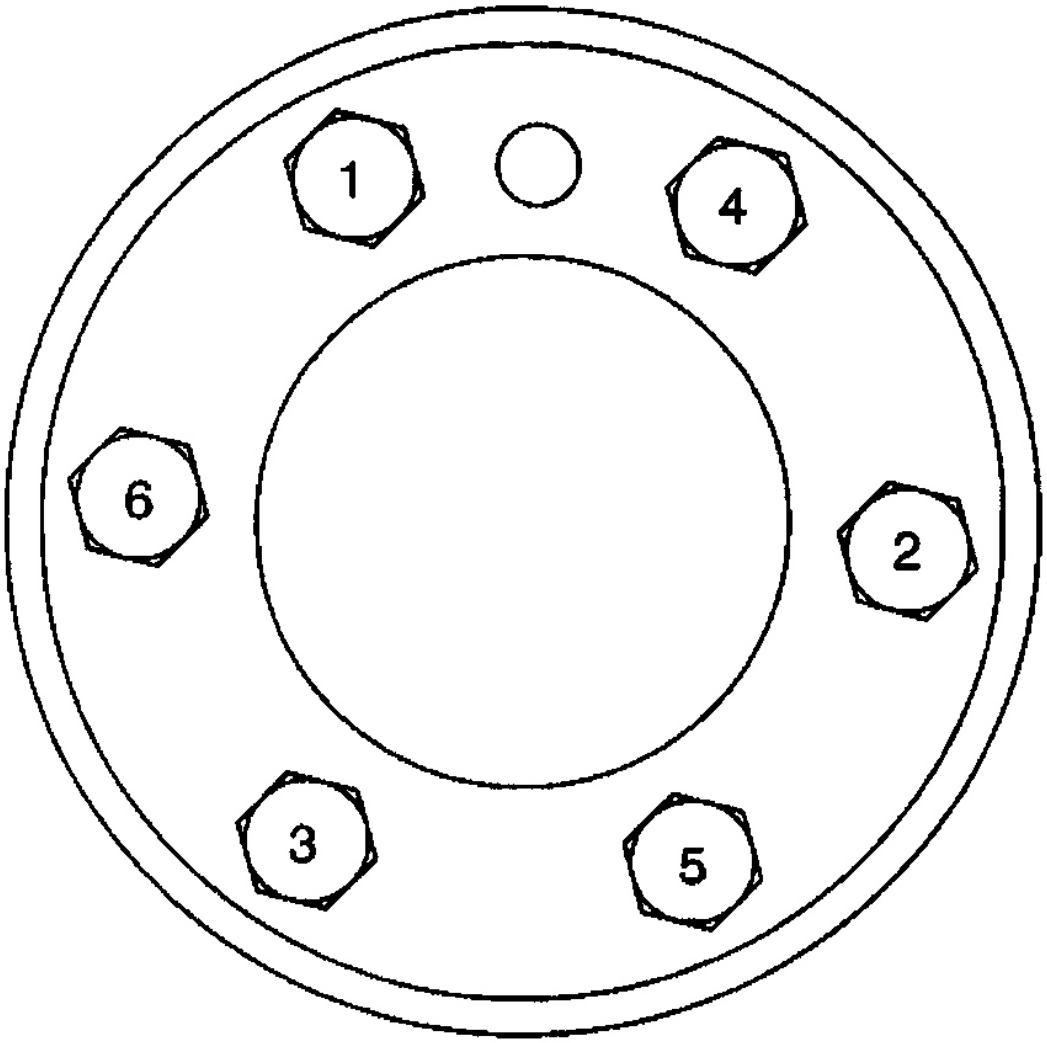

Fig. 176: Engine Flywheel Bolt Torque Sequence
Courtesy of GENERAL MOTORS CORP.

ENGINE REPLACEMENT

Tools Required:

- **J 41427** Engine Lift Bracket.
- **J 41602** Body Protection Hoist Adapter Set.
- **J 39580** Universal Engine Support Table.

NOTE: **Failure to flush out the oil cooling system or the engine cooling system may result in premature failure of the replacement engine. If the engine is damaged internally and a new engine is installed, make sure that all foreign material is completely flushed out of the cooling system. The oil cooler system should be also be flushed out, if equipped.**

IMPORTANT: **This procedure must be performed on a side lift hoist. The engine and front frame assembly will be removed out of the bottom of the vehicle. A single post hoist or a twin post hoist cannot be used to perform this procedure.**

Removal Procedure

1. Disconnect the battery negative cable.
2. Remove the engine cover.
3. Remove the air cleaner assembly.
4. Remove the air cleaner outlet duct from the throttle body.
5. Remove the following components:
   - The upper fan shroud
   - The fan
   - The clutch
   - The lower fan shroud
   - Both radiator hoses
   - The oil cooler lines
   - The transmission cooler lines
6. Disconnect the air conditioning hose at the accumulator and the condenser, if equipped.
7. Remove the bolts holding the condenser to the radiator.
8. Remove the radiator.

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.**

9. Remove the accelerator control cable.
10. Remove the cruise control cable, if equipped, from the throttle shaft.
11. Remove the cruise control cable from the accelerator control cable bracket.
12. Remove the power steering reservoir and drain the fluid.
13. Disconnect the pipes from the hydro boost unit.
14. Disconnect the master cylinder from the hydro boost unit.

15. Tie the master cylinder to the oil fill tube.
16. Disconnect the steering shaft from the steering gear.
17. Disconnect the heater hoses from the engine.
18. Disconnect the vacuum hose to the vacuum tank from the intake manifold.

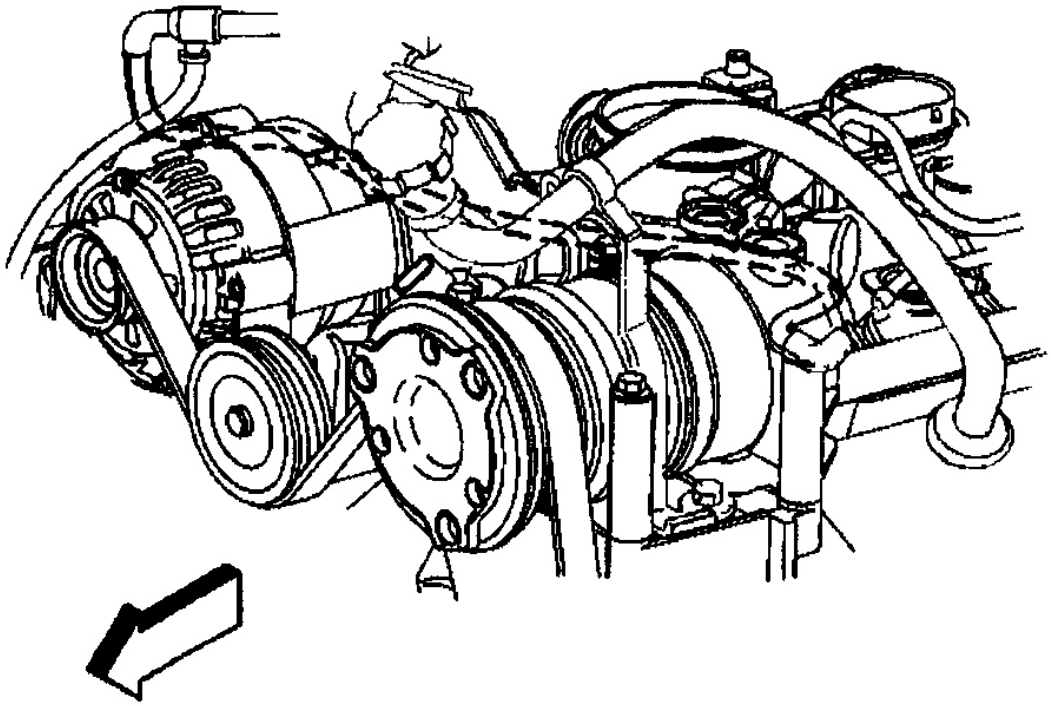

Fig. 177: Disconnecting Vacuum Hose From Intake Manifold
Courtesy of GENERAL MOTORS CORP.

19. Disconnect the engine wiring harness from the VCM.
20. Disconnect the fuse box and the wiring harness from the bulkhead connector.
21. Disconnect the negative battery cable from the battery. Disconnect the battery cable assembly from the fender and the radiator support.
22. Secure the battery cable assembly to the engine.
23. Disconnect all related electrical connectors that connect the wiring harness to the body under the hood including the following:
    - The ground wires
    - The A/C module
    - The differential pressure input switch
24. Remove the wiring harness from the retainers and lay the harness on the engine.

25. Remove the front section of the running boards, if equipped.

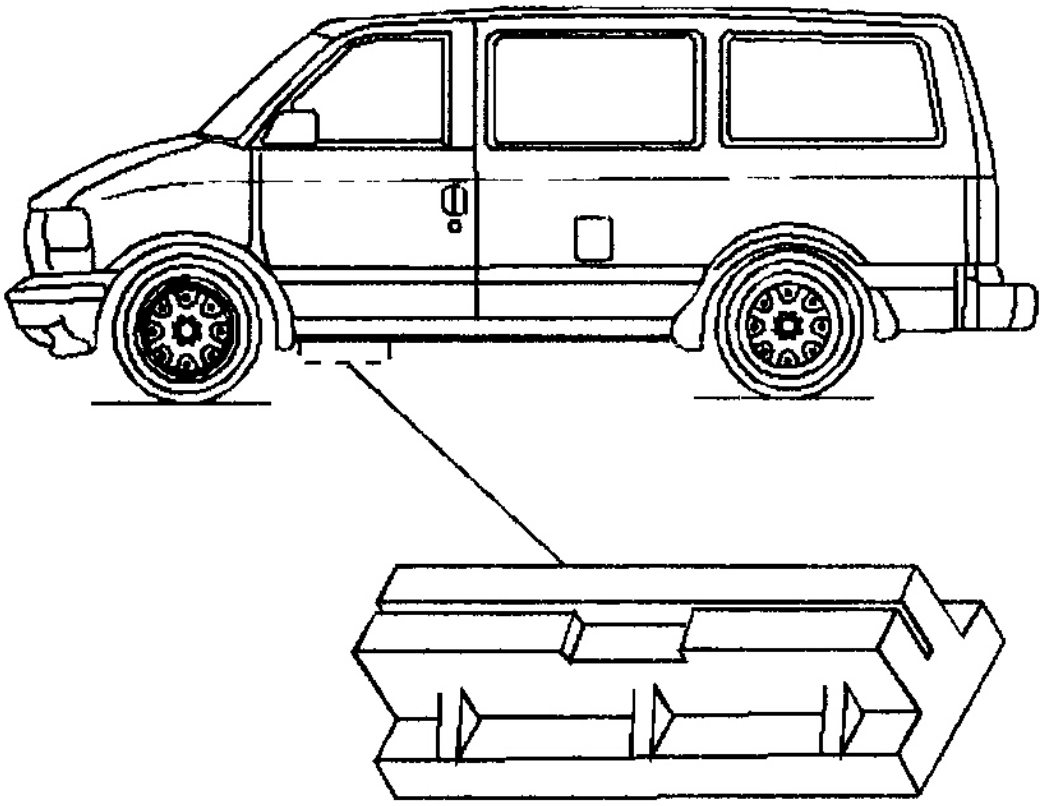

Fig. 178: Removing Front Section Of Running Boards
Courtesy of GENERAL MOTORS CORP.

26. Install the J 41602 to the pinch weld area on both sides of the vehicle.
27. Position the front hoist arms under the J 41602.
28. Make sure the rear of the vehicle is slightly higher than the front.
29. Raise the vehicle.
30. Remove the oil pan drain plug and drain the engine oil into a suitable container.

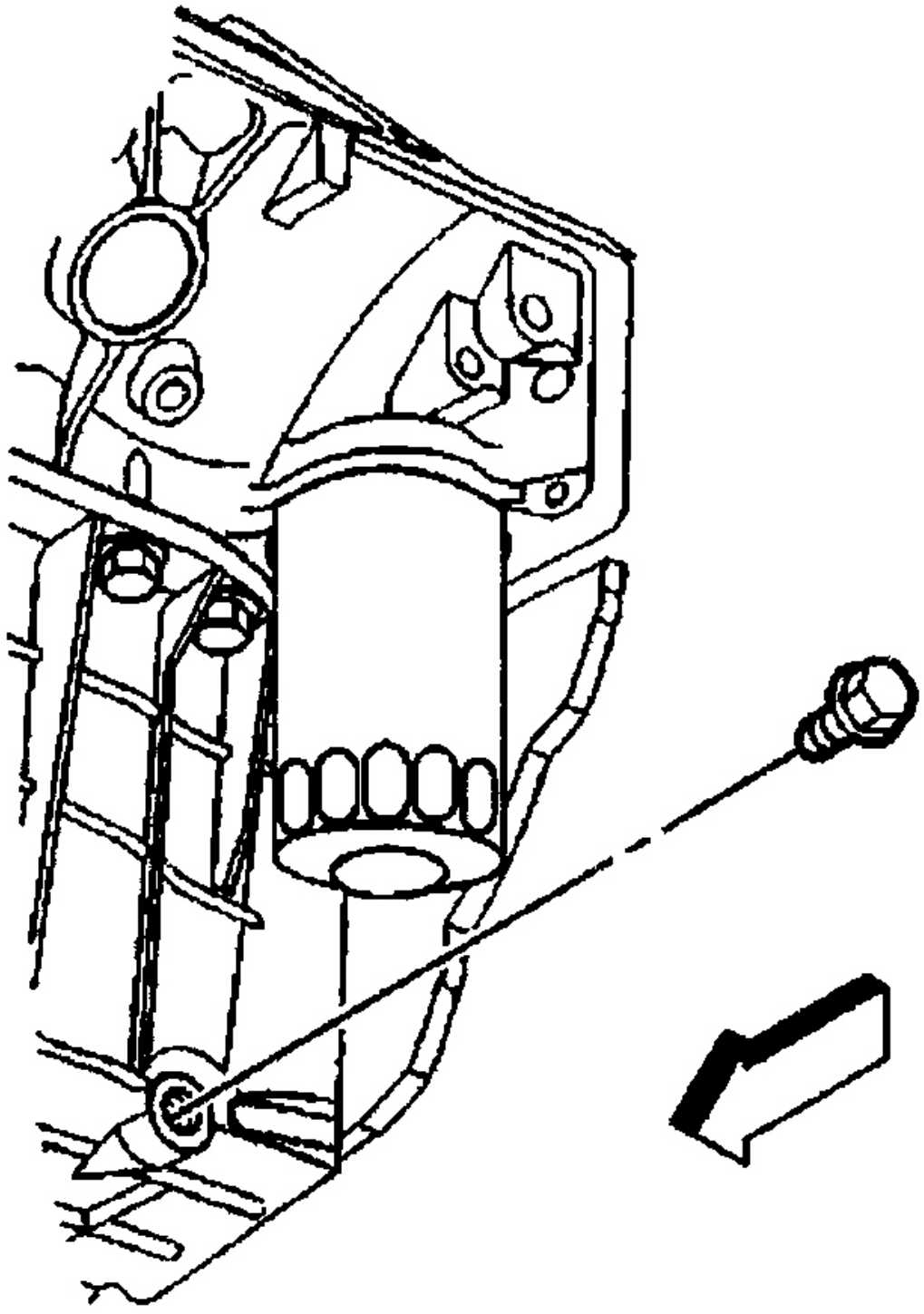

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Fig. 179: Removing Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

31. Remove the engine oil cooler pipes from the oil filter adapter.
32. Remove the rear propeller shaft.
33. Remove the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .
34. Remove the transmission cover.

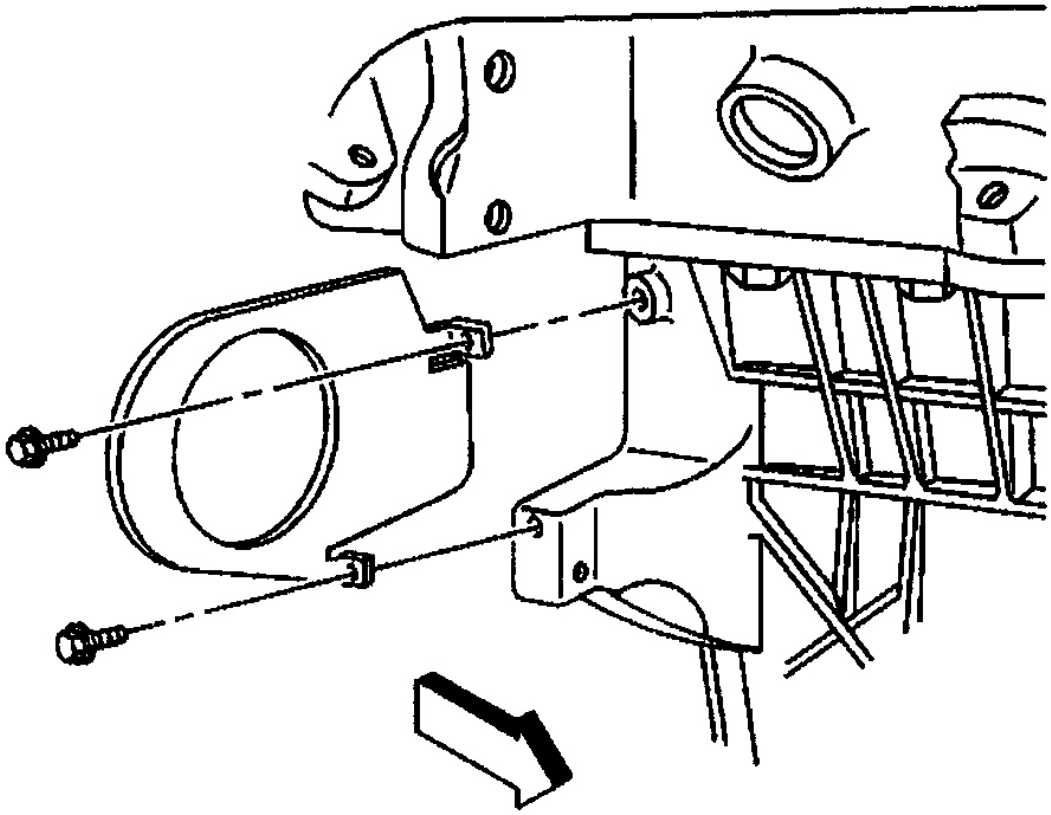

Fig. 180: Removing Transmission Cover
Courtesy of GENERAL MOTORS CORP.

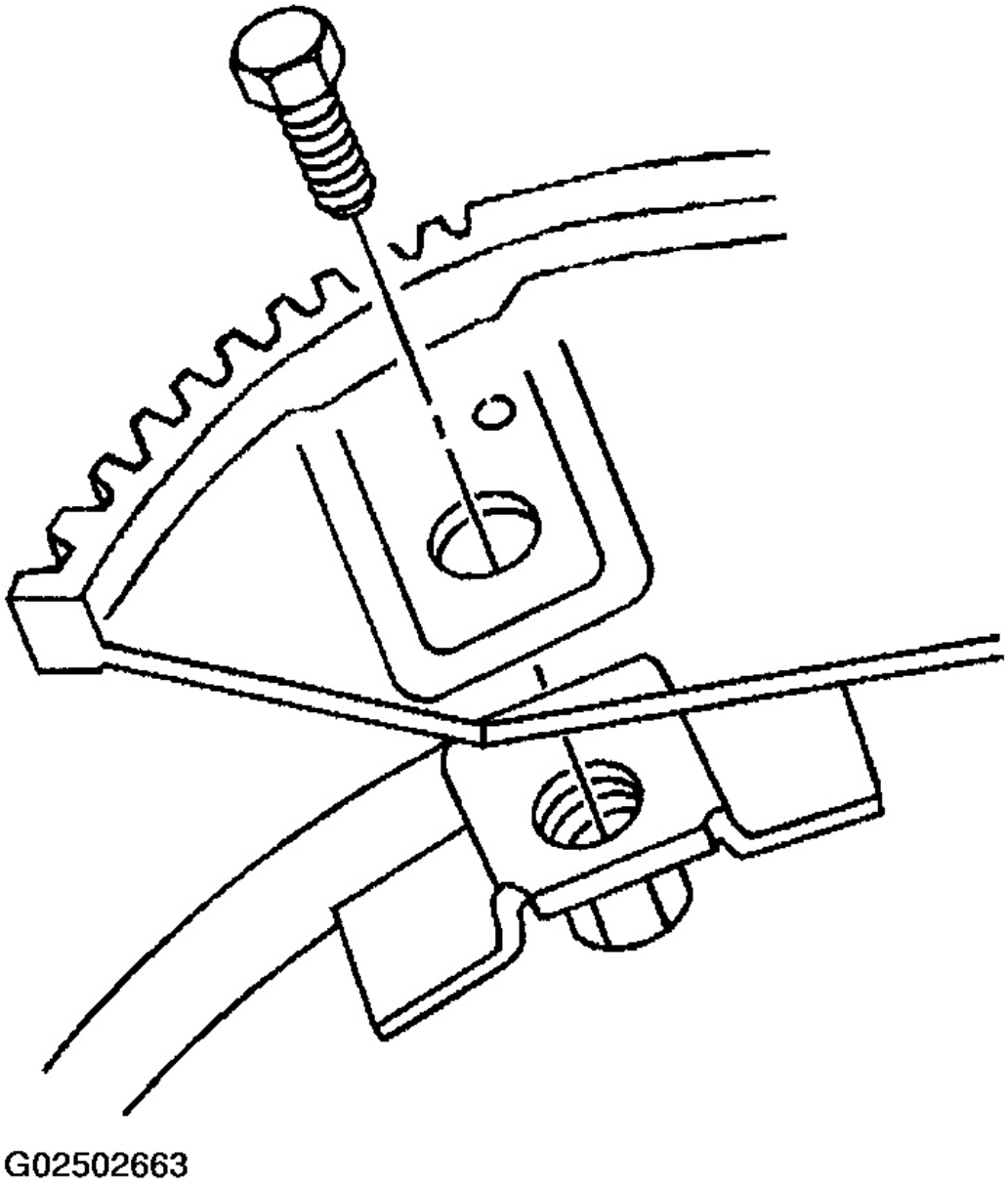

Fig. 181: Removing Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

35. Remove the torque converter bolts through the starter opening.
36. Disconnect the shift cable from the transmission.
37. Remove the heat shield.
38. Disconnect the exhaust system at the main flange behind the catalytic converter.

39. Remove the muffler and tail pipe section from the hangers and remove from the vehicle.
40. Remove the park brake bracket from the frame.

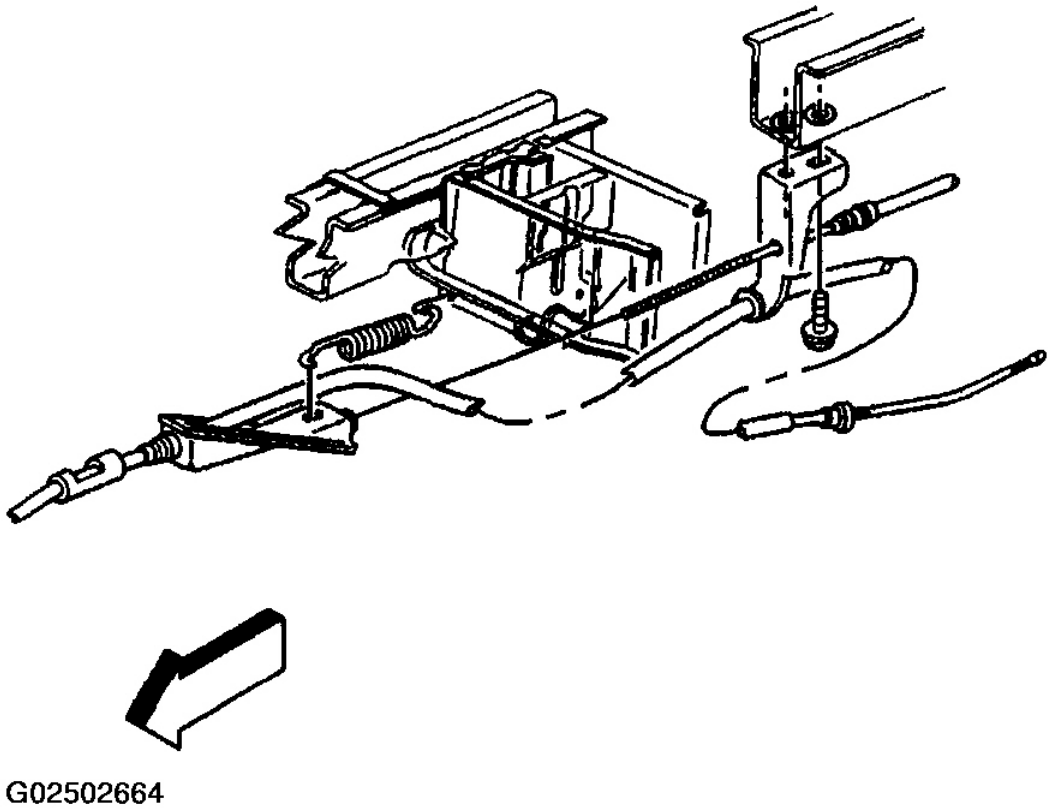

Fig. 182: Locating Parking Brake Bracket At Frame
Courtesy of GENERAL MOTORS CORP.

41. Disconnect the rear brake pipe from the brake pressure modulator valve (BPMV).
42. Remove the front bumper.
43. Disconnect the power steering cooler from the front air deflector.
44. Disconnect the inflatable restraint front end discriminating sensor electrical connector.
45. Disconnect the fender wheelhouse extensions from the chassis to the frame.
46. Disconnect the rear air conditioning pipes at the rear crossmember, if equipped. Leave the air conditioning pipes attached to the powertrain assembly.
47. Disconnect the fuel pipes at the fuel filter.
48. Pull the fuel pipes through the crossmember (forward). Lay the fuel pipes on the transmission.
49. Disconnect the fuel tank electrical connector.
50. Disconnect the EVAP vent valve electrical connector.

51. Remove the bolt and the ground wire at the chassis by the EVAP vent valve.
52. Make sure all the connections are disconnected between the chassis and the frame.
53. Remove the engine wiring harness clips from the frame and the cross sills.
54. Position the J 39580 under the engine/frame assembly.
55. Lower the vehicle.
56. Adjust J 39580 in order to correctly support the frame assembly with the following components:
    - The engine
    - The transmission
    - The front suspension components
    - The front differential carrier assembly, if equipped

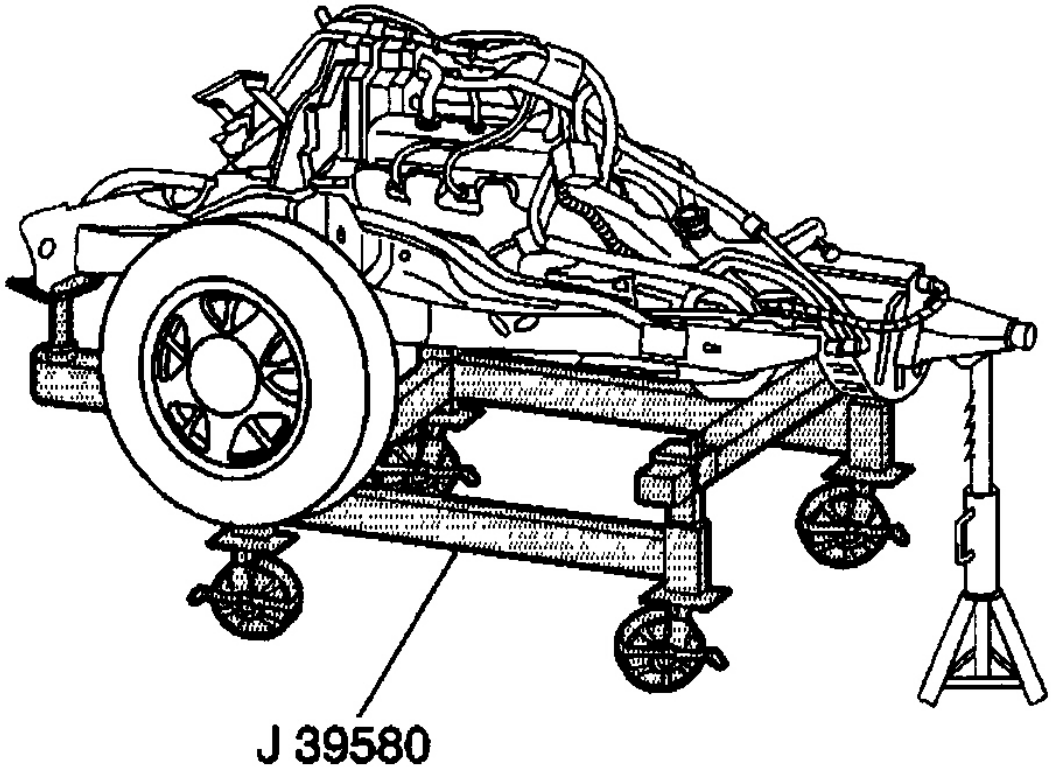

Fig. 183: Identifying Universal Engine Support Table (J 39580)
Courtesy of GENERAL MOTORS CORP.

57. Remove the body mount bolts (1, 2, 3).

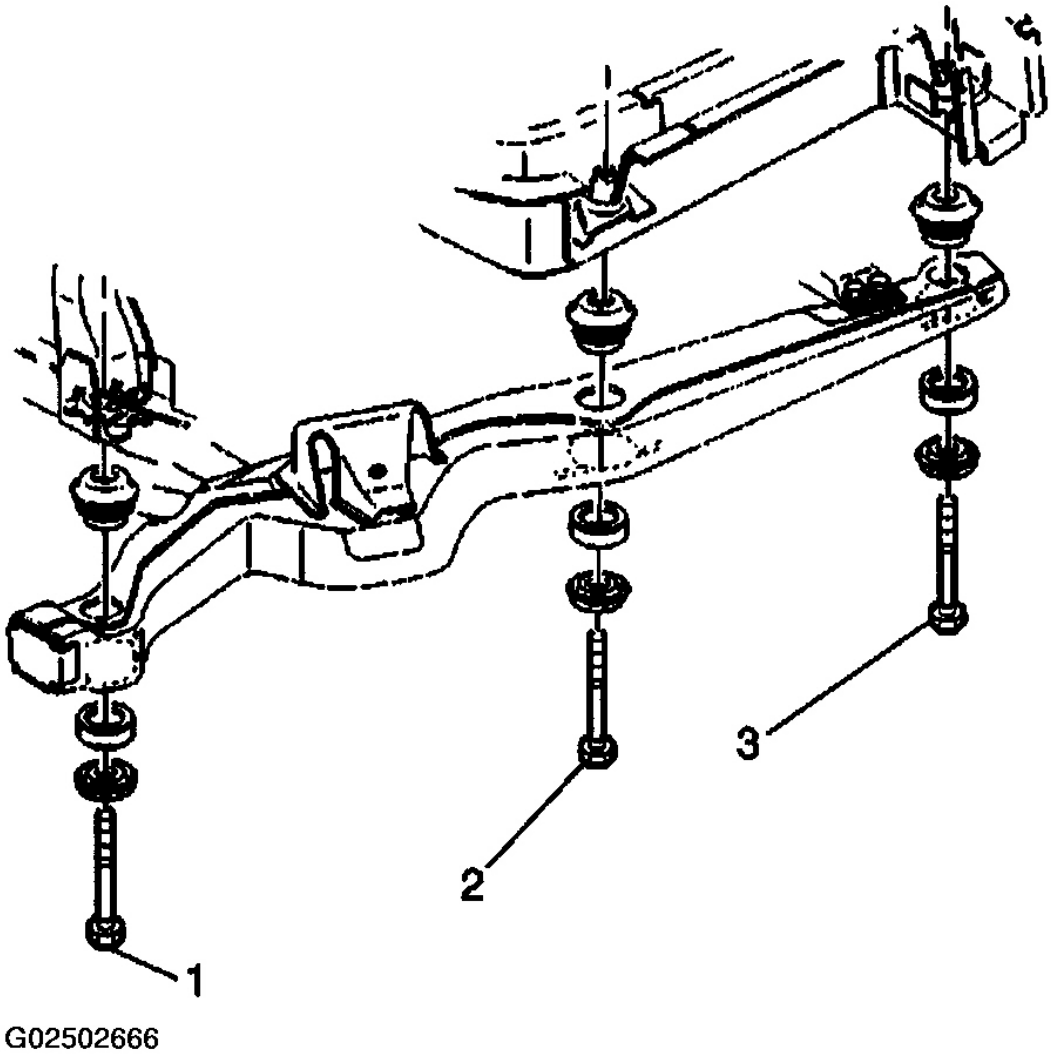

Fig. 184: Removing Body Mount Bolts
Courtesy of GENERAL MOTORS CORP.

58. Place a jack stand under the transmission crossmember to prevent the engine/frame assembly from tipping off of the J 39580.
59. Raise the hoist in order to separate the body from the engine/frame assembly.
60. Install support stands under the rear axle.
61. Move the engine/frame assembly from under the vehicle.
62. Remove the bolt holding the starter wiring harness and the transmission oil cooler pipe bracket to the oil pan.

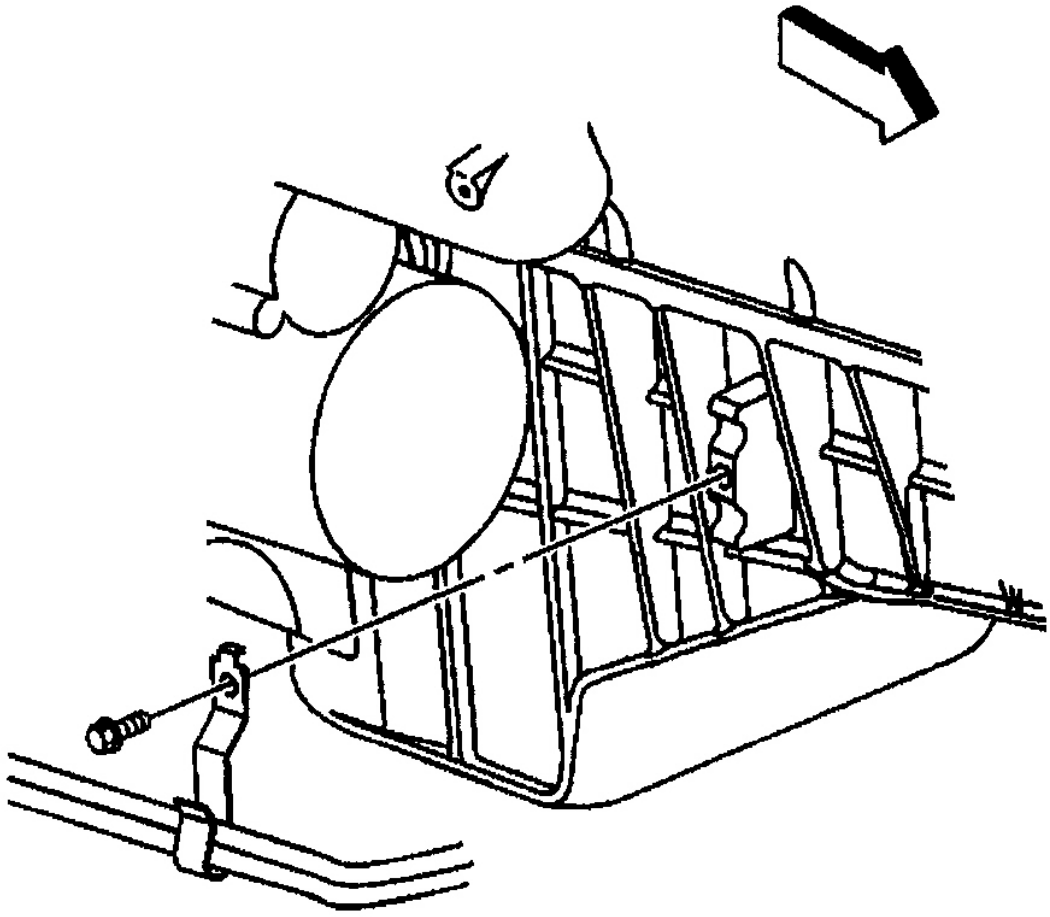

Fig. 185: Locating Bolt Holding Bracket For Starter Wiring Harness & Transmission Cooler Pipes
Courtesy of GENERAL MOTORS CORP.

63. Remove the generator.
64. Remove the nut and the A/C pipe bracket, if equipped from the fuel pipe bracket stud.
65. Remove the stud holding the fuel pipe bracket to the rear of the left cylinder head.

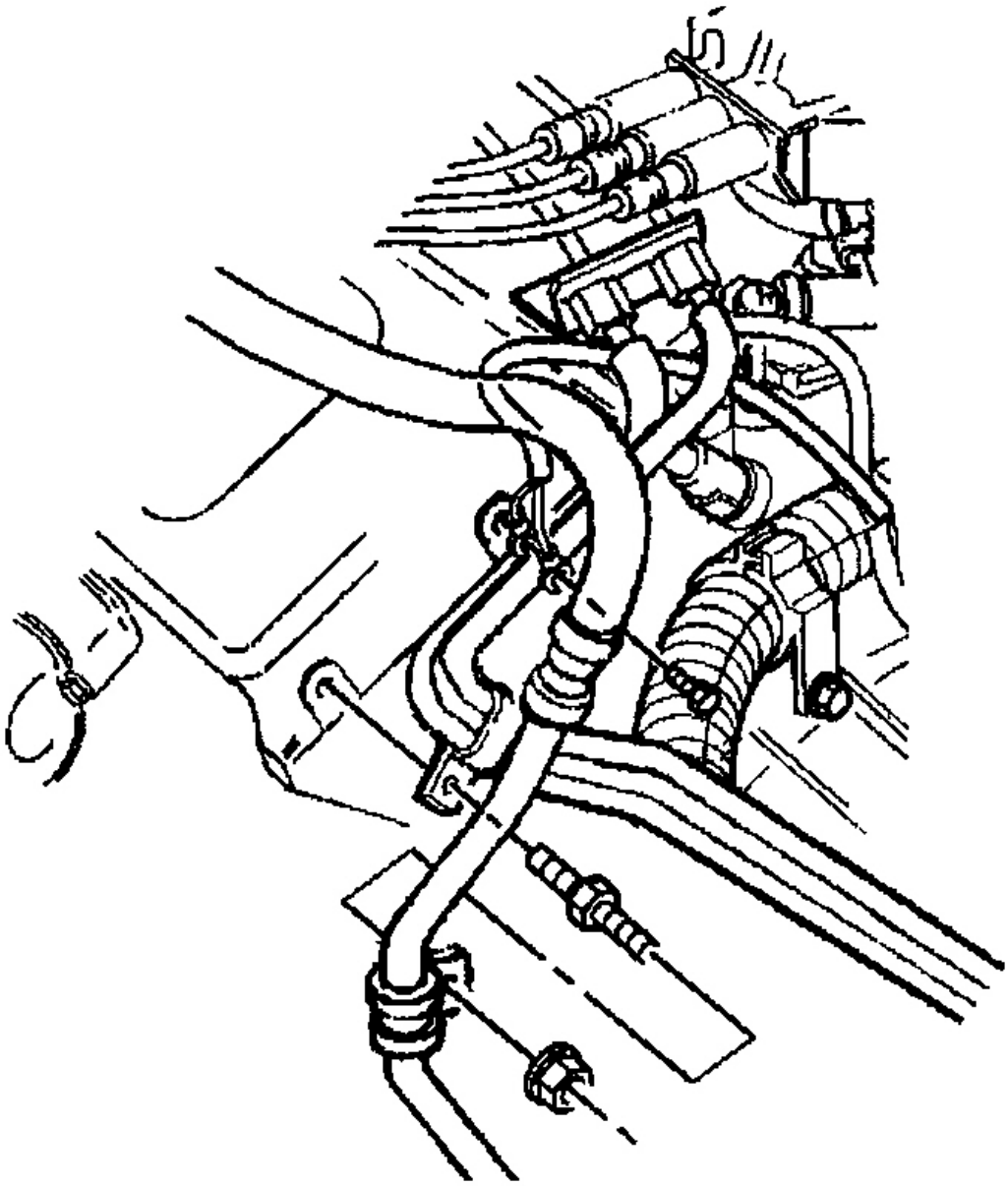

Fig. 186: Locating Ground Wires & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

66. Remove the fuel pipe stud nut on the side of the transmission.
67. Move the fuel pipes back to clear the engine.

68. Disconnect the fuel pipes at the rear of the engine.
69. Remove the ground wire bolt and ground wire from the rear of the left cylinder head.
70. Remove the bolt holding the engine wiring harness clip to the rear of the right cylinder head.

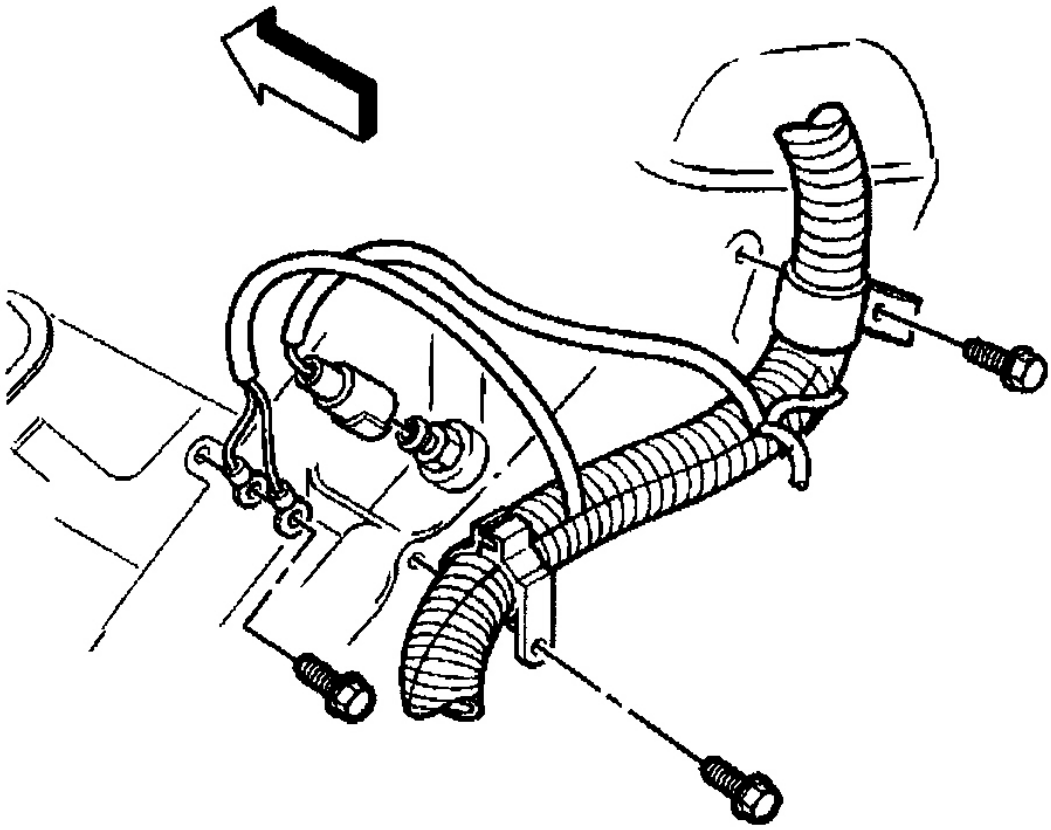

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Fig. 187: Locating Ground Wire & Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

71. Disconnect the crankcase position (CKP) sensor electrical connector (4).
72. Remove the CKP sensor wiring harness clip (3) from the bracket.
73. Remove the engine wiring harness clip (1) from the negative battery cable stud (2).
74. Remove the negative battery cable stud (1) and the cable.

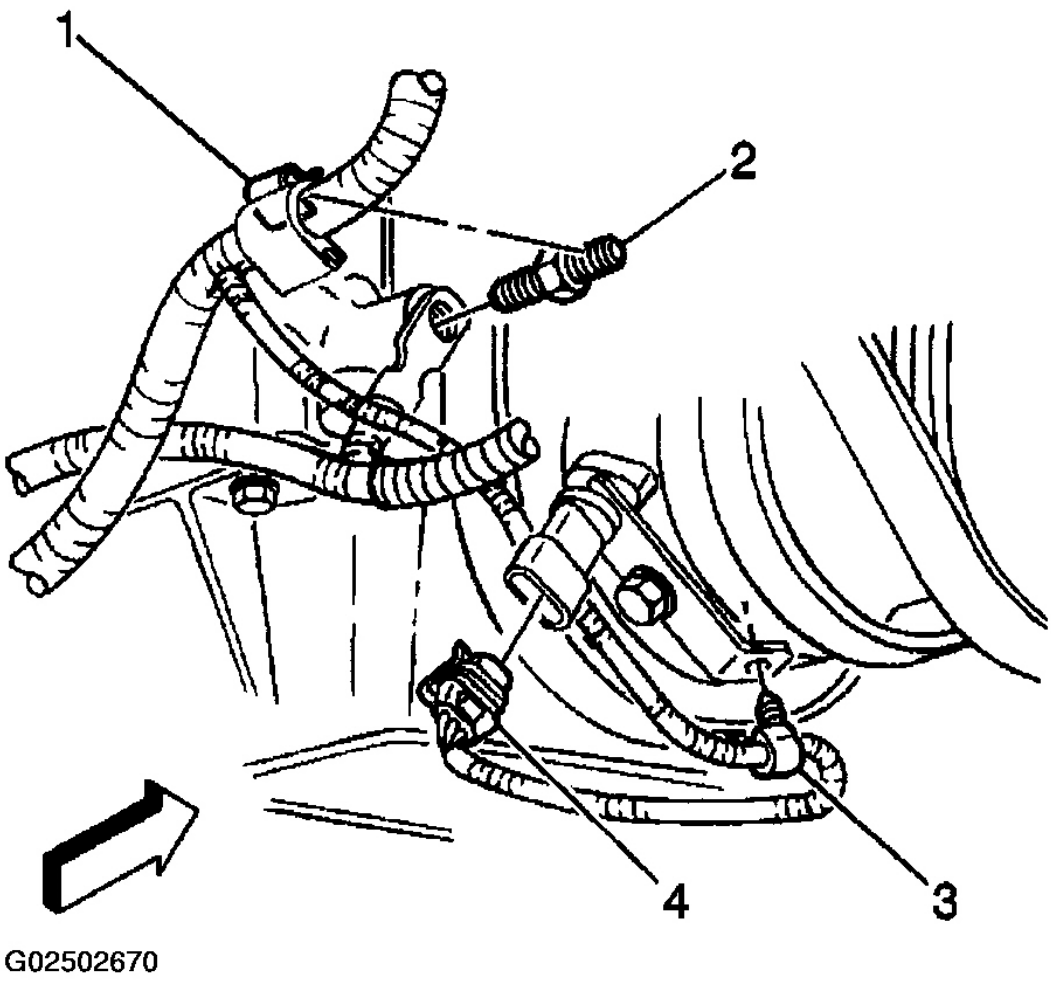

Fig. 188: Locating Crankshaft Position Sensor & Wiring Harness Components
Courtesy of GENERAL MOTORS CORP.

75. Remove the bolt holding the engine wiring harness bracket to the generator mounting bracket.

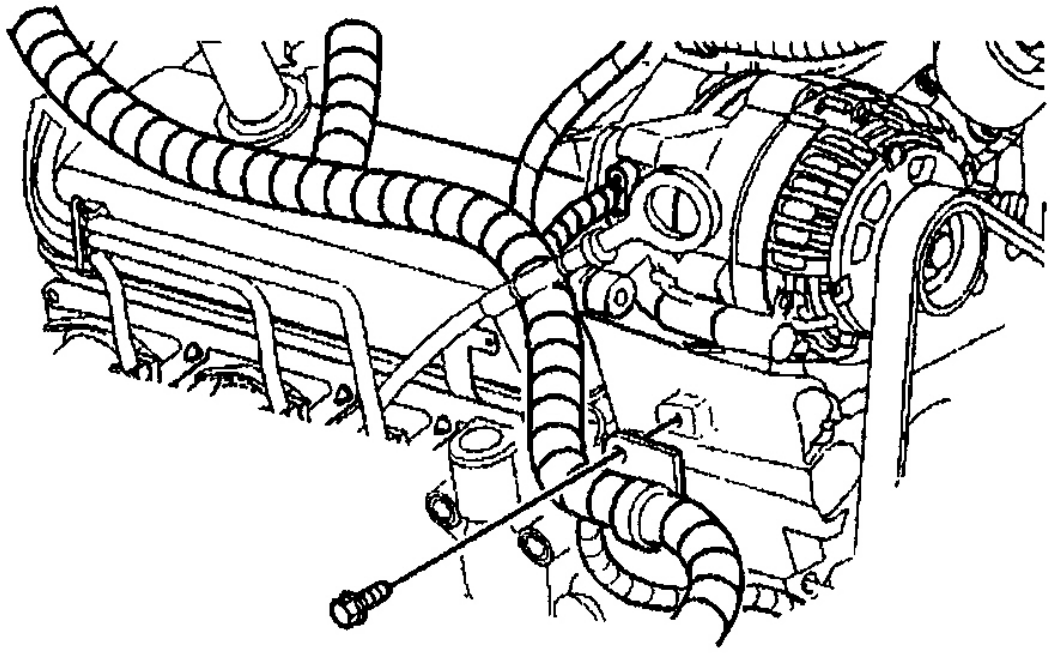

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Fig. 189: Locating Generator Mounting Bracket Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS CORP.

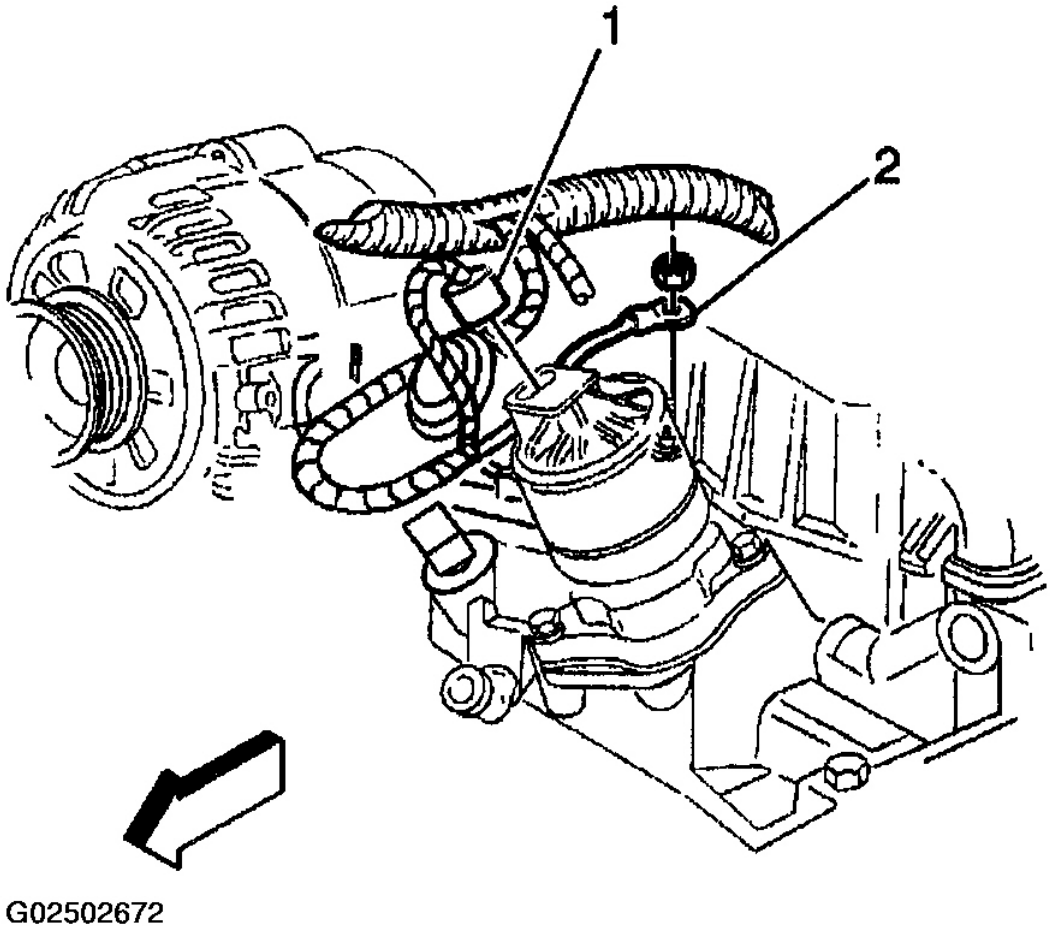

Fig. 190: Disconnecting EGR Valve Electrical Connector & Removing Ground Wire At Water Outlet Stud
Courtesy of GENERAL MOTORS CORP.

76. Disconnect the EGR valve electrical connector (1).
77. Remove the ground wire (2) from the stud at the water outlet.
78. Disconnect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)
    - The ignition coil (2)
    - The ignition coil module (ICM) (3)

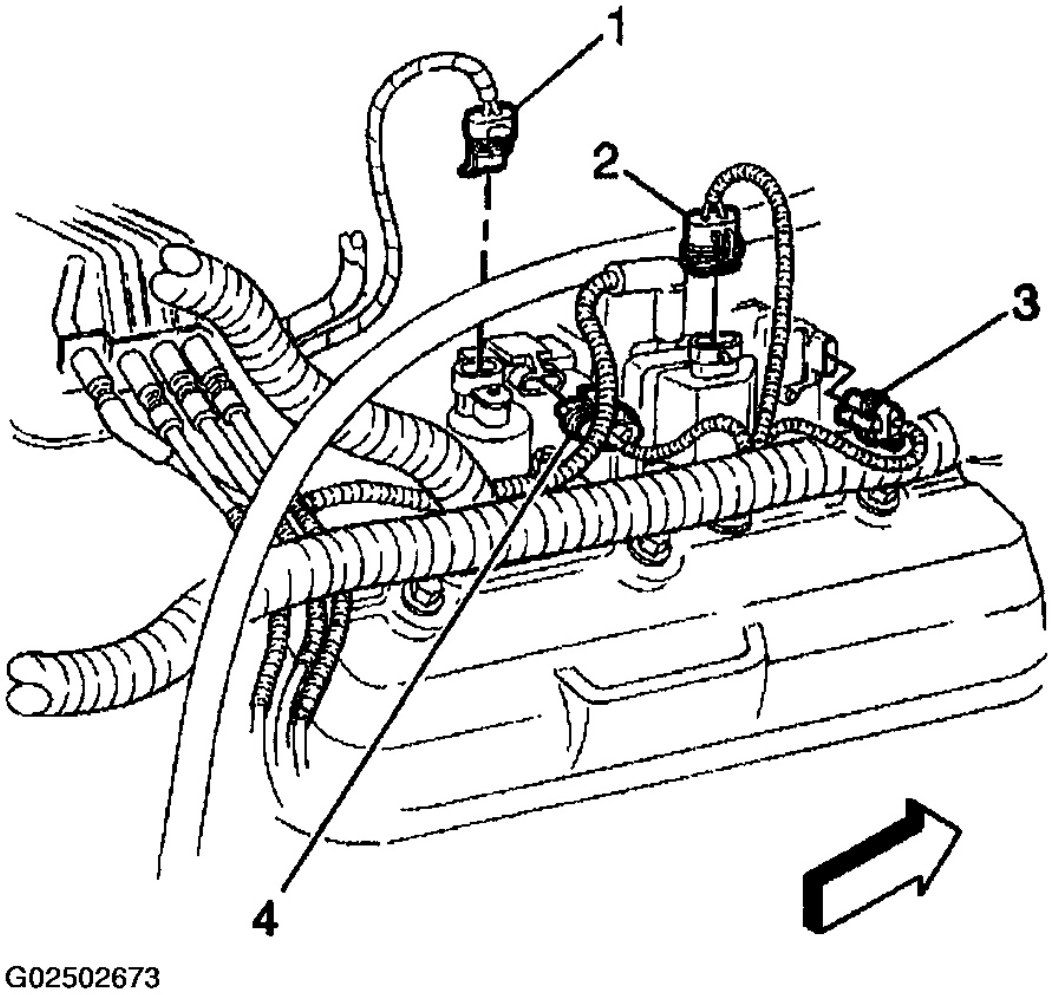

Fig. 191: Disconnecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

79. Disconnect the following electrical connectors:
    - The A/C compressor clutch, if equipped (1)
    - The A/C high pressure cutoff switch, if equipped (5)
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)
    - The fuel meter body assembly connector (4)

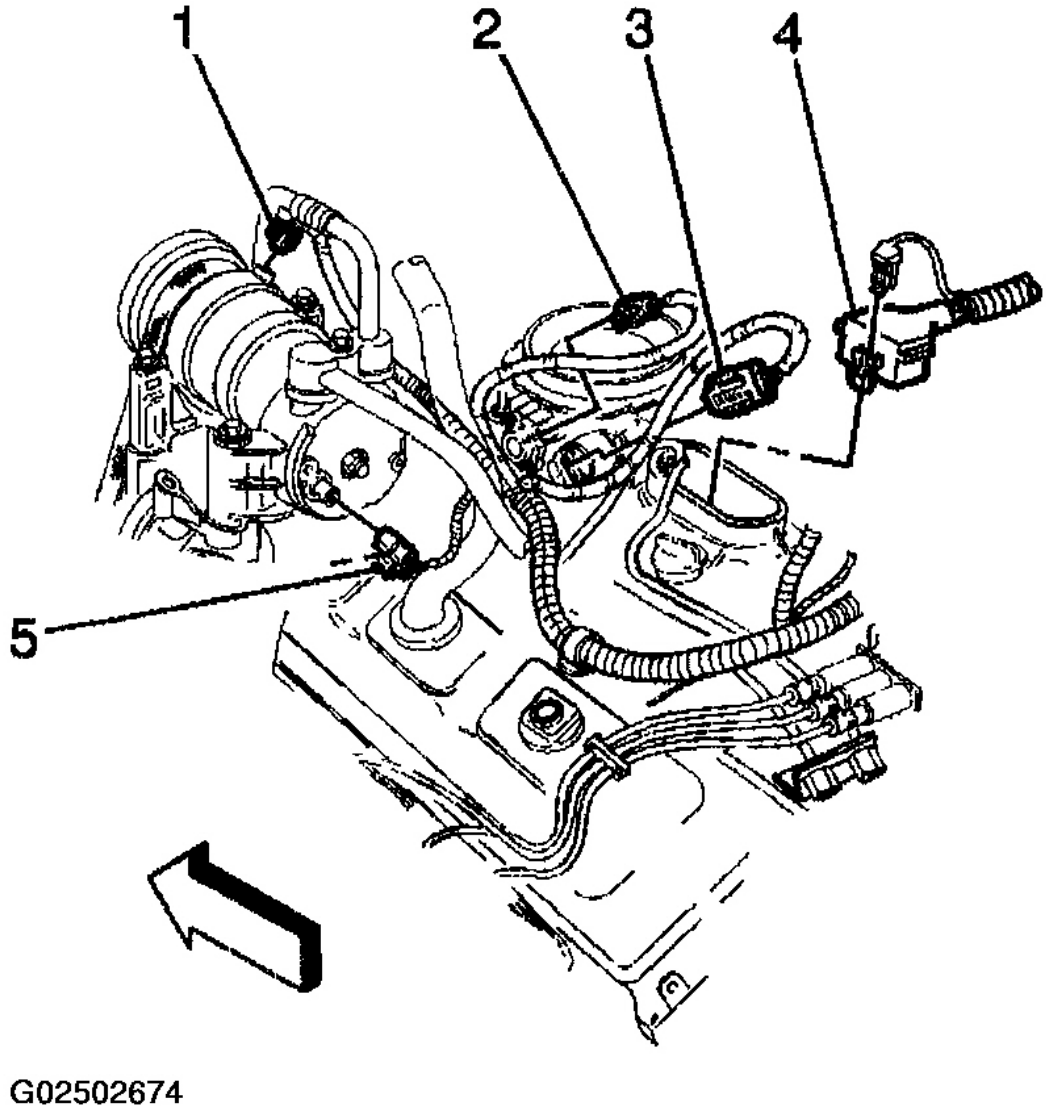

Fig. 192: Locating A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

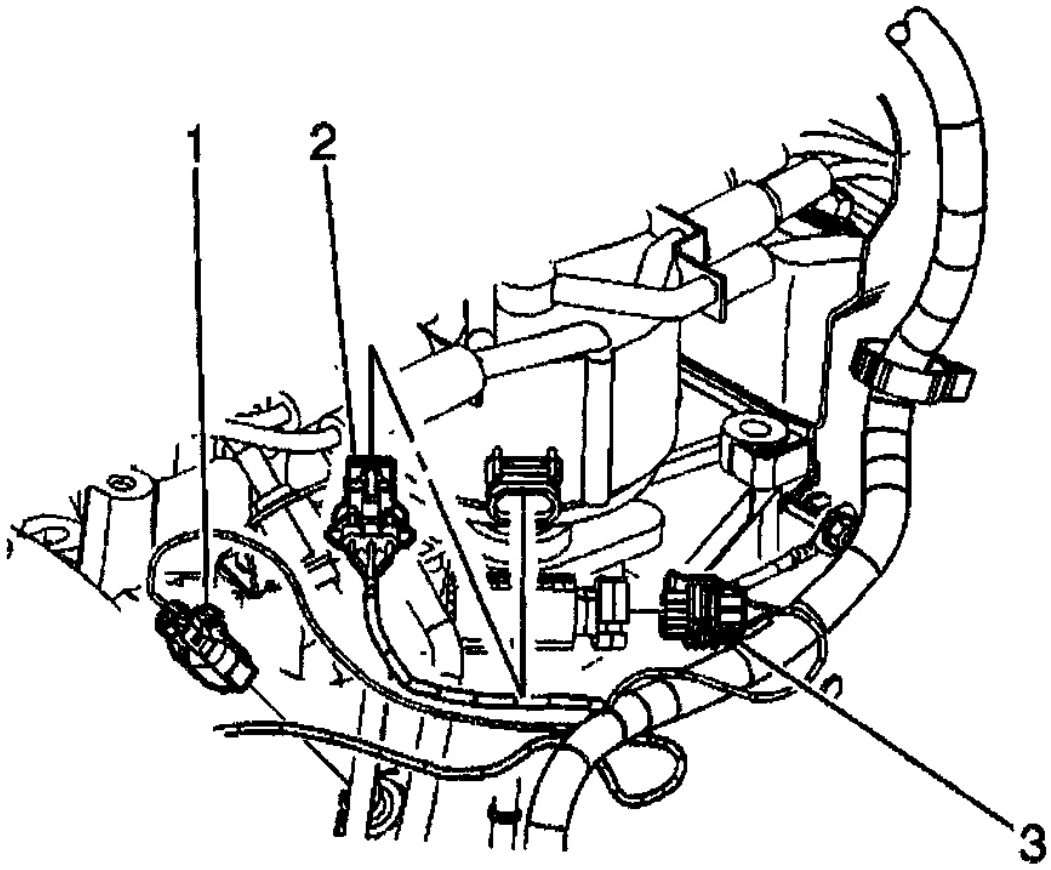

Fig. 193: Locating Knock Sensor, Distributor & Engine Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

80. Disconnect the following electrical connectors:
    - The knock sensor (KS) (1)
    - The distributor (2)
    - The engine oil pressure sensor (3)
81. Remove the engine wiring harness from the brackets.
82. Remove the bolts holding the transmission fluid fill tube from the oil indicator and the bell housing bolt.
83. Move the transmission fluid tube to the side.
84. Position the engine wiring harness out of the way.
85. Remove the transfer case to engine block brace, if equipped.
86. Remove the exhaust pipe from the exhaust manifolds.
87. Remove the spark plug wire harness retainer from the exhaust gas recirculation (EGR) valve inlet pipe.

88. Remove the clamp bolt for the EGR valve inlet pipe.
89. Remove the EGR valve inlet pipe from the intake and the exhaust manifolds.

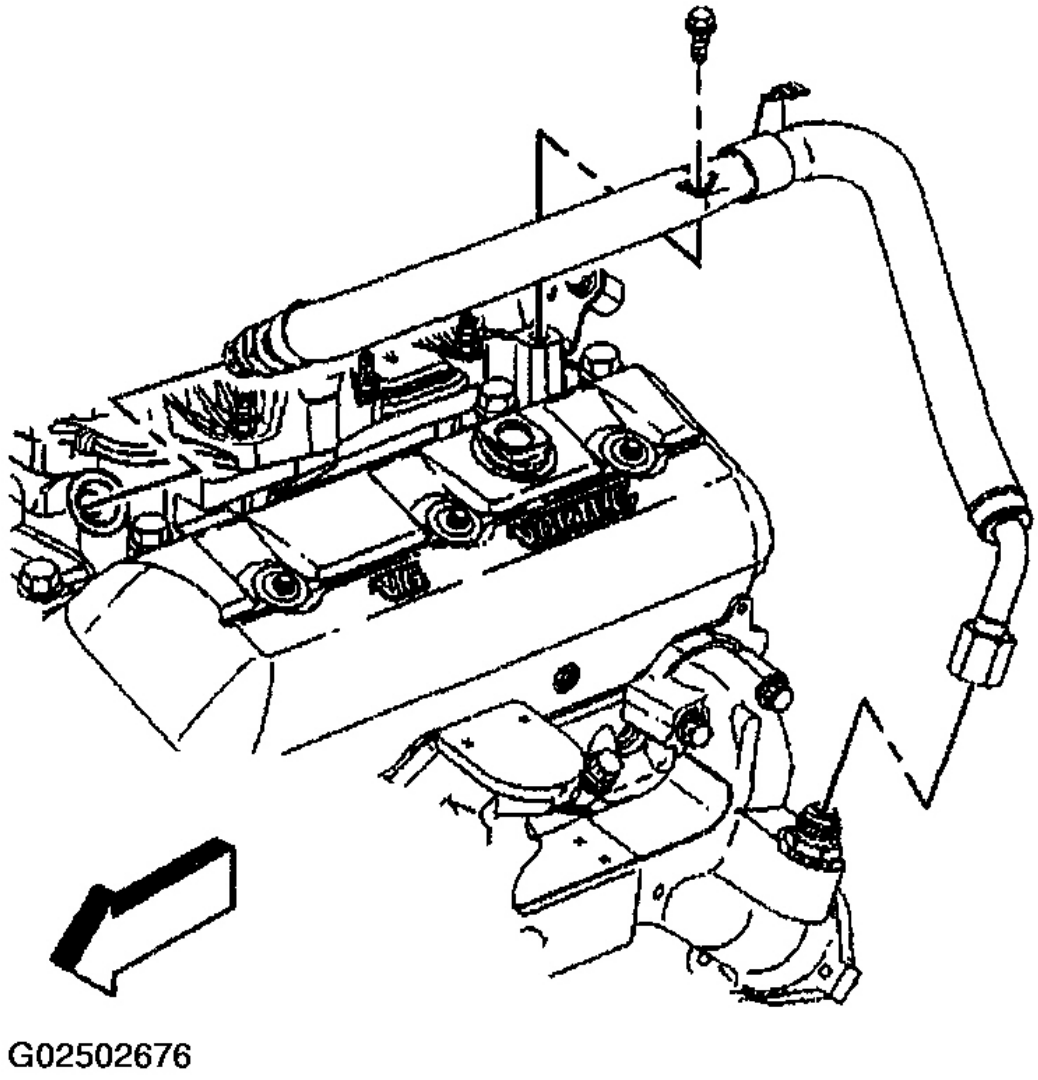

Fig. 194: Removing EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

90. Disconnect the spark plug wires from the spark plugs.
91. Remove the distributor cap with the spark plug wire harness.
92. Remove the air conditioning pipe bracket nut from the intake manifold stud.
93. Remove the air conditioning compressor and the power steering pump, leaving the pump and the compressor on the bracket.

94. Install the J 41427 using the following procedure:
    a. Remove the 2 right rear lower intake manifold bolts.
    b. Install the J 41427 marked RIGHT REAR.
    c. Install the retaining bolts. **Tighten:** Tighten the retaining bolts to 15 N.m (11 lb ft).
    d. Remove the 2 left front lower intake manifold bolts.
    e. Install the J 41427 marked LEFT FRONT with the arrow pointing to the front of the engine.
    f. Install the retaining bolts. **Tighten:** Tighten the retaining bolts to 15 N.m (11 lb ft).

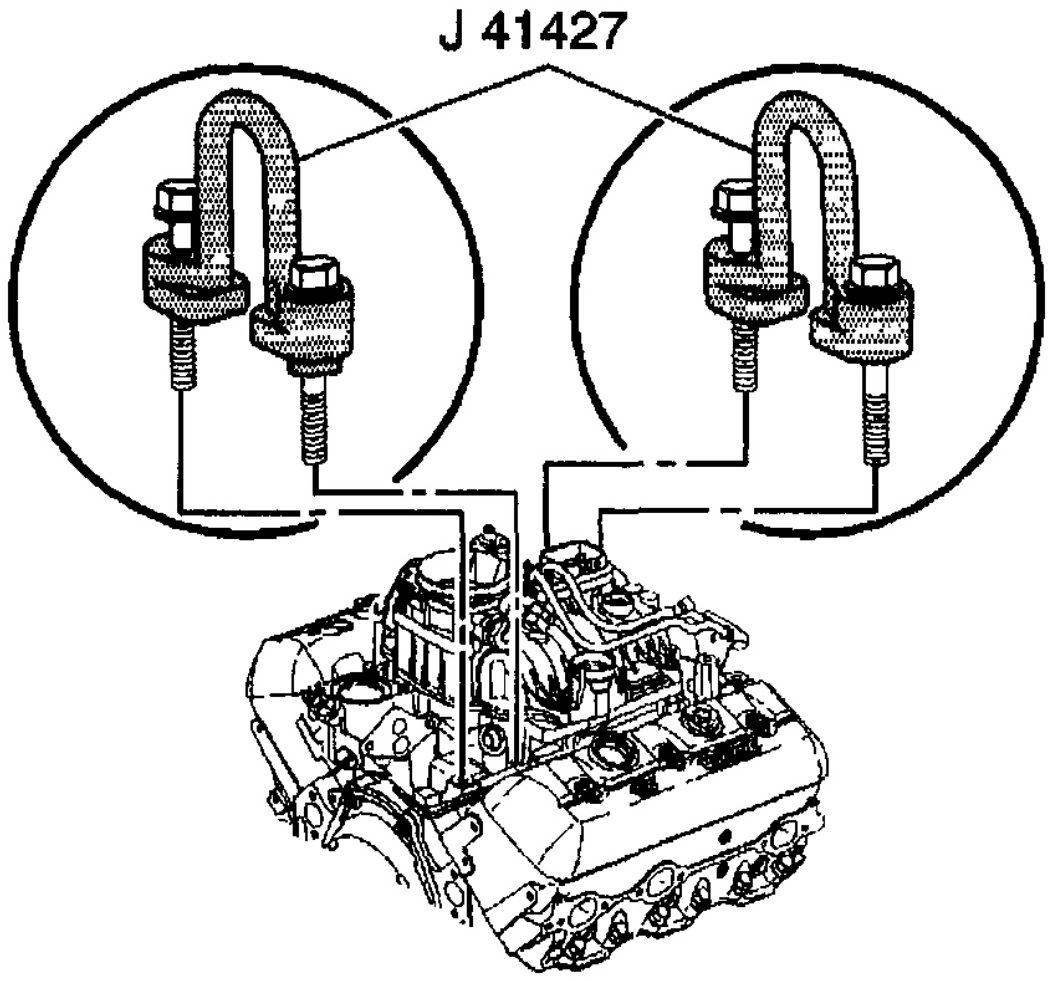

Fig. 195: Installing Engine Lift Brackets
Courtesy of GENERAL MOTORS CORP.

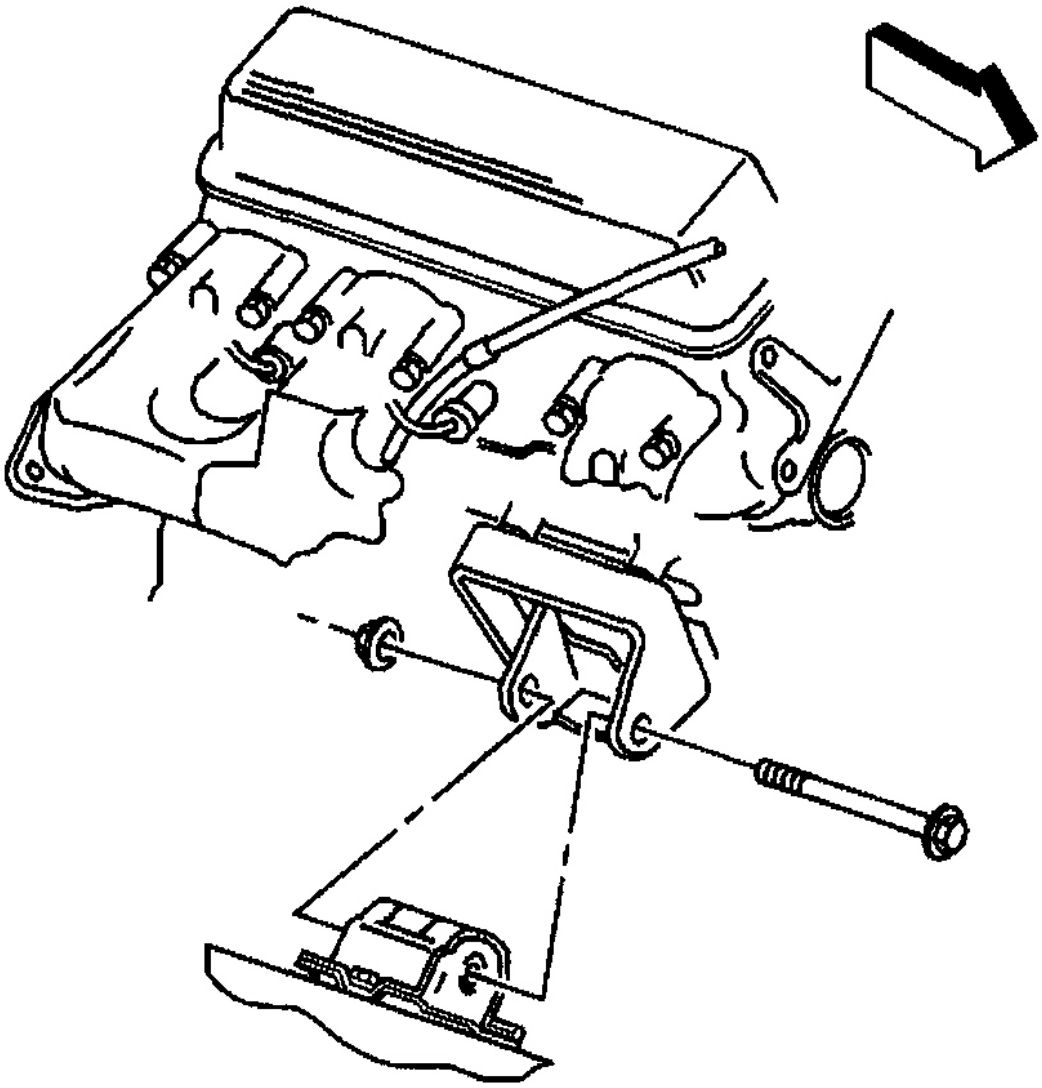

Fig. 196: Removing Engine Mount Through Bolts
Courtesy of GENERAL MOTORS CORP.

95. Remove the engine mount through bolts.
96. Raise the engine slightly. Support the front of the transmission with suitable floor stand and a block of wood. Do not support the transmission under the oil pan.
97. Remove the transmission to engine bolts.
98. Disconnect the engine from the transmission.
99. Remove the engine from the frame.

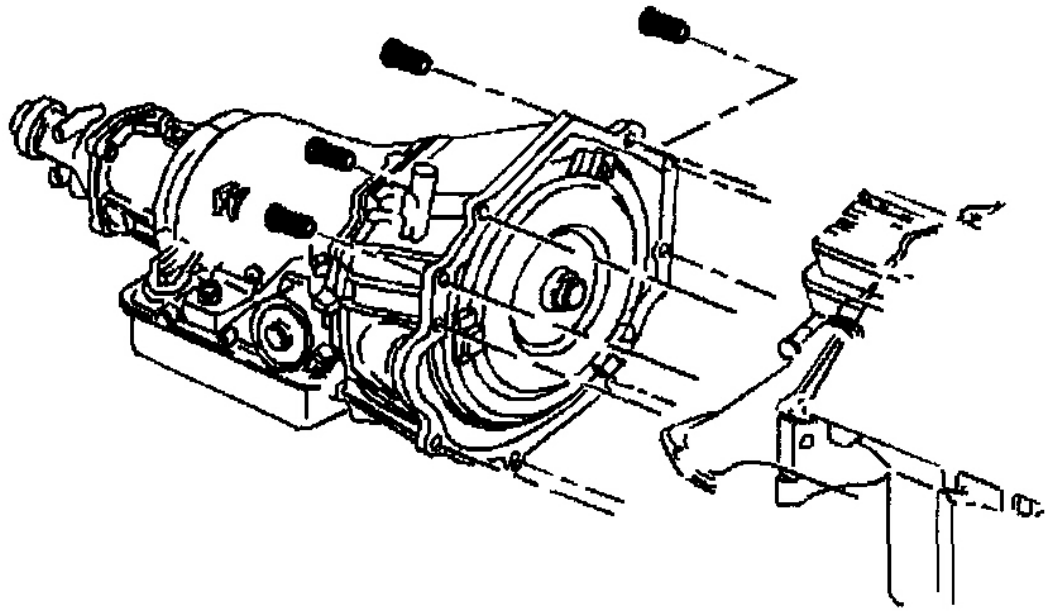

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Fig. 197: Removing Transmission-To-Engine Bolts
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

IMPORTANT: If you install a new engine, make sure any remaining components, brackets, or accessories are transferred to the new engine.

1. Install the engine into the frame.
2. Connect the engine to the transmission.
3. Remove the support from under the transmission.
4. Lower the engine and the transmission onto the engine mounts.
5. Install the engine mount through-bolts and nuts. **Tighten:** Tighten the engine mount through-bolt nuts to 68 N.m (50 lb ft).

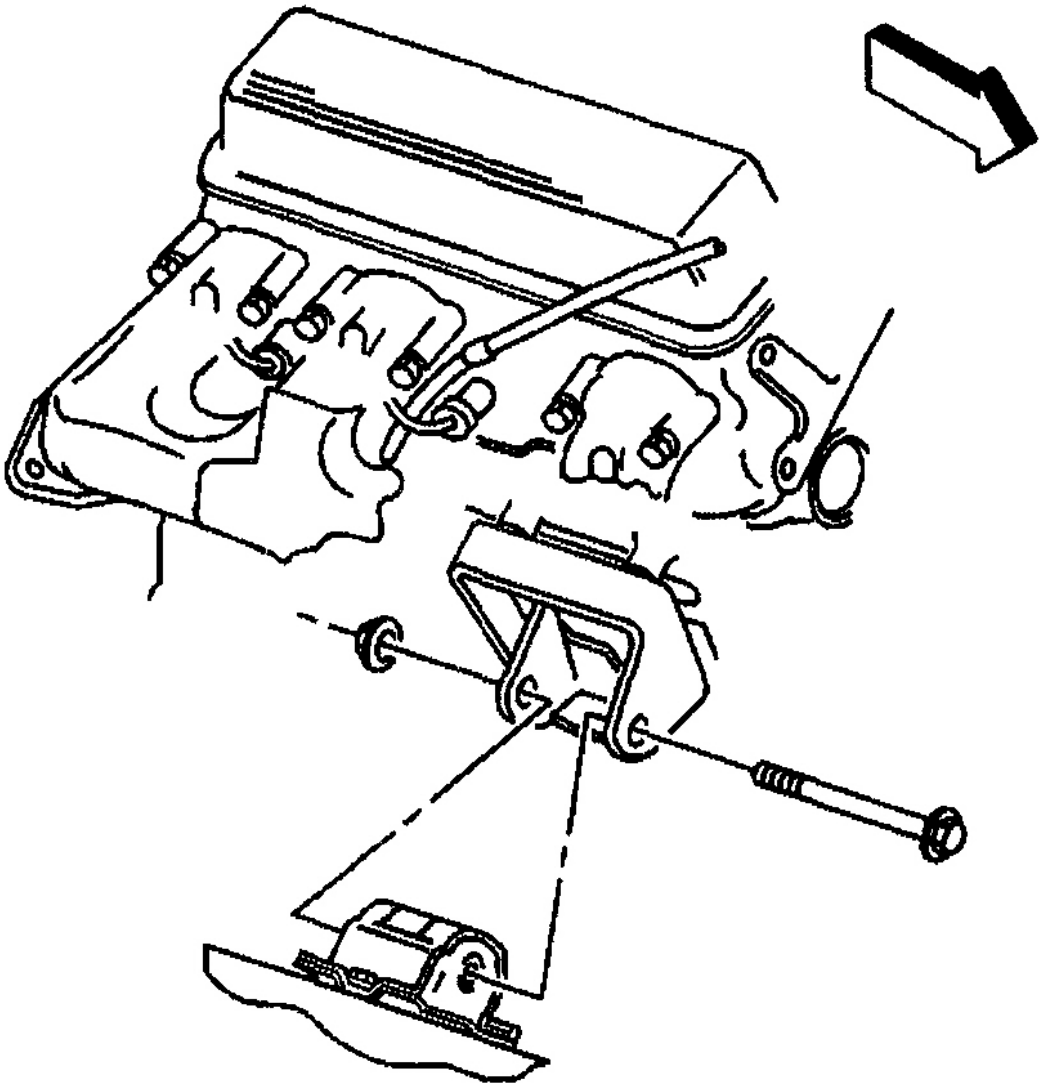

Fig. 198: Installing Engine Mount Through Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the J 41427 from the engine.

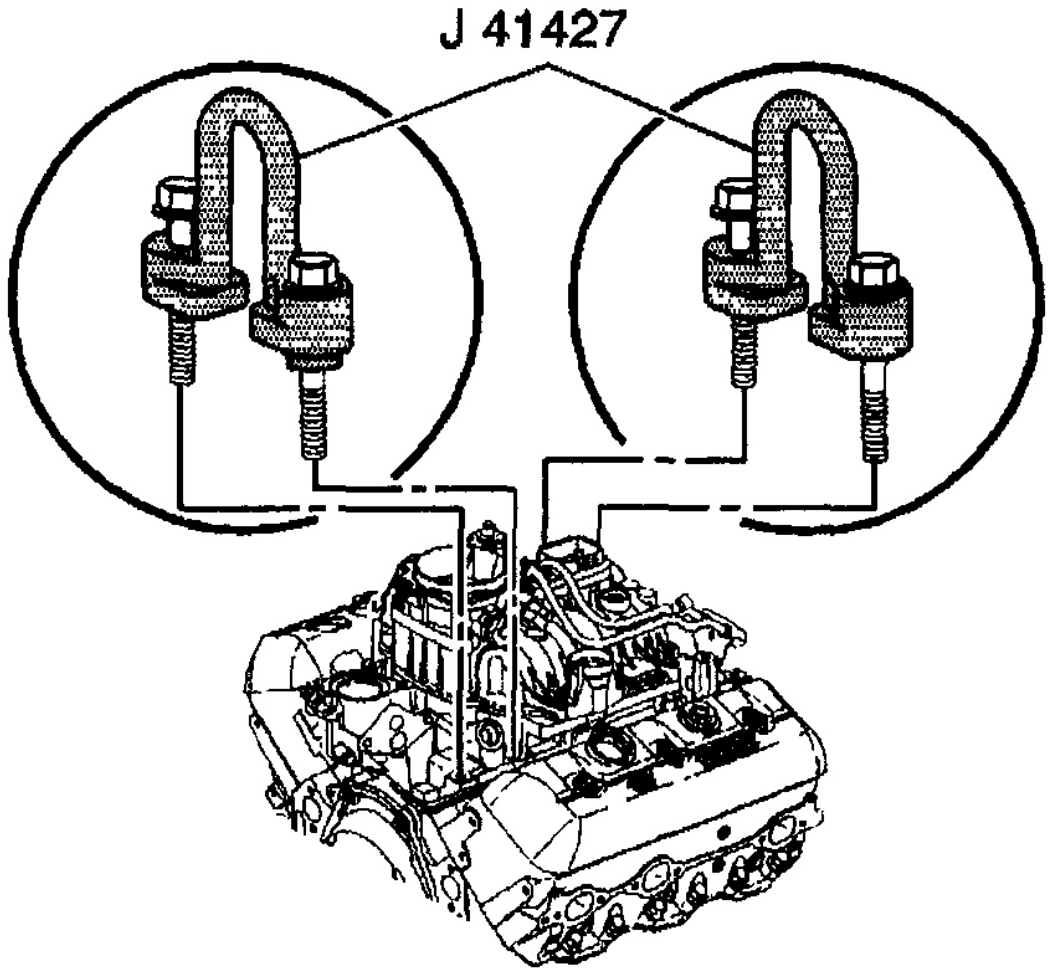

Fig. 199: Removing Engine Lift Brackets
Courtesy of GENERAL MOTORS CORP.

7. Apply thread lock GM P/N 12345382 or equivalent to the threads of the lower intake manifold bolts.
8. Install the intake manifold bolts.

   Tighten:

   a. Tighten each of the bolts to 3 N.m (27 lb in).
   b. Tighten each of the bolts to 12 N.m (106 lb in).
   c. Tighten each of the bolts to 15 N.m (11 lb ft).
9. Install the EGR valve inlet pipe to the intake manifold and the exhaust manifold.

   Tighten:

   a. Tighten the EGR valve inlet pipe intake manifold nut to 25 N.m (18 lb ft).

b. Tighten the EGR valve inlet pipe exhaust manifold nut to 30 N.m (22 lb ft).
c. Tighten the EGR valve inlet pipe clamp bolt 25 N.m (18 lb ft).

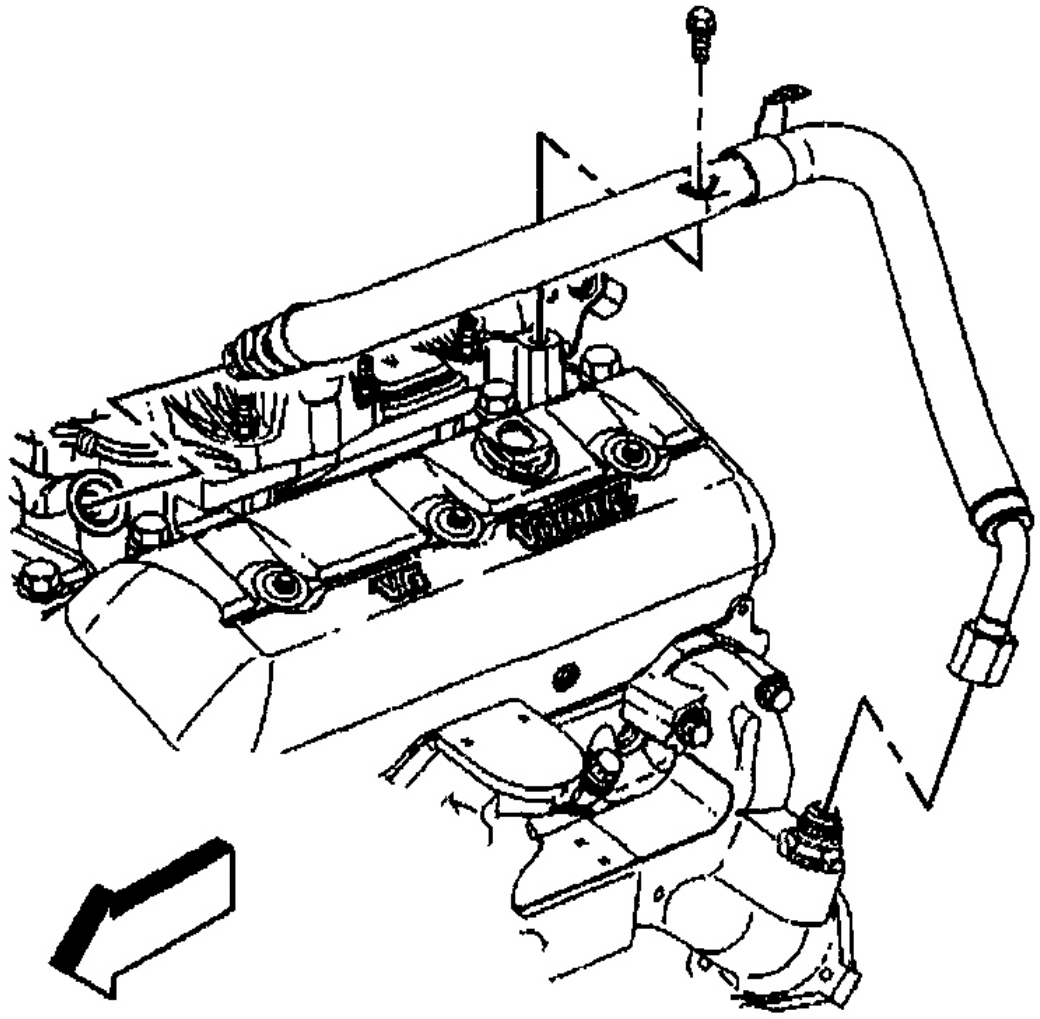

Fig. 200: Installing EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

10. Install the air conditioning compressor, if equipped, and the power steering pump mounting bracket.
11. Install the distributor cap.
12. Install the spark plug wires.
13. Install the spark plug wire harness retainer on the EGR valve inlet pipe.

14. Install the exhaust pipe to the exhaust manifolds.
15. Connect the fuel pipes at the rear of the engine.
16. Install the transfer case to engine block brace, if equipped.
17. Install the fuel pipe bracket and stud to the rear of the left cylinder head. **Tighten:** Tighten the fuel pipe bracket stud to 33 N.m (24 lb ft).

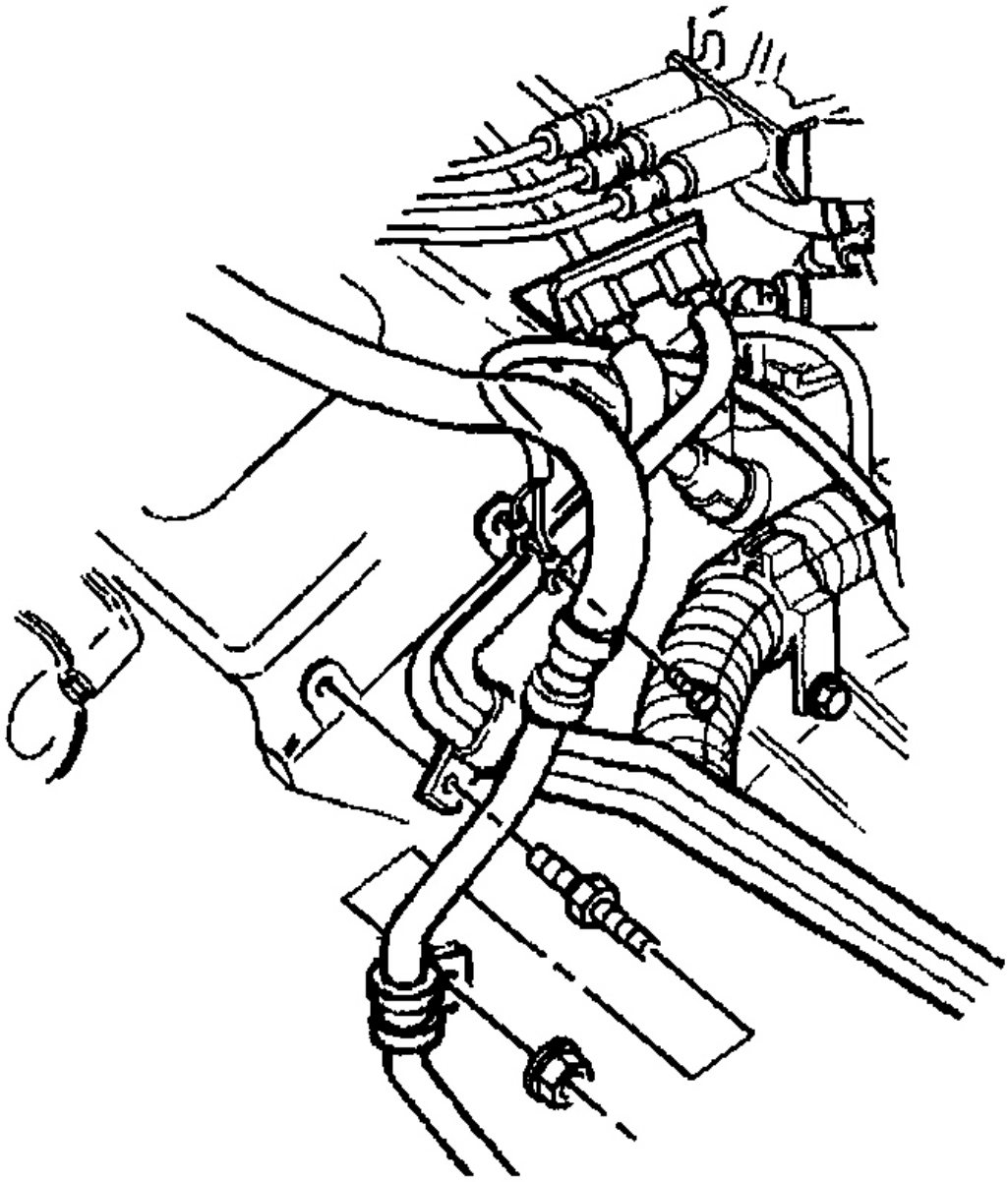

Fig. 201: Locating Ground Wires & Fuel Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

18. Install the A/C pipe bracket and nut, if equipped, to the fuel pipe bracket stud. **Tighten:** Tighten the A/C pipe bracket nut to 35 N.m (26 lb ft).
19. Position the engine wiring harness.

20. Install the engine wiring harness clips in the brackets.
21. Install the engine wiring harness clip bolt to the rear of the right cylinder head. **Tighten:** Tighten the engine wiring harness clip bolt to 36 N.m (27 lb ft).
22. Install the ground wire and bolt at the rear of the left cylinder head. **Tighten:** Tighten the ground wire bolt to 35 N.m (26 lb ft).

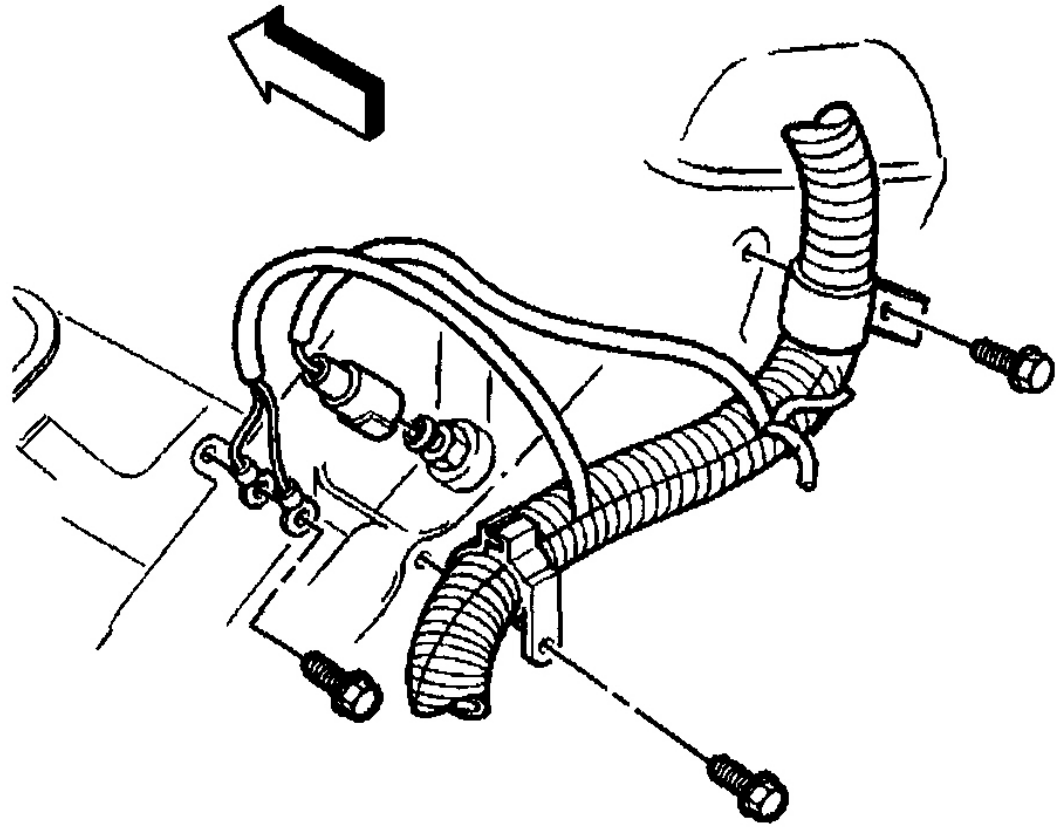

Fig. 202: Locating Ground Wire & Engine Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

23. Install the engine wiring harness bracket and bolt to the generator mounting bracket. **Tighten:** Tighten the engine wiring harness bolt to 35 N.m (26 lb ft).

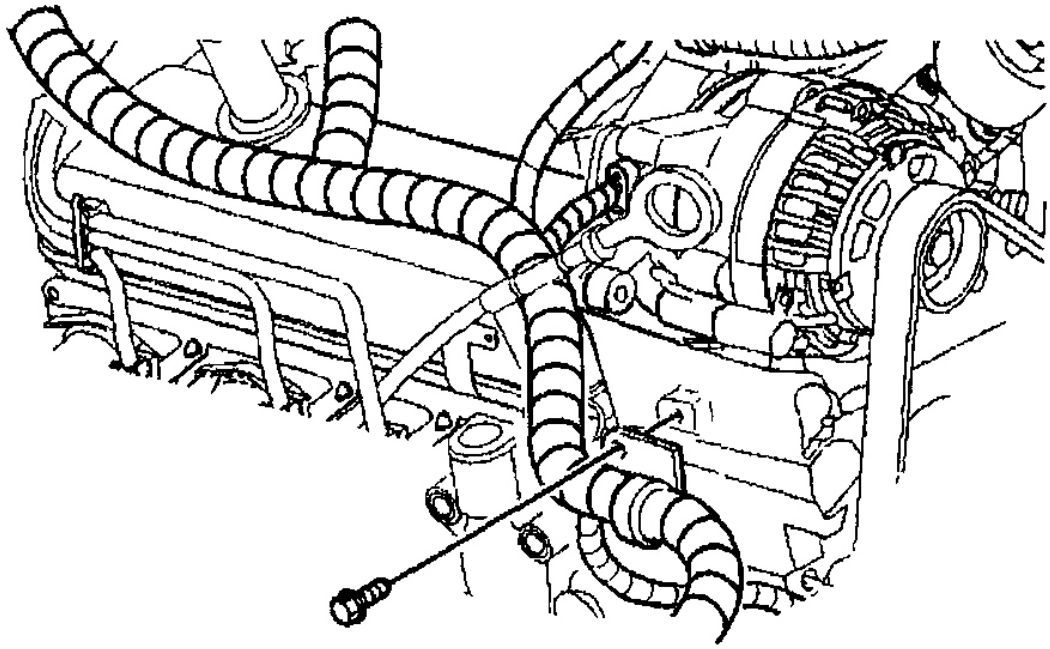

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Fig. 203: Locating Generator Mounting Bracket Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS CORP.

24. Install the negative battery cable and stud (2). **Tighten:** Tighten the negative battery cable stud to 40 N.m (30 lb ft).
25. Install the CKP sensor wiring harness clip (3) in the bracket.
26. Connect the CKP sensor electrical connector (4).

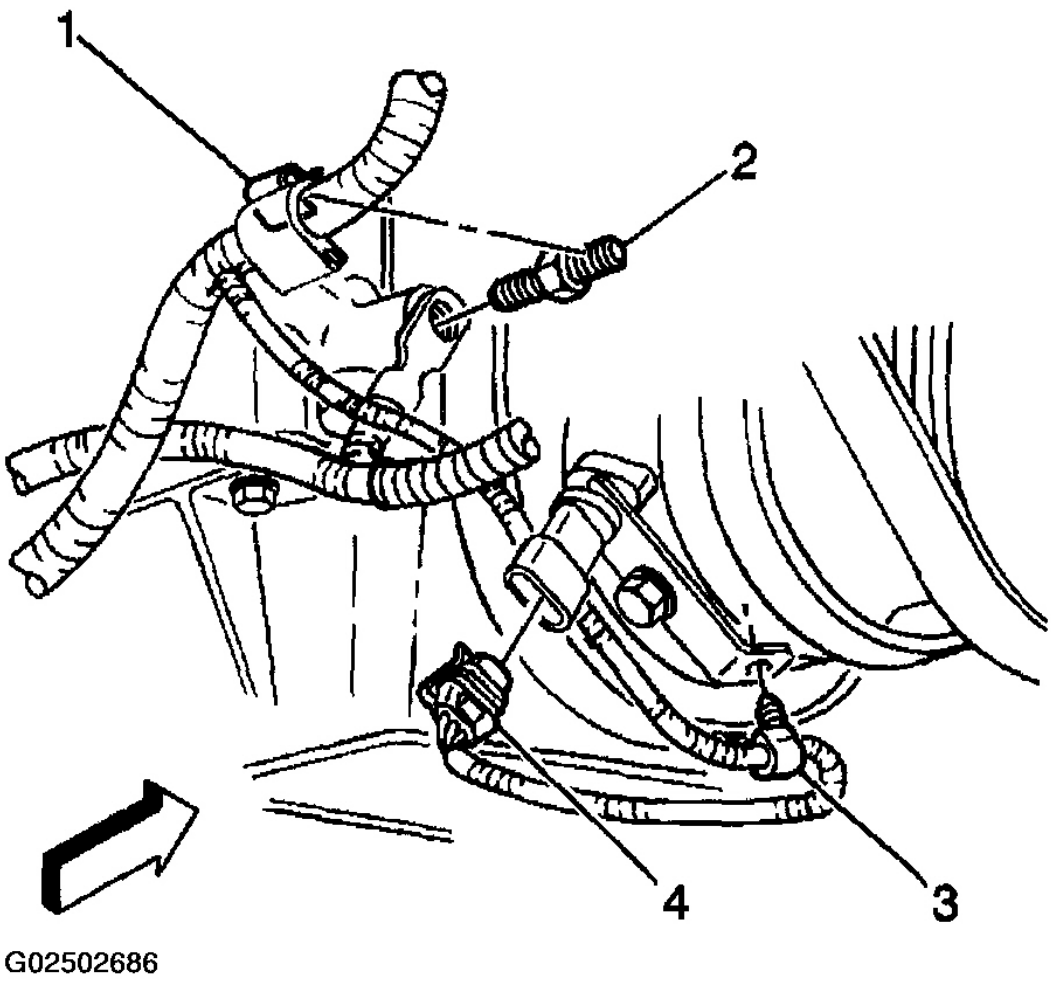

Fig. 204: Locating Crankshaft Position Sensor & Wiring Harness Components
Courtesy of GENERAL MOTORS CORP.

27. Install the engine wiring harness clip (1) on the negative battery cable stud (2).
28. Connect the following electrical connectors:
    - The knock sensor (KS) (1)
    - The distributor (2)
    - The engine oil pressure sensor (3)

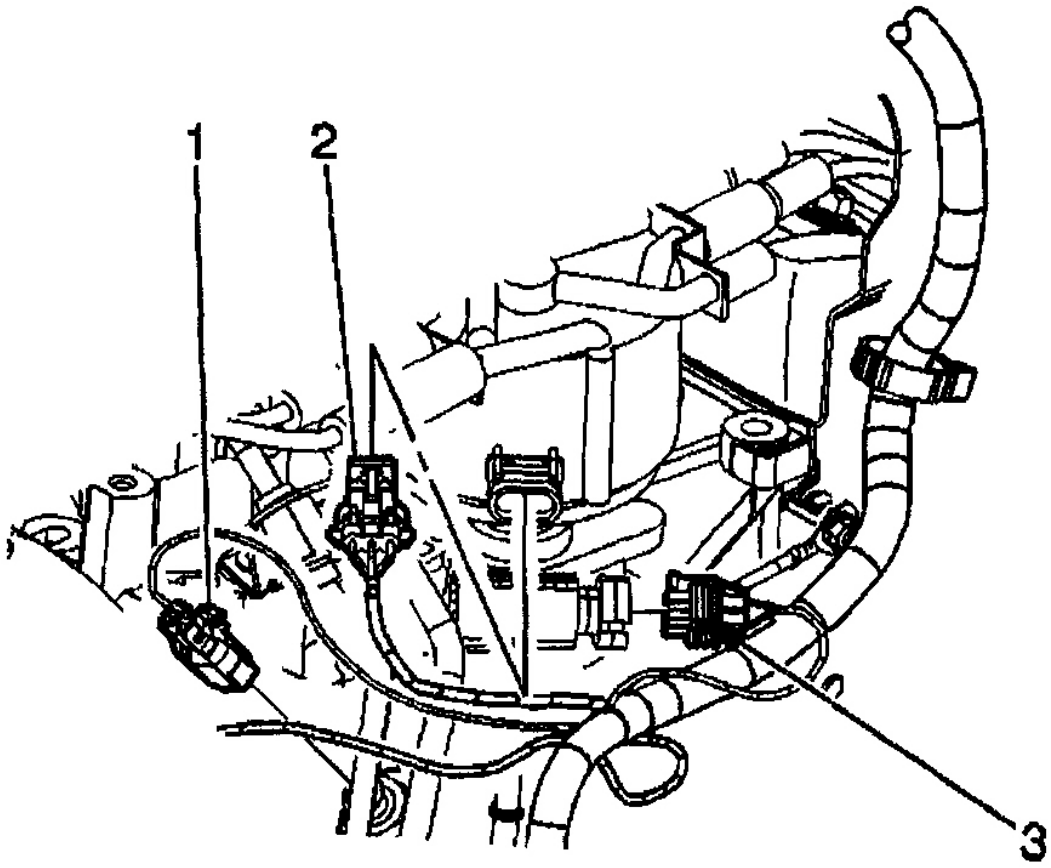

Fig. 205: Locating Knock Sensor, Distributor & Engine Oil Pressure Sensor Connectors
Courtesy of GENERAL MOTORS CORP.

29. Connect the following electrical connectors:
    - The manifold absolute pressure (MAP) sensor (4)
    - The EVAP canister purge solenoid valve (1)
    - The ignition coil (2)
    - The ICM (3)

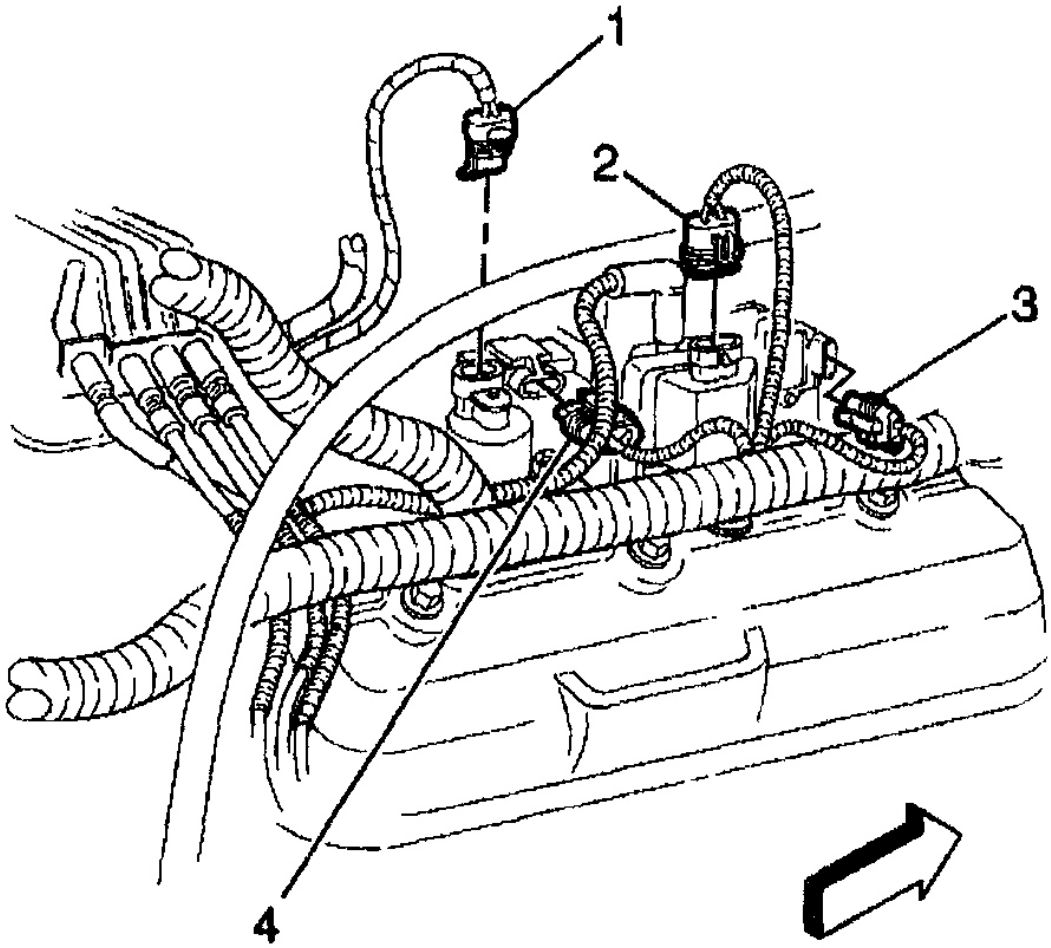

Fig. 206: Disconnecting Manifold Absolute Pressure Sensor & EVAP Canister Purge Solenoid Valve Connectors
Courtesy of GENERAL MOTORS CORP.

30. Connect the following electrical connectors:
    - The A/C compressor clutch (1), if equipped
    - The A/C high pressure cutoff switch (5), if equipped
    - The throttle position (TP) sensor (2)
    - The idle air control (IAC) motor (3)
    - The fuel meter body assembly connector (4)

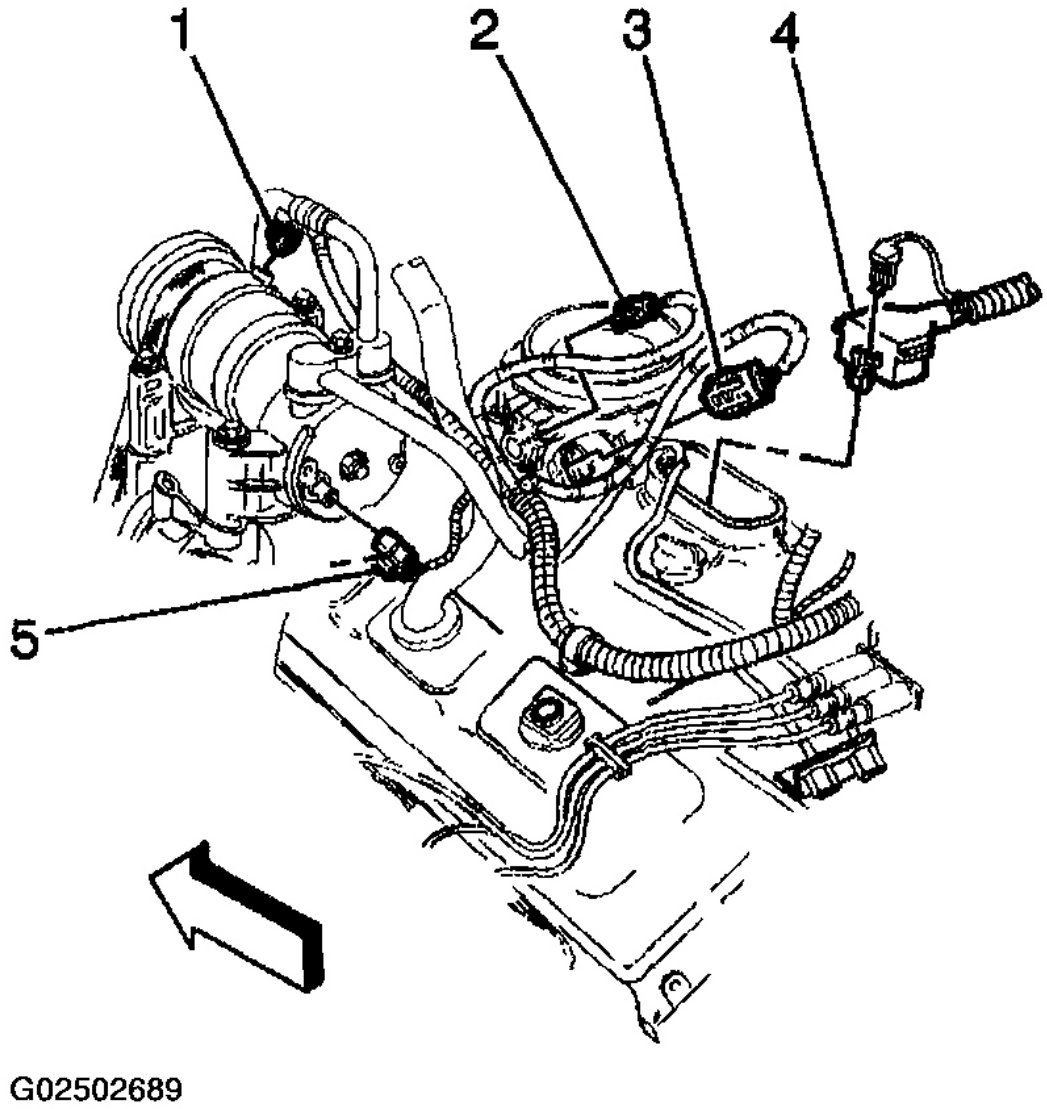

Fig. 207: Locating A/C Compressor Clutch, A/C High Pressure Cutoff Switch, Throttle Position, Idle Air Control Motor & Fuel Meter Body Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

31. Connect the EGR valve electrical connector (1).
32. Install the ground wire (2) and the nut to the water outlet stud. **Tighten:** Tighten the ground wire nut to 19 N.m (14 lb ft).

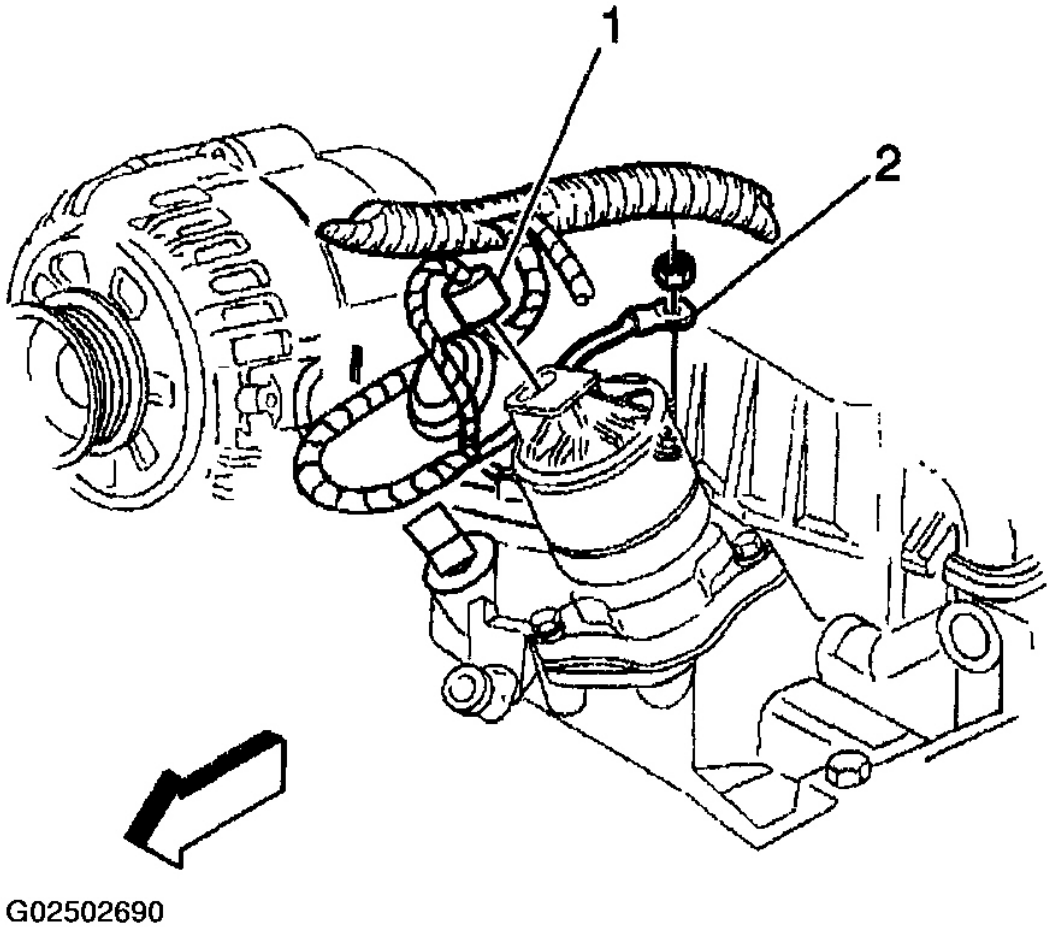

Fig. 208: Connecting EGR Valve Electrical Connector & Installing Ground Wire At Water Outlet Stud
Courtesy of GENERAL MOTORS CORP.

33. Install the generator.
34. Install the bolt for the starter wiring harness and the transmission oil cooler pipe bracket. **Tighten:** Tighten the starter wiring harness bracket bolt to 10 N.m (89 lb in).

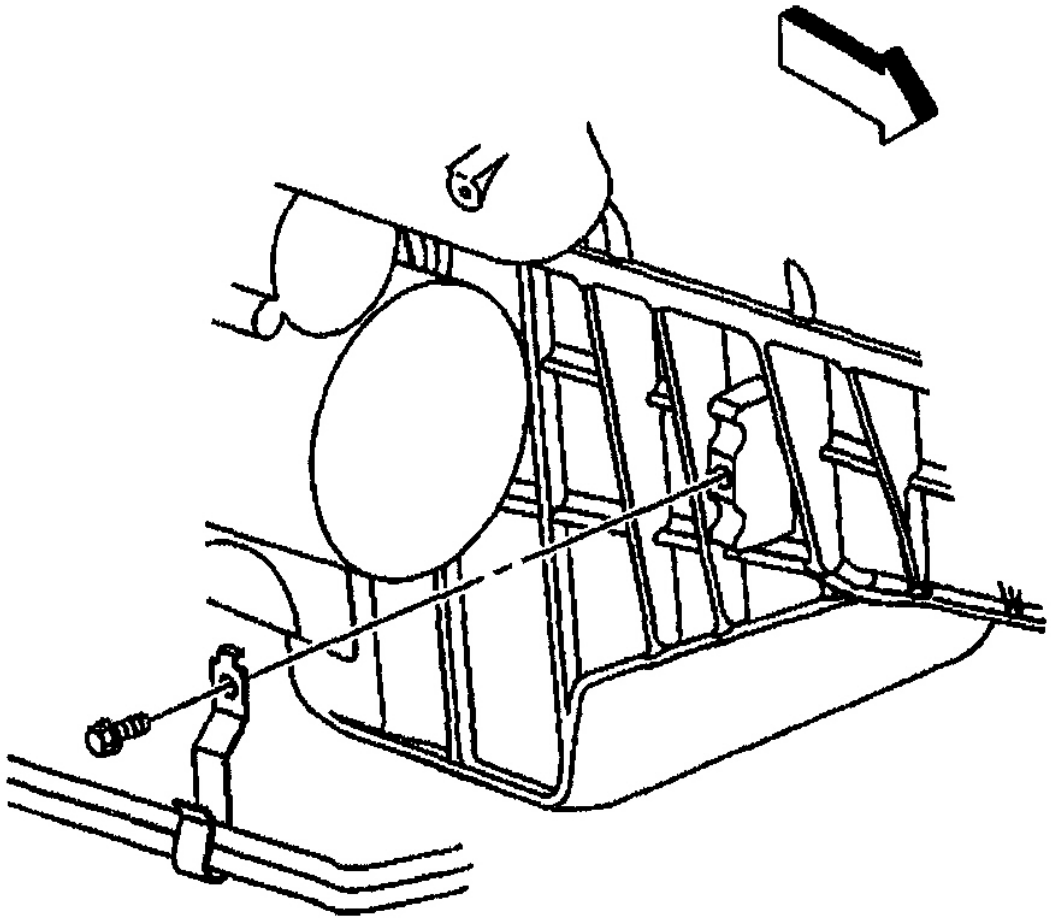

Fig. 209: Locating Bolt Holding Bracket For Starter Wiring Harness & Transmission Cooler Pipes
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the frame using the 2 alignment holes in the frame and the body. Use a pry bar or dowel pin in order to align the holes as the vehicle is being lowered onto the engine/frame assembly.

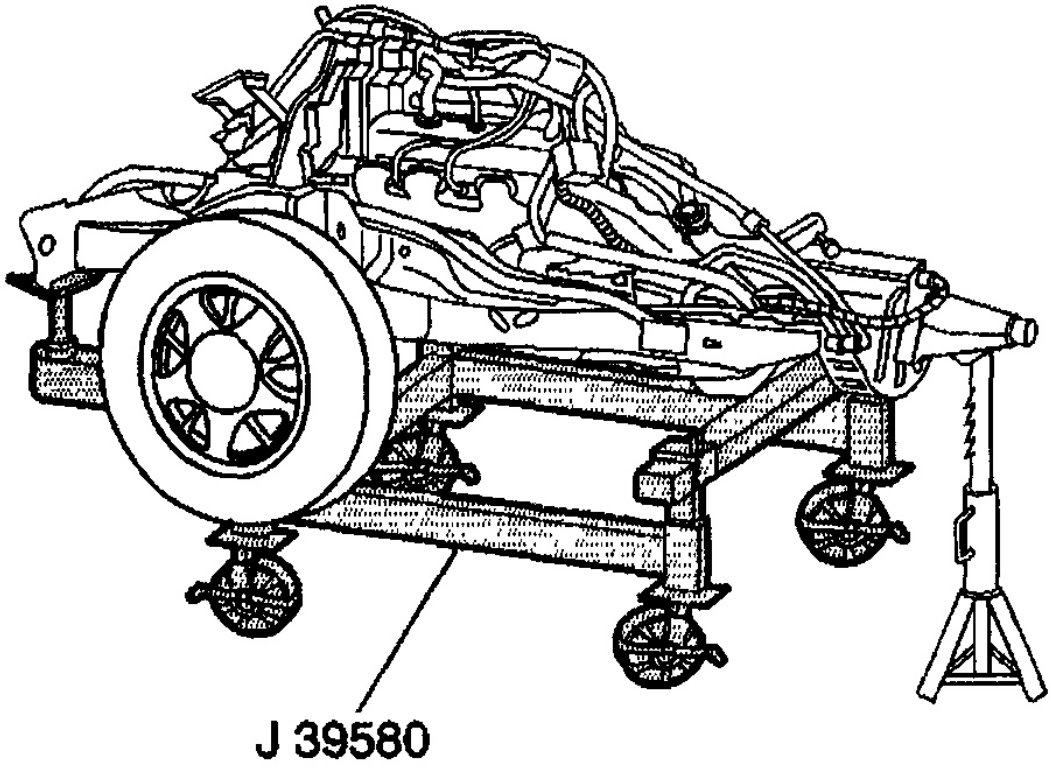

Fig. 210: Identifying Universal Engine Support Table (J 39580)
Courtesy of GENERAL MOTORS CORP.

35. Lower the vehicle onto the engine/frame assembly and the J 39580.

IMPORTANT: The 6 frame-to-body bolts must be tightened in sequence in order to ensure correct alignment of the frame to the chassis.

36. Install the bolts (1,2, 3).

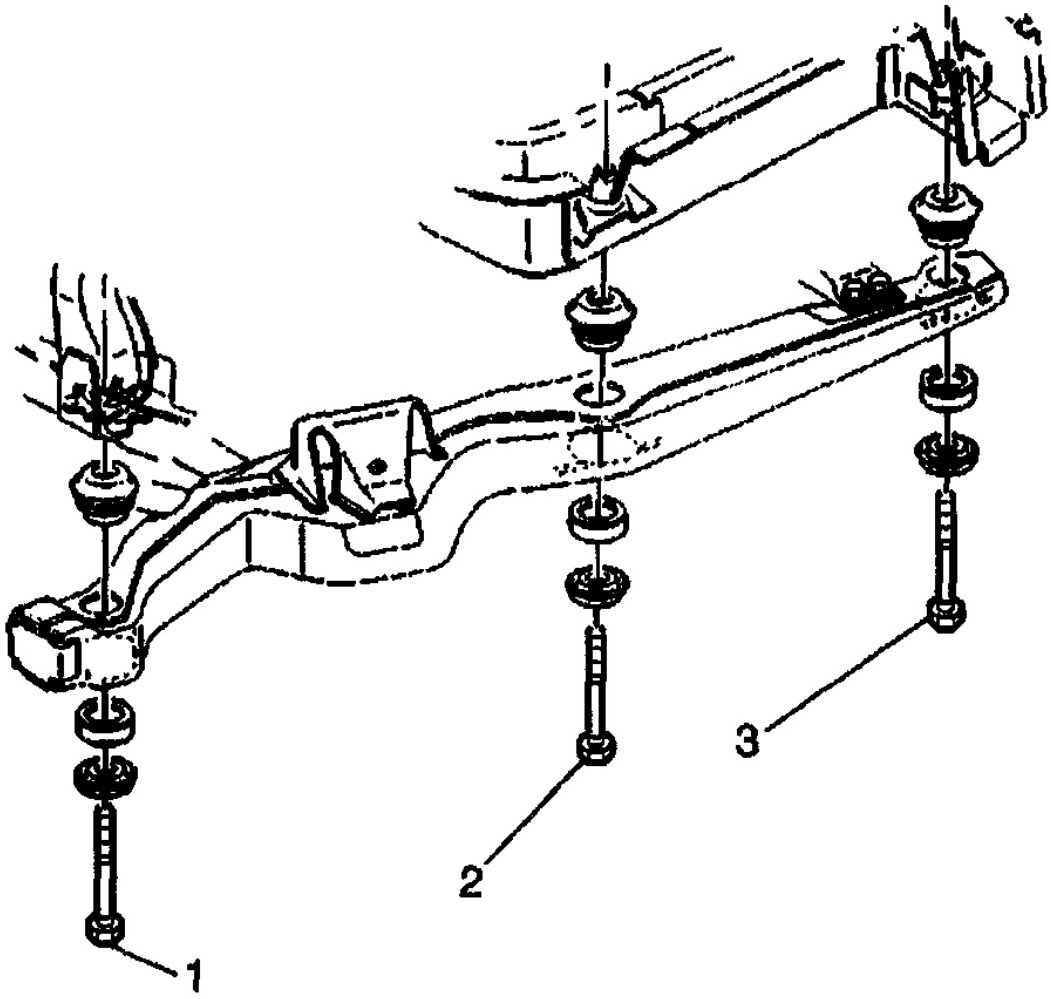

Fig. 211: Identifying Frame-To-Body Bolts
Courtesy of GENERAL MOTORS CORP.

37. Tighten the body bolts using the following sequence:
    - **Tighten:**
        a. Tighten all of the body bolts in the sequence shown to 35 N.m (26 lb ft).
        b. Tighten the right center body bolt to 155 N.m (114 lb ft).
        c. Tighten the left center body bolt to 155 N.m (114 lb ft).
        d. Tighten the right front body bolt to 90 N.m (66 lb ft).
        e. Tighten the left rear body bolt to 90 N.m (66 lb ft).
        f. Tighten the left front body bolt to 90 N.m (66 lb ft).

g. Tighten the right rear body bolt to 90 N.m (66 lb ft).

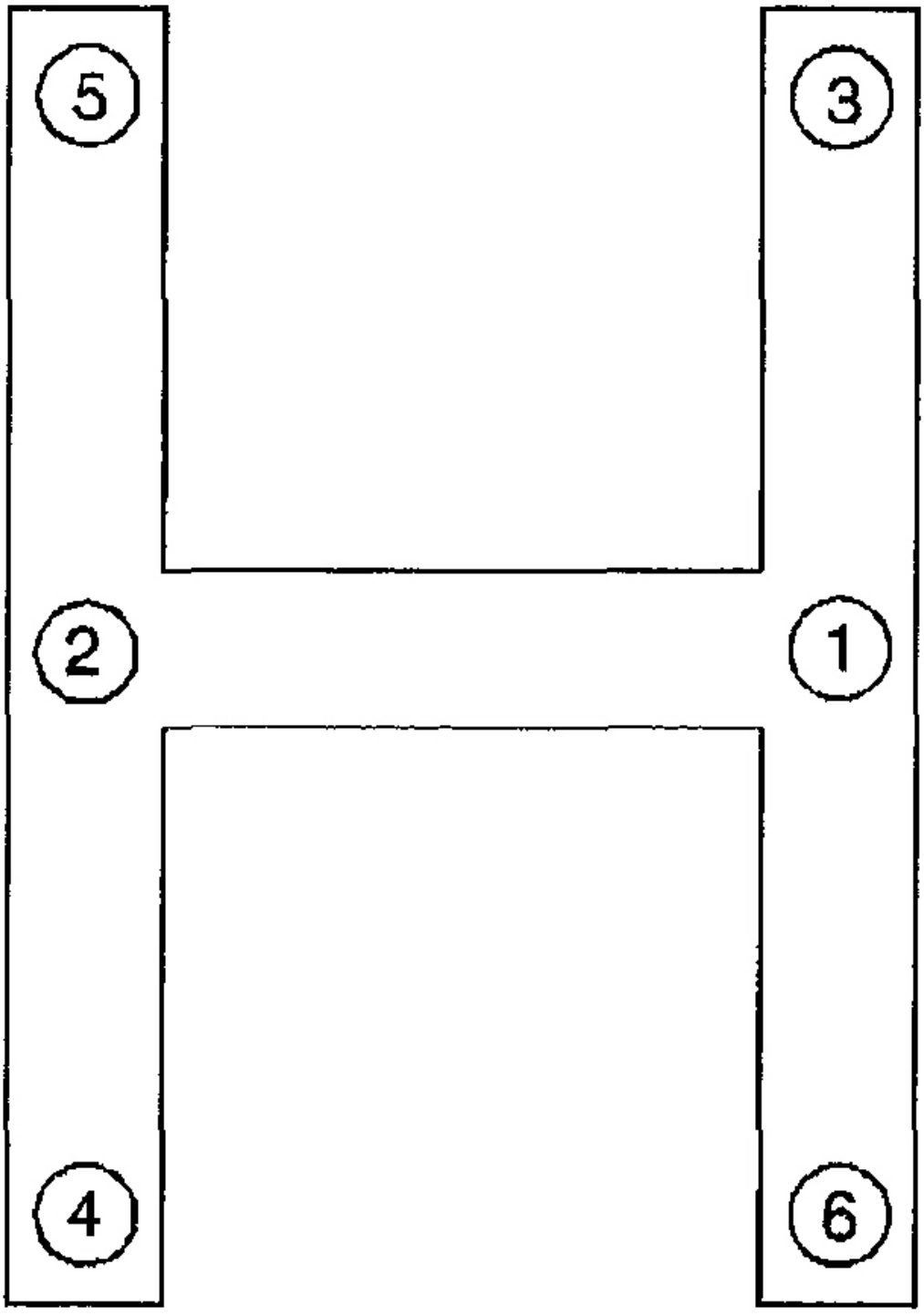

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Fig. 212: Identifying Frame-To-Body Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

38. Raise the vehicle.
39. Install the transfer case vent tube, if equipped.
40. Connect the wire connector to the wiring harness above the transmission.
41. Connect the shift cable to the transmission.
42. Install the torque converter bolts. **Tighten:** Tighten the bolts to 62 N.m (46 lb ft).
43. Install the transmission cover. **Tighten:** Tighten the transmission cover bolts to 12 N.m (106 lb in).

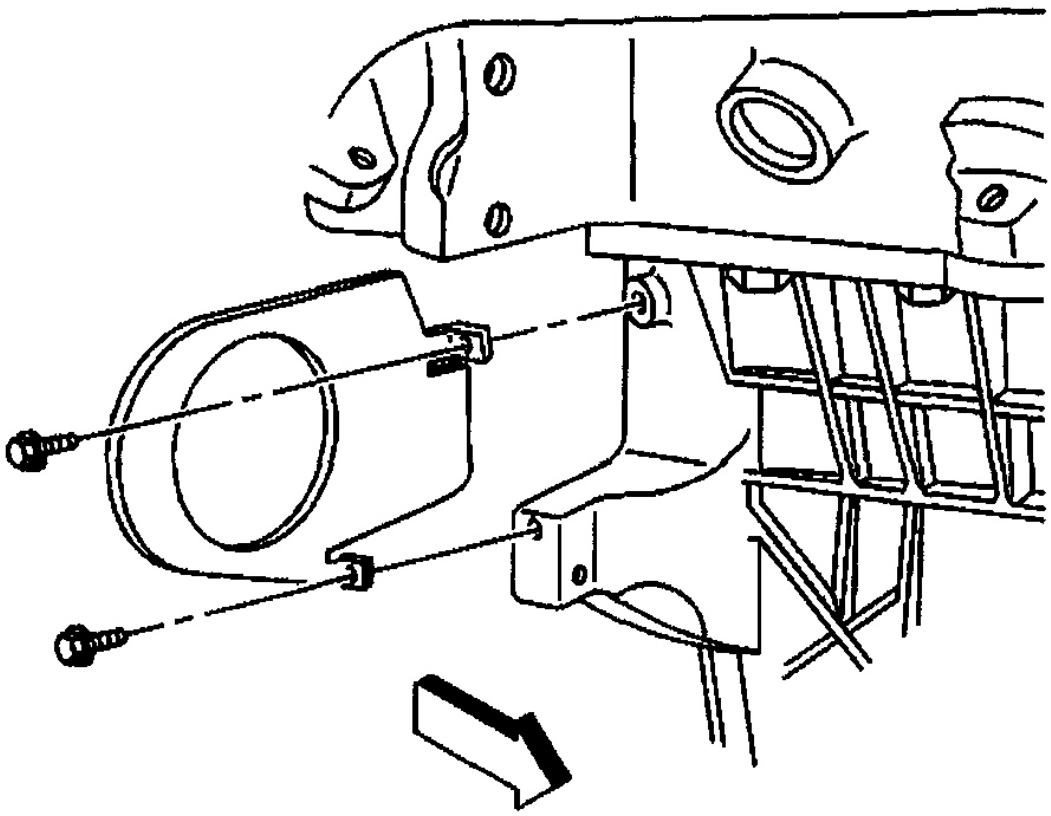

Fig. 213: Installing Transmission Cover
Courtesy of GENERAL MOTORS CORP.

44. Install the starter. Refer to **STARTERS 2000** or **STARTERS 2001** .
45. Install the oil cooler pipes to the oil filter adapter.
46. Install the rear propeller shaft.

47. Connect the power steering cooler.
48. Connect the inflatable restraint front end discriminating sensor electrical connector.
49. Connect the fender wheelhouse extensions from chassis to the frame.
50. Install the front bumper.
51. Install the muffler and the tail pipe section to the hangers and install it to the converter assembly.
52. Connect the fuel pipes at the fuel filter.
53. Position the engine wiring harness in the clips on the frame and the cross sills.
54. Connect the fuel tank electrical connector.
55. Connect the EVAP vent valve electrical connector.
56. Install the bolt and the ground wire at the chassis by the EVAP vent valve. **Tighten:** Tighten the ground wire bolt to 9 N.m (80 lb in).
57. Ensure that all of the electrical connections are connected between the chassis and the frame.
58. Install the bolt and the park brake bracket to the frame. **Tighten:** Tighten the park brake bracket bolt to 24 N.m (17 lb ft).

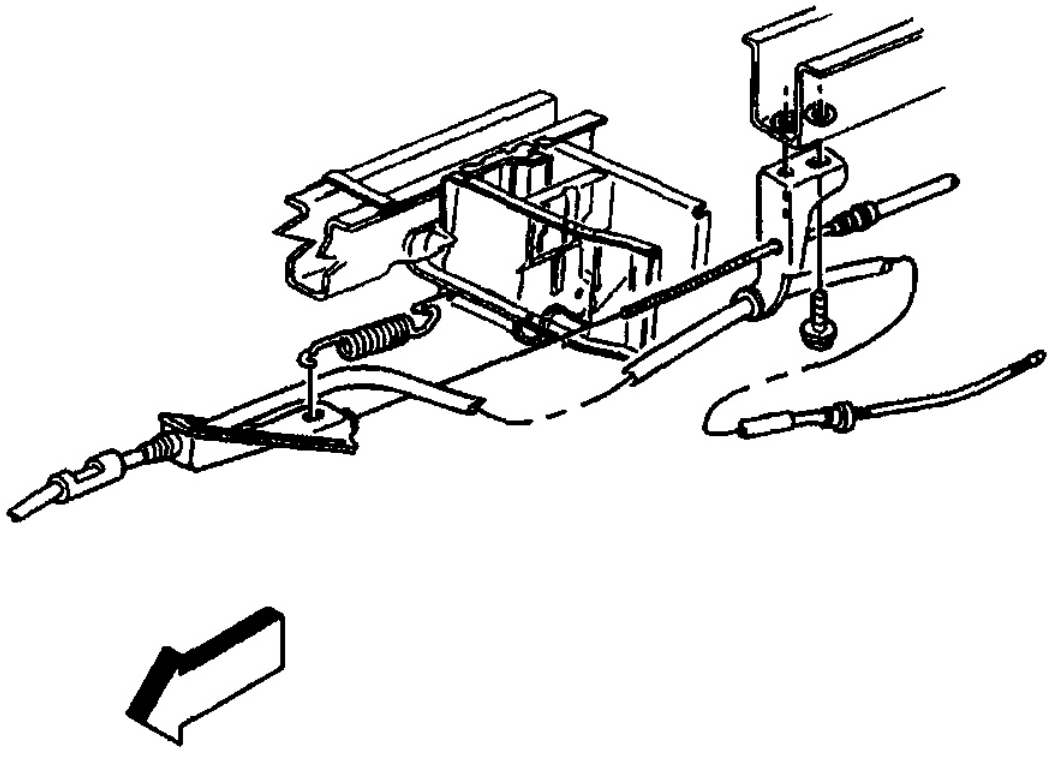

Fig. 214: Locating Parking Brake Bracket At Frame
Courtesy of GENERAL MOTORS CORP.

59. Connect the rear air conditioning pipes at the rear crossmember by the fuel tank fill hoses, if equipped.
60. Connect the rear brake pipe to the BPMV.
61. Remove the bell housing to transmission bolt.
62. Lower the vehicle.
63. Remove both of the J 41602.
64. Install the front section of the running boards.
65. Install the battery cable assembly to the fender and the radiator support.
66. Install the battery positive cable but do not install the battery negative cable.

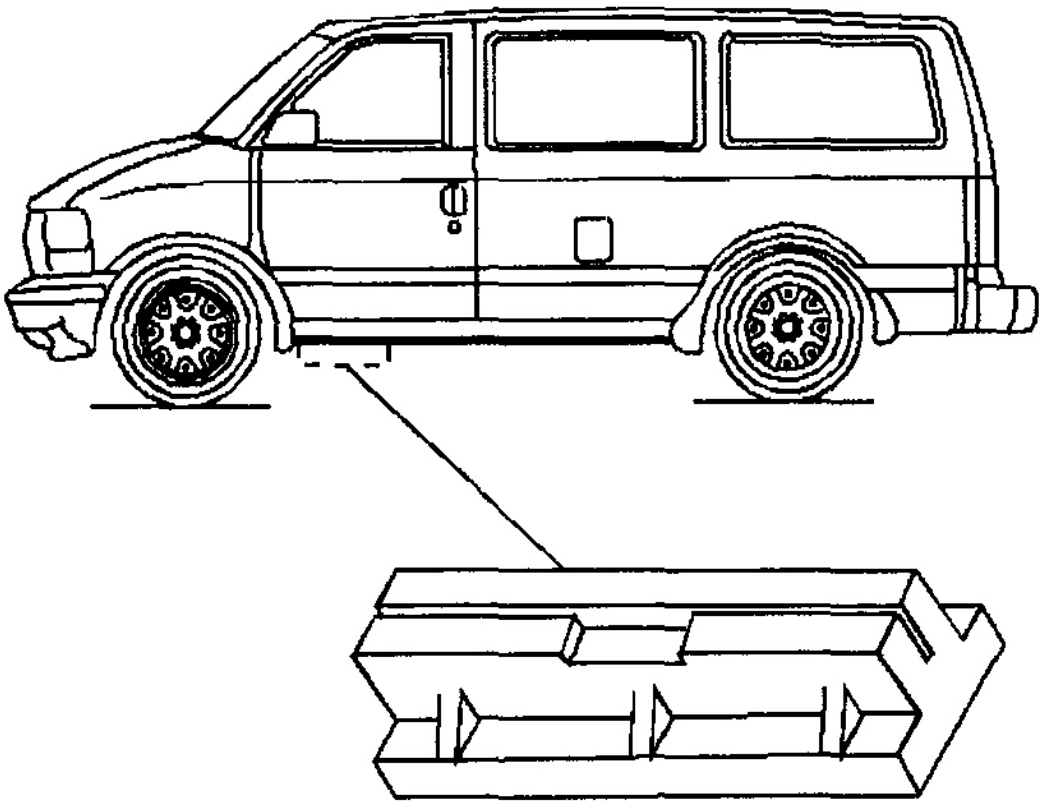

Fig. 215: Installing Front Section Of Running Boards
Courtesy of GENERAL MOTORS CORP.

67. Install the wiring harness in the retainers clips along the bulkhead.
68. Connect the fuse box and the wiring harness to the bulkhead connector.
69. Connect all related connectors including the following:

- The ground wires
- The A/C module
- The cruise control module
- The wiper motor
- The differential pressure input switch

70. Connect the steering shaft to the steering gear.
71. Connect the heater hoses to the engine.
72. Connect the vacuum hose for the vacuum tank to the intake manifold.

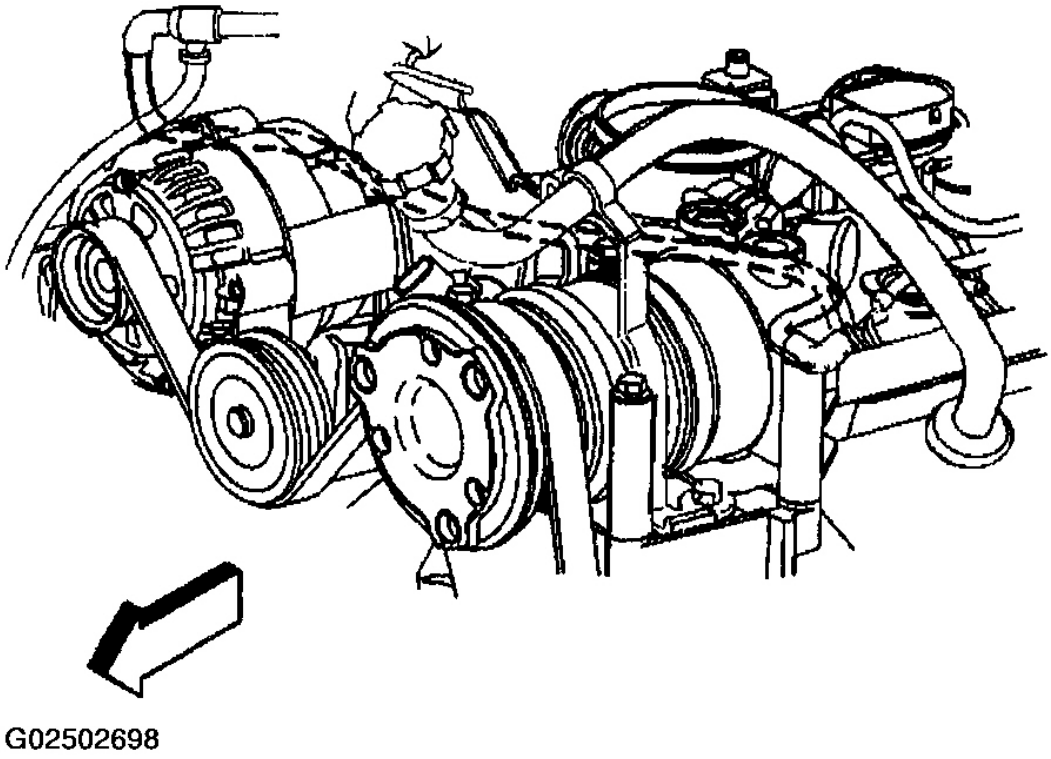

Fig. 216: Connecting Vacuum Hose From Intake Manifold
Courtesy of GENERAL MOTORS CORP.

73. Connect the pipes to the hydro boost.
74. Install the power steering reservoir.
75. Install the master cylinder to the hydro boost.

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.

76. Install the NEW accelerator control cable.
77. Connect the cruise control cable to the throttle shaft and the accelerator control cable bracket.
78. Connect the air conditioning pipes at the accumulator and the condenser, if equipped.
79. Install the radiator.
80. Fill the cooling system with the correct grade of engine coolant.
81. Install the air cleaner outlet duct to the throttle body.
82. Install the air cleaner assembly.
83. Fill the crankcase with the correct grade of engine oil. Refer to **ENGINE OIL & OIL FILTER REPLACEMENT**.
84. Fill and bleed the brake system.
85. Fill the transmission with the correct grade and quantity of transmission fluid.
86. Fill the power steering system with the correct grade and quantity of power steering fluid.
87. Connect the battery negative cable.
88. Recharge the air conditioning system and check for correct operation, if equipped.
89. Install the engine cover.
90. Perform a crankshaft variation learn procedure.
91. Operate the engine and check for correct operation.

ENGINE OIL & OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle and support with safety stands.
2. Remove the oil pan drain plug and drain the engine oil in a suitable container.

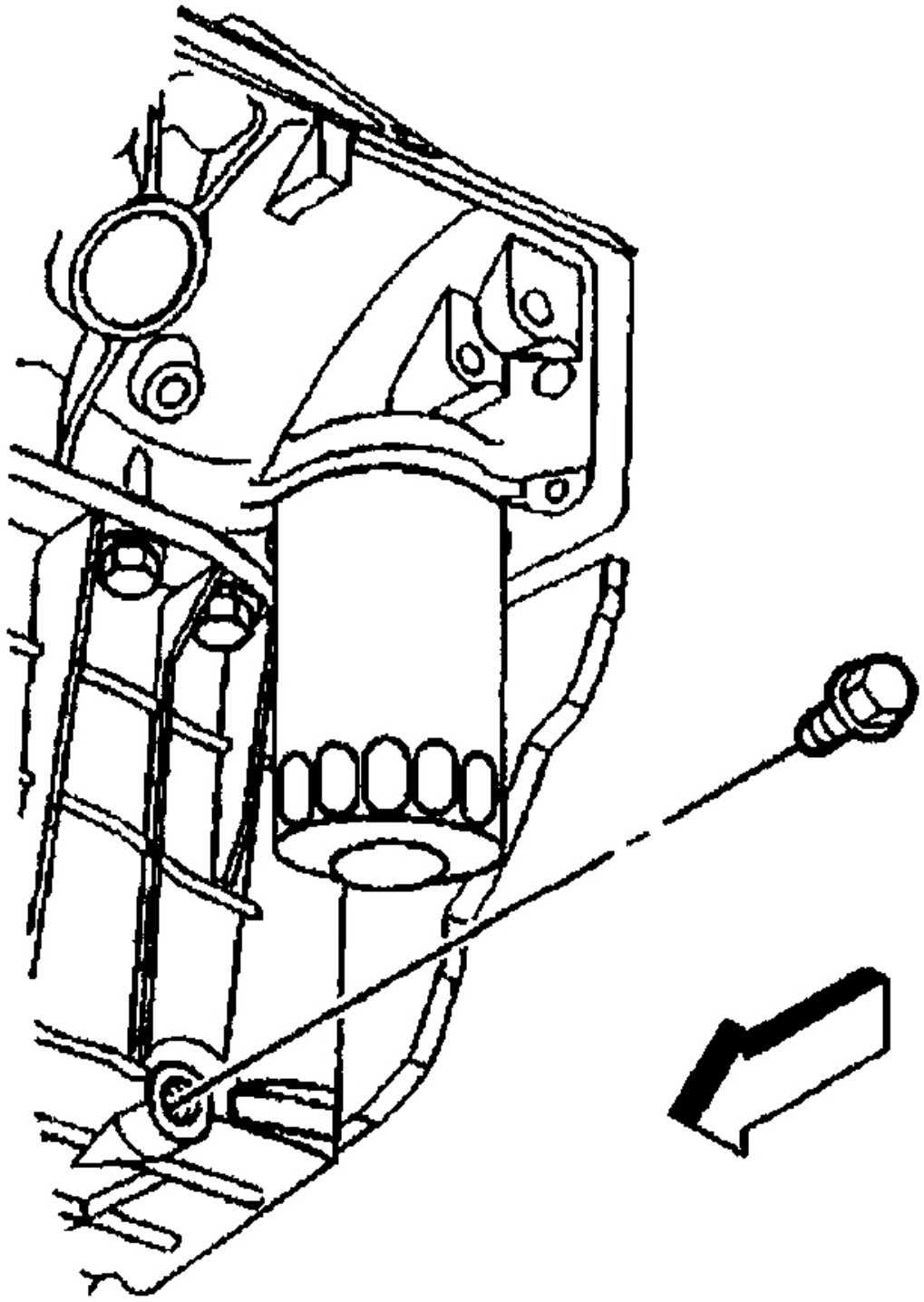

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Fig. 217: Removing Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil filter.
4. Inspect to ensure the engine oil filter gasket is removed.

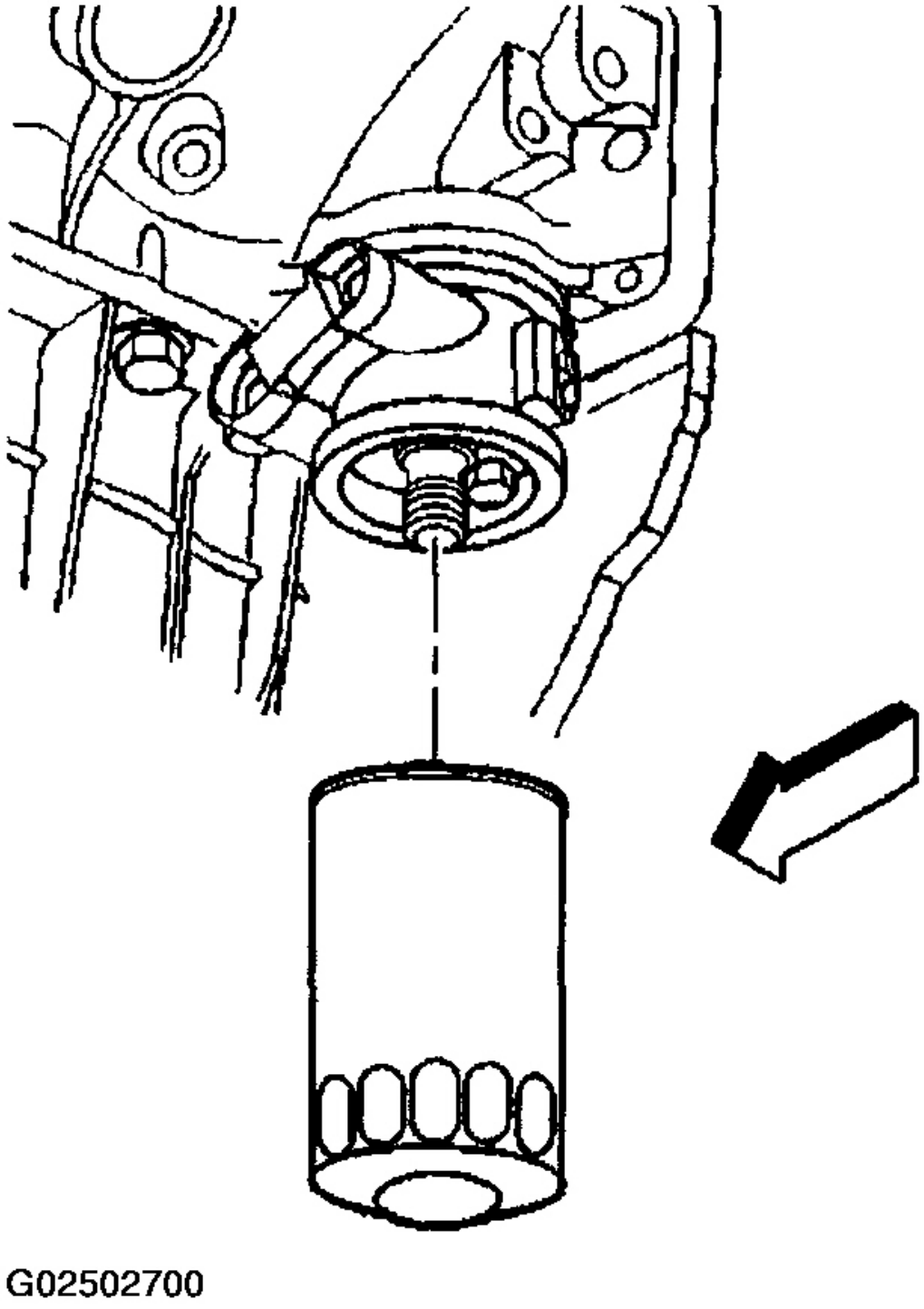

Fig. 218: Removing Engine Oil Filter

Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Lubricate the engine oil filter gasket with clean engine oil.
2. Install the engine oil filter.
3. Follow the tightening instructions on the oil filter.

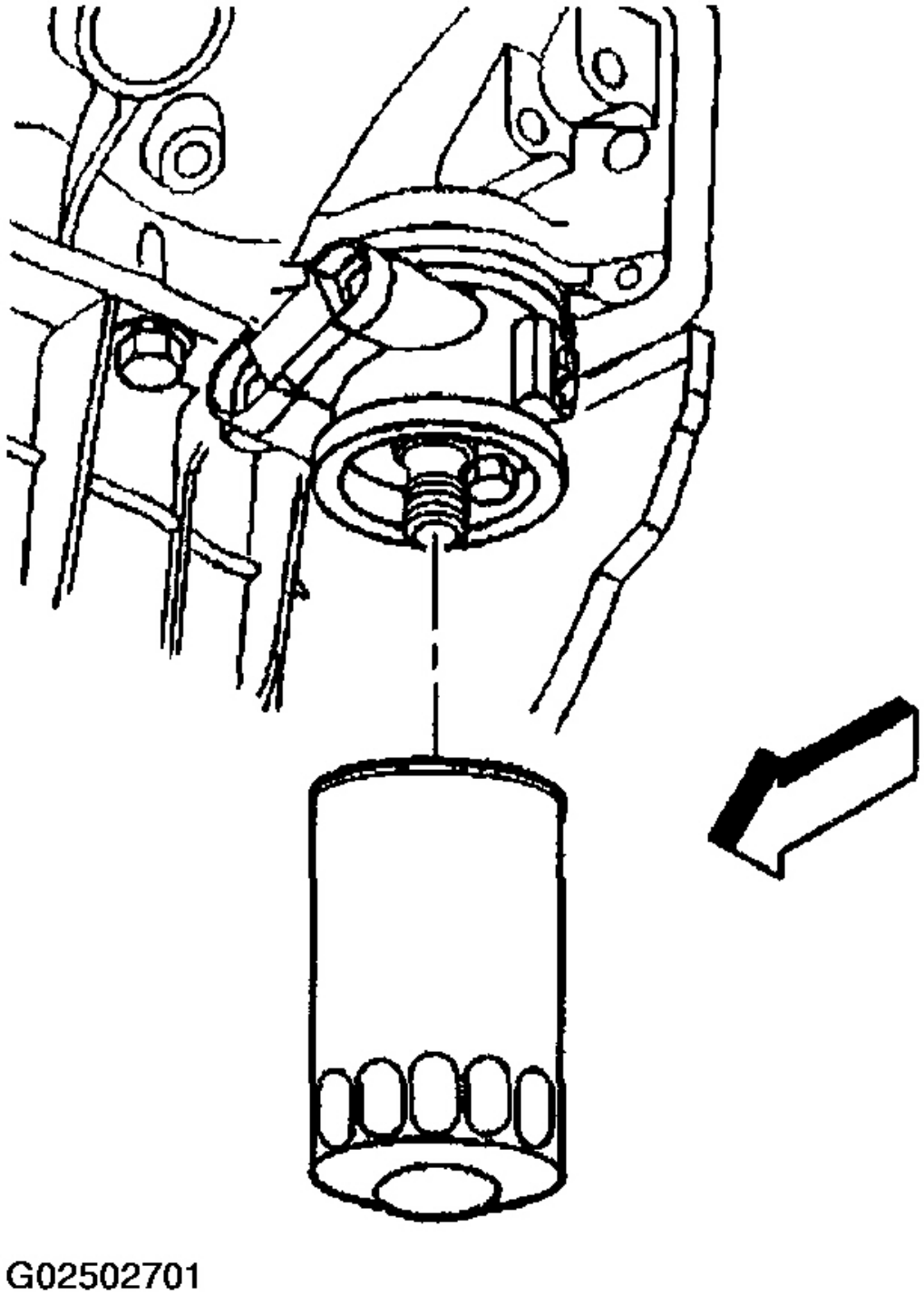

Fig. 219: Installing Oil Filter

Courtesy of GENERAL MOTORS CORP.

4. Install the drain plug to the oil pan. **Tighten:** Tighten the oil pan plug to 25 N.m (18 lb ft).

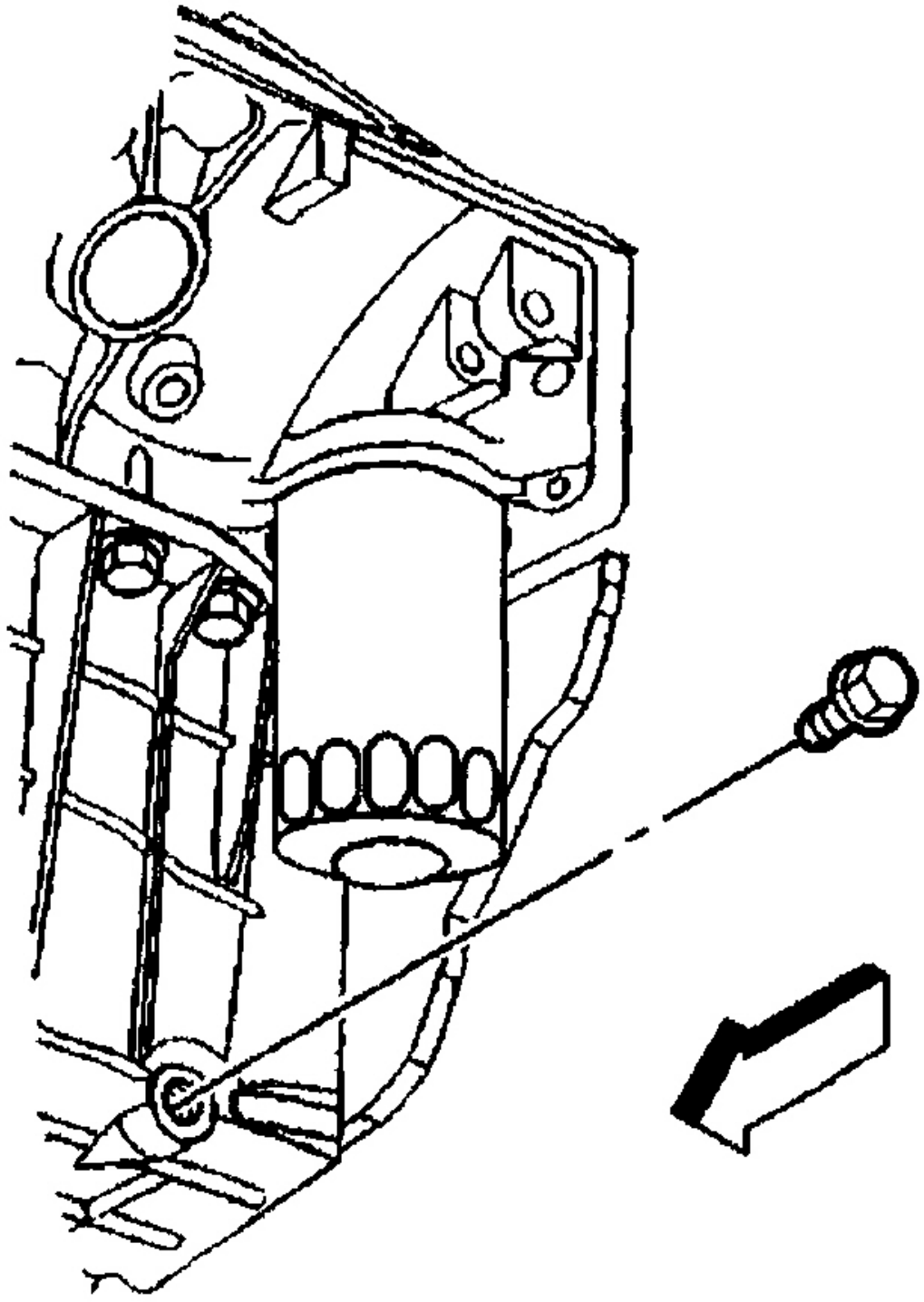

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Fig. 220: Installing Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

5. Remove the safety stands and lower the vehicle.
6. Fill the engine with the proper capacity and quality of engine oil.
7. Operate the engine, check for leaks and oil pressure.
8. Check the oil level and add as required.

DRAINING FLUIDS & OIL FILTER REMOVAL

1. Remove the oil pan drain plug and allow the engine oil to drain into a suitable container.

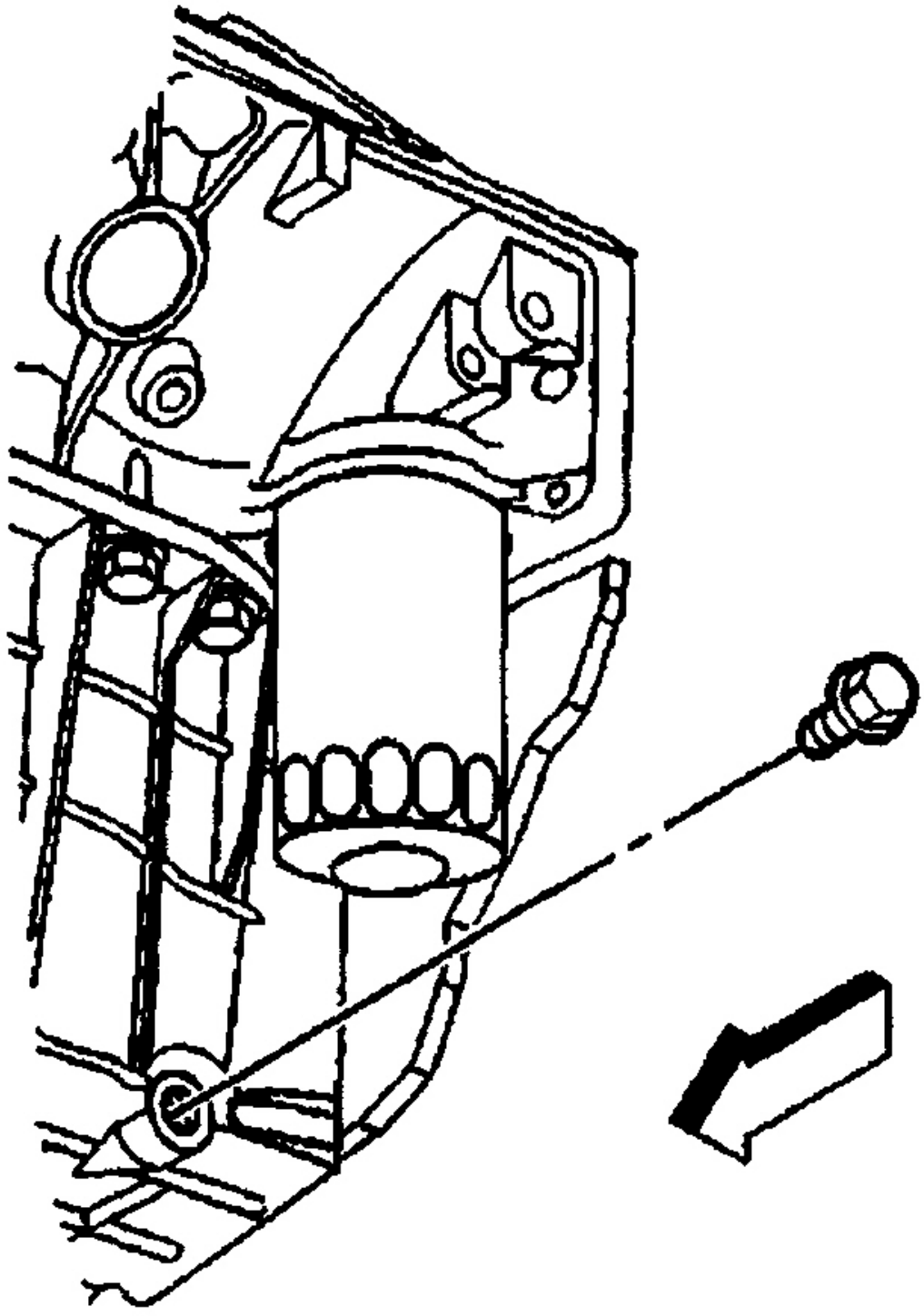

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Fig. 221: Removing Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter (if applicable).
3. Discard the oil filter (if applicable).

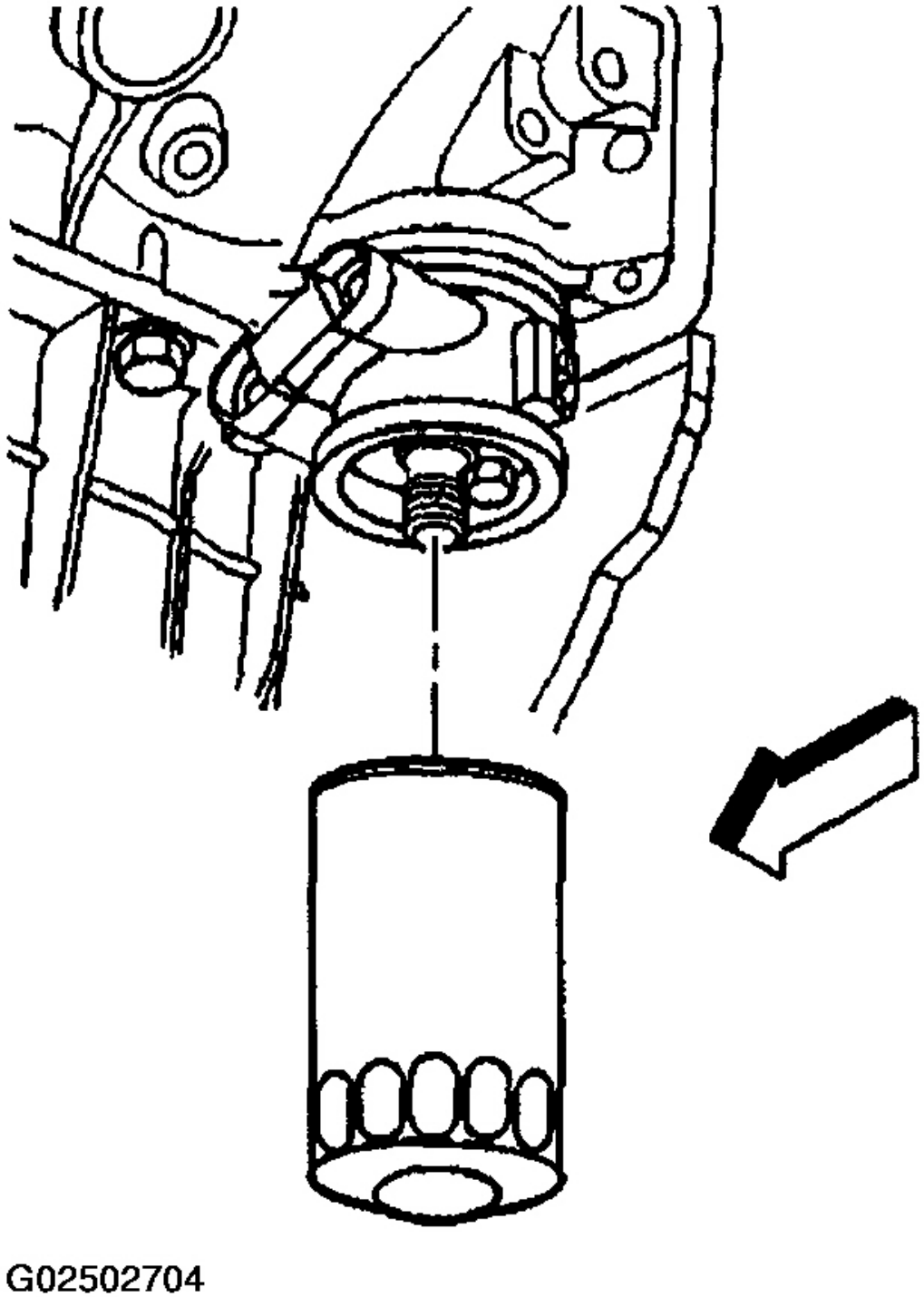

Fig. 222: Removing Oil Filter

Courtesy of GENERAL MOTORS CORP.

4. Remove both the engine block coolant drain hole plugs and allow the coolant to drain into a suitable container.

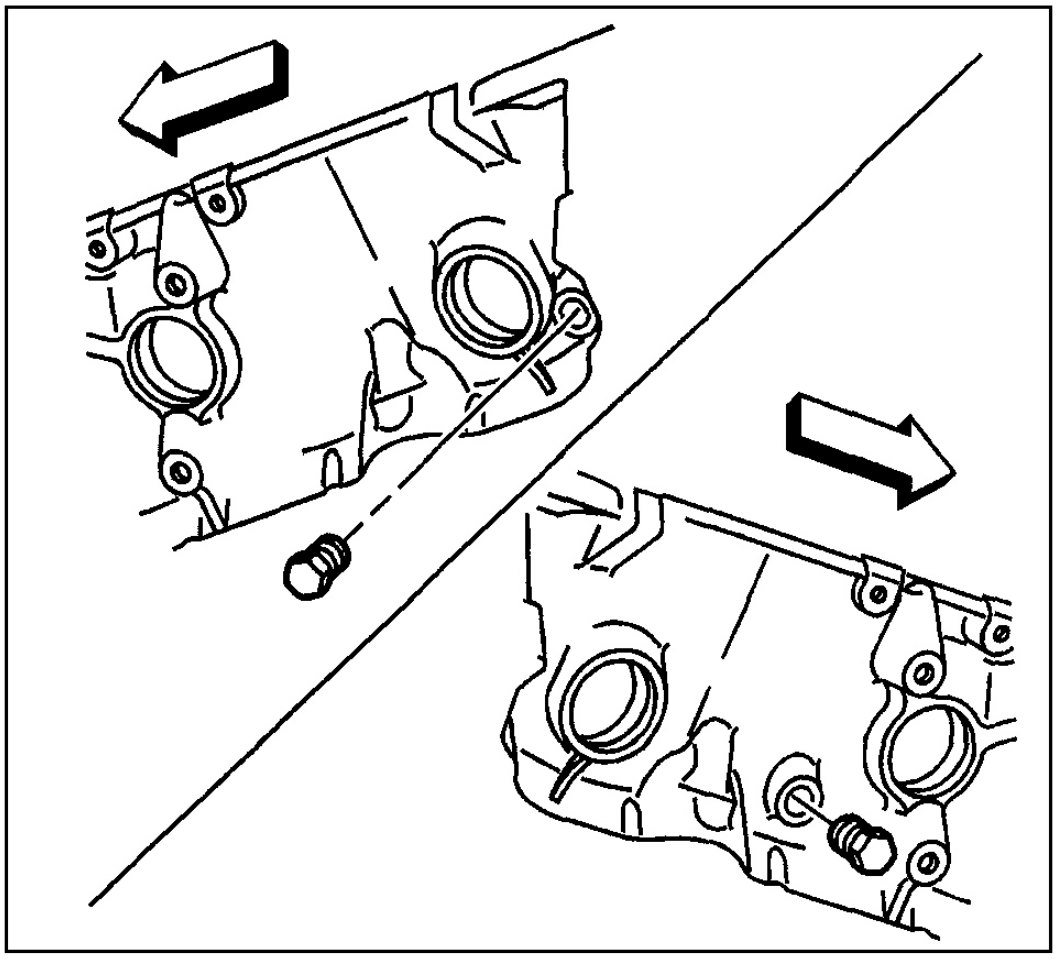

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Fig. 223: Locating Engine Block Coolant Drain Hole Plugs
Courtesy of GENERAL MOTORS CORP.

ENGINE FLYWHEEL REMOVAL

1. Remove the engine flywheel bolts.
2. Remove the engine flywheel.

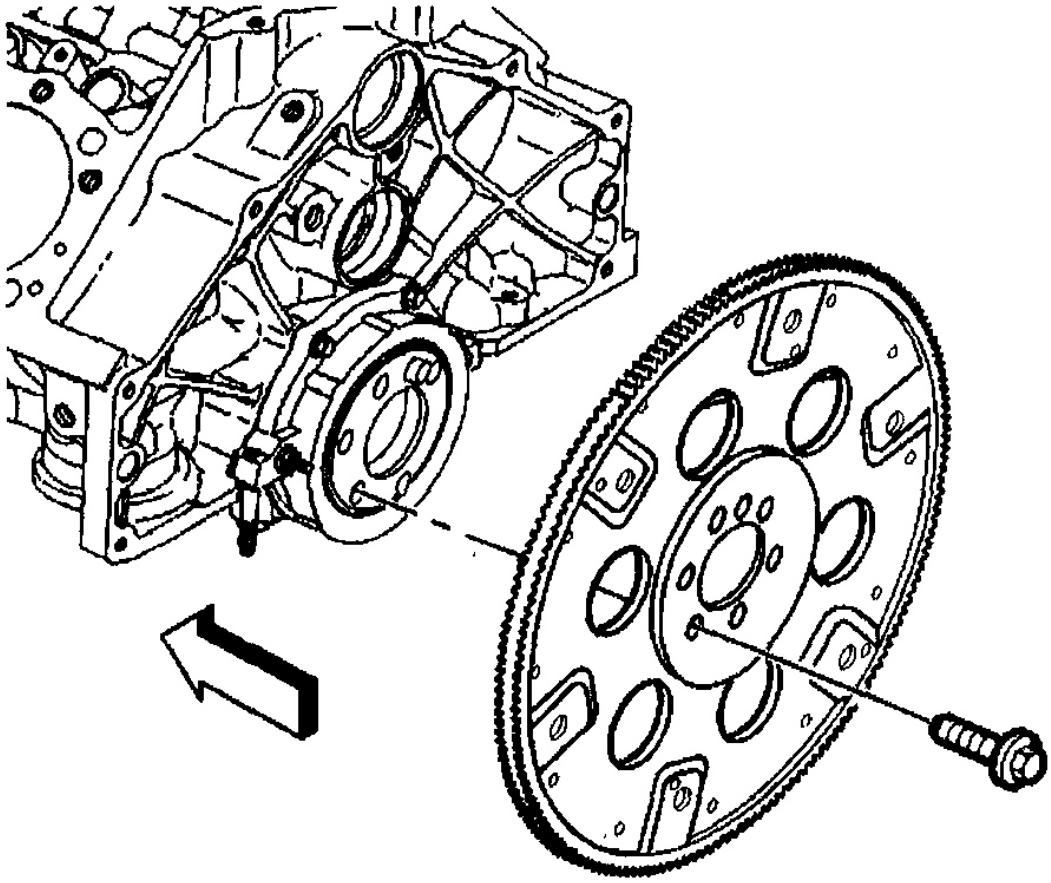

Fig. 224: Removing Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

DESCRIPTION & OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

A crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapors. The air cleaner supplies fresh air through a filter to the crankcase. The crankcase mixes the fresh air with blow-by gases. This mixture then passes through a crankcase ventilation valve into the intake manifold.

The primary control is through the crankcase ventilation valve (1), which meters the flow at a rate depending on the manifold vacuum.

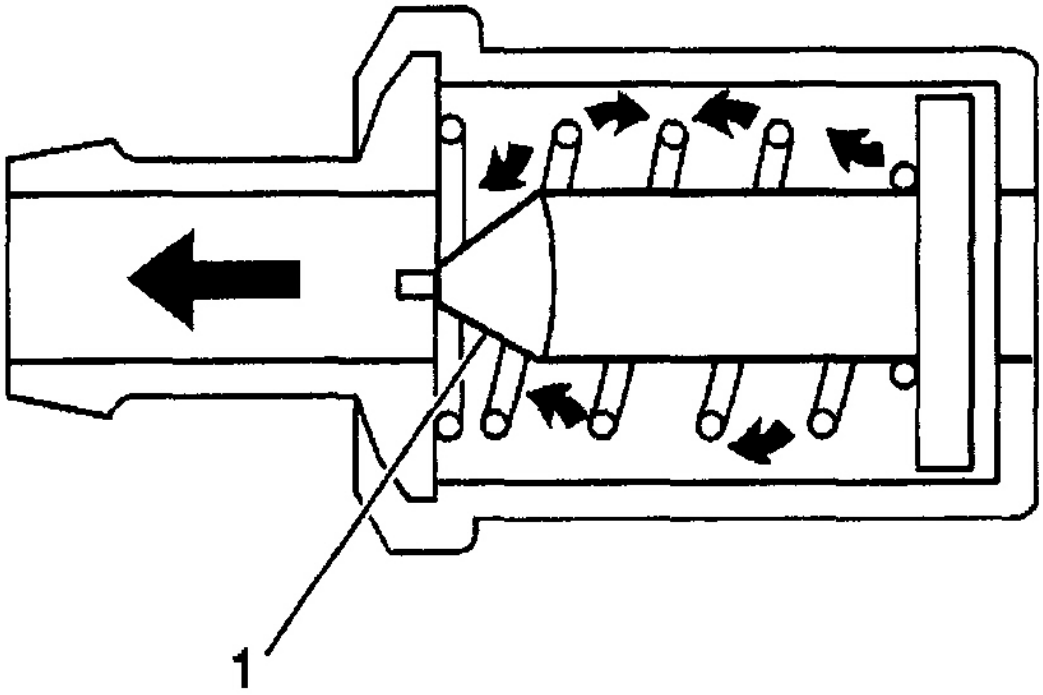

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Fig. 225: Cross-Sectional View Of Crankcase Ventilation Valve
Courtesy of GENERAL MOTORS CORP.

In order to maintain an idle quality, the crankcase ventilation valve restricts the flow when the intake manifold vacuum is high. If abnormal operating conditions arise, the system is designed in order to allow the excessive amounts of blow-by gases to back flow through the crankcase vent tube into the air cleaner in order to be consumed by normal combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

a. The drive belt
b. The drive belt tensioner
c. The drive belt idler pulley
d. The crankshaft balancer pulley
e. The accessory drive component mounting brackets
f. 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. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubbers - chloroprene or EPDM - and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

SPECIAL TOOLS & EQUIPMENT

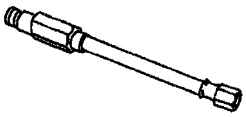
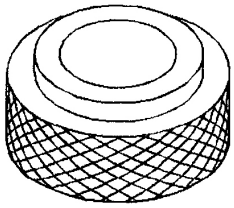
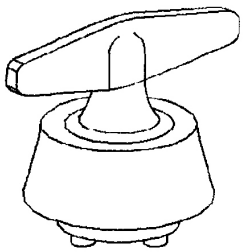
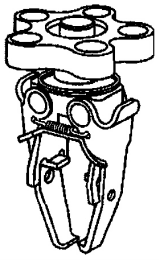
Illustration	Tool Number/ Description
	J 5892-D Valve Spring Compressor
	J 22794 Spark Plug Port Adapter
	J 35468 Cover Aligner/Seal Installer
	J 35621-B Rear Main Seal Installer
	J 38606 Valve Spring Compressor

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Fig. 226: Identifying Special Tools & Equipment (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

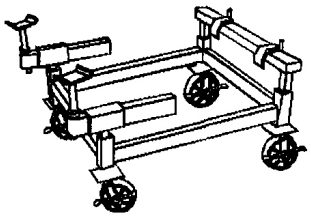
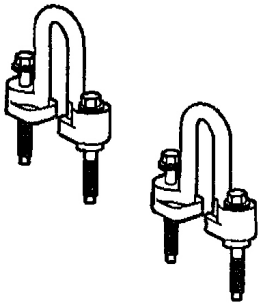
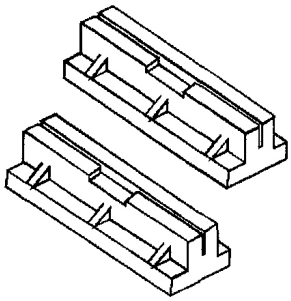
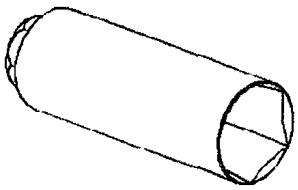
Illustration	Tool Number/ Description
	J 39580 Universal Engine Support Table
	J 41427 Engine Lift Bracket
	J 41602 Body Protection Hoist Adapter Set
	J 41712 Oil Pressure Switch Socket

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Fig. 227: Identifying Special Tools & Equipment (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

