

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

2002 ENGINES**Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire****SPECIFICATIONS****TORQUE SPECIFICATIONS****TORQUE SPECIFICATIONS**

Application	Ft. Lbs. (N.m)
Balance Shaft Driven Sprocket Bolt (Left Hand Thread)	
First Pass	30 (40)
Final Pass	Tighten an Additional 45°
Balance Shaft Housing Bolts 10mm Hex. See ⁽¹⁾ .	
First Pass	11 (15)
Final Pass	Tighten an Additional 40°
Balance Shaft-to-Block Bolts 13mm Hex	
First Pass	18 (25)
Final Pass	Tighten an Additional 70°
Balance Shaft-to-Block Bolts 15mm Hex	39 (53)
Balance Shaft-to-Block Bolts 18mm Hex	30 (40)
Camshaft Sprocket to the Camshaft Bolt. See ⁽²⁾ .	52 (70)
Connecting Rod Nuts	
First Pass	18 (25)
Final Pass	Tighten an Additional 60°
Cooler Bleeder Valve	Fully Driven, Seated, Not Stripped
Coolant Outlet to Cylinder Head	19 (26)
Coolant Outlet to Cylinder Head	19 (26)
Coolant Pump Cover to the Block	19 (26)
Coolant Pump to the Timing Chain Housing	19 (26)
Crankshaft Balancer to the Crankshaft	
First Pass	129
Final Pass	Tighten an Additional 90°
Crankshaft Bearing Cap Bolts	
First Pass	15 (20)
Final Pass	Tighten an Additional 90°

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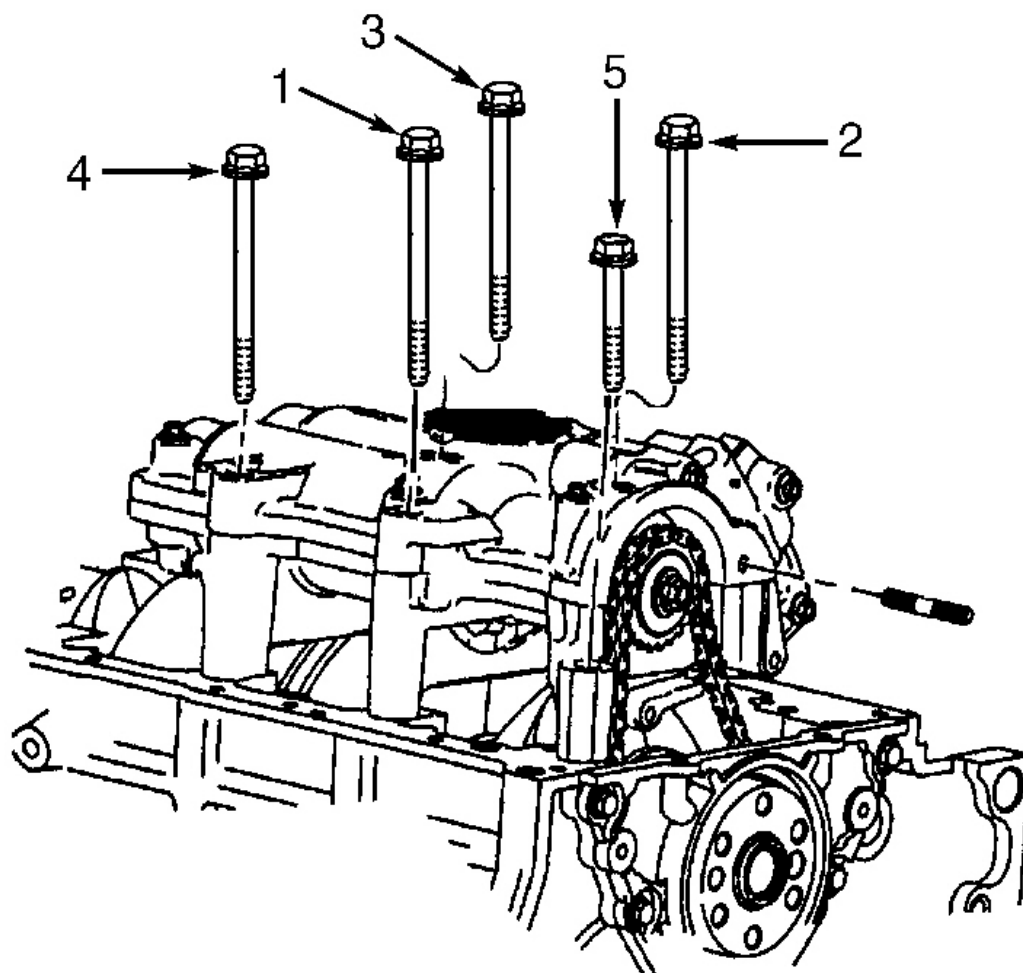
Cylinder Head Bolts

1st Step (Bolts # 1 Through 8 - In Sequence) See ⁽³⁾ .	40 (65)
2nd Step (Bolts # 9 and 10 - In Sequence)	30 (40)
Final Step (In Sequence)	Tighten an Additional 90°
Engine Coolant Air Bleed Pipe Nut	31 (42)
Engine Lift Bracket	68 (96)
Exhaust Manifold Upper Heat Shield to the Manifold Bolts	19 (26)
Flywheel to the Crankshaft	
First Pass	22 (30)
Final Pass	Tighten an Additional 45°
Fuel Pipe Bracket to the Camshaft Housing	
First Pass	11 (15)
Final Pass	Tighten an Additional 30°
Fuel Pipe to the Fuel Rail Nut	22 (30)
Fuel Rail to the Camshaft Housing	19 (26)
Ignition Coil and Module Assembly to the Camshaft Housings	16 (22)
Intake Manifold to the Cylinder Head Bolts/Nuts	18 (24)
Knock Sensor	15 (20)
Oil/Air Separator to Block Nuts	18 (24)
Oil Filter Connector to the Block	21 (29)
Oil Filter to the Block	3/4 To One Complete Turn After Gasket Contact
Oil Pan Bolts. See ⁽⁴⁾ .	18 (24)
Oil Pan Drain Plug	19 (26)
Oil Pan Studs	19 (26)
Oil Passage Plug Bolt	22 (30)
Oil Passage Plugs	
3/8 x 18	22 (30)
1/4 x 18	15 (20)
Oxygen Sensor to Exhaust Manifold	31 (42)
Power Steering Pipe to the Pump Nut	20 (27)
Power Steering Pump to the Cam Carrier Bolts	19 (26)
Spark Plugs to the Cylinder Head	13 (18)
Starter to the Block Bolt	66 (90)
Tensioner to Tensioner Bracket Nut	40 (54)
Timing Chain Housing to the Block Bolts/Studs	21 (29)
Timing Chain Housing to the Camshaft Housing	19 (26)

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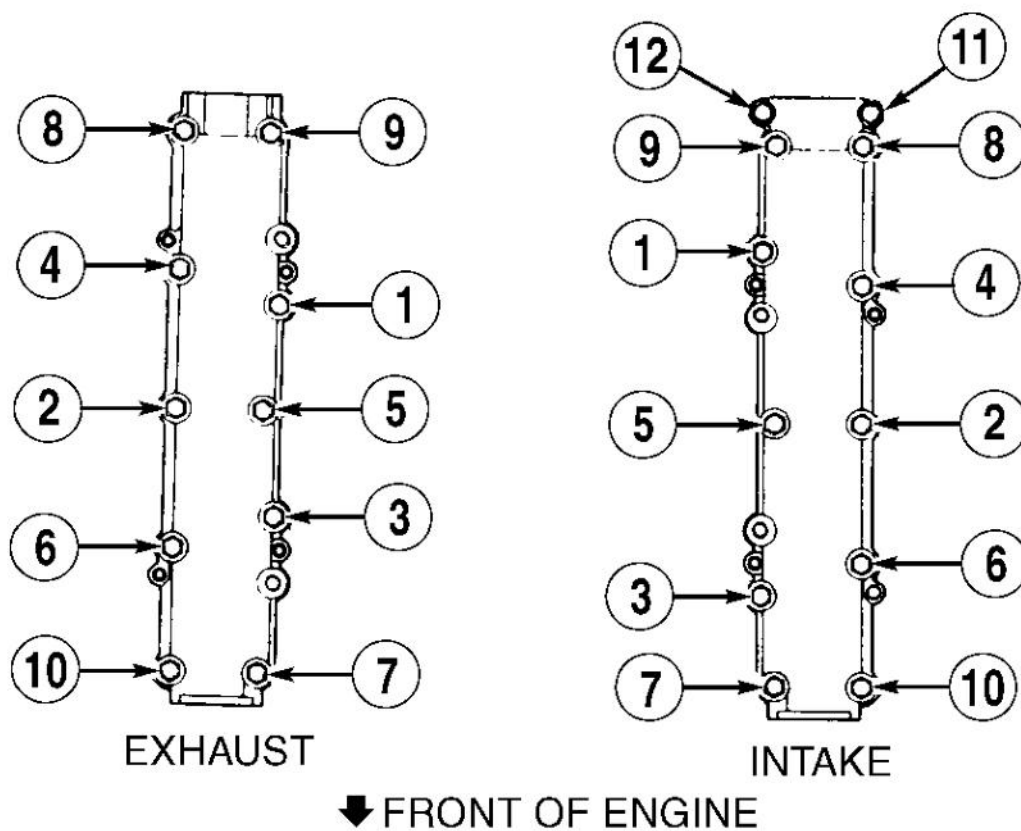
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	INCH Lbs. (N.m)
Balance Shaft Cover Nut and Bolt	115 (13)
Balance Shaft to Housing Bolts 8 mm Hex	
First Pass	89 (10)
Final Pass	Tighten an Additional 40°
Camshaft (Exhaust) Rear Cover	124 (14)
Camshaft Position Sensor Bolt	89 (10)
Coolant Pipe to the Coolant Pump Cover	124 (14)
Crankshaft Position Sensor to Block	80 (9)
Engine Coolant Air Bleed Pipe	124 (14)
Engine Coolant Temperature Sensor to the Coolant Outlet	97 (11)
EVAP Canister Purge Valve Solenoid Bracket Bolt	72 (8)
Exhaust Manifold to the Cylinder Head Studs	97 (11)
Front Cover to the Timing Chain Housing	106 (12)
Intake Manifold to the Cylinder Head Studs	97 (11)
Oil Dipstick Tube Bolt/Screw	71 (8)
Oil Pan Bolts (Second Set)	106 (12)
Oil Passage Plugs (Block 1/8 x 27)	89 (10)
Oil Pressure Switch	124 (14)
Oil Pump to the Balance Shaft Housing	
Long Bolts	106 (12)
Short Bolts	89 (10)
Rear Crankshaft Seal Housing to Block	106 (12)
Throttle Body to the Intake Manifold	89 (10)
Thrust Plate to the Balance Shaft Housing	115 (13)
Timing Chain Tensioner to Housing	89 (10)
(1) Tighten in sequence. See Fig. 1 .	
(2) Tighten in sequence. See Fig. 2 .	
(3) Tighten in sequence. See Fig. 3 .	
(4) Tighten in sequence. See Fig. 4 .	



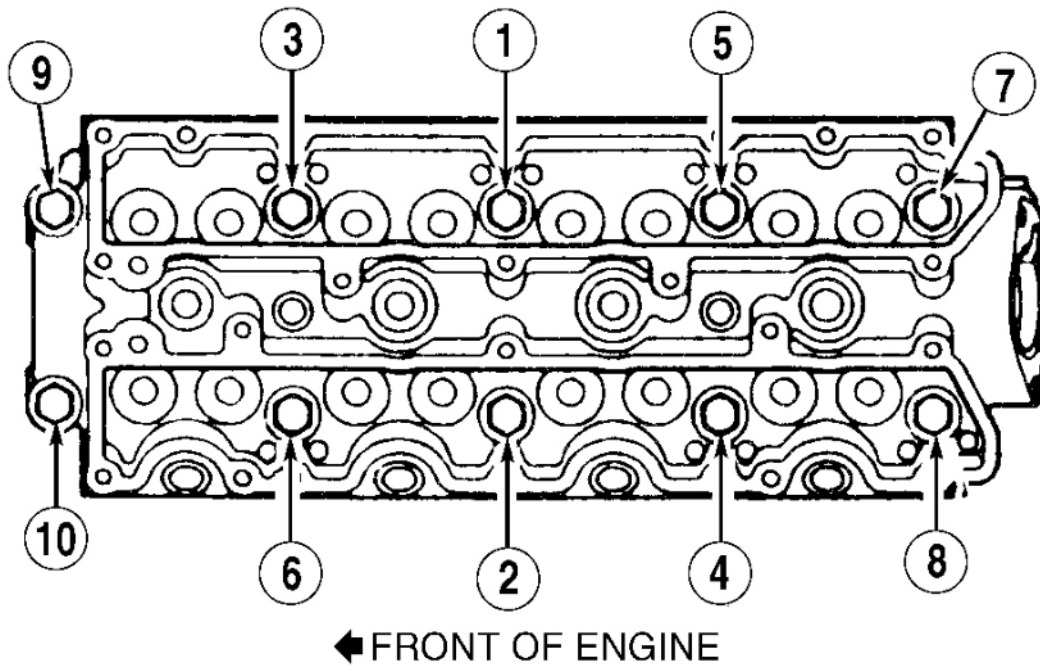
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Fig. 1: Balance Shaft Housing-To-Block Torque Sequence
Courtesy of GENERAL MOTORS CORP.



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Fig. 2: Camshaft Housing Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.



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Fig. 3: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

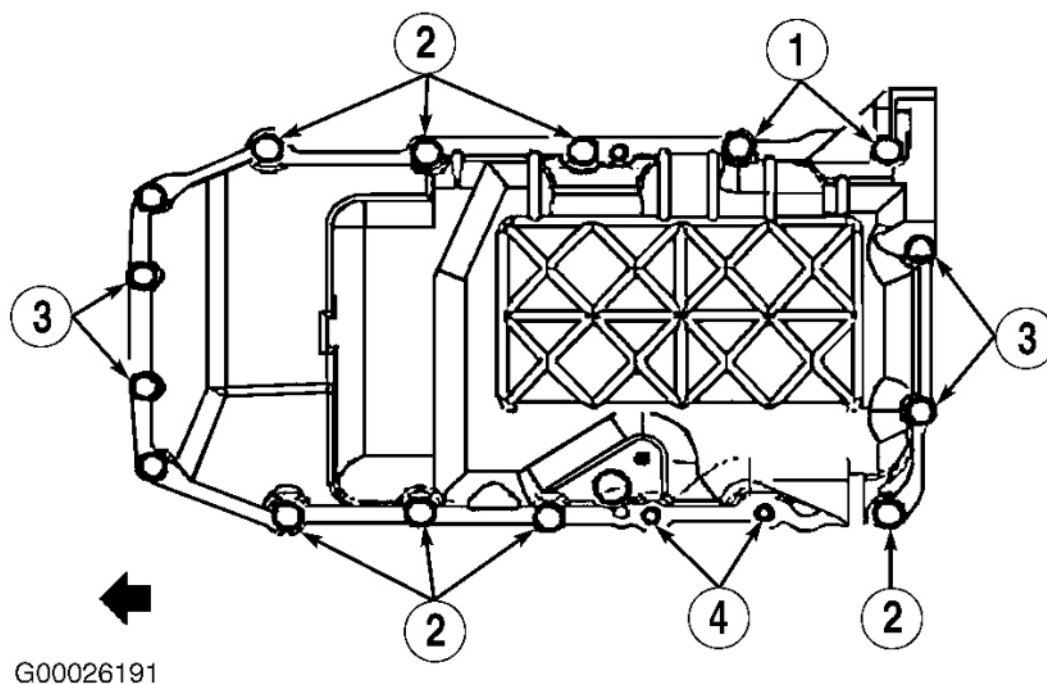


Fig. 4: Oil Pan Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

ENGINE MECHANICAL SPECIFICATIONS

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
Engine Type	Inline 4 Cylinder	
Displacement	2.4 L	146 CID
Regular Production Option (RPO) Code LD9 VIN Code T		
Bore	90 mm	3.54 in
Stroke	94 mm	3.70 in
Compression Ratio	9.5 to 1	
Firing Order	1-3-4-2	
Do Not Resurface if the Overall Measurement is Less Than	0.076 mm	0.003 in
Resurface the Head if the Overall Measurement is More Than	0.076-0.25 mm	0.003-0.010 in
Lubricating System		
Oil Pressure @ 3,000 RPM	207 kPa	30 psi min
Oil Pressure @ 900 RPM	69 kPa	10 psi min

SEALERS, ADHESIVES & LUBRICANTS

Application	Type of Material	GM Part Number	
		United States	Canada
Balance Shaft Housing to Block Bolts	Thread Locker	12345493	10953488
Cam Carrier Oil Cup Plugs	Sealant	12346004	10953480
Cam Carrier Oil Passage Plug	Sealant	12345382	10953489
Camshaft Lobes and Journals	Camshaft and Lifter Prelube	12345501	992704
Camshaft Sprocket Bolts	Thread Locker	12345493	10953488
Chain Housing to Cam Housing Bolts	Thread Locker	12345382	10953489
Coolant Air Bleed Pipe O-rings	Coolant	—	—
Coolant Outlet O-rings	Coolant	—	—
Coolant Temperature Sensor	Thread Locker	12346004	10953480
Crankshaft Rear Main Seal Lip	Engine Oil	—	—
Cylinder Head Bolts	Engine Oil	—	—
Cylinder Head Coolant Plugs	Sealant	12345382	10953489
Engine Block Threaded Plugs	Sealer	12346004	10953480
Flywheel to Crankshaft Bolts	Thread Locker	12345493	10953488
Front Oil Seal	Chassis Grease	01051344	993037
Heater H2O Control Assembly Valve	Thread Locker	12346004	10953480
Lifters	Camshaft and Lifter Prelube	12345501	992704
Lifters — Store submerged	Engine Oil	—	—
New Camshaft	Engine Oil Supplement	01052367	992869
New Lifters	Engine Oil Supplement	01052367	992869
Oil Filter Plug	Sealant	12345382	10953489
Oil Level Sensor	Thread Locker	12345382	10953489
Power Steering Pump to Cam Housing Seal	Sealant	12346286	10953472
Water Outlet Valve	Thread Locker	12346004	10953480

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Fig. 5: Sealer, Adhesive & Lubricant Usage
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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 **DIAGNOSTIC SYSTEM CHECK** 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

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <i>Drive Belt Replacement</i> .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <i>Engine Flywheel Replacement</i> or <i>Crankshaft Balancer Replacement</i> .
Improper installation or a loose propeller shaft hub clamp Corvette automatic transmission applications	Repair or replace as required.
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing and/or O-ring seal	Replace the intake manifold.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	• 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. Coolant consumption may or may not cause the engine to overheat.	• 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 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 identify the cause. • Repair or replace as required.

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Fig. 6: Base Engine Misfire Without Internal Engine Noises Diagnosis (1 Of 2)
 Courtesy of GENERAL MOTORS CORP.

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

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Fig. 7: Base Engine Misfire Without Internal Engine Noises Diagnosis (2 Of 2)
 Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to <i>Drive Belt Replacement</i>.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to <i>Engine Flywheel Replacement</i> or <i>Crankshaft Balancer Replacement</i>.
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.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

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Fig. 8: Base Engine Misfire With Abnormal Internal Lower Engine Noises Diagnosis
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BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

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Cause	Correction
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace as required.

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Fig. 9: Base Engine Misfire With Abnormal Valve Train Noise Diagnosis
Courtesy of GENERAL MOTORS CORP.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	• 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. 10: Base Engine Misfire With Coolant Consumption Diagnosis
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. 11: Base Engine Misfire With Excessive Oil Consumption Diagnosis
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ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

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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, 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.
High valve lifter leak down rate	Replace the lifters as required.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Damaged or faulty oil filter by-pass valve	• Inspect the oil filter by-pass valve for proper operation. • Repair or replace as required.

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Fig. 12: Engine Noise On Start-Up, But Only Lasting A Few Seconds Diagnosis
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UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A light rattle/tapping noise may indicate a valve train, upper engine concern.	
Low oil pressure	• Perform an oil pressure test. Refer to <i>Oil Pressure Diagnosis and Testing</i>. • Repair or replace as required.
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	Set or replace the timing chain and sprockets.
Worn or improperly set 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. 13: Upper Engine Noise, Regardless Of Engine Speed Diagnosis (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

Cause	Correction
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. 14: Upper Engine Noise, Regardless Of Engine Speed Diagnosis (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Important: A cold piston knock which disappears in 1.5 minutes should be considered acceptable. A cold engine knock usually disappears when the specific cylinder's secondary ignition circuit is grounded out during diagnosis. A low rumble/knocking may indicate a crankshaft or piston, lower engine concern.	
Low oil pressure	- 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 ignition controls system. Refer to 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. 15: Lower Engine Noise, Regardless Of Engine Speed Diagnosis
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 ignition controls. Refer to 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. 16: Engine Noise Under Load Diagnosis
Courtesy of GENERAL MOTORS CORP.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove the accessory drive belt or belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location. Refer to Unit Repair Manual - Manual Transmission.
Broken timing chain and/or gears	• Inspect timing chain and gears. • Repair as required.
Seized balance shaft	• Inspect balance shaft. • Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material	• Inspect cylinder for damaged components and/or foreign materials. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Repair as required.
Bent or broken connecting rod	• Inspect connecting rods. • Repair as required.
Broken crankshaft	• Inspect crankshaft. • Repair as required.

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

ENGINE COMPRESSION TEST

Perform the following steps in order to conduct a compression test for VIN T.

1. Conduct the following steps in order to check cylinder compression.
 - 1.1. Engine should be at room temperature.
 - 1.2. Disconnect wiring from the ignition module.
 - 1.3. Remove the spark plugs.
 - 1.4. Throttle body valve should be wide open.
 - 1.5. Battery should be at or near full charge.
2. For each cylinder, crank engine through four compression strokes.
3. The lowest reading cylinder should not be less than 70 percent of the highest.
4. No cylinder reading should be less than 689 kPa (100 psi).

Important: The results of a compression test will fall into the following categories:

- Normal - Compression builds up quickly and evenly to specified compression on each cylinder.

- Piston Rings - Compression low on first stroke. Tends to build up on following strokes but does not reach normal. Improves considerably with addition of oil.
- Valves - Compression low on first stroke. Does not tend to build up on the following strokes. Does not improve much with the addition of oil. Use approximately three squirts from a plunger-type oiler.

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 0.9 L (1 qt) or more of engine oil within 3 200 kilometers (2,000 miles). The causes of excessive oil consumption include the following conditions:

- External oil leaks - Tighten bolts and/or replace gaskets and oil seals as necessary.
- Incorrect oil level or improper reading of oil level indicator - With the vehicle on a level surface, allow adequate drain down time and check for the correct oil level.
- Improper oil viscosity - Use recommended SAE viscosity for the prevailing temperatures.
- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted - Ream guides and install oversize service valves and/or new valve stem oil seals.
- Piston rings broken, improperly installed, worn, or not seated properly - Allow adequate time for rings to seat. Replace broken or worn rings as necessary.
- Piston improperly installed or mis-fitted.

OIL PRESSURE DIAGNOSIS & TESTING

- With the vehicle on a level surface, allow an adequate drain down time of 10 minutes and measure for a low oil level.
- Add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
- Run the engine and verify low or no oil pressure on the vehicle gage or light. Listen for a noisy valve train or a knocking noise.
- Inspect for the following:
 - A. Oil diluted by moisture or unburned fuel mixtures.
 - B. Improper oil viscosity for the expected temperature.
 - C. Incorrect or malfunctioning oil pressure sender.
 - D. Incorrect or malfunctioning oil pressure gage.
 - E. Plugged oil filter.
 - F. Malfunctioning oil bypass valve.
- Remove the oil pressure sender.
- Install a oil pressure gage and measure the engine oil pressure.
- Compare the readings to specifications. Refer to **Engine Mechanical Specifications**.
- If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
 - A. Oil pump worn or dirty. Refer to **OIL PUMP**.

- B. Oil pump-to-engine block bolts loose. Refer to **OIL PUMP** .
- C. Oil pump screen loose, plugged, or damaged.
- D. Malfunctioning oil pump pressure regulator valve.
- E. Excessive bearing clearance. Refer to **CRANKSHAFT & BEARINGS** .
- F. Cracked, porous or restricted oil galleries
- G. Oil gallery plugs missing or incorrectly installed. Refer to **ENGINE BLOCK PLUG INSTALLATION** .
- H. Broken valve lifters.

OIL LEAK DIAGNOSIS

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2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

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>

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Fig. 18: Oil Leak Diagnosis (1 Of 2)

Courtesy of GENERAL MOTORS CORP.

Step	Action	Yes	No
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use J 28428-E High Intensity Black Light Kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

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Fig. 19: Oil Leak Diagnosis (2 Of 2)

Courtesy of GENERAL MOTORS CORP.

DRIVE BELT CHIRPING DIAGNOSIS**Diagnostic Aids**

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

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(s) 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 mis-aligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a mis-aligned 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 Symptoms - Engine Mechanical 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. Refer to <i>Drive Belt Replacement</i> . 2. Operate the engine for no longer than 30 to 40 seconds. Does the chirping noise still exist?	Go to Engine Noise on Start-Up, but Only Lasting a Few Seconds. Upper Engine Noise, Regardless of Engine Speed, Lower Engine Noise, Regardless of Engine Speed, or Engine Noise Under Load	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. 20: 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 number(s) below refer to the step number(s) 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(s) 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(s) 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 mis-aligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a mis-aligned 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.

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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 Symptoms - Engine Mechanical 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. Refer to <i>Drive Belt Replacement</i> 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. Upper Engine Noise, Regardless of Engine Speed. Lower Engine Noise, Regardless of Engine Speed, or Engine Noise Under Load	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 <i>Drive Belt Tensioner Diagnosis</i> . 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 <i>Drive Belt Replacement</i> . Did you find and correct the condition?	Go to Step 9	Go to Step 7
7	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 9	Go to Step 8
8	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 9	Go to Diagnostic Aids
9	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

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

DRIVE BELT WHINE DIAGNOSIS

Diagnostic Aids

The drive belt(s) will not cause the whine noise.

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

Test Description

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

- 3)** - This test is to verify that the noise is being caused by the drive belt(s) or the accessory drive components. When removing the drive belt the water pump may not be operating and the engine may

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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(s) may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the 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 Symptoms - Engine Mechanical 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, Upper Engine Noise, Regardless of Engine Speed, Lower Engine Noise, Regardless of Engine Speed, or Engine Noise Under Load	Go to Step 4
4	Inspect for a failed accessory drive component bearing. Did you find and repair the condition?	Go to Step 5	Go to Diagnostic Aids
5	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

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

DRIVE BELT RUMBLING DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

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

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

4) - Inspecting the drive belt(s) is to ensure that it is not causing a the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plays 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 Symptoms - Engine Mechanical 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, Upper Engine Noise, Regardless of Engine Speed, Lower Engine Noise, Regardless of Engine Speed, or Engine Noise Under Load	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. 23: Drive Belt Rumbling Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT VIBRATION DIAGNOSIS

Diagnostic Aids

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

Test Description

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

- 2)** - This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom such as the exhaust system, or the drivetrain.
- 3)** - This test is to verify that the drive belt(s) or accessory drive components may be causing the vibration. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt removed.
- 4)** - The drive belt(s) may cause a vibration. While the drive belt(s) is removed this is the best time to inspect the condition of the belt.
- 6)** - Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.
- 8)** - This step should only be performed if the fan is driven by the drive belt. Inspect the engine cooling fan for bent, twisted, loose, or cracked blades. Inspect the fan clutch for smoothness, ease of turning. Inspect for a bent fan shaft or bent mounting flange.
- 9)** - This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smoothness and excessive play. Compare the water pump with a known good water pump.
- 10)** - Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

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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 Symptoms - Engine Mechanical operation and perform the necessary inspections?	Go to <i>Step 2</i>	Go to <i>Symptoms - Engine Mechanical</i>
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to <i>Step 3</i>	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 <i>Step 4</i>
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 <i>Step 5</i>	Go to <i>Step 6</i>
5	Install a new drive belt. Refer to <i>Drive Belt Replacement</i> . Did you complete the replacement?	Go to <i>Step 11</i>	—
6	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to <i>Step 7</i>	Go to <i>Step 8</i>
7	Tighten any loose fasteners. Replace improper or missing fasteners. Refer to <i>Fastener Tightening Specifications</i> . Did you complete the repair?	Go to <i>Step 11</i>	—
8	Inspect for damaged fan blades or bent fan clutch shaft, if the fan is belt driven. Did you find and correct the condition?	Go to <i>Step 11</i>	Go to <i>Step 9</i>
9	Inspect for a bent water pump shaft, if the water pump is belt driven. Did you find and correct the condition?	Go to <i>Step 11</i>	Go to <i>Step 10</i>
10	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to <i>Step 11</i>	Go to Diagnostic Aids
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <i>Step 3</i>

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

DRIVE BELT FALLS OFF DIAGNOSIS

Diagnostic Aids

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

Test Description

The number(s) below refer to the step number(s) 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 mis-aligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a mis-aligned 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.

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 Symptoms - Engine Mechanical 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. 25: Drive Belt Falls Off Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT EXCESSIVE WEAR DIAGNOSIS

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2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

Diagnostic Aids

Excessive wear on a drive belt(s) 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(s) 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(s) fall off.

Test Description

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

- 2) - The inspection is to verify the drive belt(s) is correctly installed on all of the drive belt pulleys. Wear on the drive belt(s) may be caused by mis-positioning the drive belt(s) by one groove on a pulley.
- 3) - The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.
- 4) - This inspection is to verify the drive belt(s) is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt(s) should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Symptoms - Engine Mechanical 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	—

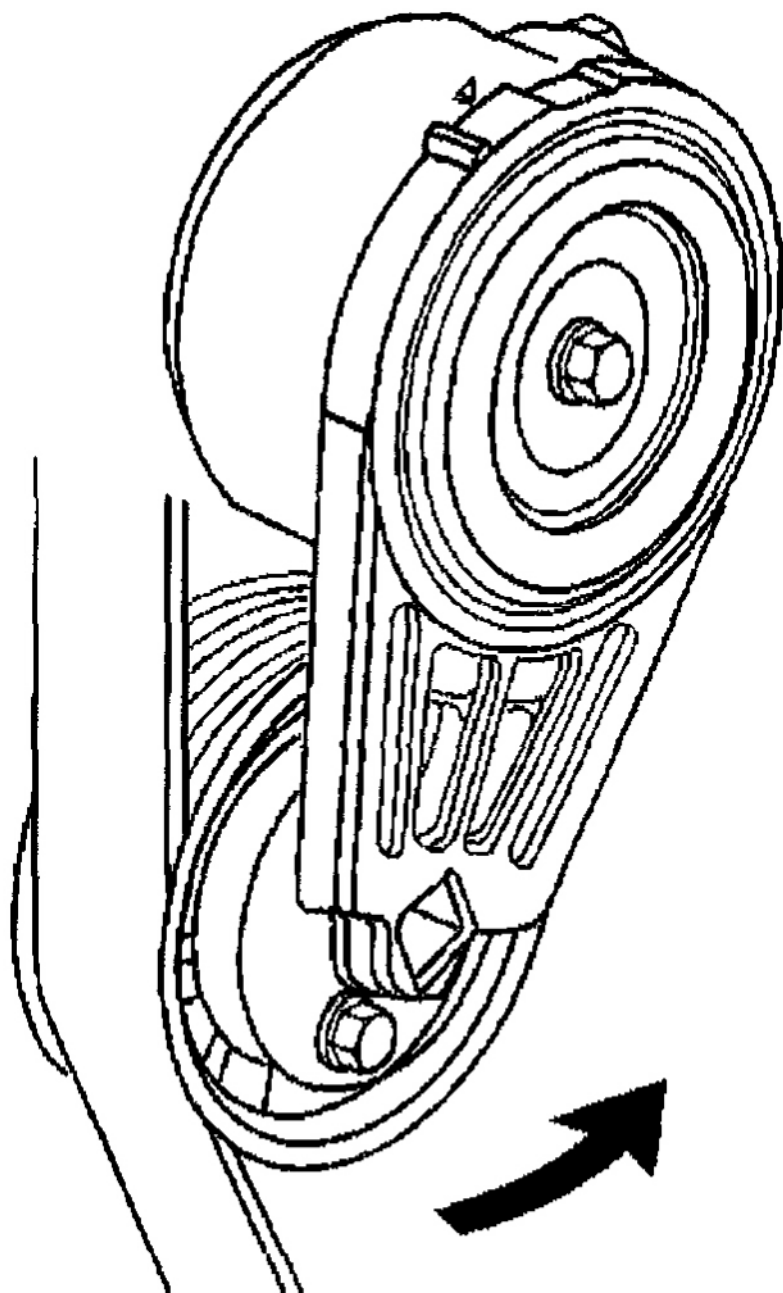
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Fig. 26: Drive Belt Excessive Wear Diagnosis
Courtesy of GENERAL MOTORS CORP.

DRIVE BELT TENSIONER DIAGNOSIS

Inspection Procedure

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



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

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

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

REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT

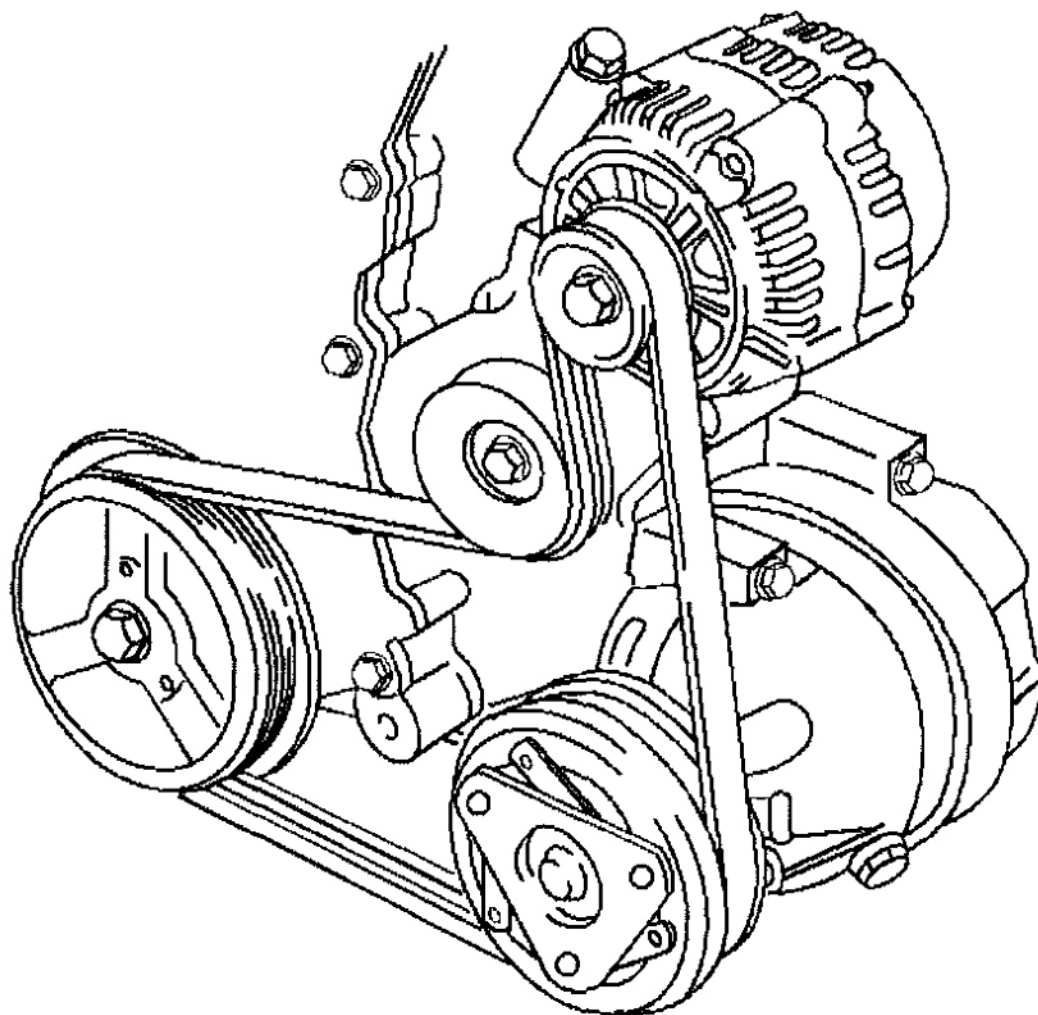
CAUTION: To avoid personal injury when rotating the accessory drive belt tensioner, use a tight fitting 13 mm wrench that is at least 46 cm (18 in) long.

Tools Required

J 37059 Accessory Drive Belt Tensioner Wrench

Removal Procedure

Using the **J 37059** , remove the accessory drive belt by rotating the tensioner counterclockwise.



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Fig. 28: Drive Belt Routing

Courtesy of GENERAL MOTORS CORP.

Installation Procedure

Using the **J 37059** , install the accessory drive belt by rotating the tensioner counterclockwise.

DRIVE BELT TENSIONER REPLACEMENT**Removal Procedure**

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

3. Raise and support the vehicle.
4. Remove the A/C compressor bolts. Position the A/C compressor aside.
5. Remove the tensioner bolts and tensioner.

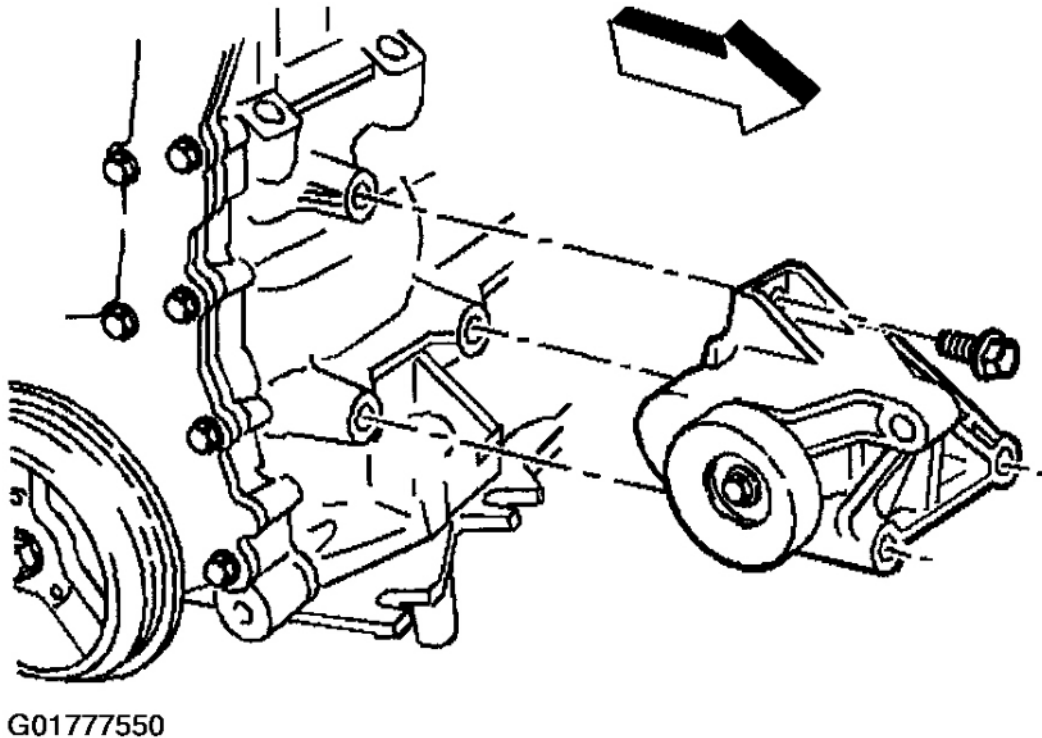


Fig. 29: Drive Belt Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the tensioner and bolts. Tighten the drive belt tensioner bolts to 50 N.m (37 ft lbs).
2. Install the A/C compressor.
3. Install the A/C compressor mounting bolts. Tighten the bolts to 54 N.m (40 ft lbs).
4. Lower the vehicle.
5. Install the generator assembly.
6. Install the drive belt. Refer to **Drive Belt Replacement**.

ENGINE MOUNT INSPECTION

CAUTION: It is the design intent of the torque axis mounting systems to allow more engine movement than other mounting systems. Do not replace any torque

axis mounts for excessive engine movement. Replace them if damage exists on the mount or rubber.

Tools Required

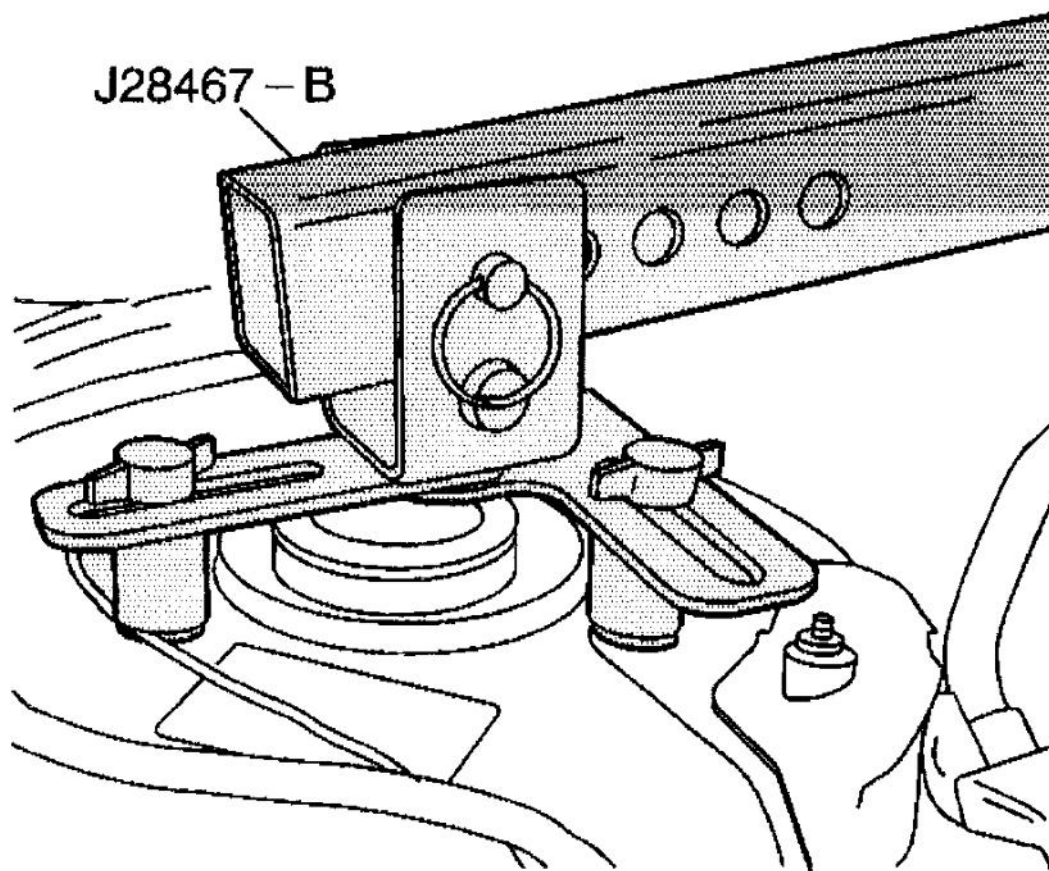
J 28467-500 Engine Support Fixture

1. Raise the engine enough to apply slight tension on the engine mount.
2. Replace the engine mount if any of the following conditions exist:
 - The hard rubber surface is covered with heat cracks.
 - The rubber split through the center.
3. Lower the engine.
4. Verify the engine mount fastener torque. Refer to **Torque Specifications**.

ENGINE SUPPORT FIXTURE

Tools Required

- **J 28467-B** Universal Engine Support Fixture
- **J 36462** Engine Support Adapter Leg



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Fig. 30: Universal Engine Support Fixture
Courtesy of GENERAL MOTORS CORP.

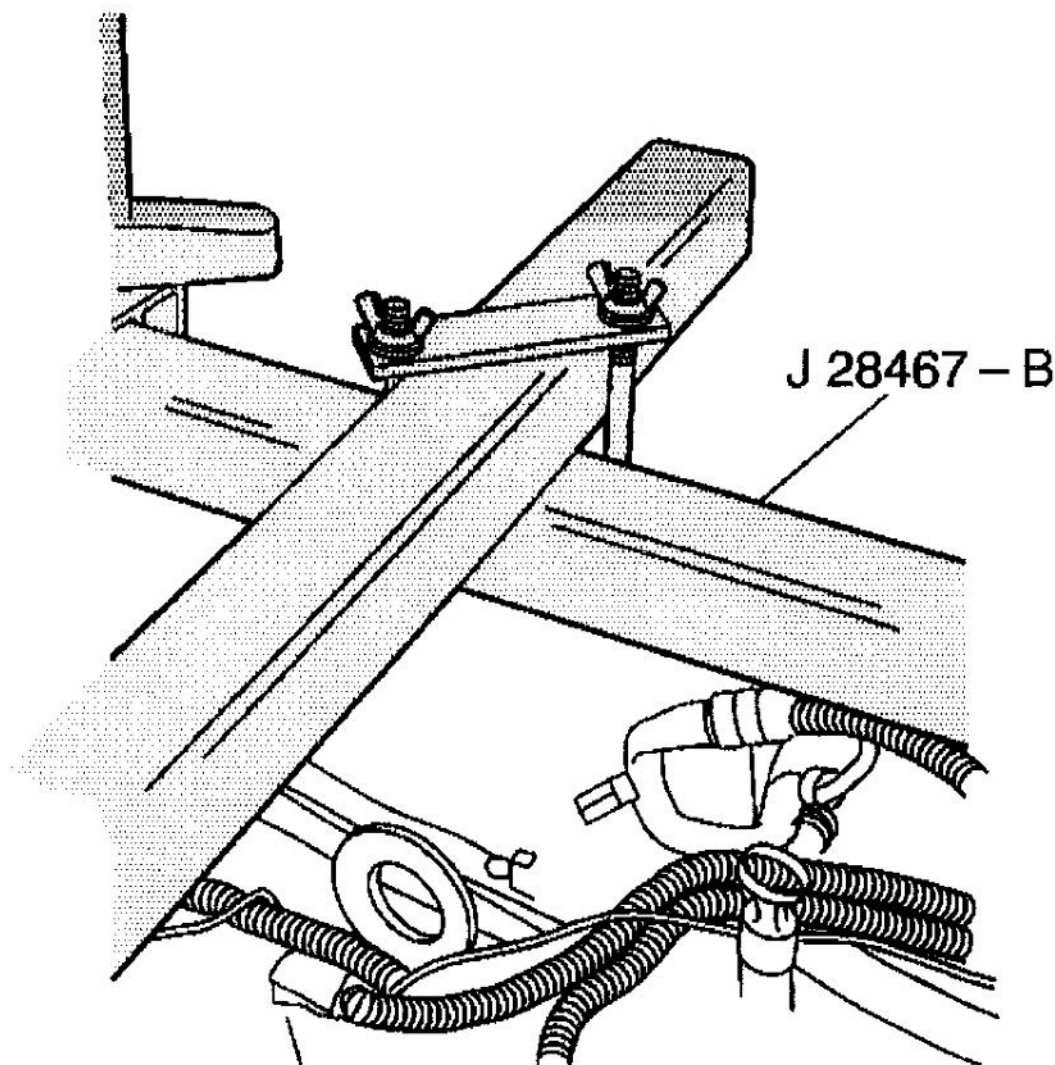
Installation Procedure

1. Raise the hood.
2. Install the thread support nuts (J 28467-33A) onto the strut attaching studs.
3. Install the strut tower support assemblies (J 28467-5A) over the thread support nuts (J 28467-33A).
4. Install the T-bolts (J 28467-53) with washers through the strut tower support assemblies (J 28467-5A) into the thread support nuts (J 28467-33A). Hand tighten the bolts.
5. Install the 2 cross bracket assemblies (J 28467-1A) over the strut tower tube (J 28467-3).
6. Install the strut tower tube (J 28467-3) into the strut tower support assemblies (J 28467-5A).
7. Install the 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.
8. Install the radiator shelf tube (J 28467-2A) through the driver side cross bracket assembly (J 28467-1A) on the top of the strut tower tube (J 28467-3).

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9. Install the round tube of the front support assembly (J 28467-4A) through the large hole in the radiator shelf tube (J 28467-2A). The hole used in the radiator shelf tube (J 28467-2A) depends on the vehicle application.
10. Place the rubber padded foot of the front support assembly (J 28467-4A) on the vehicle radiator shelf. The foot position used in the front support assembly (J 28467-4A) depends on the vehicle application.
11. Install the 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). The hole used in the front support assembly (J 28467-4A) depends on the vehicle application.
12. Install the lift hook (J 28467-7A) through the lift hook bracket (J 28467-6A).
13. Install the lift hook washer and lift hook wing nut (J 28467-34) onto the lift hook (J 28467-7A).
14. Install the assembled lift hook bracket (J 28467-6A) over the radiator shelf tube (J 28467-2A).



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Fig. 31: Lift Hook Bracket**Courtesy of GENERAL MOTORS CORP.**

15. Adjust the radiator shelf tube (J 28467-2A) and the assemblage lift hook bracket (J 28467-6A) in order to align the hook with the left (front), rear of engine, lift hook bracket part of the left engine mount strut bracket.
16. Hand tighten the driver side cross bracket assembly (J 28467-1A) wing nuts.
17. Install the second radiator shelf tube (J 28467-2A) through the passenger side cross bracket assembly (J 28467-1A) on the top of the strut tower tube (J 28467-3).
18. Install the round tube of the front support assembly (J 28467-4A) through the large hole in the radiator shelf tube (J 28467-2A). The hole used in the radiator shelf tube (J 28467-2A) depends on the vehicle

application.

19. Place the rubber padded foot of the front support assembly (J 28467-4A) on the vehicle radiator shelf. The foot position used in the front support assembly (J 28467-4A) depends on the vehicle application.
20. Install the 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). The hole used in the front support assembly (J 28467-4A) depends on the vehicle application.
21. Install the lift hook (J 28467-7A) through the lift hook bracket (J 28467-6A).
22. Install the lift hook washer and lift hook wing nut (J 28467-34) onto the lift hook (J 28467-7A).
23. Install the assemblage lift hook bracket (J 28467-6A) over the radiator shelf tube (J 28467-2A).
24. Adjust the radiator shelf tube (J 28467-2A) and the assemblage lift hook bracket (J 28467-6A) in order to align the hook with the right (rear), front of engine, lift hook bracket located next to the generator.
25. Hand tighten the passenger side cross bracket assembly (J 28467-1A) wing nuts.
26. Hand tighten the lift hook wing nuts (J 28467-34) securely in order to remove all slack from the engine support fixture assembly.

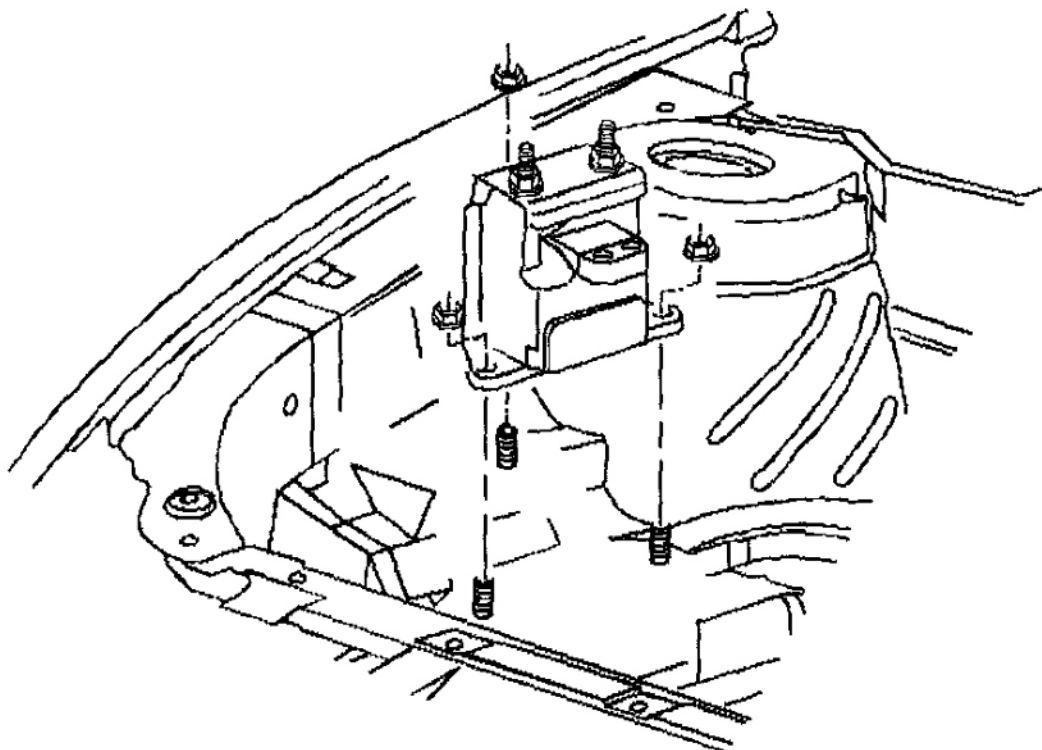
ENGINE MOUNT REPLACEMENT

Tools Required

J 28467-500 Engine Support Fixture

Removal Procedure

1. Remove the one bolt attaching the coolant recovery tank.
2. Remove the coolant recovery tank and position it aside.
3. Install the **J 28467-360** and raise the engine off of the mount.
4. Remove the nuts holding the mount to the body.
5. Remove the bolts holding the engine bracket to the mount.
6. Remove the engine mount assembly.



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

Installation Procedure

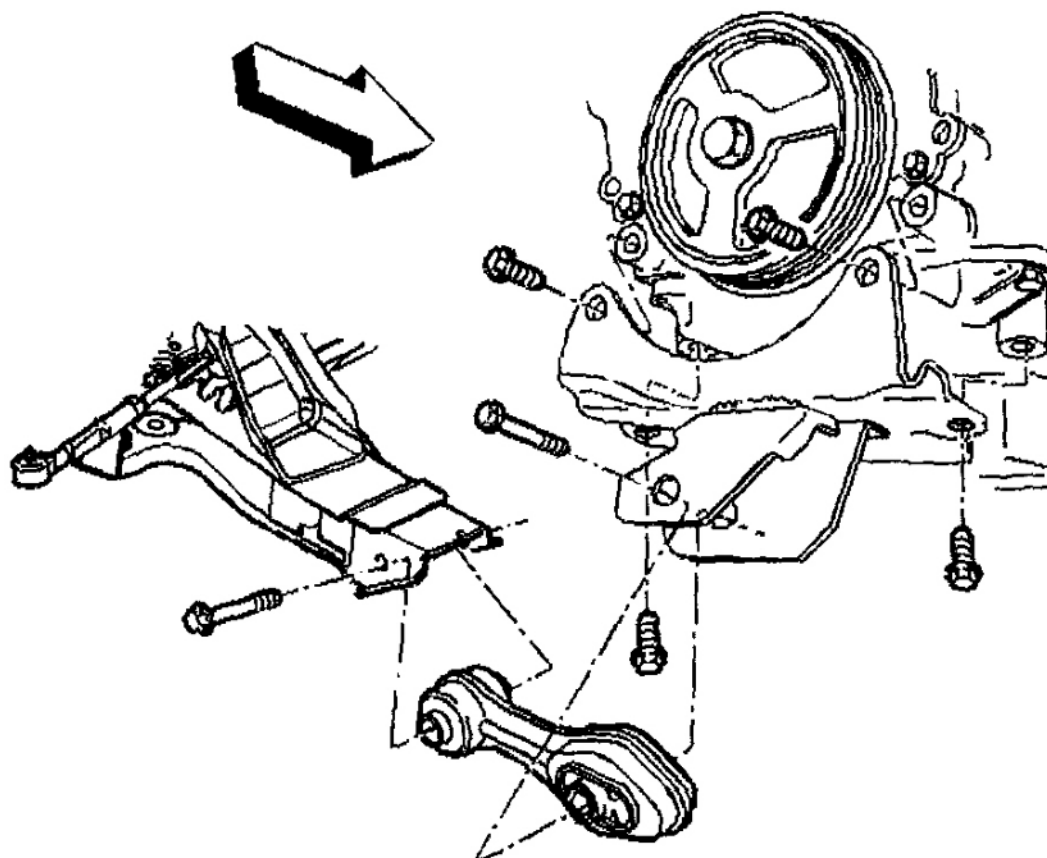
1. Install the engine mount assembly.
2. Install the nuts holding the mount to the body. Do not tighten.
3. Install the bolts holding the engine bracket to the mount.
 - Tighten the bolts holding the engine bracket to the mount to 60 N.m (44 ft lbs) + 90 degrees.
 - Tighten the nuts holding the mount to the body to 75 N.m (55 ft lbs).
4. Remove the **J 28467-360**.
5. Install the coolant recovery tank.

ENGINE MOUNT STRUT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle.
2. Remove the right engine splash shield.

3. Remove the engine mount strut bolts.
4. Remove the engine mount strut.



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Fig. 33: Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

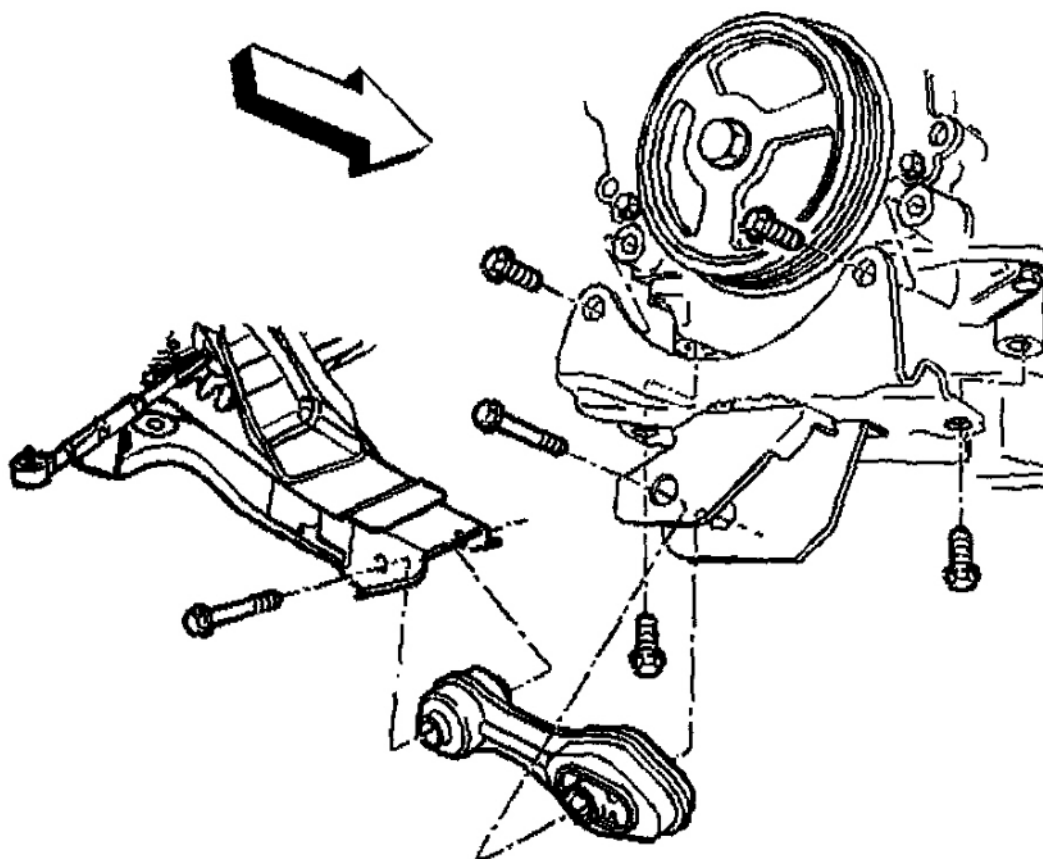
Installation Procedure

1. Install the engine mount strut.
2. Install the engine mount strut bolts. Tighten the engine mount strut bolts to 100 N.m (74 ft lbs) + 90 degrees.
3. Install the right engine splash shield.
4. Lower the vehicle.

ENGINE MOUNT STRUT BRACKET REPLACEMENT

Removal Procedure

1. Raise and support the vehicle.
2. Remove the right engine splash shield.
3. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement**.
4. Remove the engine mount strut bracket bolts.
5. Remove the engine mount strut bracket.



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Fig. 34: Engine Mount Strut
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the engine mount strut bracket and the bolts. Tighten the engine mount strut bracket bolts to 66 N.m (49 ft lbs).
2. Install the engine mount strut. Refer to **Engine Mount Strut Replacement**.

3. Install the right engine splash shield.
4. Lower the vehicle.

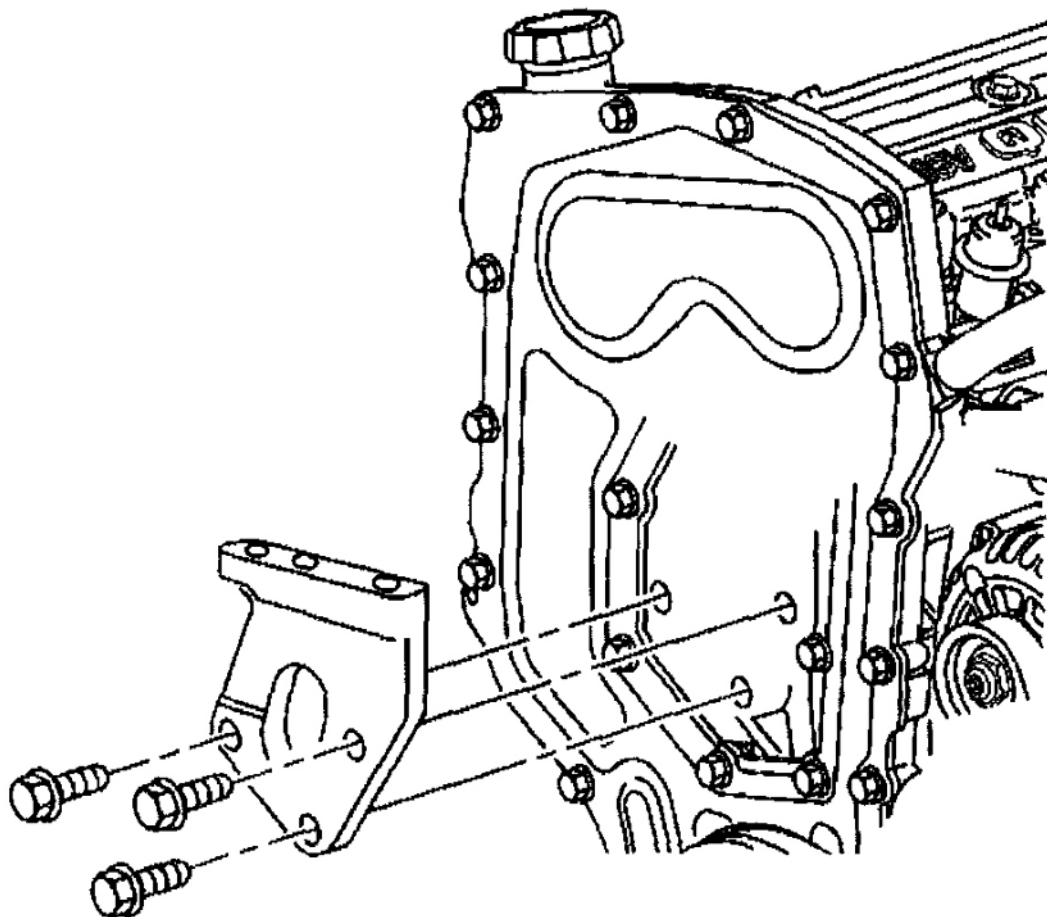
ENGINE MOUNT BRACKET REPLACEMENT

Tools Required

- **J 28467-500** Engine Support Fixture
- **J 36462** Engine Support Adapter Leg

Removal Procedure

1. Install the **J 28467-360** .
2. Install the **J 36462** .
3. Remove engine mount. Refer to **Engine Mount Replacement**.
4. Remove engine mount bracket bolt and bracket.



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Fig. 35: Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

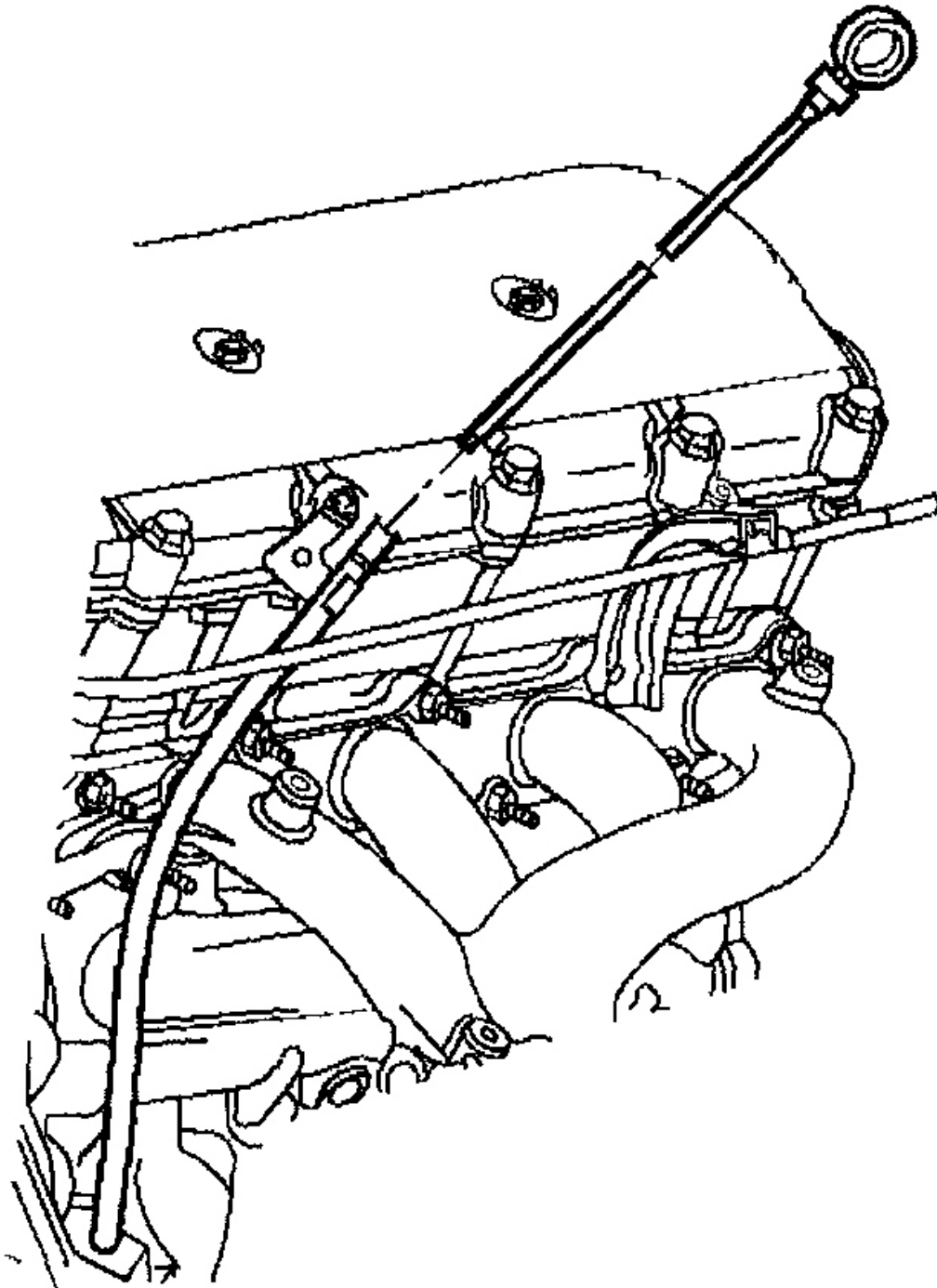
1. Install engine mount bracket and bolts. Tighten the bolts to 102 N.m (75 ft lbs).
2. Install engine mount. Refer to **Engine Mount Replacement**.
3. Remove the **J 28467-360** .
4. Remove the **J 36462** .

OIL LEVEL INDICATOR & TUBE REPLACEMENT

Removal Procedure

1. Remove the tube bracket to the rear cam carrier lift bracket nut.

2. Remove the tube from the block.



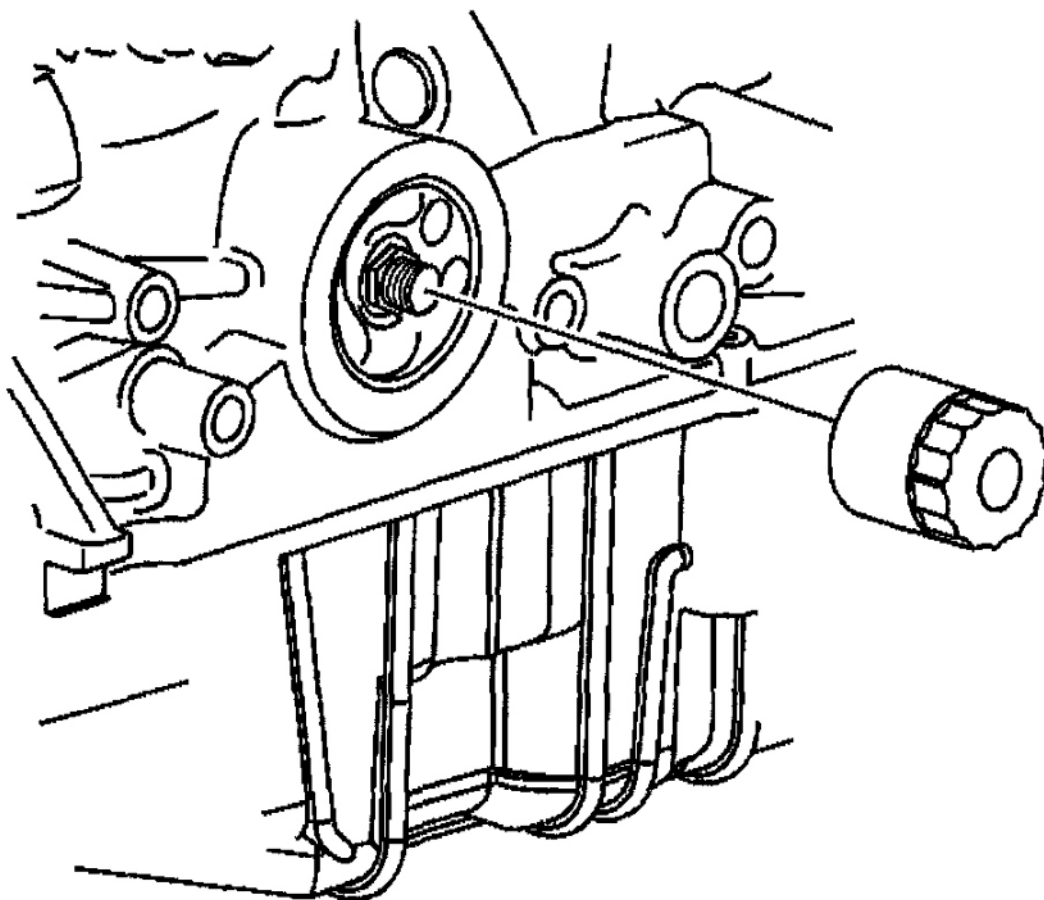
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Fig. 36: Oil Dipstick Tube**Courtesy of GENERAL MOTORS CORP.****Installation Procedure**

1. Install the tube to the block.
2. Install the tube bracket to the rear cam carrier lift bracket nut. Tighten the oil level indicator tube nut to 8 N.m (72 in lbs).

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

1. Raise the vehicle.
2. Remove the oil filter.
3. Verify that the gasket is removed with the filter.

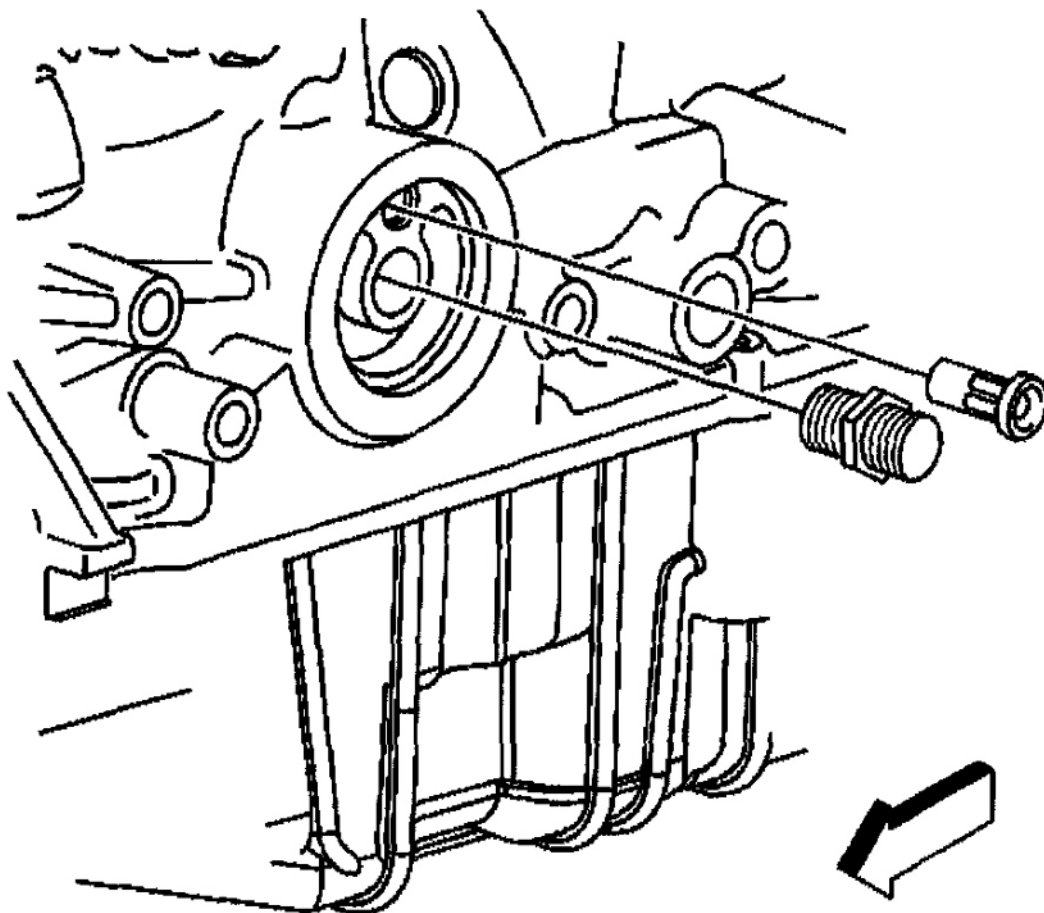


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Fig. 37: Locating Oil Filter

Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filter adapter.
5. Remove the oil filter bypass valve using a screwdriver or a punch in order to pry the valve out.



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Fig. 38: Oil Filter Bypass Valve
Courtesy of GENERAL MOTORS CORP.

6. Clean the oil filter mounting surface.

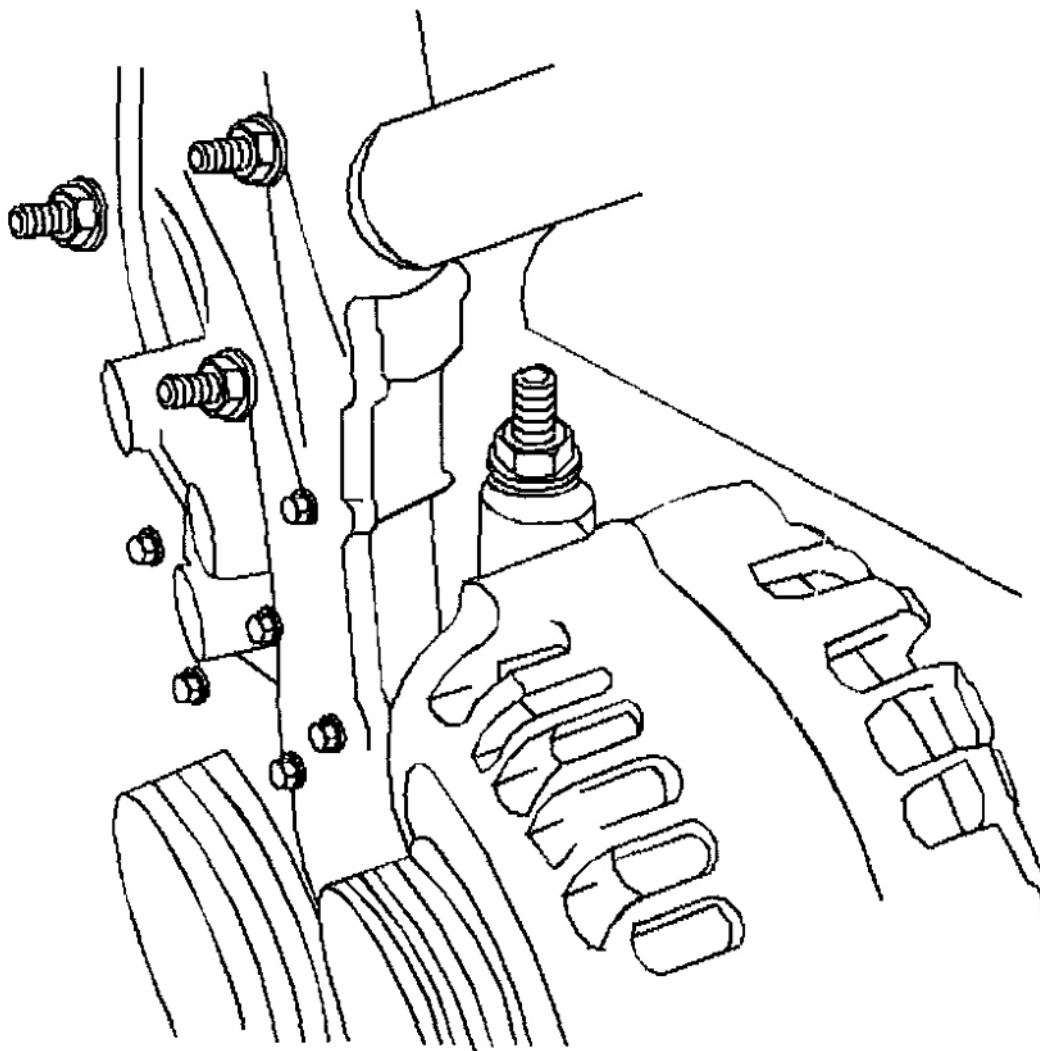
Installation Procedure

1. Install the oil filter bypass valve. Seat the valve using a socket of the same diameter and a mallet.
2. Install the oil filter adapter. Tighten the oil filter adapter to 29 N.m (21 ft lbs).
3. Install the filter. Turn the filter 3/4-1 complete turn after the gasket contacts the surface of the block.
4. Lower the vehicle.
5. Top off engine oil.
6. Start the vehicle and check for leaks.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

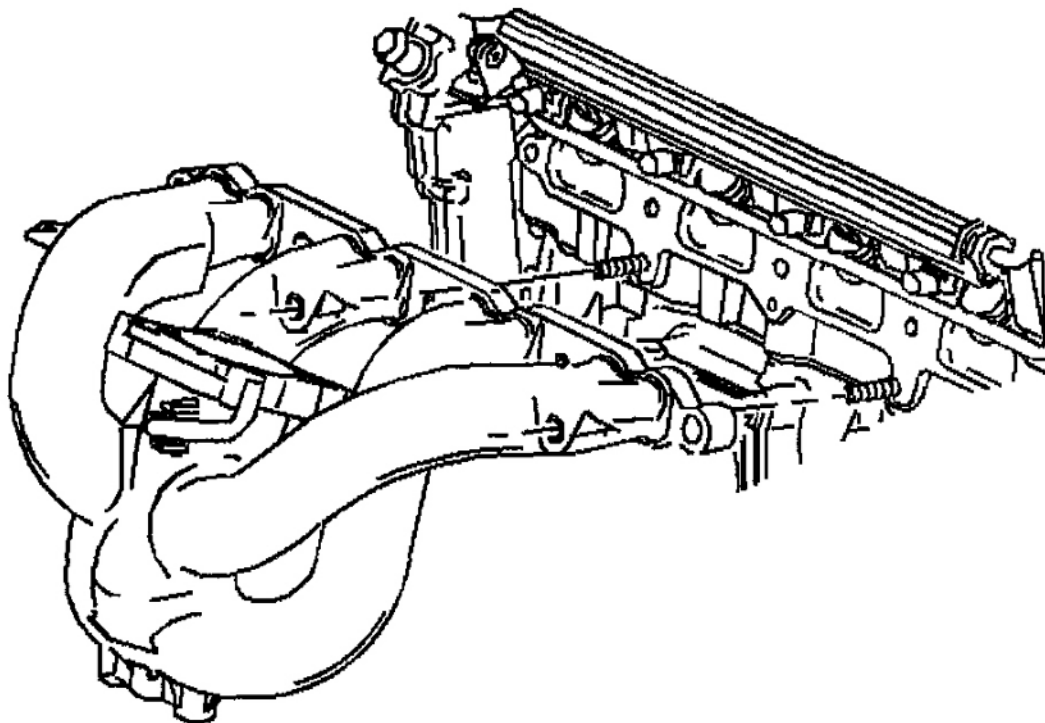
1. Remove the air cleaner duct and resonator.
2. Disconnect the following electrical connectors:
 - Manifold Absolute Pressure (MAP) sensor
 - Intake Air Temperature (IAT) sensor
 - EVAP Canister Purge solenoid
 - Fuel injector harness
3. Disconnect the vacuum hoses from the fuel regulator and the EVAP canister purge solenoid to the canister.
4. Remove the accelerator control cable bracket.
5. Remove the stud ended generator mount bolt.



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Fig. 39: Stud Ended Generator Mount Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove brake booster vacuum line from throttle body.
7. Remove wiring harness from retainer on bottom of intake.
8. Remove the intake manifold retaining nuts and bolts.
9. Remove the intake manifold and the gasket.



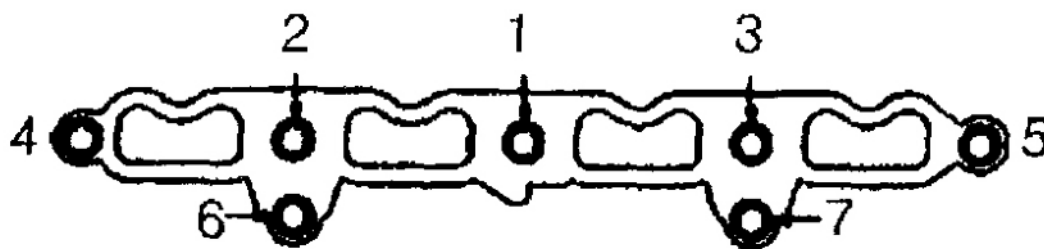
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Fig. 40: Intake Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

Important: The engine and the manifold should be at ambient temperature when assembled. Do not attempt to install a cold manifold on a hot engine.

1. Install the intake manifold and the gasket. If the gasket is damaged, install a new one with the stamped numbers facing towards the manifold surface.
2. Install the intake manifold nut and bolts. Tighten the nuts and bolts in sequence (1,2,3,4,5,6 and 7) to 24 N.m (18 ft lbs).



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Fig. 41: Intake Manifold Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

3. Install wiring harness to retainer on bottom of intake.
4. Install brake booster vacuum line to throttle body.
5. Install the stud ended generator mount bolt.
6. Install the accelerator control cable bracket.
7. Connect the vacuum hoses to the fuel regulator and to the EVAP canister purge solenoid.

Important: If the IAT sensor is removed, apply sealant GM P/N 1052080 (Canadian P/N 10953480) or equivalent to its threads before installation.

8. Connect the following electrical connections:
 - MAP sensor
 - IAT sensor
 - EVAP canister purge solenoid
 - Fuel injector harness
9. Install the air cleaner resonator and duct.

INTAKE CAMSHAFT, HOUSING & LIFTER REPLACEMENT

Tools Required

- J 36660-A Torque Angle Meter
- J 36011 Spark Plug Wire Remover

Removal Procedure

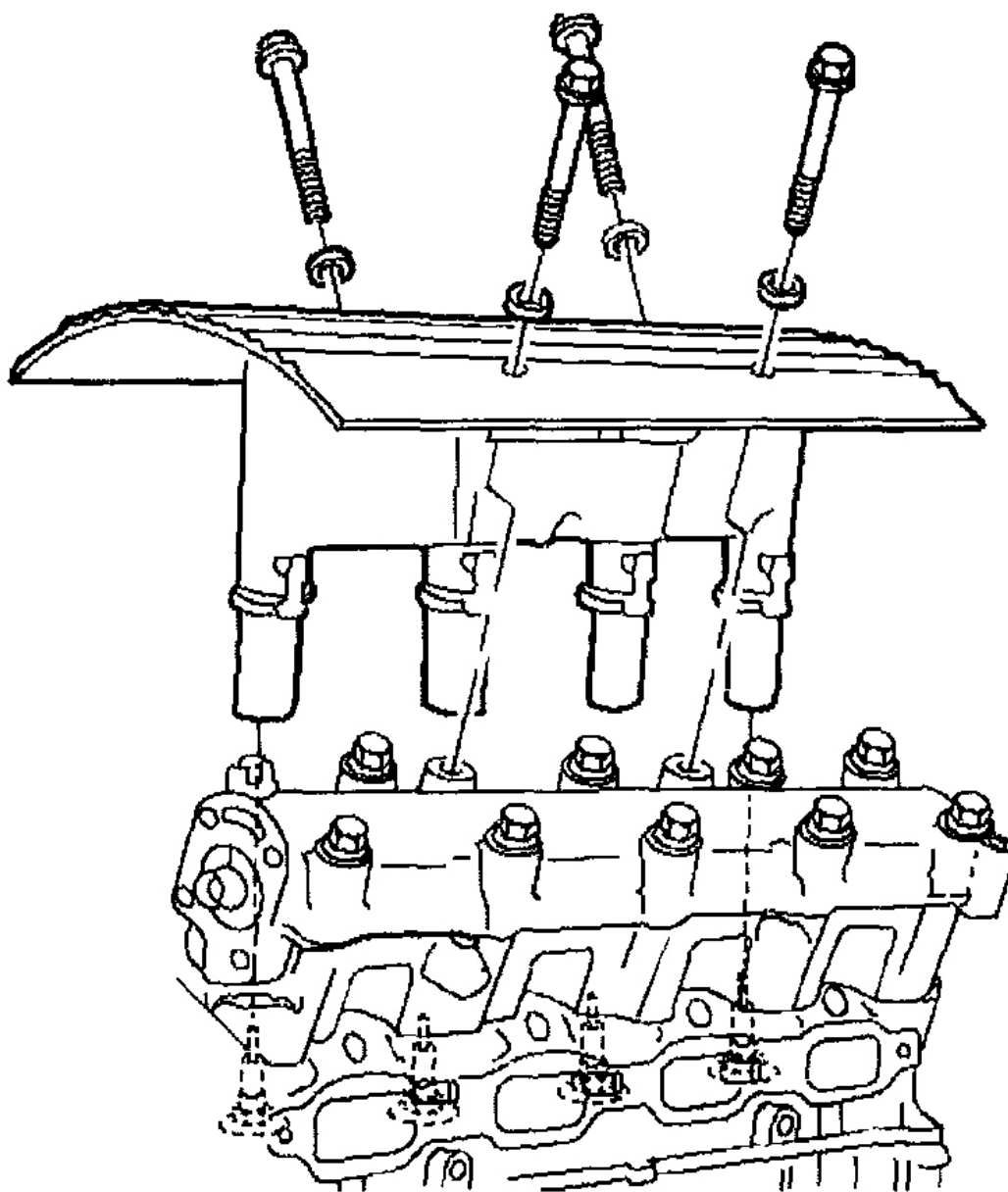
Important:

- Any time the camshaft housing to the cylinder head bolts are loosened or removed, the camshaft housing

to the cylinder head gasket must be replaced.

- During disassembly, ensure that the valve lifters are kept together and identified so that they can be reinstalled in the original locations.
- Before disassembling the valve mechanism, make a compression test and note the results.

1. Disconnect the negative battery cable.
2. Remove the ignition coil and the module assembly.

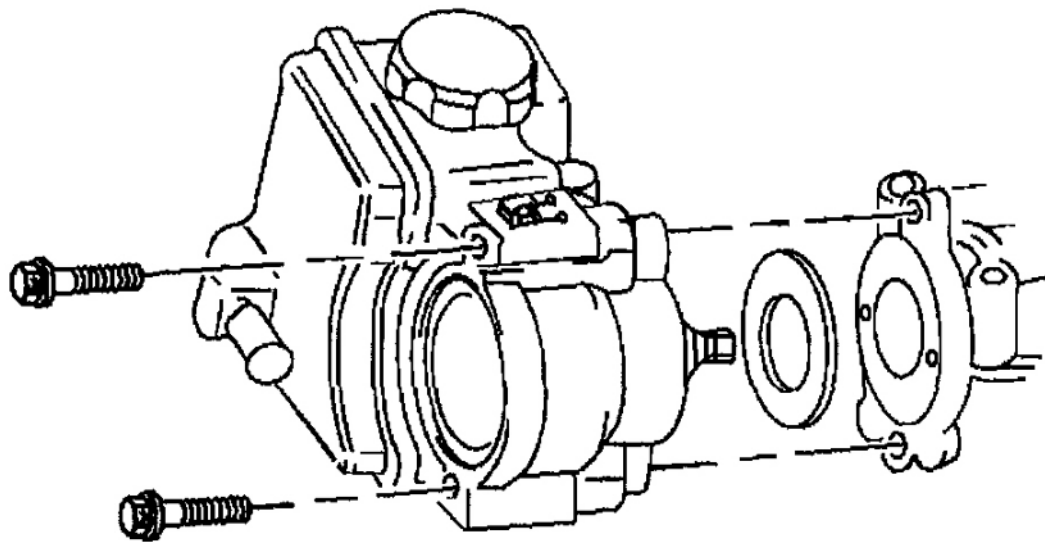


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Fig. 42: Ignition Coil And Module Assembly
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position sensor connector.
4. Remove the power steering pump and position aside. Do not disconnect the power steering lines.
5. Disconnect electrical from oil pressure sensor.

6. Remove the vacuum line from the fuel pressure regulator.

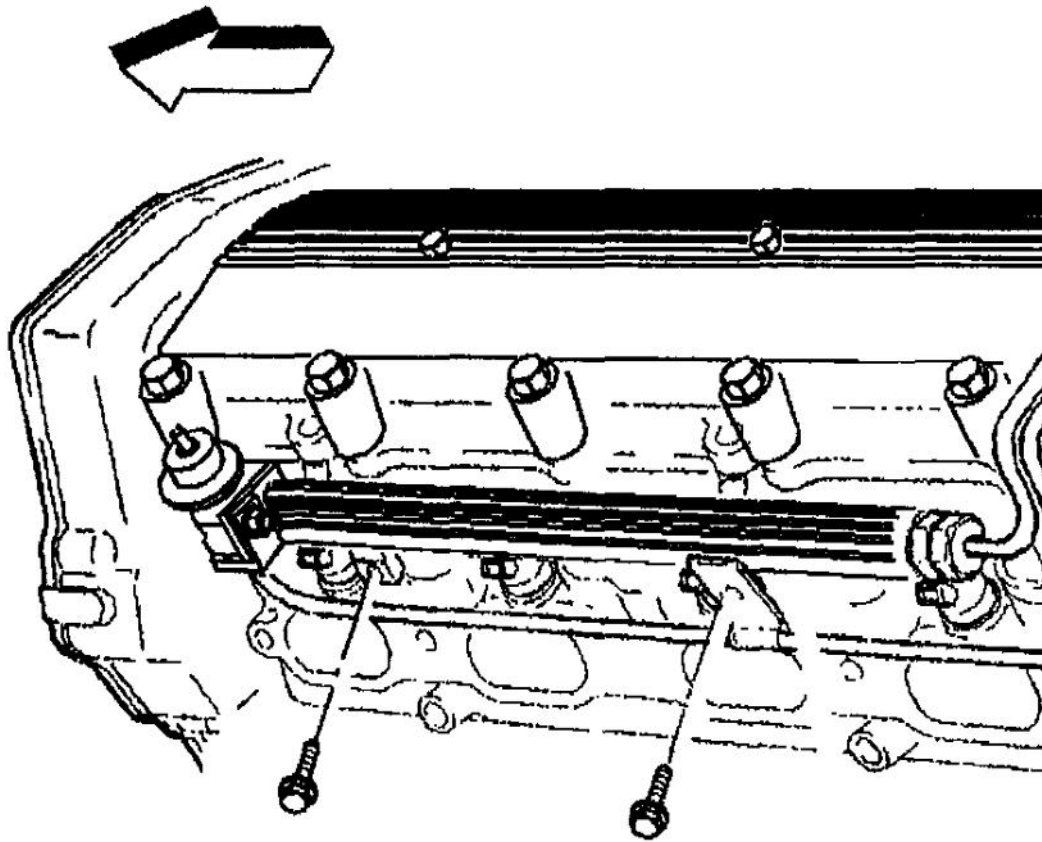


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Fig. 43: Power Steering Pump

Courtesy of GENERAL MOTORS CORP.

7. Remove the fuel rail. Refer to **FUEL RAIL & INJECTORS** .
8. Disconnect, but do not remove from the vehicle, the timing chain housing at the intake camshaft housing. Refer to **Timing Chain Housing Replacement**.

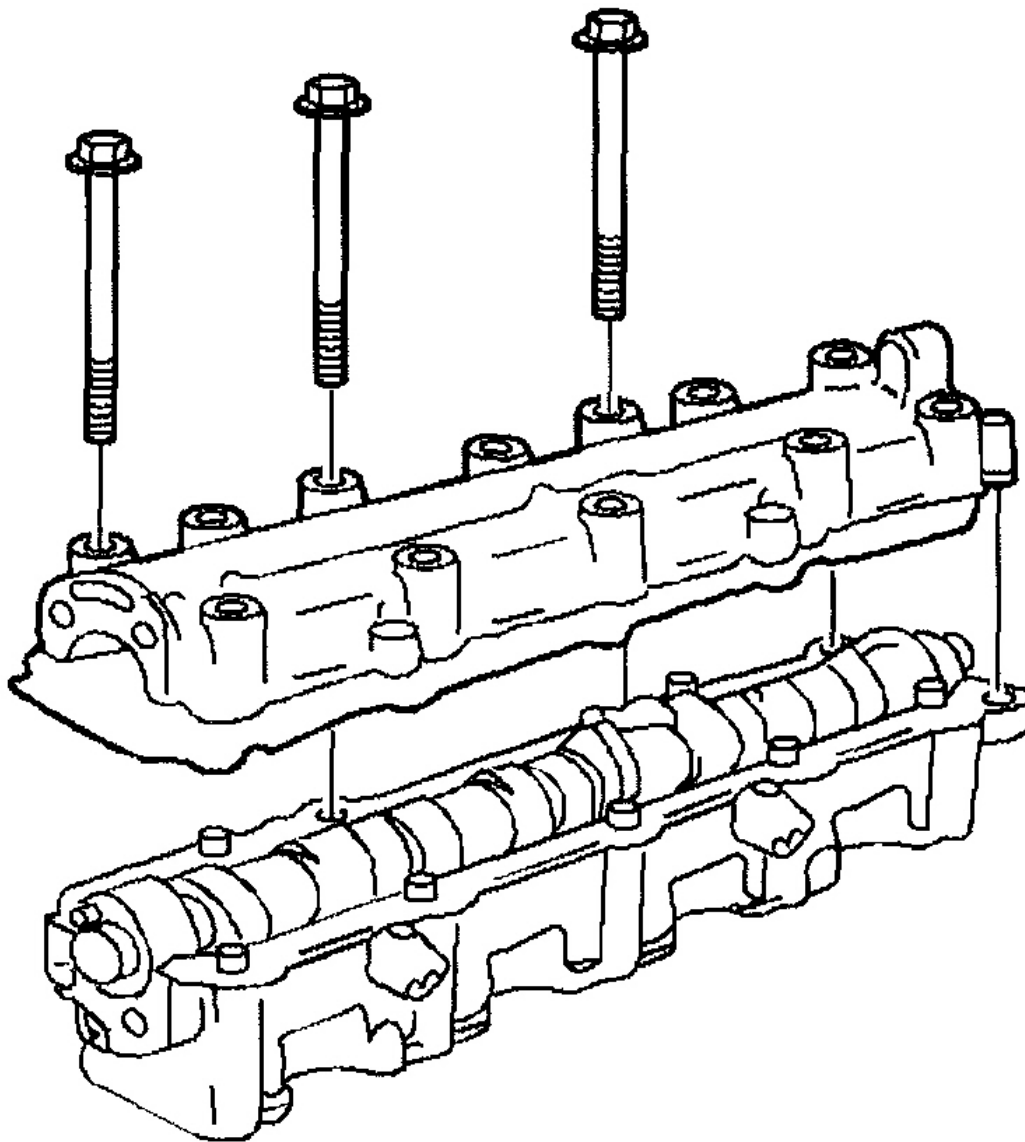


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Fig. 44: Fuel Rail

Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft housing cover to the camshaft housing retaining bolts.



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Fig. 45: Camshaft Housing Cover
Courtesy of GENERAL MOTORS CORP.

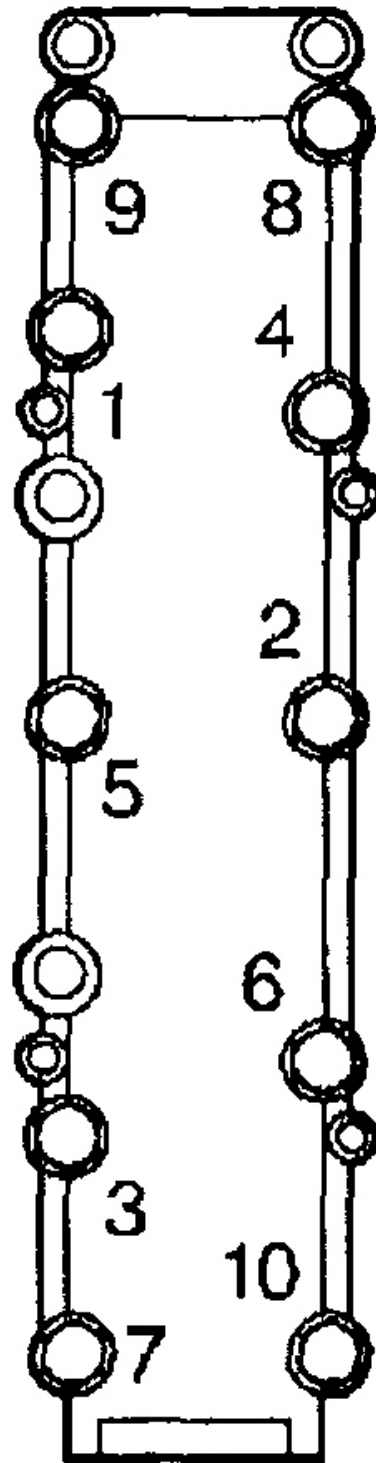
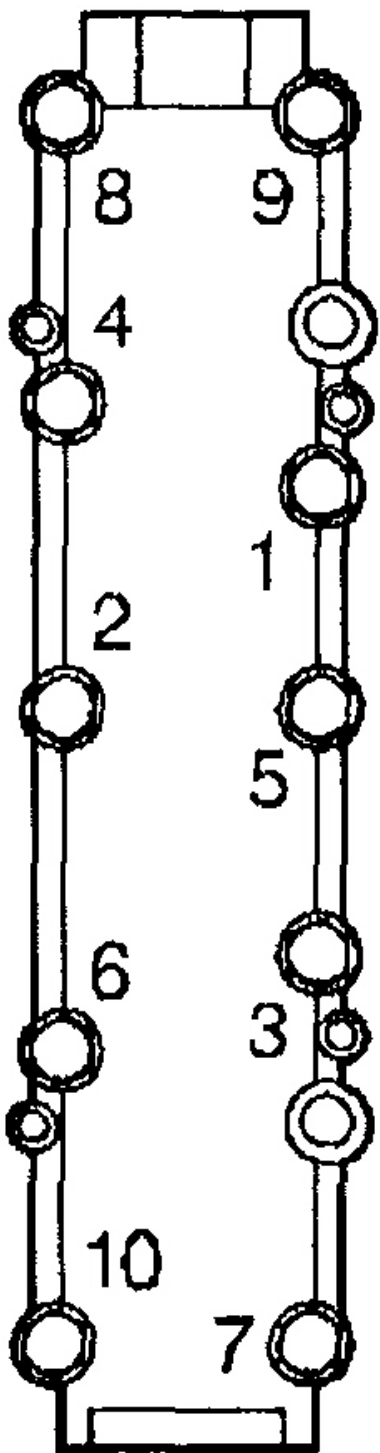
Important:

- Use the reverse of the tightening procedure when loosening the camshaft housing to the cylinder head retaining bolts.
- Leave the 2 bolts loosely in place in order to hold the camshaft housing while separating the

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camshaft cover from the housing.



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Fig. 46: Camshaft Housing-To-Cylinder Head Retaining Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft housing to the cylinder head retaining bolts.

Important: Tighten the bolts evenly in order to prevent the cover from binding on the dowel pins.

11. Push the cover off the housing by threading four of the housing to head retaining bolts into the tapped holes in the camshaft housing cover.
12. Remove the 2 loosely installed camshaft housing to head bolts.
13. Remove the cover and discard the gaskets.
14. Loosely reinstall one camshaft housing to cylinder head bolt in order to retain the housing during the camshaft and lifter removal.
15. Note the position of the chain sprocket dowel pin for reassembly. Remove the camshaft being careful not to damage the camshaft or the journals.

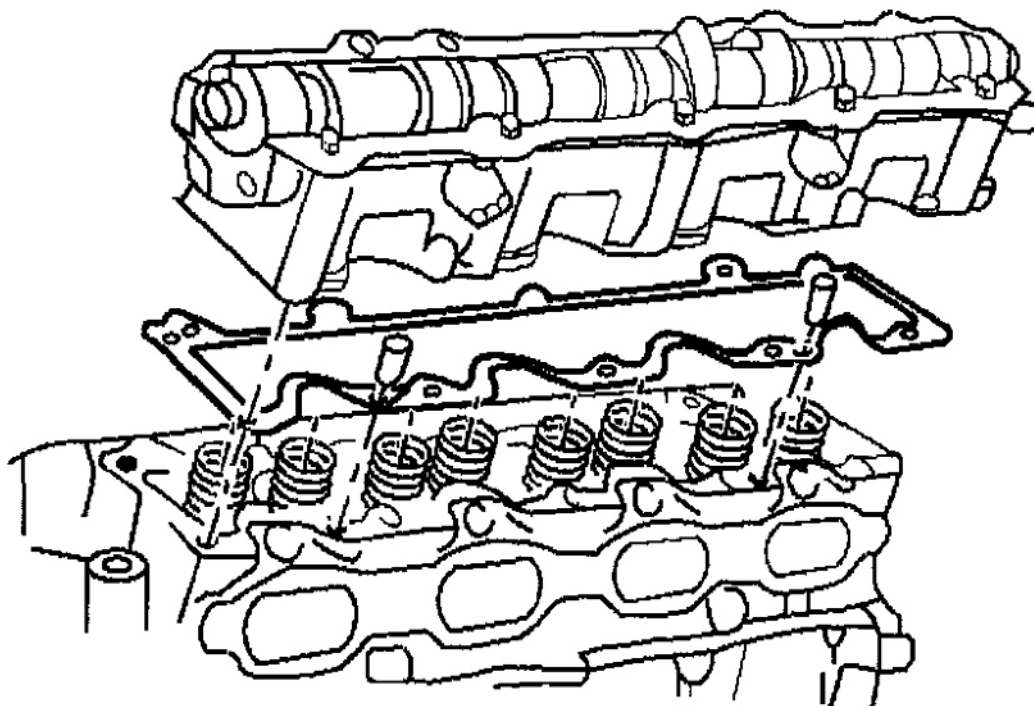
Important: The valve lifters are not serviceable. Replace faulty valve lifters.

Coat the valve lifter with the camshaft and lifter prelube GM P/N 12345501 (Canadian P/N 992704), or the equivalent. If the new lifters are installed, add the engine oil supplement GM P/N 1052367 (Canadian P/N 992869), or the equivalent, to the engine oil.

16. Remove the valve lifters as follows:
 - Keep the lifters in order to reinstall the lifters to the original locations.
 - In order to minimize the lifter bleed down, perform the following procedure:
 - A. Store the lifters upside down, opposite of the installed position, on a level surface.
 - B. Store the lifters submerged in clean engine oil.

Important: Ensure that the alignment dowel pins are in the cylinder head prior to installing the camshaft housing.

- Remove the camshaft housing and the gasket.



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Fig. 47: Camshaft Housing And Gasket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the camshaft housing to the cylinder head with a new gasket. Sealer is unnecessary.
2. Loosely install on camshaft housing to the cylinder head bolt in order to hold the housing in place.

Important: Used lifters must be returned to the original position in the camshaft housing. If the camshaft is being replaced, the lifters actuated by the camshaft must also be replaced.

3. Install the lifters into the lifter bores.
4. Install the camshaft in the same position as when removed. The timing chain sprocket dowel pin should be straight up and line up with the centerline of the lifter bores.
5. Install the new camshaft housing to the green colored camshaft housing cover seals and into the cover. Sealant is unnecessary.
6. Remove the bolt holding the housing in place.
7. Apply the pipe sealant GM P/N 1052080 (Canadian P/N 10953480) or the equivalent to the camshaft housing and the cover retaining bolt threads.
8. Install the camshaft housing cover to the camshaft housing.

Important: The top intake camshaft housing bolts are tightened to a different specification than the other camshaft housing bolts.

9. Using the **J 36660-A** Torque Angle Meter: Tighten the camshaft housing to cylinder head bolts to 15 N.m (11 ft lbs) + 90 degrees.
10. Tighten the camshaft housing cover to camshaft housing bolts to 15 N.m (11 ft lbs) + 30 degrees.
11. Install the timing chain housing and the timing chain.
12. Install the camshaft position sensor connector.
13. Install electrical to oil pressure sensor.

Important: When reinstalling the power steering pump, apply a 3 mm bead of GM P/N 12346286 (Canadian P/N 10953472) sealer or the equivalent to the joint at the end of the camshaft housing halves before the installation of the power steering pump and the pump face seal.

14. Install the power steering pump assembly.
15. Install ignition coil and module assembly.

Important: Do not compress the lifter plungers using a vise or other tool. This will cause more air to enter the lifter assembly and will take more time to bleed out once the lifters are installed.

16. If new lifters have been installed or the lifters bled down while the engine was disassembled, excessive lifter noise may be experienced. This is a normal condition and no engine damage is occurring. Use the following procedure to purge air from the lifters:
 - 15.1. Start the engine and allow the engine to warm up at idle for 5 minutes.
 - 15.2. Increase the engine speed to 2,000 RPM until the lifter noise is gone.
 - 15.3. Return the engine to idle for an additional 5 minutes or perform a road test.
17. Connect the negative battery cable.

EXHAUST CAMSHAFT, HOUSING & LIFTER REPLACEMENT

Tools Required

- **J 36660-A** Torque Angle Meter
- **J 36011** Spark Plug Boot Remover

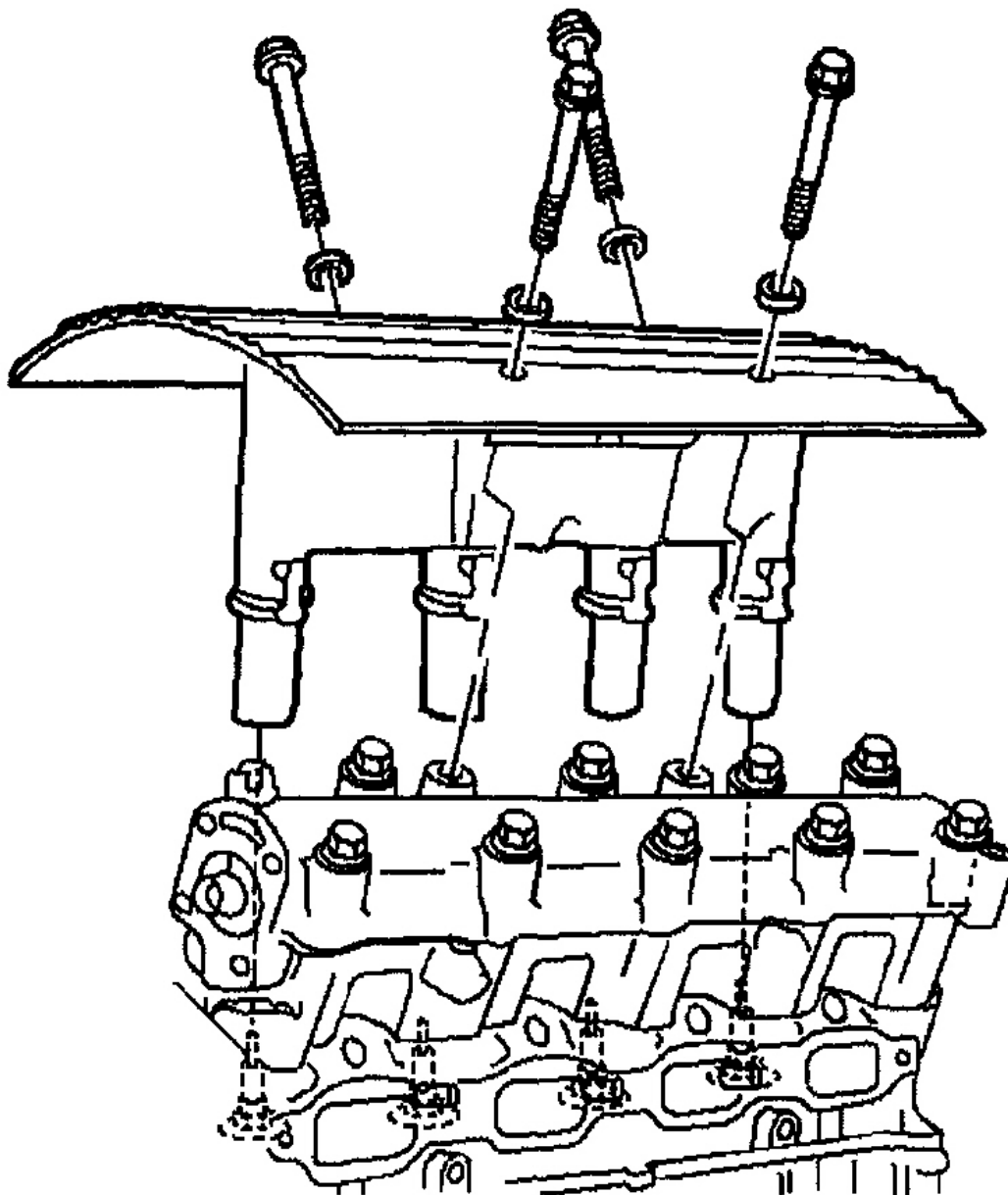
Removal Procedure

Important: Any time the camshaft housing to cylinder head bolts are loosened or removed, the camshaft housing to cylinder head gasket must be replaced.

During disassembly, ensure that the valve lifters are kept together and identified so that they can be reinstalled in the original locations.

Before disassembling the valve mechanism, make a compression test and note the results. Refer to **Engine Compression Test**.

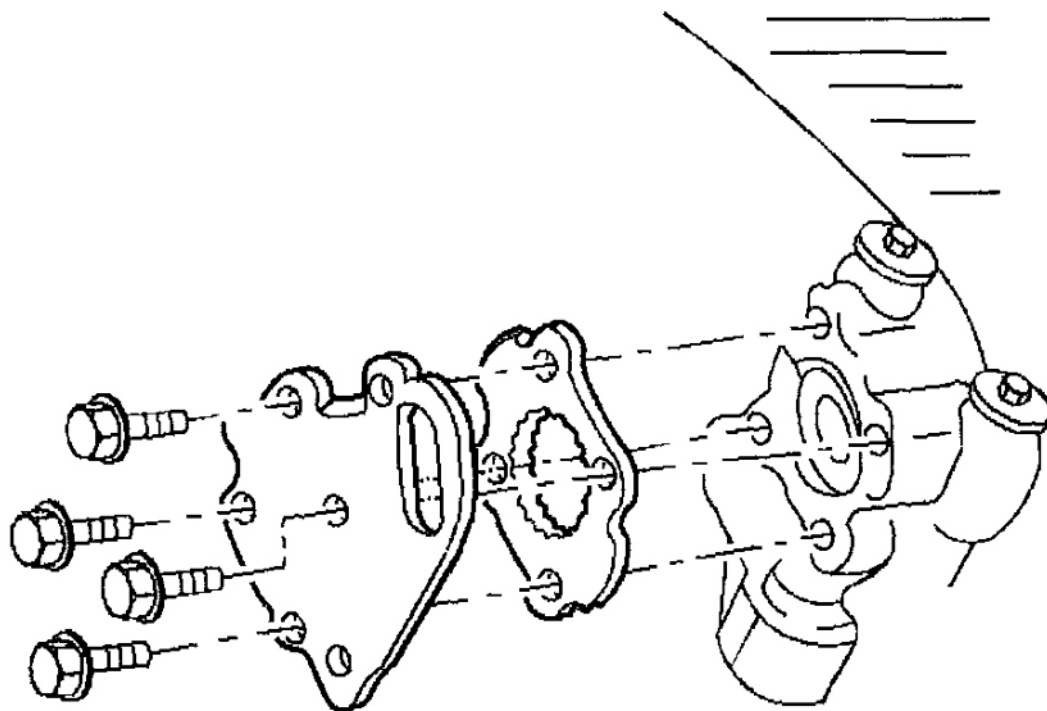
1. Disconnect the negative battery cable.
2. Remove the ignition coil and the module assembly.



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Fig. 48: Ignition Coil & Module Assembly
Courtesy of GENERAL MOTORS CORP.

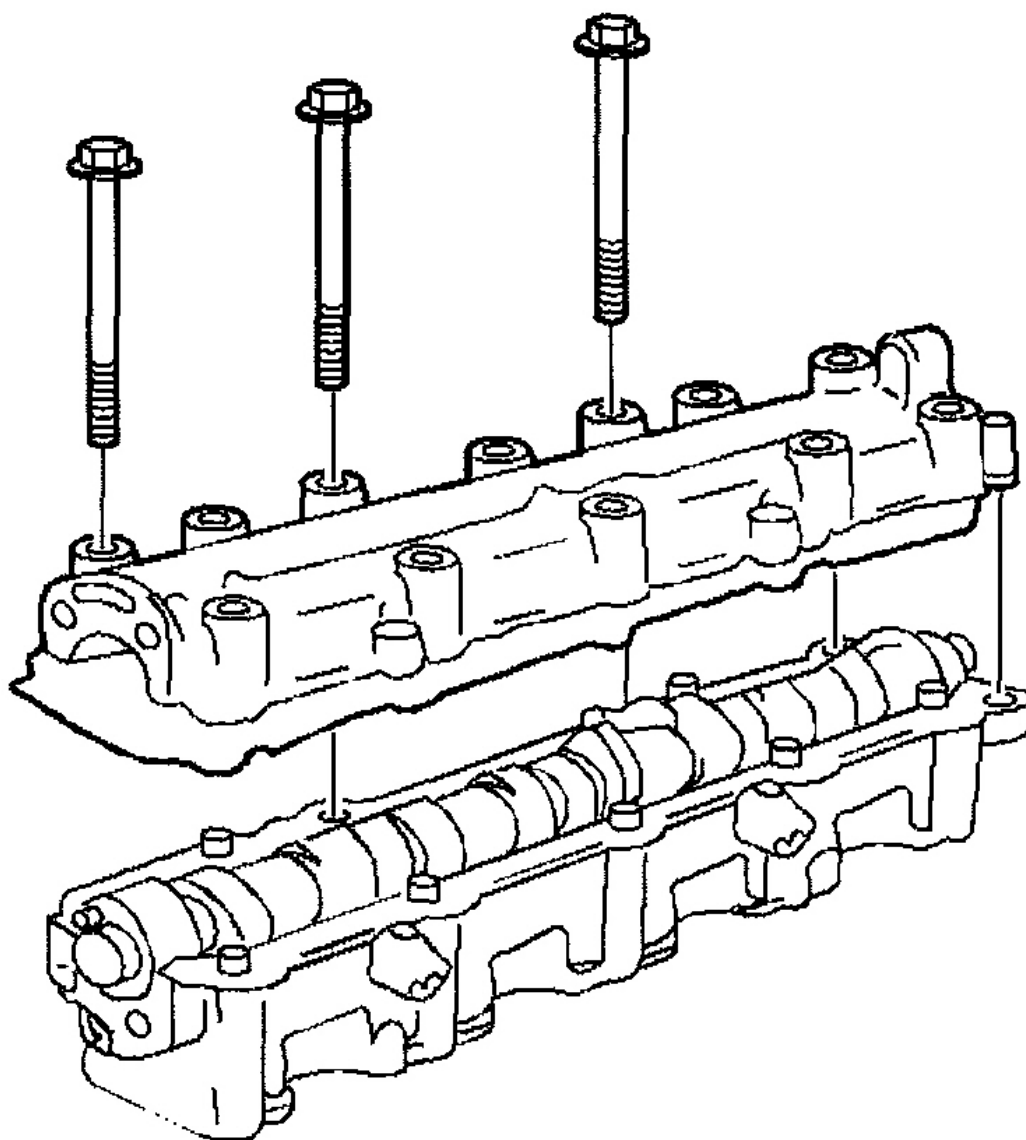
3. Disconnect the timing chain housing at the exhaust camshaft housing but do not remove from the parts from the vehicle. Refer to **TIMING CHAIN HOUSING -- REMOVAL**.
4. Remove the exhaust camshaft end cover and gasket.



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Fig. 49: Exhaust Camshaft End Cover And Gasket
Courtesy of GENERAL MOTORS CORP.

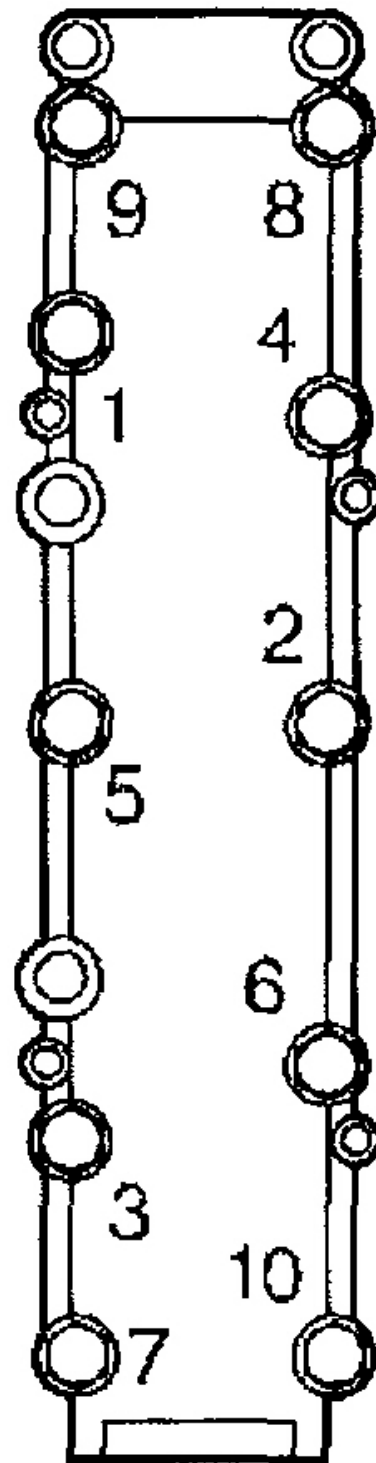
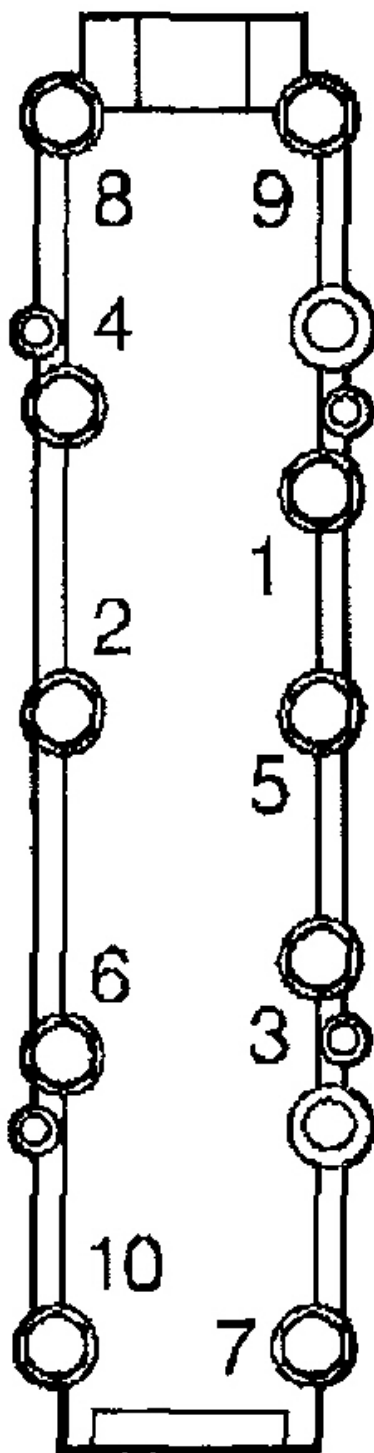
5. Remove the exhaust camshaft housing to the cylinder head bolts.



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Fig. 50: Exhaust Camshaft Housing To The Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

6. Use the reverse of the tightening procedure when loosening the camshaft housing to the cylinder head retaining bolts.



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Fig. 51: Camshaft Housing-To-Cylinder Head Retaining Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

7. Leave two bolts loosely in place in order to hold the camshaft housing while separating the camshaft cover from the housing.

Important: Tighten the bolts in evenly in order to prevent the cover from binding on the dowel pins.

8. Push the cover off the housing by threading the four of the housing to head retaining bolts into the tapped holes in the camshaft cover.
9. Remove the two loosely installed camshaft housing to head bolts.
10. Remove the cover.
11. Discard the gaskets.
12. Loosely reinstall the one camshaft housing to the cylinder head bolt in order to retain the housing during the camshaft and the lifter removal.
13. Notice the position of the chain sprocket dowel pin for reassembly. Remove the camshaft carefully in order to prevent damage to the camshaft or the journals.
14. Remove the valve lifters.

Keep the lifters in order so that the lifters can be reinstalled in the original location.

Important:

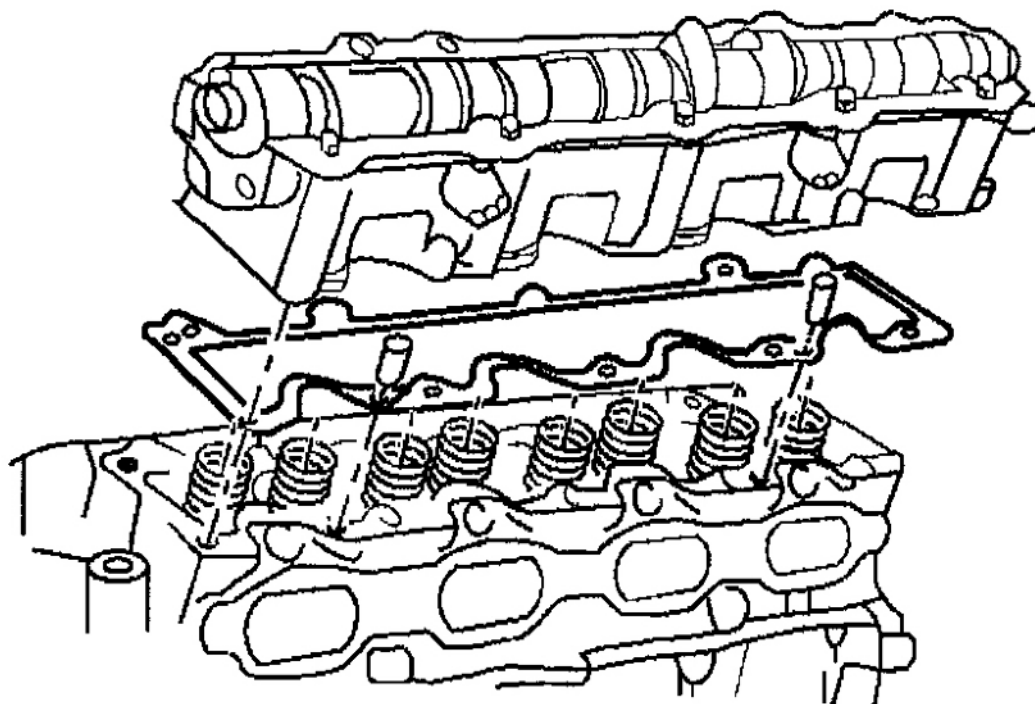
- These lifters are not serviceable. Replace any faulty lifters.
- Coat the lifter with Camshaft and Lifter Prelube GM P/N 12345501 (Canadian P/N 992704) or the equivalent.

If new lifters are installed, add the Engine Oil Supplement GM P/N 1052367 (Canadian P/N 992869) or the equivalent to the engine oil.

15. In order to minimize lifter bleed down, use the following procedure:
 - Store lifters upside down (the camshaft contact surface down) on a level surface.
 - Store the lifters submerged in clean engine oil.

Important: Ensure that the camshaft housing alignment dowel pins are in the cylinder head prior to installing the housing.

16. Remove the camshaft housing gasket.



G01777587

Fig. 52: Camshaft Housing Gasket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the camshaft housing to the cylinder head with a new gasket. Sealer is unnecessary.
2. Loosely install one camshaft housing to the cylinder head bolt in order to hold the housing in place.

Important:

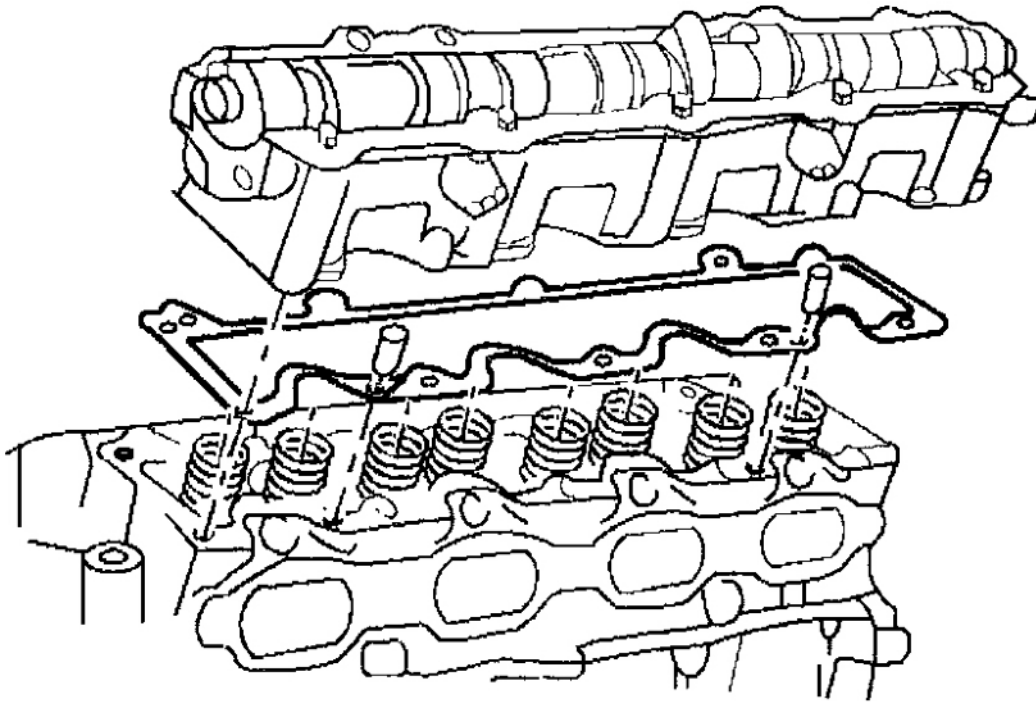
- Used lifters must be returned to their original position in the camshaft housing.
 - If the camshaft is being replaced, the lifters must also be replaced.
3. Install the lifters into the lifter bores.

NOTE: The camshaft lobes and the journals must be adequately lubricated or serious engine damage will occur upon start up.

4. Lube the camshaft lobes and the journals with the Camshaft and Lifter Prelube GM P/N 12345501 (Canadian P/N 992704) or the equivalent.
5. Install the camshaft in the same position as when removed. The timing chain sprocket dowel pin should

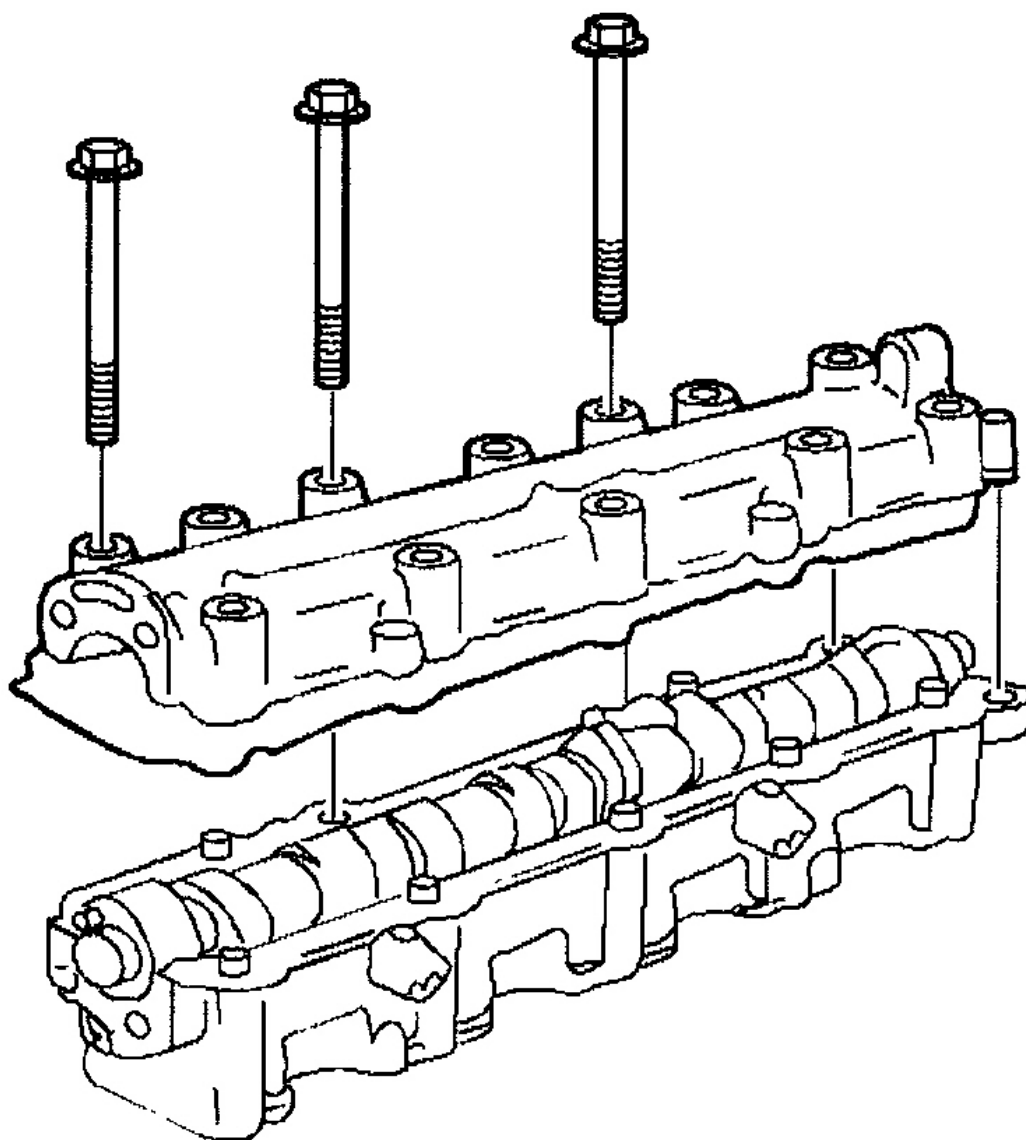
be straight up and line up with the centerline of the lifter bores.

6. Install the new camshaft housing to the orange camshaft housing cover seals into the cover. Sealer is unnecessary.
7. Remove the bolt holding the housing in place.
8. Apply pipe sealant GM P/N 1052080 (Canadian P/N 10953480) or the equivalent to the camshaft housing and the cover retaining bolt threads.
9. Install the camshaft housing cover to the camshaft housing.



G01777588

Fig. 53: Camshaft Housing Cover-To-Camshaft Housing
Courtesy of GENERAL MOTORS CORP.



G01777589

Fig. 54: Camshaft Housing Cover Bolts
Courtesy of GENERAL MOTORS CORP.

10. Use the **J 36660-A** Torque Angle Meter, in order to install the bolts.
 - Tighten the camshaft housing to cylinder head bolts to 15 N.m (11 ft lbs) + 90 degrees.
 - Tighten the camshaft housing cover to camshaft housing bolts to 15 N.m (11 ft lbs) + 30 degrees.
11. Install the timing chain housing to camshaft housing and the timing chain. Refer to **Timing Chain Housing Replacement**.

12. Install the exhaust camshaft housing end cover gasket and cover.
13. Reinstall any spark plugs boot connector assembly that stuck to a spark plug, back onto the ignition coil and module assembly.
14. Install ignition coil and module assembly.
15. Connect the negative battery cable.

Important: Do not compress the lifter plungers using a vise or other tool. This will cause more air to enter the lifter assembly and will take more time to bleed out once the lifters are installed.

16. If new lifters have been installed or the lifters bled down while the engine was disassembled excessive lifter noise may be experienced. This is a normal condition and no engine damage is occurring. Use the following procedure in order to purge the air from the lifters:
 - 16.1. Start the engine and allow to warm up at the idle for 5 minutes.
 - 16.2. Increase the engine speed to 2,000 RPM until the lifter noise is gone.
 - 16.3. Return the engine to idle for an additional 5 minutes or perform a road test.
17. Start the engine and inspect for leaks.

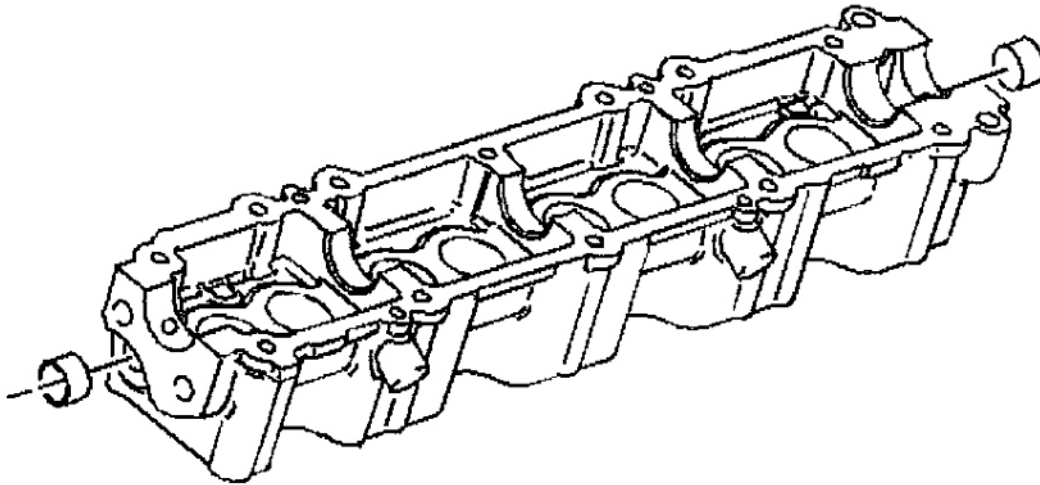
CAMSHAFT HOUSING OIL GALLERY PLUGS REPLACEMENT

Tools Required

J 37868 Camshaft Oil Gallery Plug Installer

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the camshaft housing. Refer to **Intake Camshaft, Housing & Lifter Replacement** for the intake camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement** for the exhaust camshaft housing.
3. Disassemble the oil gallery plug as follows:
 - 3.1. Using a 8.33 mm (21/64 in) bit, drill the oil gallery plug.
 - 3.2. With a 10.0 mm (0.3937 in) bottoming tap, thread the plug.
 - 3.3. Install a 10.0 mm bolt into the plug and pull the plug out.
4. Clean the oil gallery plug hole.



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Fig. 55: Oil Gallery Plug Hole
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Assemble the oil gallery plug with the **J 37868** Oil Gallery Plug Installer.
2. Install the camshaft housing. Refer to **Intake Camshaft, Housing & Lifter Replacement** for the intake camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement** for the exhaust camshaft housing.
3. Connect the negative battery cable.

VALVE STEM OIL SEAL & VALVE SPRING REPLACEMENT

Tools Required

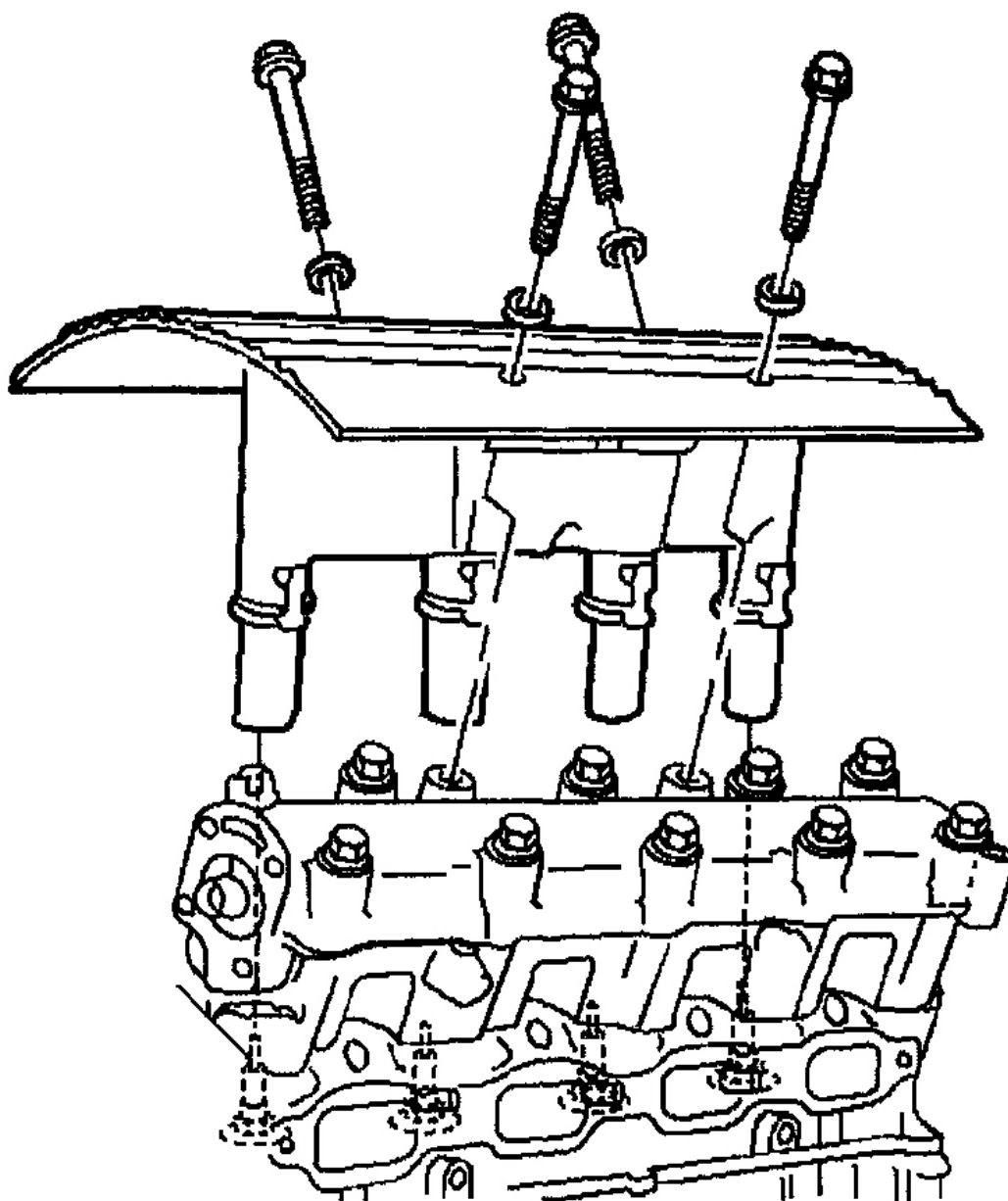
- **J 36588** Valve Spring Compressor T-Bolt
- **J 5892-D** Valve Spring Compressor
- **J 36017** Valve Guide Seal Remover
- **J 36660-A** Torque Angle Meter

Removal Procedure

Important: Any time the camshaft housing to the cylinder head bolts are loosened or removed, the camshaft housing to the cylinder head gasket must be replaced.

1. Disconnect the negative battery cable.

2. Remove the ignition coil and module assembly.



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Fig. 56: Ignition Coil And Module Assembly
Courtesy of GENERAL MOTORS CORP.

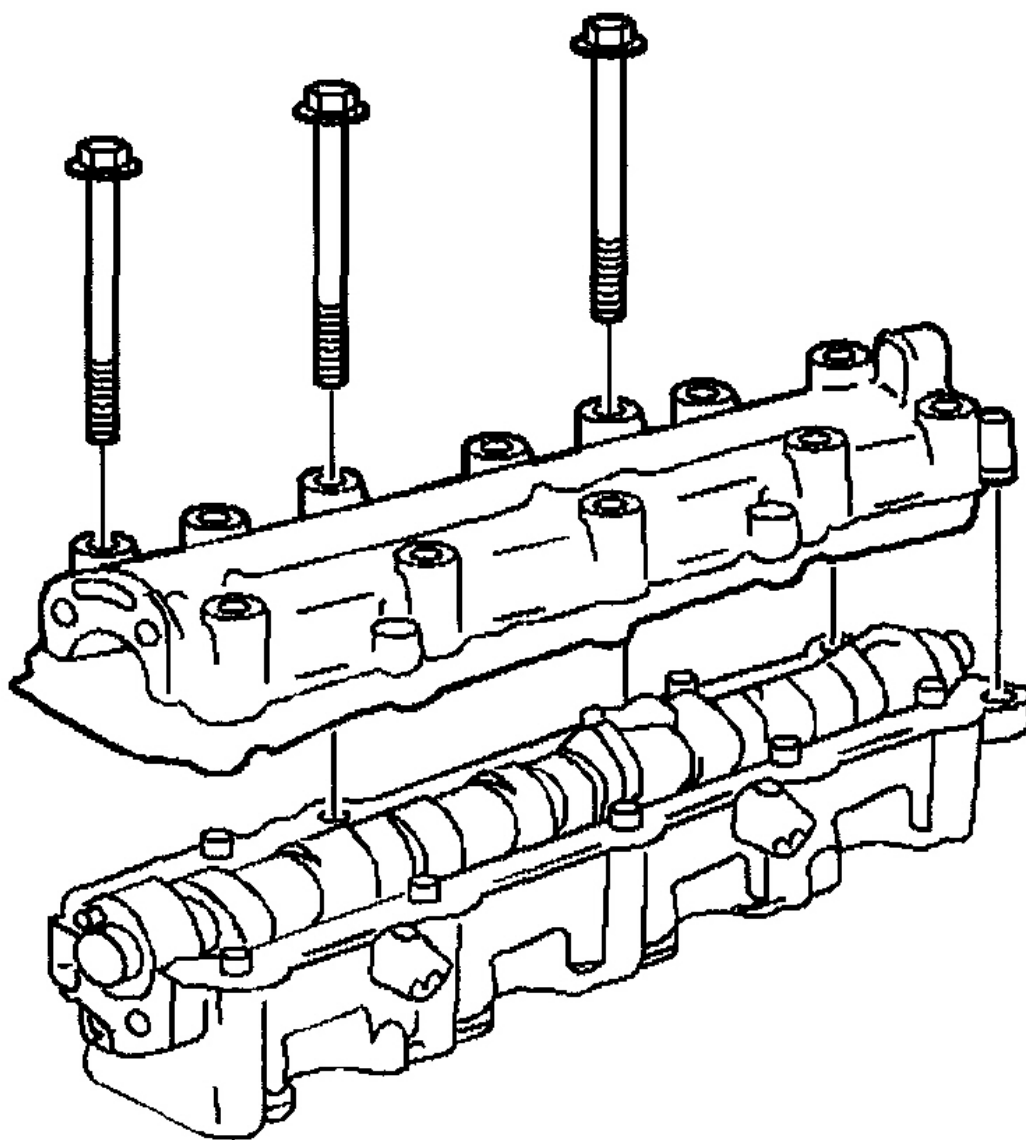
3. Disconnect the electrical connection from the oil pressure switch.

4. Disconnect the timing chain housing at the camshaft housing, but do not remove it from the vehicle. Refer to **Timing Chain Housing Replacement**.

NOTE: Turn the camshaft housing upside down as soon as it is removed from the cylinder head. The lifters will fall out of the camshaft housing if it is not turned upside down. The lifters can be damaged if they fall out and hit a hard surface.

Important: Use the reverse of the tightening procedure when loosening the camshaft housing to the cylinder head retaining bolts.

5. Remove the camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement** or **Intake Camshaft, Housing & Lifter Replacement** .



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Fig. 57: Camshaft Housing
Courtesy of GENERAL MOTORS CORP.

6. Remove the spark plug.
7. Using a suitable adapter, apply air pressure to the cylinder.
8. Compress the valve spring. Use the **J 5892-D** and the **J 36588**.

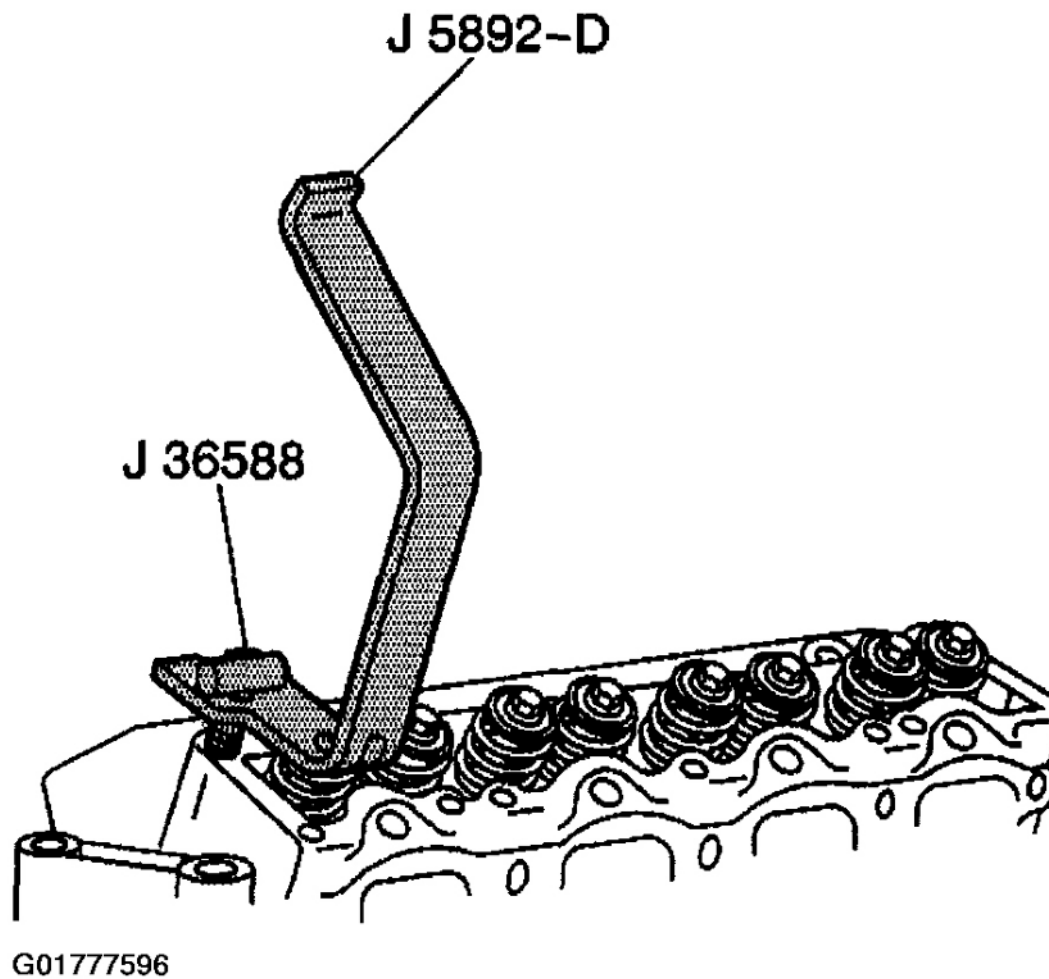
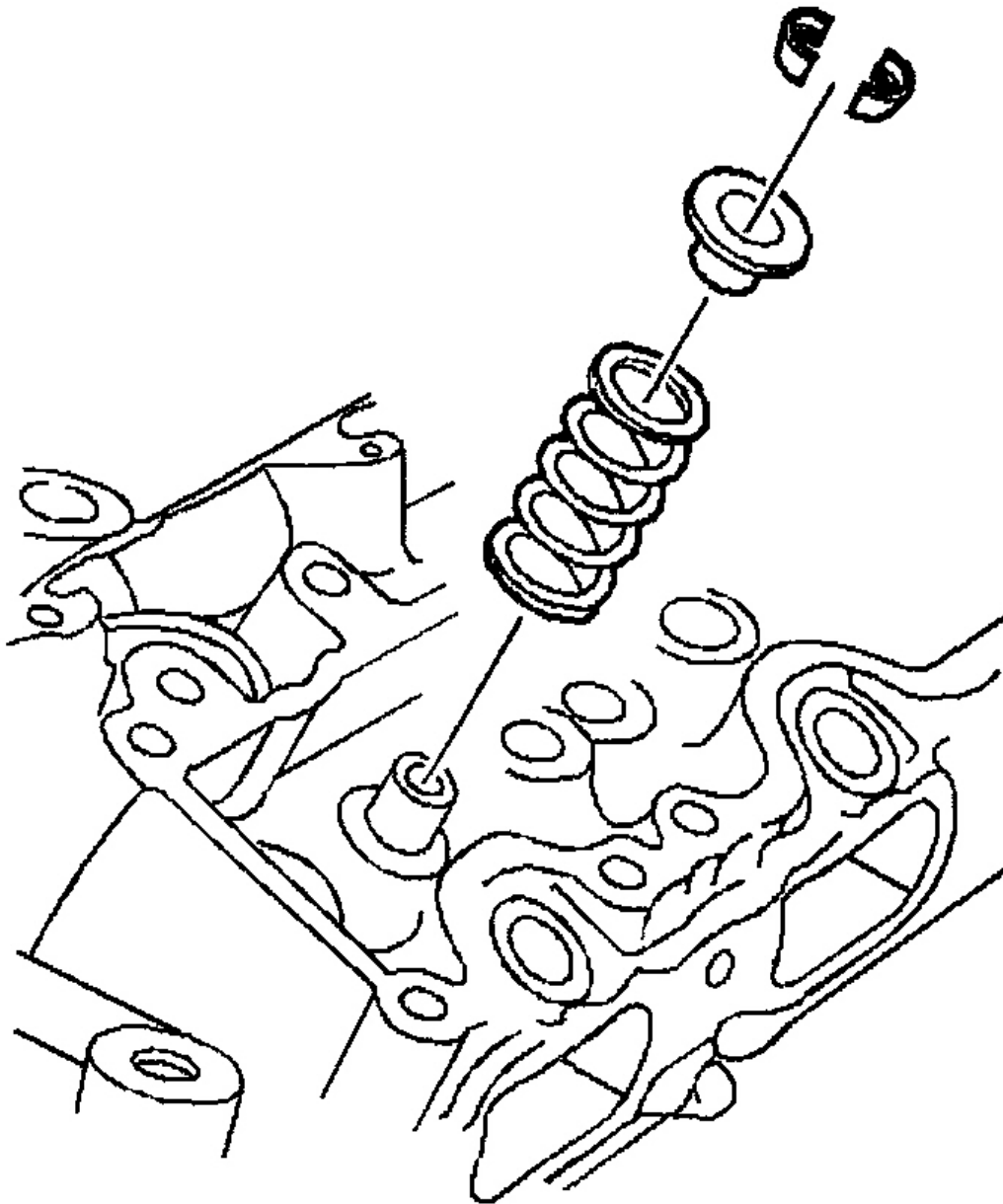


Fig. 58: Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

9. Disassemble the following components:

- The valve keys
- The retainer
- The spring
- The valve seal using **J 36017**
- The rotator (intake)
- The valve spring seat (exhaust)



G01777597

Fig. 59: Valve Spring Components
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Assemble the following components:

- The rotator (intake)
 - The valve spring seat (exhaust)
 - A new, clean and dry valve seal. Push the seal on by hand in order to ensure that the seal is fully seated.
 - The spring and retainer. Use the **J 36588** and the **J 5892-D** in order to compress the valve spring.
 - The valve keys.
2. Inspect for proper valve key seating.
 3. Remove the air line adapter.
 4. Install the spark plug.

NOTE: Carefully roll the camshaft housing right side up as it is installed onto the cylinder head. The lifters can be damaged if they fall out and hit a hard surface.

5. Install the camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement** or **Intake Camshaft, Housing & Lifter Replacement**.
6. Install the timing chain housing to the camshaft housing and timing chain. Refer to **Timing Chain Housing Replacement**.
7. Connect the electrical connection to the oil pressure switch.
8. Install the ignition coil and module assembly.
9. Connect the negative battery cable.

CRANKSHAFT BALANCER REPLACEMENT

Tools Required

- **J 38122-A** Harmonic Balancer Holder
- **J 24420-B** Crankshaft Balancer Puller

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Raise and suitably support the vehicle.
3. Remove the right engine splash shield.
4. Remove the balancer retaining bolt and the washer using **J 38122-A** to prevent crankshaft rotation when loosening the bolt.
5. Remove the balancer assembly using **J 24420-B**.

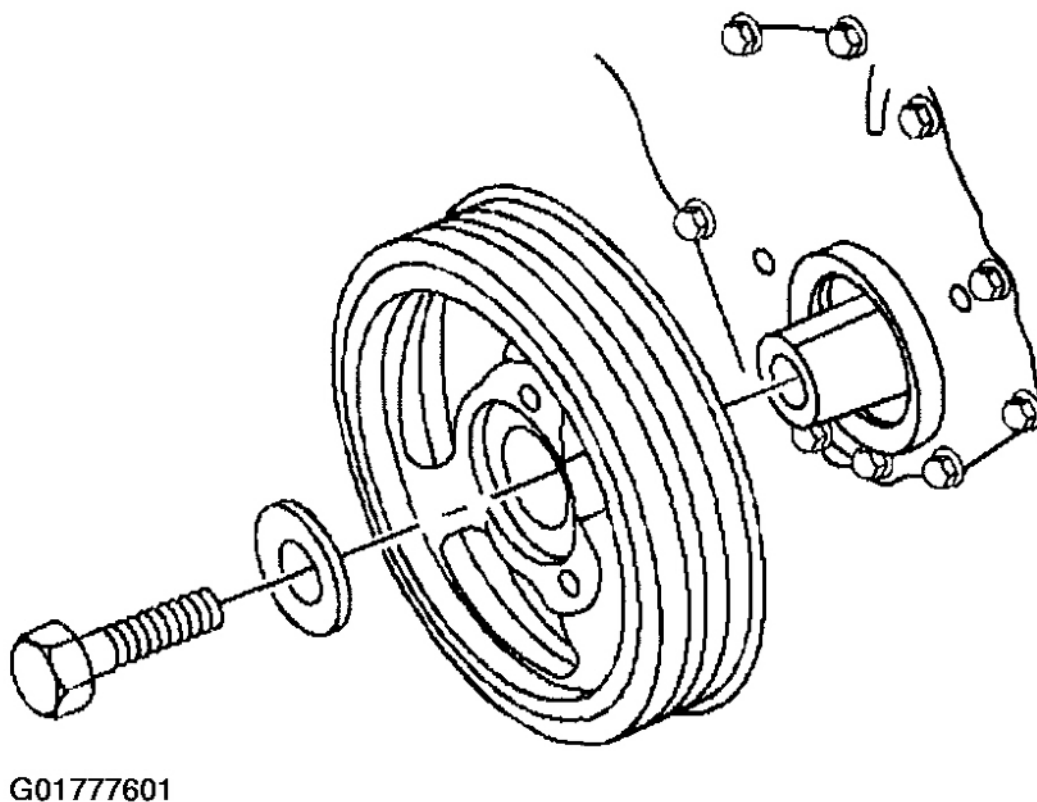


Fig. 60: Balancer Assembly

Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Lubricate the front seal and the sealing surface of the balancer with Chassis Grease GM P/N 1051344 (Canadian P/N 993037) or equivalent.

Important: The automatic transmission crankshaft balancer must not be installed on a manual transmission equipped engine.

2. Install the balancer onto the crankshaft indexing keyway. Tap into place using a rubber or sand-filled mallet.
3. Install the retaining bolt and the washer. Tighten the bolt to 175 N.m (129 ft lbs) while using **J 38122-A** in order to prevent crankshaft rotation. Put a mark on the socket next to one of the four marks on **J 38122-A**. This mark will represent the 0 degree point. Tighten the bolt by rotating the socket clockwise 90 degrees. At 90 degrees the socket will index with the next mark on the tool.
4. Install the right engine splash shield.
5. Lower the vehicle.

6. Install the accessory drive belt. Refer to **Drive Belt Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

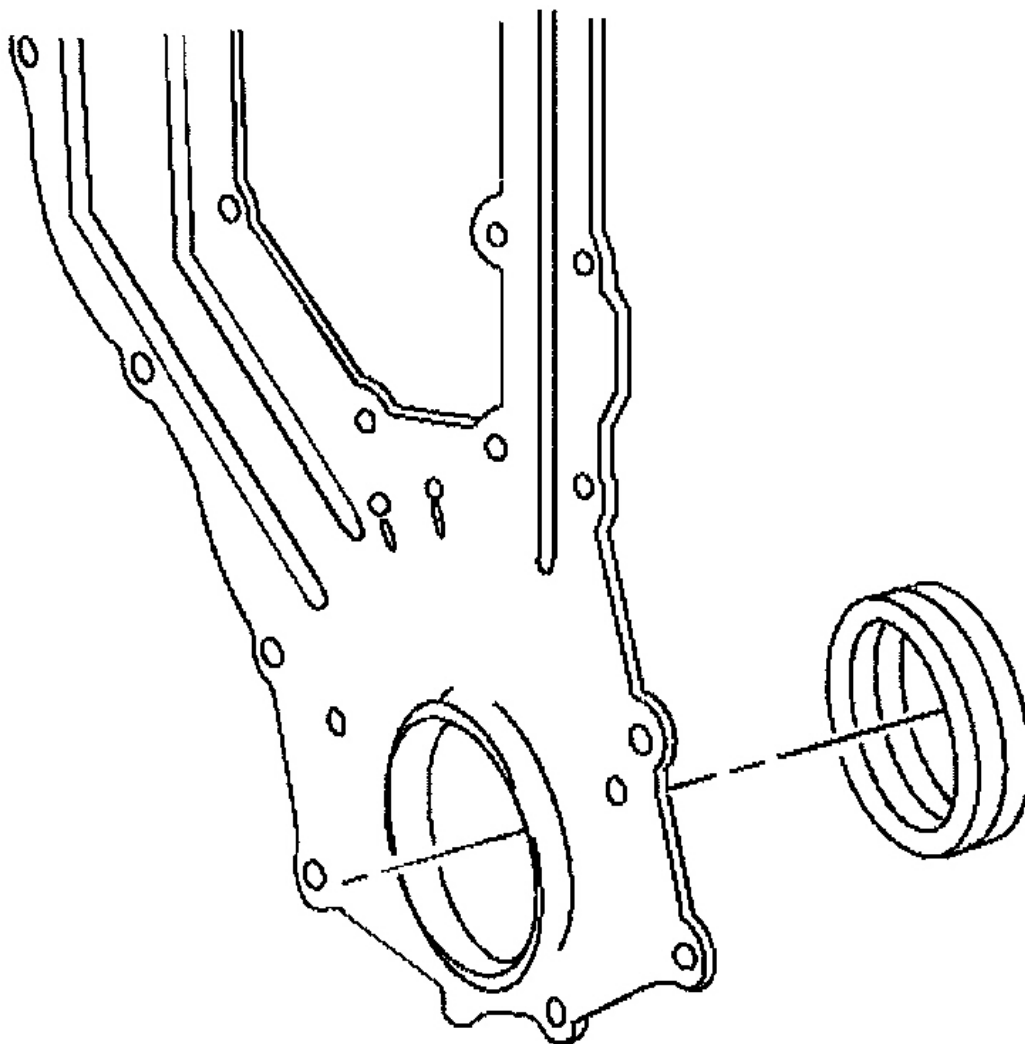
J 36010 Front Crankshaft Seal Installer

Removal Procedure

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

NOTE: **The engine front cover could be damaged if it is not properly supported during seal removal.**

2. Support the front cover and drive the oil seal out the timing chain side of the cover.



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Fig. 61: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the seal into the front cover by driving it in from the timing chain side using **J 36010**. The **J 36010** will properly position the seal in the front cover.
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

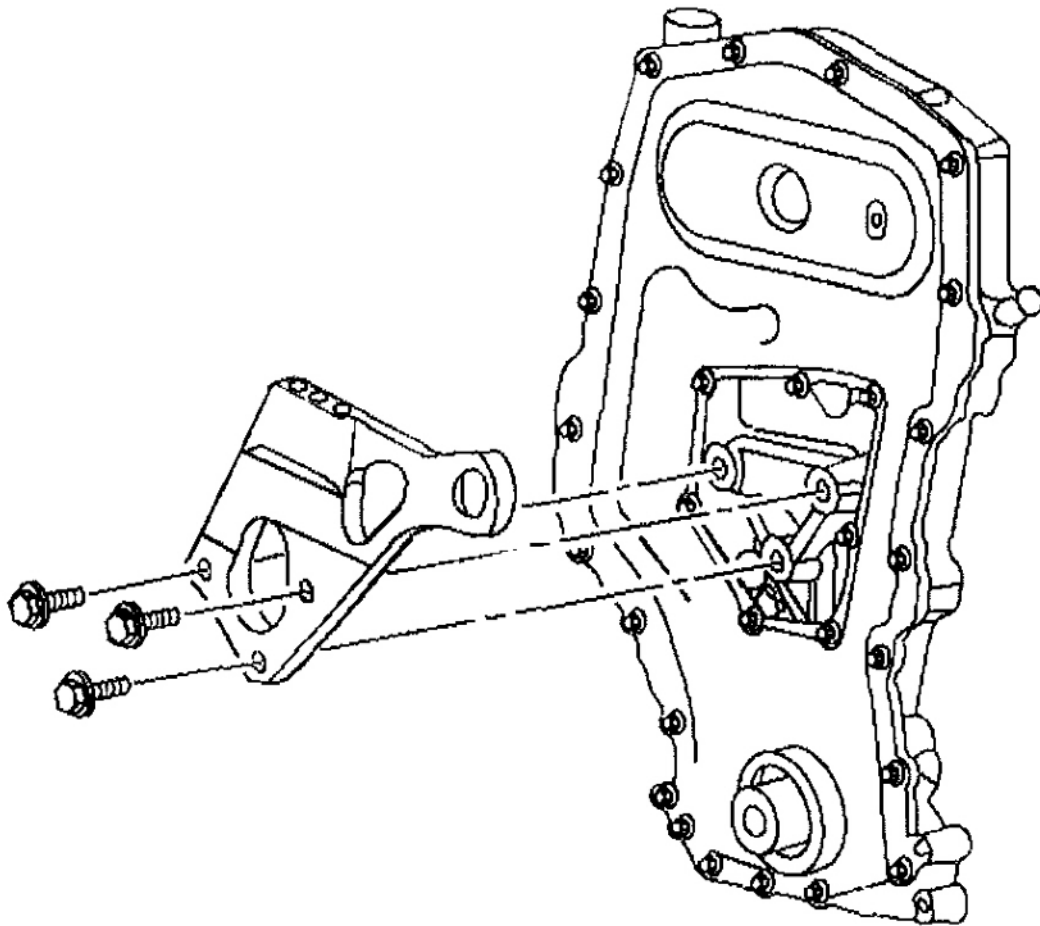
ENGINE FRONT COVER REPLACEMENT

Tools Required

- **J 28467-360** Engine Support Fixture Adapter
- **J 28467-380** Engine Support Bracket
- **J 36660-A** Torque Angle Meter

Removal Procedure

1. Disconnect the negative battery cable.
2. Drain and recover the coolant.
3. Remove the coolant surge tank.
4. Remove the drive belt. Refer to **Drive Belt Replacement**.
5. Install the **J 28467-B**.
6. Remove the upper fasteners from the front cover.
7. Remove the engine mount bracket. Refer to **Engine Mount Bracket Replacement**.



G01777606

Fig. 62: Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

8. Raise and support the vehicle.
9. Remove the right front wheel and the tire assembly.
10. Remove the right engine splash shield.
11. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
12. Remove the lower front cover fasteners.
13. Lower the vehicle.
14. Remove the front cover and the gasket.
15. Inspect the front cover gasket. Replace the gasket if it is damaged.

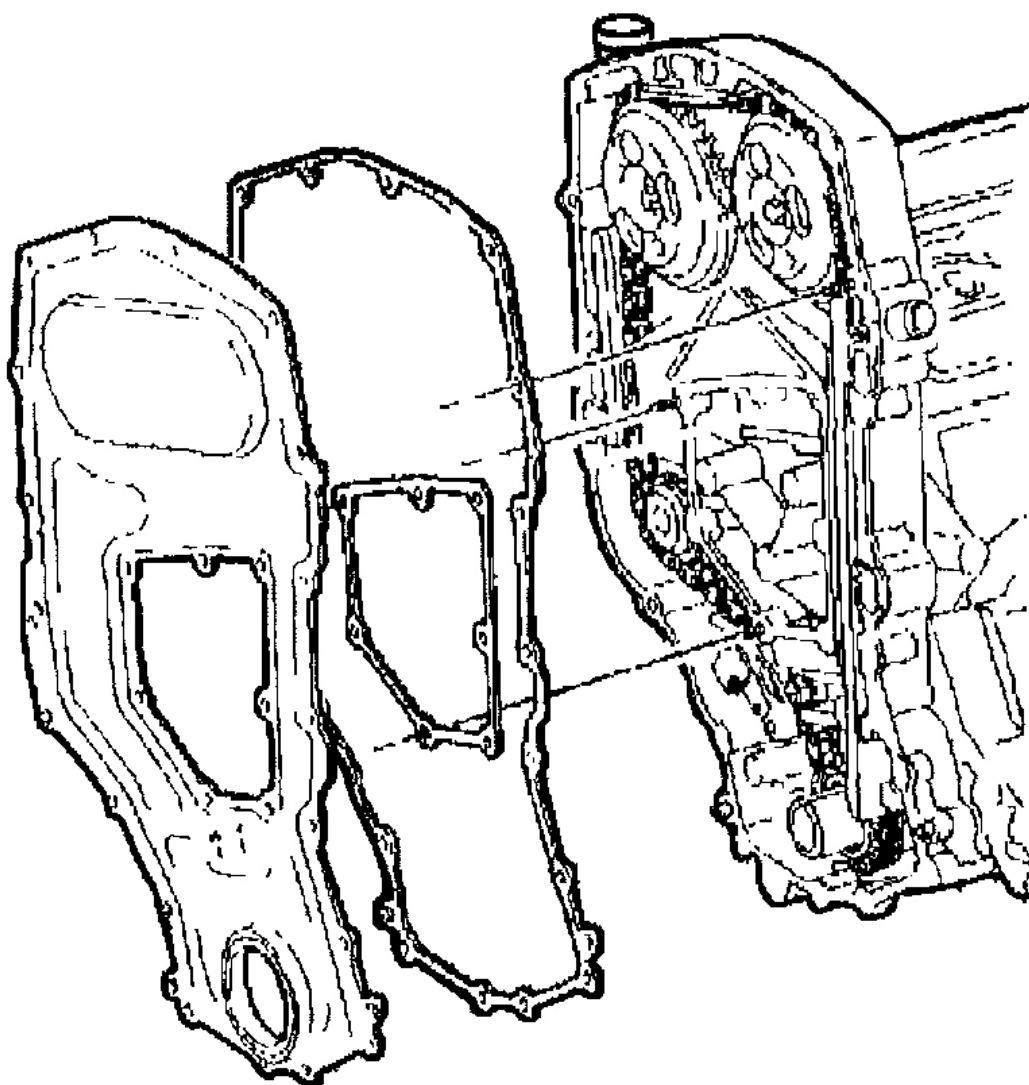
**G01777607**

Fig. 63: Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the front cover gasket. The gasket is reusable and does not require sealer.
2. Install the upper front cover fasteners. Tighten the fasteners to 13 N.m (115 in lbs).
3. Raise and suitably support the vehicle.
4. Install the remaining front cover fasteners. Tighten the fasteners to 13 N.m (115 in lbs).

5. Lubricate the front oil seal and the sealing surface of the crankshaft balancer with Chassis Grease GM P/N 1051344 (Canadian P/N 993037) or equivalent.
6. Install the crankshaft balancer.
7. Install the right engine splash shield.
8. Install the right front wheel and tire assembly.
9. Lower the Vehicle.
10. Install the engine mounting bracket.
11. Install the engine mount assembly.
12. Remove the **J 28467-400** Engine Lift Hook and the **J 28467-B**.
13. Install the drive belt. Refer to **Drive Belt Replacement**.
14. Install the coolant surge tank.
15. Fill cooling system.
16. Connect the negative battery cable.

TIMING CHAIN, SPROCKETS AND/OR TENSIONER REPLACEMENT

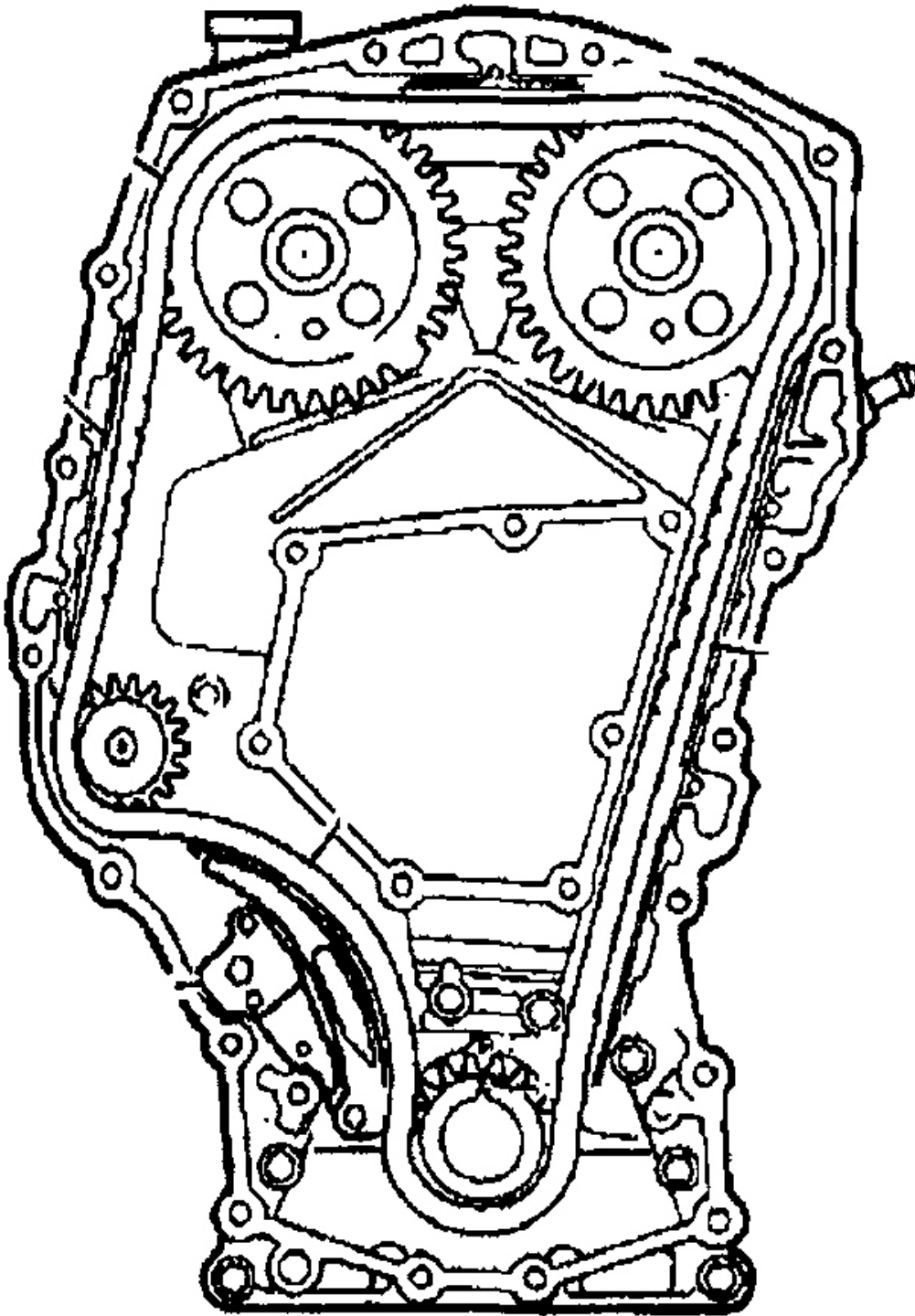
Tools Required

- **J 36008-A** Camshaft Sprocket Timing Alignment Pin
- **J 39579** Camshaft Sprocket Wrench

Removal Procedure

Important:

- Before remove the timing chain, read the entire procedure.
- The timing chain on the LD9 (VIN T) Twin Cam Engine is not to be replaced with the timing chain from any other model year. The timing sprockets are different on the Twin Cam engine and the shape of the links matches the sprockets. Engine damage may result if the wrong timing chain is used.
- The timing chain and the crankshaft sprocket must be marked in order to insure reassembly with the same side facing out at the time of reassembly.



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Fig. 64: Timing Chain

Courtesy of GENERAL MOTORS CORP.

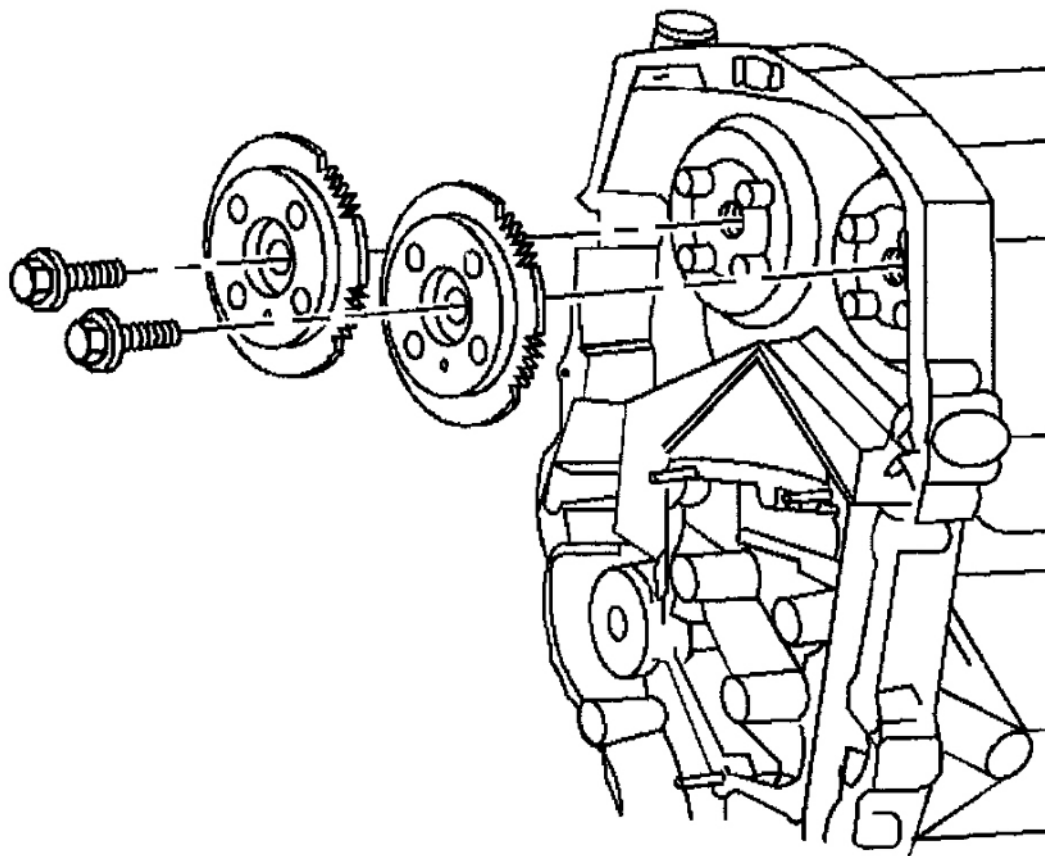
1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Rotate the crankshaft clockwise (as viewed from the front of the engine, normal rotation) until the camshaft sprocket timing dowel pin holes line up with the holes in the timing chain housing.
3. The crankshaft sprocket keyway should point upwards and line up with the centerline of the cylinder bores. This is the Timed position.
4. Remove the timing chain guides.
5. Raise and support the vehicle.
6. Ensure that all of the slack in the timing chain is above the tensioner assembly.
7. Remove the timing chain tensioner.
8. The timing chain must be disengaged from any wear grooves in the tensioner shoe in order to remove the shoe. Slide a screwdriver blade under the timing chain while pulling the shoe outward.

NOTE: Do not attempt to pry the sprocket off the camshaft or damage to the sprocket or chain housing could occur.

9. If difficulty is encountered in removing the timing chain tensioner shoe, use the following procedure in order to remove the intake camshaft sprocket:
 - 9.1. Lower the vehicle.
 - 9.2. Hold the intake camshaft sprocket with the **J 39579** and remove the sprocket bolt and washer.
 - 9.3. Remove the washer from the bolt and rethread the bolt back into the camshaft by hand (the bolt provides a surface to push against).
10. Remove the intake camshaft sprocket. Use a three-jaw puller in the 3 relief holes in the sprocket.

Important: The timing chain and the crankshaft sprocket must be marked prior to removal. If the chain or the crankshaft sprocket is installed with the wear pattern in the opposite direction, noise and increased wear may occur.

11. Mark the crankshaft sprocket and the timing chain outer surface.
12. Remove the timing chain.
13. Remove camshaft sprocket bolts and sprockets.



G01777611

Fig. 65: Camshaft Sprocket

Courtesy of GENERAL MOTORS CORP.

14. Clean the old sealant off of the bolt with a wire brush.
15. Clean the threaded hole in the camshaft with a round nylon bristle brush.
16. Inspect the parts for wear and replace the parts as necessary. Some scoring of the timing chain shoe and the guides is normal.

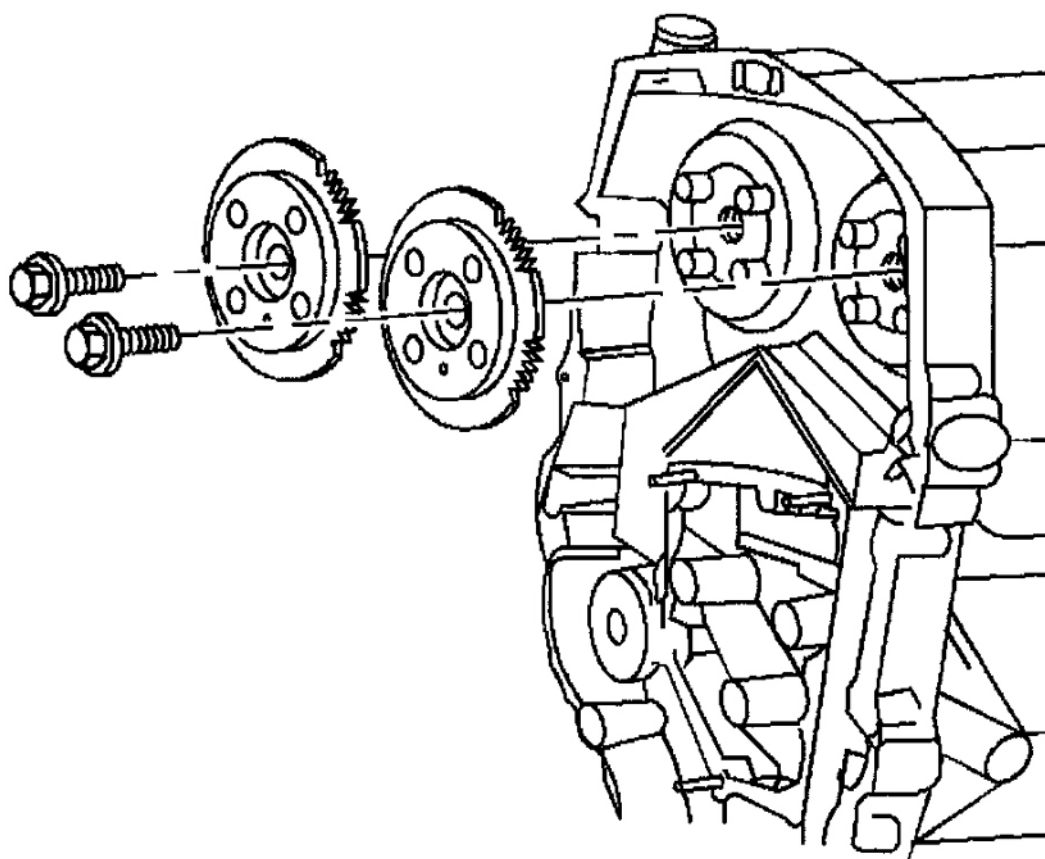
Installation Procedure

NOTE: Failure to follow this procedure could result in severe engine damage.

1. Install the intake camshaft sprocket onto the camshaft with the marked surface showing.
2. Install the intake camshaft sprocket retaining bolt and washer. Tighten the bolt to 70 N.m (52 ft lbs) while holding the sprocket with the **J 39579**.
3. Use Adhesive/Sealant Compound GM P/N 12345493 (Canadian P/N 10953488) or equivalent on the

camshaft sprocket bolt.

4. Install the **J 36008-A** through the holes in the camshaft sprockets into the holes in the timing chain housing in order to position the camshaft for correct timing.
5. If the camshafts are out of position and must be rotated more than 1/8 turn in order to install the alignment dowel pins, use the following procedure:
 - 5.1. The crankshaft must be rotated 90 degrees clockwise off of the TDC in order to give the valves adequate clearance to open.
 - 5.2. Once the camshafts are in position and the dowels installed, rotate the crankshaft counter clockwise back to the top dead center.



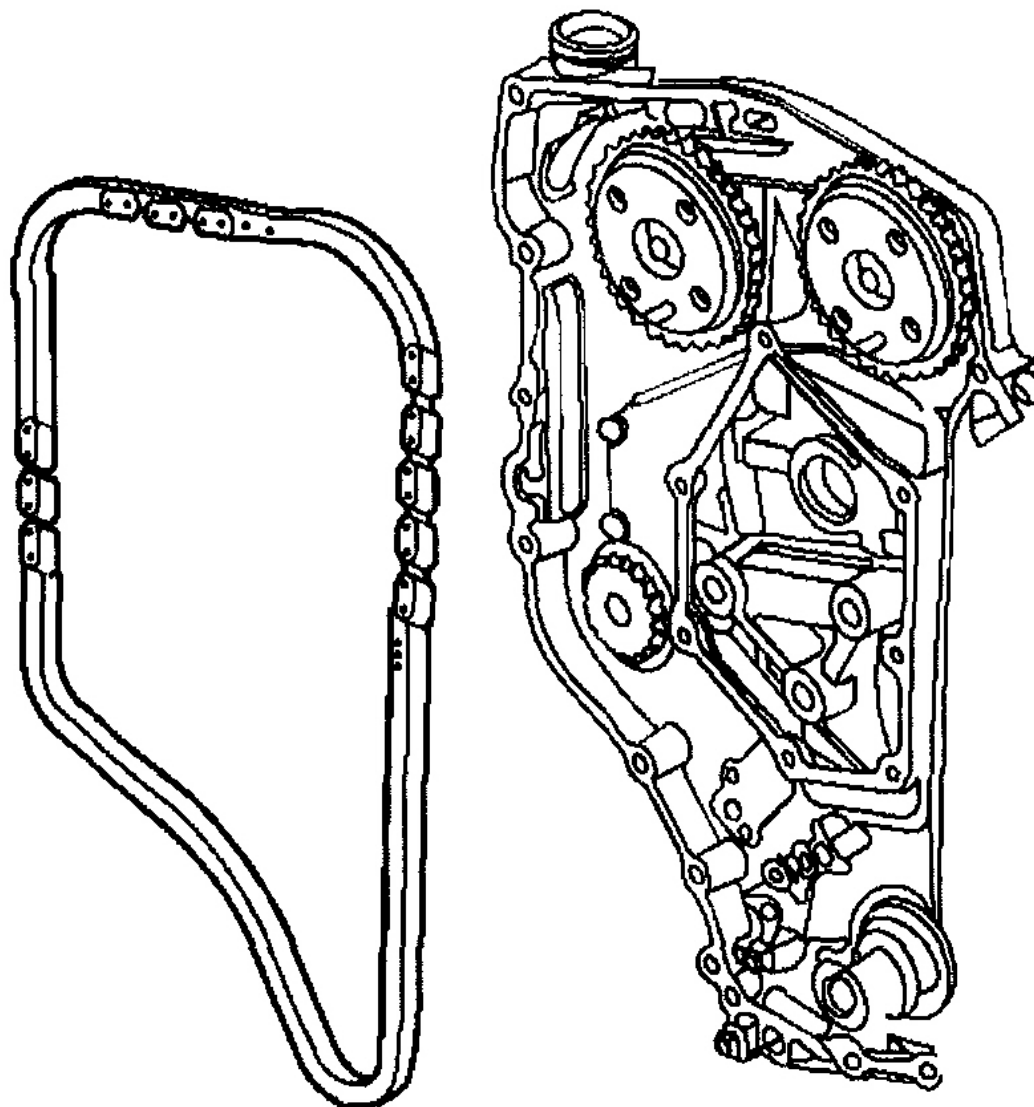
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Fig. 66: Camshaft Sprockets
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not rotate the crankshaft clockwise to TDC. Valve or piston damage could occur.

Important: The side of the timing chain that was marked during removal must be showing when the chain is installed.

6. Install the timing chain over the exhaust camshaft sprocket, around the idler sprocket and around the crankshaft sprocket.



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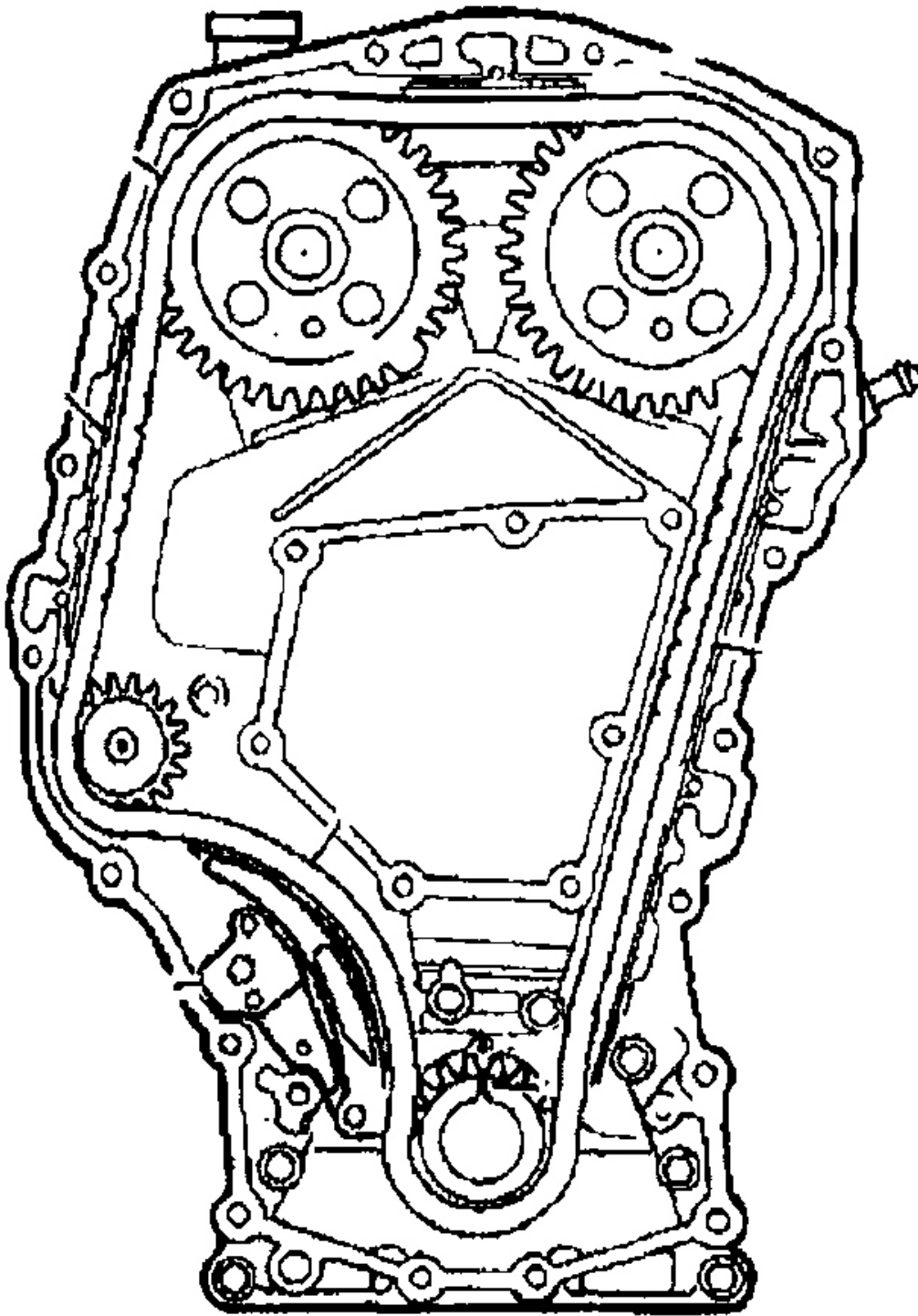
Fig. 67: Timing Chain

Courtesy of GENERAL MOTORS CORP.

7. Set the camshaft sprockets at the timed position and use the following procedure in order to install the

timing chain:

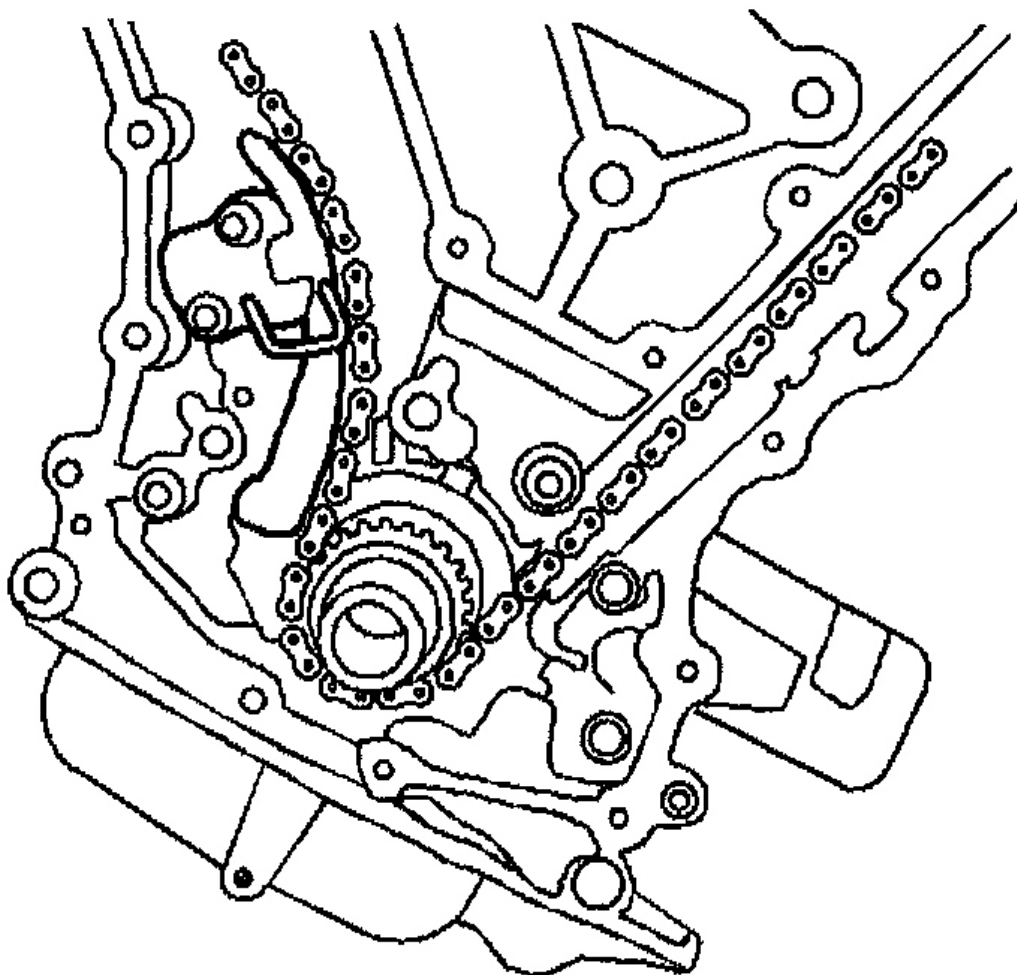
- 7.1. Remove the alignment dowel pin from the intake camshaft.
- 7.2. Use the **J 39579** in order to rotate the intake camshaft sprocket counter clockwise enough to slide the timing chain over the intake camshaft sprocket.
- 7.3. Release the **J 39579**. The length of the chain between the 2 camshaft sprockets will tighten.
- 7.4. If properly timed the intake camshaft alignment dowel pin should slide in easily. If the dowel pin does not fully index, the camshafts are not timed correctly and the procedure must be repeated.
8. Leave the alignment dowel pins installed.
9. Raise and support the vehicle.
10. With the slack removed from the chain between the intake camshaft sprocket and the crankshaft sprocket, the timing marks on the crankshaft and the cylinder block should be aligned. If the marks are not aligned, move the chain one tooth forward or rearward, remove the slack and the recheck marks.



G01777614

Fig. 68: Aligning Timing Chain**Courtesy of GENERAL MOTORS CORP.**

11. The timing chain tensioner must be reset on the workbench. Refer to **TIMING CHAIN, SPROCKETS & TENSIONER**.
12. Install the tensioner assembly to the chain housing. Recheck the plunger assembly installation, it is correctly installed when the long end is toward the crankshaft.
13. Install the timing chain tensioner bolts. Tighten the bolts to 10 N.m (89 in lbs).
14. Lower the vehicle enough to reach and remove the alignment dowel pins.
15. Rotate the crankshaft clockwise (normal rotation) 2 full rotations.
16. Align the crankshaft keyway with the mark on the cylinder block and reinstall alignment dowel pins.



G01777615

Fig. 69: Aligning Crankshaft Keyway
Courtesy of GENERAL MOTORS CORP.

17. Alignment dowel pins will slide in easily if the engine is timed correctly.
18. Install the timing chain guides.
19. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
20. Connect the negative battery cable.

TIMING CHAIN HOUSING REPLACEMENT

Tools Required

- **J 28467-360** Engine Support Fixture Adapter
- **J 39579** Camshaft Sprocket Wrench

Removal Procedure

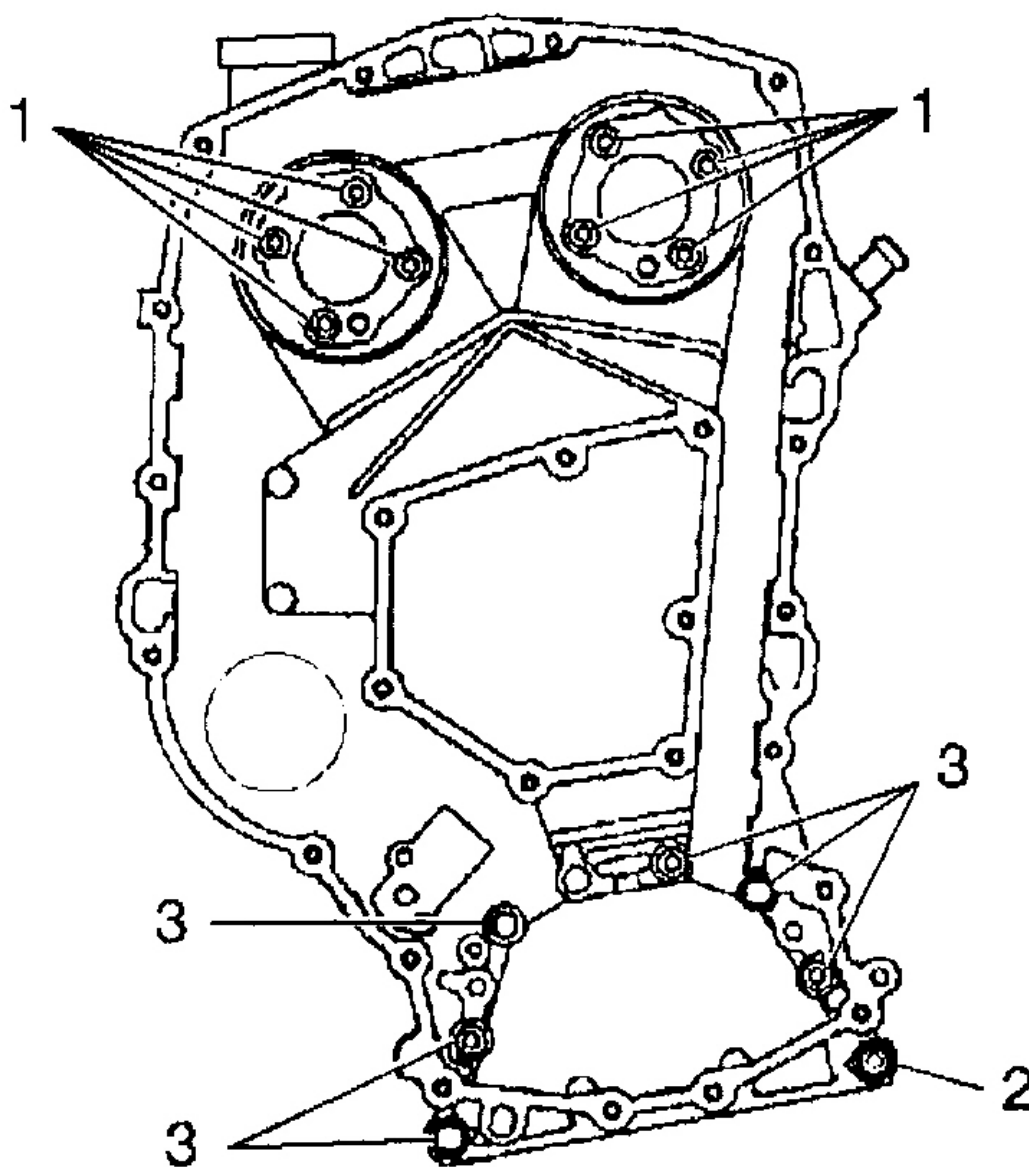
Important: The timing chain housing to cylinder block and the camshaft housing gaskets can be replaced without removing the timing chain housing from the vehicle.

Removal of the timing chain housing is only required when additional service is being performed on the timing chain housing.

1. Disconnect the negative battery cable.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Raise and support the vehicle.
4. Drain cooling system.

Important: The timing chain must be marked prior to removal. If the chain is installed with the wear pattern in the opposite direction, noise and increased wear may occur.

5. Remove the timing chain and tensioner.
6. Remove the coolant pump assembly to the timing chain housing nuts.
7. Remove the timing chain housing to the block fasteners (2, 3).

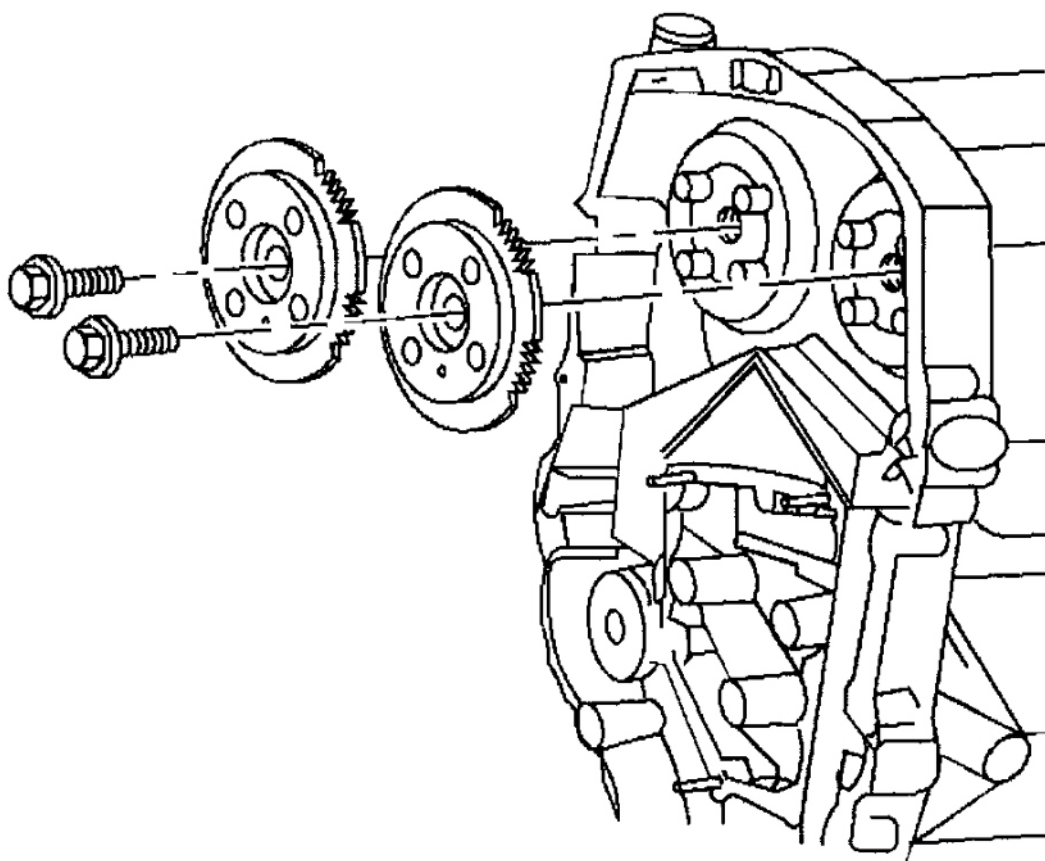


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Fig. 70: Timing Chain Housing-To-Block Fasteners
Courtesy of GENERAL MOTORS CORP.

8. Remove strut mount bracket. Refer to **Engine Mount Strut Bracket Replacement**.
9. Remove the four oil pan to front cover bolts.
10. Remove the lowest front cover retaining stud from the timing chain housing. This stud will catch on the body if it is not removed.

11. Lower the vehicle.
12. Remove the camshaft sprocket retaining bolts and the washers while holding the sprockets with the **J 39579**.
13. Remove the camshaft sprockets. The camshaft sprockets are identical and interchangeable.



G01777617

Fig. 71: Camshaft Sprockets

Courtesy of GENERAL MOTORS CORP.

14. Remove the chain housing to the camshaft housing bolts (1).
15. Remove the timing chain housing and the gaskets. It may be necessary to raise the engine slightly using the **J 28467-360**.
16. Inspect the oil pan gasket silicone bead for the following conditions:
 - Cuts or nicks
 - Deformation
 - Separation from the aluminum carrier

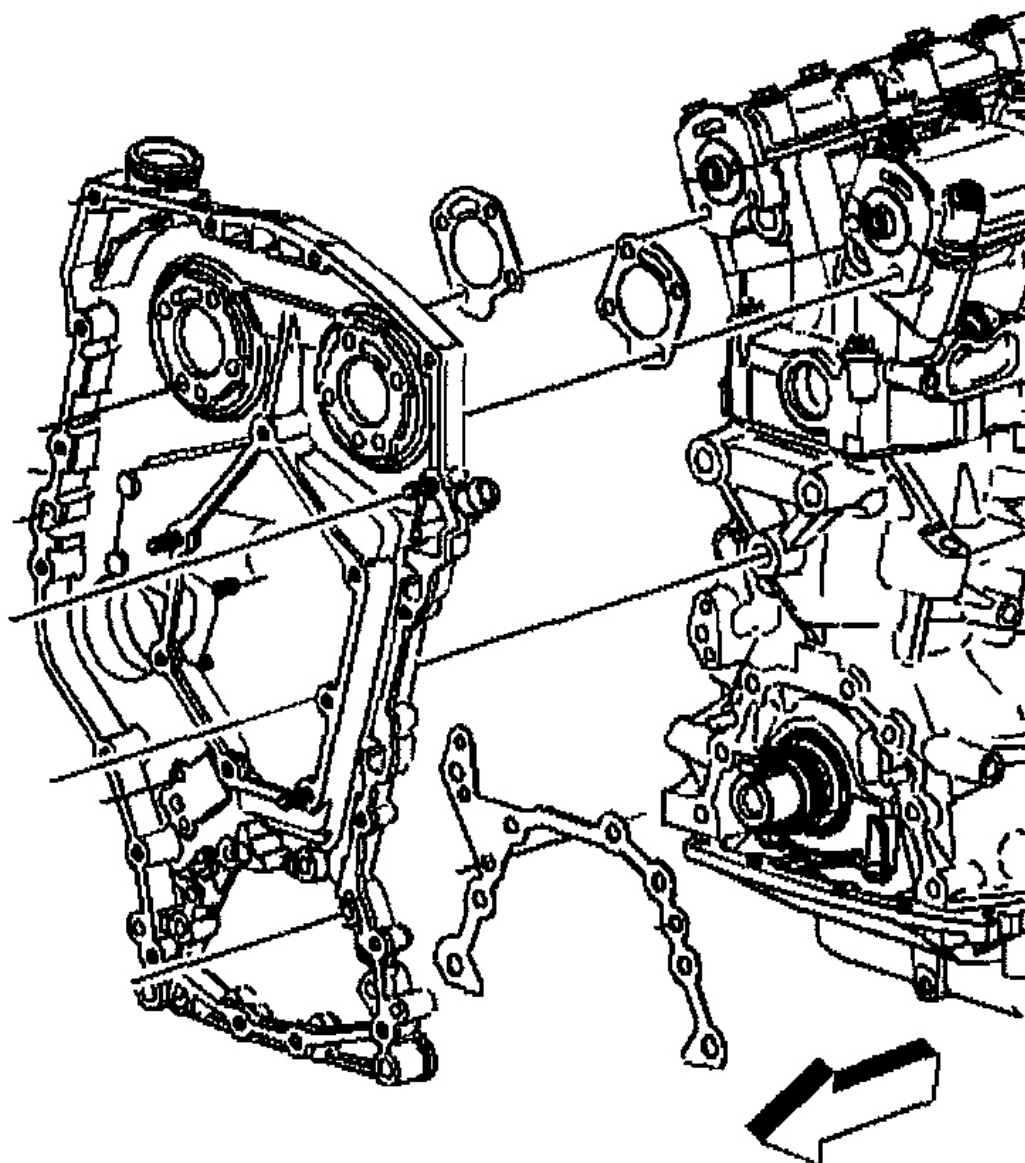
17. If any of the conditions exist, replace the pan gasket.

Important: Use only enough sealant to restore the silicone bead to its original dimension. Excess application of sealant may cause part misalignment and oil leaks.

18. Inspect the silicone bead across the top of the aluminum carrier at the oil pan, in the cylinder block, and to the timing chain housing three way joint. Repair a damaged bead using the Silicone Rubber Sealant GM P/N 12345739 (Canadian P/N 10953541) or the equivalent.

Installation Procedure

1. Prior to installing the timing chain housing, ensure that the alignment dowel pins are in the cylinder block and the timing chain housing. The dowel pins ensure proper chain housing and the front cover location for correct front oil seal-to-crankshaft alignment.
2. Install the timing chain housing and the new gaskets. Gasket Sealer is unnecessary.



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Fig. 72: Timing Chain Housing & New Gaskets
Courtesy of GENERAL MOTORS CORP.

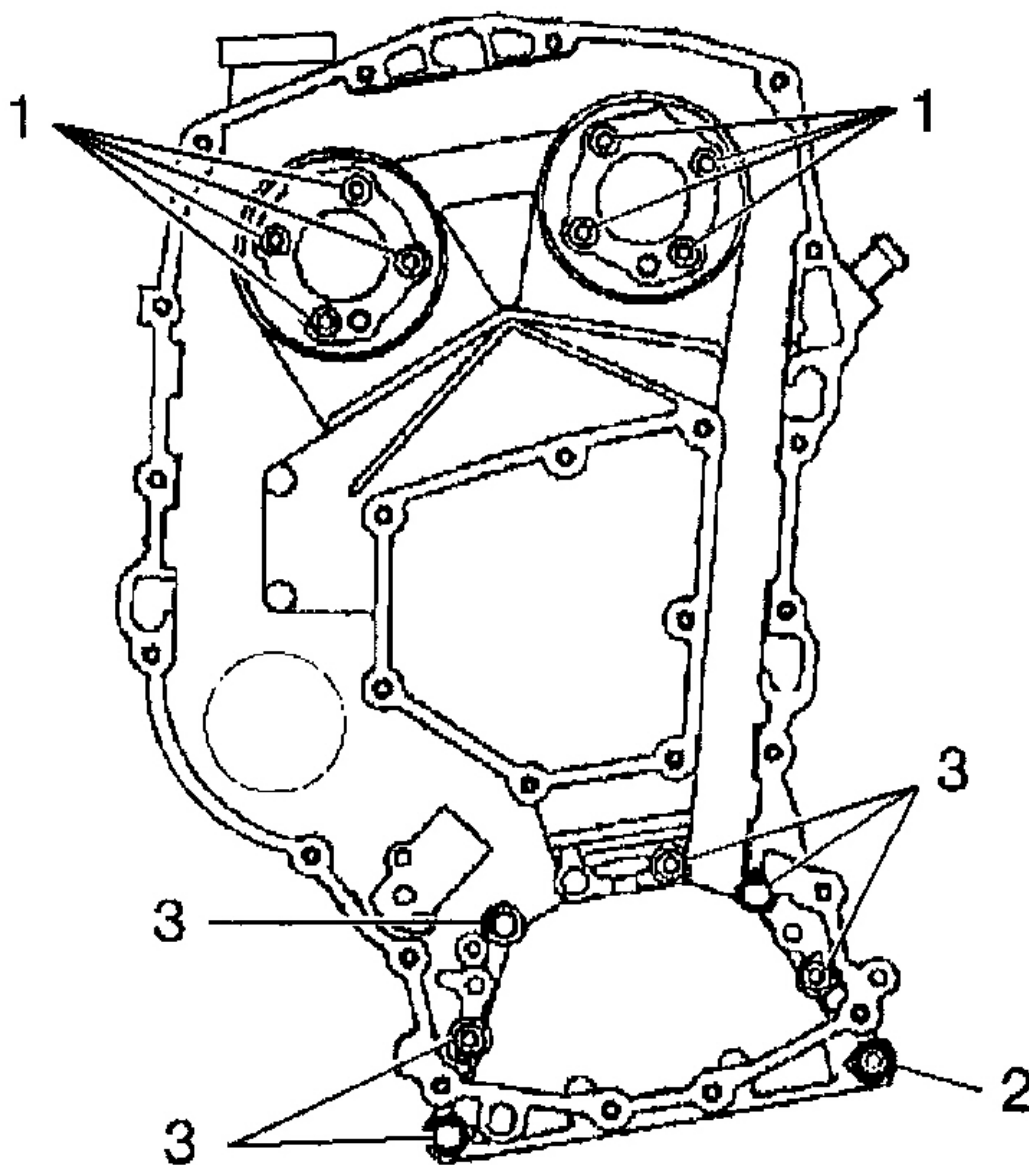
Important: Hand tighten all chain housing bolts before tightening to specifications.

3. Install the chain housing to the camshaft housing bolts and hand tighten.
4. Raise and support the vehicle.

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

5. Install the timing chain housing block fasteners and hand tighten.
6. Install the oil pan to the timing chain housing bolts and hand tighten.
7. Tighten the timing chain housing block fasteners.
 - Tighten the M8 X 1.25 X 25 bolts (1) to 26 N.m (19 ft lbs).
 - Tighten the M8 X 1.55 X 55 bolts (2) to 50 N.m (37 ft lbs).
 - Tighten the M10 X 1.25 X 35 bolts (3) to 29 N.m (21 ft lbs).



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Fig. 73: Timing Chain-To-Housing Block Fasteners
Courtesy of GENERAL MOTORS CORP.

8. Tighten the oil pan to the timing chain housing bolts. Tighten the M6 X 1.00 X 25 bolts (3) to 12 N.m (106 ft lbs).
9. Install the lowest front cover retaining stud into the timing chain housing.
10. Install the coolant pump to the timing chain housing and the timing chain housing nuts. Tighten the

timing chain housing nuts to 26 N.m (19 ft lbs).

11. Lower the vehicle.
12. Tighten the timing chain housing to the camshaft housing bolts.
 - Tighten the M8 X 1.25 X 25 bolts (1) to 26 N.m (19 ft lbs).
 - Tighten the M10 X 1.55 X 55 bolts (2) to 50 N.m (37 ft lbs).
 - Tighten the M8 X 1.25 X 35 bolts (3) to 29 N.m (21 ft lbs).
13. Install the camshaft sprockets. The camshaft sprockets are identical and interchangeable.
14. Install the camshaft sprocket bolts and the washers.
15. Tighten the camshaft sprocket bolts and the washers while holding the sprocket with the **J 39579** . Tighten the camshaft sprocket bolts to 70 N.m (52 ft lbs).
16. Use adhesive/sealant compound GM P/N 12345493 (Canadian P/N 10953488) or equivalent on the camshaft sprocket bolts.
17. Clean the old sealant off of the bolt with a wire brush.
18. Clean the threaded hole in the camshaft with a round nylon brush.
19. Clean the threaded hole in the camshaft with a round nylon brush.

Important: The side of the timing chain that was marked during the removal must be showing when the chain is installed.

20. Install the timing chain and the tensioner.
21. Install the front cover and the gaskets. Refer to **Engine Front Cover Replacement**.
22. Connect the negative battery cable.

CYLINDER HEAD REPLACEMENT

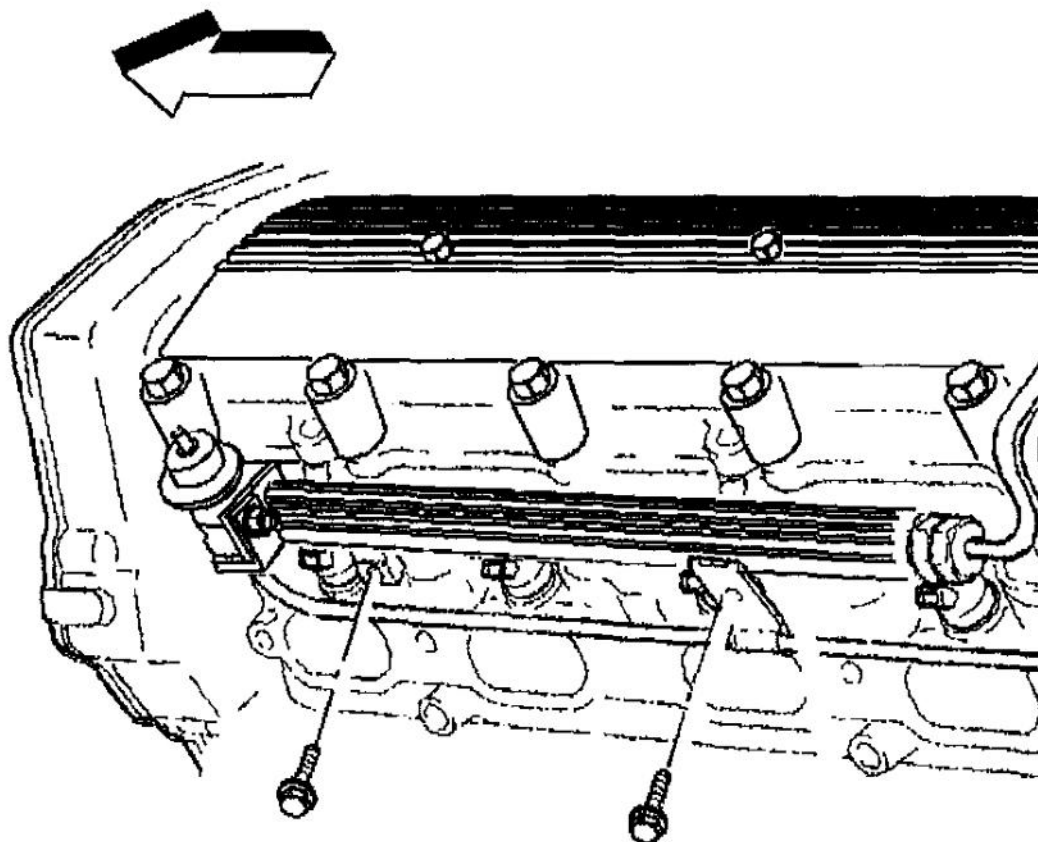
Tools Required

- **J 36660-A** Torque Angle Meter
- **J 28467-360** Engine Support Fixture Adapter
- **J 28467-380** Engine Support Bracket

Removal Procedure

1. Disconnect the negative battery cable.
2. Drain cooling system.
3. Remove the intake manifold.
4. Install the generator stud-ended bolt.
5. Remove the exhaust manifold.
6. Install the **J 28467-360** and **J 28467-380** in order to support the engine.
7. Remove the ignition coil and the module assembly to the camshaft housing bolts. Remove the assembly by pulling it straight up.
8. Disconnect the camshaft position sensor connector.

9. Remove the power steering pump.
10. Remove the fuel rail from the cylinder head. See **FUEL RAIL & INJECTORS**.

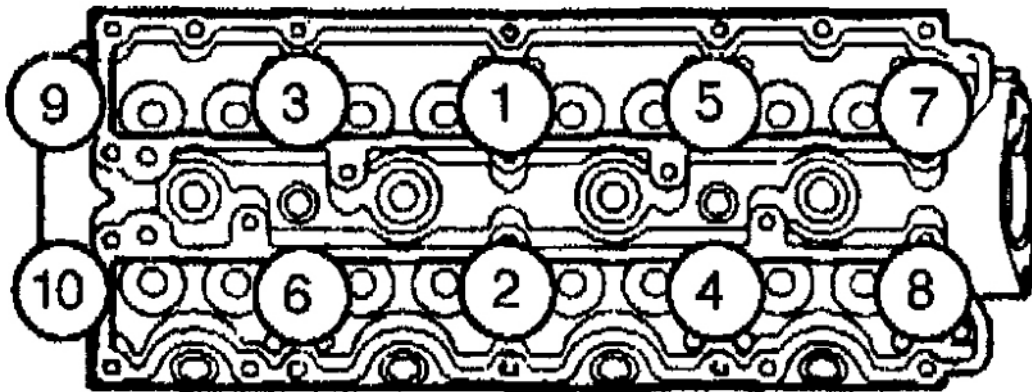


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Fig. 74: Fuel Rail

Courtesy of GENERAL MOTORS CORP.

11. Use the following procedure in order to remove the fuel rail from the cylinder head:
12. Disconnect the timing chain housing at the intake camshaft housing. Do not remove it from the vehicle. Refer to **Timing Chain Housing Replacement**.
13. Disconnect the electrical connection from the oil pressure switch.
14. Remove the intake camshaft housing. Refer to **Intake Camshaft, Housing & Lifter Replacement**.
15. Remove the exhaust camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement**.
16. Disconnect the radiator inlet (upper) hose from the coolant outlet.
17. Remove the coolant temperature sensor connectors.
18. Reverse the tightening sequence shown in order to remove the cylinder head to block bolts.



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Fig. 75: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

19. Remove cylinder head and gasket.

NOTE: Engine damage may result if an abrasive paper, pad, or motorized wire brush is used to clean any engine gasket surfaces.

Important:

- Use a razor blade gasket scraper in order to clean the cylinder head and the cylinder block gasket surfaces. Do not gouge or scratch the gasket surfaces or the combustion chamber surfaces. Use a new razor blade for each cylinder head and the cylinder block.
 - Hold the gasket scraper so the blade is as parallel to the gasket surface as possible.
 - The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.
 - Do not use any other method or technique to clean the gasket surfaces.
 - Do not use a tap to clean the cylinder head bolt holes. Use a nylon bristle brush.
20. Clean the old sealer/lube and dirt from the bolt, the studs, and the bolt holes. Clean the bolt holes with a nylon bristle brush.

CAUTION: Wear safety glasses when using compressed air in order to prevent eye injury.

21. When cleaning the cylinder head long bolt holes, use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun in order to reach the bottom of the holes.

22. Clean the following components:

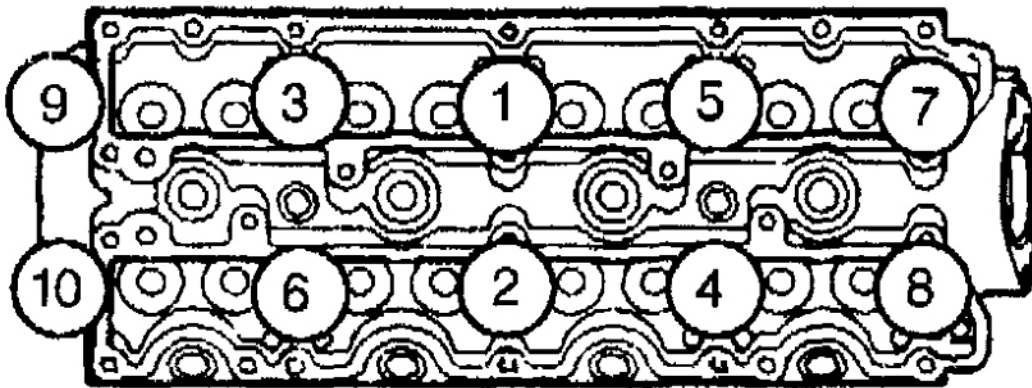
- The cylinder head bolts.
- The cylinder head. Remove all the varnish, the soot, and the carbon to the bare metal. Do not use a wire brush on any gasket sealing surface.
- The valve guides
- The threaded holes
- The remains of sealer from the plug holes

Important:

- Do not remove the spark plugs from an aluminum cylinder head until the cylinder head has cooled.
- Clean the dirt and debris from the spark plug recess area.
- If the spark plug opening threads are damaged and not restorable with a Thread Chaser, use the thread inserts in order to repair the threads.
- Remove the spark plugs.
- Inspect the cylinder head bolts for damaged threads or stretching and damaged heads caused by an improper use of tools. Replace any suspected bolts.
- Clean and inspect cylinder head. Refer to **CYLINDER HEAD** .

Installation Procedure

1. If removed, install spark plugs.
2. Install cylinder head gasket.
3. Install cylinder head.
4. Install cylinder head bolts.
 - 4.1. Tighten bolts 1 through 8 to 65 N.m (40 ft lbs).
 - 4.2. Tighten bolts 9 and 10 to 40 N.m (30 ft lbs).
 - 4.3. Then turn all bolts an additional 90 degrees in sequence, using the **J 36660-A** .



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Fig. 76: Cylinder Head Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

5. Connect coolant temperature sensor connector.
6. Install intake camshaft housing. Refer to **Intake Camshaft, Housing & Lifter Replacement**
7. The exhaust camshaft housing. Refer to **Exhaust Camshaft, Housing & Lifter Replacement**.
8. Install the timing chain housing and the timing chain. Refer to **Timing Chain Housing Replacement**.
9. Install the fuel rail to the cylinder head. Refer to **FUEL RAIL & INJECTORS** .
10. Install the vacuum line to the fuel pressure regulator.
11. Install the camshaft position sensor connector.

Important: When reinstalling the power steering pump apply a 3 mm (0.12 in) bead of GM P/N 12346586 (Canadian P/N 10953472) sealer or the equivalent to the joint at the end of the camshaft housing halves before installation of the power steering pump and the pump face seal.

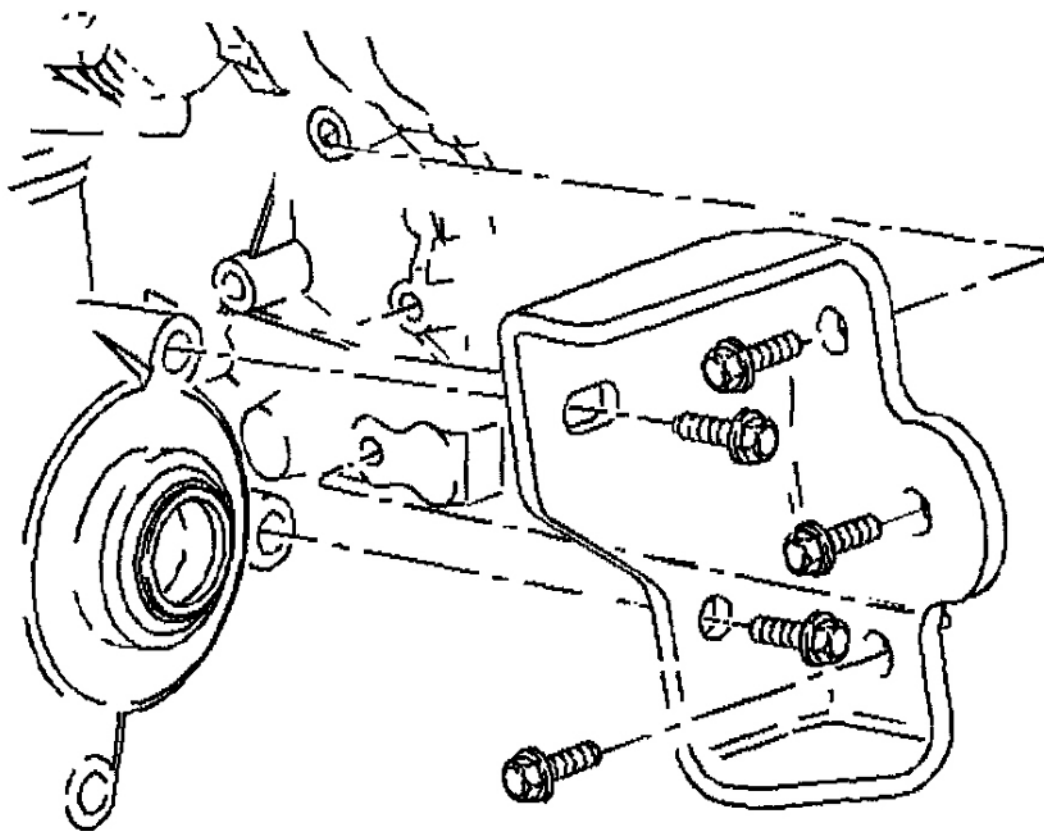
12. Install the power steering pump assembly.
13. Install the electrical connection from the oil pressure switch.
14. Reinstall any spark plug boot connector assembly that stuck to a spark plug back onto the ignition coil and module assembly.
15. Locate the ignition coil and the module assembly over the spark plugs and push straight down.
16. Clean any loose lubricant that is present on the ignition coil and the module assembly to the camshaft housing bolts.
17. Apply the Pipe Sealant GM P/N 1052080 (Canadian P/N 10953480) or the equivalent onto the ignition coil and the module cover assembly to the camshaft housing bolts. Tighten the bolts to 15 N.m (11 ft lbs) + 30 degrees.
18. Install the electrical connector to the ignition coil and the module assembly.
19. Remove the **J 28467-360** and the stud-ended generator bolt.

20. Install the intake manifold.
21. Connect the coolant temperature sensor connectors.
22. Connect the upper radiator hose to the coolant outlet.
23. Connect the following electrical connectors:
 - The MAP sensor
 - The IAT sensor
 - The purge solenoid
 - The fuel injectors
24. Install the exhaust manifold.
25. Install the resonator and air cleaner duct.
26. Fill the cooling system.
27. Connect the negative battery cable.

OIL PAN REPLACEMENT

Removal Procedure

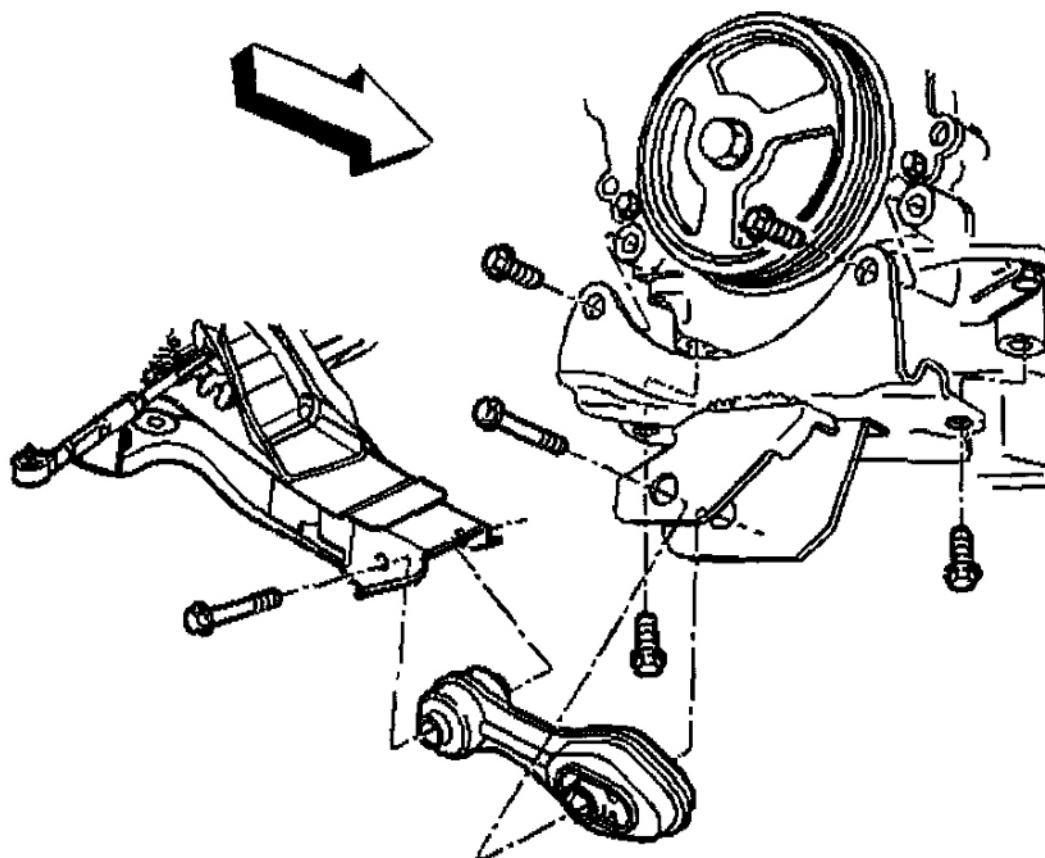
1. Raise vehicle.
2. Drain the engine oil.
3. Drain cooling system.
4. Remove the flywheel inspection shield.
5. Remove the right front wheel and tire assembly.
6. Remove the right engine splash shield.
7. Remove the drive belt. Refer to **Drive Belt Replacement**.
8. Remove the A/C compressor lower bolts.
9. Remove the transmission to the engine brace.



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Fig. 77: Transmission-To-Engine Brace
Courtesy of GENERAL MOTORS CORP.

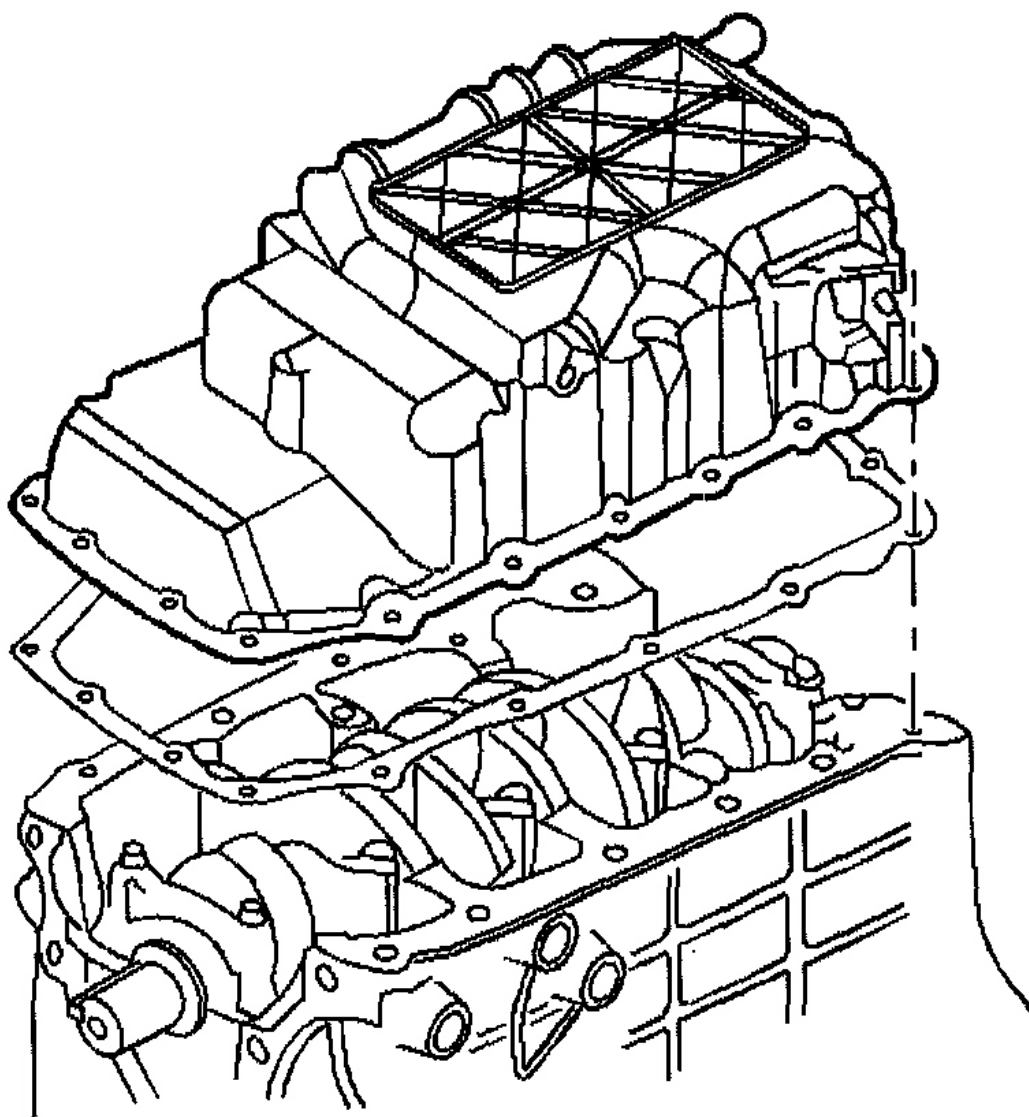
10. Remove the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement**.



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Fig. 78: Engine Mount Strut Bracket
Courtesy of GENERAL MOTORS CORP.

11. Remove the radiator outlet pipe.
12. Remove the oil pan-to-transmission nut and bolts.
13. Remove the oil pan-to-transmission stud for clearance.
14. Remove the oil pan bolts.
15. Remove the oil pan.



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Fig. 79: Oil Pan
Courtesy of GENERAL MOTORS CORP.

Installation Procedure

1. Install the oil pan
2. Place the spacer in its approximate installed location but allow clearance to tighten the pan bolt directly above the spacer.
3. Tighten the oil pan bolts.

- Tighten the M8X1.25X80 (1) to 24 N.m (18 ft lbs).
- Tighten the M8X1.25X22 (2) to 24 N.m (18 ft lbs).
- Tighten the M6X1.00X25 (3) to 12 N.m (106 in lbs).
- Tighten the oil pan bolts (4) to 26 N.m (19 ft lbs).

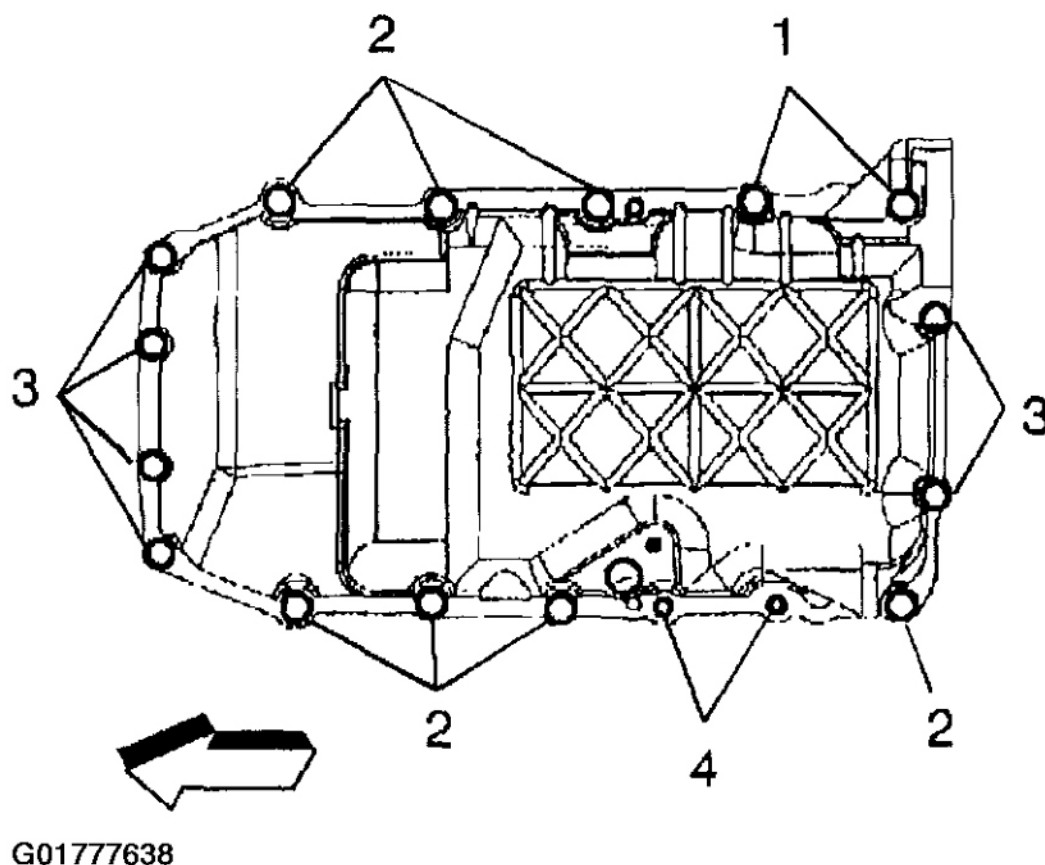


Fig. 80: Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

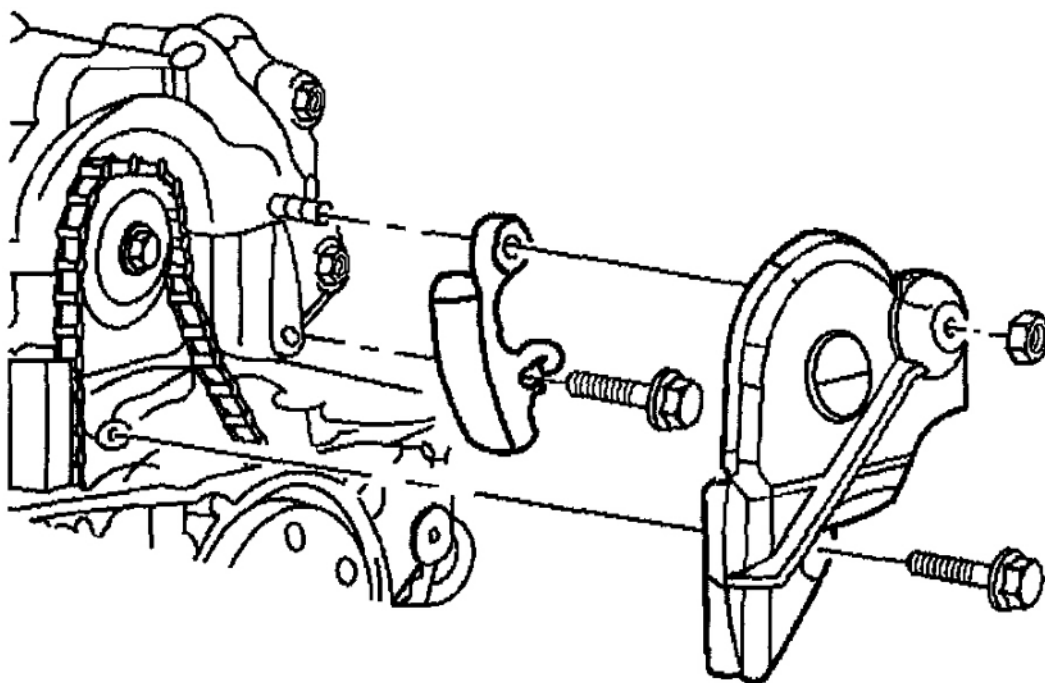
4. Position the spacer into its proper location and install the stud.
5. Install the oil pan-to-transmission nut and bolts.
6. Install the radiator outlet pipe.
7. Install the engine mount strut bracket. Refer to **Engine Mount Strut Bracket Replacement**.
8. Install the transmission to the engine brace. Tighten the bolts to 50 N.m (37 ft lbs).
9. Install the A/C compressor lower bolts.
10. Install the drive belt. Refer to **Drive Belt Replacement**.
11. Install the right engine splash shield.

12. Install the right front wheel and tire assembly.
13. Install the flywheel inspection shield.
14. Install the oil filter if removed.
15. Lower vehicle.
16. Fill the cooling system.
17. Fill the crankcase with the specified type and amount of oil.

OIL PUMP REPLACEMENT

Removal Procedure

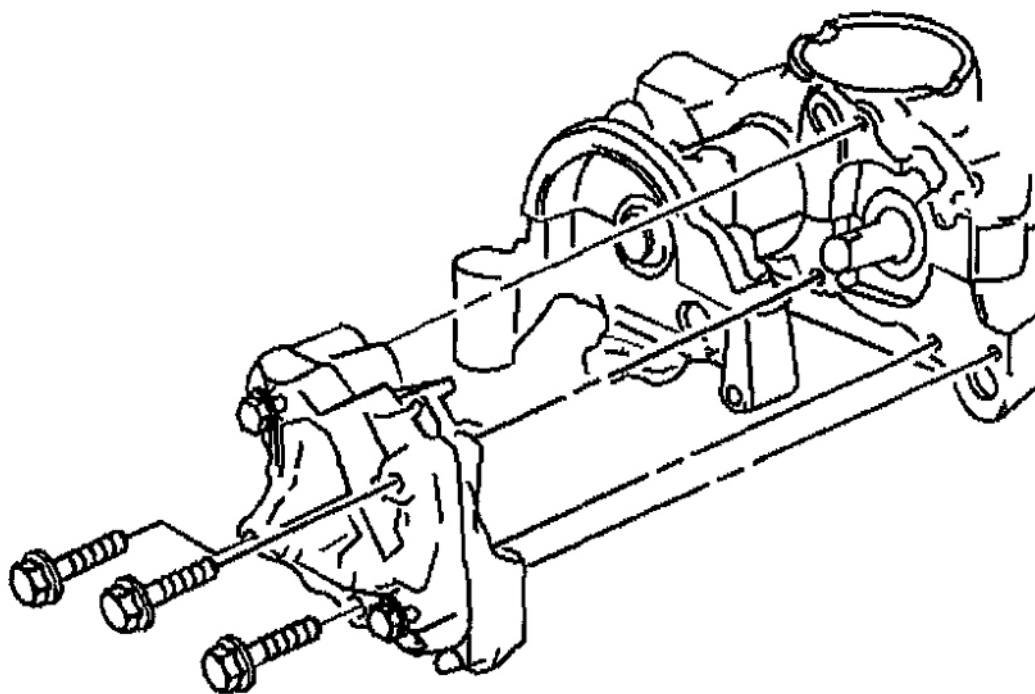
1. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
2. Remove the balance shaft chain cover.



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Fig. 81: Balance Shaft Chain Cover
Courtesy of GENERAL MOTORS CORP.

3. Remove the balance shaft chain tensioner assembly.
4. Remove the oil pump cover.



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Fig. 82: Oil Pump Cover
Courtesy of GENERAL MOTORS CORP.

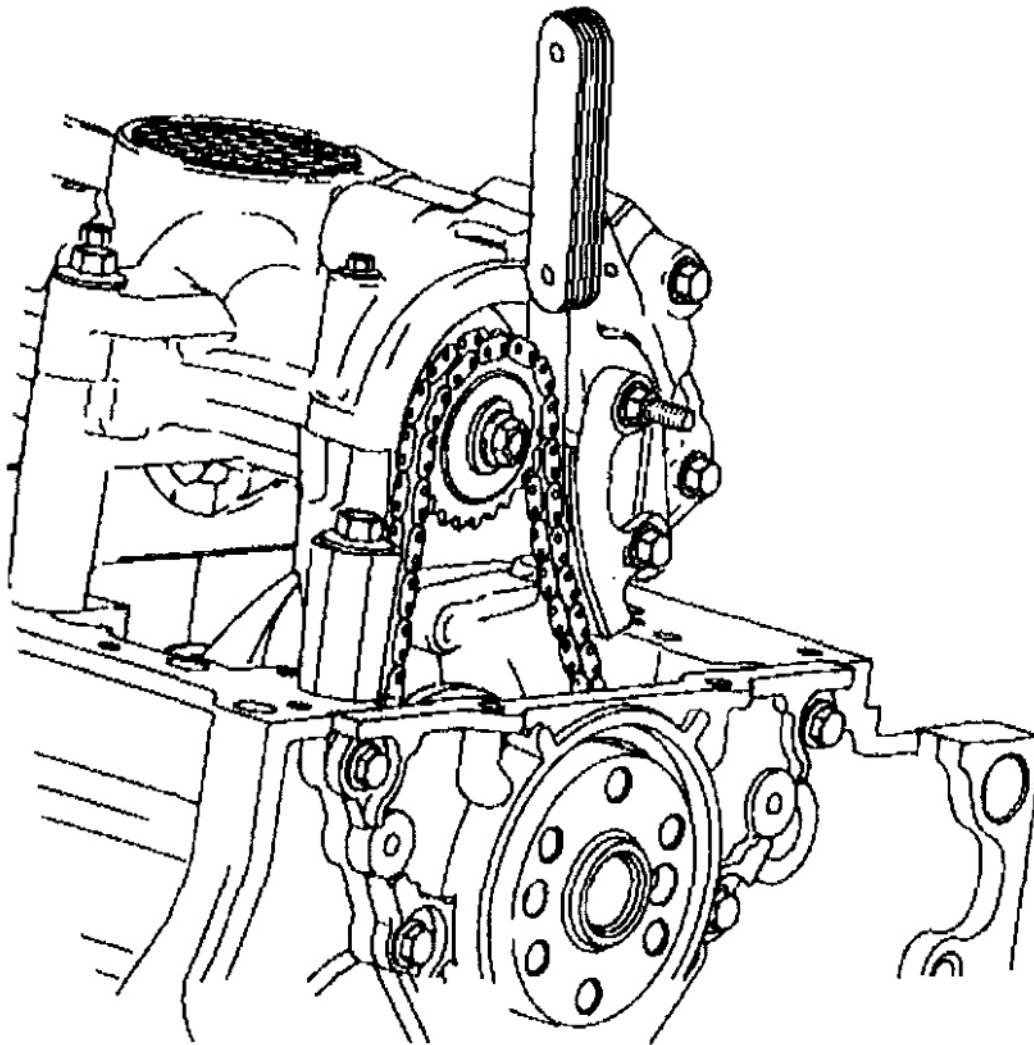
5. Remove the oil pump.

Installation Procedure

1. Install the oil pump.
2. Install the oil pump cover to balance shaft housing. Tighten the bolts to 54 N.m (40 ft lbs).
3. Install the balance shaft chain tensioner.

Important: A brass feeler gauge needs to be used to ensure correct measurements are obtained. If a steel gauge is used, it will not bend to conform to the guide and will not allow for correct measurements.

4. Adjust the balance shaft drive chain tension by inserting a 1 mm (0.40 in). Brass feeler gauge between the chain guide and the chain.



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Fig. 83: Adjusting Balance Shaft Drive Chain Tension
Courtesy of GENERAL MOTORS CORP.

5. Press the guide against the chain using about 3 pounds of force.
6. Tighten the chain tensioner. Tighten the bolt to 10 N.m (89 in lbs).
7. Install the oil pan gasket and the oil pan. Refer to **Oil Pan Replacement**.

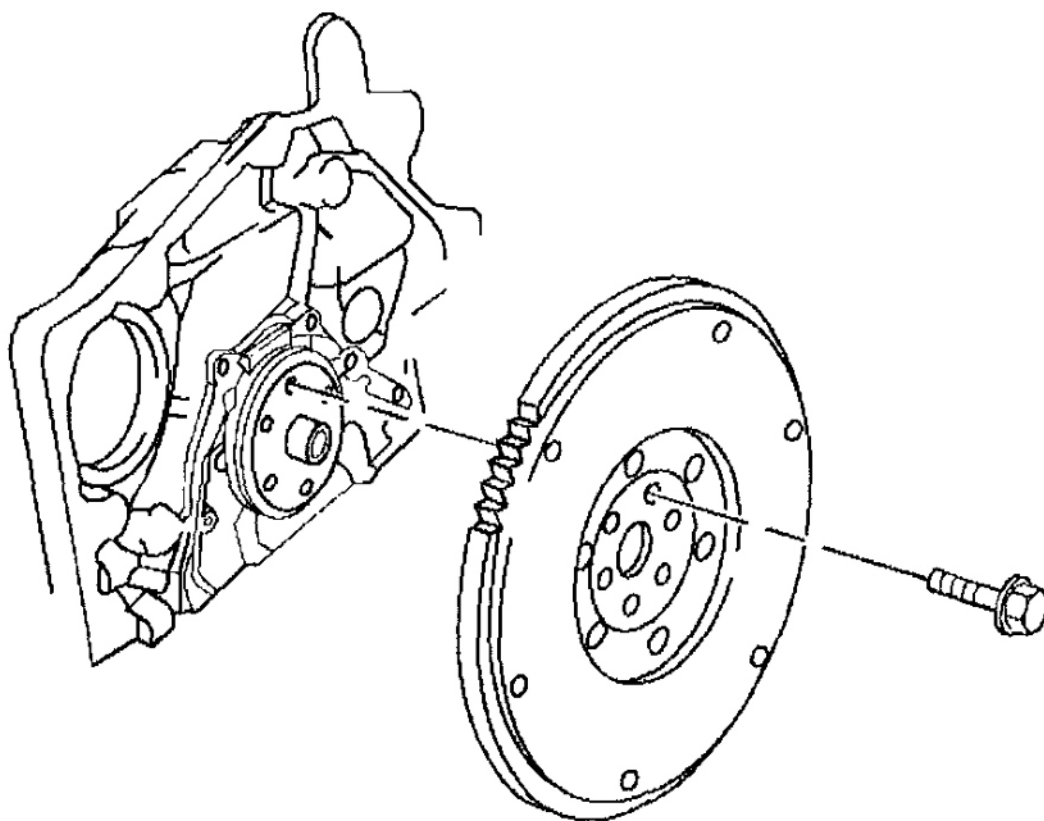
CRANKSHAFT REAR OIL SEAL & HOUSING REPLACEMENT

Tools Required

- **J 36005** Rear Crankshaft Seal Installer
- **J 36660-A** Torque Angle Meter
- **J 38122-A** Crankshaft Balancer Holder

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the flywheel.



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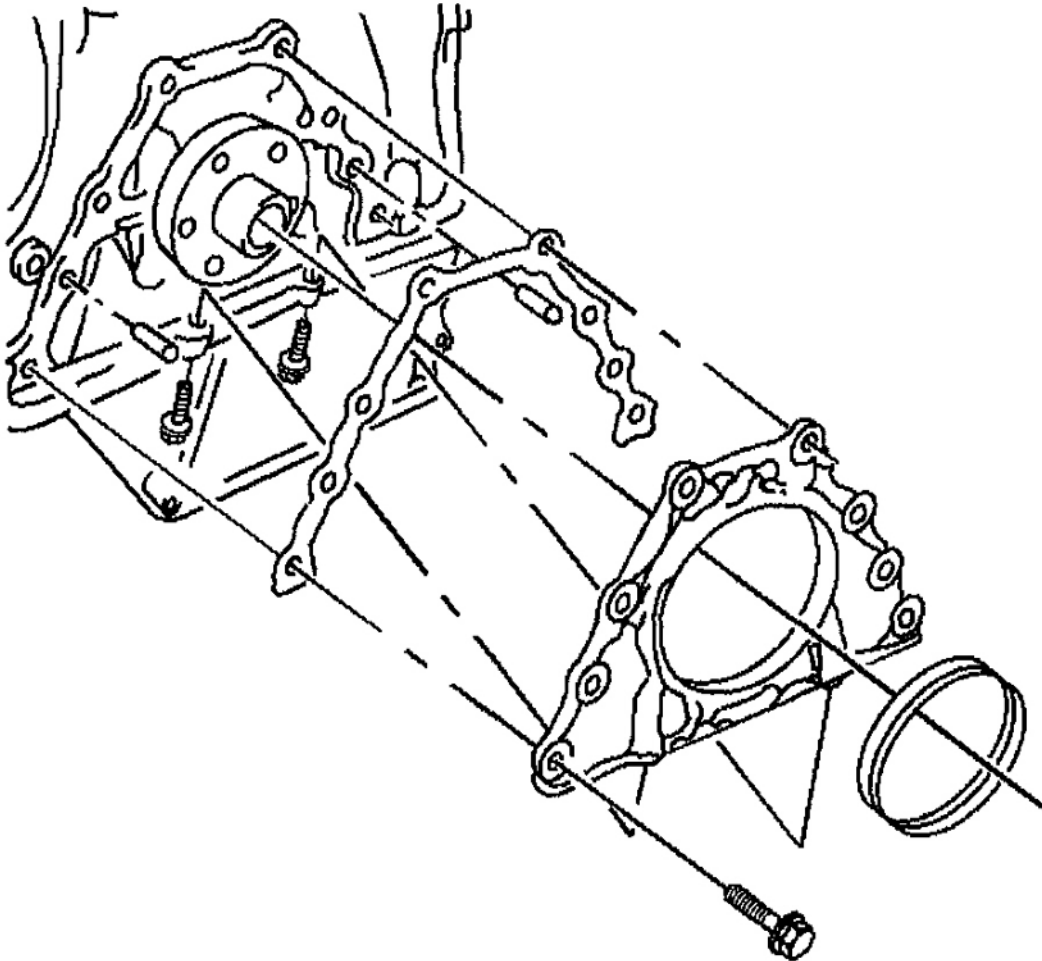
Fig. 84: Flywheel Assembly
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan to the crankshaft seal housing bolts.
4. Remove the seal housing to block bolts.
5. Remove the seal housing and gasket.

NOTE: Properly support the seal housing to prevent damage to the seal during

removal. Damage to the seal will result in an oil leak.

6. Support the seal housing for the seal removal using two wood blocks of equal thickness. With the wood blocks on a flat surface, position the seal housing and the blocks so that the transmission side of the seal housing is supported across the dowel pin and center bolt holes on both sides of the seal opening.



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Fig. 85: Seal Housing

Courtesy of GENERAL MOTORS CORP.

7. Drive the crankshaft seal evenly out of the transmission side of the seal housing using a small chisel in the relief grooves on the crankshaft side of the seal housing.

Installation Procedure

1. Replace the oil pan gasket if any of the following conditions exist:
 - Cuts or nicks
 - Deformation
 - Separation from the aluminum carrier
2. Inspect the strips of silicone across the top of the aluminum carrier at the oil pan, at the cylinder block, and at the seal housing three way joint.
3. If these strips are damaged they may be repaired using Silicone Sealant GM P/N 12345739 (Canadian P/N 10953541) or equivalent. Use only enough sealant to restore the silicone strip to its original dimension.
4. Install seal into housing using the following steps:
 - Lightly grease seal lip.
 - Tap seal into housing using plastic hammer, make sure seal seats in housing.
5. Install the oil pan to the seal housing bolts. Tighten the bolts to 12 N.m (106 in lbs).
6. Install the flywheel.
7. For vehicle equipped with a manual transmission, install the clutch and pressure plate and clutch cover assembly.
8. Install the transmission assembly. Transaxle-4T40-E/4T45-E.
9. Connect the negative battery cable.
10. Start the engine.

ENGINE FLYWHEEL REPLACEMENT

Tools Required

- **J 36660-A** Torque Angle Meter
- **J 38122-A** Harmonic Balancer Holder

Removal Procedure

Important: It may be necessary to remove the chamfer from the edge of an 18 mm socket to obtain a full socket engagement on the thin headed flywheel bolts.

The flywheel can not be rotated to balance the flywheel to the engine because it can only be installed on the vehicle one way.

1. Remove the transmission assembly.
2. Remove the right engine splash shield.

Important: Mark the relationship of the clutch cover assembly to the flywheel in order to assure proper balance during reassembly.

3. For vehicle equipped with a manual transmission, install the clutch and pressure plate and clutch cover assembly.

4. Remove the flywheel attaching bolt while using **J 38122-A** to prevent crankshaft rotation.
5. Remove the flywheel and retainer.
6. The thread adhesive must be thoroughly removed from the flywheel.

Installation Procedure

1. Install the new bolts or apply adhesive/Sealant compound GM P/N 123454493 or equivalent to all flywheel to crankshaft bolts that are being re-used.
2. Carefully follow the instructions included with the thread locking compound to ensure proper bolt retention.
3. Install the flywheel and the attaching bolts.
4. Install the **J 38122-A**.
 - Tighten bolts to 30 N.m (22 ft lbs).
 - Then rotate the bolts 45 degrees using **J 36660-A**.
5. For vehicle equipped with a manual transmission, install the clutch and pressure plate and clutch cover assembly.
6. Install the transmission assembly. Remove the transmission assembly.
7. Install the right engine splash shield.

ENGINE REPLACEMENT (AUTOMATIC TRANSMISSION)**Removal Procedure**

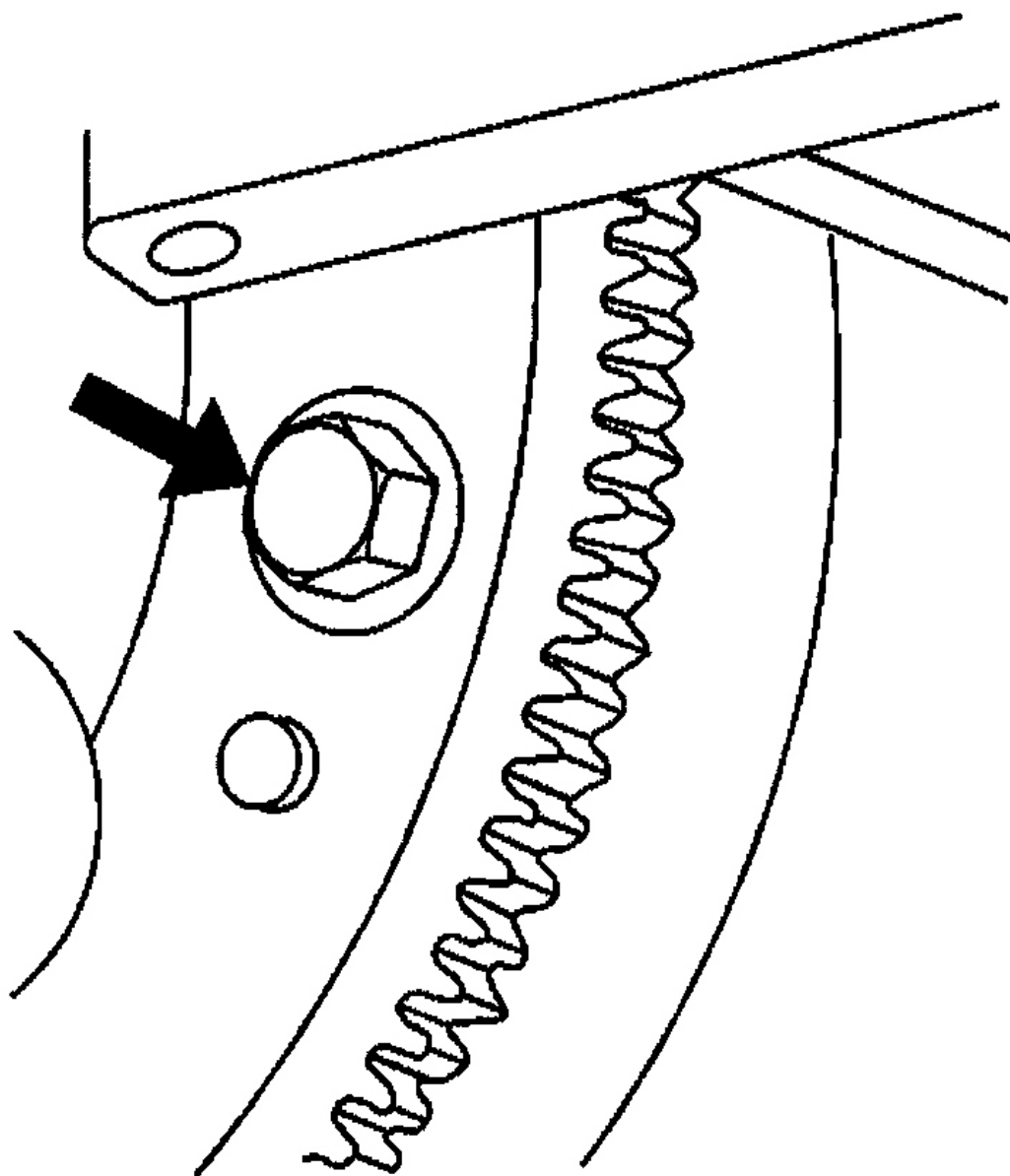
1. Disconnect the negative battery cable.
2. Remove the hood.
3. Drain the engine coolant.
4. Recover the refrigerant.
5. Remove the air cleaner assembly.
6. Disconnect the brake booster vacuum line at the intake manifold.

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a **NEW** cable whenever you remove the engine from the vehicle.

NOTE: In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

7. Remove the accelerator and the cruise control cables from the cable bracket.
8. Disconnect the engine wiring harness from the underhood engine components.
9. Remove the cruise control module.

10. Disconnect the A/C line from the accumulator.
11. Remove the drive belt. Refer to **Drive Belt Replacement**.
12. Remove the surge tank.
13. Remove the upper and lower radiator hoses.
14. Remove heater hoses.
15. Remove power steering pump.
16. Remove the fuel rail from the engine. Refer to **FUEL RAIL & INJECTORS** .
17. Raise and support the vehicle.
18. Remove the radiator outlet pipe assembly.
19. Remove the right side wheel and tire assembly.
20. Remove the right engine splash shield.
21. Remove the engine mount strut.
22. Remove the flywheel inspection shield.
23. Remove the catalytic converter from manifold.
24. Remove the starter.
25. Remove the support the A/C compressor.
26. Drain the engine oil.
27. Remove the torque converter bolts.

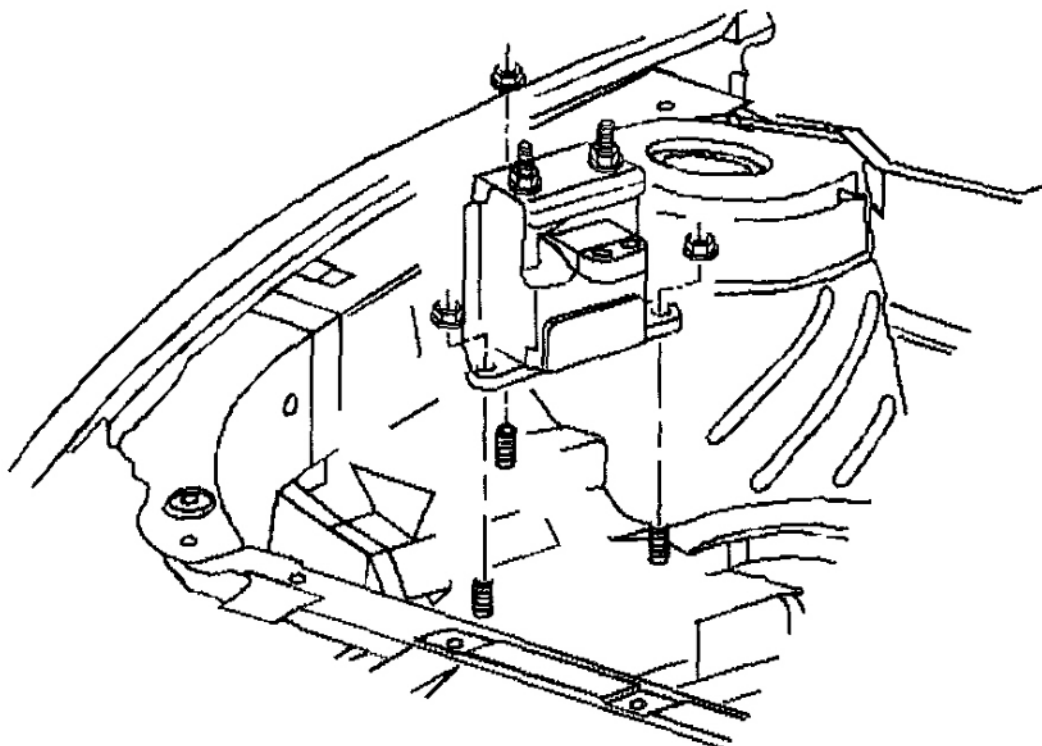


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Fig. 86: Torque Converter Bolt
Courtesy of GENERAL MOTORS CORP.

28. Remove the bolts which secure the lower transmission to the engine.
29. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
30. Lower the vehicle.

31. Support the transmission with a suitable jack.
32. Install the engine lifting device to the engine lifting eyes.
33. Remove the upper front engine mount. Refer to **Engine Mount Replacement**.



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Fig. 87: Upper Front Engine Mount
Courtesy of GENERAL MOTORS CORP.

34. Remove the remaining bolts which secure the transmission to the engine.
35. Separate the engine from the transmission and lift the engine from the vehicle.

Installation Procedure

1. Position the engine in the vehicle.
2. Hand-tighten the bolts which secure the upper transmission to the engine.
3. Install the front upper engine mount.
4. Remove the engine lifting device from the lifting eyes.
5. Remove the jack supporting the transmission.
6. Raise the vehicle.

7. Install the crankshaft balancer.
8. Install the bolts which secure the lower transmission to the engine.
9. Install the torque converter bolts.
10. Remove the A/C compressor.
11. Install the starter.
12. Install the catalytic converter from manifold.
13. Install the flywheel inspection shield.
14. Install the engine mount strut.
15. Install the right engine splash shield.
16. Install the right side wheel and tire assembly.
17. Install the radiator pipe assembly.
18. Lower the vehicle.
19. Install the fuel rail to the engine.
20. Connect the upper and lower radiator hoses.
21. Install heater hoses to the engine.
22. Install the surge tank.
23. Install the power steering pump.
24. Install the drive belt. Refer to **Drive Belt Replacement**.
25. Connect the A/C line to the accumulator.
26. Install the cruise control module.
27. Install the engine wiring harness.

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a NEW cable whenever you remove the engine from the vehicle.

NOTE: In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

28. Install the accelerator and the cruise control cable.
29. Connect the brake booster vacuum line at the manifold.
30. Install the air cleaner assembly.
31. Fill the cooling system.
32. Fill engine oil.
33. Recharge the A/C system.
34. Install the hood.
35. Connect the battery cable.

36. Start the engine and inspect for leaks.

37. Inspect all of the fluid levels.

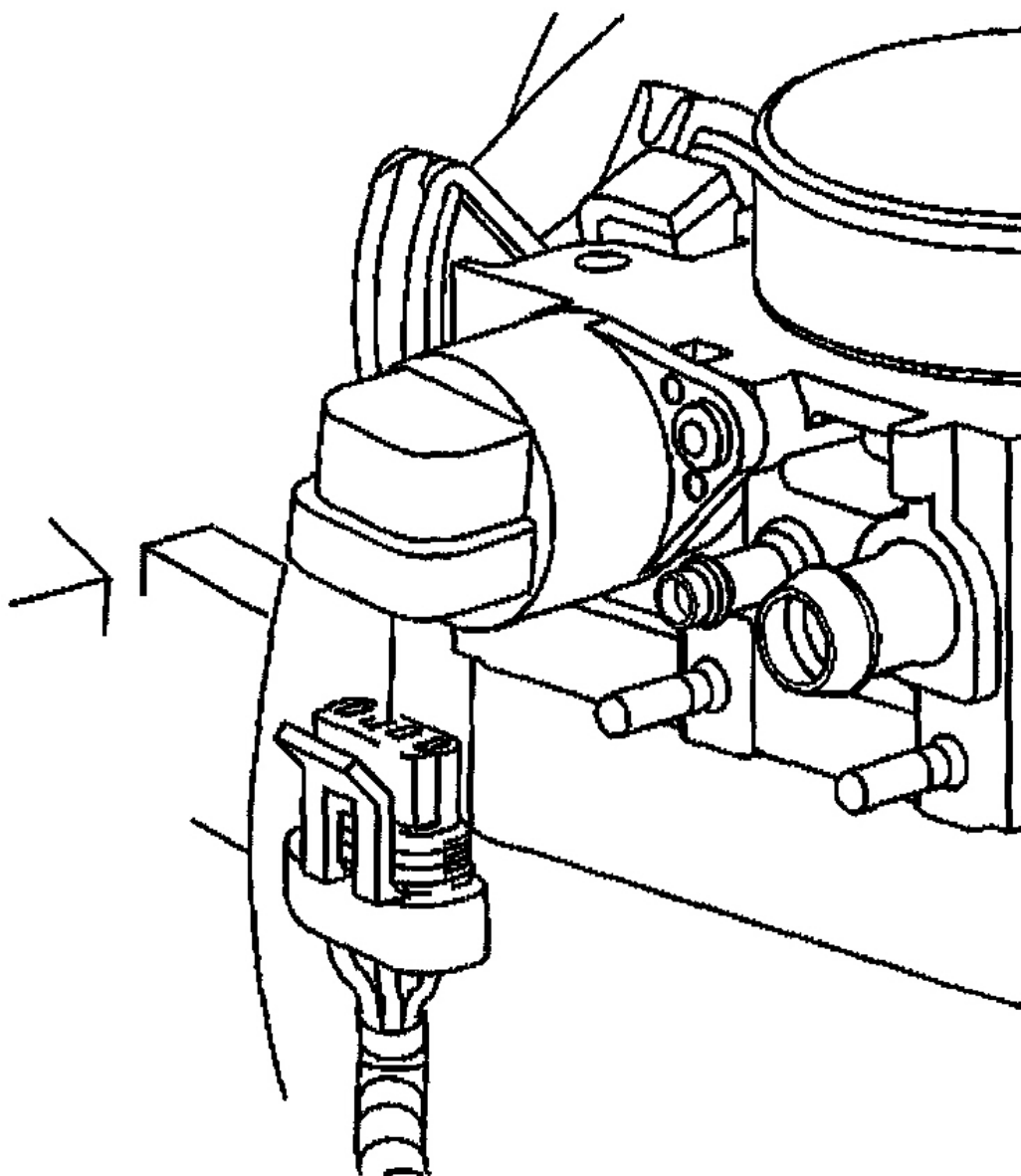
ENGINE REPLACEMENT (MANUAL TRANSMISSION)

Tools Required

J 28467-360 Engine Support Bracket

Removal Procedure

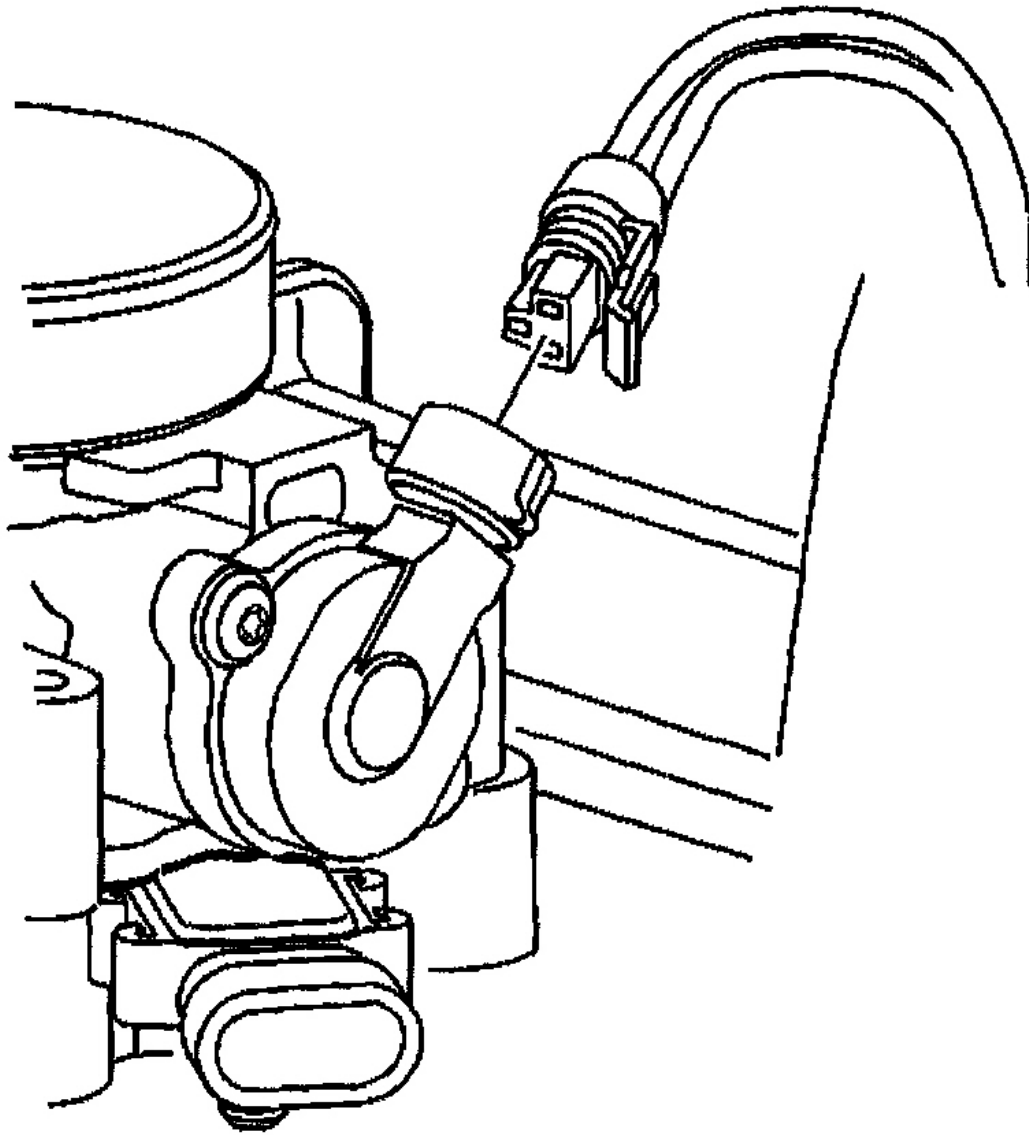
1. Disconnect the negative battery cable.
2. Drain cooling system.
3. Recover the refrigerant if equipped with A/C.
4. Disconnect the heater hose at the thermostat housing.
5. Disconnect the radiator inlet (upper) hose.
6. Remove the air cleaner assembly.
7. Remove the cooling fan.
8. Remove the compressor/condenser hose assembly at the compressor and discard the O-rings, if the vehicle is A/C equipped.
9. Disconnect the vacuum hoses from the front of the engine.
10. Remove the generator electrical connection.
11. Remove the A/C compressor electrical connection if equipped.
12. Remove the injector harness electrical connection.
13. Remove the IAC sensor electrical connection at the throttle body.



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Fig. 88: IAC Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

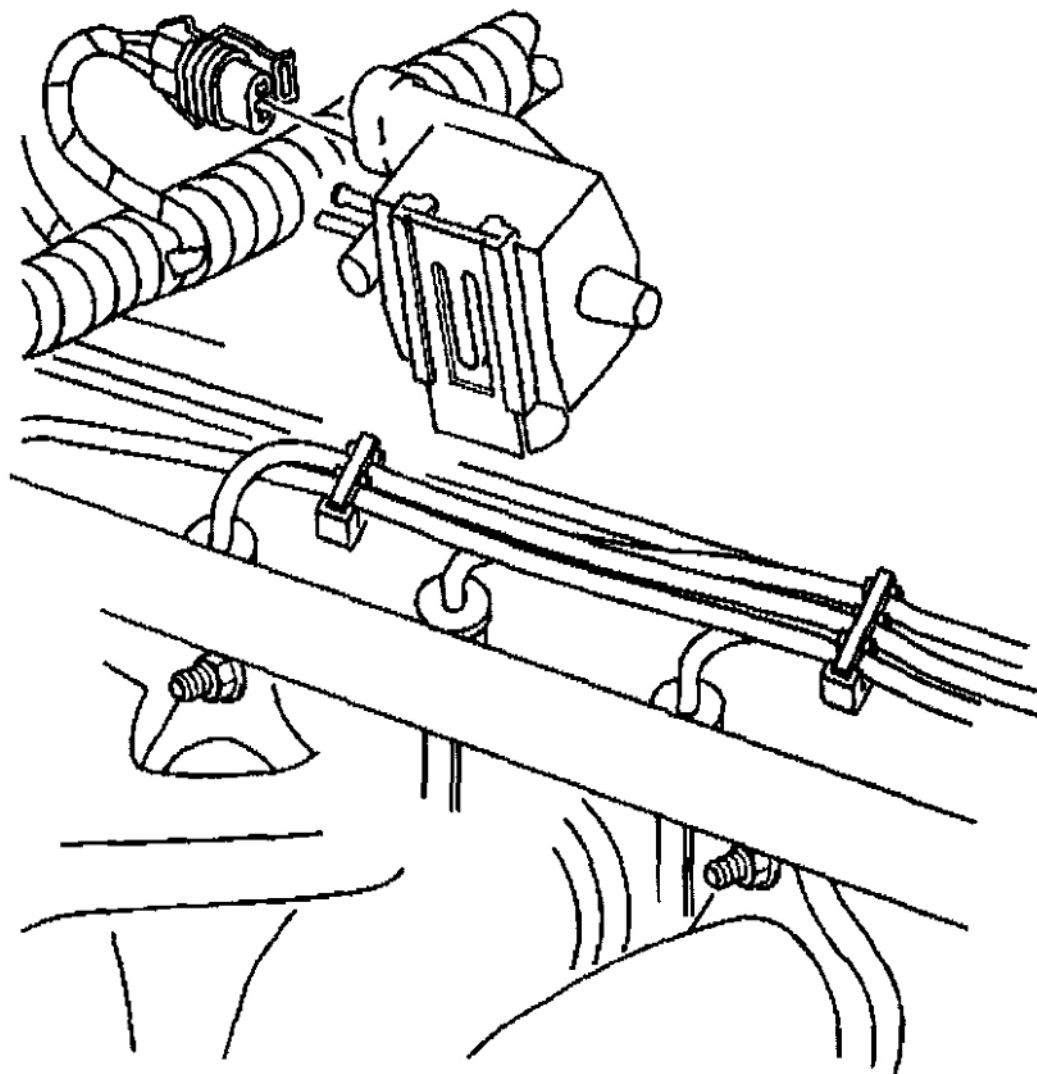
14. Remove the TP sensor electrical connection at the throttle body.



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Fig. 89: TP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

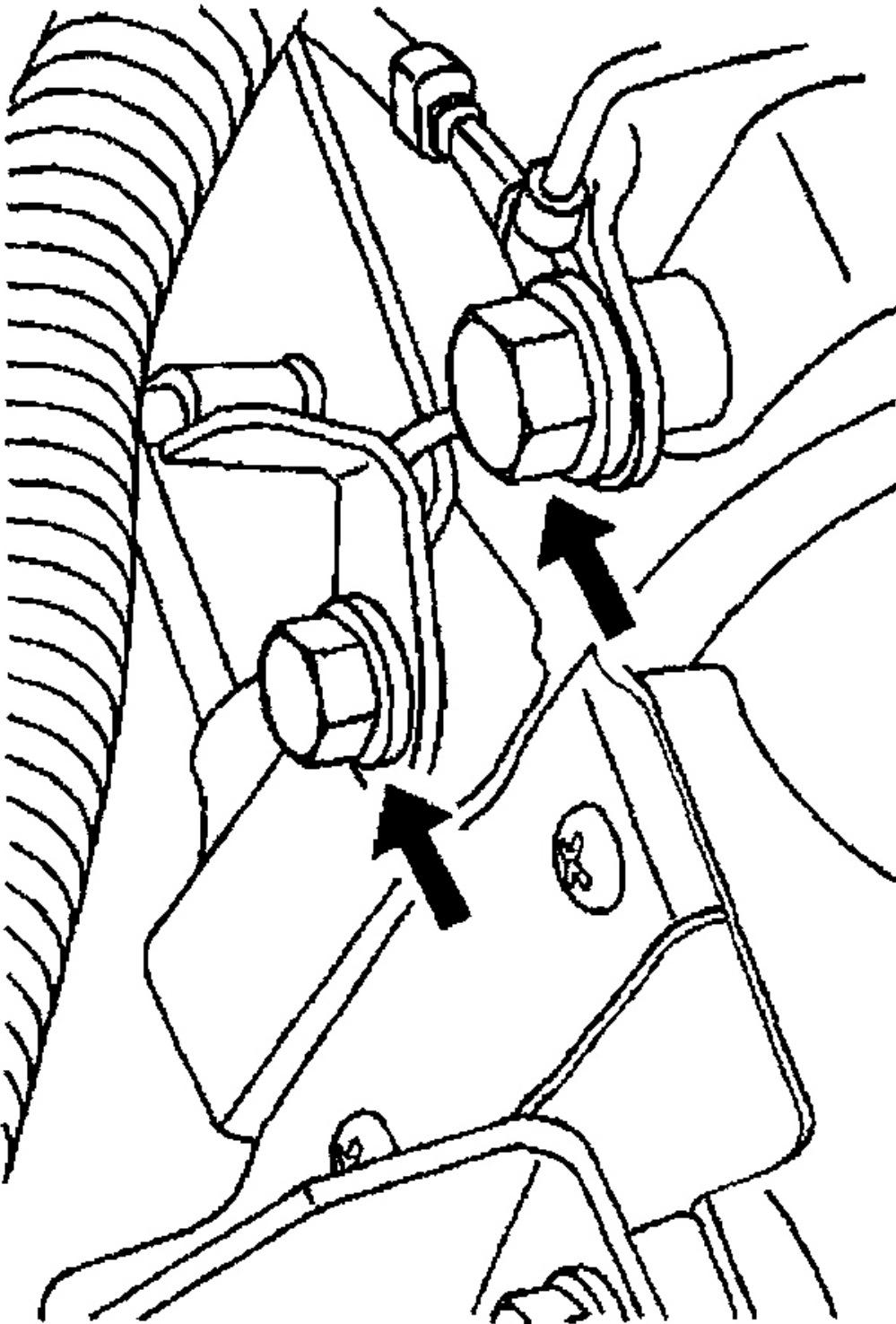
15. Remove the MAP sensor electrical connection.



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Fig. 90: MAP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

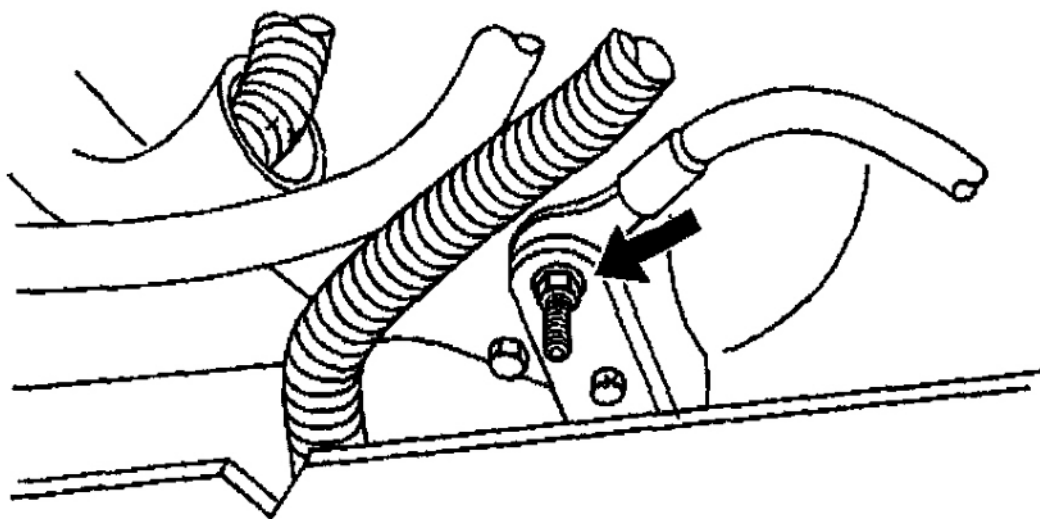
16. Remove the EVAP Canister Purge solenoid electrical connection.
17. Remove the ground connections.



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Fig. 91: Ground Connections**Courtesy of GENERAL MOTORS CORP.**

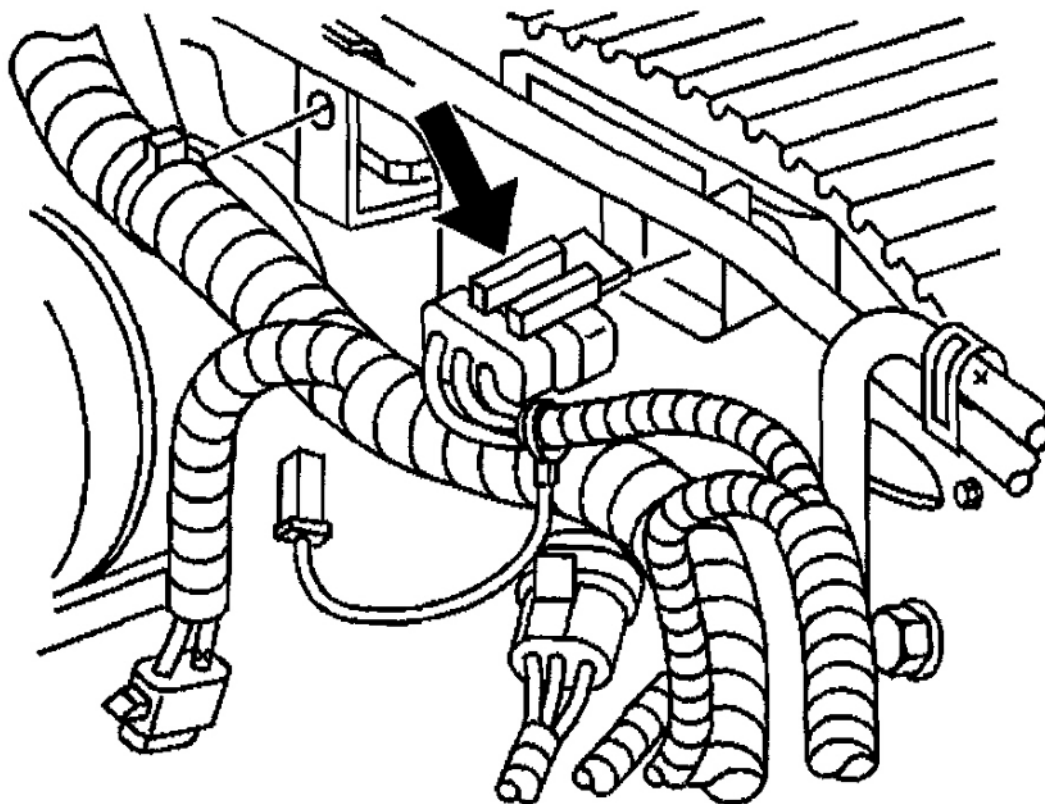
18. Remove the negative battery cable from the transmission.



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Fig. 92: Ground Connections**Courtesy of GENERAL MOTORS CORP.**

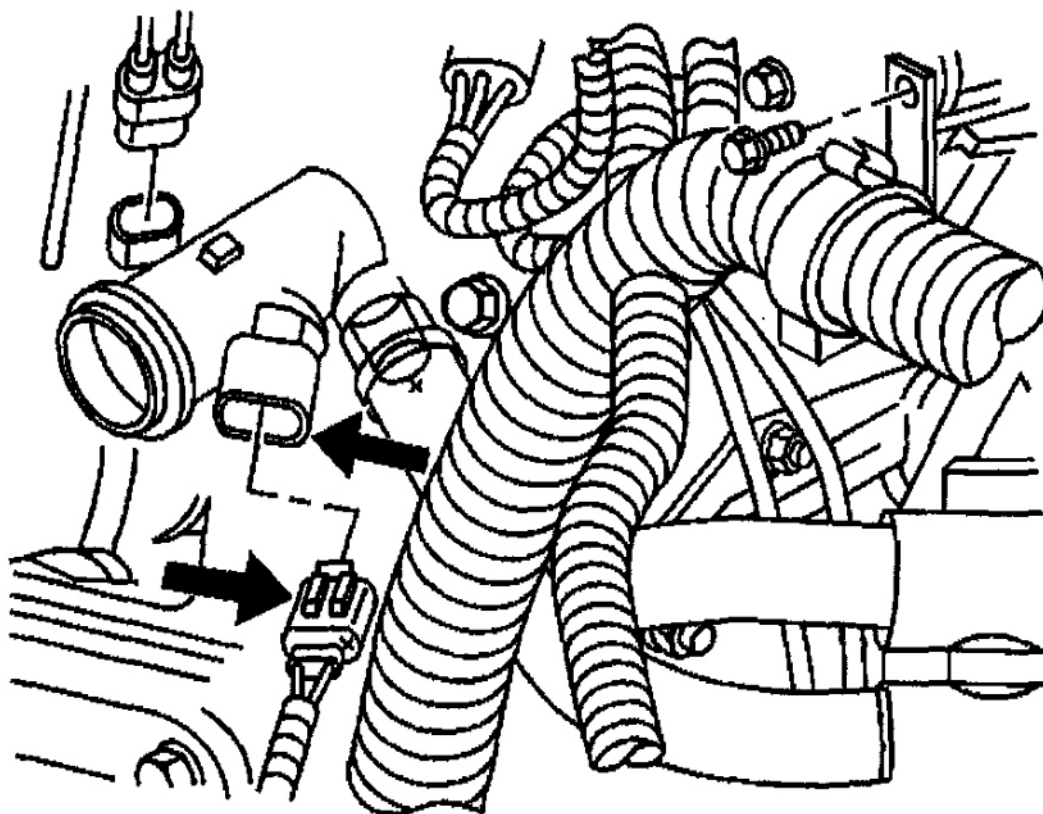
19. Remove the electronic ignition coil and module assembly electrical connection.



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Fig. 93: Electronic Ignition Coil And Module Assembly Connector
Courtesy of GENERAL MOTORS CORP.

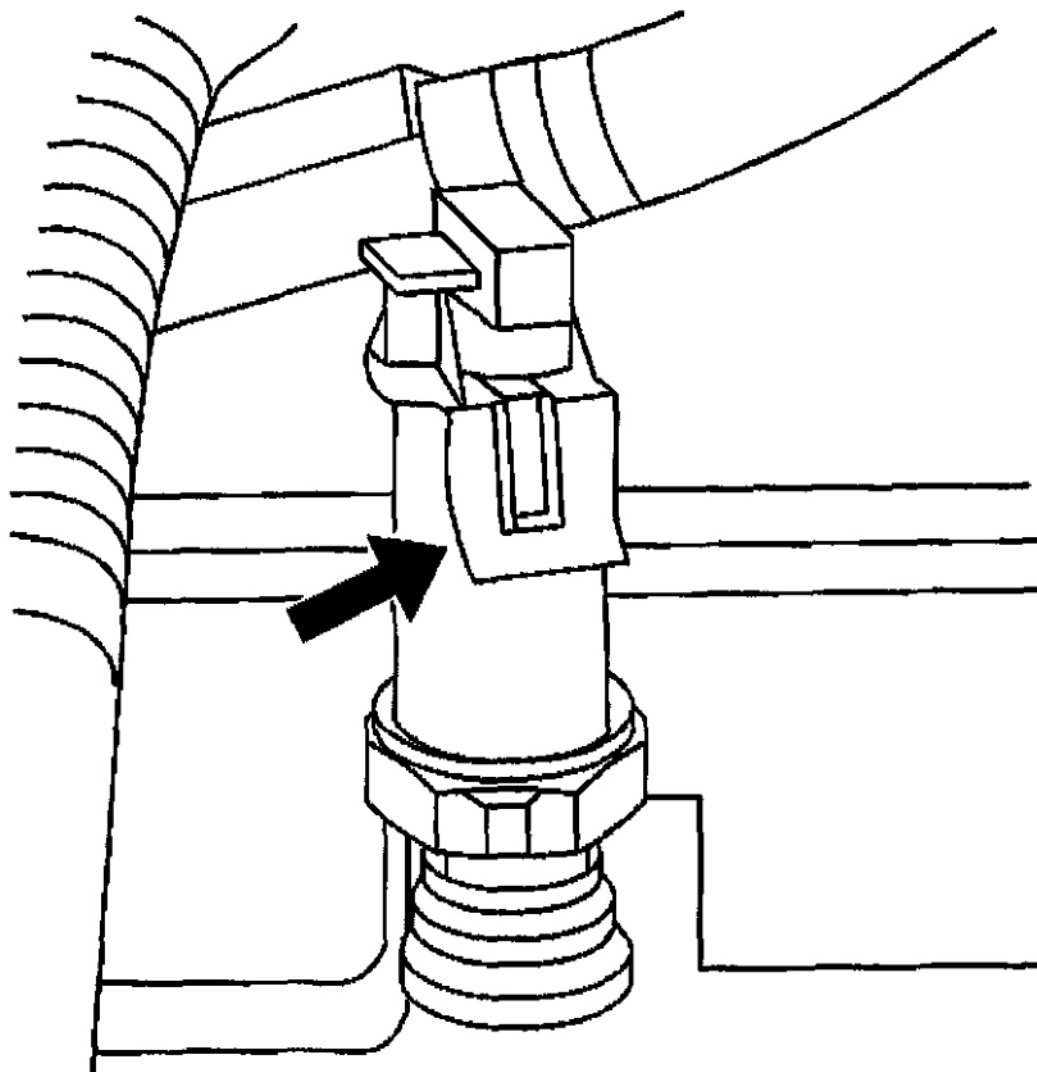
20. Remove the engine coolant temperature sensor electrical connection.



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Fig. 94: Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

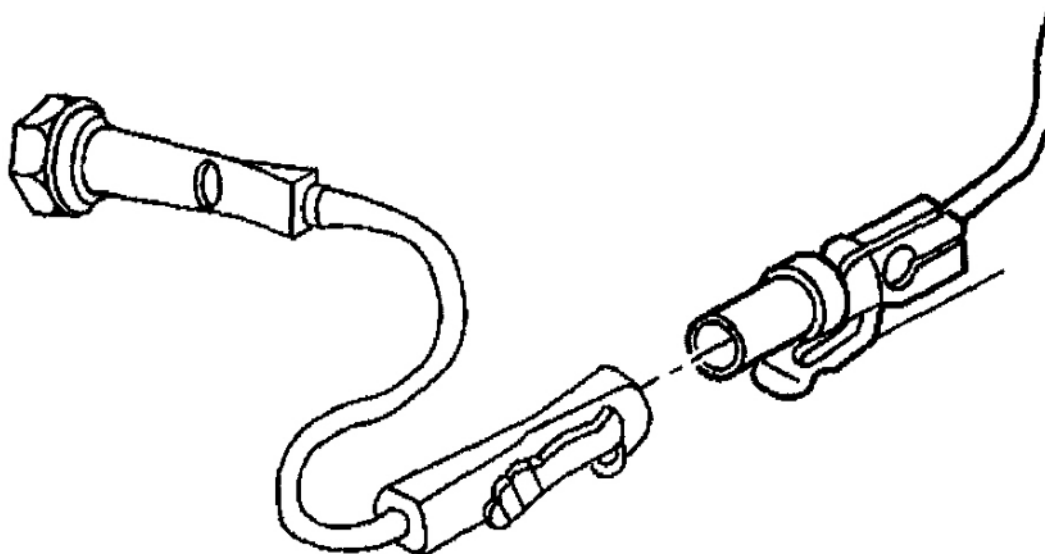
21. Remove the oil pressure sensor/switch electrical connection.



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Fig. 95: Oil Pressure Sensor/Switch Electrical Connector
Courtesy of GENERAL MOTORS CORP.

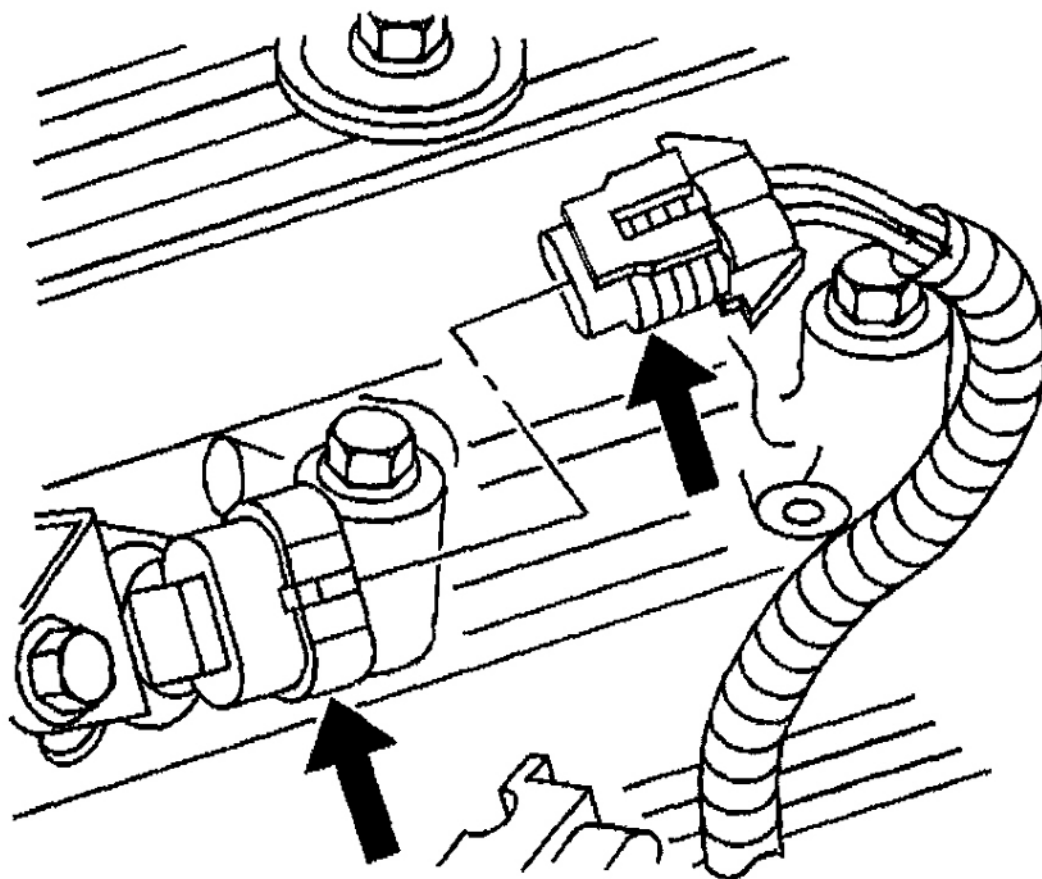
22. Remove the oxygen sensor (O2S) electrical connection.



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Fig. 96: Oxygen Sensor (O2S) Electrical Connector
Courtesy of GENERAL MOTORS CORP.

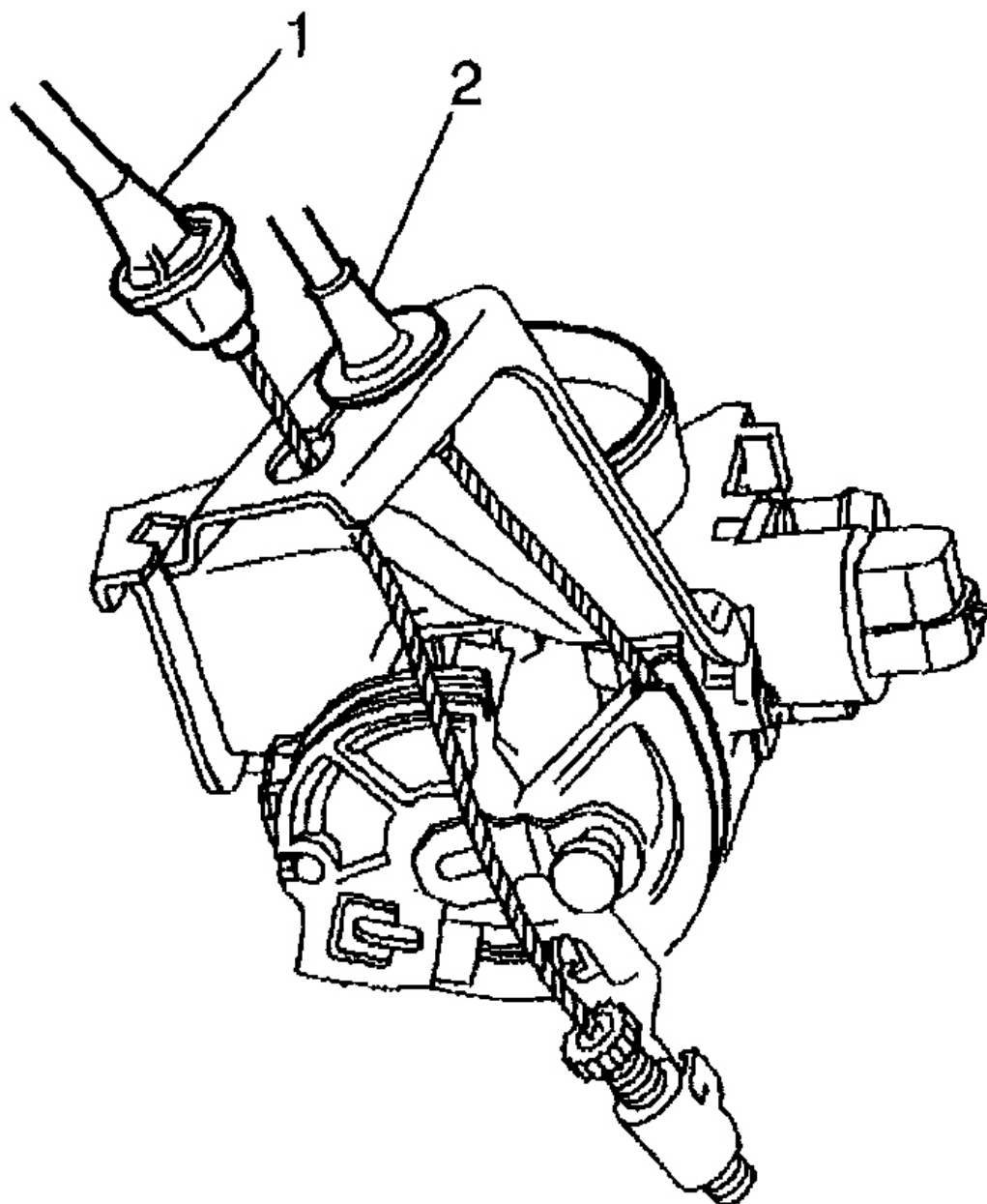
23. Remove the crankshaft position sensor.
24. Remove the back up lamp switch electrical connection and position the harness aside.
25. Remove the camshaft position sensor electrical connection.



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Fig. 97: Camshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

26. Remove the power brake vacuum hose from the throttle body.
27. Remove the following components:
 - The accelerator control cable (1)
 - The cruise control cable (2)

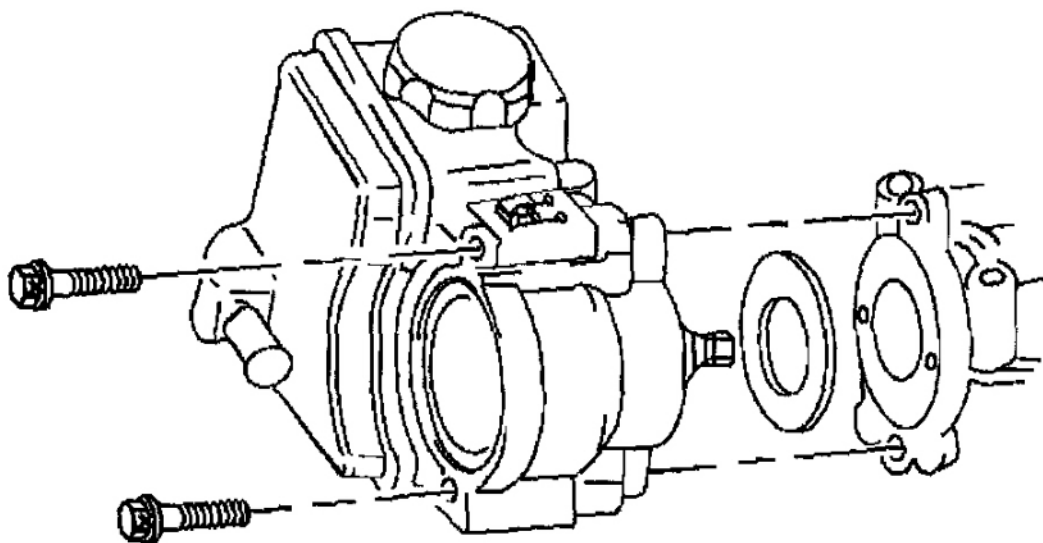


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Fig. 98: Accelerator & Cruise Control Cables
Courtesy of GENERAL MOTORS CORP.

28. Remove the power steering bolts.
29. Remove the power steering pump. Position the pump aside with the lines attached.

CAUTION: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

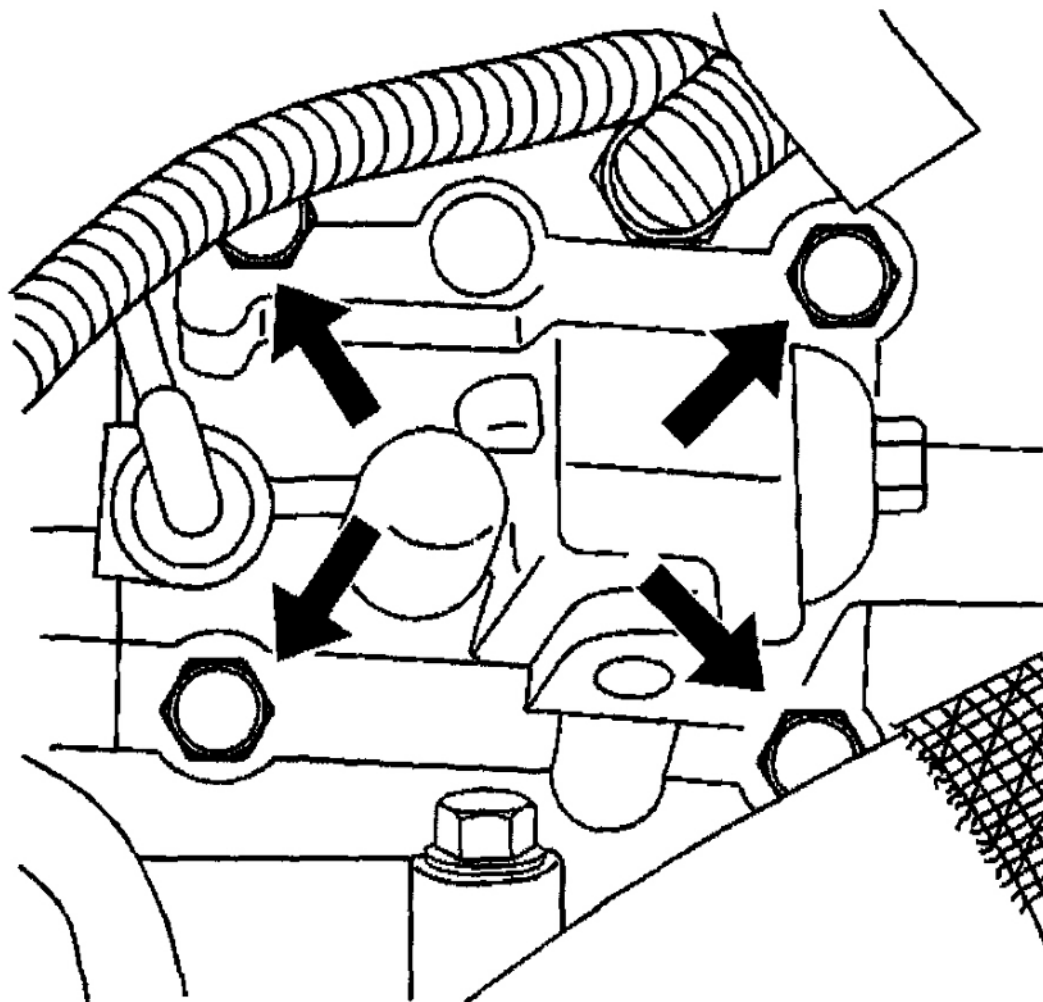


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Fig. 99: Power Steering Pump

Courtesy of GENERAL MOTORS CORP.

30. Disconnect the fuel lines.
31. Remove the shift control housing and position aside.

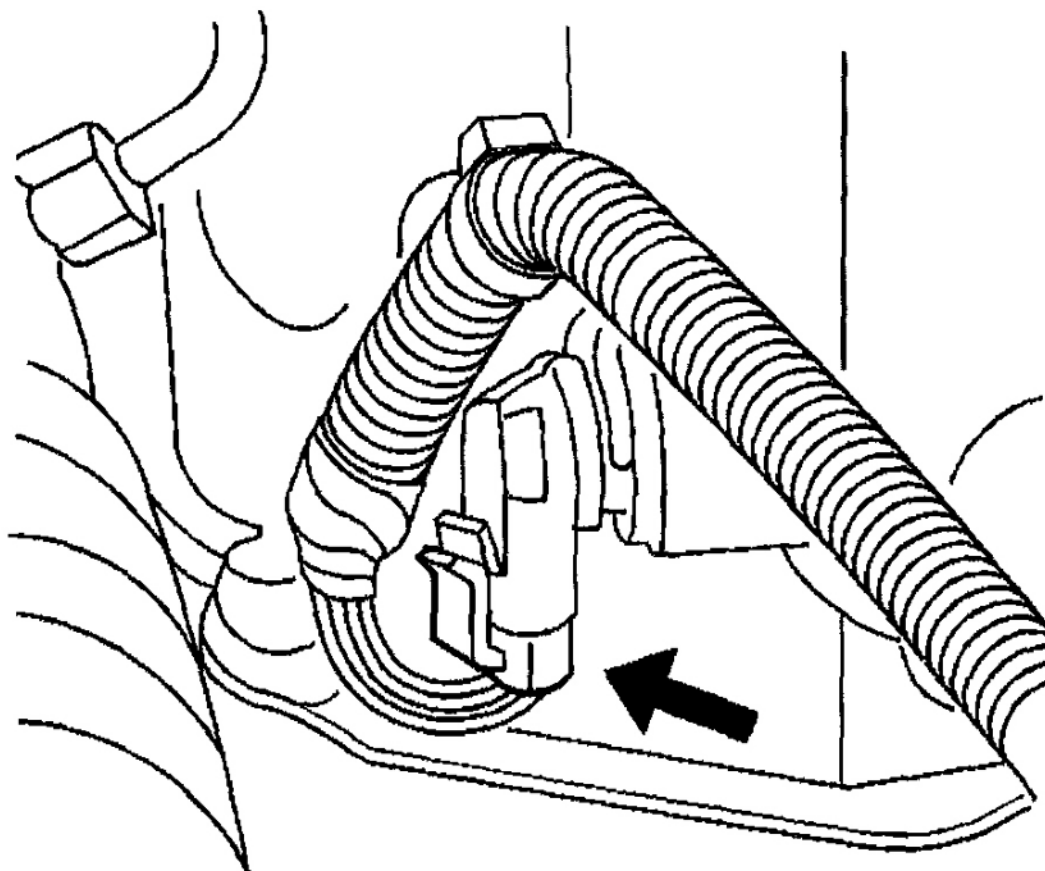


G01777670

Fig. 100: Shift Control Housing
Courtesy of GENERAL MOTORS CORP.

32. Disconnect the clutch actuator line.
33. Remove the exhaust manifold and heat shield.
34. Disconnect the radiator outlet (lower) hose from the radiator.
35. Install the **J 28467-360**.
36. Remove the surge tank. Position the tank aside with the hoses connected.
37. Remove the engine mount assembly. Refer to **Engine Mount Replacement**.
38. Raise and support the vehicle.
39. Remove the front wheel and tire assemblies.

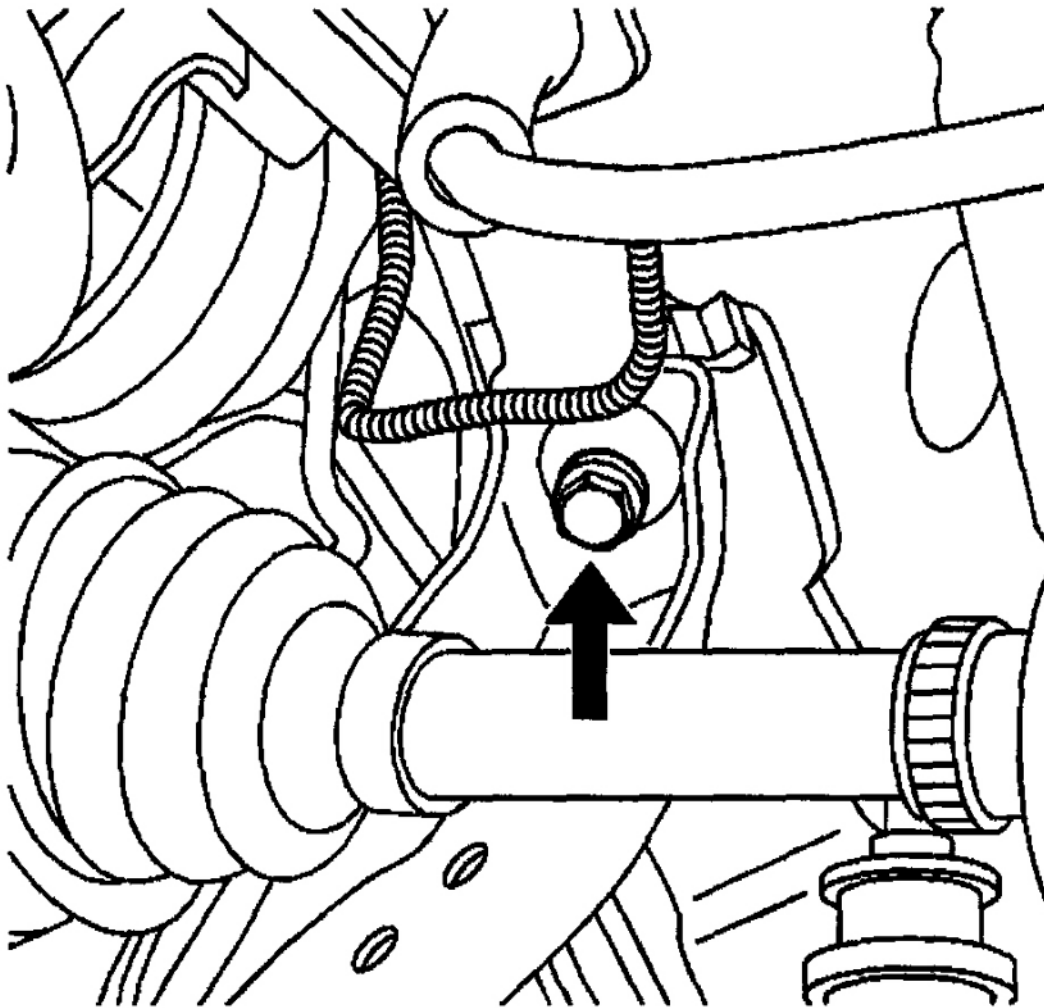
40. Remove the right engine splash shield.
41. Remove the VSS electrical connection.
42. Remove the knock sensor electrical connection.
43. Remove the starter.
44. Remove the both of the front ABS wheel speed sensor electrical connections.



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Fig. 101: Front ABS Wheel Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

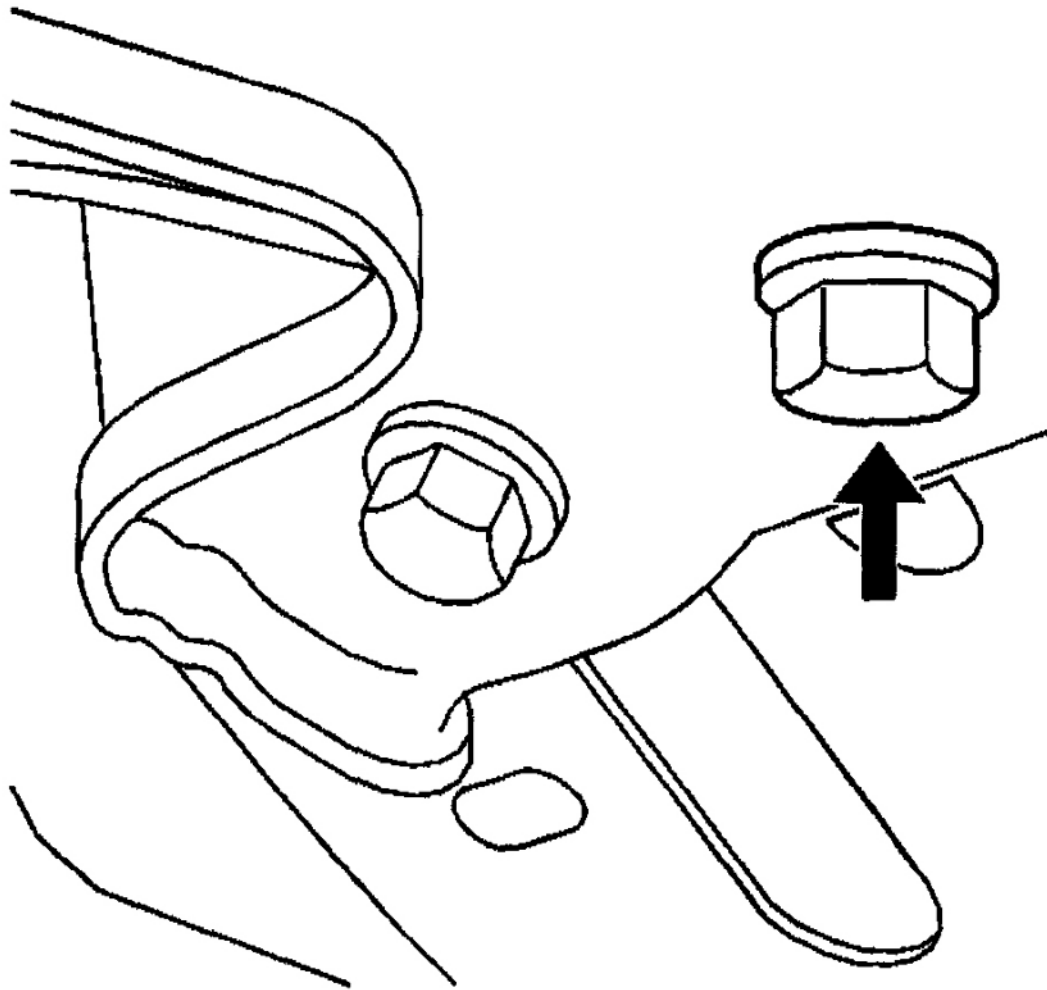
45. Remove the engine mount strut. Refer to **Engine Mount Strut Replacement**.
46. Unroute the ABS wheel speed sensor.
47. Remove the transmission mount.
48. Separate the ball joints from the steering knuckles.
49. Remove the suspension support upper bolts.



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Fig. 102: Suspension Support Upper Bolts
Courtesy of GENERAL MOTORS CORP.

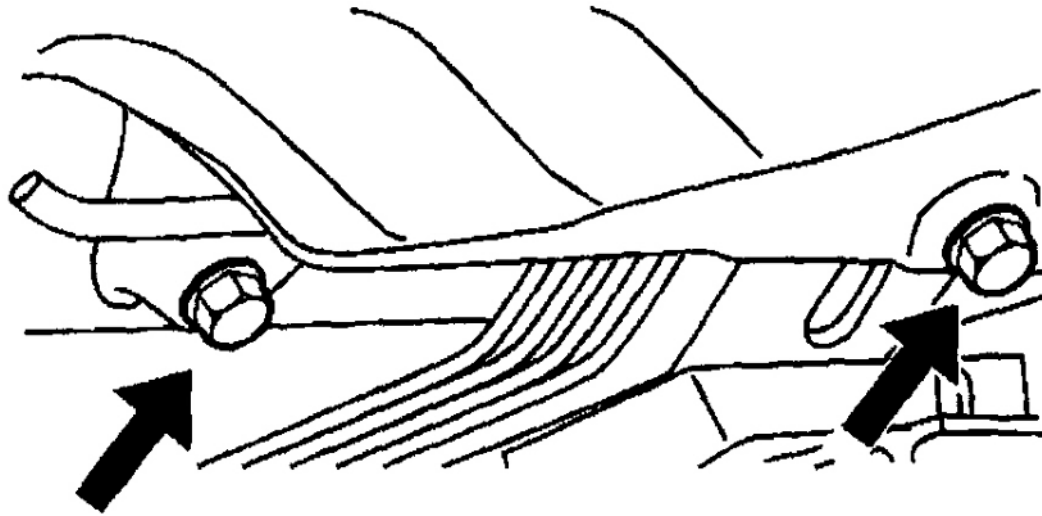
50. Remove the suspension support lower bolts.



G01777676

Fig. 103: Suspension Support Lower Bolts
Courtesy of GENERAL MOTORS CORP.

51. Remove the suspension support center bolts and the support.



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Fig. 104: Suspension Support Center Bolts And Support
Courtesy of GENERAL MOTORS CORP.

52. Disconnect the heater outlet hose from the radiator outlet pipe.
53. Remove the wheel drive shaft from the transmission and intermediate shaft (manual transmission only). Position the axle shaft aside.
54. Remove the flywheel housing cover.
55. Position suitable support below the engine and lower the car into the support.
56. Mark the threads on the support fixture hooks in order to duplicate the setting when reinstalling the engine.
57. Remove the engine support fixture J-hooks.
58. Raise the vehicle slowly off of the engine and transmission assembly. It may be necessary to move the engine/transmission assembly rearward in order to clear the intake manifold.
59. Separate the engine from the transmission.

Installation Procedure

Important: Place the bolts in their correct locations.

1. Assemble the engine to the transmission.
2. Position the engine and the transmission assembly under the engine compartment.
3. Slowly lower the vehicle over the assembly until the transmission mount is indexed.
4. Install the bolt.
5. Install the **J 28467-360** adjust to the previous setting.

6. Install the engine mount assembly. Refer to **Engine Mount Replacement**.
7. Install the transmission mount.
8. Raise the vehicle off of the support.
9. Install the axle shafts to the transmission.
10. Connect the heater outlet hose to the radiator outlet pipe.
11. Install the suspension support upper bolts.
12. Install the suspension support lower bolts.
13. Install the suspension support center bolts and the support.
14. Install the ball joint nuts.
15. Install the engine strut mount.
16. Route the ABS wheel speed sensor harness.
17. Connect the VSS electrical connections
18. Connect the knock sensor electrical connections
19. Install the starter.
20. Connect the front ABS wheel speed sensors electrical connections.
21. Install the flywheel housing cover.
22. Connect the lower radiator hose.
23. Install the right engine splash shield.
24. Install the front tires and wheels.
25. Lower the vehicle.
26. Remove the **J 28467-360** .
27. Install the surge tank.
28. Install the generator electrical connection.
29. Install the injector harness electrical connection.
30. Install the A/C compressor electrical connection, if equipped.
31. Install the IAC sensor electrical connection at the throttle body.
32. Install the TP sensor electrical connection at the throttle body.
33. Install the MAP sensor electrical connection.
34. Install the EVAP canister purge solenoid electrical connection.
35. Install the ground connections.
36. Install the negative battery cable to the transmission.
37. Install the engine coolant temperature sensor electrical connection.
38. Install the oil pressure sensor/switch electrical connection.
39. Install the oxygen sensor (O2S) electrical connection.
40. Install the crankshaft position sensor electrical connection.
41. Install the backup light switch electrical connection.
42. Install the electronic ignition coil and module assembly electrical connection.
43. Install the camshaft position sensor electrical connection.

44. Connect the vacuum hoses.
45. Connect the compressor/condenser hose assembly to the compressor, if A/C equipped.
46. Install the clutch actuator line.
47. Install the shift control housing.
48. Install the exhaust manifold and heat shield.
49. Connect the fuel lines.
50. Connect the positive battery cable to the battery. Tighten the bolt to 16 N.m (12 ft lbs).
51. Install the power steering pump to the block.
52. Install the power steering pump bolts.
53. Connect the vacuum hoses to intake manifold.

CAUTION: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a NEW cable whenever you remove the engine from the vehicle.

NOTE: In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

54. Install the accelerator control cable bracket.
55. Install the throttle cable (1).
56. Install the coolant fan.
57. Install the air cleaner assembly.
58. Install the radiator outlet (upper) hose.
59. Fill the cooling system.
60. Connect the heater hose at the thermostat housing.
61. Check and fill the transmission with fluid.
62. Fill engine oil.
63. Connect the negative battery cable.
64. If the vehicle is A/C equipped, evaporate, charge and leak test the A/C system.

ENGINE OIL & OIL FILTER REPLACEMENT

Removal Procedure

1. Raise and suitable support the vehicle.
2. Remove the oil pan drain bolt.
3. Remove the oil filter.

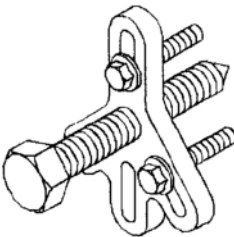
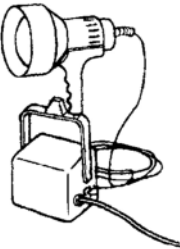
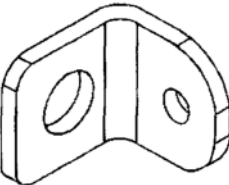
Installation Procedure

1. Install the oil filter.
2. Install the oil pan drain bolt. Tighten the oil pan drain bolt to 26 N.m (19 ft lbs).
3. Lower the vehicle.
4. Fill the engine with oil to the appropriate mark.
5. Start engine and inspect for leaks.

SPECIAL TOOLS & EQUIPMENT

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

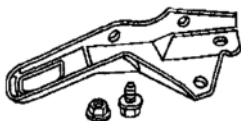
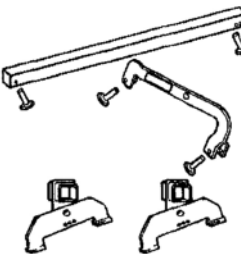
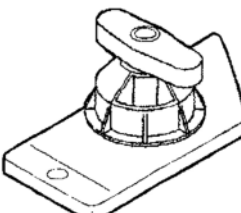
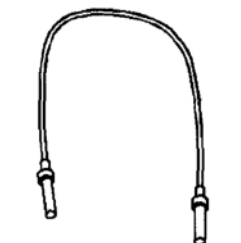
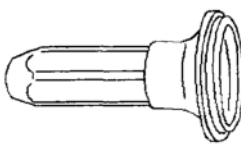
Illustration	Tool Number/Description
	J 5892-D Valve Spring Compressor
	J 24420-B Crankshaft Pulley Hub Puller
	J 28428-E High Intensity Black Light
	J 28467-B Universal Engine Support Fixture
	J 28467-360 Engine Support Fixture

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Fig. 105: Special Tools & Equipment (1 Of 4)
Courtesy of GENERAL MOTORS CORP.

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

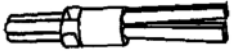
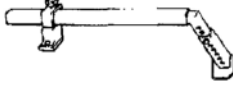
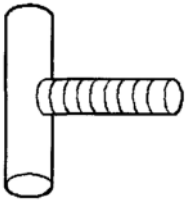
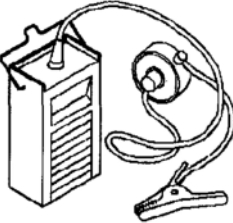
Illustration	Tool Number/Description
	J 28467-380 Engine Support Bracket
	J 28467-500 Engine Support Fixture
	J 36005 Rear Crankshaft Seal Installer
	J 36008-A Camshaft Sprocket Timing Alignment Pins
	J 36010 Front Crankshaft Seal Installer

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Fig. 106: Special Tools & Equipment (2 Of 4)
Courtesy of GENERAL MOTORS CORP.

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

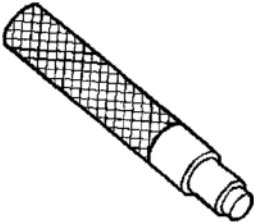
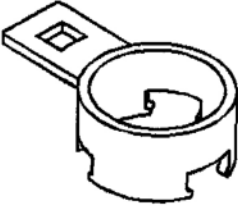
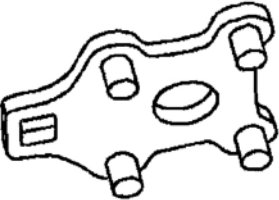
Illustration	Tool Number/Description
	J 36011 Spark Plug Boot Remover
	J 36017 Valve Guide Seal Remover
	J 36462 Engine Support Adapter Leg
	J 36588 Valve Spring Compressor T-Bolt
	J 36660-A Torque Angle Meter

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Fig. 107: Special Tools & Equipment (3 Of 4)
Courtesy of GENERAL MOTORS CORP.

2002 Pontiac Sunfire SE

2002 ENGINES Engine Mechanical - 2.4L 4-Cylinder - Cavalier & Sunfire

Illustration	Tool Number/Description
	J 37059 Accessory Drive Belt Tensioner Wrench
	J 37868 Camshaft Oil Gallery Plug Installer
	J 38122-A Harmonic Balancer Holder
	J 39579 Camshaft Sprocket Wrench

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Fig. 108: Special Tools & Equipment (4 Of 4)
Courtesy of GENERAL MOTORS CORP.