

2009 Pontiac G3 Wave SE

2009 ENGINE Engine Mechanical - 1.6L (LXV) - Aveo & G3 Wave (Canadian)

2009 ENGINE**Engine Mechanical - 1.6L (LXV) - Aveo & G3 Wave (Canadian)****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS**

Application	Specification	
	Metric	English
Camshaft Adjuster Bolts	65 N.m + 120° + 15°	47.9 lb ft + 120° + 15°
Camshaft Bearing Cap Bolts	8 N.m	70.8 lb in
Camshaft Sprocket Bolt Cap	50 N.m	36.8 lb ft
Camshaft Sprocket Bolts	65 N.m	47.9 lb ft
Closure Bolt	15 N.m	11 lb ft
Connecting-rod Cap Bolts	35 N.m + 45° + 15°	25.8 lb ft + 45° + 15°
Coolant Pipe To Coolant Distributor Case Bolts	8 N.m	70.8 lb in
Crankshaft Cap Bolts	50 N.m + 50°	36.8 lb ft + 50°
Crankshaft Pulley Bolt	25 N.m	18.4 lb ft
Cylinder Head Bolts	25 N.m + 90° + 90° + 90° + 45°	18.4 lb ft + 90° + 90° + 90° + 45°
Drive Belt Tensioner Bolt	50 N.m	36.8 lb ft
Engine Front Cover Assembly Bolts	20 N.m	14.7 lb ft
Engine Mount Bolts and Nuts	55 N.m	40.5 lb ft
Engine Mount Bracket Bolt	65 N.m	47.9 lb ft
Exhaust Manifold Lower Bracket Bolts	20 N.m	14.7 lb ft
Exhaust Manifold Nuts	20 N.m	14.7 lb ft
Flex Plate Bolts	35 N.m + 30° + 15°	25.8 lb ft + 30° + 15°
Generator B+ Nut	15 N.m	11 lb ft
Ground Nut	12 N.m	8.8 lb ft
Heat Exchanger Bolts	8 N.m	70.8 lb in
Heat Shield Bolts	8 N.m	70.8 lb in
Ignition Coil Bolt	8 N.m	70.8 lb in
Intake Manifold Bolts	20 N.m	14.7 lb ft
Intake Manifold Lower Bracket Bolt	8 N.m	70.8 lb in
Oil Cooler Bolts	25 N.m	18.4 lb ft
Oil Level Indicator Tube Bolt	10 N.m	7.3 lb ft
Oil Pan Baffle Bolts	10 N.m	7.3 lb ft
Oil Pan Bolts	14 N.m	10.3 lb ft
Oil Pan Heater Bolt	8 N.m	70.8 lb in
Oil Pan-to-Transmission Bolts	40 N.m	29.5 lb ft

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Reaction Rod-to-Bracket Bolt and Nut	80 N.m	59 lb ft
Reaction Rod-to-Crossmember Bolts	55 N.m	40.5 lb ft
Spark Plug	25 N.m	18.4 lb ft
Starter Solenoid B+ Nut	10.5 N.m	7.7 lb ft
Starter Solenoid Ground Nut	38 N.m	28 lb ft
Timing Belt Idler Bolt	50 N.m	36.8 lb ft
Timing Belt Lower Cover Bolts	6 N.m	53.1 lb in
Timing Belt Rear Cover Bolts	6 N.m	53.1 lb in
Timing Belt Tensioner Bolt	55 N.m	40.6 lb ft
Timing Belt Upper Cover Bolts	4 N.m	35.4 lb in
Transmission Bolt	60 N.m	44.2 lb ft
Valve Rocker Arm Cover Bolts	8 N.m	70.8 lb in

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
Camshaft		
• Lift - Intake	46.3 mm	1.8228 in
• Lift - Exhaust	45.3 mm	1.7835 in
• Bending	0.04 mm	0.0016 in
• Journal Outer Diameter : No. 1	27.939-27.960 mm	1.1000-1.1008 in
• Journal Outer Diameter : No. 2	27.939-27.960 mm	1.1000-1.1008 in
• Journal Outer Diameter : No. 3	27.939-27.960 mm	1.1000-1.1008 in
• Journal Outer Diameter : No. 4	27.939-27.960 mm	1.1000-1.1008 in
• Journal Outer Diameter : No. 5	27.939-27.960 mm	1.1000-1.1008 in
• Trust Clearance (End Play)	0.13-0.215 mm	0.0051-0.0085 in
Connecting Rod		
• Thrust Clearance - End Play	0.07-0.242 mm	0.0028-0.0095 in
• Width	21.838-21.890 mm	0.8598-0.8618 in
• Diameter - Piston Pin	19.012-19.020 mm	0.7485-0.7488 in
• Diameter - Crankshaft	45.999-46.013 mm	1.8110-1.8115 in
• Bending	0.04 mm	0.0016 in
• Twist	0.016 mm	0.0006 in
• Journal Bearing Oil Clearance	0.018-0.064 mm	0.0007-0.0025 in
Crankshaft		
• Thrust Clearance - End Play	0.1-0.202 mm	0.0039-0.0080 in

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• Journal Outer Diameter	Main: 54.980-54.997 mm Pin: 42.971-42.987 mm	Main: 2.1646-2.1652 in Pin: 1.6918-1.6924 in
• Journal Bearing Oil Clearance	Main: 0.0155-0.047 mm Pin: 0.019-0.067 mm	Main: 0.0006-0.0019 in Pin: 0.0007-0.0026 in
• Bending	0.03 mm	0.0012 in
Cylinder Block		
• Diameter	79 mm	3.1102 in
• Deck Surface Flatness	0.025/65 mm	0.0010/2.5591 in
• Cylindricity	0.0065 mm	0.0003 in
Cylinder Head		
• Journal Inner Diameter: No. 1	28.000-28.021 mm	1.1024-1.1032 in
• Journal Inner Diameter: No. 2	28.000-28.021 mm	1.1024-1.1032 in
• Journal Inner Diameter: No. 3	28.000-28.021 mm	1.1024-1.1032 in
• Journal Inner Diameter: No. 4	28.000-28.021 mm	1.1024-1.1032 in
• Journal Inner Diameter: No. 5	28.000-28.021 mm	1.1024-1.1032 in
• Journal Clearance	0.04-0.082 mm	0.0016-0.0032 in
• Height	135.55 mm	5.3366 in
• Surface Flatness Deformation Cover/Block	0.02/50-0.025/150 mm	0.0008/1.9685-0.0010/5.9055 in
• Manifolds Surface Deformation	0.05 mm	0.002 in
Valve		
• Deviation	0.3 mm	0.0118 in
• Seat Inner Diameter - Intake	30.7 mm	1.2087 in
• Seat Inner Diameter - Exhaust	27.2 mm	1.0709 in
• Face Diameter - Intake	30.92-31.12 mm	1.2173-1.2252 in
• Face Diameter - Exhaust	27.4-27.6 mm	1.0787-1.0866 in
• Guide Inner Diameter - Intake	5.0-5.016 mm	0.1969-0.1975 in
• Guide Inner Diameter - Exhaust	5.0-5.016 mm	0.1969-0.1975 in
• Valve Stem Outer Diameter - Intake	4.965-4.980 mm	0.1955-0.1961 in
• Valve Stem Outer Diameter - Exhaust	4.950-4.965 mm	0.1945-0.1955 in
• Valve Length - Intake	117.10-117.30 mm	4.6102-4.6181 in
• Valve Length - Exhaust	116.16-116.36 mm	4.5732-4.5811 in
• Valve Spring - Free Length	41.6 mm	1.6378 in

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• Valve Spring - Straightness	1.5°	1.5°
• Clearance - Intake	0.21-0.29 mm (Nominal 0.25 mm)	0.0083-0.0114 in (Nominal 0.0098 in)
• Clearance - Exhaust	0.27-0.35 mm (Nominal 0.25 mm)	0.0106-0.0138 in (Nominal 0.0098 in)
Oil Pump Axial Clearance	0.02-0.058 mm	0.0008-0.0023 in
Piston		
• Piston	79 mm	3.1102 in
• Diameter	0.030-0.060 mm	0.0012-0.0024 in
Piston Ring		
• Groove Clearance - Top Ring	0.04-0.08 mm	0.0016-0.0031 in
• Groove Clearance - 2nd Ring	0.03-0.07 mm	0.0012-0.0028 in
• Groove Clearance - Oil Ring	0.06-0.15 mm	0.0024-0.0059 in
• End Gap - Top Ring	0.15-0.30 mm	0.0059-0.0118 in
• End Gap - 2nd Ring	0.30-0.50 mm	0.0118-0.0197 in
• End Gap - Oil Ring	0.20-0.70 mm	0.0079-0.0276 in
Piston Pin		
• Diameter	19.000-19.005 mm	0.7480-0.7482 in
• Length	49.84 mm	1.9268 in
• Clearance	0.007-0.020 mm	0.0003-0.0008 in

COMPONENT LOCATOR**DISASSEMBLED VIEWS**

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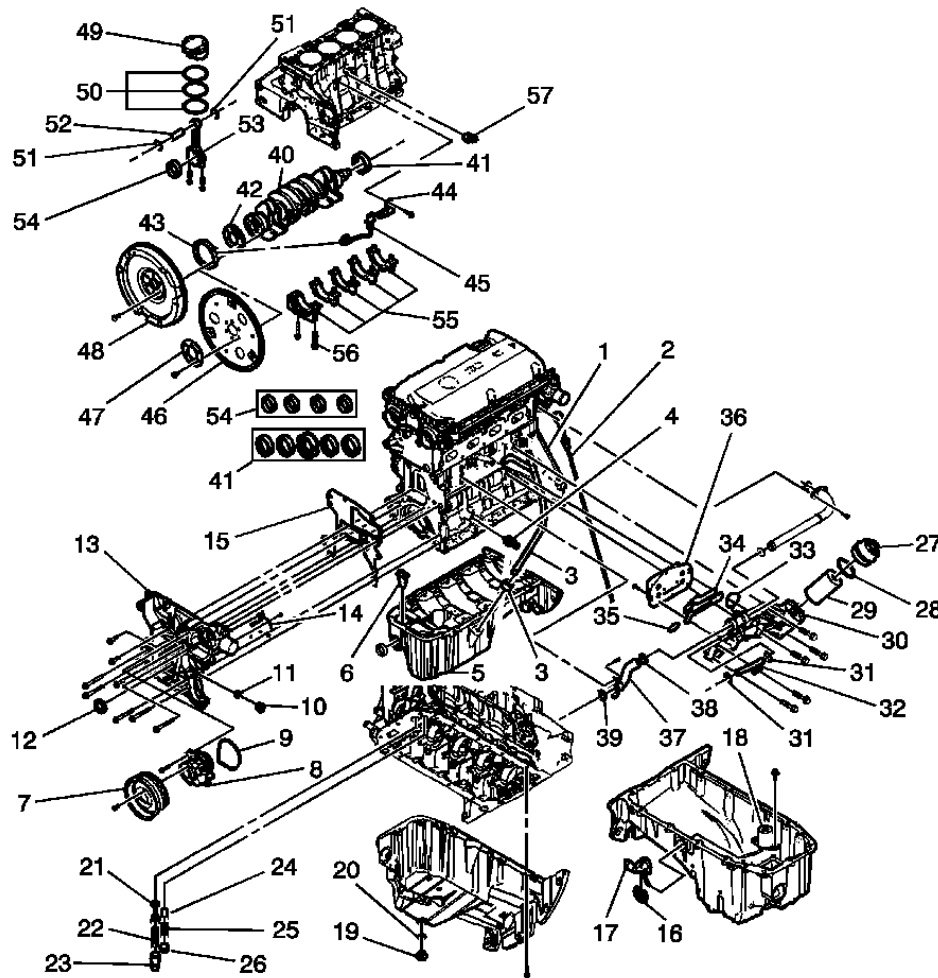


Fig. 1: Exploded View Of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Cylinder Block
2	Engine Oil Level Indicator
3	Oil Level Indicator Tube
4	Oil Switch
5	Oil Pan
6	Oil Pump Filter
7	Crankshaft Balancer (Pulley)
8	Water Pump
9	Water Pump Gasket
10	Oil Pump Plug
11	Check Valve
12	Crankshaft Front Seal
13	Engine Front Cover

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14	Engine Oil Pump Cover
15	Engine Front Cover Gasket
16	Retainer
17	Engine Oil Level Switch Connector
18	Engine Oil Level Switch
19	Oil Plug
20	Oil Plug Washer
21	Oil Pressure Relief Valve
22	Oil Pressure Relief Valve Spring
23	Oil Pressure Relief Valve Spring Plug
24	Oil Pressure Relief Valve
25	Oil Overpressure Relief Valve Spring
26	Oil Overpressure Relief Valve Spring Plug
27	Oil Filter Cap
28	Oil Filter Cap Seal
29	Oil Filter
30	Oil Filter Housing Assembly
31	Oil Cooler Pipe Seal
32	Oil Cooler Pipe
33	Oil Filter Housing Gasket
34	Oil Cooler Gasket
35	Oil Cooler Seal
36	Engine Oil Cooler
37	Engine Oil Cooler Outlet Pipe
38	Engine Oil Cooler Outlet Pipe Seal
39	Crankshaft
40	Crankshaft Journal Bearings
41	Crankshaft Flywheel Retainer
42	Crankshaft Rear Oil Seal Housing and Seal Ring
43	Crankshaft Position Sensor Bracket
44	Crankshaft Position Sensor
45	Flexible Plate (A/T only)
46	Flexible Plate Retainer (A/T only)
47	Flywheel
48	Piston
49	Piston Rings
50	Piston Pin Retainer
51	Piston Pin
52	Connecting Rod
53	Connection Rod Bearing
54	Crankshaft Journal Bearing Cap
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	Crankshaft Journal Bearing Cap Bolt
56	Knock Sensor

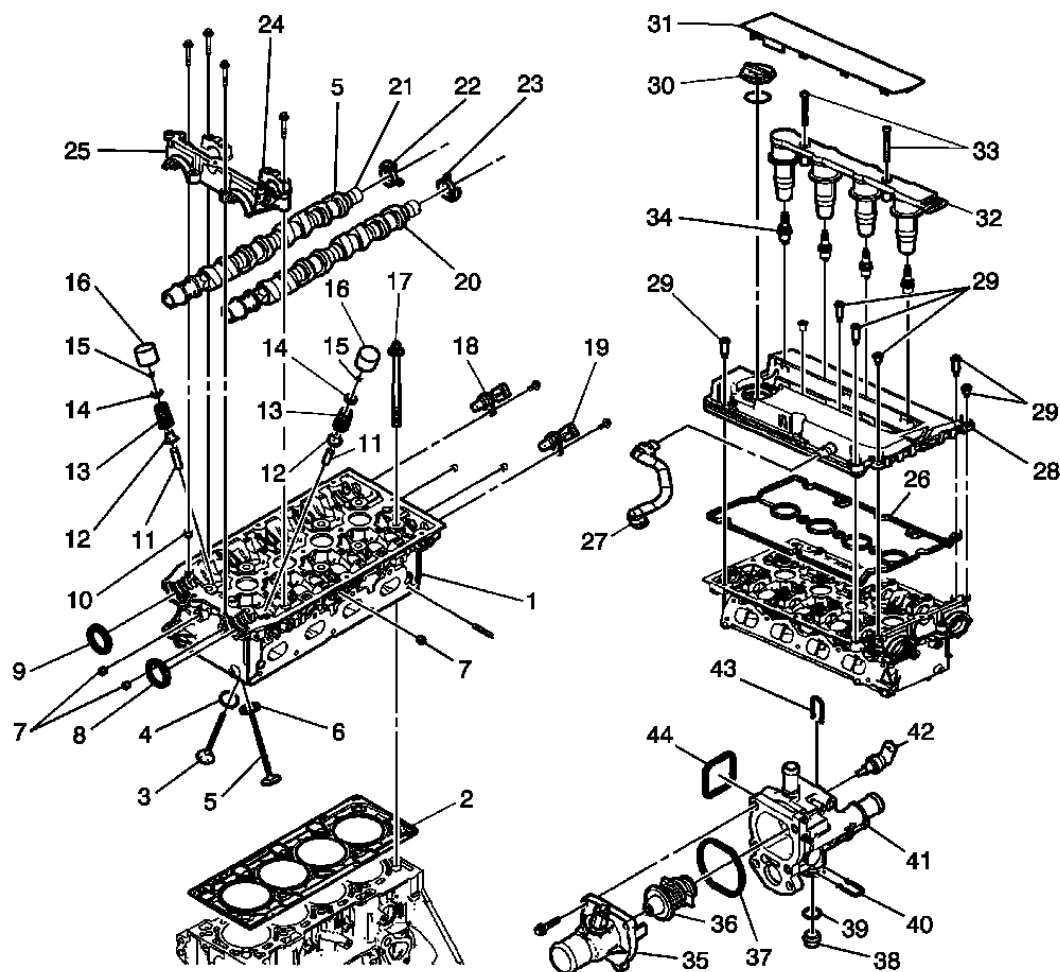


Fig. 2: Exploded View Of Cylinder Head
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Cylinder Head
2	Cylinder Head Gasket
3	Intake Valve
4	Intake Valve Seat Ring
5	Exhaust Valve
6	Exhaust Valve Seat Ring
7	Closure Plug
8	Exhaust Camshaft Seal Ring
9	Intake Camshaft Seal Ring
10	Dowel Pin

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11	Valve Guide
12	Valve Spring Seat
13	Valve Spring
14	Valve Spring Retainer
15	Valve Key
16	Valve Tappet
17	Cylinder Head Bolt
18	Intake Camshaft Position Sensor
19	Exhaust Camshaft Position Sensor
20	Exhaust Camshaft
21	Intake Camshaft
22	Exhaust Camshaft Sensor Target Wheel
23	Intake Camshaft Sensor Target Wheel
24	Camshaft Cap
25	Camshaft Front Cap
26	Cylinder Head Cover Gasket
27	PCV Pipe
28	Cylinder Head Cover
29	Cylinder Head Cover Bolt
30	Engine Oil Cap
31	Ignition Coil Cover
32	Ignition Coil
33	Ignition Coil Bolt
34	Spark Plug
35	Thermostat Housing
36	Thermostat
37	Thermostat Housing Gasket
38	Plug
39	Seal
40	Retainer
41	Engine Coolant Distributor
42	Engine Coolant Temperature Sensor
43	Retainer
44	Engine Coolant Distributor Gasket

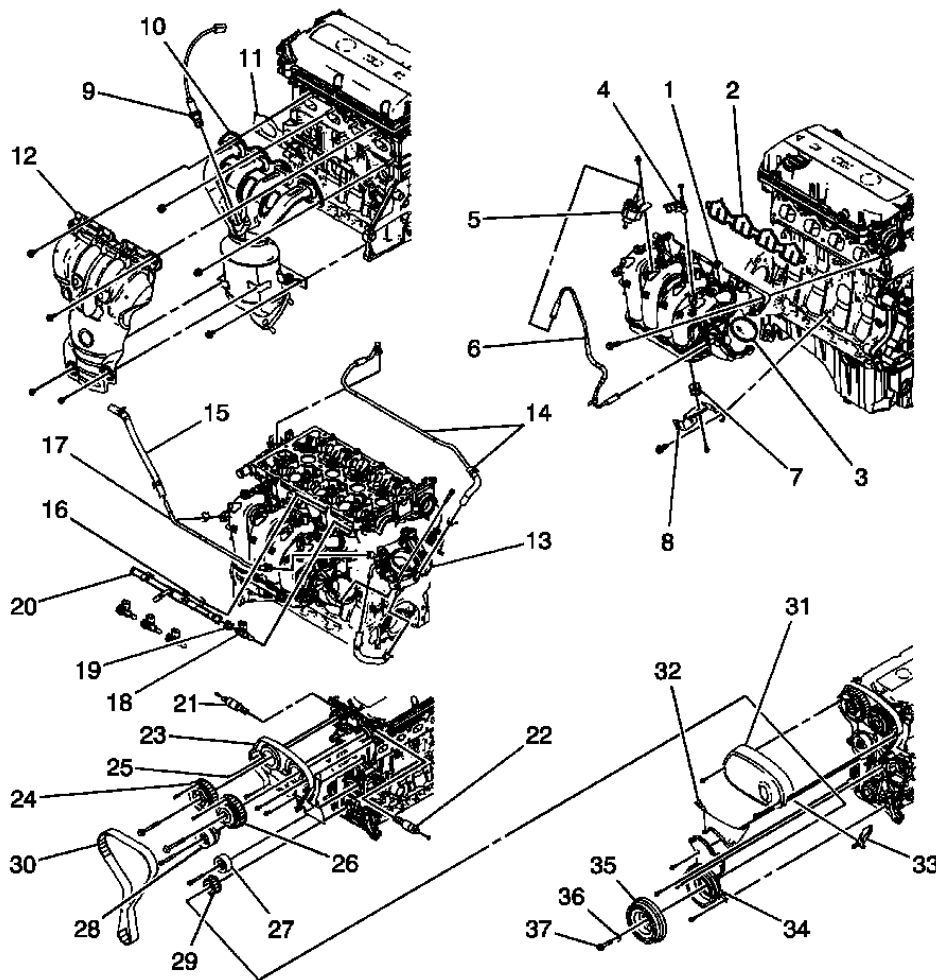


Fig. 3: Exploded view OF Intake Manifoldm Exhaust Manifold And Engine Camshaft Timing System
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Intake Manifold Assembly
2	Intake Manifold Gasket
3	Throttle Body Seal
4	MAP Sensor
5	EVAP Canister Purge Solenoid Valve
6	EVAP Pipe
7	Intake Manifold Mount
8	Intake Manifold Mount Bracket
9	Oxygen Sensor
10	Exhaust Manifold
11	Exhaust Manifold Gasket
12	Exhaust Manifold Shield
13	Throttle Body

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14	Throttle Body Heater Coolant Inlet Pipe
15	Throttle Body Heater Coolant Outlet Hose
16	Fuel Rail Retaining Bolt
17	Throttle Body Heater Coolant Outlet Pipe
18	Fuel Injector
19	Injector Retainer
20	Fuel Rail
21	Intake Camshaft Position Actuator Solenoid Valve
22	Exhaust Camshaft Position Actuator Solenoid Valve
23	Timing Belt Rear Cover
24	Intake Camshaft Sprocket
25	Timing Belt Rear Cover Bolt
26	Exhaust Camshaft Sprocket
27	Timing Belt Idler
28	Timing Belt Tensioner
29	Crankshaft Sprocket
30	Timing Belt
31	Timing Belt Front Upper Cover
32	Timing Belt Front Center Cover
33	Timing Belt Sheet Part
34	Timing Belt Front Lower Cover
35	Crankshaft Balancer (Pulley)
36	Washer
37	Crankshaft Balancer Bolt

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the **Oil Pressure Diagnosis and Testing**, **Disassembled Views**. 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 a **Diagnostic System Check - Vehicle** before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views**, **Engine Component Description**.

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

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 Will Not Crank - Crankshaft Will Not Rotate**
- **Engine Compression Test**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Coolant in Combustion Chamber**
- **Coolant in Engine Oil**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**

- **Drive Belt Falls Off and Excessive Wear Diagnosis**

OIL PRESSURE DIAGNOSIS AND TESTING**Special Tools**

- **KM-498-B** Oil Pressure Gage
- KM-232 Adapter

Test

IMPORTANT: The engine should be at normal operating temperature

1. Remove the exhaust manifold heat shield.

CAUTION: Refer to Fastener Caution .

2. Unscrew the closure bolt.

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

3. Install **KM-498-B** (a) and KM-232 (b) in the hole.
4. Start the engine.
5. Check the engine oil pressure.

The engine oil pressure must be at least 130 kPa (18.85 psi) at idle speed and oil temperature must be greater than or equal to 27°C (80°F).

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions, a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. Identify where the fluid is leaking from.
 1. After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
 2. Wait a few minutes.
 3. Find the approximate location of the leak by the drippings on the paper.

3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam, or spray solvent.
 1. Thoroughly clean the area.
 2. Dry the area.
 3. Operate the vehicle for several miles at normal operating temperature and varying speeds.
 4. After operating the vehicle, visually check the suspected component.
 5. If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

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.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle under normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are improperly tightened or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs, or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.

- An improper seal was used, where applicable.

Seals

- The fluid/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged, scratched, burred, or nicked.
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the component.
- The shaft surface is scratched, nicked, or damaged.
- A loose or worn bearing is causing excess seal wear.

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.

COOLANT IN COMBUSTION CHAMBER

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage.	
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u>. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component.	

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4. Inspect by performing a cylinder compression test. 2 cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.

Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner	Replace the components, as required.
Cylinder head or block porosity	Replace the components, as required.

COOLANT IN ENGINE OIL

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	
1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to <u>Lower Engine Noise, Regardless of Engine Speed</u>. 2. Inspect by performing a cylinder leak down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u>.	
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner	Replace the components, as required.
Cylinder head or block porosity	Replace the components, as required.

ENGINE NOISE UNDER LOAD

Step	Action	Values	Yes	No
1	Is there a heavy knock when the engine is hot and torque is applied?	-	Go to Step 2	System OK
2	Inspect the balancer and the pulley hub. Is the balancer or the pulley hub broken?	-	Go to Step 3	Go to Step 4

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3	Replace the broken balancer or the pulley hub. Is the repair complete?	-	Go to Step 1	-
4	Inspect the torque converter bolts. Are the bolts tightened to specified value?	45 N.m (33 lb ft)	Go to Step 5	Go to Step 6
5	Tighten the torque converter bolts. Is the repair complete?	-	Go to Step 1	-
6	Inspect the accessory belts. Are the belts too tight or nicked?	-	Go to Step 7	Go to Step 8
7	Replace and/or tension the belts to specifications, as necessary. Is the repair complete?	-	Go to Step 1	-
8	Inspect the exhaust system. Is the system grounded?	-	Go to Step 9	Go to Step 10
9	Reposition the system, as necessary. Is the repair complete?	-	Go to Step 1	-
10	Inspect the flywheel. Is the flywheel cracked?	-	Go to Step 11	Go to Step 12
11	Replace the flywheel. Is the repair complete?	-	Go to Step 1	-
12	Inspect the main bearing clearance. Is the clearance more than the specified value?	0.026-0.046 mm (0.001-0.0018 in)	Go to Step 13	Go to Step 14
13	Replace the main bearings, as necessary. Is the repair complete?	-	Go to Step 1	-
14	Inspect the rod bearing clearance. Is the clearance more than the specified value?	0.019-0.07 mm (0.0007-0.0028 in)	Go to Step 15	System OK
15	Replace the rod bearings, as necessary. Is the repair complete?	-	Go to Step 1	-

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 lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.

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Malfunctioning camshaft position actuators - improper oil viscosity or contamination. The result is camshaft actuator locking pin does not lock

1. Verify correct engine oil viscosity by changing the engine oil and filter. Reevaluate the concern.
2. Isolate the noise to a specific camshaft position actuator.
3. Replace the camshaft actuator, oil and filter.

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 revolutions per minute (RPM) variations and lead to a misfire diagnostic trouble code (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 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.
A 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.
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 manifold absolute pressure (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	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the	Repair or replace as required.

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valve not to close properly.	
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • 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 communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a DTC P0300 or P0336.	Replace the sensor and/or crankshaft as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt	Replace the drive belt.

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Abnormalities in the accessory drive system and/or components may cause engine revolutions per minute (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.	
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. Refer to <u>Engine Compression Test</u>. • 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 diagnostic trouble code (DTC) without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not 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 lash adjusters.
Sticking lifters	Replace as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

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Cause	Correction
Faulty cylinder head gasket and/or cracking, or other damage to the cylinder head 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 head 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. Refer to <u>Engine Compression Test</u>. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. - Repair or replace as required.
Loose and/or worn valve rocker arm attachments	- Inspect the valve rocker arm stud, nut, or bolt. - Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace as required: - The valve rocker arm - The valve lifter - The oil filter bypass valve - The oil pump and pump screen - The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lifters	Replace the valve lifters.

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Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace tensioners
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	1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. 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	1. Inspect the accessory drive system. 2. Repair or replace, as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <u>Symptoms - Engine Controls</u> .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace, as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace, as required.
Oil pump screen loose, damaged, or restricted	1. Inspect the oil pump screen. 2. Repair or replace, as required.

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Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair, as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. 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.	1. Verify the pistons, piston pins, and connecting rods are installed correctly. 2. Repair, as required.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or

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	flywheel location.
Broken timing chain and/or gears	• Inspect timing chain and gears. • Repair as required.
Seized balance shaft	• Inspect balance shaft. • Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material • Cracked cylinder wall	• Inspect cylinder for damaged components and/or foreign materials. • Inspect for fallen cylinder wall. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Inspect for fallen cylinder wall. • Repair as required.
Bent or broken connecting rod	• Inspect connecting rods. • Repair as required.
Broken crankshaft	• Inspect crankshaft. • Repair as required.

ENGINE COMPRESSION TEST

Special Tools

- EN-49077 Compression Pressure Gage
- EN-49154 Adapter

NOTE: **Test the compression pressure for each cylinder. The following conditions should be considered when you check the cylinder compression.**

Test

- The engine should be at normal operating temperature.
 - The battery must be at or near full charge.
 - The engine cranking time for compression test should be less than 10 seconds at interval of 30 seconds.
1. Disconnect the crankshaft position sensor (CKP) connector.
 2. Remove the fuel pump relay from the engine room fuse box.

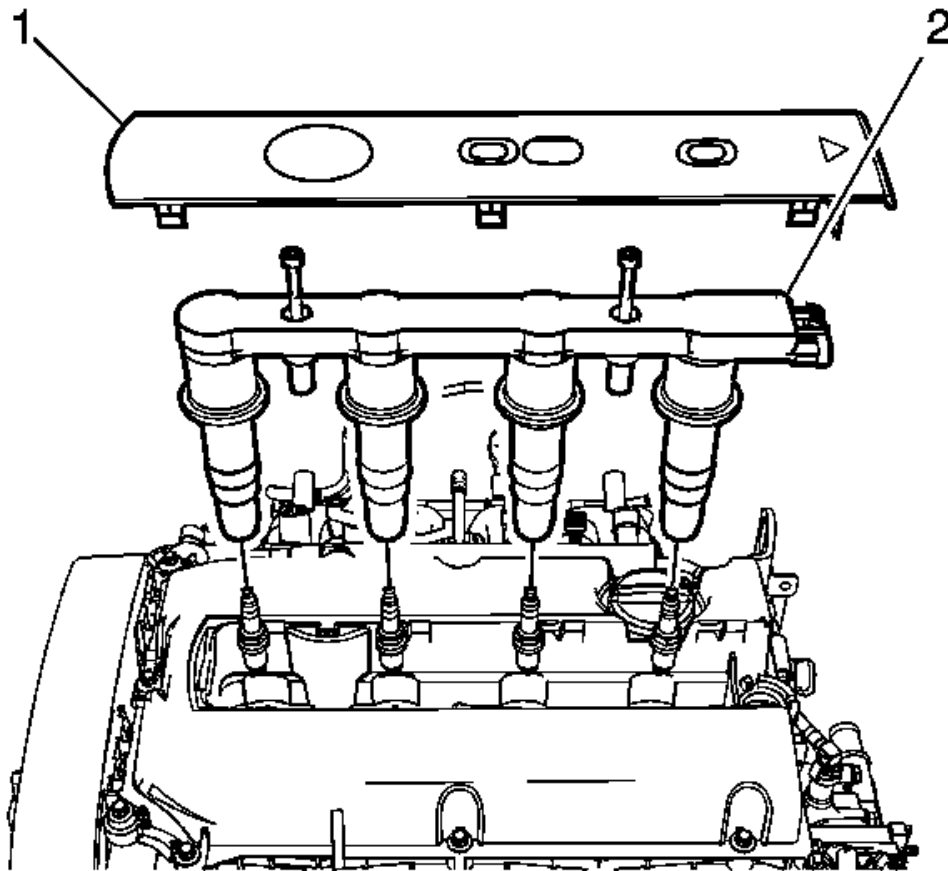


Fig. 4: Ignition Coil & Cover
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil cover.

CAUTION: Refer to Fastener Caution .

4. Remove the ignition coil and spark plugs and tighten.
 - The ignition coil bolt to 8 N.m (70.8 lb in).
 - The spark plug to 25 N.m (18.4 lb ft).
5. Crank the engine with the start motor to remove a foreign substance in the cylinder within 5 seconds.

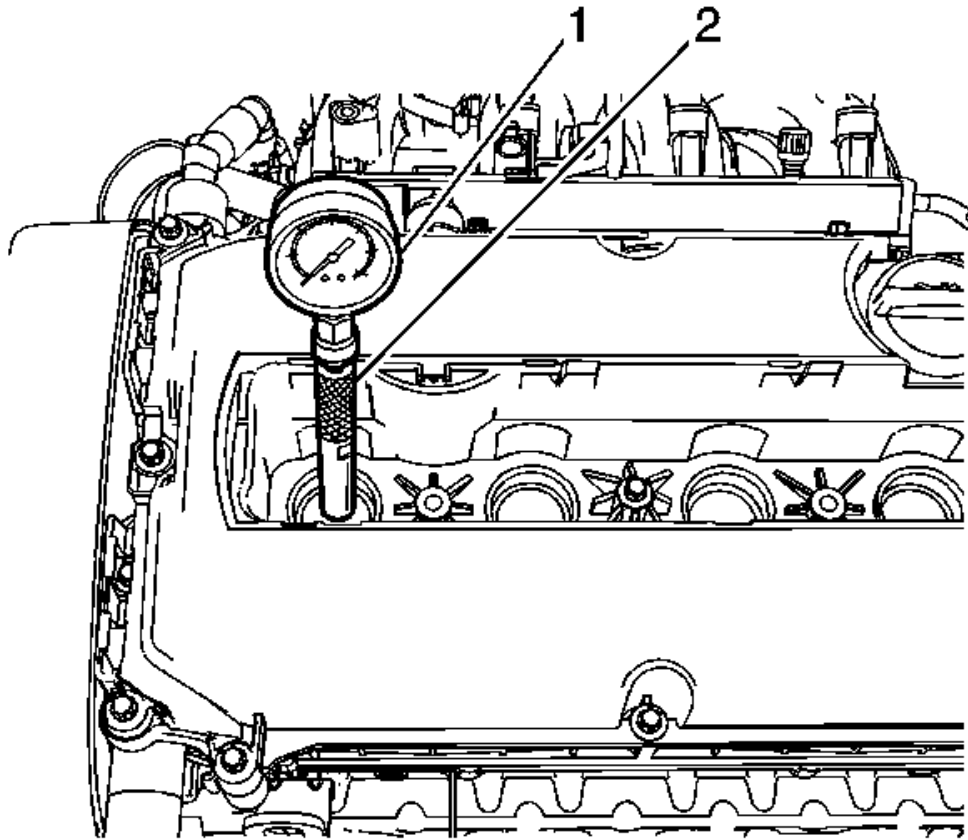


Fig. 5: Tester Installed In Spark Plug Hole
Courtesy of GENERAL MOTORS CORP.

6. Install EN-49077 (a) and EN-49154 (b) in the spark plug hole for the cylinder that is being checked.
7. Using the vehicles starter motor, rotate or crank the engine for less than 4 seconds at interval of 30 seconds by an assistant.
8. Read the compression pressure gage.
9. Compare the all cylinder values. Maximum pressure differential 100 kPa (14.50 psi). Engine revs at least 300 RPM.
10. Examine the gage readings obtained after the four "puffs" per cylinder are obtained from cranking the starter motor.

The readings are explained in the following descriptions:

- Normal Condition: Compression builds up quickly and evenly to the specified compression on each cylinder.
- Piston Rings Faulty: Compression is low on the first stroke and tends to build up on following strokes, but the compression pressure does not reach normal. The compression pressure improves

considerably with the addition of oil into the cylinder.

- Valves Faulty: Low compression pressure on the first stroke. The compression pressure does not tend to build up on the following strokes. The compression pressure does not improve much with the addition of oil into the cylinder.

11. Repeat the above procedure in the rest cylinders.

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
CAUTION: Refer to <u>Belt Dressing 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. • 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
	1. Remove the drive belt. If the engine has multiple drive belts, remove the		

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3	belts one at a time and perform the test below each time a belt is removed.		
	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 Symptoms - Engine Mechanical	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. Do 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	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 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 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

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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 Drive Belt Replacement . 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 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
CAUTION: Refer to <u>Belt Dressing 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 ○ A worn drive belt idler pulley			
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. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 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. Refer to <u>Drive Belt Replacement</u> . 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	Go to Step 9
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	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Refer to <u>Coolant Pump Replacement (1.4L LDT/1.6 LXV)</u> . 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.

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 two or three 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
CAUTION: 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>

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2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . 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	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 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>Drive Belt Tensioner Replacement</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. Refer to <u>Drive Belt Replacement</u> . 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	-
	Operate the system in order to verify the repair.		

17 Did you correct the condition?

System OK

-

DRIVE BELT TENSIONER DIAGNOSIS

Diagnosis consists of a function check on the automatic belt tensioner and a visual check on the belt and the components linked to the belt.

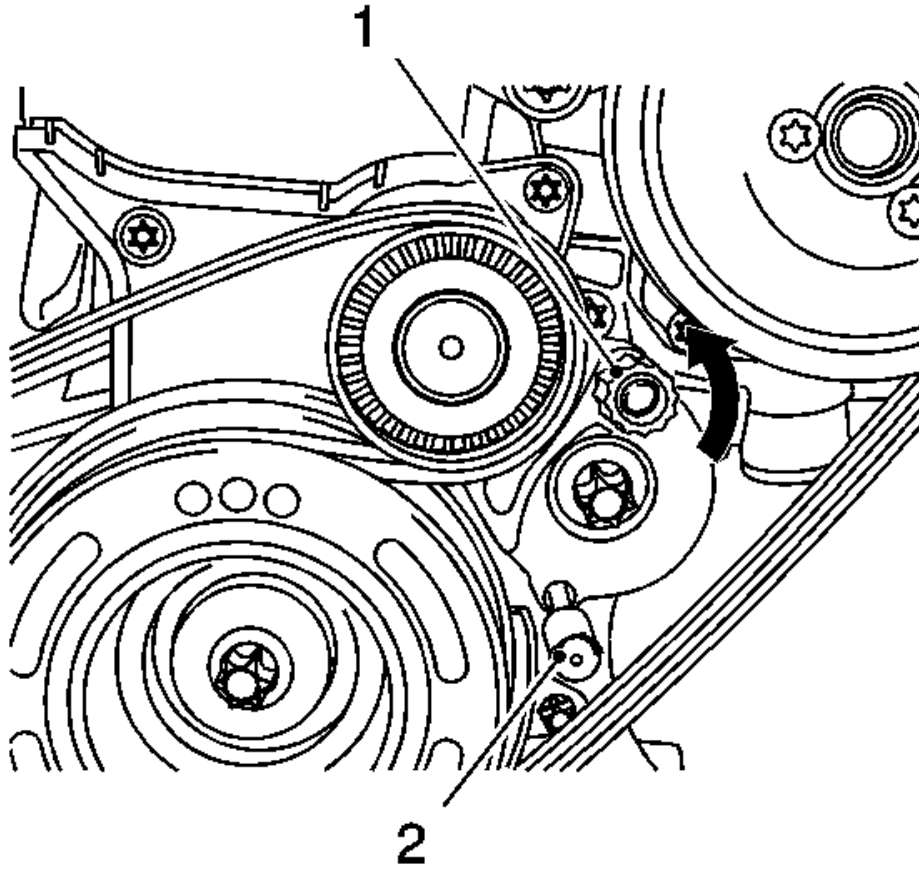


Fig. 6: Drive Belt Tensioner

Courtesy of GENERAL MOTORS CORP.

- Apply tension to the belt tensioner via the cast projection (1) in the direction of the arrow, counterclockwise, and allow to slide back slowly.
- The tensioner must slide back to the initial position.

REPAIR INSTRUCTIONS - ON VEHICLE**DRIVE BELT REPLACEMENT**

Removal Procedure

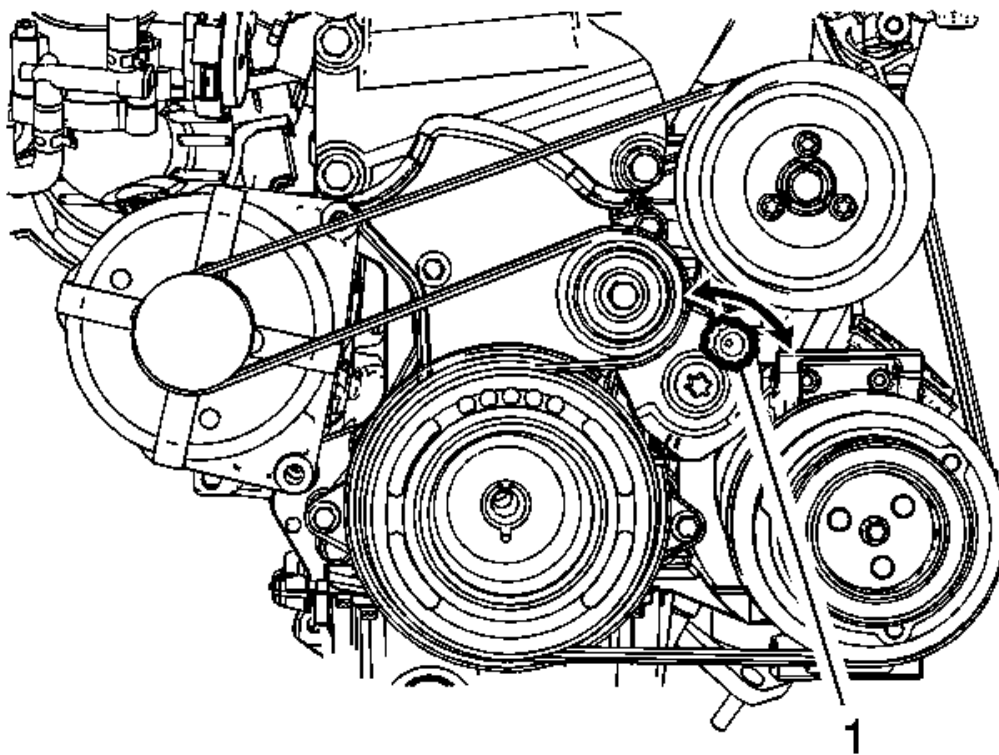


Fig. 7: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: To remove the power steering pump belt, do remove the accessory belt in advance.

1. Rotate the tensioner star-nut and remove the accessory belt.
2. Remove the power steering belt. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .

Installation Procedure

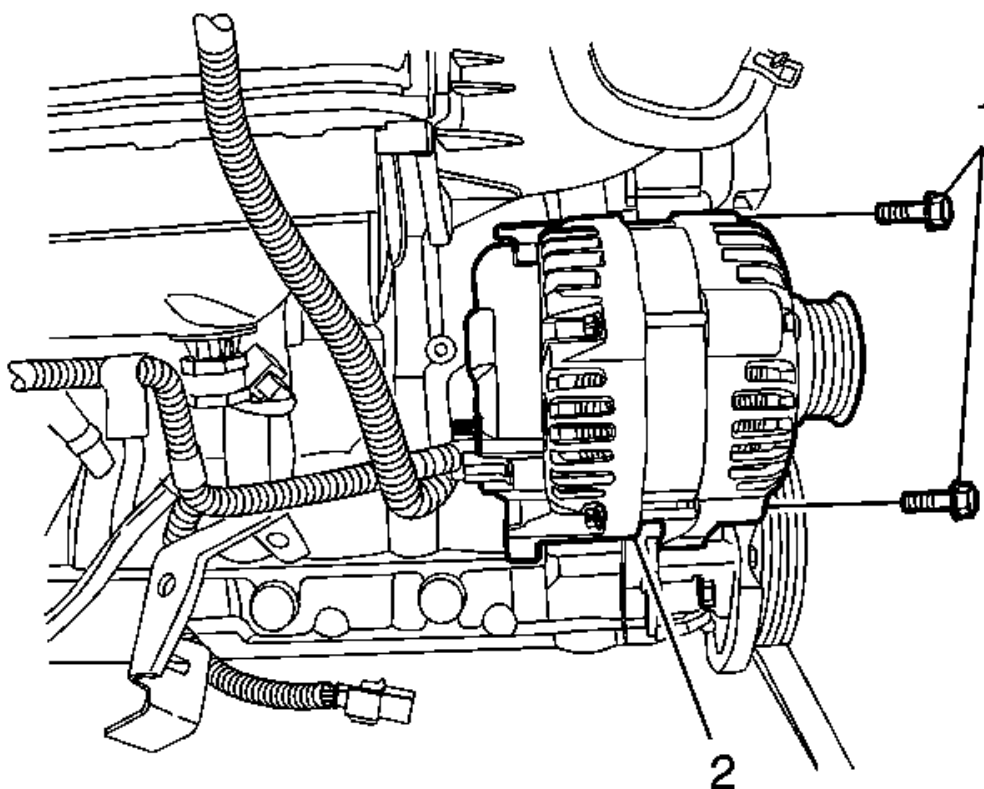


Fig. 8: Generator Retaining Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the power steering belt. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .
2. Rotate the tensioner star-nut and install the accessory belt.
3. Install the engine front shield at the position of right front wheel.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

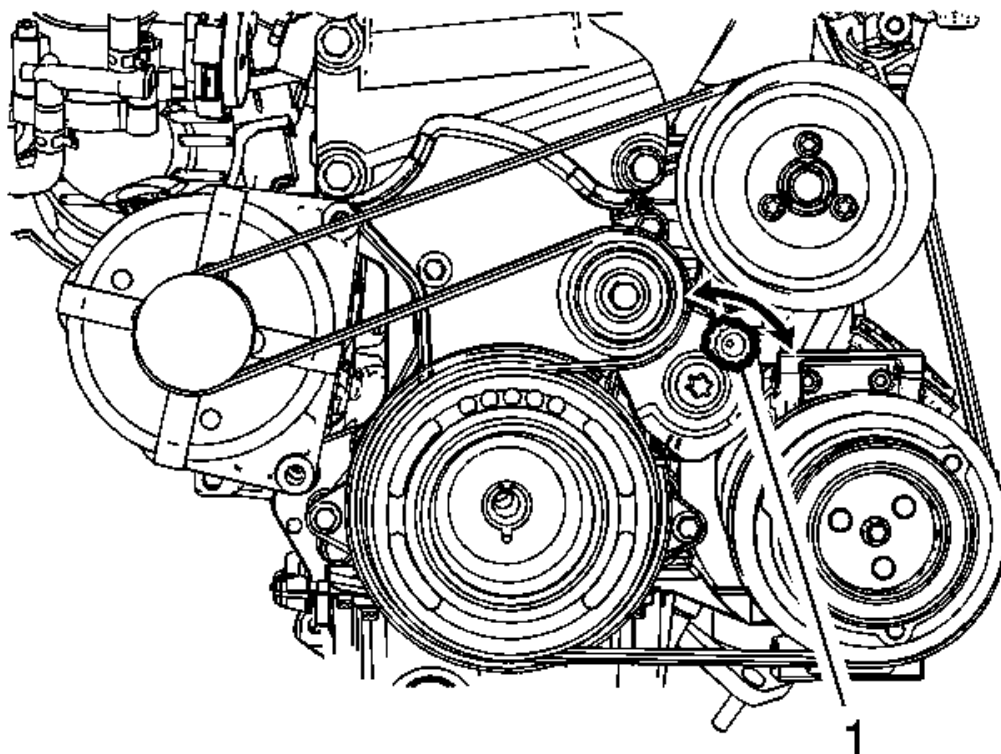


Fig. 9: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

NOTE: To remove the power steering pump belt, do remove the accessory belt in advance.

1. Rotate the tensioner star-nut and remove the accessory belt.
2. Remove the power steering belt. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .

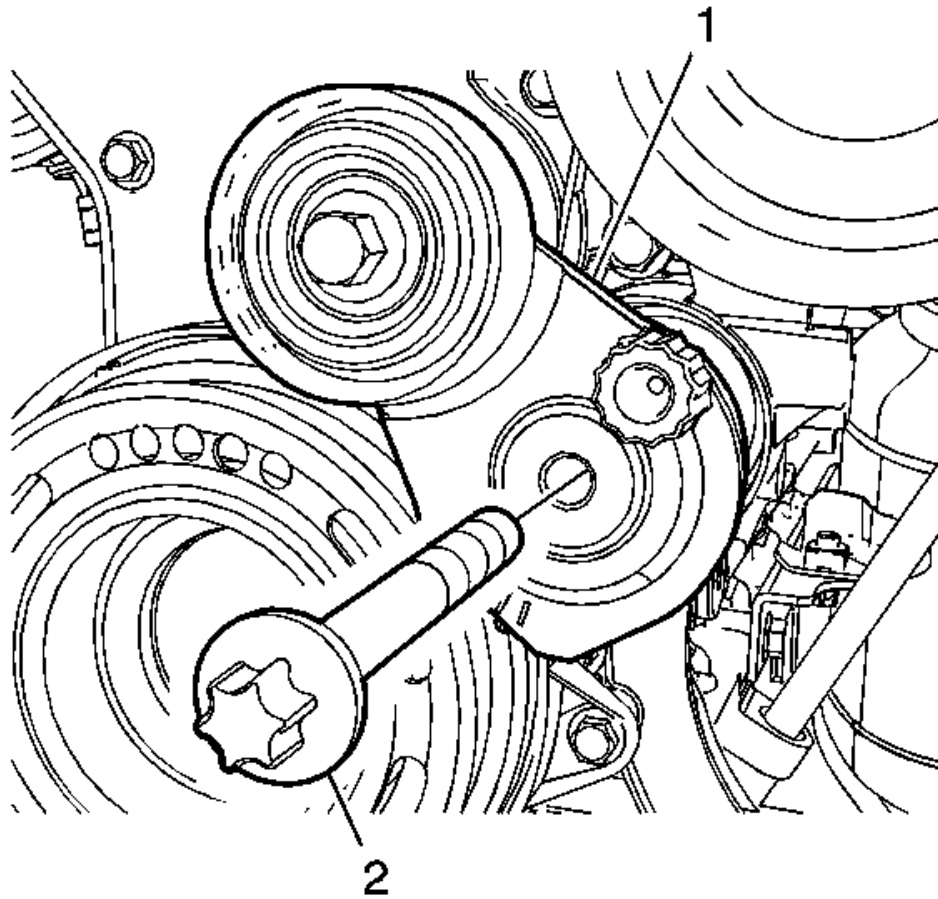


Fig. 10: Accessory Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Remove the accessory belt tensioner.

Installation Procedure

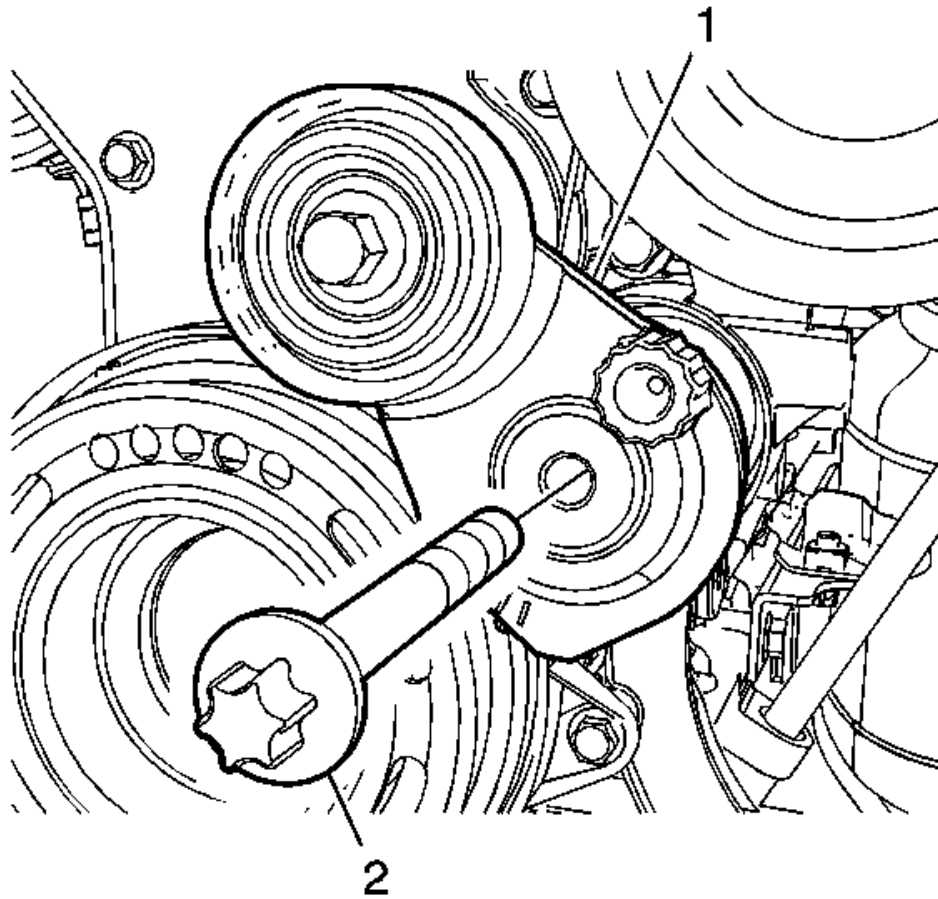


Fig. 11: Accessory Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the accessory belt tensioner and tighten to 50 N.m (36.8 lb ft).

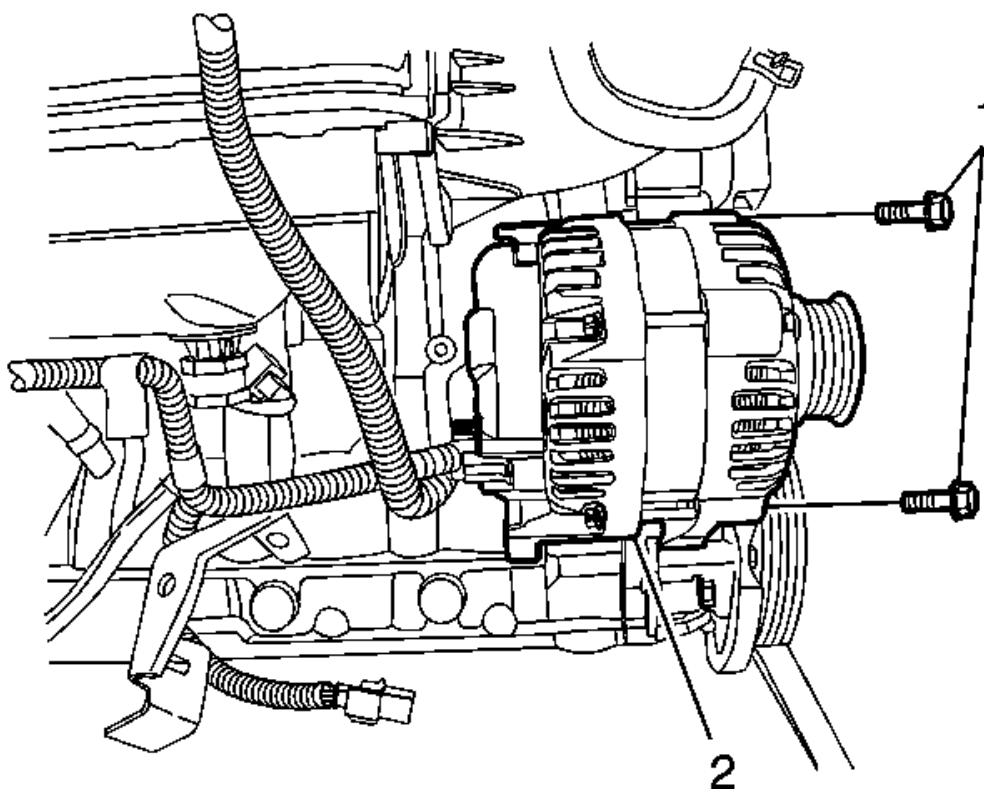


Fig. 12: Generator Retaining Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

2. Install the power steering belt. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .
3. Rotate the tensioner star-nut and install the accessory belt.
4. Install the engine front shield at the position of right front wheel.

ENGINE MOUNT REPLACEMENT

Special Tools

EN-48356 Engine Fixture

Removal Procedure

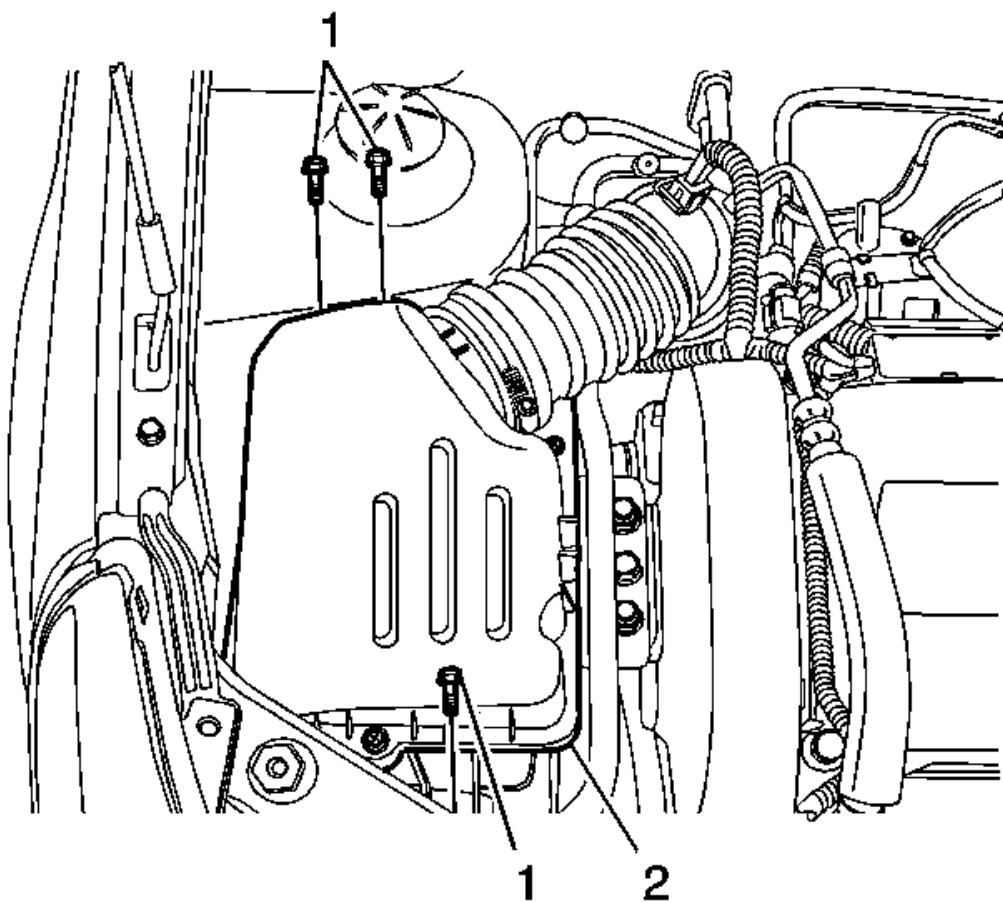


Fig. 13: Air Cleaner Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner assembly.

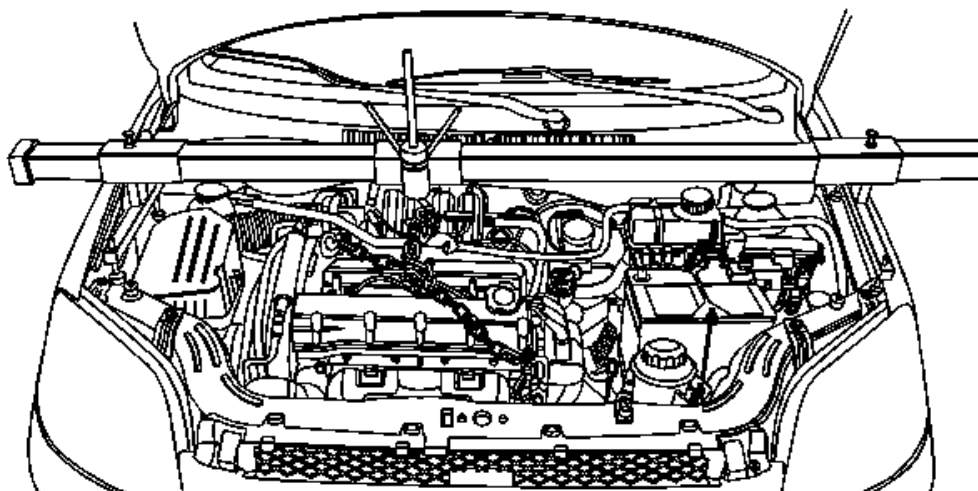


Fig. 14: Engine Support Tool
Courtesy of GENERAL MOTORS CORP.

2. Install EN-48356.

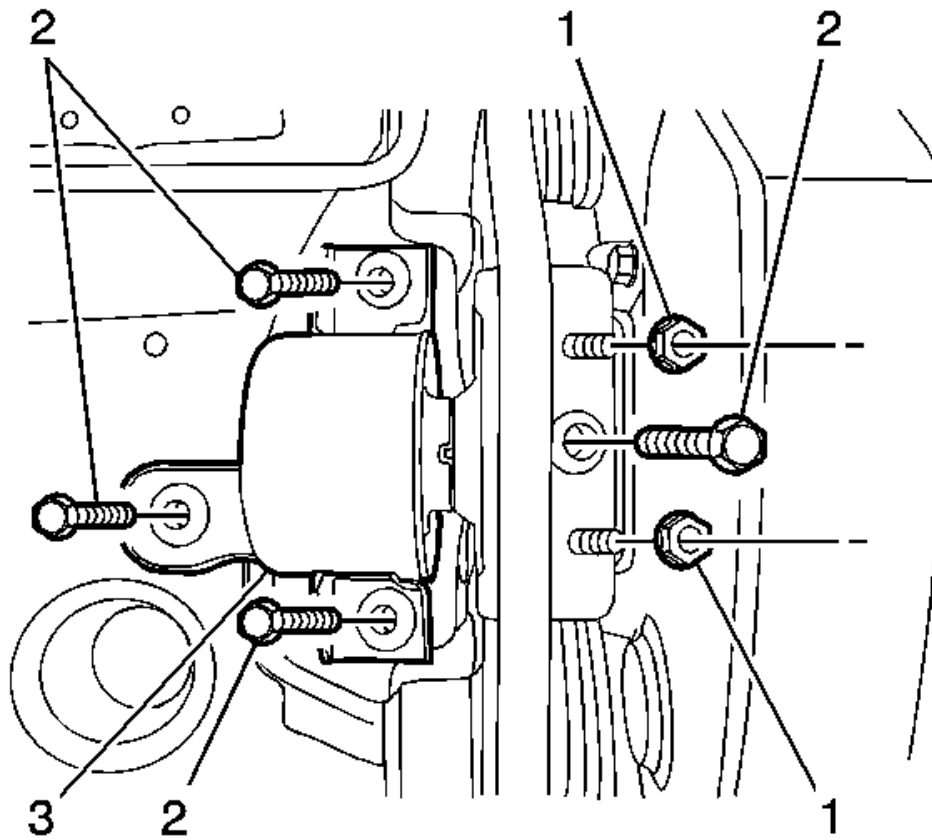


Fig. 15: Engine Mount, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine mount bolts and nuts.

Installation Procedure

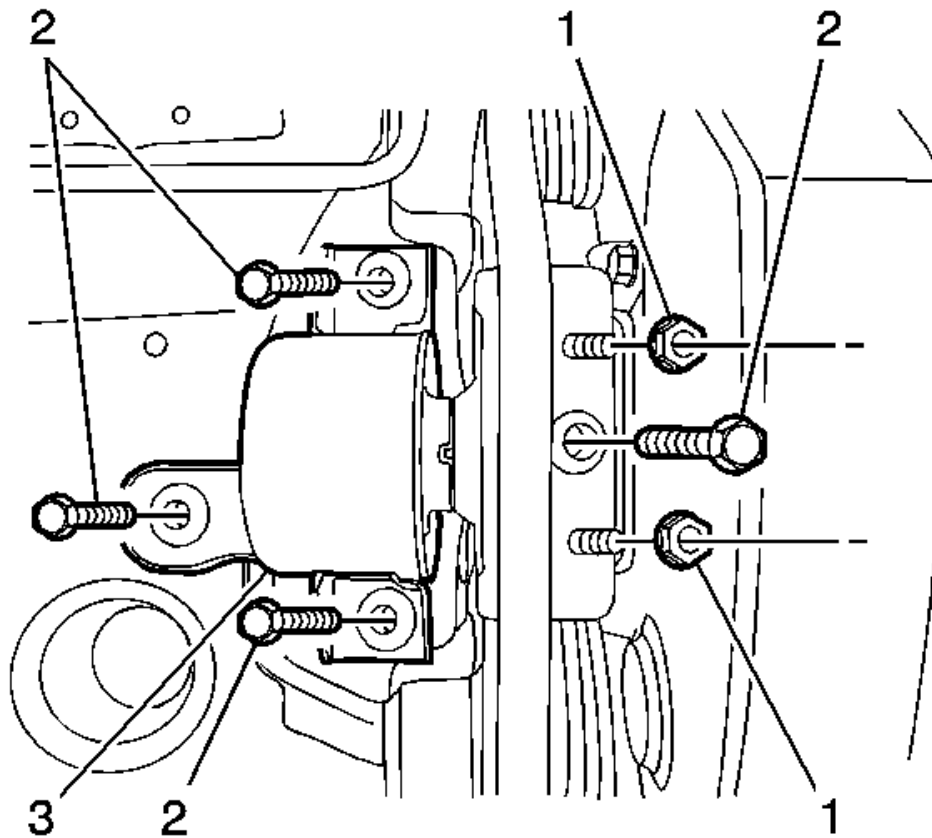


Fig. 16: Engine Mount, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the engine mount bolts and nuts and tighten to 55 N.m (40.5 lb ft).

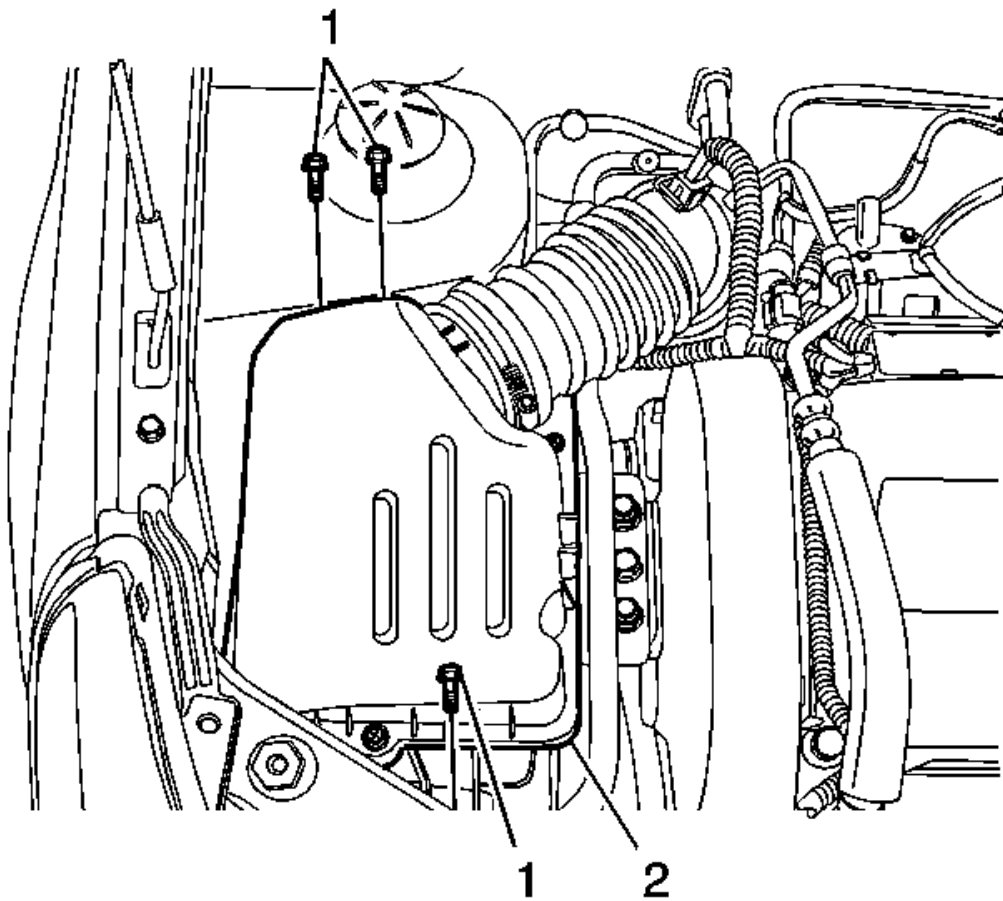


Fig. 17: Air Cleaner Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove EN-48356.
3. Install the air cleaner assembly.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

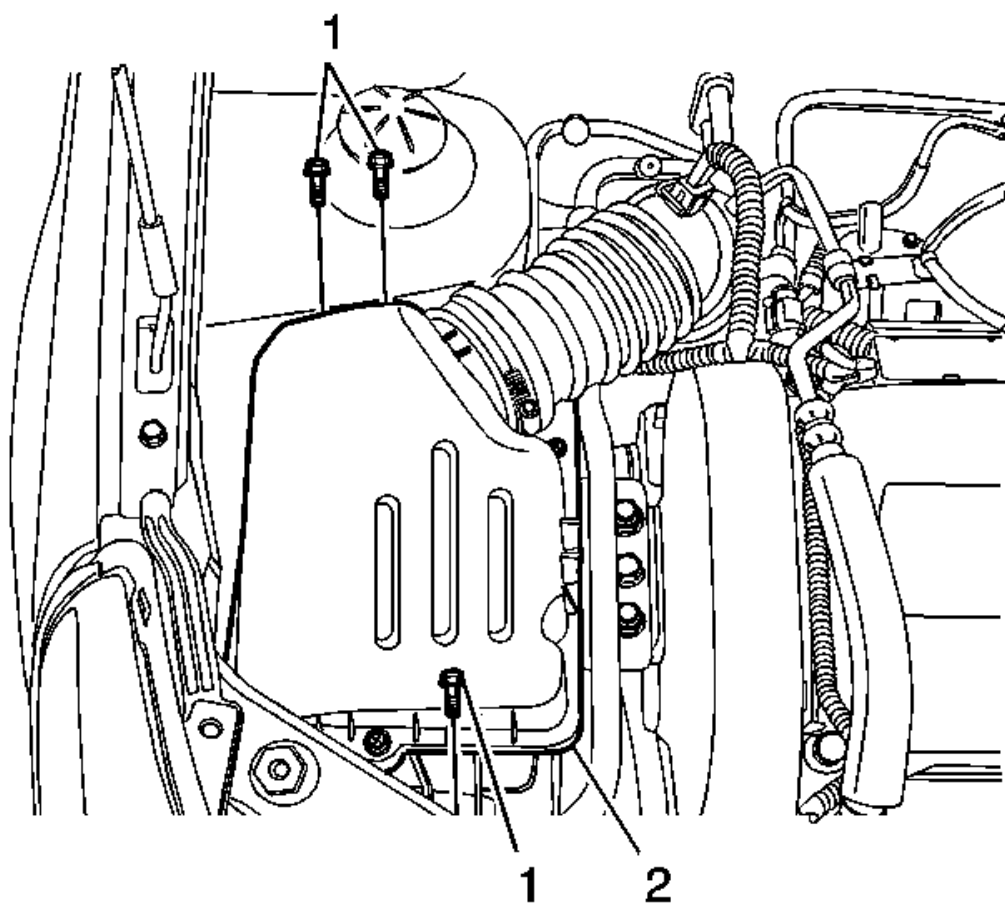


Fig. 18: Air Cleaner Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery negative cable.
2. Release the fuel pressure. Refer to FUEL PRESSURE RELIEF .
3. Remove the air cleaner assembly.
4. Remove the power steering pressure pipe clamp from the intake manifold.

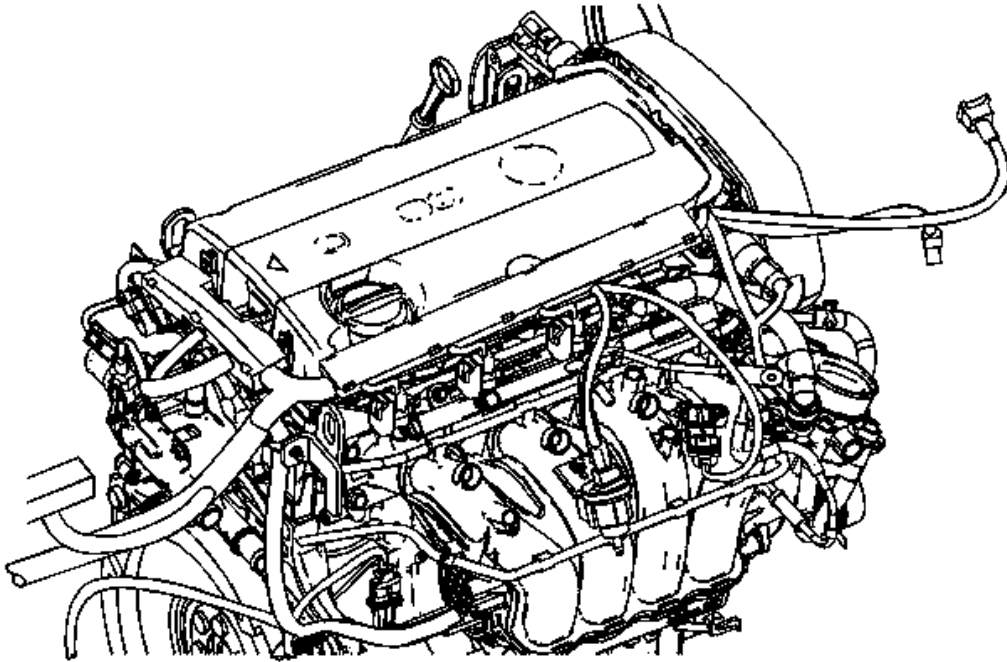


Fig. 19: Related Sensor And Actuator Connectors
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the related sensor and actuator connectors and the pull engine wiring harness aside.
 - A/C pressure sensor (ACP) connector
 - CAM position solenoid valve connector
 - Electric throttle controller (ETC) connector
 - Manifold air pressure (MAP) sensor connector
 - EVAP solenoid valve connector
 - Injector connectors

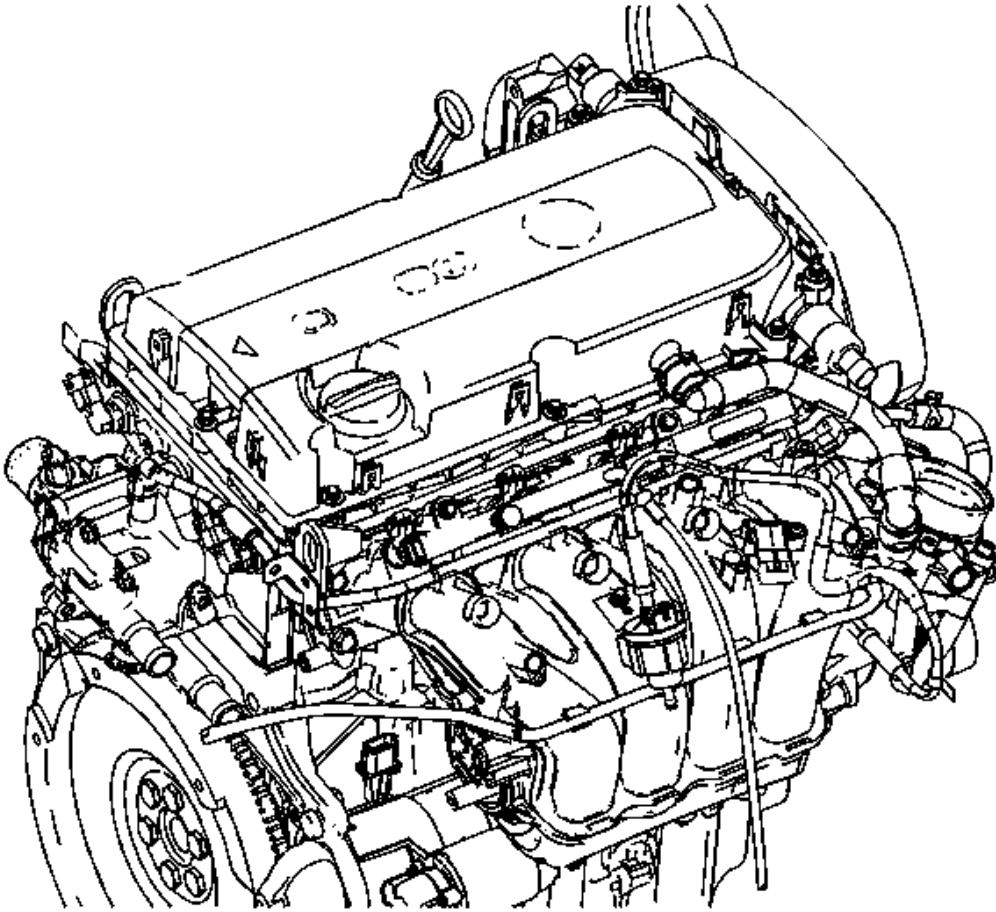


Fig. 20: Fuel Line At Fuel Rail
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel line from the fuel rail.
7. Disconnect the ETC coolant inlet/outlet hoses and then pull it aside.
8. Remove the PCV hose from the ETC.
9. Remove the cylinder head cover.

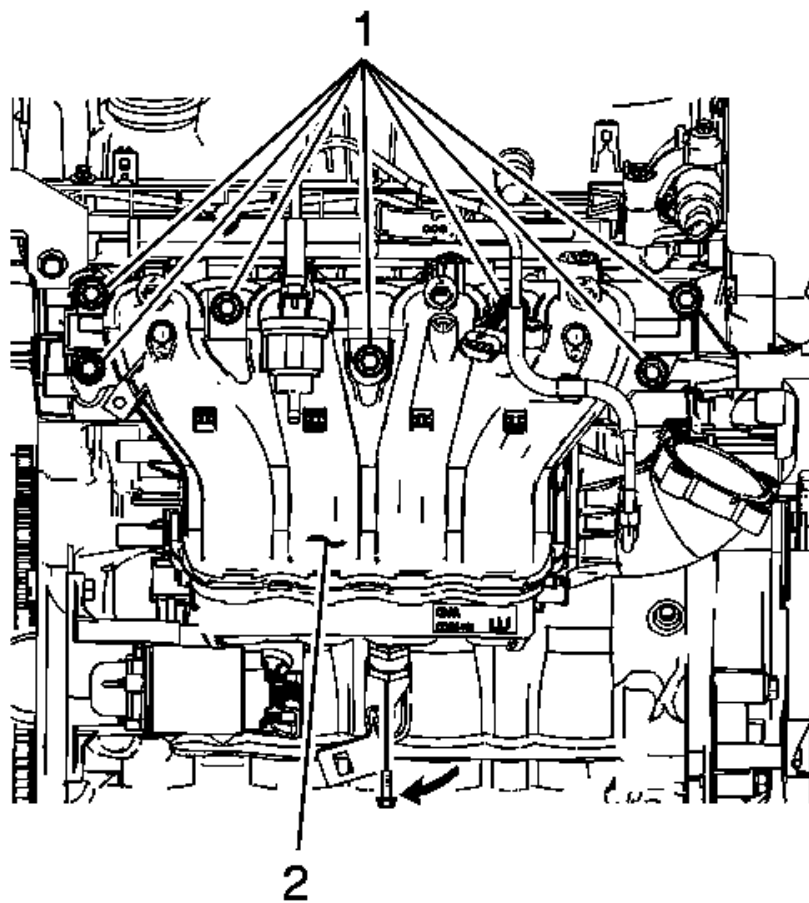


Fig. 21: Intake Manifold & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the electric throttle controller (ETC).
11. Remove the intake manifold with the gasket.

Installation Procedure

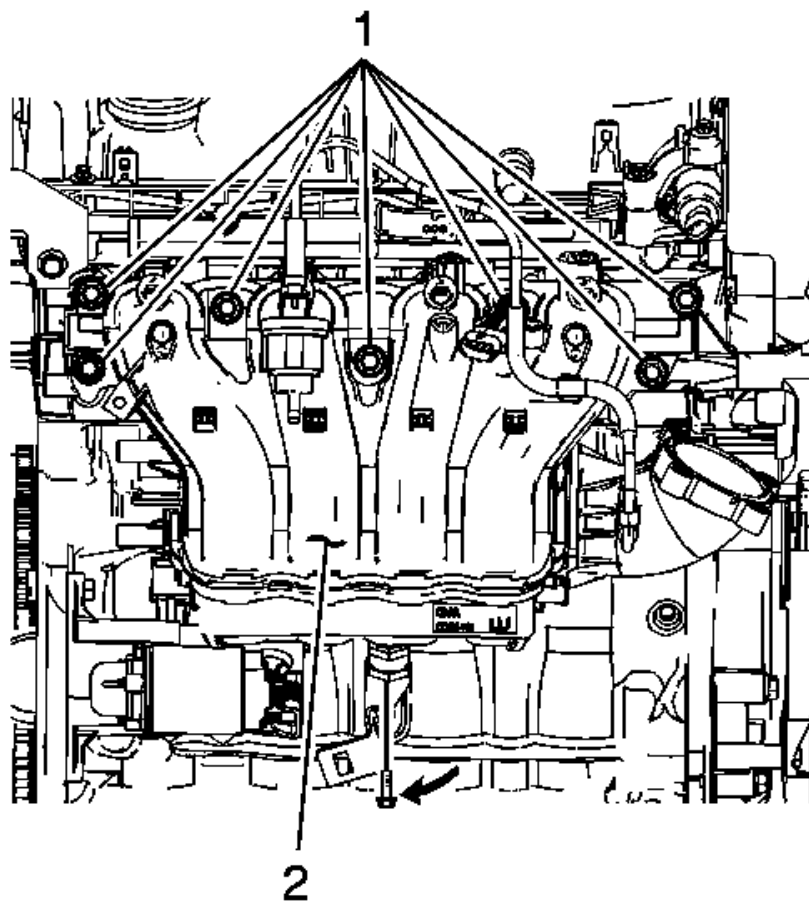


Fig. 22: Intake Manifold & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Do not reuse the intake manifold gasket.

1. Install the intake manifold with the new gasket and tighten.
 - The intake manifold bolts to 20 N.m (14.7 lb ft).
 - The intake manifold lower bracket bolt to 8 N.m (70.8 lb in).
2. Install the electric throttle controller (ETC).

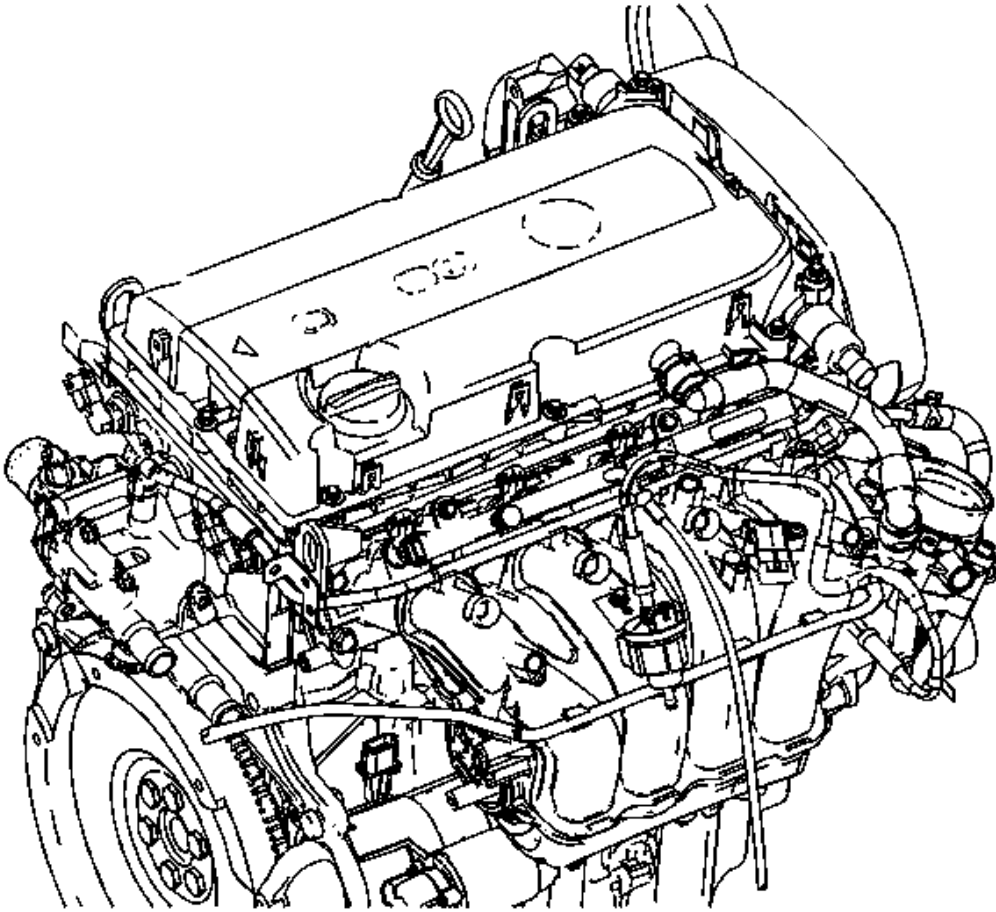


Fig. 23: Fuel Line At Fuel Rail
Courtesy of GENERAL MOTORS CORP.

3. Install the cylinder head cover.
4. Install the PCV hose to the ETC.
5. Connect the ETC coolant inlet/outlet hoses.
6. Connect the fuel line to the fuel rail.

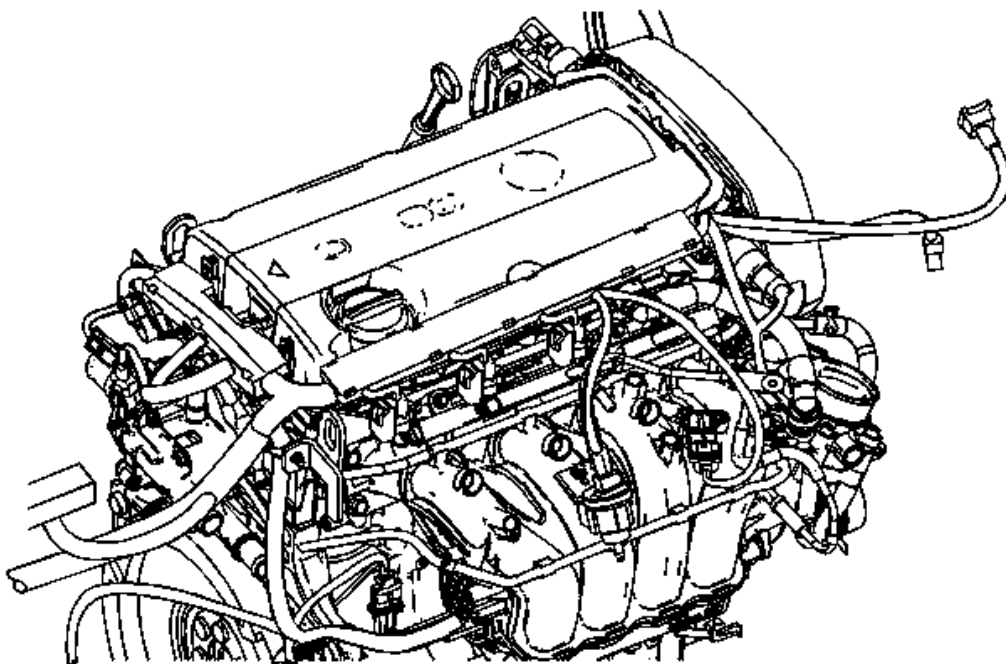


Fig. 24: Related Sensor And Actuator Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the related sensor and actuator connectors.
 - A/C pressure sensor (ACP) connector
 - CAM position solenoid valve connector
 - Electric throttle controller (ETC) connector
 - Manifold air pressure (MAP) sensor connector
 - EVAP solenoid valve connector
 - Injector connectors

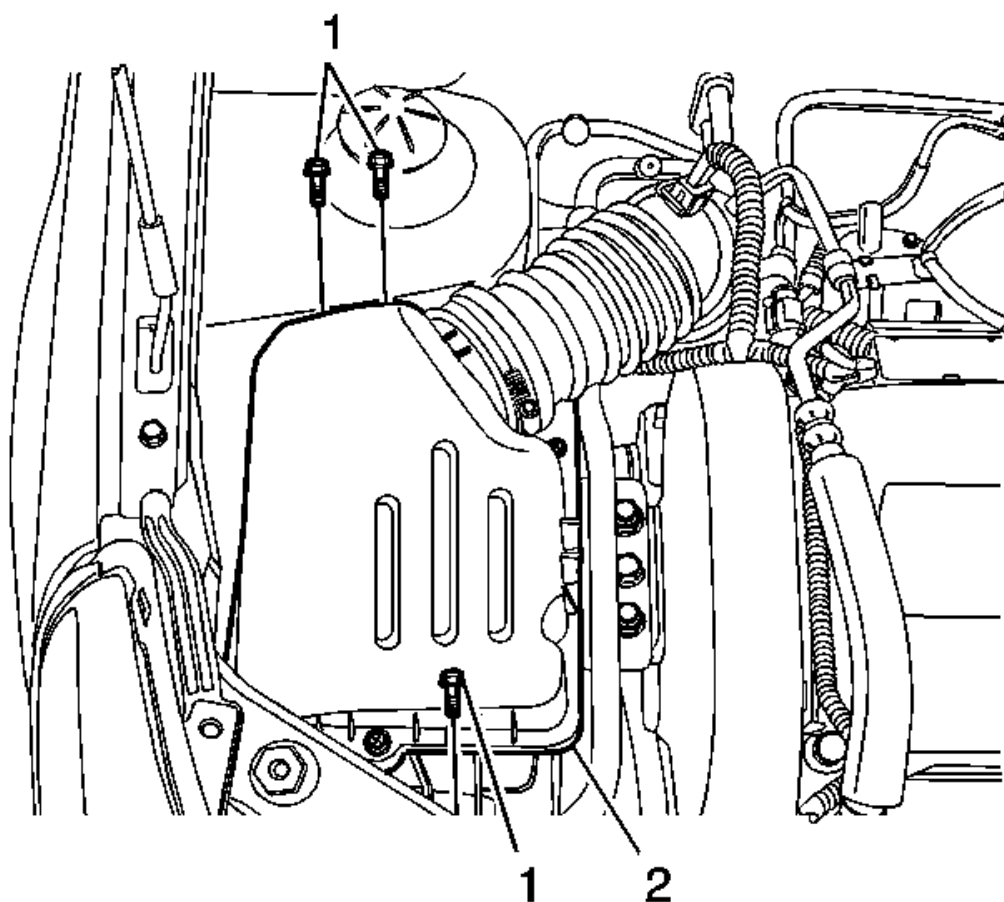


Fig. 25: Air Cleaner Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the power steering pressure pipe clamp to the intake manifold.
9. Install the air cleaner assembly.
10. Connect the battery negative cable.

TIMING BELT REPLACEMENT

Special Tools

- EN-48356 Engine Fixture
- **KM-6625** Flywheel Locking Device
- **KM-6333** Fixing Rod

- **MK-6628** Locking Tool
- **MK-6340** Locking Tool

Removal Procedure

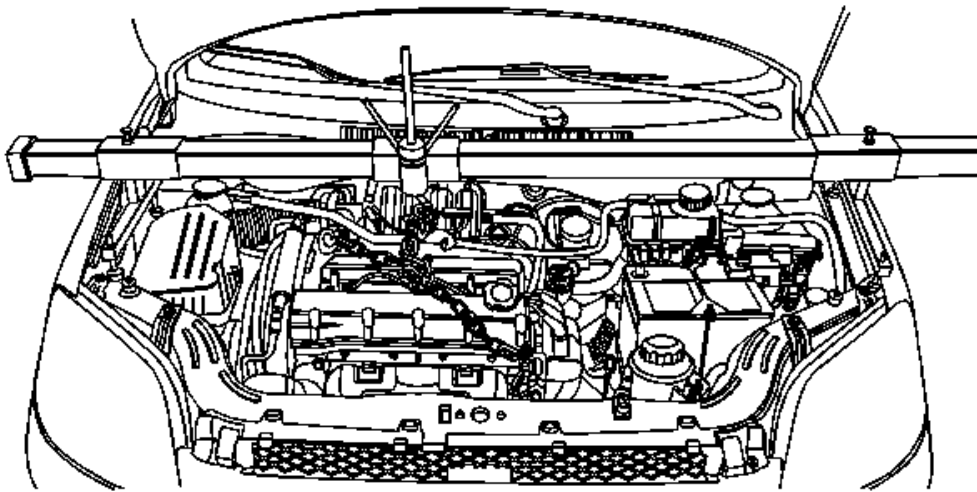


Fig. 26: Engine Support Tool
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery negative cable.
2. Remove the air cleaner assembly.
3. Install EN-48356.

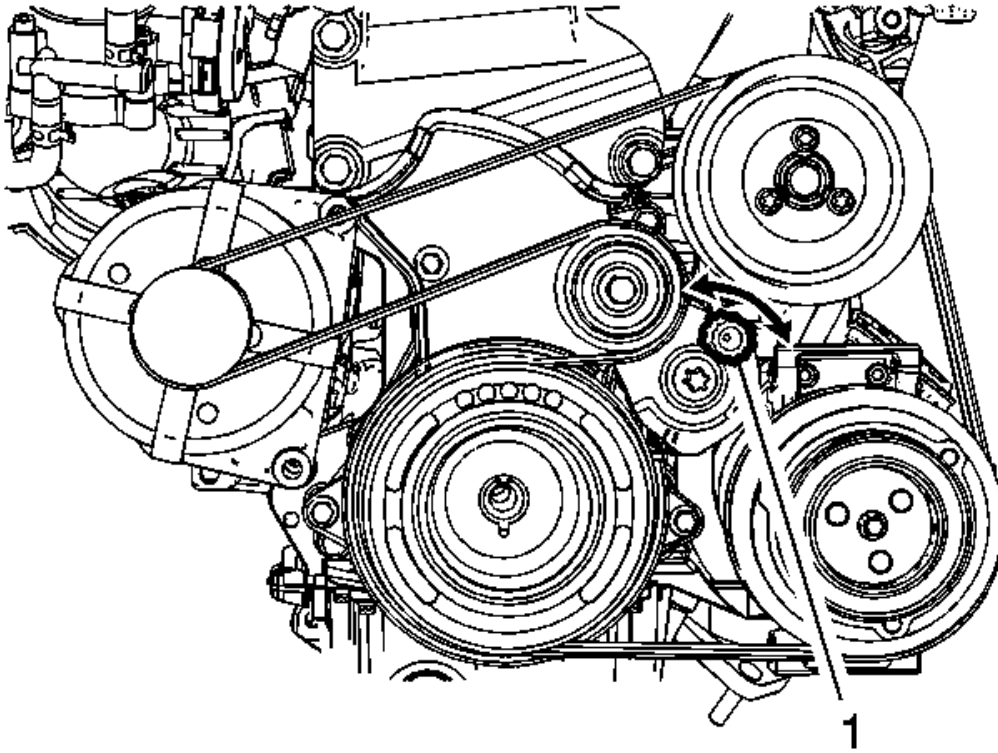


Fig. 27: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

4. Remove the accessory belt. Refer to **Drive Belt Replacement**.
5. Remove the accessory belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

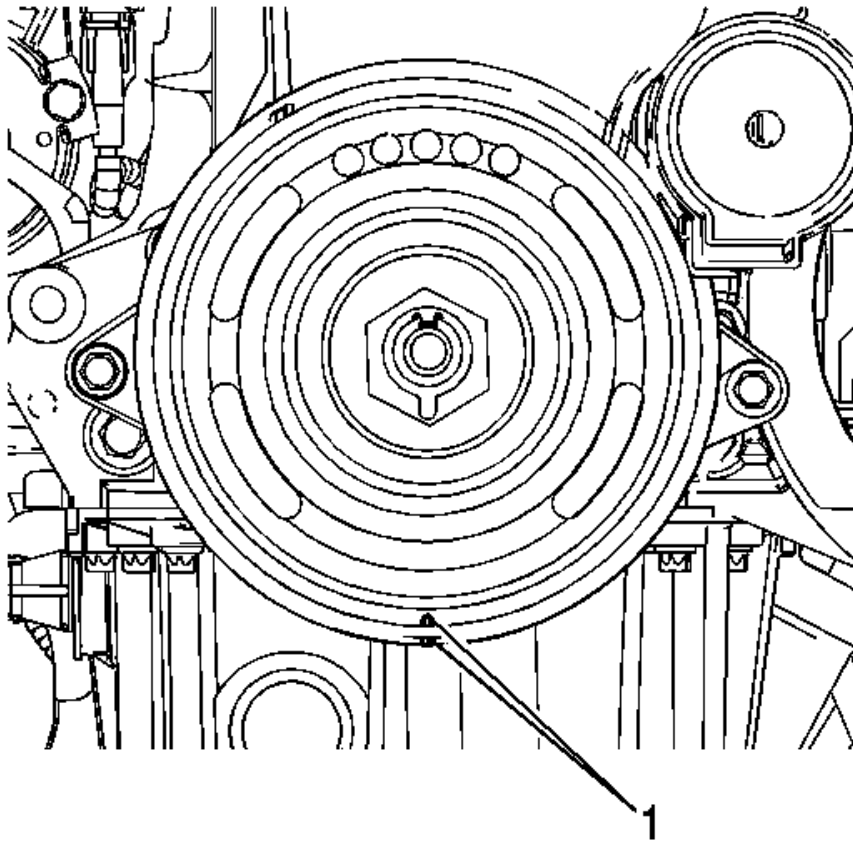


Fig. 28: Crankshaft Pulley Notches
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft pulley clockwise.
7. Align the notches between the pulley and the cover.

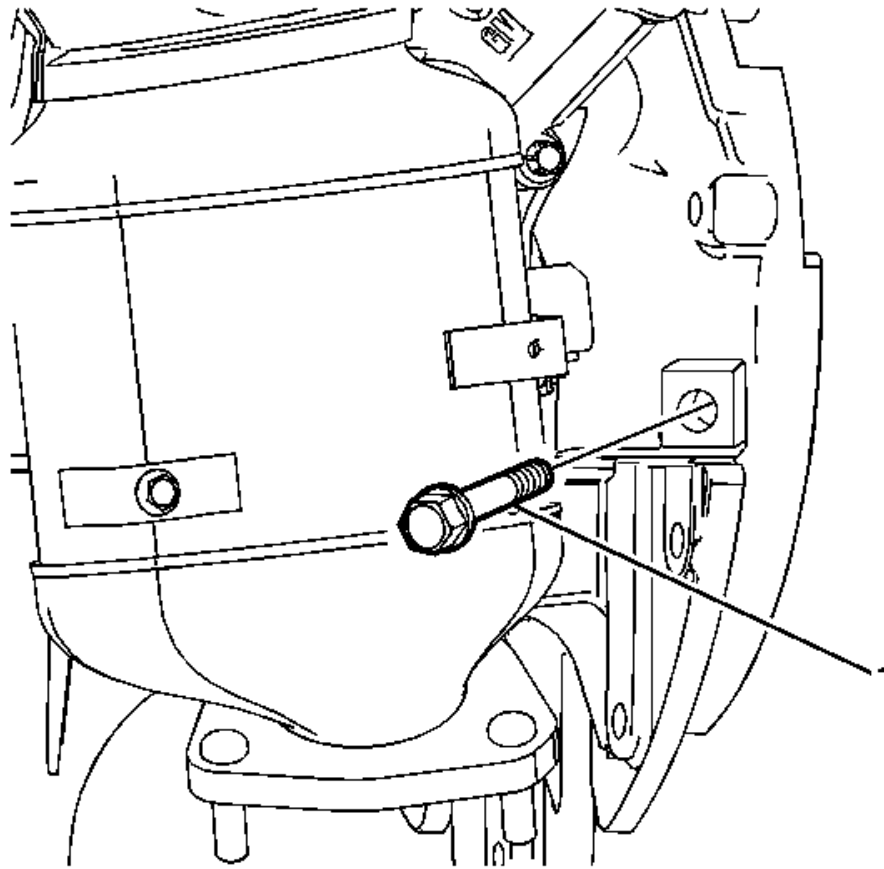


Fig. 29: Transmission Tightening Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the transmission tightening bolt.
9. Install **KM-6625** to block the crankshaft.
10. Install the transmission tightening bolt.

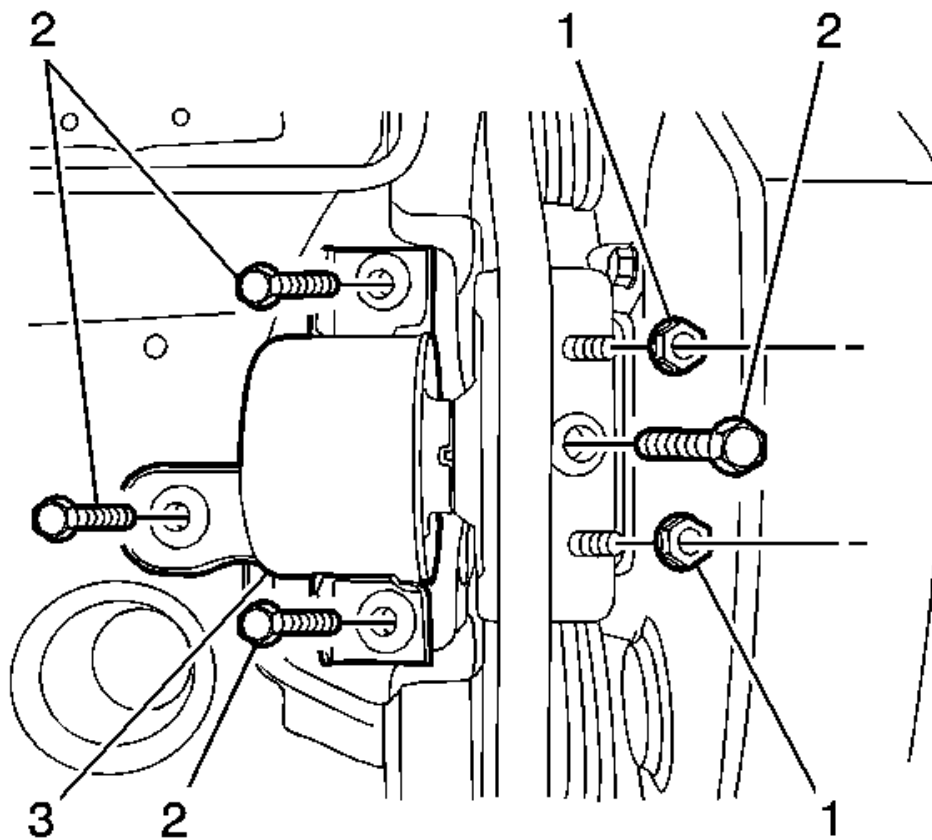


Fig. 30: Engine Mount, Bolts & Nuts
Courtesy of GENERAL MOTORS CORP.

11. Remove the cylinder head cover.
12. Remove the engine mount.

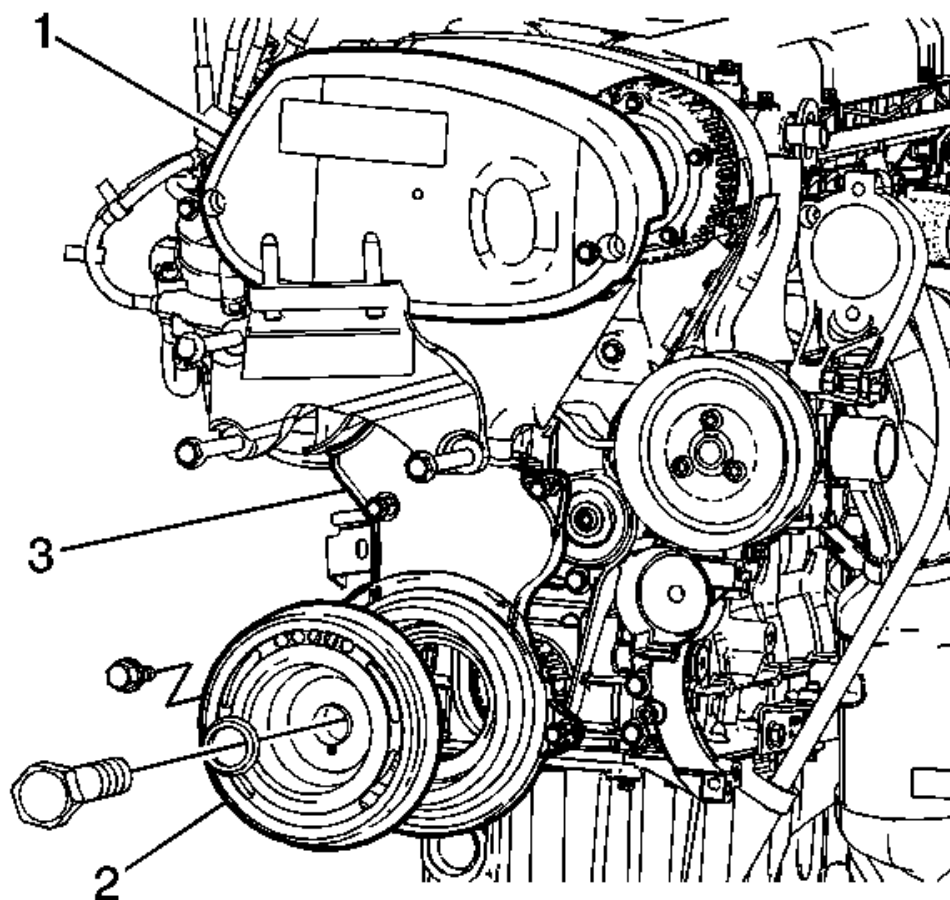


Fig. 31: Crankshaft Pulley & Timing Belt Upper Cover
Courtesy of GENERAL MOTORS CORP.

13. Remove the crankshaft pulley.
14. Remove the timing belt upper cover.
15. Remove the engine mount bracket.
16. Remove the timing belt lower cover.
17. Remove the timing belt center cover.

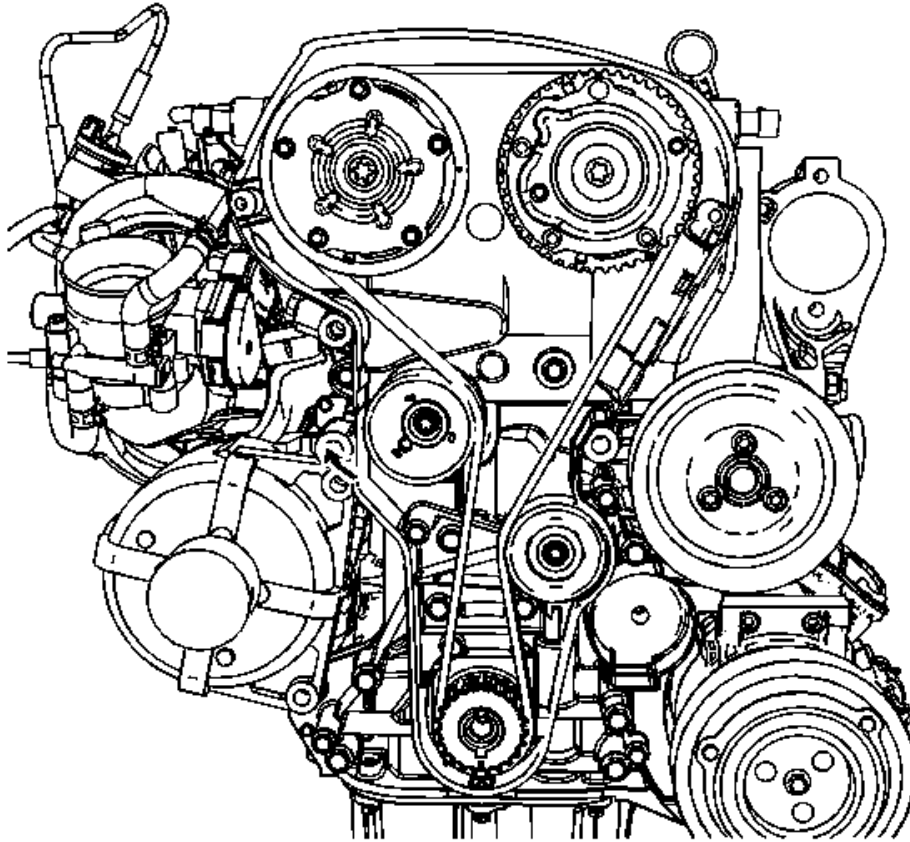


Fig. 32: Timing Belt

Courtesy of GENERAL MOTORS CORP.

18. Install **KM-6333** during rotating the timing belt tensioner.
19. Remove the timing belt.

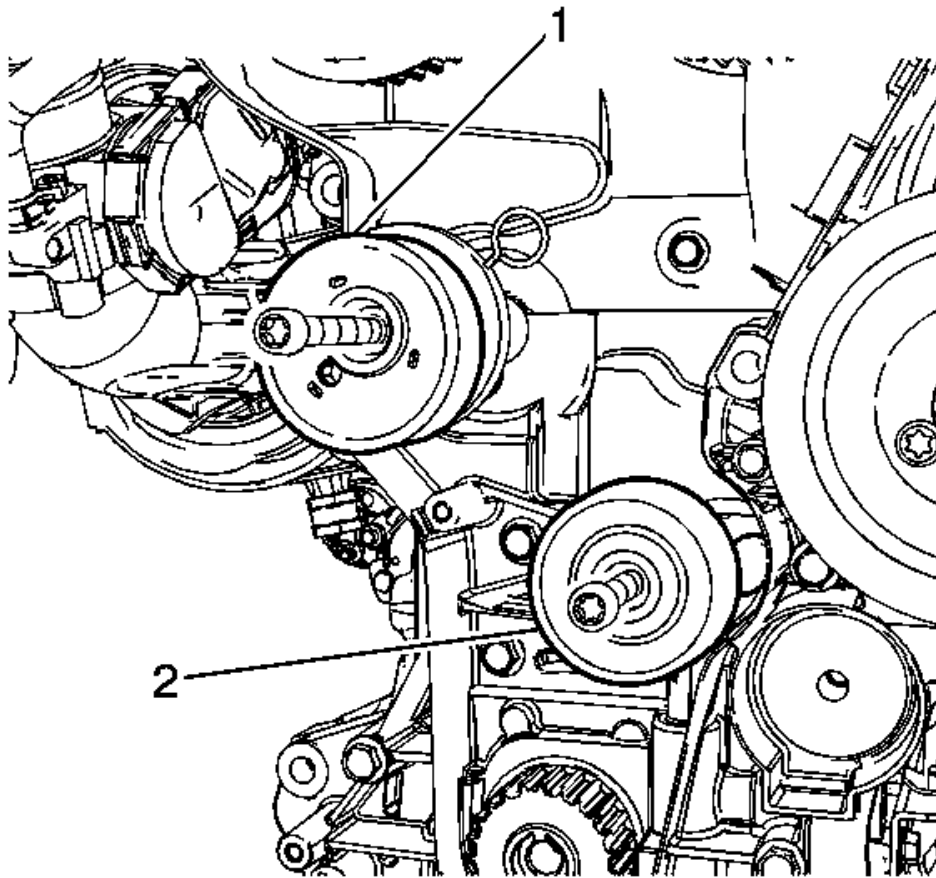


Fig. 33: Timing Belt Tensioner & Timing Belt Idler
Courtesy of GENERAL MOTORS CORP.

20. Remove the timing belt tensioner.
21. Remove the timing belt idler.

Adjustment Procedure

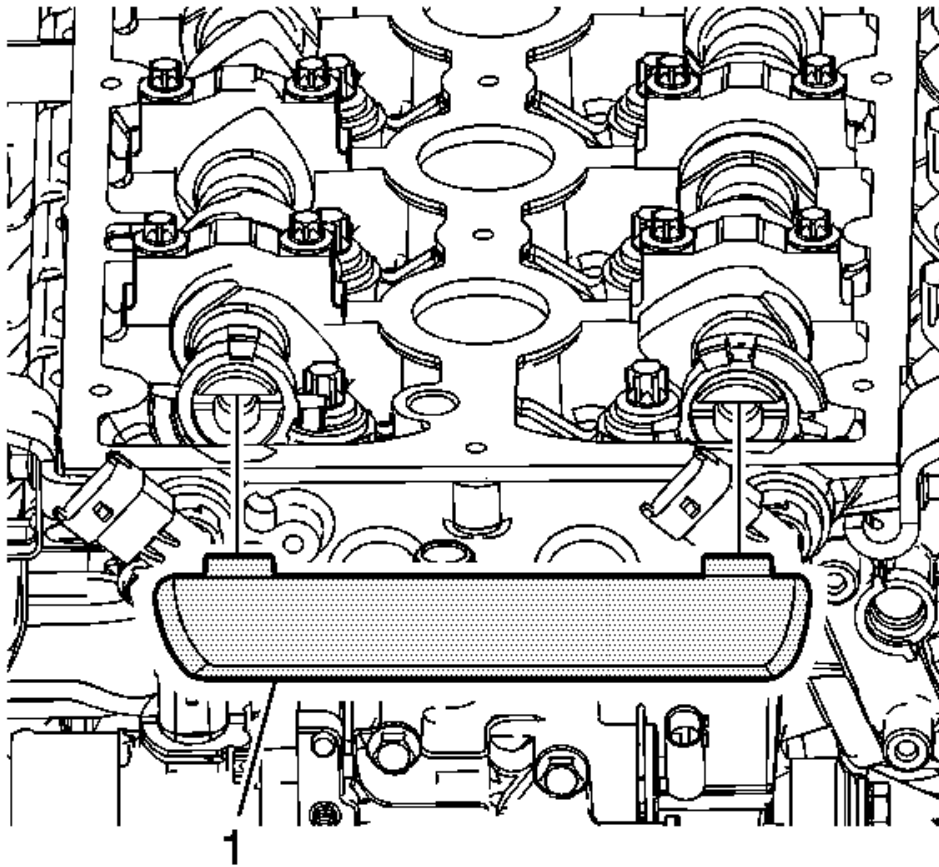


Fig. 34: Camshaft Alignment Tool
Courtesy of GENERAL MOTORS CORP.

1. Align the both camshaft horizontally to install the **MK-6628** .
2. Confirm the both camshaft sprocket spot aligned.

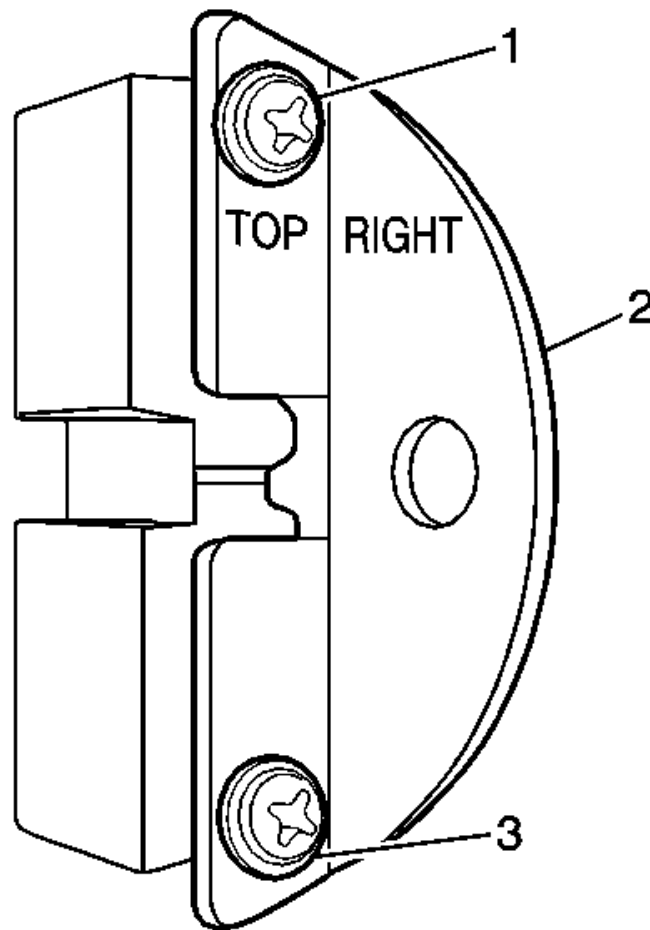


Fig. 35: MK-6340

Courtesy of GENERAL MOTORS CORP.

3. Prepare the right half of MK-6340 .

NOTE: Recognizable from the lettering "Right"

4. Unscrew the bolts (1) and detach the front panel (2) from MK-6340 .

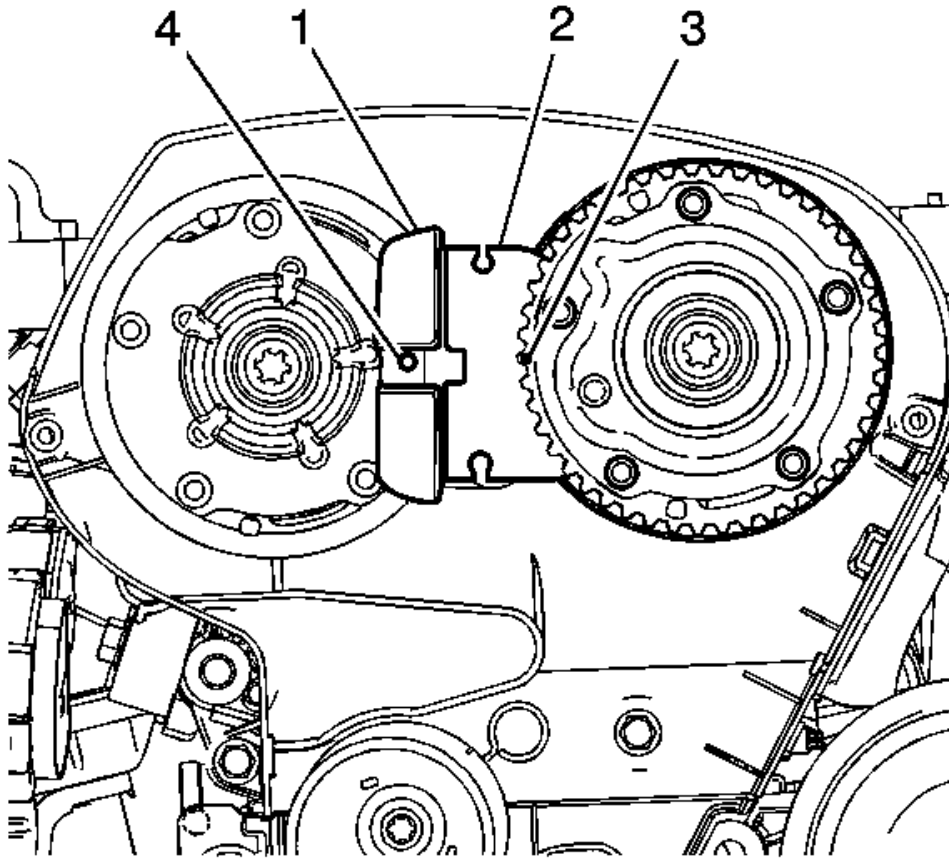


Fig. 36: Sprocket Holding Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: The spot-type marking (4) on the intake camshaft sprocket does not correspond to the groove of MK-6340 during this process.

5. Confirm aligning between the intake side spot (3) and the exhaust side spot (4) on the camshaft sprockets.
6. If not aligned as shown, remove and install the camshaft sprocket to align.
7. Insert the left of **MK-6340** (1) into the intake camshaft sprocket side.
8. Insert the right of **MK-6340** (2) into the exhaust camshaft sprocket side.

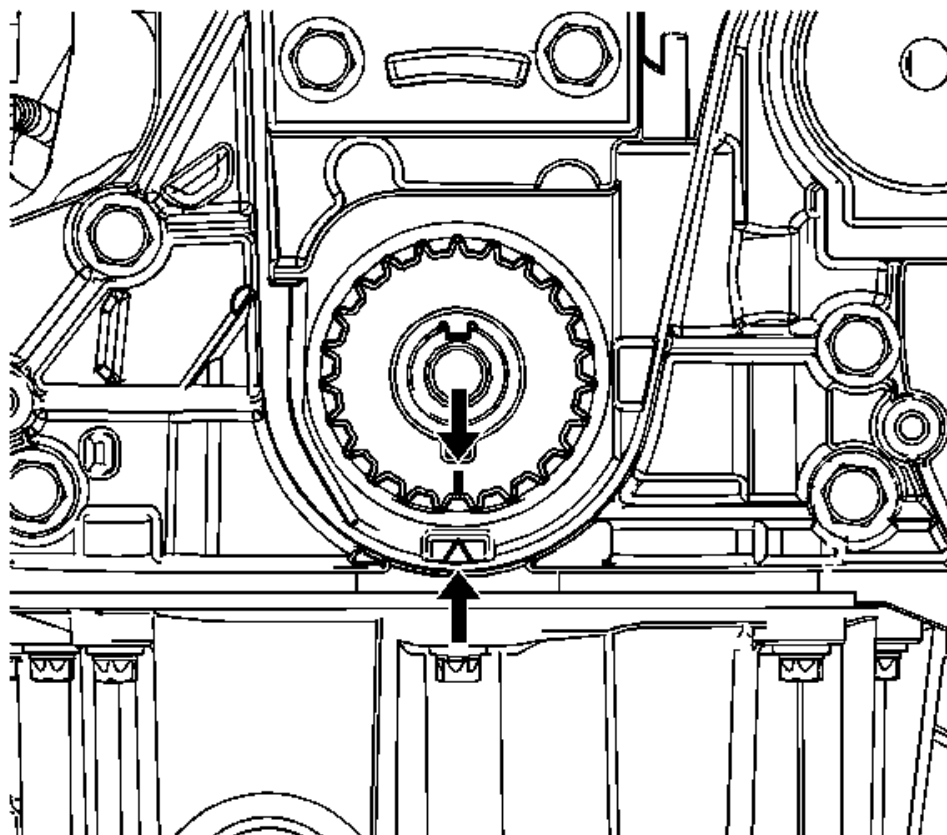


Fig. 37: Crankshaft Sprocket Notches
Courtesy of GENERAL MOTORS CORP.

NOTE: If not aligned the notches, rotate the crankshaft until aligning after remove KM-6625 .

9. Confirm align the notches between the crankshaft sprocket and the cover.

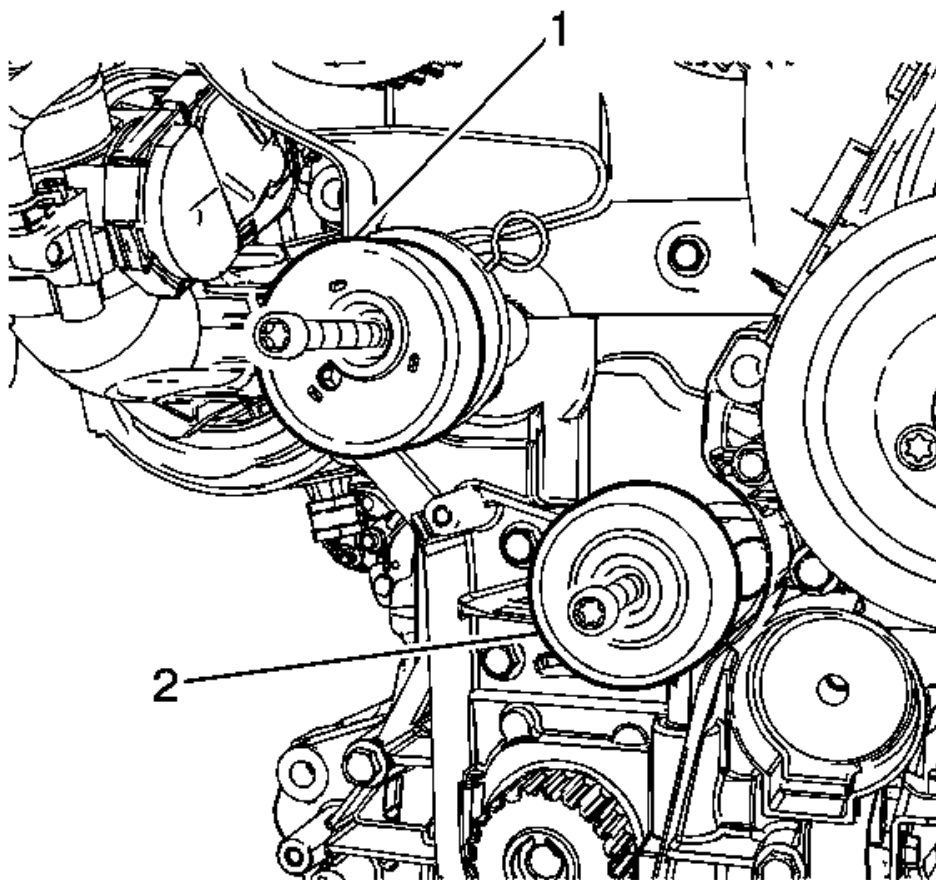


Fig. 38: Timing Belt Tensioner & Timing Belt Idler
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Install the timing belt idler and tighten to 50 N.m (36.8 lb ft).
11. Install the timing belt tensioner and tighten to 55 N.m (40.6 lb ft).

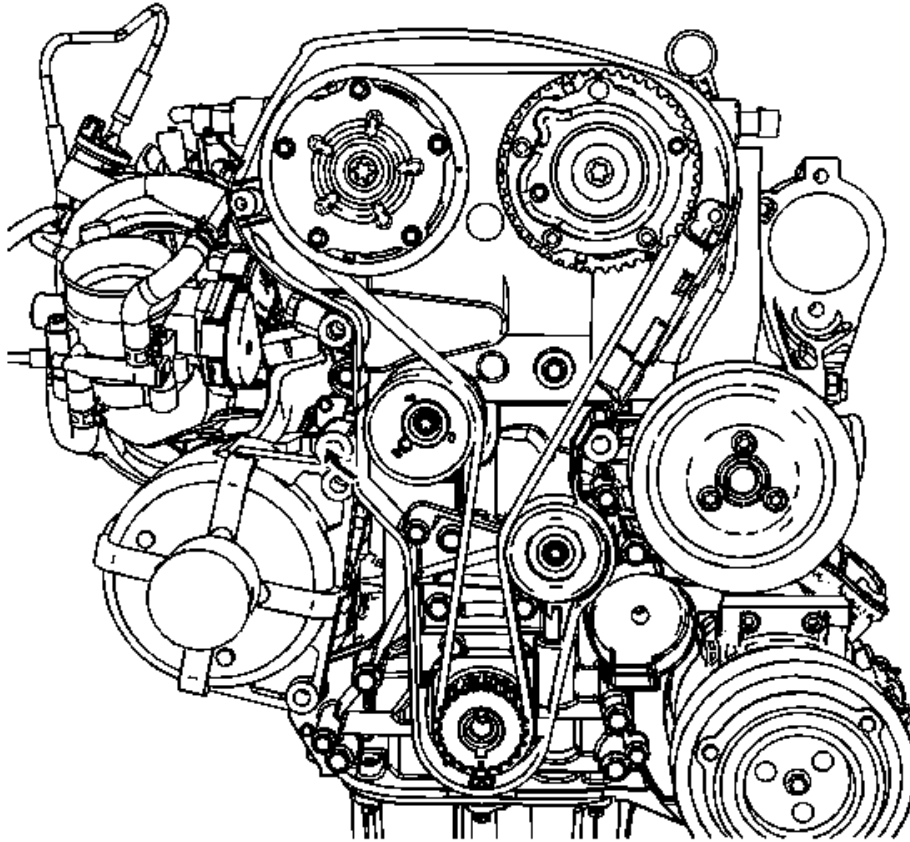


Fig. 39: Timing Belt
Courtesy of GENERAL MOTORS CORP.

12. Install the timing belt adjust.
13. Pull out **KM-6333** .

Installation Procedure

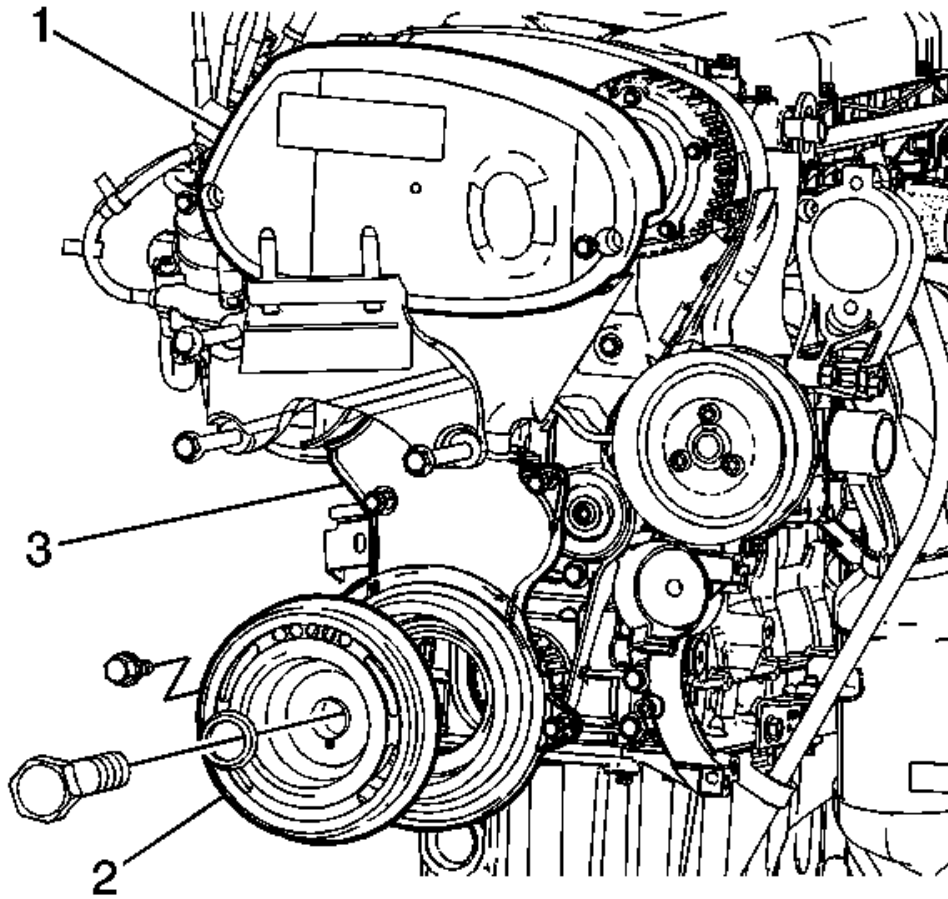


Fig. 40: Crankshaft Pulley & Timing Belt Upper Cover
Courtesy of GENERAL MOTORS CORP.

1. Install the timing belt center cover.

CAUTION: Refer to Fastener Caution .

2. Install the timing belt lower cover and tighten the bolts to 6 N.m (53.1 lb in).
3. Install the engine mount bracket and tighten the bolt to 65 N.m (47.9 lb ft).
4. Install the timing belt upper cover and tighten the bolts to 4 N.m (35.4 lb ft).
5. Install the crankshaft pulley with aligning crankshaft pulley notches and tighten to 25 N.m (18.4 lb ft).

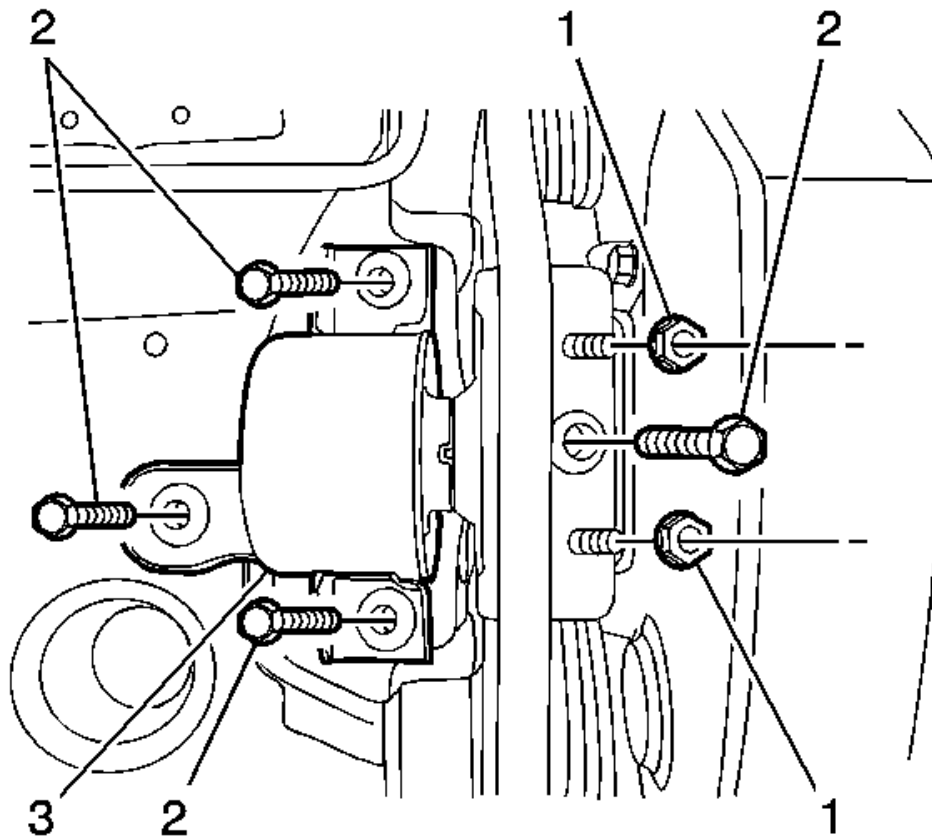


Fig. 41: Engine Mount, Bolts & Nuts
 Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount.
7. Install the cylinder head cover.

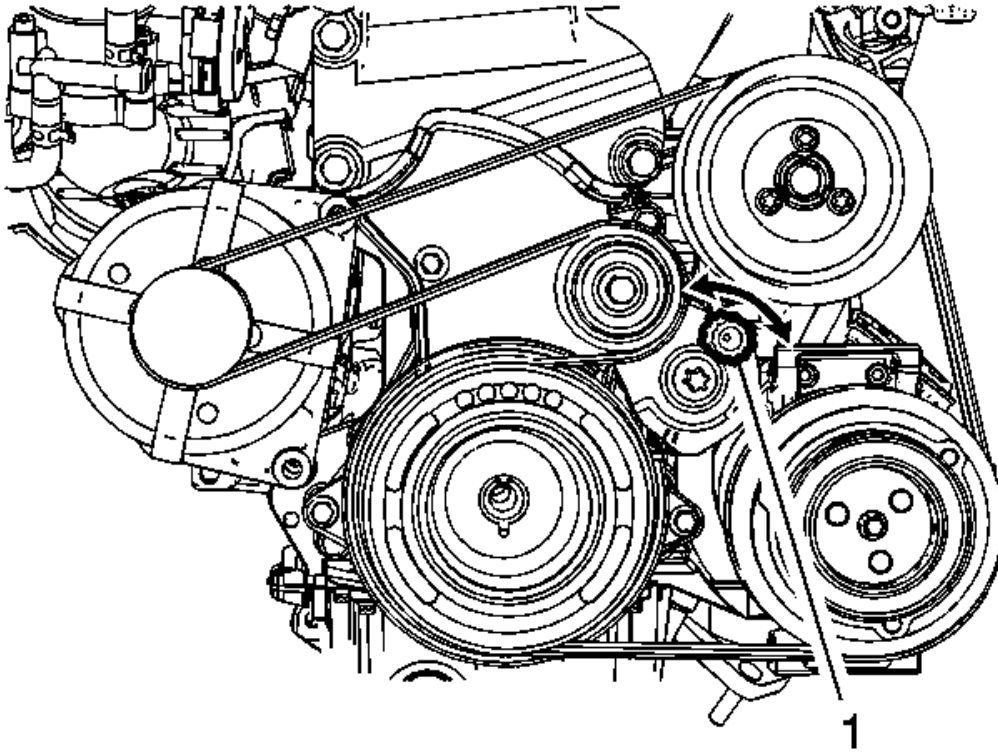


Fig. 42: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

8. Install the accessory belt. Refer to **Drive Belt Replacement**.
9. Install the accessory belt tensioner. Refer to **Drive Belt Tensioner Replacement**.

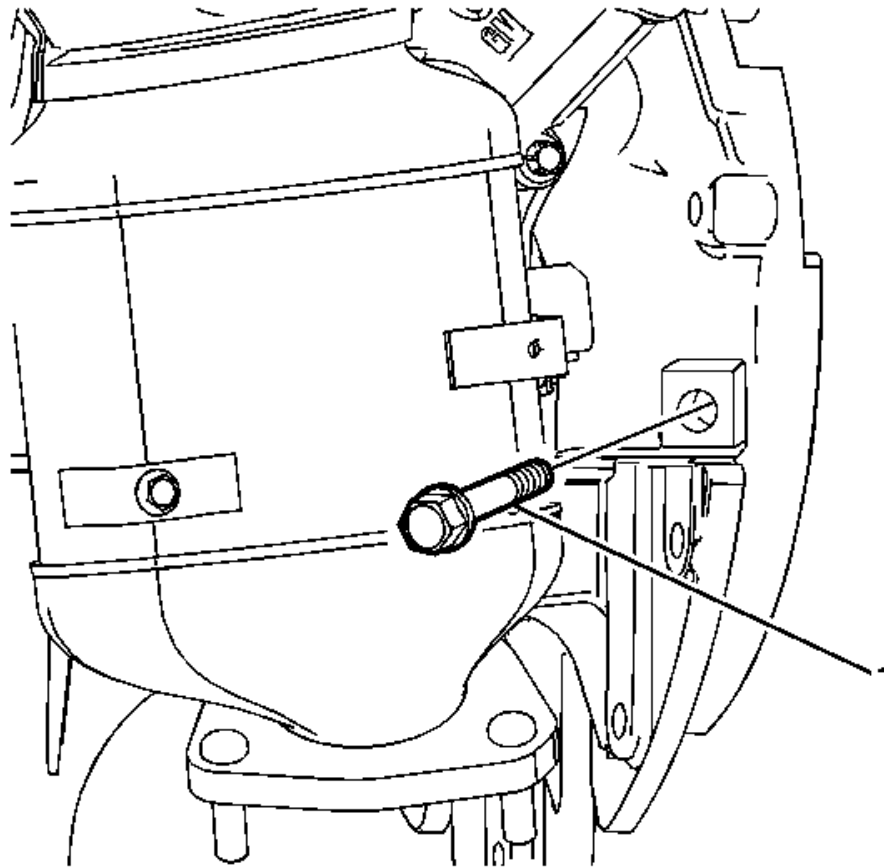


Fig. 43: Transmission Tightening Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the transmission tightening bolt.
11. Remove **KM-6625** to block the crankshaft.
12. Install the transmission tightening bolt and tighten to 60 N.m (44.2 lb ft).

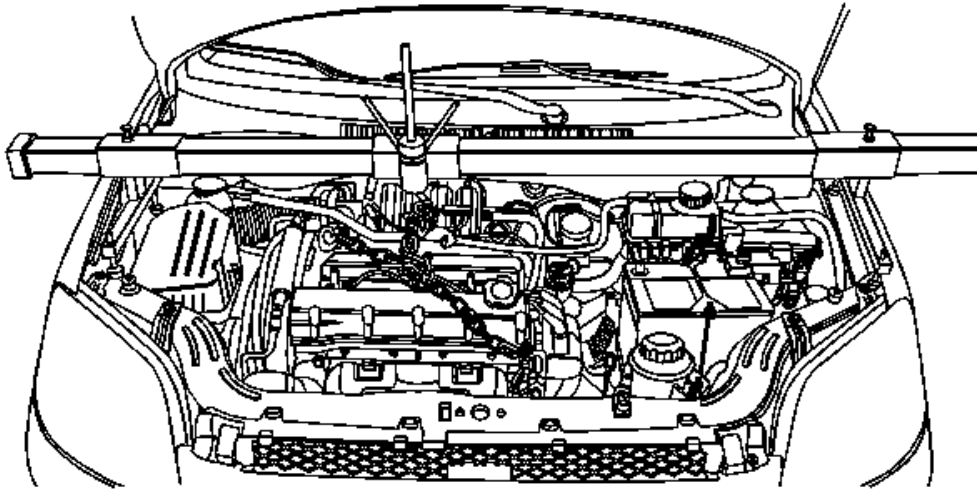


Fig. 44: Engine Support Tool
Courtesy of GENERAL MOTORS CORP.

13. Remove EN-48356.
14. Install the air cleaner assembly.
15. Connect the battery negative cable.

VALVE ROCKER ARM COVER REPLACEMENT

Removal Procedure

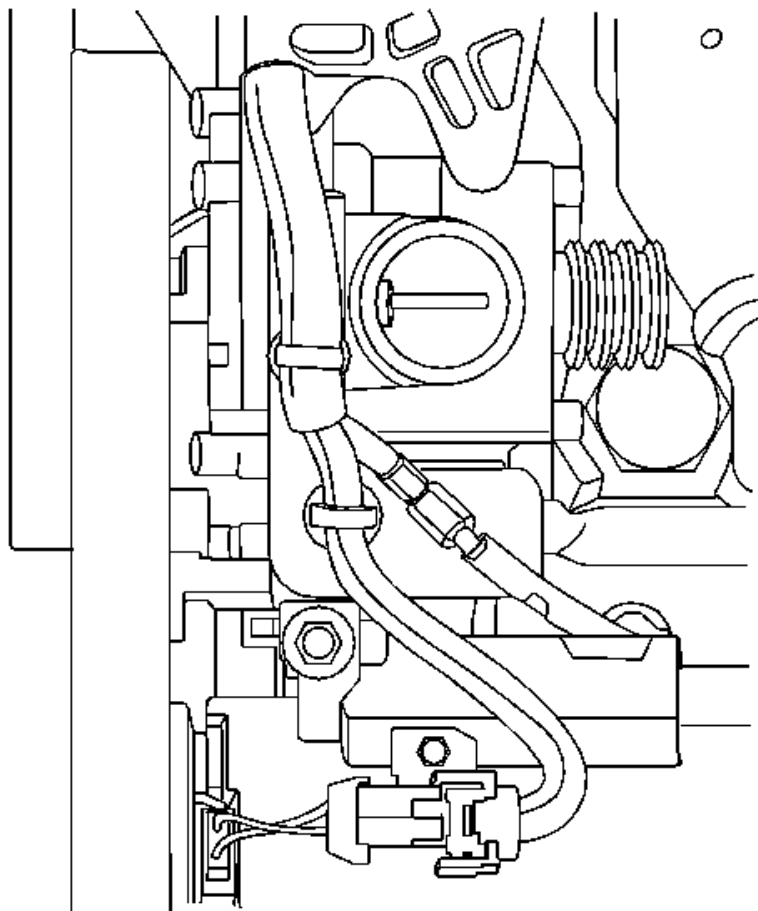


Fig. 45: A/C Compressor Connector
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery negative cable.
2. Disconnect the related sensor and actuator connector and pull engine wiring harness aside.
3. Disconnect the oil switch wiring connector.
4. Disconnect the A/C compressor connector.

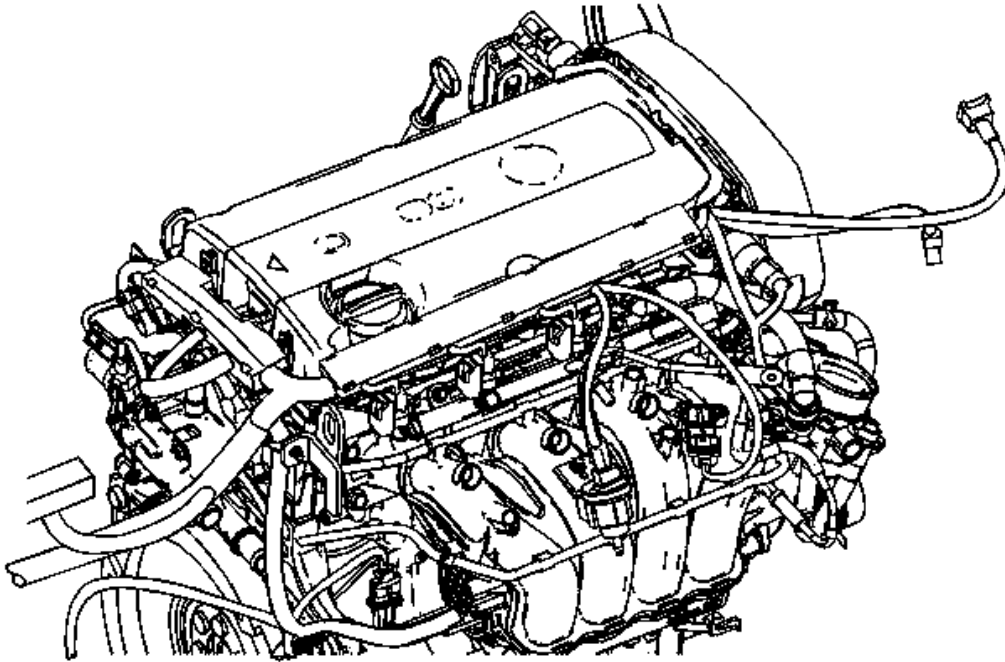


Fig. 46: Related Sensor And Actuator Connectors
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the manifold air temperature (MAT) sensor connector.
6. Disconnect the A/C pressure (ACP) sensor connector.
7. Disconnect the CAM position solenoid valve connectors (right/left).
8. Disconnect the manifold air pressure (MAP) sensor connector.
9. Disconnect the EVAP canister purge solenoid valve connector.
10. Disconnect the injectors connectors.
11. Disconnect the ignition coil connector.
12. Disconnect the camshaft position sensor (CPS) connectors (right/left).
13. Remove the ignition coil.
14. Detach the PCV clips from the PCV hose.
15. Remove the PCV hose from the cylinder head cover.
16. Unscrew the cylinder head cover bolts.
17. Remove the cylinder head cover.

Installation Procedure

NOTE: Check and Confirm the damage or crack of the cylinder head gasket. If damaged or cracked, replace the new one.

1. Install the cylinder head with the gasket.

CAUTION: Refer to Fastener Caution .

2. Screw the cylinder head cover bolts and tighten to 8 N.m (70.8 lb in).
3. Install the PCV hose to the cylinder head cover.
4. Attach the PCV clips to the PCV hose.

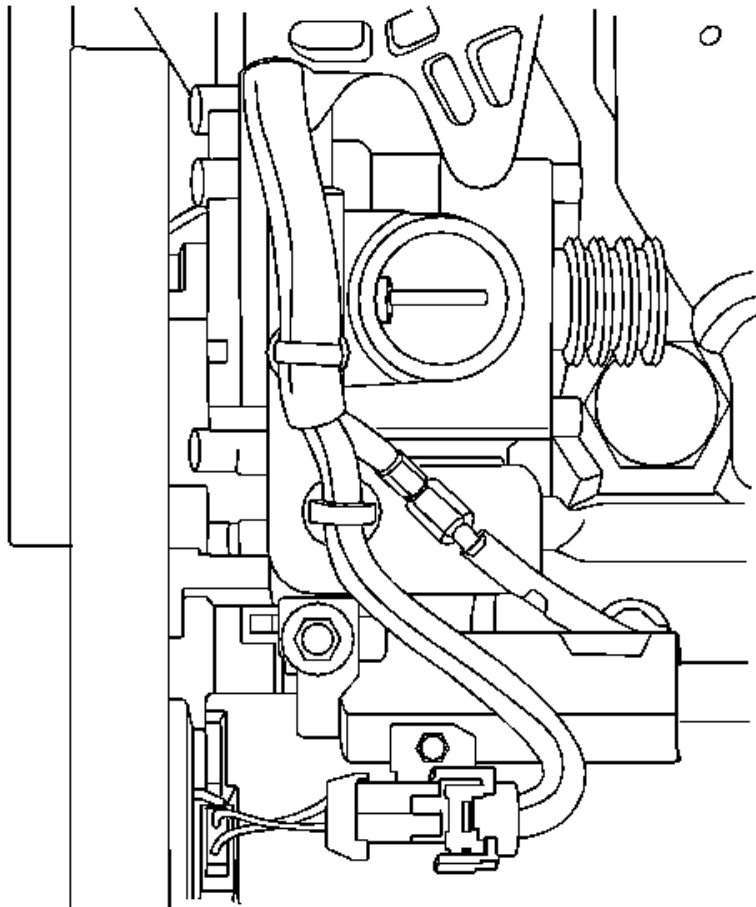


Fig. 47: A/C Compressor Connector
Courtesy of GENERAL MOTORS CORP.

5. Install the engine wiring harness and connect the related sensor and actuator connector.
6. Connect the oil switch wiring connector.

7. Connect the A/C compressor connector.

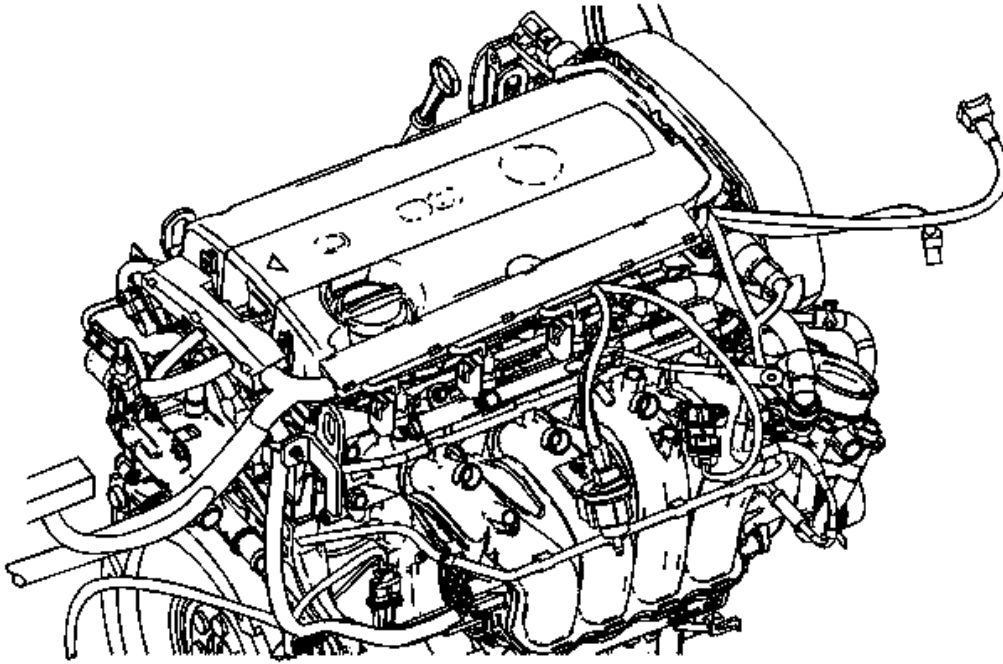


Fig. 48: Related Sensor And Actuator Connectors
Courtesy of GENERAL MOTORS CORP.

8. Connect the manifold air temperature (MAT) sensor connector.
9. Connect the A/C pressure (ACP) sensor connector.
10. Connect the CAM position solenoid valve connectors (right/left).
11. Connect the manifold air pressure (MAP) sensor connector.
12. Connect the EVAP canister purge solenoid valve connector.
13. Connect the ignition coil connector.
14. Connect the camshaft position sensor (CPS) connectors (right/left).
15. Connect the battery negative cable

CAMSHAFT POSITION INTAKE ACTUATOR REPLACEMENT

Removal Procedure

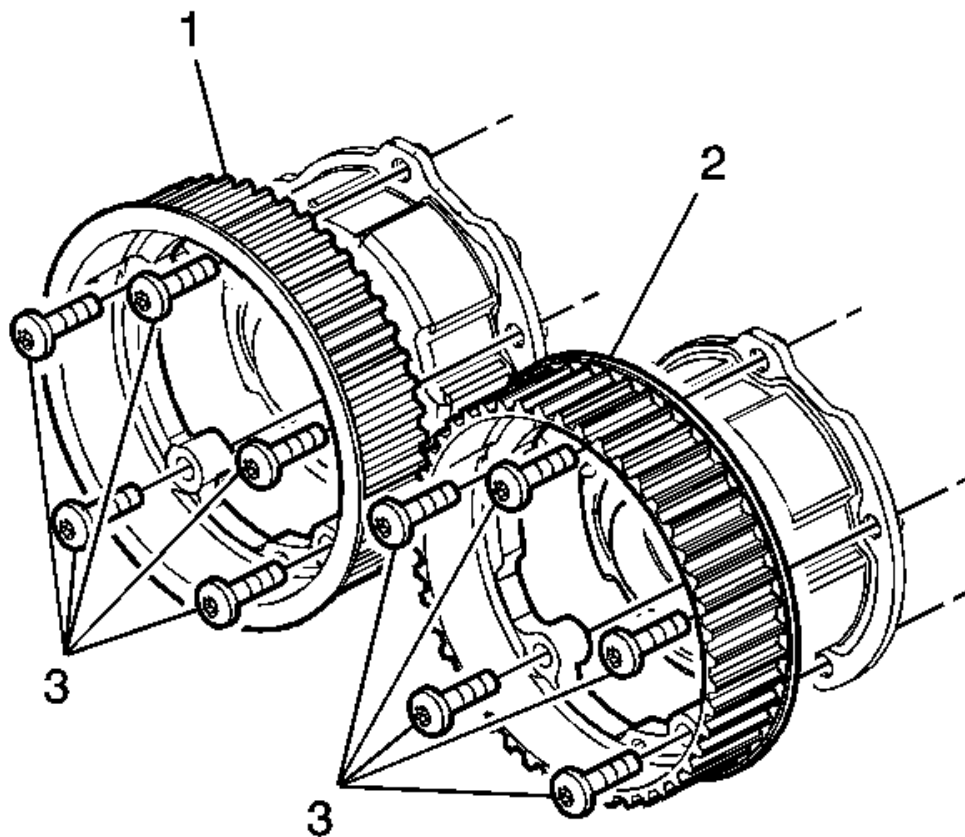


Fig. 49: Camshaft Adjusters & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft adjuster bolts.

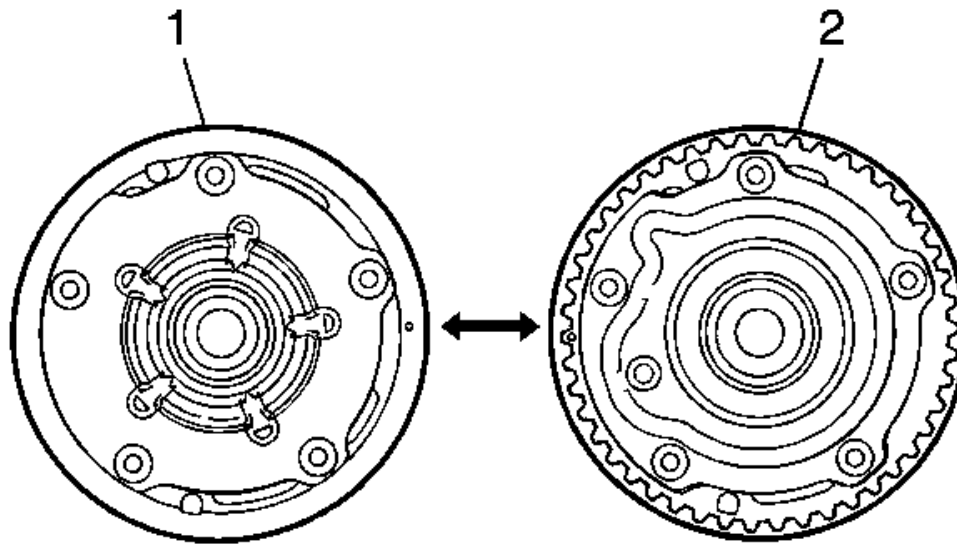


Fig. 50: Intake/Exhaust Adjusters
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the location and direction of the intake/exhaust adjusters when removed.

2. Remove the camshaft adjusters.

Installation Procedure

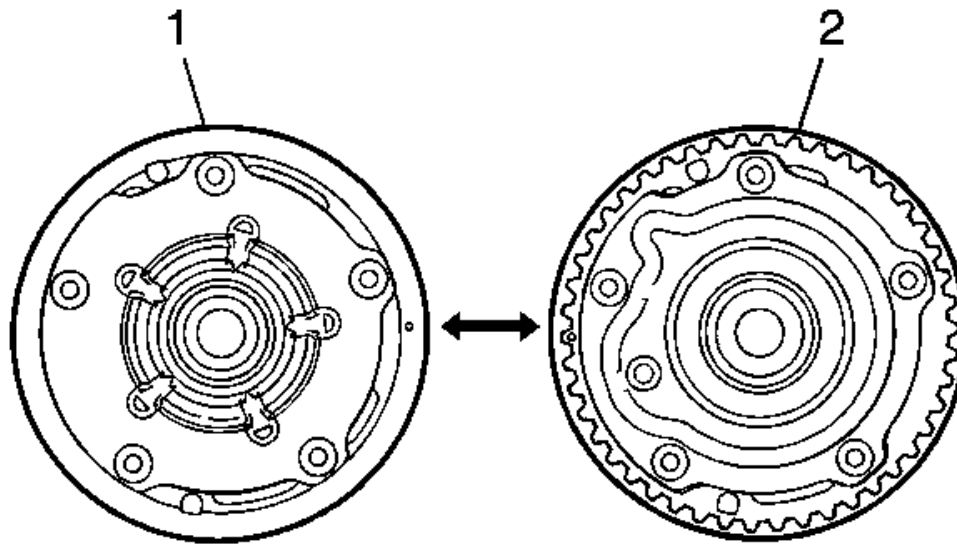


Fig. 51: Intake/Exhaust Adjusters
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the location and direction of the intake/exhaust adjusters when removed.

1. Install the camshaft adjusters.

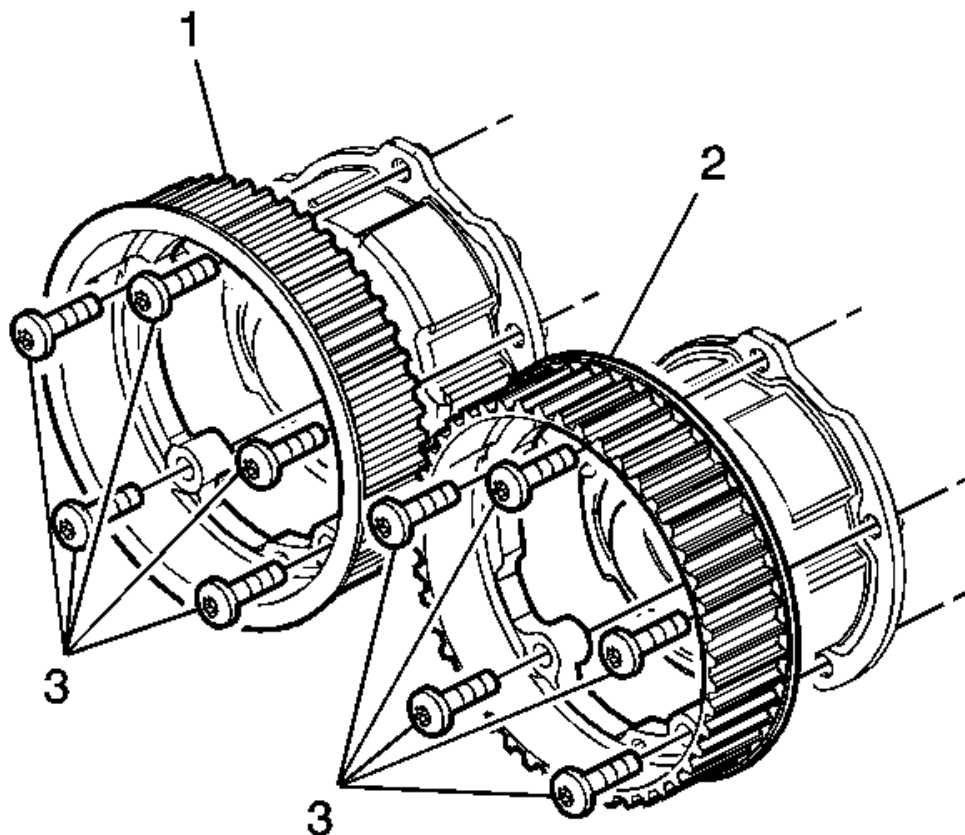


Fig. 52: Camshaft Adjusters & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft adjuster bolts and tighten to 65 N.m +120° +15° (47.9 lb ft +120° +15°).

CAMSHAFT POSITION EXHAUST ACTUATOR REPLACEMENT

Removal Procedure

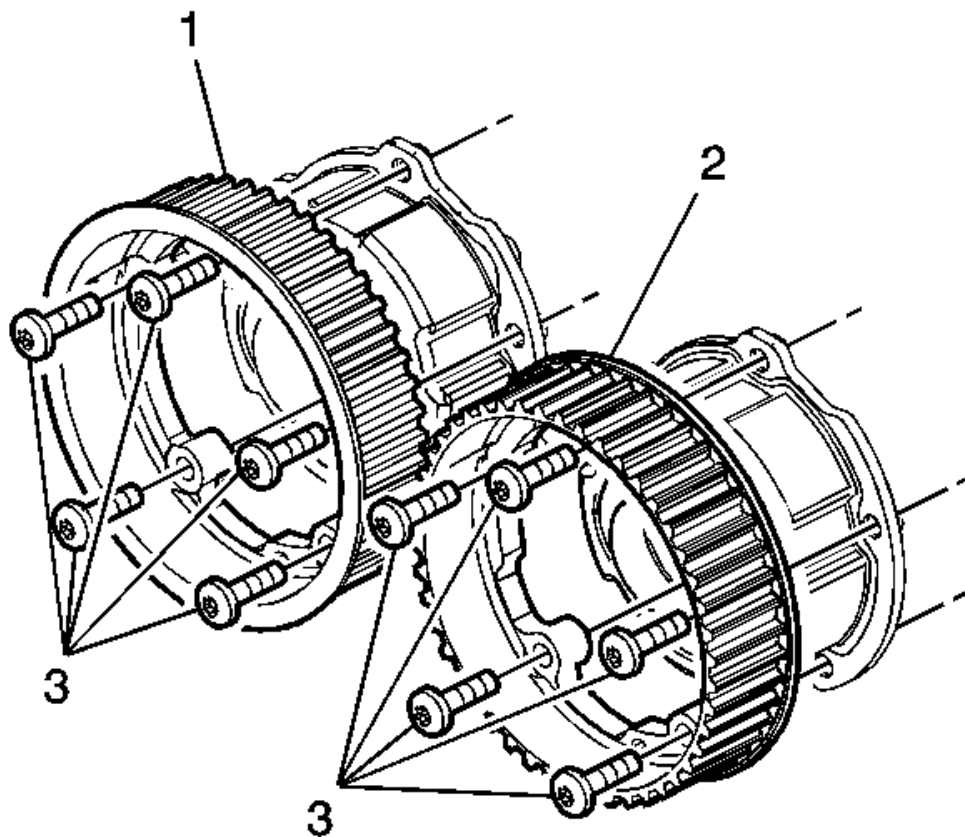


Fig. 53: Camshaft Adjusters & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft adjuster bolts.

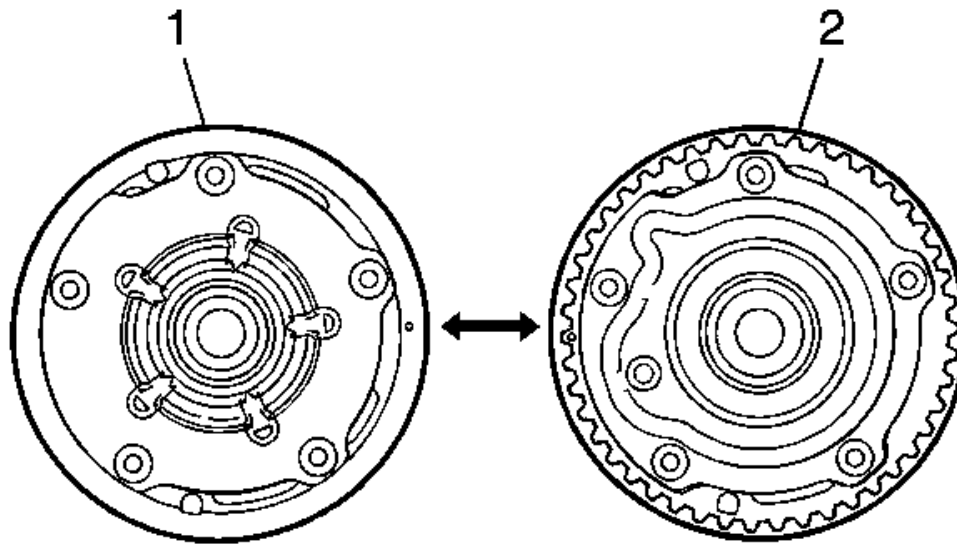


Fig. 54: Intake/Exhaust Adjusters
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the location and direction of the intake/exhaust adjusters when removed.

2. Remove the camshaft adjusters.

Installation Procedure

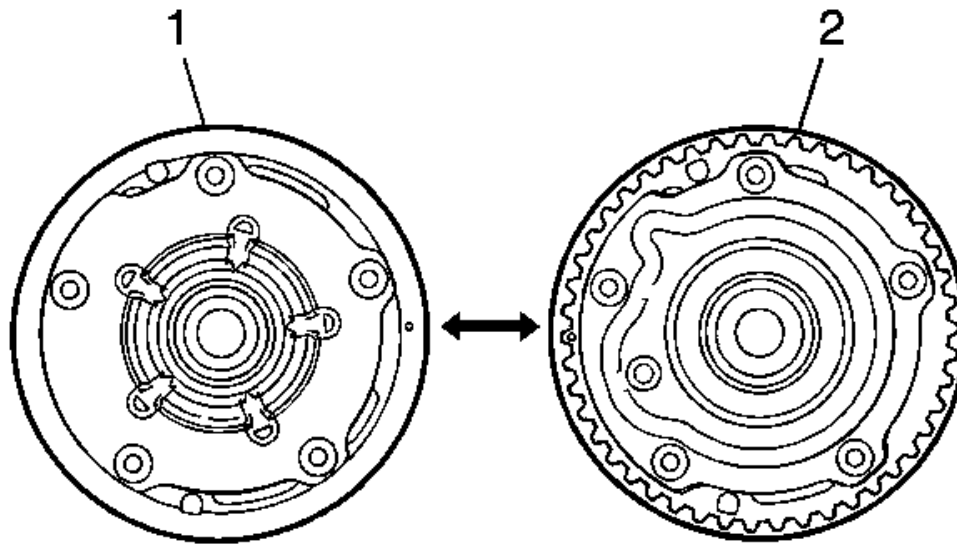


Fig. 55: Intake/Exhaust Adjusters
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the location and direction of the intake/exhaust adjusters when removed.

1. Install the camshaft adjusters.

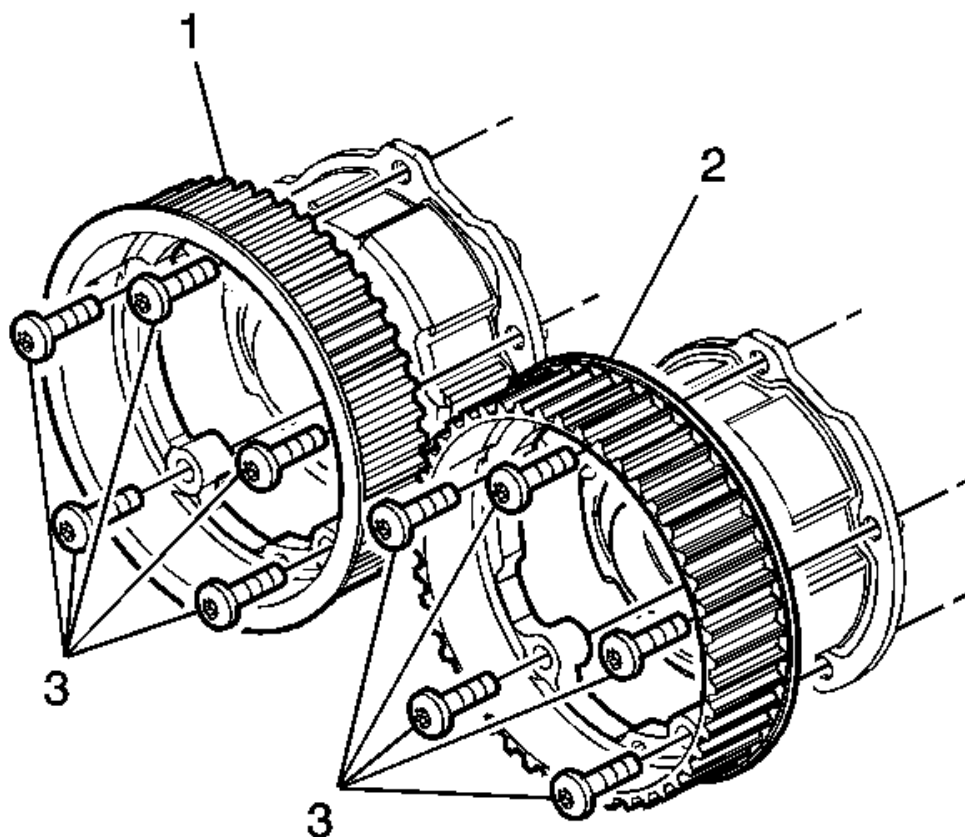


Fig. 56: Camshaft Adjusters & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft adjuster bolts and tighten to 65 N.m +120° +15° (47.9 lb ft +120° +15°).

CYLINDER HEAD REPLACEMENT

Removal Procedure

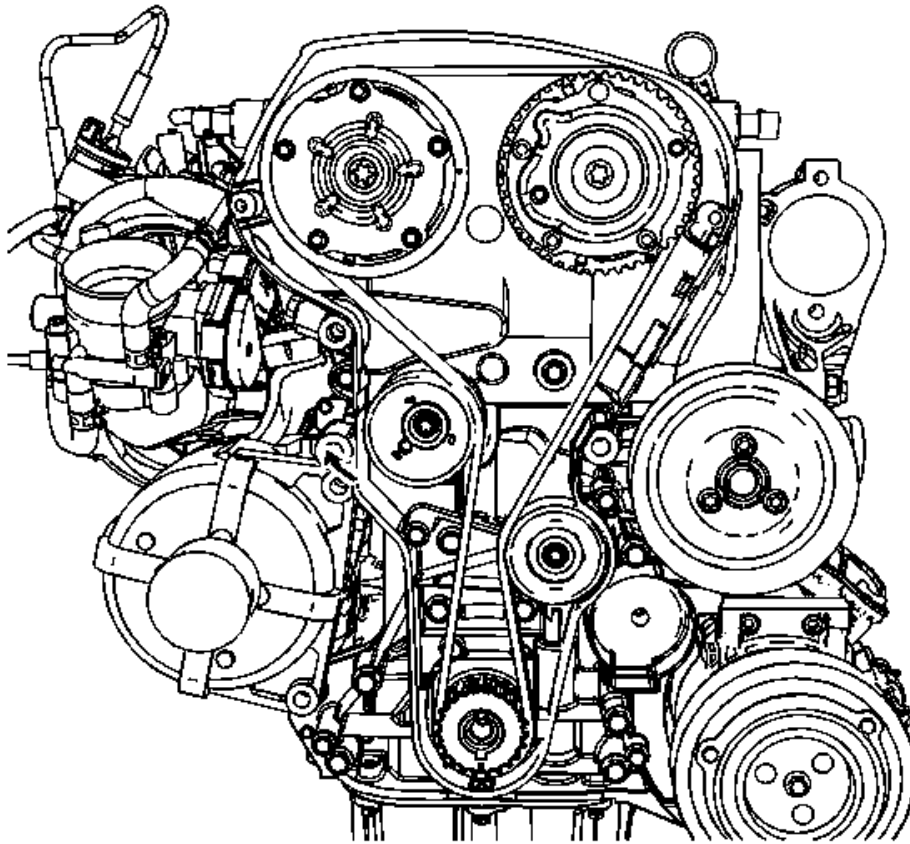


Fig. 57: Timing Belt

Courtesy of GENERAL MOTORS CORP.

1. Drain the engine coolant. Refer to Cooling System Draining and Filling .
2. Release the fuel pressure. Refer to FUEL PRESSURE RELIEF .
3. Remove the timing belt. Refer to Timing Belt Replacement.
4. Remove the timing belt tensioner. Refer to Timing Belt Replacement.

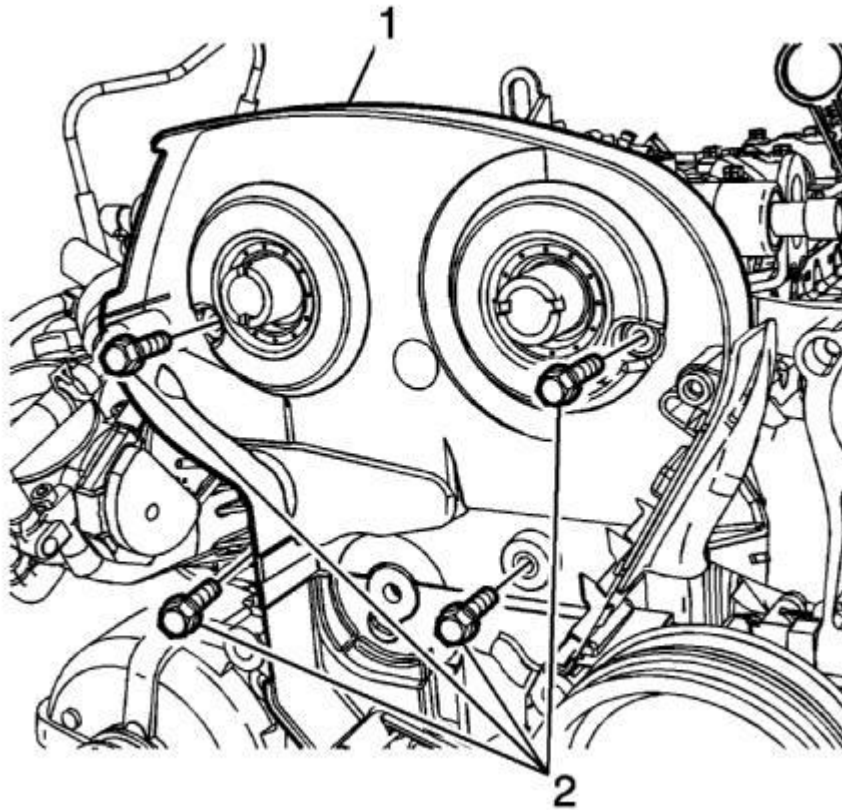


Fig. 58: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the camshaft. Refer to **Camshaft Gear Replacement**.
6. Remove the timing belt rear cover.

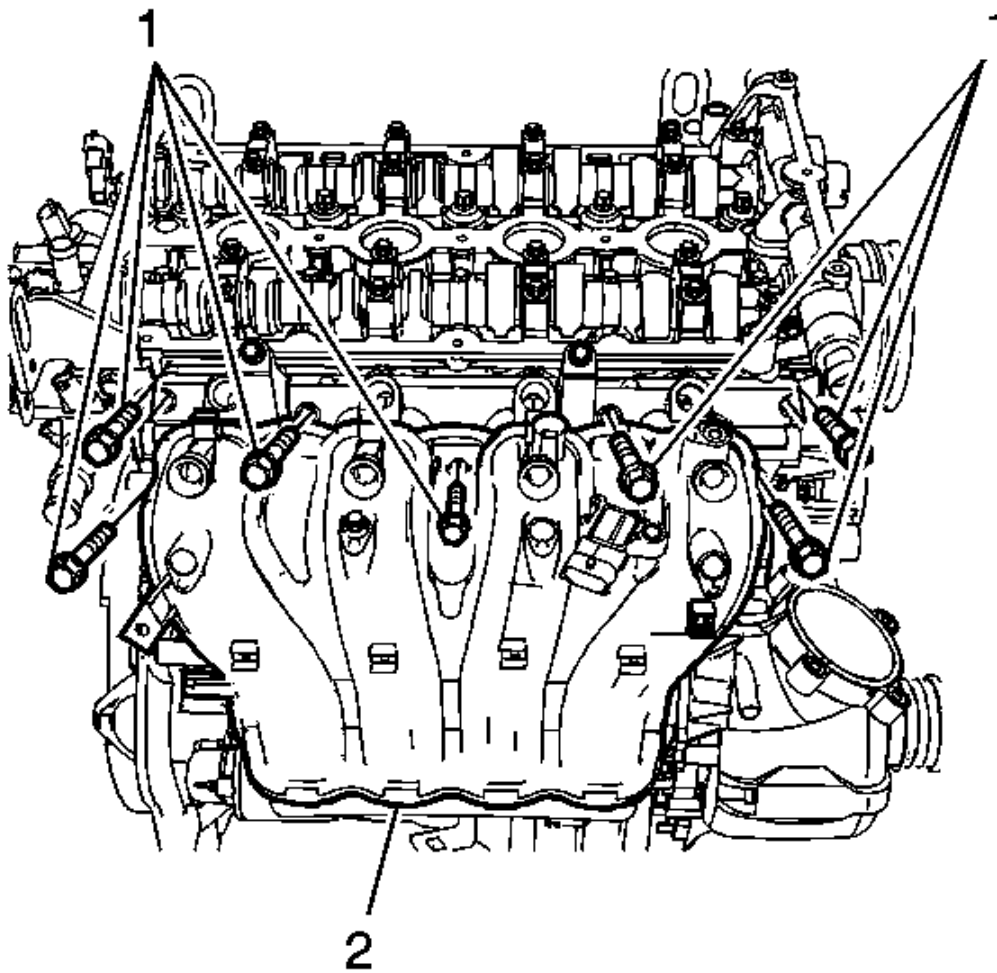


Fig. 59: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the intake manifold. Refer to **Intake Manifold Replacement**.

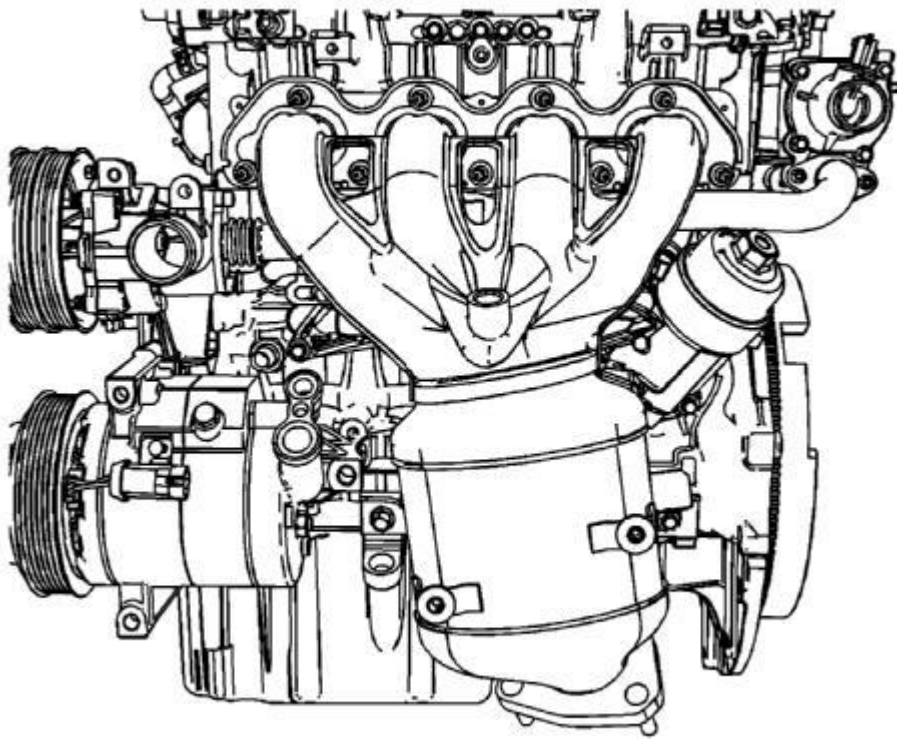


Fig. 60: Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS CORP.

8. Remove the exhaust manifold.

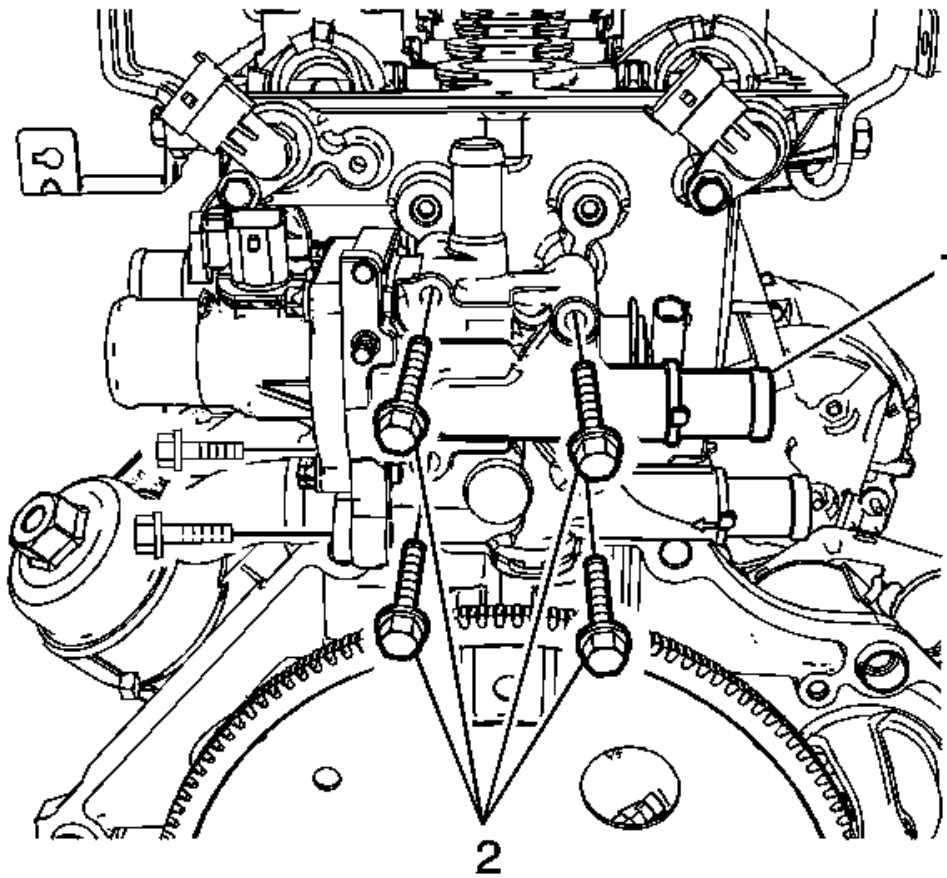


Fig. 61: Coolant Distributor And Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the coolant distributor.

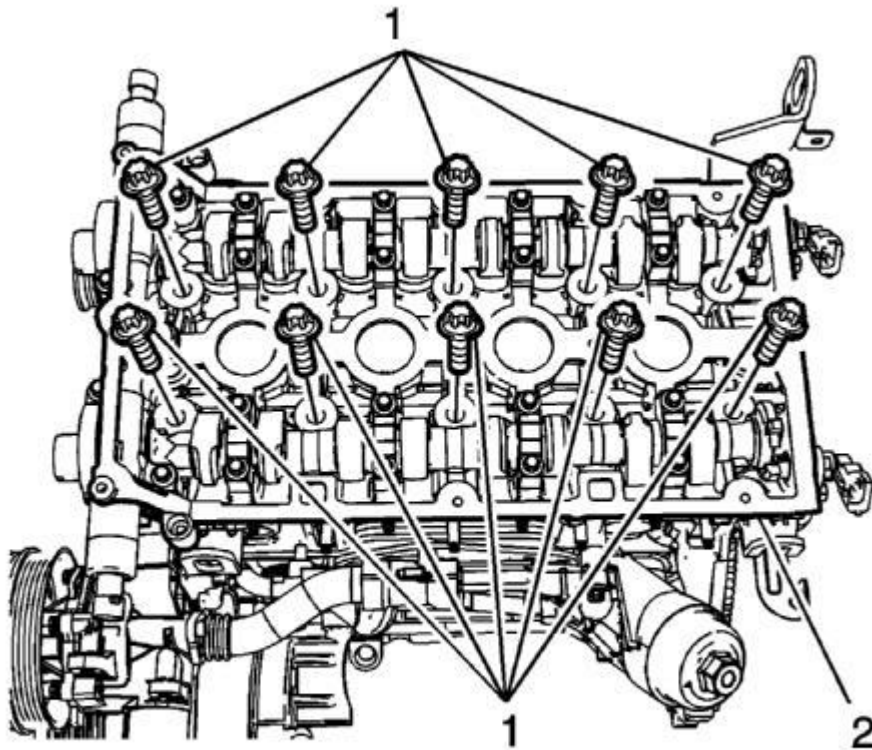


Fig. 62: Cylinder Head Bolts

Courtesy of GENERAL MOTORS CORP.

10. Remove the cylinder head bolts.
11. Remove the cylinder head with the gasket.

Installation Procedure

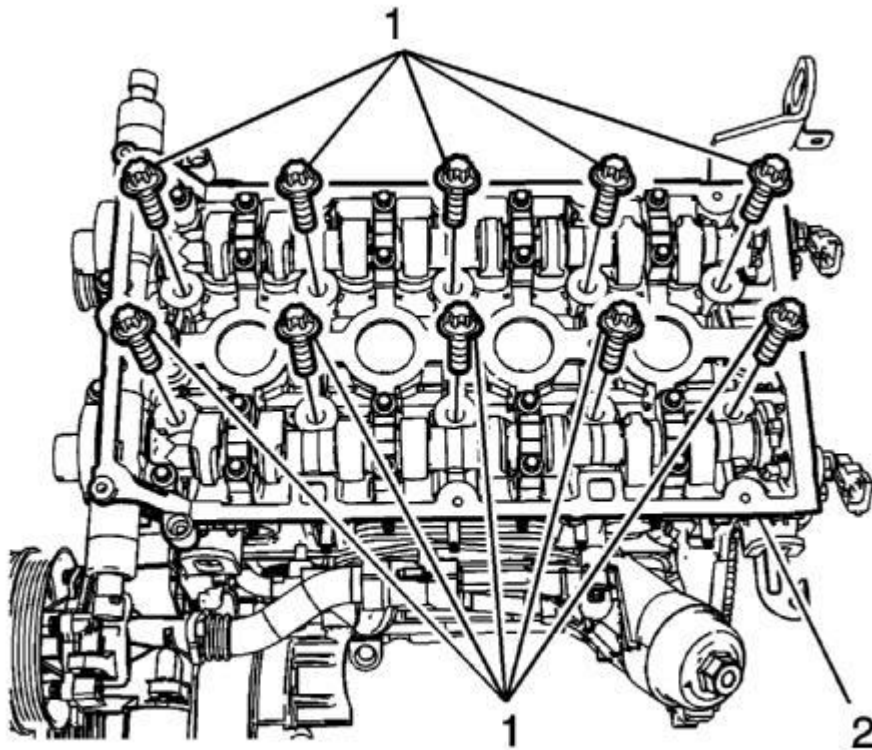


Fig. 63: Cylinder Head Bolts

Courtesy of GENERAL MOTORS CORP.

1. Install the cylinder head with the new gasket.

CAUTION: Refer to Fastener Caution .

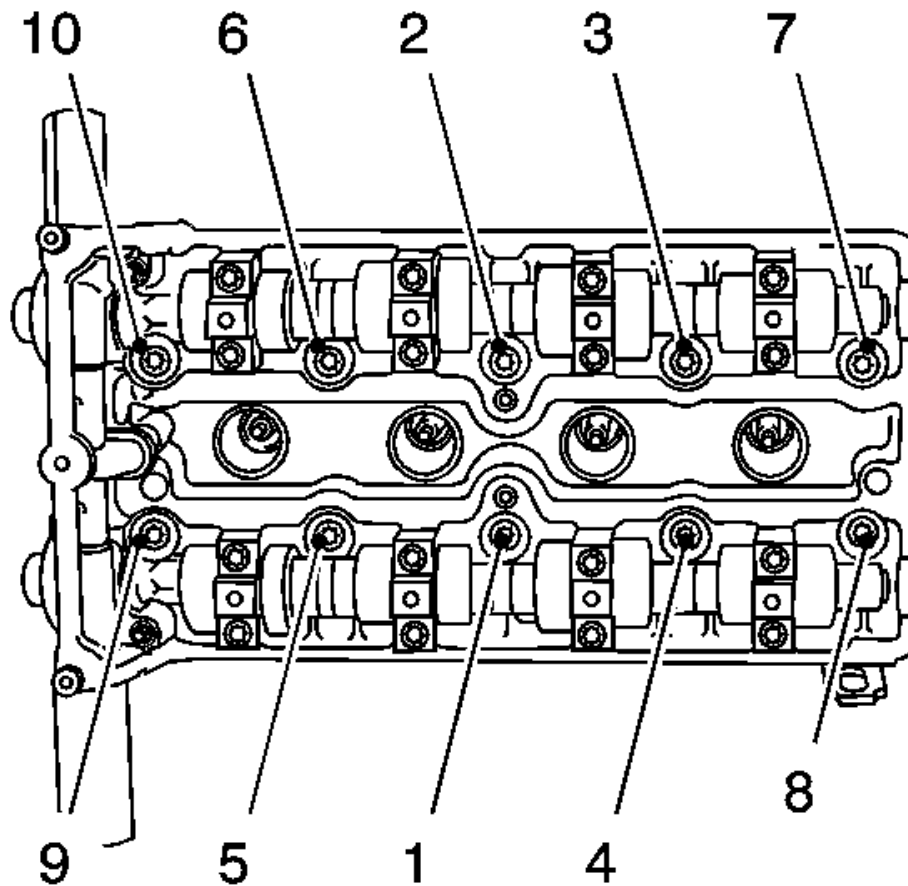


Fig. 64: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

2. Install the cylinder head bolts and tighten to 25 N.m +90° +90° +90° +45° (18.4 lb ft +90° +90° +90° +45°).

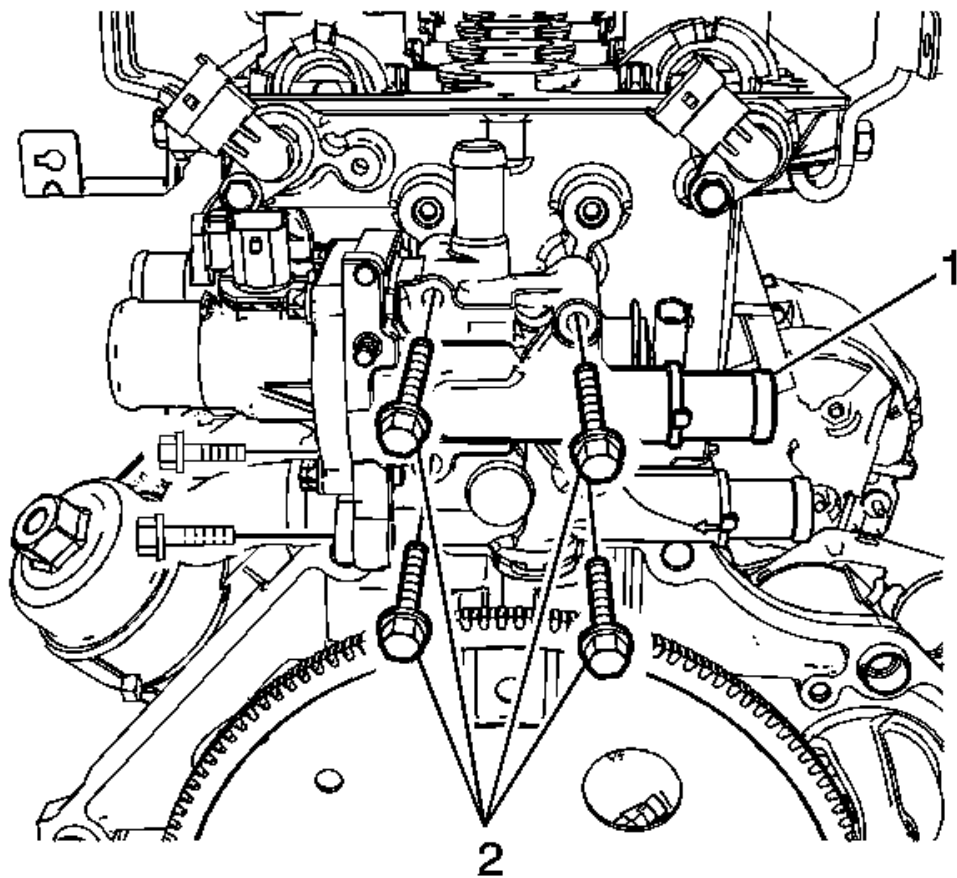


Fig. 65: Coolant Distributor And Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the coolant distributor.

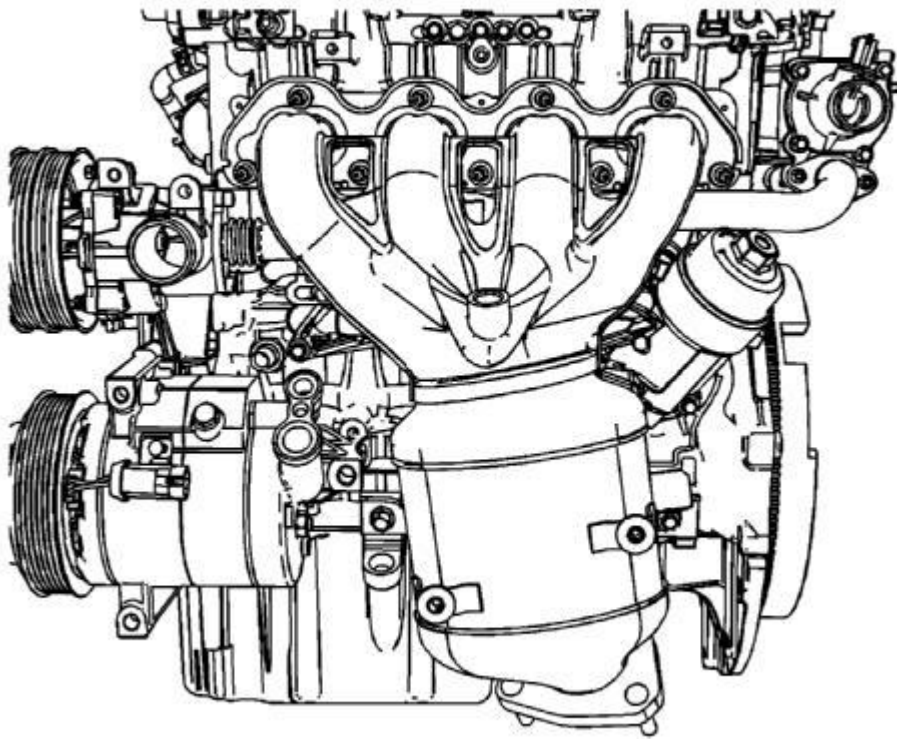


Fig. 66: Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS CORP.

4. Install the exhaust manifold.
5. Install the intake manifold. Refer to **Intake Manifold Replacement**.

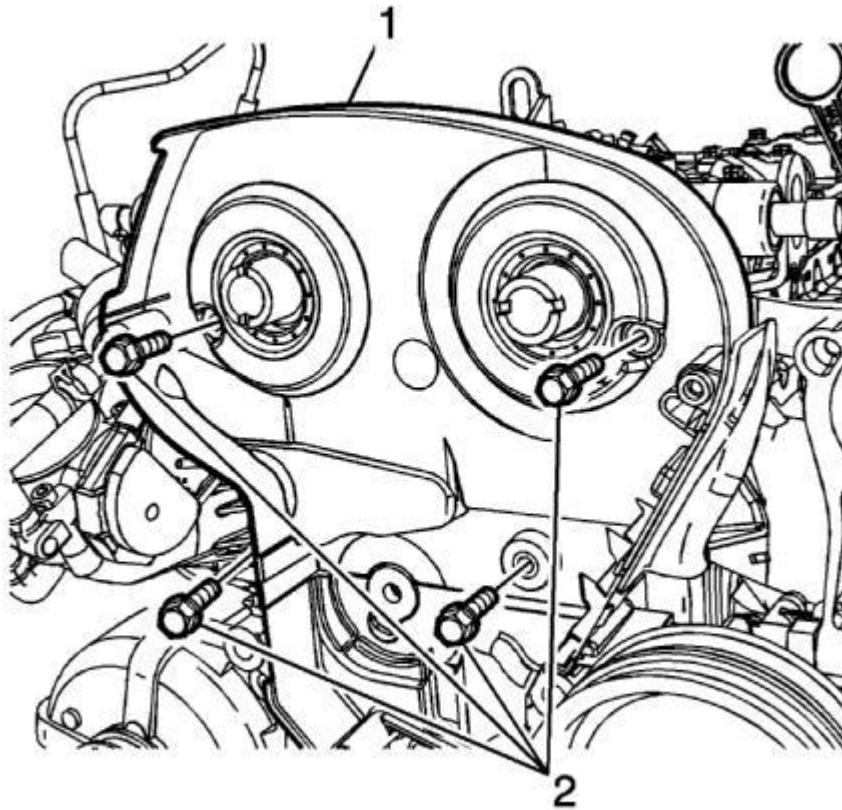


Fig. 67: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the timing belt rear cover and tighten to 6 N.m (53.1 lb in).
7. Install the camshaft. Refer to **Camshaft Gear Replacement**.

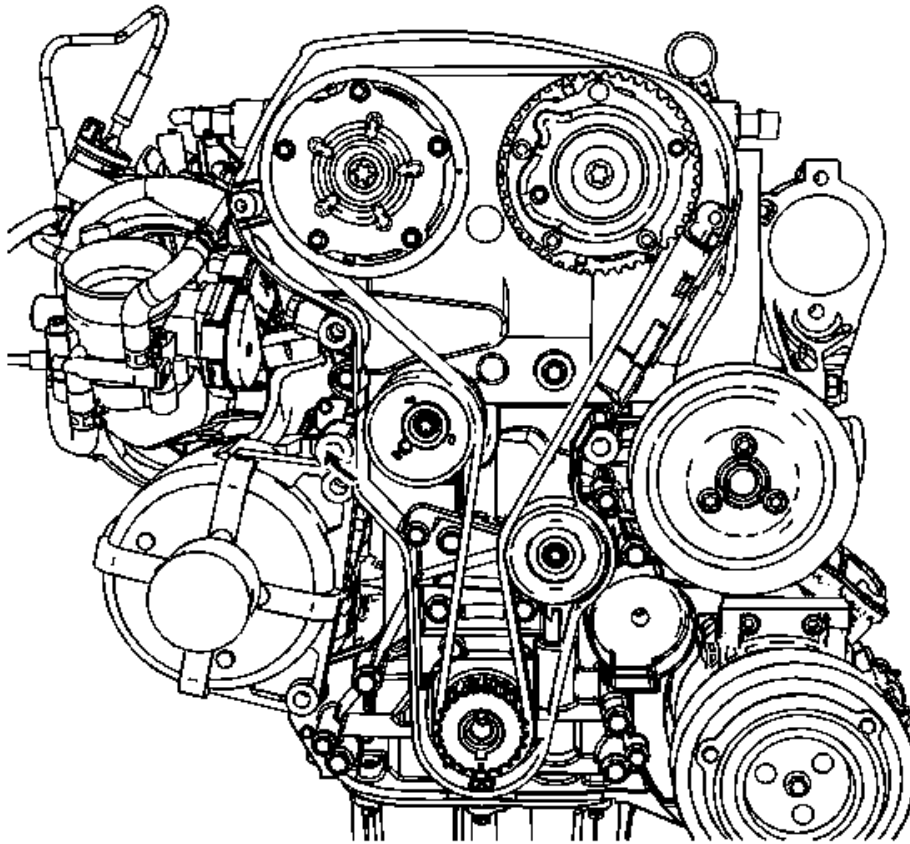


Fig. 68: Timing Belt
Courtesy of GENERAL MOTORS CORP.

8. Adjust the belt timing. Refer to Timing Belt Replacement.

ENGINE OIL PAN REPLACEMENT

Special Tools

EN-49152 Oil Pan Bolt Remover/Installer

Removal Procedure

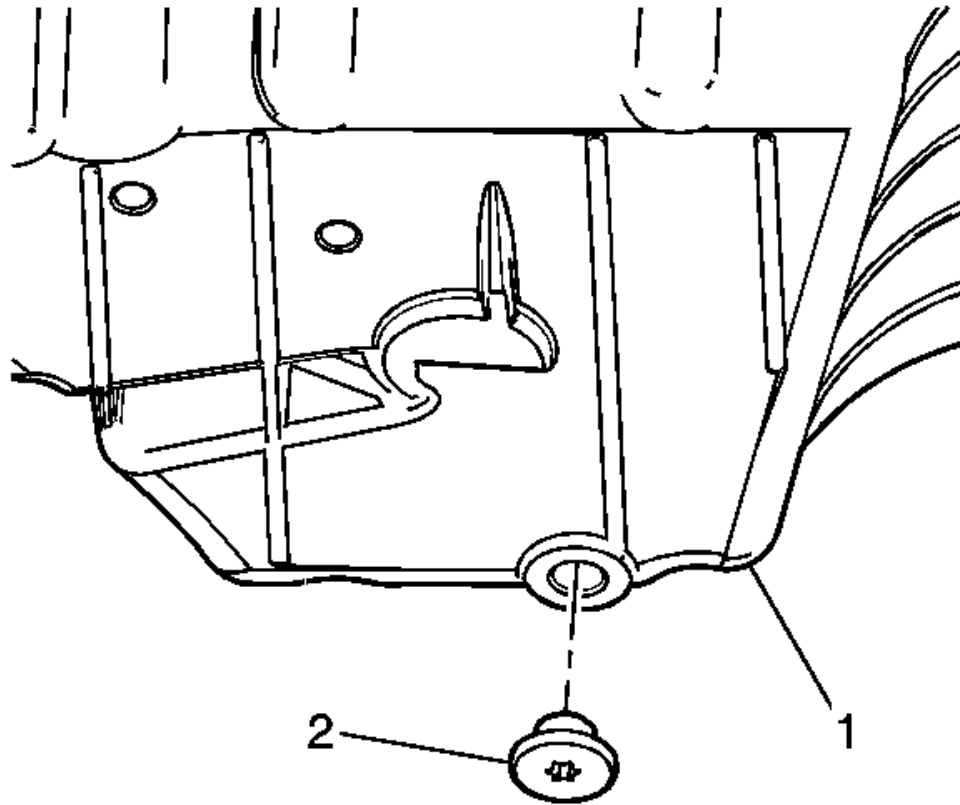


Fig. 69: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine oil.
2. Remove the front exhaust pipe.

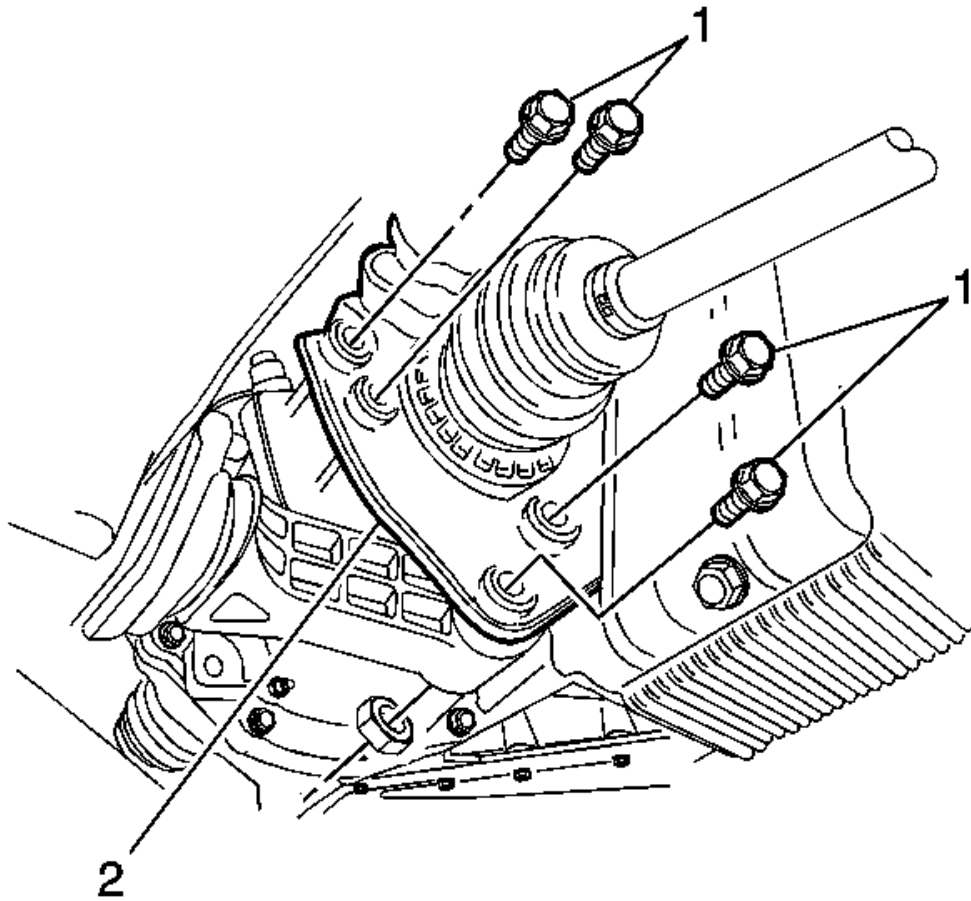


Fig. 70: Transmission Rear Mounting Bracket (A/T)
Courtesy of GENERAL MOTORS CORP.

3. Remove the transmission rear mounting bracket, for automatic transmission only.

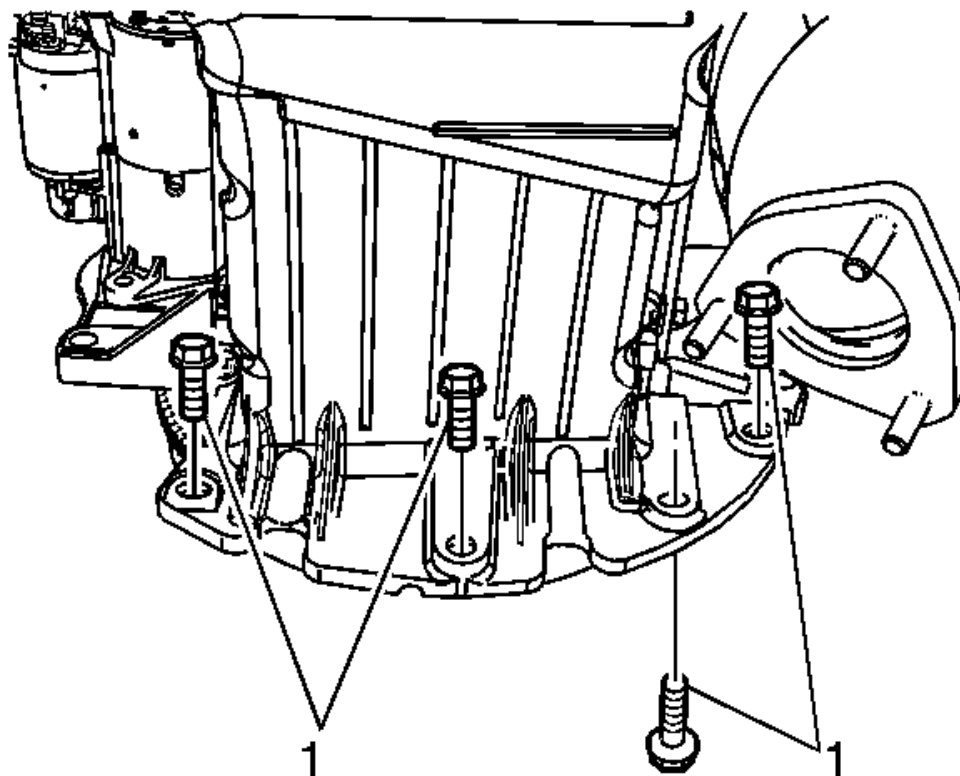


Fig. 71: Oil Pan-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan-to-transmission bolts.

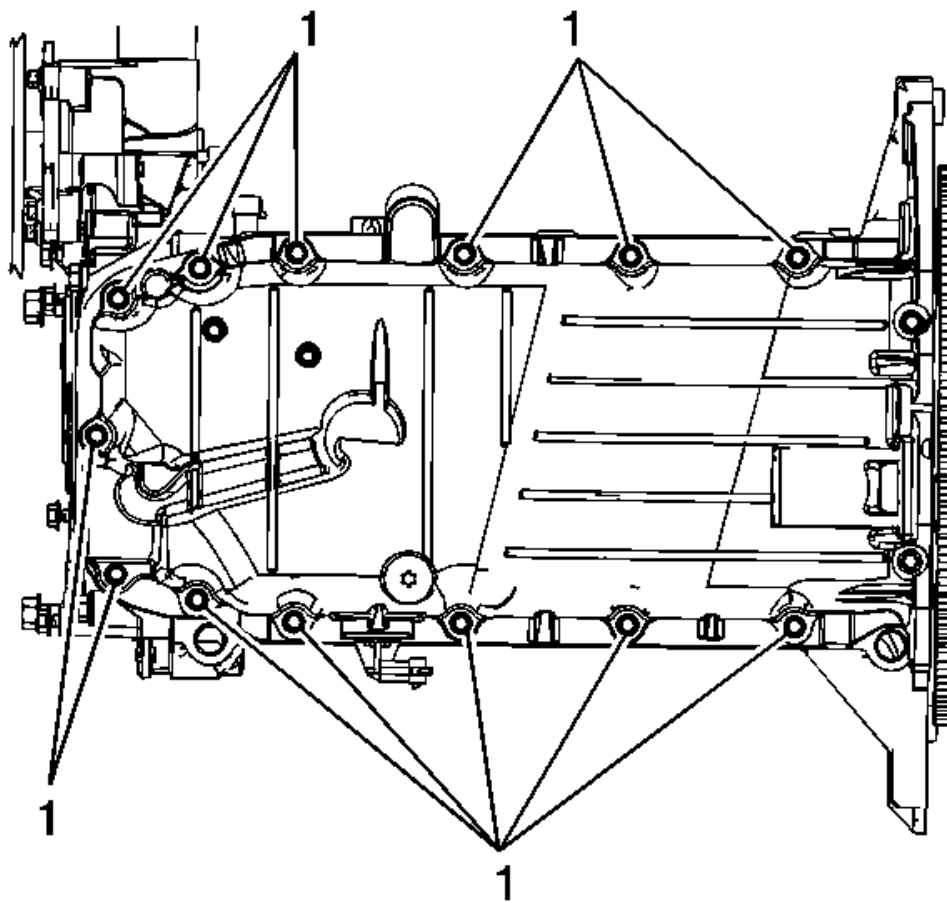


Fig. 72: Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pan bolts using EN-49152.

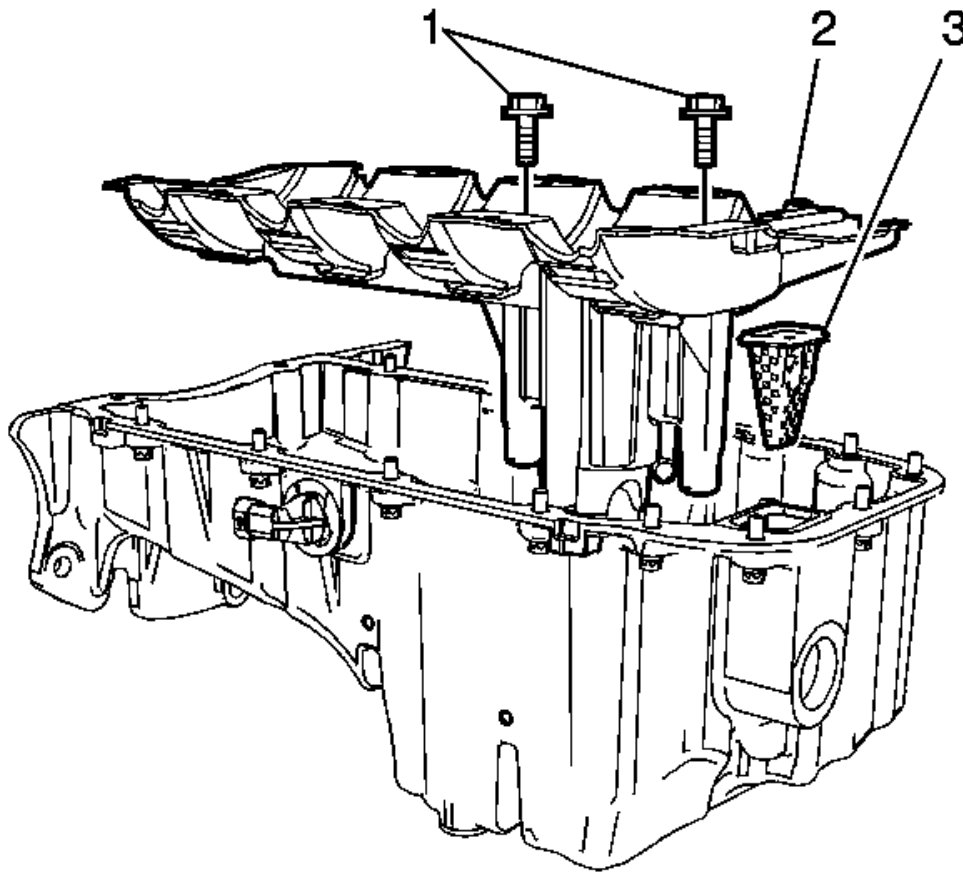


Fig. 73: Oil Pan Baffle & Oil Suction Filter
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pan baffle.
7. Remove the oil suction filter.

Installation Procedure

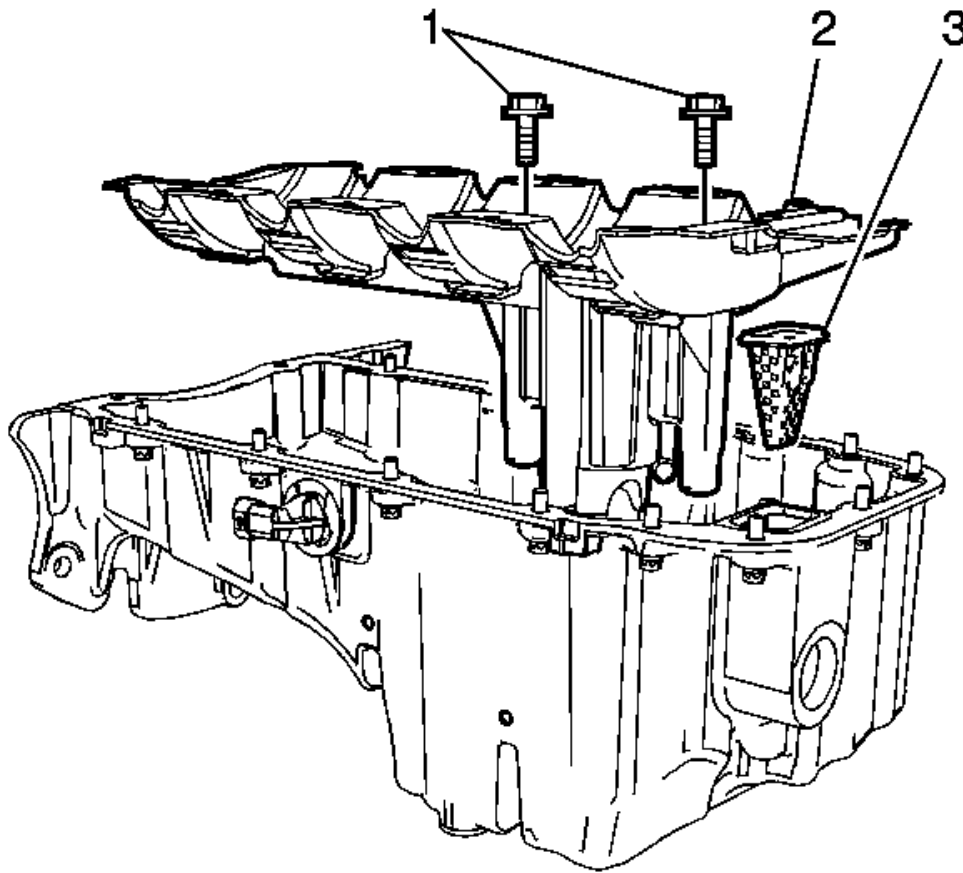


Fig. 74: Oil Pan Baffle & Oil Suction Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil suction filter to the oil pan.

CAUTION: Refer to Fastener Caution .

2. Remove the oil pan baffle.

Tighten: Tighten the oil pan baffle bolts to 10 N.m (7.3 lb ft).

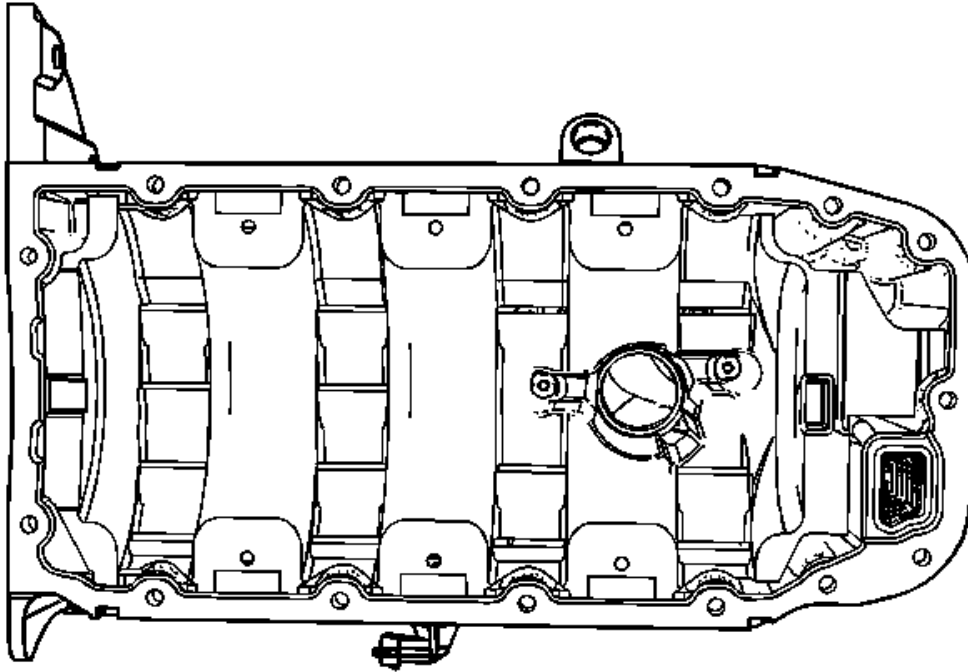


Fig. 75: Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS CORP.

3. Clean the oil pan sealing surface.
4. Apply the oil pan sealant LOCTITE 5900 on the sealing surface.

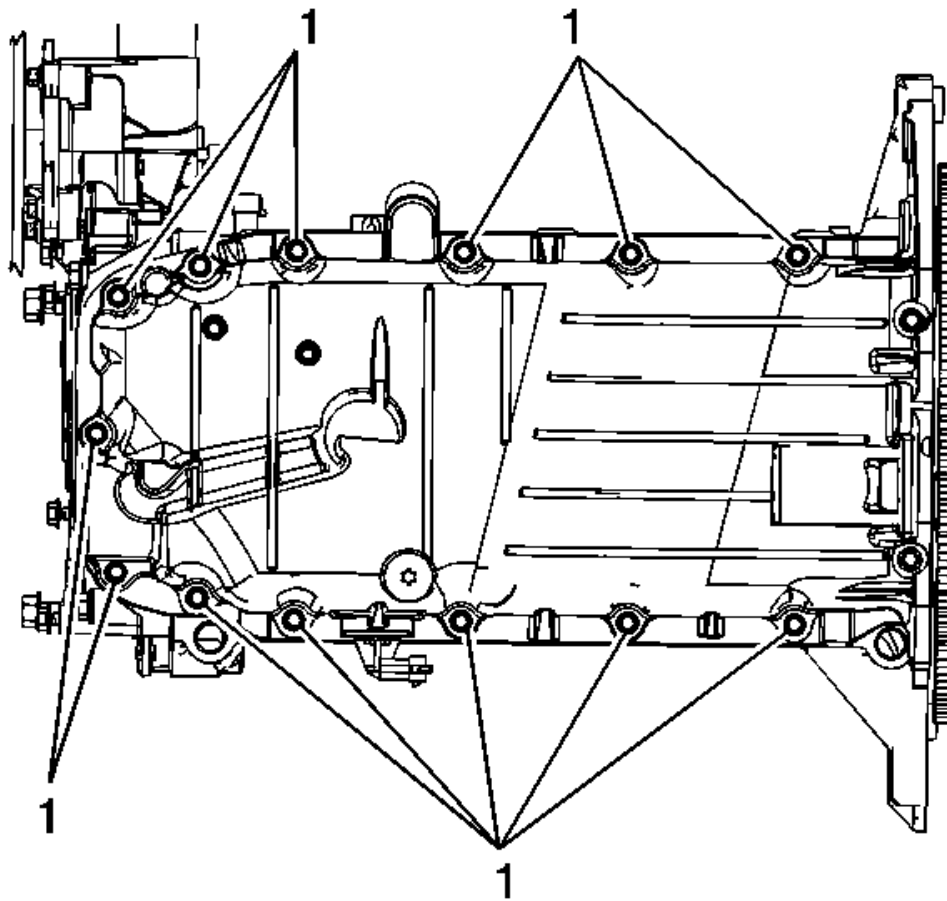


Fig. 76: Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

5. Install the oil pan bolts using EN-49152.

Tighten: Tighten the oil pan bolts to 14 N.m (10.3 lb ft).

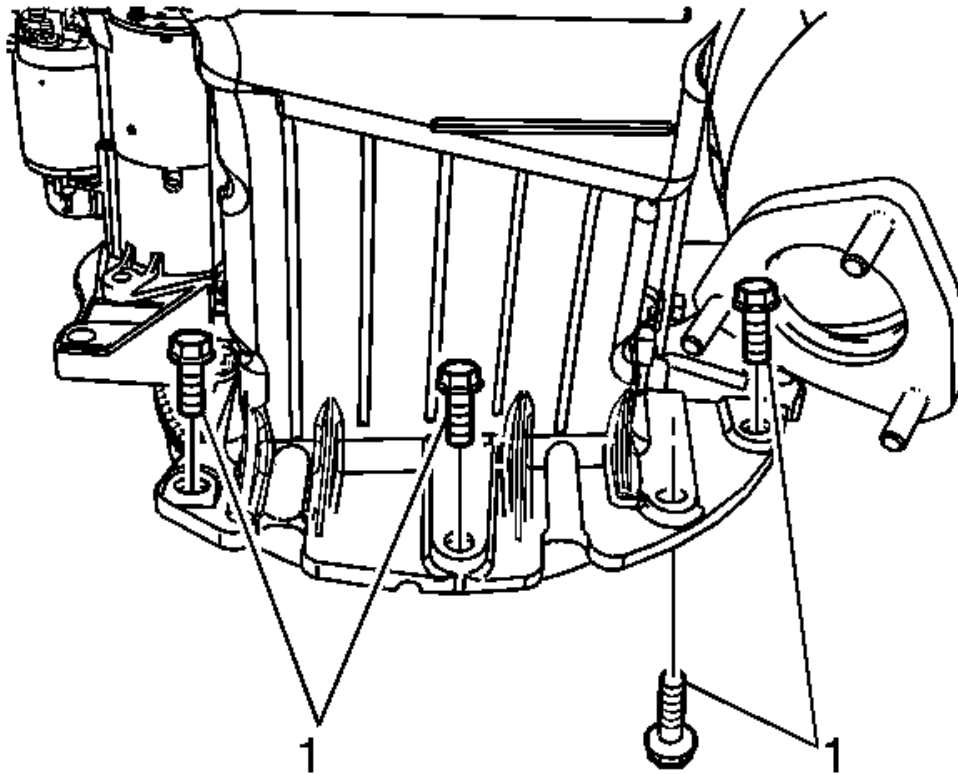


Fig. 77: Oil Pan-To-Transmission Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan-to-transmission bolts.

Tighten: Tighten the oil pan-to-transmission bolts to 40 N.m (29.5 lb ft).

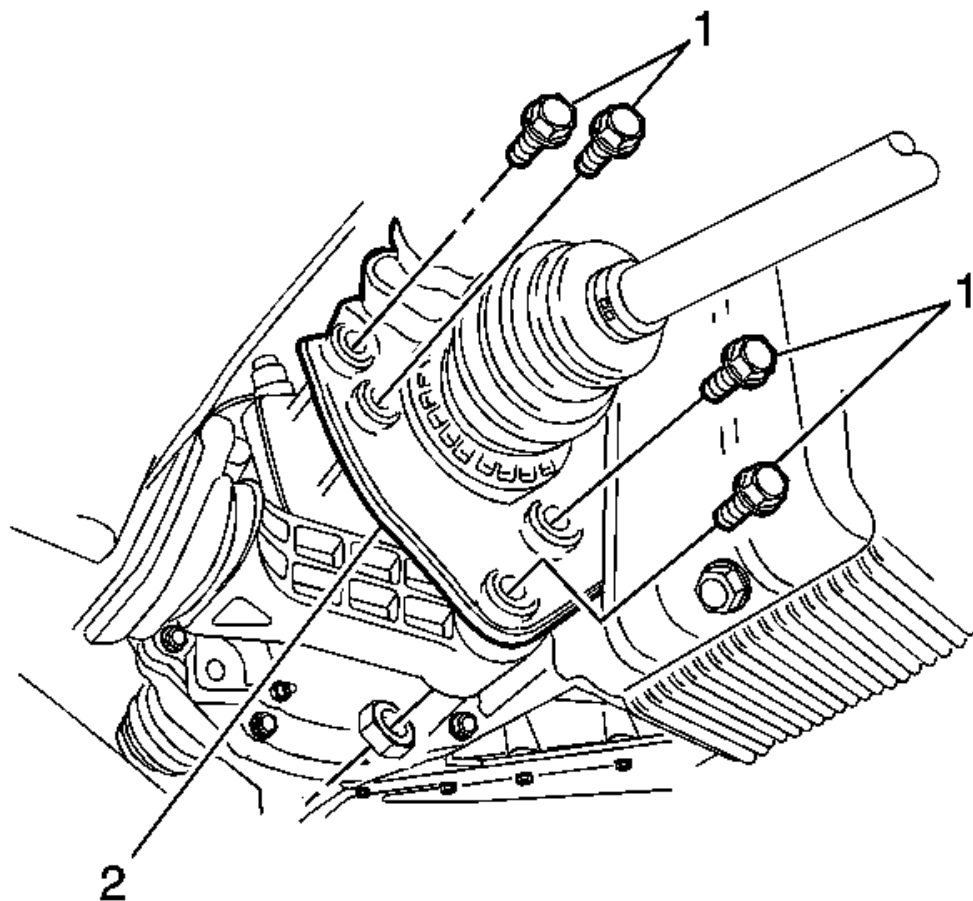


Fig. 78: Transmission Rear Mounting Bracket (A/T)
Courtesy of GENERAL MOTORS CORP.

7. Install the transmission rear mounting bracket, for automatic transmission only.

Tighten: Tighten the transmission rear mounting bracket bolts and nut to 80 N.m (59 lb ft).

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

- EN-48356 Engine Fixture
- KM-652 Flywheel Locking Device

Removal Procedure

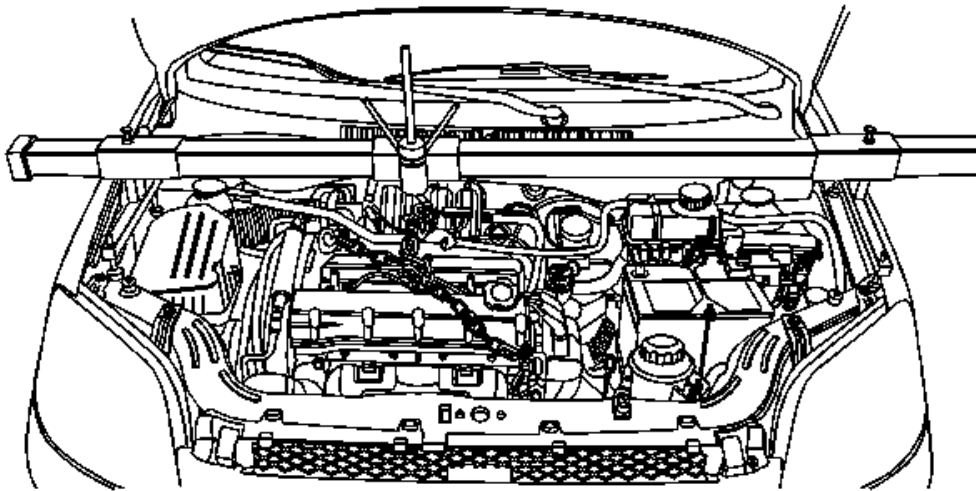


Fig. 79: Engine Support Tool
Courtesy of GENERAL MOTORS CORP.

1. Install EN-48356.
2. Remove the automatic transmission. Refer to **TRANSMISSION REPLACEMENT** .

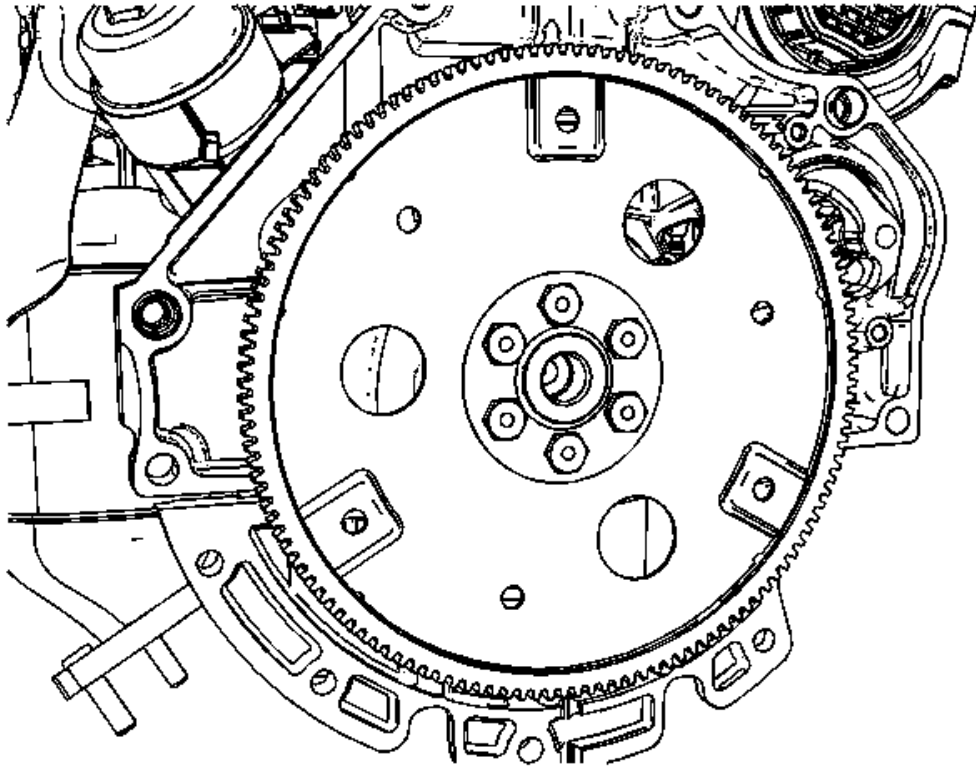


Fig. 80: Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

3. Install KM-652 to block the crankshaft.
4. Install the transmission tightening bolt with KM-652.

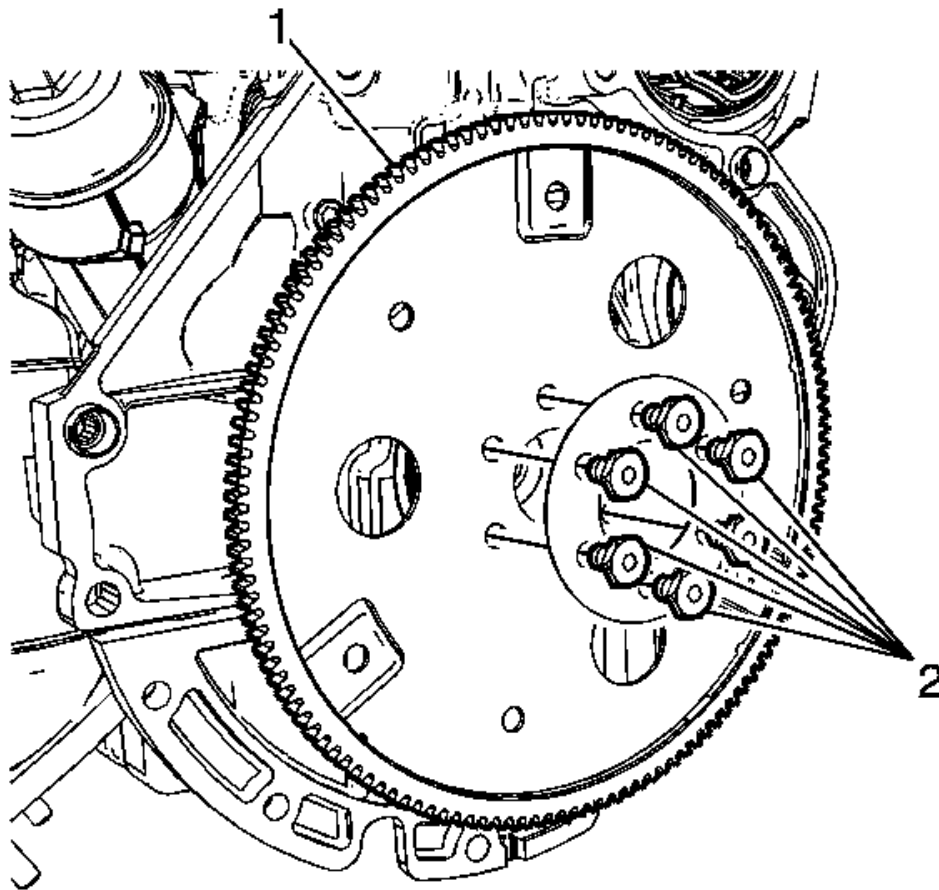


Fig. 81: Flexible Plate Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the flexible plate bolts.
6. Remove the flexible plate.

Installation Procedure

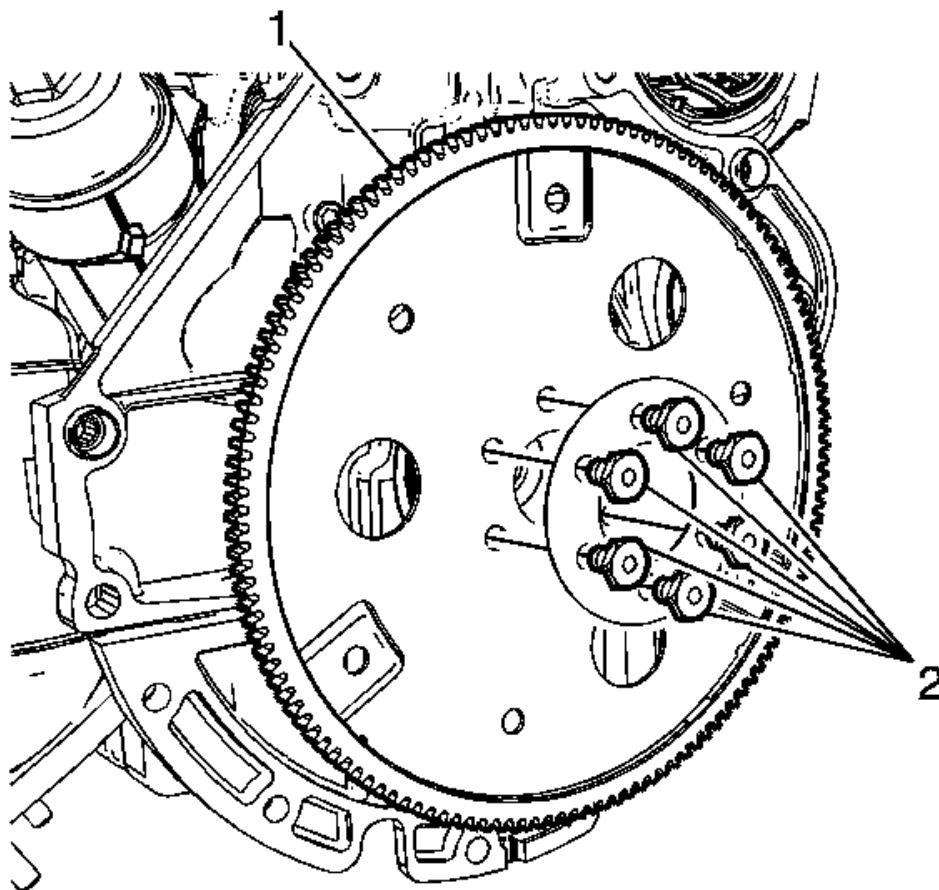


Fig. 82: Flexible Plate Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the flexible plate.

CAUTION: Refer to Fastener Caution .

2. Install the flexible plate bolts.

Tighten: Tighten the flexible plate bolts to 35 N.m +30° +15° (25.8 lb ft +30° +15°).

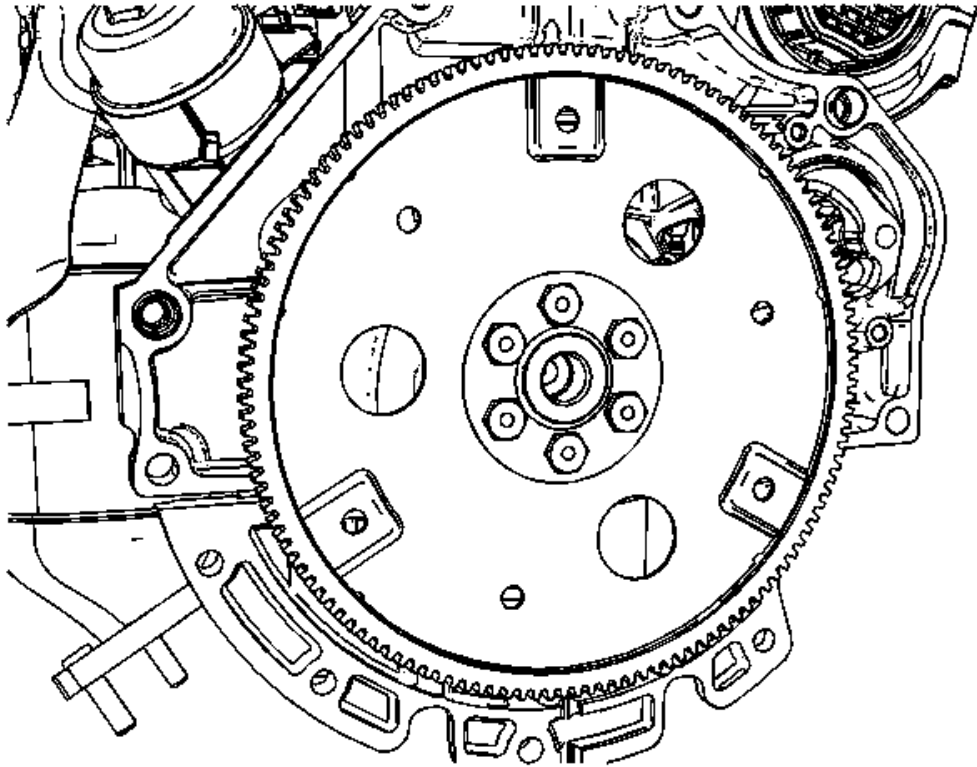


Fig. 83: Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

3. Remove KM-652 to unblock the crankshaft.

ENGINE FLYWHEEL REPLACEMENT

Special Tools

- EN-48356 Engine Fixture
- KM-652 Flywheel Locking Device

Removal Procedure

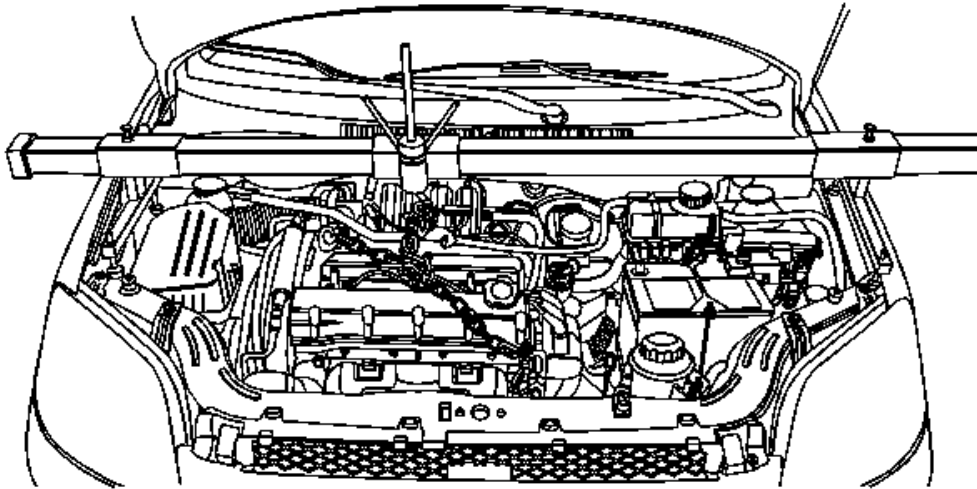


Fig. 84: Engine Support Tool
Courtesy of GENERAL MOTORS CORP.

1. Install EN-48356.
2. Remove the manual transmission. Refer to **TRANSMISSION REPLACEMENT** for D16.

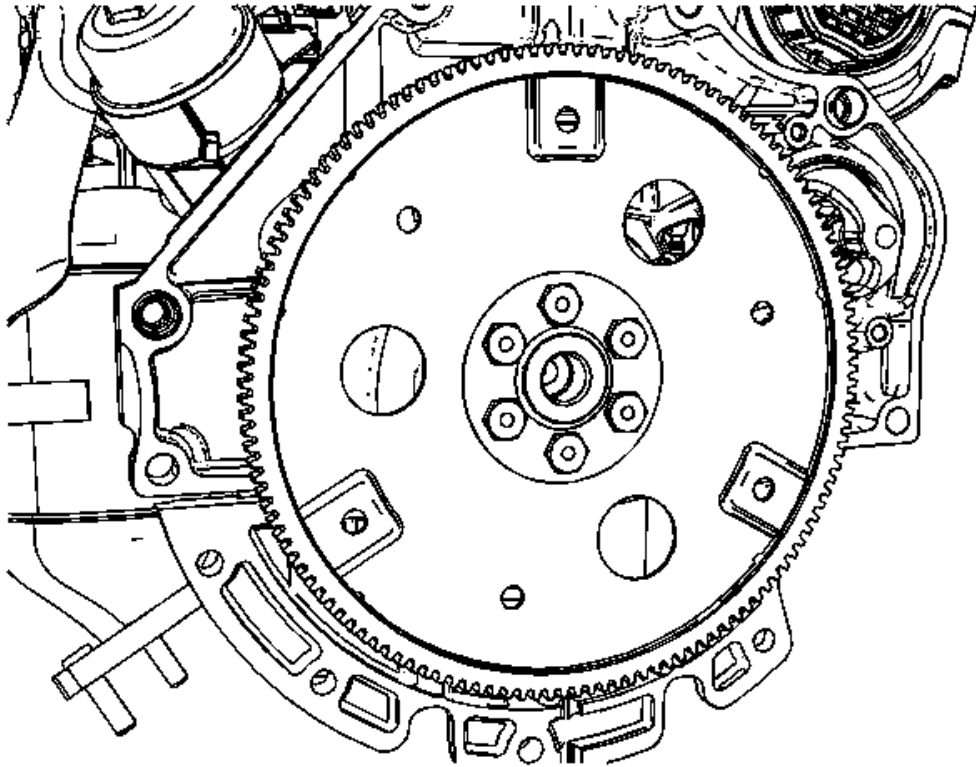


Fig. 85: Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

3. Install KM-652 to block the crankshaft.
4. Install the transmission tightening bolt with KM-652.

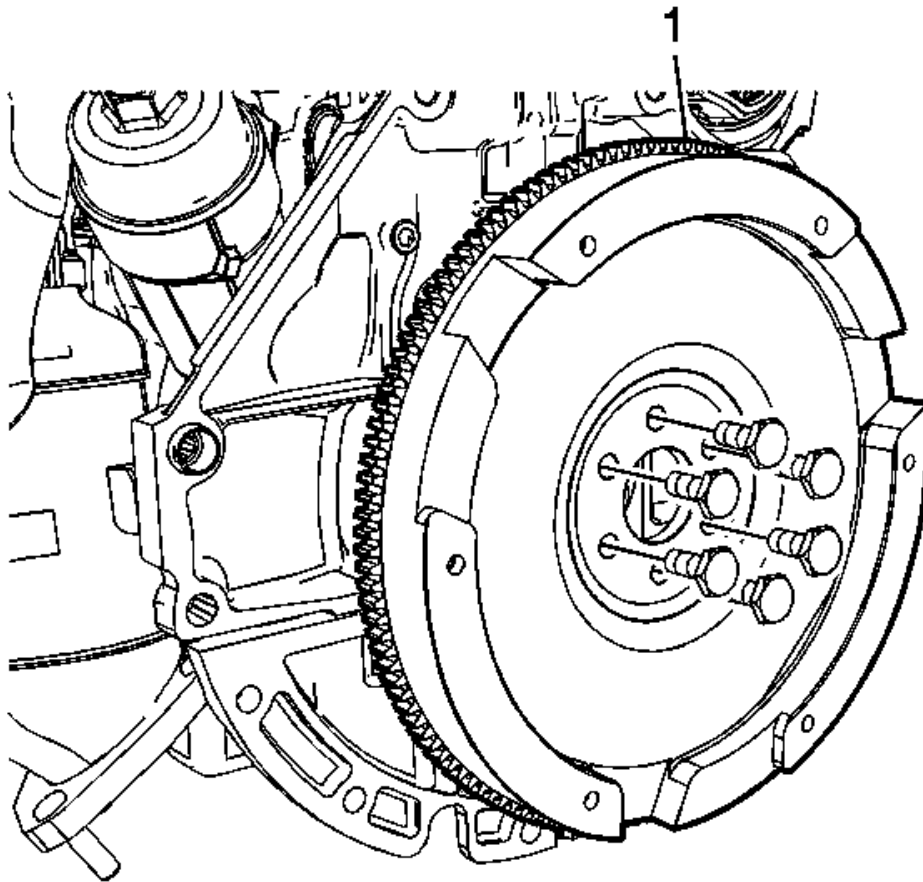


Fig. 86: Flywheel Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the flywheel bolts.
6. Remove the flywheel.

Installation Procedure

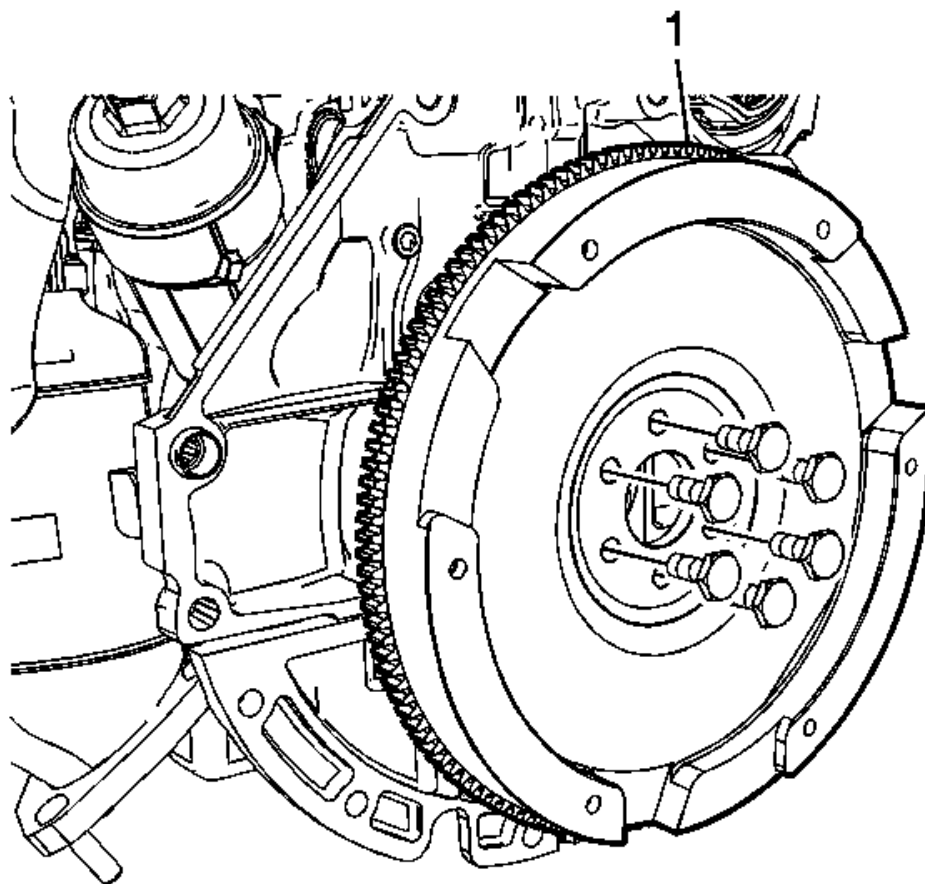


Fig. 87: Flywheel Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel.

CAUTION: Refer to Fastener Caution .

2. Install the flywheel bolts.

Tighten: Tighten the flywheel bolts to 35 N.m +30° +15° (25.8 lb ft +30° +15°).

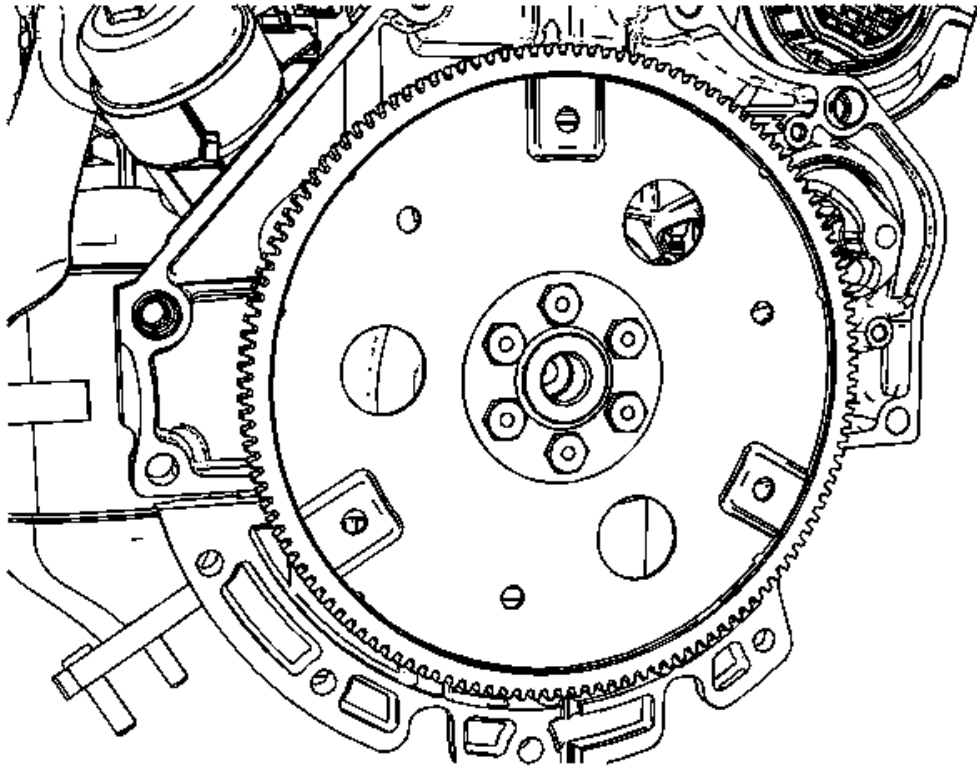


Fig. 88: Flywheel Holder
Courtesy of GENERAL MOTORS CORP.

3. Install KM-652 to unblock the crankshaft.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

KM-6351 Assembly Sleeves

Removal Procedure

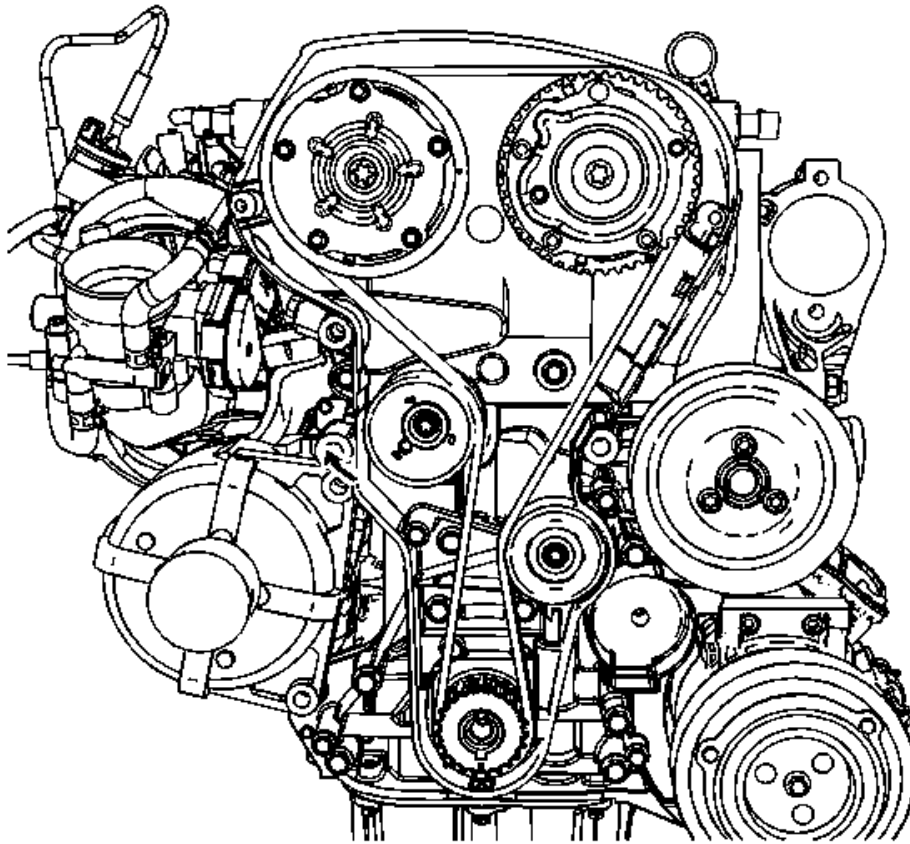


Fig. 89: Timing Belt

Courtesy of GENERAL MOTORS CORP.

1. Remove the timing belt. Refer to **Timing Belt Replacement**.
2. Remove the crankshaft sprocket.

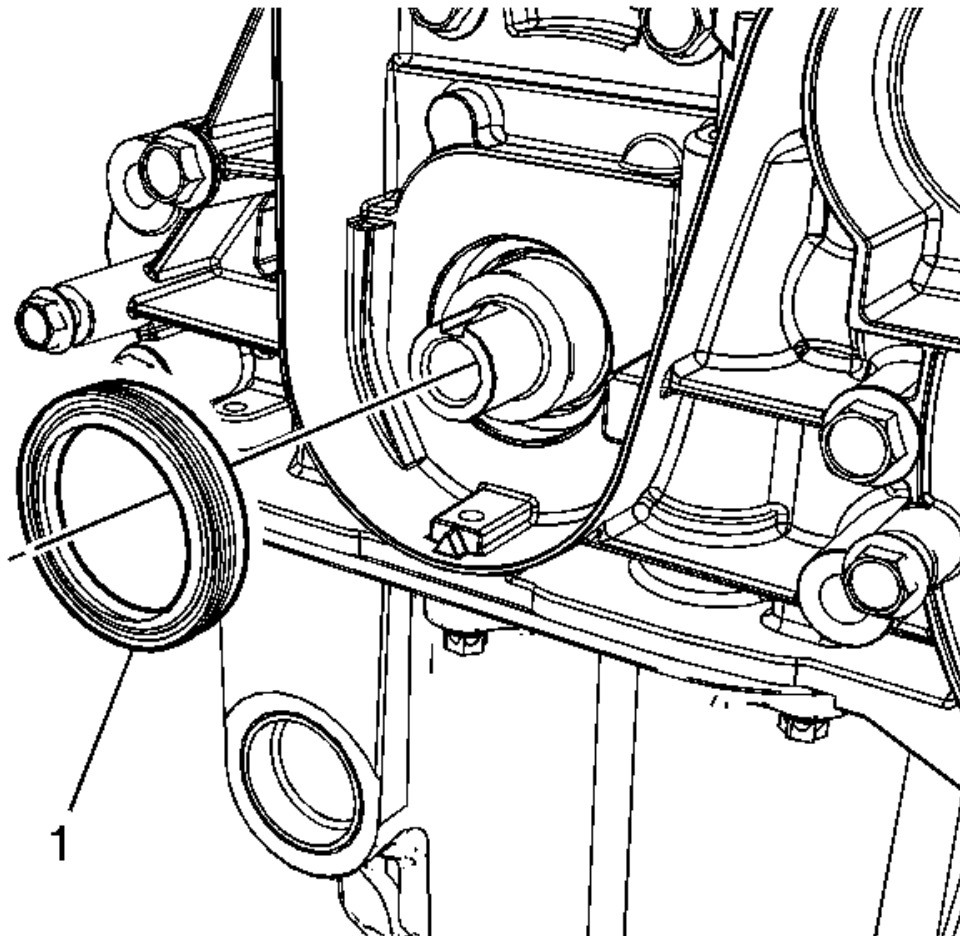


Fig. 90: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft front oil seal ring.

Installation Procedure

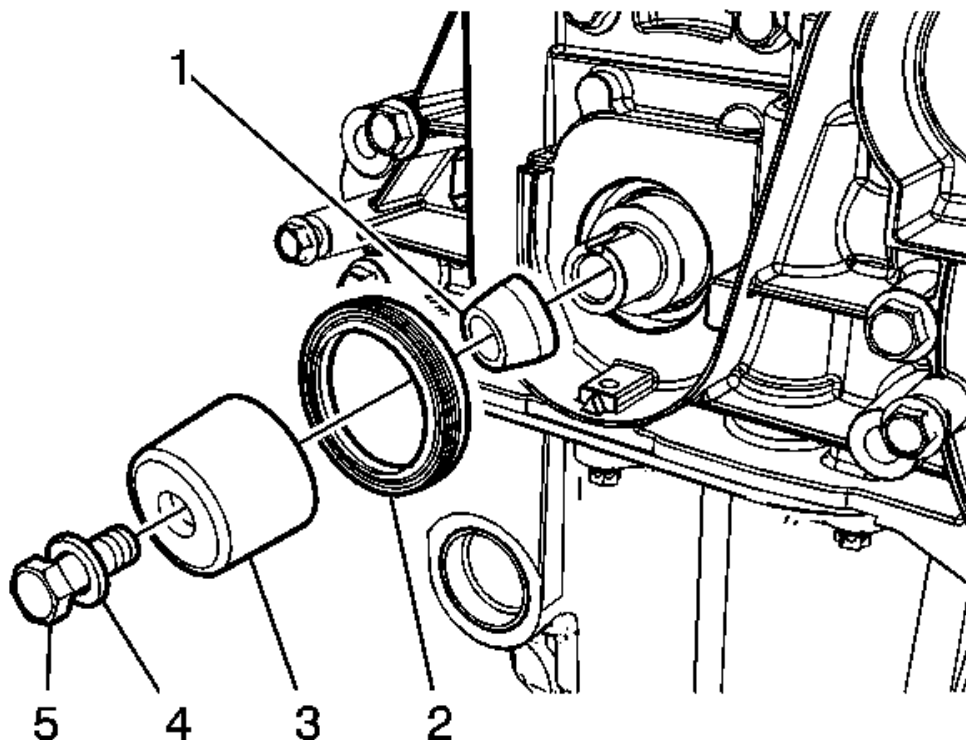


Fig. 91: Crankshaft Front Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

1. Attach the installer inside sleeve (a).
2. Attach the crankshaft front oil seal ring to the inside sleeve (a).
3. Attach the installer outside sleeve (b).
4. Install the crankshaft bolt (d) and washer (c).

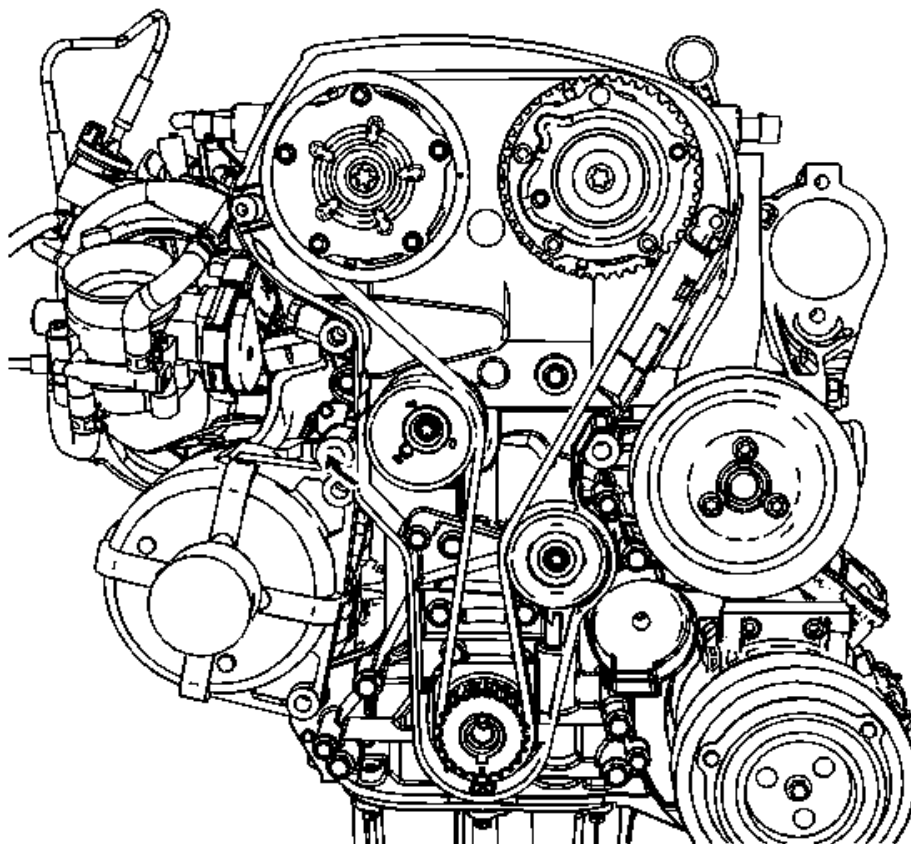


Fig. 92: Timing Belt

Courtesy of GENERAL MOTORS CORP.

5. Install the crankshaft sprocket.
6. Install the timing belt. Refer to **Timing Belt Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-49204 Crankshaft Rear Oil Seal Installer

Removal Procedure

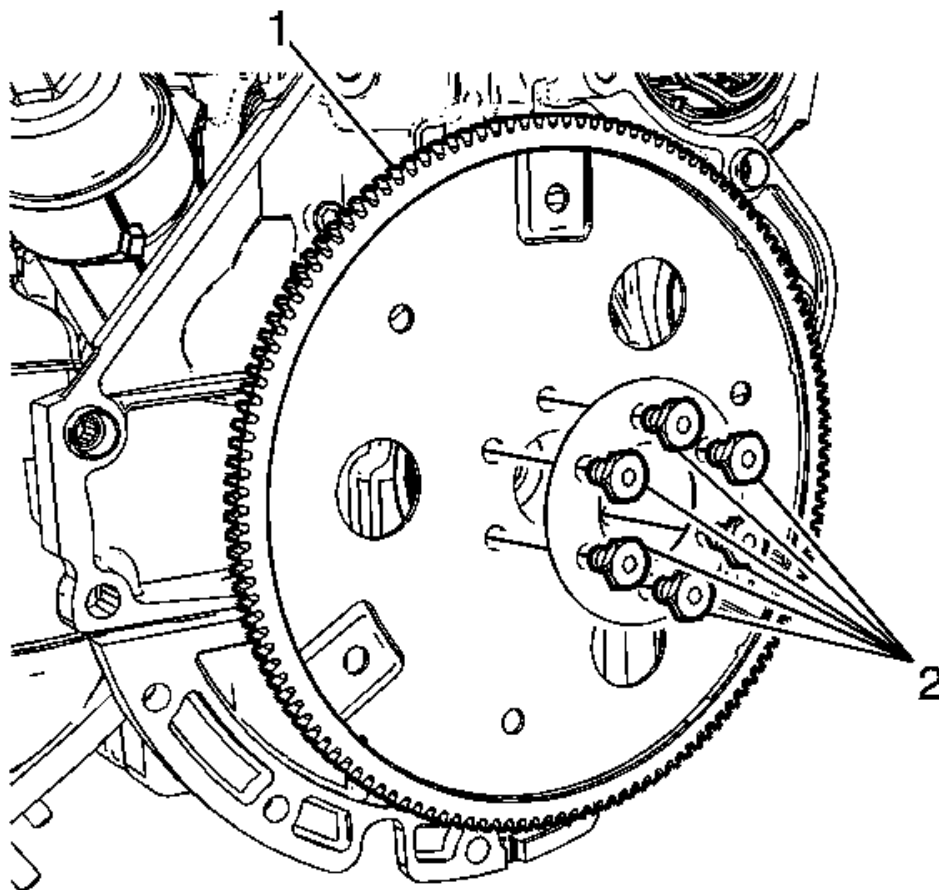


Fig. 93: Flexible Plate Bolts

Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel or flexible plate. Refer to **Engine Flywheel Replacement**.
2. Remove the crankshaft position (CKP) sensor.

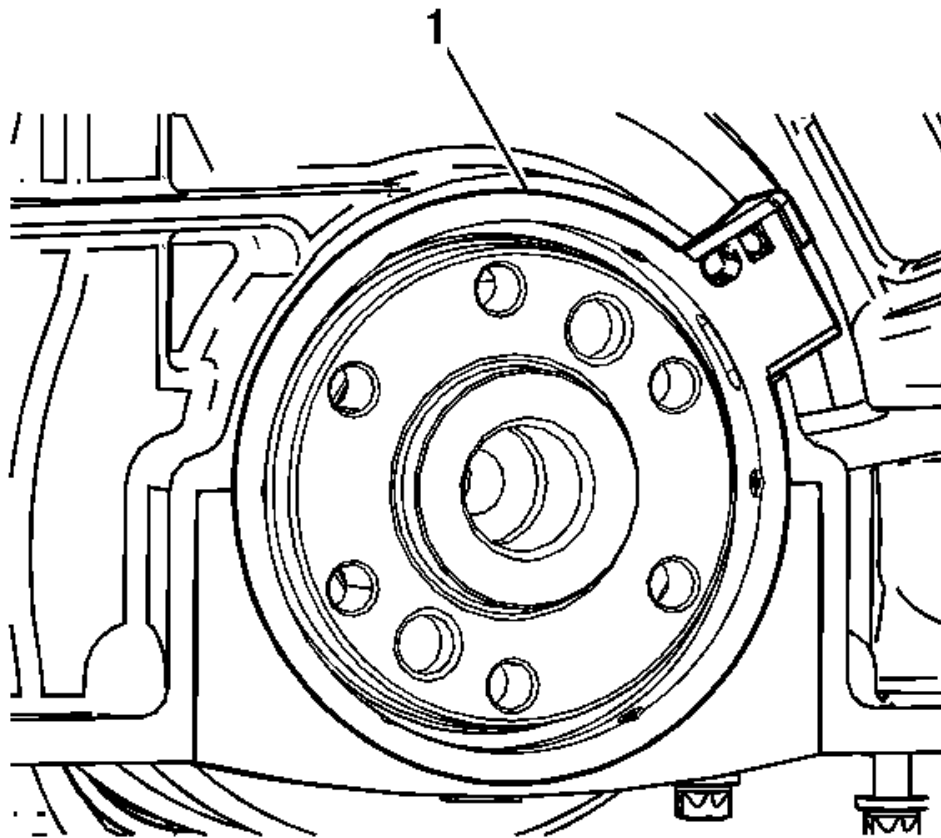


Fig. 94: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft rear oil seal with housing.

Installation Procedure

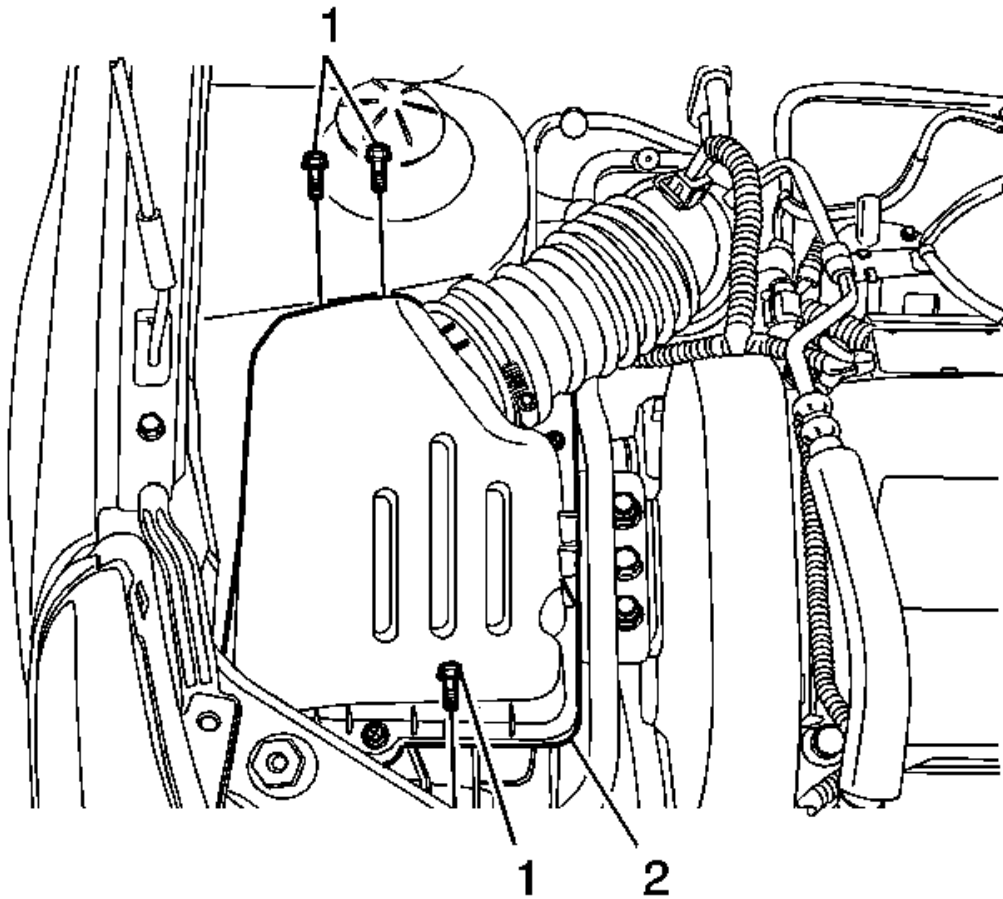


Fig. 95: Air Cleaner Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the new crankshaft rear oil seal.
2. Install EN-49204 and then tighten the bolts to press seal ring all the way in.
3. Remove EN-49204.

CRANKSHAFT REPLACEMENT

Special Tools

EN-49204 Crankshaft Rear Oil Seal Installer

Removal Procedure

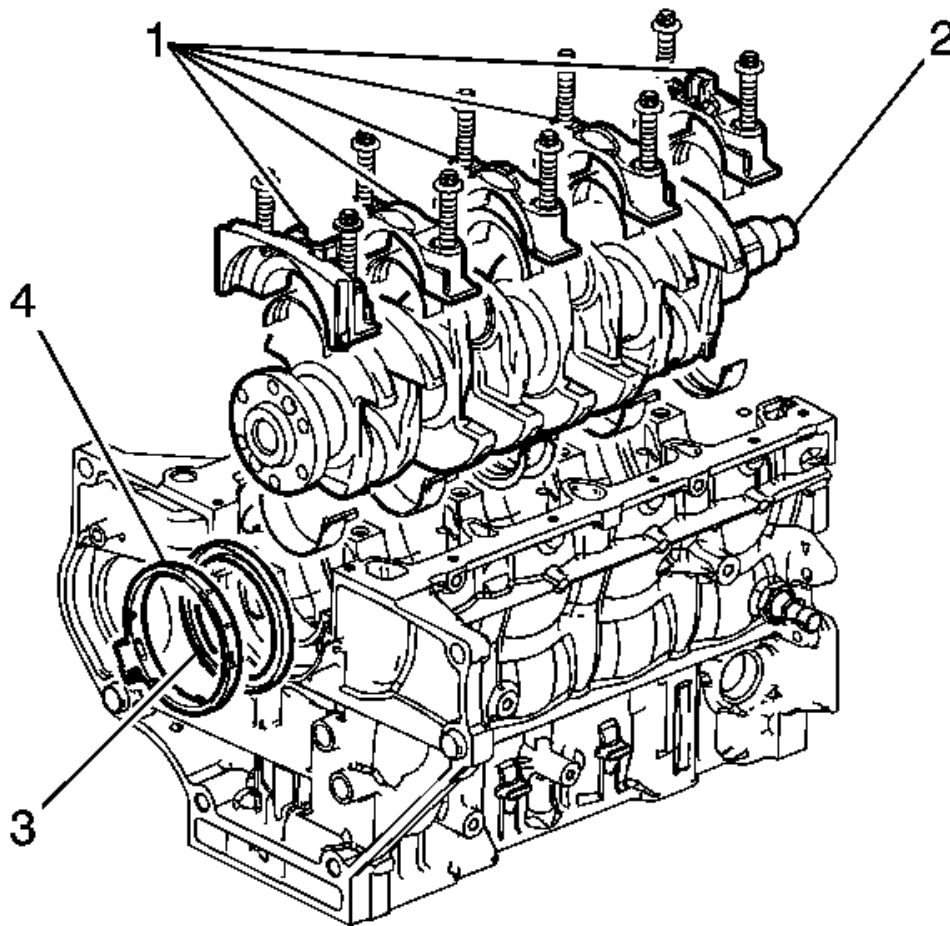


Fig. 96: Crankshaft, Crankshaft Rear Oil Seal, Crankshaft Bearing Caps & Crankshaft Bearing Cap Bolts

Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches, nicks or damage to the inner side of the cylinder and bearings. If scratched, the engine may be damaged.

IMPORTANT: Check and confirm the sequence of the crankshaft caps and bearings.

1. Remove the pistons and connecting rods. Refer to **Piston, Connecting Rod, and Connecting Rod Bearing Replacement**.
2. Remove the crankshaft cap bolts.
3. Remove the crankshaft caps with journal bearings.
4. Remove the crankshaft.
5. Remove the crankshaft rear oil seal with housing.

6. Detach the crankshaft rear oil seal from the housing.

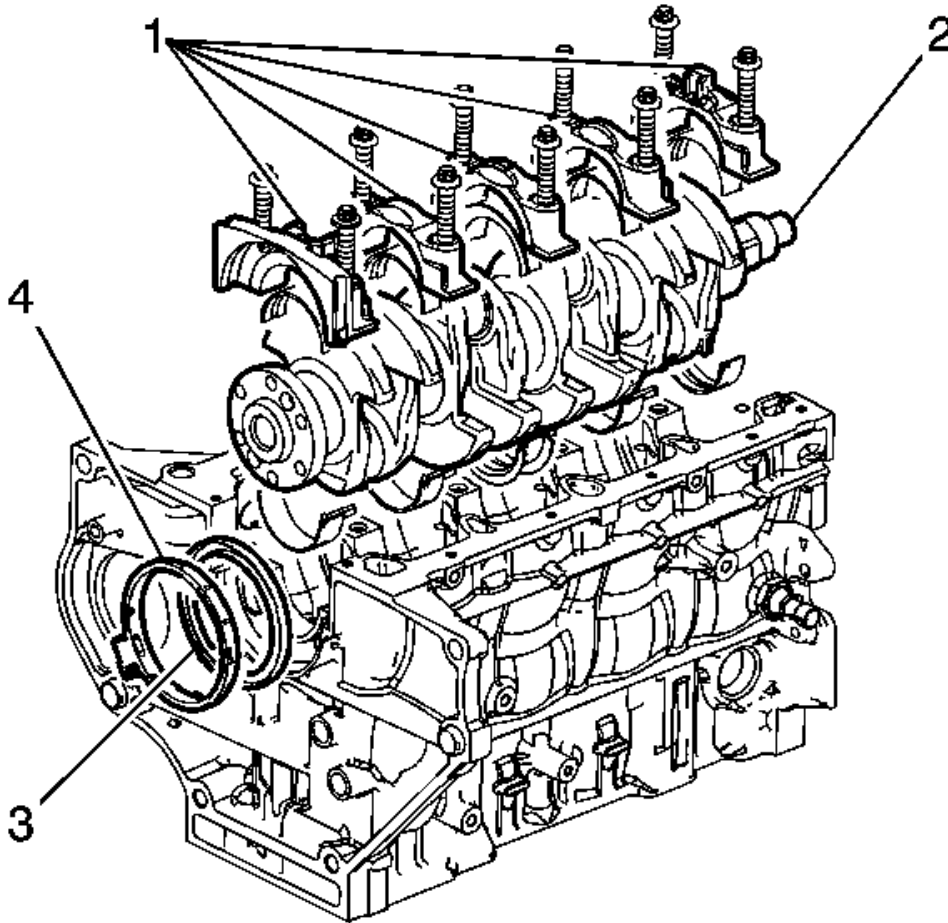
Installation Procedure

Fig. 97: Crankshaft, Crankshaft Rear Oil Seal, Crankshaft Bearing Caps & Crankshaft Bearing Cap Bolts

Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches, nicks or damage to the inner side of the cylinder and bearings. If scratched, the engine may be damaged.

IMPORTANT: Check and confirm the sequence of the crankshaft caps and bearings.

1. Coat and lubricate the crankshaft caps and bearings.
2. Install the crankshaft with bearings in sequences.
3. Install the crankshaft caps with journal bearings.

Tighten: Tighten the crankshaft cap bolts to 50+50° N.m (36.8+50° lb ft).

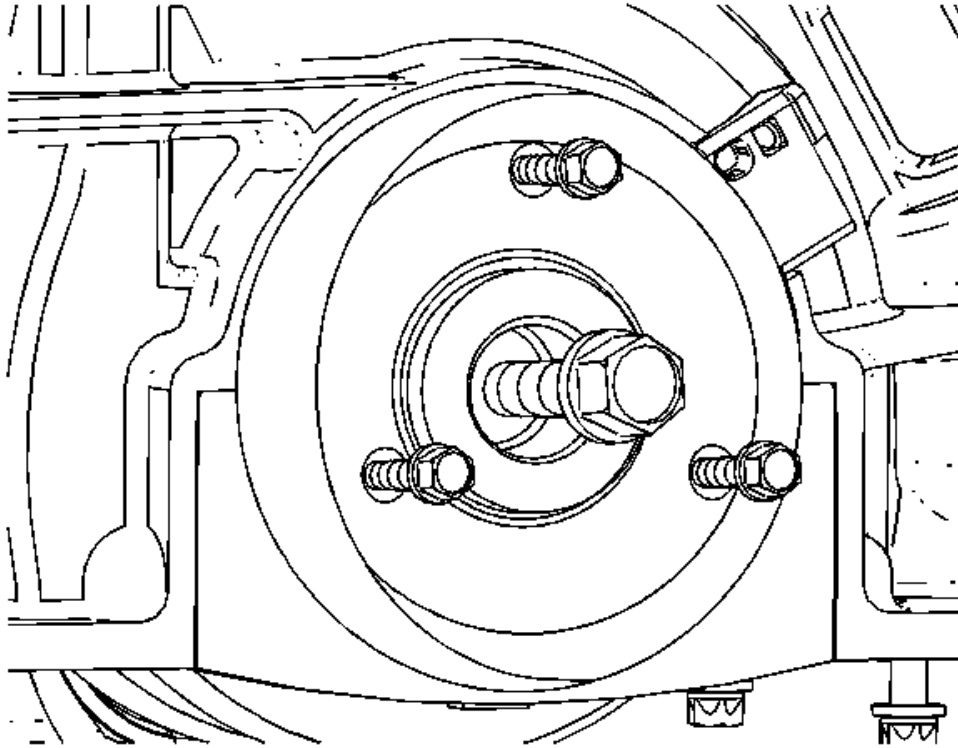


Fig. 98: Crankshaft Rear Oil Seal Housing & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Attach the crankshaft rear oil seal to the housing.
5. Install the crankshaft rear oil seal with housing using the crankshaft rear oil seal installer (EN-49204).
6. Install the pistons and connecting rods. Refer to **Piston, Connecting Rod, and Connecting Rod Bearing Replacement**.

ENGINE OIL HEATER REPLACEMENT

Removal Procedure

1. Disconnect the injector cable connector.
2. Remove the oil pan heater mounting bolts.
3. Remove the oil pan heater.

Installation Procedure

1. Apply suitable silicon on oil pan heater mounting surface.
2. Install the oil pan heater.

CAUTION: Refer to Fastener Caution .

3. Install the oil pan heater bolts.

Tighten: Tighten the coil pan heater bolts to 8 N.m (71 lb in).

4. Connect the injector cable connector.

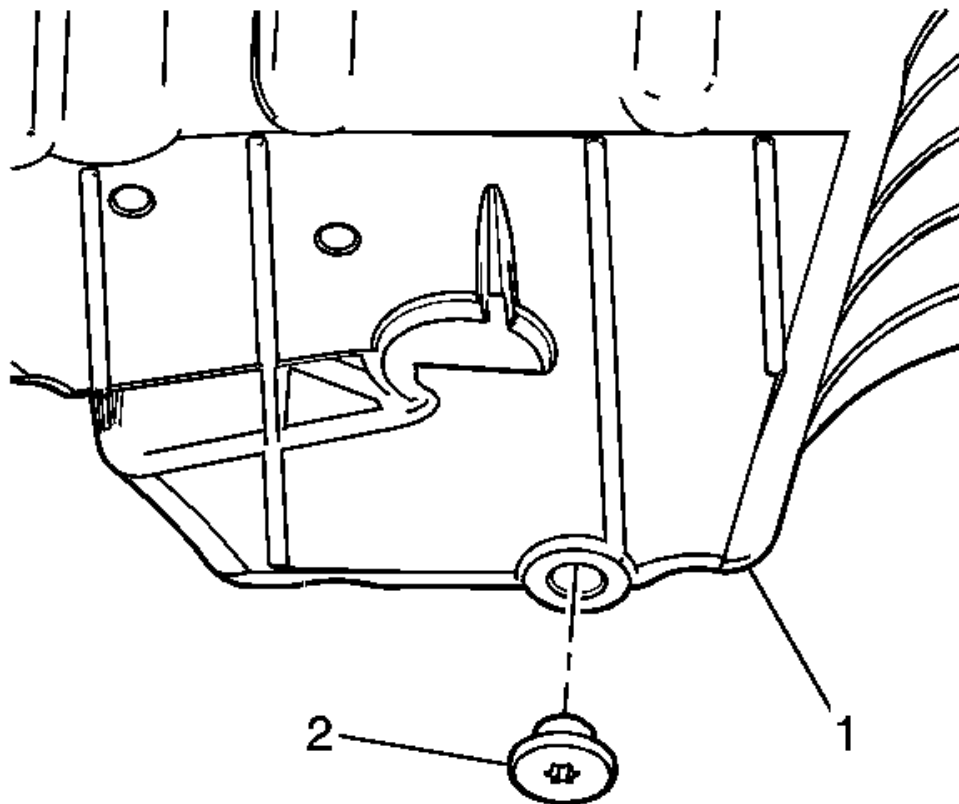
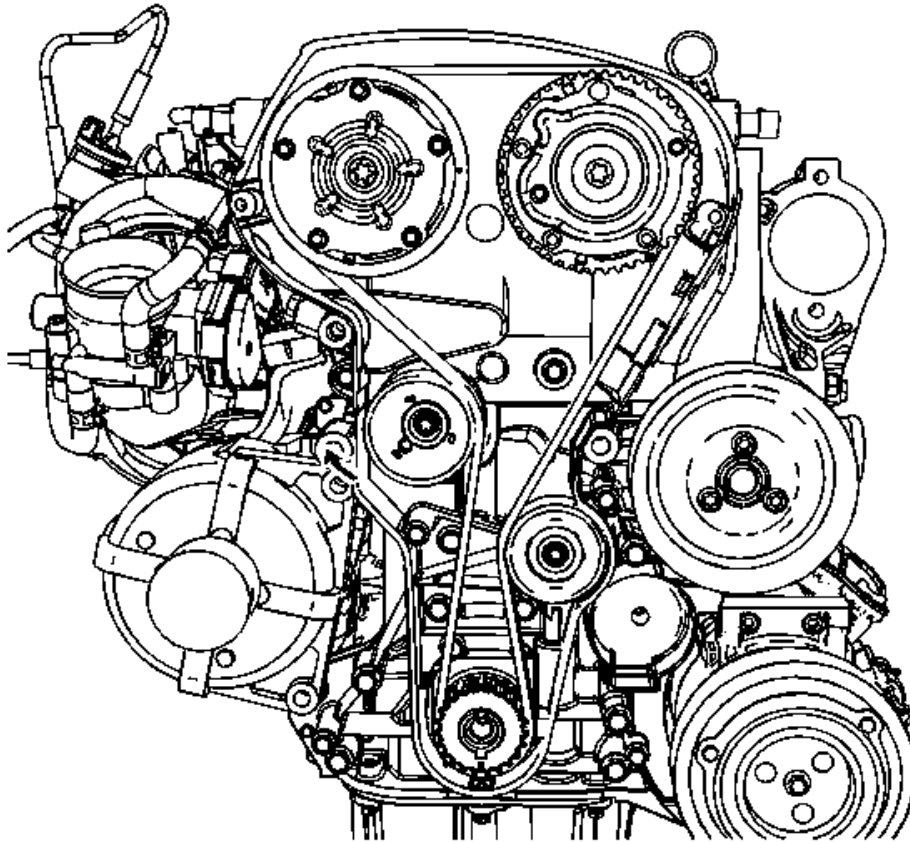
ENGINE OIL PUMP REPLACEMENT**Removal Procedure**

Fig. 99: Engine Oil Pan Drain Plug**Courtesy of GENERAL MOTORS CORP.**

1. Drain the engine coolant. Refer to Cooling System Draining and Filling .
2. Drain the engine oil. Refer to Engine Oil and Engine Oil Filter Replacement.
3. Remove the exhaust manifold.

**Fig. 100: Timing Belt****Courtesy of GENERAL MOTORS CORP.**

4. Remove the timing belt. Refer to Timing Belt Replacement.
5. Remove the oil pan. Refer to Engine Oil Pan Replacement.
6. Remove the power steering pump and bracket. Refer to Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines) .
7. Remove the alternator. Refer to GENERATOR REPLACEMENT (1.4L LDT, 1.6L LXV) .
8. Remove the A/C compressor. Refer to AIR CONDITIONING COMPRESSOR REPLACEMENT .

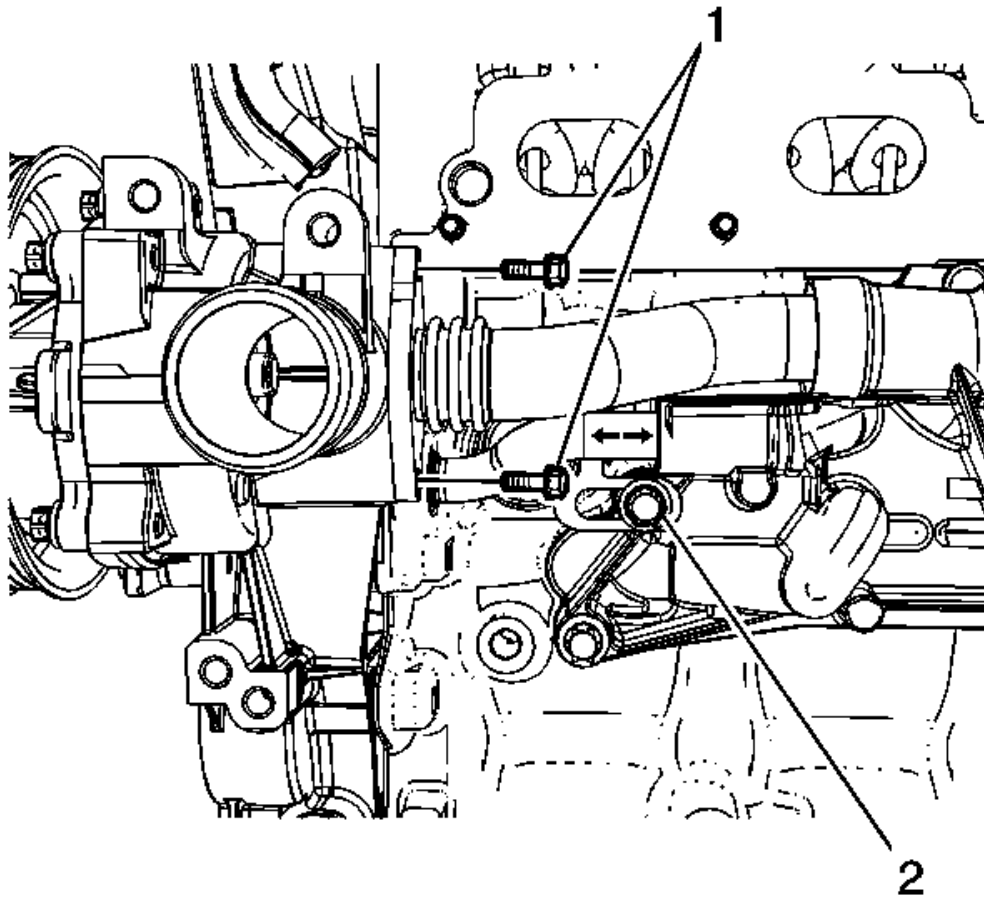


Fig. 101: Engine Coolant Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine coolant pipe (1) bolts.
10. Remove the engine coolant pipe (2) bracket bolt and then push the pipe into the oil cooler housing.

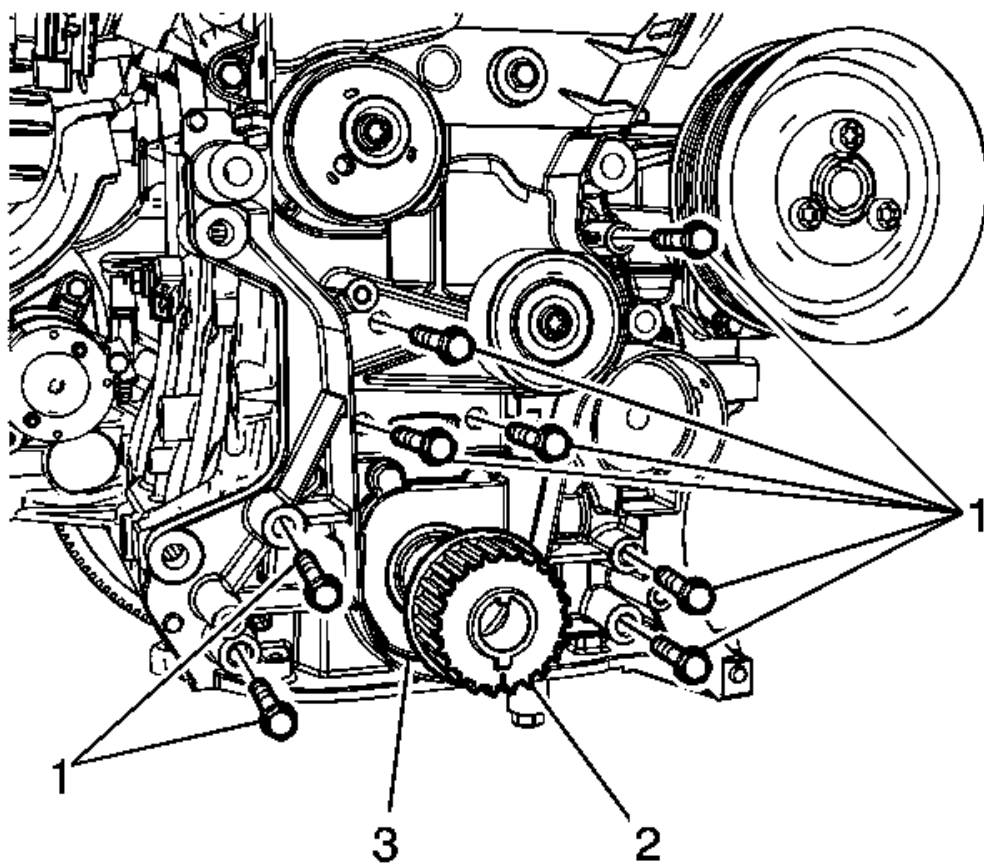


Fig. 102: Crankshaft Sprocket & Engine Front Cover Assembly
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft sprocket.
12. Remove the engine front cover assembly with the gasket.

Inspection Procedure

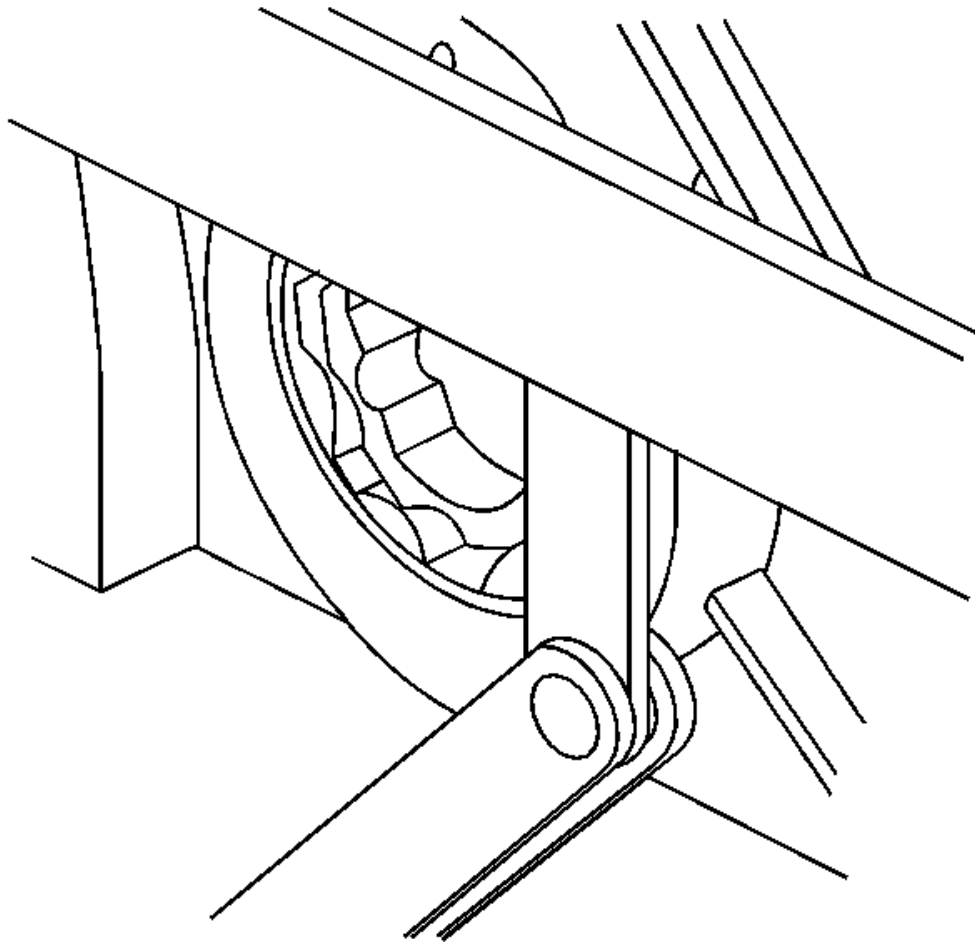


Fig. 103: Measuring Engine Oil Pump Axial Clearance Of Rotors
Courtesy of GENERAL MOTORS CORP.

1. Clean the measuring surface.
2. Measure the axial clearance of rotors.

If out-of-specifications, replace with a new one. Refer to **Engine Mechanical Specifications**.

Installation Procedure

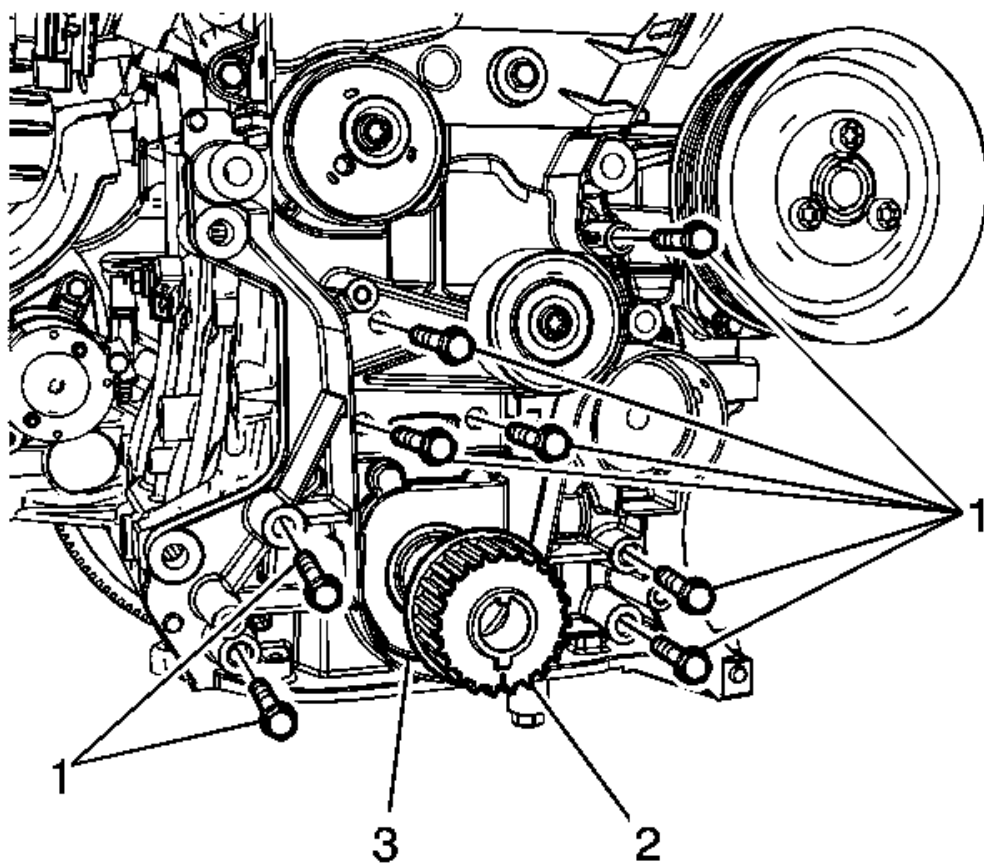


Fig. 104: Crankshaft Sprocket & Engine Front Cover Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Do not reuse the engine front cover gasket.

1. Install the engine front cover assembly with the new gasket.

Tighten: Tighten the engine front cover assembly bolts to 20 N.m (14.7 lb ft).

2. Install the crankshaft sprocket.

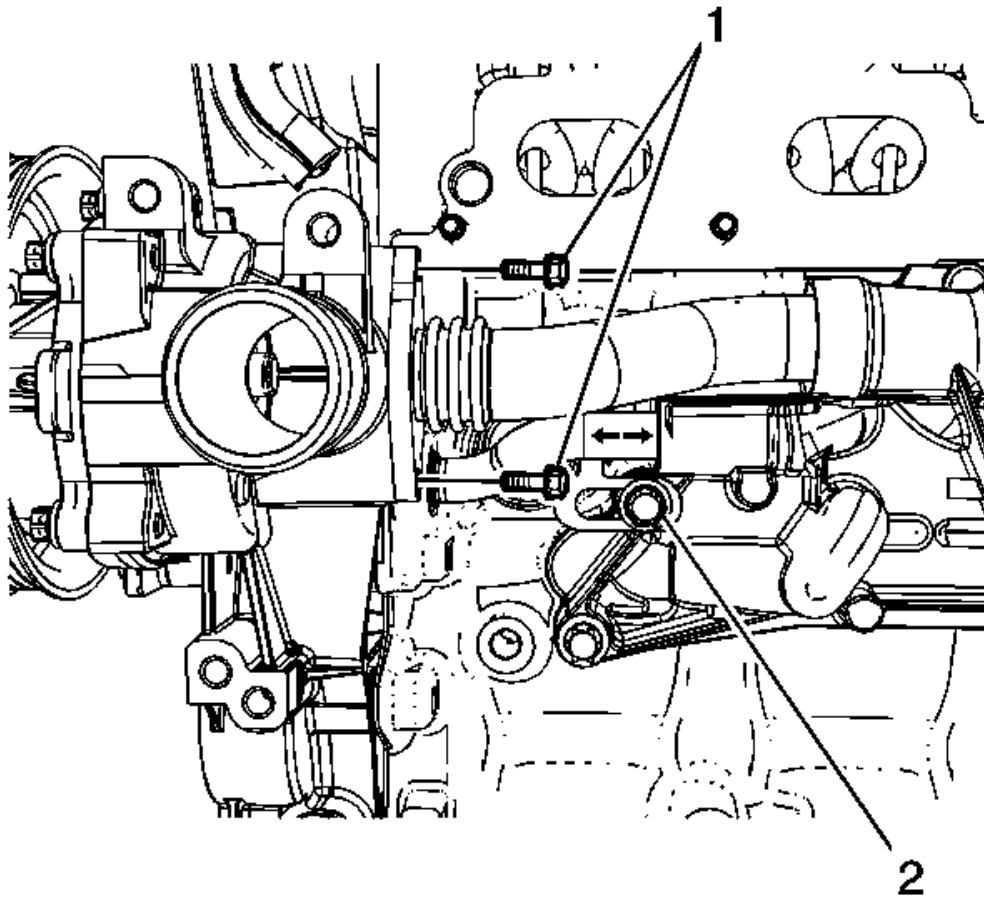


Fig. 105: Engine Coolant Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the engine coolant pipe (1) bolts.
4. Install the engine coolant pipe (2) bracket bolt and then push the pipe into the oil cooler housing.

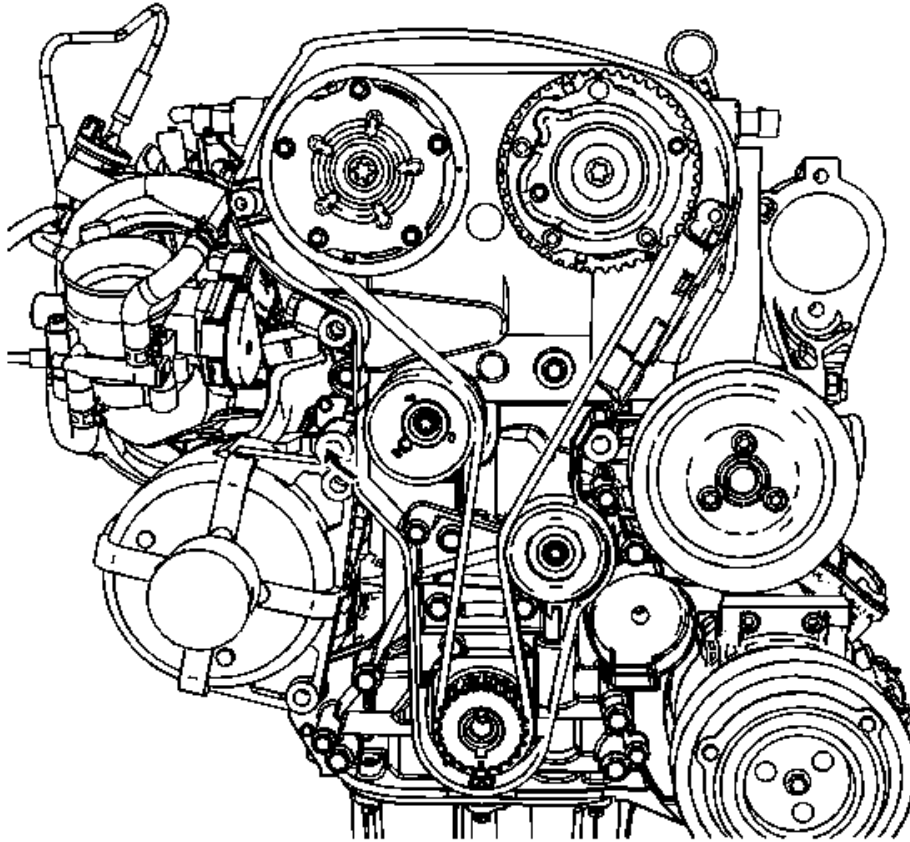


Fig. 106: Timing Belt

Courtesy of GENERAL MOTORS CORP.

5. Install the A/C compressor. Refer to **AIR CONDITIONING COMPRESSOR REPLACEMENT** .
6. Install the alternator. Refer to **GENERATOR REPLACEMENT (1.4L LDT, 1.6L LXV)** .
7. Install the power steering pump and bracket. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .
8. Install the oil pan. Refer to **Engine Oil Pan Replacement**.
9. Install the timing belt. Refer to **Timing Belt Replacement**.

OIL PRESSURE RELIEF VALVE REPLACEMENT (PRIMARY)

Removal Procedure

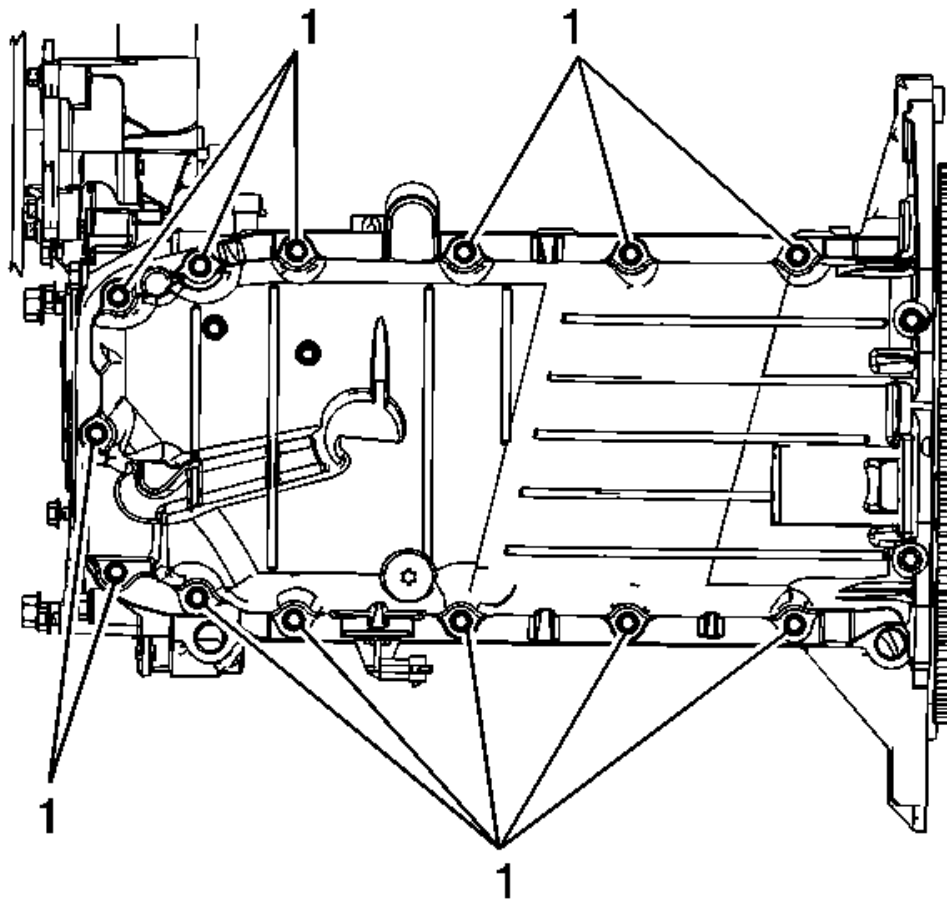


Fig. 107: Engine Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to Engine Oil Pan Replacement.

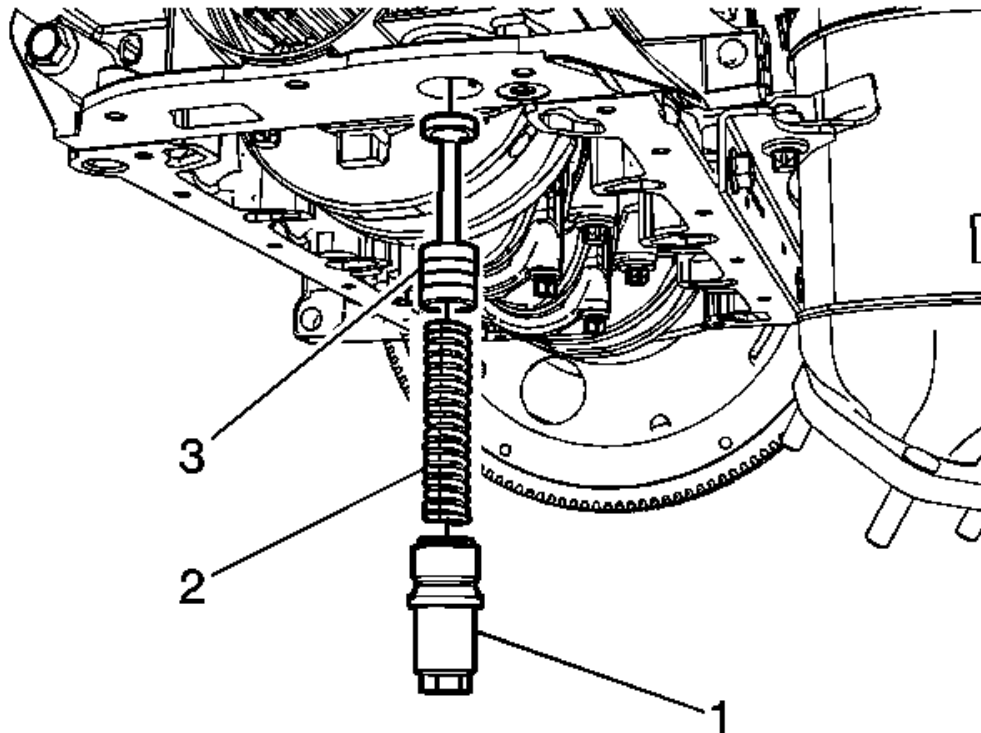


Fig. 108: Oil Pressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pressure relief valve plug.
3. Remove the valve spring.
4. Remove the valve piston.

Installation Procedure

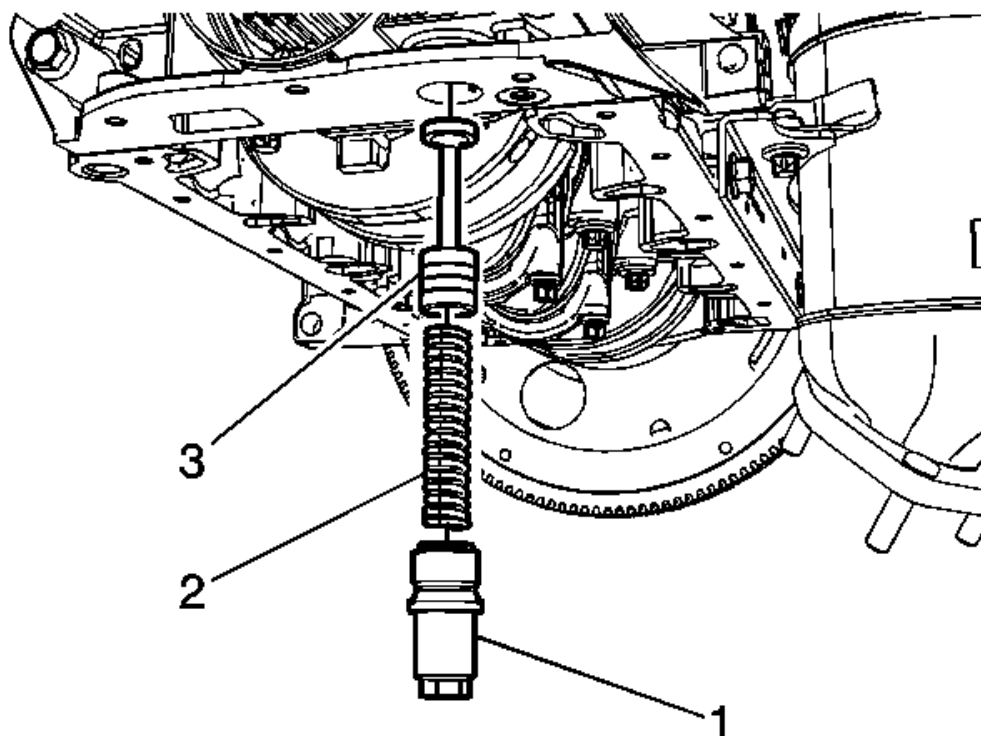


Fig. 109: Oil Pressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

1. Clean the plug thread, spring and piston.
2. Install the valve piston.
3. Install the valve spring.

CAUTION: Refer to Fastener Caution .

4. Install the oil pressure relief valve plug.

Tighten: Tighten the oil pressure relief valve plug to 21 N.m (15.5 lb ft).

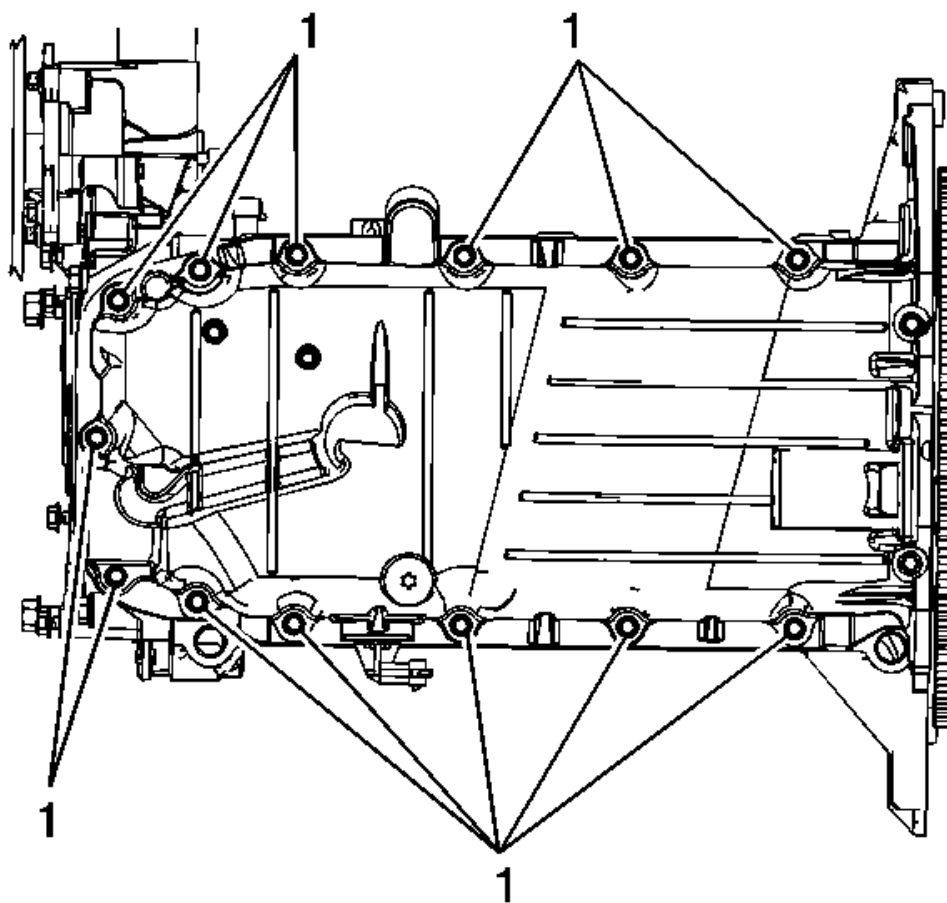


Fig. 110: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the oil pan. Refer to Engine Oil Pan Replacement.

OIL PRESSURE RELIEF VALVE REPLACEMENT (SECONDARY)

Removal Procedure

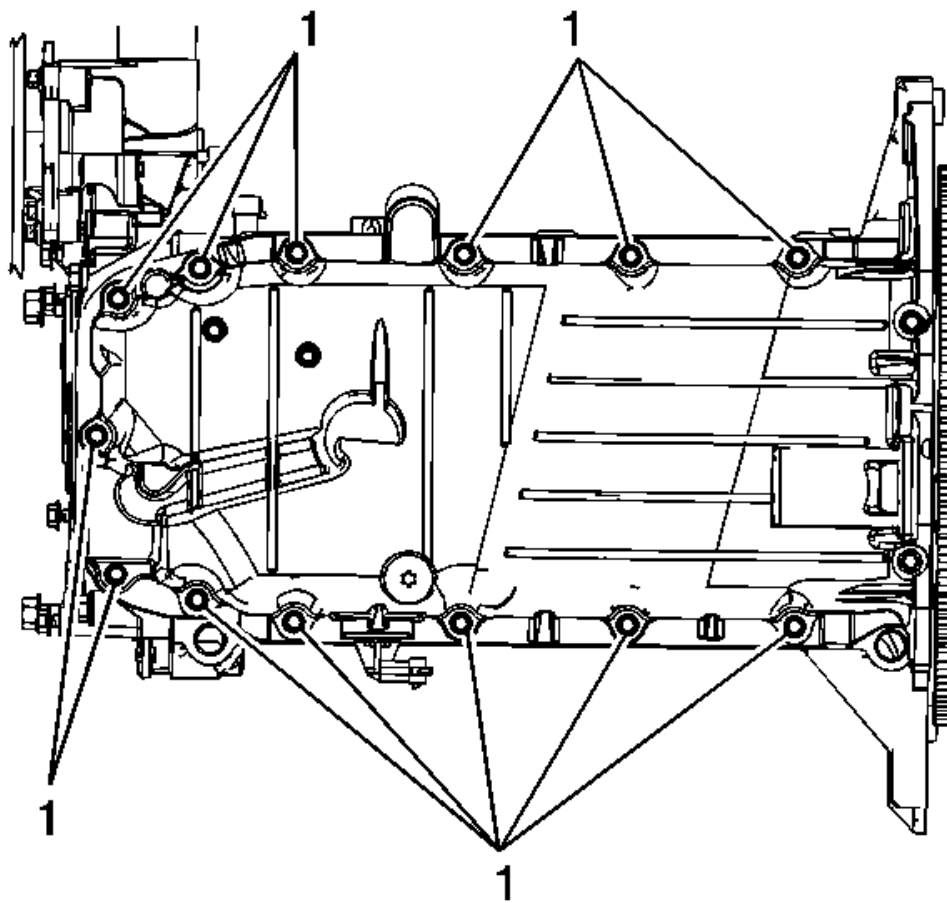


Fig. 111: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan. Refer to Engine Oil Pan Replacement.

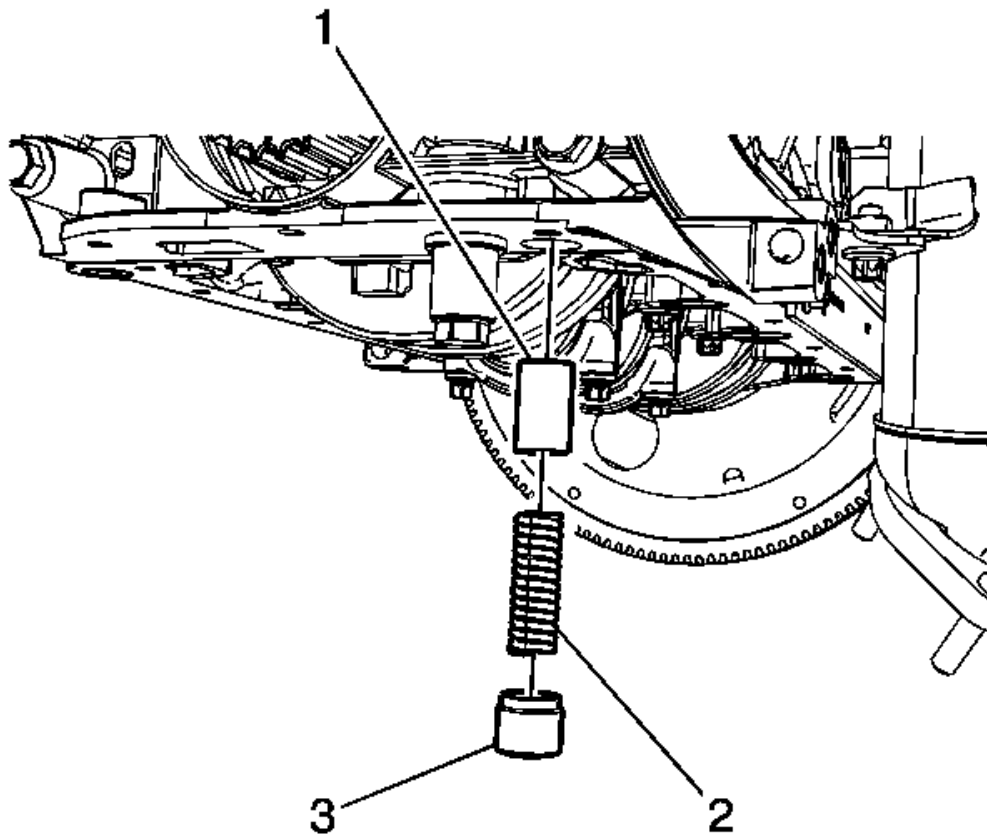


Fig. 112: Oil Overpressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil overpressure relief valve plug.
3. Remove the valve spring.
4. Remove the valve piston.

Installation Procedure

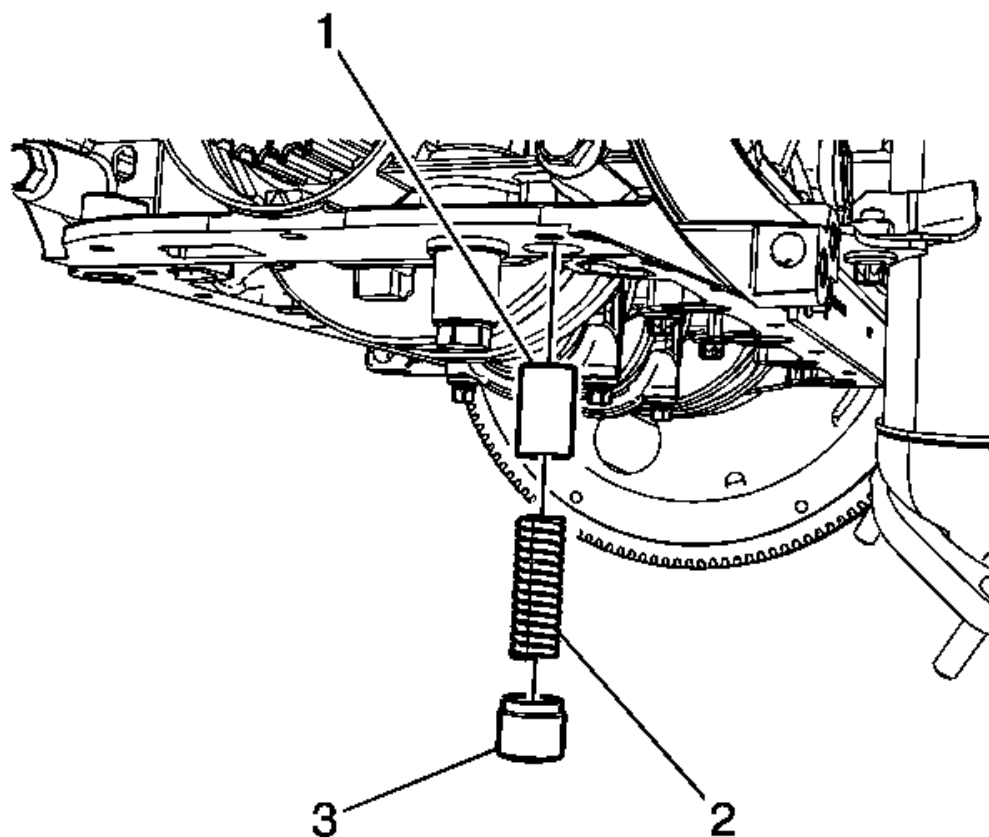


Fig. 113: Oil Overpressure Relief Valve Plug
Courtesy of GENERAL MOTORS CORP.

1. Clean the plug thread, spring and piston.
2. Install the valve piston.
3. Install the valve spring.

CAUTION: Refer to Fastener Caution .

4. Install the oil overpressure relief valve plug.

Tighten: Tighten the oil pressure relief valve plug to 10 N.m (88.5 lb in).

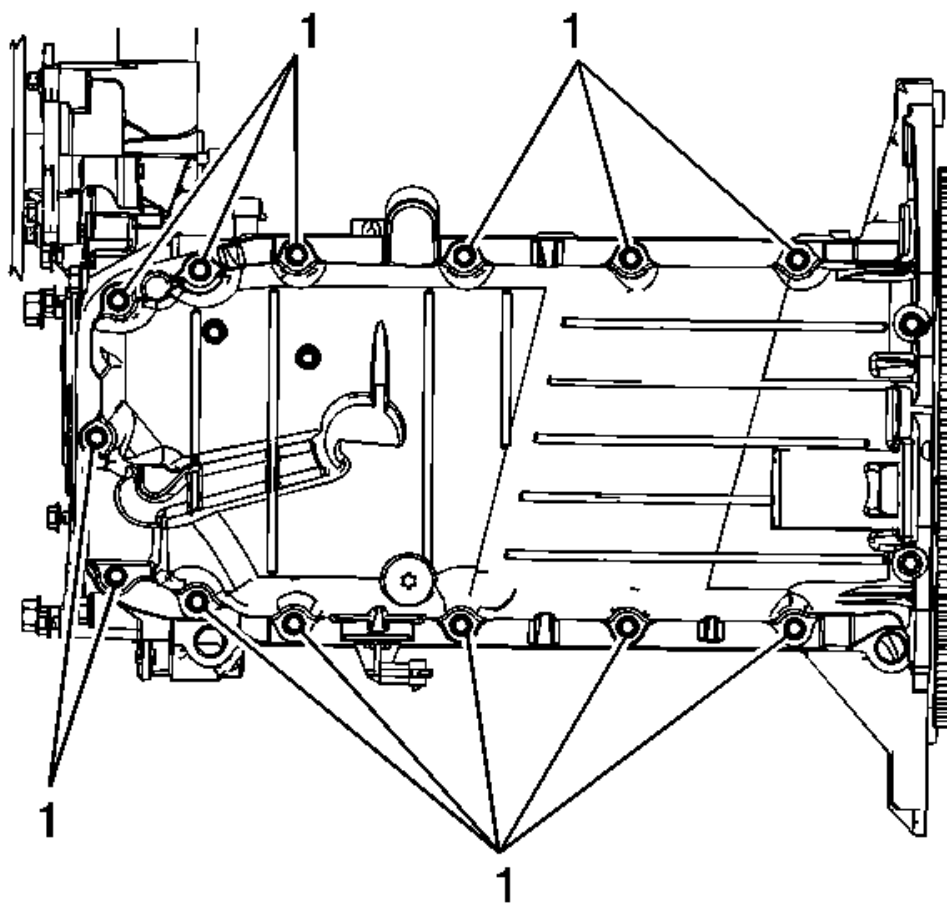


Fig. 114: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the oil pan. Refer to Engine Oil Pan Replacement.

OIL LEVEL INDICATOR AND OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

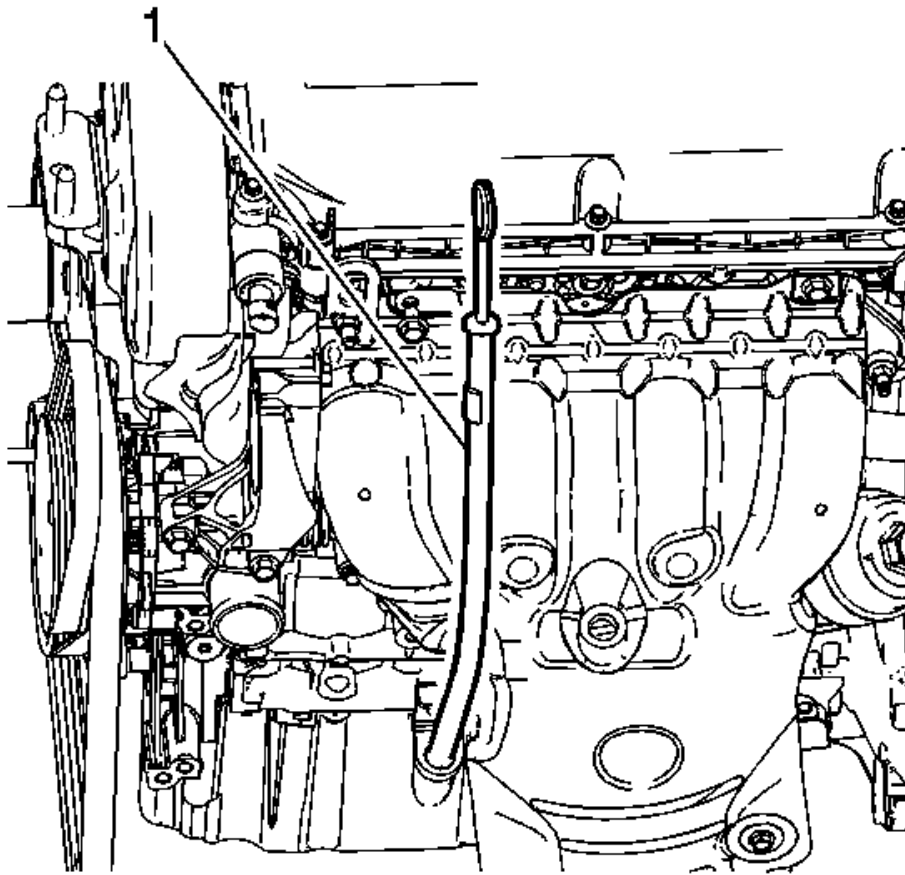


Fig. 115: Oil Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil indicator tube tightening bolt.
2. Remove the oil indicator and tube.

Installation Procedure

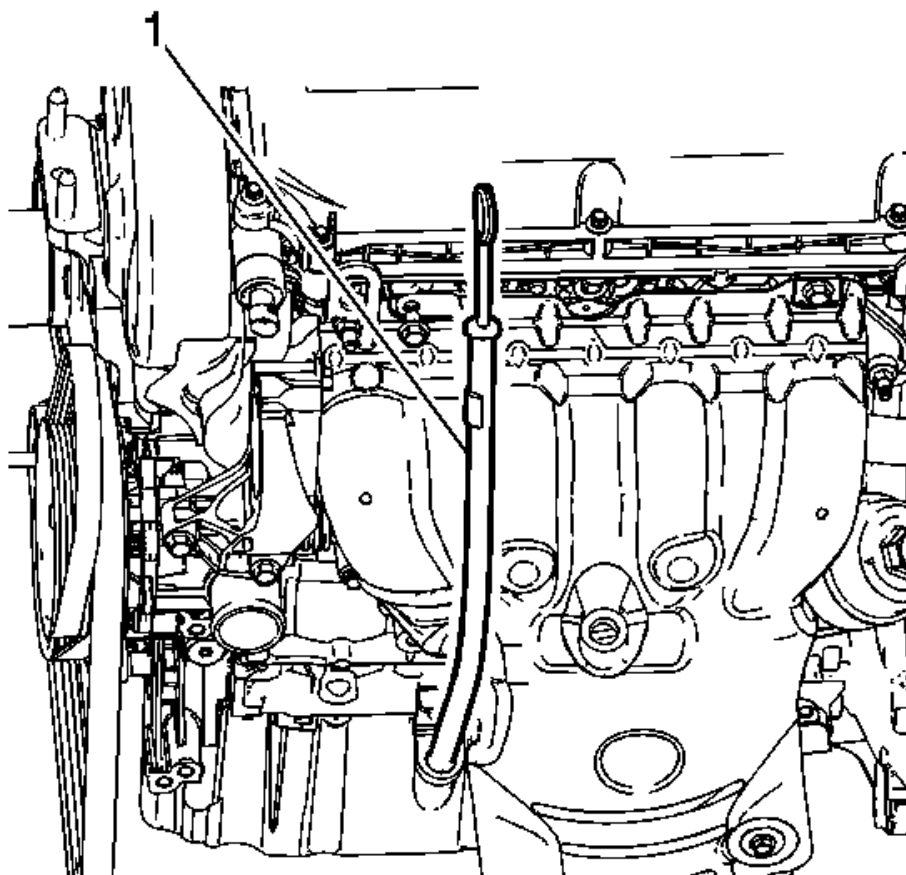


Fig. 116: Oil Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the oil indicator and tube.

CAUTION: Refer to Fastener Caution .

2. Install the oil indicator tube tightening bolt.

Tighten: Tighten the oil indicator tube tightening bolt to 10 N.m (7.3 lb ft).

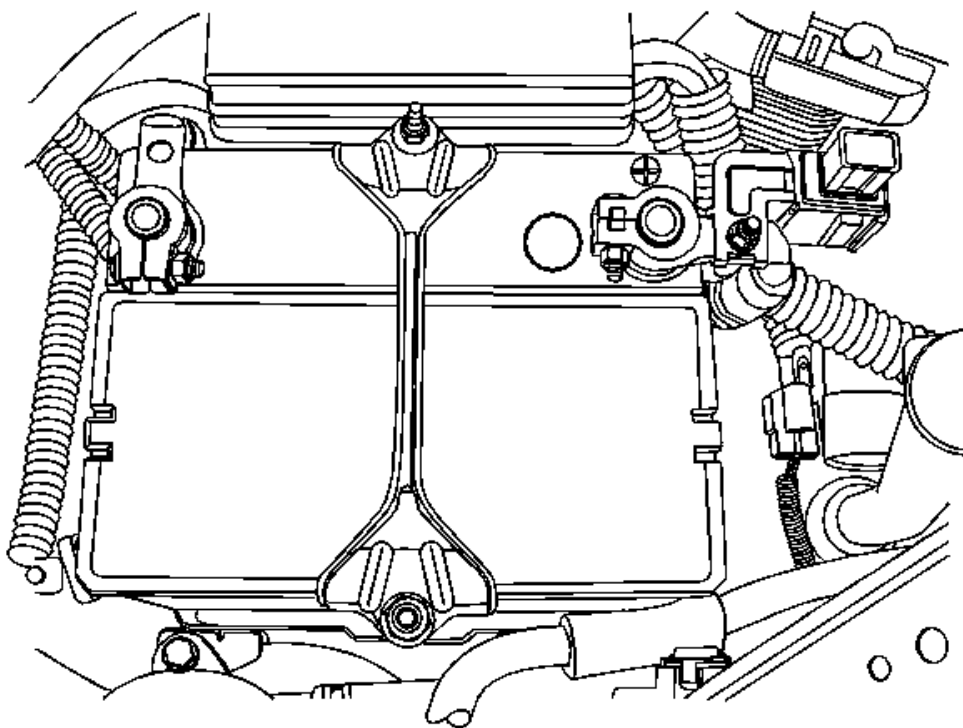
ENGINE REPLACEMENT

Special Tools

- EN-48244 Engine Assembly Remove/Install Pallet Supporter
- EN-49156 Engine Assembly Remove/Install Pallet

Removal Procedure

1. Release the fuel pressure. Refer to **FUEL PRESSURE RELIEF** .
2. Disconnect the fuel pipe from the fuel rail.
3. Disconnect the EVAP hose from the EVAP canister solenoid valve.
4. Drain the engine coolant. Refer to **Cooling System Draining and Filling** .
5. Remove the air cleaner assembly.

**Fig. 117: Battery****Courtesy of GENERAL MOTORS CORP.**

6. Remove the battery and tray. Refer to **Battery Tray Replacement** .
7. Remove the fuse box tightening bolts.

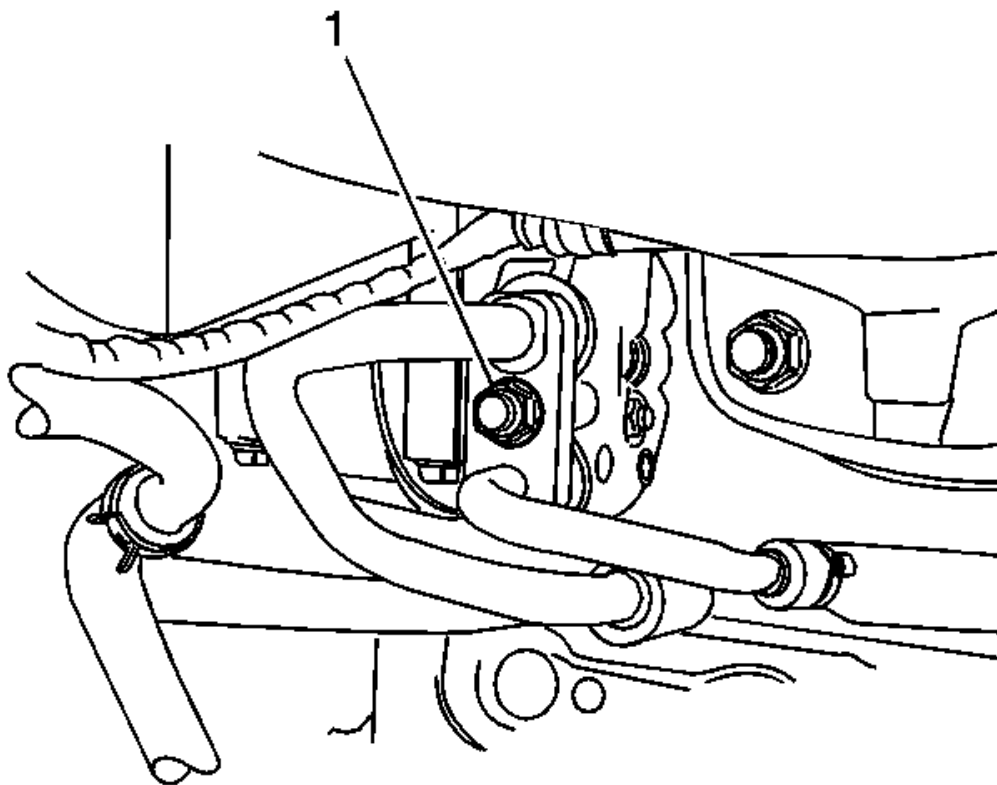


Fig. 118: A/C Inlet/Outlet Pipe Tightening Bolt
Courtesy of GENERAL MOTORS CORP.

8. Discharge the A/C gas system, if equipped. Refer to **REFRIGERANT RECOVERY AND RECHARGING**.
9. Remove the A/C inlet/outlet pipe tightening bolt from the A/C compressor.

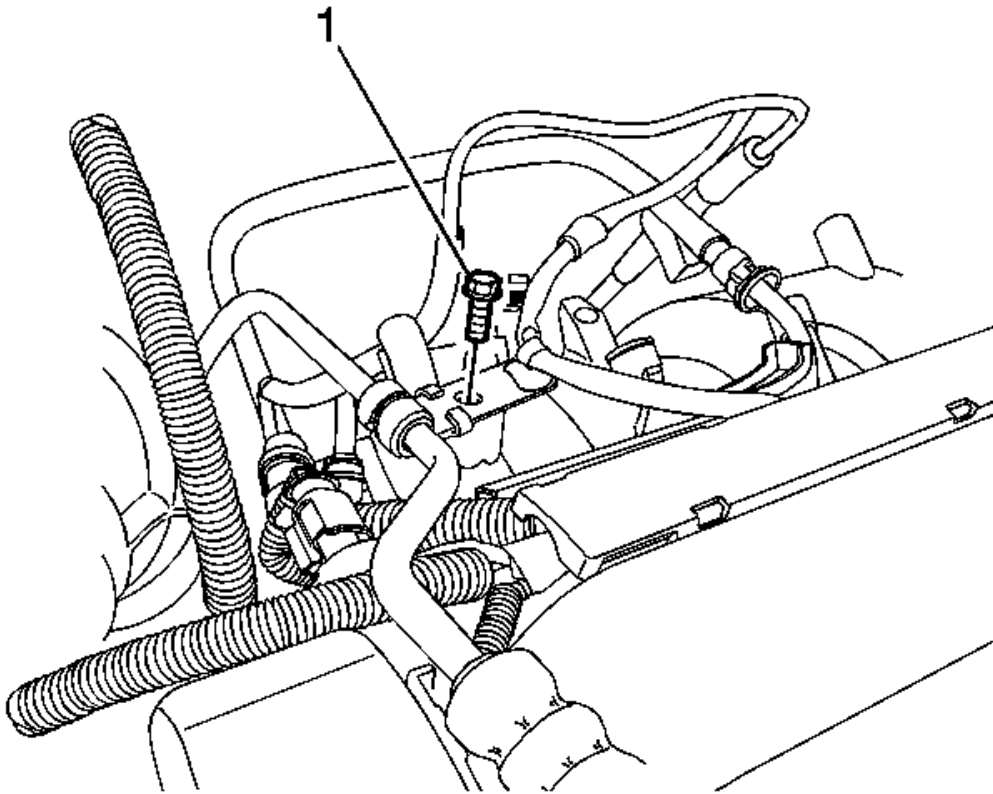


Fig. 119: Power Steering Pump Pressure Line Union Nut
Courtesy of GENERAL MOTORS CORP.

10. Drain the power steering oil if equipped. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .
11. Remove the power steering pump pressure line union nut. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .
12. Remove the power steering pressure pipe retaining clamp bolt from the intake manifold.
13. Disconnect the power steering hose from the power steering pump.

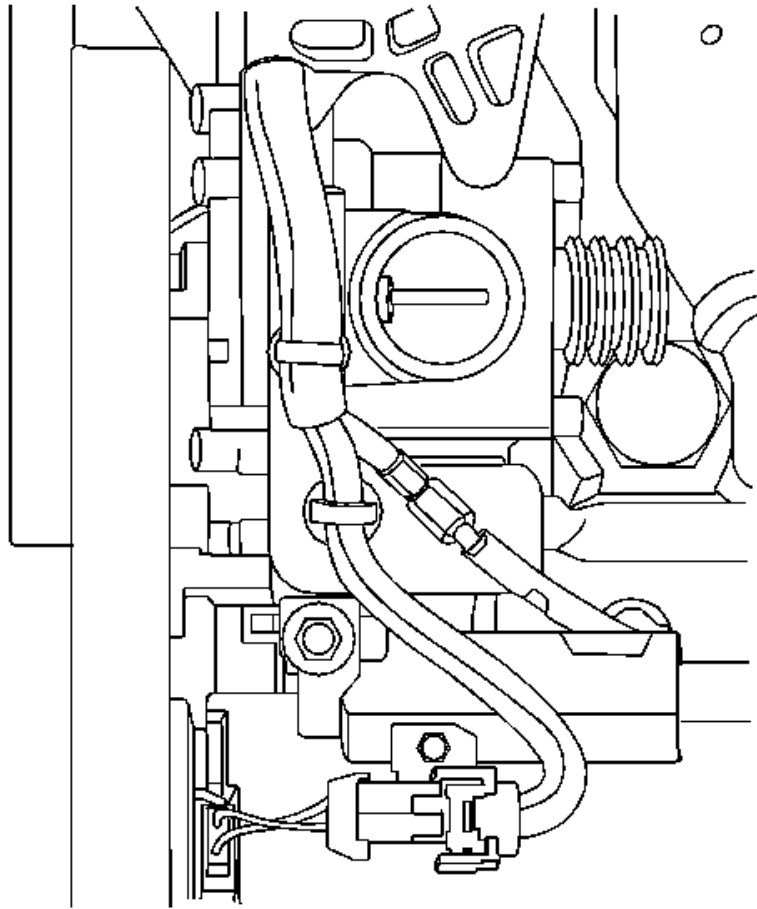


Fig. 120: A/C Compressor Connector
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the following:
- Oil switch wiring connector
 - A/C compressor connector

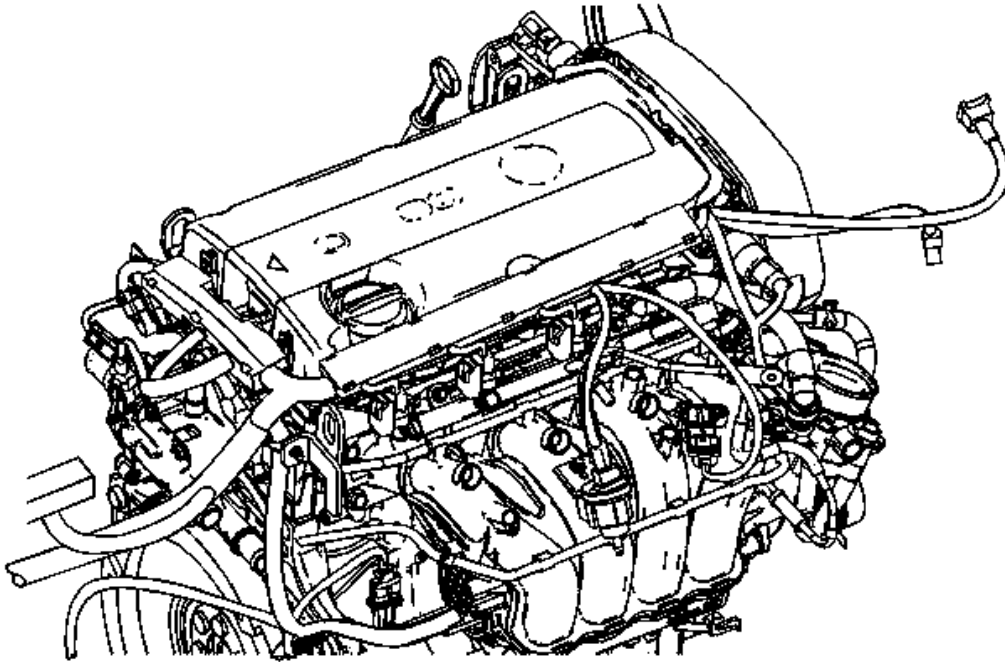


Fig. 121: Related Sensor And Actuator Connectors
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the following:
 - Intake air temperature sensor connector
 - A/C pressure sensor (ACP) connector
 - Cam position solenoid valve connector
 - Electric throttle controller (ETC) connector
 - Manifold air pressure (MAP) sensor connector
 - EVAP solenoid valve connector
 - Injector connectors
16. Disconnect the following
 - Ignition coil connector
 - Camshaft position sensor (CPS) connectors (right/left)
 - Coolant temperature sensor connector
 - Oxygen sensor connector
 - Ground tightening bolt
 - Thermostat heater connector

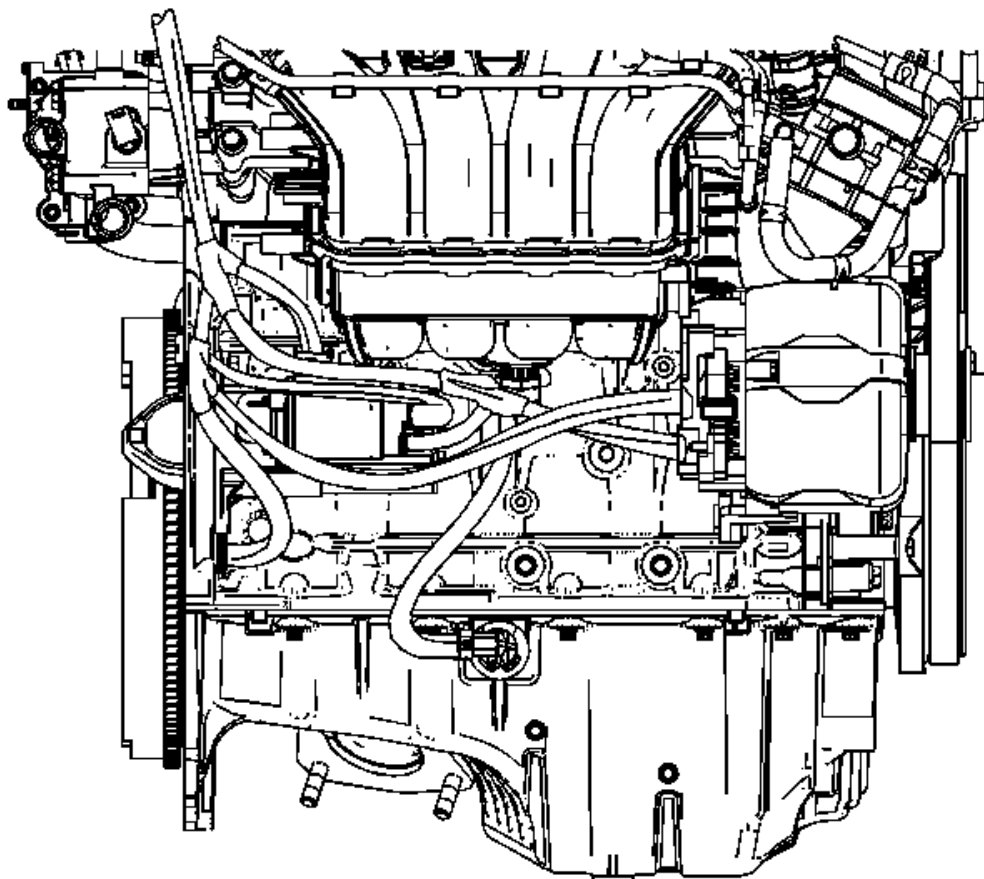


Fig. 122: Right Side Engine View
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the following and pull the engine harness aside.
 - Crankshaft position (CKP) sensor connector
 - Knock sensor connector
 - Alternator connector
 - Alternator B+ tightening nut
 - Oil level switch connector, if equipped
 - Starter solenoid B+ tightening nut
 - Ground tightening nut
 - Starter solenoid ground tightening nut

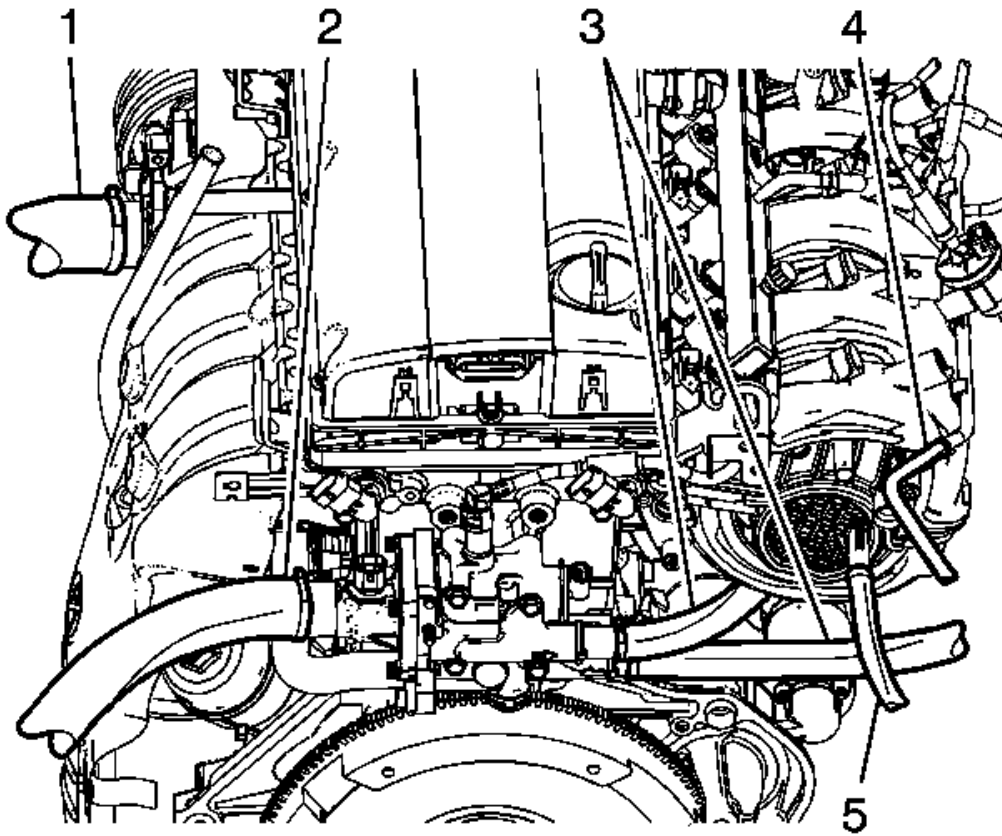


Fig. 123: Coolant & Brake Boost Hoses
Courtesy of GENERAL MOTORS CORP.

18. Disconnect the coolant hose (1) from water pump.
19. Disconnect the coolant hose (2) from the thermostat housing.
20. Disconnect the heater core coolant inlet/outlet hoses (3) from the coolant distributor.
21. Disconnect the ETC-to-coolant tank hose (4).
22. Disconnect the brake boost hose (5) from the intake manifold.

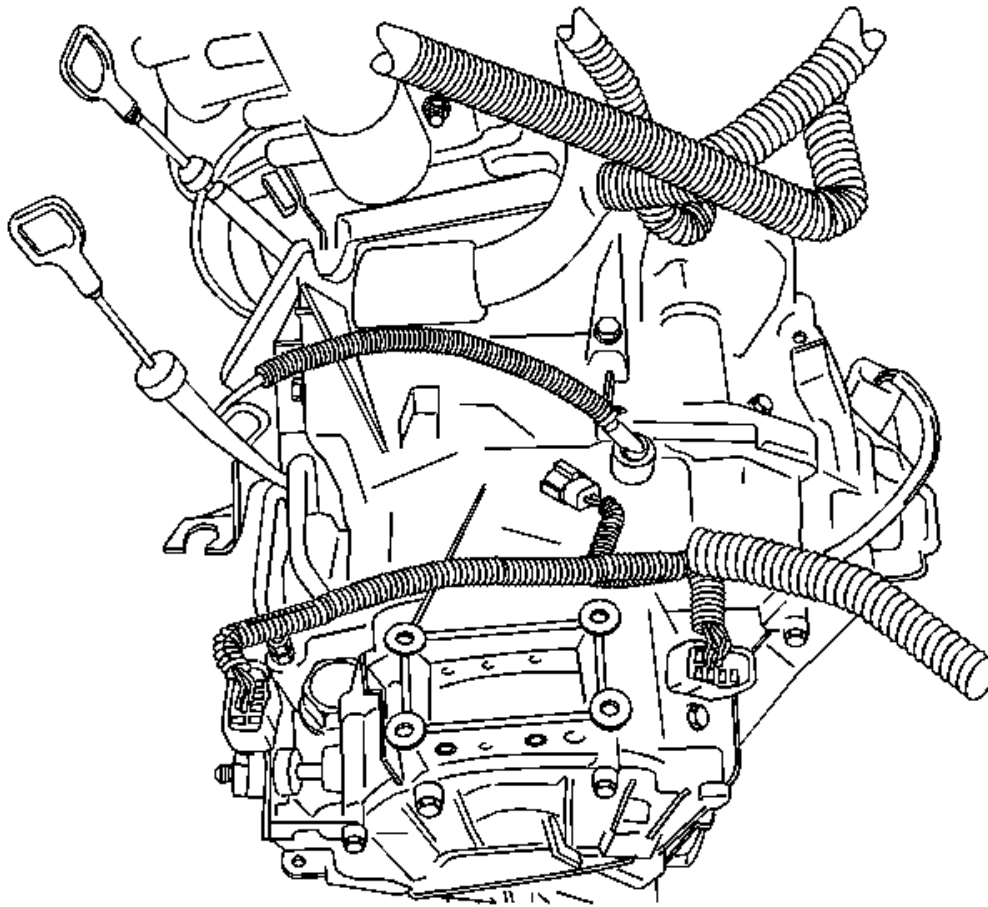


Fig. 124: Cables And Wiring Harness Related To The Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

23. Remove and disconnect the cables and wiring harness related to the automatic transaxle.
24. Disconnect the auto transaxle fluid cooler inlet/outlet hoses.

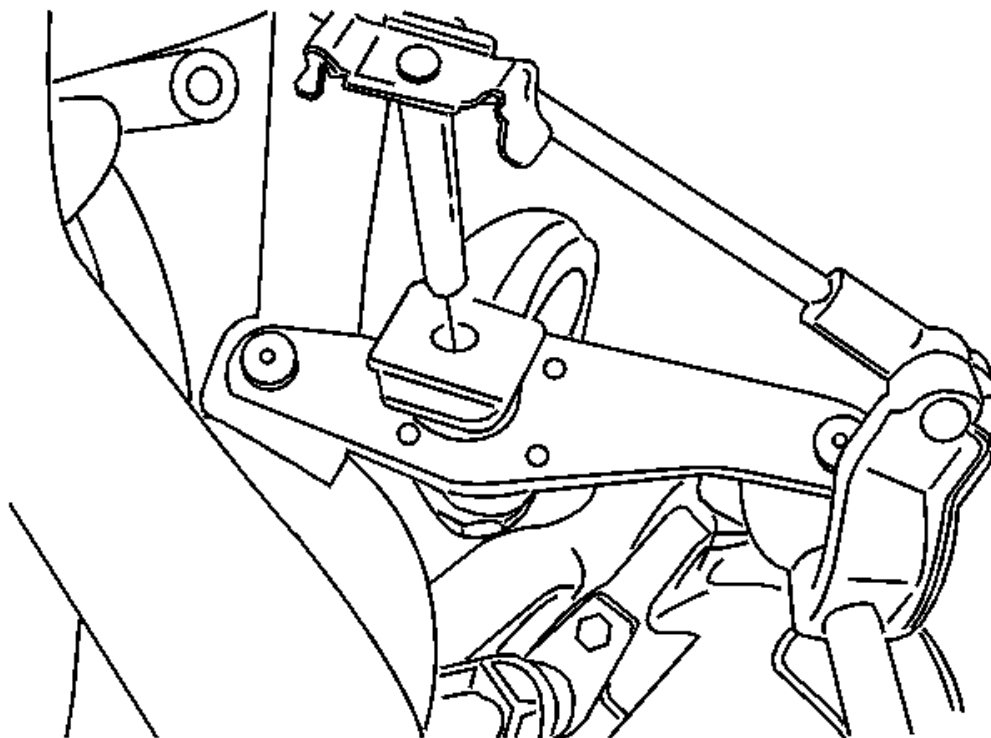


Fig. 125: Reaction Rod
Courtesy of GENERAL MOTORS CORP.

25. Remove and disconnect the cables and wiring harness related to the manual transaxle.
26. Remove the reaction rod.
27. Remove the exhaust front pipe.
28. Remove the drive axle shafts. Refer to **FRONT DRIVE AXLE INNER SHAFT REPLACEMENT**

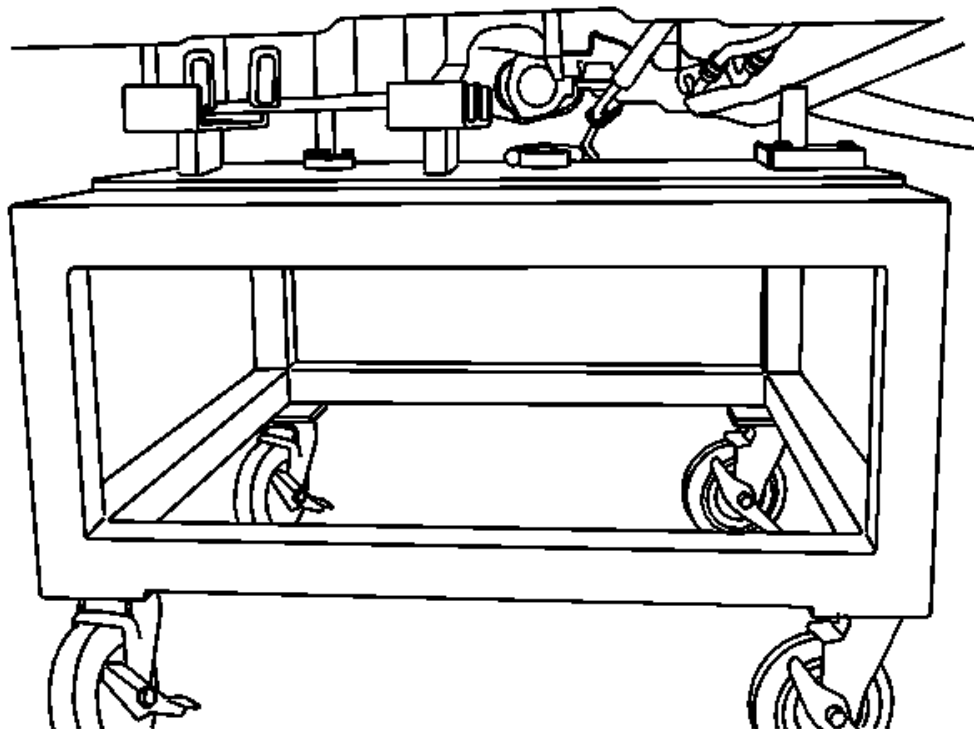


Fig. 126: Pallet And Supporter
Courtesy of GENERAL MOTORS CORP.

29. Install EN-49156 on to EN-48244.
30. Lift the vehicle up using by lifter.
31. Locate the pallet and supporter under the vehicle engine and transaxle.
32. Lift the vehicle down until engine assembly fixing on the pallet EN-49156.

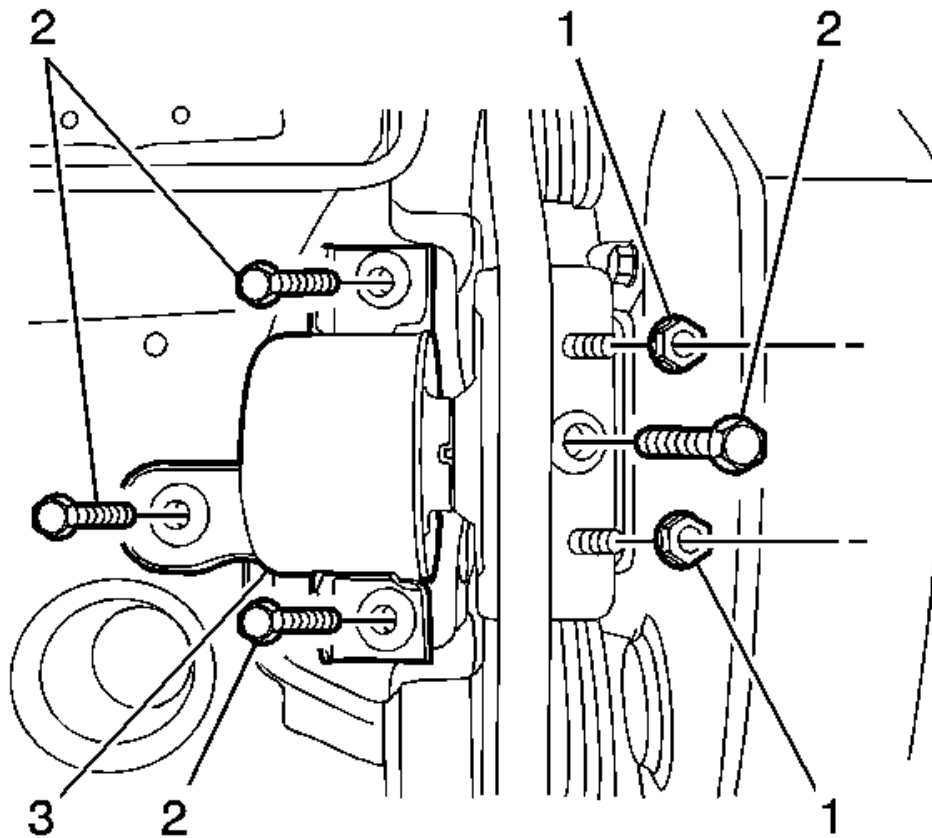


Fig. 127: Engine Mount, Bolts & Nuts
 Courtesy of GENERAL MOTORS CORP.

33. Remove the engine mount. Refer to **Engine Mount Replacement**.
34. 31. Remove the transaxle mount.

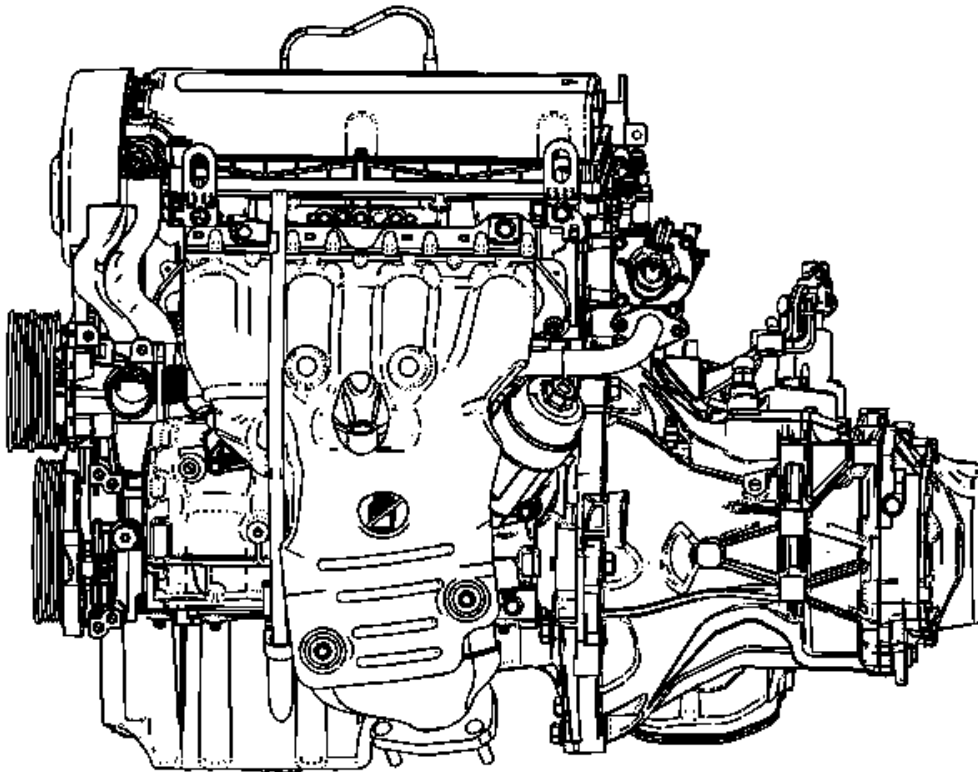


Fig. 128: Engine And Transaxle
Courtesy of GENERAL MOTORS CORP.

35. Separate the engine and the transaxle.

Installation Procedure

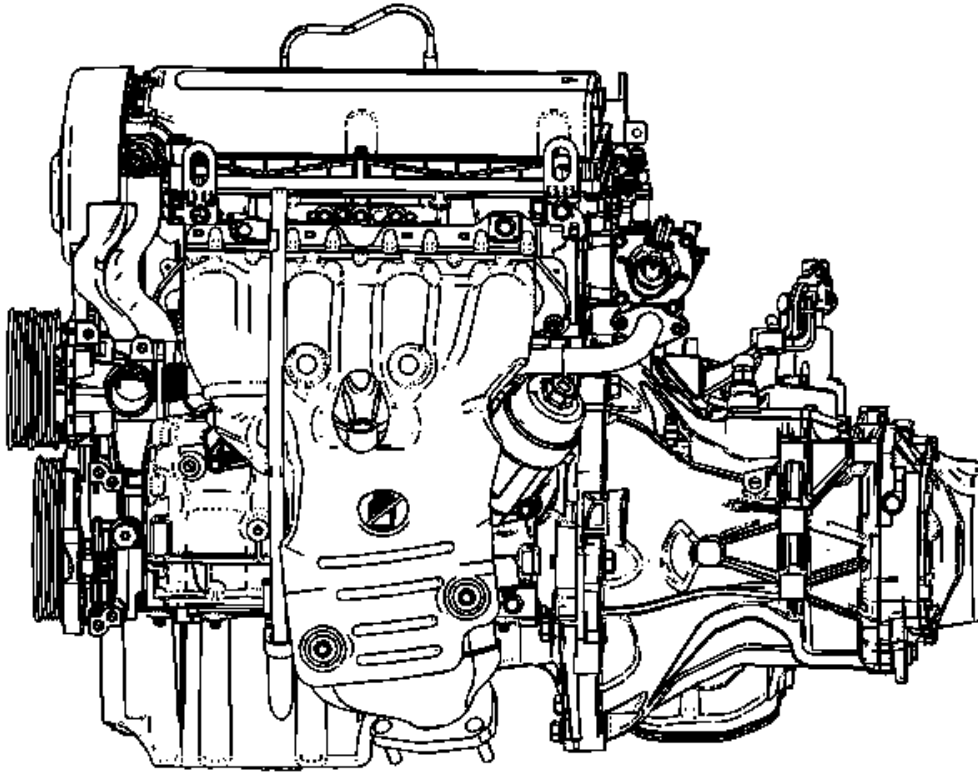


Fig. 129: Engine And Transaxle
Courtesy of GENERAL MOTORS CORP.

1. Assemble the engine and the transaxle.

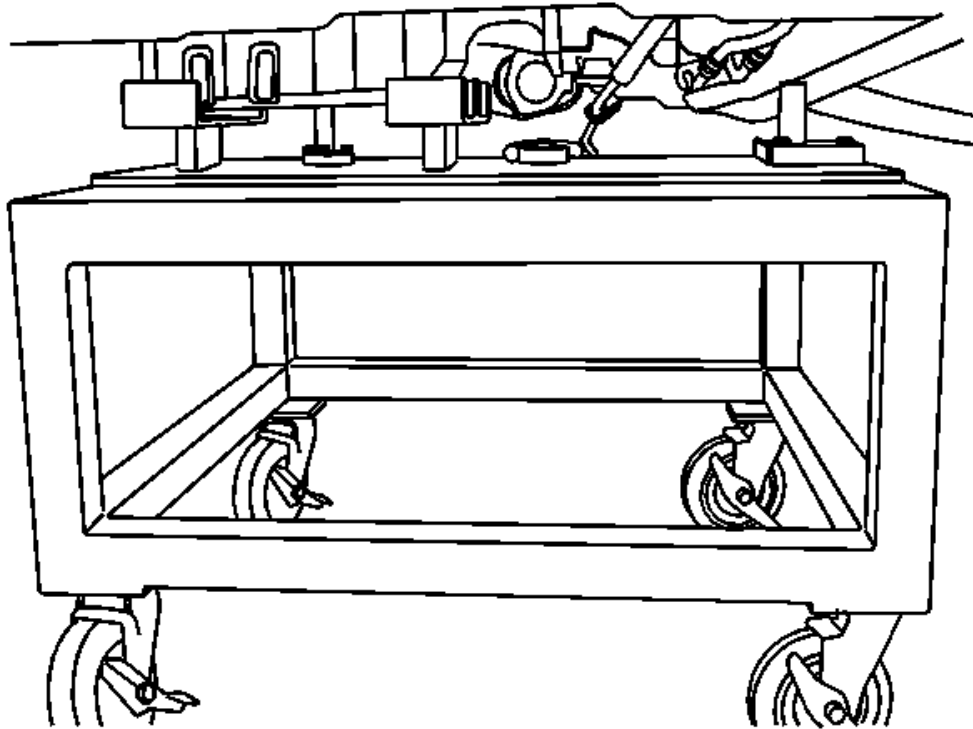


Fig. 130: Pallet And Supporter
Courtesy of GENERAL MOTORS CORP.

2. Place the engine assembly on the pallet EN-49156 on the supporter EN-48244.
3. Lift the vehicle up using by lifter.
4. Locate the engine assembly with the pallet and supporter.
5. Lift the vehicle down.

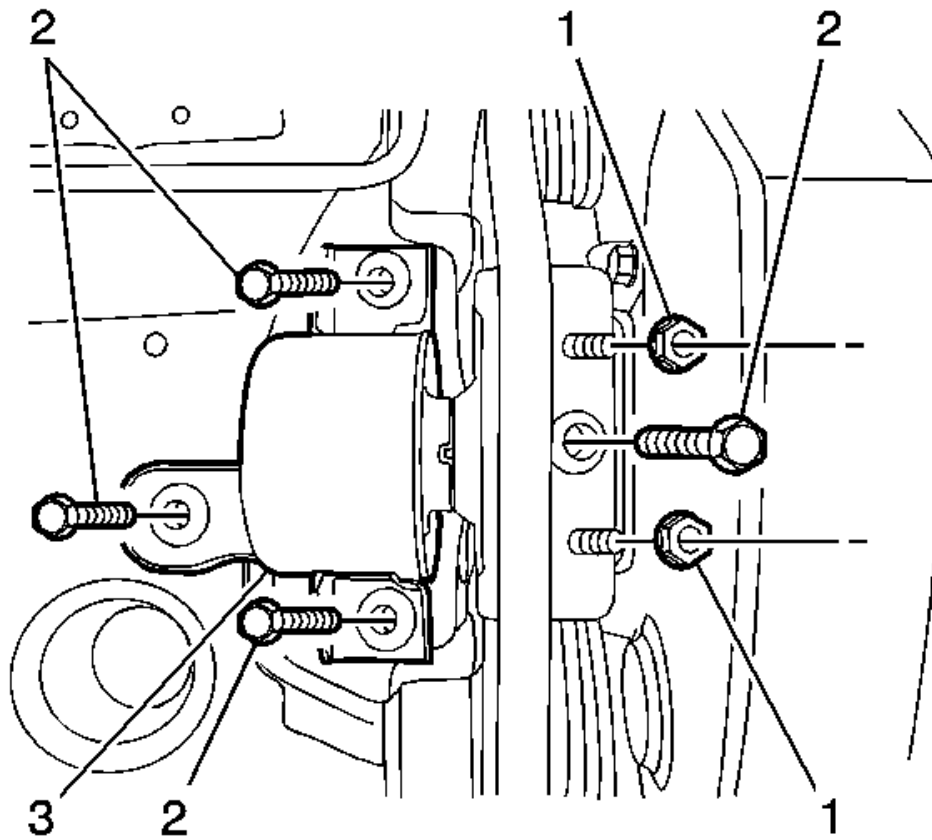


Fig. 131: Engine Mount, Bolts & Nuts
 Courtesy of GENERAL MOTORS CORP.

6. Install the engine mount. Refer to [Engine Mount Replacement](#).
7. Install the transaxle mount.

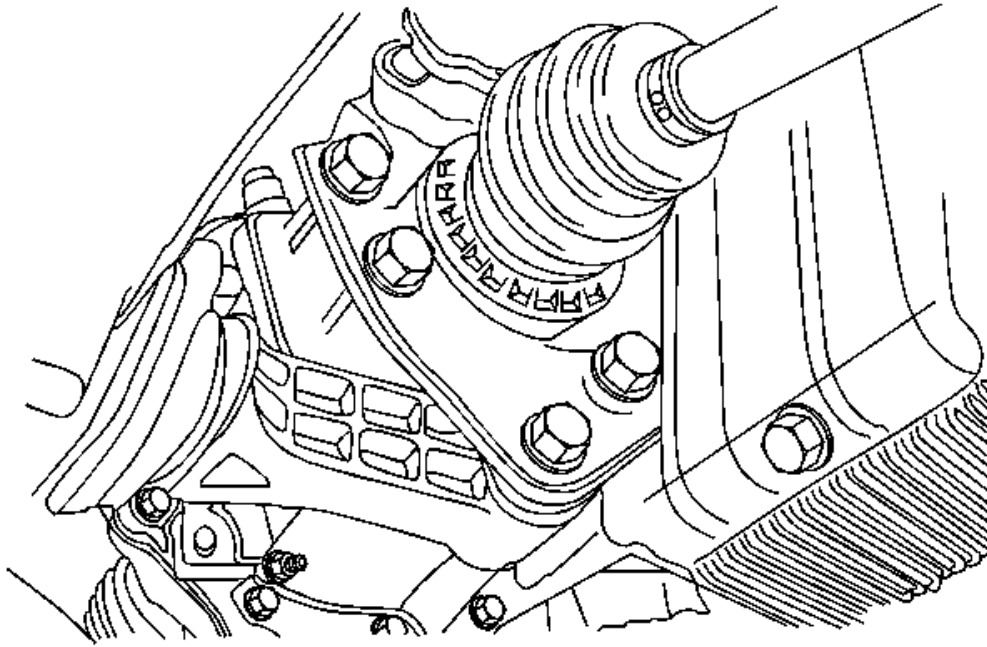


Fig. 132: Drive Axle Shafts

Courtesy of GENERAL MOTORS CORP.

8. Install the drive axle shafts. Refer to **FRONT DRIVE AXLE INNER SHAFT REPLACEMENT** .
9. Install the exhaust front pipe.
10. Install the reaction rod.

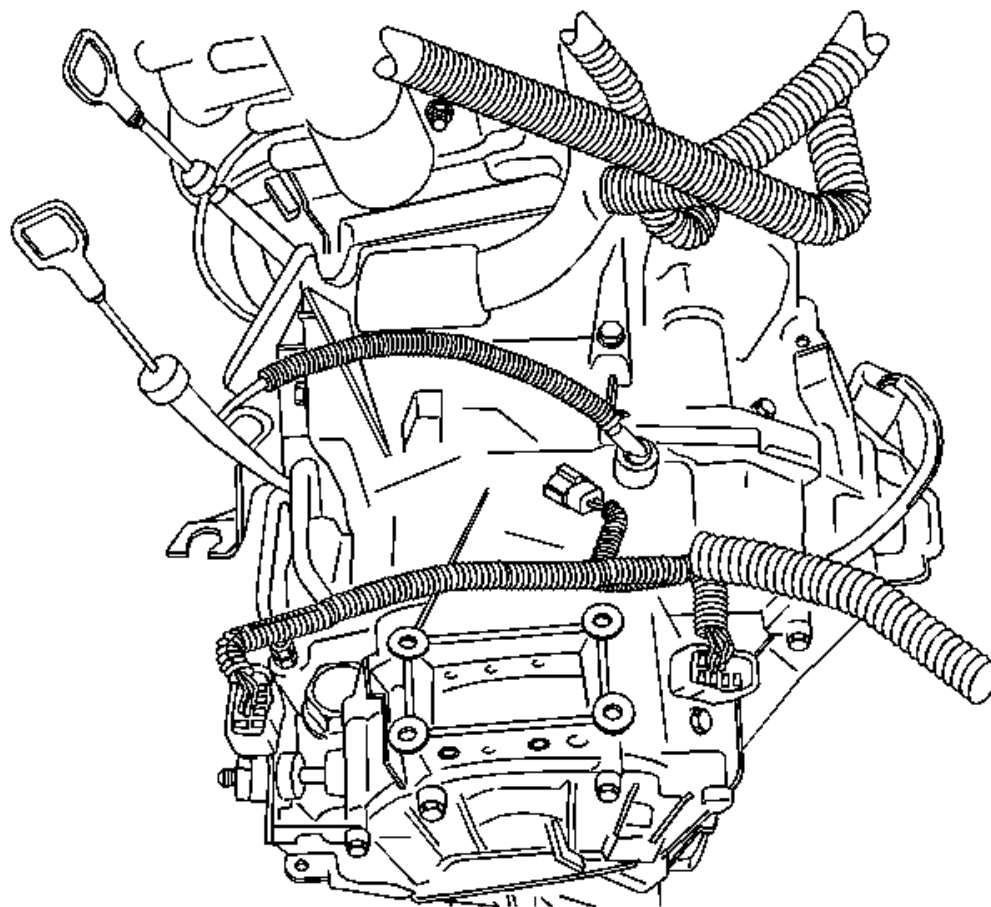


Fig. 133: Cables And Wiring Harness Related To Automatic Transaxle
Courtesy of GENERAL MOTORS CORP.

11. Install and connect the cables and wiring harness related to the automatic transaxle.
12. Connect the auto transaxle fluid cooler inlet/outlet hoses.

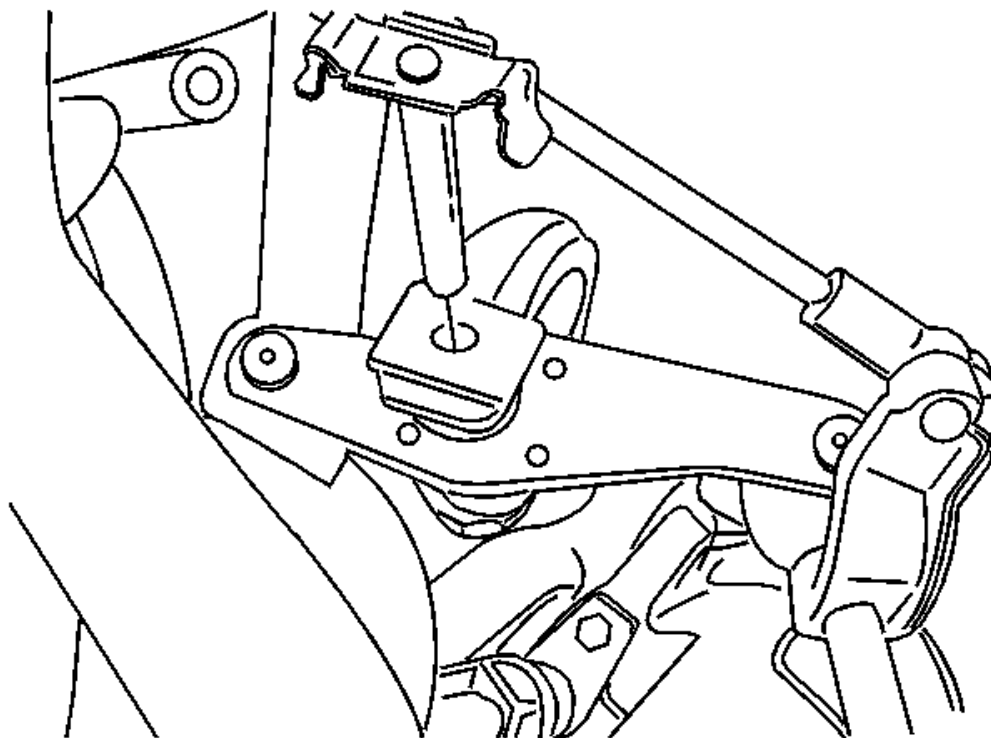


Fig. 134: Reaction Rod
Courtesy of GENERAL MOTORS CORP.

13. Install and connect the cables and wiring harness related to the manual transaxle.

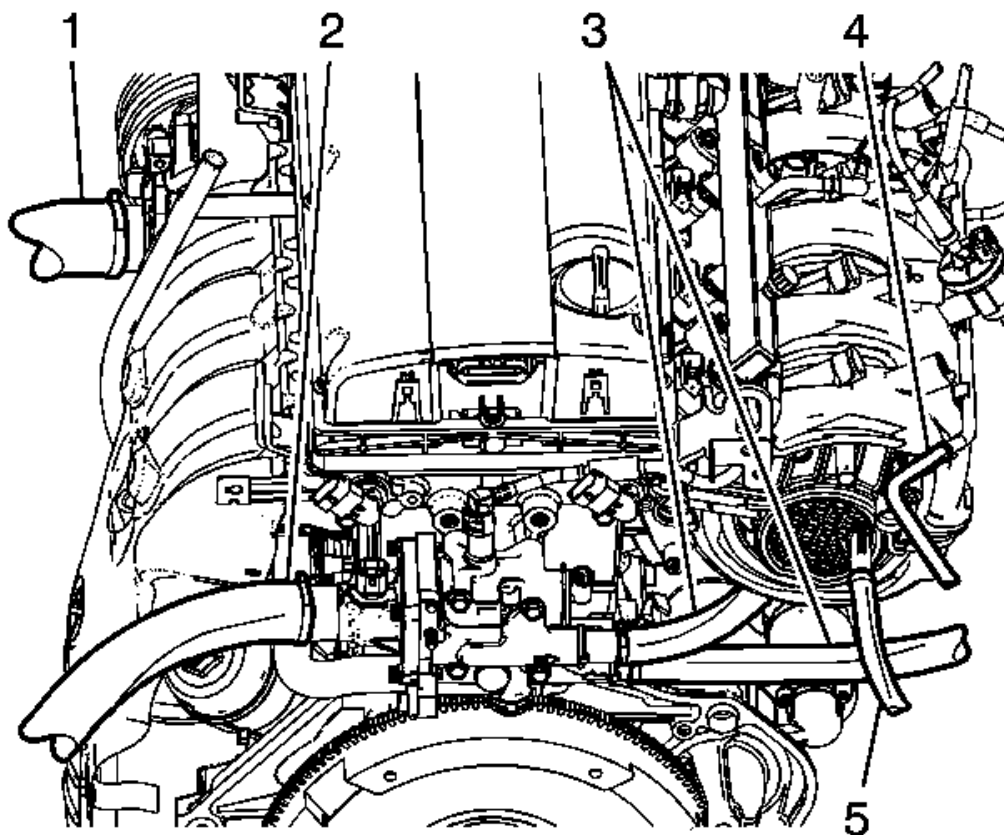


Fig. 135: Coolant & Brake Boost Hoses
Courtesy of GENERAL MOTORS CORP.

14. Connect the coolant hose (1) to the water pump.
15. Connect the coolant hose (2) to the thermostat housing.
16. Connect the heater core coolant inlet/outlet hoses (3) to the coolant distributor.
17. Connect the ETC-to-coolant tank hose (4).
18. Connect the brake boost hose (5) to the intake manifold.

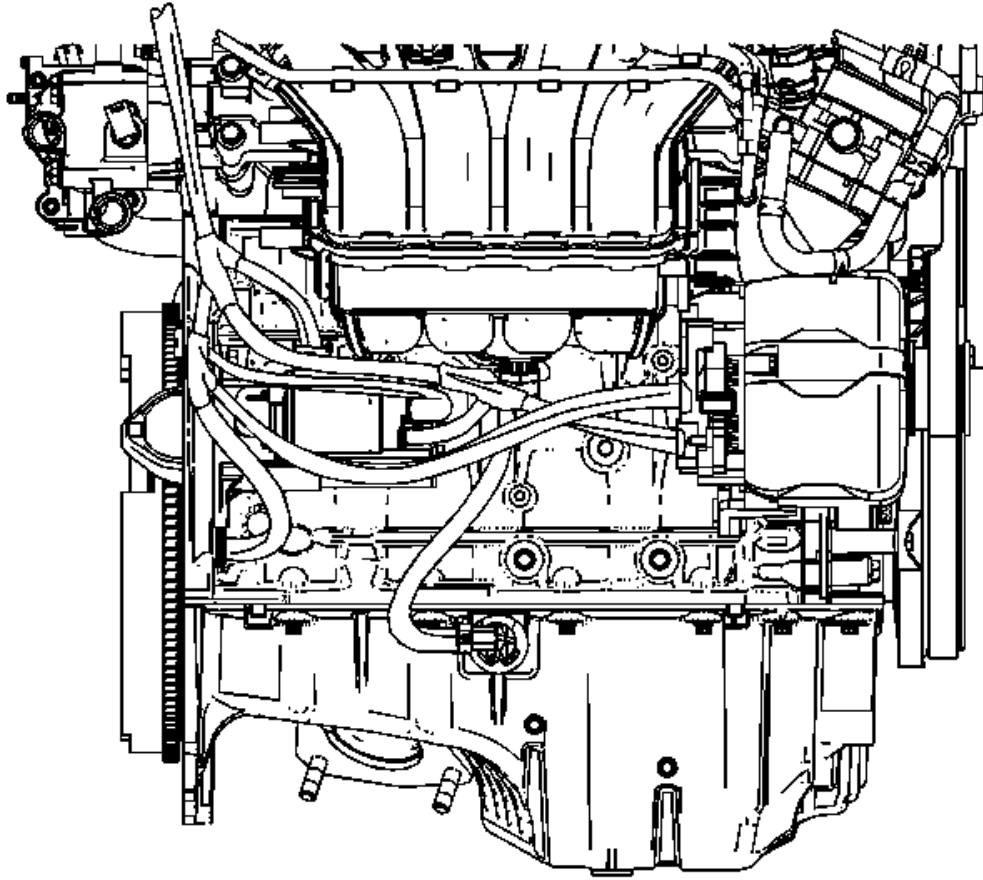


Fig. 136: Right Side Engine View
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

19. Position the engine harness and connect the following connectors.

- Crankshaft position (CKP) sensor connector
- Knock sensor connector
- Alternator connector
- Alternator B+ tightening nut
- Oil level switch connector, if equipped
- Starter solenoid B+ tightening nut
- Ground tightening nut
- Starter solenoid ground tightening nut

Tighten:

- Tighten the alternator B+ tightening nut to 15 N.m (11 lb ft).
- Tighten the starter solenoid B+ tightening nut to 10.5 N.m (7.7 lb ft).
- Tighten the ground tightening nut to 12 N.m (8.8 lb ft).
- Tighten the starter solenoid ground tightening nut to 38 N.m (28 lb ft).

20. Connect the following:

- Ignition coil connector
- Camshaft position sensor (CPS) connectors (right/left)
- Coolant temperature sensor connector
- Oxygen sensor connector
- Ground tightening bolt

Tighten: Tighten the ground tightening bolt to 12 N.m (8.8 lb ft).

- Thermostat heater connector

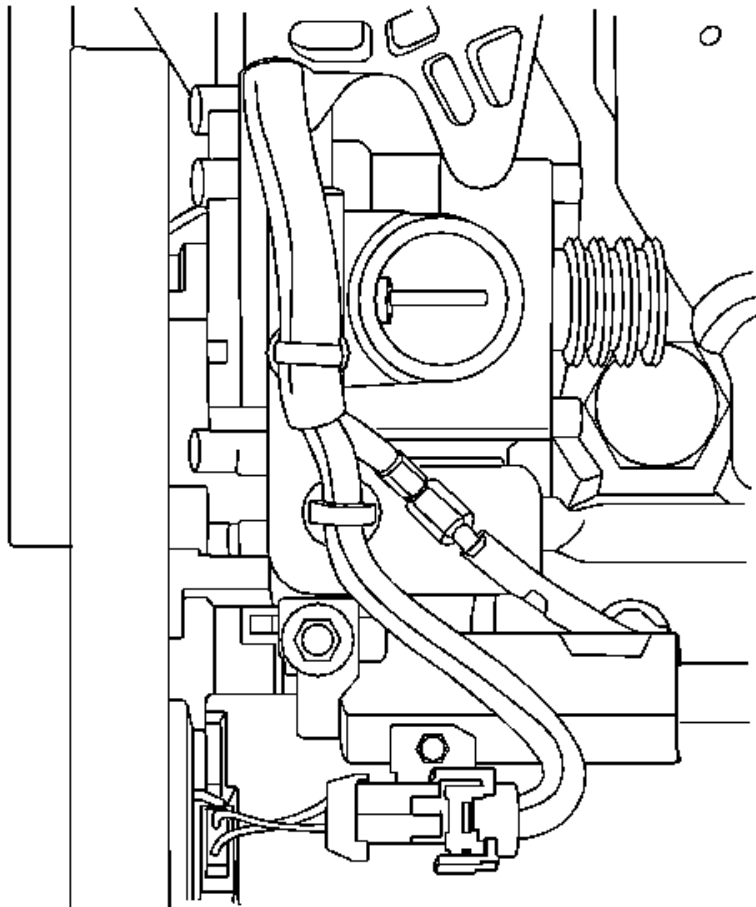


Fig. 137: A/C Compressor Connector
Courtesy of GENERAL MOTORS CORP.

21. Connect the following:
- Oil switch wiring connector
 - A/C compressor connector

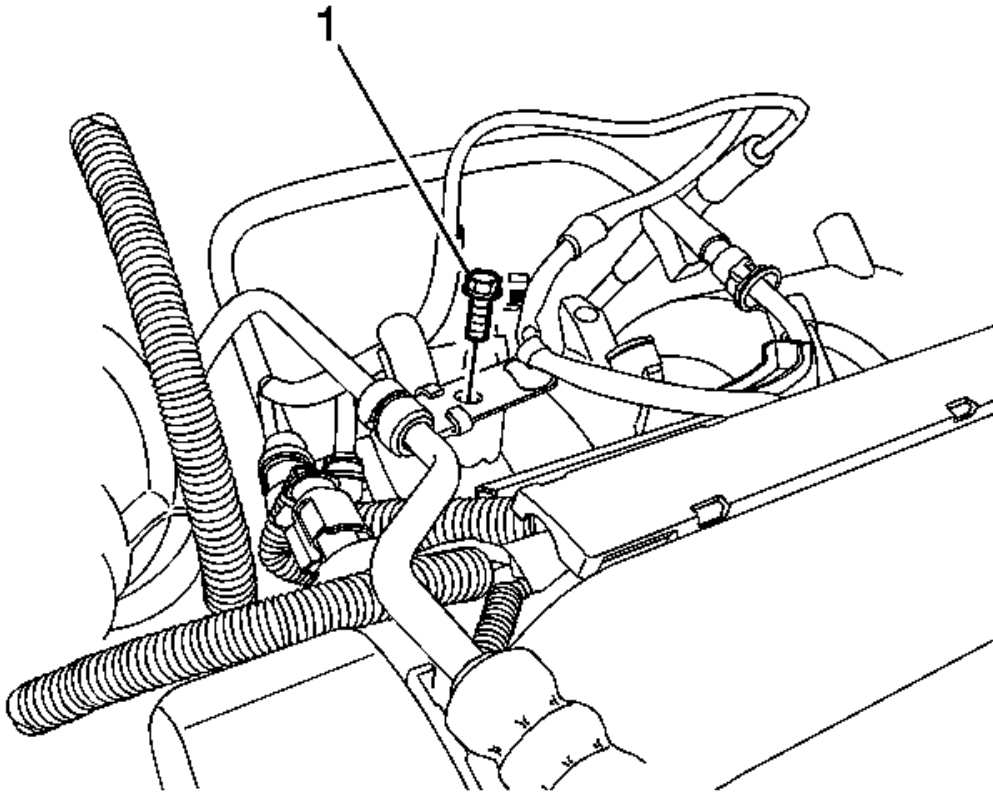


Fig. 138: Power Steering Pump Pressure Line Union Nut
Courtesy of GENERAL MOTORS CORP.

22. Install the power steering pump pressure line union nut.
23. Install the power steering pressure pipe retaining clamp bolt to the intake manifold.
24. Connect the power steering hose to the power steering pump.

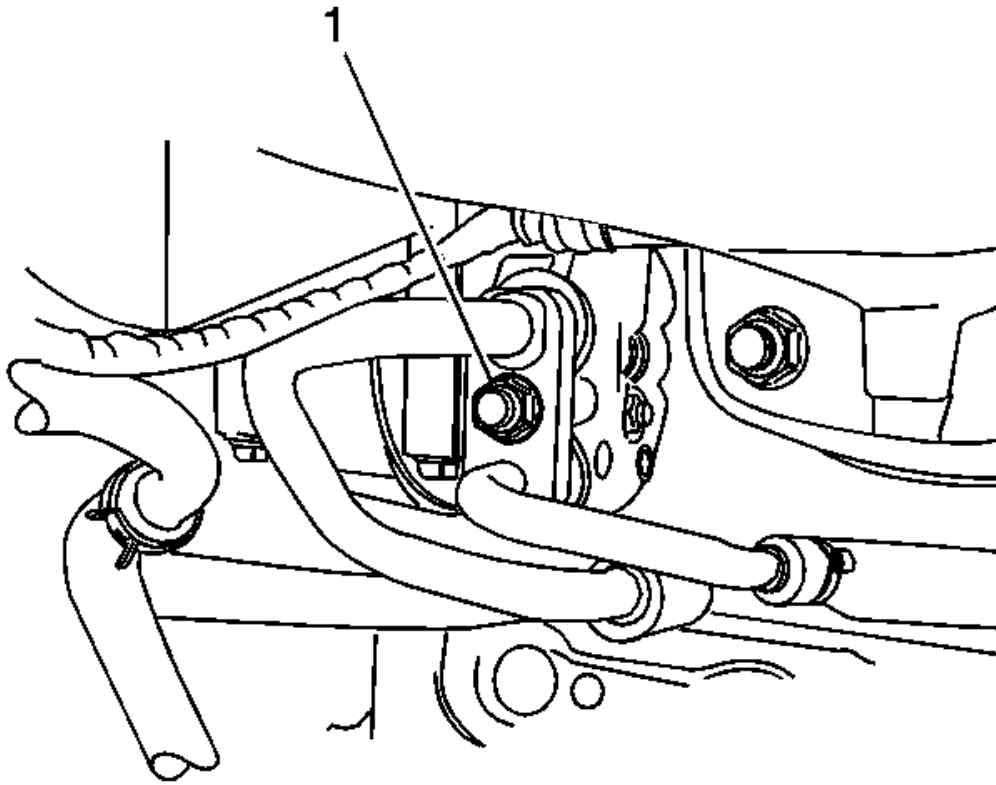


Fig. 139: A/C Inlet/Outlet Pipe Tightening Bolt
Courtesy of GENERAL MOTORS CORP.

25. Install the A/C inlet/outlet pipe tightening bolt from the A/C compressor if equipped.
26. Charge the A/C gas system. Refer to **REFRIGERANT RECOVERY AND RECHARGING** .

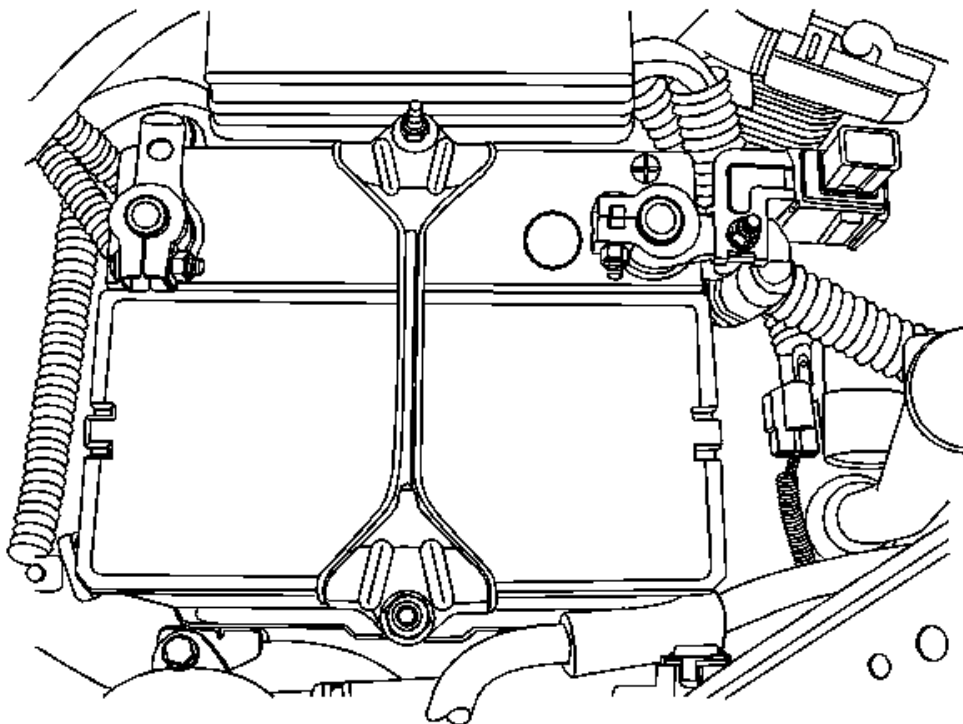


Fig. 140: Battery

Courtesy of GENERAL MOTORS CORP.

27. Install the fuse box tightening bolts.
28. Install the battery and tray. Refer to **Battery Tray Replacement** .
29. Install the air cleaner assembly.
30. Connect the fuel pipe to the fuel rail.
31. Connect the EVAP hose to the EVAP canister solenoid valve.

ENGINE OIL AND ENGINE OIL FILTER REPLACEMENT

Removal Procedure

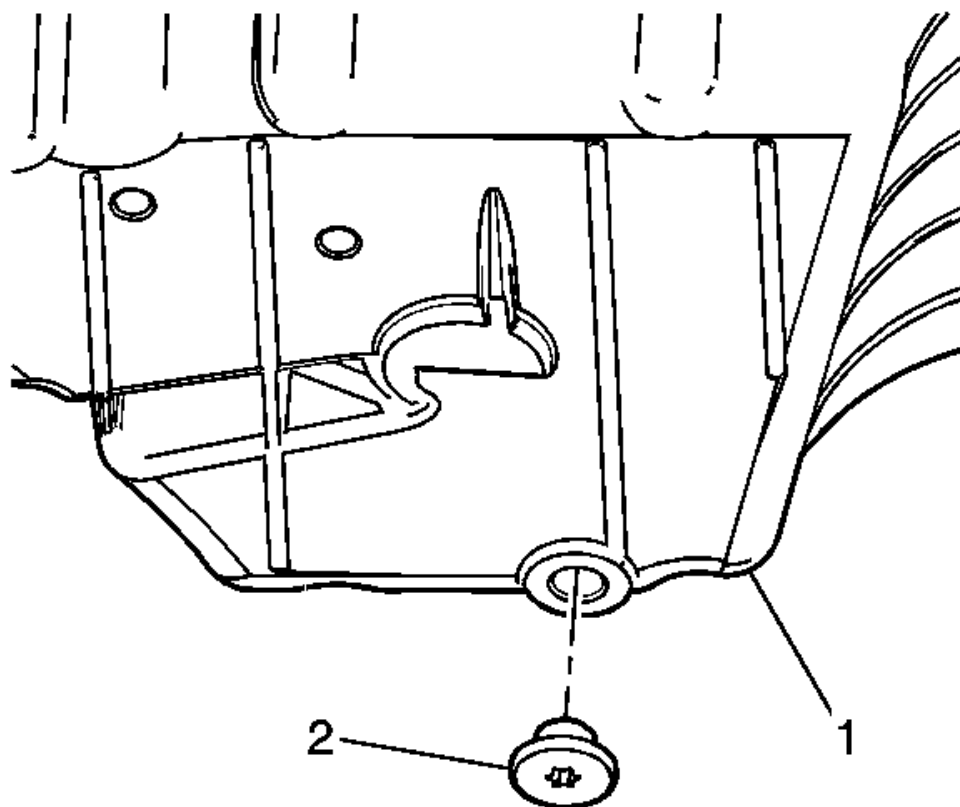


Fig. 141: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Locate the vessel for containing engine oil beneath drain plug of the vehicle.
3. Remove the oil drain carefully.
4. Drain the engine oil.
5. Remove the oil filter cap.

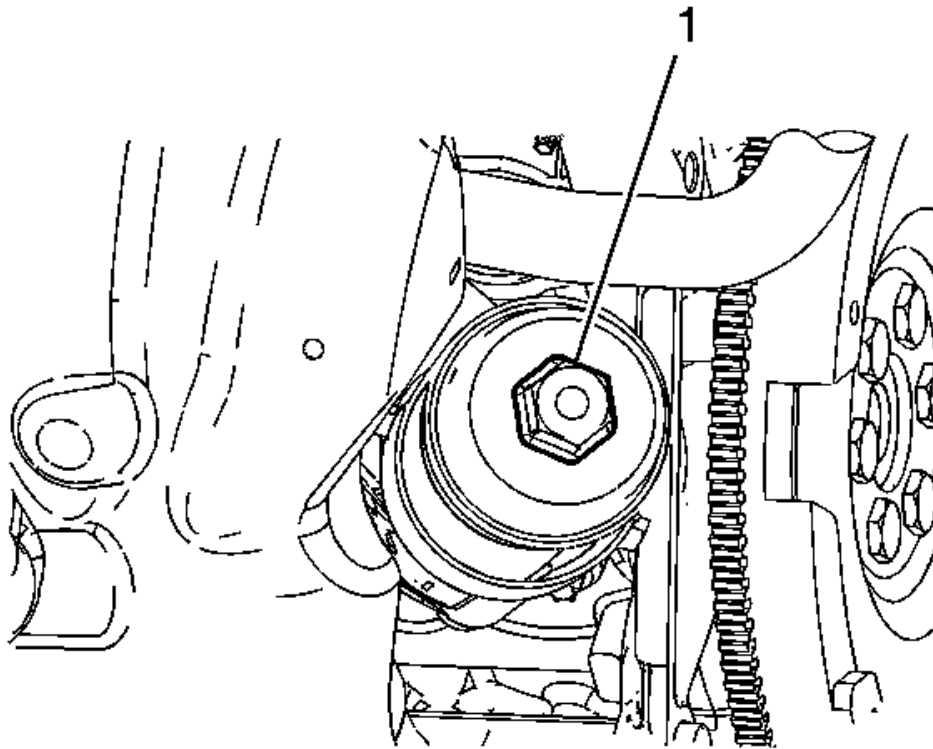


Fig. 142: Engine Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil filter.

Installation Procedure

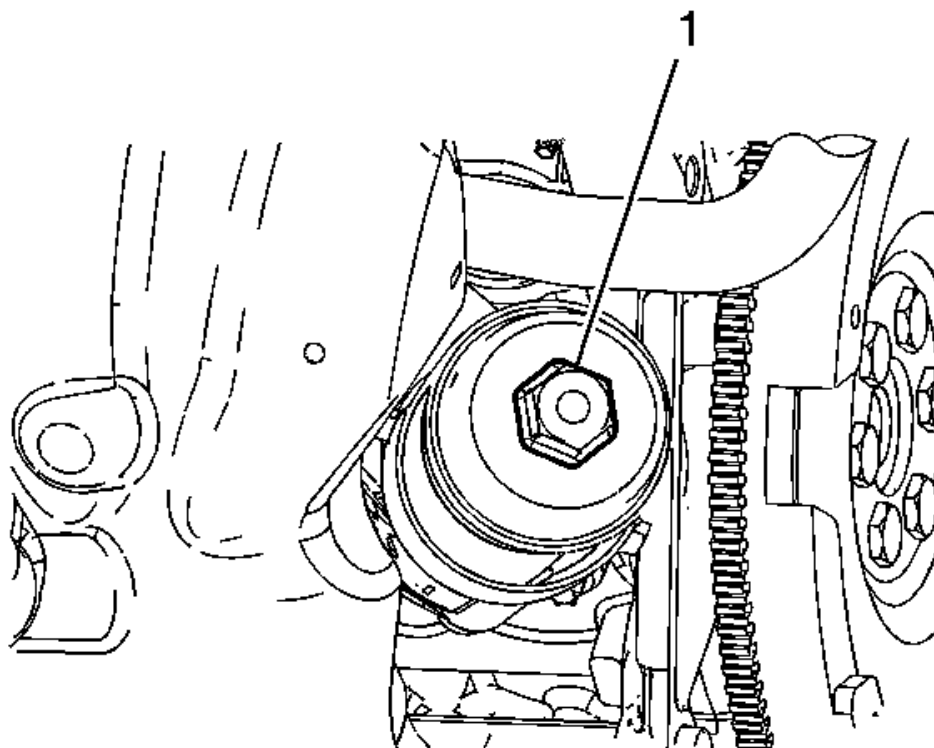


Fig. 143: Engine Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not re-use the engine oil filter.

1. Install the new oil filter.

CAUTION: Refer to Fastener Caution .

2. Install the oil filter cap.

Tighten: Tighten the oil filter cap to 25 N.m (18.4 lb ft).

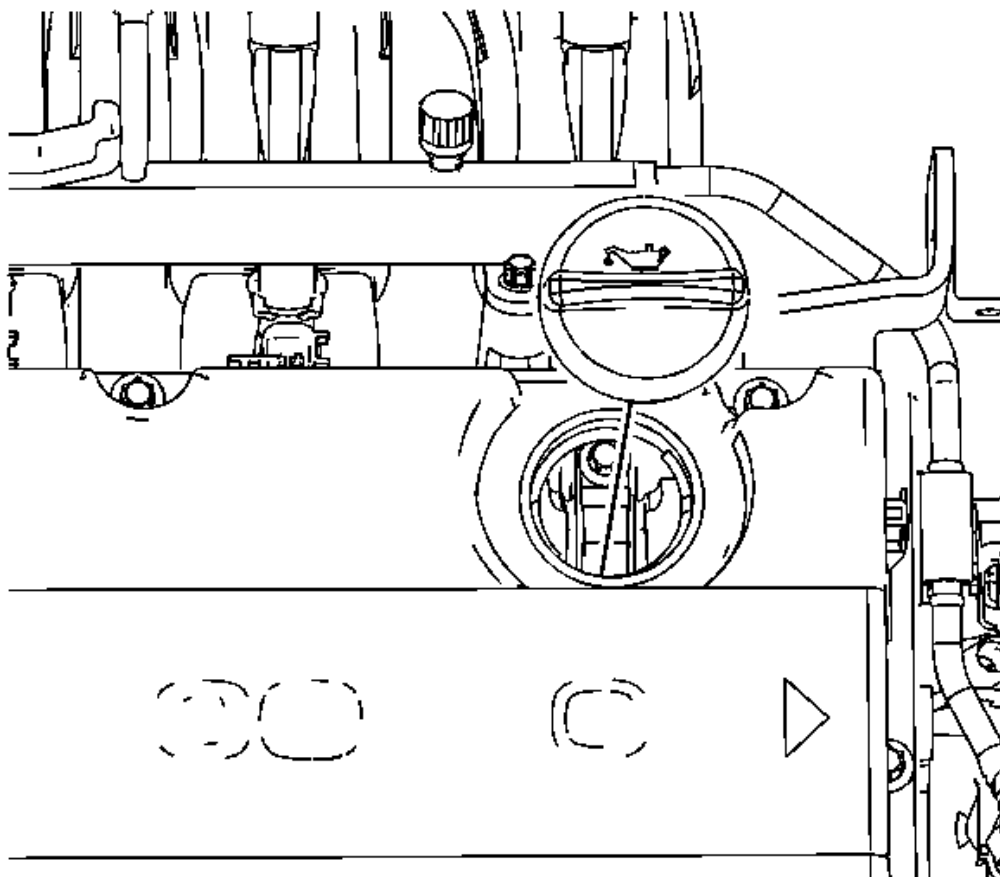


Fig. 144: Engine Oil Filling Cap

Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to engine oil specifications in the owners manual and refill with the recommended engine oil and quantity.

3. Remove the drain plug.

Tighten: Tighten the drain plug to 9 N.m (79.7 lb in).

4. Open the oil filling cap.
5. Refill the new engine oil.

PISTON, CONNECTING ROD, AND CONNECTING ROD BEARING REPLACEMENT

Special Tools

DW110-030 Engine Overhaul Stand

Removal Procedure

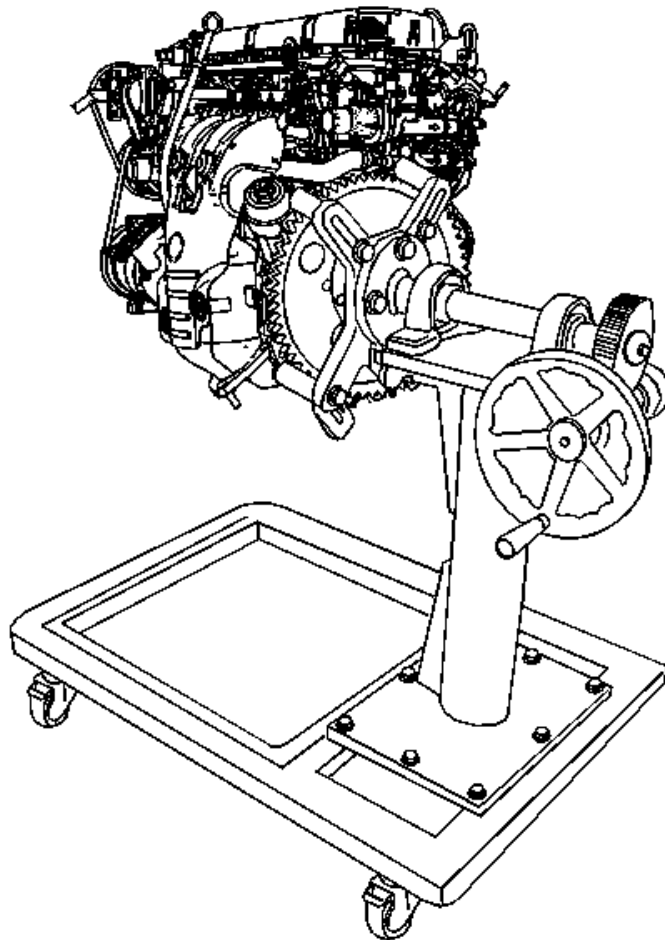


Fig. 145: Engine Assembly On DW110-030
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine assembly. Refer to **Engine Replacement**.
2. Install the engine assembly to the DW110-030.

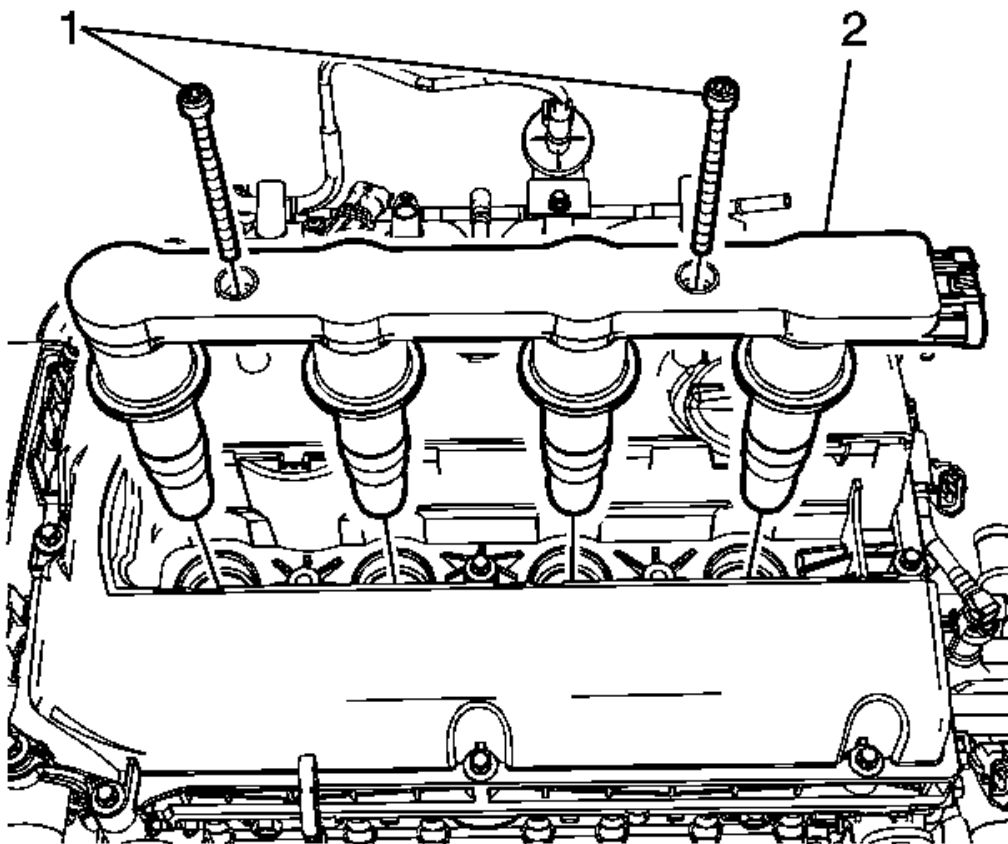


Fig. 146: Ignition Coil Assembly
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil.

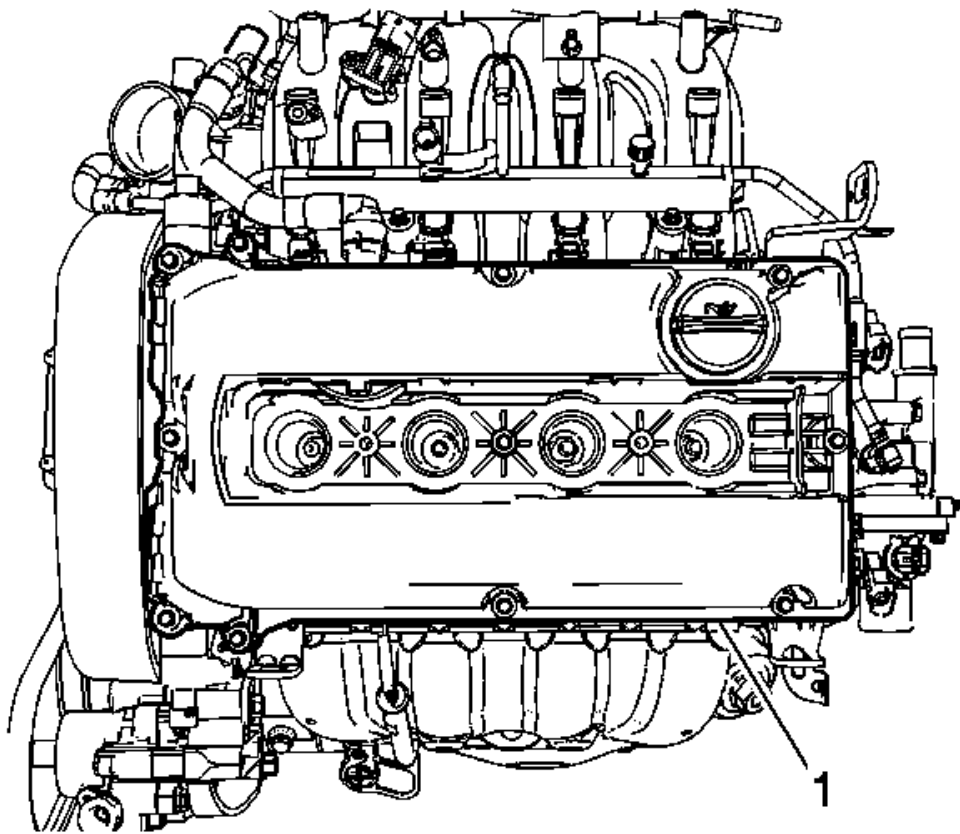


Fig. 147: Cylinder Head Cover
Courtesy of GENERAL MOTORS CORP.

4. Detach the PCV clips from the PCV hose.
5. Remove the PCV hose from the cylinder head cover.
6. Unscrew the cylinder head cover bolts.
7. Remove the cylinder head cover.

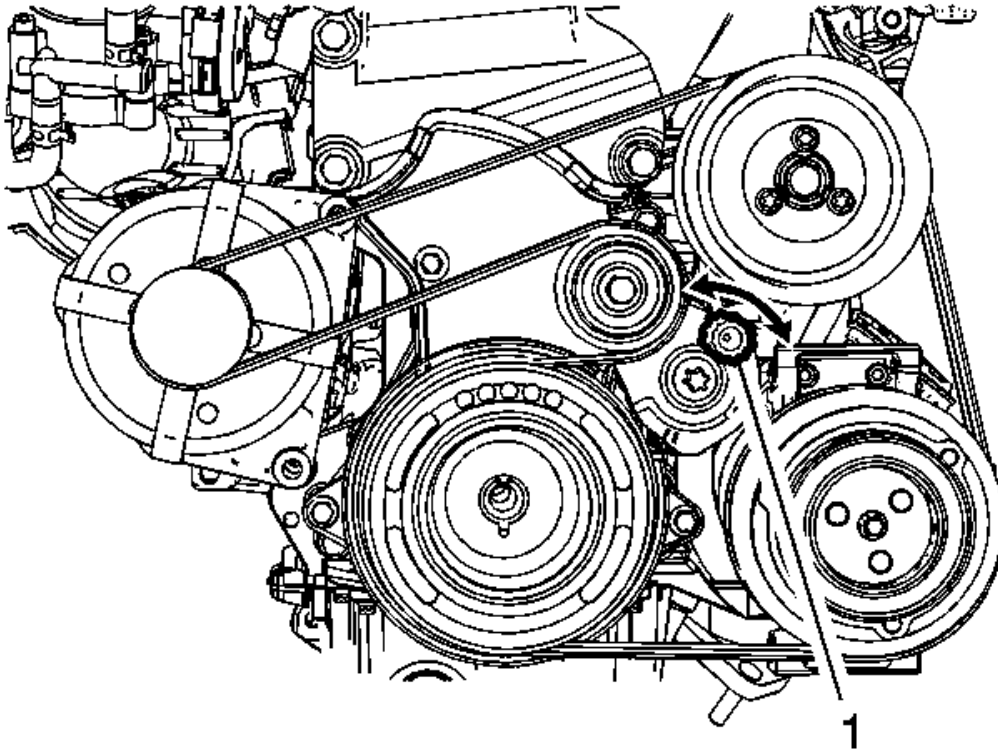


Fig. 148: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

8. Remove the power steering pump and bracket. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** and **Accessory Belt and Tensioner** .

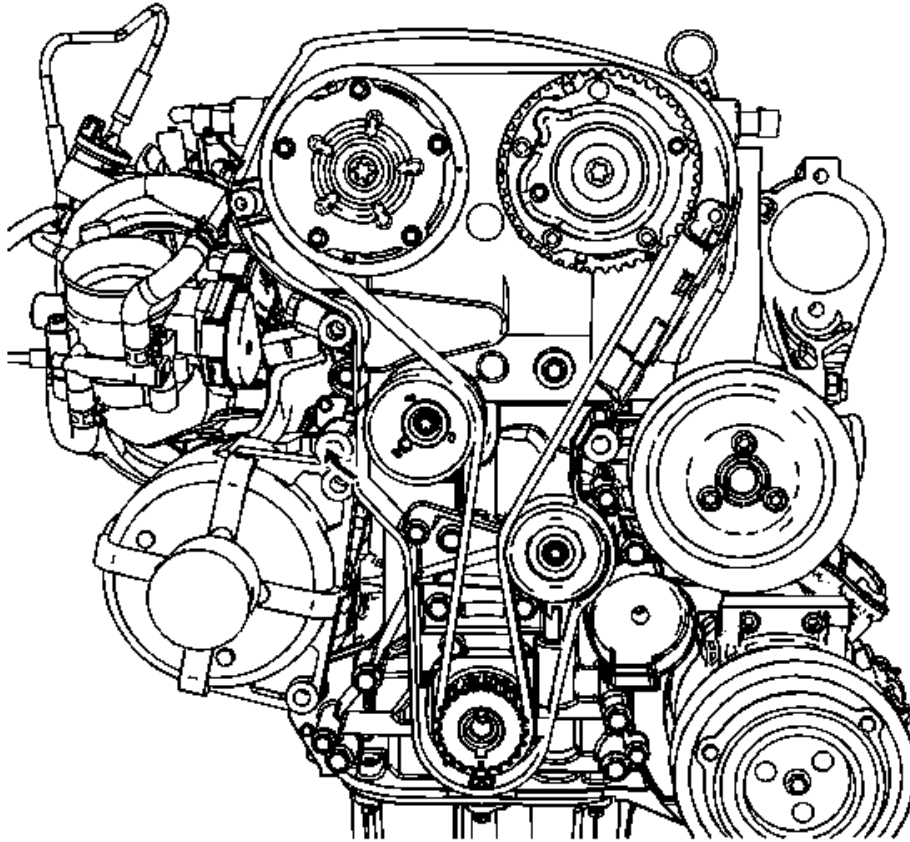


Fig. 149: Timing Belt

Courtesy of GENERAL MOTORS CORP.

9. Remove the timing belt. Refer to **Timing Belt Replacement**.
10. Remove the timing belt tensioner. Refer to **Timing Belt Replacement**.

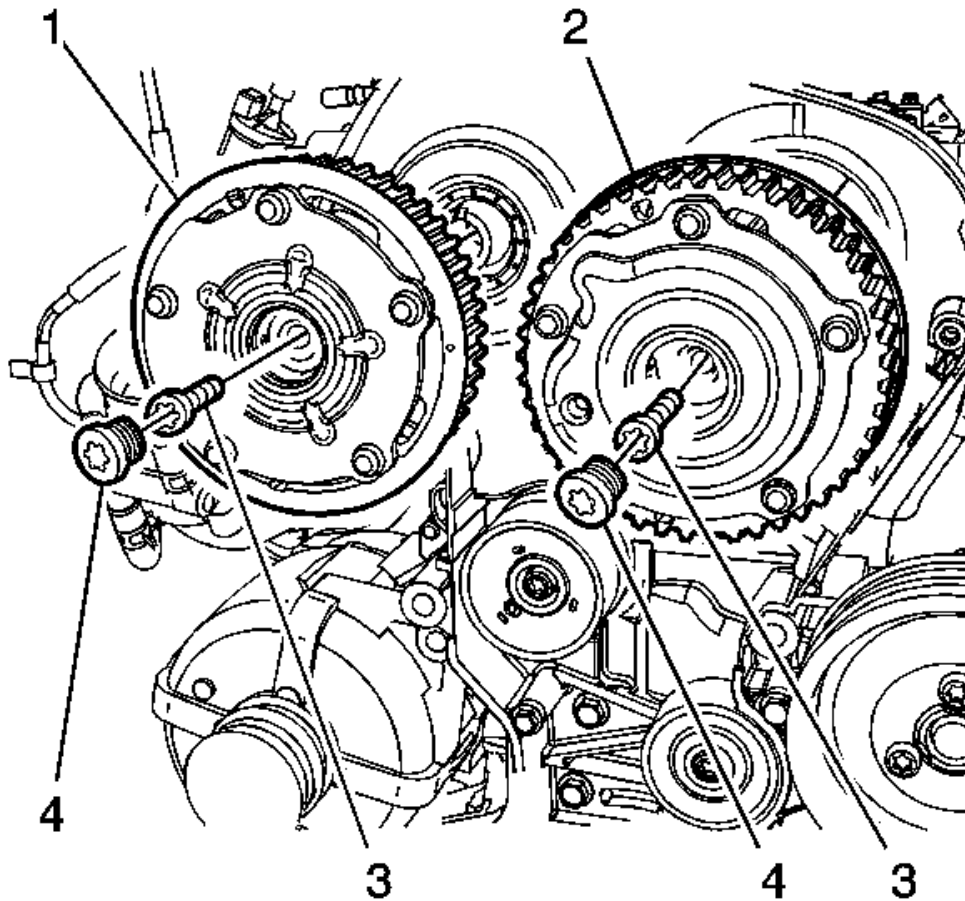


Fig. 150: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the camshaft sprocket. Refer to Camshaft Gear Replacement.

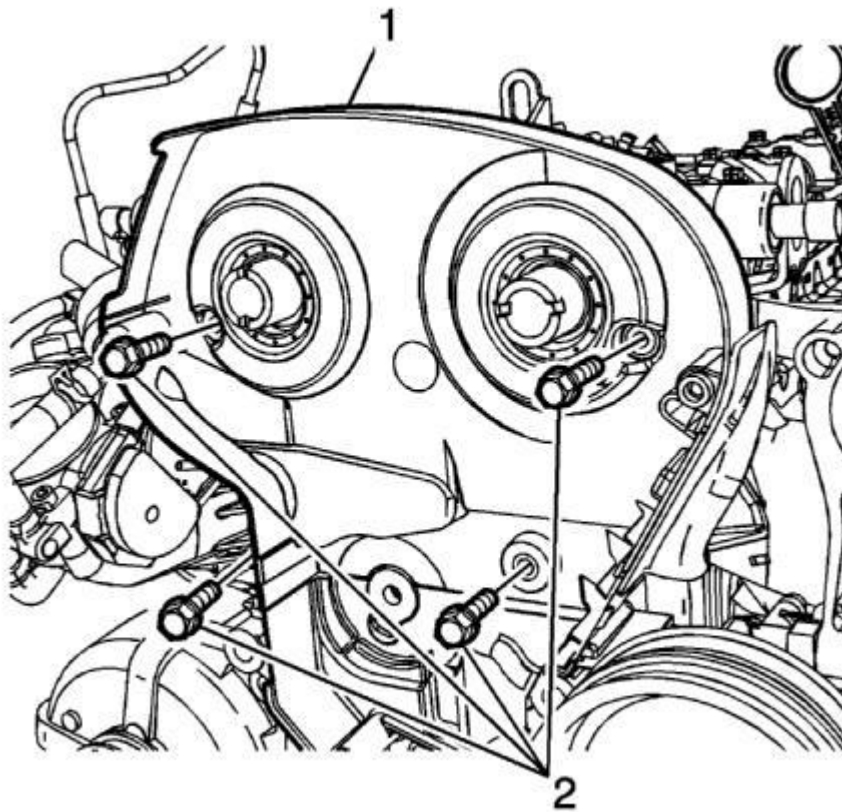


Fig. 151: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the camshaft rear cover.

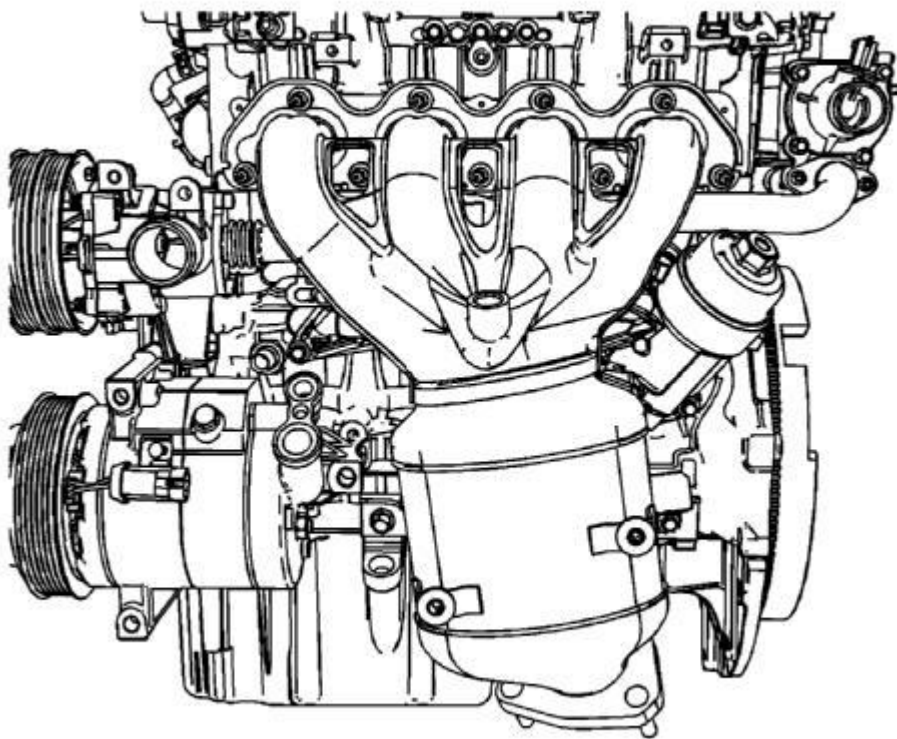


Fig. 152: Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS CORP.

13. Remove the exhaust manifold.

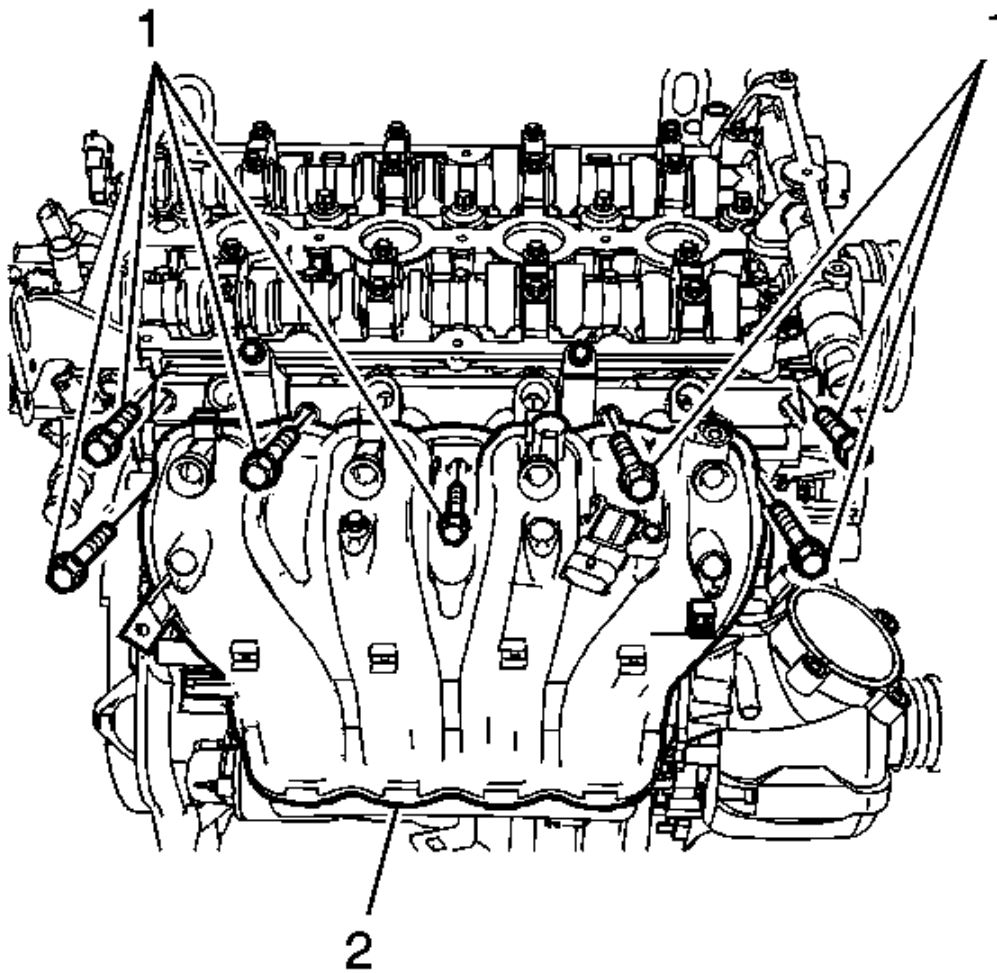


Fig. 153: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the throttle body.
15. Remove the intake manifold. Refer to **Intake Manifold Replacement**.

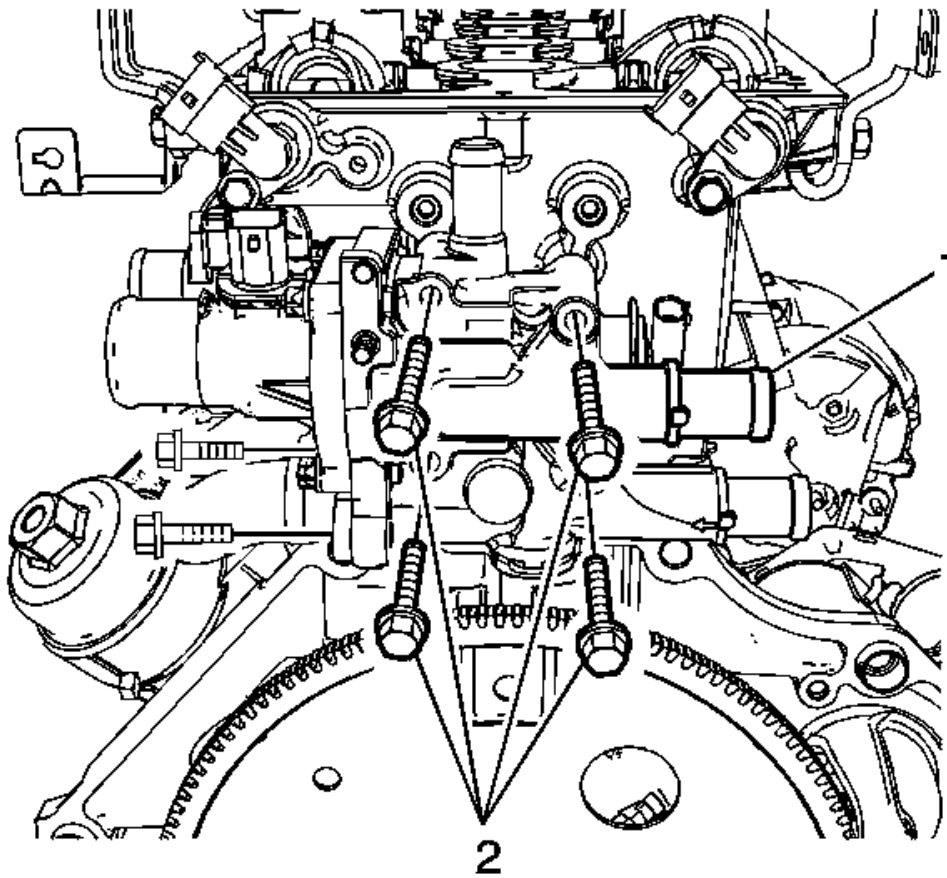


Fig. 154: Coolant Distributor And Bolts
Courtesy of GENERAL MOTORS CORP.

16. Remove the engine coolant distributor.

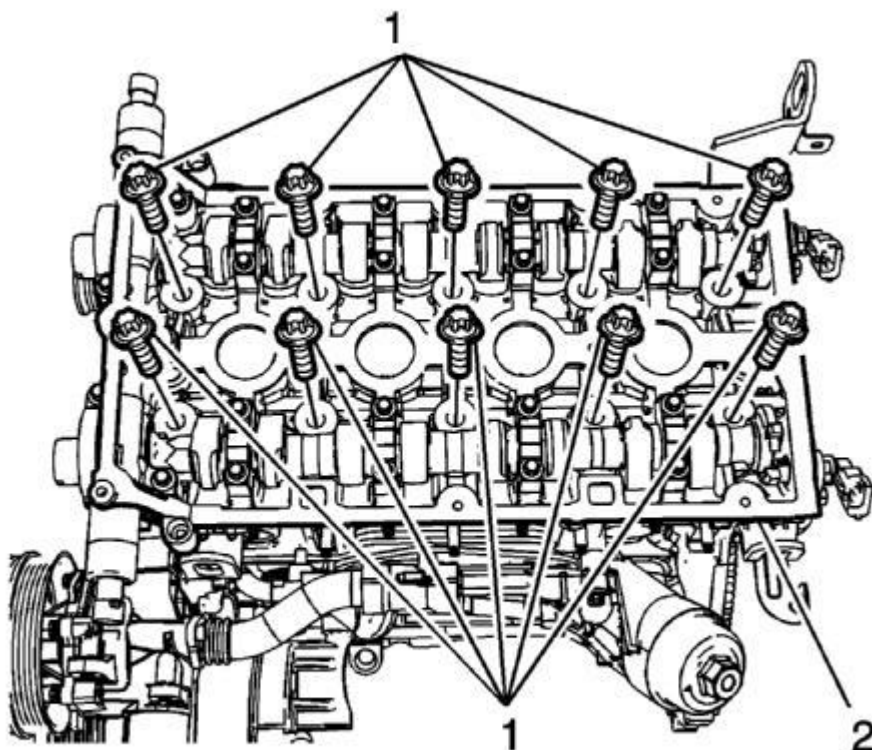


Fig. 155: Cylinder Head Bolts

Courtesy of GENERAL MOTORS CORP.

17. Remove the cylinder head bolts.
18. Remove the cylinder head assembly with the cylinder head gasket.

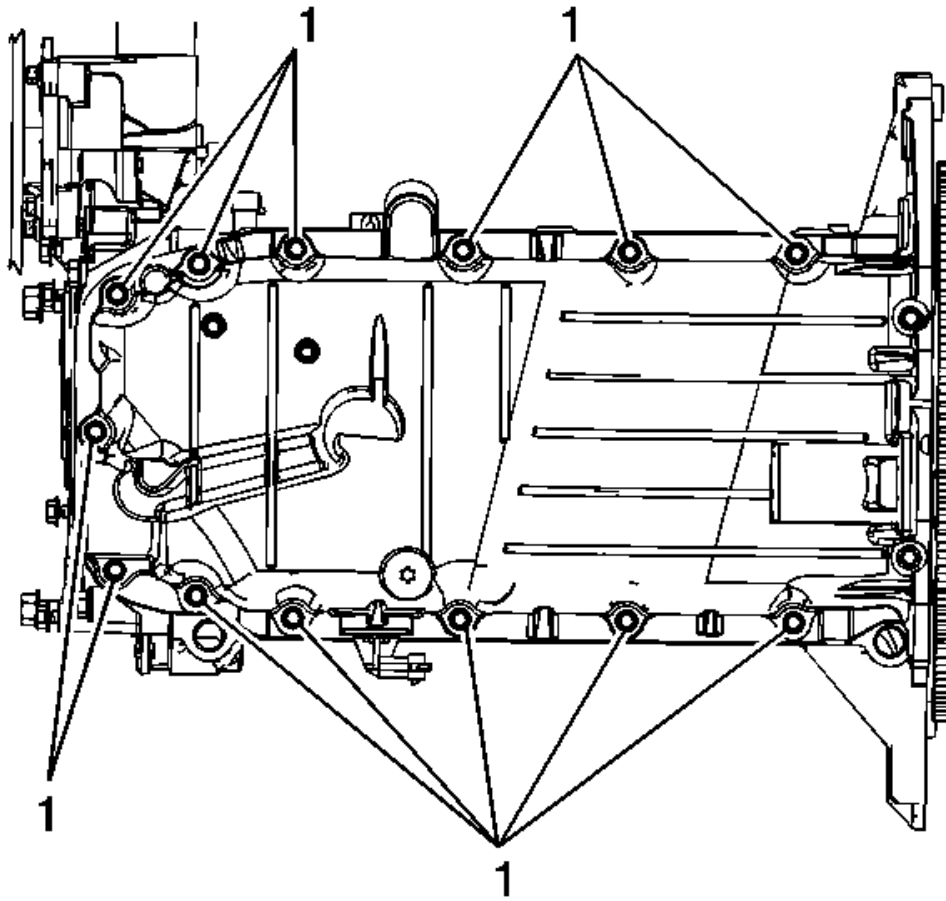


Fig. 156: Engine Oil Pan Bolts
 Courtesy of GENERAL MOTORS CORP.

19. Remove the engine oil cooler. Refer to **Engine Oil Cooler Replacement** .
20. Remove the A/C compressor. Refer to **AIR CONDITIONING COMPRESSOR REPLACEMENT** .
21. Remove the alternator. Refer to **GENERATOR REPLACEMENT (1.4L LDT, 1.6L LXV)** .
22. Remove the starter. Refer to **Starter Motor Replacement (1.4L LDT, 1.6 LXV)** .
23. Remove the oil pan. Refer to **Engine Oil Pan Replacement**.
24. Remove the oil pump assembly. Refer to **Oil Pump Replacement**.

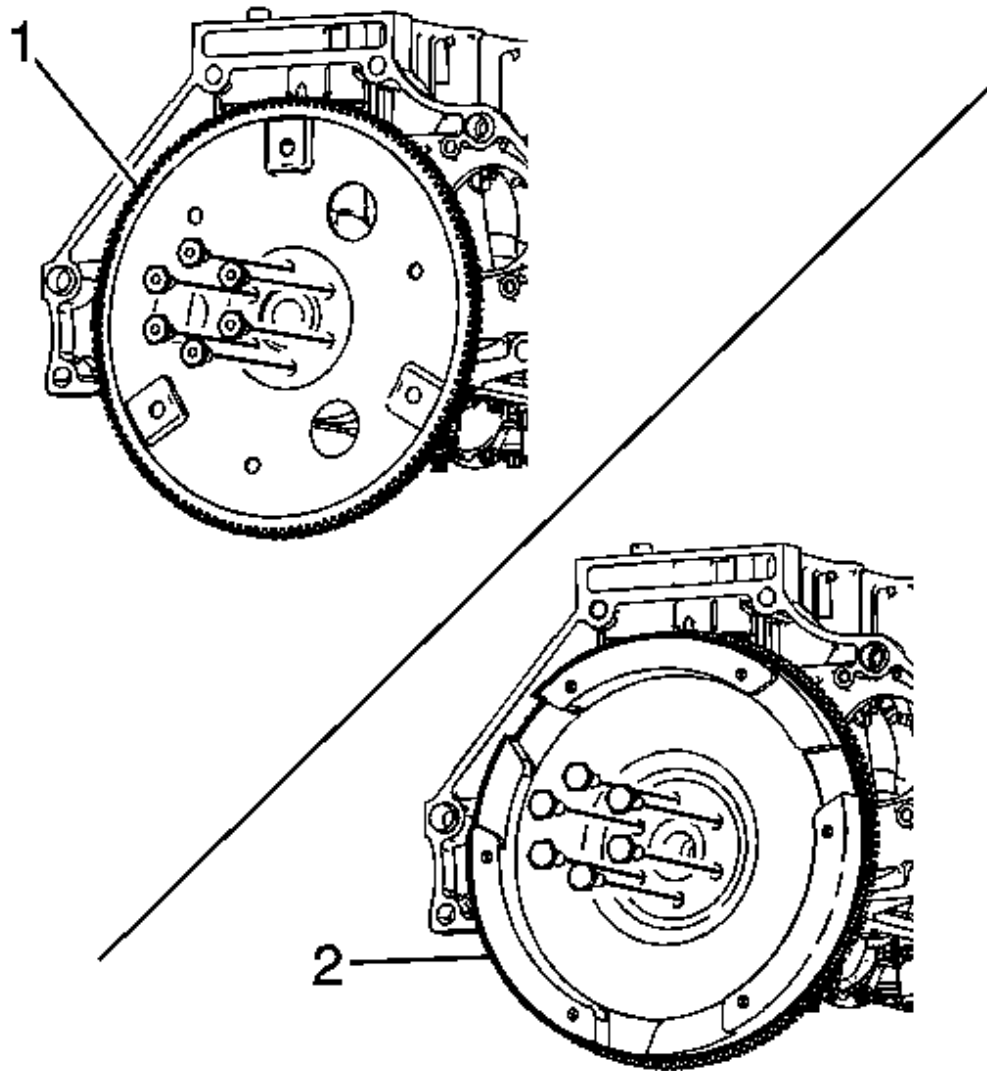


Fig. 157: Flexible Plate/Flywheel
Courtesy of GENERAL MOTORS CORP.

25. Remove the flexible plate or flywheel. Refer to Engine Flywheel Replacement.

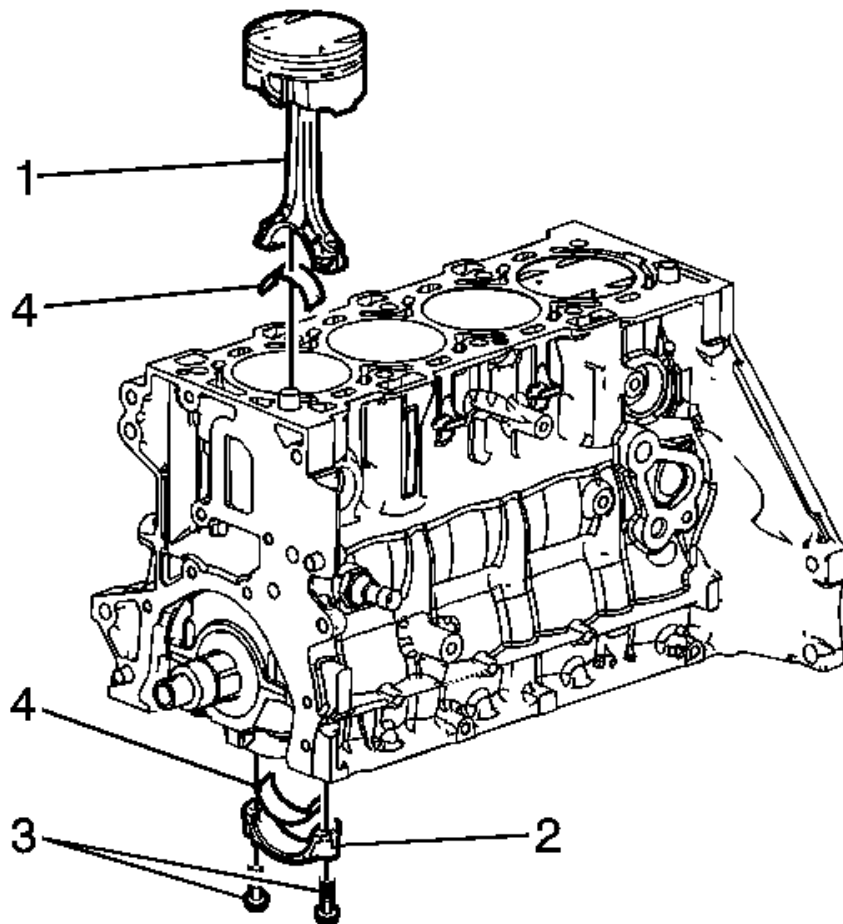


Fig. 158: Piston, Connecting Rod, Connecting Rod Bearing Cap And Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Check and confirm the piston assembly sequence and the connecting rod bearing sequence, to not confuse.

26. Remove the connecting rod cap and bolts.
27. Remove the piston assembly.

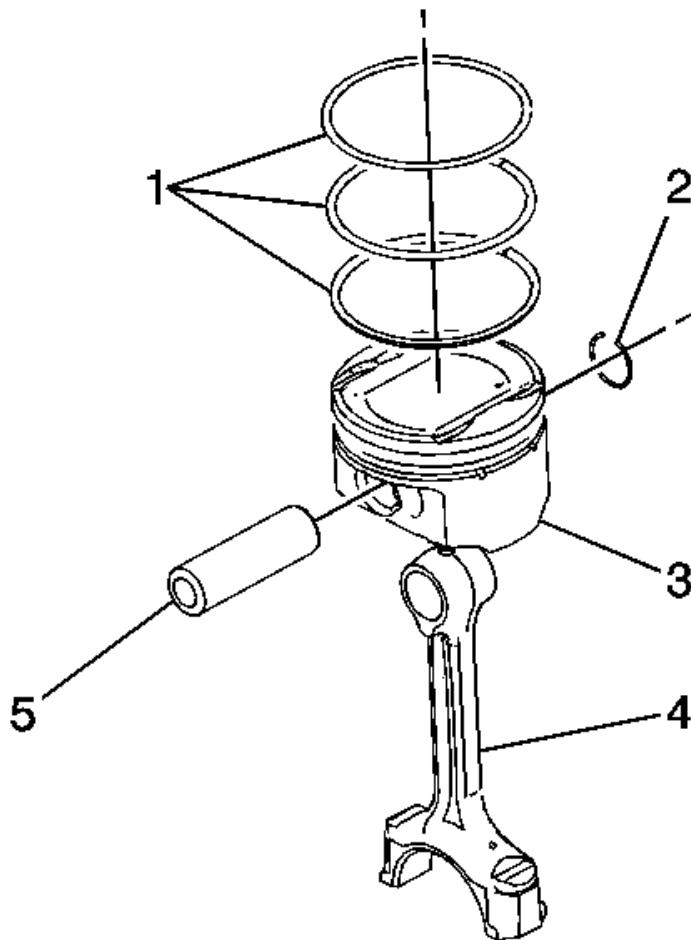


Fig. 159: Exploded View Of Piston
Courtesy of GENERAL MOTORS CORP.

28. Separate the piston pin from the piston.
29. Separate the piston ring from the piston using the expansion tool.

Installation Procedure

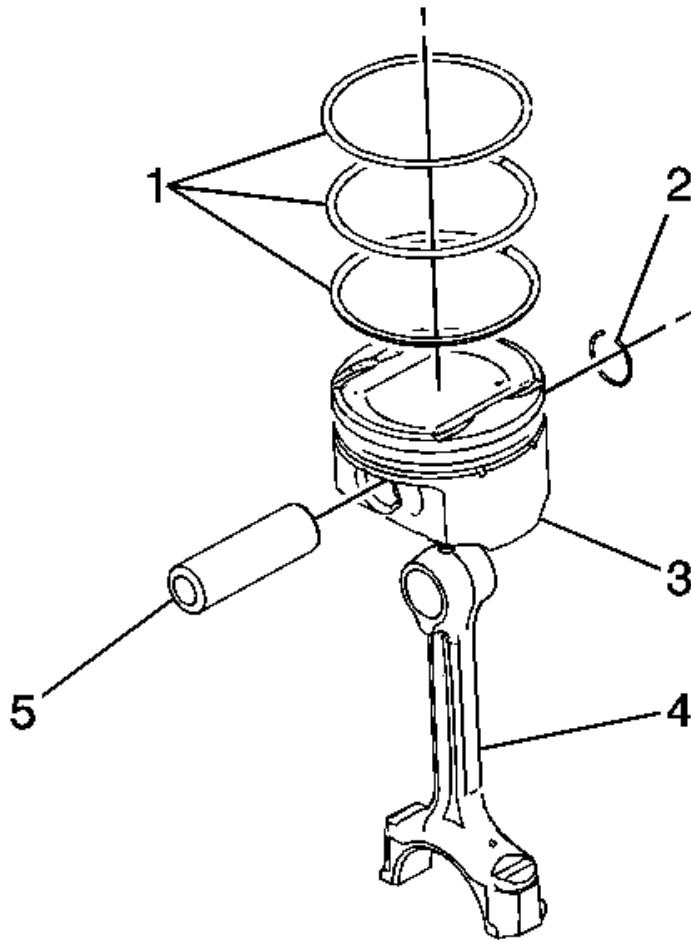


Fig. 160: Exploded View Of Piston
Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches or damage to the inner side of the cylinder, piston, and connecting rod cap bearings.

1. Install the piston pin from the piston.
2. Install the piston ring from the piston using the expansion tool.

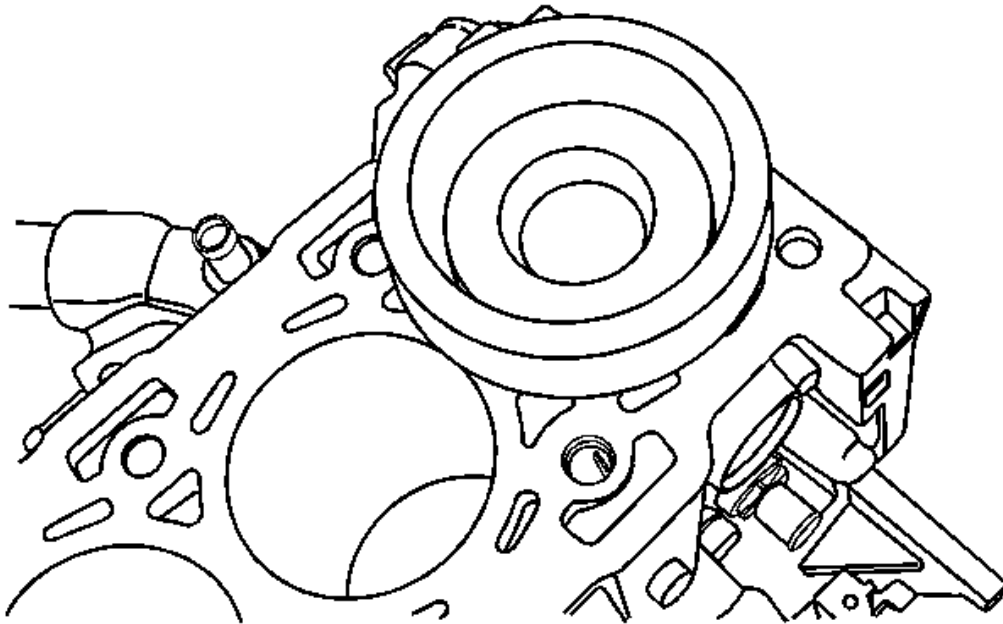


Fig. 161: Piston Installer

Courtesy of GENERAL MOTORS CORP.

NOTE: Check and confirm the piston assembly sequence and the connecting rod bearing sequence, to not confuse.

3. Install the piston assembly using the piston installer (1.6L only - EN-49153).

CAUTION: Refer to Fastener Caution .

4. Install the connecting rod cap and bolts with bearings.

Tighten: Tighten the connecting rod caps bolts to 35+45° +15° N.m (25.8+45° +15° lb ft).

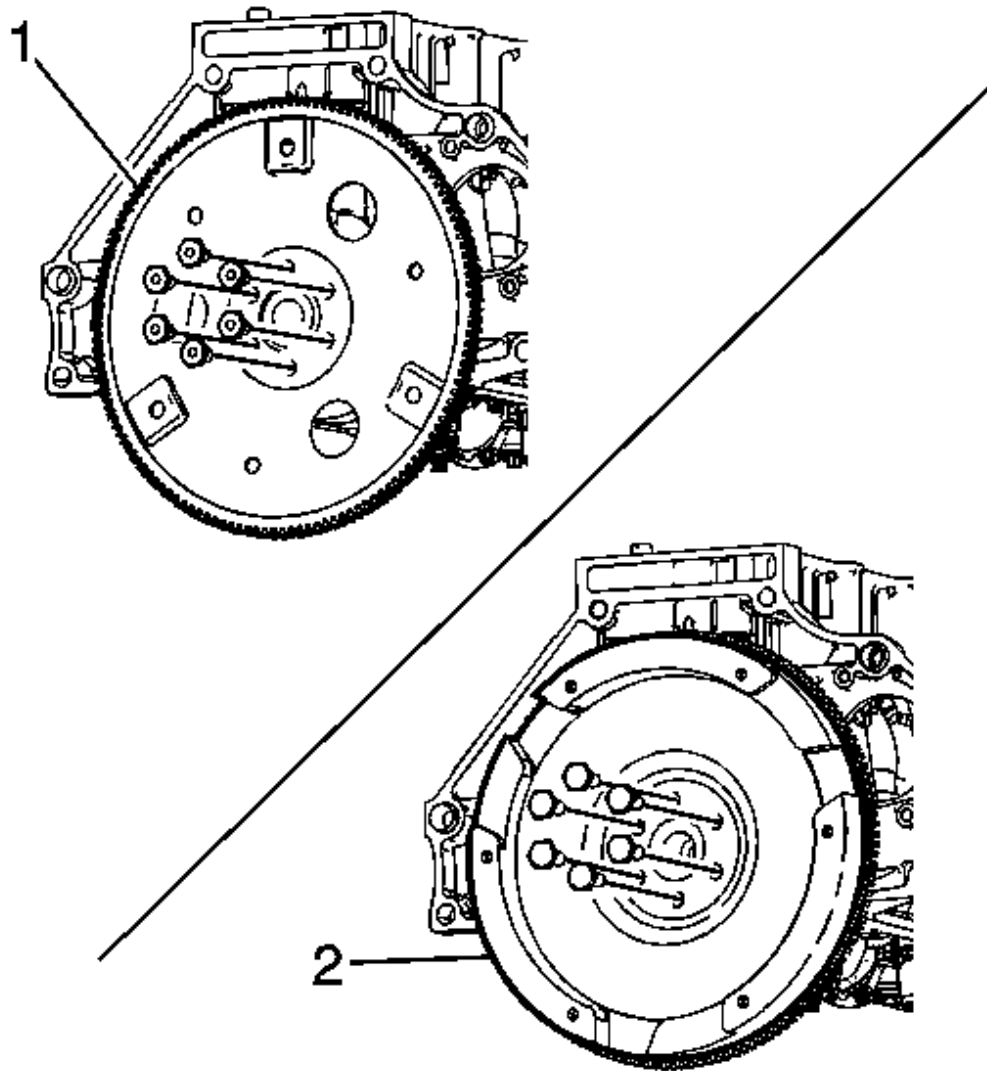


Fig. 162: Flexible Plate/Flywheel
Courtesy of GENERAL MOTORS CORP.

5. Install the flexible plate or flywheel. Refer to Engine Flywheel Replacement.
6. Install the oil pump assembly. Refer to Oil Pump Replacement.

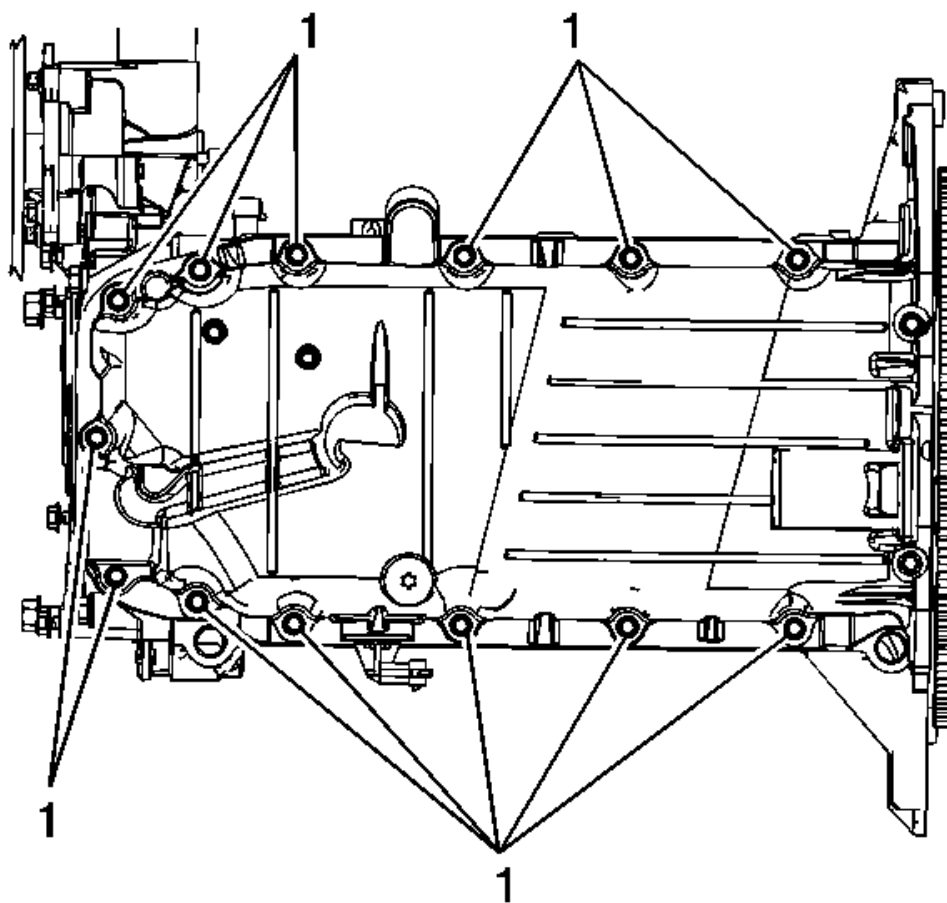


Fig. 163: Engine Oil Pan Bolts

Courtesy of GENERAL MOTORS CORP.

7. Install the engine oil cooler. Refer to Engine Oil Cooler Replacement .
8. Install the A/C compressor. Refer to AIR CONDITIONING COMPRESSOR REPLACEMENT .
9. Install the alternator. Refer to GENERATOR REPLACEMENT (1.4L LDT, 1.6L LXV) .
10. Install the starter. Refer to Starter Motor Replacement (1.4L LDT, 1.6 LXV) .
11. Install the oil pan. Refer to Engine Oil Pan Replacement.

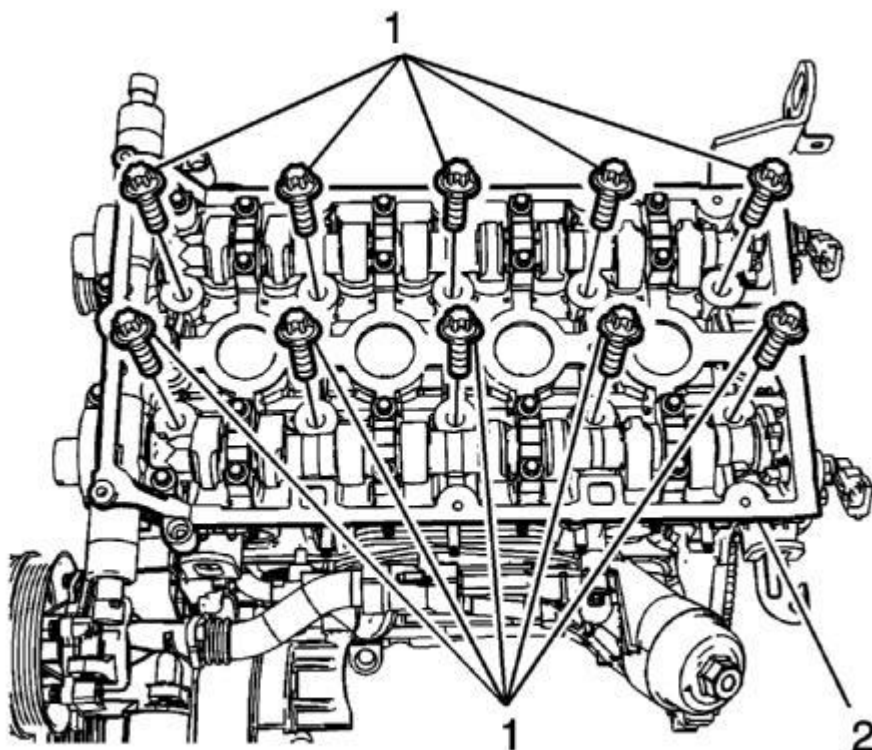


Fig. 164: Cylinder Head Bolts

Courtesy of GENERAL MOTORS CORP.

NOTE: Do not reuse the cylinder head gasket.

12. Install the cylinder head assembly with the new cylinder head gasket.
13. Install the cylinder head bolts.

Tighten: Tighten the cylinder head bolts to 25+90° +90° +90° +45° N.m (18.4+90° +90° +90° +45° lb ft).

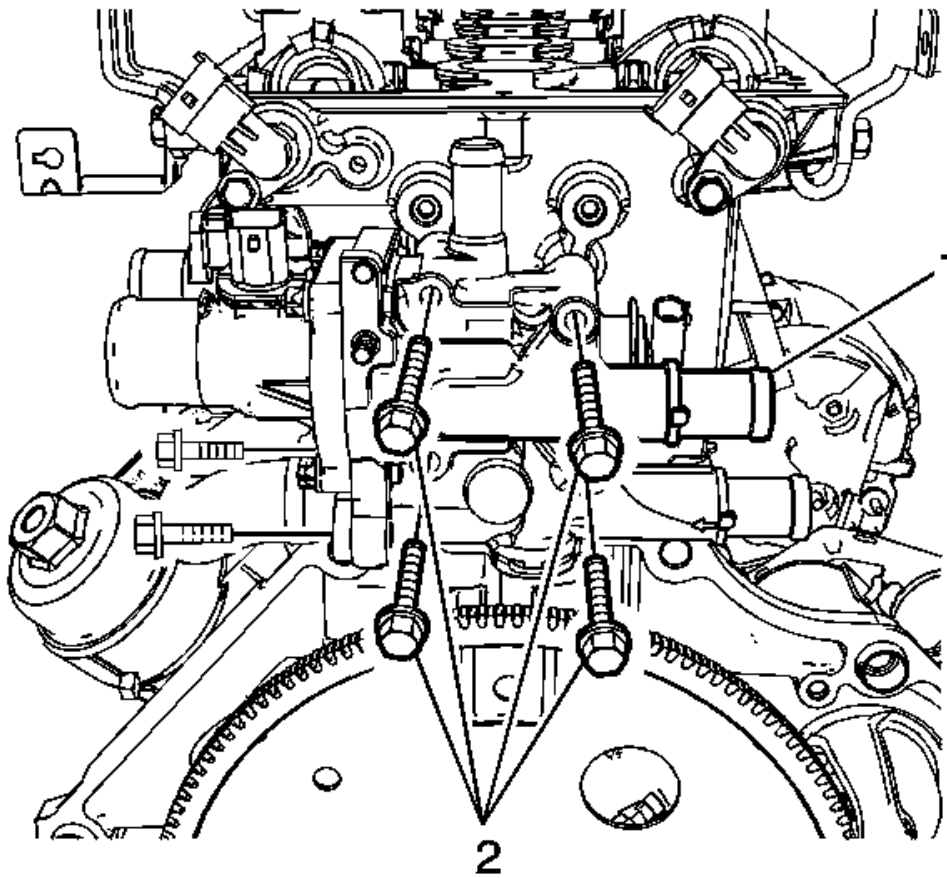


Fig. 165: Coolant Distributor
Courtesy of GENERAL MOTORS CORP.

14. Install the engine coolant distributor.

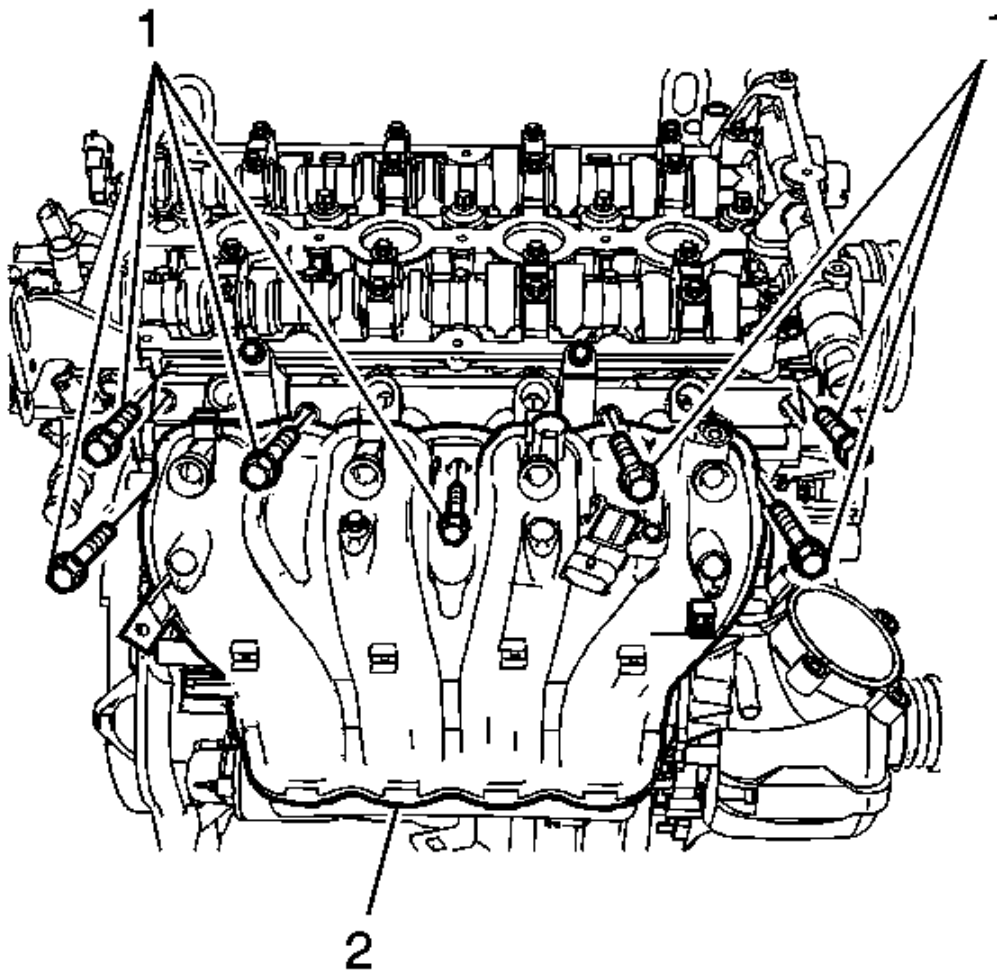


Fig. 166: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS CORP.

15. Install the intake manifold. Refer to **Intake Manifold Replacement**.
16. Install the throttle body.

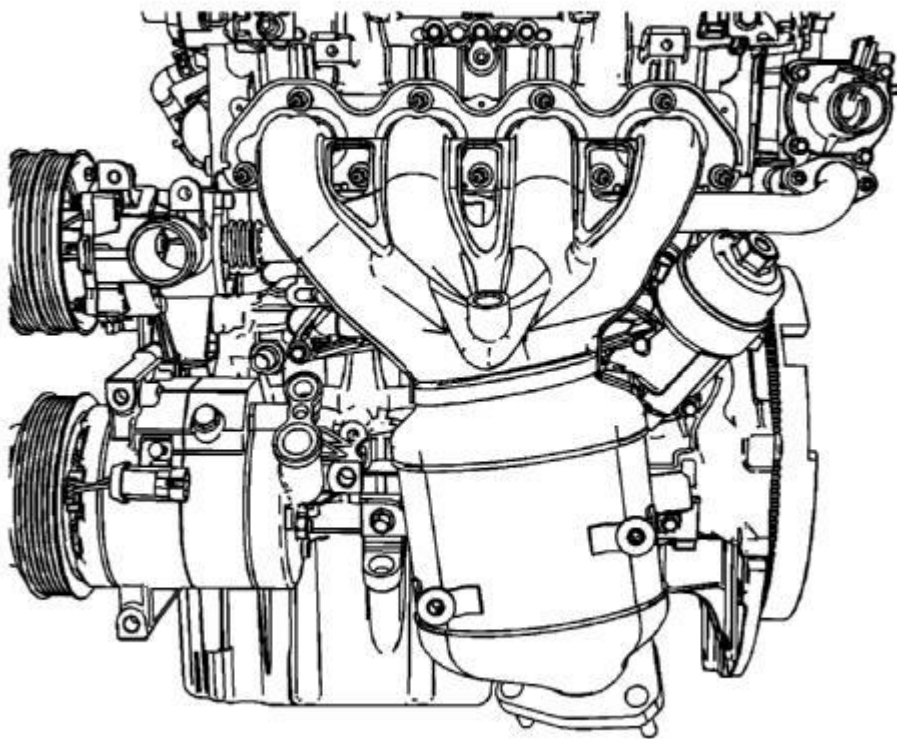


Fig. 167: Exhaust Manifold And Catalytic Converter
Courtesy of GENERAL MOTORS CORP.

17. Install the exhaust manifold.

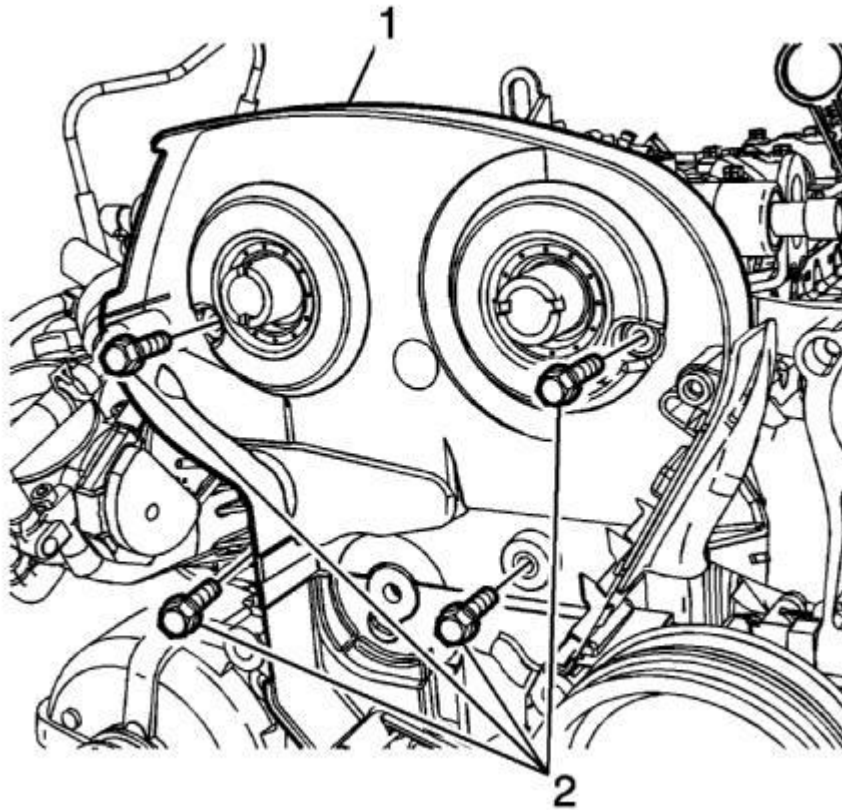


Fig. 168: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

18. Install the camshaft rear cover.
19. Install timing belt system and adjust the timing. Refer to **Timing Belt Replacement**.

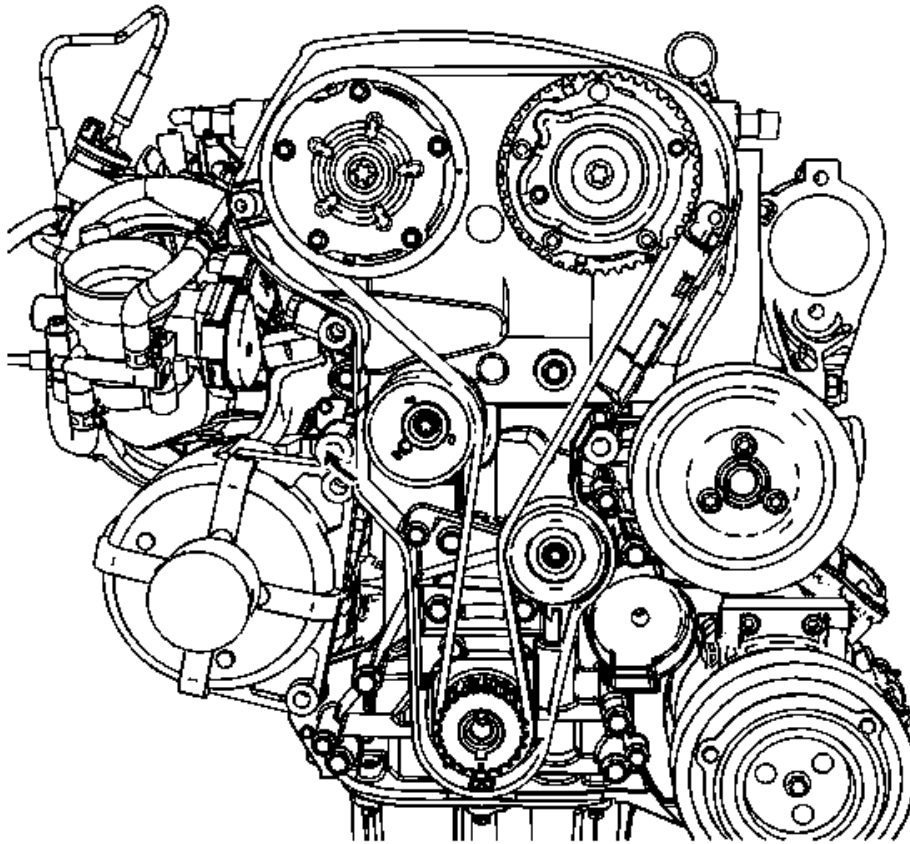


Fig. 169: Timing Belt

Courtesy of GENERAL MOTORS CORP.

20. Install the timing system. Refer to **Timing Belt Replacement**.

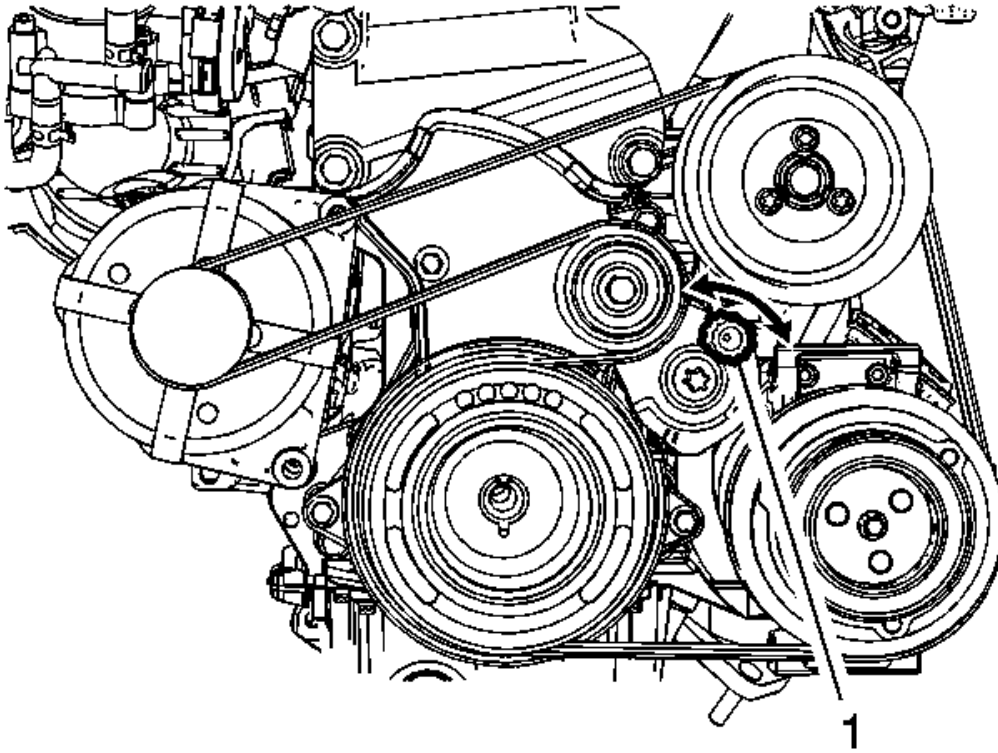


Fig. 170: Serpentine Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

21. Install the accessory belt.
22. Install the power steering pump and bracket. Refer to **Power Steering Pump Replacement (1.4L LDT and 1.6L LXV Engines)** .

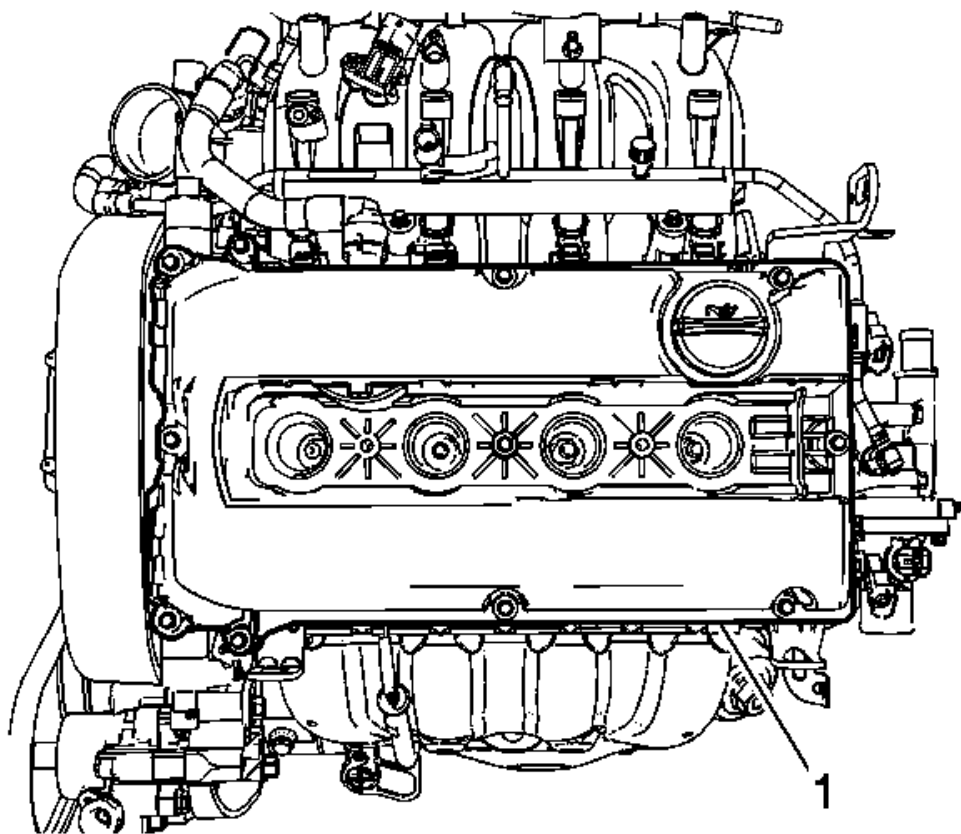


Fig. 171: Cylinder Head Cover
Courtesy of GENERAL MOTORS CORP.

23. Install the cylinder head cover.
24. Screw the cylinder head cover bolts.
25. Install the PCV hose from the cylinder head cover.
26. Attach the PCV clips from the PCV hose.

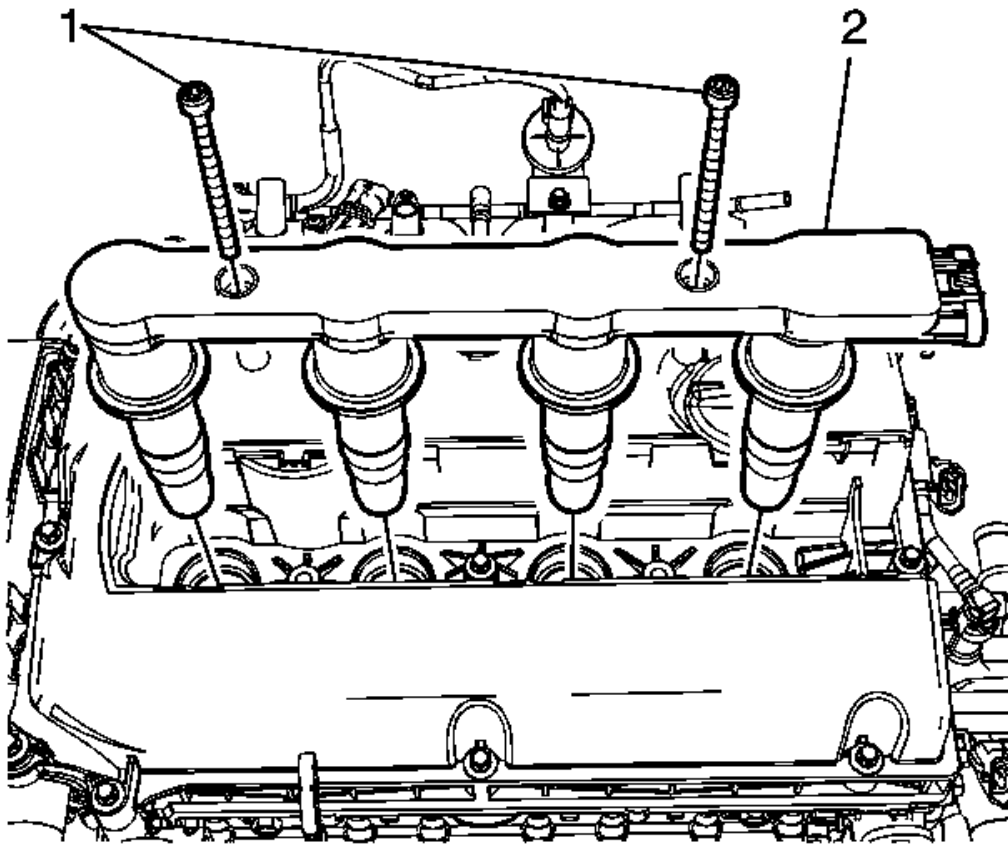


Fig. 172: Ignition Coil Assembly
Courtesy of GENERAL MOTORS CORP.

27. Install the ignition coil.

CAMSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

KM-422 Installer

Removal Procedure

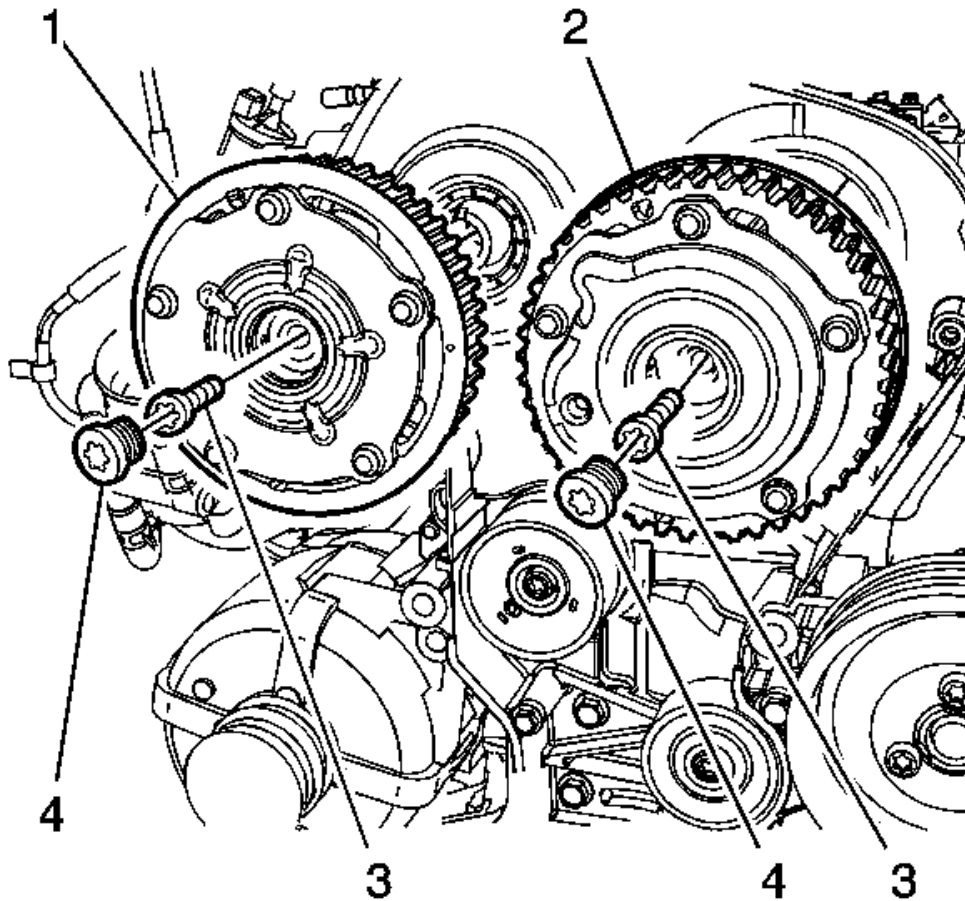


Fig. 173: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft sprocket. Refer to Camshaft Gear Replacement.

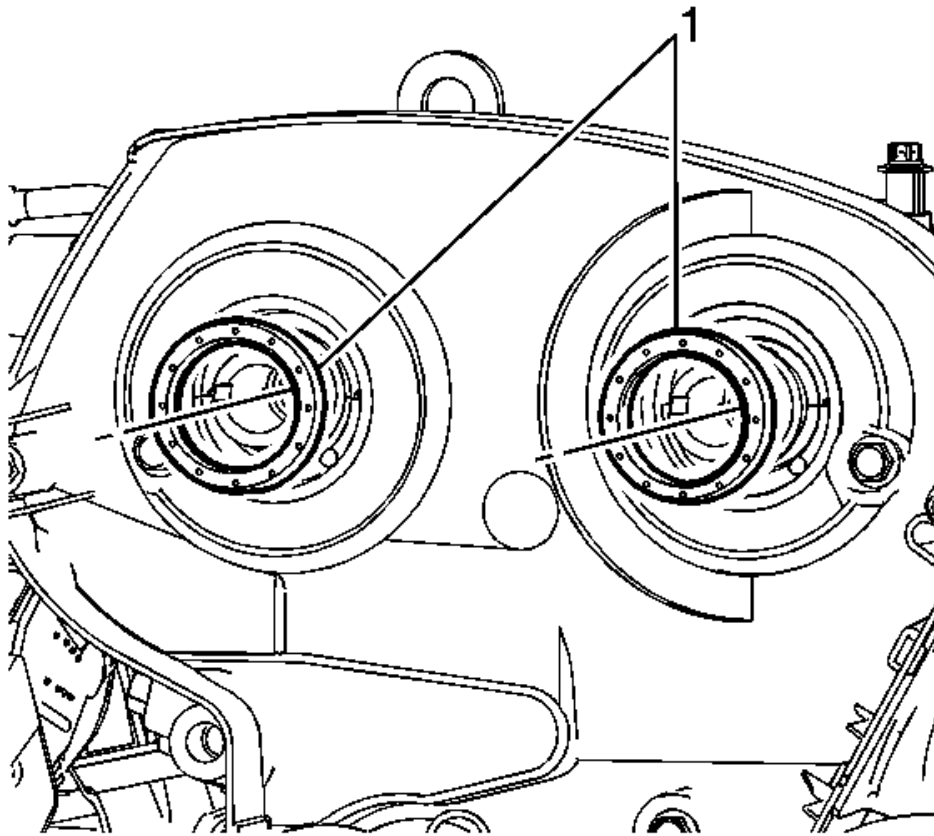


Fig. 174: Camshaft Seal Rings
Courtesy of GENERAL MOTORS CORP.

NOTE: Extremely take care of contacting of camshaft surface. If damaged on the camshaft surface, engine oil could be leaked.

2. Remove the camshaft seal ring.

Installation Procedure

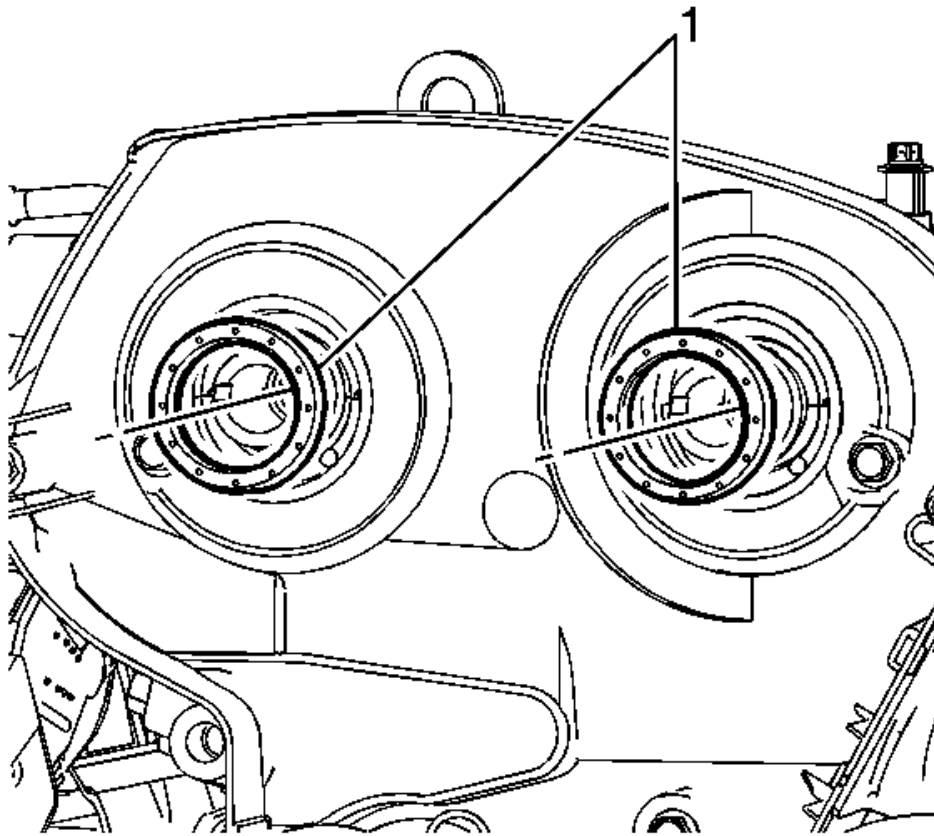


Fig. 175: Camshaft Seal Rings
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not reuse the camshaft seal ring.

1. Install the camshaft seal ring with new one.

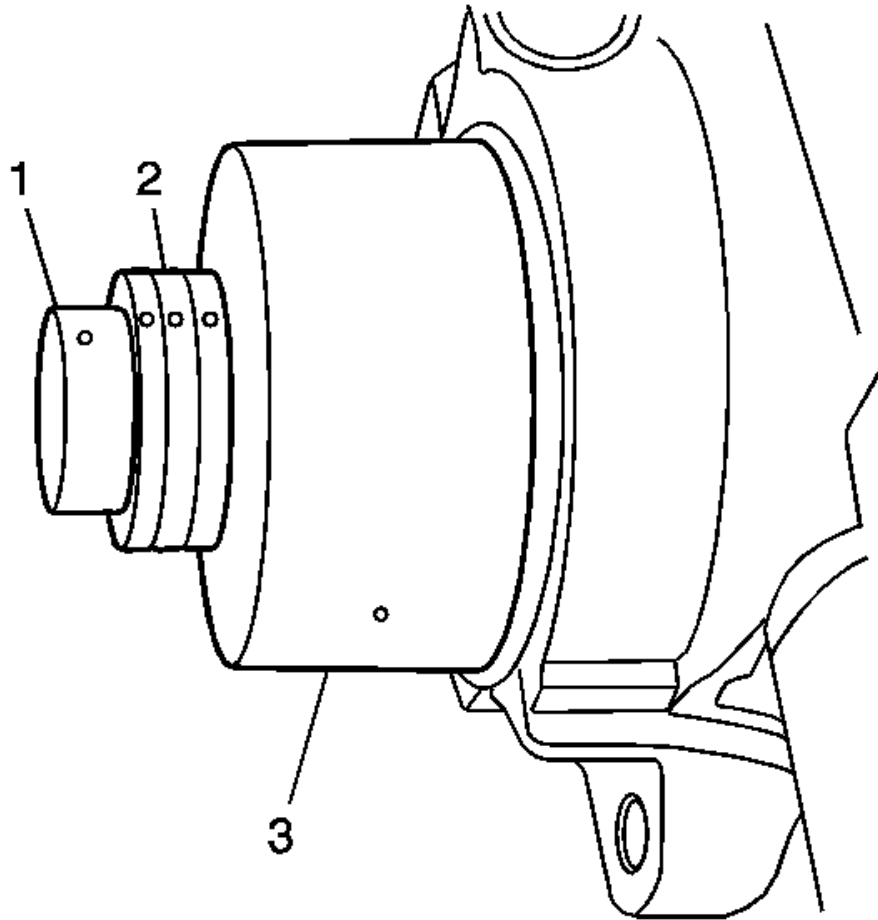


Fig. 176: KM-422 (3) With Shims
Courtesy of GENERAL MOTORS CORP.

2. Install the **KM-422 (3)** with shims (2), with a total thickness of approximately 10 mm and tighten the camshaft bolt (1) manually.
3. Remove the **KM-422** .

CAMSHAFT REPLACEMENT

Special Tools

KM-422 Installer

Removal Procedure

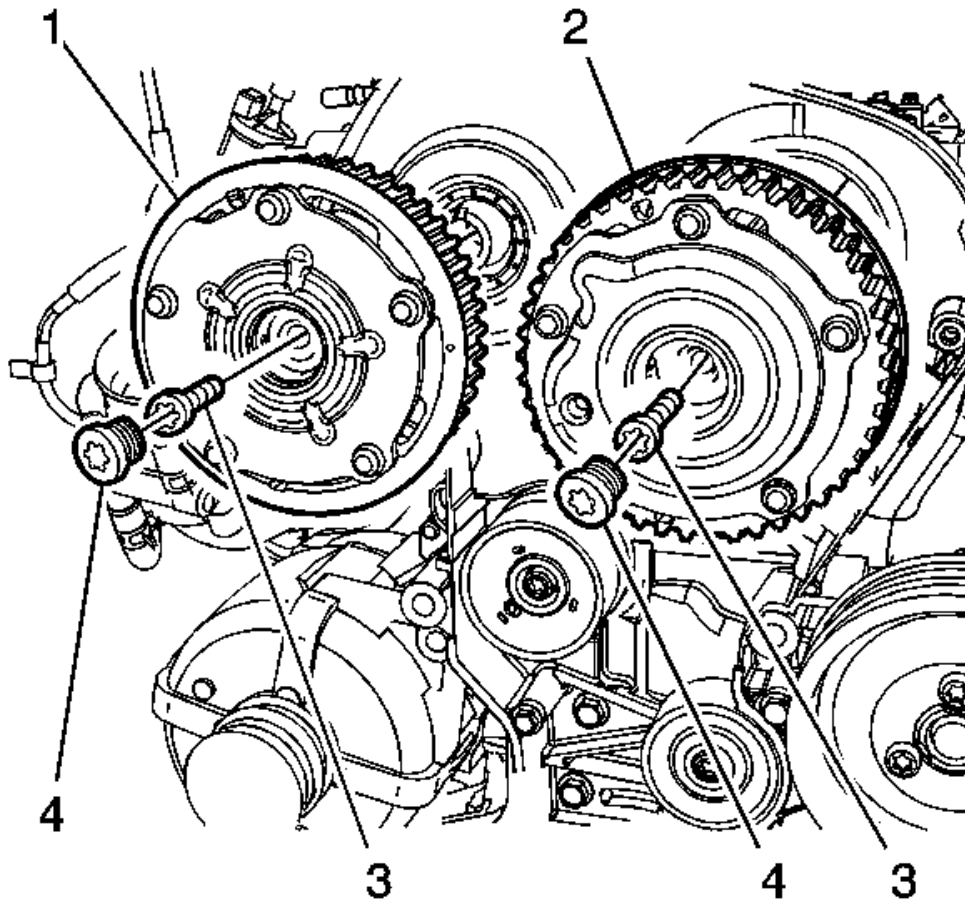


Fig. 177: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches, nicks or damage to the camshafts and caps bearing surfaces. If scratched, damage may happen to engine.

1. Remove the camshaft sprocket. Refer to [Camshaft Gear Replacement](#).
2. Remove the timing belt tensioner. Refer to [Timing Belt Replacement](#).

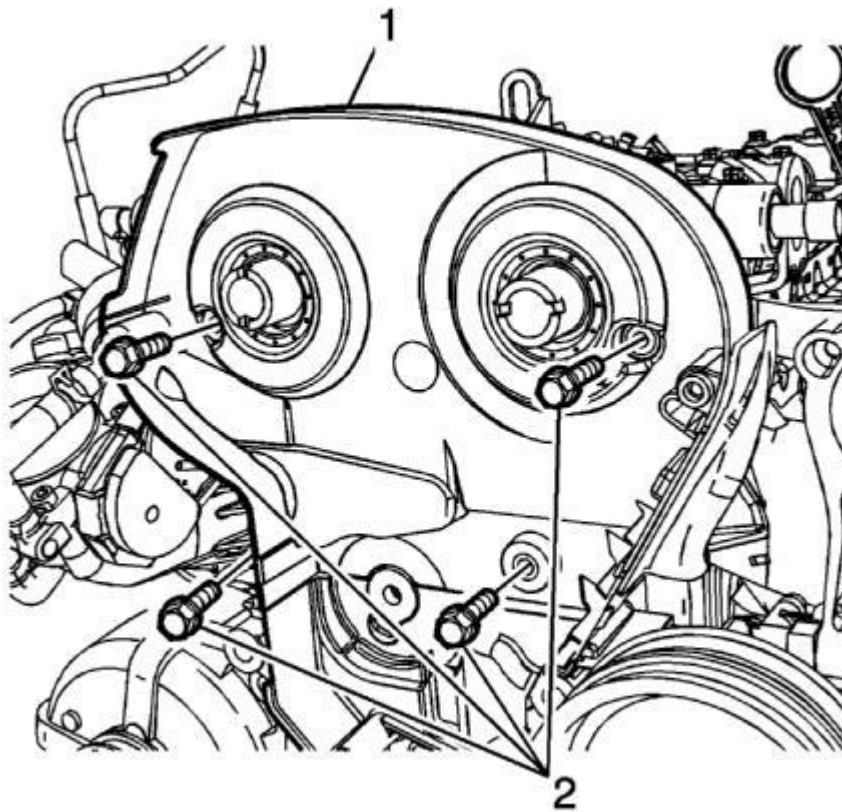


Fig. 178: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the timing belt rear cover.

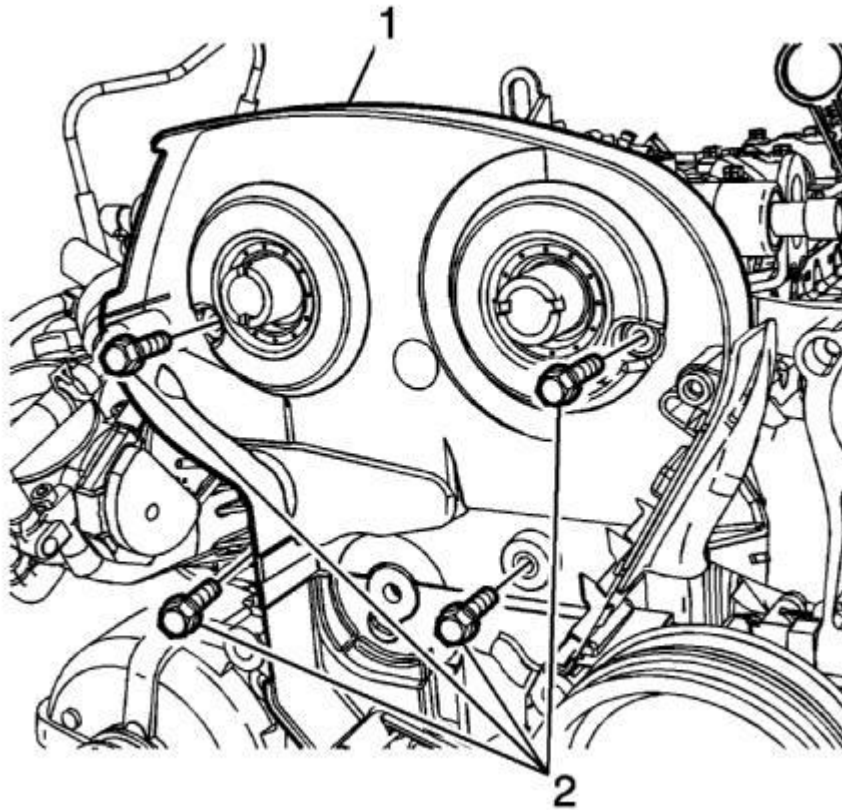


Fig. 179: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft position solenoid valve housing.
5. Remove the camshaft cap bolts in sequence (1, 4, 2, 3).
6. Remove the camshaft caps.

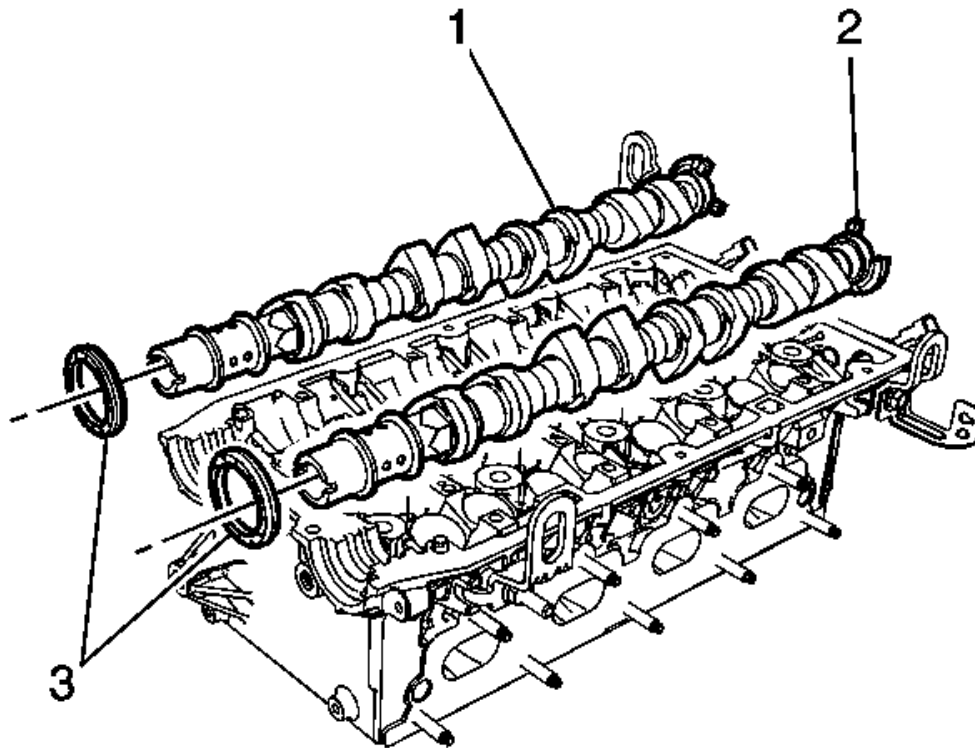


Fig. 180: Intake/Exhaust Camshafts With The Seal Rings
Courtesy of GENERAL MOTORS CORP.

7. Remove the intake/exhaust camshafts with the seal rings.

Installation Procedure

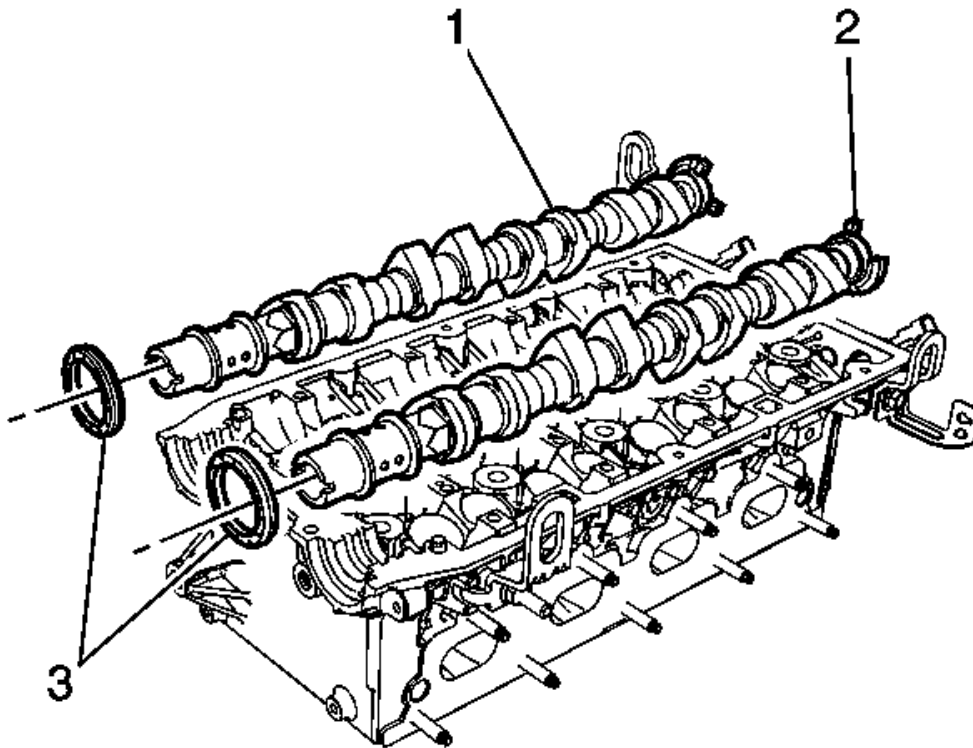


Fig. 181: Intake/Exhaust Camshafts With The Seal Rings
Courtesy of GENERAL MOTORS CORP.

1. Coat/Lubricate the camshaft bearing and cam surfaces with clean engine oil.

NOTE: It is essential to ensure that no sealant is applied outside the marked sealing areas.

2. Install the camshafts on the cylinder head.

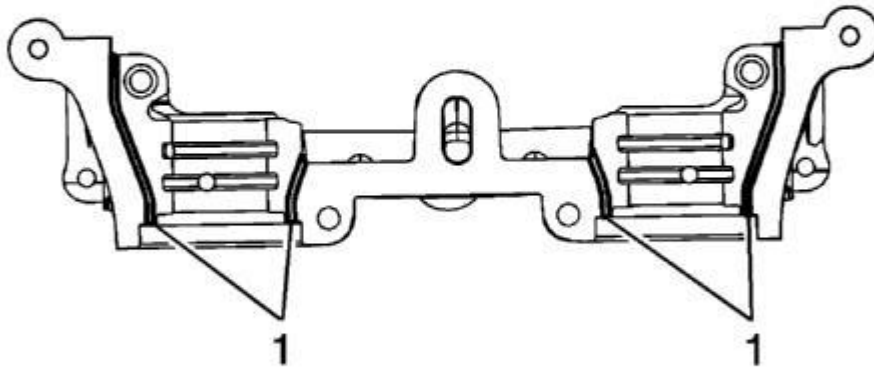


Fig. 182: Grooves Adjacent To Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

NOTE: The grooves (1) adjacent to the sealing surfaces must remain free from sealant

3. Apply surface sealant LOCTITE 574 to sealing surfaces (1) of the 1st camshaft bearing cap thinly and evenly.

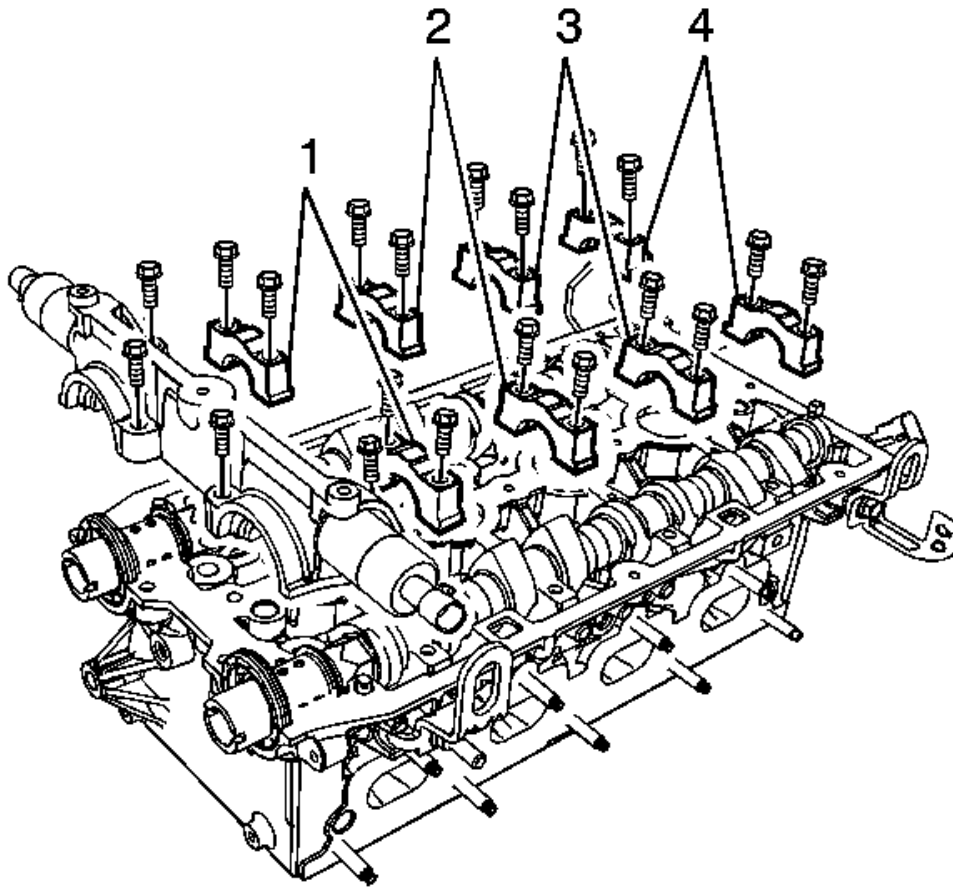


Fig. 183: Identifying Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

4. Install the camshaft bearing caps in sequence (2, 3, 1, 4).

CAUTION: Refer to Fastener Caution .

5. Install the camshaft position solenoid valve housing.

Tighten: Tighten the camshaft bearing cap bolts to 8 N.m (70.8 lb in).

6. Install the new camshaft oil seal rings using **KM-422** .

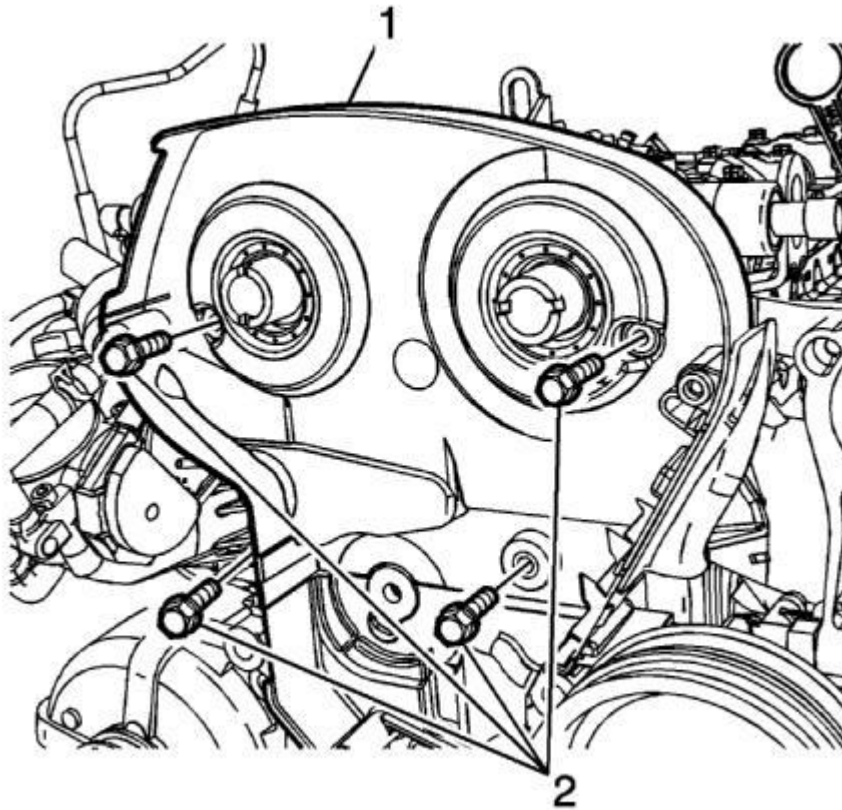


Fig. 184: Timing Belt Rear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the timing belt rear cover.

Tighten: Tighten the timing belt rear cover bolts to 6 N.m (53.1 lb in).

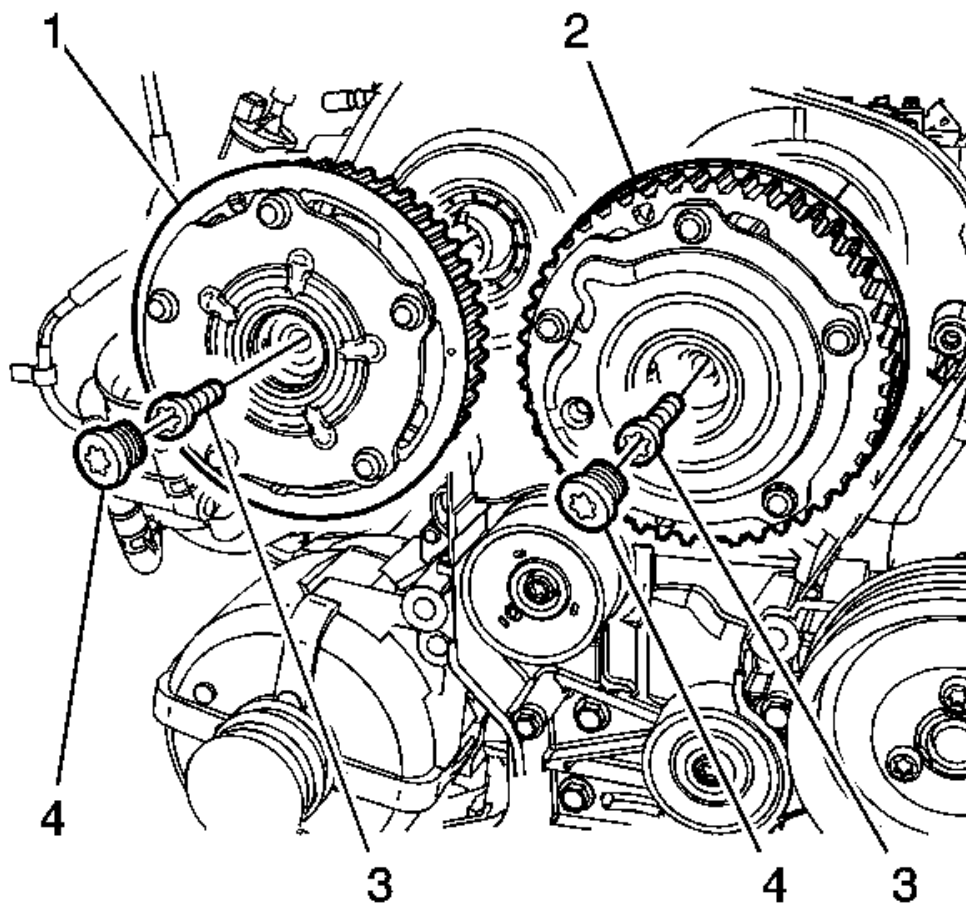


Fig. 185: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the timing belt tensioner. Refer to **Timing Belt Replacement**.
9. Install the camshaft sprocket. Refer to **Camshaft Gear Replacement**.

CAMSHAFT GEAR REPLACEMENT

Removal Procedure

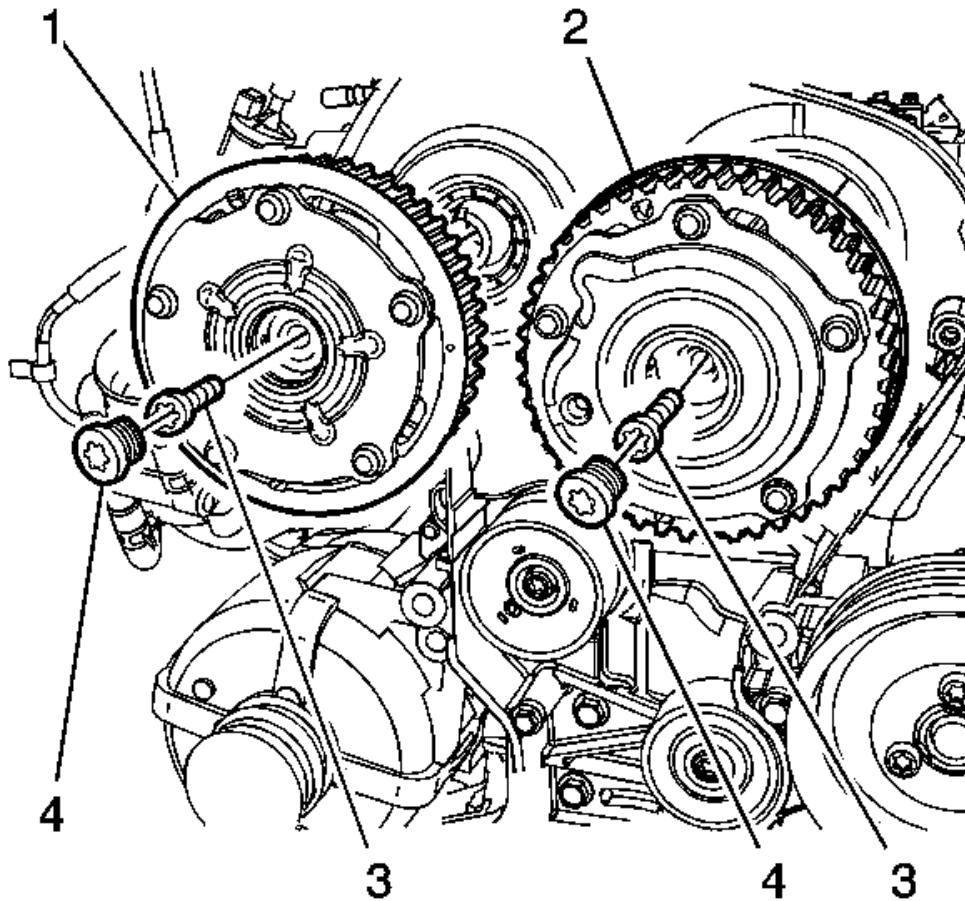


Fig. 186: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the timing belt. Refer to **Timing Belt Replacement**.
2. Remove the camshaft sprocket bolt cap.
3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprockets.

Installation Procedure

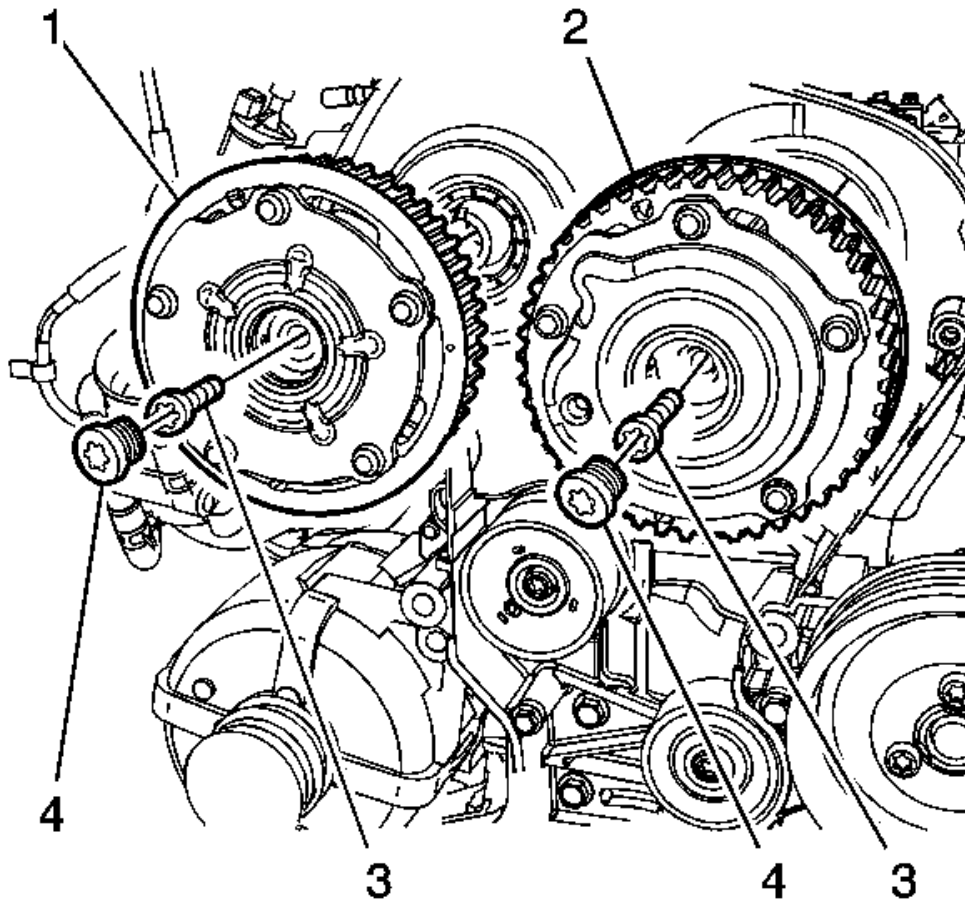


Fig. 187: Camshaft Sprockets & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: When installing the camshaft sprockets, the timing adjustment procedure must be accomplished. Refer to Timing Belt Replacement.

1. Install the camshaft sprockets.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft sprocket bolts.

Tighten: Tighten the camshaft sprocket bolts to 65 N.m (47.9 lb ft).

3. Install the camshaft sprocket bolt caps.

Tighten: Tighten the camshaft sprocket bolt cap to 50 N.m (36.8 lb ft).

4. Install the timing belt. Refer to **Timing Belt Replacement**.

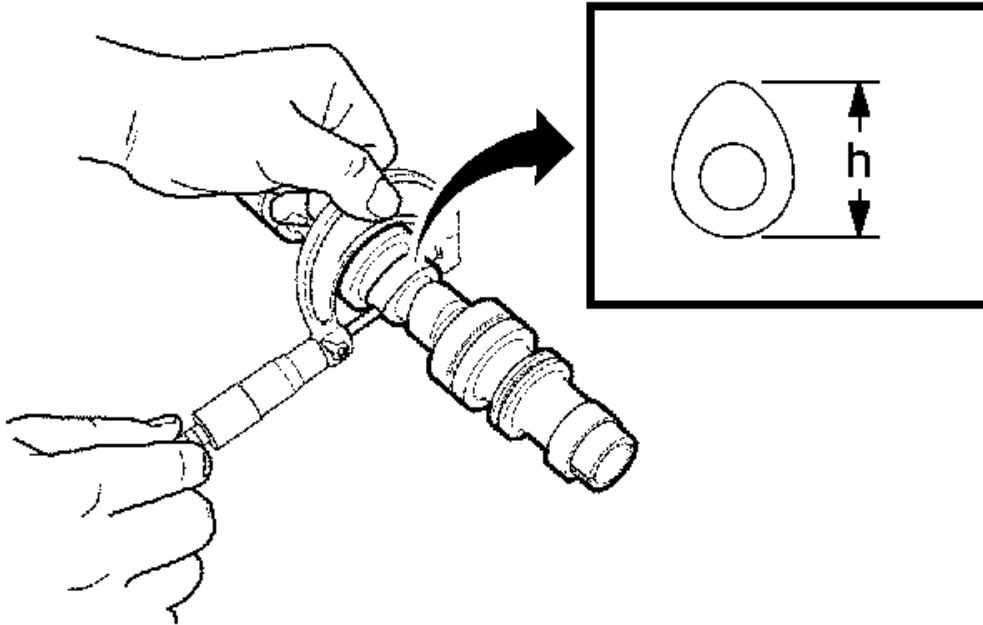
CAMSHAFT CLEANING AND INSPECTION

Fig. 188: Measuring Camshaft Lobe
Courtesy of GENERAL MOTORS CORP.

1. Measure the camshaft lift.
2. Replace the camshaft if the measured value is not as specified.

Specification: The specification is 46.3 mm (1.8228 in).

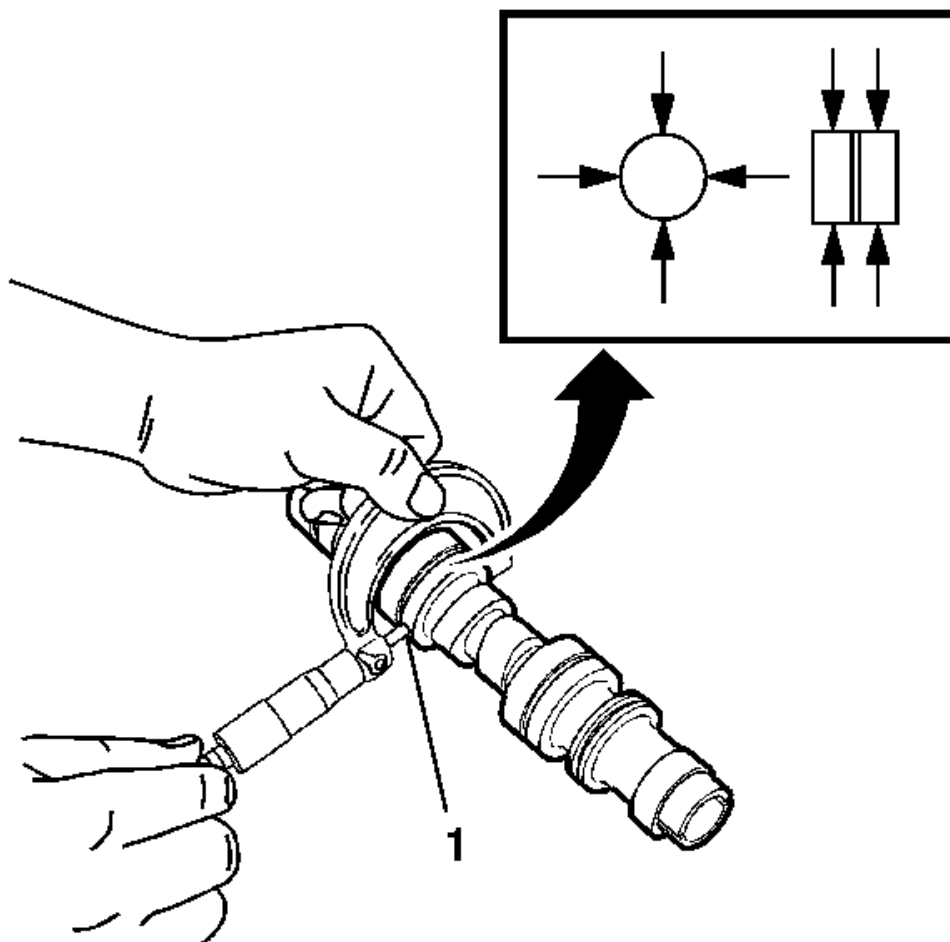


Fig. 189: Measuring Outer Diameter Of Each Camshaft Journal AT 5 Different Places
Courtesy of GENERAL MOTORS CORP.

3. Measure the outer diameter of each journal at the 4 different places.
4. Replace the camshaft if the measured value is not as specified.

Specification: The specification is 27.939-27.960 mm (1.1000-1.1008 in).

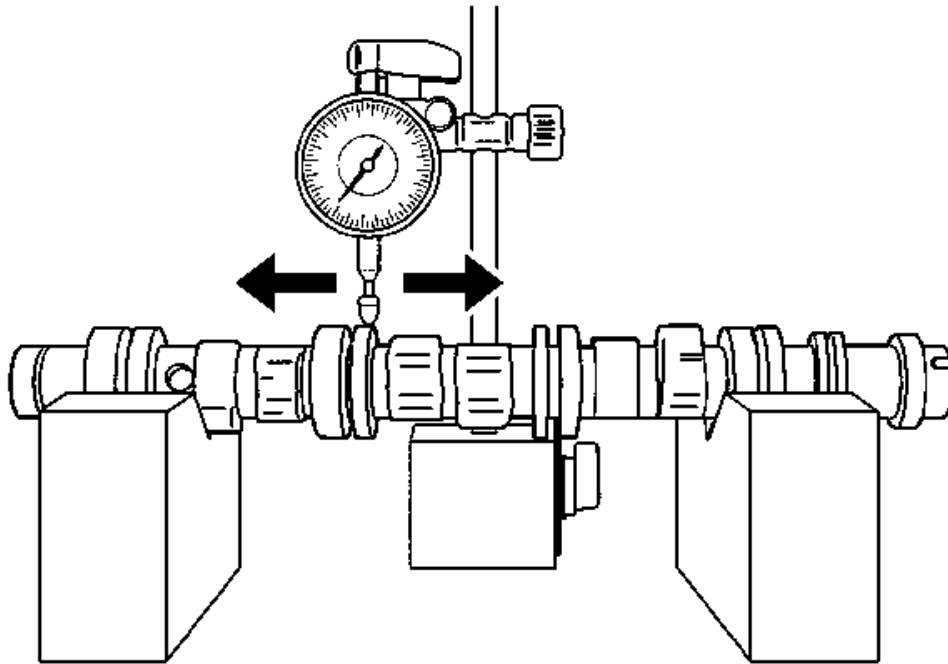


Fig. 190: Measuring Straightness Of Camshaft
Courtesy of GENERAL MOTORS CORP.

5. Measure the straightness of the camshaft using a dial gage.
6. Replace the camshaft if the measured value is over the specified limit.

Specification: The specification limit is 0.04 mm (0.0016 in).

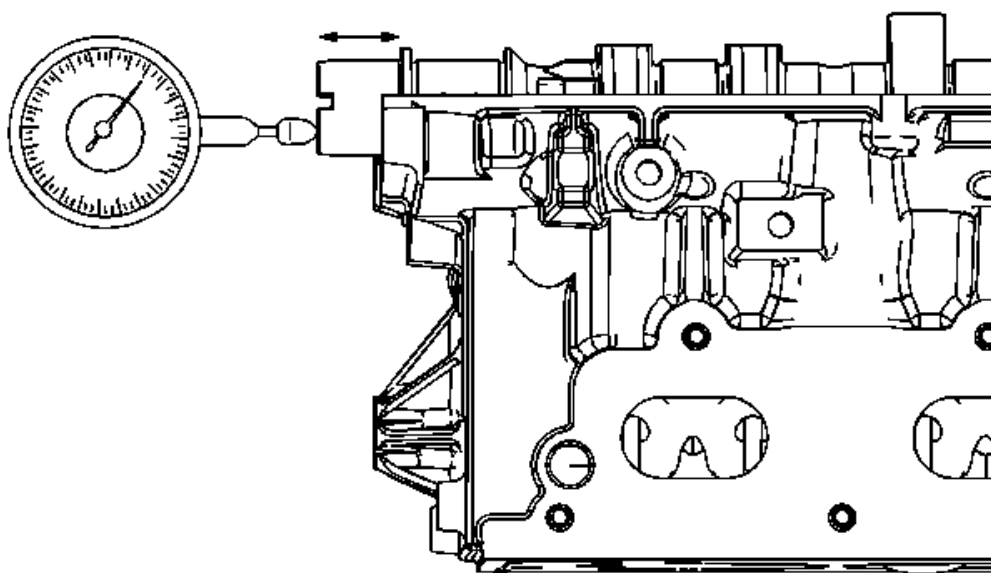


Fig. 191: Measuring Camshaft Endplay
Courtesy of GENERAL MOTORS CORP.

7. Measure the camshaft endplay using a dial gage.
8. Replace the camshaft if the measured value is over the specified limit.

Specification: The specification limit is 0.130-.215 mm (0.0051-.0085 in).

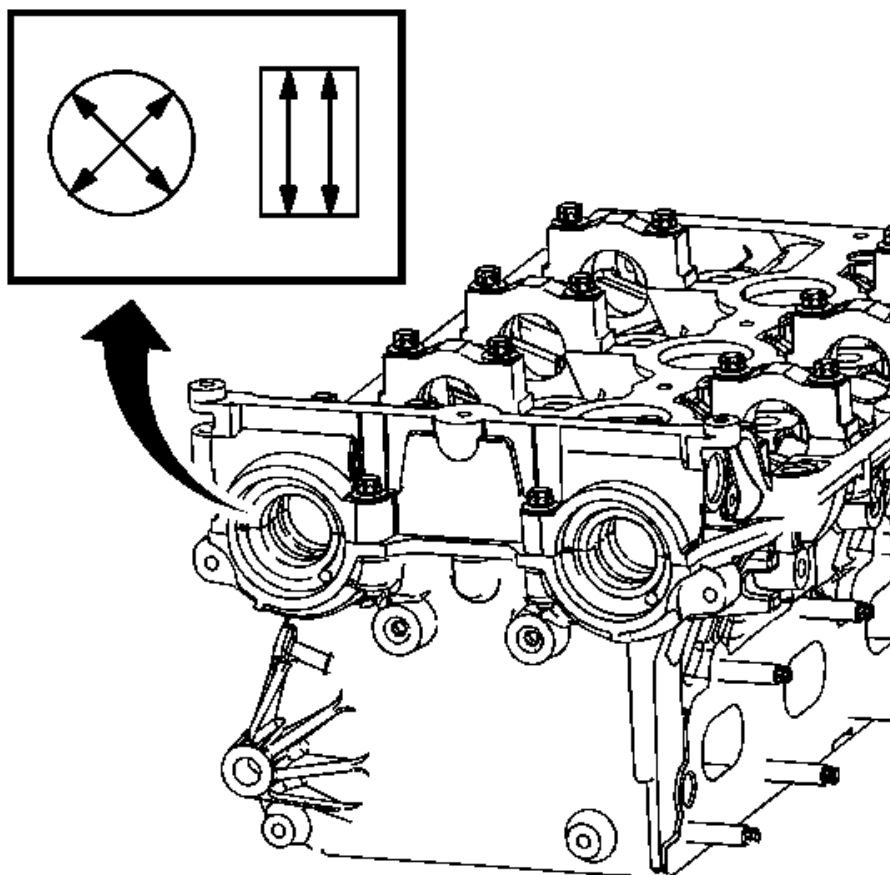


Fig. 192: Measuring Camshaft Journal Inside Diameter
Courtesy of GENERAL MOTORS CORP.

9. Measure the inner diameter of the cylinder head journal at the 2 places.

Specification: The specification limit is 28.000-28.021 mm (1.1024-1.1032 in).

10. If necessary, replace cylinder head.

VALVE CLEARANCE ADJUSTMENT

Measurement

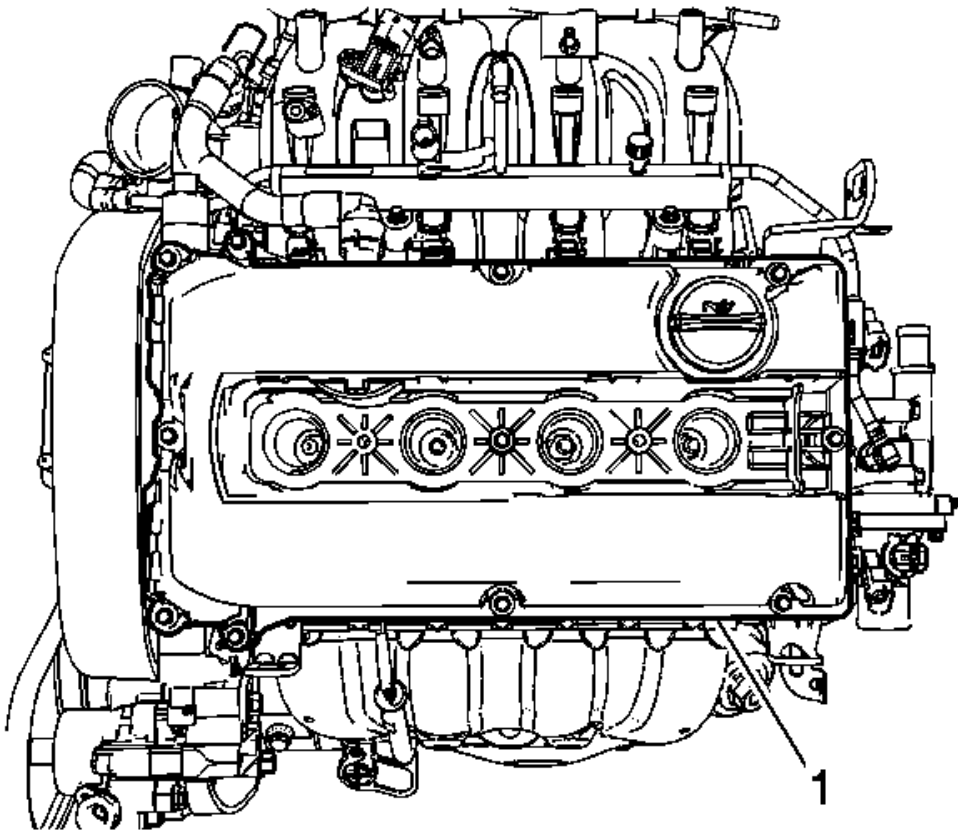


Fig. 193: Cylinder Head Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arm cover. Refer to Valve Rocker Arm Cover Replacement.

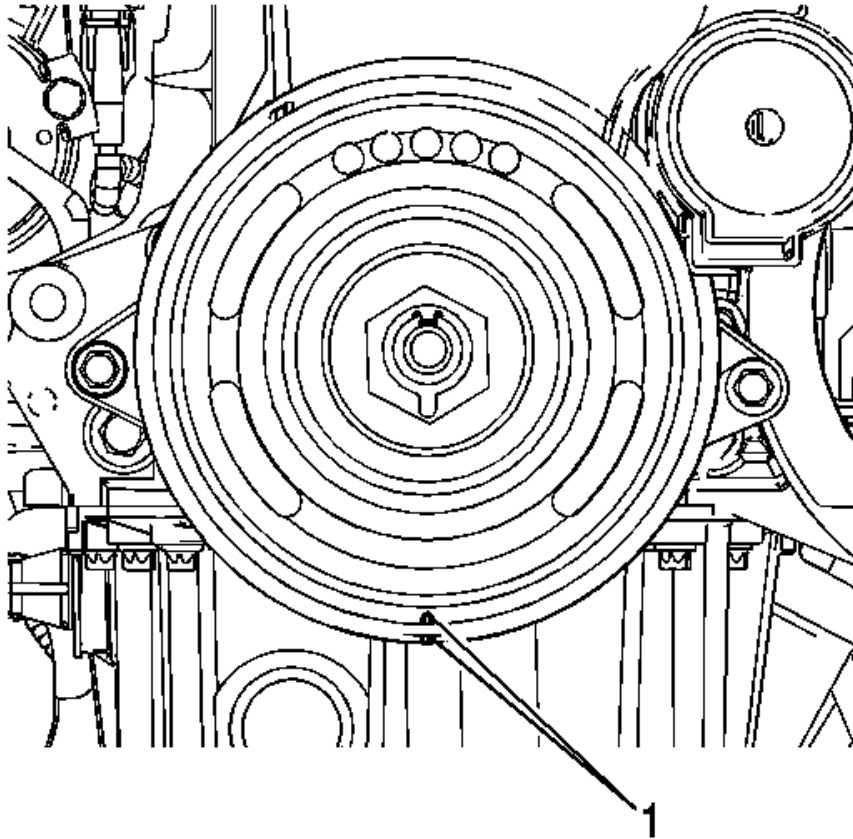


Fig. 194: Crankshaft Pulley Notches
Courtesy of GENERAL MOTORS CORP.

2. Rotate the crankshaft pulley clockwise, aligning the notches (1) between the pulley and the cover.

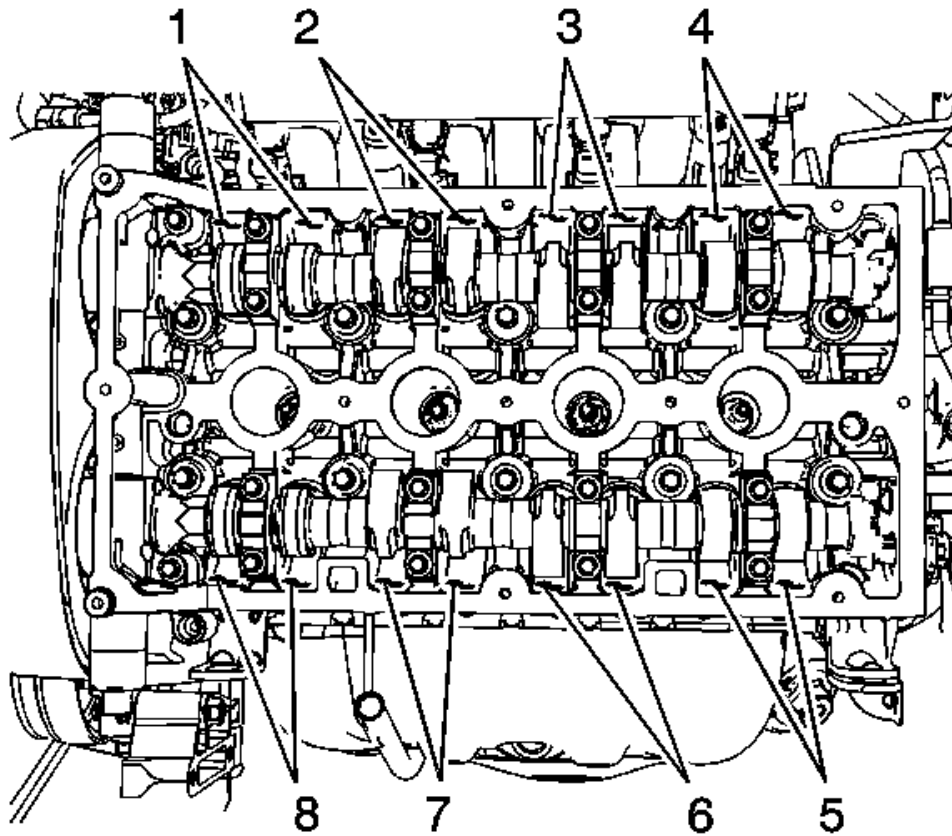


Fig. 195: Identifying Valve Clearance Adjustment Points
Courtesy of GENERAL MOTORS CORP.

3. Measure the valve clearance at positions (2) and (6). Rotate the crankshaft pulley clockwise 180 degrees.
4. Measure the valve clearance at positions (3) and (7). Rotate the crankshaft pulley clockwise 180 degrees.
5. Measure the valve clearance at positions (4) and (8). Rotate the crankshaft pulley clockwise 180 degrees.
6. Measure the valve clearance at positions (1) and (5). Rotate the crankshaft pulley clockwise 180 degrees.
7. If the measured values are not within specifications, replace the valve tappets.

Specifications:

- Intake Side: 0.21-0.29 mm (Nominal Value: 0.25 mm)
- Exhaust Side: 0.27-0.35 mm (Nominal Value: 0.30 mm)

8. Determine the tappet size. Refer to Determining Replacement Tappet Size below.
9. Replace the valve tappets if necessary. Refer to Valve Stem Oil Seal and Valve Spring Replacement.

Determine Replacement Tappet Size

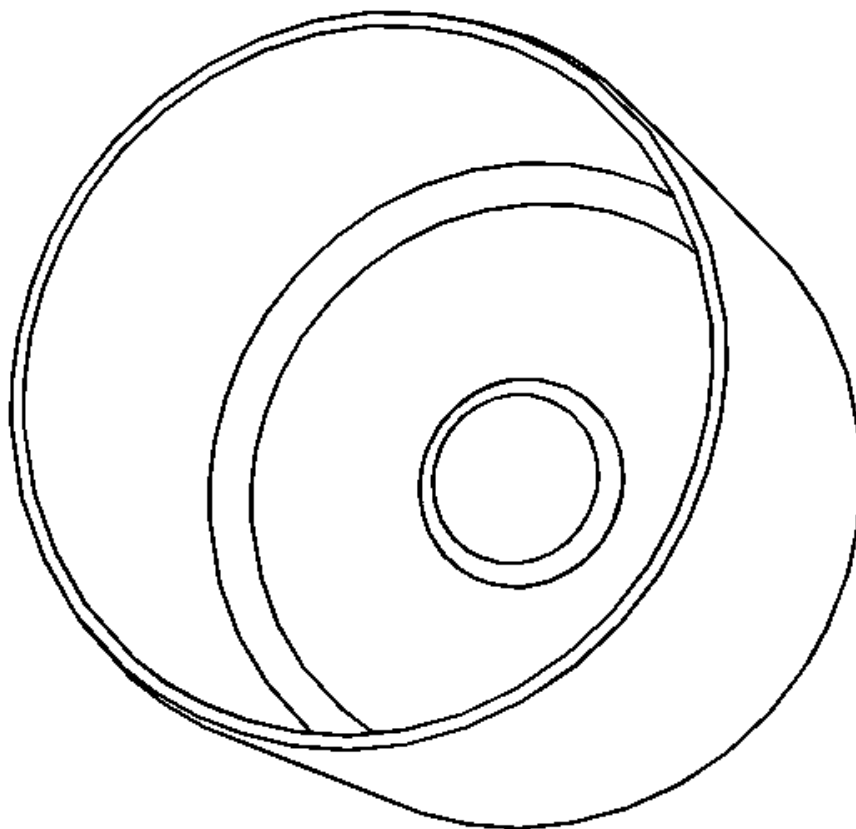


Fig. 196: Inside Tappet
Courtesy of GENERAL MOTORS CORP.

1. Remove the old tappet.
2. Locate the ID number inside old tappet.
3. Locate the ID number in the following table and record the value.
4. Perform the following calculation to determine the replacement tappet size.

Value of removed tappet + measured clearance - nominal value = new tappet size

Example:

- ID of old tappet = 20 = 3.20 mm, clearance was 0.31 mm, nominal value is 0.25 mm
- $3.20 \text{ mm} + 0.31 \text{ mm} - 0.25 \text{ mm} = 3.265 \text{ mm}$
- $3.265 \text{ mm} = 27\text{X}$ (ID number) = 55353766 (part number)

Tappet Selection

2009 Pontiac G3 Wave SE

2009 ENGINE Engine Mechanical - 1.6L (LXV) - Aveo & G3 Wave (Canadian)

Part Number	ID Number	Value (mm)
24465260	04	3.060-3.050
24465261	06	3.050-3.070
24438041	08	3.070-3.090
24438145	10	3.090-3.110
24438146	12	3.110-3.130
24438147	14	3.130-3.150
24438148	16	3.150-3.170
24438149	18	3.170-3.190
24438150	20	3.190-3.210
24438151	22	3.210-3.230
55353764	24X	3.230-3.244
55353765	25X	3.244-3.258
55353766	27X	3.258-3.272
55353767	28X	3.272-3.286
55353768	30X	3.286-3.300
55353769	31X	3.300-3.314
55353770	32X	3.314-3.328
55353771	34X	3.328-3.342
55353772	35X	3.342-3.356
55353773	36X	3.356-3.370
55353774	38X	3.370-3.384
55353775	39X	3.384-3.398
55353776	41X	3.398-3.412
55353777	42X	3.412-3.426
55353778	43X	3.426-3.440
55353779	45	3.440-3.460
55353780	47	3.460-3.480
55353781	49	3.480-3.500
55353782	51	3.500-3.520
55353783	53	3.520-3.540
55353784	55	3.540-3.560
55353785	57	3.560-3.580
55353786	59	3.580-3.600

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT**Special Tools**

- EN-49074 Universal Valve Spring Compressor
- EN-49155 Valve Spring Compressing Adapter
- EN-49154 Adapter-Cylinder Pressure

- **KM-845 Suction Device**

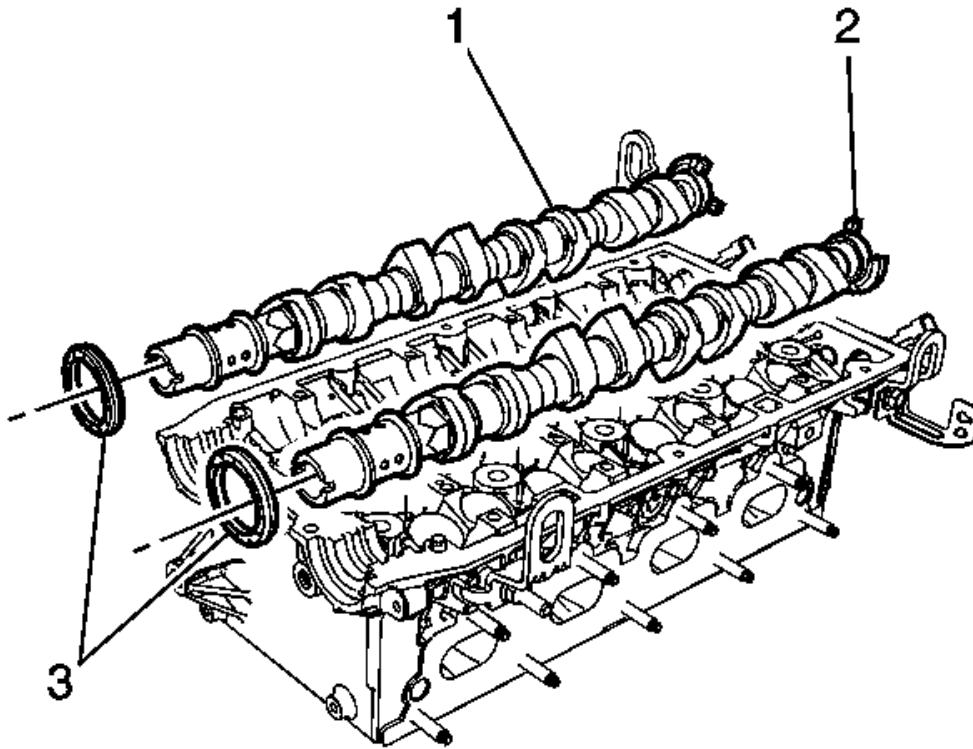
Removal Procedure

Fig. 197: Intake/Exhaust Camshafts With Seal Rings
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft. Refer to **Camshaft Replacement**.

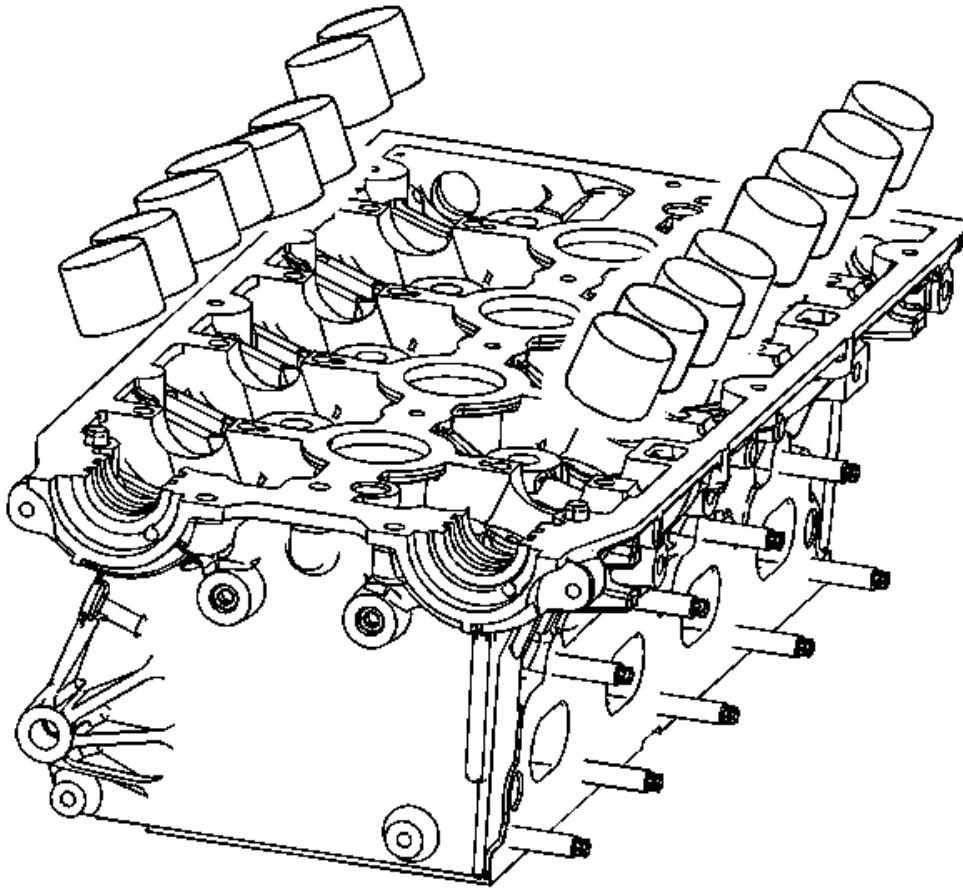


Fig. 198: Valve Tappets
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve tappet using **KM-845** .

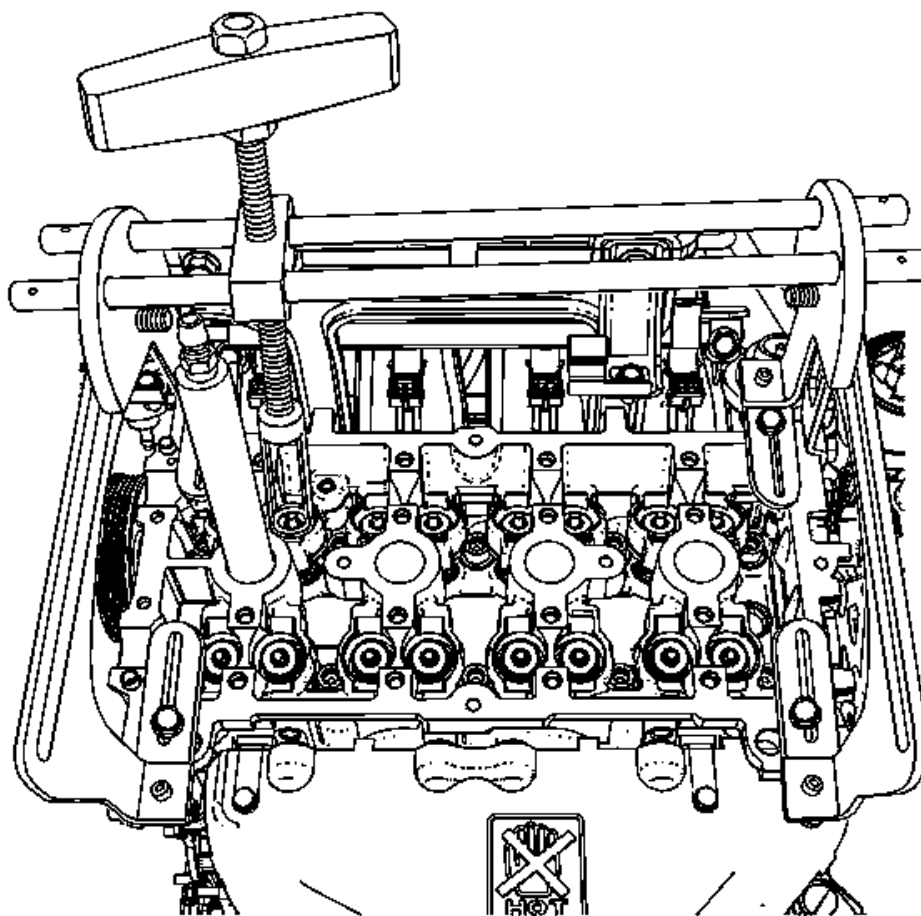


Fig. 199: EN-49074 and EN-49075
Courtesy of GENERAL MOTORS CORP.

3. Remove the spark plugs and then install the EN-49154.
4. Apply the compressed air to the adapter to avoid dropping of valves in the cylinders inside.
5. Install EN-49074 and EN-49155.

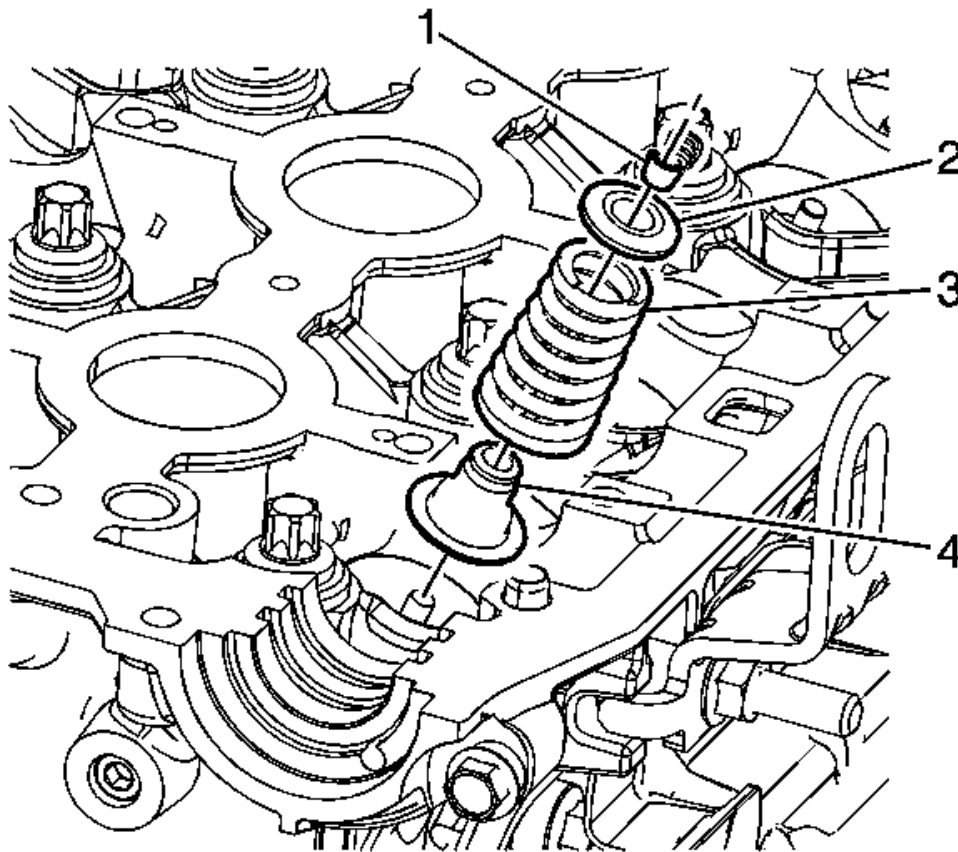


Fig. 200: Valve Key, Valve Spring, Retainer, And Seal
Courtesy of GENERAL MOTORS CORP.

6. Remove the valve key.
7. Remove the valve springs, retainers, and seals.
8. Remove the EN-49074 and EN-49155.

Installation Procedure

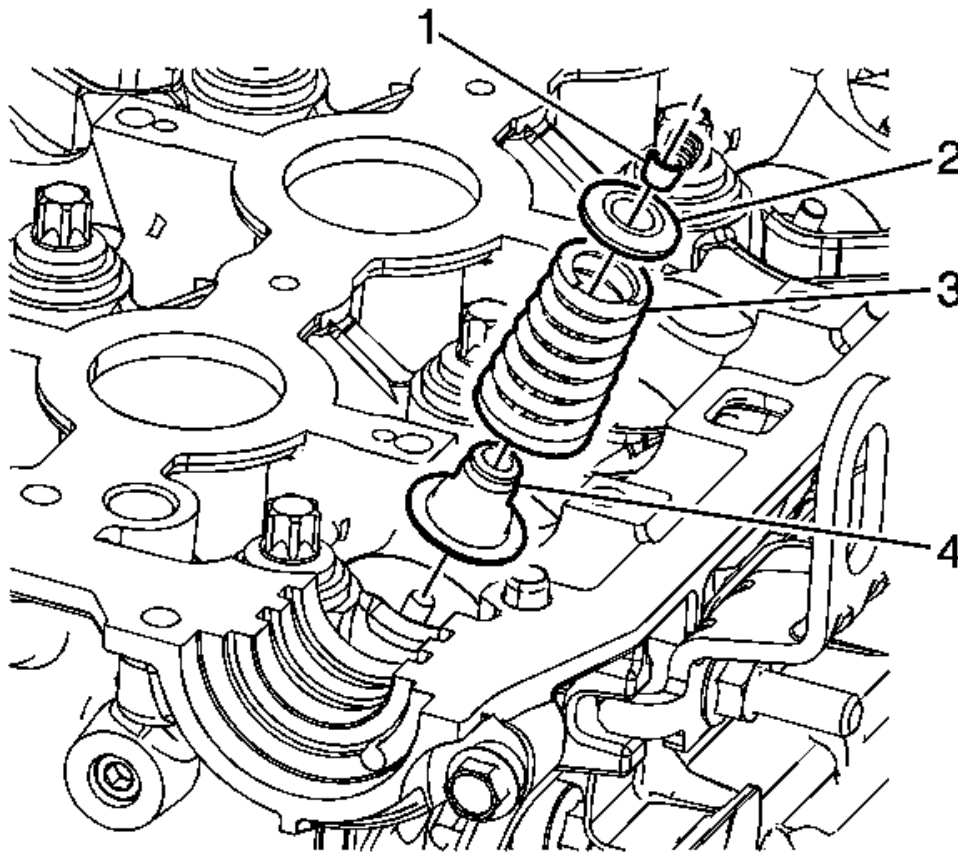


Fig. 201: Valve Key, Valve Spring, Retainer, And Seal
Courtesy of GENERAL MOTORS CORP.

1. Install the seals, retainers, and valve springs.
2. Install EN-49074 and EN-49155.
3. Install the valve key.
4. Install the valve spring, retainer, and seal.

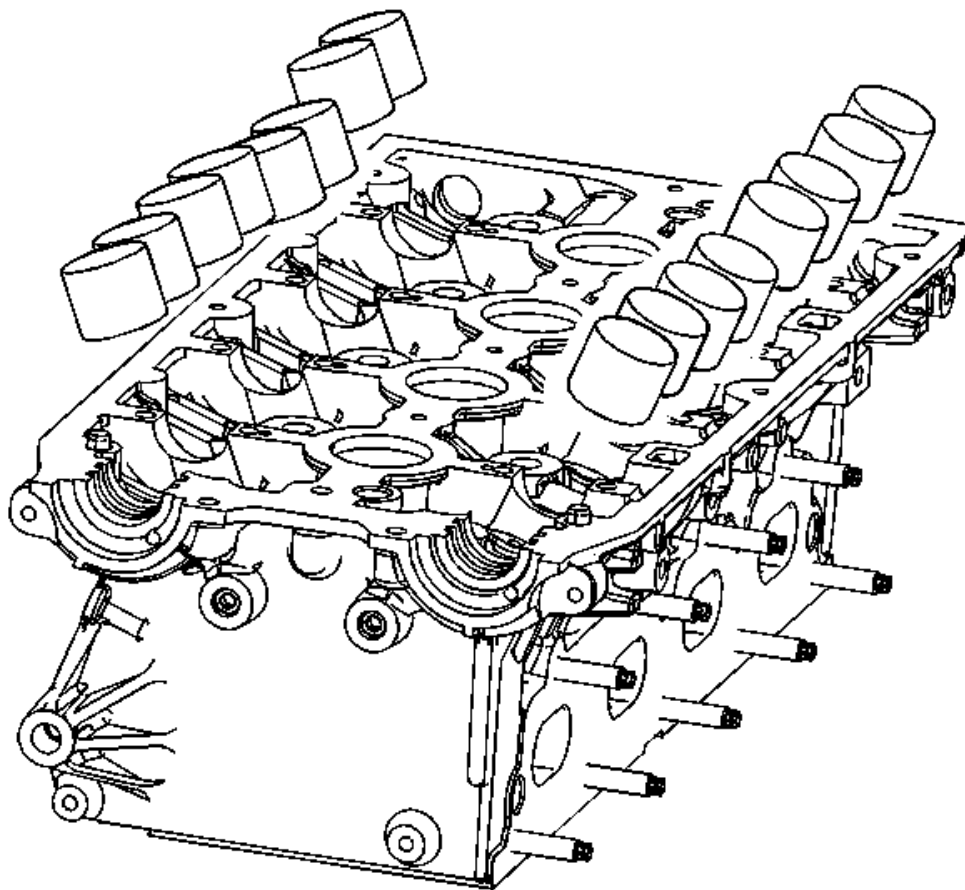


Fig. 202: Valve Tappets
Courtesy of GENERAL MOTORS CORP.

5. Install the valve tappet using **KM-845** .

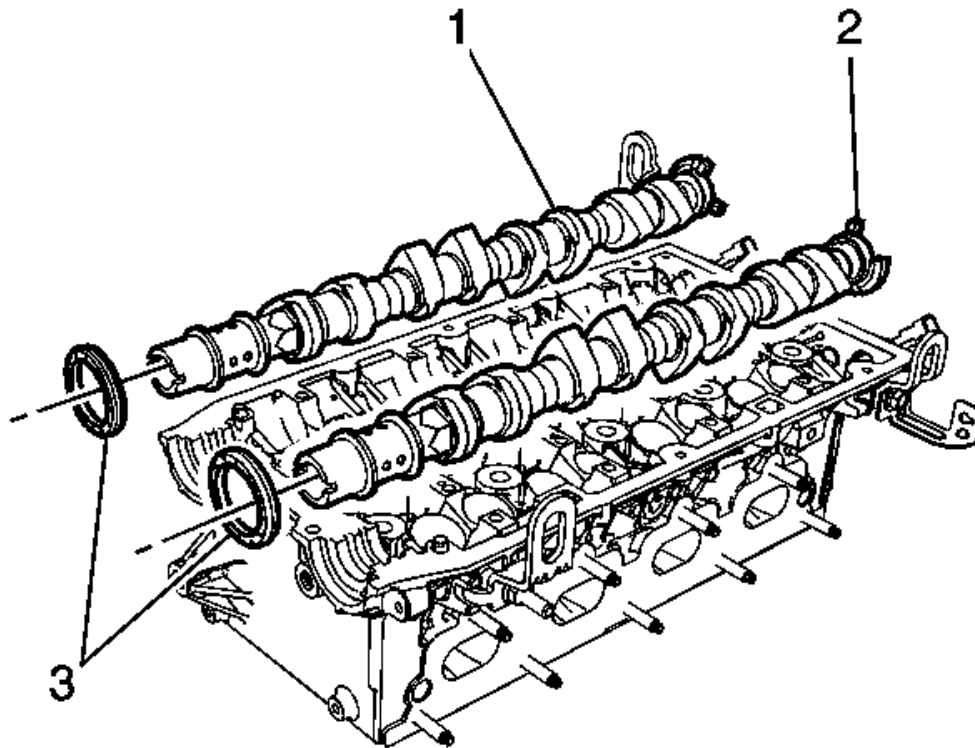


Fig. 203: Intake/Exhaust Camshafts With The Seal Rings
Courtesy of GENERAL MOTORS CORP.

6. Install the camshaft. Refer to Camshaft Replacement.

VALVE SPRING INSPECTION AND MEASUREMENT

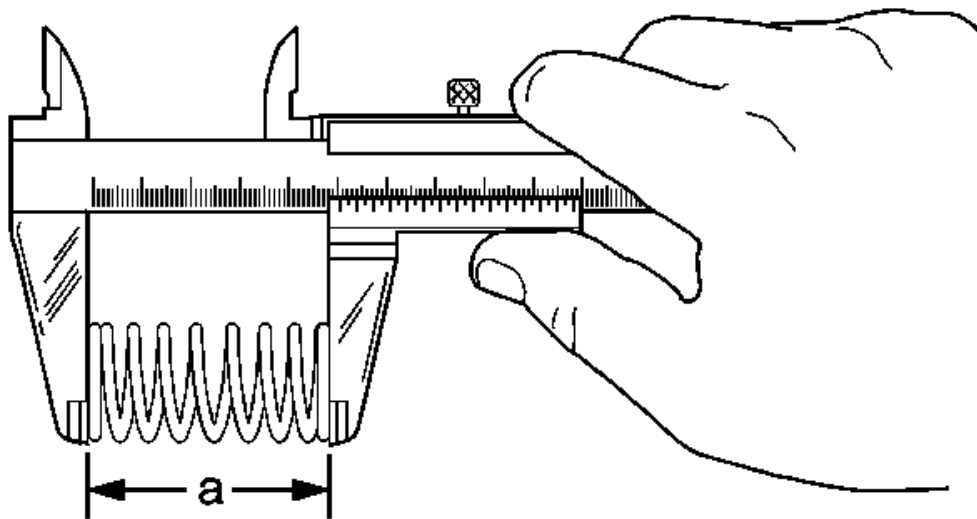


Fig. 204: Inspecting Valve Spring Height
Courtesy of GENERAL MOTORS CORP.

1. Measure the valve spring height. Refer to **Engine Mechanical Specifications**. If the valve spring height does not match the specifications, replace the valve spring.

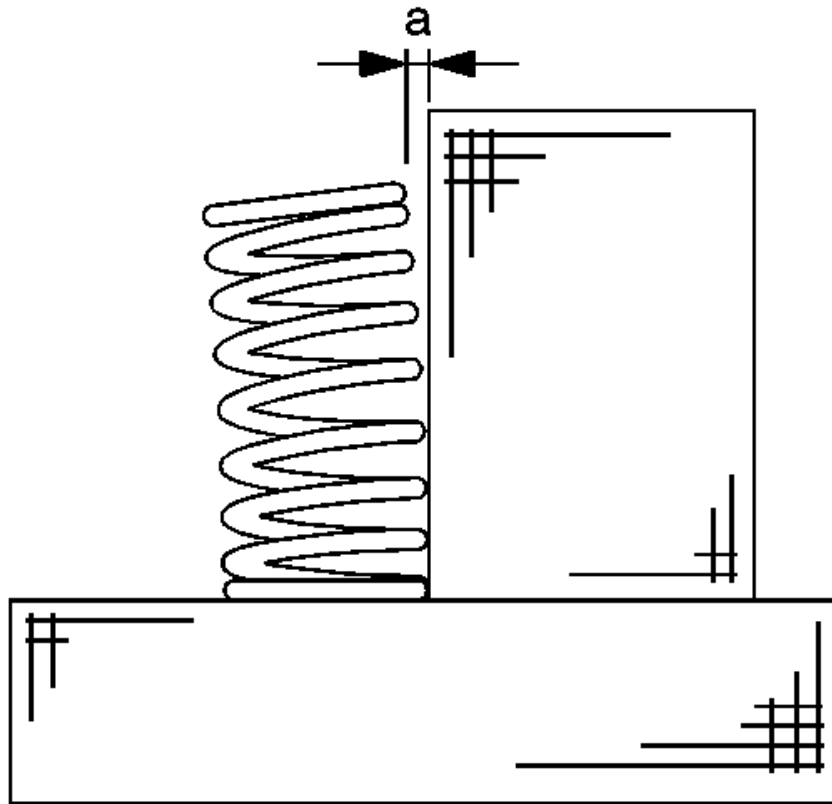


Fig. 205: Measuring Valve Spring Out Of Square
Courtesy of GENERAL MOTORS CORP.

2. Measure the valve spring squareness. Refer to **Engine Mechanical Specifications**. If the valve spring squareness does not match the specifications, replace the valve spring.
3. Inspect the valve spring seating surface of the valve rotators for wear or gouges. Replace as required.

REPAIR INSTRUCTIONS - OFF VEHICLE

CRANKSHAFT AND CRANKSHAFT BEARING CLEANING AND INSPECTION

Inspection Procedure

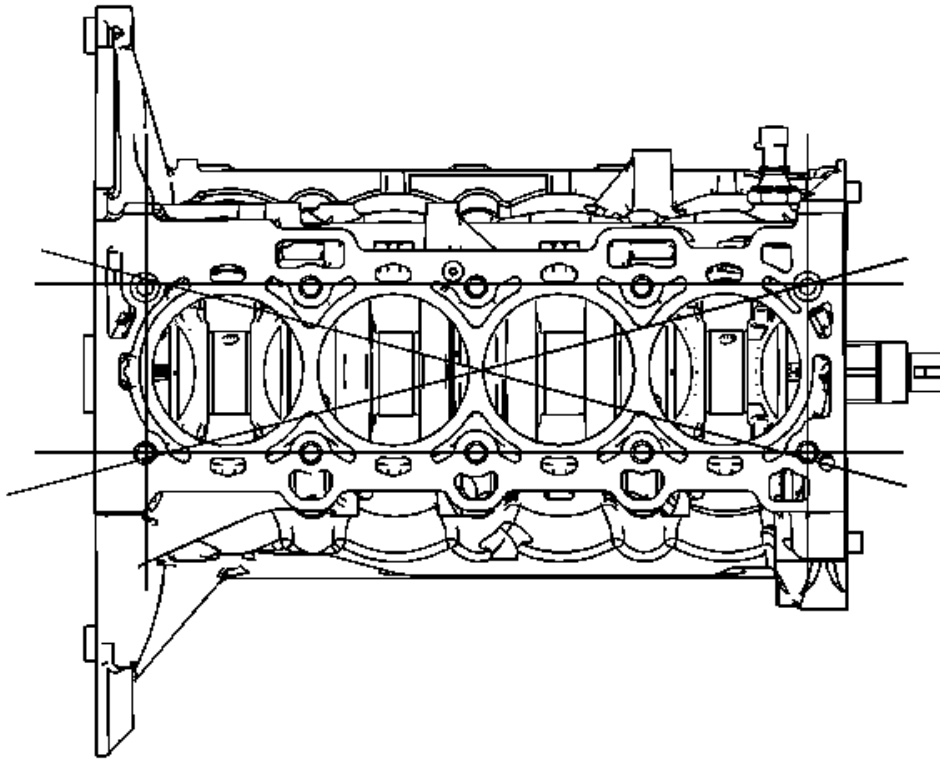


Fig. 206: Measuring Block Flatness

Courtesy of GENERAL MOTORS CORP.

1. Measure the block flatness. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

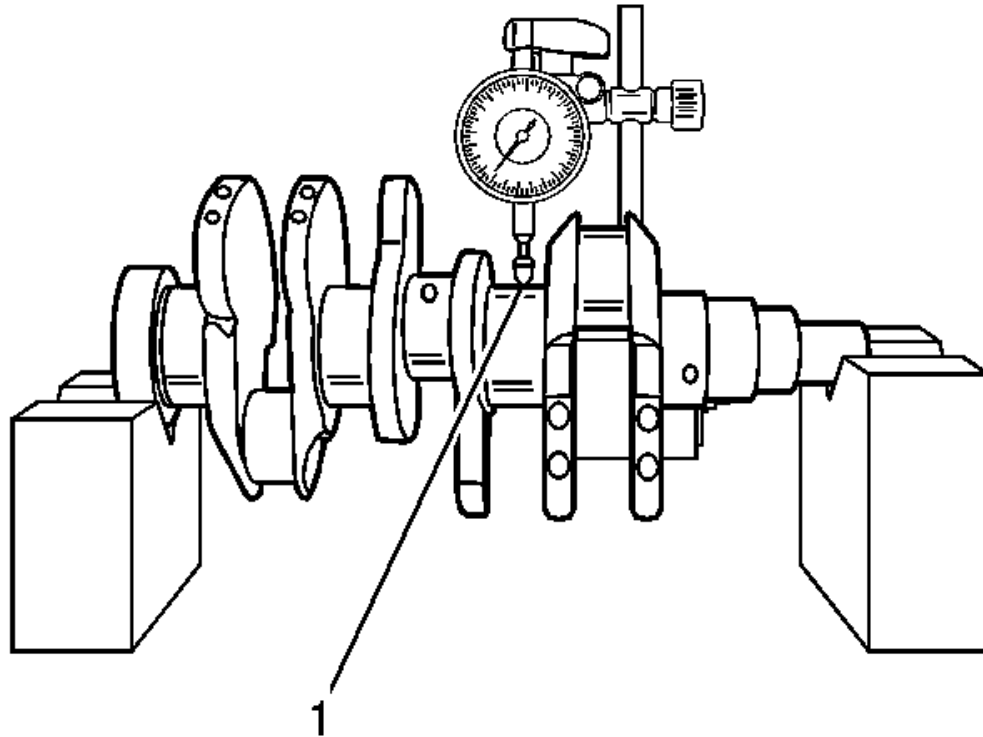


Fig. 207: Measure Crankshaft Bending (Out-Of-Round)
Courtesy of GENERAL MOTORS CORP.

2. Measure the crankshaft bending (out-of-round). If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

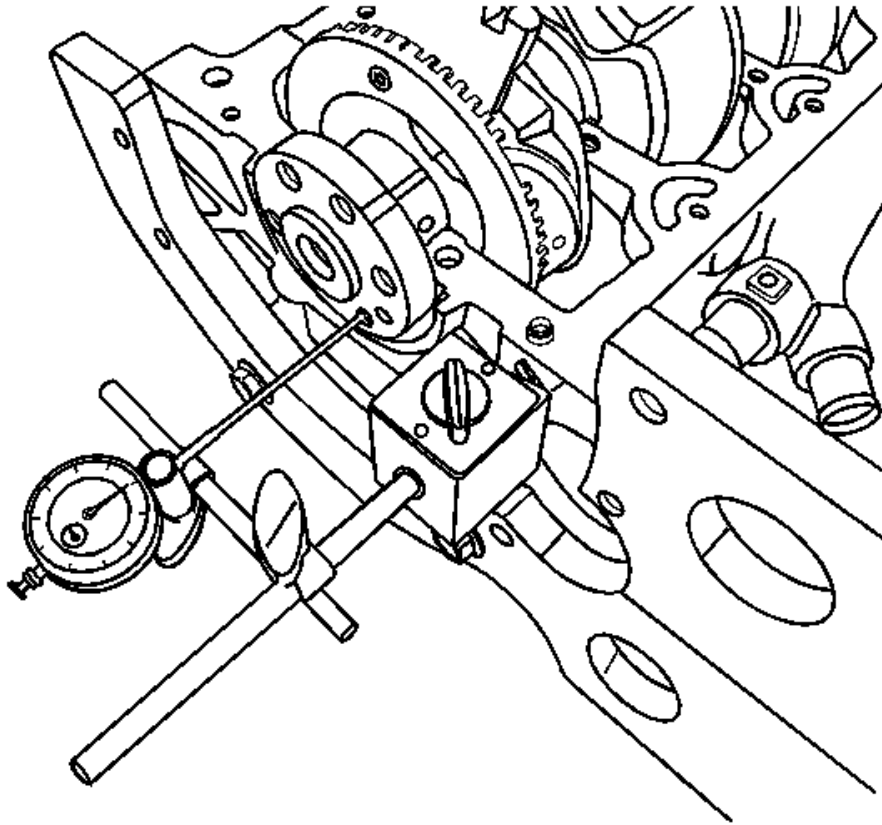


Fig. 208: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

3. Measure the crankshaft end play. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

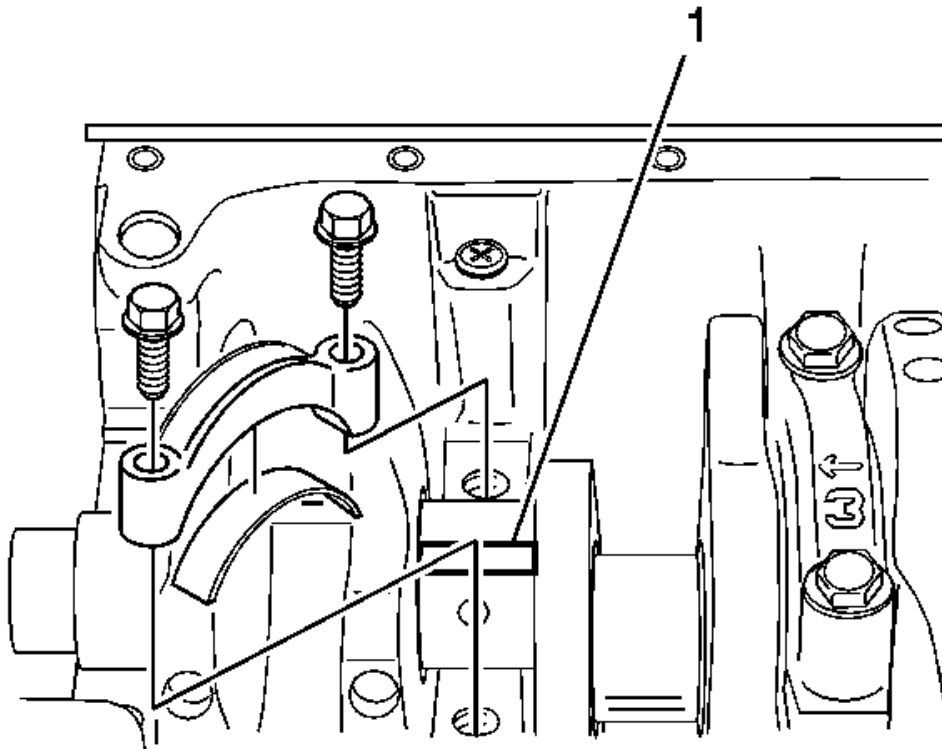


Fig. 209: Plastic Gauge On Crankshaft Journal
Courtesy of GENERAL MOTORS CORP.

4. Cut the plastic gauge (a) the same length of the bearing width and put it on the crankshaft bearing. It should be parallel with the crankshaft.
5. Install the crankshaft journal bearing and cap.
6. Remove the connecting rod bearing and cap again.
7. Measure the clearance of the connecting rod bearing oil. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

VALVE ROCKER ARM CLEANING AND INSPECTION

Valve Inspection Procedure

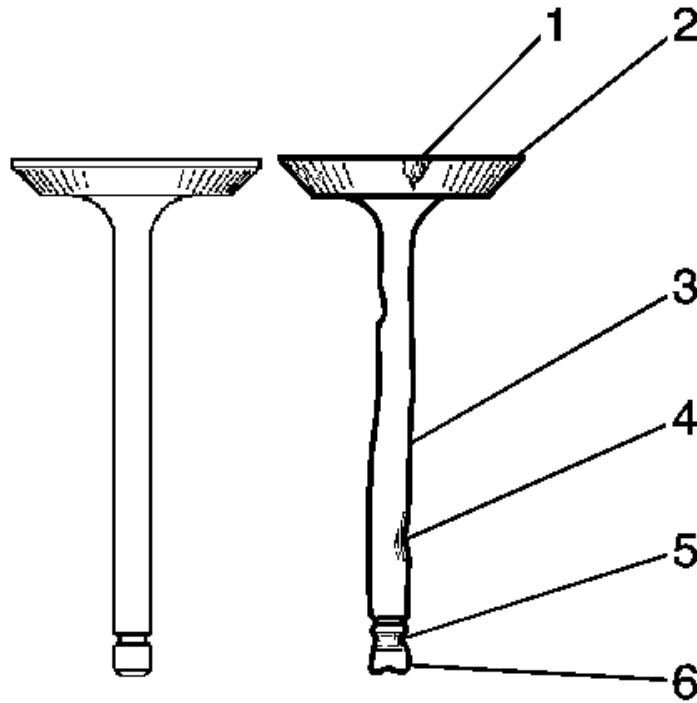


Fig. 210: Valve Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. 1. Inspect the valve for damage from the head to tip for the following conditions:
 - pitting in the valve seat area (1)
 - lack of valve margin (2)
 - bending in the valve stem (3)
 - pitting or excessive wear in the stem (4)
 - worn valve key grooves (5)
 - worn valve tip (6)
2. Replace the valve if any of these conditions exist.
3. Inspect the valve springs. If the valve spring ends are not parallel, replace the valve spring.
4. Inspect the valve spring seating surface of the valve rotators for wear or gouges. Replace as required.

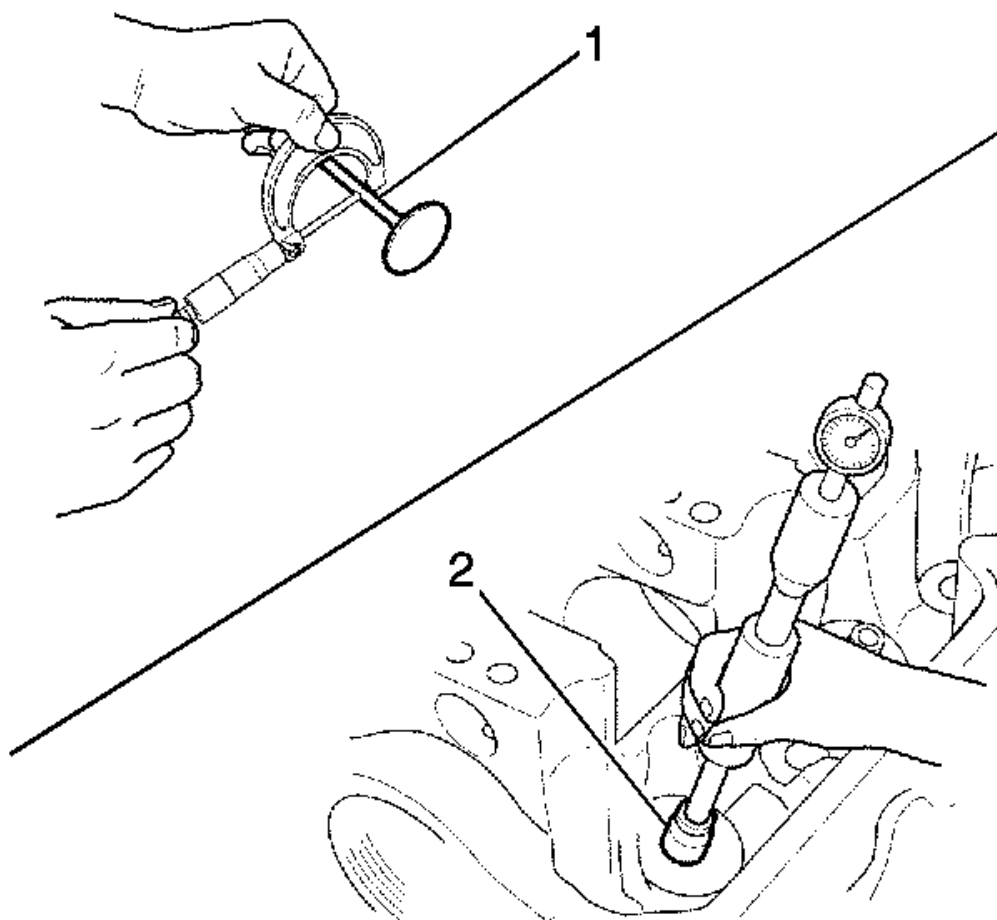


Fig. 211: Measureing Valve Stem and Guide Diameter
Courtesy of GENERAL MOTORS CORP.

NOTE: Valve guide is not movable. Replace the cylinder head if it is out of specification.

5. Measure the valve stem diameter and valve guide inside diameter. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

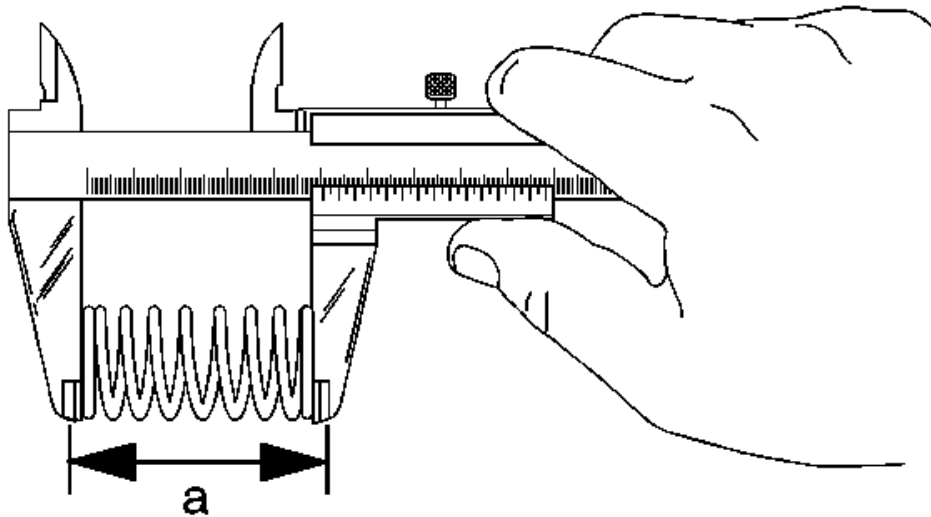


Fig. 212: Measuring Valve Spring Free Length
Courtesy of GENERAL MOTORS CORP.

6. Measure the valve spring free length. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

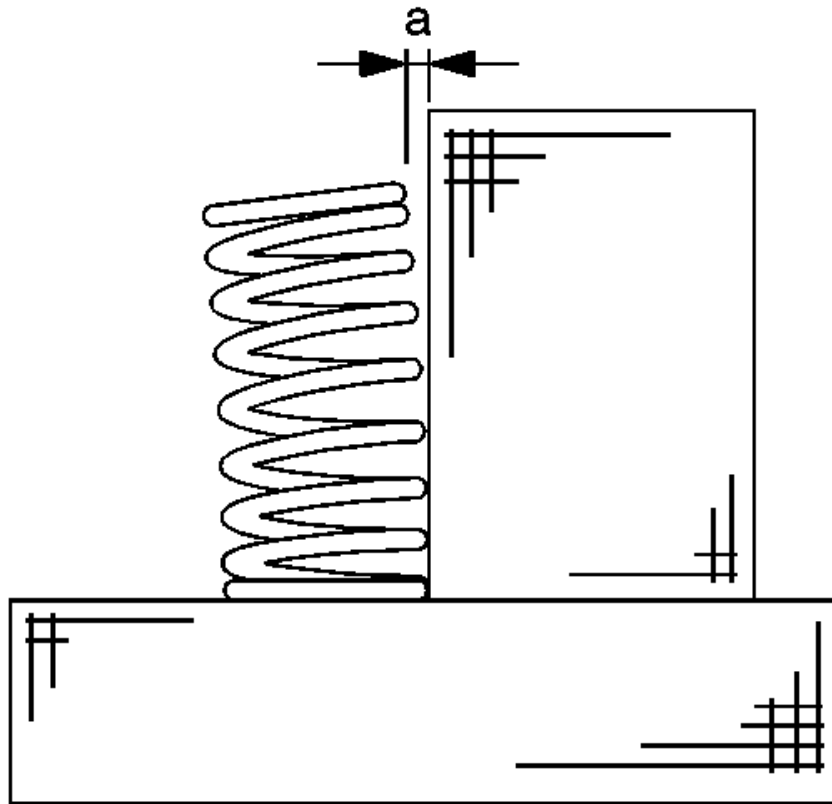


Fig. 213: Measuring Valve Spring Out Of Square
Courtesy of GENERAL MOTORS CORP.

7. Measure the valve spring right angles. If it is out of specification, replace it. Refer to **Engine Mechanical Specifications**.

CYLINDER HEAD DISASSEMBLE

Disassemble Procedure

Special Tools

- KM-845 Suction Device
- EN-49074 Universal Valve Spring Compressor
- EN-49155 Valve Spring Compressing Adapter

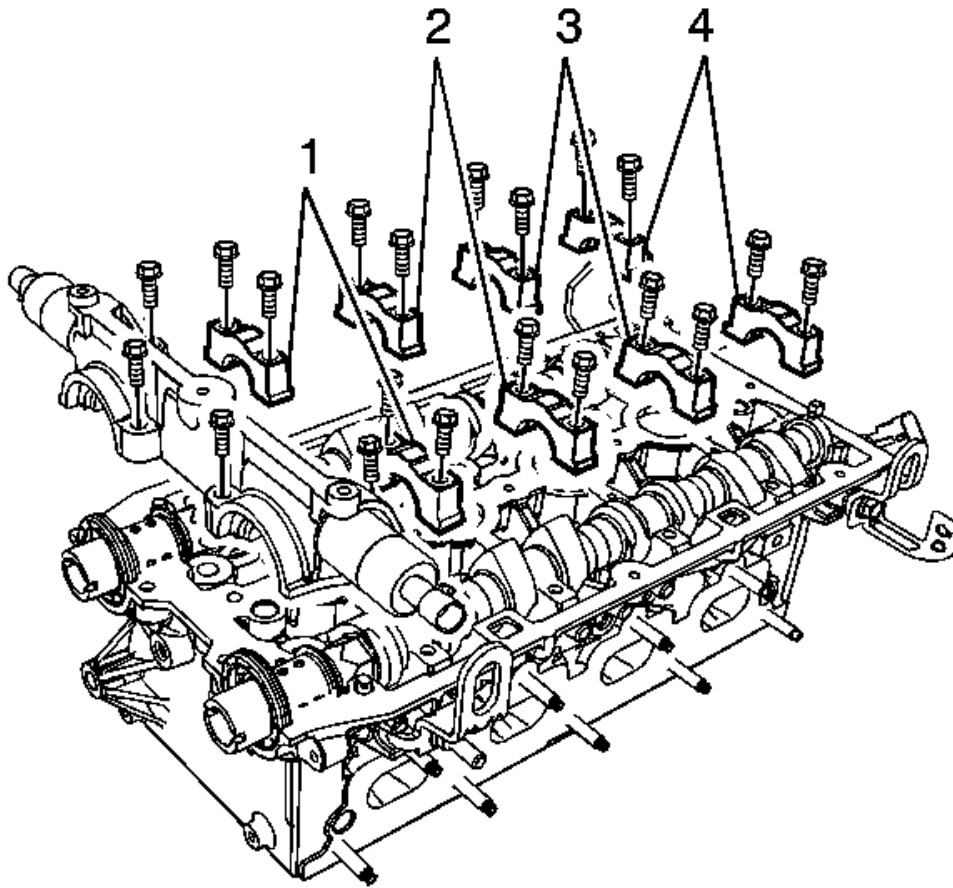


Fig. 214: Identifying Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches, nicks or damage to the camshaft surfaces. If scratched, the engine may be damaged.

1. Remove the camshaft position solenoid valve housing.
2. Remove the camshaft cap bolts in this sequence (1)-(4)-(2)-(3).
3. Remove the camshaft caps.

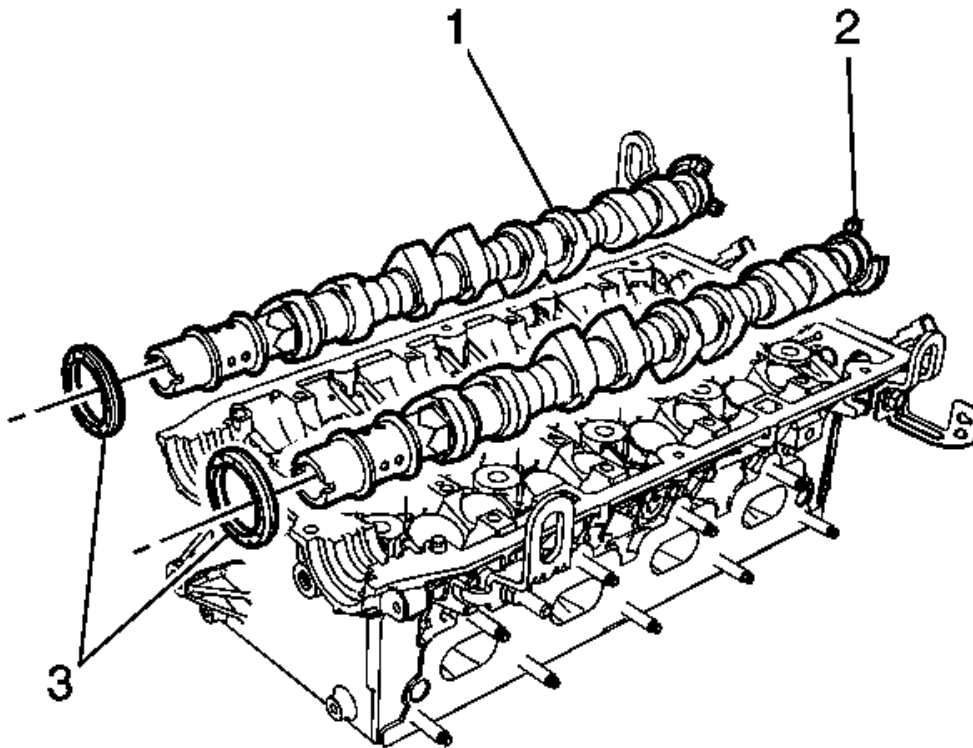


Fig. 215: Intake/Exhaust Camshafts With Seal Rings
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshafts and oil seal rings.

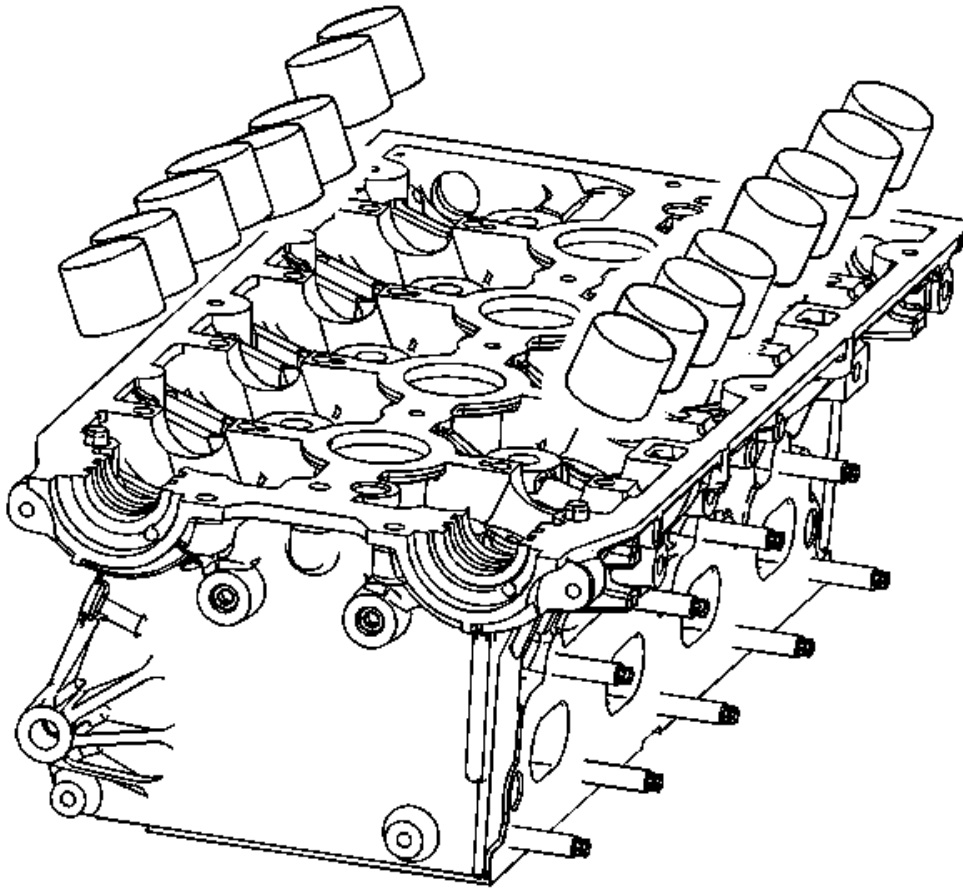


Fig. 216: Valve Tappets
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve tappet using the suction device (KM-845).

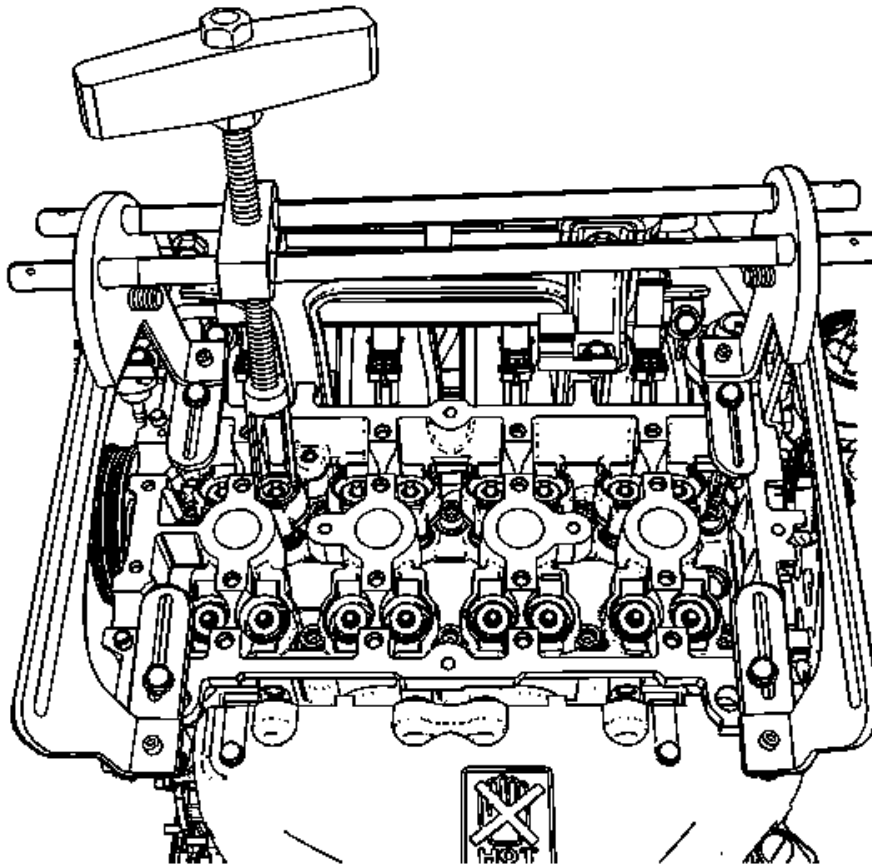


Fig. 217: Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

6. Install the universal valve spring compressor (EN-49074) and adapter (EN-49155).
7. Remove the valve key.

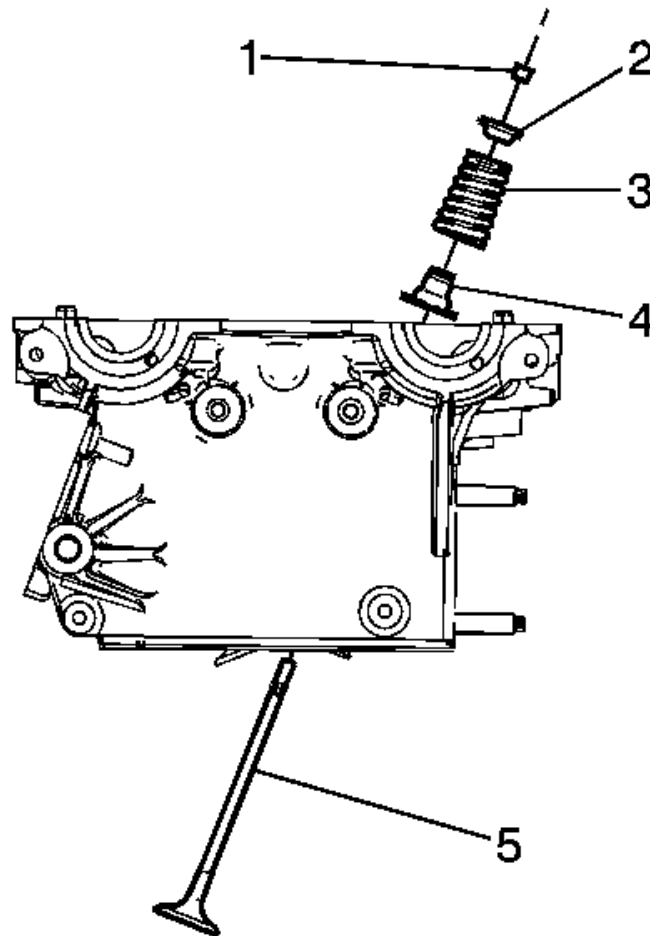


Fig. 218: Valve Key, Valve, Spring, Retainer, And Seal
Courtesy of GENERAL MOTORS CORP.

8. Remove the valves, springs, retainers, and seals.

CYLINDER HEAD CLEANING AND INSPECTION

Inspection Procedure

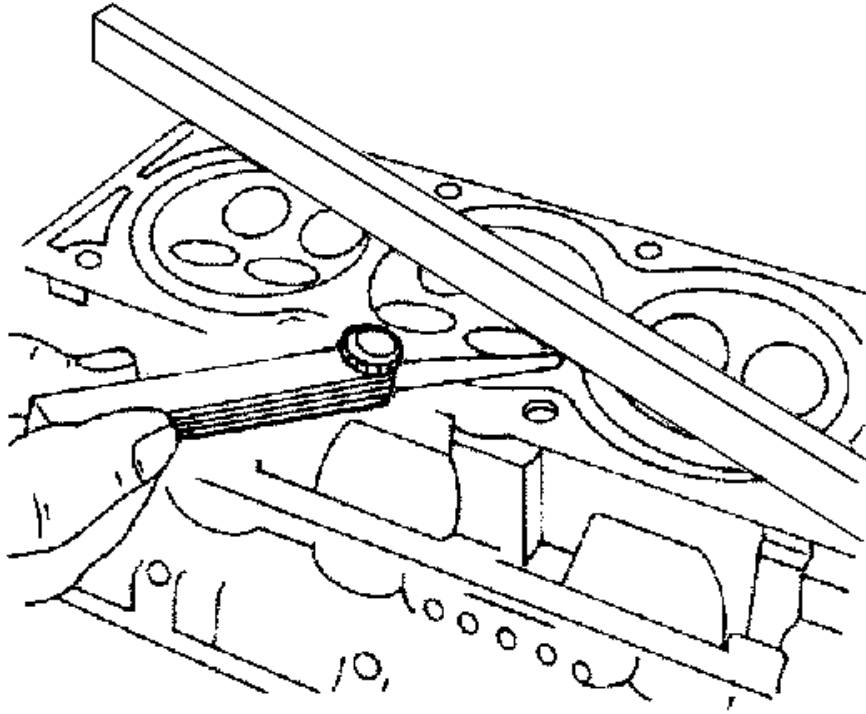


Fig. 219: Checking Cylinder Head Surface Flatness
Courtesy of GENERAL MOTORS CORP.

NOTE: Take extreme care to prevent any scratches, nicks or damage to the cylinder head surface. If scratched, the engine may be damaged.

1. Clean the sealing surfaces.
2. Inspect the cylinder head for the following:
 - Cracks, damage or pitting in the combustion chambers.
 - Debris in the oil galleries. Continue to clean the galleries until all debris is removed.
 - Coolant leaks or damage to the deck face sealing surface.
 - Damage to any gasket surfaces.
 - Damage to any threaded bolt holes.
 - Burnt or eroded areas in the combustion chamber.
 - Cracks in the exhaust ports and combustion chambers.
 - External cracks in the water passages.

- Restrictions in the intake or exhaust passages.
 - Restrictions in the cooling system passages.
 - Rusted, damaged or leaking core plugs.
3. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.
 4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gauge at four points along the straight-edge.
 5. Check the sealing surfaces for deformation and warping. The cylinder head sealing surfaces (include the intake and exhaust sealing surfaces) must be flat within the specification. Refer to **Engine Mechanical Specifications**.

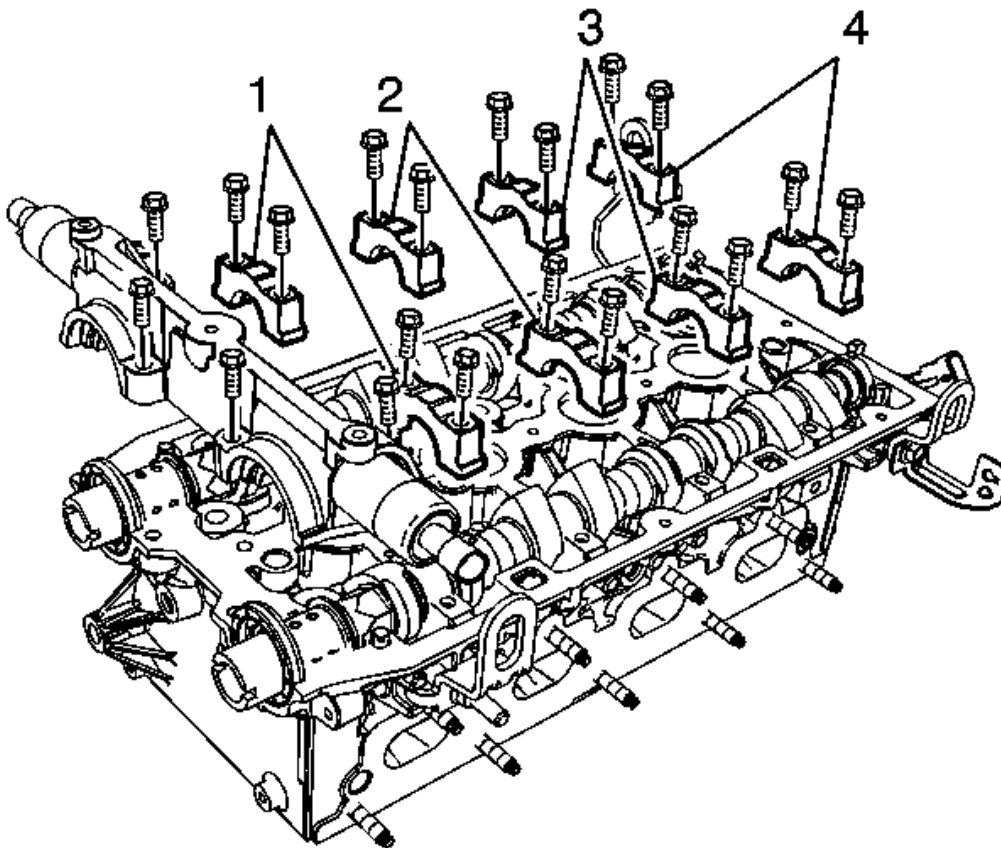


Fig. 220: Identifying Camshaft Caps
Courtesy of GENERAL MOTORS CORP.

6. Remove the intake and exhaust camshafts. Refer to **Camshaft Replacement**.

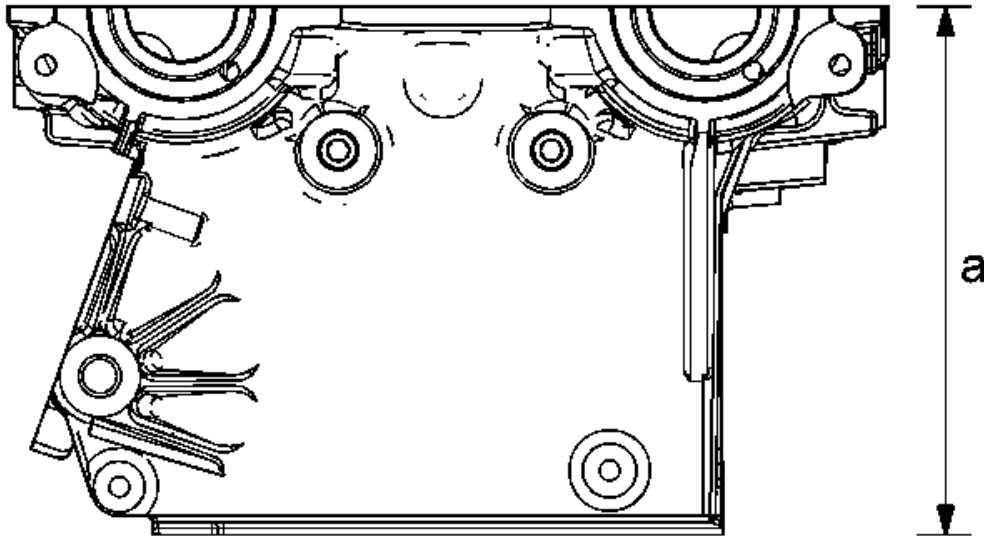


Fig. 221: Cylinder Head Height Measuring Points
Courtesy of GENERAL MOTORS CORP.

7. Measure the height of the cylinder head from sealing surface to sealing surface. The cylinder head height should be within specifications. Replace the cylinder head. If the cylinder head height is out of specifications, replace the cylinder head. Refer to **Engine Mechanical Specifications**.

CYLINDER HEAD ASSEMBLE

Assemble Procedure

Special Tools

- EN 49074 Universal Valve Spring Compressor
- EN 49155 Valve Spring Compressing Adapter
- KM 422 Installer

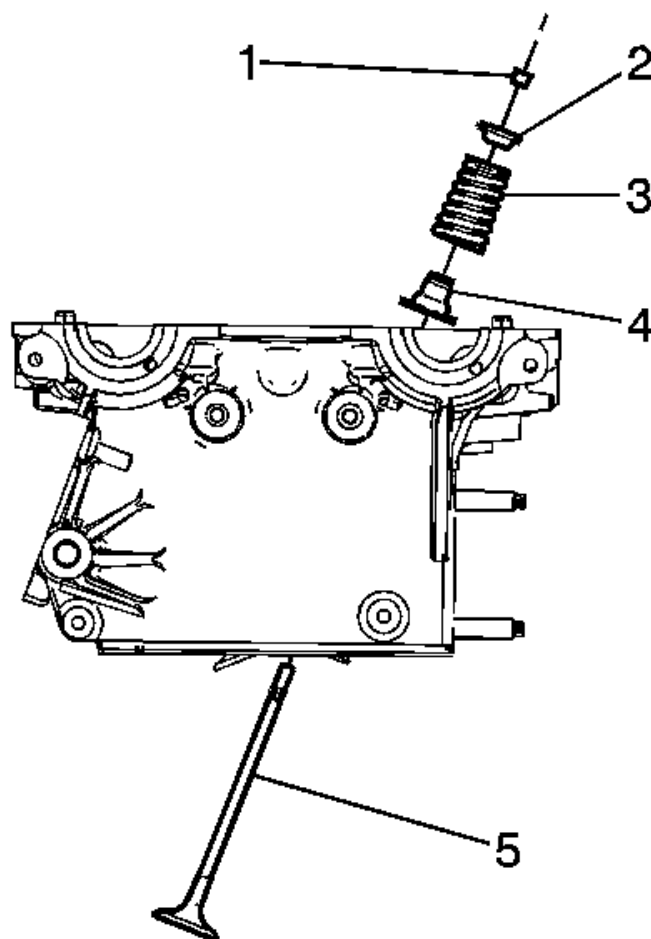


Fig. 222: Valve Key, Valve, Spring, Retainer, And Seal
Courtesy of GENERAL MOTORS CORP.

1. Install the valve spring, retainer, and seal.

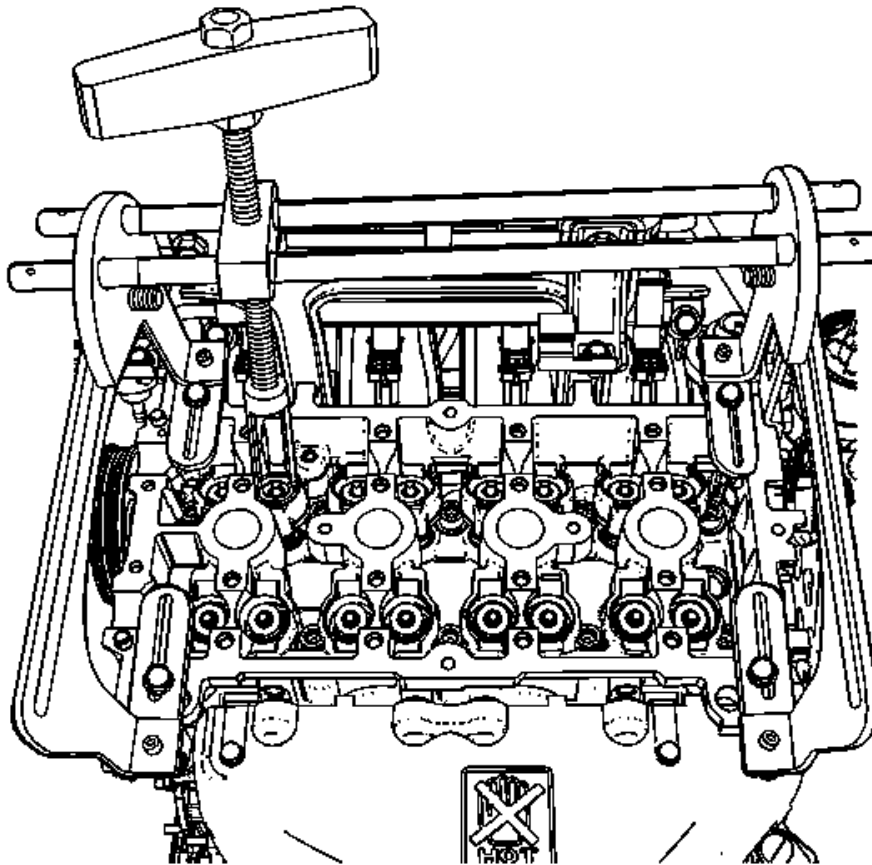


Fig. 223: Valve Spring Compressor
Courtesy of GENERAL MOTORS CORP.

2. Install the universal valve spring compressor (EN-49074) and adapter (EN-49155).
3. Install the valve key.

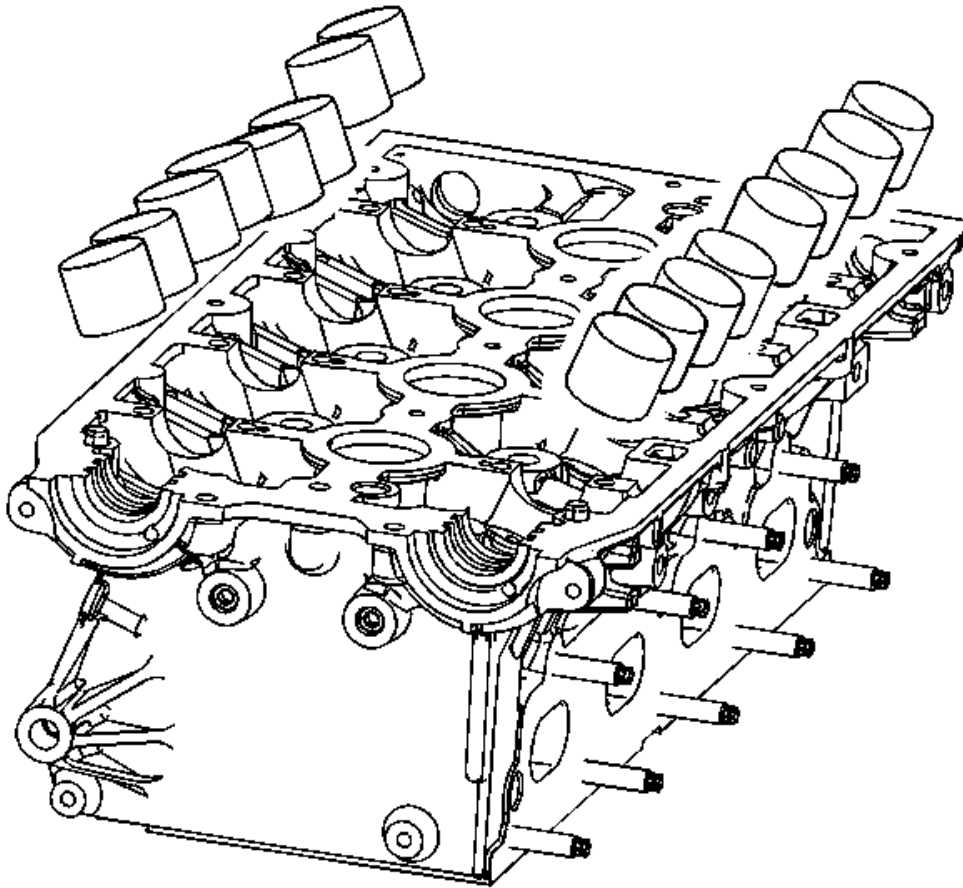


Fig. 224: Valve Tappets

Courtesy of GENERAL MOTORS CORP.

NOTE: Do not scratch the valve tappet. Do not use gloves or tools, except special service tools.

4. Install the valve tappet.

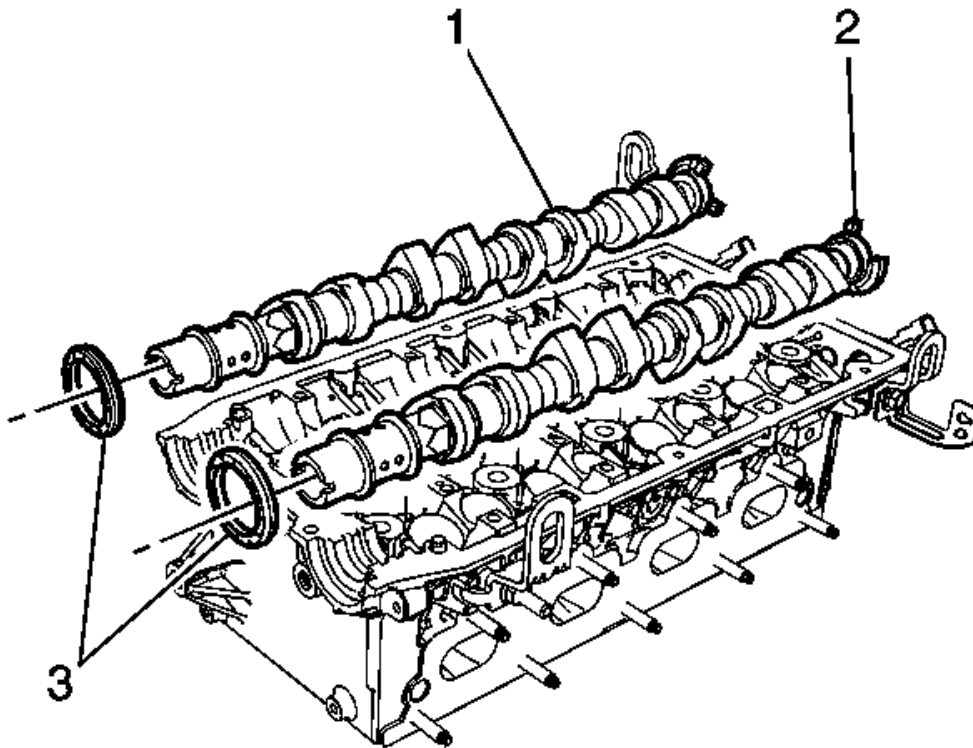


Fig. 225: Intake/Exhaust Camshafts With The Seal Rings
Courtesy of GENERAL MOTORS CORP.

5. Install the camshaft.

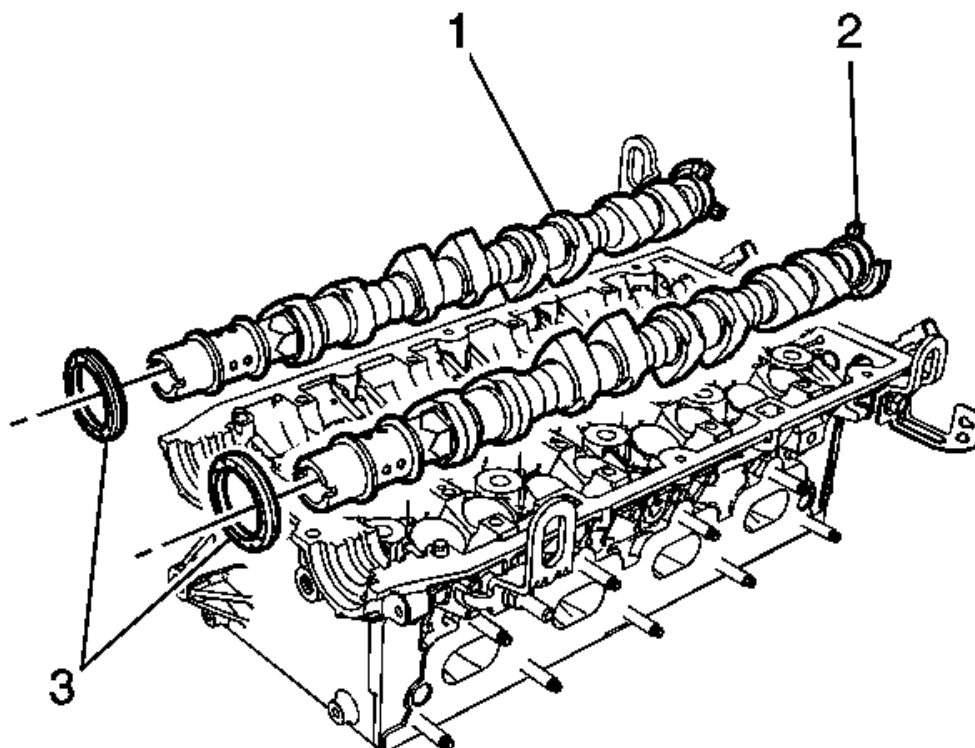


Fig. 226: Intake/Exhaust Camshafts With The Seal Rings
Courtesy of GENERAL MOTORS CORP.

6. Coat and lubricate the camshaft bearing and cam surfaces with clean engine oil.
7. Install the camshafts on the cylinder head.

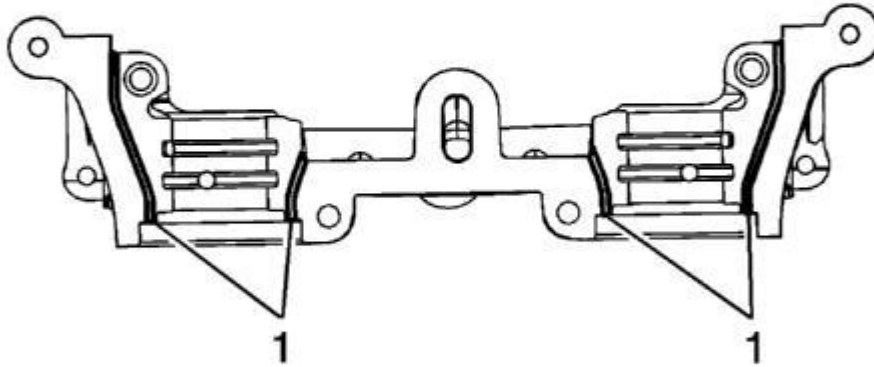


Fig. 227: Grooves Adjacent To Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: It is essential to ensure that no sealant is applied outside the marked sealing areas.

NOTE: The grooves (1) adjacent to the sealing surfaces must remain free from sealant.

8. Apply surface sealant LOCTITE 574 to sealing surfaces (1) of the 1st camshaft bearing cap thinly and evenly.

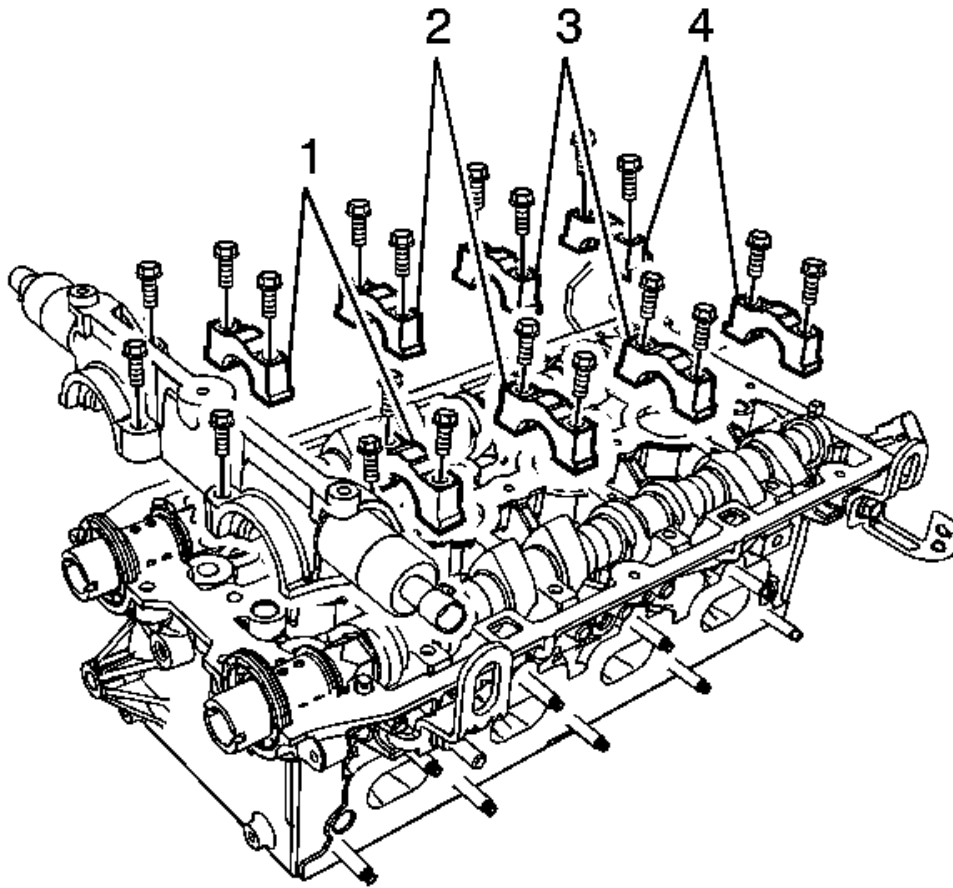


Fig. 228: Identifying Camshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

9. Install the camshaft bearing caps in this sequence (2)-(3)-(1)-(4).
10. Install the camshaft position solenoid valve housing.

Tighten: Tighten the camshaft bearing cap bolts to 8 N.m (70.8 lb in).

11. Install the new camshaft oil seal rings using Installer (KM-422).

DESCRIPTION AND OPERATION

ENGINE COMPONENT DESCRIPTION

Intake and Exhaust Manifold

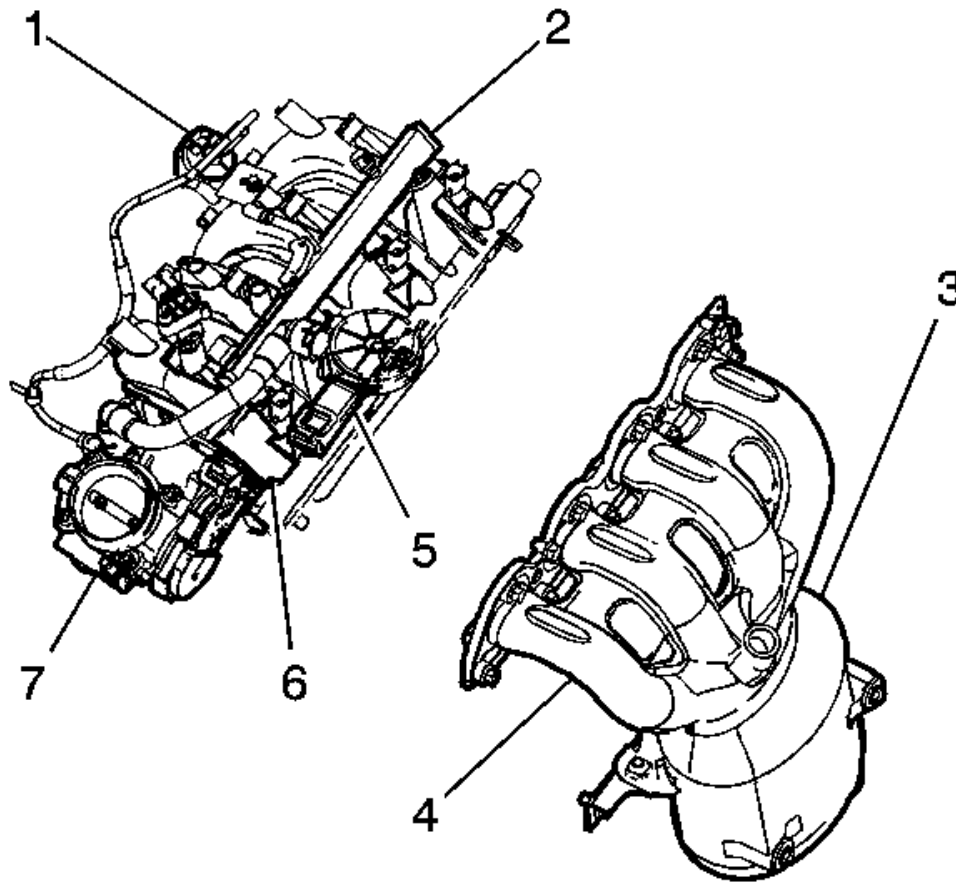


Fig. 229: Identifying Intake And Exhaust Manifold Components
Courtesy of GENERAL MOTORS CORP.

The intake manifold (1) is an air flow passage to the combustion chamber through the throttle body. It has an effect on engine torque, power, noise, drivability, emission, fuel economy and performance. It is made of poly amid for weight reduction.

The exhaust manifold (6) catalytic converter (7) is located on the cylinder head. It directs the exhaust gas out of the combustion chamber and into the exhaust pipes. It is designed to endure high pressure and high temperature and made of Stainless steel material.

Valve Train

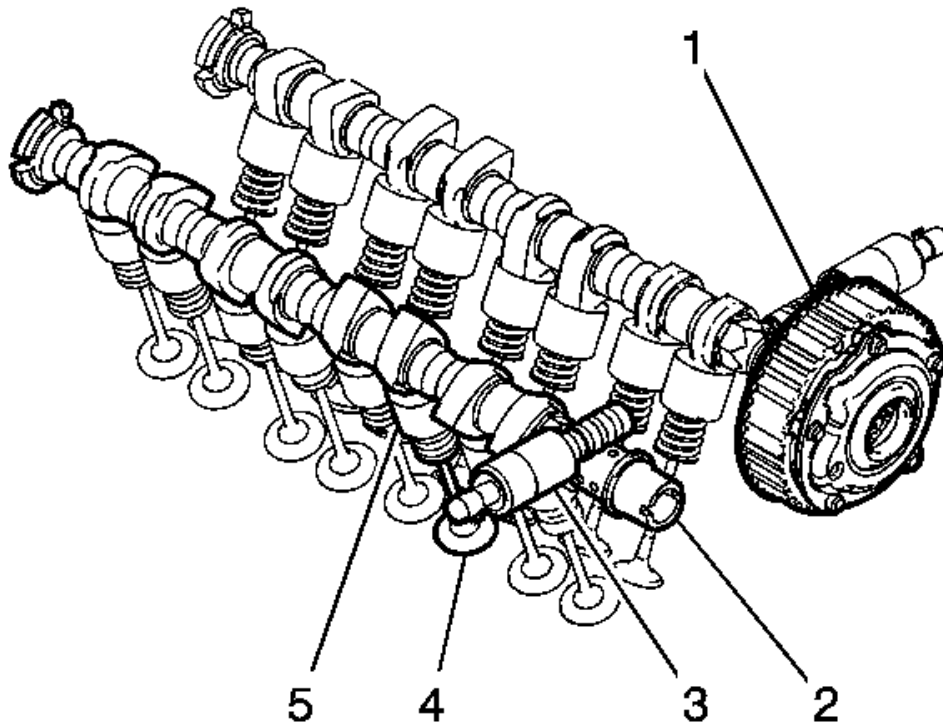


Fig. 230: Valve Train Components
 Courtesy of GENERAL MOTORS CORP.

This valve train system is applied on direct acting type. By crankshaft rotation, intake/exhaust camshaft can be drove and this operation occur the each opening/closing of 2 intake valve/2 exhaust valve. This total operation brings out the combustion of cylinder space. VCP is applied for variable cam timing.

Due to systematical characteristics (direct acting type), the tappet can be directly contacted with the cam-profile of camshaft and each different gap between intake valve and exhaust valve with tappet must be maintained. And this valve train system is composed of valve spring, valve stem seal, valve spring retainer and valve key.

Cylinder Head

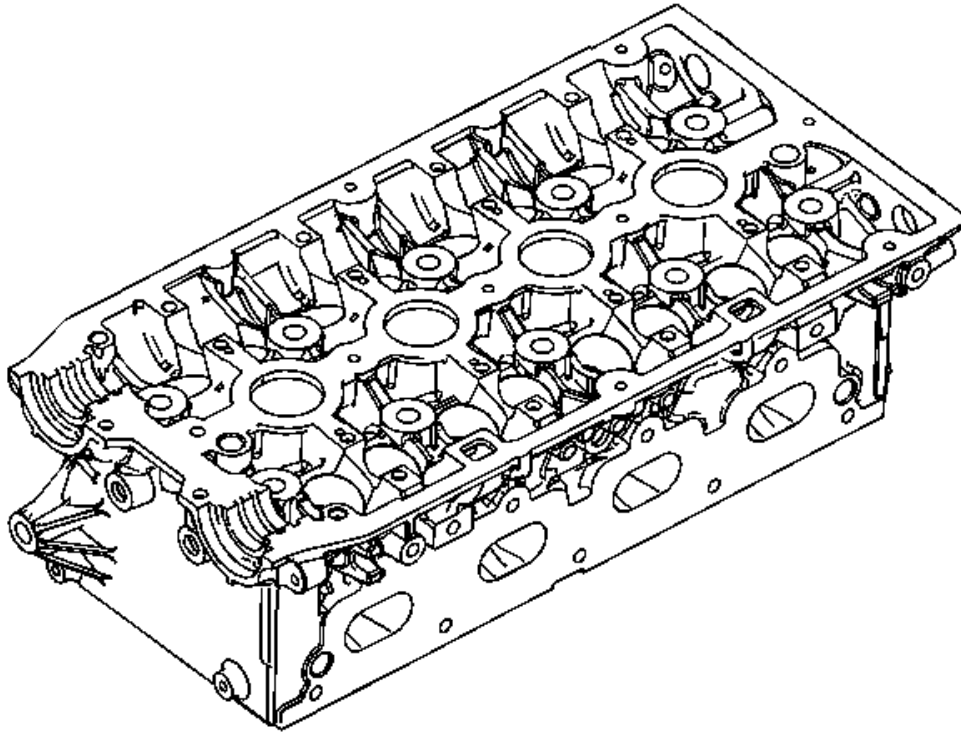


Fig. 231: Cylinder Head

Courtesy of GENERAL MOTORS CORP.

This cylinder head is of a Dual Over Head Camshaft type. It houses two camshafts that rotate by combustion force made in the combustion chamber and operate (open & close) 4 valves per cylinder. The bottom part of the cylinder head contains the combustion chamber. The material of the cylinder head is an aluminum alloy that has good cooling characteristics and stiffness for protecting it from high temperatures and combustion pressures.

The cylinder head has a water jacket for coolant flow and is fitted with steel valve seats to seal the valves.

Crankshaft and Piston

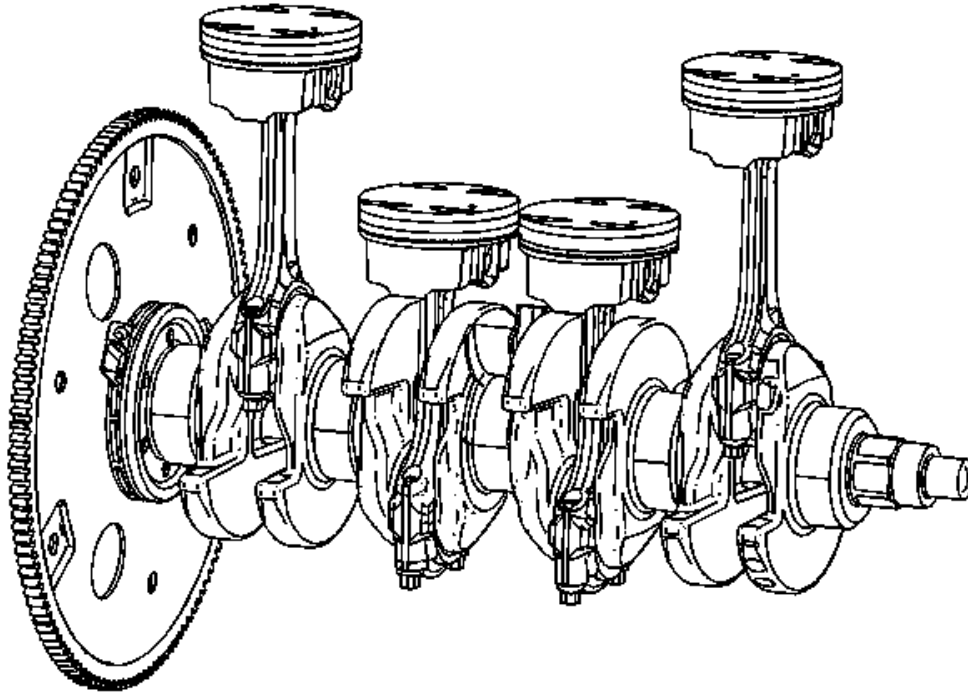


Fig. 232: Crankshaft and Pistons
Courtesy of GENERAL MOTORS CORP.

The crankshaft is of cast iron design. 5 main journals are supported by the cylinder block, bearing cap and main bearings with a suitable oil clearance. The 3rd main bearing is selective and provides an axial clearance of crankshaft and is a thrust bearing. The connecting rods are assembled on 4 pin journals each with metal bearings to change the movement from reciprocating to rotating. On the front side, there is a damper pulley for belt drive and a timing sprocket for belt drive. On the rear side, there is a flywheel or a flexible plate to transport the engine torque to transmission.

The pistons are a cast aluminum crown design. They have 2 compression rings and 1 oil ring. There is a piston pin of full floating type. It floats in the piston pin bore and connecting rod pin bore, and it is fixed by retainers at both ends.

The connecting rod and rod cap are assembled on the crankshaft with bearings.

Lubrication System

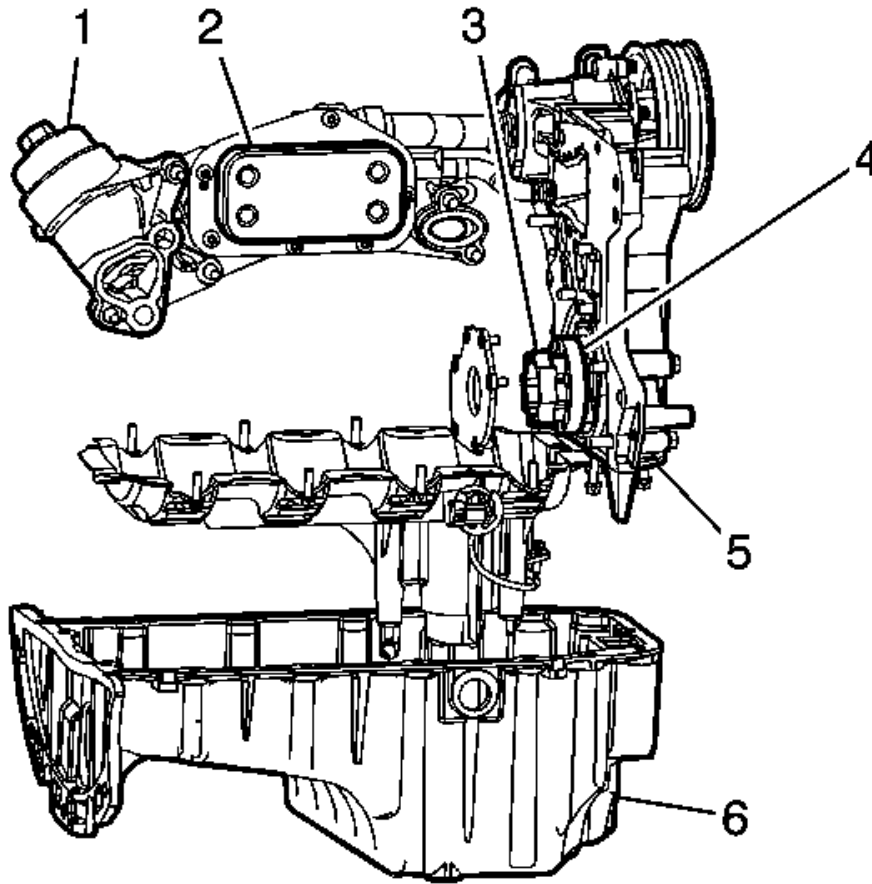


Fig. 233: Identifying Lubrication System Components
Courtesy of GENERAL MOTORS CORP.

The oil pump (1) supplies engine oil from the oil pan (4) and feeds it to the various parts of the engine under pressure.

An oil strainer is mounted before the inlet of the oil pump to remove impurities that could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. It makes the space between inner rotor and outer rotor to constantly open and narrow enough to pull the oil from the pan into the main gallery of block.

At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication pressure of the engine. A relief valve relieves the amount of oil entering the engine lubrication passages.

During lower engine speeds the relief valve is closed by the coil spring tension, so all of the oil is delivered to the engine parts. If the engine speed is increased, the oil pressure becomes high enough to overcome and open the force of the spring. The bypassed oil is returned to oil pump inlet.

For cooling the engine oil, the heat oil cooler (5) is located on the engine block side.

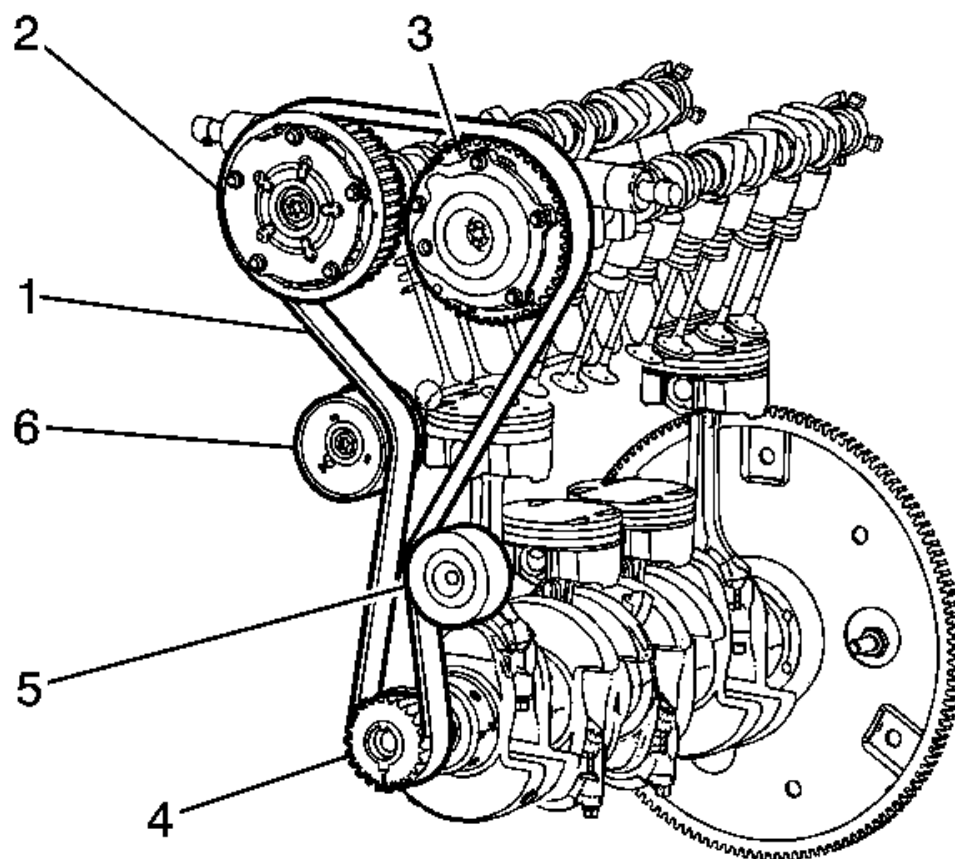
Timing System

Fig. 234: Identifying Camshaft Timing System Components
Courtesy of GENERAL MOTORS CORP.

The crankshaft is connected to the intake and exhaust cam shafts by using a timing belt (1). An automatic tensioner (2) and idler puller (4) maintain proper belt tension and increase the wrap angles around the drive gears.

Engine Block

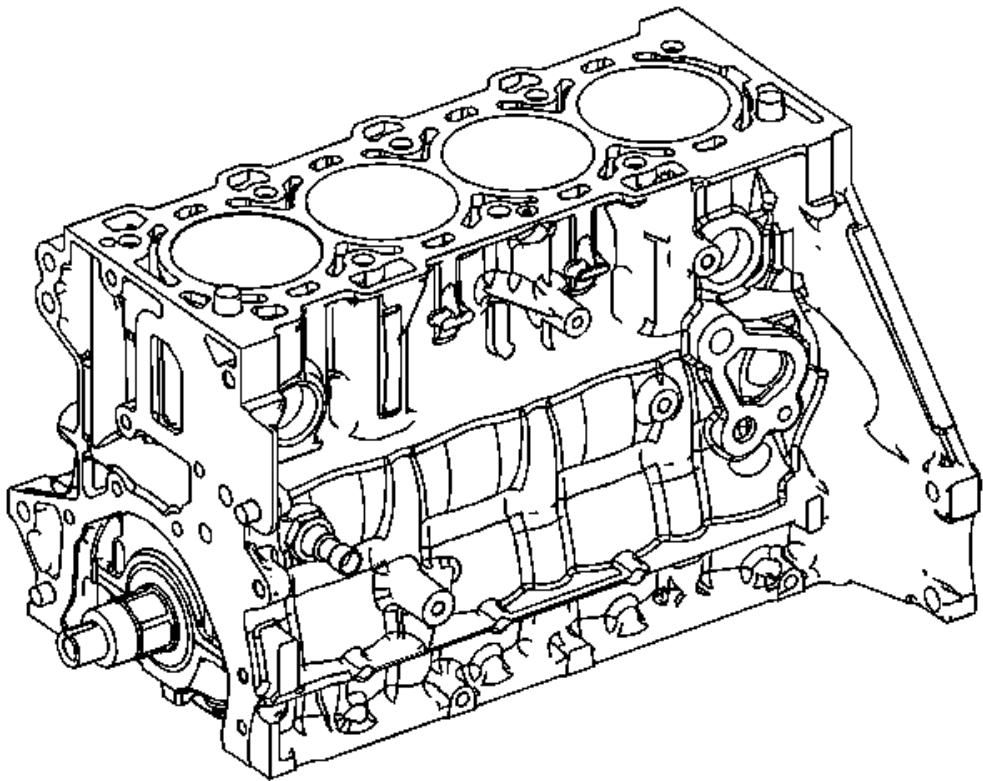


Fig. 235: Engine Block
Courtesy of GENERAL MOTORS CORP.

The cylinder block is made of cast iron. Many related parts are assembled internally and externally.

There are engine coolant and oil passages for cooling and lubricating in the inside of engine block.

On the inside of the engine block, machined piston bore surfaces help the piston to seal. Also oil cooling jets are installed to help the cooling of the piston.

The cylinder block has main bearing saddles and main bearing cap to support the crankshaft on the lower side.

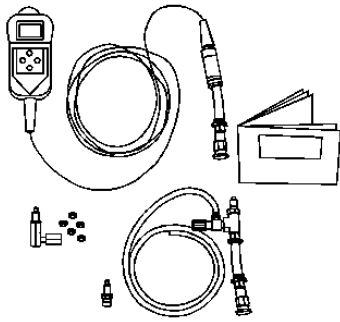
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

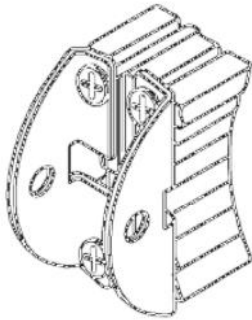
Illustration	Tool Number/ Description

2009 Pontiac G3 Wave SE

2009 ENGINE Engine Mechanical - 1.6L (LXV) - Aveo & G3 Wave (Canadian)



CH-48027
Oil Pressure Gauge



KM-6340
Locking Tool



KM-6333
Fixing Rod

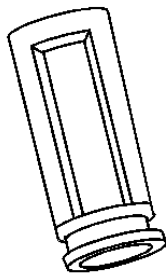
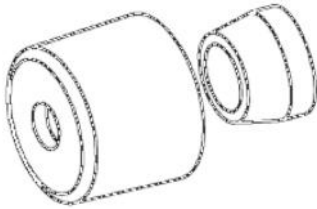


KM-422
Installer

KM-6351
Assembly Sleeves

2009 Pontiac G3 Wave SE

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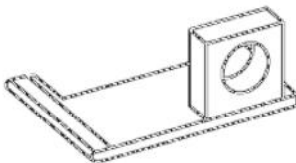
EN-46119
Valve Spring Compressor Adapter



J-38722
Compression Tester

KM-6628-A

KM-6628-A
Locking Tool

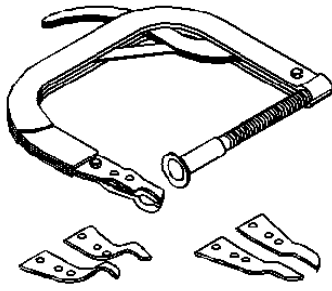


KM-6625
Flywheel Locking Device

J-8062
Valve Spring Compressor - Head Off

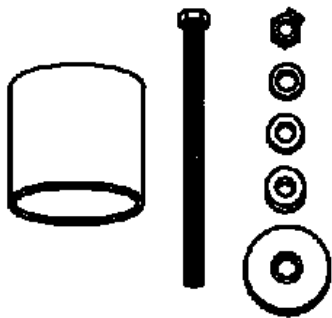
2009 Pontiac G3 Wave SE

2009 ENGINE Engine Mechanical - 1.6L (LXV) - Aveo & G3 Wave (Canadian)



EN-48356

EN-48356
Engine Fixture



J45296-1
Frame Insulator Remover/Installer



J7079-2
Universal Driver Handle - Non-Threaded