

2002 Chevrolet Monte Carlo LS

2002 ENGINES Engine Mechanical - Impala & Monte Carlo - 3.8L

2002 ENGINES**Engine Mechanical - Impala & Monte Carlo - 3.8L****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS**

Application	Specifications	
	Metric	English
A/C Compressor Bracket Bolt	50 N.m	37 lb ft
A/C Compressor Nut	30 N.m	22 lb ft
Balance Shaft Gear Bolt		
First Pass	22 N.m	16 lb ft
Second Pass	70 degrees	
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Camshaft Sprocket Bolt		
First Pass	100 N.m	74 lb ft
Second Pass	90 degrees	
Camshaft Thrust Plate Bolt	15 N.m	11 lb ft
Connecting Rod Bearing Cap Nut		
First Pass	27 N.m	20 lb ft
Second Pass	50 degrees	
Crankshaft Balancer Bolt		
First Pass	150 N.m	111 lb ft
Second Pass	76 degrees	
Crankshaft Position Sensor Stud	30 N.m	22 lb ft
Crankshaft Rear Oil Seal Housing Bolt		
First Pass	15 N.m	11 lb ft
Second Pass	50 degrees	
Cylinder Head Bolt		
First Pass	50 N.m	37 lb ft
Second Pass	120 degrees	
Drive Belt Tensioner Bolt	50 N.m	37 lb ft
EGR Valve Adapter Bolt	50 N.m	37 lb ft
EGR Valve Nut	29 N.m	21 lb ft
EGR Valve Outlet Pipe Bolt/Nut	29 N.m	21 lb ft
EGR Valve Wiring Harness Heat Shield Bolt/Nut	10 N.m	89 lb in
Engine Block Coolant Drain Plug-Knock Sensors	18 N.m	13 lb ft
Engine Coolant Temperature Sensor	25 N.m	18 lb ft
Engine Flywheel Bolt		

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First Pass	15 N.m	11 lb ft
Second Pass	50 degrees	
Engine Front Cover Bolt/Stud		
First Pass	20 N.m	15 lb ft
Second Pass	40 degrees	
Engine Ground Nut	35 N.m	26 lb ft
Engine Lift Bracket Bolt/Nut/Stud	30 N.m	22 lb ft
Engine Mount Bracket Bolt	102 N.m	75 lb ft
Engine Mount Nut (Lower)	78 N.m	58 lb ft
Engine Mount Nut (Upper)	78 N.m	58 lb ft
Engine Mount Strut Bolt	48 N.m	35 lb ft
Engine Mount Strut Bracket Bolt	50 N.m	37 lb ft
Engine Mount Strut Bracket Bolt (Upper Radiator Support)	28 N.m	21 lb ft
Engine Mount Strut Bracket nut (Lower)	30 N.m	22 lb ft
Engine Mount Strut Nut	48 N.m	35 lb ft
Engine Oil Pressure Sensor	16 N.m	12 lb ft
Engine to Transaxle Bolt	75 N.m	55 lb ft
Engine Wiring Harness Bolt	10 N.m	89 lb in
Fuel Injector Sight Shield Bracket Nut	30 N.m	22 lb ft
Generator Brace Bracket Bolt	50 N.m	37 lb ft
Lower Intake Manifold Bolt	15 N.m	11 lb ft
Oil Filter Adapter Bolt	30 N.m	22 lb ft
Oil Level Sensor	20 N.m	15 lb ft
Oil Level Indicator Tube Nut	19 N.m	14 lb ft
Oil Pan Bolt	14 N.m	10 lb ft
Oil Pan Drain Plug	30 N.m	22 lb ft
Oil Pump Cover Screw	11 N.m	98 lb in
Oil Pump, Pipe and Screen Bolt	15 N.m	11 lb ft
Positive Battery Terminal Nut	15 N.m	11 lb ft
Power Steering Bolt	34 N.m	25 lb ft
Throttle Body Support Bolt	10 N.m	89 lb in
Timing Chain Dampener Bolt	22 N.m	16 lb ft
Upper Intake Manifold Bolt	10 N.m	89 lb in
Valve Lifter Guide Bolt	30 N.m	22 lb ft
Valve Rocker Arm Bolt		
First Pass	15 N.m	11 lb ft
Second Pass	90 degrees	
Valve Rocker Arm Cover Bolt	10 N.m	89 lb in
Water Outlet Housing Bolt	27 N.m	20 lb ft
Water Pump Pulley Bolt	13 N.m	116 lb in

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ENGINE MECHANICAL SPECIFICATIONS

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
Engine Type	90° V-6	
Displacement	3.8L	231 cu in
RPO	L36	
Bore	96.52 mm	3.8 in
Stroke	86.36 mm	3.4 in
Compression Ratio (VIN K)	9.4:1	
Firing Order	1-6-5-4-3-2	

SEALERS, ADHESIVES & LUBRICANTS

Application	Type of Material	GM Part Number/CAN
Coolant Temperature Sensor Threads	Sealant	12346004/10953480
Crankshaft Position Sensor Bolt/Stud Threads	Threadlock	12345382/10953489
Engine Block Coolant Drain Plug Threads	Sealant	12346004/10953480
Engine Block Oil Gallery Plug Threads	Sealant	12346004/10953480
Engine Front Cover Bolt Threads	Sealant	12346004/10953480
Engine Oil	Oil-10W-30	12345616/993182
Engine Oil Supplement	Lubricant	1052367/992869
Intake Manifold Bolt Threads (Lower)	Threadlock	12345382/10953489
Intake Manifold Coolant Pipe	Sealant	12345493/10953488
Intake Manifold to Engine Block Mating Surface	Sealant	12346286/10953472
Oil Filter Bypass Hole Plug Threads	Sealant	12346004/10953480
Oil Pan Bolt Threads	Threadlock	12345382/10953489
Oil Pressure Switch Threads	Sealant	12346004/10953480
Valve Lifter and Camshaft Prelube	Lubricant	12345501/992704
Valve Rocker Arm Cover Bolt Threads	Threadlock	12345382/10953489
Valve Rocker Arm Bolt Threads	Threadlock	12345493/10953488

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Fig. 1: Sealer, Adhesive & Lubricant Usage
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION & PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the description and operation information. This will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform A Diagnostic System Check in Engine Controls before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions.

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

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- See **Base Engine Misfire Without Internal Engine Noises.**
- See **Base Engine Misfire With Abnormal Internal Lower Engine Noises.**
- See **Base Engine Misfire With Abnormal Valve Train Noise.**
- See **Base Engine Misfire With Coolant Consumption.**
- See **Base Engine Misfire With Excessive Oil Consumption.**
- See **Engine Compression Test.**
- See **Engine Noise On Start-Up, But Only Lasting A Few Seconds.**
- See **Upper Engine Noise, Regardless Of Engine Speed.**
- See **Lower Engine Noise, Regardless Of Engine Speed.**
- See **Engine Noise Under Load.**
- See **Engine Will Not Crank - Crankshaft Will Not Rotate.**
- See **Oil Consumption Diagnosis.**

- See **Oil Pressure Diagnosis & Testing.**
- See **Oil Leak Diagnosis.**
- See **Drive Belt Chirping Diagnosis.**
- See **Drive Belt Squeal Diagnosis.**
- See **Drive Belt Whine Diagnosis.**
- See **Drive Belt Rumbling Diagnosis.**
- See **Drive Belt Vibration Diagnosis.**
- See **Drive Belt Falls Off Diagnosis.**
- See **Drive Belt Excessive Wear Diagnosis.**
- See **Drive Belt Tensioner Diagnosis.**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

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Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt <i>Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.</i>	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. <i>A misfire code may be present without an actual misfire condition.</i>	Inspect the components, and repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer <i>A misfire code may be present without an actual misfire condition.</i>	Repair or replace the flywheel and/or balancer as required. Refer to <i>Engine Flywheel Replacement</i> or <i>Crankshaft Balancer Replacement</i> .
Restricted exhaust system <i>A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.</i>	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Worn or loose rocker arms <i>The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position</i>	Replace the valve rocker arms as required.
Worn or bent pushrods	Replace the pushrods.
Stuck valves <i>Carbon buildup on the valve stem can cause the valve not to close properly.</i>	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure <i>A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.</i>	- Perform an oil pressure test. Refer to <i>Oil Pressure Diagnosis and Testing</i>. - Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. <i>Coolant consumption may or may not cause the engine to overheat.</i>	- Inspect for spark plugs saturated by coolant. - Inspect the cylinder heads, engine block, and/or head gaskets. - Repair or replace as required.
Worn Piston Rings <i>Oil consumption may or may not cause the engine to misfire.</i>	- Inspect the spark plugs for oil deposits. - Inspect the cylinders for a loss of compression. Refer to <i>Engine Compression Test</i>. - Perform cylinder leak down and compression testing to identify the cause. - Repair or replace as required.

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Fig. 2: Base Engine Misfire Without Internal Engine Noises
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

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Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt <i>Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.</i>	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout <i>A misfire code may be present without an actual misfire condition.</i>	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer <i>A misfire code may be present without an actual misfire condition.</i>	Repair or replace the flywheel and/or balancer as required. Refer to <i>Engine Flywheel Replacement</i> or <i>Crankshaft Balancer Replacement</i> .
Worn Piston Rings <i>Oil consumption may or may not cause the engine to misfire.</i>	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <i>Engine Compression Test</i>. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn Crankshaft Thrust Bearings <i>Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.</i>	Replace the crankshaft and bearings as required.

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Fig. 3: Base Engine Misfire With Abnormal Internal Lower Engine Noises
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

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

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Fig. 4: Base Engine Misfire With Abnormal Valve Train Noise
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

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Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Perform a cylinder leak down test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

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Fig. 5: Base Engine Misfire With Coolant Consumption
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

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

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Fig. 6: 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 oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
High valve lifter leak down rate	Replace the lifters as required.

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Fig. 7: Engine Noise On Start-Up, But Only Lasting A Few Seconds
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UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

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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	• Perform an oil pressure test. Refer <i>Oil Pressure Diagnosis and Testing</i>. • Repair or replace as required.
Loose and/or worn valve rocker arm attachments	• Inspect the valve rocker arm stud, nut, or bolt. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Bent or damaged push rod	Inspect the following components, and replace as required: • The valve rocker arm • The valve push rod • The valve lifter
Improper lubrication to the valve rocker arms	Inspect the following components, and repair or replace as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn and/or damaged valve rotators	Replace the valve rotators as required.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn timing chain tensioner, if applicable	Replace the timing chain tensioners as required.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lifters as required.

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Fig. 8: Upper Engine Noise, Regardless Of Engine Speed (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
Damaged, broken, or dirty, balance shaft sprocket teeth, if applicable	Inspect the following components, and repair as required: • The balance shaft gear • The camshaft gear • The balance shaft rear bushing
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
Stuck Valves Carbon on the valve stem or valve seat may cause the valve to stay open	Inspect the following components, and repair as required: • The valves • The valve guides

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Fig. 9: Upper Engine Noise, Regardless Of Engine Speed (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

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

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Fig. 10: Lower Engine Noise, Regardless Of Engine Speed
 Courtesy of GENERAL MOTORS CORP.

ENGINE NOISE UNDER LOAD

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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. Refer to <i>Oil Pressure Diagnosis and Testing</i>. - Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the Knock Sensor System. Refer to <i>Knock Sensor (KS) System Description</i> in Engine Controls.
Loose torque converter bolts	- Inspect the torque converter bolts and flywheel. - Repair as required.
Cracked flywheel, automatic transmission	- Inspect the flywheel bolts and flywheel. - Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: - The connecting rod bearings - The connecting rods - The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: - The crankshaft bearings - The crankshaft journals - The cylinder block crankshaft bearing bore

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Fig. 11: Engine Noise Under Load
 Courtesy of GENERAL MOTORS CORP.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	- Remove accessory drive belt or belts. - Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder - Coolant/antifreeze in cylinder - Oil in cylinder - Fuel in cylinder	- Remove spark plugs and check for fluid. - Inspect for broken head gasket or gaskets. - Inspect for cracked engine block or cylinder head. - Inspect for a sticking fuel injector and/or leaking fuel regulator.
Seized automatic transmission torque converter	- Remove the torque converter bolts. - Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or timing chain gears	- Inspect timing chain and gears. - Repair as required.
Seized balance shaft bearing if equipped	- Inspect balance shaft bearings. - 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. 12: Engine Will Not Crank - Crankshaft Will Not Rotate
Courtesy of GENERAL MOTORS CORP.

ENGINE COMPRESSION TEST

Tools Required

J 38722 Compression Tester

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

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

Important: Remove the Powertrain Control Module (PCM) and the ignition fuses from the I/P fuse block.

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

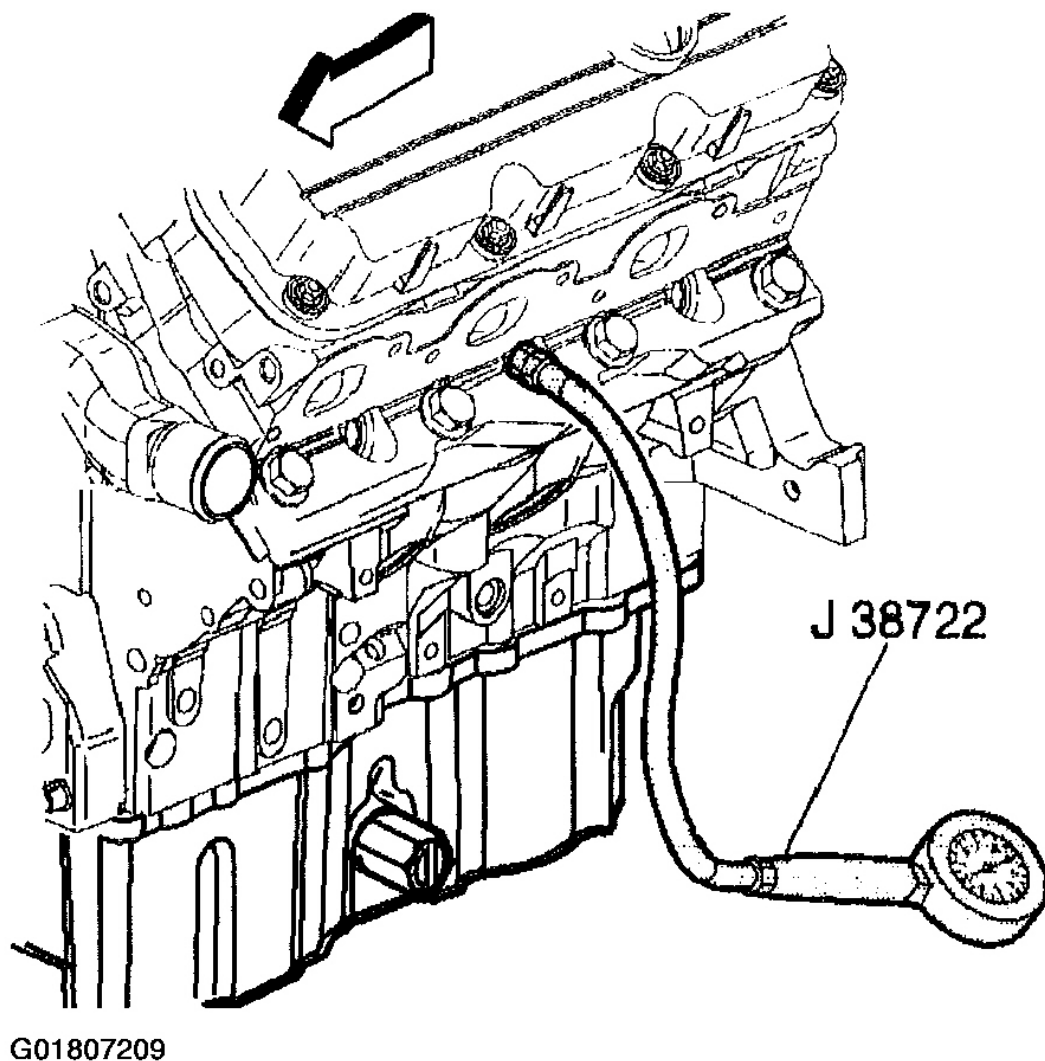


Fig. 13: Checking Compression Using J 38722
Courtesy of GENERAL MOTORS CORP.

8. Measure the engine compression, using the following procedure:
 - 8.1. Firmly install **J 38722** to the spark plug hole.
 - 8.2. Have an assistant crank the engine through at least four compression strokes in the testing cylinder.
 - 8.3. Check and record the readings on **J 38722** at each stroke.
 - 8.4. Disconnect **J 38722**.
 - 8.5. Repeat the compression test for each cylinder.
9. Record the compression readings from all of the cylinders.

- The lowest reading should not be less than 70 percent of the highest reading.
 - No cylinder reading should be less than 689 kPa (100 psi).
10. The following are examples of the possible measurements:
 - When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.
 - When the compression is low on the first stroke and tends to build up on the following strokes, but does not reach the normal compression, or if the compression improves considerably with the addition of three squirts of oil, the piston rings may be the cause.
 - When the compression is low on the first stroke and does not build up in the following strokes, or the addition of oil does not affect the compression, the valves may be the cause.
 - When the compression is low on two adjacent cylinders, or coolant is present in the crankcase, the head gasket may be the cause.
 11. Remove the block from the throttle plate.
 12. Install the air duct to the throttle body.
 13. Install the spark plugs.
 14. Install the Powertrain Control Module (PCM) fuse.
 15. Install the ignition fuse to the I/P fuse block.

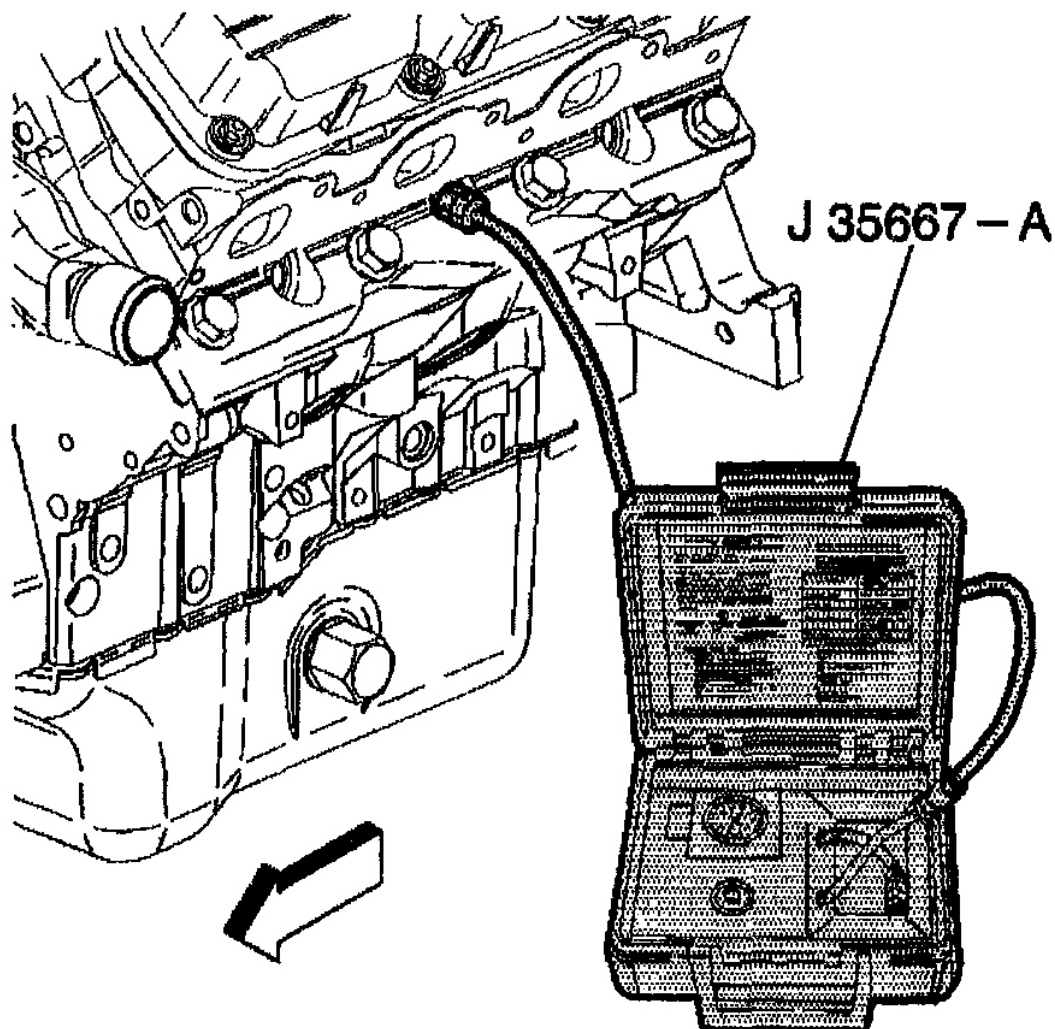
CYLINDER LEAKAGE TEST

Tools Required

J35667-A Cylinder Head Leakdown Tester

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

1. Remove the battery ground - negative cable.
2. Remove the spark plugs.
3. Install the **J 35667-A**.



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Fig. 14: Installing Cylinder Head Leakdown Tester
Courtesy of GENERAL MOTORS CORP.

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

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

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

Important:

- Normal cylinder leakage is from 12-18 percent.
 - Make a note of any cylinder with more leakage than the other cylinders.
 - Any cylinder with 30 percent leakage or more requires service.
7. Inspect the four primary areas, to properly diagnose a leaking cylinder.
 8. If air is heard from the intake or exhaust system, perform the following procedure:
 - Remove the valve rocker arm cover of the suspect cylinder head.
 - Ensure that both valves are closed.
 - Inspect the cylinder head for a broken valve spring.
 - Remove the suspect cylinder head and inspect. Refer to **CYLINDER HEAD CLEANING & INSPECTION**.
 9. If air is heard from the crankcase system at the crankcase, oil filler tube, perform the following procedure:
 - Remove the piston from the suspect cylinder.
 - Inspect the piston and connecting rod assembly. Refer to **PISTON, CONNECTING ROD & BEARINGS - CLEANING & INSPECTION**.
 - Inspect the engine block. Refer to **ENGINE BLOCK - CLEANING & INSPECTION**.
 10. If bubbles are found in the radiator, perform the following procedure:
 - Remove both cylinder heads and inspect. Refer to **CYLINDER HEAD - CLEANING & INSPECTION**.
 - Inspect the engine block. Refer to **ENGINE BLOCK - CLEANING & INSPECTION**.
 11. Remove the **J 35667-A**.
 12. Install the spark plugs.
 13. Install the battery ground - negative cable.

OIL CONSUMPTION DIAGNOSIS

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

- An improperly read oil level indicator - dipstick
 - Inspect the oil level while the vehicle is parked on a level surface.
 - Allow adequate drain-down time.
- Improper oil viscosity
 - Use the recommended SAE viscosity for prevailing temperatures.
- Continuous high-speed driving
- Severe hauling, such as a trailer. This causes decreased oil mileage.
- A malfunctioning crankcase ventilation system
- External oil leaks
 - Tighten the bolts, as needed.
 - Replace the gaskets and seals, as needed.
- Worn or omitted valve guides and/or valve stem seals

- Ream the guides.
- Install oversized service valves and/or new valve stem seals.
- Broken or worn piston rings
- Improperly installed or unseated piston rings
- Improperly installed or improperly fitted piston
- Plugged cylinder head gasket oil drain holes
- Damaged intake gaskets

OIL PRESSURE DIAGNOSIS & TESTING

Low or No Oil Pressure

The following can cause low or no oil pressure:

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

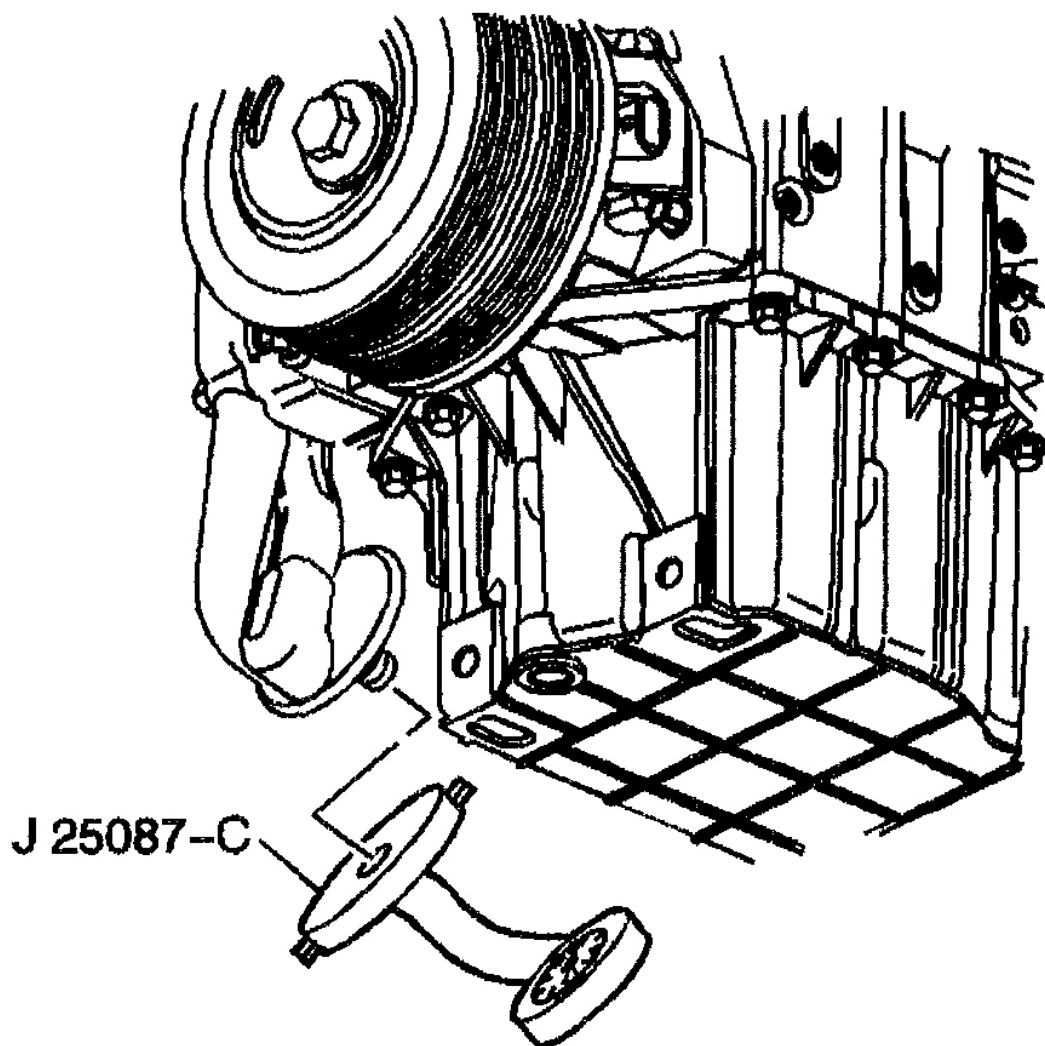
Oil Pressure Testing

Tools Required

J 25087-C Oil Pressure Tester

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

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



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Fig. 15: Oil Pressure Tester
Courtesy of GENERAL MOTORS CORP.

6. Start the engine and check the overall oil pressure, the oil pressure switch, and for noisy lifters. The

engine should be at operating temperature before checking the oil pressure. The oil pressure should be approximately 414 kPa (60 psi) at 1850 RPM using 10W30 engine oil.

7. If adequate oil pressure is indicated, check the oil pressure switch.
8. If a low reading is indicated, press the valve on the tester base to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time indicates a good pump and the previous low pressure was due to worn bearings, etc. A low reading while pressing the valve would indicate a faulty pump.

OIL LEAK DIAGNOSIS

2002 Chevrolet Monte Carlo LS

2002 ENGINES Engine Mechanical - Impala & Monte Carlo - 3.8L

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 <i>Step 2</i>	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to <i>Step 10</i>	Go to <i>Step 3</i>
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 <i>Step 10</i>	Go to <i>Step 4</i>
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 <i>Step 10</i>	Go to <i>Step 5</i>
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 <i>Step 10</i>	Go to <i>Step 6</i>
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 <i>Step 10</i>	Go to <i>Step 7</i>
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 <i>Step 10</i>	Go to <i>Step 8</i>

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Fig. 16: Oil Leak Diagnosis (1 Of 2)

Courtesy of GENERAL MOTORS CORP.

2002 Chevrolet Monte Carlo LS

2002 ENGINES Engine Mechanical - Impala & Monte Carlo - 3.8L

Step	Action	Yes	No
8	Use <i>J 28428-E</i> 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 <i>Step 10</i>	Go to <i>Step 9</i>
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 <i>Step 10</i>	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 <i>Step 11</i>	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to <i>Step 1</i>	System OK

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Fig. 17: Oil Leak Diagnosis (2 Of 2)

Courtesy of GENERAL MOTORS CORP.

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

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

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Fig. 18: Crankcase Ventilation System Inspection/Diagnosis

Courtesy of GENERAL MOTORS CORP.

DRIVE BELT CHIRPING DIAGNOSIS

Diagnostic Aids

The symptom may be intermittent due to moisture on the drive belt or the pulleys. It may be necessary to spray a small amount of water on the drive belt in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.

A loose or improper 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 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 for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.
- 4)** - Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.
- 6)** - Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misalign pulley using a straight edge in the pulley grooves across two or three pulleys. If a misalign pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.
- 10)** - Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.
- 12)** - Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.
- 14)** - Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

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Step	Action	Yes	No
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. • 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 30–40 seconds. Does the chirping noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	Inspect for 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 improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	Tighten any loose fasteners. Replace any improper or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . 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. Refer to <i>Drive Belt Replacement</i> . 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. 19: Drive Belt Chirping Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT SQUEAL DIAGNOSIS

Diagnostic Aids

A loose or improper installation of a body component, a suspension component, or other items of the vehicle

may cause the squeal noise.

If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.

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 for a brief period will verify the squeal noise is the drive belt or an accessory drive component. 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) - This test is to verify that an accessory drive component does not have a seized bearing. With the belt remove test the bearings in the accessory drive components for turning smoothly. Also test the accessory drive components with the engine operating by varying the load on the components to verify that the components operate properly.
- 5) - This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.
- 6) - This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.
- 7) - Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misalign pulley using a straight edge in the pulley grooves across two or three pulleys. If a misalign pulley is found refer to that accessory drive component for the proper 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
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. 2. Operate the engine for no longer than 30 to 40 seconds. Does the noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed	Go to Step 4
4	Inspect for 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 proper operation. Refer to Drive Belt Tensioner Diagnosis. Did you find and correct the condition?	Go to Step 9	Go to Step 6
6	Inspect for the correct drive belt length. Refer to Drive Belt Replacement. 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. 20: Drive Belt Squeal Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT WHINE DIAGNOSIS

Diagnostic Aids

The drive belt 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 operating 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 or the accessory drive components. 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 inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper inspection and - Replacement procedure.

Step	Action	Yes	No
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. Refer to <i>Drive Belt Replacement</i> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the whine noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed on or Lower Engine Noise, Regardless of Engine Speed	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. 21: Drive Belt Whine Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

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

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

If replacing the drive belt, complete the diagnostic table, and if the noise is only heard when the drive belt 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 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 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 proper operation.

Step	Action	Yes	No
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. Refer to <i>Drive Belt Replacement</i> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds or Upper Engine Noise, Regardless of Engine Speed or Lower Engine Noise, Regardless of Engine Speed.	Go to Step 4
4	Inspect the drive belt 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. Refer to <i>Drive Belt Replacement</i> . Did you complete the repair?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <i>Drive Belt Replacement</i> . 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. 22: 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 belts 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 may cause a vibration. While the drive belt 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
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. Refer to <i>Drive Belt Replacement</i> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Check and repair cause of vibration.	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. Refer to <i>Drive Belt Replacement</i> . 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	Tighten any loose fasteners. Replace improper or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . 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. Refer to <i>Fan Shroud Replacement</i> in Engine Cooling. 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. 23: Drive Belt Vibration Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

- 2)** - This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.
- 4)** - Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misalign pulley using a straight edge in the pulley grooves across two or three pulleys. If a misalign pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.
- 5)** - Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.
- 6)** - Accessory drive component brackets that are bent or cracked will let the drive belt fall off.
- 7)** - Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

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Step	Action	Yes	No
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. Refer to <i>Drive Belt Replacement</i> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	Tighten any loose fasteners. Replace improper or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <i>Drive Belt Tensioner Diagnosis</i> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <i>Drive Belt Tensioner Replacement</i> . 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. 24: Drive Belt Falls Off Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

- 2) - The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.
- 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 is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
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 for the proper installation. Refer to <i>Drive Belt Replacement</i> . 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. Refer to <i>Drive Belt Replacement</i> . 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. 25: Drive Belt Excessive Wear Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT TENSIONER DIAGNOSIS

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

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Fig. 26: Drive Belt Tensioner Diagnosis

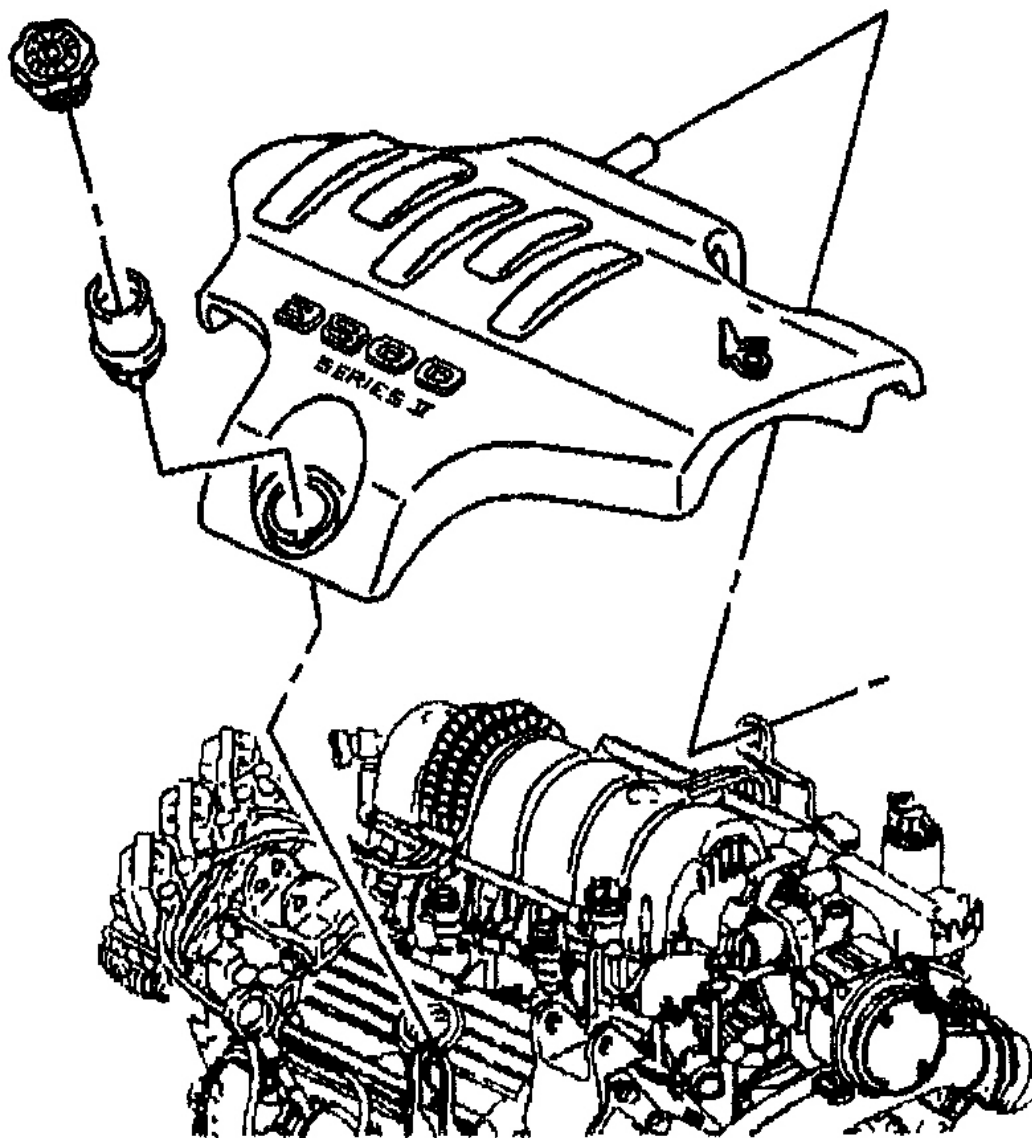
Courtesy of GENERAL MOTORS CORP.

REPAIR INSTRUCTIONS

FUEL INJECTOR SIGHT SHIELD - REPLACEMENT

Removal Procedure

1. Clean the area around the tube/oil fill cap before removing the tube/oil fill cap in order to prevent contaminants from falling into the valve rocker arm cover opening.
2. Twist counterclockwise to unlock the tube/oil fill cap from the valve rocker arm cover.
3. Lift the fuel injector sight shield up at the front and slide the tab out of the engine bracket.



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Fig. 27: Fuel Injector Sight Shield
Courtesy of GENERAL MOTORS CORP.

4. Replace the tube/oil fill cap in the valve rocker arm cover.

Installation Procedure

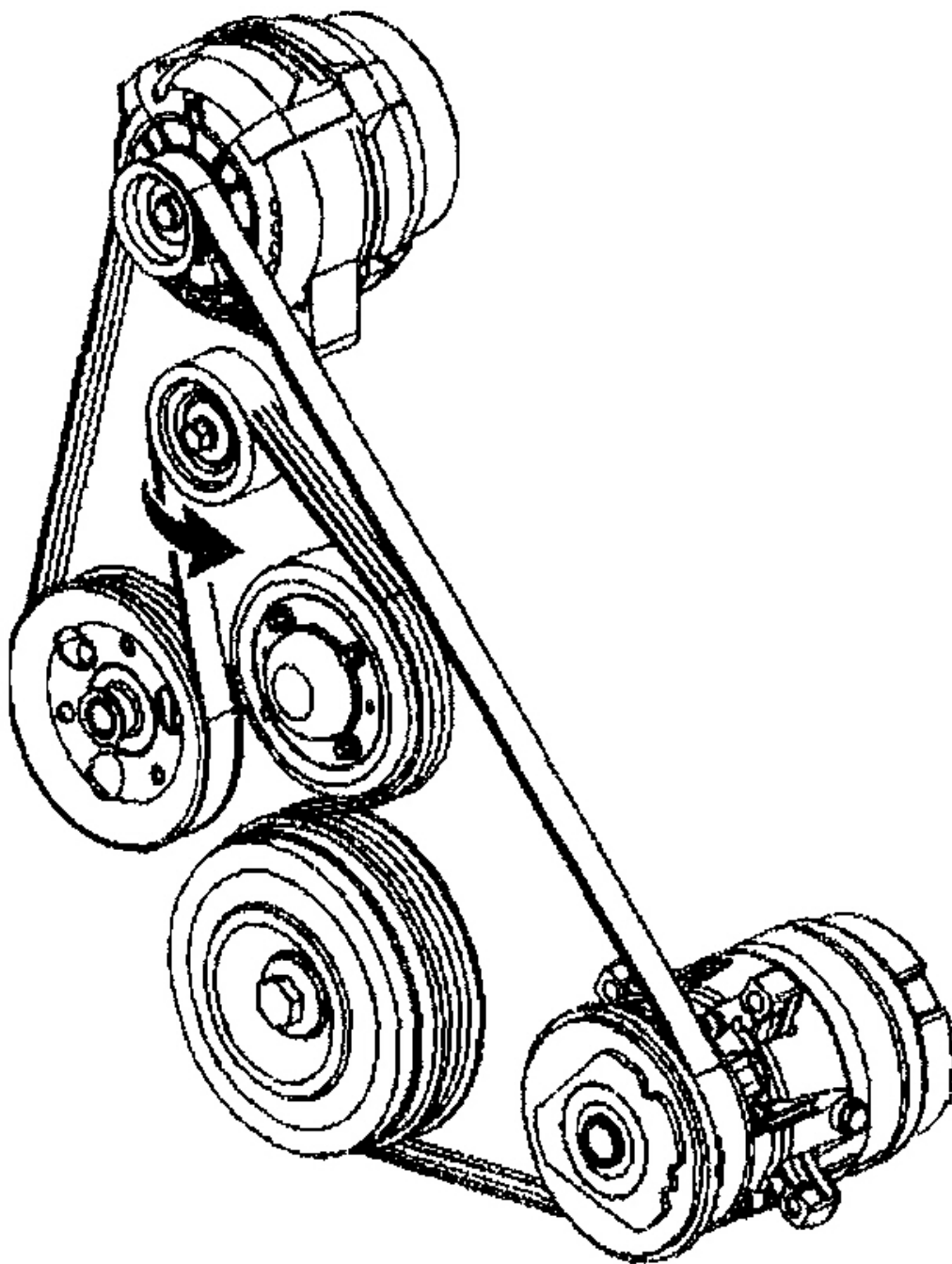
1. Remove the tube/oil fill cap from the valve rocker arm cover.
2. Insert the tab of the fuel injector sight shield under the engine bracket.

3. Place the hole of the fuel injector sight shield onto the oil fill neck of the valve rocker arm cover.
4. Install the tube/oil fill cap into the valve rocker arm cover and twist clockwise in order to lock the detent on the tube into the notch in the cover.

DRIVE BELT - REPLACEMENT

Removal Procedure

1. Rotate the drive belt tensioner using a 15-mm box end wrench on the pulley nut.
2. Remove the drive belt.



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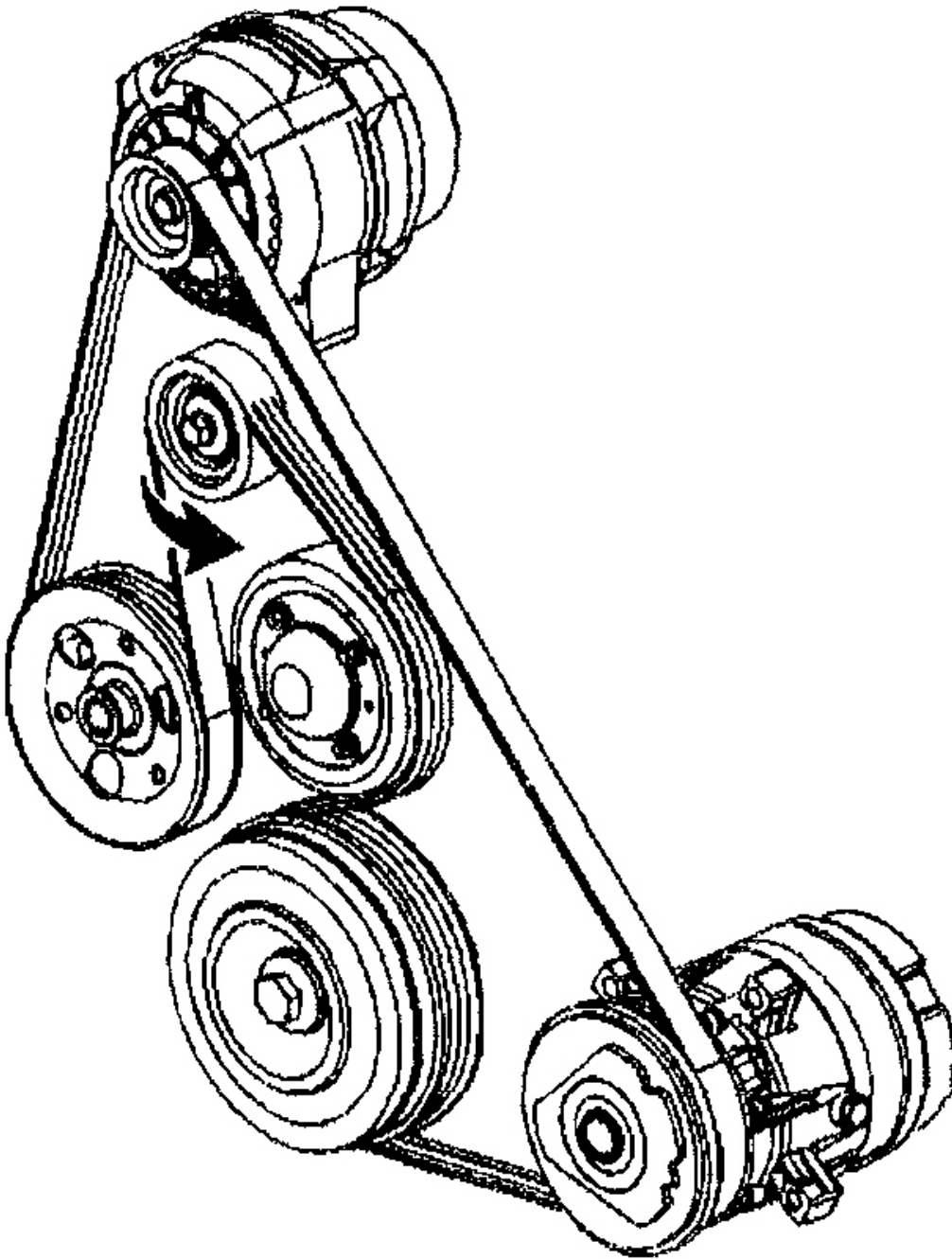
Fig. 28: Drive Belt Routing

Courtesy of GENERAL MOTORS CORP.

Installation Procedure

Important: After the new drive belt is installed, make sure that the mark on the drive belt tensioner is within range, as indicated on the tensioner housing.

1. Lift or rotate the drive belt tensioner using a 15-mm box end wrench on the pulley nut.
2. Install the drive belt.
3. Make sure the drive belt is properly routed.
4. Make sure the drive belt tensioner is operating properly.

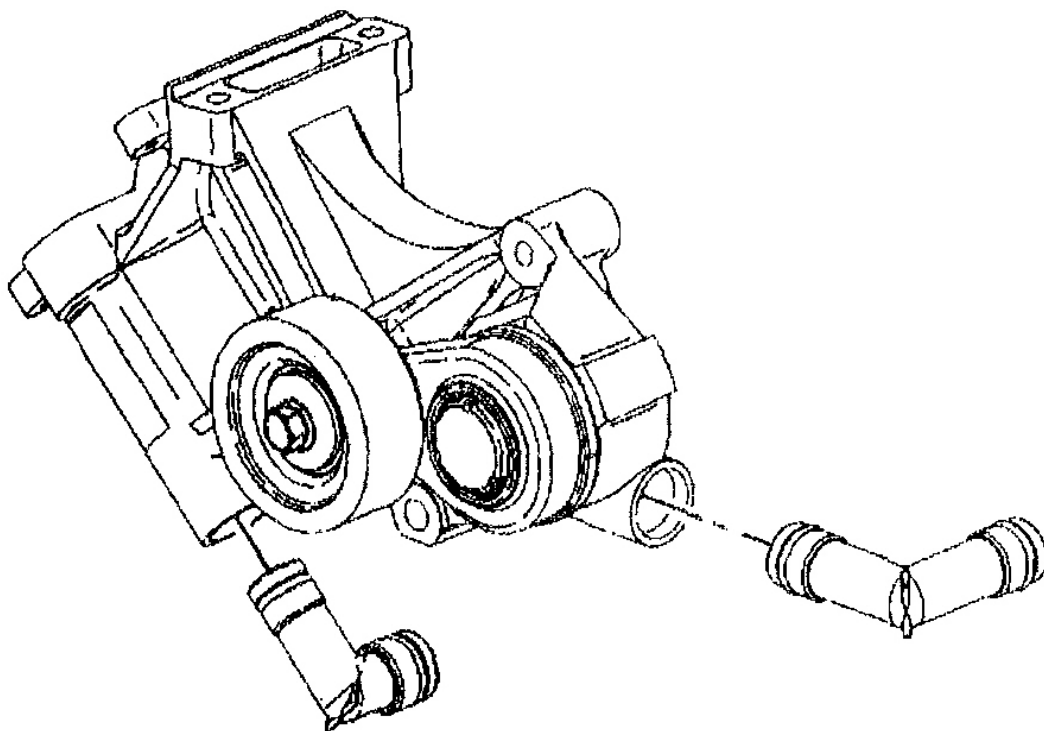


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Fig. 29: Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT TENSIONER - REPLACEMENT**Removal Procedure**

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the coolant recovery reservoir.
4. Remove the drive belt. Refer to **Drive Belt - Replacement**.
5. Remove the generator.
6. Remove the heater hose adapters with the heater hoses from the drive belt tensioner.



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Fig. 30: Heater Hose Adapters

Courtesy of GENERAL MOTORS CORP.

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

Installation Procedure

1. If replacing the drive belt tensioner, lubricate the thermostat bypass upper and lower pipe assembly seals with engine coolant and install the upper and lower pipe assemblies.
2. Install the drive belt tensioner.
3. Install the drive belt tensioner bolts. Tighten the bolts to 50 N.m (37 ft lbs).
4. Install the heater hose adapters with the heater hoses to the drive belt tensioner.
5. Install the generator.
6. Install the drive belt. Refer to **Drive Belt - Replacement**.
7. Install the coolant recovery reservoir.
8. Fill the cooling system.
9. Connect the negative battery cable.

ENGINE MOUNT INSPECTION

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

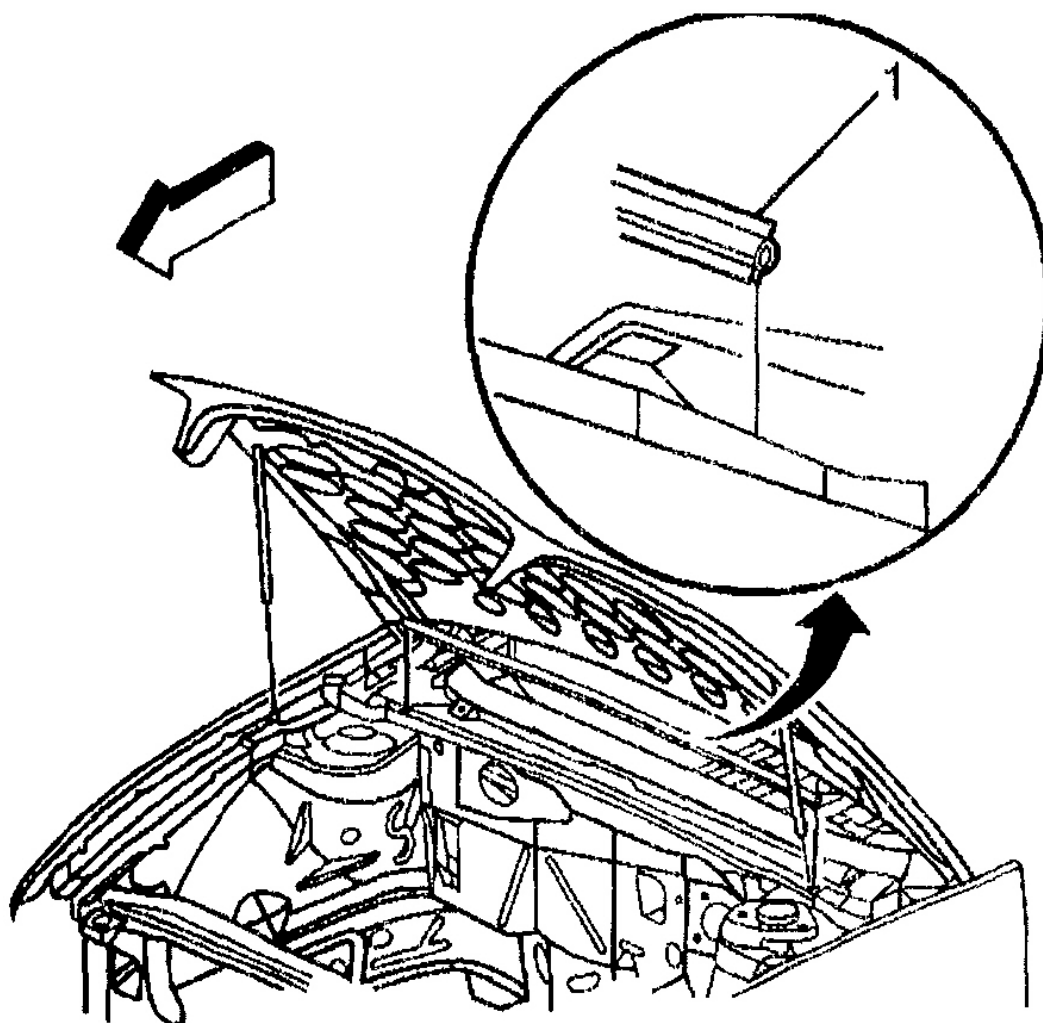
1. Install the engine support fixture. Refer to **Engine Support Fixture**. Raise the engine to release the weight from the engine mount and create slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber surface is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Fastener Tightening Specifications**.
4. For information on the transaxle mount, refer to **TRANSAXLE MOUNT**.

ENGINE SUPPORT FIXTURE

Tools Required

- **J 28467-90A** Engine Support Adapters
- **J 28467-B** Universal Engine Support Fixture

1. Raise the hood.
2. Disconnect the negative battery cable.
3. Remove the cross vehicle brace.
4. Remove the hood side rear seal from the pinchweld flange.

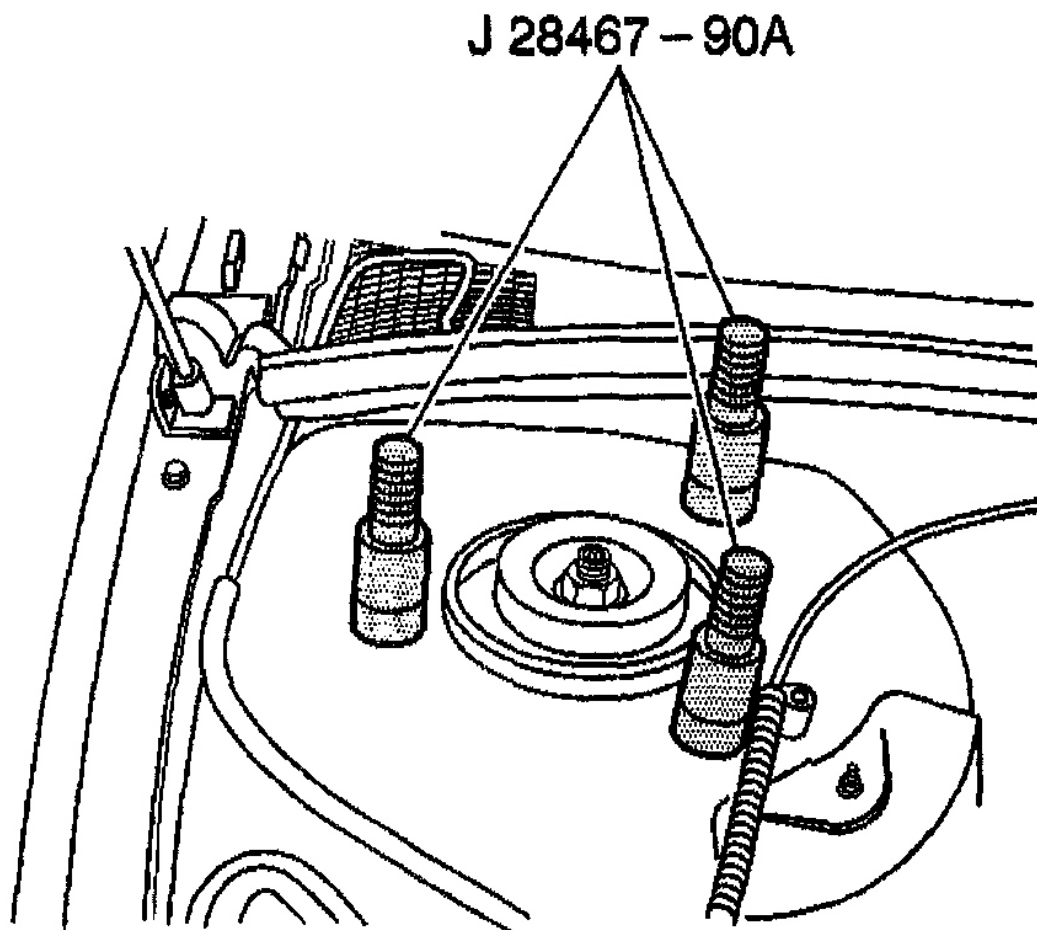


G01807229

Fig. 31: Hood Side Rear Seal

Courtesy of GENERAL MOTORS CORP.

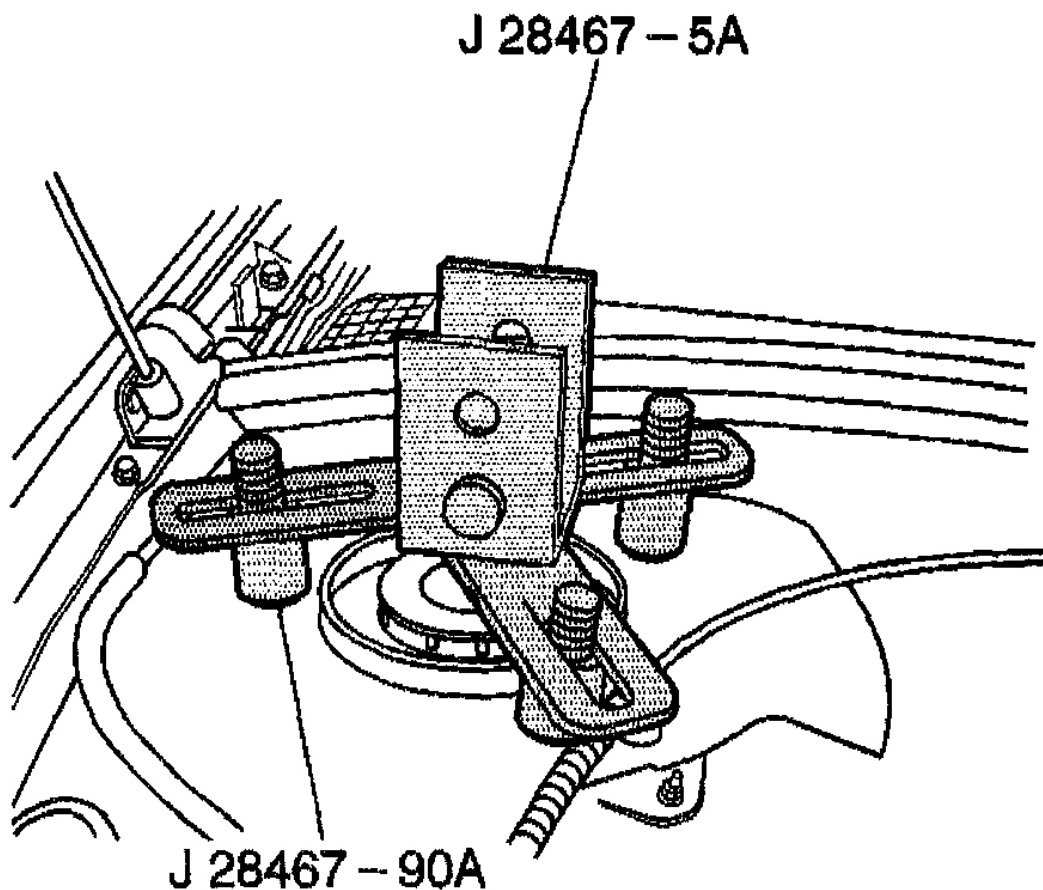
5. Install the **J 28467-90A** onto the strut attaching studs.



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Fig. 32: Engine Support Adapters
Courtesy of GENERAL MOTORS CORP.

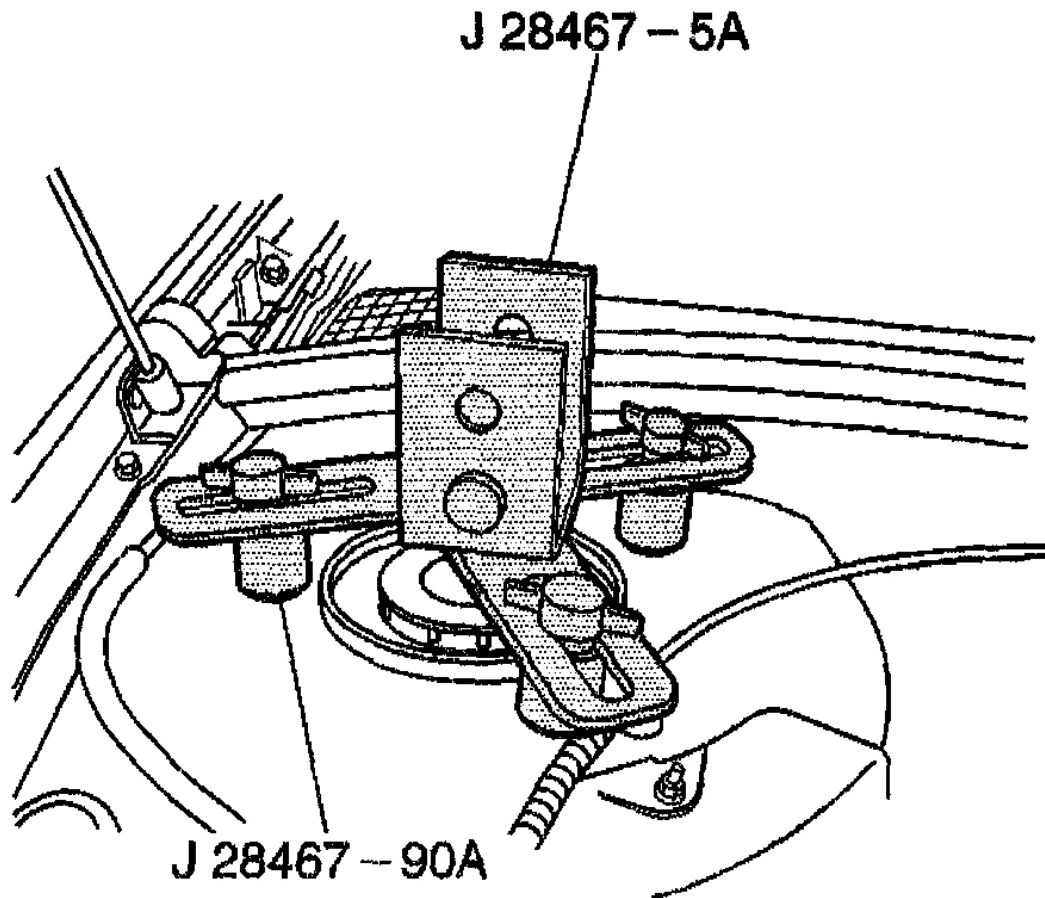
6. Install the strut tower support assemblies J 28467-5A over the **J 28467-90A** .



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Fig. 33: Strut Tower Support Assemblies
Courtesy of GENERAL MOTORS CORP.

7. Install the wing nuts to the J 28467-90A .



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Fig. 34: Engine Support Adapter Brackets
Courtesy of GENERAL MOTORS CORP.

8. Install the strut tower tube J 28467-3 into the strut tower support assemblies J 28467-5A.

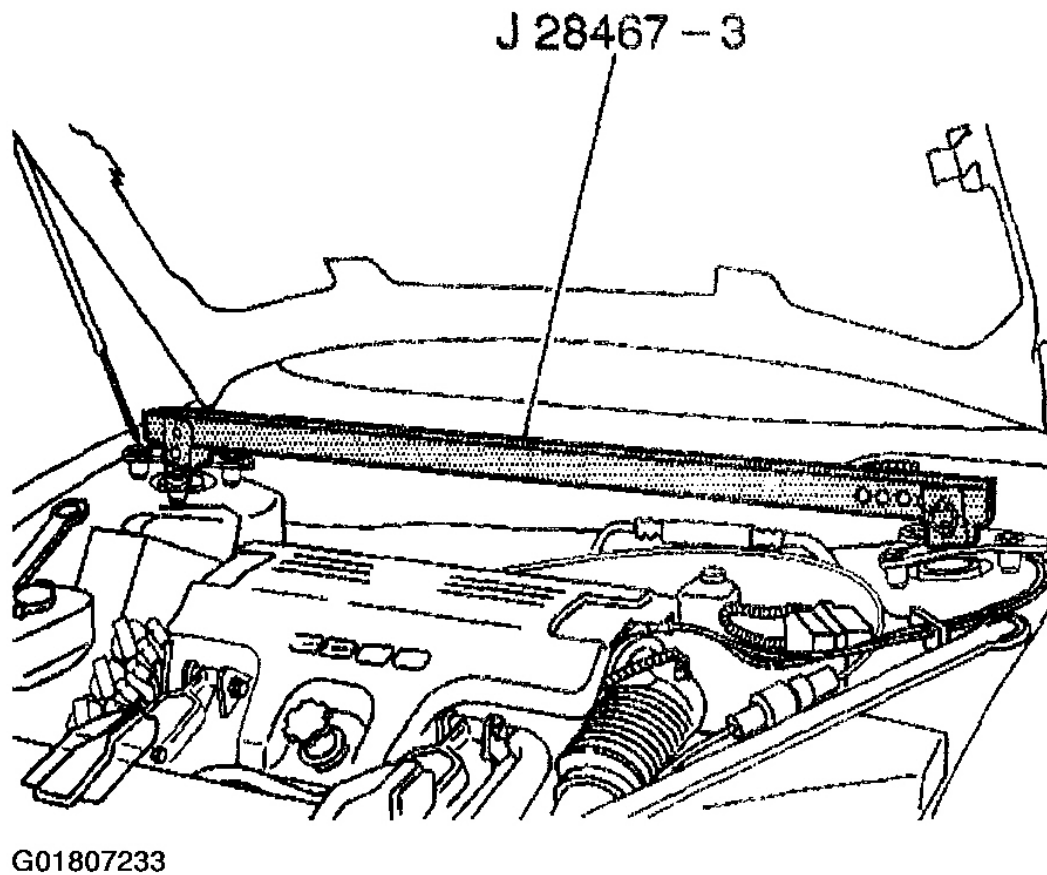


Fig. 35: Strut Tower Tube
Courtesy of GENERAL MOTORS CORP.

9. Install the 1/2 inch x 2.5 inch quick release pin J 28467-10 through the strut tower support assemblies J 28467-5A and the strut tower tube J 28467-3 on one side only.

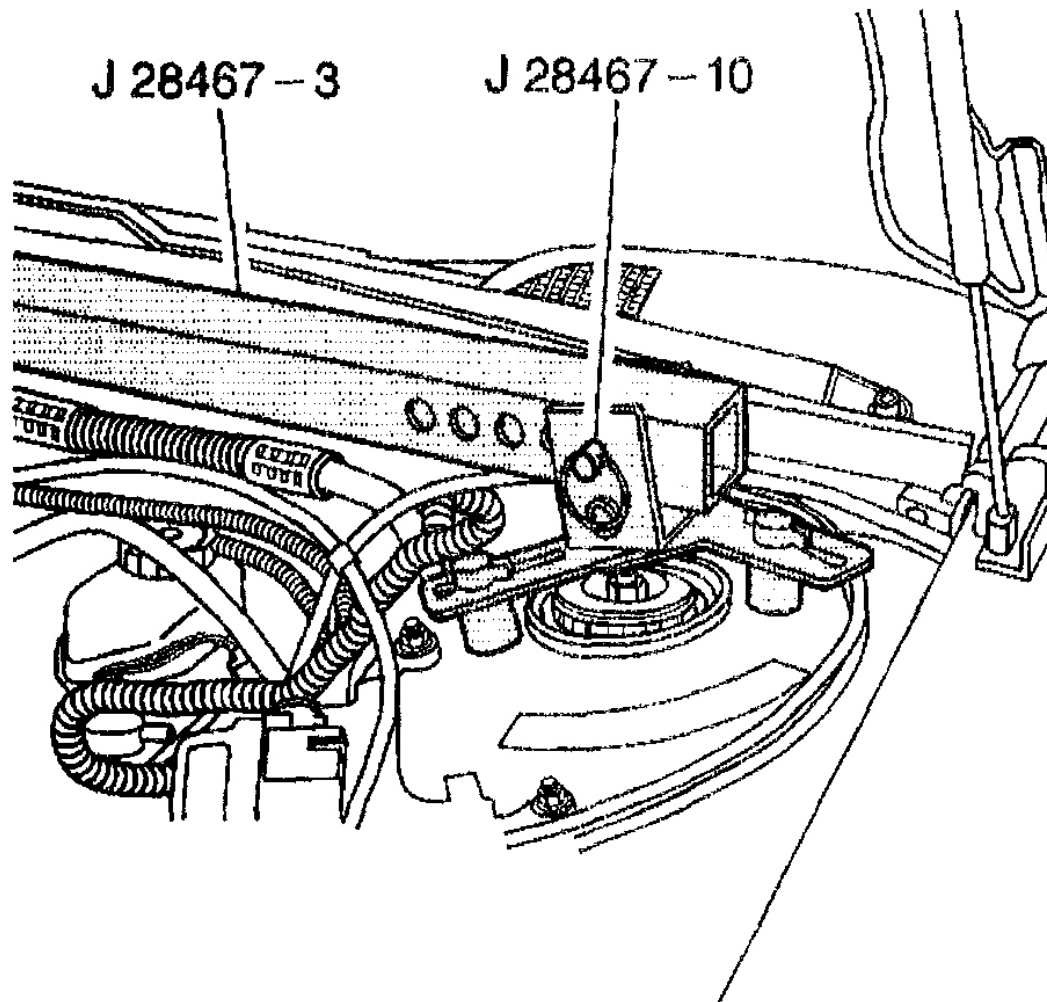


Fig. 36: Quick Release Pin
Courtesy of GENERAL MOTORS CORP.

10. Install the radiator shelf tube J 28467-2A on the top of the strut tower tube J 28467-3 on the driver side.

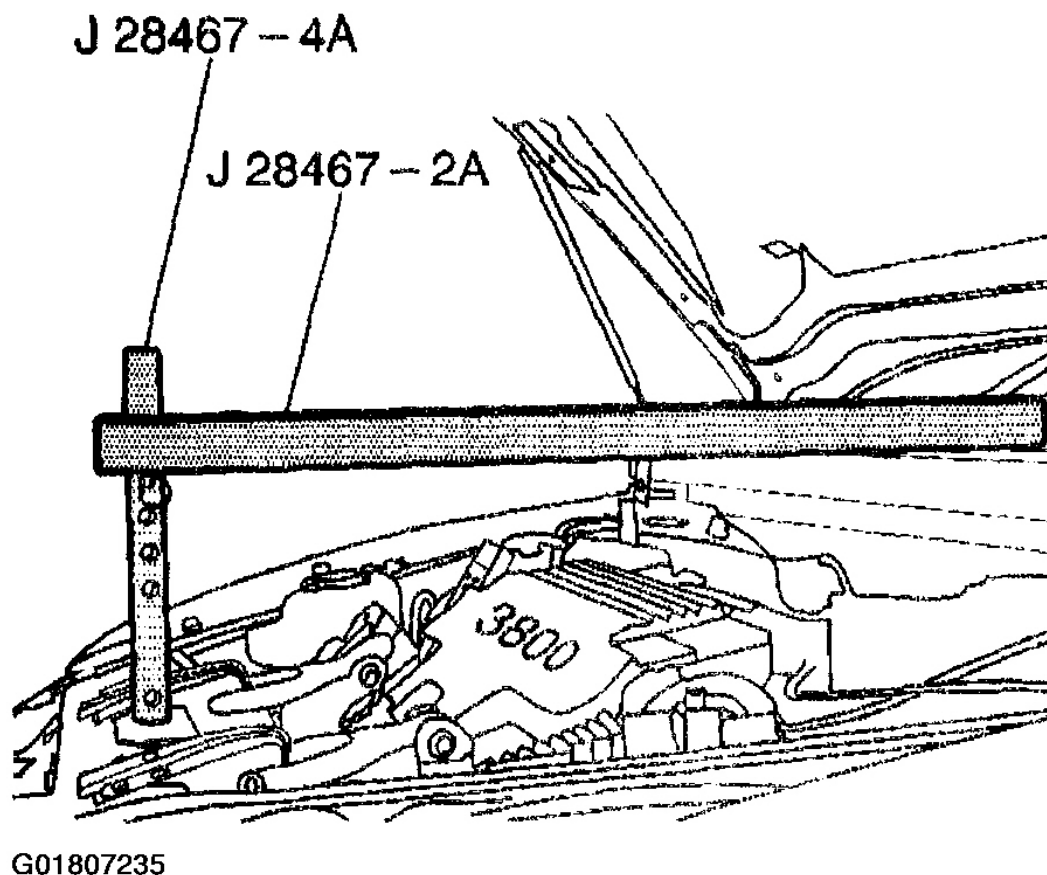
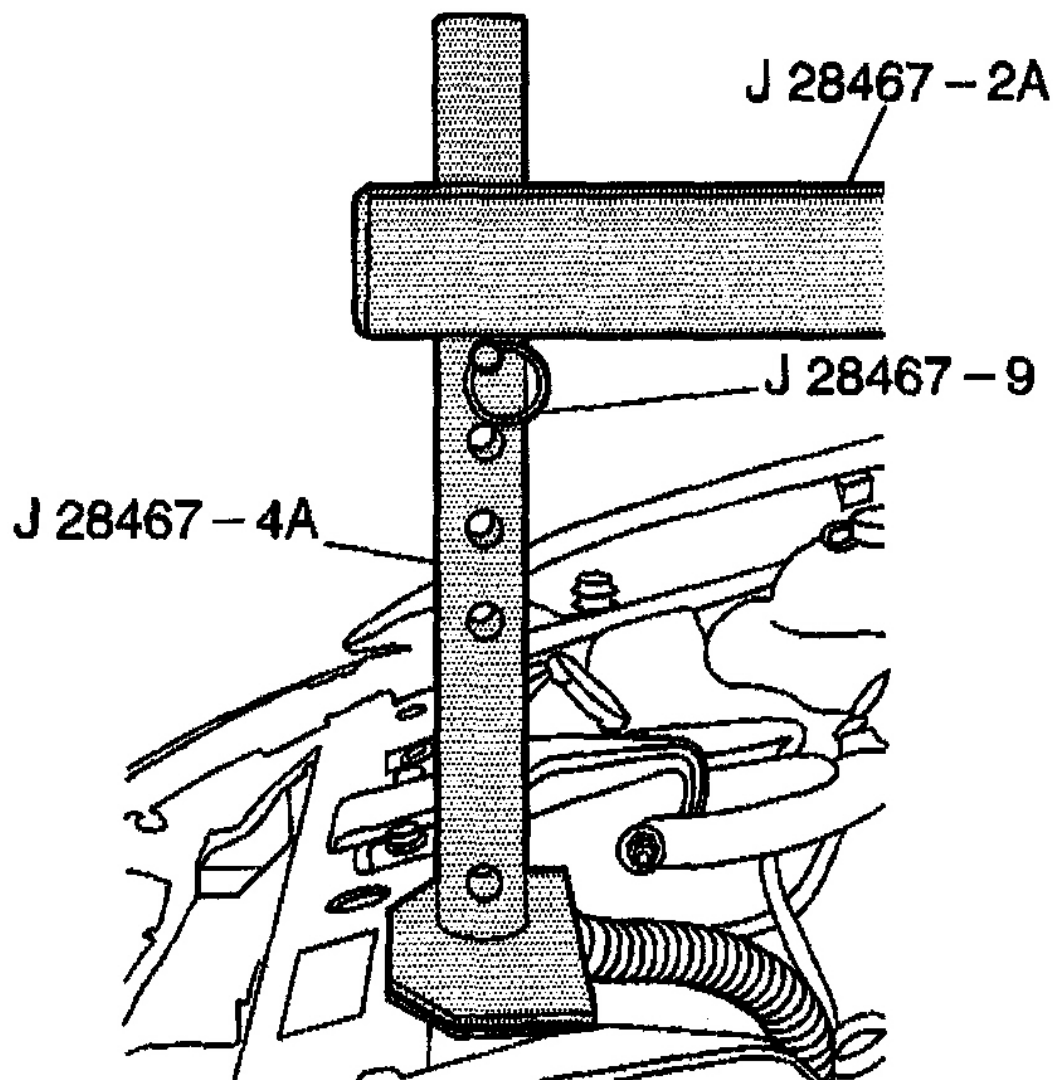


Fig. 37: Radiator Shelf Tube

Courtesy of GENERAL MOTORS CORP.

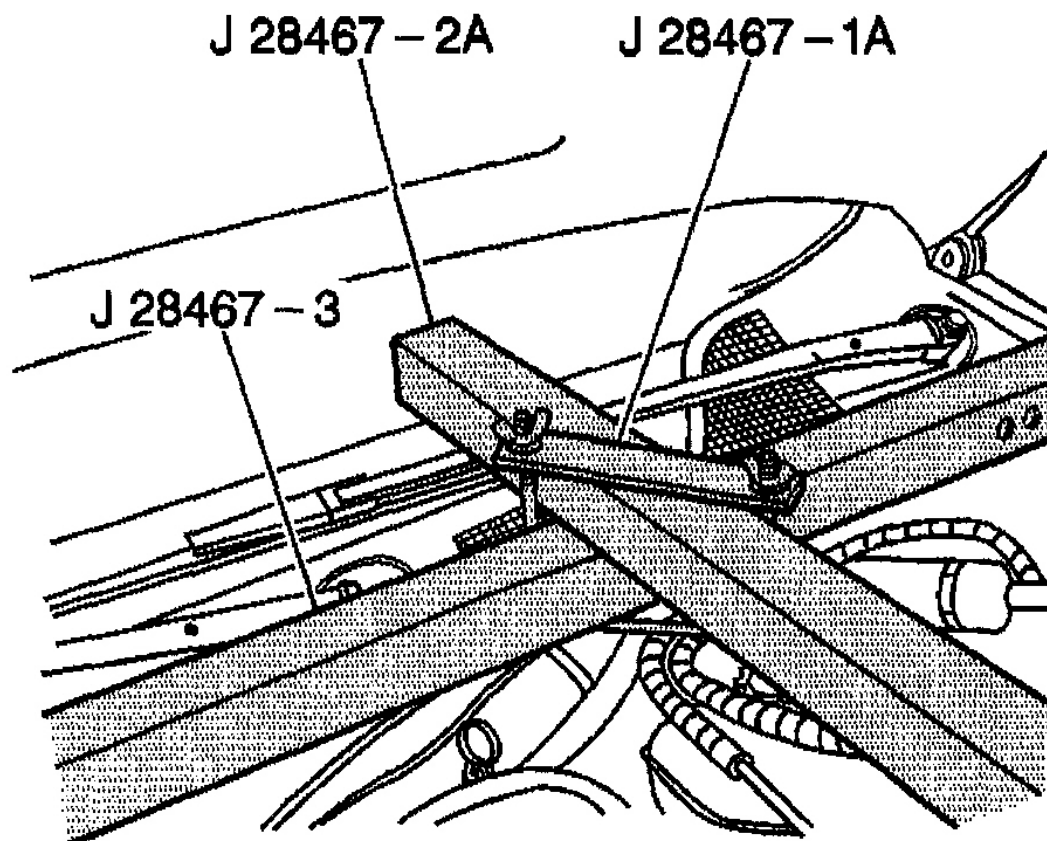
11. Install the round tube of the front support assembly J 28467-4A through the large hole in the radiator shelf tube J 28467-2A.
12. Install the 7/16 inch x 2.0 inch quick release pin J 28467-9 through the hole in the front support assembly J 28467-4A in order to level the radiator shelf tube J 28467-2A.



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Fig. 38: Front Support Assembly
Courtesy of GENERAL MOTORS CORP.

13. Install the cross bracket assembly J 28467-1A.
14. Install the lift hook J 28467-7A through the lift hook bracket J 28467-6A.
15. Install the 1/2 inch lift hook washer and lift hook wing nut J 28467-34 onto the lift hook J 28467-7A.
16. Install the assembled lift hook bracket J 28467-6A over the passenger side radiator shelf tube J 28467-2A.

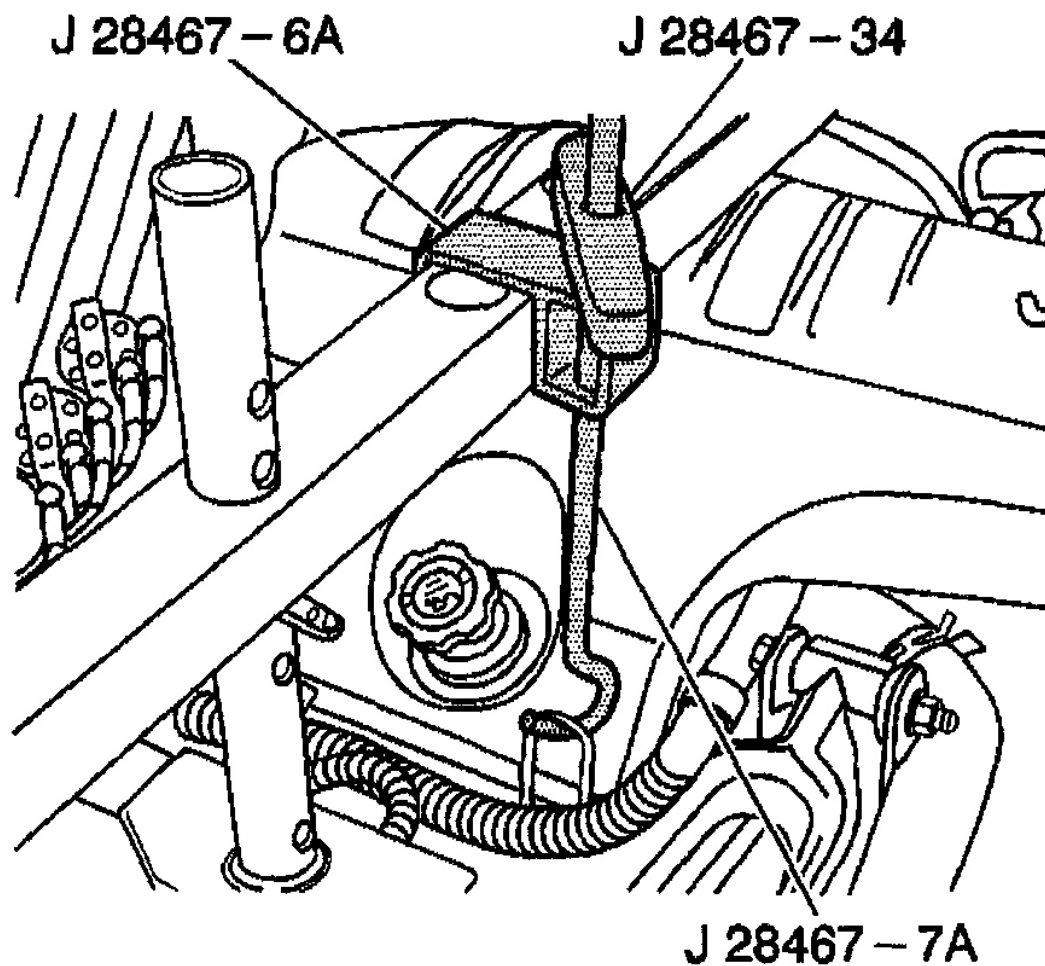


G01807237

Fig. 39: Lift Hook Bracket

Courtesy of GENERAL MOTORS CORP.

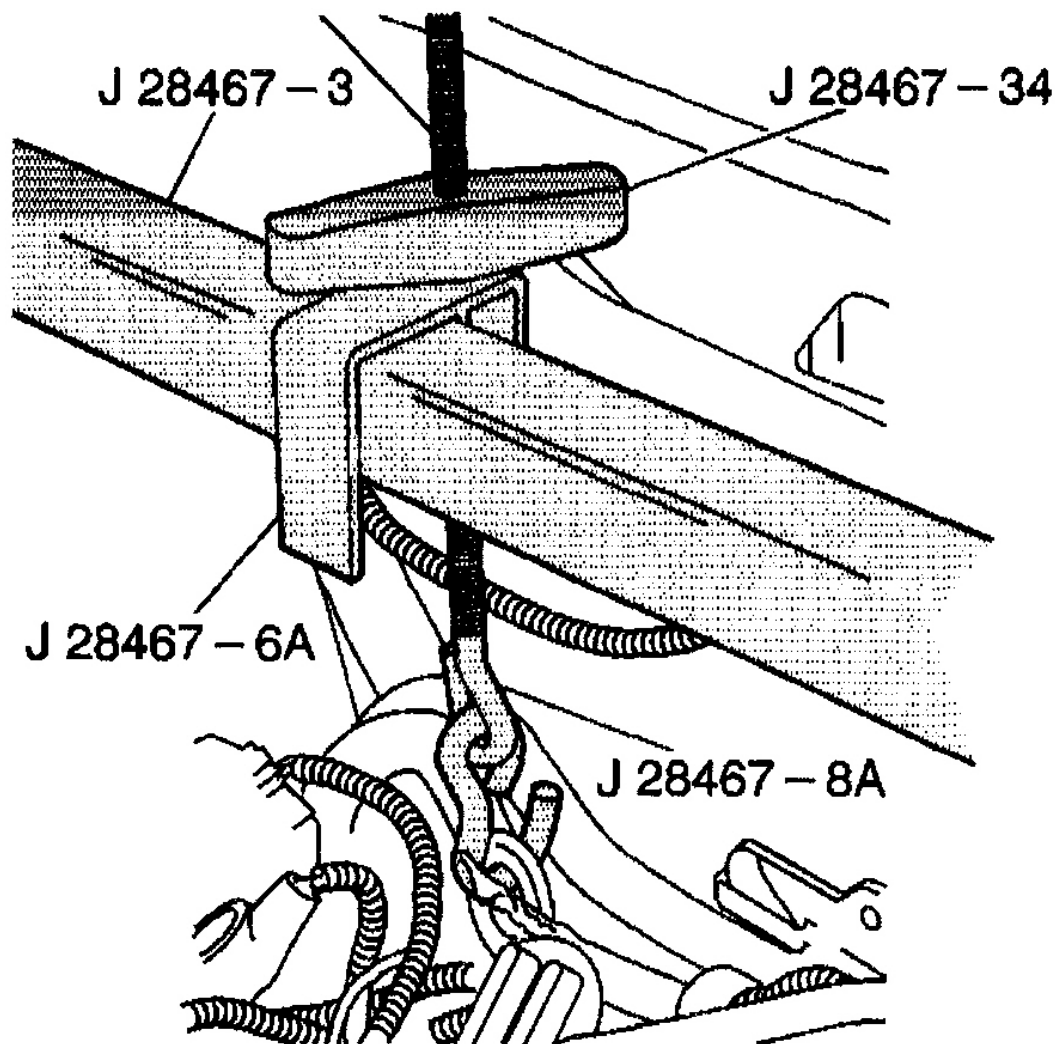
17. Adjust the passenger side radiator shelf tube J 28467-2A and the assembled lift hook bracket J 28467-6A in order to align the hook with the left, rear of engine, lift hook bracket attached to the left exhaust manifold.
18. Install the lift hook J 28467-7A through the lift hook bracket J 28467-6A.
19. Install the 1/2 inch lift hook washer and lift hook wing nut J 28467-34 onto the lift hook J 28467-7A.
20. Install the assembled lift hook bracket J 28467-6A over the strut tower tube J 28467-3.



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Fig. 40: Lift Hook Bracket J 28467-6A
Courtesy of GENERAL MOTORS CORP.

21. Adjust the assembled swivel lift hook bracket J 28467-8A in order to align the hook with the right, front of engine, lift hook bracket attached to the right exhaust manifold.

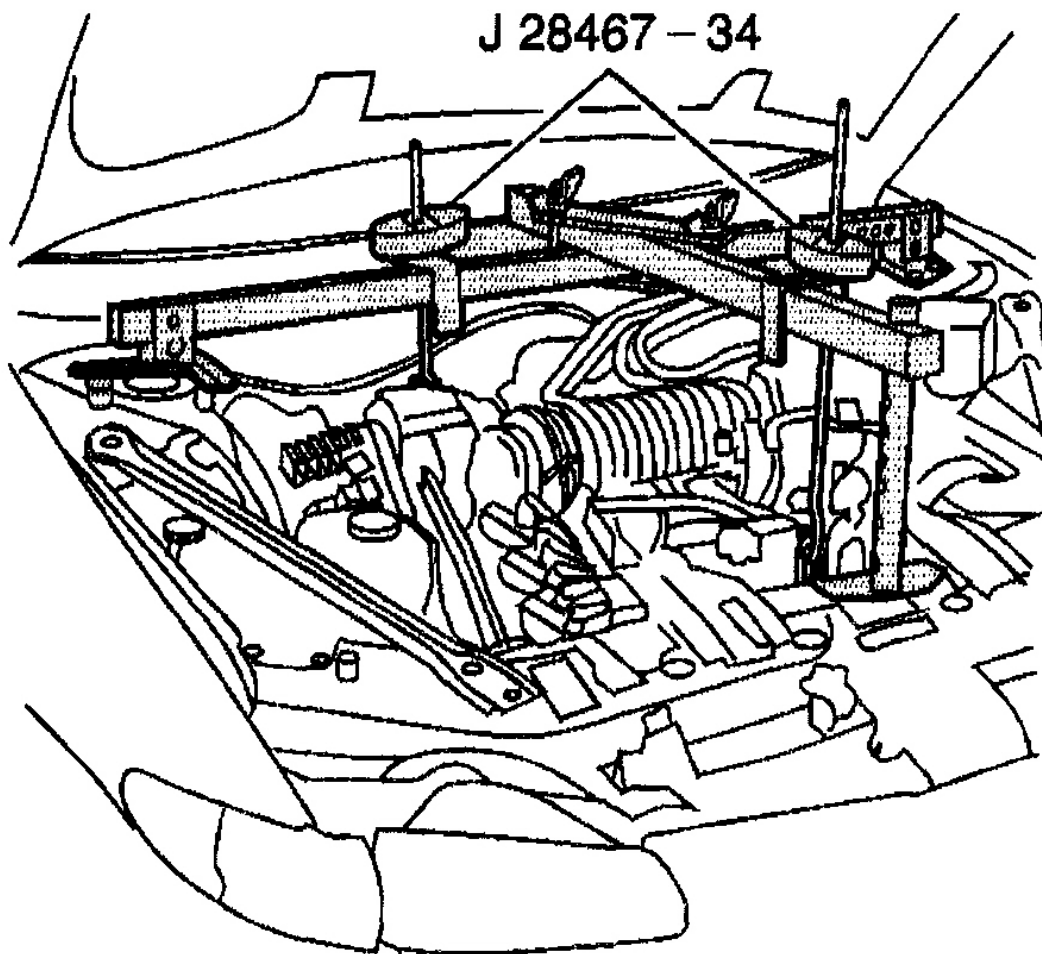


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Fig. 41: Cross Bracket Assembly

Courtesy of GENERAL MOTORS CORP.

22. Hand tighten the cross bracket assembly J 28467-1A wing nuts.
23. Hand tighten the lift hook wing nuts J 28467-34 securely to remove all slack from the engine support fixture assembly.



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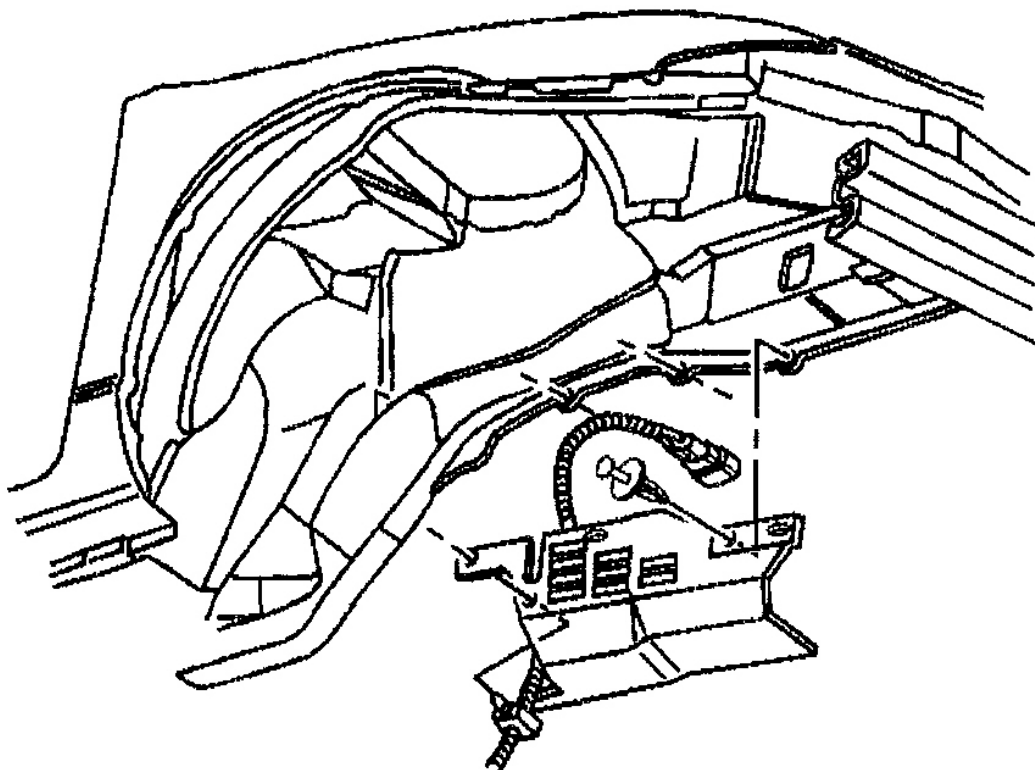
Fig. 42: Lift Hook Wing Nuts

Courtesy of GENERAL MOTORS CORP.

ENGINE MOUNT & BRACKET - REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
3. Disconnect the intake air temperature (IAT) sensor electrical connector.

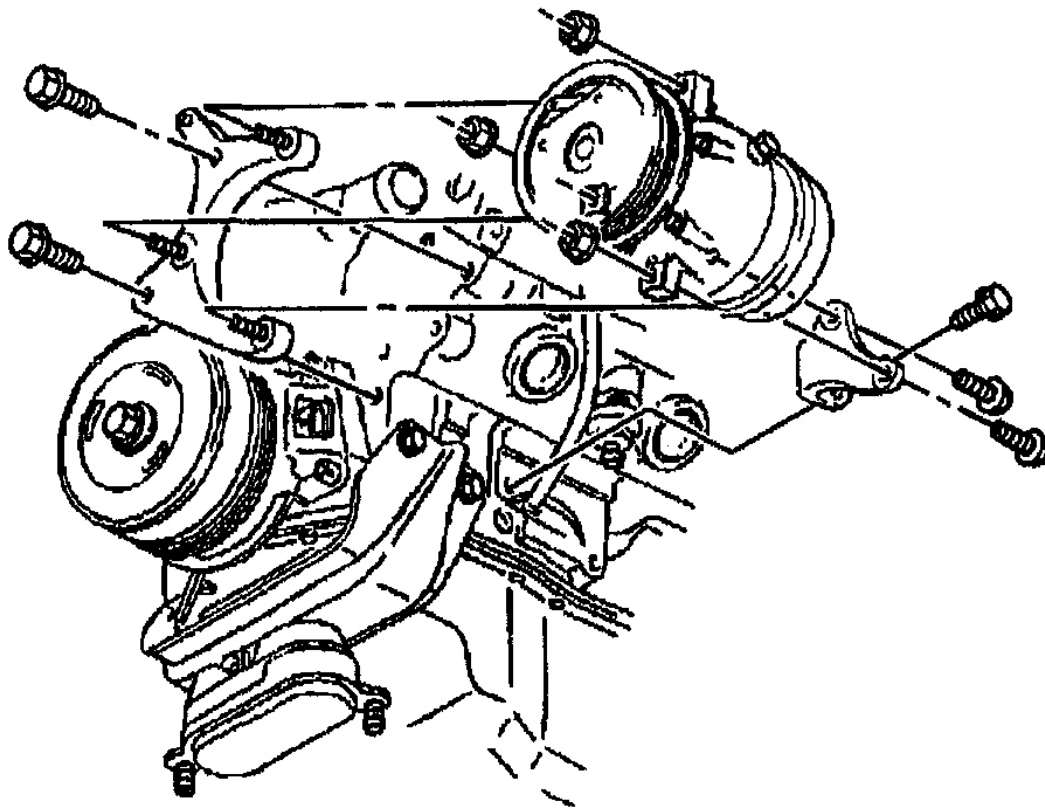


G01807241

Fig. 43: Locating IAT Sensor

Courtesy of GENERAL MOTORS CORP.

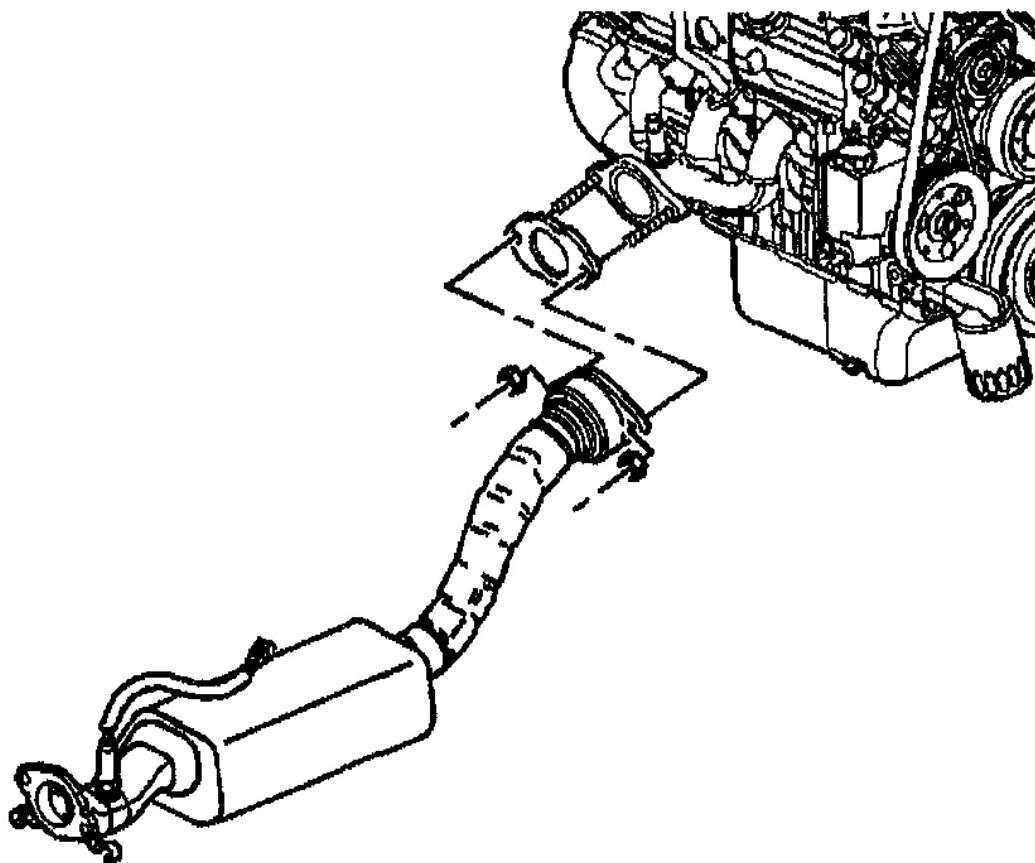
4. Remove the air inlet duct from the throttle body.
5. Remove the right and left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
6. Remove the drive belt. Refer to **Drive Belt - Replacement**.
7. Raise and support the vehicle.
8. Remove the right front tire and wheel.
9. Remove the right engine splash shield.
10. Remove the power steering oil cooler pipe brackets from the frame.
11. Remove the A/C compressor and the A/C compressor bracket. **DO NOT** discharge the A/C system. Secure the compressor.



G01807242

Fig. 44: A/C compressor & Bracket
Courtesy of GENERAL MOTORS CORP.

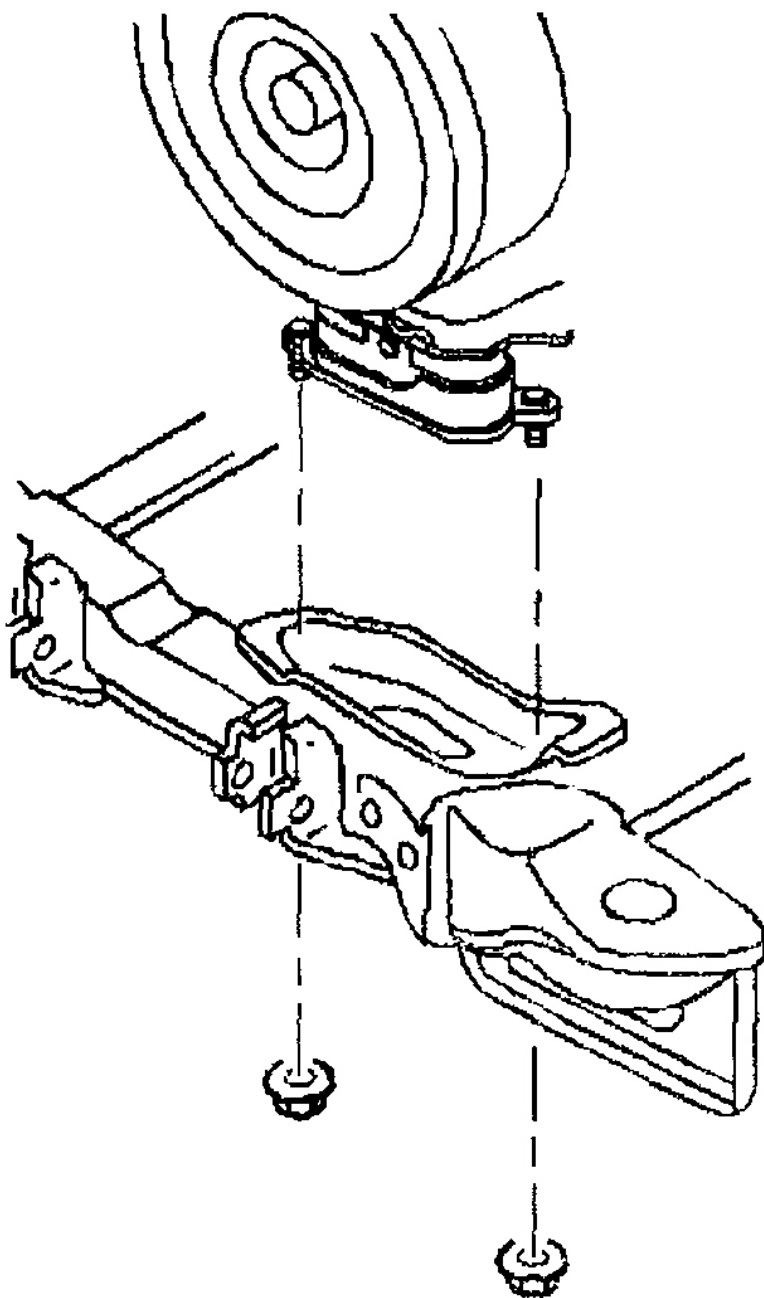
12. Remove the right exhaust manifold pipe stud nuts from the catalytic converter.



G01807243

Fig. 45: Right Exhaust Manifold Pipe
Courtesy of GENERAL MOTORS CORP.

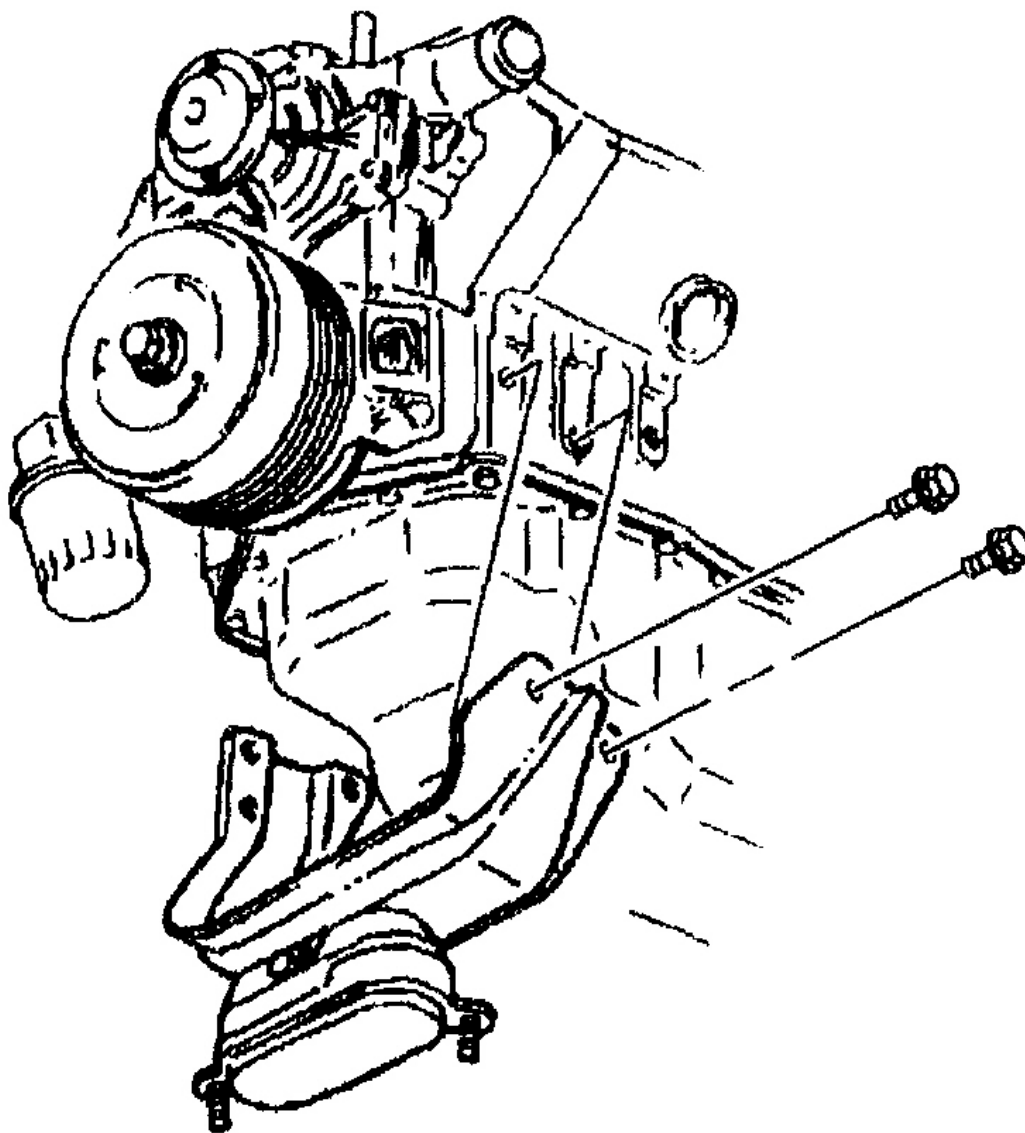
13. Remove the engine mount lower nuts from the frame.
14. Lower the vehicle.
15. Install the engine support fixture. Refer to **Engine Support Fixture**.
16. Use the engine support fixture to raise the engine.
17. Raise the vehicle.
18. Remove the left engine mount bracket bolts from the engine.



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

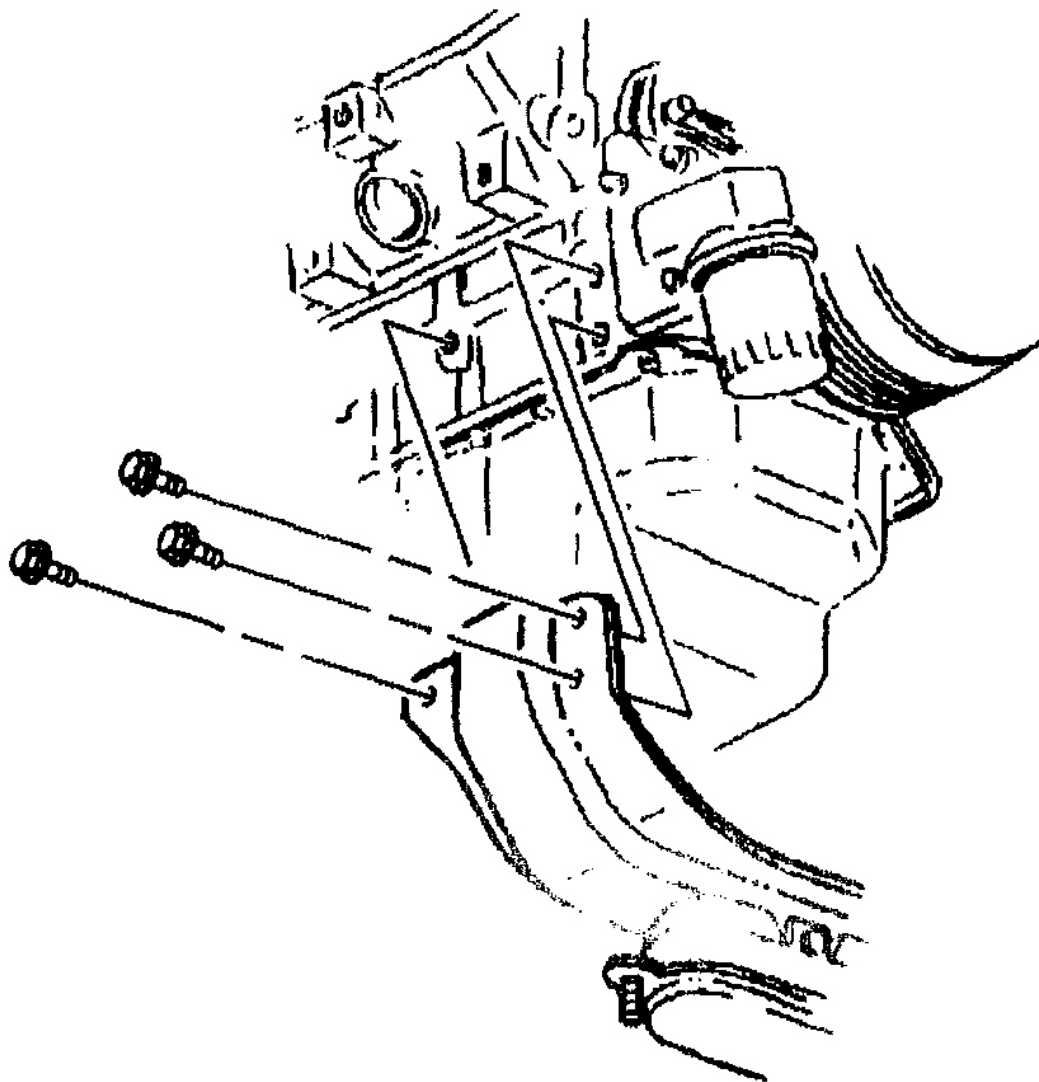
19. Remove the right engine mount bracket bolts from the engine.



G01807245

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

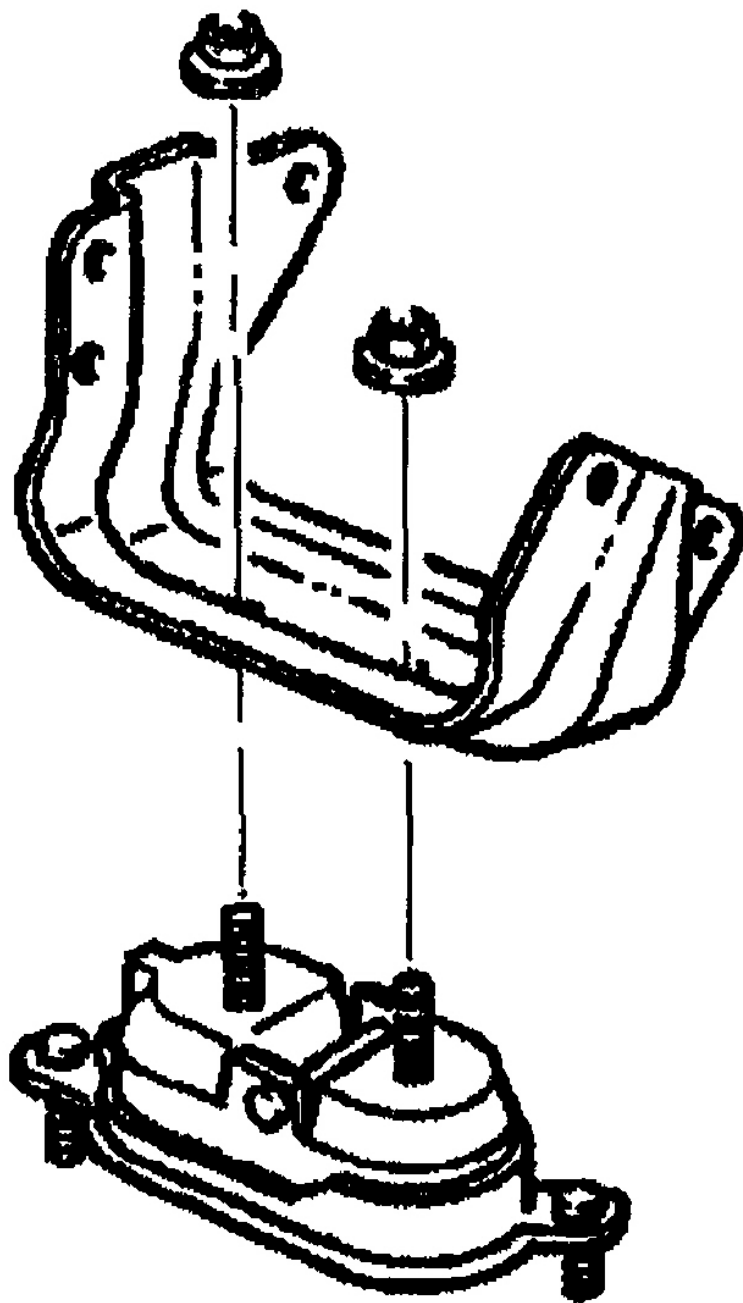
20. Support the frame with jackstands.
21. Loosen the left side frame bolts. Remove the right side frame bolts. Using the jackstands lower the frame for engine mount bracket removal.
22. Remove the engine mount bracket with the engine mount from the engine.



G01807246

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

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



G01807247

Fig. 49: Engine Mount
Courtesy of GENERAL MOTORS CORP.

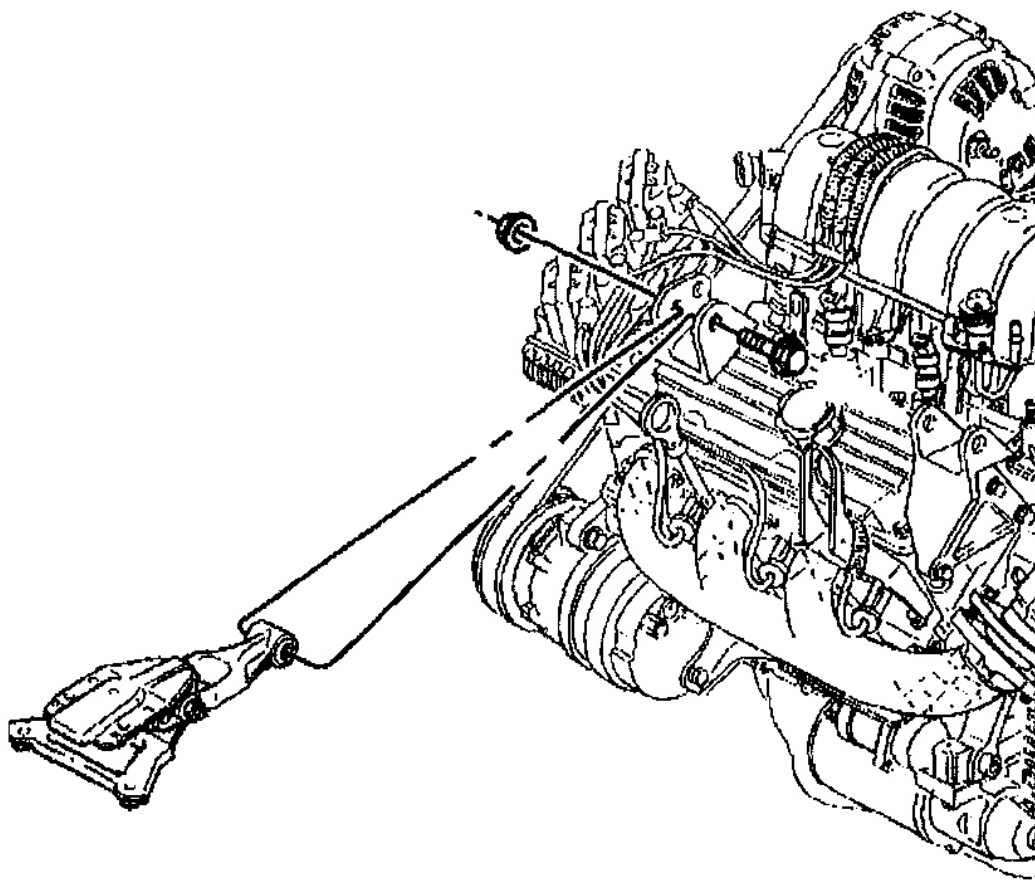
Installation Procedure

1. Install the engine mount to the engine mount bracket.
2. Install the engine mount upper nuts to the engine mount and the engine mount bracket. Tighten the engine mount upper nuts to 78 N.m (58 ft lbs).
3. Install the engine mount bracket with the engine mount to the engine.
4. Loosely install the right engine mount bracket bolts to the engine.
5. Loosely install the left engine mount bracket bolts to the engine. Tighten the left and the right engine mount bracket bolts to 102 N.m (75 ft lbs).
6. Using the jackstands raise the frame to the original position.
7. Install the right side frame bolts. Tighten the right and the left side frame bolts to 180 N.m (133 ft lbs).
8. Lower the vehicle.
9. Use the engine support fixture to lower the engine.
10. Raise the vehicle.
11. Install the engine mount lower nuts to the frame. Tighten the engine mount lower nuts to 78 N.m (58 ft lbs).
12. Install the catalytic converter to the right exhaust manifold.
13. Install the right exhaust manifold pipe stud nuts. Tighten the right exhaust manifold pipe stud nuts to 32 N.m (24 ft lbs).
14. Install the A/C compressor bracket and the A/C compressor bracket bolts. Tighten the A/C compressor bracket bolts to 50 N.m (37 ft lbs).
15. Install the A/C compressor and the A/C compressor nuts. Tighten the A/C compressor nuts to 30 N.m (22 ft lbs).
16. Install the power steering oil cooler pipe brackets to the frame.
17. Install the right engine splash shield.
18. Install the right front tire and wheel.
19. Lower the vehicle.
20. Remove the engine support fixture.
21. Install the right and left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
22. Install the air inlet duct to the throttle body.
23. Connect the intake air temperature (IAT) sensor electrical connector.
24. Install the drive belt. Refer to **Drive Belt - Replacement**.
25. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
26. Connect the negative battery cable.

ENGINE MOUNT STRUT - REPLACEMENT - RIGHT

Removal Procedure

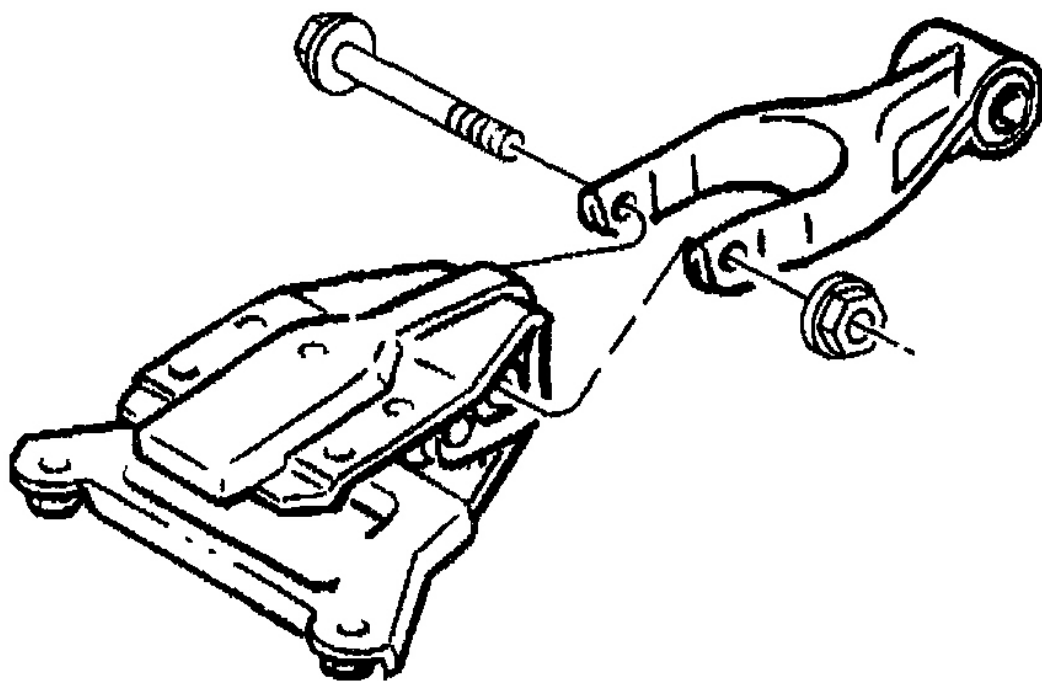
1. Remove the bolt and the nut from the right engine mount strut at the right engine mount strut bracket on the engine.



G01807255

Fig. 50: Right Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

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



G01807256

Fig. 51: Engine Mount Strut

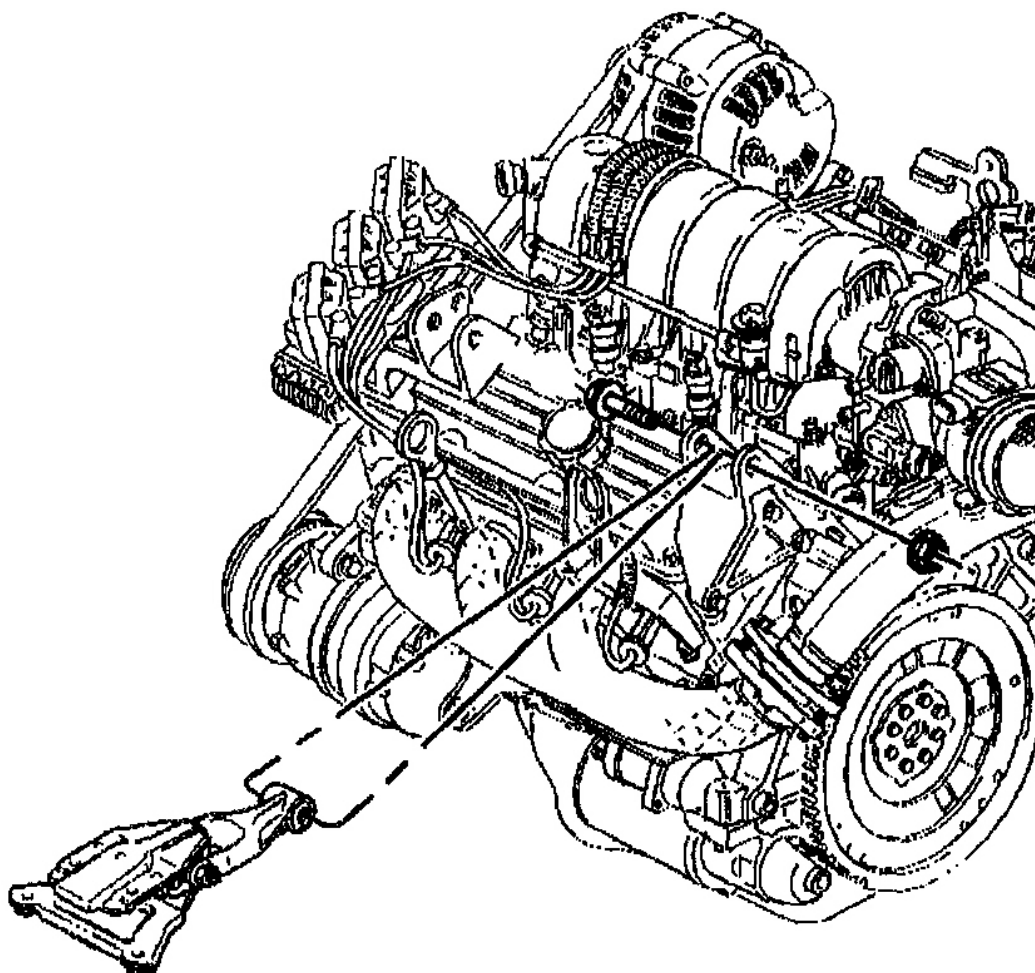
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine mount strut.
2. Install the bolt and the nut to the right engine mount strut at the right engine mount strut bracket on the upper radiator support. Tighten the engine mount strut bolt to 48 N.m (35 ft lbs).
3. Install the bolt and the nut to the right engine mount strut at the right engine mount strut bracket on the engine. Tighten the engine mount strut nut to 48 N.m (35 ft lbs).

ENGINE MOUNT STRUT - REPLACEMENT - LEFT**Removal Procedure**

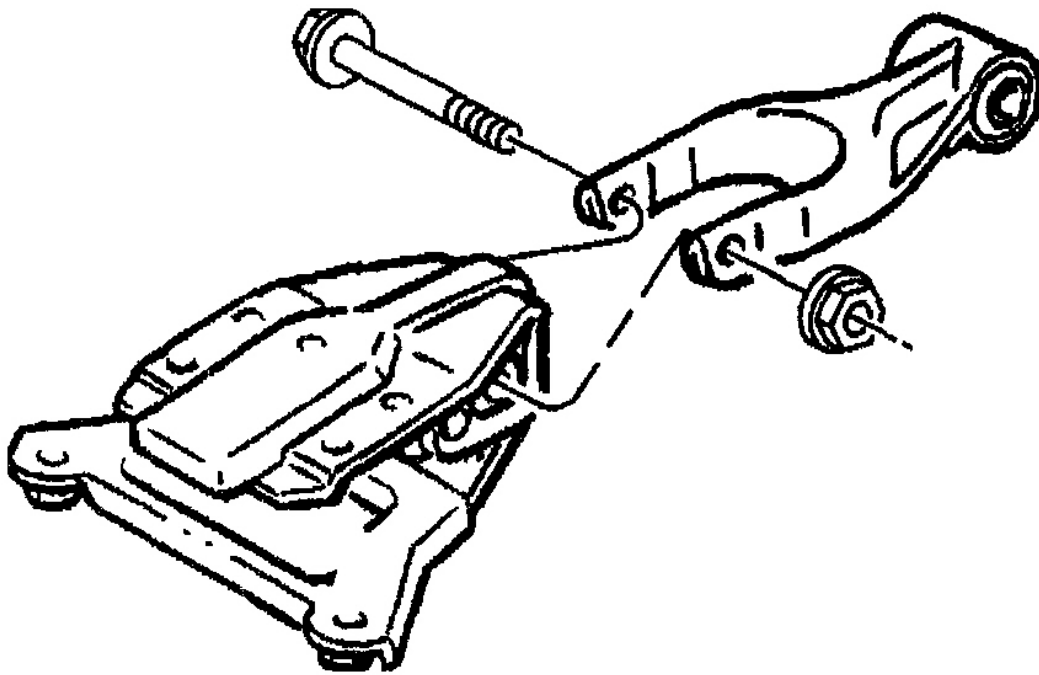
1. Remove the bolt and the nut from the left engine mount strut at the left engine mount strut bracket on the engine.



G01807259

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

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



G01807260

Fig. 53: Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine mount strut.
2. Install the bolt and the nut to the left engine mount strut at the left engine mount strut bracket on the upper radiator support. Tighten the engine mount strut bolt to 48 N.m (35 ft lbs).
3. Position the P-clip to the left engine mount strut bracket bolt.

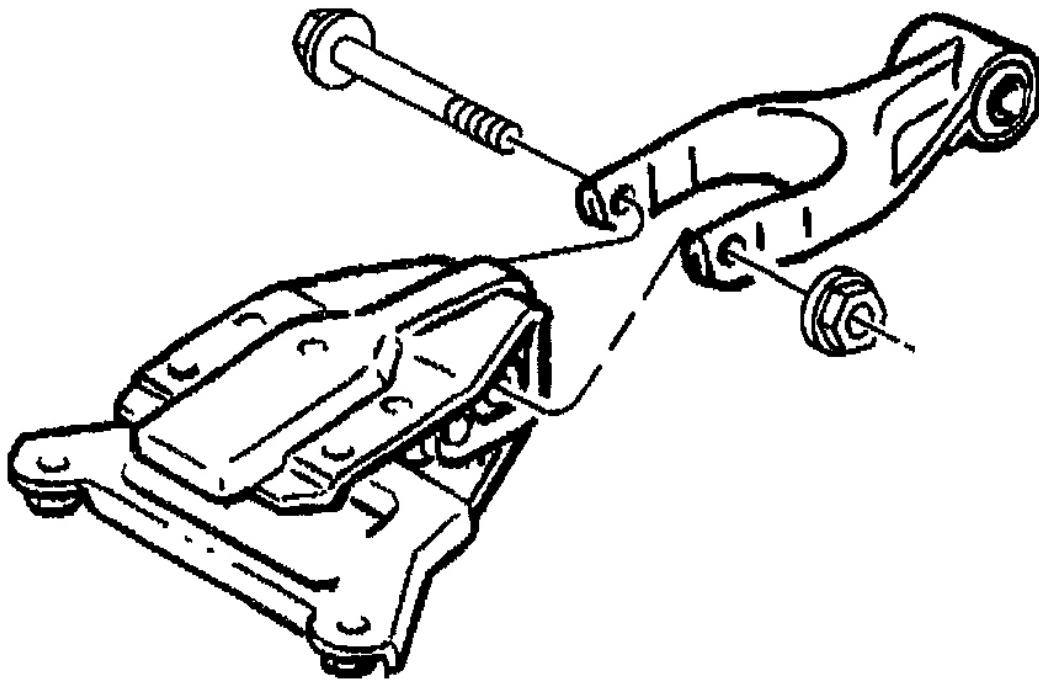
Important: The engine mount strut bolt must always be installed as shown in the graphic.

4. Install the bolt and the nut to the left engine mount strut at the left engine mount strut bracket on the engine. Tighten the engine mount strut nut to 48 N.m (35 ft lbs).

ENGINE MOUNT STRUT BRACKET - REPLACEMENT - UPPER RADIATOR SUPPORT

Removal Procedure

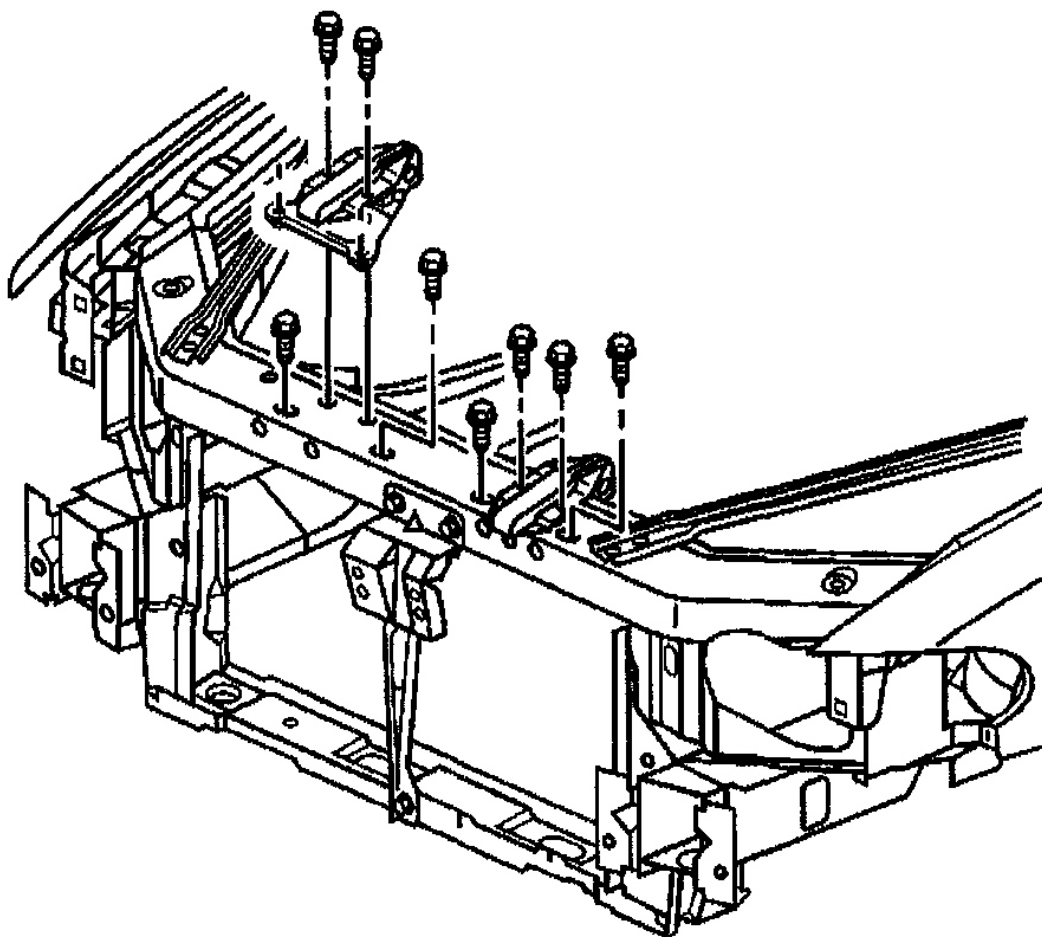
1. Remove the engine mount struts from the engine mount strut brackets at the upper radiator support. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.



G01807264

Fig. 54: Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

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



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Fig. 55: Engine Mount Strut Bracket At Upper Radiator Support
Courtesy of GENERAL MOTORS CORP.

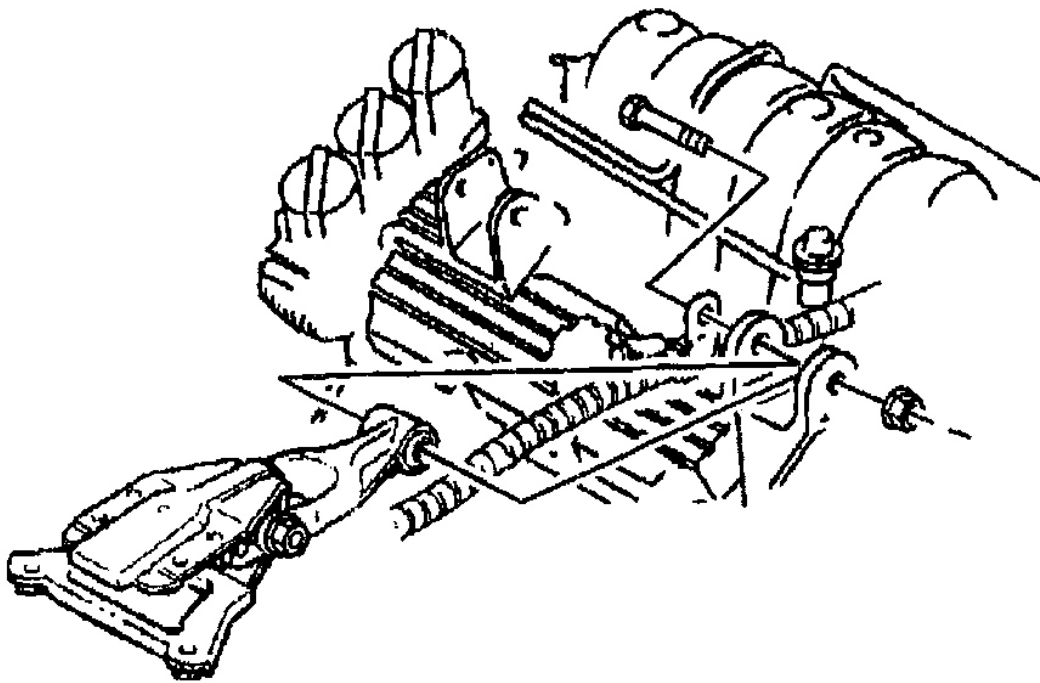
Installation Procedure

1. Position the engine mount strut bracket over the upper radiator support so the engine mount strut bracket and the engine mount strut are aligned. Align the engine mount strut bracket with the proper holes of the upper radiator support.
2. Install the four bolts through the engine mount strut bracket to the upper radiator support. Tighten the engine mount strut bracket bolts at the upper radiator support to 28 N.m (21 ft lbs).
3. Install the engine mount struts to the engine mount strut brackets at the upper radiator support. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.

ENGINE MOUNT STRUT BRACKET - REPLACEMENT - LEFT

Removal Procedure

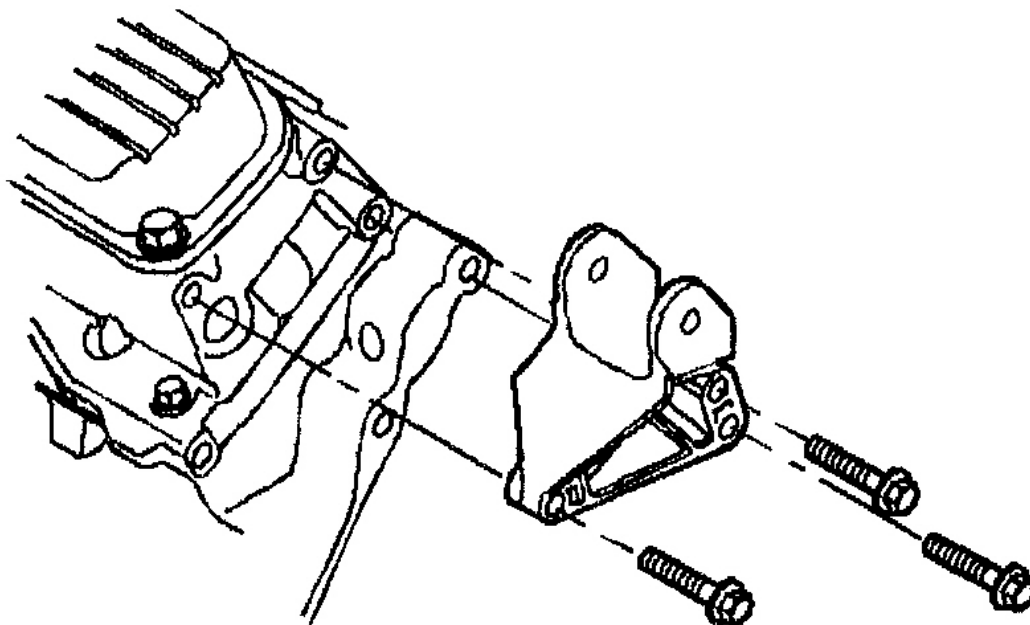
1. Drain the cooling system.
2. Remove the engine coolant temperature sensor.
3. Remove the engine mount strut at the left engine mount strut bracket. Refer to **Engine Mount Strut - Replacement - Left.**



G01807268

Fig. 56: Left Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

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



G01807269

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

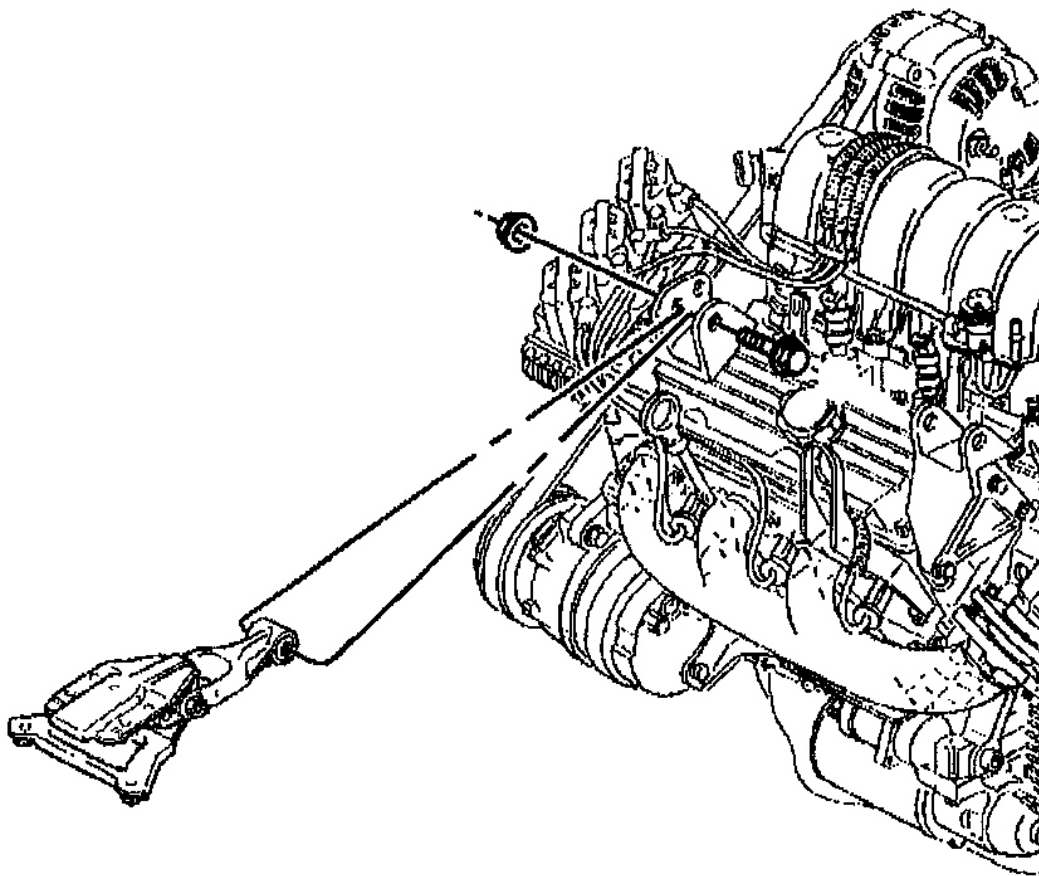
Installation Procedure

1. Install the engine mount strut bracket.
2. Install the engine mount strut bracket bolts. Tighten the engine mount strut bracket bolts to 50 N.m (37 ft lbs).
3. Install the engine mount strut to the left engine mount strut bracket. Refer to **Engine Mount Strut - Replacement - Left**.
4. Install the engine coolant temperature sensor. Tighten the sensor to 25 N.m (18 ft lbs).
5. Fill the cooling system.

ENGINE MOUNT STRUT BRACKET - REPLACEMENT - RIGHT UPPER

Removal Procedure

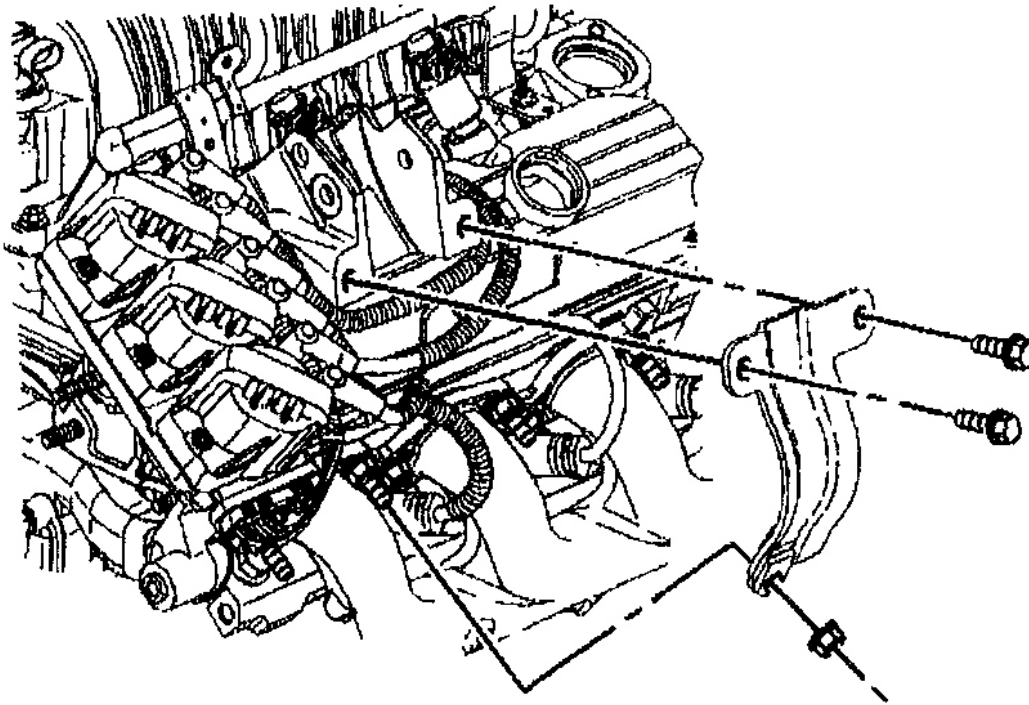
1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
3. Remove the right engine mount strut at the upper engine mount strut bracket. Refer to **Engine Mount Strut - Replacement - Right**.



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Fig. 58: Upper Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

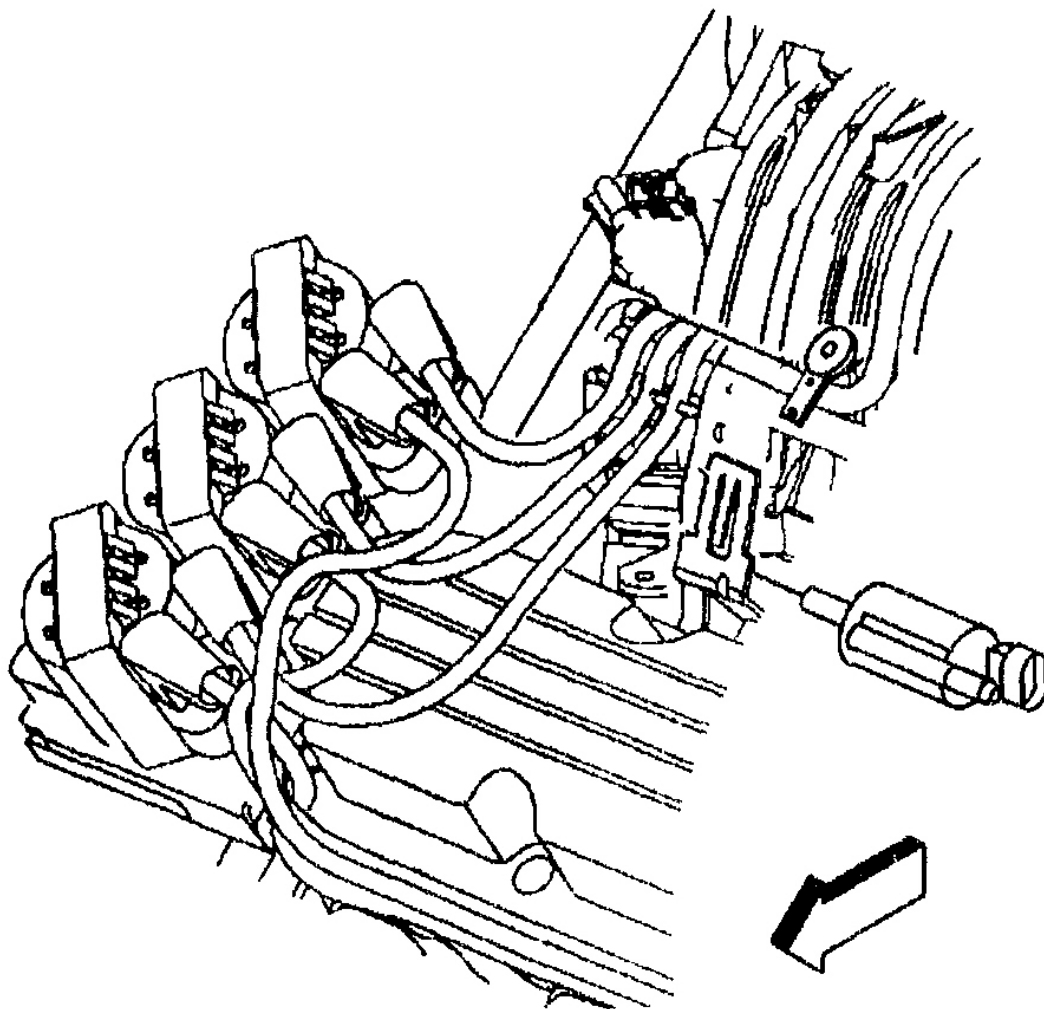
4. Remove the lower engine mount strut bracket nut.
5. Remove the lower engine mount strut bracket bolts and the lower engine mount strut bracket.



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Fig. 59: Lower Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

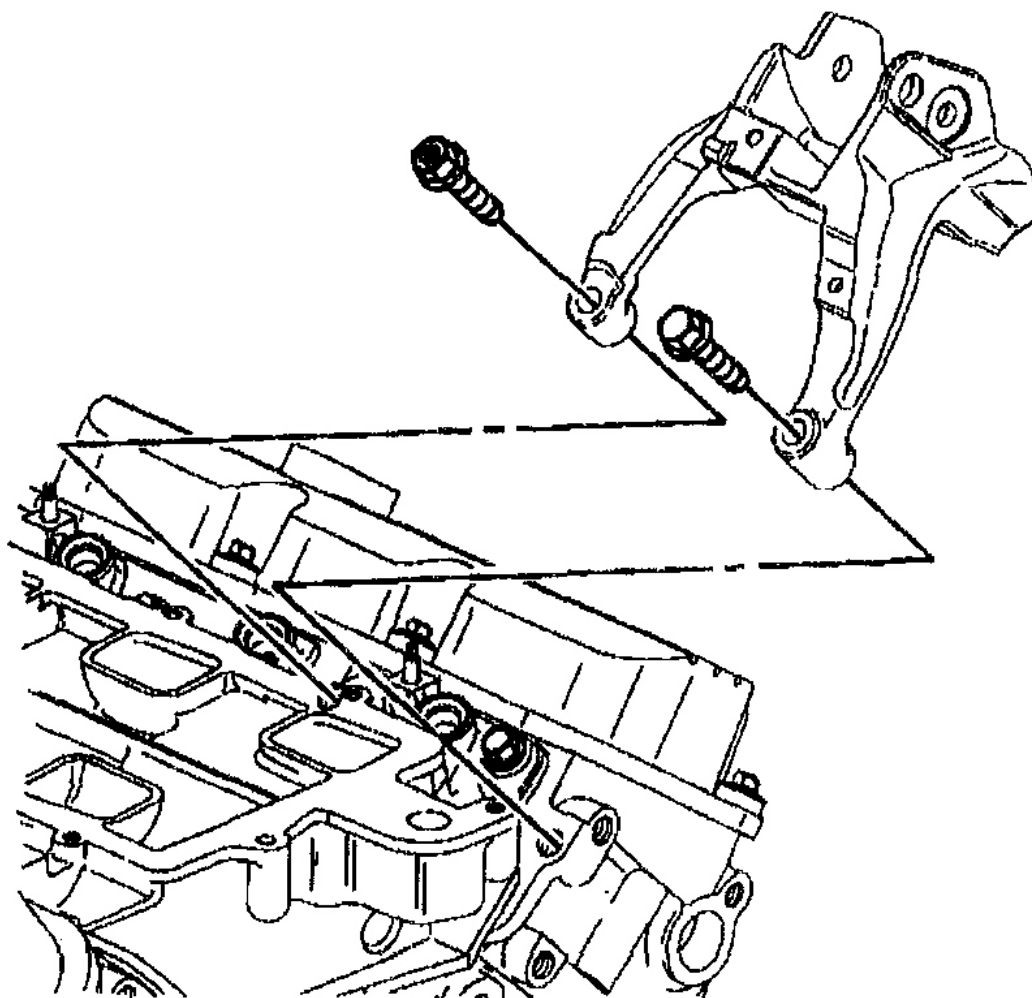
6. Remove the evaporative emission (EVAP) canister purge valve.



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

7. Relieve the fuel pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
8. Remove the fuel rail assembly. Refer to **FUEL RAIL & INJECTORS** .
9. Remove the upper engine mount strut bracket bolts.
10. Remove the upper engine mount strut bracket.



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Fig. 61: Upper Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

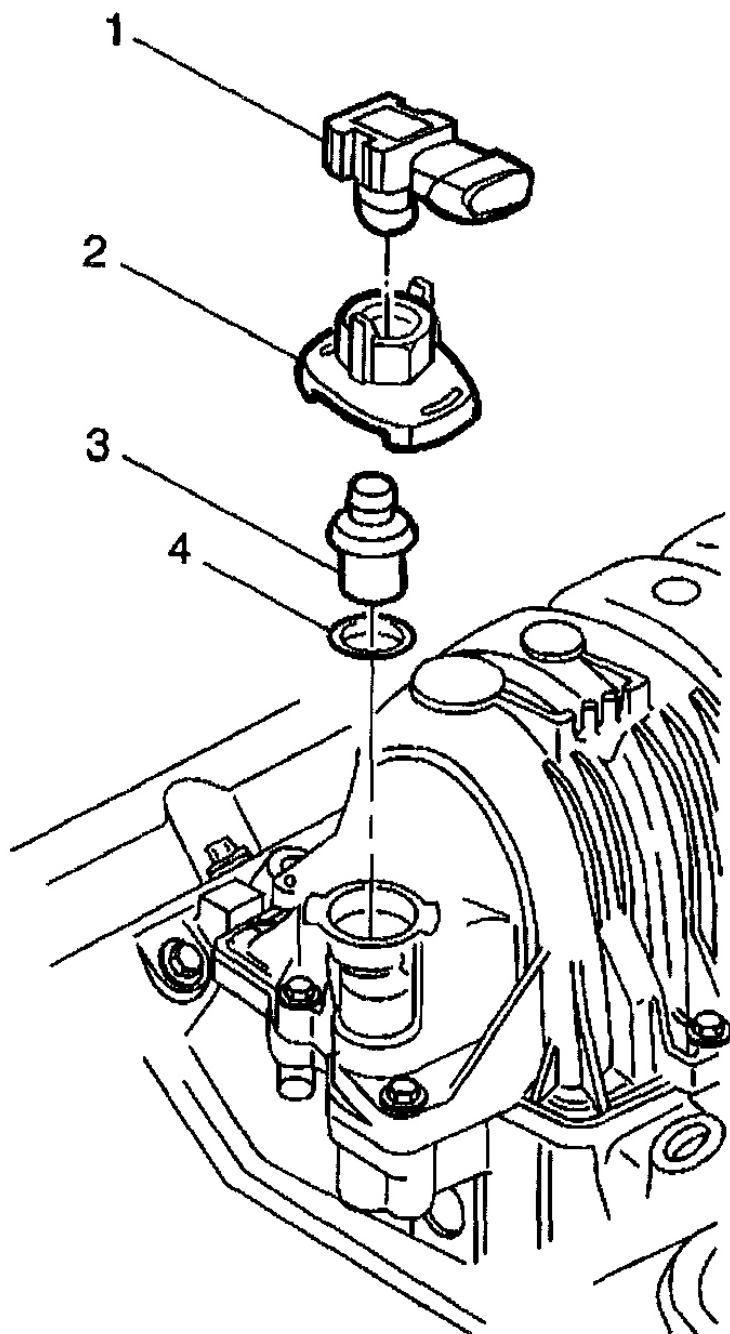
1. Install the upper engine mount strut bracket.
2. Install the upper engine mount strut bracket bolts. Tighten the upper engine mount strut bracket bolts to 50 N.m (37 ft lbs).
3. Install the fuel rail assembly. Refer to **FUEL RAIL & INJECTORS**.
4. Install the evaporative emission (EVAP) canister purge valve.
5. Install the lower engine mount strut bracket bolts. Tighten the lower engine mount strut bracket bolts to 50 N.m (37 ft lbs).

6. Install the lower engine mount strut bracket nut. Tighten the lower engine mount strut bracket nut to 30 N.m (22 ft lbs).
7. Install the right engine mount strut to the upper engine mount strut bracket. Refer to **Engine Mount Strut - Replacement - Right**.
8. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
9. Connect the negative battery cable.

POSITIVE CRANKCASE VENTILATION (PCV) VALVE - REPLACEMENT

Removal Procedure

1. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
2. Disconnect the MAP sensor electrical connector.
3. Remove the MAP sensor (1).
4. Use a 16 mm (5/8 in) socket to press the access cover (2) down and rotate 1/4 turn counterclockwise.
5. Remove the access cover.
6. Remove the PCV valve (3) and the O-ring (4) from the intake manifold.



G01807280

Fig. 62: PCV Valve
Courtesy of GENERAL MOTORS CORP.

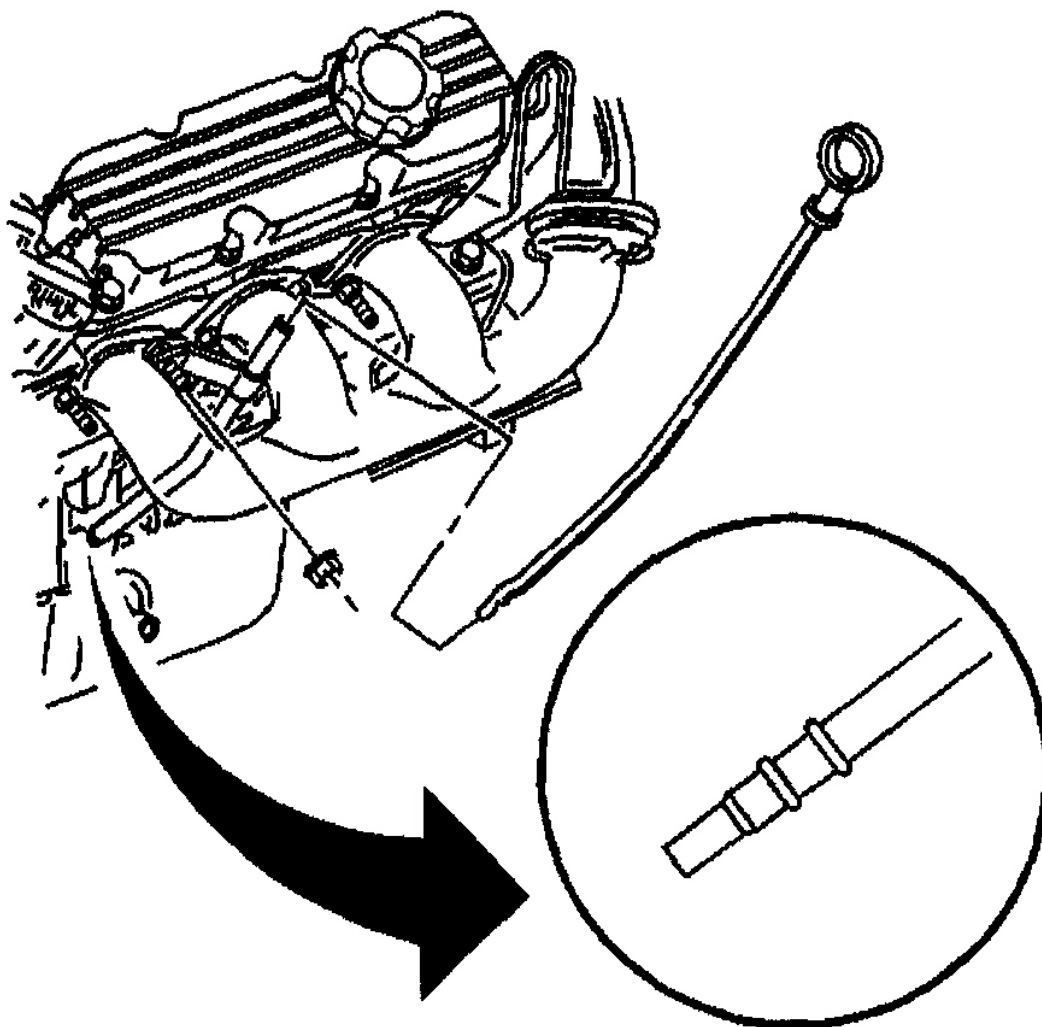
Installation Procedure

1. Install the new O-ring (4) and the PCV valve (3).
2. Install the access cover (2).
3. Install the MAP sensor (1).
4. Connect the MAP sensor electrical connector.
5. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.

OIL LEVEL INDICATOR & TUBE - REPLACEMENT

Removal Procedure

1. Remove the oil level indicator.
2. Remove the oil level indicator tube bracket nut.
3. Remove the oil level indicator tube.



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Fig. 63: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

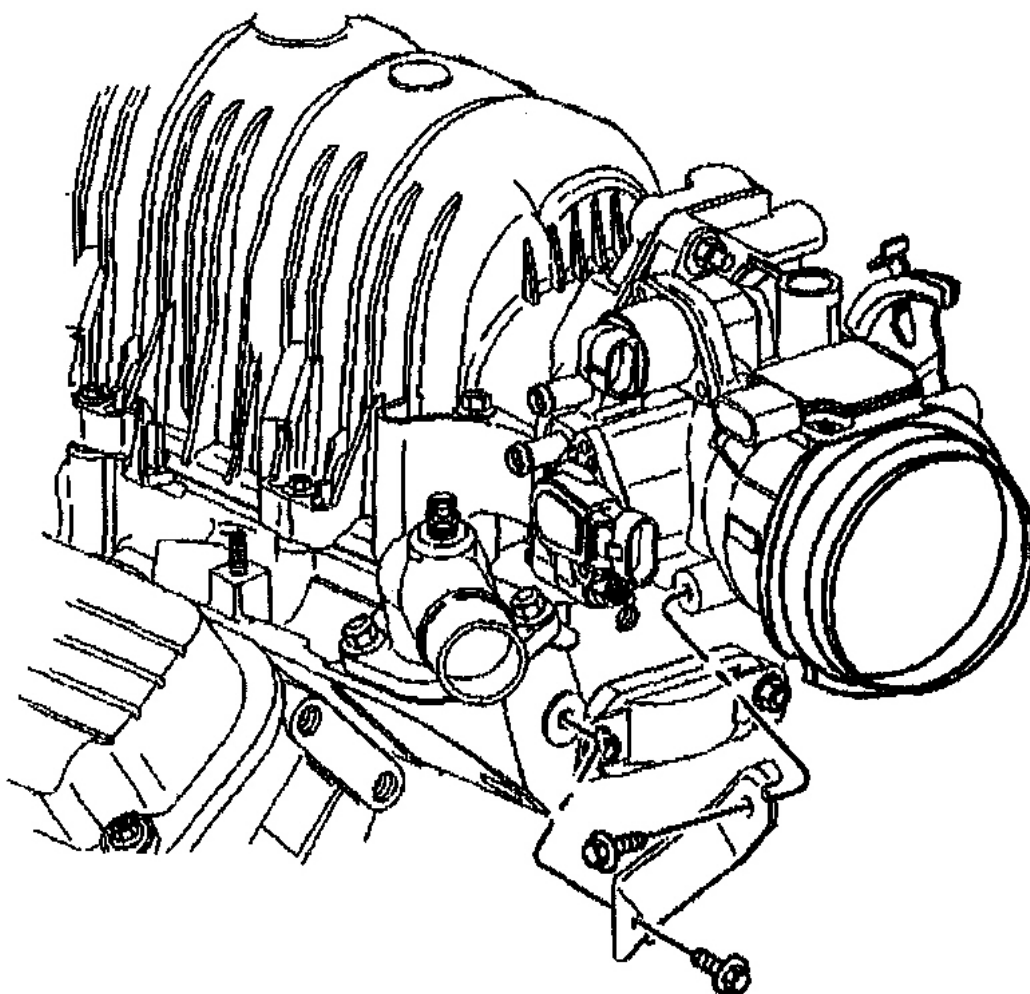
Installation Procedure

1. Make sure that the O-ring is in place and install the oil indicator tube to the engine.
2. Install the oil indicator tube bracket to the exhaust manifold stud.
3. Install the oil level indicator tube bracket nut. Tighten the nut to 19 N.m (14 ft lbs).
4. Install the oil level indicator.
5. Check and fill the engine oil as necessary.

INTAKE MANIFOLD - REPLACEMENT - UPPER

Removal Procedure

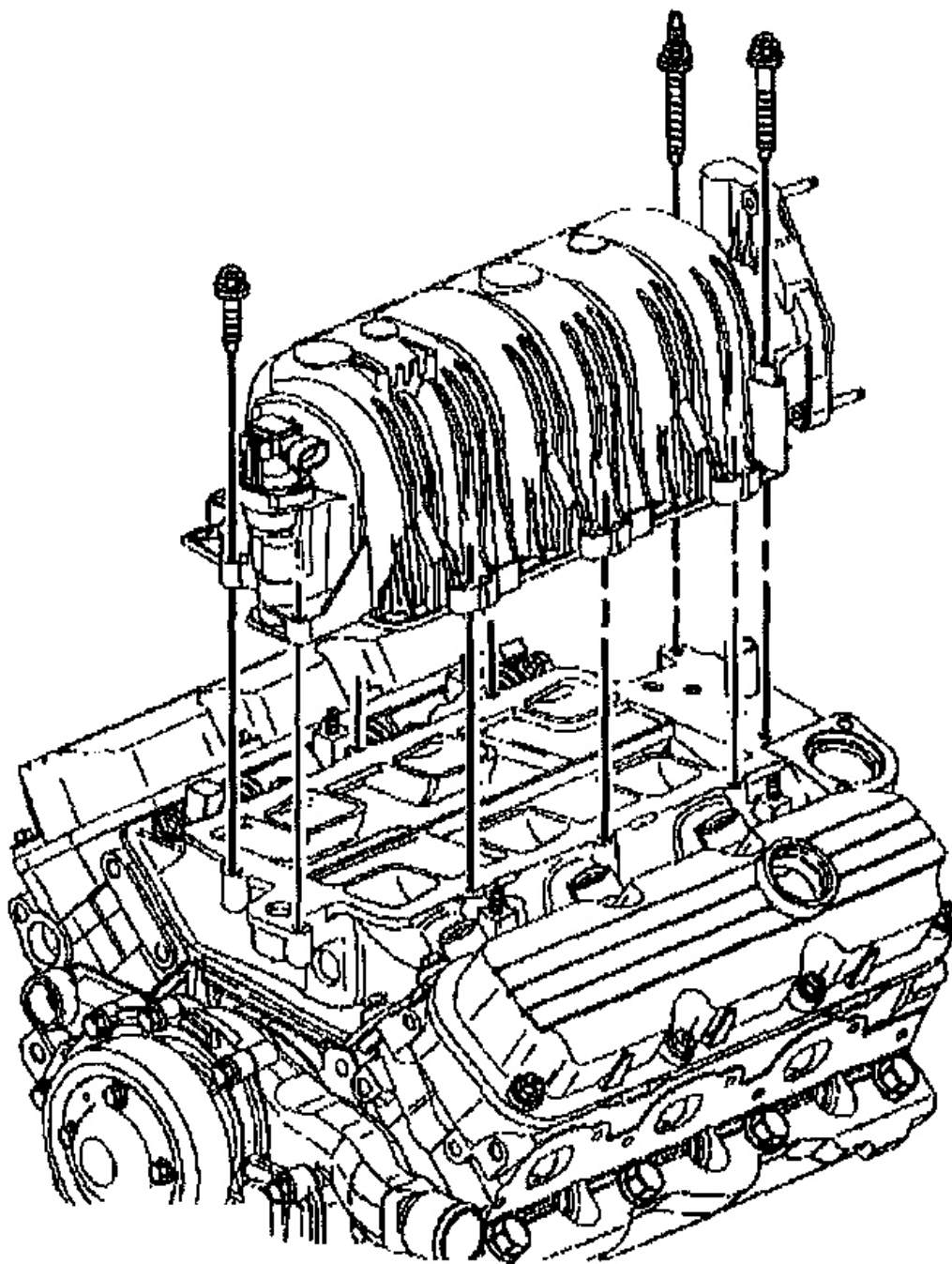
1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
3. Remove the air cleaner intake duct.
4. Drain the cooling system.
5. Remove the right spark plug wires from the ignition control module and reposition.
6. Relieve the fuel pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE** .
7. Remove the fuel rail assembly. Refer to **FUEL RAIL & INJECTORS** .
8. Remove the brake booster hose from the vacuum source manifold in the upper intake manifold.
9. Remove the exhaust gas recirculation valve (EGR) wiring harness heat shield nut, bolt and the EGR heat shield.
10. Remove the throttle body support bracket upper bolt.
11. Disconnect the electrical connectors from the following:
 - EVAP purge solenoid
 - Throttle position (T/P) sensor
 - Idle air control (IAC) valve
 - Manifold absolute pressure (MAP) sensor
 - Mass air flow (MAF) sensor
12. Remove the EVAP purge solenoid vacuum line from the throttle body.
13. Remove the accelerator and the cruise control cables with the bracket from the throttle body.



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Fig. 64: Accelerator & Cruise Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

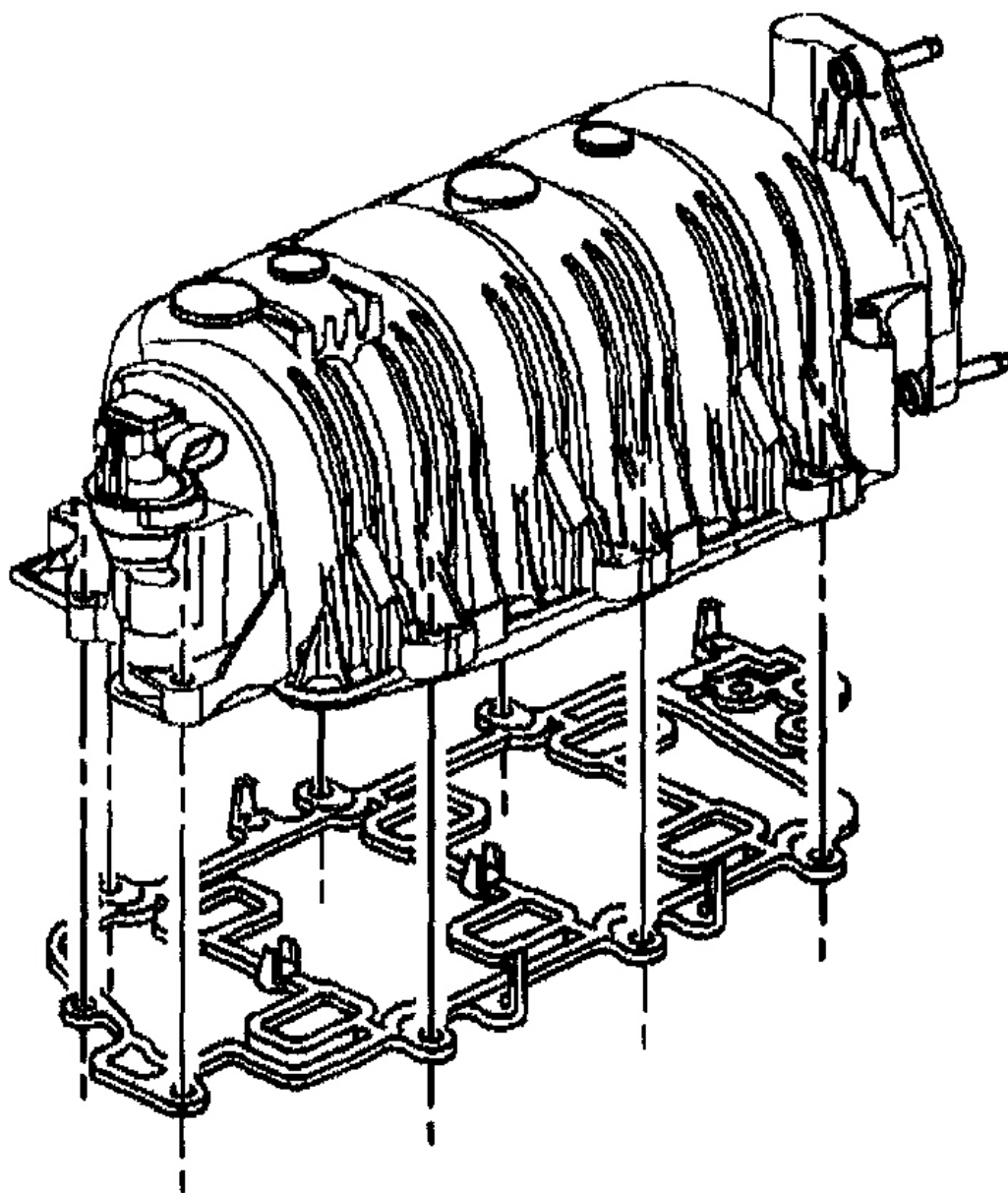
14. Remove the upper intake manifold bolts and stud.
15. Clean the upper intake manifold bolt threads.
16. Remove the upper intake manifold by lifting the back of the intake and sliding the manifold forward from the throttle body support bracket.



G01807286

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

17. Remove the upper-to-lower intake manifold carrier gasket from the upper intake manifold.
18. If the upper intake manifold is being replaced, remove the following:
 - Throttle body assembly.
 - Manifold absolute pressure (MAP) sensor.
 - Positive crankcase ventilation (PCV) valve.
 - Vacuum source manifold.



G01807287

Fig. 66: Upper Intake Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

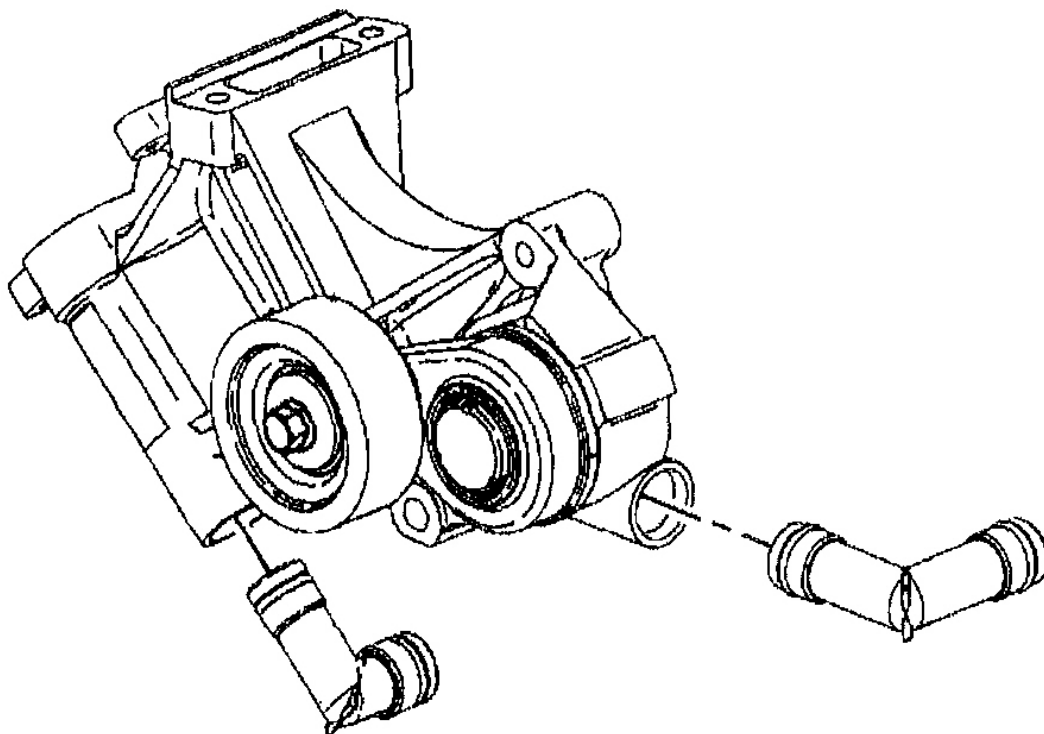
1. If the manifold was replaced install the following:

- Vacuum source manifold.
 - Positive crankcase ventilation (PCV) valve.
 - Manifold absolute pressure (MAP) sensor.
 - Throttle body assembly.
2. Install the upper-to-lower intake manifold carrier gasket to the upper intake manifold.
 3. Carefully place the upper intake manifold onto the lower intake manifold. Ensure that the alignment pins in the upper intake manifold align with the holes in the lower intake manifold.
 4. Install the upper intake manifold.
 5. Apply thread lock compound GM P/N 12345382, (Canadian P/N 10953489) or equivalent, to the bolt threads before assembly.
 6. Install the upper intake manifold bolts (1-10). Tighten the upper intake manifold bolts in sequence to 10 N.m (89 in lbs).
 7. Install the accelerator and the cruise control cables with the bracket to the throttle body.
 8. Install the EVAP purge solenoid vacuum line to the throttle body.
 9. Connect the electrical connectors to the following:
 - Mass air flow (MAF) sensor
 - Manifold absolute pressure (MAP) sensor
 - Idle air control (IAC) valve
 - Throttle position (T/P) sensor
 - EVAP purge solenoid
 10. Install the throttle body upper support bracket bolt. Tighten the bolt to 10 N.m (89 in lbs).
 11. Install the EGR valve wiring harness heat shield, nut and the bolt. Tighten the nut and the bolt to 10 N.m (89 in lbs).
 12. Install the brake booster hose to the vacuum source manifold.
 13. Install the fuel rail assembly. Refer to **FUEL RAIL & INJECTORS**.
 14. Install the right spark plug wires.
 15. Install the air cleaner intake duct.
 16. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
 17. Connect the negative battery cable.
 18. Fill the cooling system.
 19. Inspect for fluid or vacuum leaks.

INTAKE MANIFOLD - REPLACEMENT - LOWER

Removal Procedure

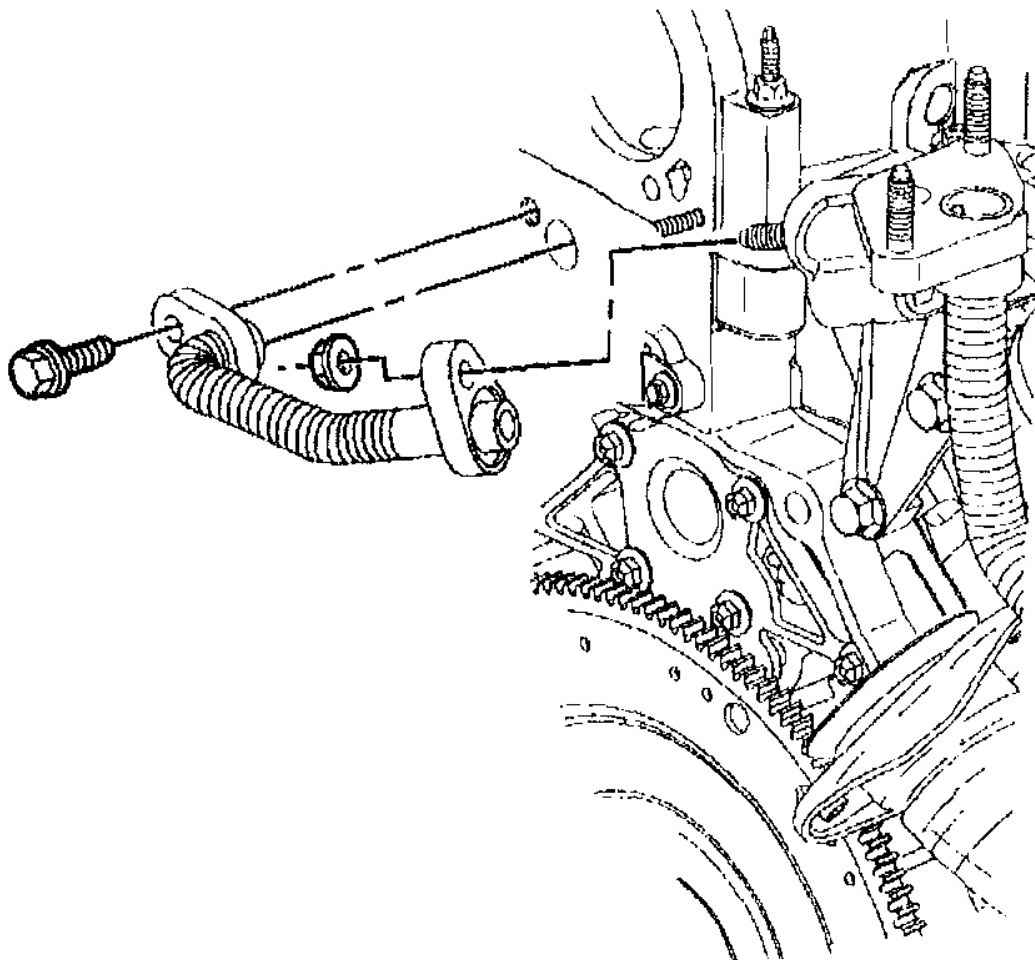
1. Remove the upper intake manifold. Refer to **Intake Manifold - Replacement - Upper**.
2. Remove the generator brace.
3. Remove the drive belt tensioner with mounting bracket and the heater water bypass inlet pipe. Refer to **Drive Belt Tensioner - Replacement**.



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Fig. 67: Drive Belt Tensioner & Bracket
Courtesy of GENERAL MOTORS CORP.

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

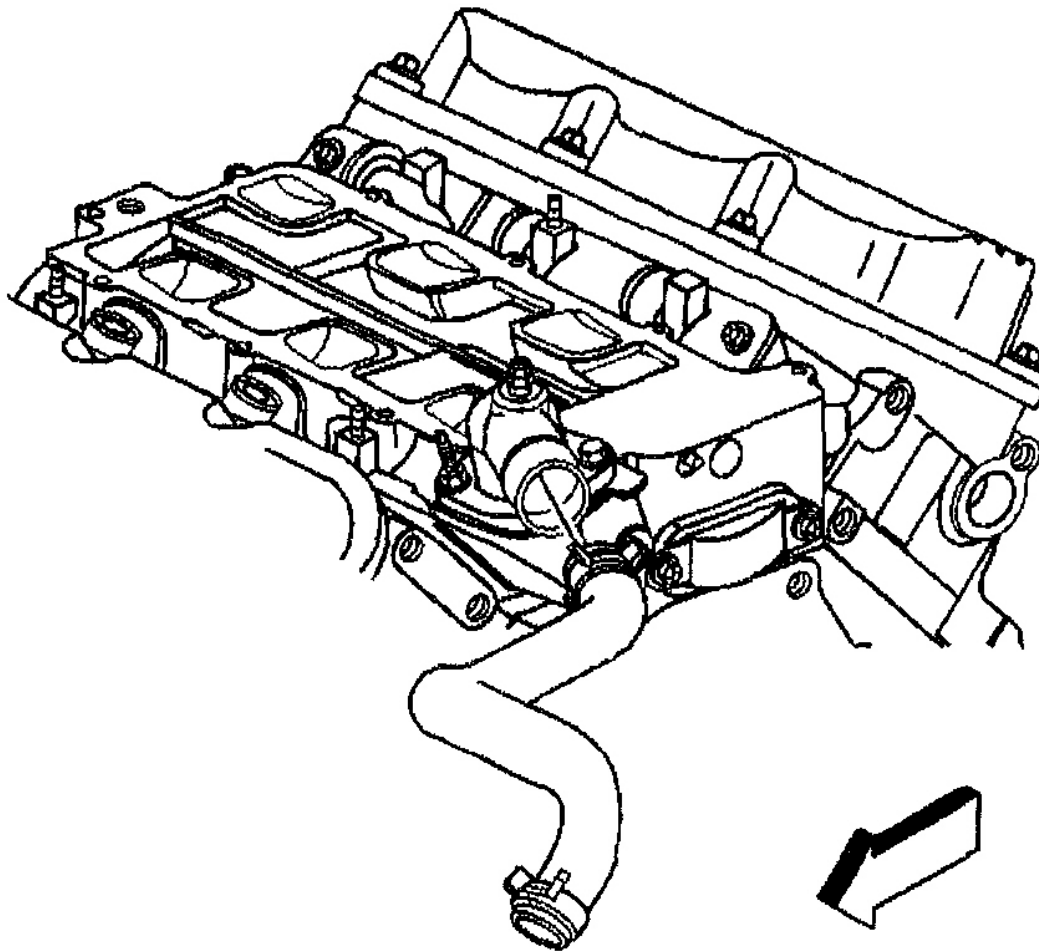


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Fig. 68: EGR Outlet Pipe

Courtesy of GENERAL MOTORS CORP.

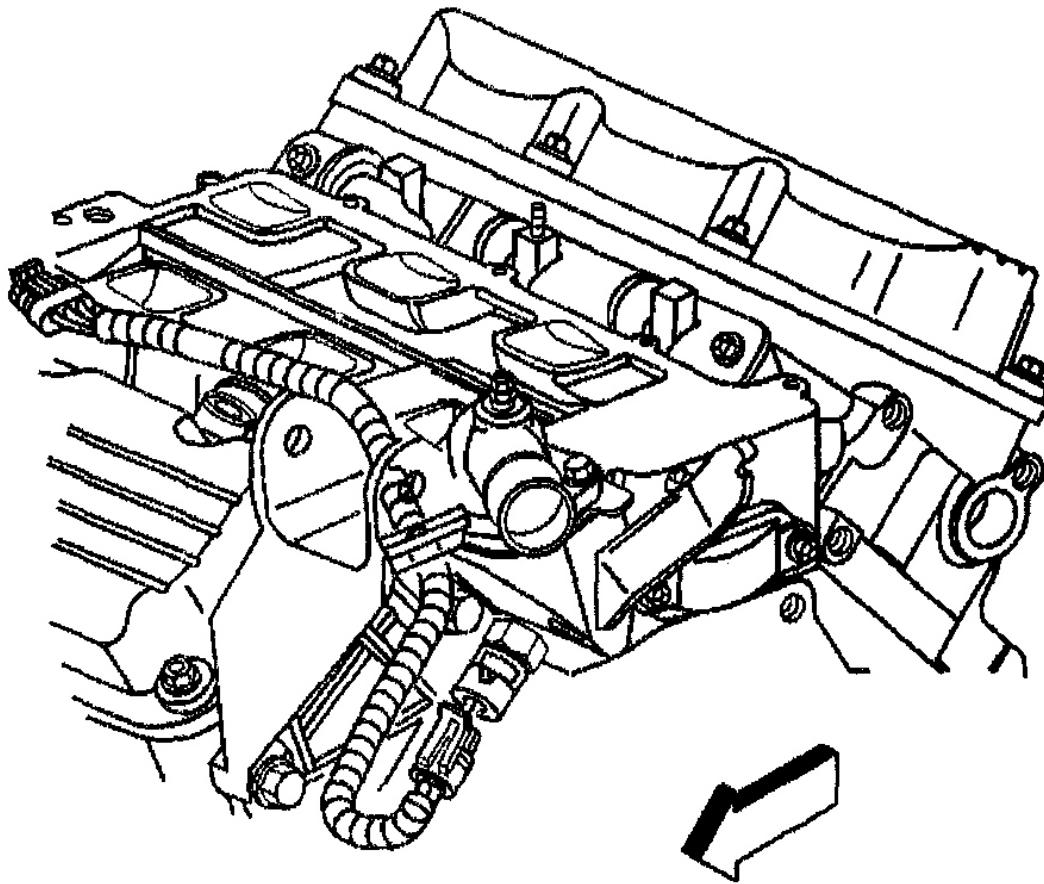
5. Remove the radiator inlet hose from the water outlet housing.



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Fig. 69: Water Outlet Housing
Courtesy of GENERAL MOTORS CORP.

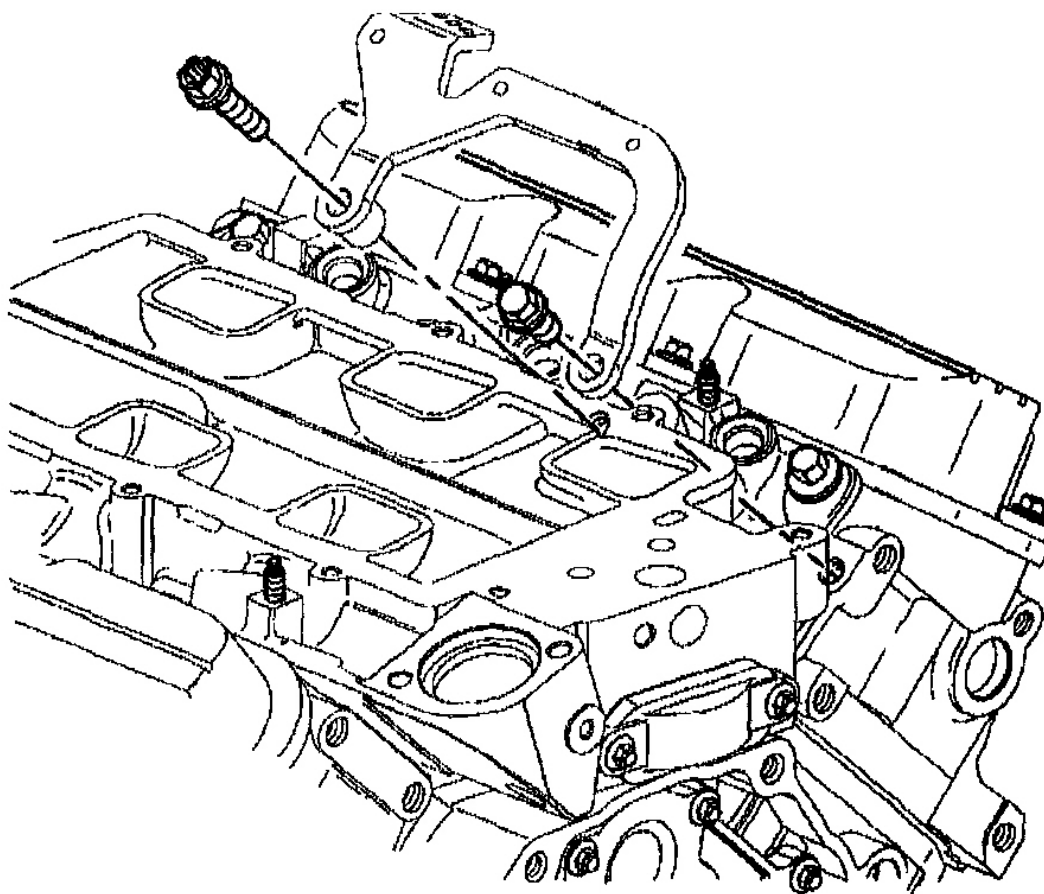
6. Disconnect the engine coolant temperature (ECT) sensor electrical connector.
7. Remove the right upper engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.



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Fig. 70: Right Upper Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

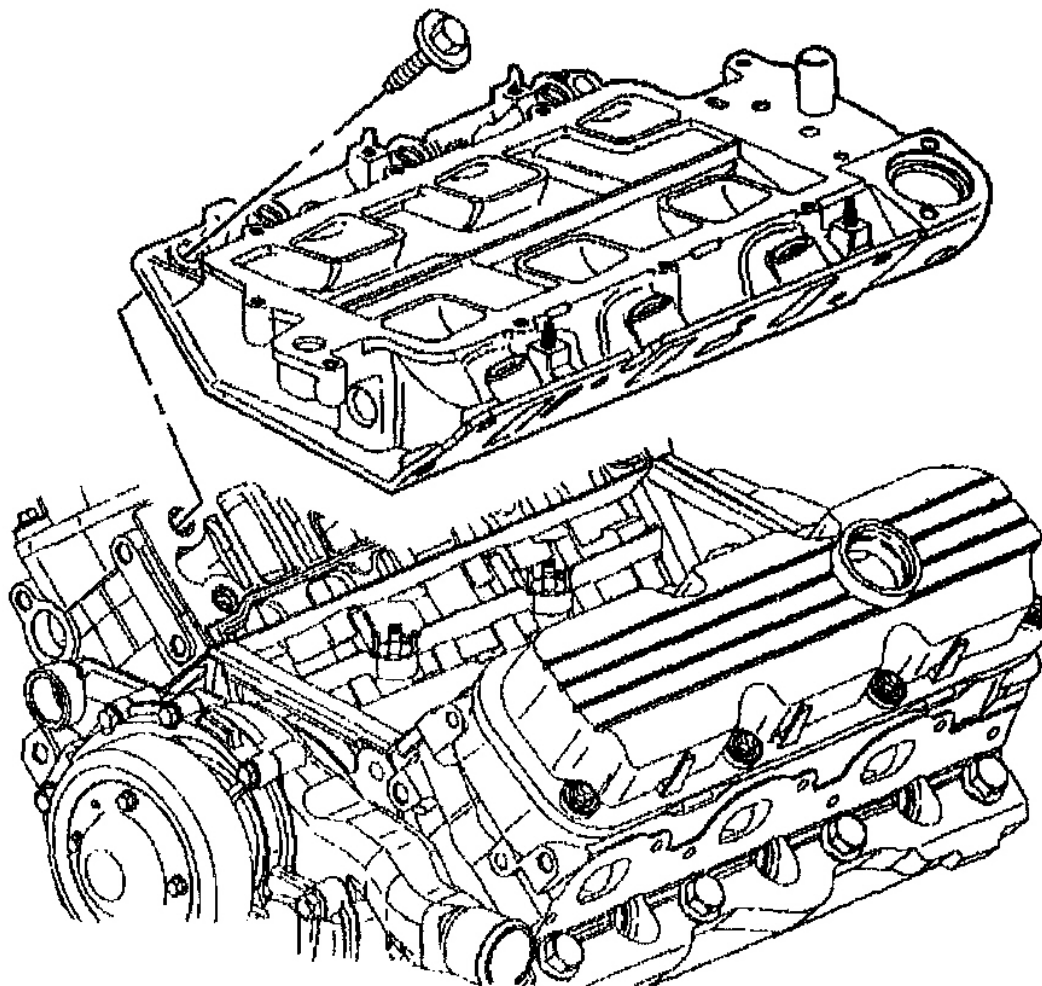
8. Remove the generator brace bracket bolts.
9. Remove the generator brace bracket.



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Fig. 71: Generator Brace Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

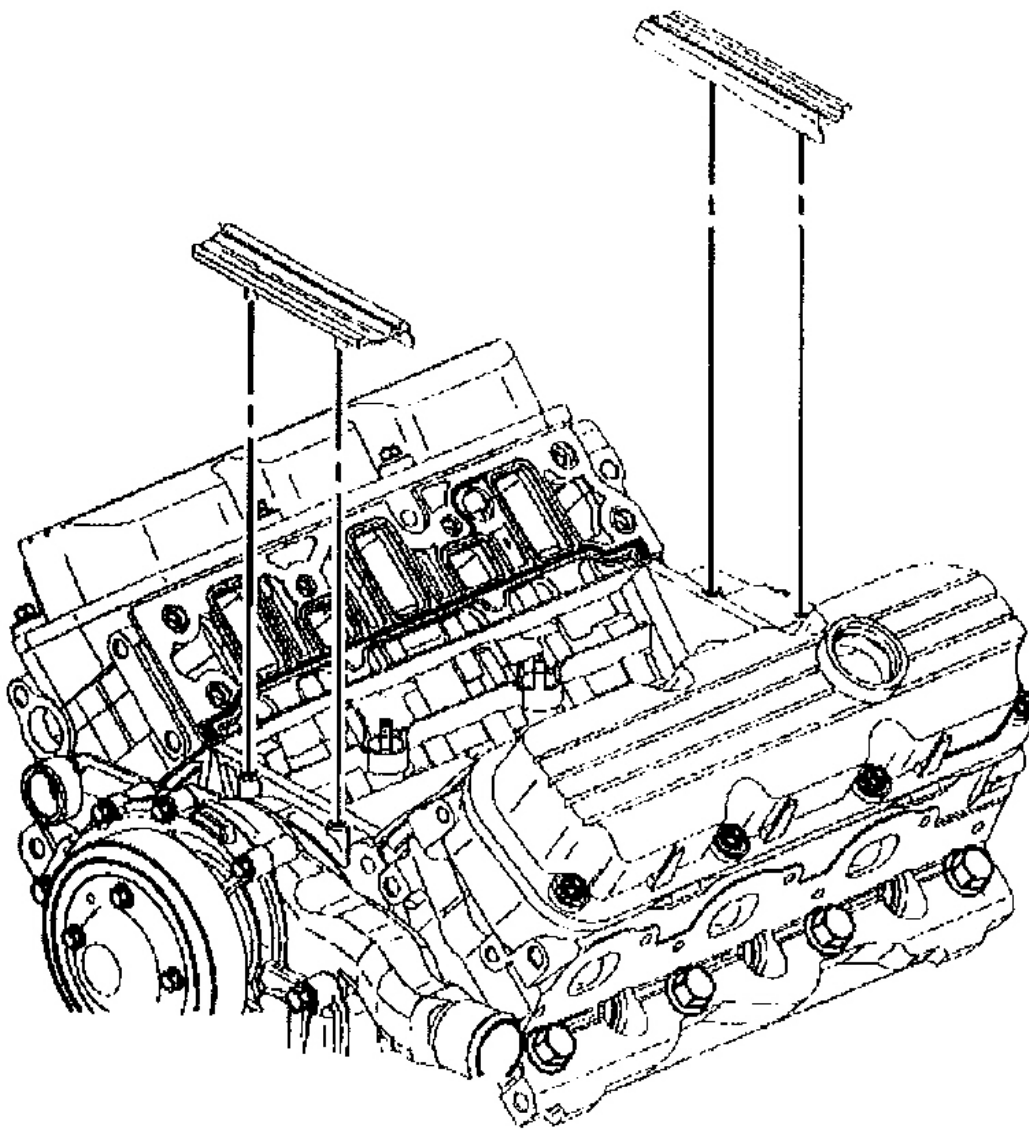
10. Remove the lower intake manifold bolts.
11. Remove the lower intake manifold.



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Fig. 72: Lower Intake Manifold
Courtesy of GENERAL MOTORS CORP.

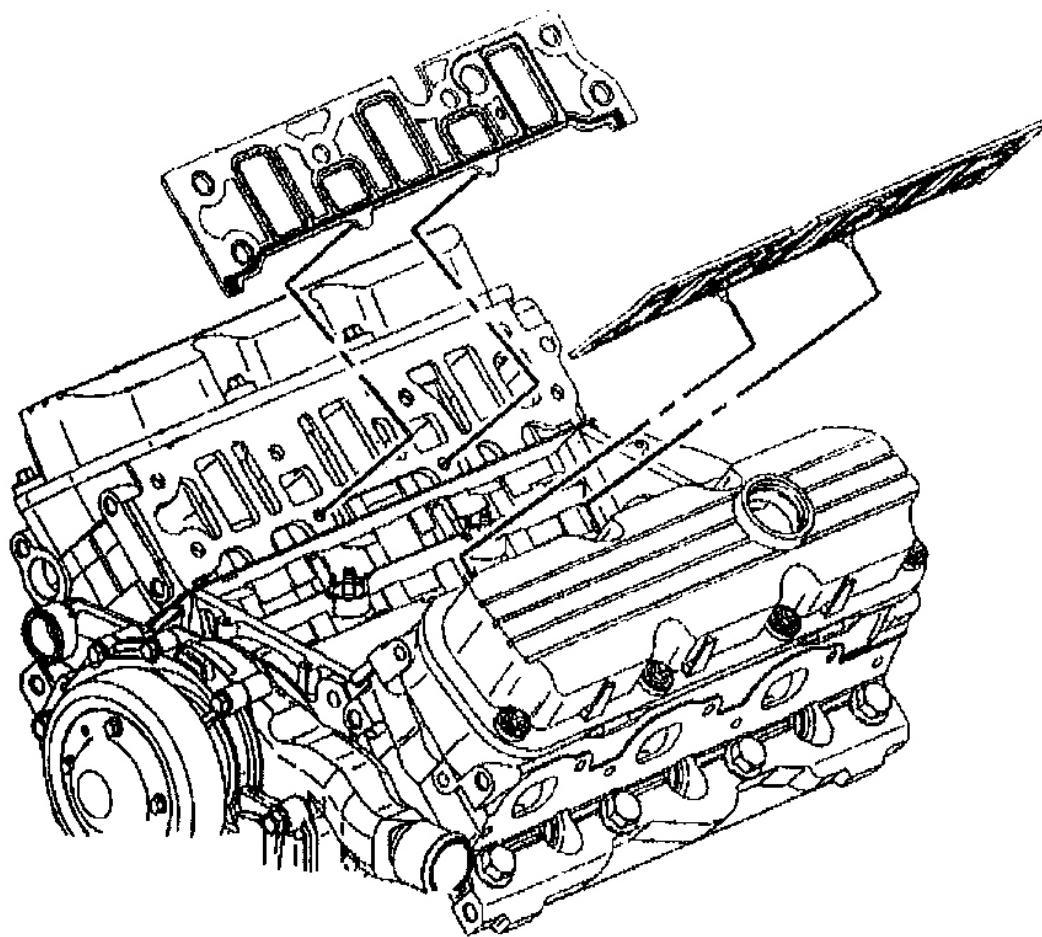
12. Remove the lower intake manifold seals.



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Fig. 73: Lower Intake Manifold Seals
Courtesy of GENERAL MOTORS CORP.

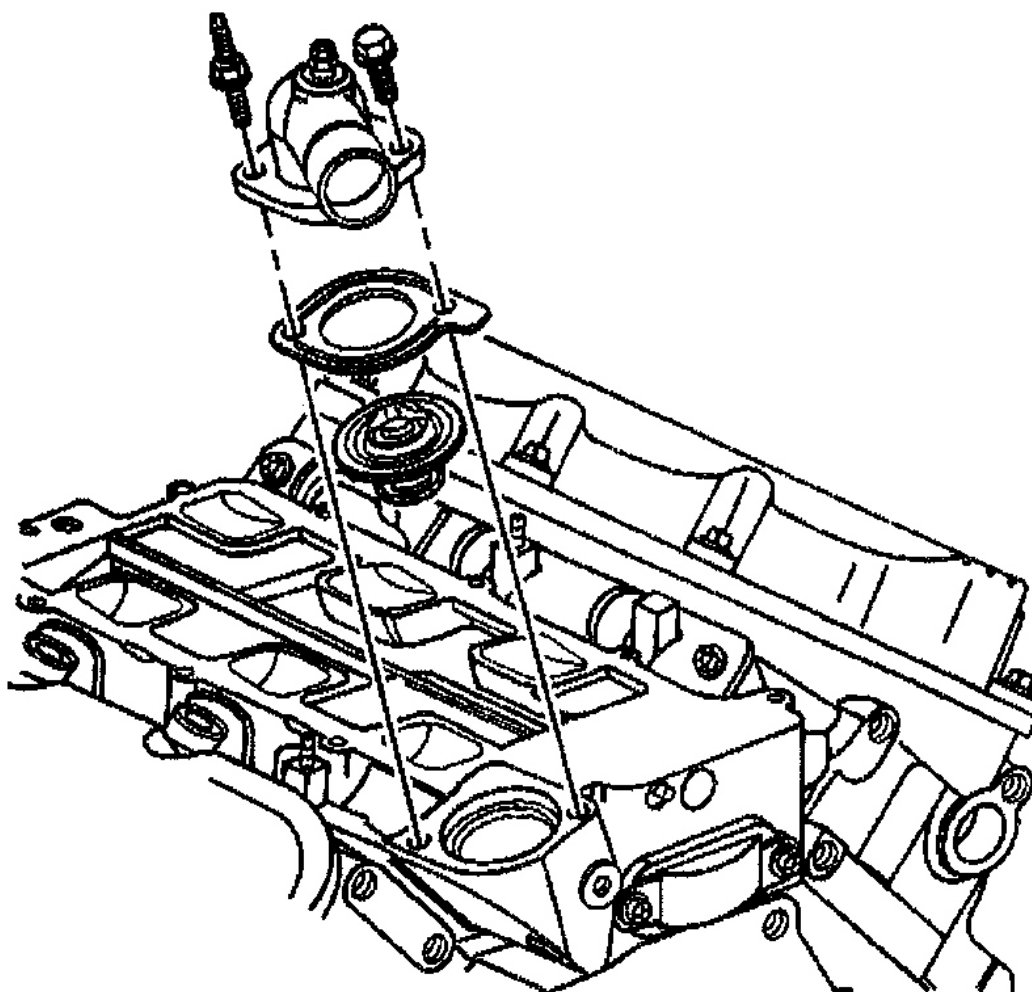
13. Remove the lower intake manifold gaskets.



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Fig. 74: Lower Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

14. If replacing the lower intake manifold, remove the water outlet housing bolt and stud, the water outlet housing, the gasket and the thermostat.



G01807301

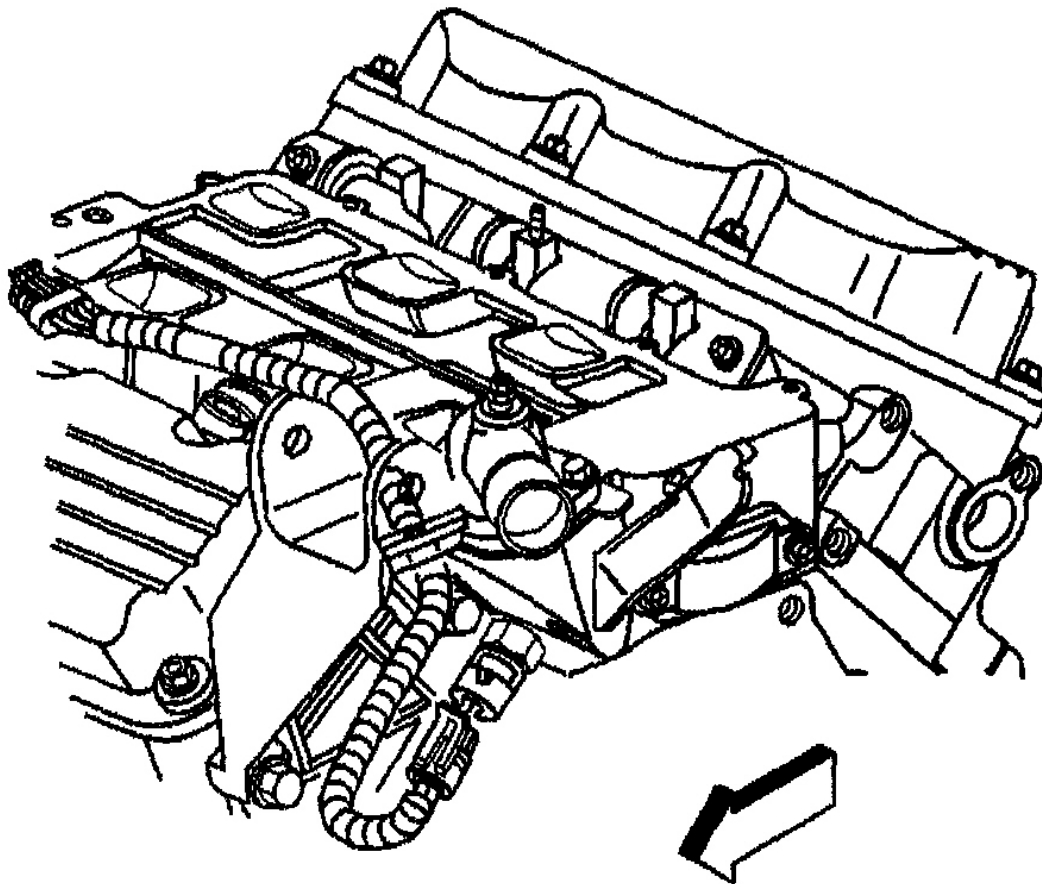
Fig. 75: Water Outlet Housing, Gasket & Thermostat
Courtesy of GENERAL MOTORS CORP.

15. If replacing the lower intake manifold, remove the engine coolant temperature (ECT) sensor.
16. Inspect the flatness of inlet flanges.
17. Clean the intake manifold mating surfaces.
18. Clean the intake manifold bolts and bolt holes of adhesive compound.

Installation Procedure

1. If removed, install the engine coolant temperature (ECT) sensor. Tighten the engine coolant temperature (ECT) sensor to 25 N.m (18 ft lbs).

2. If removed, install the thermostat, the gasket, and the water outlet housing.
3. Install the water outlet housing bolt and stud. Tighten the water outlet housing bolt and stud to 27 N.m (20 ft lbs).
4. Install the lower intake manifold gaskets.
5. Apply sealer GM P/N 12346286 or equivalent to the ends of the intake manifold seals.
6. Install the lower intake manifold seals.
7. Install the lower intake manifold.
8. Install the lower intake manifold bolts (1-12). Apply thread lock compound GM P/N 12345382 or equivalent to the two hidden bolts and ensure they are installed. Tighten the lower intake manifold bolts in sequence to 15 N.m (11 ft lbs).
9. Install the generator brace bracket.
10. Install the generator brace bracket bolts. Tighten the generator brace bracket bolts to 50 N.m (37 ft lbs).
11. Install the right upper engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.
12. Connect the engine coolant (ECT) temperature sensor electrical connector.

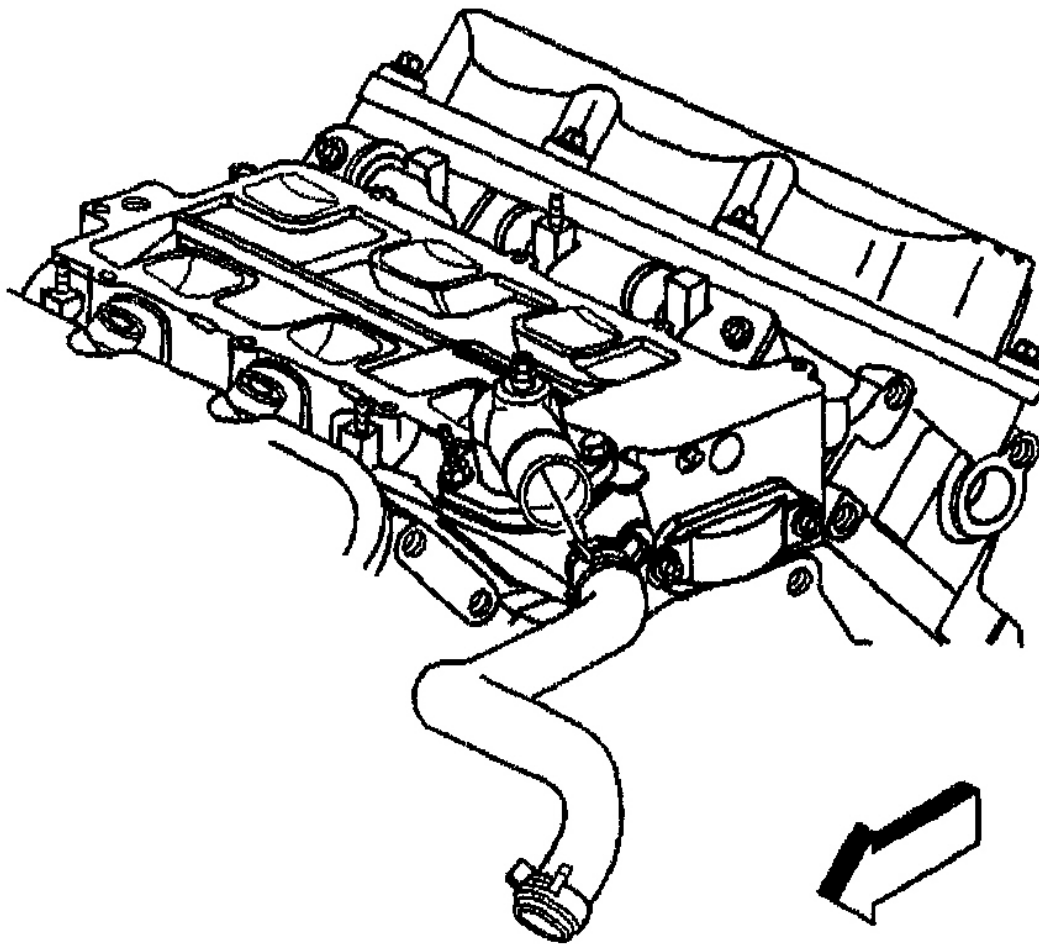


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Fig. 76: ECT Sensor

Courtesy of GENERAL MOTORS CORP.

13. Install the radiator inlet hose to the water outlet housing.

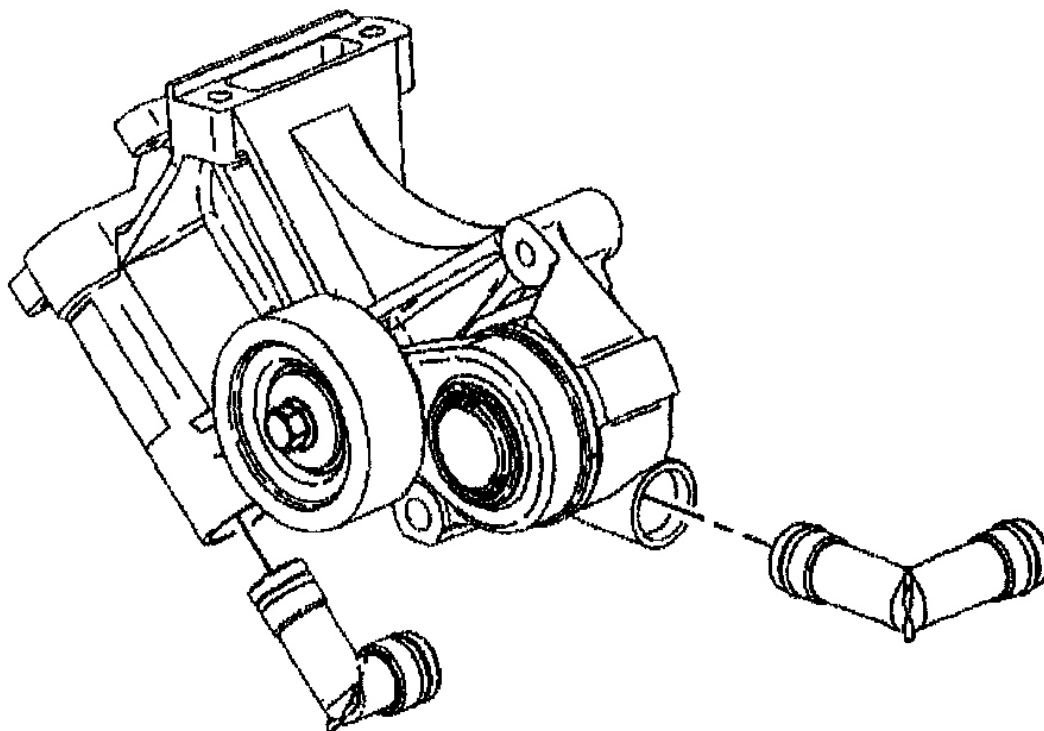


G01807309

Fig. 77: Radiator Inlet Hose

Courtesy of GENERAL MOTORS CORP.

14. Install the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.



G01807310

Fig. 78: Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

15. Install the EGR outlet pipe to the lower intake manifold.
16. Install the EGR outlet pipe bolt to the lower intake manifold. Tighten the EGR outlet pipe bolt to 29 N.m (21 ft lbs).
17. Install the generator brace.
18. Install the upper intake manifold. Refer to **Intake Manifold - Replacement - Upper.**

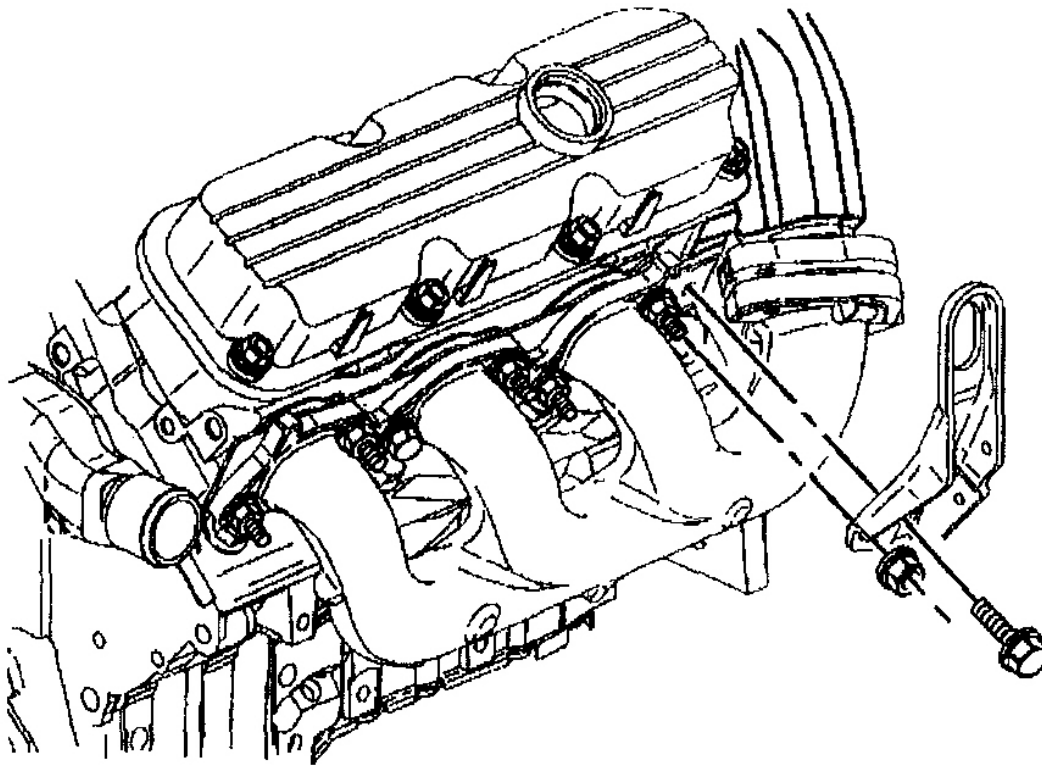
VALVE ROCKER ARM COVER - REPLACEMENT - LEFT

Removal Procedure

1. Disconnect the negative battery cable.

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

2. Remove the engine lift bracket from the exhaust manifold studs.

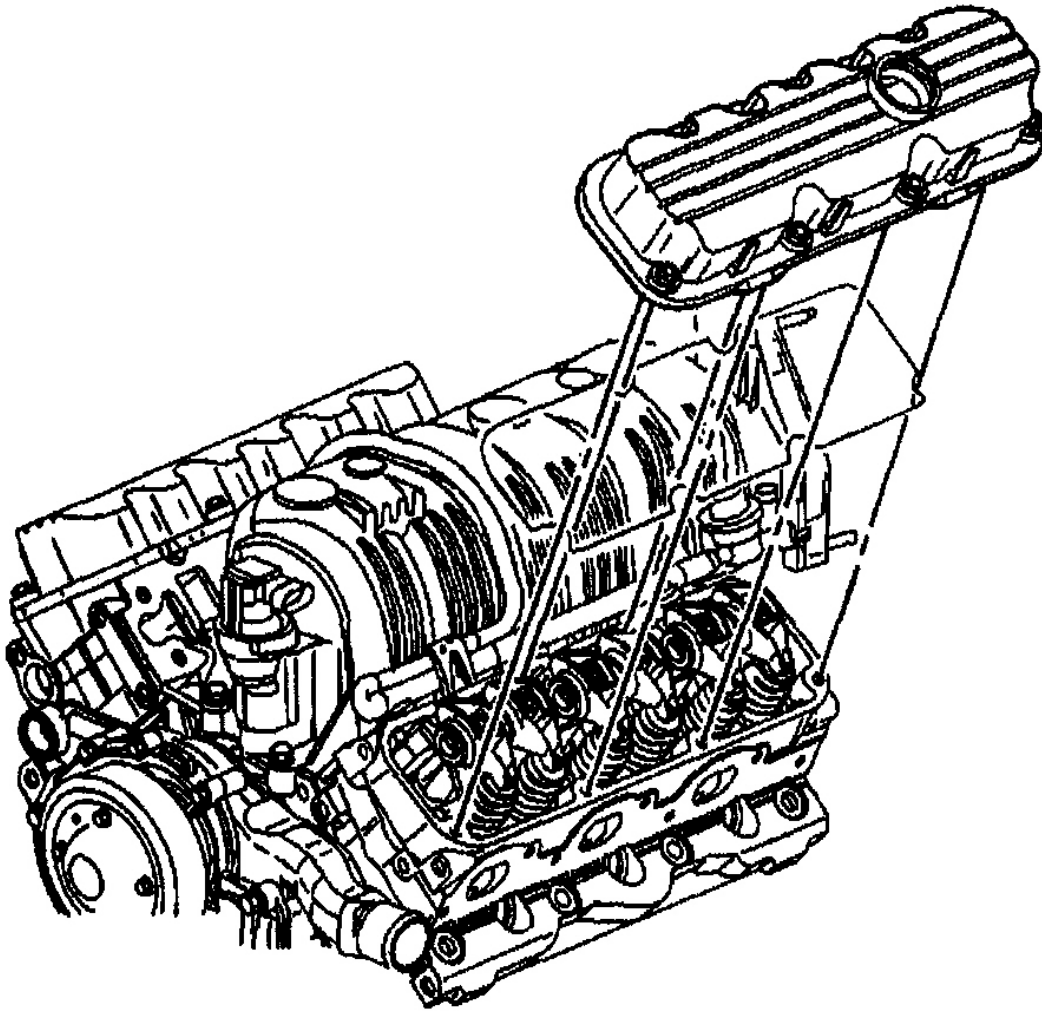


G01807312

Fig. 79: Engine Lift Bracket

Courtesy of GENERAL MOTORS CORP.

3. Remove the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.
4. Remove the left spark plug wires from the left spark plugs.
5. Remove the left spark plug wire cover from the left valve rocker arm cover.
6. Remove the left valve rocker arm cover bolts. **Important:** If the valve rocker arm cover adheres to the cylinder head, remove the valve rocker arm cover by bumping the end of the valve rocker arm cover with palm of hand or with a soft rubber mallet.
7. Remove the left valve rocker arm cover.
8. Remove the left valve rocker arm cover gasket.
9. Clean the valve rocker arm cover mating surfaces.
10. Clean the valve rocker arm cover bolts of all thread locking adhesive.



G01807313

Fig. 80: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the new valve rocker arm cover gasket. Make sure that valve rocker arm cover gasket is seated properly in the valve rocker arm cover groove.
2. Install the left valve rocker arm cover.
3. Apply thread lock compound GM P/N 12345493 or equivalent, to the valve rocker arm cover bolt threads.
4. Install the left valve rocker arm cover bolts. Tighten the left valve rocker arm cover bolts to 10 N.m (89 in lbs).

5. Install the left spark plug wire cover to the left valve rocker arm cover.
6. Install the left spark plug wires to the spark plugs.
7. Install the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.
8. Install the engine lift bracket to the exhaust manifold studs. Tighten the engine lift bracket bolt and nut to 30 N.m (22 ft lbs).
9. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
10. Connect the negative battery cable.
11. Check and fill crankcase as necessary.
12. Inspect for oil leaks.

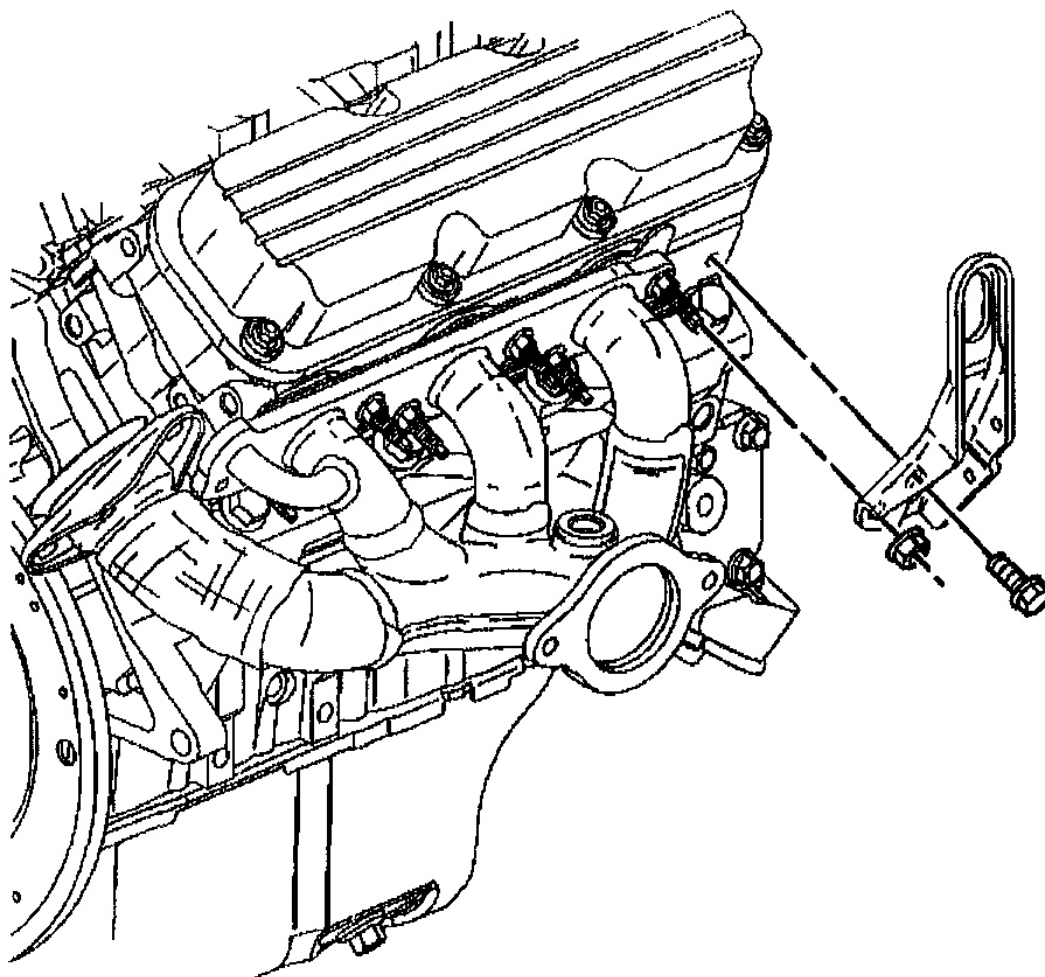
VALVE ROCKER ARM COVER - REPLACEMENT - RIGHT

Tools Required

J 41131 Engine Tilt Strap

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
3. Disconnect the intake air temperature (IAT) sensor electrical connector.
4. Remove the air inlet duct from the throttle body.
5. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
6. Remove the AIR valve, if equipped.
7. Remove the AIR pipe, if necessary.
8. Remove the right and left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
9. Rotate the engine for access. Refer to **Rotating Engine For Service Access**.
10. Remove the right side spark plug wires from the spark plugs.
11. Remove the fuel injector sight shield bracket nuts and bracket.
12. Remove the right side lift bracket nut, bolt and lift bracket.



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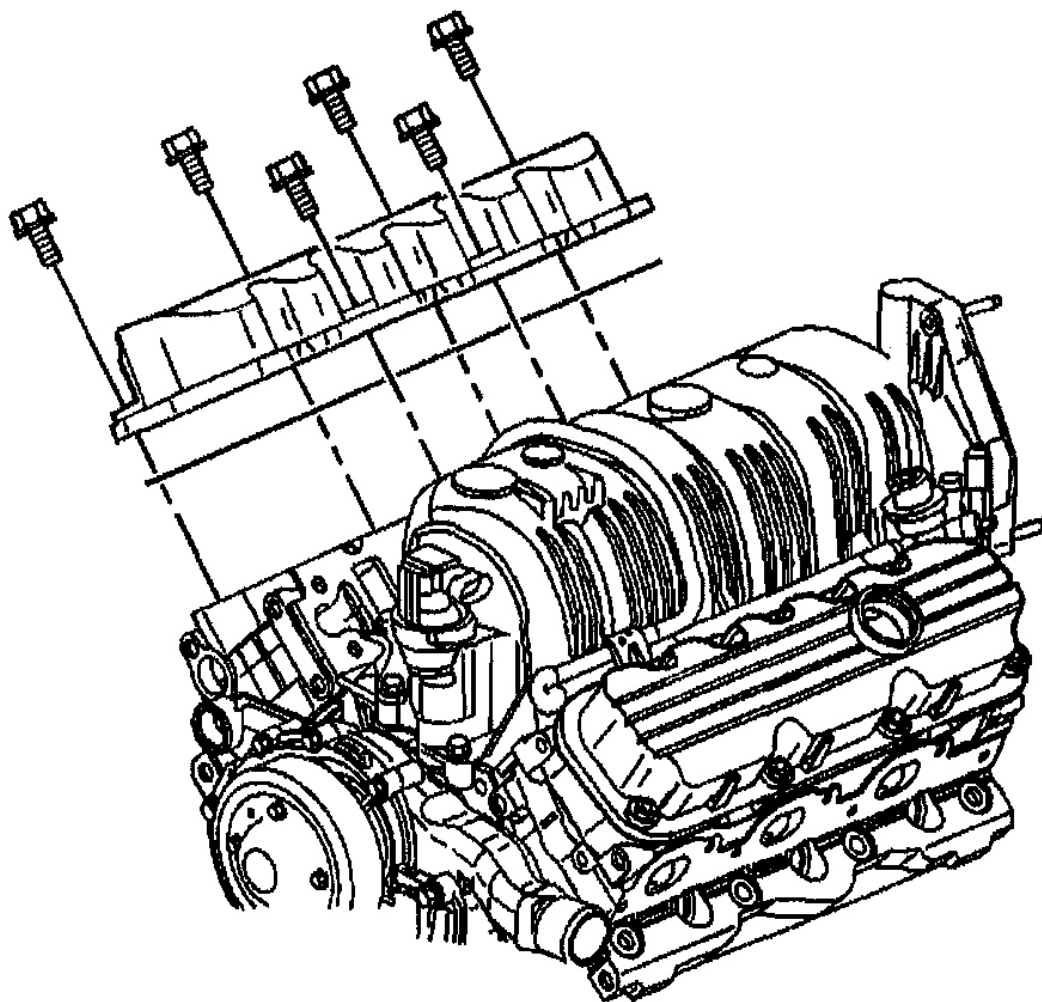
Fig. 81: Right Side Lift Bracket

Courtesy of GENERAL MOTORS CORP.

13. Remove the right side valve rocker arm cover bolts.

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

14. Remove the right side valve rocker arm cover.
15. Remove the right side valve rocker arm cover gasket.
16. Clean the valve rocker arm cover mating surface.
17. Clean the valve rocker arm cover bolts of all thread locking adhesive.



G01807318

Fig. 82: Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the new valve rocker arm cover gasket. Make sure that the valve rocker arm cover gasket is seated properly in the valve rocker arm cover groove.
2. Install the right side valve rocker arm cover.
3. Apply thread lock compound GM P/N 1234593 or equivalent to the valve rocker arm cover bolt threads.
4. Install the right valve rocker arm cover bolts. Tighten the right side valve rocker arm cover bolts to 10 N.m (89 in lbs).
5. Install the right side lift bracket, nut and bolt. Tighten the right side lift bracket nut and bolt to 30 N.m (22

ft lbs).

6. Install the fuel injector sight shield bracket to the exhaust manifold studs.
7. Install the fuel injector sight shield bracket nuts. Tighten the fuel injector sight shield bracket nuts to 30 N.m (22 ft lbs).
8. Install the right side spark plug wires to the spark plugs.
9. Carefully release the **J 41131** . Return the engine to the proper position.
10. Install the right and left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left** .
11. Install the AIR pipe, if necessary.
12. Install the AIR valve, if equipped.
13. Install the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
14. Install the air inlet duct to the throttle body.
15. Connect the intake air temperature (IAT) sensor electrical connector.
16. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
17. Connect the negative battery cable.
18. Check and fill crankcase as necessary
19. Inspect for oil leaks.

VALVE ROCKER ARM & PUSH ROD - REPLACEMENT

Tools Required

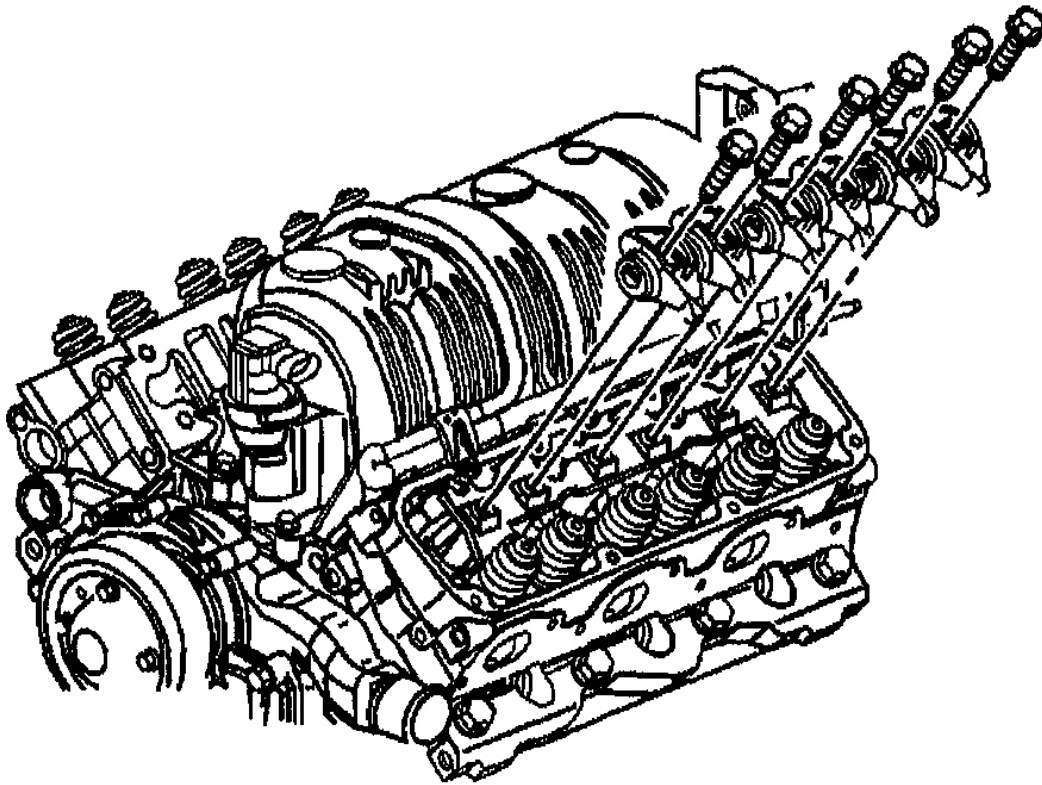
J 36660-A Torque Angle Meter

Removal Procedure

1. Remove the valve rocker arm covers. Refer to **Valve Rocker Arm Cover - Replacement - Left** or **Valve Rocker Arm Cover - Replacement - Right** .
2. Remove the valve rocker arm bolts.

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

3. Remove the valve rocker arms.

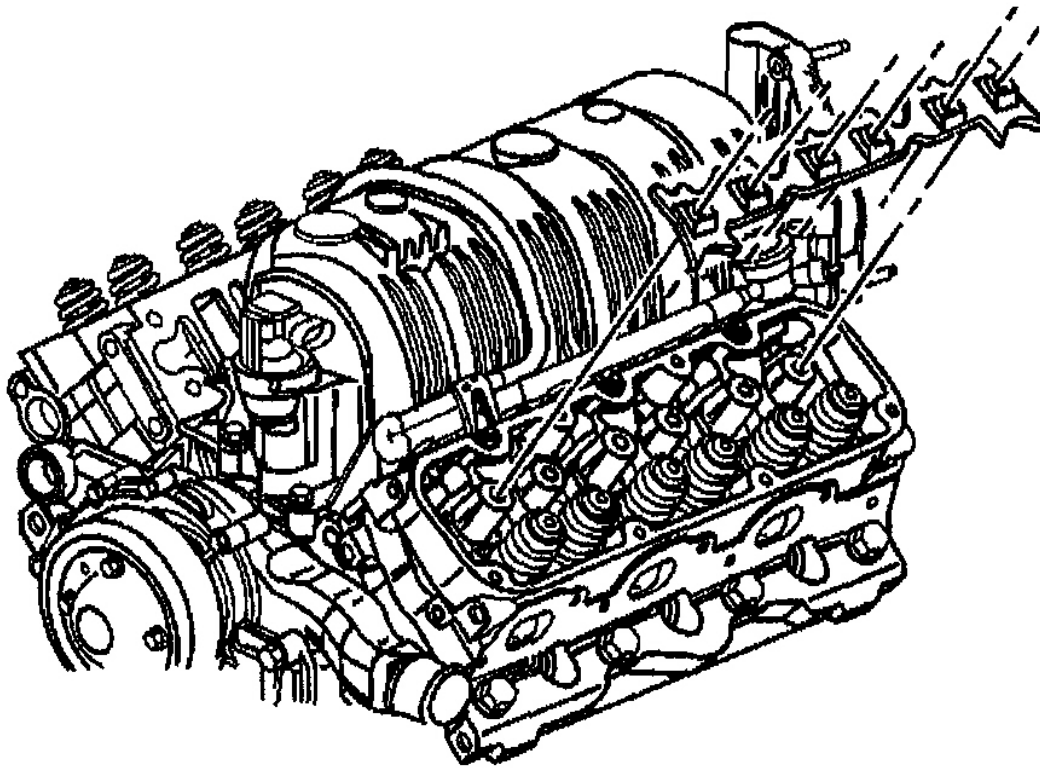


G01807322

Fig. 83: Valve Rocker Arms

Courtesy of GENERAL MOTORS CORP.

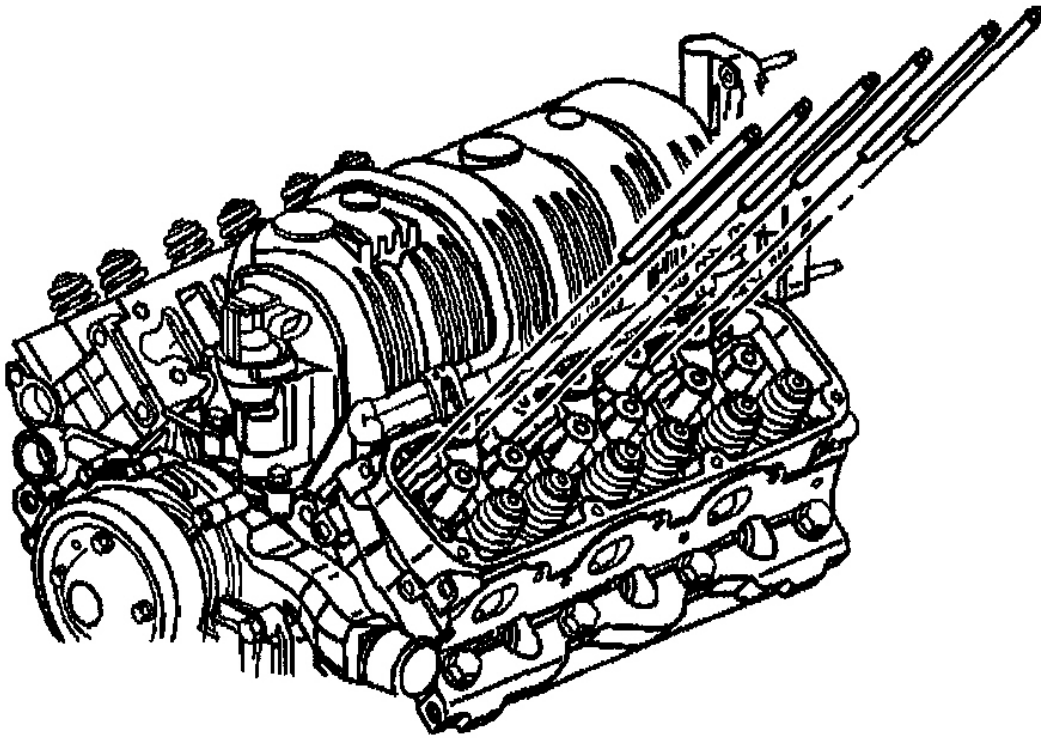
4. Remove the valve rocker arm guide plate if all of the rocker arms are removed.



G01807323

Fig. 84: Valve Rocker Arm Guide Plate
Courtesy of GENERAL MOTORS CORP.

5. Remove the push rods.



G01807324

Fig. 85: Push Rods

Courtesy of GENERAL MOTORS CORP.

6. Clean the push rods, the valve rocker arms, the bolts, and the guide plates in a suitable solution.
7. Clean the valve rocker arm bolts of all thread adhesive.

Installation Procedure

1. Use compressed air in order to blow oil out of the tapped holes in the cylinder head.
2. Lubricate the ends of the push rods with new engine oil. Install the push rods to the same position the push rods was removed from.
3. Install the valve rocker arm guide plates.
4. Install the valve rocker arms.
5. Apply GM P/N 12345493, (Canadian P/N 10953488) threadlocker or equivalent to the rocker arm bolt threads
6. Install the rocker arm bolts.
 - 6.1. Tighten the bolts to 15 N.m (11 ft lbs).
 - 6.2. Use the **J 36660-A** to rotate the bolts an additional 90 degrees.

7. Install the valve rocker arm covers. Refer to **Valve Rocker Arm Cover - Replacement - Left** or **Valve Rocker Arm Cover - Replacement - Right** .
8. Inspect the valve train for noise.

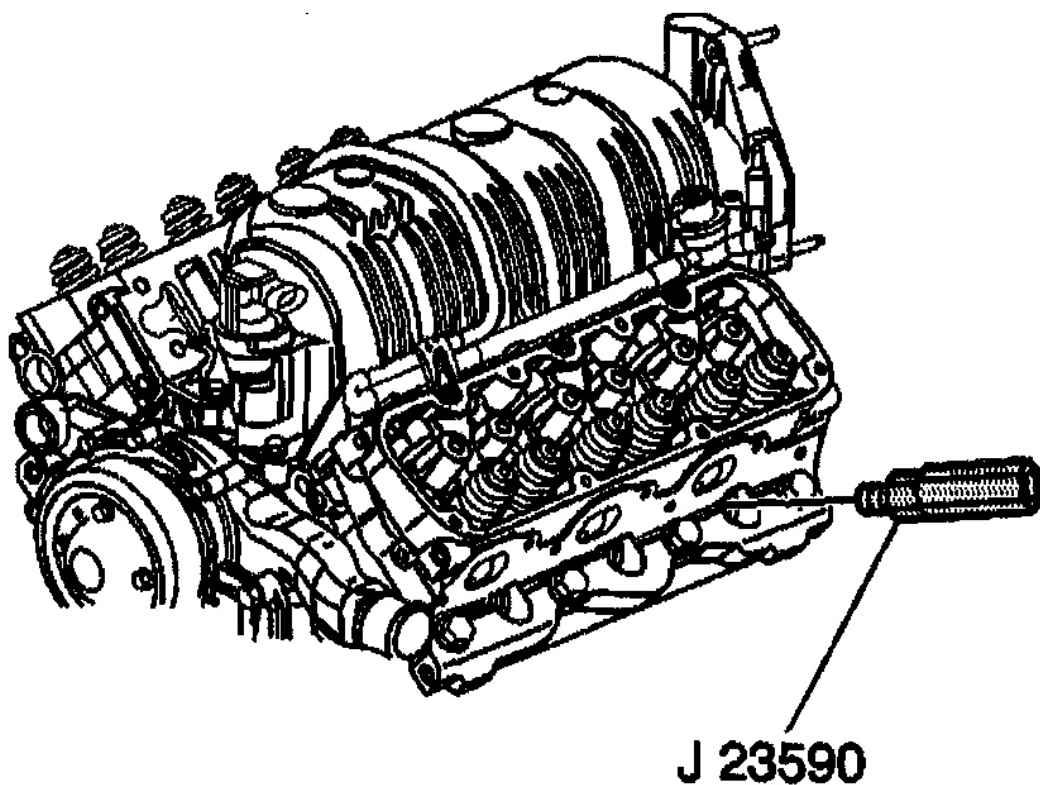
VALVE STEM OIL SEAL & VALVE SPRING - REPLACEMENT

Tools Required

- **J 23590** Spark Plug Port Adapter
- **J 38606** Valve Spring Compressor
- **J 42863** Valve Stem Seal Installer

Removal Procedure

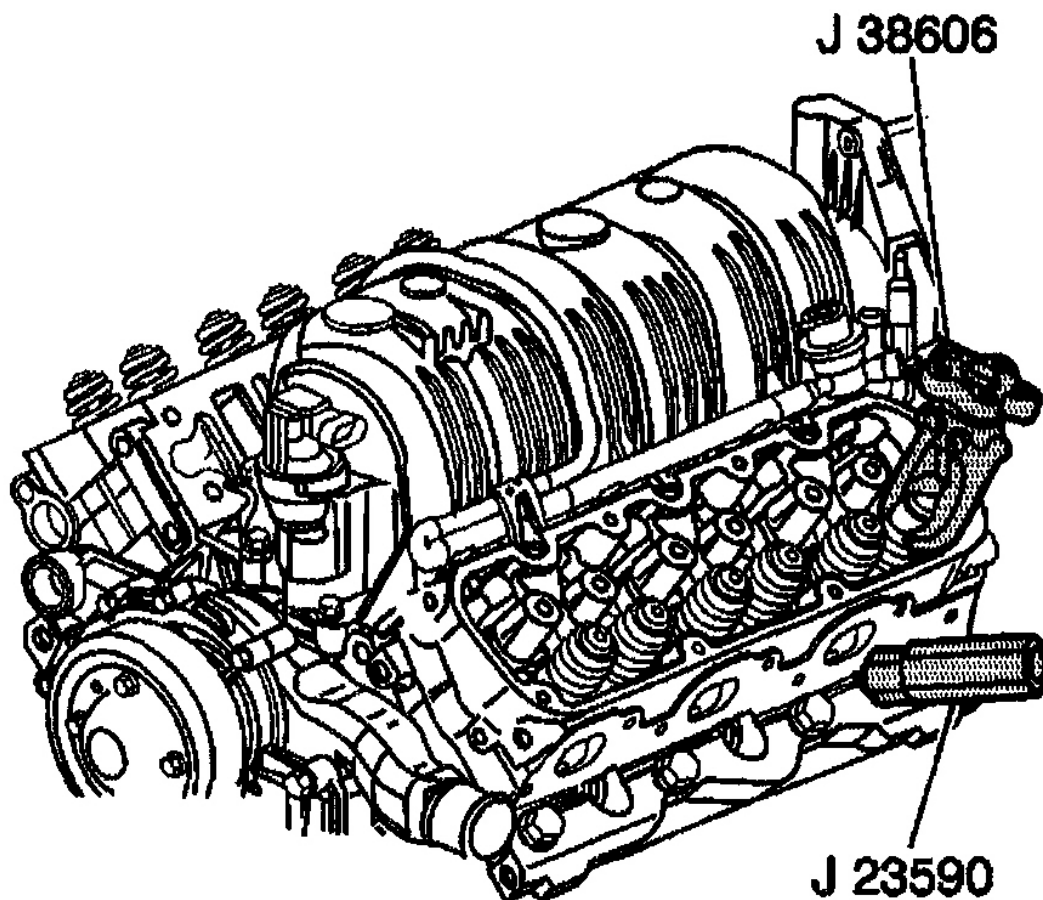
1. Remove the valve rocker arm covers. Refer to **Valve Rocker Arm Cover - Replacement - Left** or **Valve Rocker Arm Cover - Replacement - Right** .
2. Remove the rocker arms and the push rods. Refer to **Valve Rocker Arm & Push Rod - Replacement**.
3. Remove the spark plug.



G01807328

Fig. 86: Installing Spark Plug Port Adapter
Courtesy of GENERAL MOTORS CORP.

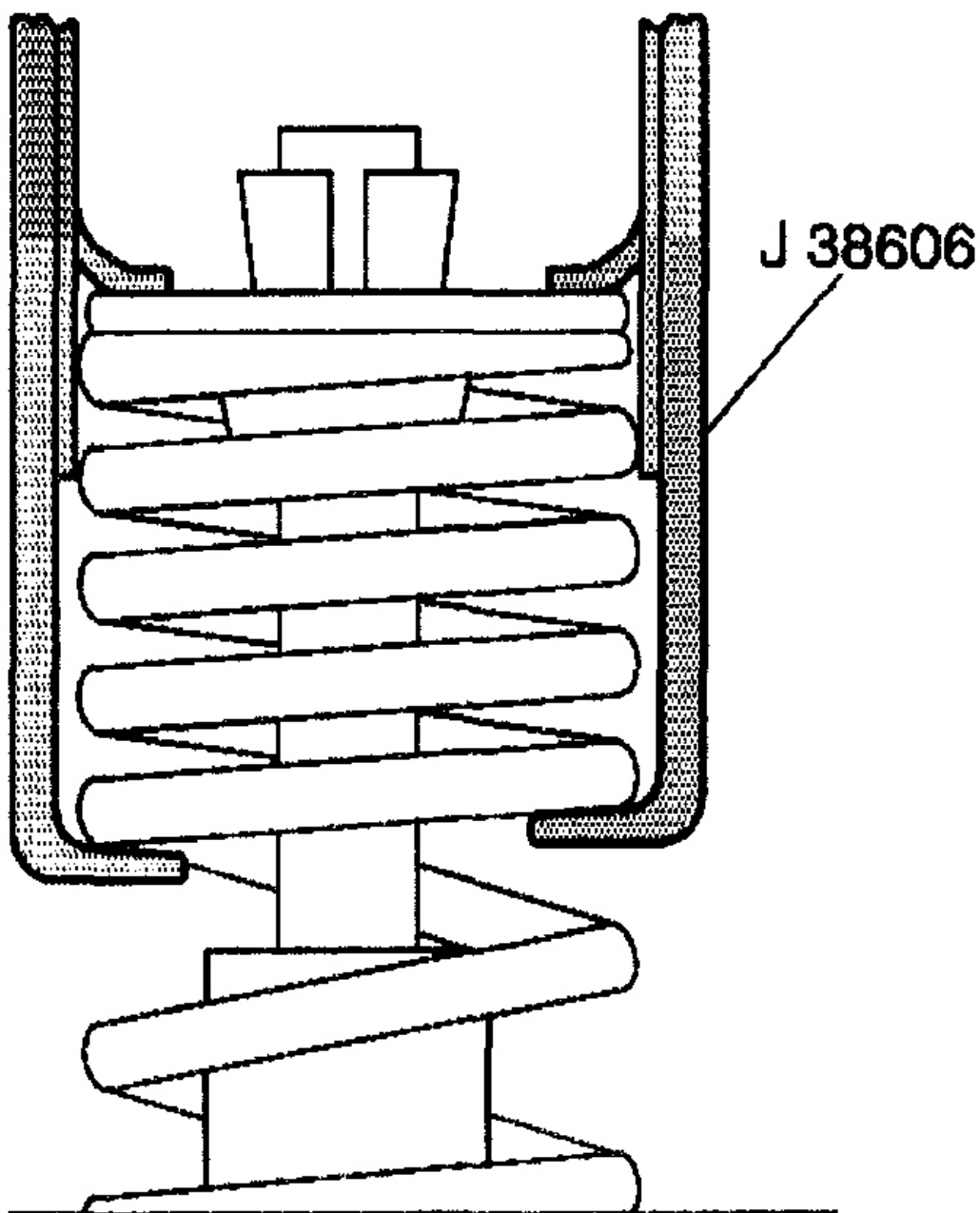
4. Install the **J 23590** to the spark plug port and apply compressed air in order to hold the valves closed.
5. Install the **J 38606** on the valve spring.



G01807329

Fig. 87: Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

6. Compress the valve spring using the J 38606 .
7. Remove the valve locks.
8. Remove the valve spring and cap.
9. Remove the valve stem oil seal.
10. Inspect the valve spring for bent, cracked or broken parts. Replace the valve spring if necessary. Refer to **CYLINDER HEAD - CLEANING & INSPECTION** .



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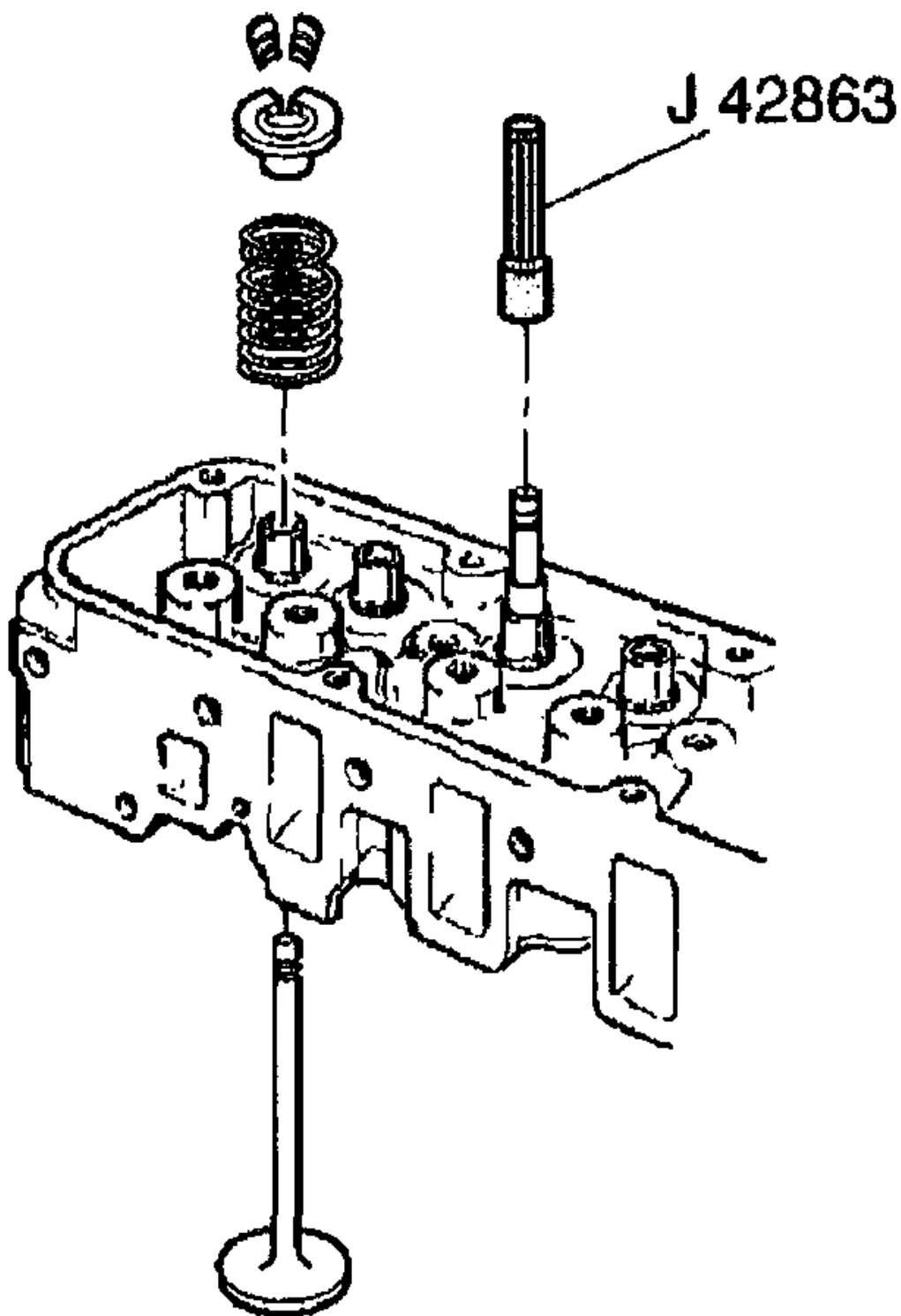
Fig. 88: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Place the oil seal over the stem until the seal begins to contact the valve guide.

Important: The color of the - Replacement seal may not be the same color as the original seal. Install the seals in their correct location based on GM part and package description. Make sure that the seal is fully seated on the valve guide.

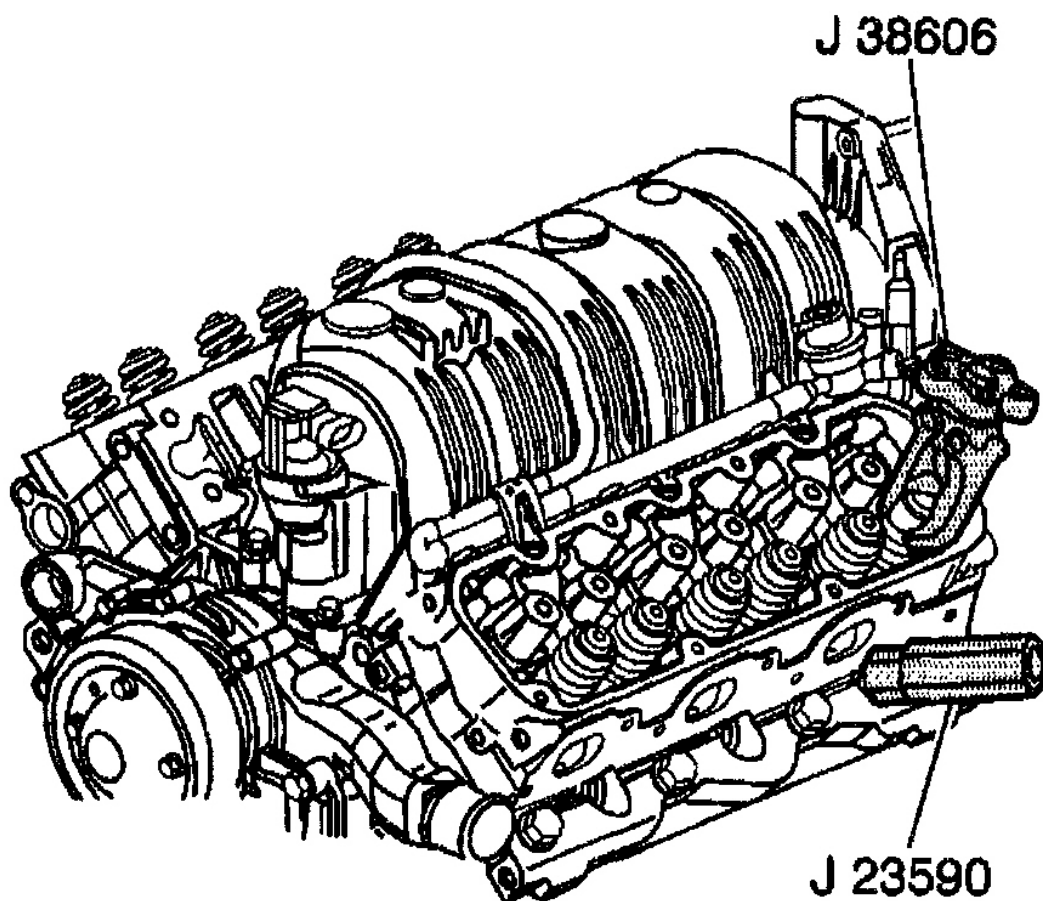
2. Use hand pressure to push the valve stem oil seal over the valve guide. Use the **J 42863** until the tool bottoms on the valve spring seat.



G01807331

Fig. 89: Valve Stem Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

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



G01807332

Fig. 90: Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

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

Important: Make sure that the valve locks are seated.

8. Release the air pressure and remove the **J 23590** .
9. Install the spark plug.
10. Install the push rods and the valve rocker arms. Refer to **Valve Rocker Arm & Push Rod - Replacement**.
11. Install the valve rocker arm covers. Refer to **Valve Rocker Arm Cover - Replacement - Left** or **Valve Rocker Arm Cover - Replacement - Right** .

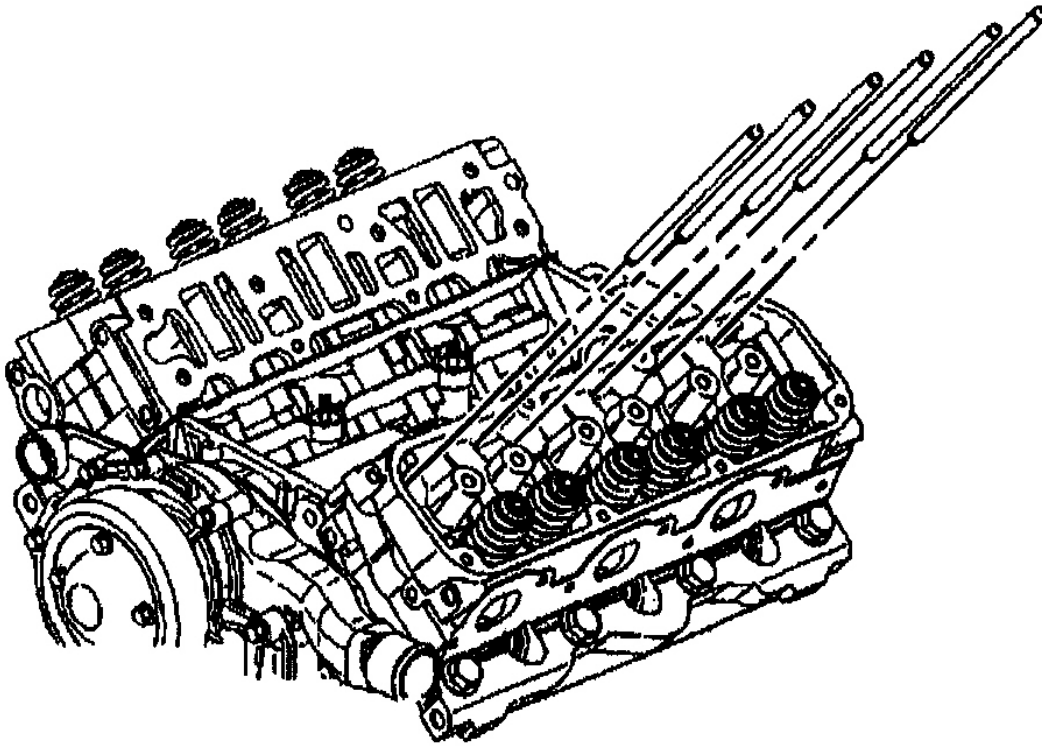
VALVE LIFTER - REPLACEMENT

Removal Procedure

1. Remove the valve rocker arm covers. Refer to **Valve Rocker Arm Cover - Replacement - Left** or **Valve Rocker Arm Cover - Replacement - Right** .
2. Remove the lower intake manifold. Refer to **Intake Manifold - Replacement - Lower**.

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

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



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Fig. 91: Push Rods

Courtesy of GENERAL MOTORS CORP.

4. Remove the valve lifter guide bolts.
5. Remove the valve lifter guides.
6. Remove the valve lifters.
7. Clean all the gasket mating surfaces.
8. Clean the valve train parts.
9. Inspect the valve lifters and cam lobes for wear. Refer to **VALVE LIFTERS & GUIDES - CLEANING & INSPECTION**.

Installation Procedure

1. Dip the valve lifters in prelube GM P/N 12345501, (Canadian P/N 992704) or equivalent before installation.
2. Install the valve lifters to the same position the valve lifters was removed from.
3. Install the valve lifter guides.
4. Install the valve lifter guide bolts. Tighten the bolts to 30 N.m (22 ft lbs).

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

CRANKSHAFT BALANCER - REPLACEMENT

Tools Required

- **J 37096** Flywheel Holder
- **J 38197-A** Crankshaft Balancer Puller
- **J 36660-A** Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the drive belt. Refer to **Drive Belt - Replacement**.
3. Raise and support the vehicle.
4. Remove the right front tire and wheel.
5. Remove the right engine splash shield retainers and the engine splash shield.
6. Remove the torque converter cover.
7. Install the **J 37096** to hold the flywheel.

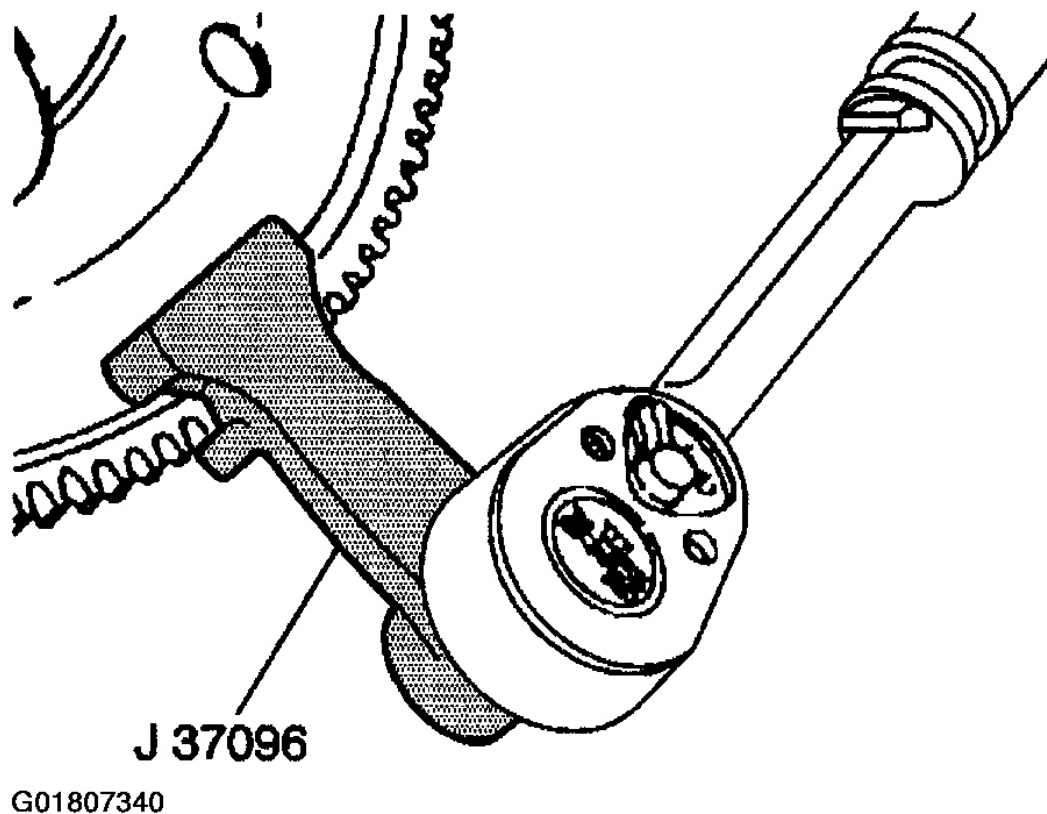


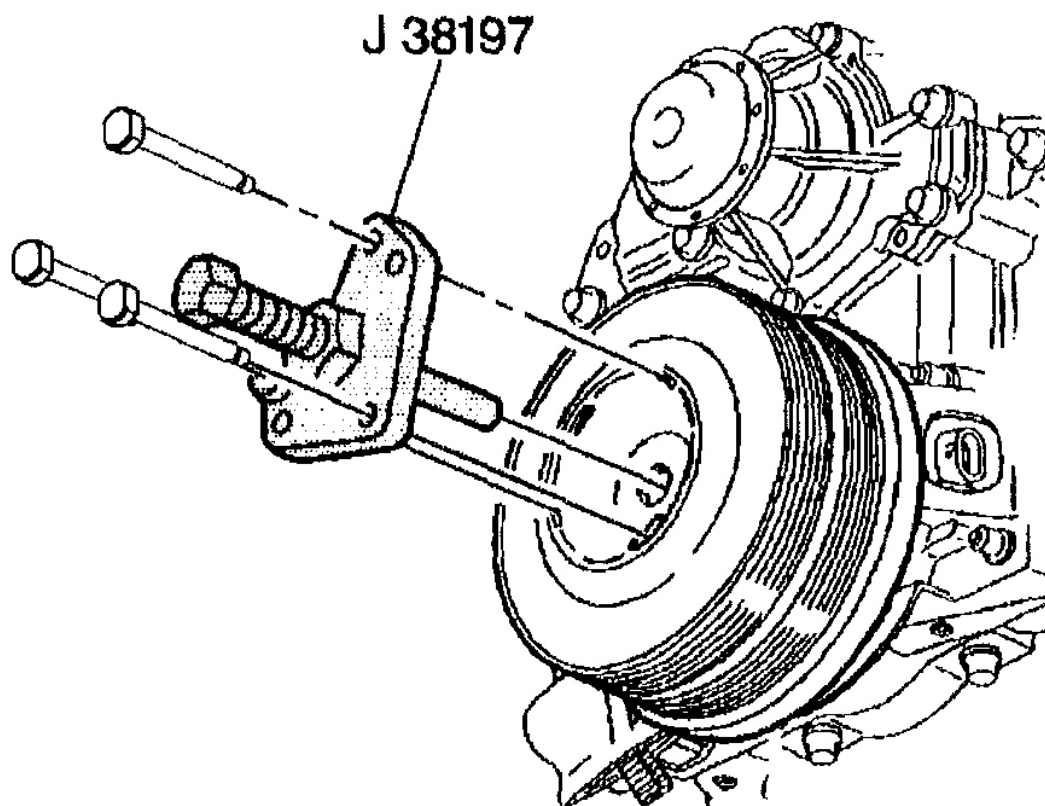
Fig. 92: Flywheel Holder

Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft balancer retaining bolt.

Important: DO NOT separate the crankshaft pulley from the crankshaft balancer. Service the crankshaft pulley and the crankshaft balancer as an assembly.

9. Install the J 38197-A .
10. Remove the crankshaft balancer.
11. Remove the J 38197-A .



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Fig. 93: Crankshaft Balancer Puller
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Coat the engine front cover seal contact area on the crankshaft balancer, and the seal surface with engine oil.
2. Install the crankshaft balancer.
3. Install the crankshaft balancer bolt. Use the **J 37096** to keep the flywheel from turning.
 - 3.1. Tighten the bolt to 150 N.m (111 ft lbs).
 - 3.2. Use the **J 36660-A** to rotate the bolt an additional 76 degrees.
4. Remove the **J 37096**.
5. Install the torque converter cover.
6. Install the right engine splash shield and the engine splash shield retainers.
7. Install the right front tire and wheel.
8. Lower the vehicle.

9. Install the drive belt. Refer to **Drive Belt - Replacement**.
10. Connect the negative battery cable.
11. Perform the CKP system variation learn procedure. Refer to **CRANKSHAFT POSITION SENSOR**.

CRANKSHAFT FRONT OIL SEAL - REPLACEMENT

Tools Required

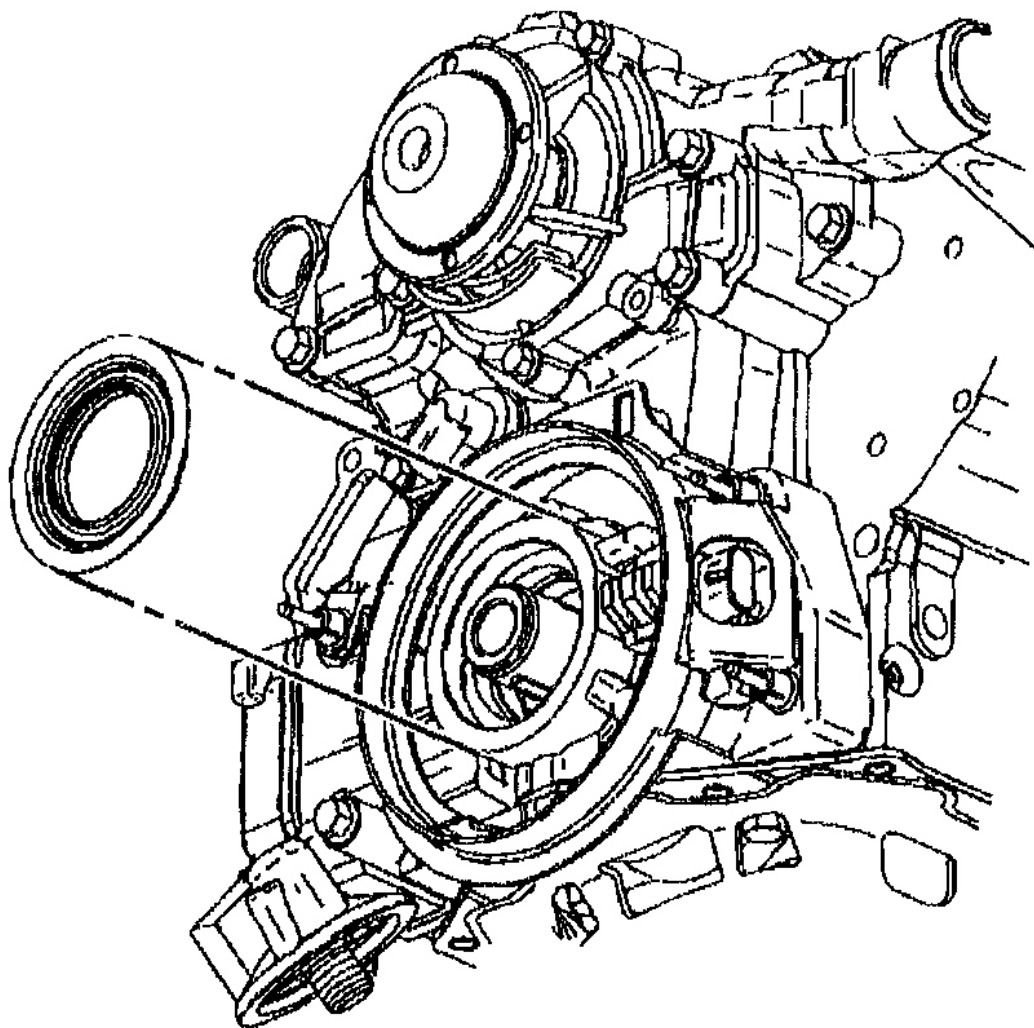
J 35354-A Seal Installer

Removal Procedure

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

Important: Be careful not to damage the crankshaft.

2. Pry out the crankshaft front oil seal with a suitable tool such as a large screwdriver. Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.



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Fig. 94: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Inspect the crankshaft balancer and engine front cover for scratches.

Installation Procedure

1. Install the crankshaft front oil seal in the engine front cover using the **J 35354-A**.
2. Tighten the bolt until the crankshaft front oil seal is seated in the engine front cover.
3. Remove the **J 35354-A**.
4. Install the crankshaft balancer.

5. Inspect for leaks.

ENGINE FRONT COVER - REPLACEMENT

Tools Required

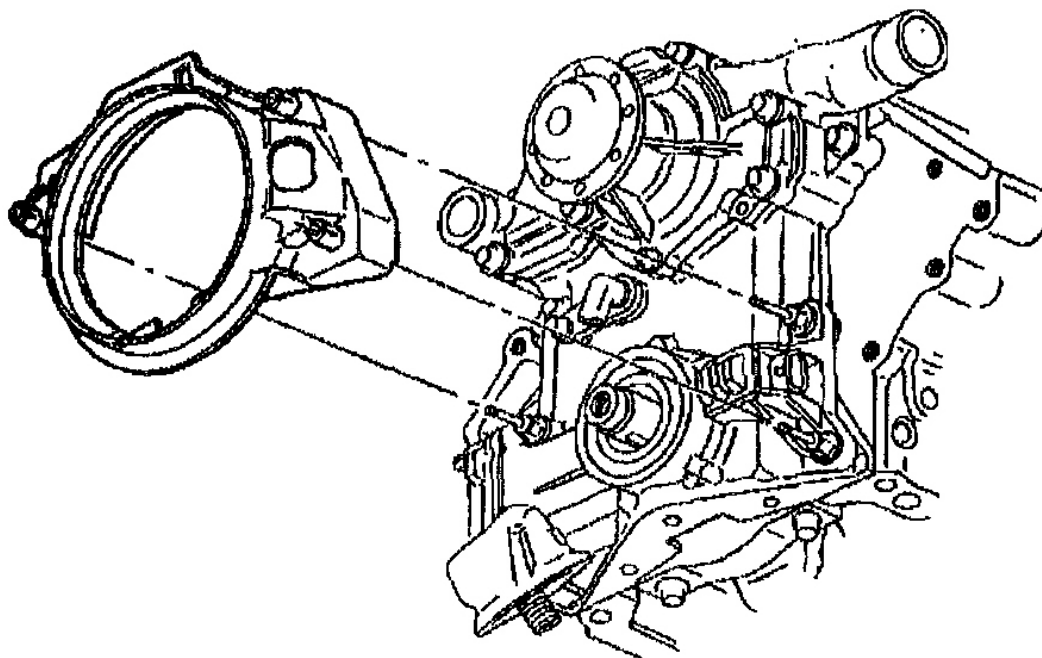
J 36660-A Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Drain the engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
4. Drain the cooling system.
5. Lower the vehicle.
6. Loosen the water pump pulley bolts.
7. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
8. Remove the water pump pulley.
9. Remove the crankshaft balancer. Refer to **Crankshaft Balancer - Replacement**.

Important: Be careful not to damage the crankshaft.

10. Pry out the crankshaft front oil seal with a suitable tool such as a large screwdriver. Use care to avoid damaging the crankshaft front oil seal bore or the crankshaft front oil seal contact surfaces.



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Fig. 95: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

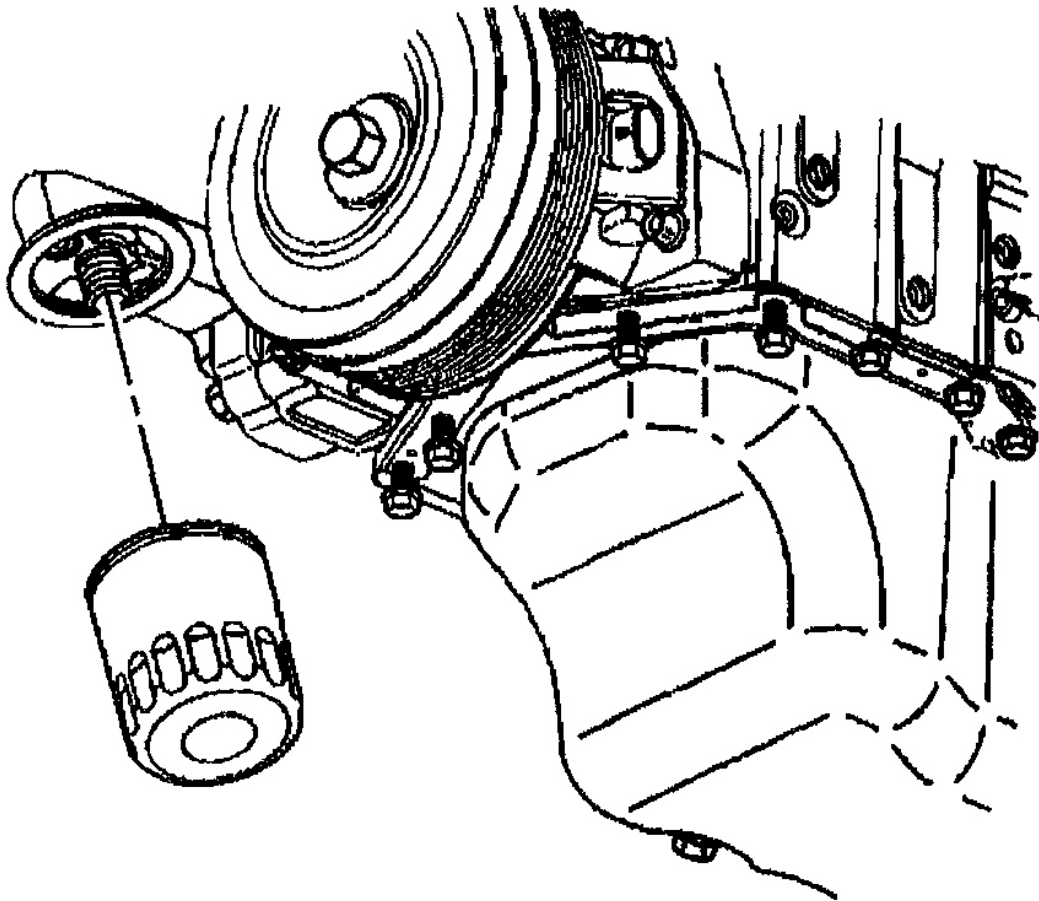
11. Disconnect the electrical connectors from the following:
 - Camshaft position (CMP) sensor.
 - Crankshaft position (CKP) sensor.
 - Oil pressure sensor.
12. Remove the crankshaft position sensor shield.
13. Lower the vehicle.
14. Remove the radiator outlet hose from the water pump.
15. Install the engine support fixture. Refer to **Engine Support Fixture**.
16. Remove the engine mount bracket for oil pan access. Refer to **Engine Mount & Bracket - Replacement**.

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

17. Disconnect the oil level sensor electrical connector.
18. Remove the oil level sensor.
19. Remove the oil pan-to-engine front cover bolts.

Important : DO NOT remove the remaining oil pan bolts.

20. Loosen the remaining oil pan bolts to gain access for the engine front cover removal.
21. Remove the oil filter.

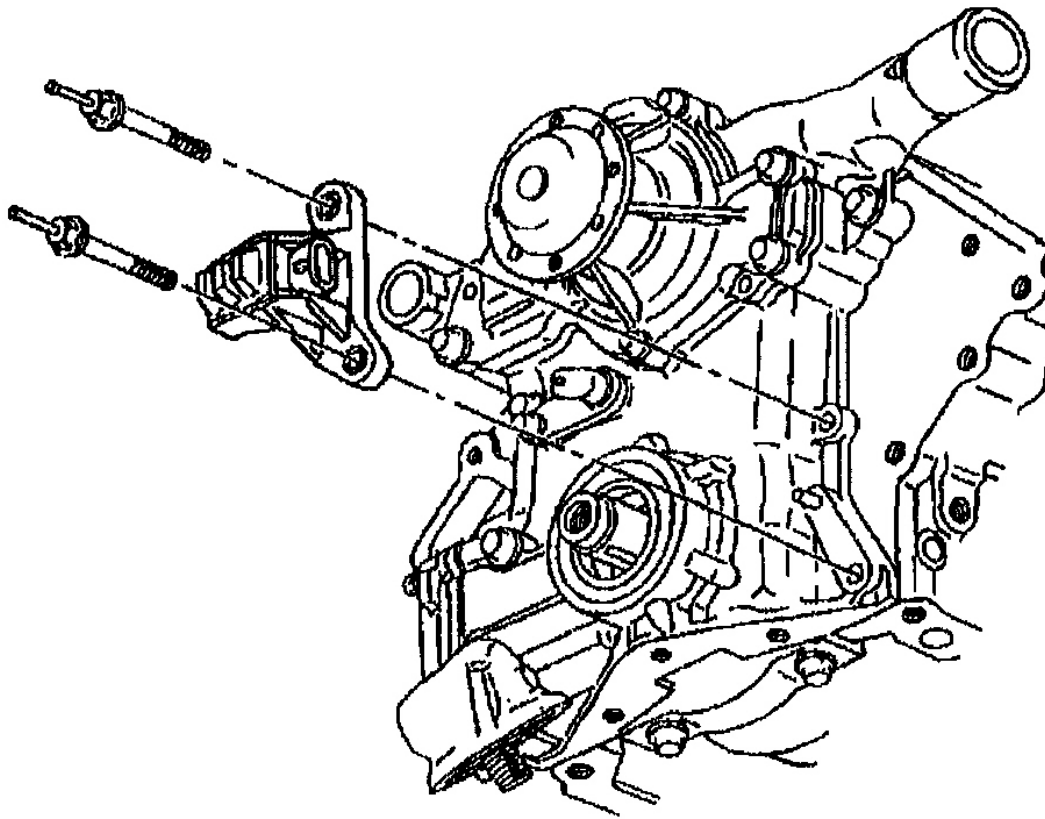


G01807347

Fig. 96: Oil Filter

Courtesy of GENERAL MOTORS CORP.

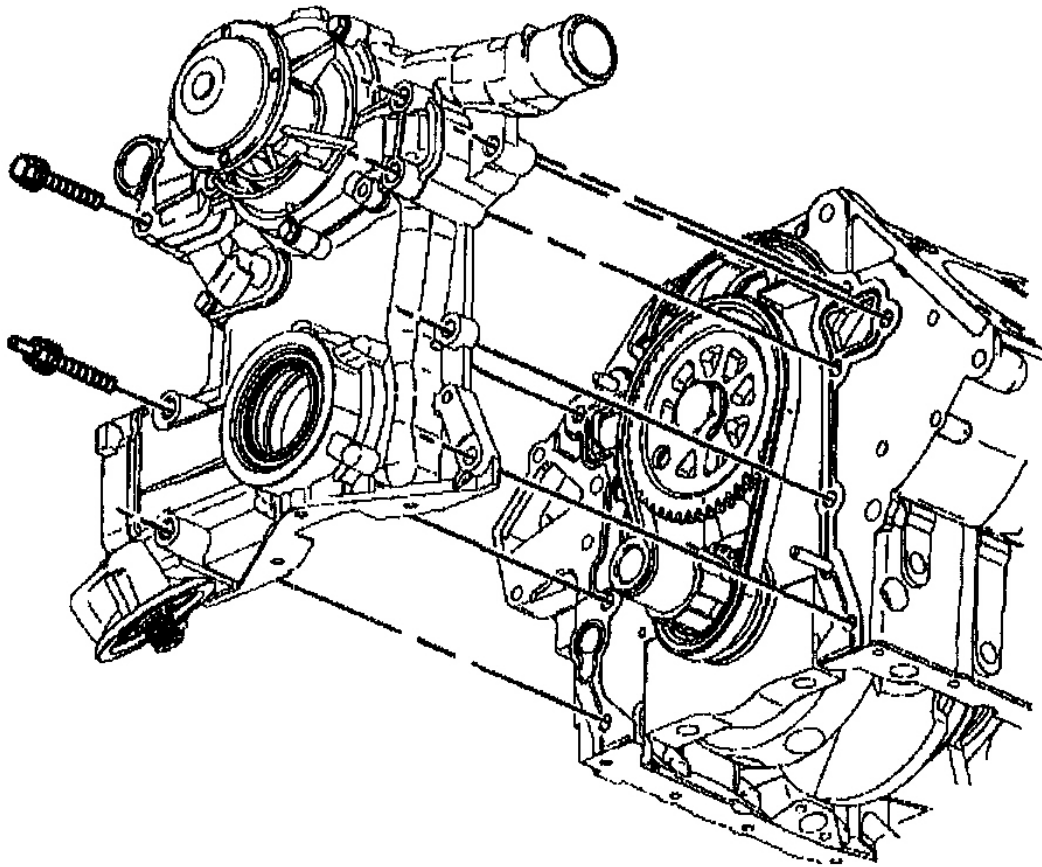
22. Remove the crankshaft position sensor.



G01807348

Fig. 97: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

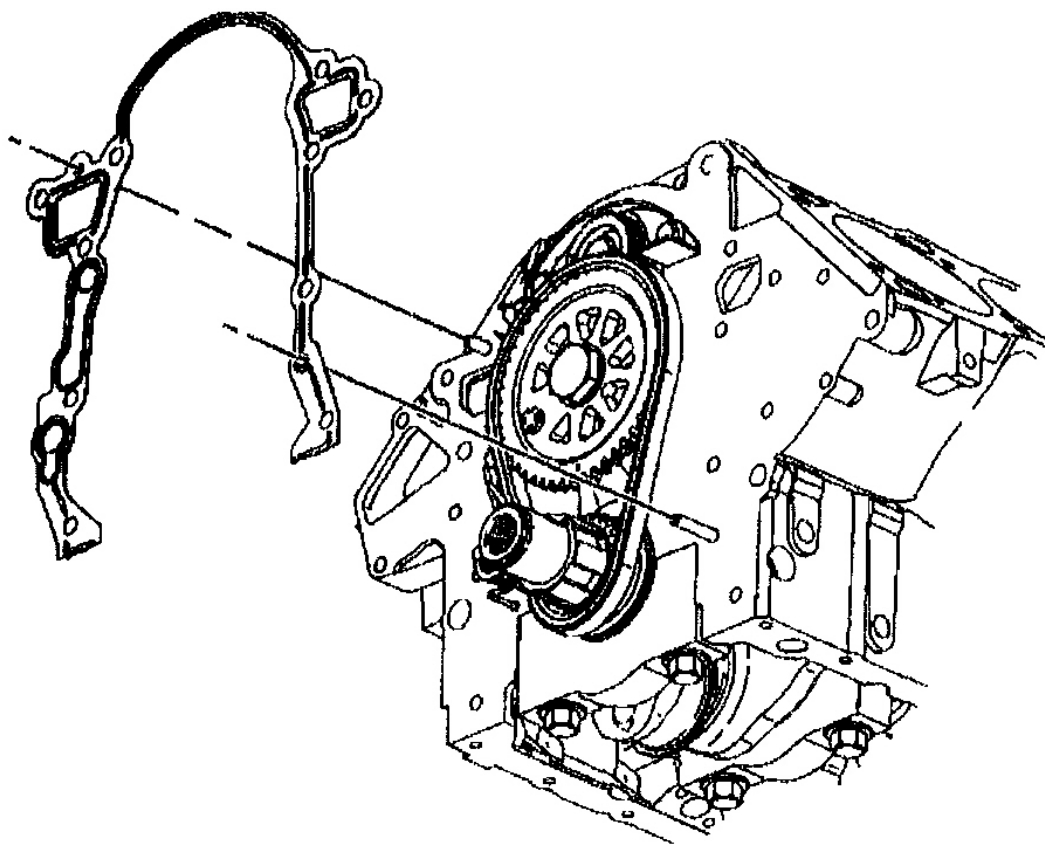
23. Remove the engine front cover bolts.
24. Remove the engine front cover with the oil filter adapter as one assembly.



G01807349

Fig. 98: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

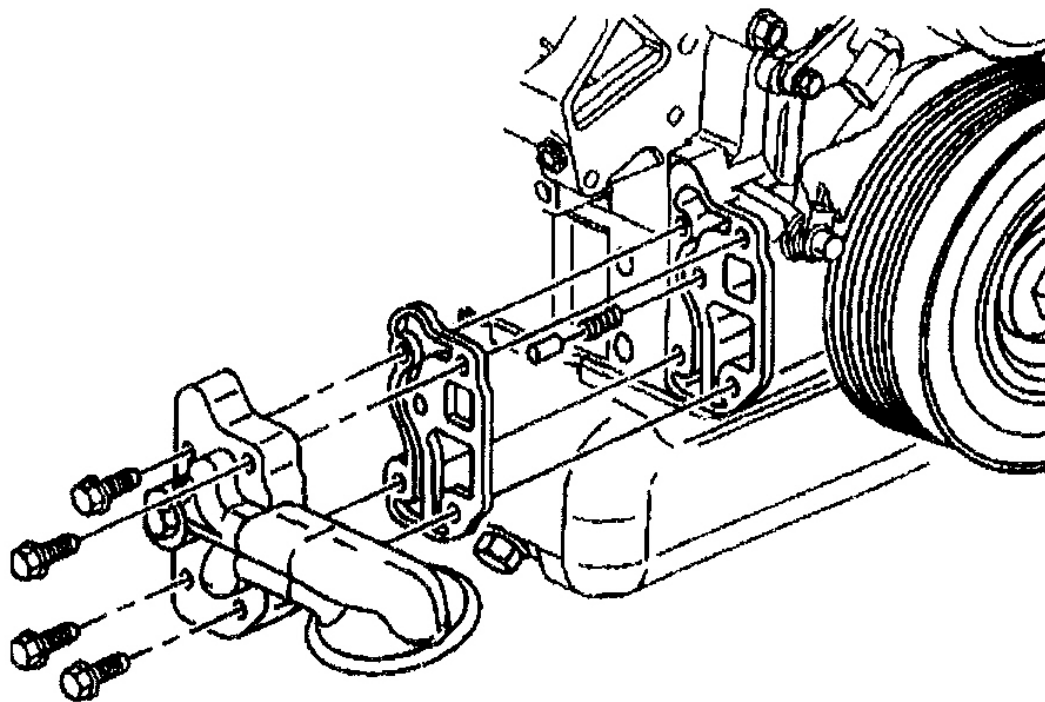
25. Remove the engine front cover gasket.



G01807350

Fig. 99: Engine Front Cover Gasket
Courtesy of GENERAL MOTORS CORP.

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

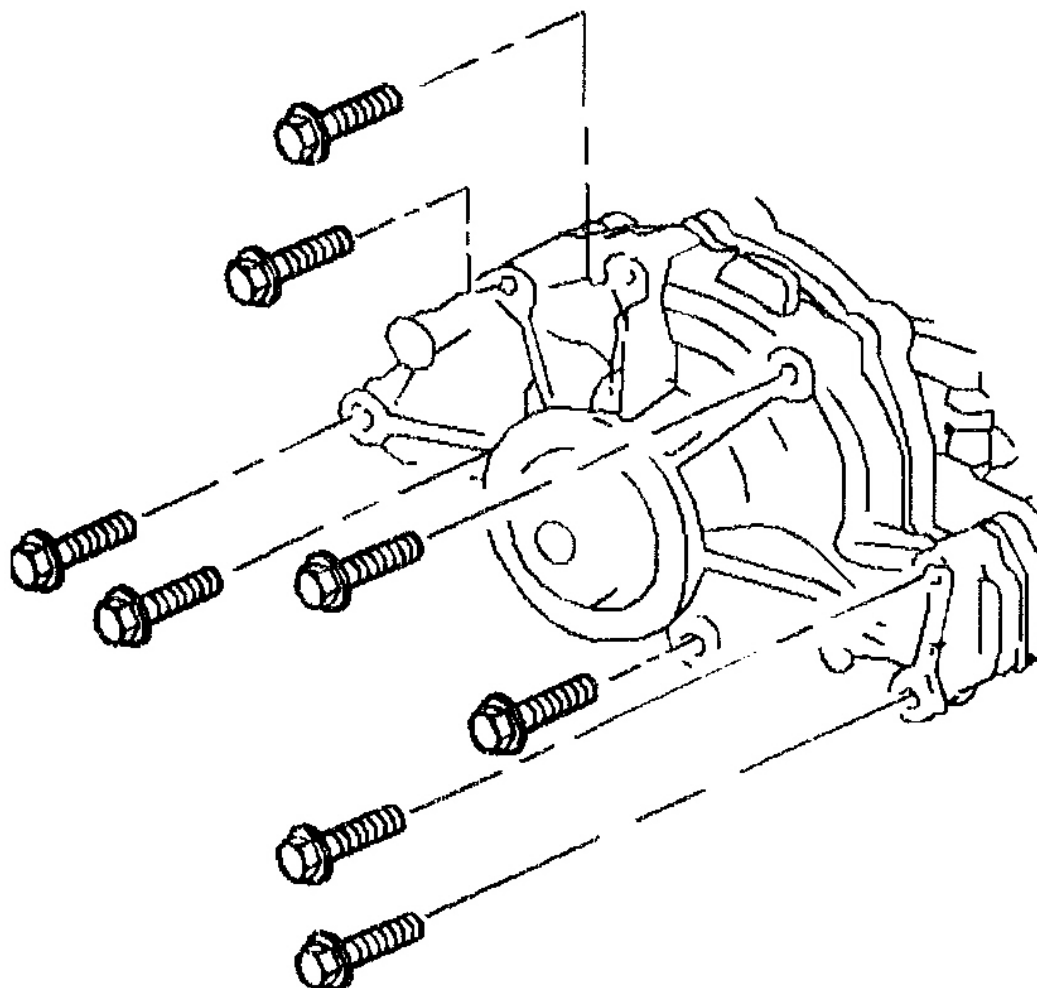


G01807351

Fig. 100: Oil Filter Adapter

Courtesy of GENERAL MOTORS CORP.

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

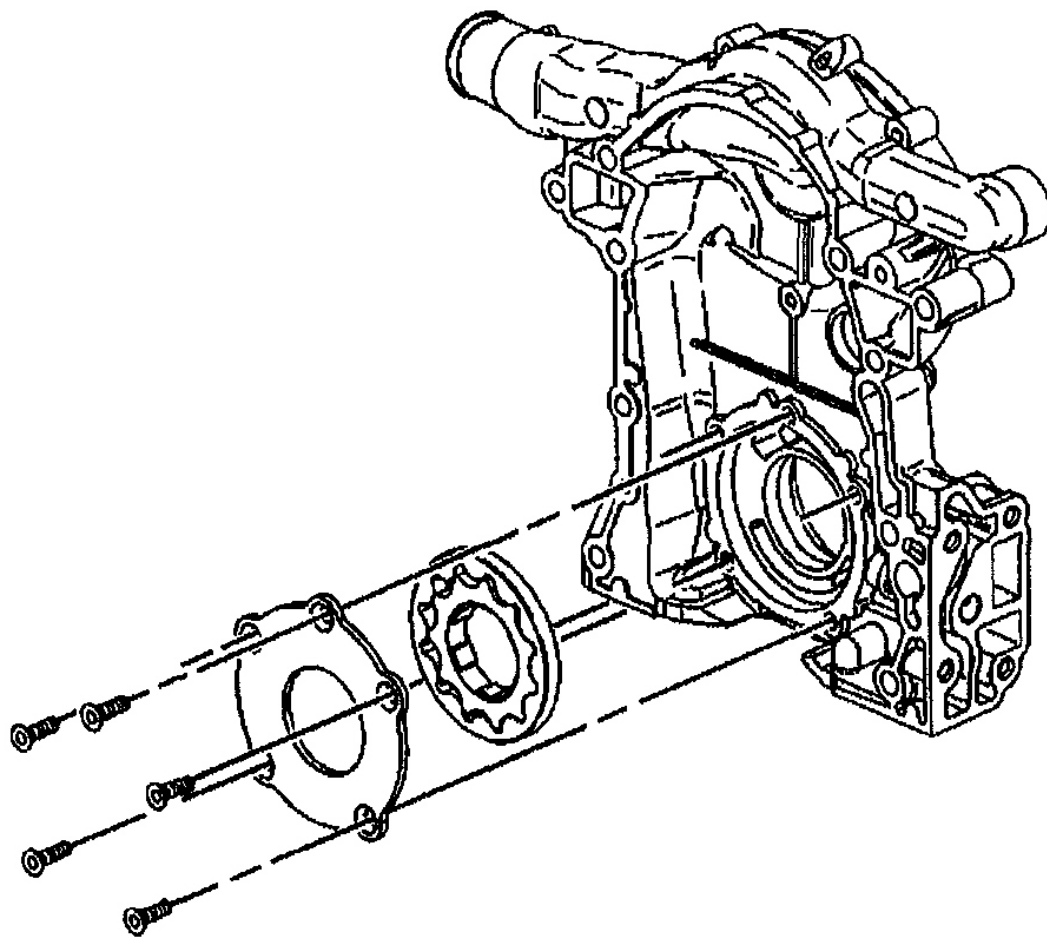


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Fig. 101: Water Pump

Courtesy of GENERAL MOTORS CORP.

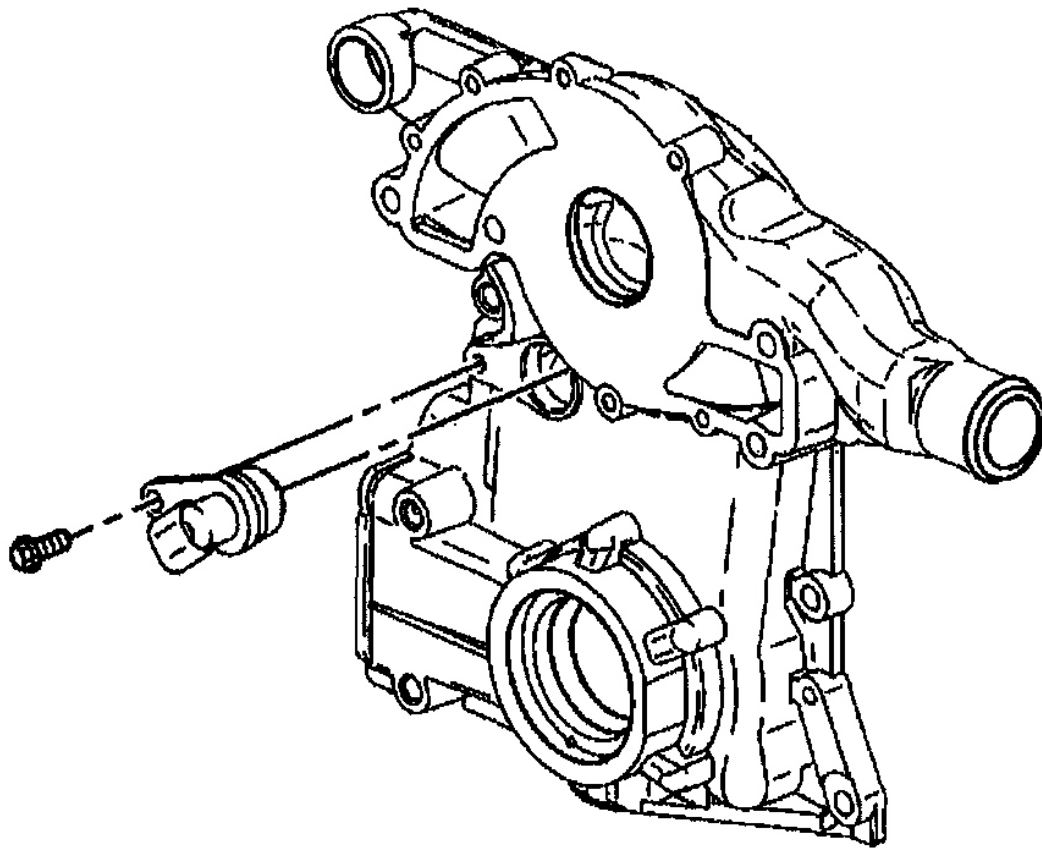
28. If replacing the engine front cover, remove the oil pump cover and gear set from the engine front cover. Refer to **Oil Pump Cover & Gear Set - Replacement**.
29. Inspect the oil pump cover and gear set. Refer to **OIL PUMP - CLEANING & INSPECTION**.



G01807353

Fig. 102: Oil Pump Cover & Gear Set
Courtesy of GENERAL MOTORS CORP.

30. If replacing the engine front cover, remove the camshaft position sensor from the engine front cover.



G01807354

Fig. 103: Camshaft Position Sensor

Courtesy of GENERAL MOTORS CORP.

31. Inspect the timing chain for overall in and out movement. Maximum movement is 25.4 mm (1 in). Refer to **TIMING CHAIN & SPROCKETS - CLEANING & INSPECTION (L36)** or **TIMING CHAIN & SPROCKETS - CLEANING & INSPECTION (L67)**.
32. Inspect the sprockets for wear.
33. Inspect the oil pan gasket. Replace the oil pan gasket if necessary.
34. Clean the engine front cover mating surfaces.

Installation Procedure

1. If replacing the engine front cover, install the camshaft position sensor.
2. Install the camshaft position sensor bolt. Tighten the bolt to 10 N.m (89 in lbs).
3. If replacing the engine front cover, install the oil pump cover and gear set to the engine front cover. Refer to **Oil Pump Cover & Gear Set - Replacement**.

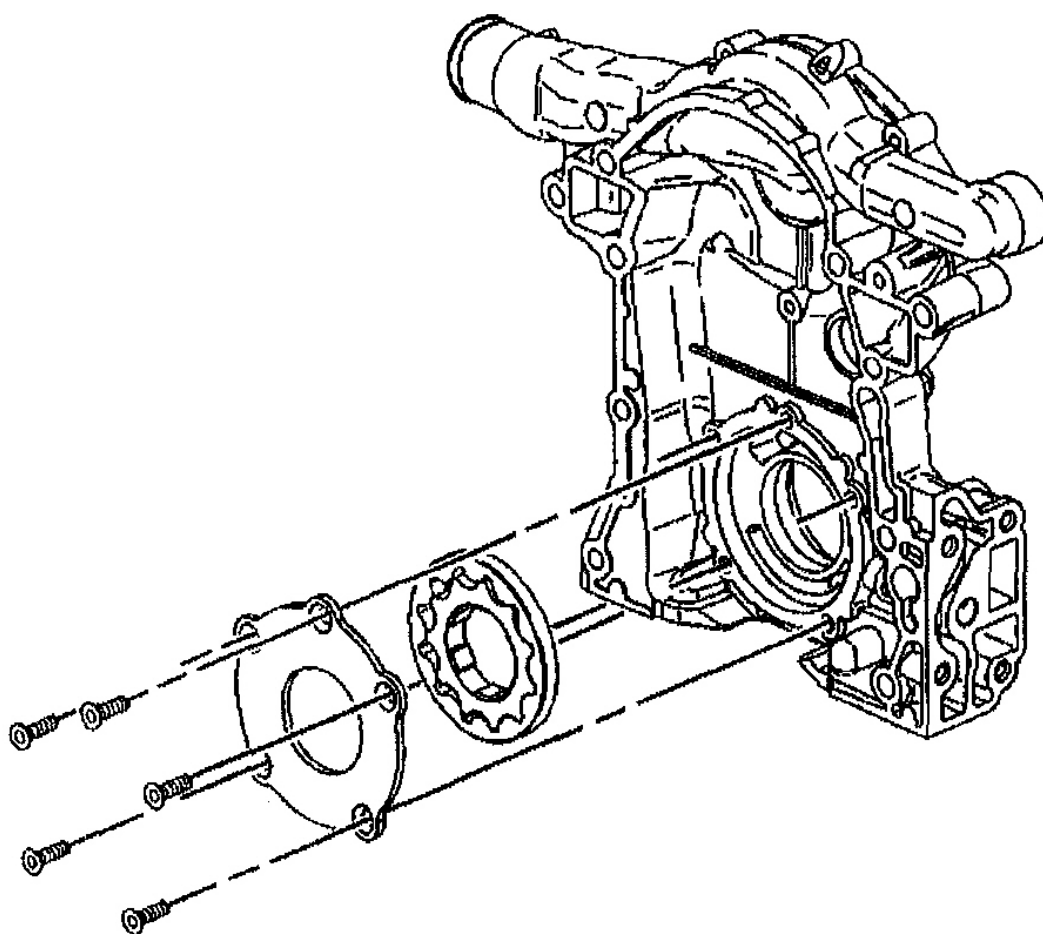
4. If replacing the engine front cover, install the water pump to the engine front cover.
5. Install the long water pump bolts to the water pump. Tighten the long water pump bolts to 20 N.m (15 ft lbs).
6. Install the short water pump bolts to the water pump. Tighten the short water pump bolts to 15 N.m (11 ft lbs).
7. If replacing the engine front cover, install the oil filter adapter and pressure relief valve to the engine front cover.
8. Install the oil filter adapter bolts. Tighten the bolts to 30 N.m (22 ft lbs).
9. Install the new engine front cover gasket. Ensure that the sealing surfaces are not damaged.
10. Apply sealer GM P/N 12346004, (Canadian P/N 10953480) or equivalent to the bolt threads.
11. Align the cogs on the crankshaft sprocket with the cogs on the oil pump gear set in the engine front cover.
12. Install the engine front cover to the engine.
13. Install the engine front cover bolts (1-7).
 - 13.1. Tighten the bolts to 20 N.m (15 ft lbs).
 - 13.2. Use the **J 36660-A** to rotate the bolts an additional 40 degrees.
14. Install the crankshaft position sensor.
15. Install the crankshaft position sensor studs. Tighten the studs to 30 N.m (22 ft lbs).
16. Install the new crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal - Replacement**.
17. Install the oil pan-to-engine front cover bolts. Tighten the oil pan bolts to 14 N.m (125 in lbs).
18. Install the oil level sensor. Tighten the sensor to 20 N.m (15 ft lbs).
19. Connect the oil level sensor electrical connector.
20. Install the engine mount bracket. Refer to **Engine Mount & Bracket - Replacement**.
21. Install the water pump pulley and the bolts. Tighten the bolts to 13 N.m (116 in lbs).
22. Install the oil filter and the oil pan drain plug. Refer to **Engine Oil & Oil Filter - Replacement**.
23. Install the crankshaft position sensor shield.
24. Connect the electrical connectors to the following:
 - Oil pressure sensor
 - Crankshaft position (CKP) sensor.
 - Camshaft position (CMP) sensor.
25. Install the crankshaft balancer. Refer to **Crankshaft Balancer - Replacement**.
26. Lower the vehicle.
27. Install the radiator outlet hose.
28. Remove the engine support fixture.
29. Install the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
30. Fill the cooling system.
31. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
32. Connect the negative battery cable.
33. Inspect for leaks.

34. Perform the CKP system variation learn procedure. Refer to **CRANKSHAFT POSITION SENSOR** .

OIL PUMP COVER & GEAR SET - REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover - Replacement**.
2. Remove the oil pump cover screws.
3. Remove the oil pump cover.
4. Remove the oil pump gear set.
5. Inspect the oil pump gear set and housing. Refer to **OIL PUMP - CLEANING & INSPECTION** .



G01807366

Fig. 104: Oil Pump Gear Set & Housing
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Lubricate the oil pump gear set with petroleum jelly.
2. Install the oil pump gear set.
3. Pack the oil pump gears with petroleum jelly.
4. Install the oil pump cover.
5. Install the oil pump cover screws. Tighten the screws to 11 N.m (98 in lbs).
6. Install the engine front cover. Refer to **Engine Front Cover - Replacement**.

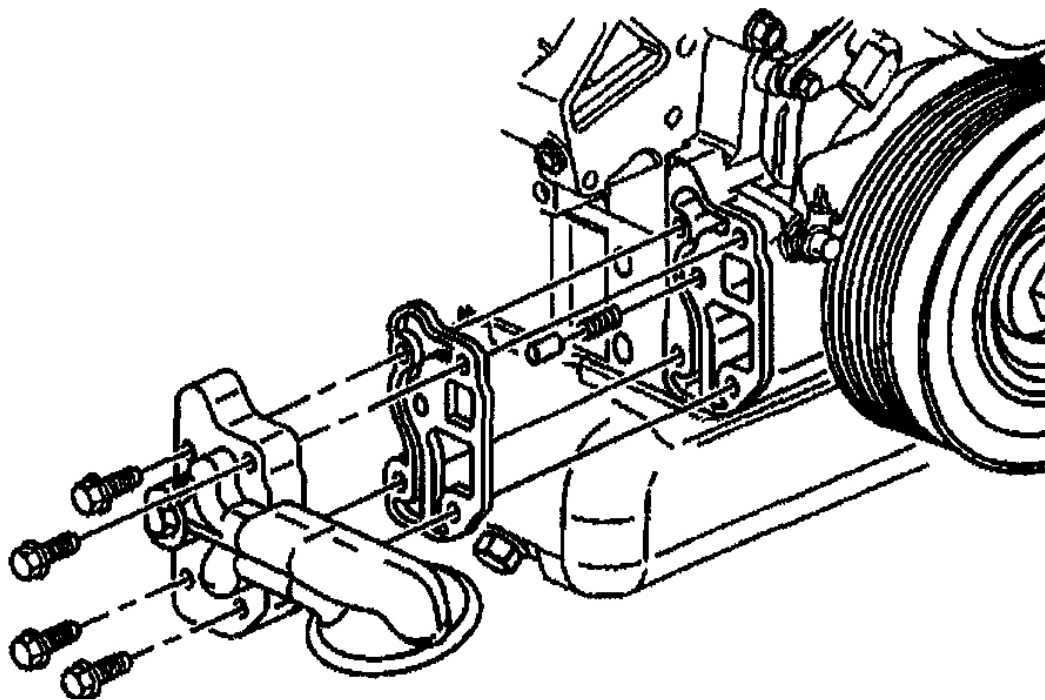
NOTE: **DO NOT run the engine until the oil pressure is tested. Running the engine without measurable oil pressure will cause extensive damage.**

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

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

OIL FILTER ADAPTER & BYPASS VALVE ASSEMBLY - REPLACEMENT**Removal Procedure**

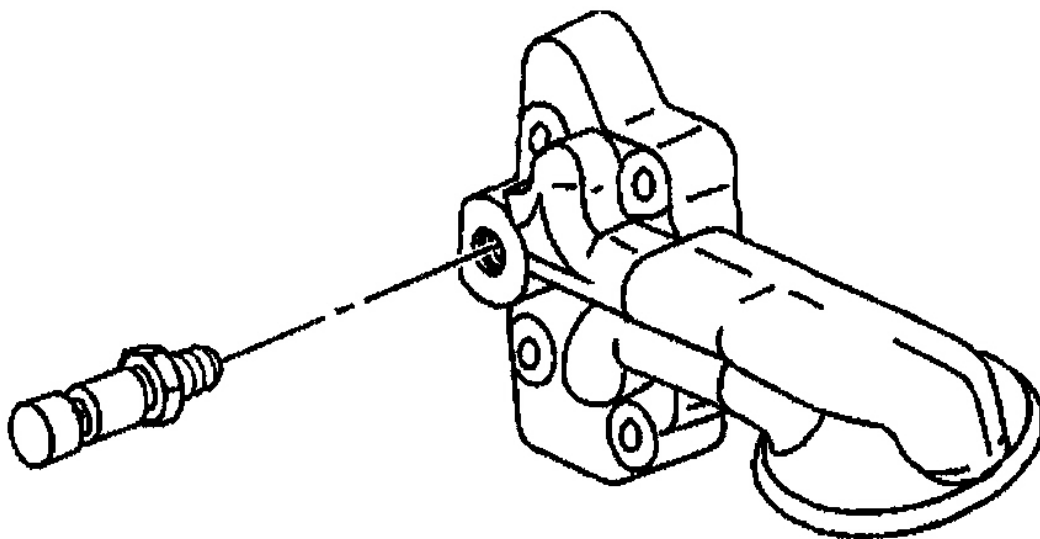
1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Remove the right side wheel drive shaft.
4. Disconnect the oil pressure sensor electrical connector.
5. Drain the engine oil and remove the oil filter. Refer to **Engine Oil & Oil Filter - Replacement**.
6. Remove the oil filter adapter bolts.
7. Remove the following components:
 - Oil filter adapter
 - Oil filter adapter gasket
 - Oil pressure valve and spring
8. Clean the parts in a suitable solvent. Dry the parts.
9. Clean the oil filter adapter gasket mating surfaces.
10. Inspect the following areas:
 - The oil pressure valve and the valve bore for burrs
 - The spring for loss of tension, replace the spring if necessary.



G01807369

Fig. 105: Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

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



G01807370

Fig. 106: Oil Pressure Valve
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

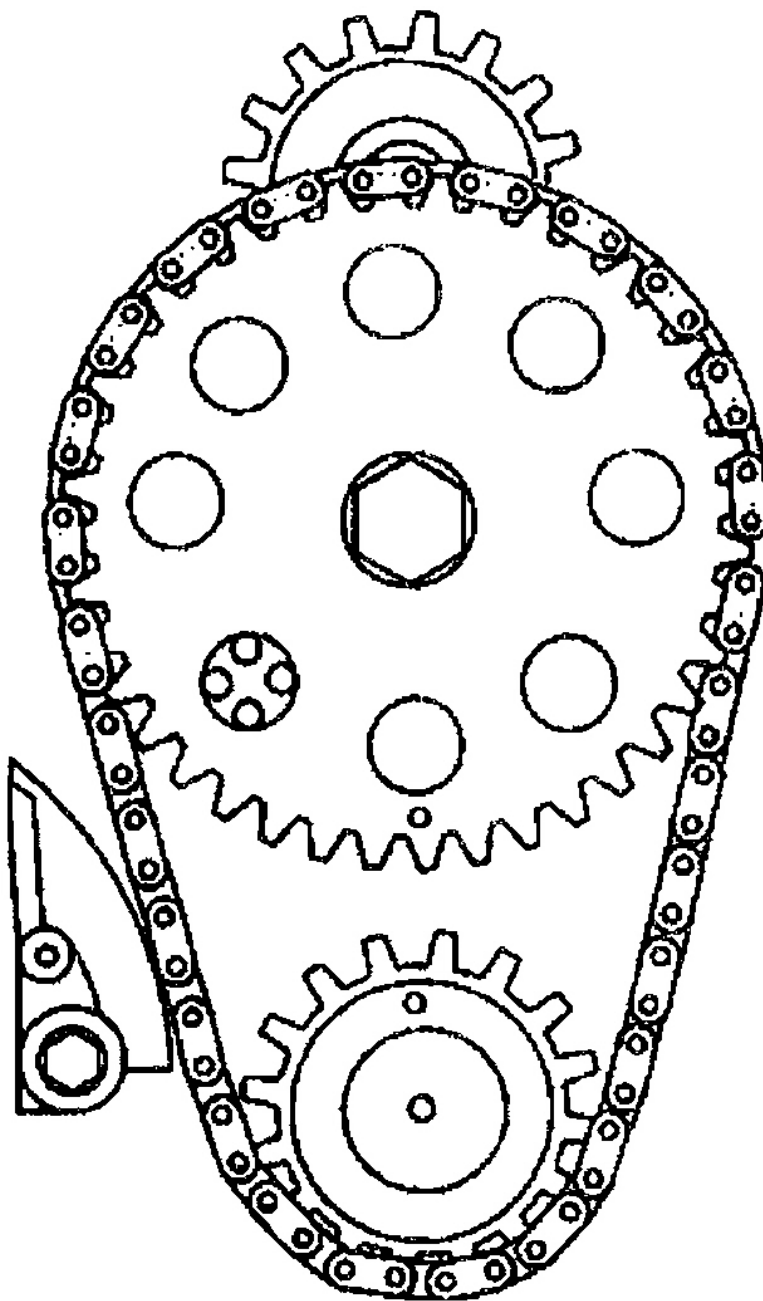
1. If replacing the oil filter adapter and valve assembly, install the engine oil pressure sensor to the oil filter adapter and valve assembly. Tighten the sensor to 16 N.m (12 ft lbs).
2. Install the spring into the engine front cover.
3. Install the oil pressure valve into the engine front cover.
4. Install the oil filter adapter and a new gasket.
5. Install the oil filter adapter bolts. Tighten the bolts to 30 N.m (22 ft lbs).
6. Install the engine oil filter and the engine oil drain plug. Refer to **Engine Oil & Oil Filter - Replacement**.
7. Connect the oil pressure sensor electrical connector.
8. Install the right side wheel drive shaft.
9. Lower the vehicle.
10. Connect the negative battery cable.
11. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
12. Inspect for leaks.

TIMING CHAIN & SPROCKETS - REPLACEMENT

Tools Required

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

1. Remove the engine front cover. Refer to **Engine Front Cover - Replacement**.
2. Align the timing marks on the sprockets so that they are as close as possible.

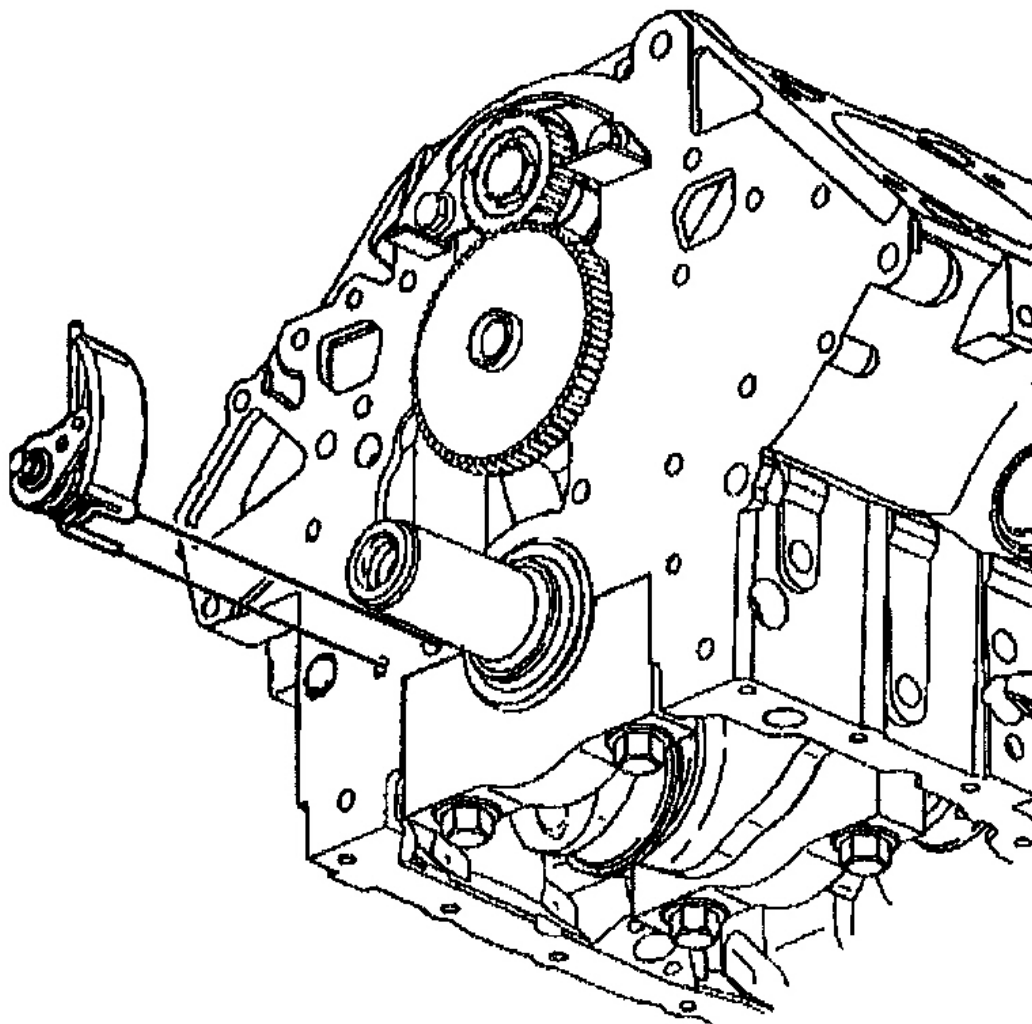


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Fig. 107: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

3. Remove the timing chain dampener bolt.

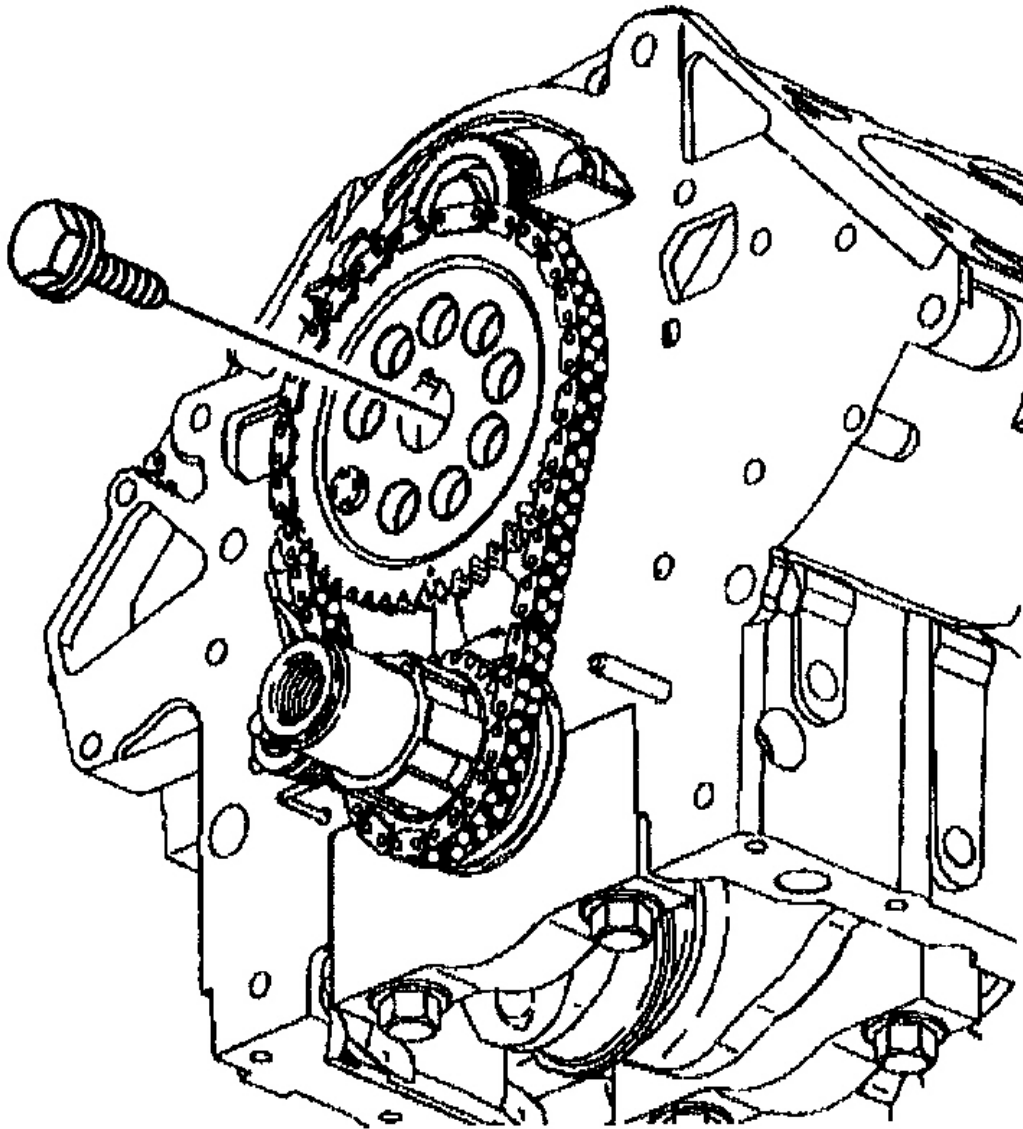
4. Remove the timing chain dampener.



G01807375

Fig. 108: Timing Chain Dampener
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft sprocket bolt.

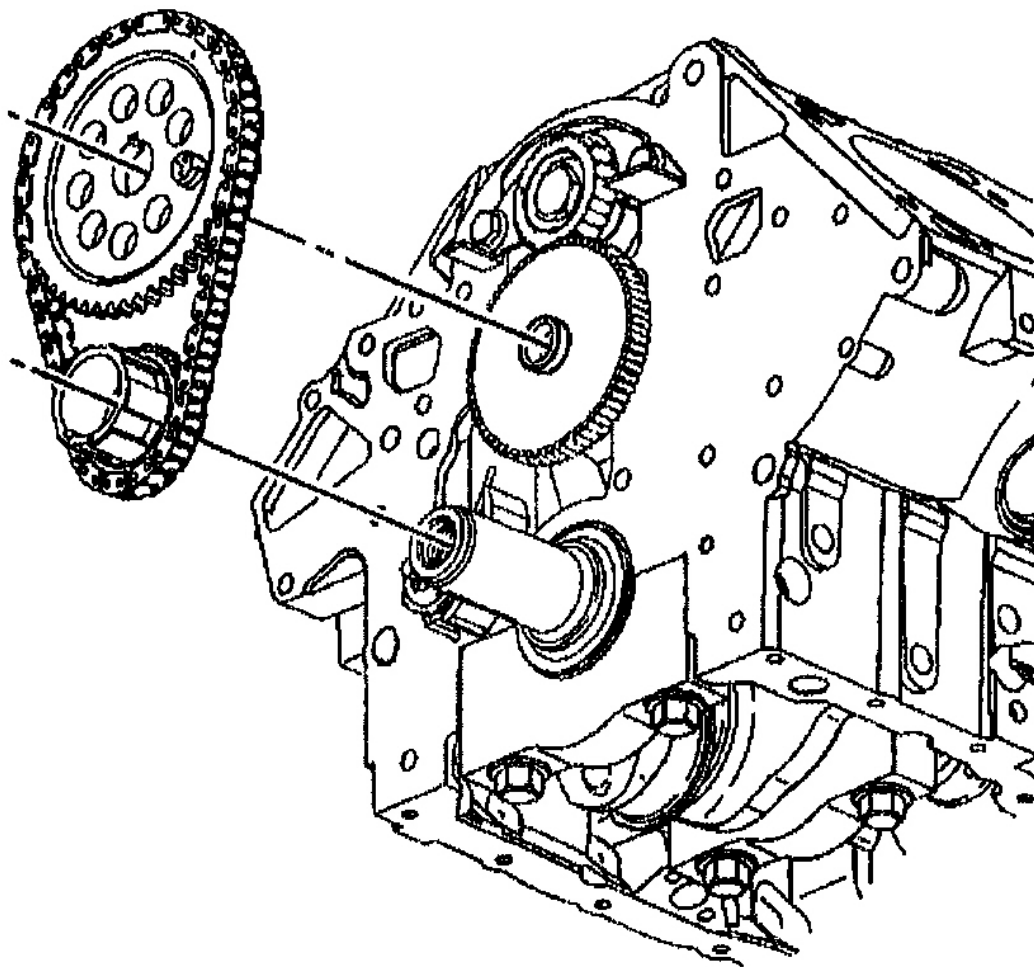


G01807376

Fig. 109: Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft sprocket and the timing chain.

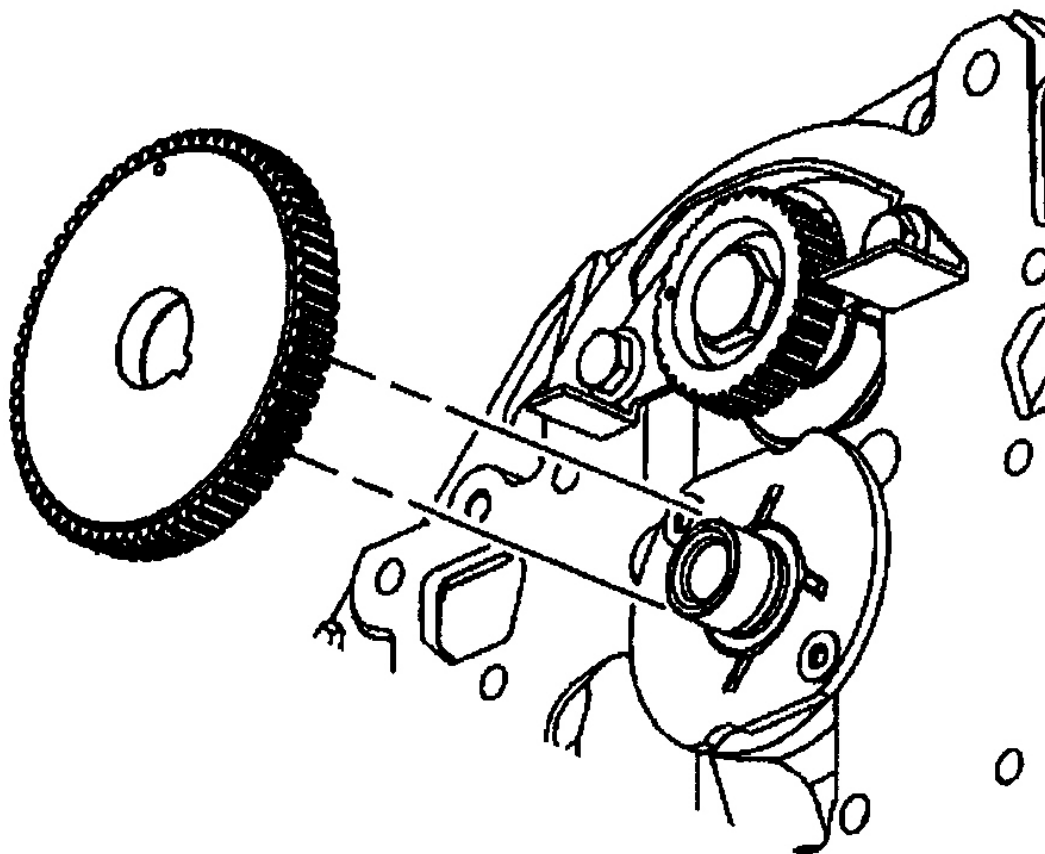
Important: If the sprocket does not come off easily, a light blow on the lower edge of the sprocket with a plastic mallet should dislodge the sprocket.



G01807377

Fig. 110: Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket.
8. Remove the balance shaft drive gear in order to access the camshaft thrust plate, if required.

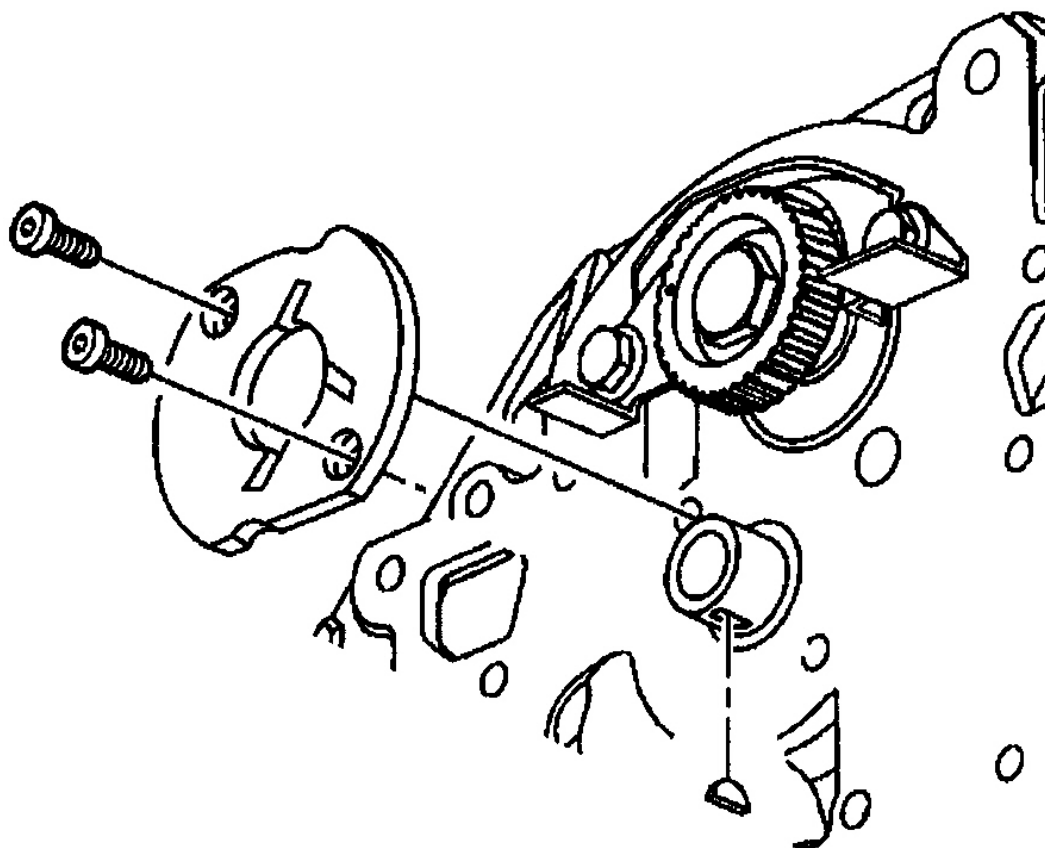


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Fig. 111: Balance Shaft Drive Gear

Courtesy of GENERAL MOTORS CORP.

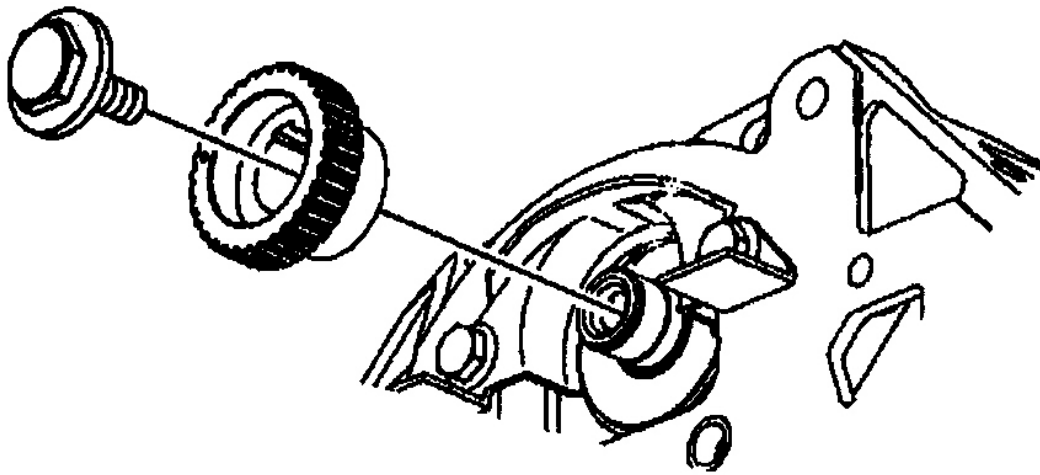
9. Remove the camshaft thrust plate bolts, if required.
10. Remove the camshaft thrust plate, if required.



G01807379

Fig. 112: Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

11. Remove the balance shaft driven gear bolt, if required.
12. Remove the balance shaft driven gear, if required.
13. Clean and inspect all of the components for wear and/or damage. Refer to **TIMING CHAIN & SPROCKETS - CLEANING & INSPECTION (L36)** or **TIMING CHAIN & SPROCKETS - CLEANING & INSPECTION (L67)**.
14. If the pistons have been moved in the engine, use the following procedure:
 - 14.1. Turn the crankshaft so that the number one piston is at top dead center.
 - 14.2. Turn the camshaft so that, with the sprocket temporarily installed, the timing mark is straight down.



G01807380

Fig. 113: Crankshaft Gear
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the balance shaft driven gear, if required.
2. Prevent the balance shaft from rotating and install the balance shaft driven gear bolt, if required.
 - 2.1. Tighten the balance shaft driven gear bolt to 22 N.m (16 ft lbs).
 - 2.2. Use the **J 36660-A** to rotate the bolt an additional 70 degrees.
3. Install the camshaft thrust plate, if required.
4. Install the camshaft thrust plate bolts, if required. Tighten the bolts to 15 N.m (11 ft lbs).
5. Install the balance shaft drive gear.
6. Align the timing marks on the balance shaft drive gear and the balance shaft driven gear.
7. Install the crankshaft sprocket.
8. Install the timing chain and sprocket.
9. Assemble the timing chain on the sprockets with the timing marks as close together as possible.
10. Install the camshaft sprocket bolt.
 - 10.1. Tighten the bolt to 100 N.m (74 ft lbs).
 - 10.2. Use the **J 36660-A** to rotate the bolts an additional 90 degrees.
11. Install the timing chain dampener.
12. Install the timing chain dampener bolt. Tighten the bolt to 22 N.m (16 ft lbs).

Important: Rotate the engine two revolutions and check the timing marks. Make sure that the marks are aligned.

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

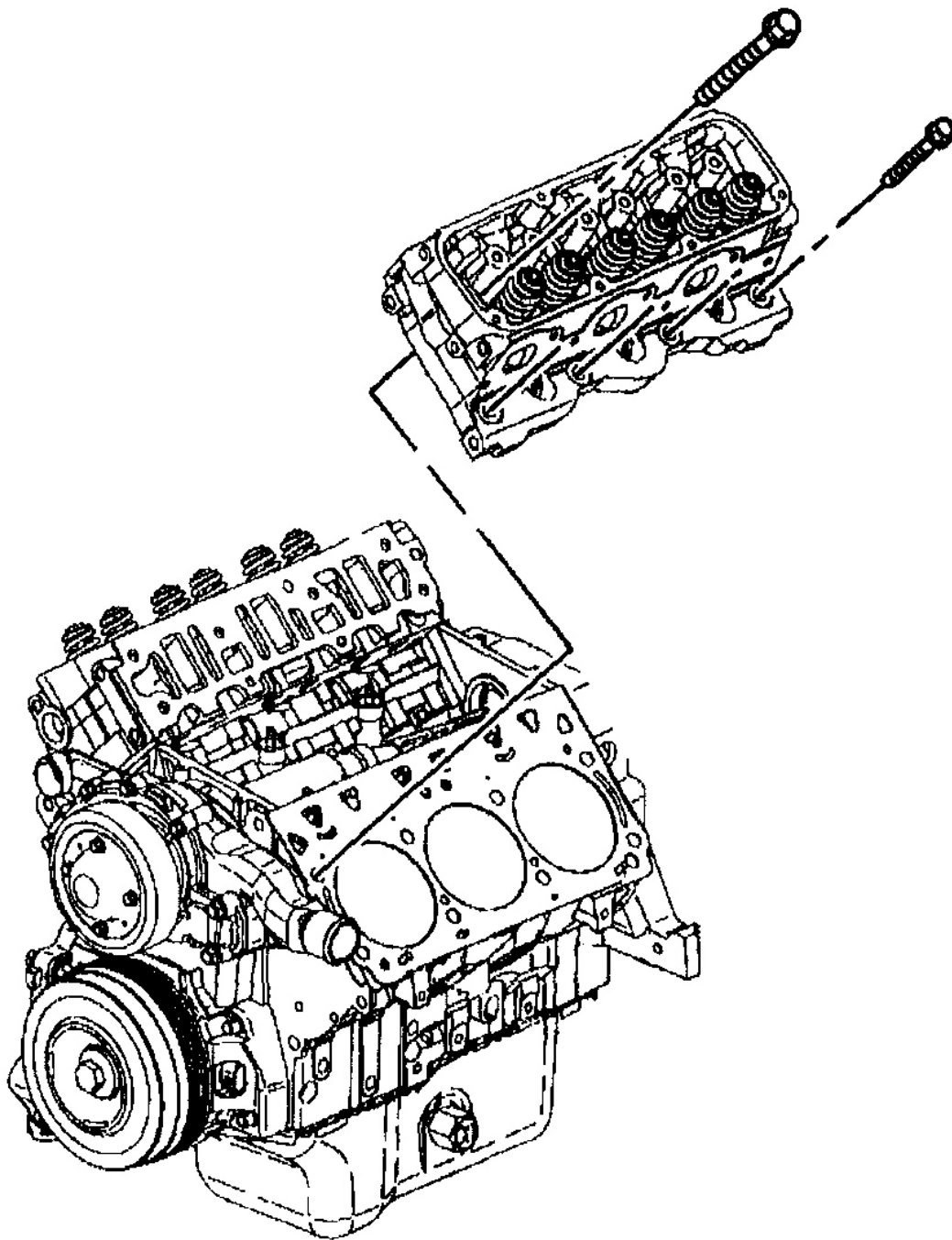
CYLINDER HEAD (LEFT SIDE) - REPLACEMENT

Tools Required

J 36660-A Torque Angle Meter

Removal Procedure

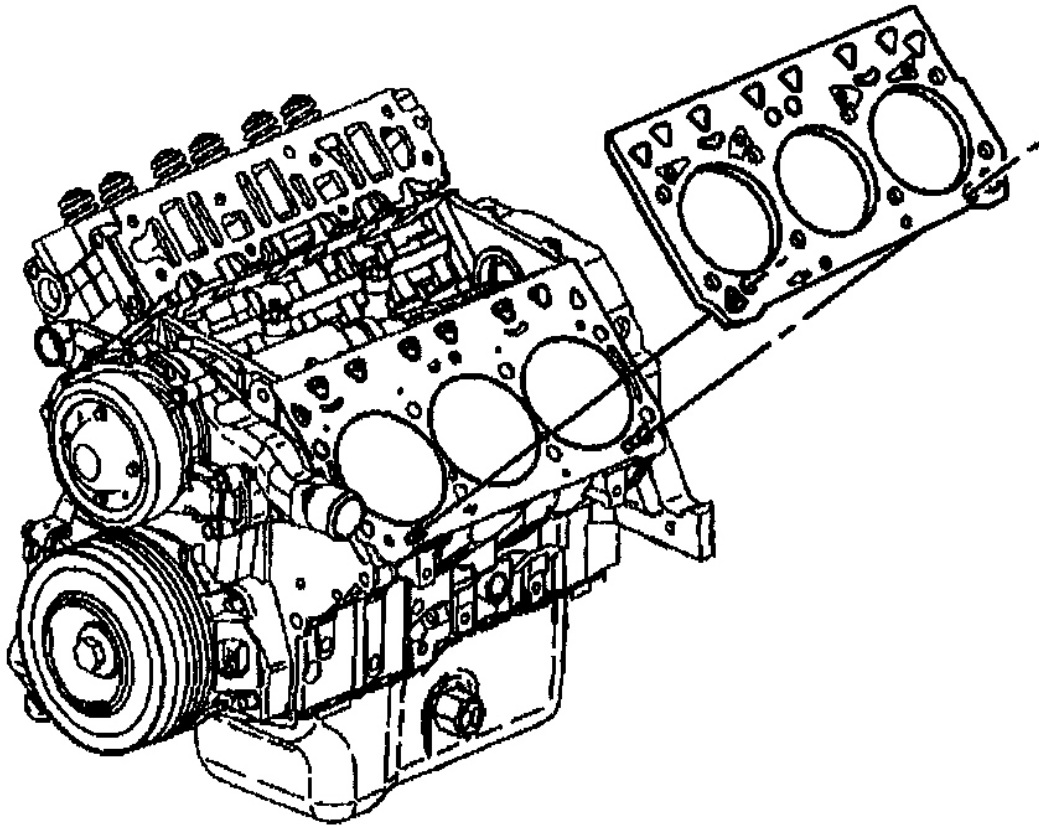
1. Disconnect the negative battery cable.
2. Raise and support the vehicle.
3. Drain the engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
4. Drain the cooling system.
5. Lower the vehicle.
6. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
7. Disconnect the intake air temperature sensor (IAT) sensor.
8. Remove the air inlet duct from the throttle body.
9. Remove the ignition control module and bracket from the left cylinder head.
10. Remove the right engine mount strut brackets. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.
11. Remove the left engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Left**.
12. Remove the left side spark plugs.
13. Remove the lower intake manifold. Refer to **Intake Manifold - Replacement - Lower**.
14. Remove the left exhaust manifold.
15. Remove the left valve rocker arm cover. Refer to **Valve Rocker Arm Cover - Replacement - Left**.
16. Remove the left rocker arms and push rods. Refer to **Valve Rocker Arm & Push Rod - Replacement**.
17. Remove the left cylinder head bolts. Discard the cylinder head bolts.
18. Remove the left cylinder head.



G01807389

Fig. 114: Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

19. Remove the cylinder head gasket.



G01807390

Fig. 115: Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

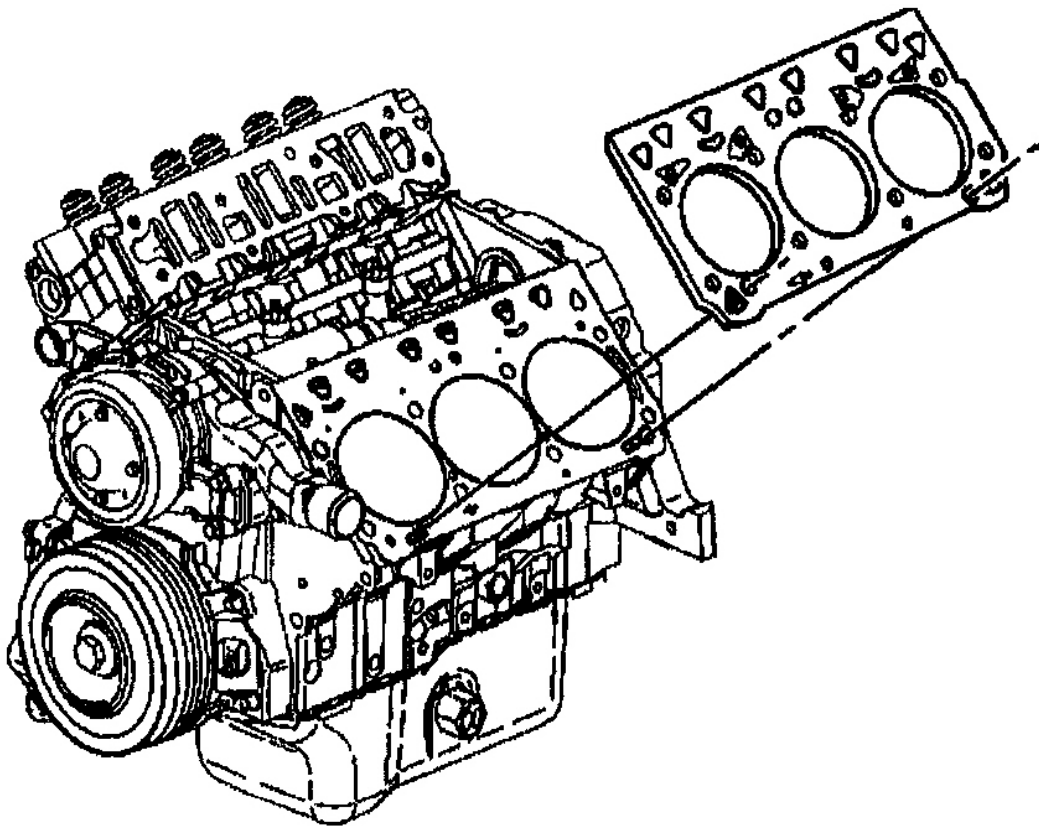
20. Remove the caps, the springs, the valves, and the seals from the cylinder head. Refer to **CYLINDER HEAD - DISASSEMBLE** .
21. Clean the gasket mating surfaces on the cylinder head, the cylinder block and the intake manifold.
22. Clean the cylinder block bolt hole threads.
23. Inspect the engine block. Refer to **ENGINE BLOCK - CLEANING & INSPECTION** .
24. Inspect the cylinder head. Refer to **CYLINDER HEAD - CLEANING & INSPECTION** .

Installation Procedure

1. Install the springs, the caps, the seals, and the valves to the cylinder head. Refer to **CYLINDER HEAD - ASSEMBLE** .

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

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



G01807391

Fig. 116: Positioning Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install the left cylinder head.

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

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

- 4.1. Tighten the cylinder head bolts (1-8) in the following sequence to 50 N.m (37 ft lbs).
- 4.2. Use the **J 36660-A** to rotate the cylinder head bolts (1-8) an additional 120 degrees.

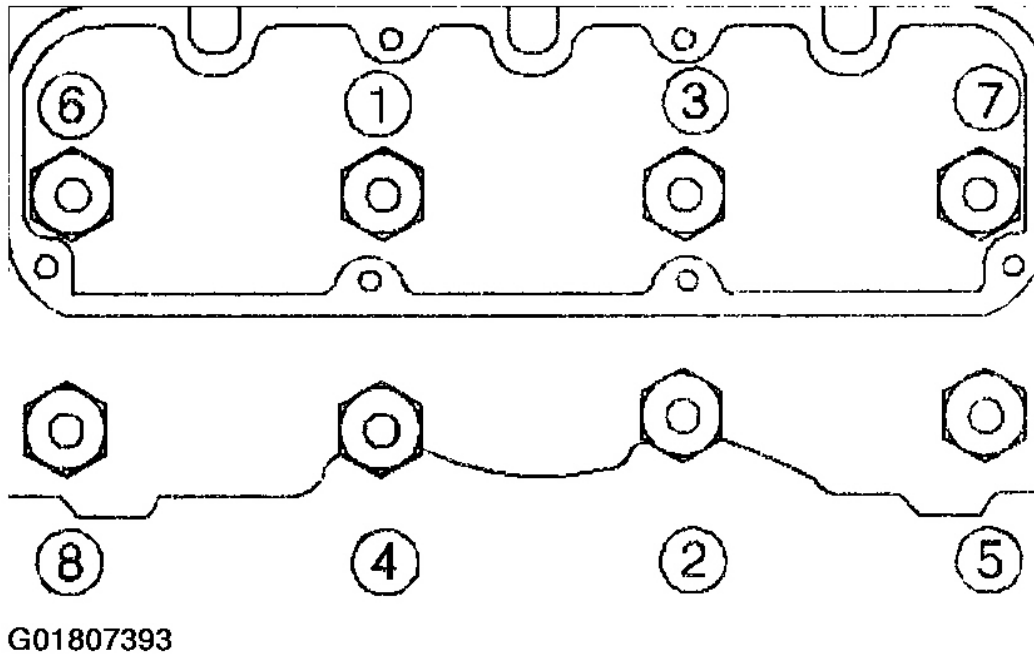


Fig. 117: Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

5. Install the left push rods and rocker arms. Refer to **Valve Rocker Arm & Push Rod - Replacement**.
6. Install the left valve rocker arm cover. Refer to **Valve Rocker Arm Cover - Replacement - Right**.
7. Install the left exhaust manifold.
8. Install the lower intake manifold. Refer to **Intake Manifold - Replacement - Lower**.
9. Install the left side spark plugs.
10. Install the left engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Left**.
11. Install the right engine mount strut bracket. Refer to **Engine Mount Strut Bracket - Replacement - Right Upper**.
12. Install the ignition control module bracket and the ignition control module to the left cylinder head.
13. Install the air inlet duct to the throttle body.
14. Connect the intake air temperature (IAT) sensor electrical connector.
15. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
16. Fill the cooling system.
17. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.

18. Connect the negative battery cable.
19. Inspect for leaks.

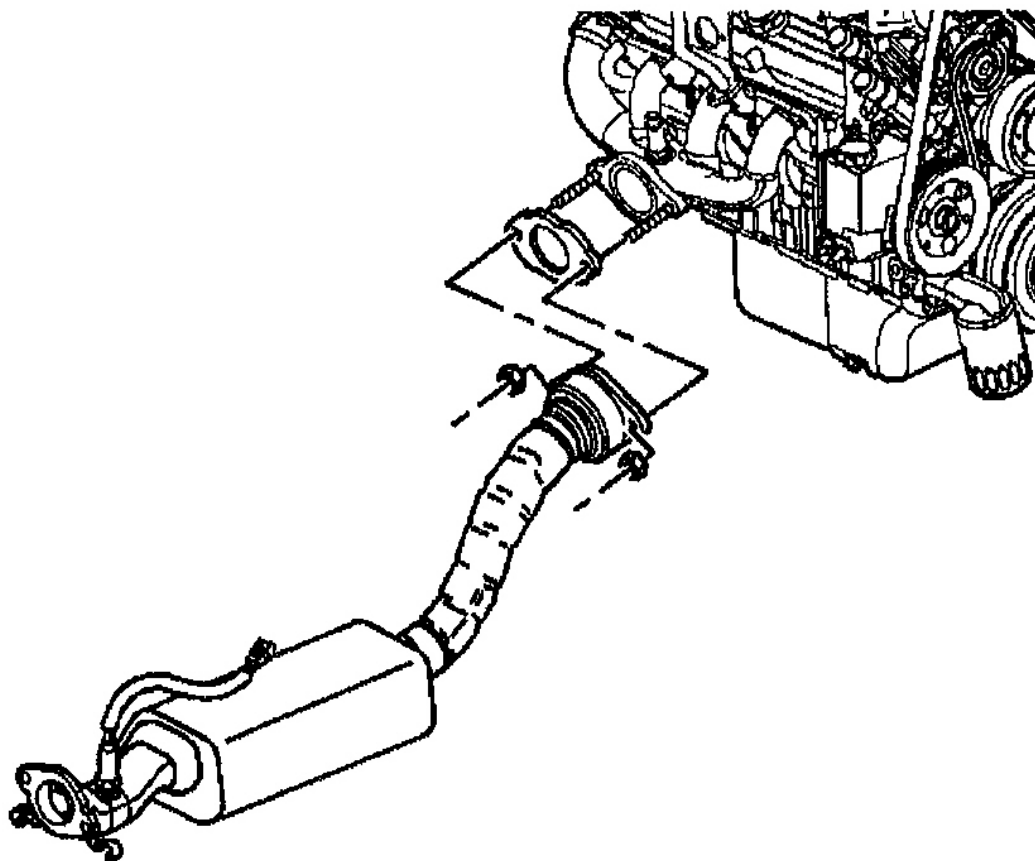
CYLINDER HEAD (RIGHT SIDE) - REPLACEMENT

Tools Required

- **J 41131** Engine Tilt Strap
- **J 36660-A** Torque Angle Meter

Removal Procedure

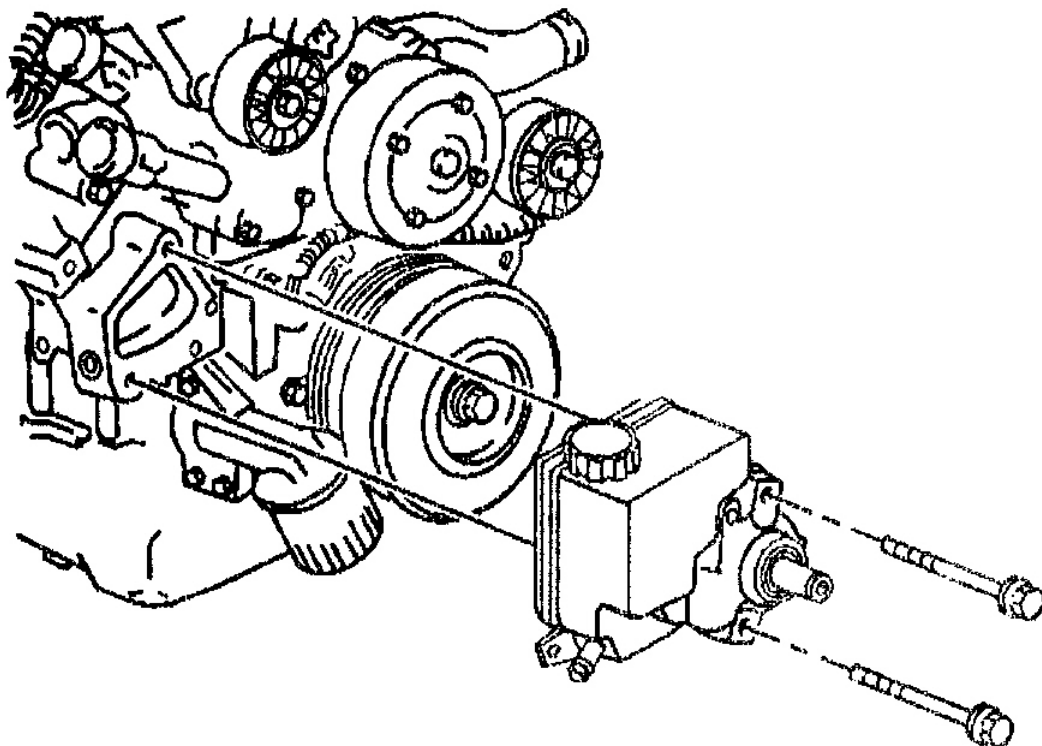
1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement.**
3. Raise and support the vehicle.
4. Drain the cooling system.
5. Drain the engine oil. Refer to **Engine Oil & Oil Filter - Replacement.**
6. Remove the 3-way catalytic converter pipe from the right exhaust manifold.



G01807394

Fig. 118: 3-Way Catalytic Converter Pipe
Courtesy of GENERAL MOTORS CORP.

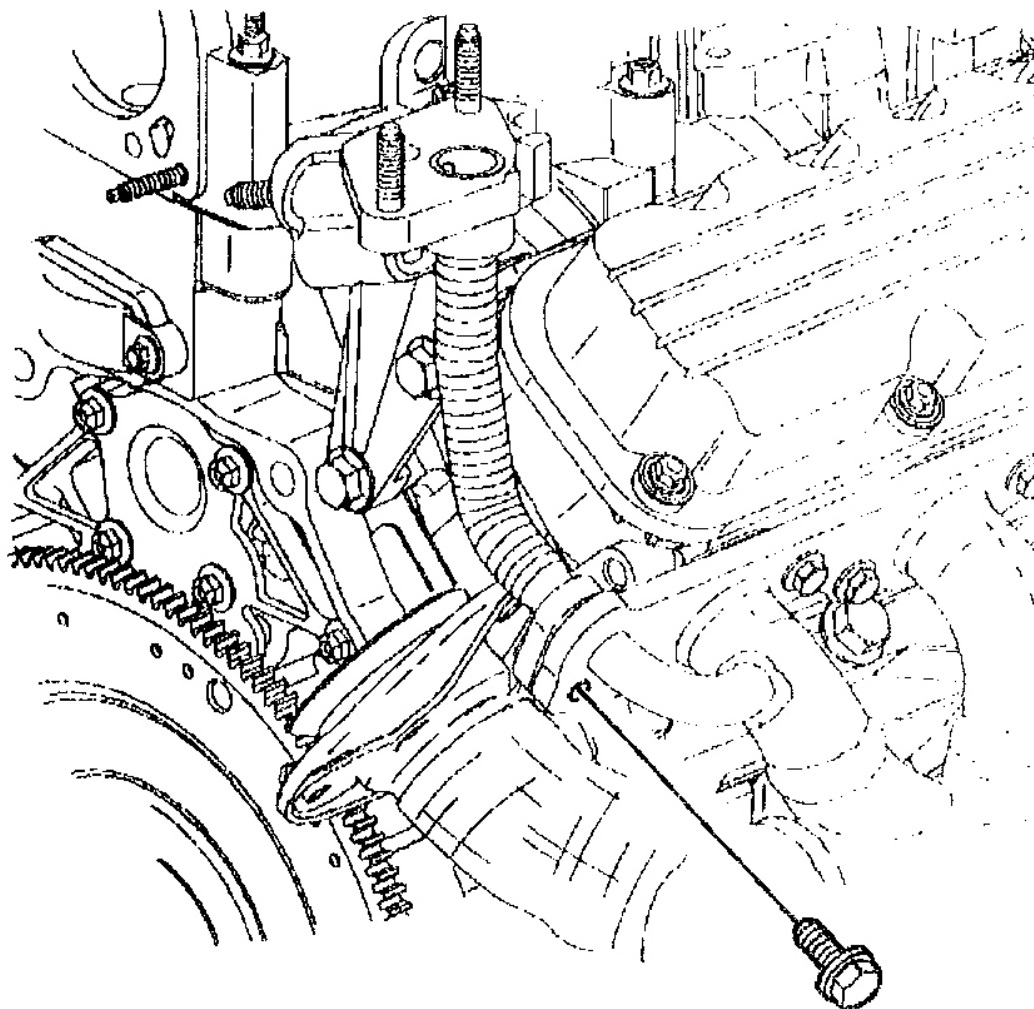
7. Remove the EGR valve adapter bolt from the right exhaust manifold.
8. Lower the vehicle.
9. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
10. Remove the power steering pump and reposition.



G01807396

Fig. 119: Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

11. Rotate the engine to access the right cylinder head. Refer to **Rotating Engine For Service Access**.
12. Remove the AIR pipe, if necessary.

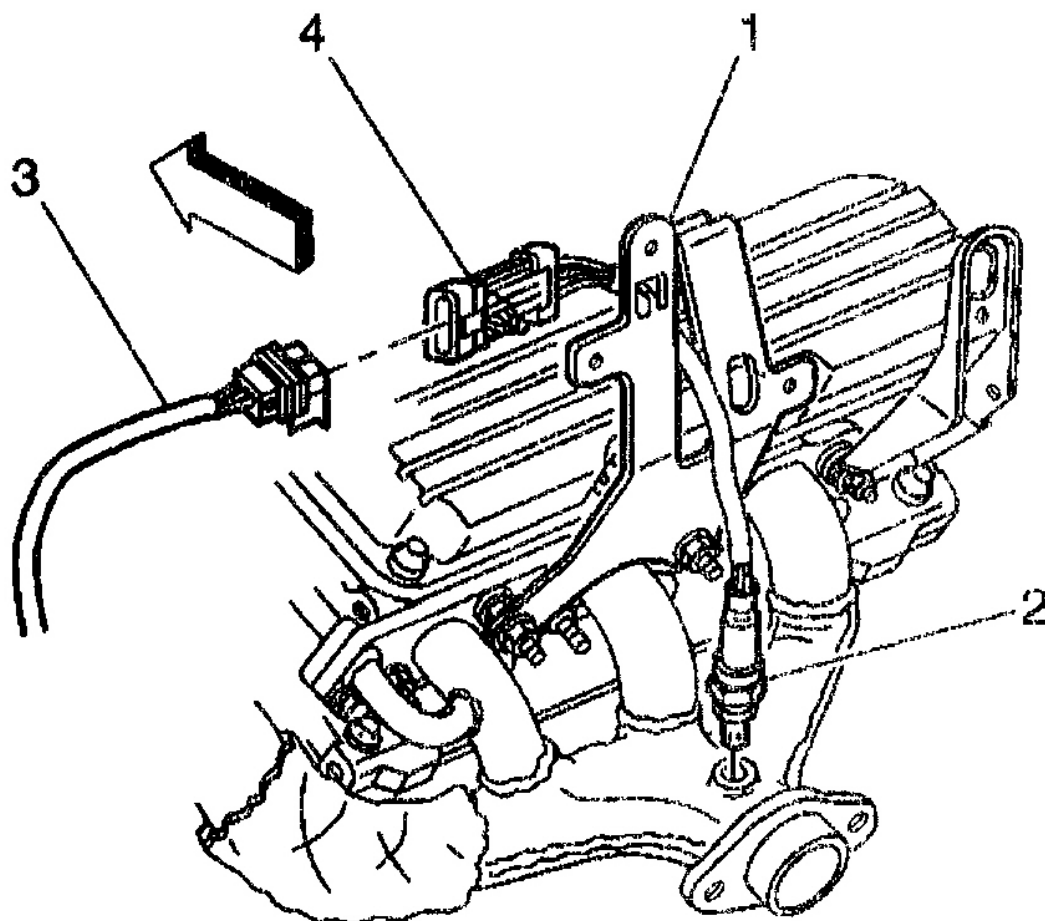


G01807395

Fig. 120: AIR Pipe

Courtesy of GENERAL MOTORS CORP.

13. Remove the right spark plugs.
14. Disconnect the oxygen sensor electrical connector (4).

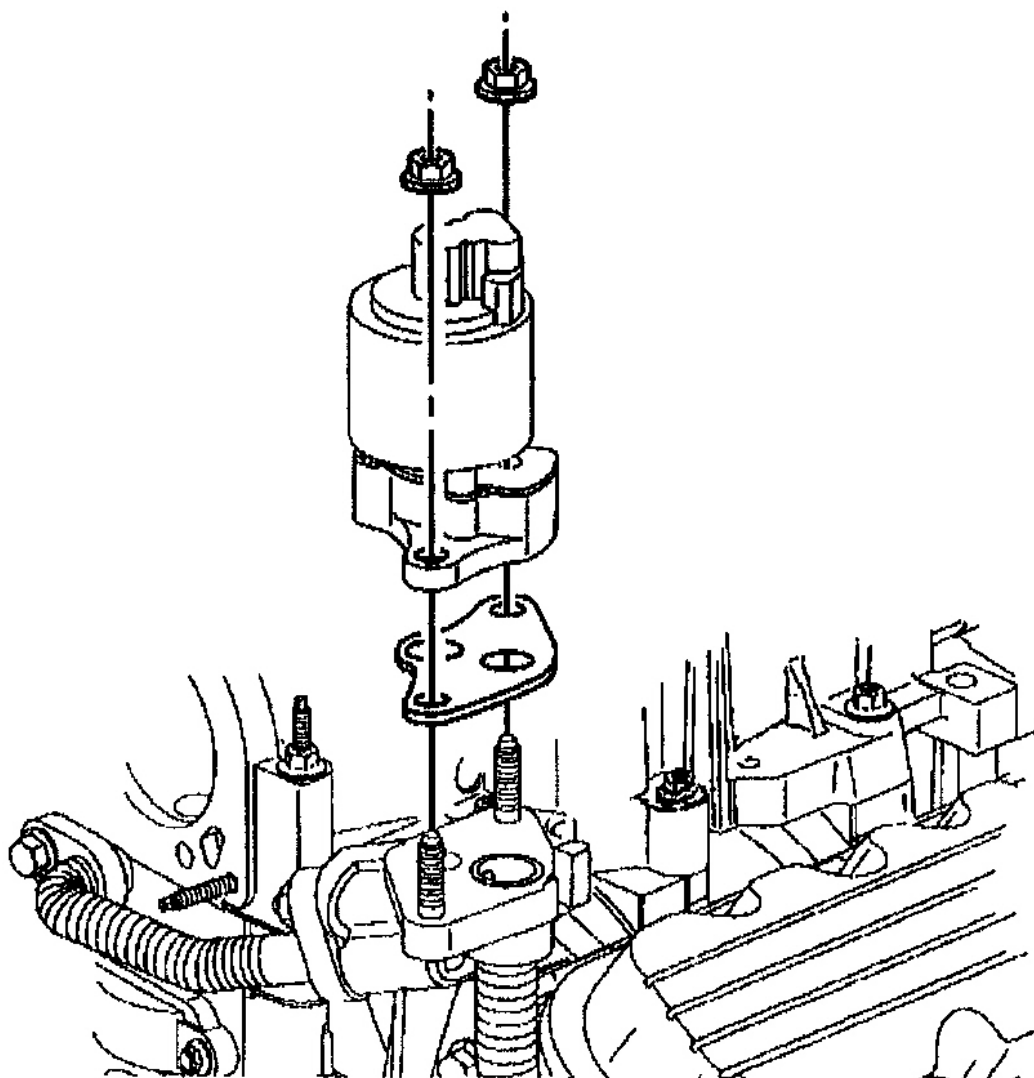


G01807397

Fig. 121: Oxygen Sensor

Courtesy of GENERAL MOTORS CORP.

15. Remove the lower intake manifold. Refer to **Intake Manifold - Replacement - Lower.**
16. Remove the EGR valve nuts.
17. Remove the EGR valve.

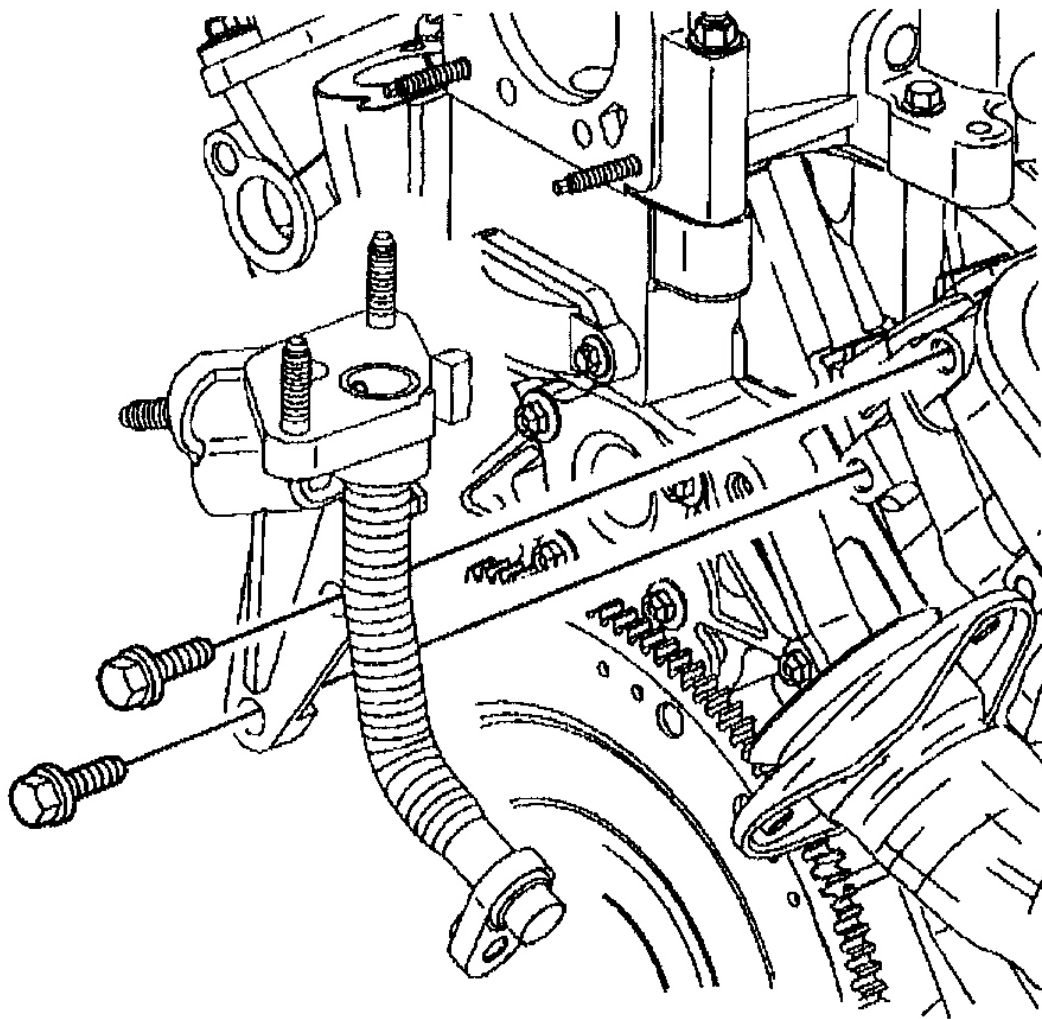


G01807398

Fig. 122: EGR Valve

Courtesy of GENERAL MOTORS CORP.

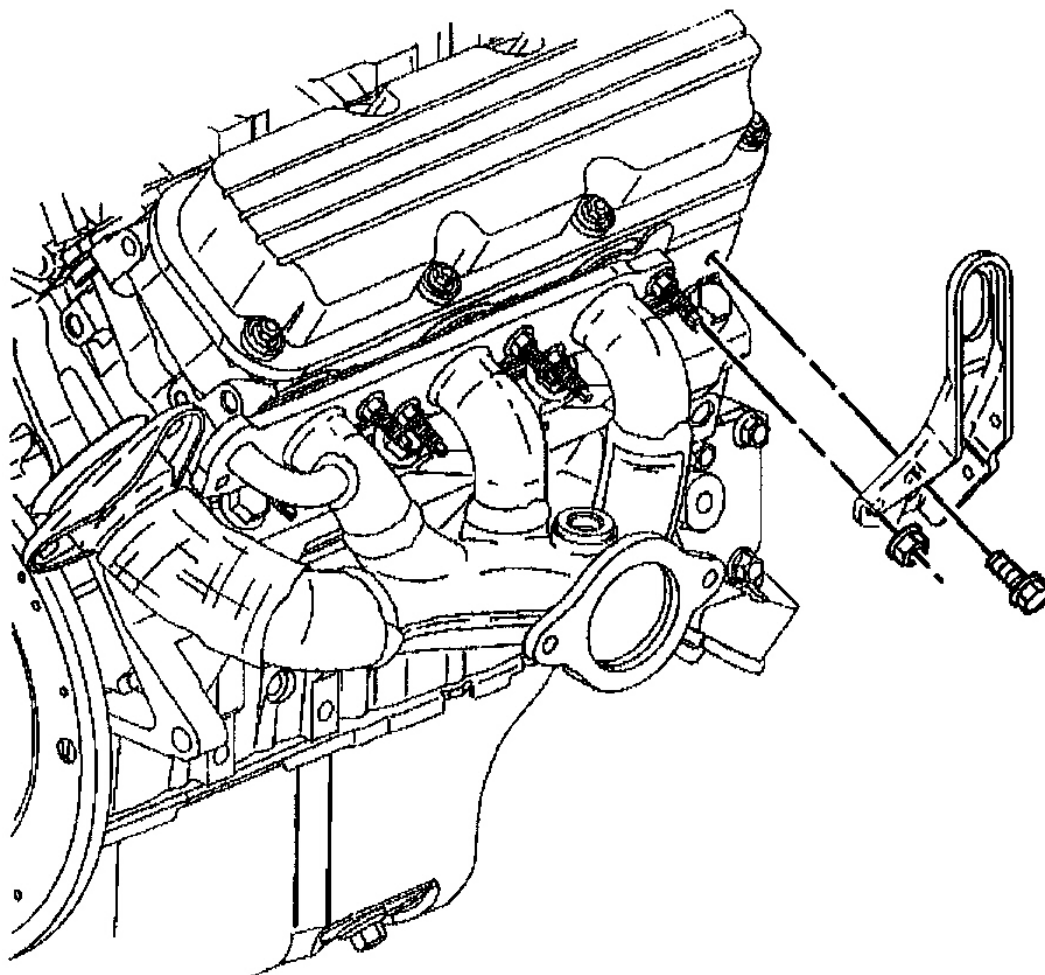
18. Remove the EGR valve adapter bolts from the right cylinder head.
19. Remove the EGR valve adapter from the right cylinder head.



G01807399

Fig. 123: EGR Valve Adapter
Courtesy of GENERAL MOTORS CORP.

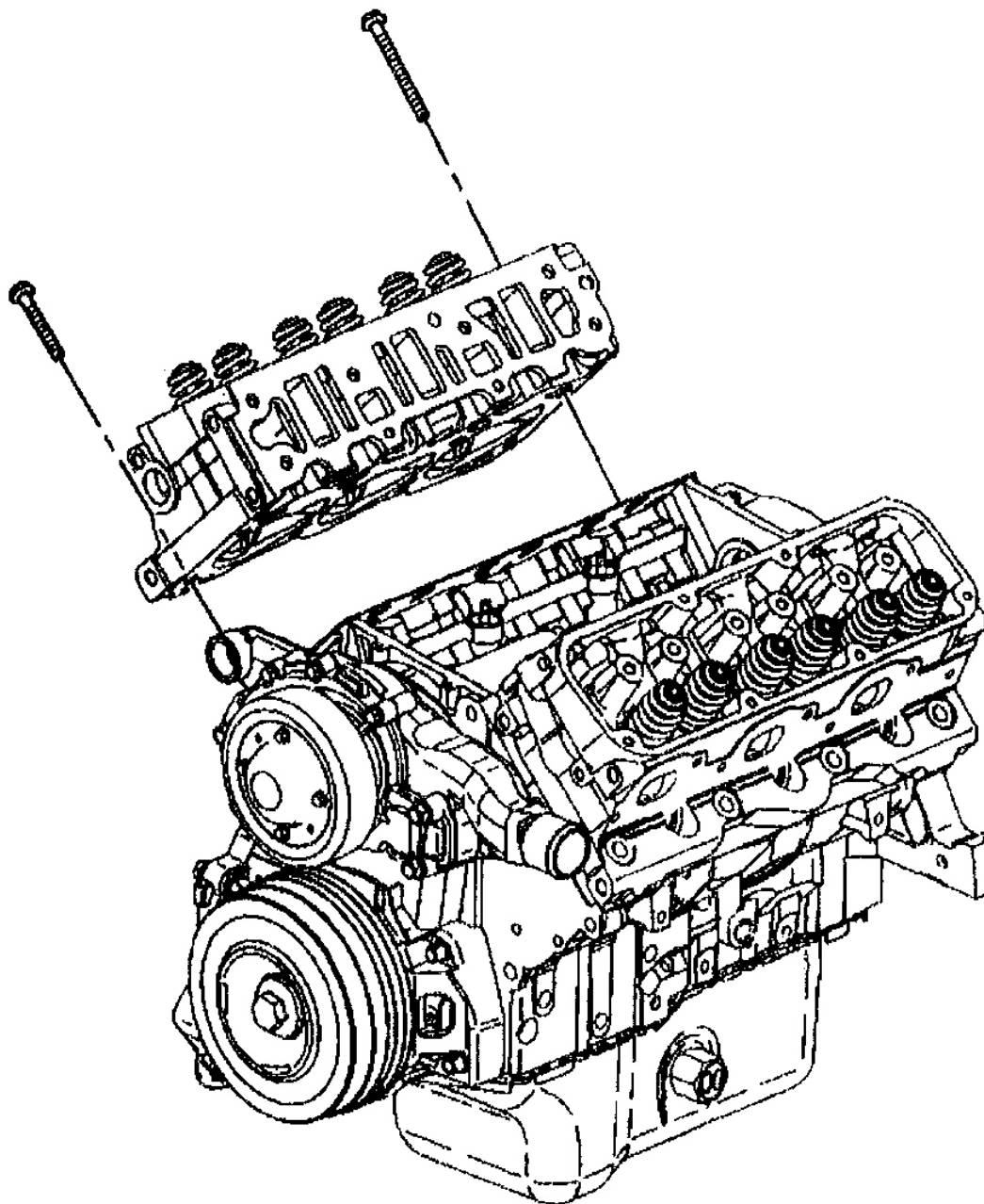
20. Remove the right engine lift bracket.



G01807400

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

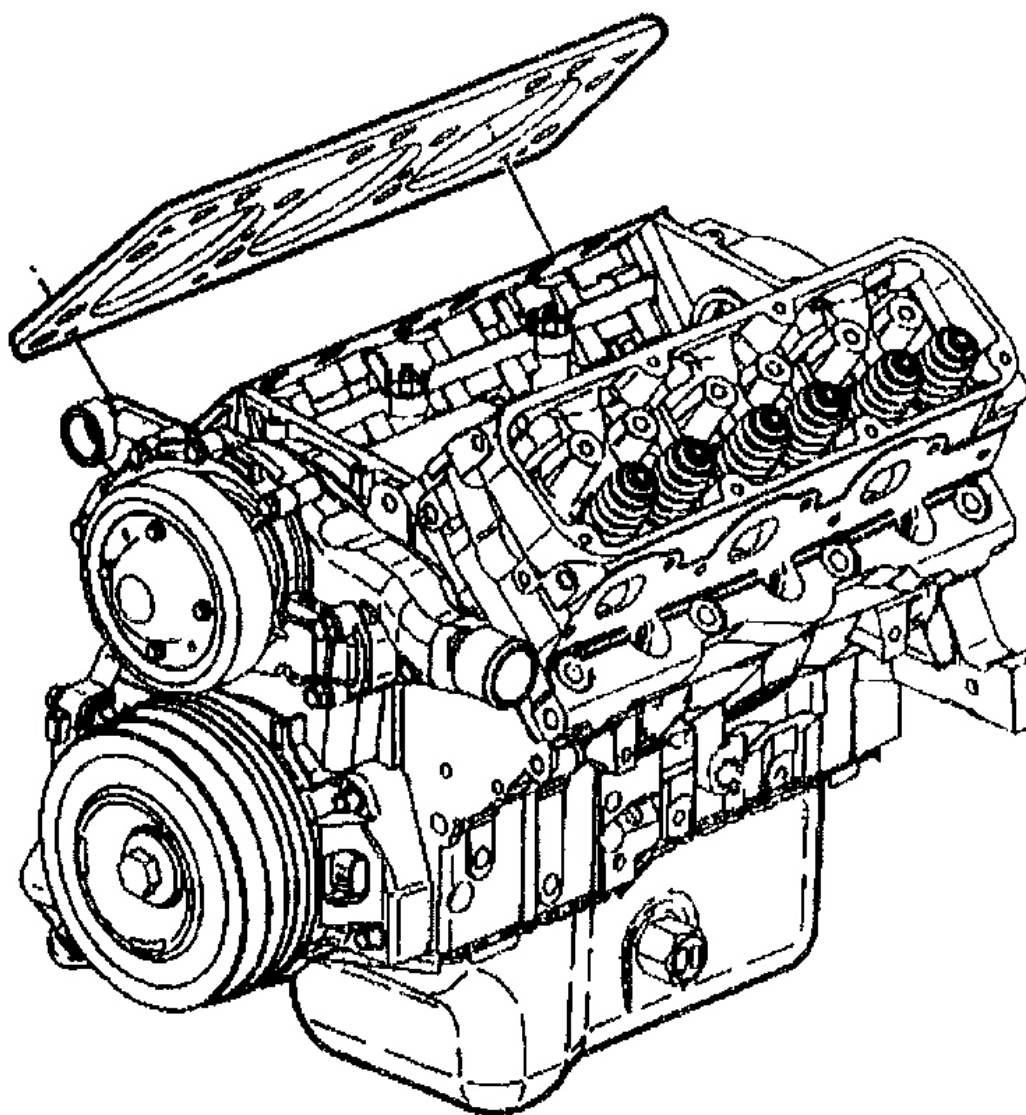
21. Remove the exhaust crossover pipe.
22. Remove the right exhaust manifold.
23. Remove the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover - Replacement - Right.**
24. Remove the right rocker arms and push rods. Refer to **Valve Rocker Arm & Push Rod - Replacement.**
25. Remove the right cylinder head bolts. Discard the bolts.
26. Remove right the cylinder head.



G01807401

Fig. 125: Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

27. Remove the right cylinder head gasket.



G01807402

Fig. 126: Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

28. Remove the caps, the springs, the valves and the seals from the cylinder head. Refer to **CYLINDER HEAD - DISASSEMBLE** .
29. Clean the gasket mating surfaces on the cylinder head, the cylinder block and the intake manifold.
30. Clean the cylinder block bolt hole threads.
31. Inspect the engine block. Refer to **ENGINE BLOCK - CLEANING & INSPECTION** .

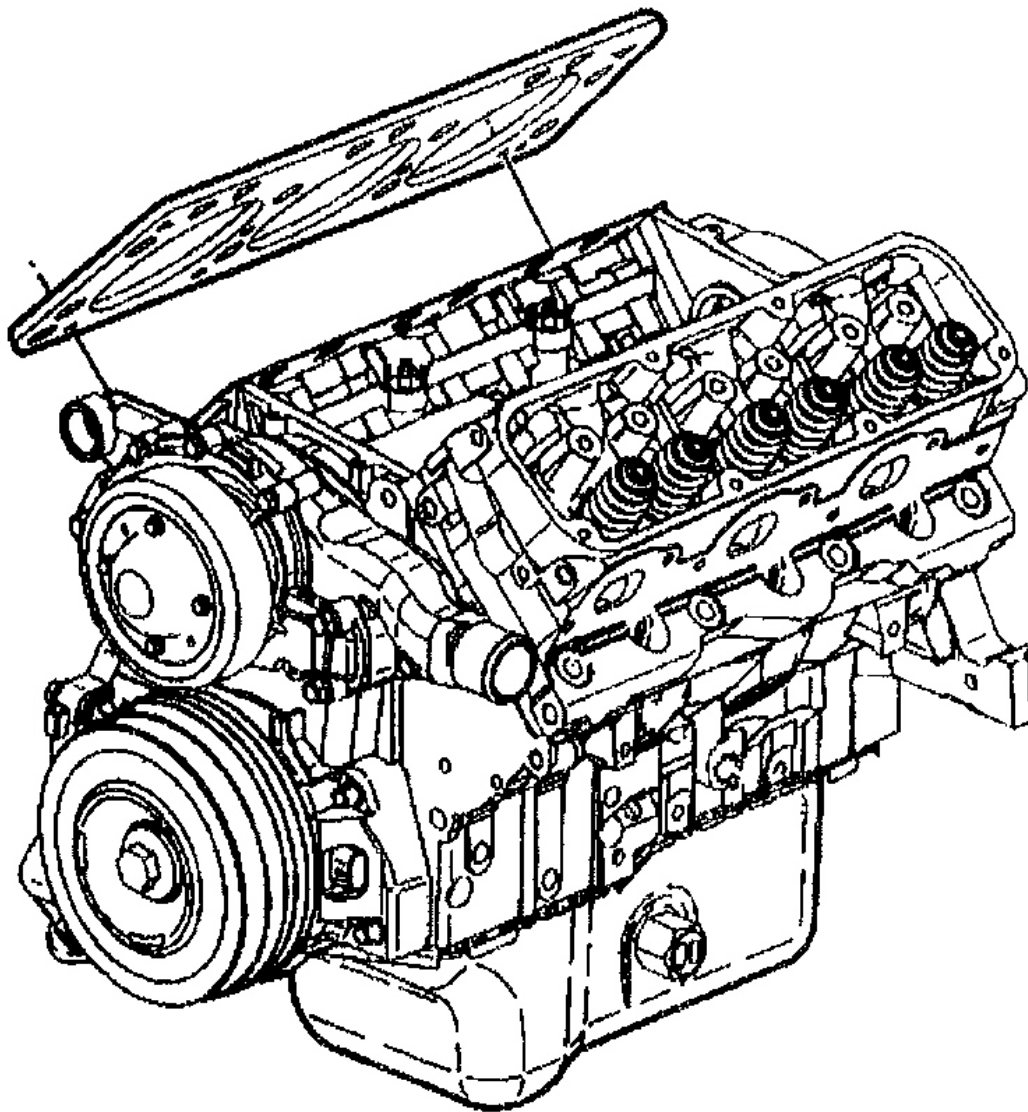
32. Inspect the cylinder head. Refer to **CYLINDER HEAD - CLEANING & INSPECTION** .

Installation Procedure

1. Install the seals, the valves, the springs, and the caps to the cylinder head. Refer to **CYLINDER HEAD - ASSEMBLE** .

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

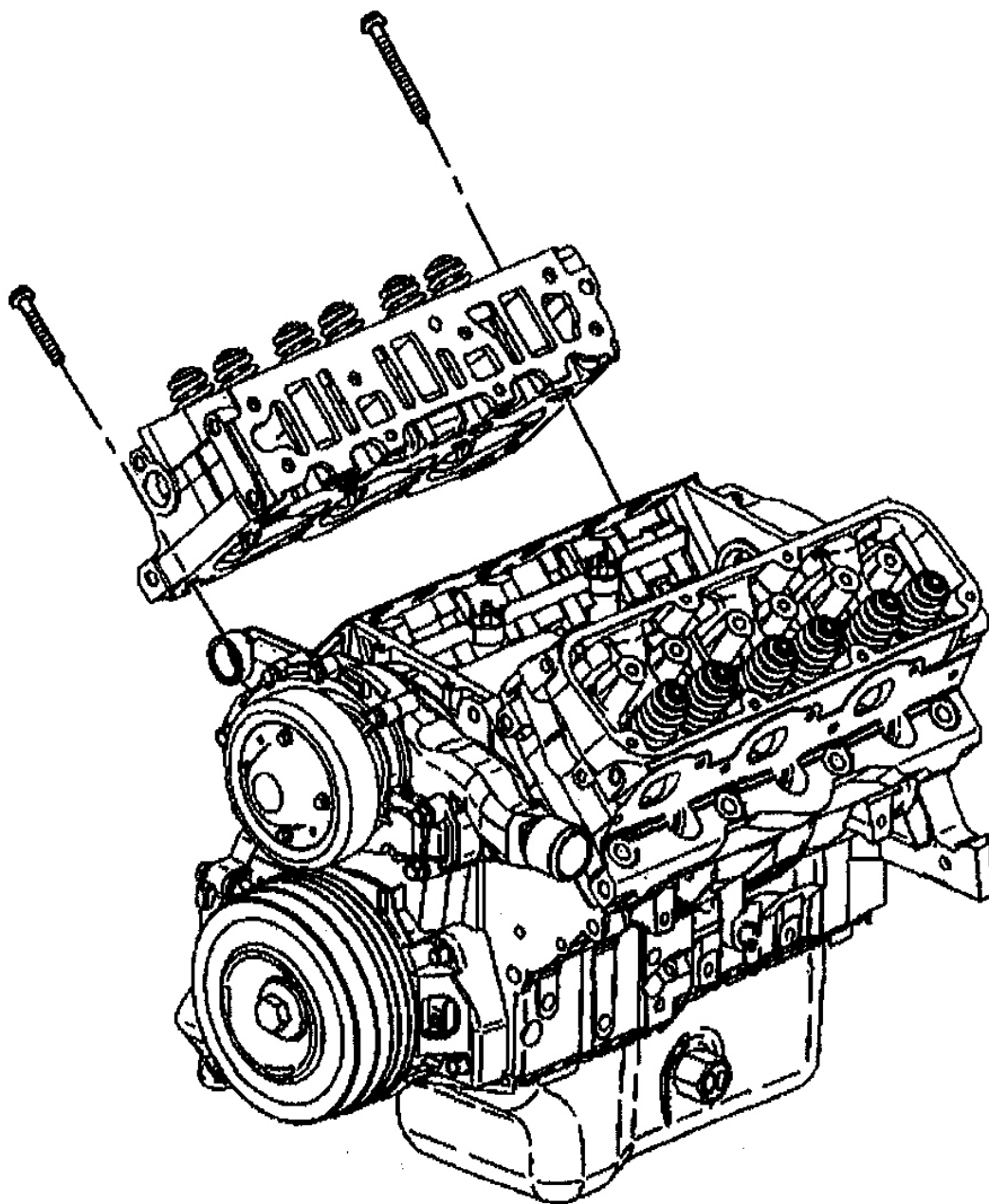
2. Position and install the head gasket with the arrow pointing to the front of the engine.



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Fig. 127: Positioning Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install right the cylinder head.



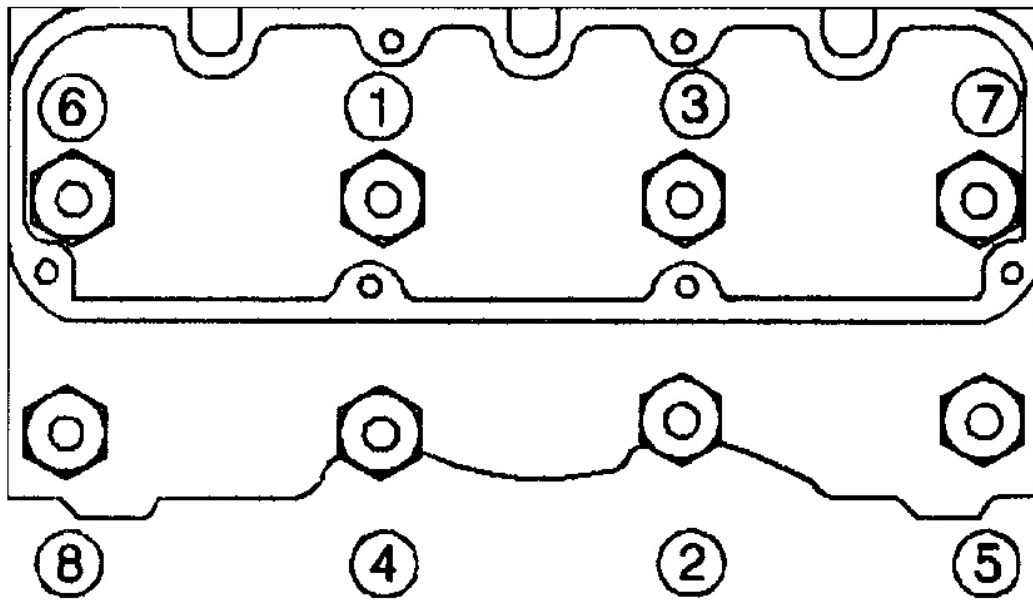
G01807404

Fig. 128: Right Cylinder Head

Courtesy of GENERAL MOTORS CORP.

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

4. Install the new cylinder head bolts (1-8).
 - 4.1. Tighten the cylinder head bolts (1-8) in the following sequence to 50 N.m (37 ft lbs).
 - 4.2. Use the **J 36660-A** to rotate the cylinder head bolts (1-8) an additional 120 degrees.



G01807405

Fig. 129: Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

5. Install the right push rods and rocker arms. Refer to **Valve Rocker Arm & Push Rod - Replacement**.
6. Install the right valve rocker arm cover. Refer to **Valve Rocker Arm Cover - Replacement - Right**.
7. Install the right exhaust manifold.
8. Install the exhaust crossover pipe.
9. Install the right engine lift bracket.
10. Install the right engine lift bracket nut and bolt. Tighten the right engine lift bracket nut and bolt to 30 N.m (22 ft lbs).
11. Install the EGR valve adapter to the right cylinder head.
12. Install the EGR valve adapter bolts to the right cylinder head. Tighten the EGR valve adapter bolts to 50 N.m (37 ft lbs).
13. Install the EGR valve.
14. Install the EGR valve nuts. Tighten the EGR valve nuts to 29 N.m (21 ft lbs).
15. Install the lower intake manifold. Refer to **Intake Manifold - Replacement - Lower**.

16. Connect the oxygen sensor electrical connector (4).
17. Install the right spark plugs.
18. Install the AIR pipe, if necessary.
19. Carefully release the **J 41131** . Return the engine to the proper position.
20. Install the power steering pump and the power steering pump bolts. Tighten the power steering pump bolts to 34 N.m (25 ft lbs).
21. Install the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
22. Install the right and the left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left** .
23. Raise the vehicle.
24. Install the EGR valve adapter bolt to the right exhaust manifold. Tighten the EGR valve adapter bolt to 29 N.m (21 ft lbs).
25. Install the 3-way catalytic converter to the right exhaust manifold.
26. Install the right exhaust manifold pipe stud nuts. Tighten the right exhaust manifold pipe stud nuts to 32 N.m (24 ft lbs).
27. Lower the vehicle.
28. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
29. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
30. Fill the cooling system.
31. Connect the negative battery cable.
32. Inspect for leaks.

OIL PAN - REPLACEMENT

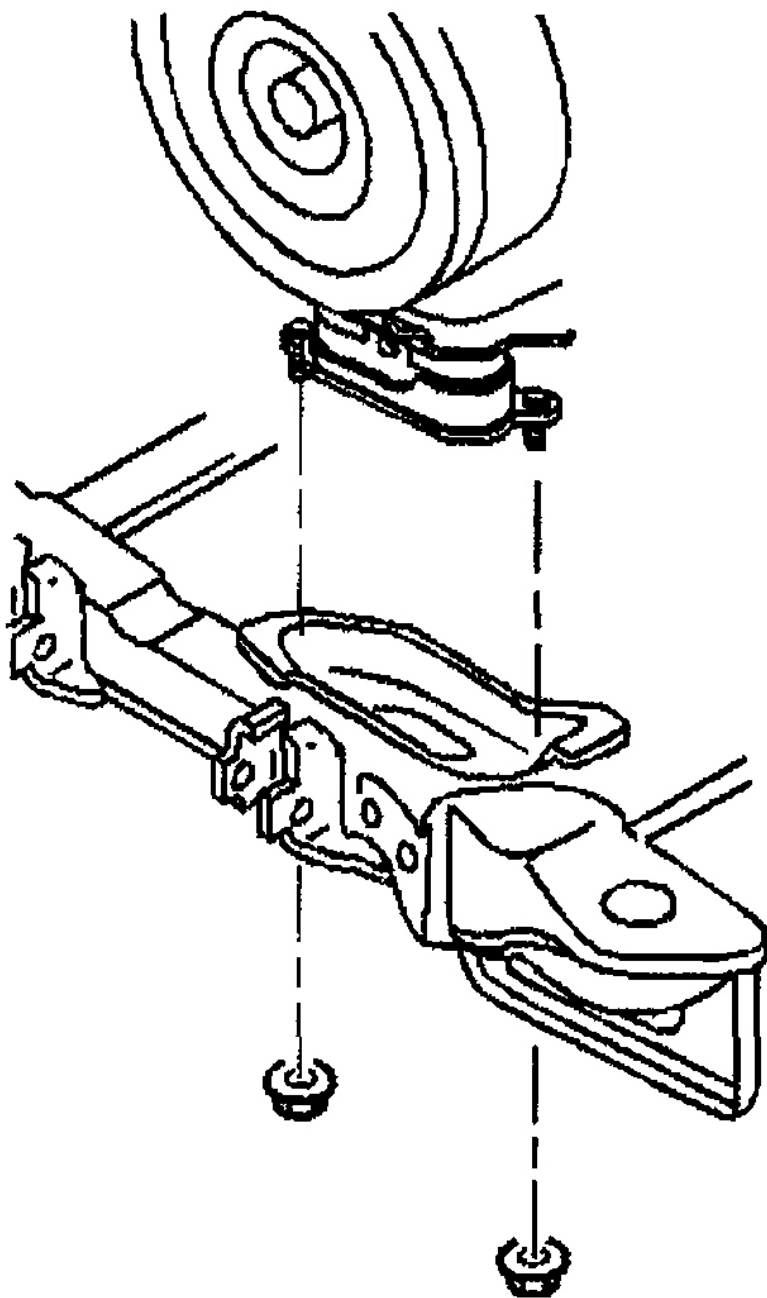
Tools Required

- **J 28467-90A** Engine Support Adapters
- **J 28467-B** Universal Engine Support Fixture
- **J 36462-A** Engine Support Adapter Leg Set

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
3. Disconnect the intake air temperature (IAT) sensor electrical connector.
4. Remove the air inlet duct from the throttle body.
5. Remove the right and the left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left** .
6. Install the engine support fixture. Refer to **Engine Support Fixture**.
7. Raise and support the vehicle.
8. Remove the right exhaust manifold pipe stud nuts from the catalytic converter.

9. Drain the engine oil and remove the oil filter. Refer to **Engine Oil & Oil Filter - Replacement**.
10. Remove the power steering oil cooler pipe brackets from the frame.
11. Disconnect the oil level sensor electrical connector.
12. Remove the oil level sensor wiring harness bolt and reposition the oil level sensor wiring harness.
13. Remove the engine mount lower nuts from the engine mount.

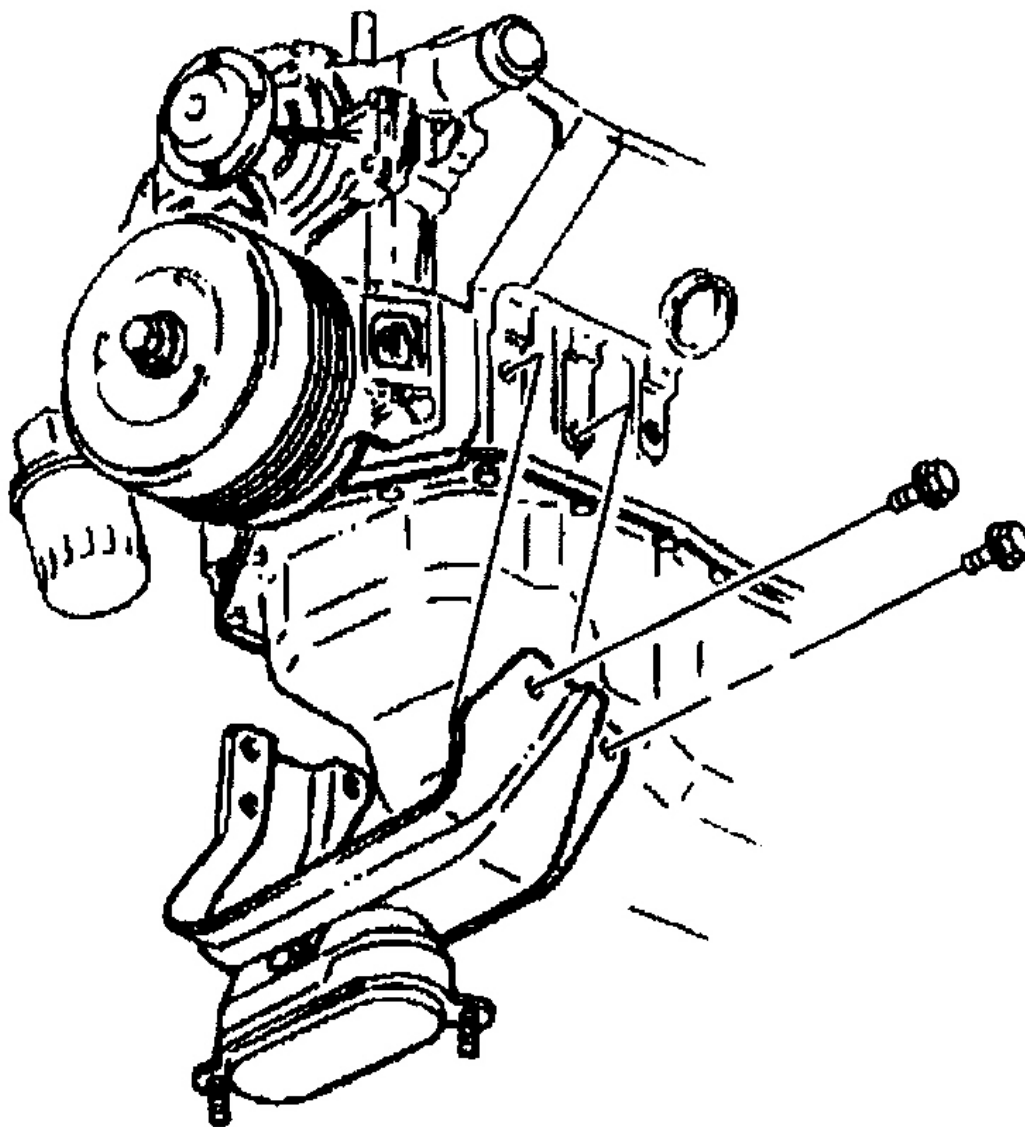


G01807414

Fig. 130: Engine Mount
Courtesy of GENERAL MOTORS CORP.

14. Remove the engine mount upper nuts from the engine mount.
15. Lower the vehicle.

16. Use the engine support fixture to raise the engine.
17. Raise the vehicle.
18. Remove the left engine mount bracket bolts from the engine.

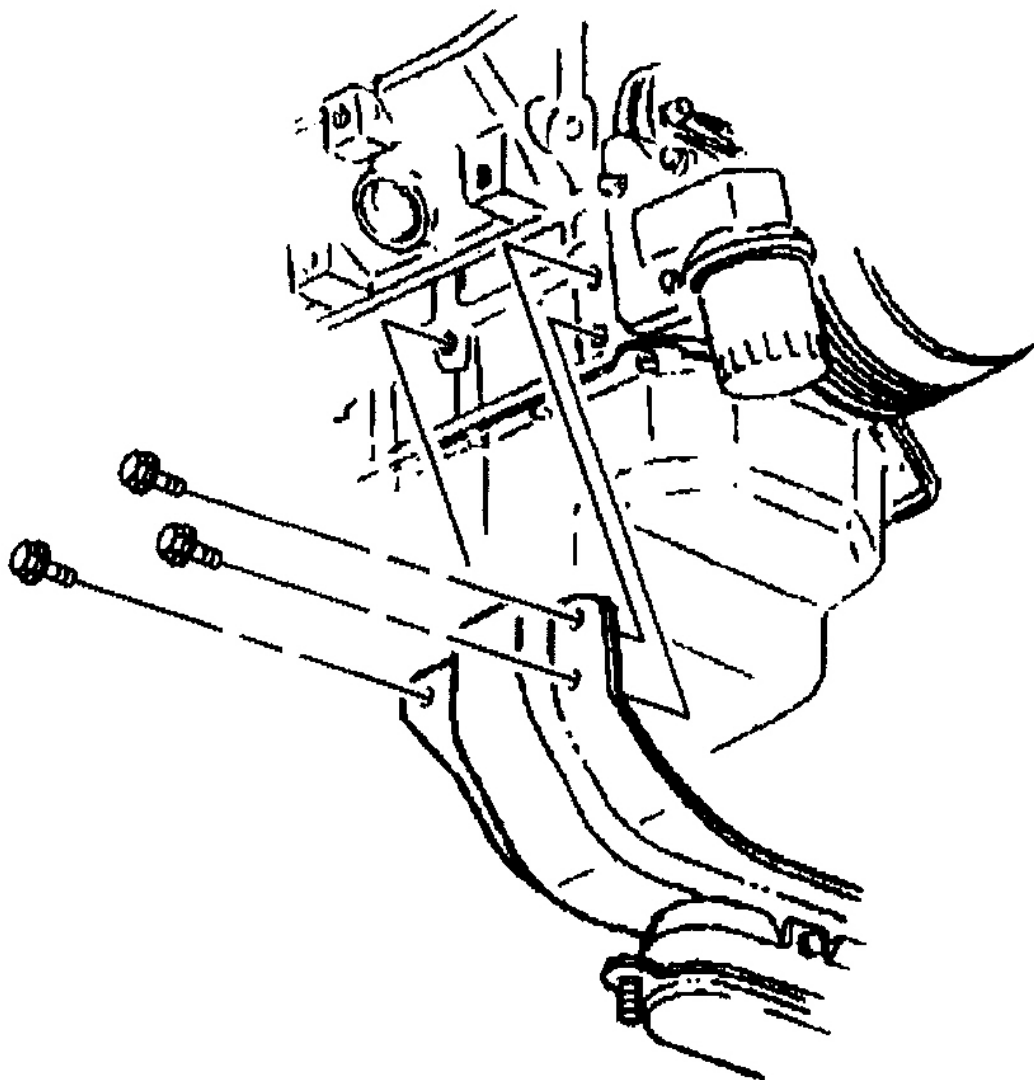


G01807416

Fig. 131: Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

19. Remove the right engine mount bracket bolts from the engine.

20. Remove the engine mount bracket.
21. Remove the torque converter covers.

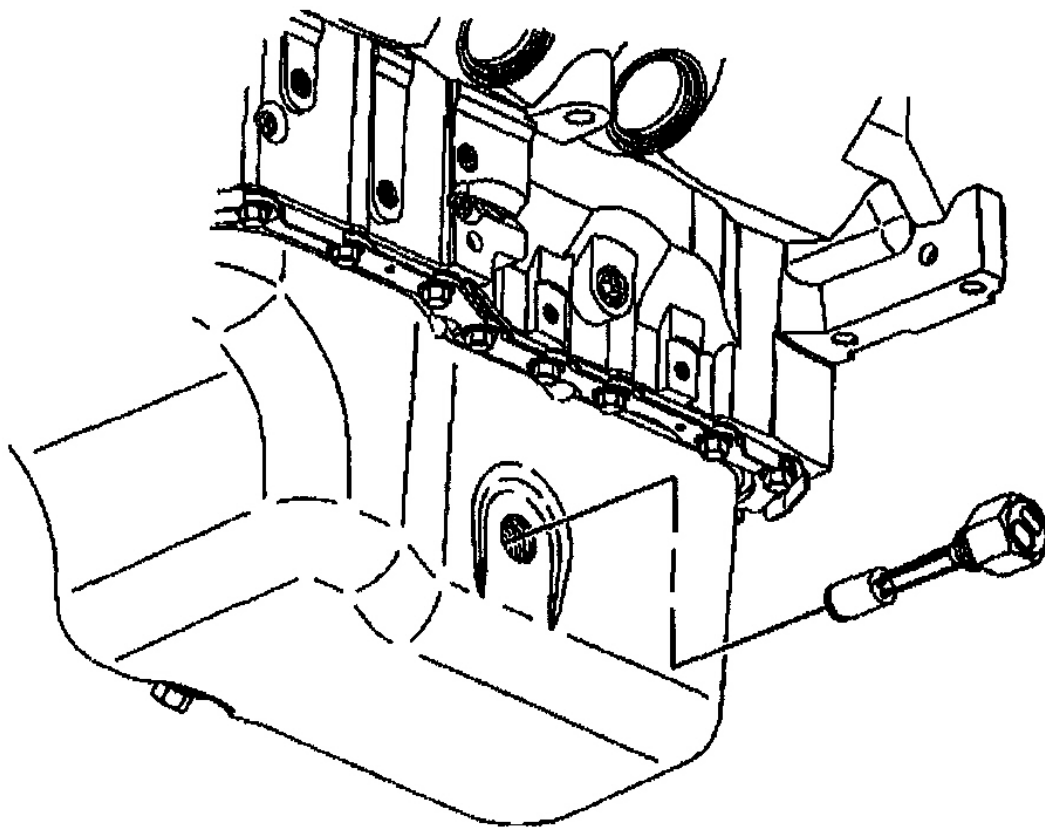


G01807417

Fig. 132: Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

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

22. Remove the oil level sensor.

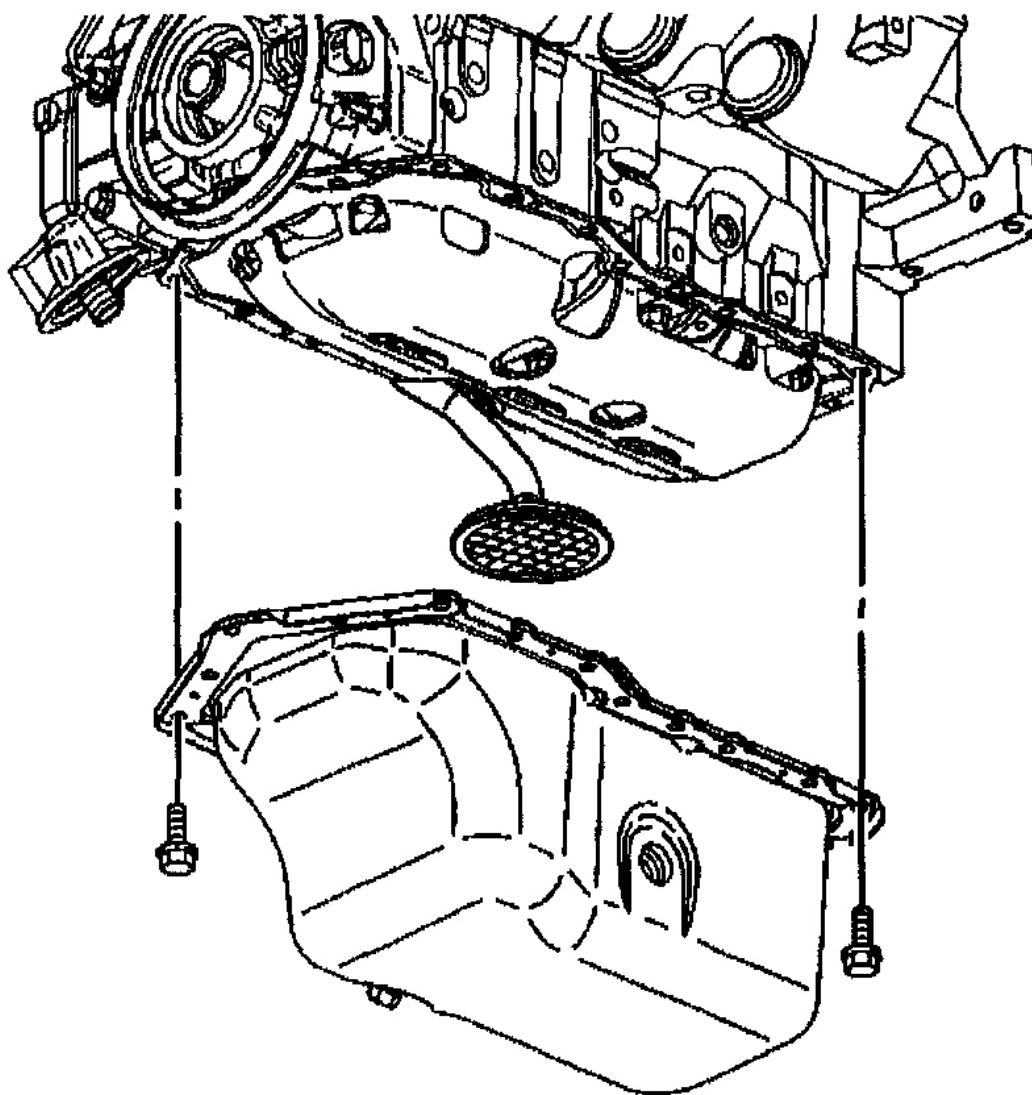


G01807418

Fig. 133: Oil Level Sensor

Courtesy of GENERAL MOTORS CORP.

23. Remove the oil pan bolts.
24. Remove the oil pan.

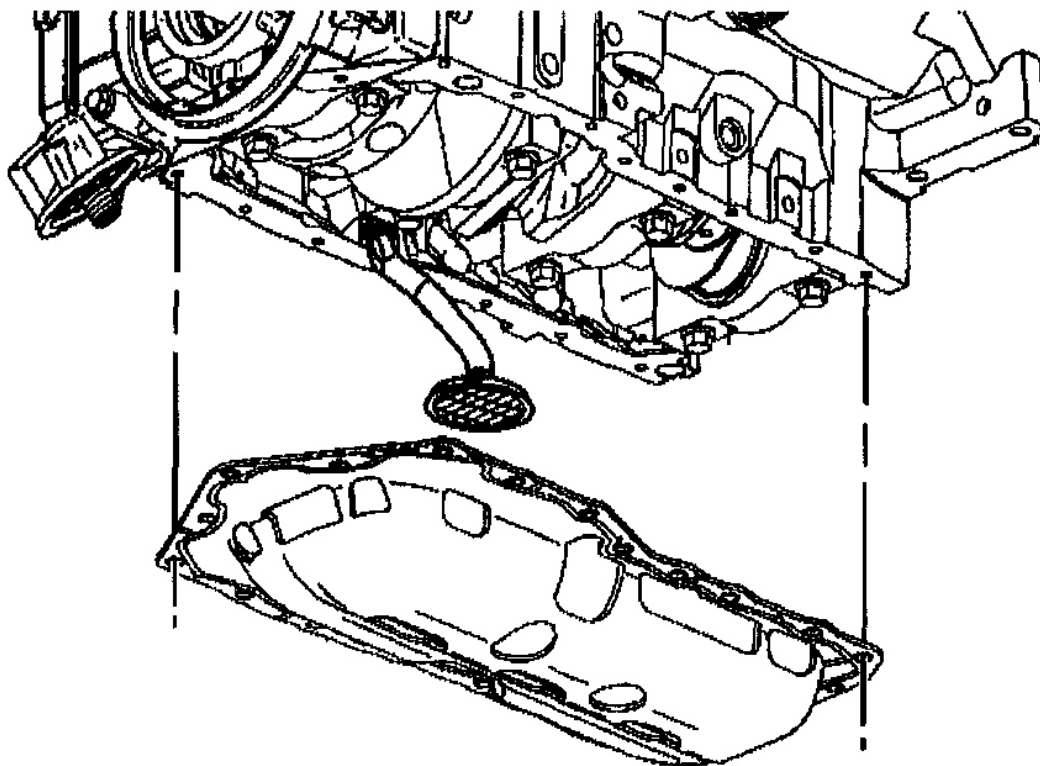


G01807419

Fig. 134: Oil Pan

Courtesy of GENERAL MOTORS CORP.

25. Remove the oil pump pipe screen assembly and the oil pan gasket.



G01807420

Fig. 135: Oil Pump Pipe Screen Assembly & Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

26. Clean the following parts:

- Oil pump screen mating surfaces.
- Oil pan flanges
- Oil pan rail
- Front cover
- Rear main bearing cap
- Threaded holes

Installation Procedure

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

1. Install the oil pan gasket and the oil pump pipe screen assembly. Tighten the oil pump pipe screen bolts to 15N.m(11 ft lbs).

2. Install the oil pan.
3. Clean the oil pan bolts and apply 1 drop of thread lock compound GM P/N 12345382 or equivalent to the oil pan bolt threads.

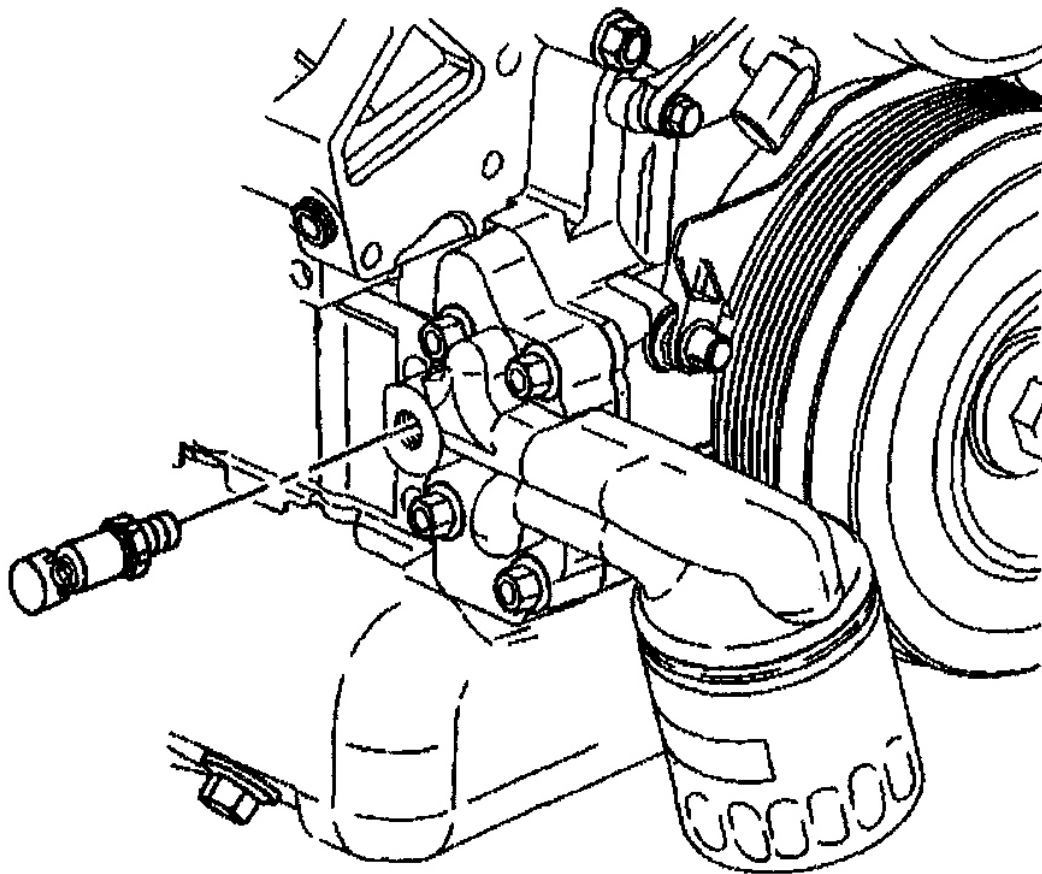
Important: Do not overtighten bolts or damage to the oil pan may occur, resulting in an oil leak.

4. Install the oil pan bolts. Tighten the oil pan bolts to 14 N.m (10 ft lbs).
5. Install the oil level sensor. Tighten the oil level sensor to 20 N.m (15 ft lbs).
6. Install the torque converter covers.
7. Install the engine mount bracket to the engine.
8. Loosely install the right engine mount bracket bolts to the engine.
9. Loosely install the left engine mount bracket bolts to the engine. Tighten the engine mount bracket bolts to 102 N.m (75 ft lbs).
10. Lower the vehicle.
11. Using the engine support fixture lower the engine.
12. Raise the vehicle.
13. Install the engine mount upper nuts to the engine mount. Tighten the engine mount upper nuts to 78 N.m (58 ft lbs).
14. Install the engine mount lower nuts to the engine mount. Tighten the engine mount lower nuts to 78 N.m (58 ft lbs).
15. Install the oil level sensor wiring harness and the oil level sensor wiring harness bolt to the engine. Tighten the oil level sensor wiring harness bolt to 10 N.m (89 in lbs).
16. Connect the oil level sensor electrical connector.
17. Install the power steering oil cooler pipe brackets to the frame.
18. Install right exhaust manifold pipe stud nuts to the catalytic converter. Tighten the right exhaust manifold pipe stud nuts to 32 N.m (24 ft lbs).
19. Install the oil filter.
20. Lower the vehicle.
21. Remove the engine support fixture.
22. Install the right and left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
23. Install the air inlet duct to the throttle body.
24. Connect the intake air temperature (IAT) sensor electrical connector.
25. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
26. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
27. Connect the negative battery cable.
28. Inspect for leaks.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH - REPLACEMENT

Removal Procedure

1. Raise and support the vehicle.
2. Disconnect the engine oil pressure switch electrical connector.
3. Remove the oil pressure switch.



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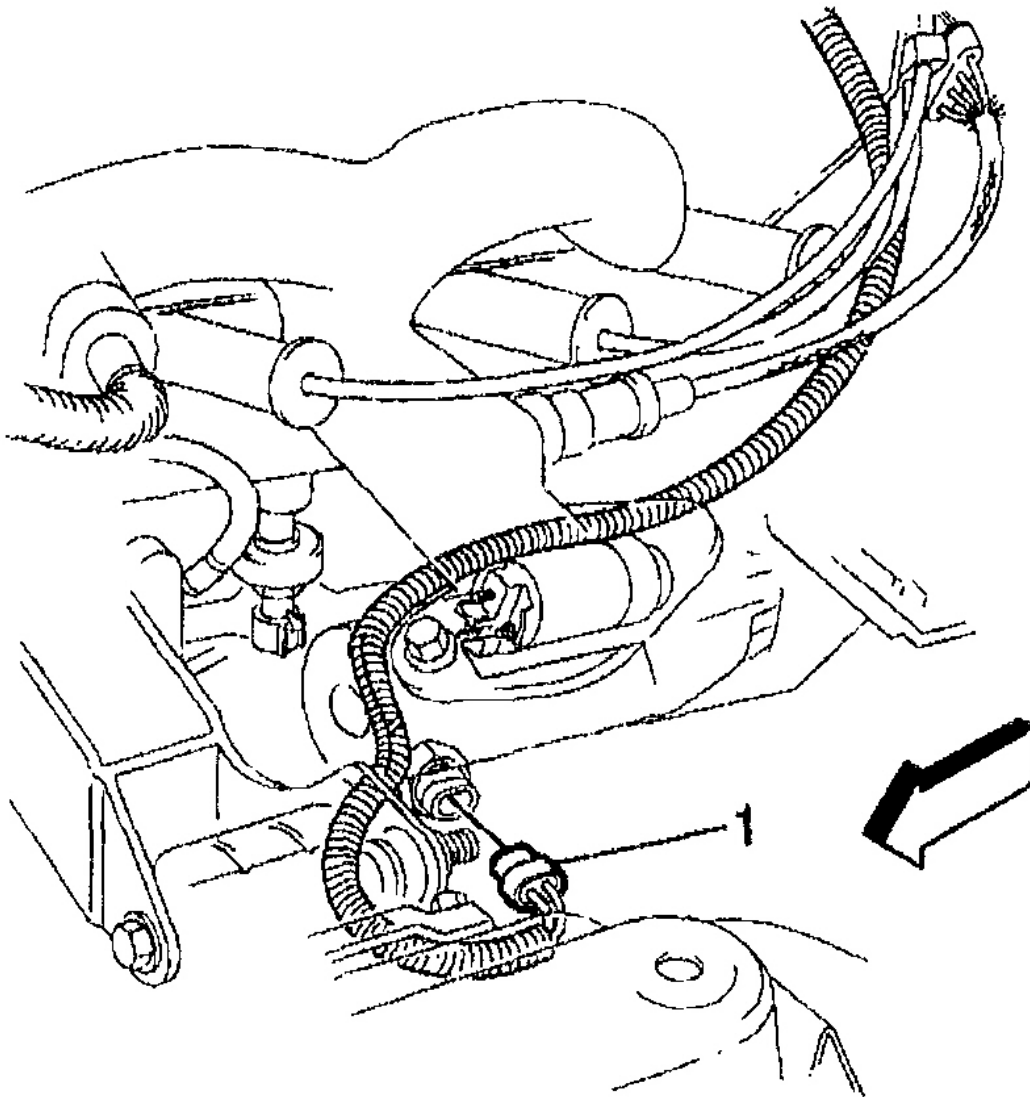
Fig. 136: Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine oil pressure switch. Tighten the switch to 16 N.m (12 ft lbs).
2. Connect the engine oil pressure switch electrical connector.
3. Lower the vehicle.

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

1. Raise and suitably support the vehicle.
2. Remove the engine oil drain plug in order to drain the engine oil.
3. Disconnect the electrical connector (1) from the oil level sensor.



G01807432

Fig. 137: Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor from the oil pan.

Installation Procedure

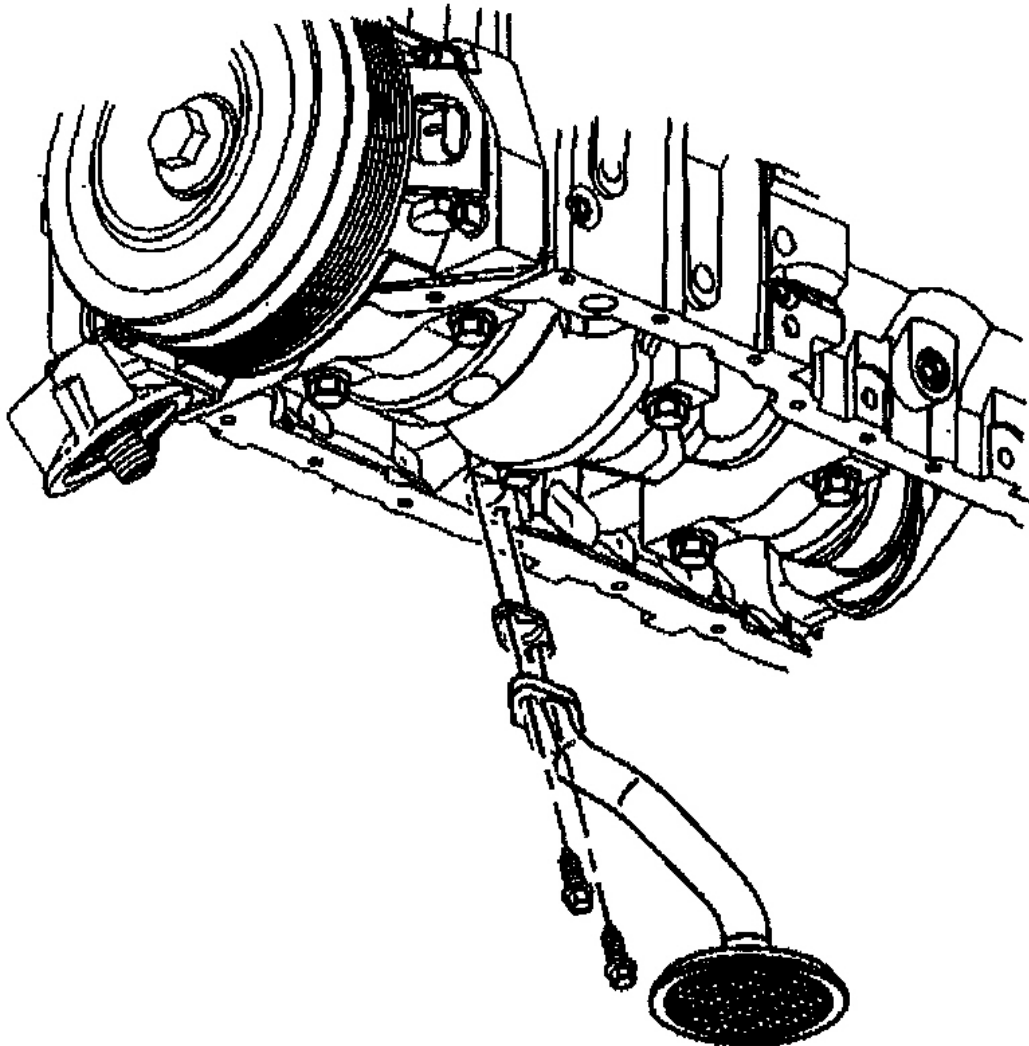
1. Install the oil level sensor to the oil pan. Tighten the oil level sensor to 20 N.m (15 ft lbs).
2. Connect the electrical connector (1) to the oil level sensor.
3. Install the engine oil drain plug. Tighten the drain plug to 30 N.m (22 ft lbs).
4. Lower the vehicle.
5. Refill the engine with new engine oil.
6. Start the engine and inspect for oil leaks.

OIL PUMP PIPE & SCREEN ASSEMBLY - REPLACEMENT

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

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan - Replacement**.
2. Remove the oil pump screen bolts.
3. Remove the oil pump pipe and the screen.
4. Remove the oil pump pipe and screen gasket.
5. Clean the screen and housing with solvent and blow dry.
6. Inspect the oil pump pipe and the screen, replace if necessary.
7. Clean the gasket mating surface on the pipe flange and the cylinder block.



G01807437

Fig. 138: Oil Pump Pipe & Screen Assembly
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the new oil pump pipe and screen gasket.
2. Install the oil pump pipe and screen.
3. Install the oil pump screen bolts. Tighten the bolts to 15 N.m (11 ft lbs).
4. Install the oil pan.

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

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

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

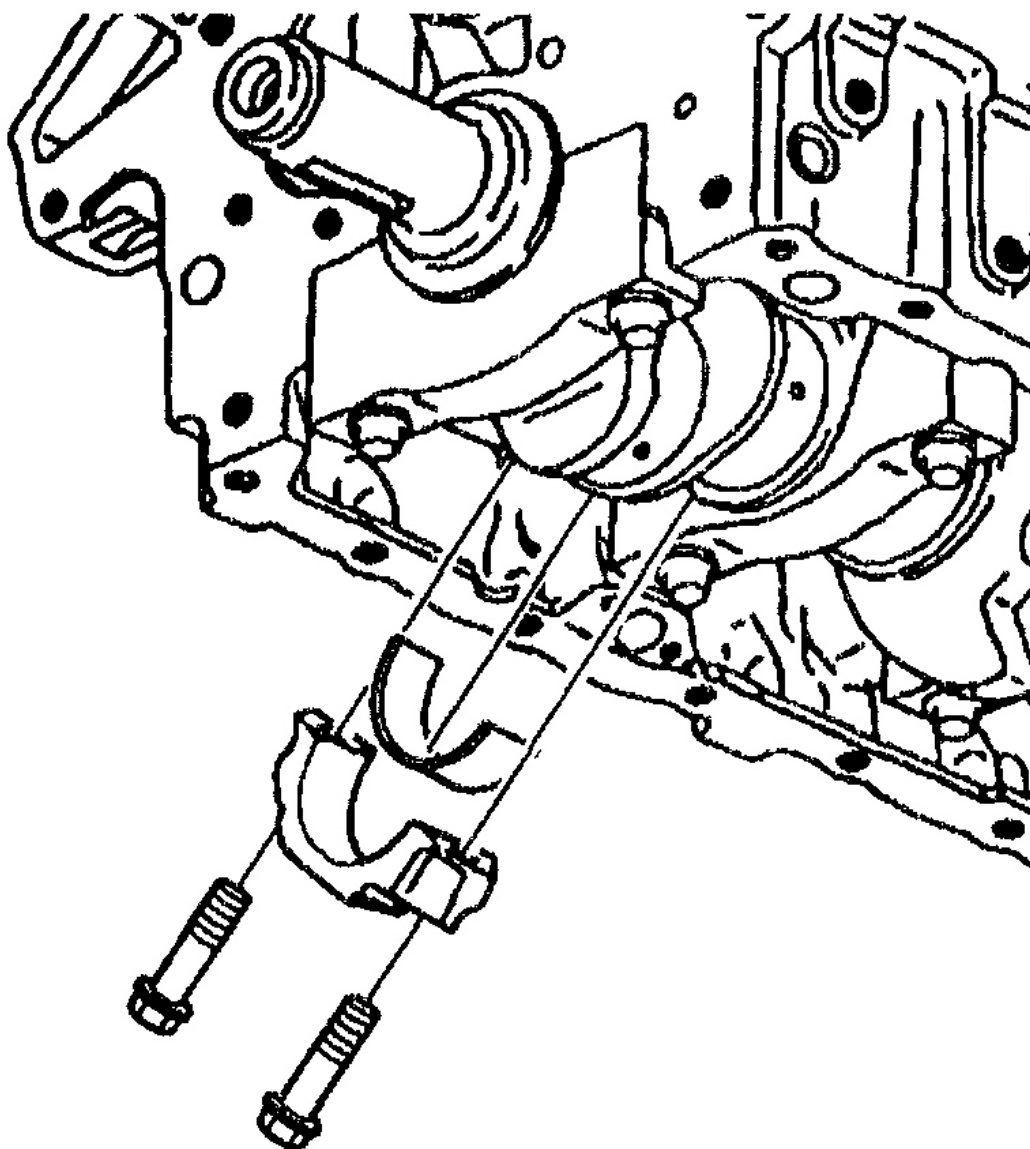
CONNECTING ROD BEARING - REPLACEMENT

Tools Required

- **J 36660-A** Torque Angle Meter
- **J 41507** Connecting Rod Assembly Guide

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan - Replacement**.
2. Remove the spark plug(s) from the cylinder(s) that is being serviced.
3. Position the connecting rod to be serviced to Bottom Dead Center (BDC) by rotating the crankshaft.
4. Remove the connecting rod cap bolts.
5. Remove the connecting rod cap and lower connecting rod bearing.

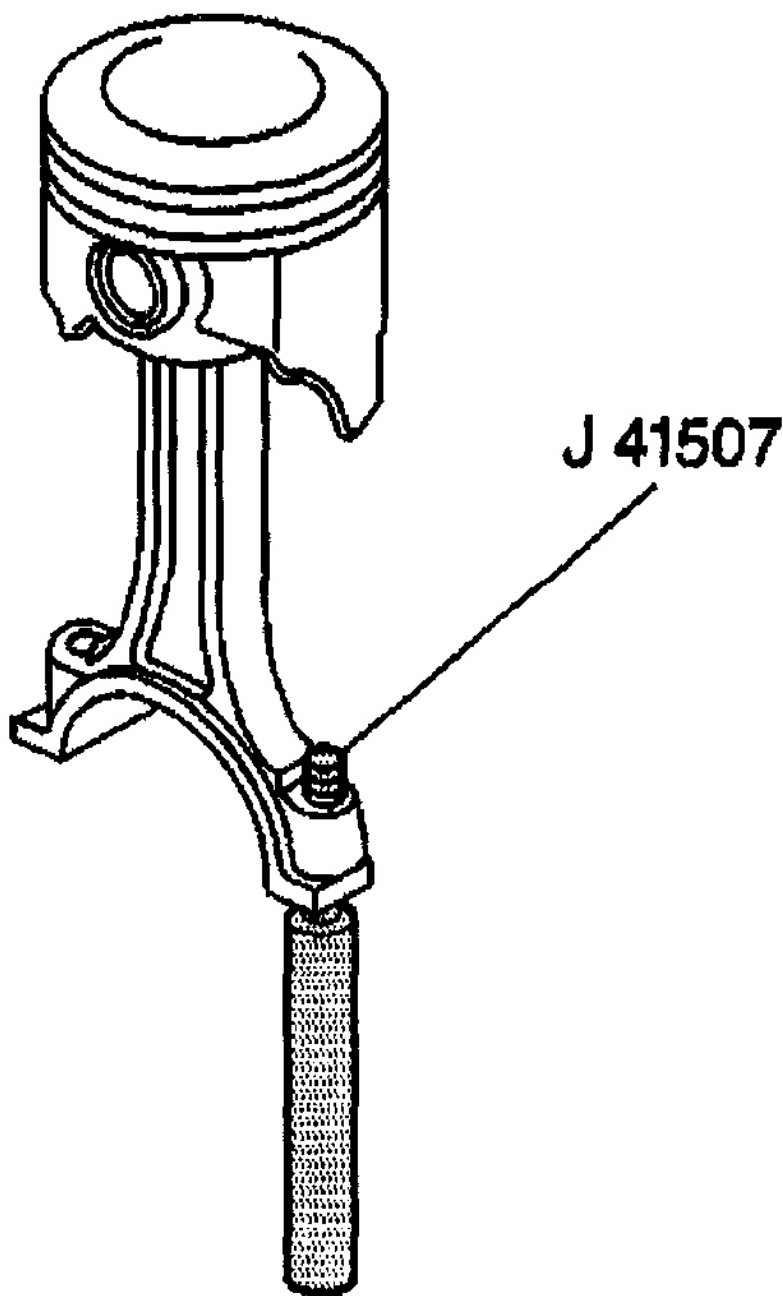


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Fig. 139: Connecting Rod Cap
Courtesy of GENERAL MOTORS CORP.

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

6. Remove the lower connecting rod bearing from the connecting rod cap.
7. Install the **J 41507** to the connecting rod.



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Fig. 140: Connecting Rod Assembly Guide
Courtesy of GENERAL MOTORS CORP.

8. Use the **J 41507** in order to push up the connecting rod and piston and access the upper connecting rod bearing.

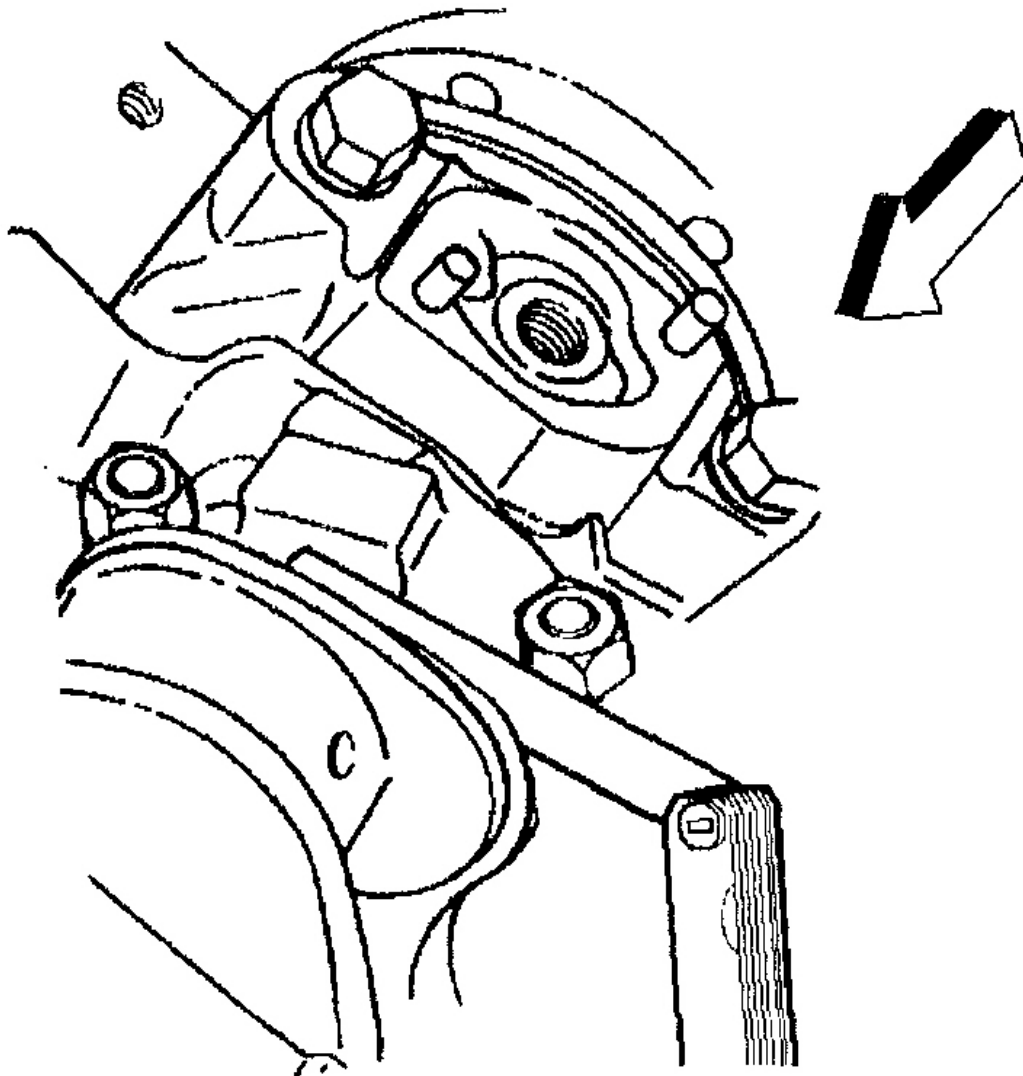
9. Remove the upper connecting rod bearing.
10. Wipe the oil from the bearings.
11. Inspect the connecting rod bearings. Refer to **CRANKSHAFT & BEARINGS - CLEANING & INSPECTION**.
12. Measure the bearing clearance. Refer to **CRANKSHAFT & BEARINGS - CLEANING & INSPECTION**.

Installation Procedure

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

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

1. Dip the connecting rod cap bolts in clean engine oil.
2. Use clean engine oil in order to lubricate the bearing surface.
3. Install the upper connecting rod bearing.
4. Use the **J 41507** in order to pull down the piston, connecting rod and upper connecting rod bearing.
5. Remove the **J 41507**.
6. Install the lower connecting rod bearing to the connecting rod cap.
7. Install the connecting rod cap.
8. Install the connecting rod cap bolts. Tighten the connecting rod cap bolts to 27 N.m (20 ft lbs). Use the **J 36660-A** in order to rotate the connecting rod cap bolts an additional 50 degrees.
9. Pry the connecting rod back and forth in order to check for binding. If necessary, loosen and then retighten the connecting rod cap bolts.
10. Measure the connecting rod side clearance. Refer to **Engine Mechanical Specifications**.



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Fig. 141: Measuring Connecting Rod Side Clearance
Courtesy of GENERAL MOTORS CORP.

11. Install the spark plug(s).
12. Install the oil pan. Refer to **Oil Pan - Replacement**.
13. Inspect for proper oil pressure.
14. Inspect for leaks.

ENGINE FLYWHEEL - REPLACEMENT

Tools Required

- **J 36660-A** Torque Angle Meter
- **J 37096** Flywheel Holder

Removal Procedure

1. Remove the transaxle.
2. Use the **J 37096** to prevent the flywheel from rotating.

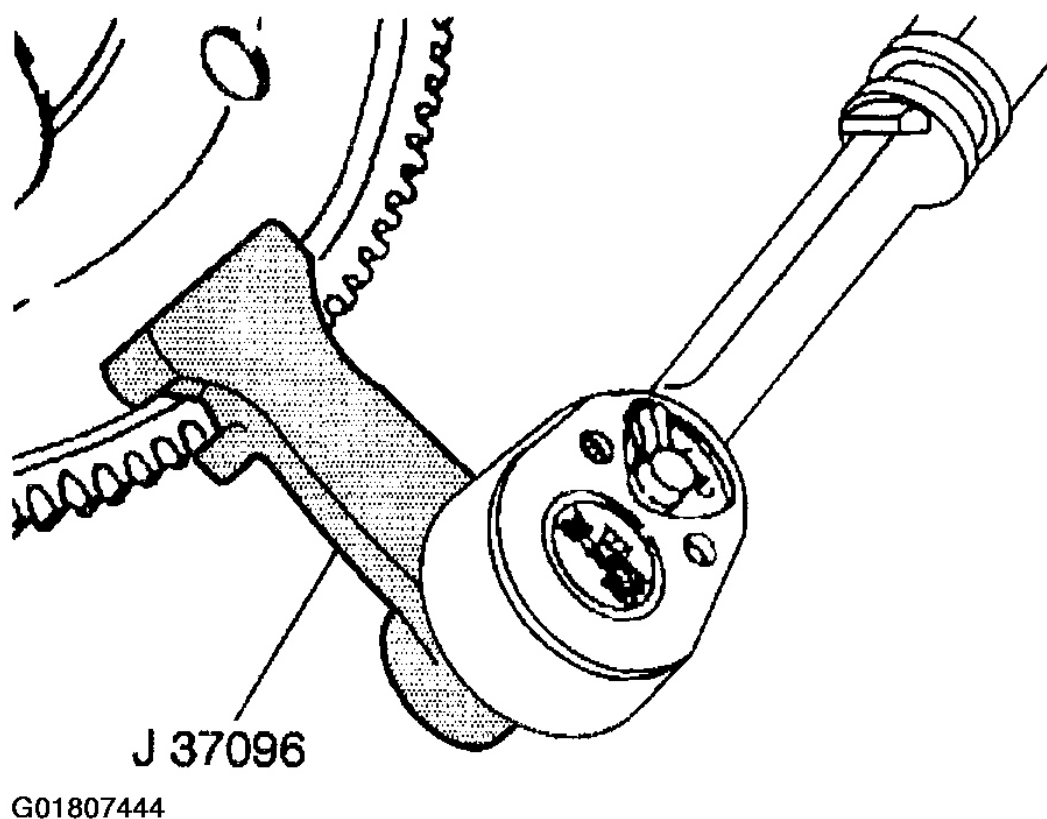


Fig. 142: Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

3. Loosen the 8 engine flywheel bolts.
4. Remove 7 of the 8 engine flywheel bolts, leaving 1 bolt at the top of the crankshaft rotation.
5. Firmly grasp the engine flywheel and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.
6. Remove the engine flywheel.

Installation Procedure

1. Install the engine flywheel.
2. Use the **J 37096** to prevent the flywheel from rotating.
3. Install the new engine flywheel bolts.
 - 3.1. Tighten the bolts to 15 N.m (11 ft lbs).
 - 3.2. Use the **J 36660-A** to rotate the bolts an additional 50 degrees.

Important: The crankshaft end play must be held in one direction during this check.

4. Use the following procedure to measure engine flywheel runout:
 - 4.1. Install a dial indicator on the engine block and check the engine flywheel runout at three attaching bosses. Refer to **Engine Mechanical Specifications**.
 - 4.2. If the runout is not within the specification and cannot be corrected, replace the engine flywheel.
5. Install the transaxle.

CRANKSHAFT REAR OIL SEAL - REPLACEMENT**Tools Required**

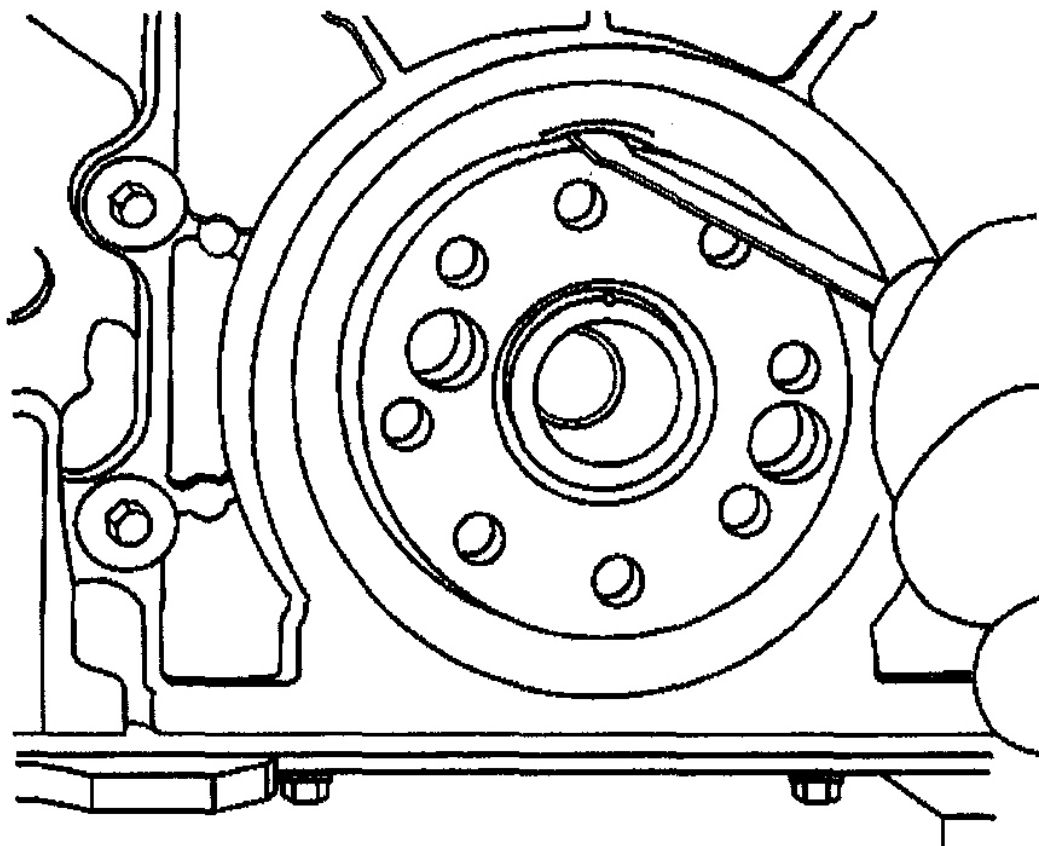
J 38196 Crankshaft Rear Oil Seal Installer

Removal Procedure

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

Important: Make sure not to damage the crankshaft outside diameter surface or chamfer with the pry tool.

2. Remove the crankshaft rear oil seal. Insert a flat-bladed tool through the dust lip at an angle. Pry out the crankshaft rear oil seal by moving the handle of the tool towards the end of the crankshaft. Repeat as necessary around the crankshaft rear oil seal.



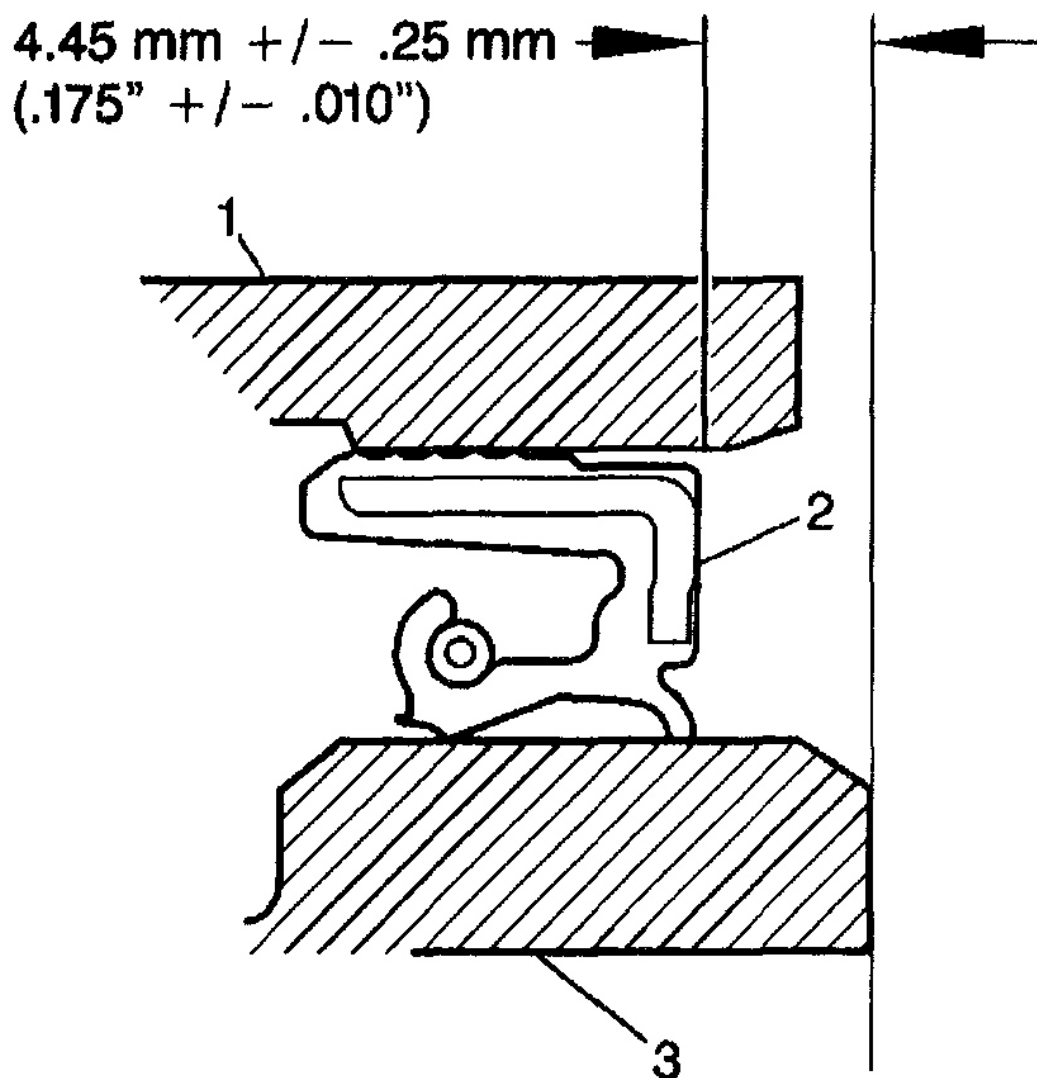
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Fig. 143: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Inspect the inside diameter of the bore. Correct or replace the crankshaft rear oil seal housing as required.
4. Inspect the crankshaft for nicks or burrs on the surface that contacts the crankshaft rear oil seal.
5. Repair or replace the crankshaft if necessary.

Installation Procedure

1. Apply engine oil to the inside and the outside diameter of the new crankshaft rear oil seal. Slide the new crankshaft rear oil seal over the mandrel until the back of the crankshaft rear oil seal bottoms squarely against the collar of the **J 38196**.



G01807449

Fig. 144: Positioning Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft rear oil seal using the following steps:
 - 2.1. Attach the **J 38196** to the crankshaft by hand, or tighten the attaching screws. Tighten the screws to 5 N.m (54 in lbs).
 - 2.2. Turn the T-handle of the **J 38196** so that the collar pushes the seal into the bore. Turn the handle until the collar is tight against the case. This will ensure that the crankshaft rear oil seal is seated properly between the crankshaft and the crankshaft rear oil seal housing.

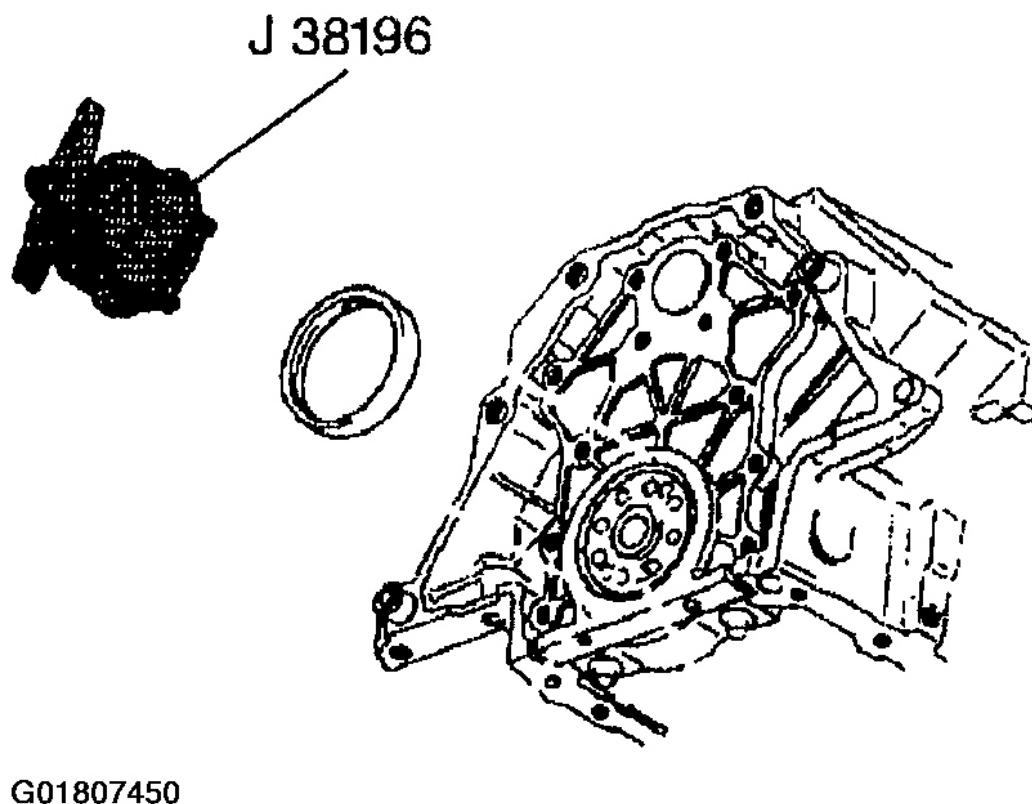


Fig. 145: Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

2.3. Loosen the T-handle of **J 38196** until it comes to a stop. This will ensure that the collar will be in the proper position for installing another new crankshaft rear oil seal.

2.4. Remove the attaching screws.

3. Install the engine flywheel.
4. Check and fill crankcase as necessary.
5. Inspect for leaks.

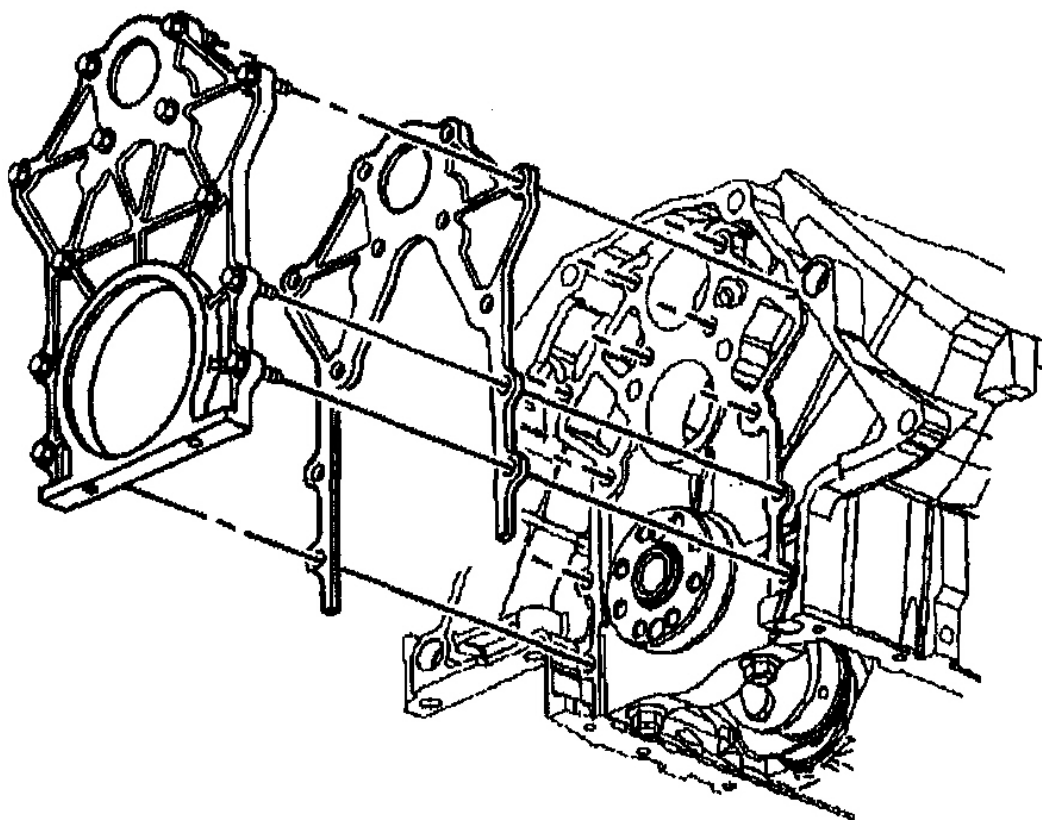
CRANKSHAFT REAR OIL SEAL & HOUSING - REPLACEMENT

Tools Required

- **J 36660-A** Torque Angle Meter
- **J 41349** Rear Cover Aligner

Removal Procedure

1. Raise and support the vehicle.
2. Drain the cooling system.
3. Drain the engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
4. Remove the engine flywheel. Refer to **Engine Flywheel - Replacement**.
5. Remove the oil pan. Refer to **Oil Pan - Replacement**.
6. Remove the crankshaft rear oil seal housing bolts.
7. Remove the crankshaft rear oil seal housing.



G01807451

Fig. 146: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft rear oil seal.

Important: Make sure not to damage the crankshaft outside diameter surface with any tool.

9. Remove the gasket from the crankshaft rear oil seal housing and the cylinder block.

10. Inspect the inside diameter of the bore. Correct or replace the crankshaft rear oil seal housing if necessary.
11. Inspect the crankshaft for nicks or burrs on the surface that contacts the seal.
12. Repair or replace the crankshaft if necessary.

Installation Procedure

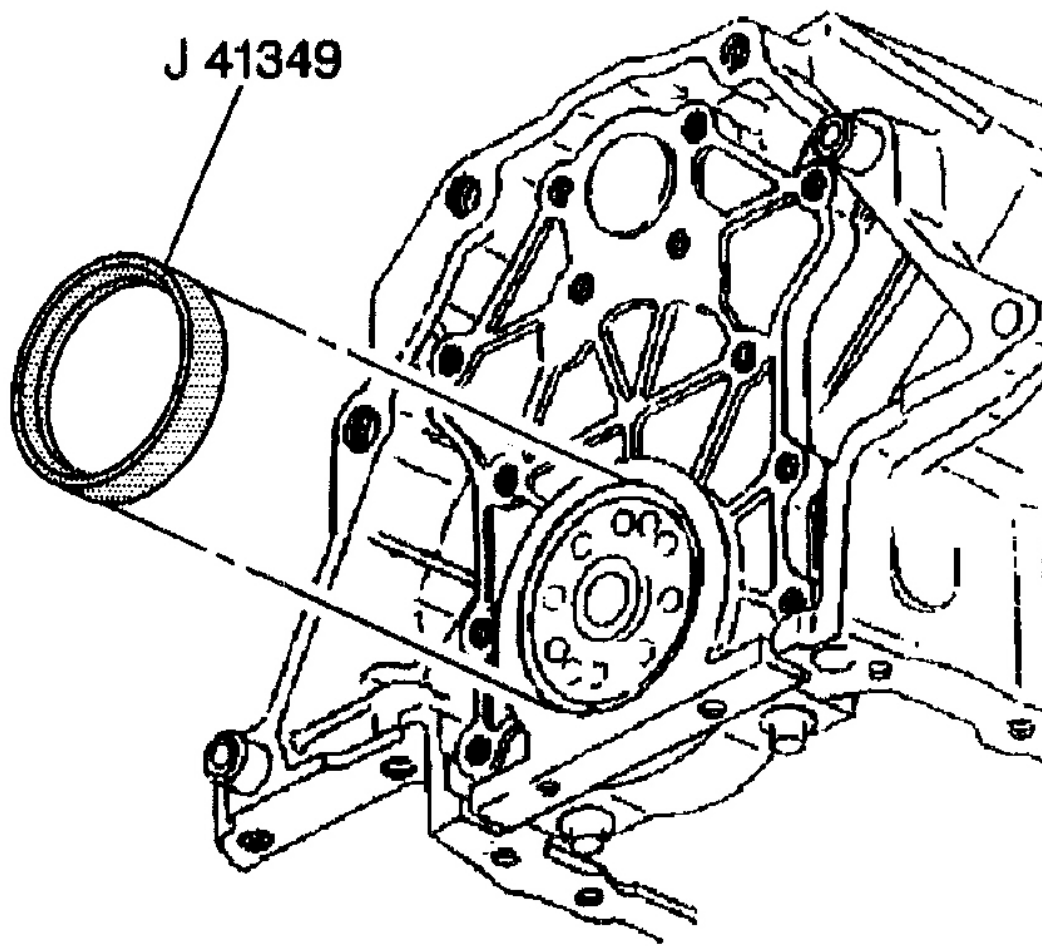
1. Make sure that the crankshaft rear oil seal is removed from the crankshaft rear oil seal housing.
2. Clean the old gasket from the crankshaft rear oil seal housing and the cylinder block.
3. Install the new gasket over the crankshaft rear oil seal housing bolt threads to aid in proper alignment of the gasket.

NOTE: **Correct alignment of the housing is crucial to sealing ability of the rear main and the oil pan. Take care when installing the housing to ensure that the housing is properly aligned. Failure to follow these procedures may result in oil leaks.**

4. Install the crankshaft rear oil seal housing and finger tighten all the bolts. Leave the rear cover bolts loose enough to adjust the crankshaft rear oil seal housing to hold the crankshaft rear oil seal housing in place. Make sure the gasket is not higher than the crankshaft rear oil seal housing.

Plastic inserts in the crankshaft rear oil seal housing are only used as an assembly aid and are not required for service.

5. Wipe a thin film of oil on both sides of the **J 41349** to aid in installation and removal from the crankshaft.
6. Install the **J 41349** over the crankshaft. Twisting or turning the **J 41349** aids in sliding it completely over the crankshaft.

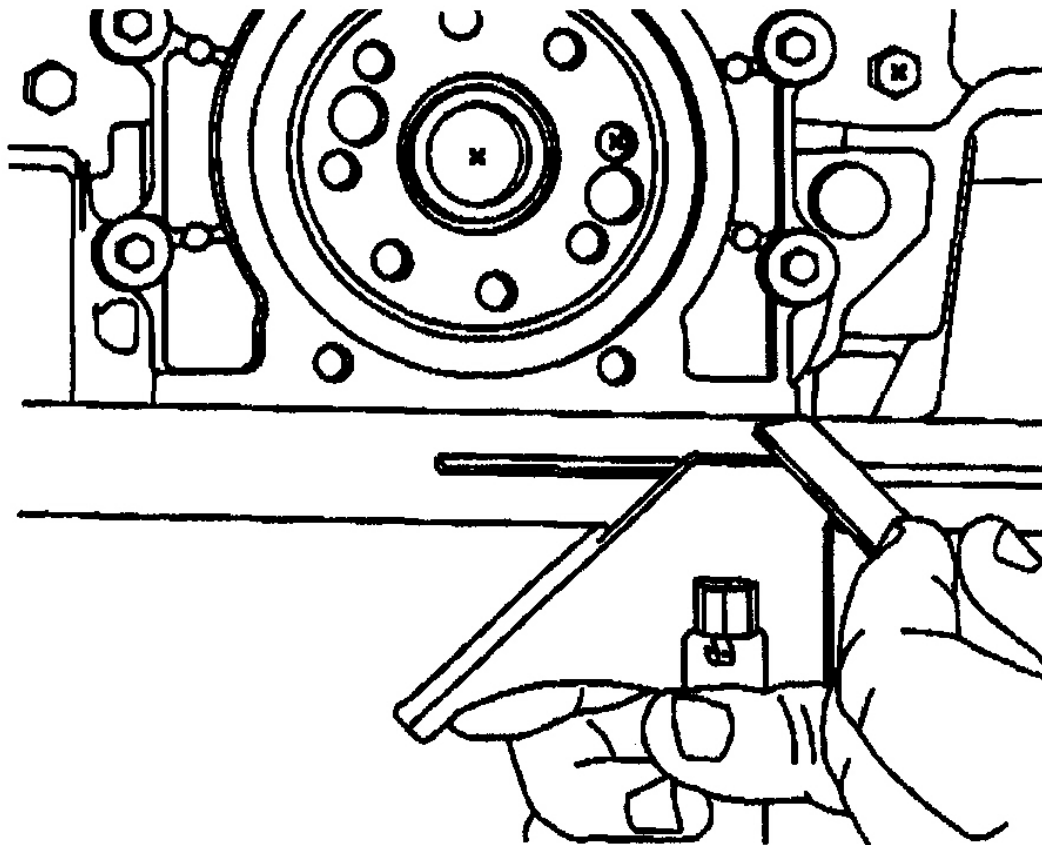


G01807453

Fig. 147: Rear Cover Aligner Tool
Courtesy of GENERAL MOTORS CORP.

7. Place a straight edge on the cylinder block oil pan flange and the rear oil seal housing flange. Use a feeler gauge to make sure that there is no more than 0.004 inch step high or low on each side. Rotate the crankshaft rear oil seal housing to get the step equal on each side, if necessary. If the crankshaft rear oil seal housing can not be rotated to get the step within specification, replace the crankshaft rear oil seal housing.
8. Tighten the crankshaft rear oil seal housing bolts. Tighten the crankshaft rear oil seal housing bolts to 15 N.m (11 ft lbs). Use the **J 36660-A** in order to rotate the crankshaft rear oil seal housing bolts an additional 50 degrees.
9. Remove the **J 41349**.
10. Recheck the step height on each side to make sure that the crankshaft rear oil seal housing did not move while tightening the bolts. If the step height is beyond specification, repeat steps through 8 and measure

again. If excessive clearance is still present, replace the crankshaft rear oil seal housing.



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Fig. 148: Checking Step Height

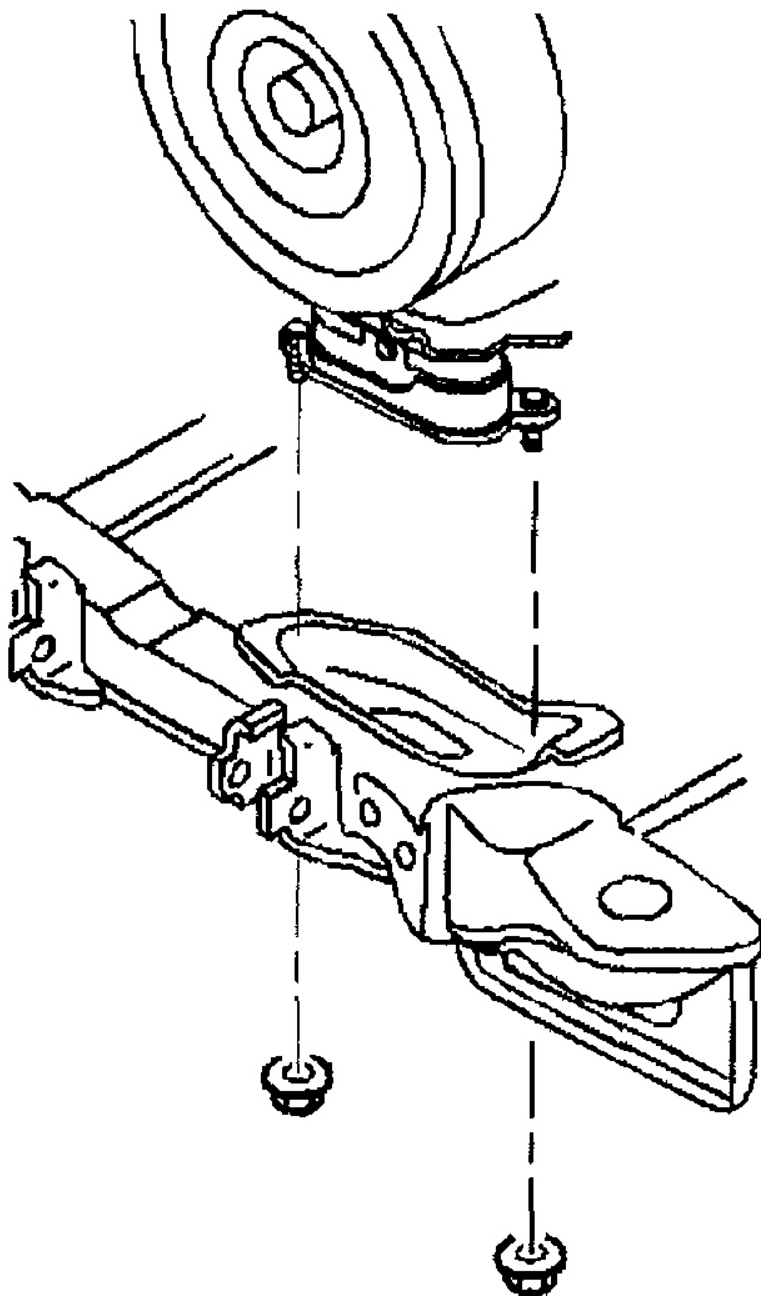
Courtesy of GENERAL MOTORS CORP.

11. Install the new crankshaft rear oil seal. Refer to Crankshaft Rear Oil Seal - Replacement.
12. Install the engine flywheel.
13. Lower the vehicle.
14. Fill the cooling system with engine coolant.
15. Fill the crankcase with engine oil. Refer to Engine Oil & Oil Filter - Replacement.
16. Inspect for leaks.

ENGINE - REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the hood.
3. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
4. Raise and support the vehicle.
5. Drain the engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
6. Drain the cooling system.
7. Remove the torque converter cover.
8. Remove the starter motor.
9. Remove the engine flywheel-to-torque converter bolts.
10. Scribe the torque converter to the flywheel for installation.
11. Remove the transaxle brace.
12. Remove the engine mount lower nuts.



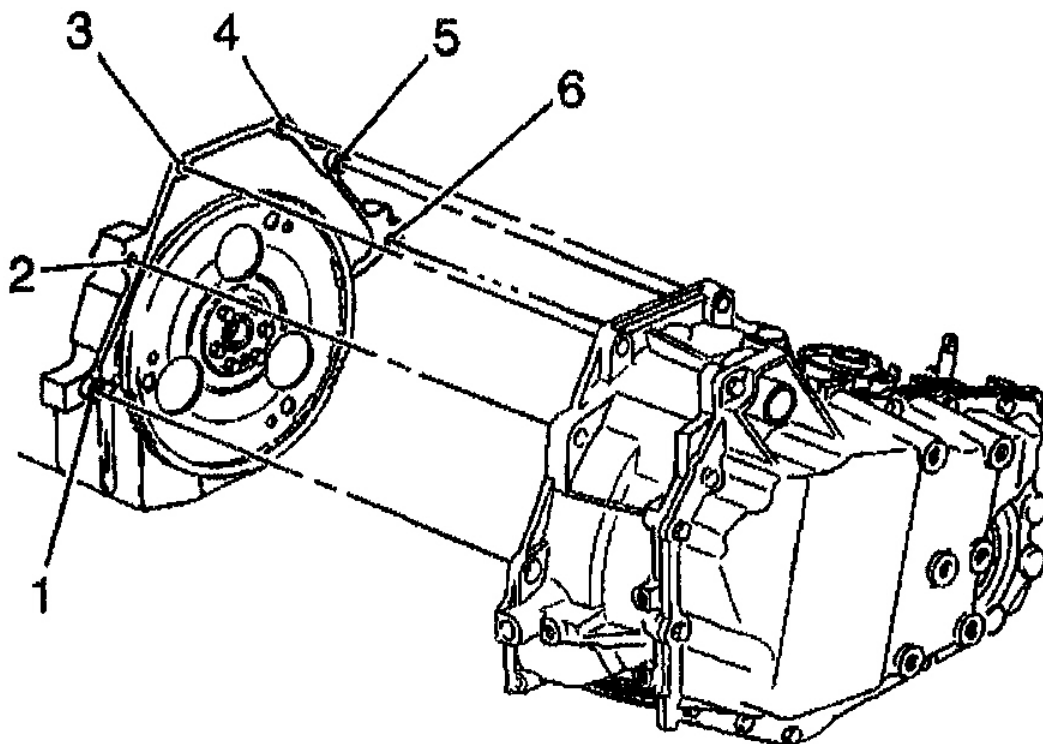
G01807455

Fig. 149: Engine Mount

Courtesy of GENERAL MOTORS CORP.

13. Remove the right exhaust manifold pipe stud nuts from the catalytic converter.
14. Remove the engine oil level sensor harness retainer bolt.

15. Remove the engine oil level harness retainer from the engine.
16. Disconnect and reposition the electrical connectors from the following components:
 - Vehicle speed sensor (VSS)
 - Engine oil pressure sensor
 - Engine oil level sensor
 - Knock sensors
 - Heated oxygen sensor (H02S)
17. Remove the oil filter adapter housing. Refer to **Oil Filter Adapter & Bypass Valve Assembly - Replacement**.
18. Remove the engine ground nut and engine ground from the transaxle stud.
19. Remove the bolt (6) and the stud (1) which secure the lower transaxle to the engine.



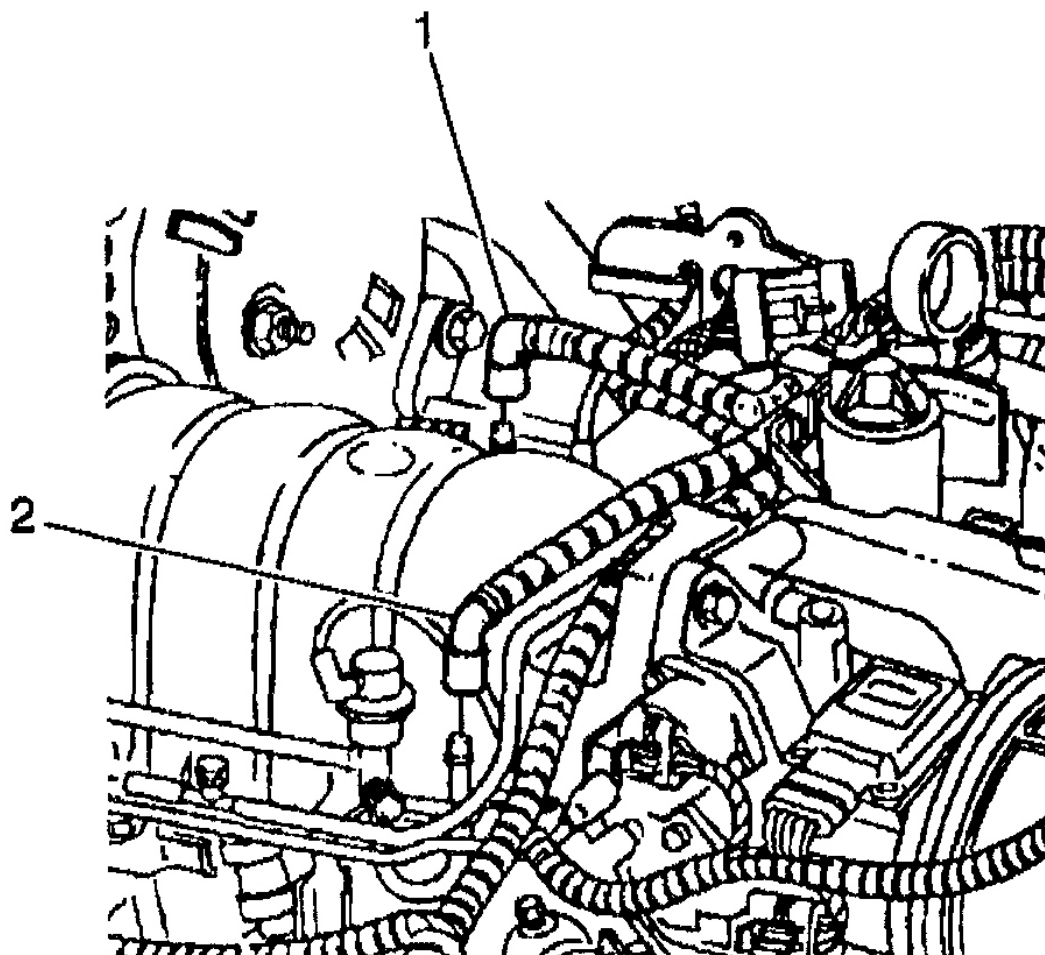
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Fig. 150: Bolt & Stud Securing Lower Transaxle To Engine
Courtesy of GENERAL MOTORS CORP.

20. Lower the vehicle while supporting the transaxle.
21. Remove the air cleaner assembly.

Important: Relieve the fuel pressure. Refer to **FUEL SYSTEM PRESSURE RELEASE**.

22. Disconnect the fuel lines (1,2) from the fuel rail. Lay the fuel lines aside.



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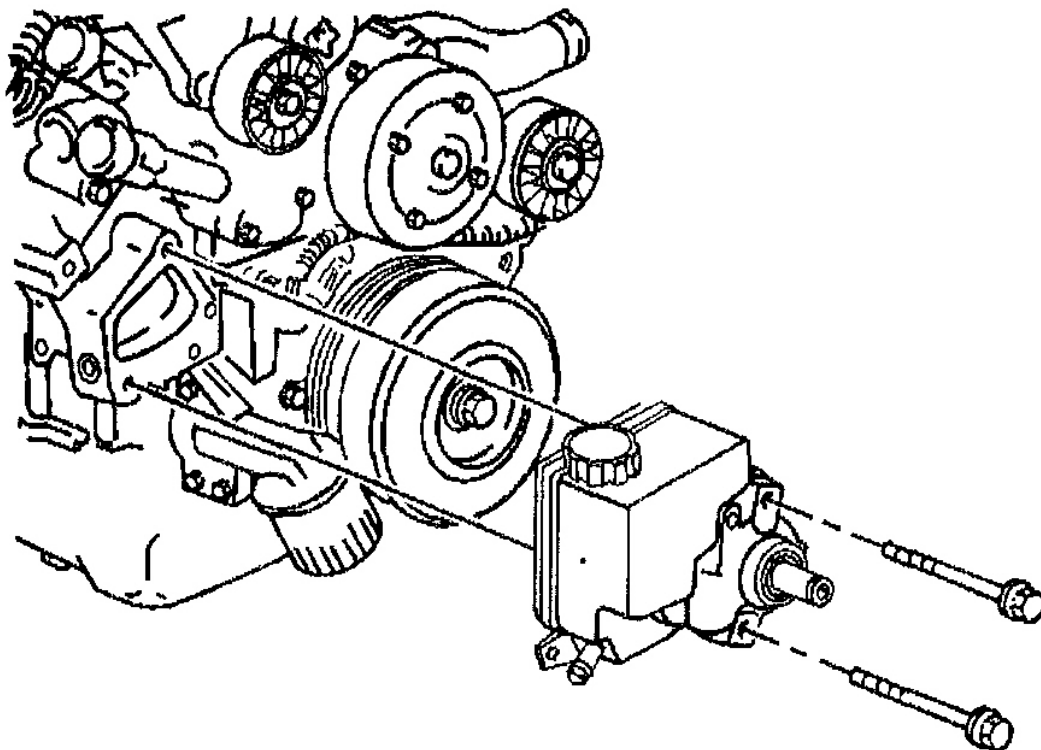
Fig. 151: Fuel Lines At Fuel Rail

Courtesy of GENERAL MOTORS CORP.

23. Disconnect the fuel vapor line.
24. Remove the throttle and cruise control cables and bracket from the throttle body.
25. Loosen the water pump pulley bolts.
26. Remove the drive belt. Refer to **Drive Belt - Replacement**.
27. Remove the water pump pulley bolts and the water pump pulley.
28. Remove the right and the left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right**

and **Engine Mount Strut - Replacement - Left**.

29. Remove the engine mount strut brackets from the radiator support. Refer to **Engine Mount Strut Bracket - Replacement - Upper Radiator Support**.
30. Disconnect the positive battery cable.
31. Remove the fan shroud.
32. Remove the vacuum booster hose from the engine.
33. Remove the A/C vacuum hose from the engine.
34. Remove the power steering pump and the power steering bolts from the engine. Lay the power steering pump aside.

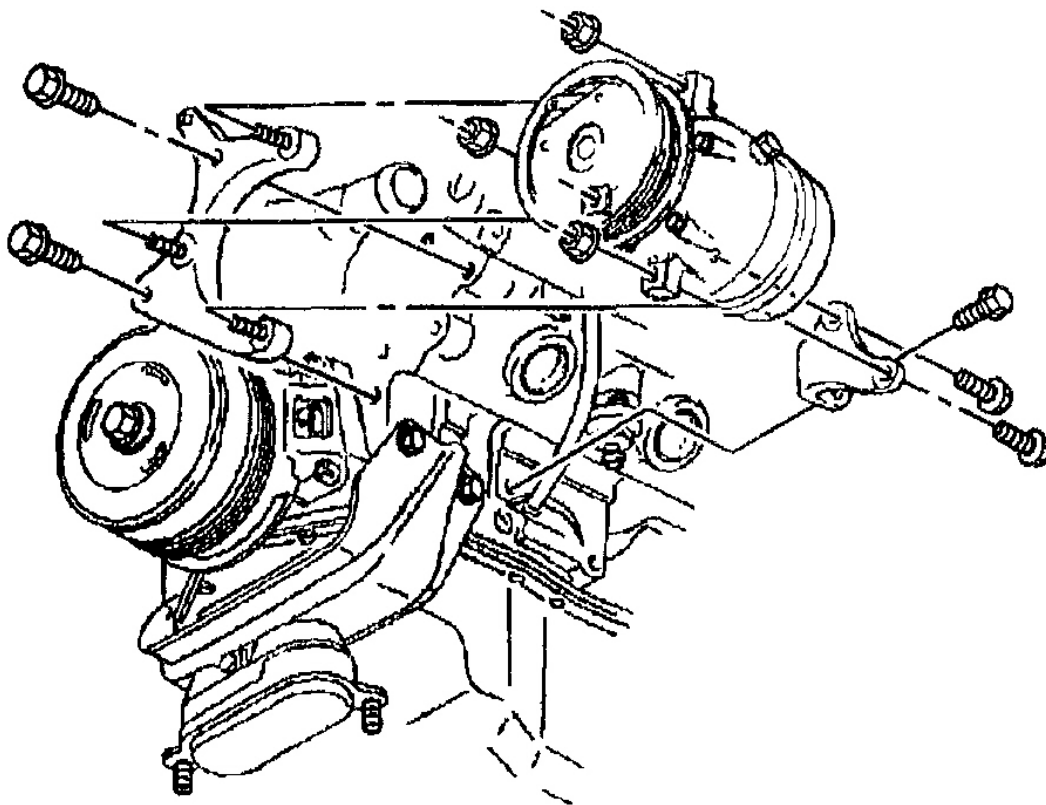


G01807460

Fig. 152: Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

35. Disconnect the upper engine electrical connectors from the following components:
 - Fuel injectors
 - Throttle position (T/P) sensor
 - Idle air control (IAC) valve
 - EVAP purge solenoid

- Exhaust gas recirculation (EGR) valve
 - Manifold absolute pressure (MAP) sensor
36. Remove upper engine wiring harness from retaining clips and reposition the engine wiring harness for engine removal.
 37. Remove the radiator inlet hose from the engine.
 38. Remove the radiator outlet hose from the water pump.
 39. Remove the heater hoses from the drive belt tensioner.
 40. Remove the A/C compressor nuts and the A/C compressor from the engine. DO NOT discharge the A/C system. Secure the compressor to the frame.

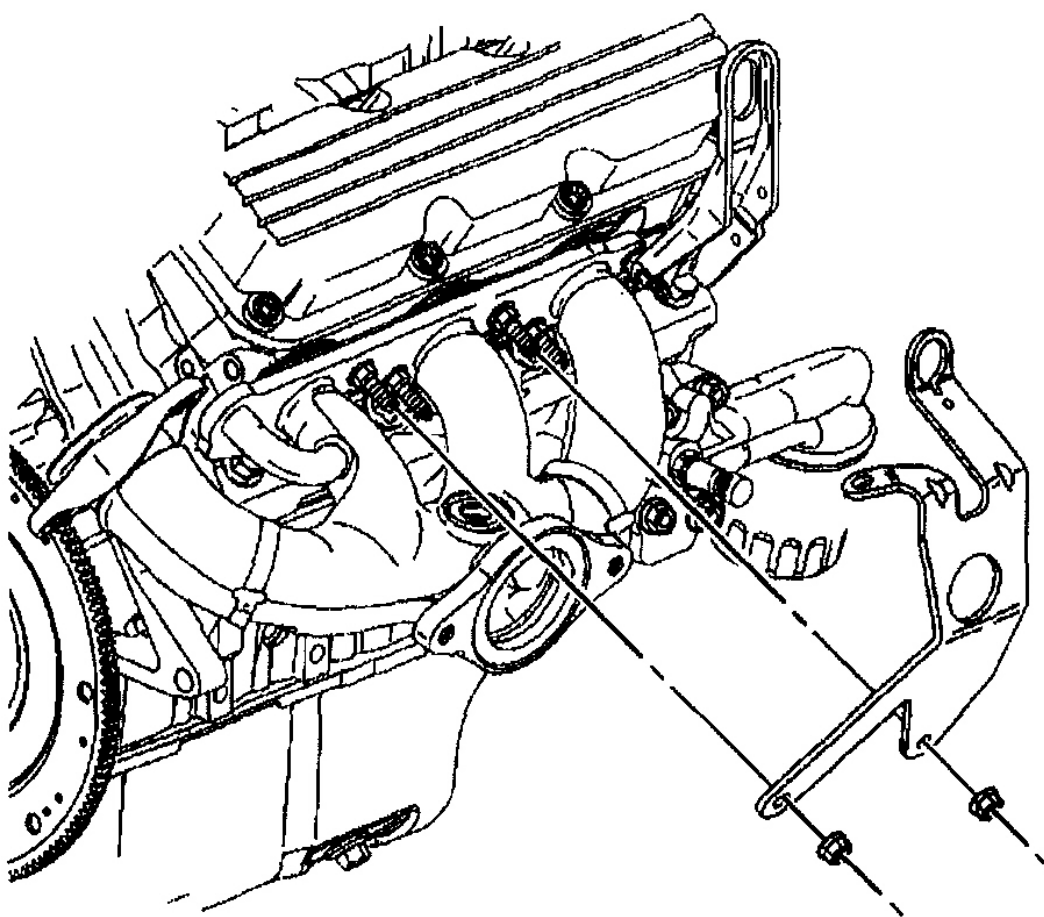


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Fig. 153: A/C Compressor
Courtesy of GENERAL MOTORS CORP.

41. Install the engine lifting device.
42. Remove the bolts (2,3,4,5) which secure the upper transaxle to the engine.
43. With the aid of an assistant, remove the engine from the vehicle.

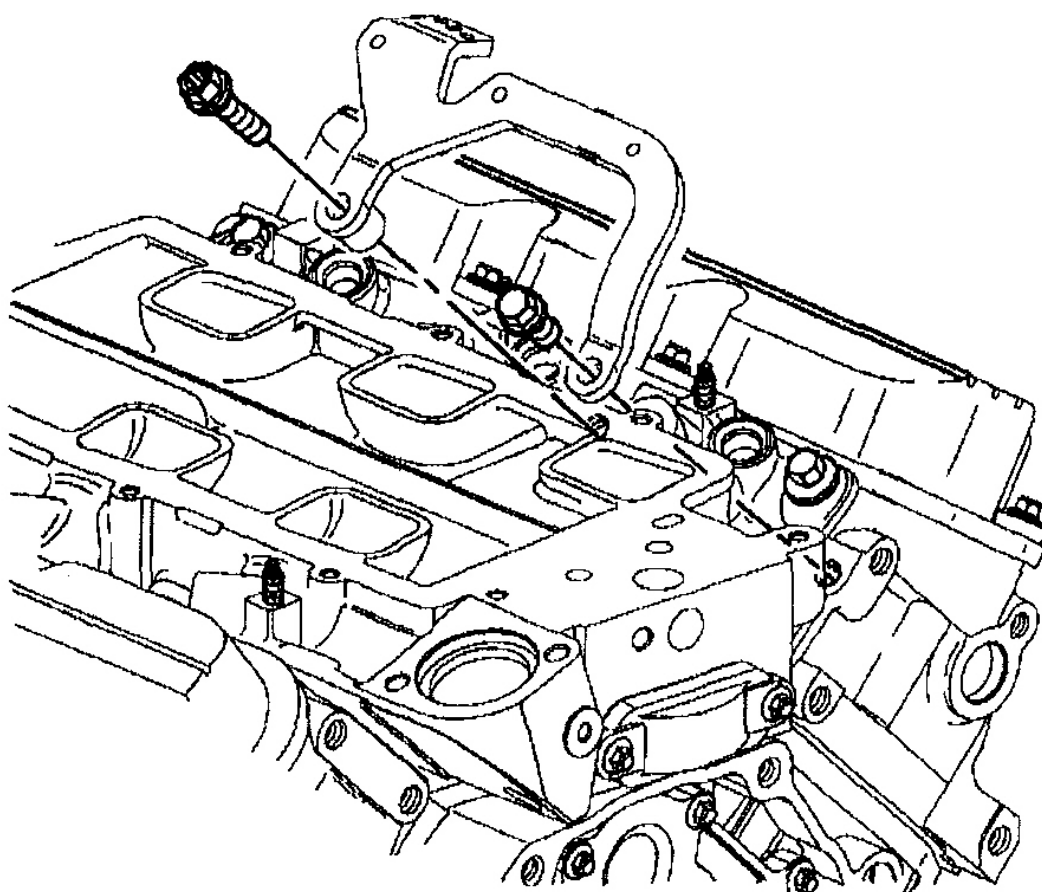
44. Remove the flywheel.
45. Install the engine to the engine stand.
46. Remove the oil level indicator tube nut from the exhaust manifold.
47. Remove the oil level indicator tube.
48. Remove the engine mount bracket with the engine mount. Refer to **Engine Mount & Bracket - Replacement**.
49. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**
50. Remove the ignition control module and the ignition control module bracket.
51. Remove the left and right side engine mount brackets. Refer to **Engine Mount Strut Bracket - Replacement - Left** and **Engine Mount Strut Bracket - Replacement - Right Upper** .
52. Remove the A/C compressor mounting bracket bolts and the A/C compressor bracket.
53. Remove the fuel injector sight shield bracket nuts.



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Fig. 154: Fuel Injector Sight Shield Bracket
Courtesy of GENERAL MOTORS CORP.

54. Remove the fuel injector sight shield bracket
55. Remove the EGR valve adapter from the right cylinder head.
56. Remove the upper intake manifold. Refer to **Intake Manifold - Replacement - Upper.**
57. Remove the generator brace bracket bolts.
58. Remove the generator brace bracket from the right cylinder head.



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Fig. 155: Generator Brace Bracket
Courtesy of GENERAL MOTORS CORP.

59. Remove the engine lift brackets.
60. Remove the crankshaft balancer. Refer to **Crankshaft Balancer - Replacement.**
61. Remove the right exhaust manifold, the left exhaust manifold and the exhaust crossover.

Installation Procedure

1. Install the right exhaust manifold, the left exhaust manifold and the exhaust crossover.
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer - Replacement**.
3. Install the engine lift brackets.
4. Install the bolts and the nuts to the engine lift brackets. Tighten the bolts and the nuts to 30 N.m (22 ft lbs).
5. Install the generator brace bracket to the right cylinder head.
6. Install the generator brace bracket bolts. Tighten the bolts to 50 N.m (37 ft lbs).
7. Install the upper intake manifold. Refer to **Intake Manifold - Replacement - Upper**.
8. Install the EGR valve adapter to the right cylinder head.
9. Install the fuel injector sight shield bracket.
10. Install the fuel injector sight shield bracket nuts. Tighten the nuts to 30 N.m (22 ft lbs).
11. Install the A/C compressor mounting bracket.
12. Install the A/C compressor bracket bolts. Tighten the bolts to 50 N.m (37 ft lbs).
13. Install the left and right side engine mount brackets. Refer to **Engine Mount Strut Bracket - Replacement - Left** and **Engine Mount Strut Bracket - Replacement - Right Upper**.
14. Install the ignition control module bracket and the ignition control module.
15. Install the drive belt tensioner. Refer to **Drive Belt Tensioner - Replacement**.
16. Install the engine mount bracket with the engine mount to the engine. Refer to **Engine Mount & Bracket - Replacement**.
17. Ensure that the O-ring is in place and Install the oil level indicator tube to the engine.
18. Install the tube nut on the oil level indicator to the exhaust manifold stud. Tighten the nut to 19 N.m (14 ft lbs).
19. Remove the engine from the engine stand.
20. Install the flywheel.
21. With the aid of an assistant install the engine to the vehicle.
22. Install the bolts (2,3,4,5) which secure the upper transaxle to the engine. Tighten the bolts to 75 N.m (55 ft lbs).
23. Remove the engine lifting device.
24. Install the A/C compressor to the engine.
25. Install the mounting nuts to the A/C compressor. Tighten the nuts to 30 N.m (22 ft lbs).
26. Install the heater hoses to the drive belt tensioner.
27. Install the radiator outlet hose to the water pump.
28. Install the radiator inlet hose to the engine.
29. Reposition the engine wiring to the engine.
30. Connect the upper engine electrical connectors to the following components:
 - Manifold absolute pressure (MAP) sensor
 - Exhaust gas recirculation (EGR) valve

- EVAP purge solenoid
 - Idle air control (IAC) valve
 - Throttle position (T/P) sensor
 - Fuel injectors
31. Install the upper engine wiring harness to the retaining clips.
 32. Install the power steering pump.
 33. Install the power steering pump bolts. Tighten the bolts to 34 N.m (25 ft lbs).
 34. Connect the A/C vacuum hose to the engine.
 35. Install the vacuum booster hose to the engine.
 36. Install the fan shroud.
 37. Connect the positive battery cable. Tighten the positive terminal bolt to 15 N.m (11 ft lbs).
 38. Install the engine mount brackets to the radiator support. Refer to **Engine Mount Strut Bracket - Replacement - Upper Radiator Support**.
 39. Install the right and the left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
 40. Install the water pump pulley.
 41. Install the water pump pulley bolts. Tighten the bolts to 13 N.m (116 in lbs).
 42. Install the drive belt. Refer to **Drive Belt - Replacement**.
 43. Install the throttle cable, the cruise control cable and bracket to the throttle body.
 44. Connect the fuel vapor line.
 45. Connect the fuel lines (1,2) to the fuel rail.
 46. Install the air cleaner assembly.
 47. Raise the vehicle and remove the transaxle support.
 48. Install the bolt (6) and the stud (1) which secure the lower transaxle to the engine. Tighten the bolt and the stud to 75 N.m (55 ft lbs).
 49. Install the engine ground to the transaxle stud.
 50. Install the engine ground nut. Tighten the nut to 35 N.m (26 ft lbs).
 51. Install the oil filter adapter housing. Refer to **Oil Filter Adapter & Bypass Valve Assembly - Replacement**.
 52. Reposition and connect the electrical connectors to the following components:
 - Heated oxygen sensor (H02S)
 - Knock sensors
 - Engine oil level sensor
 - Engine oil pressure sensor
 - Vehicle speed sensor (VSS)
 53. Install the engine oil level sensor harness retainer.
 54. Install the engine oil level sensor harness retainer bolt. Tighten the bolt to 10 N.m (89 in lbs).
 55. Install the catalytic converter pipe to the right exhaust manifold.

56. Install the stud nuts to the right exhaust manifold. Tighten the nuts to 32 N.m (24 ft lbs).
57. Install the lower nuts to the engine mount. Tighten the nuts to 78 N.m (58 ft lbs).
58. Install the transaxle brace.
59. Install the engine flywheel-to-torque converter bolts.
60. Install the starter motor.
61. Install the torque converter cover.
62. Lower the vehicle.
63. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield - Replacement**.
64. Install the hood.
65. Connect the negative battery cable.
66. Fill the crankcase with engine oil. Refer to **Engine Oil & Oil Filter - Replacement**.
67. Fill the cooling system.
68. Inspect for leaks.
69. Perform the CKP system variation learn procedure. Refer to **CRANKSHAFT POSITION SENSOR**.

ENGINE OIL & OIL FILTER - REPLACEMENT

Removal Procedure

1. Raise and support the vehicle.
2. Position the oil drain pan under the engine oil drain plug.
3. Remove the engine oil drain plug.
4. Clean and inspect the engine oil drain plug, repair or replace if necessary.
5. Clean and inspect the engine oil drain plug sealing surface on the oil pan, repair or replace oil pan if necessary.
6. Remove the oil filter.
7. Clean and inspect the oil filter sealing area on the oil filter adapter. Repair or replace if necessary. Refer to **Oil Filter Adapter & Bypass Valve Assembly - Replacement**.

Installation Procedure

1. Lightly oil the - Replacement oil filter gasket with clean oil and install the new oil filter.
2. Refer to the instructions included with the new oil filter. Install the new oil filter.
3. Install the engine oil drain plug. Tighten the engine oil drain plug to 30 N.m (22 ft lbs).
4. Remove the oil drain pan.
5. Lower the vehicle.
6. Fill the engine with new engine oil.
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.

10. Remove the oil level indicator from the oil indicator tube.
11. Clean off the indicator end of the oil level indicator with a clean paper towel or cloth.
12. Install the oil level indicator into the oil level indicator tube until the oil level indicator handle contacts the top of the oil level indicator tube.
13. Again, remove the oil level indicator from the oil level indicator tube keeping the tip of the oil level indicator down.
14. Inspect the level of the engine oil on the oil level indicator.
15. If necessary, readjust the oil level by adding or draining the engine; oil.
16. Inspect for oil leaks.

ROTATING ENGINE FOR SERVICE ACCESS

Tools Required

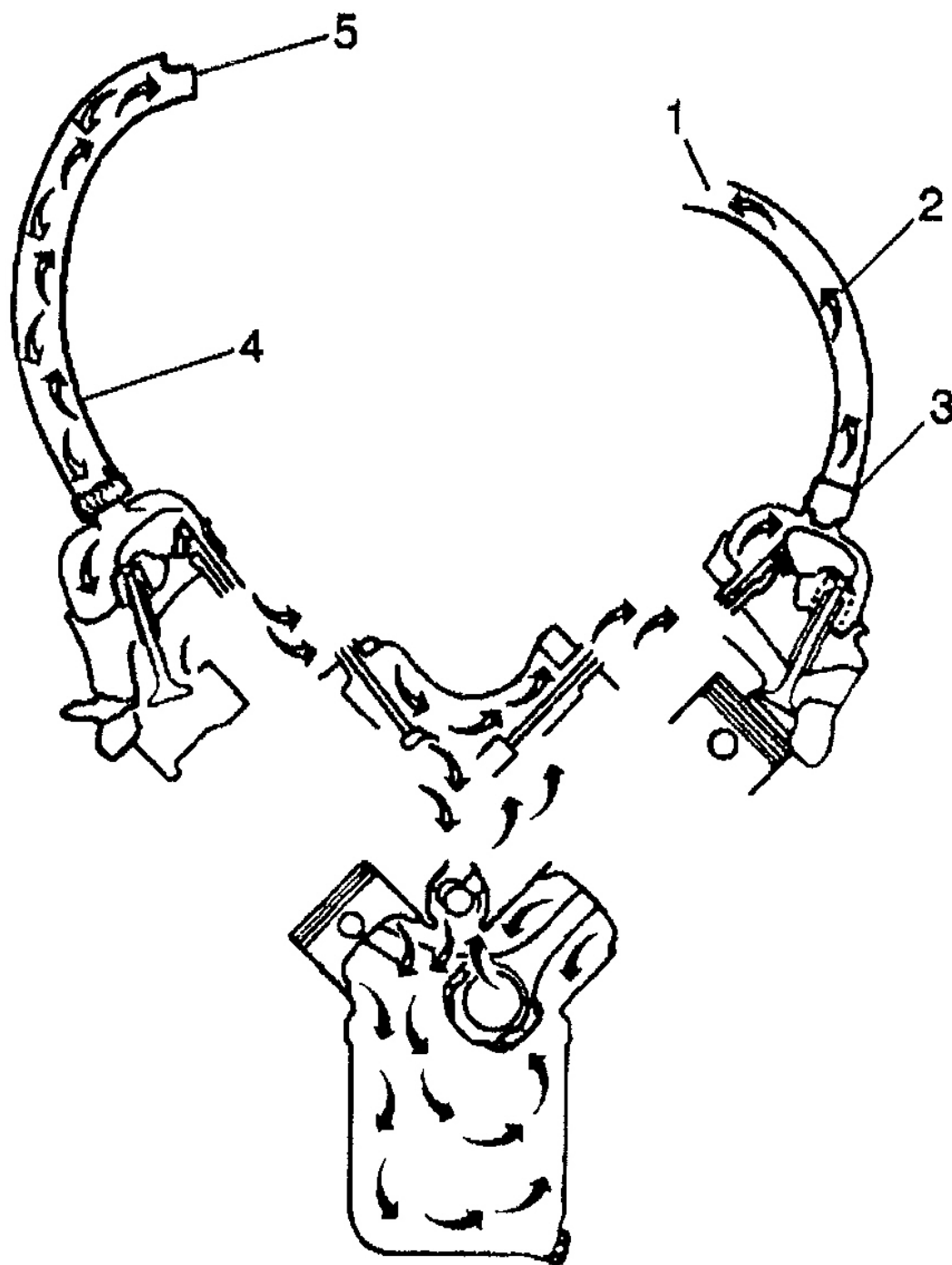
J 41131 Engine Tilt Strap

1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. Remove the air inlet duct from the throttle body.
3. Apply the parking brake.
4. Put the transaxle in the Neutral position.
5. Remove the right and the left engine mount struts. Refer to **Engine Mount Strut - Replacement - Right** and **Engine Mount Strut - Replacement - Left**.
6. Install the J 41131 to the right strut mount bracket and the upper radiator support.
7. Rotate the engine forward for component access.

DESCRIPTION & OPERATION

CRANKCASE VENTILATION SYSTEM INSPECTION/DESCRIPTION

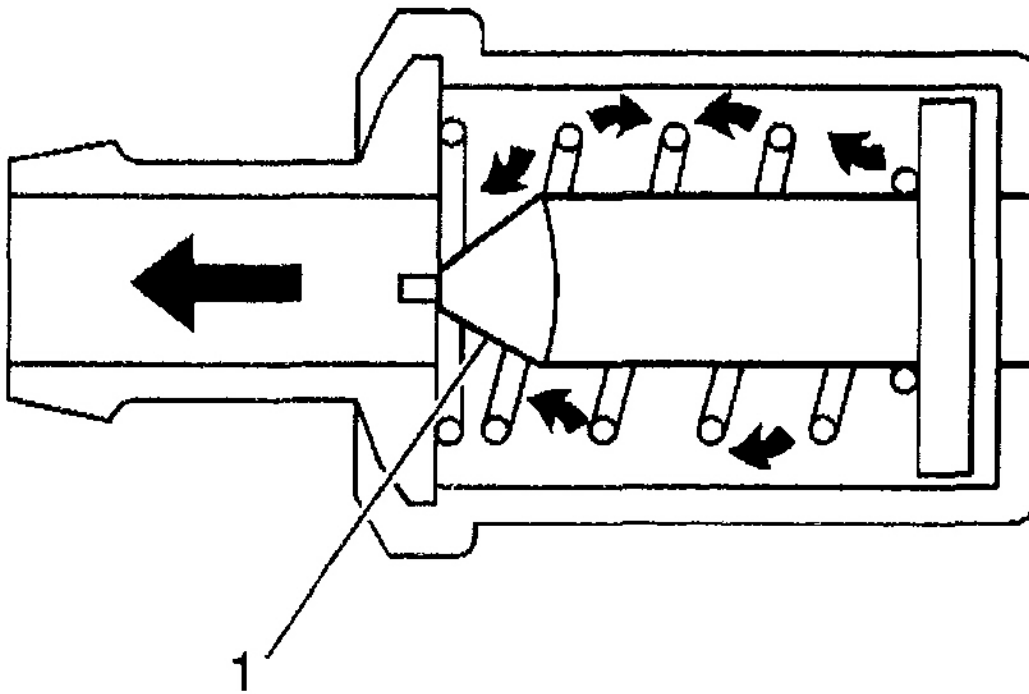
Inspection/Description



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Fig. 156: Crankcase Ventilation System
Courtesy of GENERAL MOTORS CORP.

The Crankcase Ventilation System is used to consume crankcase vapors (1) in the combustion process instead of venting them to atmosphere. Fresh air from the throttle body is supplied to the crankcase, mixed with blow-by gases and then passed through a crankcase ventilation valve into the intake manifold.



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Fig. 157: Crankcase Ventilation Valve
Courtesy of GENERAL MOTORS CORP.

The primary control is through the crankcase ventilation valve (1) which meters the flow at a rate depending on inlet vacuum. To maintain idle quality, the crankcase ventilation valve restricts the flow when inlet vacuum is high. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent into the throttle body to be consumed by normal combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley

- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. 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.

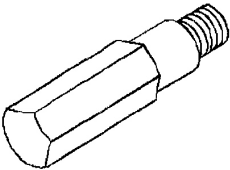
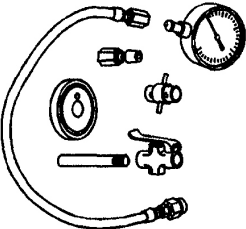
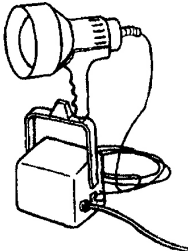
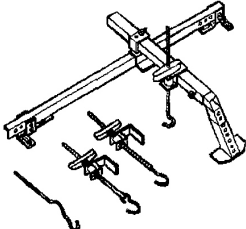
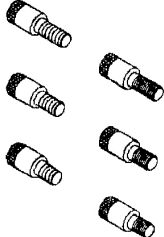
TOOLS & EQUIPMENT

Work in a clean and well-lit area. Have the following components available before you begin to work:

- A suitable parts cleaning tank.
- A compressed air supply.
- Trays, in order to keep the parts and the fasteners organized.
- An adequate set of hand tools.

An approved engine repair stand will prevent personal injury or damage to the engine components. The special tools are designed in order to quickly and safely accomplish the operations for which the tools are intended. Using the tools will minimize possible damage to the engine components. Precision measuring tools are required for the inspection of certain critical components. Torque wrenches are needed for the correct assembly of various parts.

SPECIAL TOOLS & EQUIPMENT

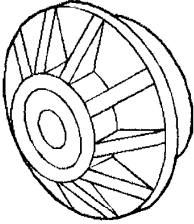
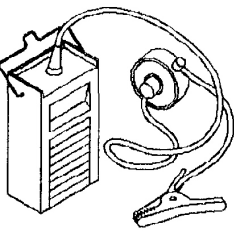
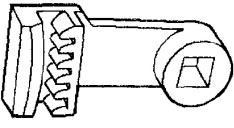
Illustration	Tool Number/Description
	J 23590 Spark Plug Port Adapter
	J 25087-C Oil Pressure Tester and Pump Primer
	J 28428-E High Intensity Black Light Kit
	J 28467-B Universal Engine Support Fixture
	J 28467-90A Engine Support Fixture Adapter

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Fig. 158: Special Tools & Equipment (1 Of 5)
Courtesy of GENERAL MOTORS CORP.

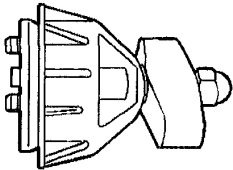
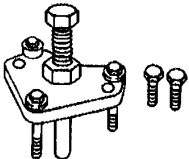
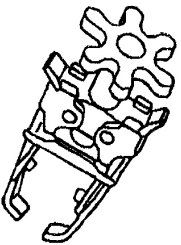
2002 Chevrolet Monte Carlo LS

2002 ENGINES Engine Mechanical - Impala & Monte Carlo - 3.8L

Illustration	Tool Number/Description
	J 35354 Seal Installer
	J 35667-A Cylinder Head Leakdown Tester
	J 36462-A Engine Support Adapter Leg Set
	J 36660-A Torque Angle Meter
	J 37096 Flywheel Holder

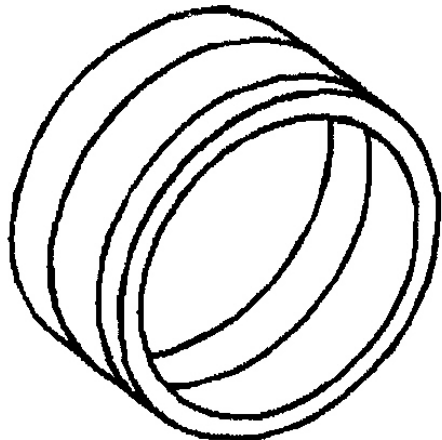
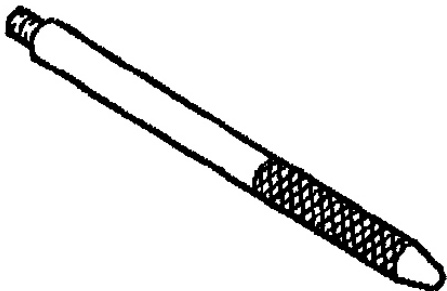
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Fig. 159: Special Tools & Equipment (2 Of 5)
Courtesy of GENERAL MOTORS CORP.

Illustration	Tool Number/Description
	J 38196 Crankshaft Rear Oil Seal Installer
	J 38197-A Crankshaft Balancer Puller
	J 38606 Valve Spring Compressor
	J 38722 Compression Tester
	J 41131 Engine Tilt Strap

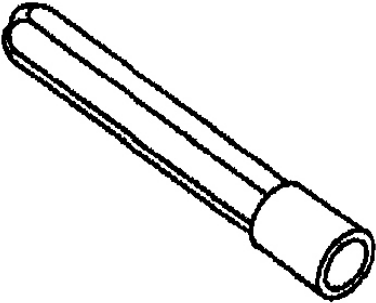
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Fig. 160: Special Tools & Equipment (3 Of 5)
Courtesy of GENERAL MOTORS CORP.

Illustration	Tool Number/Description
	J 41349 Rear Cover Aligner
	J 41507 Connecting Rod Assembly Guide

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Fig. 161: Special Tools & Equipment (4 Of 5)
Courtesy of GENERAL MOTORS CORP.

Illustration	Tool Number/Description
	J 42863 Valve Stem Seal Installer

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Fig. 162: Special Tools & Equipment (5 Of 5)
Courtesy of GENERAL MOTORS CORP.