

2009 Pontiac Vibe

2009 ENGINE Engine Mechanical - 2.4L (LAX) - Vibe

2009 ENGINE**Engine Mechanical - 2.4L (LAX) - Vibe****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS**

Application	Specification	
	Metric	English
Air Cleaner Case LH Bolt	7.0 N.m	62 lb in
Balanceshaft Housing Bolt		
• 1st	22 N.m	16 lb ft
• 2nd	Turn 90°	
Battery Carrier Bolt	13 N.m	10 lb ft
Battery Clamp Bolt	3.5 N.m	31 lb in
Battery Clamp Nut	6.5 N.m	58 lb in
Camshaft Bolt		
• No. 1	30 N.m	22 lb ft
• Other	9.0 N.m	80 lb in
Camshaft Position Sensor Bolt	9.0 N.m	80 lb in
Camshaft Timing Gear Assembly Bolt	54 N.m	40 lb ft
Camshaft Timing Gear or Sprocket Bolt	54 N.m	40 lb ft
Camshaft Timing Oil Control Valve Assembly Bolt	9.0 N.m	80 lb in
Chain Tensioner Plate Bolt	12 N.m	9 lb ft
Chain Tensioner Slipper Bolt	19 N.m	14 lb ft
Connecting Rod Cap Bolt		
• 1st	25 N.m	18 lb ft
• 2nd	Turn 90°	
Crankshaft Bearing cap Bolt		
• 1st	20 N.m	15 lb ft
• 2nd	40 N.m	30 lb ft
• 3rd	Turn 90°	
Crankshaft Position Sensor Bolt	9.0 N.m	80 lb in
Crankshaft Pulley Bolt	180 N.m	133 lb ft
Cylinder Head Cover Sub-Assembly Bolt		
• Bolt A	11 N.m	8 lb ft
• Bolt B	14 N.m	10 lb ft
• Nut	11 N.m	8 lb ft

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Cylinder Head Sub-Assembly Bolt

• 1st	70 N.m	52 lb ft
• 2nd	Turn 90°	
Drive Plate and Ring Sub-Assembly Bolt (For Automatic Transaxle)	98 N.m	72 lb ft
Drive Shaft Bearing Bracket Bolt	64 N.m	47 lb ft
Engine Mounting Insulator Sub-Assembly LH to Frame Bolt	52 N.m	38 lb ft
Engine Mounting Insulator Sub-Assembly LH to Engine Mounting Bracket Bolt	56 N.m	41 lb ft
Engine Mounting Insulator Sub-Assembly RH Bolt		
• Bolt A	52 N.m	38 lb ft
• Bolt B	95 N.m	70 lb ft
• Nut A	95 N.m	70 lb ft
• Nut B	52 N.m	38 lb ft
Engine Oil Level Dipstick Guide Bolt	9.0 N.m	80 lb in
Engine Wire Harness Relay Block Bolt	8.4 N.m	74 lb in
Exhaust Manifold Converter Sub-Assembly Bolt	37 N.m	27 lb ft
Flywheel Sub-Assembly Bolt (For Manual Transaxle)	130 N.m	96 lb ft
Front Engine Mounting Insulator Sub-Assembly Bolt	73 N.m	53 lb ft
Ground Cable Bolt	8.4 N.m	74 lb in
Ground Cable Bolt (For Automatic Transaxle)	26 N.m	19 lb ft
Ground Cable Bolt (For Manual Transaxle)	13 N.m	10 lb ft
Idler Pulley Sub-Assembly Bolt	50 N.m	37 lb ft
Inlet Water Housing Drain Cock	13 N.m	10 lb ft
Inlet Water Housing Drain Cock Assembly	25 N.m	18 lb ft
No. 1 Chain Tensioner Assembly Bolt	9.0 N.m	80 lb in
No. 1 Chain Vibration Damper Bolt	9.0 N.m	80 lb in
No. 1 Engine Hanger Bolt	38 N.m	28 lb ft
No. 1 Oil Nozzle Sub-Assembly	7.0 N.m	62 lb in
No. 1 Straight Head Screw Plug	86 N.m	64 lb ft
No. 1 Taper Head Screw Plug	26 N.m	19 lb ft
No. 1 Water By-Pass Pipe Bolt	9.0 N.m	80 lb in
No. 2 Camshaft Bolt		
• No. 2	30 N.m	22 lb ft
• Other	9.0 N.m	80 lb in
No. 2 Engine Hanger Bolt	38 N.m	28 lb ft
Oil Control Valve Filter	30 N.m	22 lb ft
Oil Filter Union	30 N.m	22 lb ft
Oil Pan Drain Plug	40 N.m	30 lb ft

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Oil Pan Sub-Assembly Bolt	9.0 N.m	80 lb in
Oil Pump Drive Shaft Sprocket Bolt	30 N.m	22 lb ft
Radiator Reserve Tank Assembly Bolt	5.0 N.m	44 lb in
Radio Setting Condenser Bolt	10 N.m	7 lb ft
Rear Engine Mounting Insulator Sub-Assembly Bolt	65 N.m	48 lb ft
Stiffening Crankcase Assembly Bolt	24 N.m	18 lb ft
Stud Bolt (Cylinder Block)		
• Bolt A	22 N.m	16 lb ft
• Bolt B	5.0 N.m	44 lb in
• Bolt C	9.5 N.m	84 lb in
• Bolt D	5.0 N.m	44 lb in
Stud Bolt (Cylinder Head)		
• Bolt A	5.0 N.m	44 lb in
• Bolt B	5.0 N.m	44 lb in
• Bolt C	9.5 N.m	87 lb in
• Bolt D	9.5 N.m	87 lb in
Timing Chain Guide Bolt	9.0 N.m	80 lb in
Timing Chain or Belt Cover Sub-Assembly Bolt		
• Bolt A	9.0 N.m	80 lb in
• Bolt B	25 N.m	18 lb ft
• Bolt C	55 N.m	41 lb ft
• Nut	11 N.m	8 lb ft
Timing Chain or Belt Cover Sub-Assembly Nut	22 N.m	16 lb ft
V-Ribbed Belt Pretensioner Assembly Bolt	60 N.m	44 lb ft
Ventilation Valve Sub-Assembly Bolt	19 N.m	14 lb ft

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
Engine		
Ignition Timing Standard		
• When Using Techstream	BTDC 8-12° at idle	
• When Not Using Techstream	BTDC 8-12° at idle (Connect terminals 13 (TC) and 4 (CG))	
	BTDC 8-15° at idle Remove terminals 13 (TC) and 4 (CG))	
• Engine Idling Speed Standard	600-700 rpm	

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Compression

• Standard	1300 kPa (189 psi)	
• Minimum	1000 kPa (145 psi)	
• Difference between each cylinder	100 kPa (15 psi)	

Camshaft**Valve Clearance Standard**

• Intake	0.19-0.29 mm	0.0075-0.0114 in
• Exhaust	0.38-0.48 mm	0.0150-0.189 in

Thrust Clearance

• Standard Intake	0.040-0.095 mm	0.0016-0.0037 in
• Standard Exhaust	0.090-0.145 mm	0.0035-0.0057 in
• Maximum Intake	0.110 mm	0.0043 in
• Maximum Exhaust	0.150 mm	0.0059 in

Oil Clearance Standard

• Camshaft No. 1 Journal Bearing Mark 1	0.007-0.038 mm	0.0003-0.0015 in
• Camshaft No. 1 Journal Bearing Mark 2	0.008-0.038 mm	0.0003-0.0015 in
• Camshaft No. 1 Journal Bearing Mark 3	0.008-0.038 mm	0.0003-0.0015 in
• Camshaft Other Journals	0.025-0.062 mm	0.0010-0.0024 in
• No. 2 Camshaft No. 1 Journal	0.040-0.072 mm	0.0016-0.0028 in
• No. 2 Camshaft No. 1 Journals	0.025-0.062	0.0010-0.0024 in
• Maximum - Intake	0.070 mm	0.0028 in
• Maximum - Exhaust	0.100 mm	0.0039 in
• Circle Runout - Maximum	0.03 mm	0.0012 in

Cam Lobe Height

• Standard - Intake	47.306-47.406 mm	1.8624-1.8664 in
• Standard - Exhaust	46.063-46.163 mm	1.8135-1.8174 in
• Minimum - Intake	47.196 mm	1.8581 in
• Minimum - Exhaust	45.953 mm	1.8092 in

Journal Diameter- Standard

• No. 1	35.971-35.985 mm	1.4162-1.4167 in
• Other	22.959-22.975 mm	0.9039-0.9045 in

Cylinder Head**Flatness Standard**

• Cylinder Block Side	0.08 mm	0.0031 in
• Intake Manifold Side	0.08 mm	0.0031 in

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• Exhaust Manifold Side	0.08 mm	0.0031 in
• Lifter Bore Diameter Standard	31.009-31.025 mm	1.2208-1.2215 in
Inner Compression Spring		
• Standard Length	47.43 mm	1.867 in
• Maximum Deviation	1.6 mm	0.063 in
Intake Valve		
• Overall Standard Length	101.71 mm	4.0043 in
• Overall Minimum Length	101.21 mm	3.9846 in
• Standard Valve Stem Diameter	5.470-5.485 mm	0.2154-0.2159 in
• Standard Margin Thickness	1.05-1.45 mm	0.0413-0.0571 in
• Minimum Margin Thickness	0.50 mm	0.0197 in
Exhaust Valve		
• Overall Standard Length	101.15 mm	3.9823 in
• Overall Minimum Length	100.70 mm	3.9646 in
• Standard Valve Stem Diameter	5.465-5.480 mm	0.2152-0.2157 in
• Standard Margin Thickness	1.20-1.60 mm	0.0472-0.0630 in
• Minimum Margin Thickness	0.50 mm	0.0197 in
Intake Valve Guide Bush		
• Standard Inside Diameter	5.510-5.530 mm	0.2169-0.2177 in
• Oil Clearance - Standard	0.025-0.060 mm	0.0010-0.0024 in
• Oil Clearance - Maximum	0.090 mm	0.0035 in
Exhaust Valve Guide Bush		
• Standard Inside Diameter	5.510-5.530 mm	0.2169-0.2177 in
• Oil Clearance - Standard	0.030-0.065 mm	0.0012-0.0026 in
• Oil Clearance - Maximum	0.095 mm	0.0037 in
Valve Lifter		
• Standard Diameter	30.966-30.976 mm	1.2191-1.2195 in
• Oil Clearance - Standard	0.033-0.059 mm	0.0013-0.0023
• Oil Clearance - Maximum	0.079 mm	0.0031 in
Connecting Rod		
• Thrust Clearance - Standard	0.160-0.362 mm	0.0063-0.0143 in
• Thrust Clearance - Maximum	0.362 mm	0.0143 in
• Oil Clearance - Standard	0.024-0.048 mm	0.0009-0.0019 in
• Oil Clearance - Maximum	0.063 mm	0.0025 in
Cylinder Block		

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• Maximum Warpage	0.05 mm	0.0020 in
• Standard Cylinder Bore Diameter	88.500-88.513 mm	3.4843-3.4847 in
• Maximum Cylinder Bore Diameter	88.613 mm	3.4887 in
Piston		
• Standard Diameter	88.469-88.479 mm	3.4830-3.4834 in
• Oil Clearance - Standard	0.021-0.044 mm	0.0008-0.0017 in
• Oil Clearance - Maximum	0.10 mm	0.0039 in
Ring Groove Clearance Standard		
• No. 1	0.020-0.070 mm	0.0008-0.0028 in
• No. 2	0.020-0.060 mm	0.0008-0.0024 in
• Oil	0.020-0.070 mm	0.0008-0.0028 in
Piston Ring		
End Gap Standard		
• No. 1	0.24-0.31 mm	0.0094-0.0122 in
• No. 2	0.33-0.43 mm	0.0130-0.0169 in
• Oil	0.10-0.30 mm	0.0040-0.0119 in
End Gap Maximum		
• No. 1	0.31 mm	0.0122 in
• No. 2	0.43 mm	0.0169 in
• Oil	0.30 mm	0.0118 in
Piston Pin		
• Oil Clearance - Standard (Piston pin x Piston pin bore)	0.001-0.007 mm	0.00004-0.00028 in
• Oil Clearance - Maximum (Piston pin x Piston pin bore)	0.010 mm	0.0004 in
• Oil Clearance - Standard (Piston pin x Connecting rod small end bore)	0.005-0.011 mm	0.0002-0.0004 in
• Oil Clearance - Maximum (Piston pin x Connecting rod small end bore)	0.011 mm	0.0004 in
Connecting Rod Bolt		
• Standard Diameter	7.2-7.3 mm	0.283-0.287 in
• Minimum Diameter	7.0 mm	0.276 in
Connecting Rod		

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• Maximum Misalignment	0.05 per 100 mm	0.0020 per 3.94 in
• Maximum Twist	0.05 per 100 mm	0.0020 per 3.94 in
Crankshaft		
• Maximum Circle Runout	0.03 mm	0.0012 in
• Standard Main Journal Diameter	54.988-55.000 mm	2.1649-2.1654 in
• Maximum Main Journal for Taper and Distortion	0.003 mm	0.0001 in
• Standard Crank Pin Diameter	47.990-48.000 mm	1.8894-1.8898 in
• Maximum Crank Pin for Taper and Distortion	0.003 mm	0.0001 in
• Thrust Clearance - Standard	0.04-0.24 mm	0.0016-0.0095 in
• Thrust Clearance - Maximum	0.30 mm	0.0118 in
• Oil Clearance - Standard	0.017-0.040 mm	0.0007-0.0016 in
• Oil Clearance - Maximum	0.060 mm	0.0024 in
Crankshaft Bearing Cap Set Bolt		
• Standard Diameter	7.5-7.6 mm	0.295-0.299 in
• Minimum Diameter	7.5 mm	0.295 in
Balanceshaft		
• Thrust Clearance - Standard	0.05-0.09 mm	0.0020-0.0035 in
• Thrust Clearance - Maximum	0.09 mm	0.0035 in
• Oil Clearance - Standard	0.022-0.049 mm	0.0009-0.0019 in
• Oil Clearance - Maximum	0.049 mm	0.0019 in
Balanceshaft Housing Bolt		
• Standard Length	58.3-59.7 mm	2.295-2.350 in
• Maximum Length	60.3 mm	2.374 in
Chain Sub-Assembly		
• Maximum Elongation	114.5 mm	4.508 in
No. 2 Chain Sub-Assembly		
• Maximum Elongation	102.2 mm	4.024 in
Oil Pump Drive Gear		
• Minimum Diameter (with chain)	48.2 mm	1.898 in
Oil Pump Drive Shaft Gear		
• Minimum Diameter (with chain)	48.2 mm	1.898 in
Camshaft Timing Gear Assembly		
• Minimum Diameter (with chain)	97.3 mm	3.831 in
Camshaft Timing Gear or Sprocket		
• Minimum Diameter (with chain)	97.3 mm	3.831 in

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Crankshaft Timing Gear or Sprocket

- Minimum Diameter (with chain)

51.6 mm

2.031 in

Chain Tensioner Slipper

- Maximum Wear

1.0 mm

0.039 in

No. 1 Chain Vibration Damper

- Maximum Wear

1.0 mm

0.039 in

Chain Tensioner Plate

- Maximum Wear

0.5 mm

0.020 in

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

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

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform 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:

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Compression Test**
- **Cylinder Leakage Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear 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.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout and 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.

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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.
Worn or faulty lifters The lifters may be worn on the camshaft or the valve tip surfaces or the lifters may be bleeding down	Replace the lifters.
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. • 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. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
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 communication, DIS or coil per cylinder and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire	Replace the sensor and/or crankshaft as required.

may occur. However, a P0300 DTC may be set.

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.
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.
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. • 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.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

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 or worn lifters	Replace as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

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

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. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.

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

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	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.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. • Repair or replace as required.
Improper lubrication to the valve train	Inspect the following components, and repair or replace as required:

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	• Restricted oil filter • The valve lifter • The valve lifter bore • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or damaged valve lifter bore	Repair or replace as required.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lifters as required.
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

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. • 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.
Loose torque converter bolts	• Inspect the torque converter bolts and flywheel.

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	• Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
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.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	• Perform an oil pressure test. • Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls.
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:

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	• 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

ENGINE COMPRESSION TEST

Perform a compression test in order to determine the cylinder compression pressure. Use a compression test in order to diagnose lack of power, excessive oil consumption, or poor fuel economy.

NOTE: This engine is equipped with an aluminum cylinder head. Allow the engine to cool before removing spark plugs. Removing the spark plugs from an engine at operating temperature may damage the spark plug threads in the cylinder head. Also be sure to clean any dirt or debris from around spark plug holes prior to removing spark plugs.

IMPORTANT: The engine should be at room temperature.

1. Verify that the battery is fully charged.

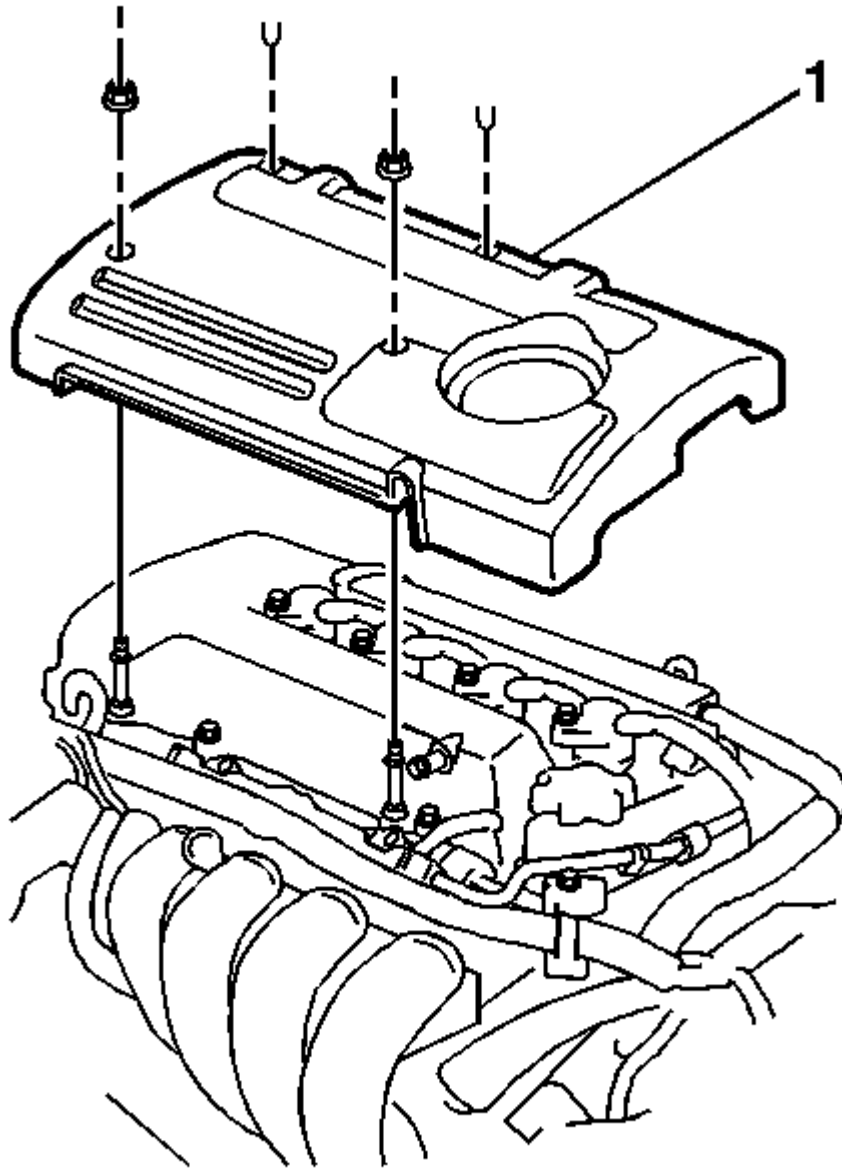


Fig. 1: View Of Engine Top Cover, Plastic Retainers & Fasteners
Courtesy of GENERAL MOTORS CORP.

2. Remove the 2 engine cover fasteners.
3. Remove the 2 engine cover plastic retainers.
4. Remove the engine cover (1) from the engine.

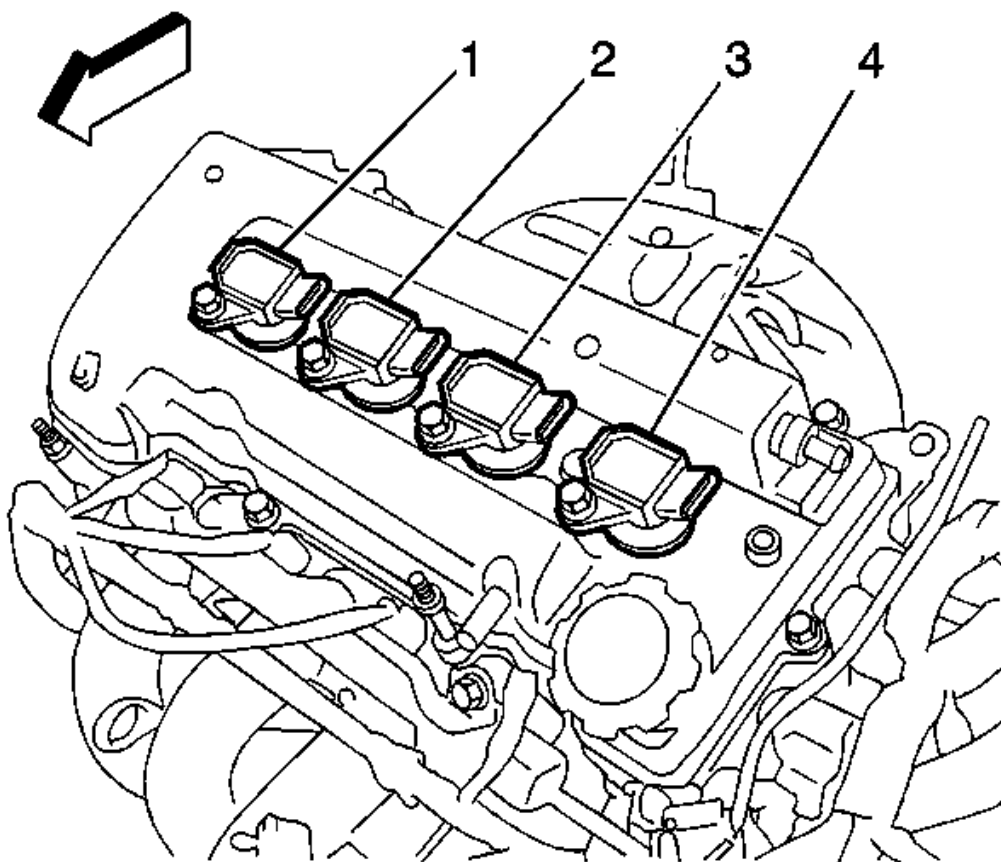


Fig. 2: Identifying Ignition Coils

Courtesy of GENERAL MOTORS CORP.

5. Remove the four ignition coils (1-4) from the cylinder head cover.
6. Remove the spark plugs from the cylinder head. See **SPARK PLUG REPLACEMENT** .

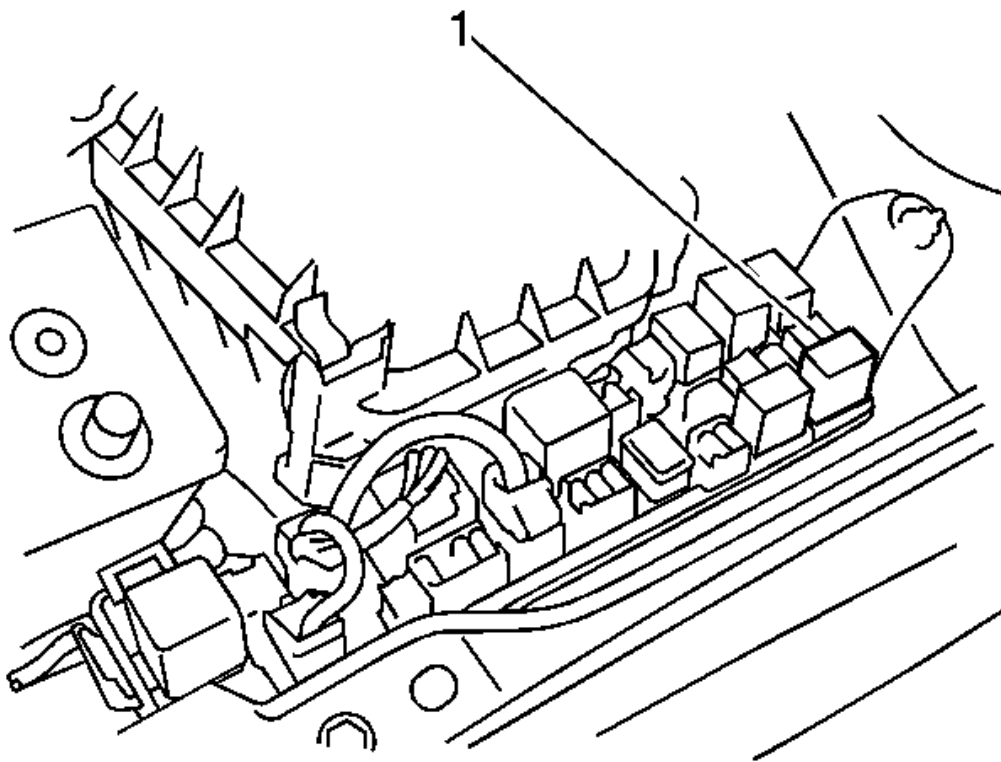


Fig. 3: Identifying EFI Main Relay
Courtesy of GENERAL MOTORS CORP.

7. Remove the EFI Main Relay (1) from the Fuse/Relay Block 1.

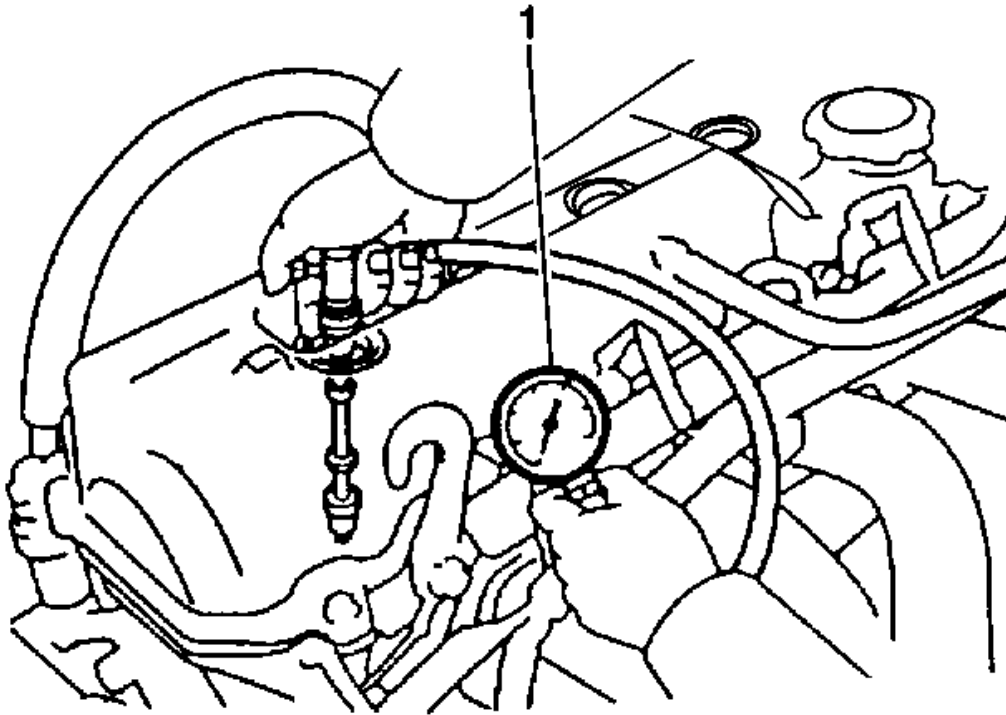


Fig. 4: View Of Compression Gage
Courtesy of GENERAL MOTORS CORP.

8. Install a compression gage into a spark plug hole.
9. Depress the clutch pedal (on vehicles that are equipped with a manual transmission).
10. Depress the accelerator pedal to the floor for a wide open throttle.
11. Crank the engine through four compression strokes for each cylinder being tested.

IMPORTANT: The maximum allowable compression pressure difference between any two cylinders is 100 kPa (15 psi).

12. Measure the highest pressure reading on the compression gage.
 - The standard compression pressure is 1,300 kPa (218 psi).
 - The minimum allowable compression pressure is 1,000 kPa (145 psi).
13. Repeat the compression test procedures for the remaining three cylinders.
14. Remove the compression gage from the engine.
15. Install the four spark plugs. See **SPARK PLUG REPLACEMENT**.

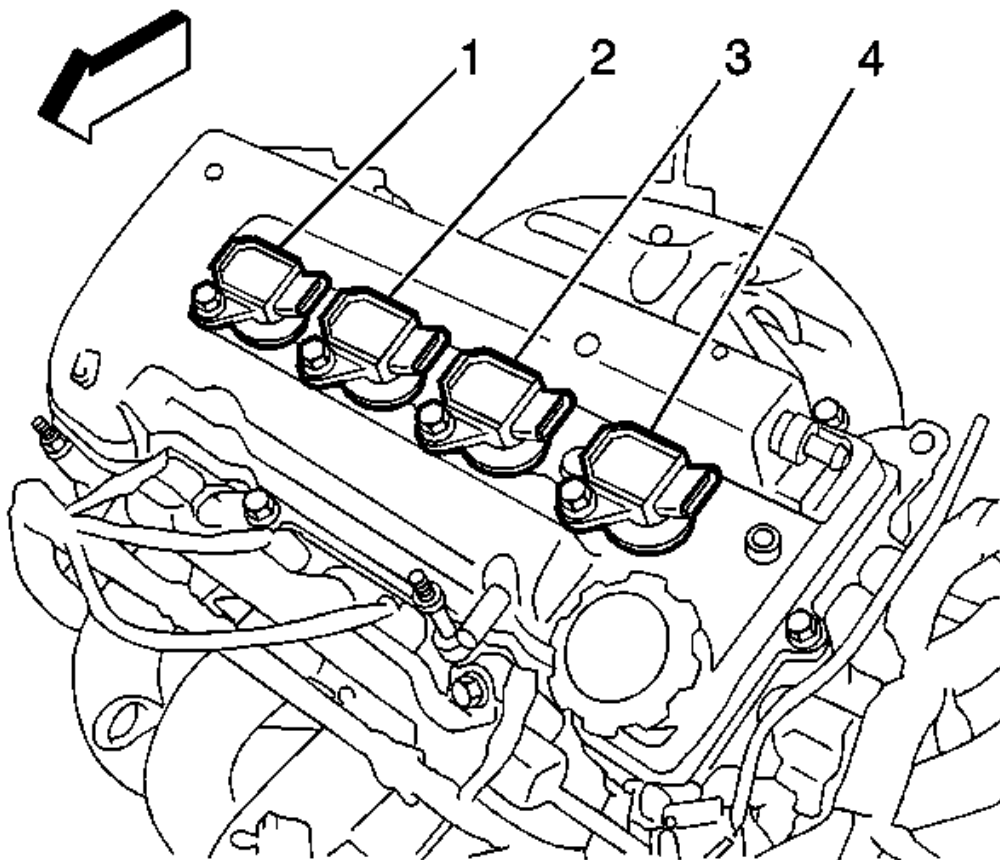


Fig. 5: Identifying Ignition Coils
Courtesy of GENERAL MOTORS CORP.

16. Install the four ignition coils (1-4) to the cylinder head cover.

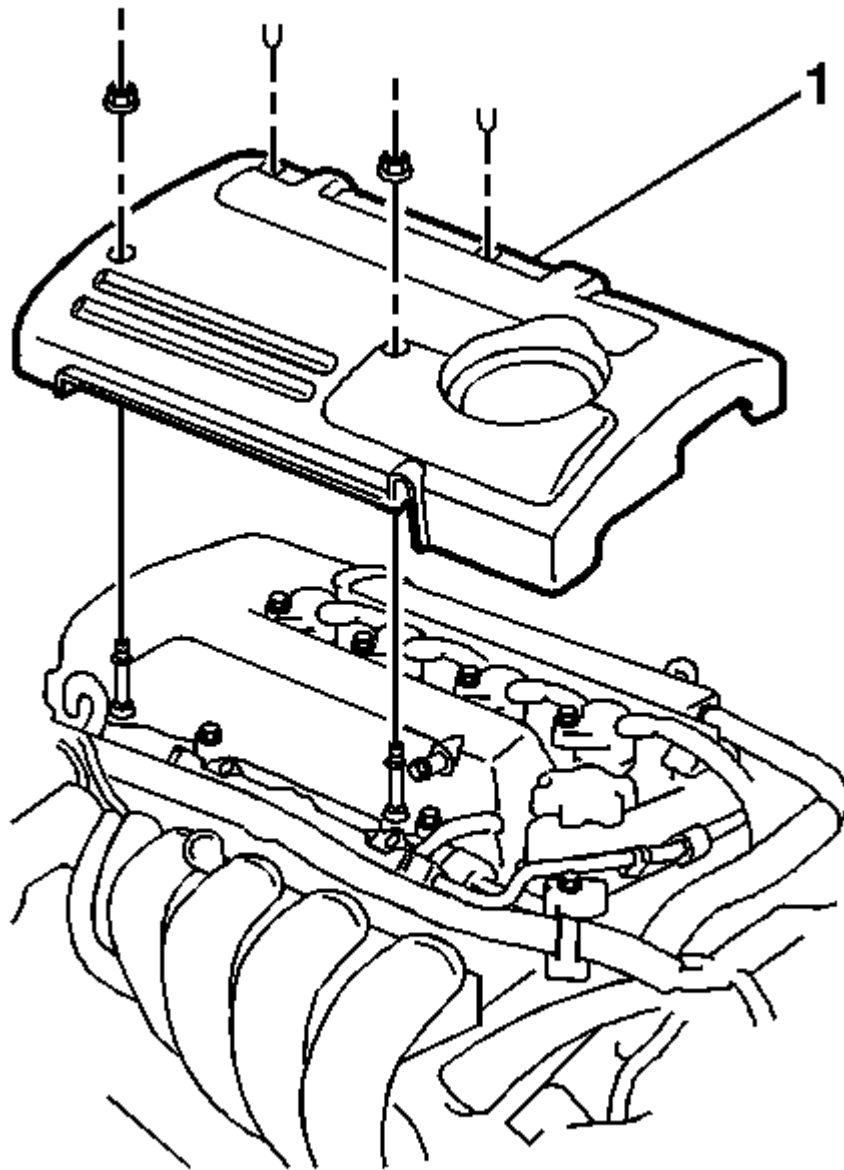


Fig. 6: View Of Engine Top Cover, Plastic Retainers & Fasteners
Courtesy of GENERAL MOTORS CORP.

17. Position the engine cover (1) to the engine.

NOTE: Refer to FASTENER CAUTION .

18. Install the 2 engine cover fasteners.

Tighten: Tighten the engine cover fasteners to 7 N.m (62 lb in).

19. Install the 2 engine cover plastic retainers.

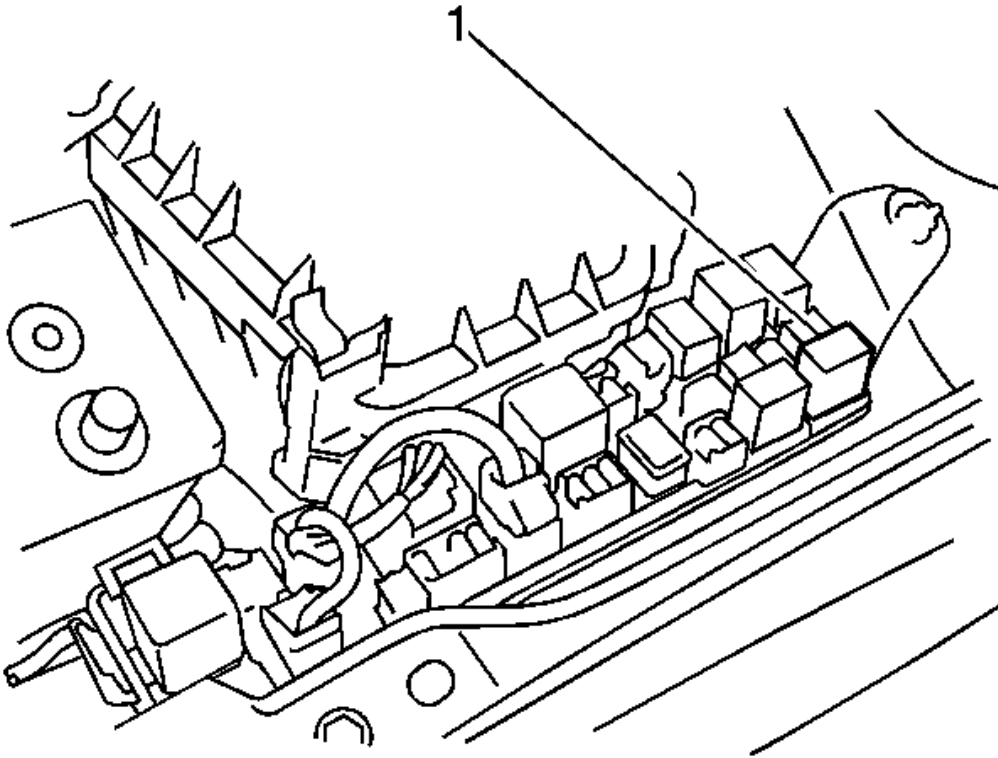


Fig. 7: Identifying EFI Main Relay
Courtesy of GENERAL MOTORS CORP.

20. Reconnect the EFI Main Relay (2) to the Fuse/Relay Block 1.
21. Inspect for the following conditions:

- Normal operation

The pistons, piston rings and valves are operating normally if the cylinder compression pressure increases quickly and evenly to the compression standard (1,300 kPa [218 psi]).

- Faulty piston rings

The following actions indicate that the piston rings are faulty:

- The cylinder compression is low on the first stroke.
- The cylinder compression increases on the following strokes but does not reach the compression standard.
- Faulty valves

The following actions indicate that the valves are faulty:

- The cylinder compression is low on the first stroke.
- The cylinder compression does not increase on the following strokes.

CYLINDER LEAKAGE TEST

Tools Required

J 35667-A Cylinder Head Leakdown Tester or equivalent

IMPORTANT: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following:

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- Incorrect valve lash/adjustment
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

Test Procedure

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

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. See **SPARK PLUG REPLACEMENT** .
3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Install the **J 35667-A** , or equivalent.

IMPORTANT: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

5. Apply shop air pressure to the and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
 - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 1.9L (2 qts) or more of engine oil within 3 200 kilometers (2,000 mi). 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 miss-fitted.

OIL PRESSURE DIAGNOSIS AND TESTING

1. Check the engine oil level.
2. Warm up and stop the engine, and then wait for 5 minutes.

IMPORTANT: Do not fill with engine oil to above the full level mark.

3. Check that the engine oil level is between the low level and full level marks on the level gauge. If low, check for leaks and add oil up to the full level mark.

4. Check the oil for deterioration, water, discoloring or thinning.

If the quality is visibly poor, replace the oil.

5. Remove the air cleaner cap sub-assembly.
6. Disconnect the oil pressure switch connector.

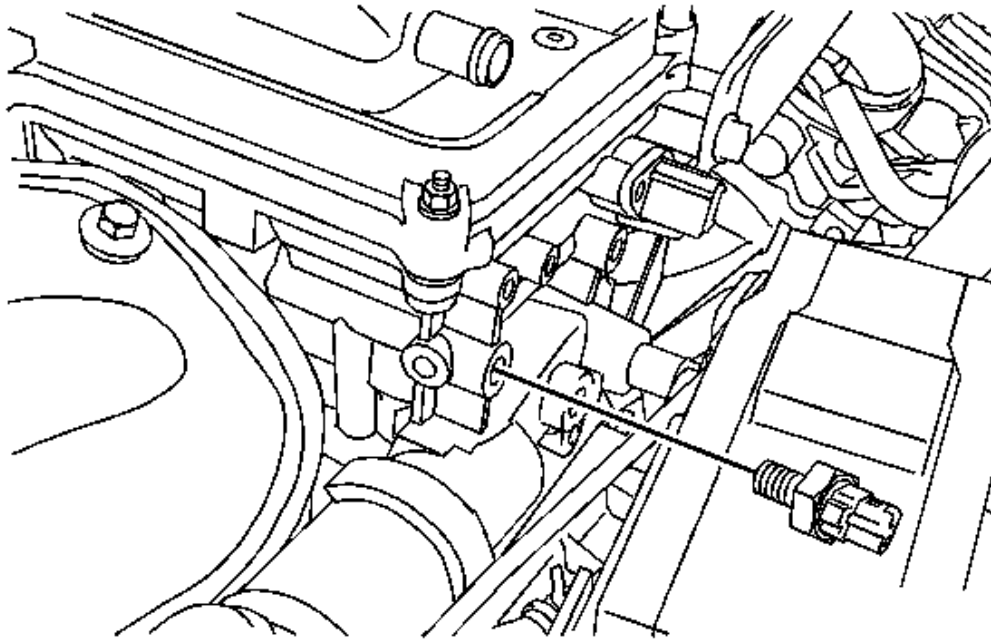


Fig. 8: View Of Oil Pressure Switch
Courtesy of GENERAL MOTORS CORP.

7. Using a 24 mm deep socket wrench, remove the oil pressure switch.

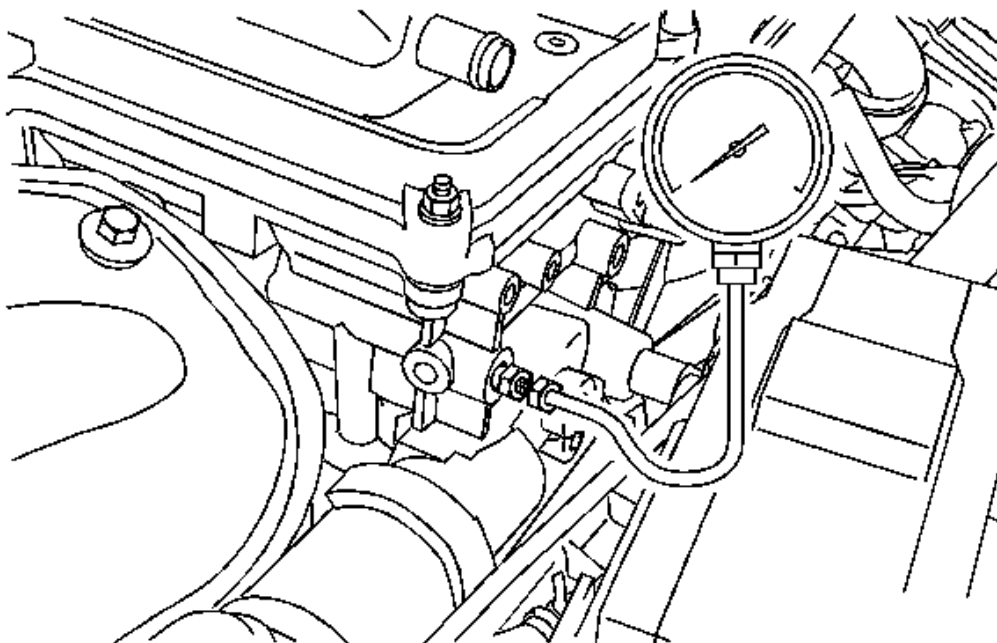


Fig. 9: View Of Oil Pressure Gauge
Courtesy of GENERAL MOTORS CORP.

8. Install the oil pressure gauge.
9. Warm up the engine.
10. Check the oil pressure.
11. If the oil pressure is not as specified, check the oil pump.
12. Remove the oil pressure gauge.

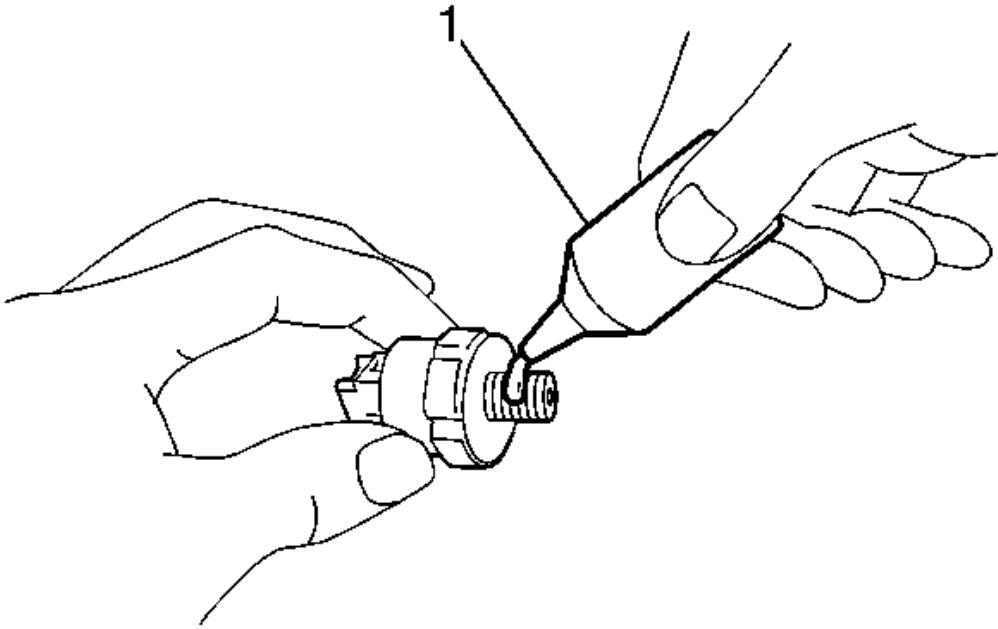


Fig. 10: Applying Adhesive To Oil Pressure Switch Threads
Courtesy of GENERAL MOTORS CORP.

13. Apply adhesive Three Bond 1344 or equivalent to 2 or 3 threads of the oil pressure switch.

NOTE: Refer to **FASTENER CAUTION** .

IMPORTANT: Do not start the engine for at least 1 hour after installation.

14. Using a 24 mm deep socket wrench, install the oil pressure switch.

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

15. Connect the oil pressure switch connector.
16. Check for engine oil leaks.
17. Install the air cleaner cap sub-assembly.

OIL LEAK DIAGNOSIS

Use one of the following methods in order to locate a fluid oil leak.

Finding the Leak

1. Determine if the fluid is one of the following types:
 - Engine oil
 - Automatic transmission fluid
 - Power steering fluid
2. Use the following steps in order to determine the location of the fluid leak:
 1. Run the vehicle at normal operating temperature.
 2. Park the vehicle over a large sheet of paper.
 3. After several minutes, observe the drops of fluid that fall on the paper.

Use the drops on the paper in order to determine the location of the leak.

3. Visually inspect around the suspected component.

Inspect around the gasket mating surfaces for leaks.

Use a mirror in order to find leaks in areas that are difficult to reach.

4. If you cannot locate the leak, use one of the following items in order to clean the suspected area:
 - A degreaser
 - Steam
 - A spray solvent
5. Thoroughly dry the area.
6. Operate the vehicle for several miles at normal operating temperature and varying speeds.
7. Visually inspect the suspected component.

If you still cannot locate the leak, use the powder method or the black light and dye method in order to locate the leak.

Powder Method

Perform the following steps in order to diagnose the leak:

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component.

Trace the leak path over the white powder surface to the source.

Tools Required

- **J 28428-E** High Intensity Black Light
- **J 28431-6** Fluorescent Oil Additive

Black Light and Dye Method

IMPORTANT: Follow the manufacturer's instructions that are included with the J 28431-6 .

1. Pour the specified amount of **J 28431-6** into the leaking component.

Refer to the manufacturer's instructions for the proper amount of oil additive.

2. Operate the vehicle under normal operating conditions.
3. Shine the **J 28428-E** onto the suspected area.

The **J 28431-6** fluid will appear as a yellow path leading to the source of the oil leak.

Repairing the Leak

After you find the source of the leak, determine the cause of the leak. This action will enable you to properly repair the faulty component.

Gaskets

Inspect for a bent sealing flange. Repair the surface if the sealing flange is bent. A new gasket will not repair the leak.

Inspect for the following conditions before repairing a leak:

- An incorrect fluid level
- High pressure
- Malfunctions in the crankcase ventilation system
- Improperly tightened fasteners
- Dirty or damaged threads on the fasteners
- Warped flanges or sealing surfaces
- Scratches, burrs or other damage to the sealing surface
- A damaged or worn gasket
- Cracking or porosity of the component
- An improper sealant

Seals

Inspect for the following conditions before repairing a leak:

- An incorrect fluid level
- High pressure
- Malfunctions in the crankcase ventilation system

- Any of the following conditions on the seal bore:
 - Scratches
 - Burrs
 - Nicks
- A damaged or worn seal
- Improper installation
- A cracked component
- Inspect the shaft surface for the following conditions:
 - Scratches
 - Nicks
 - Damage
- A loose or worn bearing

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

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

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

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

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

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

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

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

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

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

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

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

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

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

Step	Action	Yes	No
NOTE: Refer to <u>FASTENER CAUTION</u> . DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp. 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. DEFINITION: The following items are indications of drive belt whine: • A high pitched continuous noise.			

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- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <u>Drive Belt Replacement</u>. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to <u>Symptoms - Engine Mechanical</u>	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. 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 20	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 20	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 20	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	NOTE: Refer to <u>FASTENER CAUTION</u> . 1. Tighten any loose fasteners. 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition? If diagnosing a whine noise and the condition still		

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	exist, proceed to Diagnostic Aids.	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the 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.

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

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

Test Description

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

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

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

4: Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs

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of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

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

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

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

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

Step	Action	Yes	No
NOTE: Refer to <u>FASTENER CAUTION</u> .			
DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle • Heard once per revolution of the drive belt or a pulley • Rumbling may be caused from: ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. Refer to <u>Drive Belt Replacement</u> . 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to <u>Symptoms - Engine Mechanical</u>	Go to Step 4

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4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
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 belts. Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> 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 Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	NOTE: Refer to <u>FASTENER CAUTION</u> . 1. Tighten any loose fasteners. 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	-
11	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS**Diagnostic Aids**

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

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

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

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

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

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

Test Description

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

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

4: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

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

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

7: 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.

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

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

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

Step	Action	Yes	No
NOTE: Refer to <u>BELT DRESSING CAUTION</u> .			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt.		

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	Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	NOTE: Refer to <u>FASTENER CAUTION</u> . 1. Tighten any loose fasteners. 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>FASTENER CAUTION</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

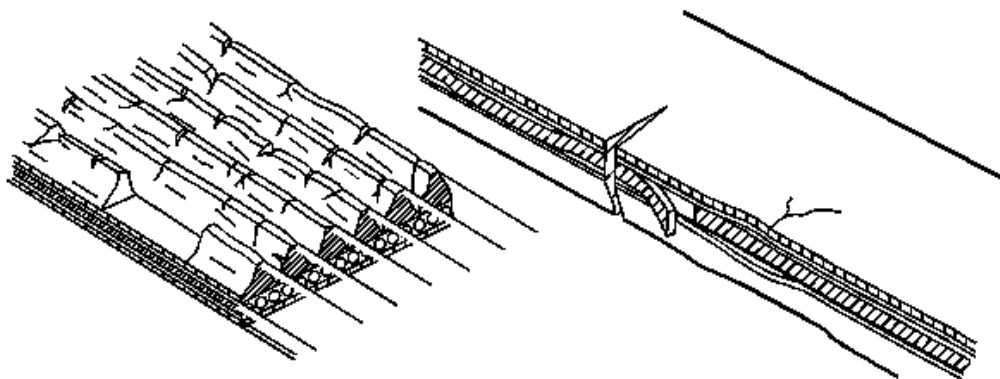
On-Vehicle Inspection

Fig. 11: View Of V-Ribbed Belt
Courtesy of GENERAL MOTORS CORP.

1. Check V-ribbed belt.
2. Check the belt for wear, cracks, or other signs of damage.
 - If any of the following defects is found, replace the V-ribbed belt:
 - The belt is cracked
 - The belt is worn out to the extent that cords are exposed
 - The belt has chunks missing from the ribs

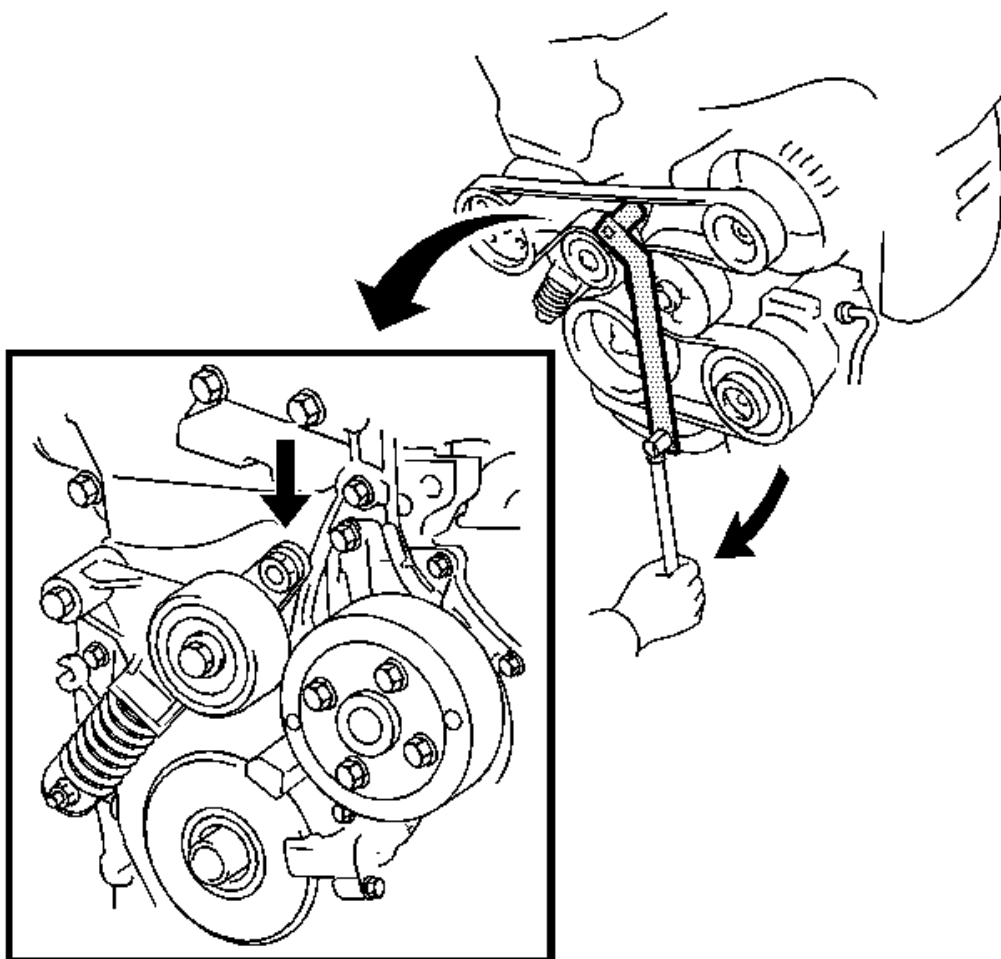


Fig. 12: Checking That Belt Fits Properly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Check by hand to confirm that the belt has not slipped out of the groove on the bottom to the pulley. If it has slipped out, replace the V-ribbed belt. Install a new V-ribbed belt correctly.

3. Check that the belt fits properly in the ribbed grooves.

Removal Procedure

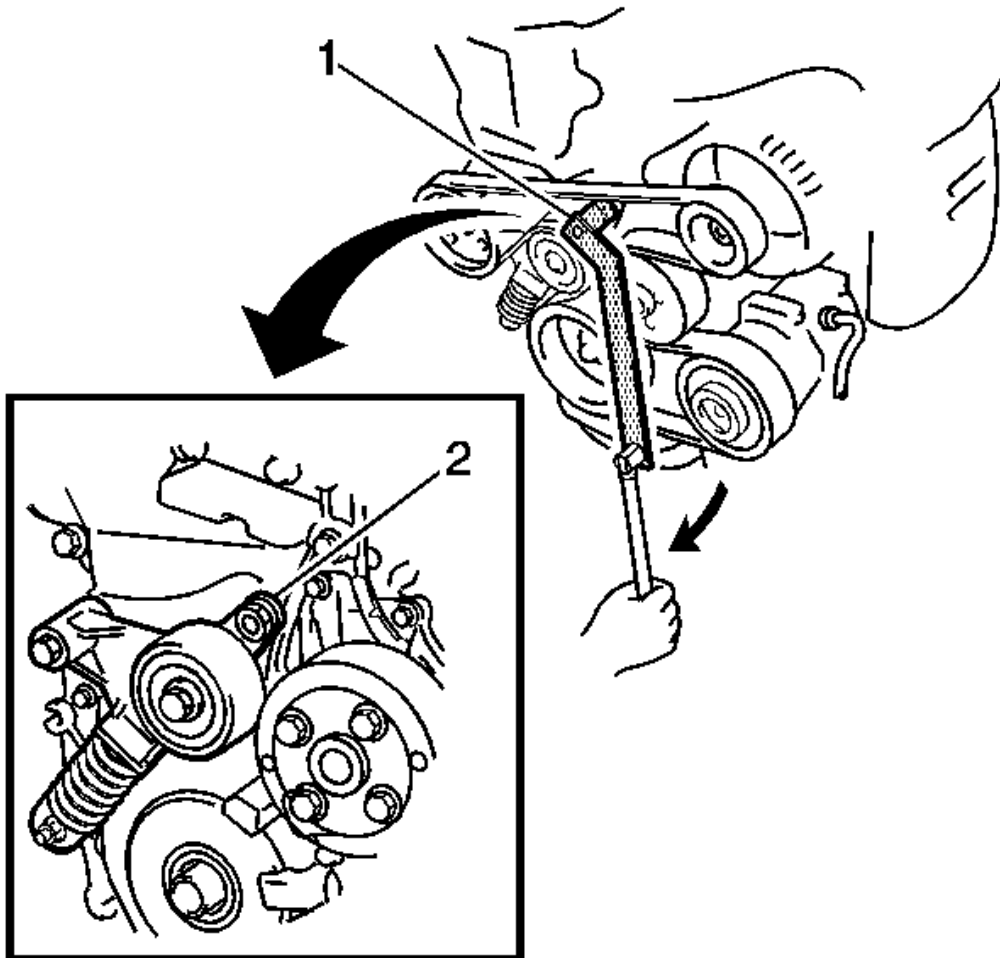


Fig. 13: View Of Belt Removal/Installation
 Courtesy of GENERAL MOTORS CORP.

1. Remove engine under cover RH.
2. Remove V-ribbed belt.
3. Using SST, slowly turn the V-ribbed belt tensioner clockwise. (SST 09216-42010 (09216-04010))

NOTE: Make sure that SST and other tools are set to the tensioner securely. When compressing the V-ribbed belt tensioner, slowly turn the tensioner. Be careful not to pinch your fingers between the parts.

4. Remove the V-ribbed belt from each pulley and slowly return the tensioner.

Installation Procedure

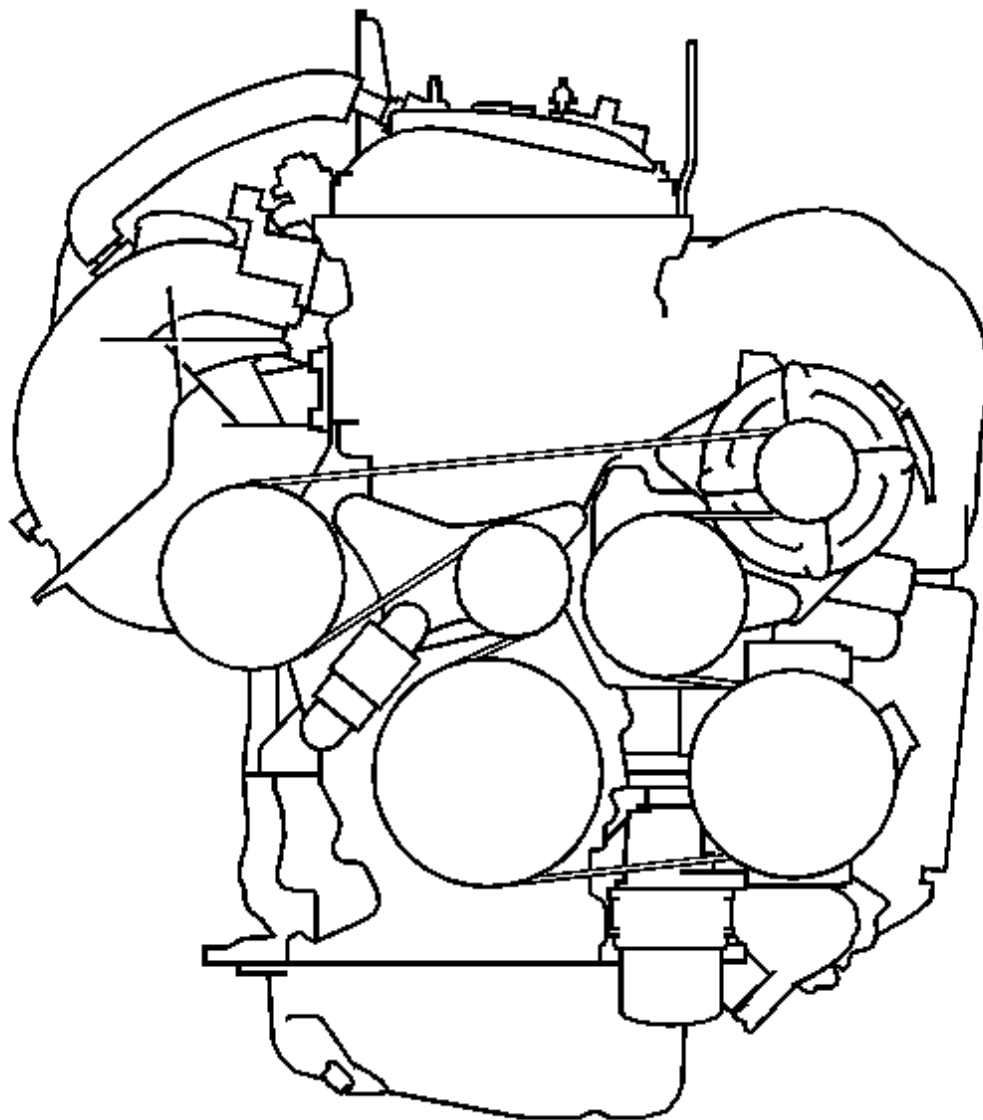


Fig. 14: View Of Belt Routing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: V-ribbed belt layout.

1. Install V-ribbed belt.

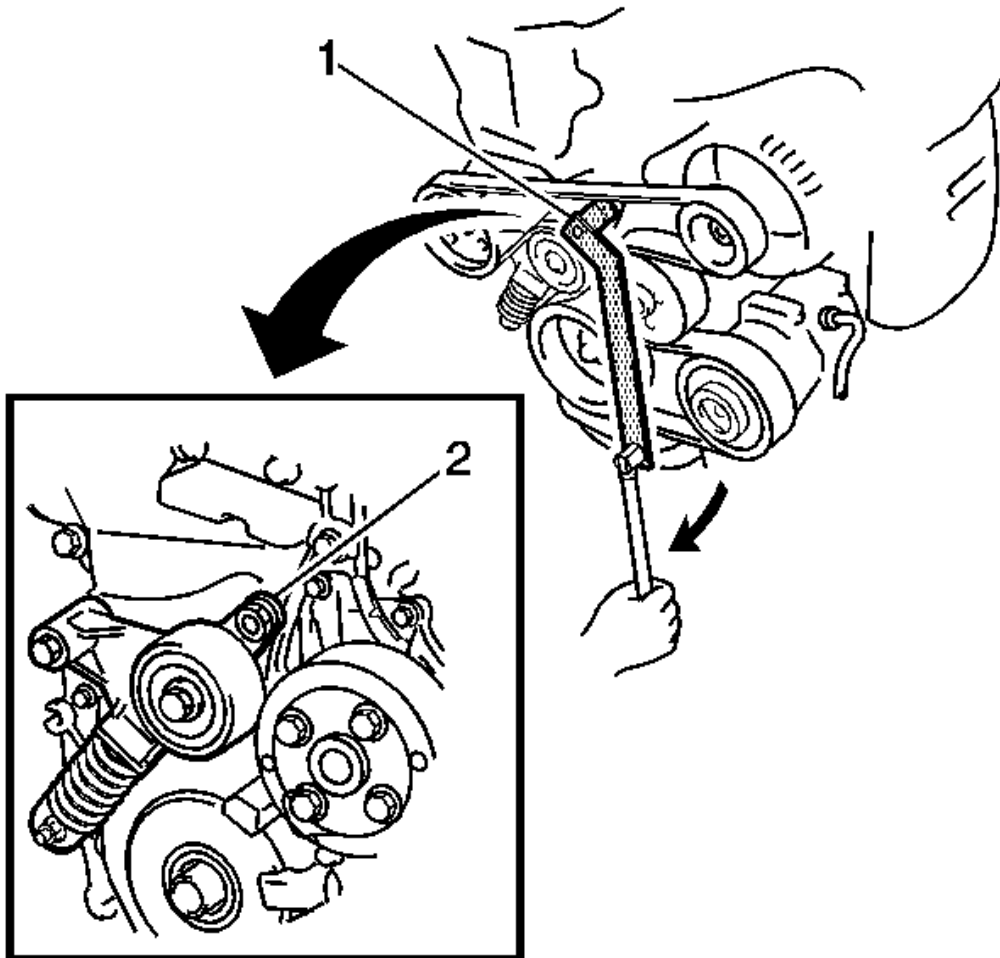


Fig. 15: View Of Belt Removal/Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: Make sure that SST and other tools are set to the tensioner securely. When compressing the V-ribbed belt tensioner, slowly turn the tensioner.

2. Using SST, slowly turn the V-ribbed belt tensioner EM clockwise and install the V-ribbed belt. (SST 09216-42010 (09216-04010))
3. Install engine under cover RH.

ENGINE SUPPORT FIXTURE

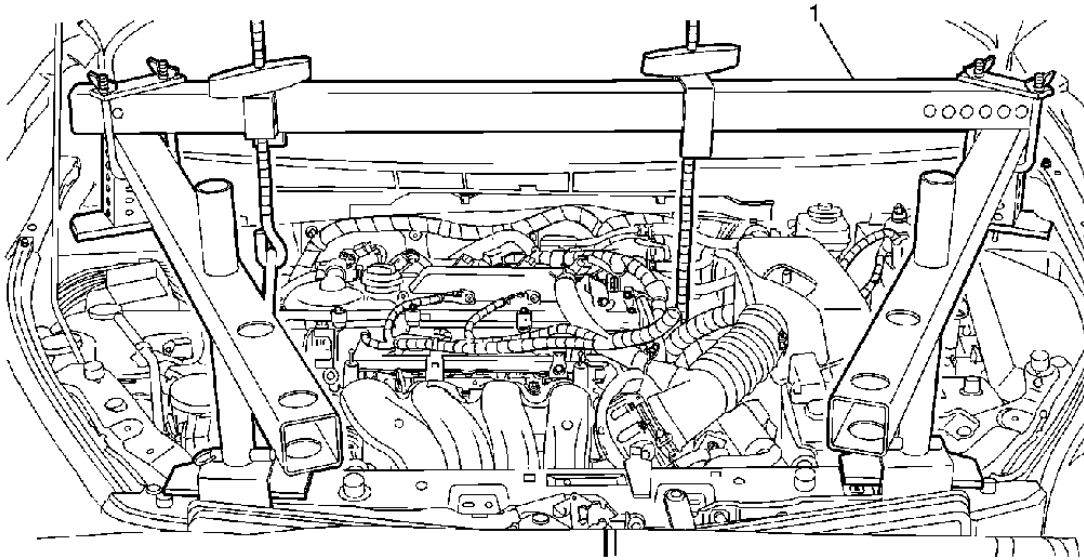


Fig. 16: View Of Engine Support Fixture
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Assemble the Engine Support Fixture. Tip: As shown in the illustration. Special Tools • J-28467-B: Universal Engine Support Fixture • J-28467-4: Engine Support Bracket • J-36462-A: Engine Support Adapter Leg Set • J-36857: Engine Lift Bracket

ENGINE MOUNT INSPECTION

IMPORTANT: 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.

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. Check the engine mount fastener torque.

ENGINE MOUNT REPLACEMENT**Removal Procedure**

WARNING: Refer to Battery Disconnect Warning

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection And Connection .

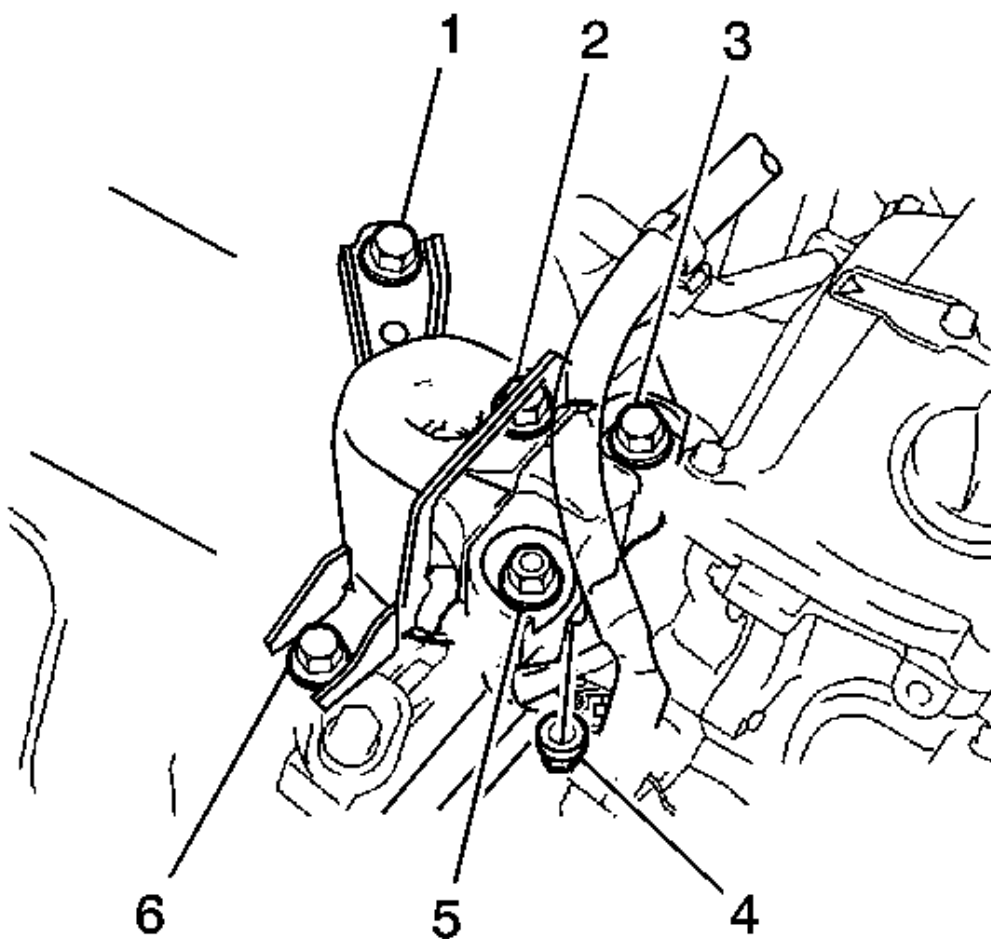


Fig. 17: Identifying Engine Mounts & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not apply excessive force to the return tube when removing the right engine mounting insulator sub-assembly.

NOTE: Keep clearance by lowering the engine using the engine support fixture when removing the front engine mounting insulator.

2. Install the engine support fixture. Refer to Engine Support Fixture.
3. Remove the 4 bolts (1, 2, 3, 6) and 2 nuts (4, 5), then remove the right engine mounting insulator.

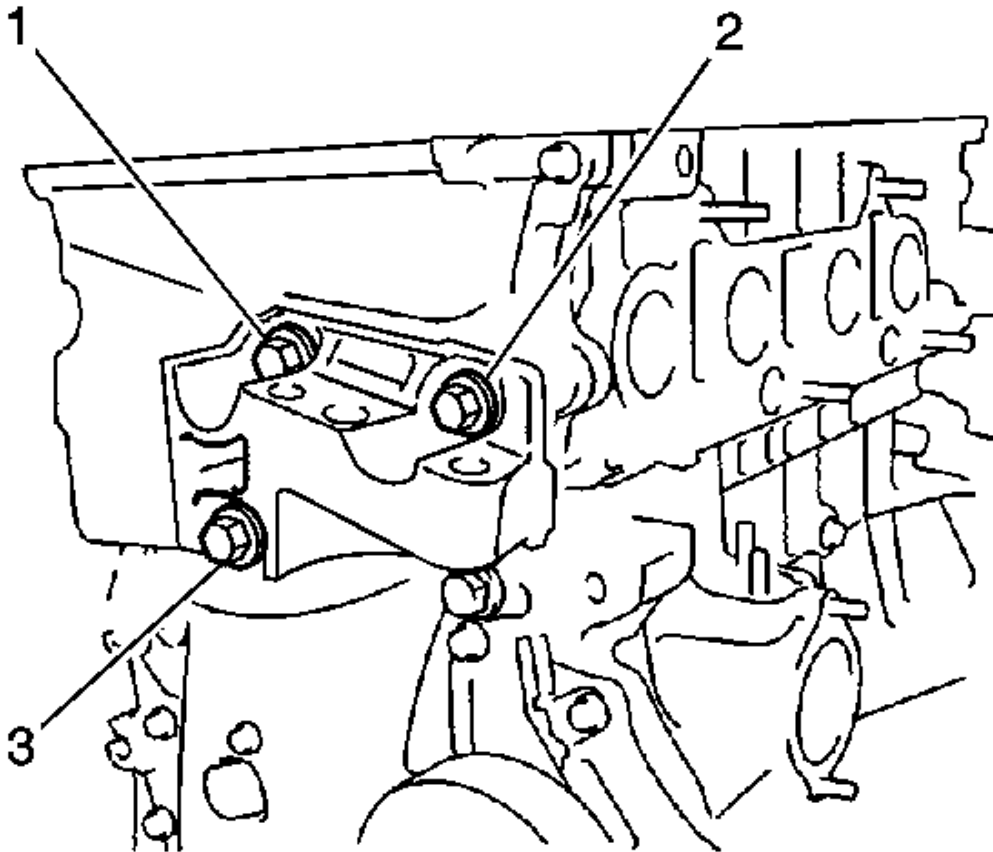


Fig. 18: Identifying Engine Mounts Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the 3 bolts (1, 2, 3) and transverse engine mounting bracket.

Installation Procedure

CAUTION: Refer to Fastener Caution

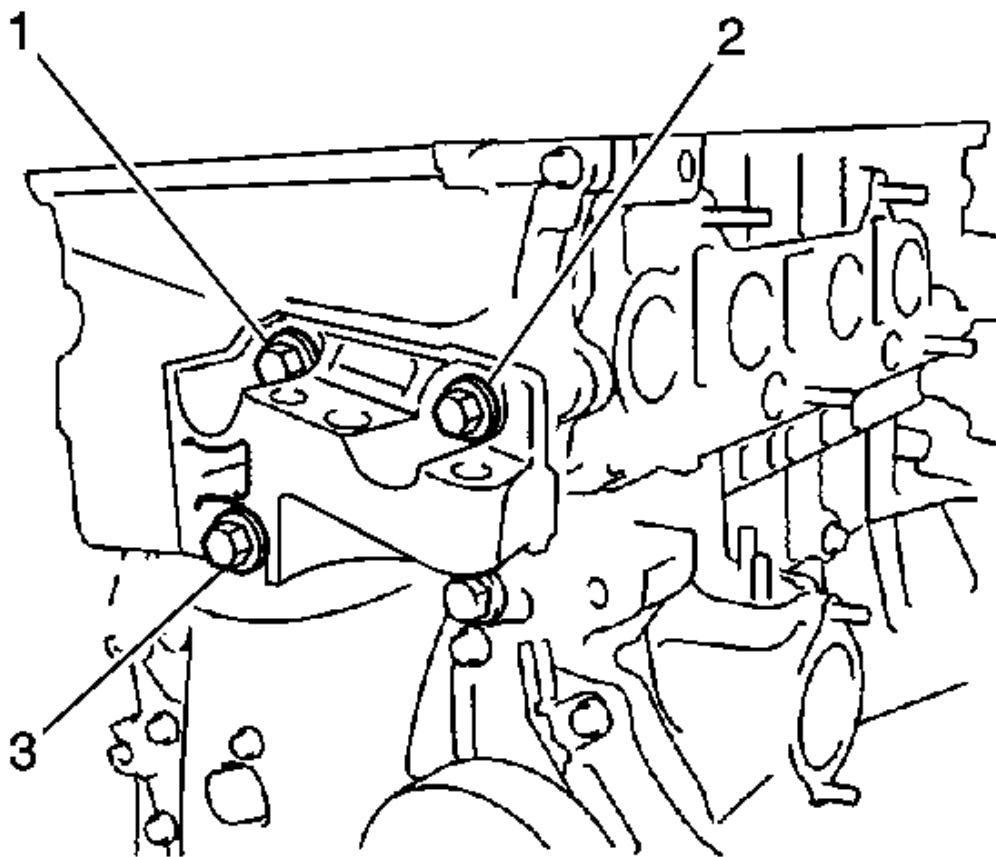


Fig. 19: Identifying Engine Mounts Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the engine transverse engine mounting bracket with the 3 bolts (1, 2, 3) and tighten to **55 N.m (41 lb ft)**.

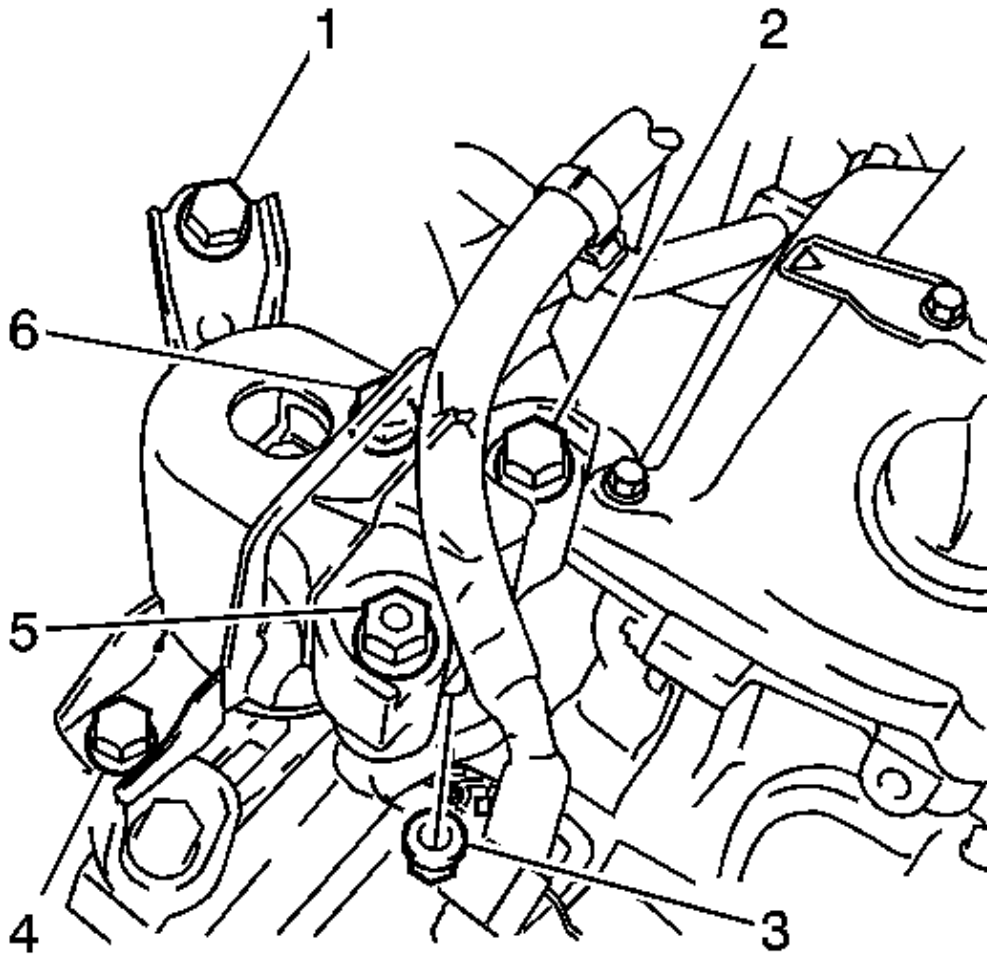


Fig. 20: View Of Right Engine Mounting Insulator Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

2. Install the right engine mounting insulator sub-assembly with the 4 bolts (1, 2, 4, 6) and 2 nuts (3, 5) and tighten
 - Bolts 1, 4 and 6 to **52 N.m (38 lb ft)**
 - Bolt 2 to **95 N.m (70 lb ft)**
 - Nut 5 to **95 N.m (70 lb ft)**
 - Nut 3 to **52 N.m (38 lb ft)**
3. Remove the engine support fixture.
4. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection And Connection** .

ENGINE BLOCK HEATER REPLACEMENT

Removal Procedure

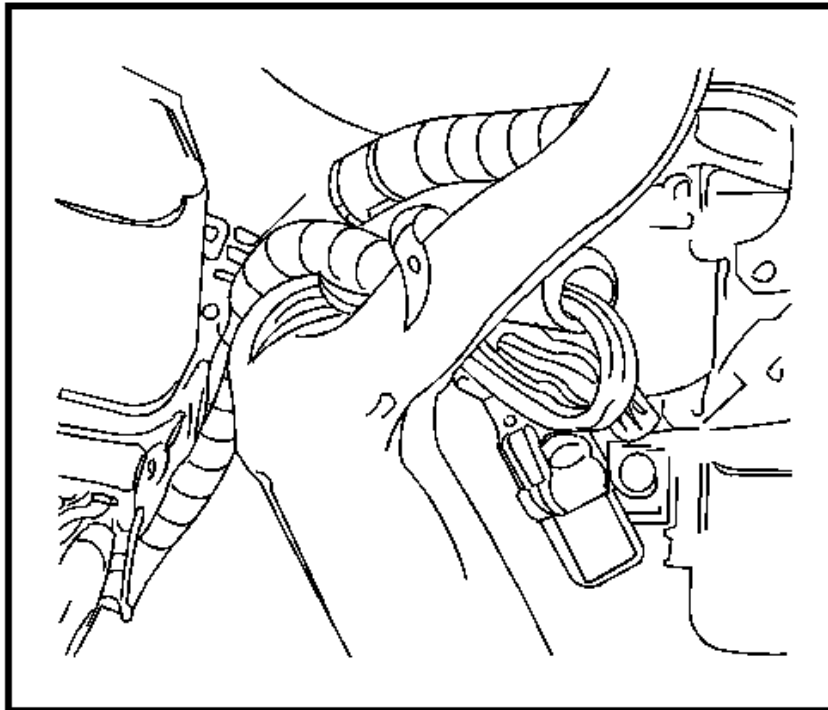
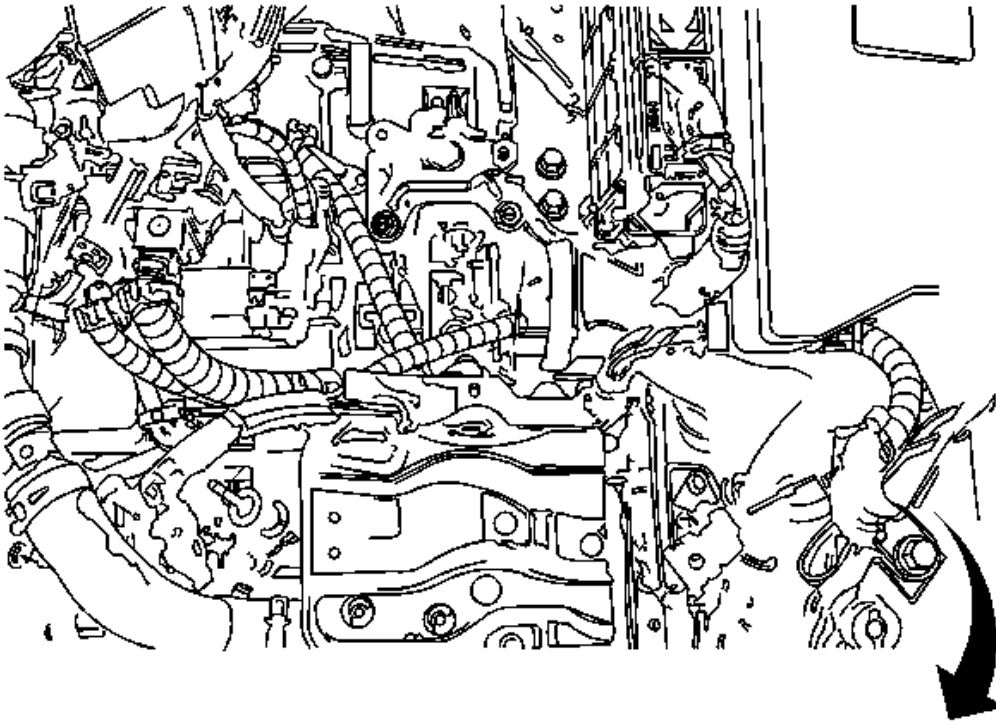


Fig. 21: Identifying Engine Block Heater Harness Plug Bundle
Courtesy of GENERAL MOTORS CORP.

1. Unclip the engine block heater harness plug bundle from the air inlet attachment flange.

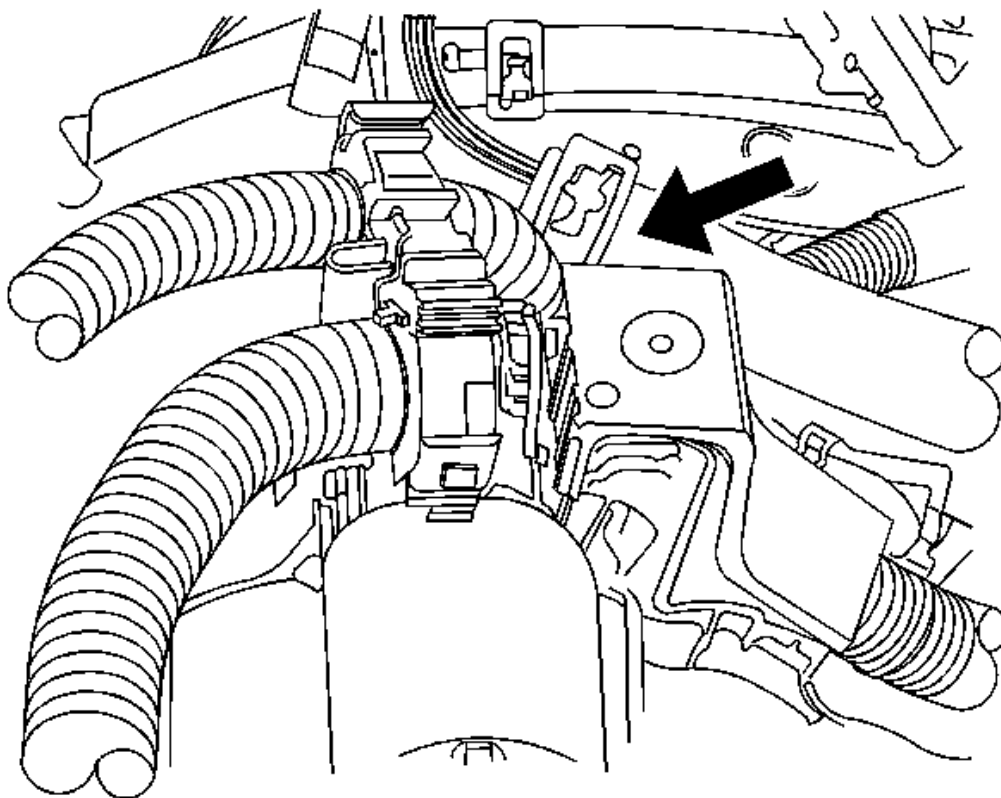


Fig. 22: Identifying Engine Block Heater Harness Retainer
Courtesy of GENERAL MOTORS CORP.

2. Detach the engine block heater harness retainer from the engine harness.

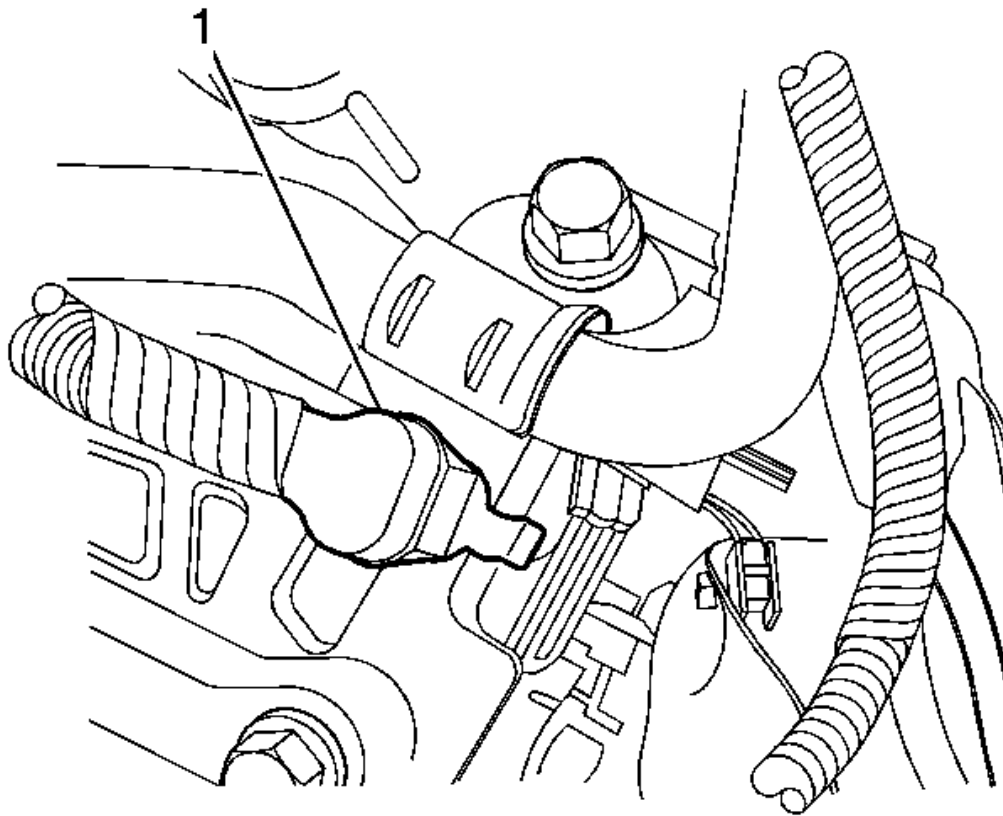


Fig. 23: Locating Engine Block Heater Element Retaining Clip
Courtesy of GENERAL MOTORS CORP.

3. Disengage the engine block heater element retaining clip from the engine block and remove the engine block heater assembly.

Installation Procedure

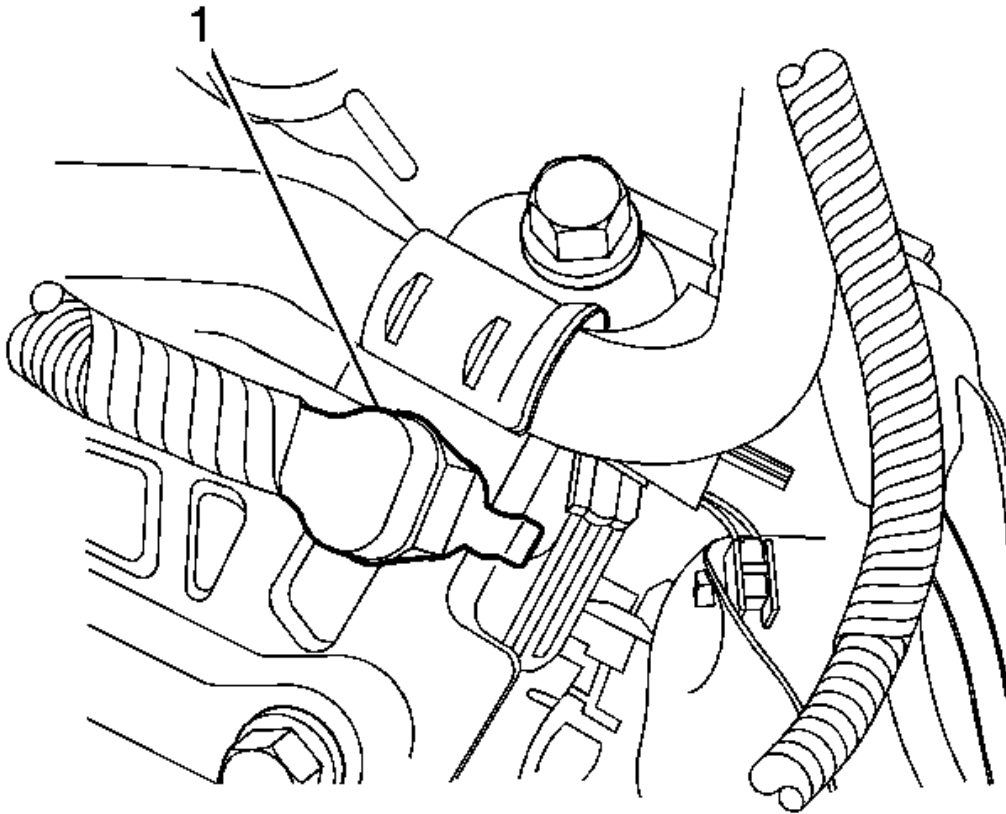


Fig. 24: Locating Engine Block Heater Element Retaining Clip
Courtesy of GENERAL MOTORS CORP.

NOTE: Visually inspect that the engine block heater harness plug is fully seated onto the element. Ensure the heating element is fully inserted into the engine block and the retaining clip is engaged. An audible click will be heard when clip is locked in position.

1. Completely insert the engine block heater element into the engine block cavity in the nine o'clock position.

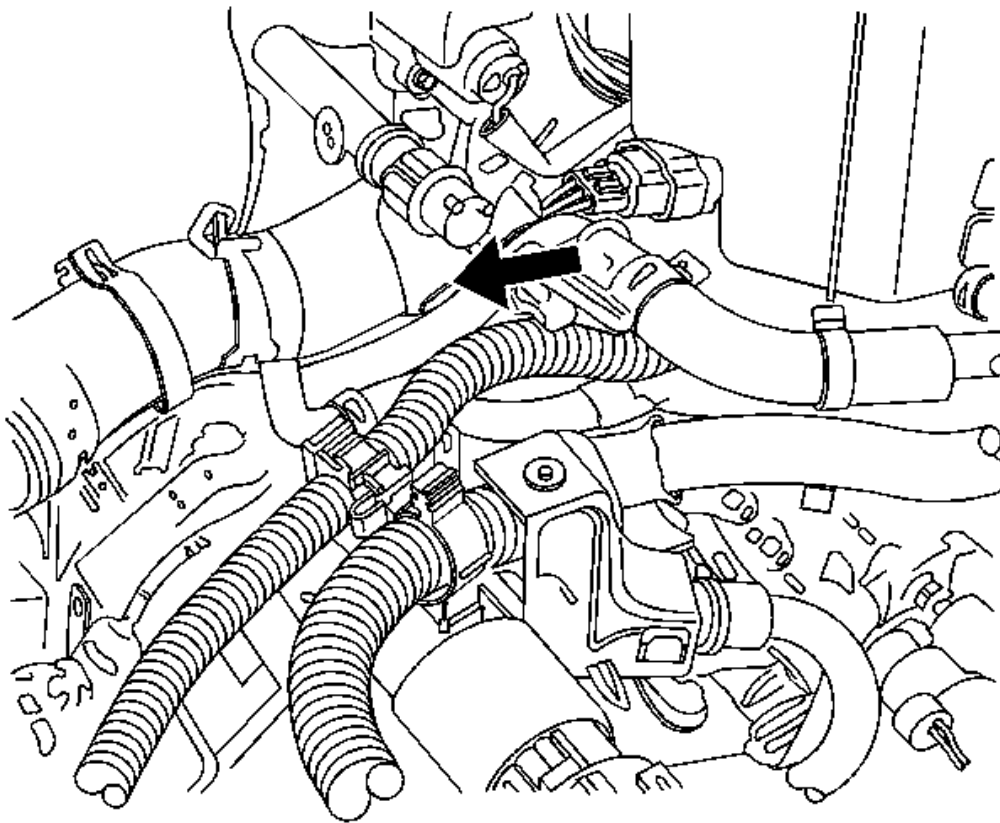


Fig. 25: Identifying Engine Block Heater Routing
Courtesy of GENERAL MOTORS CORP.

2. Route block heater harness below the heater hose.

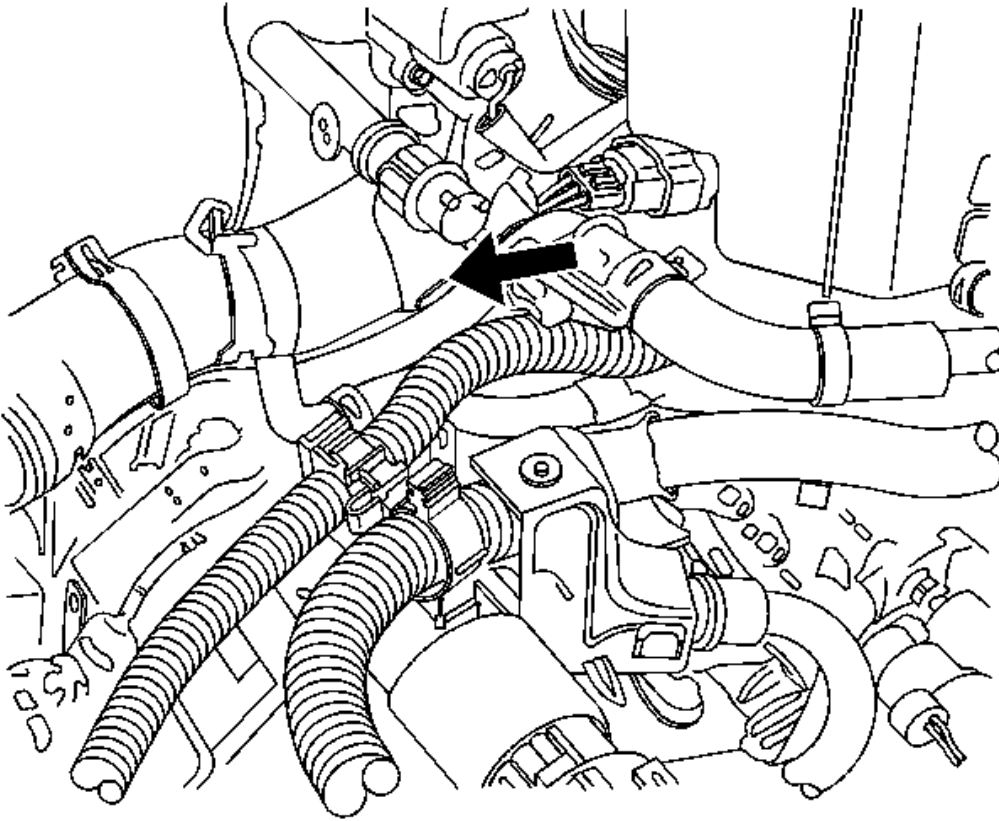


Fig. 26: Identifying Engine Block Heater Routing
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the engine block heater harness clip is fully attached to the conduit of the engine harness. An audible click will be heard when fully seated.

3. Attach the engine block heater harness forward of the engine harness protector.

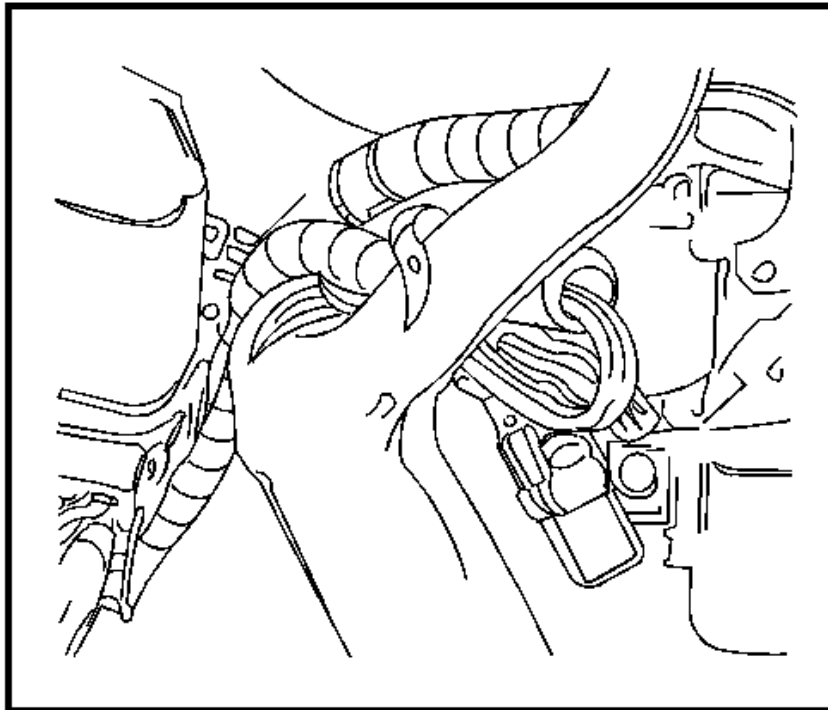
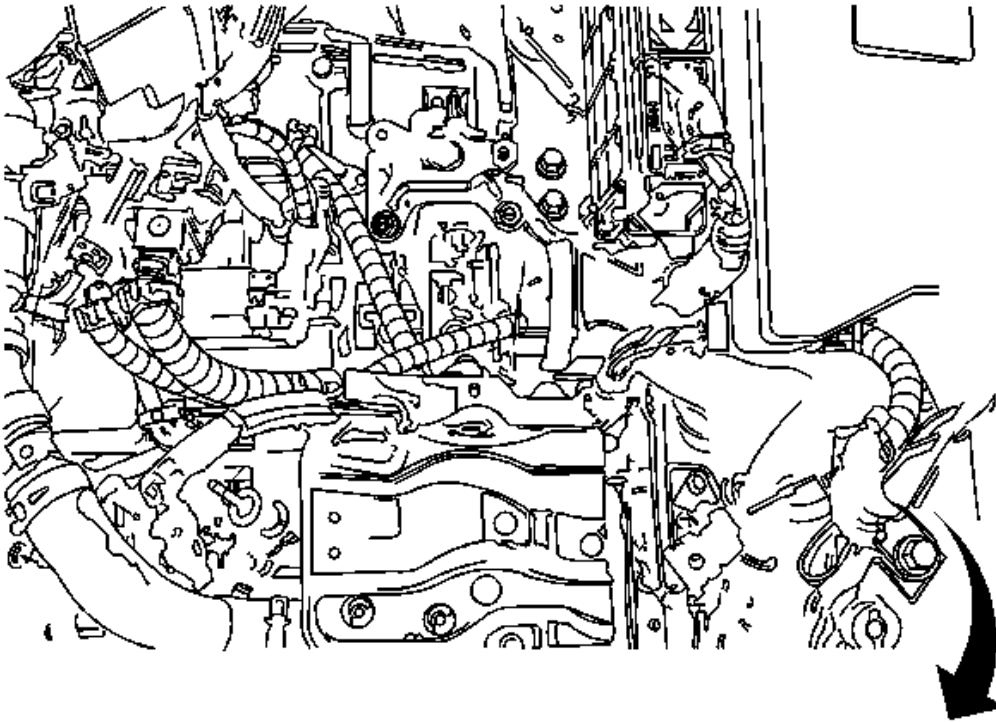


Fig. 27: Identifying Engine Block Heater Harness Plug Bundle
Courtesy of GENERAL MOTORS CORP.

4. Route the engine block heater harness below the battery tray bracket and along the battery harness.
5. Route the engine block heater harness rearward and behind the air inlet. Bring harness upward along the air inlet.

NOTE: **When installation is completed, ensure the engine block heater harness plug bundle is stowed between the air inlet and the fender.**

6. Clip the engine block heater harness plug bundle to the air inlet attachment flange close to the neck.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Discharge fuel system pressure.

CAUTION: Refer to BATTERY DISCONNECT WARNING .

2. Disconnect the cable from negative battery terminal.
3. Remove the front wiper arm head cap.
4. Remove the left front wiper arm and blade assembly.
5. Remove the right front wiper arm and blade assembly.
6. Remove the hood to cowl top seal.
7. Remove the right cowl top ventilator louver.
8. Remove the left cowl top ventilator louver.
9. Remove the windshield wiper motor and link assembly.
10. Remove the outer cowl top panel.
11. Remove the suspension tower damper assembly (with front strut bar).
12. Remove the engine cover sub-assembly.
13. Drain the engine coolant.
14. Remove the air cleaner cap sub-assembly with hose.
15. Remove the throttle body assembly.
16. Disconnect the fuel main tube.
17. Disconnect the No. 2 ventilation hose.
18. Remove the fuel delivery pipe sub-assembly.

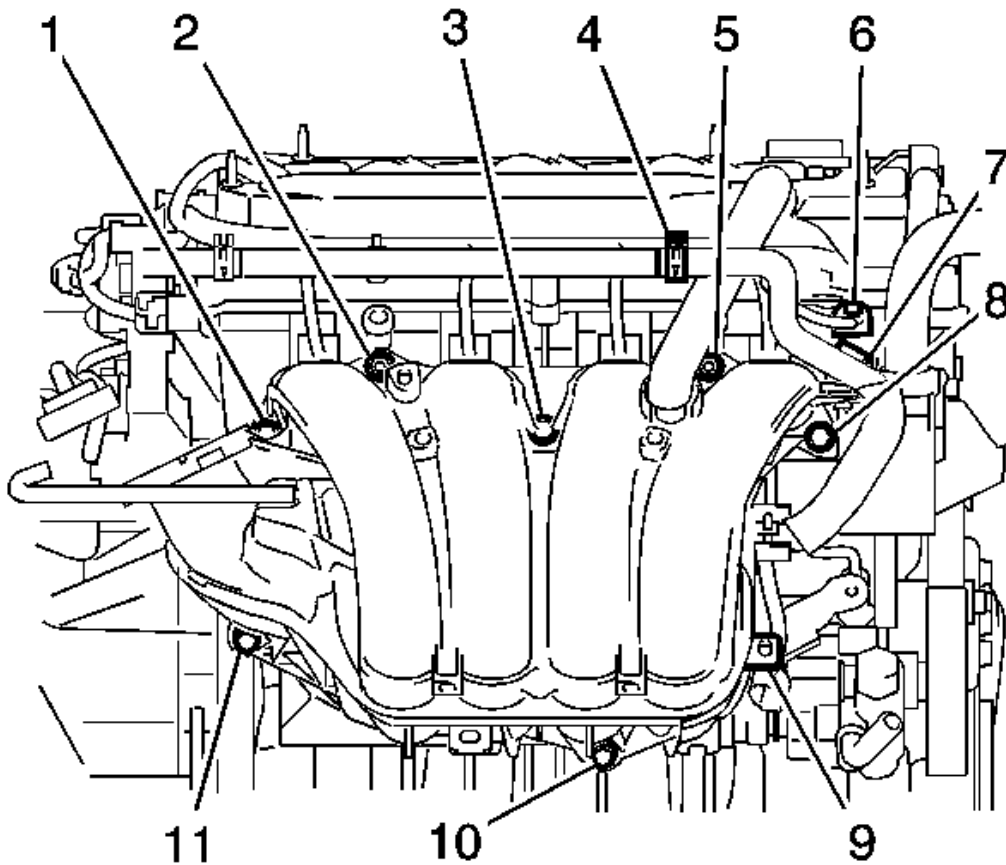


Fig. 28: View Of Intake Manifold, Bolts & Nuts Loosening/Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

19. Remove the intake manifold.
20. Disconnect the union to check valve hose from the brake booster.
21. Disconnect the camshaft timing oil control valve connector.
22. Remove the wire harness clamp.
23. Remove the union to check valve hose from the vacuum hose clamp.
24. Remove the 5 bolts, 2 nuts and intake manifold.

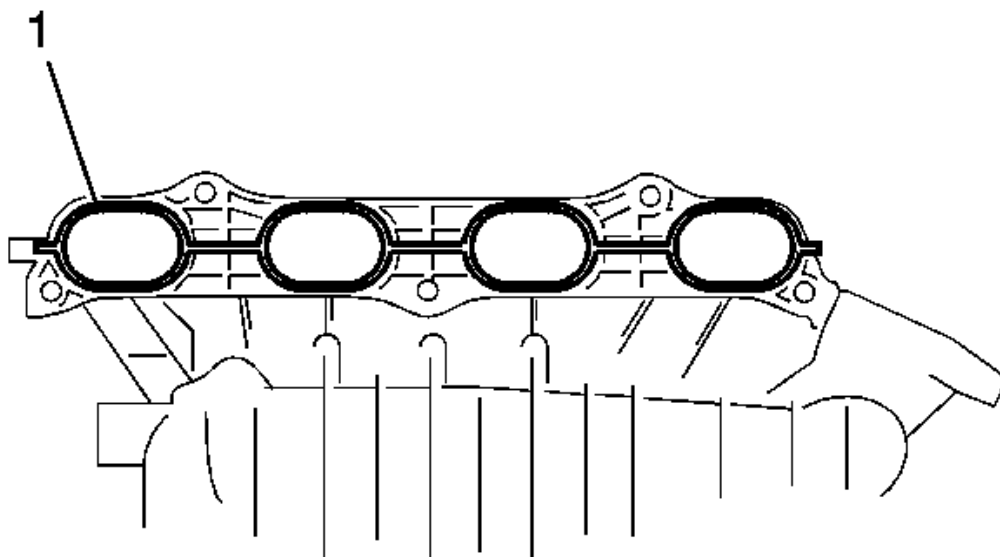


Fig. 29: View Of Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

25. Remove the gasket from the intake manifold.

Installation Procedure

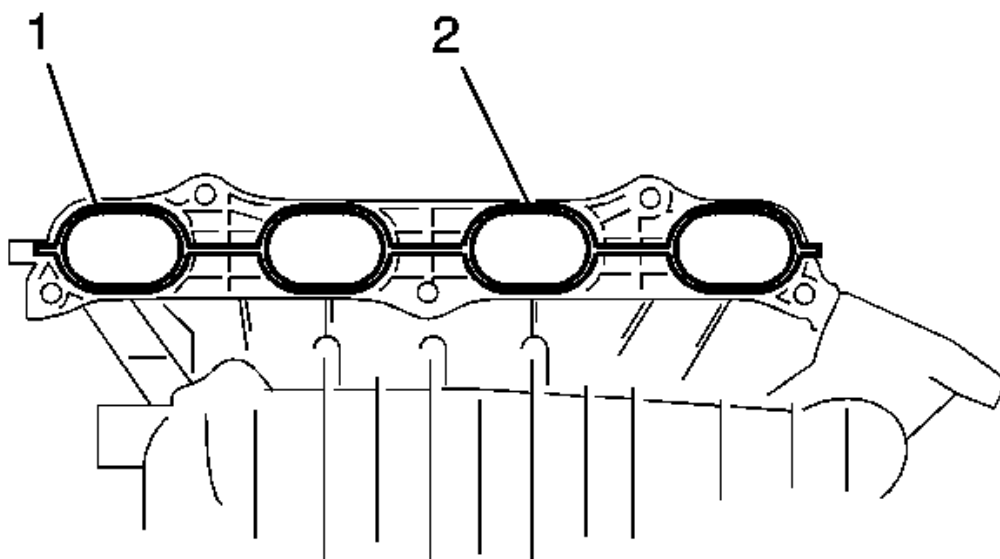


Fig. 30: Identifying Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold.
2. Install a new gasket into the intake manifold.

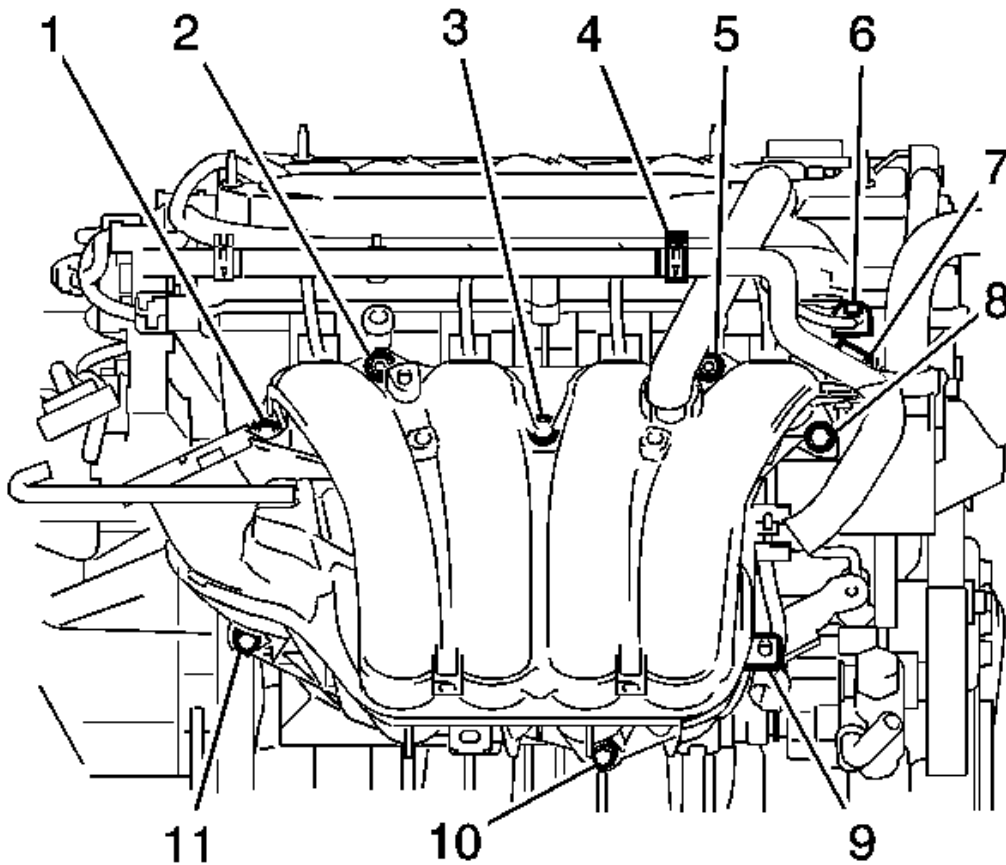


Fig. 31: View Of Intake Manifold, Bolts & Nuts Loosening/Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

3. Install the intake manifold with the 5 bolts and 2 nuts.

Tighten: Tighten the intake manifold 5 bolts and 2 nuts to 30 N.m (22 lb ft).

4. Fit the union to check valve hose into the vacuum hose clamp.
5. Install the wire harness clamp.
6. Connect the camshaft timing oil control valve connector.
7. Connect the union to check valve hose to the brake booster.
8. Install fuel delivery pipe sub-assembly.
9. Connect No. 2 ventilation hose.

10. Connect the fuel main tube.
11. Install the throttle body assembly.
12. Install the air cleaner cap sub-assembly with hose.
13. Connect the cable to negative battery terminal.
14. Add the engine coolant.
15. Inspect for coolant leak.
16. Inspect for fuel leak.
17. Install the engine cover sub-assembly.
18. Install the suspension tower damper assembly (with front strut bar).
19. Install the outer cowl top panel.
20. Install the windshield wiper motor and link assembly.
21. Install the left cowl top ventilator louver.
22. Install the right cowl top ventilator louver.
23. Install the hood to cowl top seal.
24. Install the right front wiper arm and blade assembly.
25. Install the left front wiper arm and blade assembly.
26. Install the front wiper arm head cap.

INTAKE CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

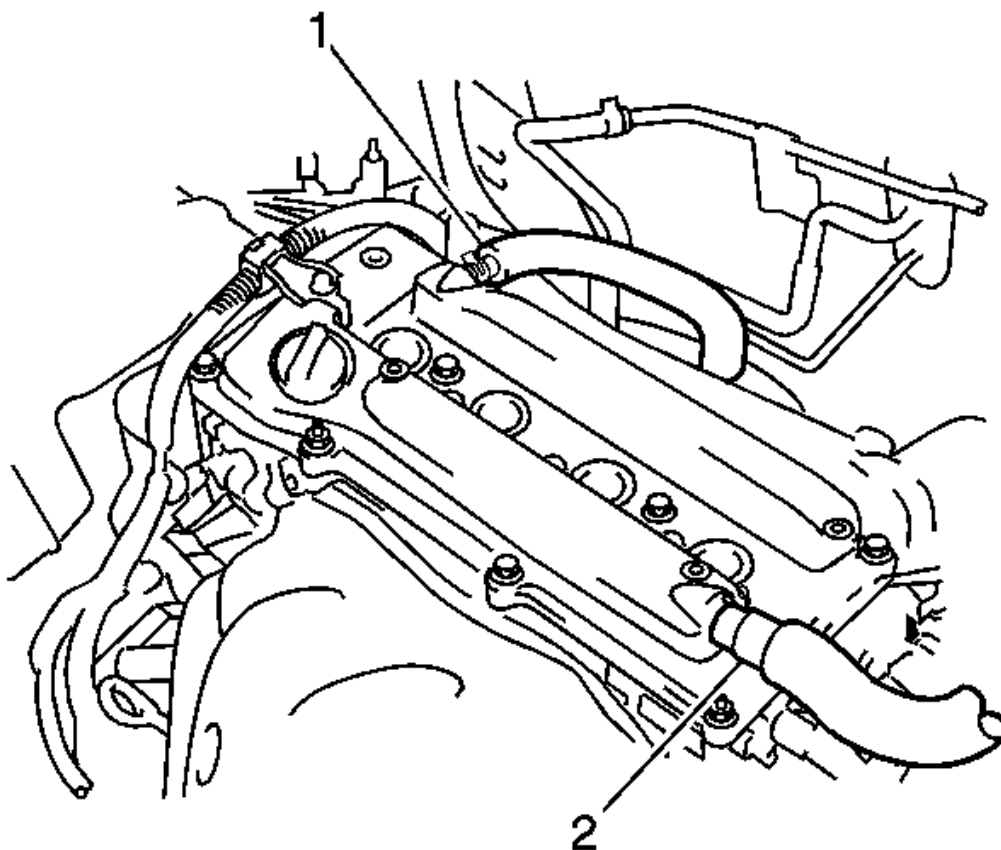


Fig. 32: View Of Engine Cover Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the right engine under cover.
2. Remove No. 1 engine cover sub-assembly.
3. Remove ignition coil assembly.
4. Remove spark plug. See **SPARK PLUG REPLACEMENT** .
5. Remove cylinder head cover sub-assembly. Remove the 2 ventilation hoses from the cylinder head cover sub-assembly.

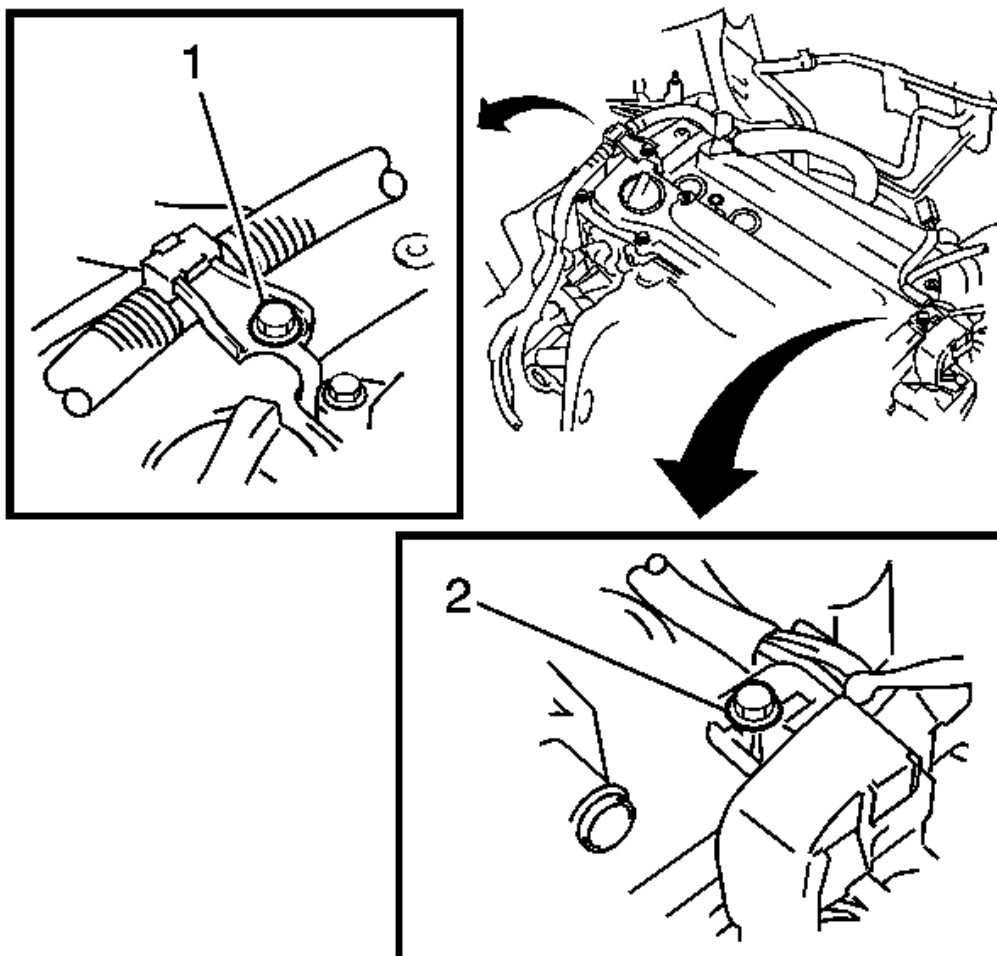


Fig. 33: View Of Wire Harness Brackets
Courtesy of GENERAL MOTORS CORP.

6. Remove the 2 bolts and separate the 2 wire harness brackets.

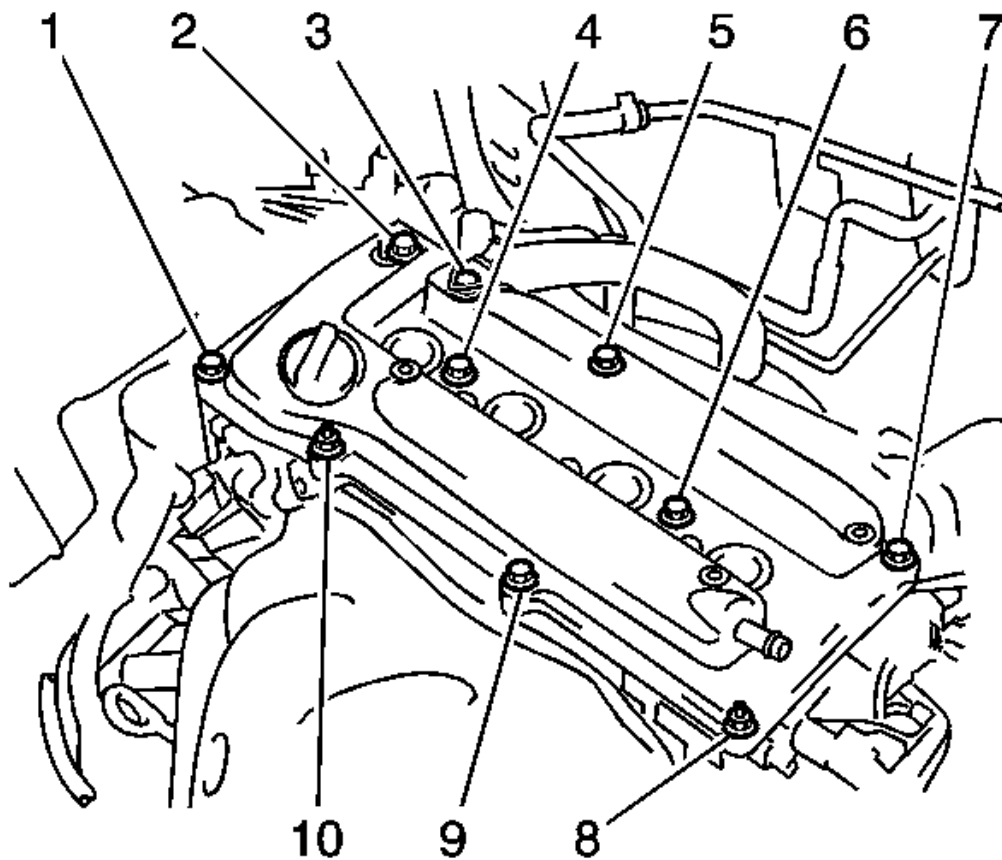


Fig. 34: Identifying Cylinder Head Cover Sub-Assembly Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the 8 bolts and 2 nuts, then remove the cylinder head cover sub-assembly and gasket.

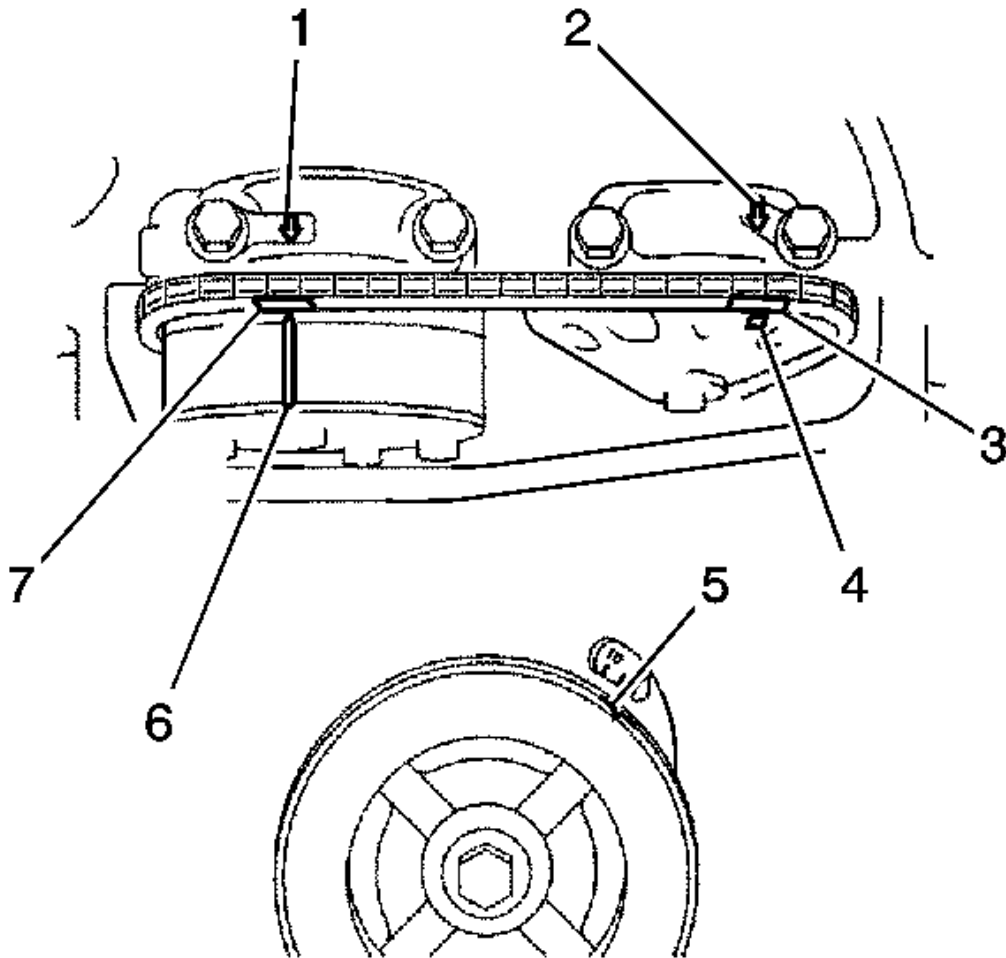


Fig. 35: Setting No. 1 Cylinder To TDC/compression Stroke
Courtesy of GENERAL MOTORS CORP.

8. Set No. 1 cylinder to TDC/compression by turning the crankshaft pulley until the groove and the timing mark "0" on the timing chain cover are aligned.
9. Check that each timing mark on the camshaft timing gear and sprocket is aligned with each timing mark located on the No. 1 and No. 2 bearing caps, as shown in the illustration.
10. If not, turn the crankshaft pulley by 1 revolution (360°) to align the timing marks as illustrated.
11. Place paint marks on the chain in alignment with the timing marks on the camshaft timing gear and camshaft timing sprocket.
12. Remove No. 1 chain tensioner assembly. See **Camshaft Timing Chain, Sprocket, and Tensioner Installation**.

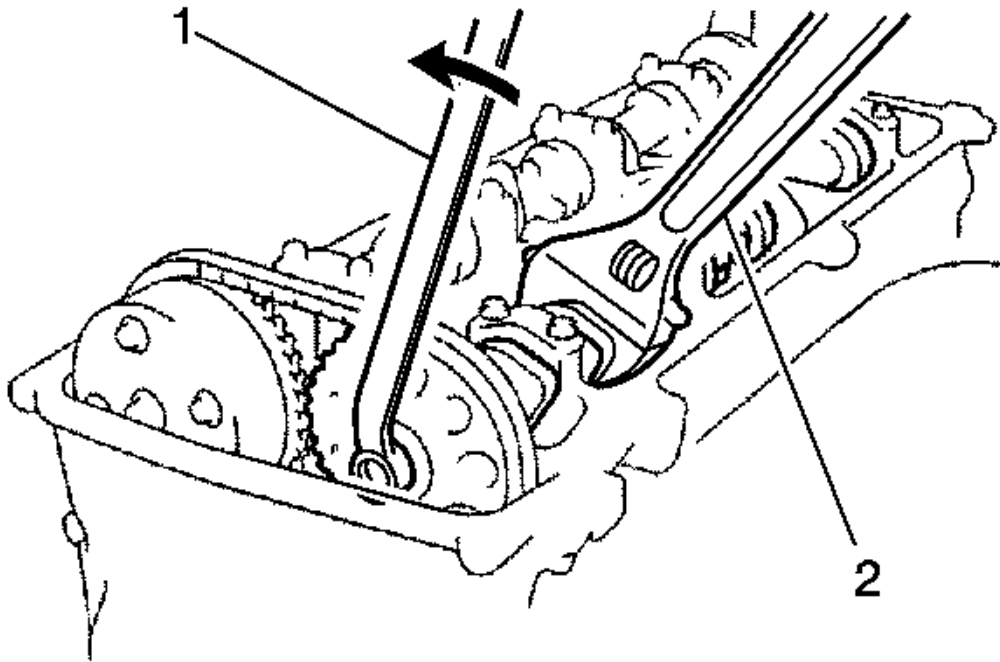


Fig. 36: Identifying Camshaft Timing Gear & Sprocket
Courtesy of GENERAL MOTORS CORP.

13. Loosen camshaft timing gear or sprocket. While holding the No. 2 camshaft with a wrench, loosen the No. 2 camshaft timing set bolt.

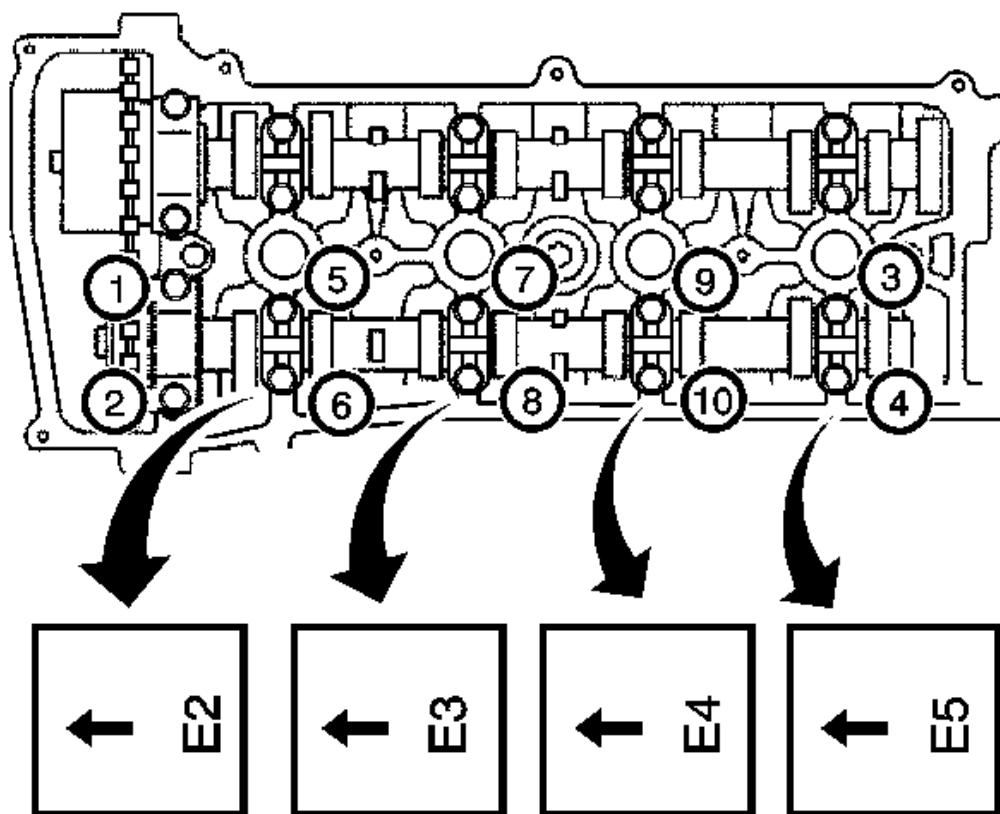


Fig. 37: View Of No. 2 Camshaft

Courtesy of GENERAL MOTORS CORP.

14. Remove No. 2 camshaft using several steps, uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.
15. Remove the 5 bearing caps.

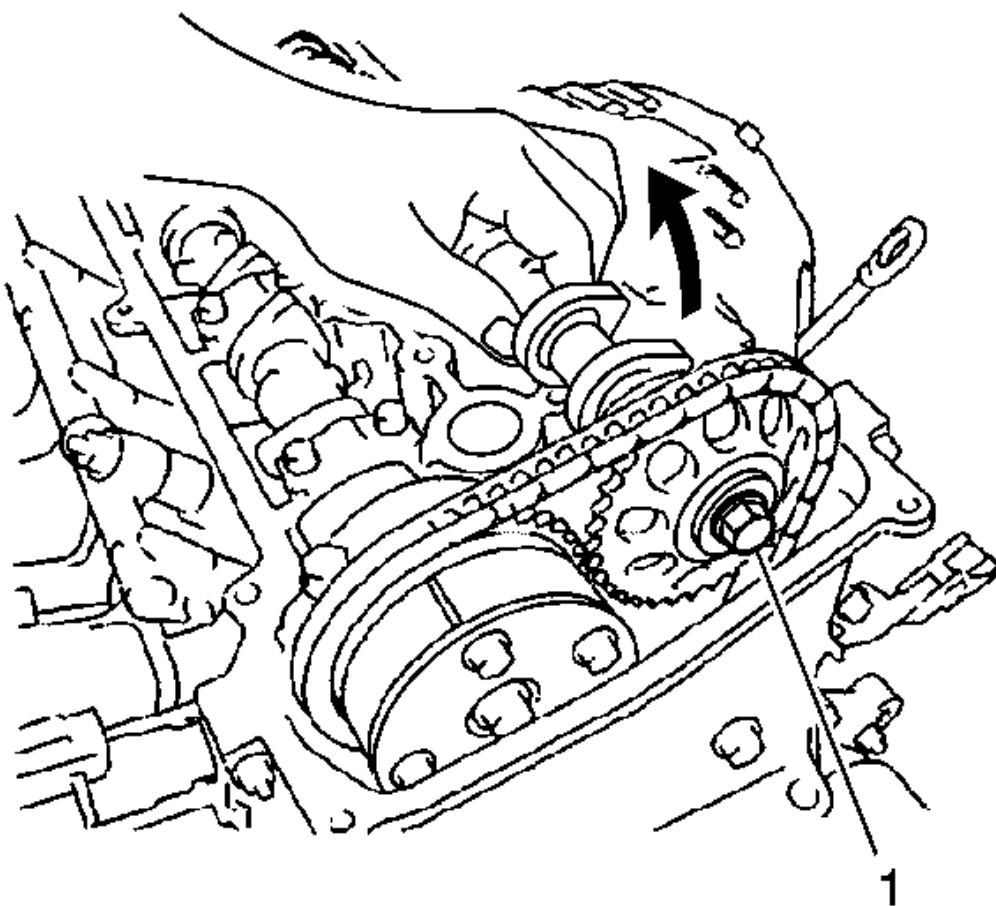


Fig. 38: View Of Camshaft Timing Sprocket & Set Bolt
Courtesy of GENERAL MOTORS CORP.

16. While holding the No. 2 camshaft by hand, remove the camshaft timing sprocket set bolt.
17. Remove the camshaft timing sprocket from the No. 2 camshaft with the timing chain wrapped on the sprocket.
18. Remove the camshaft timing sprocket from the timing chain.

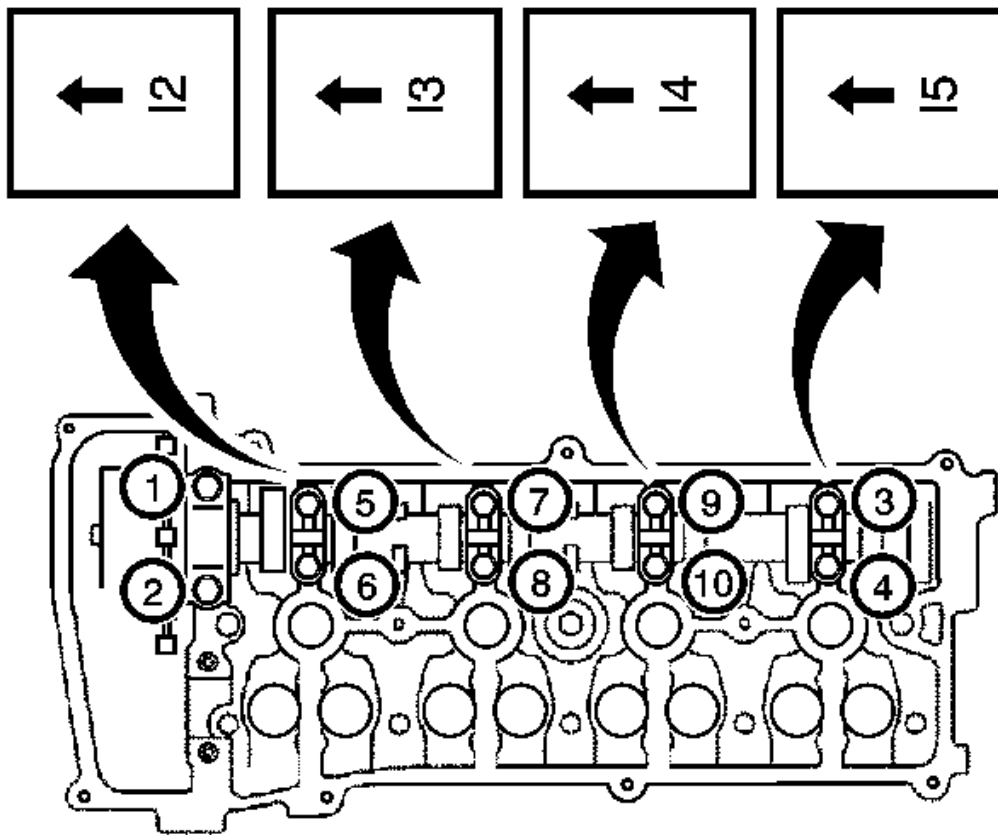


Fig. 39: View Of Removal Procedure
Courtesy of GENERAL MOTORS CORP.

19. Remove camshaft using several steps, uniformly loosen and remove the 10 bearing caps bolts in the sequence shown in the illustration.
20. Remove the 5 bearing caps.
21. Remove the camshaft and camshaft timing gear assembly while holding the timing chain by hand.

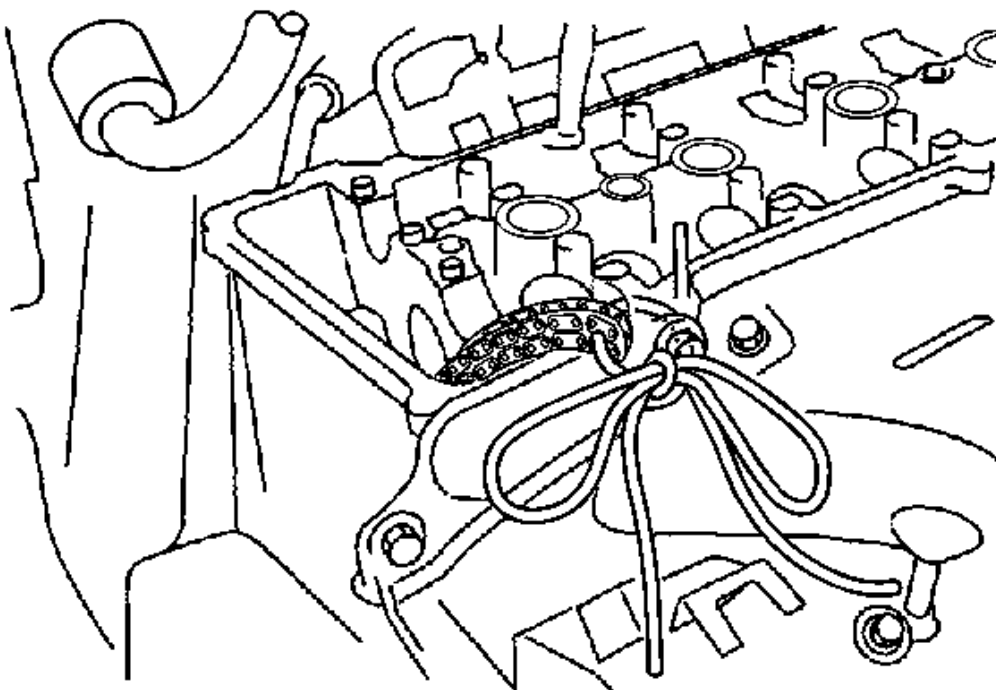


Fig. 40: View Of Supporting Timing Chain With String
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to drop anything inside the timing chain cover.

22. Support the timing chain with a string to prevent it from slipping off the crankshaft sprocket as shown in the illustration.

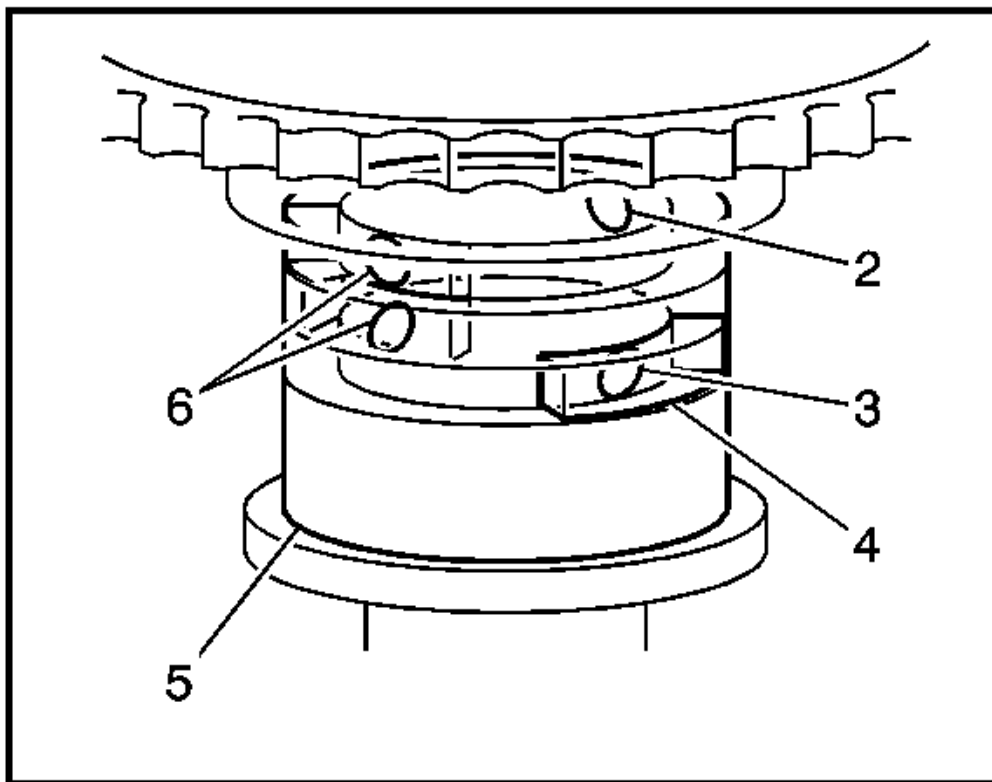
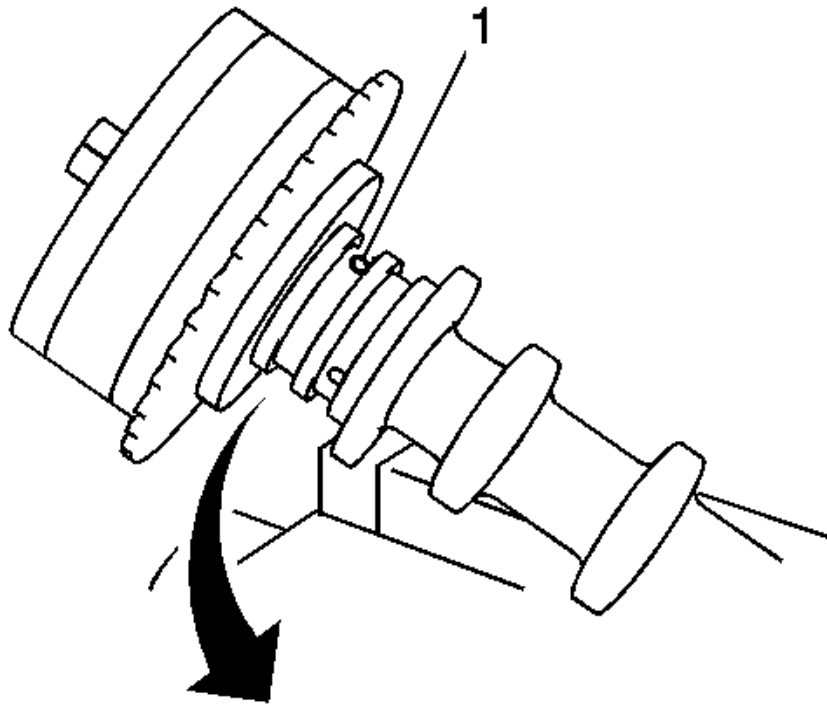


Fig. 41: View Of Camshaft & Timing Gear Assembly
Courtesy of GENERAL MOTORS CORP.

23. Remove camshaft timing gear assembly by clamping the camshaft in a vise, and make sure that the camshaft timing gear assembly does not rotate.
24. Cover all the oil path with vinyl tape except the advance side path shown in the illustration.

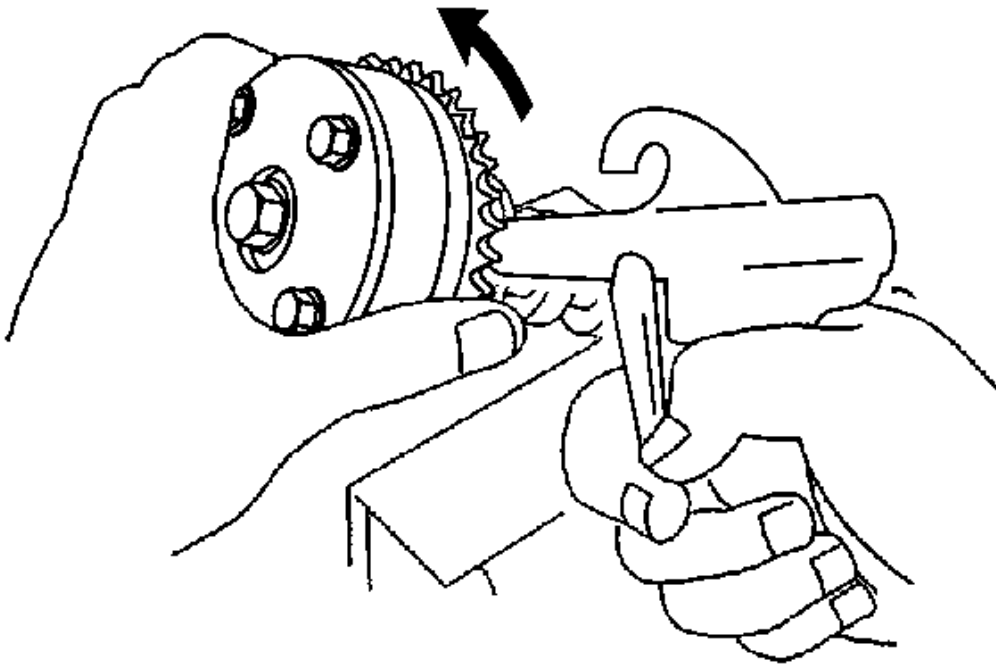


Fig. 42: View Of Oiling & Rotating Gear Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Cover the paths with a piece of cloth to avoid oil splashes.

25. Apply air pressure of 150 kPa (1.5 kgf/cm², 22 psi) to the oil path, then turn the camshaft timing gear assembly to the advance direction (counterclockwise) by hand.

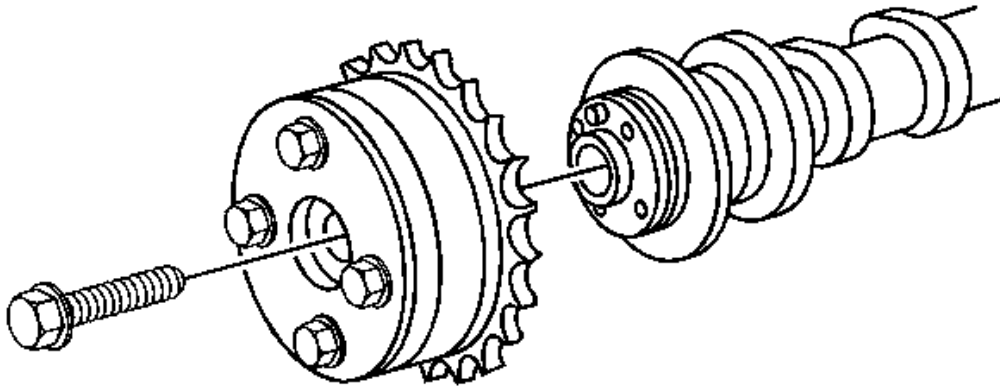


Fig. 43: View Of Camshaft Timing Gear Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure not to remove the other 4 bolts. When reusing the camshaft timing gear, release the straight pin lock first, then install the gear.

IMPORTANT: Depending on the air pressure, the camshaft timing gear assembly may turn to the advance side without applying force by hand. Also, if the pressure is difficult to apply because of air leakage from the port, the lock pin may be difficult to release.

26. Remove the flange bolt of the camshaft timing gear.

Inspection Procedure

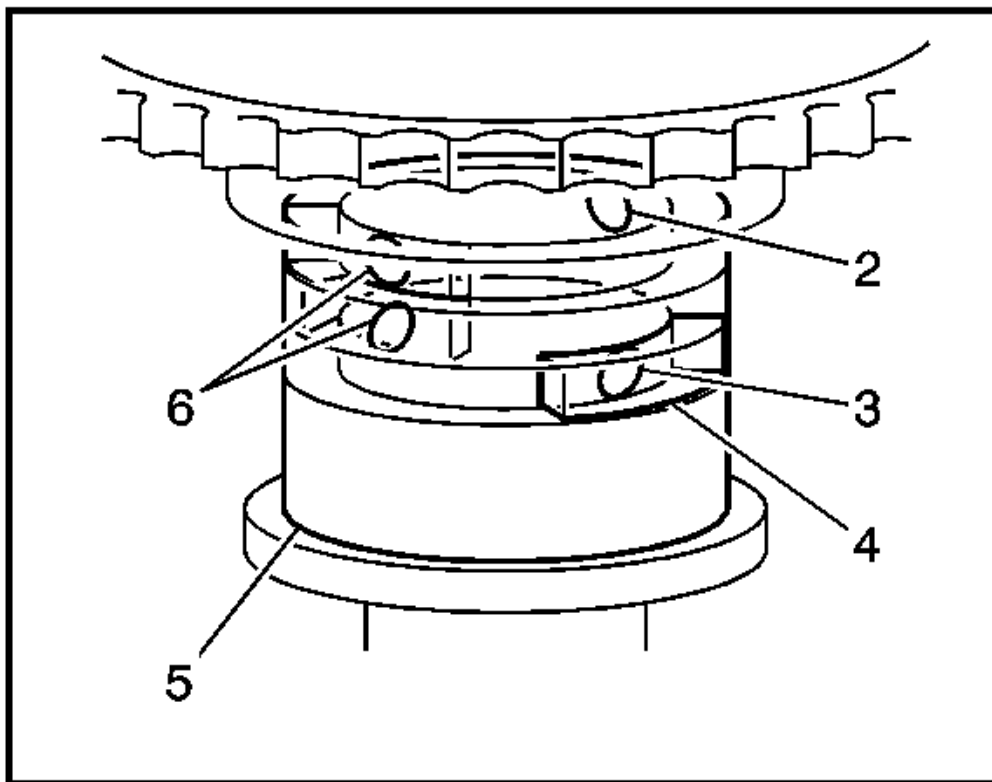
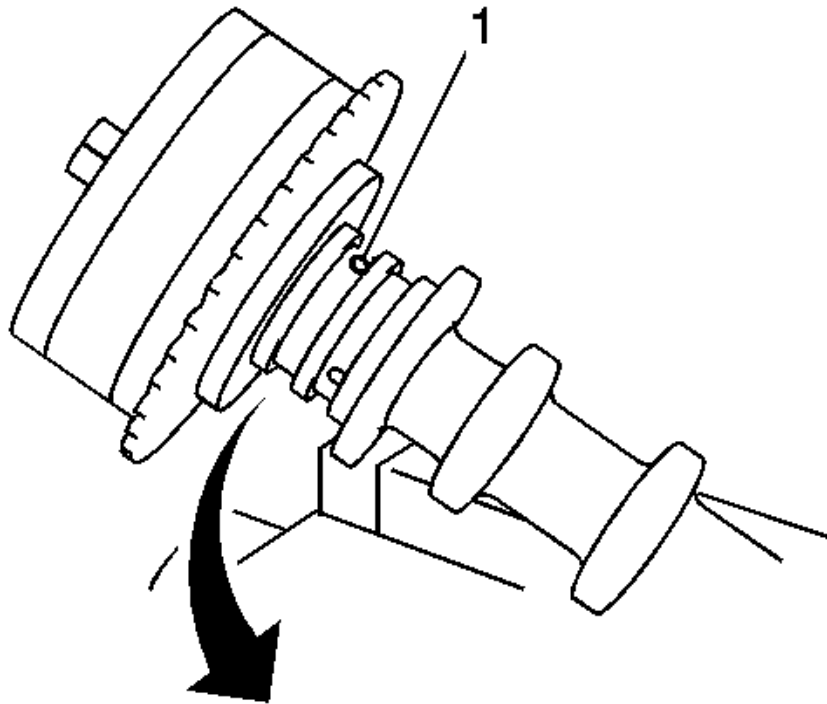


Fig. 44: View Of Camshaft Timing Gear
Courtesy of GENERAL MOTORS CORP.

1. Inspect camshaft timing gear assembly as follows.
 1. Install the camshaft timing gear assembly. See **Camshaft Timing Chain, Sprocket, and Tensioner Installation**.
 2. Clamp the camshaft in a vise, and make sure that the camshaft timing gear assembly does not rotate.
2. Cover all the oil paths with vinyl tape except the advance side path shown in the illustration.

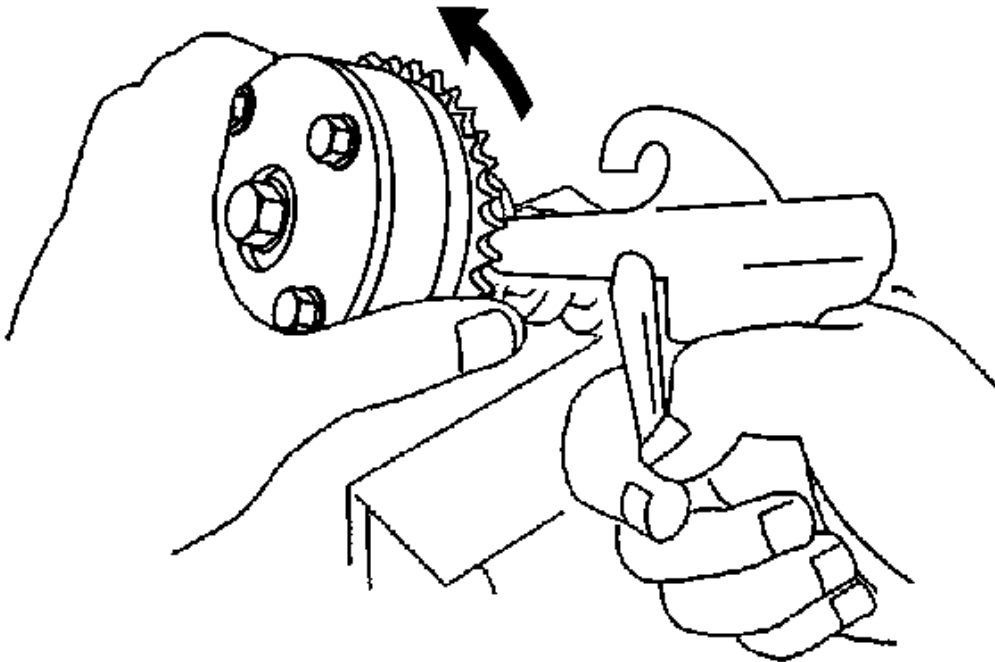


Fig. 45: View Of Oiling & Rotating Gear Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Cover the paths with a piece of cloth to avoid oil splashes.

3. Apply air pressure of 150 kPa (1.5 kgf/cm², 22 psi) to the oil path.

IMPORTANT: Depending on the air pressure, the camshaft timing gear may turn to the advance side without applying force by hand. Also, if enough air pressure

cannot be applied because of air leakage from the path, releasing the lock pin may be difficult.

4. Check that the camshaft timing gear revolves in the advance direction (counterclockwise) by hand.

NOTE: Do not use air pressure to perform the smooth rotation check.

5. Check for smooth rotation. Turn the camshaft timing gear within its movable range (21°) 2 or 3 times, but do not turn it to the most retarded position. Make sure that the gear turns smoothly.
6. Check the lock in the most retarded position. Confirm that the camshaft timing gear is locked at the most retarded position.
7. Remove the camshaft timing gear assembly. See Camshaft Timing Chain, Sprocket, and Tensioner Removal.

Installation Procedure

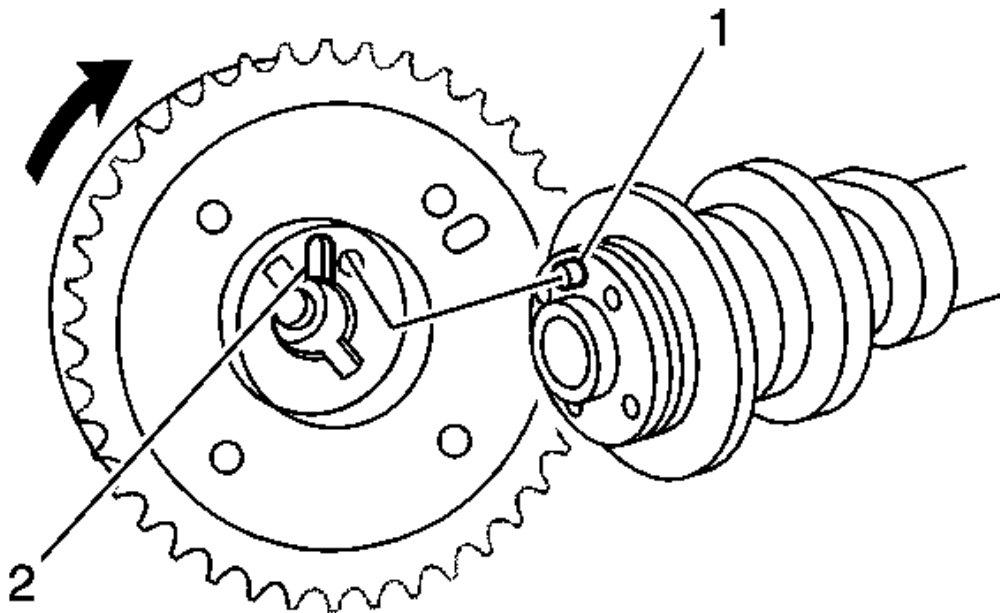


Fig. 46: View Of Camshaft Timing Gear
Courtesy of GENERAL MOTORS CORP.

1. Install camshaft timing gear assembly by putting the camshaft timing gear and camshaft together with the straight pin and key groove misaligned, as shown in the illustration.

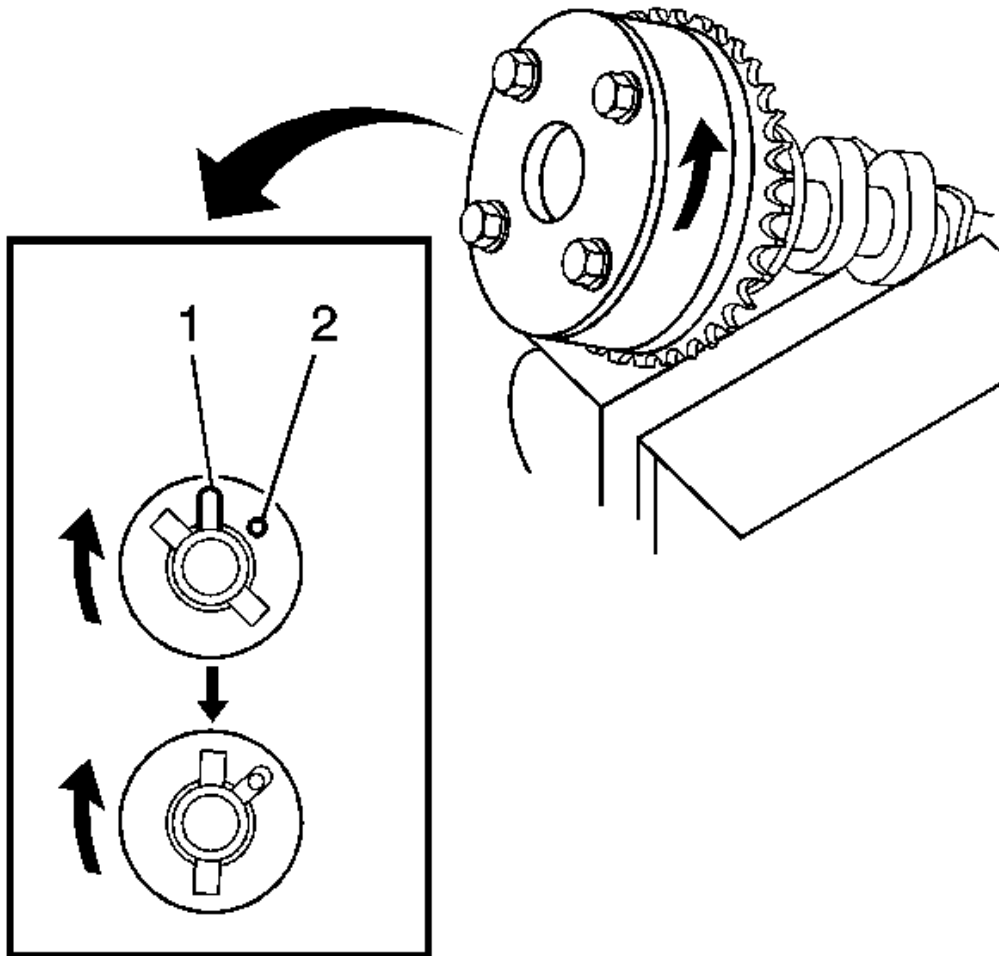


Fig. 47: View Of Turning Camshaft Timing Gear In Retard Direction (Clockwise)
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure not to turn the camshaft timing gear to the retard direction (clockwise).

2. Turn the camshaft timing gear as shown in the illustration while pushing it gently against the camshaft. Push further at the position where the pin fits into the groove.
3. Check that there is no clearance between the gear flange and camshaft.

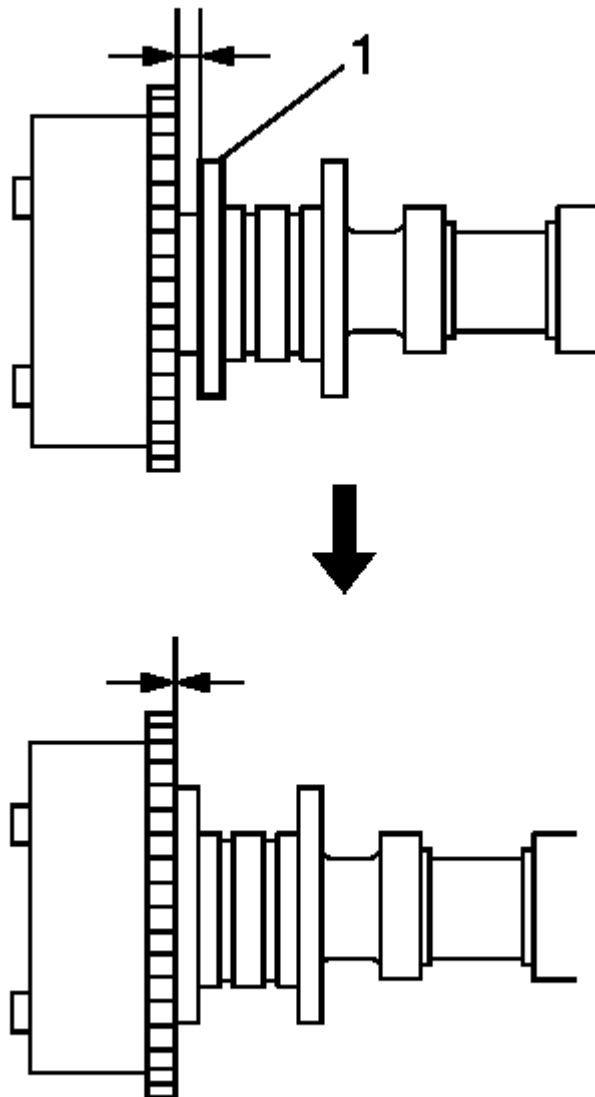


Fig. 48: Checking For Clearance Between Gear Flange & Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Check that there is no clearance between the gear flange and camshaft.

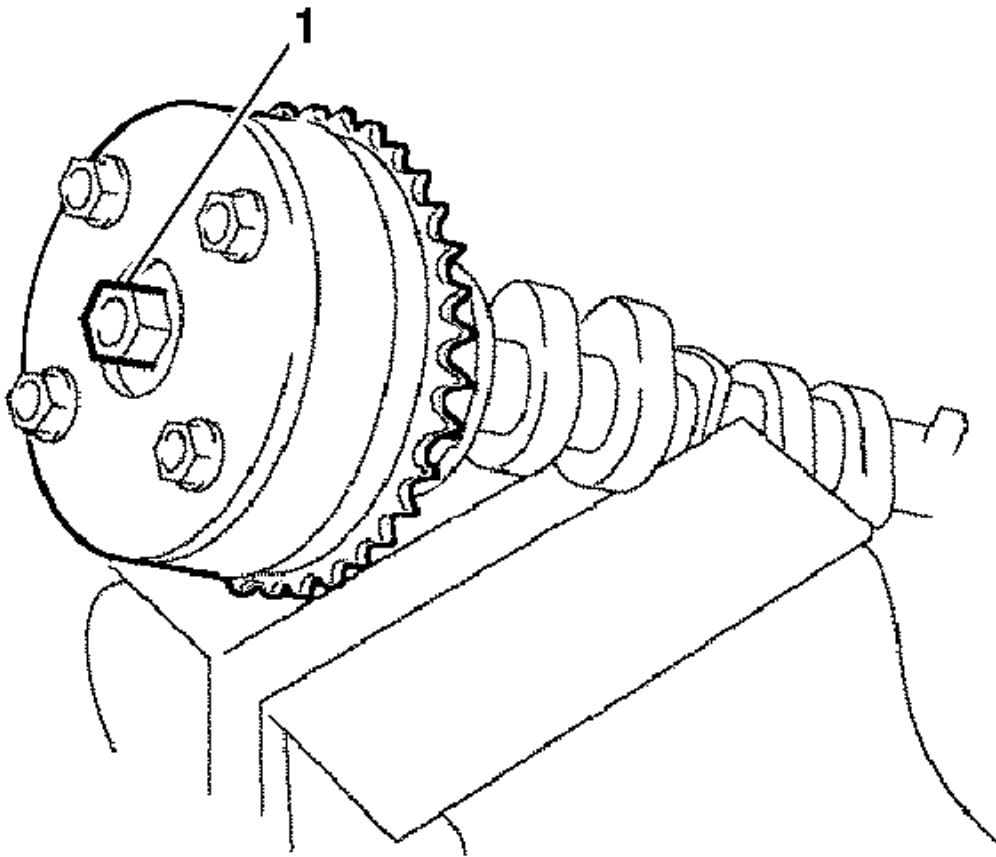


Fig. 49: View Of Camshaft Timing Gear Bolt
Courtesy of GENERAL MOTORS CORP.

5. Tighten the flange bolt with the camshaft timing gear assembly fixed in place.

Tighten: 54 N.m (40 lb ft)

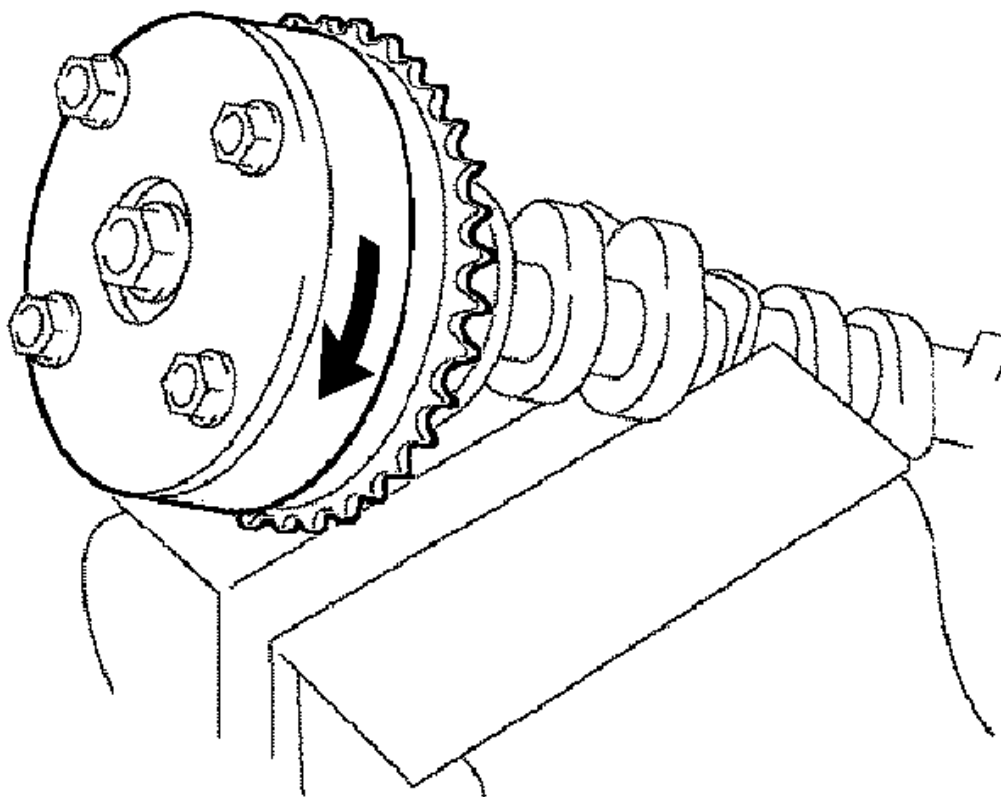


Fig. 50: Rotating Camshaft Timing Gear In Retard Direction (Clockwise)
Courtesy of GENERAL MOTORS CORP.

6. Check that the camshaft timing gear assembly can move to the retard direction (clockwise) and is locked in the most retarded position.

Installation Procedure

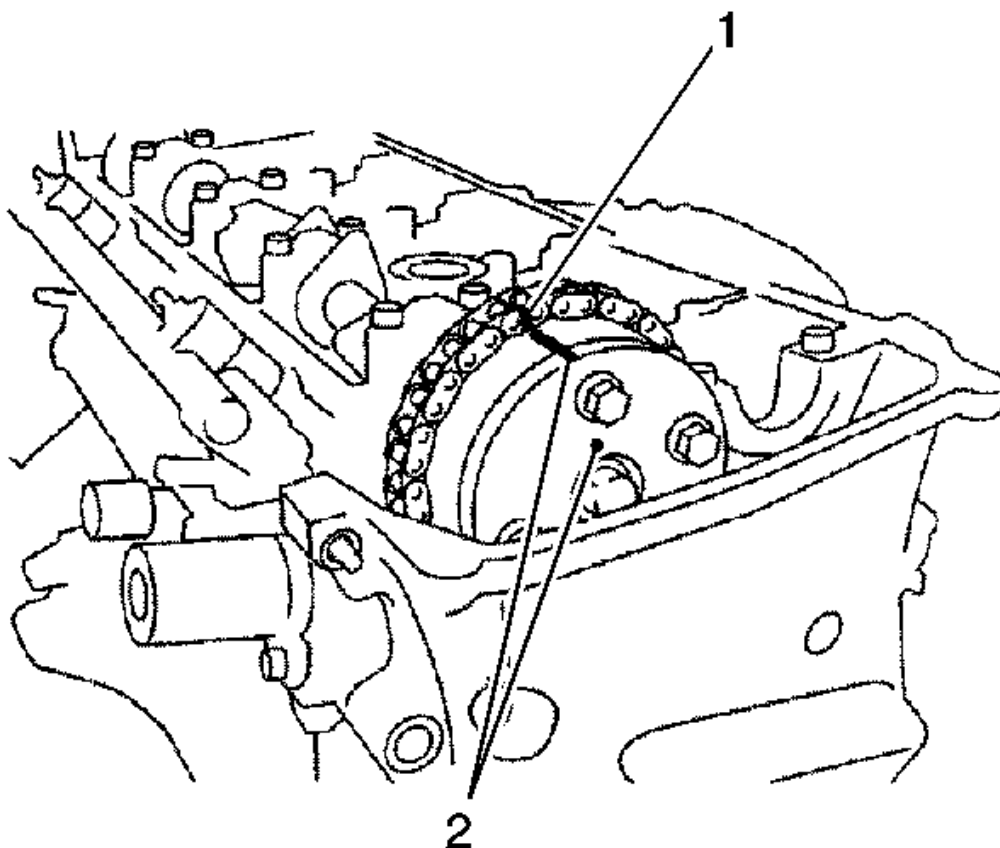


Fig. 51: View Of Journal Portion Of Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Apply a light coat of engine oil to the journal portion of the camshaft.
2. Install the timing chain onto the camshaft timing gear with the paint mark aligned with the timing mark on the camshaft timing gear as shown in the illustration.

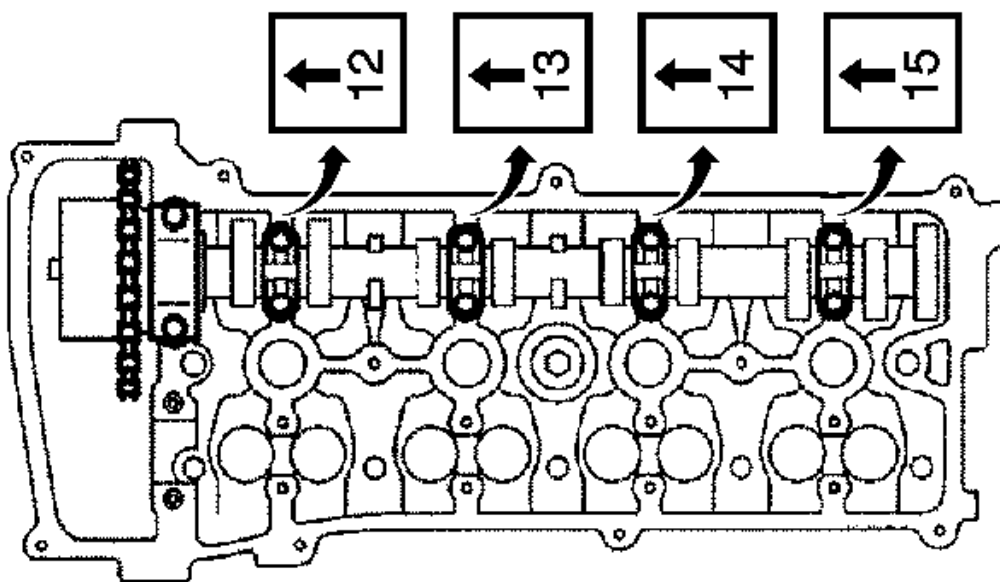


Fig. 52: Identifying Installation Procedure
Courtesy of GENERAL MOTORS CORP.

3. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps into the cylinder head.
4. Apply a light coat of engine oil on the threads and under the heads of the bearing cap bolts.

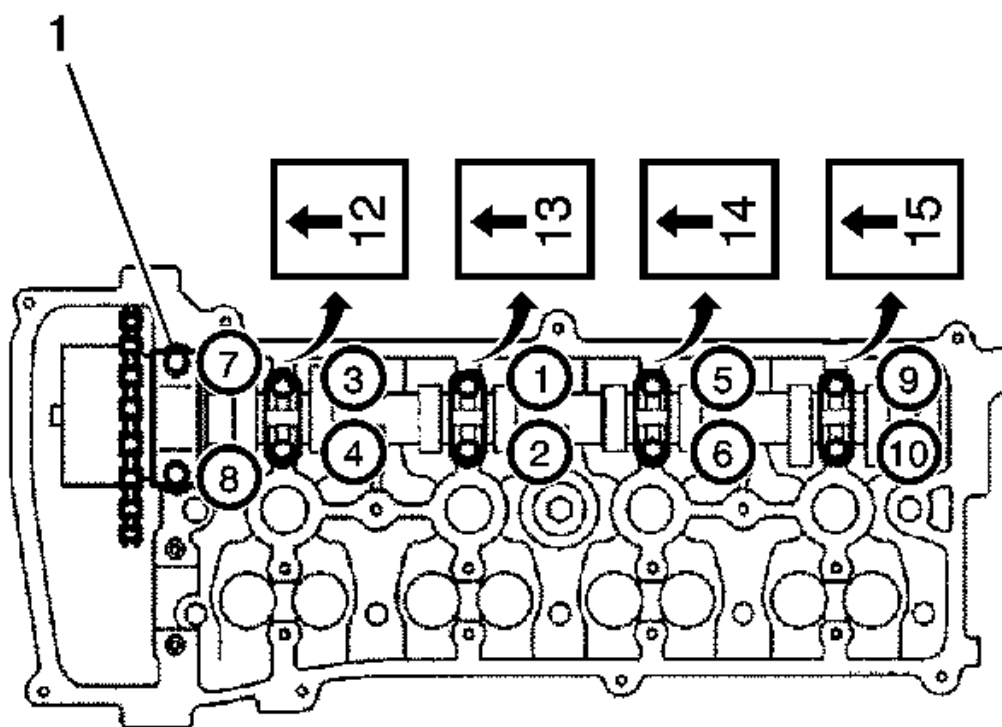


Fig. 53: View Of Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten: No. 1 bearing 30 N.m (22 lb ft). No. 3 bearing 9.0 N.m (80 lb in)

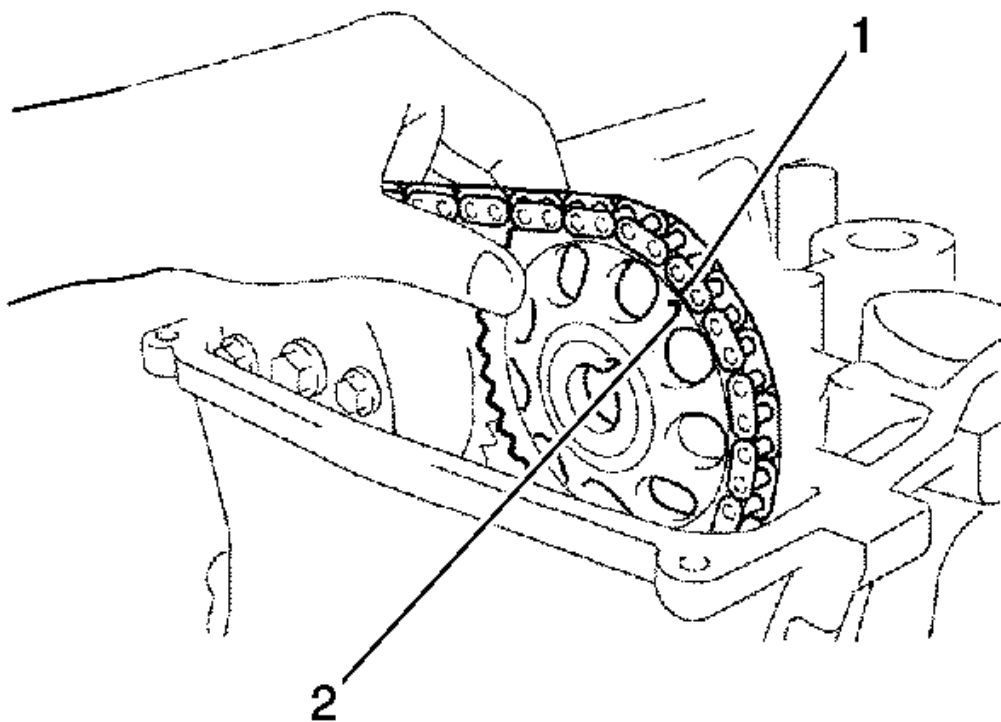


Fig. 54: View Of Timing Chain Alignment Marks
Courtesy of GENERAL MOTORS CORP.

6. Install No. 2 camshaft.
 1. Apply a light coat of engine oil to the journal portion of the No. 2 camshaft.
 2. Put the No. 2 camshaft on the cylinder head with the paint mark on the chain aligned with the timing mark on the camshaft timing sprocket.

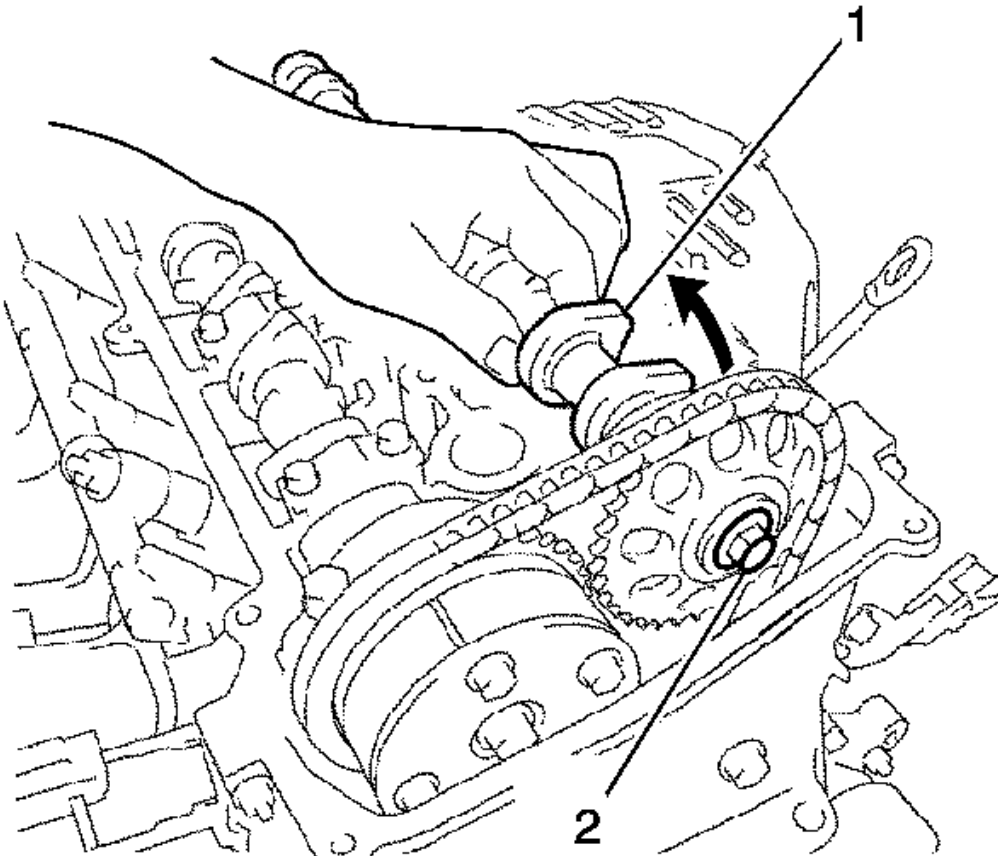


Fig. 55: View Of Tightening Camshaft Timing Sprocket Set Bolt
Courtesy of GENERAL MOTORS CORP.

7. While holding the No. 2 camshaft by hand, temporarily tighten the camshaft timing sprocket set bolt.

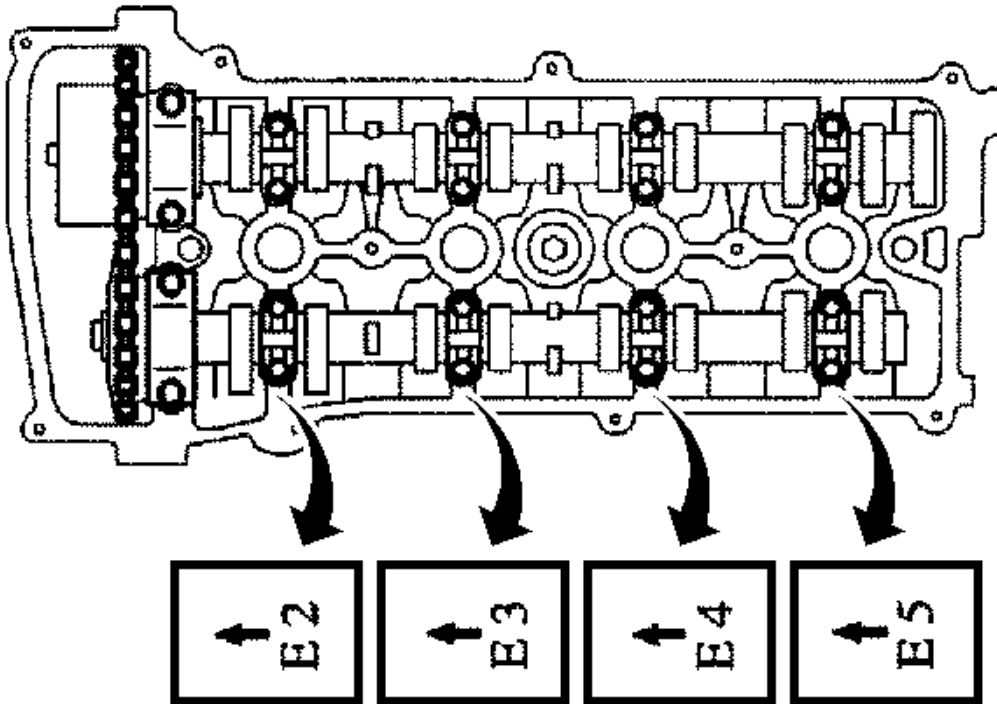


Fig. 56: View Of Front Marks & Numbers On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps onto the cylinder head.
9. Apply a light coat of engine oil to the threads and under the heads of the bearing cap bolts.

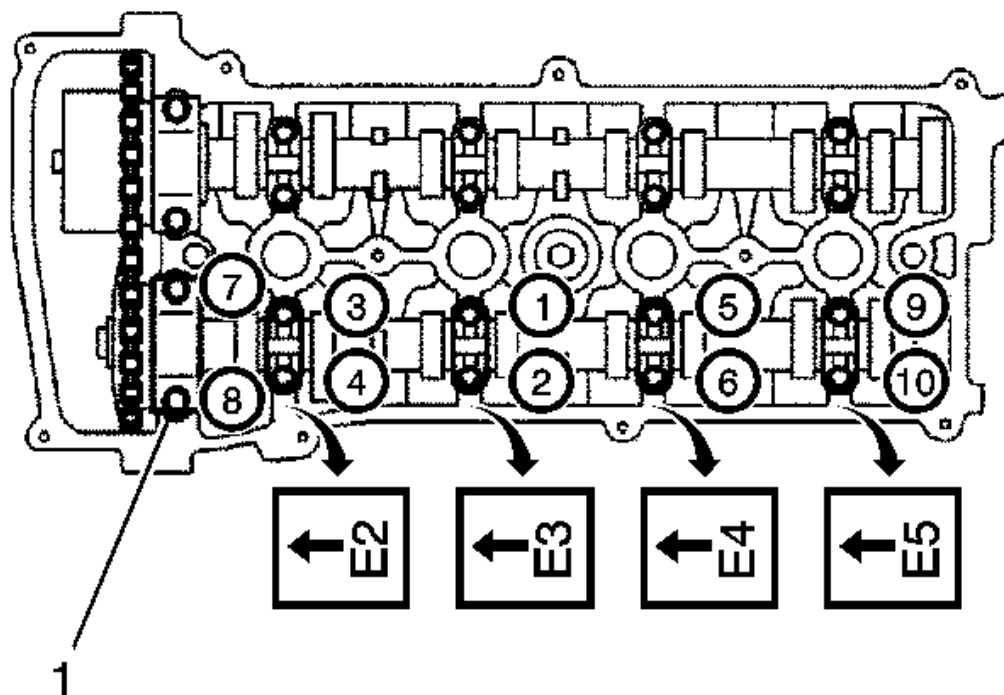


Fig. 57: Identifying Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten: No. 2 bearing 30 N.m (22 lb ft). No. 3 bearing 9.0 N.m (80 lb in).

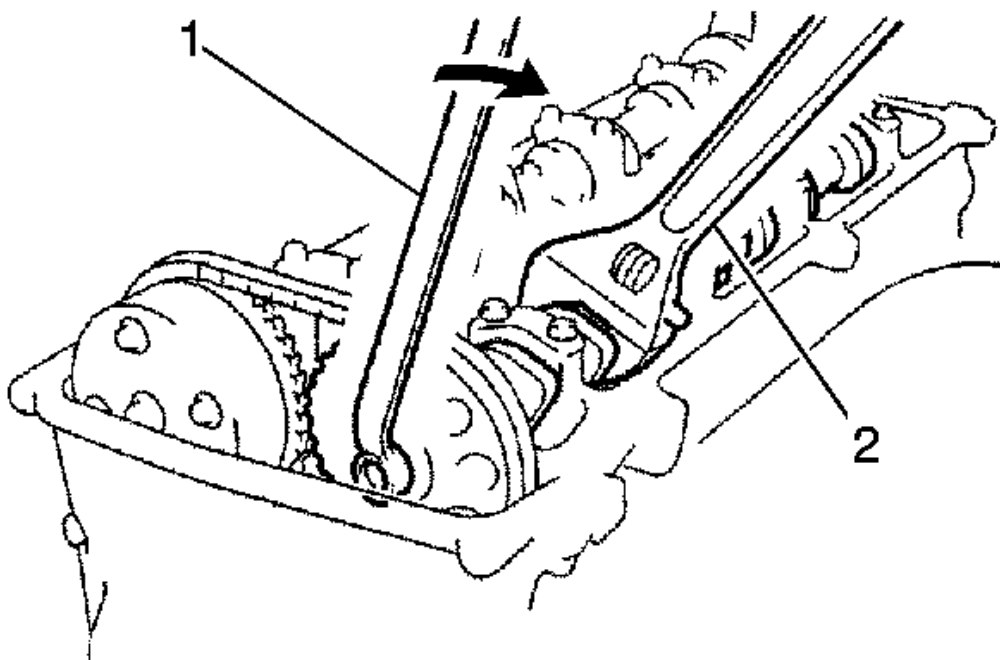


Fig. 58: View Of Tightening Camshaft Timing Sprocket Set Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the valve lifter.

11. While holding the camshaft with a wrench, tighten the camshaft timing sprocket set bolt.

Tighten: 54 N.m (40 lb ft).

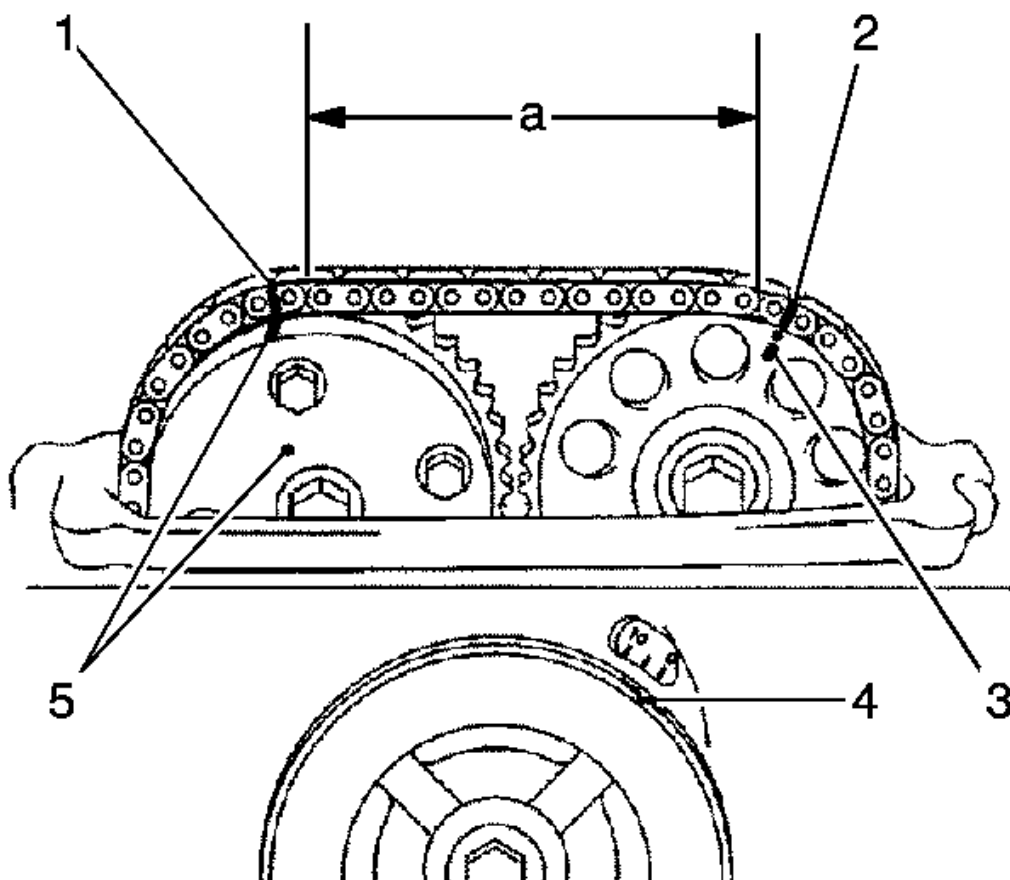


Fig. 59: Checking Timing Chain Paint Mark Alignment
Courtesy of GENERAL MOTORS CORP.

12. Check that the paint marks on the chain are aligned with the timing marks on the camshaft timing gear and camshaft timing sprocket. Also, check that the crankshaft pulley groove is aligned with the timing mark 0 on the timing mark chain cover.

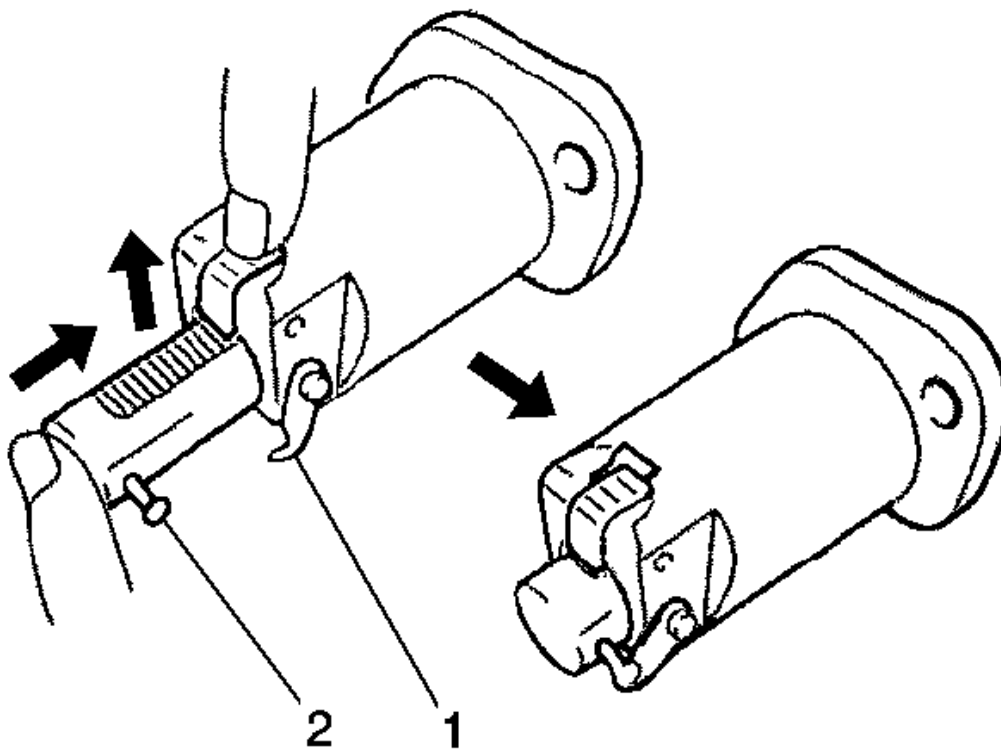


Fig. 60: View Of Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

13. Install No. 1 chain tensioner assembly. Release the ratchet pawl, then fully push in the plunger and hook the hook to the pin so that the plunger is in the position shown in the illustration.

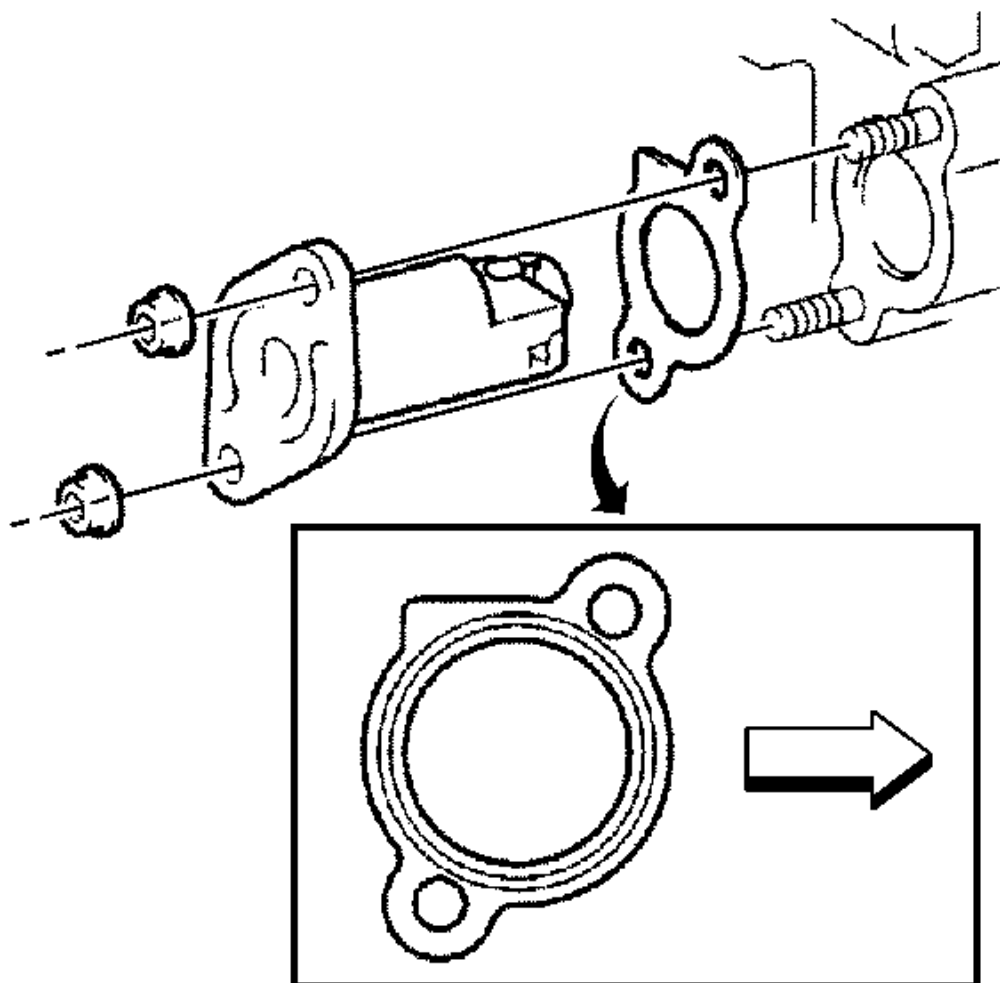


Fig. 61: View Of Chain Tensioner, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing the chain tensioner, set the hook again if the hook releases the plunger.

14. Install a new gasket and the chain tensioner with the 2 nuts.

Tighten: 9.0 N.m (80 lb in).

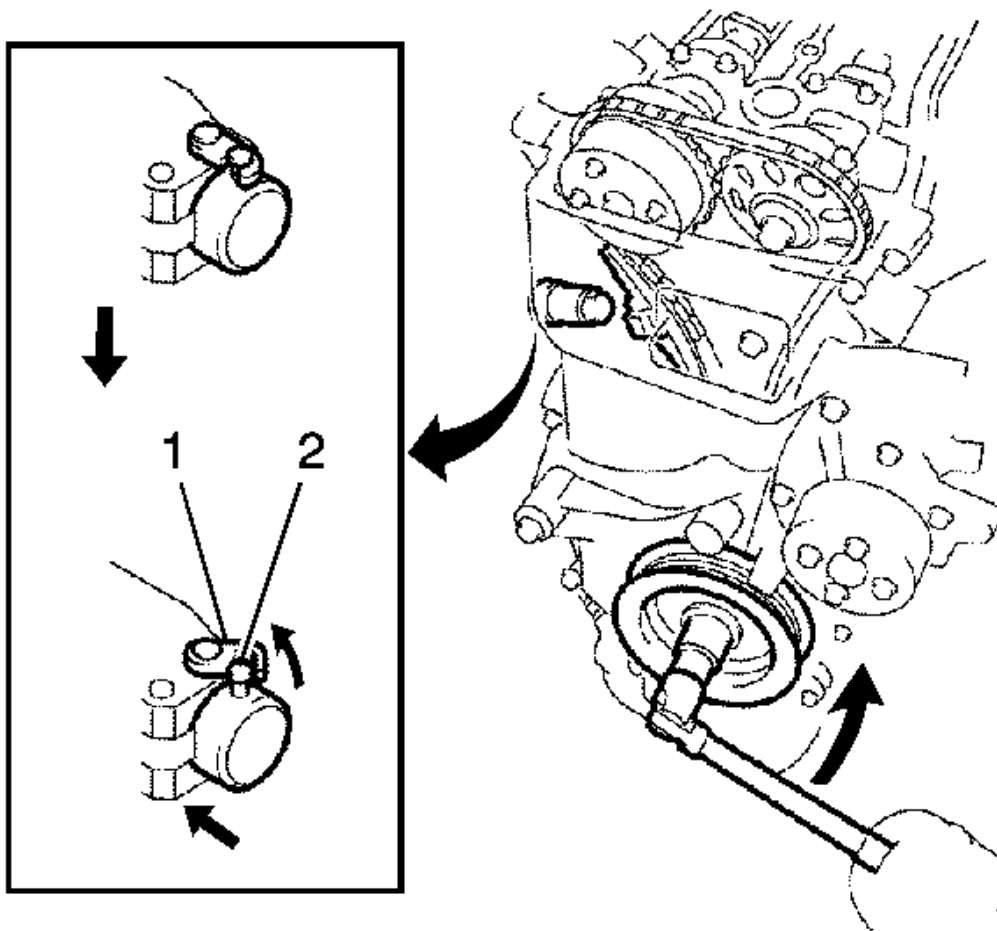


Fig. 62: Rotating Crankshaft Counterclockwise
Courtesy of GENERAL MOTORS CORP.

15. Turn the crankshaft counterclockwise, then disconnect the plunger knock pin from the hook.

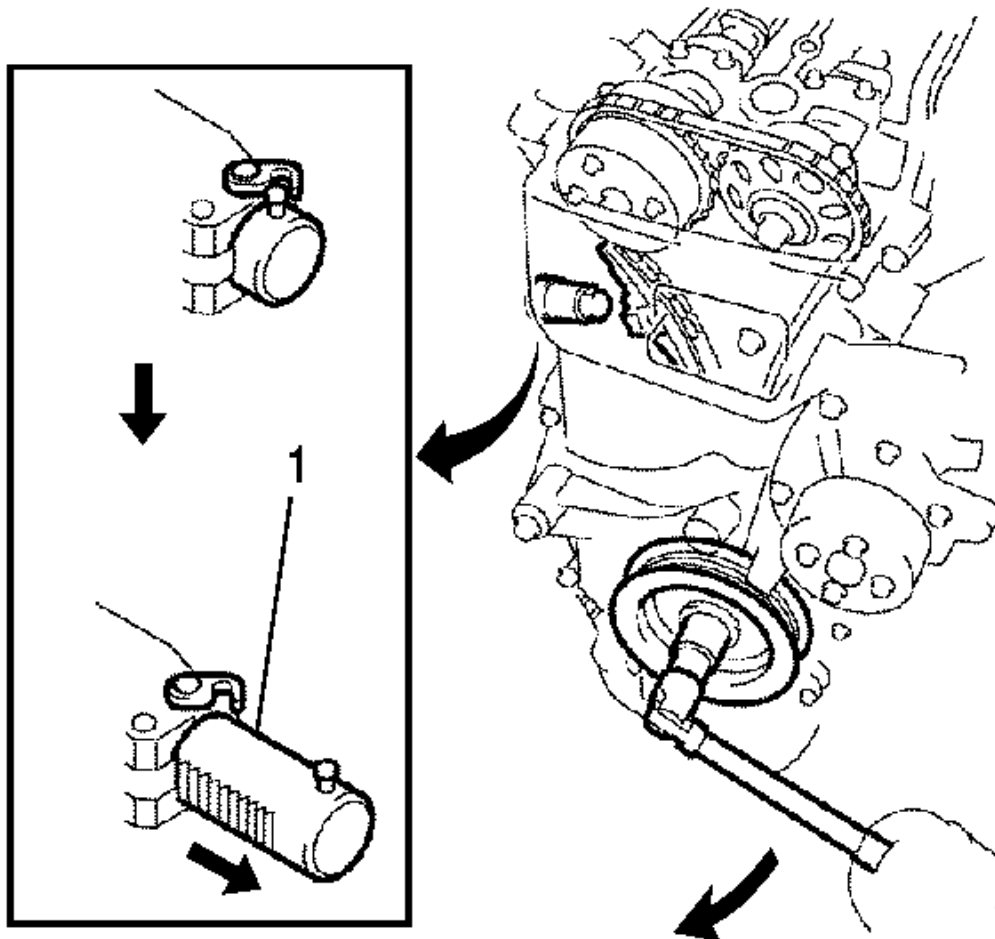


Fig. 63: View Of Chain Tensioner & Plunger
 Courtesy of GENERAL MOTORS CORP.

16. Turn the crankshaft clockwise, then check that the plunger is extended.
17. Set No. 1 cylinder to TDC/compression. See **Camshaft Timing Chain, Sprocket, and Tensioner Installation**.
18. Check valve clearance. See **Intake Camshaft and Valve Lifter Replacement**.
19. Adjust valve clearance. See **Intake Camshaft and Valve Lifter Replacement**.
20. Install cylinder head cover sub-assembly. Remove any old packing material from the contact surface.

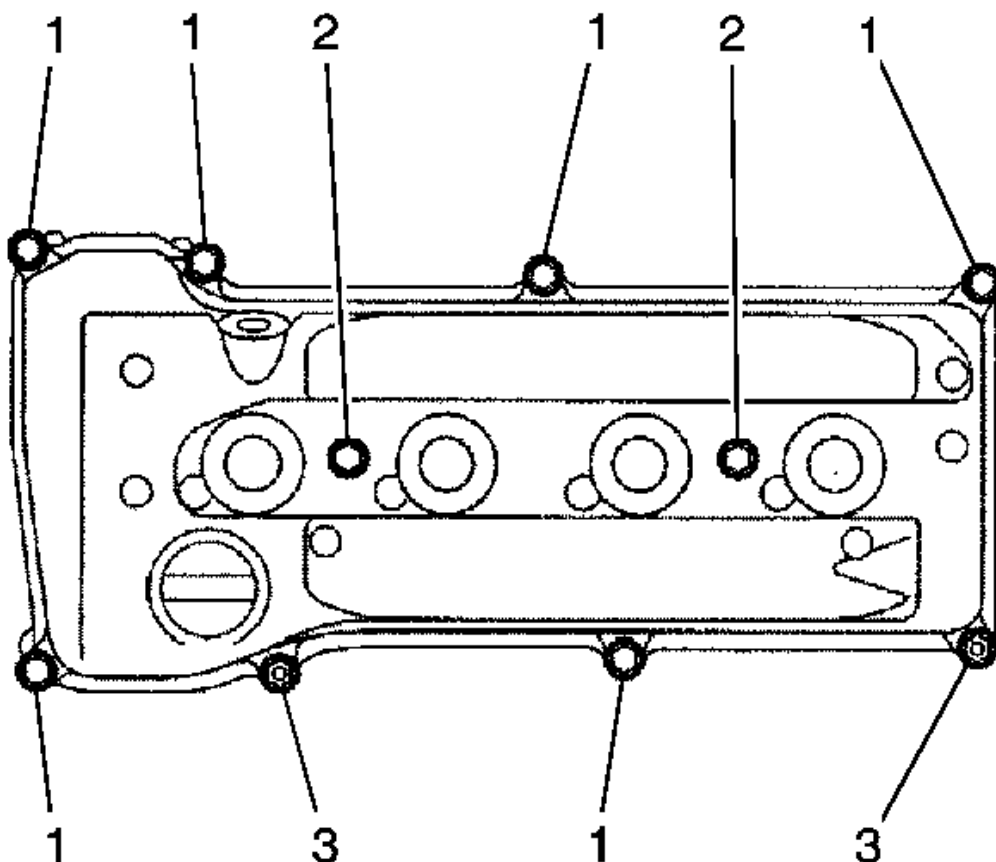


Fig. 64: Identifying Cylinder Head Cover Bolt/Nut Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

21. Install the cylinder head cover gasket and subassembly with the 8 bolts and 2 nuts.

Tighten: Bolt A-11 N.m (8 lb ft). Bolt B-14 N.m (10 lb ft) Nut 11 N.m (8 lb ft)

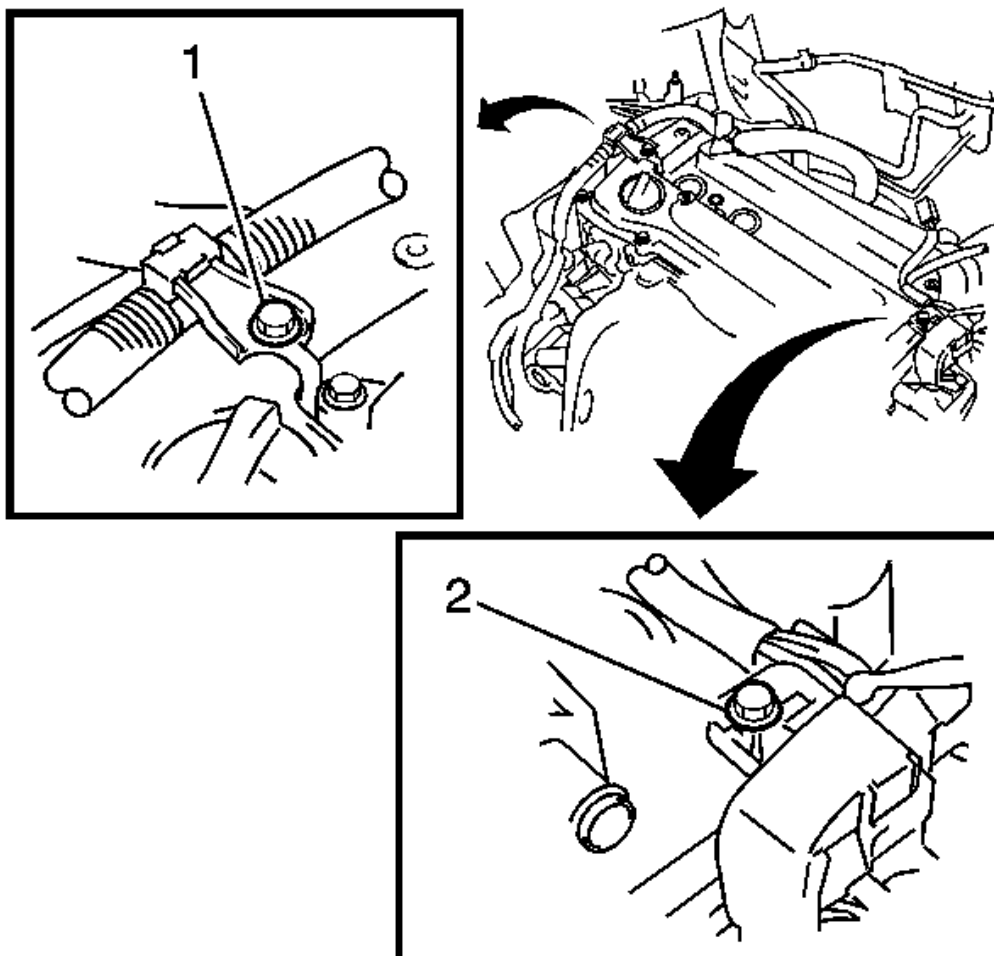


Fig. 65: View Of Wire Harness Brackets
Courtesy of GENERAL MOTORS CORP.

22. Install the 2 engine wire harness brackets with the 2 bolts.

Tighten: 8.4 N.m (74 lb in).

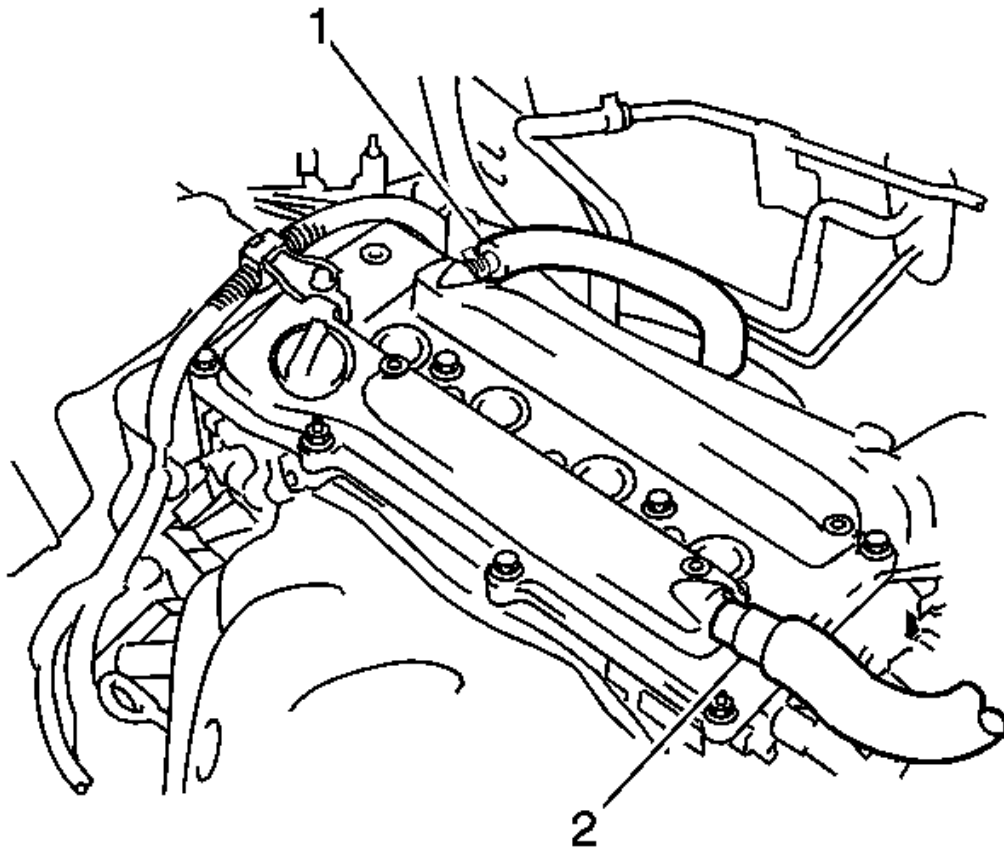


Fig. 66: View Of Engine Cover Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

23. Connect the 2 ventilation hoses to the cylinder head cover.
24. Install spark plug. See **SPARK PLUG REPLACEMENT** .
25. Install ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
26. Inspect for oil leak.
27. Inspect ignition timing. See **DIAGNOSTIC INFORMATION AND PROCEDURES** .
28. Install No. 1 engine cover sub-assembly.
29. Install engine under right cover.

EXHAUST CAMSHAFT AND VALVE LIFTER REPLACEMENT

Removal Procedure

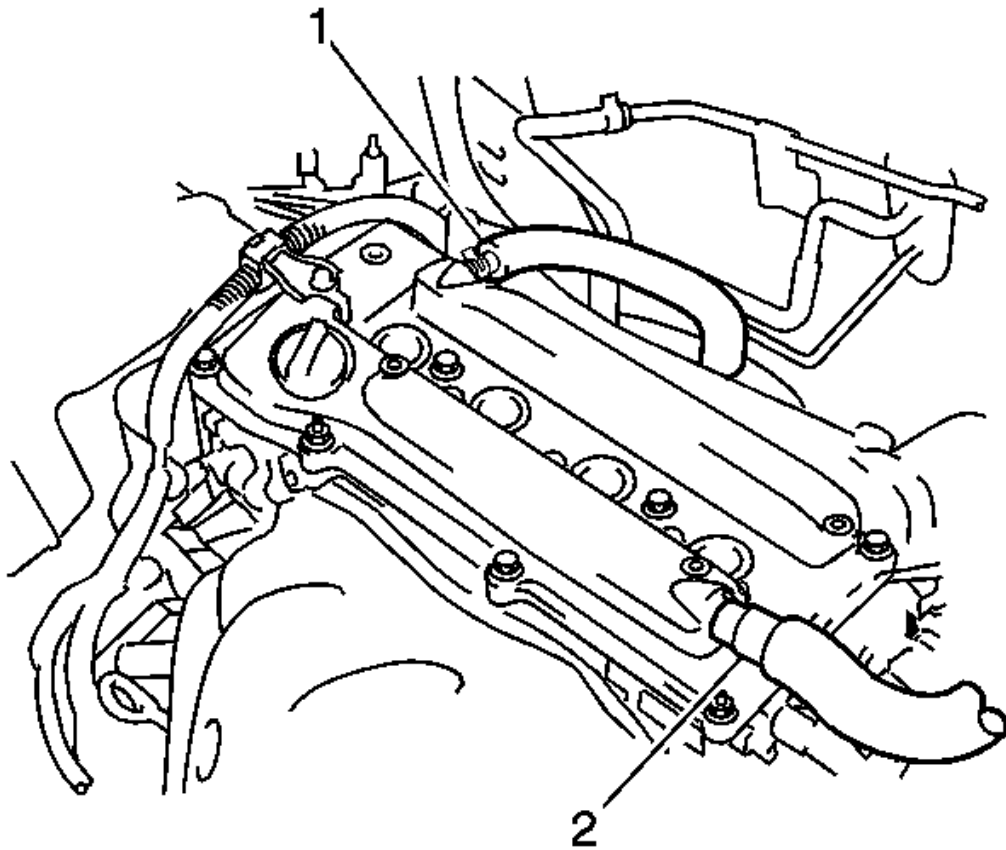


Fig. 67: View Of Engine Cover Sub-Assembly
 Courtesy of GENERAL MOTORS CORP.

1. Remove the right engine under cover.
2. Remove No. 1 engine cover sub-assembly.
3. Remove ignition coil assembly. See **IGNITION COIL REPLACEMENT**.
4. Remove spark plug. See **SPARK PLUG REPLACEMENT**.
5. Remove cylinder head cover sub-assembly. Remove the 2 ventilation hoses from the cylinder head cover sub-assembly.

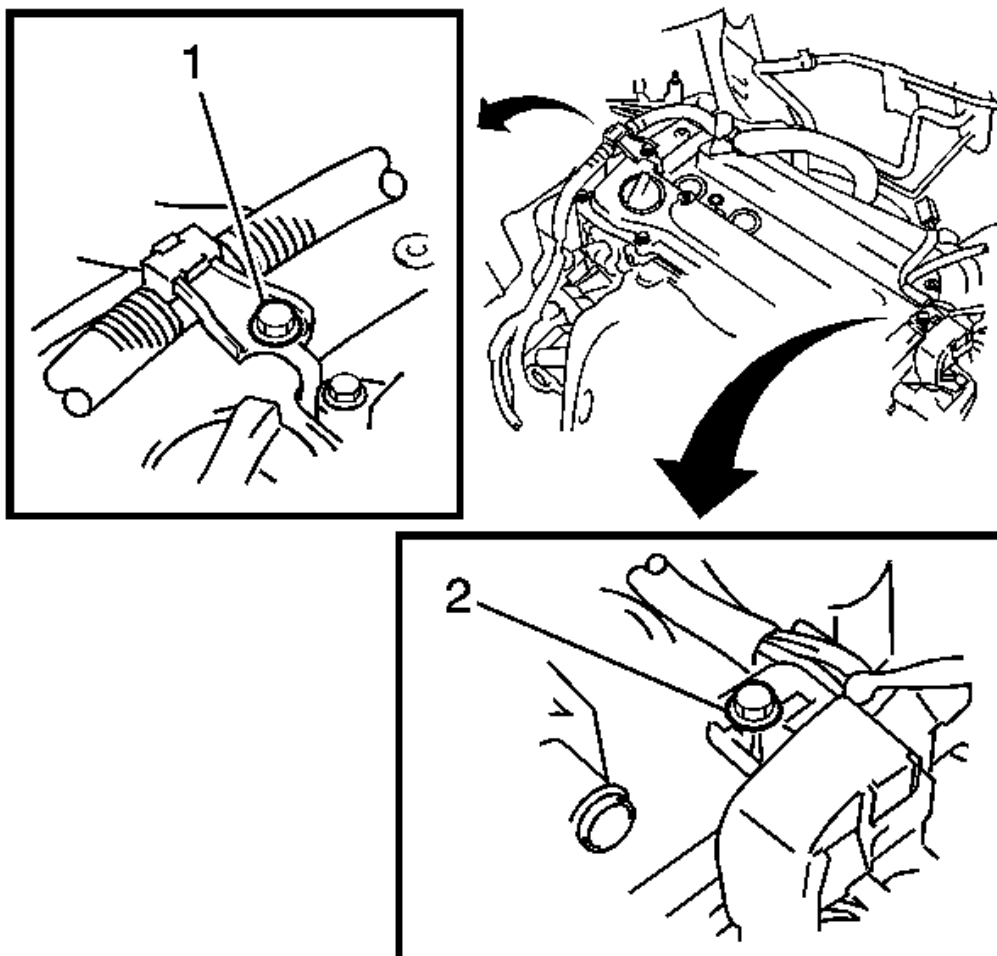


Fig. 68: View Of Wire Harness Brackets
Courtesy of GENERAL MOTORS CORP.

6. Remove the 2 bolts and separate the 2 wire harness brackets.

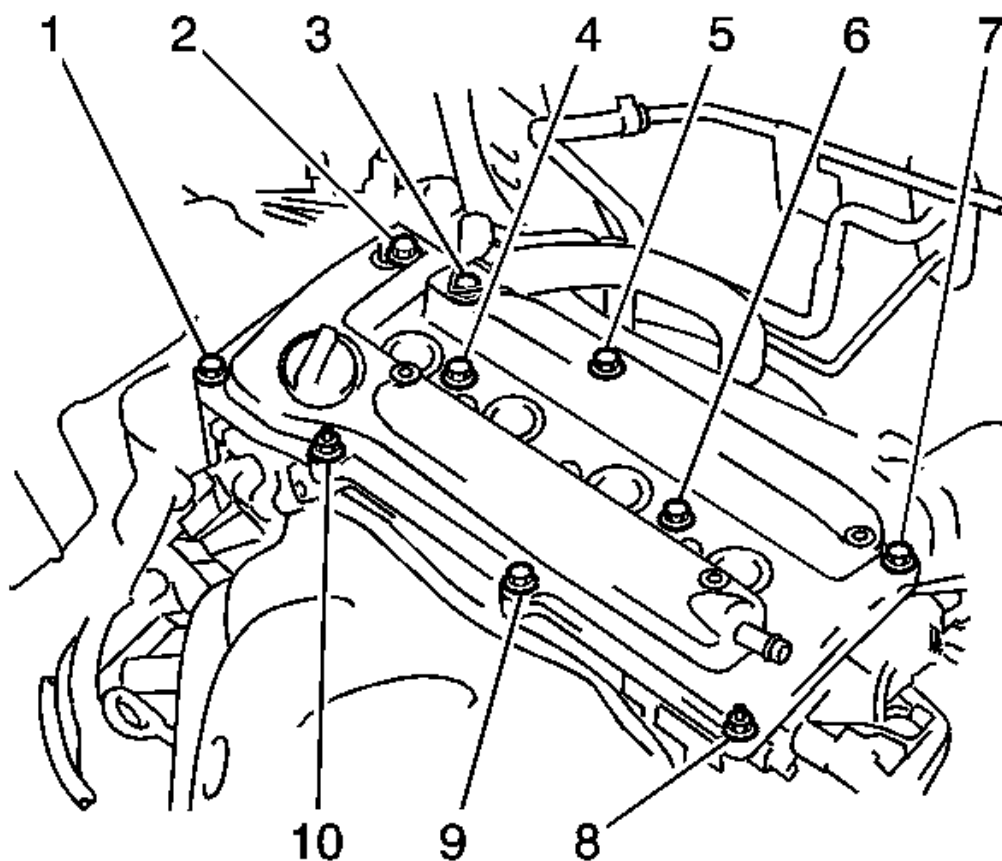


Fig. 69: Identifying Cylinder Head Cover Sub-Assembly Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the 8 bolts and 2 nuts, then remove the cylinder head cover sub-assembly and gasket.

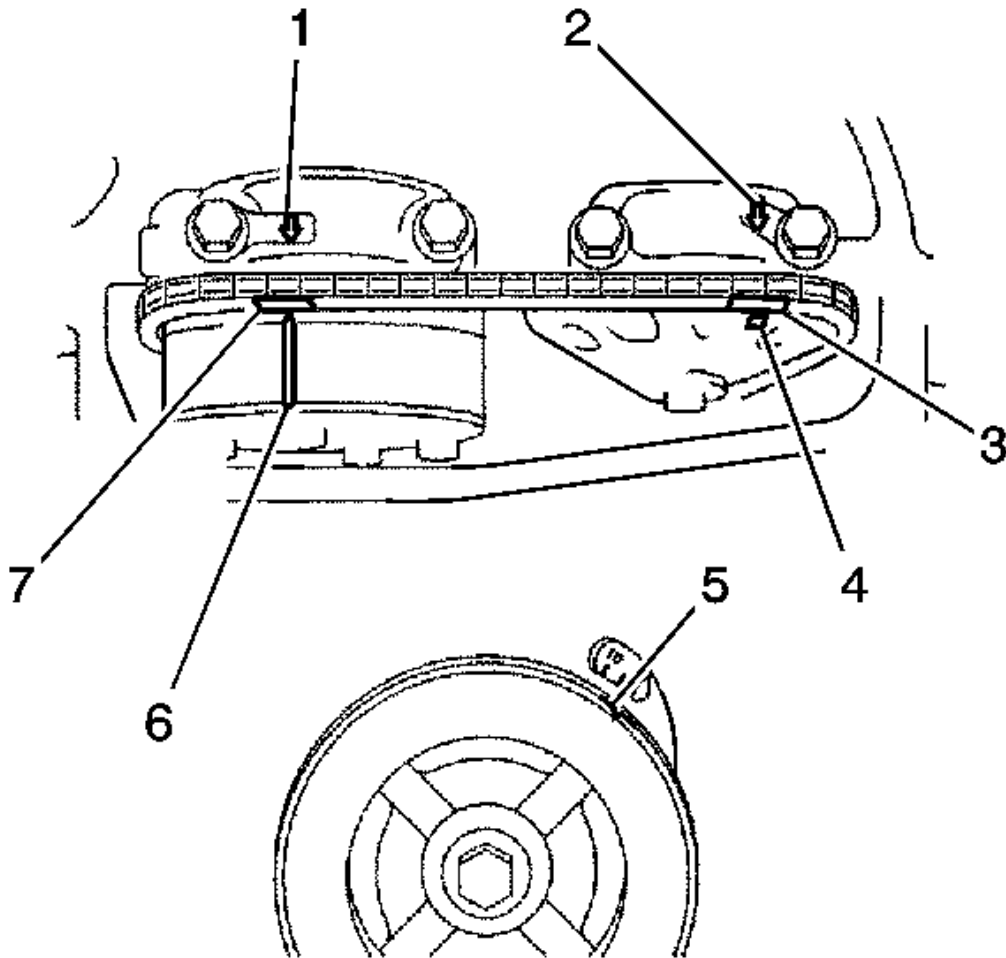


Fig. 70: Setting No. 1 Cylinder To TDC/compression Stroke
Courtesy of GENERAL MOTORS CORP.

8. Set No. 1 cylinder to TDC/compression by turning the crankshaft pulley until the groove and the timing mark "0" on the timing chain cover are aligned.
9. Check that each timing mark on the camshaft timing gear and sprocket is aligned with each timing mark located on the No. 1 and No. 2 bearing caps, as shown in the illustration.
10. If not, turn the crankshaft pulley by 1 revolution (360°) to align the timing marks as illustrated.
11. Place paint marks on the chain in alignment with the timing marks on the camshaft timing gear and camshaft timing sprocket.
12. Remove No. 1 chain tensioner assembly. See **Timing Chain Tensioner Removal**.

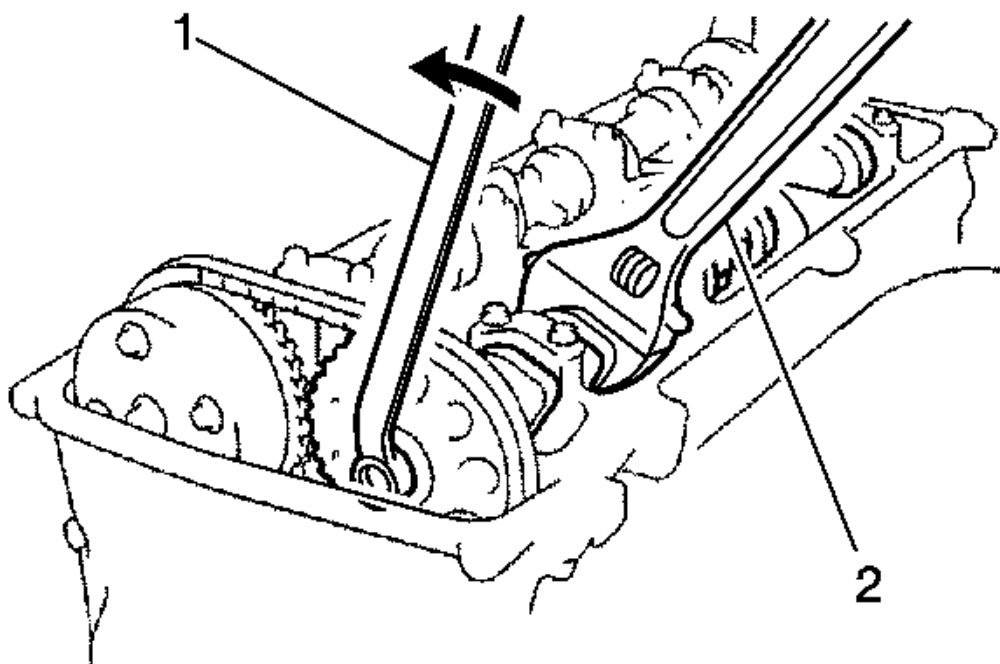


Fig. 71: Identifying Camshaft Timing Gear & Sprocket
Courtesy of GENERAL MOTORS CORP.

13. Loosen camshaft timing gear or sprocket. While holding the No. 2 camshaft with a wrench, loosen the No. 2 camshaft timing set bolt.

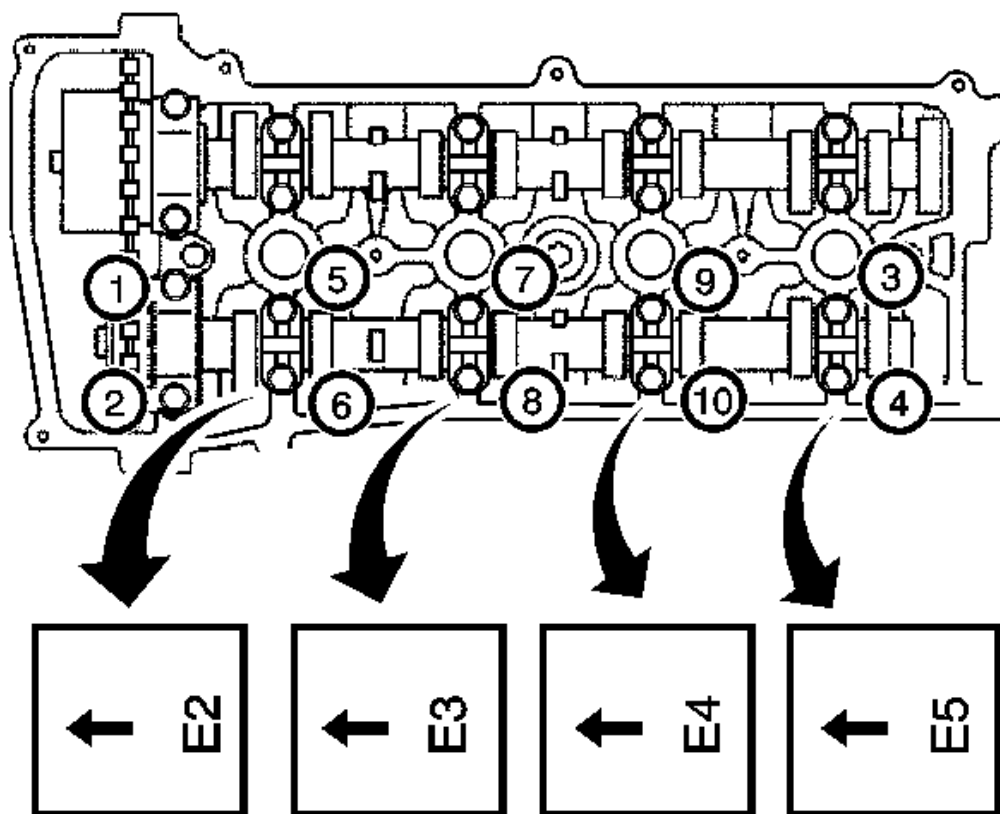


Fig. 72: View Of No. 2 Camshaft

Courtesy of GENERAL MOTORS CORP.

14. Remove No. 2 camshaft using several steps, uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.
15. Remove the 5 bearing caps.

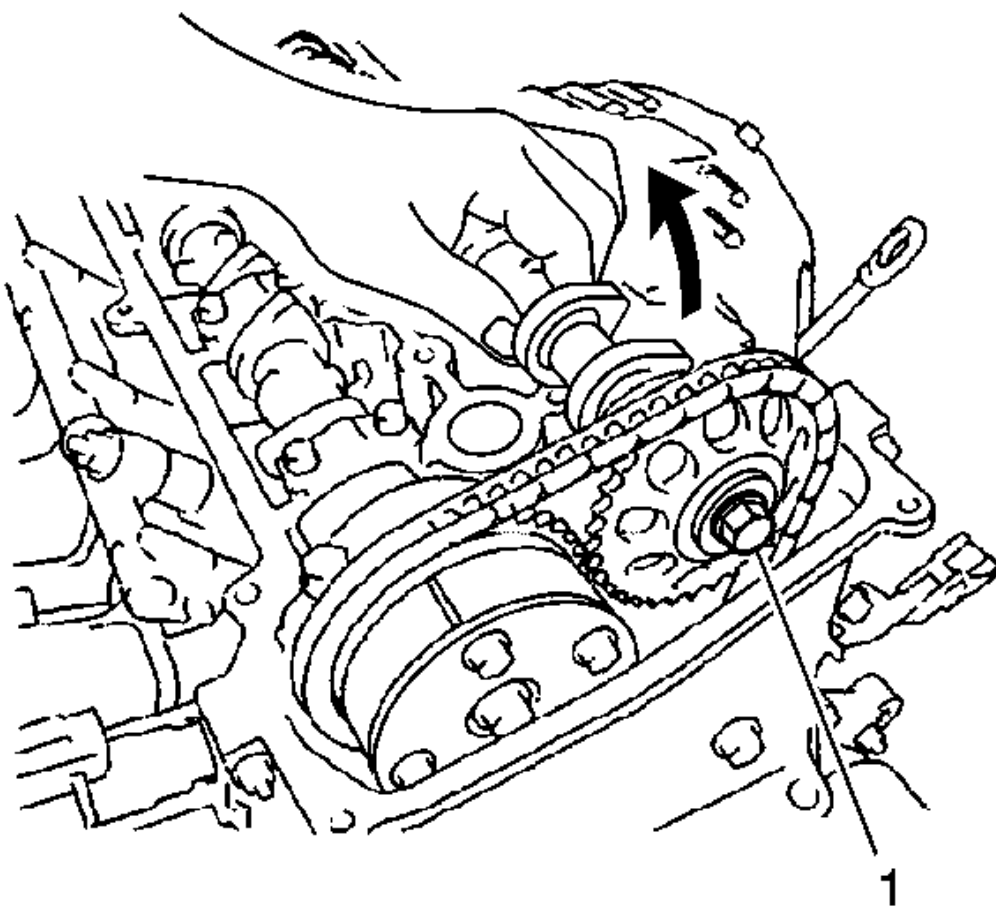


Fig. 73: View Of Camshaft Timing Sprocket & Set Bolt
Courtesy of GENERAL MOTORS CORP.

16. While holding the No. 2 camshaft by hand, remove the camshaft timing sprocket set bolt.
17. Remove the camshaft timing sprocket from the No. 2 camshaft with the timing chain wrapped on the sprocket.
18. Remove the camshaft timing sprocket from the timing chain.

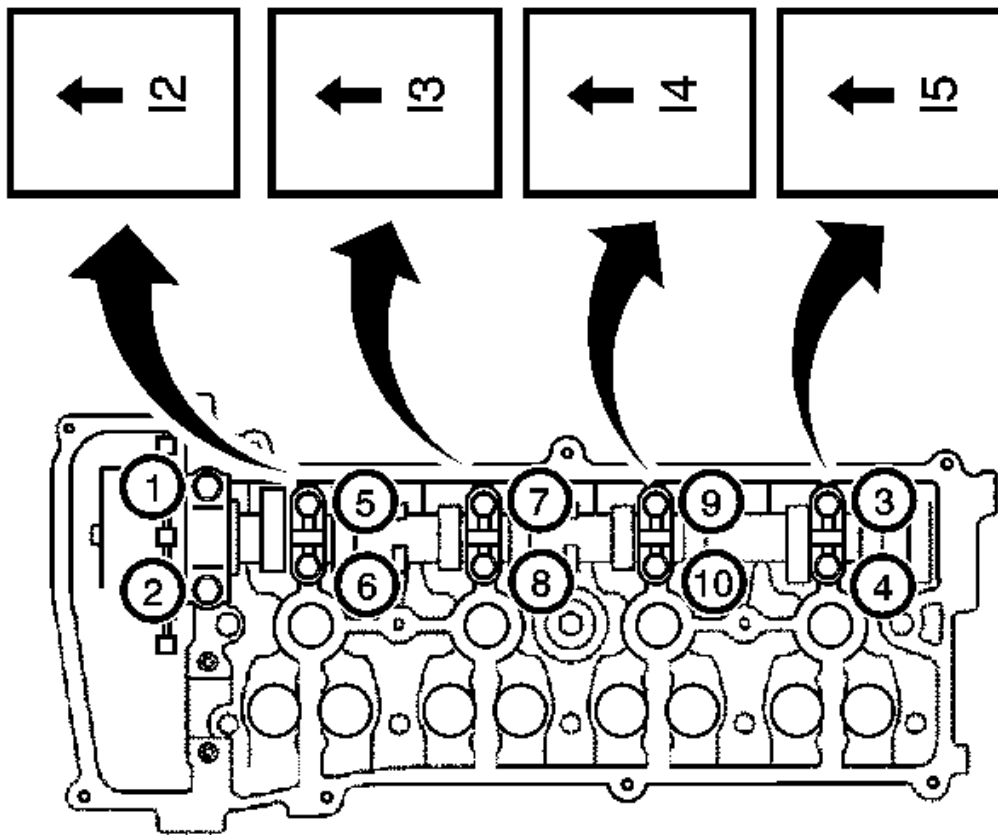


Fig. 74: View Of Removal Procedure
Courtesy of GENERAL MOTORS CORP.

19. Remove camshaft using several steps, uniformly loosen and remove the 10 bearing caps bolts in the sequence shown in the illustration.
20. Remove the 5 bearing caps.
21. Remove the camshaft and camshaft timing gear assembly while holding the timing chain by hand.

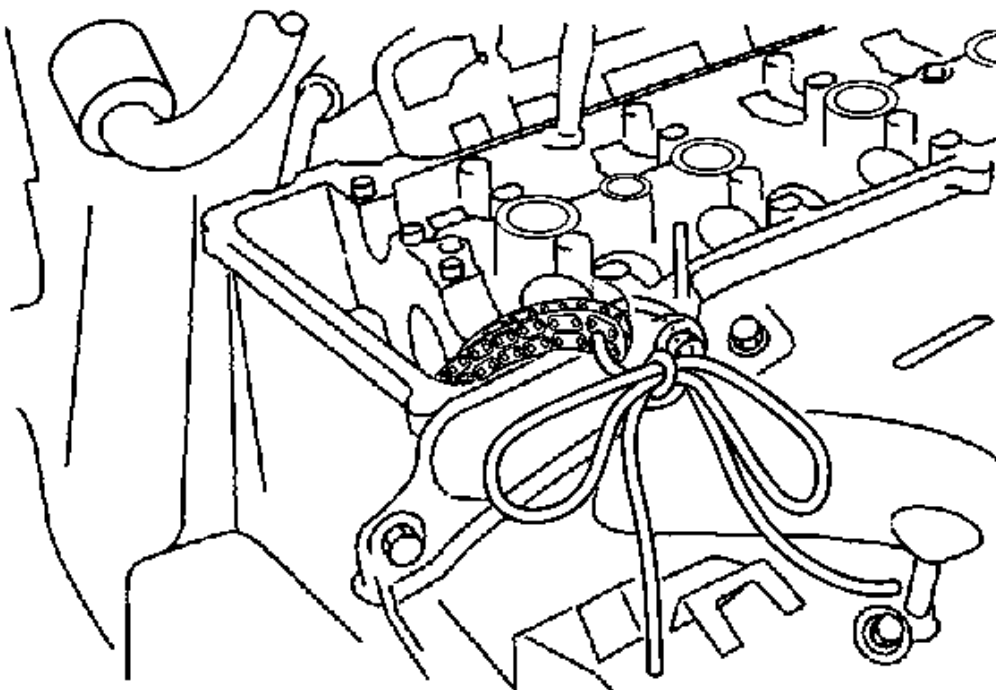


Fig. 75: View Of Supporting Timing Chain With String
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to drop anything inside the timing chain cover.

22. Support the timing chain with a string to prevent it from slipping off the crankshaft sprocket as shown in the illustration.

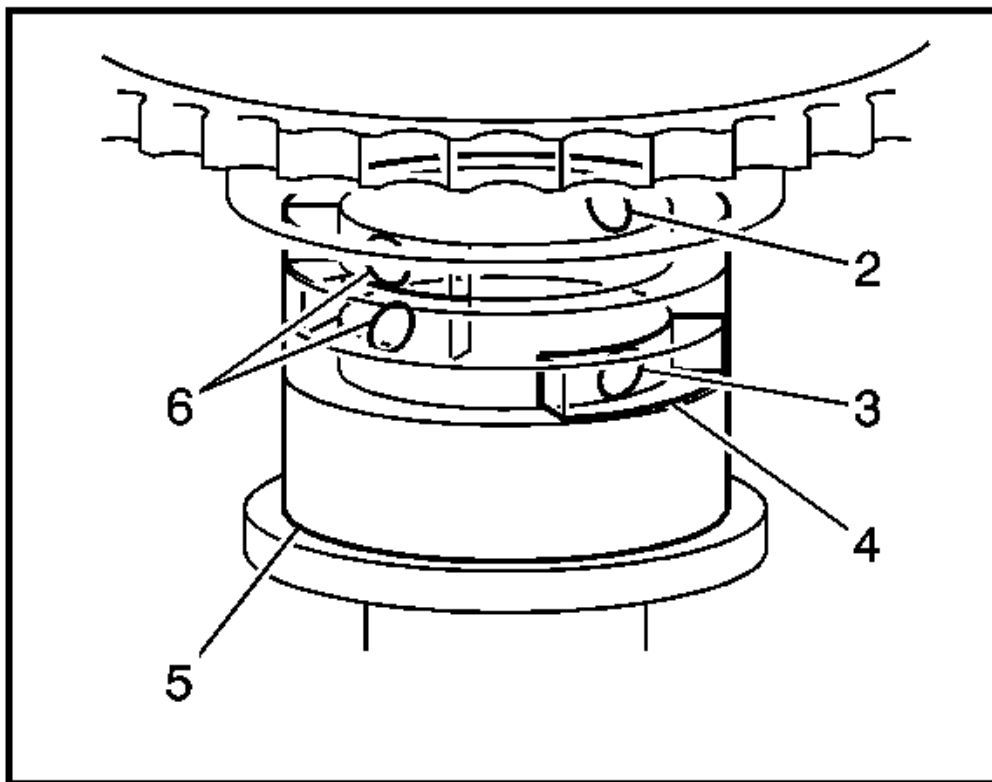
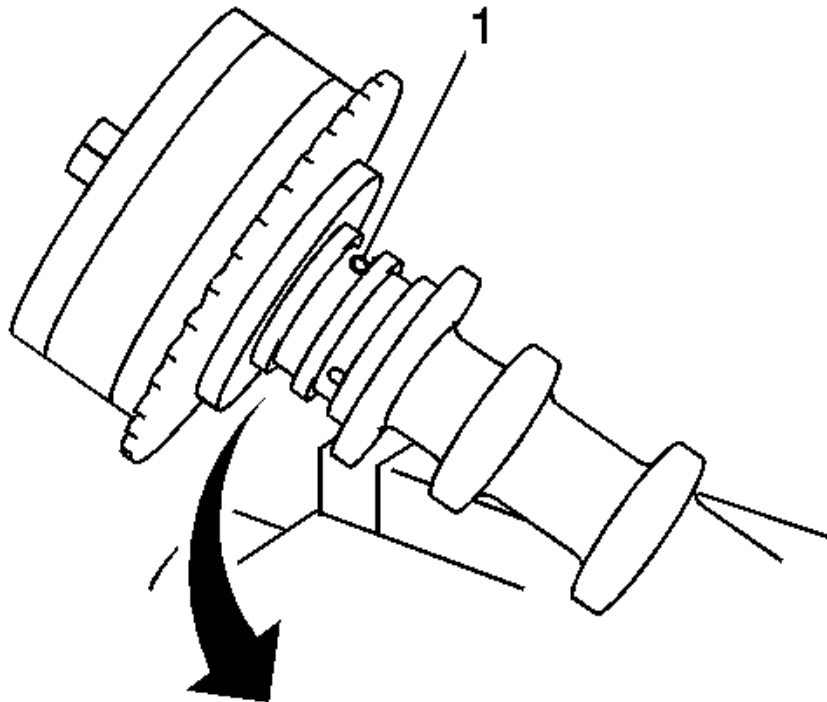


Fig. 76: View Of Camshaft & Timing Gear Assembly
Courtesy of GENERAL MOTORS CORP.

23. Remove camshaft timing gear assembly by clamping the camshaft in a vise, and make sure that the camshaft timing gear assembly does not rotate.
24. Cover all the oil path with vinyl tape except the advance side path shown in the illustration.

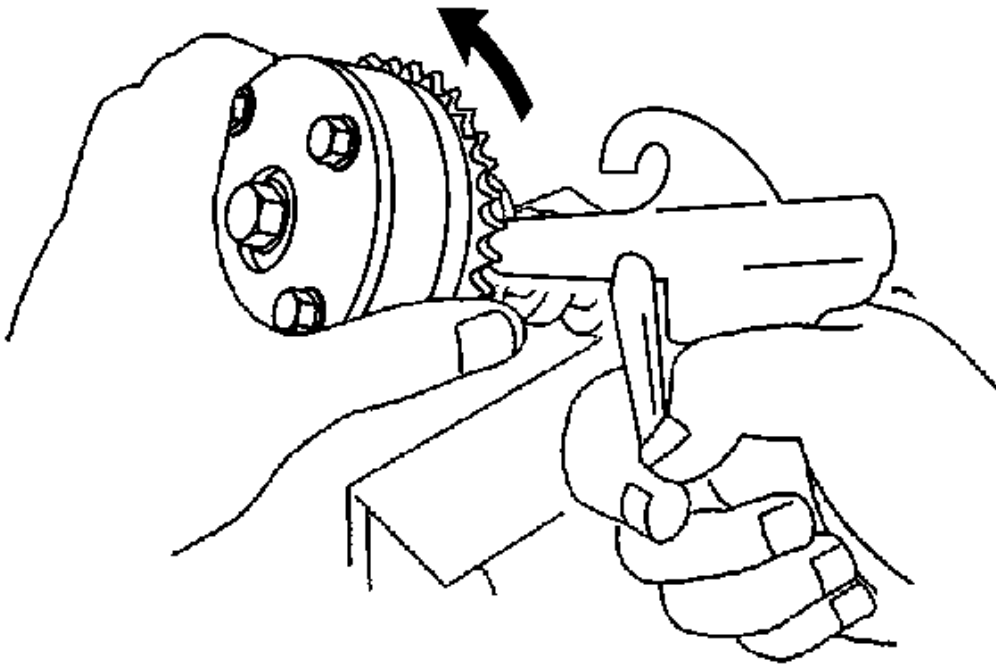


Fig. 77: View Of Oiling & Rotating Gear Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Cover the paths with a piece of cloth to avoid oil splashes.

25. Apply air pressure of 150 kPa (1.5 kgf/cm², 22 psi) to the oil path, then turn the camshaft timing gear assembly to the advance direction (counterclockwise) by hand.

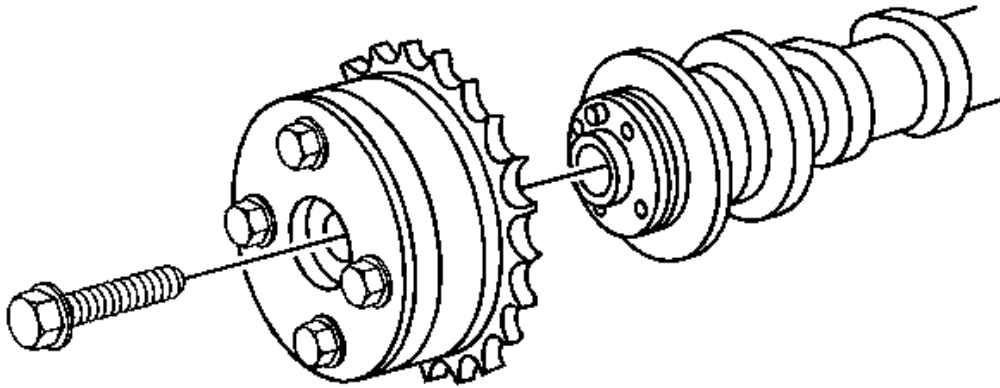


Fig. 78: View Of Camshaft Timing Gear Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure not to remove the other 4 bolts. When reusing the camshaft timing gear, release the straight pin lock first, then install the gear.

IMPORTANT: Depending on the air pressure, the camshaft timing gear assembly may turn to the advance side without applying force by hand. Also, if the pressure is difficult to apply because of air leakage from the port, the lock pin may be difficult to release.

26. Remove the flange bolt of the camshaft timing gear.

Inspection Procedure

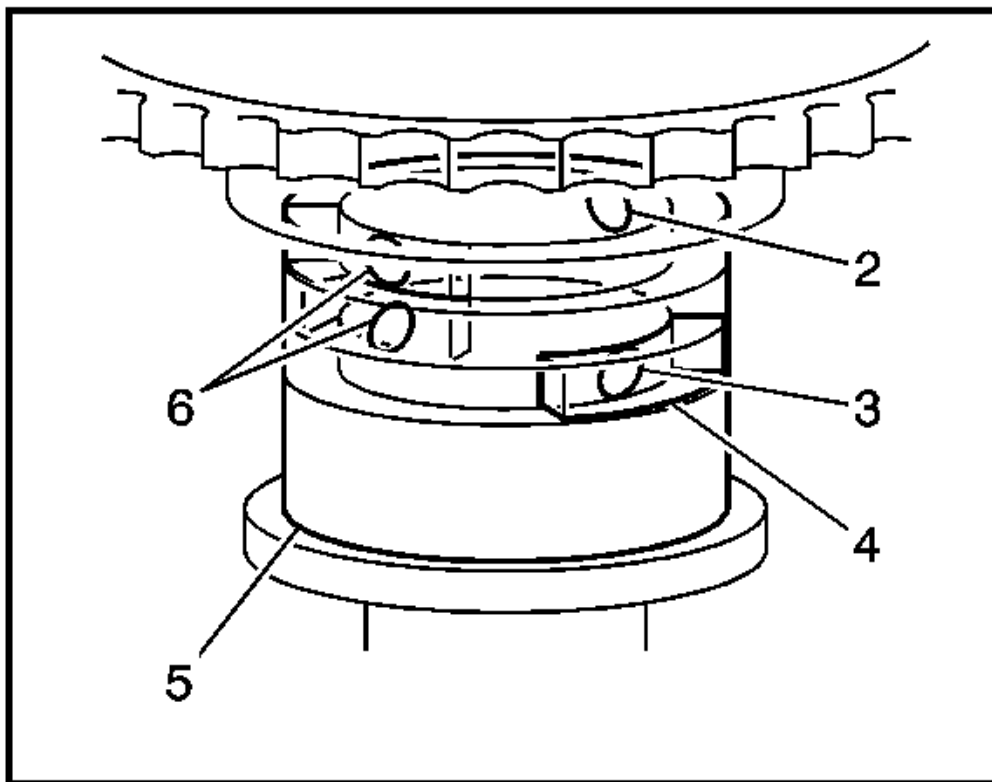
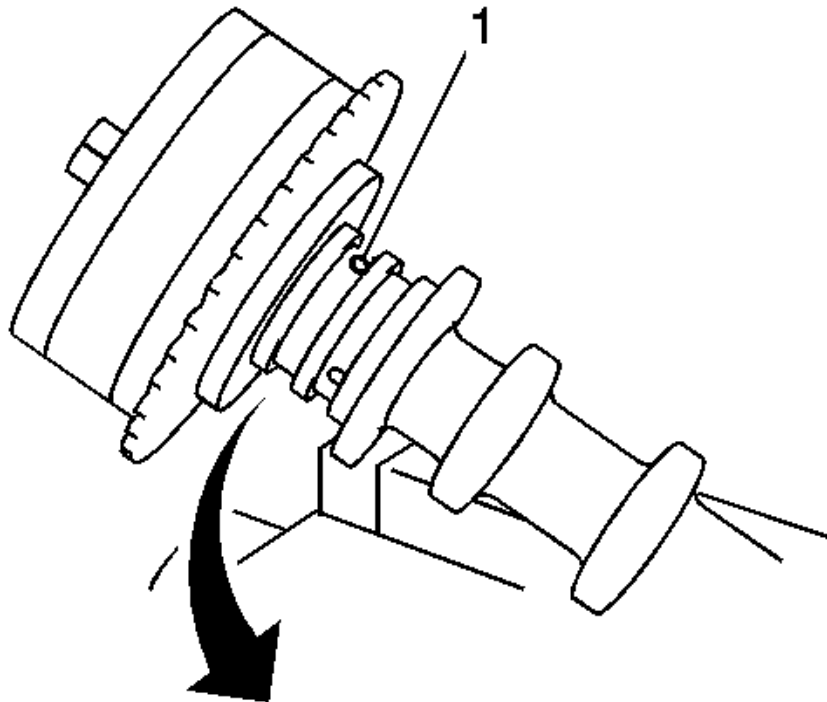


Fig. 79: View Of Camshaft Timing Gear
Courtesy of GENERAL MOTORS CORP.

1. Inspect camshaft timing gear assembly as follows.
 1. Install the camshaft timing gear assembly. See **Camshaft Timing Chain, Sprocket, and Tensioner Installation**.
 2. Clamp the camshaft in a vise, and make sure that the camshaft timing gear assembly does not rotate.
2. Cover all the oil paths with vinyl tape except the advance side path shown in the illustration.

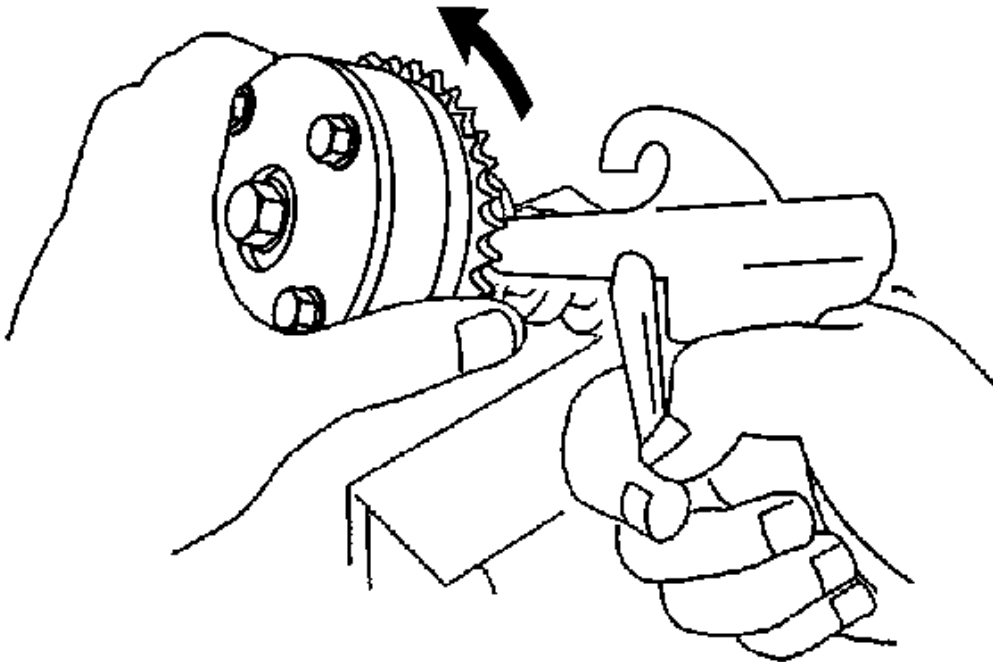


Fig. 80: View Of Oiling & Rotating Gear Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Cover the paths with a piece of cloth to avoid oil splashes.

3. Apply air pressure of 150 kPa (1.5 kgf/cm², 22 psi) to the oil path.

IMPORTANT: Depending on the air pressure, the camshaft timing gear may turn to the advance side without applying force by hand. Also, if enough air pressure

cannot be applied because of air leakage from the path, releasing the lock pin may be difficult.

4. Check that the camshaft timing gear revolves in the advance direction (counterclockwise) by hand.

NOTE: Do not use air pressure to perform the smooth rotation check.

5. Check for smooth rotation. Turn the camshaft timing gear within its movable range (21°) 2 or 3 times, but do not turn it to the most retarded position. Make sure that the gear turns smoothly.
6. Check the lock in the most retarded position. Confirm that the camshaft timing gear is locked at the most retarded position.
7. Remove the camshaft timing gear assembly.

Installation Procedure

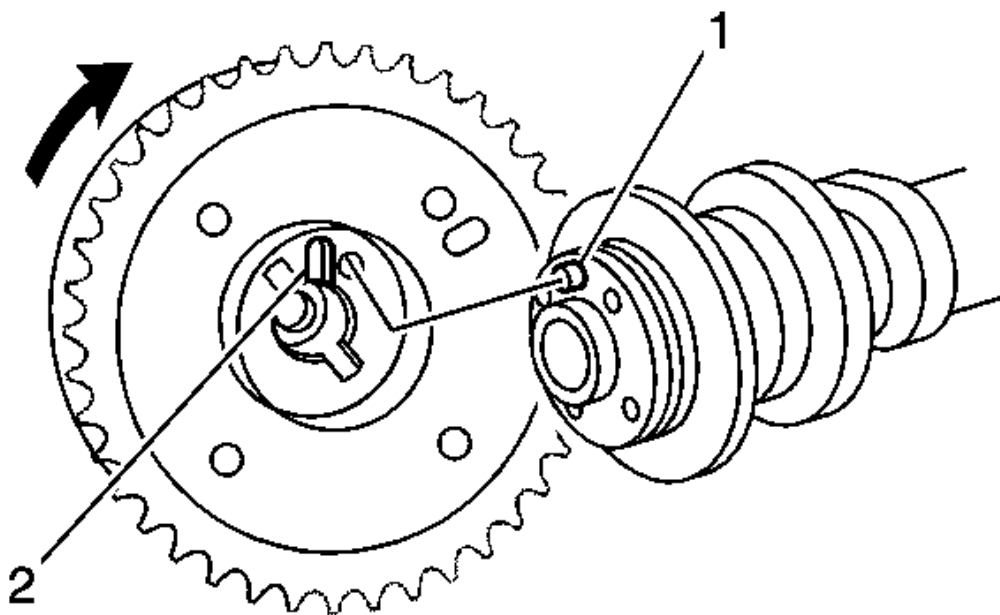


Fig. 81: View Of Camshaft Timing Gear
Courtesy of GENERAL MOTORS CORP.

1. Install camshaft timing gear assembly by putting the camshaft timing gear and camshaft together with the straight pin and key groove misaligned, as shown in the illustration.

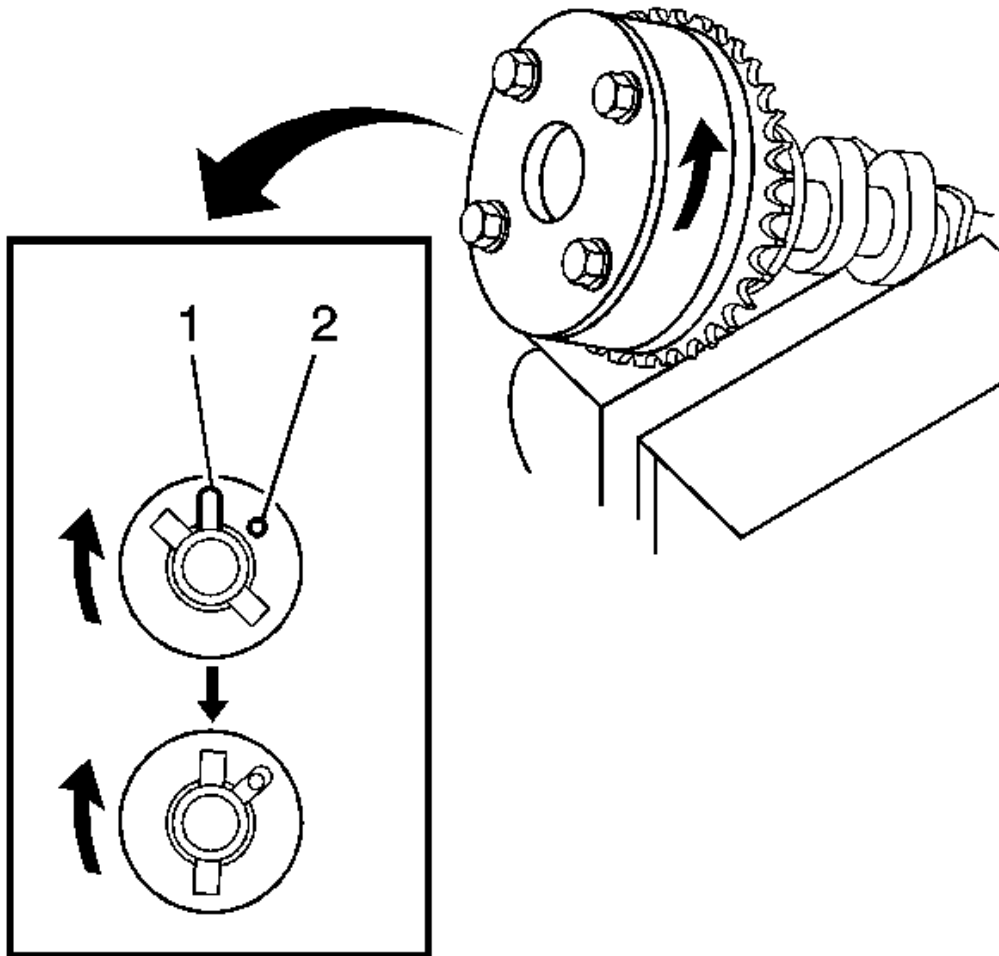


Fig. 82: View Of Turning Camshaft Timing Gear In Retard Direction (Clockwise)
Courtesy of GENERAL MOTORS CORP.

NOTE: Be sure not to turn the camshaft timing gear to the retard direction (clockwise).

2. Turn the camshaft timing gear as shown in the illustration while pushing it gently against the camshaft. Push further at the position where the pin fits into the groove.
3. Check that there is no clearance between the gear flange and camshaft.

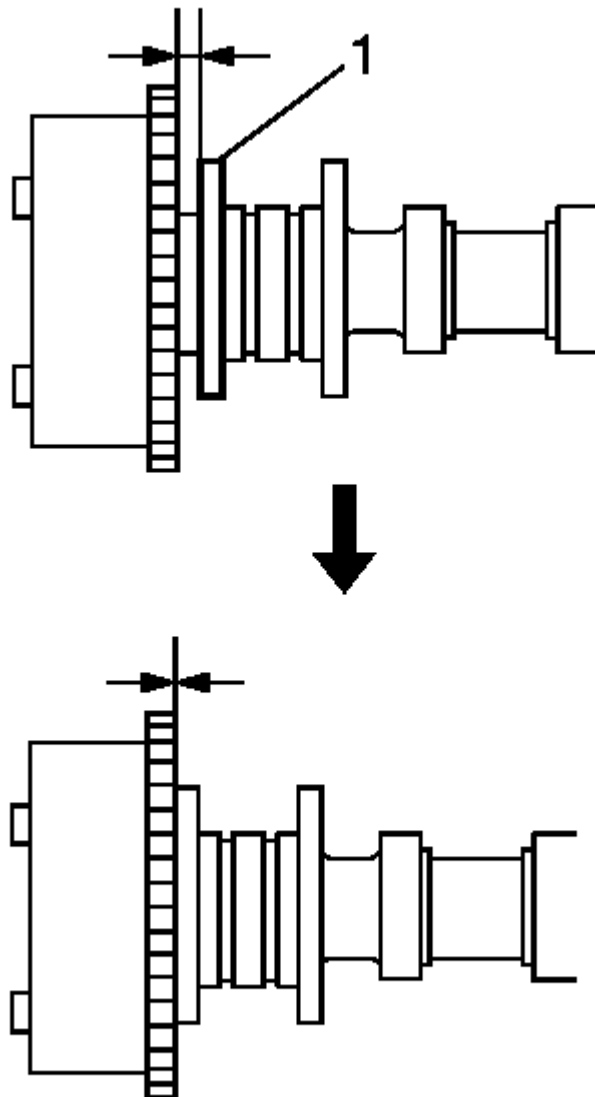


Fig. 83: Checking For Clearance Between Gear Flange & Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Check that there is no clearance between the gear flange and camshaft.

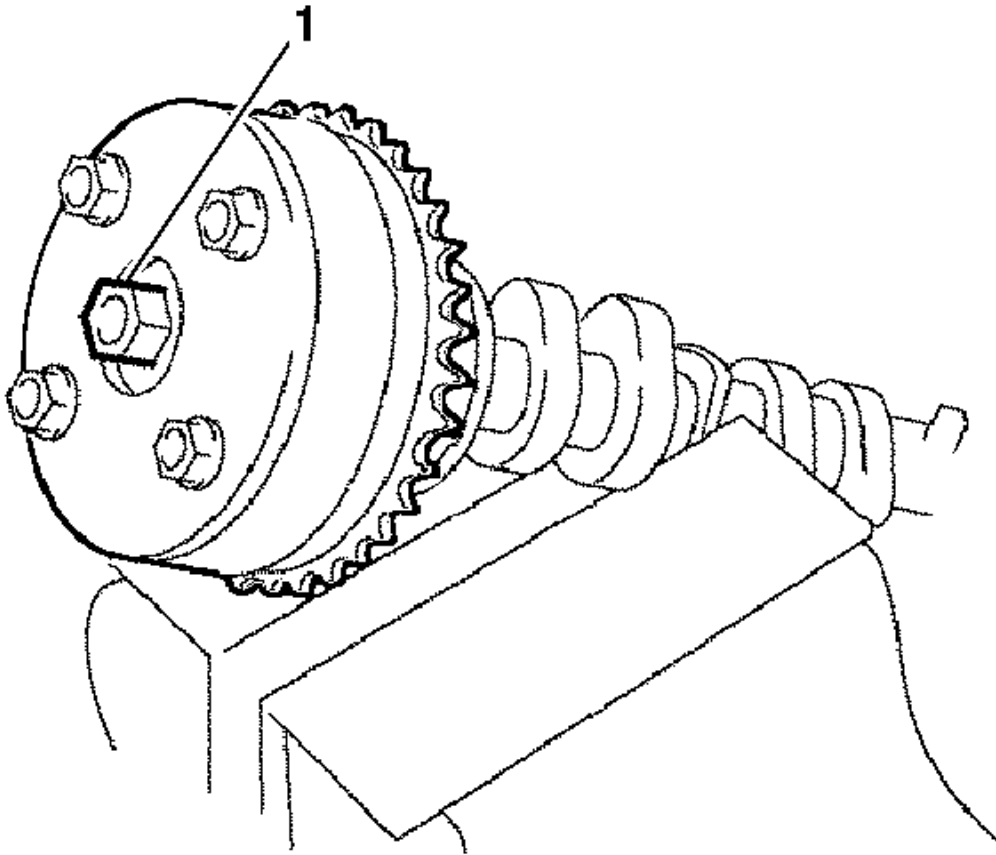


Fig. 84: View Of Camshaft Timing Gear Bolt
Courtesy of GENERAL MOTORS CORP.

5. Tighten the flange bolt with the camshaft timing gear assembly fixed in place.

Tighten: 54 N.m (40 lb ft)

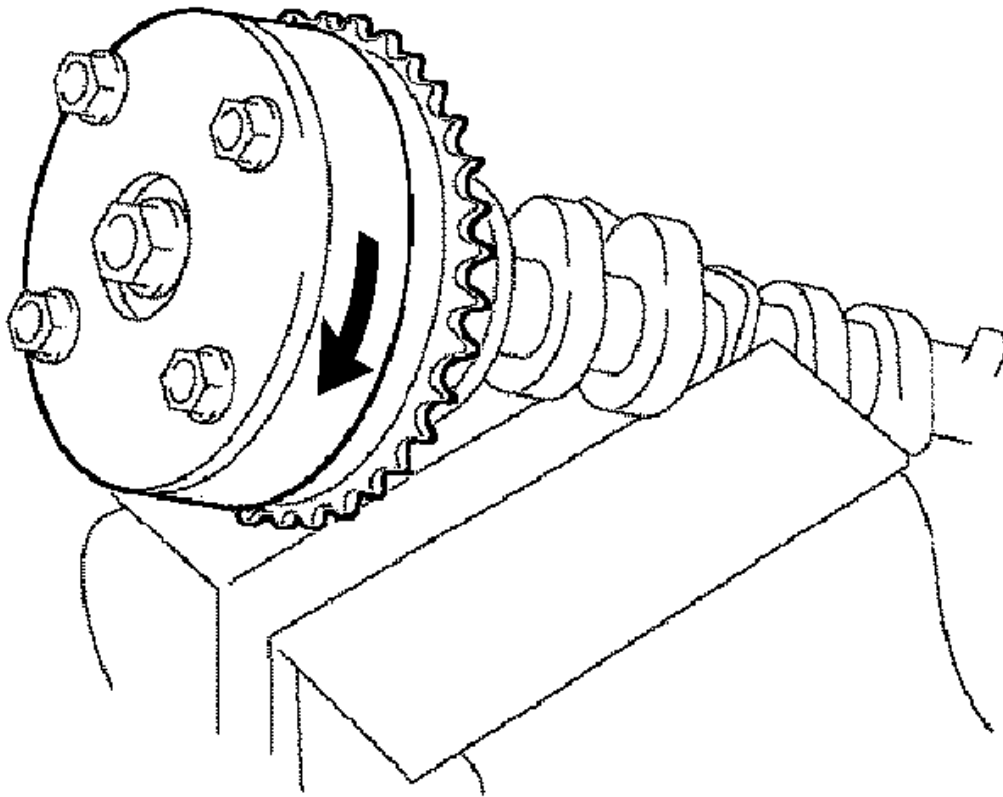


Fig. 85: Rotating Camshaft Timing Gear In Retard Direction (Clockwise)
Courtesy of GENERAL MOTORS CORP.

6. Check that the camshaft timing gear assembly can move to the retard direction (clockwise) and is locked in the most retarded position.

Installation Procedure

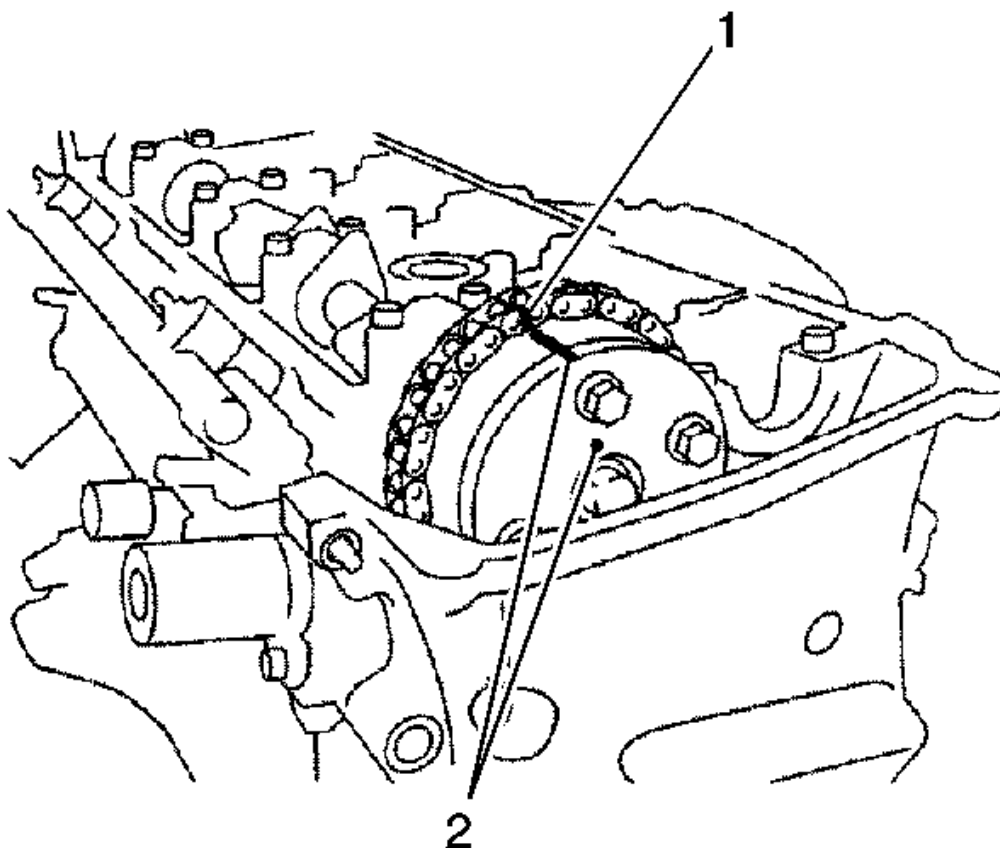


Fig. 86: View Of Journal Portion Of Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Apply a light coat of engine oil to the journal portion of the camshaft.
2. Install the timing chain onto the camshaft timing gear with the paint mark aligned with the timing mark on the camshaft timing gear as shown in the illustration.

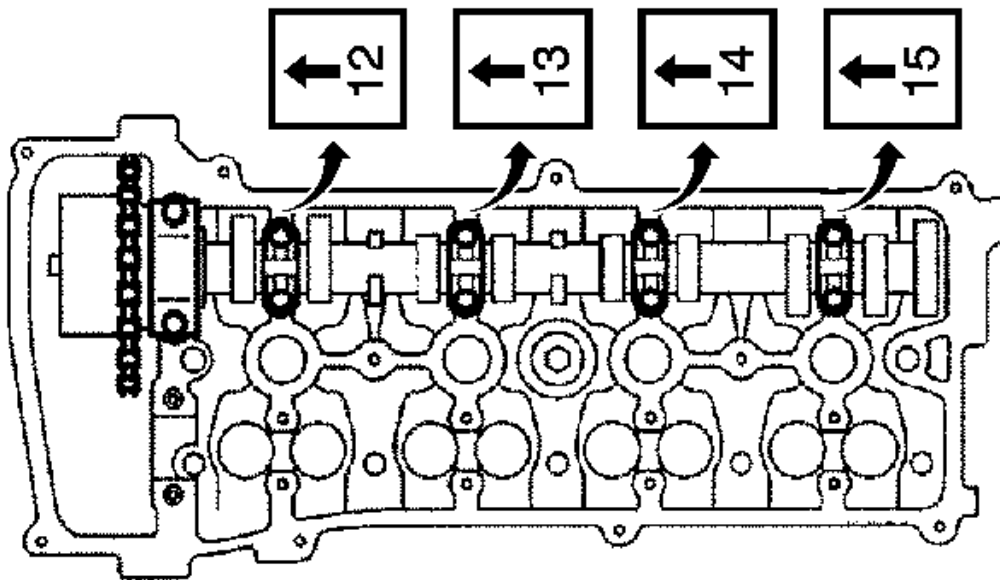


Fig. 87: Identifying Installation Procedure
Courtesy of GENERAL MOTORS CORP.

3. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps into the cylinder head.
4. Apply a light coat of engine oil on the threads and under the heads of the bearing cap bolts.

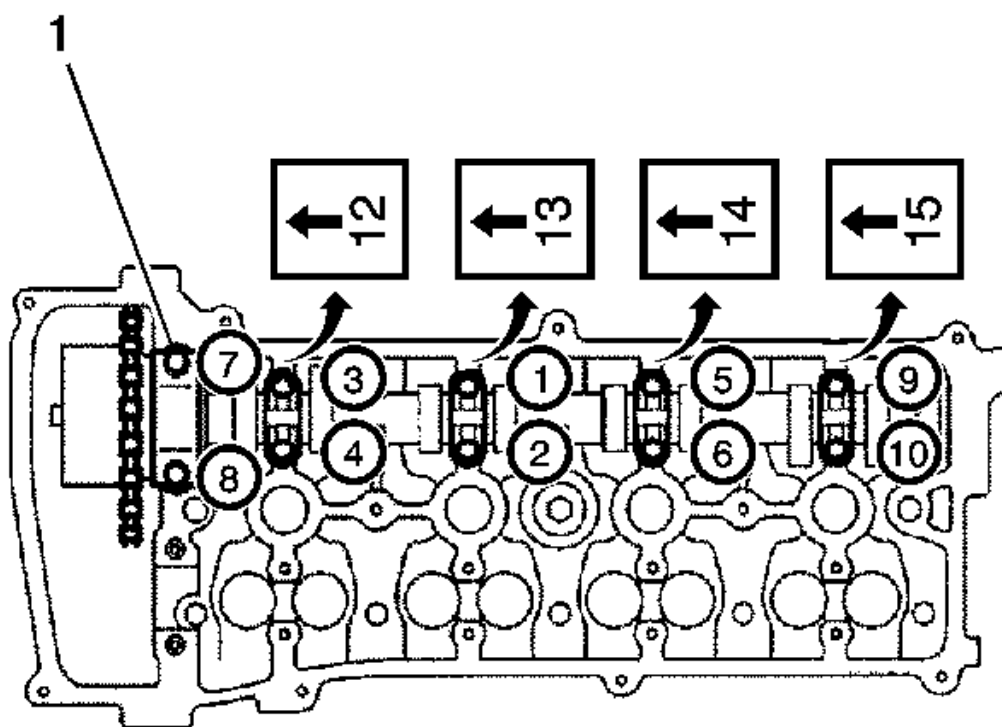


Fig. 88: View Of Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten: No. 1 bearing 30 N.m (22 lb ft). No. 3 bearing 9.0 N.m (80 lb in)

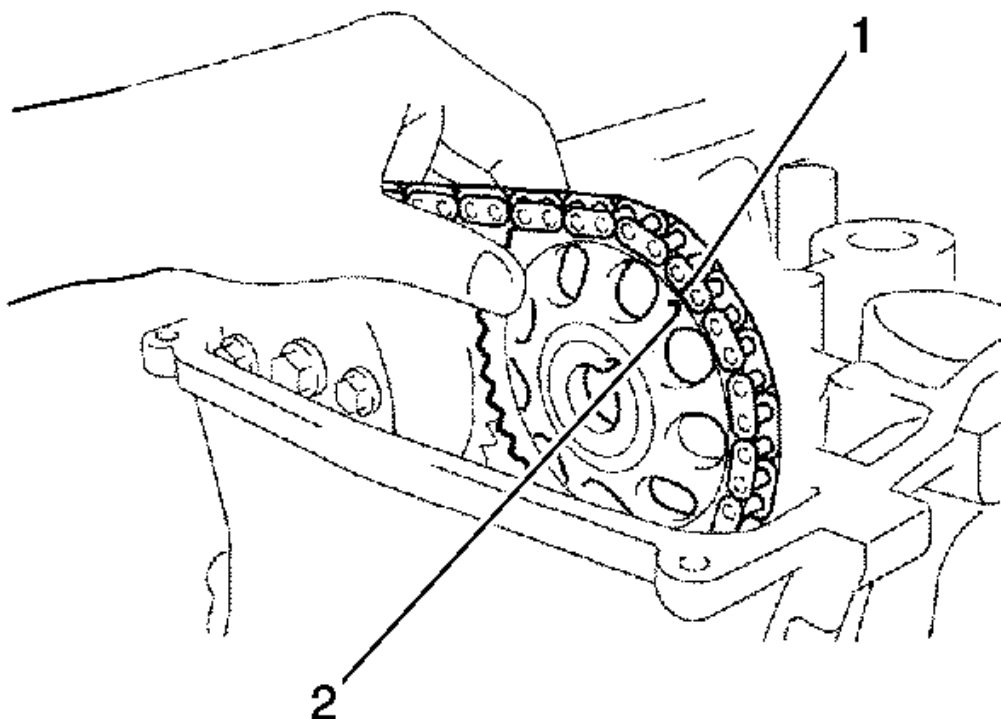


Fig. 89: View Of Timing Chain Alignment Marks
Courtesy of GENERAL MOTORS CORP.

6. Install No. 2 camshaft.
 1. Apply a light coat of engine oil to the journal portion of the No. 2 camshaft.
 2. Put the No. 2 camshaft on the cylinder head with the paint mark on the chain aligned with the timing mark on the camshaft timing sprocket.

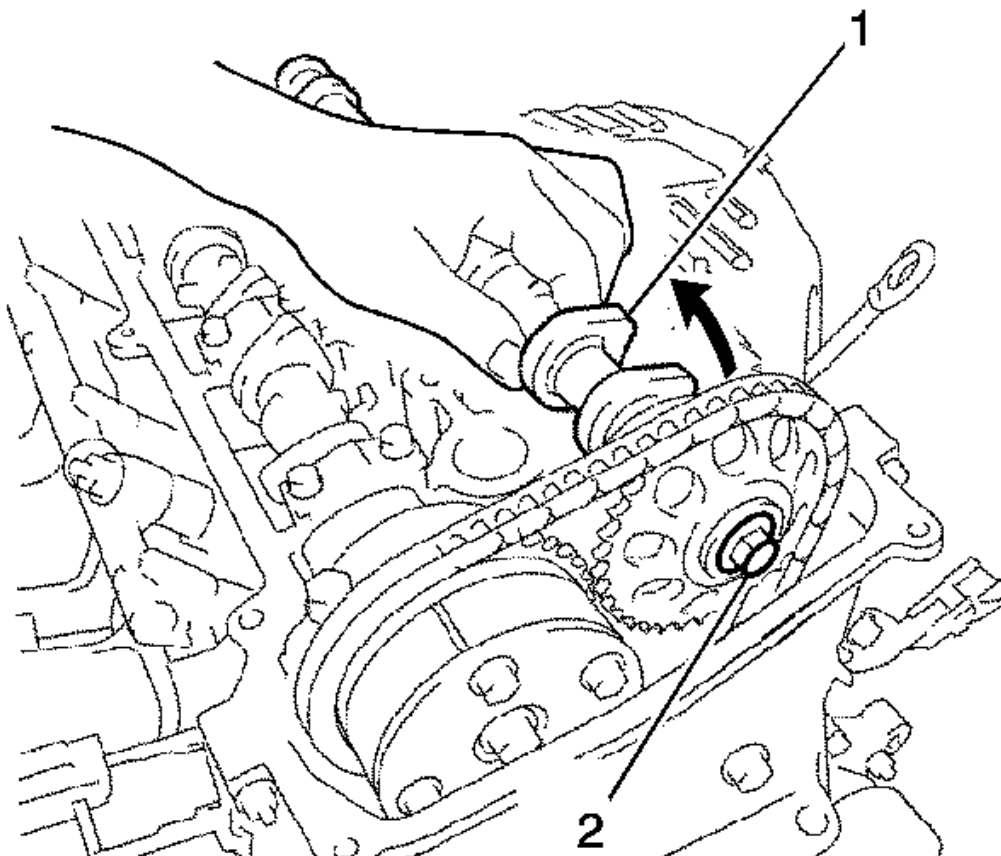


Fig. 90: View Of Tightening Camshaft Timing Sprocket Set Bolt
Courtesy of GENERAL MOTORS CORP.

7. While holding the No. 2 camshaft by hand, temporarily tighten the camshaft timing sprocket set bolt.

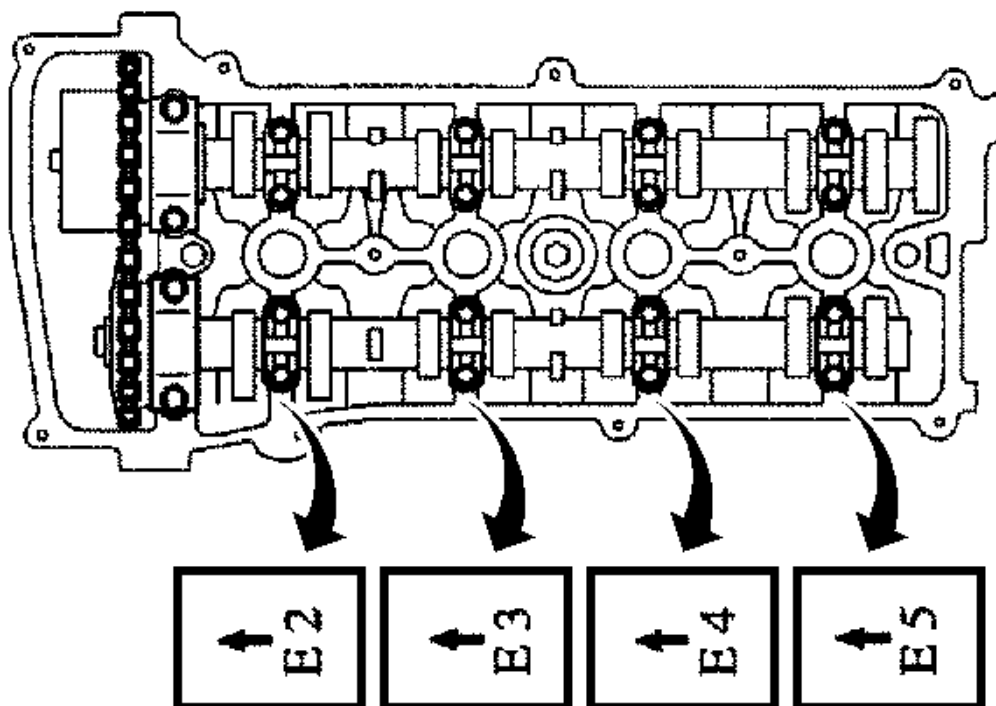


Fig. 91: View Of Front Marks & Numbers On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps onto the cylinder head.
9. Apply a light coat of engine oil to the threads and under the heads of the bearing cap bolts.

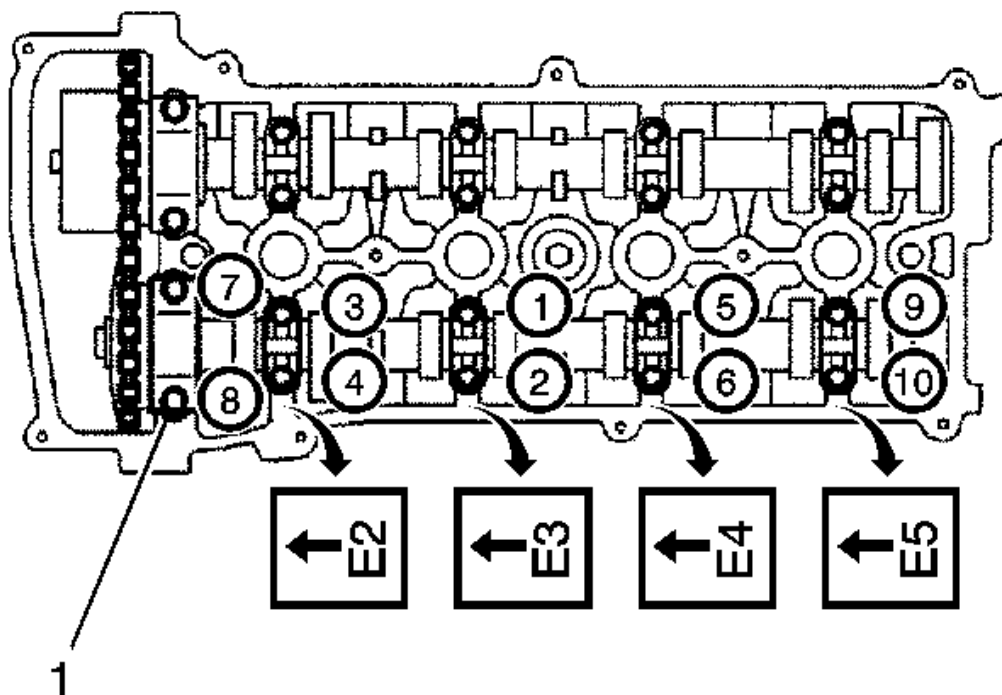


Fig. 92: Identifying Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten: No. 2 bearing 30 N.m (22 lb ft). No. 3 bearing 9.0 N.m (80 lb in).

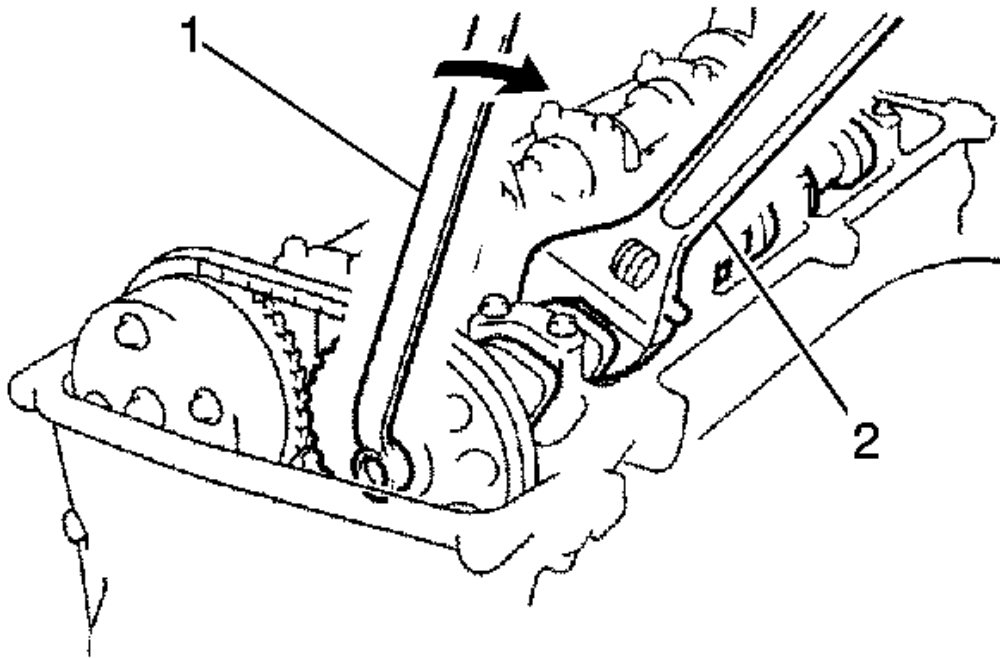


Fig. 93: View Of Tightening Camshaft Timing Sprocket Set Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the valve lifter.

11. While holding the camshaft with a wrench, tighten the camshaft timing sprocket set bolt.

Tighten: 54 N.m (40 lb ft).

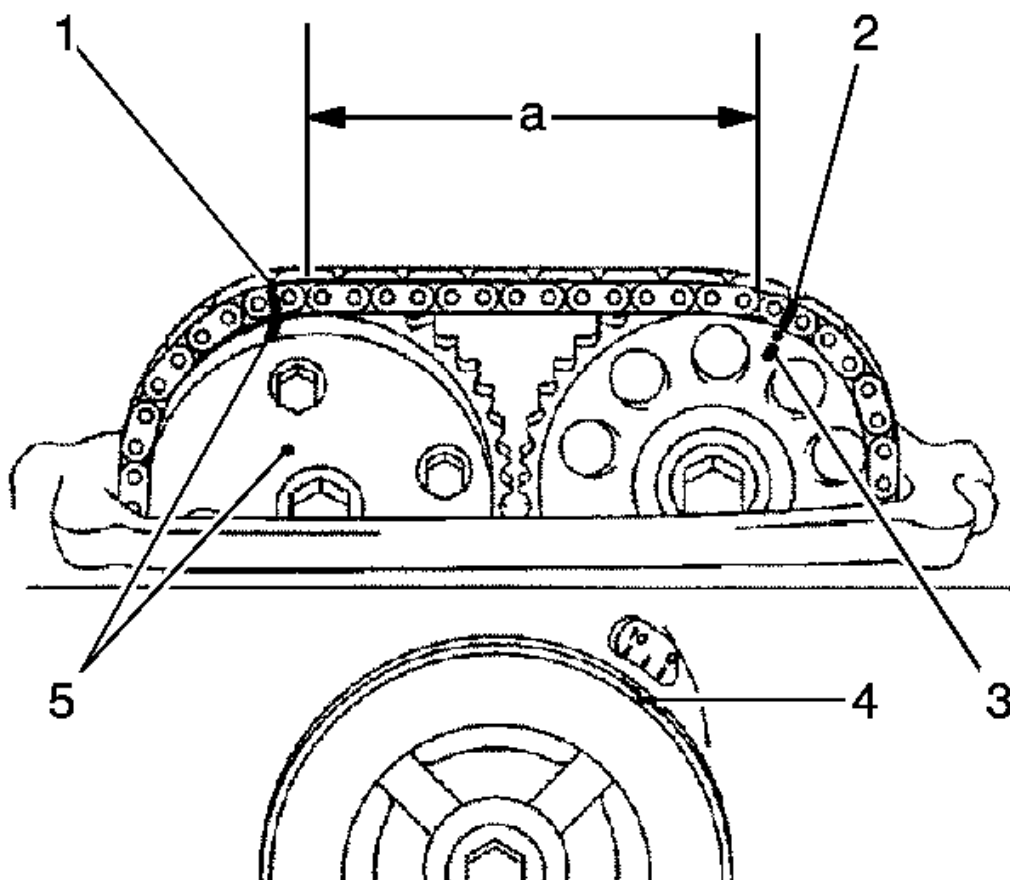


Fig. 94: Checking Timing Chain Paint Mark Alignment
Courtesy of GENERAL MOTORS CORP.

12. Check that the paint marks on the chain are aligned with the timing marks on the camshaft timing gear and camshaft timing sprocket. Also, check that the crankshaft pulley groove is aligned with the timing mark 0 on the timing mark chain cover.

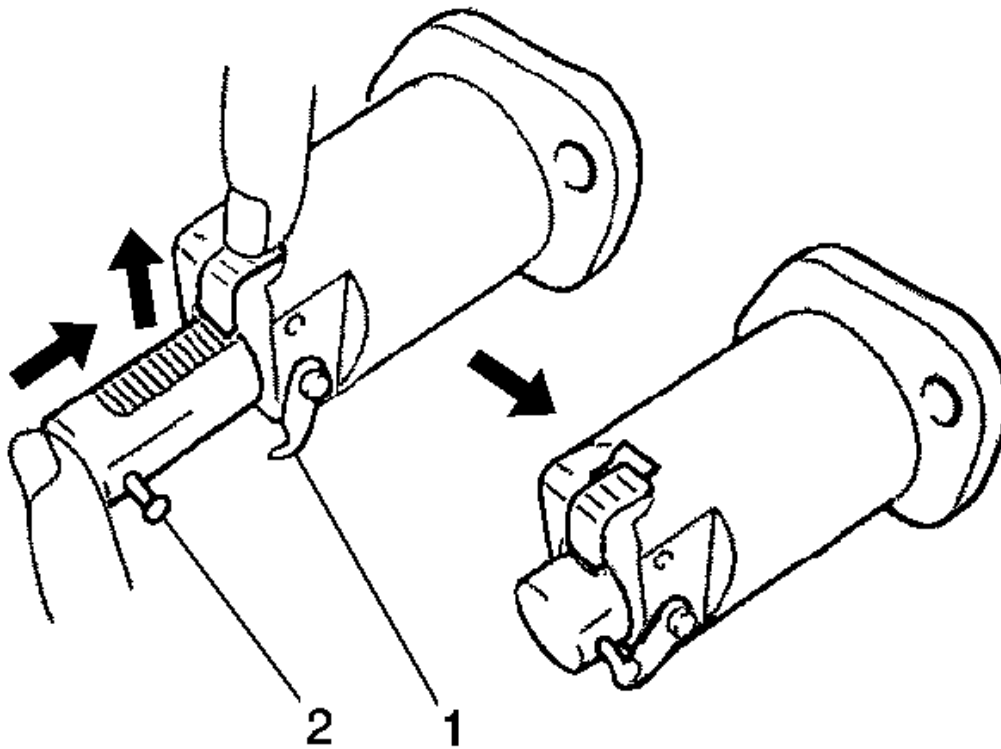


Fig. 95: View Of Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

13. Install No. 1 chain tensioner assembly. Release the ratchet pawl, then fully push in the plunger and hook the hook to the pin so that the plunger is in the position shown in the illustration.

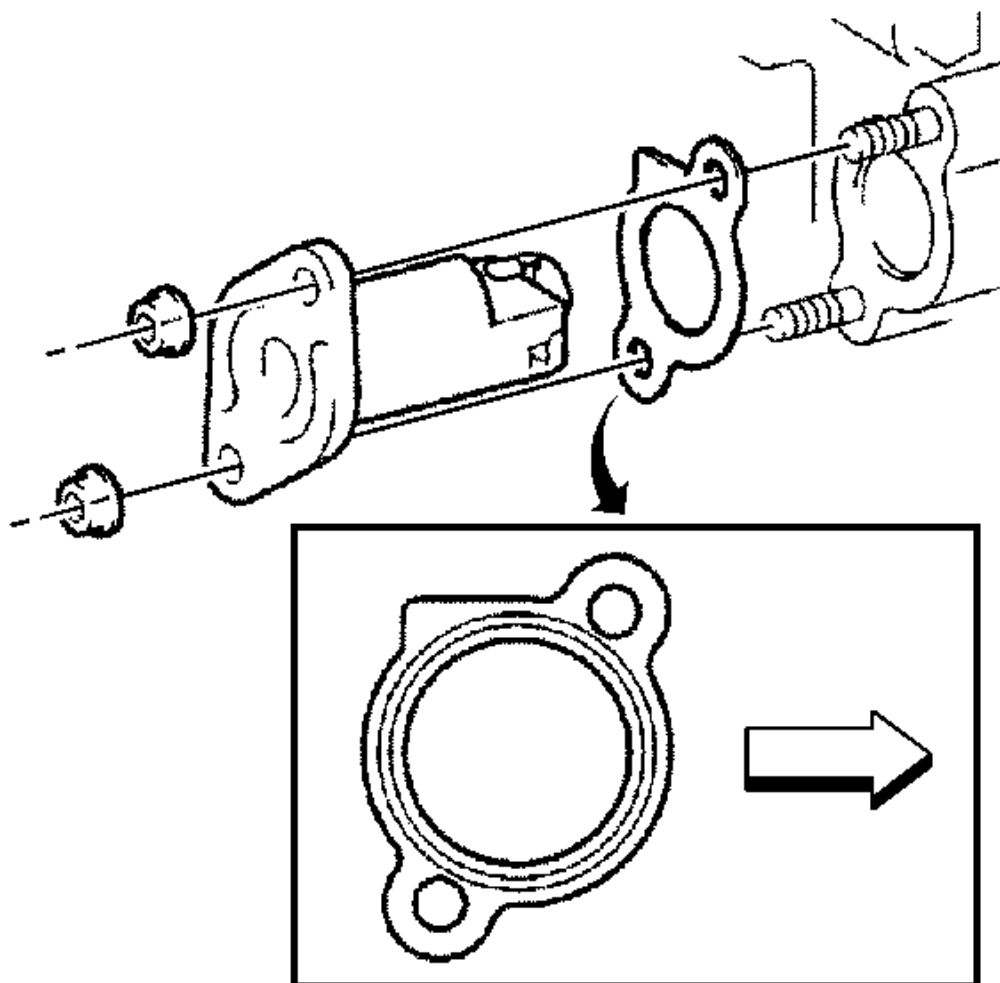


Fig. 96: View Of Chain Tensioner, Gasket & Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing the chain tensioner, set the hook again if the hook releases the plunger.

14. Install a new gasket and the chain tensioner with the 2 nuts.

Tighten: 9.0 N.m (80 lb in).

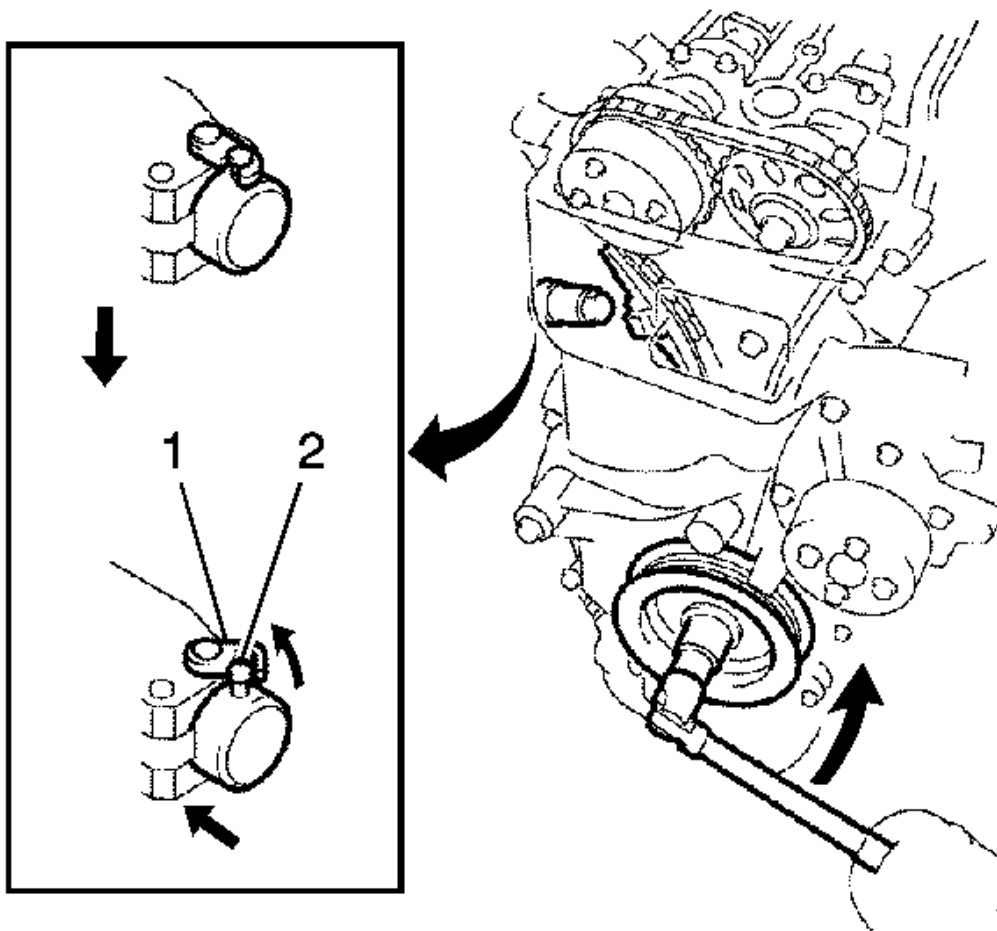


Fig. 97: Rotating Crankshaft Counterclockwise
Courtesy of GENERAL MOTORS CORP.

15. Turn the crankshaft counterclockwise, then disconnect the plunger knock pin from the hook.

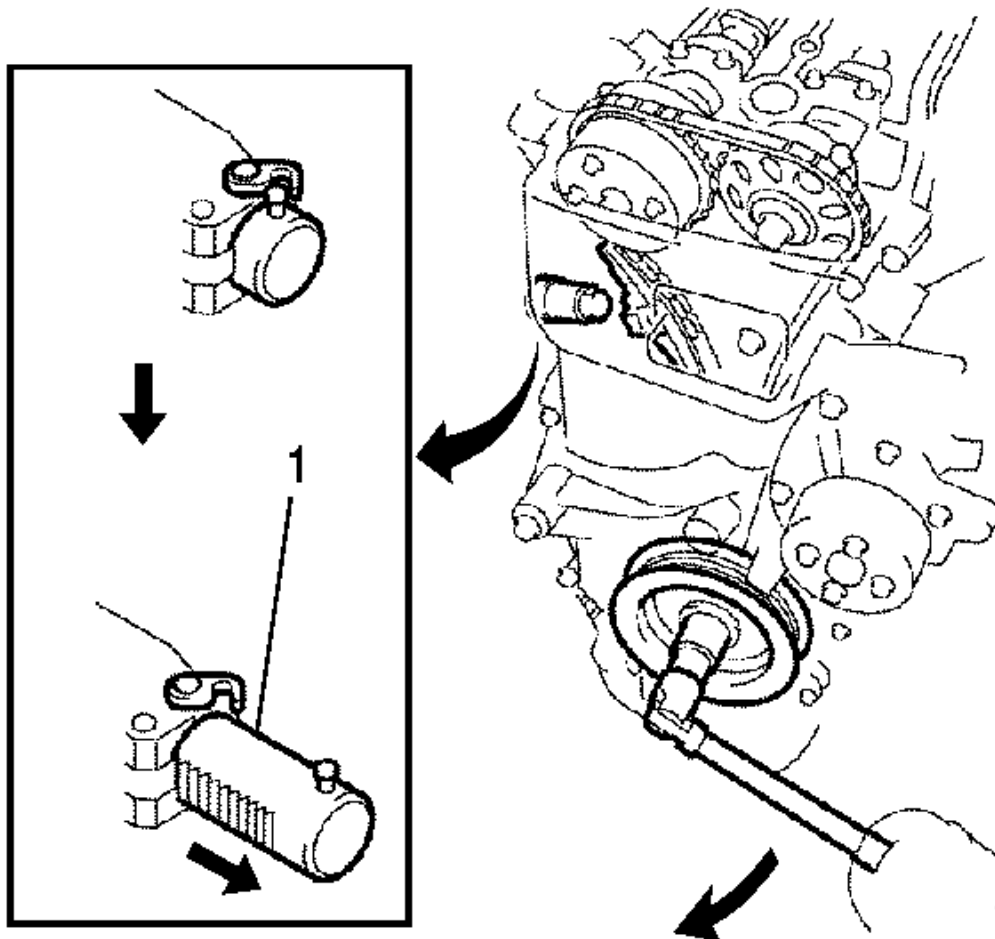


Fig. 98: View Of Chain Tensioner & Plunger
 Courtesy of GENERAL MOTORS CORP.

16. Turn the crankshaft clockwise, then check that the plunger is extended.
17. Set No. 1 cylinder to TDC/compression.
18. Check valve clearance. See Valve Clearance Adjustment.
19. Adjust valve clearance. See Valve Clearance Adjustment.
20. Install cylinder head cover sub-assembly. Remove any old packing material from the contact surface.

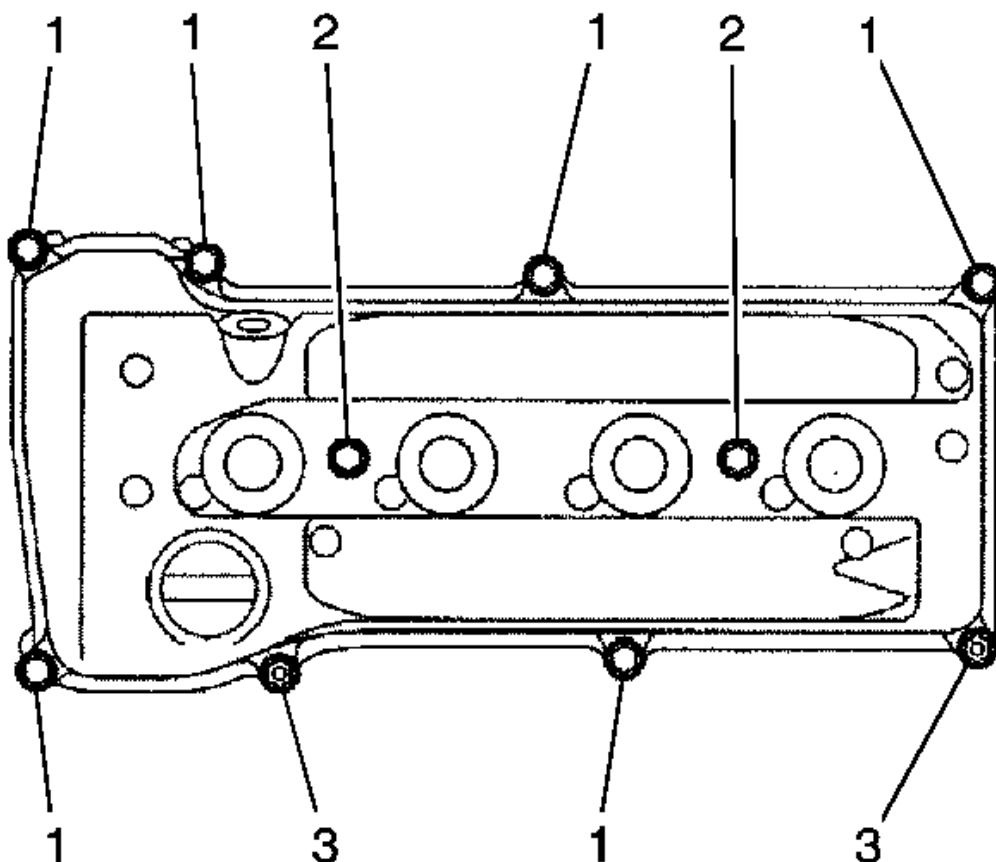


Fig. 99: Identifying Cylinder Head Cover Bolt/Nut Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

21. Install the cylinder head cover gasket and subassembly with the 8 bolts and 2 nuts.

Tighten: Bolt A-11 N.m (8 lb ft). Bolt B-14 N.m (10 lb ft) Nut 11 N.m (8 lb ft)

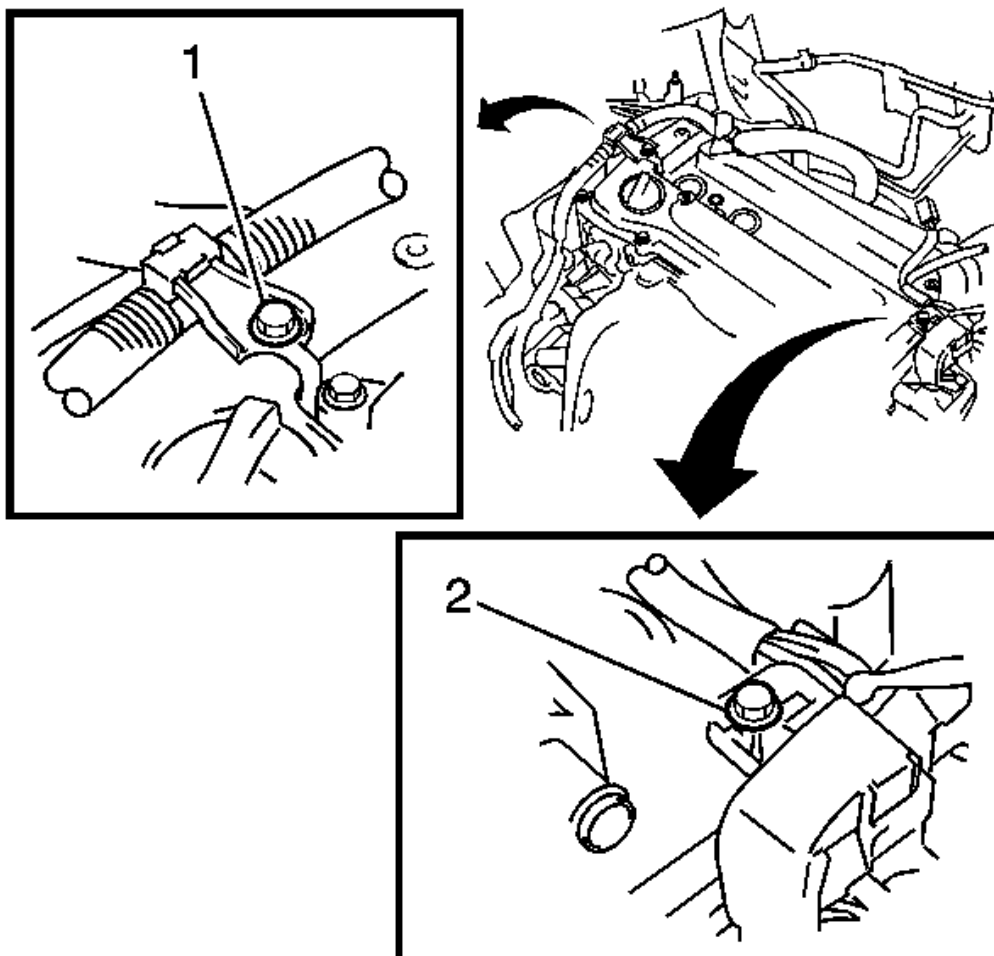


Fig. 100: View Of Wire Harness Brackets
Courtesy of GENERAL MOTORS CORP.

22. Install the 2 engine wire harness brackets with the 2 bolts.

Tighten: 8.4 N.m (74 lb in).

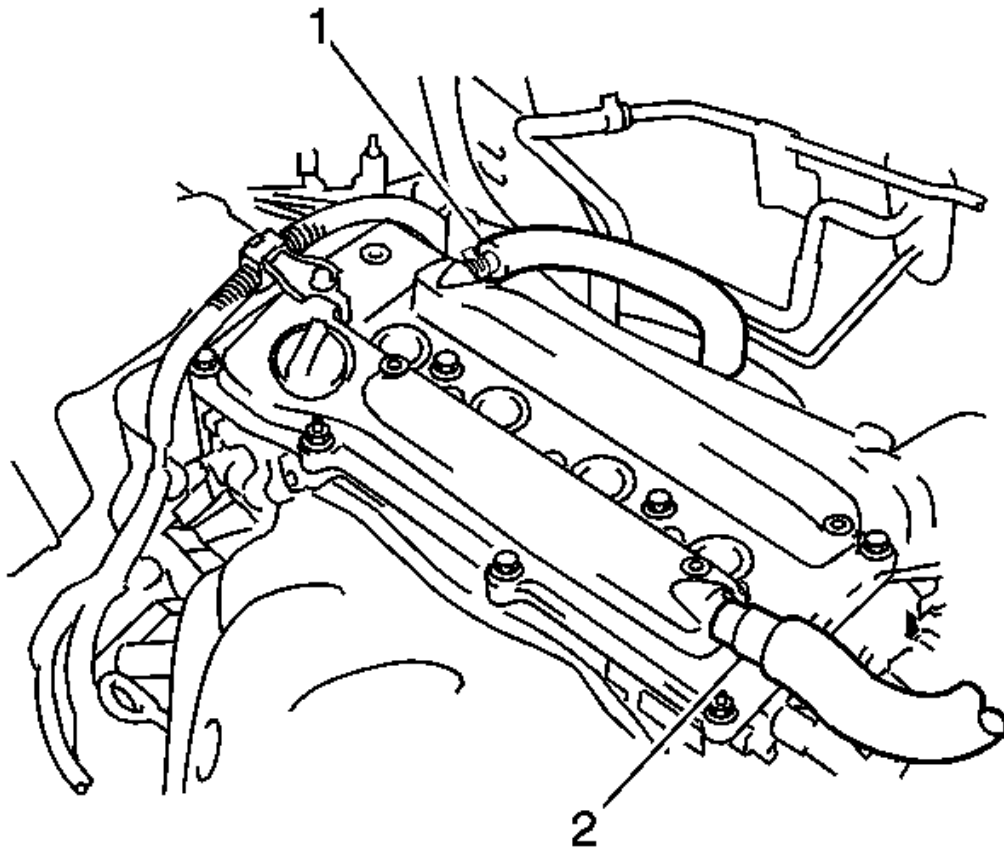


Fig. 101: View Of Engine Cover Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

23. Connect the 2 ventilation hoses to the cylinder head cover.
24. Install spark plug. See **SPARK PLUG REPLACEMENT** .
25. Install ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
26. Inspect for oil leak.
27. Inspect ignition timing.
28. Install No. 1 engine cover sub-assembly.
29. Install engine under right cover.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Removal Procedure

1. Remove front wheel RH.
2. Remove engine under cover RH.
3. Remove No. 2 cylinder head cover. See Cylinder Head Replacement.
4. Remove V-ribbed belt. See Drive Belt Replacement.

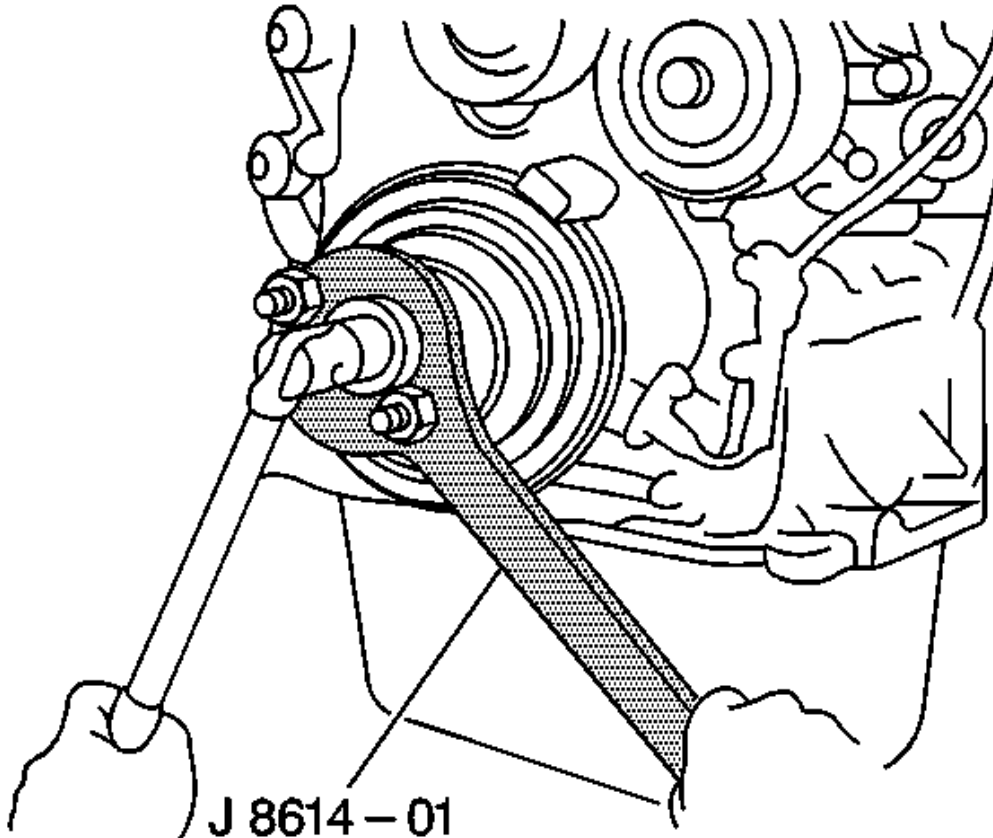


Fig. 102: View Of Crankshaft Pulley & Special Tool
Courtesy of GENERAL MOTORS CORP.

5. Remove crankshaft pulley.

NOTE: Check the SST installation positions when installing them, to prevent the SST fixing bolts from coming into contact with the timing chain cover sub-assembly.

6. Using SST, hold the pulley in place and loosen the pulley bolt.

SST 09213-58013, 09330-00021

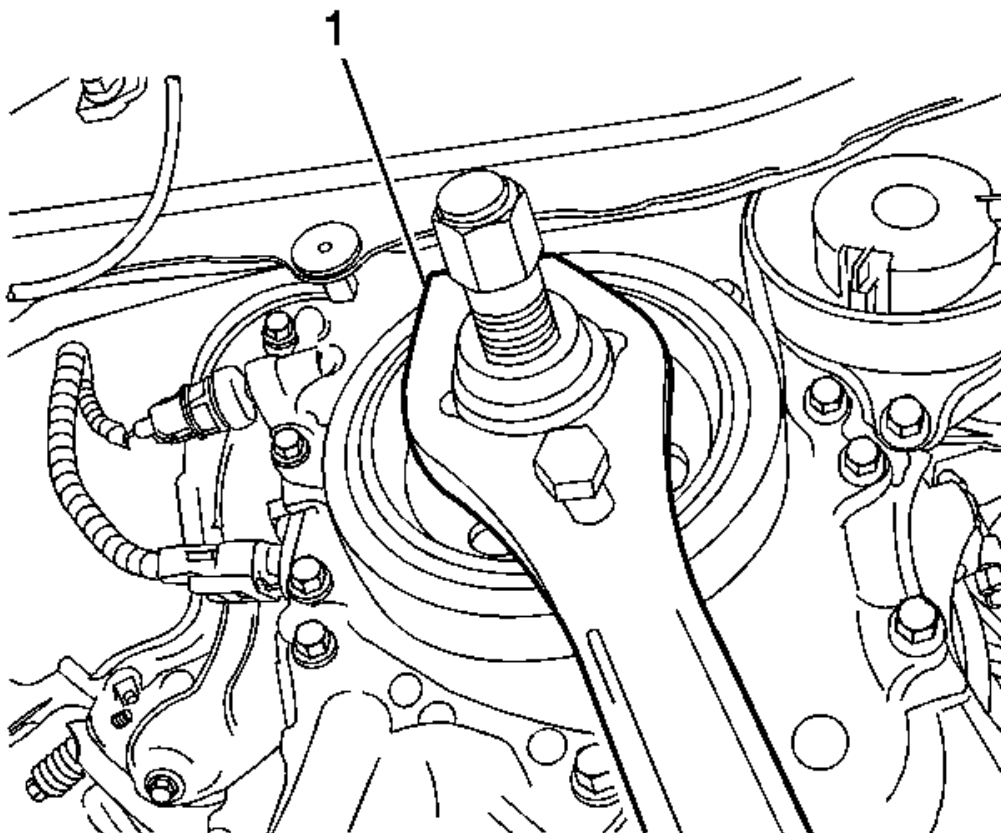


Fig. 103: View Of Crankshaft Pulley & Pulley Bolt Removal
Courtesy of GENERAL MOTORS CORP.

7. Using SST, remove the crankshaft pulley and pulley bolt.

SST 09950-50013 (09951-05010, 09952-05010, 09953-05020, 09954-05021)

8. Remove timing chain cover oil seal.
9. Using a knife, cut off the lip of the oil seal.

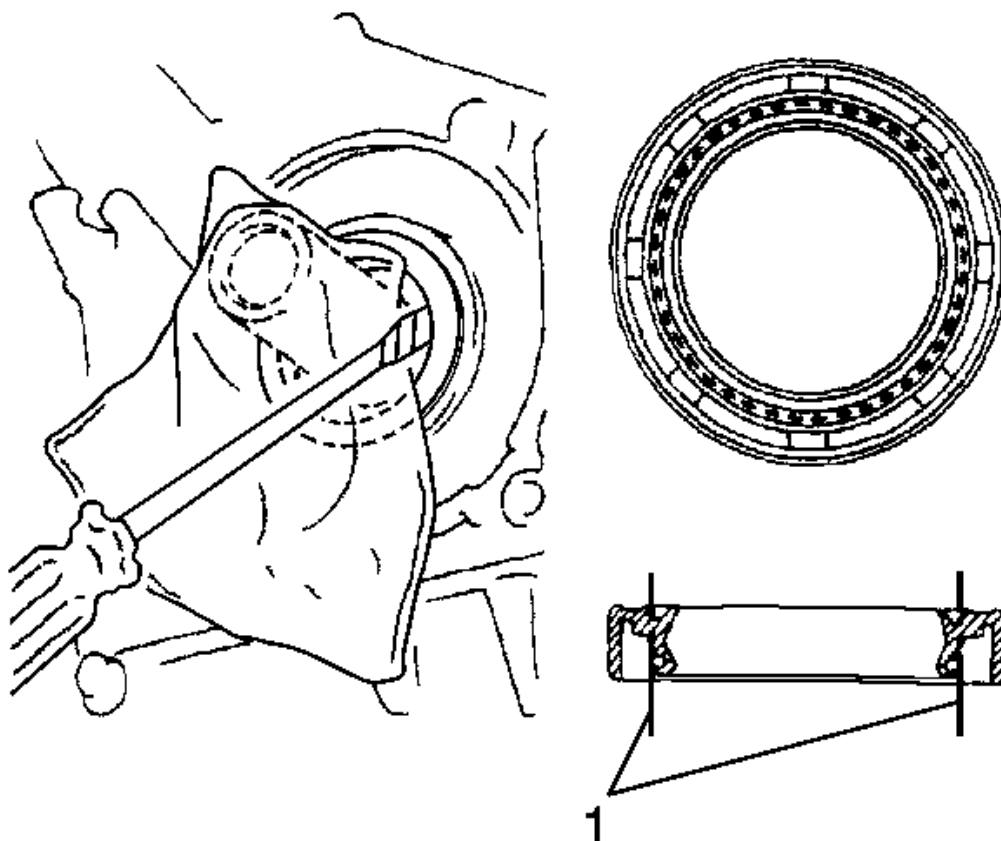


Fig. 104: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: After removing, check the crankshaft for damage. If damaged, smooth the surface with 400-grit sandpaper.

10. Using a screwdriver with its tip wrapped with tape, pry out the oil seal.

Installation Procedure

1. Install timing chain cover oil seal.

NOTE: Keep the lip free from foreign matter.

2. Apply MP grease to the lip of a new oil seal.

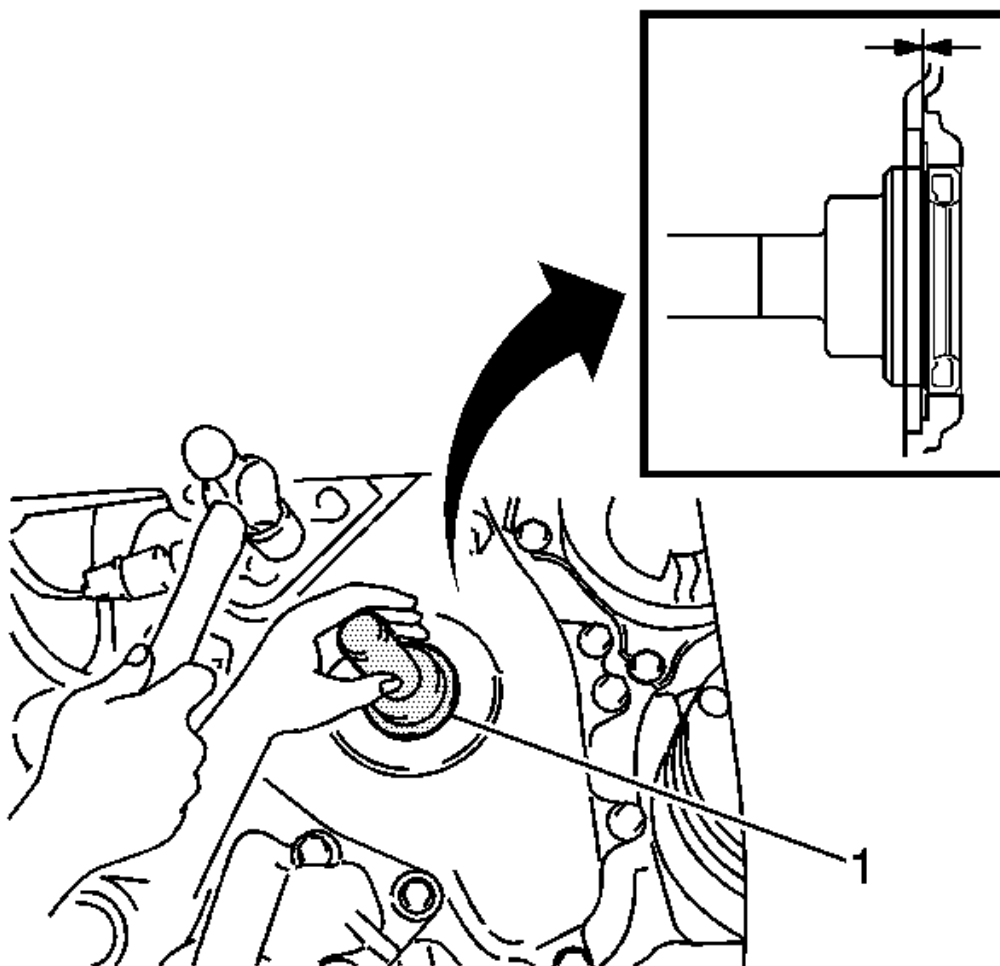


Fig. 105: View Of Crankshaft Front Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: Wipe off extra grease from the crankshaft.

3. Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

SST 09223-22010

4. Install crankshaft pulley.
5. Align the pulley set key with the key groove of the pulley.

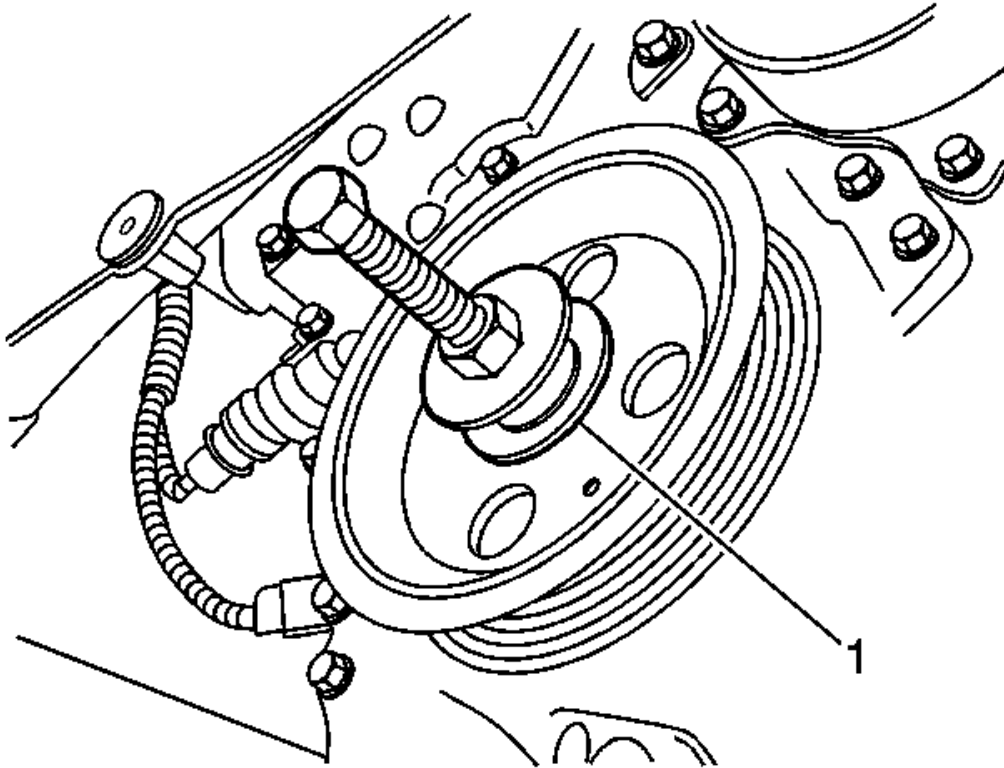


Fig. 106: View Of Tightening Crankshaft Pulley Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Check the SST installation positions when installing them, to prevent the SST fixing bolts from coming into contact with the timing chain cover sub-assembly.

NOTE: Refer to **FASTENER CAUTION** .

6. Using SST, hold the pulley in place and tighten the bolt.

SST 09213-58013, 09330-00021

Tighten: Tighten the bolt to 190 N.m (140 lb ft)

7. Install V-ribbed belt. See **Drive Belt Replacement**.
8. Adjust V-ribbed belt. See **Drive Belt Replacement**.
9. Inspect V-ribbed belt. See **Drive Belt Replacement**.

10. Add engine oil.
11. Inspect for engine oil leak.
12. Install No. 2 cylinder head cover. See Cylinder Head Replacement.
13. Install engine under cover RH.
14. Install front wheel RH.

CYLINDER HEAD REPLACEMENT

Removal Procedure

1. Discharge fuel system pressure. See FUEL PRESSURE RELIEF .

NOTE: When disconnecting the cable, some systems need to be initialized after the cable is reconnected.

2. Disconnect cable from negative battery terminal.
3. Remove front wiper arm head cap.
4. Remove left front wiper arm and blade assembly. See WINDSHIELD WIPER BLADE REPLACEMENT .
5. Remove right front wiper arm and blade assembly.
6. Remove hood to cowl top seal.
7. Remove right cowl top ventilator louver.
8. Remove left cowl top ventilator louver.
9. Remove windshield wiper motor and link assembly. See WINDSHIELD WIPER MOTOR REPLACEMENT .
10. Remove outer cowl top panel.
11. Remove suspension tower damper assembly with front strut bar. See FRONT SUSPENSION .
12. Remove right front wheel.
13. Remove left engine under cover.
14. Remove right engine under cover.
15. Remove No. 1 engine cover sub-assembly.
16. Drain engine coolant. See COOLING SYSTEM DRAINING AND FILLING .
17. Drain engine oil.
18. Remove center exhaust pipe assembly. See EXHAUST PIPE REPLACEMENT (2.4L FWD) .
19. Remove front exhaust pipe assembly. See EXHAUST PIPE REPLACEMENT (2.4L FWD) .
20. Remove V-ribbed belt. See Drive Belt Replacement.
21. Remove generator assembly. See GENERATOR REPLACEMENT (2.4L) ,
22. Separate radiator reserve tank assembly.
23. Remove air cleaner cap sub-assembly with hose.
24. Remove throttle body assembly. See THROTTLE BODY ASSEMBLY REPLACEMENT .

25. Remove ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
26. Remove spark plug. See **SPARK PLUG REPLACEMENT** .
27. Remove cylinder head cover sub-assembly.
28. Remove engine oil level dipstick.

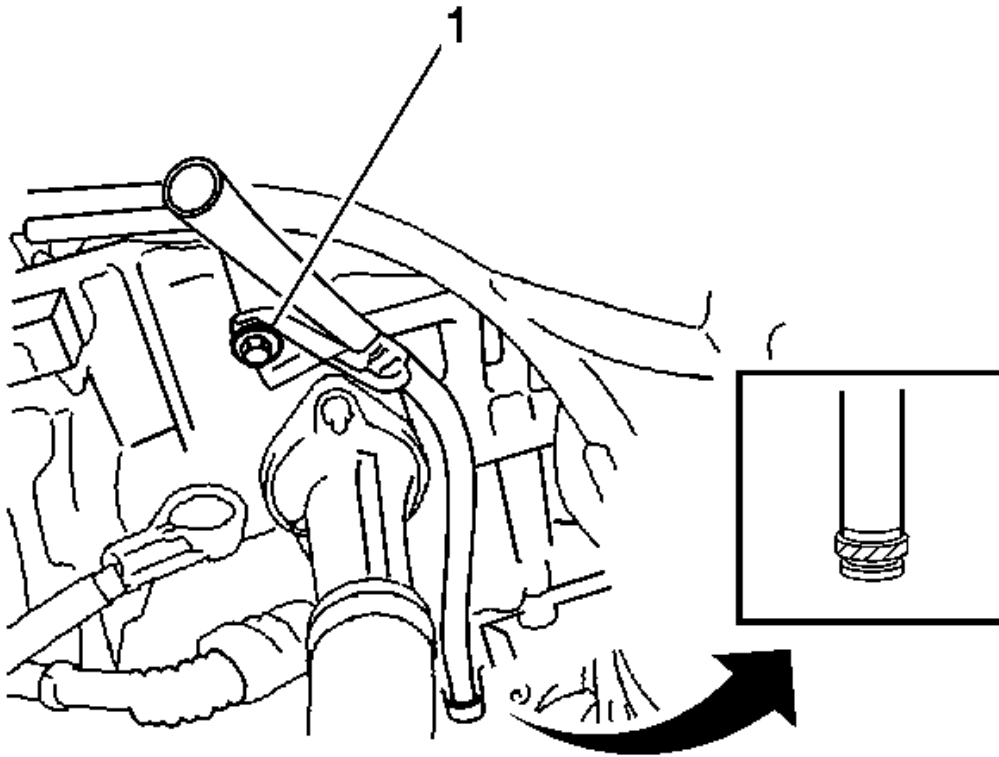


Fig. 107: Identifying Engine Oil Level Dipstick Guide
 Courtesy of GENERAL MOTORS CORP.

29. Remove the bolt and engine oil level dipstick guide.
30. Remove the O-ring from the engine oil level dipstick guide.
31. Remove engine oil level dipstick guide.
32. Disconnect fuel main tube.
33. Remove fuel delivery pipe sub-assembly.
34. Remove camshaft timing oil control valve assembly.
35. Remove intake manifold. See **Intake Manifold Replacement**.
36. Remove No. 1 intake manifold insulator. See **Intake Manifold Replacement**.

37. Remove manifold stay.
38. Remove No. 2 manifold stay.
39. Remove No. 1 exhaust manifold heat insulator.

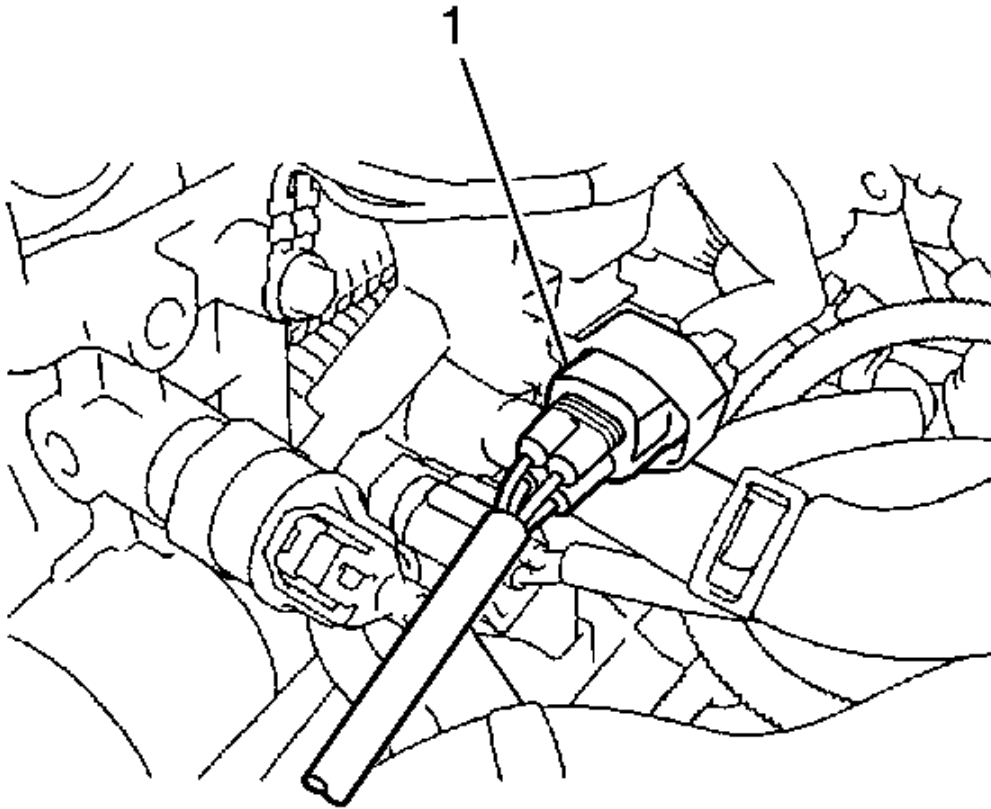


Fig. 108: Identifying Exhaust Manifold Converter Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

40. Remove exhaust manifold converter sub-assembly.
41. Disconnect the air-fuel ratio sensor connector.

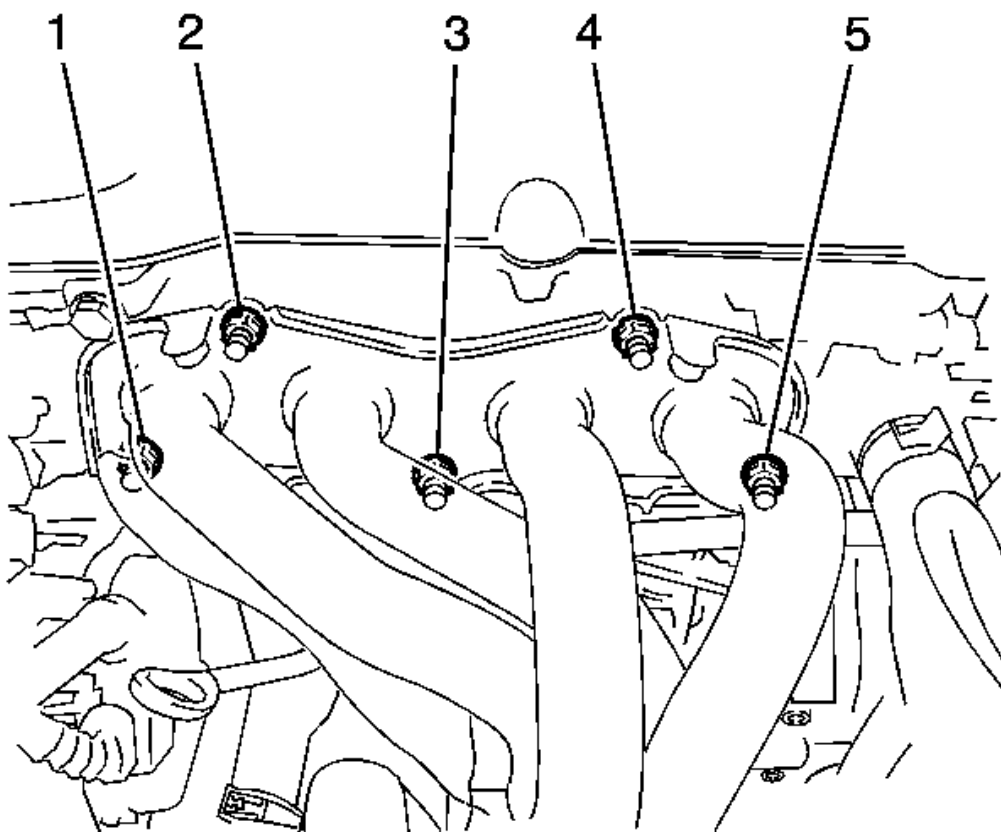


Fig. 109: Identifying Nuts & Exhaust Manifold Converter Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

42. Remove the 5 nuts, exhaust manifold converter sub-assembly, and gasket.

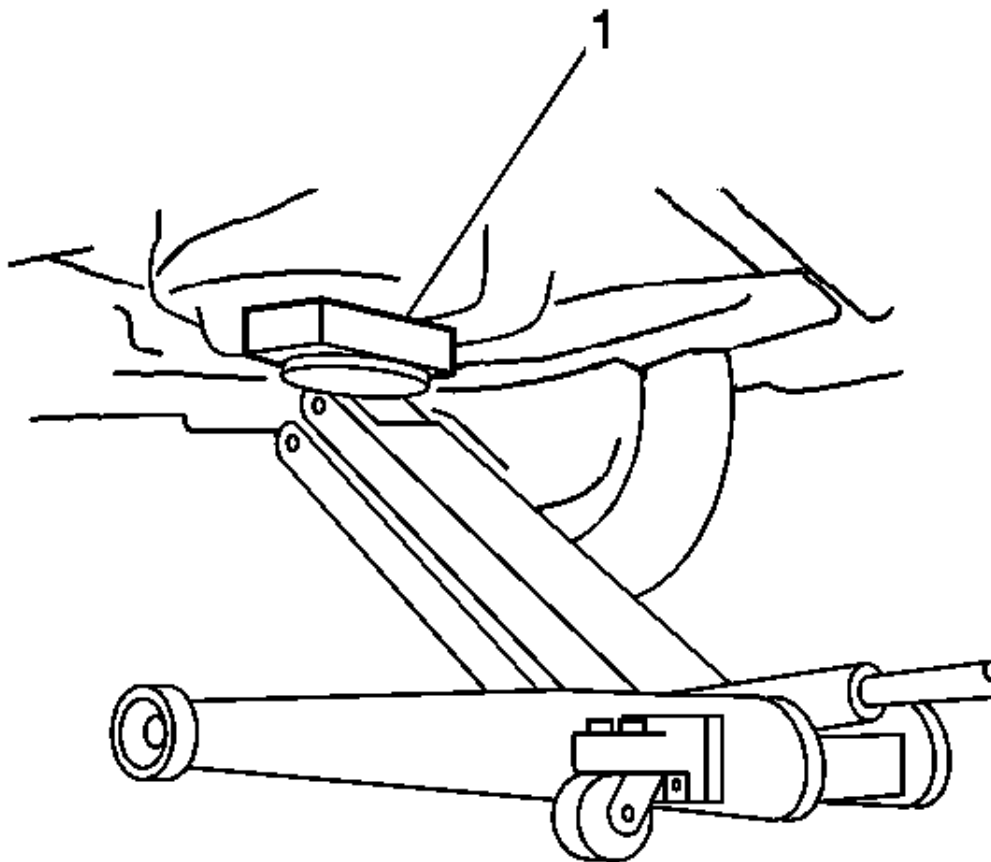


Fig. 110: Identifying Right Engine Mounting Insulator Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

43. Remove right engine mounting insulator sub-assembly.
44. Place a wooden block between a floor jack and the engine, then support the engine using the floor jack.

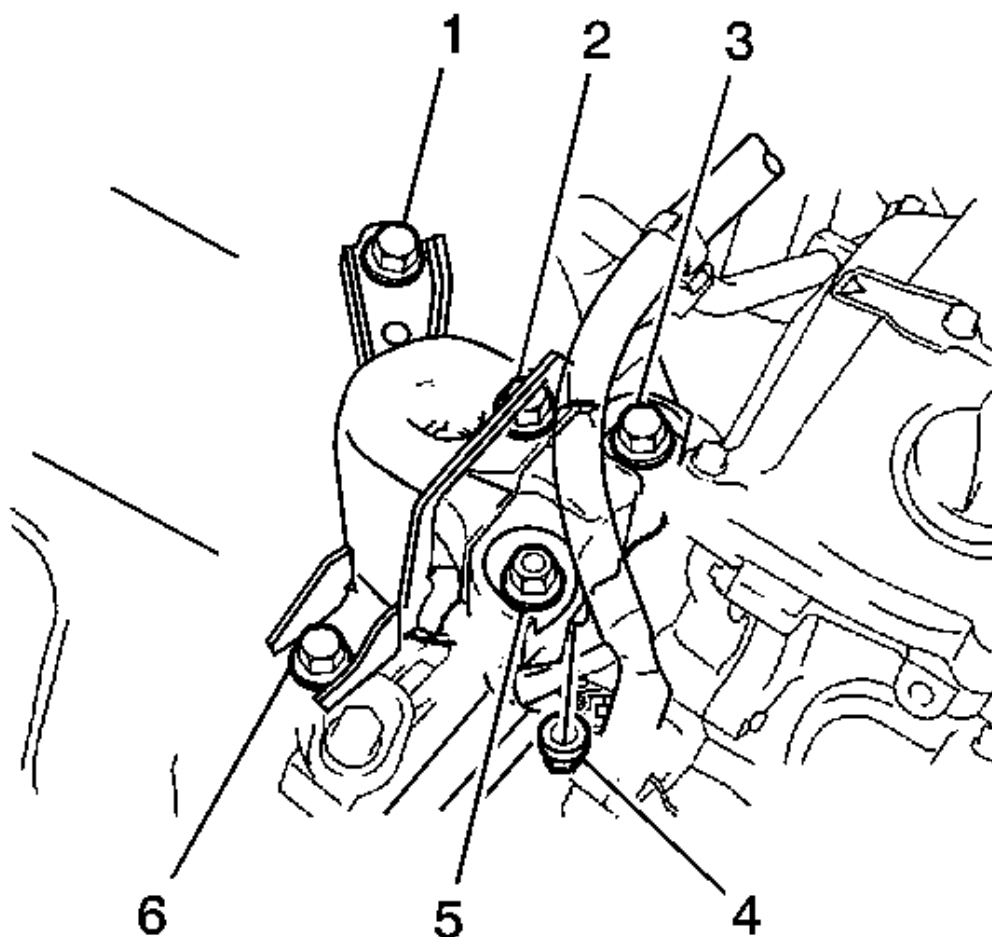


Fig. 111: Identifying Engine Mounts & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not apply excessive force to the return tube when removing the right engine mounting insulator sub-assembly.

IMPORTANT: Keep clearance by lowering the engine using the floor jack when removing the front engine mounting insulator.

45. Remove the 4 bolts and 2 nuts, then remove the right engine mounting insulator sub-assembly.

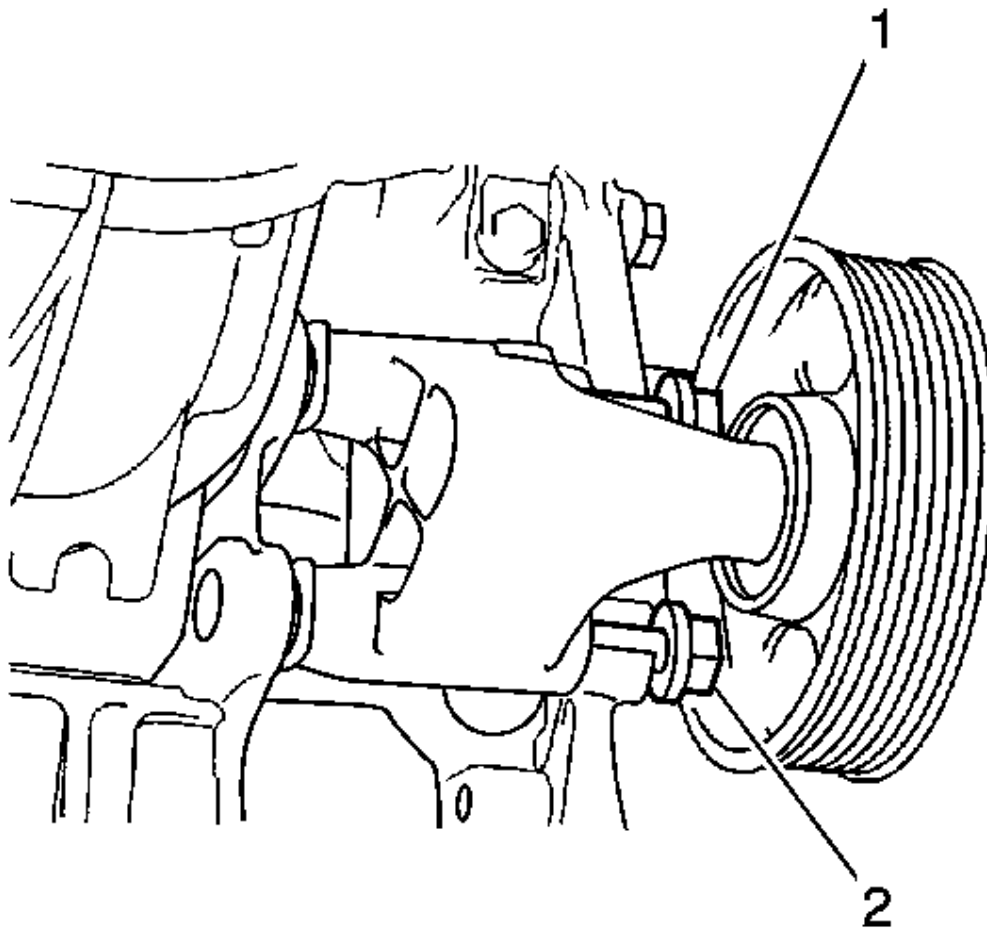


Fig. 112: Identifying Idler Pulley Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

46. Remove idler pulley sub-assembly. Loosen the 2 bolts and remove the idler pulley sub-assembly with the 2 bolts.

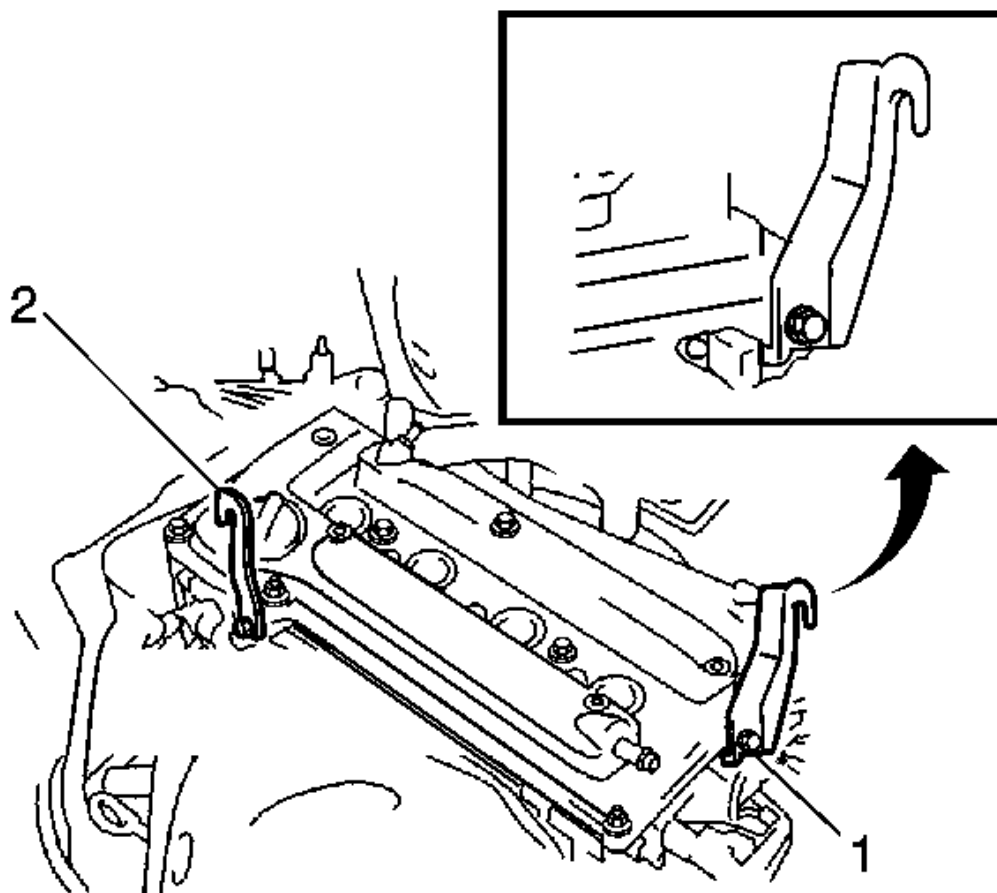


Fig. 113: Identifying Engine Lift Hangers
 Courtesy of GENERAL MOTORS CORP.

47. Remove oil pan sub-assembly.
48. Install the No. 1 and No. 2 engine hangers with the new bolts.

Tighten: 38 N.m (28 lb ft)

49. Attach the sling device to the engine hangers and chain block.

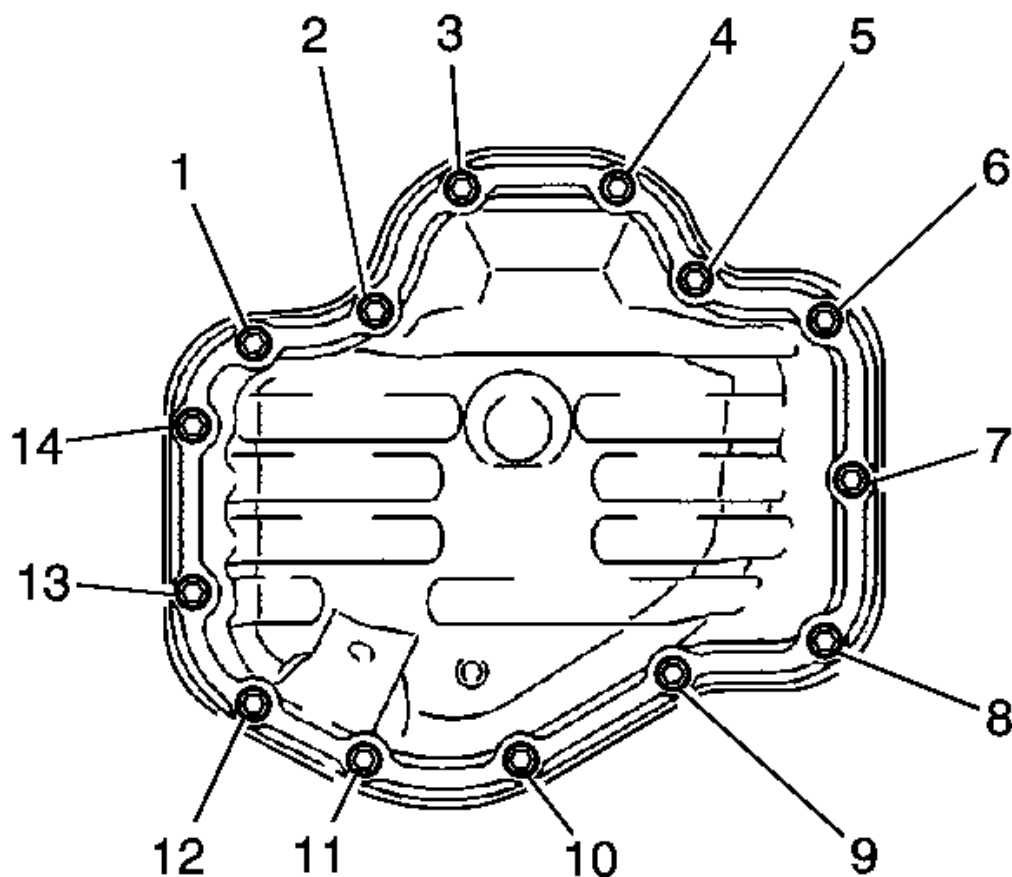


Fig. 114: Identifying oil pan sub-assembly Bolt Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

50. Remove the 12 bolts and 2 nuts.

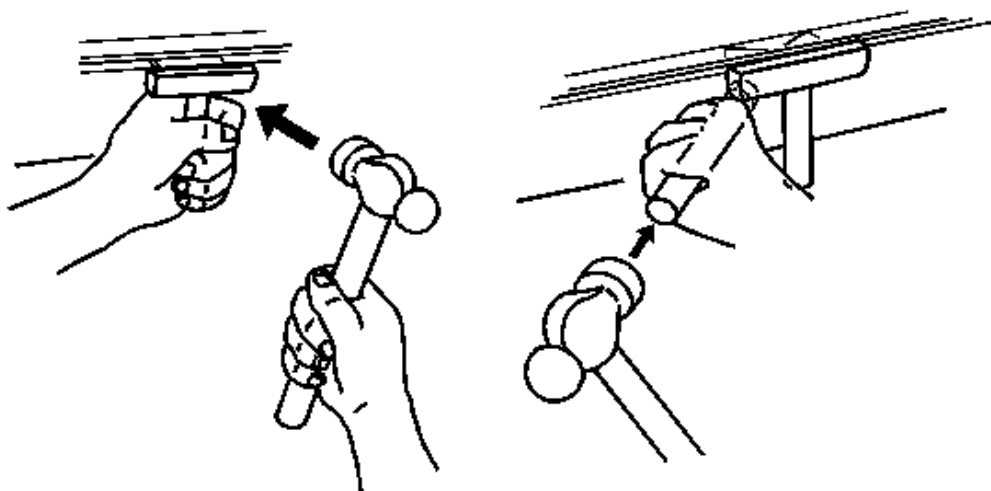


Fig. 115: View Of Oil Pan Removal Procedure
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the contact surface of the crankcase, chain cover or oil pan.

51. Insert the blade of oil pan seal cutter between the crankcase, chain cover and oil pan, then cut through the applied sealer and remove the oil pan.

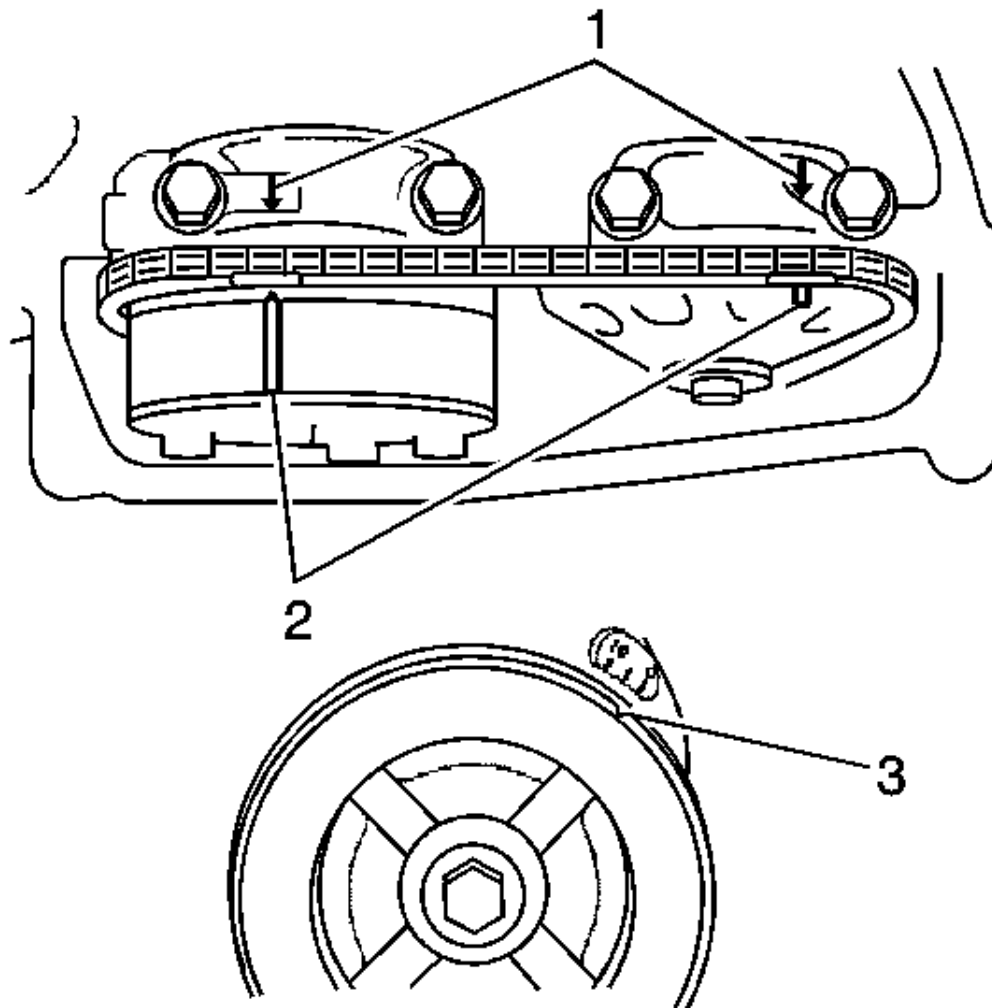


Fig. 116: Setting Engine To No. 1 Cylinder To TDC/Compression Stroke
Courtesy of GENERAL MOTORS CORP.

52. Set No. 1 cylinder to TDC/compression.
 - Turn the crankshaft pulley until the groove and the timing mark 0 on the timing chain cover are aligned.
 - Check that each timing mark on the camshaft timing gear and sprocket is aligned with the timing marks located on the No. 1 and No. 2 bearing caps as shown in the illustration. If not, turn the crankshaft by 1 revolution (360°) to align the timing marks as above.
53. Remove crankshaft pulley.

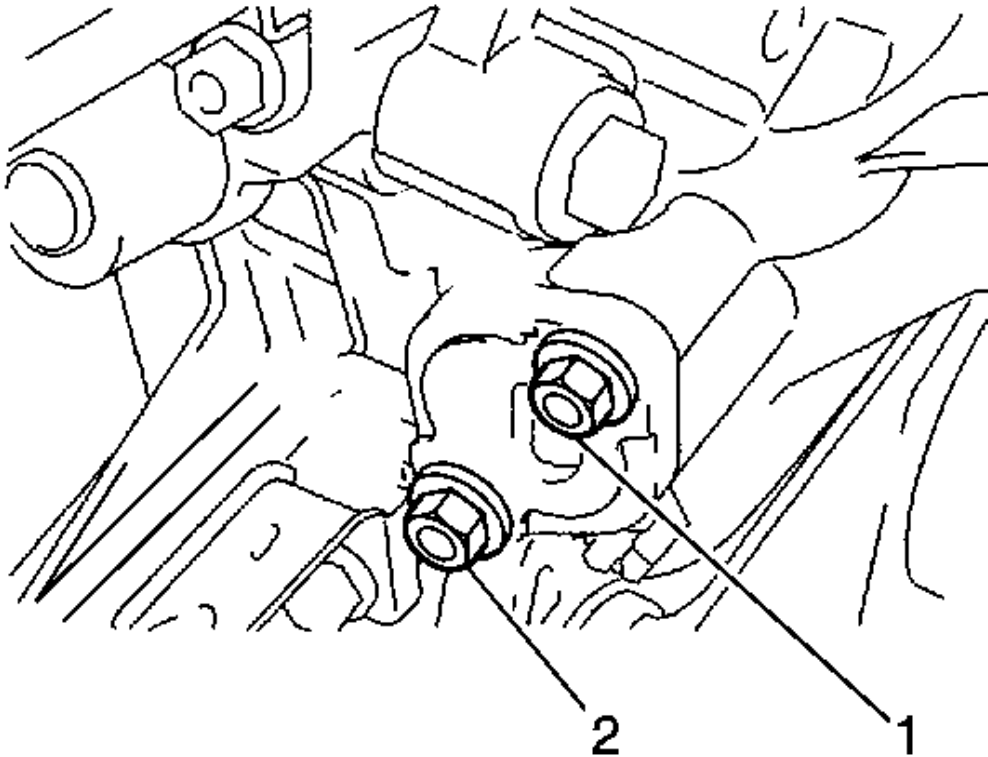


Fig. 117: View Of 1 Chain Tensioner Assembly Removal
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not turn the crankshaft without the No. 1 chain tensioner assembly.

54. Remove No. 1 chain tensioner assembly. Remove the 2 nuts, No. 1 chain tensioner assembly, and gasket.

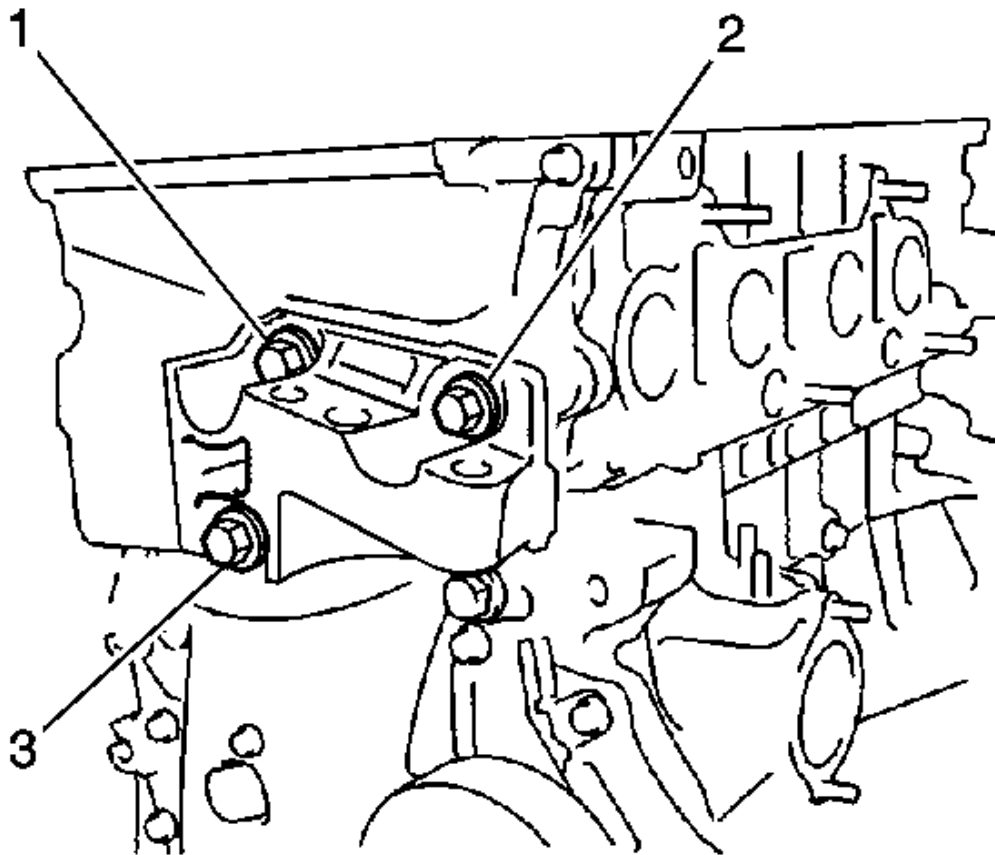


Fig. 118: Identifying Engine Mounts Bolts
Courtesy of GENERAL MOTORS CORP.

55. Remove the 3 bolts and transverse engine mounting bracket.

NOTE: **Do not lift the engine more than necessary.**

56. Remove V-ribbed belt tensioner assembly.
57. Lift the engine upward.

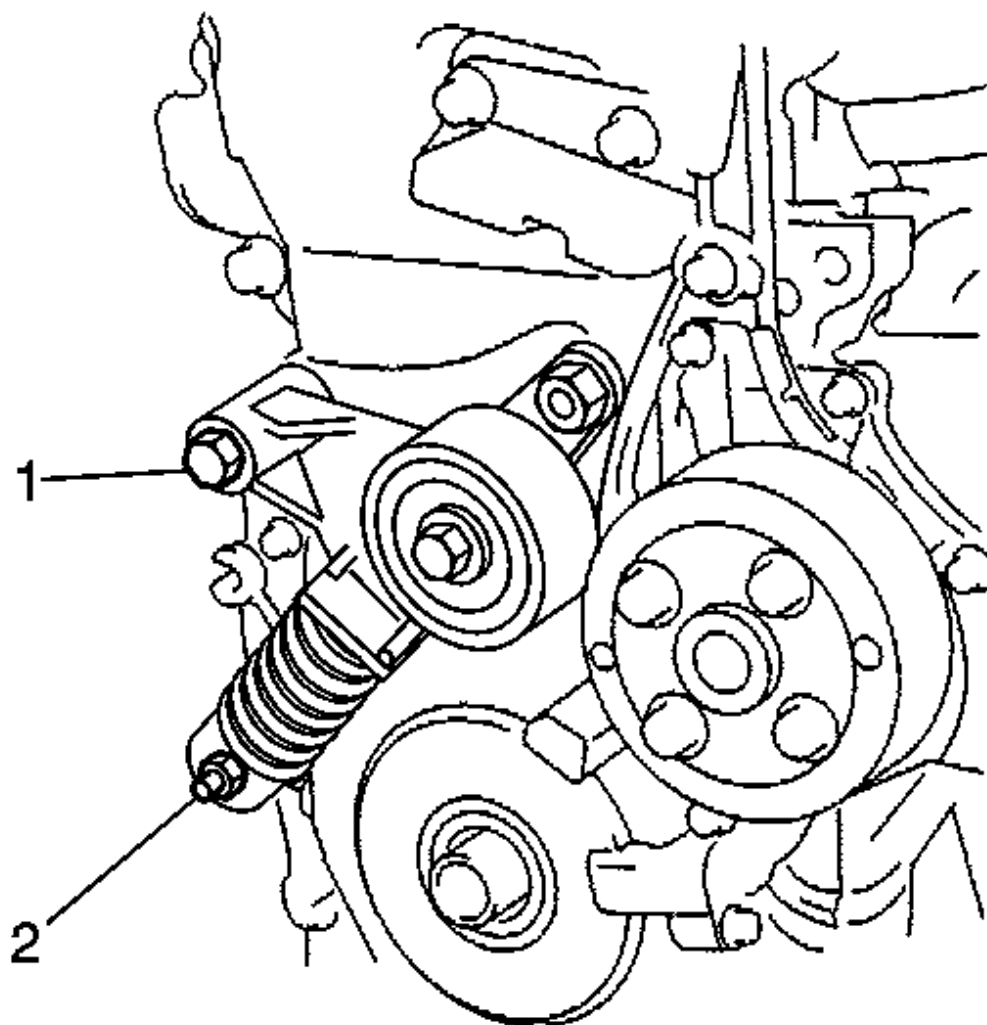


Fig. 119: Identifying V-Ribbed Belt Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

58. Remove the bolt, nut and V-ribbed belt tensioner assembly.
59. Remove crankshaft position sensor. See **CRANKSHAFT POSITION SENSOR REPLACEMENT** .
60. Remove timing chain or belt cover sub-assembly.

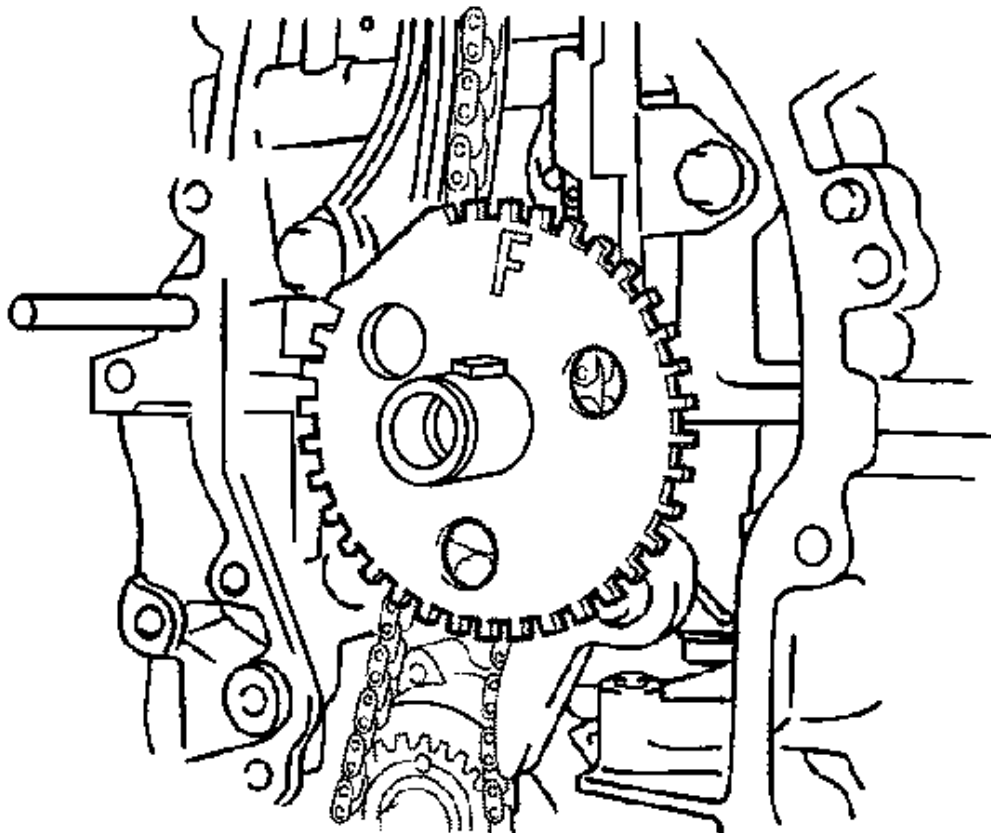


Fig. 120: Identifying Crankshaft Position Sensor Plate
Courtesy of GENERAL MOTORS CORP.

61. Remove the No. 1 crankshaft position sensor plate.

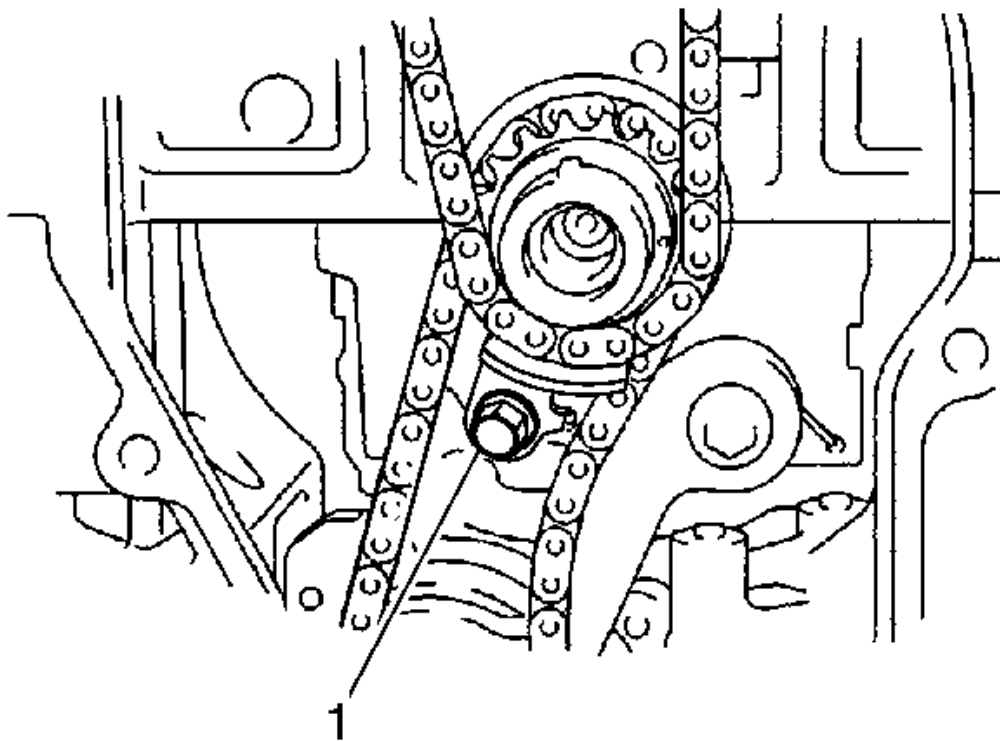


Fig. 121: Identifying Timing Chain Guide & Bolt
Courtesy of GENERAL MOTORS CORP.

62. Remove the bolt and timing chain guide.

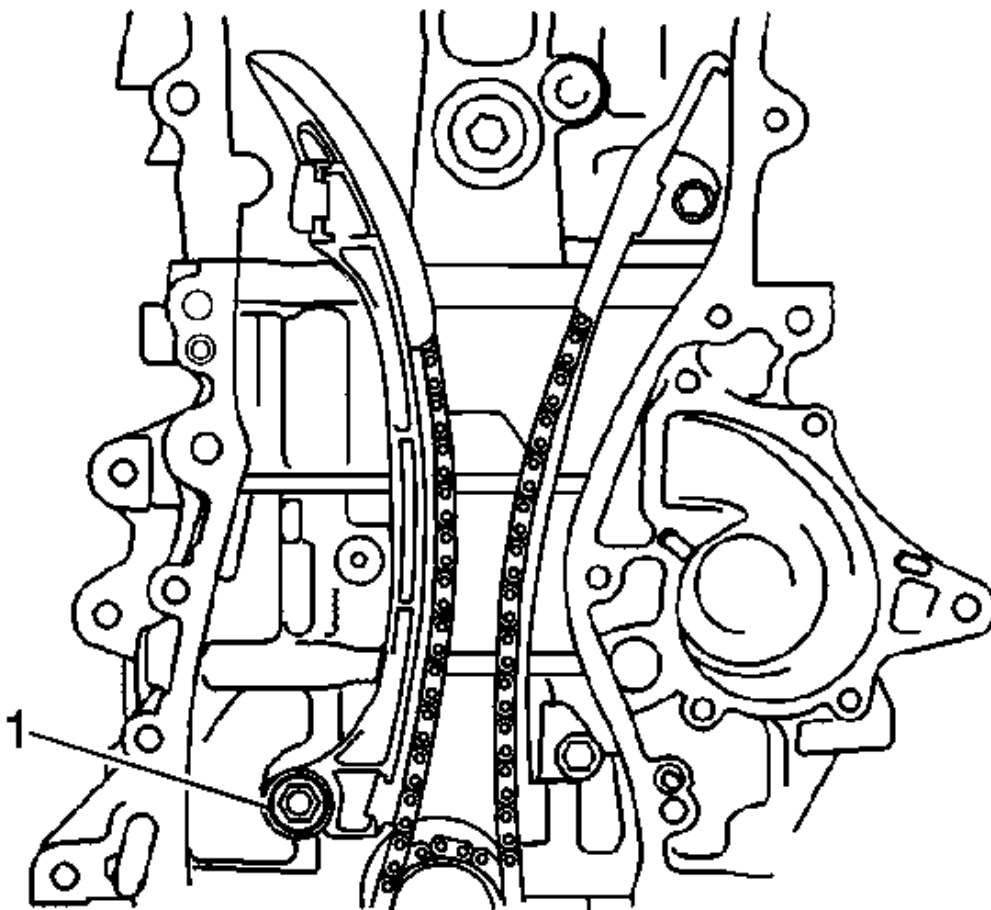


Fig. 122: View Of Chain Tensioner Slipper & Bolt
Courtesy of GENERAL MOTORS CORP.

63. Remove the bolt and chain tensioner slipper.

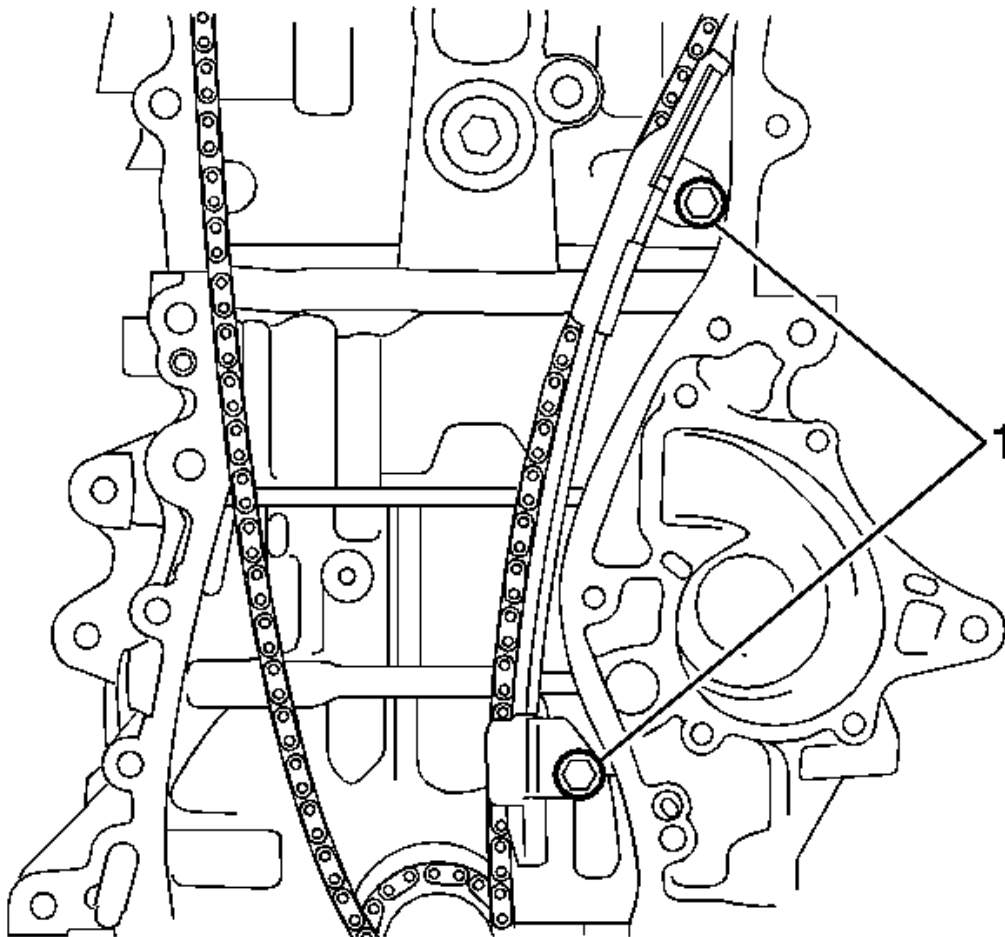


Fig. 123: View Of Chain Vibration Damper
Courtesy of GENERAL MOTORS CORP.

64. Remove the 2 bolts and No. 1 chain vibration damper.
65. Remove chain sub-assembly.

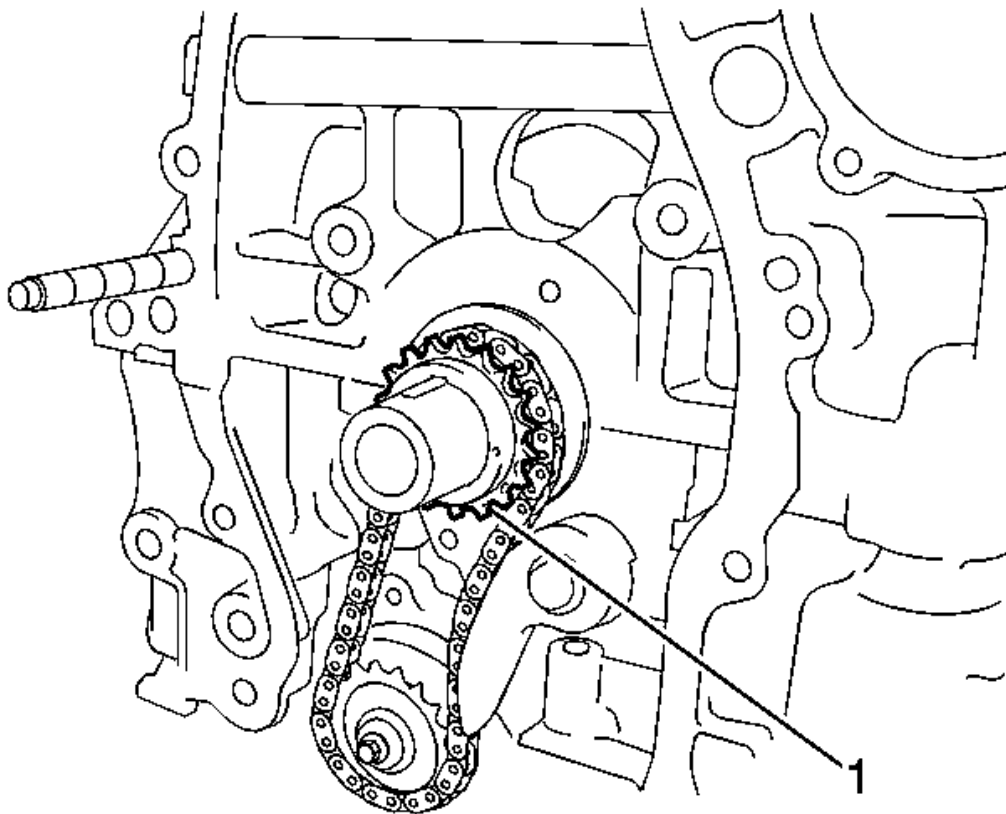


Fig. 124: View Of Crankshaft Timing Gear/Sprocket
Courtesy of GENERAL MOTORS CORP.

66. Remove the crankshaft timing gear or sprocket from the crankshaft.

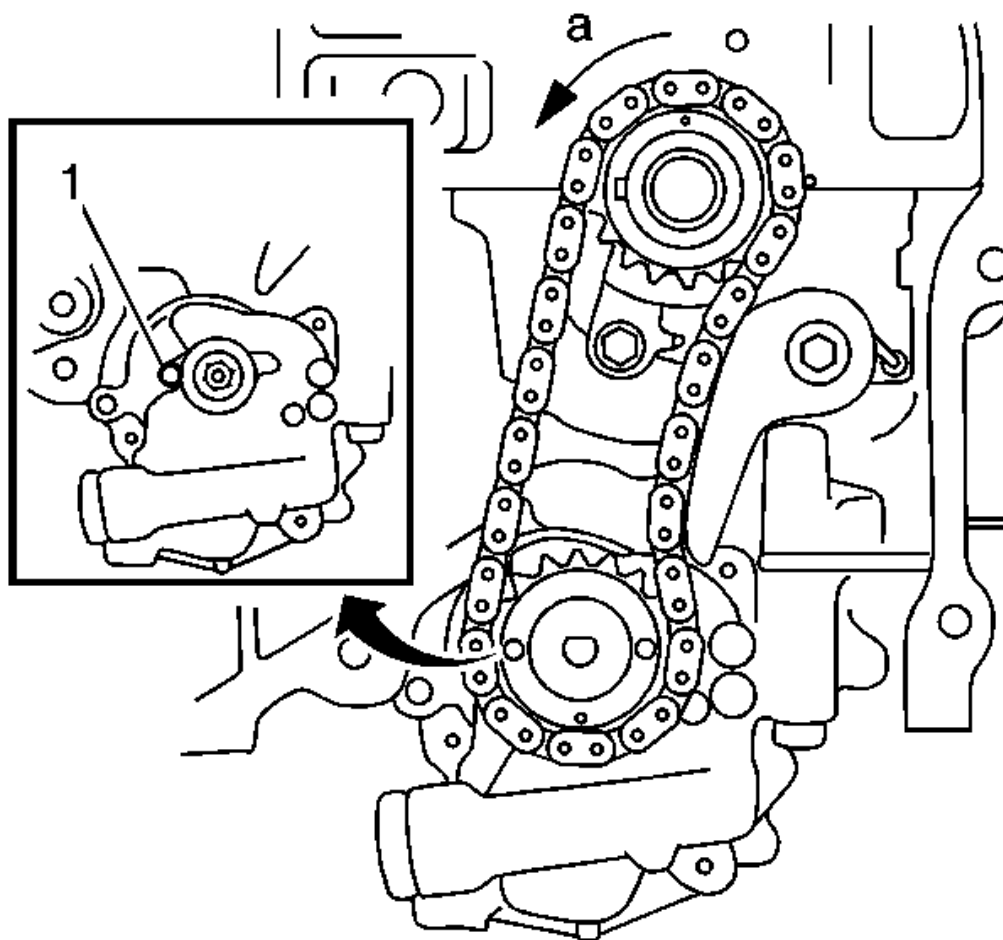


Fig. 125: Identifying No. 2 Chain Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

67. Remove No. 2 chain sub-assembly.
68. Turn the crankshaft 90° counterclockwise to align the adjusting hole on the oil pump drive shaft sprocket with the groove on the oil pump.

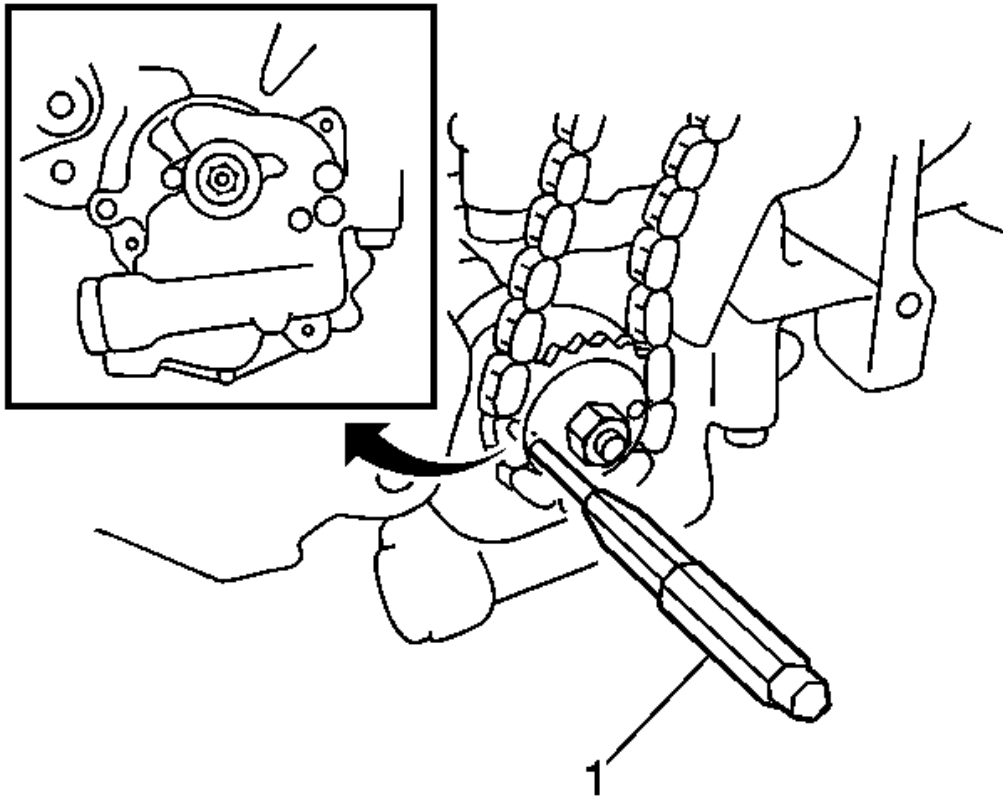


Fig. 126: View Of Locking Oil Pump Drive Shaft Sprocket In Position
Courtesy of GENERAL MOTORS CORP.

69. Insert a 4 mm diameter bar into the adjusting hole of the oil pump drive shaft sprocket to lock the gear in position, and then remove the nut.

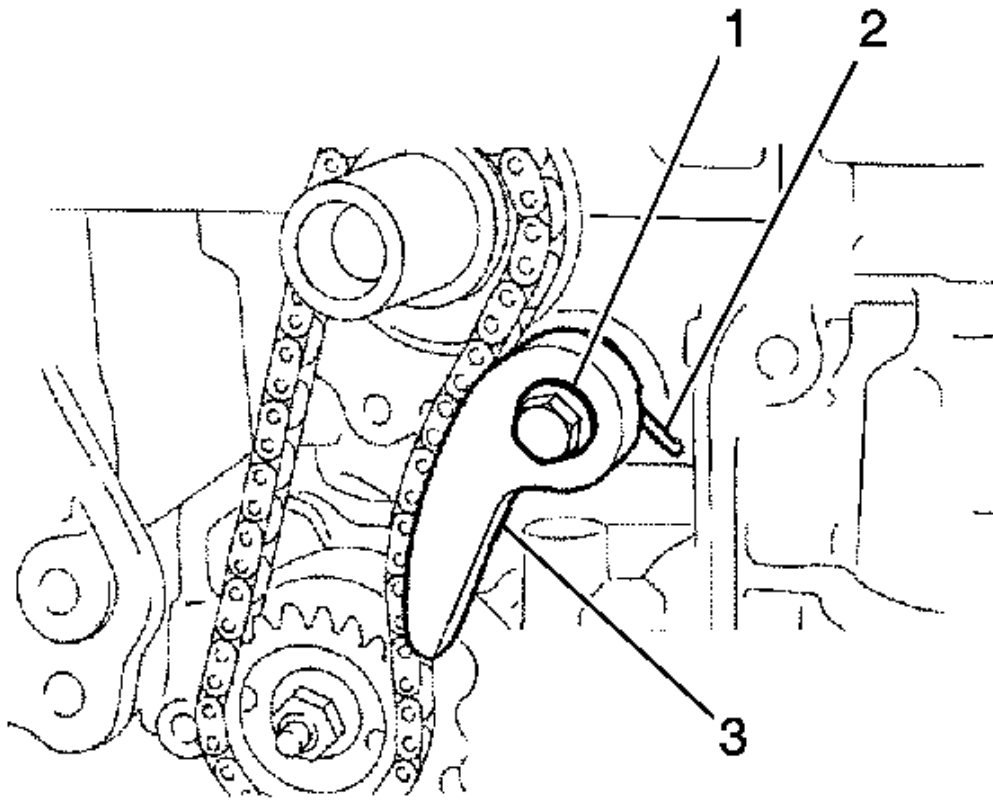


Fig. 127: View Of Chain Tensioner Plate, Spring & Bolt
 Courtesy of GENERAL MOTORS CORP.

70. Remove the bolt, chain tensioner plate and spring
71. Remove the oil pump drive sprocket, oil pump drive shaft sprocket and No. 2 chain.
72. Disconnect No. 1 radiator hose.
73. Disconnect outlet heater water hose.
74. Disconnect inlet heater water hose.
75. Disconnect engine wiring as follows:
 1. Disconnect the radio setting condenser connector.
 2. Disconnect the engine oil pressure switch connector.
 3. Disconnect the engine coolant temperature sensor connector.
 4. Disconnect the camshaft position sensor connector.
 5. Remove the bolt and ground cable.
76. Remove No. 2 camshaft.

77. Remove camshaft.
78. Remove No. 1 camshaft bearing.
79. Remove No. 2 camshaft bearing.

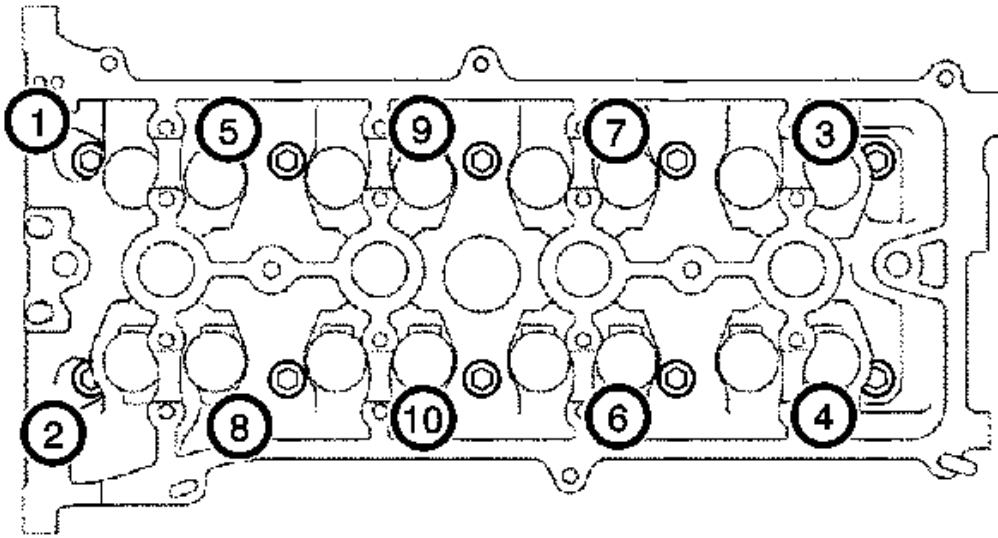


Fig. 128: View Of Cylinder Head Bolt Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

80. Remove cylinder head sub-assembly.

NOTE: **Head warpage or cracking could result from removing the bolts in the wrong order.**

81. In several steps, uniformly loosen and remove the 10 cylinder head bolts and 10 plate washers with a 10 mm bi-hexagon wrench in the sequence shown in the illustration.

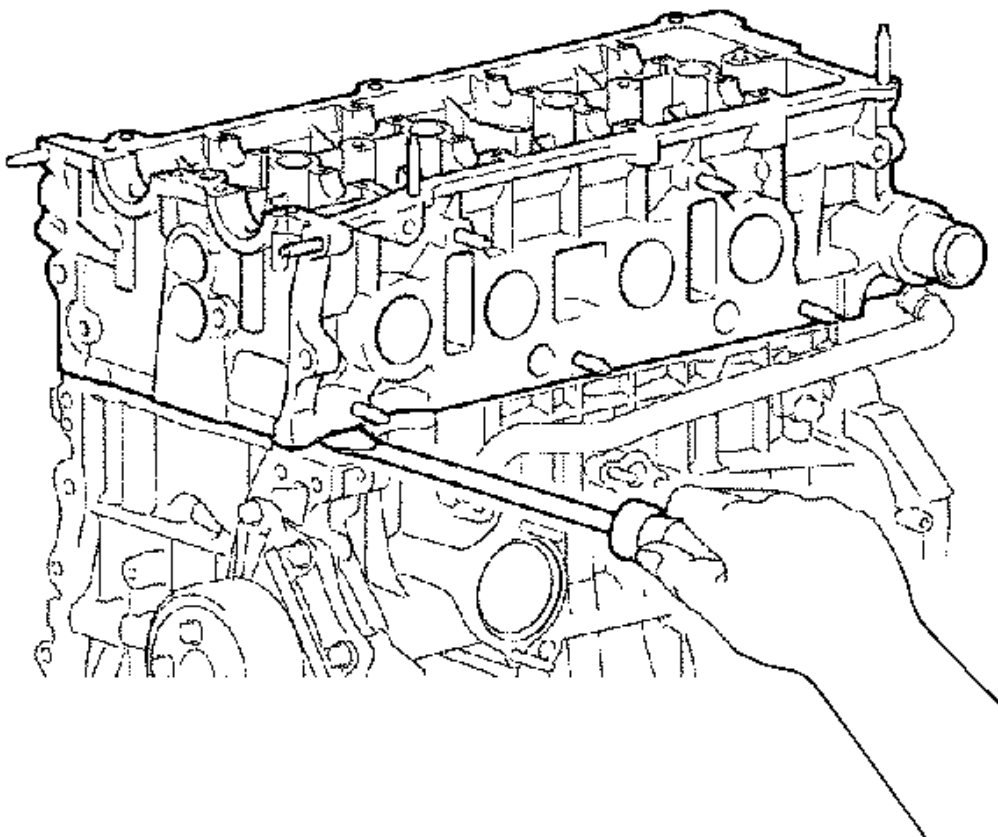


Fig. 129: View Of Cylinder Head Removal
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the contact surfaces between the cylinder head and cylinder block.

82. Using a screwdriver with its tip wrapped with tape, pry between the cylinder head and cylinder block, and remove the cylinder head.

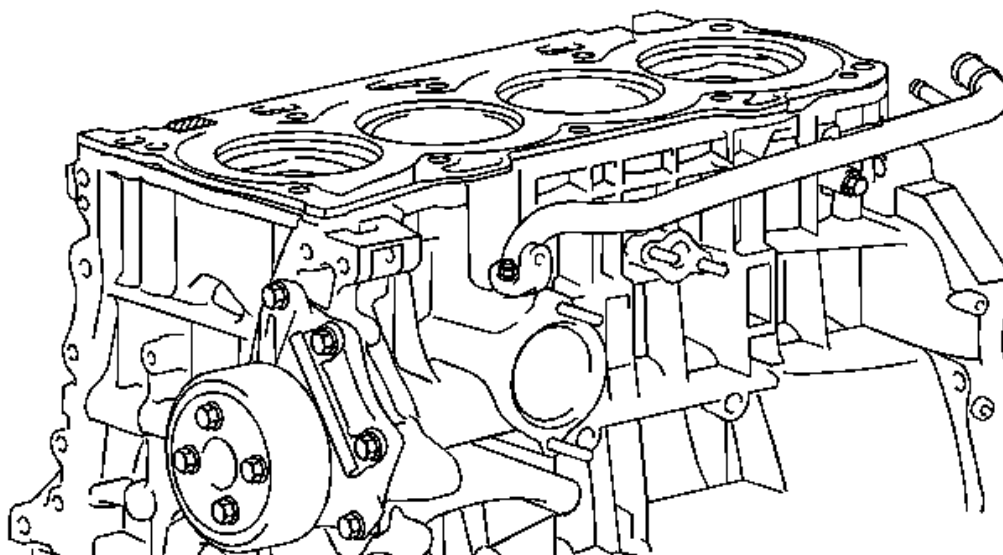


Fig. 130: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

83. Remove cylinder head gasket.

New Lifter Thickness

Item	Part No.
No. 1 engine hanger	12281-28010
No. 2 engine hanger	12282-28010
Bolt	91512-81020

Installation Procedure

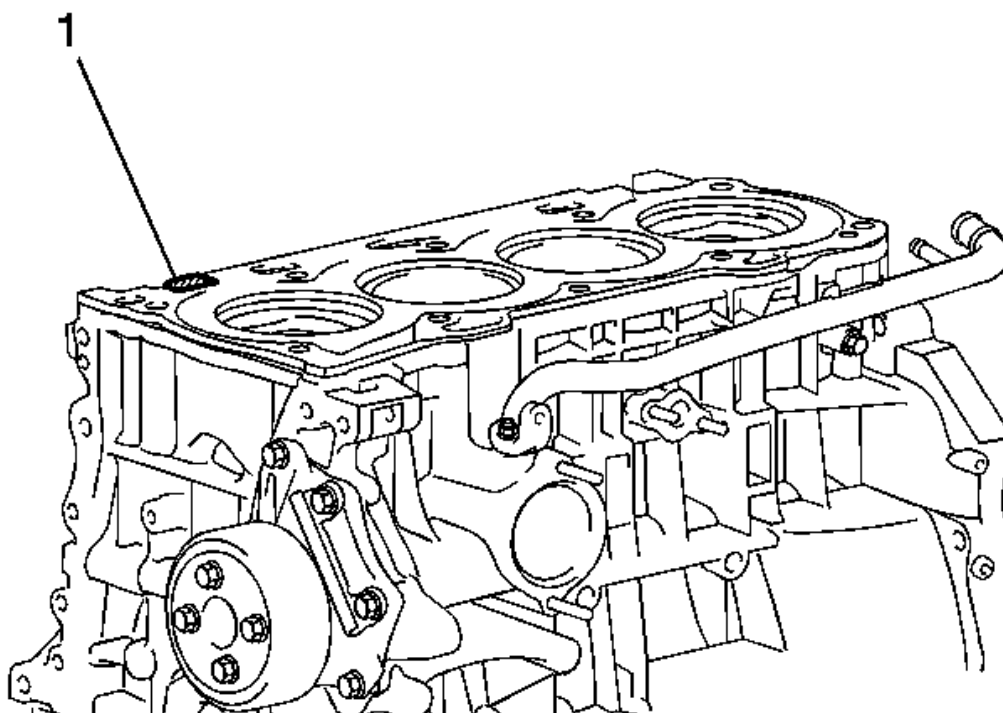


Fig. 131: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove any oil from the contact surface. Be careful of the installation direction.

1. Place a new cylinder head gasket on the cylinder block surface with the Lot No. stamp facing upward.
2. Install cylinder head sub-assembly.

NOTE: Place the cylinder head gently in order to avoid damaging the cylinder head gasket.

3. Place the cylinder head on the cylinder head gasket.

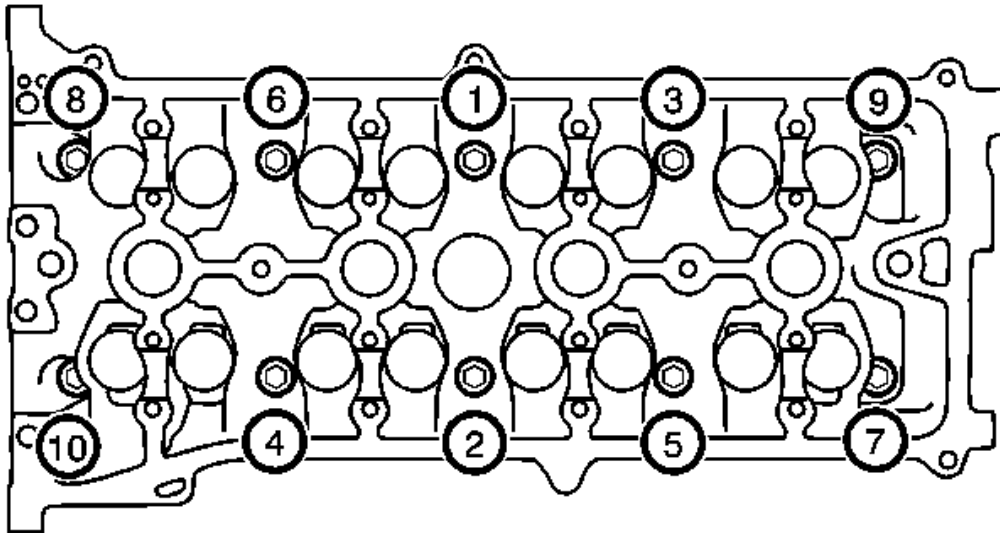


Fig. 132: View Of Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are tightened in 2 successive steps. Apply a light coat of engine oil to the threads and under the heads of the cylinder head set bolts. Using several steps, uniformly install and tighten the 10 cylinder head set bolts and plate washers with a 10 mm bi-hexagon wrench in the order shown in the illustration.

4. **Tighten:** 70 N.m (52 lb ft)

Install the cylinder head bolts.

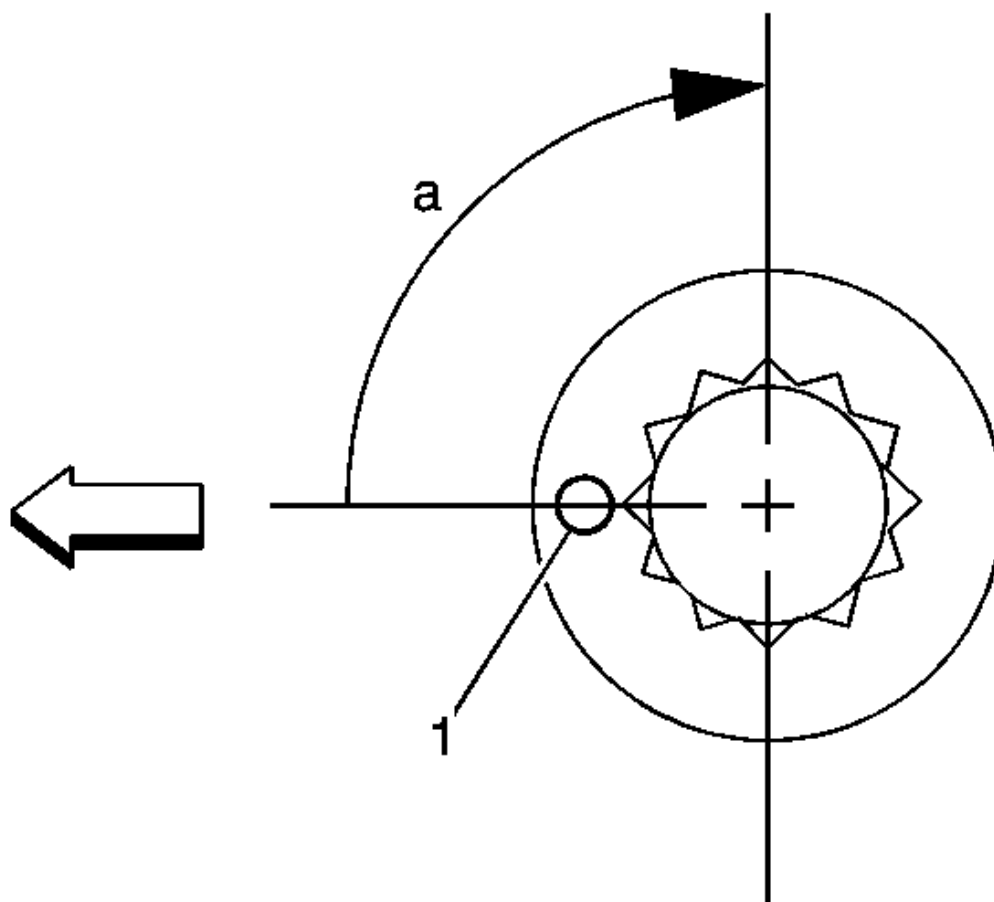


Fig. 133: Identifying Head Bolt Positioning
Courtesy of GENERAL MOTORS CORP.

5. Mark the front of the cylinder head bolts with paint.
6. Further tighten the cylinder head bolts by 90° as shown in the illustration.
7. Check that the paint mark is now at a 90° angle to the front.
8. Install No. 1 camshaft bearing.
9. Install No. 2 camshaft bearing.
10. Install camshaft.
11. Install No. 2 camshaft.
12. Connect inlet heater water hose.
13. Connect outlet heater water hose.
14. Connect No. 1 radiator hose.

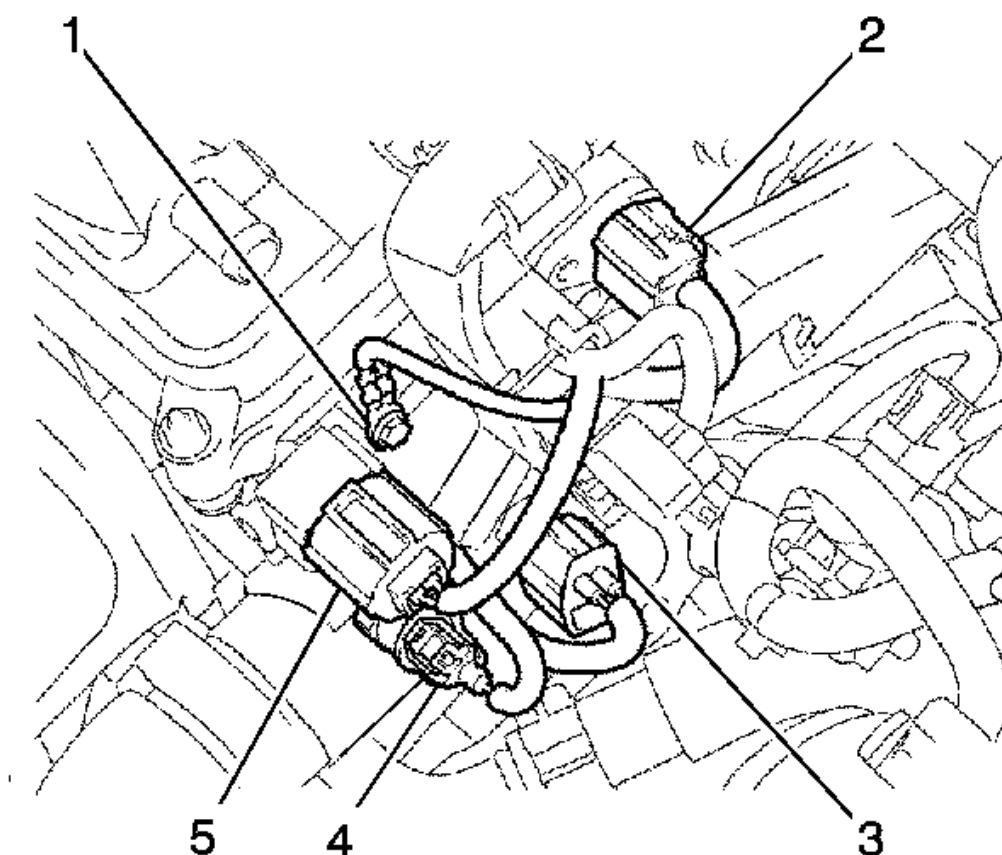


Fig. 134: Identifying Engine Wire Harness Connectors
Courtesy of GENERAL MOTORS CORP.

15. Connect engine wire.

- Connect the ground cable with the bolt.

Tighten: 8.4 N.m (74 lb in)

- Connect the camshaft position sensor connector.
- Connect the engine coolant temperature sensor connector.
- Connect the engine oil pressure switch connector.
- Connect the radio setting condenser connector.
- Connect the heater water inlet hose.

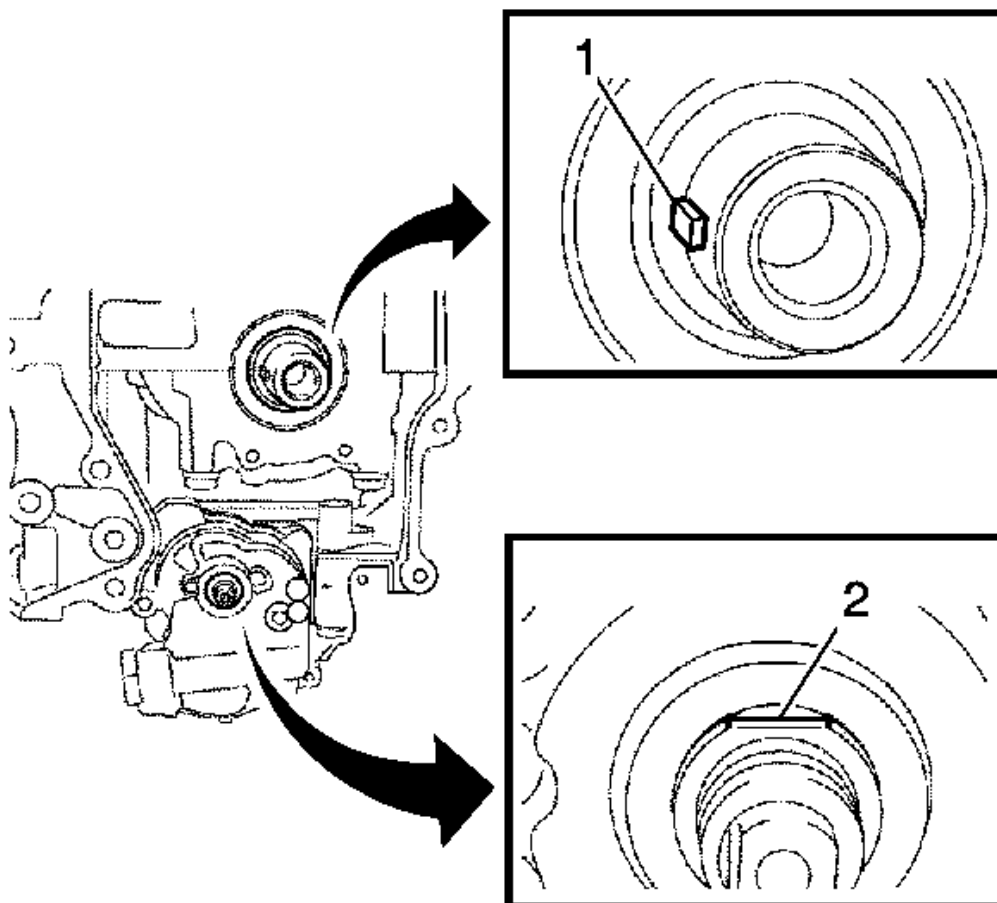


Fig. 135: Identifying Proper Crankshaft Key Positioning
Courtesy of GENERAL MOTORS CORP.

16. Install No. 2 chain sub-assembly.
17. Set the crankshaft key in the left horizontal position.

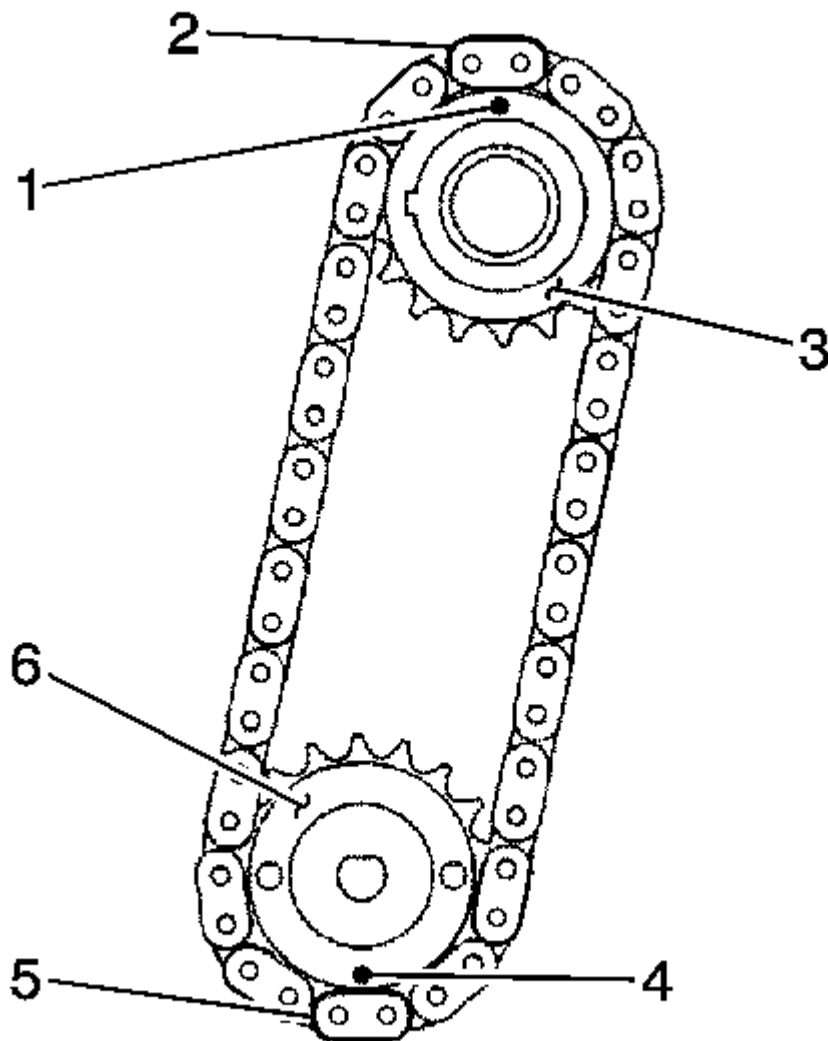


Fig. 136: View Of Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

18. Turn the cutout of the drive shaft so that it faces upward.
19. Align the yellow mark links with the timing marks of each gear as shown in the illustration.
20. Install the sprockets onto the crankshaft and oil pump shaft with the chain wrapped on the gears.
21. Temporarily tighten the oil pump drive shaft sprocket with the nut.

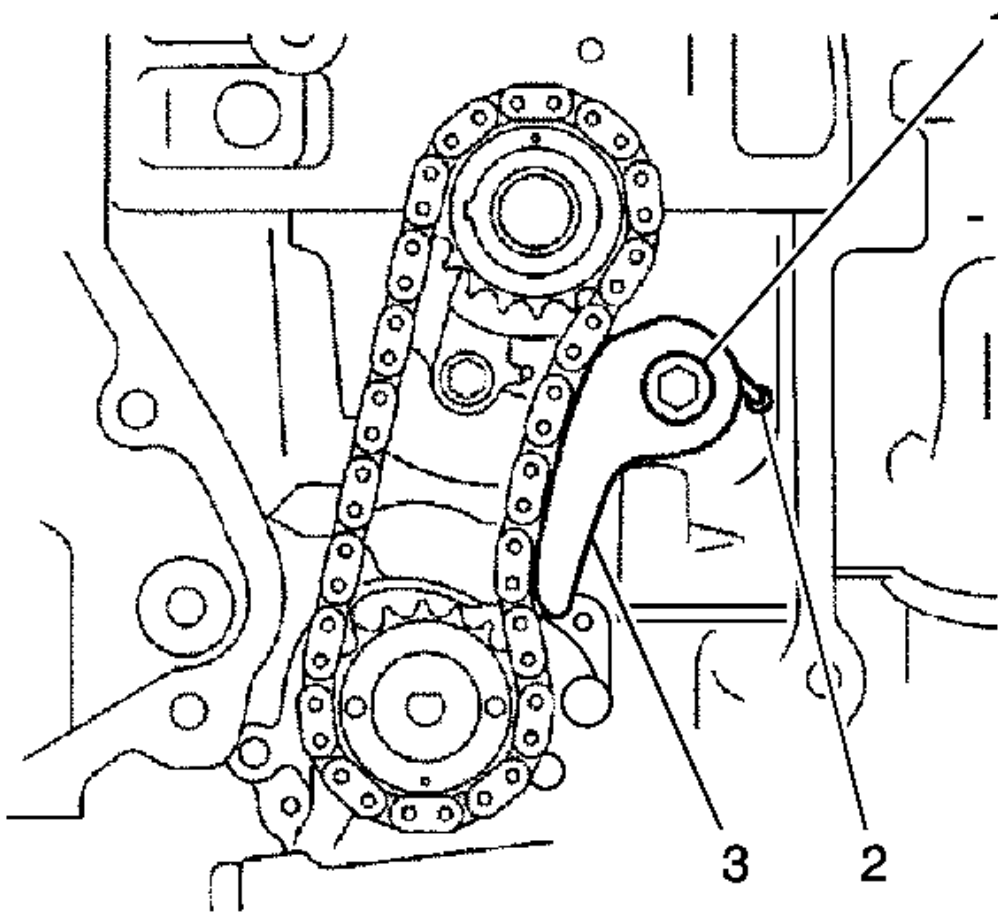


Fig. 137: Identifying Chain Tensioner Plate & Bolt
Courtesy of GENERAL MOTORS CORP.

22. Insert the damper spring into the adjusting hole, and then install the chain tensioner plate with the bolt.

Tighten: 12 N.m (9 lb ft)

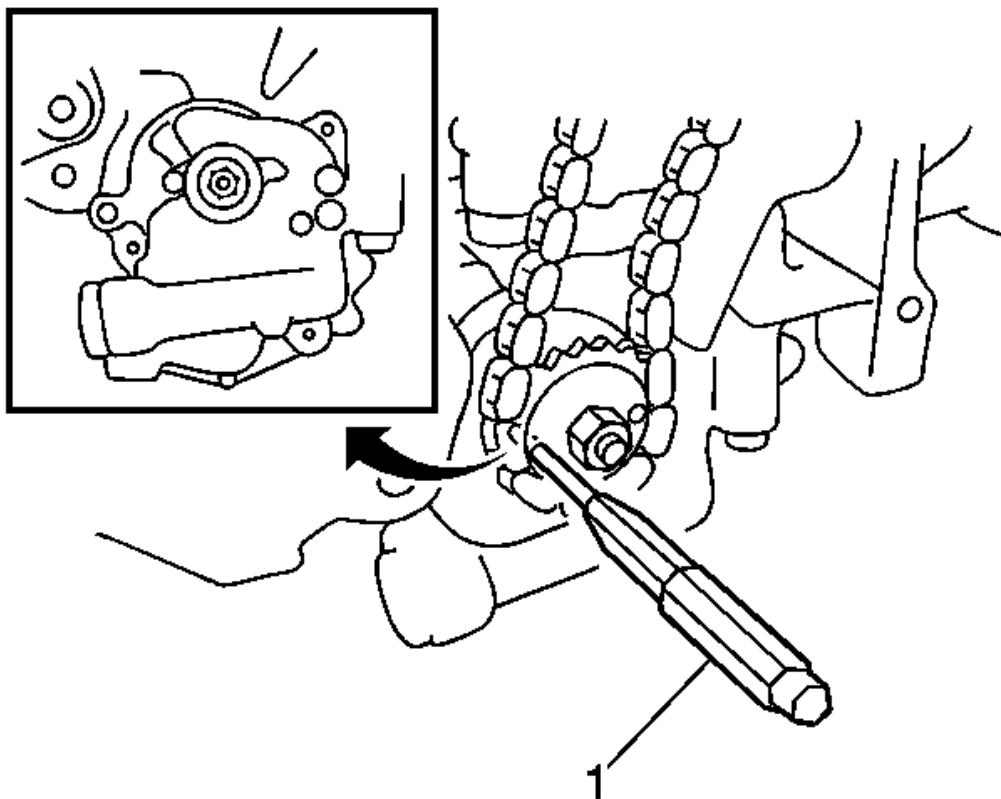


Fig. 138: View Of Locking Oil Pump Drive Shaft Sprocket In Position
Courtesy of GENERAL MOTORS CORP.

23. Align the adjusting hole on the oil pump drive shaft sprocket with the groove on the oil pump.
24. Insert a 4 mm diameter bar into the adjusting hole on the oil pump drive shaft gear to lock the gear in position, and then tighten the nut.

Tighten: 30 N.m (22 lb ft)

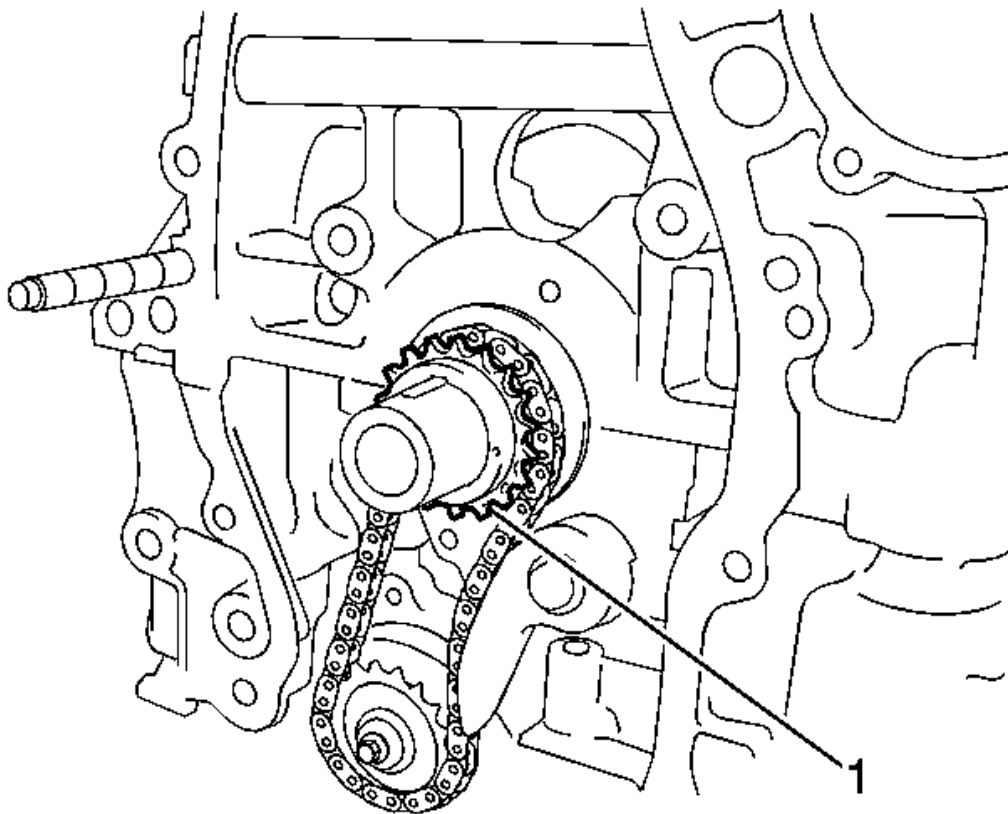


Fig. 139: View Of Crankshaft Timing Gear/Sprocket
Courtesy of GENERAL MOTORS CORP.

25. Install the crankshaft timing gear or sprocket to the crankshaft.

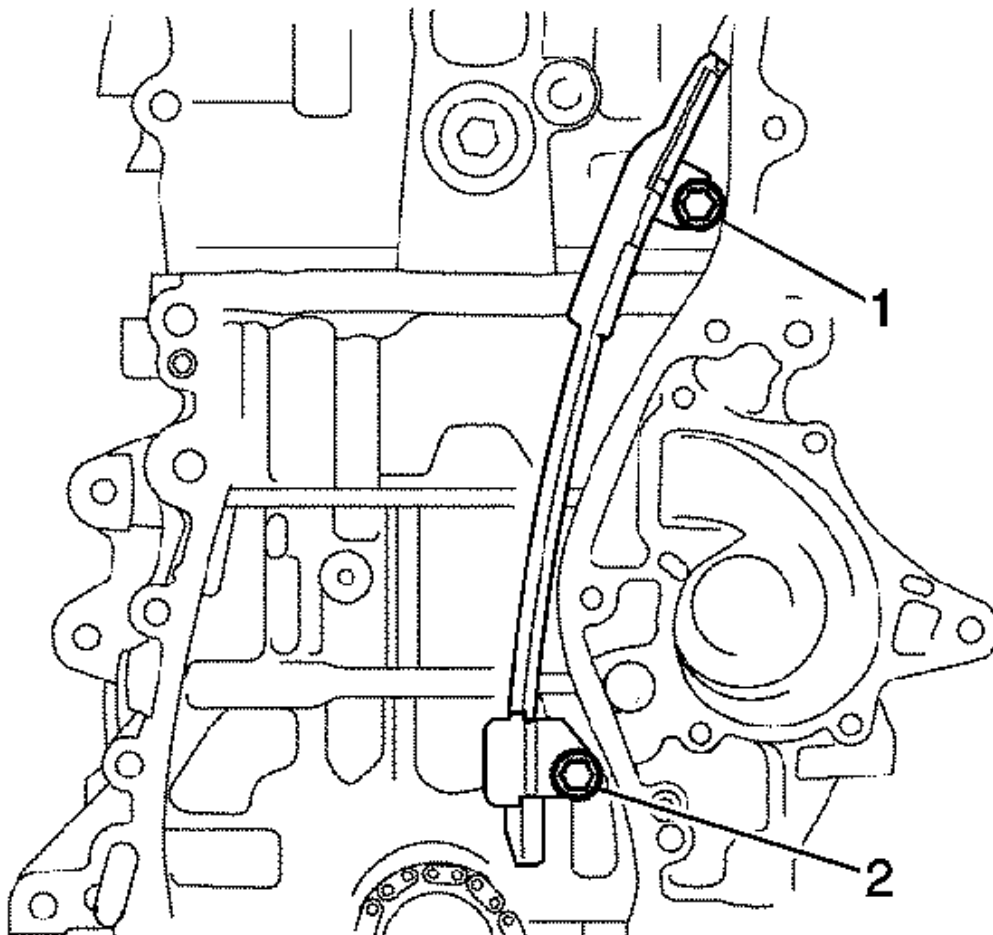


Fig. 140: Identifying Chain Vibration Damper
Courtesy of GENERAL MOTORS CORP.

26. Install the No. 1 chain vibration damper with the 2 bolts.

Tighten: 9.0 N.m (80 lb in)

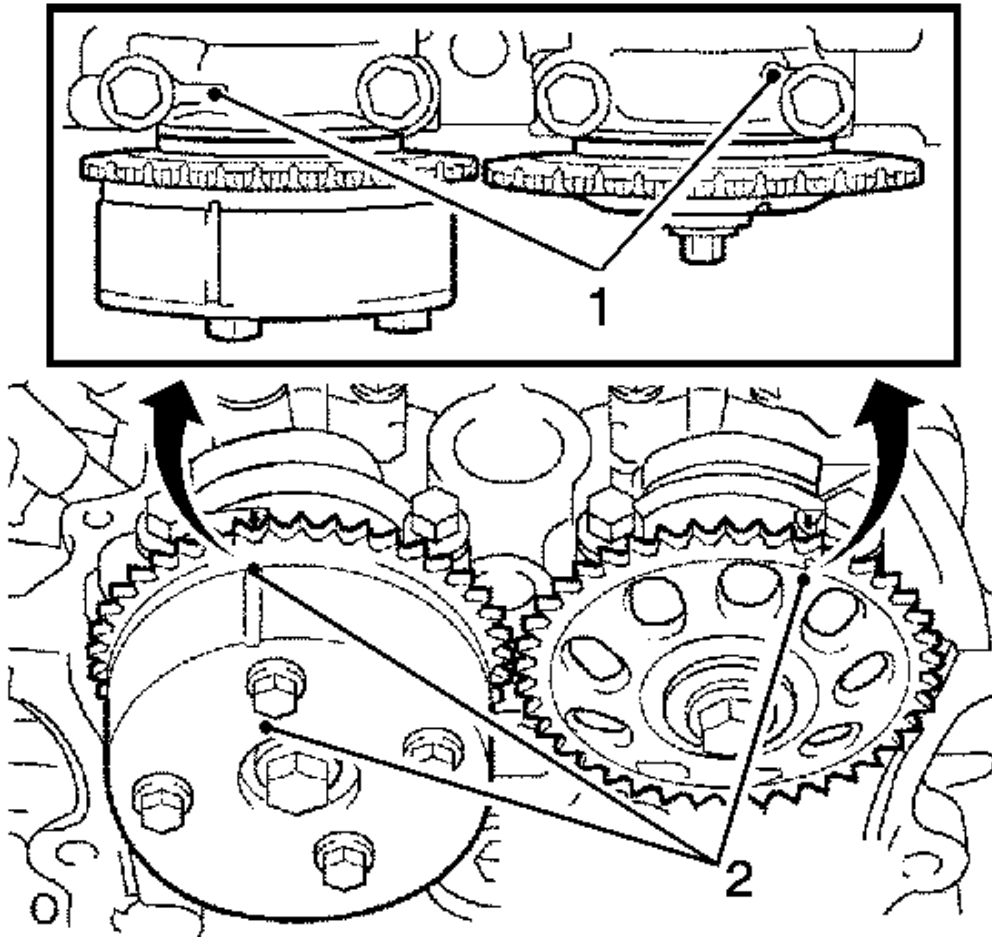


Fig. 141: View Of Setting No. 1 Cylinder To TDC Compression Stroke
 Courtesy of GENERAL MOTORS CORP.

27. Install chain sub-assembly.
28. Set the No. 1 cylinder to TDC/compression.
29. Turn the camshafts with a wrench (using the hexagonal lobe) to align the timing marks on the camshaft timing gear with the timing marks located on the No. 1 and No. 2 bearing caps as shown in the illustration.

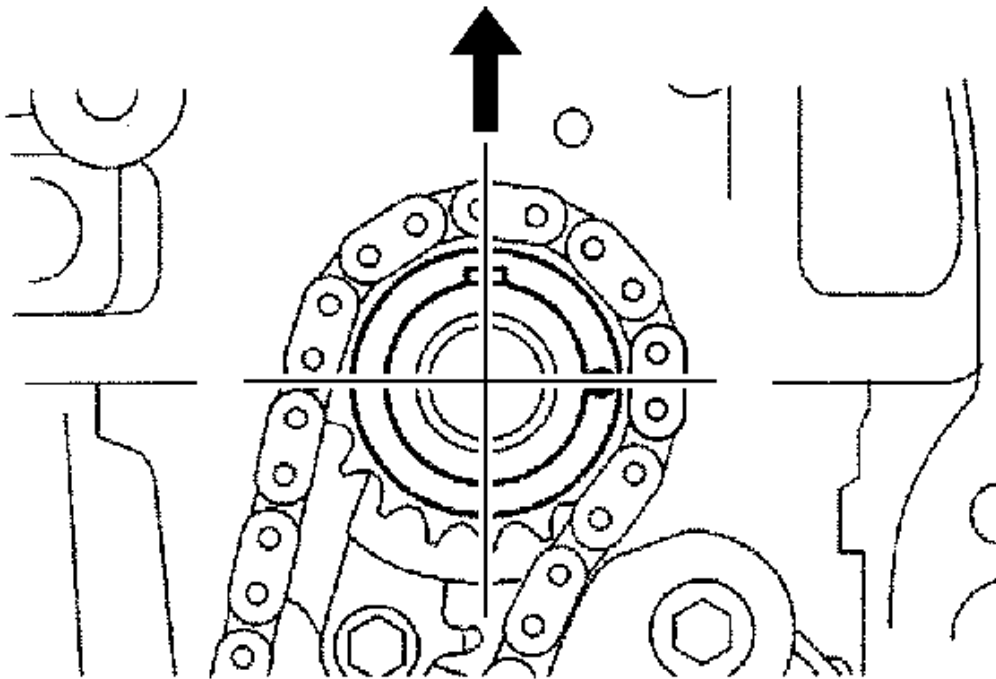


Fig. 142: View Of Setting Crankshaft Upward
Courtesy of GENERAL MOTORS CORP.

30. Using the crankshaft pulley bolt, turn the crankshaft to position the key on the crankshaft upward.

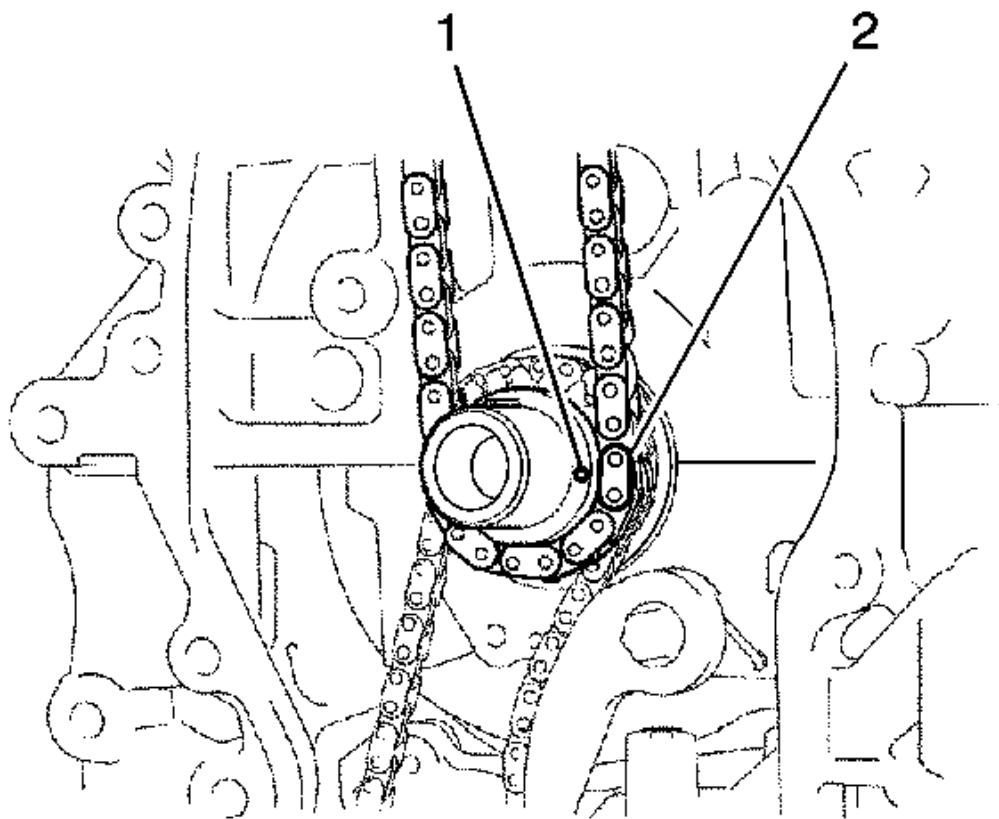


Fig. 143: View Of Crankshaft Timing Sprocket
Courtesy of GENERAL MOTORS CORP.

31. Install the chain onto the crankshaft timing sprocket with the gold or orange mark link aligned with the timing mark on the crankshaft.

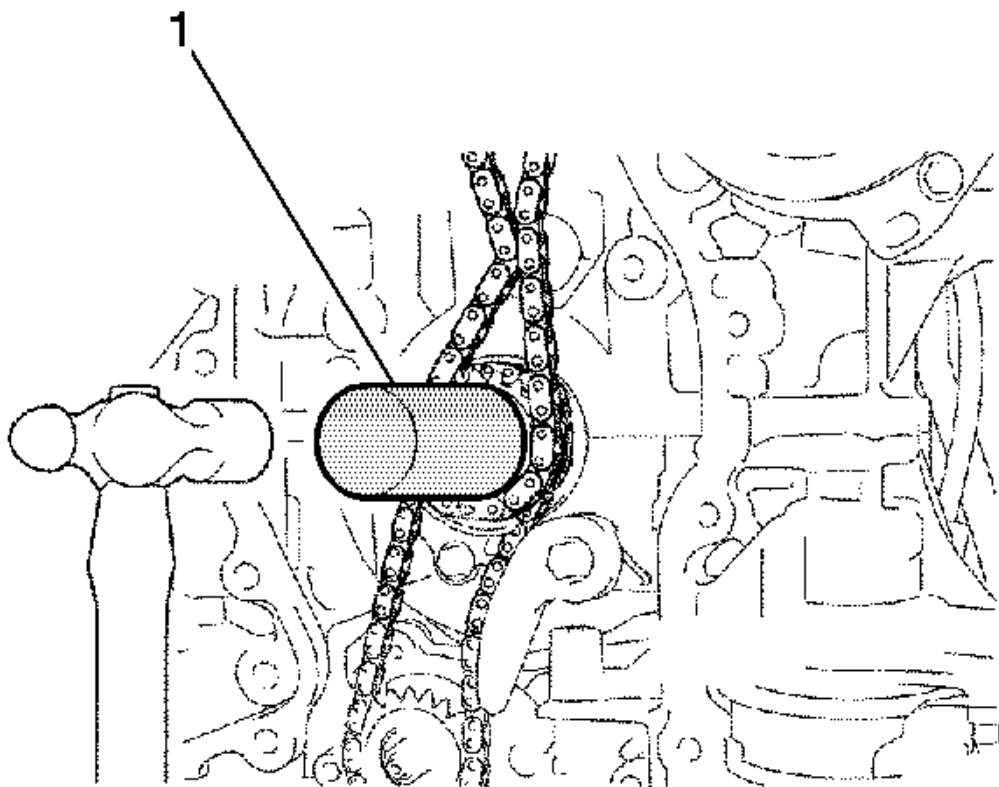


Fig. 144: View Of Crankshaft Timing Sprocket Installation
Courtesy of GENERAL MOTORS CORP.

32. Using SST and a hammer, tap in the crankshaft timing sprocket. (SST 09309-37010)

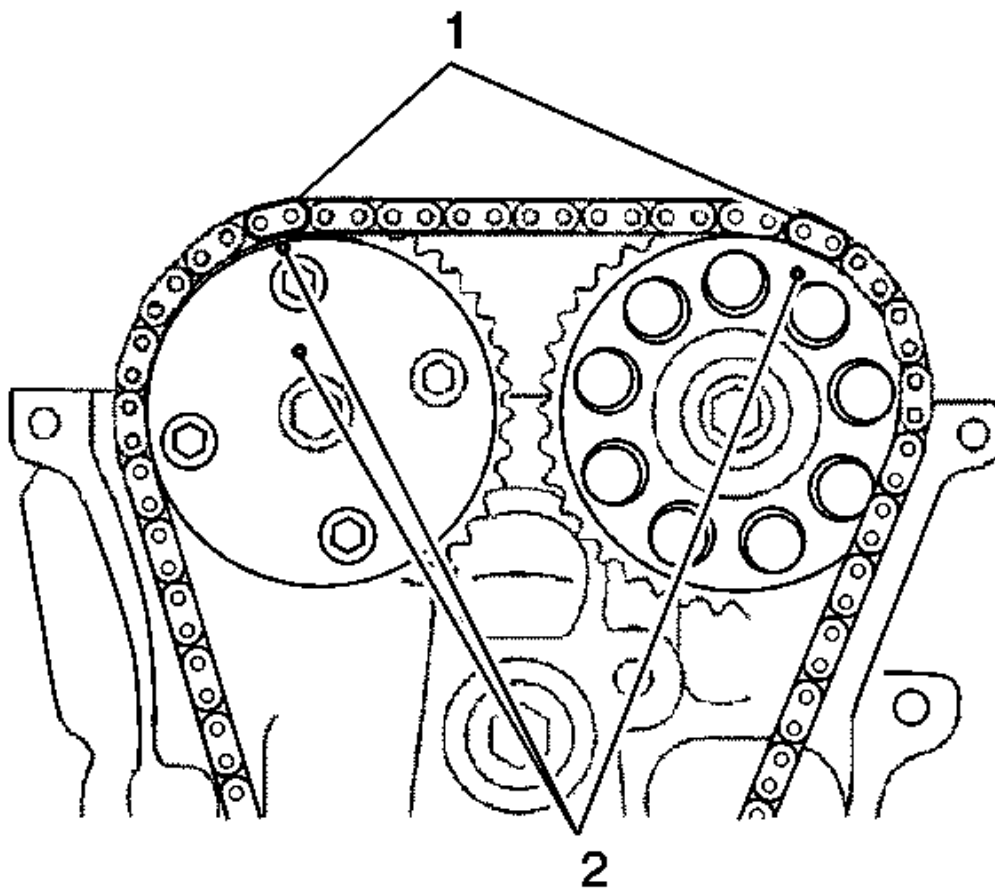


Fig. 145: Aligning Colored Timing Chain Links
Courtesy of GENERAL MOTORS CORP.

33. Align the gold or yellow links with the timing marks located on the camshaft timing gear and sprocket, then install the chain.

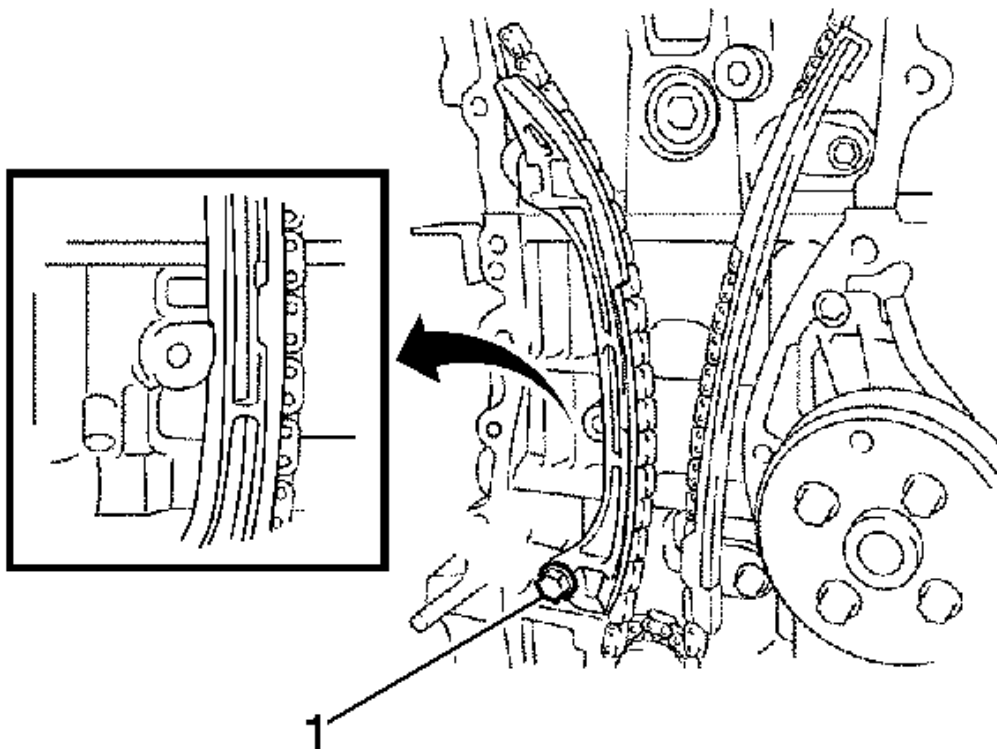


Fig. 146: View Of Chain Tensioner Slipper & Bolt
Courtesy of GENERAL MOTORS CORP.

34. Install the chain tensioner slipper with the bolt.

Tighten: 19 N.m (14 lb ft)

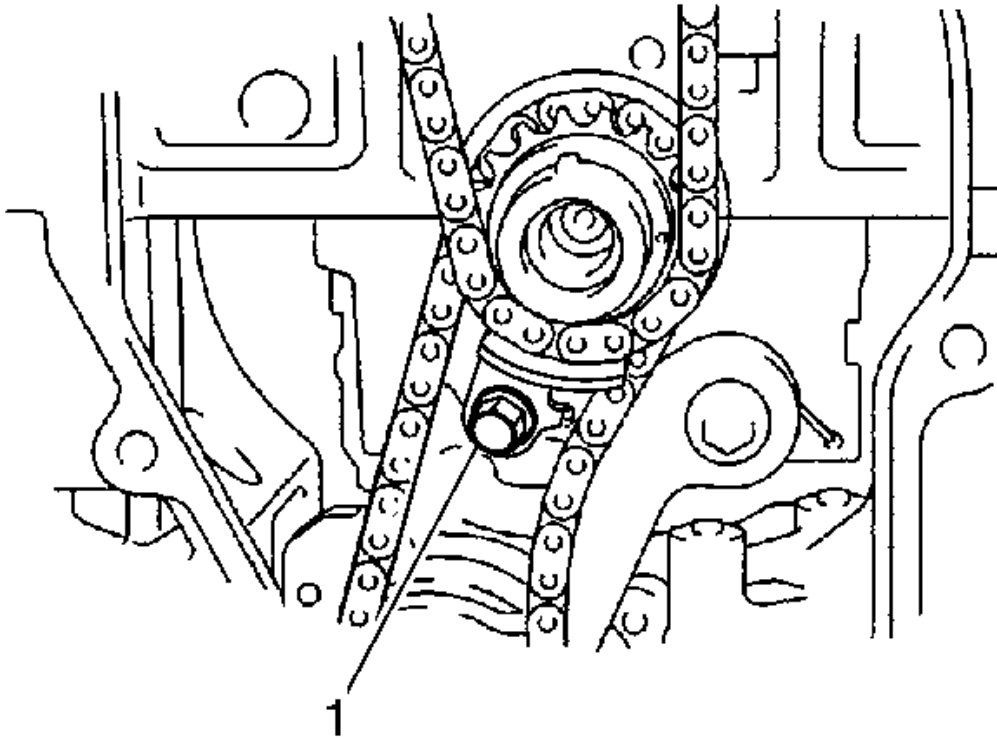


Fig. 147: Identifying Timing Chain Guide & Bolt
Courtesy of GENERAL MOTORS CORP.

35. Install the timing chain guide with the bolt.

Tighten: 9.0 N.m (80 lb in)

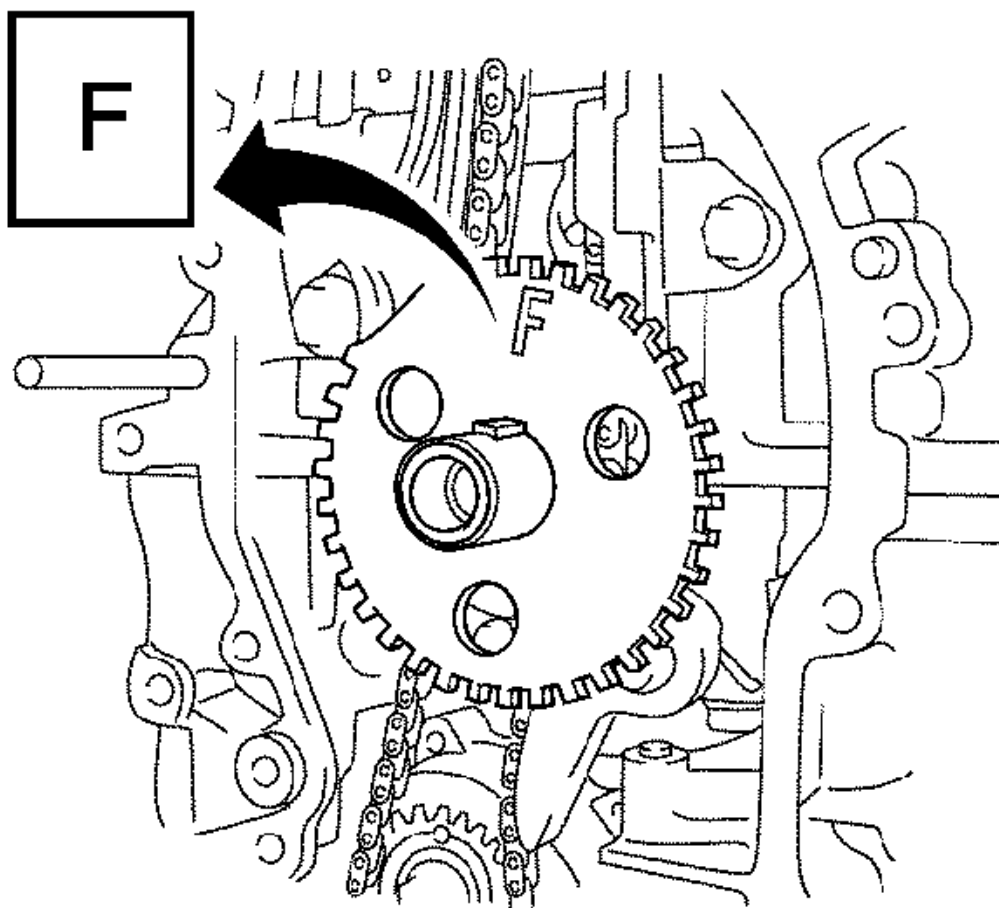


Fig. 148: Locating Sensor Plate "F" Mark
Courtesy of GENERAL MOTORS CORP.

36. Install No. 1 crankshaft position sensor plate. Install the sensor plate with the "F" mark facing forward.
37. Install timing chain or belt cover sub-assembly.

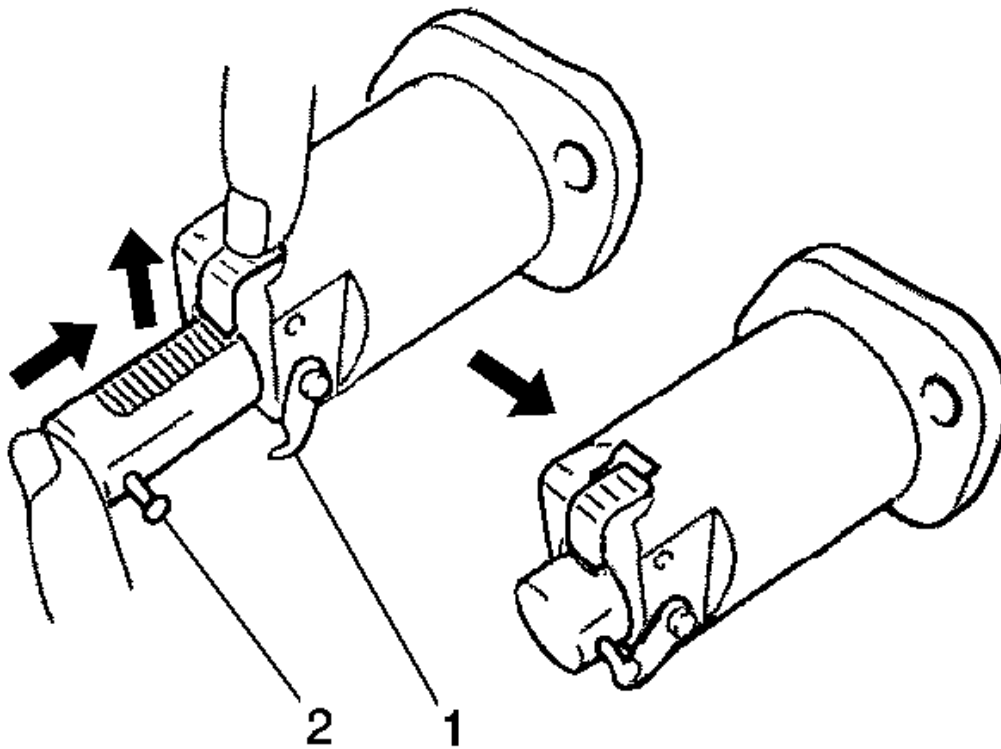


Fig. 149: View Of Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

38. Install No. 1 chain tensioner assembly.
39. Release the ratchet pawl, then fully push in the plunger and set the hook to the pin so that the plunger is in the position shown in the illustration.

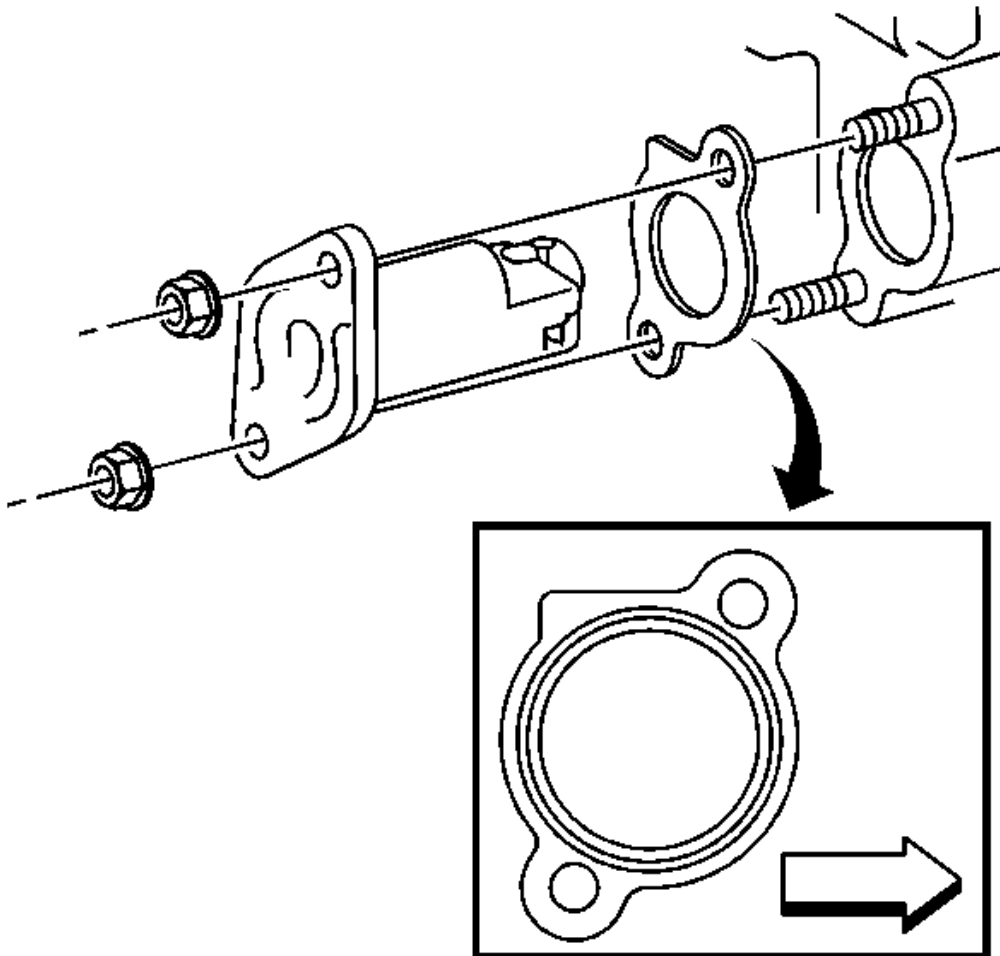


Fig. 150: View Of Gasket, Chain Tensioner & Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing the chain tensioner, set the hook again if the hook releases the plunger.

40. Install a new gasket and the chain tensioner with the 2 nuts.

Tighten: 9.0 N.m (80 lb in)

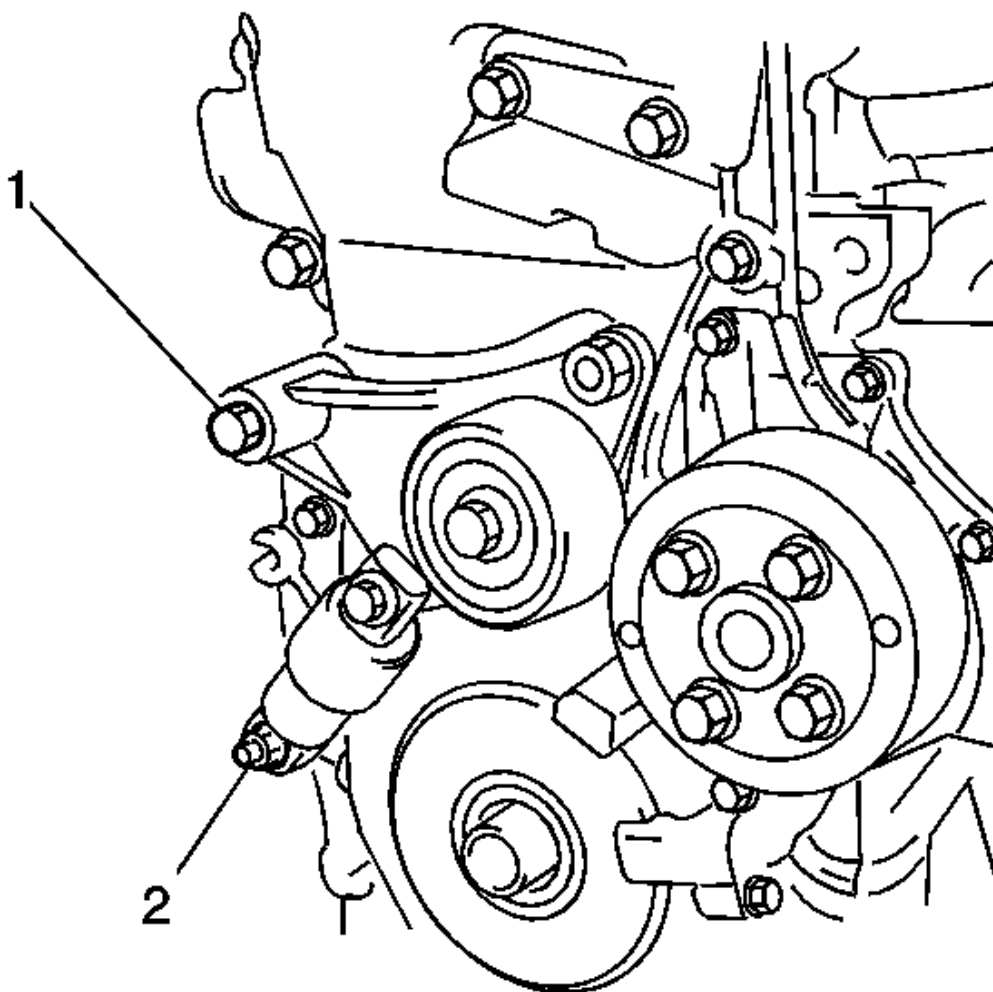


Fig. 151: Identifying Belt Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not lift the engine more than necessary.

41. Install V-ribbed belt tensioner assembly.
42. Except spring type V-ribbed belt tensioner-Install the V-ribbed tensioner assembly with the bolt and nut.

Tighten: 60 N.m (44 lb ft)

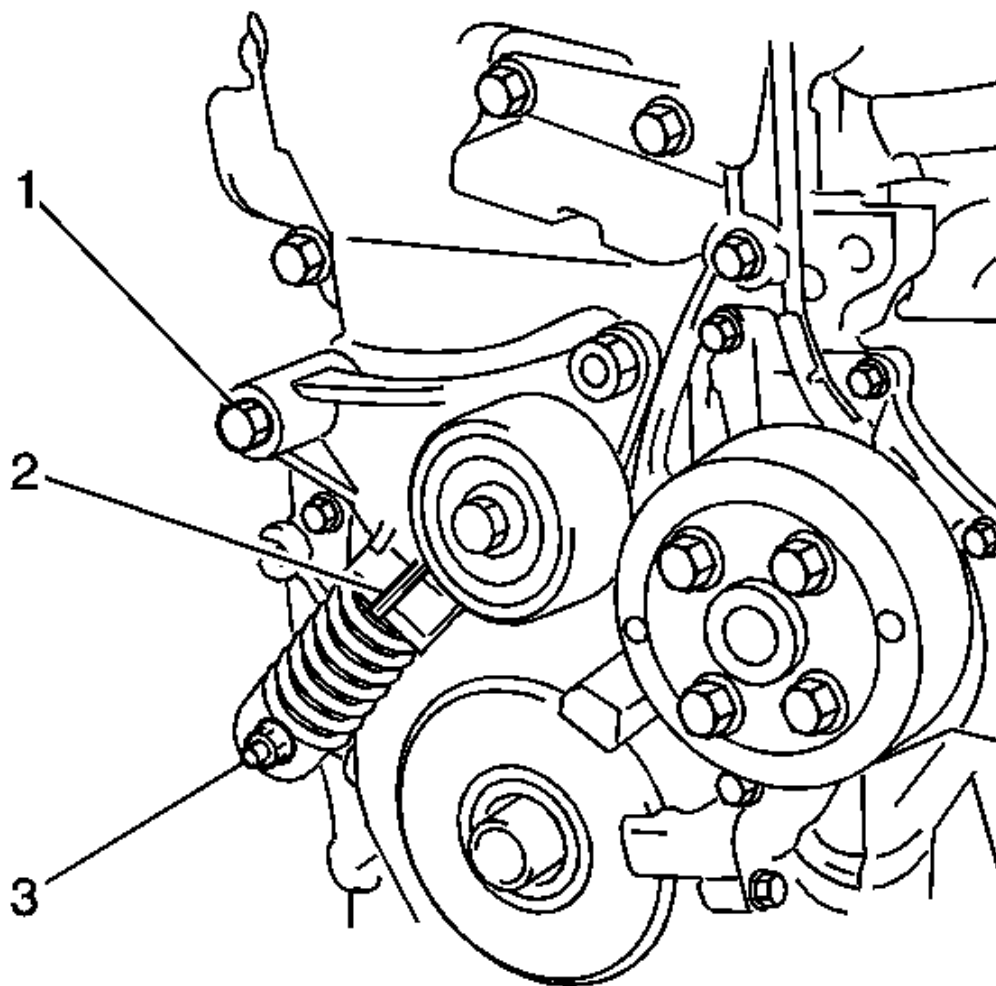


Fig. 152: Identifying Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: When replacing the V-ribbed belt tensioner with a new one, do not pull out the pin. Do not lift the engine more than necessary.

43. Spring type V-ribbed belt tensioner-Install the V-ribbed belt tensioner to the engine by first tightening the bolt and then tightening the nut.

Tighten: 60 N.m (44 lb ft)

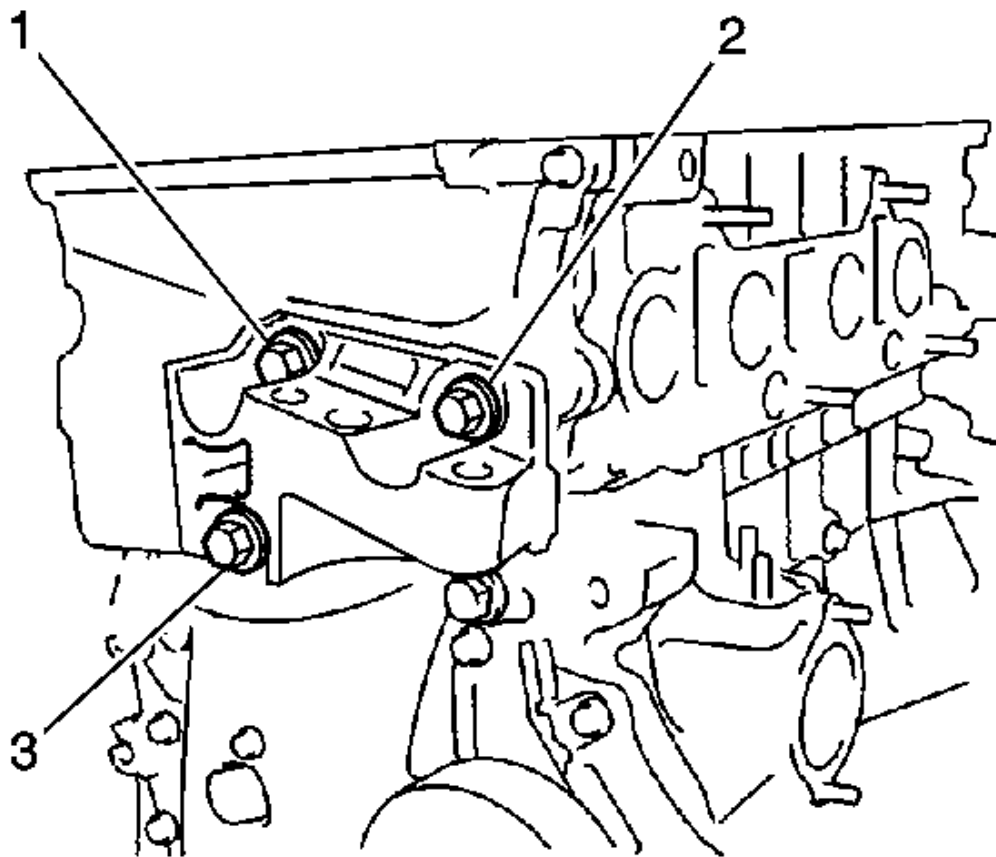


Fig. 153: Identifying Engine Mounts Bolts
Courtesy of GENERAL MOTORS CORP.

44. Install the engine transverse engine mounting bracket with the 3 bolts.

Tighten: 55 N.m (41 lb ft)

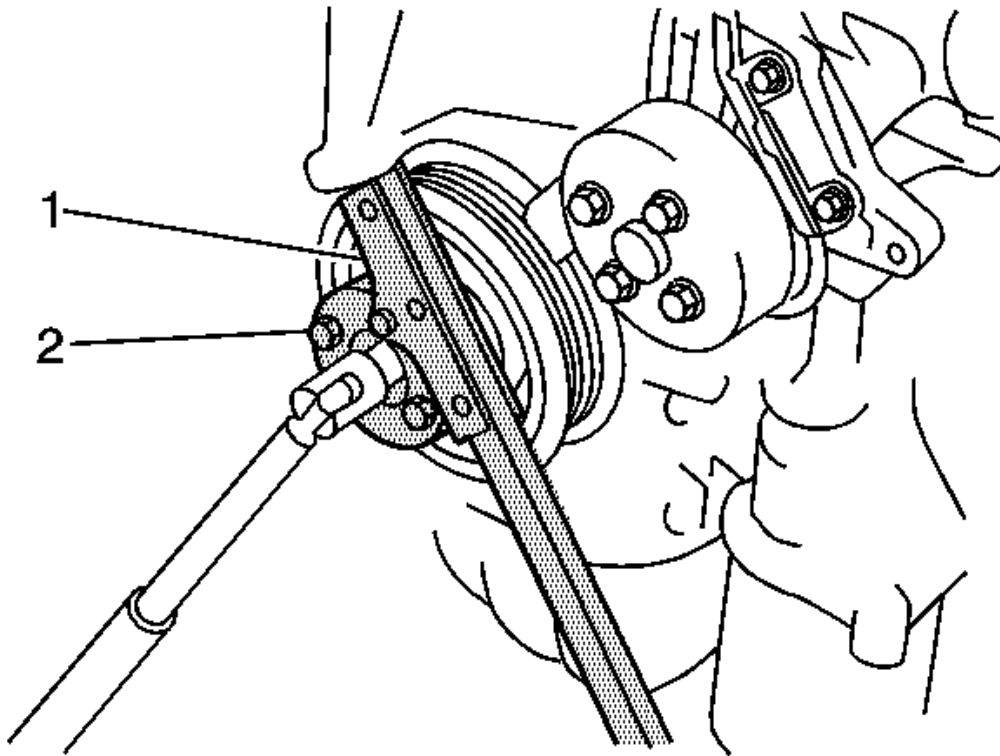


Fig. 154: View Of Crankshaft Pulley Installation
Courtesy of GENERAL MOTORS CORP.

45. Install crankshaft pulley.
46. Using SST, fix the pulley in place and tighten the bolt. (SST 09213-54015 (91651-60855), 09330-00021)

Tighten: 180 N.m (133 lb ft)

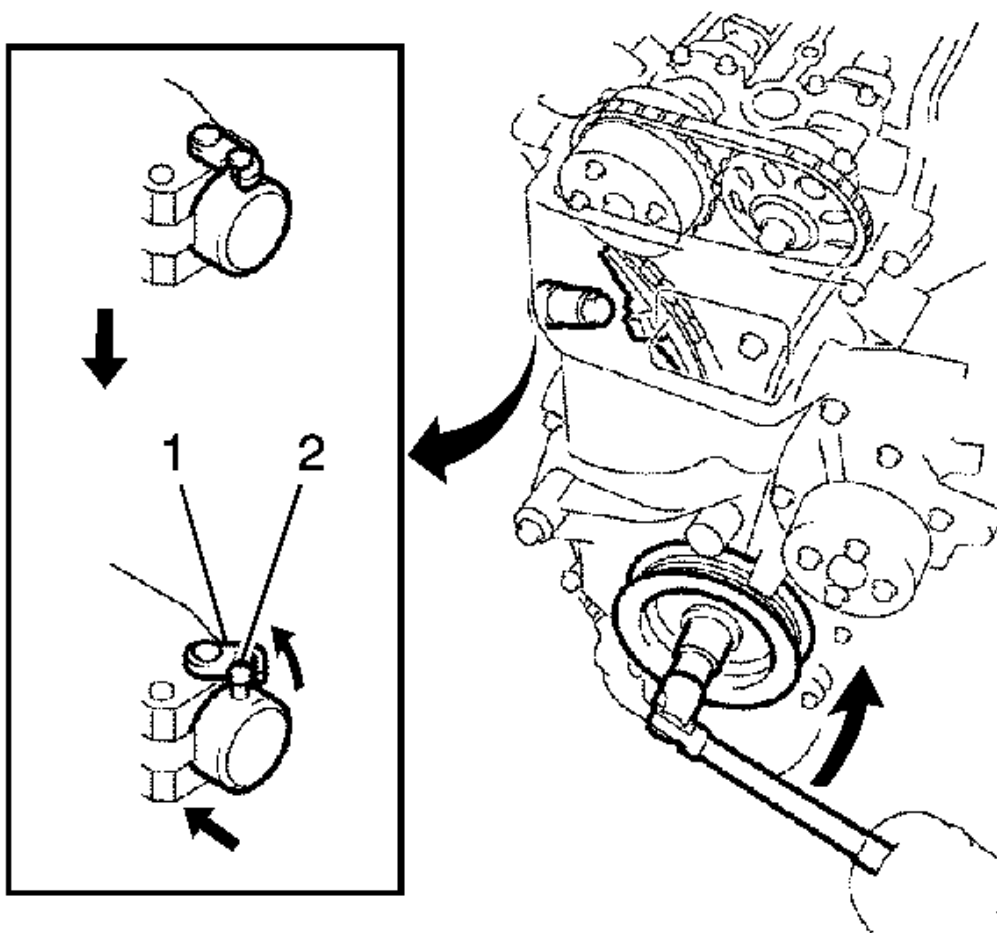


Fig. 155: Rotating Crankshaft Counterclockwise
Courtesy of GENERAL MOTORS CORP.

47. Turn the crankshaft counterclockwise, then disconnect the plunger knock pin from the hook.

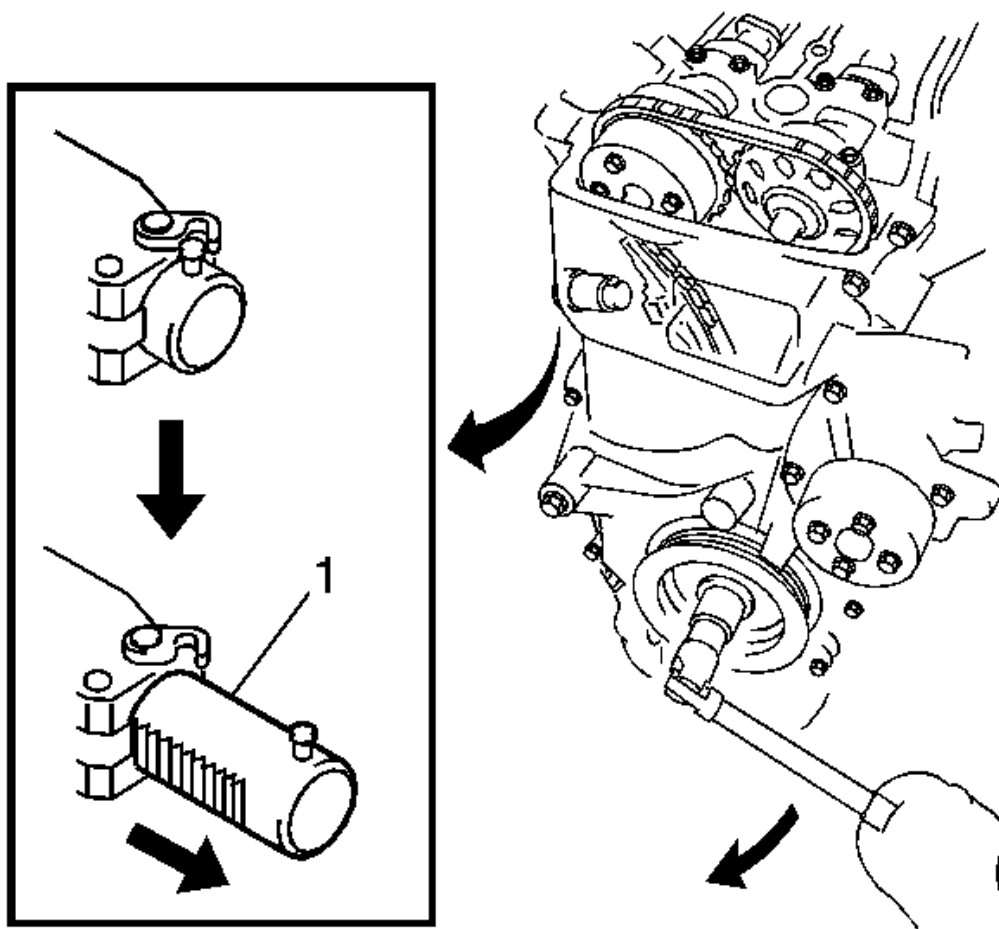


Fig. 156: View Of Tensioner Plunger Assembly
Courtesy of GENERAL MOTORS CORP.

48. Turn the crankshaft clockwise, then check that the plunger is extended.
49. Install oil pan sub-assembly.
50. Remove any old packing material and be careful not to drop any oil on the contact surfaces of the cylinder block and oil pan.

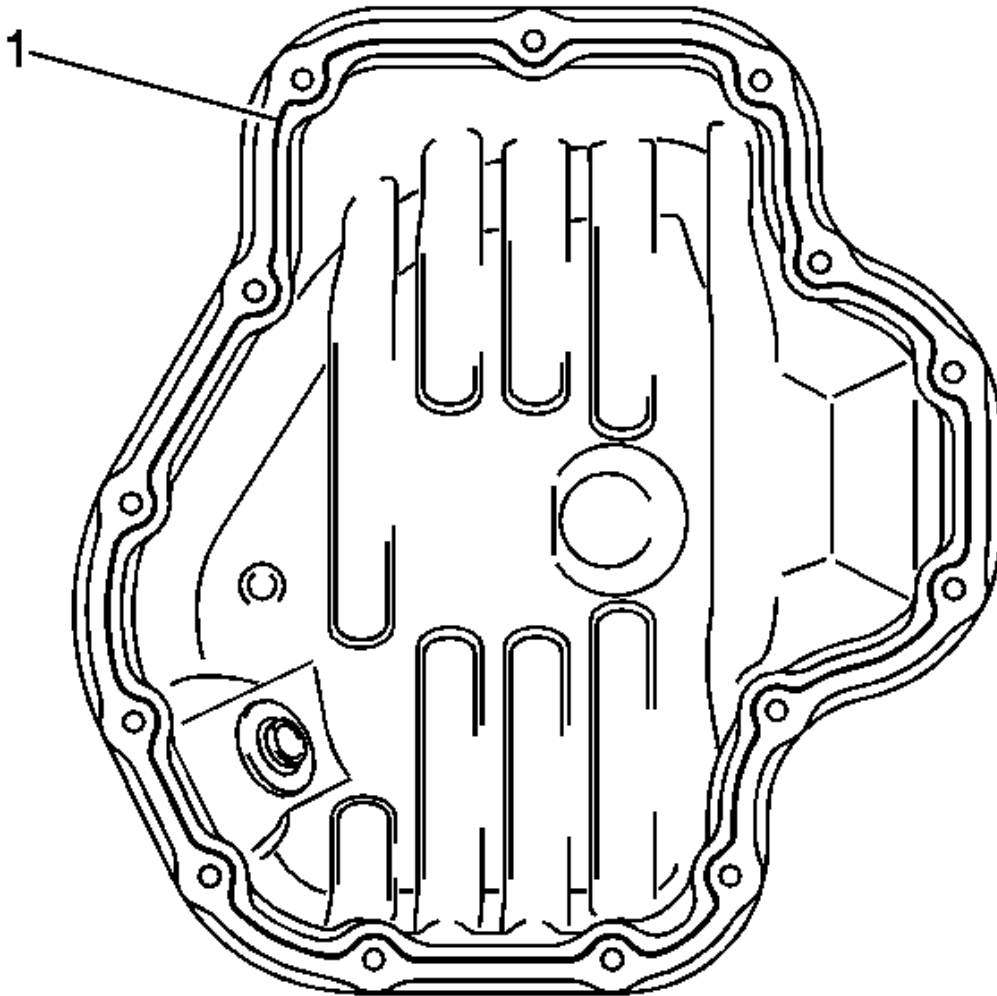


Fig. 157: View Of Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove any oil from the contact surfaces. Install the oil pan within 3 minutes of applying seal packing. Do not add engine oil for at least 2 hours after installing the oil pan.

51. Apply a continuous bead of seal packing, diameter 4.0-4.5 mm (0.158-0.177 in.), as shown in the illustration. Seal packing: Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent
52. Install the oil pan onto the cylinder block.

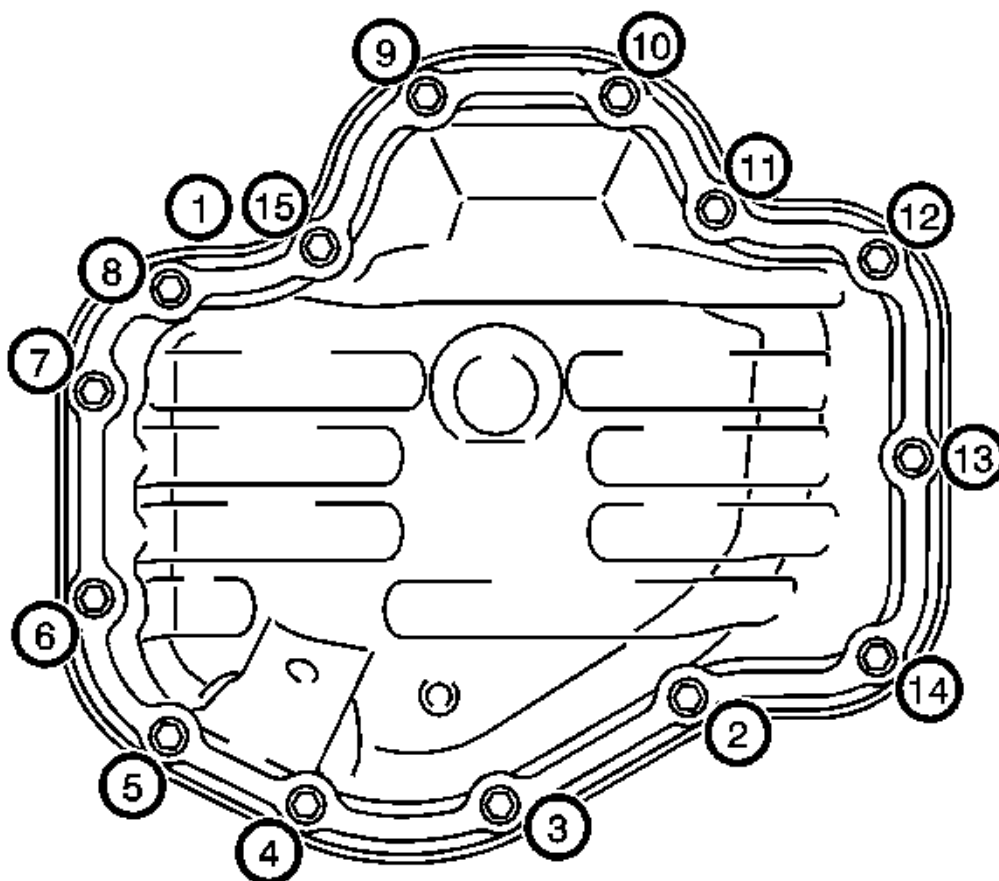


Fig. 158: Identifying Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

53. Uniformly tighten the 12 bolts and 2 nuts in the sequence shown in the illustration.

Tighten: 9.0 N.m (80 lb ft)

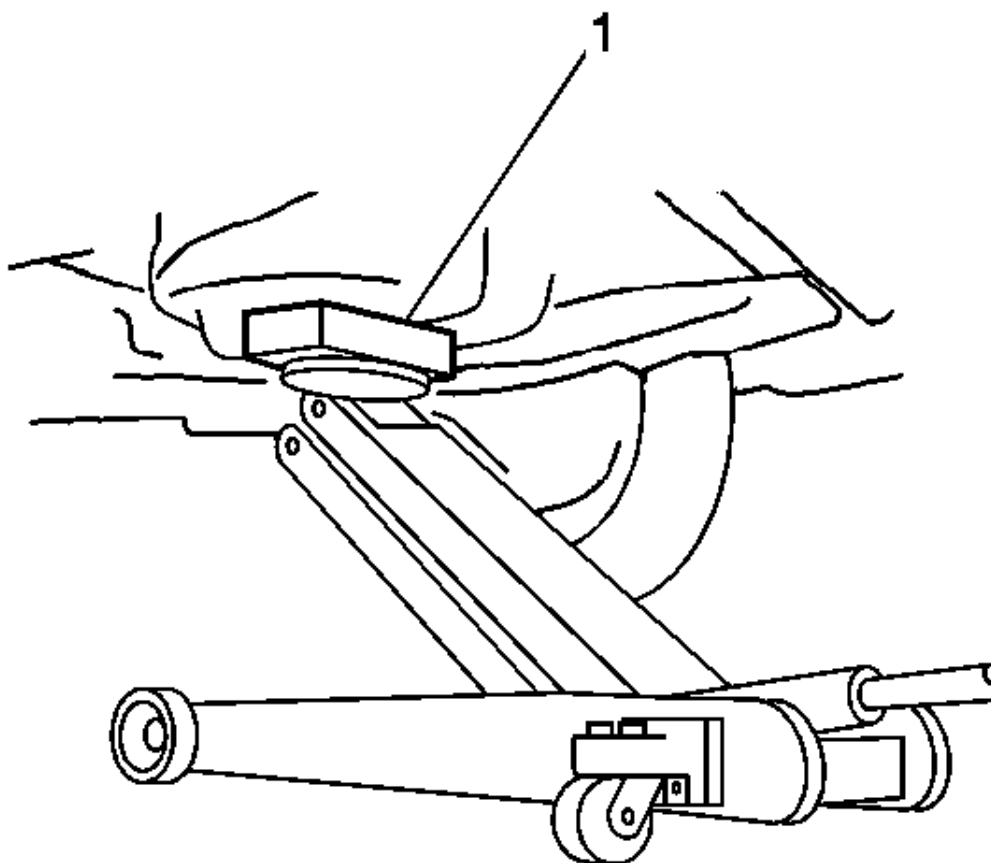


Fig. 159: Identifying Right Engine Mounting Insulator Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

54. Place a wooden block between a floor jack and the engine, then support the engine using the floor jack.
55. Remove the chain block and sling device.
56. Remove the No. 1 and No. 2 engine hangers.
57. Install crankshaft position sensor. See **CRANKSHAFT POSITION SENSOR REPLACEMENT** .

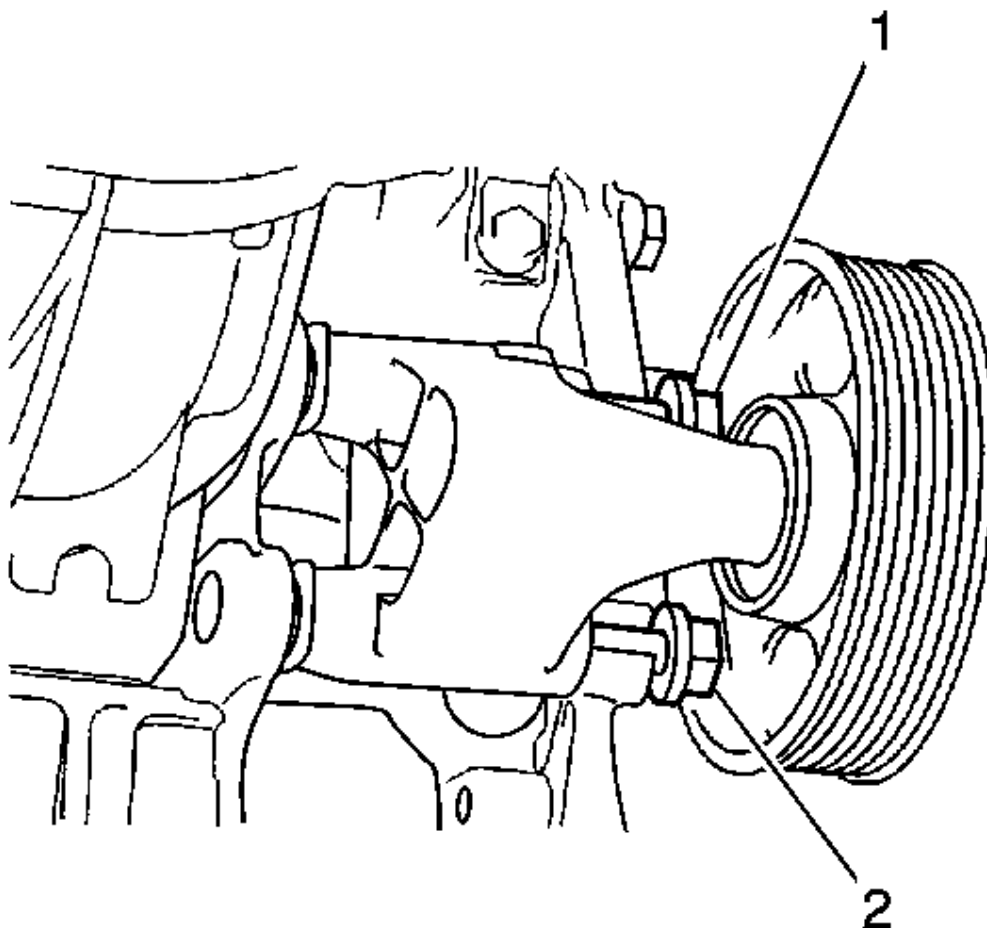


Fig. 160: Identifying Idler Pulley Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

58. Install the idler pulley sub-assembly with the 2 bolts.

Tighten: 50 N.m (37 lb ft)

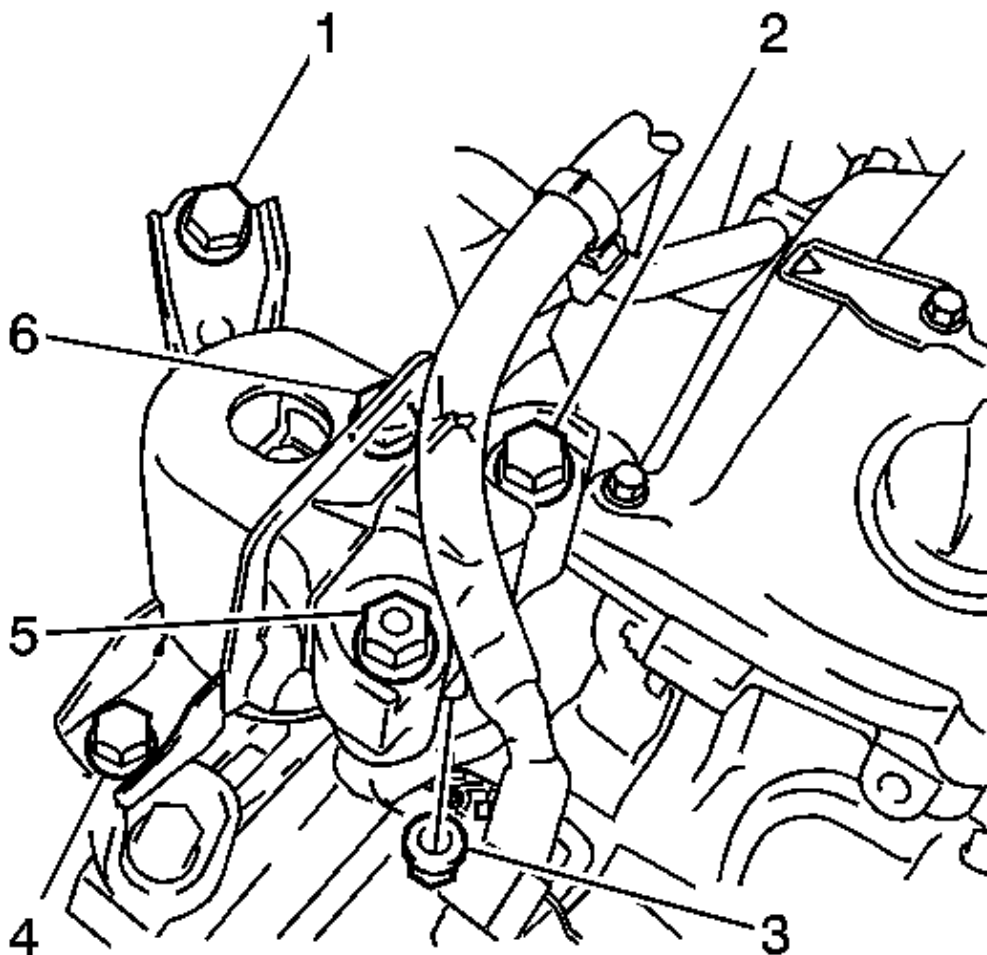


Fig. 161: View Of Right Engine Mounting Insulator Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

59. Install the right engine mounting insulator sub-assembly with the 4 bolts and 2 nuts.

Tighten: Bolt A-52 N.m (38 lb ft) Bolt B-95 N.m (70 lb ft) Nut A-95 N.m (70 lb ft) Nut B-52 N.m (38 lb ft)

60. Install exhaust manifold converter sub-assembly.
61. Install a new gasket onto the cylinder head sub-assembly.
62. Temporarily tighten the exhaust manifold converter sub-assembly with the 5 nuts.

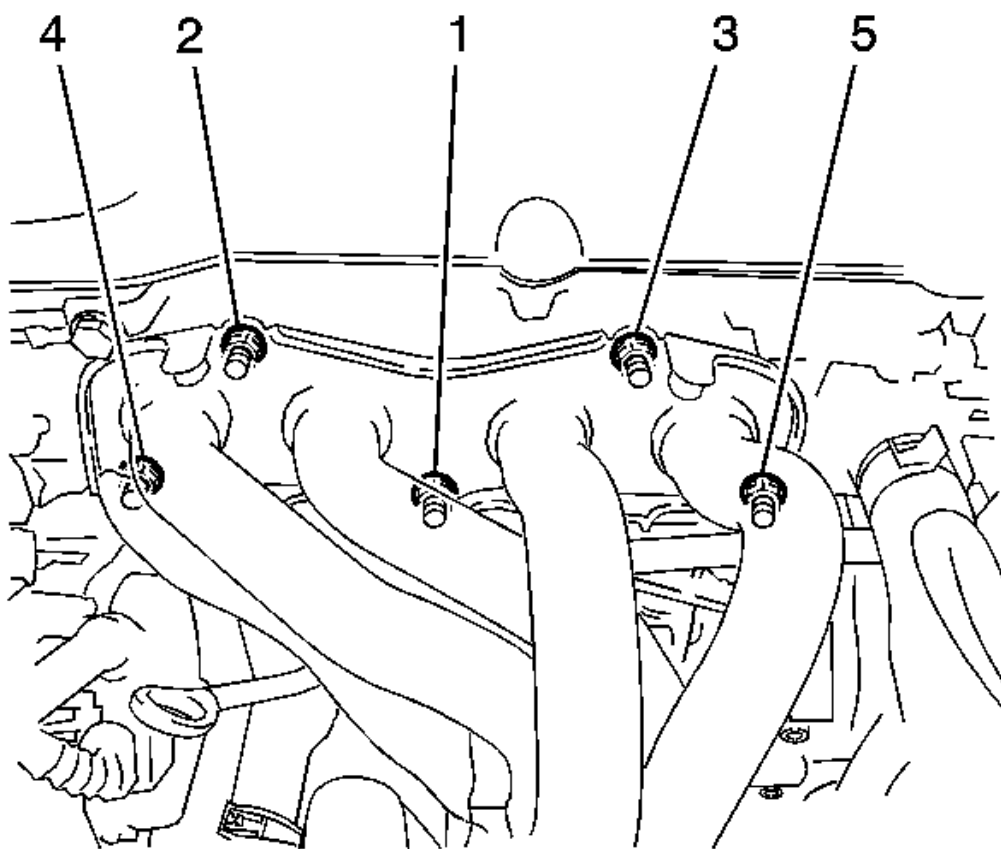


Fig. 162: Exhaust Manifold Nut Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

63. Tighten the 5 nuts in the sequence shown in the illustration.

Tighten: 37 N.m (27 lb ft)

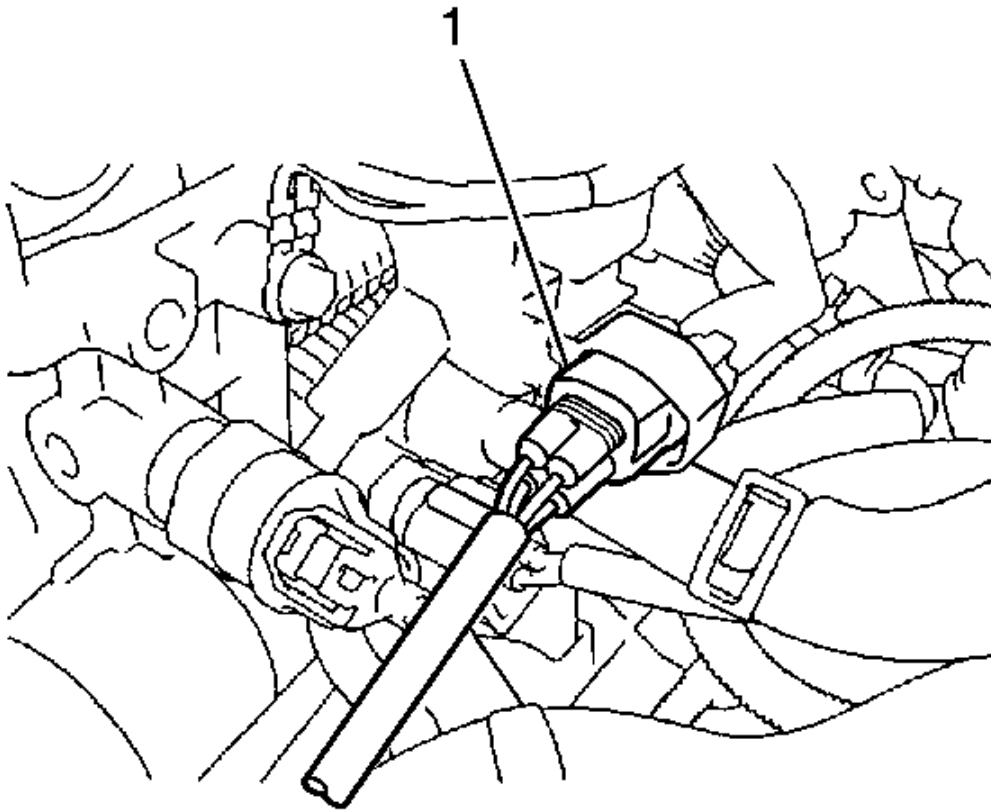


Fig. 163: Identifying Exhaust Manifold Converter Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

64. Connect the air-fuel ratio sensor connector.
65. Install No. 1 exhaust manifold heat insulator.
66. Install No. 2 manifold stay.
67. Install manifold stay.
68. Install No. 2 intake manifold insulator.
69. Install intake manifold. See **Intake Manifold Replacement**.
70. Install camshaft timing oil control valve assembly. See **CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT**.
71. Install fuel delivery pipe sub-assembly.
72. Connect fuel main tube.
73. Install engine oil level dipstick guide.
74. Apply a light coat of engine oil to a new O-ring and install it onto the engine oil level dipstick guide.

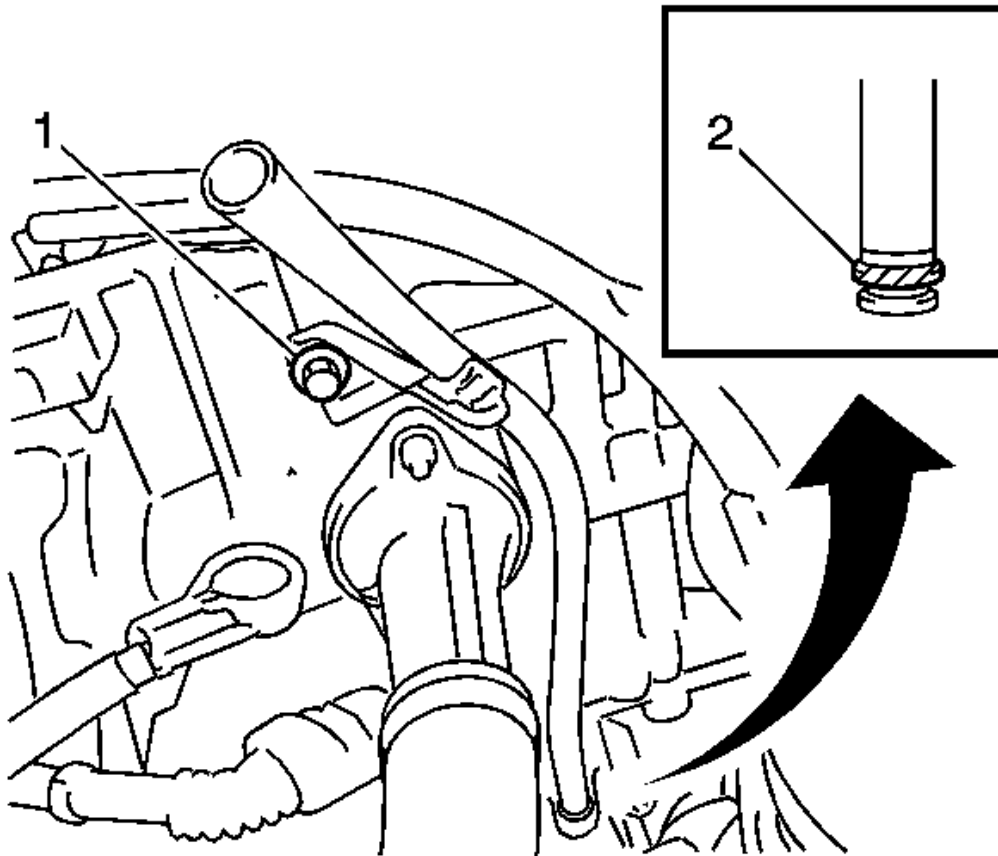


Fig. 164: Identifying Engine Oil Level Dipstick Guide & Bolt
Courtesy of GENERAL MOTORS CORP.

75. Install the engine oil level dipstick guide with the bolt.

Tighten: 9.0 N.m (80 lb ft)

76. Install engine oil level dipstick.
77. Install cylinder head cover sub-assembly. See Cylinder Head Replacement.
78. Install spark plug. See SPARK PLUG REPLACEMENT.
79. Install ignition coil assembly. See IGNITION COIL REPLACEMENT.
80. Install throttle body assembly. See THROTTLE BODY ASSEMBLY REPLACEMENT.
81. Install air cleaner cap sub-assembly with hose. See THROTTLE BODY ASSEMBLY REPLACEMENT.
82. Install radiator reserve tank assembly.

83. Install generator assembly. See **GENERATOR REPLACEMENT (2.4L)**.
84. Install V-ribbed belt.
85. Except spring type V-ribbed belt tensioner and reusing spring type V-ribbed belt tensioner, install the V-ribbed belt. See **Drive Belt Replacement**.

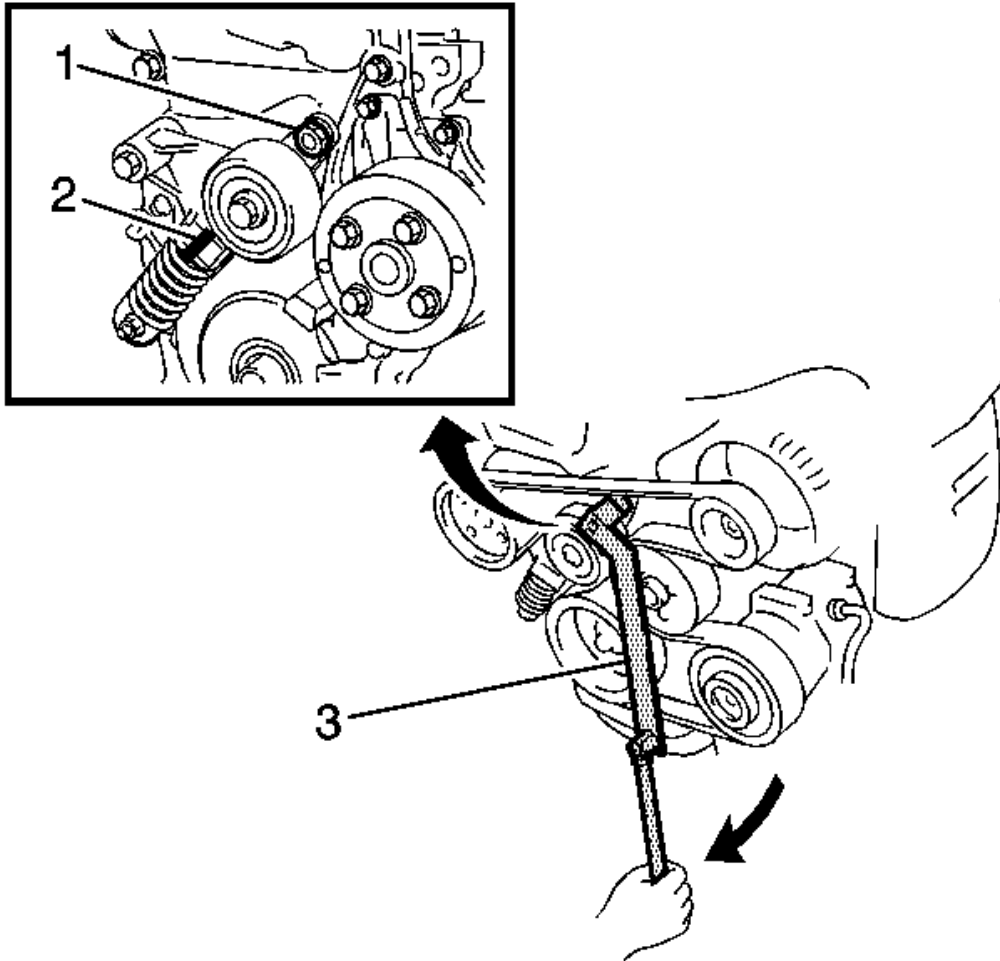


Fig. 165: View Of Spring Type V-Ribbed Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

86. Replacing spring type V-ribbed belt tensioner:
87. Using SST, slowly turn the V-ribbed belt tensioner clockwise. (SST 09216-42010 (09216-04010))
88. Pull out the pin with the V-ribbed belt tensioner being compressed in a clockwise direction.

NOTE: Make sure that SST and other tools are set to the tensioner securely. When compressing the V-ribbed belt tensioner, slowly turn the tensioner.

- 89. Slowly return the V-ribbed belt tensioner.
- 90. Install the V-ribbed belt. See Drive Belt Replacement.
- 91. Install front exhaust pipe assembly. See EXHAUST PIPE REPLACEMENT (2.4L AWD).
- 92. Install center exhaust pipe assembly. See EXHAUST PIPE REPLACEMENT (2.4L AWD).

NOTE: When disconnecting the cable, some systems need to be initialized after the cable is reconnected. Refer to BATTERY DISCONNECT WARNING.

- 93. Connect cable to negative battery terminal.
- 94. Add engine oil.
- 95. Add engine coolant.
- 96. Inspect for fuel leak.
- 97. Inspect for coolant leak.
- 98. Inspect for oil leak.
- 99. Inspect for exhaust gas leak.
- 100. Inspect ignition timing.
- 101. Inspect engine idling speed.
- 102. Inspect compression. See Engine Compression Test.
- 103. Inspect CO/HC. See EMISSION APPLICATIONS.
- 104. Install suspension tower damper assembly, with front strut bar. See FRONT SUSPENSION.
- 105. Install outer cowl top panel.
- 106. Install windshield wiper motor and link assembly. See WINDSHIELD WIPER MOTOR REPLACEMENT.
- 107. Install left cowl top ventilator louver.
- 108. Install right cowl top ventilator louver.
- 109. Install hood to cowl top seal.
- 110. Install front wiper arm and blade assembly LH.
- 111. Install front wiper arm and blade assembly RH.
- 112. Install front wiper arm head cap.
- 113. Install No. 1 engine cover sub-assembly.
- 114. Install left engine under cover.
- 115. Install right engine under cover.
- 116. Install right front wheel.

OIL PUMP REPLACEMENT

Special Tools

SST 09223-22010**Removal Procedure**

1. Discharge the fuel system pressure.

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

NOTE: When disconnecting the cable, some systems need to be initialized after the cable is reconnected.

2. Disconnect the cable from negative battery terminal.
3. Remove the front wiper arm head cap.
4. Remove the left front wiper arm and blade assembly.
5. Remove the right front wiper arm and blade assembly.
6. Remove the hood to cowl top seal.
7. Remove the right cowl top ventilator louver.
8. Remove the left cowl top ventilator louver.
9. Remove the windshield wiper motor and link assembly.
10. Remove the outer cowl top panel.
11. Remove the suspension tower damper assembly, with front strut bar.
12. Remove the right front wheel.
13. Remove the left engine under cover.
14. Remove the right engine under cover.
15. Remove the No. 1 engine cover sub-assembly.
16. Drain the engine coolant.
17. Drain the engine oil.
18. Remove the center exhaust pipe assembly.
19. Remove the front exhaust pipe assembly.
20. Remove the v-ribbed belt.
21. Remove the generator assembly.
22. Disconnect the No. 1 radiator hose.
23. Disconnect the outlet heater water hose.
24. Disconnect the inlet heater water hose.
25. Separate the radiator reserve tank assembly.
26. Remove the air cleaner cap sub-assembly with hose.
27. Remove the throttle body assembly.
28. Remove the ignition coil assembly. See **IGNITION COIL REPLACEMENT** .

29. Remove the spark plug. See **SPARK PLUG REPLACEMENT** .
30. Remove the cylinder head cover sub-assembly.
31. Remove the engine oil level dipstick.
32. Remove the engine oil level dipstick guide.
33. Remove the fuel main tube.
34. Remove the fuel delivery pipe sub-assembly.
35. Remove the camshaft timing oil control valve assembly.
36. Remove the intake manifold.
37. Remove the No. 1 intake manifold insulator.
38. Remove the manifold stay.
39. Remove the No. 2 manifold stay.
40. Remove the No. 1 exhaust manifold heat insulator.
41. Remove the exhaust manifold converter sub-assembly.
42. Remove the right engine mounting insulator sub-assembly.
43. Remove the idler pulley sub-assembly.
44. Remove the oil pan sub-assembly.
45. Set the No. 1 cylinder to TDC/compression.
46. Remove the crankshaft pulley.
47. Remove the No. 1 chain tensioner assembly
48. Remove the transverse engine mounting bracket.
49. Remove the v-ribbed belt tensioner assembly.
50. Remove the crankshaft position sensor.

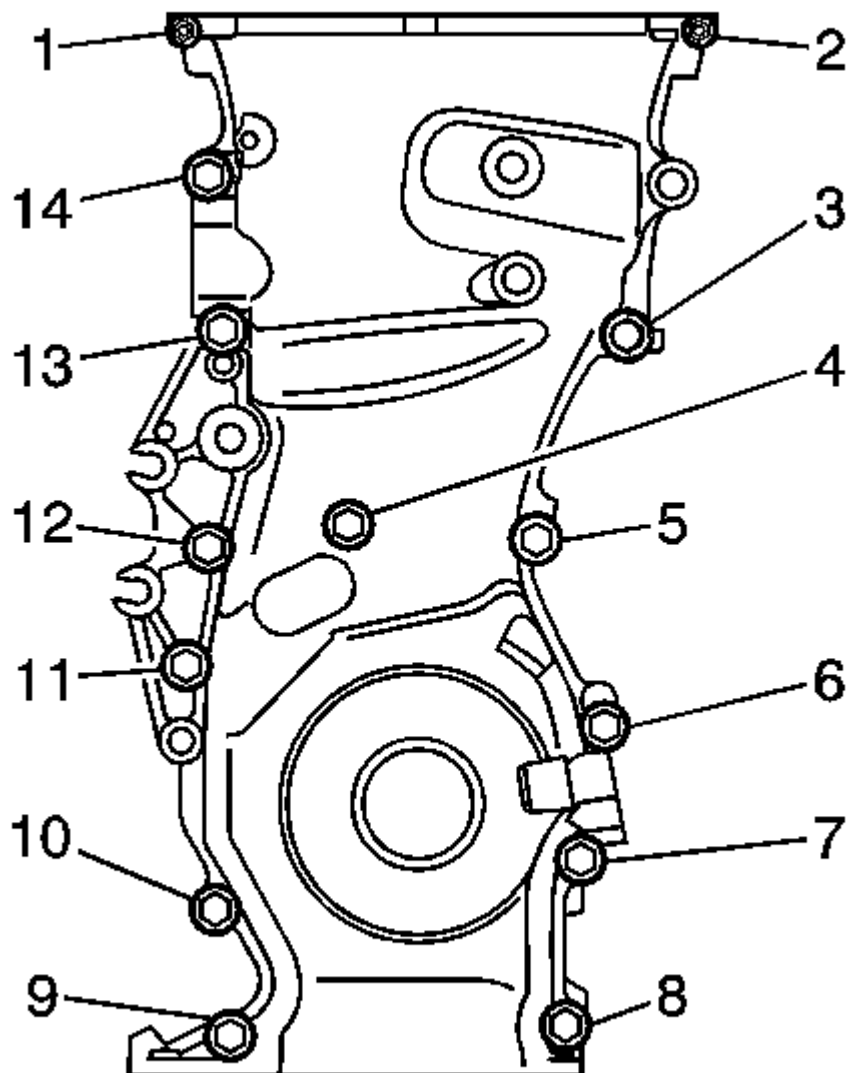


Fig. 166: Identifying Front Cover Bolt Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

51. Using an E10 TORX® socket, remove the stud bolt for the V-ribbed belt tensioner.
52. Remove the 12 bolts and 2 nuts.

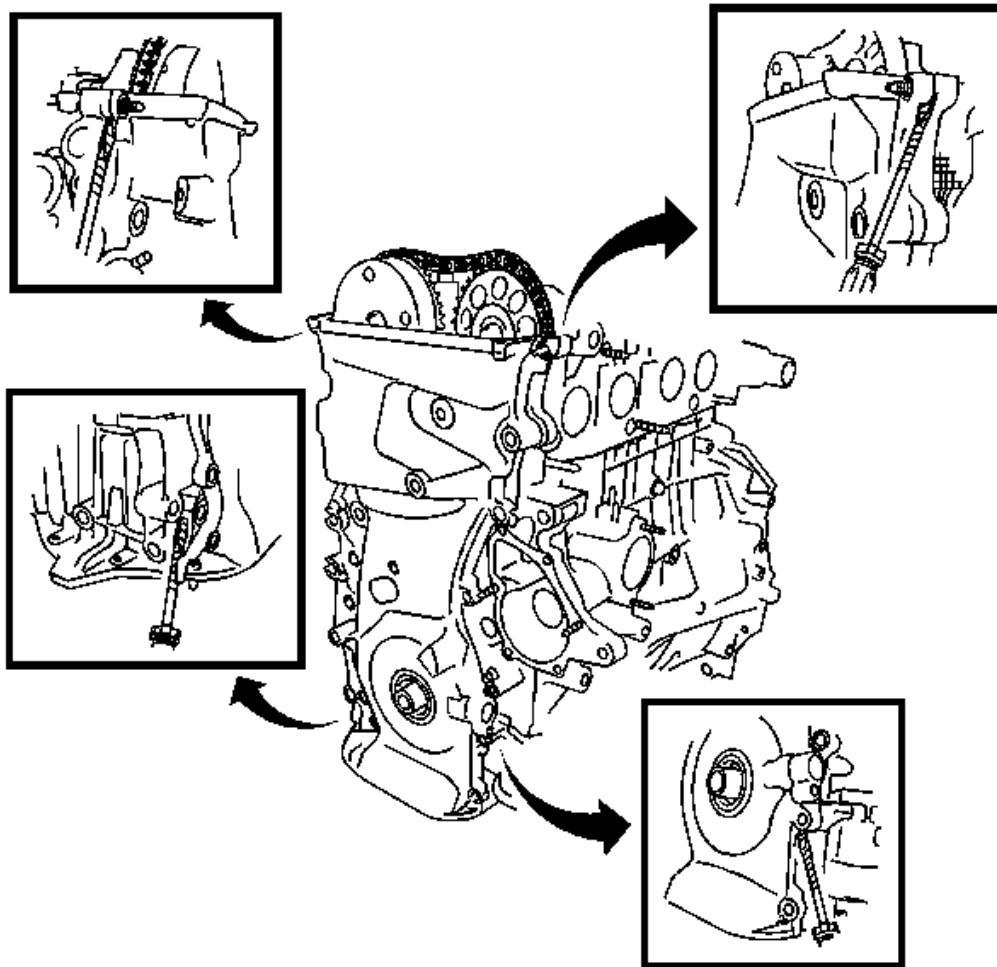


Fig. 167: Identifying Timing Chain Cover Components
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the contact surfaces of the timing chain cover, cylinder head and cylinder block.

IMPORTANT: Tape the screwdriver tip before use.

53. Remove the timing chain cover by prying the portions between the timing chain cover, cylinder head and cylinder block with a screwdriver.

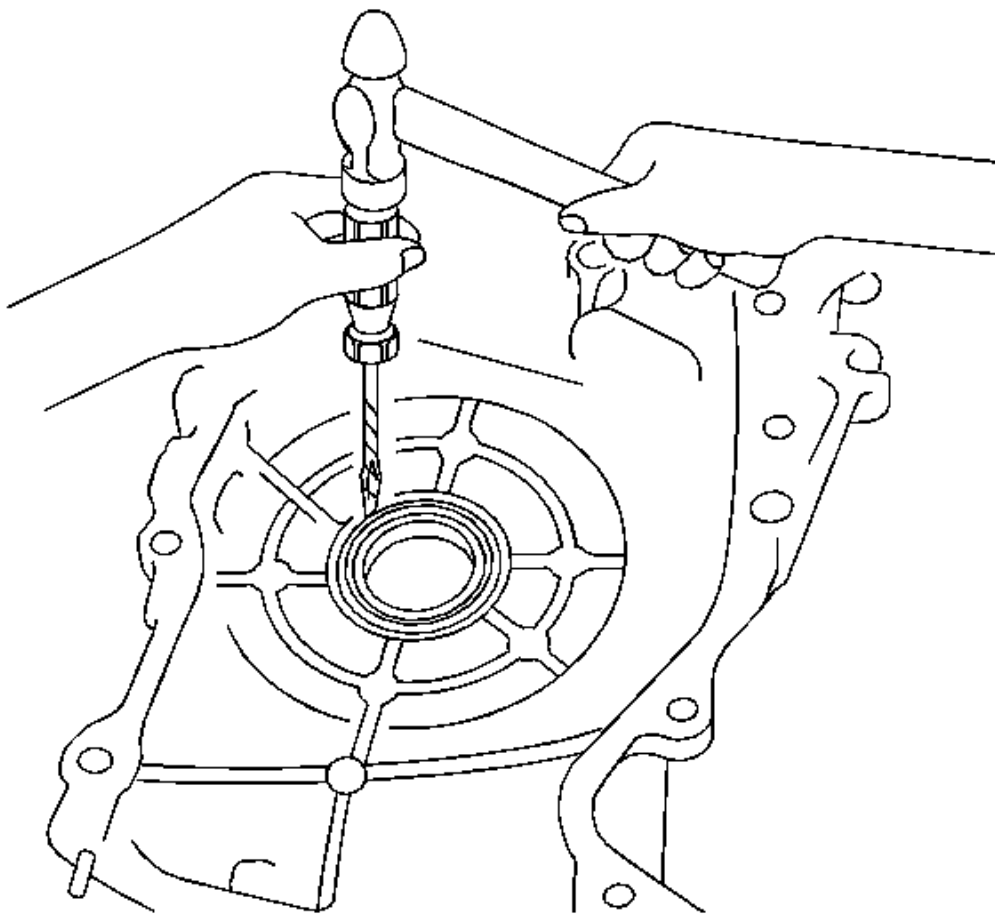


Fig. 168: View Of Seal Removal

Courtesy of GENERAL MOTORS CORP.

54. Place the timing chain cover on wooden blocks.

NOTE: Do not damage the surface of the oil seal press fit hole.

IMPORTANT: Tape the screwdriver tip before use.

55. Using a screwdriver, pry out the oil seal.
56. Remove the No. 1 crankshaft position sensor plate.
57. Remove the timing chain guide.
58. Remove the chain tensioner slipper.

- 59. Remove the No. 1 chain vibration damper.
- 60. Remove the chain sub-assembly
- 61. Remove the crankshaft timing sprocket.
- 62. Remove the No. 2 chain sub-assembly.

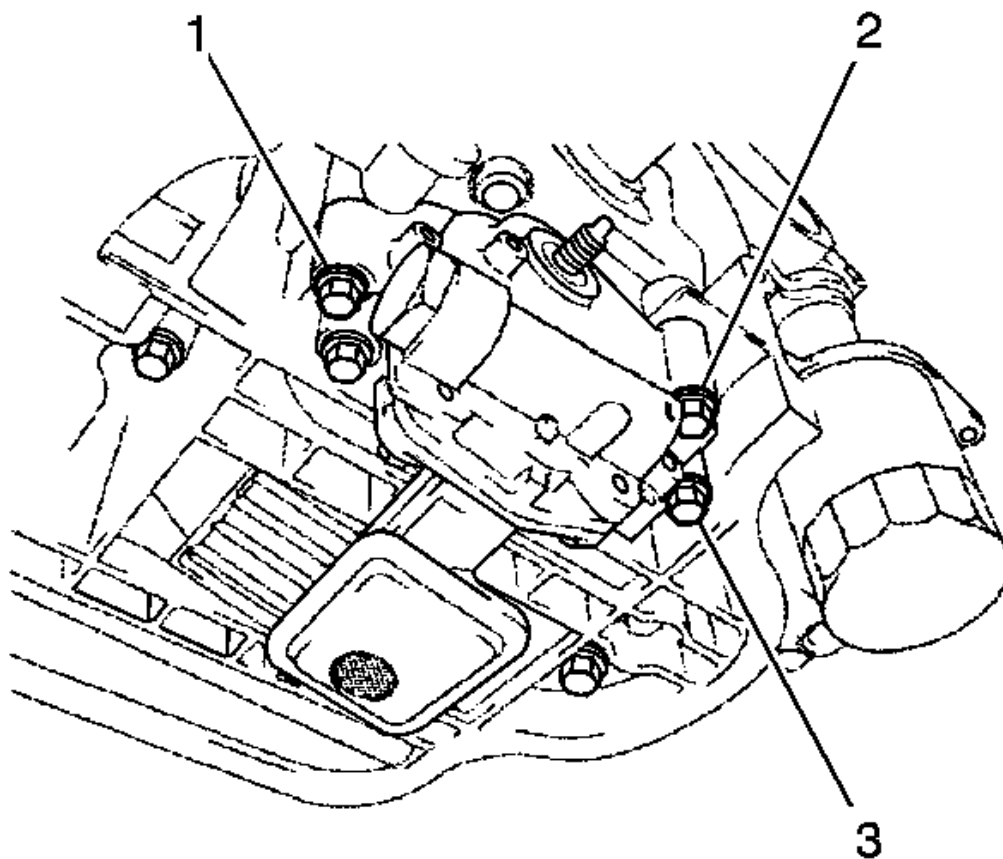


Fig. 169: View Of Oil Pump, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

- 63. Remove the 3 bolts, oil pump and gasket.

Disassembly Procedure

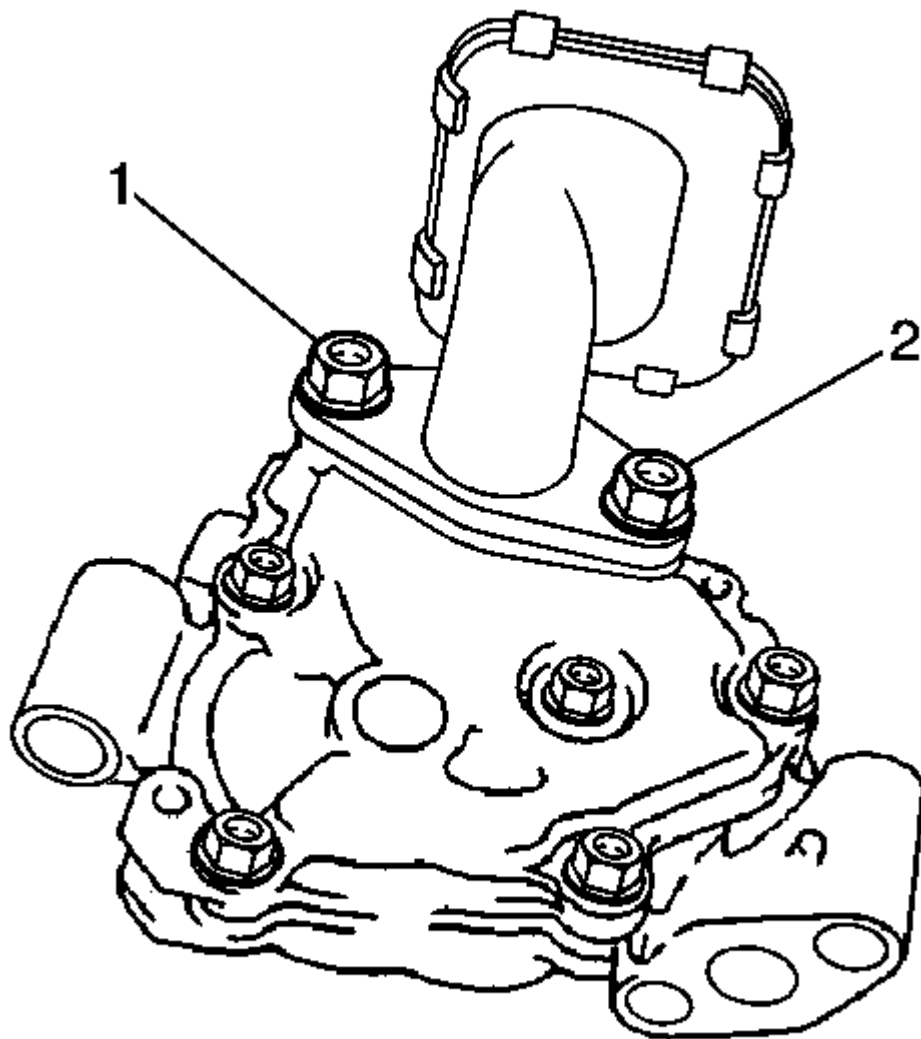


Fig. 170: Identifying Oil Pump Strainer & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the 2 nuts, oil pump strainer and gasket.

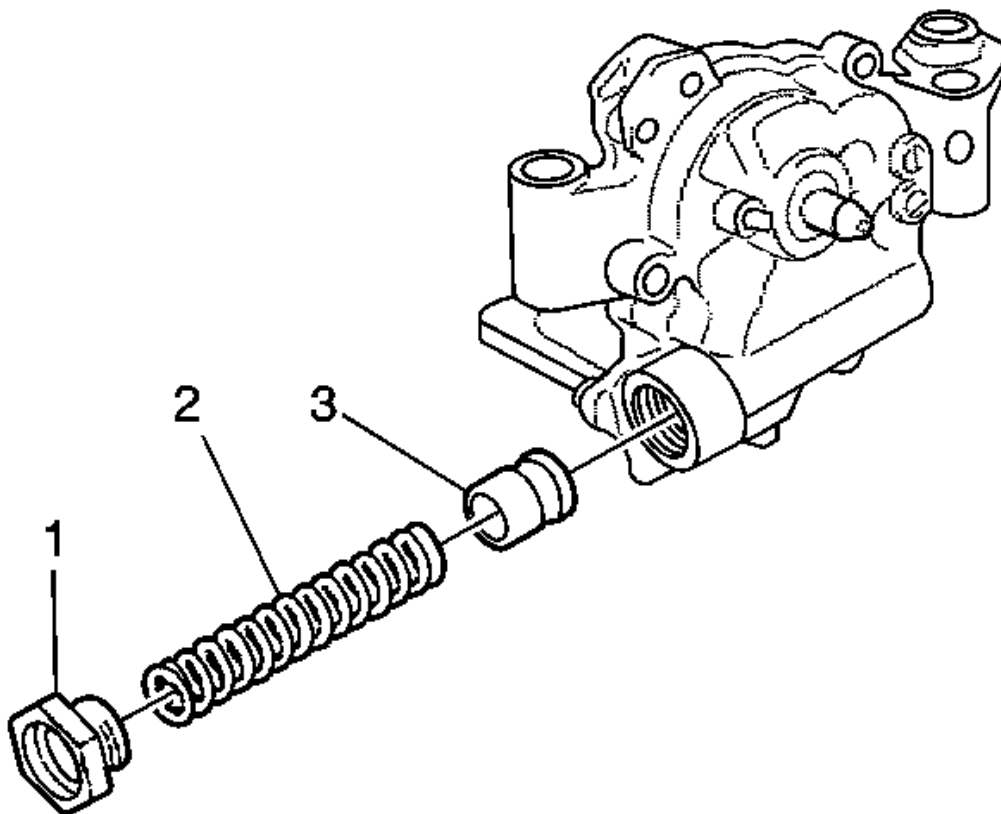


Fig. 171: View Of Oil Pump Valve Spring & Relief Valve
Courtesy of GENERAL MOTORS CORP.

2. Using a 27 mm socket wrench, remove the plug.
3. Remove the valve spring and relief valve.

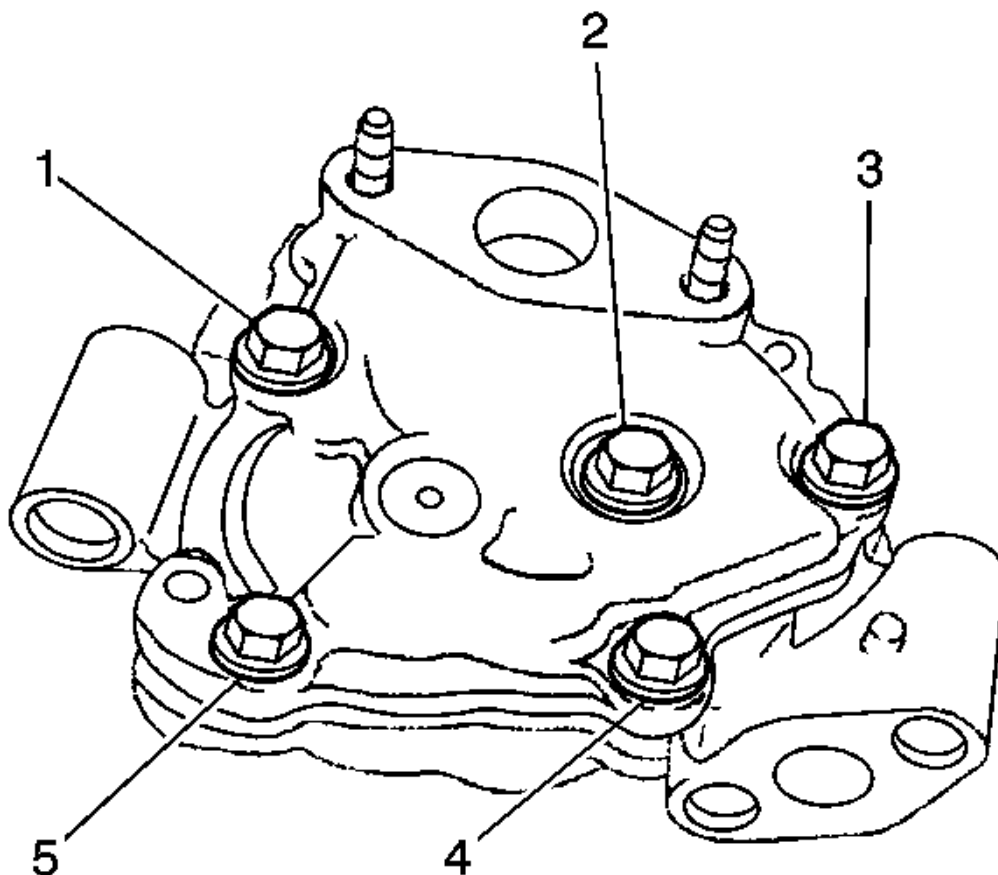


Fig. 172: View Of Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the 5 bolts and oil pump cover.
5. Remove the oil pump drive and driven rotors from the oil pump.

Inspection Procedure

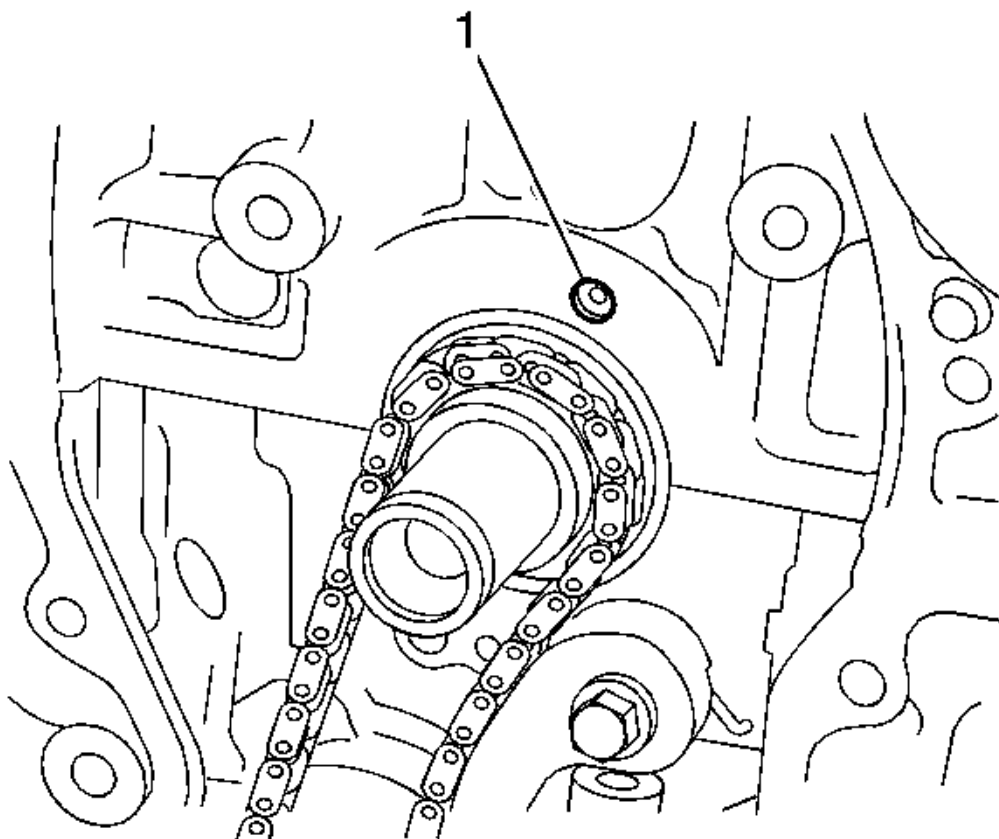


Fig. 173: Checking Oil Jet For Damage Or Clogging
Courtesy of GENERAL MOTORS CORP.

1. Check the oil jet for damage or clogging. If necessary, repair the cylinder block.

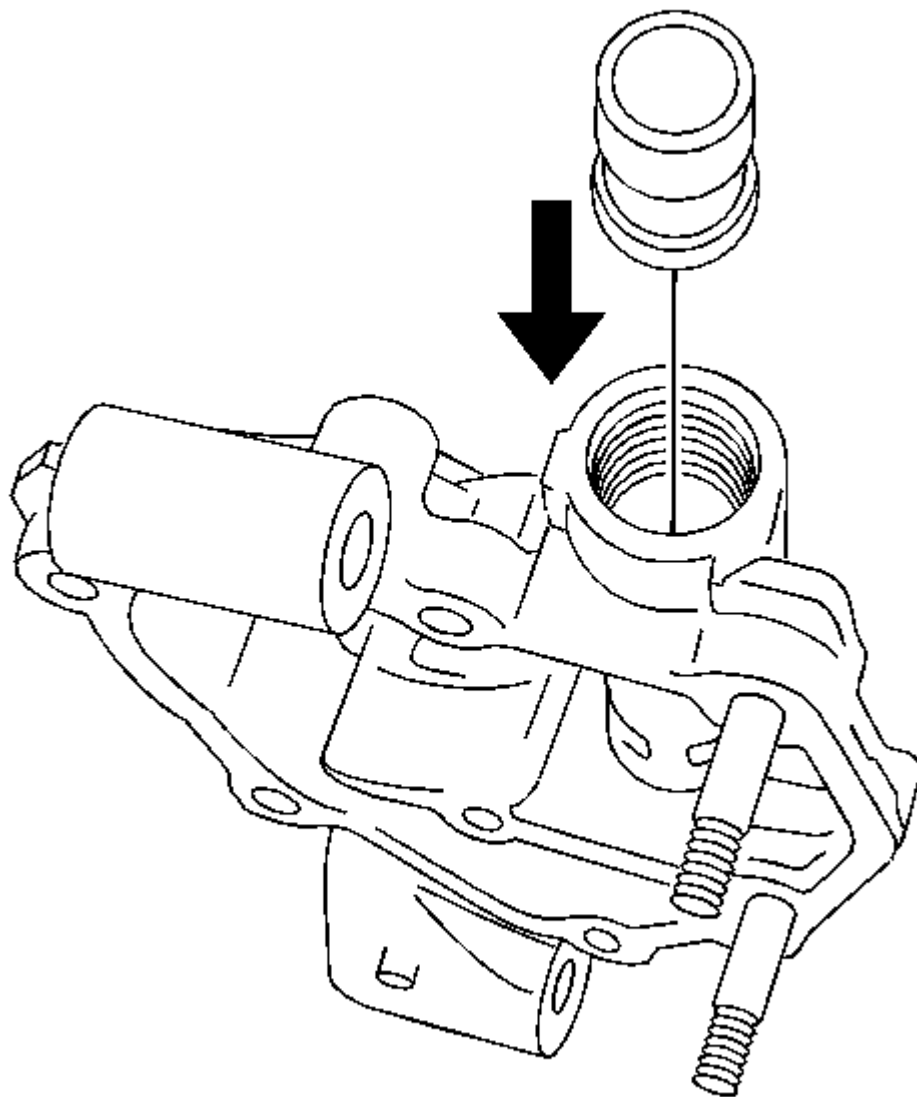


Fig. 174: Checking Oil Pump Relief Valve
Courtesy of GENERAL MOTORS CORP.

2. Check the relief valve.
3. Coat the valve with engine oil, and then check that the valve falls smoothly into the valve hole by its own weight.

If it does not, replace the relief valve. If necessary, replace the oil pump assembly.

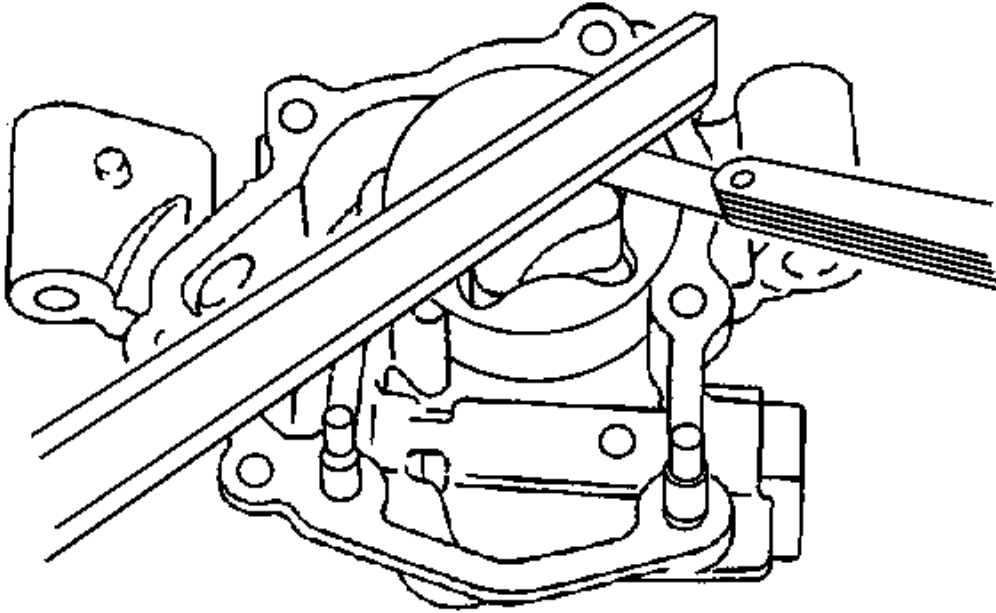


Fig. 175: Inspecting Oil Pump Side Clearance
Courtesy of GENERAL MOTORS CORP.

4. Check the side clearance.
5. Using a feeler gauge and precision straightedge, measure the clearance between the rotors and precision straightedge.

If the side clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.030 to 0.085 mm (0.0012 to 0.0034 in.)
- Maximum Clearance: 0.160 mm (0.0063 in.)

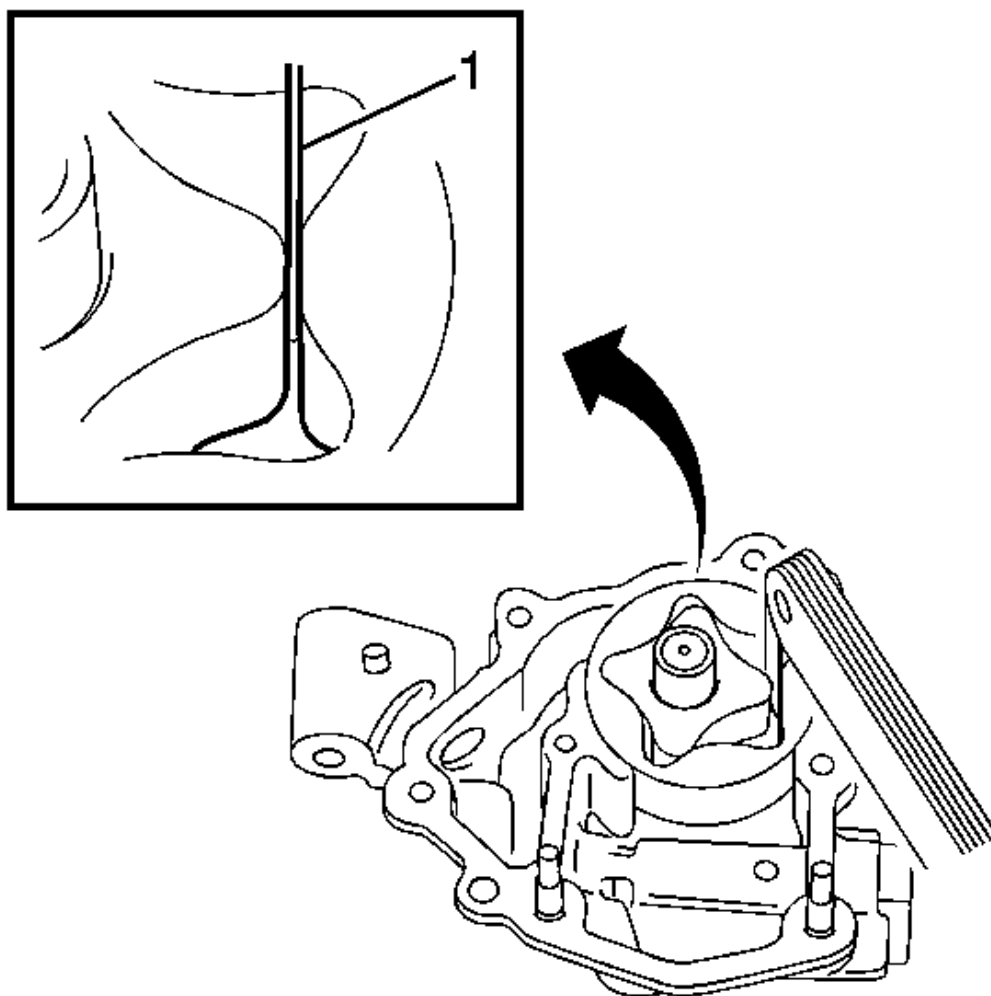


Fig. 176: Checking Oil Pump Gear Tip Clearance
Courtesy of GENERAL MOTORS CORP.

6. Check the tip clearance.
7. Using a feeler gauge, measure the clearance between the drive and driven rotor tips.

If the tip clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.080-0.160 mm (0.0031-0.0063 in).
- Maximum Clearance: 0.35 mm (0.0138 in).

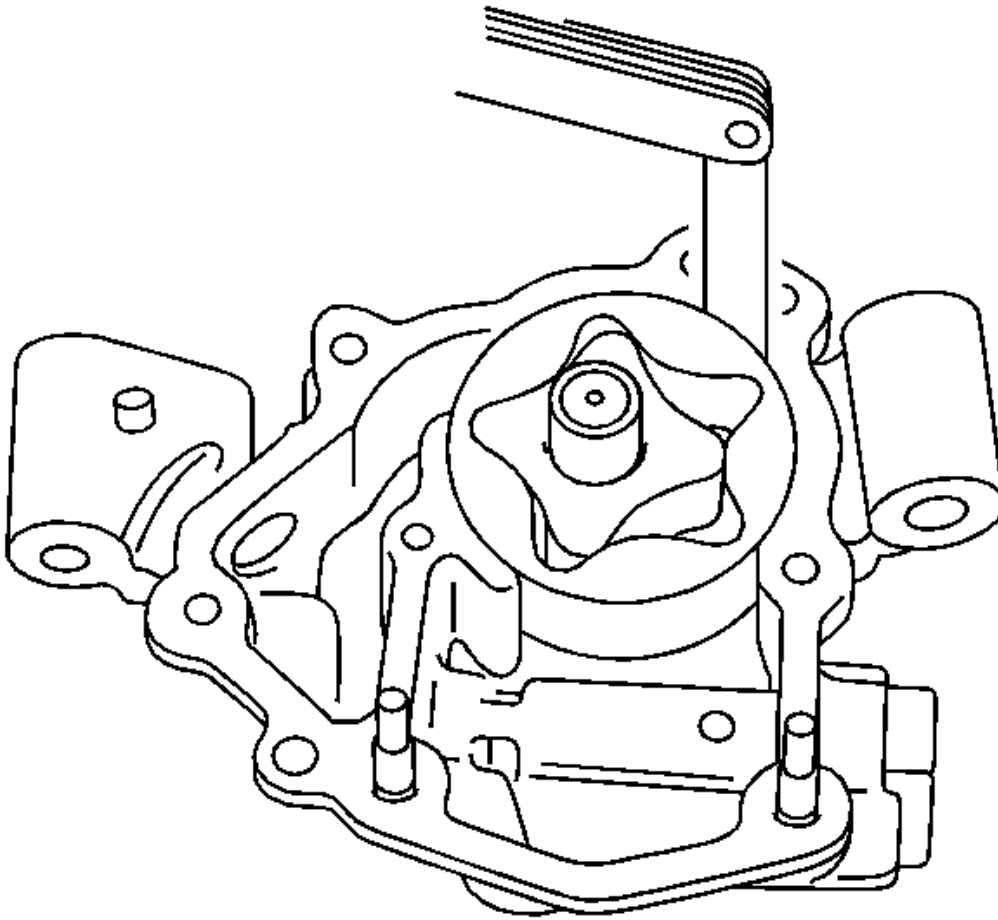


Fig. 177: Checking Oil Pump Body Clearance
Courtesy of GENERAL MOTORS CORP.

8. Check the body clearance.
9. Using a feeler gauge, measure the clearance between the driven rotor and pump body.

If the body clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.100-0.170 mm (0.0039-0.0067 in).
- Maximum Clearance: 0.325 mm (0.0128 in).

10. Inspect No. 2 chain sub-assembly.

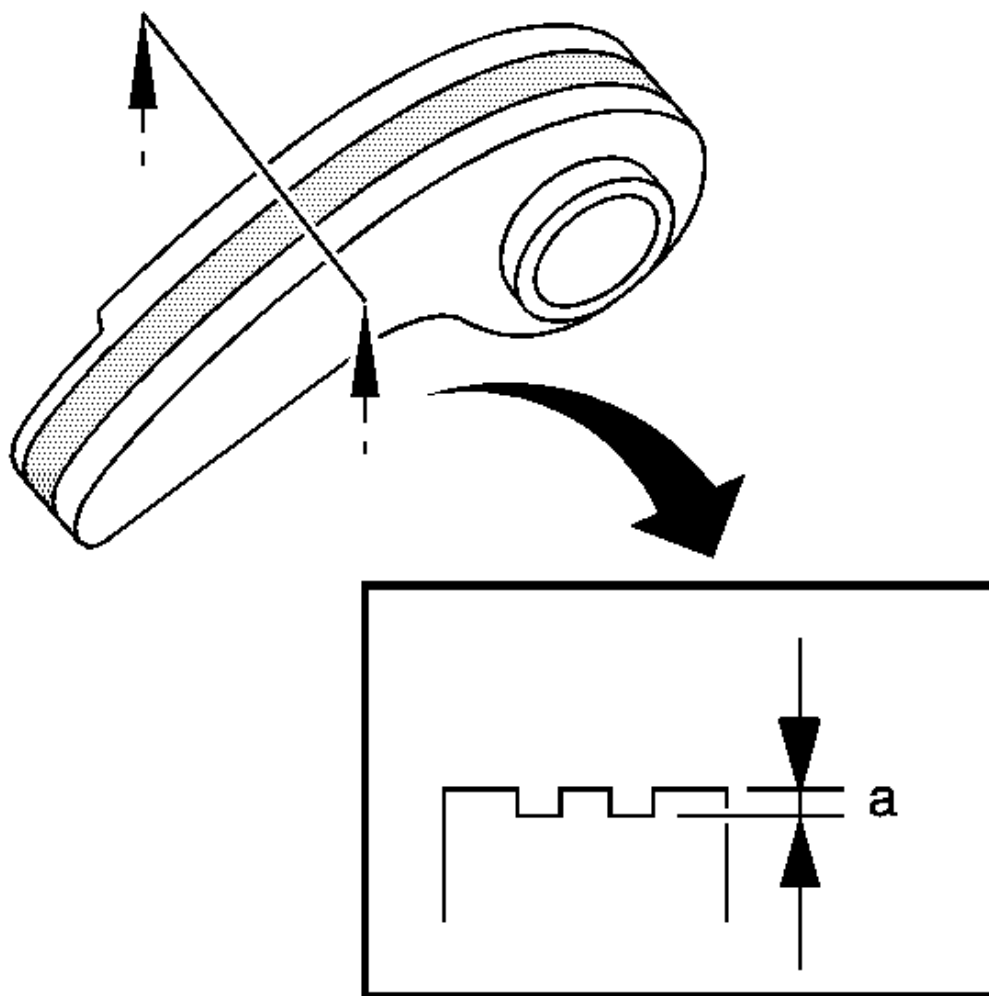


Fig. 178: Inspecting Chain Tensioner Plate
Courtesy of GENERAL MOTORS CORP.

11. Inspect chain tensioner plate.
12. Measure the chain tensioner plate wear.

If the wear is greater than the maximum, replace the chain tensioner plate.

Specification: Maximum wear: 0.5 mm (0.020 in.)

Reassembly Procedure

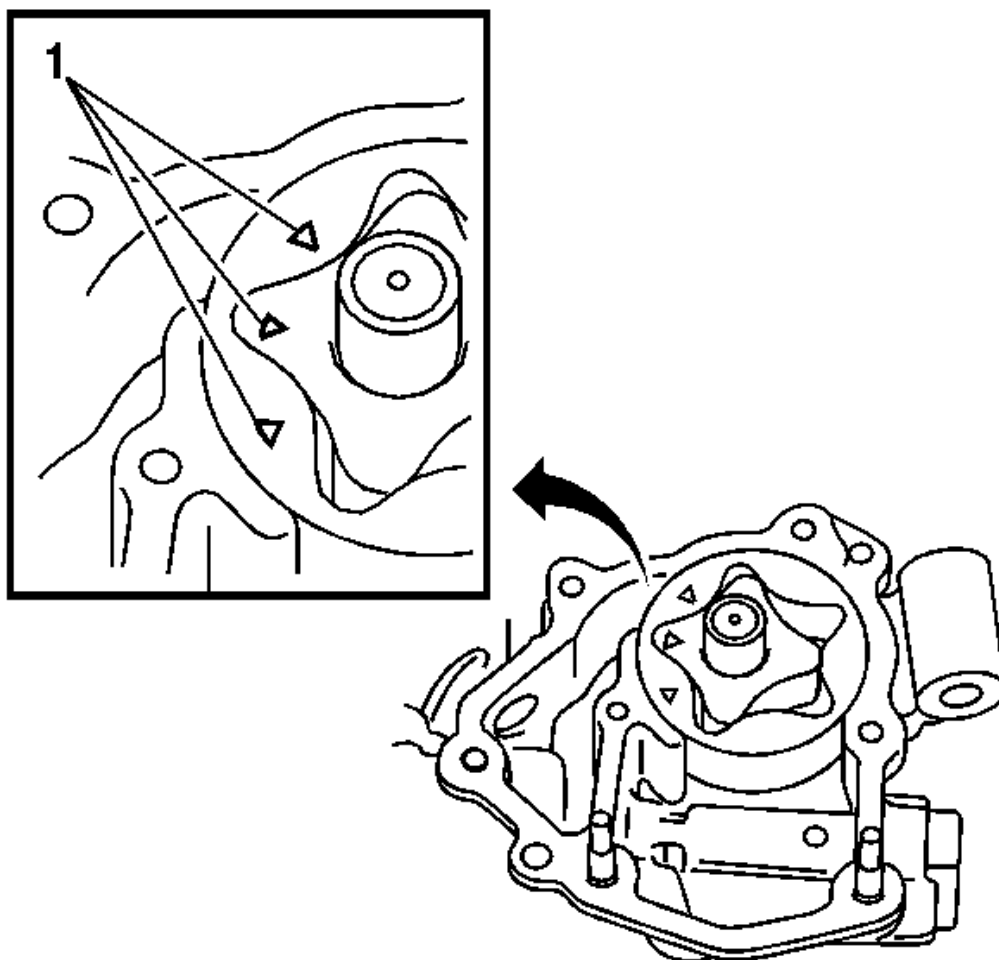


Fig. 179: View Of Coating Drive Rotor And Driven Rotor With Engine Oil.
Courtesy of GENERAL MOTORS CORP.

1. Coat the drive rotor and driven rotor with engine oil.
2. Place the drive and driven rotors into the oil pump with the marks facing the pump cover side.

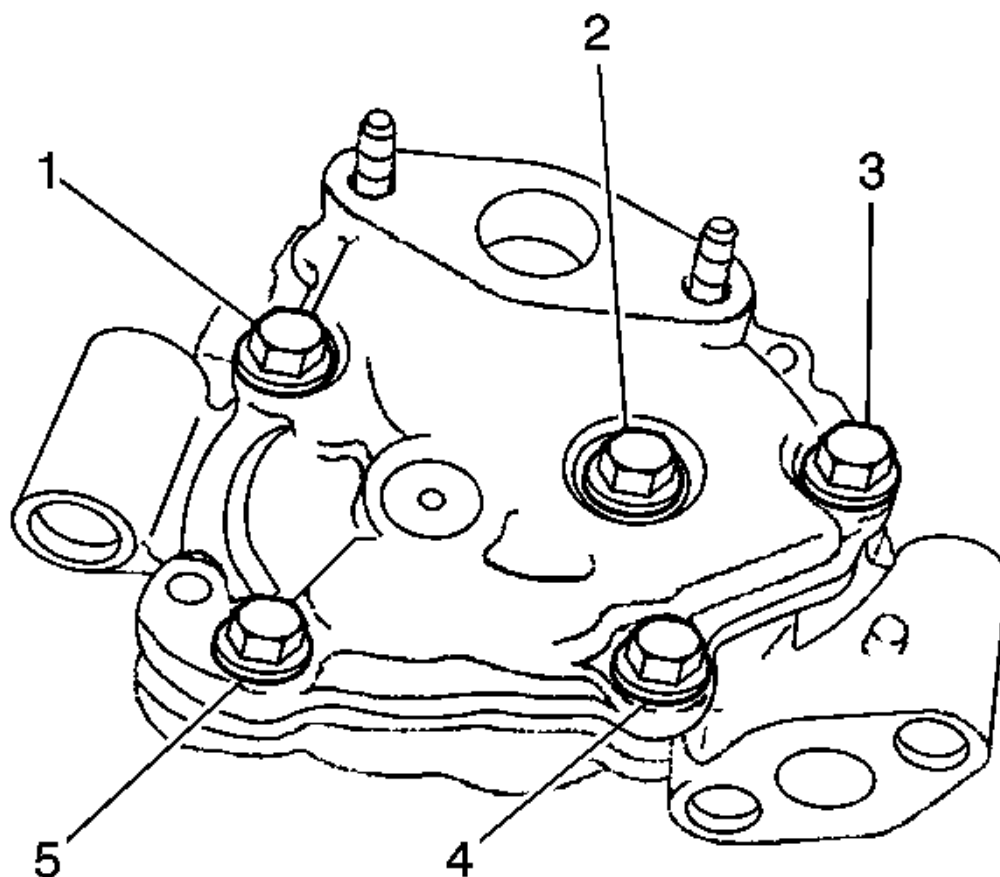


Fig. 180: View Of Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER CAUTION .

3. Install the oil pump cover with the 5 bolts.

Tighten: Tighten to 8.8 N.m (78 lb in).

4. Coat the relief valve with engine oil.

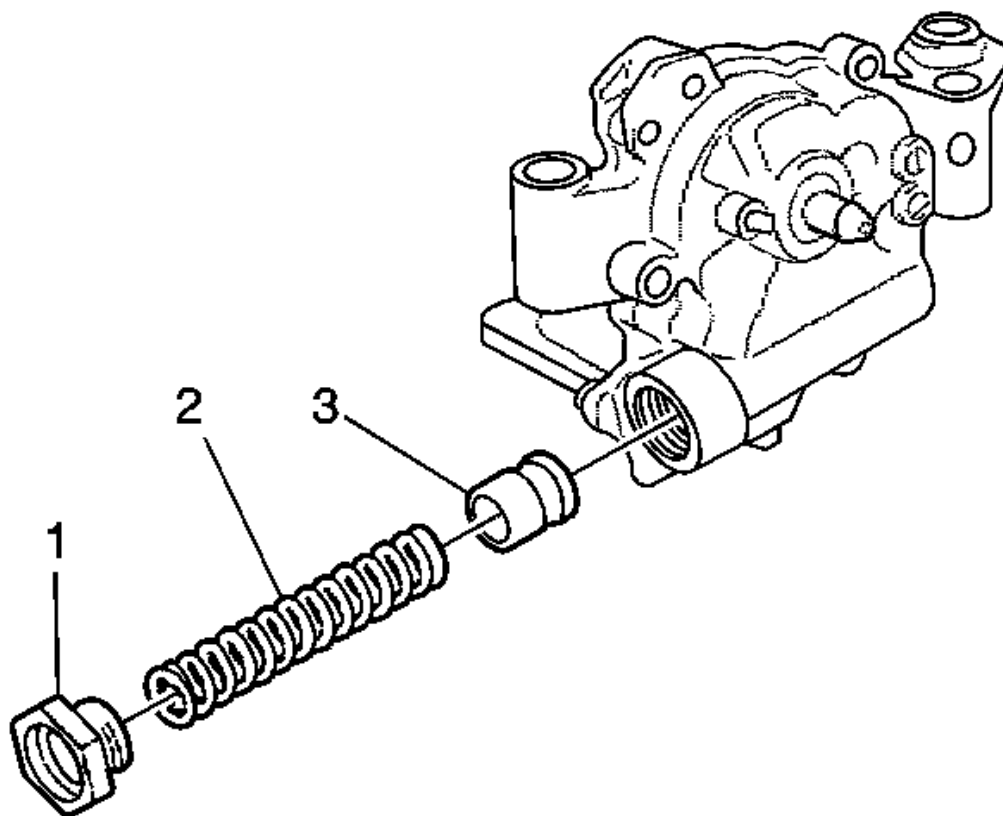


Fig. 181: View Of Oil Pump Valve Spring & Relief Valve
Courtesy of GENERAL MOTORS CORP.

5. Insert the relief valve and spring into the pump body hole.
6. Using a 27 mm socket wrench, install the plug.

Tighten: Tighten to 49 N.m (36 lb ft).

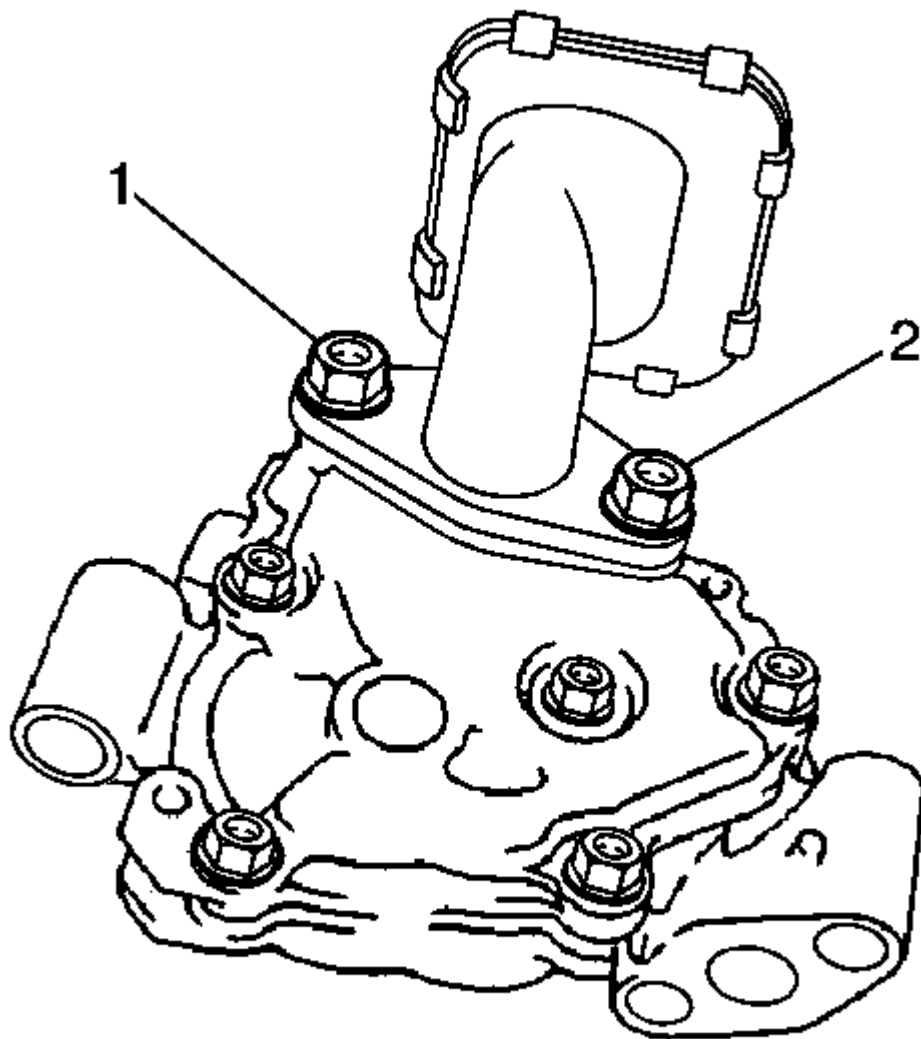


Fig. 182: Identifying Oil Pump Strainer & Gasket
Courtesy of GENERAL MOTORS CORP.

7. Install a new gasket and the oil strainer with the 2 nuts.

Tighten: Tighten to 8.8 N.m (78 lb in).

Installation Procedure

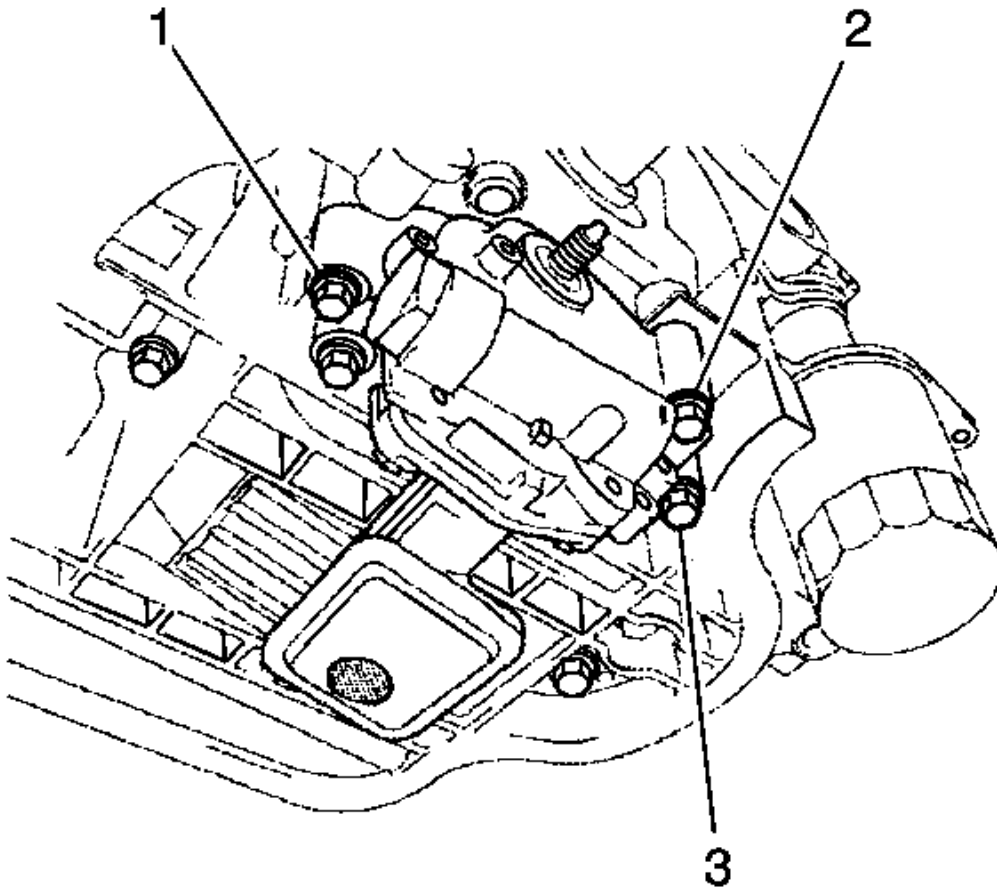


Fig. 183: Identifying Oil Pump, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install a new gasket and the oil pump with the 3 bolts.

Tighten: Tighten to 19 N.m (14 lb ft).

2. Install the No. 2 chain sub-assembly.
3. Install the crankshaft timing sprocket.
4. Install the No. 1 chain vibration damper.
5. Install the chain sub-assembly.
6. Install the chain tensioner slipper.
7. Install the timing chain guide.
8. Install the No. 1 crankshaft position sensor plate.

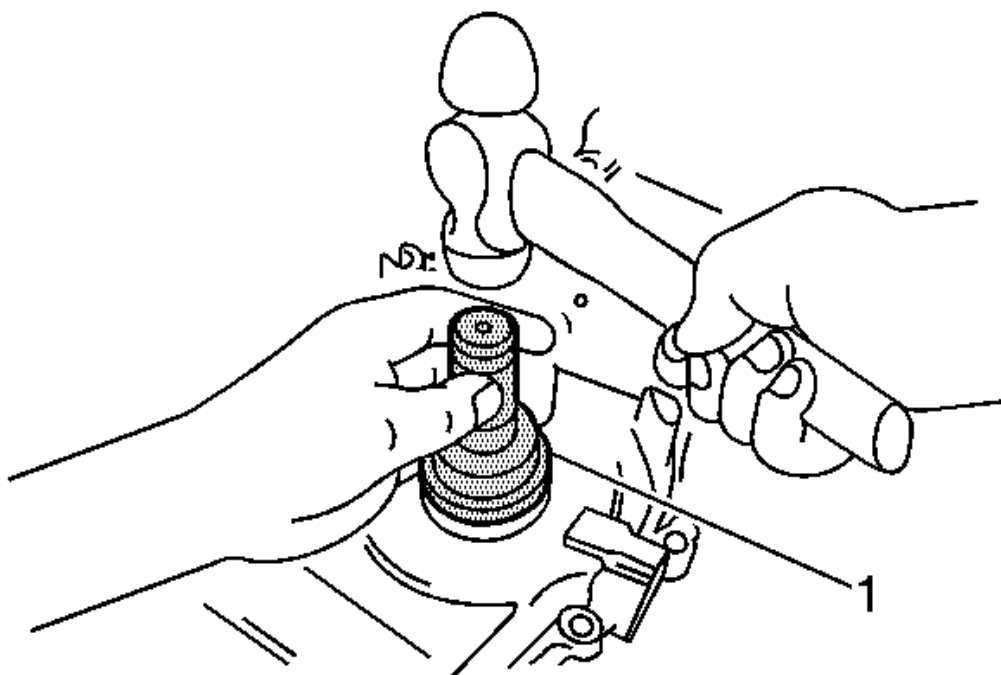


Fig. 184: View Of Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Keep the lip free from foreign matter.
- Do not tap the oil seal at an angle.

9. Using SST , tap in a new oil seal until its surface is flush with the timing chain cover edge.

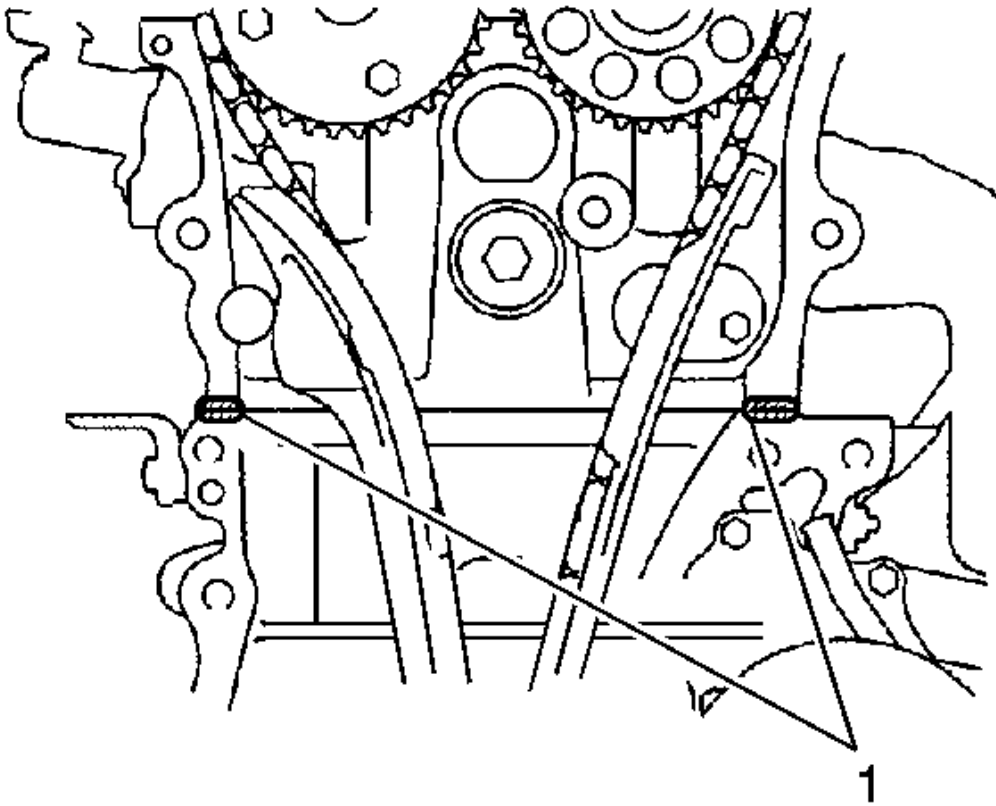


Fig. 185: Applying MP grease

Courtesy of GENERAL MOTORS CORP.

10. Apply MP grease to the lip of the oil seal.
11. Remove any old packing material and be careful not to drop any oil on the contact surfaces of the timing chain cover, cylinder head and cylinder block.

IMPORTANT:

- Remove any oil from the contact surfaces.
- Install the chain cover within 3 minutes of applying seal packing.
- Do not add engine oil for at least 2 hours after installing the chain cover.

12. Apply Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent (Diameter 4.0 to 4.5 mm (0.157 to 0.177 in).
13. Apply a continuous bead of seal packing.

IMPORTANT:

- Remove any oil from the contact surfaces.
- Install the chain cover within 3 minutes of applying seal packing.
- Do not add engine oil for at least 2 hours after installing the chain cover.

14. Apply Toyota Genuine Seal Packing Black, Three Bond 1207B or equivalent.

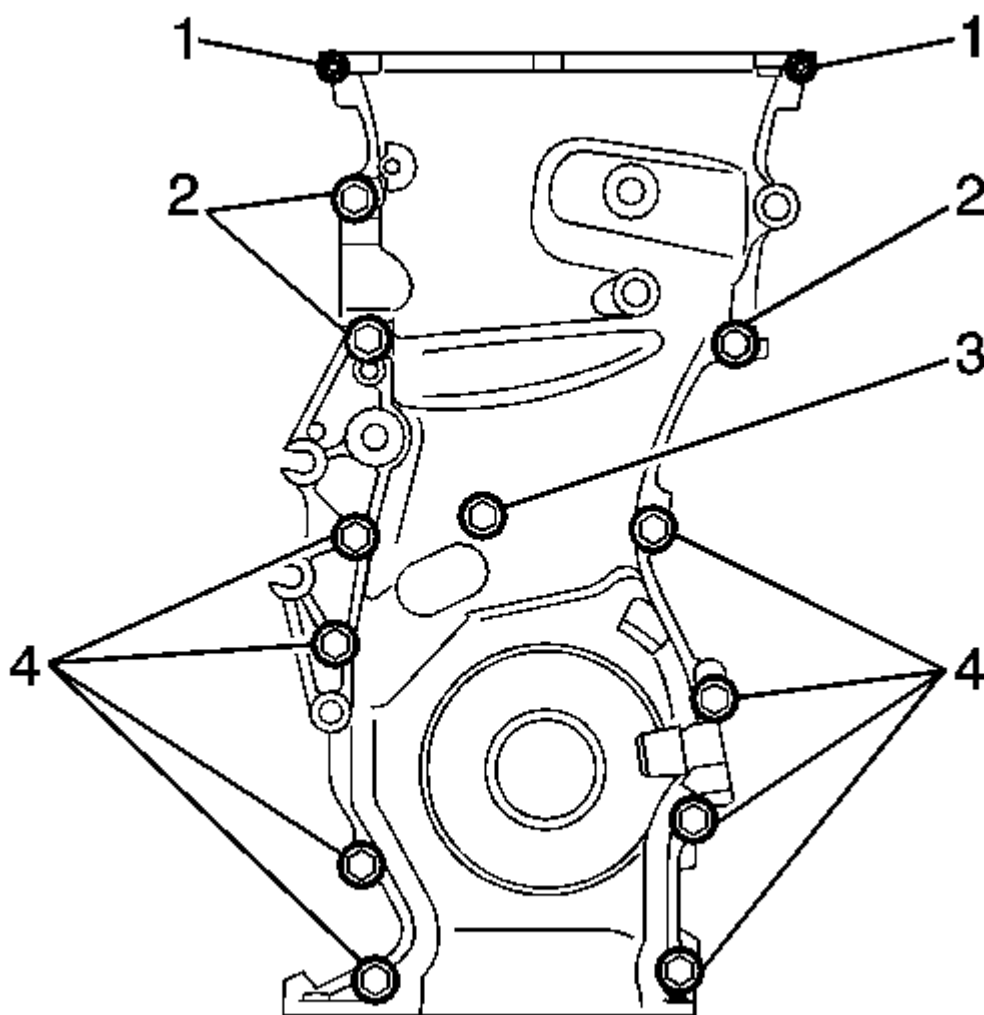


Fig. 186: Identifying Timing Chain Housing Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

15. Install the timing chain cover with the 12 bolts and 2 nuts.

Tighten:

- Tighten bolt A to 9.0 N.m (80 lb in).
- Tighten bolt B to 25 N.m (18 lb ft).
- Tighten bolt C to 55 N.m (41 lb ft).
- Tighten bolt D to 11 N.m (8 lb ft).

16. Using an E10 TORX® socket, install the stud bolt for the V-ribbed belt tensioner.

Tighten: Tighten to 22 N.m (16 lb ft).

17. Install the No. 1 chain tensioner assembly.
18. Install the v-ribbed belt tensioner assembly.
19. Install the transverse engine mounting bracket.
20. Install the crankshaft pulley.
21. Install the oil pan sub-assembly.
22. Install the crankshaft position sensor.
23. Install the idler pulley sub-assembly.
24. Install the engine mounting insulator subassembly right hand.
25. Install the exhaust manifold converter subassembly.
26. Install the No. 1 exhaust manifold heat insulator.
27. Install the No. 2 manifold stay.
28. Install the manifold stay.
29. Install the No. 1 intake manifold insulator.
30. Install the intake manifold.
31. Install the camshaft timing oil control valve assembly.
32. Install the fuel delivery pipe sub-assembly.
33. Connect the fuel main tube.
34. Install the engine oil level dipstick guide.
35. Install the engine oil level dipstick.
36. Install the cylinder head cover sub-assembly.
37. Install the spark plug. See **SPARK PLUG REPLACEMENT** .
38. Install the ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
39. Install the throttle body assembly.
40. Install the air cleaner cap sub-assembly with hose.
41. Install the radiator reserve tank assembly.
42. Connect the inlet heater water hose.
43. Connect the outlet heater water hose.

44. Install the No. 1 radiator hose.
45. Install the generator assembly.
46. Install the v-ribbed belt.
47. Install the front exhaust pipe assembly.
48. Install the center exhaust pipe assembly.

NOTE: **When disconnecting the cable, some systems need to be initialized after the cable is reconnected.**

49. Connect the cable to negative battery terminal.
50. Add the engine oil.
51. Add the engine coolant.
52. Inspect the fuel leak.
53. Inspect the coolant leak.
54. Inspect the oil leak.
55. Inspect the exhaust gas leak.
56. Inspect the ignition timing.
57. Inspect the engine idle speed.
58. Inspect the compression.
59. Inspect the CO/HC.
60. Install the suspension tower damper assembly (with front strut bar).
61. Install the outer cowl top panel.
62. Install the windshield wiper motor and link assembly.
63. Install the left cowl top ventilator louver.
64. Install the right cowl top ventilator louver.
65. Install the hood to cowl top seal.
66. Install the left front wiper arm and blade assembly.
67. Install the right front wiper arm and blade assembly.
68. Install the front wiper arm head cap.
69. Install the No. 1 engine cover sub-assembly.
70. Install the left engine under cover.
71. Install the right engine under cover.
72. Install the right front wheel.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

SST 09213-54015 (91651-60855), 09330-00021

SST 09223-15030, 09950-70010 (09951-07100)

Removal Procedure

1. Remove automatic transaxle assembly (for automatic transaxle).

IMPORTANT: See **AUTOMATIC TRANSMISSION - MVA 4 SPEED** .

2. Remove manual transaxle assembly (for manual transaxle).

IMPORTANT: See **MANUAL TRANSMISSION - MVC 5 SPEED** .

3. Remove clutch cover assembly (for manual transaxle).

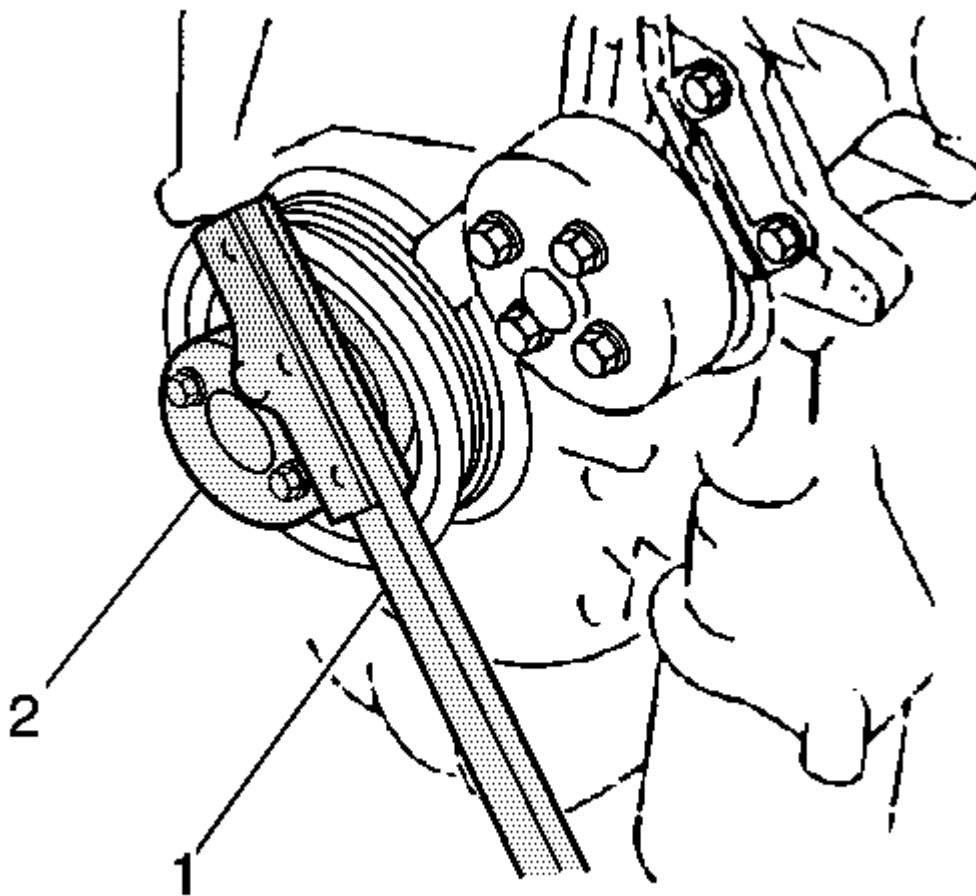


Fig. 187: View Of Holding Crankshaft Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove clutch disc assembly (for manual transaxle).
5. For automatic transaxle, using SST, hold the crankshaft.

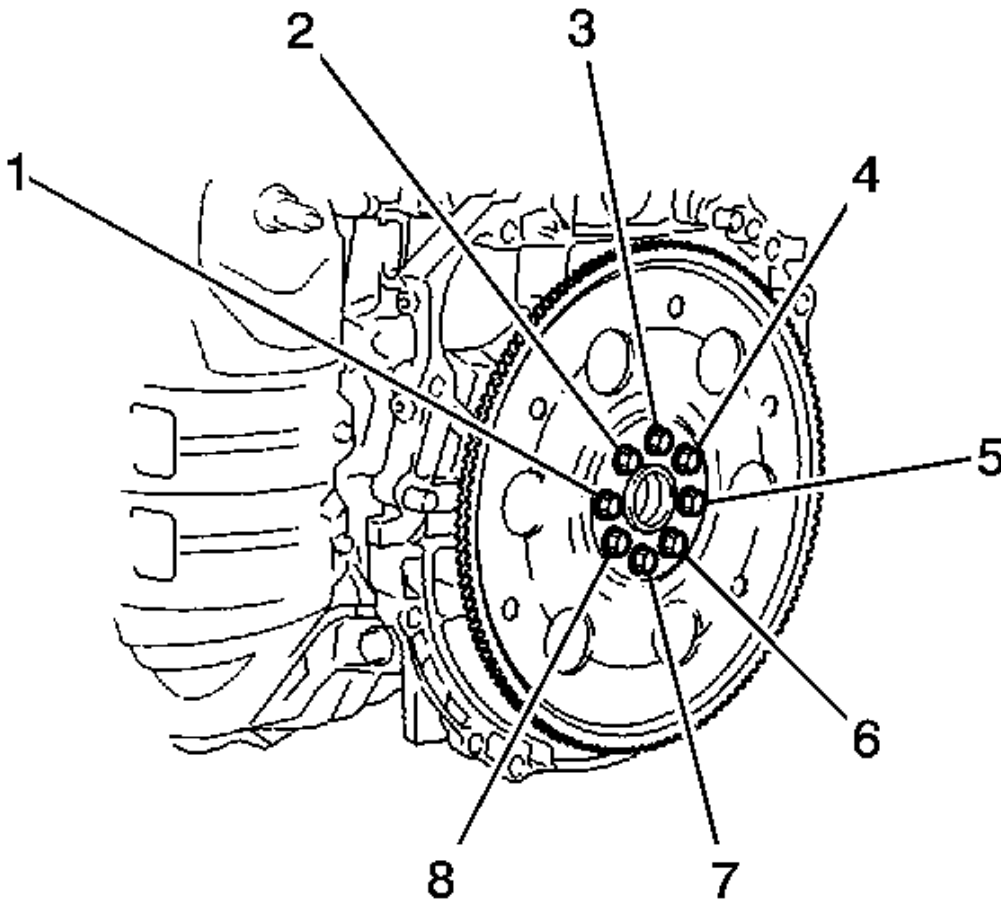


Fig. 188: Identifying Drive Plate Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

6. Remove the 8 bolts, rear drive plate spacer, drive plate and front drive plate spacer.

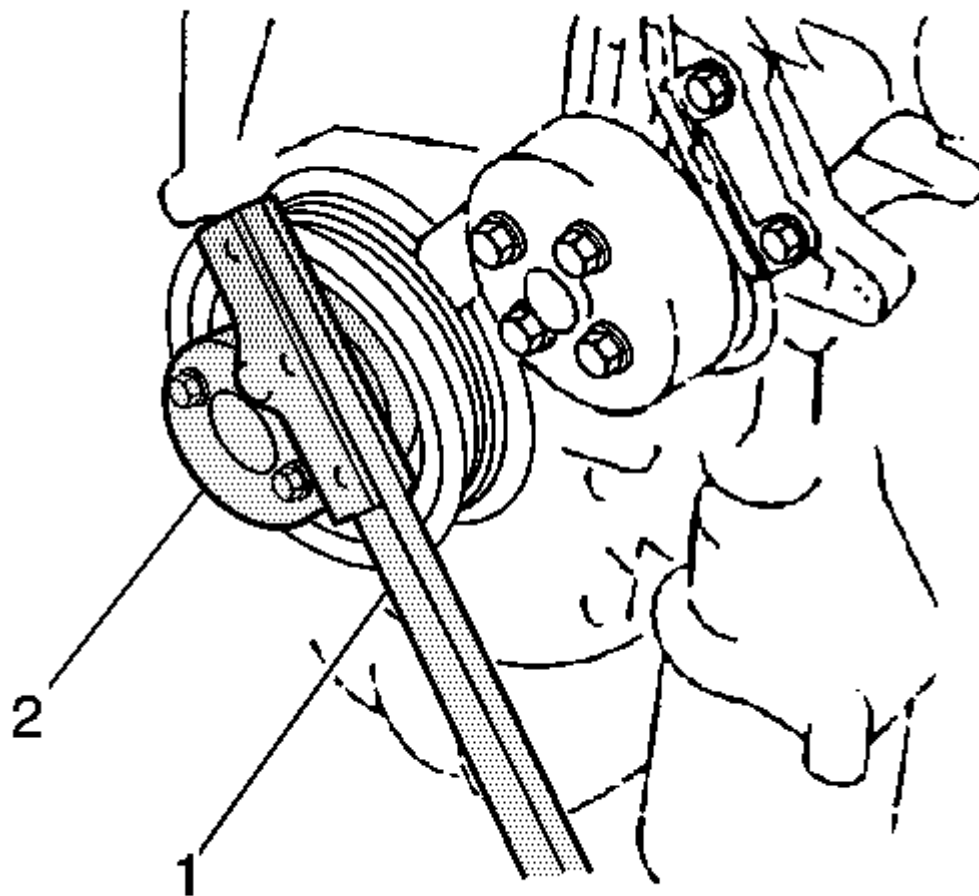


Fig. 189: View Of Holding Crankshaft Bolt
Courtesy of GENERAL MOTORS CORP.

7. For manual transaxle, using SST, hold the crankshaft.

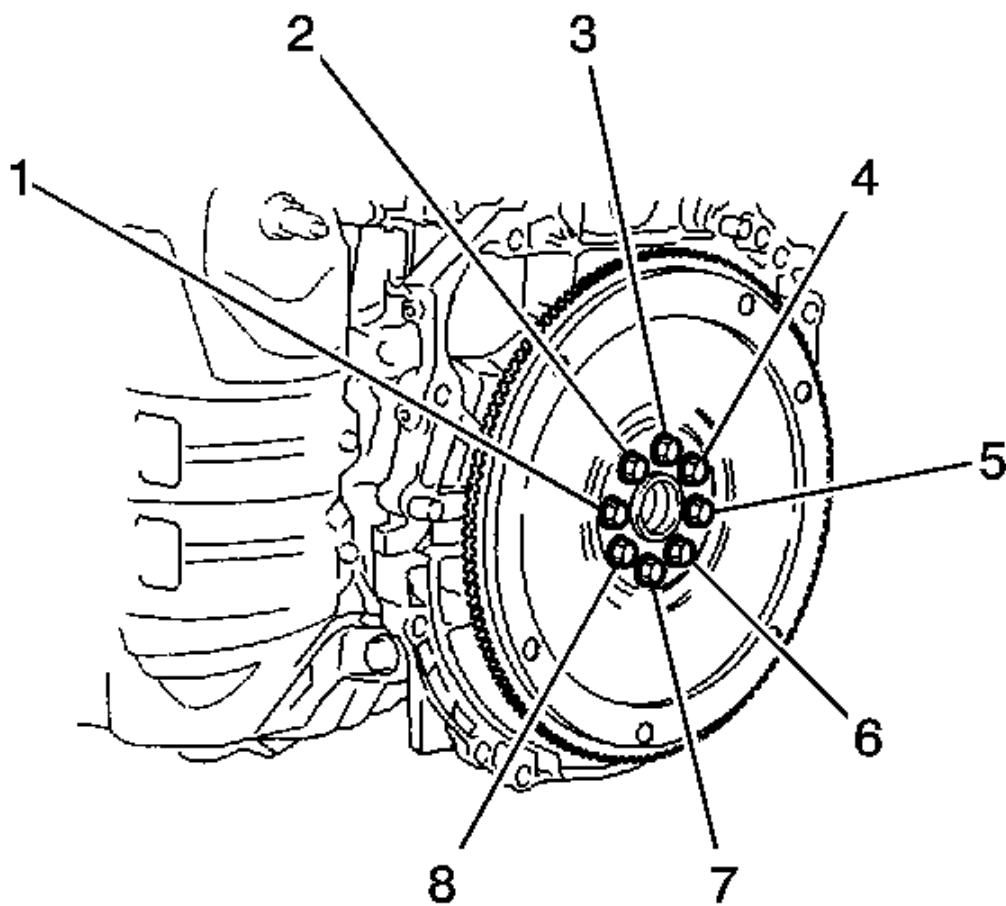


Fig. 190: View Of Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the 8 bolts and flywheel.

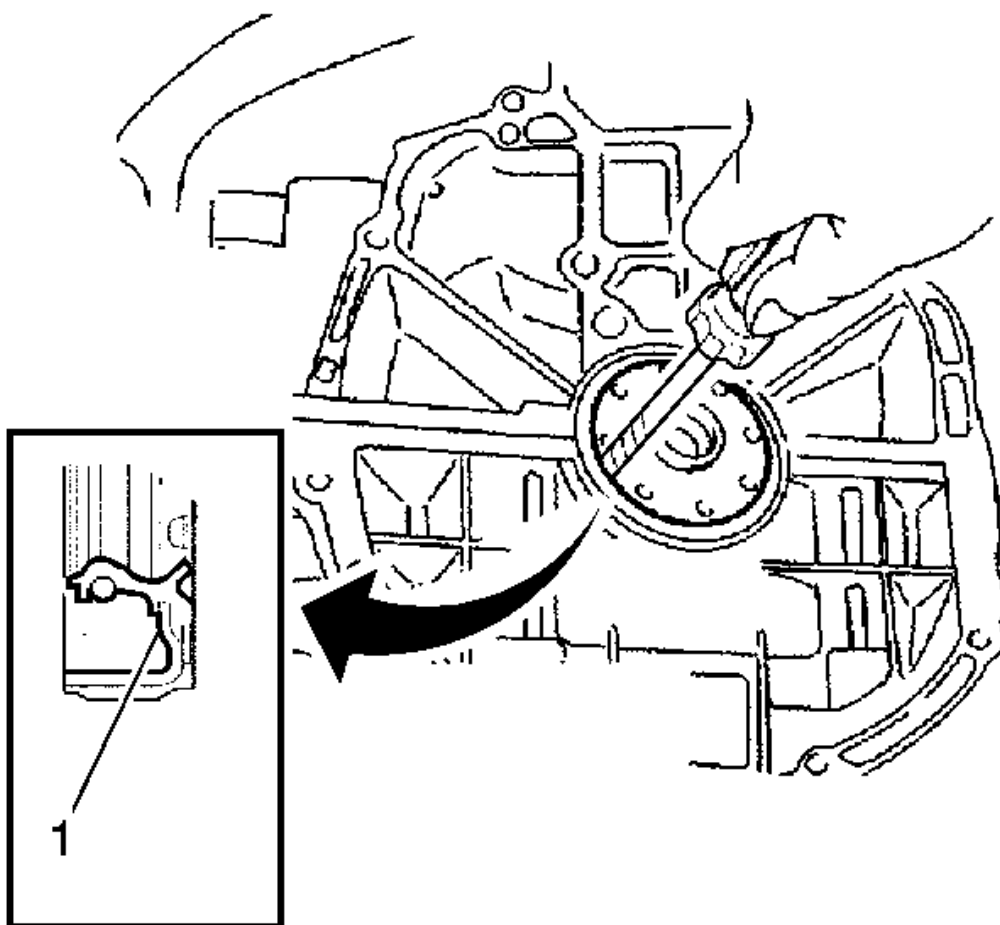


Fig. 191: View Of Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

9. Using a knife, cut off the lip of the oil seal.

NOTE: After removing, check the crankshaft for damage. If damaged, smooth the surface with 400-grit sandpaper.

IMPORTANT: Tape the screwdriver tip before use.

10. Using a screwdriver, pry out the oil seal.

Installation Procedure

1. Apply MP grease to the lip of a new rear crankshaft oil seal.

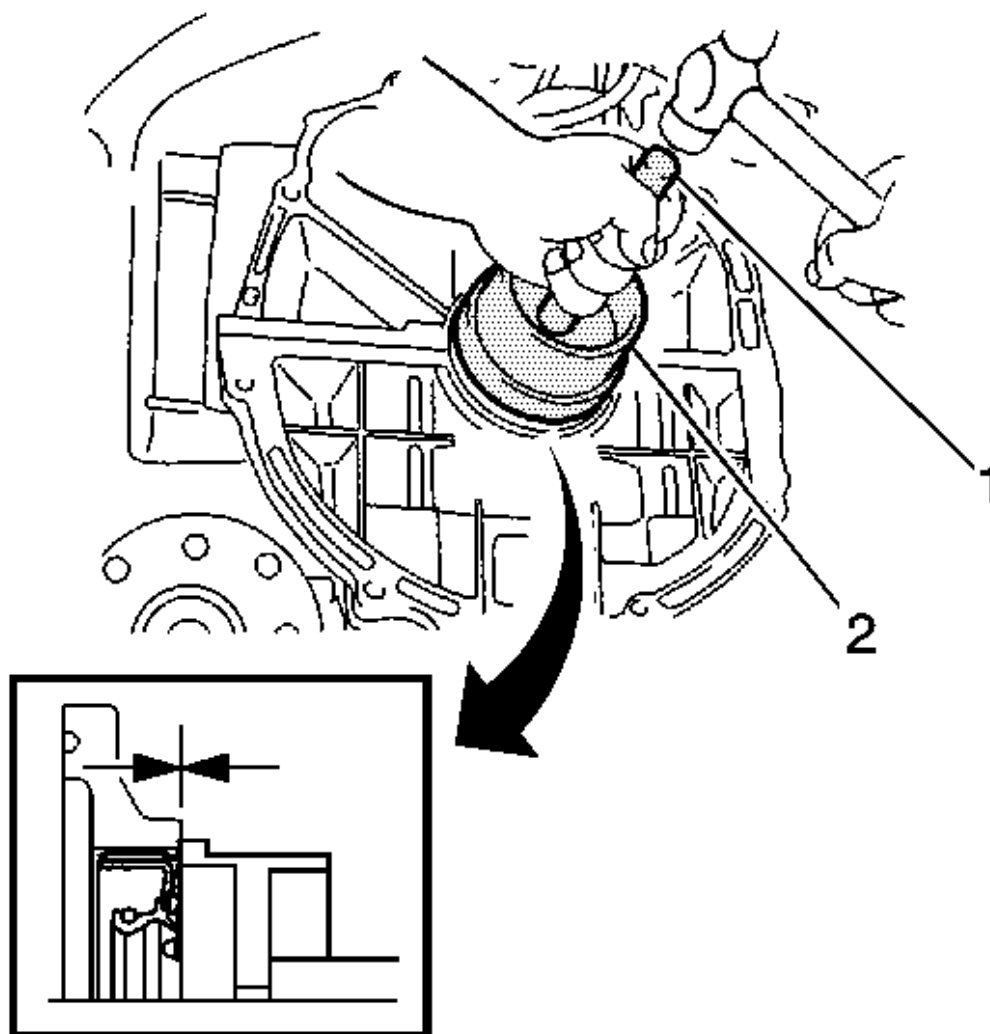


Fig. 192: View Of Rear Crankshaft Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: * Keep the lip free from foreign matter. * Do not tap on the oil seal at an angle.

2. Using SST and a hammer, tap in the rear crankshaft oil seal until its surface is flush with the rear oil seal retainer edge.

3. For automatic transaxle, clean the 8 bolts and 8 bolt holes.
4. Apply adhesive to 2 or 3 threads of the 8 bolts.

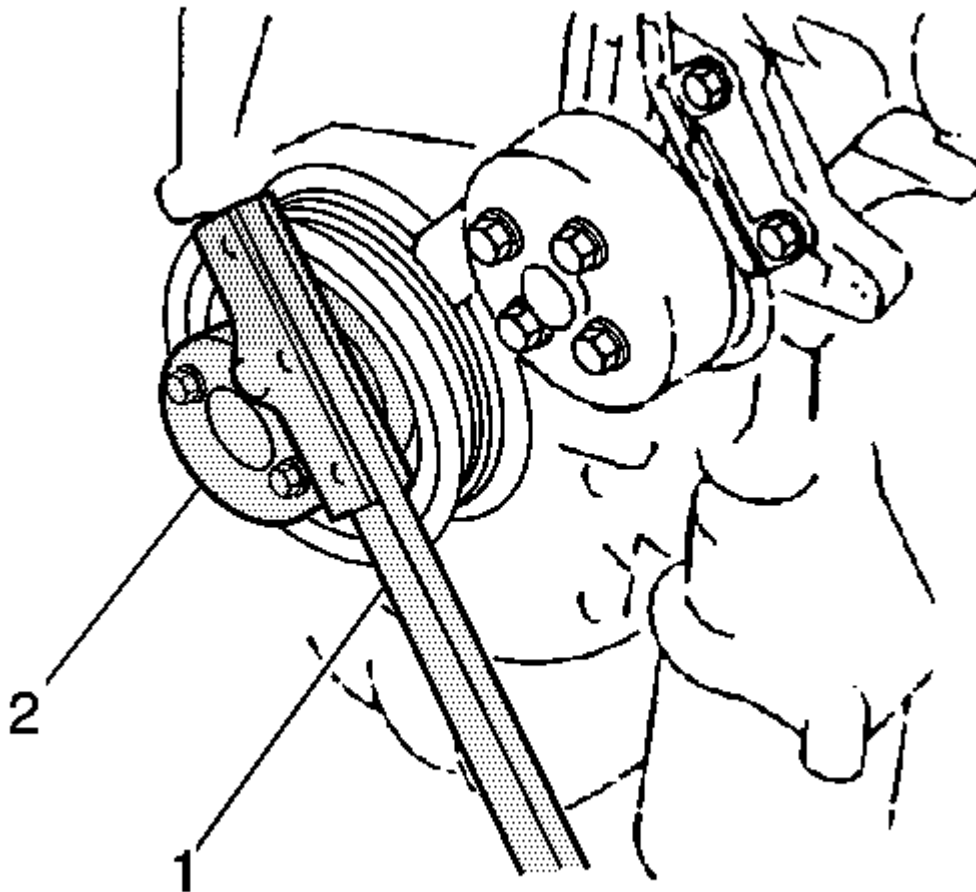


Fig. 193: View Of Holding Crankshaft Bolt
Courtesy of GENERAL MOTORS CORP.

5. Using SST, hold the crankshaft.

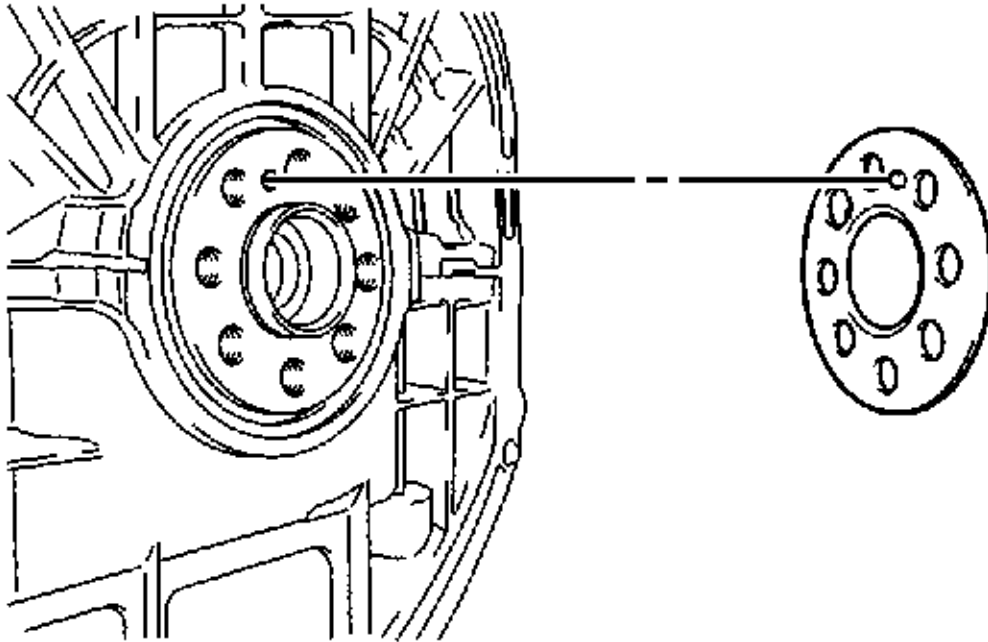


Fig. 194: Identifying Front Drive Plate Spacer
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Align the pin of the front spacer with the pin hole of the crankshaft.

6. Install the front drive plate spacer.

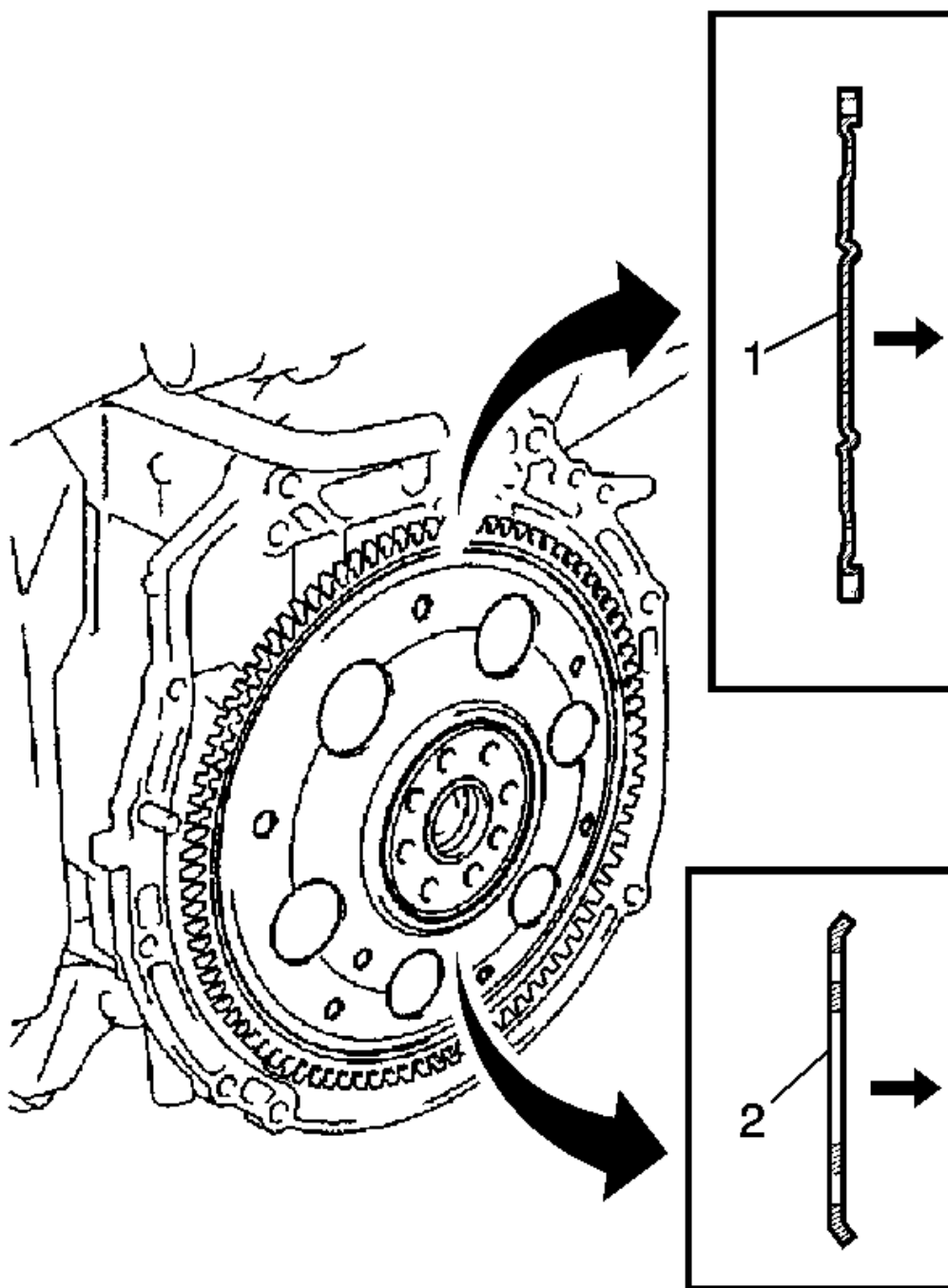


Fig. 195: View Of Drive Plate & Rear Drive Plate Spacer
Courtesy of GENERAL MOTORS CORP.

7. Install the drive plate and rear drive plate spacer onto the crankshaft.

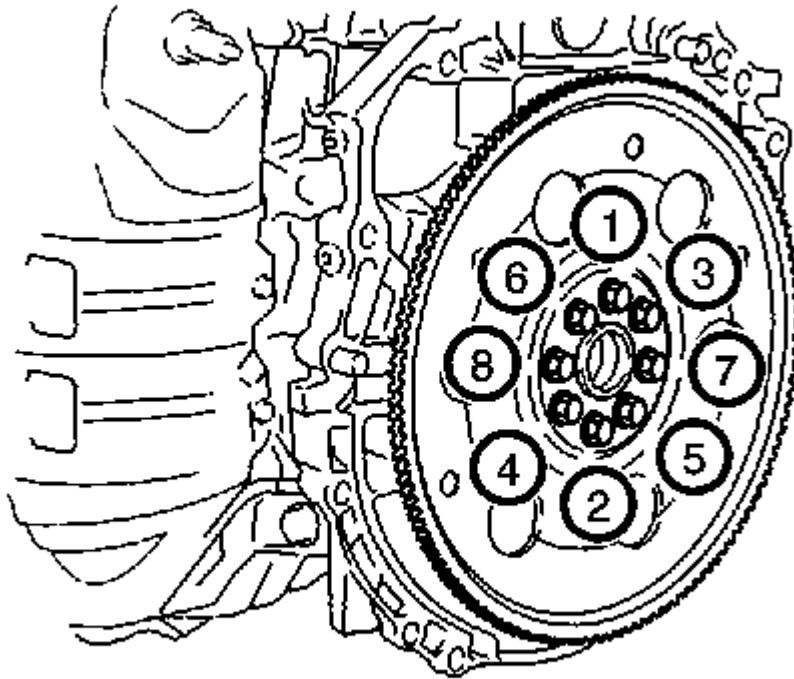


Fig. 196: Identifying Drive Plate Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

8. In several steps, uniformly install and tighten the 8 bolts in the sequence shown in the illustration.

Tighten: 98 N.m (72 lb ft)

9. For manual transaxle, clean the 8 bolts and 8 bolt holes.
10. Apply adhesive to the end 2 or 3 threads of the 8 bolts.

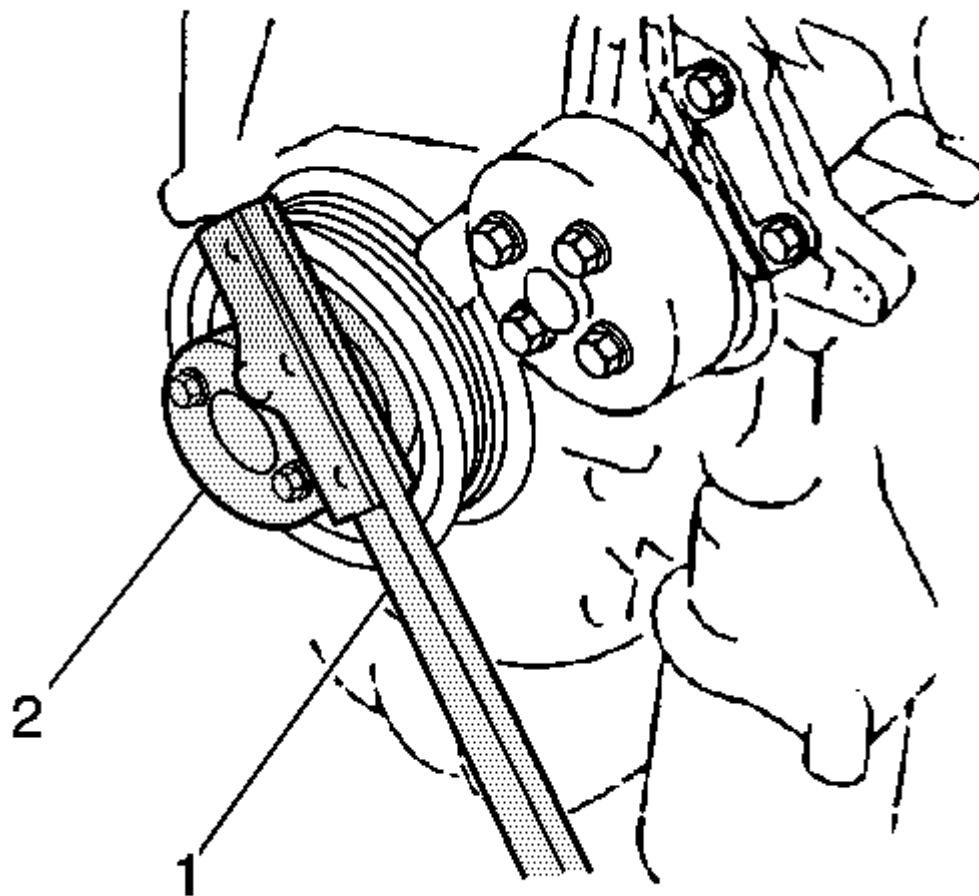


Fig. 197: View Of Holding Crankshaft Bolt
Courtesy of GENERAL MOTORS CORP.

11. Using SST, hold the crankshaft.

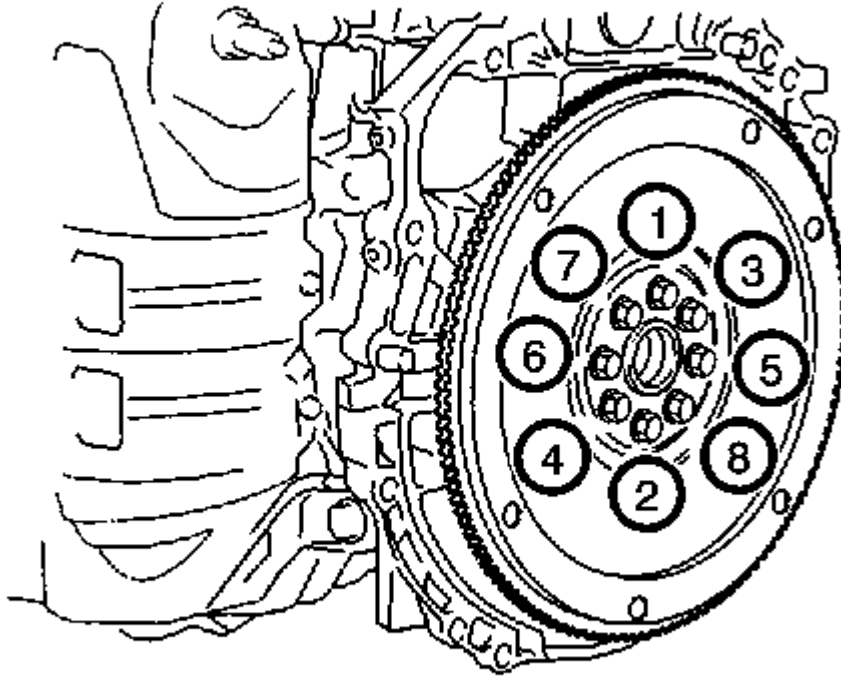


Fig. 198: View Of Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

12. In several steps, uniformly install and tighten the 8 bolts in the sequence shown in the illustration.

Tighten: 130 N.m (96 lb ft)

IMPORTANT: Refer to **FASTENER CAUTION** .

13. Install clutch disc assembly. See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
14. Install clutch cover assembly. See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
15. Install automatic transaxle assembly.
16. Install manual transaxle assembly.

ENGINE REPLACEMENT

Special Tools

TORX socket wrench

Removal Procedure

1. Discharge fuel system pressure. See **FUEL PRESSURE RELIEF** .
2. Align front wheels facing straight ahead.

NOTE: **When disconnecting the cable, some systems need to be initialized after the cable is reconnected. Refer to **BATTERY DISCONNECT WARNING** .**

3. Disconnect cable from negative battery terminal.
4. Remove front wheels.
5. Remove engine under left cover.
6. Remove engine under right cover.
7. Drain engine coolant.
8. Drain automatic transaxle fluid (for automatic transaxle).
9. Drain manual transaxle oil (for manual transaxle).
10. Drain transfer oil.

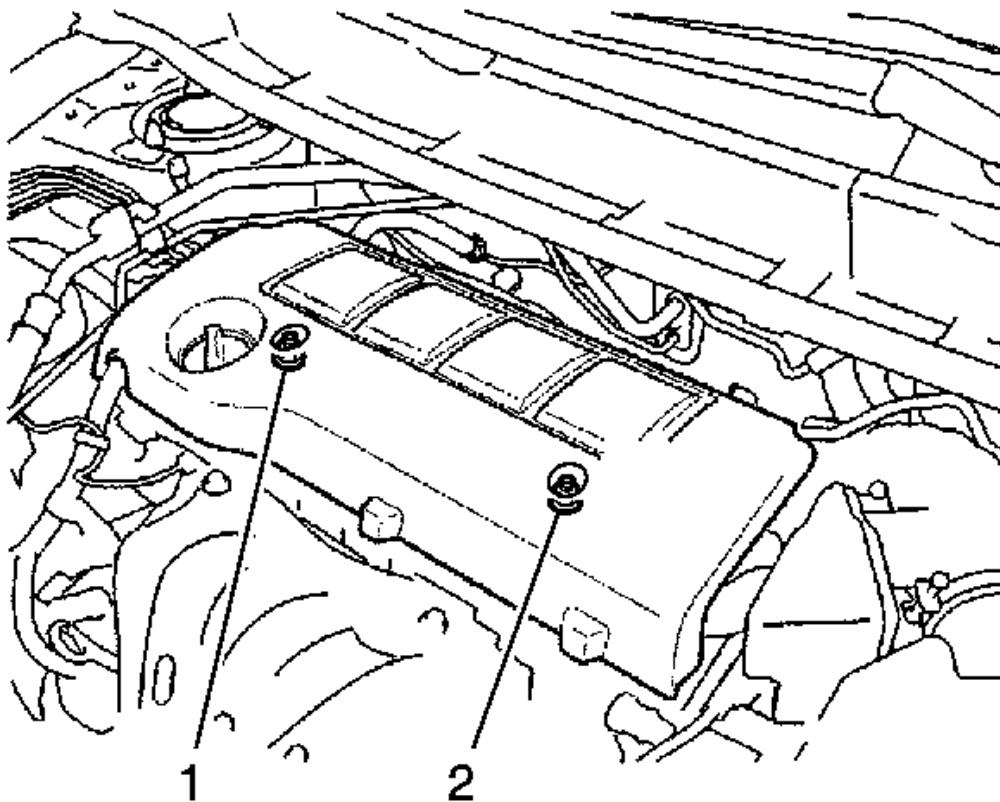


Fig. 199: Identifying Engine Cover Sub-Assembly Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

11. Remove the 2 nuts and No. 1 engine cover sub-assembly.

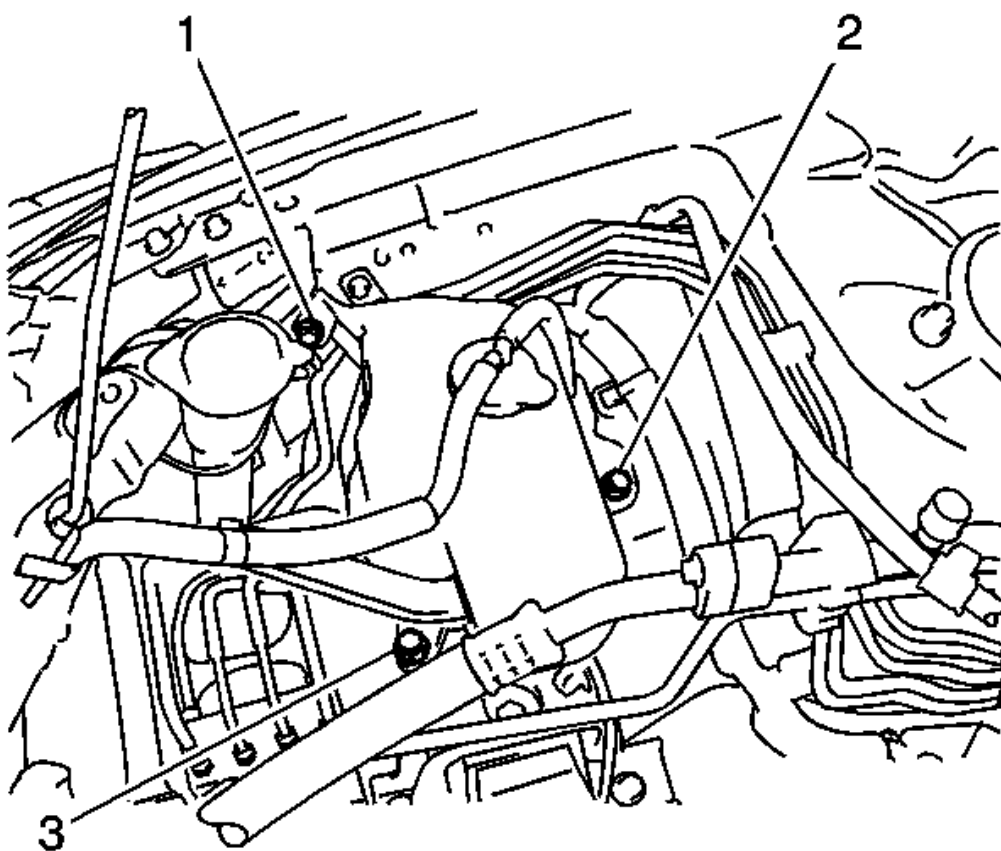


Fig. 200: Identifying Radiator Reserve Tank Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Separate the 3 bolts and radiator reserve tank assembly.
13. Remove air cleaner cap sub-assembly with hose.
14. Remove air cleaner case and remove the air cleaner filter element.

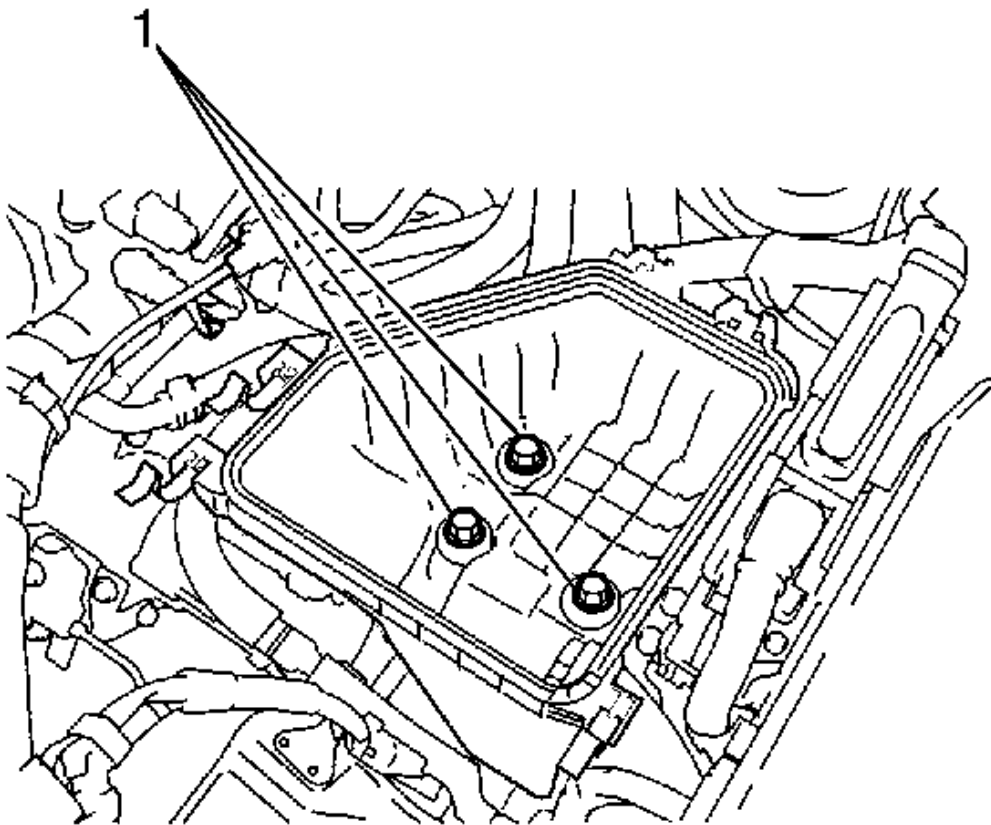


Fig. 201: Identifying Air Cleaner Case & Bolts
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the clamp of the engine wire.
16. Remove the 3 bolts and air cleaner case.

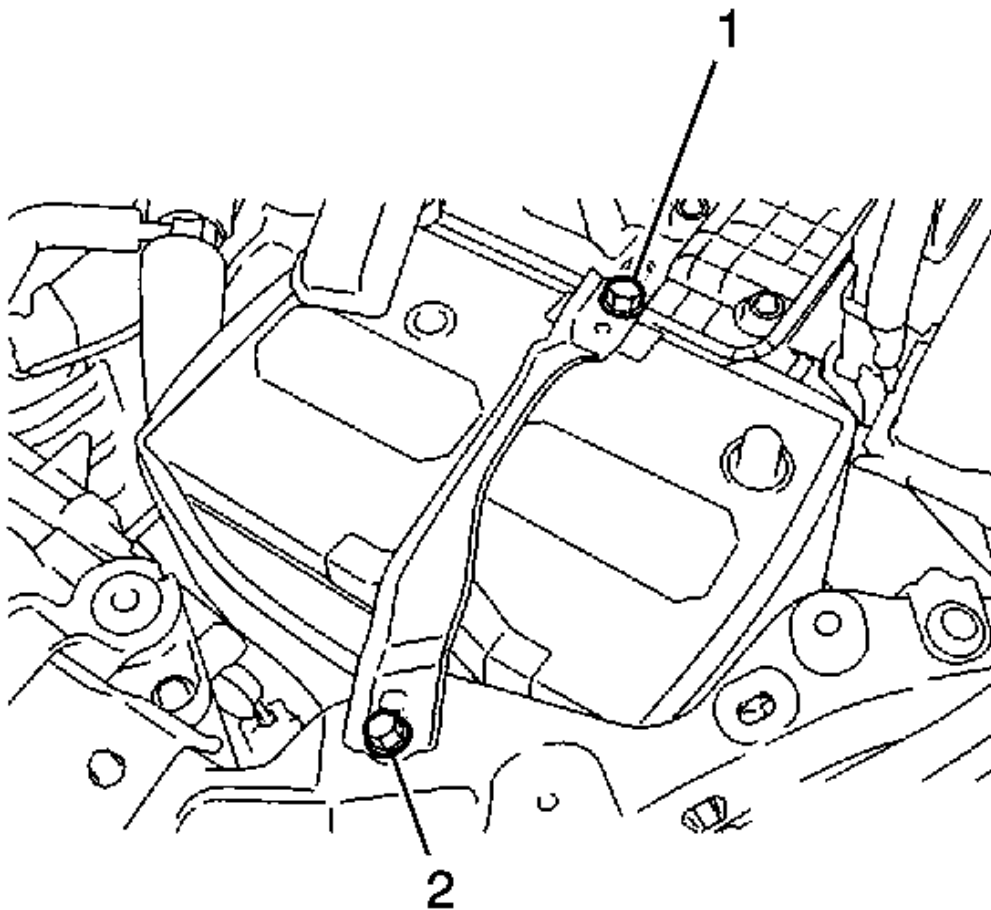


Fig. 202: Identifying Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the bolt, nut and battery clamp.
18. Remove the battery and battery insulator.
19. Remove the battery tray.

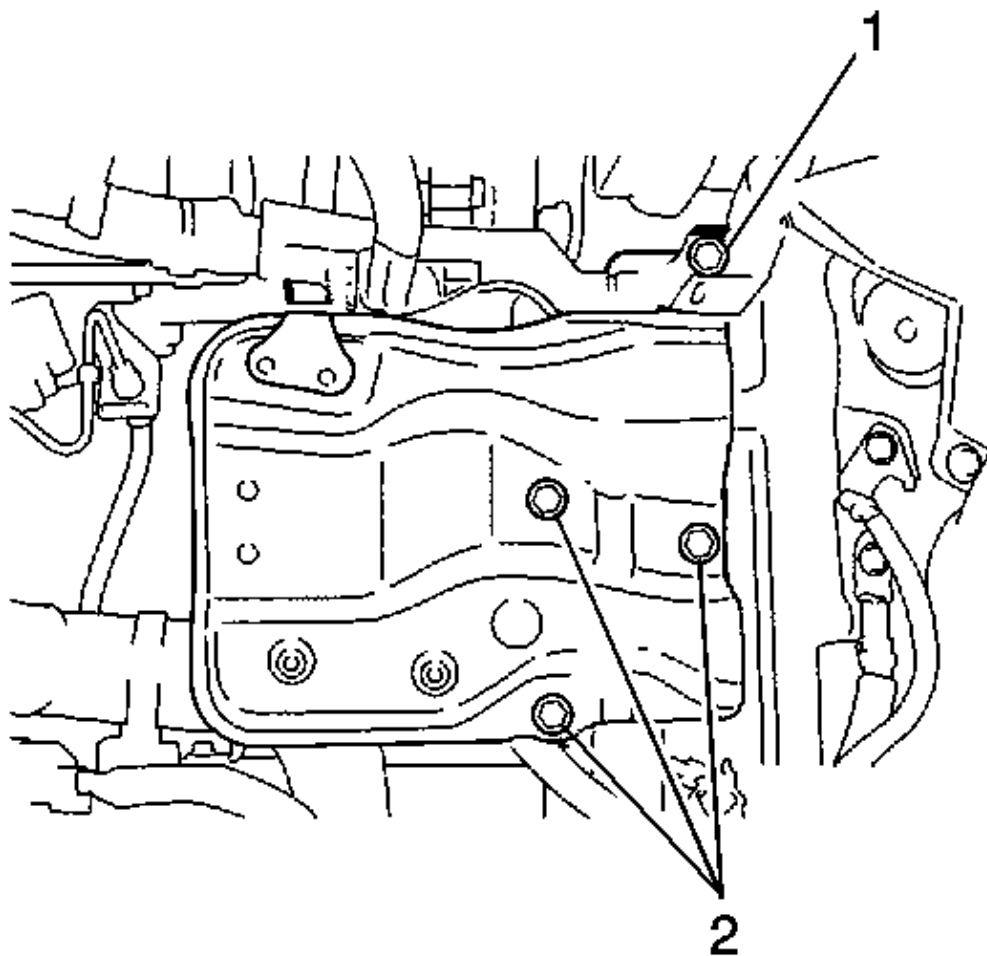


Fig. 203: Identifying Bolts & Battery Carrier
Courtesy of GENERAL MOTORS CORP.

20. Separate the 2 wire harness clamps from the battery carrier.
21. Remove the 4 bolts and battery carrier.

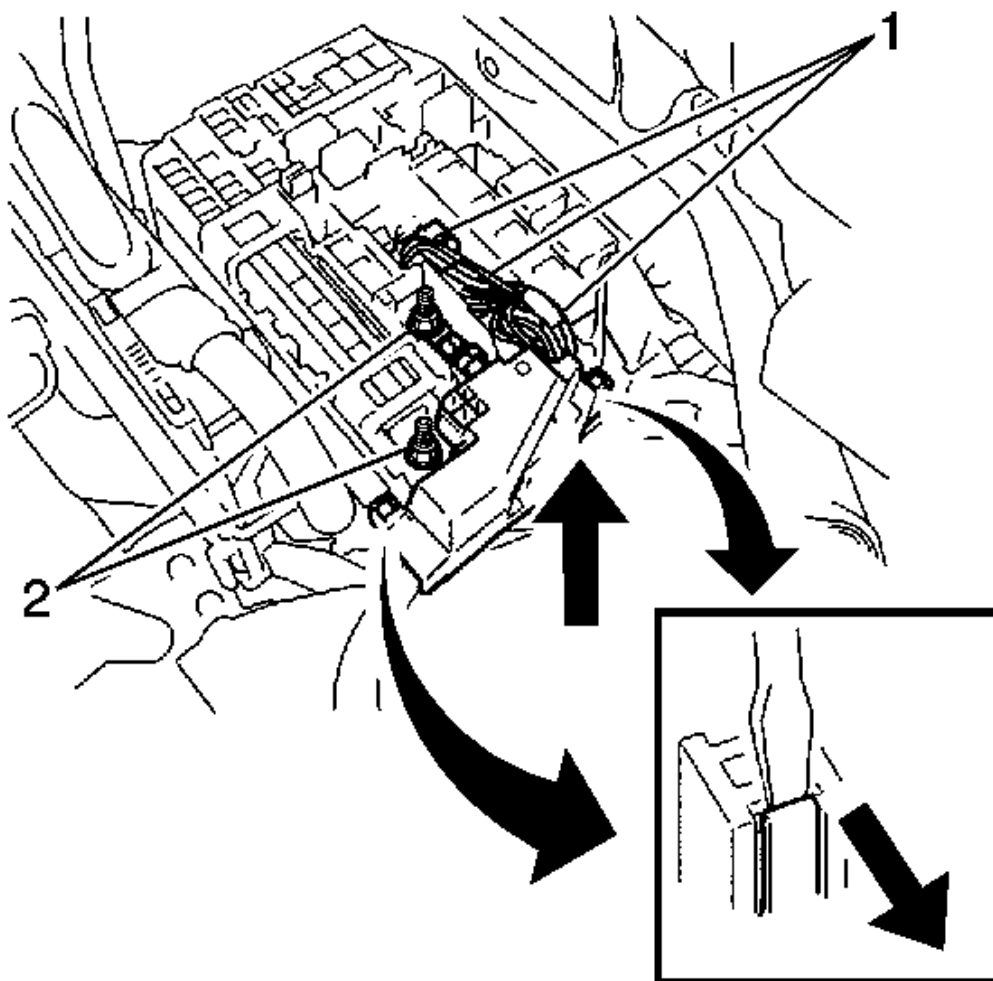


Fig. 204: Identifying Wire Harness & Fasteners
Courtesy of GENERAL MOTORS CORP.

22. Separate wire harness.
23. Disconnect the 3 connectors from the engine room relay block.
24. Remove the 2 nuts from the engine room relay block.
25. Using a screwdriver, unlock the 2 claws.
26. Pull the engine room relay block upward.

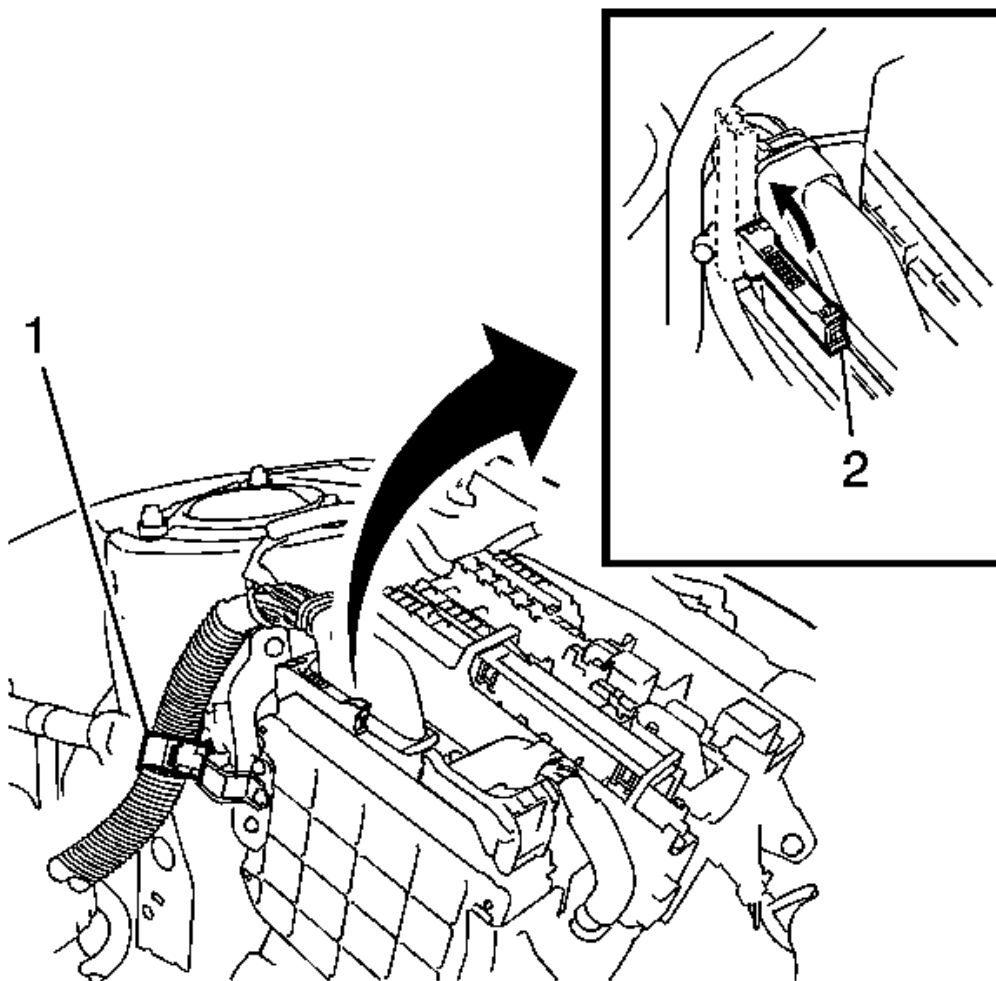


Fig. 205: View Of Lever & ECM Connector
Courtesy of GENERAL MOTORS CORP.

27. Pull up the lever and disconnect the ECM connector.
28. Disconnect the clamp.

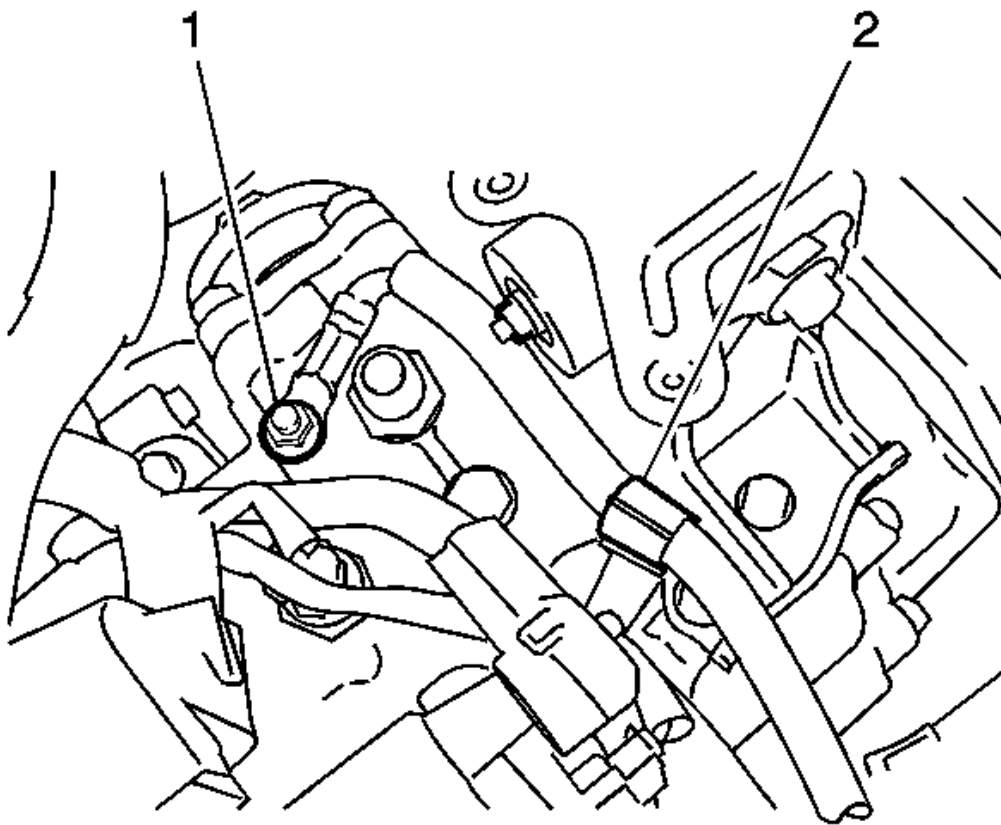


Fig. 206: Identifying Clamp & Ground Cable - Manual Transaxle
Courtesy of GENERAL MOTORS CORP.

29. Remove the bolt, clamp and disconnect the ground cable (for Manual Transaxle).

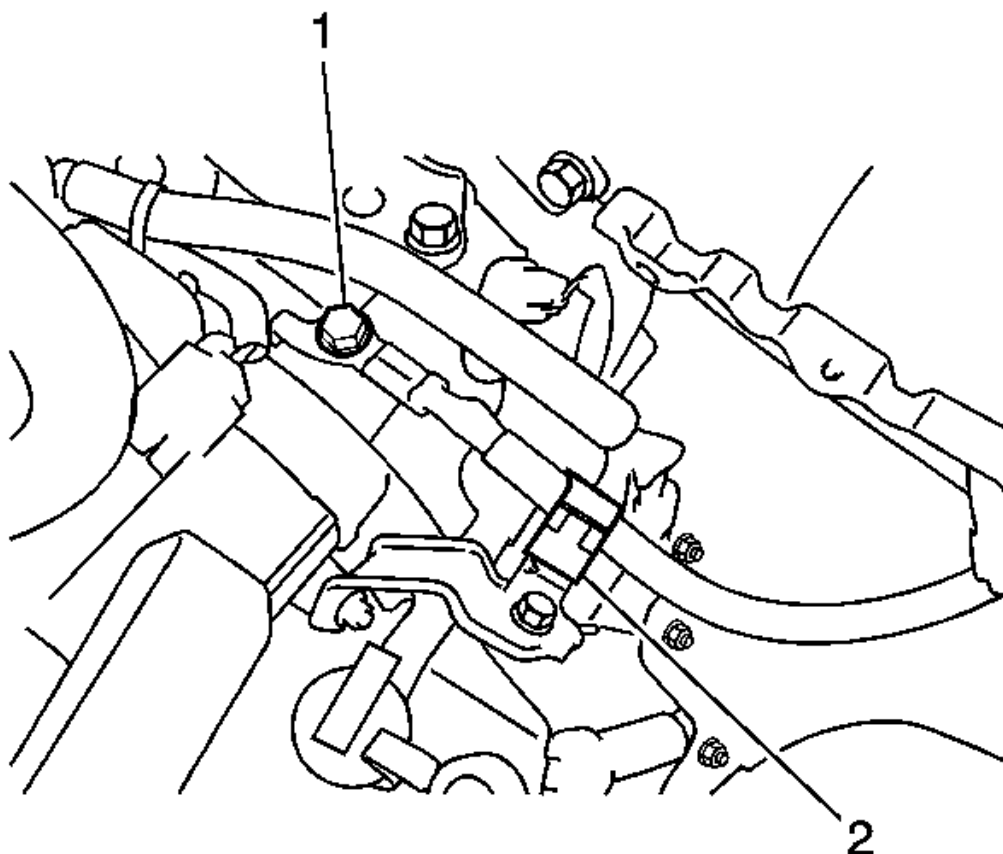


Fig. 207: Identifying Clamp & Ground Cable - Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

30. Remove the bolt, clamp and disconnect the ground cable (for Automatic Transaxle).
31. Remove throttle body assembly. See **THROTTLE BODY ASSEMBLY REPLACEMENT** .
32. Remove V-ribbed belt. See **Drive Belt Replacement**.
33. Remove generator assembly. See **GENERATOR REPLACEMENT (2.4L)** .
34. Disconnect the connector.

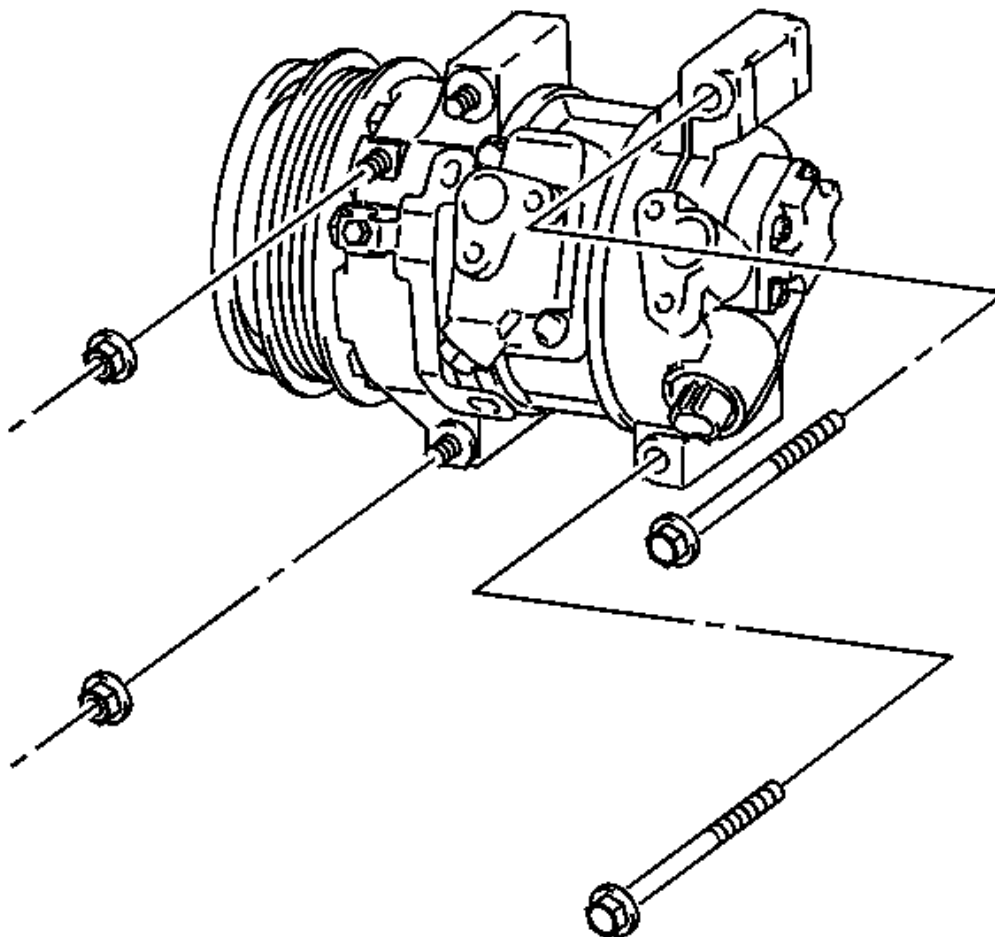


Fig. 208: Identifying A/C Compressor Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

35. Remove the 2 bolts and 2 nuts.

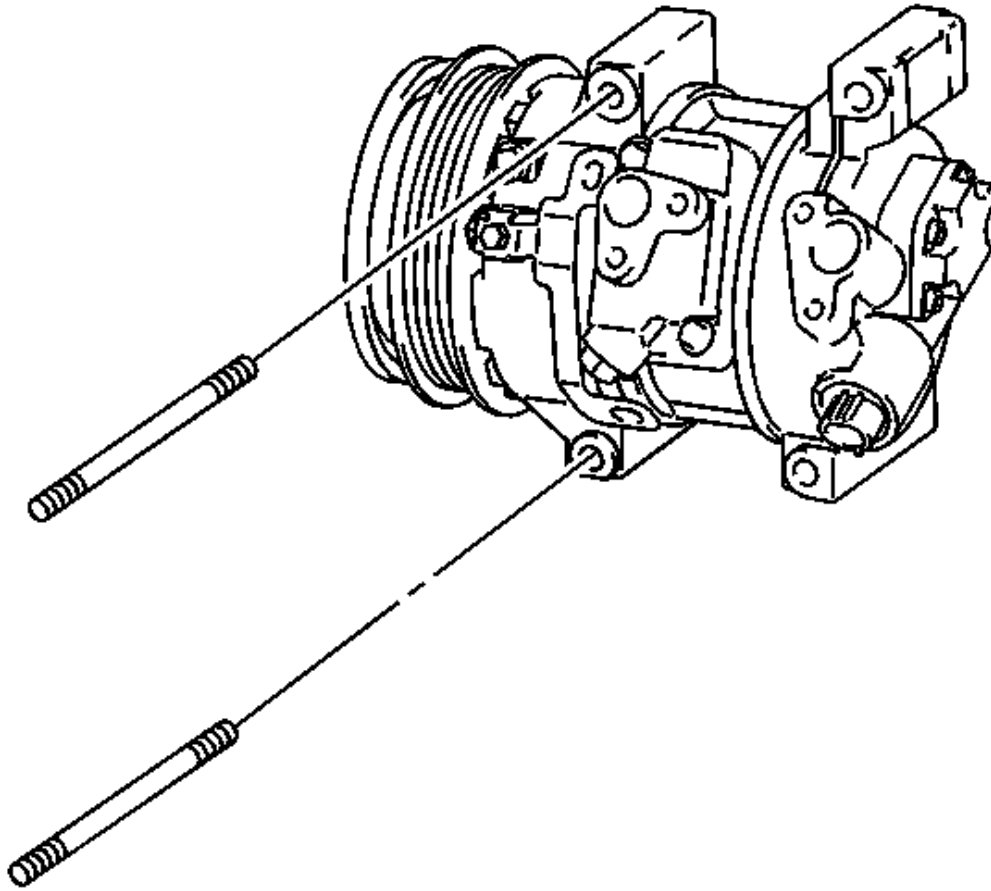


Fig. 209: Identifying A/C Compressor Studs
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Secure the compressor and hoses off to the side instead of discharging the A/C system.

36. Using a TORX socket wrench (E8), remove the 2 stud bolts and compressor assembly (with Air Conditioning System) with pulley.

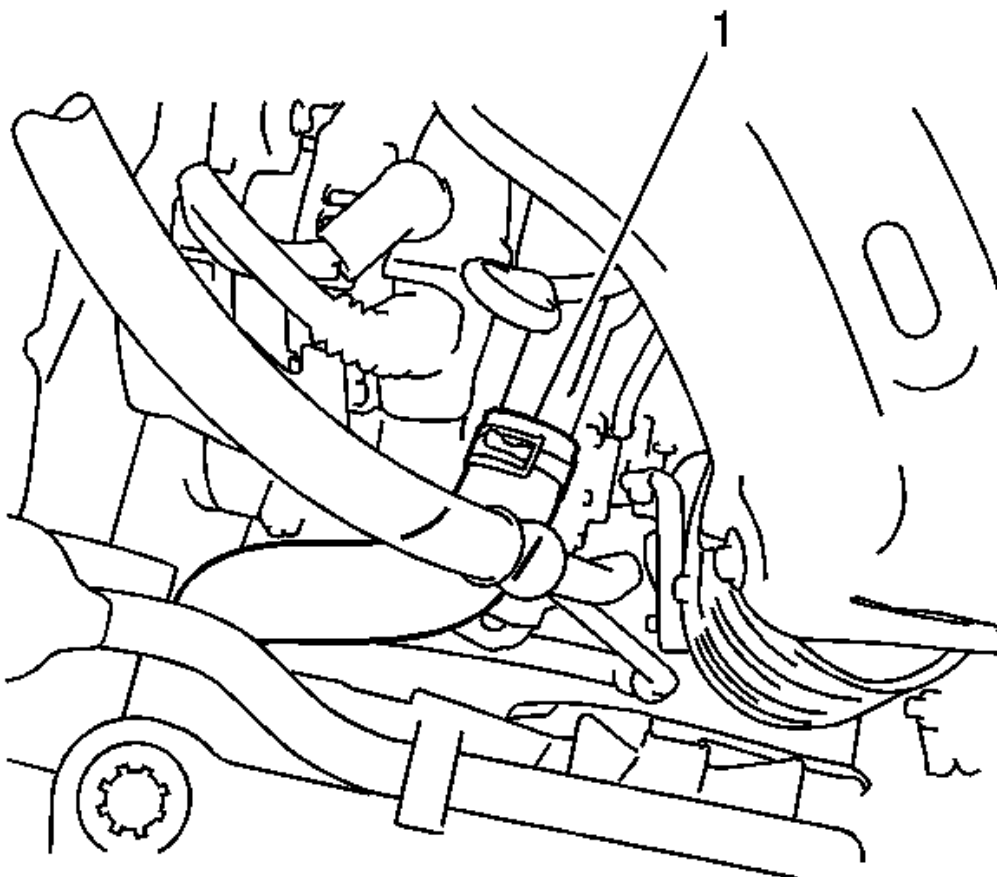


Fig. 210: Locating Upper Radiator Hose
Courtesy of GENERAL MOTORS CORP.

37. Disconnect the No. 2 radiator hose from the inlet water.

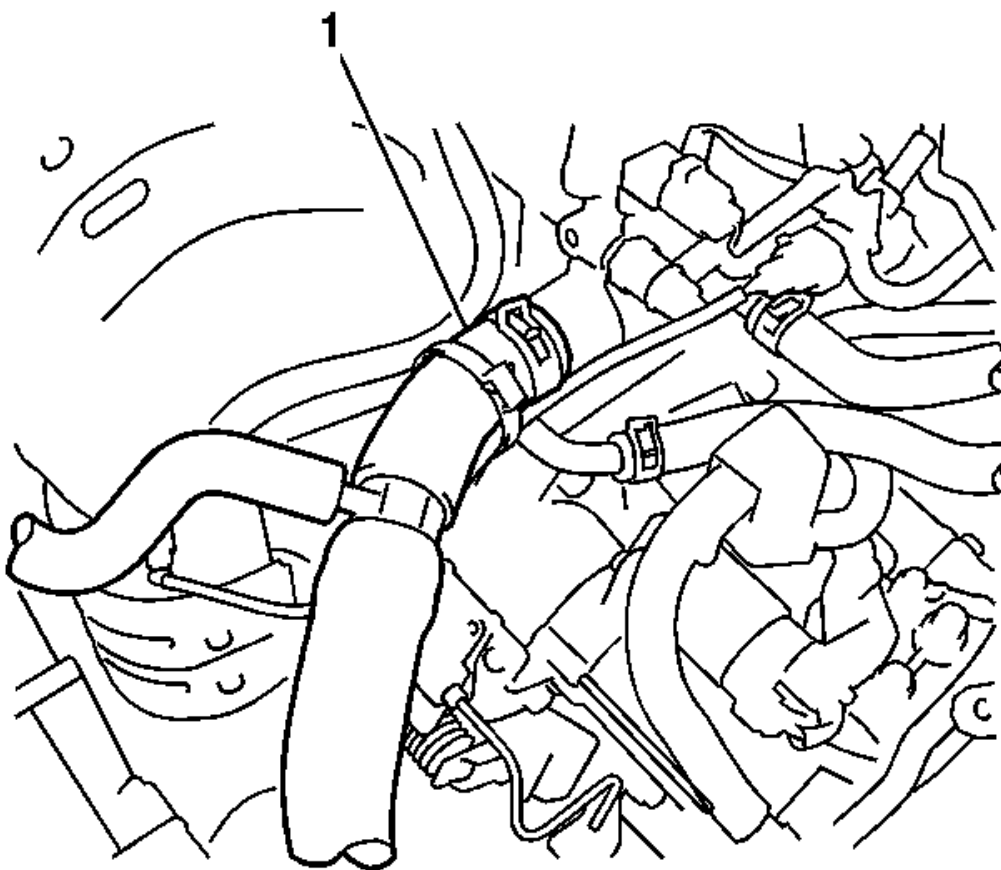


Fig. 211: View Of Upper Radiator Hose At Cylinder Head
Courtesy of GENERAL MOTORS CORP.

38. Disconnect the No. 1 radiator hose from the cylinder head.

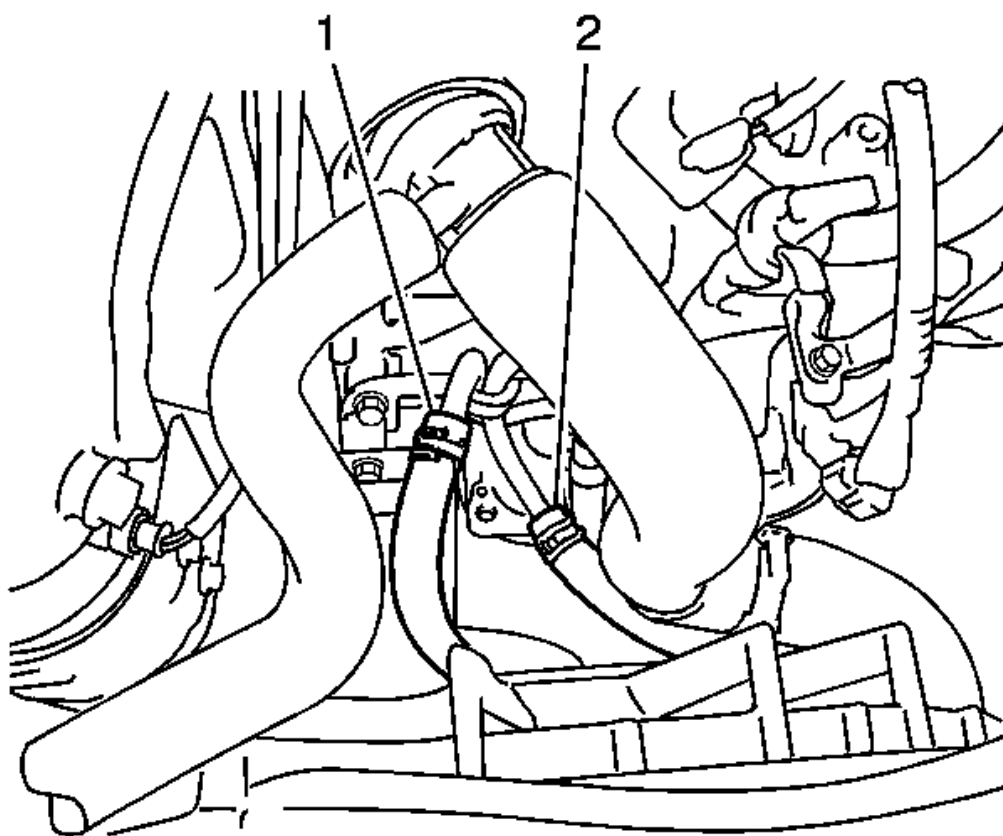


Fig. 212: View Of Oil Cooler Hoses - Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

39. Disconnect the 2 oil cooler hoses (for Automatic Transaxle).
40. Disconnect breather hose (for Automatic Transaxle).



Fig. 213: View Of Heater Water Outlet Hose
Courtesy of GENERAL MOTORS CORP.

41. Disconnect the outlet heater water hose.
42. Disconnect the inlet heater water hose.

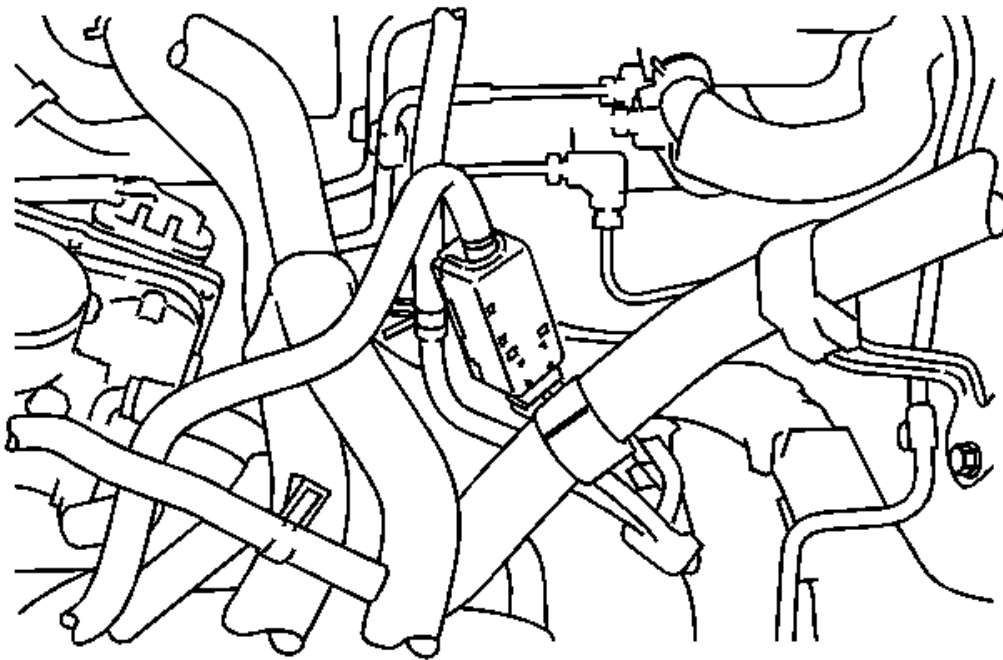


Fig. 214: Identifying Fuel Pipe Clamp
Courtesy of GENERAL MOTORS CORP.

43. Release the claw and remove the No. 1 fuel pipe clamp.

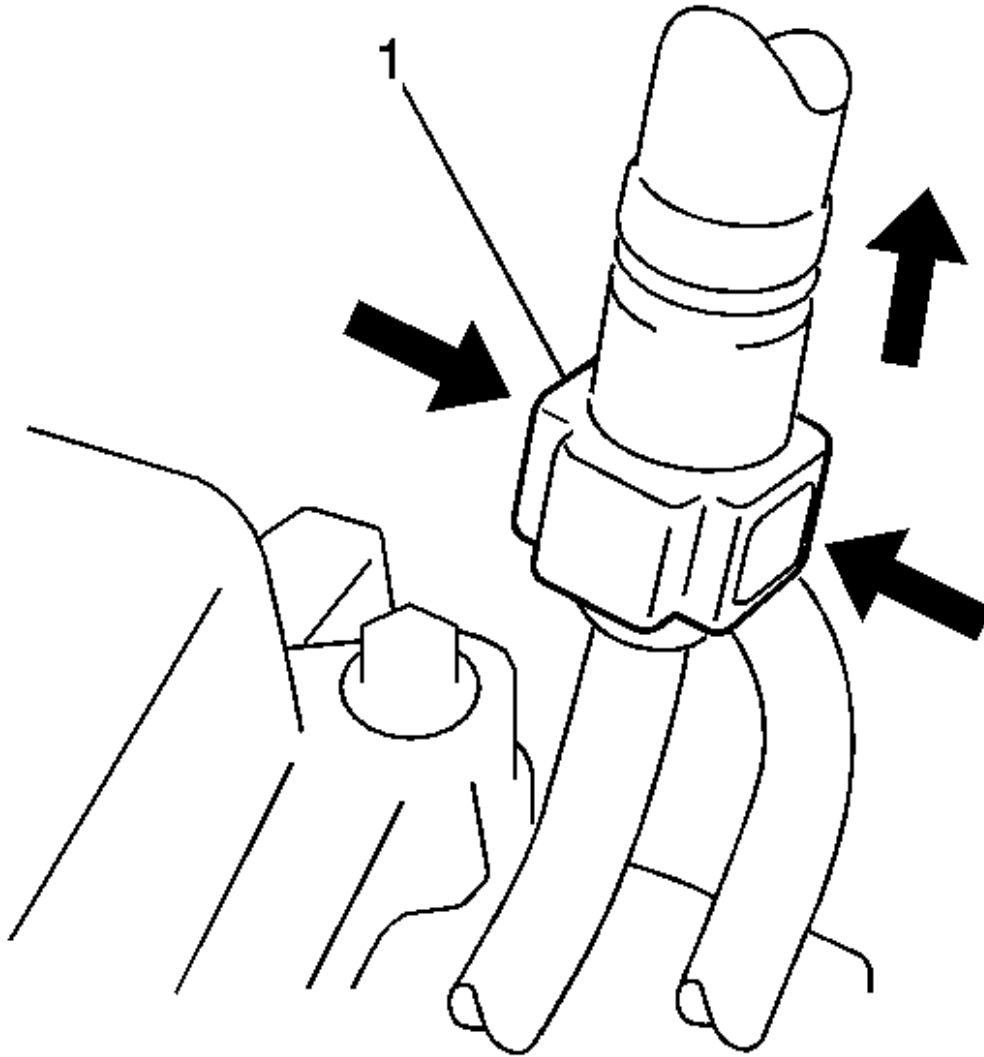


Fig. 215: View Of Fuel Tube Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove any dirt or foreign matter from the fuel tube connector before performing this work. Do not allow any scratches or foreign matter on the parts when disconnecting, as the fuel tube connector has O-rings that seal the pipe. Perform this work by hand. Do not use any tools. Do not forcibly bend, kink or twist the nylon tube. Protect the disconnected parts by covering them with vinyl bags after disconnecting the fuel tube. If the fuel tube connector and pipe are stuck, push and pull to release them.

44. Pinch the retainer as illustrated, then pull the fuel tube connector out of the pipe.

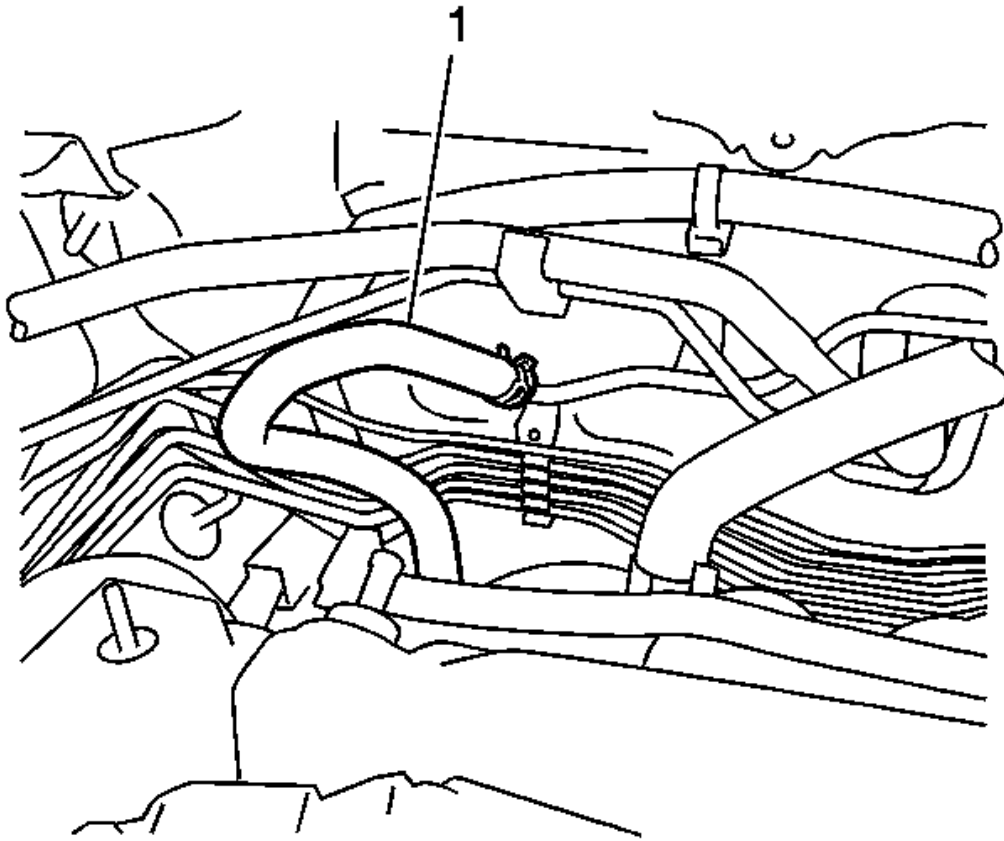


Fig. 216: Identifying Connector Tube Hose Union
Courtesy of GENERAL MOTORS CORP.

45. Disconnect the union to connector tube hose.
46. Separate clutch release cylinder assembly (for Manual Transaxle).

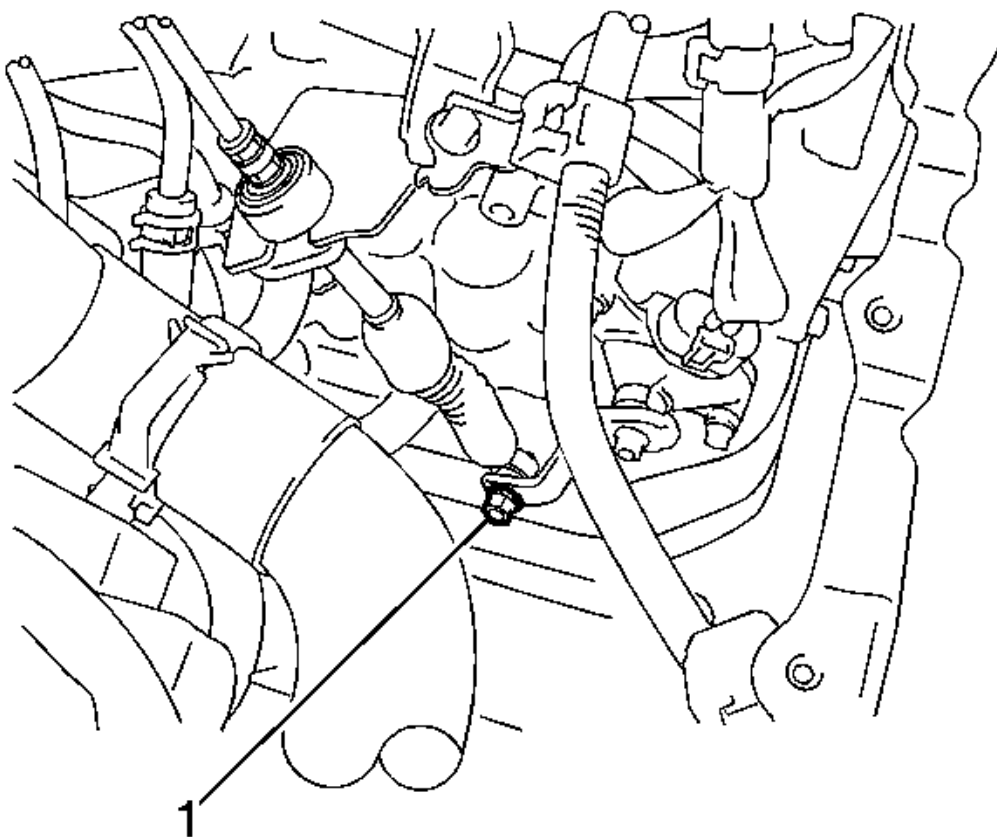


Fig. 217: Identifying Automatic Transaxle Control Cable Assembly & Control Shaft Lever
Courtesy of GENERAL MOTORS CORP.

47. U250E Automatic Transaxle-Remove the nut and disconnect the control cable assembly from the control shaft lever.
48. Remove the clip and disconnect the transmission control cable assembly from the control cable bracket.

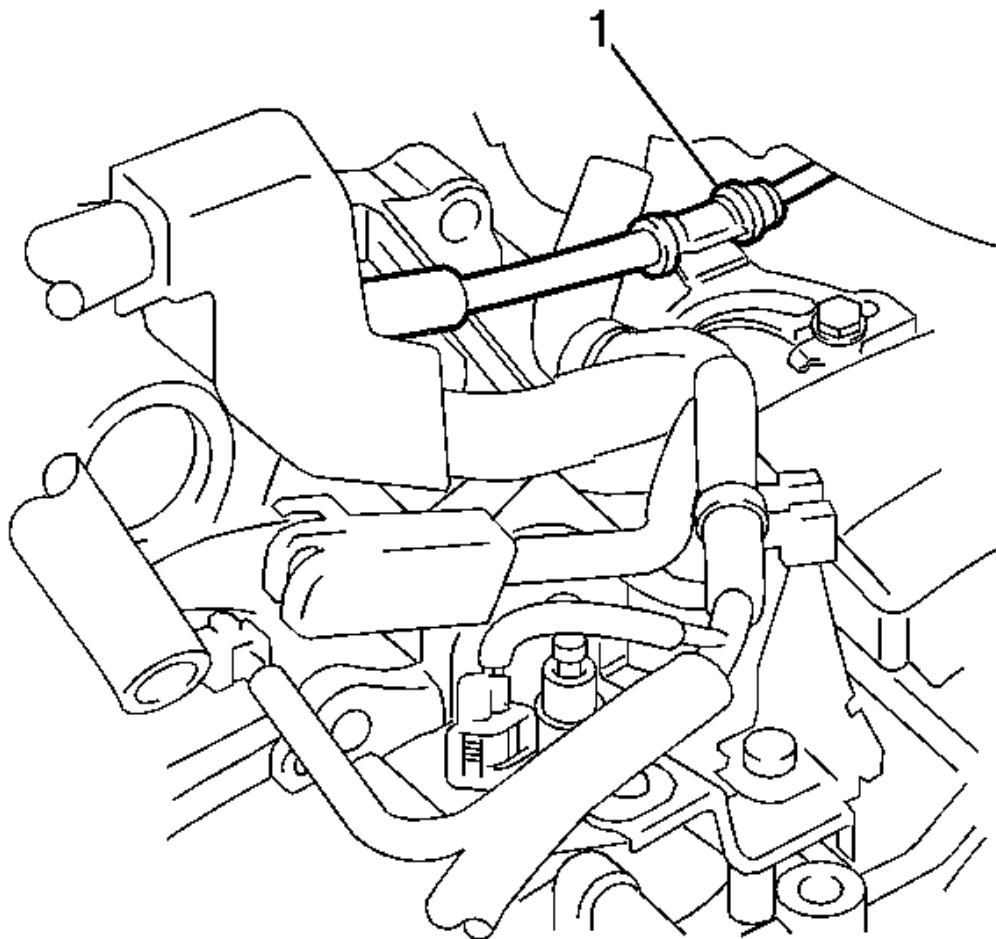


Fig. 218: Identifying Control Cable Assembly & Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

49. Disconnect the control cable assembly from the control cable bracket.

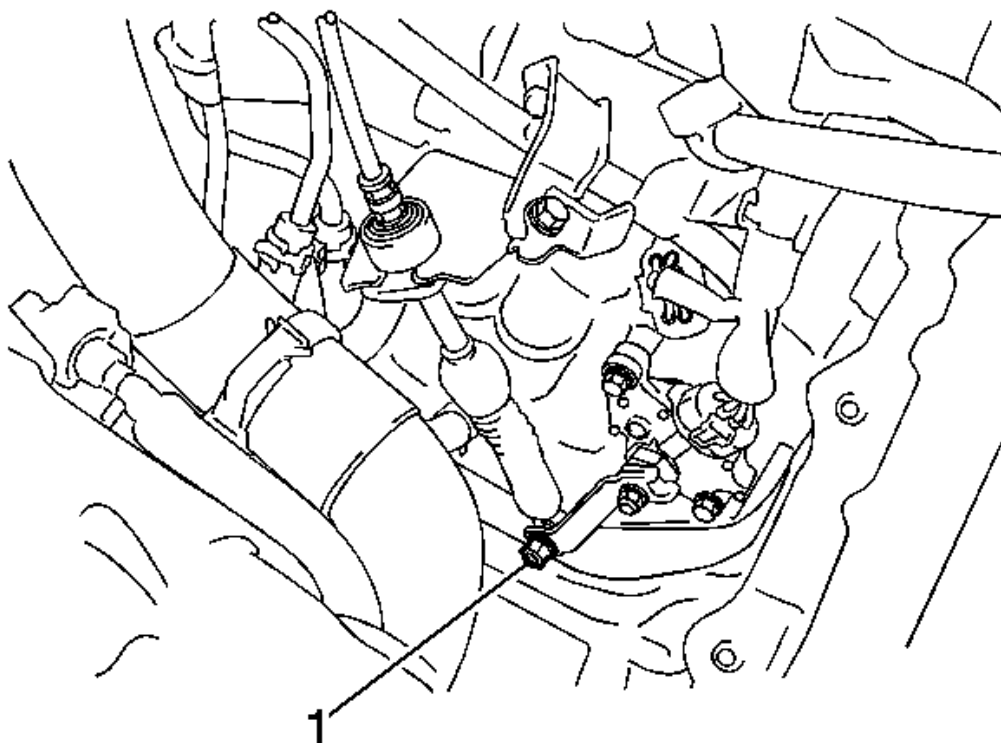


Fig. 219: Identifying Control Cable Assembly, Control Shaft Lever & Nut
Courtesy of GENERAL MOTORS CORP.

50. U140F Automatic Transaxle-Remove the nut and disconnect the control cable assembly from the control shaft lever.
51. Remove the clip and disconnect the transmission control cable assembly from the control cable bracket.

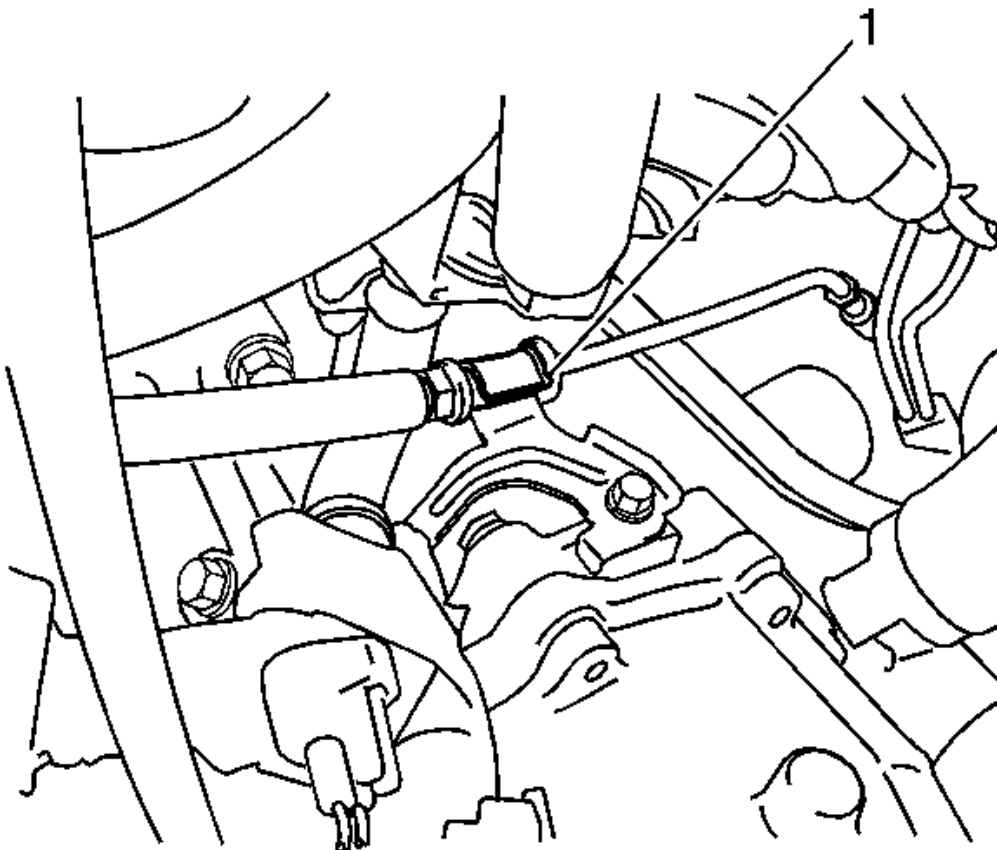


Fig. 220: Identifying Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

52. Disconnect the control cable assembly from the control cable bracket.

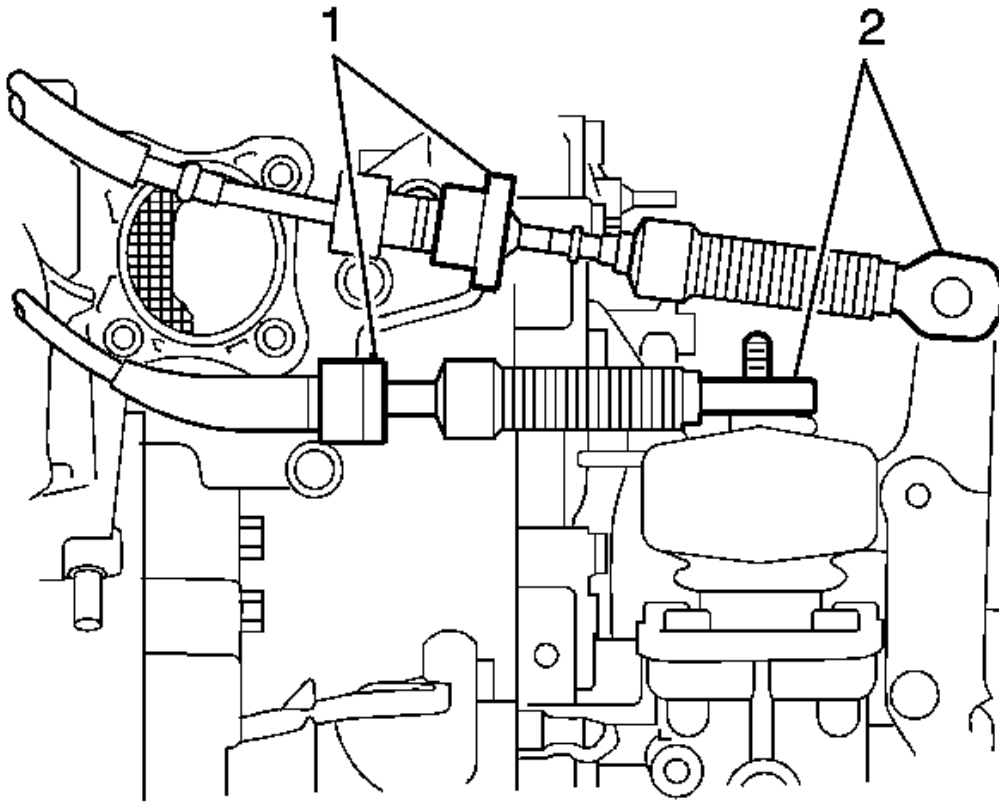


Fig. 221: Identifying Manual Transaxle Transmission Control Cables
Courtesy of GENERAL MOTORS CORP.

53. E351 Manual Transaxle: Remove the 2 clips and disconnect the 2 transmission control cables from the control cable bracket 1.
54. Remove the 2 clips and disconnect the 2 transmission control cables from the transaxle 2.
55. Secure steering wheel.
56. Remove column hole cover silencer sheet.
57. Separate No. 2 steering intermediate shaft assembly.
58. Separate No. 1 steering column hole cover sub-assembly.
59. Remove center exhaust pipe assembly. See **EXHAUST PIPE REPLACEMENT (2.4L AWD)** .
60. Remove front exhaust pipe assembly. See **EXHAUST PIPE REPLACEMENT (2.4L AWD)** .
61. Remove propeller with center bearing shaft assembly (for 4WD. See **PROPELLER SHAFT** .
62. Remove front axle shaft left nut. See **WHEEL DRIVE SHAFTS** .

IMPORTANT: Perform the same procedure for the left side.

- 63. Remove front axle shaft right nut.
- 64. Separate left front speed sensor.

IMPORTANT: Perform the same procedure for the left side.

- 65. Separate right front speed sensor.
- 66. Separate left tie rod end sub-assembly. See **FRONT SUSPENSION** .

IMPORTANT: Perform the same procedure for the left side.

- 67. Separate right tie rod end sub-assembly.
- 68. Separate left front stabilizer link assembly. See **FRONT SUSPENSION** .

IMPORTANT: Perform the same procedure for the left side.

- 69. Separate right front stabilizer link assembly.
- 70. Separate left front lower No. 1 suspension arm sub-assembly. See **FRONT SUSPENSION** .

IMPORTANT: Perform the same procedure for the left side.

- 71. Separate right front lower No. 1 suspension arm sub-assembly.

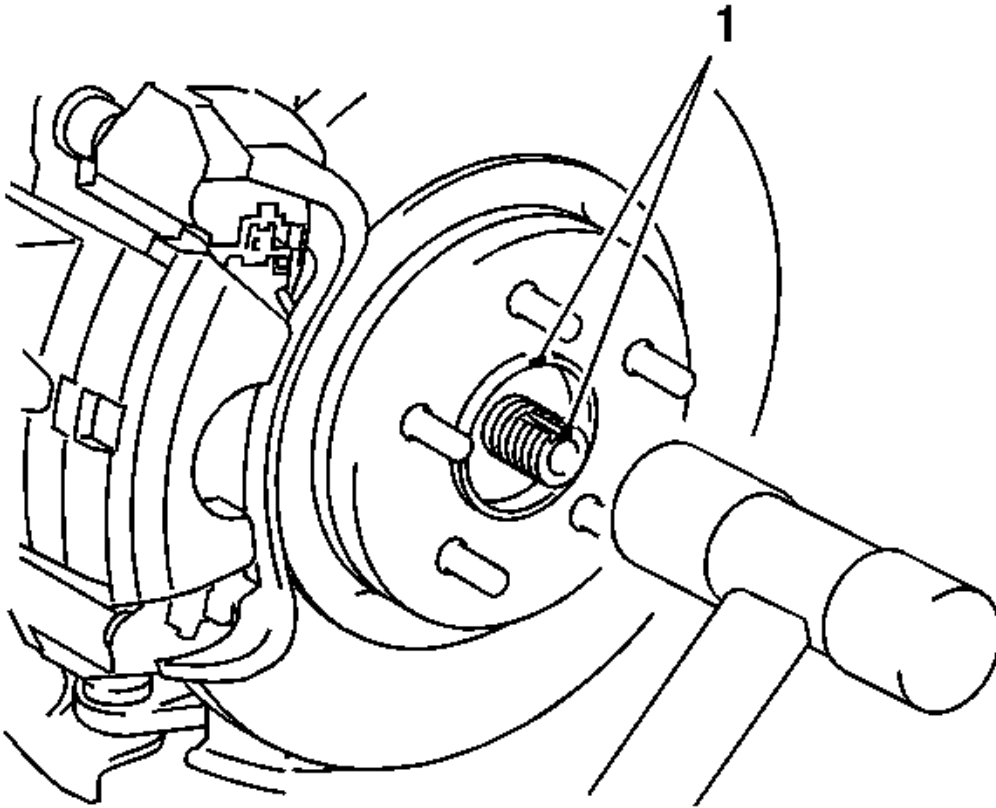


Fig. 222: View Of Axle Hub

Courtesy of GENERAL MOTORS CORP.

72. Separate left steering knuckle with axle hub.

NOTE: Do not punch the marks.

73. Put matchmarks on the drive shaft and axle hub.

NOTE: Be careful not to damage the boot and speed sensor rotor. Do not excessively push out the drive shaft from the axle assembly.

74. Using a plastic-faced hammer, disconnect the left front axle assembly.

IMPORTANT: Perform the same procedure for the left side.

75. Separate right steering knuckle with axle hub.

76. Remove left front drive shaft assembly.
77. Remove left front drive shaft hole snap ring.
78. Remove right front drive shaft assembly (for 2wd).
79. Remove right front drive shaft assembly.
80. Separate drive plate and torque converter clutch setting bolt (for automatic transaxle).
81. Remove front suspension crossmember sub-assembly.
82. Remove center engine mounting member sub-assembly.

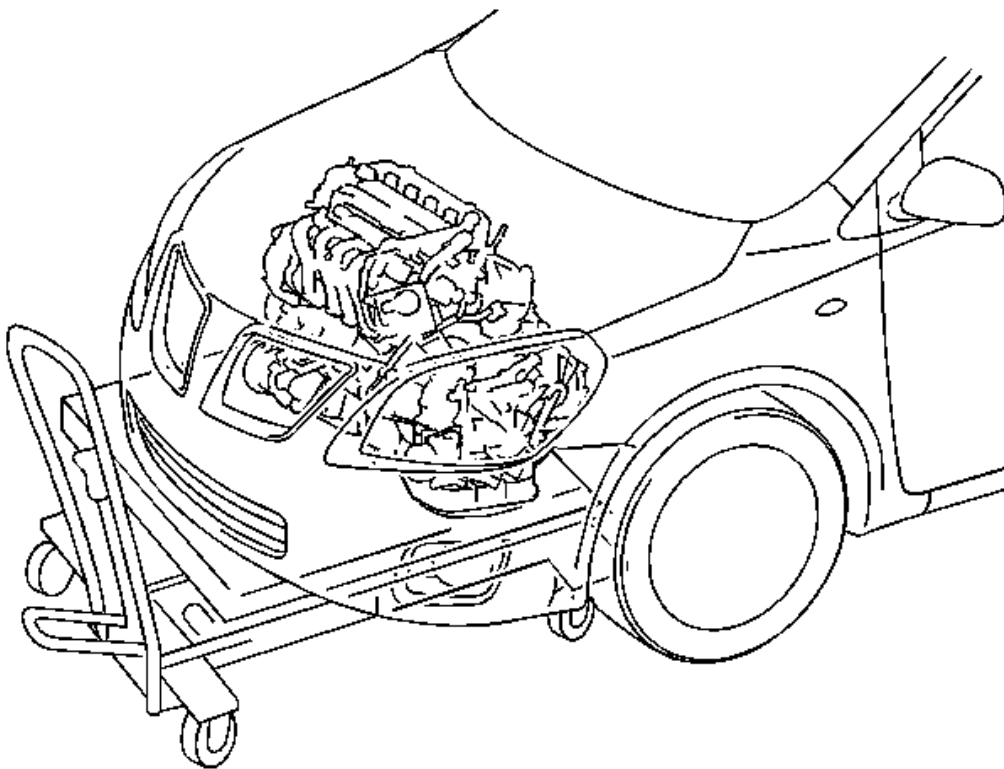


Fig. 223: View Of Engine Lifter
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the engine on wooden blocks or equivalent so that the engine is level.

83. Set the engine assembly with transaxle on the engine lifter.

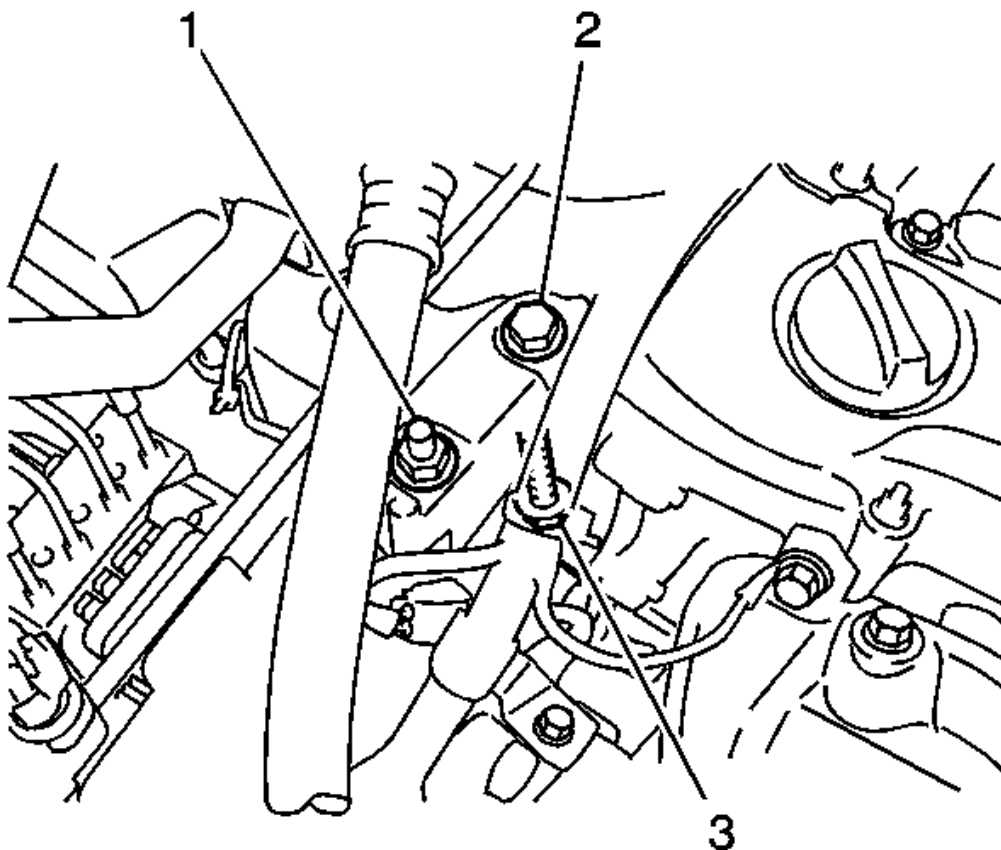


Fig. 224: Identifying Right Engine Mounting Insulator Nuts
Courtesy of GENERAL MOTORS CORP.

84. Remove the bolt and 2 nuts, and separate the right engine mounting insulator.

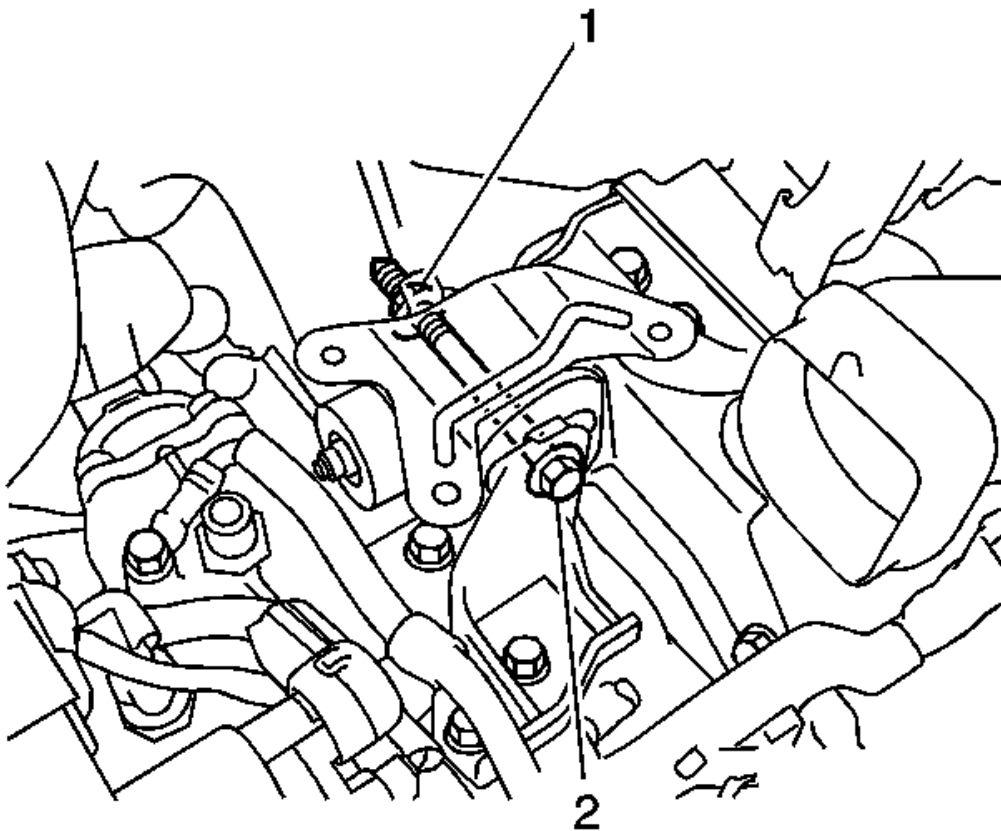


Fig. 225: Identifying Left Engine Mounting Insulator
Courtesy of GENERAL MOTORS CORP.

85. Remove the through bolt and nut, and separate the left engine mounting insulator.
86. Carefully remove the engine with transaxle from the vehicle.

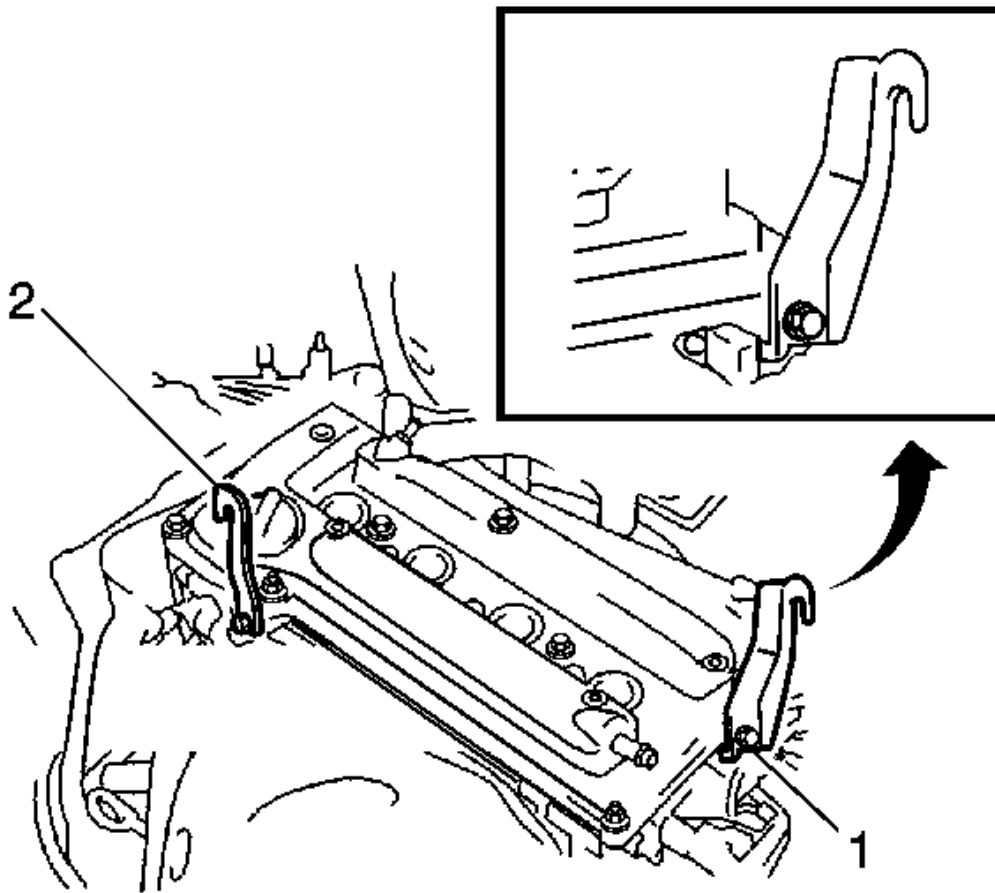


Fig. 226: Identifying Engine Lift Hangers
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER CAUTION .

87. Install the No. 1 and No. 2 engine hangers with the new bolts as shown in the illustration.

Tighten: 38 N.m (28 lb ft)

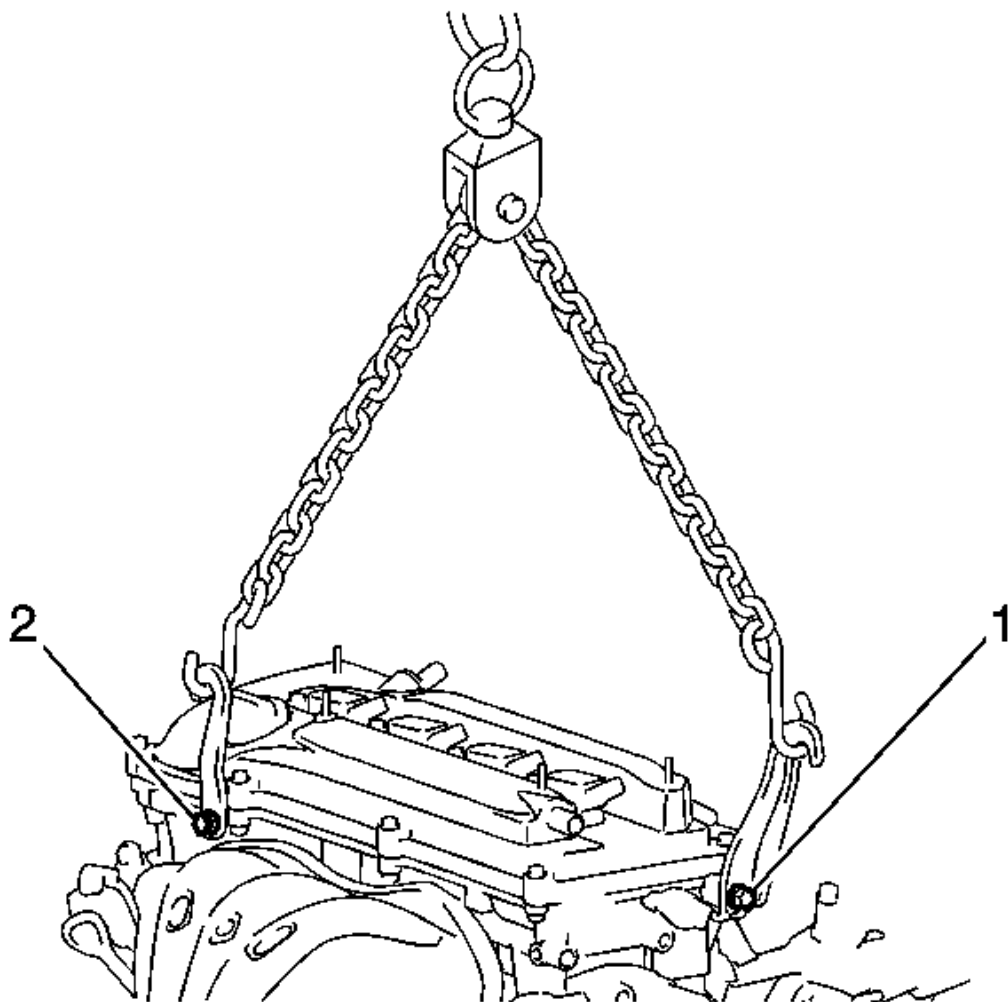


Fig. 227: View Of Engine Sling
Courtesy of GENERAL MOTORS CORP.

88. Using an engine sling device and a chain block, suspend the engine assembly with transaxle.

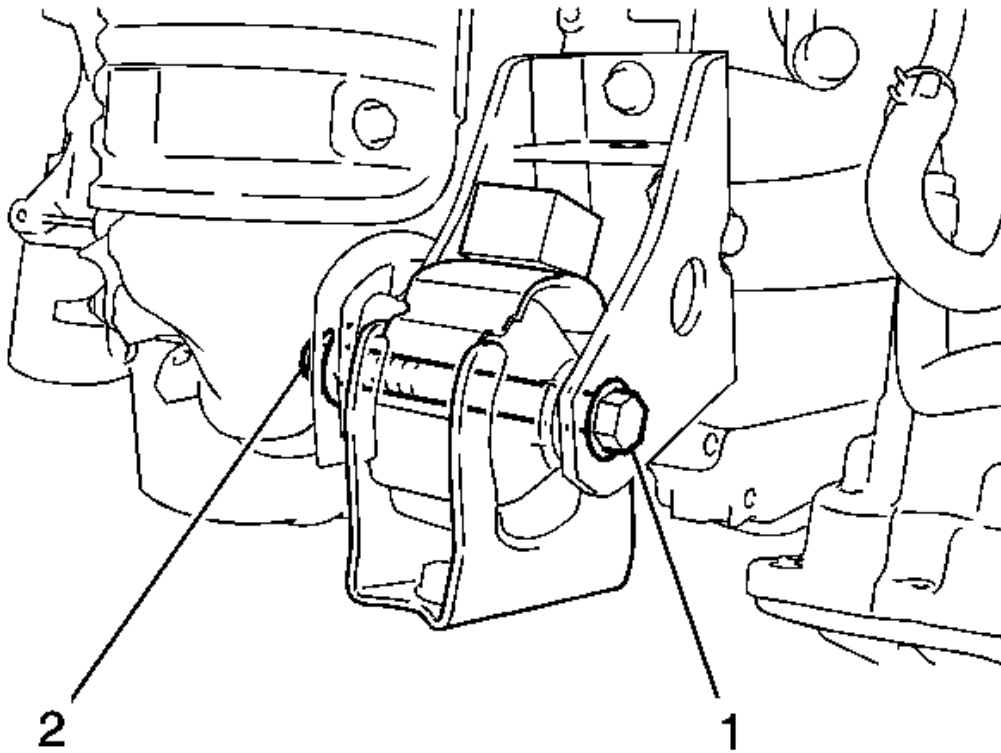


Fig. 228: Identifying Front Engine Mounting Insulator Through Bolt
Courtesy of GENERAL MOTORS CORP.

89. Remove the through bolt and nut, and separate the front engine mounting insulator.

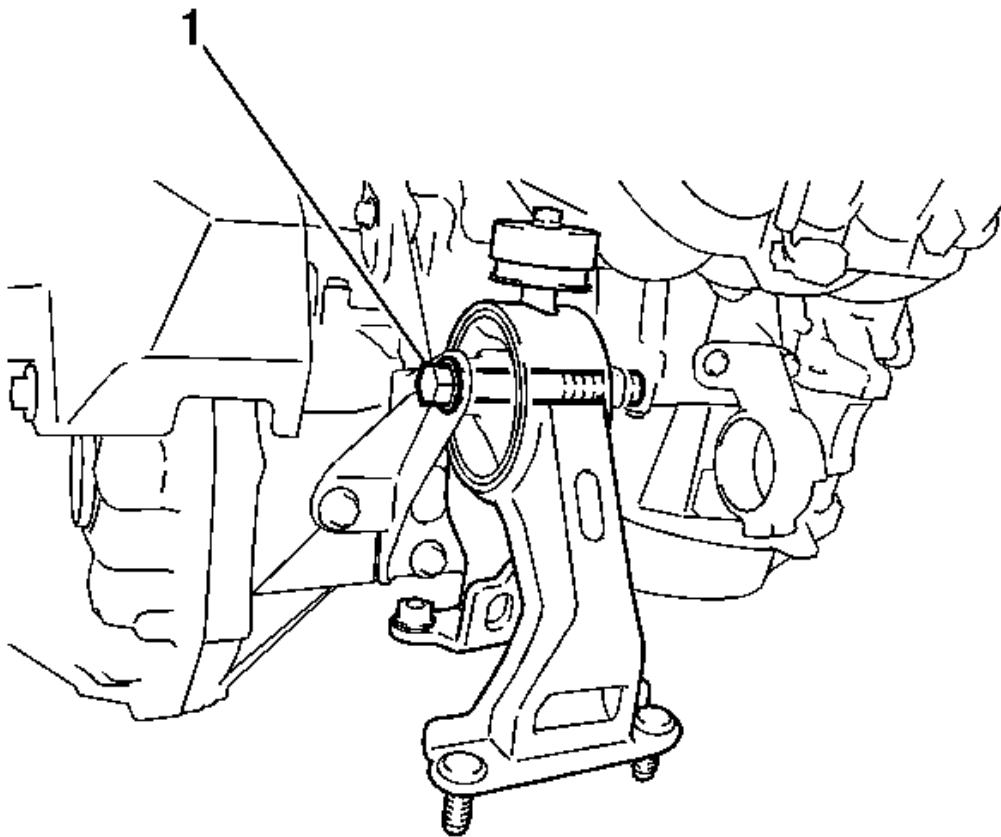


Fig. 229: Identifying Rear Engine Mounting Insulator Through Bolt
Courtesy of GENERAL MOTORS CORP.

90. Remove the through bolt and separate the rear engine mounting insulator (for 2WD).

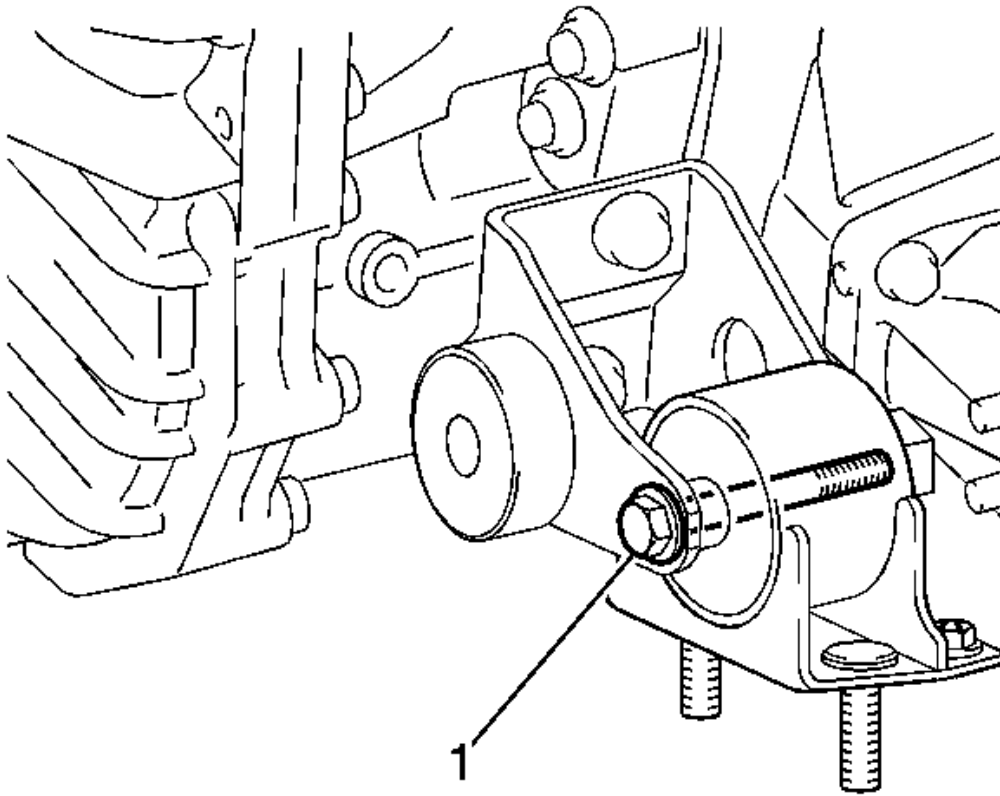


Fig. 230: Identifying Rear Engine Mounting Insulator Through Bolt - 4WD
Courtesy of GENERAL MOTORS CORP.

91. Remove the through bolt and separate the rear engine mounting insulator (for 4WD).

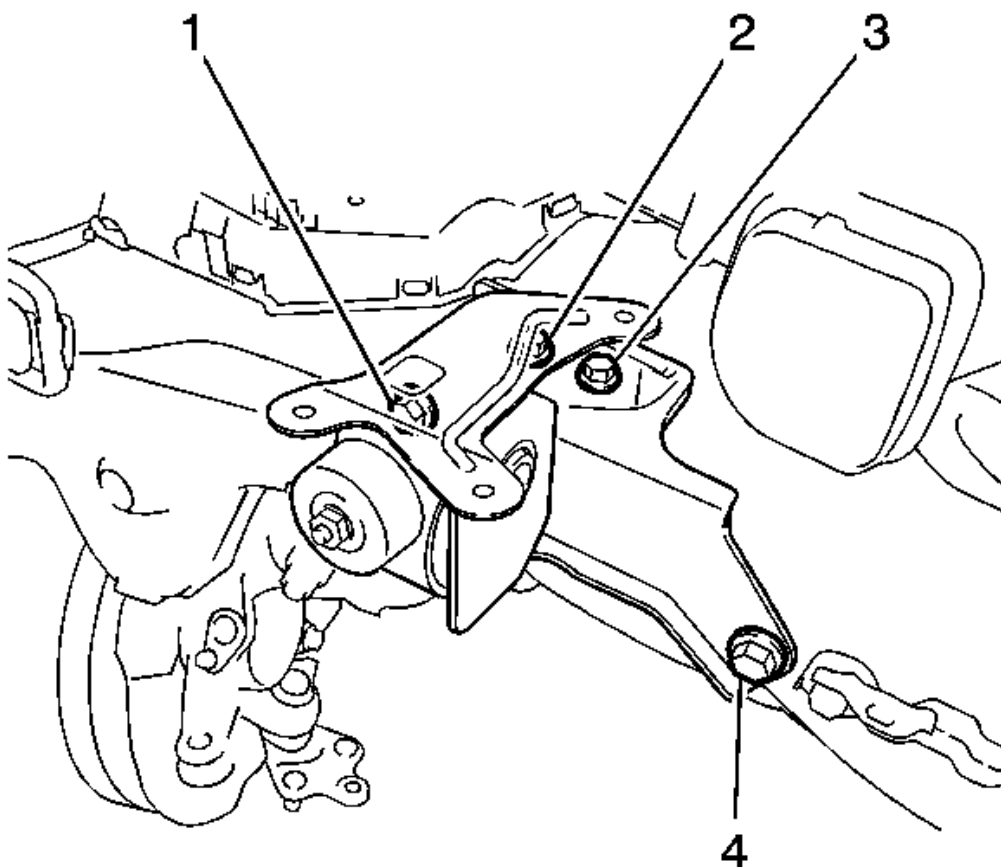


Fig. 231: Identifying Left Engine Mounting Insulator & Bolts
Courtesy of GENERAL MOTORS CORP.

92. Remove the 4 bolts and left engine mounting insulator.

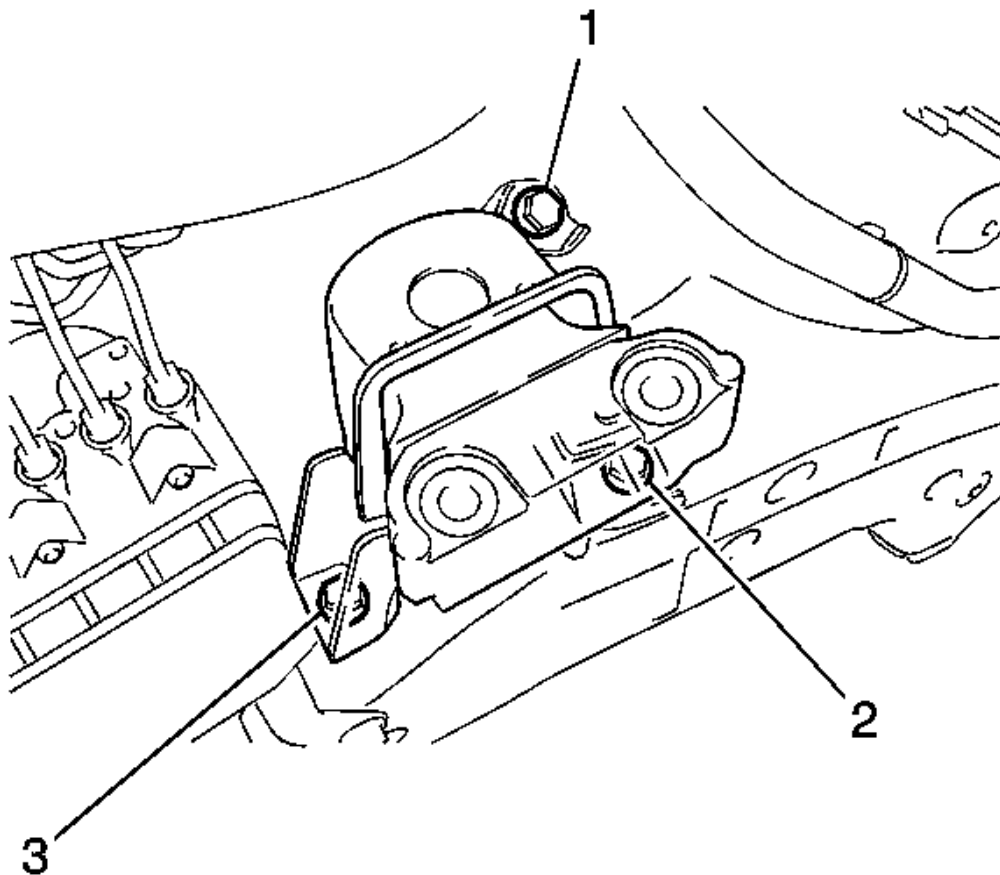


Fig. 232: Identifying Right Engine Mounting Insulator Sub-Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

93. Remove the 3 bolts and right engine mounting insulator sub-assembly.

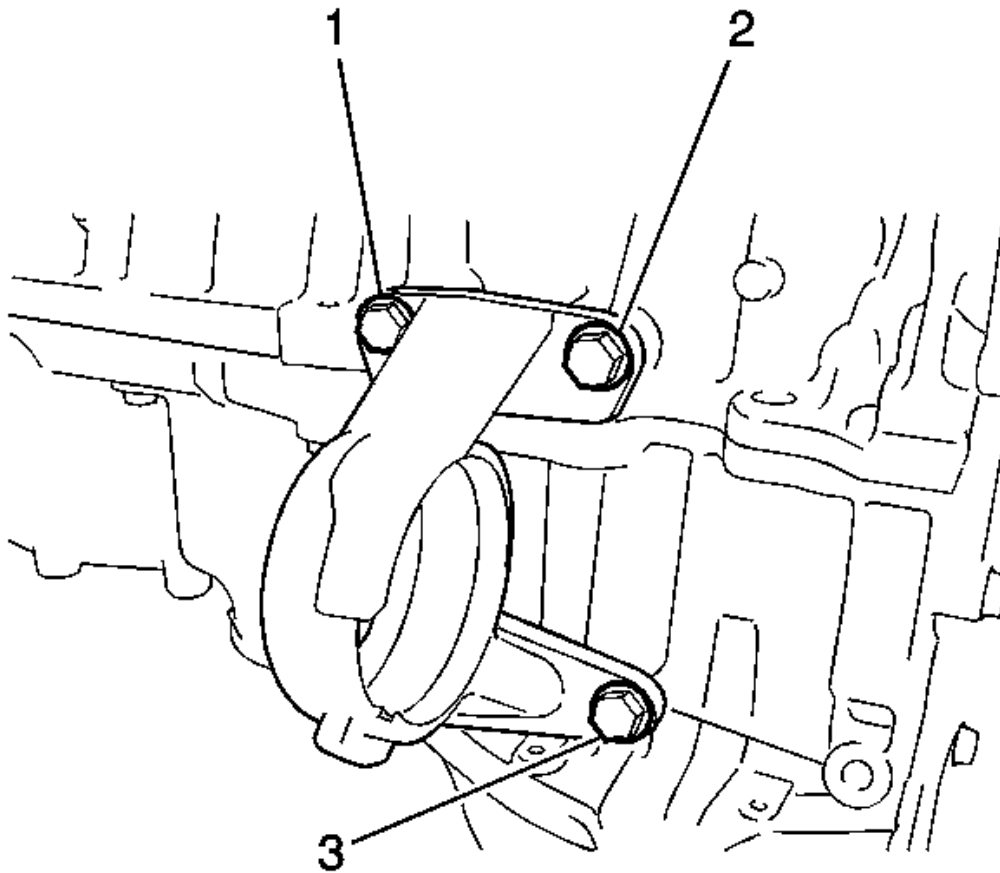


Fig. 233: Identifying Drive Shaft Bearing Bracket - 2WD)
 Courtesy of GENERAL MOTORS CORP.

94. Remove the 3 bolts and drive shaft bearing bracket (for 2wd).
95. Remove starter assembly. See **STARTER MOTOR REPLACEMENT (2.4L)** .
96. Remove starter assembly. See **STARTER MOTOR REPLACEMENT (2.4L)** .
97. Remove manual transaxle assembly.
98. Remove automatic transaxle assembly (for automatic transaxle.
99. Remove clutch cover assembly. See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
100. Remove clutch disc assembly. See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
101. Remove flywheel sub-assembly (for manual transaxle).
102. Remove drive plate and ring gear subassembly (for automatic transaxle).

2009 Pontiac Vibe

2009 ENGINE Engine Mechanical - 2.4L (LAX) - Vibe

103. Remove engine wire.

Item	Part No.
No. 1 engine hanger	12281-28010
No. 1 engine hanger	12282-28010
Bolt	91512-B1020

Installation Procedure

1. Install engine wire.
2. Install drive plate and ring gear subassembly (for automatic transaxle).
3. Install flywheel sub-assembly (for manual transaxle).
4. Install clutch disc assembly (for manual transaxle). See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
5. Install clutch cover assembly. See **CLUTCH ASSEMBLY REPLACEMENT (MVE MANUAL TRANSMISSION)** .
6. Install automatic transaxle assembly (for automatic transaxle).
7. Install manual transaxle assembly (for manual transaxle).
8. Install starter assembly (for manual transaxle). See **STARTER MOTOR REPLACEMENT (2.4L)** .
9. Install starter assembly (for automatic transaxle). See **STARTER MOTOR REPLACEMENT (2.4L)** .

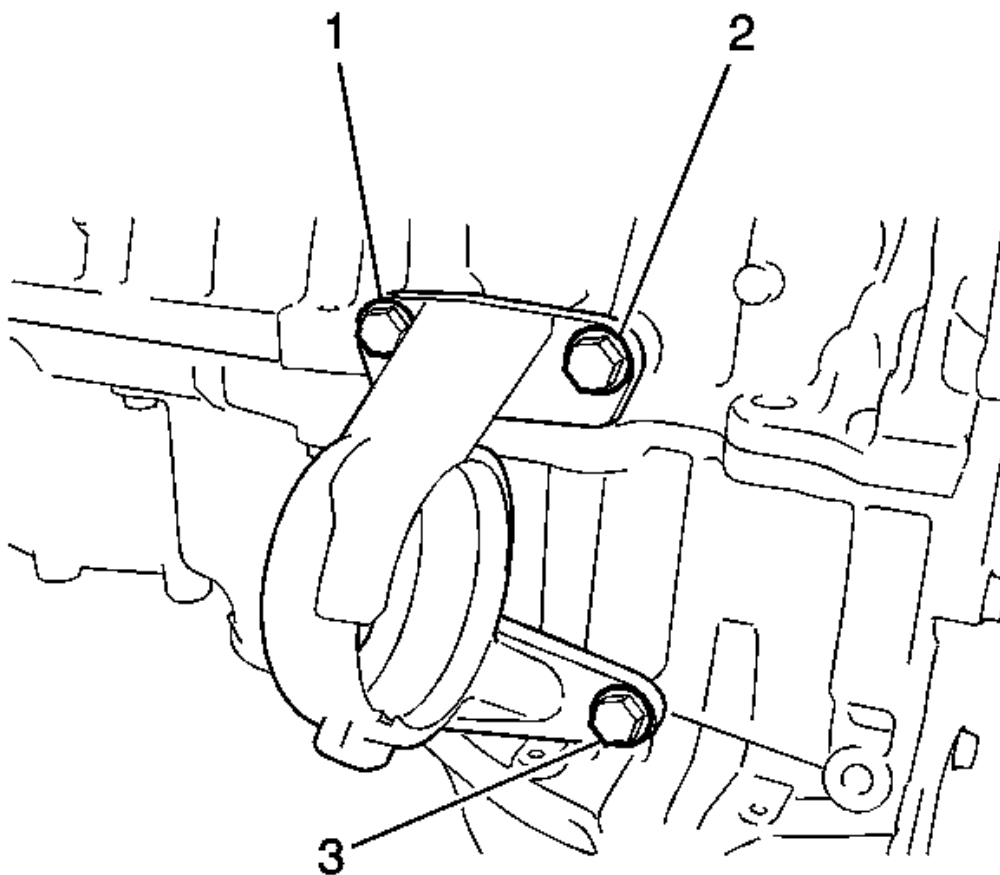


Fig. 234: Identifying Drive Shaft Bearing Bracket - 2WD)
Courtesy of GENERAL MOTORS CORP.

10. Install drive shaft bearing bracket with the 3 bolts(for 2wd).

Tighten: 64 N.m (47 lb ft)

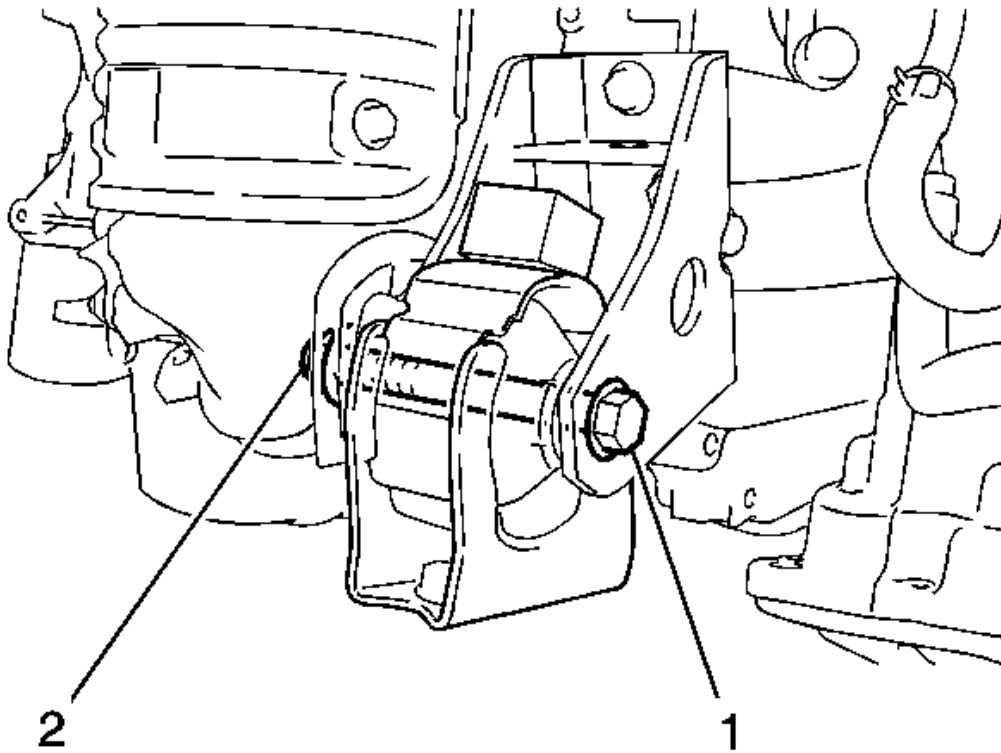


Fig. 235: Identifying Front Engine Mounting Insulator Through Bolt
Courtesy of GENERAL MOTORS CORP.

11. Temporarily tighten the front engine mounting insulator with the nut and through bolt.

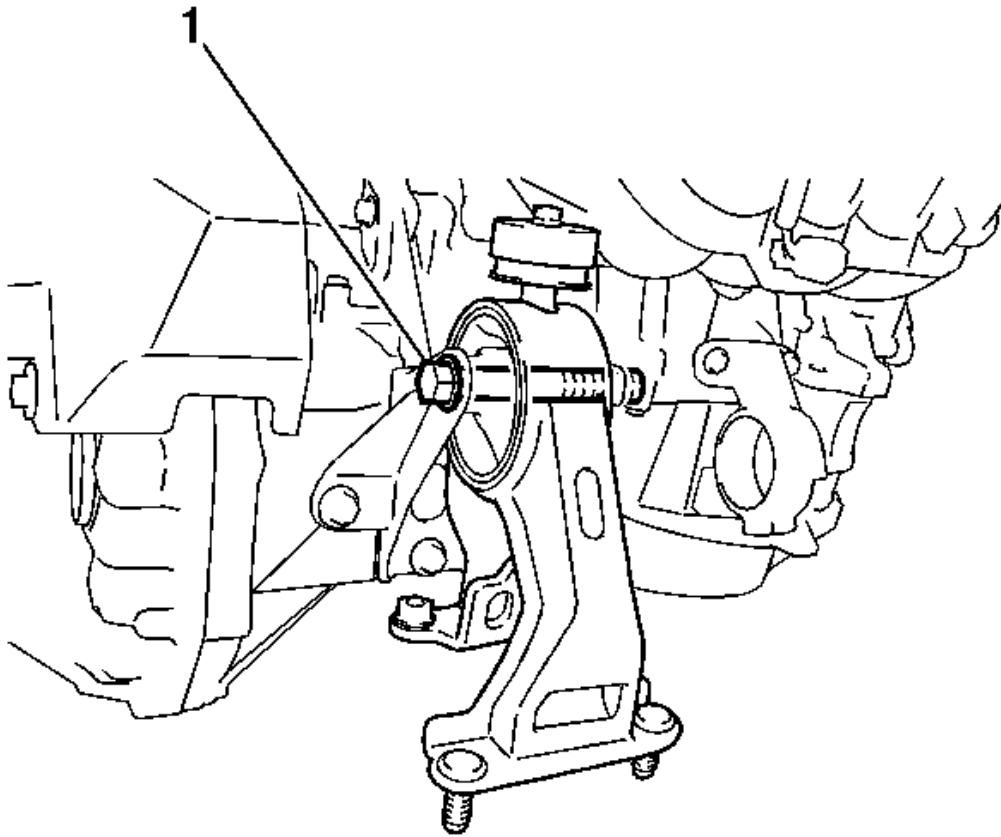


Fig. 236: Identifying Rear Engine Mounting Insulator Through Bolt
Courtesy of GENERAL MOTORS CORP.

12. Temporarily tighten the rear engine mounting insulator to the engine mounting bracket with the through bolt (for 2WD).

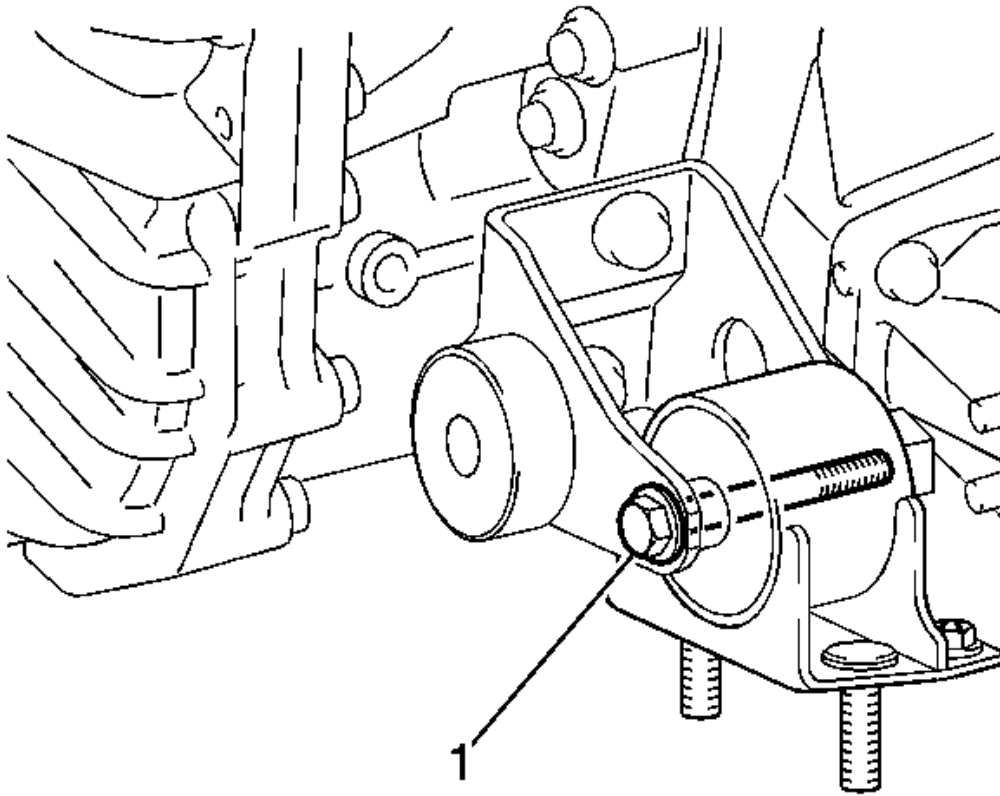


Fig. 237: Identifying Rear Engine Mounting Insulator Through Bolt - 4WD
Courtesy of GENERAL MOTORS CORP.

13. Temporarily tighten the rear engine mounting insulator to the engine mounting bracket with the through bolt (for 4WD).

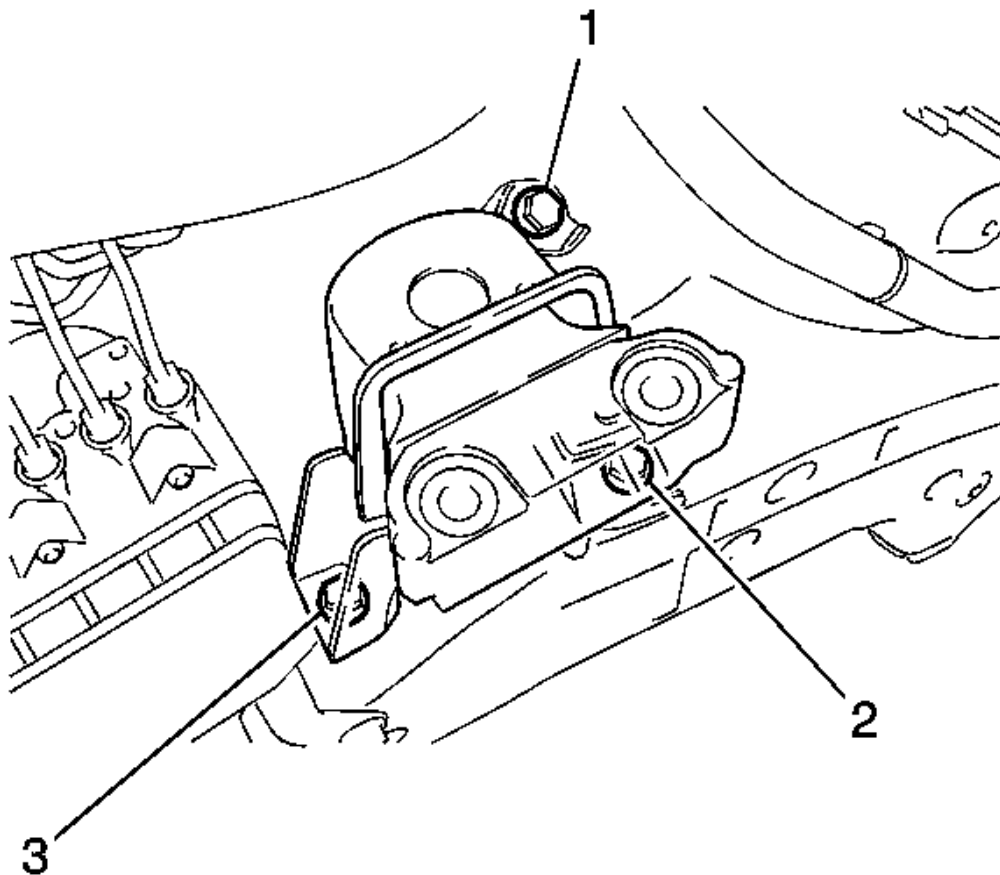


Fig. 238: Identifying Right Engine Mounting Insulator Sub-Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Install the right engine mounting insulator with the 3 bolts.

Tighten: 52 N.m (38 lb ft)

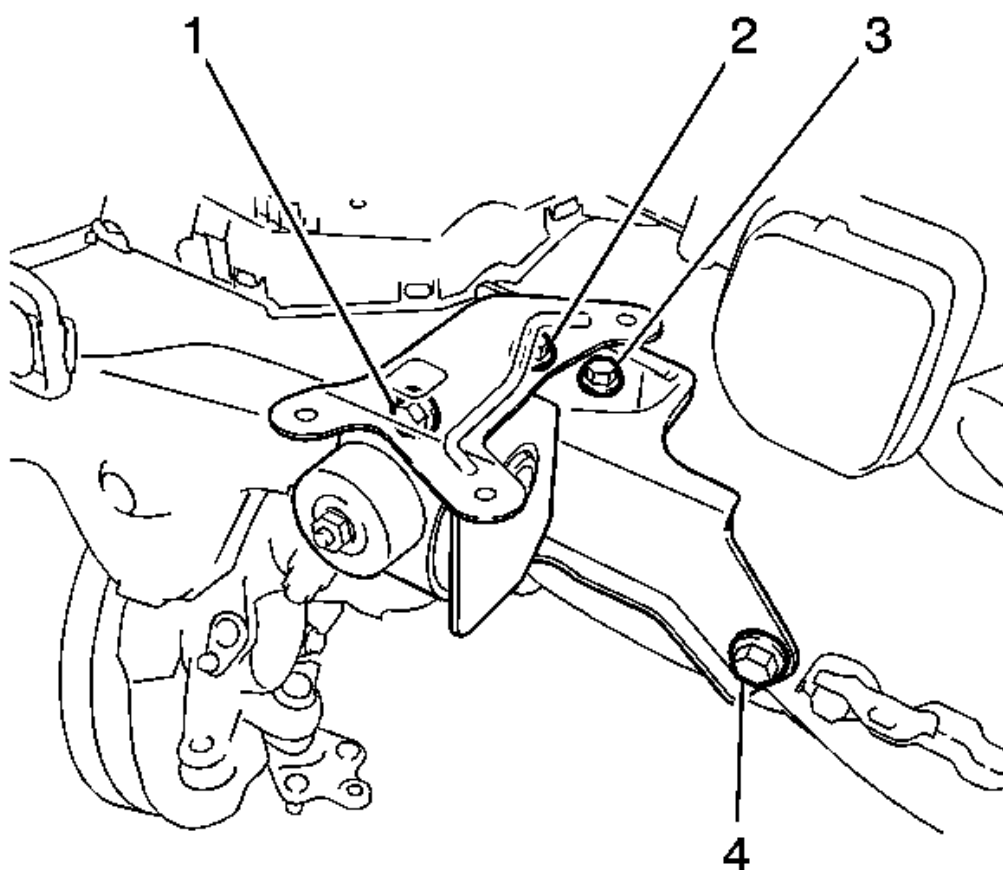


Fig. 239: Identifying Left Engine Mounting Insulator & Bolts
Courtesy of GENERAL MOTORS CORP.

15. Temporarily install the left engine mounting insulator with the 4 bolts.

IMPORTANT: Perform this procedure only when replacement of the engine mounting insulator is necessary.

16. Tighten the 4 bolts.

Tighten: 52 N.m (38 lb ft)

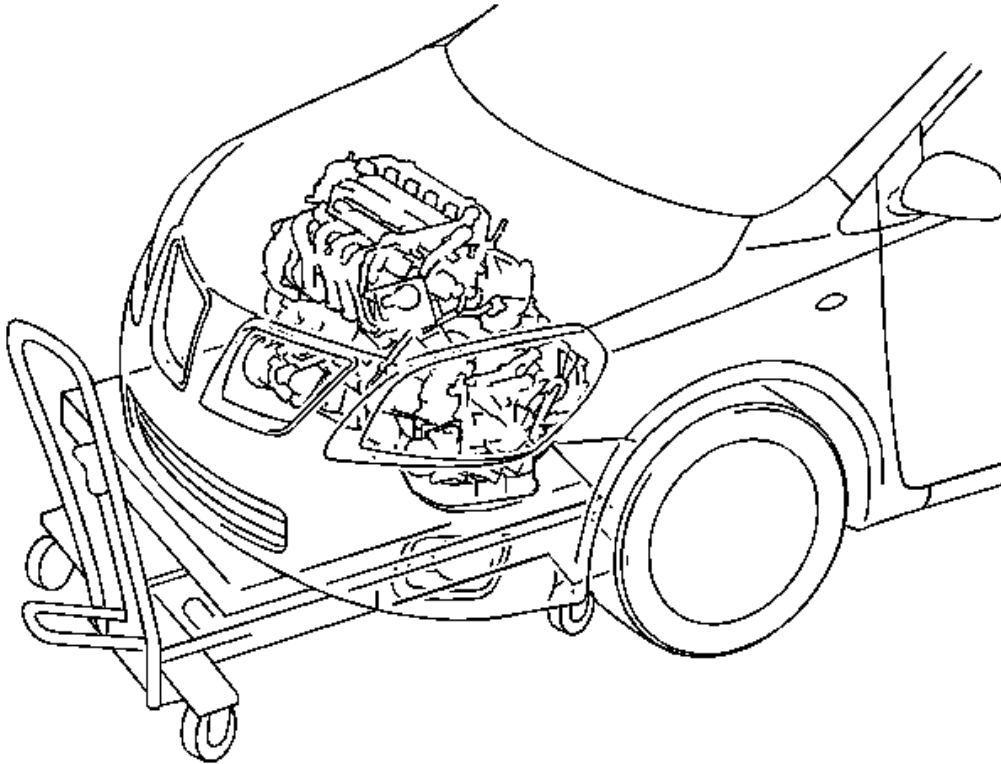


Fig. 240: View Of Engine Lifter
Courtesy of GENERAL MOTORS CORP.

17. Install engine assembly with transaxle.

NOTE: Place the engine on wooden blocks or equivalent so that the engine is level.

18. Set the engine assembly with transaxle on the engine lifter.
19. Remove the 2 bolts and 2 engine hangers.

CAUTION: Do not raise the engine more than necessary. If the engine is raised excessively, the vehicle may also be lifted up.

NOTE: Make sure that the engine is clear of all wiring and hoses. While raising the engine into the vehicle, do not allow it to contact the vehicle.

20. Operate the engine lifter and lift the engine assembly with transaxle to the position where the engine mounting insulators RH and LH can be installed.

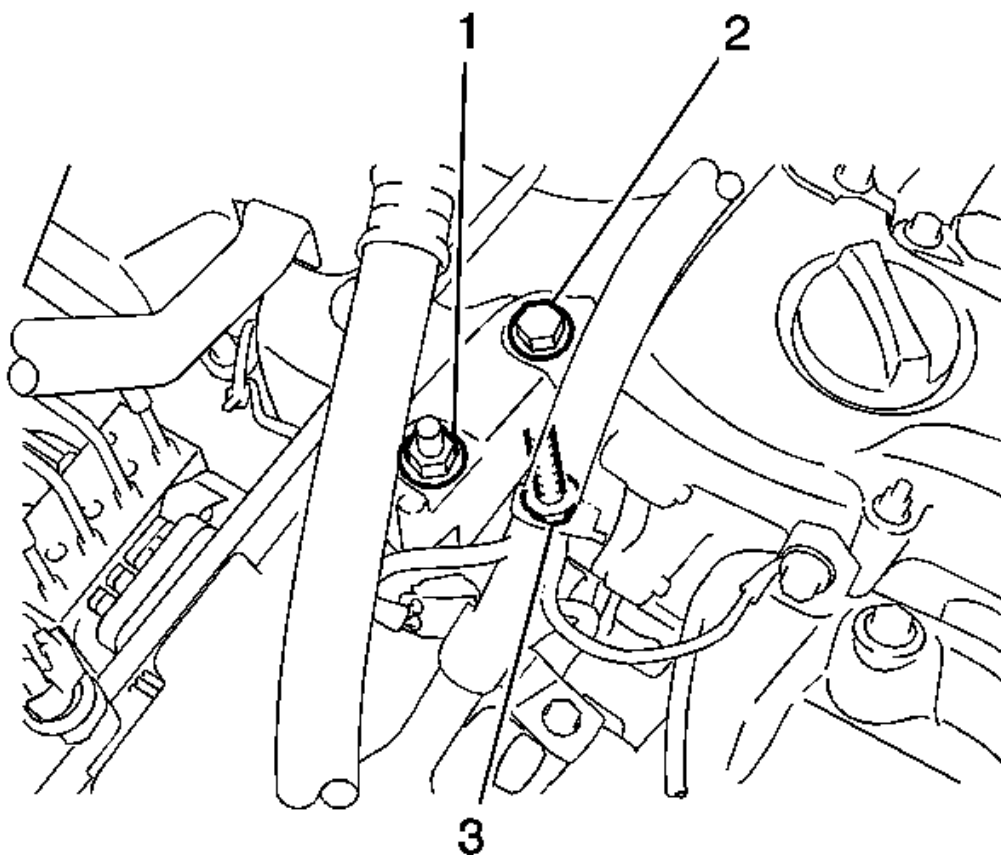


Fig. 241: View Of Right Engine Mounting Insulator, Bolt & Nuts
Courtesy of GENERAL MOTORS CORP.

21. Install the right engine mounting insulator with the bolt and 2 nuts.

Tighten:

- Nut A 95 N.m (70 lb ft)
- Nut B 52 N.m (38 lb ft)
- Bolt 95 N.m (70 lb ft)

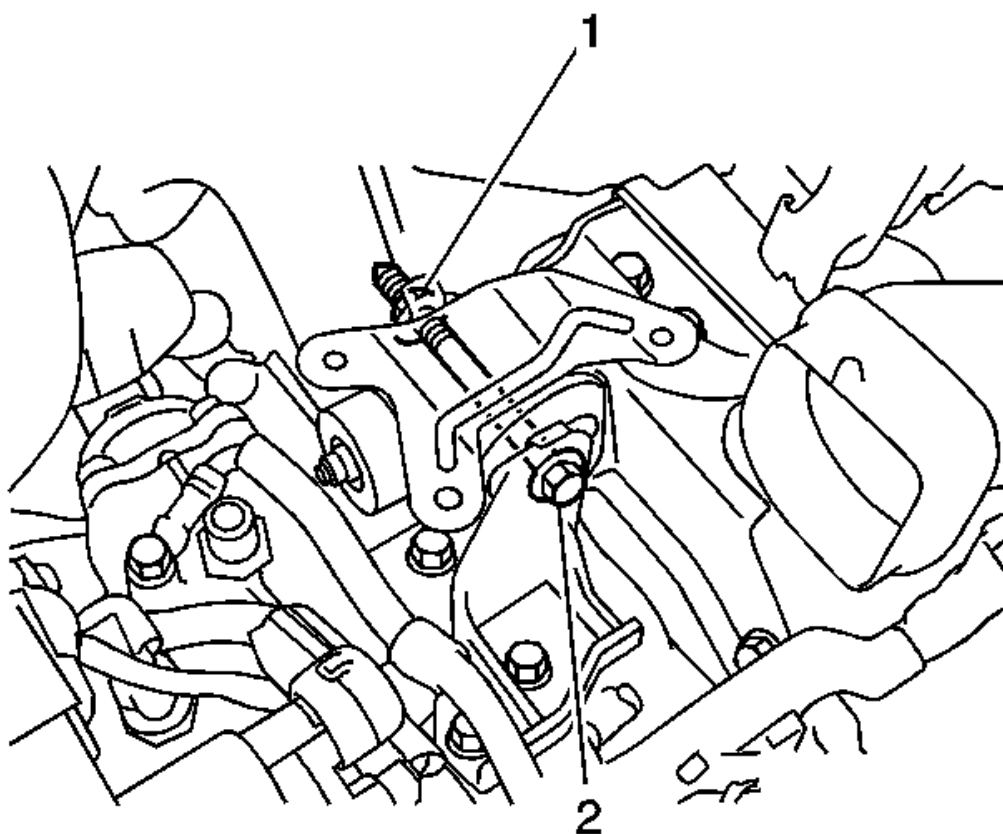


Fig. 242: Identifying Left Engine Mounting Insulator
Courtesy of GENERAL MOTORS CORP.

22. Install the engine mounting insulator LH with the through bolt and nut.

Tighten: 56 N.m (41 lb ft)

23. Temporarily tighten center engine mounting member sub-assembly.
24. Install front suspension crossmember sub-assembly.
25. Fully tighten center engine mounting member sub-assembly.

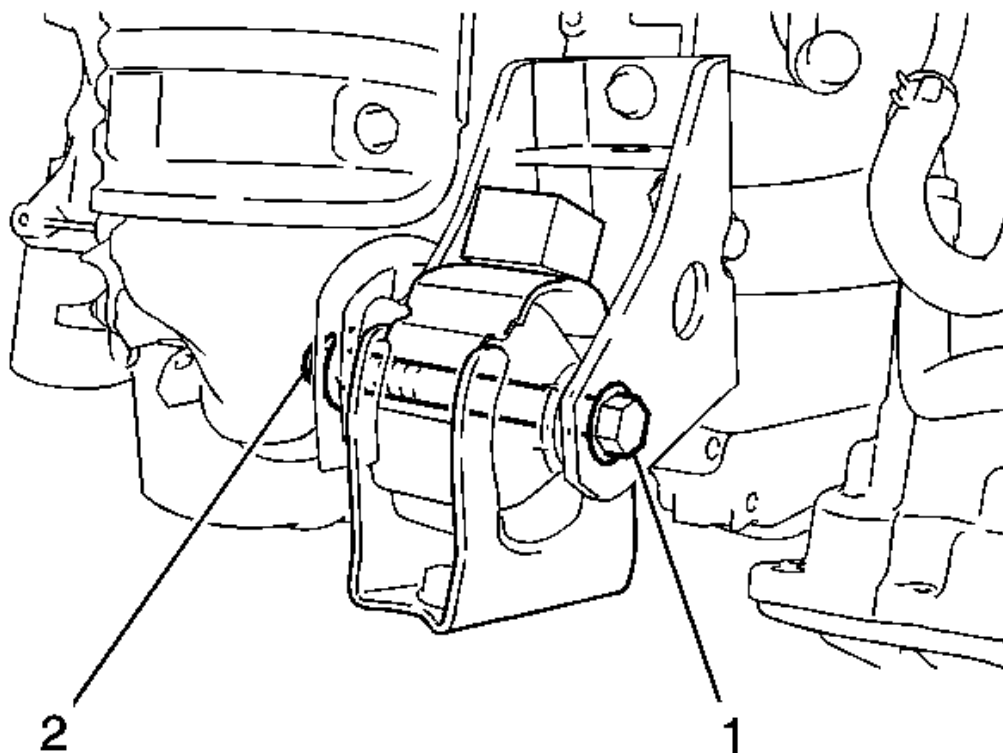


Fig. 243: Identifying Front Engine Mounting Insulator Through Bolt
Courtesy of GENERAL MOTORS CORP.

26. Fully tighten front engine mounting insulator with the nut and through bolt.

Tighten: 73 N.m (53 lb ft)

27. Fully tighten the rear engine mounting insulator to the engine mounting bracket with the through bolt (for 2wd).

Tighten: 65 N.m (48 lb ft)

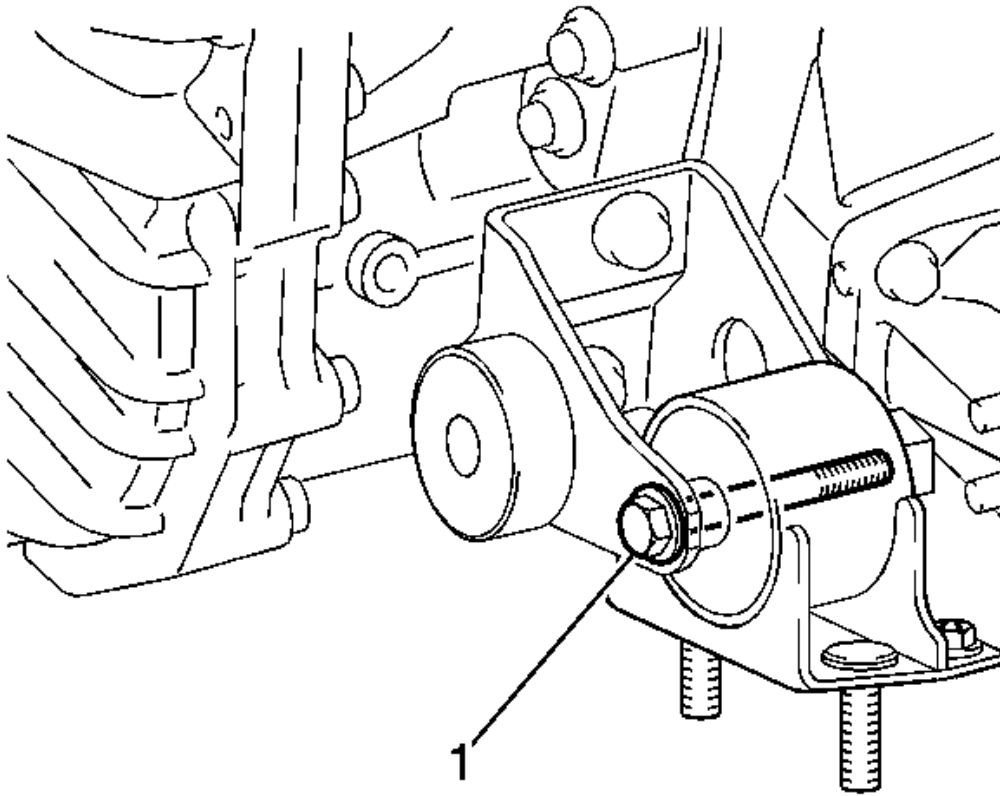


Fig. 244: Identifying Rear Engine Mounting Insulator Through Bolt - 4WD
 Courtesy of GENERAL MOTORS CORP.

28. Fully tighten the rear engine mounting insulator to the engine mounting bracket with the through bolt (for 4WD).

Tighten: 65 N.m (48 lb ft)

29. Install drive plate and torque converter clutch setting bolt (for automatic transaxle).
30. Install left front drive shaft hole snap ring.
31. Install left front drive shaft assembly.
32. Install right front drive shaft assembly (for 2wd).
33. Install right front drive shaft assembly.

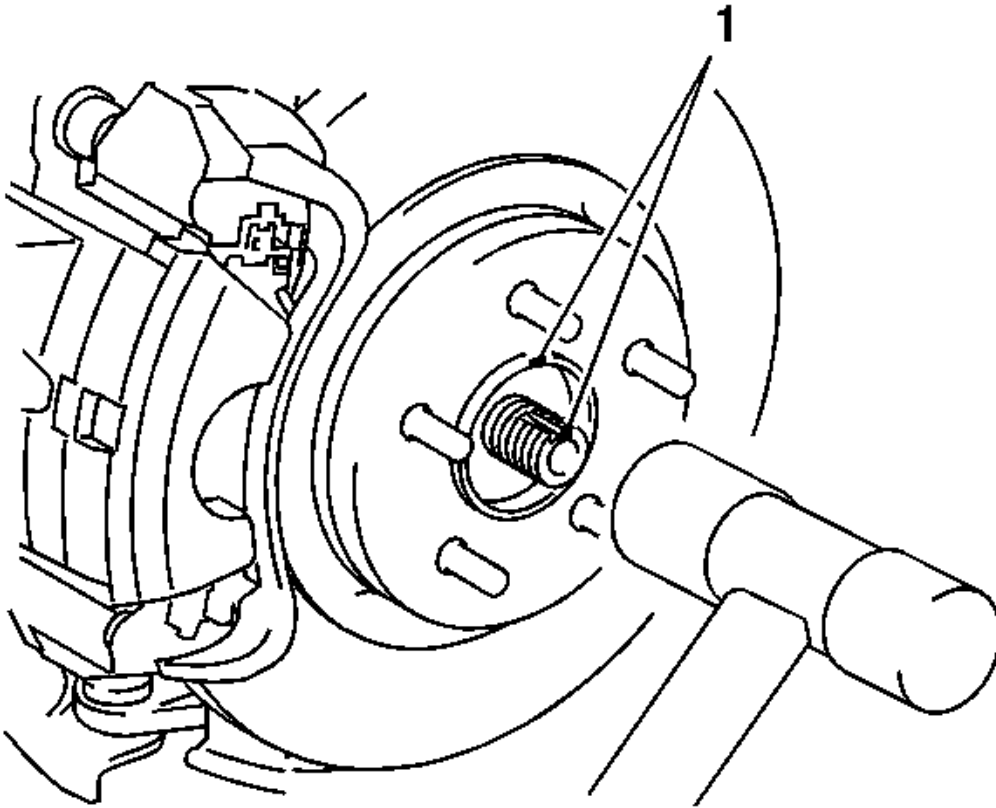


Fig. 245: View Of Axle Hub

Courtesy of GENERAL MOTORS CORP.

34. Install left steering knuckle with axle hub.
35. Align the matchmarks and connect the left front drive shaft assembly to the front axle assembly.

IMPORTANT: Perform the same procedure for the left side.

36. Install right steering knuckle with axle hub.
37. Install left front lower No. 1 suspension arm sub-assembly.

IMPORTANT: Perform the same procedure for the left side.

38. Install right front lower No. 1 suspension arm sub-assembly.
39. Install left front stabilizer link assembly.

IMPORTANT: Perform the same procedure for the left side.

- 40. Install right front stabilizer link assembly.
- 41. Install left tie rod end sub-assembly.

IMPORTANT: Perform the same procedure for the left side.

- 42. Install right tie rod end sub-assembly.
- 43. Install left front speed sensor.

IMPORTANT: Perform the same procedure for the left side.

- 44. Install right front speed sensor.
- 45. Install left front axle shaft nut.

IMPORTANT: Perform the same procedure for the left side.

- 46. Install right front axle shaft nut
- 47. Temporarily tighten propeller with center bearing shaft assembly (for 4WD).
- 48. Fully tighten propeller with center bearing shaft assembly (for 4WD).
- 49. Install front exhaust pipe assembly. See **EXHAUST PIPE REPLACEMENT (2.4L AWD)** .
- 50. Install center exhaust pipe assembly. See **EXHAUST PIPE REPLACEMENT (2.4L AWD)** .
- 51. Install No. 1 steering column hole cover sub-assembly.
- 52. Install No. 2 steering intermediate shaft assembly.
- 53. Install column hole cover silencer sheet.

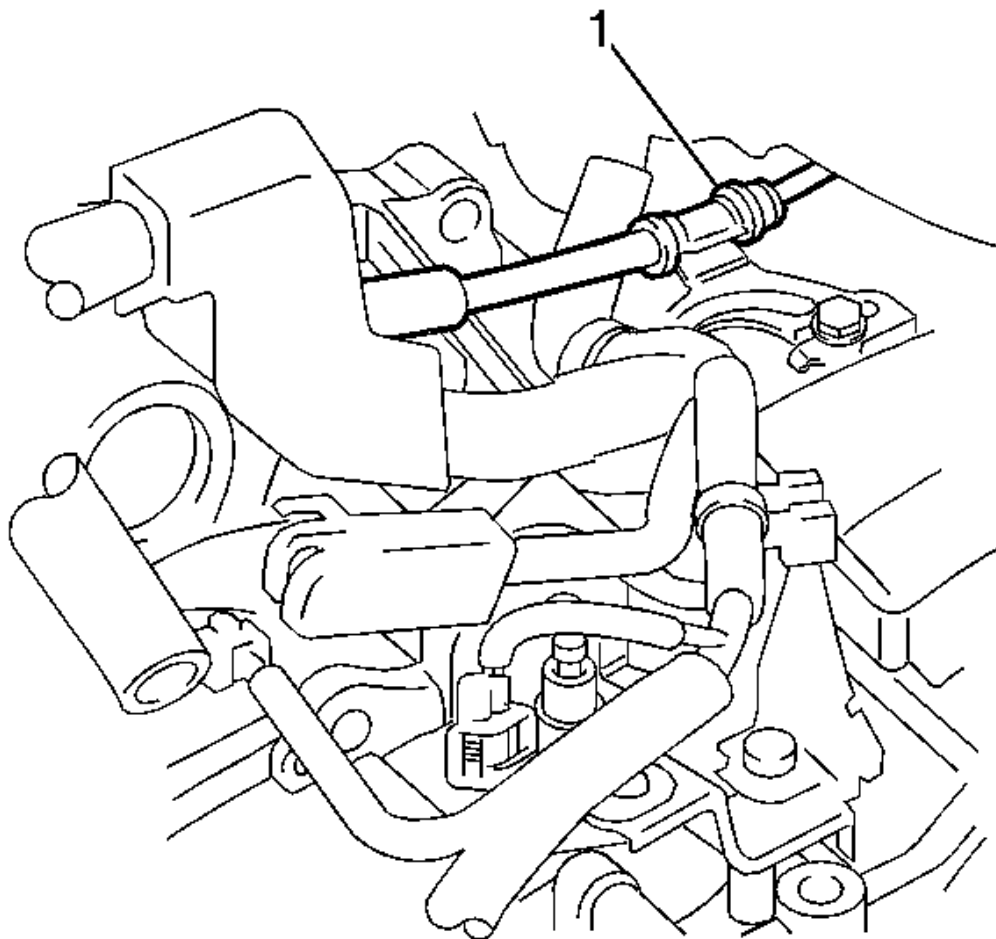


Fig. 246: Identifying Control Cable Assembly & Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

54. U250e automatic transaxle-Connect the transmission control cable to the control cable bracket.

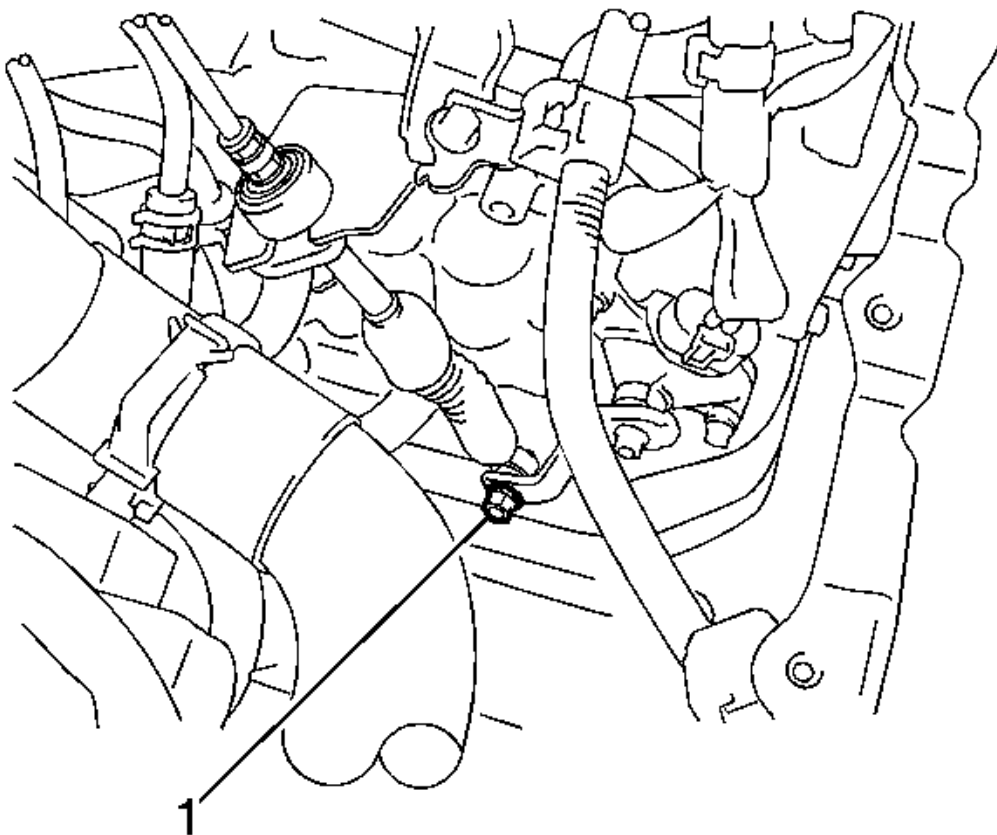


Fig. 247: Identifying Automatic Transaxle Control Cable Assembly & Control Shaft Lever
Courtesy of GENERAL MOTORS CORP.

55. Connect the transmission control cable to the bracket with a new clip.
56. Connect the transmission control cable assembly to the control shaft lever with the nut.

Tighten: 12 N.m (9 lb ft)

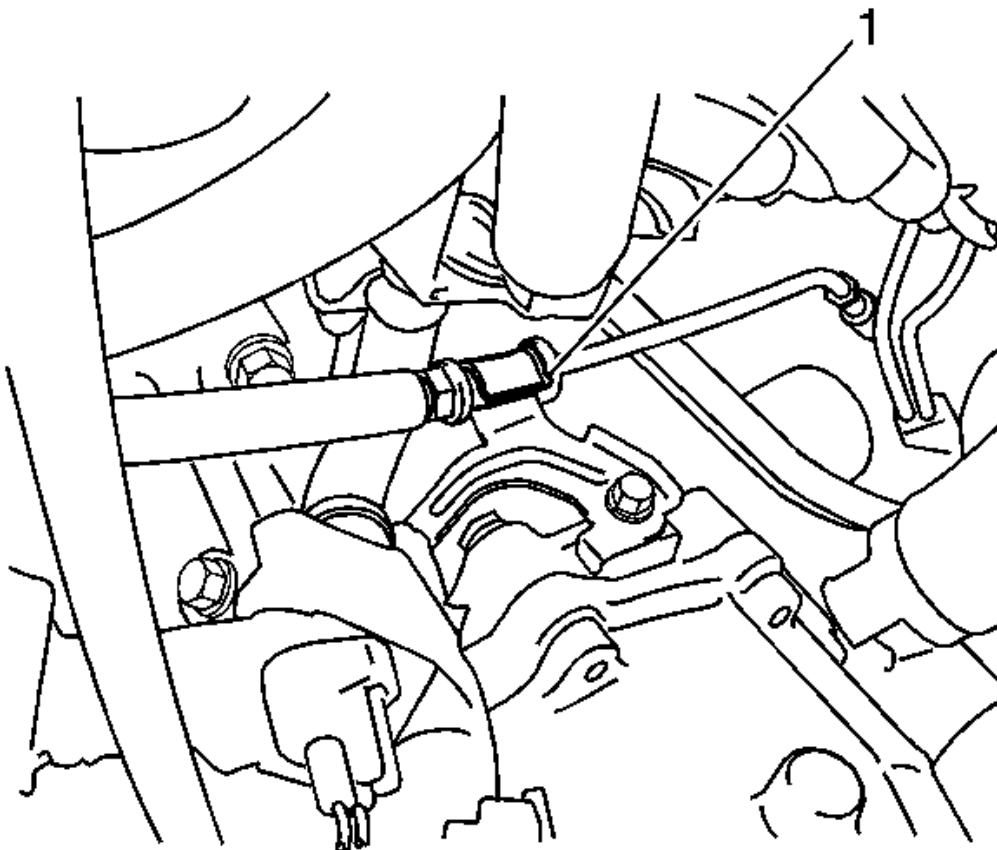


Fig. 248: Identifying Control Cable Bracket
Courtesy of GENERAL MOTORS CORP.

57. U140F Automatic Transaxle-Connect the transmission control cable to the control cable bracket.

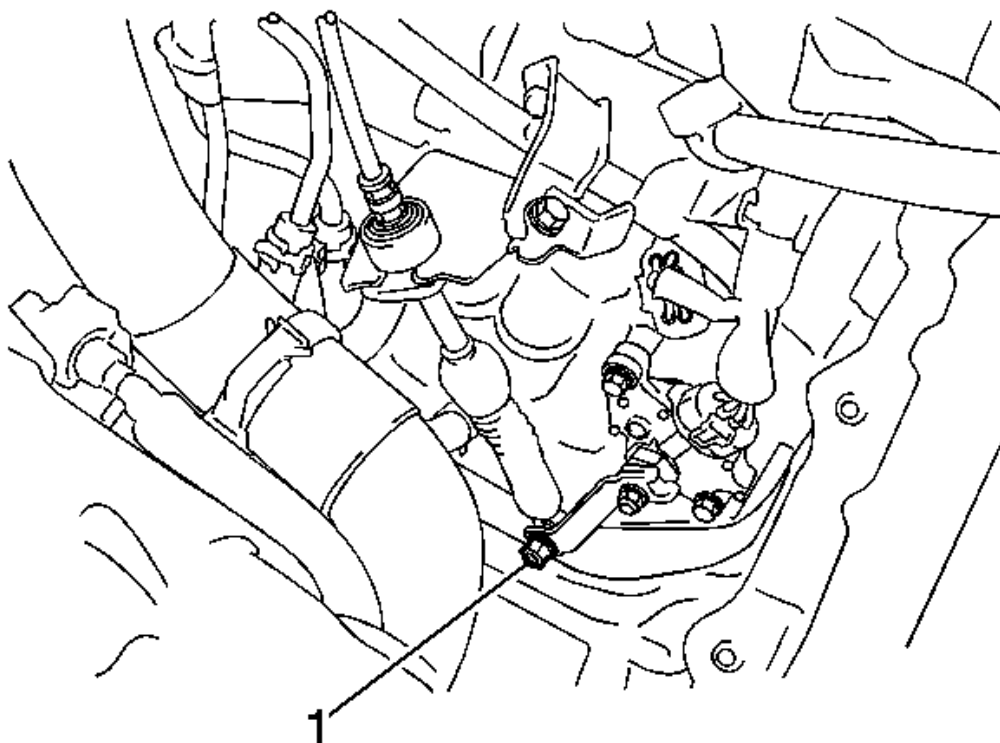


Fig. 249: Identifying Control Cable Assembly, Control Shaft Lever & Nut
Courtesy of GENERAL MOTORS CORP.

58. Connect the transmission control cable to the bracket with a new clip.
59. Connect the transmission control cable assembly to the control shaft lever with the nut.

Tighten: 12 N.m (9 lb ft)

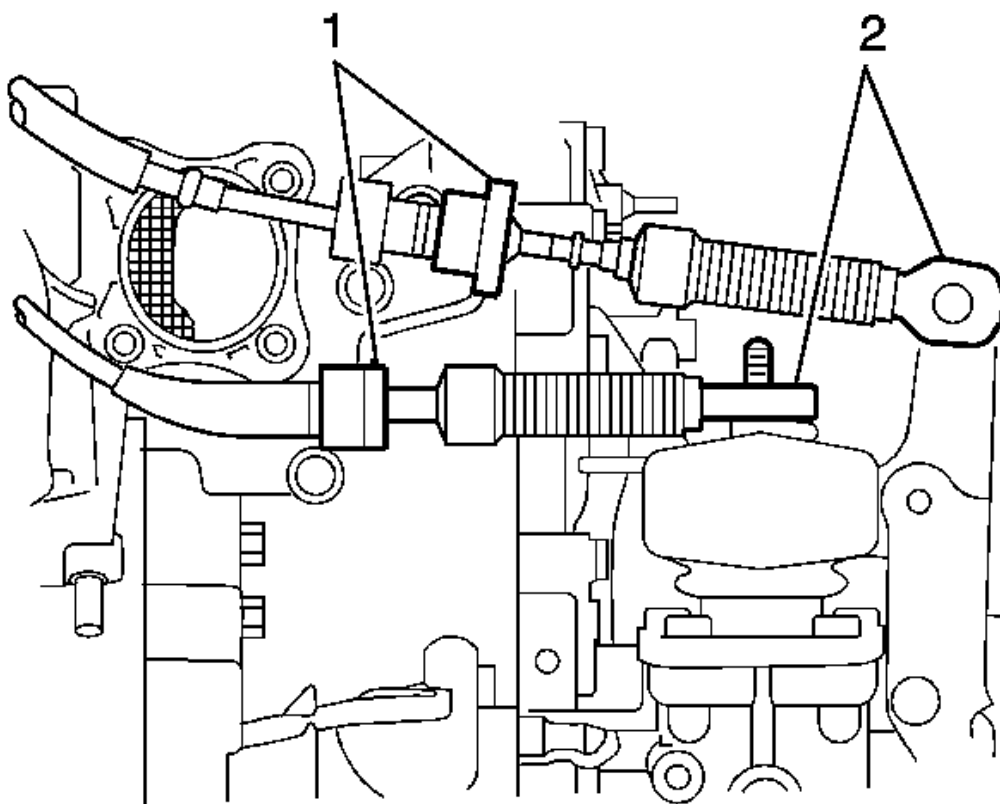


Fig. 250: Identifying Manual Transaxle Transmission Control Cables
Courtesy of GENERAL MOTORS CORP.

60. E351 Manual Transaxle-Install the 2 transmission control cables to the control cable bracket with 2 new clips*1.
61. Install the 2 transmission control cables to the transaxle with 2 new clips 2.
62. Install clutch release cylinder assembly.

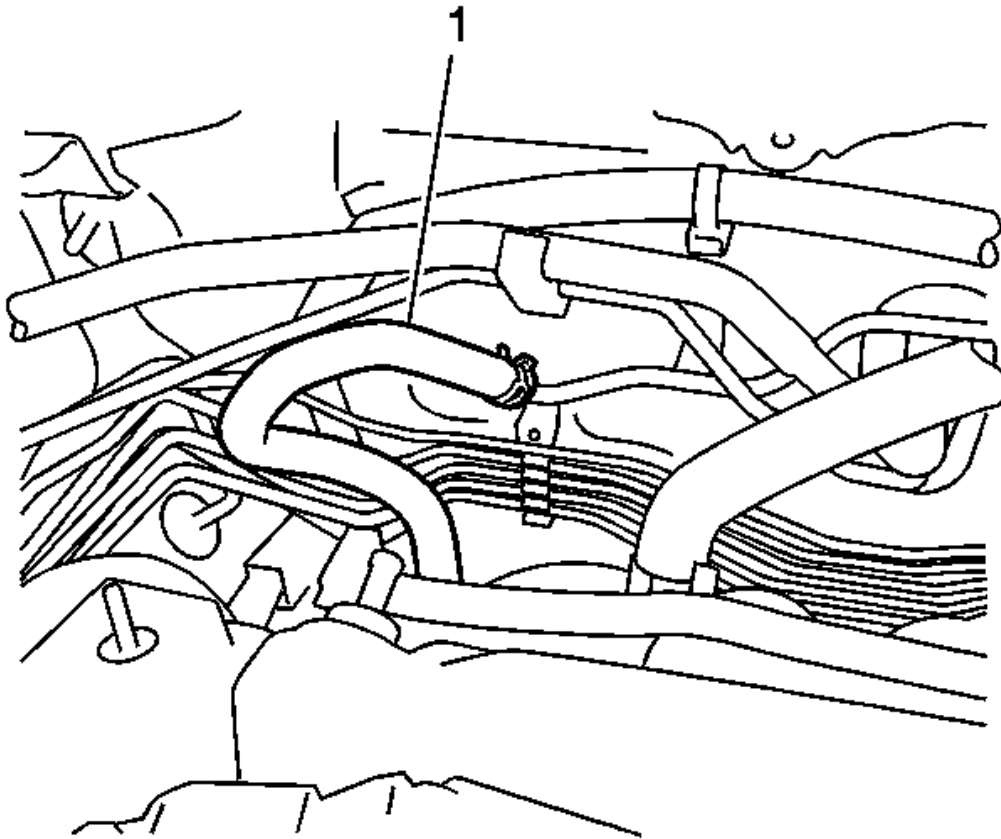


Fig. 251: Identifying Connector Tube Hose Union
Courtesy of GENERAL MOTORS CORP.

63. Connect the union to connector tube hose.

CAUTION: Align the fuel tube connector with the pipe, then push the fuel tube connector in until the retainer makes a click sound. If the connection is tight, apply a small amount of engine oil to the tip of the pipe. After connecting, pull the pipe and connector to make sure that they are securely connected.

64. Connect the fuel tube connector and fuel pipe.

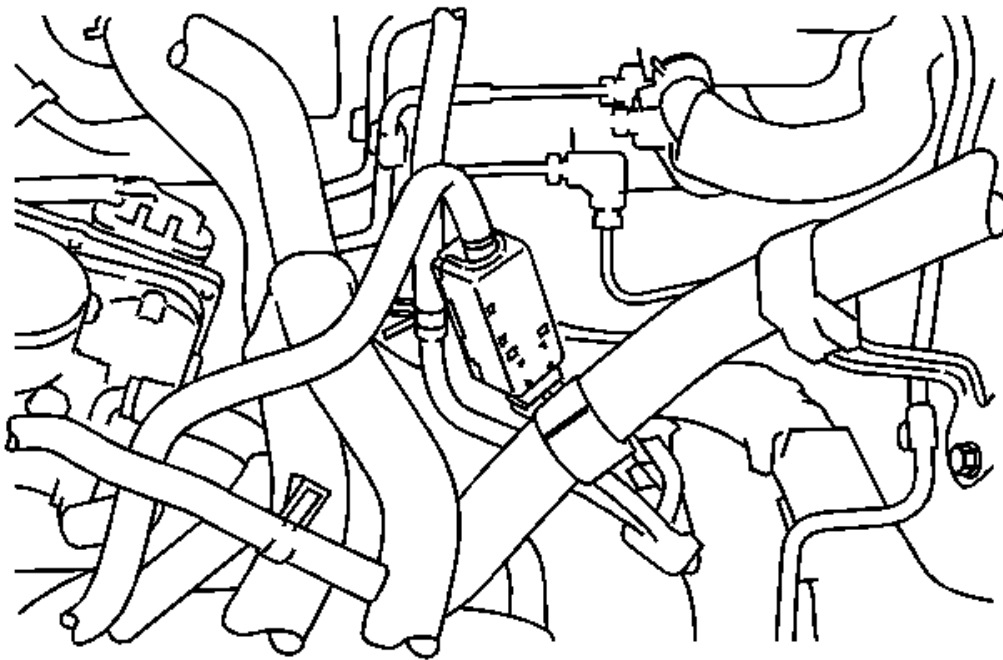


Fig. 252: Identifying Fuel Pipe Clamp
Courtesy of GENERAL MOTORS CORP.

65. Engage the claw and install the No. 1 fuel pipe clamp.

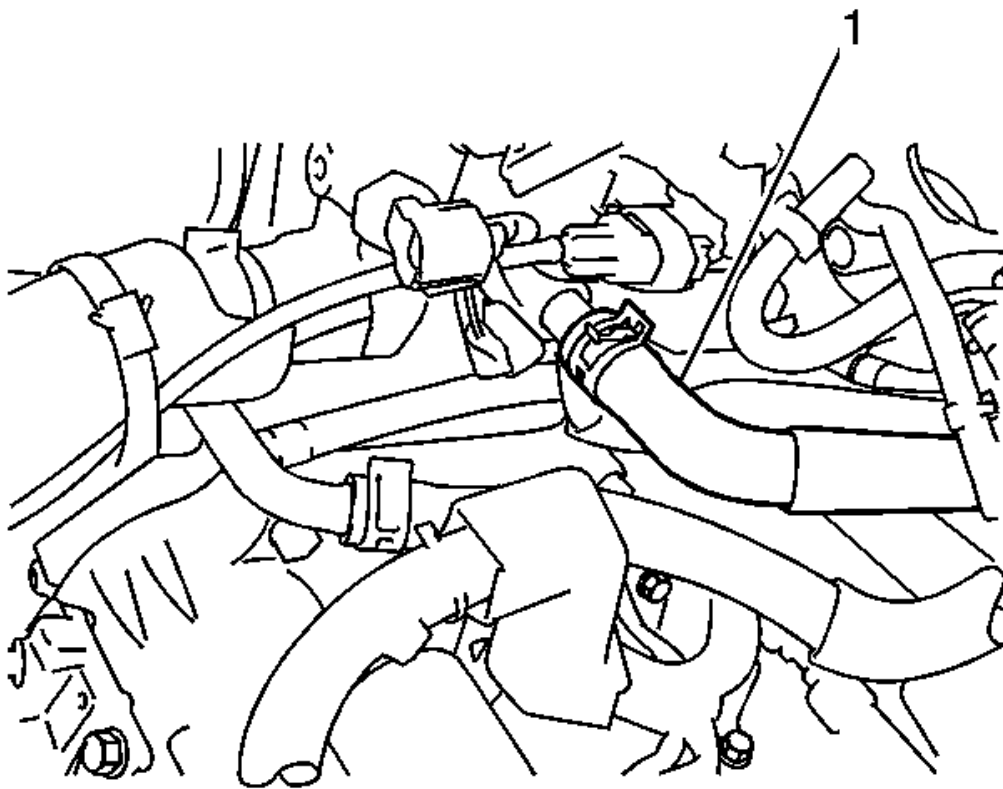


Fig. 253: Identifying Heater Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

66. Connect the inlet heater water hose with the clamp.



Fig. 254: View Of Heater Water Outlet Hose
Courtesy of GENERAL MOTORS CORP.

67. Connect the outlet heater water hose with the clamp.
68. Install breather hose.

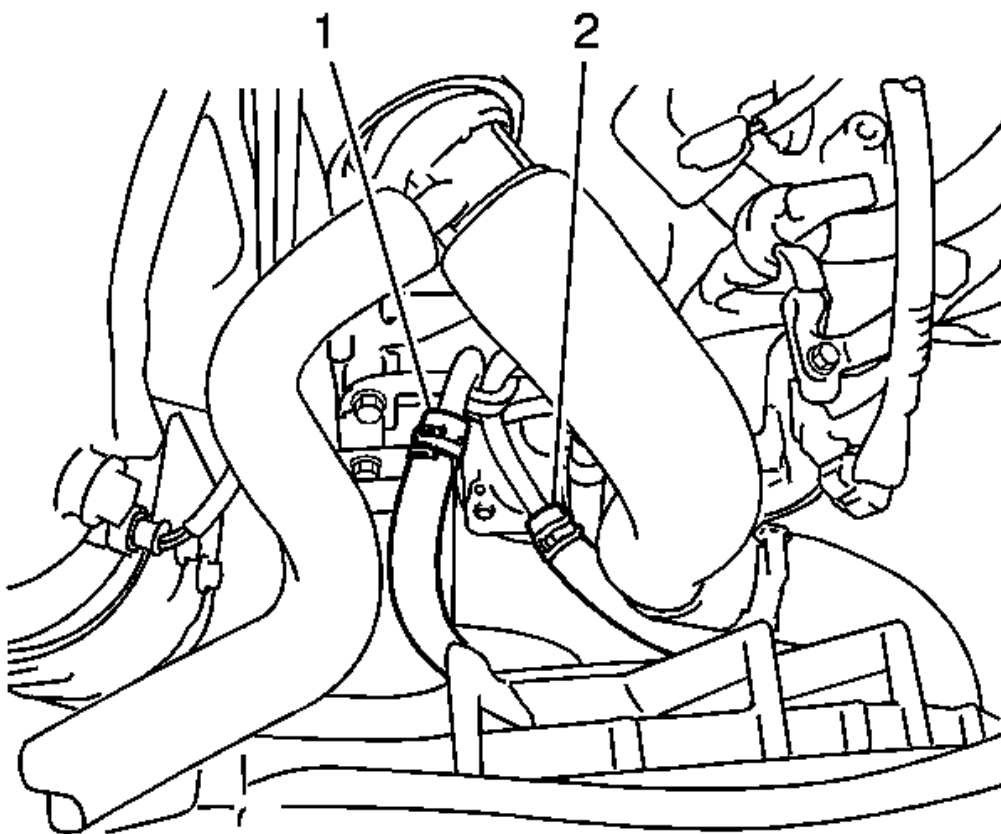


Fig. 255: View Of Oil Cooler Hoses - Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

69. Connect the 2 oil cooler hoses with the clamps (for Automatic Transaxle).

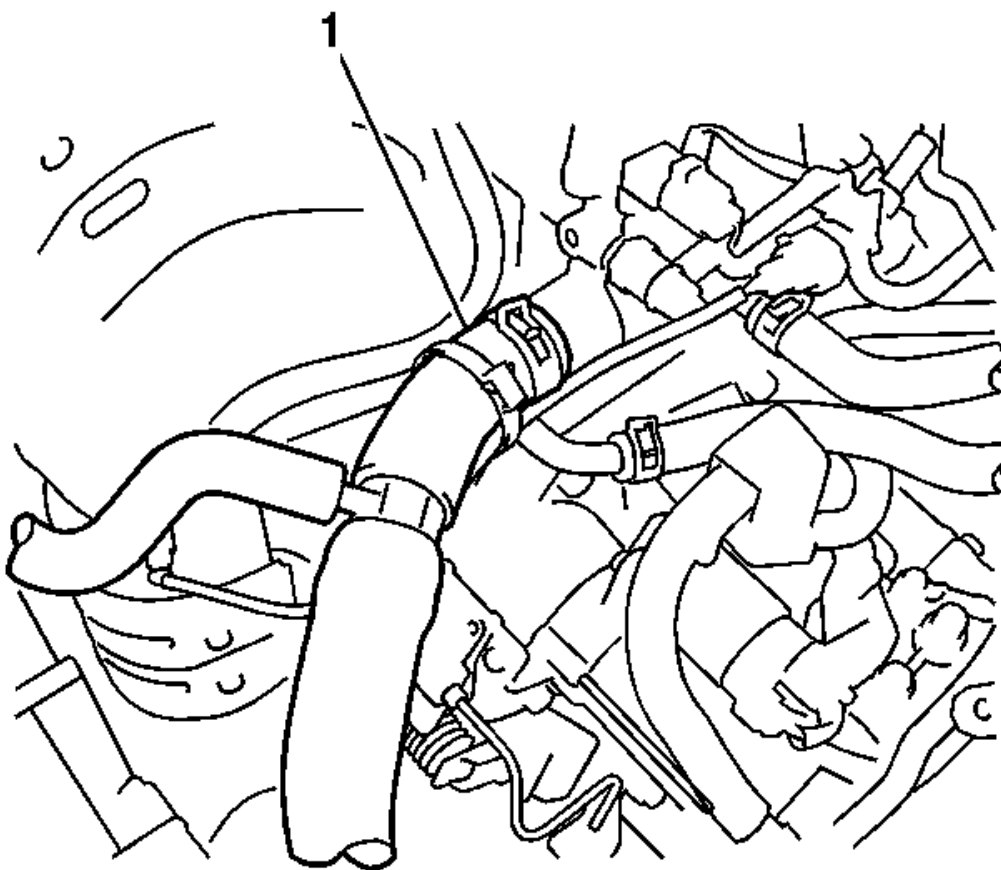


Fig. 256: View Of Upper Radiator Hose At Cylinder Head
Courtesy of GENERAL MOTORS CORP.

70. Install No. 1 radiator hose.
71. Connect the No. 1 radiator hose with the clamp.

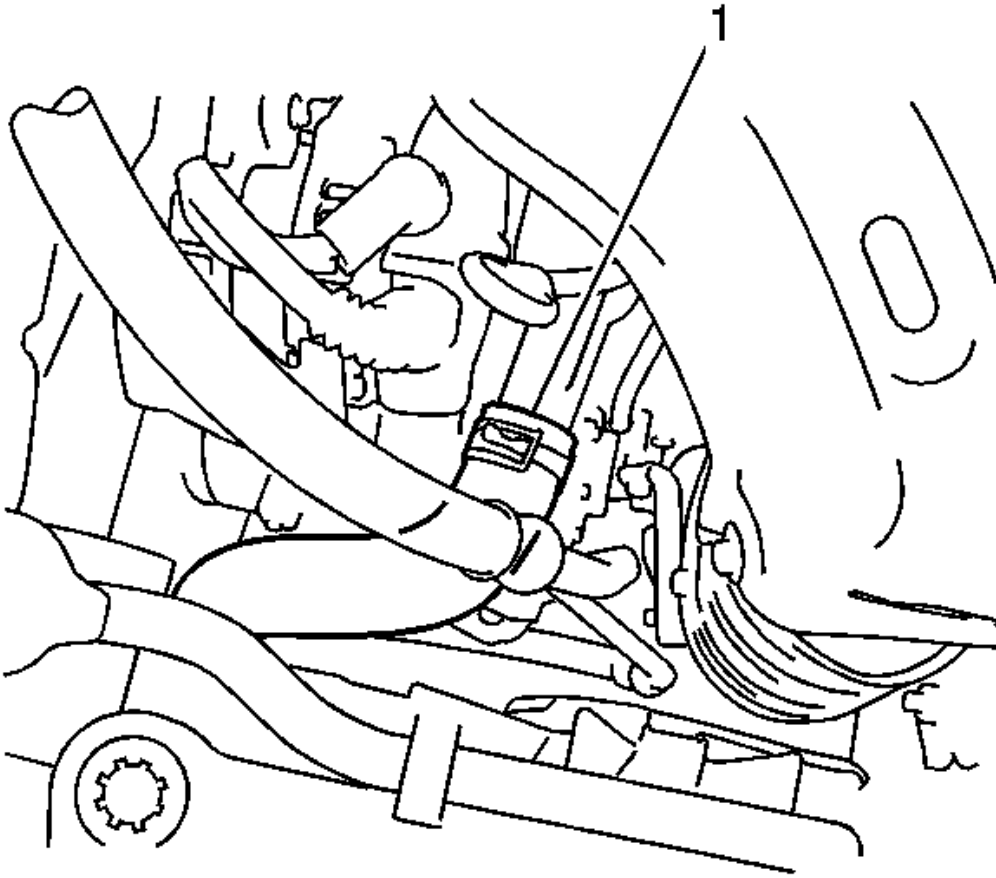


Fig. 257: Locating Upper Radiator Hose
Courtesy of GENERAL MOTORS CORP.

72. Install No. 2 radiator hose.
73. Connect the No. 2 radiator hose with the clamp.
74. Install compressor assembly with pulley (with air. See **AIR CONDITIONING COMPRESSOR REPLACEMENT (2.4L (LAX))**).
75. Install generator assembly. See **GENERATOR REPLACEMENT (2.4L)**.
76. Install V-ribbed belt. See **Drive Belt Replacement**.
77. Install throttle body assembly. See **THROTTLE BODY ASSEMBLY REPLACEMENT**.

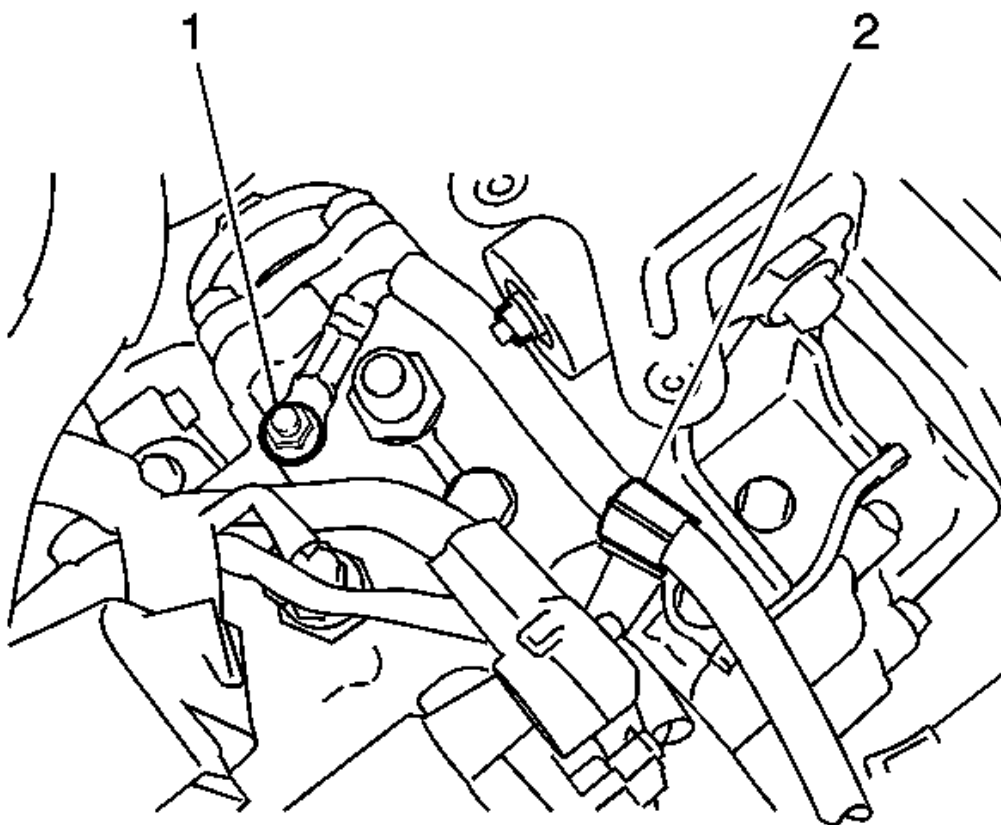


Fig. 258: Identifying Clamp & Ground Cable - Manual Transaxle
Courtesy of GENERAL MOTORS CORP.

78. Install wire harness.
79. Install the ground cable to the engine compartment wire with the bolt and clamp (for Manual Transaxle).

Tighten: 13 N.m (10 lb ft)

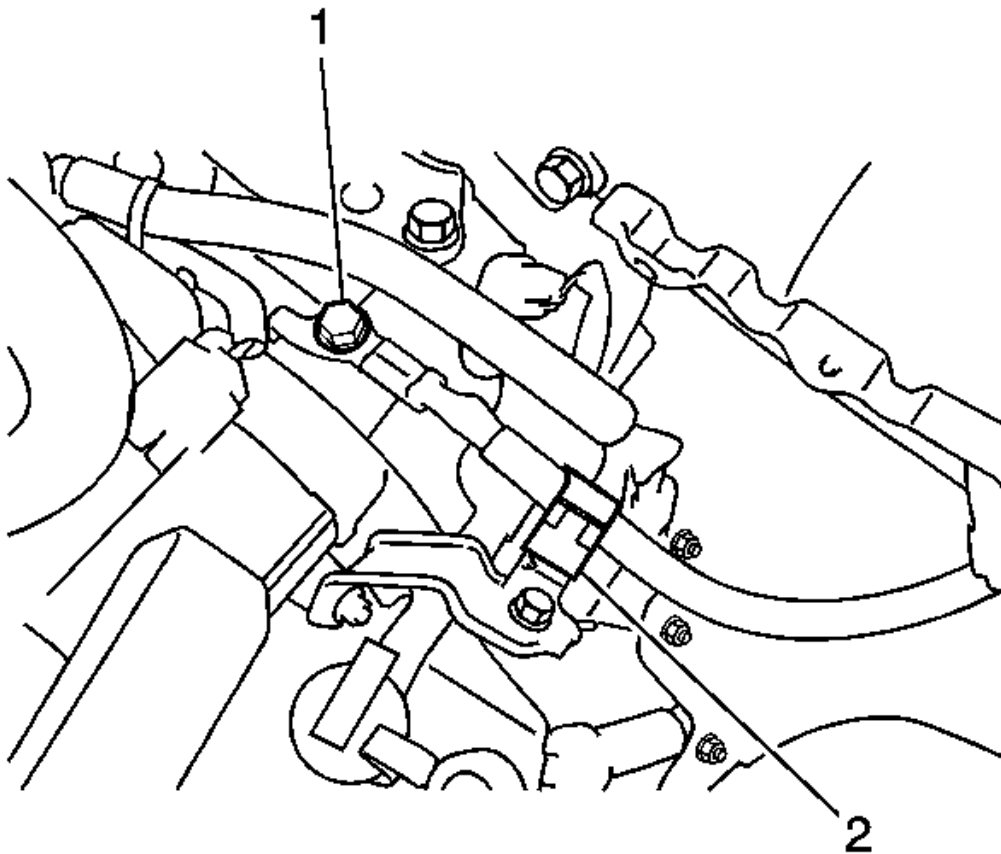


Fig. 259: Identifying Clamp & Ground Cable - Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

80. Install the earth wire to the engine compartment wire with the bolt and clamp (for Automatic Transaxle).

Tighten: 26 N.m (19 lb ft)

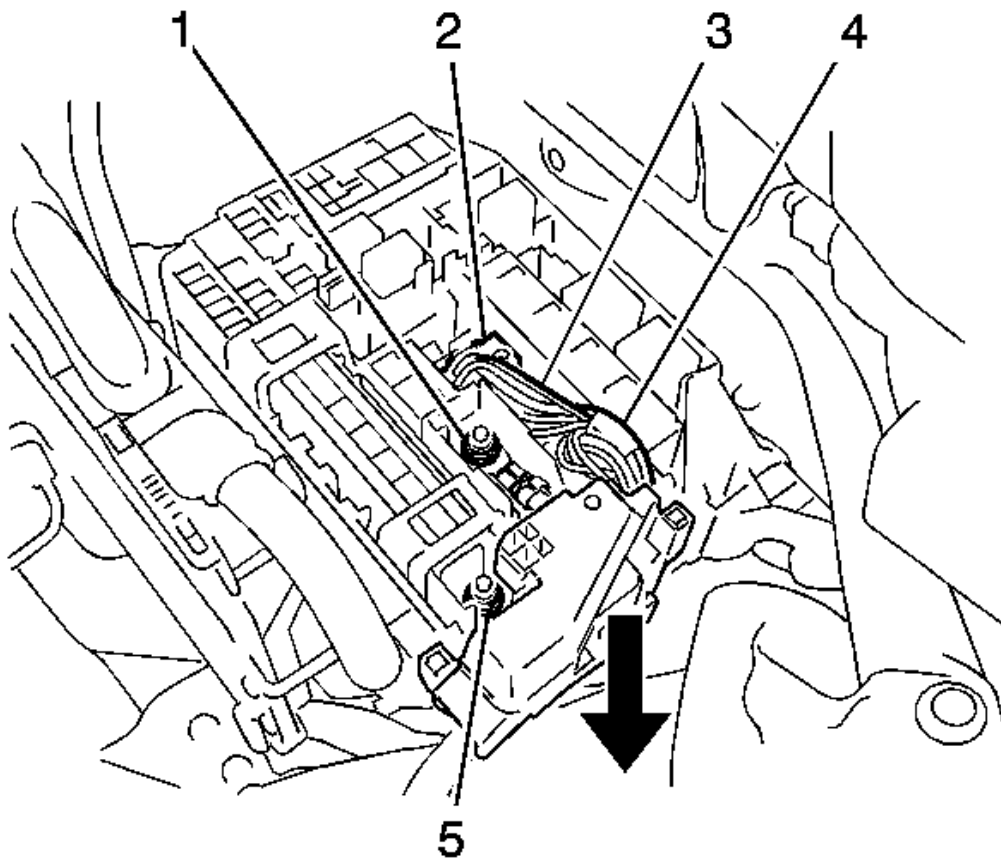


Fig. 260: Identifying Wire Harness & Nuts
Courtesy of GENERAL MOTORS CORP.

81. Install the wire harness with the 2 nuts.

Tighten: 8.4 N.m (74 lb in)

82. Connect the 3 connectors.

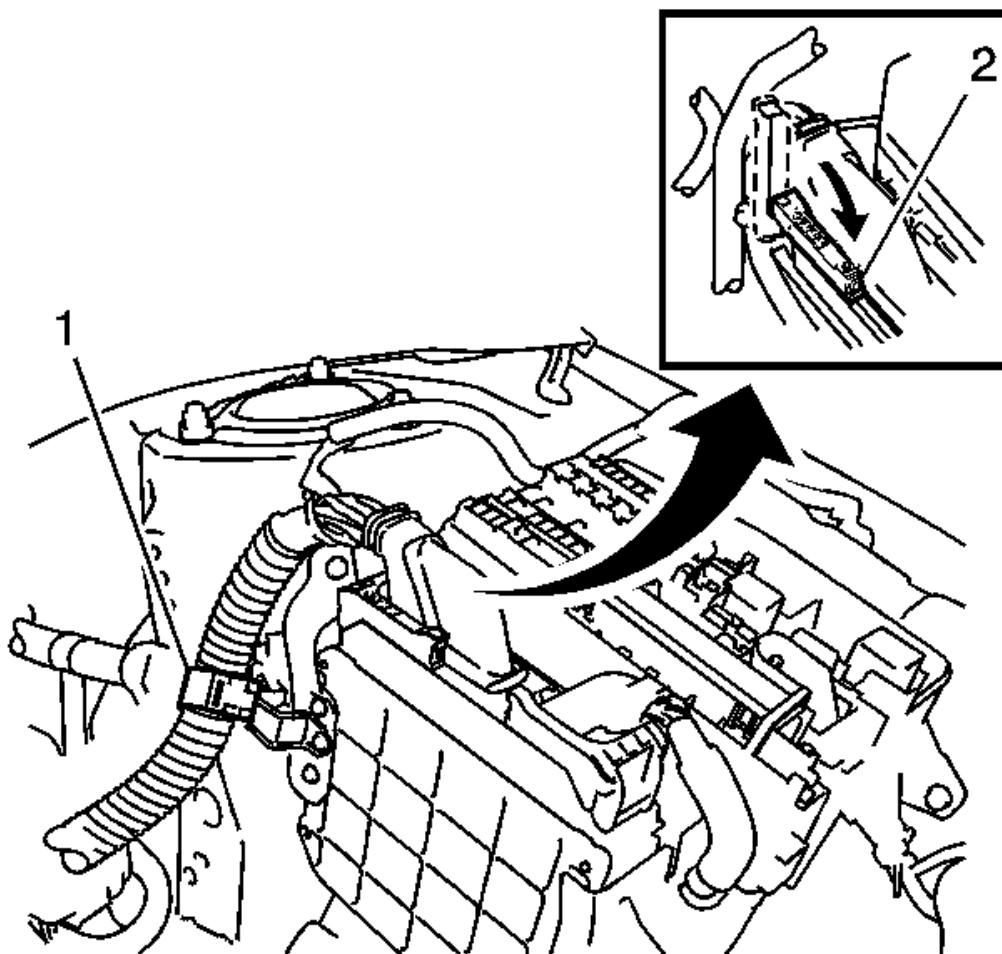


Fig. 261: Locating Engine Control Computer Connector
Courtesy of GENERAL MOTORS CORP.

83. Connect the connector to the engine control computer with the clamp and lock lever.

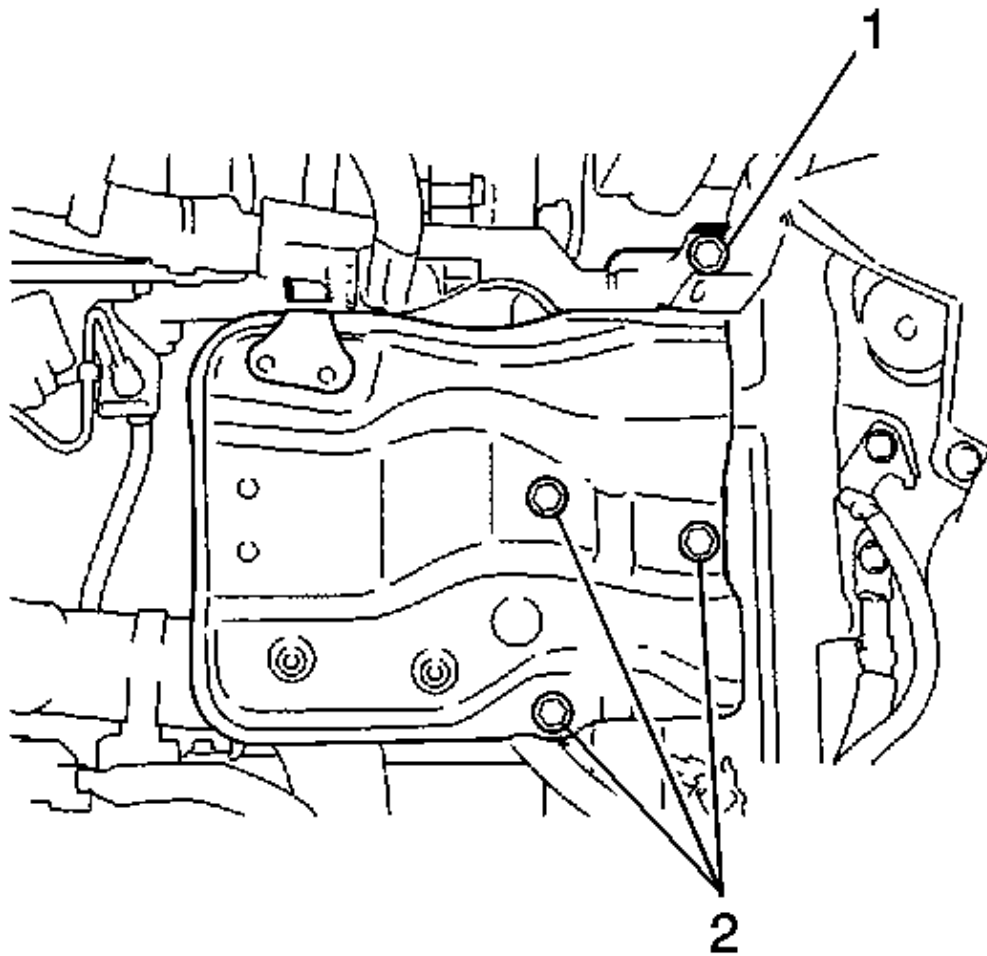


Fig. 262: Identifying Bolts & Battery Carrier
Courtesy of GENERAL MOTORS CORP.

84. Install the battery carrier with the 4 bolts.

Tighten: 13 N.m (10 lb ft)

85. Connect the 2 wire harness clamps.
86. Install the battery tray, battery and battery insulator.

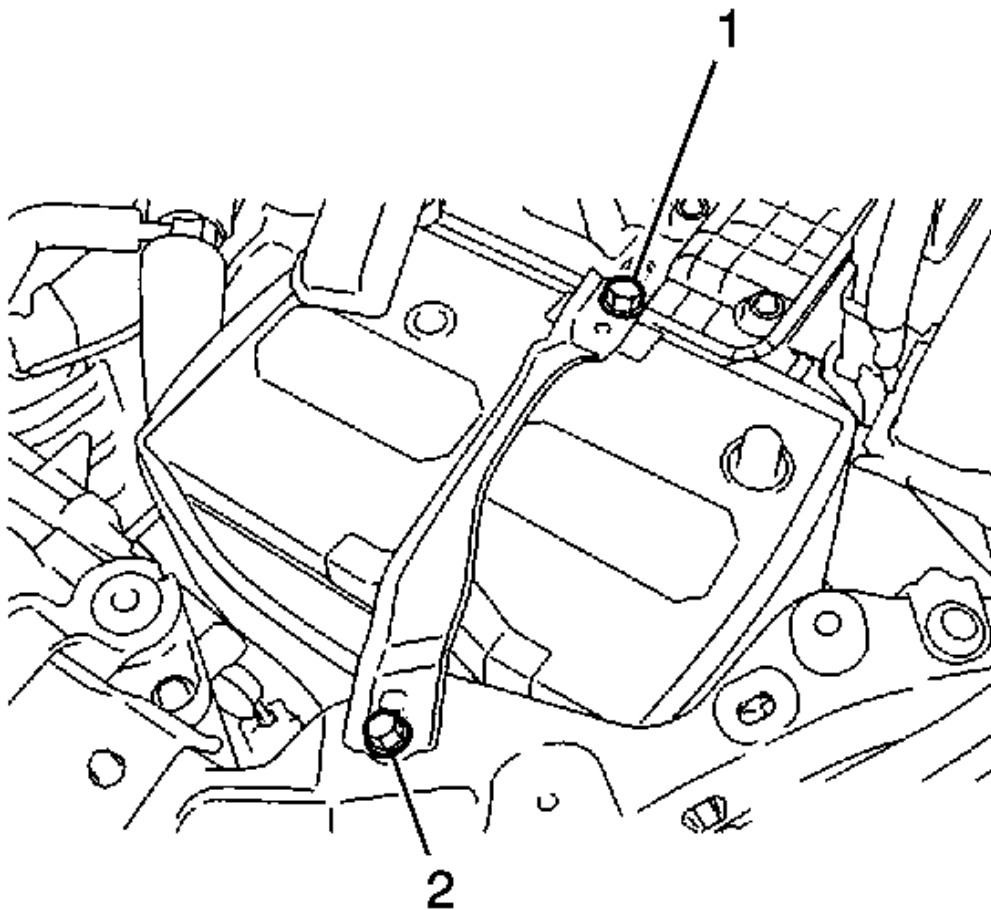


Fig. 263: Identifying Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

87. Install the battery clamp.

Tighten:

- Bolt 6.5 N.m (58 lb in)
- Nut 3.5 N.m (31 lb in)

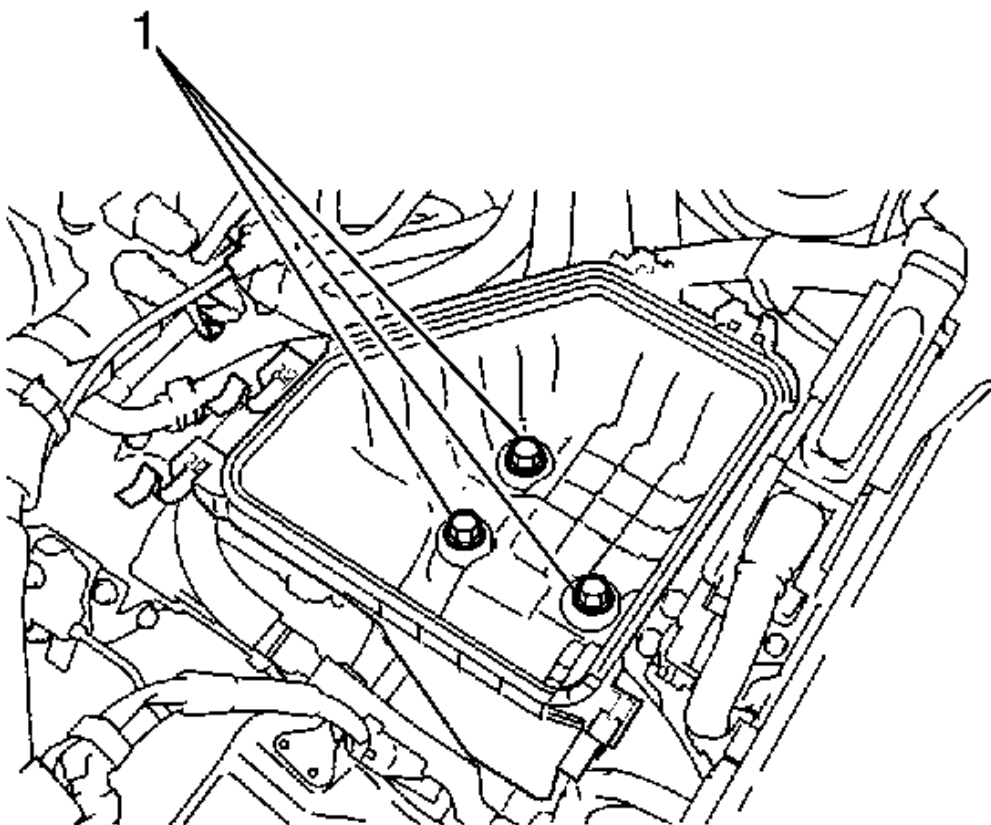


Fig. 264: Identifying Air Cleaner Case & Bolts
Courtesy of GENERAL MOTORS CORP.

88. Install the air cleaner case with the 3 bolts.

Tighten: 7.0 N.m (62 lb in)

89. Install the engine wire clamp to the air cleaner case.
90. Install the air cleaner filter element.
91. Install air cleaner cap sub-assembly with hose.

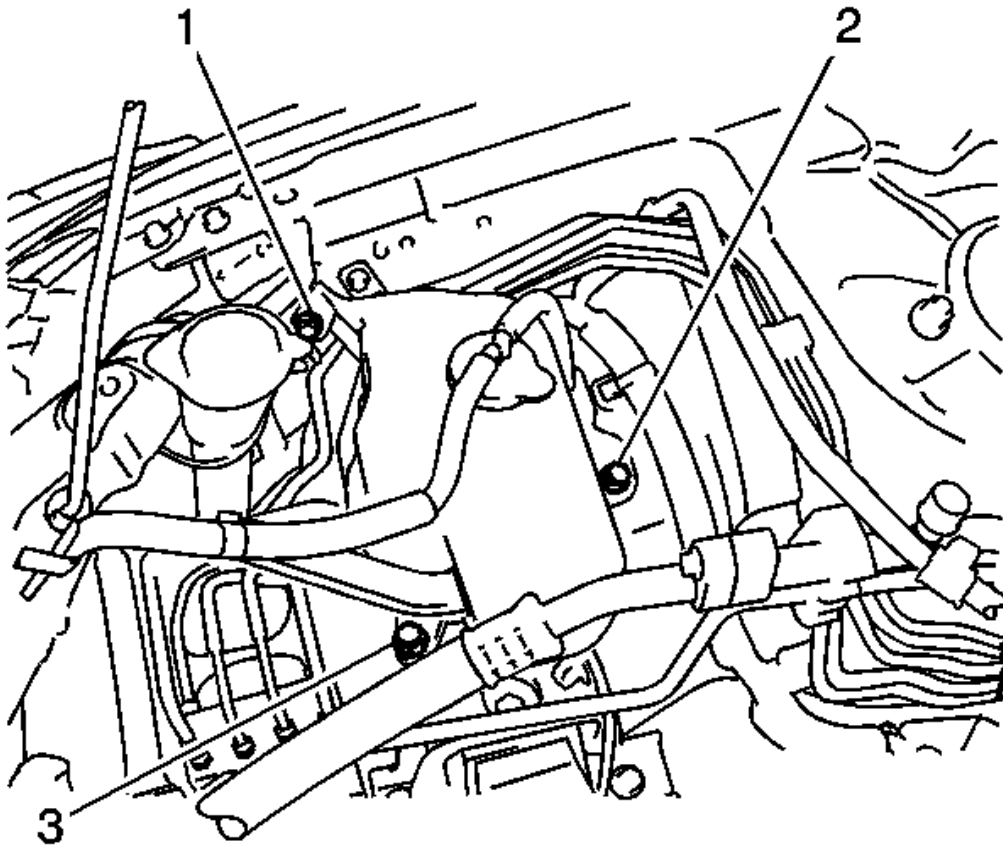


Fig. 265: Identifying Radiator Reserve Tank Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

92. Install the radiator reserve tank assembly with the 3 bolts.

Tighten: 7.0 N.m (62 lb in)

93. Add manual transaxle oil (for manual transaxle).
94. Inspect manual transaxle oil (for manual transaxle).
95. Add automatic transaxle fluid (for automatic transaxle).
96. Inspect transaxle fluid level.
97. Add transfer oil.
98. Inspect transfer oil.
99. Inspect shift lever position (for automatic transaxle). See **RANGE SELECTOR LEVER CABLE ADJUSTMENT**.

100. Adjust shift lever position (for automatic transaxle). See **RANGE SELECTOR LEVER CABLE ADJUSTMENT** .
101. Add engine coolant.

NOTE: **When disconnecting the cable, some systems need to be initialized after the cable is reconnected. Refer to **BATTERY DISCONNECT WARNING** .**

102. Connect cable to negative battery terminal.
103. Warm up engine.
104. Fill brake fluid reservoir (for manual transaxle).
105. Bleed clutch line (for manual transaxle). See **HYDRAULIC CLUTCH BLEEDING** .
106. Inspect fluid level (for manual transaxle).
107. Inspect for fuel leak.
108. Inspect for coolant leak.
109. Inspect for oil leak.
110. Inspect for exhaust gas leak.
111. Install engine under left cover.
112. Install engine under right cover.
113. Install front wheels.
114. Inspect ignition timing.
115. Inspect engine idling speed.
116. Inspect CO/HC. See **EMISSION APPLICATIONS** .
117. Adjust front wheel alignment. See **WHEEL ALIGNMENT** .

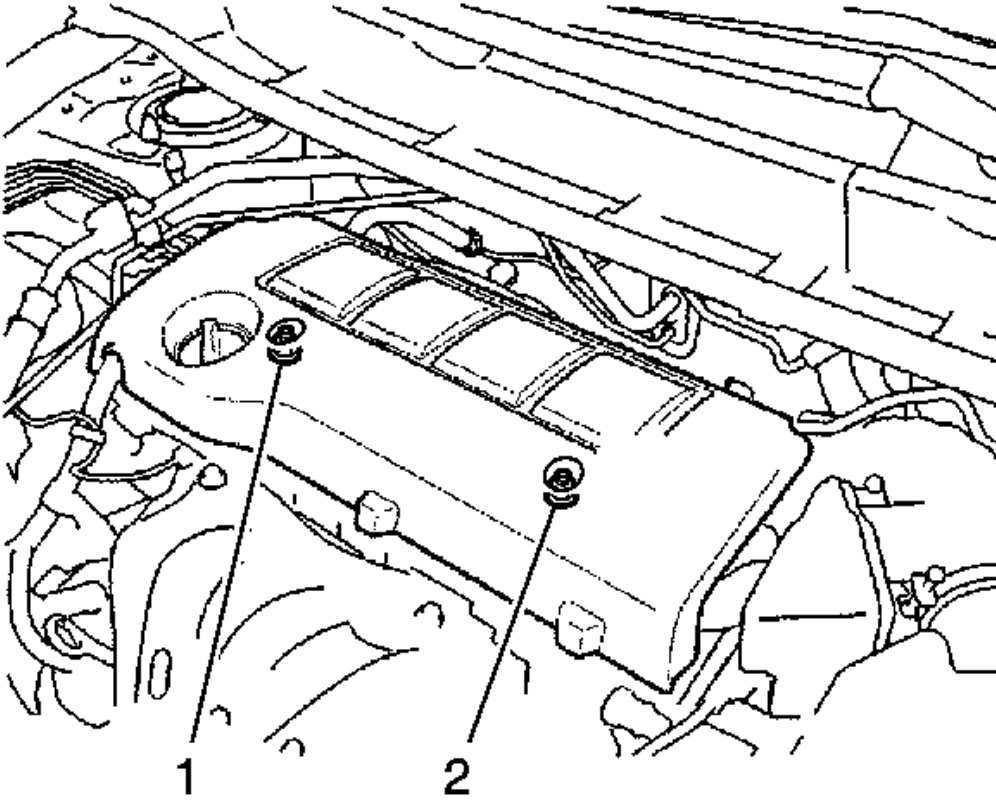


Fig. 266: Identifying Engine Cover Sub-Assembly Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

118. Install the No. 1 engine cover sub-assembly with the 2 nuts.
119. Check ABS speed sensor signal.

ENGINE OIL AND OIL FILTER REPLACEMENT

IMPORTANT: For environmental protection, used oil and used oil filters must be disposed of at designated disposal sites.

1. Remove the oil filler cap.
2. Remove the oil drain plug and drain the oil into a container.

NOTE: Refer to **FASTENER CAUTION** .

3. Clean and install the oil drain plug with a new gasket.

Tighten: Tighten to 40 N.m (29 lb ft).

4. Using a strap type wrench, remove the oil filter.
5. Clean the oil filter installation surface.
6. Apply engine oil to the oil filter gasket.
7. Lightly screw the oil filter into the engine until the oil filter dose not turn.
8. Using a strap type wrench, tighten the oil filter.
9. Depending on the work space available, choose from the following:
 - If enough space is available, use a torque wrench to tighten the oil filter.

Tighten: Tighten to 18 N.m (13 lb ft).

- If enough space is not available to use a torque wrench, tighten the oil filter a 3/4 turn by hand or use a common wrench.
10. Add fresh engine oil and install the oil filler cap.
 11. Inspect for oil leaks.

REPAIR INSTRUCTIONS - OFF VEHICLE

VALVE CLEARANCE ADJUSTMENT

Valve Clearance Adjustment

1. Remove engine under right cover.
2. Remove engine cover sub-assembly.
3. Remove ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
4. Remove spark plug. See **SPARK PLUG REPLACEMENT** .
5. Remove cylinder head cover sub-assembly.

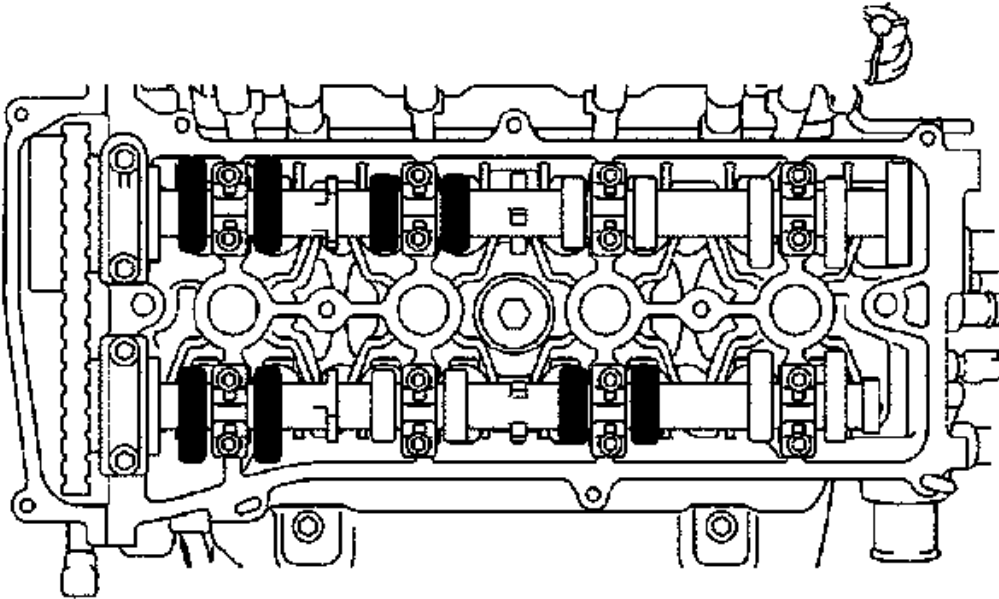


Fig. 267: Identifying Valves Indicated For Checking
Courtesy of GENERAL MOTORS CORP.

6. Set No. 1 cylinder to TDC/compression.
7. Check valve clearance.
8. Check only the valves indicated.
 - Using a feeler gage, measure the clearance between the valve lifter and camshaft.
 - Record any out-of-specification valve clearance measurements. They will be used later to determine the required replacement valve clearance lifters.
9. Turn the crankshaft 1 revolution (360°) and set the No. 4 cylinder to TDC/compression.

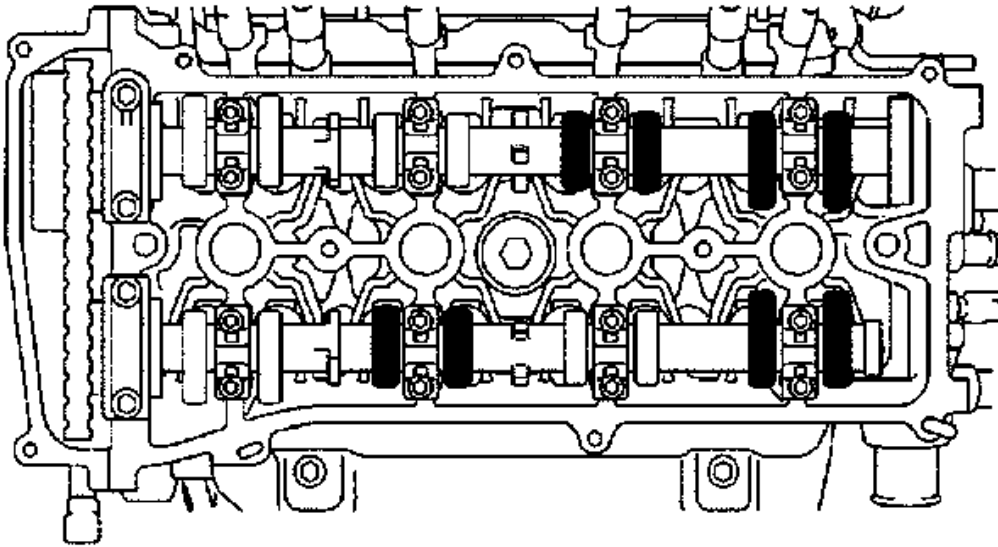


Fig. 268: Identifying Valves Indicated For Checking
Courtesy of GENERAL MOTORS CORP.

10. Check only the valves indicated in the illustration.
 - Using a feeler gage, measure the clearance between the valve lifter and camshaft.
 - Record any out-of-specification valve clearance measurements. They will be used later to determine the required replacement valve lifters.
11. Adjust valve clearance.
 - Set No. 1 cylinder to TDC/compression.
 - Remove the No. 1 chain tensioner. See **Timing Chain Tensioner Removal**.
 - Loosen the camshaft timing sprocket.
 - Remove the No. 2 camshaft.
 - Remove the camshaft.
 - Remove the valve lifters.

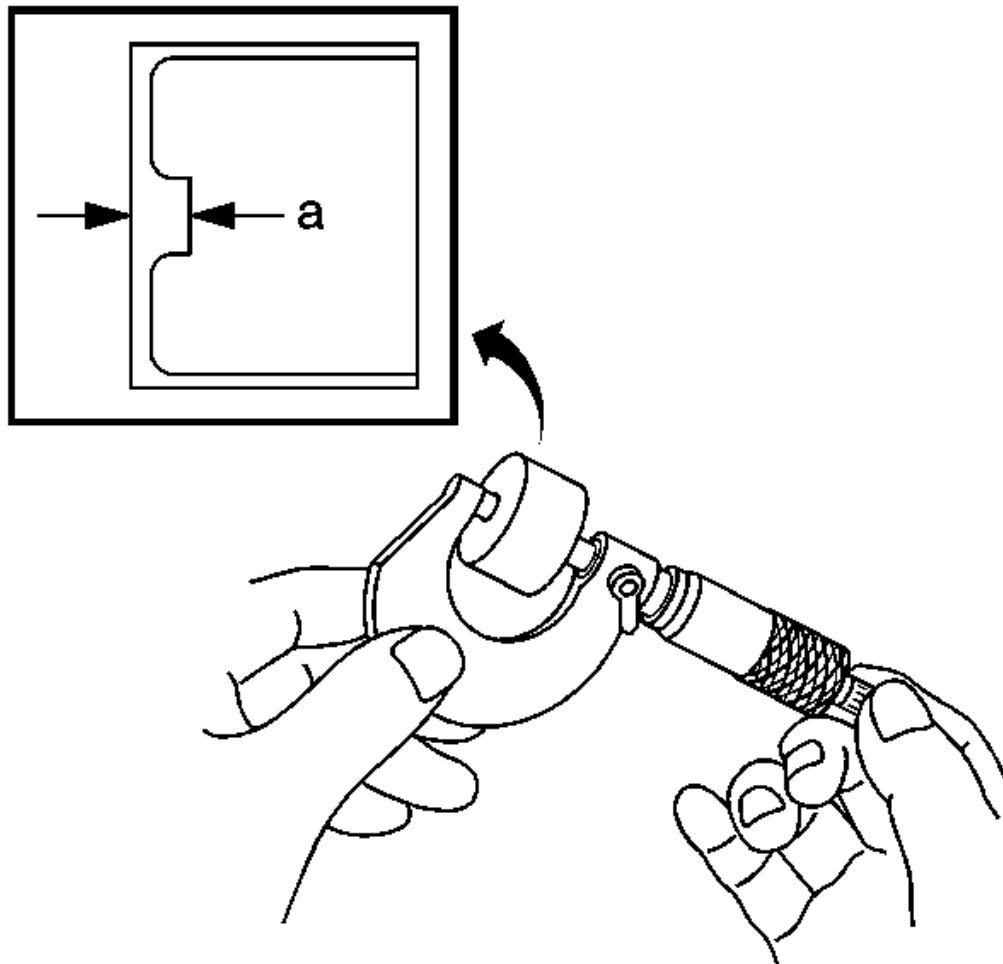


Fig. 269: Measuring Valve Lifter Thickness
Courtesy of GENERAL MOTORS CORP.

- Using a micrometer, measure the thickness of the removed valve lifters.
- Calculate the thickness of a new lifter so that the valve clearance comes within the specified values.

12. Calculation Example (intake):

1. Measured intake valve clearance equals 0.40 mm (0.0158 in.).

(Measured-Specification = Excess clearance) (a) 0.40 mm (0.0158 in.) - 0.24 mm (0.0094 in.) = 0.16 mm (0.0063 in.)

2. Measured used lifter thickness equals 5.250 mm (0.2067 in.).

3. New lifter thickness equals 5.410 mm (0.2130 in.) (Excess clearance + Used lifter thickness = Ideal new lifter)

$$(a) 0.16 \text{ mm (0.0063 in.)} + 5.250 \text{ mm (0.2067 in.)} = 5.410 \text{ mm (0.2130 in.)}$$

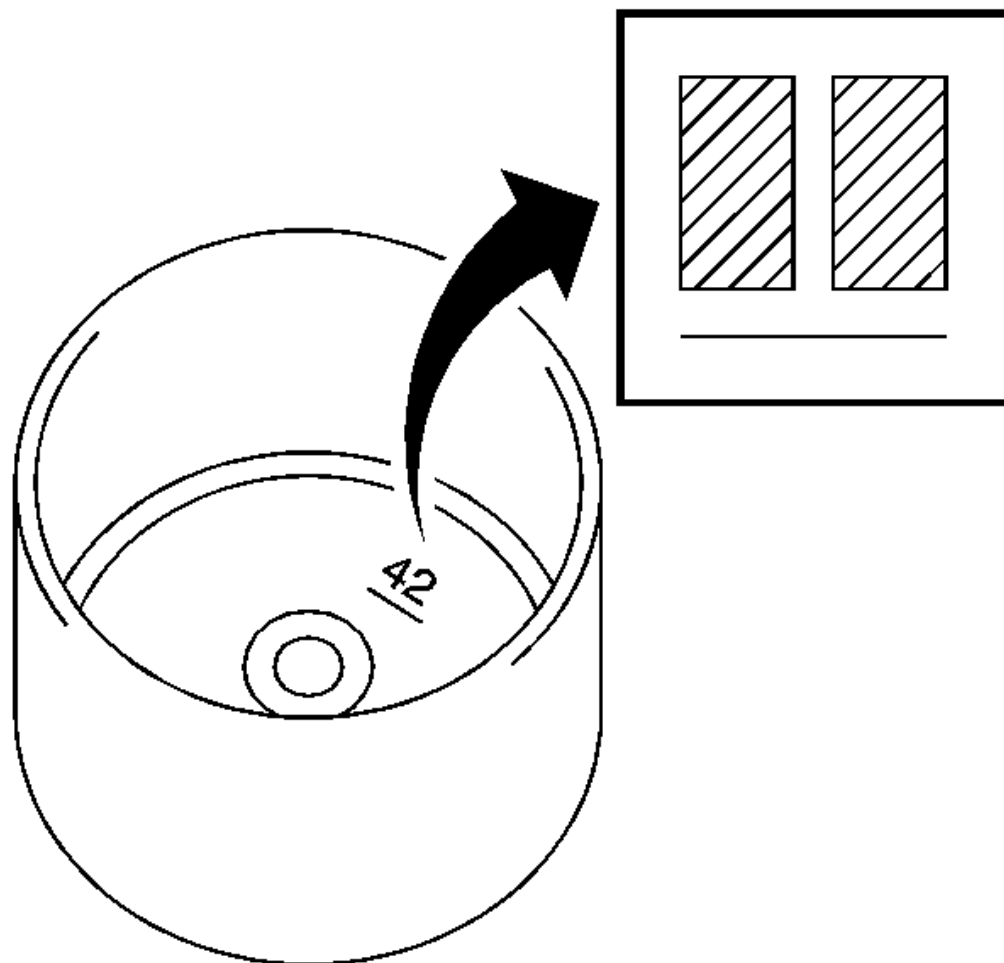


Fig. 270: View Of Lifter Base
Courtesy of GENERAL MOTORS CORP.

4. Closest new lifter equals 5.420 mm (0.2134 in.) - Select No. 42 lifter

Measured clearance mm (in.)	Installed lifter thickness	mm (in.)	
		mm (in.)	mm (in.)
5.060 (0.1992)		0.000 (0.0000)	0.000 (0.0000)
5.080 (0.2000)		0.031 (0.0012)	0.031 (0.0012)
5.100 (0.2008)		0.061 (0.0024)	0.061 (0.0024)
5.120 (0.2016)		0.091 (0.0036)	0.091 (0.0036)
5.140 (0.2024)		0.121 (0.0048)	0.121 (0.0048)
5.160 (0.2031)		0.151 (0.0060)	0.151 (0.0060)
5.180 (0.2039)		0.181 (0.0072)	0.181 (0.0072)
5.200 (0.2047)		0.211 (0.0084)	0.211 (0.0084)
5.210 (0.2051)		0.241 (0.0096)	0.241 (0.0096)
5.220 (0.2055)		0.271 (0.0108)	0.271 (0.0108)
5.230 (0.2059)		0.301 (0.0120)	0.301 (0.0120)
5.240 (0.2063)		0.331 (0.0132)	0.331 (0.0132)
5.250 (0.2067)		0.361 (0.0144)	0.361 (0.0144)
5.260 (0.2071)		0.391 (0.0156)	0.391 (0.0156)
5.270 (0.2075)		0.421 (0.0168)	0.421 (0.0168)
5.280 (0.2079)		0.451 (0.0180)	0.451 (0.0180)
5.290 (0.2083)		0.481 (0.0192)	0.481 (0.0192)
5.300 (0.2087)		0.511 (0.0204)	0.511 (0.0204)
5.310 (0.2091)		0.541 (0.0216)	0.541 (0.0216)
5.320 (0.2094)		0.571 (0.0228)	0.571 (0.0228)
5.330 (0.2098)		0.601 (0.0240)	0.601 (0.0240)
5.340 (0.2102)		0.631 (0.0252)	0.631 (0.0252)
5.350 (0.2106)		0.661 (0.0264)	0.661 (0.0264)
5.360 (0.2110)		0.691 (0.0276)	0.691 (0.0276)
5.370 (0.2114)		0.721 (0.0288)	0.721 (0.0288)
5.380 (0.2118)		0.751 (0.0300)	0.751 (0.0300)
5.390 (0.2122)		0.781 (0.0312)	0.781 (0.0312)
5.400 (0.2126)		0.811 (0.0324)	0.811 (0.0324)
5.410 (0.2130)		0.841 (0.0336)	0.841 (0.0336)
5.420 (0.2134)		0.871 (0.0348)	0.871 (0.0348)
5.430 (0.2138)		0.901 (0.0360)	0.901 (0.0360)
5.440 (0.2142)		0.931 (0.0372)	0.931 (0.0372)
5.450 (0.2146)		0.961 (0.0384)	0.961 (0.0384)
5.470 (0.2154)		0.991 (0.0396)	0.991 (0.0396)
5.490 (0.2162)		1.021 (0.0408)	1.021 (0.0408)
5.500 (0.2166)		1.051 (0.0420)	1.051 (0.0420)
5.510 (0.2169)		1.081 (0.0432)	1.081 (0.0432)
5.520 (0.2173)		1.111 (0.0444)	1.111 (0.0444)
5.530 (0.2177)		1.141 (0.0456)	1.141 (0.0456)
5.540 (0.2181)		1.171 (0.0468)	1.171 (0.0468)
5.550 (0.2185)		1.201 (0.0480)	1.201 (0.0480)
5.560 (0.2189)		1.231 (0.0492)	1.231 (0.0492)
5.570 (0.2193)		1.261 (0.0504)	1.261 (0.0504)
5.580 (0.2197)		1.291 (0.0516)	1.291 (0.0516)
5.590 (0.2201)		1.321 (0.0528)	1.321 (0.0528)
5.600 (0.2205)		1.351 (0.0540)	1.351 (0.0540)
5.620 (0.2213)		1.381 (0.0552)	1.381 (0.0552)
5.640 (0.2220)		1.411 (0.0564)	1.411 (0.0564)
5.660 (0.2228)		1.441 (0.0576)	1.441 (0.0576)
5.680 (0.2236)		1.471 (0.0588)	1.471 (0.0588)
5.700 (0.2244)		1.501 (0.0600)	1.501 (0.0600)
5.720 (0.2252)		1.531 (0.0612)	1.531 (0.0612)
5.740 (0.2260)		1.561 (0.0624)	1.561 (0.0624)
5.760 (0.2268)		1.591 (0.0636)	1.591 (0.0636)
5.780 (0.2276)		1.621 (0.0648)	1.621 (0.0648)
5.800 (0.2284)		1.651 (0.0660)	1.651 (0.0660)
5.820 (0.2292)		1.681 (0.0672)	1.681 (0.0672)
5.840 (0.2300)		1.711 (0.0684)	1.711 (0.0684)
5.860 (0.2308)		1.741 (0.0696)	1.741 (0.0696)
5.880 (0.2316)		1.771 (0.0708)	1.771 (0.0708)
5.900 (0.2324)		1.801 (0.0720)	1.801 (0.0720)
5.920 (0.2332)		1.831 (0.0732)	1.831 (0.0732)
5.940 (0.2340)		1.861 (0.0744)	1.861 (0.0744)
5.960 (0.2348)		1.891 (0.0756)	1.891 (0.0756)
5.980 (0.2356)		1.921 (0.0768)	1.921 (0.0768)
6.000 (0.2364)		1.951 (0.0780)	1.951 (0.0780)
6.020 (0.2372)		1.981 (0.0792)	1.981 (

Fig. 271: View Of Valve Lifter Size Availability
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Lifters are available in 35 sizes in increments of 0.020 mm (0.0008 in), from 5.060-5.740 mm (0.1992-0.2260 in).

- The identification number inside the valve lifters shows the value to 2 decimal places. The illustration shows 5.420 mm (0.2134 in).

13. Select a new lifter with a thickness as close as possible to the calculated values.

Measured clearance mm (in.)	Installed lifter thickness mm (in.)		mm (in.)	
	mm (in.)	mm (in.)	mm (in.)	mm (in.)
5.050 (0.1982)	5.050 (0.1982)	5.050 (0.1982)	5.050 (0.1982)	5.050 (0.1982)
5.060 (0.2000)	5.060 (0.2000)	5.060 (0.2000)	5.060 (0.2000)	5.060 (0.2000)
5.100 (0.2006)	5.100 (0.2006)	5.100 (0.2006)	5.100 (0.2006)	5.100 (0.2006)
5.120 (0.2018)	5.120 (0.2018)	5.120 (0.2018)	5.120 (0.2018)	5.120 (0.2018)
5.140 (0.2024)	5.140 (0.2024)	5.140 (0.2024)	5.140 (0.2024)	5.140 (0.2024)
5.160 (0.2031)	5.160 (0.2031)	5.160 (0.2031)	5.160 (0.2031)	5.160 (0.2031)
5.180 (0.2039)	5.180 (0.2039)	5.180 (0.2039)	5.180 (0.2039)	5.180 (0.2039)
5.200 (0.2047)	5.200 (0.2047)	5.200 (0.2047)	5.200 (0.2047)	5.200 (0.2047)
5.210 (0.2051)	5.210 (0.2051)	5.210 (0.2051)	5.210 (0.2051)	5.210 (0.2051)
5.220 (0.2055)	5.220 (0.2055)	5.220 (0.2055)	5.220 (0.2055)	5.220 (0.2055)
5.230 (0.2058)	5.230 (0.2058)	5.230 (0.2058)	5.230 (0.2058)	5.230 (0.2058)
5.240 (0.2063)	5.240 (0.2063)	5.240 (0.2063)	5.240 (0.2063)	5.240 (0.2063)
5.250 (0.2067)	5.250 (0.2067)	5.250 (0.2067)	5.250 (0.2067)	5.250 (0.2067)
5.260 (0.2071)	5.260 (0.2071)	5.260 (0.2071)	5.260 (0.2071)	5.260 (0.2071)
5.270 (0.2075)	5.270 (0.2075)	5.270 (0.2075)	5.270 (0.2075)	5.270 (0.2075)
5.280 (0.2079)	5.280 (0.2079)	5.280 (0.2079)	5.280 (0.2079)	5.280 (0.2079)
5.290 (0.2085)	5.290 (0.2085)	5.290 (0.2085)	5.290 (0.2085)	5.290 (0.2085)
5.300 (0.2087)	5.300 (0.2087)	5.300 (0.2087)	5.300 (0.2087)	5.300 (0.2087)
5.310 (0.2091)	5.310 (0.2091)	5.310 (0.2091)	5.310 (0.2091)	5.310 (0.2091)
5.320 (0.2094)	5.320 (0.2094)	5.320 (0.2094)	5.320 (0.2094)	5.320 (0.2094)
5.330 (0.2098)	5.330 (0.2098)	5.330 (0.2098)	5.330 (0.2098)	5.330 (0.2098)
5.340 (0.2102)	5.340 (0.2102)	5.340 (0.2102)	5.340 (0.2102)	5.340 (0.2102)
5.350 (0.2105)	5.350 (0.2105)	5.350 (0.2105)	5.350 (0.2105)	5.350 (0.2105)
5.360 (0.2110)	5.360 (0.2110)	5.360 (0.2110)	5.360 (0.2110)	5.360 (0.2110)
5.370 (0.2114)	5.370 (0.2114)	5.370 (0.2114)	5.370 (0.2114)	5.370 (0.2114)
5.380 (0.2118)	5.380 (0.2118)	5.380 (0.2118)	5.380 (0.2118)	5.380 (0.2118)
5.390 (0.2122)	5.390 (0.2122)	5.390 (0.2122)	5.390 (0.2122)	5.390 (0.2122)
5.400 (0.2126)	5.400 (0.2126)	5.400 (0.2126)	5.400 (0.2126)	5.400 (0.2126)
5.410 (0.2130)	5.410 (0.2130)	5.410 (0.2130)	5.410 (0.2130)	5.410 (0.2130)
5.420 (0.2134)	5.420 (0.2134)	5.420 (0.2134)	5.420 (0.2134)	5.420 (0.2134)
5.430 (0.2138)	5.430 (0.2138)	5.430 (0.2138)	5.430 (0.2138)	5.430 (0.2138)
5.440 (0.2142)	5.440 (0.2142)	5.440 (0.2142)	5.440 (0.2142)	5.440 (0.2142)
5.450 (0.2146)	5.450 (0.2146)	5.450 (0.2146)	5.450 (0.2146)	5.450 (0.2146)
5.460 (0.2150)	5.460 (0.2150)	5.460 (0.2150)	5.460 (0.2150)	5.460 (0.2150)
5.470 (0.2154)	5.470 (0.2154)	5.470 (0.2154)	5.470 (0.2154)	5.470 (0.2154)
5.480 (0.2157)	5.480 (0.2157)	5.480 (0.2157)	5.480 (0.2157)	5.480 (0.2157)
5.490 (0.2161)	5.490 (0.2161)	5.490 (0.2161)	5.490 (0.2161)	5.490 (0.2161)
5.500 (0.2165)	5.500 (0.2165)	5.500 (0.2165)	5.500 (0.2165)	5.500 (0.2165)
5.510 (0.2169)	5.510 (0.2169)	5.510 (0.2169)	5.510 (0.2169)	5.510 (0.2169)
5.520 (0.2173)	5.520 (0.2173)	5.520 (0.2173)	5.520 (0.2173)	5.520 (0.2173)
5.530 (0.2177)	5.530 (0.2177)	5.530 (0.2177)	5.530 (0.2177)	5.530 (0.2177)
5.540 (0.2181)	5.540 (0.2181)	5.540 (0.2181)	5.540 (0.2181)	5.540 (0.2181)
5.550 (0.2185)	5.550 (0.2185)	5.550 (0.2185)	5.550 (0.2185)	5.550 (0.2185)
5.560 (0.2189)	5.560 (0.2189)	5.560 (0.2189)	5.560 (0.2189)	5.560 (0.2189)
5.570 (0.2193)	5.570 (0.2193)	5.570 (0.2193)	5.570 (0.2193)	5.570 (0.2193)
5.580 (0.2197)	5.580 (0.2197)	5.580 (0.2197)	5.580 (0.2197)	5.580 (0.2197)
5.590 (0.2201)	5.590 (0.2201)	5.590 (0.2201)	5.590 (0.2201)	5.590 (0.2201)
5.600 (0.2205)	5.600 (0.2205)	5.600 (0.2205)	5.600 (0.2205)	5.600 (0.2205)
5.620 (0.2213)	5.620 (0.2213)	5.620 (0.2213)	5.620 (0.2213)	5.620 (0.2213)
5.640 (0.2220)	5.640 (0.2220)	5.640 (0.2220)	5.640 (0.2220)	5.640 (0.2220)
5.660 (0.2228)	5.660 (0.2228)	5.660 (0.2228)	5.660 (0.2228)	5.660 (0.2228)
5.680 (0.2236)	5.680 (0.2236)	5.680 (0.2236)	5.680 (0.2236)	5.680 (0.2236)
5.700 (0.2244)	5.700 (0.2244)	5.700 (0.2244)	5.700 (0.2244)	5.700 (0.2244)
5.720 (0.2252)	5.720 (0.2252)	5.720 (0.2252)	5.720 (0.2252)	5.720 (0.2252)
5.740 (0.2260)	5.740 (0.2260)	5.740 (0.2260)	5.740 (0.2260)	5.740 (0.2260)

Fig. 272: Identifying Valve Lifter Size Availability
Courtesy of GENERAL MOTORS CORP.

14. Standard intake valve clearance (cold): 0.19-0.29 mm (0.007-0.011 in).

EXAMPLE: The 5.250 mm (0.2067 in) lifter is installed, and the measured clearance is 0.400 mm

2009 Pontiac Vibe

2009 ENGINE Engine Mechanical - 2.4L (LAX) - Vibe

(0.0157 in). Replace the 5.250 mm (0.2067 in) lifter with a new No. 42 lifter.

15. Standard exhaust valve clearance (cold): 0.38-0.48 mm (0.015-0.019 in).

EXAMPLE : The 5.340 mm (0.2102 in) lifter is installed, and the measured clearance is 0.510 mm (0.020 in). Replace the 5.340 mm (0.2102 in.) lifter with a new No. 42 lifter.

16. Install the selected valve lifter.
17. Install the camshaft. See **Intake Camshaft and Valve Lifter Installation**.
18. Install the No. 2 camshaft. See **Exhaust Camshaft and Valve Lifter Installation**.
19. Install the No. 1 chain tensioner. See **Camshaft Timing Chain, Sprocket, and Tensioner Installation**.
20. Install cylinder head cover sub-assembly. See **Cylinder Head Replacement**.
21. Install spark plug. See **SPARK PLUG REPLACEMENT** .
22. Install ignition coil assembly. See **IGNITION COIL REPLACEMENT** .
23. Inspect for oil leak.
24. Inspect ignition timing.
25. Install No. 1 engine cover sub-assembly.
26. Install engine under right cover.

Standard Valve Clearance (Cold)

Item	Specified Condition
Intake	0.19-0.29 mm (0.007-0.011 in.)
Exhaust	0.38-0.48 mm (0.015-0.019 in.)

New Lifter Thickness

Item	Specification
Intake	$A = B + (C - 0.24 \text{ mm (0.0094 in)})$
Exhaust	$A = B + (C - 0.43 \text{ mm (0.0169 in)})$
A	New lifter thickness
B	Used lifter thickness
C	Measured valve clearance

New Lifter Thickness

Lifter No.	Thickness mm (in.)	Lifter No.	Thickness mm (in.)	Lifter No.	Thickness mm (in.)
06	5.060 (0.1992)	30	5.300 (0.2087)	54	5.540 (0.2181)
08	5.080 (0.2000)	32	5.320 (0.2094)	56	5.560 (0.2189)
10	5.100 (0.2008)	34	5.340 (0.2102)	58	5.580 (0.2197)
12	5.120 (0.2016)	36	5.360 (0.2110)	60	5.600 (0.2205)
14	5.140 (0.2024)	38	5.380 (0.2118)	62	5.620 (0.2213)
16	5.160 (0.2031)	40	5.400 (0.2126)	64	5.640 (0.2220)

18	5.180 (0.2039)	42	5.420 (0.2134)	66	5.660 (0.2228)
20	5.200 (0.2047)	44	5.440 (0.2142)	68	5.680 (0.2236)
22	5.220 (0.2055)	46	5.460 (0.2150)	70	5.700 (0.2244)
24	5.240 (0.2063)	48	5.480 (0.2157)	72	5.720 (0.2252)
26	5.260 (0.2071)	50	5.500 (0.2165)	74	5.740 (0.2260)
28	5.280 (0.2079)	52	5.520 (0.2173)	-	-

EXHAUST MANIFOLD REMOVAL

Removal Procedure

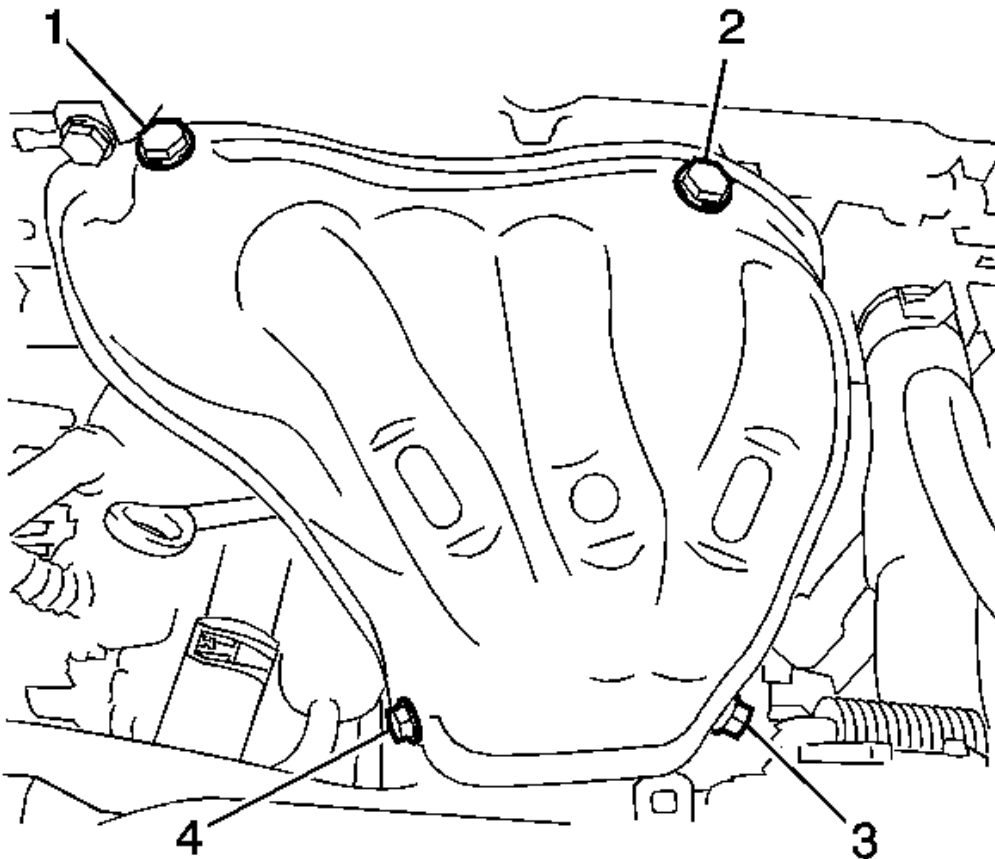


Fig. 273: Identifying Exhaust Manifold Heat Insulator Bolts
 Courtesy of GENERAL MOTORS CORP.

1. Remove the four bolts from the exhaust manifold heat insulator.

2. Remove exhaust manifold heat insulator.
3. Remove the exhaust manifold support brackets.

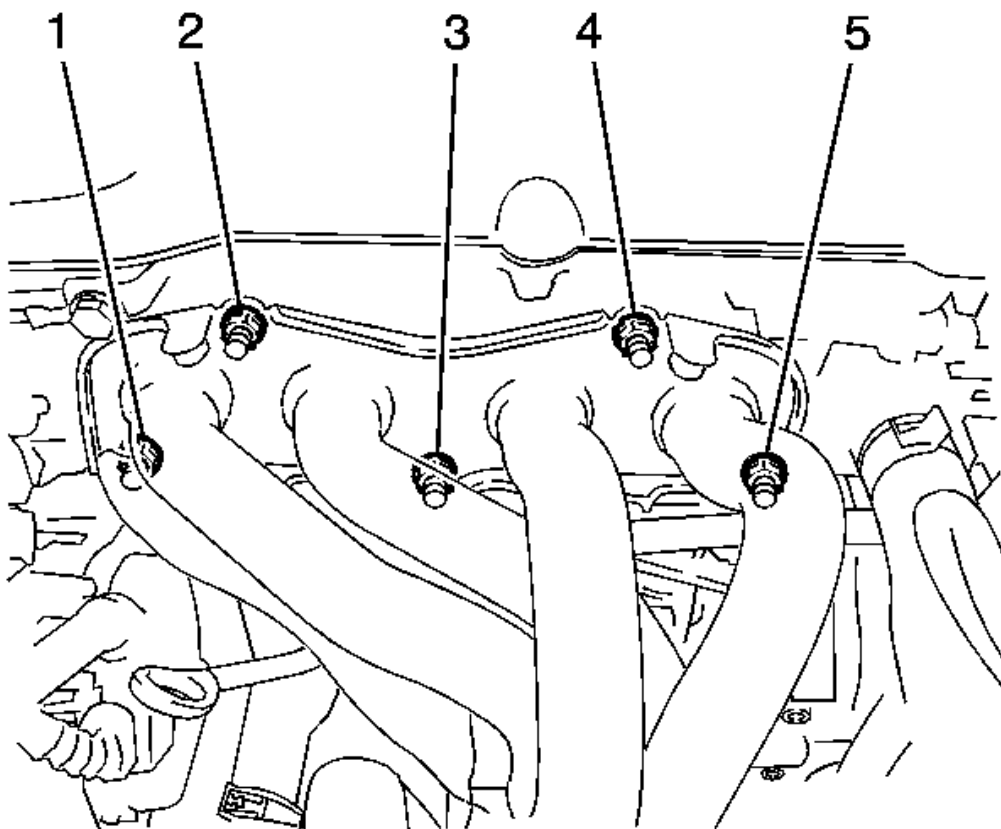


Fig. 274: Identifying Nuts & Exhaust Manifold Converter Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the five nuts retaining the exhaust manifold.
5. Remove the exhaust manifold and converter assembly.

INTAKE MANIFOLD REMOVAL

1. Remove fuel delivery pipe.
2. Remove fuel injector rail with fuel injector assemblies.

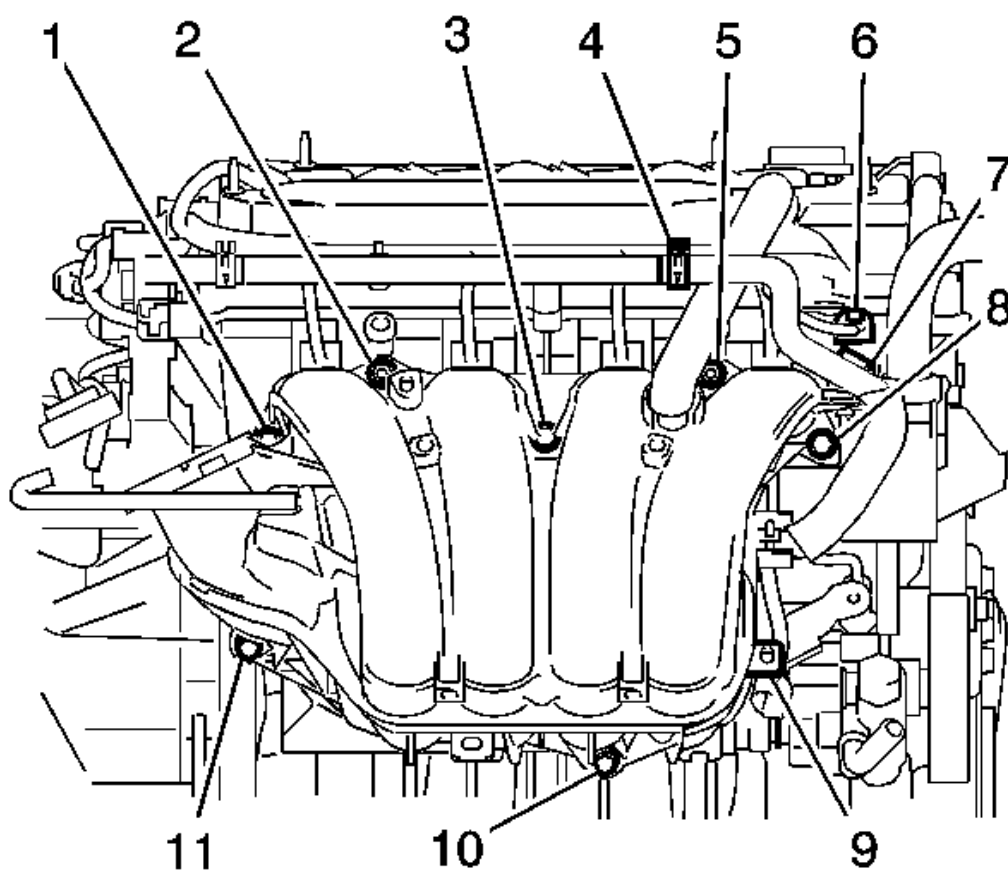


Fig. 275: View Of Intake Manifold, Bolts & Nuts Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

3. Remove the five bolts retaining the intake manifold.
4. Remove the intake manifold.
5. Remove the gasket from the intake manifold.

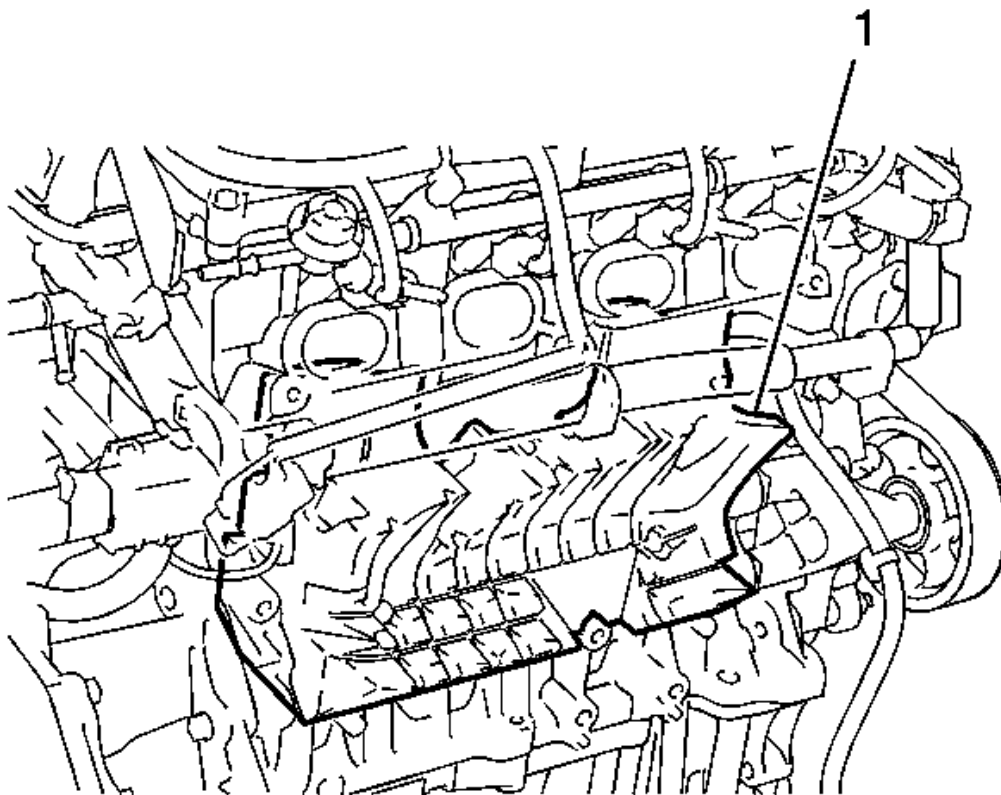


Fig. 276: View Of Intake Manifold Insulator
Courtesy of GENERAL MOTORS CORP.

6. Remove the intake manifold insulator (1).
7. Remove knock sensor.

CAMSHAFT COVER REMOVAL

Removal Procedure

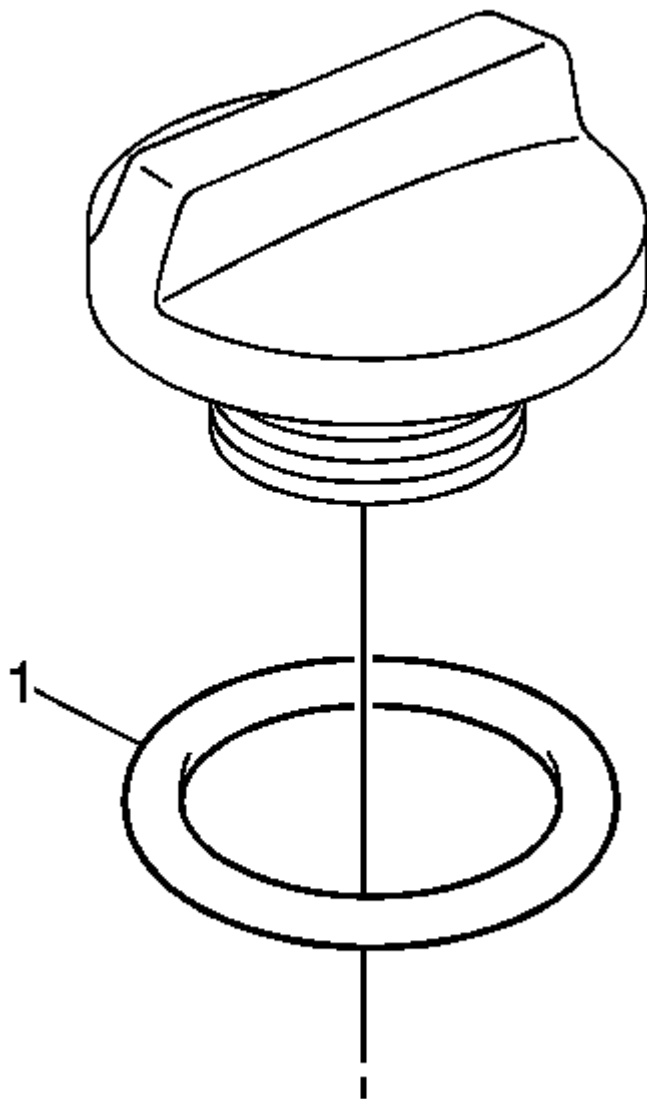


Fig. 277: View Of Oil Filler Cap
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filler cap from the cylinder head cover.
2. If necessary, remove the oil filler cap gasket from the oil filler cap.

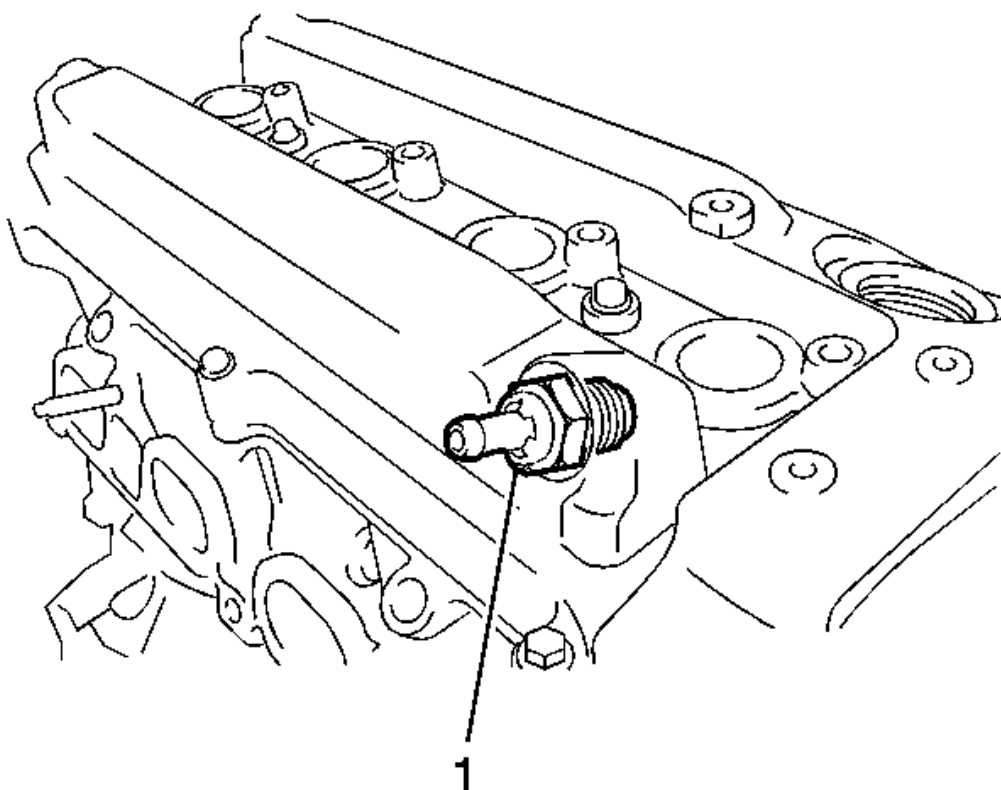


Fig. 278: Identifying Ventilation Valve
Courtesy of GENERAL MOTORS CORP.

3. If necessary, using a 22 mm deep socket wrench, remove the ventilation valve from the cylinder head cover.
4. Remove the retaining bolt from each of the ignition coils and remove the coils.
5. Remove spark plugs. See **SPARK PLUG REPLACEMENT** .

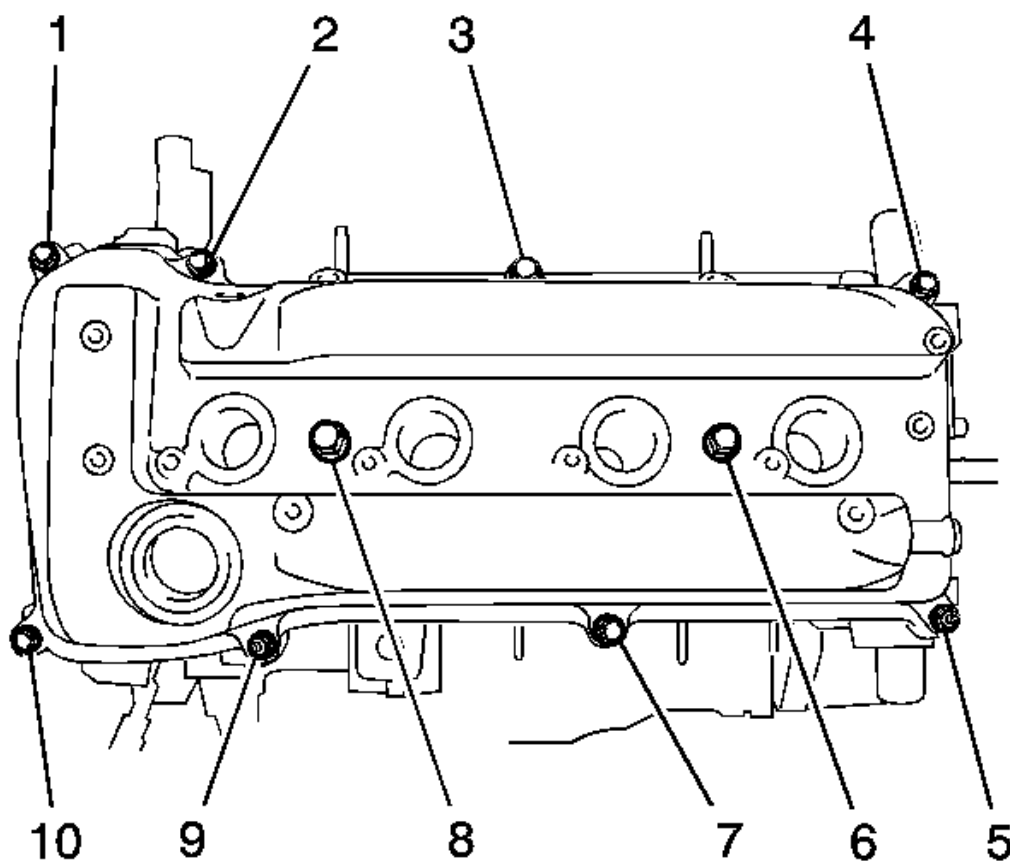


Fig. 279: Identifying Cylinder Head Cover Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the 8 bolts and 2 nuts, and remove the cylinder head cover.

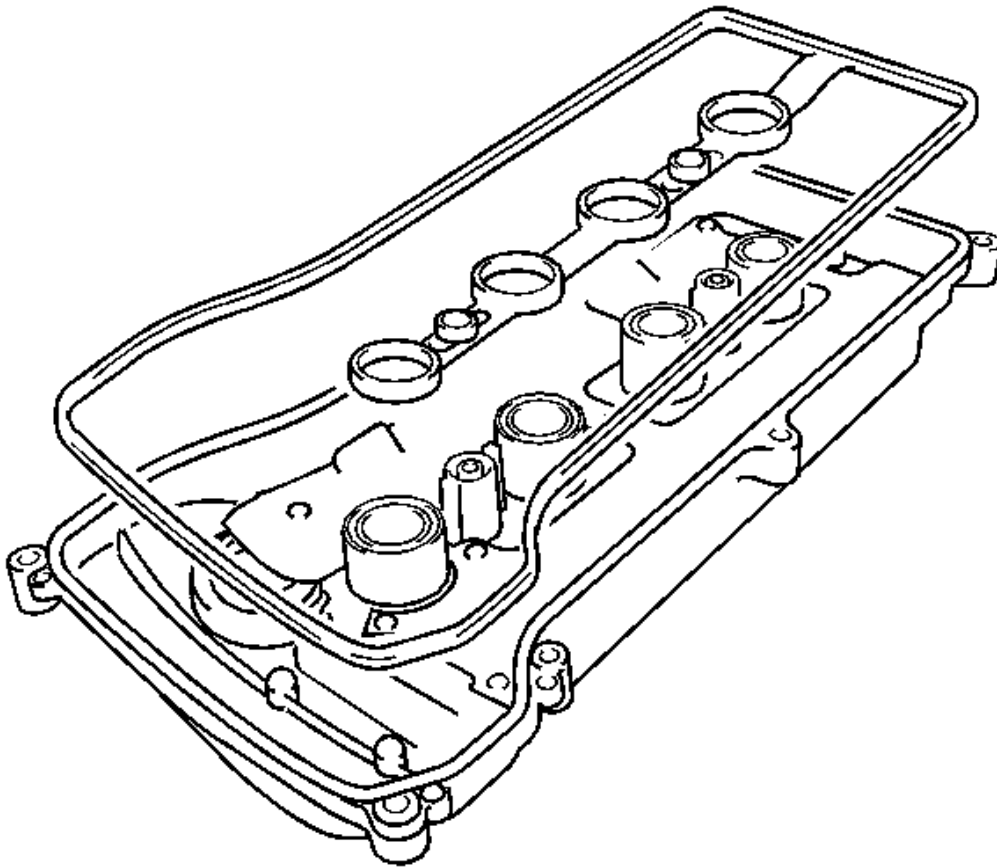


Fig. 280: Identifying Cylinder Head Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

7. Remove cylinder head cover gasket from the cylinder head cover.

WATER PUMP REMOVAL

Special Tools

EN-46104 Water Pump Pulley Holding Tool

Removal Procedure

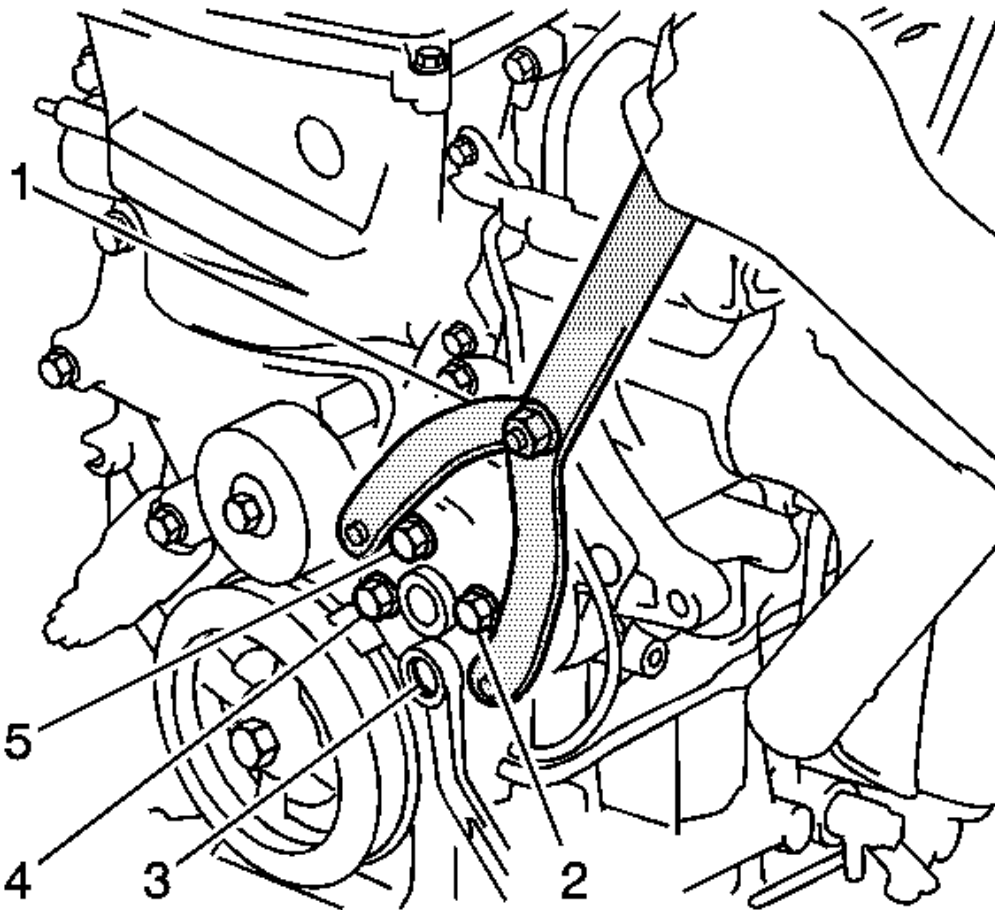


Fig. 281: Identifying Water Pump Pulley Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the four retaining bolts from the water pump pulley using EN-46104.

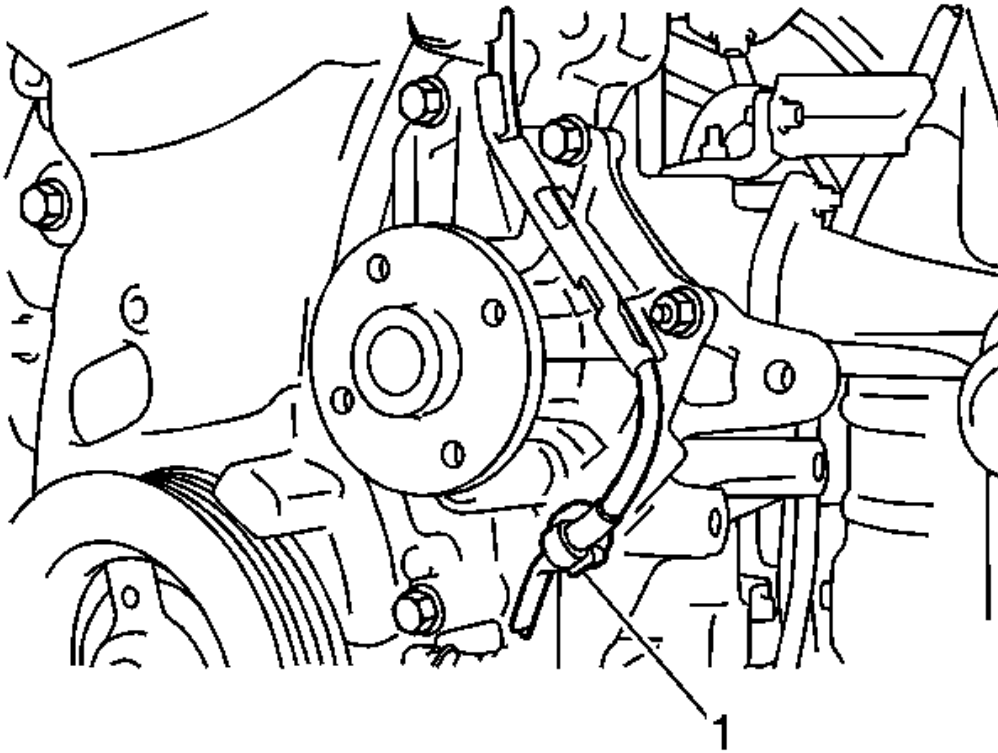


Fig. 282: Identifying Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

2. Remove the clamp of the crankshaft position sensor from the water pump.
3. Disconnect the wire of the crankshaft position sensor from the clamp bracket.

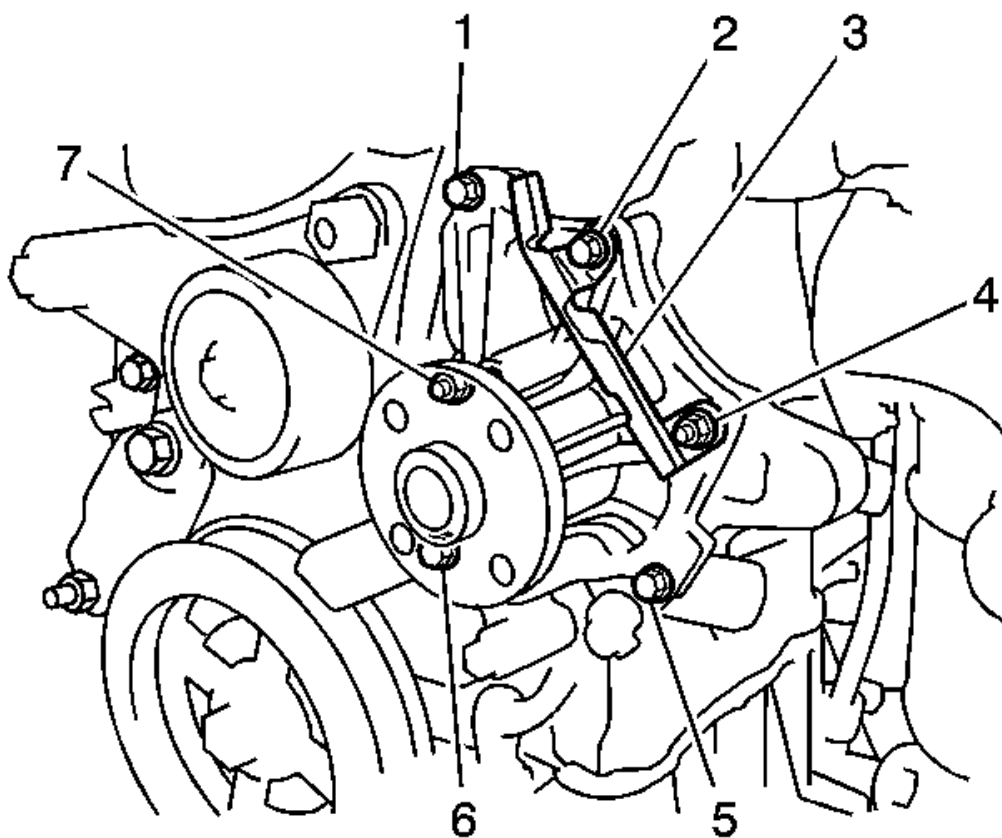


Fig. 283: Identifying Clamp Bracket Fasteners
Courtesy of GENERAL MOTORS CORP.

4. Remove the 4 bolts, 2 nuts and clamp bracket.

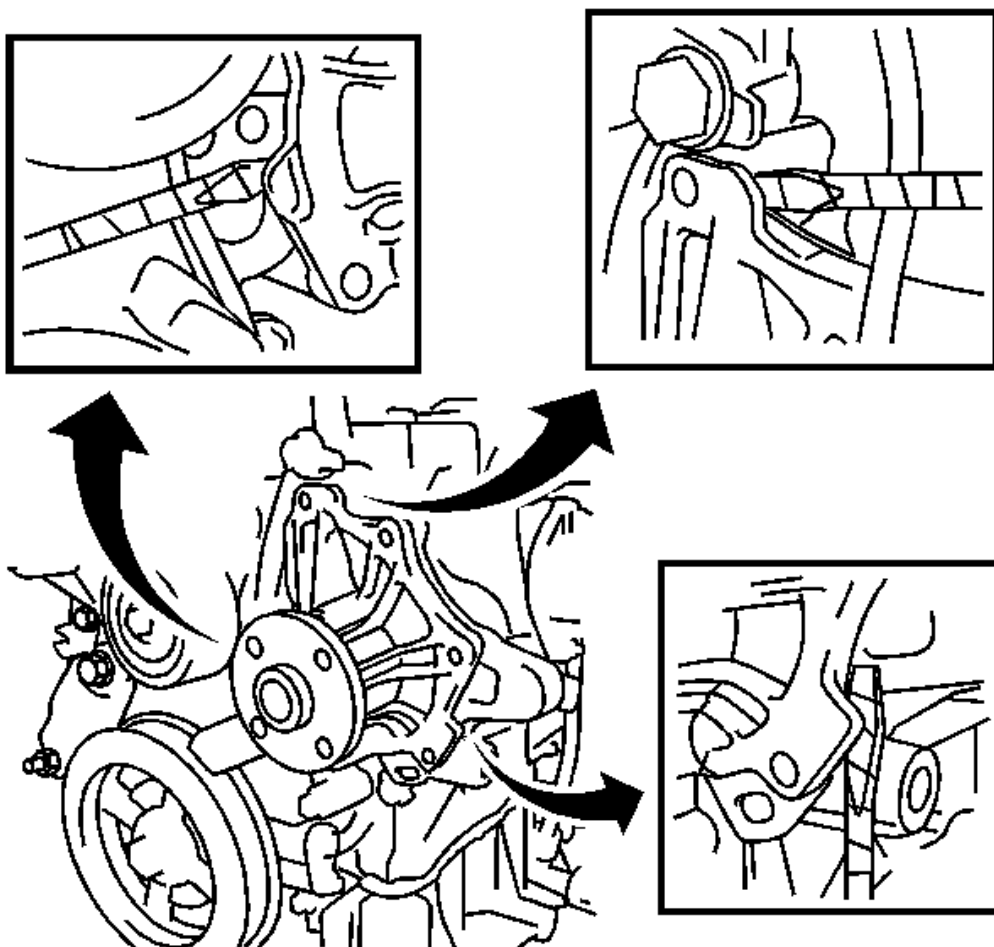


Fig. 284: Exploded View Of Water Pump & Cylinder Block Pry Locations
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Tape the screwdriver tip before use.

5. Using a screwdriver, pry between the water pump and cylinder block, and then remove the water pump.

TIMING CHAIN TENSIONER REMOVAL

Removal Procedure

1. Remove v-ribbed belt tensioner assembly.

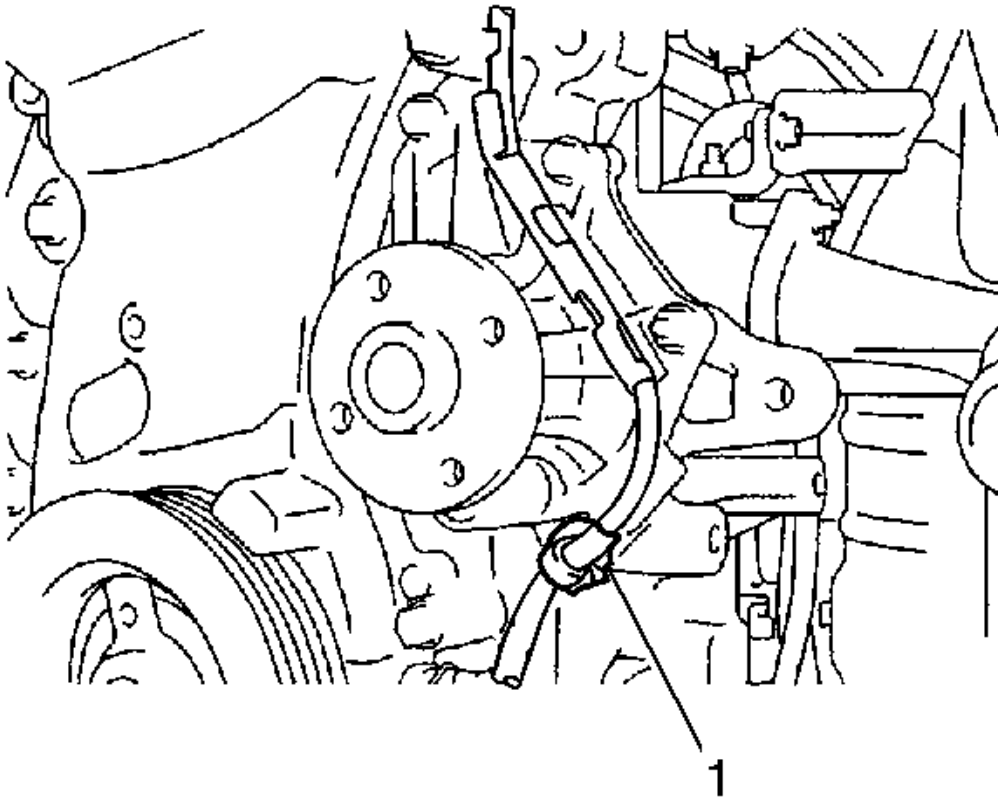


Fig. 285: Identifying Wire Harness Clamp
Courtesy of GENERAL MOTORS CORP.

2. Remove the wire harness clamp.
3. Separate the wire harness from the wire harness clamp bracket.

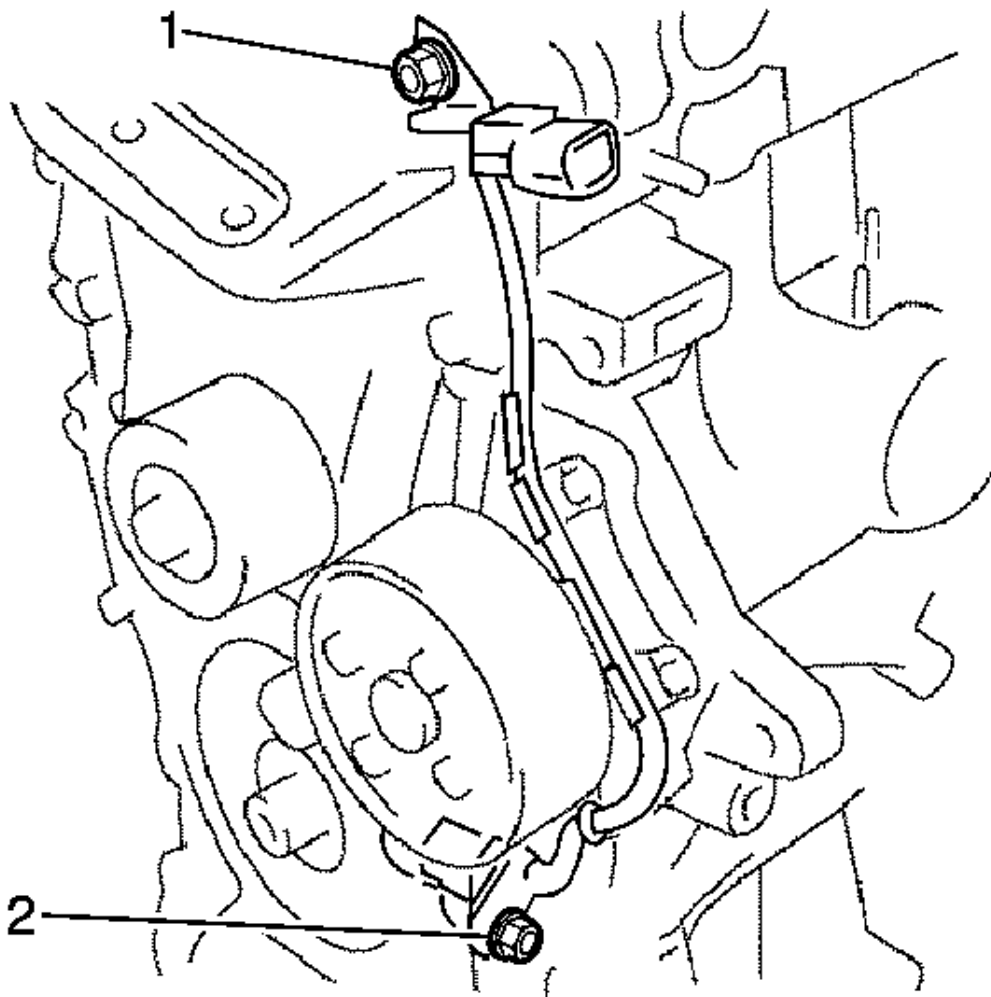


Fig. 286: Identifying Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the 2 bolts and sensor.

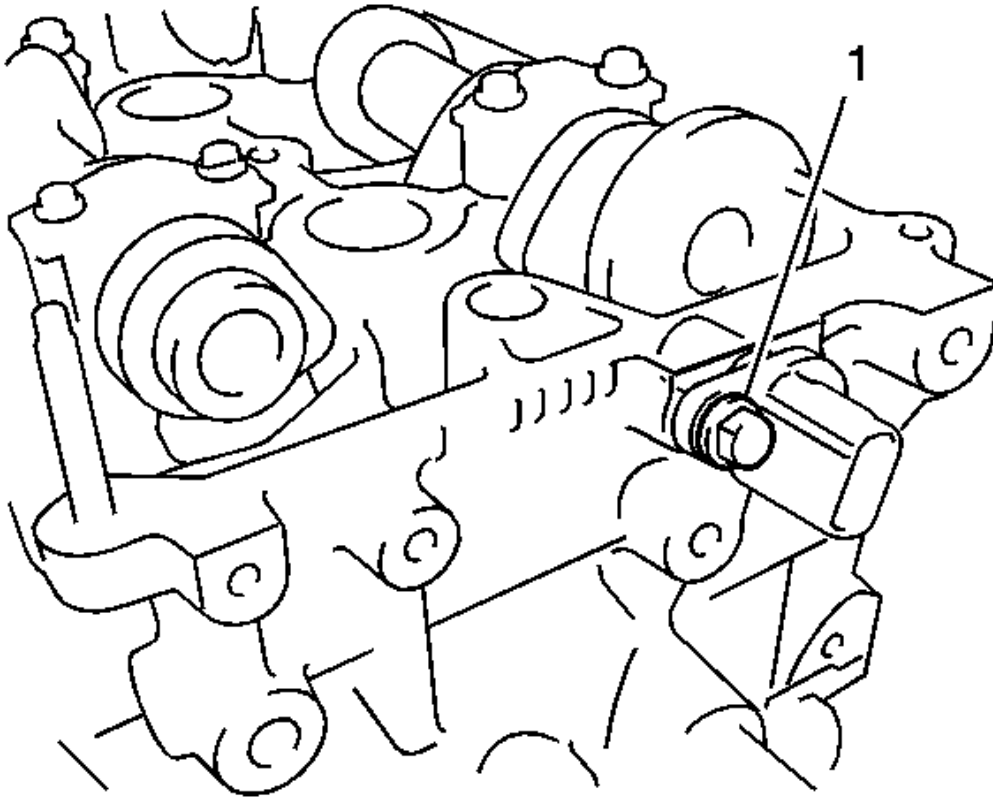


Fig. 287: Identifying Camshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolt and camshaft position sensor.
6. Set No. 1 cylinder to TDC/compression.
7. Remove crankshaft pulley.

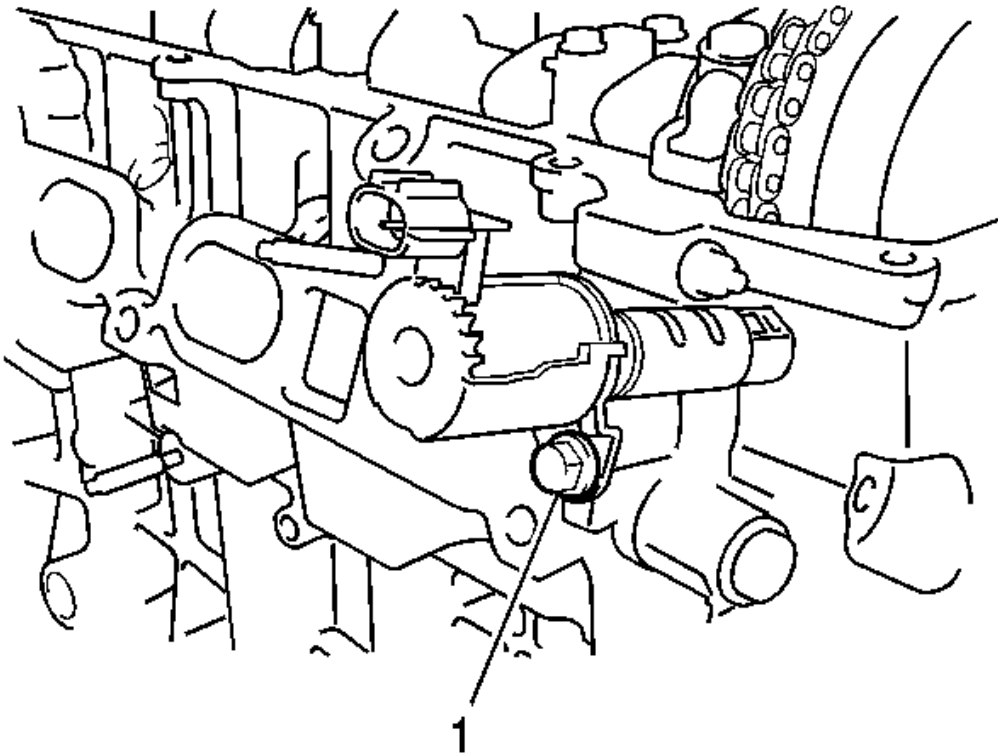


Fig. 288: Identifying Camshaft Timing Oil Control Valve Assembly
 Courtesy of GENERAL MOTORS CORP.

8. Remove camshaft timing oil control valve assembly.

IMPORTANT: The camshaft timing oil control valve may be damaged when loosening the cylinder head bolt if the camshaft timing oil control valve is not removed.

9. Remove the bolt and camshaft timing oil control valve from the cylinder head.
10. Remove No. 1 chain tensioner assembly.
11. Remove the oil pan assembly. Refer to **Oil Pan Removal**.

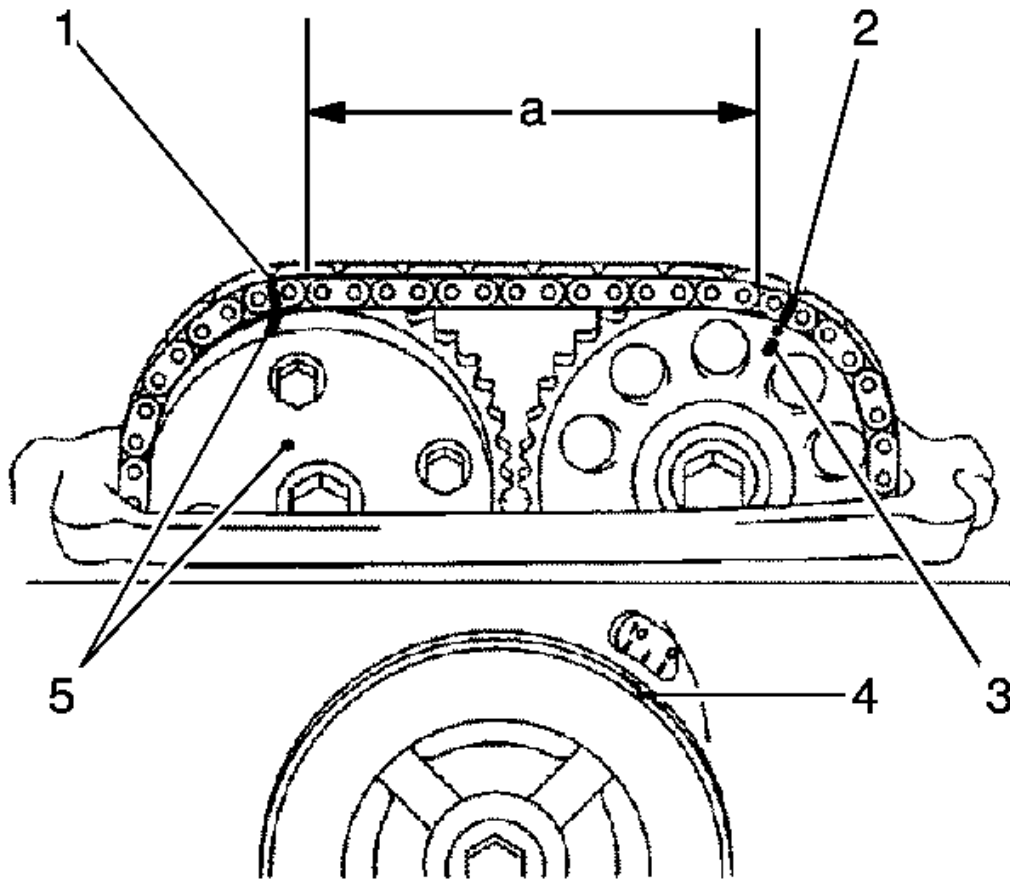


Fig. 289: Checking Timing Chain Paint Mark Alignment
 Courtesy of GENERAL MOTORS CORP.

12. Remove timing chain or belt cover subassembly.
13. Using a screwdriver with its tip wrapped with protective tape, remove the front crankshaft oil seal.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER REMOVAL

Removal Procedure

1. Remove crankshaft position sensor plate.
2. Remove timing chain guide.
3. Remove chain tensioner slipper.
4. Remove No. 1 chain vibration damper.
5. Remove chain sub-assembly.

6. Remove crankshaft timing gear or sprocket.

OIL PUMP DRIVE CHAIN AND SPROCKET REMOVAL

Removal Procedure

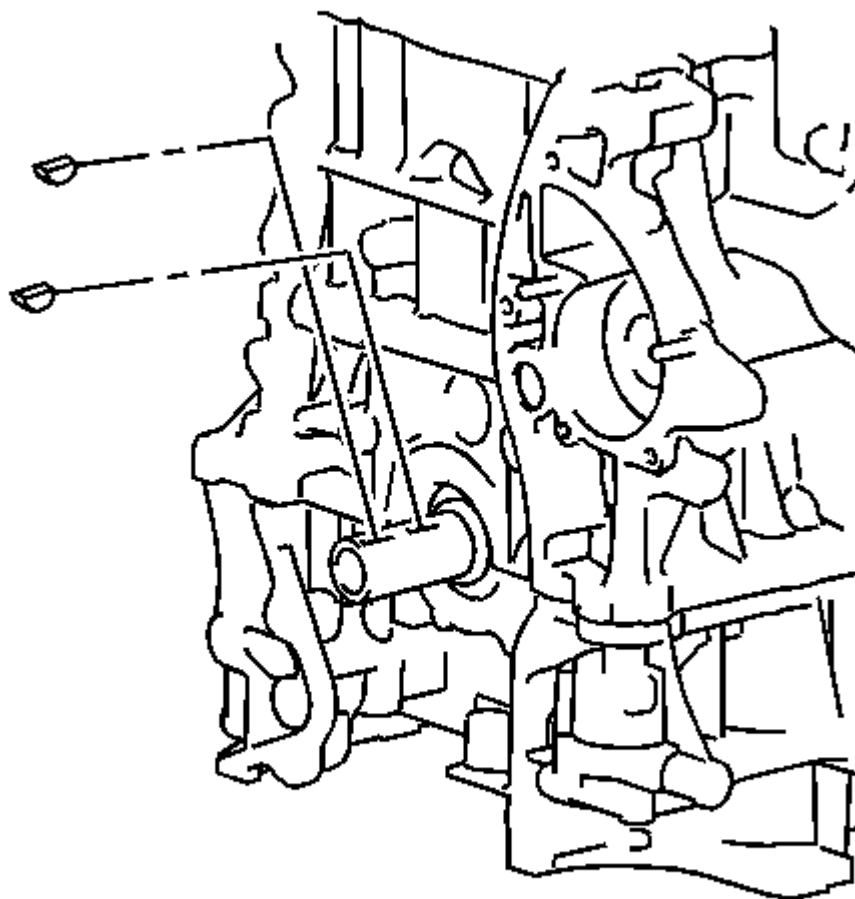


Fig. 290: Identifying Oil Pump Drive Chain Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove No. 2 chain sub-assembly.
2. Remove the 2 pulley set keys from the crankshaft.

INTAKE CAMSHAFT AND VALVE LIFTER REMOVAL

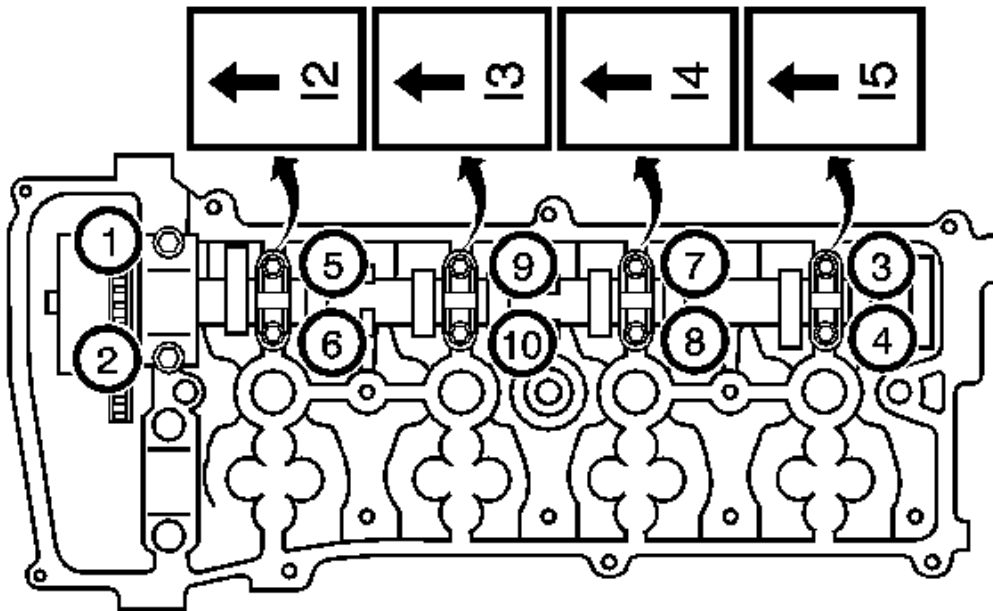
Removal Procedure

Fig. 291: Identifying Intake Camshaft and Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Uniformly loosen the bolts while keeping the camshaft level. Arrange the removed parts in the correct order.

1. Using several steps, uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.
2. Remove the 5 bearing caps.
3. Remove the intake camshaft.

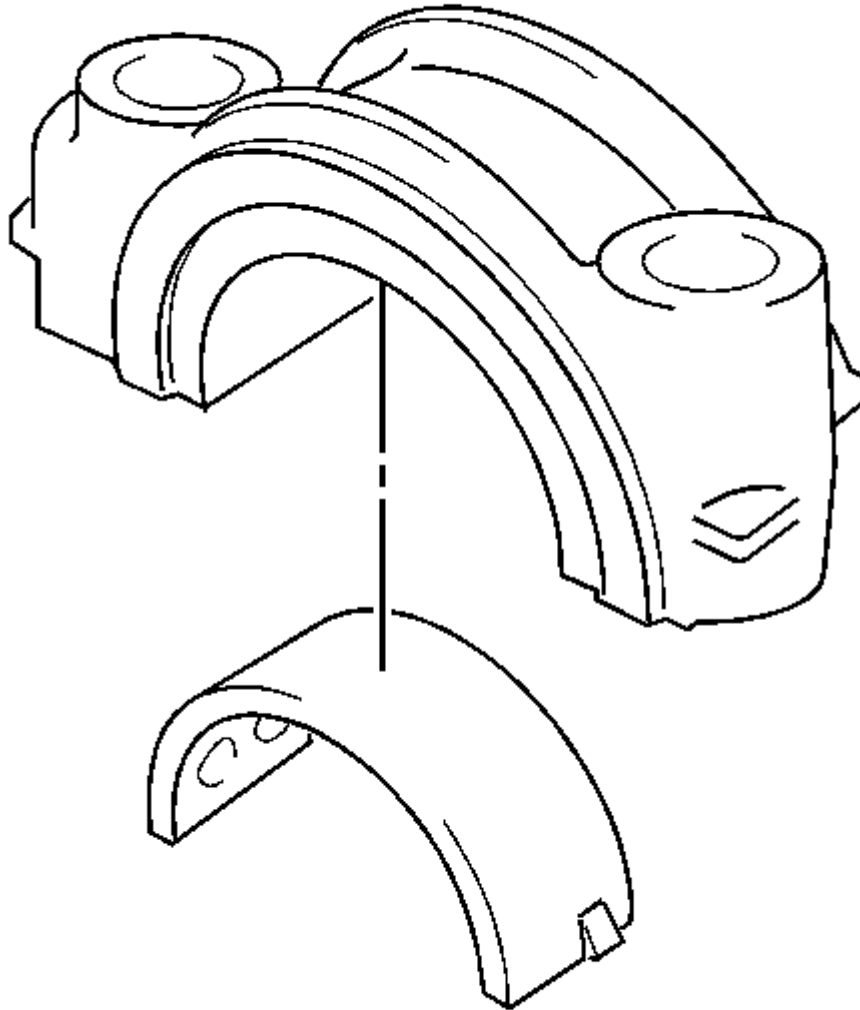


Fig. 292: View Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft bearing from the intake camshaft bearing cap.

EXHAUST CAMSHAFT AND VALVE LIFTER REMOVAL

Removal Procedure

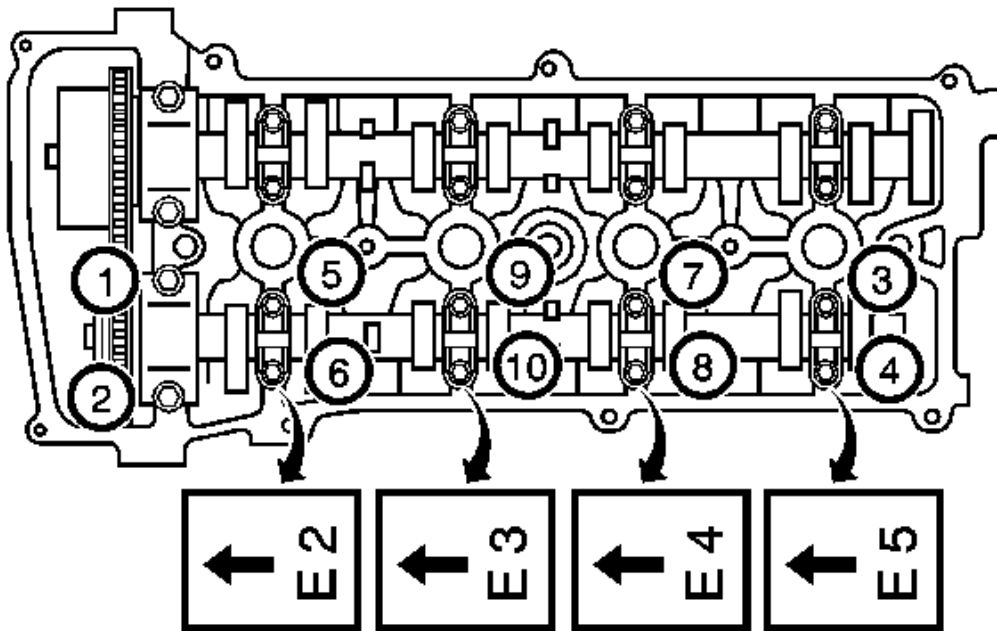


Fig. 293: Identifying Exhaust Camshaft & Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Uniformly loosen the bolts while keeping the camshaft level. Arrange the removed parts in the correct order.

1. Using several steps, uniformly loosen and remove the 10 bearing cap bolts in the sequence shown in the illustration.
2. Remove the 5 bearing caps.
3. Remove the exhaust camshaft.

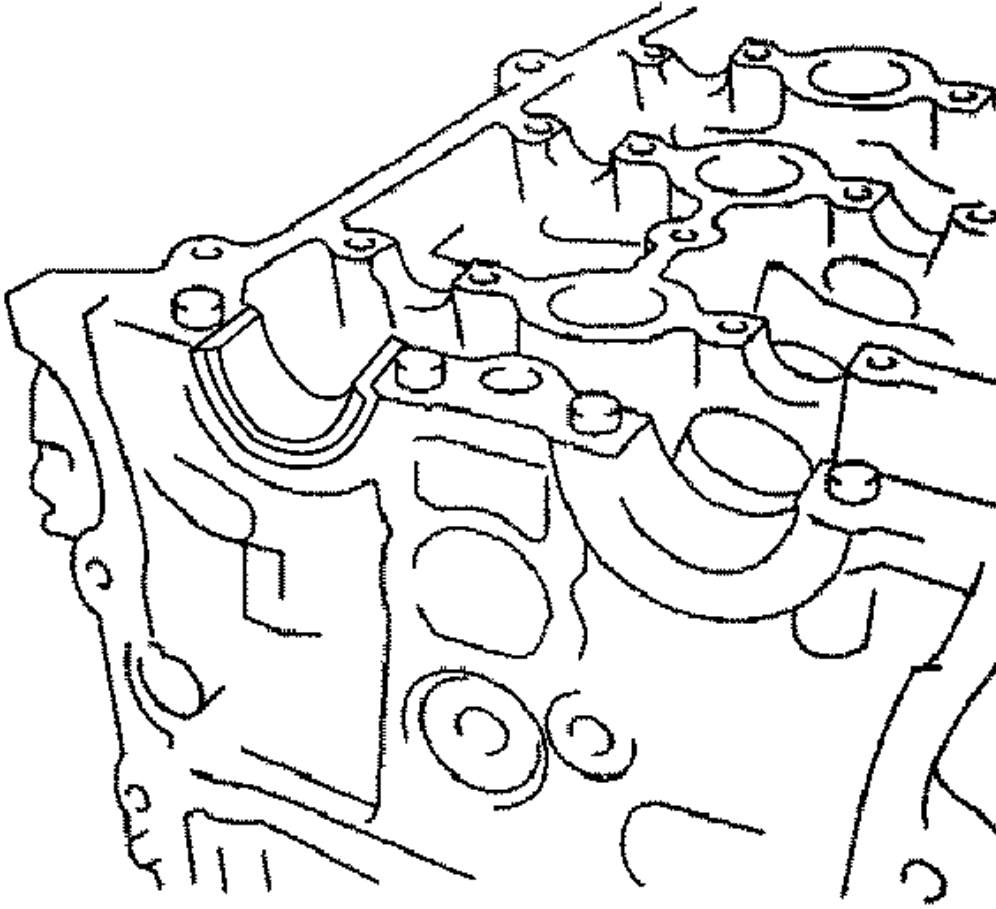


Fig. 294: View Of Exhaust Camshaft Bearing Journals
Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust camshaft bearing from the cylinder head.

CYLINDER HEAD REMOVAL

Removal procedure

1. Remove cylinder head sub-assembly.

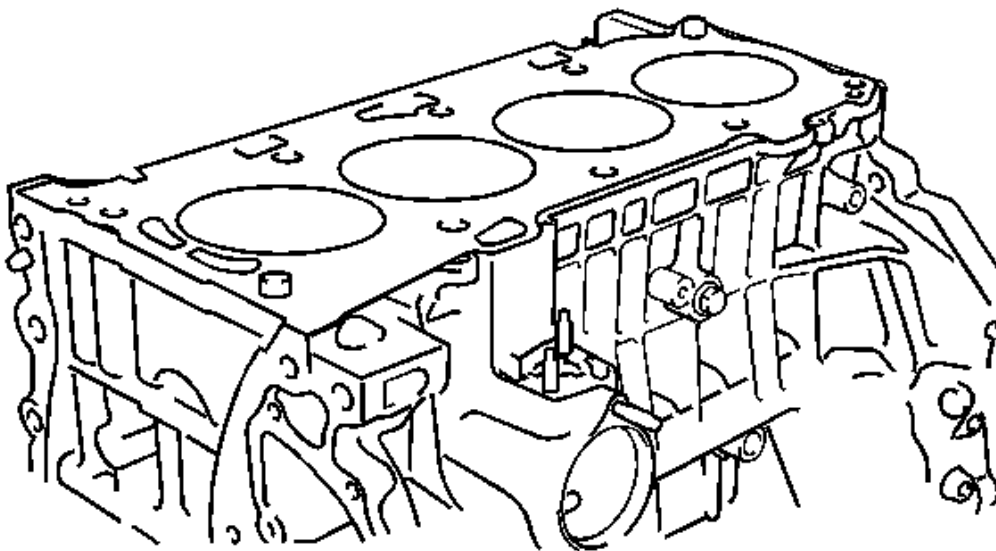


Fig. 295: Identifying Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Remove cylinder head gasket.

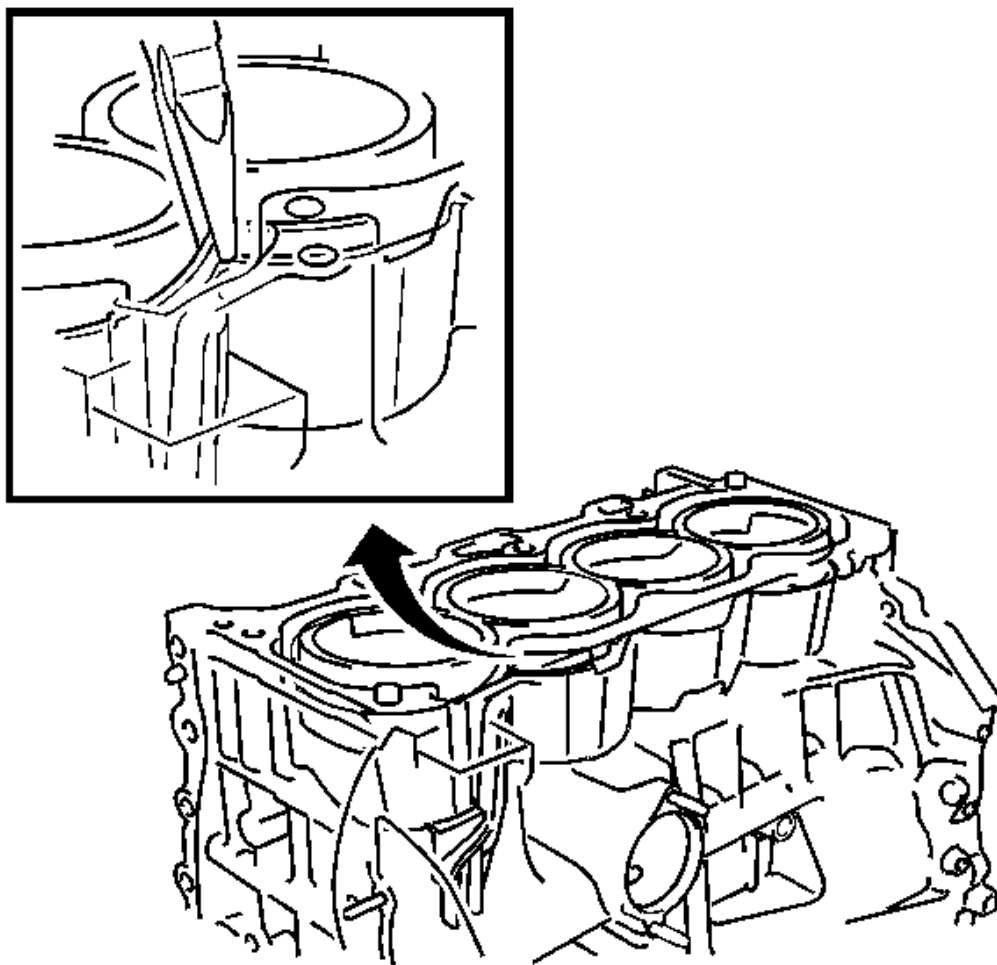


Fig. 296: Identifying Cylinder Block Water Jacket Spacer
Courtesy of GENERAL MOTORS CORP.

NOTE: Before turning the cylinder block upside down, make sure that the water jacket spacer is removed, as it will fall out.

3. Using needle nose pliers, remove the cylinder block water jacket spacer from the water jacket.

OIL PAN REMOVAL

Removal Procedure

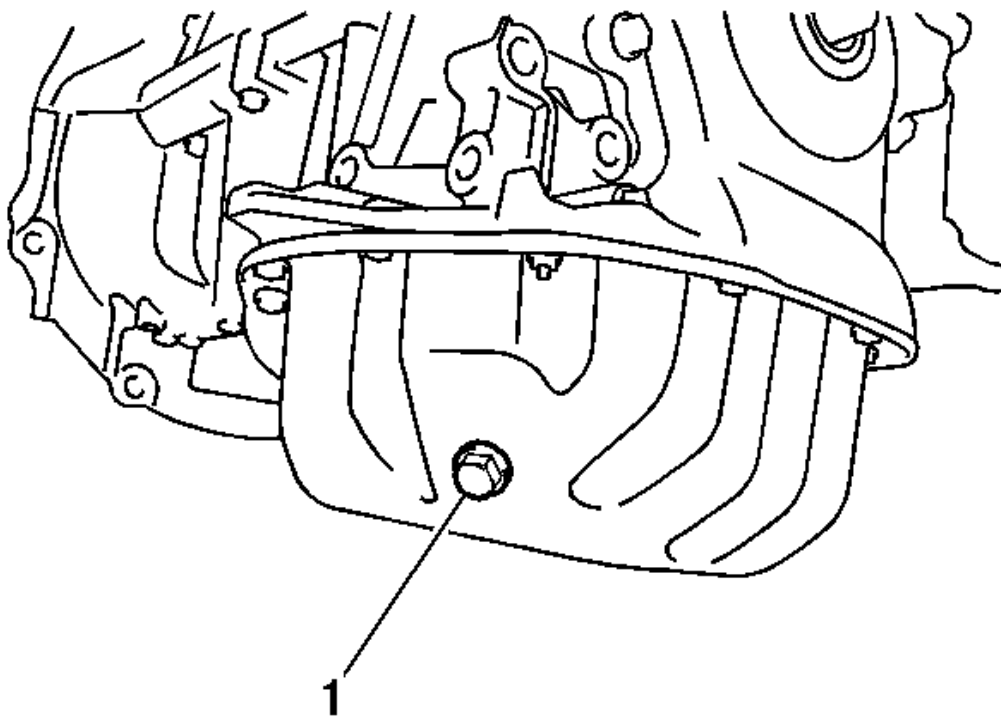


Fig. 297: Identifying Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan drain plug from the oil pan.

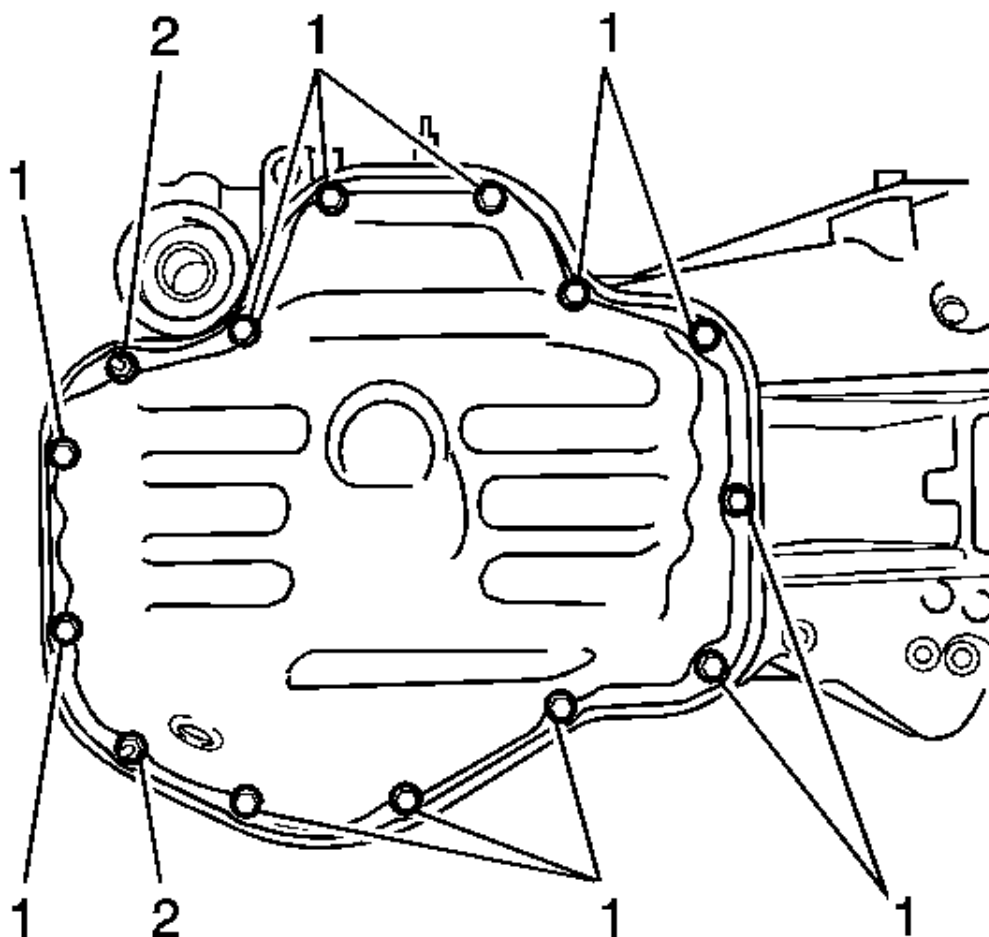


Fig. 298: Identifying Oil Pan Bolts
 Courtesy of GENERAL MOTORS CORP.

2. Remove the 12 bolts and 2 nuts.

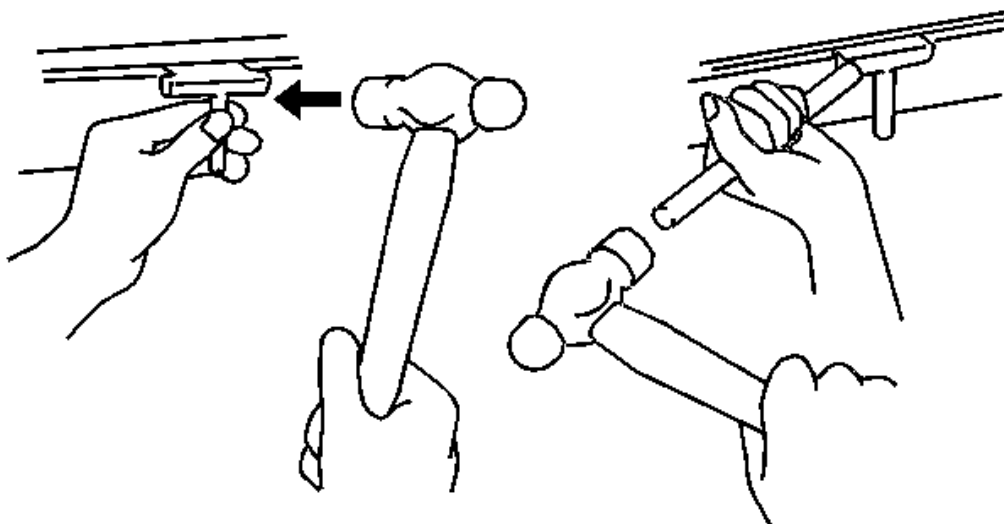


Fig. 299: Illustrating Oil Pan Removal
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the contact surfaces of the crankcase, chain cover and oil pan.

3. Insert the blade of oil pan seal cutter between the crankcase, chain cover and oil pan, then cut through the applied sealer and remove the oil pan.

OIL PUMP REMOVAL

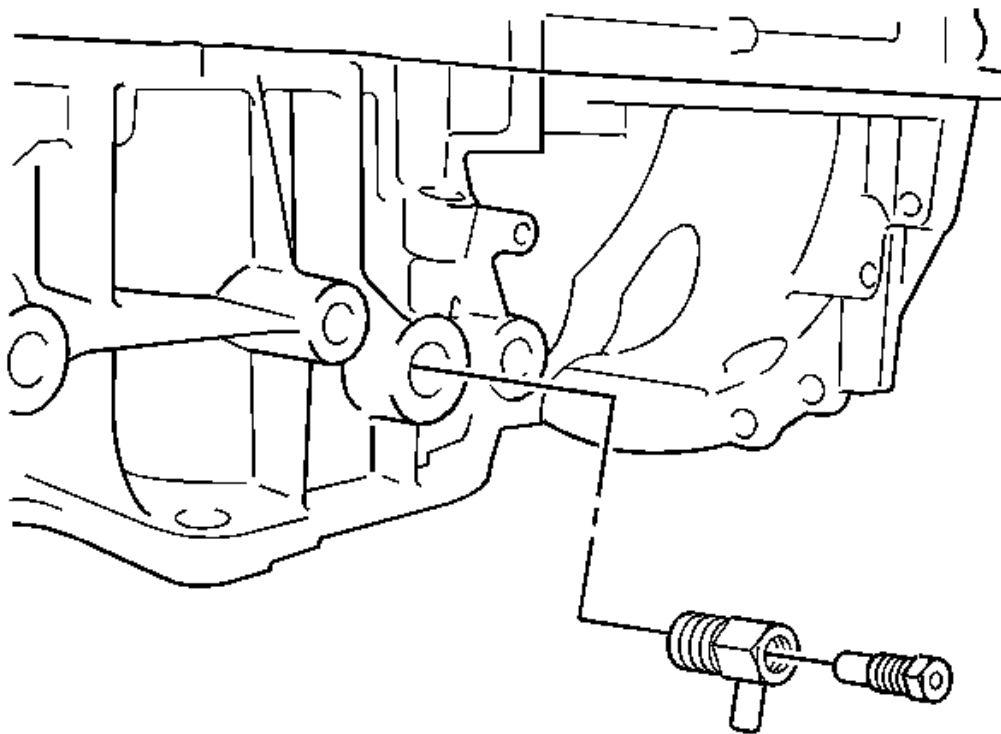


Fig. 300: Identifying Water Drain Cock
Courtesy of GENERAL MOTORS CORP.

1. Remove the water drain cock from the stiffening crankcase.
2. Remove the water drain cock plug from the water drain cock.

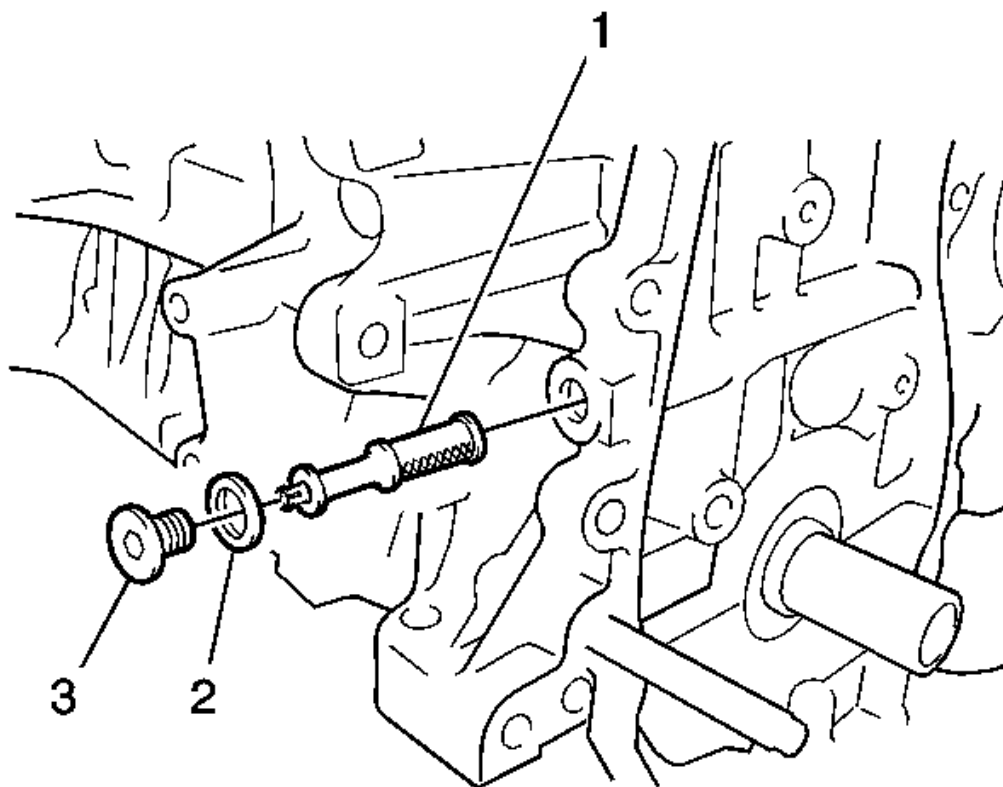


Fig. 301: View Of Control Valve Filter, Gasket & Plug
Courtesy of GENERAL MOTORS CORP.

3. Using a socket hexagon wrench 8, remove the plug, gasket and oil control valve filter.
4. Remove oil pump assembly.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Disassembly Procedure

1. Inspect connecting rod thrust and oil clearance. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection.**

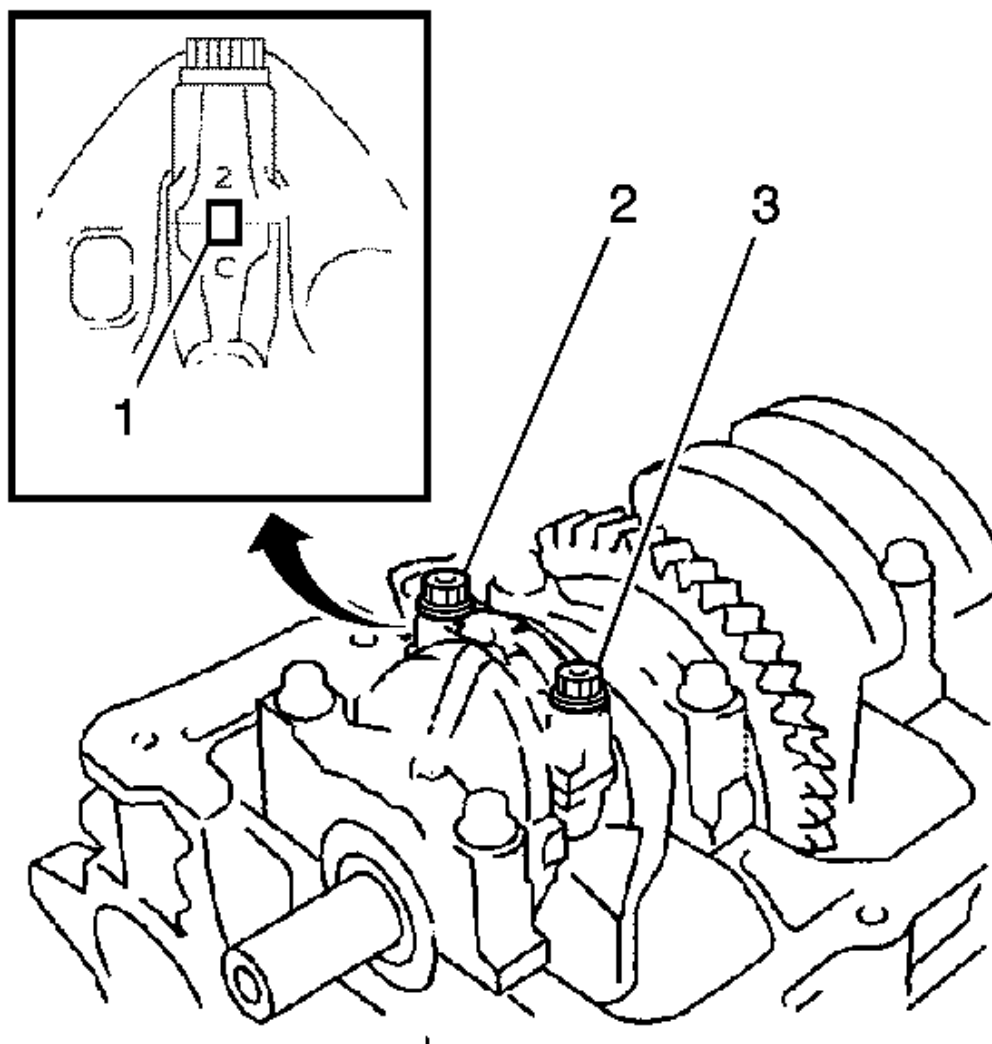


Fig. 302: Checking Matchmarks For Correct Connecting Rods & Caps Positioning
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The matchmarks on the connecting rods and caps are provided for ensuring the correct reassembly.

2. Check that the matchmarks on the connecting rod and cap are aligned to ensure the correct reassembly.

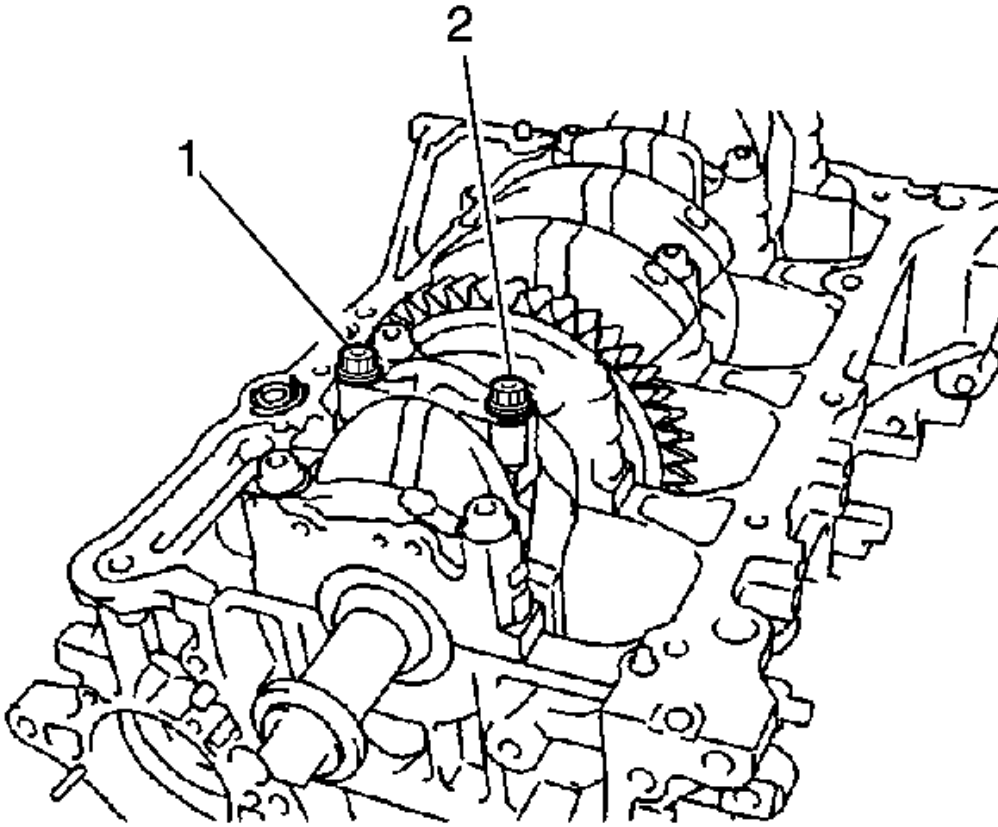


Fig. 303: View Of Loosening Connecting Rod Cap Bolts
Courtesy of GENERAL MOTORS CORP.

3. Using a 12 mm socket wrench, uniformly loosen and remove the 2 bolts.

IMPORTANT: Keep the lower bearing inserted in the connecting rod cap.

4. Using the 2 removed connecting rod cap bolts, remove the connecting rod cap and lower bearing by wiggling the connecting rod cap right and left.

IMPORTANT:

- Keep the bearing, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in the correct order.

5. Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

IMPORTANT: Arrange the removed parts in the correct order.

6. Remove the connecting rod bearings.

CRANKSHAFT REAR OIL SEAL REMOVAL

Removal Procedure

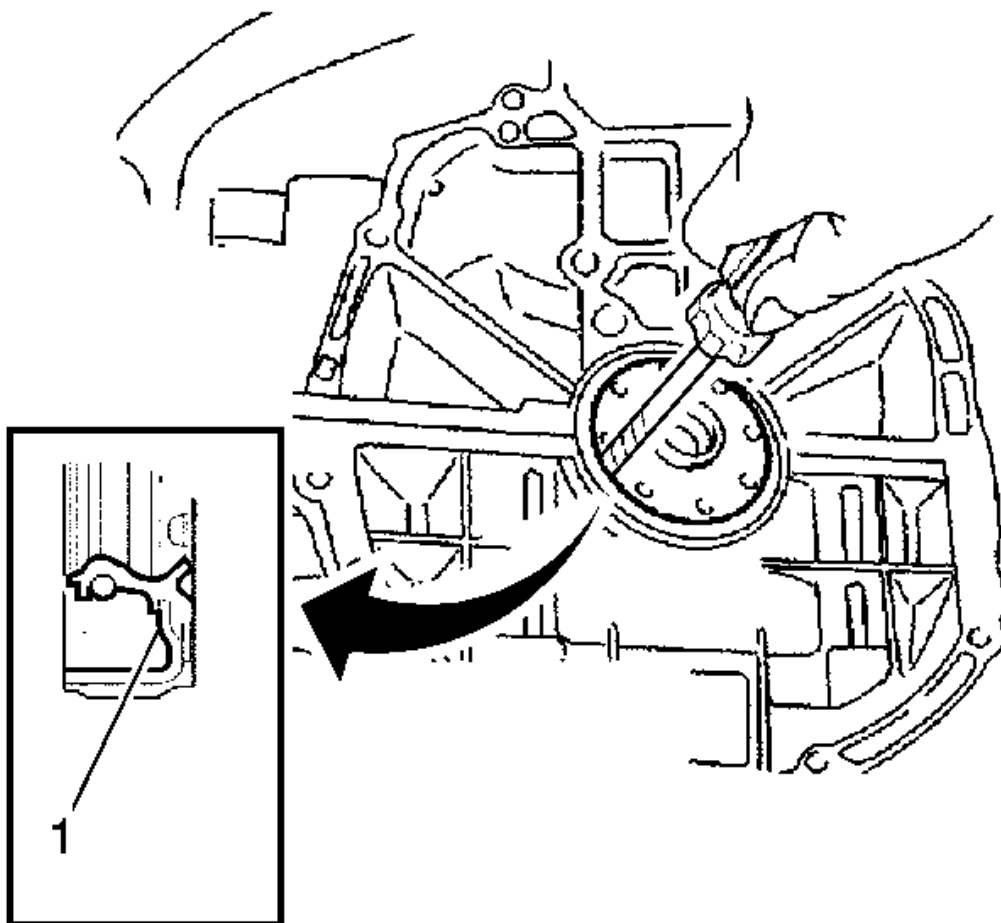


Fig. 304: View Of Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

1. Using a knife, cut off the lip of the oil seal.

IMPORTANT: After removing, check the crankshaft for damage. If damaged, smooth the

surface with 400-grit sandpaper.

IMPORTANT: Tape the screwdriver tip before use.

2. Using a screwdriver, pry out the oil seal.

BALANCE SHAFT REMOVAL

Repair Procedure

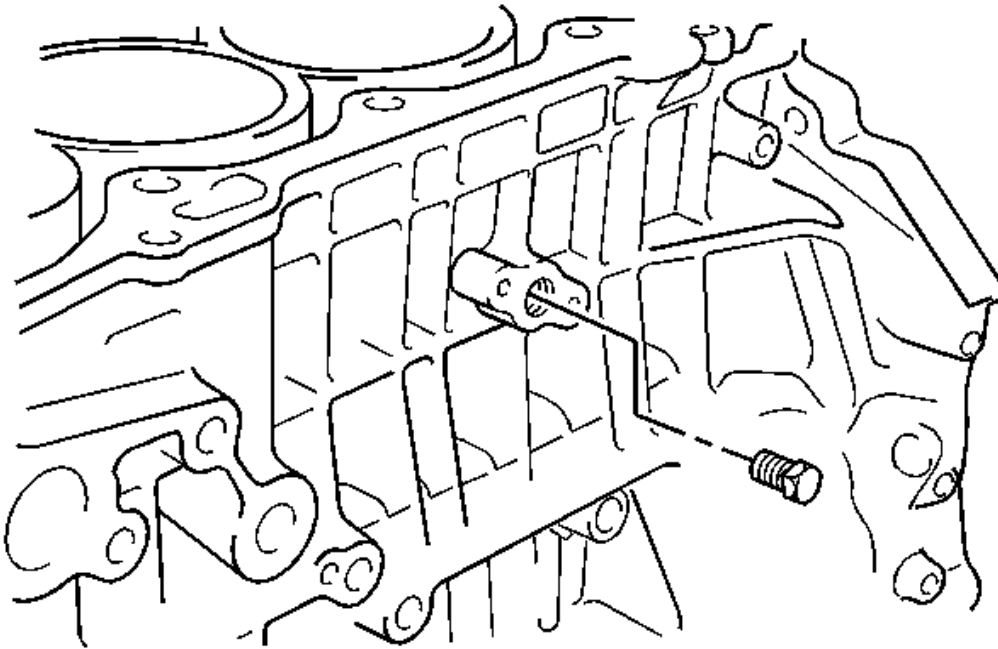


Fig. 305: Identifying Taper Head Screw Plug
Courtesy of GENERAL MOTORS CORP.

1. Remove the No. 1 taper head screw plug.
2. Inspect balanceshaft thrust clearance.
3. Inspect balanceshaft oil clearance.

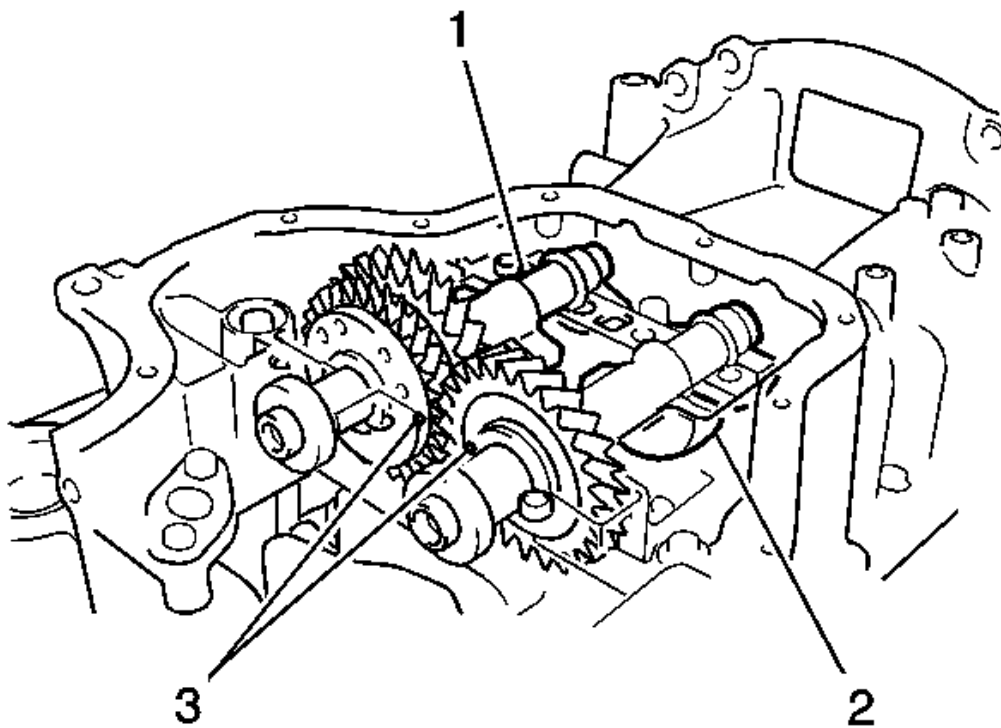


Fig. 306: Identifying Balancershafts
Courtesy of GENERAL MOTORS CORP.

4. Remove the No. 1 and No. 2 balancershafts.

BALANCER SHAFT BEARING REMOVAL

Removal Procedure

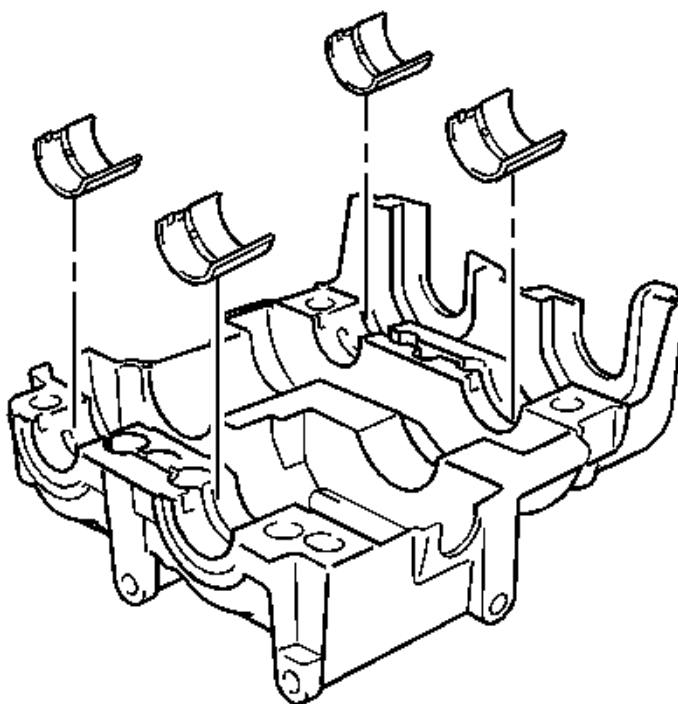
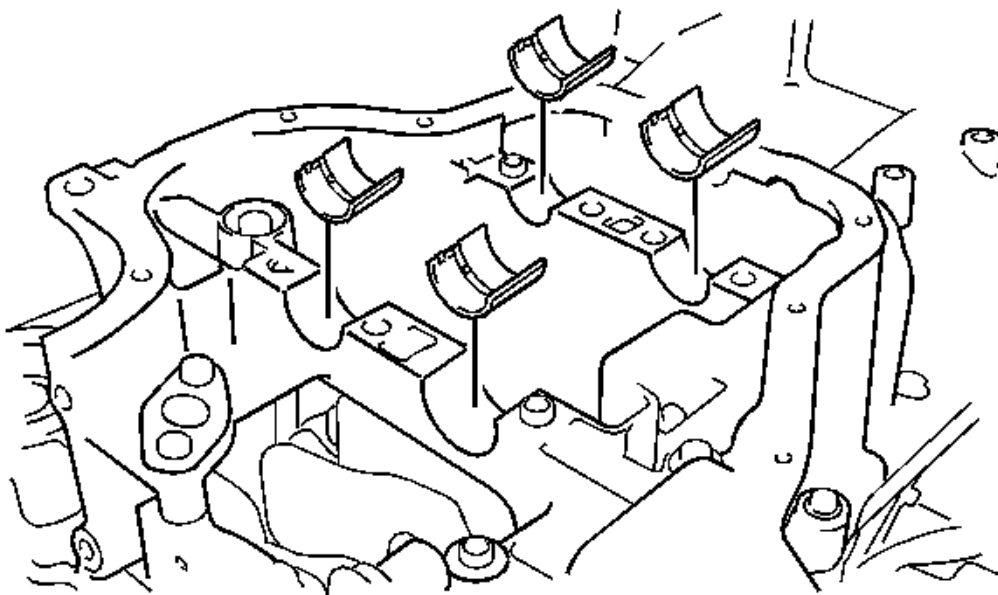


Fig. 307: Identifying Balancer Shaft Bearing

Courtesy of GENERAL MOTORS CORP.

1. Remove the 8 No. 1 balancershaft bearings shown in the illustration.
2. Remove rear crankshaft oil seal.

LOWER CRANKCASE REMOVAL

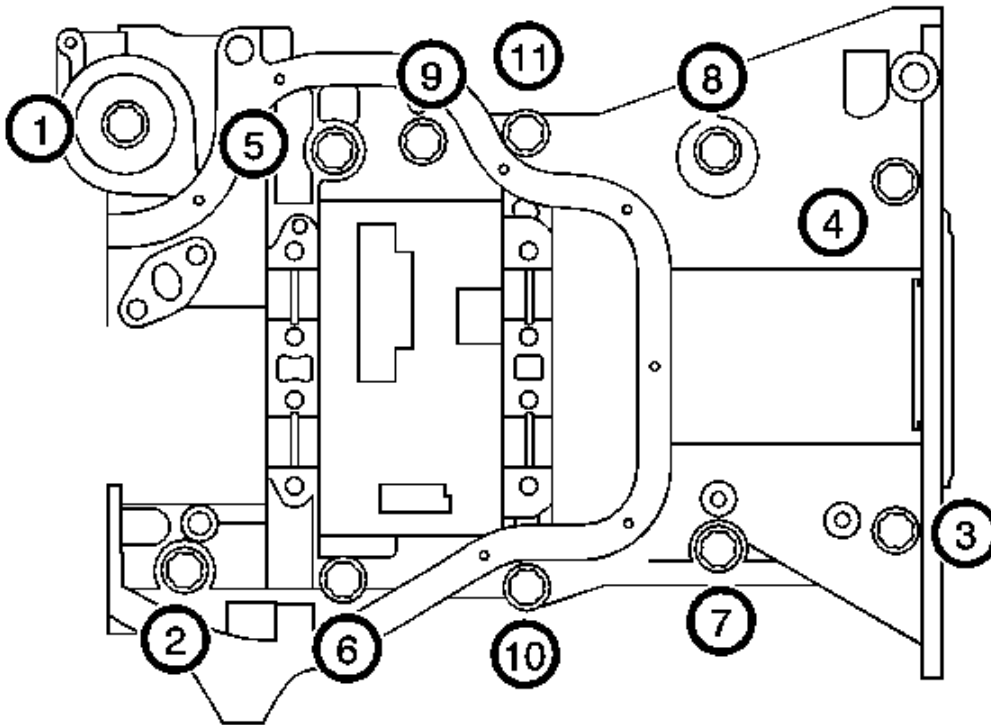


Fig. 308: Identifying Lower Crankcase Bolt Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

1. Uniformly loosen and remove the 11 bolts in the sequence shown in the illustration.

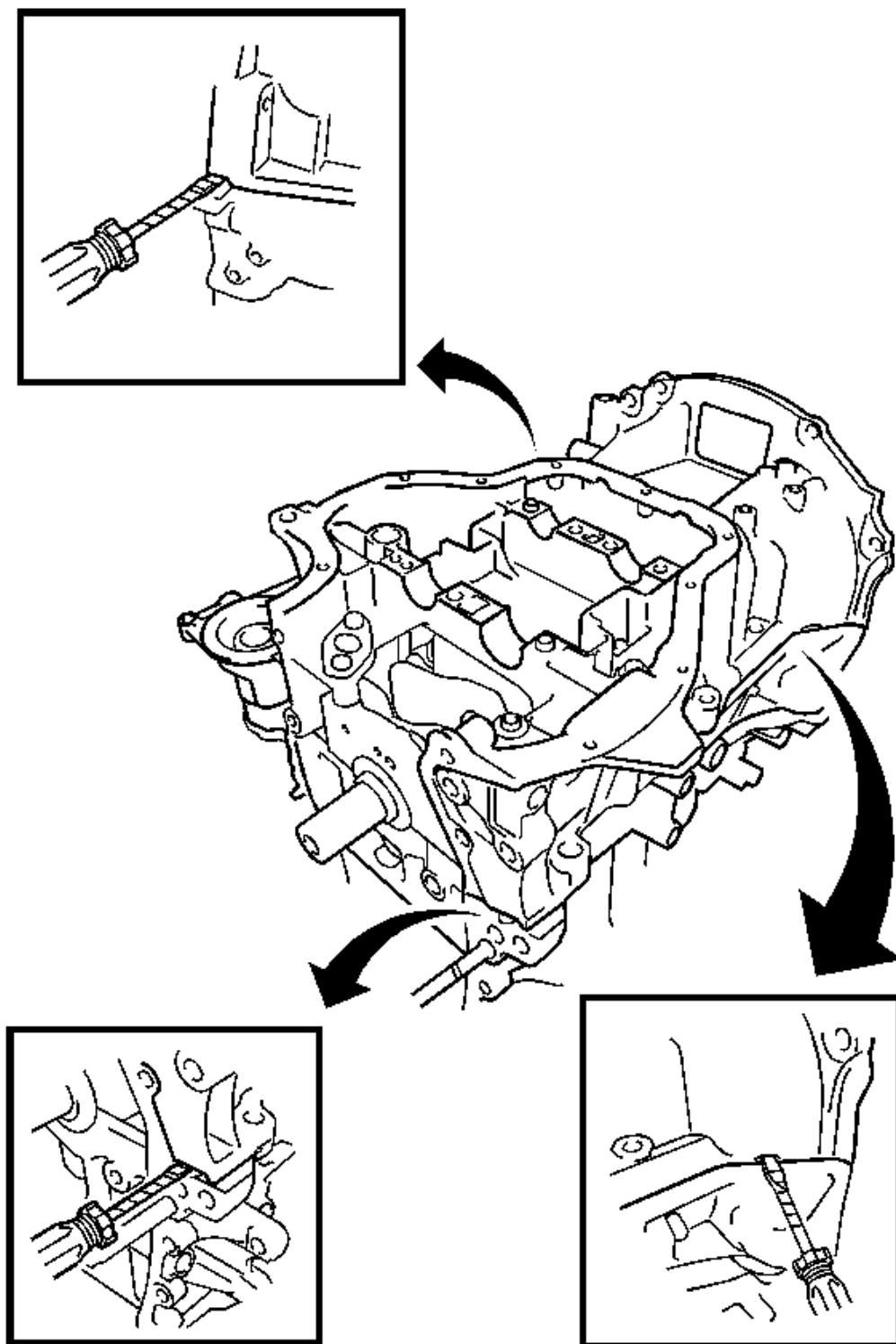


Fig. 309: Identifying Lower Crankcase Inspection Areas
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the contact surfaces between the crankcase and cylinder block.

2. Using a screwdriver with its tip wrapped with protective tape, remove the crankcase by prying between the crankcase and cylinder block.

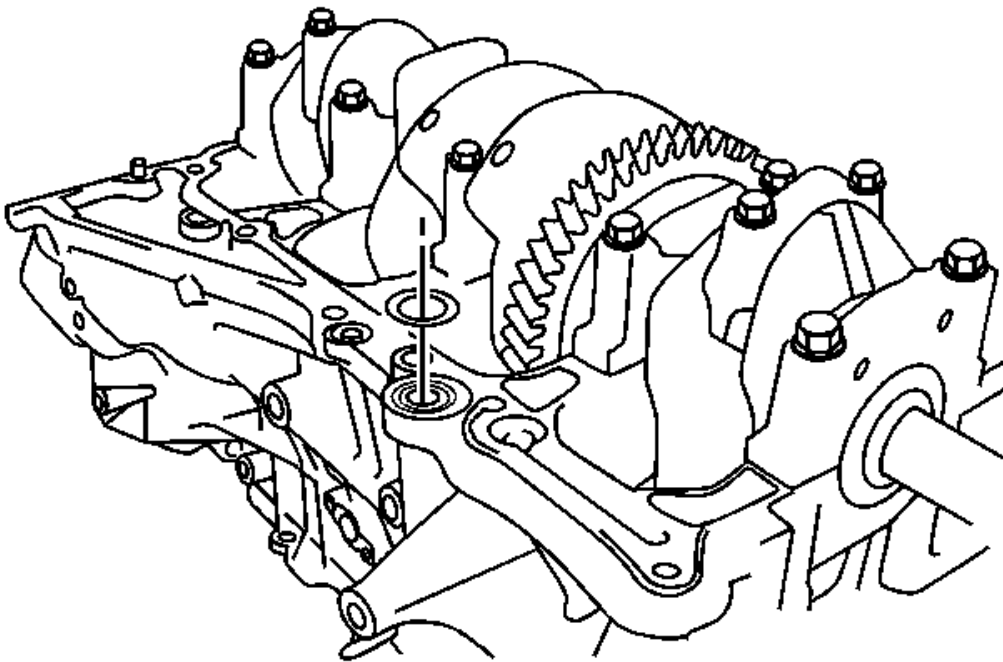


Fig. 310: Identifying Cylinder Block & Crankshaft
Courtesy of GENERAL MOTORS CORP.

3. Remove the O-ring from the cylinder block.

BALANCE SHAFT CLEANING AND INSPECTION

Repair Procedure

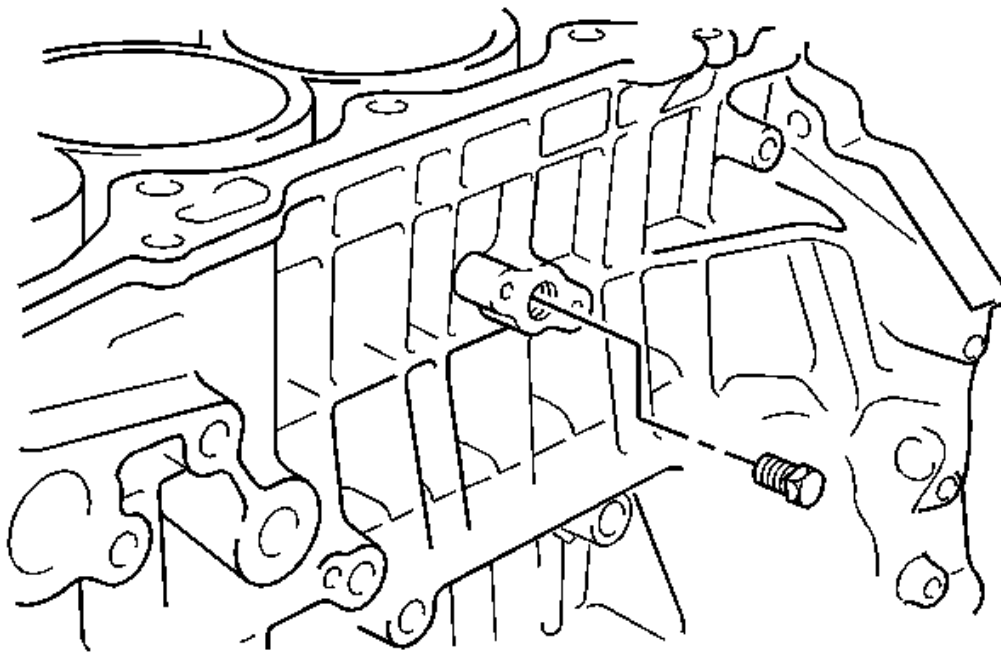


Fig. 311: Identifying Taper Head Screw Plug
Courtesy of GENERAL MOTORS CORP.

1. Remove the No. 1 taper head screw plug.
2. Inspect balancshaft thrust clearance.
3. Inspect balancshaft oil clearance.

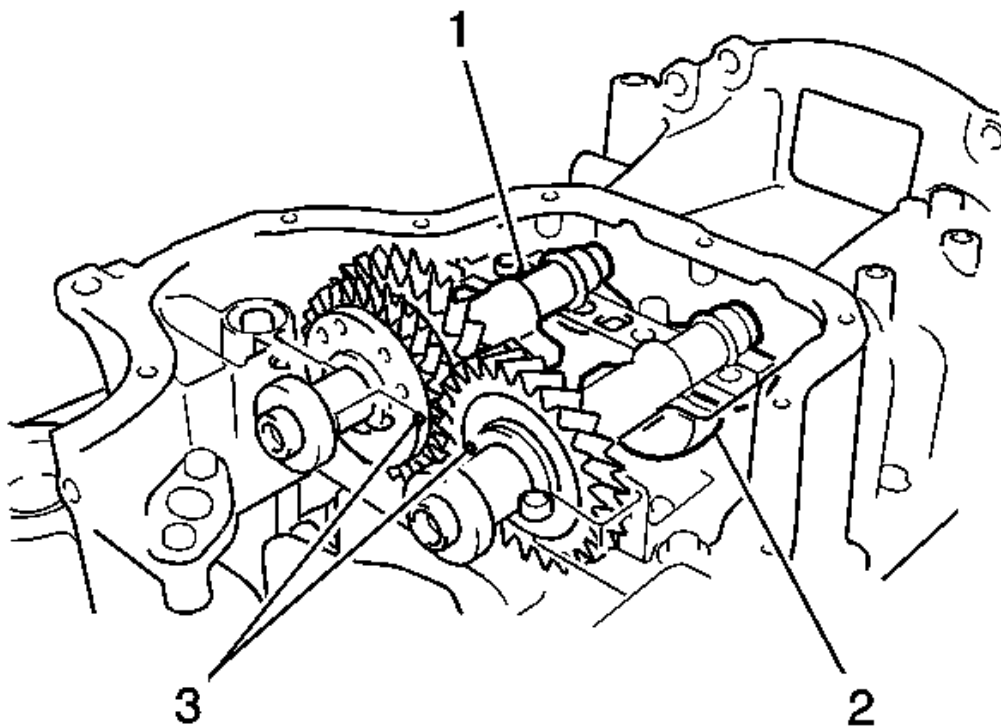


Fig. 312: Identifying Balancershafts
Courtesy of GENERAL MOTORS CORP.

4. Remove the No. 1 and No. 2 balancershafts.
5. Install the balancershafts.

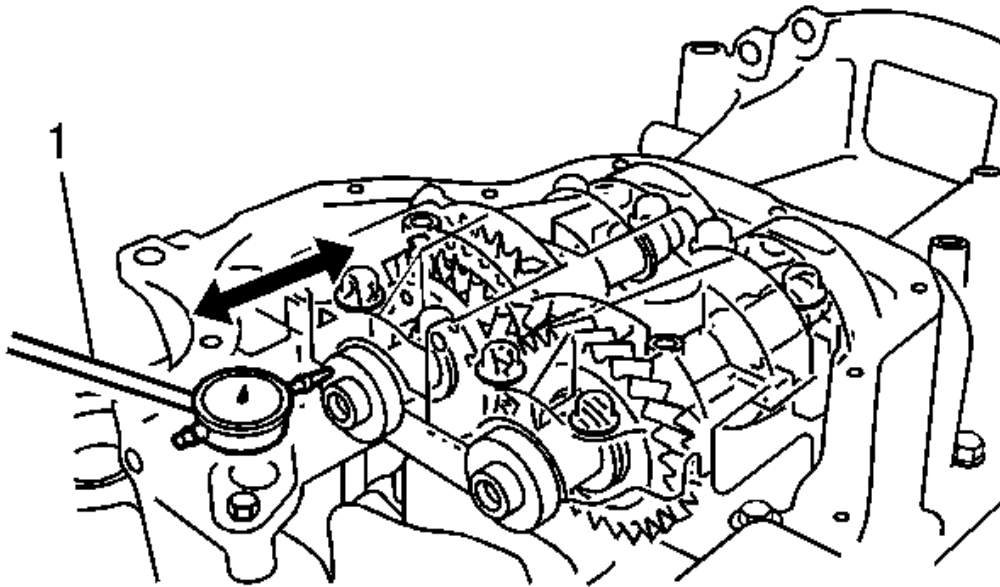


Fig. 313: Checking Crankshaft Thrust Clearance
 Courtesy of GENERAL MOTORS CORP.

6. Using a dial indicator, measure the thrust clearance while moving the balancer back and forth.

Standard thrust clearance: 0.05 to 0.09 mm (0.0020 to 0.0035 in)

Maximum thrust clearance: 0.09 mm (0.0035 in)

7. If the thrust clearance is greater than the maximum, replace the balancer housing and bearings. If necessary, replace the balancer.
8. Clean each bearing and journal.
9. Check each bearing and journal for pitting and scratches. If a bearing or journal is damaged, replace the bearings. If necessary, replace the balancer.
10. Place the No. 1 and No. 2 balancers onto the crankcase.

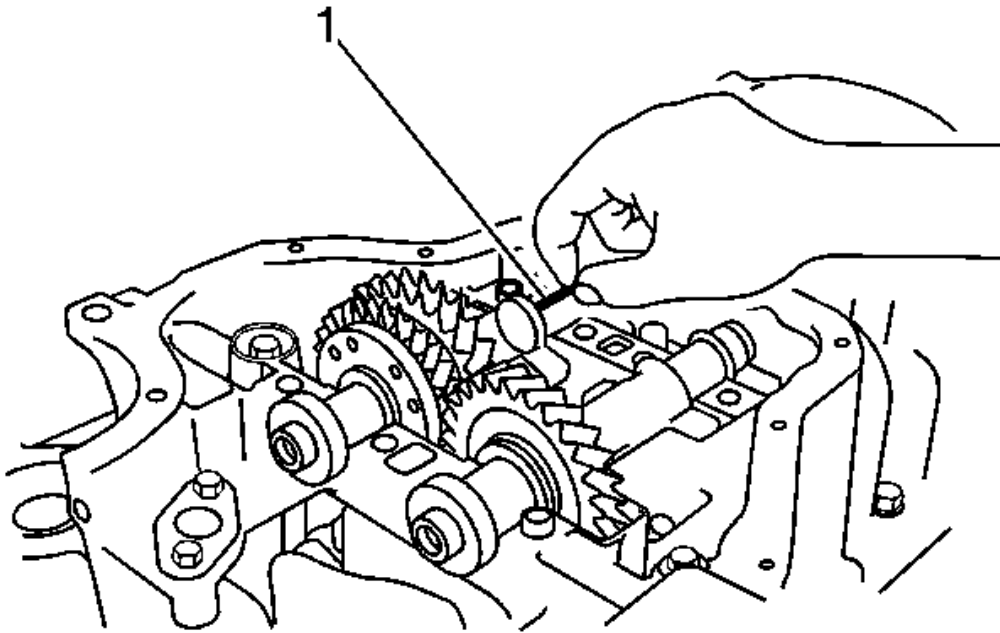


Fig. 314: Using Plastigage To measure Clearance
Courtesy of GENERAL MOTORS CORP.

11. Lay a strip of Plastigage across each journal.

NOTE: **Do not turn the balancershafts.**

12. Install the balancershaft housing.
13. Remove the balancershafts.

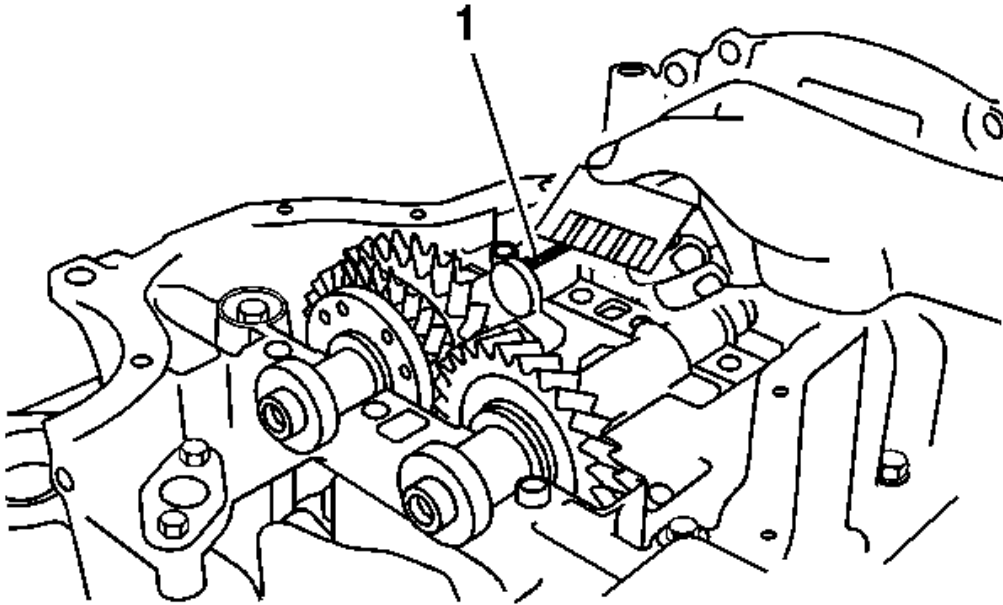


Fig. 315: Measuring Bearing Clearance Using Plastigage
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove the Plastigage completely after the measurement.

14. Measure the Plastigage at its widest point.

Standard oil clearance: 0.022 to 0.049 mm (0.0009 to 0.0019 in)

Maximum oil clearance: 0.049 mm (0.0019 in)

15. If the oil clearance is greater than the maximum, replace the bearing. If necessary, replace the balancershaft.
16. If replacing a bearing, select a new one with the same number.

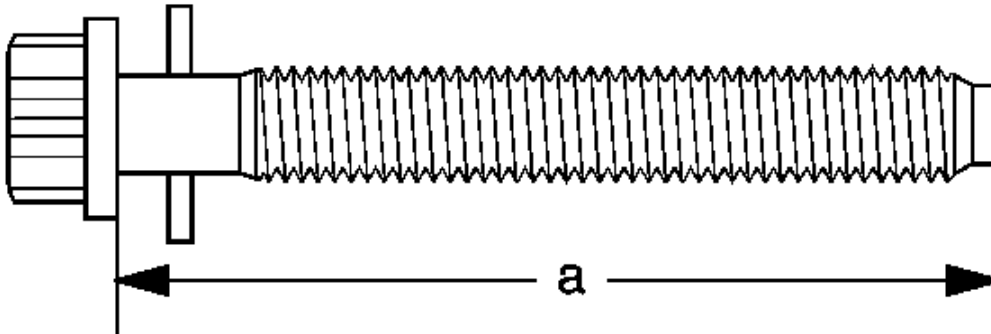


Fig. 316: Identifying Balancerhousing Bolt
Courtesy of GENERAL MOTORS CORP.

17. Inspect the balancerhousing bolts.
18. Using vernier calipers, measure the length of the bolts from the seat to the end.

Standard bolt length: 58.3 to 59.7 mm (2.295 to 2.350 in)

Maximum bolt length: 60.3 mm (2.374 in)

19. If the bolt length is greater than the maximum, replace the balancerhousing bolt.

CRANKSHAFT AND BEARING REMOVAL

Removal Procedure

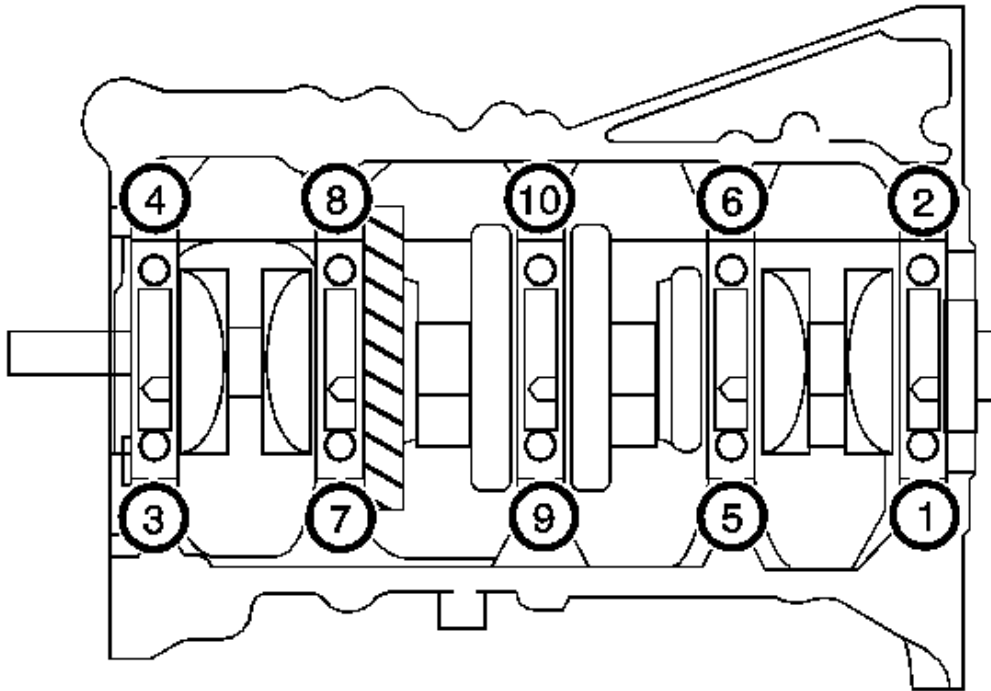


Fig. 317: Identifying Main Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

1. Uniformly loosen and remove the 10 main bearing cap bolts in the sequence shown in the illustration.

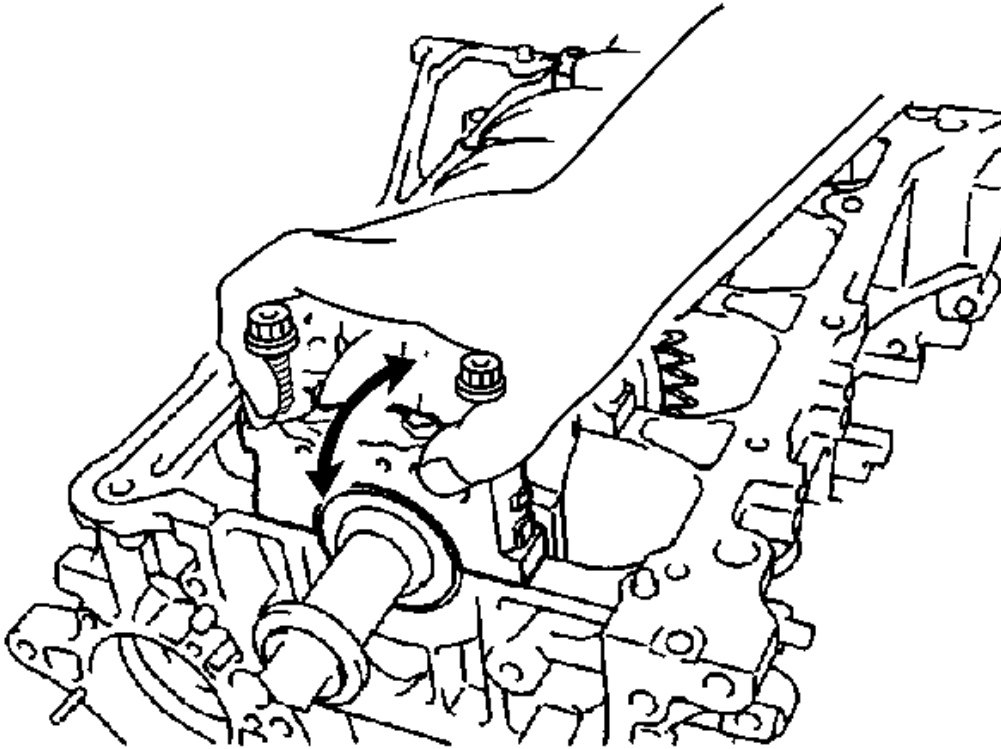


Fig. 318: View Of Crankshaft Removal Procedure
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Insert the bolts into one of the caps. Ease the cap out by gently pulling up and applying force toward the front and back side of the cylinder block, as shown in the illustration.

IMPORTANT:

- Keep the lower bearing and main bearing cap.
- Arrange the main bearing caps in the correct order.

2. Use 2 removed main bearing cap bolts to remove the 5 main bearing caps and 5 lower bearings.
3. Lift out the crankshaft.

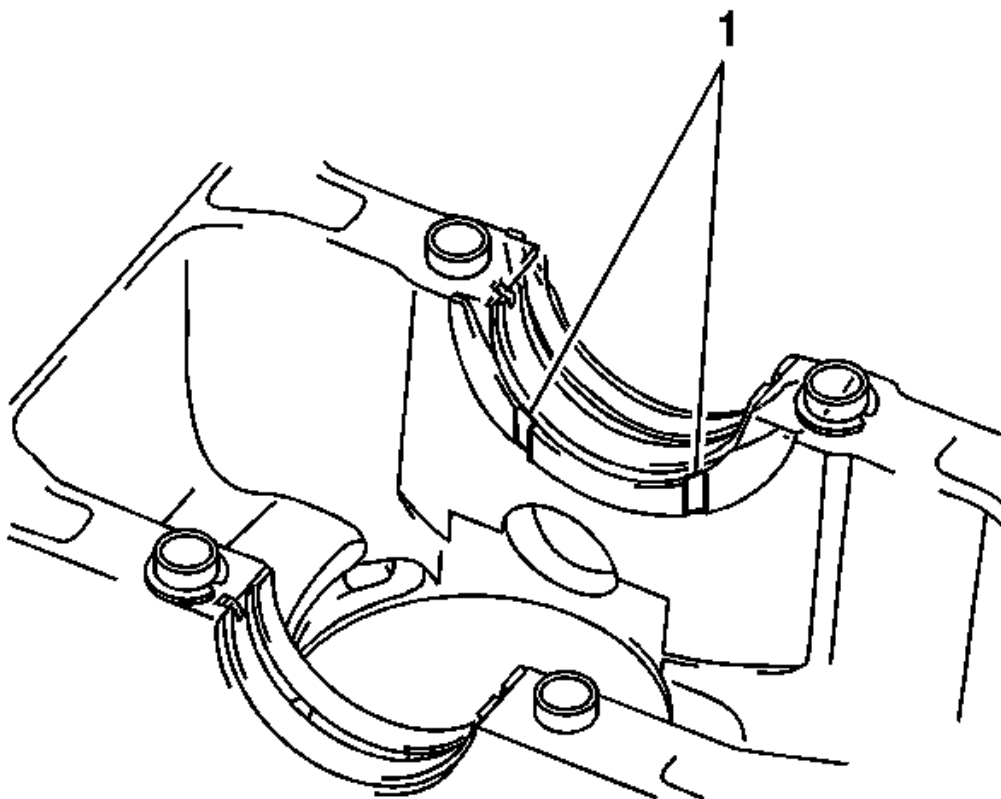


Fig. 319: Identifying Upper Thrust Washers
Courtesy of GENERAL MOTORS CORP.

4. Remove the upper thrust washers from the cylinder block.

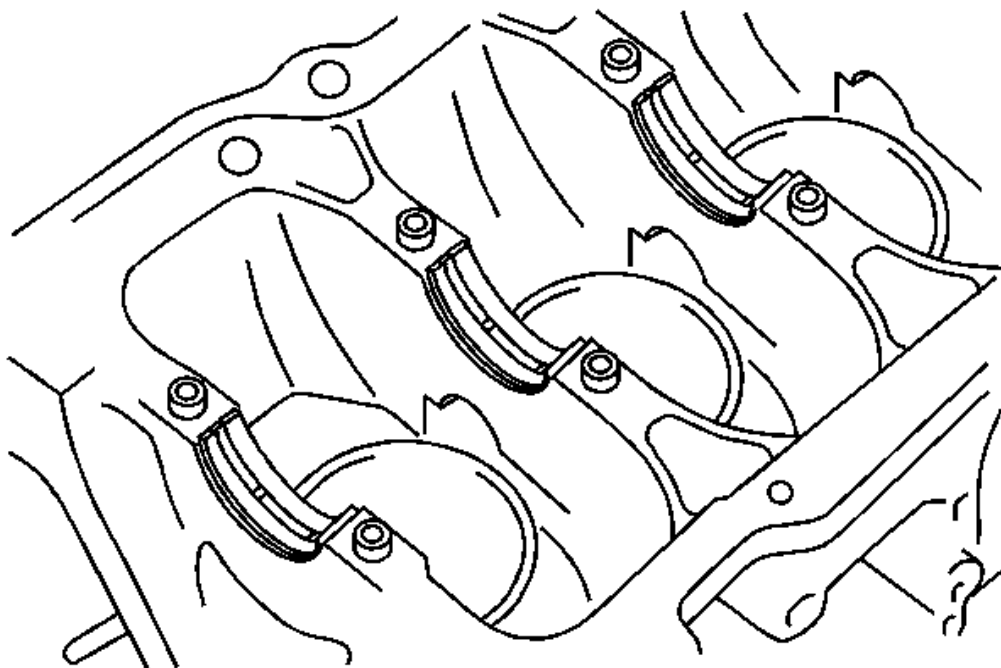


Fig. 320: Identifying Crankshaft Bearings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Arrange the removed parts in the correct order.

5. Remove the 5 crankshaft bearings from the cylinder block.

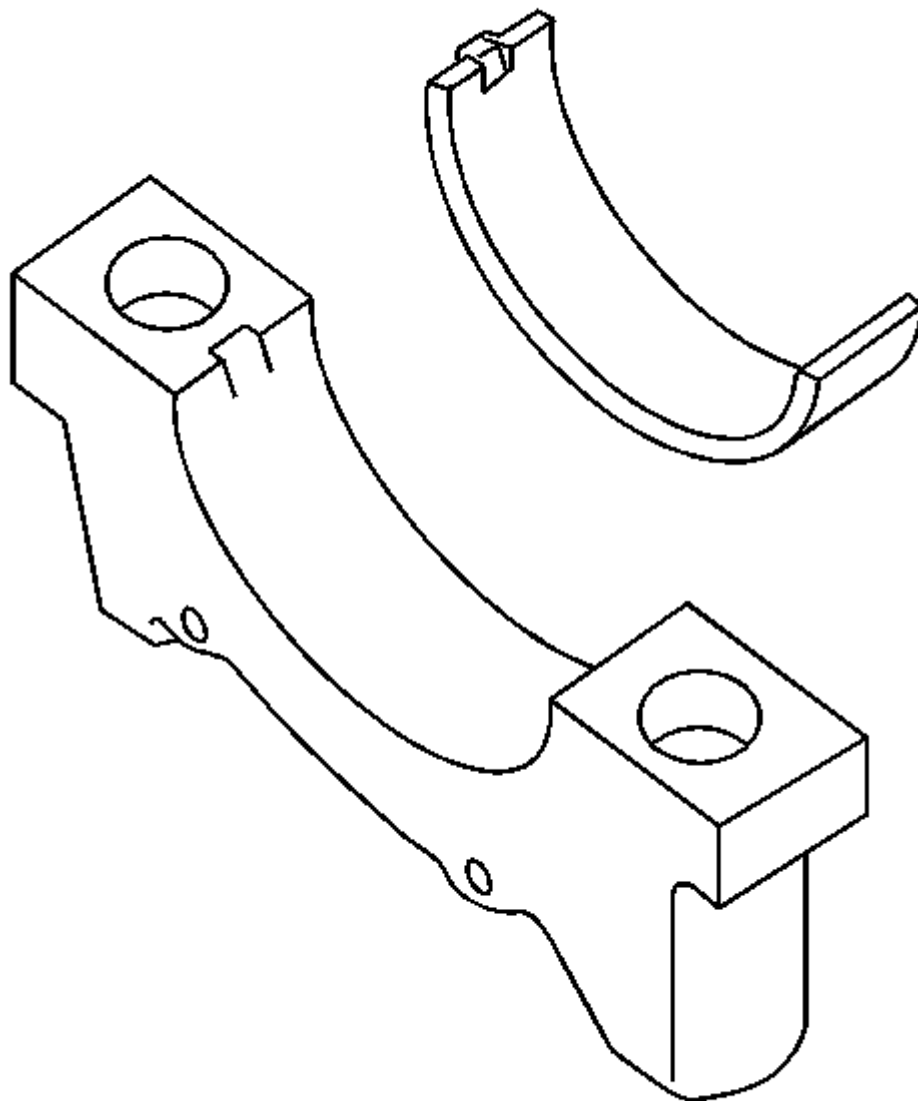


Fig. 321: View Of Main Bearing & Bearing Cap
Courtesy of GENERAL MOTORS CORP.

6. Remove the 5 crankshaft bearings from the 5 main bearing caps.

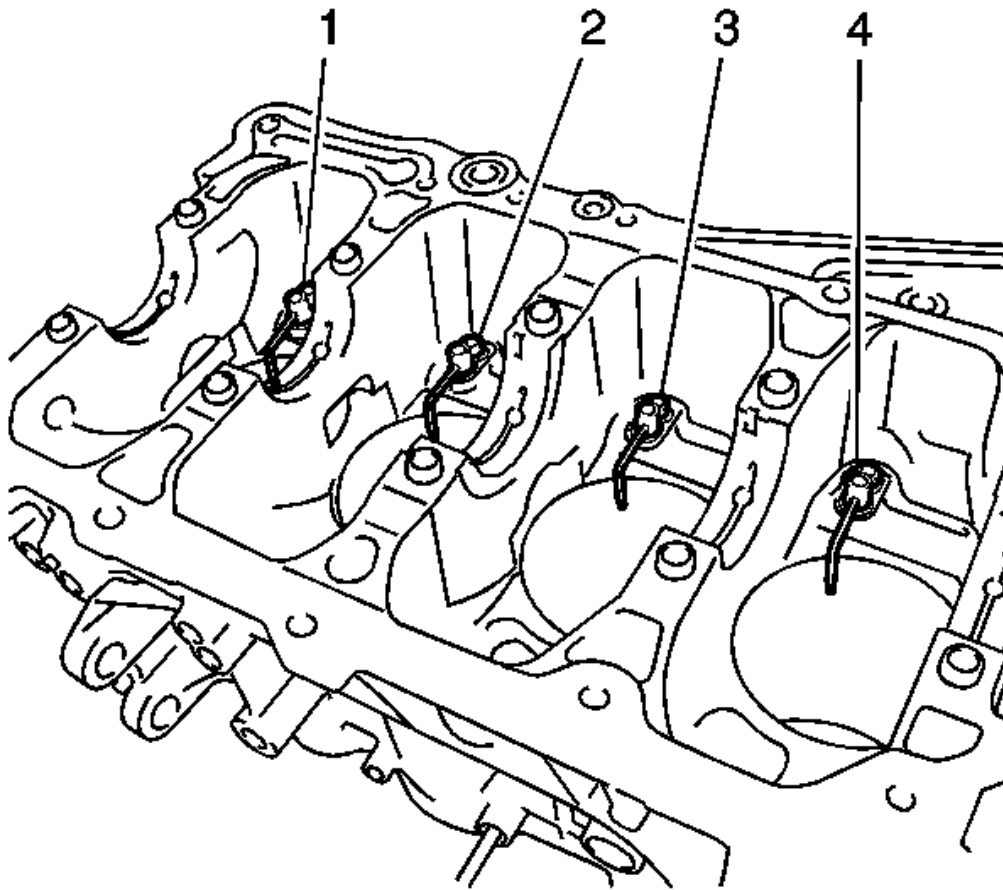


Fig. 322: Identifying Oil Nozzles

Courtesy of GENERAL MOTORS CORP.

7. Using a 5 mm hexagon wrench, remove the bolts and oil nozzles.

ENGINE BLOCK CLEANING AND INSPECTION

Inspection Procedure

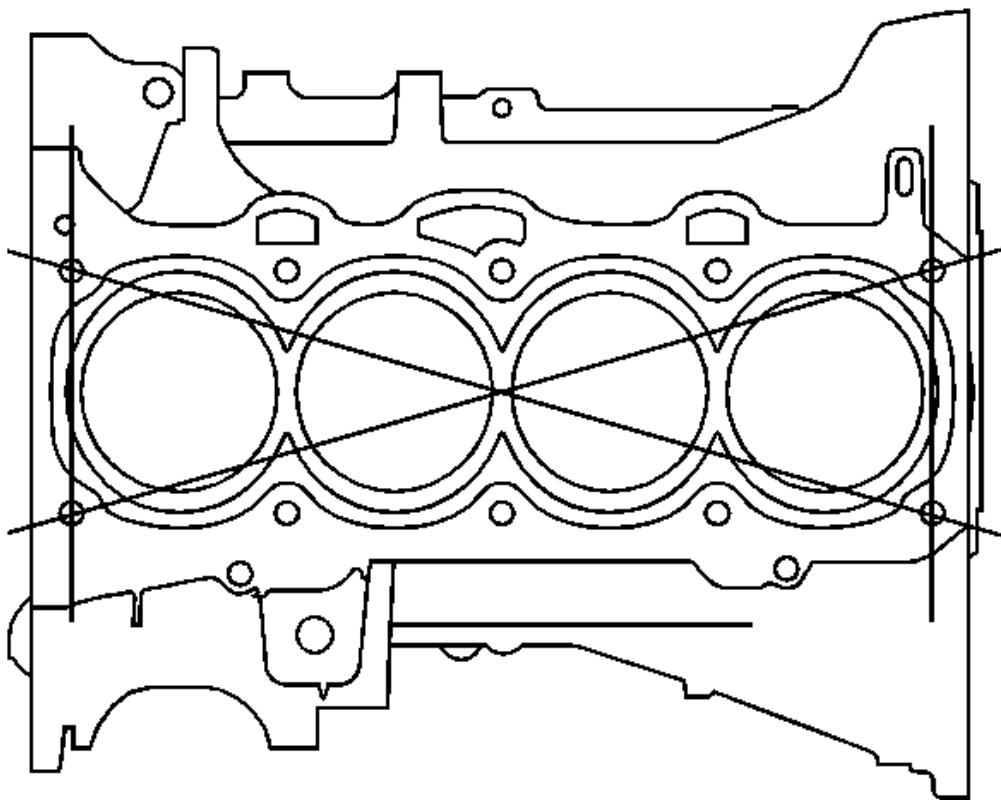


Fig. 323: Measuring Cylinder Block Warpage
Courtesy of GENERAL MOTORS CORP.

1. Using a precision straightedge and feeler gauge, measure the warpage of the surface that is in contact with the cylinder head gasket.

Maximum warpage: 0.05 mm (0.0020 in)

If the warpage is greater than the maximum, replace the cylinder block.

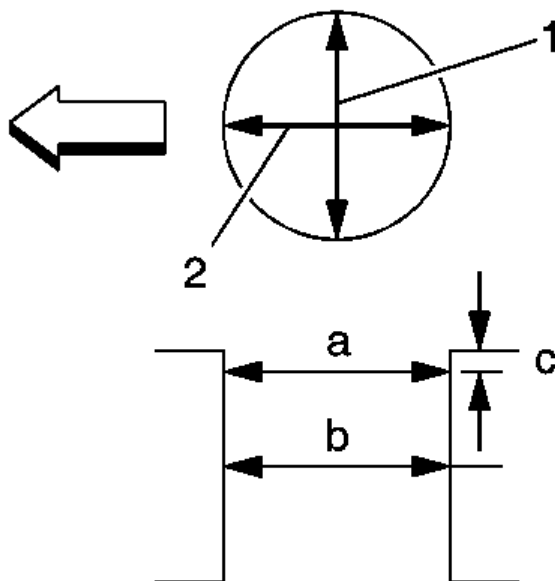
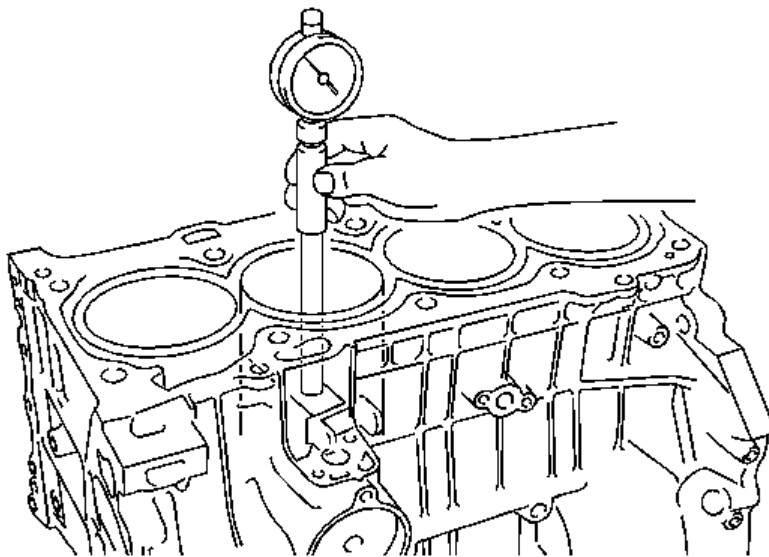


Fig. 324: Measuring Cylinder Bore Wear
Courtesy of GENERAL MOTORS CORP.

2. Using a cylinder gauge, measure the cylinder bore diameter at positions A and B in the thrust and axial directions.

Standard diameter: 88.500 to 88.513 mm (3.4843 to 3.4847 in)

Maximum diameter: 88.613 mm (3.4887 in)

If the average diameter of the 4 positions is greater than the maximum, replace the cylinder block.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Inspection Procedure

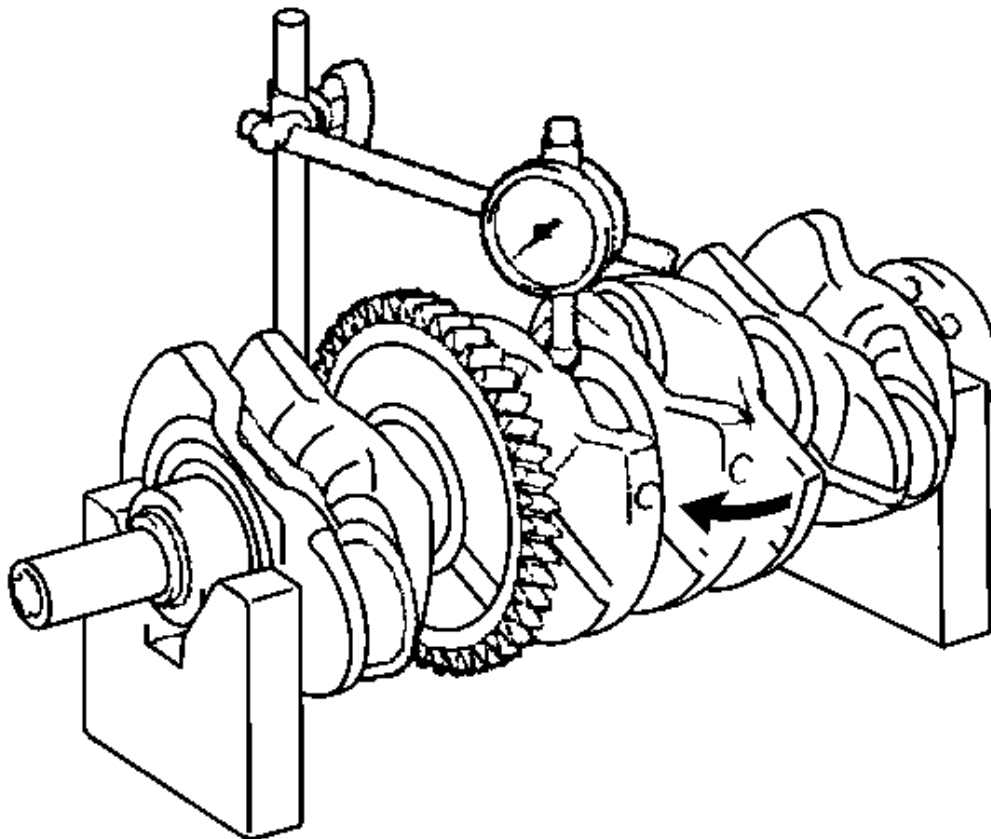


Fig. 325: Measuring Crankshaft Circle Runout
Courtesy of GENERAL MOTORS CORP.

1. Using a dial indicator and V-blocks, measure the circle runout as shown in the illustration.

Maximum circle runout: 0.03 mm (0.0012 in)

If the circle runout is greater than the maximum, replace the crankshaft.

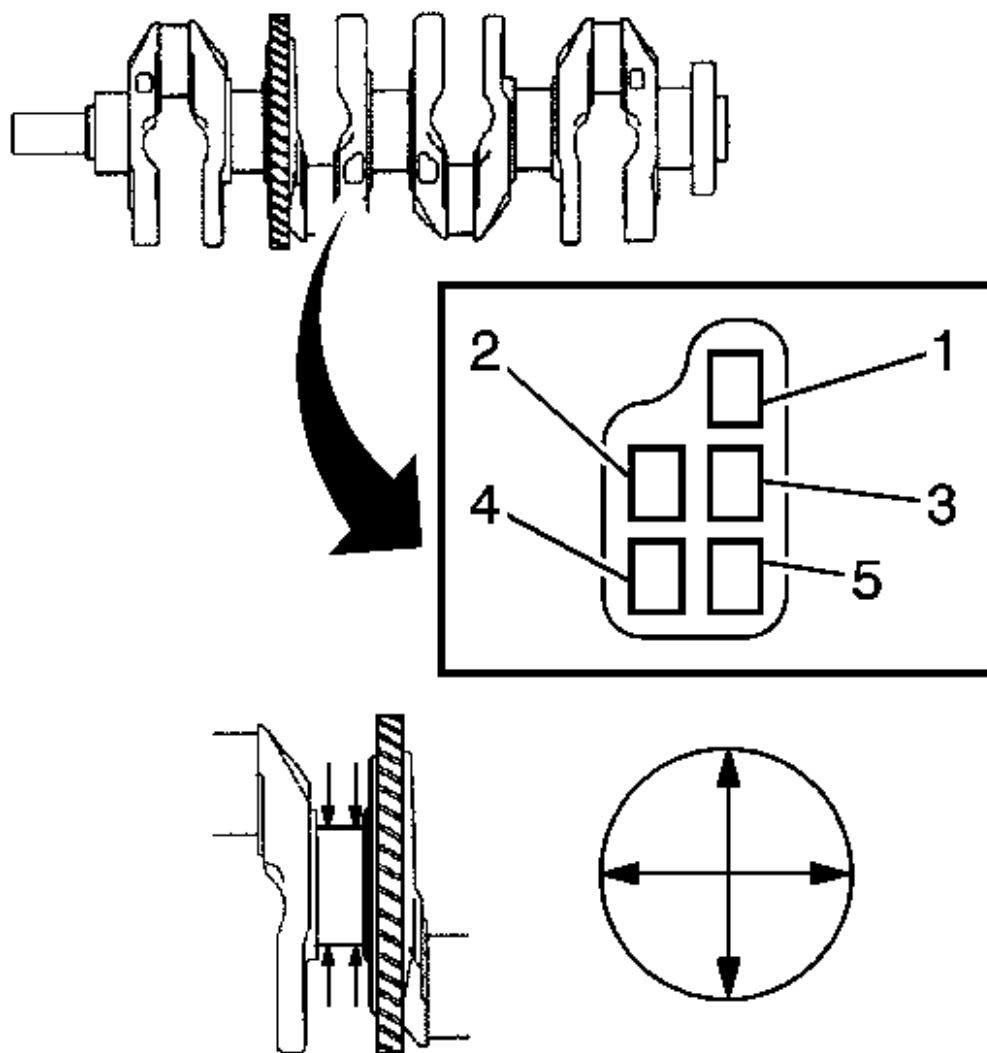


Fig. 326: Measuring Crankshaft Journal Diameter
Courtesy of GENERAL MOTORS CORP.

- Using a micrometer, measure the diameter of each main journal.

Standard diameter: 54.988 to 55.000 mm (2.1649 to 2.1654 in)

If the diameter is not as specified, check the crankshaft oil clearance.

3. Check each main journal for taper and distortion as shown in the illustration.

Maximum taper and distortion: 0.003 mm (0.0001 in)

If the taper and distortion are greater than the maximum, replace the crankshaft.

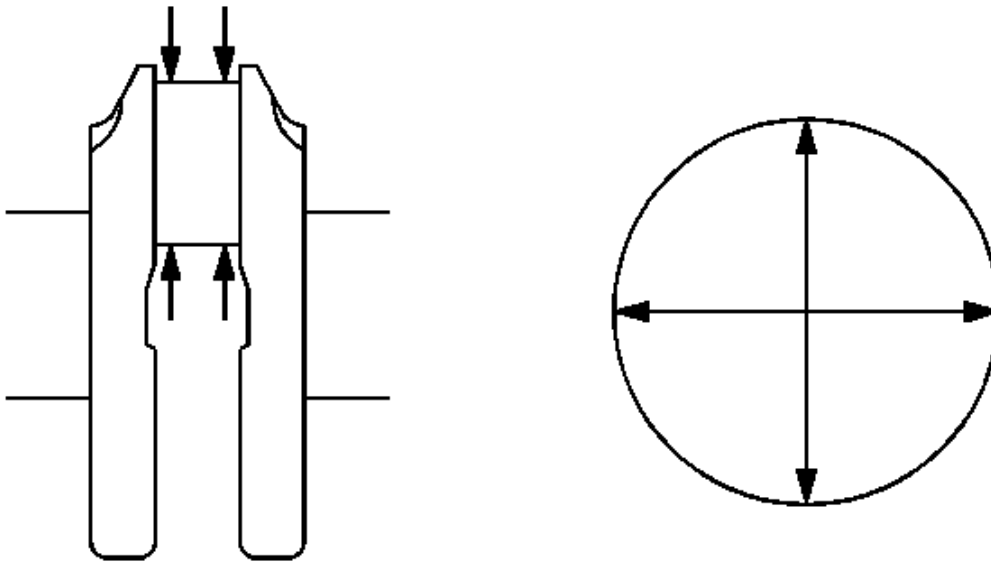


Fig. 327: Measuring Diameter Of Crank Pin
Courtesy of GENERAL MOTORS CORP.

4. Using a micrometer, measure the diameter of each crank pin.

Standard diameter: 47.990 to 48.000 mm (1.8894 to 1.8898 in)

If the diameter is not as specified, check the connecting rod oil clearance.

5. Inspect each crank pin for taper and distortion as shown in the illustration.

Maximum taper and distortion: 0.003 mm (0.0001 in)

If the taper and distortion are greater than the maximum, replace the crankshaft.

6. Install the main bearing cap.

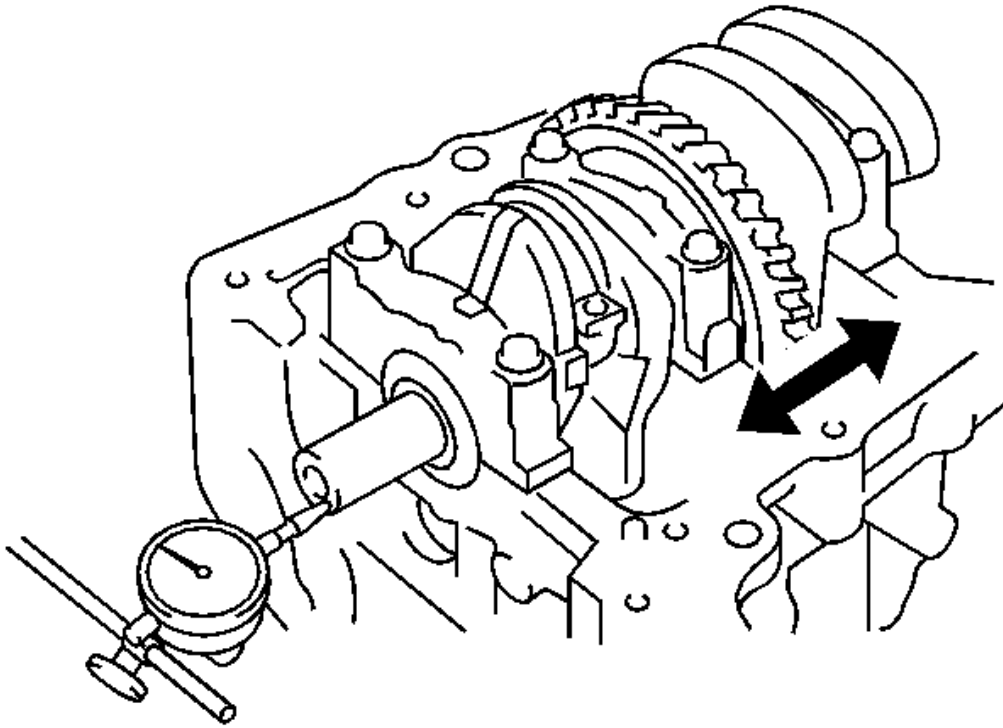


Fig. 328: Measuring Crankshaft Thrust Clearance
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The thrust washer thickness is 1.93 to 1.98 mm (0.0760 to 0.0780 in).

7. Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

Standard thrust clearance: 0.04 to 0.24 mm (0.0016 to 0.0095 in)

Maximum thrust clearance: 0.30 mm (0.0118 in)

If the thrust clearance is greater than the maximum, replace the thrust washers as a set.

8. Check the crank journal and bearing for pitting and scratches.
9. Install the crankshaft bearing.
10. Place the crankshaft on the cylinder block.

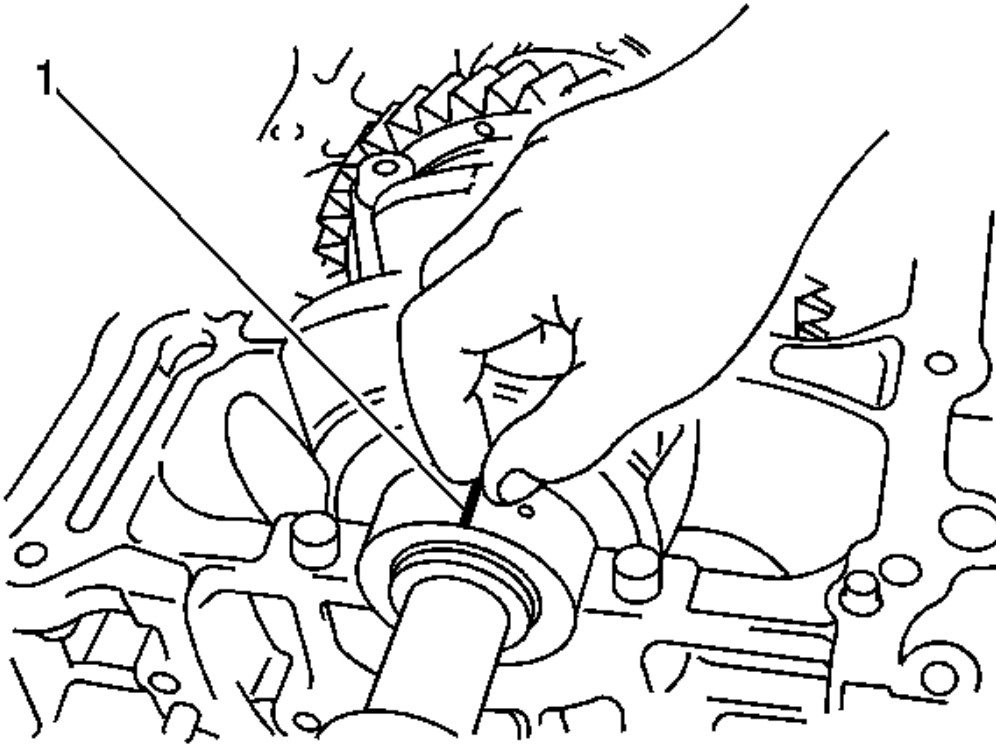


Fig. 329: Using Plastigage Across Journal
 Courtesy of GENERAL MOTORS CORP.

11. Lay a strip of Plastigage across each journal.

IMPORTANT: A number is marked on each main bearing cap to indicate the installation position.

12. Examine the front marks and numbers and install the bearing caps on the cylinder block.

IMPORTANT: Do not turn the crankshaft.

13. Install the main bearing caps.
14. Remove the main bearing caps.

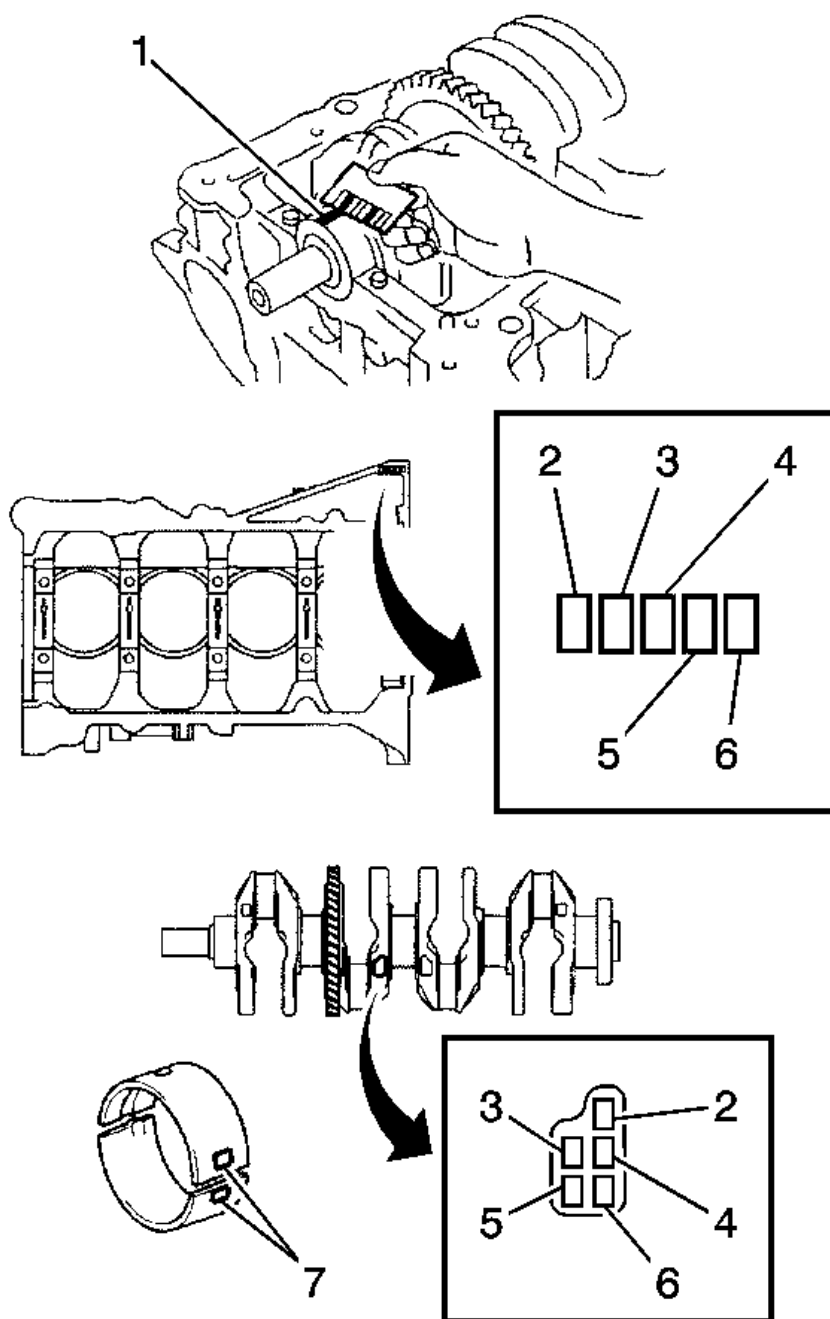


Fig. 330: View Of Keeping Caps & Bearings In Proper Order
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: • Remove the Plastigage completely after the measurement.

- If replacing a bearing, select a new one with the same number. If the number of the bearing cannot be determined, calculate the correct bearing number by adding together the numbers imprinted on the cylinder block and crankshaft. Then select a new bearing with the calculated number. There are 4 sizes of standard bearings, marked 1, 2, 3 and 4 accordingly.
- **EXAMPLE:** Cylinder block 3 + Crankshaft 5 = Total number 8 (Use bearing 3)

15. Measure the Plastigage at its widest point.

Standard oil clearance: 0.017 to 0.040 mm (0.0007 to 0.0016 in)

Maximum oil clearance: 0.060 mm (0.0024 in)

If the oil clearance is greater than the maximum, replace the crankshaft bearing. If necessary, replace the crankshaft.

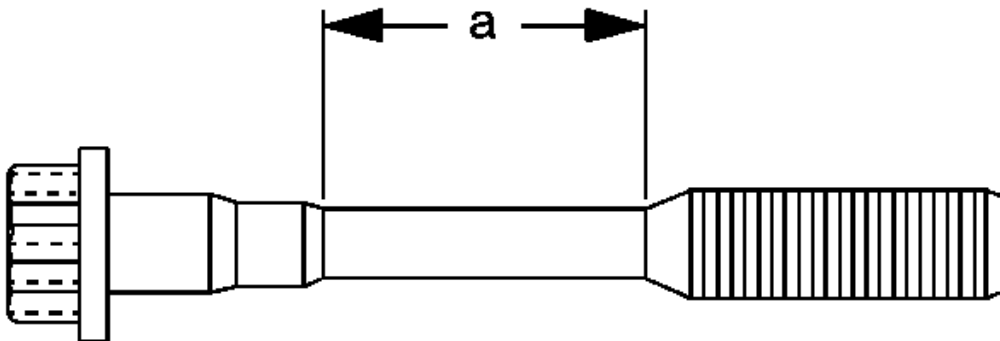


Fig. 331: Identifying Crankshaft Bearing Cap Set Ring Pin
Courtesy of GENERAL MOTORS CORP.

16. Inspect crankshaft bearing cap set ring pin.
17. Using vernier calipers, measure the tension portion diameter of the bolts.

Standard diameter: 7.3 to 7.5 mm (0.287 to 0.295 in)

Minimum diameter: 7.2 mm (0.284 in)

If the diameter is less than the minimum, replace the bolt.

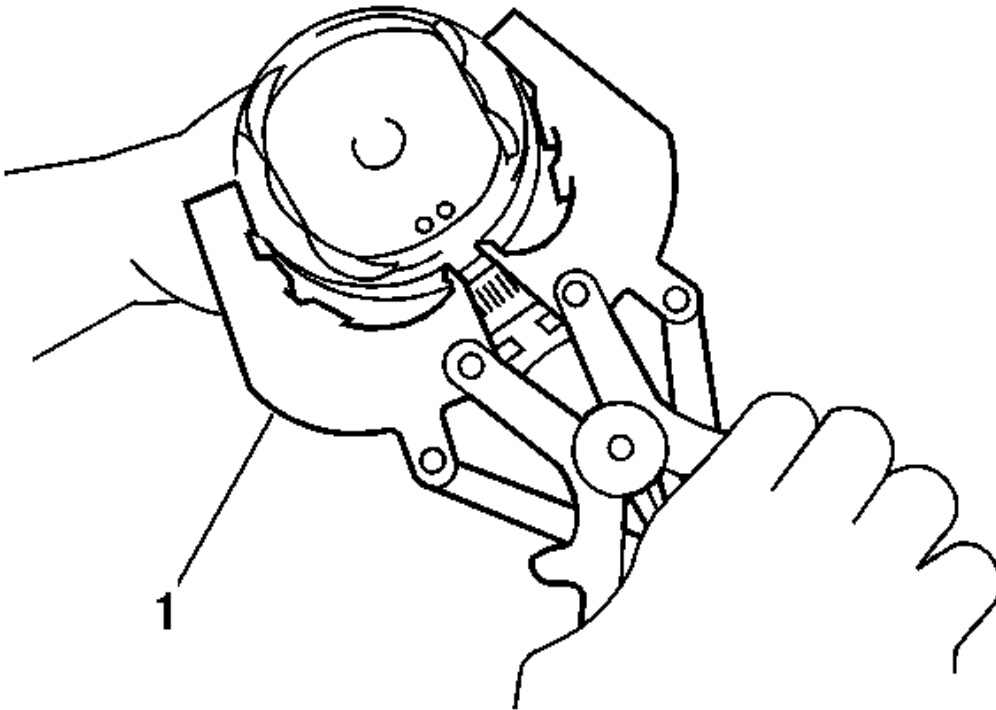
PISTON AND CONNECTING ROD DISASSEMBLE**Disassemble Procedure**

Fig. 332: View Of Piston Ring Expander
Courtesy of GENERAL MOTORS CORP.

1. Using a piston ring expander, remove the 2 compression rings.

IMPORTANT: Arrange the removed parts in the correct order.

2. Remove the oil ring rail and oil ring expander by hand.

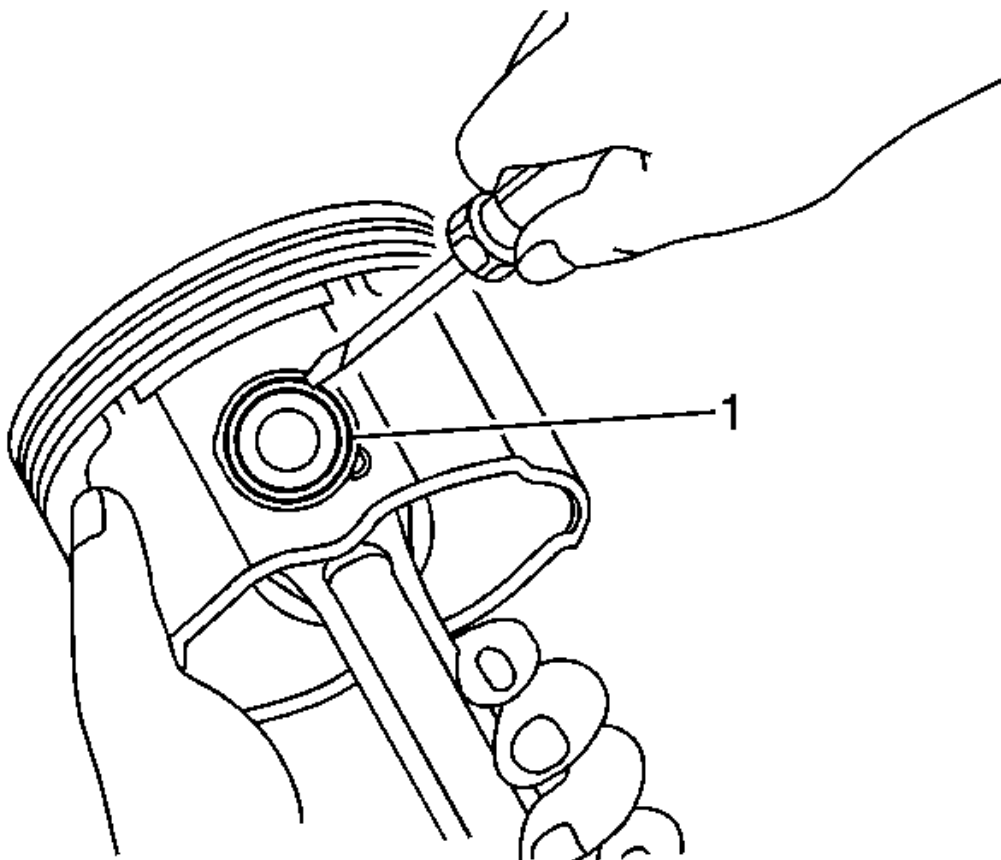


Fig. 333: Illustrating Piston Pin Snap Ring Removal
Courtesy of GENERAL MOTORS CORP.

3. Using a screwdriver, pry out the 2 piston pin hole snap rings.

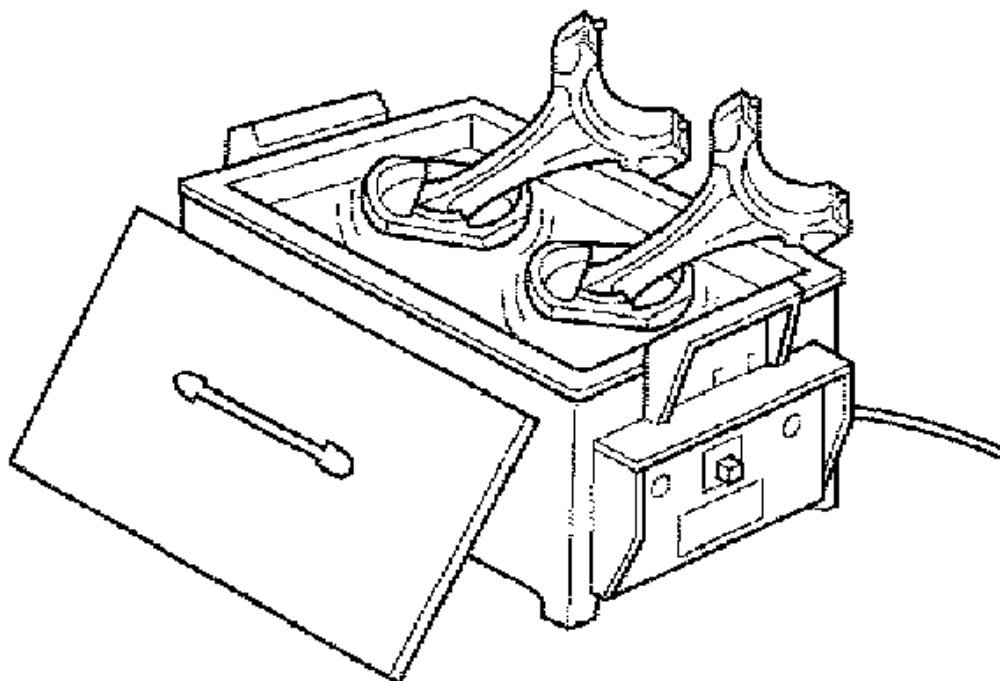


Fig. 334: View Of Heating Pistons
Courtesy of GENERAL MOTORS CORP.

4. Gradually heat the piston to between 80 and 90°C (176 and 194°F).

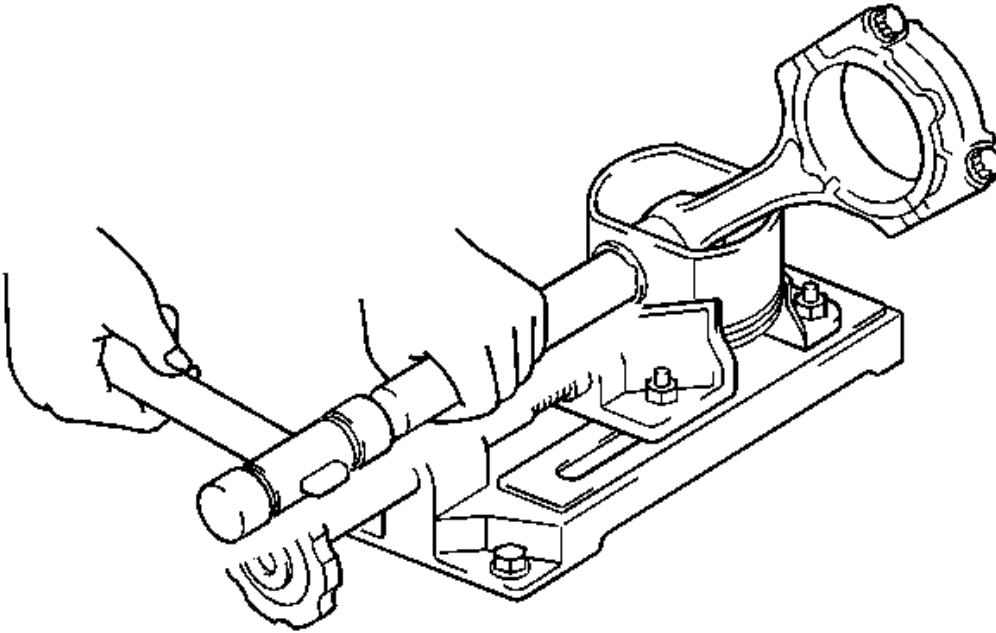


Fig. 335: View Of Piston Pin Removal Procedure
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- The piston and pin are a matched set.
- Arrange the pistons, pin, rings, connecting rods and bearings in the correct order.

5. Using a plastic hammer and brass bar, lightly tap out the piston pin and remove the connecting rod.
6. Inspect crankshaft thrust clearance. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection**.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Connecting Rod and Bearing Inspection

1. Install the connecting rod, rod bearings and rod cap on the correct rod journal.

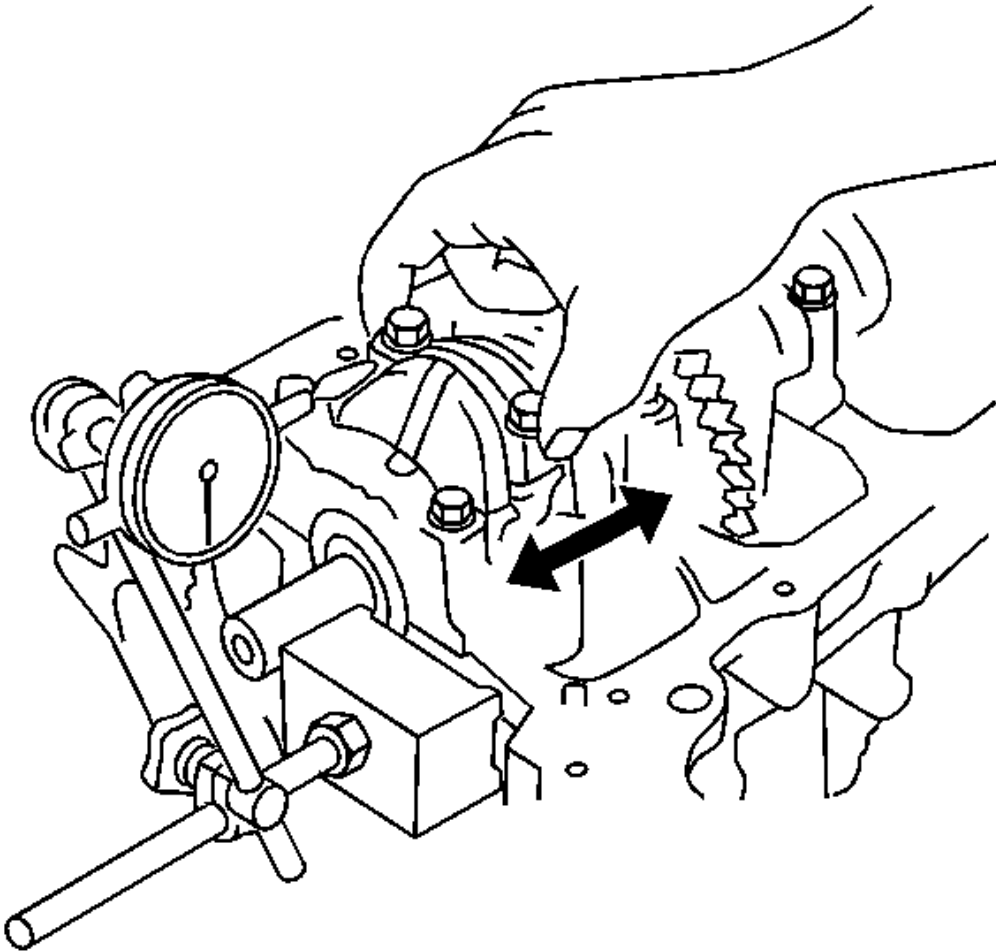


Fig. 336: Measuring Connecting Rod Thrust Clearance
Courtesy of GENERAL MOTORS CORP.

2. Using a dial indicator, measure the thrust clearance while moving the connecting rod back and forth.

Standard thrust clearance: 0.160 to 0.362 mm (0.0063 to 0.0143 in)

Maximum thrust clearance: 0.362 mm (0.0143 in)

If the thrust clearance is greater than the maximum, replace the connecting rod assemblies as necessary. If necessary, replace the crankshaft.

3. Inspect connecting rod oil clearance.

4. Clean the crank pin and bearing.
5. Check the crank pin and bearing for pitting and scratches.

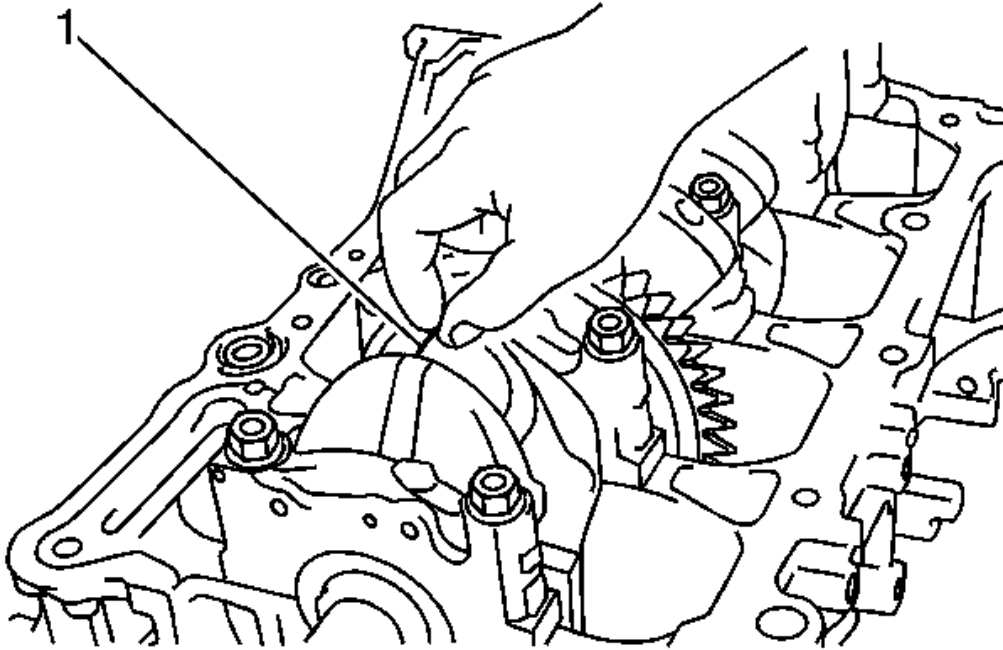


Fig. 337: Using Plastigage On Crank Pin
Courtesy of GENERAL MOTORS CORP.

6. Lay a strip of Plastigage on the crank pin.

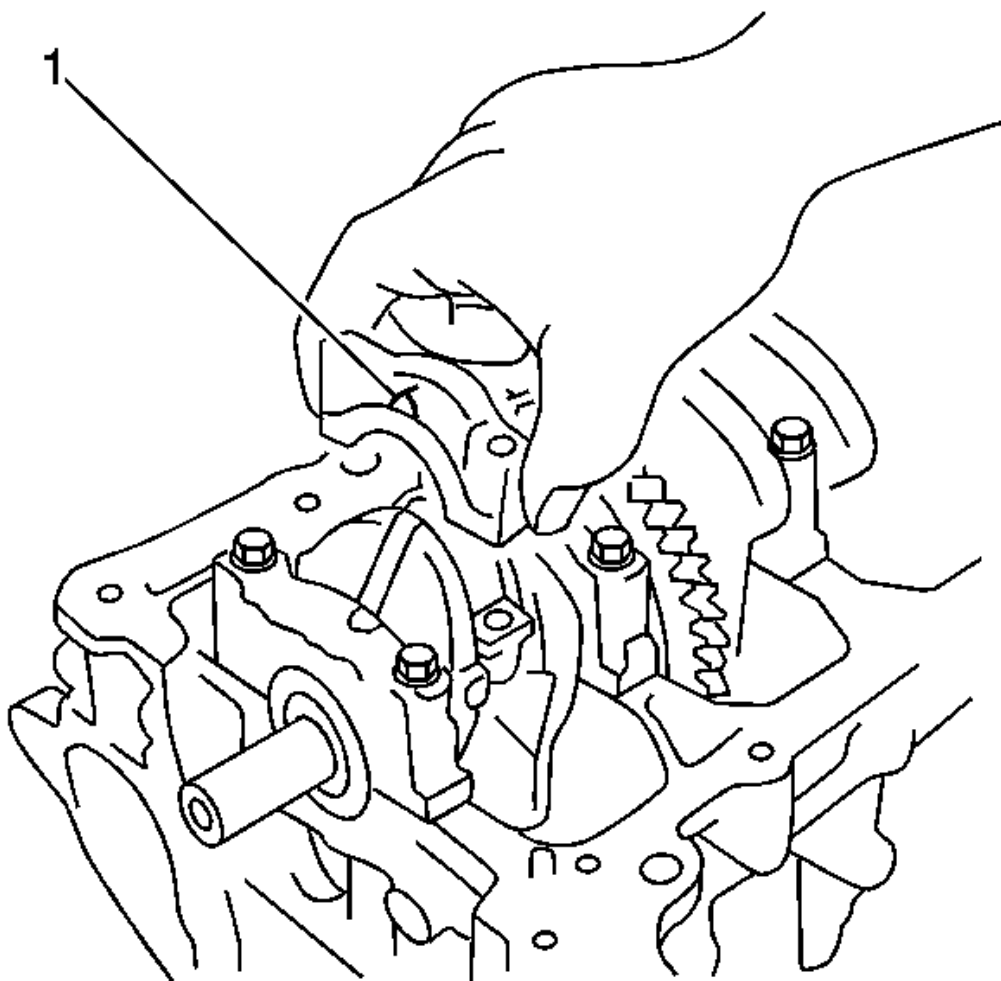


Fig. 338: Verifying Connecting Rod Cap Is Facing Forward
Courtesy of GENERAL MOTORS CORP.

7. Check that the front mark of the connecting rod cap is facing forward.

IMPORTANT: Do not turn the crankshaft.

8. Install the connecting rod cap.
9. Remove the 2 bolts and connecting rod cap.

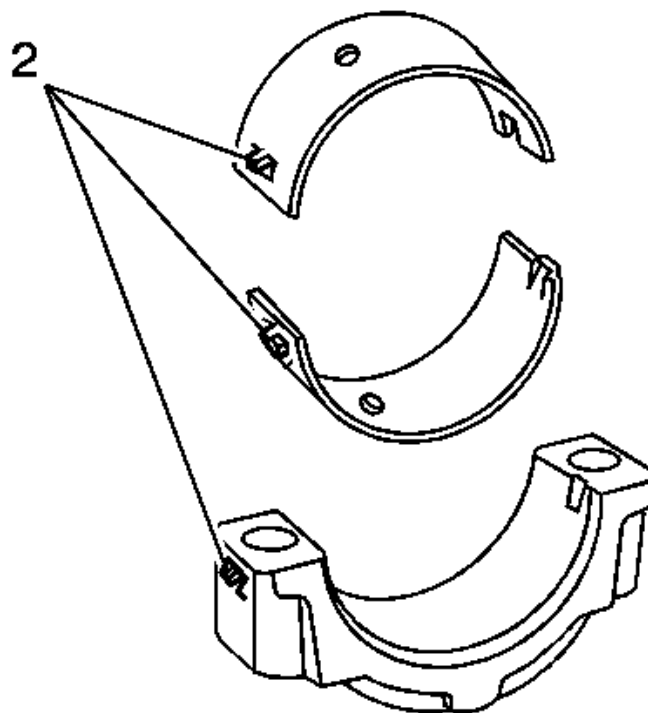
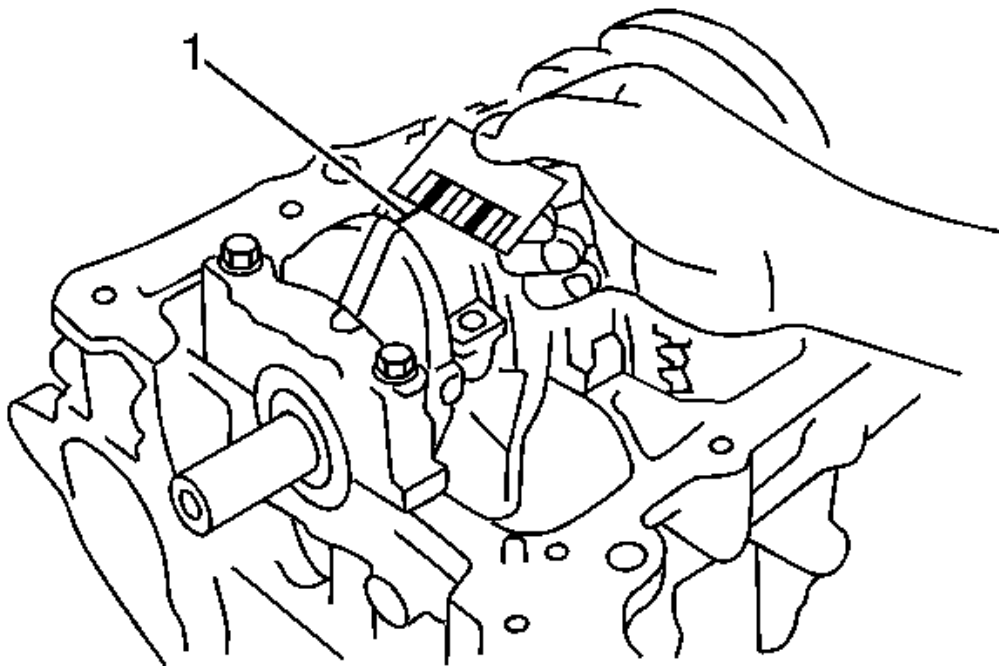


Fig. 339: View Of Checking Plastigage
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Completely remove the Plastigage after the measurement.

IMPORTANT: If replacing a bearing, replace it with one that has the same number as its respective connecting rod cap. Each bearing standard thickness is indicated by a 1, 2, or 3 mark on its surface.

10. Measure the Plastigage at its widest point.

Standard oil clearance: 0.024 to 0.048 mm (0.0009 to 0.0019 in)

Maximum oil clearance: 0.063 mm (0.0025 in)

If the oil clearance is greater than the maximum, replace the connecting rod bearings. If necessary, inspect the crankshaft.

Standard crankshaft pin diameter: 47.990 to 48.000 (1.8894 to 1.8898 in)

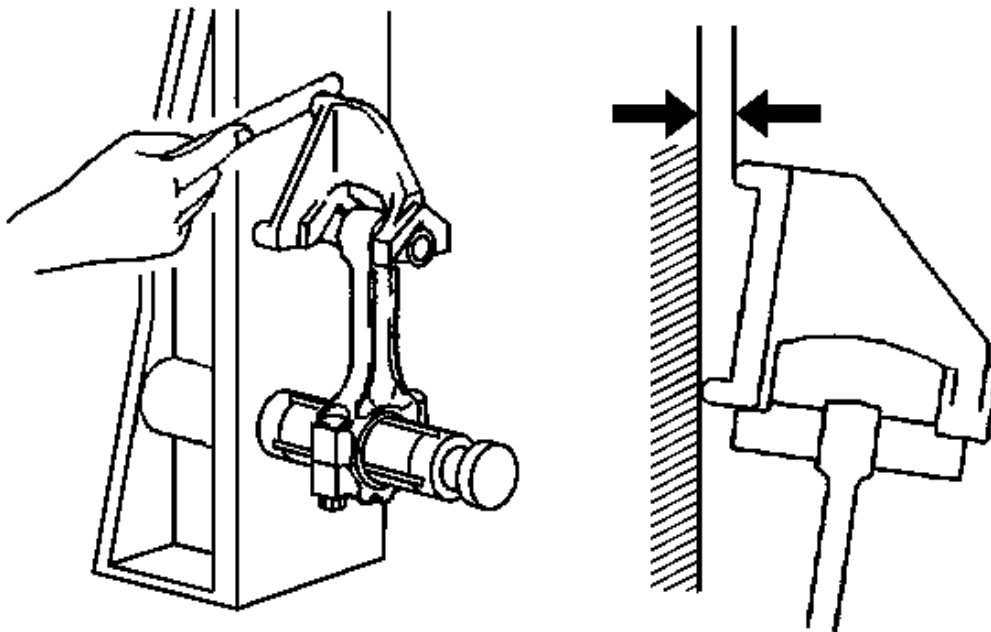


Fig. 340: Checking Connecting Rod Alignment
Courtesy of GENERAL MOTORS CORP.

11. Using a connecting rod aligner and feeler gauge, check the connecting rod alignment.
12. Check for misalignment.

Maximum misalignment: 0.05 mm (0.0020 in) per 100 mm (3.94 in)

If the misalignment is greater than the maximum, replace the connecting rod.

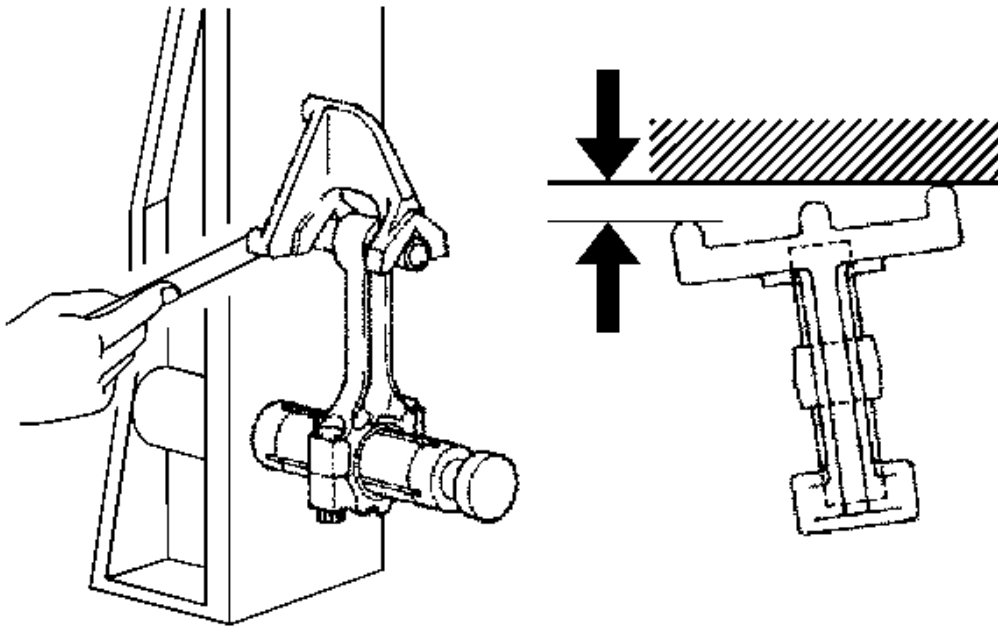


Fig. 341: Checking Connecting Rod Twist
Courtesy of GENERAL MOTORS CORP.

13. Check for twist.

Maximum twist: 0.05 mm (0.0020 in) per 100 mm (3.94 in)

If the twist is greater than the maximum, replace the connecting rod.

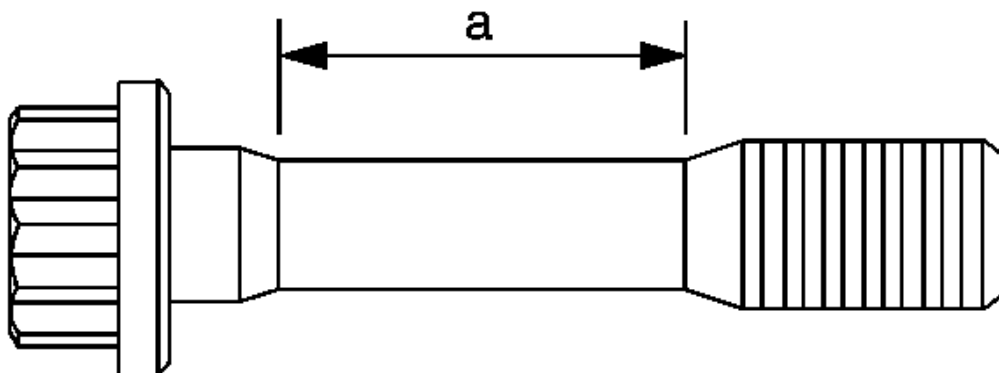


Fig. 342: View Of Connecting Rod Bolt
Courtesy of GENERAL MOTORS CORP.

14. Using vernier calipers, measure the tension portion diameter of the connecting rod bolt.

Standard diameter: 7.2 to 7.3 mm (0.283 to 0.287 in)

Minimum diameter: 7.0 mm (0.276 in)

If the diameter is less than the minimum, replace the connecting rod bolt.

Piston and Ring Inspection

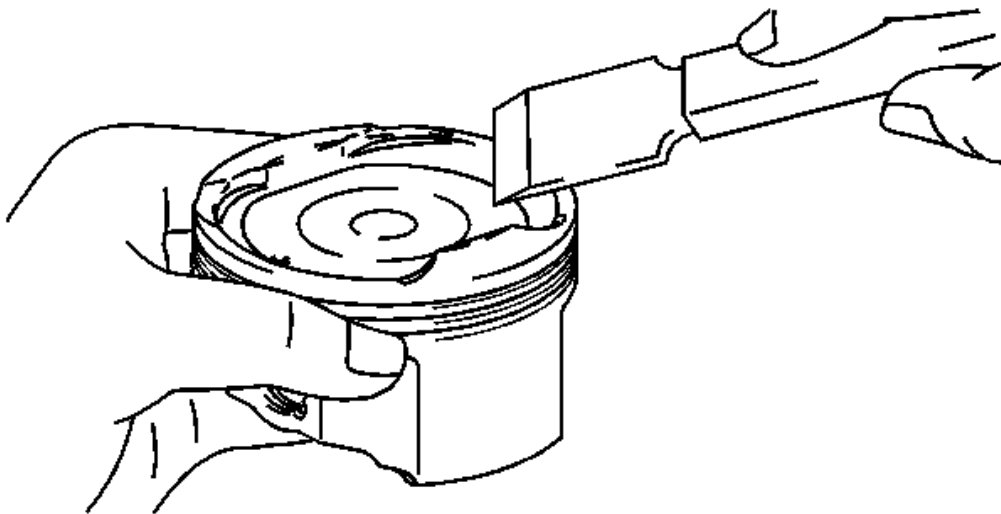


Fig. 343: View Of Carbon Removal
Courtesy of GENERAL MOTORS CORP.

1. Using a gasket scraper, remove the carbon from the top of the piston.

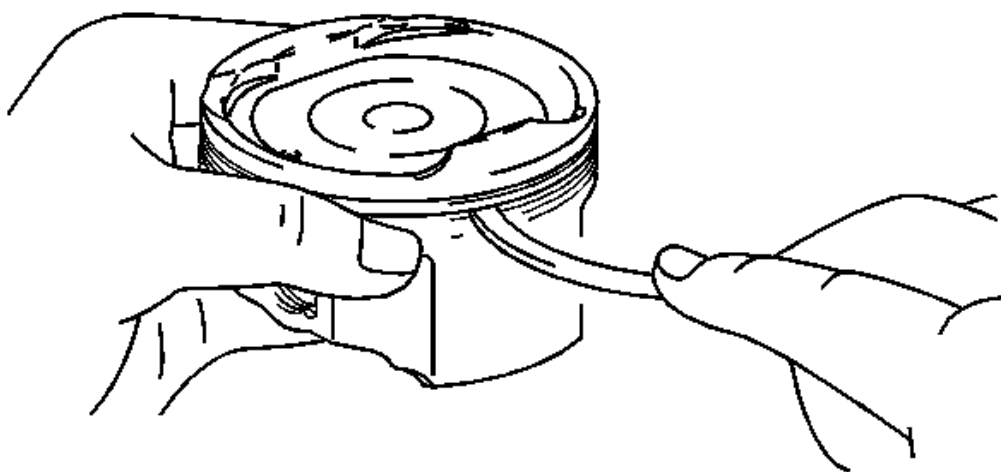


Fig. 344: View Of Cleaning Piston Ring Grooves

Courtesy of GENERAL MOTORS CORP.

2. Using a groove cleaning tool or a broken ring, clean the piston ring grooves.

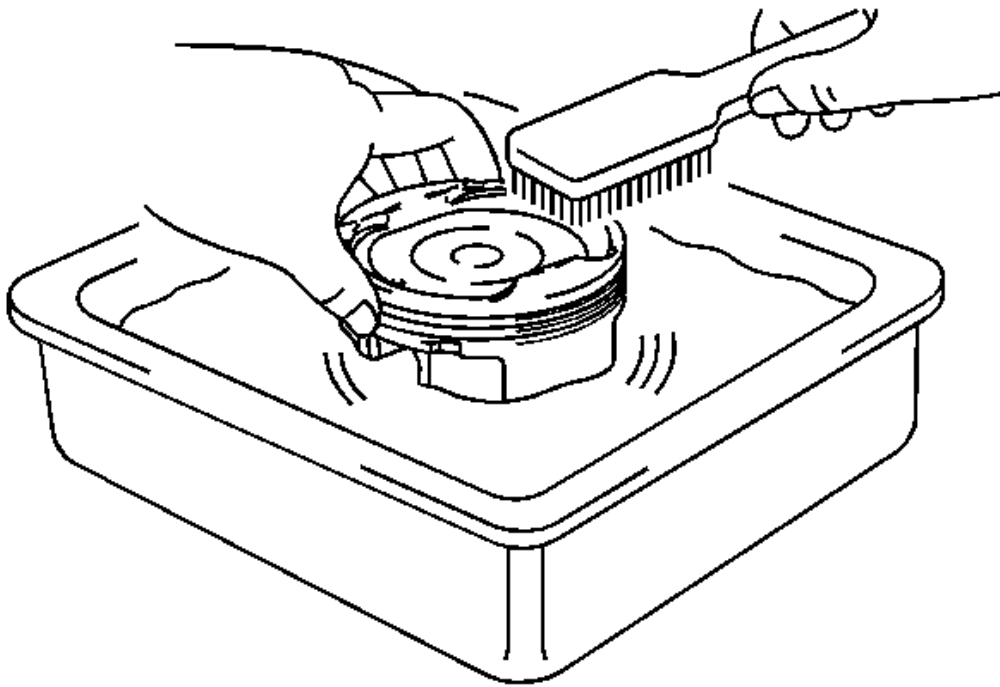


Fig. 345: View Of Cleaning Piston With Brush & Solvent
Courtesy of GENERAL MOTORS CORP.

3. Using a suitable cleaning brush and solvent, thoroughly clean the piston.

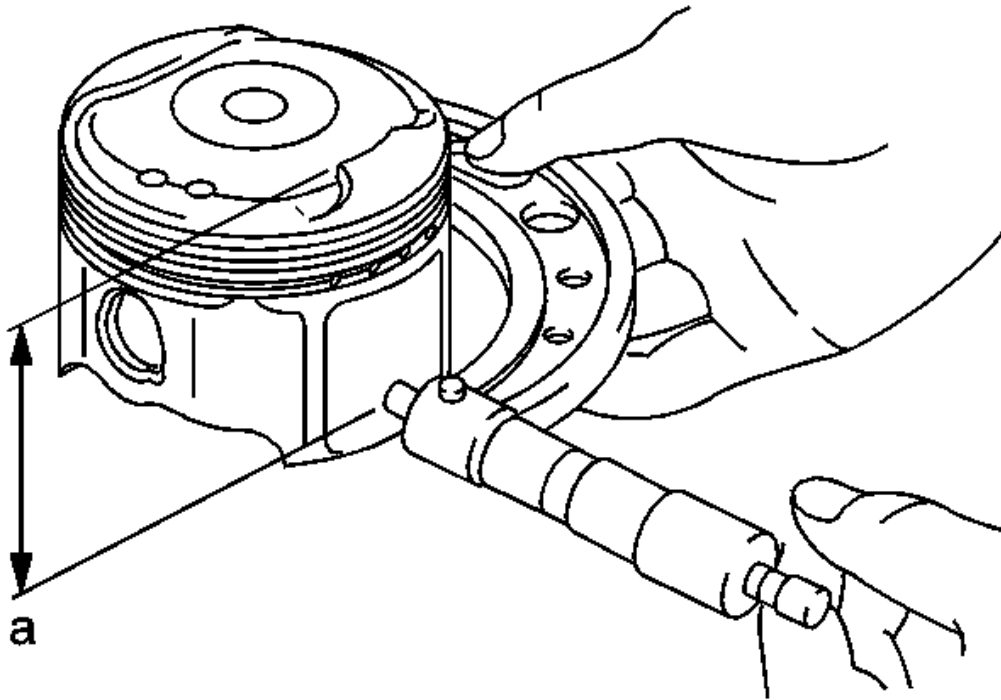


Fig. 346: Measuring Piston Diameter
Courtesy of GENERAL MOTORS CORP.

4. Using a micrometer, measure the piston diameter at right angles to the piston pin hole, and at the piston 44.3 mm (1.7441 in) from the piston head.

Standard piston diameter: 88.469 to 88.479 mm (3.4830 to 3.4834 in)

If the diameter is not as specified, replace the piston.

5. Subtract the piston diameter measurement from the cylinder bore diameter measurement.

Standard oil clearance: 0.021 to 0.044 mm (0.0008 to 0.0017 in)

Maximum oil clearance: 0.10 mm (0.0039 in)

If the oil clearance is greater than the maximum, replace all the pistons. If necessary, replace the cylinder block.

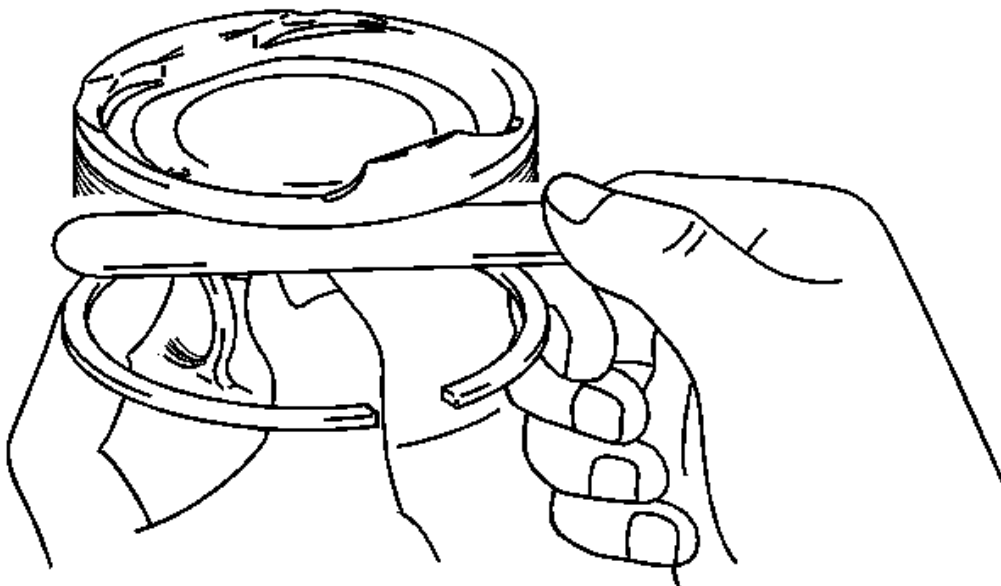


Fig. 347: Measuring Piston Ring Groove Clearance
Courtesy of GENERAL MOTORS CORP.

6. Using a feeler gauge, measure the clearance between a new piston ring and the wall of the ring groove.

If the groove clearance is not as specified, replace the piston.

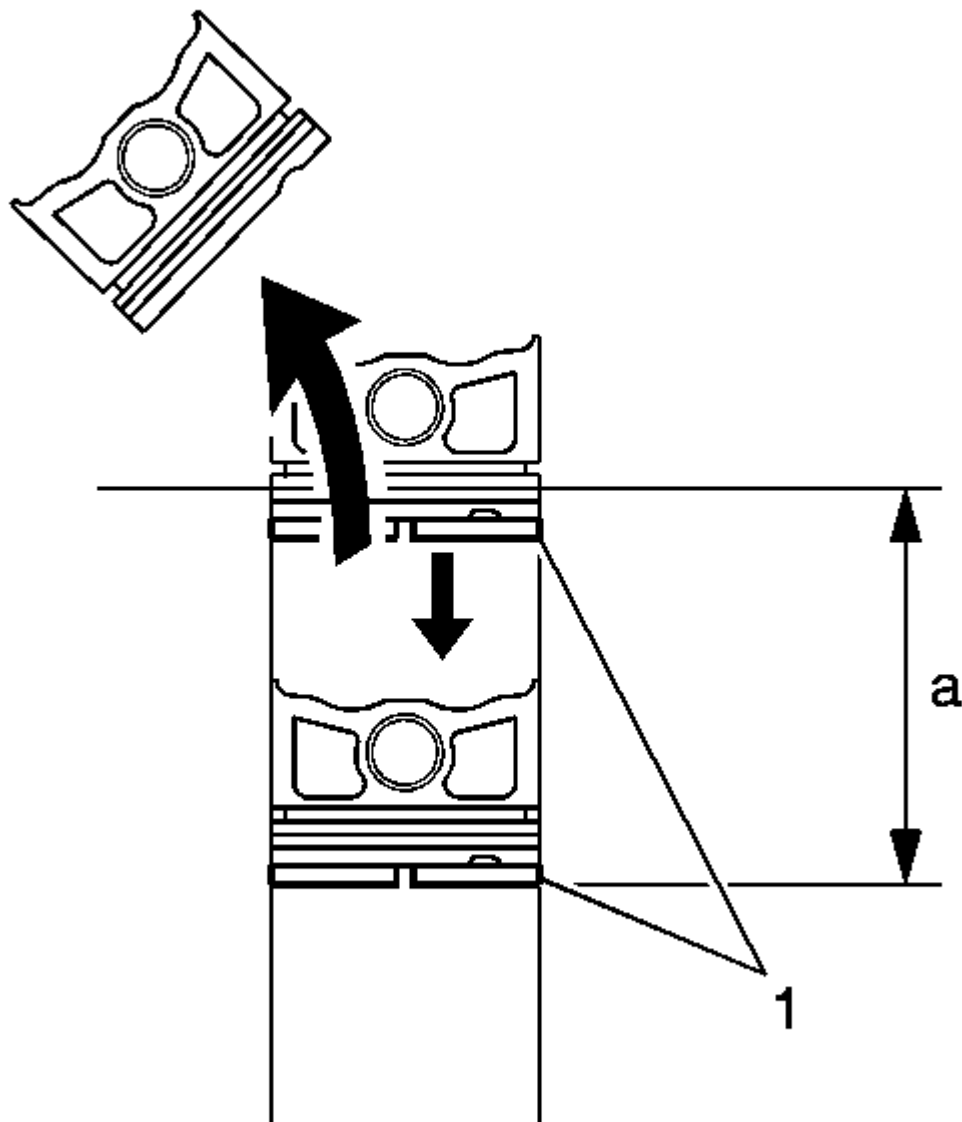


Fig. 348: Pushing Piston Ring Into Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

7. Using a piston, push the piston ring a little beyond the bottom of the ring travel, 110 mm (4.33 in) from the top of the cylinder block.

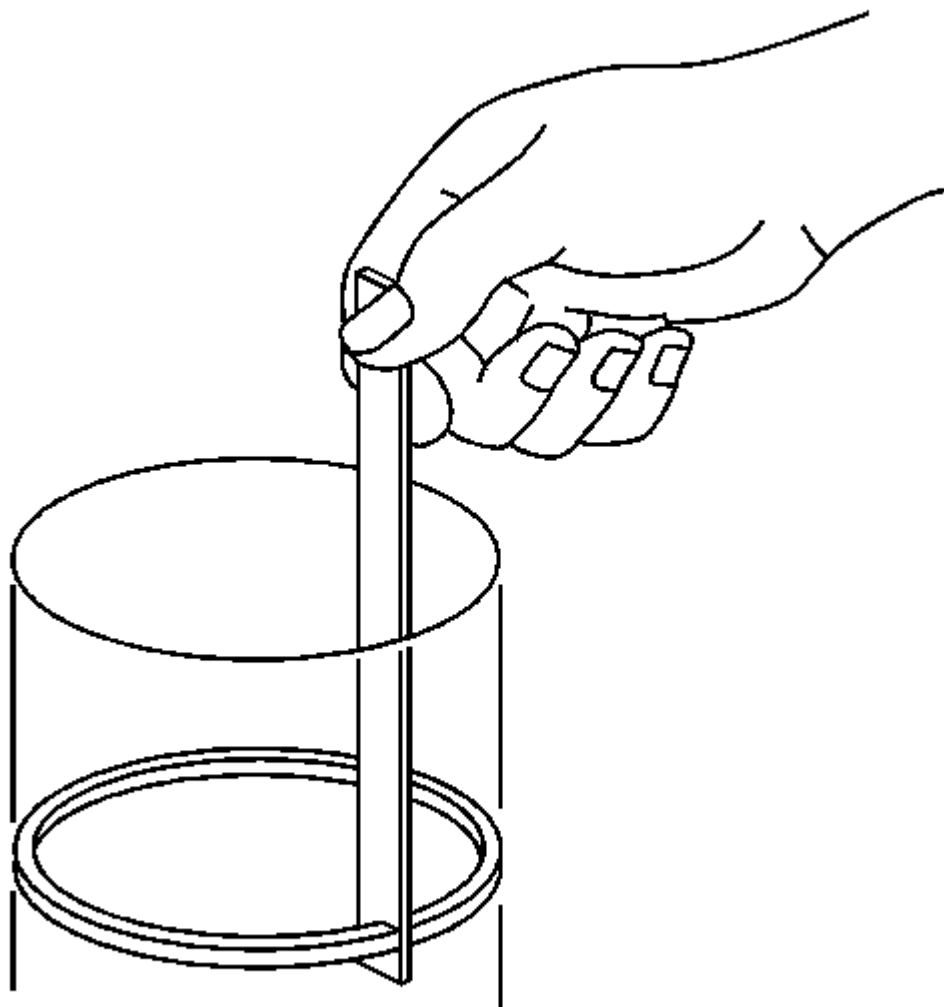


Fig. 349: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

8. Using a feeler gauge, measure the end gap.

If the end gap is greater than the maximum, replace the piston ring. If the end gap is greater than the maximum with a new piston ring, replace the cylinder block.

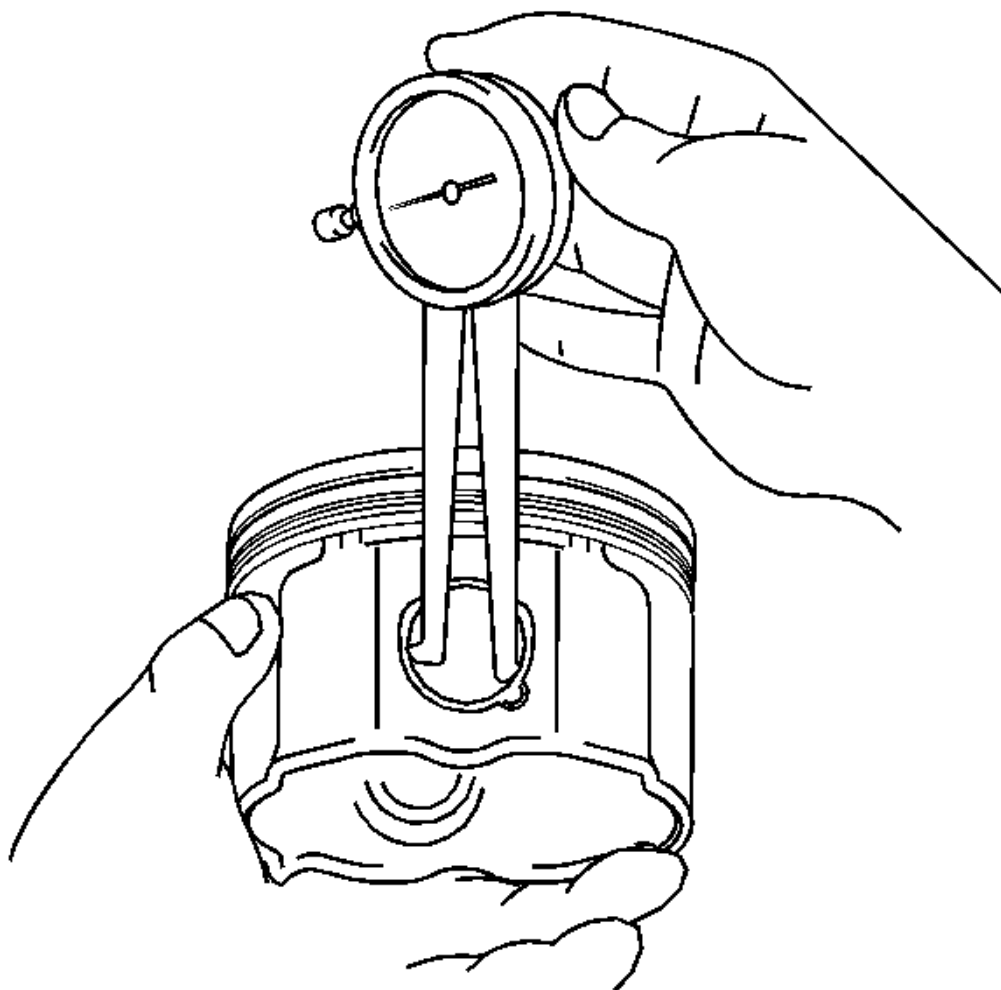


Fig. 350: Measuring Piston Pin Bore Diameter
Courtesy of GENERAL MOTORS CORP.

9. Using a caliper gauge, measure the piston pin bore diameter.

Standard piston pin bore diameter: 22.001 to 22.010 mm (0.8662 to 0.8665 in)

If the diameter is not as specified, replace the piston.

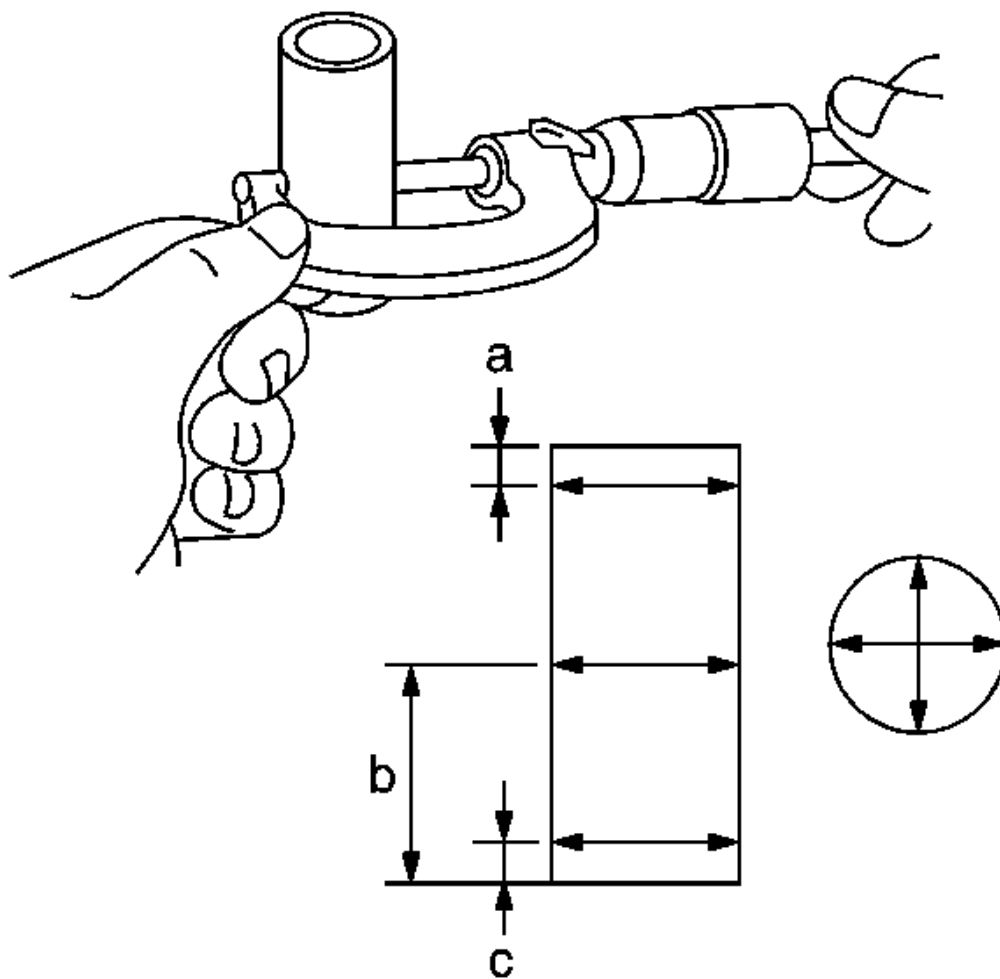


Fig. 351: Measuring Piston Diameter
Courtesy of GENERAL MOTORS CORP.

10. Using a micrometer, measure the piston pin diameter.

Standard piston pin diameter: 21.997 to 22.006 mm (0.8660 to 0.8664 in)

If the diameter is not as specified, replace the piston pin.

11. Using a caliper gauge, measure the connecting rod small end bore diameter.

Standard connecting rod small end bore diameter: 22.005 to 22.014 mm (0.8663 to 0.8667 in)

If the diameter is not as specified, replace the connecting rod.

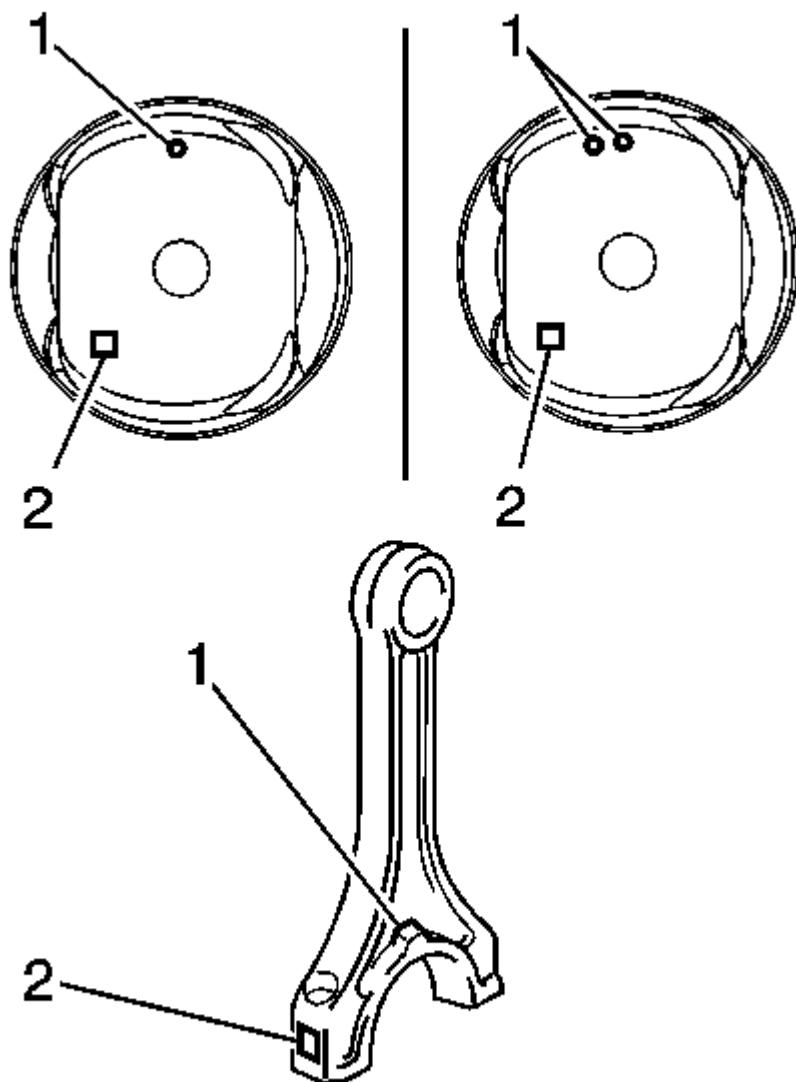


Fig. 352: Comparing Piston Pin Diameter & Pin Bore Diameter
Courtesy of GENERAL MOTORS CORP.

12. Subtract the piston pin diameter measurement from the piston pin bore diameter measurement.

Standard oil clearance: 0.001 to 0.007 mm (0.00004 to 0.0003 in)

Maximum oil clearance: 0.010 mm (0.0004 in)

If the oil clearance is greater than the maximum, replace the connecting rod. If necessary, replace the piston and piston pin as a set.

13. Subtract the piston pin diameter measurement from the connecting rod small end bore diameter measurement.

Standard oil clearance: 0.005 to 0.011 mm (0.0002 to 0.0004 in)

Maximum oil clearance: 0.011 mm (0.0004 in)

If the oil clearance is greater than the maximum, replace the connecting rod. If necessary, replace the connecting rod and piston pin as a set.

PISTON AND CONNECTING ROD ASSEMBLE

Assembly Procedure

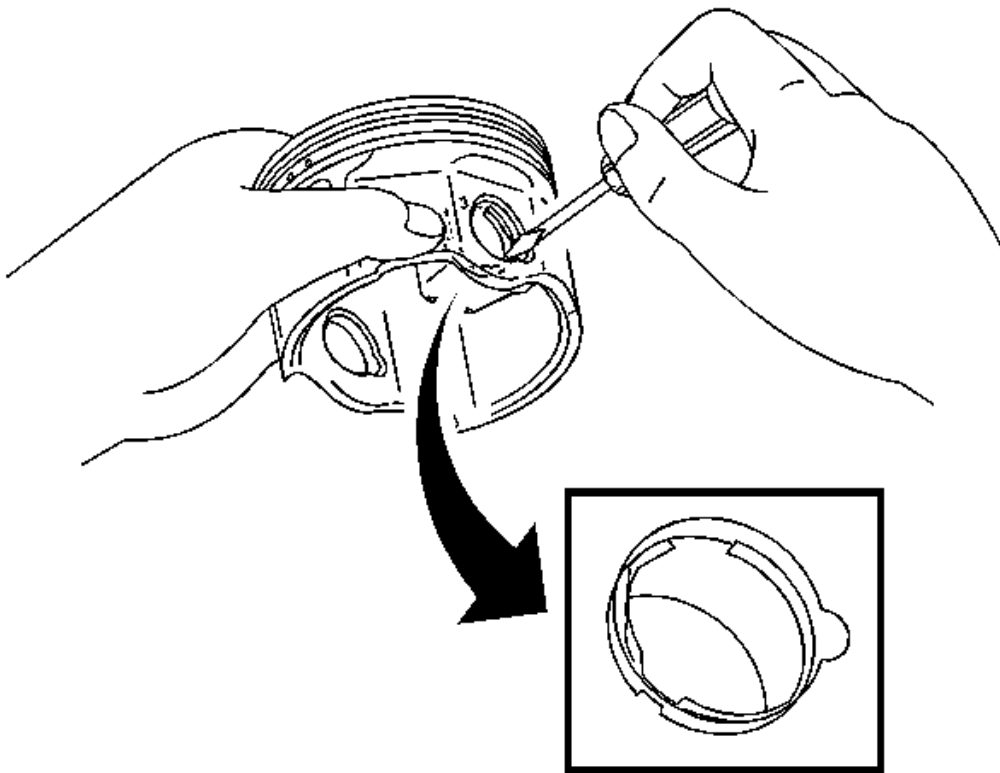
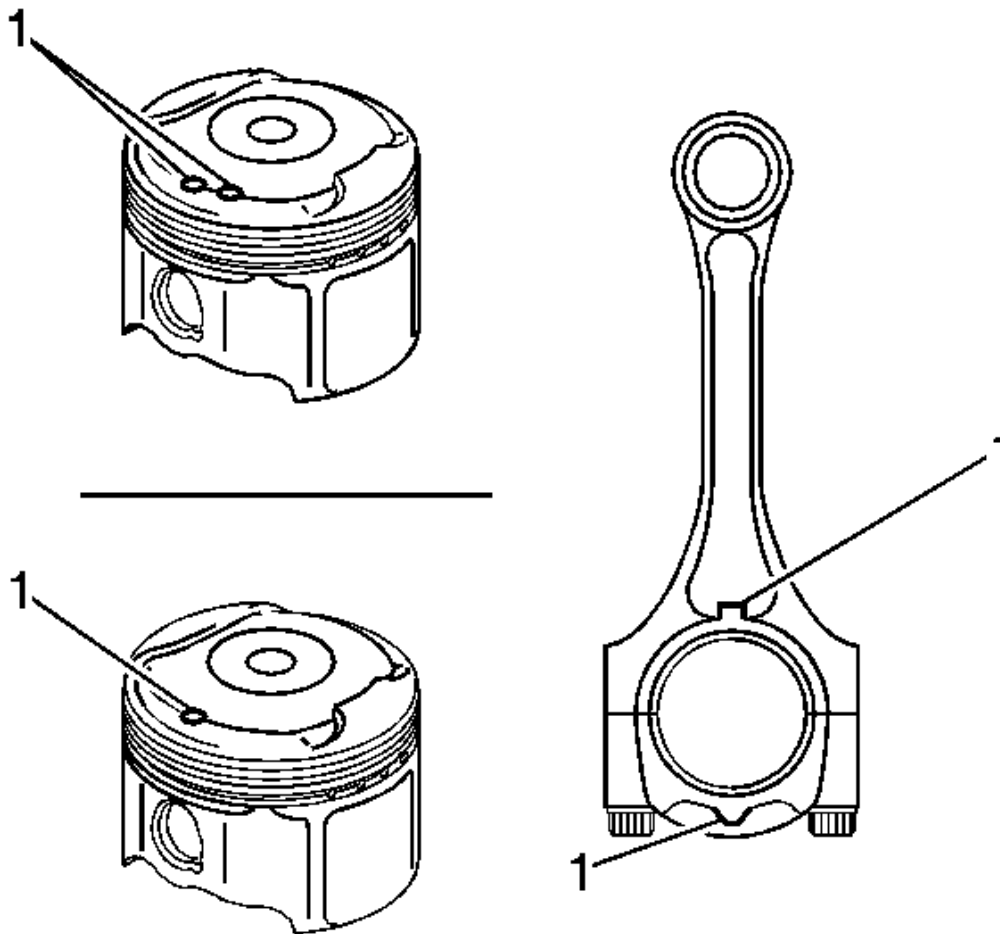


Fig. 353: View Of Piston Pin Snap Ring Installation

Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure that the end gap on the snap ring is not aligned with the pin hole cutout portion of the piston.

1. Using a screwdriver, install a new snap ring at one end of the piston pin hole.
2. Gradually heat the piston to approximately 80 to 90°C (176 to 194°F).

**Fig. 354: View Of Piston & Connecting Rod Markings**

Courtesy of GENERAL MOTORS CORP.

3. Align the front marks on the piston and connecting rod, and push in the piston with a thumb.

IMPORTANT: Make sure that the end gap on the snap ring is not aligned with the pin hole cutout portion of the piston.

4. Using a screwdriver, install a new snap ring on the other end of the piston pin hole.

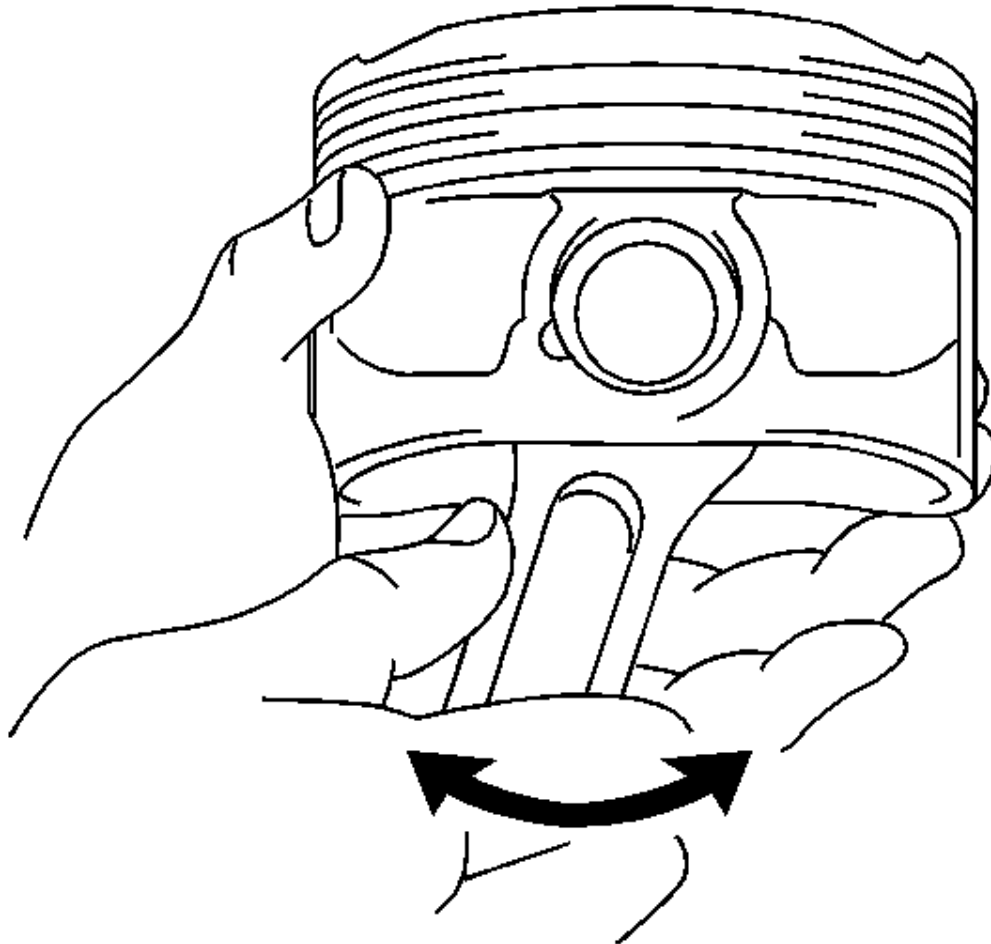


Fig. 355: Checking Fitting Condition Between Piston & Piston Pin
Courtesy of GENERAL MOTORS CORP.

5. Check the fitting condition between the piston and piston pin by trying to move the piston back and forth on the piston pin.

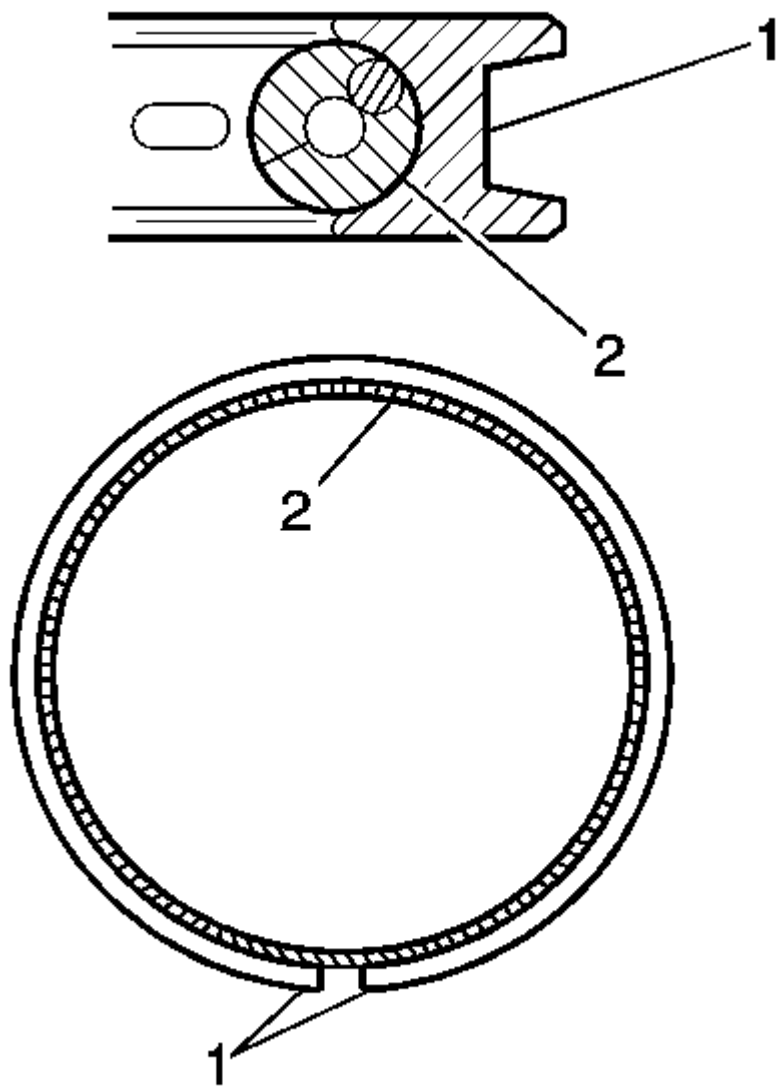


Fig. 356: View Of Piston Ring Installation
Courtesy of GENERAL MOTORS CORP.

6. Install piston ring set.

IMPORTANT: Install the expander and oil ring so that their ring ends are at opposite sides. Securely install the expander into the inner groove of the oil ring.

7. Install the oil ring expander and oil ring rail by hand.

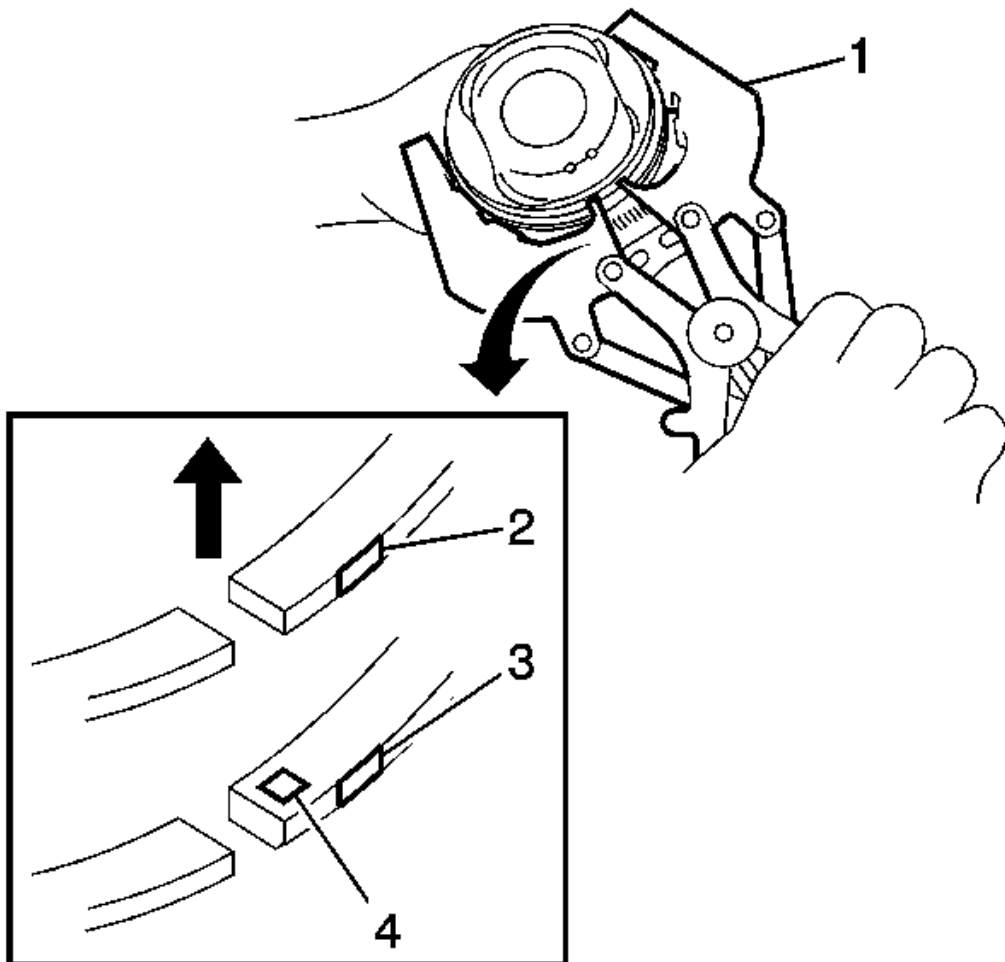


Fig. 357: Using Piston Ring Expander
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install compression ring No. 2 with the code mark (2N or 2A) facing upward.

IMPORTANT: Supply part compression springs (No. 1 and No. 2) do not have paint marks.

8. Using a piston ring expander, install the 2 compression rings so that the paint marks are positioned as shown in the illustration.

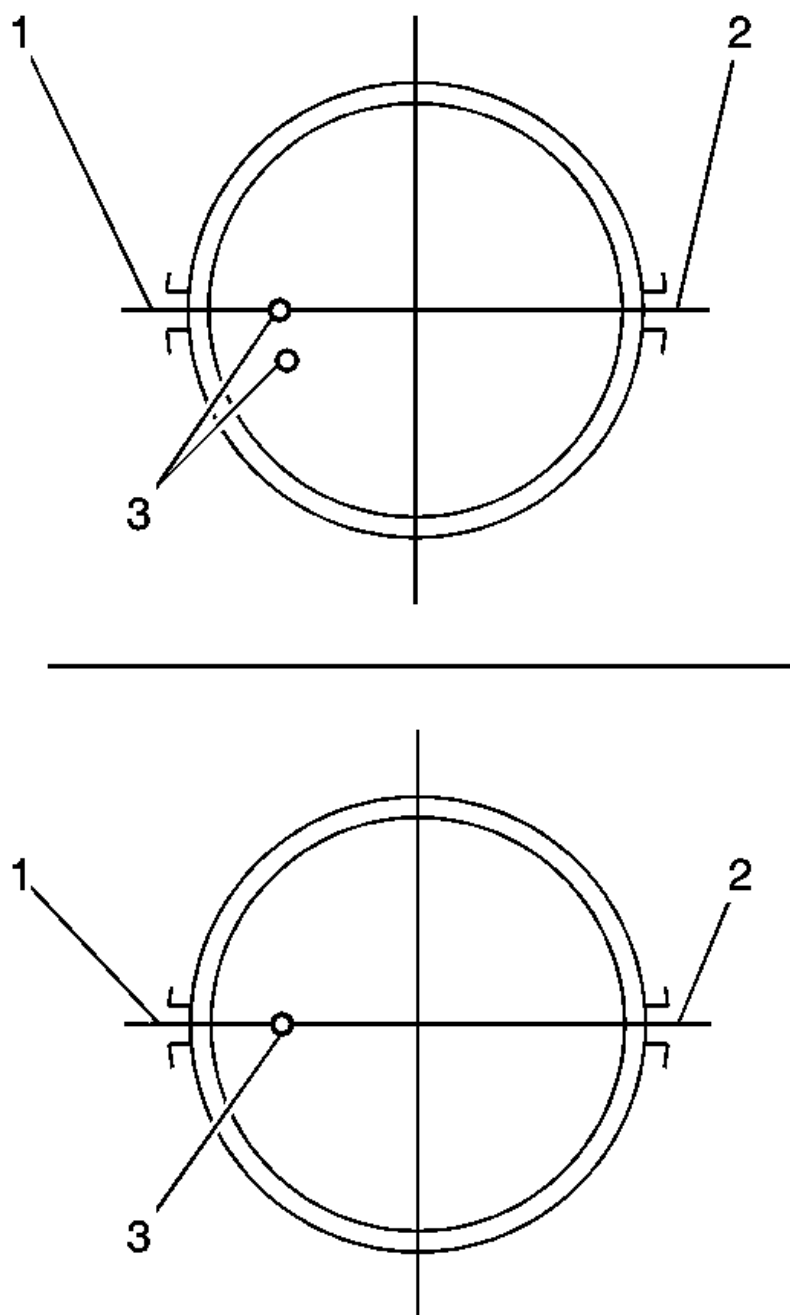


Fig. 358: View Of Correct Ring Positioning
Courtesy of GENERAL MOTORS CORP.

9. Position the piston rings so that the ring ends are as shown in the illustration.

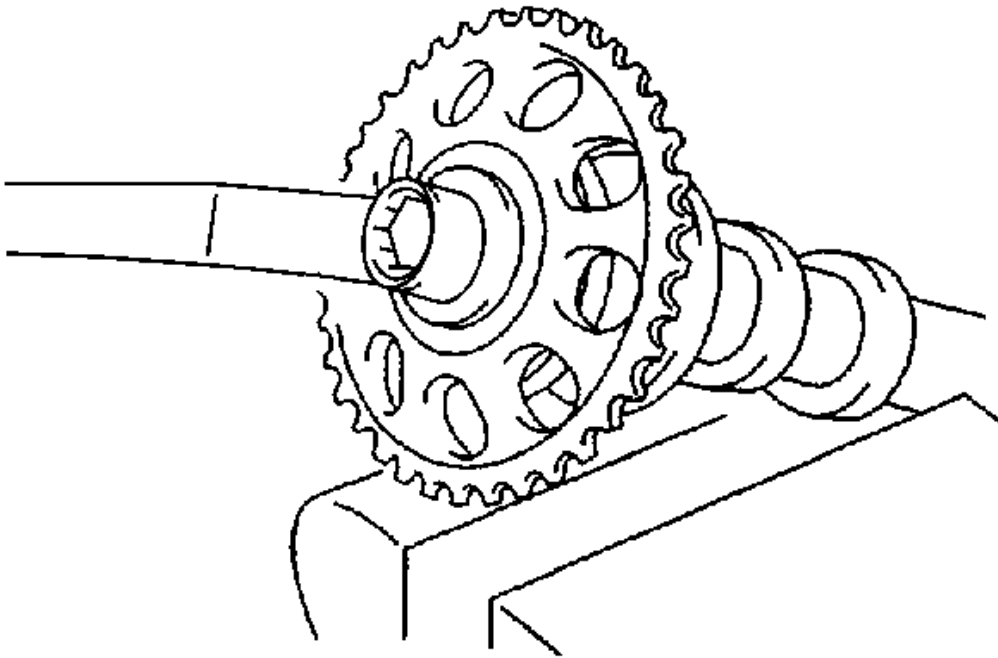
CAMSHAFT CLEANING AND INSPECTION**Inspection Procedure**

Fig. 359: View Of Camshaft, Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Clamp the camshaft in a vise, and make sure that the camshaft timing gear or sprocket does not rotate.
2. Remove the bolt and camshaft timing gear or sprocket.
3. Remove camshaft timing gear assembly.

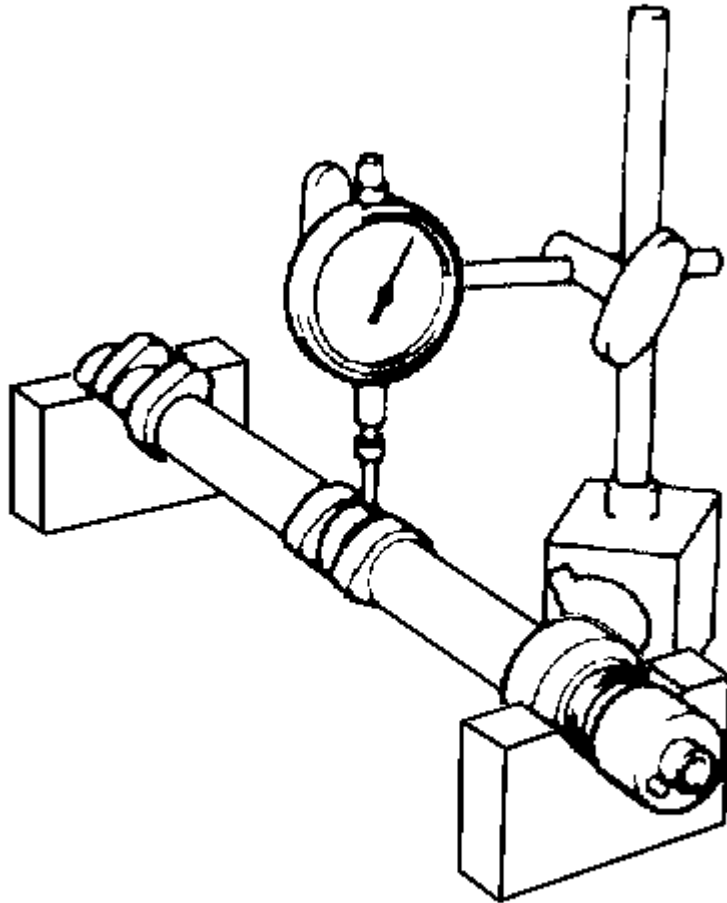


Fig. 360: Inspecting Camshaft For Runout
Courtesy of GENERAL MOTORS CORP.

4. Inspect the camshaft for runout.
5. Place the camshaft on V-blocks.
6. Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.03 mm (0.0012 in)

7. If the circle runout is greater than the maximum, replace the camshaft.

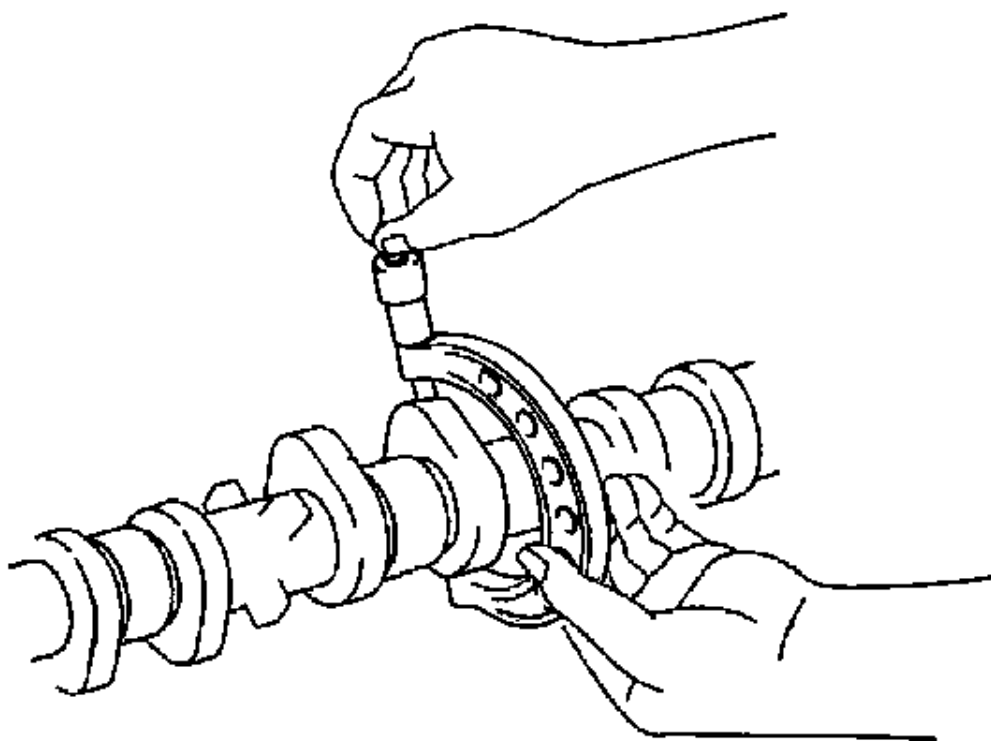


Fig. 361: Inspecting Cam Lobes
Courtesy of GENERAL MOTORS CORP.

8. Inspect the cam lobes.
9. Using a micrometer, measure the cam lobe heights.

Standard cam lobe height: 47.306 to 47.406 mm (1.8624 to 1.8664 in)

Minimum cam lobe height: 47.196 mm (1.8581 in)

10. If any of the cam lobe heights are less than the minimum, replace the camshaft.

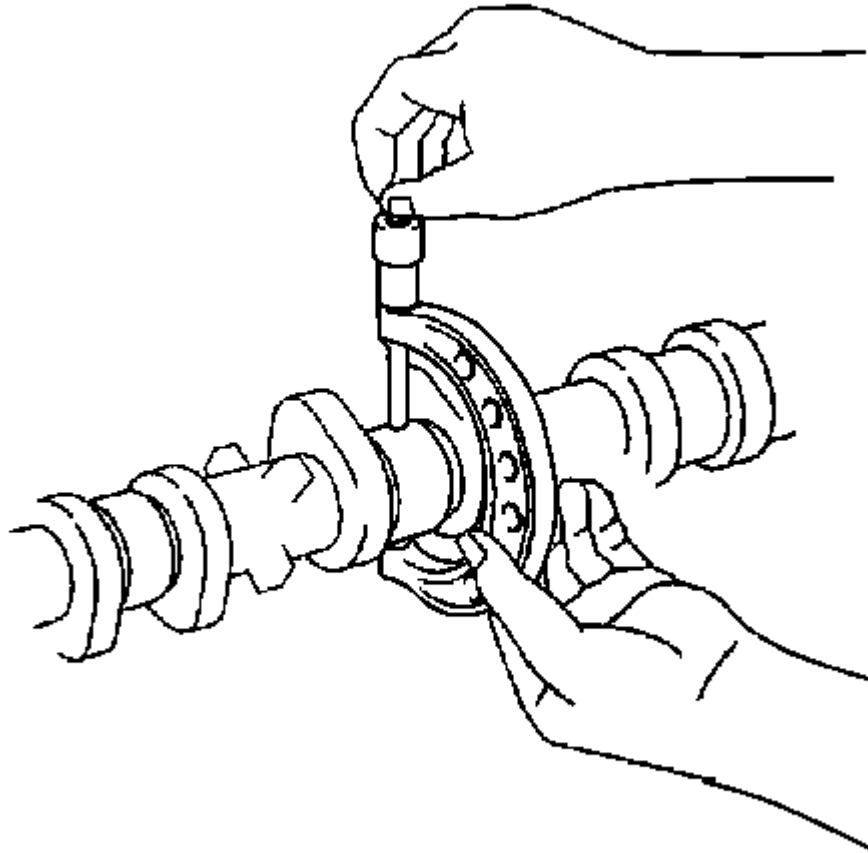


Fig. 362: Inspecting Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

11. Inspect the camshaft journals.
12. Using a micrometer, measure the journal diameter.
13. If the journal diameter is not as specified, check the oil clearance.

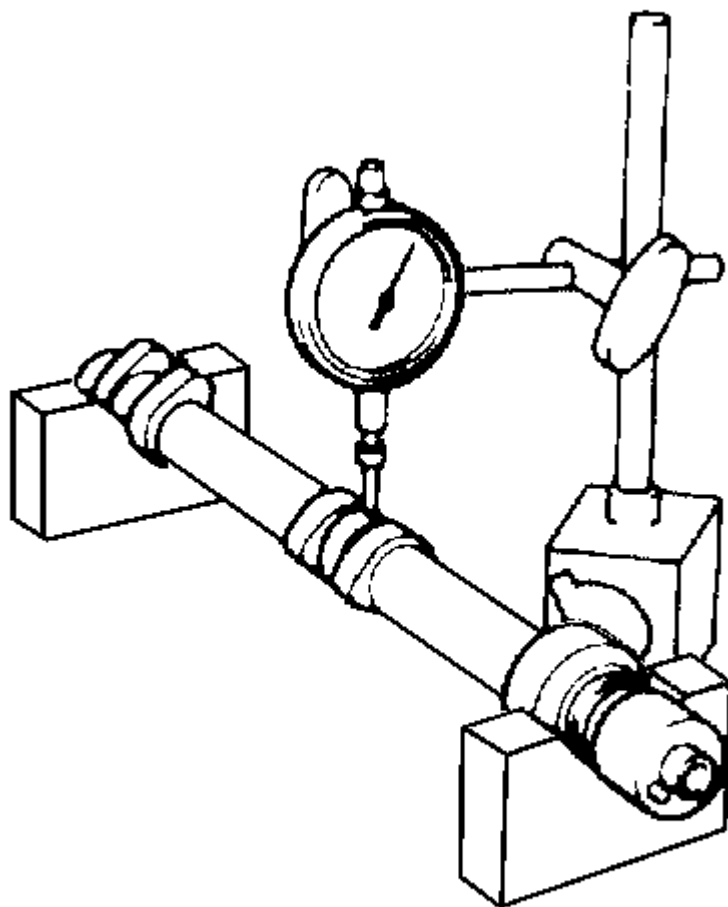


Fig. 363: Inspecting Camshaft For Runout
Courtesy of GENERAL MOTORS CORP.

14. Inspect No. 2 camshaft for runout.
15. Place the camshaft on V-blocks.
16. Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.03 mm (0.0012 in)

17. If the circle runout is greater than the maximum, replace the camshaft.

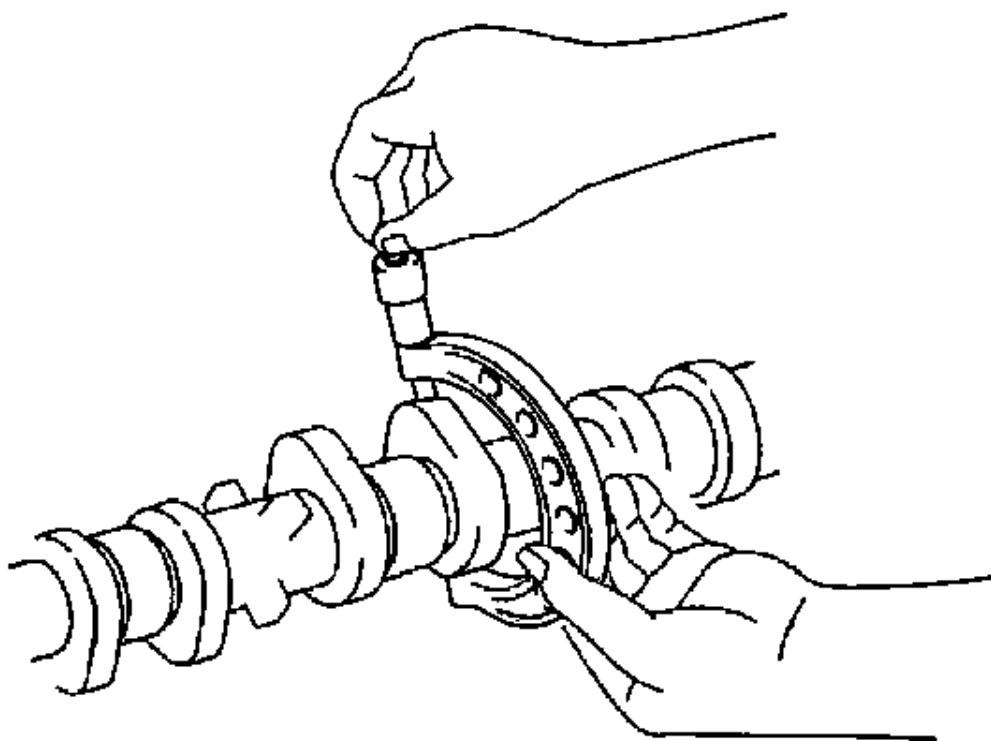


Fig. 364: Inspecting Cam Lobes
Courtesy of GENERAL MOTORS CORP.

18. Inspect the cam lobes.
19. Using a micrometer, measure the cam lobe heights.

Standard cam lobe height: 46.063 to 46.163 mm (1.8135 to 1.8174 in)

Minimum cam lobe height: 45.953 mm (1.8092 in)

20. If any of the cam lobe heights are less than the minimum, replace the camshaft.

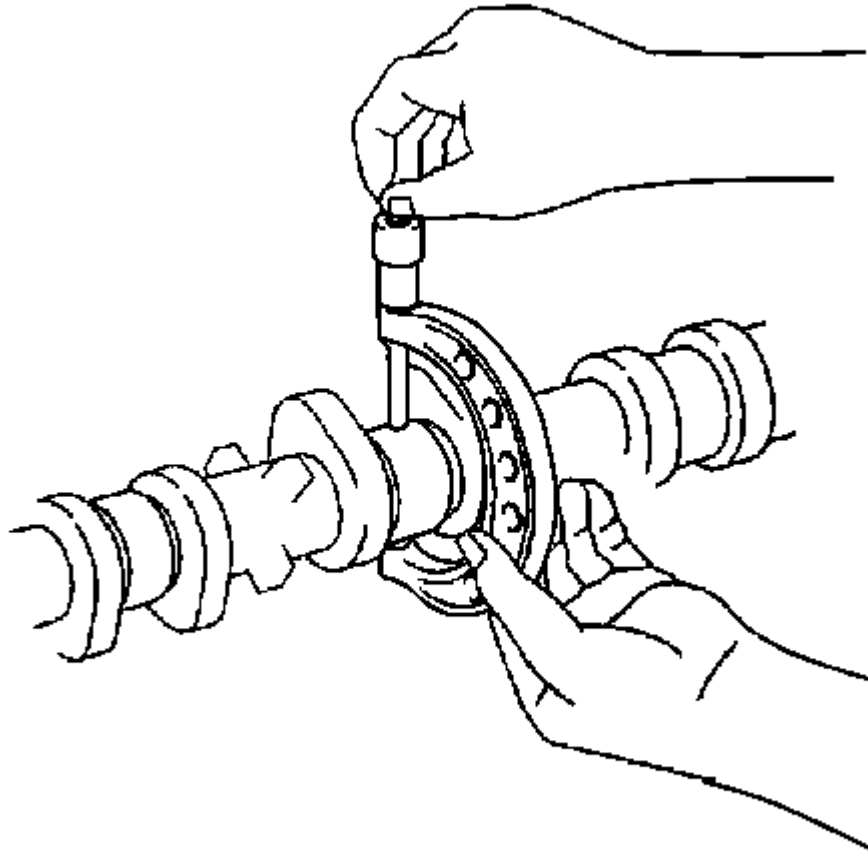


Fig. 365: Inspecting Camshaft Journals
 Courtesy of GENERAL MOTORS CORP.

21. Inspect the camshaft journals.
22. Using a micrometer, measure the journal diameter.
23. If the journal diameter is not as specified, check the oil clearance.

Item	Specified Condition
Standard balanceshaft housing journal bore diameter	
Mark 1	26.000 to 26.006 mm (1.0236 to 1.0239 in)
Mark 2	26.007 to 26.012 mm (1.0239 to 1.0241 in)
Mark 3	26.013 to 26.018 mm (1.0241 to 1.0243 in)
Standard bearing center wall thickness	
Mark 1	1.486 to 1.489 mm (0.05850 to 0.05862 in)

2009 Pontiac Vibe

2009 ENGINE Engine Mechanical - 2.4L (LAX) - Vibe

Mark 2	1.490 to 1.492 mm (0.05866 to 0.05874 in)
Mark 3	1.493 to 1.495 mm (0.0588 to 0.0589 in)

Standard Journal Diameter

Journal Position	Specified Condition
No. 1	35.971 to 35.985 mm (1.4162 to 1.416 in)
Others	22.959 to 22.975 mm (0.9039 to 0.9045 in)

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

Inspection Procedure

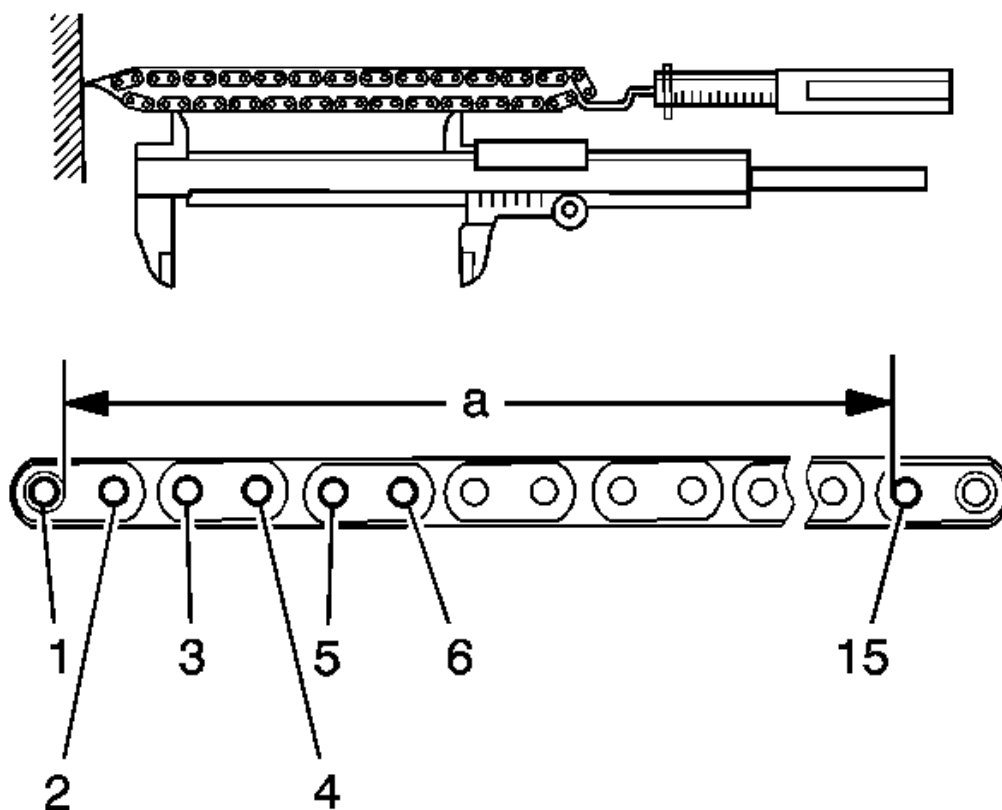


Fig. 366: Inspecting Chain Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

1. Inspect chain sub-assembly.
2. Pull the chain with a force of 140 N (14.3 kgf, 31.5 lbf) as shown in the illustration.

IMPORTANT: Perform the measurement at 3 random places. Use the average of the measurements. If the elongation is greater than the maximum, replace the chain.

- Using vernier calipers, measure the length of 15 links.

Maximum chain elongation: 114.5 mm (4.508 in)

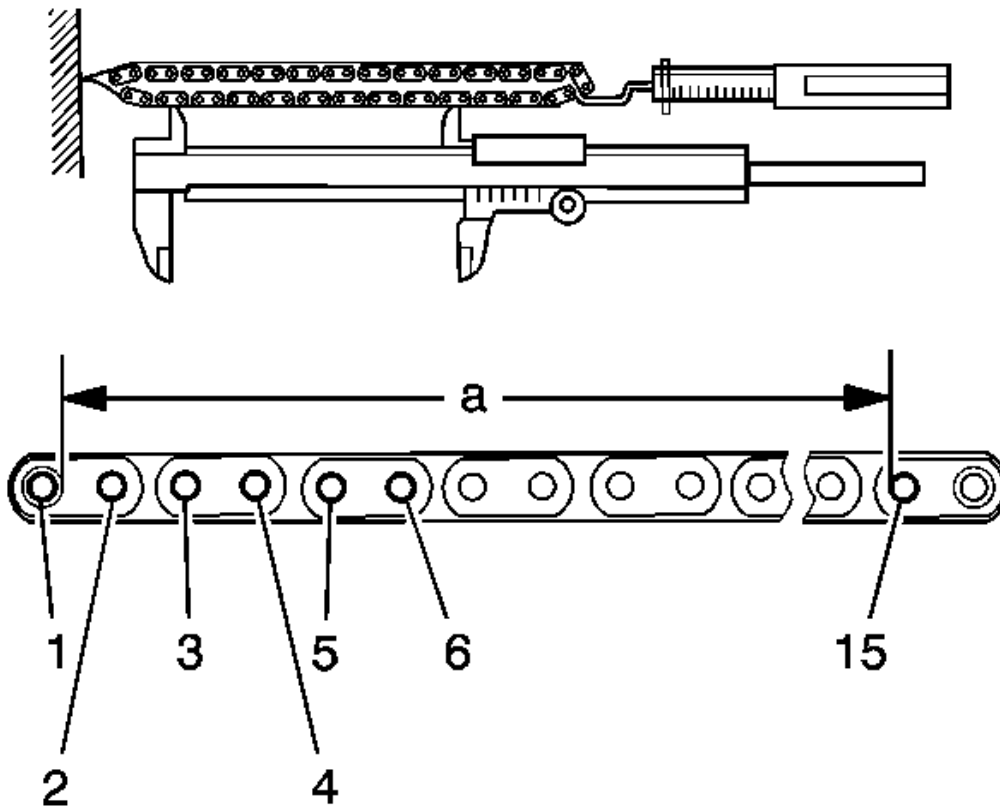


Fig. 367: Inspecting Chain Sub-Assembly
Courtesy of GENERAL MOTORS CORP.

- Inspect No. 2 chain sub-assembly.
- Pull the chain with a force of 140 N (14.3 kgf, 31.5 lbf) as shown in the illustration.

IMPORTANT: Perform the measurement at 3 random places. Use the average of the measurements.

6. Using vernier calipers, measure the length of 15 links.

Maximum chain elongation: 102.2 mm (4.024 in)

7. If the elongation is greater than the maximum, replace the No. 2 chain.

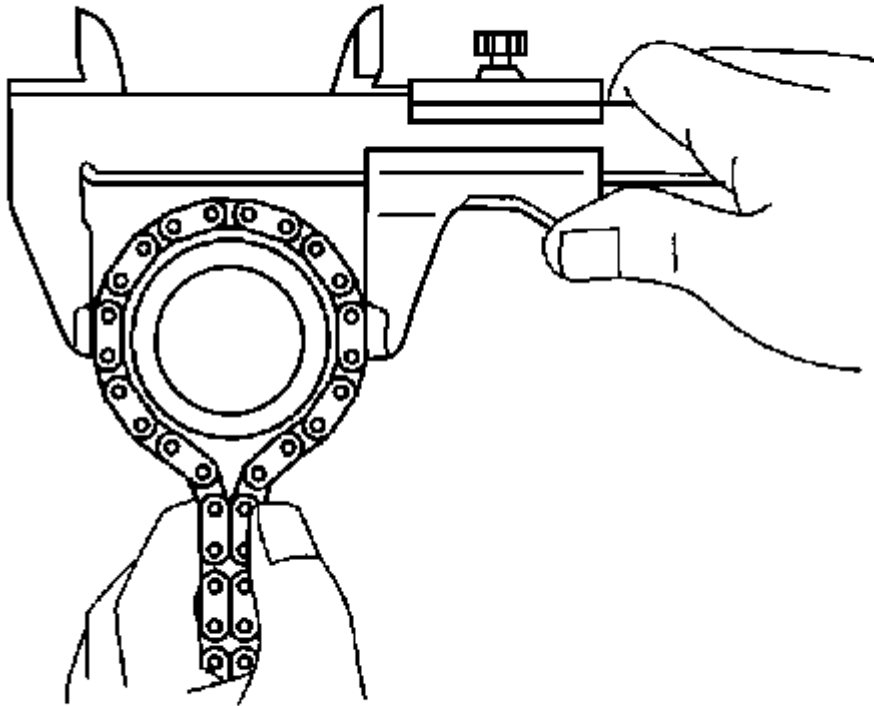


Fig. 368: Inspecting Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

8. Inspect oil pump drive gear.
9. Wrap the chain around the sprocket.

IMPORTANT: The vernier calipers must be in contact with the chain rollers when measuring.

10. Using vernier calipers, measure the sprocket diameter with the chain wrapped around.

Minimum gear diameter (with chain): 48.2 mm (1.898 in)

11. If the diameter is less than the minimum, replace the chain and sprocket.
12. Inspect oil pump drive shaft gear.
13. Wrap the chain around the sprocket.

IMPORTANT: The vernier calipers must be in contact with the chain rollers when measuring.

14. Using vernier calipers, measure the sprocket diameter with the chain wrapped around.

Minimum gear diameter (with chain): 48.2 mm (1.898 in)

15. If the diameter is less than the minimum, replace the chain and sprocket.

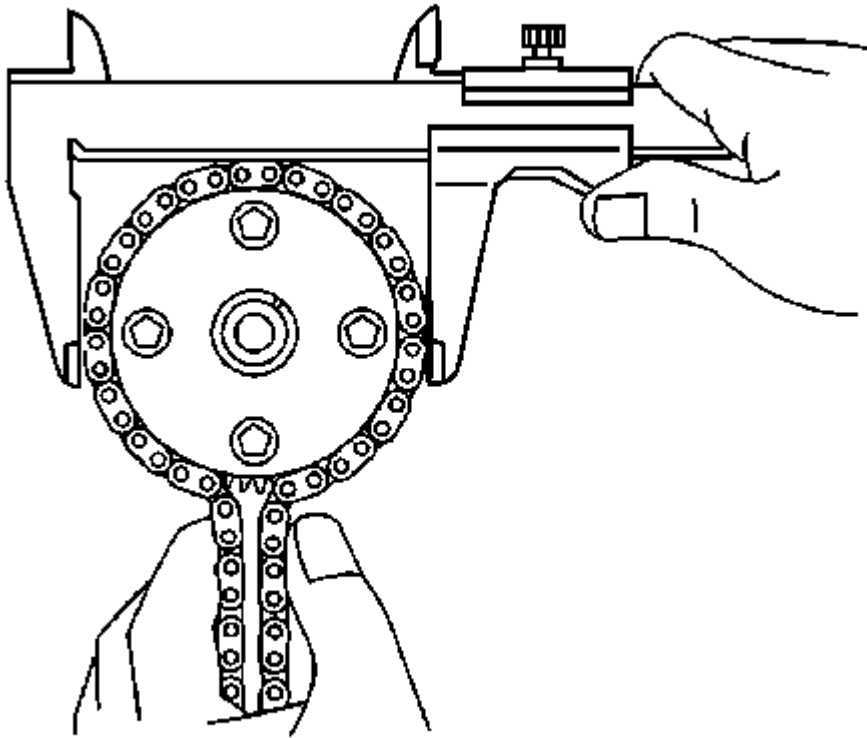


Fig. 369: Inspecting Camshaft Timing Gear Assembly
Courtesy of GENERAL MOTORS CORP.

16. Inspect camshaft timing gear assembly.

17. Wrap the chain around the sprocket.

IMPORTANT: The vernier calipers must be in contact with the chain rollers when measuring.

18. Using vernier calipers, measure the sprocket diameter with the chain wrapped around.

Minimum gear diameter (with chain): 97.3 mm (3.831 in)

19. If the diameter is less than the minimum, replace the chain and sprocket.

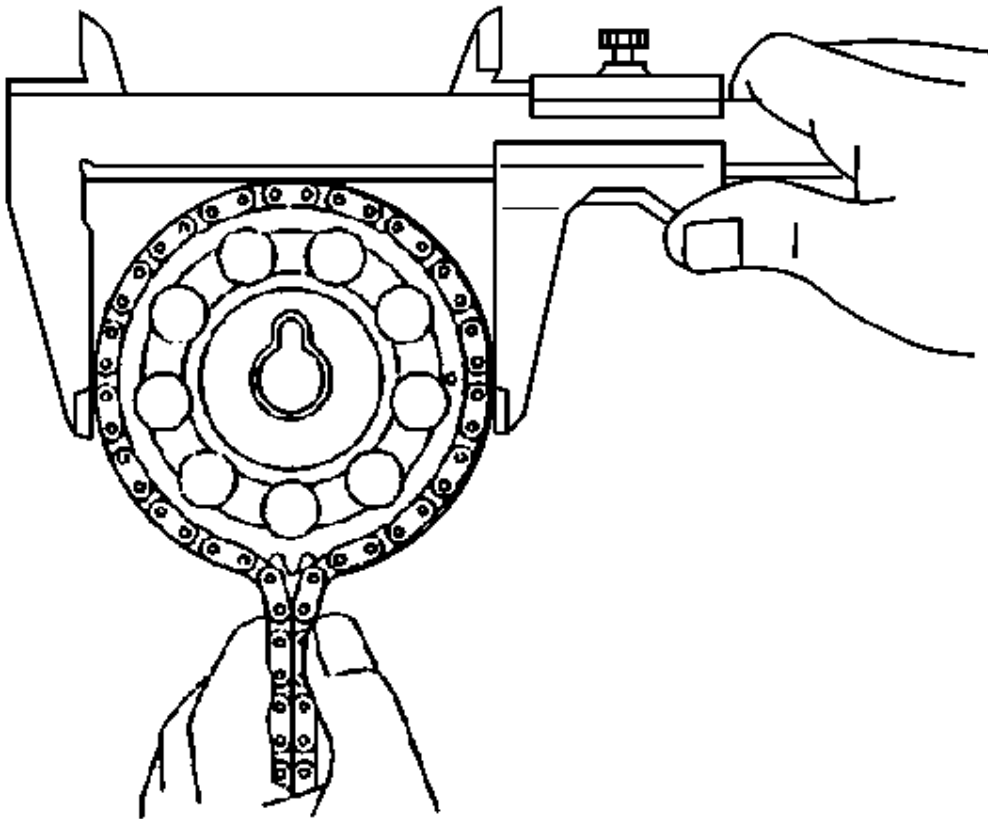


Fig. 370: Inspecting Camshaft Timing Gear/Sprocket
Courtesy of GENERAL MOTORS CORP.

20. Inspect camshaft timing gear or sprocket.
21. Wrap the chain around the sprocket.

IMPORTANT: The vernier calipers must be in contact with the chain rollers when measuring.

22. Using vernier calipers, measure the sprocket diameter with the chain wrapped around.

Minimum gear diameter (with chain): 97.3 mm (3.831 in)

23. If the diameter is less than the minimum, replace the chain and sprocket.

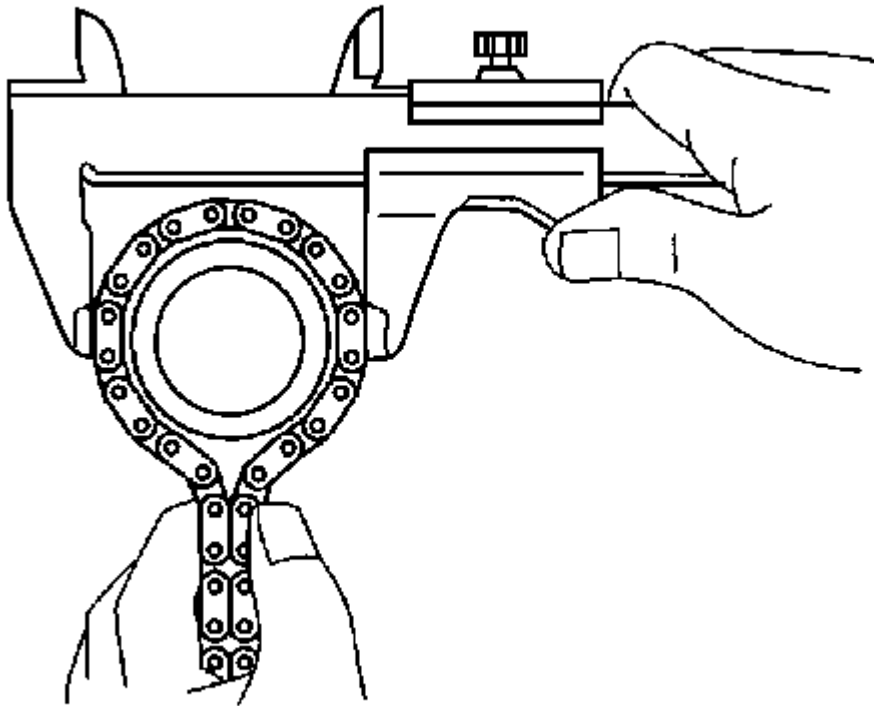


Fig. 371: Inspecting Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

24. Inspect crankshaft timing gear or sprocket.
25. Wrap the chain around the timing sprocket.

IMPORTANT: The vernier calipers must be in contact with the chain rollers when measuring.

26. Using vernier calipers, measure the timing gear diameter with the chain wrapped around.

Minimum gear diameter (with chain): 51.6 mm (2.031 in)

27. If the gear diameter is less than the minimum, replace the chain sub-assembly and crankshaft timing sprocket.

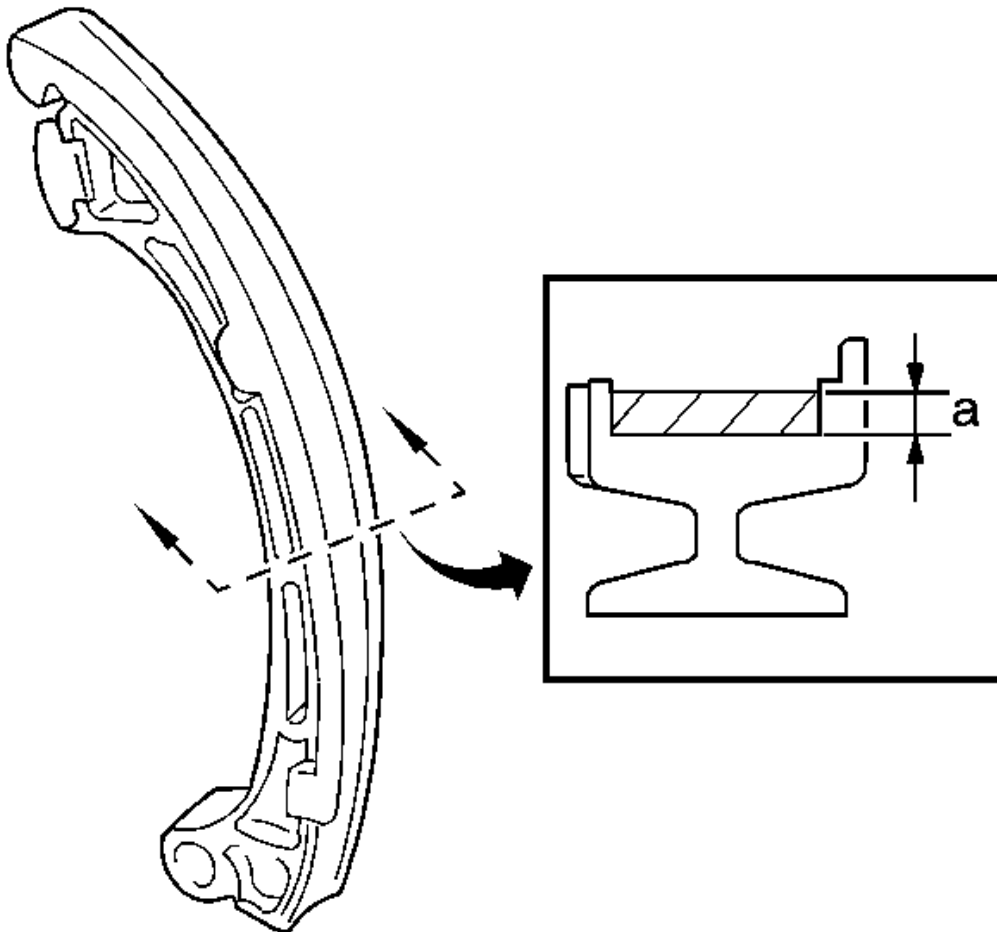


Fig. 372: Inspecting Chain Tensioner Slipper
Courtesy of GENERAL MOTORS CORP.

28. Inspect chain tensioner slipper.
29. Using vernier calipers, measure the tensioner slipper wear.

Maximum wear: 1.0 mm (0.039 in)

30. If the wear is greater than the maximum, replace the chain tensioner slipper.

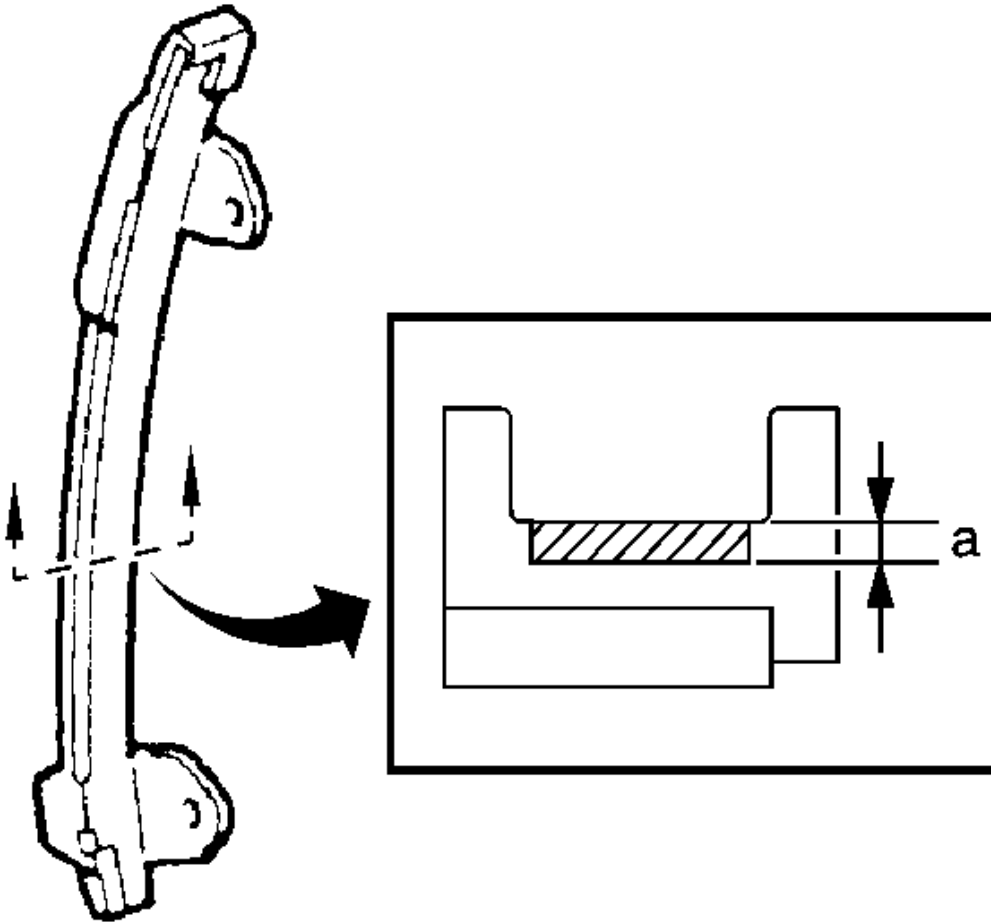


Fig. 373: Inspecting Chain Vibration Damper
Courtesy of GENERAL MOTORS CORP.

31. Inspect No. 1 chain vibration damper.
32. Using vernier calipers, measure the vibration damper wear.

Maximum wear: 1.0 mm (0.039 in)

33. If the wear is greater than the maximum, replace the No. 1 chain vibration damper.

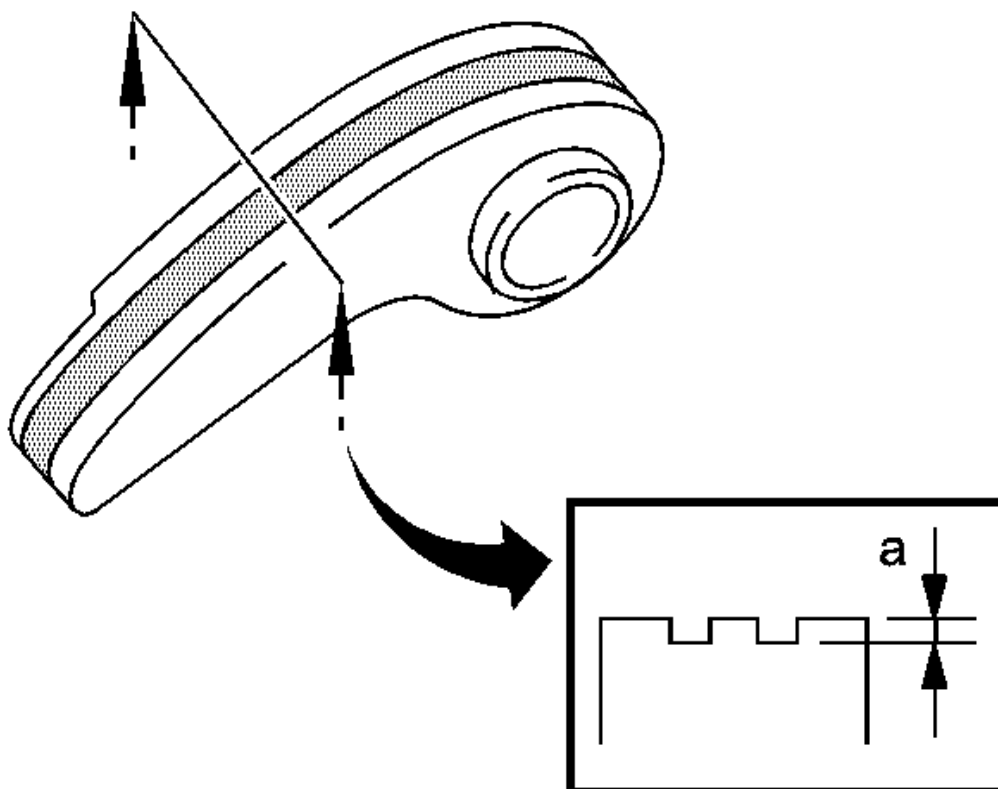


Fig. 374: Inspecting Chain Tensioner Plate
Courtesy of GENERAL MOTORS CORP.

34. Inspect chain tensioner plate.
35. Using vernier calipers, measure the vibration damper wear.

Maximum wear: 0.5 mm (0.020 in)

36. If the wear is greater than the maximum, replace the chain tensioner plate.

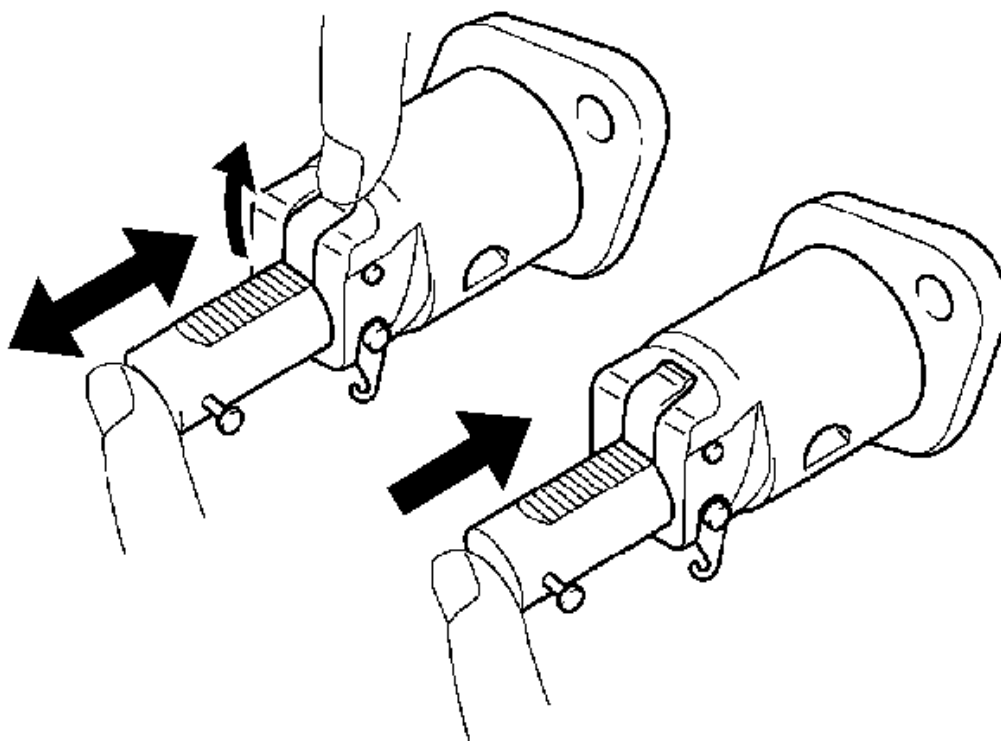


Fig. 375: Inspecting Chain Tensioner Assembly
Courtesy of GENERAL MOTORS CORP.

37. Inspect No. 1 chain tensioner assembly.
38. Check that the plunger moves smoothly when the ratchet pawl is raised with your finger.
39. Release the ratchet pawl, then check that the plunger is locked in place by the ratchet pawl and does not move when pushed with your finger.

CYLINDER HEAD DISASSEMBLE

Disassembly Procedure

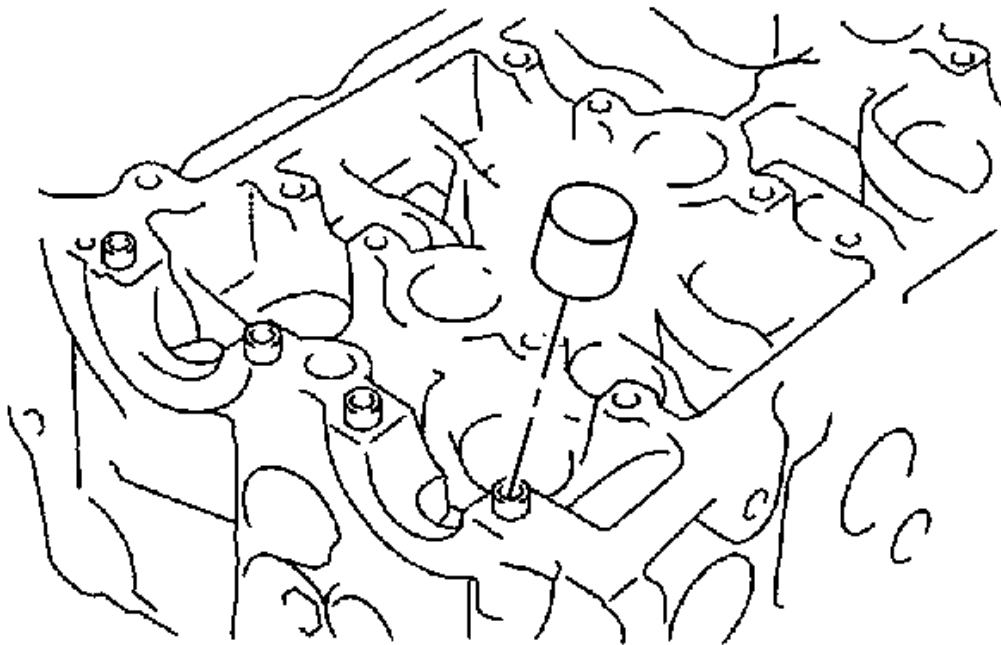


Fig. 376: Identifying Valve Lifters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Arrange the valve lifters in the correct order.

1. Remove the 16 valve lifters from the cylinder head.

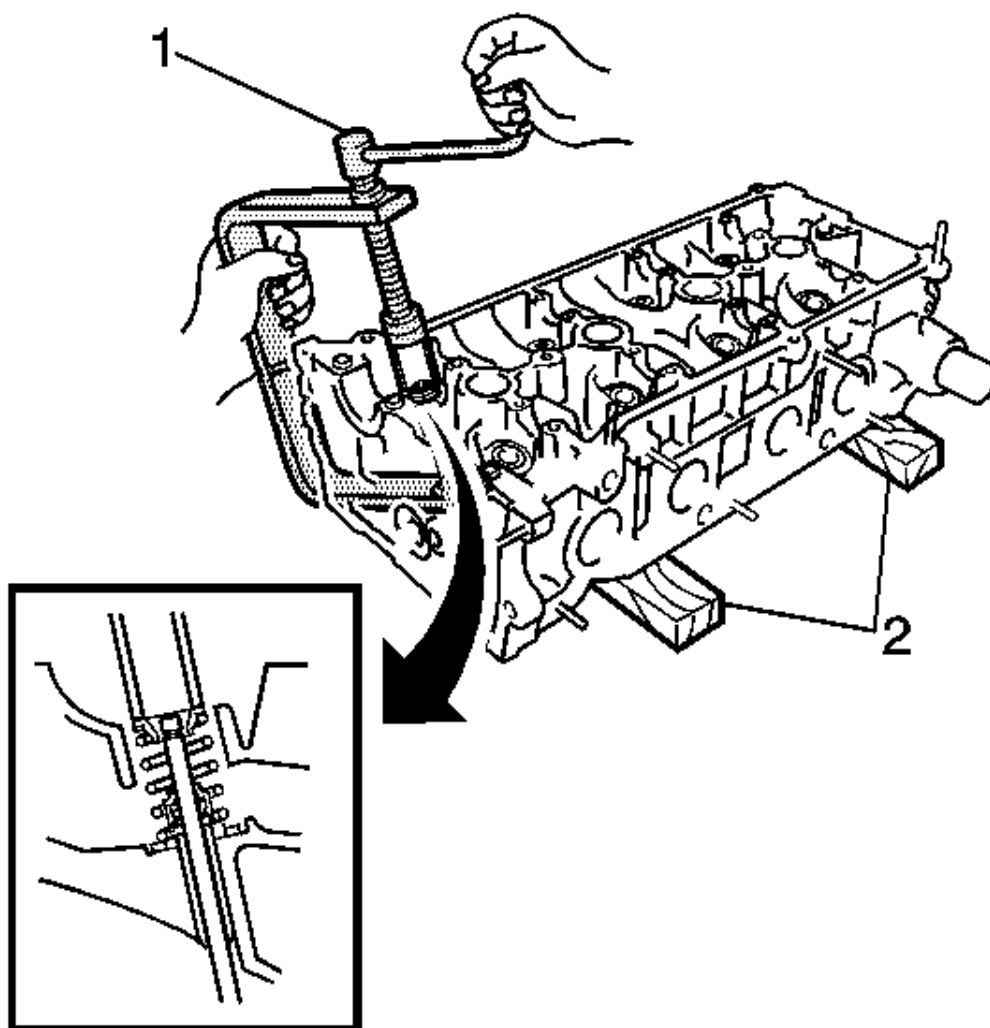


Fig. 377: Illustrating Retainer Lock Removal/Installation
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Arrange the removed parts in the correct order.

2. Using SST and wooden blocks, remove the 16 retainer locks.
3. Remove the 8 retainers, compression springs and intake valves.

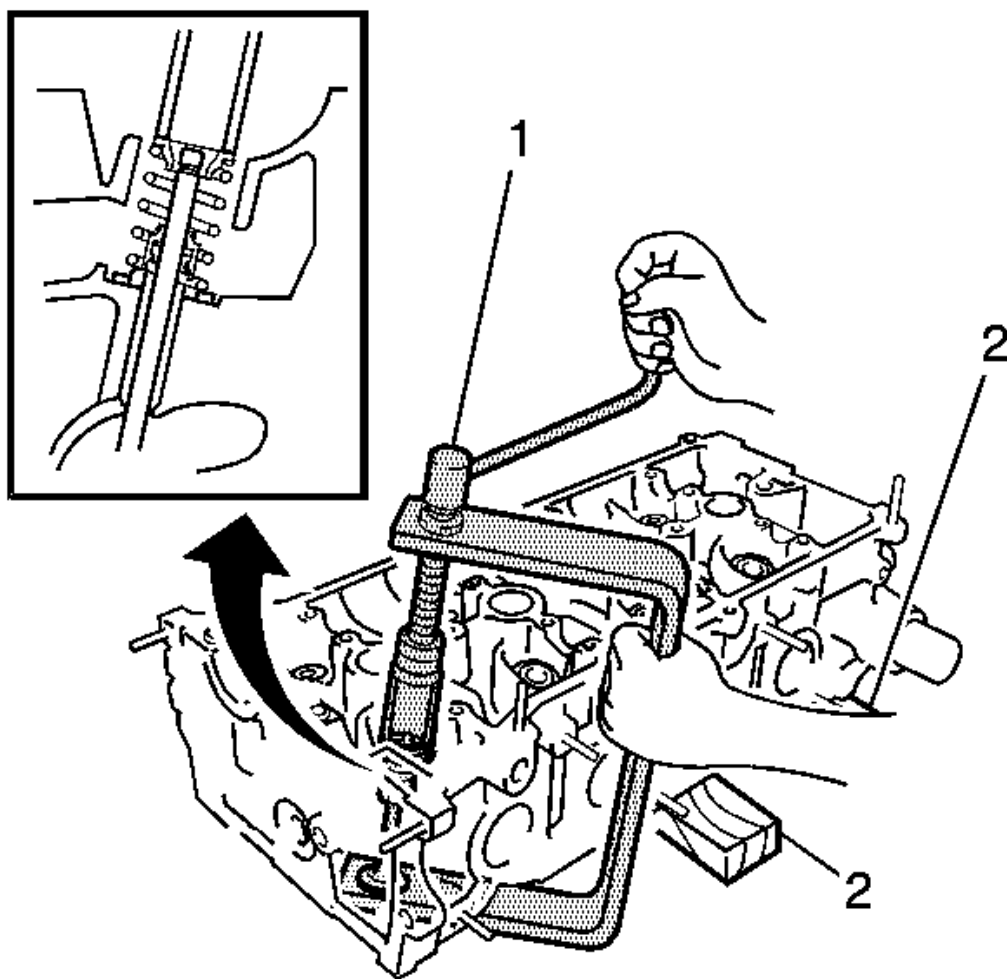


Fig. 378: Identifying Retainer Locks
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Arrange the removed parts in the correct order.

4. Using SST and wooden blocks, remove the 16 retainer locks.
5. Remove the 8 retainers, compression springs and exhaust valves.



Fig. 379: Illustrating Valve Stem Oil Seal Removal
Courtesy of GENERAL MOTORS CORP.

6. Using needle nose pliers, remove the valve stem oil seals.

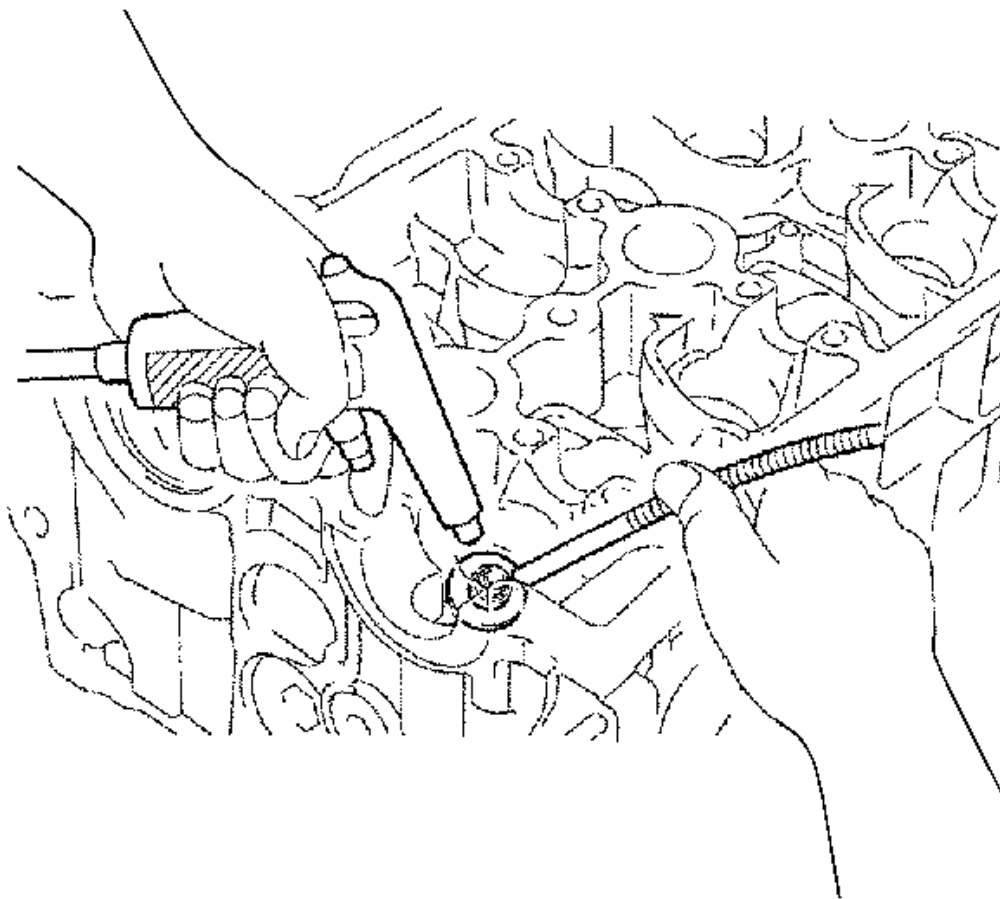


Fig. 380: View Of valve spring seat Removal Using Magnetic Tool & Compressed Air
Courtesy of GENERAL MOTORS CORP.

7. Using compressed air and a magnetic pick-up tool, remove the valve spring seats by blowing air onto them.

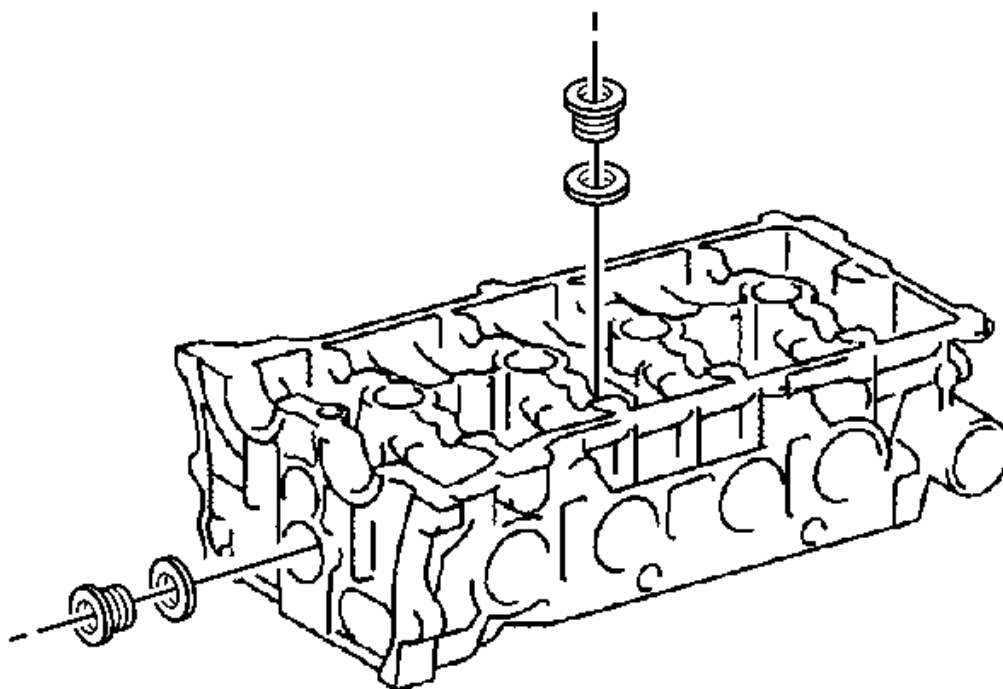


Fig. 381: View Of Coolant Plugs

Courtesy of GENERAL MOTORS CORP.

NOTE: If water leaks from the straight screw plug or the plug is corroded, replace it.

8. Using a 14 mm straight hexagon wrench, remove the 2 No. 1 straight head screw plugs and 2 gaskets.
9. Remove stud bolt.
10. Remove ring pin.

CYLINDER HEAD CLEANING AND INSPECTION

Inspection Procedure

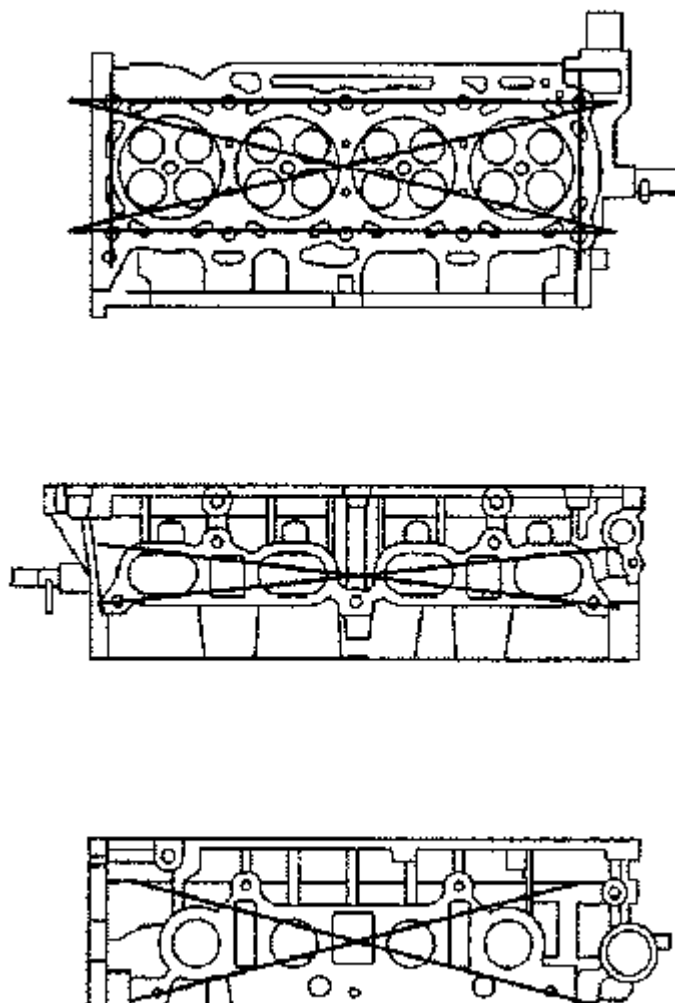


Fig. 382: Inspecting Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

1. Inspect cylinder head for warpage.
2. Using a precision straight edge and a feeler gauge, measure the surface contacting the cylinder block and the manifolds for warpage.

If the warpage is greater than the maximum, replace the cylinder head.

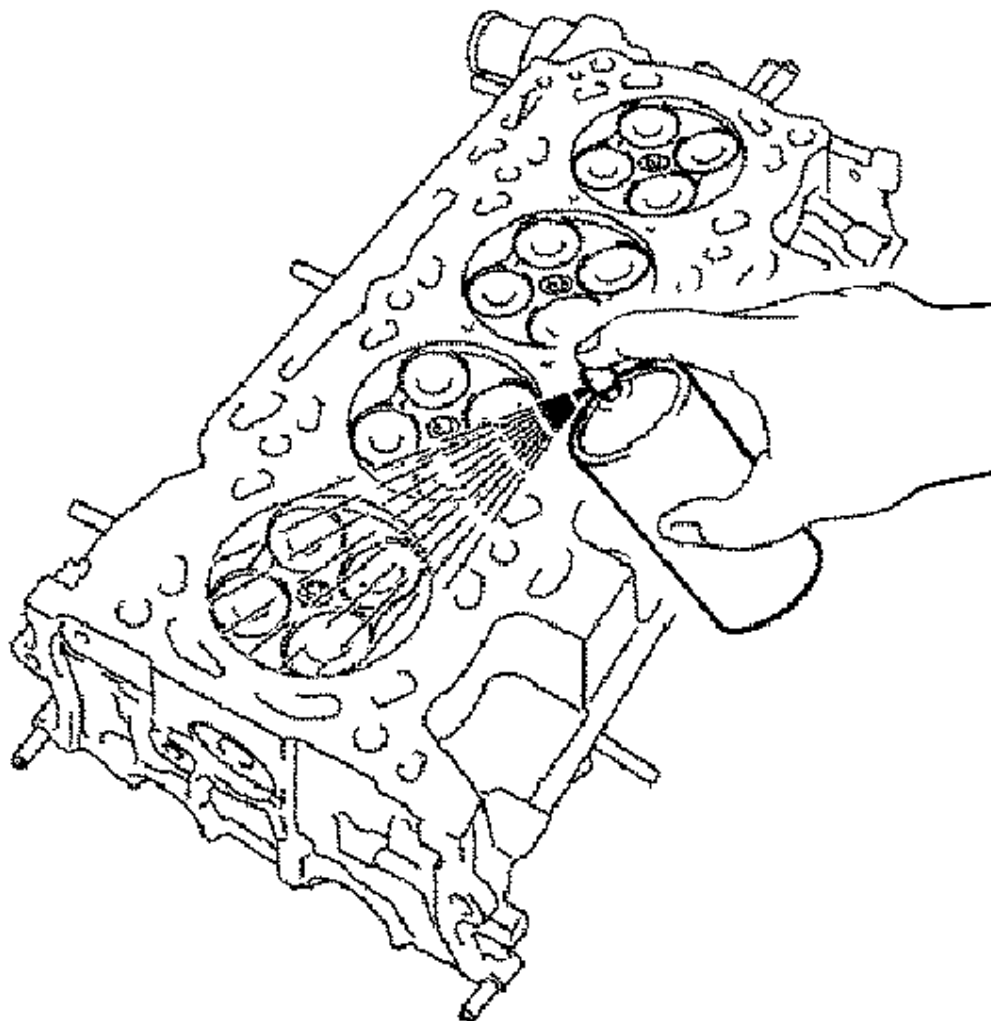


Fig. 383: Checking Valve Ports & Head Surface for cracks
Courtesy of GENERAL MOTORS CORP.

3. Using a dye penetrant, check the intake ports, exhaust ports and cylinder surface for cracks. If cracked, replace the cylinder head.
4. Install the camshafts.

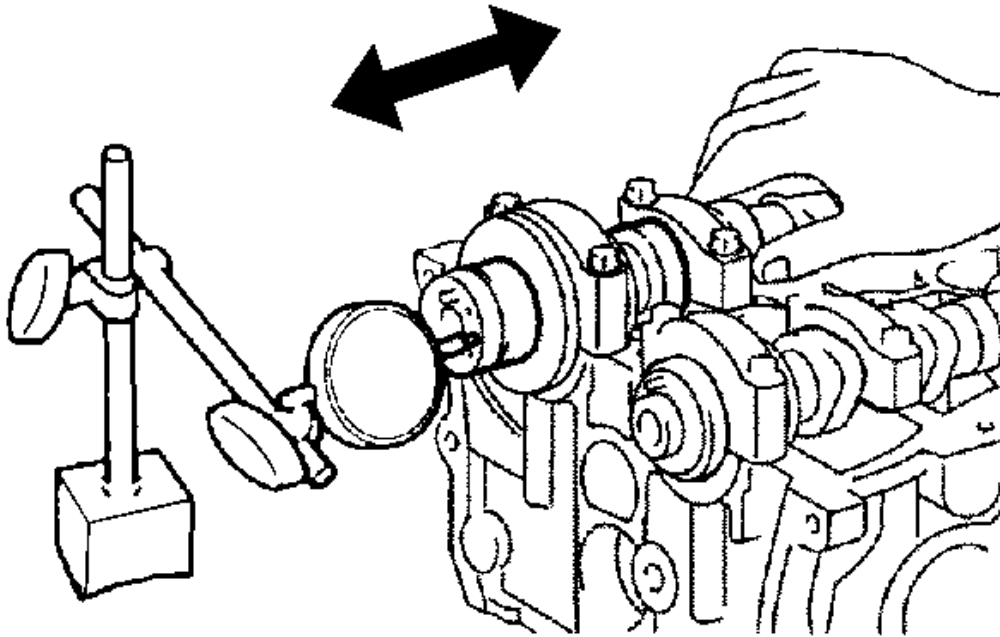


Fig. 384: Checking Camshaft For Clearance & Movement On Head
Courtesy of GENERAL MOTORS CORP.

5. Using a dial indicator, measure the thrust clearance while moving the camshaft back and forth.

If the thrust clearance is greater than the maximum, replace the cylinder head. If the thrust surface is damaged, replace the camshaft.

6. Inspect camshaft oil clearance.
7. Clean the bearing caps and camshaft journals.
8. Place the camshafts on the cylinder head.

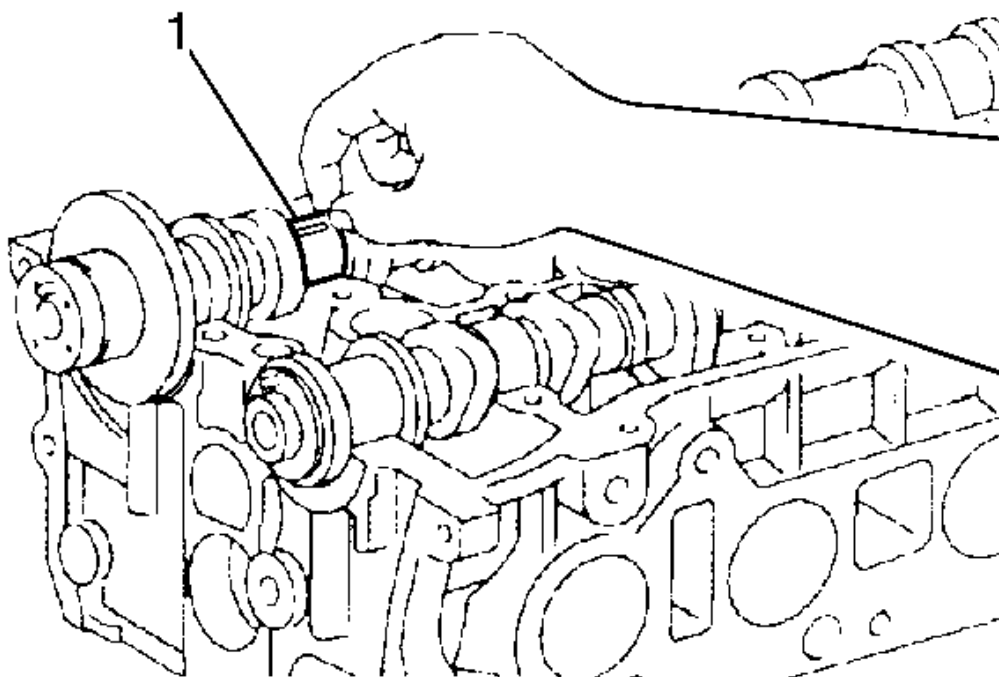


Fig. 385: Using Plastigage On Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

9. Lay a strip of Plastigage across each of the camshaft journals.

NOTE: **Do not turn the camshaft.**

10. Install the bearing caps.
11. Remove the bearing caps.

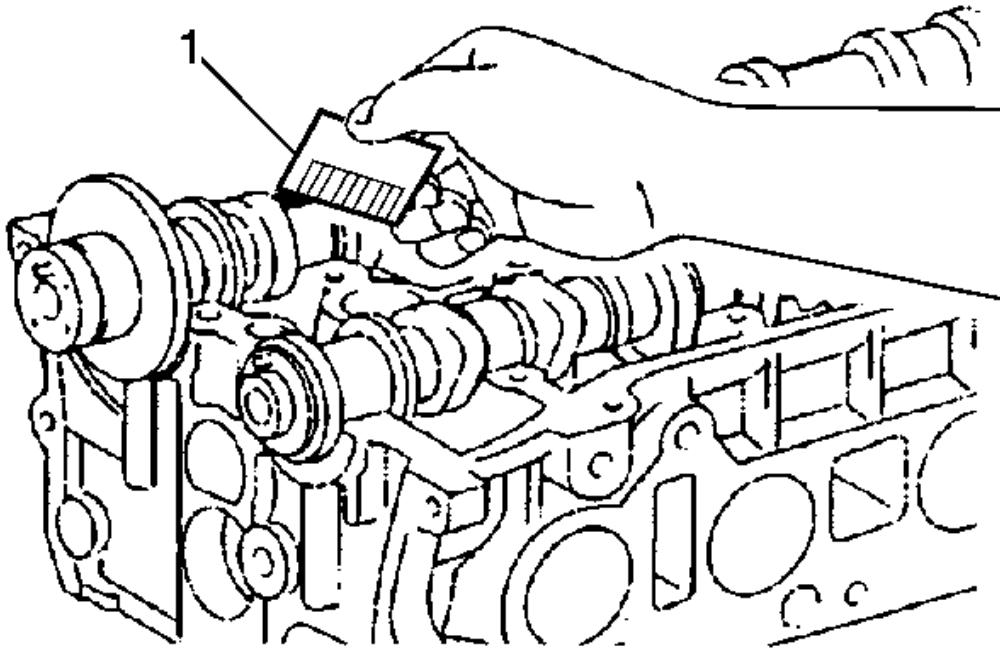


Fig. 386: Measuring Plastigage At Widest Point
 Courtesy of GENERAL MOTORS CORP.

NOTE: Completely remove the Plastigage after the inspection.

12. Measure the Plastigage at its widest point.
13. If the oil clearance is greater than the maximum, replace the camshaft. If necessary, replace the cylinder head.
14. If the oil clearance on the camshaft No. 1 journal is greater than the maximum, choose a new bearing and install it.

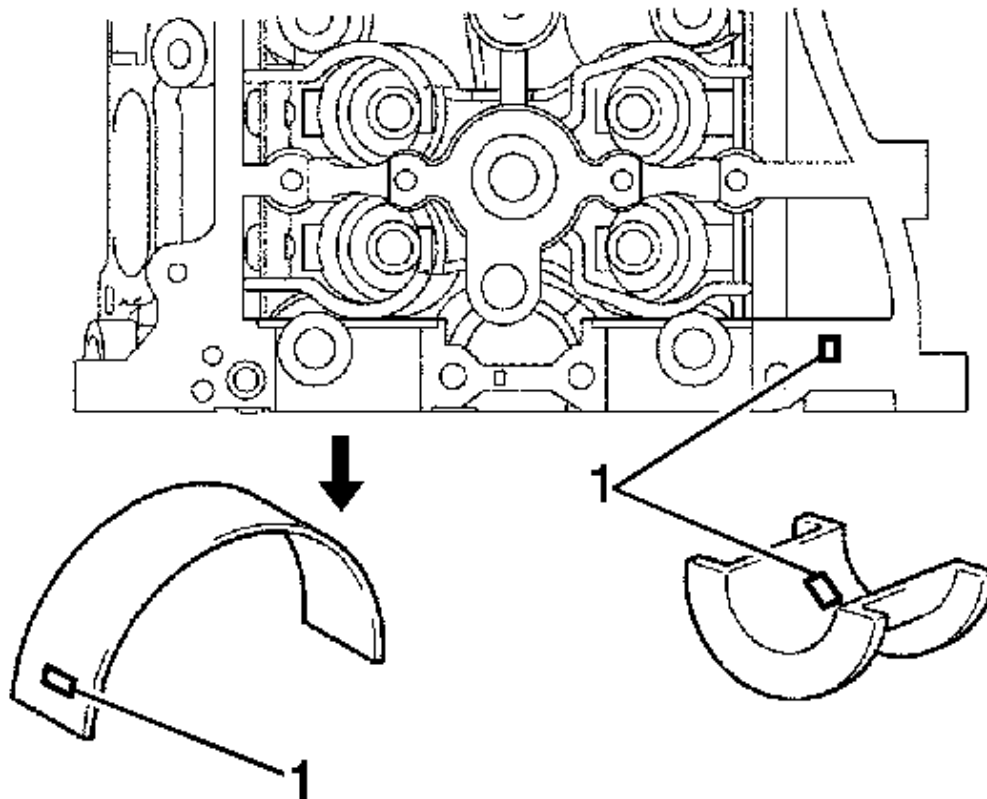


Fig. 387: Checking Number Marks

Courtesy of GENERAL MOTORS CORP.

15. Check the number mark shown in the illustration.

Camshaft journal diameter: 35.971 to 35.985 mm (1.4162 to 1.4167 in)

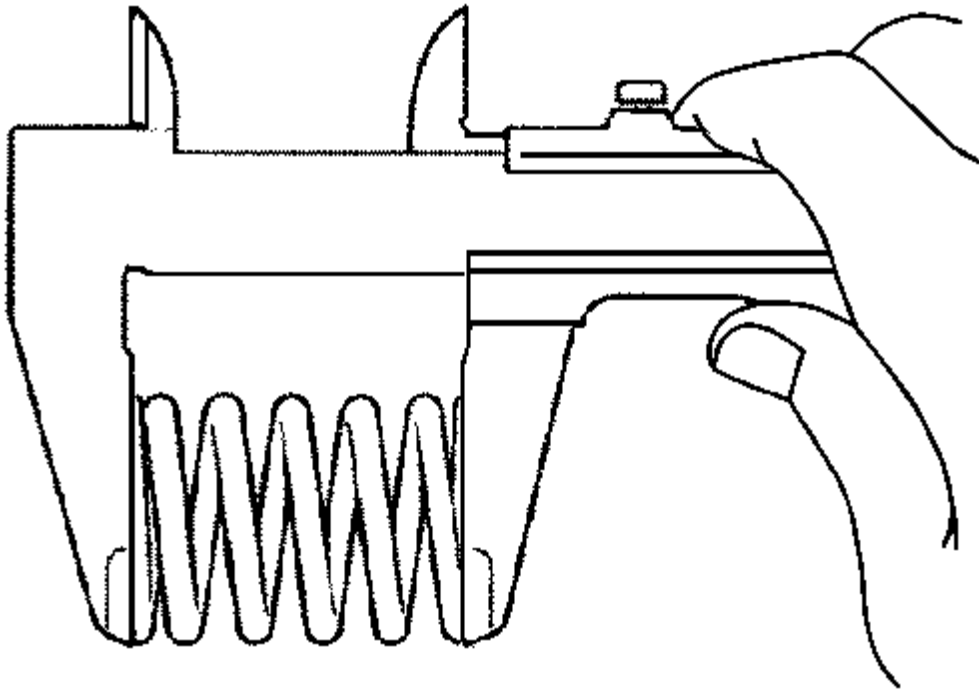


Fig. 388: Inspecting Compression Spring
Courtesy of GENERAL MOTORS CORP.

16. Inspect inner compression spring.
17. Using vernier calipers, measure the free length of the valve spring.

Free length: 47.43 mm (1.867 in)

If the free length is not as specified, replace the valve spring.

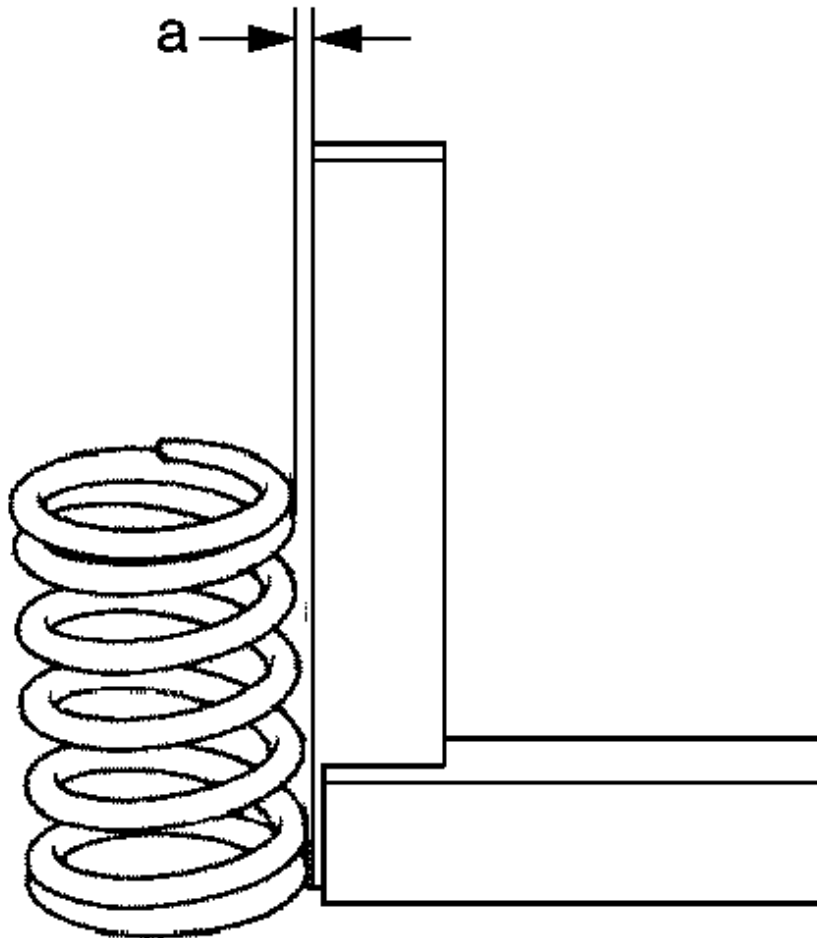


Fig. 389: Measuring Spring Deviation
Courtesy of GENERAL MOTORS CORP.

18. Using a steel set square, measure the deviation of the valve spring.

Maximum deviation: 1.6 mm (0.063 in)

If the deviation is greater than the maximum, replace the valve spring.

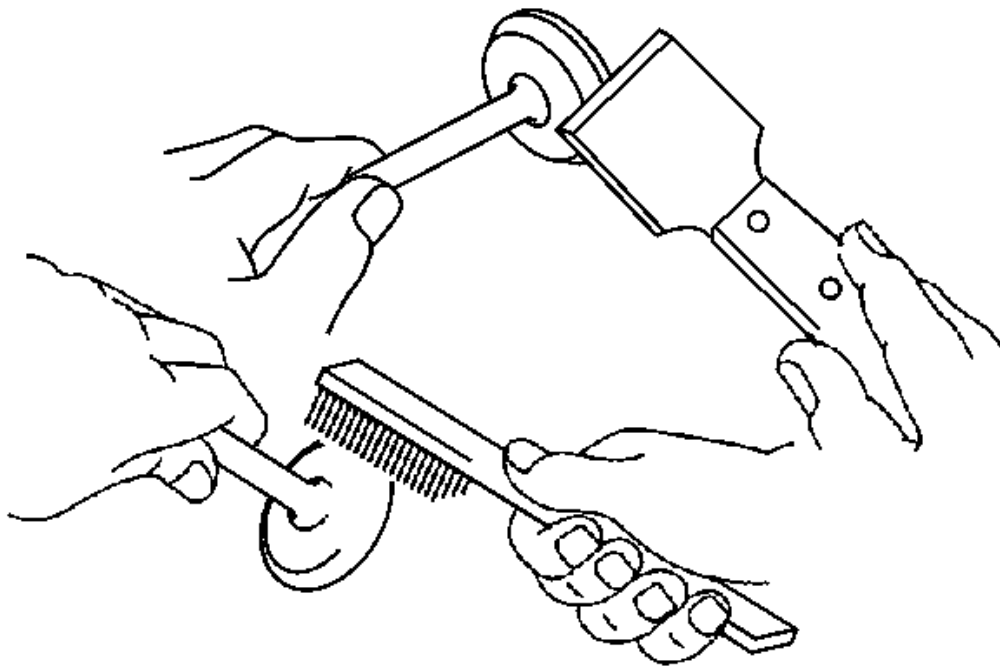


Fig. 390: Cleaning & Inspecting Valve
Courtesy of GENERAL MOTORS CORP.

19. Inspect intake valve
20. Using a gasket scraper, scrape off any carbon on the valve head.

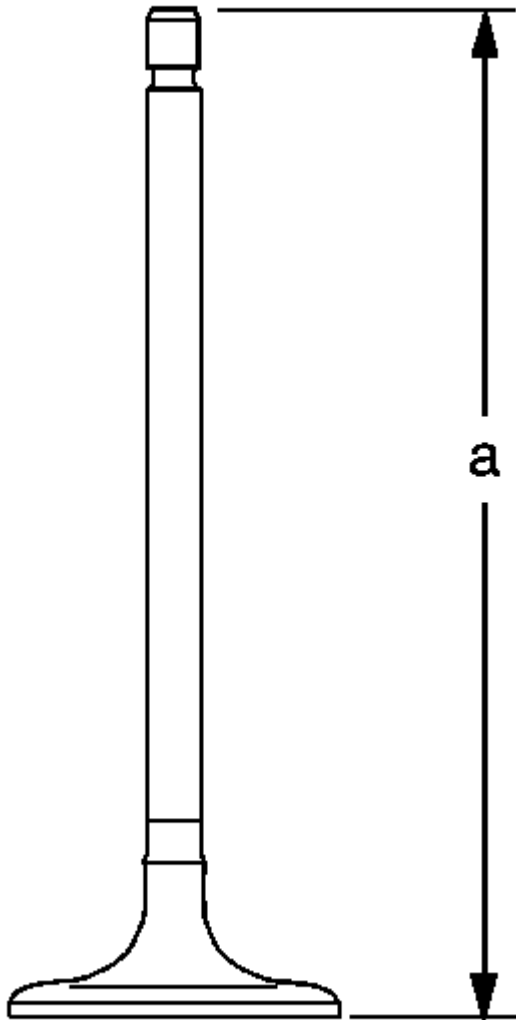


Fig. 391: Measuring Overall Valve Length
Courtesy of GENERAL MOTORS CORP.

21. Using vernier calipers, measure the overall length of the valve.

Specification:

- Standard overall length: 101.71 mm (4.0043 in)
- Minimum overall length: 101.21 mm (3.9846 in)

If the overall length is less than the minimum, replace the valve.

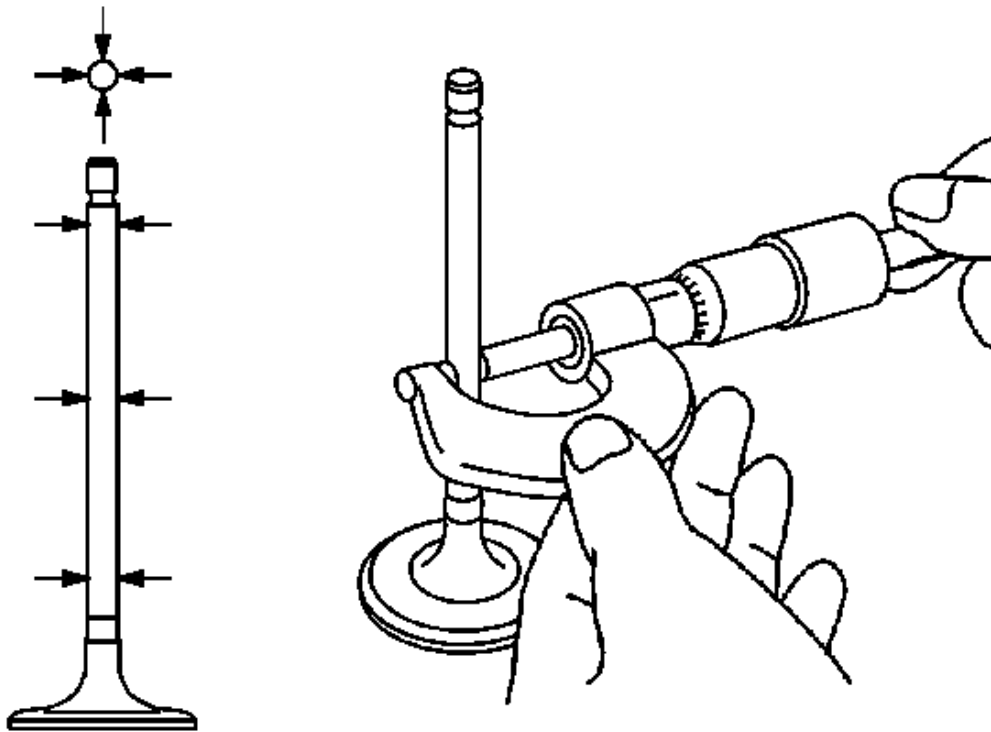


Fig. 392: Measuring Valve Stem Using Micrometer
Courtesy of GENERAL MOTORS CORP.

22. Using a micrometer, measure the diameter of the valve stem.

Valve stem diameter: 5.470 to 5.485 mm (0.2154 to 0.2159 in)

If the valve stem is not as specified, check the oil clearance.

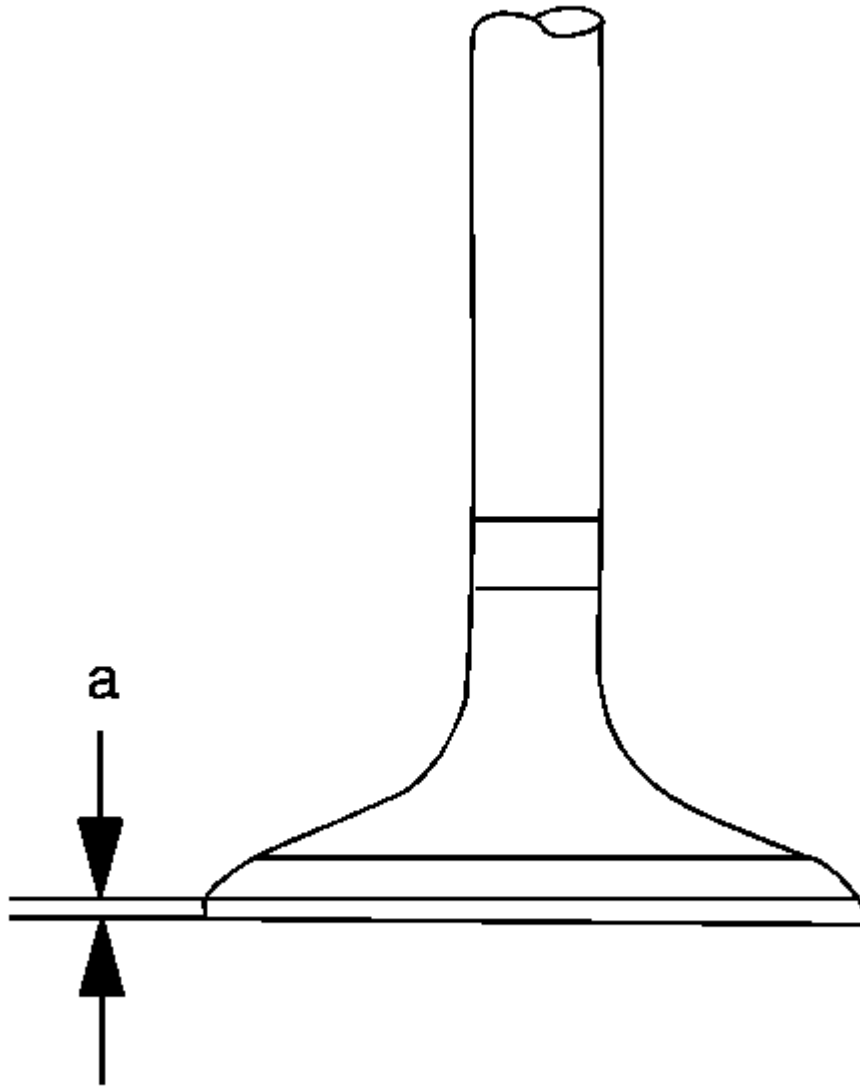


Fig. 393: Identifying Valve Head Margin
Courtesy of GENERAL MOTORS CORP.

23. Using vernier calipers, measure the valve head margin thickness.

Specifications:

- Standard margin thickness: 1.05 to 1.45 mm (0.0413 to 0.0571 in)
- Minimum margin thickness: 0.50 mm (0.0197 in)

If the margin thickness is less than the minimum, replace the valve.

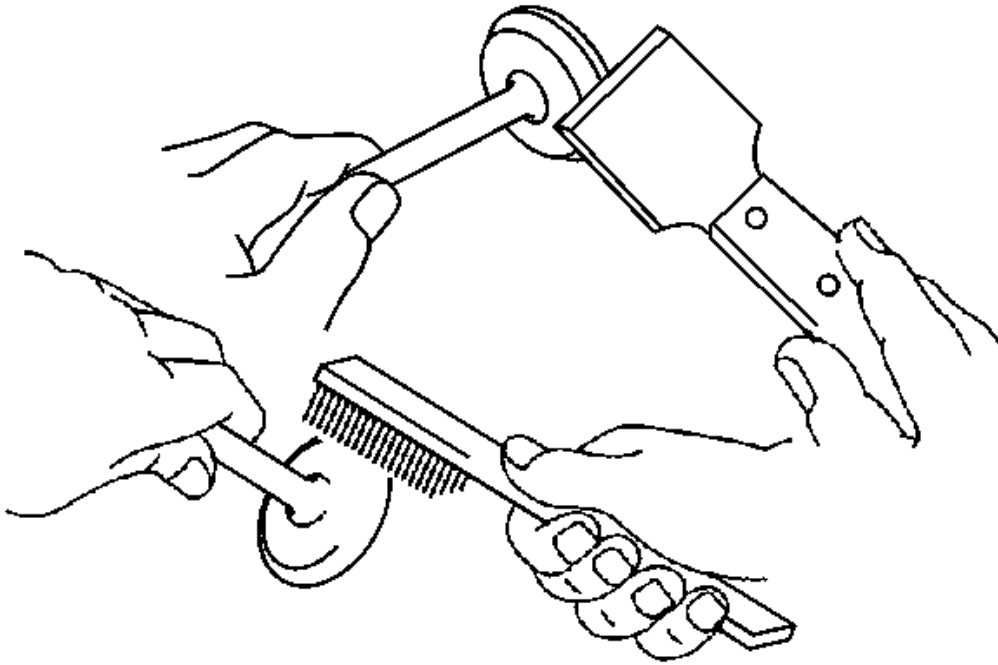


Fig. 394: Cleaning & Inspecting Valve
Courtesy of GENERAL MOTORS CORP.

24. Using a gasket scraper, scrape off any carbon on the valve head.

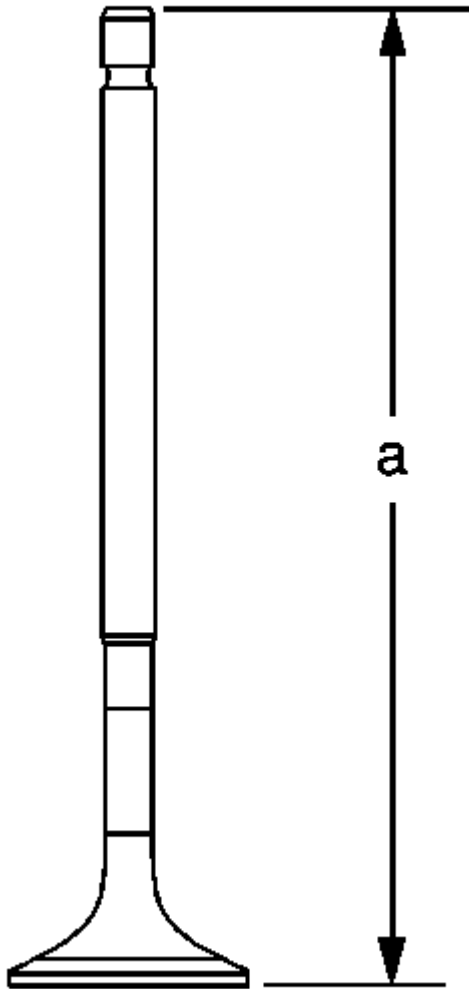


Fig. 395: Measuring Overall Valve Length
Courtesy of GENERAL MOTORS CORP.

25. Using vernier calipers, measure the overall length of the valve.

Specifications:

- Standard overall length: 101.15 mm (3.9823 in)
- Minimum overall length: 100.70 mm (3.9646 in)

If the overall length is less than the minimum, replace the valve.

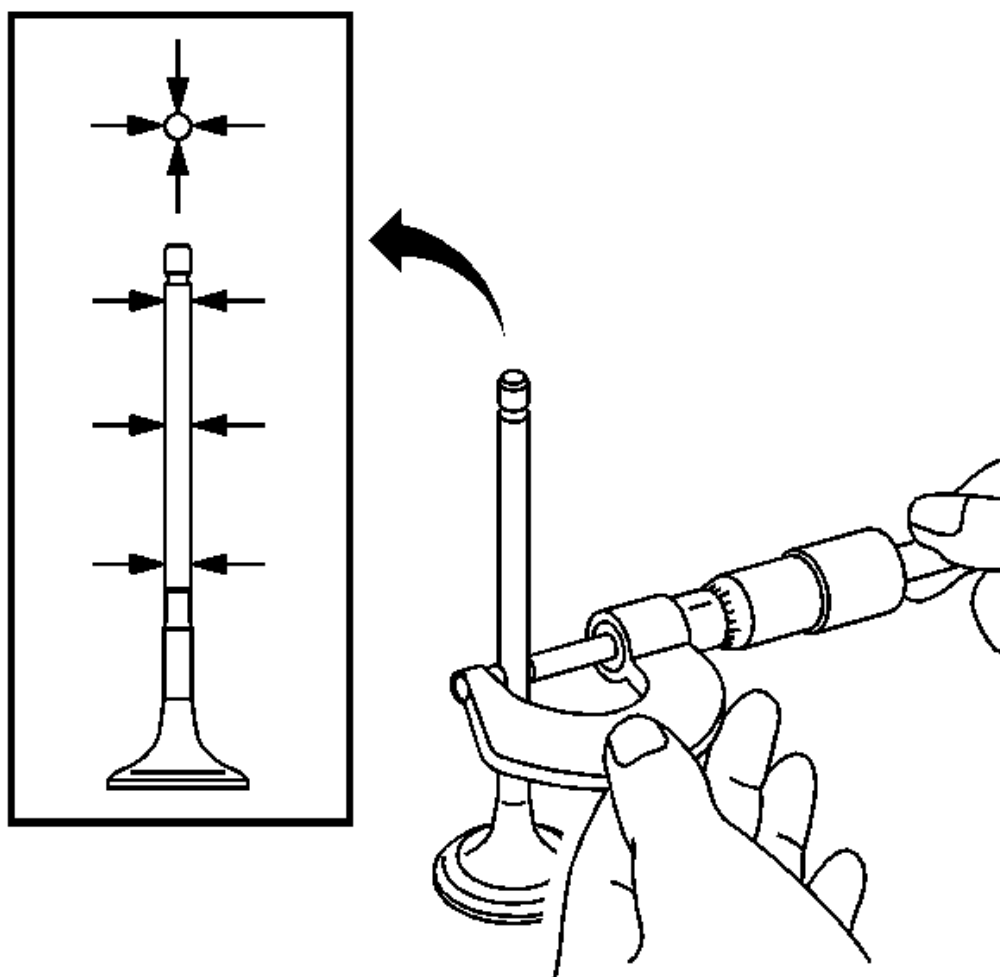


Fig. 396: Measuring Valve Stem Using Micrometer
Courtesy of GENERAL MOTORS CORP.

26. Using a micrometer, measure the diameter of the valve stem.

Valve stem diameter: 5.465 to 5.480 mm (0.2152 to 0.2157 in)

If the valve stem is not as specified, check the oil clearance.

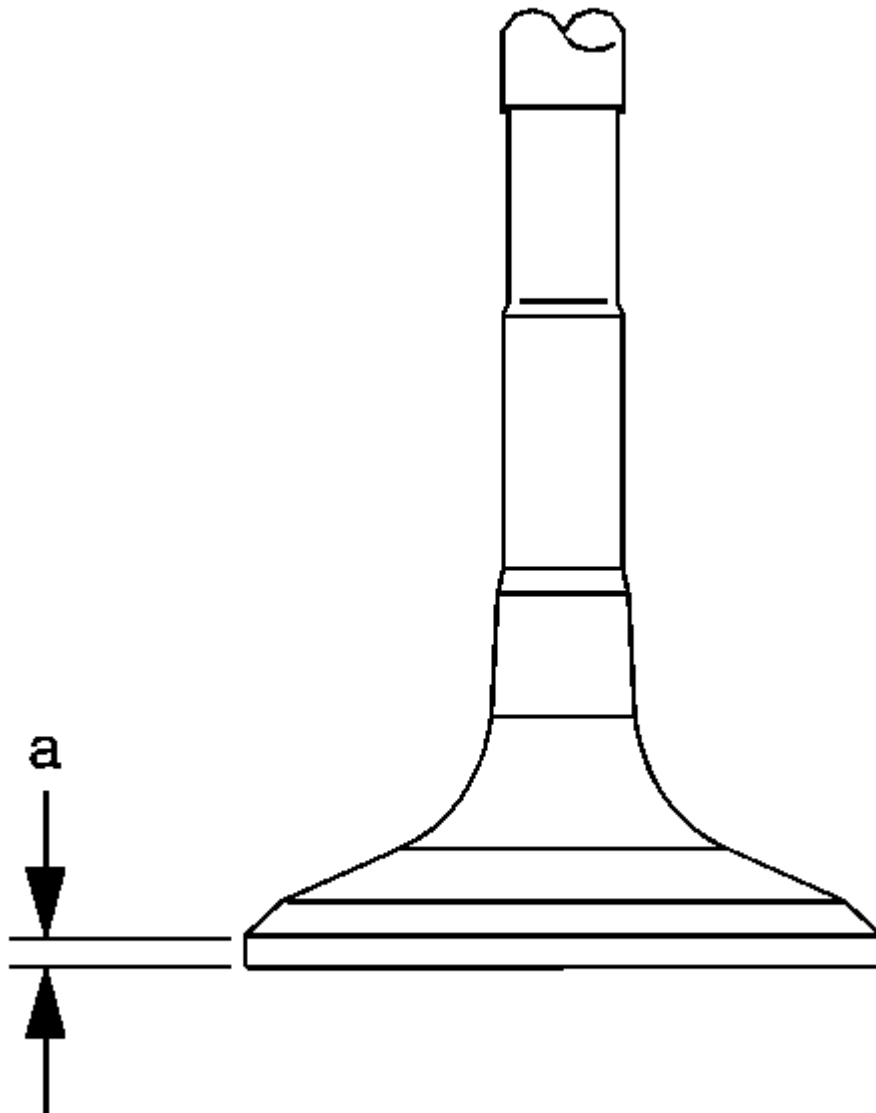


Fig. 397: Measuring Valve Head Margin
Courtesy of GENERAL MOTORS CORP.

27. Using vernier calipers, measure the valve head margin thickness.

Specification:

- Standard margin thickness: 1.20 to 1.60 mm (0.0472 to 0.0630 in)
- Minimum margin thickness: 0.50 mm (0.0197 in)

If the margin thickness is less than the minimum, replace the valve.

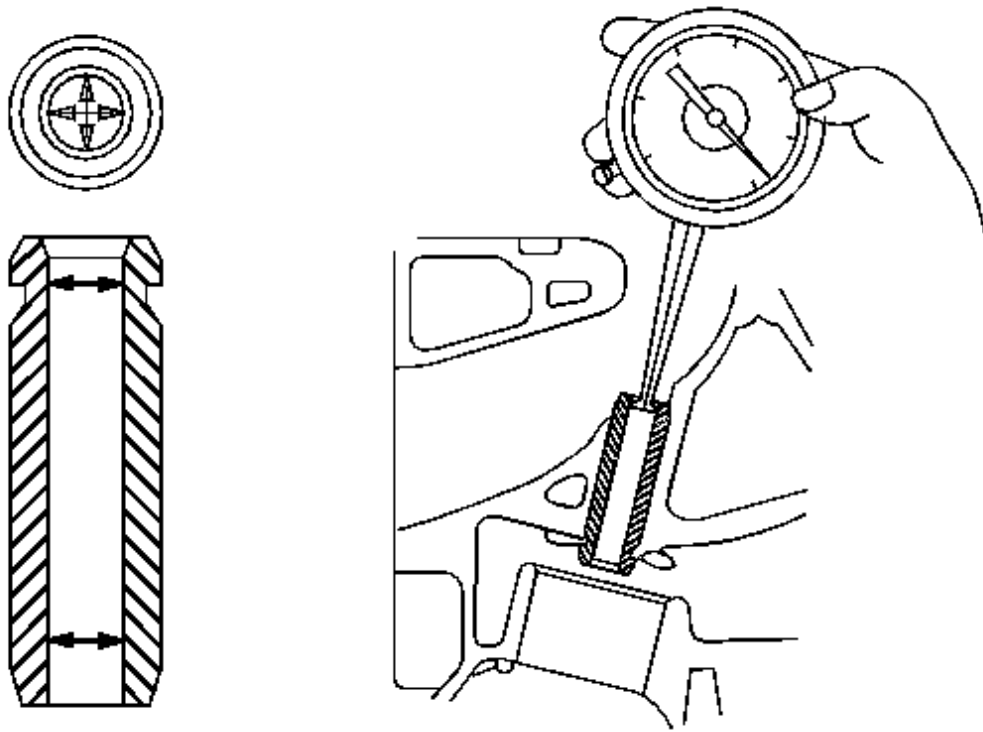


Fig. 398: Measuring Inside Diameter Of The Guide Bush
Courtesy of GENERAL MOTORS CORP.

28. Using a caliper gauge, measure the inside diameter of the guide bush.

Bushing inside diameter: 5.510 to 5.530 mm (0.2169 to 0.2177 in)

29. Subtract the valve stem diameter measurement from the guide bush inside diameter measurement.

Specifications:

- Standard oil clearance: 0.025 to 0.060 mm (0.0010 to 0.0024 in)
- Maximum oil clearance: 0.090 mm (0.0035 in)

If the clearance is greater than the maximum, replace the valve and guide bush.

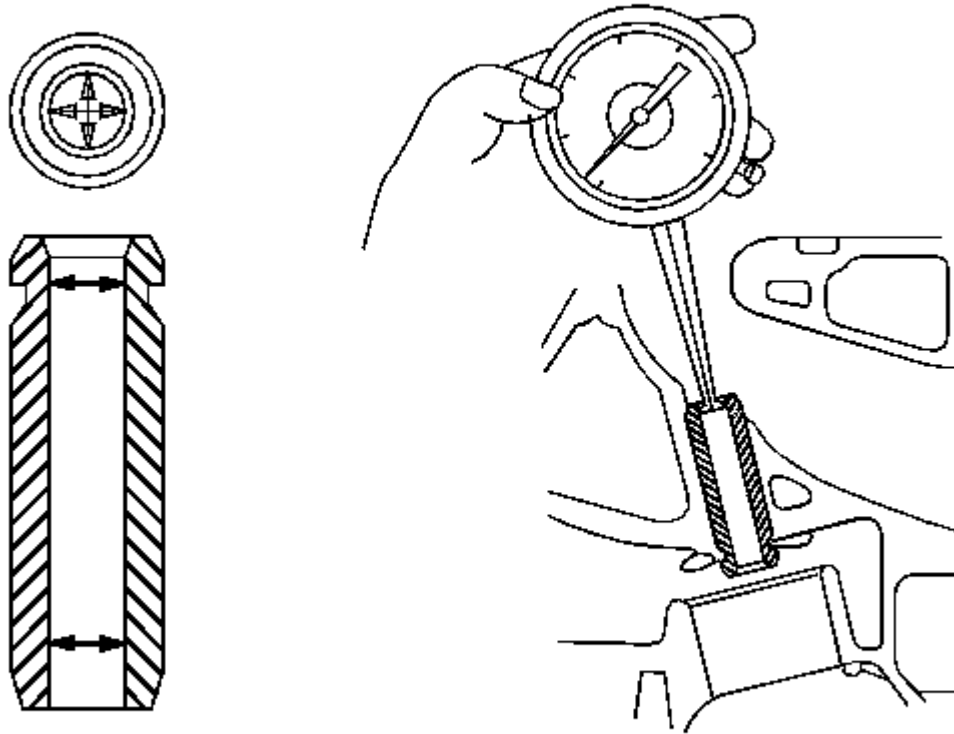


Fig. 399: Measuring Inside Diameter Of The Guide Bush Using Caliper Gauge
Courtesy of GENERAL MOTORS CORP.

30. Using a caliper gauge, measure the inside diameter of the guide bush.

Bushing inside diameter: 5.510 to 5.530 mm (0.2169 to 0.2177 in)

31. Subtract the valve stem diameter measurement from the guide bushing inside diameter measurement.

Specifications:

- Standard oil clearance: 0.030 to 0.065 mm (0.0012 to 0.0026 in)
- Maximum oil clearance: 0.095 mm (0.0037 in)

If the clearance is greater than the maximum, replace the valve and guide bush.

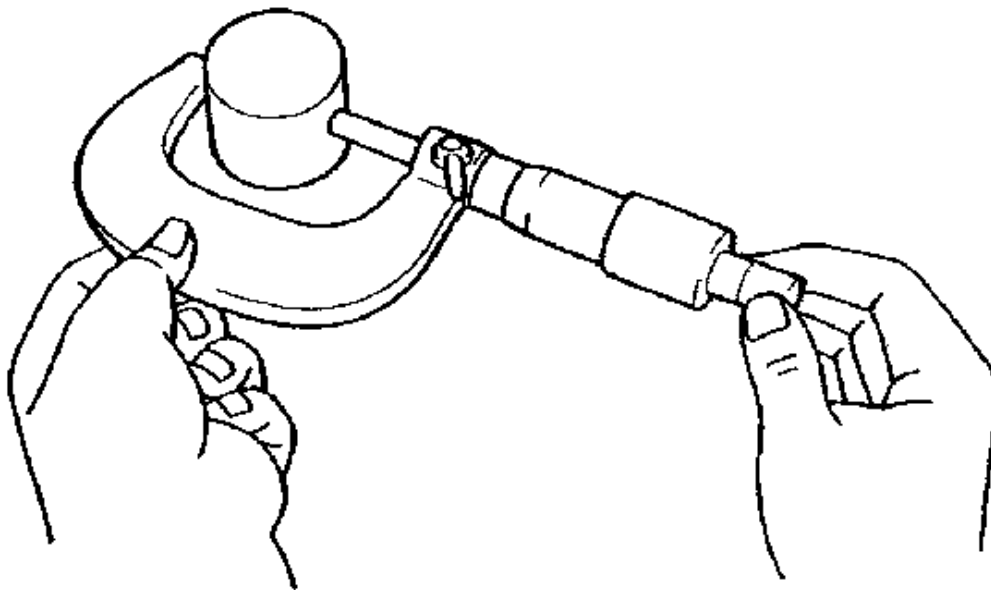


Fig. 400: Measuring Lifter Diameter
Courtesy of GENERAL MOTORS CORP.

32. Using a micrometer, measure the lifter diameter.

Lifter diameter: 30.966 to 30.976 mm (1.2191 to 1.2195 in)

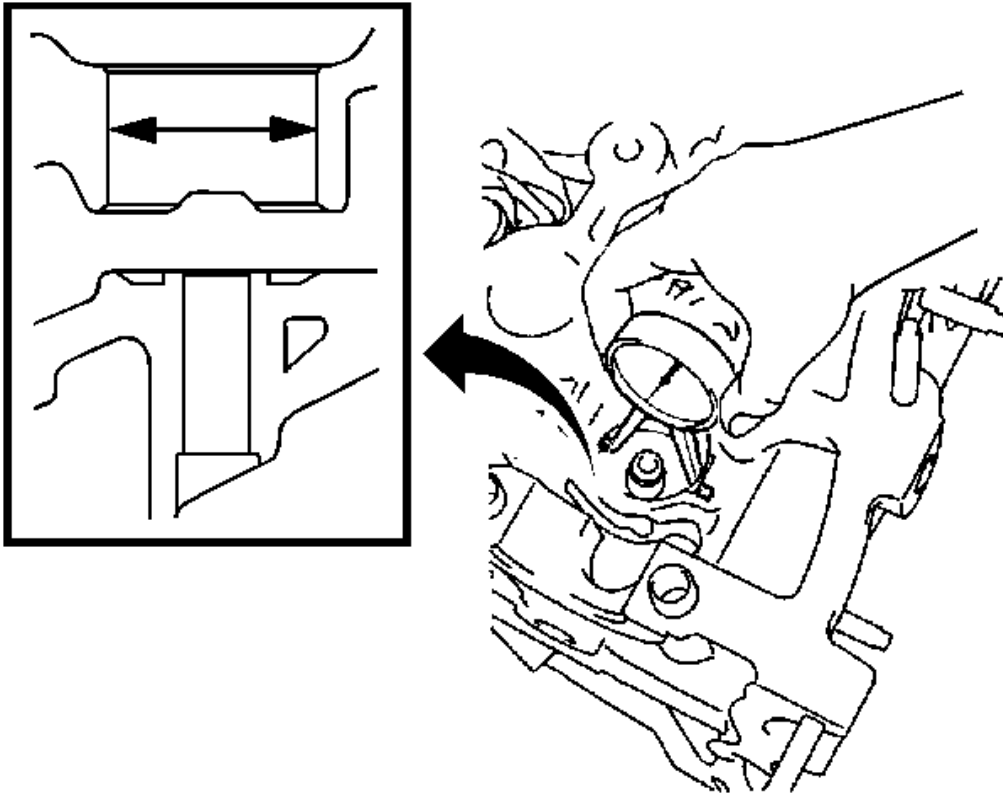


Fig. 401: Measuring Lifter Bore Diameter
Courtesy of GENERAL MOTORS CORP.

33. Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

Standard lifter bore diameter: 31.009 to 31.025 mm (1.2208 to 1.2215 in)

34. Subtract the lifter diameter measurement from the lifter bore diameter measurement.

Oil Clearance:

- Standard oil clearance: 0.033 to 0.059 mm (0.0013 to 0.0023 in)
- Maximum oil clearance: 0.079 mm (0.003 in)

If the oil clearance is greater than the maximum, replace the lifter. If necessary, replace the cylinder head.

35. Inspect cylinder head set bolt.
36. Using vernier calipers, measure the length of the head bolts from the seat to the end.

2009 Pontiac Vibe

2009 ENGINE Engine Mechanical - 2.4L (LAX) - Vibe

Specifications:

- Standard bolt length: 141.3 to 142.7 mm (5.563 to 5.618 in)
- Maximum bolt length: 144.2 mm (5.677 in)

If the bolt length is greater than the maximum, replace the cylinder head set bolt.

Item	Specified Condition
Maximum Warp	
Cylinder block side	0.08 mm (0.0031 in)
Intake manifold side	0.08 mm (0.0031 in)
Exhaust manifold side	0.08 mm (0.0031 in)
Standard Thrust Clearance	
Intake	0.040 to 0.095 mm (0.0016 to 0.0037 in)
Exhaust	0.090 to 0.145 mm (0.0035 to 0.0057 in)
Maximum Thrust Clearance	
Intake	0.110 mm (0.0043 in)
Exhaust	0.150 mm (0.0059 in)
Standard Oil Clearance	
Camshaft No. 1 journal bearing mark 1	0.007 to 0.038 mm (0.0003 to 0.0015 in)
Camshaft No. 1 journal bearing mark 2	0.008 to 0.038 mm (0.0003 to 0.0015 in)
Camshaft No. 1 journal bearing mark 3	0.008 to 0.038 mm (0.0003 to 0.0015 in)
Camshaft other journals	0.025 to 0.062 mm (0.0010 to 0.0024 in)
No. 2 camshaft No. 1 journal	0.040 to 0.072 mm (0.0016 to 0.0028 in)
No. 2 camshaft other journals	0.025 to 0.062 mm (0.0010 to 0.0024 in)
Maximum Oil Clearance	
Intake	0.070 mm (0.0028 in)
Exhaust	0.100 mm (0.0039 in)

Mark 1	Mark 2	Mark 3
Cylinder Head Journal Bore Diameter		
40.000 to 40.009 mm (1.5748 to 1.5752 in)	40.010 to 40.017 mm (1.5752 to 1.5755 in)	40.018 to 40.025 mm (1.5755 to 1.5758 in)
Standard Bearing Center Wall Thickness		
2.000 to 2.004 mm (0.0787 to 0.0789 in)	2.005 to 2.008 mm (0.0789 to 0.0791 in)	2.009 to 2.012 mm (0.0791 to 0.0792 in)

VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING**Valve Guide Replacement Procedure**

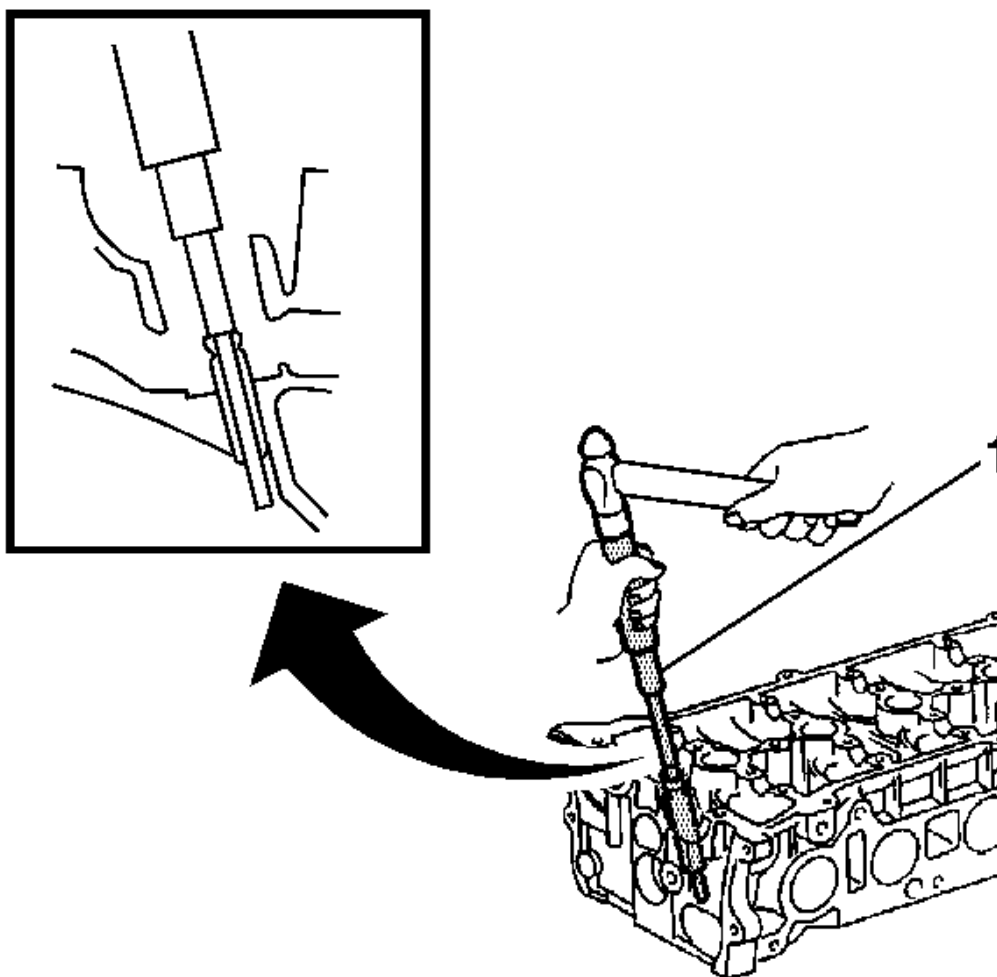


Fig. 402: View Of Valve Guide Bush Removal
Courtesy of GENERAL MOTORS CORP.

1. Remove intake valve guide bush.
2. Heat the cylinder head to 80 to 100°C (176 to 212°F).
3. Place the cylinder head on wooden blocks.
4. Using SST and a hammer, tap out the guide bush.

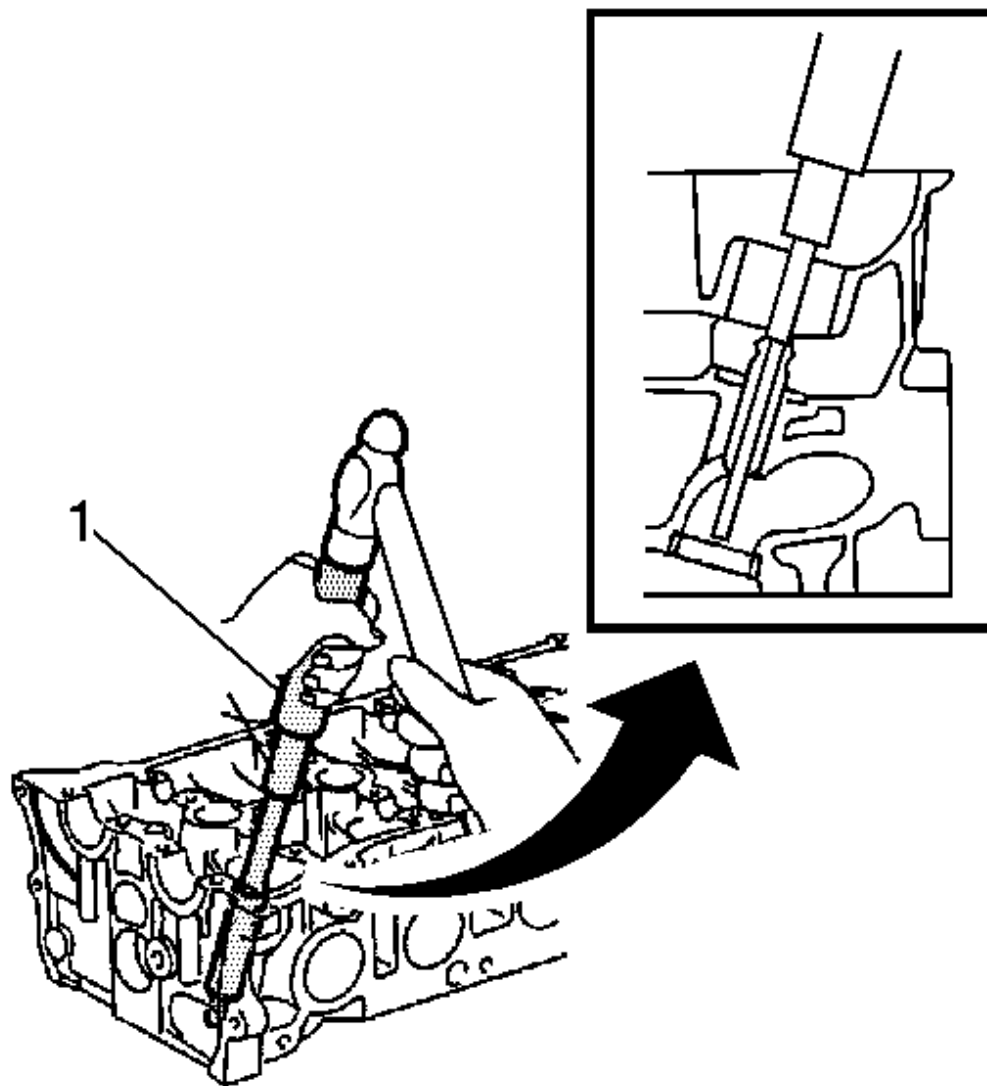


Fig. 403: Tapping Out Guide Bush
Courtesy of GENERAL MOTORS CORP.

5. Heat the cylinder head to 80 to 100°C (176 to 212 °F).
6. Place the cylinder head on wooden blocks.
7. Using SST and a hammer, tap out the guide bush.

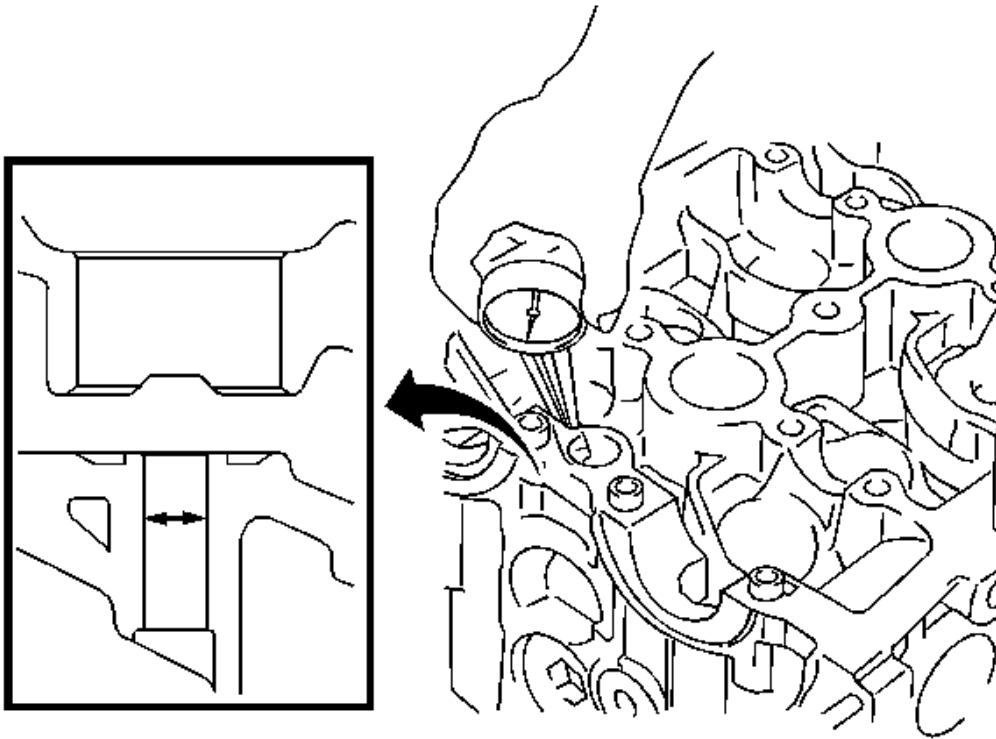


Fig. 404: Measuring Bush Bore
Courtesy of GENERAL MOTORS CORP.

8. Using a caliper gauge, measure the bush bore diameter of the cylinder head.

Cylinder bore diameter: 10.285 to 10.306 mm (0.4049 to 0.4057 in)

If the cylinder head bush bore diameter is greater than 10.306 mm (0.4057 in), machine the bush bore to a dimension of 10.335 to 10.356 mm (0.4069 to 0.4077 in) and install an O/S 0.05 valve guide bush. If the bush bore diameter of the cylinder head is greater than 10.356 mm (0.4077 in), replace the cylinder head.

9. Heat the cylinder head to 80 to 100°C (176 to 212°F).
10. Place the cylinder head on wooden blocks.

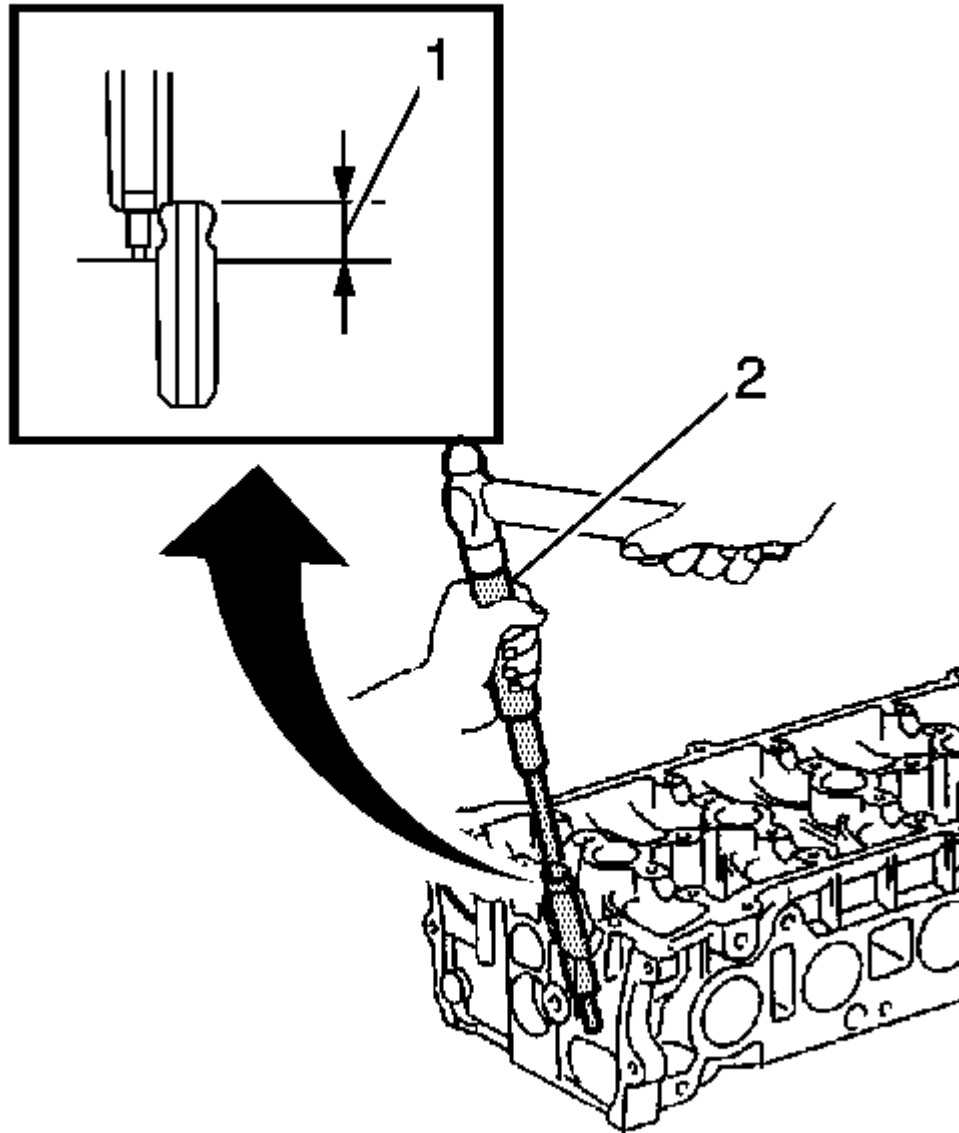


Fig. 405: View Of Guide Bush Installation
Courtesy of GENERAL MOTORS CORP.

11. Using SST and a hammer, tap in a new guide bush to the specified protrusion height.

Protrusion height: 9.6 to 10.0 mm (0.3779 to 0.3937 in)

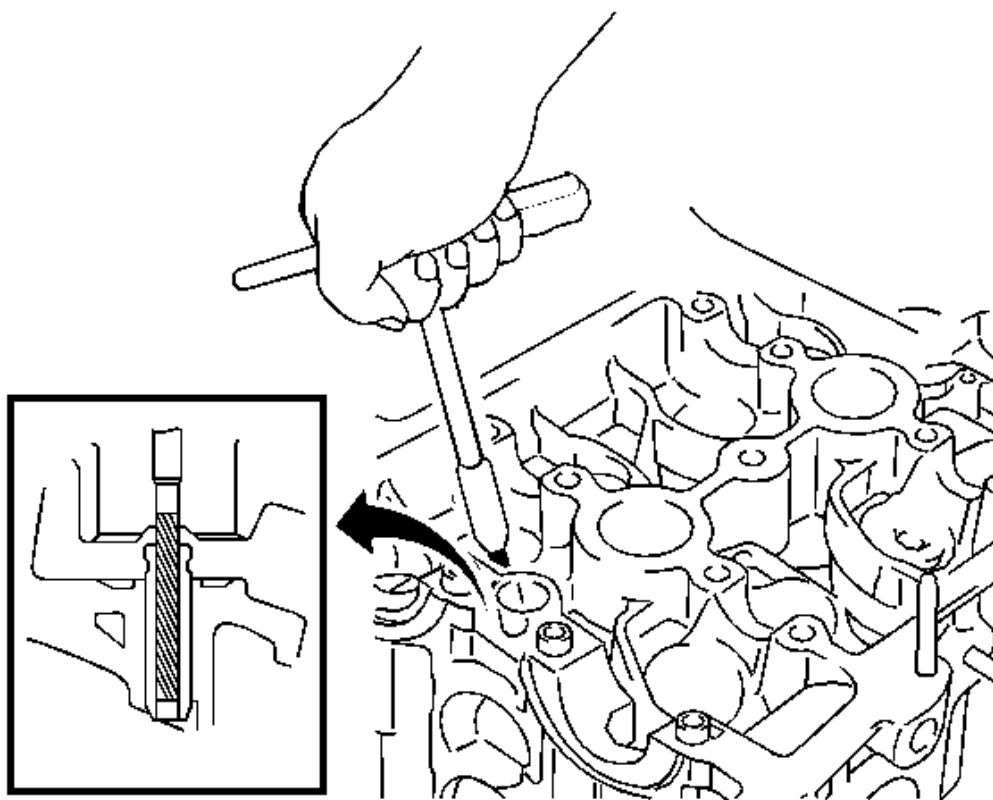


Fig. 406: Reaming Guide Bush

Courtesy of GENERAL MOTORS CORP.

12. Using a sharp 5.5 mm reamer, ream the guide bush to obtain the standard specified clearance between the guide bush and valve stem.

Standard oil clearance: 0.025 to 0.060 mm (0.0010 to 0.0024 in)

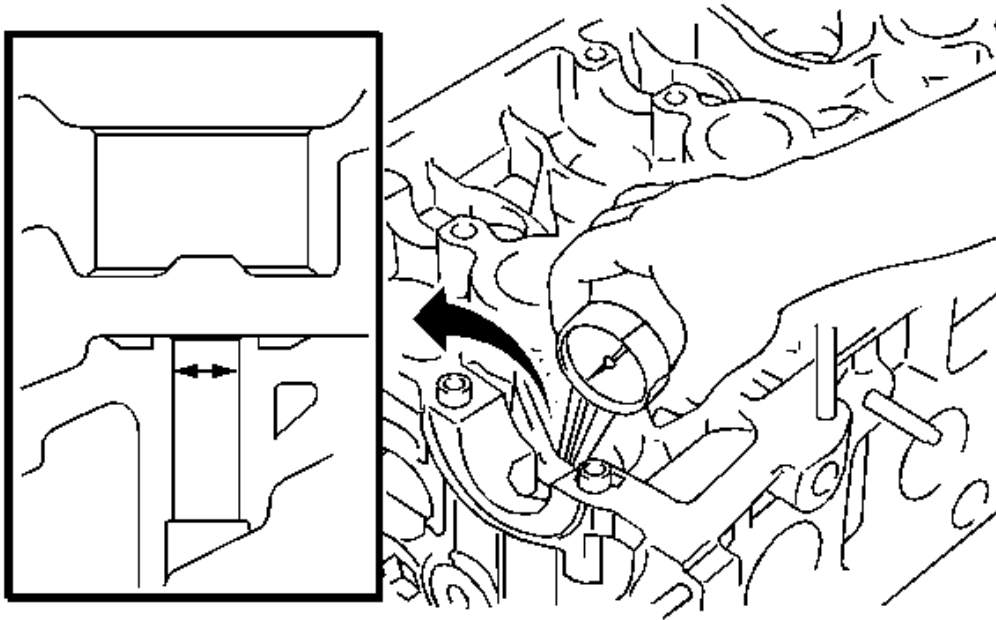


Fig. 407: View Of Valve Guide Bush Installation
Courtesy of GENERAL MOTORS CORP.

13. Install exhaust valve guide bush.
14. Using a caliper gauge, measure the bush bore diameter of the cylinder head.

Cylinder bore diameter: 10.285 to 10.306 mm (0.4049 to 0.4057 in)

If the cylinder head bush bore diameter is greater than 10.306 mm (0.4057 in), machine the bush bore to a dimension of 10.335 to 10.356 mm (0.4069 to 0.4077 in) and install an O/S 0.05 valve guide bush. If the bush bore diameter of the cylinder head is greater than 10.356 mm (0.4077 in), replace the cylinder head.

15. Heat the cylinder head to 80 to 100°C (176 to 212°F).
16. Place the cylinder head on wooden blocks.

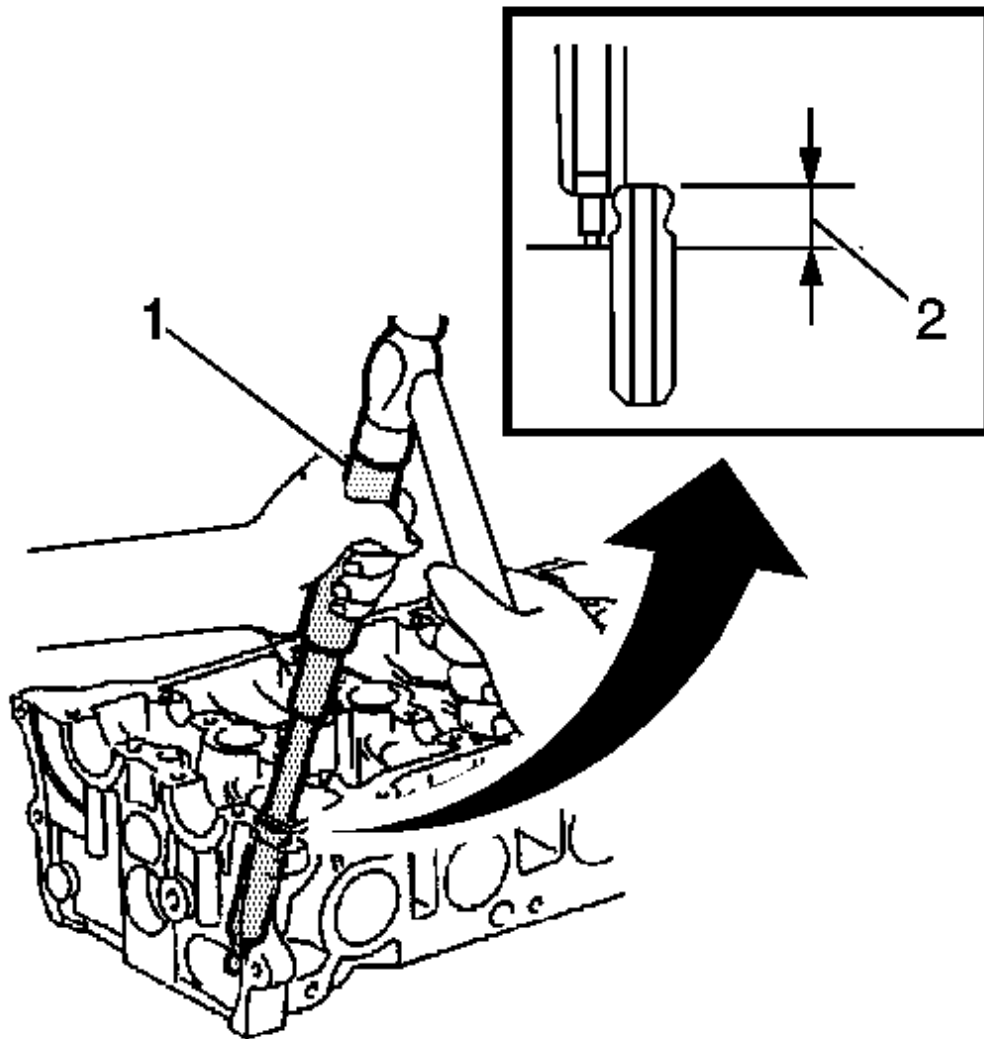


Fig. 408: View Of Installing Valve Guide Bush To Proper Height
Courtesy of GENERAL MOTORS CORP.

17. Using SST and a hammer, tap in a new guide bush to the specified protrusion height.

Protrusion height: 9.6 to 10.0 mm (0.3779 to 0.3937 in)

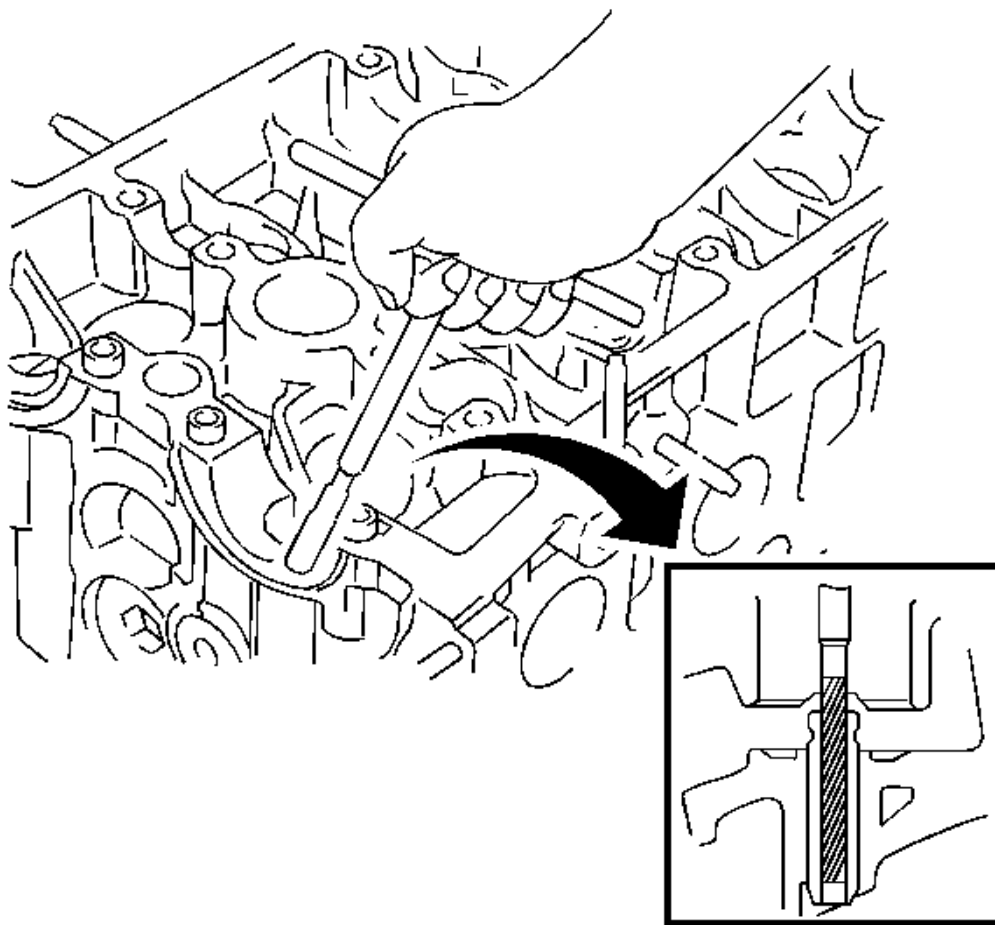


Fig. 409: Reaming Guide Bush
Courtesy of GENERAL MOTORS CORP.

18. Using a sharp 5.5 mm reamer, ream the guide bush to obtain the standard specified clearance between the guide bush and valve stem.

Standard oil clearance: 0.030 to 0.060 mm (0.0012 to 0.0024 in)

Bush size	Bush bore diameter
Use STD	10.285 to 10.306 mm (0.4049 to 0.4057 in)
Use O/S 0.05	10.335 to 10.356 mm (0.4069 to 0.4077 in)

Valve and Valve Seat Repair Procedure

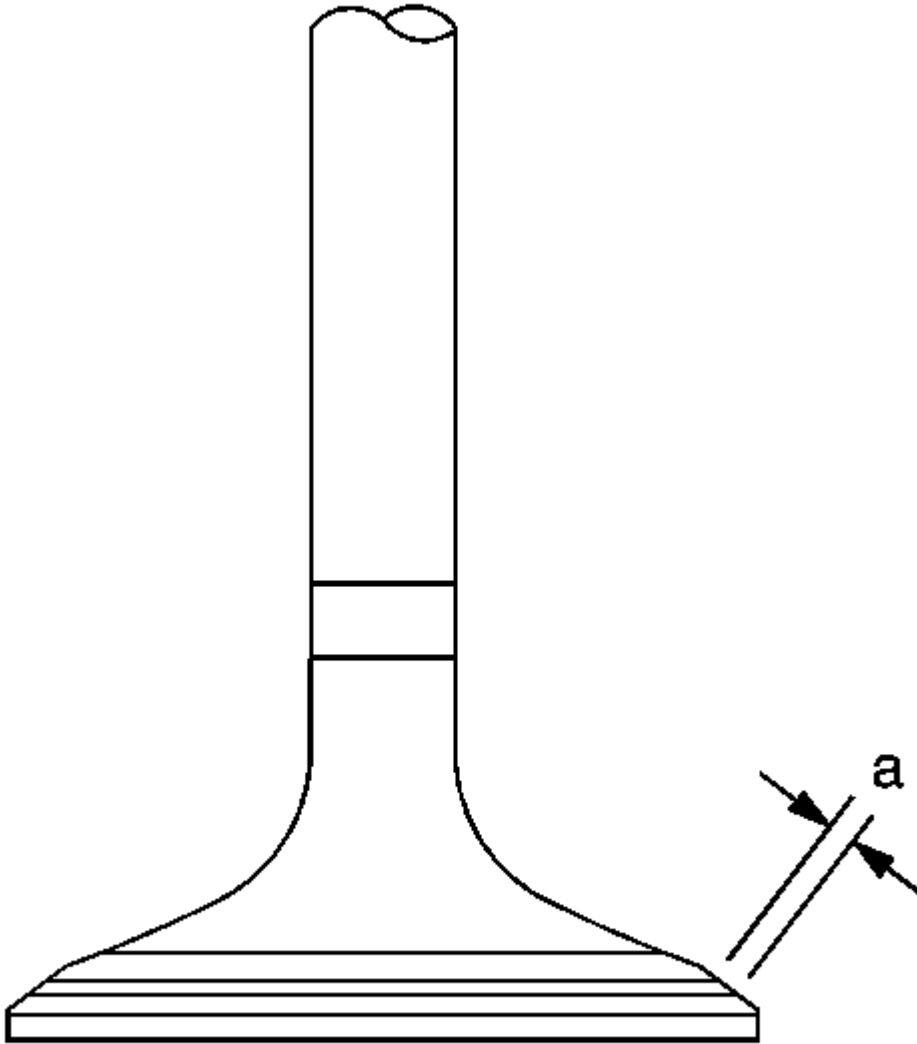


Fig. 410: Identifying Valve Face Contact Area
Courtesy of GENERAL MOTORS CORP.

1. Apply a light coat of prussian blue to the valve face.
2. Lightly press the valve face against the valve seat.
3. Check the valve face and valve seat according to the following procedure:
 1. If prussian blue appears 360° around the valve face, the valve face is concentric. If not, replace valve.
 2. If prussian blue appears 360° around the valve seat, the guide and valve face are concentric. If not,

resurface the valve seat.

3. Check that the valve seat contact is in the middle of the valve face with the width between 1.0 to 1.4 mm (intake side (0.039 to 0.055 in).
4. Check that the valve face width is between 1.2 to 1.6 mm (Exhaust side (0.047 to 0.063 in).

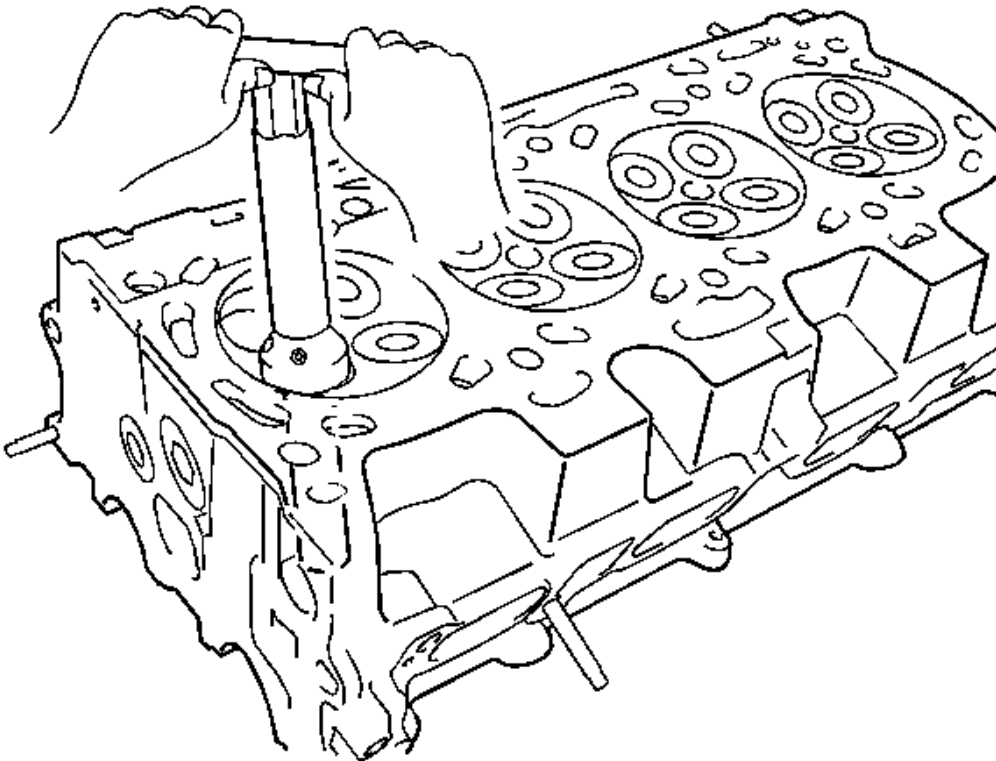


Fig. 411: Identifying Valve Seat Repair Procedure
Courtesy of GENERAL MOTORS CORP.

NOTE: **Repair the seat while checking the seating position. Keep the lip free from foreign matter.**

4. Using a 45° cutter, resurface the valve seat so that the valve seat width is more than the specification.

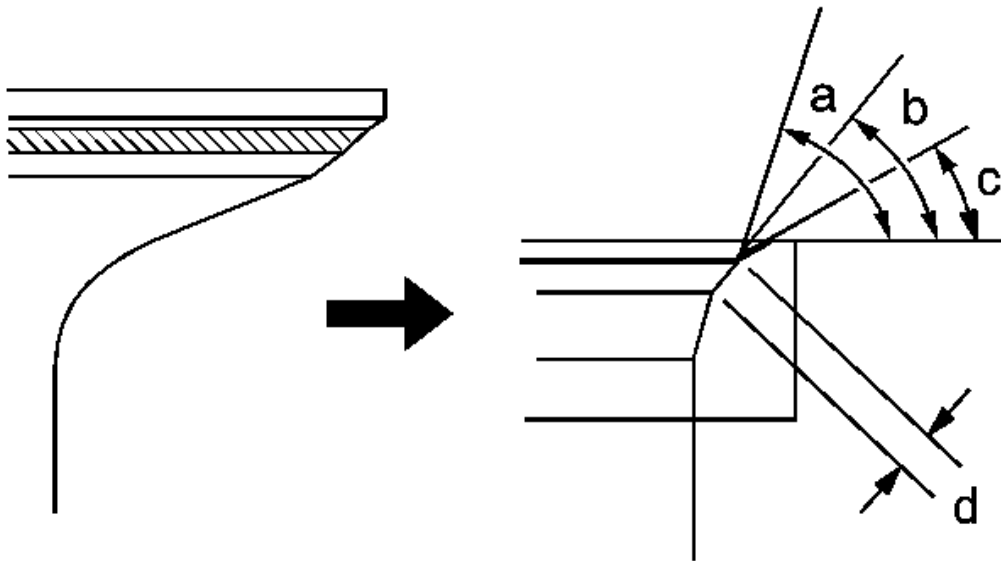


Fig. 412: Identifying Valve Face Angles
 Courtesy of GENERAL MOTORS CORP.

5. Using 30° to 75° cutters, correct the valve seat so that the valve contacts the entire circumference of the seat. The contact should be in the center of the valve seat, and the valve seat width should be maintained within the specified range around the entire circumference of the seat.
6. Handrub the valve and valve seat with an abrasive compound.
7. Check the valve seating position.

Valve Seat Width

Item	Specified Condition
Intake Side	1.0 to 1.4 mm (0.039 to 0.055 in)
Exhaust Side	1.2 to 1.6 mm (0.047 to 0.063 in)

CYLINDER HEAD ASSEMBLE

Assembly Procedure

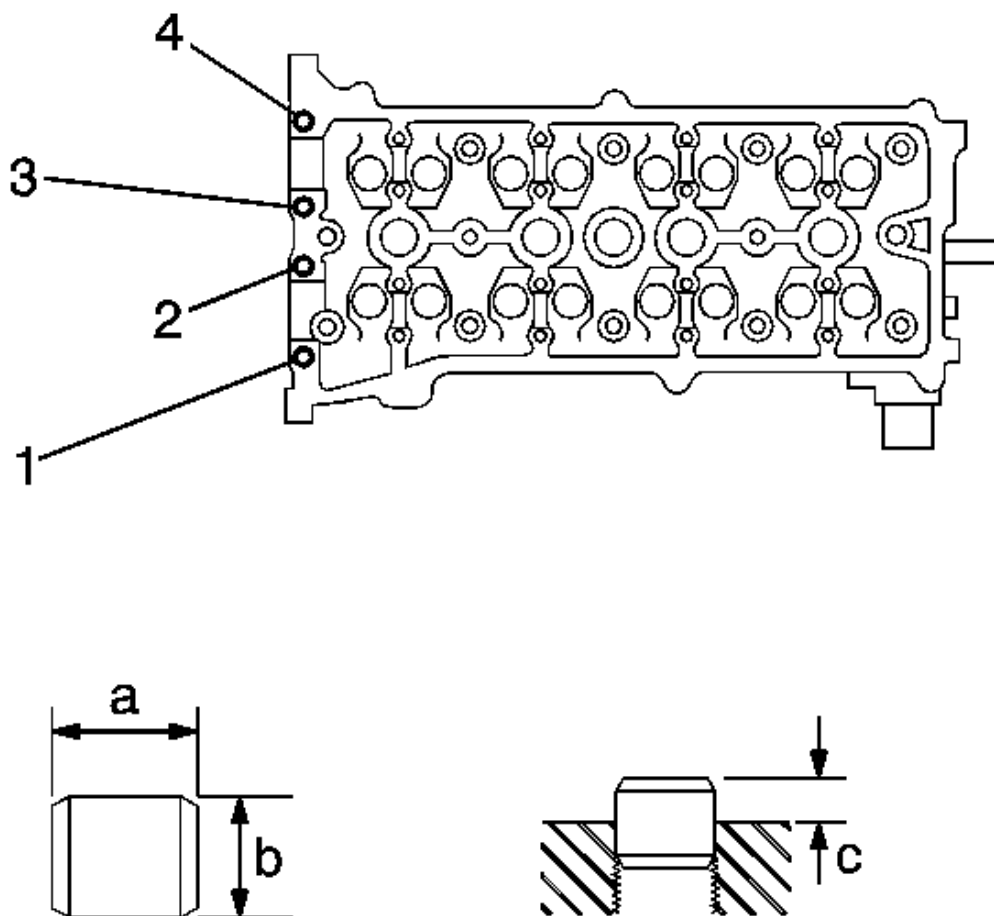


Fig. 413: Identifying Ring Pin Protrusion Height
Courtesy of GENERAL MOTORS CORP.

1. Using a plastic-faced hammer, tap in a new ring pin to the specified protrusion height.

Protrusion height: 3 mm (0.12 in)

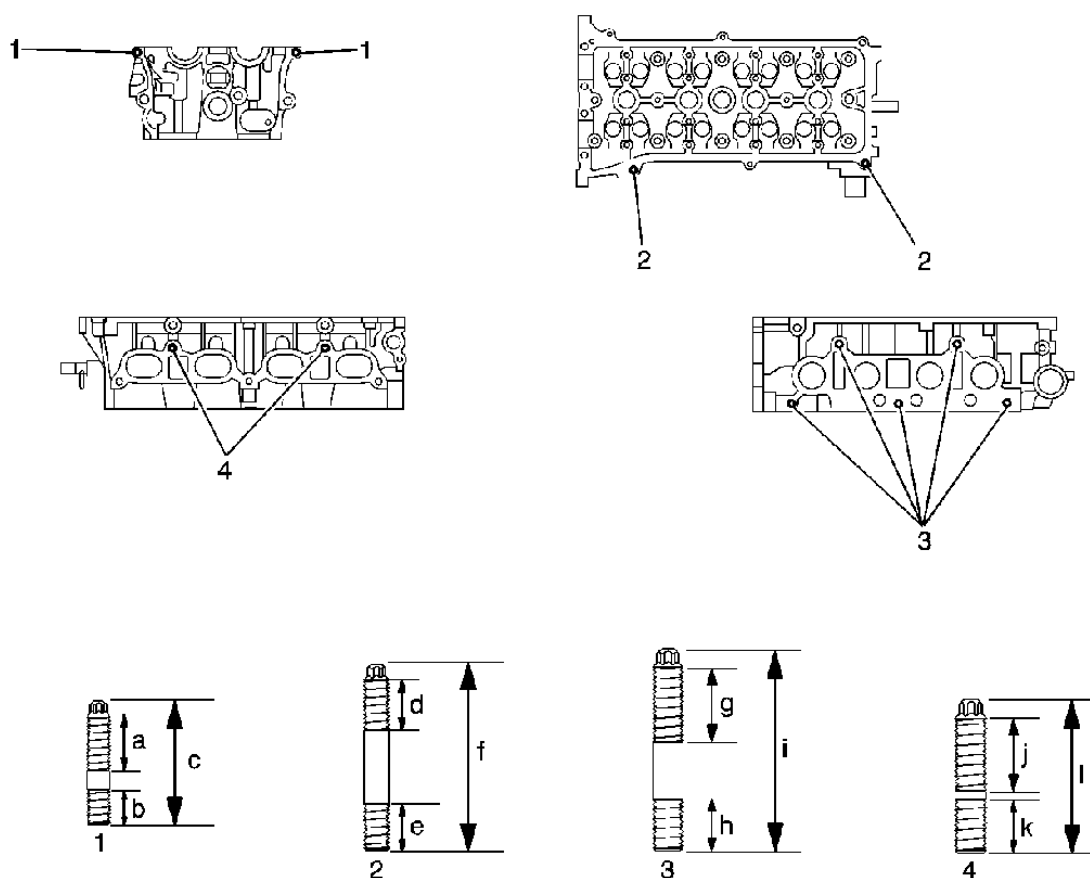


Fig. 414: Identifying Proper Stud Bolt Placement
Courtesy of GENERAL MOTORS CORP.

NOTE: If any stud bolt is deformed or the threads are damaged, replace it.

2. Using E5 and E7 TORX sockets, install the stud bolts.

Tighten:

- Bolt A 5.0 N.m (44 lb in)
- Bolt B 5.0 N.m (44 lb in)
- Bolt C 9.5 N.m (84 lb in)
- Bolt D 9.5 N.m (84 lb in)

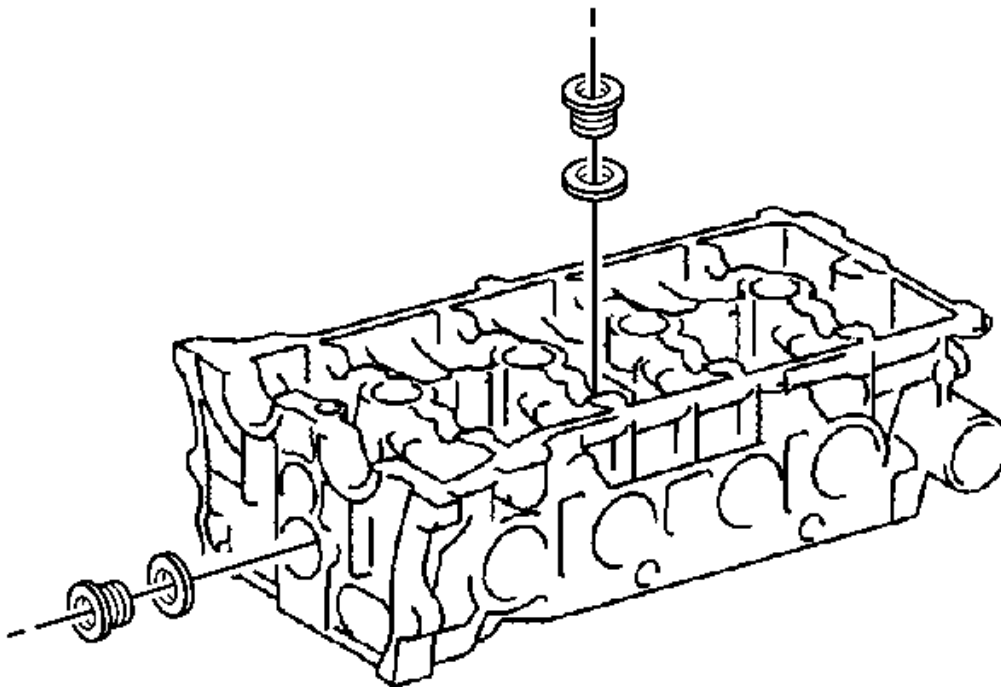


Fig. 415: View Of Coolant Plugs
Courtesy of GENERAL MOTORS CORP.

3. Using a 14 mm straight hexagon wrench, install 2 new gaskets and the 2 No. 1 straight screw plugs.

Tighten: 86 N.m (64 lb ft)

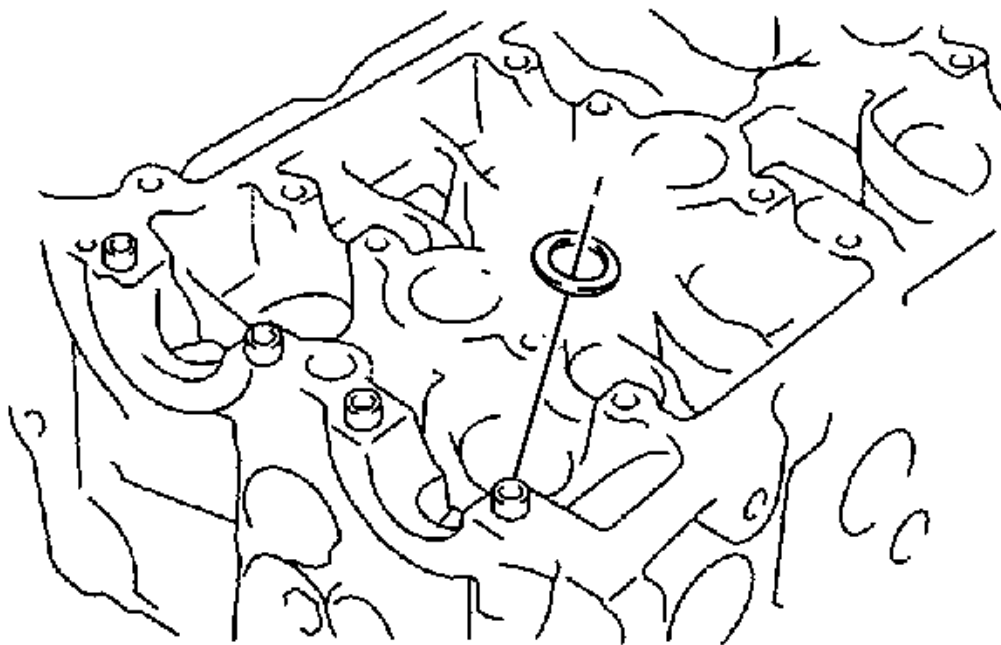


Fig. 416: Identifying Valve Spring Seats
Courtesy of GENERAL MOTORS CORP.

4. Install the valve spring seats into the cylinder head.

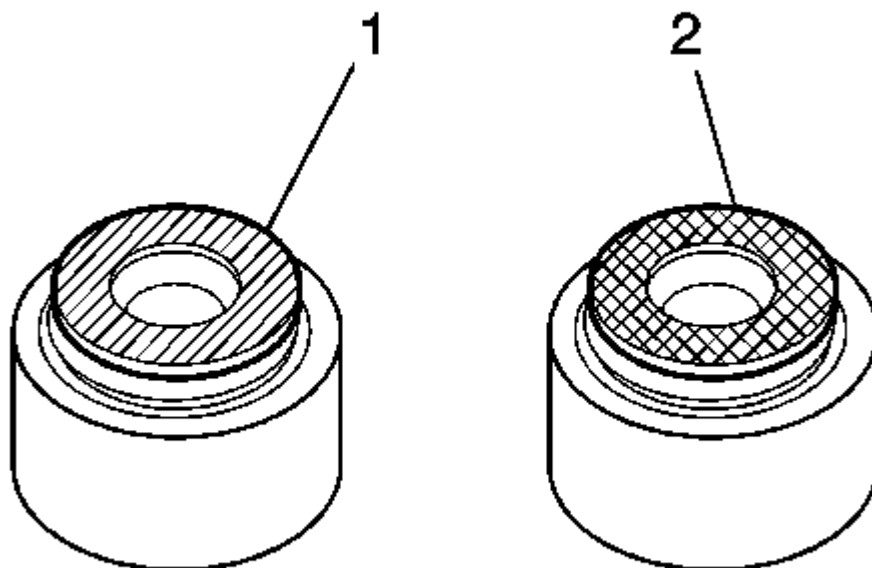


Fig. 417: View Of Valve Stem Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: Pay close attention when installing the intake and exhaust oil seals. Installing the intake oil seal into the exhaust side or installing the exhaust oil seal into the intake side may cause installation problems later.

IMPORTANT: The intake valve oil seal is gray and the exhaust valve oil seal is black.

5. Apply a light coat of engine oil to a new oil seal.

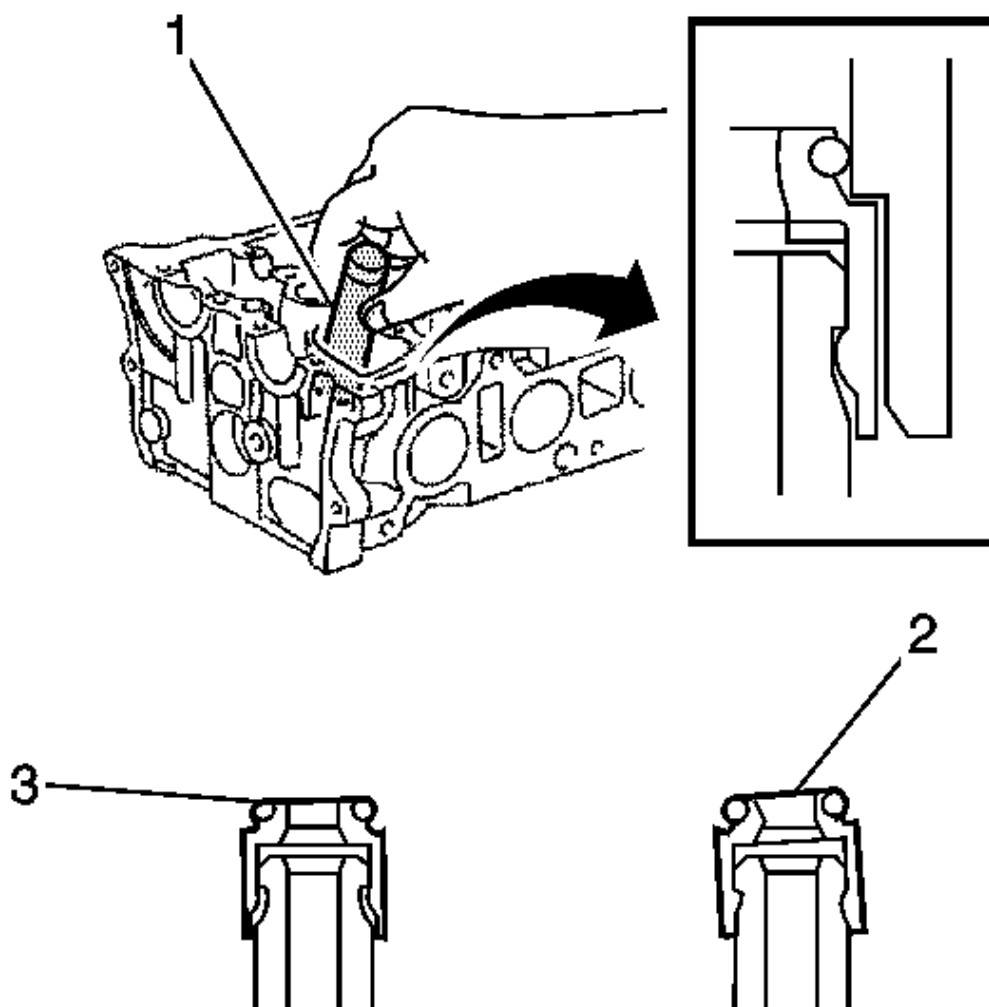


Fig. 418: View Of Valve Stem Seal Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: Failure to use SST will cause the seal to be damaged or improperly seated.

6. Using SST, push in the oil seal.

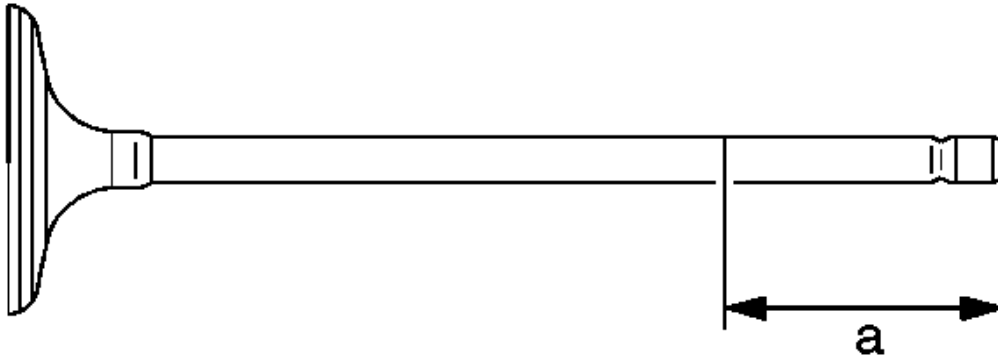


Fig. 419: Identifying Valve Stem Lubrication Area
Courtesy of GENERAL MOTORS CORP.

7. Apply a sufficient coat of engine oil to the tip area of the intake valve shown in the illustration.

NOTE: **Install the same parts in the same combination to the original locations.**

8. Install the valve, compression spring and spring retainer to the cylinder head.

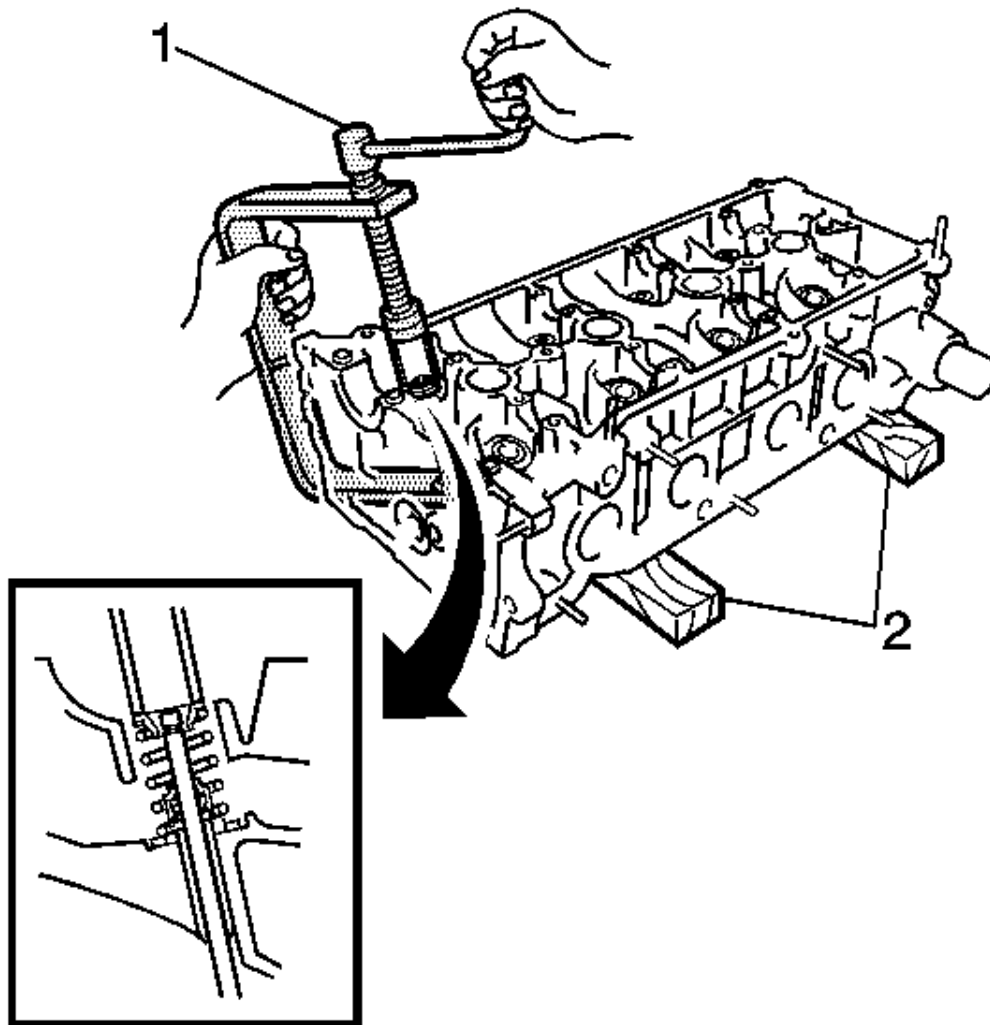


Fig. 420: Illustrating Retainer Lock Removal/Installation
Courtesy of GENERAL MOTORS CORP.

9. Using SST and wooden blocks, compress the spring and install the 2 retainer locks.

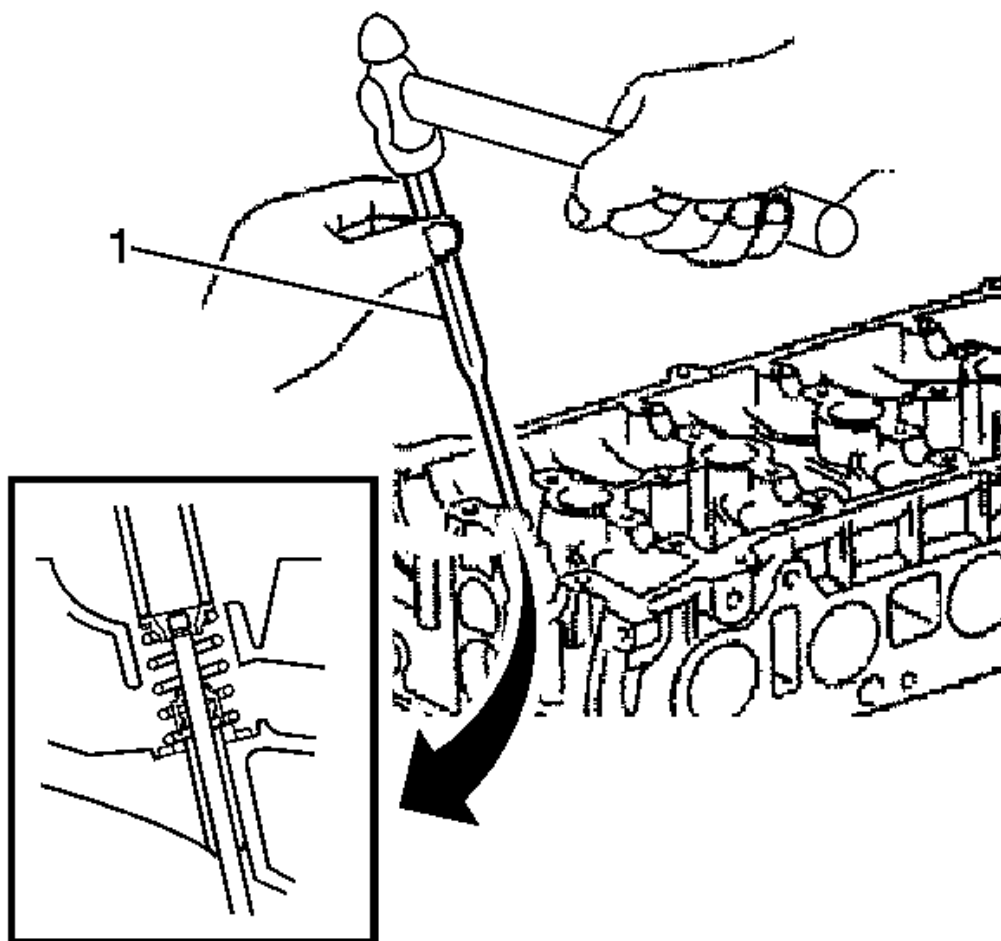


Fig. 421: Tapping Valve Stem Tip For Proper Fit
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the valve stem tip.

10. Using a 5 mm pin punch and plastic hammer, lightly tap the valve stem tip to ensure a proper fit.

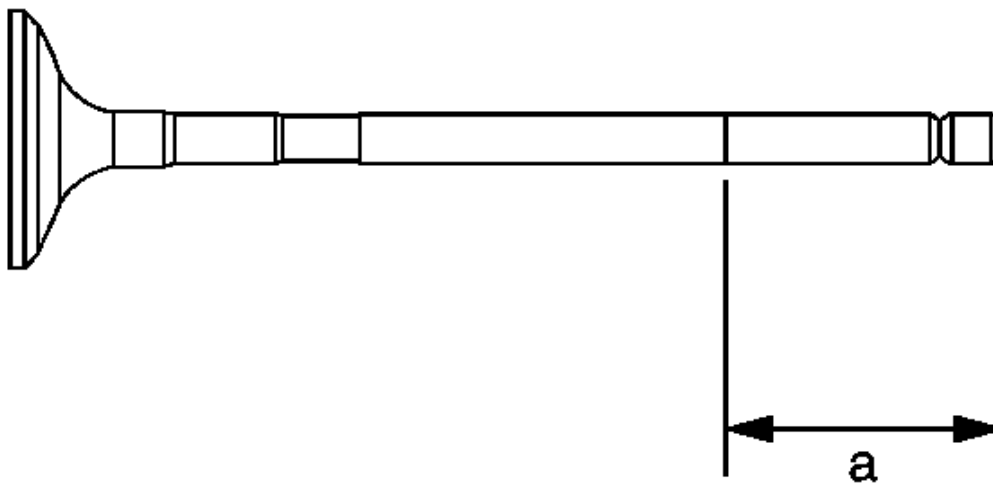


Fig. 422: Identifying Valve Stem Lubrication Area
Courtesy of GENERAL MOTORS CORP.

11. Apply a sufficient coat of engine oil to the tip area of the intake valve shown in the illustration.

NOTE: **Install the same parts in the same combination to the original locations.**

12. Install the valve, compression spring and spring retainer to the cylinder head.

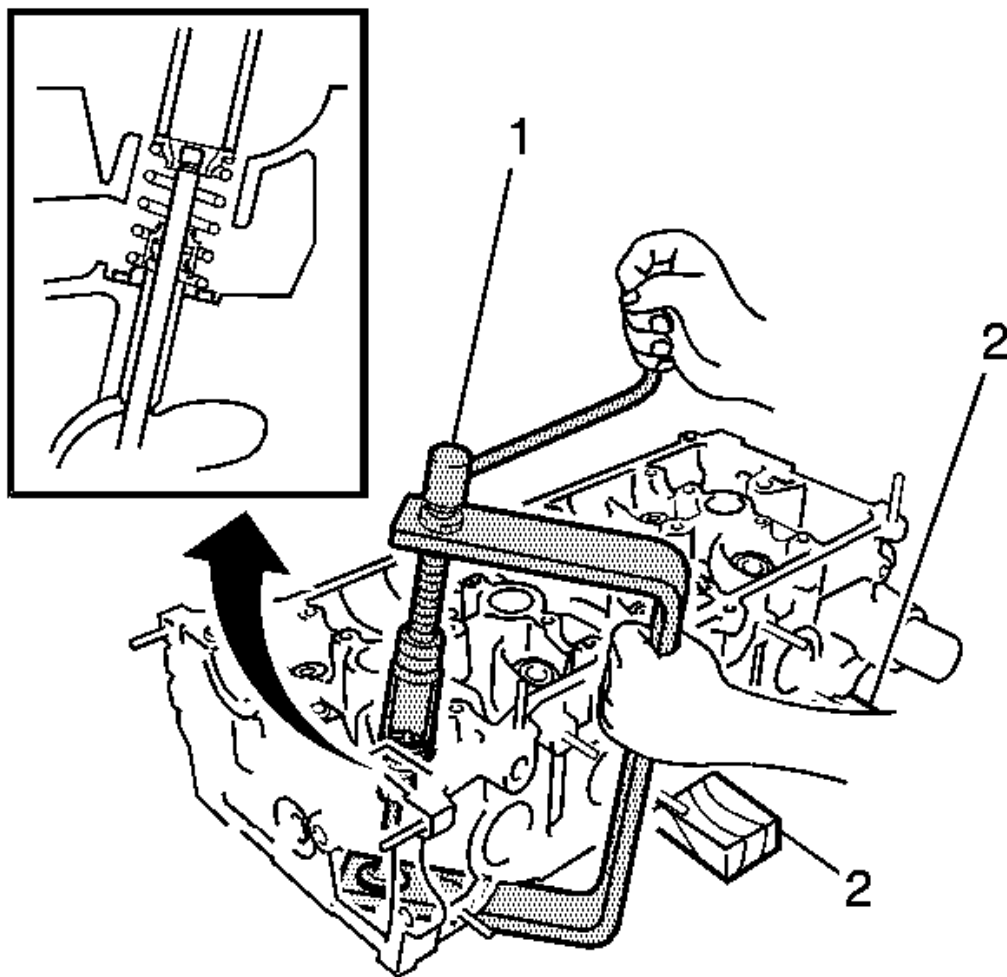


Fig. 423: Identifying Retainer Locks
 Courtesy of GENERAL MOTORS CORP.

13. Using SST, and wooden blocks, compress the spring and install the 2 retainer locks.

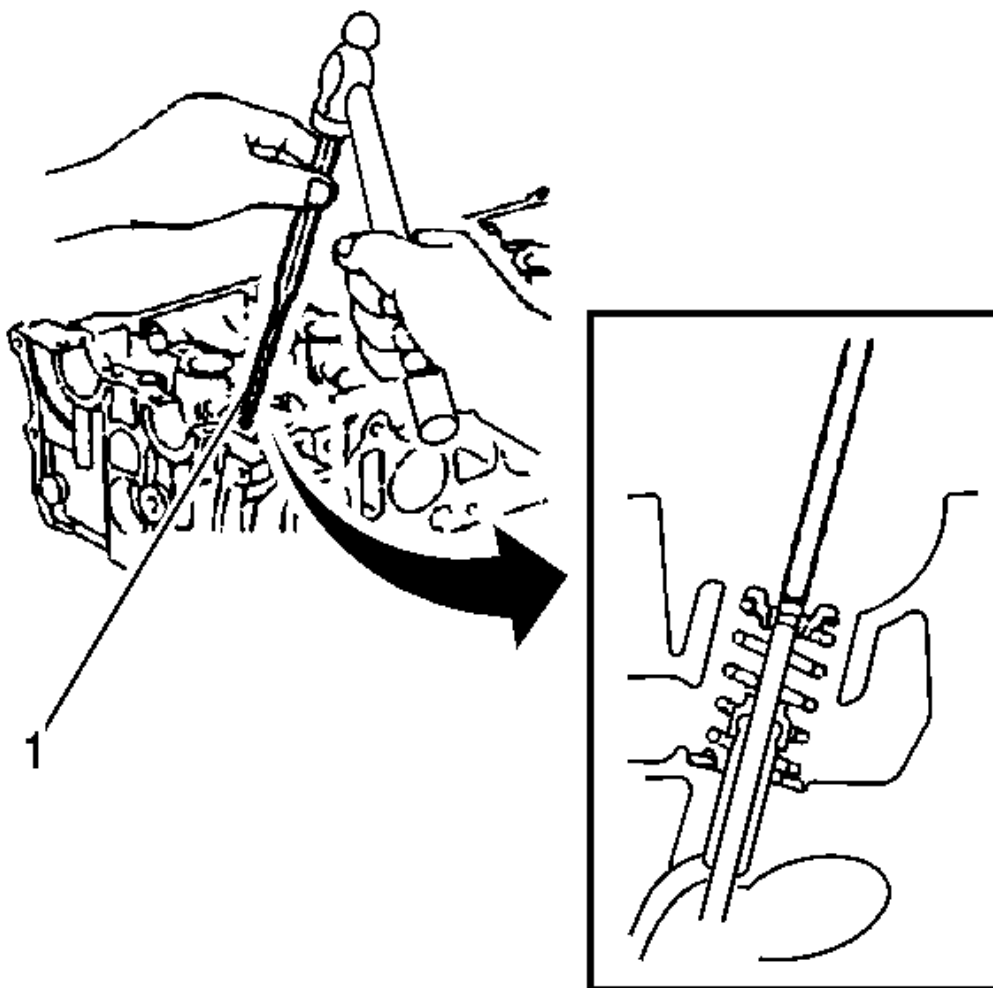


Fig. 424: Tapping Valve Stem Tip For Proper Fit
Courtesy of GENERAL MOTORS CORP.

NOTE: Be careful not to damage the valve stem tip.

14. Using a 5 mm pin punch and plastic hammer, lightly tap the valve stem tip to ensure a proper fit.
15. Apply a light coat of engine oil.

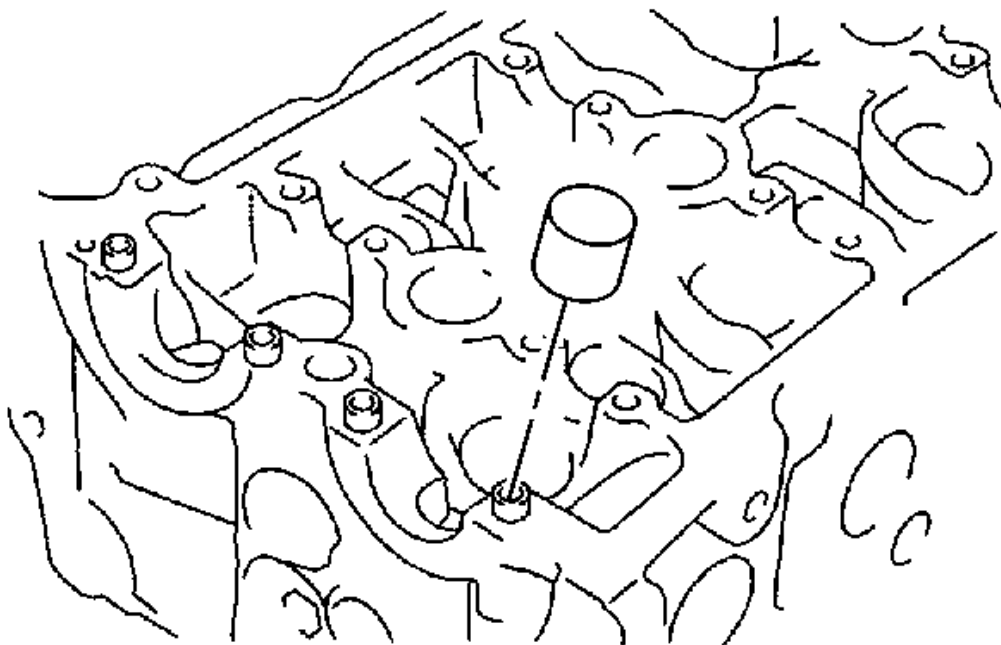


Fig. 425: Identifying Valve Lifters
Courtesy of GENERAL MOTORS CORP.

NOTE: Install the same parts in the same combination to the original locations.

16. Assemble the valve lifter and the tip of the valve stem.

OIL PUMP DISASSEMBLE

Disassembly Procedure

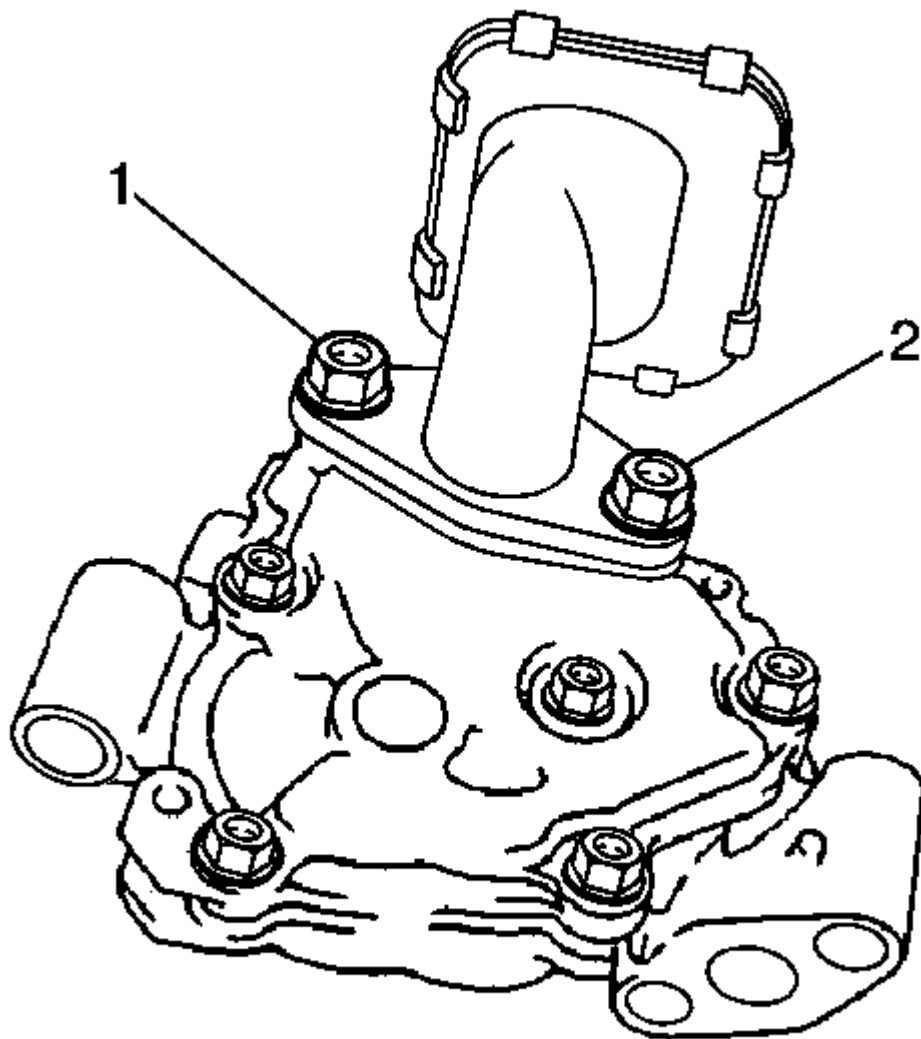


Fig. 426: Identifying Oil Pump Strainer & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the 2 nuts, oil pump strainer and gasket.

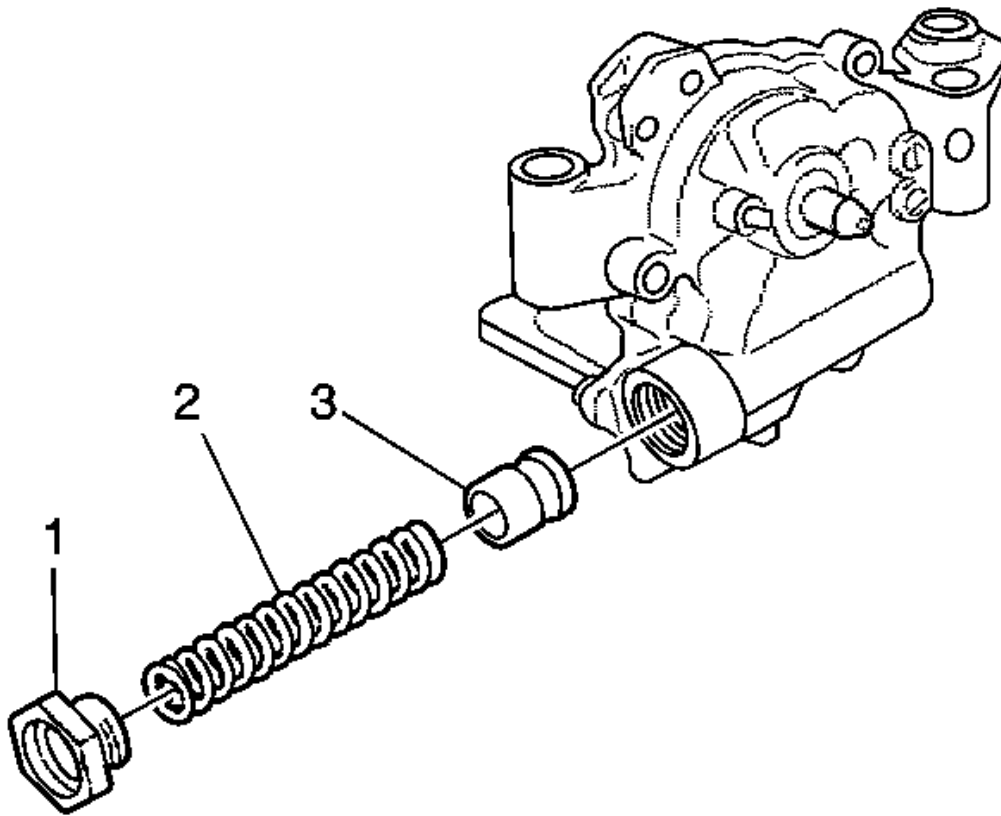


Fig. 427: View Of Oil Pump Valve Spring & Relief Valve
Courtesy of GENERAL MOTORS CORP.

2. Using a 27 mm socket wrench, remove the plug.
3. Remove the valve spring and relief valve.

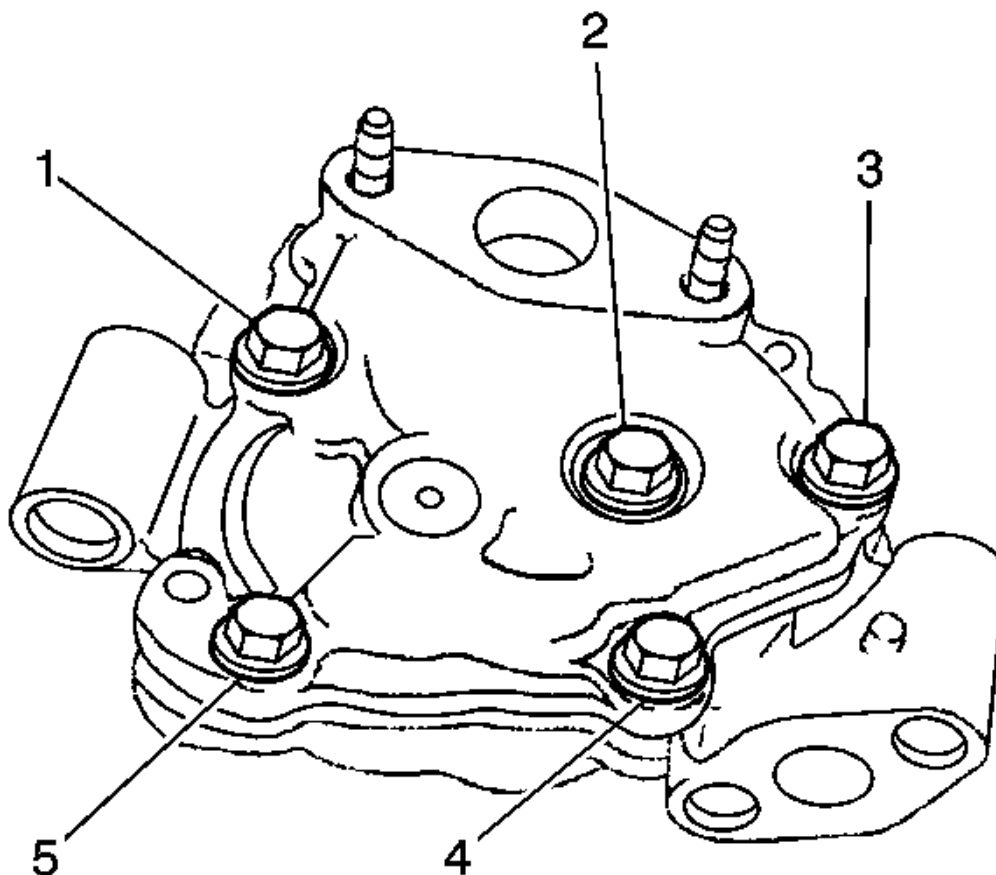


Fig. 428: View Of Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the 5 bolts and oil pump cover.
5. Remove the oil pump drive and driven rotors from the oil pump.

OIL PUMP CLEANING AND INSPECTION

Inspection Procedure

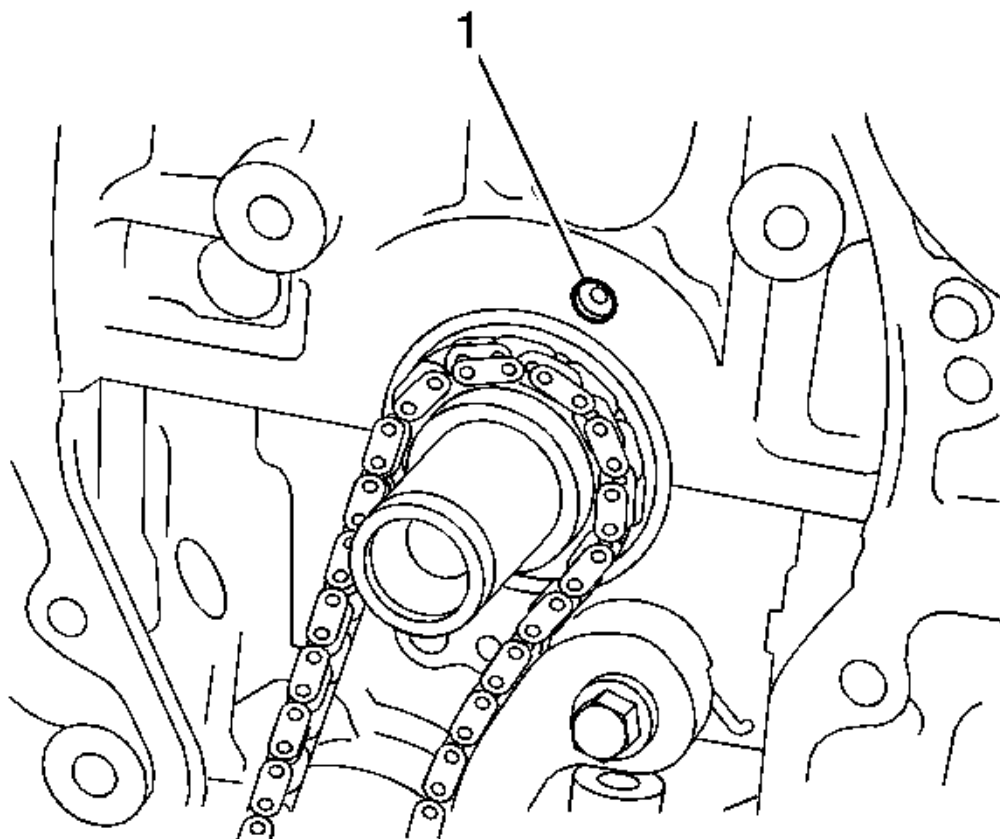


Fig. 429: Checking Oil Jet For Damage Or Clogging
Courtesy of GENERAL MOTORS CORP.

1. Check the oil jet for damage or clogging. If necessary, repair the cylinder block.

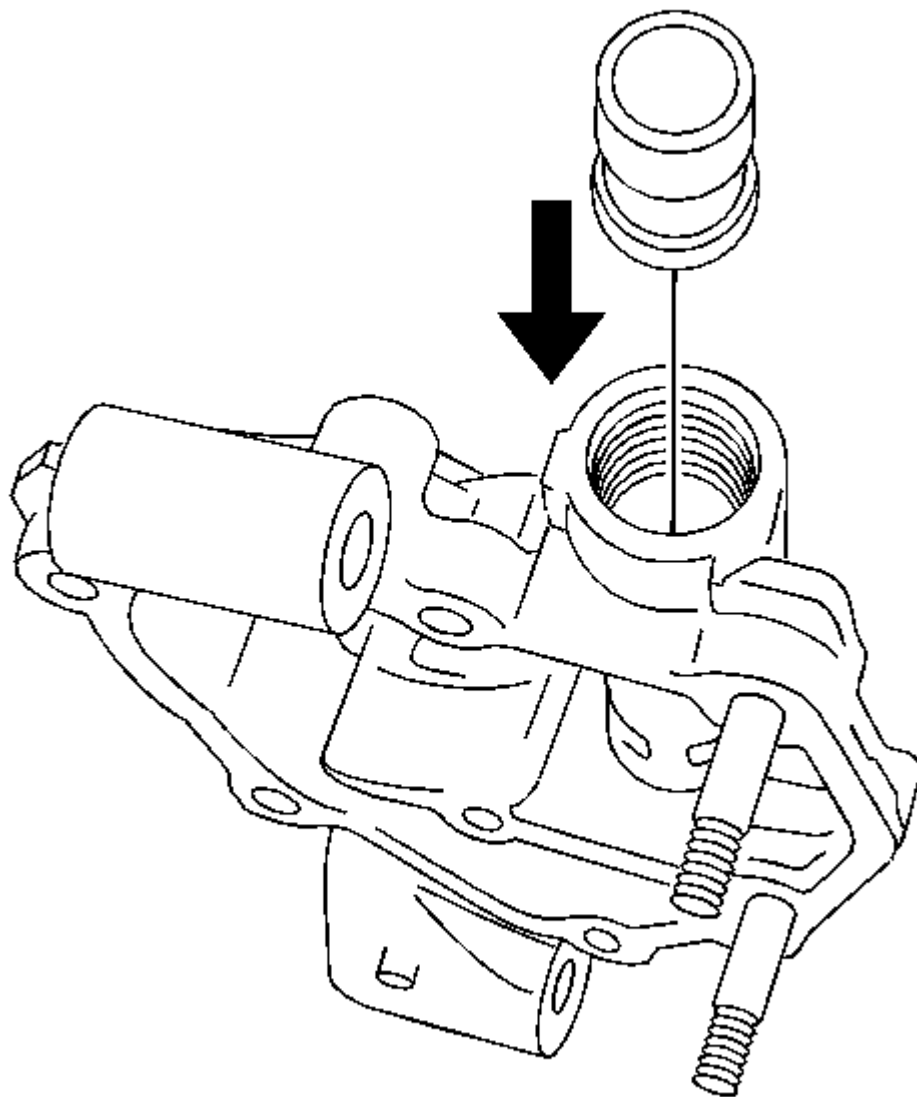


Fig. 430: Checking Oil Pump Relief Valve
Courtesy of GENERAL MOTORS CORP.

2. Check the relief valve.
3. Coat the valve with engine oil, and then check that the valve falls smoothly into the valve hole by its own weight.

If it does not, replace the relief valve. If necessary, replace the oil pump assembly.

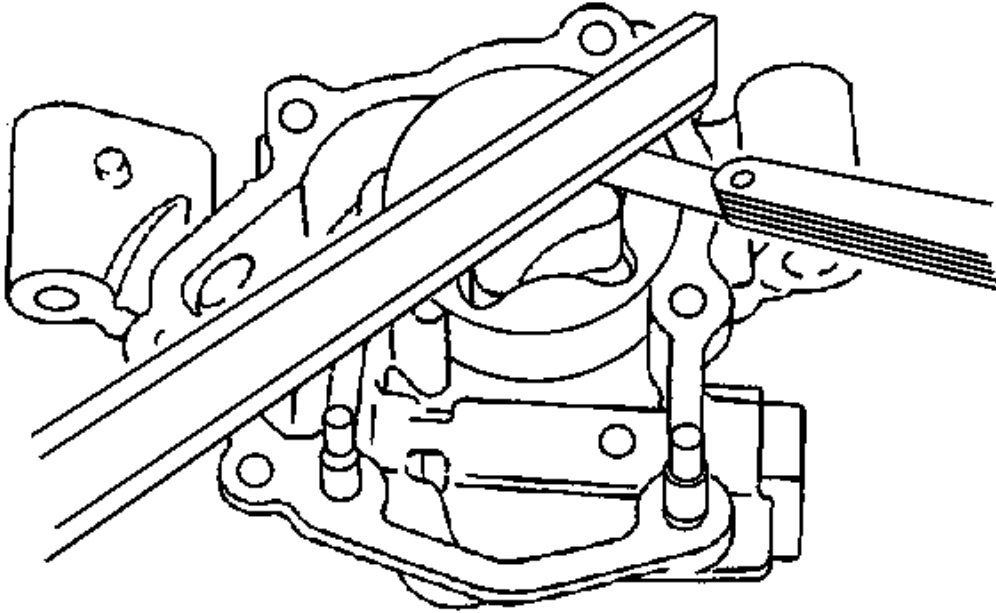


Fig. 431: Inspecting Oil Pump Side Clearance
Courtesy of GENERAL MOTORS CORP.

4. Check the side clearance.
5. Using a feeler gauge and precision straightedge, measure the clearance between the rotors and precision straightedge.

If the side clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.030 to 0.085 mm (0.0012 to 0.0034 in.)
- Maximum Clearance: 0.160 mm (0.0063 in.)

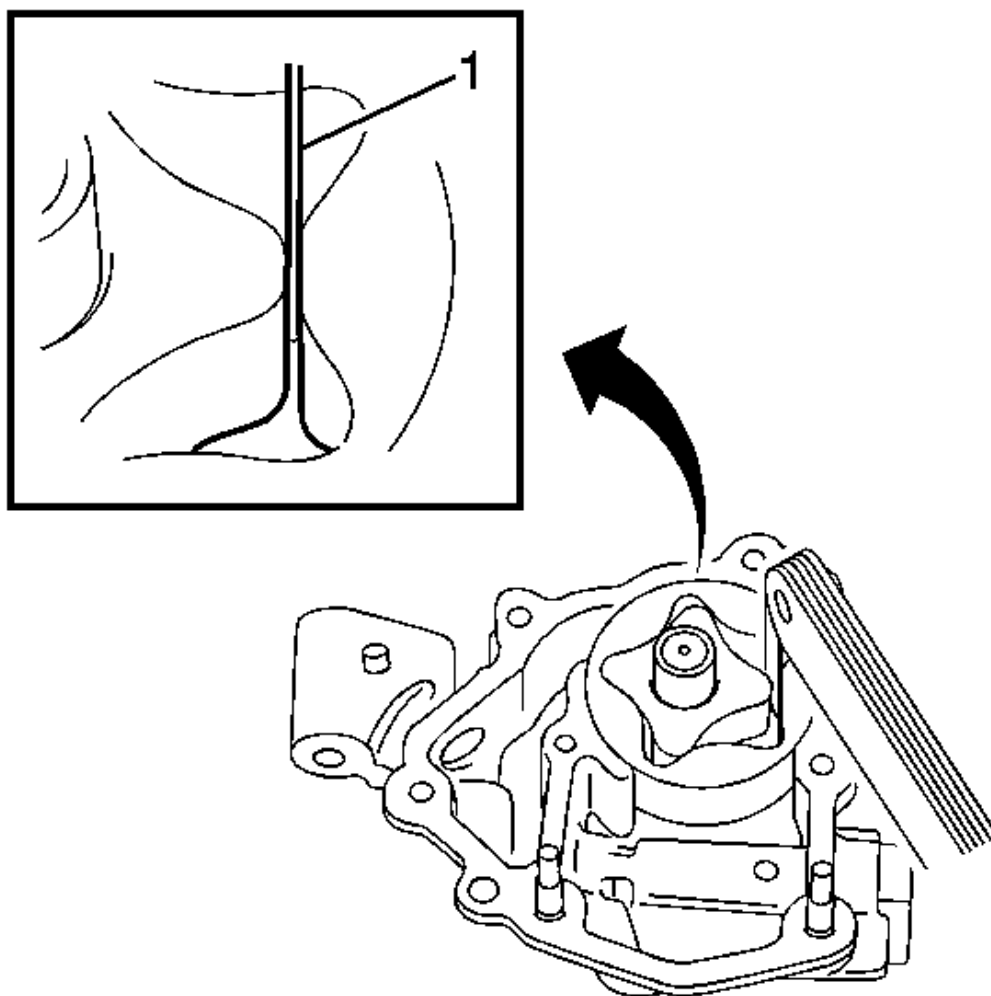


Fig. 432: Checking Oil Pump Gear Tip Clearance
Courtesy of GENERAL MOTORS CORP.

6. Check the tip clearance.
7. Using a feeler gauge, measure the clearance between the drive and driven rotor tips.

If the tip clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.080-0.160 mm (0.0031-0.0063 in).
- Maximum Clearance: 0.35 mm (0.0138 in).

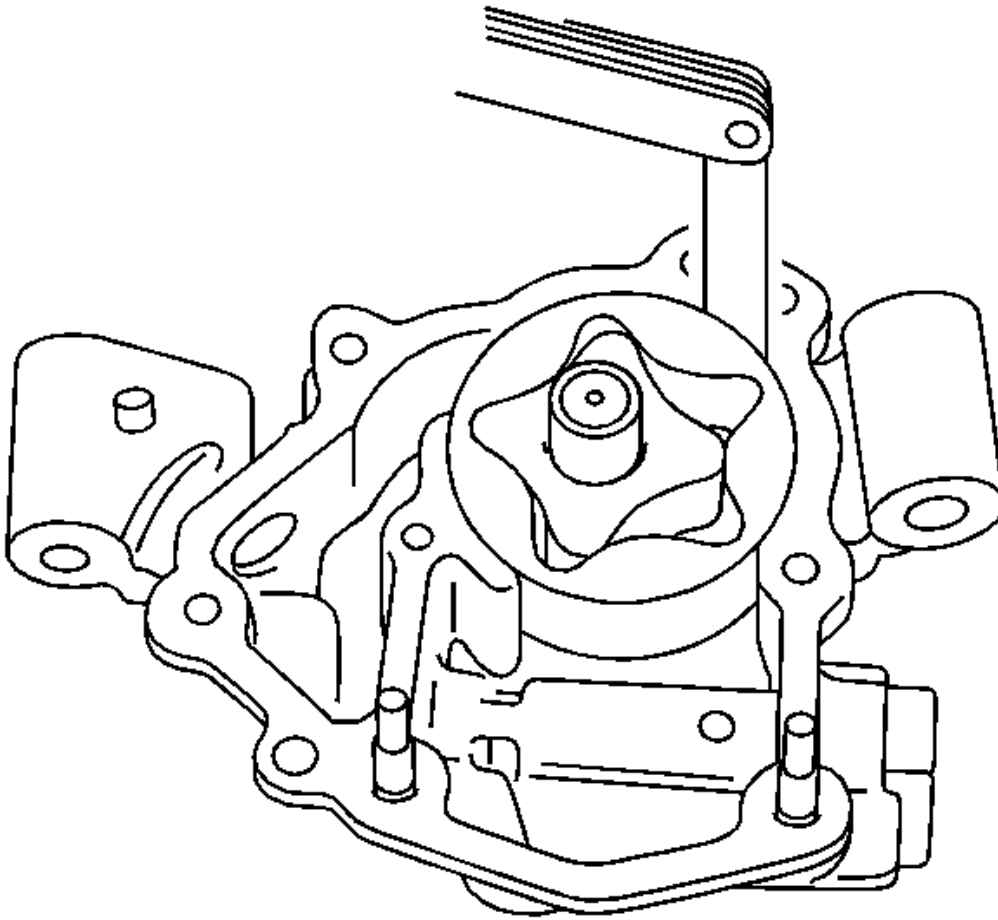


Fig. 433: Checking Oil Pump Body Clearance
Courtesy of GENERAL MOTORS CORP.

8. Check the body clearance.
9. Using a feeler gauge, measure the clearance between the driven rotor and pump body.

If the body clearance is greater than the maximum, replace the oil pump assembly.

Specification:

- Standard Clearance: 0.100-0.170 mm (0.0039-0.0067 in).
- Maximum Clearance: 0.325 mm (0.0128 in).

OIL PUMP ASSEMBLY

Reassembly Procedure

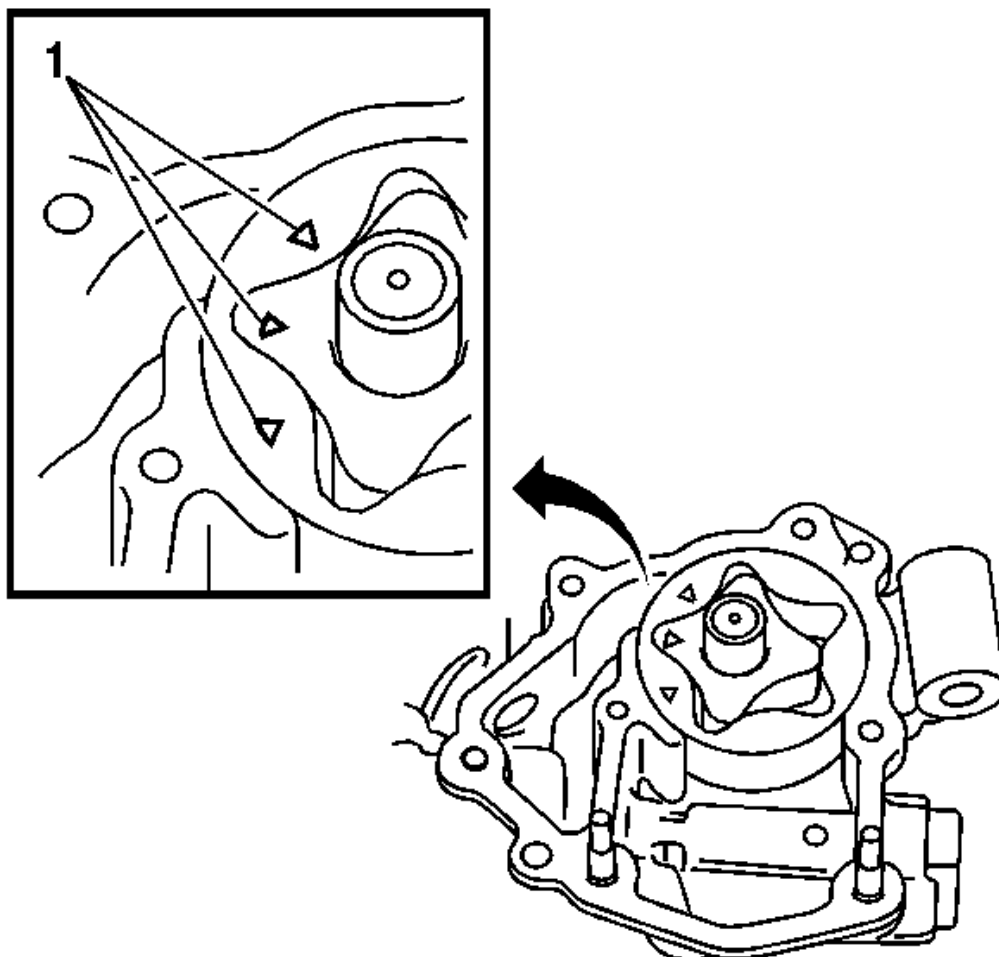


Fig. 434: View Of Coating Drive Rotor And Driven Rotor With Engine Oil.
Courtesy of GENERAL MOTORS CORP.

1. Coat the drive rotor and driven rotor with engine oil.
2. Place the drive and driven rotors into the oil pump with the marks facing the pump cover side.

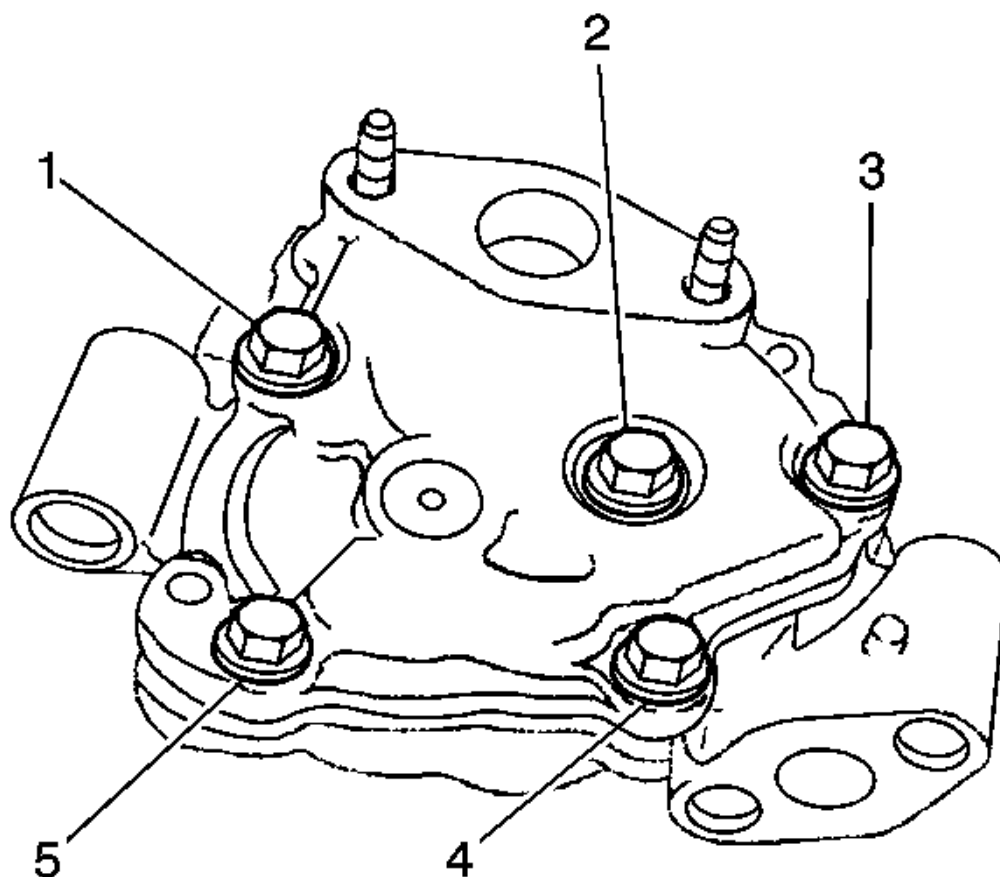


Fig. 435: View Of Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER CAUTION .

3. Install the oil pump cover with the 5 bolts.

Tighten: Tighten to 8.8 N.m (78 lb in).

4. Coat the relief valve with engine oil.

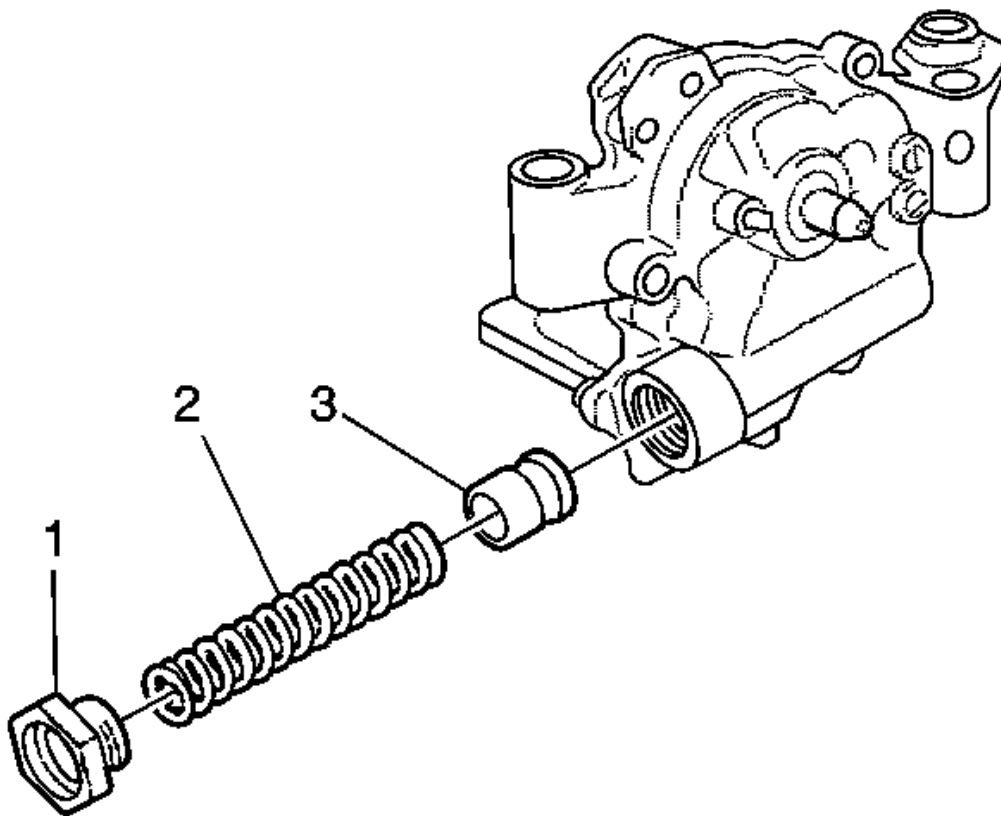


Fig. 436: View Of Oil Pump Valve Spring & Relief Valve
Courtesy of GENERAL MOTORS CORP.

5. Insert the relief valve and spring into the pump body hole.
6. Using a 27 mm socket wrench, install the plug.

Tighten: Tighten to 49 N.m (36 lb ft).

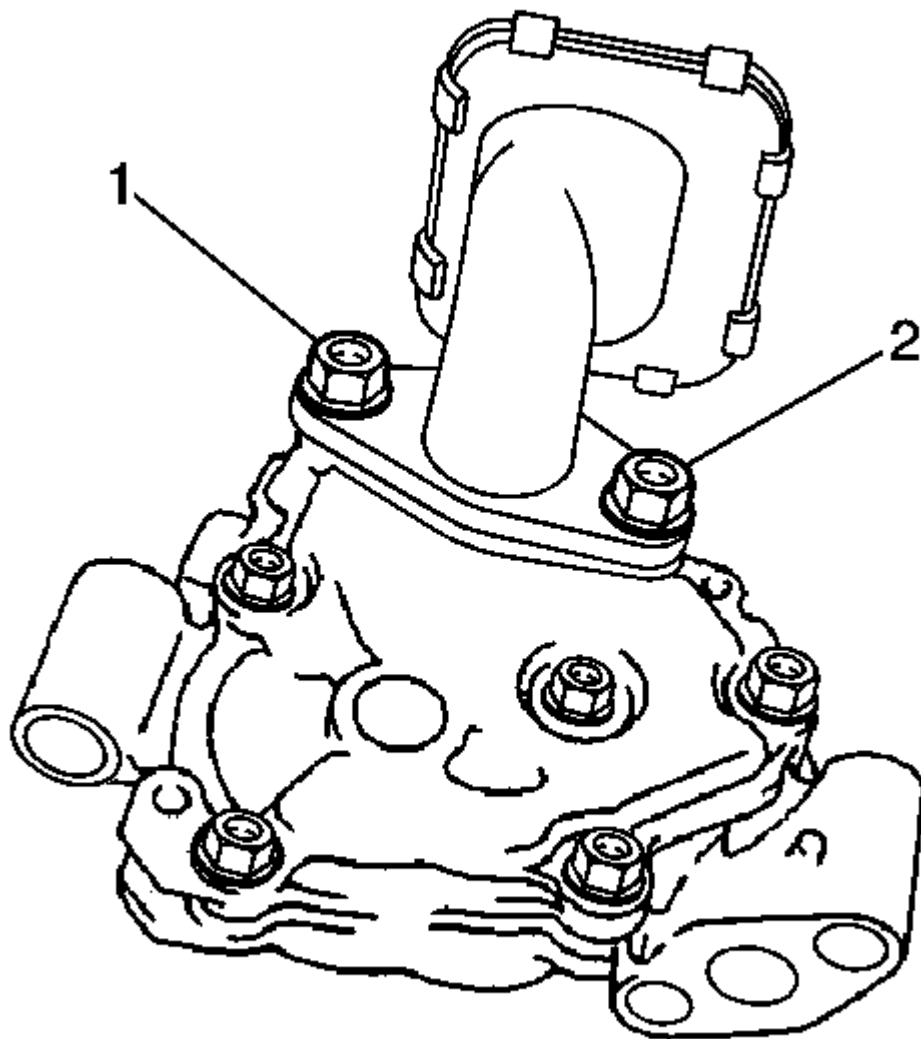


Fig. 437: Identifying Oil Pump Strainer & Gasket
Courtesy of GENERAL MOTORS CORP.

7. Install a new gasket and the oil strainer with the 2 nuts.

Tighten: Tighten to 8.8 N.m (78 lb in).

CRANKSHAFT AND BEARING INSTALLATION

Installation Procedure

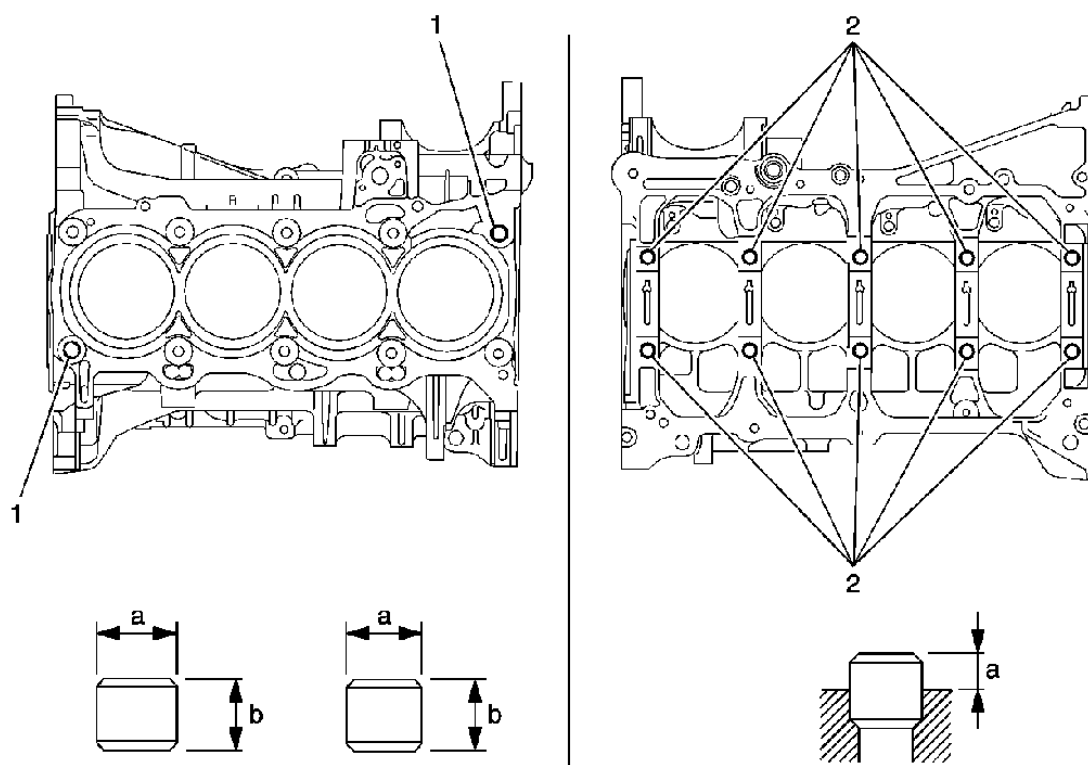


Fig. 438: Identifying Ring Pins

Courtesy of GENERAL MOTORS CORP.

1. Using a plastic hammer, tap in the ring pins.

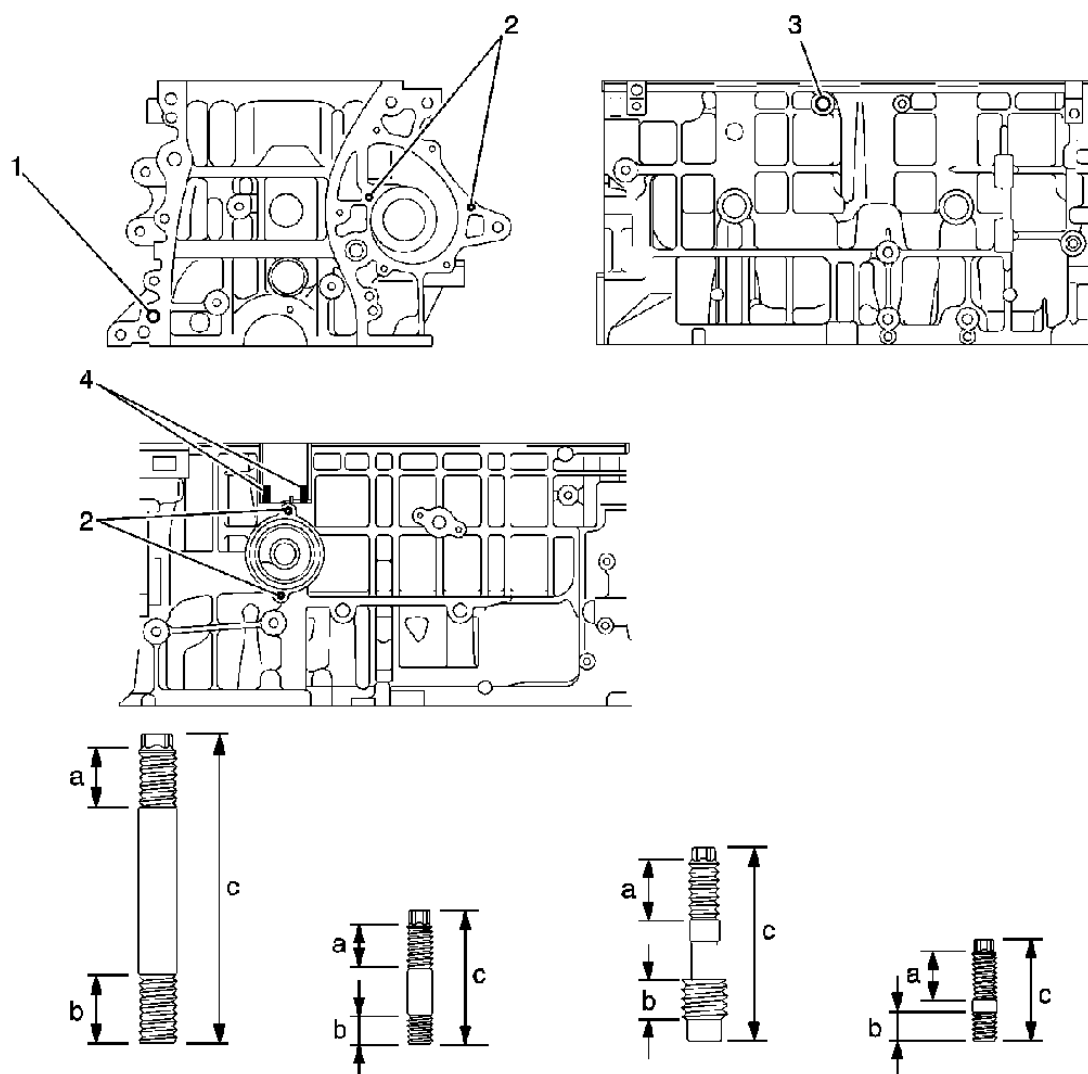


Fig. 439: Identifying Stud Bolt Locations
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

2. Install the stud bolts as shown in the illustration.

Tighten:

- Stud Bolt A 22 N.m (16 lb in)
- Stud Bolt B 5.0 N.m (44 lb in)
- Stud Bolt C 9.5 N.m (84 lb in)
- Stud Bolt D 5.0 N.m (44 lb in)

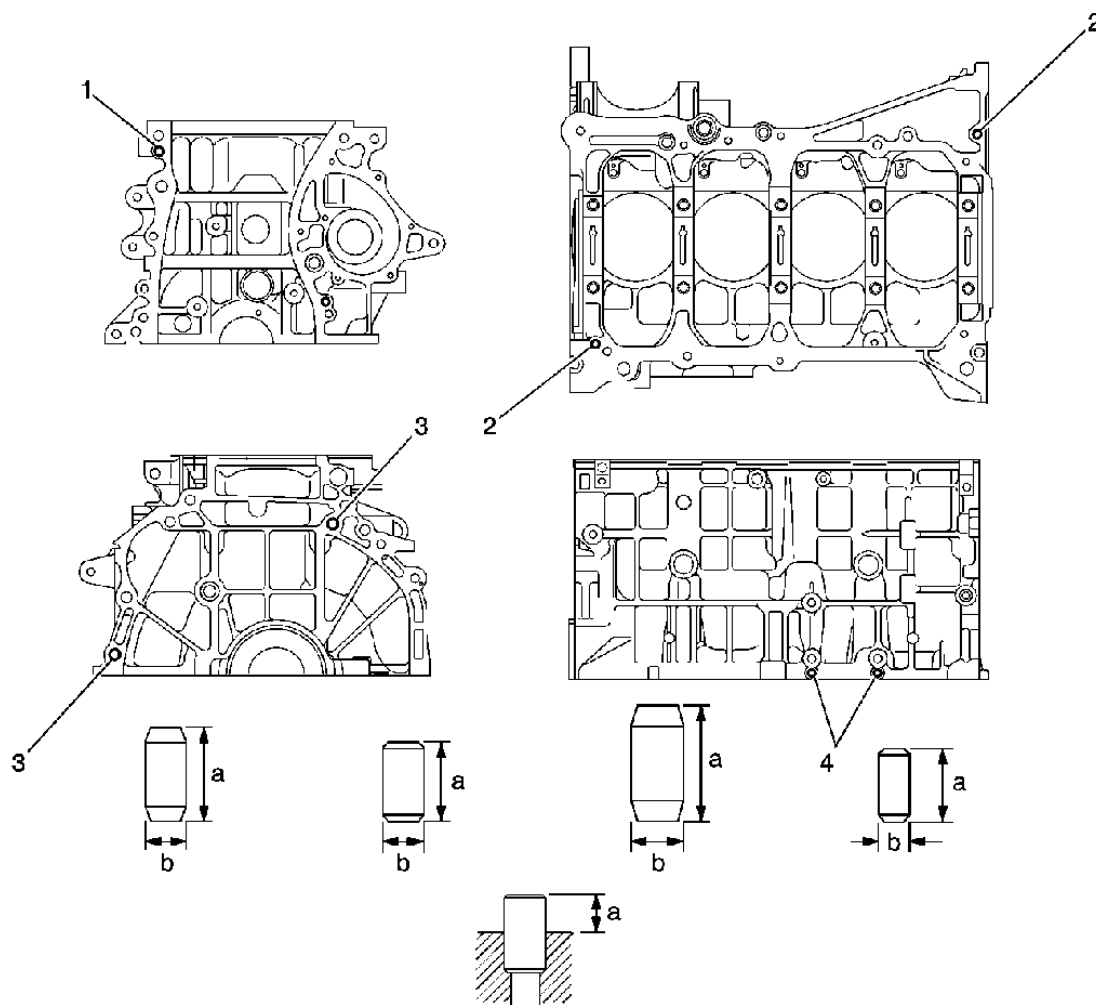


Fig. 440: Identifying Straight Pin Locations
Courtesy of GENERAL MOTORS CORP.

3. Using a plastic hammer, tap in the straight pins.

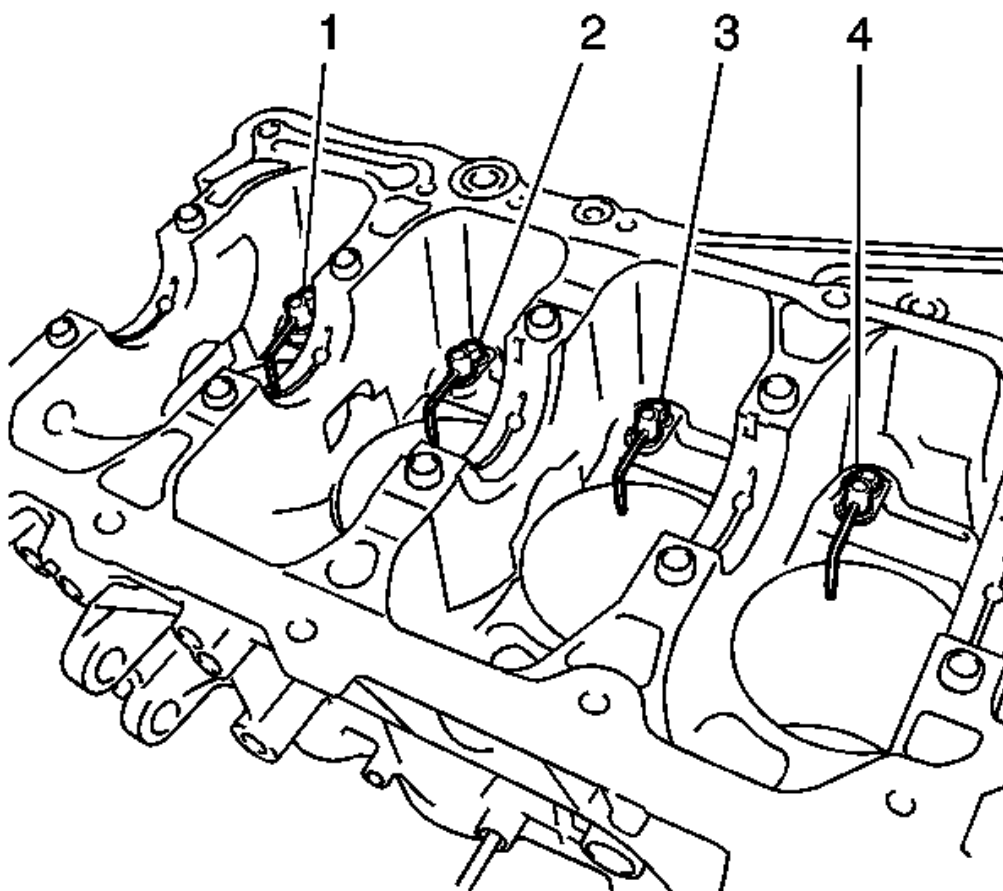


Fig. 441: Identifying Oil Nozzles

Courtesy of GENERAL MOTORS CORP.

4. Using a 5 mm hexagon wrench, install the oil nozzles with the bolts.

Tighten: 7.0 N.m (62 lb in)

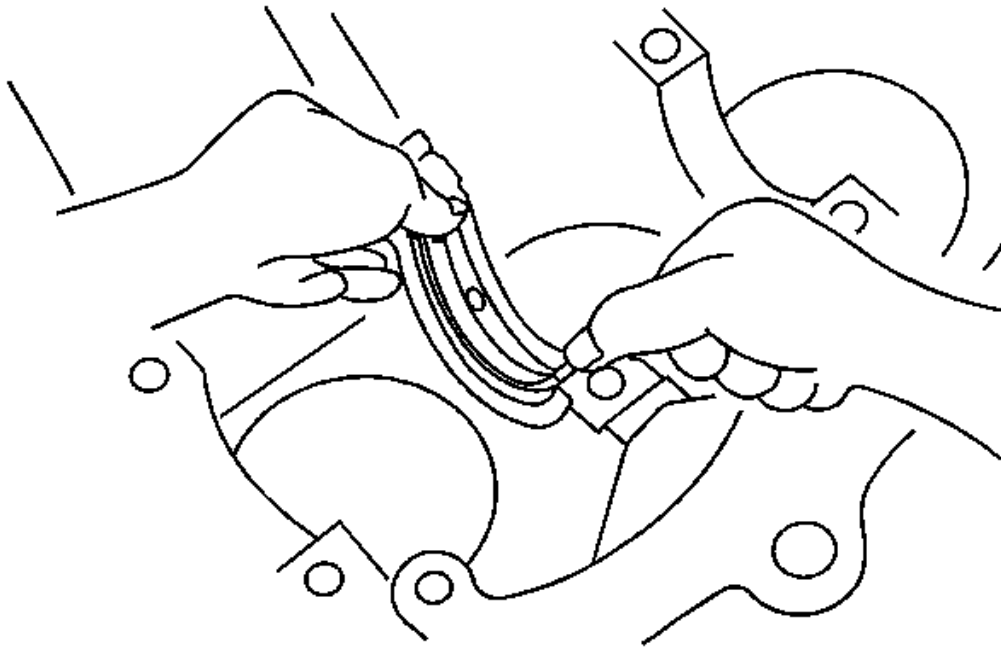


Fig. 442: View Of Upper Crankshaft Bearing Installation
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not apply engine oil to the bearings or the contact surfaces.

5. Install the upper crankshaft bearing with an oil groove on the cylinder block.

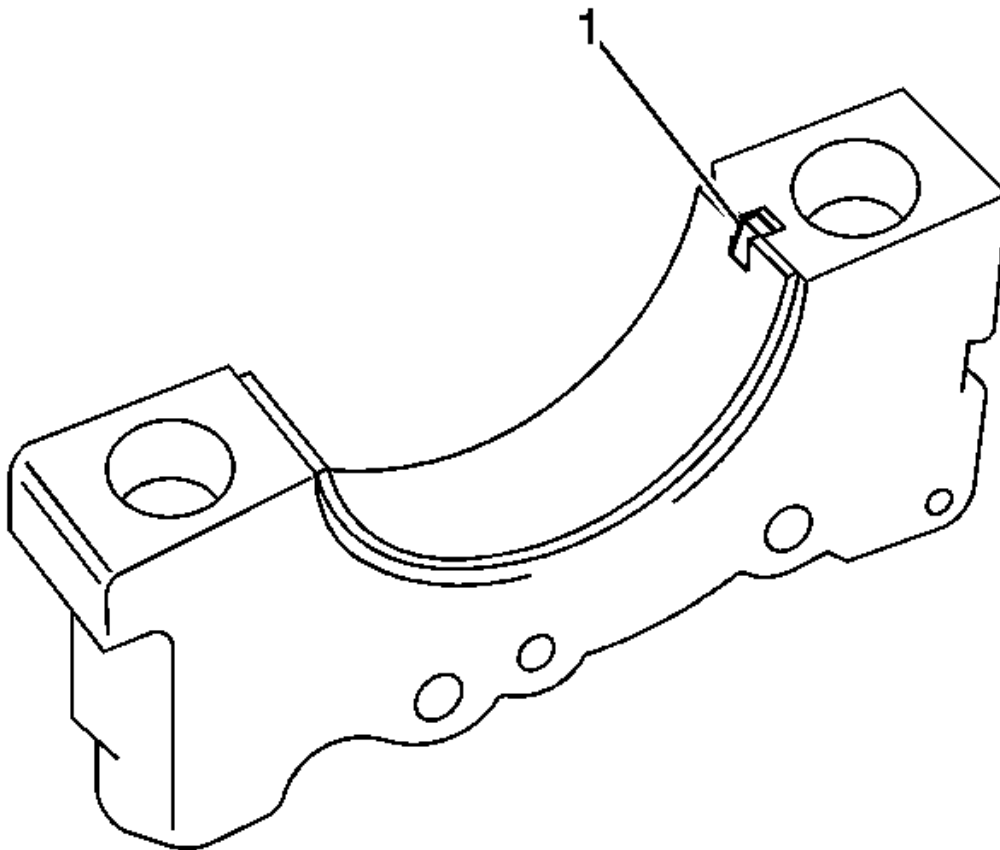


Fig. 443: View Of Lower Crankshaft Bearing Installation In Bearing Cap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Clean the backside of the bearing and the bearing surface of the connecting rod. The surface should be free of dust and oils.

6. Install the crankshaft bearing on the bearing cap.

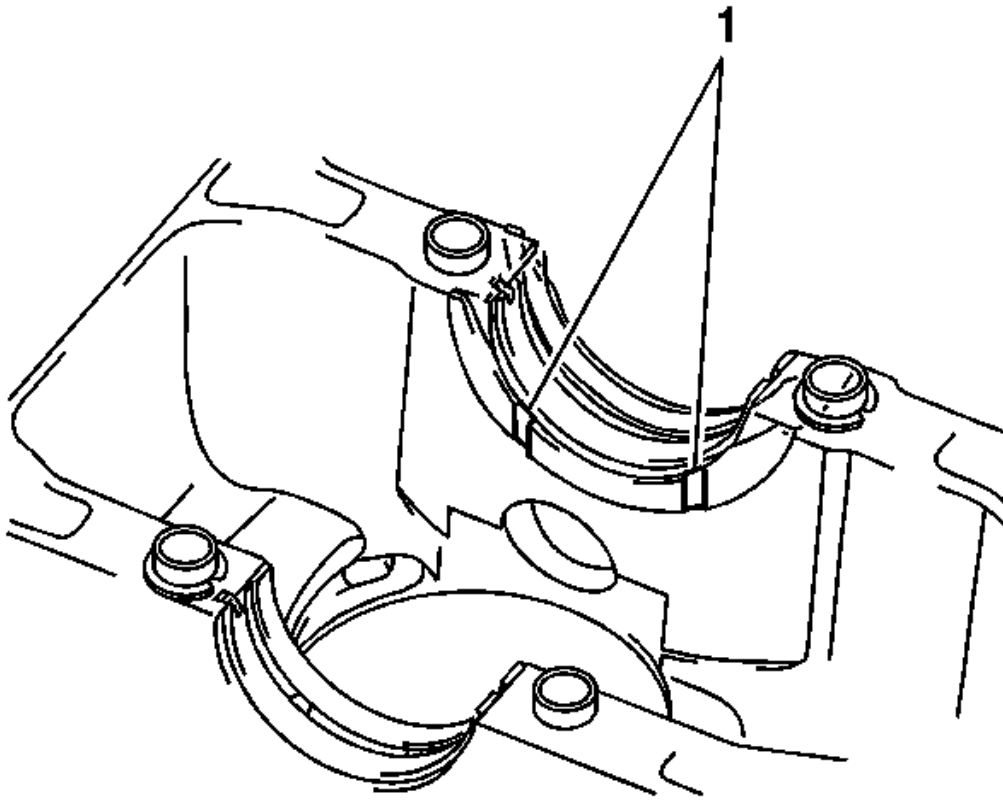


Fig. 444: Identifying Upper Thrust Washers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Make sure to install the proper thrust washers.

7. Install the 2 upper crankshaft thrust washers under the No. 3 journal of the cylinder block with the oil grooves facing outward.
8. Apply engine oil to the crankshaft thrust washer.
9. Apply engine oil to the upper bearing and install the crankshaft on the cylinder block.
10. Apply engine oil to the lower bearing.

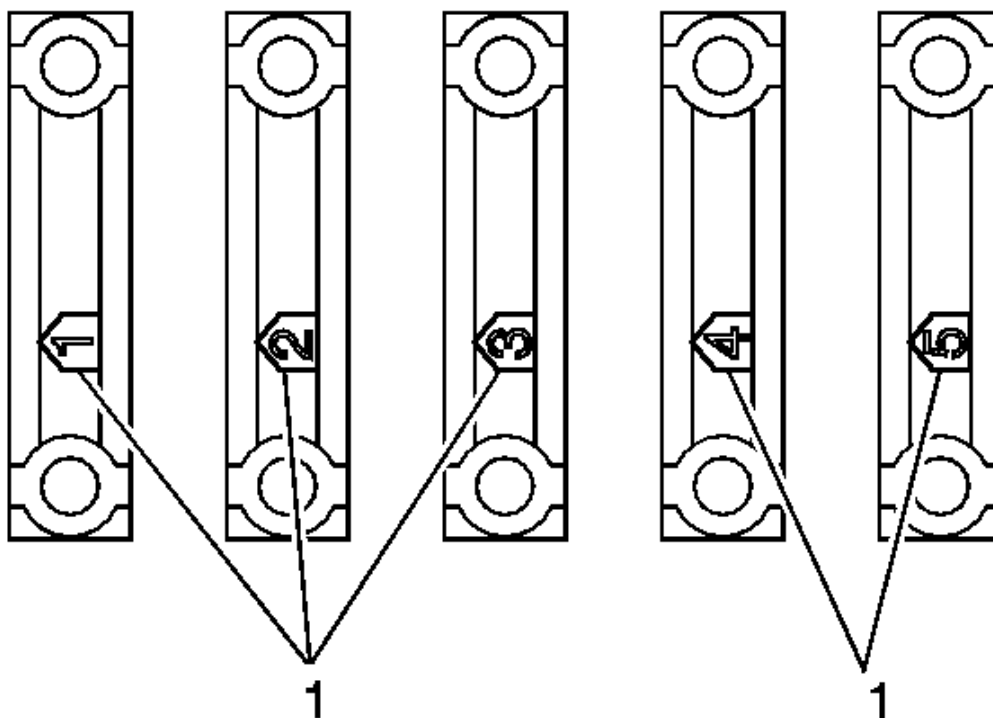


Fig. 445: View Of Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

11. Examine the front marks and install the bearing caps on the cylinder block.
12. Apply a light coat of engine oil to the threads and under the bearing cap bolts.

IMPORTANT: The main bearing cap bolts are tightened in 2 progressive steps.

13. Install the crankshaft bearing cap bolts.

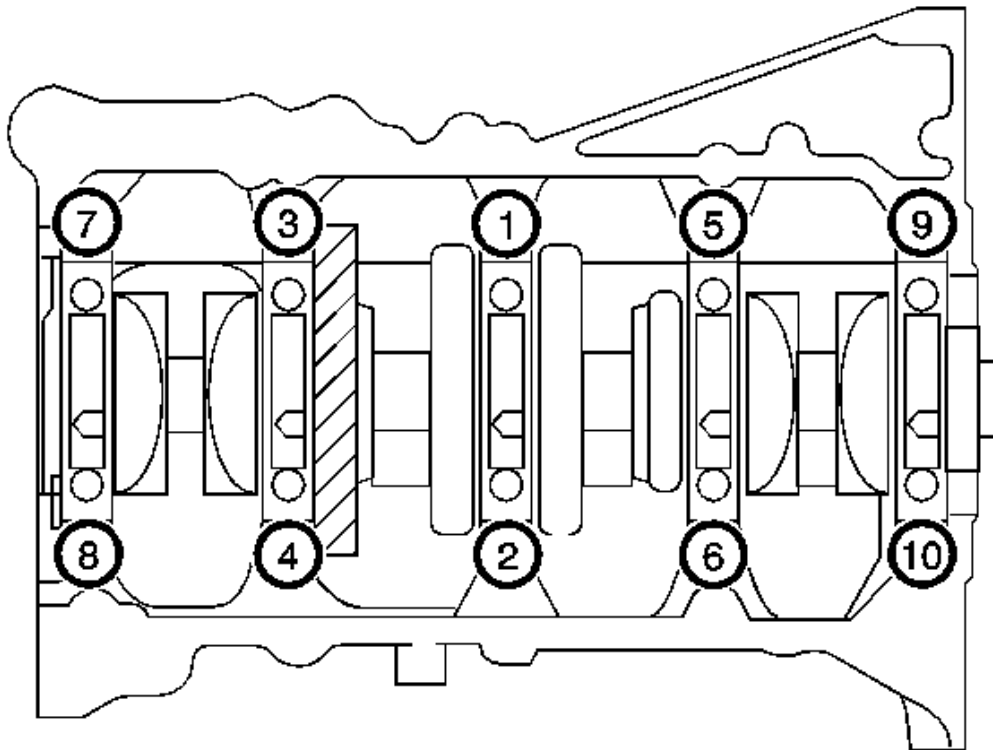


Fig. 446: Identifying Crankshaft Bearing Cap Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

14. Install and uniformly tighten the 10 main bearing cap bolts in the sequence shown in the illustration.

Tighten: 20 N.m (15 lb ft)

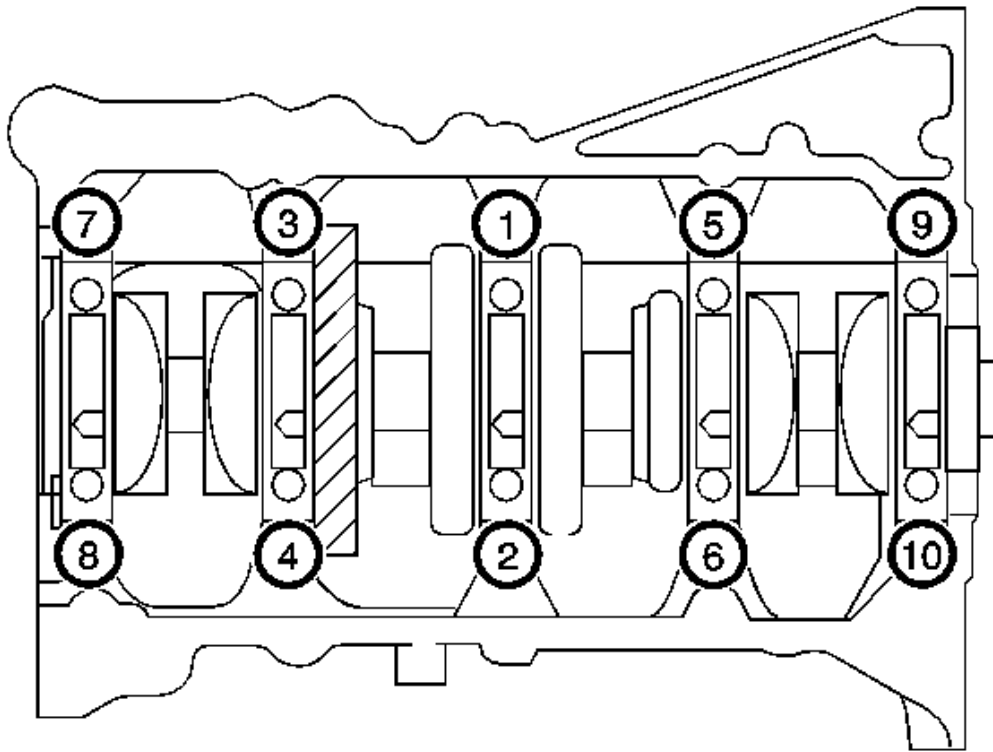


Fig. 447: Identifying Crankshaft Bearing Cap Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

15. Retighten the 10 main bearing cap bolts in the sequence shown in the illustration.

Tighten: 40 N.m (30 lb ft)

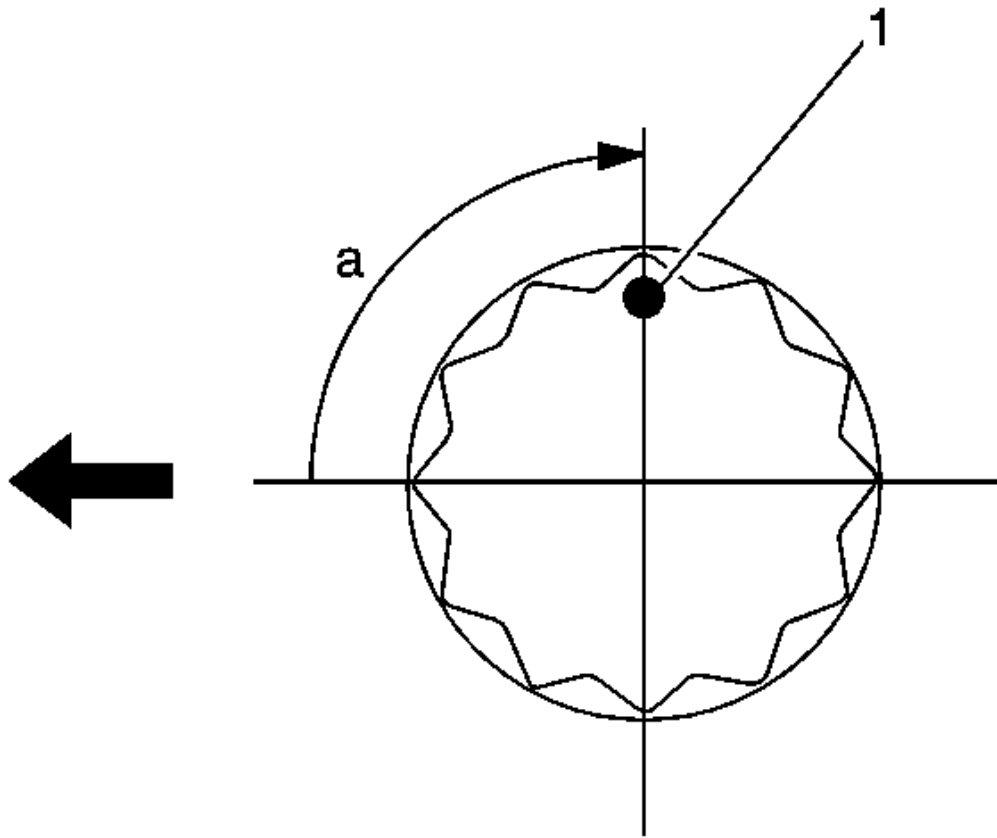


Fig. 448: Identifying Crankshaft Bearing Cap Tightening Final Step
Courtesy of GENERAL MOTORS CORP.

16. Mark the front of the bearing cap bolts with paint.
17. Retighten the bearing cap bolts by 90° in the numerical order shown in the illustration.
18. Check that the paint mark is now at a 90° angle to the front.
19. Check that the crankshaft turns smoothly.
20. Check the crankshaft thrust clearance. Refer to **Crankshaft and Bearing Removal**.

BALANCER SHAFT BEARING INSTALLATION

Installation Procedure

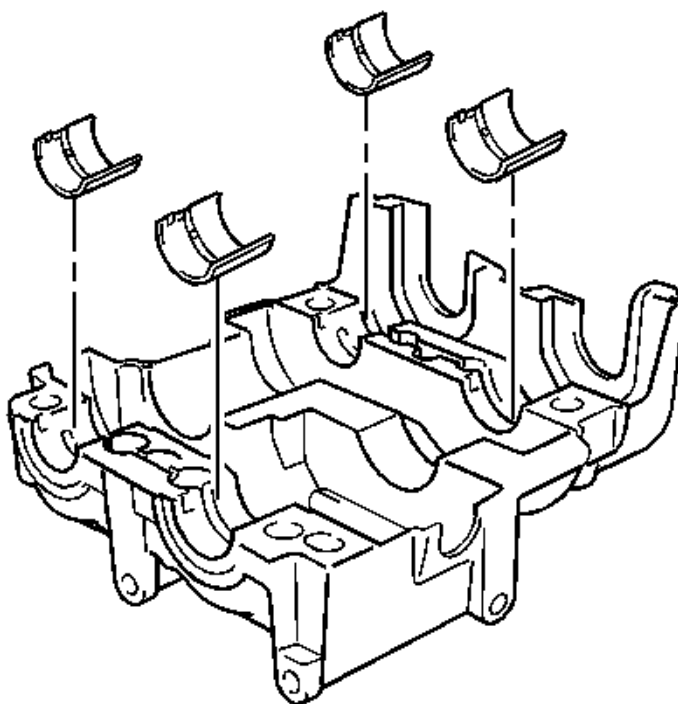
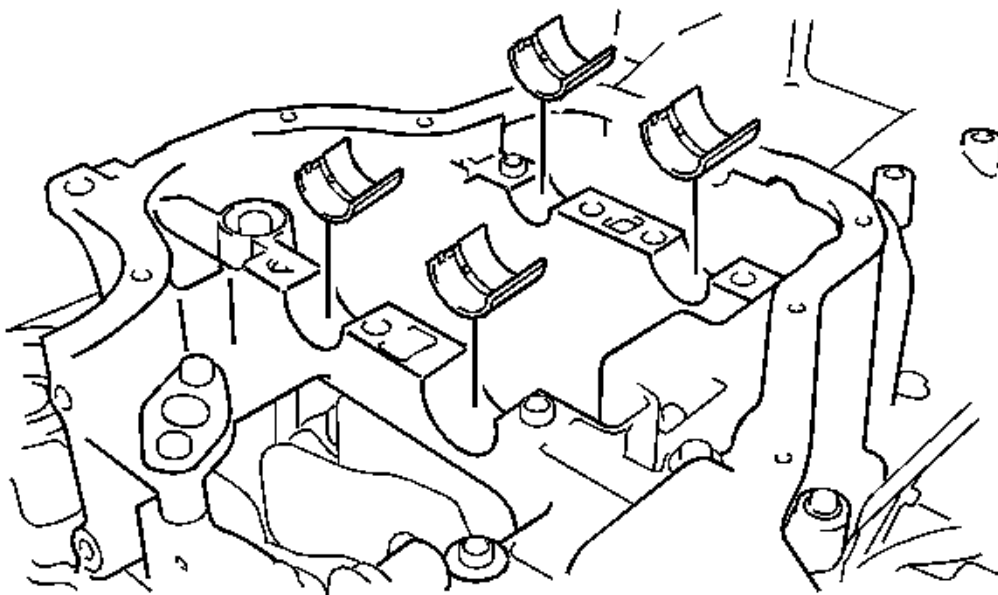


Fig. 449: Identifying Balancer Shaft Bearing

Courtesy of GENERAL MOTORS CORP.

1. Install No. 1 balancshaft bearing.

IMPORTANT: Do not apply engine oil to the contact surfaces of the balancshaft bearing and balancshaft housing.

2. Align the bearing claw with the claw groove, and push in the 8 bearings.
3. Apply a light coat of the engine oil to the bearings.

BALANCE SHAFT INSTALLATION

Installation Procedure

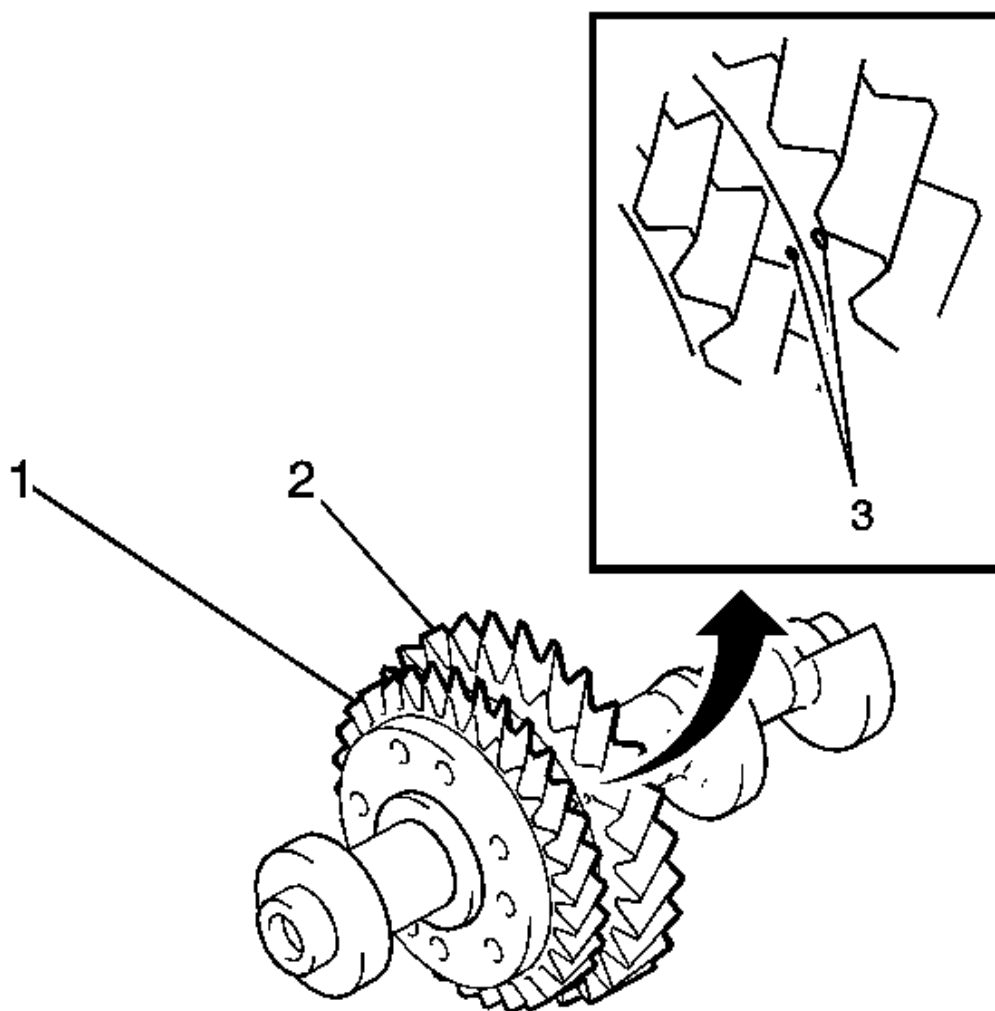


Fig. 450: View Of Balancershaft
 Courtesy of GENERAL MOTORS CORP.

1. Install No. 1 and No. 2 balancershafts

IMPORTANT: Confirm that the matchmarks on the No. 1 and No. 2 driven gears are matched.

2. Rotate the No. 1 driven gear of the No. 1 balancershaft in the rotating direction until it hits the stopper.

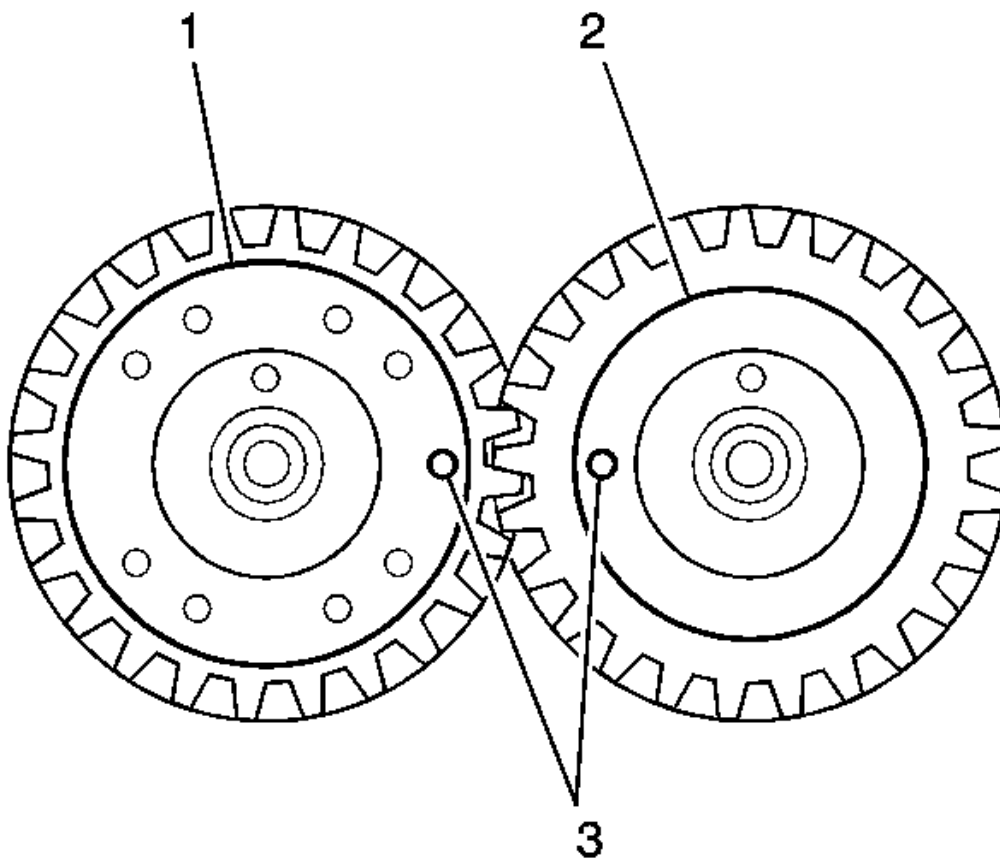


Fig. 451: View Of Balance Shaft Alignment Marks
Courtesy of GENERAL MOTORS CORP.

3. Confirm that the timing marks on the No. 1 and No. 2 balancershaft are aligned.

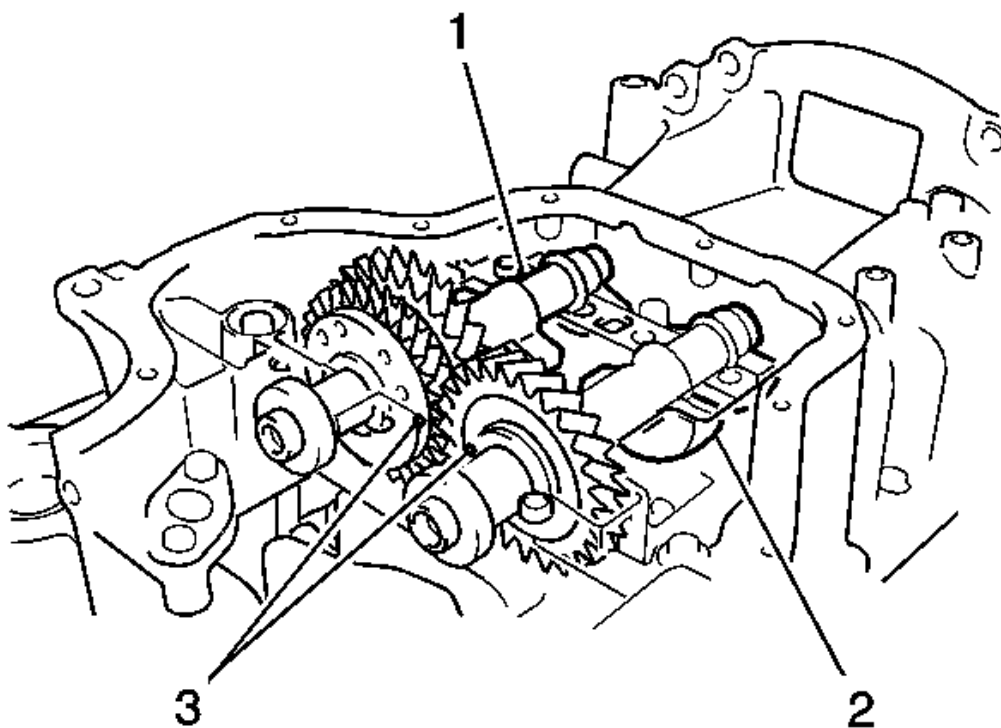


Fig. 452: Identifying Balancershafts
Courtesy of GENERAL MOTORS CORP.

4. Align the timing marks on the No. 1 and No. 2 balancershafts as shown in the illustration.
5. Place the No. 1 and No. 2 balancershafts onto the crankcase.
6. Apply a light coat of engine oil to the threads and under the heads of the bolts.

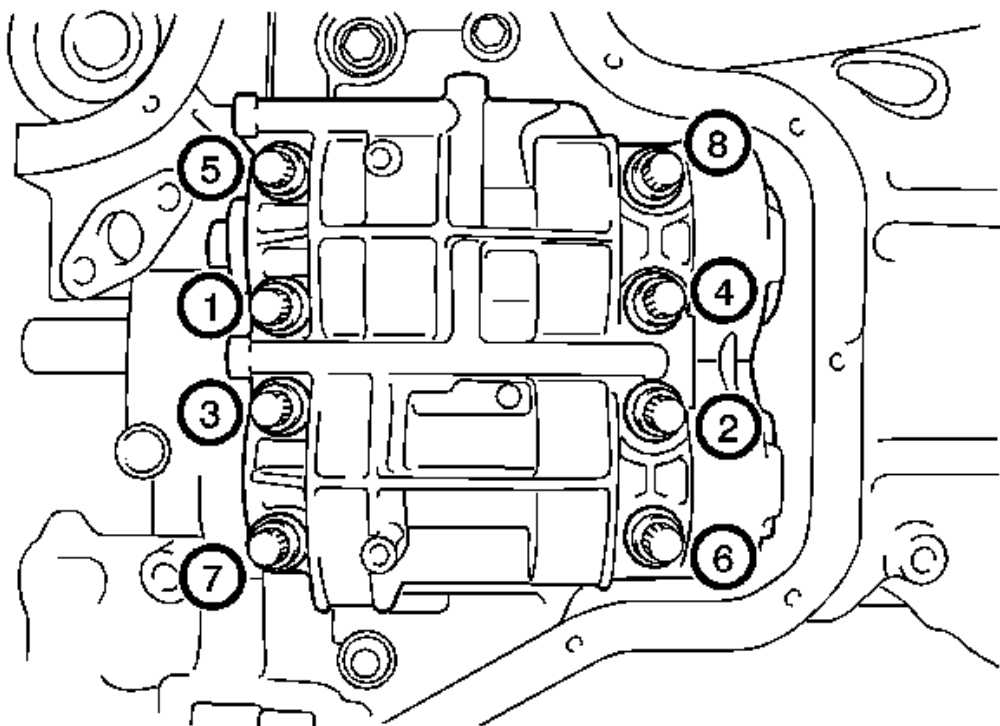


Fig. 453: Identifying Balancer Shaft Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **FASTENER CAUTION** .

7. Using several steps, uniformly install and tighten the 8 bolts in the sequence shown in the illustration.

Tighten: 22 N.m (16 lb ft)

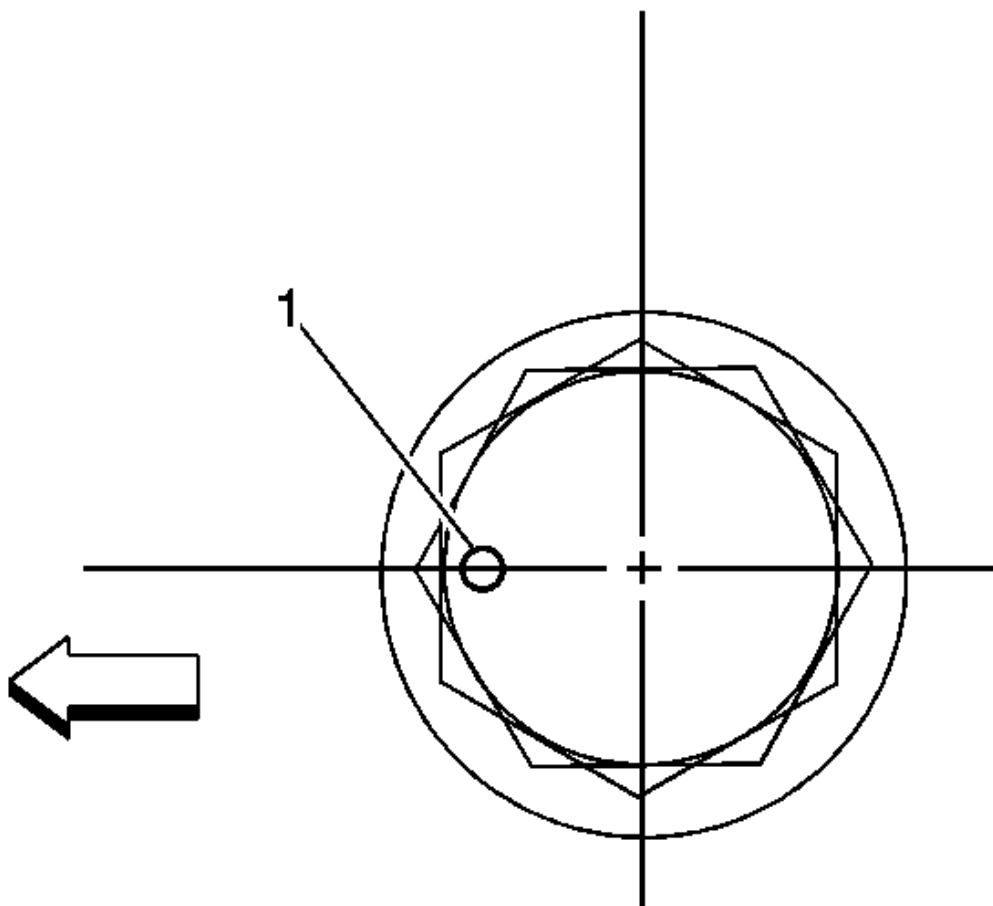


Fig. 454: Marking Balancershaft For Final Tightening Step
Courtesy of GENERAL MOTORS CORP.

8. Mark the front of the bolts with paint.

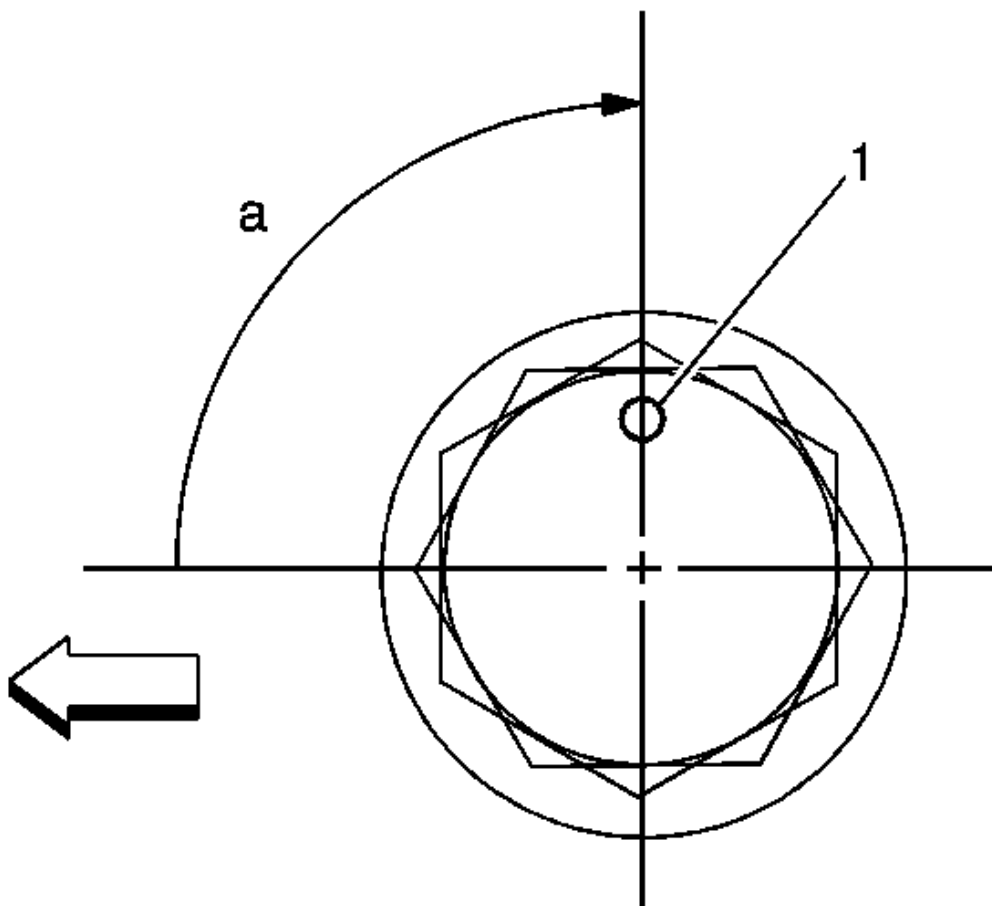


Fig. 455: Identifying Balanceshaft Tightening Final Step
Courtesy of GENERAL MOTORS CORP.

9. Further tighten the bolts by 90° as shown in the illustration.
10. Check that the paint mark is now at a 90° angle to the front.

LOWER CRANKCASE INSTALLATION

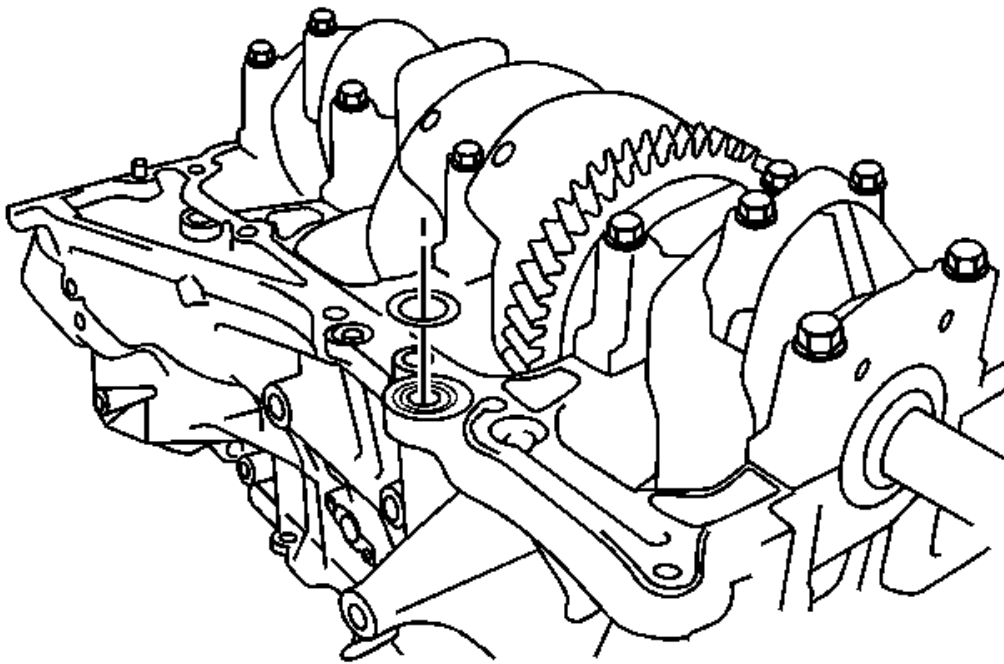


Fig. 456: Identifying Cylinder Block & Crankshaft
Courtesy of GENERAL MOTORS CORP.

1. Install stiffening crankcase assembly.
2. Place a new O-ring on the cylinder block as shown in the illustration.

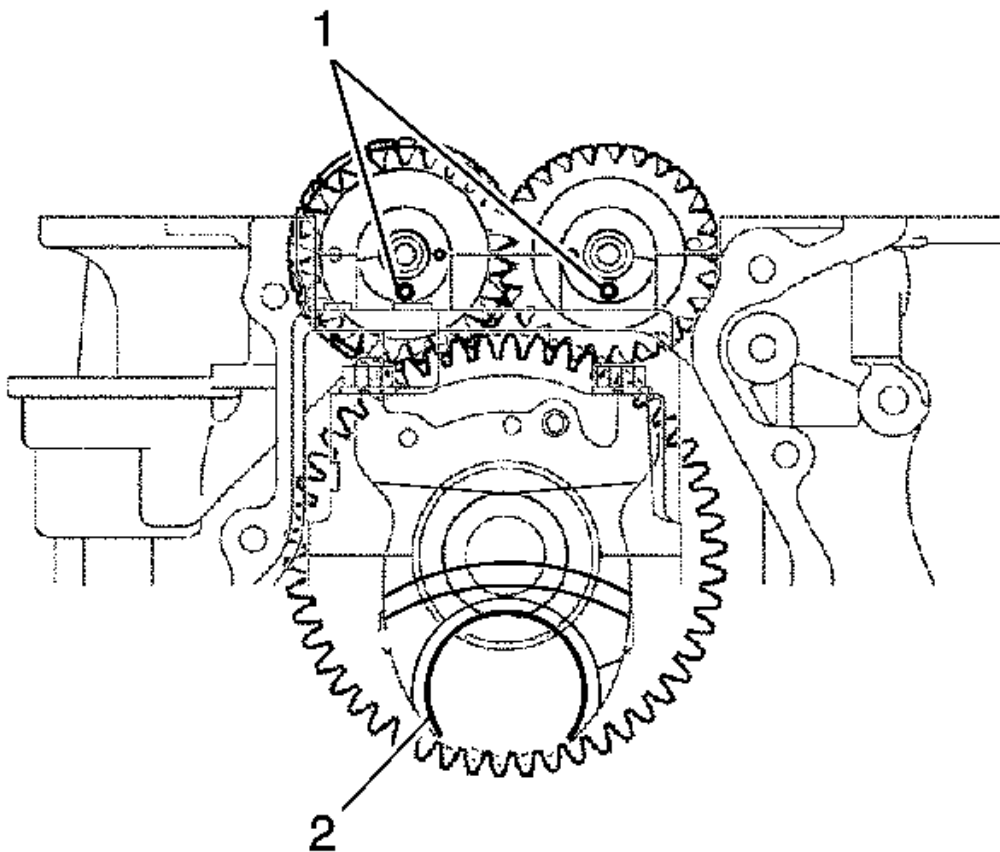


Fig. 457: Placing Crank Pin In 6 O'clock Position
Courtesy of GENERAL MOTORS CORP.

3. With the No. 1 crank pin of the crankshaft placed at the 6 o'clock position, install the No. 1 and No. 2 balancershafts and align the adjusting holes as shown in the illustration.

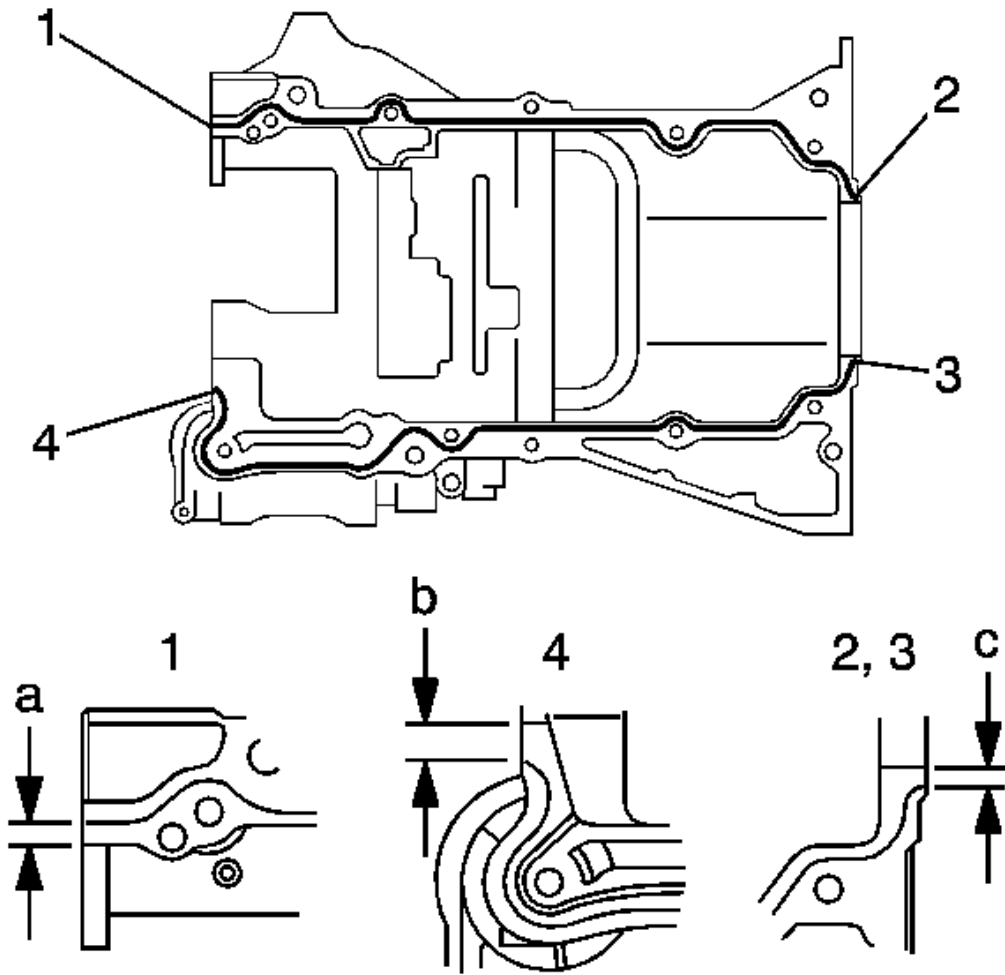


Fig. 458: Identifying Oil Pan Sealant Locations
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove any oil from the contact surfaces. Install the crankcase within 3 minutes of applying seal packing. Do not add engine oil for at least 2 hours after installing the crankcase.

4. Apply a continuous bead of seal packing (Diameter 2.5 to 3.0 mm (0.098 to 0.118 in)) as shown in the illustration.

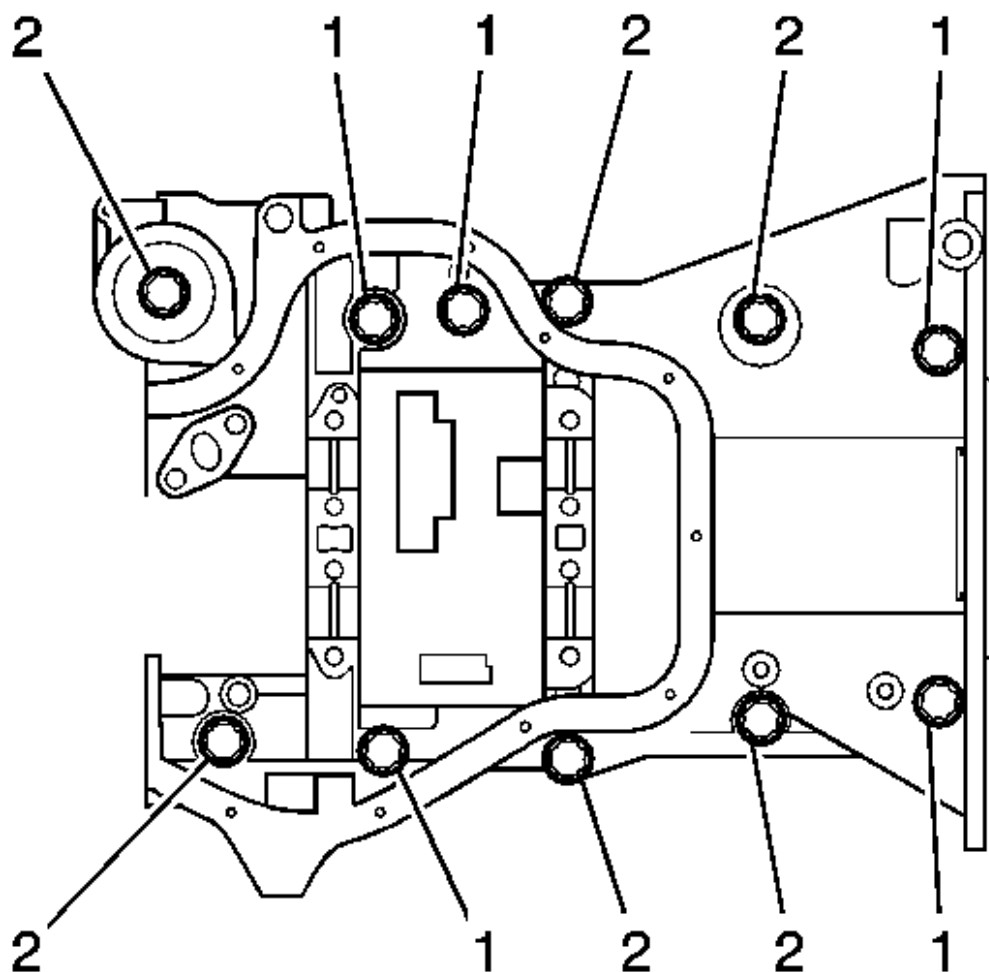


Fig. 459: Identifying Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Temporarily install the crankcase with the 11 bolts.
6. Uniformly tighten the bolts.

Tighten: 24 N.m (18 lb ft)

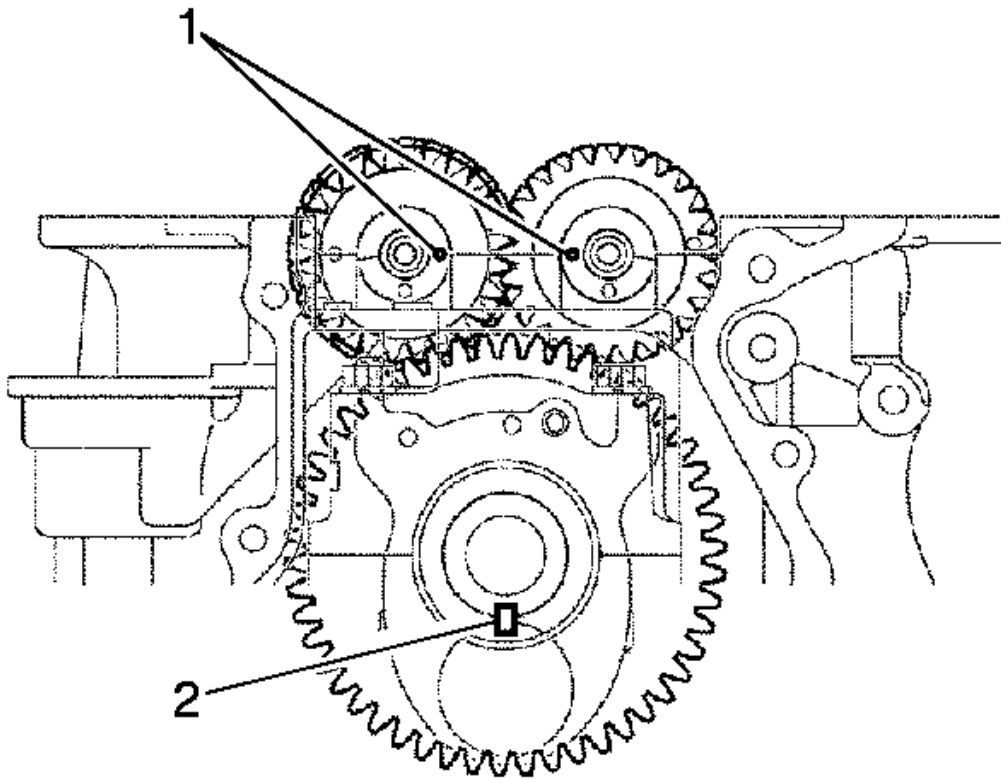


Fig. 460: Confirming Balancershafts Timing Marks Are In Proper Position
Courtesy of GENERAL MOTORS CORP.

7. Confirm that the timing marks on the balancershafts are aligned when the key groove is placed at the 6 o'clock position, as shown in the illustration.

CRANKSHAFT REAR OIL SEAL INSTALLATION

Installation Procedure

1. Apply MP grease to the lip of a new rear crankshaft oil seal.

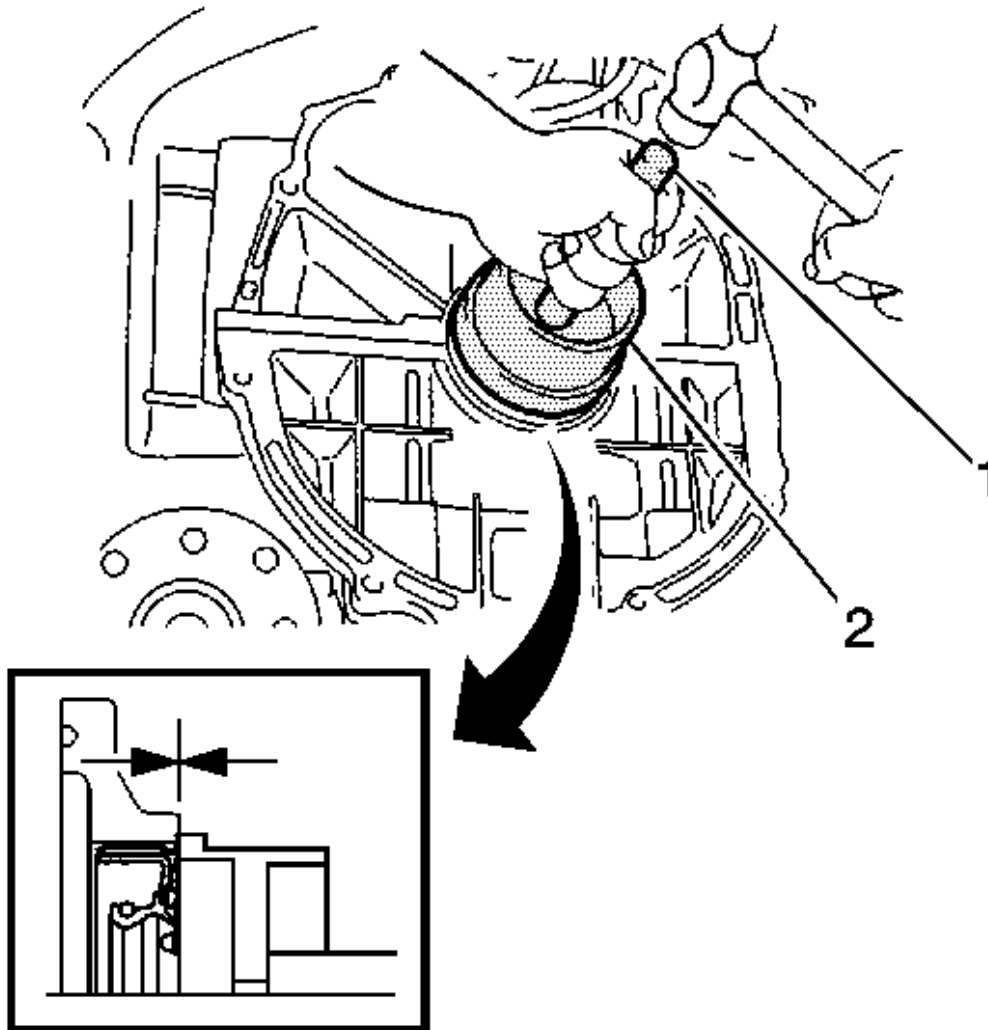


Fig. 461: View Of Rear Crankshaft Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: * Keep the lip free from foreign matter. * Do not tap on the oil seal at an angle.

2. Using SST and a hammer, tap in the rear crankshaft oil seal until its surface is flush with the rear oil seal retainer edge.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

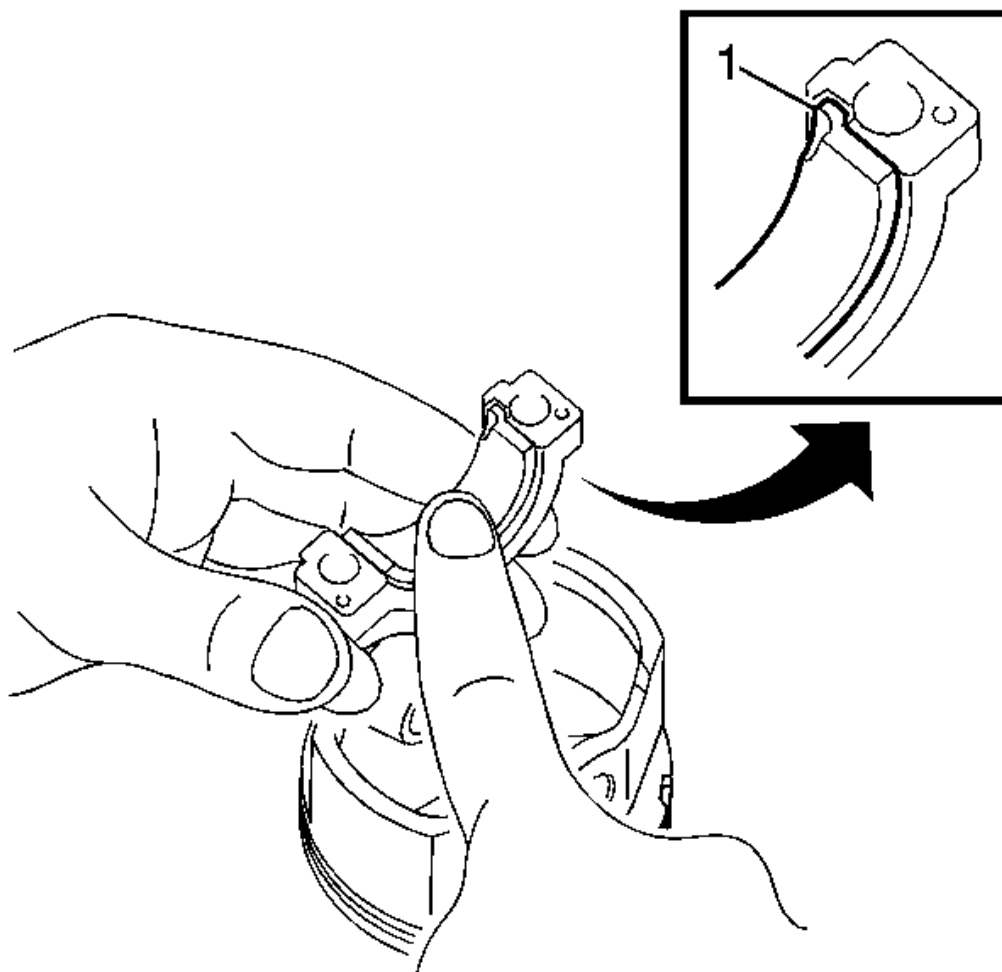
Installation Procedure

Fig. 462: View Of Connecting Rod Bearing Installation
Courtesy of GENERAL MOTORS CORP.

1. Install connecting rod bearing.

IMPORTANT: Do not apply engine oil to the bearings or the contact surfaces.

2. Align the bearing claw with the groove on the connecting rod or connecting cap.

IMPORTANT: The connecting rod cap bolts are tightened in 2 progressive steps.

3. Install piston sub-assembly with connecting rod.
4. Apply engine oil to the cylinder walls, the pistons, and the surfaces of connecting rod bearings.

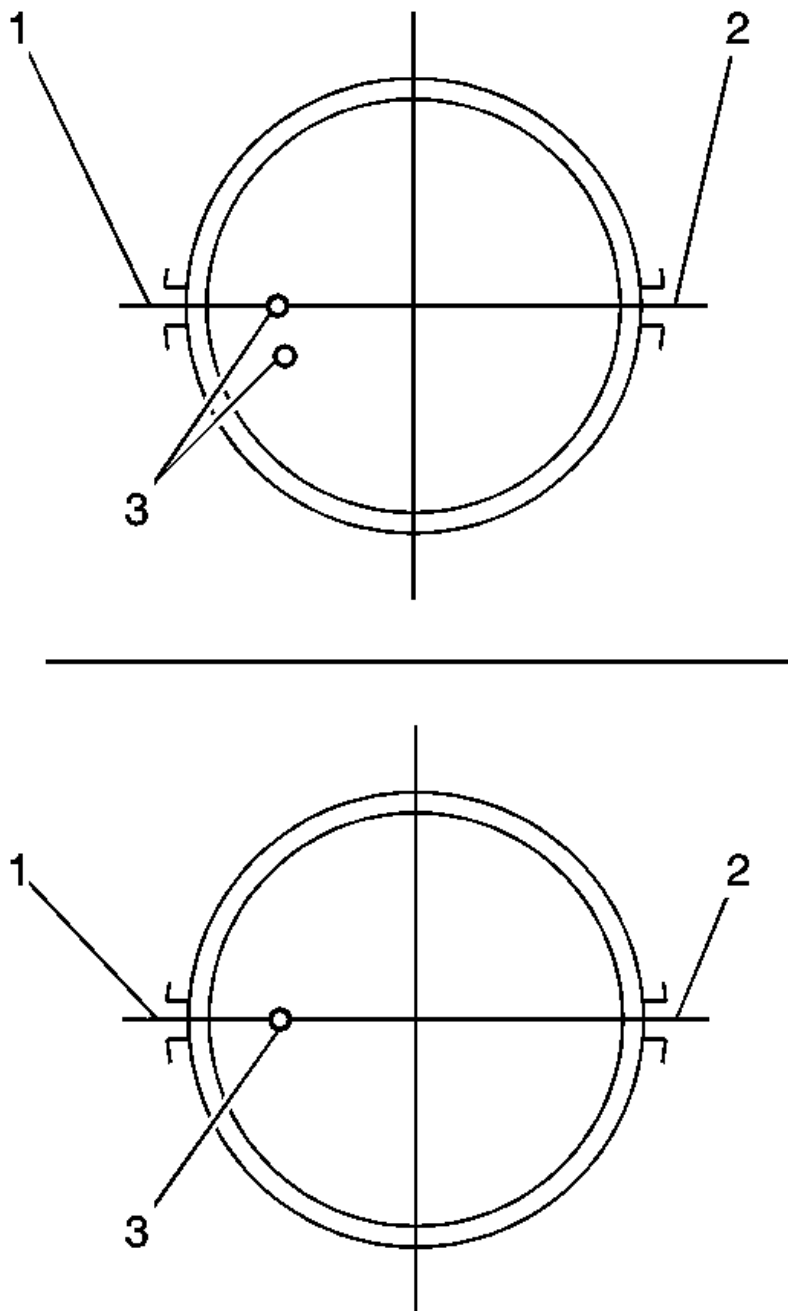


Fig. 463: View Of Correct Ring Positioning

Courtesy of GENERAL MOTORS CORP.

5. Check the position of the piston ring ends.

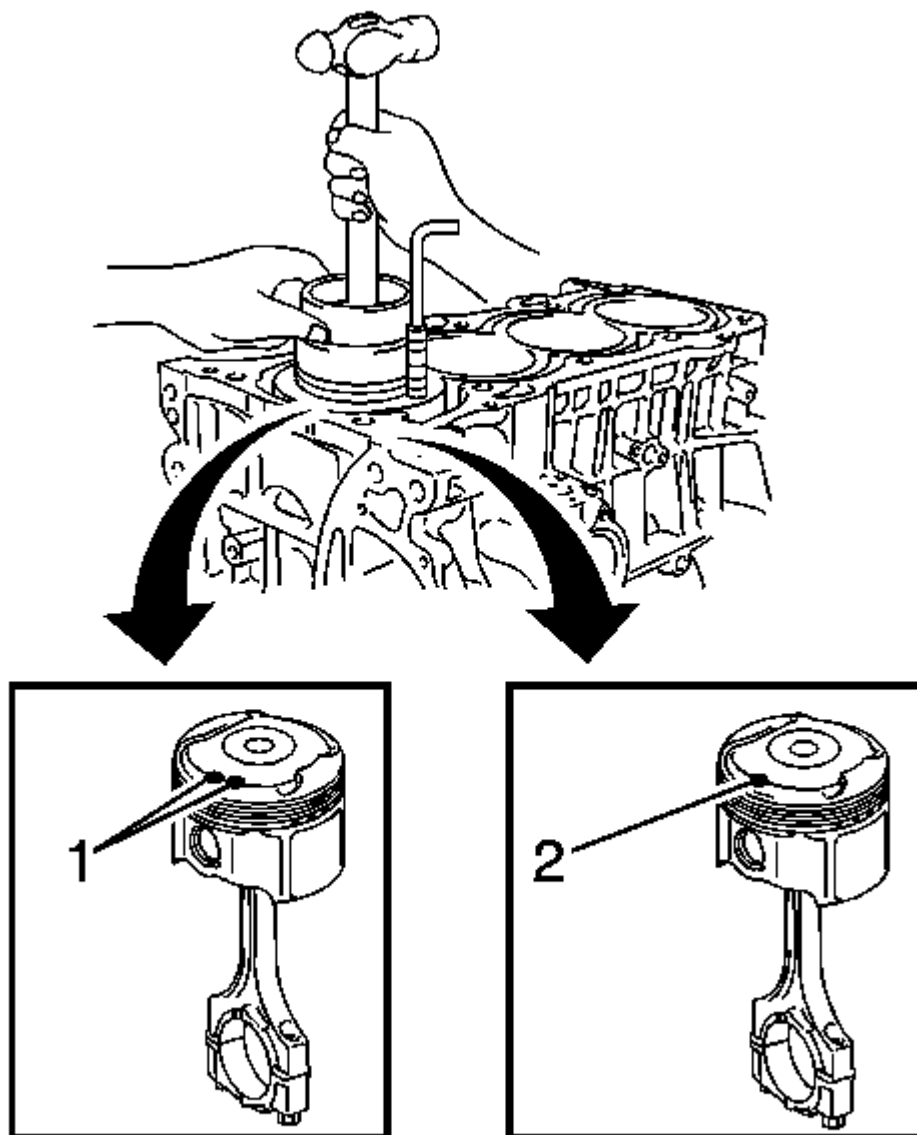


Fig. 464: View Of Pistons & Connecting Rods
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Match the numbered connecting rod cap with the connecting rod.

6. Using a piston ring compressor, push the correctly numbered piston and connecting rod assemblies into each cylinder with the front mark of the piston facing forward.

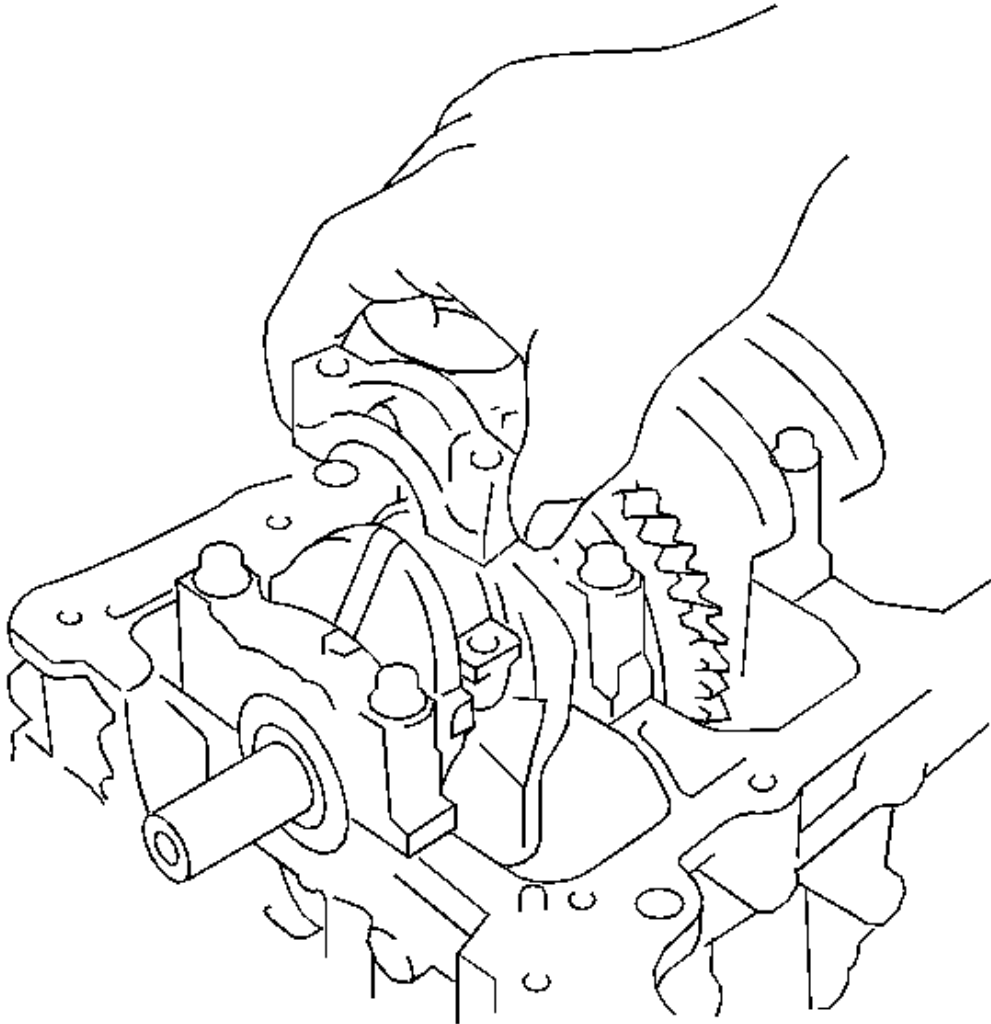


Fig. 465: Verifying Connecting Rod Cap Placement
Courtesy of GENERAL MOTORS CORP.

7. Check that the protrusion on the connecting rod cap is facing in the correct direction.
8. Apply a light coat of engine oil to the threads and under the heads of the connecting rod cap bolts.

IMPORTANT: The connecting cap bolts should be tightened in 2 progressive steps.

9. Install the connecting cap bolts.

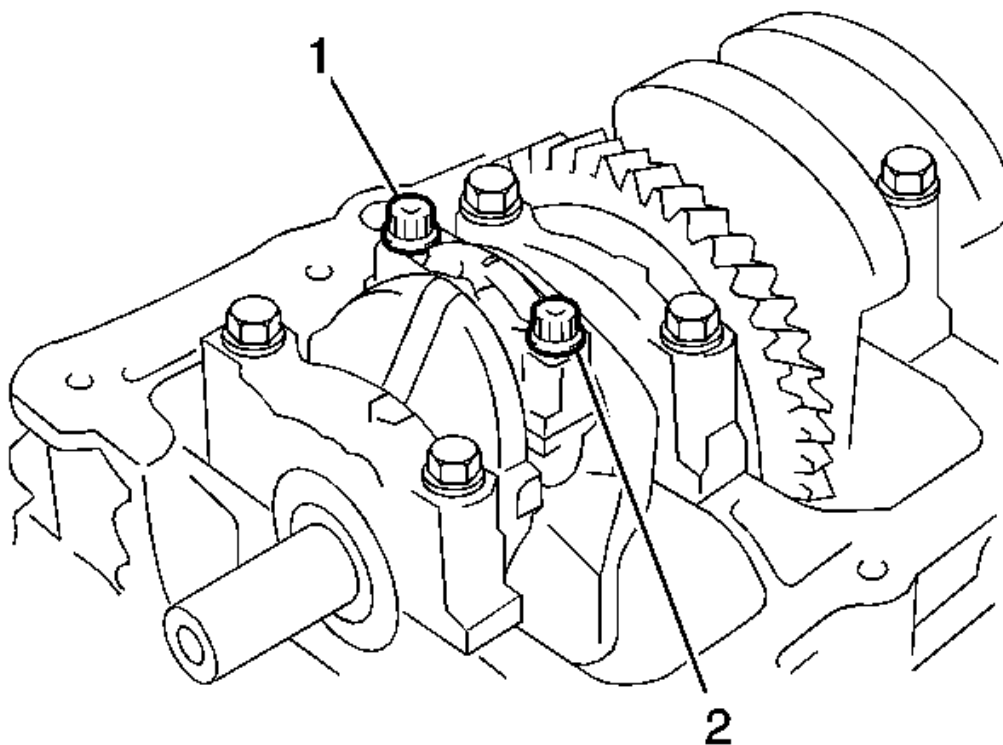


Fig. 466: View Of Connecting Rod Cap Bolts
Courtesy of GENERAL MOTORS CORP.

10. Install and alternately tighten the bolts of the connecting rod cap in several steps.

Tighten: 25 N.m (18 lb ft)

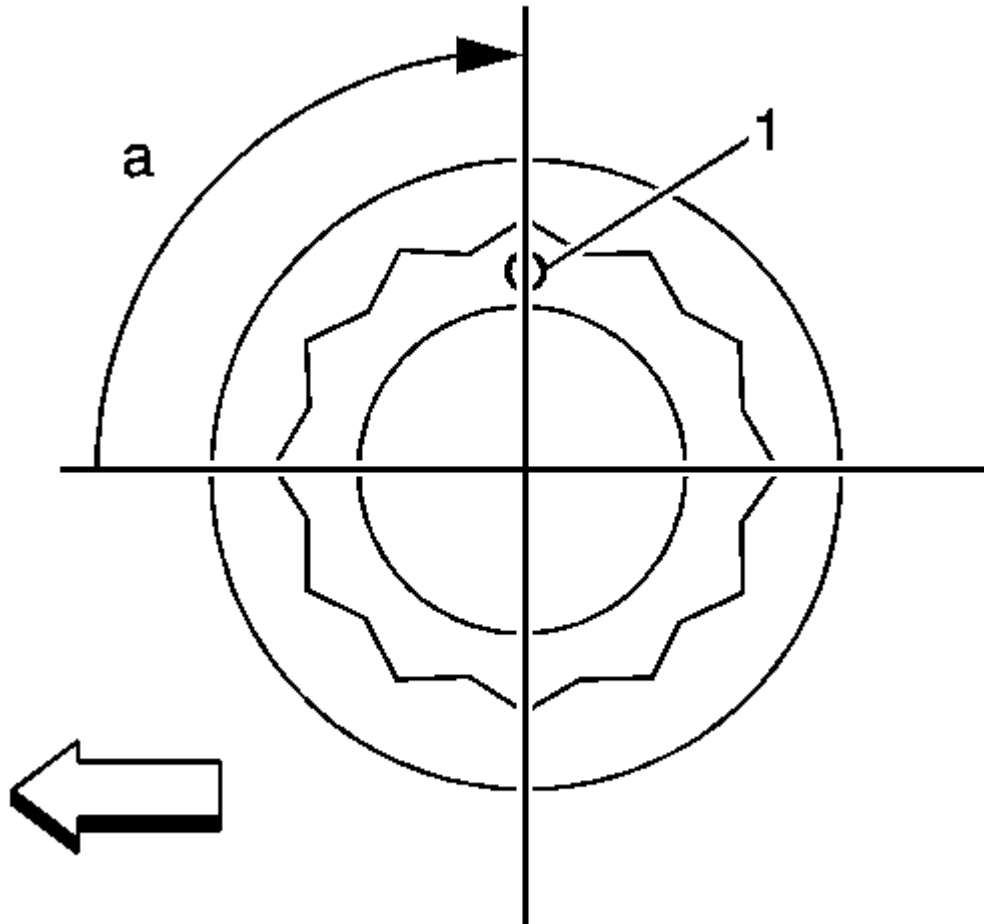


Fig. 467: Marking Connecting Rod Cap Bolts For Final Tightening Step
Courtesy of GENERAL MOTORS CORP.

11. Mark the front of the connecting rod cap bolts with paint.
12. Retighten the cap bolts by 90° as shown in the illustration.
13. Check that the crankshaft turns smoothly.
14. Check the connecting rod thrust clearance. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection**.

OIL PUMP INSTALLATION

Installation Procedure

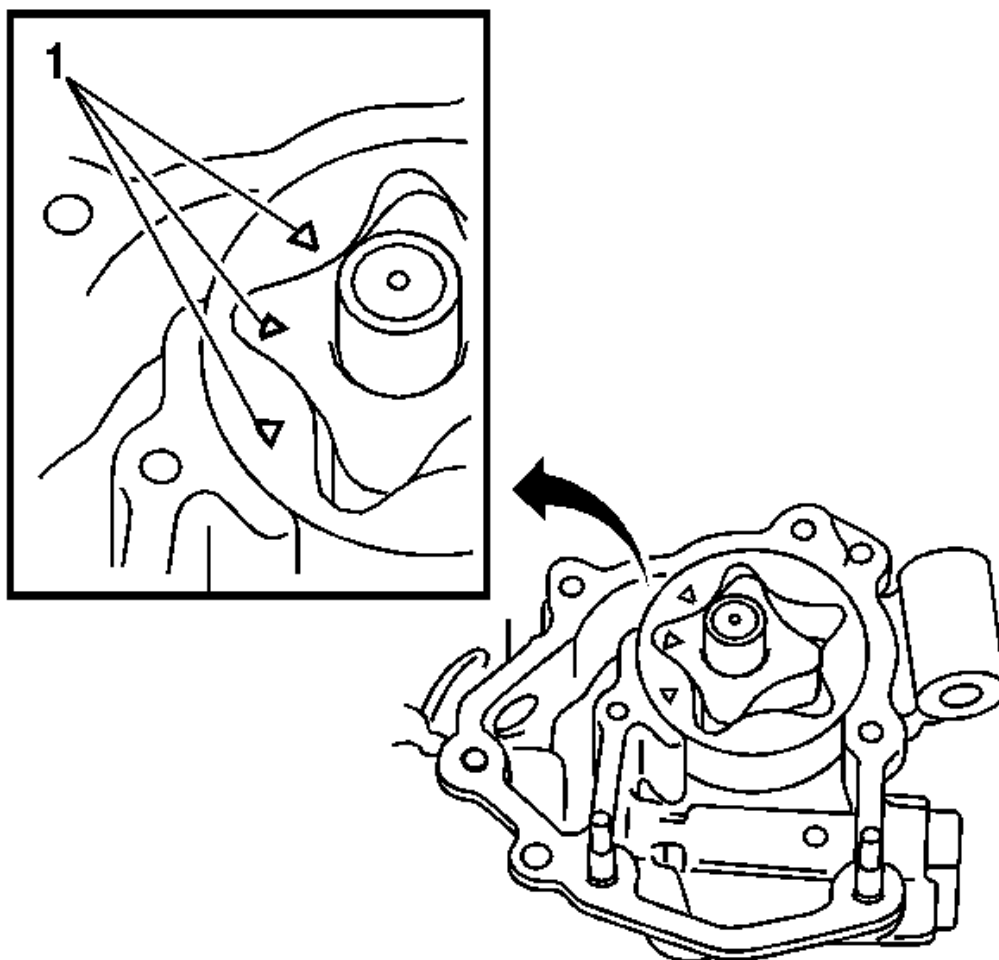


Fig. 468: View Of Coating Drive Rotor And Driven Rotor With Engine Oil.
Courtesy of GENERAL MOTORS CORP.

1. Coat the drive rotor and driven rotor with engine oil.
2. Place the drive and driven rotors into the oil pump with the marks facing the pump cover side.

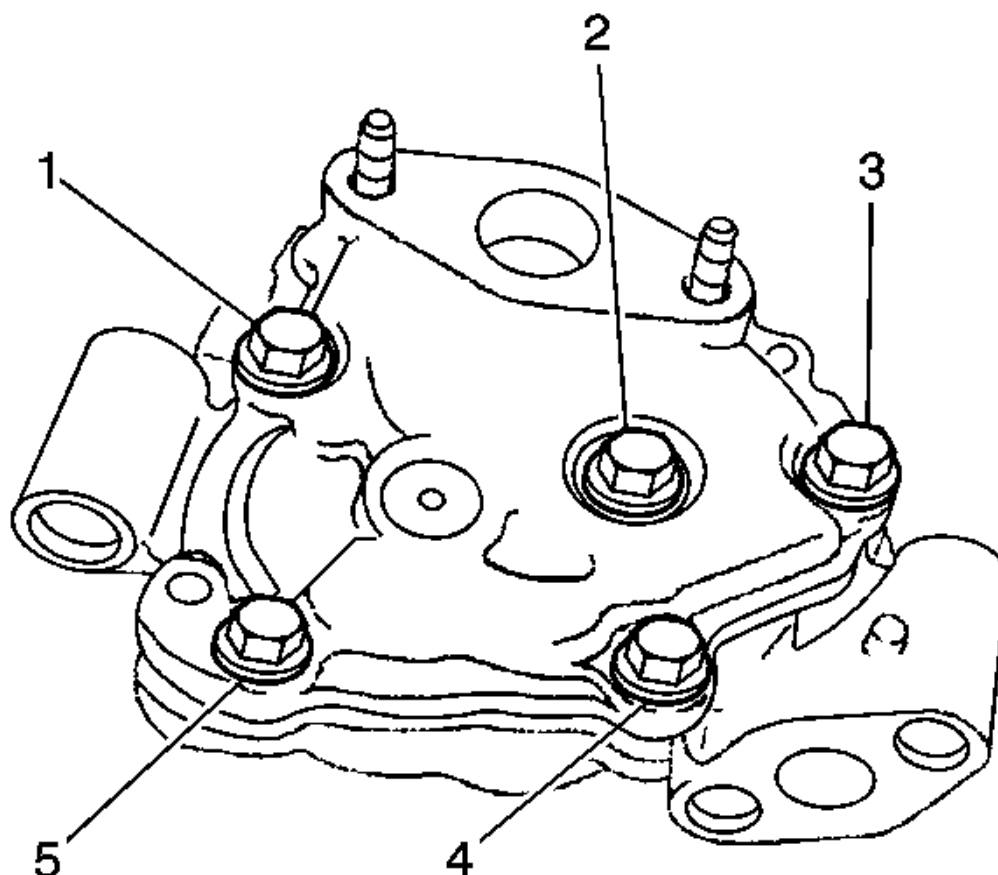


Fig. 469: View Of Oil Pump Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER CAUTION .

3. Install the oil pump cover with the 5 bolts.

Tighten: Tighten to 8.8 N.m (78 lb in).

4. Coat the relief valve with engine oil.

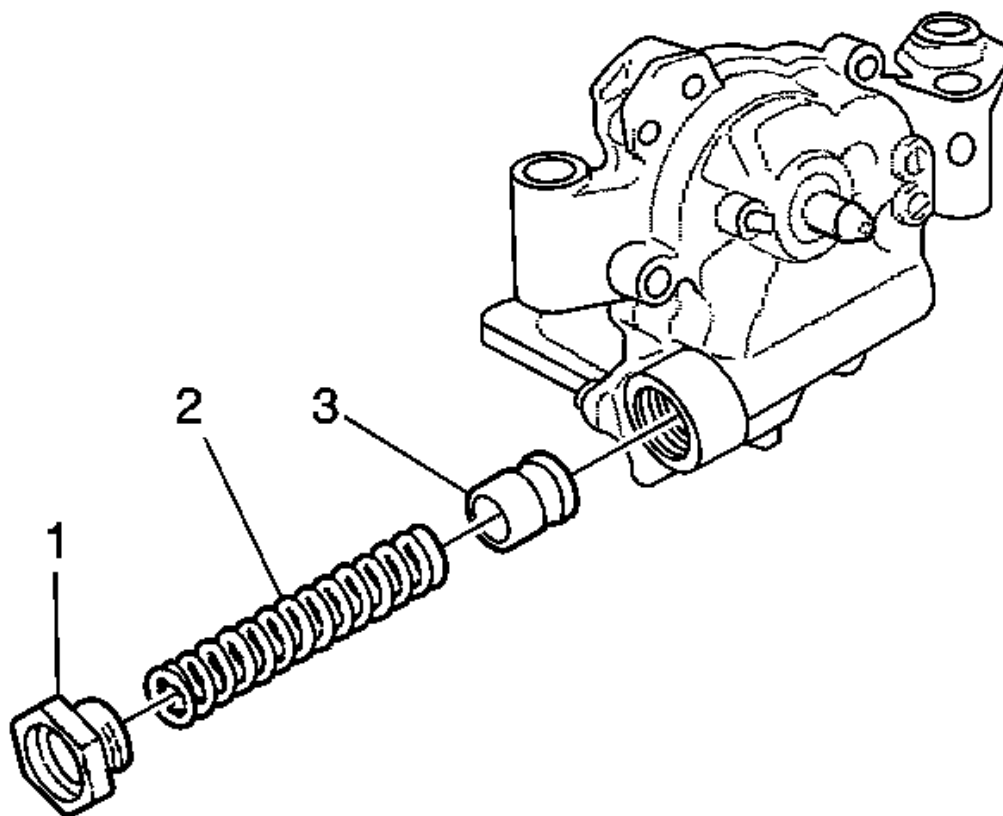


Fig. 470: View Of Oil Pump Valve Spring & Relief Valve
Courtesy of GENERAL MOTORS CORP.

5. Insert the relief valve and spring into the pump body hole.
6. Using a 27 mm socket wrench, install the plug.

Tighten: Tighten to 49 N.m (36 lb ft).

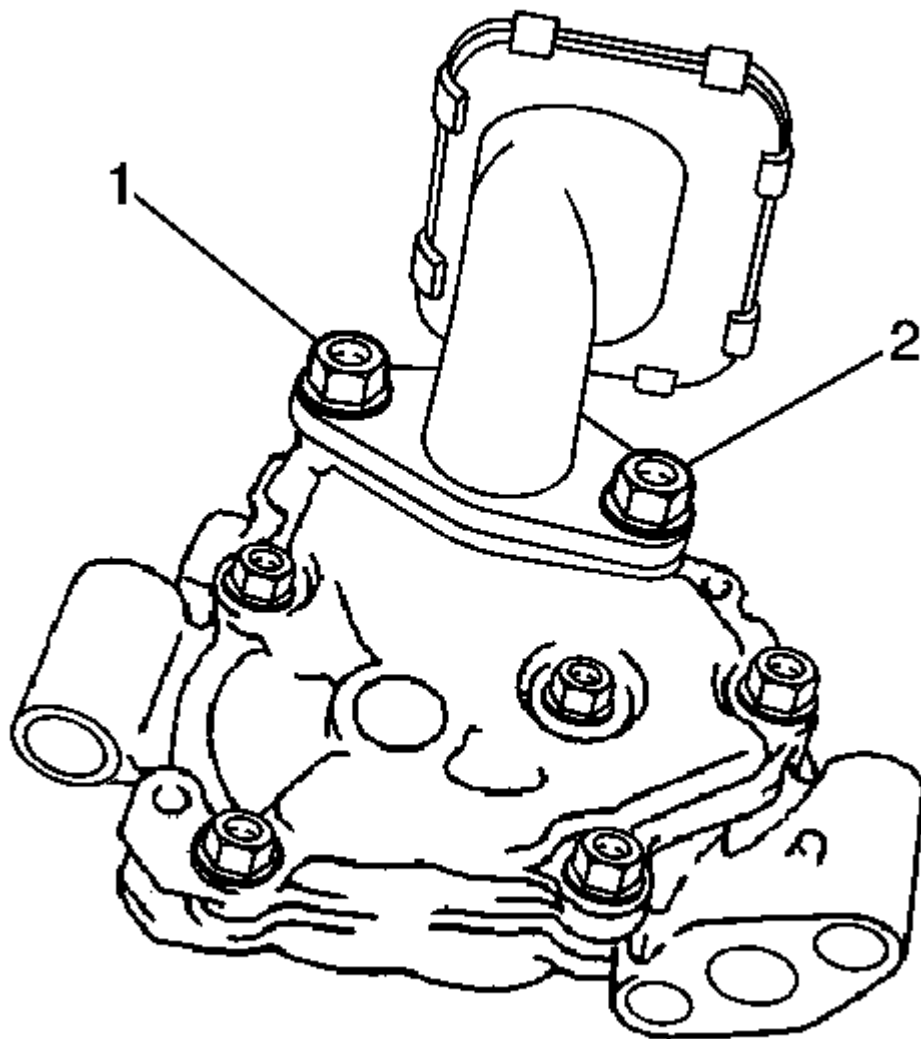


Fig. 471: Identifying Oil Pump Strainer & Gasket
Courtesy of GENERAL MOTORS CORP.

7. Install a new gasket and the oil strainer with the 2 nuts.

Tighten: Tighten to 8.8 N.m (78 lb in).

CYLINDER HEAD INSTALLATION

Installation Procedure

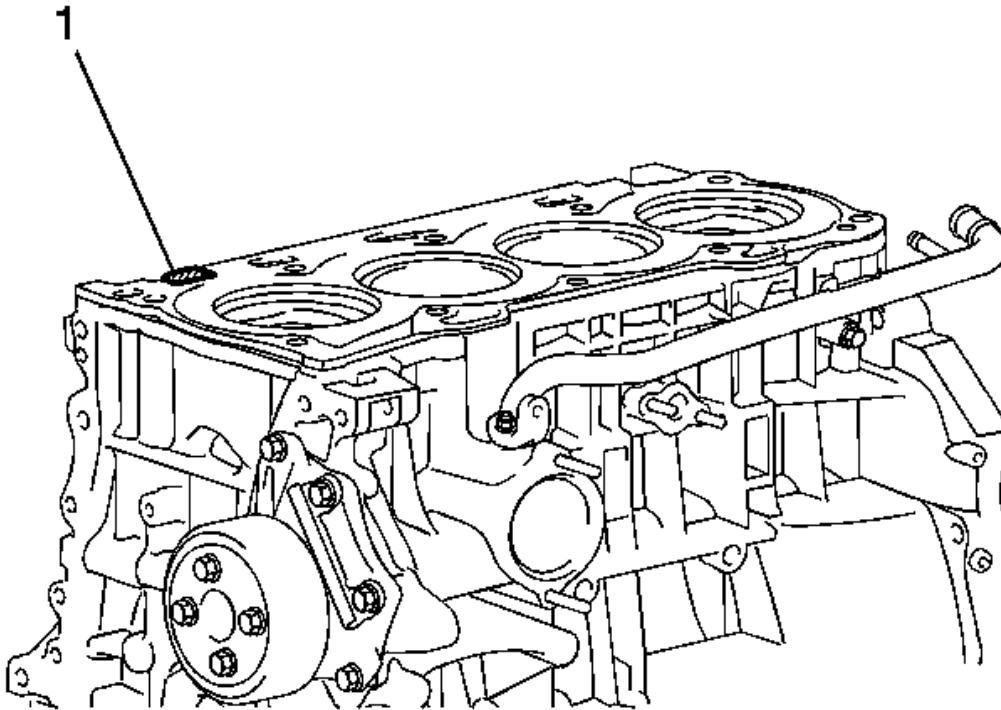


Fig. 472: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove any oil from the contact surface. Be careful of the installation direction.

1. Place a new cylinder head gasket on the cylinder block surface with the Lot No. stamp facing upward.

IMPORTANT: Place the cylinder head gently in order to avoid damaging the cylinder head gasket.

2. Place the cylinder head on the cylinder head gasket.

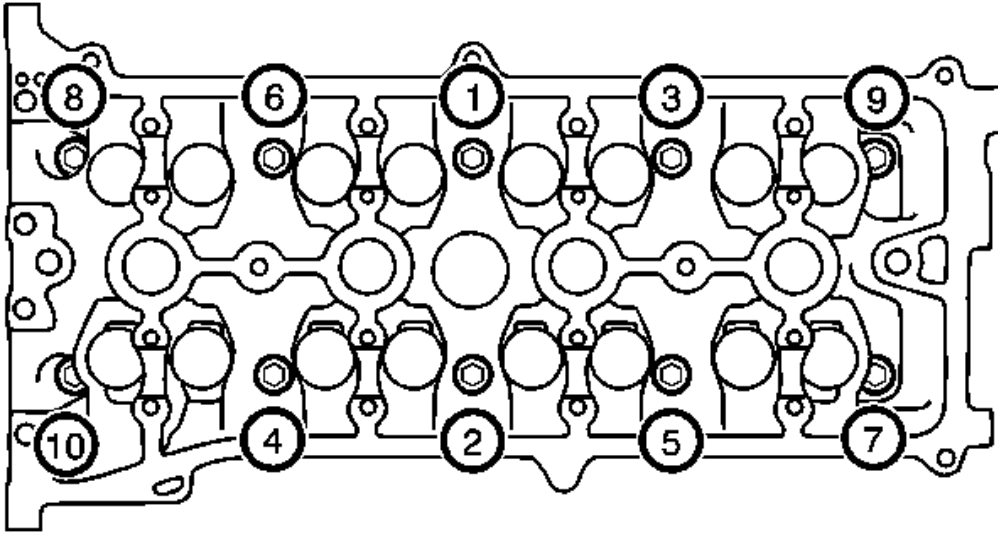


Fig. 473: View Of Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The cylinder head bolts are tightened in 2 successive steps. Apply a light coat of engine oil to the threads and under the heads of the cylinder head set bolts. Using several steps, uniformly install and tighten the 10 cylinder head set bolts and plate washers with a 10 mm bi-hexagon wrench in the order shown in the illustration.

3. **Tighten:** 70 N.m (52 lb ft)

Install the cylinder head bolts.

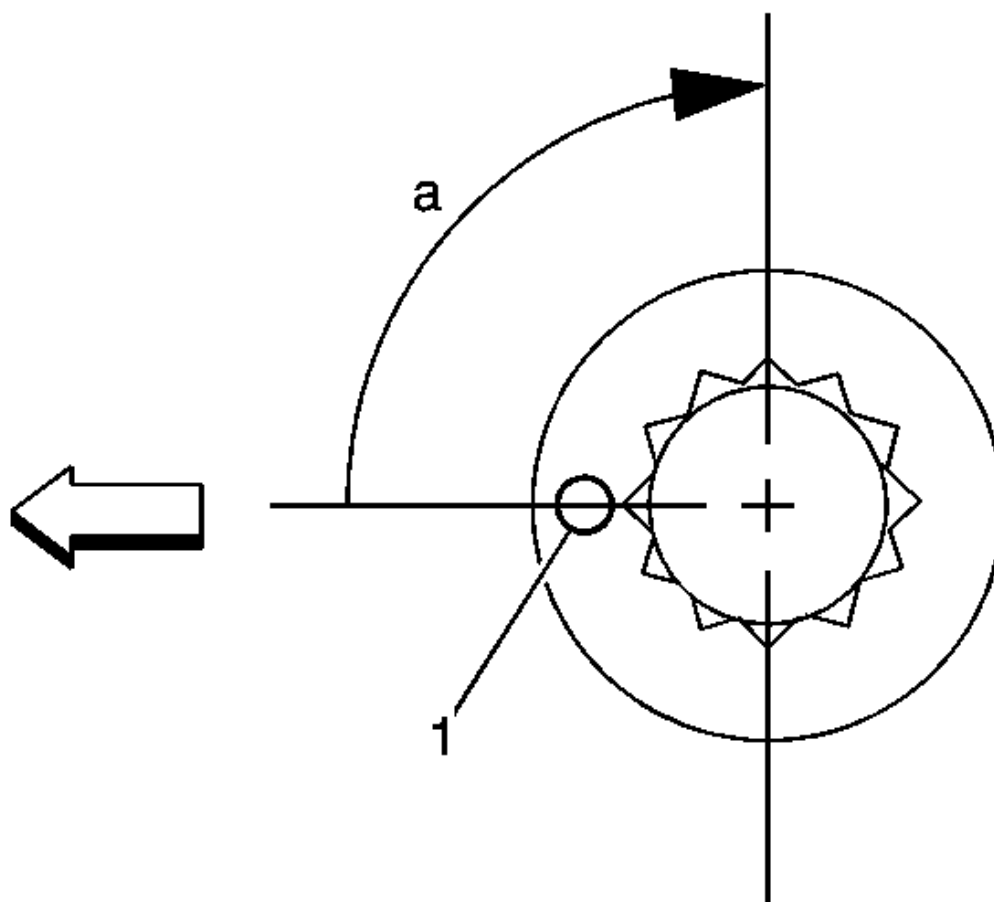


Fig. 474: Identifying Head Bolt Positioning
Courtesy of GENERAL MOTORS CORP.

4. Mark the front of the cylinder head bolts with paint.
5. Further tighten the cylinder head bolts by 90° as shown in the illustration.
6. Check that the paint mark is now at a 90° angle to the front.

INTAKE CAMSHAFT AND VALVE LIFTER INSTALLATION

Installation Procedure

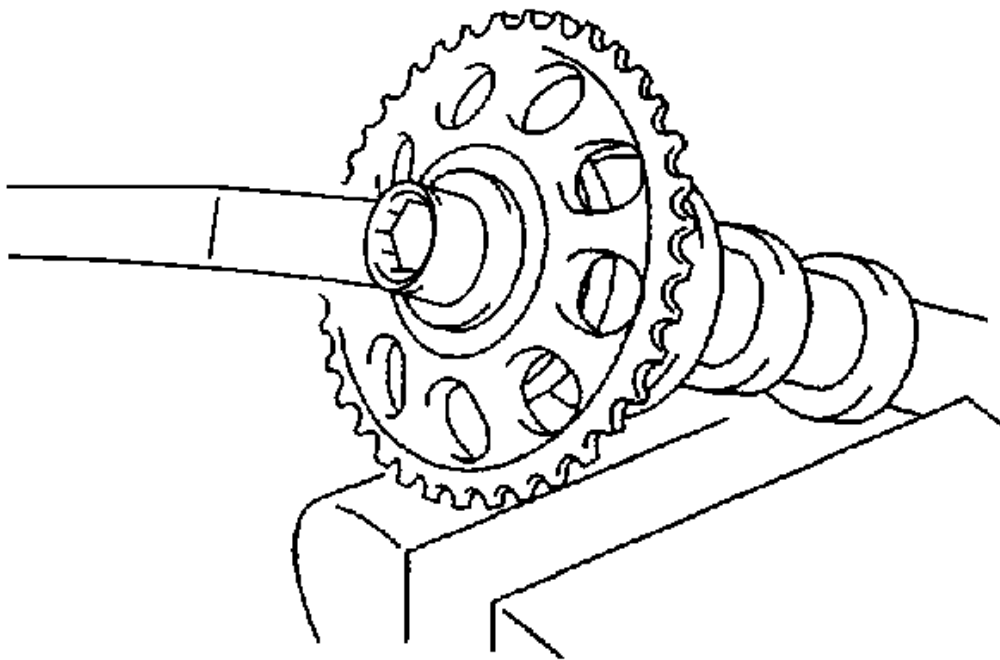


Fig. 475: View Of Camshaft, Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Clamp the camshaft in a vise, then install the camshaft timing sprocket with the bolt.

Tighten: 54 N.m (40 lb ft)

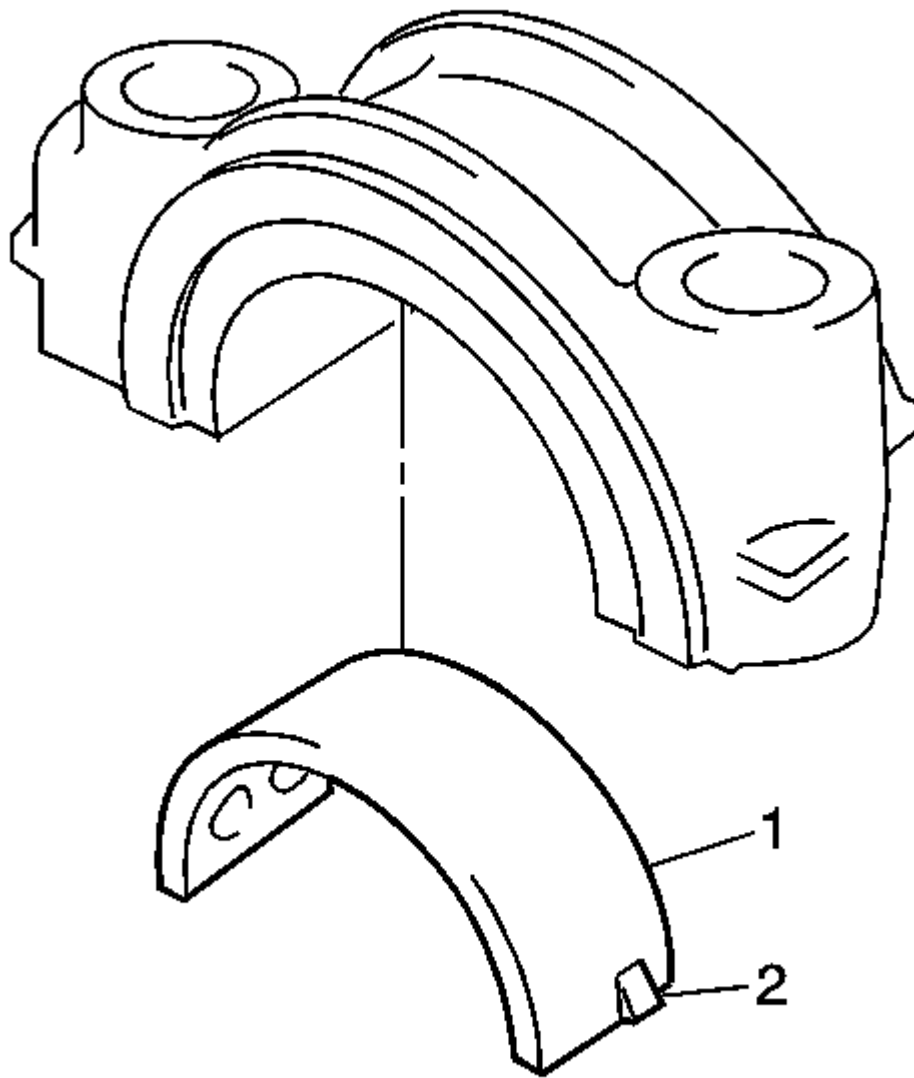


Fig. 476: View Of Camshaft Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Keep the installation surfaces and the back surfaces of the bearing free of engine oil.

2. Align the claws and install camshaft bearing onto camshaft bearing cap.

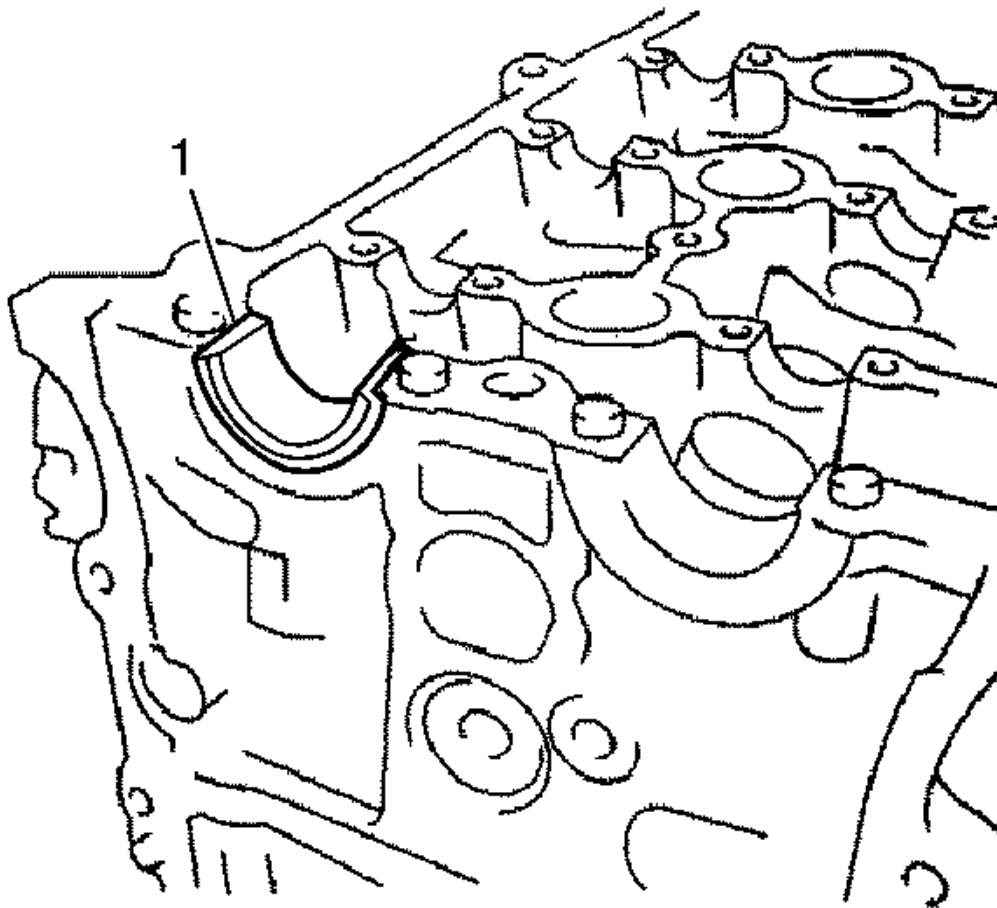


Fig. 477: View Of Camshaft Bearing Installation Into Head
Courtesy of GENERAL MOTORS CORP.

3. Install the camshaft bearing onto the cylinder head.
4. Install camshaft.
5. Apply a light coat of engine oil to the journal portion.

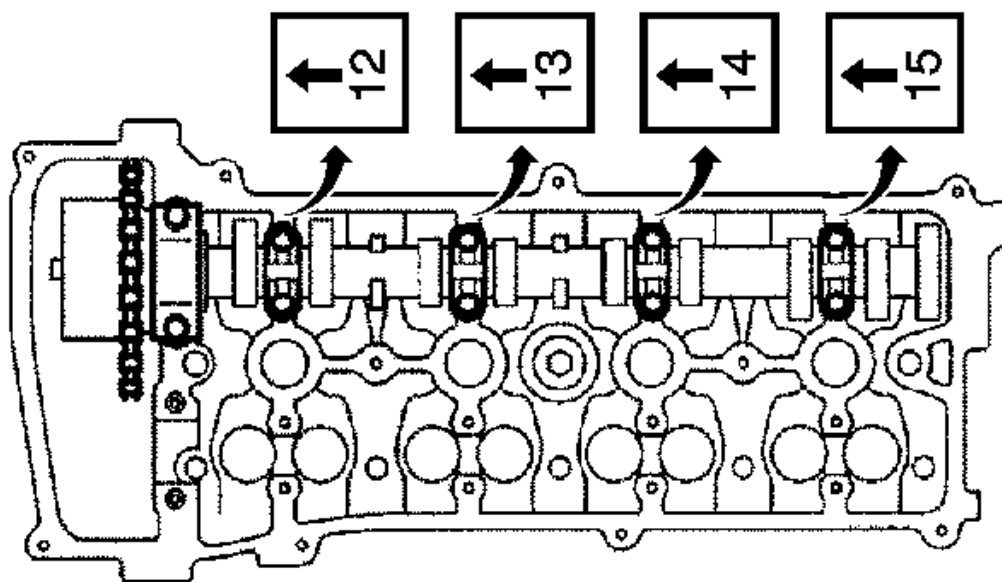


Fig. 478: Identifying Installation Procedure
Courtesy of GENERAL MOTORS CORP.

6. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps into the cylinder head.
7. Apply a light coat of engine oil to the threads and under the heads of the bearing cap bolts.

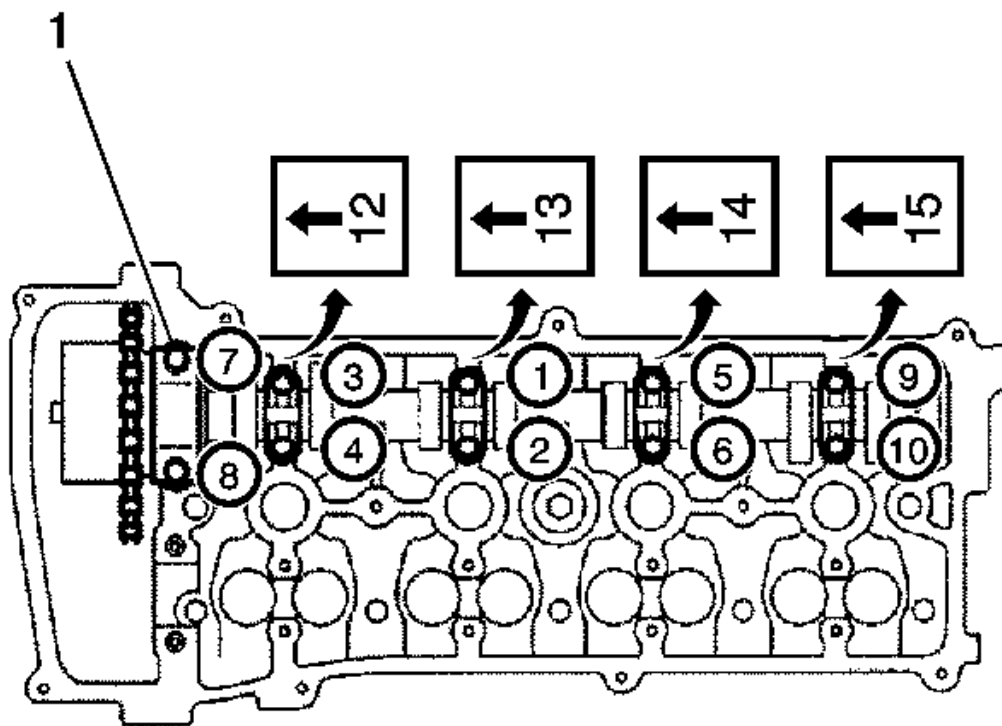


Fig. 479: View Of Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

8. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten:

- No. 1 Bearing cap 30 N.m (22 lb ft)
- No. 3 Bearing cap 9.0 N.m (80 lb in)

EXHAUST CAMSHAFT AND VALVE LIFTER INSTALLATION

Installation Procedure

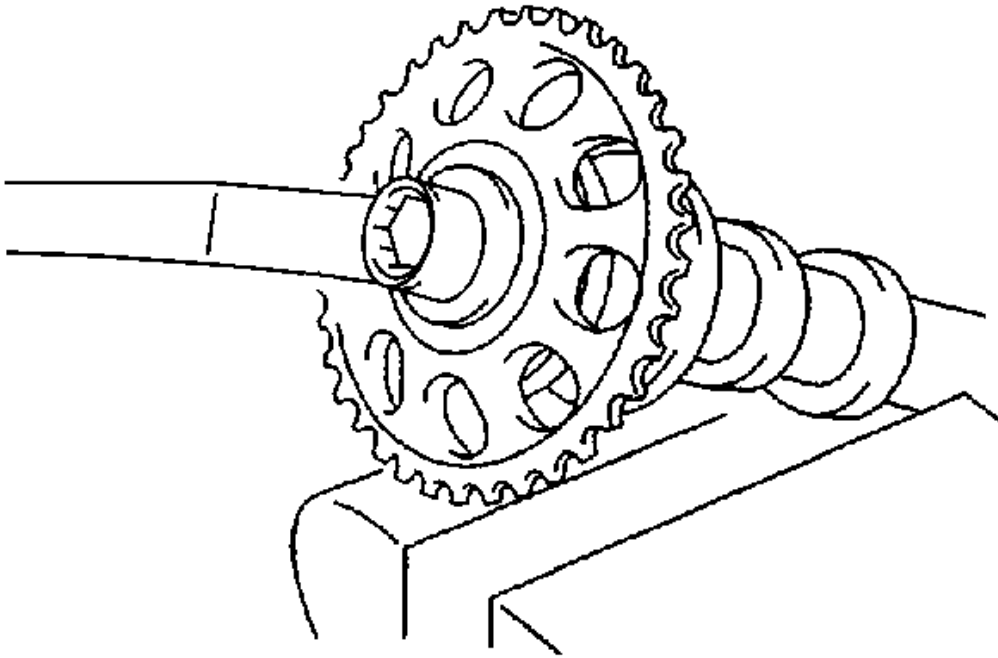


Fig. 480: View Of Camshaft, Sprocket & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Clamp the camshaft in a vise, then install the camshaft timing sprocket with the bolt.

Tighten: 54 N.m (40 lb ft)

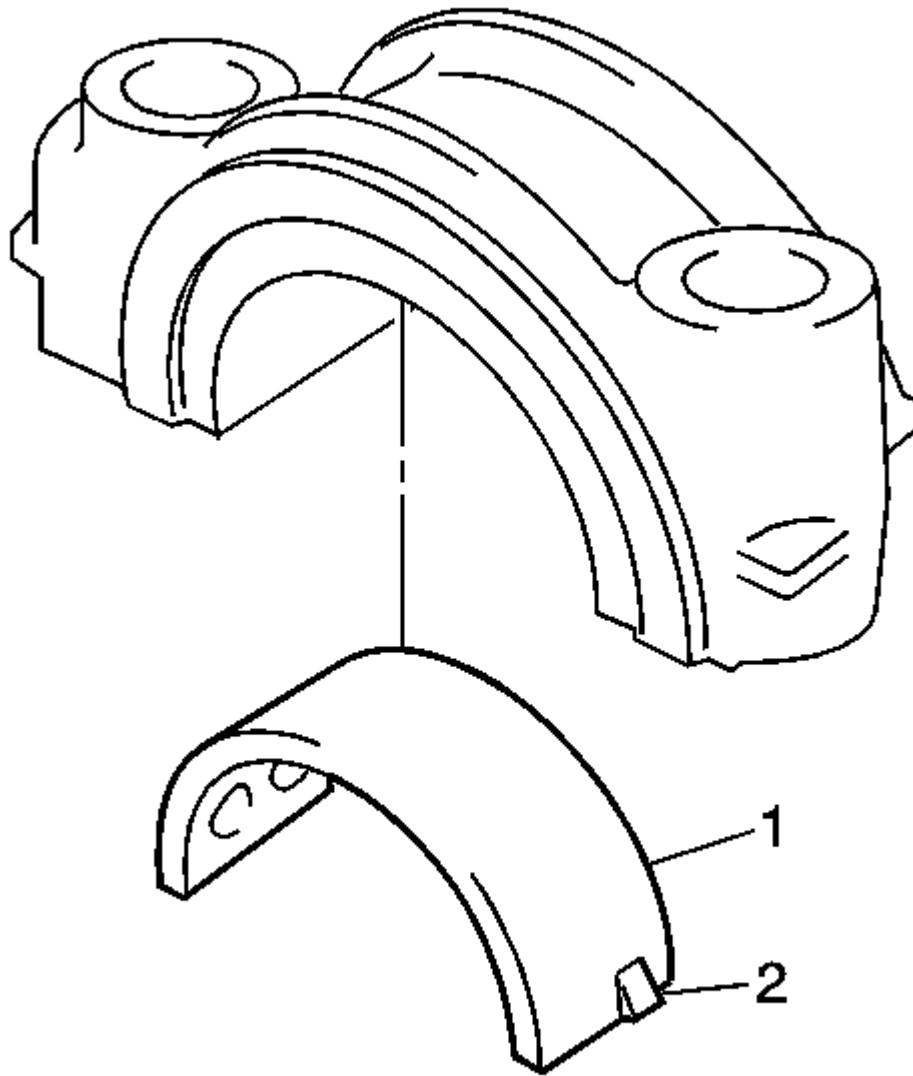


Fig. 481: View Of Camshaft Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Keep the installation surfaces and the back surfaces of the bearing free of engine oil.

2. Align the claws and install camshaft bearing onto camshaft bearing cap.

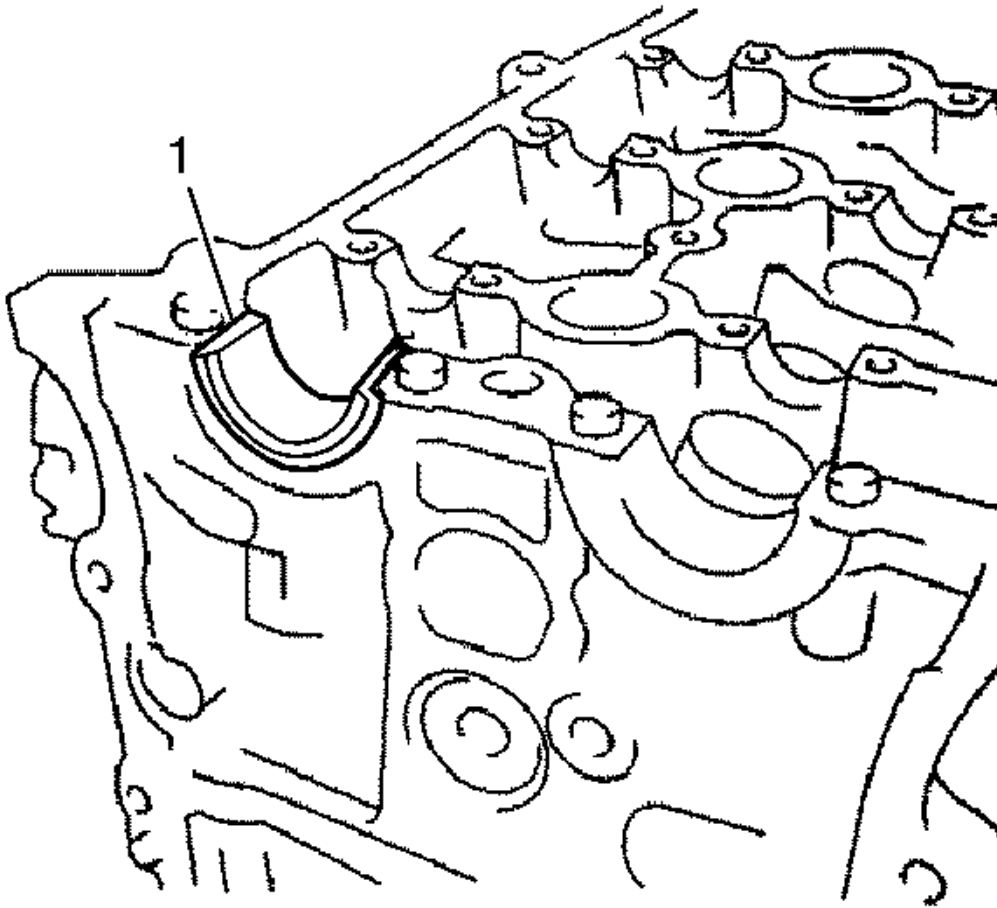


Fig. 482: View Of Camshaft Bearing Installation Into Head
Courtesy of GENERAL MOTORS CORP.

3. Install the camshaft bearing onto the cylinder head.
4. Install camshaft.
5. Apply a light coat of engine oil to the journal portion.

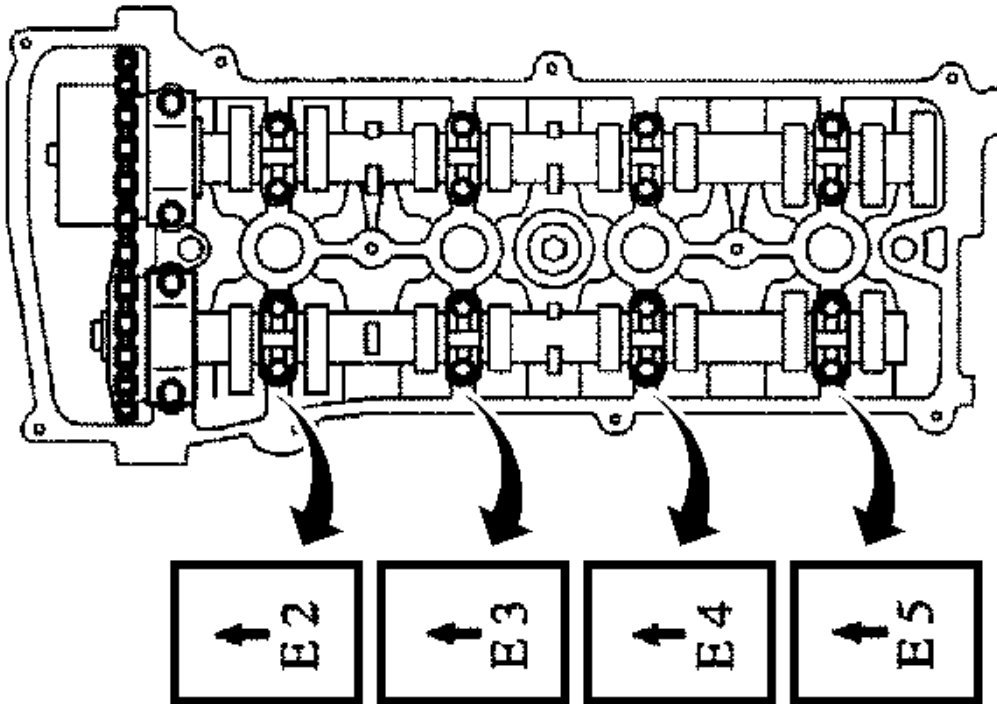


Fig. 483: View Of Front Marks & Numbers On Bearing Caps
 Courtesy of GENERAL MOTORS CORP.

6. Examine the front marks and numbers, and check that the order is as shown in the illustration. Then install the bearing caps onto the cylinder head.
7. Apply a light coat of engine oil to the threads and under the heads of the bearing cap bolts.

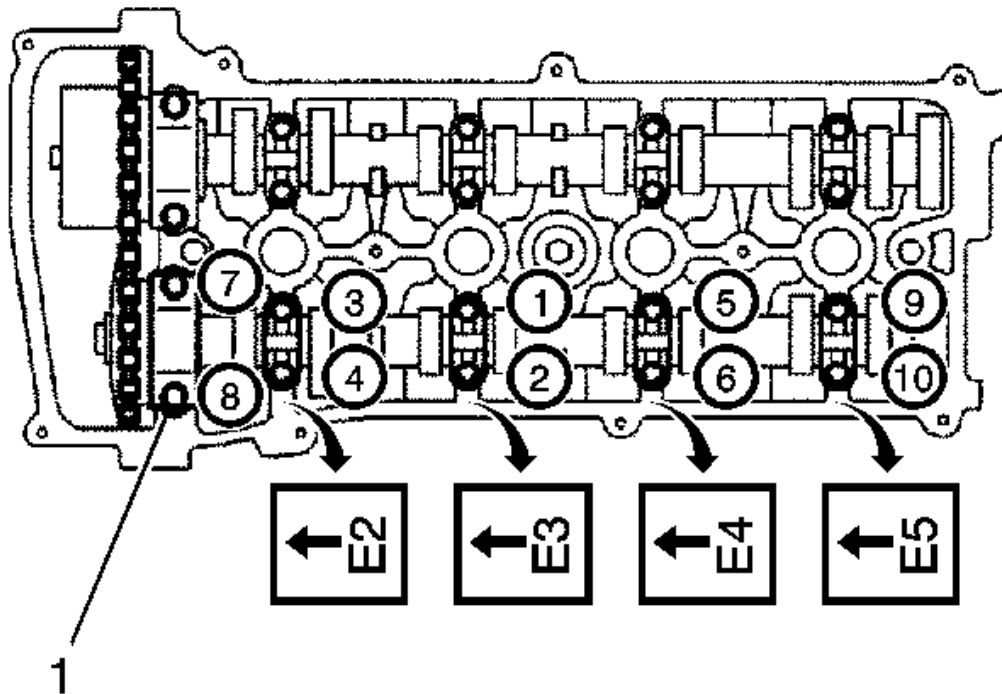


Fig. 484: Identifying Bearing Cap Bolts Tightening Sequence
 Courtesy of GENERAL MOTORS CORP.

8. Using several steps, uniformly tighten the 10 bearing cap bolts in the sequence shown in the illustration.

Tighten:

- No. 2 Bearing cap 30 N.m (22 lb ft)
- No. 3 Bearing cap 9.0 N.m (80 lb in)

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER INSTALLATION

Installation Procedure

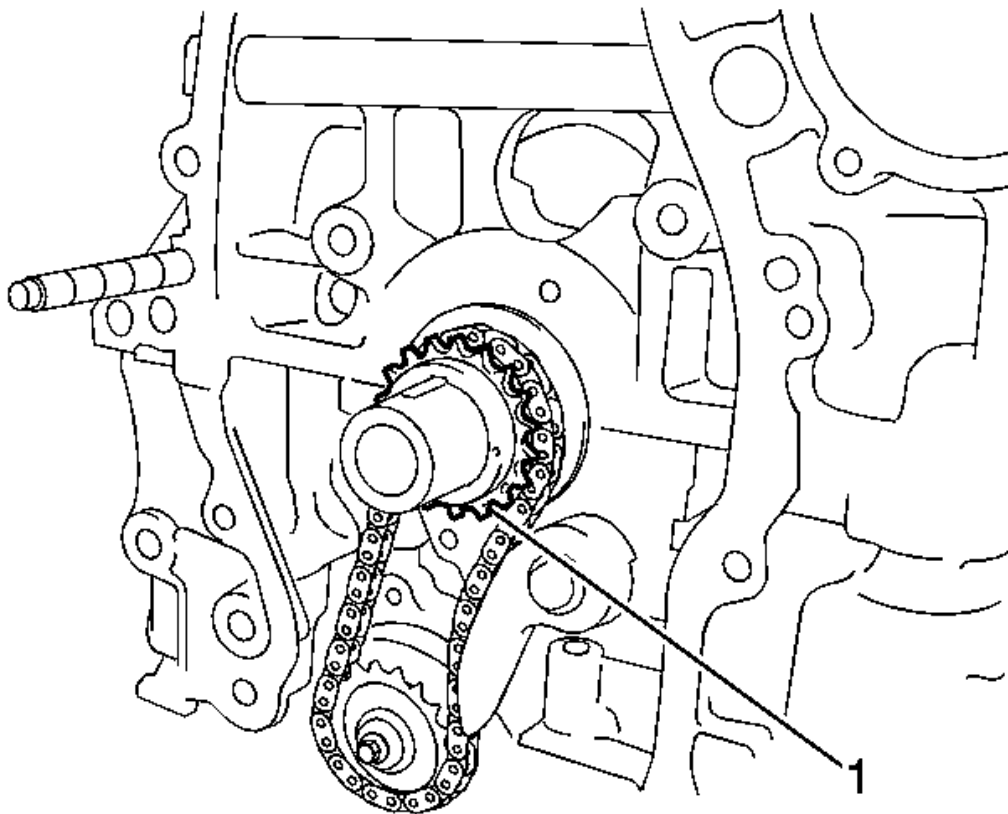


Fig. 485: View Of Crankshaft Timing Gear/Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft timing gear or sprocket to the crankshaft.

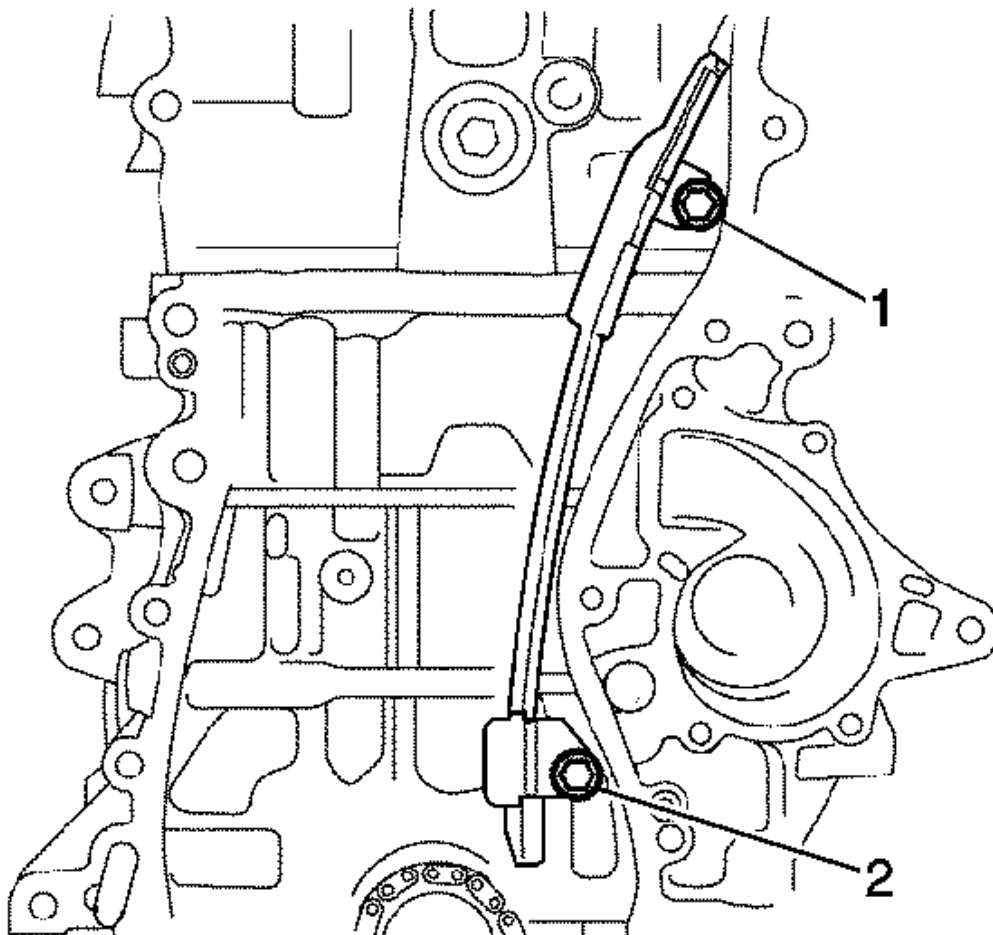


Fig. 486: Identifying Chain Vibration Damper
Courtesy of GENERAL MOTORS CORP.

2. Install the No. 1 chain vibration damper with the 2 bolts.

Tighten: 9.0 N.m (80 lb in)

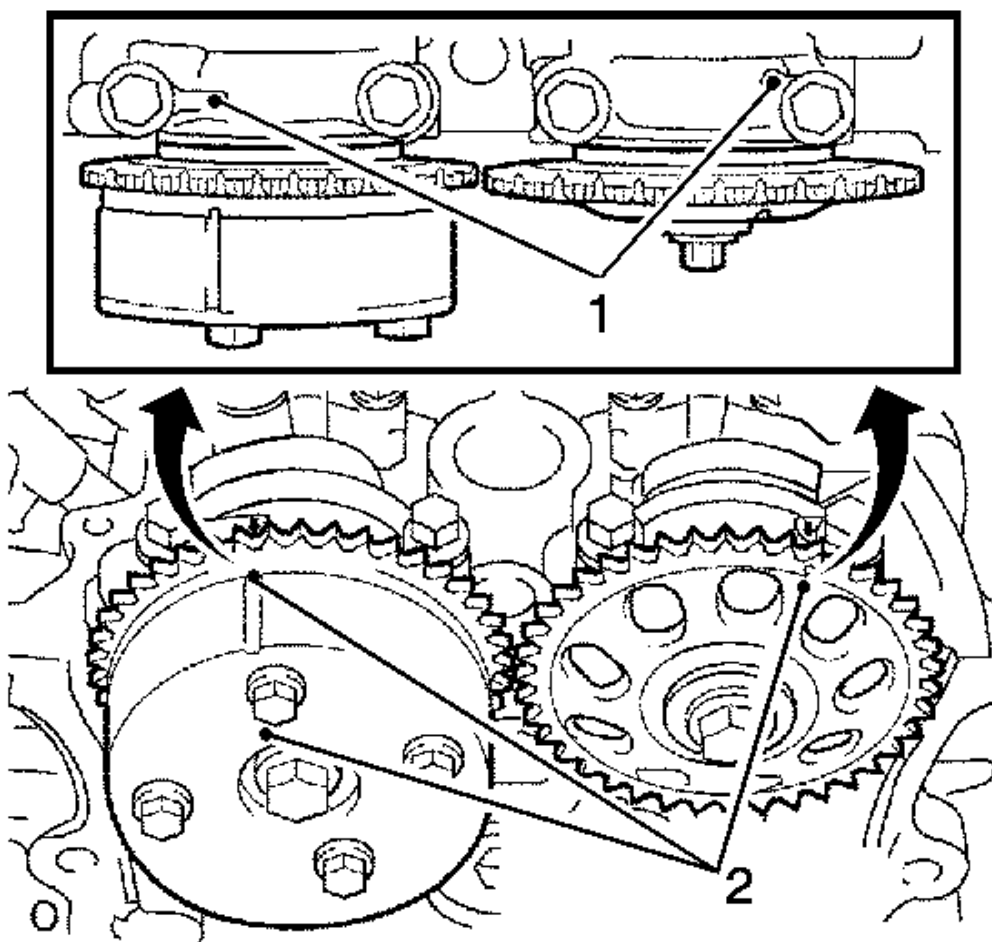


Fig. 487: View Of Setting No. 1 Cylinder To TDC Compression Stroke
Courtesy of GENERAL MOTORS CORP.

3. Install chain sub-assembly.
4. Set the No. 1 cylinder to TDC/compression.
5. Turn the camshafts with a wrench (using the hexagonal lobe) to align the timing marks on the camshaft timing gear with the timing marks located on the No. 1 and No. 2 bearing caps as shown in the illustration.

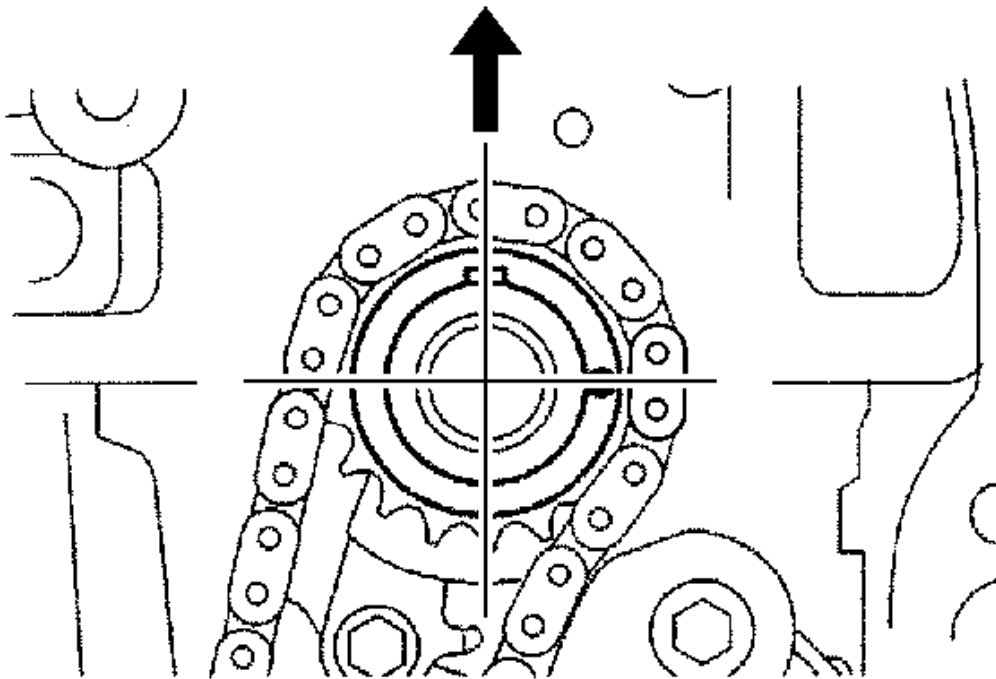


Fig. 488: View Of Setting Crankshaft Upward
Courtesy of GENERAL MOTORS CORP.

6. Using the crankshaft pulley bolt, turn the crankshaft to position the key on the crankshaft upward.

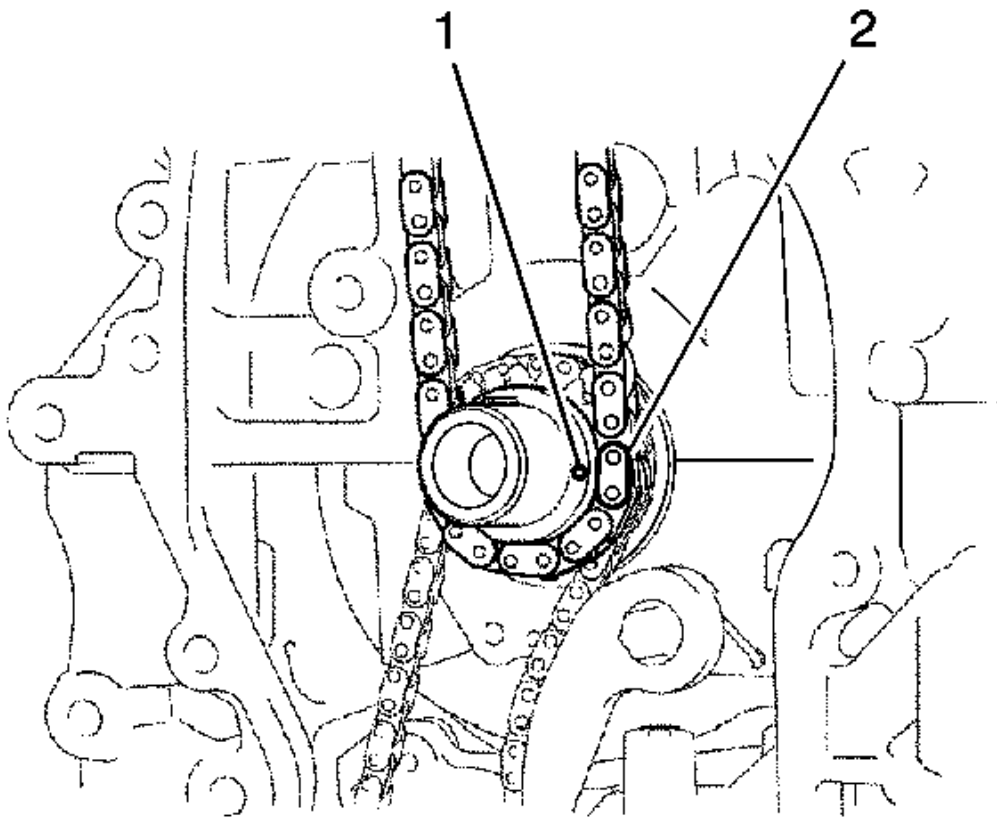


Fig. 489: View Of Crankshaft Timing Sprocket
Courtesy of GENERAL MOTORS CORP.

7. Install the chain onto the crankshaft timing sprocket with the gold or orange mark link aligned with the timing mark on the crankshaft.

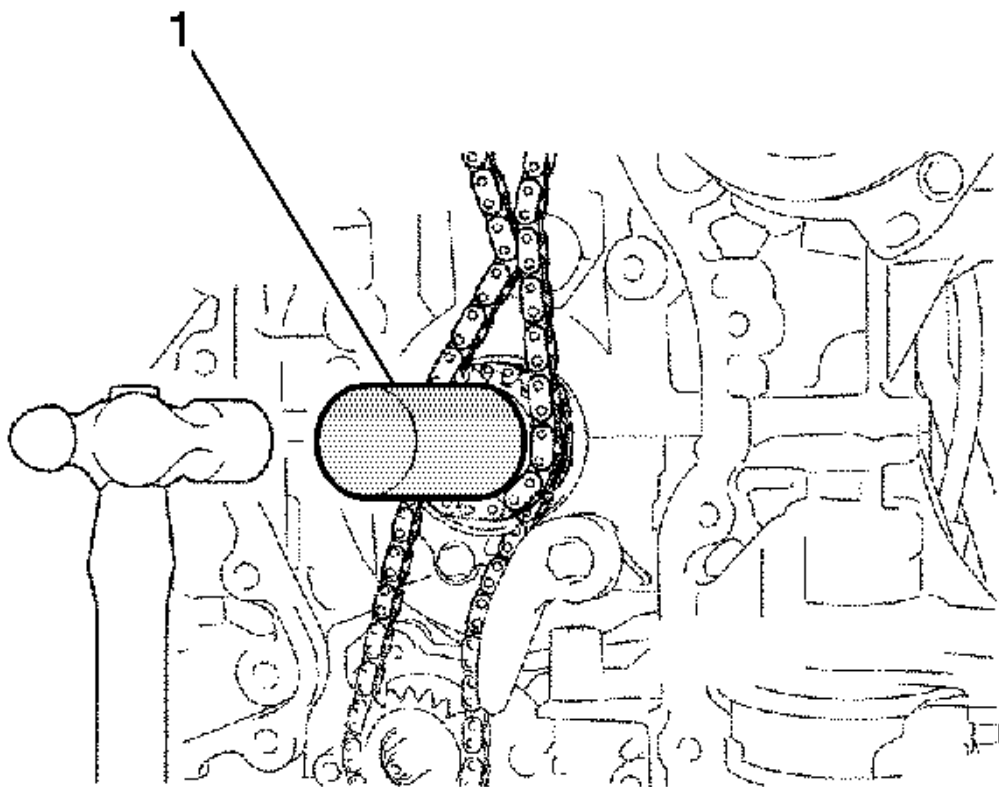


Fig. 490: View Of Crankshaft Timing Sprocket Installation
Courtesy of GENERAL MOTORS CORP.

8. Using SST and a hammer, tap in the crankshaft timing sprocket. (SST 09309-37010)

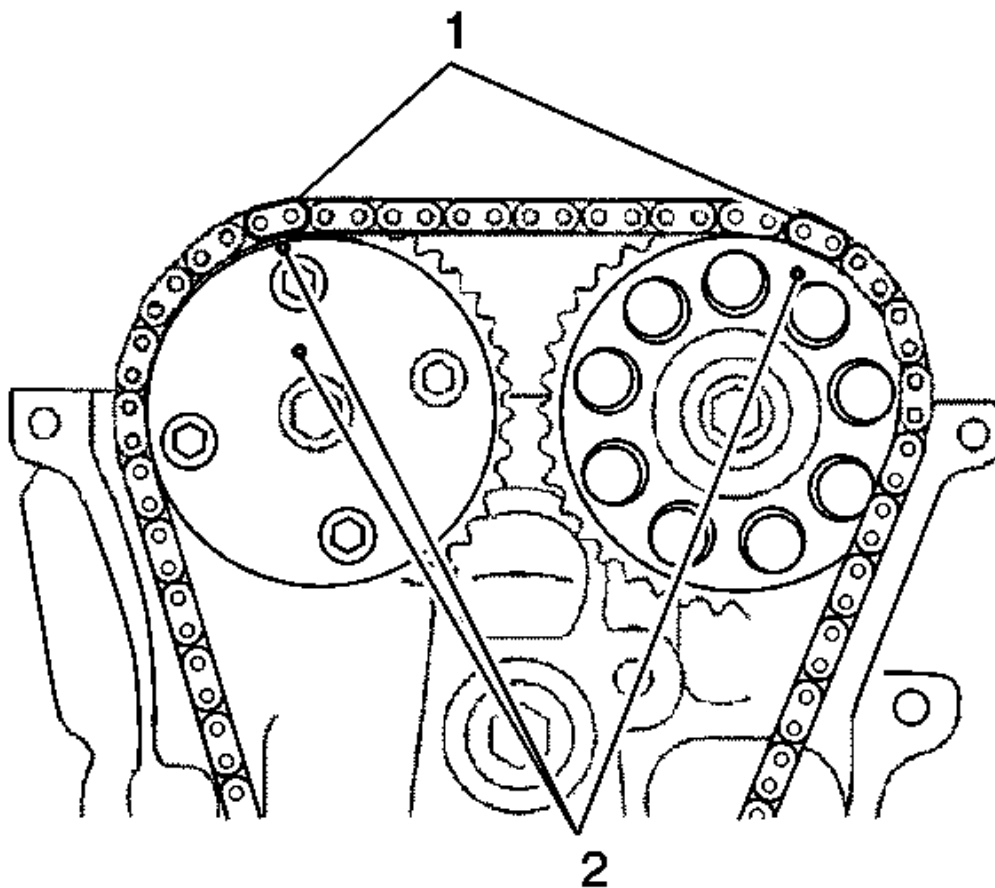


Fig. 491: Aligning Colored Timing Chain Links
Courtesy of GENERAL MOTORS CORP.

9. Align the gold or yellow links with the timing marks located on the camshaft timing gear and sprocket, then install the chain.

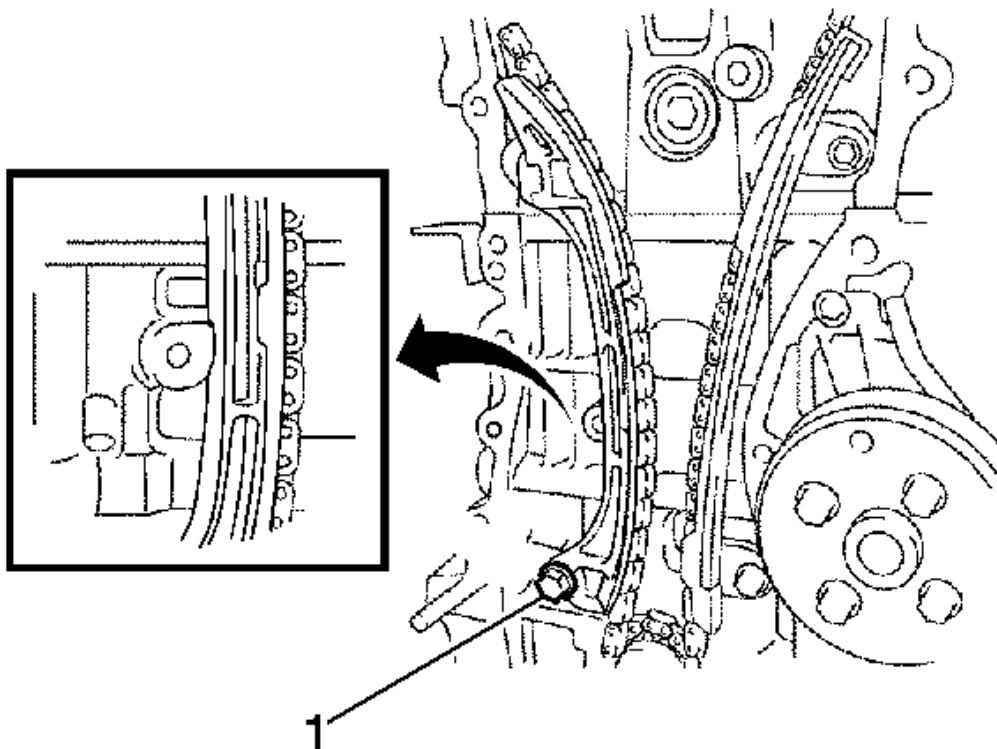


Fig. 492: View Of Chain Tensioner Slipper & Bolt
Courtesy of GENERAL MOTORS CORP.

10. Install the chain tensioner slipper with the bolt.

Tighten: 19 N.m (14 lb ft)

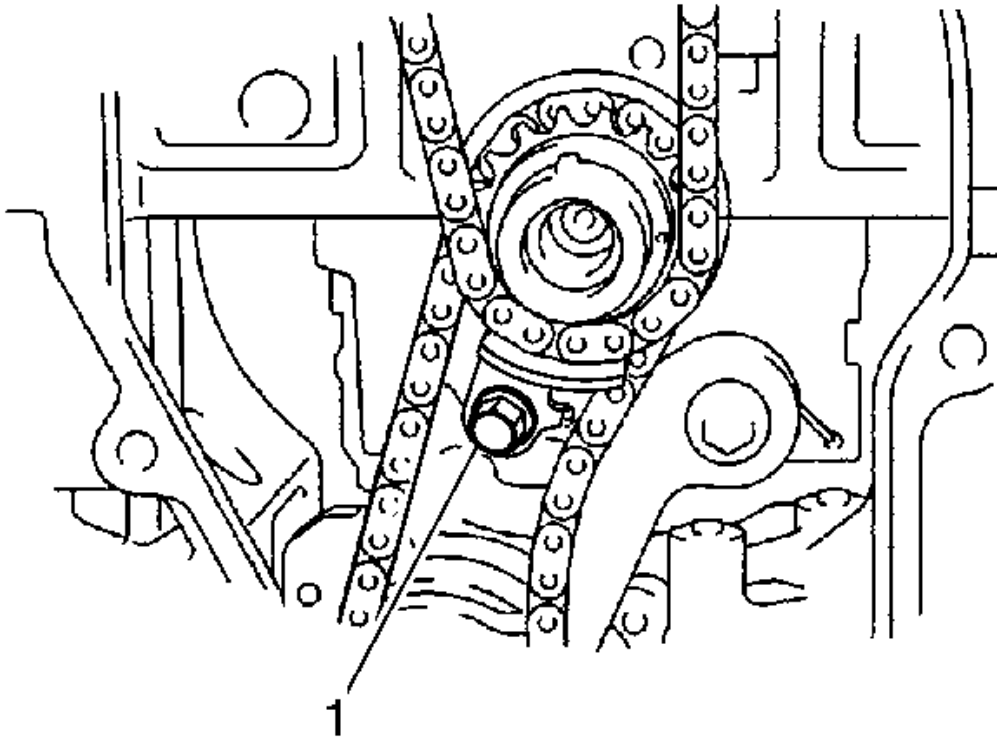


Fig. 493: Identifying Timing Chain Guide & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Install the timing chain guide with the bolt.

Tighten: 9.0 N.m (80 lb in)

OIL PUMP DRIVE CHAIN AND SPROCKET INSTALLATION

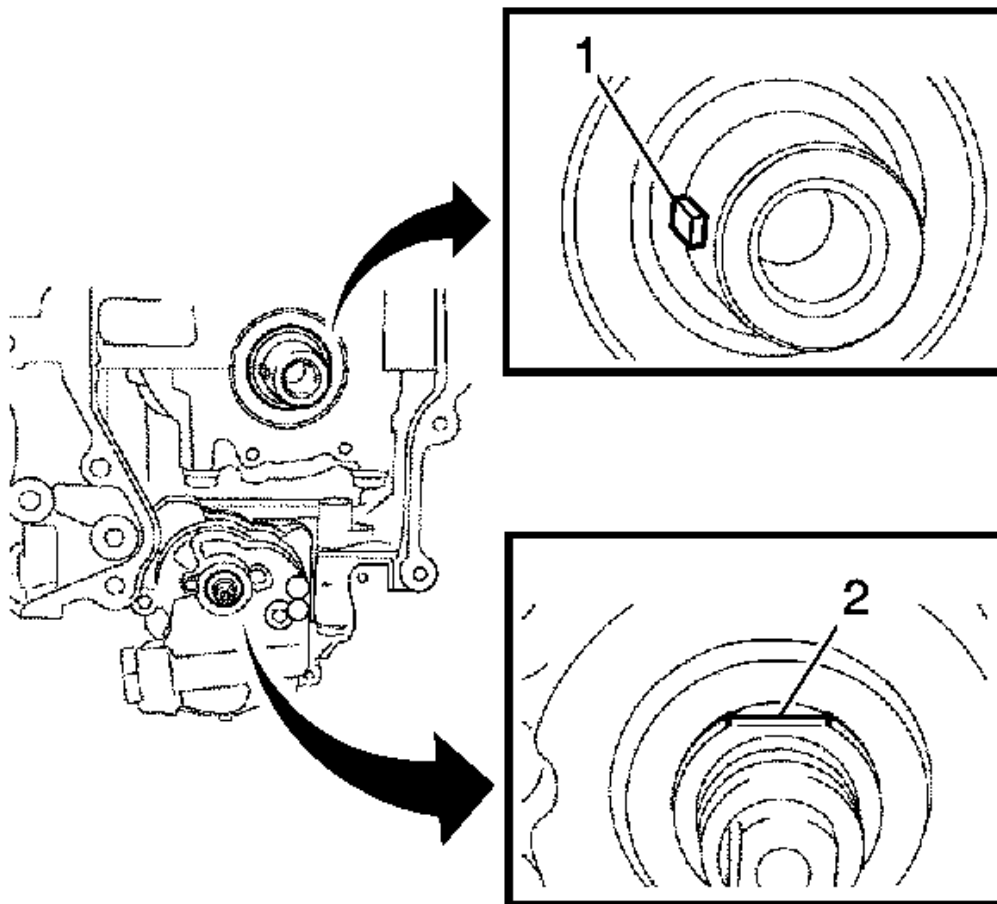


Fig. 494: Identifying Proper Crankshaft Key Positioning
Courtesy of GENERAL MOTORS CORP.

1. Install No. 2 chain sub-assembly.
2. Set the crankshaft key in the left horizontal position.

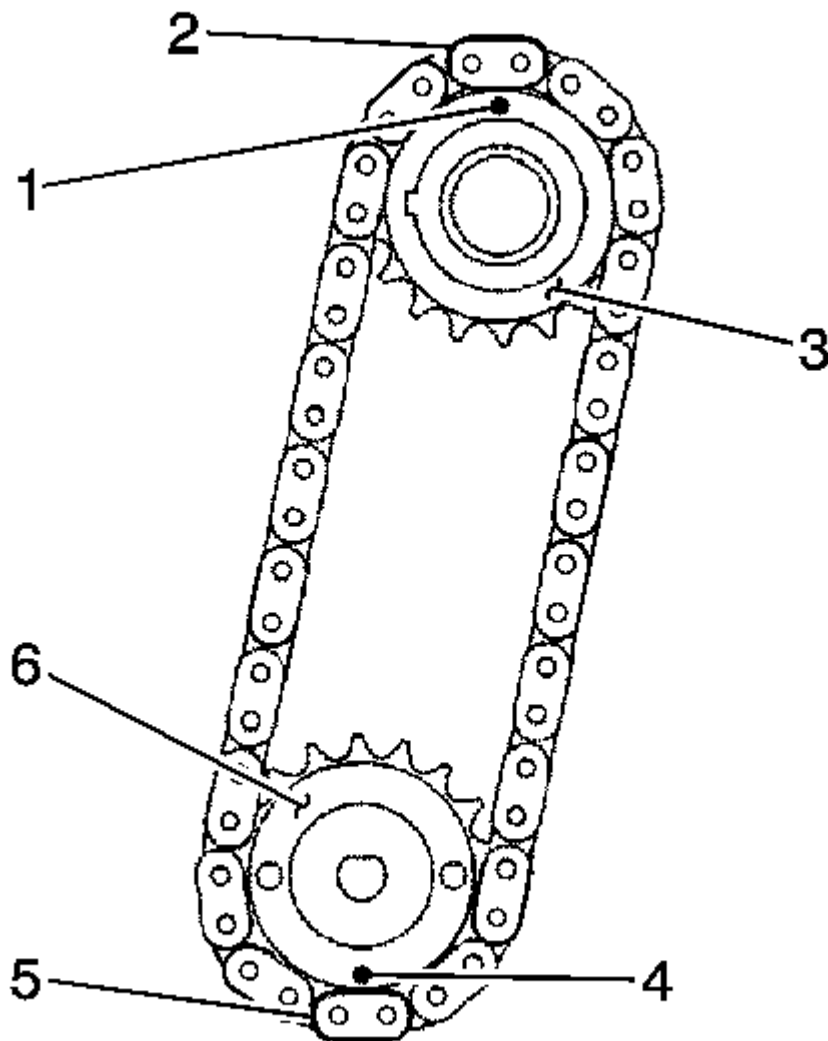


Fig. 495: View Of Chain & Sprockets
Courtesy of GENERAL MOTORS CORP.

3. Turn the cutout of the drive shaft so that it faces upward.
4. Align the yellow mark links with the timing marks of each gear as shown in the illustration.
5. Install the sprockets onto the crankshaft and oil pump shaft with the chain wrapped on the gears.
6. Temporarily tighten the oil pump drive shaft sprocket with the nut.

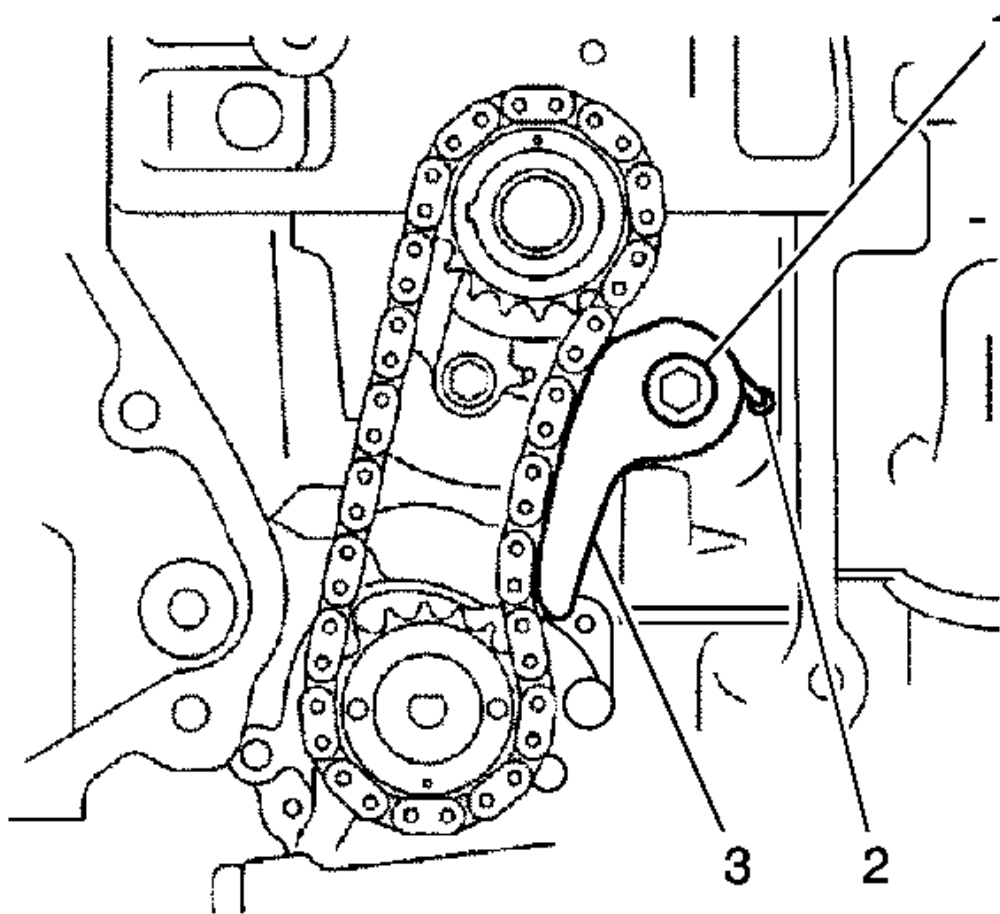


Fig. 496: Identifying Chain Tensioner Plate & Bolt
Courtesy of GENERAL MOTORS CORP.

7. Insert the damper spring into the adjusting hole, and then install the chain tensioner plate with the bolt.

Tighten: 12 N.m (9 lb ft)

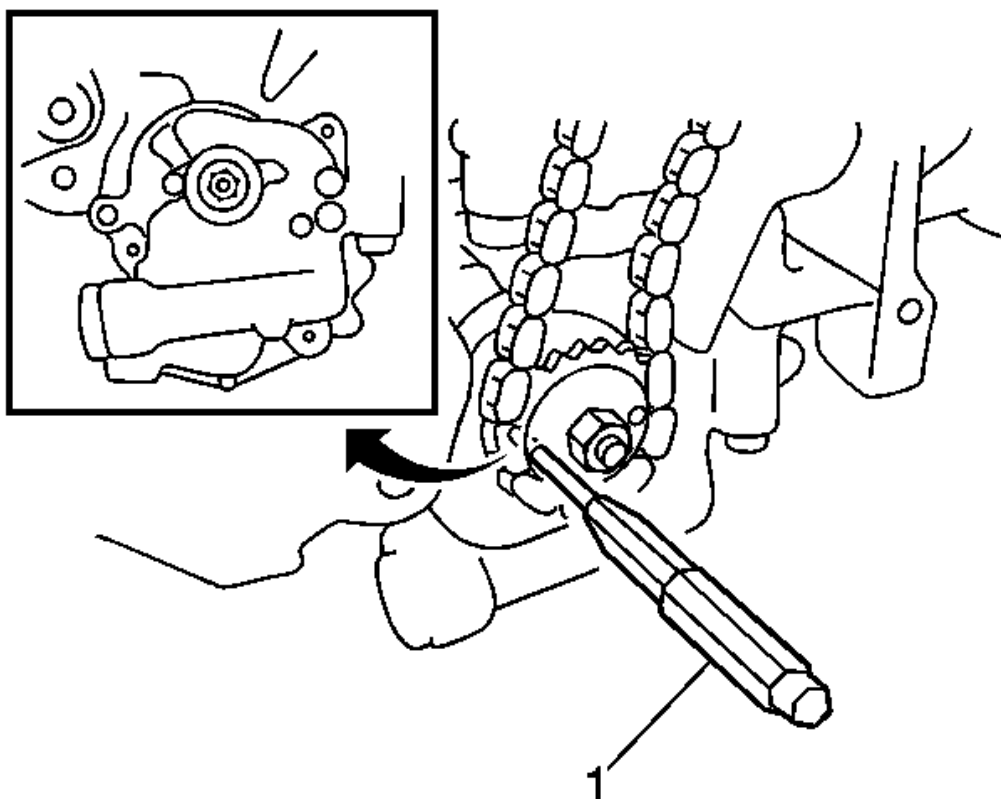


Fig. 497: View Of Locking Oil Pump Drive Shaft Sprocket In Position
Courtesy of GENERAL MOTORS CORP.

8. Align the adjusting hole on the oil pump drive shaft sprocket with the groove on the oil pump.
9. Insert a 4 mm diameter bar into the adjusting hole on the oil pump drive shaft gear to lock the gear in position, and then tighten the nut.

Tighten: 30 N.m (22 lb ft)

TIMING CHAIN HOUSING INSTALLATION

Installation Procedure

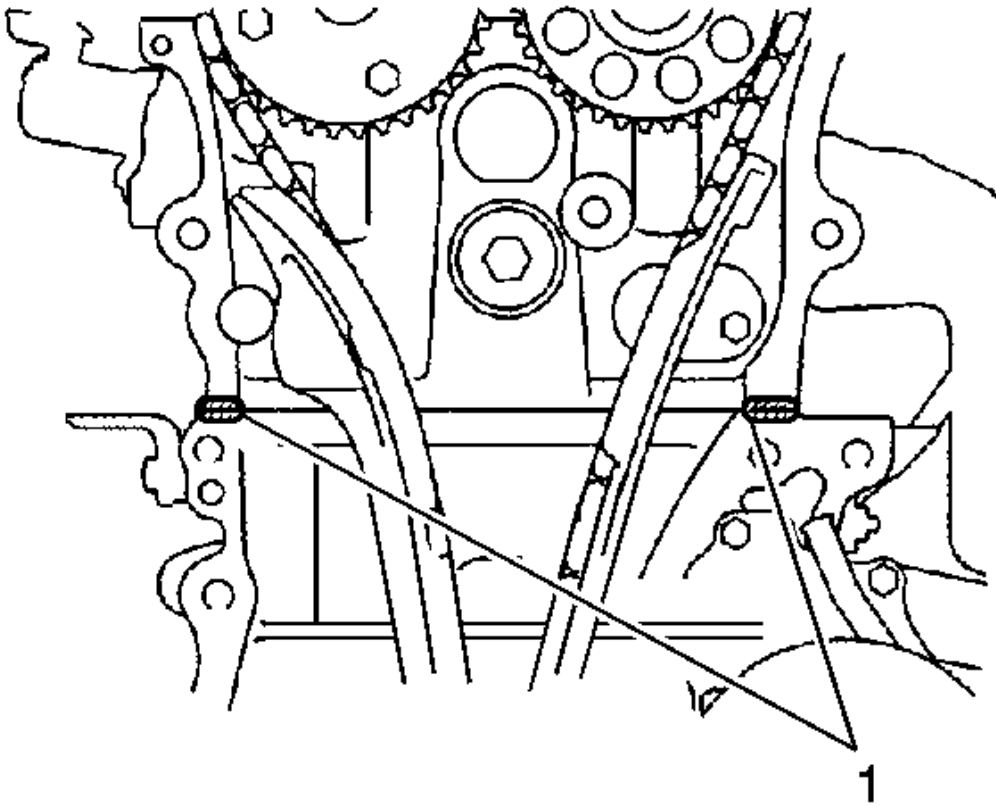


Fig. 498: Applying MP grease

Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- Remove any oil from the contact surfaces.
- Install the chain cover within 3 minutes of applying seal packing.
- Do not add engine oil for at least 2 hours after installing the chain cover.

1. Apply Three Bond 1207B or equivalent (Diameter 4.0 to 4.5 mm (0.157 to 0.177 in).
2. Apply a continuous bead of seal packing.

IMPORTANT:

- Remove any oil from the contact surfaces.
- Install the chain cover within 3 minutes of applying seal packing.
- Do not add engine oil for at least 2 hours after installing the chain cover.

3. Apply Three Bond 1207B or equivalent.

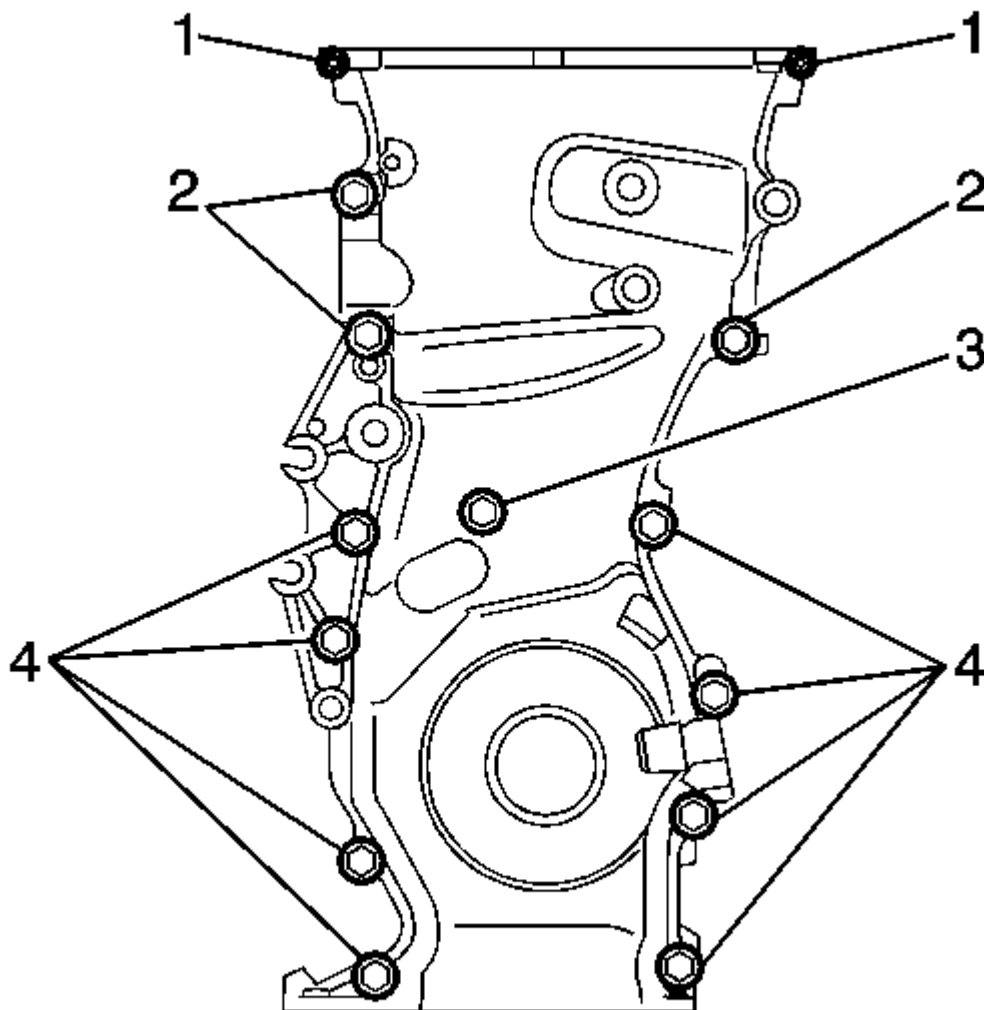


Fig. 499: Identifying Timing Chain Housing Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Install the timing chain cover with the 12 bolts and 2 nuts.

Tighten:

- Tighten bolt A to 9.0 N.m (80 lb in).
- Tighten bolt B to 25 N.m (18 lb ft).

- Tighten bolt C to 55 N.m (41 lb ft).
- Tighten bolt D to 11 N.m (8 lb ft).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Installation Procedure

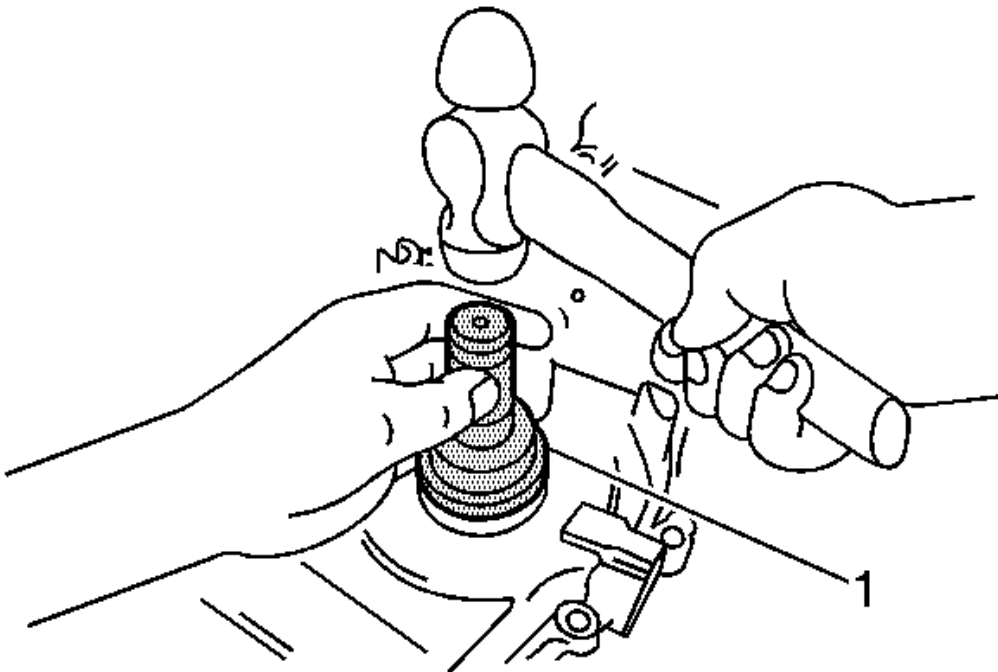


Fig. 500: View Of Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

- IMPORTANT:**
- Keep the lip free from foreign matter.
 - Do not tap the oil seal at an angle.

1. Using SST , tap in a new oil seal until its surface is flush with the timing chain cover edge.
2. Apply MP grease to the lip of the oil seal.
3. Remove any old packing material and be careful not to drop any oil on the contact surfaces of the timing chain cover, cylinder head and cylinder block.

CAMSHAFT COVER INSTALLATION

Installation Procedure

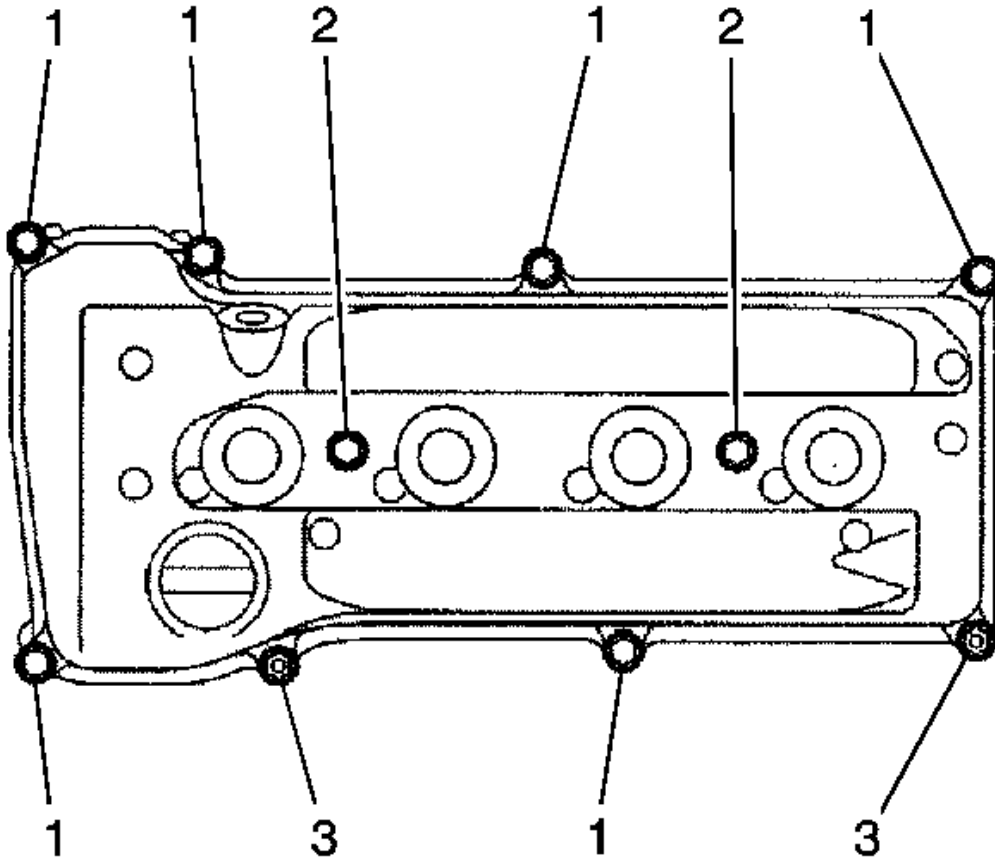


Fig. 501: Identifying Cylinder Head Cover Bolt/Nut Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove any old packing material from the contact surface of the cover and cylinder head.

1. Install the cylinder head cover gasket to the cover.
2. Install the cover with the 8 bolts and 2 nuts.

Tighten: Bolt A-11 N.m (8 lb ft). Bolt B-14 N.m (10 lb ft) Nut 11 N.m (8 lb ft)

OIL PAN INSTALLATION

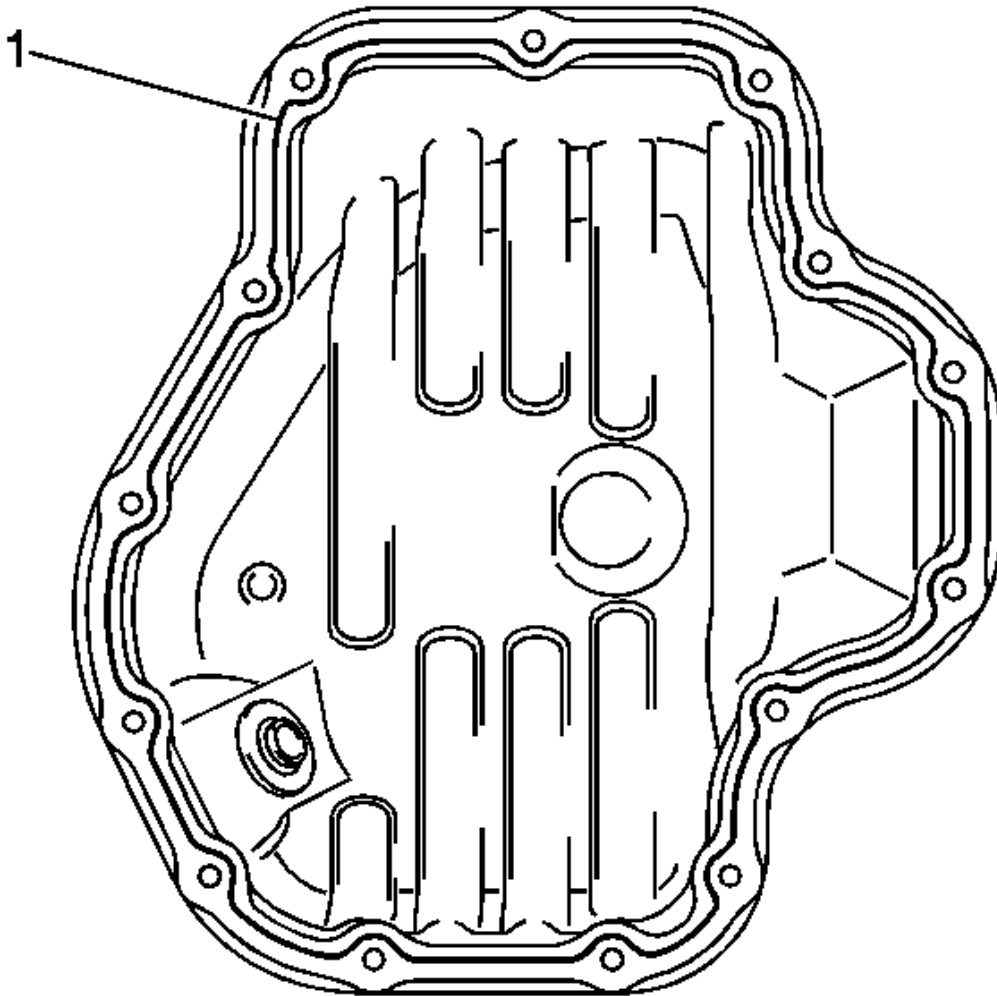


Fig. 502: View Of Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove any oil from the contact surfaces. Install the oil pan within 3 minutes of applying seal packing. Do not add engine oil for at least 2 hours after installing the oil pan.

1. Apply a continuous bead of Three Bond 1207B or equivalent, diameter 4.0-4.5 mm (0.158-0.177 in.), as shown in the illustration.
2. Install the oil pan onto the cylinder block.

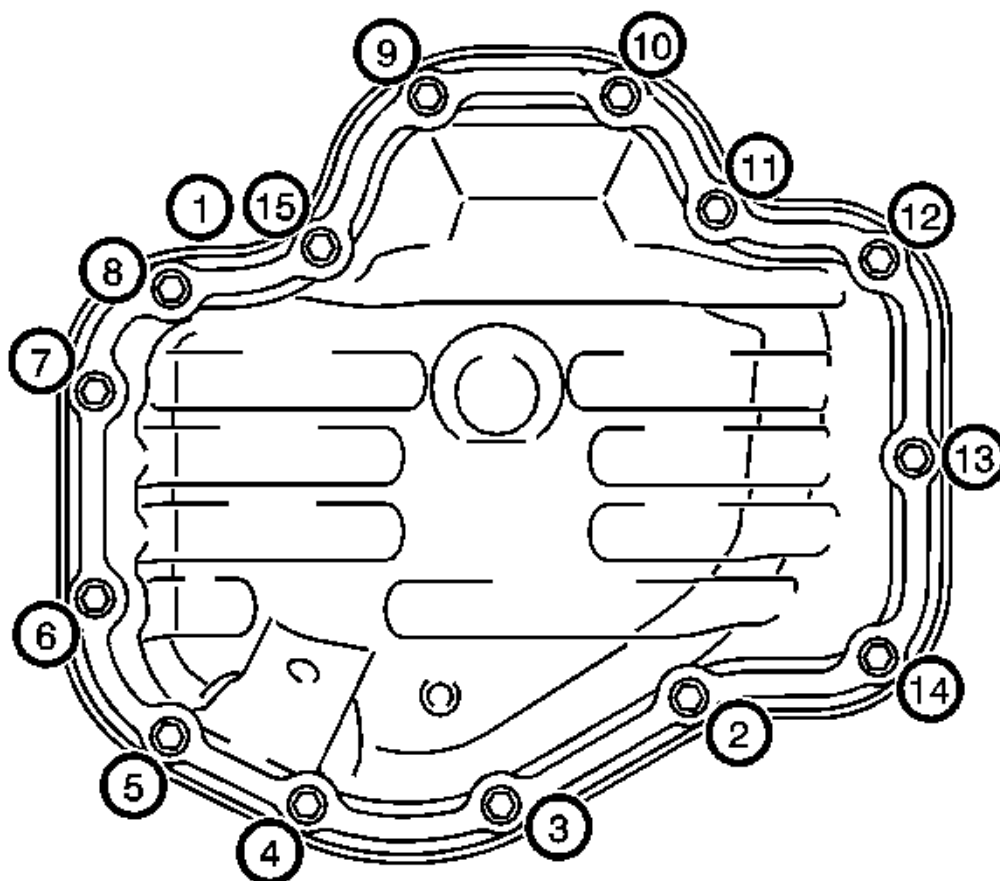


Fig. 503: Identifying Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

3. Uniformly tighten the 12 bolts and 2 nuts in the sequence shown in the illustration.

Tighten: 9.0 N.m (80 lb ft)